ZORG BIOGAS

Proposal

Biogas plant
electric power 6900 kW
using 100% maiz

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CONTENTS

OVERVIEW

We offer a solution to process maize silage into biogas in high-load reactors (HLR). The proposed HLR technology is superior to the coventional CSTR . HLR is 3 times smaller and cheaper than CSTR. To produce 6,9MW using maize just 3 HLR x 3776 m3 are enough.

Raw material potential

Substrate	Quantity (tonnes/day)	Quantity (tonnes/year)	DM content: (%)	ODM content (%)	DM quantity (tonnes/ day)	ODM quantity (tonnes / day	Biogas yield (m^3 / tonneODM)	Biogas (m^3 /day)	Methane content (%)	Biogas (m^3 /year)
Maize silage	324	118 260	36	94.8	116.6	110.6	670	74 080	52	27 040 295

Biogas plant technical performances

Characteristics	Values	Figures
Number of digesters	units	3
Digester		
a) volume:		
Work	m^3	3 433
Overall	m^3	3 776
b) Organic load	kgODM/ m^3	10,76
c) Hydraulic retention time (gross)	days	35
d) Overall dimensions of the digester (diameter / height)	m	27,0/6,6
e) Temperature	^0C	+48
Gasholder		
a) Volume	m^3	800
b) Number of gasholders	units	1
c) Dimensions of the gasholder (diameter / height)	m	12,6/9,7

WORKING PRINCIPLE

Biogas plant working principle

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

Organic compounds + $H_2O \rightarrow C_5H_7NO_2 + HCO_3$.

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

Maize silage is transported to the biogas plant area and discharged into a loader. The loader is equipped with a moving floor. The supply of raw materials is carried out by screws into the digesters evenly throughout the day. In the high-load digesters the substrate is brought up to a temperature of +48 °C. Constant temperature is sustained for the entire digesting period. The digester operating regime is thermophilic. The heated substrate in the digester is blended periodically by vertical agitators. The average time of processing in the digesters is 35 days (gross).

After the digesters, the substrate is fed by the pumps to the separator area where it is separated into solid and liquid bio-fertilizer. Solid bio-fertilizer is discharged to the separation area and transported for storage; liquid filtrate is directed to a filtrate tank and then to a lagoon. Biogas plant is equipped with gasholder for accumulating of biogas. The gas holder's weather protective film protects the gasholder from precipitation and damage by foreign objects. The weather protective film is fixed firmly by a special system. To protect the gasholder from overpressure, digesters are equipped with safety valves, which starts working at a pressure of 5 mbars and bleeds biogas to the atmosphere.

The biogas then goes through a gas pipeline to a compressor, where the pressure is raised up to 80-150 mbar to meet engine requirements. After the compressor, biogas is supplied to a cogeneration power plant, where biogas is used as fuel for production of electricity and heat energy in the same time.

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

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

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

Digesters

Digester 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. In the center of the digester there is a column with chapiter. Overlap of digester 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 digester 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 digester bottom has a slope 1%.

Specifications

Height:	6,6 m
Diameter:	27,0 m
Overall volume:	3776 m^3
Quantity:	3 pcs

Window with spotlight

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

Specifications

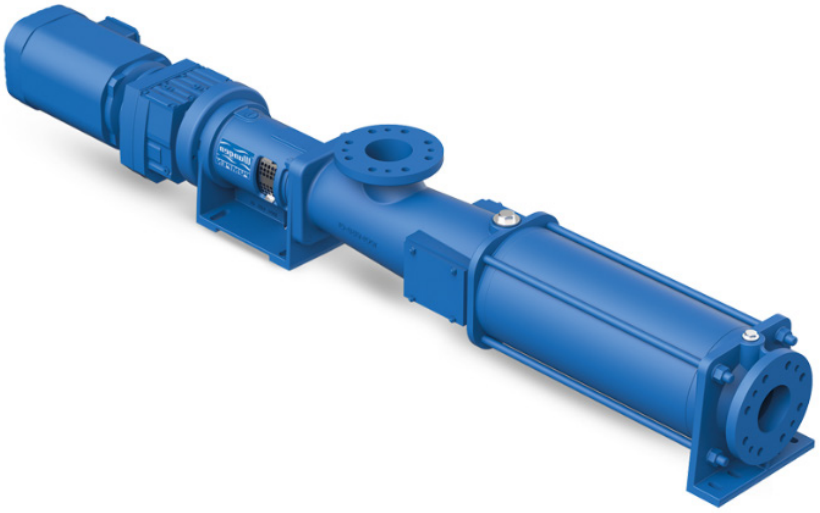
Inspection windows Ø300
Spotlight VISULUX UL50 -G -H
230V, 50W, IP65

Digester vertical mixer

Mixers 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

Nominal power	N=15 kW
Quantity per digester:	6 pcs
Quantity total:	18 pcs



Pump equipment

Pumps are used to transport substrate to the equipment and facilities in the biogas plant and away. Kinematic viscosity is a real physical factor that influences pump curves, and thus the choice of pump. Viscosity is essentially resistance to flow and this has implications for pumps. Fluid viscosity or thickness will affect how it will behave in a pump. Screw pumps are used for pumping flowable thin sludge,- excess sludge and mechanically thickened sludge and conveying the substrates with their mostly high dry substance contents (DS) containing up to 10% dry matter. Optimum pumping results are guaranteed by the flow-optimized suction housing and a constant joint diameter which prevents the plaiting of long fibers.

