

**01**

version

# Proposal

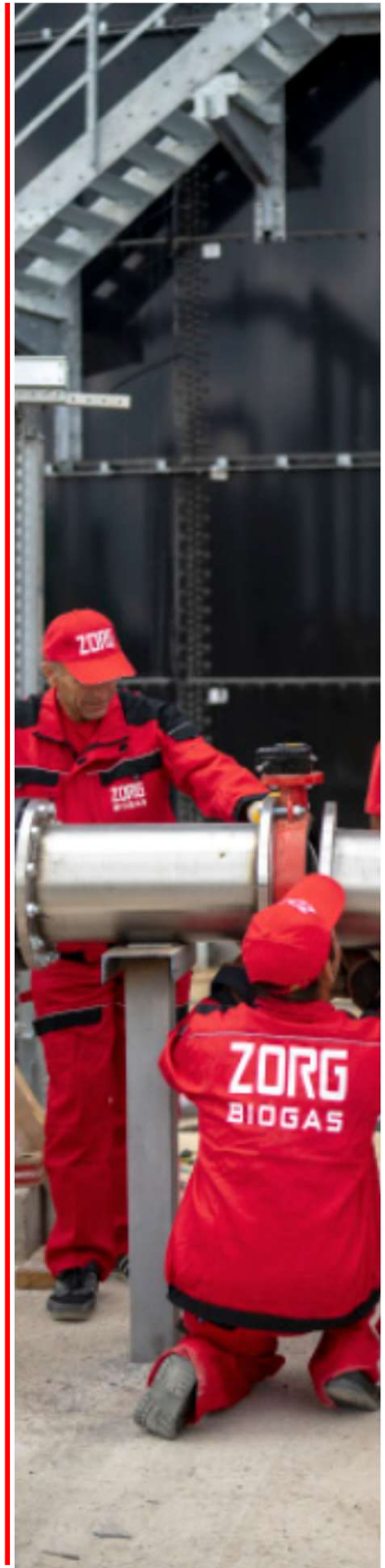
Biogas plant 780 t silaged pressed sugar beet  
pulp per day

Electrical power -12,6MW



Date: 02/10/2026

Validity: 12 months



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## OVERVIEW

Zorg Biogas proposes an integrated plant processing 780 tonnes of silaged pressed sugar beet pulp per day. Three vertical steel CSTR digesters with central agitators provide controlled mixing and temperature regulation. A downstream post-digester extends biological conversion and collects gas beneath a double-membrane roof.

The feedstock balance gives 138,575 m<sup>3</sup> of biogas per day. Seven containerised CHP units, each rated at 2,000 kW, provide 14,000 kW of installed electrical capacity. At the stated feedstock supply, the project gross output remains 12,645 kW of electricity and 11,902 kW of heat. The additional installed capacity provides operating headroom; it does not increase the gas yield.

Biological gas cleaning uses three scrubbers rated at 2,200 m<sup>3</sup>/h each. Air is supplied to the scrubbers at 10% of the raw biogas volume. Cooling, compression and activated carbon filtration prepare the gas for the engines. Iron hydroxide dosing is eliminated, while micronutrient dosing to the digestion process is 15 litres per day.

Digestate separation produces solid and liquid fractions for managed nutrient recovery. Process monitoring, a laboratory and automatic controls support stable operation and provide access to operating data and alarms.

Zorg supplies detailed engineering, process equipment, construction supervision, commissioning and operator training. The customer carries out civil works and installation under Zorg's technical supervision.

Using the pulp for biogas production can reduce fossil fuel use and the carbon footprint of sugar production. Any claim concerning verified emission reductions is established through a project-specific assessment.

## Raw material potential

| Substrate                          | Quantity<br>(tonnes/day) | Quantity<br>(tonnes/year) | DM content:<br>(%) | ODM<br>content<br>(%) | DM quantity<br>(tonne s/ day) | ODM quantity<br>(tonnes / day) | Biogas yield<br>(m <sup>3</sup> / tonneODM) | Biogas<br>(m <sup>3</sup> /day) | Methane<br>content<br>(%) | Electrical<br>power<br>(kW) |
|------------------------------------|--------------------------|---------------------------|--------------------|-----------------------|-------------------------------|--------------------------------|---------------------------------------------|---------------------------------|---------------------------|-----------------------------|
| Silaged pressed<br>sugar beet pulp | 780                      | 284 700                   | 27                 | 94                    | 210,6                         | 197,96                         | 700                                         | 138 575                         | 58                        | 12645                       |

\*-DM- Dry matter

\*\*-ODM- organic dry matter

## Biogas plant characteristics

| Characteristics                      | Values               | Figures |
|--------------------------------------|----------------------|---------|
| Number of reactors (vCTR)            | units                | 3       |
| Volume:                              |                      |         |
| Work                                 | m <sup>3</sup>       | 7092    |
| Overall                              |                      | 7422    |
| Temperature                          | °C                   | 48      |
| Overall dimensions of the digester:  |                      |         |
| diameter                             | m                    | 22,9    |
| height                               |                      | 18,0    |
| Organic load                         | kgODM/m <sup>3</sup> | 8,4     |
| Hydraulic retention time (gross/net) | days                 | 28/27   |
| Number of gasholders                 | units                | 0       |
| Postdigester                         | units                | 1       |
| Volume:                              |                      |         |
| Work                                 | m <sup>3</sup>       | 4620    |
| Overall                              |                      | 5082    |
| Temperature                          | °C                   | 46      |
| Overall dimensions of the digester:  |                      |         |
| diameter                             | m                    | 31,3    |
| height                               |                      | 6,6     |
| Organic load                         | kgODM/m <sup>3</sup> | 4,3     |
| Hydraulic retention time (gross/net) | days                 | 8/6     |
| Number of gasholders                 | units                | 1       |
| Volume:                              | m <sup>3</sup>       | 2047    |
| Dimensions of the gasholder:         |                      |         |
| diameter                             | m                    | 32,0    |
| height                               |                      | 6,4     |

### Number of personnel

|                | Shift 1 | Shift 2 | Shift 3 |
|----------------|---------|---------|---------|
| Chief Engineer | 1       | -       | -       |
| Manager        | 1       | -       | -       |
| Operator       | 1       | 1       | 1       |
| Driver         | 1       | 1       | -       |
| Electrician    | 1       | -       | -       |
| Mechanic       | 1       | -       | -       |
| Total          | 9       |         |         |



## 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 +  $H_2O \rightarrow C_5H_7NO_2 + HCO_3$ .

Further conversion of obtained dissolved compounds like organic acids and alcohols ( $C_5H_7NO_2, HCO_3$ ) into gases -  $CH_4, CO_2$ .  $C_5H_7NO_2 + HCO_3 + H_2O \rightarrow CH_4 + CO_2 + NH_4$ .

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 dioxide, and free hydrogen. The

other part of the organic compound including acetate forms C1 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  $CH_4$ , water  $H_2O$  and carbon dioxide  $CO_2$ . 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

The silage pressed sugar beet pulp is directed into a central loader, from where the silage is distributed to reactors' solid feeders by a conveyor line. The solid feeder is installed next to each of the reactors and loads the substrate by portions with augers sets.

In the reactors the substrate is brought up to a temperature of +48°C. The constant temperature is sustained for the entire digesting period. To prevent a rise in temperature the biogas plant is equipped with coolers (dry cooling). The reactors' operating regime is thermophilic. The heated substrate in the digesters is blended periodically. Mixing is performed by a central vertical agitator. The average retention time in the reactor is 28 days. After the reactor, the substrate is fed to a postdigester tank. The postdigester is used to extract remaining energy from organic matter and safely store the material before utilization. The postdigester tank equipped with gasholder roof to collect produced biogas. The substrate after post digester tank is supplied to a separation area, where it is separated into solid and liquid bio-fertilizer. Solid bio-fertilizer is discharged and transported for storage; liquid filtrate is directed to the technological needs (dilution).

