ZORG BIOGAS

01

version

Proposal

Biogas plant
16,1 MW gross
14,91 MW net

Date: 14/07/2025
Validity: 3 months

CONTENT

OVERVIEW

We offer a solution to process Napier grass into biogas and power in the high-load reactors (HLR). The proposed HLR technology is superior to the conventional CSTR. HLR is 3 times smaller and cheaper than CSTR. For 16,1 MW gross / 14,9 MW net electrical power just 9HLR reactors x 4000 m3 are enough. The plant will produce 141 million kWh electric energy net for sale annually. Motor-hours 8400 annually.

Zorg makes the detailed engineering, supplies equipment and provides supervision during construction as well as training and start-up.

The construction and installation are done by Client under Zorg' supervision.

Raw material potential

Substrate	Quantity (tonnes/day)	Quantity (tonnes/year)	DM content: (%)	ODM content (%)	DM quantity (tonne s/ day)	ODM quantity (tonnes / day)	Biogas yield (m^3 / tonneODM)	Biogas (m^3 /day)	Methane content (%)
Napier grass	1000	365 000	27	96	270,0	259,2	690	178 848	52

*-DM- Dry matter
**-ODM- organic dry matter

Biogas plant characteristics

Characteristics	Values	Figures
Number of reactors	units	9
Volume:		
Work	m^3	3720
Overall		4005
Temperature	^0C	52
Overall dimensions of the digester:		
diameter	m	27,0
height		7,0
Organic load	kgODM/m3	7,74
Hydraulic retention time (gross/net)	days	36/34
Number of gasholders	units	1
Volume:	m^3	1000
Dimensions of the gasholder:		
diameter	m	13,5
height		10,4

Number of personnel

	Shift 1	Shift 2	Shift 3
Plant manager	1	-	-
Operator	1	1	1
Driver	1	-	-
Electrician	1	-	-
Mechanic	1	-	-
Total	7		

Biogas plant working principle

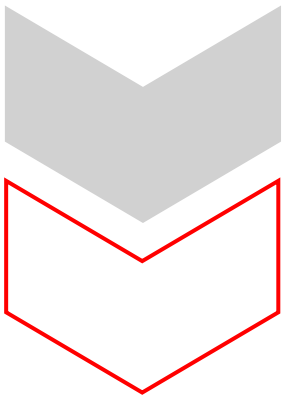
The technology is based on the biochemical conversion of organic materials from high molecular weight compounds to low molecular weight compounds. The first stage of this process is hydrolysis. Hydrolysis produces organic acids and alcohols.
Organic compounds + H2O→ C5H7NO2+HCO3.
Further conversion of obtained dissolved compounds like organic acids and alcohols (C5H7NO2,HCO3) into gases - CH4, CO2. C5H7NO2 + HCO3 + H2O → CH4+CO2+NH4.
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 CH4, water H20 and carbon dioxide CO2. 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

Napier grass is transported to a biogas plant area and discharged into loaders. The loaders input all substrates by portion to reactors using augers.
In the reactors the substrate is brought up to a temperature of +52°C. Constant temperature is sustained for the entire digesting period. To prevent a rise in temperature (for example, in summer), the biogas station is equipped with a coolers (dry cooling). The reactors operating regime is thermophilic. The heated substrate in the digesters is blended periodically. Mixing is performed by vertical agitators. The average time of processing in the reactors is 34 days. After the reactors, the substrate is fed by pump to the separator area where it is separated into solid and liquid bio-fertilizer. Solid bio-fertilizer is discharged from the separation area and transported for storage; liquid filtrate is directed to a storage. Biogas goes up under overlap and delivered into a gasholder through pipelines. 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.

Then accumulated in gasholders biogs goes through a gas pipeline to a biogas cooler with a condensate discharge unit and then 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 (H2S). After filters, biogas goes to CHP, 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



Solid feeder (SF-01 ... SF-09)

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 20m³/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

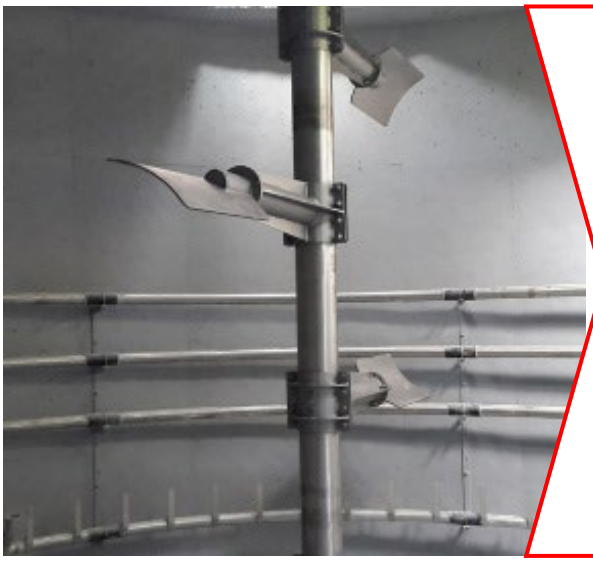
Height:	**3,6 m**
Length:	**13,5 m**
Width:	**2,8 m**
Volume:	**50 m³**
Quantity:	**9 pcs.**

Reactor (R-01... R-09)

Reactor is a tank of cylindrical form (for better mixing during the fermentation). It is built of cast-in-situ reinforced concrete based on sulphate-resistant cement with thickness of walls and bottom - 0,25m. Overlap of reactor is reinforce concrete plate. On the tank's wall and in the bottom there is to be installed pipelines for heating, intended for assurance and maintenance of the optimal fermentation process temperature at thermophilic conditions. For heat conservation and reduction of heat energy consumption, the reactor walls, overlap and bottom are insulated outside with 100 mm slabs of extruded polystyrene foam. Over the heater, the substructure walls and bottom are insulated with roll damp proofing. Superstructure and substructure heat insulation is protected by shaped sheet from the outside mechanical damages and rodents. The reactor`s bottom has a slope 1%.

