

01

version

Proposal

Biogas plant
11,5 MW brutto/10 MW
netto using Napier grass
built in stages



Date: 06/05/2025

Validity: 8 months



CONTENT

Overview	3
Raw material potential	4
Biogas plant characteristics	5
Working principle	6
Technological process of biogas production	7
Main equipment	8
Solid feeder	9
Receiving tank and Filtrate tank	10
Submersible mixer	11
Reactor	12
Reactor vertical agitator	13
Window with spotlight	14
Pump equipment	15
Separator	16
Gasholder	17
Biogas cooling system	18
Biogas compressor	19
Desulphurization system	20
Cogeneration power plant	21
Biogas burner	22
Water supplying and sewerage system	23
Heating system	24
Dry cooler (cooling substrate system)	25
Automation and electrical equipment	26
Gas analyzer	27
Sensors set	28
Laboratory	29
Bibliography list	30
Annexes:	35
Annex 1 Material overview	36
Annex 2.1 Basic diagram (Stage 1)	37
Annex 2.1 Basic diagram (Stage 2)	38
Annex 3.1 Plan of biogas plant (Stage 1)	39
Annex 3.2 Plan of biogas plant (Stage 2)	40
Annex 4.1 Electric power consumption (Stage 1)	41
Annex 4.2 Electric power consumption (Stage 2)	42
Annex 5. Implementation terms and payment	43



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 10 MW electrical power just 5 HLRs x 4521 m³ are enough.

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.

The implementation of the project will be carried out in 2 stages.

Raw material potential

I stage

Substrate	Quantity (tonnes/day)	Quantity (tonnes/year)	DM *content: (%)	ODM** content (%)	DM quantity (tonne s/ day)	ODM quantity (tonnes / day)	Biogas yield (m ³ /)	Biogas (m ³ /day)	Methane content (%)	Biogas (m ³ /year)
Napier grass	105	38 300	33	96	34,63	33,24	690	22 937	52	8 372 000

II stage

Substrate	Quantity (tonnes/day)	Quantity (tonnes/year)	DM *content: (%)	ODM** content (%)	DM quantity (tonne s/ day)	ODM quantity (tonnes / day)	Biogas yield (m ³ /)	Biogas (m ³ /day)	Methane content (%)	Biogas (m ³ /year)
Napier grass	526	191 808	33	96	173,42	166,48	690	114 870	52	41 927 600

*-DM- Dry matter

**-oDM- organic dry matter

Biogas plant characteristics

Characteristics	Values	Figures
Number of reactors	units	5
a) volume:		
Work	m ³	3680
Overall	m ³	3434
b) Organic load	kgODM/ m ³	9.03
c) Hydraulic retention time (gross)	days	35/33
d) Overall dimensions of the reactor (diameter / height)	m	25.0/7.5
e) Temperature	°	+52
Gasholder (external)		
a) Volume	m ³	2500
b) Number of gasholders	units	1
c) Dimensions of the gasholder (diameter / height)	m	18.2/13.9