Biogas goes up under overlaps of the reactors and delivered into a gasholder through pipeline. The gasholder system has a two-layer construction. The gas holder's weather protective film protects the gasholder from precipitation and damage by foreign objects. To protect the gasholder from

The gasholder is protected against excessive and negative pressure by dedicated safety devices.

Collected biogas passes through the first blower, which supplies the biological scrubbers at 50 mbar. Three scrubbers operate in parallel, each rated at 2,200 m<sup>3</sup>/h.

Process air is supplied at 10% of the raw biogas volume. The total scrubber micronutrient dose is 30 kg/day. Acidic water from the scrubber liquid circuit returns to the digesters. No iron hydroxide is added. Digester microelements are dosed separately at 15 litres/day.

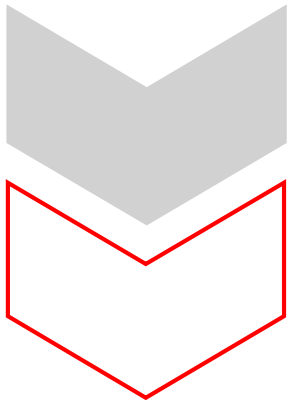
The scrubber outlet pressure is 45 mbar and the specified H<sub>2</sub>S concentration is 100 ppm. Gas is cooled and condensate is removed before the second blower raises its pressure to 200 mbar.

Two activated carbon filters polish the gas to a specified H<sub>2</sub>S outlet concentration of 0 ppm. Their pressure drop is 5 mbar, leaving 195 mbar at the CHP gas inlet.

Seven CHP units, each rated at 2,000 kW, produce electricity and recoverable heat. The project energy output is determined by the available biogas.

Plant automation monitors process measurements, equipment status and alarms. The central control system supports automatic and manual operation.

# MAIN EQUIPMENT





## Central solid feeder (SF-04)

Solid feeder machines have been proven in various situations. Solid feeder has the solid design, which guarantees a maximum functionality and less maintenance, combined to a low energy consumption. Because of the vertically oriented walls, there is no change for the material to get stuck or build bridges. The conveyor chains and the milling-unit allow continuous dosing by various types of materials. Furthermore, the material is loosened by this dosing process. The user is able to control the material flow up to 20m<sup>3</sup>/h or more, regarding to the own consumption of electrical power by the machine. In addition, the corrosion protection, wear resistance and high quality allow customers to use our product for a long period of time.

### Specifications

---

|           |                    |
|-----------|--------------------|
| Height:   | 3,2 m              |
| Length:   | 18,0 m             |
| Width:    | 3,6 m              |
| Volume:   | 200 m <sup>3</sup> |
| Quantity: | 1 pcs.             |



## Reactors` solid feeder (SF-01 ... SF-03)

Solid feeder machines have been proven in various situations. Solid feeder has the solid design, which guarantees a maximum functionality and less maintenance, combined to a low energy consumption. Because of the vertically oriented walls, there is no change for the material to get stuck or build bridges. The conveyor chains and the milling-unit allow continuous dosing by various types of materials. Furthermore, the material is loosened by this dosing process.

### Specifications

---

|           |                   |
|-----------|-------------------|
| Height:   | 2,6 m             |
| Length:   | 7,0 m             |
| Width:    | 2,8 m             |
| Volume:   | 30 m <sup>3</sup> |
| Quantity: | 3 pcs.            |



## Receiving tank and filtrate tank

Reservoir for reception of liquid kinds of raw materials. Tank is equipped with level sensors and side agitators for mixing raw materials. Tanks serve as a buffer for collection substrates and then to supply substrates to points of biogas plant according the technological process.

### Specifications

#### Receiving tank

|           |                    |
|-----------|--------------------|
| Diameter: | 8,4 m              |
| Height:   | 3,0 m              |
| Volume:   | 166 m <sup>3</sup> |
| Quantity: | 1 pcs.             |

#### Filtrate tank

|           |                    |
|-----------|--------------------|
| Diameter: | 8,4 m              |
| Height:   | 3,0 m              |
| Volume:   | 166 m <sup>3</sup> |
| Quantity: | 1 pcs.             |

Plates (tank wall enameled, roof)  
 Flange, nozzle, lap joint flanges outside  
 Control glass  
 Ex light  
 Manhole  
 Ladder, stair and walkway  
 Brackets and clamps for pipe along tank edge  
 (internal/external)



## Side agitator (AG-04...AG-09)

Side mixers are used in biogas reactors and receiving tanks for mixing medium and low viscosity substrates. 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. Suitable for use in aggressive environments with a dry matter content of up to 11 %. The special design of the shovel-like blades works good both with mixing different types of substrates and breaking up floating layers and crust.

### Specifications

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#### Receiving tank:

|                    |        |
|--------------------|--------|
| Engine power:      | 7,5 kW |
| Quantity per tank: | 1 pcs  |
| Quantity total:    | 1 pcs  |

#### Filtrate tank:

|                    |        |
|--------------------|--------|
| Engine power:      | 5,5 kW |
| Quantity per tank: | 1 pcs  |
| Quantity total:    | 1 pcs  |

#### Post-Digester tank:

|                    |       |
|--------------------|-------|
| Engine power:      | 15 kW |
| Quantity per tank: | 4 pcs |
| Quantity total:    | 4 pcs |



## Reactor (RT-01...RT-03)

Reactor is an important part of a biogas plant made of enameled sheet metal. The steel 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. Enameled digester assembled from steel segments. Such a digester is quickly and safely mounted. 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 smooth

## Specifications

|                         |                           |
|-------------------------|---------------------------|
| <b>Height:</b>          | <b>18,0 m</b>             |
| <b>Diameter:</b>        | <b>22,92 m</b>            |
| <b>Total volume:</b>    | <b>7422 m<sup>3</sup></b> |
| <b>Substrate volume</b> | <b>7092 m<sup>3</sup></b> |
| <b>Quantity:</b>        | <b>3 pcs.</b>             |

Plates (tank wall enameled, roof)  
 Flange, nozzle, lap joint flanges outside  
 2 off control glass 2 x DN 250 with water flush  
 Ex light  
 Manhole  
 Ladder, stair and walkway  
 Brackets and clamps for pipe along tank edge  
 (internal/external)



## Reactor central vertical agitator (AG-01 ... AG-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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Engine power: 37 kW

Quantity per reactor: 1 pcs

Total quantity: 3 pcs



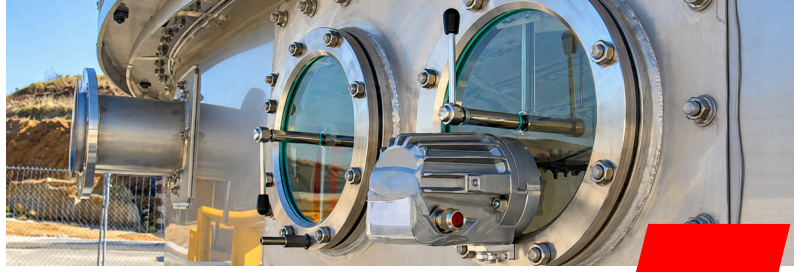
## Post-Digester (D-01)

The steel post-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. Enameled digester assembled from steel segments. Such a digester is quickly and safely mounted. 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

|                         |                           |
|-------------------------|---------------------------|
| <b>Height:</b>          | <b>6,0 m</b>              |
| <b>Diameter:</b>        | <b>31,32 m</b>            |
| <b>Total volume:</b>    | <b>5082 m<sup>3</sup></b> |
| <b>Substrate volume</b> | <b>4620 m<sup>3</sup></b> |
| <b>Quantity:</b>        | <b>1 pcs.</b>             |

Plates (tank wall enameled, roof)  
 Flange, nozzle, lap joint flanges outside  
 2 off control glass 2 x DN 250 with water flush  
 Ex light  
 Manhole  
 Ladder, stair and walkway  
 Brackets and clamps for pipe along tank edge  
 (internal/external)



## Window with spotlight (SG-01)

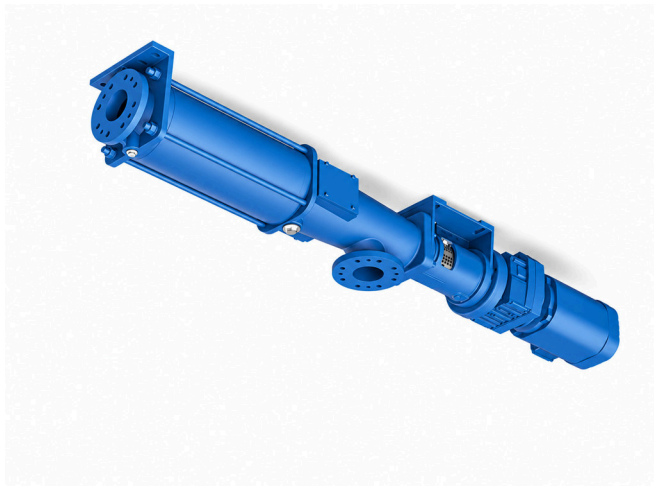
Inspection windows are designed for visual control of processes inside the fermenter. Spotlights were made in explosion-proof with automatic disconnection. Inspection windows are equipped with a cleaning washing system.