Specifications

Height:	**7,0 m**
Diameter:	**27,0 m**
Total volume:	**4005 m^3**
Substrate volume	**3720 m^3**
Quantity:	**9 pcs.**



Reactor vertical agitator (AG-01 ... AG-54)

Vertical agitators are designed and engineered to guarantee high energy efficiency. We use gear units and motors from respected European manufacturers. This guarantees the long life of our mixers. All motors and gear units are available with ATEX certifications.
Agitators are designed for mixing substrates with a high solids content of 13-18%. The blades of the mixers are set at an optimum angle, and the external motor of the mixer is mounted on a special support.

Specifications

Engine power:	**15 kW**
Quantity per reactor:	**6 pcs**
Total quantity:	**54 pcs**

Window with spotlight (SG-01... SG-09)

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

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 pump (PU-01... PU-09)

Engine power:	**11 kW**
Flow rate:	**40 m3/hour**
Pressure:	**2 bar**
Quantity:	**9 pcs**

Filtrate pump (PU-11 ... PU-14)

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

Separator (SR-01... SR-09)

The Press Screw Separator covers a broad spectrum of applications, from agriculture to biogas and bioethanol plants. The innovative technology separates substrates in its solid and liquid elements. The secret of the versatility of the press screw separator is that it can adjust to different dry matter contents and Thick liquids (20% dry matter content). Slotted screens have different assortment and width of table cells and give possibility work with small solids and fiber contents. In the slotted screen, the solids are screened out from the liquid. The solids build up a layer which also acts as a filter to separate finer particles from the liquid. The auger flights convey this layer to the solids outlet. The screen surface is cleaned and a new filter layer is formed. The design of the screens is not conducive to plugging. The pressure in the first part of the screen is low but increases with the solid consistency to the solid output. The consistence of the gained solid can be varied with the help of a output regulator by the amount and position of counter weights. This way the required consistency of the final product for either further storage, use as fertilizer or the basis for compost can be reached. The liquid phase can easily be drained through a pipe or hose system.

Specifications

Engine power:	**5,5 kW**
Flow rate:	**8-30 m3/hour**
Quantity:	**9 pcs**

Equipment
Frame
Screw
Sieve for the filtration
Counterweights
The design of the protective room

Filtrate tank (FT-01 ... FT-04)

Reinforced concrete reservoir for reception of liquid kinds of raw materials. The reservoirs are equipped with level sensors and submersible agitators for mixing substrate.

Specifications

Diameter:	**8,0 m**
Height:	**3,0 m**
Total volume:	**150 m^3**
Quantity:	**4 pcs**

Submersible mixer (AG-55 ... AG-58)

The submersible motor agitator serves for mixing renewable raw materials (RRM), liquid substrate as manure and similar substrates. The electro-motor driven submersible agitator is designed for submersion operations in potentially explosive environments of Ex zone 2 and complies with Directive 94/9 EC. The submersible agitator can be attached to most sliding masts by means of the motor support. A mounting option for a hauling cable is provided on the motor support for height adjustment purposes.
Due to the 4-roller guidance of the motor support, the agitator can be lifted and lowered without friction and the square mast, even if the pull of the hauling cable is slightly angular. The motor support is designed for a 100 x 100 mm square sliding mast as standard, but can also be used for an 80 x 80 mm sliding mast by changing the rollers. The strain relief of the connecting cable can be positioned in the extension of the motor or towards the top on the motor support, depending on the requirements. This enables universal utilization with the most various installation kits.
The geared motor is made of spheroidal graphite iron(GGG40) and painted, the propeller is galvanized and the motor support is made of stainless steel. The submersible motor agitator is designed as a water pressure-tight monoblock unit for driving the three-vane propeller. The submersible agitator is of modular design, submersible electro-motor with flange-mounted planetary gear and bearing flange for holding the propeller. The conical shaft in the bearing flange is mounted in the oil bath by two angular roller bearings and sealed off from the agitating substrate with a mechanical seal.

Specifications

Nominal power:	**3,5 kW**
Quantity:	**4 pcs**

Gasholder

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 cm3/m2 * 1 bar biogas resistance. The gasholder film temperature range allows operation from -30°C to +60°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

Height:	**10,4 m**
Diameter:	**13,5 m**
The total volume :	**1000 m^3**
Quantity:	**1 pcs**

Biogas dryer and cooling (CHL-01... CHL-04)

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

Gas volume flow:	**3750 m^3/hour**
Gas inlet temperature:	**+55°C**
Gas outlet temperature:	**+10°C**
Electric power:	**65 кВт**
Quantity:	**4 pcs**

Biogas compressor (BC-01, BC-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 (biogas upgrading plant in our case).

