

# Proposal

Biogas plant  
262 500 tonnes sugar beet pulp /year



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Validity: 6 months



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## OVERVIEW

We offer a solution to process 262 500 tonnes sugar beet pulp per year into 18,5 million m<sup>3</sup> clean biomethane and injection to the gas grid 50 bar. Alternatively to biomethane purification there may be electric power generation 10MW.

There are 2 seasons. In the 1st season 100 days fresh sugar beet pulp will be processed. And in the 2nd season silaged sugar beet pulp 265 days. The silage storage is for 10 months of storage.

In this proposal we offer vertical CSTR reactors. The vertical shape provides the optimal mass and heat transfer, as a result the electric energy consumption is very little. To compare different concepts of biogas plant it is necessary to pay attention not only to the price, but also to the quality and small but very important details. The temperature is maintained with an accuracy of 0,1°C. The roof of the reactor and next two rows of rings are made from stainless steel. There is a double filtration of biogas, which save burners life. The biogas plant is equipped with a modern laboratory. Biogas plants has a lot of features, which are known only to the experienced company. Zorg Biogas built turn key 5 biogas plants for sugar mills. And we know very well the specifics of the sugar beet pulp.

### Raw material potential .

Substrate	Quantity (tonnes/day)	Quantity (tonnes/season)	DM content: (%)	ODM content (%)	DM quantity (tonne s/ day)	ODM quantity (tonnes / day)	Biogas yield (m <sup>3</sup> / tonneODM)	Biogas (m <sup>3</sup> /day)	Methane content (%)	Biomethane (m <sup>3</sup> /day)	Biomethane (m <sup>3</sup> /season)
Sugar beet pulp (fresh)	719	71 900	24	92	173	159	620	98 453	53	45 355	4 535 500
Sugar beet pulp	719	190 600	24	92	173	159	650	103 216	58	52 642	13 950 042
Total (year)		262 500									18 485 542

## Biogas plant technical performances

Characteristics	Values	Figures
Number of digesters	units	3
Digester		
a) volume:		
Work	m <sup>3</sup>	8204
Overall	m <sup>3</sup>	7870
b) Organic load	kgODM/ m <sup>3</sup>	6.76
c) Hydraulic retention time (gross)	days	34
d) Overall dimensions of the digester (diameter / height)	m	23.05/ 19.67
e) Temperature	°C	+48
Gasholder		
a) Volume	m <sup>3</sup>	2000
b) Number of gasholders	units	1
c) Dimensions of the gasholder (diameter / height)	m	16.9/12.5

## Number of personnel

	Shift 1	Shift 2	Shift 3
Chief engineer	1	-	-
Operator	1	1	1
Electrician	1	-	-
Mechanic	1	-	-
Driver	1	1	-



# WORKING PRINCIPLE

## Biogas plant working principle

The technology is based on the biochemical conversion of organic materials from high molecular weight compounds to low molecular weight compounds. The first stage of this process is hydrolysis. Hydrolysis produces organic acids and alcohols.

Organic compounds + H<sub>2</sub>O → C<sub>5</sub>H<sub>7</sub>N<sub>0</sub>2 + HCO<sub>3</sub>.

Further conversion of obtained dissolved compounds like organic acids and alcohols (C<sub>5</sub>H<sub>7</sub>N<sub>0</sub>2, HCO<sub>3</sub>) into gases - CH<sub>4</sub>, CO<sub>2</sub>. C<sub>5</sub>H<sub>7</sub>N<sub>0</sub>2 + HCO<sub>3</sub> + H<sub>2</sub>O → CH<sub>4</sub> + CO<sub>2</sub> + NH<sub>4</sub>.

Biological process of consecutive (phasic) conversion of organic compounds take place in anaerobic environment i.e. in oxygen-free tank (biological reactor). At the first stage of fermentation, substrate hydrolysis take place under acidogenic bacteria influence. At the second stage, elementary organic compounds come through hydrolysis oxidation by means of hetero-acidogenic bacteria with production of acetate, carbon diox-

ide, and free hydrogen. The other part of the organic compound including acetate forms C<sub>1</sub> compounds (elementary organic acids). Produced substances are the feedstock for methanogenic bacteria of the third type. This stage flows in two processes of A and B type the character which depends on caused by different bacteria type. These two types of bacteria convert the compound obtained during the first and second stages into methane CH<sub>4</sub>, water H<sub>2</sub>O and carbon dioxide CO<sub>2</sub>. Methanogenic bacteria are more sensitive to the living environment compared to acidogenic bacteria. They require a complete anaerobic environment and a longer reproduction period. The speed and scale of anaerobic fermentation depends on bacteria metabolic activity. That is why the biogas plant chemical process includes hydrolysis stage, oxidation, and methanization stage. For that kind of substrate, these processes take place in the same reactor

## Technological process of biogas production

Sugar beet pulp silage is transported to the biogas plant area every day and discharged into the loaders. The loaders are equipped with a moving floor. The supply of raw materials is carried out by Bio-mix pumps into the digesters evenly throughout the day.

In the digesters the substrate is brought up to a temperature of +48 C. Constant temperature is sustained for the entire digesting period. The digester operating regime is thermophilic. The heated substrate in the digester is blended periodically by mixers. The average time of processing in the digesters is 34 days (gross).

After the digesters, the substrate is fed by the pumps to the separator areas where it is separated into solid and liquid bio-fertilizer. Solid bio-fertilizer is discharged to the separation area and transported for storage; liquid filtrate is directed to a filtrate tank.

Biogas plant is equipped with gasholder for accumulating of biogas. The gas holder's weather protective film protects the gasholder from precipitation and damage by foreign objects. The weather protective film is fixed firmly by a special system. To protect the gasholder from overpressure, digesters are equipped with safety valves, which start working at a pressure of 5 mbars and bleeds biogas to the atmosphere.

The biogas then goes through a gas pipeline to a compressor, where the pressure is raised up to 80-150 mbar to meet engine requirements. After the compressor, biogas is fed to activated coal filters to remove hydrogen sulfide (H<sub>2</sub>S).

Sulfur removal is three-stage:

-by Oxygen- first stage of purification (in the digesters);

-by Iron hydroxide- second stage of purification (in the digesters);

-coal column - the third stage.

After the filter, biogas is supplied to a biogas upgrading plant and cogeneration power plant, where it is used as fuel for production of electricity and heat. Heat from the cogenerators is fed to a heat exchanger for heating the digesters. Heating equipment is used for distribution of heat between biogas plant facilities.

All technological processes are controlled and operated by an automatic system. Biogas plant work is monitored at the central control room monitor. The control room is equipped with a central control unit, which allows the switching of any biogas plant module into automatic or manual mode with local or remote control.



# MAIN EQUIPMENT





## Loader (SF-01..3)

The main components

- buffer bunker 100 m<sup>3</sup>
- assembly of conveyor chains of scrapers
- support structure for horizontal or inclined implantation

This system contains systems that provide the speed of rotation of the frequency converter. The range of measurements depends on:

- Special weight gauge after material transport
- Transport speed (discharge)
- Type of implantation (horizontal or inclining)
- Feeding screws set

## Specifications

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<b>Length:</b>	20.5m
<b>Height:</b>	2.3 m
<b>Width</b>	2,0 m
<b>Volume:</b>	100 m <sup>3</sup>
<b>Quantity:</b>	3 pcs.



## Digester (TK-01..03)

Digester is an important part of a biogas plant made of enamelled sheet metal. The metal digester is installed on a concrete basis. A layer of enamel protects the surface of the entire metal structure. The enamel is vitreous and very resistant to aggressive pH and mechanical damage. Enamelled digester assembled from steel segments. Such a digester is quickly and safely mounted.