Number of personnel

	Shift 1	Shift 2	Shift 3
Director	1	-	-
Operator	1	1	1
Driver	1	-	-
Electrician	1	-	-
Mechanic	2	-	-
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 $C_2H_5CO_2$ - $C_3H_7CO_2$ - $C_4H_9CO_2$ - $C_5H_{11CO_2}$ - $C_6H_{13CO_2}$ - $C_7H_{15CO_2}$ - $C_8H_{17CO_2}$ - $C_9H_{19CO_2}$ - $C_{10}H_{21CO_2}$ - $C_{11}H_{23CO_2}$ - $C_{12}H_{25CO_2}$ - $C_{13}H_{27CO_2}$ - $C_{14}H_{29CO_2}$ - $C_{15}H_{31CO_2}$ - $C_{16}H_{33CO_2}$ - $C_{17}H_{35CO_2}$ - $C_{18}H_{37CO_2}$ - $C_{19}H_{39CO_2}$ - $C_{20}H_{41CO_2}$ - $C_{21}H_{43CO_2}$ - $C_{22}H_{45CO_2}$ - $C_{23}H_{47CO_2}$ - $C_{24}H_{49CO_2}$ - $C_{25}H_{51CO_2}$ - $C_{26}H_{53CO_2}$ - $C_{27}H_{55CO_2}$ - $C_{28}H_{57CO_2}$ - $C_{29}H_{59CO_2}$ - $C_{30}H_{61CO_2}$ - $C_{31}H_{63CO_2}$ - $C_{32}H_{65CO_2}$ - $C_{33}H_{67CO_2}$ - $C_{34}H_{69CO_2}$ - $C_{35}H_{71CO_2}$ - $C_{36}H_{73CO_2}$ - $C_{37}H_{75CO_2}$ - $C_{38}H_{77CO_2}$ - $C_{39}H_{79CO_2}$ - $C_{40}H_{81CO_2}$ - $C_{41}H_{83CO_2}$ - $C_{42}H_{85CO_2}$ - $C_{43}H_{87CO_2}$ - $C_{44}H_{89CO_2}$ - $C_{45}H_{91CO_2}$ - $C_{46}H_{93CO_2}$ - $C_{47}H_{95CO_2}$ - $C_{48}H_{97CO_2}$ - $C_{49}H_{99CO_2}$ - $C_{50}H_{101CO_2}$ - $C_{51}H_{103CO_2}$ - $C_{52}H_{105CO_2}$ - $C_{53}H_{107CO_2}$ - $C_{54}H_{109CO_2}$ - $C_{55}H_{111CO_2}$ - $C_{56}H_{113CO_2}$ - $C_{57}H_{115CO_2}$ - $C_{58}H_{117CO_2}$ - $C_{59}H_{119CO_2}$ - $C_{60}H_{121CO_2}$ - $C_{61}H_{123CO_2}$ - $C_{62}H_{125CO_2}$ - $C_{63}H_{127CO_2}$ - $C_{64}H_{129CO_2}$ - $C_{65}H_{131CO_2}$ - $C_{66}H_{133CO_2}$ - $C_{67}H_{135CO_2}$ - $C_{68}H_{137CO_2}$ - $C_{69}H_{139CO_2}$ - $C_{70}H_{141CO_2}$ - $C_{71}H_{143CO_2}$ - $C_{72}H_{145CO_2}$ - $C_{73}H_{147CO_2}$ - $C_{74}H_{149CO_2}$ - $C_{75}H_{151CO_2}$ - $C_{76}H_{153CO_2}$ - $C_{77}H_{155CO_2}$ - $C_{78}H_{157CO_2}$ - $C_{79}H_{159CO_2}$ - $C_{80}H_{161CO_2}$ - $C_{81}H_{163CO_2}$ - $C_{82}H_{165CO_2}$ - $C_{83}H_{167CO_2}$ - $C_{84}H_{169CO_2}$ - $C_{85}H_{171CO_2}$ - $C_{86}H_{173CO_2}$ - $C_{87}H_{175CO_2}$ - $C_{88}H_{177CO_2}$ - $C_{89}H_{179CO_2}$ - $C_{90}H_{181CO_2}$ - $C_{91}H_{183CO_2}$ - $C_{92}H_{185CO_2}$ - $C_{93}H_{187CO_2}$ - $C_{94}H_{189CO_2}$ - $C_{95}H_{191CO_2}$ - $C_{96}H_{193CO_2}$ - $C_{97}H_{195CO_2}$ - $C_{98}H_{197CO_2}$ - $C_{99}H_{199CO_2}$ - $C_{100}H_{201CO_2}$ - $C_{101}H_{203CO_2}$ - $C_{102}H_{205CO_2}$ - $C_{103}H_{207CO_2}$ - $C_{104}H_{209CO_2}$ - $C_{105}H_{211CO_2}$ - $C_{106}H_{213CO_2}$ - $C_{107}H_{215CO_2}$ - $C_{108}H_{217CO_2}$ - $C_{109}H_{219CO_2}$ - $C_{110}H_{221CO_2}$ - $C_{111}H_{223CO_2}$ - $C_{112}H_{225CO_2}$ - $C_{113}H_{227CO_2}$ - $C_{114}H_{229CO_2}$ - $C_{115}H_{231CO_2}$ - $C_{116}H_{233CO_2}$ - $C_{117}H_{235CO_2}$ - $C_{118}H_{237CO_2}$ - $C_{119}H_{239CO_2}$ - $C_{120}H_{241CO_2}$ - $C_{121}H_{243CO_2}$ - $C_{122}H_{245CO_2}$ - $C_{123}H_{247CO_2}$ - $C_{124}H_{249CO_2}$ - $C_{125}H_{251CO_2}$ - $C_{126}H_{253CO_2}$ - $C_{127}H_{255CO_2}$ - $C_{128}H_{257CO_2}$ - $C_{129}H_{259CO_2}$ - $C_{130}H_{261CO_2}$ - $C_{131}H_{263CO_2}$ - $C_{132}H_{265CO_2}$ - $C_{133}H_{267CO_2}$ - $C_{134}H_{269CO_2}$ - $C_{135}H_{271CO_2}$ - $C_{136}H_{273CO_2}$ - $C_{137}H_{275CO_2}$ - $C_{138}H_{277CO_2}$ - $C_{139}H_{279CO_2}$ - $C_{140}H_{281CO_2}$ - $C_{141}H_{283CO_2}$ - $C_{142}H_{285CO_2}$ - $C_{143}H_{287CO_2}$ - $C_{144}H_{289CO_2}$ - $C_{145}H_{291CO_2}$ - $C_{146}H_{293CO_2}$ - $C_{147}H_{295CO_2}$ - $C_{148}H_{297CO_2}$ - $C_{149}H_{299CO_2}$ - $C_{150}H_{301CO_2}$ - $C_{151}H_{303CO_2}$ - $C_{152}H_{305CO_2}$ - $C_{153}H_{307CO_2}$ - $C_{154}H_{309CO_2}$ - $C_{155}H_{311CO_2}$ - $C_{156}H_{313CO_2}$ - $C_{157}H_{315CO_2}$ - $C_{158}H_{317CO_2}$ - $C_{159}H_{319CO_2}$ - $C_{160}H_{321CO_2}$ - $C_{161}H_{323CO_2}$ - $C_{162}H_{325CO_2}$ - $C_{163}H_{327CO_2}$ - $C_{164}H_{329CO_2}$ - $C_{165}H_{331CO_2}$ - $C_{166}H_{333CO_2}$ - $C_{167}H_{335CO_2}$ - $C_{168}H_{337CO_2}$ - $C_{169}H_{339CO_2}$ - $C_{170}H_{341CO_2}$ - $C_{171}H_{343CO_2}$ - $C_{172}H_{345CO_2}$ - $C_{173}H_{347CO_2}$ - $C_{174}H_{349CO_2}$ - $C_{175}H_{351CO_2}$ - $C_{176}H_{353CO_2}$ - $C_{177}H_{355CO_2}$ - $C_{178}H_{357CO_2}$ - $C_{179}H_{359CO_2}$ - $C_{180}H_{361CO_2}$ - $C_{181}H_{363CO_2}$ - $C_{182}H_{365CO_2}$ - $C_{183}H_{367CO_2}$ - $C_{184}H_{369CO_2}$ - $C_{185}H_{371CO_2}$ - $C_{186}H_{373CO_2}$ - $C_{187}H_{375CO_2}$ - $C_{188}H_{377CO_2}$ - $C_{189}H_{379CO_2}$ - $C_{190}H_{381CO_2}$ - $C_{191}H_{383CO_2}$ - $C_{192}H_{385CO_2}$ - $C_{193}H_{387CO_2}$ - $C_{194}H_{389CO_2}$ - $C_{195}H_{391CO_2}$ - $C_{196}H_{393CO_2}$ - $C_{197}H_{395CO_2}$ - $C_{198}H_{397CO_2}$ - $C_{199}H_{399CO_2}$ - $C_{200}H_{401CO_2}$ - $C_{201}H_{403CO_2}$ - $C_{202}H_{405CO_2}$ - $C_{203}H_{407CO_2}$ - $C_{204}H_{409CO_2}$ - $C_{205}H_{411CO_2}$ - $C_{206}H_{413CO_2}$ - $C_{207}H_{415CO_2}$ - $C_{208}H_{417CO_2}$ - $C_{209}H_{419CO_2}$ - $C_{210}H_{421CO_2}$ - $C_{211}H_{423CO_2}$ - $C_{212}H_{425CO_2}$ - $C_{213}H_{427CO_2}$ - $C_{214}H_{429CO_2}$ - $C_{215}H_{431CO_2}$ - $C_{216}H_{433CO_2}$ - $C_{217}H_{435CO_2}$ - $C_{218}H_{437CO_2}$ - $C_{219}H_{439CO_2}$ - $C_{220}H_{441CO_2}$ - $C_{221}H_{443CO_2}$ - $C_{222}H_{445CO_2}$ - $C_{223}H_{447CO_2}$ - $C_{224}H_{449CO_2}$ - $C_{225}H_{451CO_2}$ - $C_{226}H_{453CO_2}$ - $C_{227}H_{455CO_2}$ - $C_{228}H_{457CO_2}$ - $C_{229}H_{459CO_2}$ - $C_{230}H_{461CO_2}$ - $C_{231}H_{463CO_2}$ - $C_{232}H_{465CO_2}$ - $C_{233}H_{467CO_2}$ - $C_{234}H_{469CO_2}$ - $C_{235}H_{471CO_2}$ - $C_{236}H_{473CO_2}$ - $C_{237}H_{475CO_2}$ - $C_{238}H_{477CO_2}$ - $C_{239}H_{479CO_2}$ - $C_{240}H_{481CO_2}$ - $C_{241}H_{483CO_2}$ - $C_{242}H_{485CO_2}$ - $C_{243}H_{487CO_2}$ - $C_{244}H_{489CO_2}$ - $C_{245}H_{491CO_2}$ - $C_{246}H_{493CO_2}$ - $C_{247}H_{495CO_2}$ - $C_{248}H_{497CO_2}$ - $C_{249}H_{499CO_2}$ - $C_{250}H_{501CO_2}$ - $C_{251}H_{503CO_2}$ - $C_{252}H_{505CO_2}$ - $C_{253}H_{507CO_2}$ - $C_{254}H_{509CO_2}$ - $C_{255}H_{511CO_2}$ - $C_{256}H_{513CO_2}$ - $C_{257}H_{515CO_2}$ - $C_{258}H_{517CO_2}$ - $C_{259}H_{519CO_2}$ - $C_{260}H_{521CO_2}$ - $C_{261}H_{523CO_2}$ - $C_{262}H_{525CO_2}$ - $C_{263}H_{527CO_2}$ - $C_{264}H_{529CO_2}$ - $C_{265}H_{531CO_2}$ - $C_{266}H_{533CO_2}$ - $C_{267}H_{535CO_2}$ - $C_{268}H_{537CO_2}$ - $C_{269}H_{539CO_2}$ - $C_{270}H_{541CO_2}$ - $C_{271}H_{543CO_2}$ - $C_{272}H_{545CO_2}$ - $C_{273}H_{547CO_2}$ - $C_{274}H_{549CO_2}$ - $C_{275}H_{551CO_2}$ - $C_{276}H_{553CO_2}$ - $C_{277}H_{555CO_2}$ - $C_{278}H_{557CO_2}$ - $C_{279}H_{559CO_2}$ - $C_{280}H_{561CO_2}$ - $C_{281}H_{563CO_2}$ - $C_{282}H_{565CO_2}$ - $C_{283}H_{567CO_2}$ - $C_{284}H_{569CO_2}$ - $C_{285}H_{571CO_2}$ - $C_{286}H_{573CO_2}$ - $C_{287}H_{575CO_2}$ - $C_{288}H_{577CO_2}$ - $C_{289}H_{579CO_2}$ - $C_{290}H_{581CO_2}$ - $C_{291}H_{583CO_2}$ - $C_{292}H_{585CO_2}$ - $C_{293}H_{587CO_2}$ - $C_{294}H_{589CO_2}$ - $C_{295}H_{591CO_2}$ - $C_{296}H_{593CO_2}$ - $C_{297}H_{595CO_2}$ - $C_{298}H_{597CO_2}$ - $C_{299}H_{599CO_2}$ - $C_{300}H_{601CO_2}$ - $C_{301}H_{603CO_2}$ - $C_{302}H_{605CO_2}$ - $C_{303}H_{607CO_2}$ - $C_{304}H_{609CO_2}$ - $C_{305}H_{611CO_2}$ - $C_{306}H_{613CO_2}$ - $C_{307}H_{615CO_2}$ - $C_{308}H_{617CO_2}$ - $C_{309}H_{619CO_2}$ - $C_{310}H_{621CO_2}$ - $C_{311}H_{623CO_2}$ - $C_{312}H_{625CO_2}$ - $C_{313}H_{627CO_2}$ - $C_{314}H_{629CO_2}$ - $C_{315}H_{631CO_2}$ - $C_{316}H_{633CO_2}$ - $C_{317}H_{635CO_2}$ - $C_{318}H_{637CO_2}$ - $C_{319}H_{639CO_2}$ - $C_{320}H_{641CO_2}$ - $C_{321}H_{643CO_2}$ - $C_{322}H_{645CO_2}$ - $C_{323}H_{647CO_2}$ - $C_{324}H_{649CO_2}$ - $C_{325}H_{651CO_2}$ - $C_{326}H_{653CO_2}$ - $C_{327}H_{655CO_2}$ - $C_{328}H_{657CO_2}$ - $C_{329}H_{659CO_2}$ - $C_{330}H_{661CO_2}$ - $C_{331}H_{663CO_2}$ - $C_{332}H_{665CO_2}$ - $C_{333}H_{667CO_2}$ - $C_{334}H_{669CO_2}$ - $C_{335}H_{671CO_2}$ - $C_{336}H_{673CO_2}$ - $C_{337}H_{675CO_2}$ - $C_{338}H_{677CO_2}$ - $C_{339}H_{679CO_2}$ - $C_{340}H_{681CO_2}$ - $C_{341}H_{683CO_2}$ - $C_{342}H_{685CO_2}$ - $C_{343}H_{687CO_2}$ - $C_{344}H_{689CO_2}$ - $C_{345}H_{691CO_2}$ - $C_{346}H_{693CO_2}$ - $C_{347}H_{695CO_2}$ - $C_{348}H_{697CO_2}$ - $C_{349}H_{699CO_2}$ - $C_{350}H_{701CO_2}$ - $C_{351}H_{703CO_2}$ - $C_{352}H_{705CO_2}$ - $C_{353}H_{707CO_2}$ - $C_{354}H_{709CO_2}$ - $C_{355}H_{711CO_2}$ - $C_{356}H_{713CO_2}$ - $C_{357}H_{715CO_2}$ - $C_{358}H_{717CO_2}$ - $C_{359}H_{719CO_2}$ - $C_{360}H_{721CO_2}$ - $C_{361}H_{723CO_2}$ - $C_{362}H_{725CO_2}$ - $C_{363}H_{727CO_2}$ - $C_{364}H_{729CO_2}$ - $C_{365}H_{731CO_2}$ - $C_{366}H_{733CO_2}$ - $C_{367}H_{735CO_2}$ - $C_{368}H_{737CO_2}$ - $C_{369}H_{739CO_2}$ - $C_{370}H_{741CO_2}$ - $C_{371}H_{743CO_2}$ - $C_{372}H_{745CO_2}$ - $C_{373}H_{747CO_2}$ - $C_{374}H_{749CO_2}$ - $C_{375}H_{751CO_2}$ - $C_{376}H_{753CO_2}$ - $C_{377}H_{755CO_2}$ - $C_{378}H_{757CO_2}$ - $C_{379}H_{759CO_2}$ - $C_{380}H_{761CO_2}$ - $C_{381}H_{763CO_2}$ - $C_{382}H_{765CO_2}$ - $C_{383}H_{767CO_2}$ - $C_{384}H_{769CO_2}$ - $C_{385}H_{771CO_2}$ - $C_{386}H_{773CO_2}$ - $C_{387}H_{775CO_2}$ - $C_{388}H_{777CO_2}$ - $C_{389}H_{779CO_2}$ - $C_{390}H_{781CO_2}$ - $C_{391}H_{783CO_2}$ - $C_{392}H_{785CO_2}$ - $C_{393}H_{787CO_2}$ - $C_{394}H_{789CO_2}$ - $C_{395}H_{791CO_2}$ - $C_{396}H_{793CO_2}$ - $C_{397}H_{795CO_2}$ - $C_{398}H_{797CO_2}$ - $C_{399}H_{799CO_2}$ - $C_{400}H_{801CO_2}$ - $C_{401}H_{803CO_2}$ - $C_{402}H_{805CO_2}$ - $C_{403}H_{807CO_2}$ - $C_{404}H_{809CO_2}$ - $C_{405}H_{811CO_2}$ - $C_{406}H_{813CO_2}$ - $C_{407}H_{815CO_2}$ - $C_{408}H_{817CO_2}$ - $C_{409}H_{819CO_2}$ - $C_{410}H_{821CO_2}$ - $C_{411}H_{823CO_2}$ - $C_{412}H_{825CO_2}$ - $C_{413}H_{827CO_2}$ - $C_{414}H_{829CO_2}$ - $C_{415}H_{831CO_2}$ - $C_{416}H_{833CO_2}$ - $C_{417}H_{835CO_2}$ - $C_{418}H_{837CO_2}$ - $C_{419}H_{839CO_2}$ - $C_{420}H_{841CO_2}$ - $C_{421}H_{843CO_2}$ - $C_{422}H_{845CO_2}$ - $C_{423}H_{847CO_2}$ - $C_{424}H_{849CO_2}$ - $C_{425}H_{851CO_2}$ - $C_{426}H_{853CO_2}$ - $C_{427}H_{855CO_2}$ - $C_{428}H_{857CO_2}$ - $C_{429}H_{859CO_2}$ - $C_{430}H_{861CO_2}$ - $C_{431}H_{863CO_2}$ - $C_{432}H_{865CO_2}$ - $C_{433}H_{867CO_2}$ - $C_{434}H_{869CO_2}$ - $C_{435}H_{871CO_2}$ - $C_{436}H_{873CO_2}$ - $C_{437}H_{875CO_2}$ - $C_{438}H_{877CO_2}$ - $C_{439}H_{879CO_2}$ - $C_{440}H_{881CO_2}$ - $C_{441}H_{883CO_2}$ - $C_{442}H_{885CO_2}$ - $C_{443}H_{887CO_2}$ - $C_{444}H_{889CO_2}$ - $C_{445}H_{891CO_2}$ - $C_{446}H_{893CO_2}$ - $C_{447}H_{895CO_2}$ - $C_{448}H_{897CO_2}$ - $C_{449}H_{899CO_2}$ - $C_{450}H_{901CO_2}$ - $C_{451}H_{903CO_2}$ - $C_{452}H_{905CO_2}$ - $C_{453}H_{907CO_2}$ - $C_{454}H_{909CO_2}$ - $C_{455}H_{911CO_2}$ - $C_{456}H_{913CO_2}$ - $C_{457}H_{915CO_2}$ - $C_{458}H_{917CO_2}$ - $C_{459}H_{919CO_2}$ - $C_{460}H_{921CO_2}$ - $C_{461}H_{923CO_2}$ - $C_{462}H_{925CO_2}$ - $C_{463}H_{927CO_2}$ - $C_{464}H_{929CO_2}$ - $C_{465}H_{931CO_2}$ - $C_{466}H_{933CO_2}$ - $C_{467}H_{935CO_2}$ - $C_{468}H_{937CO_2}$ - $C_{469}H_{939CO_2}$ - $C_{470}H_{941CO_2}$ - $C_{471}H_{943CO_2}$ - $C_{472}H_{945CO_2}$ - $C_{473}H_{947CO_2}$ - $C_{474}H_{949CO_2}$ - $C_{475}H_{951CO_2}$ - $C_{476}H_{953CO_2}$ - $C_{477}H_{955CO_2}$ - $C_{478}H_{957CO_2}$ - $C_{479}H_{959CO_2}$ - $C_{480}H_{961CO_2}$ - $C_{481}H_{963CO_2}$ - $C_{482}H_{965CO_2}$ - $C_{483}H_{967CO_2}$ - $C_{484}H_{969CO_2}$ - $C_{485}H_{971CO_2}$ - $C_{486}H_{973CO_2}$ - $C_{487}H_{975CO_2}$ - $C_{488}H_{977CO_2}$ - $C_{489}H_{979CO_2}$ - $C_{490}H_{981CO_2}$ - $C_{491}H_{983CO_2}$ - $C_{492}H_{985CO_2}$ - $C_{493}H_{987CO_2}$ - $C_{494}H_{989CO_2}$ - $C_{495}H_{991CO_2}$ - $C_{496}H_{993CO_2}$ - $C_{497}H_{995CO_2}$ - $C_{498}H_{997CO_2}$ - $C_{499}H_{999CO_2}$ - $C_{500}H_{1001CO_2}$ - $C_{501}H_{1003CO_2}$ - $C_{502}H_{1005CO_2}$ - $C_{503}H_{1007CO_2}$ - $C_{504}H_{1009CO_2}$ - $C_{505}H_{1011CO_2}$ - $C_{506}H_{1013CO_2}$ - $C_{507}H_{1015CO_2}$ - $C_{508}H_{1017CO_2}$ - $C_{509}H_{1019CO_2}$ - $C_{510}H_{1021CO_2}$ - $C_{511}H_{1023CO_2}$ - $C_{512}H_{1025CO_2}$ - $C_{513}H_{1027CO_2}$ - $C_{514}H_{1029CO_2}$ - $C_{515}H_{1031CO_2}$ - $C_{516}H_{1033CO_2}$ - $C_{517}H_{1035CO_2}$ - $C_{518}H_{1037CO_2}$ - $C_{519}H_{1039CO_2}$ - $C_{520}H_{1041CO_2}$ - $C_{521}H_{1043CO_2}$ - $C_{522}H_{1045CO_2}$ - $C_{523}H_{1047CO_2}$ - $C_{524}H_{1049CO_2}$ - $C_{525}H_{1051CO_2}$ - $C_{526}H_{1053CO_2}$ - $C_{527}H_{1055CO_2}$ - $C_{528}H_{1057CO_2}$ - $C_{529}H_{1059CO_2}$ - $C_{530}H_{1061CO_2}$ - $C_{531}H_{1063CO_2}$ - $C_{532}H_{1065CO_2}$ - $C_{533}H_{1067CO_2}$ - $C_{534}H_{1069CO_2}$ - $C_{535}H_{1071CO_2}$ - $C_{536}H_{1073CO_2}$ - $C_{537}H_{1075CO_2}$ - $C_{538}H_{1077CO_2}$ - $C_{539}H_{1079CO_2}$ - $C_{540}H_{1081CO_2}$ - $C_{541}H_{1083CO_2}$ - $C_{542}H_{1085CO_2}$ - $C_{543}H_{1087CO_2}$ - $C_{544}H_{1089CO_2}$ - $C_{545}H_{1091CO_2}$ - $C_{546}H_{1093CO_2}$ - $C_{547}H_{1095CO_2}$ - $C_{548}H_{1097CO_2}$ - $C_{549}H_{1099CO_2}$ - $C_{550}H_{1101CO_2}$ - $C_{551}H_{1103CO_2}$ - $C_{552}H_{1105CO_2}$ - $C_{553}H_{1107CO_2}$ - $C_{554}H_{1109CO_2}$ - $C_{555}H_{1111CO_2}$ - $C_{556}H_{1113CO_2}$ - $C_{557}H_{1115CO_2}$ - $C_{558}H_{1117CO_2}$ - $C_{559}H_{1119CO_2}$ - $C_{560}H_{1121CO_2}$ - $C_{561}H_{1123CO_2}$ - $C_{562}H_{1125CO_2}$ - $C_{563}H_{1127CO_2}$ - $C_{564}H_{1129CO_2}$ - $C_{565}H_{1131CO_2}$ - $C_{566}H_{1133CO_2}$ - $C_{567}H_{1135CO_2}$ - $C_{568}H_{1137CO_2}$ - $C_{569}H_{1139CO_2}$ - $C_{570}H_{1141CO_2}$ - $C_{571}H_{1143CO_2}$ - $C_{572}H_{1145CO_2}$ - $C_{573}H_{1147CO_2}$ - $C_{574}H_{1149CO_2}$ - $C_{575}H_{1151CO_2}$ - $C_{576}H_{1153CO_2}$ - $C_{577}H_{1155CO_2}$ - $C_{578}H_{1157CO_2}$ - $C_{579}H_{1159CO_2}$ - $C_{580}H_{1161CO_2}$ - $C_{581}H_{1163CO_2}$ - $C_{582}H_{1165CO_2}$ - $C_{583}H_{1167CO_2}$ - $C_{584}H_{1169CO_2}$ - $C_{585}H_{1171CO_2}$ - $C_{586}H_{1173CO_2}$ - $C_{587}H_{1175CO_2}$ - $C_{588}H_{1177CO_2}$ - $C_{589}H_{1179CO_2}$ - $C_{590}H_{1181CO_2}$ - $C_{591}H_{1183CO_2}$ - $C_{592}H_{1185CO_2}$ - $C_{593}H_{1187CO_2}$ - $C_{594}H_{1189CO_2}$ - $C_{595}H_{1191CO_2}$ - $C_{596}H_{1193CO_2}$ - $C_{597}H_{1195CO_2}$ - $C_{598}H_{1197CO_2}$ - $C_{599}H_{1199CO_2}$ - $C_{600}H_{1201CO_2}$ - $C_{601}H_{1203CO_2}$ - $C_{602}H_{1205CO_2}$ - $C_{603}H_{1207CO_2}$ - $C_{604}H_{1209CO_2}$ - $C_{605}H_{1211CO_2}$ - $C_{606}H_{1213CO_2}$ - $C_{607}H_{1215CO_2}$ - $C_{608}H_{1217CO_2}$ - $C_{609}H_{1219CO_2}$ - $C_{610}H_{1221CO_2}$ - $C_{611}H_{1223CO_2}$ - <