### Specifications

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Inspection windows: Ø300

Spotligh:  
VISULUX UL50 -G -H 230V, 50W, IP65



## Pump equipment

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, robust 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

---

#### Substrate feed pump

|               |            |
|---------------|------------|
| Engine power: | 11 kW      |
| Flow rate:    | 50 m3/hour |
| Pressure:     | 4 bar      |
| Quantity:     | 1 pcs      |

#### Substrate circulation pump

|               |            |
|---------------|------------|
| Engine power: | 11 kW      |
| Flow rate:    | 40 m3/hour |
| Pressure:     | 4 bar      |
| Quantity:     | 3 pcs      |

#### Substrate pump

|               |            |
|---------------|------------|
| Engine power: | 11 kW      |
| Flow rate:    | 40 m3/hour |
| Pressure:     | 4 bar      |
| Quantity:     | 3 pcs      |

#### Discharge pump

|               |            |
|---------------|------------|
| Engine power: | 11 kW      |
| Flow rate:    | 60 m3/hour |
| Pressure:     | 4 bar      |
| Quantity:     | 3 pcs      |

#### Filtrate pump

|               |            |
|---------------|------------|
| Engine power: | 18 kW      |
| Flow rate:    | 60 m3/hour |
| Pressure:     | 4 bar      |
| Quantity:     | 2 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 PELD (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 handmade 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

|                           |                           |
|---------------------------|---------------------------|
| <b>Height:</b>            | <b>13,2m</b>              |
| <b>Diameter:</b>          | <b>32,0 m</b>             |
| <b>The total volume :</b> | <b>2047 m<sup>3</sup></b> |
| <b>Quantity:</b>          | <b>1 pcs</b>              |



## Biological biogas scrubbers (SC-01...SC-03)

Three biological scrubbers remove hydrogen sulphide from the collected biogas before cooling and activated carbon polishing. The parallel vessels provide a combined treatment capacity of 6,600 m<sup>3</sup>/h.

Biogas contacts recirculating liquid and an active biofilm. Controlled air addition supports biological conversion of sulphur compounds. Air is supplied to the scrubbers, not to the digesters. The liquid circulation, gas distribution and operating measurements are integrated with the plant control system.

### Specifications

|                                   |                         |
|-----------------------------------|-------------------------|
| Gas capacity, each                | 2,200 m <sup>3</sup> /h |
| Quantity                          | 3 units                 |
| Combined capacity                 | 6,600 m <sup>3</sup> /h |
| Air supply                        | 10% of raw biogas flow  |
| Specified H <sub>2</sub> S outlet | 100 ppm                 |
| Pressure drop                     | 5 mbar                  |
| Scrubber micronutrients           | 30 kg/day total         |

Acidic water from the scrubber circuit returns to the digesters.



## Biogas drying and cooling (CHL-01, CHL-02)

Biogas drying 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 AD Merkblätter and factory pressure test.

## Specifications

---

|                         |                           |
|-------------------------|---------------------------|
| Gas volume flow:        | 3200 m <sup>3</sup> /hour |
| Gas inlet temperature:  | +55°C                     |
| Gas outlet temperature: | +20°C                     |
| Electric power:         | 61.6 kW                   |
| Quantity:               | 2 pcs                     |



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

### Biogas blowers (BC-01, BC-02)

Two biogas blowers are arranged in series. The first blower supplies gas to the biological scrubbers at 50 mbar. After scrubbing and cooling, the second blower raises the pressure to 200 mbar for activated carbon filtration and delivery to the CHP units.

Each blower is specified for 6,600 m<sup>3</sup>/h. Speed control adjusts delivery to operating demand.

### Specifications

|                          |                         |
|--------------------------|-------------------------|
| Gas capacity, each       | 6,600 m <sup>3</sup> /h |
| BC-01 discharge pressure | 50 mbar                 |
| BC-01 electrical load    | 18.5 kW                 |
| BC-02 discharge pressure | 200 mbar                |
| BC-02 electrical load    | 66 kW                   |
| Quantity                 | 2 units in series       |



## Activated Carbon Filter (CF-01, CF-02)

The activated carbon filters provide final polishing after biological scrubbing, cooling and compression. Their porous media adsorb residual hydrogen sulphide before the gas reaches the CHP units.

The specified H<sub>2</sub>S concentration is 100 ppm upstream of the filters and 0 ppm downstream. A 5 mbar pressure drop reduces the gas pressure from 200 to 195 mbar. Gas analysis is used to monitor filter performance and determine when the carbon charge requires replacement.

Two parallel filter vessels provide the required flow capacity.

## Specifications

|                                   |                         |
|-----------------------------------|-------------------------|
| Gas flow, each                    | 3,200 m <sup>3</sup> /h |
| Activated carbon, each            | 1,000 kg                |
| Pressure drop                     | 5 mbar                  |
| Gas outlet pressure               | 195 mbar                |
| Specified H <sub>2</sub> S outlet | 0 ppm                   |
| Quantity                          | 2 units                 |



## Gas analyzer (CH<sub>4</sub>, CO<sub>2</sub>, H<sub>2</sub>S) (GA-01)

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

Quantity: 1 pcs

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



## Flare (BF-01)

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

---

**Flow rate:**

**6600 m<sup>3</sup>/hour**

**Pressure:**

**min 10 mbar-**

**max 60 mbar**

**Quantity:**

**2 pcs**



## CHP generation - 7 x 2,000 kW

Seven containerised 2020 V20 CHP units convert conditioned biogas into electricity and recoverable heat. Each package includes the gas engine, generator, controls, ventilation and cooling equipment. Heat recovery connects to the plant heating circuits.

The installed electrical capacity is 14 MW. The project energy balance remains governed by the available biogas: 12,645 kW gross electrical output and 11,902 kW gross thermal output.

### Specifications

|                                     |                    |
|-------------------------------------|--------------------|
| Engine model                        | 2020 V20           |
| Electrical rating, each             | 2,000 kW           |
| Number of units                     | 7                  |
| Total installed electrical capacity | 14,000 kW          |
| Rated speed / frequency             | 1,500 rpm / 50 Hz  |
| Cylinders / displacement            | V20 / 88.5 litres  |
| Gas pressure at CHP inlet           | 195 mbar           |
| Fuel                                | Conditioned biogas |

## CHP container and engine compartment



Container exterior, cooling and ventilation equipment



Engine compartment and service access

The container protects the equipment and provides ventilation and access for inspection and maintenance. The engine and generator are mounted on a common base, with service connections arranged within the enclosure.

Automatic controls manage operation, electrical protection, alarms and communication with the plant control system. The photographs show typical container arrangements.