Steel digester has the following advantages:

- Steel panels are joined on bolted joints with a special sealant.
- The enamel

coating is layered according to the PUESTA method. This is a special powder that is laid in layers by electrostatic attraction. Thus, uniformity of coating, density and smoothness are achieved;

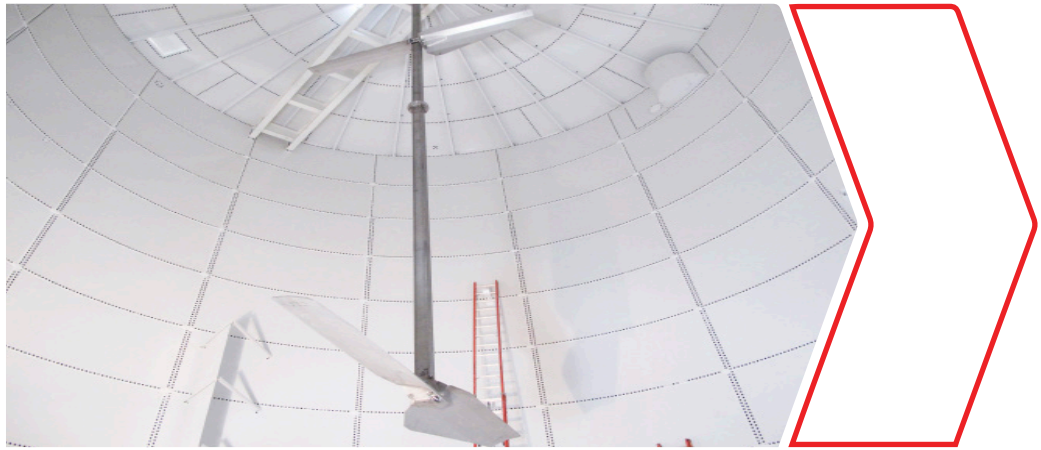
- Bolts made of stainless steel;
- All elements (flanges, etc.) are connected through an EPDM membrane to protect the enamel.

To reduce heat consumption and maintain a constant temperature, the digester is isolated. Outside the digester is coated with a decorative coating.

## Specifications

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<b>Height:</b>	19.67 m
<b>Diameter:</b>	23.05 m
<b>Overall volume:</b>	8204 m <sup>3</sup>
<b>Quantity:</b>	3 pcs



## Digester vertical mixer (AG-01..03)

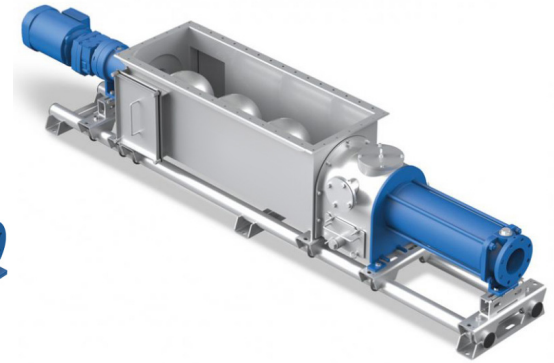
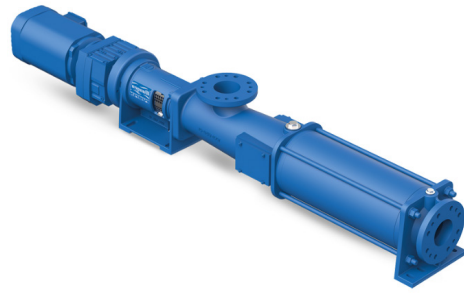
The agitator is fixed to the center of the rigid overlap of the fermenter. Mixer blades are designed in different directions. This design of the blades helps to create a lifting force that lifts the substrate from the bottom of the digester to the top of the tank. The upper blades rotate distributing the substrate along the digester, directing the flow downward. The agitator works constantly, mixing the substrate in the digester all the time.

## Specifications

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**Nominal power**  
**Quantity:**

N=37 kW  
3 pcs  
(1 pcs per digester)



## Pump equipment (PU-01..13)

Pumps are used to transport substrate to the equipment and facilities in the biogas plant and away. Biogas plant design allows to access easily to all pumps. Pumps are driven by helical geared motor. Stator has hopper inlet for optimum filling of the pumping chamber, wear-protected, robust universal joint with feeding screw, ro-

bust bearing pedestal with close-coupled drive and self-centering of the drive shaft. Pumps have modular design for high flexibility, low life-cycle-costs.

### Specifications

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#### Substrate pump to separator

**Flow rate:** 10-25 m<sup>3</sup>/hour  
**Engine power:** 11.0 kW  
**Pressure:** 4 bar  
**Quantity:** 3 pcs

#### Filtrate pump

**Flow rate:** 60 m<sup>3</sup>/hour  
**Engine power:** 15,0 kW  
**Pressure:** 4 bar  
**Quantity:** 1pcs

#### Substrate pump (to Heat-Exchange)

**Flow rate:** 45 m<sup>3</sup>/hour  
**Engine power:** 15.0 kW  
**Pressure:** 4 bar  
**Quantity:** 3 pcs

#### BIO-MIX

**Flow rate:** 160 m<sup>3</sup>/hour  
**Engine power:** 60.0 kW  
**Pressure:** 4 bar  
**Quantity:** 3 pcs

#### Substrate pump to BIO-MIX

**Flow rate:** 120 m<sup>3</sup>/hour  
**Engine power:** 30.0 kW  
**Pressure:** 4 bar  
**Quantity:** 3 pcs



## Gasholder (GH-01)

The gasholder provides for biogas storage and for equalizing pressure and biogas composition. The gasholder system has a two-layer construction. The external material consists of a weather-proof film of PVC-coated polyester fabrics with UV protection. Both sides are finished with an external N/5cm, internal membrane PE (gasholder) membrane.

The gasholder has a methane permeation maximum of  $260 \text{ cm}^3/\text{m}^2 \cdot 1 \text{ bar}$  biogas resistance. The gasholder film temperature range allows operation from  $-30^\circ\text{C}$  to  $+60^\circ\text{C}$ .

The internal film is stretched under normal biogas pressure. Air is blown into the space between the external and internal membranes to pressurize the internal membrane and form the shape of the external membrane.

The biogas pressure in the gasholder is 2-5 mbar. The membranes are designed and cut out on NC machines. Welding is executed by high frequency currents. These steps yield substantial improvements for quality and service life compared to hand-made membranes welded by standard welding equipment.

To prevent damage to the gasholder as a result of overpressure conditions, a safety valve is installed. To survey the internal membrane, an inspection window is installed on the external membrane.

## Specifications

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<b>Height :</b>	12.5 m
<b>Diameter :</b>	16.9 m
<b>The total volume :</b>	2000 m <sup>3</sup>
<b>Quantity:</b>	1 pcs



## Window with spotlight (SG-01..03)

Inspection windows are designed for visual control of processes inside the fermenter and post-digester. Spotlights were made in explosion-proof with automatic disconnec-

tion. Inspection windows are equipped with a cleaning washing system.

### Specifications

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**Inspection windows Ø300**  
**Spotlight VISULUX UL50 -G -H**  
**230V, 50W, IP65**



## Separator (SR-01..03)

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.

## Specifications

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<b>Engine power</b>	<b>7.5 kW</b>
<b>Flow rate</b>	<b>10-25 m<sup>3</sup> / h</b>
<b>Quantity</b>	<b>3 pcs</b>
<b>Equipment</b>	
<b>Frame</b>	
<b>Screw</b>	
<b>Sieve for the filtration</b>	
<b>Counterweights</b>	
<b>The design of the protective room</b>	





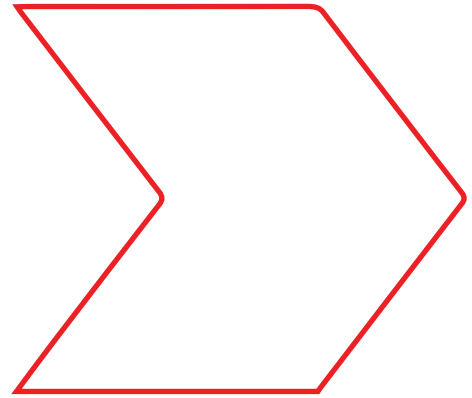
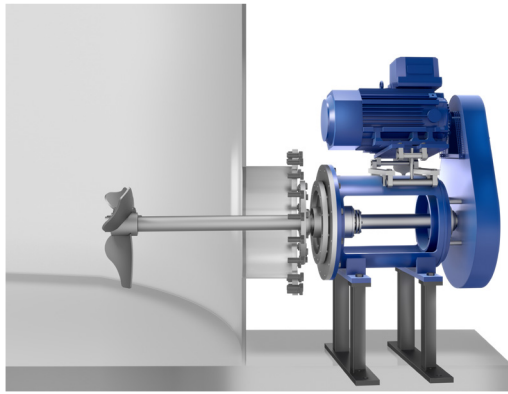
## Filtrate tank (TK-04)

The filtrate tank to receive the mass of filtrate. The tank is made of enamelled metal and has a metal roof with a hatch and safety valves.