Technological process of biogas production

Napier grass is transported to a biogas plant area and discharged into loaders. The loaders input 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 reactors is blended periodically. Mixing is performed by vertical agitators. The average time of processing in the reactors is 43 days. After the reactors, the substrate is fed by pump to a separator area where it is separated into solid and liquid bio-fertilizer. Solid bio-fertilizer is discharged to the separation area and transported or storage liquid substrate is directed to a liquid residue storage tank. Biogas goes up under overlap and delivered into an external gas holder through pipeline.

The gas holder is equipped with a float valve that protects the gasholder from precipitation and damage by foreign objects. The float valve is controlled by a special system. To protect the gas-

holder from overpressure, digesters are equipped with safety valves, which start working at a pressure of 5 mbars and bleed biogas to the atmosphere.

Then accumulated in gasholders biogas 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 sent to a biogas engine to produce energy. The biogas goes to the co-generators to produce electric and heat energy.

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-02, SF-03 , SF-04, SF-05)

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 the rotating rollers. The user is able to control the material flow up to 20 % 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:	11.0 m
Width:	2.3 m
Height:	2.0 m
Volume:	50 m ³
Quantity:	5 pcs.



Receiving tank (RT-01) and filtrate tank (FT-01)

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

Receiving tank (RT-01)

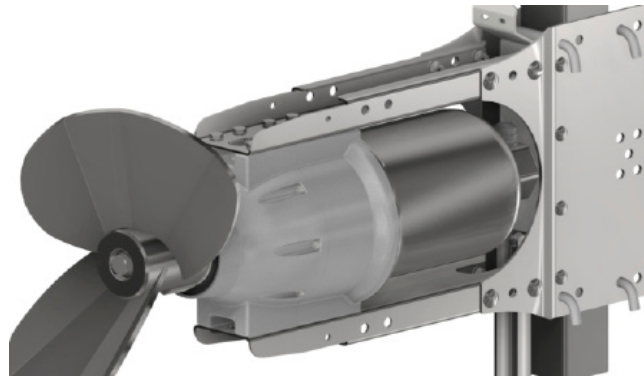
Diameter:	10.0 m
Height	3.0 m
Total volume:	236 m ³

Quantity:	1 pcs
------------------	-------

Filtrate tank (FT-01)

Diameter:	10.0 m
Height	3.0 m
Total volume:	236 m ³

Quantity:	1 pcs
------------------	-------



Submersible agitator (AG-26, AG-27)

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 electric motor it angle mounted planetary gear and bearing angle or oil - ing the propeller. The conical shaft in the bearing angle is mounted in the oil bath by two angular roller bearings and sealed off from the agitating substrate with a mechanical seal.

Specifications

Submersible agitator of the receiving tank (AG-26)

Nominal power

N=3.0 kW

Quantity:

1 pcs

Submersible agitator of the filtrate tank (AG-27)

Nominal power

N=3.0 kW

Quantity:

1 pcs



Reactor (R-01, R-02, R-03, R-04, R-05)

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. In the center of the reactor there is a column with chapter. 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 con-

sumption, 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 insulate it roll a roofing Superstructure and substructure heat insulation is protected by shaped sheet from the outside mechanical damages and rodents. The reactor bottom has a slope 1%.

Specifications

Height :	7.5 m
Diameter :	25,0 m
The total volume :	3680 m ³
The substrate volume :	3434 m ³
Quantity:	5 pcs



Reactor vertical agitator (AG-01 ... AG-25)

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 CE 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:	N=15 kW
Quantity per digester:	5 pcs
Quantity total:	25 pcs



Window with spotlight (SG-01, SG-02, SG-03, SG-04)

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



Pump equipment (PU-01, PU-02, PU-03, PU-04, PU-05, PU-06, PU-07, PU-08)

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 ribbed elastic gear motor rotor as outer inlet or outlet 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 to ensure regular design and rigidity, to ensure the best

Specifications

Substrate pump to separator (PU-01, PU-02, PU-03, PU-04, PU-05)

Flow rate:	10-25 m ³ /hour
Engine power:	11.0 kW
Pressure:	4 bar
Quantity:	5 pcs

Liquid substrate pump (PU-06, PU-07)

Flow rate:	45 m ³ /hour
Engine power:	11.0 kW
Pressure:	4 bar
Quantity:	2 pcs

Filtrate pump (PU-08)

Flow rate:	60 m ³ /hour
Engine power:	18.5 kW
Pressure:	4 bar
Quantity:	1 pcs



Separator (SR-01, SR-02, SR-03, SR-04, SR-05)

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 possibilities for different solid and liquid contents. In the slotted screen, the solids are screened out from the liquid. The solids built up a layer in the filter to separate particles from the liquid. The auger digests on the table is larger to the solid outlet. The screen surface is leaned and a net layer is formed. The design of the screens is not suitable for logging. The pressure in the first part of the screen is low but increases with the solid consistency to the solid output. The consistency of the gained solid can be varied with the help of an output regulator by the amount and position of counterweights. It is a requirement to ensure the final product or 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	7.5 kW
Flow rate	8-25 m³ / h
Quantity	5 pcs
Equipment	
Frame	
Screw	
Sieve for the filtration	
Counterweights	
The design of the protective room	



Gasholder (GH-01)

The gasholder provides for biogas storage and for equalizing pressure and biogas composition. The gasholder system has a two-layer construction. The external material consists of a heat-resistant PVC-coated polyester fabrics with UV protection. The internal membrane is a PE (polyethylene) membrane. The external membrane thickness is 5mm, internal membrane PE (polyethylene) membrane.

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

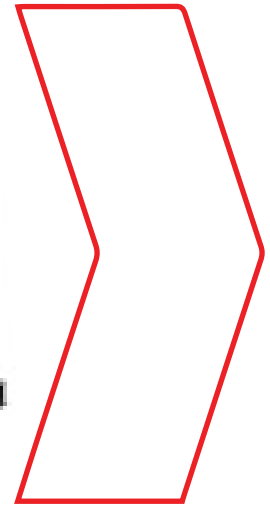
The internal membrane is stretched under normal biogas pressure. Air is blown into the space between the external and internal membranes to pressurize the internal membrane and form the shape of the external membrane.

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 :	13.9 m
Diameter :	18.2 m
The total/working volume :	2500 m ³
Quantity:	1 pcs



Biogas dryer and cooling (CHL-01, CHL-02, CHL-03)

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 radial. Material selection according to 201 /68/ in accordance with ADMerkblätter and factory pressure test.

Specifications

Stage 1

Gas volume flow	1000 m ³ / h
Gas inlet temperature	50
Gas outlet temperature	20
Engine power	30 kW
Quantity	1 pcs

Stage 2

Gas volume flow	2400 m ³ / h
Gas inlet temperature	50
Gas outlet temperature	20
Engine power	91.6 kW
Quantity	2 pcs



Biogas compressor (BC-01, BC-02, BC-03, BC-04)

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

Stage 1

Flow rate:	1200 m ³ /h
Pressure:	150 mbar
Engine power:	10 kW
Quantity:	2 pcs

Stage 2

Flow rate:	5800 m ³ /h
Pressure:	150 mbar
Engine power:	54 kW
Quantity:	2 pcs

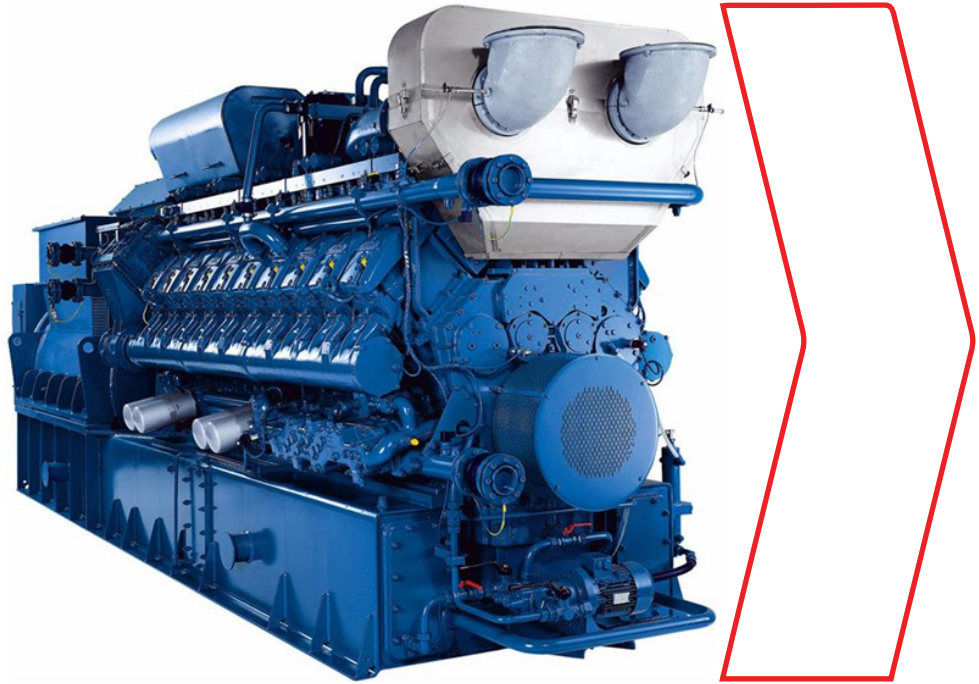


Desulphurization system (CF-01, CF-02)

The desulphurization system is a 3-step system. Stage 1 is adding Ferrum Hydroxide. 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 concentration is 80 mg/l. Stage 3 is a final adsorption, as a final adsorbent has the ability to absorb sulphur. After passing through a final adsorbent filter, the sulphur concentration is reduced to 0 ppm.