## 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

---

**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**



## 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 heat carrier

|               |                         |
|---------------|-------------------------|
| Engine power: | 2,0 kW                  |
| Flow:         | 20 m <sup>3</sup> /hour |
| Pressure:     | 1 bar                   |

### Circulating pump feeding heat carrier

|               |                        |
|---------------|------------------------|
| Engine power: | 0,8 kW                 |
| Flow:         | 3 m <sup>3</sup> /hour |
| Pressure:     | 1 bar                  |

### The pumping station feeding propylene glycol

|               |                        |
|---------------|------------------------|
| Engine power: | 0,8 kW                 |
| Flow:         | 1 m <sup>3</sup> /hour |
| Pressure:     | 4 bar                  |



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

As of today, the design of dismountable plate heat exchangers is the most advanced in the field of solving heat exchange problems. Dismountable plate heat exchangers with thermal capacities ranging from 5 kW to 30 MW can be implemented for various technological processes.

The collapsible plate heat exchanger consists of a frame and a set of heat transfer plates. The frame of the heat exchanger consists of movable and fixed plates, upper and lower guides and a rear stand. All heat exchanger plates in the package are identical in size, but are rotated 180 degrees relative to each other. This arrangement ensures alternating hot and cold channels. During the heat exchange process, the working fluids move towards each other (counter currently). The hot medium transfers heat through the plate wall. There are dozens of plate sizes available for the collapsible heat exchanger. And for each plate size, there are several corrugations. The combination of plates with different reliefs (corrugations) increases the number of possible combinations of heat exchange channels. All of this makes it possible to model a plate heat exchanger that is as close as possible to the specified power and losses.

### Specifications

---

Volumetric capacity  
Temperature  
Working pressure

5 to 100 m<sup>3</sup>/h  
up to 90°C  
at 4 bar

Capacity of the heat exchanger for substrate  
Quantity:

600 kW  
3 pcs



## Dry cooler (cooling substrate system)

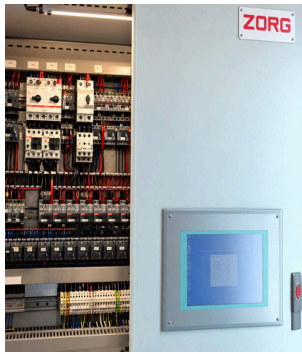
Device is designed to cool the substrate to working temperature according to technological regime. When use high temperature substrate, there is a chance of uncontrolled heating. The cooler is connected to the heating pipes, heat exchangers and it will be activated if it is need.

### Specifications

---

#### Substrate in reactors

|                 |        |
|-----------------|--------|
| Heat power:     | 100 kW |
| Electric power: | 4 kW   |
| 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**



## Sensors set

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

## Specifications

---

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

---

Analytical scales

Moisture analyzer

Automatic titrator

Laboratory pH meter

Centrifuge

A set of flasks

# Equipment specification list



| Nº        | Equipment                                             | Characteristic               | Quantity |
|-----------|-------------------------------------------------------|------------------------------|----------|
| <b>1</b>  | <b>Side mixer</b>                                     | <b>N=7,5 kW</b>              | <b>1</b> |
| 1.1       | Airtight motor gearbox                                |                              | 1        |
| 1.2       | Hydraulic screw (wear-resistant steel)                |                              | 1        |
| 1.3       | Mixer control mechanism                               |                              | 1        |
| 1.4       | Electric motor mount                                  |                              | 1        |
| 1.5       | Set of fasteners                                      |                              | 1        |
| <b>2</b>  | <b>Side mixer</b>                                     | <b>N=5,5 kW</b>              | <b>1</b> |
| <b>3</b>  | <b>Reactor central vertical agitator</b>              | <b>N=37 kW</b>               | <b>3</b> |
| 3.1       | Airtight motor gearbox                                |                              | 3        |
| 3.2       | Hydraulic screw (wear-resistant steel)                |                              | 3        |
| 3.3       | Shaft (adapted to the height of the fermenter)        |                              | 3        |
| 3.4       | Blade                                                 |                              | 3        |
| 3.5       | Frequency converter                                   |                              | 3        |
| 3.6       | Mounting bracket to bottom of the mixer               |                              | 3        |
| <b>4</b>  | <b>Post-digester`s side mixer</b>                     | <b>N=15 kW</b>               | <b>4</b> |
| <b>5</b>  | <b>Safety valve of digesters</b>                      |                              | <b>4</b> |
| <b>6</b>  | <b>Window with a searchlight</b>                      | <b>set</b>                   | <b>4</b> |
| 6.1       | Inspection window RD300 (mounts and sealant included) | Ø300                         | 6        |
| 6.2       | Spotlight (mount system bundled) VISULUX UL50 -G -H   | 230V, 50W, IP65              | 3        |
| <b>7</b>  | <b>Substrate feed pump</b>                            | <b>40 m3/hour<br/>N=11kW</b> | <b>1</b> |
| <b>8</b>  | <b>Substrate digested pump</b>                        | <b>40 m3/hour<br/>N=11kW</b> | <b>3</b> |
| <b>7</b>  | <b>Substrate circulation pump</b>                     | <b>40 m3/hour<br/>N=11kW</b> | <b>3</b> |
| <b>9</b>  | <b>Discharge pump</b>                                 | <b>40 m3/hour<br/>N=11kW</b> | <b>3</b> |
| <b>10</b> | <b>Filtrate pump</b>                                  | <b>60 m3/hour<br/>N=18kW</b> | <b>2</b> |
| <b>11</b> | <b>PVC gas holder</b>                                 | <b>2047 m3</b>               | <b>1</b> |

| Nº   | Equipment                          | Characteristic                 | Quantity |
|------|------------------------------------|--------------------------------|----------|
| 11.1 | Weather protection membrane        | Ø32 m                          | 1        |
| 11.2 | Gas membrane, PELD                 | CH4-resistant                  | 1        |
| 11.3 | Membrane support air blower        | 0.5 kW                         | 1        |
| 11.4 | Over- and under-pressure safeguard |                                | 1        |
| 11.5 | Dome level sensor                  |                                | 1        |
| 11.6 | Mounting system                    |                                | 1        |
| 11.7 | Gasholder accessories              | set                            | 1        |
| 11.8 | Safety valve                       |                                | 1        |
| 12   | Biogas cooling systems             | 3,200 m³/h each                | 2        |
| 12.1 | Chiller                            | 61.6 kW each                   | 2        |
| 12.2 | Gas heat exchanger                 |                                | 2        |
| 12.3 | Propylene glycol tank              |                                | 2        |
| 12.4 | Biological scrubbers               | 2,200 m³/h each                | 3        |
| 13   | Activated Carbon Filter            | 3,200 m³/h; 1,000 kg           | 2        |
| 14.1 | Biogas booster BC-01               | 6,600 m³/h; 50 mbar<br>18.5 kW | 1        |
| 14.2 | Biogas compressor BC-02            | 6,600 m³/h; 200 mbar<br>66 kW  | 1        |
| 15   | Electromagnetic gas flow meter     |                                | 1        |
| 16   | Biogas flare                       | 6,600 m³/h each                | 2        |
| 17   | Gas analyser                       | set                            | 1        |
| 18   | Gas piping and accessories         | set                            | 1        |
| 18.1 | Drainage pump with float           | DN50; 1 m³/h; 13 m             | 2        |
| 19   | CHP 2020 V20                       | 2,000 kW each                  | 7        |
| 20   | Heat supply system                 | set                            | 1        |
| 20.1 | Diaphragm expansion tank           | 1,000 l; 6 bar; 120°C          | 1        |
| 20.2 | Heating circulation pump           | 30 m³/h; 1 bar                 | 2        |
| 20.3 | Propylene glycol feed pump         | 1 m³/h; 4 bar                  | 1        |
| 20.4 | Digester heat circulation pump     | 18 m³/h; 1.1 bar               | 4        |
| 20.5 | Plate heat exchanger               | 600 kW                         | 3        |