Specifications

Substrate feed pump	
Flow rate:	30 m3/hour
Engine power:	11 kW
Pressure:	4 bar
Quantity:	1 pcs
Substrate pump to separator	
Flow rate:	30 m3/hour
Engine power:	11 kW
Pressure:	4 bar
Quantity:	3 pcs
Filtrate pump	
Flow rate:	30 m3/hour
Engine power:	11 kW
Pressure:	4 bar
Quantity:	1pcs

Separator

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

Specifications

Engine power	**5,5 kW**
Flow rate	**up to 30 m³ / h**
Quantity	**3 pcs**

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

Submersible mixer

The submersible motor agitator serves for mixing renewable raw materials (RRM), liquid substrate as manure, poltry dung 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

Filtrate tank	
Nominal power	N= 3,0 kW
Quantity:	1 pcs

Height:
adapted to the height of digester
Material: stainless steel 8 mm

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 :	9,7 m
Diameter :	12,6 m
The total volume :	800 m³
Quantity:	1 pcs

Biogas dryer and cooling

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	1600 m^3/ h
Gas inlet temperature	+48 C
Gas outlet temperature	+10 C
Engine power	75 kW
Quantity	2 pcs

Biogas compressor

Biogas blower is a device used to move gas and increase pressure thanks to a rotating impeller within a toroidal channel, so there is a progressive increase of energy. Blower is used to transporting biogas from gasholder storage to consumer.

Specifications

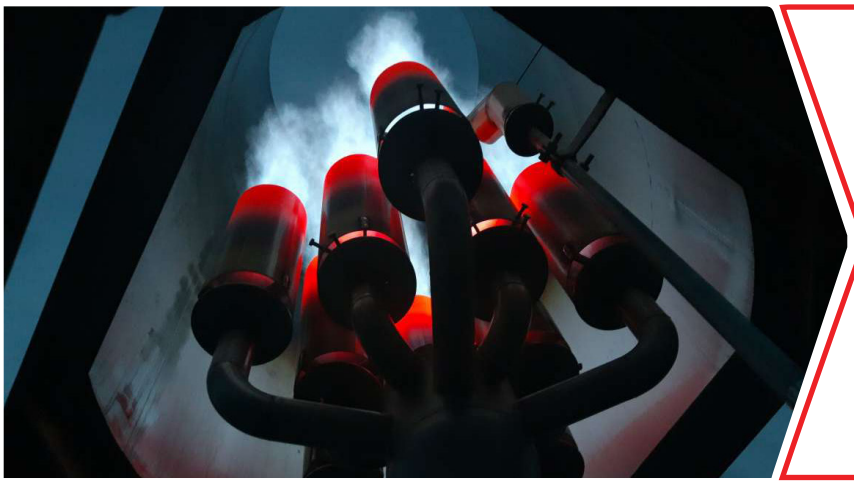
Flow rate	3100 m^3/h
Pressure	150 mbar
Engine	36,0 kW
Quantity	1 pcs

Desulphurization system

The desulphurization system is a one-step purification of biogas to remove sulfur. The system cleans biogas of sulfur using activated charcoal filtration, as activated charcoal has the capability to absorb sulfur. After passing through activated charcoal filters, the sulfur concentration is reduced to 0 ppm.

Specifications

The volume of charcoal	3 000 kg
Numbers of charcoal columns	3 pcs



Flare

The flare is designed for the temporary or periodical complete combustion of the biogas produced by biogas plants without the possibility of its use as an energy source. The burn system consists of a burner and additional equipment. The burner is designed on the principle of injection and consists of a combustion nozzle with an injector with an air supply control system, flame protection tube, fitting and burner control system. The biogas combustion system is made of stainless steel.

The supporting structure holds the burner and vertically mounted socket. The burn control system is installed in a case, which is mounted on the supporting structure of the combustion system and contains all the elements for monitoring and controlling ignition and flame.

