ZORG BIOGAS

Proposal

Biogas plant 100 tpd MSW into 1MW el. power

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OVERVIEW

Herewith we offer a solution to process 100 tonnes per day of the pre-sorted municipal solid waste MSW into biogas with the next power generation. The technology is the dry fermentation batch-type process. The main advantage of the proposed method are
(1) very low electric energy consumption for own needs (less than 5%),
(2) very low maintenance. Except of percolate pumps and gas preparation there is no equipment. No screws, no solid feeders, no agitators.
(3) This is the only technology that can work with high amount of impurities.

The initial amount of the unsorted municipal solid waste 200-250 tonnes per day. A screening on drums is sufficient.

The produced biogas will be burned in co-generation power plant Jenbacher 1MW electric power and 1MW thermal power (24 000 kWh electric energy a day brutto plus 24 000 kWh thermal energy brutto).

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** (%)	Biogas (m^3 / year)
Pre-sorted municipal solid waste	100	36 500	40	60	40	24	416	10 000	55	3 650 000

Biogas plant characteristics

Characteristics	Figures
Quantity of feedstock (tonnes/day)	100
Wet (%)	60
Biogas production (m^3/day)	10 000
Methane content, CH_4 (%)	55
Calorific value (ccal /m^3)	4708
Number of digesters (pcs.)	8
Digester volume gross (m^3)	1224
Digester working volume (m^3)	816
Retention time (days)	25
Operation temperature in the digester (°C)	+52
Overall dimensions of the digester, LxWxH (m)	34/6 /6

Number of personnel

Personnel	Shift 1	Shift 2	Shift 3
Chief engineer	1	-	-
Operator	1	1	1
Loader driver	1	1	-

WORKING PRINCIPLE

Dry fermentation is a single-step batch process. The different stages of degradation (i.e., hydrolysis, acid and methane formation) take place in the same garage-type digester. In a batch system, biomass is added to the reactor at the start of the process. The reactor is then sealed for the duration of the process (retention time), the biomass is left to ferment in the digester until the end of retention time. 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 an anaerobic environment i.e. in an oxygen-free tank (biological reactor). In the first stage of fermentation, substrate hydrolysis takes place under acidogenic bacteria influence. In the second stage, elementary organic compounds come through hydrolysis oxidation by means of heteroacidogenic bacteria with the 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 feed stock for methanogenic bacteria in the third stage. This stage flows in two processes of A and B type. The character depends on the 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 particular to their living environment compared to acidogenic bacteria. They require a complete anaerobic environment and need a longer reproduction period. The speed and scale of anaerobic fermentation depends on the bacteria's metabolic activity.

That is why the biogas plant chemical process includes hydrolysis oxidation, and methanization stages. For that kind of substrate these processes take place within the same garage-type digester.

Technological process of biogas production

Feedstocks are transported to the biogas plant area and loaded into digesters one-by-one. Because of the large contact surfaces (floor and wall heating), the fermentation substrate is very quickly heated to the target temperature of approx. 55 °C. After closing and sealing the gate, blowing with CO_2 (from CHP) has to be done. After removing oxygen from the digester, spraying with preheated percolate is started. As a result of these procedures, the reactor quickly collects heat and reaches the necessary conditions for anaerobic fermentation. The fermentation process is maintained at a temperature of approx. 55 °C for approx. 25 days. During this period, a great quantity of available biodegradable organic elements is converted to biogas.

During the anaerobic phase, the process is monitored for the parameters of temperature, gas production, gas quality (CH_4, CO_2, H_2S, O_2) and percolate supply or amount. As necessary, temperature and the amount of percolate introduced are readjusted fully automatically. In batch operation, the substrate is anaerobically fermented throughout the entire retention time in the digester without additional mixing or agitating. Because no pumps, agitators, or other mixing or conveying equipment is needed, the technology is characterized by extremely high tolerance to mechanical impurities in the substrate. Susceptibility to malfunction or the requisite maintenance or repair expenditure during the gas process is therefore also very low, which applies as well to the operation of the entire facility. To accelerate the anaerobic fermentation process after the digester gates are sealed and immediately stimulate biogas production, the newly filled gas zone of the box digester is once again specifically inertised with gas. This process method occurs early resulting in high gas yields of good quality. At the end of the fermentation cycle, the rinse process is reinitiated in the digester (see above description). The garage-type digesters are equipped with percolate sprinklers with nozzles developed especially by Zorg, to ensure a particularly even and effective percolate distribution over the biomass. The sprayed percolate provides an optimal continuous moistening of the substrate to guarantee the greatest possible gas yields. Leaching percolate is drawn off at the digester floor through a drainage channel with additional side drainage, purified through a separate filter system, tempered in a percolate tank, temporarily stored, and when required, resprayed over the substrate to moisten it. At approx. 55 °C, the fermentation process takes place in the digester within the temperature range of thermophilic bacteria; temperature is modulated by floor and wall heating. Such design ensures optimal heat transfer to the substrate.