### Specifications

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<b>Diameter:</b>	8.54 m
<b>Height</b>	4,42 m
<b>Total volume:</b>	252 m <sup>3</sup>
<b>Quantity:</b>	1 pcs



## Side mixer (AG-04)

Side mixers are used in biogas reactors and receiving tanks for mixing medium and low viscosity substrates. Most often they are installed on reinforced concrete tanks because they can be easily attached to the wall. When installed on a metal tank, the stirrer is attached to a support column. The agitator drive is located outside, and a shaft with a screw goes into the reactor through a flange installed in the wall. Installation through a flange prevents the transfer of forces from the agitator to the tank walls.

## Specifications

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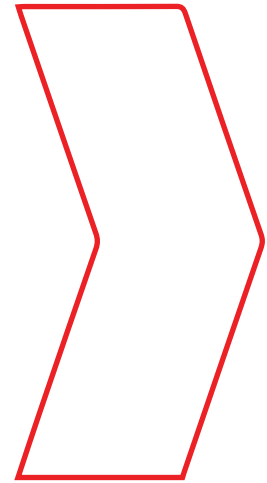
**Nominal power**

N= 6 kW

Height:

adapted to the height of digester

Material: stainless steel 8 mm



## Biogas dryer and cooling (CHL-01..02)

Biogas dryer and cooling are provided with special equipment as GAS COOLER and AIR-COOLED LIQUID CHILLER. Biogas plants thanks to an extensive range of dedicated Biogas solutions, low pressure heat exchangers, a comprehensive range of water chillers and RWD Dry Coolers. Designed as one-way shell-and-tube heat exchanger. Process gas inside of the tubes; cooling water in the shell. All parts in contact with the process gas made of stainless steel 316Ti or 316L; heat exchanger shell made of stainless steel/ Designed with gas outlet chamber outlet connection radial; inspection opening axial Official acceptance according to PED 2014/68/EU in accordance with ADMerkblätter and factory pressure test.

### Specifications

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<b>Gas volume flow</b>	2150 m <sup>3</sup> / h
<b>Gas inlet temperature</b>	+48 C
<b>Gas outlet temperature</b>	+10 C
<b>Engine power</b>	48.5 kW
<b>Quantity</b>	2 pcs



## Biogas compressor (BC-01..02)

Biogas blower is a device used to move gas and increase pressure thanks to a rotating impeller within a toroidal channel, so there is a progressive increase of energy.

Blower is used to transporting biogas from gasholder storage to consumer

### Specifications

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Flow rate	4300 m <sup>3</sup> /h
Pressure	150 mbar
Engine	39.0 kW
Quantity	2 pcs



## Desulphurization system (CF-01..02)

Sulfur removal is three-stage:

- by Oxygen- first stage of purification (in the digesters);
- by Iron hydroxide- second stage of purification (in the digesters);
- the coal column - the third stage purification of biogas to remove sulfur. The system cleans biogas of sulfur using activated charcoal filtration, as activated charcoal has the capability to absorb sulfur. After passing through activated charcoal filters, the sulfur concentration is reduced to 0 ppm.

### Specifications

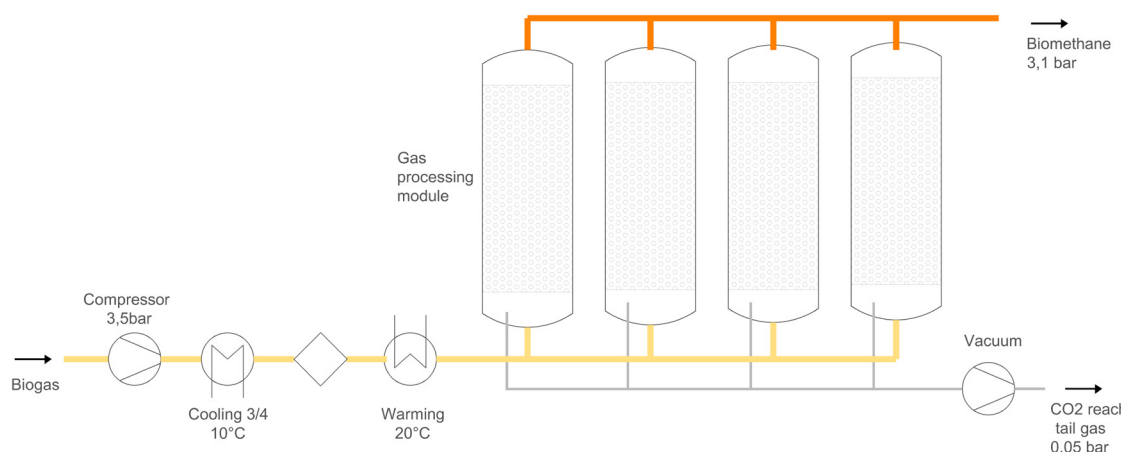
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<b>The volume of charcoal</b>	1 000 kg
<b>Numbers of charcoal columns</b>	2 pcs



## Biogas upgrading plant (BUP-01)

The biogas upgrading plant is used to purify biogas, landfill gas or sewage gas. The CO<sub>2</sub> content is separated from the main gas stream with this plant and thus a product gas of natural gas quality is generated, which can be fed into the natural gas grid via a downstream feed-in plant. The gas mixture is separated by means of pressure swing adsorption (PSA), a physical process for separating gas mixtures under pressure by means of adsorption. The separation effect occurs because one of the components to be separated (CO<sub>2</sub>) adsorbs more strongly than the other (CH<sub>4</sub>). This results in an enrichment of the less adsorbent component (CH<sub>4</sub>) in the gas phase. The desulphurised and dried biogas is fed into the adsorbers under pressure. The gas flows through the adsorbers from bottom to top, whereby the CO<sub>2</sub> is adsorbed. At the outlet of the adsorber, biomethane that meets the specifications is extracted. At the end of the adsorption time, the adsorber is saturated with CO<sub>2</sub>. By lowering the pressure into a vacuum, the adsorber is regenerated and is then ready for adsorption again. The advantage of this technology is the absence of the use of additional chemical reagents and less consumption of electrical energy (compared to installations of other manufacturers).