Specifications

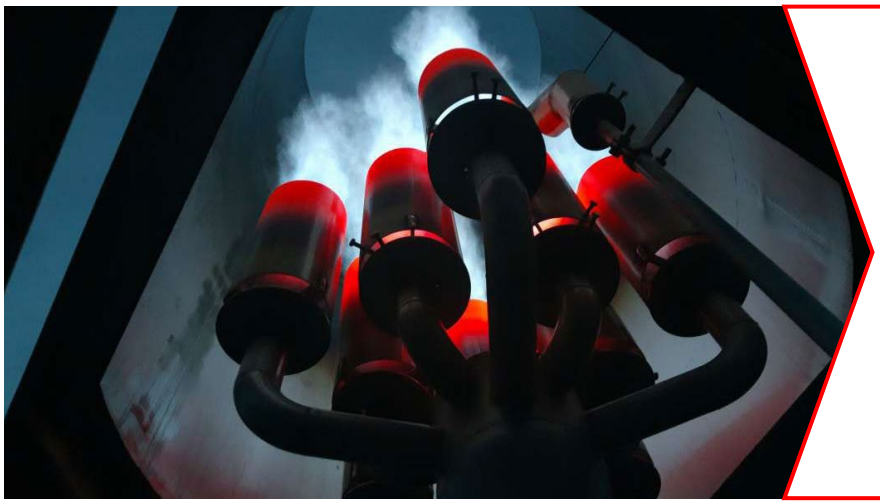
Flow rate:	**7500 m3/hour**
Pressure:	**150 mbar**
Engine power:	**64 kW**
Quantity:	**2 pcs**

Desulphurization system

The desulphurization system is a 3-step system. Stage 1 is adding Ferrum Hydrooxide. Stage 2 - biological. Adding a certain portion of air to the fermenter. Air by special bacteria, converting H2S into S. After 1 and 2 steps the sulphur contcentration is 80 ppm. Stage 3 - 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

Charcoal filter	**(CF-01, CF-02)**
The volume of charcoal:	**1000 kg**
Quantity:	**2 pcs**



Flare

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:	**3750 m^3/hour**
Pressure:	**min 10 mbar- max 60 mbar**
Quantity:	**2 pcs**

Cogeneration power plant (CHP-01 ... CHP-07)

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 CO2 emissions in comparison with combined-cycle gas turbines.

Specifications

Produced electric power:	**2300 kW**
Produced heat power:	**2290 kW**
Emissions:	**NOx < 500 mg/Nm³ (5% O2)**
Generator:	**400V, 50Hz**
Quantity:	**7 pcs**

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 m3 / h
Engine 0,24 kW

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

Heating system

Heating equipment is using 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:	**3,5 kW**
Flow:	**28 m^3/hour**
Pressure:	**6 bar**

Circulating pump feeding heat carrier

Engine power:	**2,0 kW**
Flow:	**12m^3/hour**
Pressure:	**9 bar**

The pumping station feeding propylene glycol

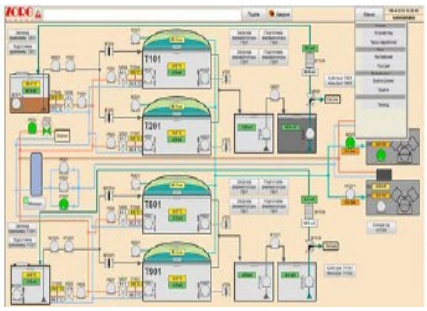
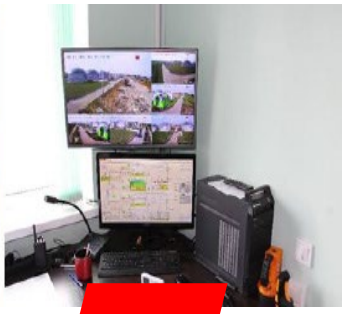
Engine power:	**0,7 kW**
Flow:	**1 m^3/hour**
Pressure:	**4 bar**

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

Heat power:	**100 kW**
Electric power:	**4 kW**
Quantity:	**9 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 ET2005, 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.

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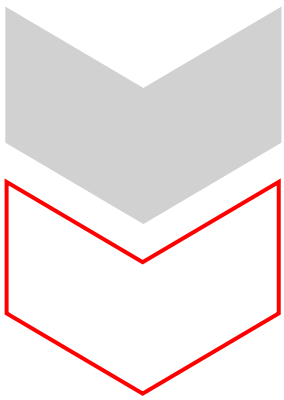
Equipment

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

Equipment specification list



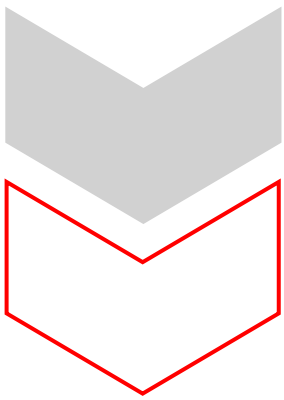
№	Equipment	Characteristic	Quantity
1	**Loader**	**V=50m3**	**9**
1.1	Container bunker		9
1.2	Feeding screws	set.	9
2	**Submersible mixer**	**N=3.5kW**	**4**
2.1	Airtight motor gearbox		4
2.2	Hydraulic screw (wear-resistant steel)		4
2.3	Mixer control mechanism		4
2.4	Electric motor mount		4
2.5	Set of fasteners		4
3	**Reactor vertical agitator**	**N=15 kW**	**54**
3.1	Airtight motor gearbox		54
3.2	Hydraulic screw (wear-resistant steel)		54
3.3	Shaft (adapted to the height of the fermenter)		54
3.4	Blade		54
3.5	Frequency converter		54
3.6	Mounting bracket to bottom of the mixer		54
4	**Safety valve of digesters**		**9**
5	**Window with a searchlight**	**set**	**9**
5.1	Inspection window RD300 (mounts and sealant included)	Ø300	18
5.2	Spotlight (mount system bundled) VISULUX UL50 -G -H	230V, 50W, IP65	9
6	**Substrate digested pump**	**40m3/hour N=11 kW**	**9**