Specifications

Flow rate	31 00 m³/h
Quantity:	1 pcs

Cogeneration Power Plant

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	2165 kW
Emissions	NOx < 500 mg/Nm³ (5% O2)
Generator	400V, 50Hz
Quantity:	3 pcs

Gas analyzer (CH4, CO2, H2S, O2) (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

Set includes

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

Defined gases methane % (CH4), carbon dioxide % (CO2), hydrogen sulfide ppm (H2S)

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

Circulation pump for supplying network water and electric boiler

Flow	7,8m³/h, ,
Pressure	6 m
Electric power	0,37 kW;

Circulation pump of heat carrier

Flow rate	0,4 m3 / h;
Pressure	0,3m
Electric power	0,04 kW;

Circulation pump for supplying heat carrieer to CHP

Flow	31 m3 / h;
Pressure	8 m ,
Electric power	1,5 kW;

The pumping station feeding propylene glycol

Flow	1,0 m3/h;
Pressure	4 bar,

Circulation pump for mains supply to the digester

Flow	11 m3 / h;
Pressure	10m
Electric power	0,75 kW;

Diaphragm expansion tank with volume V = 500L

Propylene glycol storage tank with volume V = 300L with overflow line and float shut-off valve

Electric hot water boiler with temperature limiter and safety valve

Electric hot water boiler with temperature limiter and safety valve

Dry cooler (digester cooling)

The device is designed to cool the reactor. When using highly loaded technology, there is a chance of uncontrolled self-heating.
The cooler is connected to the heating pipes, and when active, the same lines are used.

Specifications

Power	100 kW
Engine power	4,0 kW
Quantity:	3 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

Water supply pump station (drinking water)
Pressure 28 m
Flow 9 m3 / h
Engine 0,75 kW

Water fire extinguishing pump station
Pressure 28 m
Flow 51 m3 / h
Engine 7.5 kW

Drain pump
Pressure 5 m
Flow 4.5 m3 / h
Engine 0.37 kW

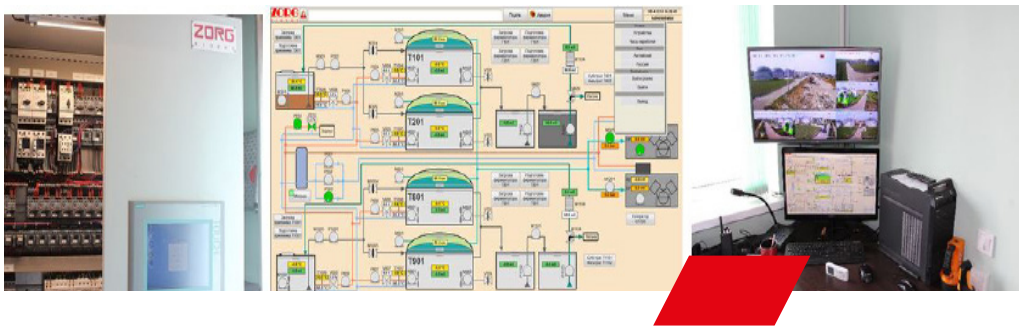
Equipment
Pump case control
Stove-base
gauges