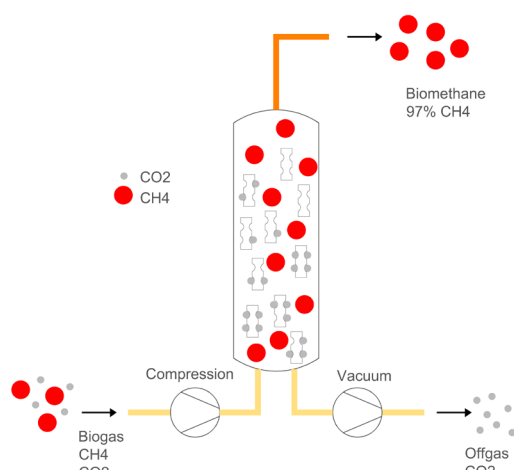
# Biogas upgrading plant nominal conditions

## Season 1

	Biogas	Biomethane	CO <sub>2</sub> reach tail gas
Flow (Nm <sup>3</sup> /h)	3548	1890	1658
CH <sub>4</sub> (Vol %)	53.0	99.0	2,97
CO <sub>2</sub> (Vol %)	40,03	0,60	94,63
H <sub>2</sub> O (Vol %)	6.59	Dew-point < -65°C	2,01
N <sub>2</sub> (Vol %)	0,19	0,29	0,07
O <sub>2</sub> (Vol %)	0.19	0,10	0,33
H <sub>2</sub> S (ppm)	<3	-	-
Temperature (°C)	20	25	40
Pressure (bar)	0,09	3,0	0,05
Wobbe Index (kWh/Nm <sup>3</sup> )	5.51	14,6	0,27

## Season 2

	Biogas	Biomethane	CO <sub>2</sub> reach tail gas
Flow (Nm <sup>3</sup> /h)	3763	2193	1570
CH <sub>4</sub> (Vol %)	58.0	99.0	2,97
CO <sub>2</sub> (Vol %)	35,03	0,60	94,63
H <sub>2</sub> O (Vol %)	6.59	Dew-point < -65°C	2,01
N <sub>2</sub> (Vol %)	0,19	0,29	0,07
O <sub>2</sub> (Vol %)	0.19	0,10	0,33
H <sub>2</sub> S (ppm)	<3	-	-
Temperature (°C)	20	25	40
Pressure (bar)	0,09	0,05	
Wobbe Index (kWh/Nm <sup>3</sup> )	5.51	14,6	0,27



## Specifications

Flow rate	3800 m <sup>3</sup> /h
Quantity:	1 pcs



## Cogeneration Power Plant (CHP-01)

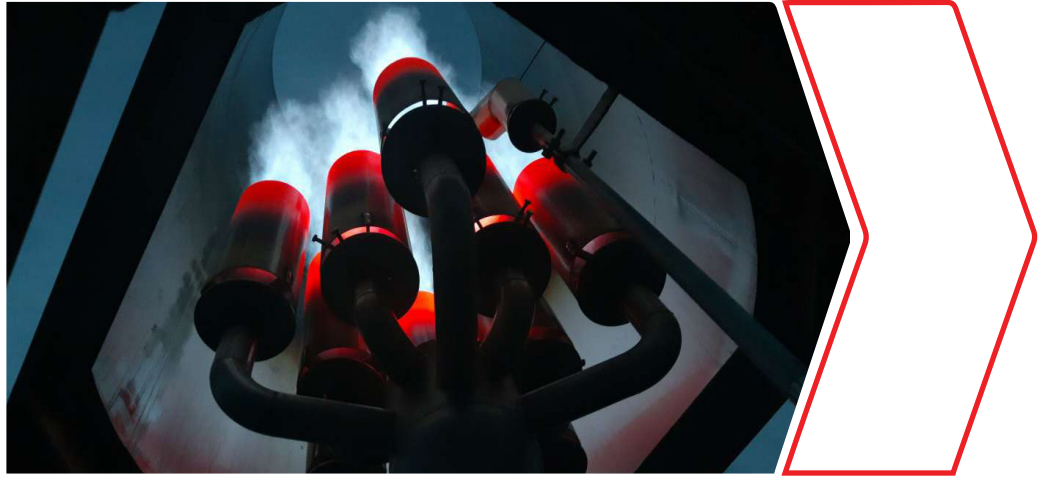
A cogeneration power plant (CHP) is used for producing electricity and heat. CHP is a very efficient technology for generating electricity and heat together. A CHP plant is an installation where there is simultaneous generation of usable electric power and heat in a single process, and it can provide a secure and highly efficient method of generating electricity and heat at the point of use. Due to the utilization of heat from electricity generation and the avoidance of transmission losses, due to electricity being generated on site, CHP typically achieves a 35 per cent reduction in primary energy usage compared with power stations and heat only boilers. This allows for economic savings where there is a suitable balance between heat and power loads. Another important factor, showing the benefits of cogeneration and CHP, is its low environmental impact. CHP produces lower quantities of pollutant emissions and heat pollution of the atmosphere. The current mix of CHP installations achieves a reduction of over 10 per cent in CO<sub>2</sub> emissions in comparison with combined-cycle gas turbines.

### Specifications

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Produced electric power	1500 kW
Produced heat power	1492 kW
Emissions	NO <sub>x</sub> < 500 mg/Nm <sup>3</sup> (5% O <sub>2</sub> )
Generator	400V, 50Hz
Quantity:	1 pcs





## Flare (BF-01)

The 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.

## Specifications

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**Flow rate**

4300 m<sup>3</sup>/h

Quantity:

1 pcs



## Heating system

Heating equipment is used for biogas plant heating and for sustaining constant temperature in the fermenter. Heating equipment includes circulation pumps, heat exchanger, heating manifold and pipes. The heat from the boiler is transferred to the biogas plant by using heat exchanger, and then is pumped through of biogas plant by circulation pumps. A heat carrier prepares water with an additive of ethylene glycol. Inlet temperature in the fermenter is 60C, the outlet is 40C.

## Specifications

Circulating pump feeding water network		The pumping station feeding propylene glycol	
Flow	19 m <sup>3</sup> / h;	Flow	1,0m <sup>3</sup> / h;
Pressure	0,65 bar	Pressure	4 bar,
Circulating pump feeding network water to electric boiler		Circulating pump feeding water network in the digester	
Flow rate	4.6 m <sup>3</sup> / h;	Flow	4.6 m <sup>3</sup> / h;
Pressure	0.8 bar	Pressure	1.1 bar
Circulating pump feeding network water heating		Three-way valves, control actuators, diaphragm expansion vessel	
Flow	4.6 m <sup>3</sup> / h;		
Pressure	1 bar,		

# Water supplying and sewerage system

Water supplying system provides biogas plant feed water, water for network circuits, the domestic water and fire safety systems. As used centrifugal single stage pumps as main pumping elements. These pumps are designed for pumping waste water, household / domestic water and sewage. Pressure Boosting Systems are designed for pure water pressure boosting in industrial plants. The booster comprises 2 to 3 (connected in parallel pumps) installed on a common base frame, and provided with all the necessary fittings.

## Specifications

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Drain pump  
Pressure 4m  
Flow 2-3 m<sup>3</sup> / h  
Engine 0,24 kW

Equipment  
Pump case control  
Stove-base  
gauges  
Check valves  
Float switches  
Brackets  
Valves

# Air supply system

Air supply system ensures retention of the protective dome digester. This is achieved by installing a pneumatic lock and maintain the required pressure therein.

## Specifications

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<b>Flow rate</b>	200l/min
<b>Max. Pressure</b>	8Bar
<b>Speed</b>	2850 rev/min
<b>Receiver capacity</b>	9,5l



## Spiral Heat Exchanger (HE-01..03)

Using as modular design for vinasse, sludge and biological mass and for mediums that are badly contaminated and burden by solids with a distinctive fouling behavior. The main component of the Spiral Heat Exchanger is an aluminum cast member made of a no corrosive alloy. A number of left-handed and right-handed components, one on top of the other, from a compact, high-capacity heat exchanger. To avoid hard alteration of the direction of the flow, the spiral channel has an anti-clockwise curvature (left-hand element) and a clockwise curvature (right-hand element).