№	Equipment	Characteristic	Quantity
7	**Separator**	**N=5.5kW**	**9**
7.1	Body		9
7.2	Substrate Supply Pipe 4 ´´		9
7.3	Engine - Gearbox	N=5,5 kW	9
7.4	Frame		9
7.5	Screw		9
7.6	Sieve for filtration		9
8	**Filtrate pump**	**40 m3/hour N=11 kW**	**4**
9	**PVC gas holder**	**1000 m3**	1
9.1	Weather protection film	Ø13,5m	1
9.2	Gasholder film PELD methane permeation max.260 cm3/m2*d*1 bar, 650 N/5cm biogas resistant		1
9.3	Air blower	16A, 0,5kW	
9.4	Excess and minimum pressure valve		1
9.5	Dome level sensor		1
9.6	Mounting system		1
9.7	Accessories		1
9.8	Safety valve		1
10	**Biogas Cooling System**	**3750m3/h**	**4**
10.1	Chiller		4
10.2	Heat exchanger		4
10.3	Polypropylene glycol tank		4
11	**Desulphurization system**		**1**
11.1	Numbers of charcoal columns	1000 kg	2

№	Equipment	Characteristic	Quantity
12	**Biogas compressor**	**Q=7500m3/h, H=150mBar, N=64kW**	**2**
13	**Electromagnetic flow meter**		**1**
14	**Flare**	**3750 m3/h**	**2**
15	**Gas equipment included**	**set**	**1**
15.1	Drainage pump with float	DN=50, Q=1m3/h, H=13 m	2
16	**The heat supply system**	**set**	**1**
16.1	Diaphragm expansion tank	V=1000 l,P=6Bar T=120°C	1
16.2	Circulating pump for supplying heat carrier	Q=30 m3/h,H=1bar	6
16.3	Propylene glycol feed pump station heating systems	Q=1,0 m3/h, H=4 bar	2
16.4	Circulation pump for supplying heat carrier to the digester	Q=18 m3/h, H=1.1 bar	9
17	**Water supply and sewerage system, complete, disassembled**	**set**	**1**
18	**Cogeneration power plant**	**2300kW**	**6**
19	**Automation with electrical equipment**	**set**	**1**
19.1	Incoming distribution cabinet with a set of automation DB-1		1
19.2	Incoming distribution cabinet with a set of automation DB-2		1
20	**Sensors, set**		**1**
20.1	Gas pressure sensor 0,025Bar		9
20.2	Gas pressure sensor 0,4Bar		2
20.3	Pressure sensor(substrate level) 1,0Bar		13
20.4	Pressure sensor (substrate pressure) 2,5bar		13