Specifications

Air compressor	5 m ³ /h
The volume of charcoal (CF-01, CF02)	500 kg
Numbers of charcoal columns	2 pcs



Cogeneration Power Plant (CHP-01..05)

A cogeneration power plant (CHP) is used for producing electricity and heat. CHP is a more efficient technology for generating electricity and heat together. A cogeneration plant is an installation where there is simultaneous generation of usable electric power and heat in a single process, and it can reduce energy and improve efficiency 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 requirements. An important factor, so that 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	1198 kW
Emissions	NOx < 500 mg/Nm ³ [5% O ₂]
Generator	400V, 50Hz

Quantity: 5 pcs



Flare (BF-01, BF-02)

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, an air supply control system, a rotation tube, and a 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 a e

Specifications

Stage 1

Flow rate:	1200 m ³ /h
Quantity:	1 pcs

Stage 2

Flow rate:	5000 m ³ /h
Quantity:	1 pcs

Water supplying and sewerage system

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

Specifications

Circulating pump feeding heat carrier heating

Flow 30 m³ / h;
Pressure 1 bar

Circulating pump feeding heat carrier to the digester

Flow 18 m³ / h;
Pressure 1.1 bar

The pumping station feeding propylene glycol

Flow 0.8 m³ / h;
Pressure 4 bar

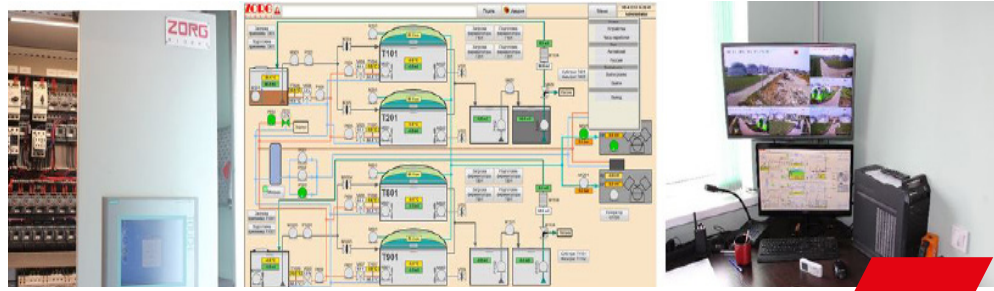


Dry cooler (cooling substrate system) (DC-01..05)

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:	5 pcs



Automation and electrical equipment

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

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

Specifications

Incoming control case with automatic set ASE-1, 2, 3
Base Siemens CPU315-DP2 controller
Peripherals Simatic ET200S
Control panel OP277 touchscreen
Communication PROFIBUS and MPI
Interface RS-485
Control system Simatic Step7



Gas analyzer (CH₄, CO₂, H₂S, O₂)

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

Stage 1

Gas analyzer (mobile)

Set includes:

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

Stage 2

Gas analyzer (stationary)

Set includes:

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

the gases methane, carbon dioxide, hydrogen sulfide (H₂S),



Sensors set

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

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 the separator.

Equipment

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

EQUIPMENT SPECIFICATION LIST



Nº	Equipment	Characteristic	Quantity
1	Solid feeder	V=50 m3	5
1.1	Container bunker		5
1.2	Feeding screws	set.	5
2	Submersible mixer	N=3.0kW	1
2.1	Airtight motor gearbox		1
2.2	Hydraulic screw (wear-resistant steel)		1
2.3	Mixer control mechanism		1
2.4	Electric motor mount		1
2.5	Set of fasteners		1
3	Reactor vertical agitator	N=15 kW	25
3.1	Airtight motor gearbox		25
3.2	Hydraulic screw (wear-resistant steel)		25
3.3	Shaft (adapted to the height of the fermenter)		25
3.4	Blade		25
3.5	Frequency converter		25
3.6	Mounting bracket to bottom of the mixer		25
4	Safety valve of reactors		5
5	Window with a searchlight	set	5
5.1	Inspection window RD300 (mounts and sealant included)	Ø300	10
5.2	Spotlight (mount system bundled) VISULUX UL50 -G -H	230V, 50W, IP65	5
6	Substrate digested pump	10-25 m3/hour N=11.0 kW	5

Nº	Equipment	Characteristic	Quantity
7	Separator	N=7.5 kW, Q=8-12m3/h	5
7.1	Body		5
7.2	Substrate Supply Pipe 4 ''		5
7.3	Engine - Gearbox	N=7,5 kW	5
7.4	Frame		5
7.5	Screw		5
7.6	ie e or ltration		5
8	Filtrate pump	60 m3/hour N=18.5kW	1
9	Submersible mixer	N=3.0kW	1
10	PVC external gas holder		1
10.1	Weat er rote tion l	Ø18.2m	1
10.2	as ol er l et ane er eation max.260 cm3/m2*d*1 bar, 650 N/5cm bio- gas 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
10.8	Safety valve		1
11	Biogas Cooling System	1000 m3/h	1
11.1	Chiller		1
11.2	Heat exchanger		1
11.3	Polypropylene glycol tank		1
12	Biogas Cooling System	2400 m3/h	2
12.1	Chiller		2

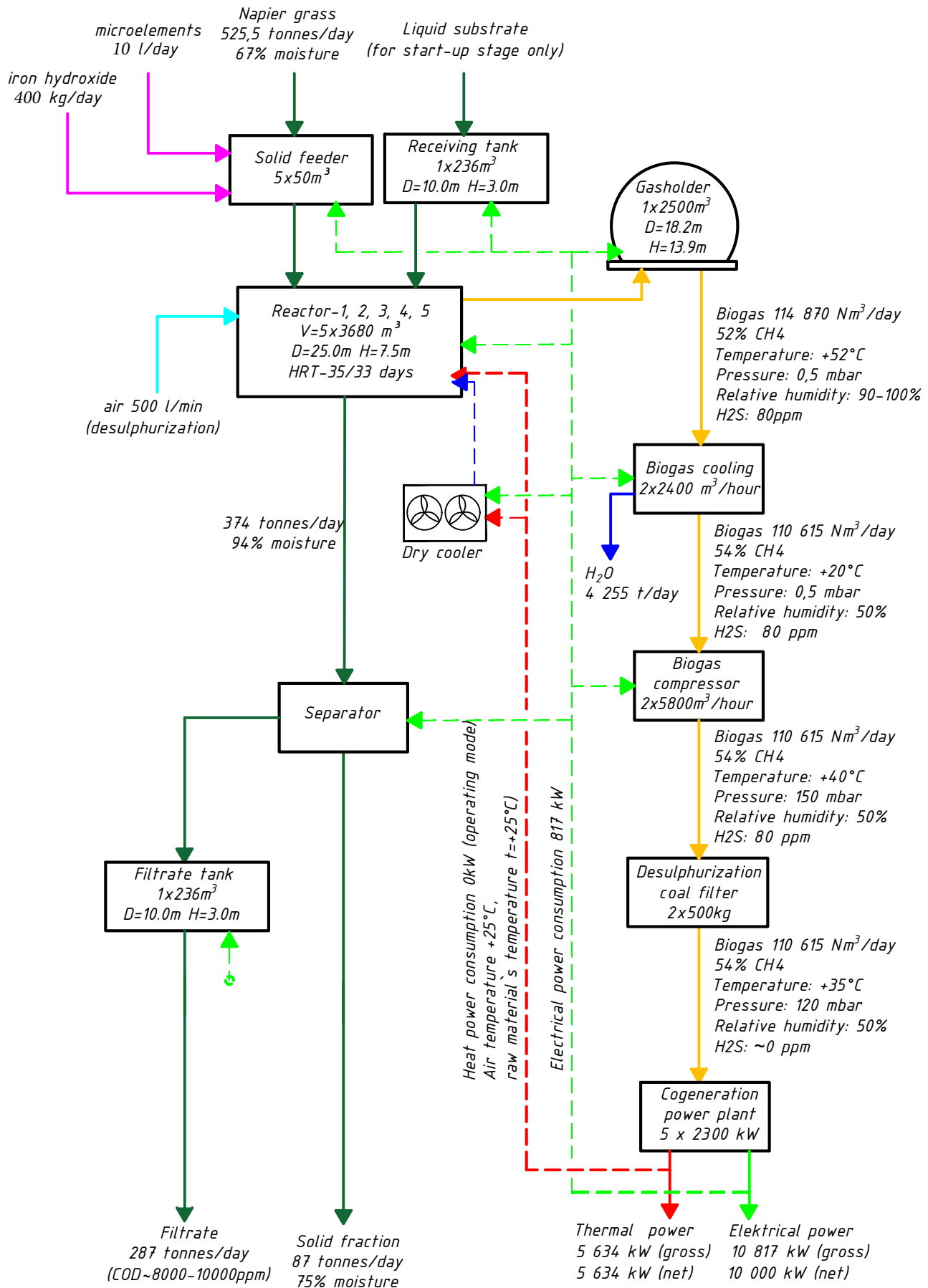
Nº	Equipment	Characteristic	Quantity
12.2	Heat exchanger		2
12.3	Polypropylene glycol tank		2
13	Desulphurization system		1
13.1	Numbers of charcoal columns	500 kg	2
14	Biogas compressor	Q=1200m³/h H=150mBar N=10kW	2
15	Biogas compressor	Q=5800m³/h H=150mBar N=54kW	2
16	Biogas analyzer (CH₄, CO₂, H₂S, O₂) (mobile)		1
17	Electromagnetic flow meter		1
18	Flare	1200 m³/h	1
19	Gas equipment included	set	1
19.1	rainage unit	DN=50 Q=1m ³ /h H=13 m	2
20	The heat supply system	set	1
20.1	Diaphragm expansion tank	V=1000 l bar 120	1
20.2	Circulating pump for supplying heat carrier	Q=30 m ³ /h H=1bar	1
20.3	Propylene glycol feed pump station heating systems	Q=1,0 m ³ /h, bar	1
20.4	Circulation pump for supplying heat carrier to the digester	Q=18 m ³ /h, H=1.1 bar	1
21	Water supply and sewerage system, complete, disassembled	set	1
22	Automation with electrical equipment complete, disassembled	set	1
22.1	Incoming distribution cabinet with a set of automation DB-1		1
22.2	Incoming distribution cabinet with a set of automation DB-2		1
23	Sensors, set		1