Because the heating pipes were already incorporated into their concrete walls during construction of the digesters, no interventions within the digesters themselves are required.

All of this combines to facilitate optimal temperature control within the digesters. After the pretreatment of the biogas, the biogas is compressed to the necessary pressure for

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

MAIN EQUIPMENT

Digester (D-01..08)

The digesters are gas-tight concrete garage-type chambers, where raw materials are loaded using a front loader.
The digesters are located side by side with a common wall to save building materials. The number of reactors is selected in such a way as to have a continuous loading of the daily feed of raw materials to the biogas plant.
The temperature in the insulated digester is controlled by heated floors and walls, as well as the temperature of the bacterial liquid supplied for irrigation (percolate). Heating pipes are installed in the walls and floor of the fermenter during construction, so there are no protruding elements in the digester. The digesters are equipped with hydraulically operated gas tight steel gates.

Specifications

Height:	6,0 m
Width:	6,0 m
Length:	34 m
The total volume:	1224 m^3

Digester gate (DG-01..08)

Digesters have hydraulically operated, gas-tight, steel gates. They have a seal which, when inflated towards the cement entry wall, make the entrance gas-tight. Before the gates are opened, the air in the seal is released. The inflatable seal lies within the gate's edge and is therefore protected from damage. The system is run under light overpressure at 20 hPA, thus categorically preventing any potential form of gas-air explosion, even in the case of leakage.

Specifications

Height:	5,5 m
Width:	5,0 m

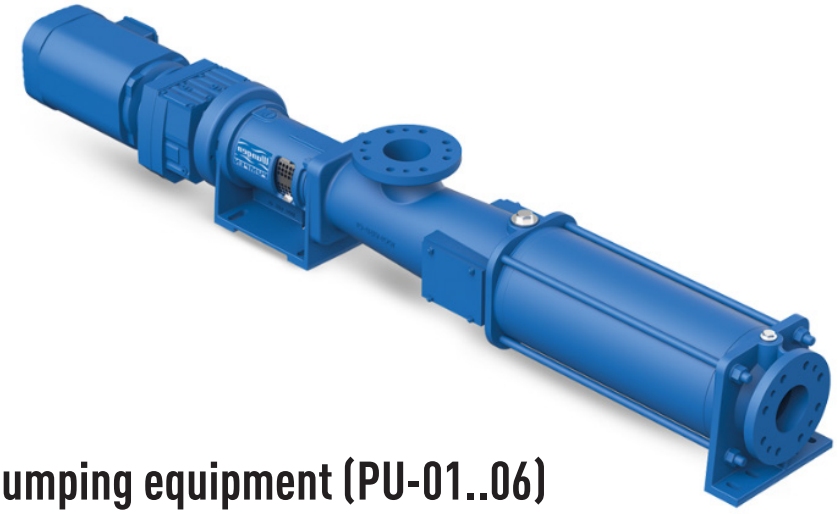
Spray nozzle (set)

In the tunnels the set of spray nozzles is using for spraying the percolate. The spray nozzles have the non clogging nozzle without swirl insert, dust suppression and can use for broadcast spraying, wide area spray (G1'').
(The number of nozzles in one set depends on the geometric dimensions of the tunnel).

Specifications

Connection diameter:	1"
Nozzle's diameter:	100 mm
Quantity (set):	8 pcs.

(1 set- 90 spray nozzles)



Pumping equipment (PU-01..06)

Pumps are used to transport percolate to digesters and back to the percolate tank. Design of a biogas plant provides fast access to all pumps as required. The clear benefit is in the low lifecycle costs. This universally usable pump works with almost every low and extremely high viscous mediums. Good pumping performance is provided in high pressure operation with high operational reliability.
Pumps are modular for high flexibility, low stocking of spare parts, short downtimes for maintenance and repairs, while providing pulse-free transfer, and a long service life, even with difficult media.

Specifications

Flow rate:	25-80 m^3/h
Pressure:	2-6 bar
Engine power:	5.5-22 kW

Percolate tank (PT-01)

Percolate tank is concrete tank with heat system for storing and circulating percolate to digesters. A heating system is installed on internal walls. The tank is equipped with submersible mixers and pump station.

Specifications

Height:	3.0 m
Diameter:	10 m
The total volume:	943 m^3

Gasholder (GH-01)

Gasholder provides biogas storage and equalizing pressure and biogas composition. The gasholder system has a two-layer construction. The external material consists of a weather-proof foil of PVC-coated polyester fabrics with UV protection. Both sides are finished with an external N/5cm, internal PELD (gasholder) membrane.
The gasholder has a methane permeation maximum of 260 cm^3/m^2 * 1 bar biogas resistance. The gasholder foil temperature range allows operation from -30 °C to +60 °C.
The internal foil 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.