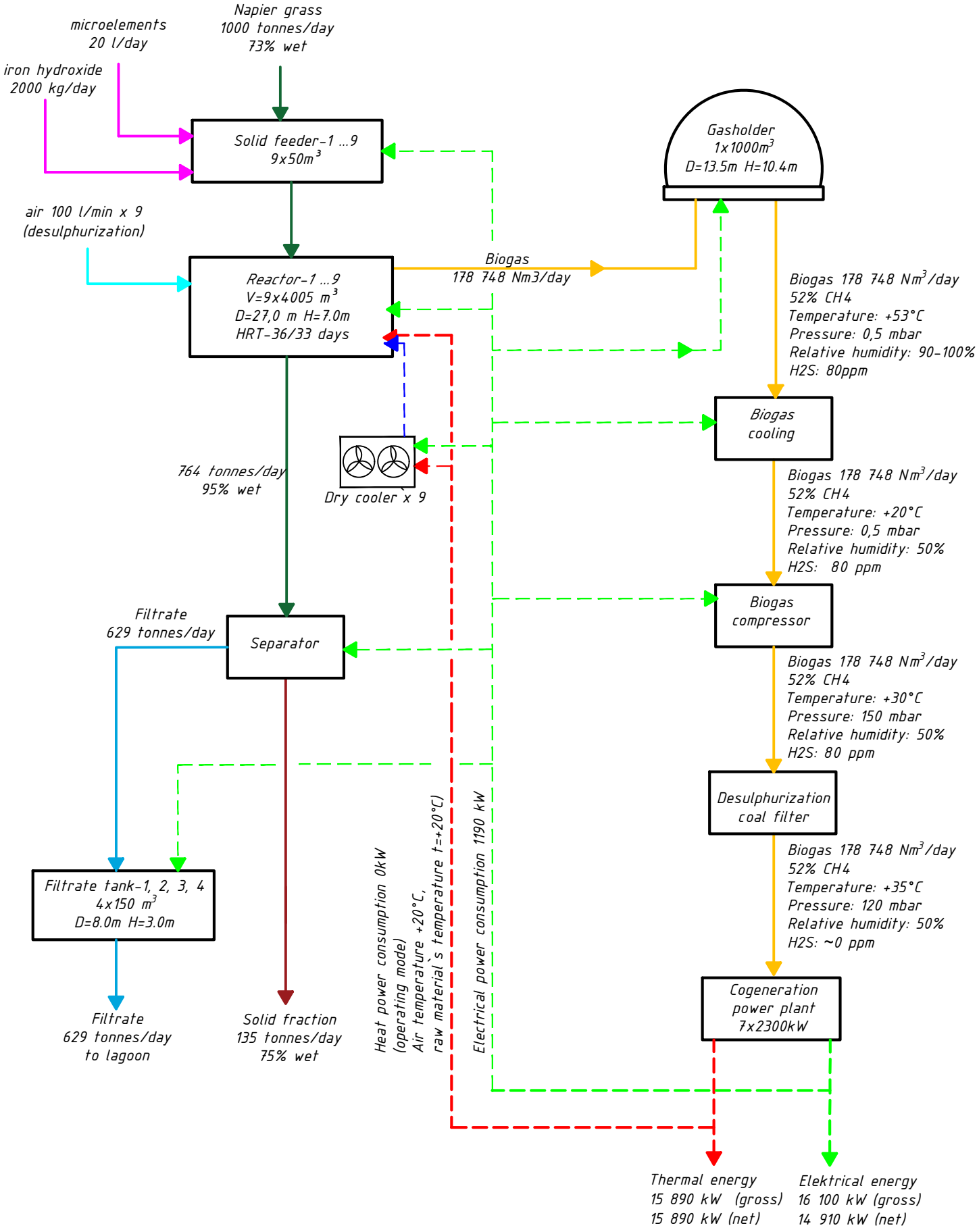
№	Equipment	Characteristic	Quantity
20.5	Resistive thermometer (gas temperature)		9
20.6	Resistive thermometer with thermo well (fermenter substrate temperature)		9
20.7	Resistive thermometer with thermo-well (digester tank substrate temperature)		9
20.8	Resistive thermometer (heat conductor temperature)		13
20.9	Conductometric sensor of maximum level		13
20.10	Conductometric sensor of water level		13
20.11	Dome position sensor		1
20.12	Coolant pressure sensor	SEN 3276 B065 G1/2 6Bar	9
20.13	Humidity and gas temperature sensor	ESFTF-I	2
21	**Dry cooler 100kW heat pow.**		**9**
22	**Laboratory**	**set**	**1**

APPENDICES



Material flow diagram

Appendix 1



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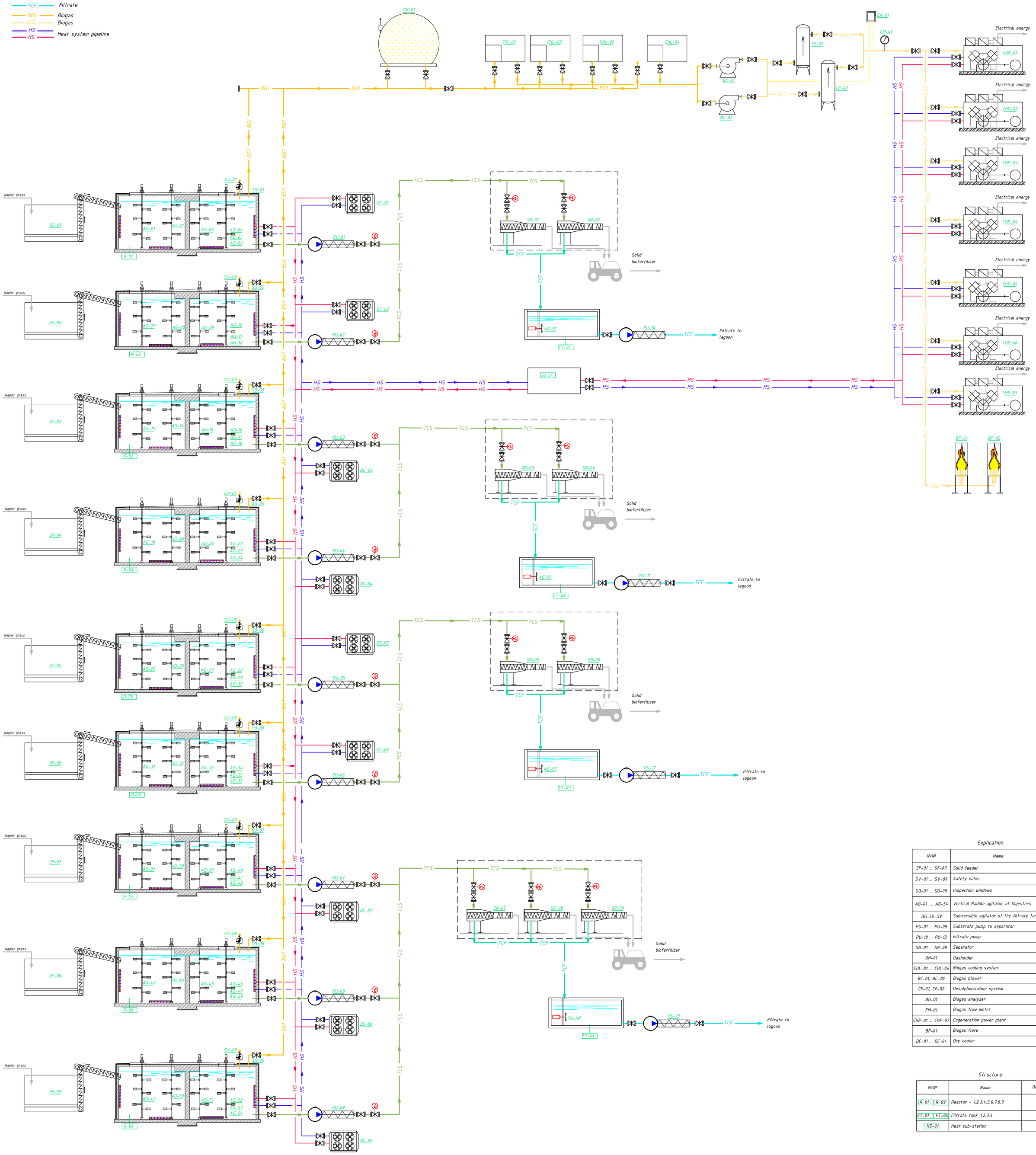
Appendix 2