Nº	Equipment	Characteristic	Quantity
23.1	Gas pressure sensor 0,025Bar		6
23.2	Gas pressure sensor 0,4Bar		5
23.3	Pressure sensor(substrate level) 1,0Bar		7
23.4	Pressure sensor (substrate pressure) 2,5bar		7
23.5	Resistive thermometer (gas temperature)		7
23.6	Resistive thermometer with thermo well (fermenter substrate temperature)		7
23.7	Resistive thermometer with thermo-well (digester tank substrate temperature)		7
23.7	Resistive thermometer (heat conductor temperature)		7
23.9	Conductometric sensor of maximum level		7
23.10	Conductometric sensor of water level		7
23.11	Dome position sensor		1
23.12	Coolant pressure sensor	SEN 3276 B065 G1/2 6Bar	4
23.13	Humidity and gas temperature sensor	ESFTF-I	2
24	Biogas analyzer (CH₄ , CO₂ , H₂S, O₂) (stationary)		1
25	Flare	5000 m³/h	1
26	Dry cooler 100kW heat pow.		5
27	Laboratory		1
28	Cogeneration power plant	2300 kW	5

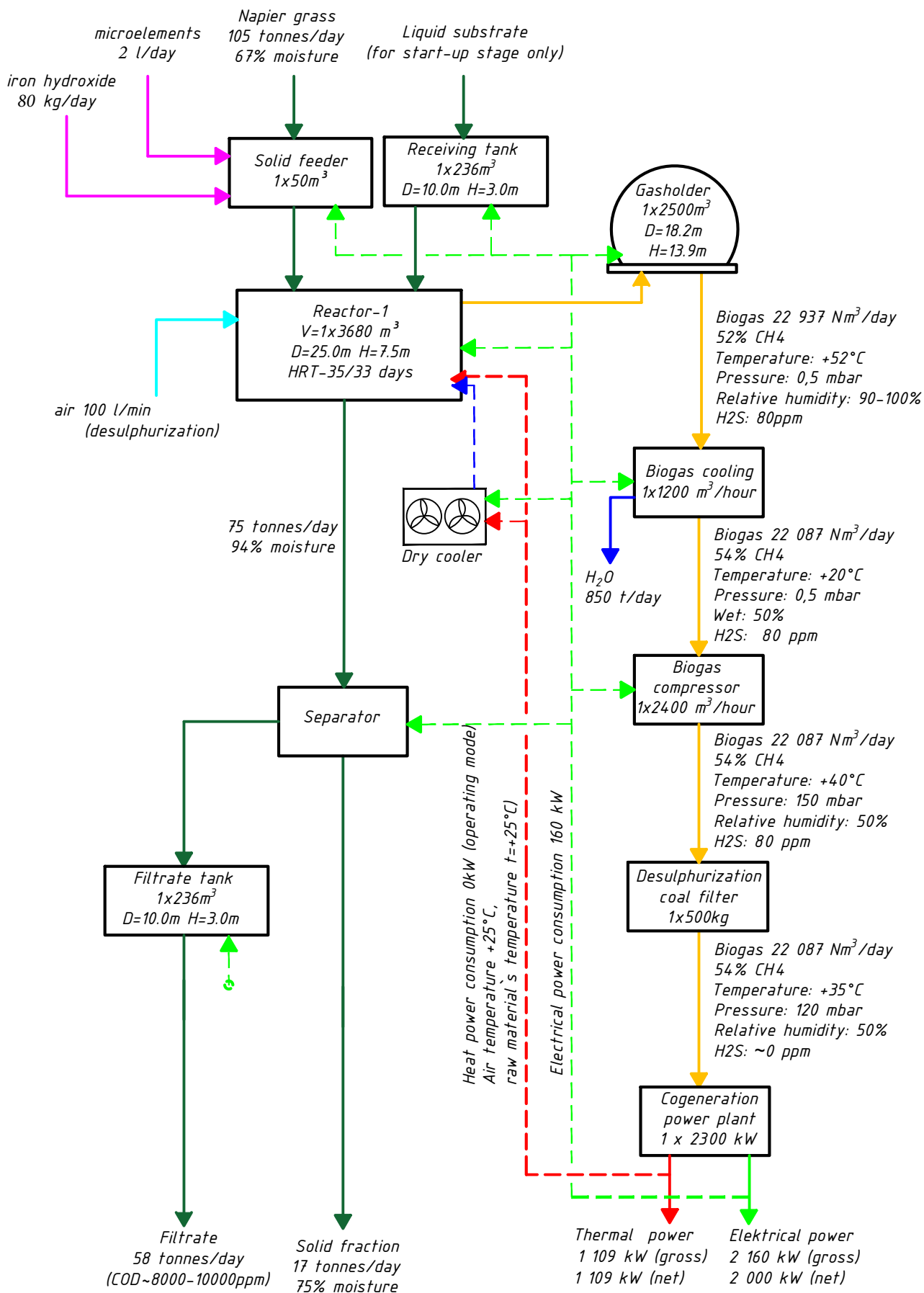
ANNEXES



Material flow diagram

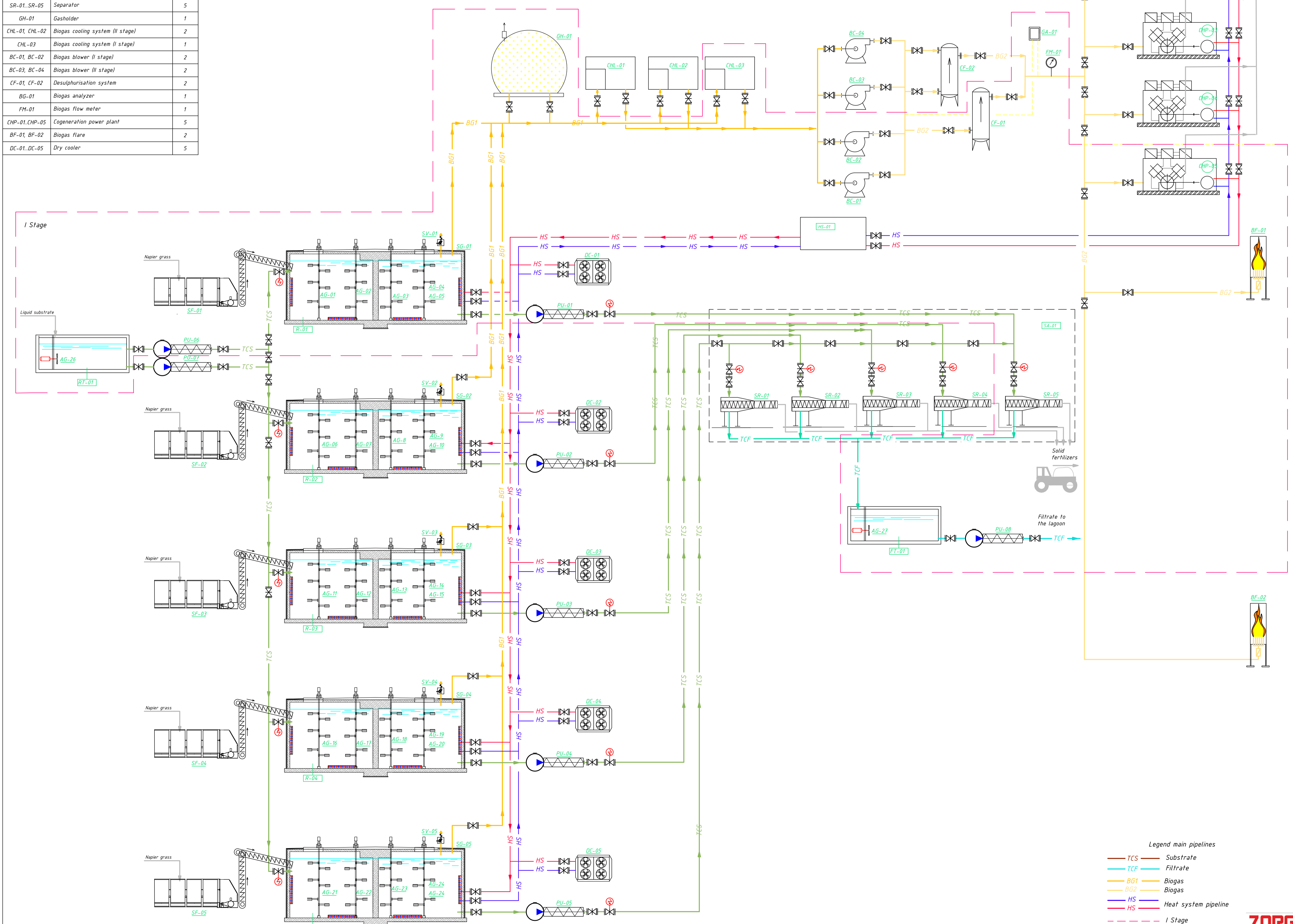


Material flow diagram



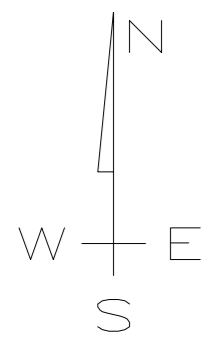
Explication			Structure		
N/°	Name	Quantity	N/°	Name	Quantity
SF-01..SF-05	Solid feeder	5	R-01 R-02 R-03 R-04 R-05	Reactor - 1,2,3,4,5	5
SV-01..SV-05	Safety valve	5	RT-01	Receiving tank	1
SG-01..SG-05	Inspection windows	5	FT-01	Filtrate tank	1
AG-01 ... AG-25	Vertical agitator of Reactor-1,2,3,4,5	5x5	HS-01	Heat sub-station	1
AG-26	Submersible agitator of the receiving tank	1	SA-01	Separator area	1
AG-27	Submersible agitator of the filtrate tank	1			
PU-01, PU-02, PU-03, PU-04, PU-05	Substrate pump from Digesters to separator	5			
PU-06, PU-07	Liquid substrate pump	2			
PU-08	Filtrate pump	1			
SR-01..SR-05	Separator	5			
GH-01	Gas holder	1			
CHL-01, CHL-02	Biogas cooling system (II stage)	2			
CHL-03	Biogas cooling system (I stage)	1			
BC-01, BC-02	Biogas blower (I stage)	2			
BC-03, BC-04	Biogas blower (II stage)	2			
CF-01, CF-02	Desulphurisation system	2			
BG-01	Biogas analyzer	1			
FM-01	Biogas flow meter	1			
CHP-01..CHP-05	Cogeneration power plant	5			
BF-01, BF-02	Biogas flare	2			
DC-01..DC-05	Dry cooler	5			

Basic diagram

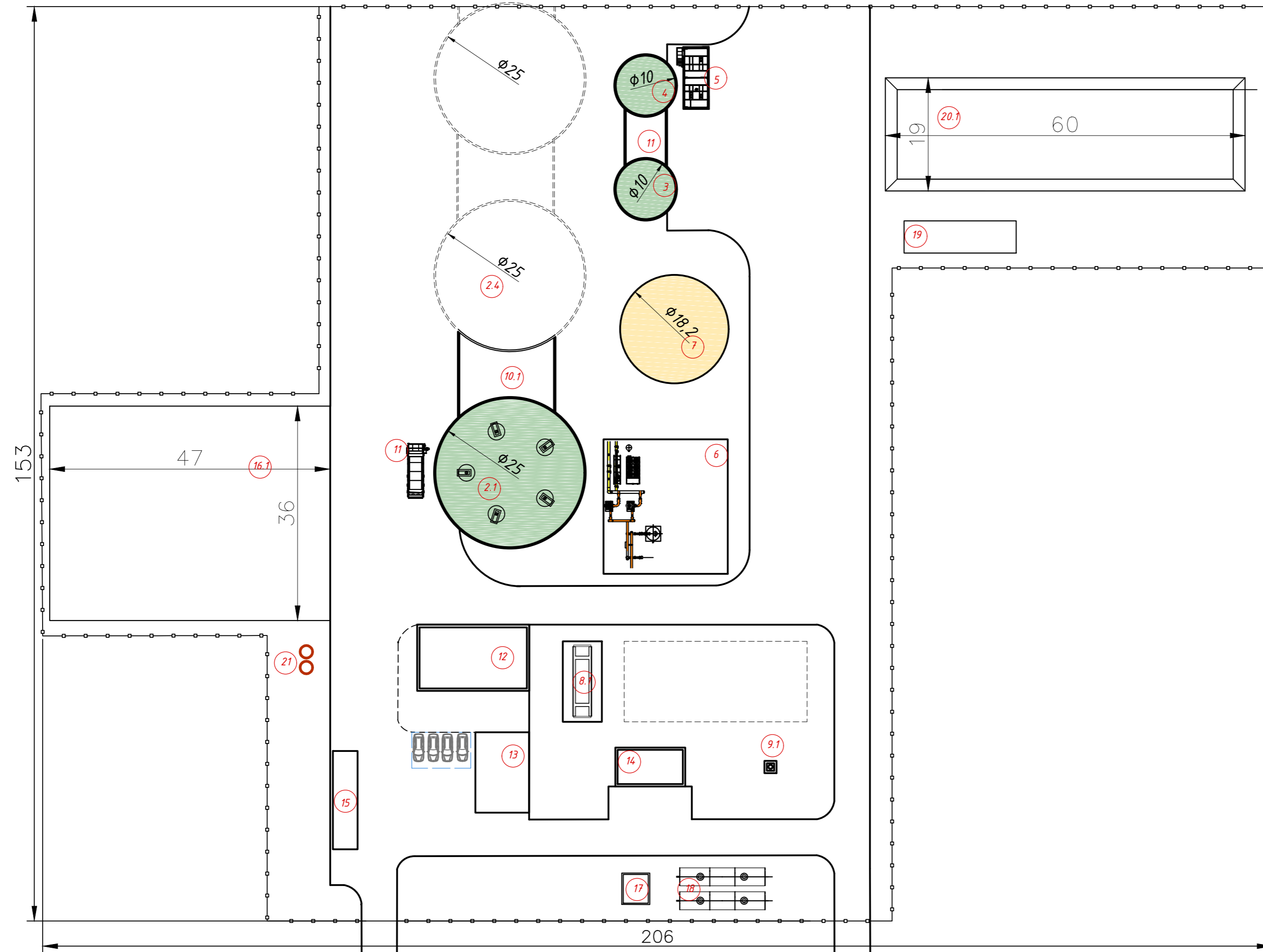


- Legend main pipelines
- TCS Substrate
 - TCF Filtrate
 - BG1 Biogas
 - BG2 Biogas
 - HS HS
 - HS HS
 - I Stage





Plan layout (1 stage)



Explication

N/Nº	Name	Note
1.1	Solid loader -1	
2.1	Reactor -1	
3	Receiving tank	
4	Filtrate tank	
5	Separator area	
6	Gas preparation	
7	Gasholder	
8.1	Cogeneration power plant	
9.1	Biogas flare	
10.1	Technological room	
11	Equipment room	
12	Operators room	
13	Warehouse	
14	Transformer substation	
15	Weigh bridge	
16.1	Storage of raw materials	
17	Fire pump station	
18	Fire tank	
19	Rainwater treatment	
20.1	Lagoon	
21	Local treatment facilities	