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.

Specifications

Height:	9.7 m
Diameter:	12.6 m
The total volume:	800 m^3

Biogas dryer and cooler (CHL-01)

Biogas always contains water vapor in an unsaturated state. During combustion, the water vapor results in considerable corrosion damage to the gas engines and turbines in the cogeneration units. The use of a gas dehumidification system can considerably extend the engines' service life and notably reduce maintenance costs.
A coil is used for the first stage. For the second stage is used biogas dryer and cooler (chiller).
The strong galvanized steel beam structure supports the dryer and features an industrial chiller with an integrated hydraulic module and a thermally insulated drying system, in turn formed by a gas/water heat exchanger, an economizer exchanger and a condensate separation and drain system. All parts in contact with the biogas are in stainless steel, ensuring stable and secure operation through time.

Specifications

Gas volume flow:	400 m^3/h
Gas inlet temperature:	+55 °C
Gas outlet temperature:	+10 °C
Power consumption:	27.2 kW

Biogas compressor(BC-01..02)

A gas compressor is a device used to move gas and increase pressure by use of a rotating impeller within a toroidal channel, resulting in a progressive increase of energy. The blower is used to transport biogas from the gasholder to end-usage unit (cogeneration power plant in our case).

Specifications

Flow rate:	400 m^3/h
Pressure:	150 mbar
Engine power:	8,5 kW
Quantity:	2 pcs/

Desulphurization system (CF-01)

The desulfurization system is a one-step purification of sulfur that is contained in the biogas. The unit is a biogas cleaning system using activated charcoal filtration. Activated charcoal has the property to absorb sulfur. After passing through the activated charcoal filters, the sulfur concentration is reduced to 20 ppm.

Specifications

The volume of charcoal:	200 kg
Numbers of charcoal columns:	1 pcs.

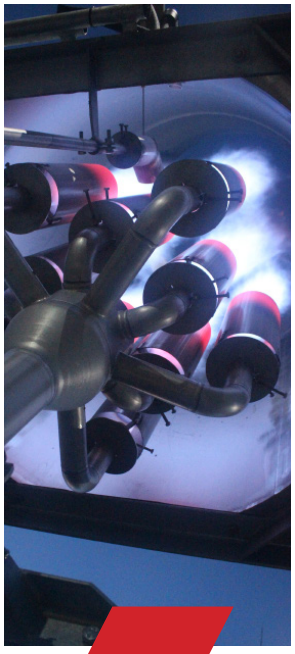
Biological desulphurisation reactor (DS-01)

The bio-bed reactor plant is inoculated with the selected micro-organisms which are immobilised on the filling material. The reactor is delivered and assembled together with a container made of polypropylene with a flat bottom and a cone roof. A grate made of synthetic material is integrated into the container. The filling material is inside of it. The micro-organism suspension is pumped into the circulation and the H2S dissolved into it. Micro-organisms of the Thiobacillus (Thiooxidans) type are used. These bacteria are chemolithotrophs and use carbon dioxide as their carbon source. Oxygen in the form of air is needed for their metabolism. The air addition is regulated over flow of biogas volume stream. A signal (4...20 mA) of the biogas volume stream is required. Air is provided by a fan, which is controlled with a frequency converter. The container is made in PP. The heating is not necessary. All pipes are made of PVC or PP (due to the low pH value of the suspension). The switchboard and the complete technology are installed in a room made of PP which is fixed to the container. A secure ATEX-shutdown is installed on a second switchboard outside the technology room. The pipes for the gas are DN=200 in size for each pipe.

The advantages of biological desulphurisation plants against other processes such as activated carbon filters or chemical washers are that there is no extra use of chemicals. Sulphur removal is 94% from 2500 ppm to 150 ppm.

The bio-bed reactor plant is the first step of biogas two-stage cleaning from sulfide (H2S)

Flow rate:	400 Nm³/h
Electrric power demand:	11,5 kW
Quantity:	1 pcs.



Biogas flare (BF-01)

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

Specifications

Flow rate:	400 m^3/h

Gas analyzer (CH_4, CO_2, H_2S) (GA-01)

The gas analyzer is a combined measuring device. It consists of a fixed Control block and a mobile gas measuring device.
The Control block is designed for the automatic measurement and monitoring of the amount* and composition of gases produced in biogas plants.
The device measures the gas compositions at the individual measuring locations sequentially.
The mobile gas measuring device is usually docked to the Control box via the docking station (stationary measurements).
As an option, mobile measurements can be taken at selected measuring locations. The gas measuring device is removed from the Control docking station to carry out the measurement.