Air supply system

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

Specifications

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



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

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

SPECIFICATION LIST

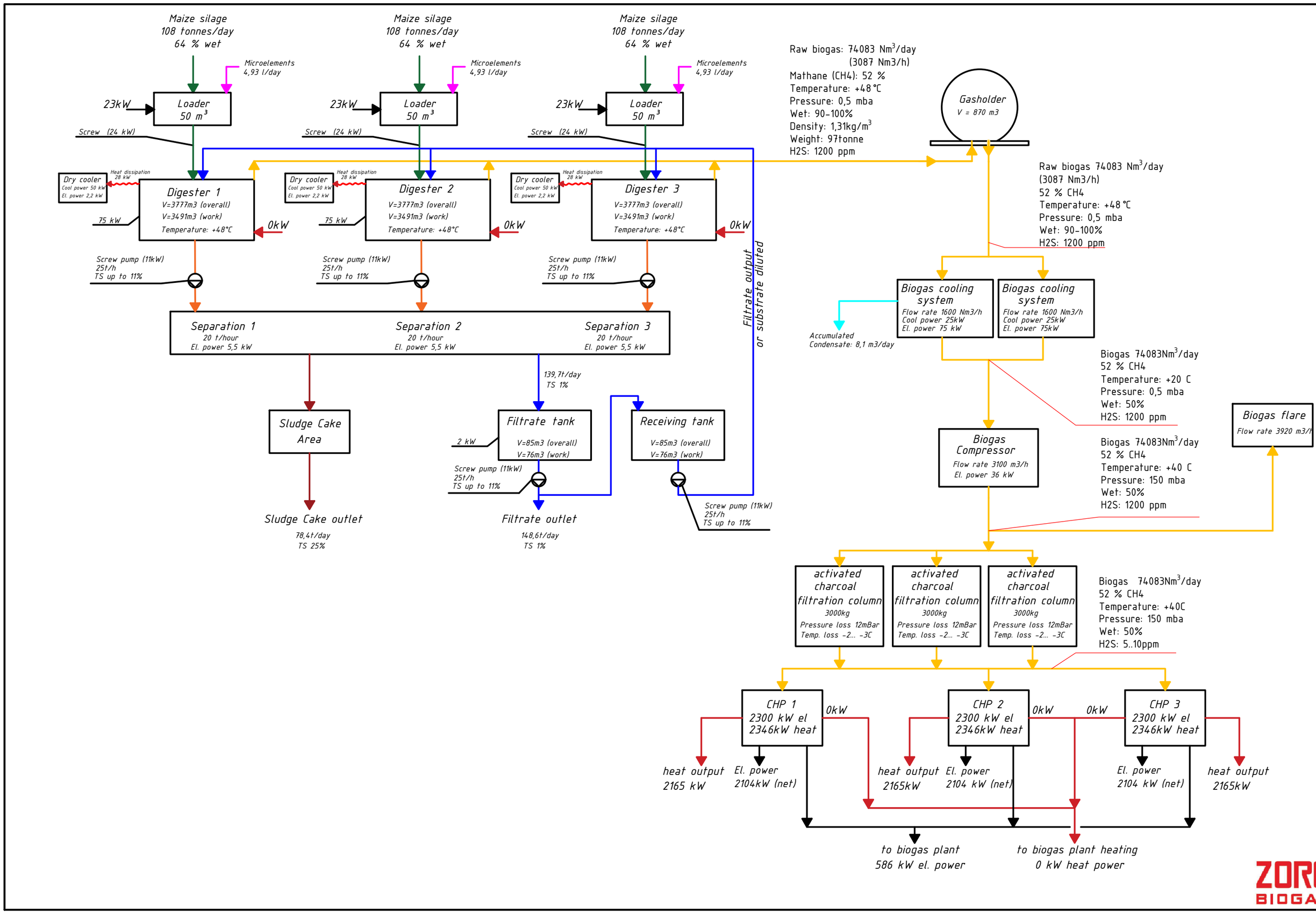
№	Equipment	Characteristic	Q-ty
2	**Loader**	**N=50 m3**	**3**
2.1	Container bunker		3
2.2	Feeding screws	set.	3
3	**Vertical mixer (digester)**	**N=15,0 kW**	**18**
3.1	Airtight motor gearbox		18
3.2	Hydraulic screw (wear-resistant steel)		18
3.3	Mixer control mechanism (high-quality structural galvanized steel)		18
3.4	Electric motor mount (high-quality structural galvanized steel)		18
3.5	Set of fasteners (coating - hot dip galvanized)		18
4	**Safety valve of digester**		**3**
5	**Window with a searchlight, complete, disassembled**	**set**	**3**
5.1	Inspection window RD300 (mounts and sealant included)	Ø300	6
5.2	Spotlight (mount system bundled) VISULUX UL50 -G -H	230V, 50W, IP65	6
6	**Substrate pump to Separator with Frequency converters**	**30m3/hour N=11 kW**	**3**
7	**Separator**	**N=5,5 kW, Q=30 m³/h**	**3**
7.1	Body		3
7.2	Substrate Supply Pipe 4 ’’		3
7.3	Engine - Gearbox	N=5,5 kW	3
7.4	Frame		3
7.5	Screw		3
7.6	Sieve for filtration		3

№	Equipment	Characteristic	Q-ty
8	**Submersible mixer (Receiving tank)**	**N=3.0 kW**	**1**
8.1	Airtight motor gearbox		1
8.2	Hydraulic screw (wear-resistant steel)		1
8.3	Mixer control mechanism (high-quality structural galvanized steel)		1
8.4	Electric motor mount (high-quality structural galvanized steel)		1
8.5	Set of fasteners (coating - hot dip galvanized)		1
9	**Filtrate pump**	**30 m3/hour N=11 kW**	**1**
10	**PVC external gas holder, complete, disassembled**	**V=800m^3**	**1**
10.1	Weather protection film	Ø12,6m	1
10.2	Gasholder film PELD methane permeation max.260 cm3/m2*d*1 bar, 650 N/5cm biogas resistant		1
10.3	Air blower	16A, 0,5kW	1
10.4	Excess and minimum pressure valve		1
10.5	Dome level sensor		1
10.6	Mounting system		1
10.7	Accessories		1
11	**Biogas cooling system**	**1600 m3/hour N=75,0 kW**	**2**
12	**Biogas compressor**	**Q=3100 m^3/h H=150mBar N=36,0 kW**	**2**
13	**Desulphurization system**	**3 000 kg**	**3**
13.1	Numbers of charcoal columns		3
14	**Electromagnetic flow meter**		**1**
15	**Gas analyzer**		**1**