### Specifications

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<b>Digester heat exchanger</b>	
<b>Volumetric capacity from</b>	45m <sup>3</sup> / h
<b>Temperature</b>	up to 90 ° C;
<b>Working pressure</b>	at 4 bar
<b>Quantity</b>	3 pcs



## Dry cooler (digester cooling) (DC-01..03)

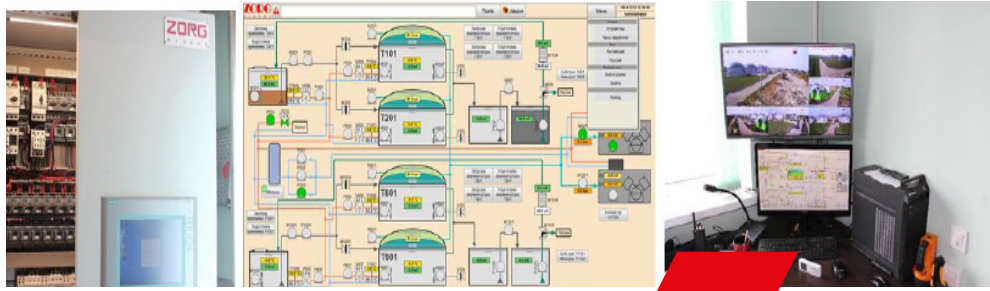
The device is designed to cool the reactor. When using highly loaded technology, there is a chance of uncontrolled self-heating.

The cooler is connected to the heating pipes, and when active, the same lines are used.

### Specifications

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Power	100 kW
Engine power	2,2kW
Quantity:	3 pcs



## Automation and electrical equipment

Process control equipment is used for supervision and regulation operation of the plant and for the limitation of damage. In case of emergency (for example, breakdown of the electrical power supply) the biogas plant is automatically transferred to safe operating conditions by the process instrumentation. Critical electrically driven devices are supplied with emergency power. An automatic system allows the supervision of the plant in real time and to recognize and correct aberrations immediately; to run the plant at its optimum saving resources and costs; and to record for the electronic database operation parameters. The automatic system consists of a control cabinet and sensors for parameter control of technological processes and execution

devices.

The control cabinet is designed based on the industrial controller Siemens CPU315-DP2, using periphery distributing system Simatic ET200S, and operator panel OP277 Touch with touch-sensitive controls. Communications is executed by PROFIBUS and MPI with physical interface RS-485. The control program is designed based on the Simatic Step7. The control cabinet is a modular design. The upper part has a power box with central and front-end processor. The periphery distributing system, Simatic ET200S, is installed with input - output units. The lower part with interface relay and clips is installed for connecting execution devices. The entire plant is controlled by a single operator.

## Specifications

**Incoming control case with automatic set ASE-1, 2, 3**

**Base Siemens CPU315-DP2 controller**

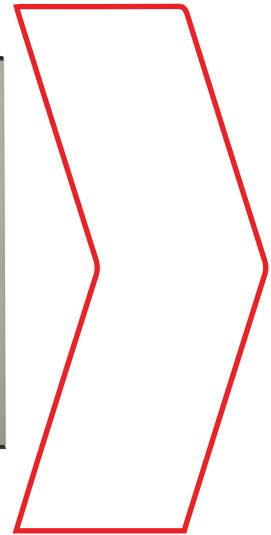
**Peripherals Simatic ET200S**

**Control panel OP277 touchscreen**

**Communication PROFIBUS and MPI**

**Interface RS-485**

**Control system Simatic Step7**



## Gas analyzer (CH<sub>4</sub>, CO<sub>2</sub>, H<sub>2</sub>S, O<sub>2</sub>)

Gas analyzer - a measuring device to determine the qualitative and quantitative composition of the gas mixture. In a biogas plant's installed absorption gas analyzers, biogas mixture components are absorbed sequentially with various reagents. Automatic gas analyzers continuously measure any physical or physicochemical characteristics of the gas mixture or its individual components. Operation is based on physical methods of analysis, including auxiliary chemical reactions.

### Specifications

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#### Set includes

- Device for wall mounting
- LCD display menu
- Flow meter / control valve
- Sensors

Defined gases methane % (CH<sub>4</sub>), carbon dioxide % (CO<sub>2</sub>), hydrogen sulfide ppm (H<sub>2</sub>S)



## Sensors

Sensors are used to measure physical quantities (temperature, pressure, level of moisture) data collection.  
installation kits

## Specifications

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Conductometric sensor  
Pressure Sensor / level  
Ultrasonic sensor  
Gas Pressure Sensor  
Temperature converters with protective sleeves  
The moisture sensor and the gas temperature





## 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

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**Analytical scales**  
**Moisture analyzer**  
**Automatic titrator**  
**Laboratory pH meter**  
**Centrifuge**  
**A set of flasks**

# EQUIPMENT SPECIFICATION LIST



Nº	Equipment	Characteristic	Q-ty
<b>1</b>	<b>Loader</b>	<b>N=100 m3</b>	<b>3</b>
1.1	Container bunker		3
1.2	Feeding screws	set.	3
<b>2</b>	<b>Digester</b>	<b>V=8204m3</b>	<b>3</b>
2.1	Steel roof		3
2.2	Accessories: Stairs, platforms, flanges, insulation, sheathing, et	set	3
<b>3</b>	<b>Vertical mixer (digester)</b>	<b>N=37,0 kW</b>	<b>3</b>
3.1	Airtight motor gearbox		3
3.2	Hydraulic screw (wear-resistant steel)		3
3.3	Mixer control mechanism (high-quality structural galvanized steel)		3
3.4	Electric motor mount (high-quality structural galvanized steel)		3
3.5	Set of fasteners (coating - hot dip galvanized)		3
<b>4</b>	<b>Safety valve of digester</b>		<b>3</b>
<b>5</b>	<b>Window with a searchlight, complete, disassembled</b>	<b>set</b>	<b>3</b>
5.1	Inspection window RD300 (mounts and sealant included)	Ø300	6
5.2	Spotlight (mount system bundled) VISULUX UL50 -G -H	230V, 50W, IP65	3
<b>6</b>	<b>PVC external gas holder, complete, disassembled</b>	<b>V=2000 m³</b>	<b>1</b>
6.1	Weather protection film	Ø16.9 m	1
6.2	Gasholder film PELD methane permeation max.260 cm3/m2*d*1 bar, 650 N/5cm biogas resistant		1
6.3	Air blower	16A, 0,5kW	1

Nº	Equipment	Characteristic	Q-ty
6.4	Excess and minimum pressure valve		1
6.5	Dome level sensor		1
6.6	Mounting system		1
6.7	Accessories		1
<b>7</b>	<b>BIO-MIX pump</b>	<b>160 m3/hour N=60 kW</b>	<b>3</b>
<b>8</b>	<b>Substrate pump to BIO-MIX</b>	<b>120 m3/hour N=30.0 kW</b>	<b>3</b>
<b>9</b>	<b>Substrate pump to Separator</b>	<b>25 m3/hour N=11.0kW</b>	<b>3</b>
<b>10</b>	<b>Separator for separating the substrate, complete, disassembled</b>	<b>N=7.5 kW, Q=10-25 m3/h</b>	<b>3</b>
10.1	Body		3
10.2	Substrate Supply Pipe 4 ''		3
10.3	Engine - Gearbox	N=7,5 kW	3
10.4	Frame		3
10.5	Screw		3
10.6	Sieve for filtration		3
<b>11</b>	<b>Filtrate tank</b>	<b>V=252 m3</b>	<b>1</b>
11.1	Steel roof		1
11.2	Accessories: Stairs, platforms, flanges, insulation, sheathing, et	set	1

Nº	Equipment	Characteristic	Q-ty
12	Side mixer (filtrate tank)	N=6,0 kW	1
13	Filtrate pump	60 m3/hour N=15,0 kW	1
14	Biogas compressor	Q=4300 m <sup>3</sup> /h H=150mBar N=39,0 kW	2
15	Electromagnetic flow meter		1
16	Gas analyzer		1
17	Flare	4300 m3/h	1
17.1	Compressor		1
17.2	Manual locking element		1
17.3	Deflagration fuse		1
17.4	On-site control cabinet		1
17.5	Auto ignition system		1
17.6	Auto Main Gas Solenoid Valve		1
20	Biogas cooling system	2150 m3/hour N=48.5 kW	2
21	The heat supply system, complete, disassembled	set	1
22	Substrate pump to Heat Exchanger	45 m3/hour N=15.0 kW	3
23	Heat Exchanger (digester`s)		3