Specifications

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

Cogeneration Power Plant (CHP-01)

A cogeneration power plant (CHP) is used for producing electricity and heat. CHP is a very efficient technology for generating electricity and heat together. A CHP plant is an installation where there is simultaneous generation of usable electric power and heat in a single process, and it can provide a secure and highly efficient method of generating electricity and heat at the point of use. Due to the utilization of heat from electricity generation and the avoidance of transmission losses, due to electricity being generated on site, CHP typically achieves a 35 per cent reduction in primary energy usage compared with power stations and heat only boilers. This allows for economic savings where there is a suitable balance between heat and power loads. Another important factor, showing the benefits of cogeneration and CHP, is its low environmental impact. CHP produces lower quantities of pollutant emissions and heat pollution of the atmosphere. The current mix of CHP installations achieves a reduction of over 10 per cent in CO2 emissions in comparison with combined-cycle gas turbines.

Specifications

Produced electric power	1000 kW
Produced heat power	591 kW
Emissions	NOx < 500 mg/Nm³ (5% O2)
Generator	400V, 50Hz
Quantity:	1 pcs

Heating system

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

Specifications

Circulating pump feeding water network at heat station	
Flow	110 m³/h
Pressure	1,1 bar
Engine	7,5 kW

The pumping station feeding propylene glycol	
Flow	1,0 m³/h
Pressure	4 bar
Engine	0,775 kW

Circulating pump feeding network water at ITB	
Flow rate	27,3 m³/h
Pressure	1 bar
Engine	1,5 kW

Circulating pump feeding water network in the digester	
Flow	12,65 m³/h
Pressure	1,1 bar
Engine	1,1 kW

Circulating pump feeding network water heating	
Flow	0,6 m³/h
Pressure	1 bar
Engine	0,165 kW

Circulating pump feeding water on the network percolate tank	
Flow	1,9 m³/h
Pressure	1 bar
Engine	0,55 kW

Dry cooler (cooling substrate system) (DC-01..08)

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

Power (cooling)	100 kW
Length:	3,0 m
Width:	2,5 m
Height:	1,5 m
Power electrical	4 kW
Quantity:	8 pcs

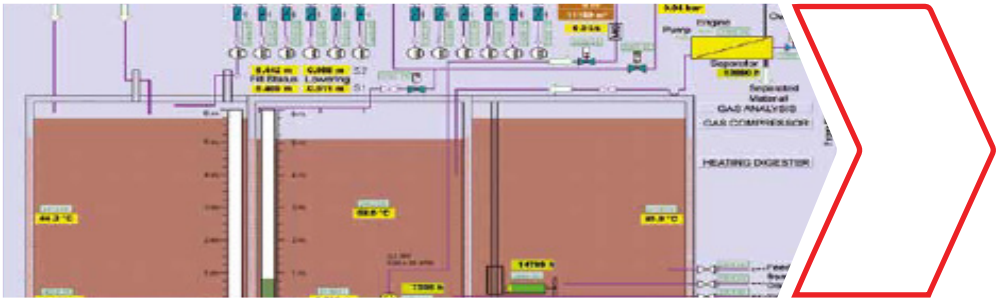
Water supply and sewerage system

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

Specifications

Water supply pump	
Pressure	2,5 bar
Flow	25 m³/h
Engine	5,5 kW
Submersible pump	
Pressure	1,1 bar
Flow	180 m³/h
Engine	7,5 kW
Submersible pump with power cable	
Pressure	1,1 bar
Flow	1,7 l / s
Engine	0,9 kW

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



Electrical and automation 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. Necessary electrically driven devices are supplied with emergency power. An automatic system allows the supervision of plant parameters in real-time and to recognize and correct aberrations immediately; to run the plant at its optimum and thereby to save resources and costs; to make recordings to the logs of operating parameters. The automatic system consists of control cabinet, sensors for parameter control of technological processes and execution devices.

The control cabinet is designed based on the industrial controller Siemens CPU315-DP2 using a peripheral distribution system Simatic ET200S and operator panel OP277 Touch with touch-sensitive control. Communication is executed by PROFIBUS and MPI with the physical interface RS-485. The control program is designed based on Simatic Step7. The control cabinet is a modular design. The upper part has a power box with a central and front-end processor. Below the peripheral distributing system, the Simatic ET200S is installed with an input/output unit. In the lower section, the interface relay and switches are installed for connecting of execution devices. The entire plant is operated by a single operator.