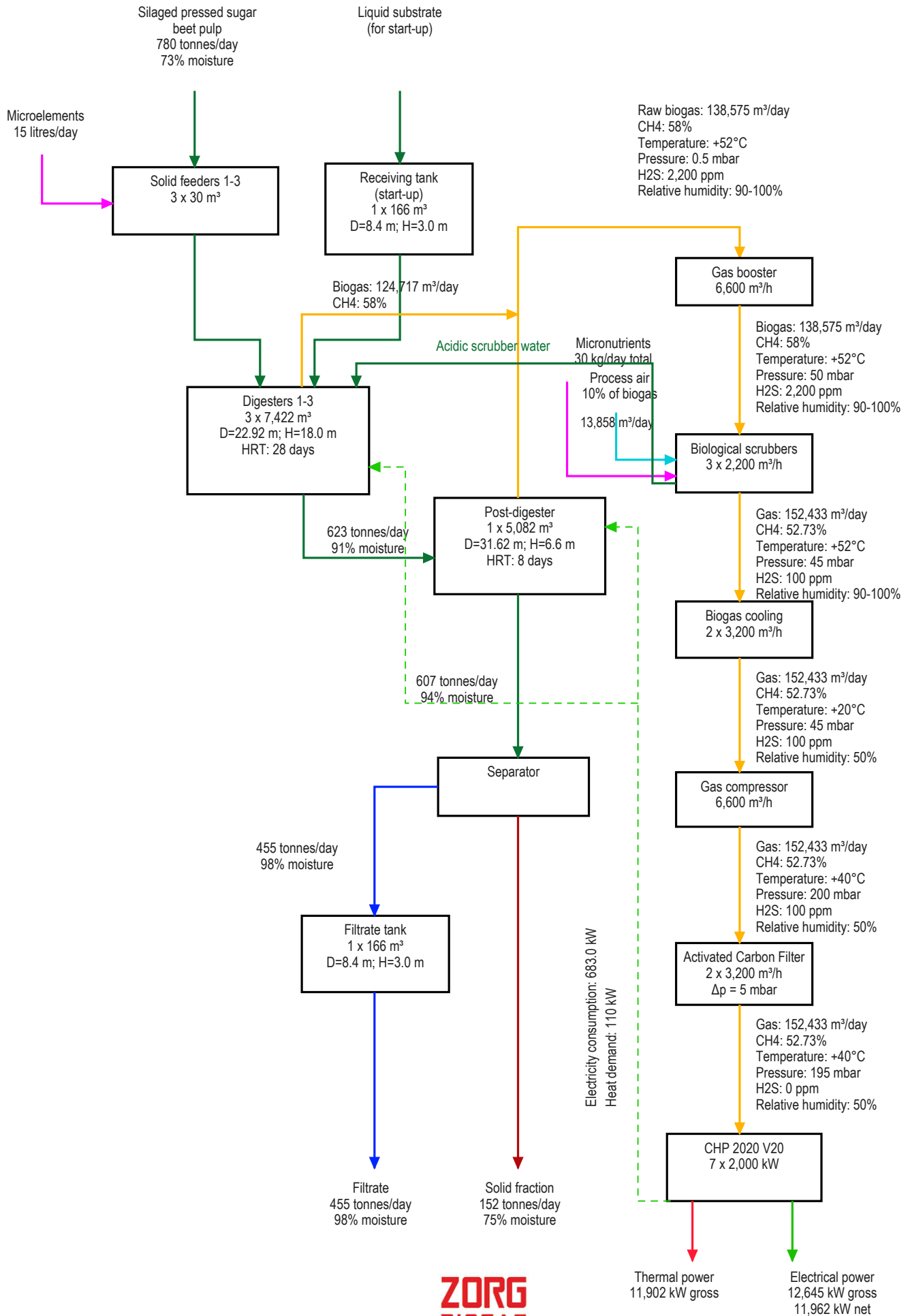
| Nº        | Equipment                                                                    | Characteristic             | Quantity |
|-----------|------------------------------------------------------------------------------|----------------------------|----------|
| <b>21</b> | <b>Water supply and sewerage system, complete, disassembled</b>              | <b>set</b>                 | <b>1</b> |
| <b>22</b> | <b>Automation with electrical equipment</b>                                  | <b>set</b>                 | <b>1</b> |
| 22.1      | Incoming distribution cabinet with a set of automation DB-1                  |                            | 1        |
| 22.2      | Incoming distribution cabinet with a set of automation DB-2                  |                            | 1        |
| <b>23</b> | <b>Sensors, set</b>                                                          |                            | <b>1</b> |
| 23.1      | Gas pressure sensor 0,025Bar                                                 |                            | 3        |
| 23.2      | Gas pressure sensor 0,4Bar                                                   |                            | 2        |
| 23.3      | Pressure sensor(substrate level) 1,0Bar                                      |                            | 7        |
| 23.4      | Pressure sensor (substrate pressure) 2,5bar                                  |                            | 7        |
| 23.5      | Resistive thermometer (gas temperature)                                      |                            | 4        |
| 23.6      | Resistive thermometer with thermo well (fermenter substrate temperature)     |                            | 4.       |
| 23.7      | Resistive thermometer with thermo-well (digester tank substrate temperature) |                            | 4        |
| 23.8      | Resistive thermometer (heat conductor temperature)                           |                            | 4        |
| 23.9      | Conductometric sensor of maximum level                                       |                            | 5        |
| 23.10     | Conductometric sensor of water level                                         |                            | 5        |
| 23.11     | Dome position sensor                                                         |                            | 1        |
| 23.12     | Coolant pressure sensor                                                      | SEN 3276 B065<br>G1/2 6Bar | 6        |
| <b>24</b> | <b>Dry cooler 100 kW heat pow.</b>                                           |                            | <b>3</b> |
| <b>25</b> | <b>Laboratory</b>                                                            | <b>set</b>                 | <b>1</b> |
| <b>26</b> | <b>Steel enamel tank</b>                                                     | <b>166 m3</b>              | <b>2</b> |
| <b>27</b> | <b>Steel enamel tank</b>                                                     | <b>7422 m3</b>             | <b>3</b> |
| <b>27</b> | <b>Steel enamel tank</b>                                                     | <b>5028 m3</b>             | <b>1</b> |