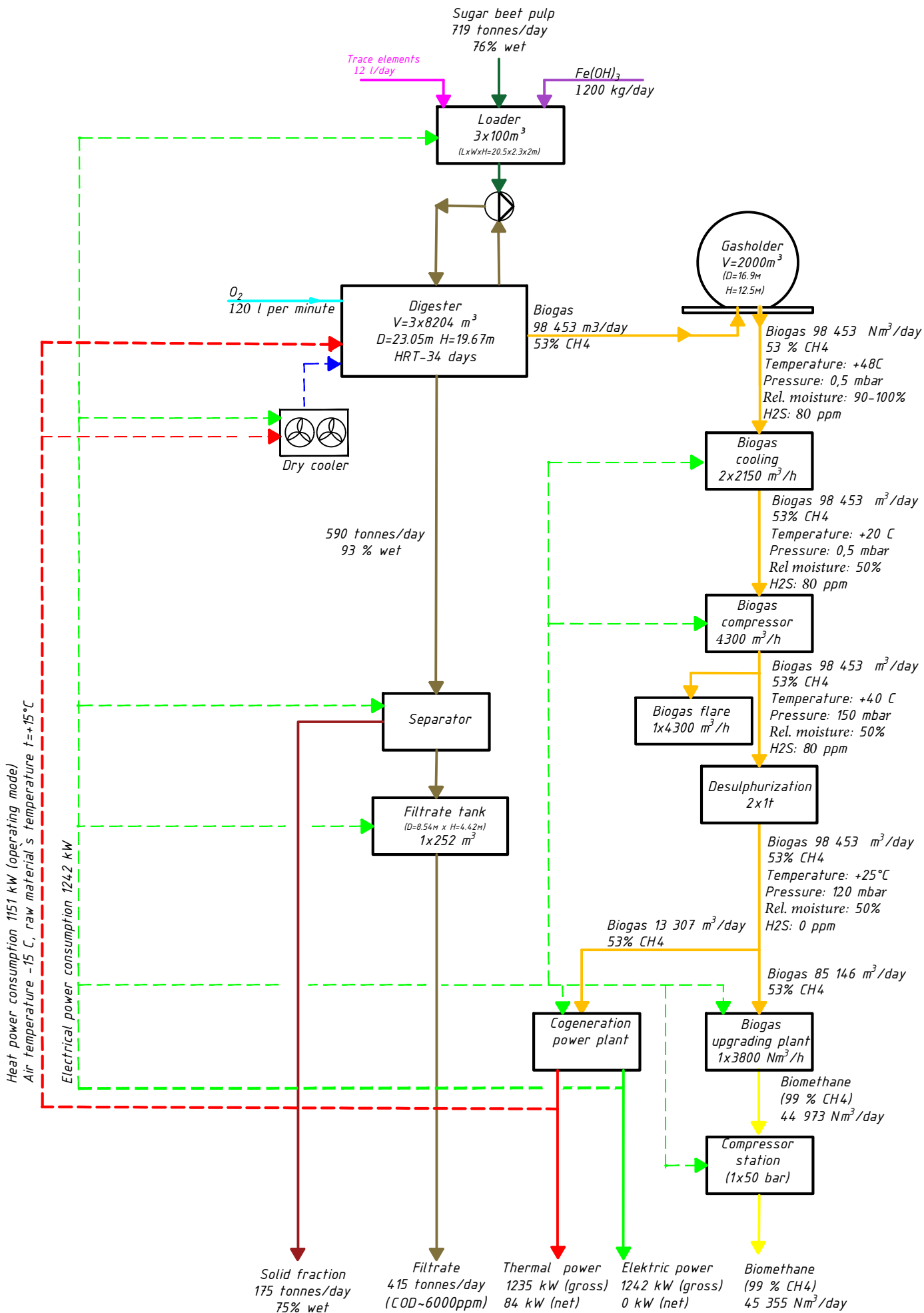
Nº	Equipment	Characteristic	Q-ty
<b>24</b>	<b>Water supply and sewerage system, complete, disassembled</b>		<b>1</b>
<b>25</b>	<b>Automation with electrical equipment complete, disassembled</b>		<b>1</b>
25.1	Incoming distribution cabinet with a set of automation DB-1		1
25.2	Incoming distribution cabinet with a set of automation DB-2		1
<b>26</b>	<b>Sensor set</b>		<b>1</b>
26.1	Conductivity sensor		4
26.2	Pressure / level sensor		4
26.3	Ultrasonic sensor	SPA-380-08 (0-6m)	3
26.4	Gas pressure sensor	SEN 3276 B156 G1/2 0,4Bar	3
26.5	Thermal converter	TR10-B-M-DZ ZKTA-2-QRZZM- 150-DCK-CE-R- 00735-ZZ	3
26.6	Thermowells for thermocouples	TR10-B	3
26.7	Thermal converter heating circuit	TR30-P-Z-Z- A-ZZZ-13R- DBB-ZZZZ- B000025-ZZ	3
26.8	Substrate pressure sensor	SEN-3251 B055 G1 4Bar	3
26.9	Substrate pressure sensor	SEN-3251 B045 G1 2,5Bar	3

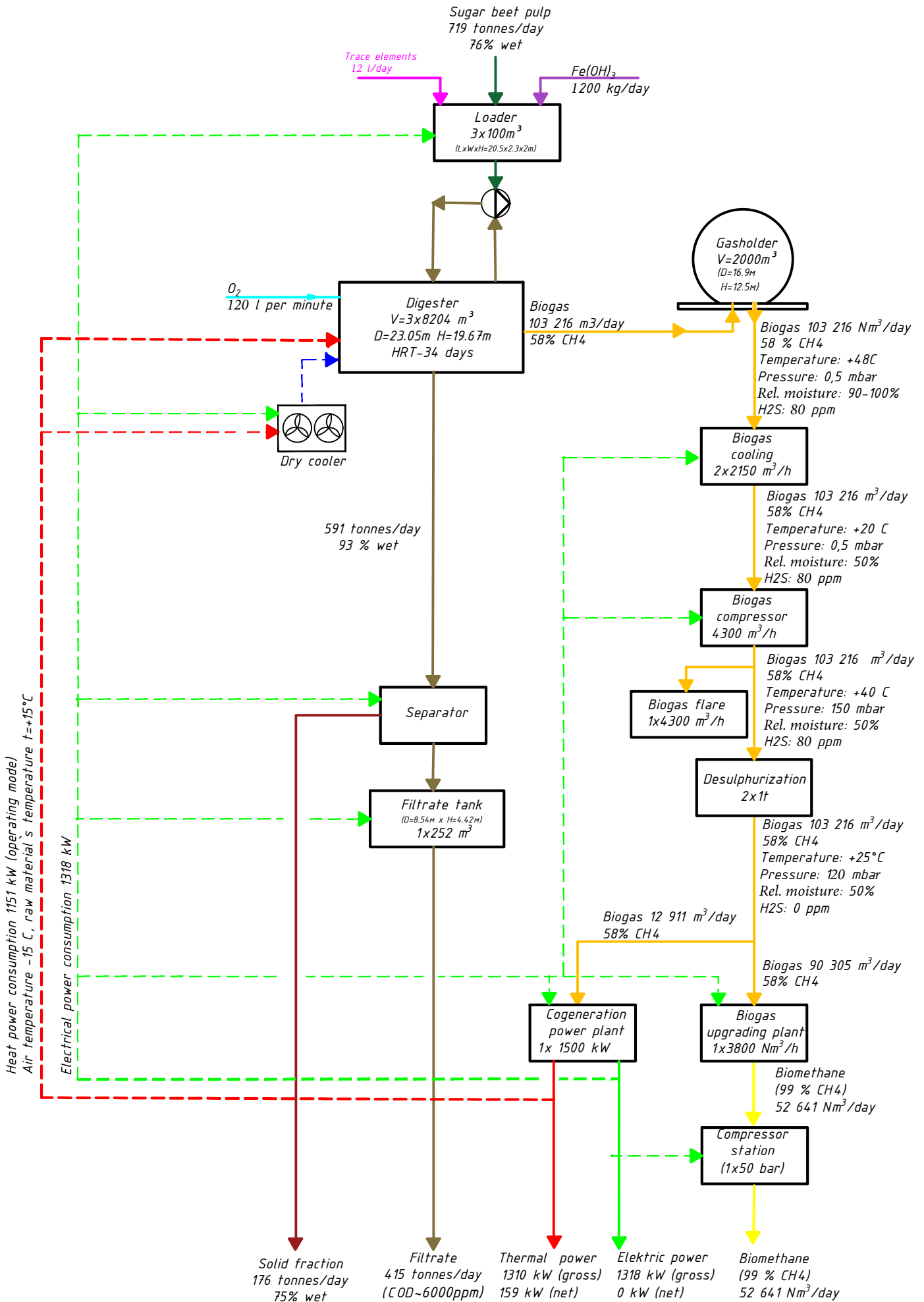
Nº	Equipment	Characteristic	Q-ty
26.10	Coolant pressure sensor	SEN 3276 B065 G1/2 6Bar	3
26.11	Immersion level sensor	LS-10 0,6Bar 4-20 mA	3
26.12	Humidity and gas temperature sensor	ESFTF-I	3
<b>27</b>	<b>Motorized valves</b>	N=0,1 kW	21
<b>28</b>	<b>Desulphurization system</b>	<b>1 000 kg</b>	<b>2</b>
28.1	Numbers of charcoal columns		10
<b>29</b>	<b>Biogas upgrading plant</b>	<b>3800 m3/h</b>	<b>1</b>
<b>30</b>	<b>Compressor module</b>	<b>set</b>	<b>1</b>
<b>31</b>	<b>Cogeneration power plant</b>	<b>1500 kW</b>	<b>1</b>
<b>32</b>	<b>Dry cooler</b>	<b>100 kW</b>	<b>3</b>