Specifications

Incoming control case with automatic set
Base Siemens CPU315-DP2 controller
Peripherals Simatic ET200S
Control panel OP277 touchscreen
Communication PROFIBUS and MPI
Interface RS-485
Control system Simatic Step7

EQUIPMENT SPECIFICATION LIST

Nr.	Equipment	Characteristic	Q-ty
1	**Safety valve**		**8**
2	**Digester equipment**		**8**
2.1	Hermetic gate		8
2.2	Spray nozzles	set	8
2.3	Sewage pipeline flanges	set	8
2.4	Heating pipes supporting structures	set	8
3	**Percolate pump**	**5,5 kW**	**3**
4	**Biogas flow meter**		**8**
5	**Air supply system**	**set**	**1**
5.1	Compressor	Q=210 l/min P=3,0 atm N=2,2 kW	
5.2	Air fan	Q=800 l/h P=1500 Pa N=1,1 kW	
5.3	Solenoid valve		
5.4	Rotameter	1-50 m^3	
5.5	Filter-regulator	G1/2"	
5.6	Manometer	G1/8 16 bar	
5.7	Manometer	P=0...0.4 bar	
5.8	Pressure regulator	M112; G1/2"	
5.9	Back-flow prevention valve	G1/2"	

Nr.	Equipment	Characteristic	Q-ty
6	**Submersible mixer**	**N = 7.5 kW**	**1**
6.1	Airtight motor gearbox		1
6.2	Mixer control mechanism (high-quality structural galvanized steel)	set	1
6.3	Electric motor mount (high-quality structural galvanized steel)	set	1
6.4	Support (high-quality structural galvanized steel)	set	1
7	**Sewage percolate pump**	**5,5 kW**	**3**
8	**PVC external gasholder, complete, disassembled**	**Ø12,6 m**	**1**
8.1	Weather protection foil	Ø12,6 m	1
8.2	Gasholder foil PELD methane permeation max.260 cm3/m2*d*1 bar, 650 N/5cm biogas resistant		1
8.3	Air blower	0,5kW	1
8.4	Excess and minimum pressure valve		1
8.5	Dome level sensor		1
8.6	Mounting system		1
8.7	Accessories		1
9	**Safety valve**		**1**
10	**Air blower**	**0,5 kW**	**1**
11	**Biogas Cooler System**	**375 m³/h**	**1**
11.1	Chiller		1
11.2	Heat exchanger		1
11.3	Polypropylene glycol tank		1
12	**Biogas compressor**	**Q=450 m³/h N=4.2 kW**	**2**

Nr.	Equipment	Characteristic	Q-ty
13	**Activated coal filters**	**200 kg**	**1**
14	**Gas analyzer (CH_4, CO_2, H_2S)**		**1**
15	**Co-generator**	**1000 kW**	1
15.1	V-engine		
15.2	Generator		
15.3	Power distributor		
15.4	Heat exchanger water-water		
15.5	Gas and fire alarm system		
15.6	Heat water pump		
15.7	Gas pressure amplifier		
15.8	Sensor system		
15.9	Muffler		
15.10	Gas piping with stop valves		
15.11	Oil system		
15.12	Cooling system		
16	**Biogas flare**	**400 m^3/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	**The heat supply system, complete, disassembled**	set	
17.1	Diaphragm expansion tank	V=1.000 l P=6 bar T=120 °C	2

Nr.	Equipment	Characteristic	Q-ty
17.2	Circulating pump for supplying network water	Q=27,3 m³/h H=1 bar N=1,5 kW DN65	4
17.3	Circulation pump for supplying heating water to the office building	Q=0,6 m³/h H=1 bar N=0,165 kW	2
17.4	Propylene glycol feed pump station heating systems comprising: - Thread make-up pump. 1 '' connections - 24 L diaphragm tank - pressure switch -P= 0 ... 6 bar - pressure gauge - 1" straight hose (anti-vibration sleeve) - 5-way connections	Q=1,0 m³/h H=4 bar N=0,775 kW 220 V	2
17.5	Circulation pump for supplying network water to the fermenter	Q=12,65 m3/h H=1.1 bar N=1,1 kW, DN32	4
18	**Water supply and sewerage system, complete, disassembled**		**1**
18.1	Drainage pump	H=4 m Q=0,28 l/sec N=0,24 kW	1
18.2	Electric rubber wedge damper	DN 80	3
18.3	Water supply pump station Pump N = 5.5 kW - 2 Pressure tank with a volume of 18l - 1 Pressure switch (dry run protection) - 1 Pressure switch (on the drain valve) - 2 Dial gauge - 1 Base plate - 1 Pump control cabinet - 1 Damper - 2 Dial gauge - 1 Check valve - 1 The collector soaking up (giving) - 2	Q=25 m³/h N=5.5 kW U=3x3x380-415V	1
18.4	Submersible pump	H=11 m Q=180 m³/h N=7,5 kW	1
18.5	Float switch		1
18.6	Pump control cabinet LCD108.400.3.20.SD (GB / DK / S / RU)		1
18.7	Submersible pump with 10 m power cable and float switch	H=10,3 m Q= 1,7 l/sec N=0,9 kW	1