№	Equipment	Characteristic	Q-ty
16	**Flare**	**3100 m3/h**	**1**
16.1	Compressor		1
16.2	Manual locking element		1
16.3	Deflagration fuse		1
16.4	On-site control cabinet		1
16.5	Auto ignition system		1
16.6	Auto Main Gas Solenoid Valve		1
17	**Cogeneration power plant**	**2300 kW**	**3**
18	**The heat supply system**	**set**	**1**
18.1	Circulation pump for supplying network water and electric boiler	G=7,8m³/h, H=6 m, Ne=0,37 kW, Dn40	1
18.2	Circulation pump of network supply water	G=0,74 m³/h, H=3m, Ne=0,04 kW, Dn15	1
18.3	Circulation pump for supplying network water to CHP	G=31 m³/h, H=8m, Ne=1,5 kWт, Dn65	1
18.4	Propylene glycol feed pumping station for the heat supply system	G = 1.0 m³/h, H = 40 m, N = 0.775 kW,	1
18.5	Diaphragm expansion tank with volume V = 500L	P=10Bar, T=120°C, R1''	1
18.6	Propylene glycol storage tank with volume V = 300L with overflow line and float shut-off valve (kit)		1
18.7	Propylene glycol consumption meter for feeding the heat supply system of the biogas plant	DN15, G = 1.5 m³/h	**1**
18.8	Circulation pump for mains supply to the digester	G=11 m³/h, H=10m, Ne=0,75 kW, Dn50 ATEX EEx	**1**
20.9	Butterfly valve with el. drive	400V 3PH 50Hz	1
18.10	Three-way flanged control valve KVs6,3, Pn = 1.6MPa, DN20 with electric drive	U = 220V, N = 3.5 W, T = 150 s, 3-position	
18.11	Three-way flanged control valve KVs40, Pn = 1.6MPa, DN50 with electric drive	U = 220V, N = 3.5 W, T = 150 s, 3-position	
21	**Automation with electrical equipment complete**		**1**
21.1	Introductory switchgear VRU-1		1

№	Introductory switchgear VRU-2		1
21.2	Introductory switchgear VRU-3		1
21.3	Ventilation board for generator room SHVG-1		1
21.4	Ventilation board for generator room SHVG-2		1
21.5	Ventilation board for generator room SHVG-3		1
21.6	Ventilation board for generator room SHVG-3	SPA-380-08 (0-6m)	5
22	**Sensors set**		**1**
22.1	Pressure sensor (gas pressure)	0,025 bar	3
22.2	Pressure sensor (gas pressure)	0,4 bar	3
22.3	Pressure sensor (substrate level)	1 bar	3
22.4	Pressure sensor (substrate pressure)	2,5 bar	5
22.5	Pressure sensor (coolant pressure)	6 bar	12
22.6	Thermoconverter (gas)	Pt100	3
22.7	Thermoconverter (substrate in fermenters)	Pt100	6
22.8	Thermoconverter (heat carrier)	Pt100	12
22.9	Conductometric sensor		6
22.10	Conductometric sensor		1
22.11	Radar level sensor		2
22.12	Gas level sensor (gas holder)		1