# ANNEXES



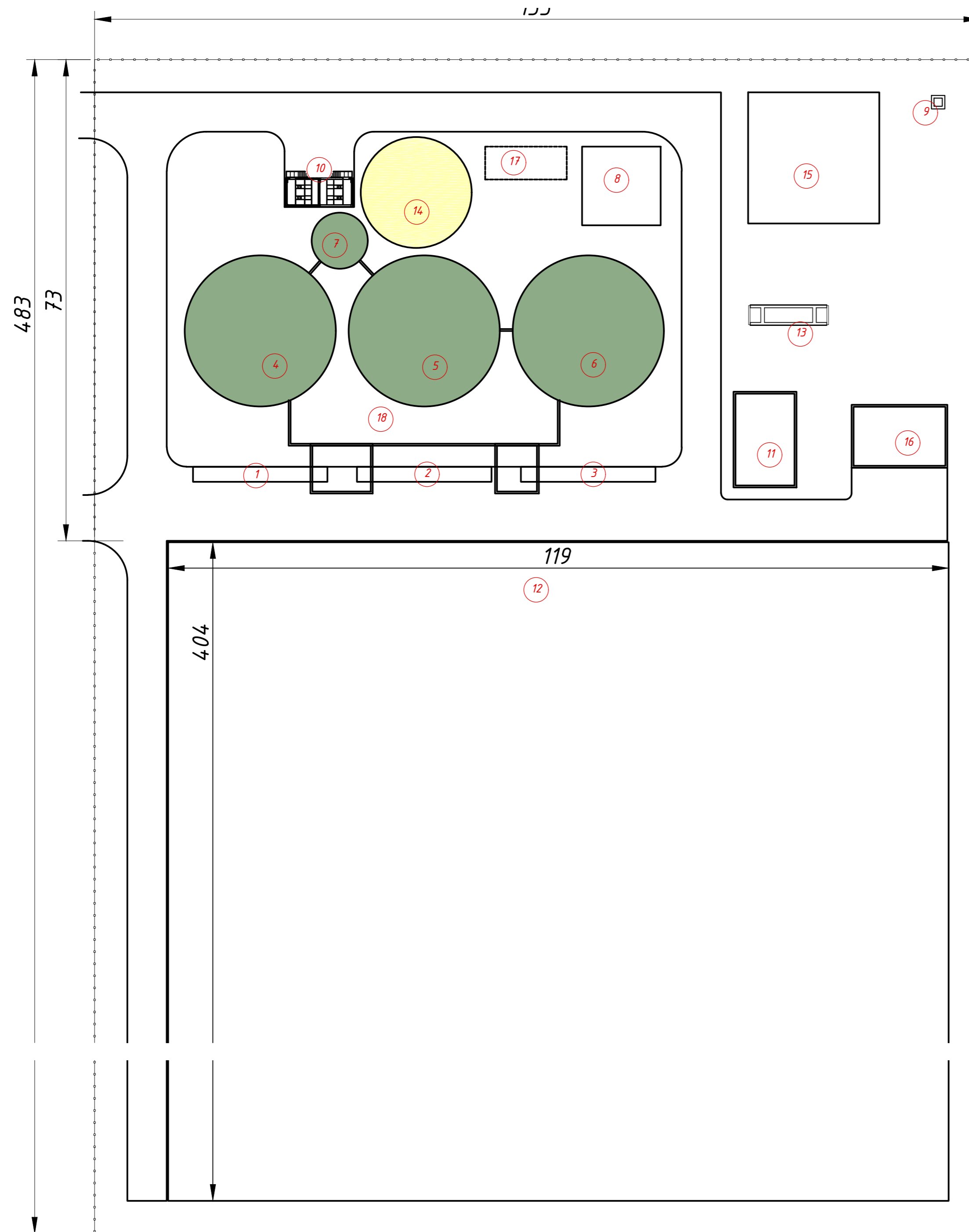








Plan



Explication

N/№	Name	Note
1	Solid loader (SF-01)	
2	Solid loader (SF-02)	
3	Solid loader (SF-03)	
4	Digester (TK-01)	
5	Digester (TK-02)	
6	Digester (TK-03)	
7	Filtrate tank (TK-04)	
8	Gas preparation	
9	Biogas flare (BF-01)	
10	Separator area (SA-01)	
11	Operators room	
12	Silo	48000m2
13	Co-generator (CHP-01)	
14	Gas holder (GH-01)	
15	Biomethane module (BUP-01)	
16	Warehouse	
17	Fire tank	

## Annex 4.1

### Electrical load

Name equipment	Instal. Pow. (kW)	Q-y (pcs)	Total installed power (kW)	Working hours per day	Consumption kWh per day
Loader V=100 m <sup>3</sup>	23,0	3	69,0	6,0	414,0
Screw	20,0	3	60,0	6,0	360,0
BIO-MIX Pump	60,0	3	180,0	6,0	1080,0
Substrate Pump to Bio-Mix	30,0	3	90,0	6,0	540,0
Digester Vertical mixer	37,0	3	111,0	18,0	1998,0
Substrate pump to Heat-Exchanger	15,0	3	45,0	16,0	720,0
Separator	7,5	3	22,5	12,8	288,0
Substrate pump to separator	11,0	3	33,0	12,8	422,4
Mixer in filtrate tank	6,0	1	6,0	12,0	72,0
Biogas cooling system	48,5	2	97,0	24,0	2328,0
Biogas compressor	39,0	2	78,0	12,0	936,0
Electric valve	0,1	21	2,9	0,5	1,5
Filtrate pump	15,0	1	15,0	8,5	127,5
Co-generator	19,2	1	19,2	24,0	460,8
Circulating pump feeding water network at co-generator	5,5	1	5,5	24,0	132,0
Air compressor for gasholder lock	1,5	3	4,5	1,0	4,5
Air blower for double membrane	1,0	3	3,0	24,0	72,0
Digester cooling system	2,2	3	6,6		
Circulation pump for supplying network water to the digester cooling system	2,0	3	6,0		
Circulating pump feeding hot water at technical building	0,1	1	0,1		
Propylene glycol pump station	0,8	1	0,8	0,5	0,4
Drinage pump	1,0	2	2,0	0,5	1,0
Lighting of the biogas plant territory	2,0	1	2,0	8,0	16,0
Spot light for digesters inspection windows	0,1	2	0,2	0,5	0,1
Total installed power, kW			<b>859</b>		
Total consumed electric energy, kWh per day					<b>9974</b>
Total consumed power, kW					<b>416</b>