Nr.	Equipment	Characteristic	Q-ty
19	**Dry-cooler**		**8**
20	**Sensor set**		
20.1	Conductivity sensor	31SCM50	8
20.2	Pressure / level sensor	SEN-3251 B025 G1	8
20.3	Ultrasonic sensor	SPA-380-08 (0-6 m)	8
20.4	Gas pressure sensor	SEN 3276 B156 G1/2	8
20.5	Thermal converter	TR10-B-M-DZZ-KTA-2-QRZZM-150-DCK-CE-R-00735-ZZ	8
20.6	Thermowells for thermocouples	TR10-B	8
20.7	Thermal converter heating circuit	TR30-P-Z-Z-A-ZZZ-13R-DBB-ZZZZ-B000025-ZZ	8
20.8	Substrate pressure sensor	SEN-3251 B055 G1 4Bar	8
20.9	Substrate pressure sensor	SEN-3251 B045 G1 2,5Bar	8
20.10	Coolant pressure sensor	SEN 3276 B065 G1/2 6 bar (87psi)	8
20.11	Immersion level sensor	LS-10 0,6 bar 4-20 mA	8
20.12	Humidity and gas temperature sensor	ESFTF-I	8
21	**Biological desulphurisation reactor**	**400 m3/h**	**1**

ANNEXES

	Day	Digester 1	Digester 2	Digester 3	Digester 4	Digester 5	Digester 6	Digester 7	Digester 8
	1	Loading 100 t							
	2	Loading 100 t							
	3	Loading 100 t							
	4	Loading 100 t							
1	5	Percolate sprayed	Loading 100 t						
2	6	Percolate sprayed	Loading 100 t						
3	7	Percolate sprayed	Loading 100 t						
4	8	Percolate sprayed	Loading 100 t						
5	9	Percolate sprayed	Percolate sprayed	Loading 100 t					
6	10	Percolate sprayed	Percolate sprayed	Loading 100 t					
7	11	Percolate sprayed	Percolate sprayed	Loading 100 t					
8	12	Percolate sprayed	Percolate sprayed	Loading 100 t					
9	13	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t				
10	14	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t				
11	15	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t				
12	16	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t				
13	17	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t			
14	18	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t			
15	19	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t			
16	20	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t			
17	21	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t		
18	22	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t		
19	23	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t		
20	24	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t		
21	25	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t	
22	26	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t	
23	27	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t	
24	28	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t	
25	29	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t
26	30	Drying	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t
27	31	Drying	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t
28	32	Discharge400 t	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t
	1	Loading 100 t	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed
	2	Loading 100 t	Drying	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed
	3	Loading 100 t	Drying	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed
	4	Loading 100 t	Discharge400 t	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed
	5	Percolate sprayed	Loading 100 t	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed
	6	Percolate sprayed	Loading 100 t	Drying	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed
	7	Percolate sprayed	Loading 100 t	Drying	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed
	8	Percolate sprayed	Loading 100 t	Discharge400 t	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed
	9	Percolate sprayed	Percolate sprayed	Loading 100 t	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed
	10	Percolate sprayed	Percolate sprayed	Loading 100 t	Drying	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed
	11	Percolate sprayed	Percolate sprayed	Loading 100 t	Drying	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed
	12	Percolate sprayed	Percolate sprayed	Loading 100 t	Discharge400 t	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed
	13	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed
	14	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t	Drying	Percolate sprayed	Percolate sprayed	Percolate sprayed
	15	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t	Drying	Percolate sprayed	Percolate sprayed	Percolate sprayed
	16	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t	Discharge400 t	Percolate sprayed	Percolate sprayed	Percolate sprayed
	17	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t	Percolate sprayed	Percolate sprayed	Percolate sprayed
	18	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t	Drying	Percolate sprayed	Percolate sprayed
	19	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t	Drying	Percolate sprayed	Percolate sprayed
	20	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t	Discharge400 t	Percolate sprayed	Percolate sprayed
	21	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t	Percolate sprayed	Percolate sprayed
	22	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t	Drying	Percolate sprayed
	23	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t	Drying	Percolate sprayed
	24	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t	Discharge400 t	Percolate sprayed
	25	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t	Percolate sprayed
	26	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t	Drying
	27	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t	Drying
	28	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t	Discharge400 t
	29	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t
	30	Drying	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t
	31	Drying	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t
	32	Discharge400 t	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Percolate sprayed	Loading 100 t

Basic diagram

municipal solid waste

Air

Sulphate

Electrical energy

Water to start

Explication of equipment

N/№	Name	Amount
HG-01...HG-08	Hermetic gate gateway type	8
SNS-01...SNS-08	Spray nozzles (set)	8
BFM-01...BFM-08	Biogas flow meter	8
HS-01...HS-08	Heating system	8
SV-01...SV-08	Pressure safety valve	8
AC-01	Air compressor	1
PU-01...03	Percolate pump	3
PU-04...06	Sewage percolate pump	3
AG-01	Submirsible mixer	1
GH-01	Gasholder	1
CHL-01	Biogas cooling system	1