Legend main pipelines

TCS — Substrate
TCF — Filtrate
BG1 — Biogas
BG2 — Biogas
HS — Heat system pipeline
HS — Heat system pipeline

Basic diagram



Explication

N/№	Name	Quantity
SF-01 ... SF-09	Solid feeder	4
SV-01 ... SV-09	Safety valve	4
SG-01 ... SG-09	Inspection windows	4
AG-01 .... AG-54	Vertical Paddle agitator of Digesters	6x9
AG-56...59	Submersible agitator of the filtrate tank	4
PU-01 ... PU-09	Substrate pump to separator	9
PU-10 ... PU-13	Filtrate pump	4
SR-01 ... SR-09	Separator	9
GH-01	Gasholder	1
CHL-01 ... CHL-04	Biogas cooling system	4
BC-01, BC-02	Biogas blower	2
CF-01, CF-02	Desulphurisation system	2
BG-01	Biogas analyzer	1
FM-01	Biogas flow meter	1
CHP-01 ... CHP-07	Cogeneration power plant	7
BF-01	Biogas flare	1
DC-01 ... DC-04	Dry cooler	4

Structure

N/№	Name	Quantity
R-01 ... R-09	Reactor - 1,2,3,4,5,6,7,8,9	9
FT-01 ... FT-04	Filtrate tank-1,2,3,4	4
HS-01	Heat sub-station	1

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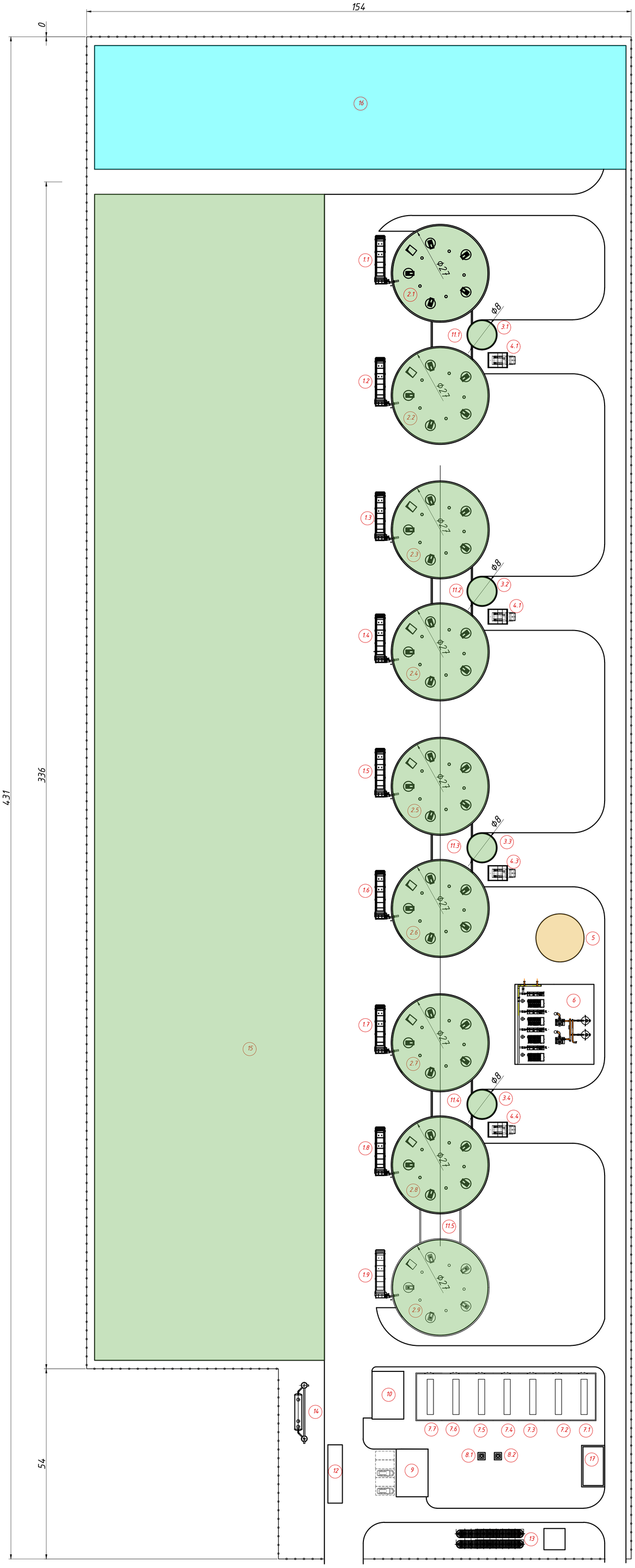