APPENDICES


Maize silage
108 tonnes/day
64 % wet
Microelements
4,93 l/day
23kW
Loader
50 m3
Screw (24 kW)
Dry cooler
Cool power 50 kW
El. power 2,2 kW
Heat dissipation
28 kW
Digester 1
V=3777m3 (overall)
V=3491m3 (work)
Temperature: +48°C
75 kW
0kW
Screw pump (11kW)
25t/h
TS up to 11%
Digester 2
Digester 3
Filtrate output
or substrate diluted
Separation 1
20 t/hour
El. power 5,5 kW
Separation 2
Separation 3
Sludge Cake Area
Sludge Cake outlet
78,4t/day
TS 25%
139,7t/day
TS 1%
Filtrate tank
V=85m3 (overall)
V=76m3 (work)
2 kW
Receiving tank
Filtrate outlet
148,6t/day
TS 1%
Raw biogas: 74083 Nm3/day
(3087 Nm3/h)
Mathane (CH4): 52 %
Temperature: +48 °C
Pressure: 0,5 mba
Wet: 90-100%
Density: 1,31kg/m3
Weight: 97tonne
H2S: 1200 ppm
Gasholder
V = 870 m3
Raw biogas 74083 Nm3/day
(3087 Nm3/h)
52 % CH4
Temperature: +48 °C
Pressure: 0,5 mba
Wet: 90-100%
H2S: 1200 ppm
Biogas cooling system
Flow rate 1600 Nm3/h
Cool power 25kW
El. power 75 kW
Accumulated
Condensate: 8,1 m3/day
Biogas 74083Nm3/day
52 % CH4
Temperature: +20 C
Pressure: 0,5 mba
Wet: 50%
H2S: 1200 ppm
Biogas Compressor
Flow rate 3100 m3/h
El. power 36 kW
Biogas 74083Nm3/day
52 % CH4
Temperature: +40 C
Pressure: 150 mba
Wet: 50%
H2S: 1200 ppm
Biogas flare
Flow rate 3920 m3/h
activated charcoal filtration column
3000kg
Pressure loss 12mBar
Temp. loss -2... -3C
Biogas 74083Nm3/day
52 % CH4
Temperature: +40C
Pressure: 150 mba
Wet: 50%
H2S: 5..10ppm
CHP 1
2300 kW el
2346kW heat
CHP 2
CHP 3
heat output
2165 kW
El. power
2104kW (net)
to biogas plant
586 kW el. power
to biogas plant heating
0 kW heat power
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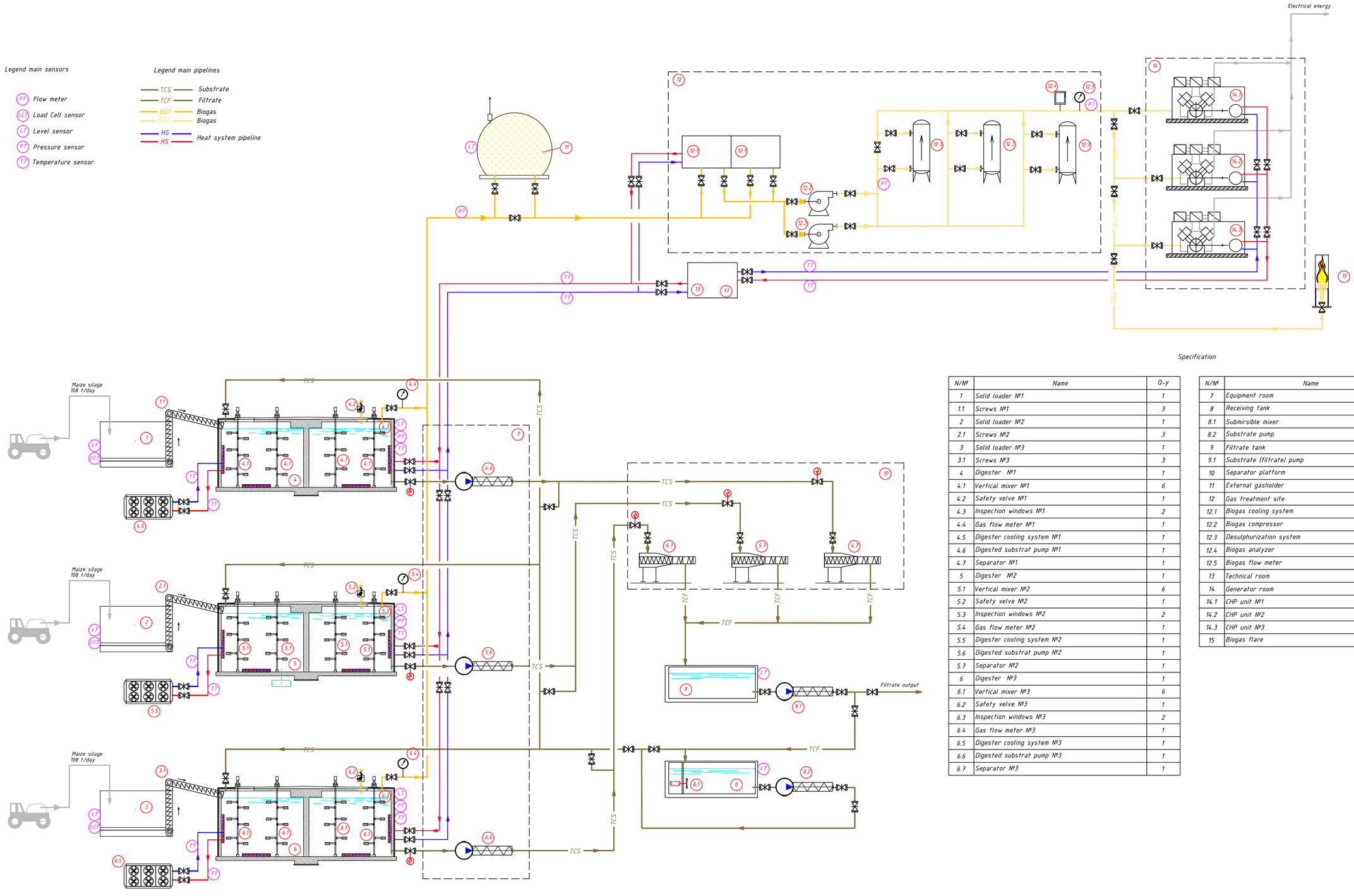
BIOGAS

Legend main sensors

- F1 Flow meter
- LC1 Load Cell sensor
- LT Level sensor
- PT Pressure sensor
- TT Temperature sensor

Legend main pipelines

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



Specification

N/№	Name	Q-y
1	Solid loader №1	1
1.1	Screws №1	3
2	Solid loader №2	1
2.1	Screws №2	3
3	Solid loader №3	1
3.1	Screws №3	3
4	Digester №1	1
4.1	Vertical mixer №1	6
4.2	Safety velve №1	1
4.3	Inspection windows №1	2
4.4	Gas flow meter №1	1
4.5	Digester cooling system №1	1
4.6	Digested substrat pump №1	1
4.7	Separator №1	1
5	Digester №2	1
5.1	Vertical mixer №2	6
5.2	Safety velve №2	1
5.3	Inspection windows №2	2
5.4	Gas flow meter №2	1
5.5	Digester cooling system №2	1
5.6	Digested substrat pump №2	1
5.7	Separator №2	1
6	Digester №3	1
6.1	Vertical mixer №3	6
6.2	Safety velve №3	1
6.3	Inspection windows №3	2
6.4	Gas flow meter №3	1
6.5	Digester cooling system №3	1
6.6	Digested substrat pump №3	1
6.7	Separator №3	1