N/№	Name	Amount
BC-01, BC-02	Biogas compressor	2
CF-01	Desulfurization system	1
DS-01	Biological desulphurisation reactor	1
GA-01	Gas analyzer	1
BMF-05	Electromagnetic flow meter	1
BF-01	Biogas flare	1
CHP-01	Cogeneration power plant	1
DC-01...DC-08	Digester cooling system	8
CS-01	Chemical reagent supply station	1

Explication of buildings

N/№	Name	Amount
D-01...D-08	Digester V=828 m³	8
PT-01	Percolate tank V=800 m³	1
HS-01	Boiler / operator room	1

Legend main pipelines

- TA — Technological pipeline of air
- TP — Technological pipeline of percolate
- BG1 — Biogas
- BG1 — Biogas
- HS — Heat system pipeline
- HS — Heat system pipeline
- WS — Water supply

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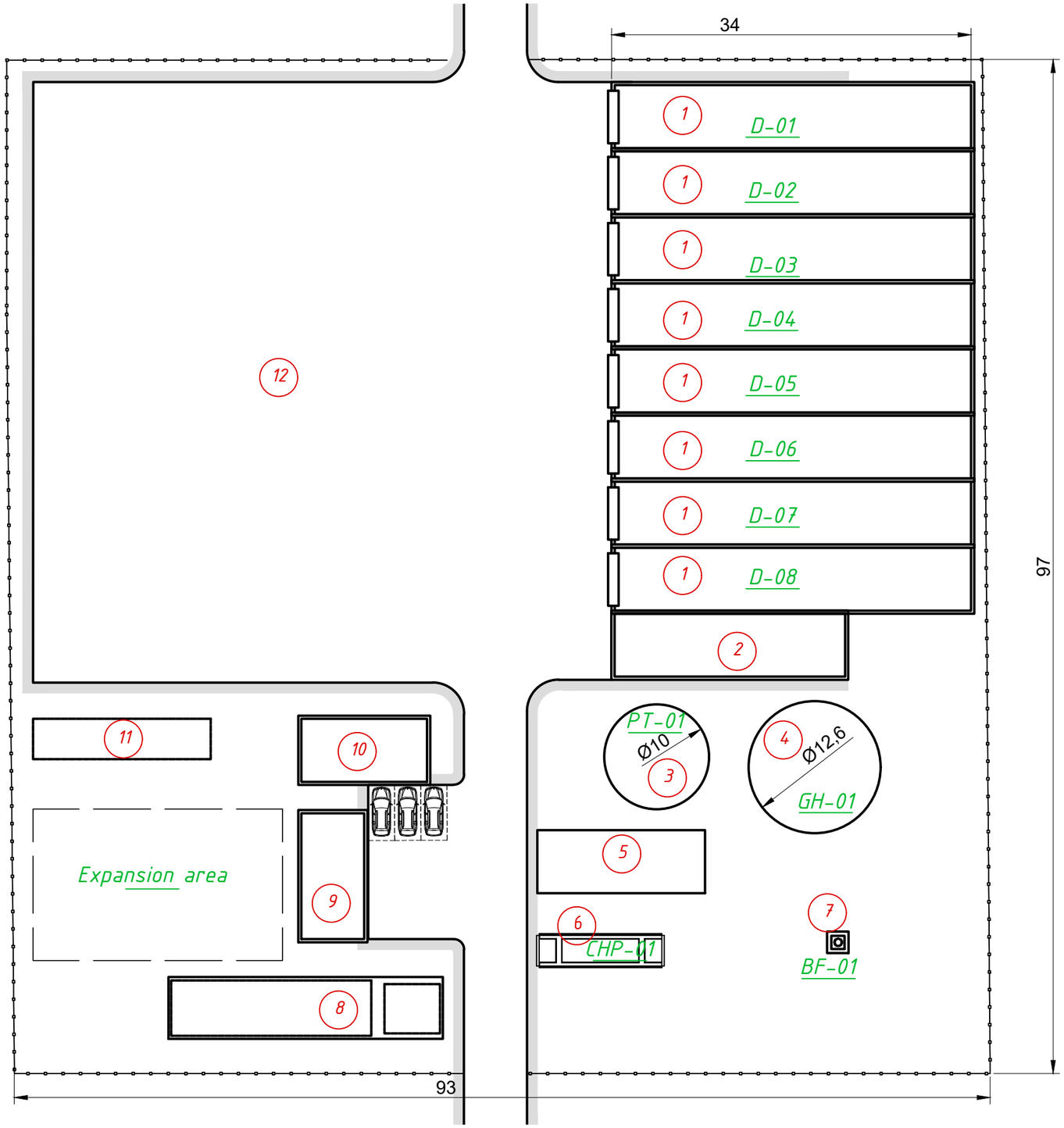
Plan



Explication

N/№	Name	Note
1	Digester (D01..08)	
2	Equipment room	
3	Percolate tank (PT-01)	
4	Gasholder (GH-01)	
5	Gas preparation stage	
6	Cogeneration power plant (CHP-01)	
7	Flare (BF-01)	
8	Water supply pump station & water storage tanks	
9	Warehouse	
10	Administrative building	
11	Rainwater treatment facilities	
12	Composting area	

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Annex 4.