Area: F= 2.3 hectares= 5.6 acres

Annex 4.1

Name equipment	Instal. Pow. (kW)	Quantity (pcs)	Total installed power (kW)	Working hours per day	Consumption kWh per day
Loader V=50 m ³	23,0	5	115,0	8,0	920,0
Screw set.	23,0	5	115,0	8,0	920,0
Reactor Vertical agitator	15,0	25	375,0	18,0	6750,0
Submersible agitator in receiving tank	3,0	1	3,0	12,0	36,0
Submersible agitator in filtrate tank	3,0	1	3,0	12,0	36,0
Biogas cooling system	91,6	2	183,2	24,0	4396,8
Biogas compressor	54,0	2	108,0	12,0	1296,0
Separator	7,5	5	37,5	5,0	187,5
Substrate pump to separator	11,0	5	55,0	5,0	275,0
Liquid substrate pump	11,0	2	22,0	1,0	22,0
Filtrate pump	18,5	1	18,5	4,8	88,8
CHP	25,0	5	125,0	24,0	3000,0
Circulation pump for CHP	5,5	5	27,5	24,0	660,0
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
Air compressor for desulphurization	1,5	5	7,5	24,0	180,0
Digester cooling system	4,0	5	20,0	24,0	480,0
Circulation pump for supplying heat carrier to the digester	0,8	5	3,8	24,0	90,0
Circulation pump for supplying heat carrier to the digester cooling system	2,0	5	10,0	24,0	240,0
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	3	3,0	0,5	1,5
Lighting of the biogas plant territory	1,0	1	1,0	8,0	8,0
Spot light for digesters inspection windows	0,1	5	0,4	0,5	0,2
Working lighting of switchboard	0,1	1	0,1	0,5	0,1
Total installed power, kW			1237		
Total consumed electric energy, kWh per day					19616
Total consumed power, kW					817

Annex 4.2

Name equipment	Instal. Pow. (kW)	Quantity (pcs)	Total installed power (kW)	Working hours per day	Consumption kWh per day
Loader V=50 m ³	23,0	1	23,0	8,0	184,0
Screw set.	23,0	1	23,0	8,0	184,0
Reactor Vertical agitator	15,0	5	75,0	18,0	1350,0
Submersible agitator in receiving tank	3,0	1	3,0	12,0	36,0
Submersible agitator in filtrate tank	3,0	1	3,0	12,0	36,0
Biogas cooling system	30,0	1	30,0	24,0	720,0
Biogas compressor	10,0	2	20,0	12,0	240,0
Separator	7,5	1	7,5	5,0	37,5
Substrate pump to separator	11,0	1	11,0	5,0	55,0
Liquid substrate pump	11,0	1	11,0	1,0	11,0
Filtrate pump	18,5	1	18,5	1,0	18,5
CHP	25,0	1	25,0	24,0	600,0
Circulation pump for CHP	5,5	1	5,5	24,0	132,0
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
Air compressor for desulphurization	1,5	1	1,5	24,0	36,0
Digester cooling system	4,0	1	4,0	24,0	96,0
Circulation pump for supplying heat carrier to the digester	0,8	1	0,8	24,0	18,0
Circulation pump for supplying heat carrier to the digester cooling system	2,0	1	2,0	24,0	48,0
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	1	1,0	0,5	0,5
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
Total installed power, kW			269		
Total consumed electric energy, kWh per day					3838
Total consumed power, kW					160

Stage 1. Prices for a biogas plant with the gen set 2,3MW el max / 2 MW el. netto.