# APPENDICES



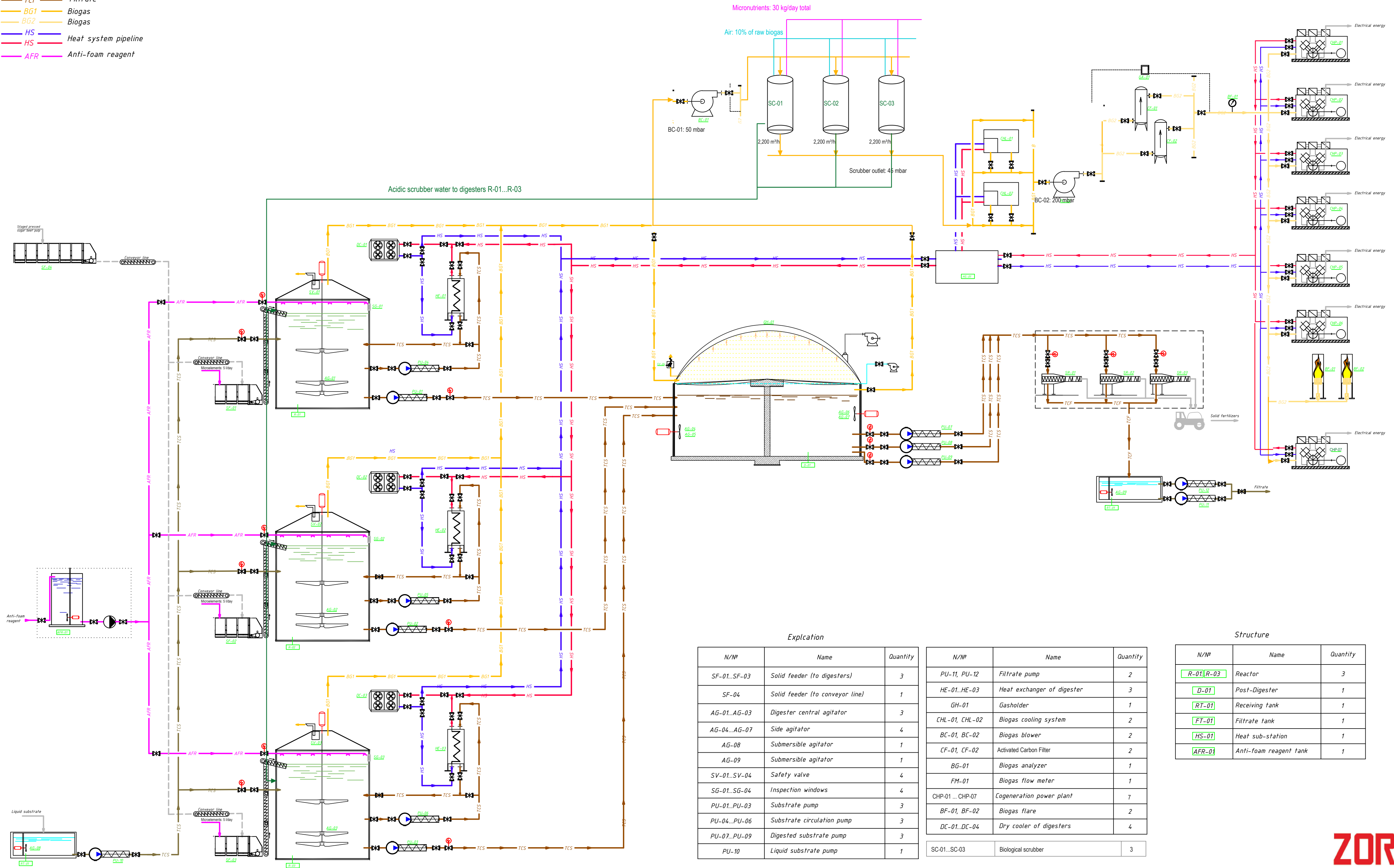
# Material flow diagram

Appendix 1



 *TCS*      Substrate  
 *TCF*      Filtrate  
 *BG1*      Biogas  
 *BG2*      Biogas  
 *HS*      Heat system pipeline  
 *HS*      Heat system pipeline  
 *AFR*      Anti-foam reagent

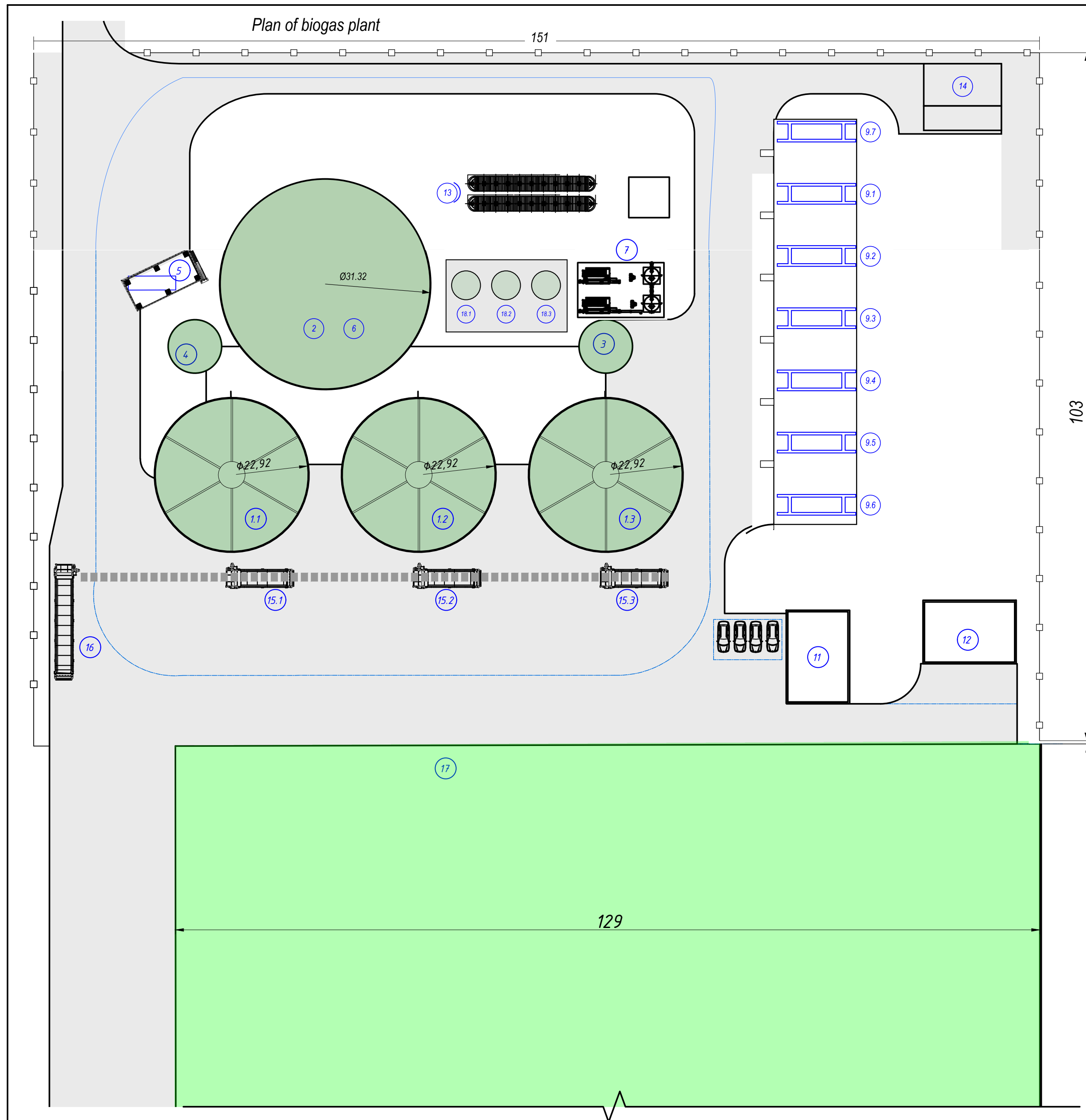
Micronutrients: 30 kg/day total



| <i>N/Nº</i>          | <i>Name</i>                            | <i>Quantity</i> |
|----------------------|----------------------------------------|-----------------|
| <i>SF-01...SF-03</i> | <i>Solid feeder (to digesters)</i>     | <i>3</i>        |
| <i>SF-04</i>         | <i>Solid feeder (to conveyor line)</i> | <i>1</i>        |
| <i>AG-01...AG-03</i> | <i>Digester central agitator</i>       | <i>3</i>        |
| <i>AG-04...AG-07</i> | <i>Side agitator</i>                   | <i>4</i>        |
| <i>AG-08</i>         | <i>Submersible agitator</i>            | <i>1</i>        |
| <i>AG-09</i>         | <i>Submersible agitator</i>            | <i>1</i>        |
| <i>SV-01...SV-04</i> | <i>Safety valve</i>                    | <i>4</i>        |
| <i>SG-01...SG-04</i> | <i>Inspection windows</i>              | <i>4</i>        |
| <i>PU-01...PU-03</i> | <i>Substrate pump</i>                  | <i>3</i>        |
| <i>PU-04...PU-06</i> | <i>Substrate circulation pump</i>      | <i>3</i>        |
| <i>PU-07...PU-09</i> | <i>Digested substrate pump</i>         | <i>3</i>        |
| <i>PU-10</i>         | <i>Liquid substrate pump</i>           | <i>1</i>        |