N/№	Name	Q-y
7	Equipment room	1
8	Receiving tank	1
8.1	Submirsible mixer	1
8.2	Substrate pump	1
9	Filtrate tank	1
9.1	Substrate (filtrate) pump	1
10	Separator platform	1
11	External gasholder	1
12	Gas treatment site	1
12.1	Biogas cooling system	2
12.2	Biogas compressor	2
12.3	Desulphurization system	3
12.4	Biogas analyzer	1
12.5	Biogas flow meter	1
13	Technical room	1
14	Generator room	1
14.1	CHP unit №1	1
14.2	CHP unit №2	1
14.3	CHP unit №3	1
15	Biogas flare	1

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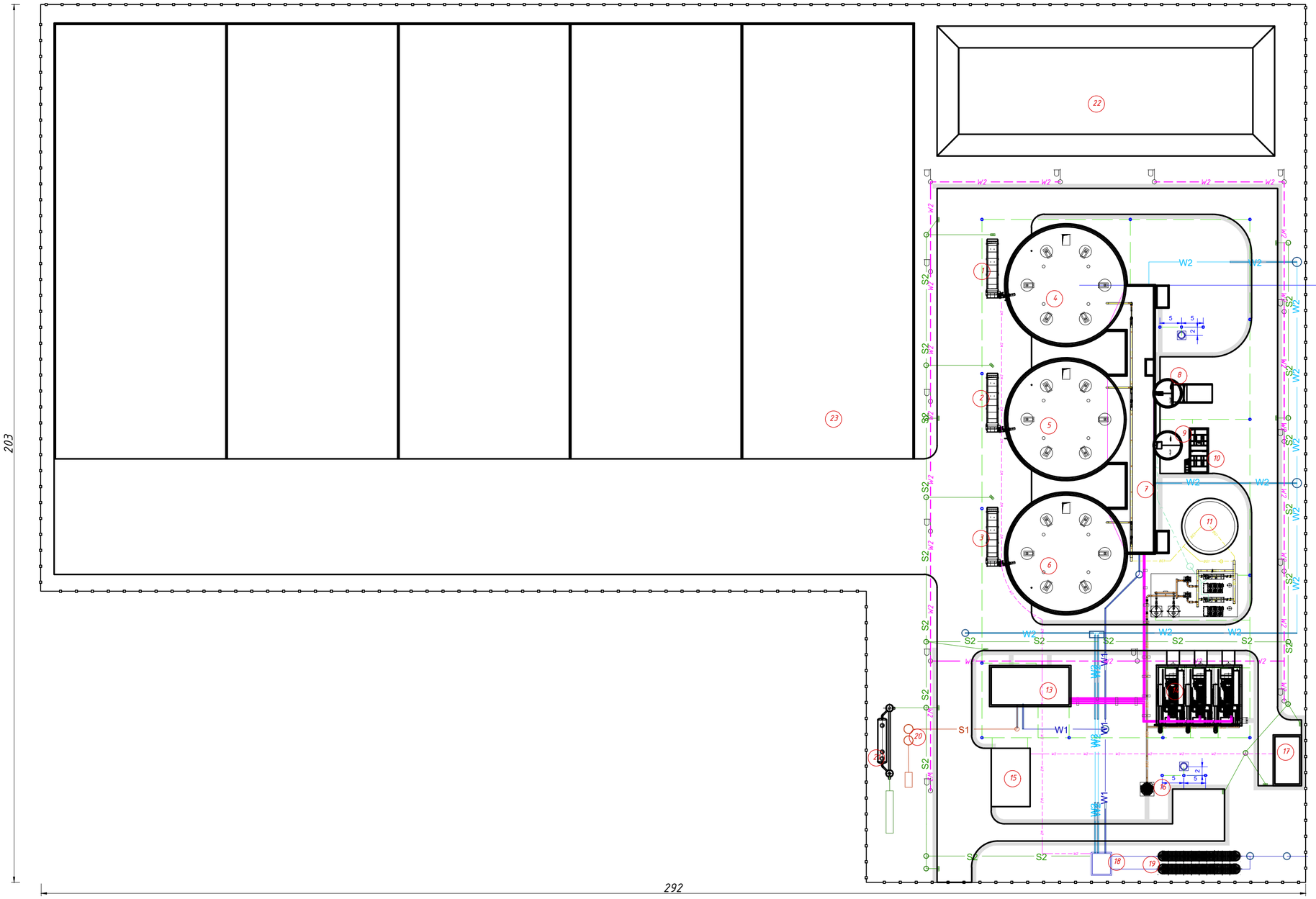
Plan



Legend of buildings and structures

N/№	Name	Note
1	Solid loader №1	
2	Solid loader №2	
3	Solid loader №3	
4	Digester №1	
5	Digester №2	
6	Digester №3	
7	Equipment room	
8	Receiving tank	
9	Filtrate tank	
10	Separator platform	
11	External gasholder	
12	Gas treatment site	
13	Technical room	
14	Generator room	
15	Spare parts warehouse	
16	Biogas flare	
17	Electric control room (external design)	
18	Water supply pump station	
19	Water storage tanks	
20	Waste water treatment	
21	Rainwater treatment facilities	
22	Lagoon	
23	Silo	