Explication

N/№	Name	Note
1	Solid loader	
2	Digester	
3	Filtrate tank	
4	Separator platform	
5	External gasholder	
6	Gas treatment site	
7	Cogeneration power plant	
8	Biogas flare	
9	Technical room	
10	Spare parts warehouse	
11	Equipment room	
12	Truck Scale (Weighbridge)	
13	Water storage tanks and pumping station	
14	Rainwater treatment facilities	
15	Silage storage	
16	Lagoon	
17	Transformer substation	

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Appendix 4

Biogas plant					
Name equipment	**Instal. Pow. (kW)**	**Q-y (pcs)**	**Total installed power (kW)**	**Working hours per day**	**Consumption kWh per day**
Loader V=50 m^3	24,0	9	216,0	6,0	1296,0
Screw set.	22,0	9	198,0	6,0	1188,0
Digester Vertical mixer	15,0	54	810,0	18,0	14580,0
Submersible mixer in filtrate tank	3,5	4	14,0	12,0	168,0
Biogas cooling system	62,0	4	248,0	12,0	2976,0
Biogas compressor	64,0	2	128,0	12,0	1536,0
Separator	5,5	9	49,5	12,0	594,0
Substrate pump to separator	11,0	9	99,0	12,0	1188,0
Filtrate pump	11,0	4	44,0	6,0	264,0
Air compressor for gasholder lock	1,5	1	1,5	1,0	1,5
Air blower for double membrane	1,0	1	1,0	24,0	24,0
Digester cooling system	4,0	9	36,0	24,0	864,0
Circulation pump for supplying heat carrier to the digester	0,8	9	6,8	24,0	162,0
Circulation pump for supplying heat carrier to the digester cooling system	2,0	7	14,0	24,0	336,0
Circulating pump feeding hot water at technical building	0,1	1	0,1	24,0	1,9
Propylene glycol pump station	0,8	1	0,8	0,5	0,4
Drinage pump	1,0	4	4,0	0,5	2,0
Lighting of the biogas plant territory	1,0	1	1,0	8,0	8,0
Spot light for digesters inspection windows	0,1	1	0,1	0,5	0,0
Working lighting of switchboard	0,1	1	0,1	0,5	0,1
CHP self consumption	20,0	7	140,0	24,0	3360,0
Total installed power, kW			**2012**		
Total consumed electric energy, kWh per day					**28550**
Total consumed power, kW					**1190**

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Appendix 5

Biogas plant 1000 tpd Napier grass 27% TS - 16,1 MW el. gross / 14,9MW netto

Pos	Name	Number of units	Unit price, EUR	Discounts*	Discounted unit price, EUR	Discounted price sub-total, EUR	
1	Detailed design	1	165 000	0%	0	165 000	
2	Supervision	1	70 000	0%	0	70 000	
3	Startup and training	1	70 000	0%	0	70 000	
4	Living and travel expences	1	70 000	0%	0	70 000	
5	Delivery of the equipment and CHPs	33	8 500	0%	0	280 500	
6	Laboratory	1	27 000	0%	0	27 000	
7	Reactor vertical agitator 15kW	54	84 000	0%	0	4 536 000	
8	Frame for agitators pos.7	54	6 500	0%	0	351 000	
9	Filtrate submersible agitator 3kW	4	12 000	0%	0	48 000	
10	Solid feeder 50m3	9	165 000	0%	0	1 485 000	
11	Screw set	9	145 000	0%	0	1 305 000	
12	Digested substrate pump 11kW	9	29 000	0%	0	261 000	
13	Filtrate supply pump 11kW	4	29 000	0%	0	116 000	
14	Separator 5,5kW	9	54 000	0%	0	486 000	
15	Gasholder 1000m3	1	75 000	0%	0	75 000	
16	Biogas chiller	4	225 000	0%	0	900 000	
17	Biogas blower 7500 m3/h	2	85 000	0%	0	170 000	
18	Desulphurization column with active coal 1000 kg	2	55 000	0%	0	170 000	
19	Biogas burner 3750 m3/h	2	255 000	0%	0	510 000	
20	Gas analyzer	1	27 000	0%	0	27 000	
21	Gas conditioning unit	1	124 000	0%	0	124 000	
22	Over- and under pressure safeguard	9	12 000	0%	0	108 000	
23	Sight glasses/viewing windows with projector	9	7 000	0%	0	63 000	
24	Water supply and canalization system	1	150 000	0%	0	150 000	
25	Heat supply station	1	168 000	0%	0	168 000	
26	Dry-cooler (Substrate cooling system for fermenter)	9	45 000	0%	0	405 000	
27	Automation and electric cabinet	1	780 000	0%	0	780 000	
28	Sensors (set)	12	27 000	0%	0	324 000	
29	Reserve diesel generagor 1MW	1	500 000	0%	0	500 000	
30	CHPs MWM 2300 kWin with extras	7	1 075 000	0%	0	7 525 000	
31	Construction and installation	1	7 000 000	0%	0	7 000 000	Client
32	Weight control (truck scale)	1	50 000	0%	0	50 000	Client
33	Silage storage for the grass 86 000 m3	1	800 000	0%	0	800 000	Client
34	Filtrate lagoon 20 000 m3	1	220 000	0%	0	220 000	Client
		by ZORG, EUR				**21 269 500**	
		by Client, EUR				8 070 000	
		TOTAL Zorg + Client, EUR				**29 339 500**	