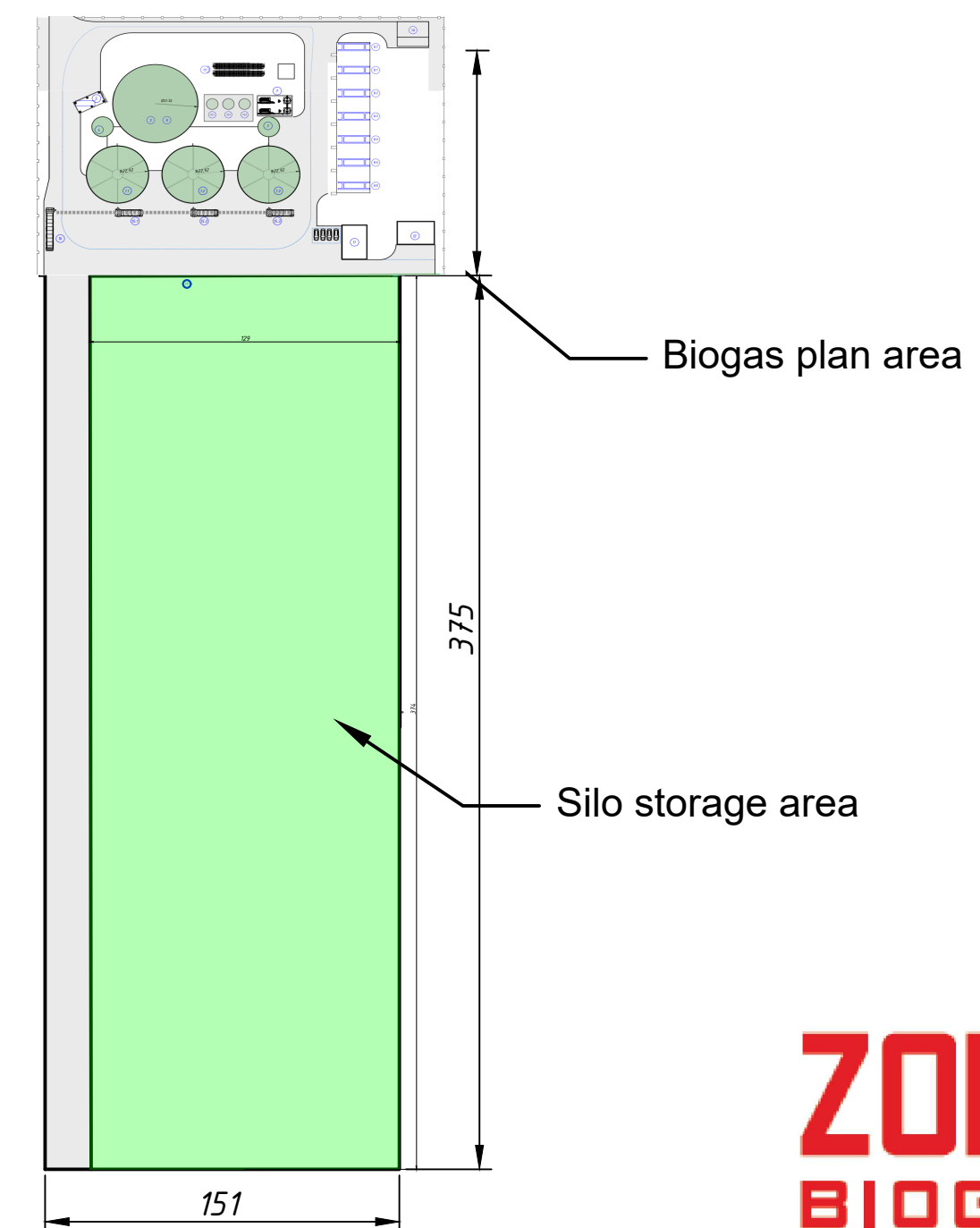
| <i>N/№</i>               | <i>Name</i>                       | <i>Quantity</i> |
|--------------------------|-----------------------------------|-----------------|
| <i>PU-11, PU-12</i>      | <i>Filtrate pump</i>              | <i>2</i>        |
| <i>HE-01...HE-03</i>     | <i>Heat exchanger of digester</i> | <i>3</i>        |
| <i>GH-01</i>             | <i>Gasholder</i>                  | <i>1</i>        |
| <i>CHL-01, CHL-02</i>    | <i>Biogas cooling system</i>      | <i>2</i>        |
| <i>BC-01, BC-02</i>      | <i>Biogas blower</i>              | <i>2</i>        |
| <i>CF-01, CF-02</i>      | <i>Activated Carbon Filter</i>    | <i>2</i>        |
| <i>BG-01</i>             | <i>Biogas analyzer</i>            | <i>1</i>        |
| <i>FM-01</i>             | <i>Biogas flow meter</i>          | <i>1</i>        |
| <i>CHP-01 ... CHP-07</i> | <i>Cogeneration power plant</i>   | <i>7</i>        |
| <i>BF-01, BF-02</i>      | <i>Biogas flare</i>               | <i>2</i>        |
| <i>DC-01...DC-04</i>     | <i>Dry cooler of digesters</i>    | <i>4</i>        |
| <i>SC-01...SC-03</i>     | <i>Biological scrubber</i>        | <i>3</i>        |

| N/Nº      | Name                   | Quantity |
|-----------|------------------------|----------|
| R-01/R-03 | Reactor                | 3        |
| D-01      | Post-Digester          | 1        |
| RT-01     | Receiving tank         | 1        |
| FT-01     | Filtrate tank          | 1        |
| HS-01     | Heat sub-station       | 1        |
| AFR-01    | Anti-foam reagent tank | 1        |



## Explication

| N/Nº          | Name                          | Note |
|---------------|-------------------------------|------|
| 1.1, 1.2, 1.3 | Reactor                       |      |
| 2             | Post-Digester                 |      |
| 3             | Receiving tank                |      |
| 4             | Filtrate tank                 |      |
| 5             | Separation area               |      |
| 6             | Gas holder                    |      |
| 7             | Biogas preparation area       |      |
| 8             | Biogas burner                 |      |
| 9.1...9.7     | CHP                           |      |
| 10            | Equipment room                |      |
| 11            | Technical room                |      |
| 12            | Warehouse                     |      |
| 13            | Fire water tank               |      |
| 14            | Transformer substation        |      |
| 15.1...15.3   | Solid feeder                  |      |
| 16            | Solid feeder to conveyor line |      |
| 17            | Silo storage                  |      |
| 18.1...18.3   | Biological scrubbers          |      |



#### Appendix 4

### Biogas plant - electrical power consumption

| Equipment                                          | Power per unit<br>kW | Quantity | Installed power<br>kW | Hours per day | Energy per day<br>kWh |
|----------------------------------------------------|----------------------|----------|-----------------------|---------------|-----------------------|
| Central solid feeder, 200 m³                       | 26                   | 1        | 26                    | 8             | 208.00                |
| Conveyor line                                      | 45                   | 1        | 45                    | 8             | 360.00                |
| Digester solid feeder, 30 m³                       | 22                   | 3        | 66                    | 8             | 528.00                |
| Screw conveyors                                    | 46                   | 3        | 138                   | 8             | 1,104.00              |
| Digester central agitator                          | 37                   | 3        | 111                   | 18            | 1,998.00              |
| Post-digester side agitator                        | 15                   | 4        | 60                    | 18            | 1,080.00              |
| Receiving tank mixer                               | 7.5                  | 1        | 7.5                   | 12            | 90.00                 |
| Filtrate tank mixer                                | 3                    | 1        | 3                     | 12            | 36.00                 |
| Biogas cooling system                              | 61.6                 | 2        | 123.2                 | 24            | 2,956.80              |
| Biogas booster, 50 mbar                            | 18.5                 | 1        | 18.5                  | 24            | 444.00                |
| Biogas compressor, 200 mbar                        | 66                   | 1        | 66                    | 24            | 1,584.00              |
| Biological scrubber package                        | 6                    | 3        | 18                    | 24            | 432.00                |
| Separator                                          | 7.5                  | 3        | 22.5                  | 8             | 180.00                |
| Substrate feed pump                                | 11                   | 1        | 11                    | 2             | 22.00                 |
| Substrate circulation pump                         | 11                   | 3        | 33                    | 12            | 396.00                |
| Substrate pump to digester                         | 11                   | 3        | 33                    | 3             | 99.00                 |
| Substrate pump to separator                        | 11                   | 3        | 33                    | 8             | 264.00                |
| Filtrate pump                                      | 18.5                 | 2        | 37                    | 4             | 148.00                |
| Gasholder lock air compressor                      | 1.5                  | 1        | 1.5                   | 1             | 1.50                  |
| Membrane support air blower                        | 1                    | 1        | 1                     | 24            | 24.00                 |
| Digester cooling system                            | 4                    | 4        | 16                    | 24            | 384.00                |
| Digester heating circulation pump                  | 0.8                  | 3        | 2.4                   | 24            | 57.60                 |
| Digester cooling circulation pump                  | 2                    | 6        | 12                    | 24            | 288.00                |
| Technical building heating pump                    | 0.1                  | 1        | 0.1                   | 24            | 2.40                  |
| Propylene glycol pump                              | 0.8                  | 1        | 0.8                   | 0.5           | 0.40                  |
| Drainage pump                                      | 1                    | 1        | 1                     | 0.5           | 0.50                  |
| Outdoor lighting                                   | 1                    | 1        | 1                     | 8             | 8.00                  |
| Inspection window lighting                         | 0.1                  | 1        | 0.1                   | 0.5           | 0.05                  |
| Switchboard lighting                               | 0.1                  | 1        | 0.1                   | 0.5           | 0.05                  |
| CHP auxiliaries                                    | 22                   | 7        | 154                   | 24            | 3,696.00              |
| <b>Total installed electrical power, kW</b>        |                      |          |                       |               | <b>1,041.7</b>        |
| <b>Total daily electrical consumption, kWh/day</b> |                      |          |                       |               | <b>16,392.3</b>       |
| <b>Average electrical consumption, kW</b>          |                      |          |                       |               | <b>683.0</b>          |