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	23,0	3	69,0	7,0	483,0
Screw set.	24,0	3	72,0	7,0	504,0
Digester Vertical agitator	15,0	18	270,0	18,0	4860,0
Submersible agitator in receiving tank	2,0	1	2,0	12,0	24,0
Biogas cooling system	75,0	2	150,0	24,0	3600,0
Biogas compressor	36,0	1	36,0	24,0	864,0
Separator	7,5	3	22,5	9,0	202,5
Substrate feed pump	11,0	1	11,0	3,0	33,0
Substrate pump to separator	11,0	3	33,0	9,0	297,0
Filtrate pump	11,0	1	11,0	3,0	33,0
Cogenerator self consumption	21,0	3	63,0	24,0	1512,0
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	3	12,0	at t>55°C	
Circulation pump for supplying heat carrier to the digester	0,75	3	2,3	24,0	54,0
Circulation pump for supplying network water to the digester cooling system	2,0	1	2,0	24,0	48,0
Circulating pump feeding hot water at technical building	0,37	1	0,4	only ambiant temp +15°C	
Propylene glycol pump station	0,8	1	0,8	0,5	0,4
Water supply pump station (drinking water)	0,75	1	0,8	3,0	2,3
Drinage pump	0,37	1	0,4	0,5	0,2
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
Cogenerators self-consumption	21,0	3	63,0	24,0	1512,0
Total installed power, kW			**825**		
Total consumed electric energy, kWh per day					**14063**
Total consumed power, kW					**586**

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Equipment price

Pos.	Description	Quantity	Unit Price, EUR	Total Price, EUR
1	Solid feeder (dosing buffer machine)	3	112 400,00	337 200,00
2	Screw conveyor	3	108 000,00	324 000,00
3	Digester vertical mixer N=15kW	18	48 200,00	867 600,00
4	External gasholder V=870m3	1	76 600,00	76 600,00
5	Over- and under pressure safeguard	3	4 100,00	12 300,00
6	Substrate separation unit 5,5kW	3	44 400,00	133 200,00
7	Substrate supply pump to separator unit	3	18 500,00	55 500,00
8	Submersible mixer with guiding unit for receiving tank 3 kW	1	8 000,00	8 000,00
9	Filtrate supply pump	1	18 500,00	18 500,00
10	Biogas burner	1	144 200,00	144 200,00
11	Biogas chiller (Biogas cooling system)	2	89 000,00	178 000,00
12	Desulphurization column with active coal	2	48 500,00	97 000,00
13	Biogas blower	1	31 200,00	31 200,00
14	Gas conditioning unit	1	16 800,00	16 800,00
15	Heat supply station	1	52 900,00	52 900,00
16	Motorized valves (set)	13	4 300,00	55 900,00
17	Automatic with electric equipment	1	290 600,00	290 600,00
18	Sensors (set)	1	47 700,00	47 700,00
19	Water supply and canalization system	1	41 800,00	41 800,00
20	Dry-cooler (Substrate cooling system for fermenter)	3	11 700,00	35 100,00
21	Biogas analyzer (CH4, CO2, H2S)	1	24 900,00	24 900,00
22	Sight glasses/viewing windows with projector	3	3 800,00	11 400,00
23	Substrate supply pump	1	18 500,00	18 500,00
24	Frame for pos.3	18	5 800,00	104 400,00
TOTAL: (DAP (Incoterms 2010): Ruse, Bulgaria):				**2 983 300,00**

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Price

Name	Price (DAP any place in EU)
Project documentation	89 000 Euro
Start-up and training	47 000 Euro
Supervision and adjustment	47 000 Euro
Living and travel expenses*	47 320 Euro
Equipment	2 983 300 Euro
Cogeneration power plants MWM Caterpillar 2300kW el. x 3	1 908 000 Euro
Construction and installation**	3 000 000 Euro
Total	8 121 620 Euro

* Living and travel expenses:

During supervision:
8 visits x 7 days, airtickets 700 EUR x 8, hotel 5 days x 8 visits x 120 EUR, daily exp. 54 days x 120 EUR = 17 120 EUR

During startup and training:
1 visit x 60 days x 2 specialists, airtickets 700 x 2, hotel 120 x 2 x 60, daily exp 60 x 120 x 2= 30 200 EUR

TOTAL 47 320 EUR

** INCLUDES Excavation 1,5 m, concrete reactor, technical building, concrete tanks, concrete foundations, steel structures, reactor thermal insulation, gas pipes, substrate pipes, cables, construction machinery lease, equipment installation
Doesn't include maize silage storages 150 000 m3 (2 million EUR) or lagoons 10 000 m3 (150 000 EUR)

Implementation terms and payment

Months	1	2	3	4	5	6	7	8	9	10	11	12
Project documentation	50%	50%										
Equipment supply	30%		20%	20%		10%						
CHP unit	30%					70%						
Construction												
Supervision	50%				50%							
Plant start-up									50%		50%	

Contracts

Project implementation is executed simultaneously under several contracts

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

ZORG BIOGAS

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