Electrical load

Name equipment	Instal. Pow. (kW)	Q-y (pcs)	Total installed power (kW)	Working hours per day	Consumption kWh per day
Submirsible mixer in percolate tank	7,5	1	7,5	12,0	90,0
Biogas compressor	4,2	1	4,2	24,0	100,8
Biogas cooling system	18,0	1	18,0	24,0	432,0
Electric valve	0,1	16	2,2	0,5	1,1
Circulation pump for supplying network water to the digester	1,1	1	1,1	24,0	26,4
Percolate pump	1,5	3	4,5	24,0	108,0
Sewage percolate pump	1,5	3	4,5	24,0	108,0
Air compressor for gasholder lock	1,5	1	1,5	24,0	36,0
Air blower for double membrane	1,0	1	1,0	24,0	24,0
Co-generator 1000 kW	7,0	1	7,0	24,0	168,0
Circulating pump feeding water network at co-generator	2,5	1	2,5	24,0	60,0
Circulating pump feeding network water at technical building	1,5	1	1,5	24,0	36,0
Biologacal Desulphurization reactor	7,5	1	7,5	25,0	187,5
Propylene glycol pump station	0,8	1	0,8	0,5	0,4
Drinage pump	2,1	1	2,1	0,5	1,1
Lighting of the biogas plant territory	1,0	1	1,0	12,0	12,0
Working lighting of switchboard	0,1	1	0,1	0,5	0,1
Digester cooling system	4,0	8	32,0	at t>55°C	
Circulation pump for supplying network water to the digester cooling system	2,0	8	16,0		
Desulphurization system compressor	1,5	1	1,5	24,0	36,0
Biogas analyzer	0,1	1	0,1	24,0	2,4
Total instal power, kW			**116,7**		
Total consumed electric energy, kWh per day					**1429,7**
Total consumer power, kWh per hour					**59,6**

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Equipment price

Pos.	Description	Quantity	Unit Price, EUR	Total Price, EUR
1	Digester gate (h= 6m)	8	75 000,00	600 000,00
2	Spray nozzles (set)	8	9 000,00	72 000,00
3	Percolate pump	3	19 000,00	57 000,00
4	Percolate pump (drainage)	3	19 000,00	57 000,00
5	Submersible mixer for percolate tank (7,5 kW)	1	15 000,00	15 000,00
6	Gasoholder external 800 m^3	1	85 000,00	85 000,00
7	Gas analyzer	1	25 700,00	25 700,00
8	Biogas flow meter	1	8 100,00	8 100,00
9	Biogas blower 400 m3/hour	2	3 000,00	6 000,00
10	Biogas burner 400 m3/hour	1	57 000,00	57 000,00
11	Biogas cooling system 375 m3/hour	1	35 000,00	35 000,00
12	Biological desulphurisation reactor 400 m3/hour	1	127 000,00	127 000,00
13	Desulfurization system 300 kg	1	35 000,00	35 000,00
14	Gas conditioning unit 400 m3/hour	1	65 000,00	65 000,00
15	Heat supply station, as a unit, knocked-down.	1	26 100,00	26 100,00
16	Automatic with electric equipment, as a unit	1	220 000,00	220 000,00
17	Motorized valves (set)	16	5 600,00	89 600,00
18	Sensors (set)	1	80 000,00	80 000,00
19	Water supply and canalization system, as a unit.	1	15 600,00	15 600,00
20	Air supply system, as a unit.	1	11 900,00	11 900,00
21	Digester dry-cooler 100 kW	8	7 000,00	56 000,00
	TOTAL (EXW, Memmingen, Germany):			**1 744 000,00**

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Price

Equipment made in: Germany

Name	Price (EXW, Memmingen)
Project documentation	78 000 Euro
Start-up&training + living&travel	50 000 Euro
Supervision&adjustment + living&travel	50 000 Euro
Equipment	1 744 000 Euro
CHP plant Jenbacher 1063 kWel	540 000 Euro
Delivery	60 000 Euro
Construction (local in India)	1 000 000 Euro
Total	3 522 000 Euro

Implementation terms and payment

Months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Data collection																
Project documentation	50%			50%												
Obtaining permits																
Equipment supply			50%			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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