## Prices - biogas plant using 780 tonnes of sugar beet pulp per day

| No. | Equipment / services                                                                                         | Qty | Unit price, EUR | Subtotal, EUR    |
|-----|--------------------------------------------------------------------------------------------------------------|-----|-----------------|------------------|
| 1   | Detailed design                                                                                              | 1   | 87,500          | 87,500           |
| 2   | Supervision                                                                                                  | 1   | 56,000          | 56,000           |
| 3   | Startup and training                                                                                         | 1   | 56,000          | 56,000           |
| 4   | Living and travel expences                                                                                   | 1   | 42,000          | 42,000           |
| 5   | Delivery of the equipment                                                                                    | 85  | 8,000           | 680,000          |
| 6   | Laboratory                                                                                                   | 1   | 18,900          | 18,900           |
| 7   | Central solid feeder 200m3                                                                                   | 1   | 215,000         | 215,000          |
| 8   | Screw set                                                                                                    | 1   | 135,000         | 135,000          |
| 9   | Conveyor line                                                                                                | 1   | 245,000         | 245,000          |
| 10  | Solid feeder 30m3                                                                                            | 3   | 125,000         | 375,000          |
| 11  | Screw set                                                                                                    | 3   | 145,000         | 435,000          |
| 12  | Central agitator 37kW                                                                                        | 3   | 117,600         | 352,800          |
| 13  | Side agitator 7,5kW                                                                                          | 1   | 22,400          | 22,400           |
| 14  | Side agitator 7,5kW                                                                                          | 1   | 22,400          | 22,400           |
| 15  | Side agitator 15kW (post digester)                                                                           | 4   | 33,600          | 134,400          |
| 16  | Substrate feed pump 11kW                                                                                     | 1   | 20,300          | 20,300           |
| 17  | Digested substrate pump 11kW                                                                                 | 3   | 20,300          | 60,900           |
| 18  | Circulation substrate pump 11kW                                                                              | 3   | 20,300          | 60,900           |
| 19  | Discharge substrate pump 11kW                                                                                | 3   | 20,300          | 60,900           |
| 20  | Filtrate pump 18kW                                                                                           | 2   | 32,200          | 64,400           |
| 21  | Substrate gate valve                                                                                         | 20  | 4,900           | 98,000           |
| 22  | Substrate valve with el.drive                                                                                | 20  | 5,600           | 112,000          |
| 23  | Gasholder 2047 m3                                                                                            | 1   | 67,900          | 67,900           |
| 24  | Biogas chiller 3200 m³/h                                                                                     | 2   | 136,500         | 273,000          |
| 25  | Biogas blower 6600 m³/h                                                                                      | 2   | 43,400          | 86,800           |
| 26  | Activated carbon filter 3200 m³/h, 1000 kg                                                                   | 2   | 38,500          | 77,000           |
| 27  | Biogas flare 6600 m³/h                                                                                       | 2   | 129,500         | 259,000          |
| 28  | Gas analyzer                                                                                                 | 1   | 18,900          | 18,900           |
| 29  | Gas conditioning unit                                                                                        | 1   | 98,000          | 98,000           |
| 30  | Water supply and canalization system                                                                         | 1   | 52,500          | 52,500           |
| 31  | Heat supply station                                                                                          | 1   | 94,500          | 94,500           |
| 32  | Dry-cooler (Substrate cooling system for fermenter)                                                          | 4   | 25,900          | 103,600          |
| 33  | Automation and electric cabinet                                                                              | 1   | 480,000         | 480,000          |
| 34  | Sensors (set)                                                                                                | 6   | 27,000          | 162,000          |
| 35  | Reactor 7422 m3                                                                                              | 3   | 757,600         | 2,272,800        |
| 36  | Post-Digester tank 5082 m3                                                                                   | 1   | 249,000         | 249,000          |
| 37  | Receiving tank 166 m3                                                                                        | 1   | 84,000          | 84,000           |
| 38  | Filtrater tank 166 m3                                                                                        | 1   | 84,000          | 84,000           |
| 39  | Heat exchanger substrate                                                                                     | 3   | 15,400          | 46,200           |
| 40  | CHP 2020 V20, 2000 kW, container, cooling, pumps, heat exchangers, exhaust silencers, oil tanks and controls | 7   | 650,000         | 4,550,000        |
| 41  | Biological biogas scrubber 2200 m³/h                                                                         | 3   | 250,000         | 750,000          |
| 42  | Silaged pulp storage 290 000 m3                                                                              | 1   | 0               | 1,500,000 Client |
| 43  | Construction and installation                                                                                | 1   | 0               | 2,000,000 Client |

**ZORG supply and services**

**13,164,000**

**TOTAL including client civil works**

**16,664,000**

## Implementation terms and payment

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| Months                | 1   | 2 | 3   | 4   | 5 | 6   | 7   | 8   | 9   | 10 | 10  | 11  | 12 |
|-----------------------|-----|---|-----|-----|---|-----|-----|-----|-----|----|-----|-----|----|
| Project documentation | 50% |   | 50% |     |   |     |     |     |     |    |     |     |    |
| Approvals and permits |     |   |     |     |   |     |     |     |     |    |     |     |    |
| Equipment             |     |   |     | 30% |   | 25% | 25% | 20% |     |    |     |     |    |
| Delivery              |     |   |     |     |   | 25% | 25% | 25% | 25% |    |     |     |    |
| Construction          |     |   |     |     |   |     |     |     |     |    |     |     |    |
| Supervision           |     |   |     | 50% |   |     | 50% |     |     |    |     |     |    |
| Biogas plant start-up |     |   |     |     |   |     |     |     |     |    | 50% | 50% |    |

## Contracts

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Project implementation is executed simultaneously under several contracts

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

## List of exclusions :

### List of exclusions

- 1) Topographic and geological surveys: 3,000-7,000 EUR.
- 2) Electrical transformer and external electrical connections for construction, start-up and normal operation.
- 3) External roads to the biogas plant.
- 4) Temporary water supply for construction and hydraulic testing. At least 7,422 m<sup>3</sup> of non-saline technical water is required for testing one reactor.
- 5) Bacterial seed for start-up, supplied by the customer. Suitable sources include digestate from an operating biogas plant, manure or sewage sludge. The start-up filling procedure is defined for the selected inoculum.
- 6) Vehicles for transporting feedstock to the site and between storage and solid feeders.
- 7) Activated carbon: 2 tonnes per two years x 1,800 EUR/tonne.
- 8) Digester microelements: 15 l/day; 5,475 l/year x 25 EUR/l = 136,875 EUR/year.
- 9) Scrubber micronutrients: 30 kg/day; 10,950 kg/year.
- 10) Demineralised water for the heating circuit: 10 tonnes.
- 11) Spare parts for two years: 530,000 EUR.



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