Pos	Name	Number of units	Unit price, EUR	Discounts *	Discounted unit price, EUR	Discounted price sub-total, EUR
1	Project documentation	1	137.000	0%	137.000	137.000
2	Supervision	1	50.000	0%	50.000	50.000
3	Startup and training	1	50.000	0%	50.000	50.000
4	Living and travel expences	1	50.000	0%	50.000	50.000
5	Delivery of the equipment (container)	8	10.000	0%	10.000	80.000
6	Laboratory	1	28.000	0%	28.000	28.000
7	Solid feeder (dosing buffer machine) 50 m3	1	125.000	0%	125.000	125.000
8	Screw conveyor	1	114.000	0%	114.000	114.000
9	Digester vertical agitator 15 kW	5	86.000	0%	86.000	430.000
10	Frame for Digester vertical agitator pos 3	5	7.000	0%	7.000	35.000
11	Substrate pump 11 kW	1	29.000	0%	29.000	29.000
12	Digested substrate pump 11 kW	1	29.000	0%	29.000	29.000
13	Filtrate supply pump 18.5 kW	1	32.000	0%	32.000	32.000
14	Substrate separation unit	1	58.000	0%	58.000	58.000
15	Submersible agitator for receiving tank 3 kW	1	12.000	0%	12.000	12.000
16	Submersible agitator for filtrate tank 3 kW	1	12.000	0%	12.000	12.000
17	Over- and under pressure safeguard	1	9.000	0%	9.000	9.000
18	Sight glasses/viewing windows with projector	1	6.000	0%	6.000	6.000
19	Water supply and canalization system	1	27.000	0%	27.000	27.000
20	Heat supply station	1	25.000	0%	25.000	25.000
21	Dry-cooler cooling system for reactors	1	36.000	0%	36.000	36.000
22	Automation and electric cabinet	1	157.000	0%	157.000	157.000
23	Motorized valves (set)	6	9.000	0%	9.000	54.000
24	Sensors (set)	3	25.000	0%	25.000	75.000
25	Gasholder	1	145.000	0%	145.000	145.000
26	Biogas chiller (Biogas cooling system) 1000 m3/h	1	95.000	0%	95.000	95.000
27	Biogas blower 1200 m3/h	2	15.000	0%	15.000	30.000
28	Desulphurization column with active coal 500 kg	1	45.000	0%	45.000	45.000
29	Biogas flarer 1200 m3/h	1	67.000	0%	67.000	67.000
30	Gas analyzer (mobile)	1	7.000	0%	7.000	7.000
31	Gas conditioning unit	1	25.000	0%	25.000	25.000
32	Cogeneration power plant 2.3 MW (if not needed client may exlude from our scope)	1	950.000	0%	950.000	950.000
33	Construction	1	1.000.000	0%	1.000.000	1.000.000
34	Filtrate Storage 3500 m3	1	35.000	0%	35.000	35.000
35	Silage storage for the grass 9 000 m3	1	160.000	0%	160.000	160.000
36	Weight control (truck scale)	1	50.000	0%	50.000	50.000
	TOTAL by ZORG, EUR					3.024.000
						1.245.000
						4.269.000

Total by client, EUR
Total ZORG +Client. EUR

Stage 2. Prices for a biogas plant with gen sets 9,2MW el max/ 8,0 MW el netto . 4 reactors.

Pos	Name	Number of units	Unit price, EUR	Discounts *	Discounted unit price, EUR	Discounted price sub-total, EUR
1	Project documentation	1	137.000	0%	137.000	137.000
2	Supervision	1	50.000	0%	50.000	50.000
2	Startup and training	1	50.000	0%	50.000	50.000
3	Living and travel expences	1	50.000	0%	50.000	50.000
4	Delivery of the equipment (container)	22	10.000	0%	10.000	220.000
5	Solid feeder (dosing buffer machine) 50 m3	4	125.000	0%	125.000	500.000
6	Screw conveyor	4	114.000	0%	114.000	456.000
7	Digester vertical agitator 15 kW	20	86.000	0%	86.000	1.720.000
8	Frame for Digester vertical agitator pos 3	20	7.000	0%	7.000	140.000
9	Substrate pump 11 kW	4	29.000	0%	29.000	116.000
10	Digested substrate pump 11 kW	1	29.000	0%	29.000	29.000
8	Substrate separation unit 7.5 kW	4	58.000	0%	58.000	232.000
11	Over- and under pressure safeguard	4	9.000	0%	9.000	36.000
12	Sight glasses/viewing windows with projector	4	6.000	0%	6.000	24.000
13	Water supply and canalization system	1	35.000	0%	35.000	35.000
14	Heat supply station	1	25.000	0%	25.000	25.000
15	Dry-cooler cooling system for reactors	4	36.000	0%	36.000	144.000
16	Automation and electric cabinet	1	420.000	0%	420.000	420.000
17	Motorized valves (set)	8	9.000	0%	9.000	72.000
18	Sensors (set)	6	27.000	0%	27.000	162.000
19	Gas conditioning unit	1	75.000	0%	75.000	75.000
20	Biogas chiller (Biogas cooling system) 2400 m3/h	2	145.000	0%	145.000	290.000
21	Biogas blower 5800 m3/h	2	57.000	0%	57.000	114.000
22	Desulphurization column with active coal 500 kg	2	45.000	0%	45.000	90.000
23	Biogas адфкы 4800 m3/h	1	178.000	0%	178.000	178.000
24	Gas analyzer	1	27.000	0%	27.000	27.000
25	Cogeneration power plant 2.3 MW (Client may exclude if not needed)	4	950.000	0%	950.000	3.800.000
27	Construction	1	3.800.000	0%	3.800.000	3.800.000
28	Filtrate Storage 13800 m3	1	140.000	0%	140.000	140.000
29	Silage storage for the grass 36 000 m3	1	300.000	0%	300.000	300.000
TOTAL by ZORG, EUR						9.192.000
Total by client, EUR						4.240.000
Total ZORG +Client. EUR						13.432.000

Implementation terms and payment

Months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Project documentation	50%	50%																						
Approvals and permits																								
Equipment supply			30%	20%	20%	20%	10%							30%	20%	20%	20%	10%						
CHP			30%				70%							30%				70%						
Construction																								
Supervision			50%			50%								50%		50%								
Plant start-up																								
1 stage												2 stage												

Contracts

Project implementation is executed simultaneously under several contracts

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

List of exclusions for 10.0 MW biogas plant:

- 1) Import taxes and local duties in Guinea. The importer needs to apply the Ministry of Economy of Guinea. To get waiving of the import duties. Biogas plant is a plant for renewables.
- 2) Project report, civil permits and authorizations, adaptation of the project documentation by a licensed local engineering organisation for the permit purposes. Namely the organisation puts their stamp and acts act the face of the project. The design documentation is not changed in fact. 10 000 – 15 000 EUR
- 3) Topographic and geological surveys 3000-7000 EUR
- 4) Electric transformer and the external electric line 370 kW for start-up
- 5) External roads
- 6) Temporary water supply during the construction and the hydraulic test of reactors at least 700 m³ water per day. It can be a technical quality water from a river, lake, well. Not salty.
- 7) Bacterial seed for the start-up. It can be biomass from another biogas plant. Possibly 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 550-900 m³. The rest is filled with the water item 7 above.
- 8) Machinery to transport Napier grass to and from silage storage to the solid feeders (a truck, a frontal loader, a tractor)
- 9) Machinery to transport filtrate and the digested mass from the biogas plant to the agricultural fields (a truck, a frontal loader, a tractor)
- 10) Activated carbon 1,0 tonne per year x 4800 EUR/tonne = 4800 EUR
- 11) Fe(OH)₃ concentrate – 146 tonnes per year x 800 EUR/tonne = 116 000 EUR
- 12) Anti-foam reagent 7 tonnes annually (all kinds of vegetable oil, for example, palm oil or rapeseed oil)
- 13) Microelements 3650 l per year total x 25 EUR/l = 91250 EUR
- 14) PVC foil for the silage storage to cover grass 8550 m²
- 15) Demineralized water to the heating system 3 tonnes
- 16) Spare parts for two years 180 000 EURO

ZORG
BIOGAS

Business center "Twin Yards"
Walter-Gropius-Straße 23,
DE-80807, München, Germany

Mob. +49 1511 457 29 45 (WhatsApp, Viber, Telegram)

igor.reddikh@zorg-biogas.com
www.zorg-biogas.com