Appendix 5

Biogas plant 1000 tpd Napier grass 33 % TS - 20,7 MW max / 19,95 MW el. gross / 18,6MW netto

Pos	Name	Number of units	Unit price, EUR	Discounts*	Discounted unit price, EUR	Discounted price sub-total, EUR	
1	Detailed design	1	165 000	0%	0	165 000	
2	Supervision	1	70 000	0%	0	70 000	
3	Startup and training	1	70 000	0%	0	70 000	
4	Living and travel expences	1	70 000	0%	0	70 000	
5	Delivery of the equipment and CHPs	39	8 500	0%	0	331 500	
6	Laboratory	1	27 000	0%	0	27 000	
7	Reactor vertical agitator 15kW	54	84 000	0%	0	4 536 000	
8	Frame for agitators pos.7	54	6 500	0%	0	351 000	
9	Filtrate submersible agitator 3kW	4	12 000	0%	0	48 000	
10	Solid feeder 50m3	9	165 000	0%	0	1 485 000	
11	Screw set	9	145 000	0%	0	1 305 000	
12	Digested substrate pump 11kW	9	29 000	0%	0	261 000	
13	Filtrate supply pump 11kW	4	29 000	0%	0	116 000	
14	Separator 5,5kW	9	54 000	0%	0	486 000	
15	Gasholder 2000m3	1	145 000	0%	0	145 000	
16	Biogas chiller 4600 m3/h	4	265 000	0%	0	1 060 000	
17	Biogas blower 9200 m3/h	2	105 000	0%	0	210 000	
18	Desulphurization column with active coal 1000 kg	2	55 000	0%	0	210 000	
19	Biogas burner 4600 m3/h	2	290 000	0%	0	580 000	
20	Gas analyzer	1	27 000	0%	0	27 000	
21	Gas conditioning unit	1	148 000	0%	0	148 000	
22	Over- and under pressure safeguard	9	12 000	0%	0	108 000	
23	Sight glasses/viewing windows with projector	9	7 000	0%	0	63 000	
24	Water supply and canalization system	1	150 000	0%	0	150 000	
25	Heat supply station	1	168 000	0%	0	168 000	
26	Dry-cooler (Substrate cooling system for fermenter)	9	45 000	0%	0	405 000	
27	Automation and electric cabinet	1	780 000	0%	0	780 000	
28	Sensors (set)	12	27 000	0%	0	324 000	
29	Reserve diesel generagor 1MW	1	500 000	0%	0	500 000	
30	CHPs MWM 2300 kWin with extras	9	1 075 000	0%	0	9 675 000	
31	Construction and installation	1	7 100 000	0%	0	7 100 000	Client
32	Weight control (truck scale)	1	50 000	0%	0	50 000	Client
33	Silage storage for the grass 86 000 m3	1	800 000	0%	0	800 000	Client
34	Filtrate lagoon 20 000 m3	1	220 000	0%	0	220 000	Client
			by ZORG, EUR			**23 874 500**	
			by Client, EUR			8 170 000	
			TOTAL Zorg + Client, EUR			**32 044 500**	

Implementation terms and payment

Year	2025					2026										
Months	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11
Project documentation	50%		50%													
Approvals and permits																
Equipment supply				30%		30%		30%	10%							
CHP				30%								70%				
Construction																
Supervision					20%		20%		20%		20%		10%			
Biogas plant start-up													25%	25%	25%	25%

Contracts

Project implementation is executed simultaneously under several contracts

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

List of exclusions :

1) Topographic and geological surveys 3000-7000 EUR
2) Electric transformer and the external electric line 500 kW for start-up, for construction period and 1200 kW for normal operation.
3) Construction and installation materials and works, mentioned in apendisx 5 of the proposal. Zorg provides prelim drawings and bill of quantities for your evaluation and our fore cast verification.
4) External roads to the biogas plant.
5) Temporary water supply during the construction and the hydraulic test of reactors at least 500 m3 water per day. It can be a technical quality water from a river, lake, well. Not salty.
6) Bacterial seed for the start-up. It can be biomass from another biogas plant. Possible also cow manure, any kind of manure, sludge from city sewage treatment plant. Customer needs to bring the seed one-time during a 1–2-week period and to fill with it at least 15-20% of the reactor volume 600-800 m3. The rest is filled with the water item 5 above.
7) Machinery to transport raw material to and from storage to the solid feeders (a truck, a frontal loader, a tractor).
8) Machinery to transport filtrate and the digested mass from the biogas plant to the agricultural fields (a truck, a frontal loader, a tractor)
9) Activated carbon 1 tonne per year x 4800 EUR/tonne = 4800 EUR
10) Microelements 20lx 365= 7300 l per year x 25 EUR/l= 182 500 EUR
11) Fe(OH)3, Fe(OH)2 – 730 tonnes per year x 180 EUR/tonne = 131 400 EUR
12) Demineralized water to the heating system 10,0 tonnes,
13) Spare parts for 2 years - 120 000 EUR

ZORG BIOGAS

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