### Biogas upgrading plant

Name equipment	Instal. Pow. (kW)	Q-y (pcs)	Total installed power (kW)	Working hours per day	Consumption kWh per day
Biogas upgrading plant	550,0	1	550,0	24,0	13200,0
Compressor module 50bar	265,0	1	265,0	25,0	6625,0
Total installed power, kW			<b>815,0</b>		
Total consumed electric energy, kWh per day					<b>19825</b>
Total consumed power, kW					<b>826</b>
Total average consumed electric power, kW					<b>1242</b>

## Annex 4.2

### Electrical load

Name equipment	Instal. Pow. (kW)	Q-y (pcs)	Total installed power (kW)	Working hours per day	Consumption kWh per day
Loader V=100 m <sup>3</sup>	23,0	3	69,0	6,0	414,0
Screw	20,0	3	60,0	6,0	360,0
BIO-MIX Pump	60,0	3	180,0	6,0	1080,0
Substrate Pump to Bio-Mix	30,0	3	90,0	6,0	540,0
Digester Vertical mixer	37,0	3	111,0	18,0	1998,0
Substrate pump to Heat-Exchanger	15,0	3	45,0	16,0	720,0
Separator	7,5	3	22,5	12,8	288,0
Substrate pump to separator	11,0	3	33,0	12,8	422,4
Mixer in filtrate tank	6,0	1	6,0	12,0	72,0
Biogas cooling system	48,5	2	97,0	24,0	2328,0
Biogas compressor	39,0	2	78,0	12,0	936,0
Electric valve	0,1	21	2,9	0,5	1,5
Filtrate pump	15,0	1	15,0	8,5	127,5
Co-generator	19,2	1	19,2	24,0	460,8
Circulating pump feeding water network at co-generator	5,5	1	5,5	24,0	132,0
Air compressor for gasholder lock	1,5	3	4,5	1,0	4,5
Air blower for double membrane	1,0	3	3,0	24,0	72,0
Digester cooling system	2,2	3	6,6		
Circulation pump for supplying network water to the digester cooling system	2,0	3	6,0		
Circulating pump feeding hot water at technical building	0,1	1	0,1		
Propylene glycol pump station	0,8	1	0,8	0,5	0,4
Drainage pump	1,0	2	2,0	0,5	1,0
Lighting of the biogas plant territory	2,0	1	2,0	8,0	16,0
Spot light for digesters inspection windows	0,1	2	0,2	0,5	0,1
	Total installed power, kW		<b>859</b>		
	Total consumed electric energy, kWh per day				<b>9974</b>
	Total consumed power, kW				<b>416</b>

### Biogas upgrading plant

Name equipment	Instal. Pow. (kW)	Q-y (pcs)	Total installed power (kW)	Working hours per day	Consumption kWh per day
Biogas upgrading plant	581,0	1	583,0	24,0	13992,0
Compressor module 50bar	306,0	1	307,0	25,0	7675,0
	Total installed power, kW		<b>890,0</b>		
	Total consumed electric energy, kWh per day				<b>21667</b>
	Total consumed power, kW				<b>903</b>
	Total average consumed electric power, kW				<b>1318</b>

**Equipment price**

Pos.	Description	Quantity	Unit Price, EUR	Total Price, EUR
1	Steel enamel tank (Digester) V=8204 m <sup>3</sup>	3	750 000,00	2 250 000,00
2	Accessories for the reactor (stainless steel roof, gas relief valves, flanges, foam valves, profiles for thermal insulation, platforms, stair-cases, manholes, windows)	3	180 000,00	540 000,00
3	Steel enamel tank ( filtrate tank) V=252m <sup>3</sup>	1	90 200,00	90 200,00
4	Solid feeder 100 m <sup>3</sup>	3	180 000,00	540 000,00
5	Horizontal screw	3	30 000,00	90 000,00
6	BIO-MIX pump unit 60 kW	3	75 000,00	225 000,00
7	Substrate supply pump to BIO-MIX unit N= 30 kW	3	65 000,00	195 000,00
8	Digester Vertical mixer 37kW	3	145 000,00	435 000,00
9	Side mixer (filtrate tanks) 6 kW	1	25 800,00	25 800,00
10	Gas-Holder V=2000 m <sup>3</sup>	1	125 000,00	125 000,00
11	Over- and underpressure safeguard	3	4 200,00	12 600,00
12	Sight glasses/viewing windows with projector	3	4 900,00	14 700,00
13	Heat-Exchanger	3	97 000,00	291 000,00
14	Substrate supply pump to Heat-Exchanger unit N=15,0 kW	3	23 000,00	69 000,00
15	Substrate separation unit 7,5 kW	3	48 000,00	144 000,00
16	Substrate supply pump to separator unit N= 11,0 kW	3	21 200,00	63 600,00
17	Filtrate pump unit N=15,0 kW	1	23 000,00	23 000,00
18	Biogas burner 4300 m <sup>3</sup> /hour	1	175 000,00	175 000,00
19	Biogas cooling system 2150 m <sup>3</sup> /hour	2	132 000,00	264 000,00
20	Desulphurization column with active carbon 1000 kg	2	28 800,00	57 600,00
21	Biogas blower 4300 m <sup>3</sup> /hour	2	52 500,00	105 000,00
22	Gas conditioning unit 4300 m <sup>3</sup> /hour	1	29 800,00	29 800,00
23	Heat supply station, as a unit, knocked-down.	1	54 500,00	54 500,00
24	Motorized valves (set)	21	5 600,00	117 600,00
25	Automatic with electric equipment, as a unit	1	350 000,00	350 000,00
26	Sensors (set)	1	100 000,00	100 000,00
27	Water supply and canalization system, as a unit.	1	43 100,00	43 100,00
28	Dry-cooler, as a unit.	3	12 300,00	36 900,00
29	Gas analyzer	1	25 700,00	25 700,00
<b>TOTAL (EXW, MEMMINGEN GERMANY): Six million four hundred ninety three thousand one hundred Euro 00 eurocents</b>				<b>6 493 100,00</b>

## Price

Name	Price (EXW, Memmingen)
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➤ Project documentation	127 000 Euro
➤ Supervision	70 000 Euro
➤ Start-up, training	70 000 Euro
➤ Biogas upgrading plant (1x3800 m <sup>3</sup> /h)	4 900 000 Euro
➤ Compressor station 50 bar	400 000 Euro
➤ THT odorization and gas metering devices	50 000 Euro
➤ Equipment	6 493 100 Euro
➤ Delivery in EU (80 trucks x 2800 EUR)	224 000 Euro
➤ Construction and installation *	3 000 000 Euro
➤ Laboratory	25 000 Euro
➤ Co-generator 1500 kW	670 000 Euro
➤ Silo 240 000 m <sup>3</sup>	3 000 000 Euro

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<b>Total</b>	<b>19 029 100 Euro</b>
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\* includes: gas pipelines (stainless steel); substrate pipes (stainless steel); heating lines; cables; reactor insulation and decorative cladding; foundations for loaders, torch, separators` area; heating point; metal structure of the separator; installation of equipment; rental of equipment.



## Implementation terms and payment

Months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Project documentation	50%				50%														
Approvals and permissions (by customer)																			
Equipment supply					50%			20%		20%		10%							
CHP unit					30%								70%						
BUP unit					30%								70%						
Construction																			
Supervision					50%										50%				
Plant start-up																	50%	50%	

## Contracts

Project implementation is executed simultaneously under several contracts

- Engineering contract
- Equipment supply contract
- Supervision contract
- Start-up and training contract

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