PLANT PROJECT FOR O.F.M.S.W. AND P.O.F. TREATMENT

UDINE Municipality

Udine City

PROJECT

The project illustrated in this paper is an anaerobic digestion plant for the production of biogas and consequently for the production of electricity and biomethane, powered by 35.000 t/year O.F.M.S.W., 19.000 t/year P.O.F. and 12.500 t/year of green waste (CER 20.02.01). The O.F.S.M.W. and the P.O.F. will be processed on two different lines, in particulare the biogas from the anarobic digestion of the O.F.M.S.W. will be used for the production of biomethane and the solid fraction of digestate will be sent to composting with the green matrix, while the biogas from the anerobic digestion of P.O.F. will be sent to cogeneration and the solid digestate will be sent to disposal after biostabilization.

The realization of the new plant will improve the processing activities of waste due to the matrices valorization and outgoing products quality.

INLET FLUX

Matrix	Unit	Quantity
Organic Fraction of M.S.W. (O.F.M.S.W.)	t/y	35.000
Putrescible fraction of M.S.W. (P.O.F.)	t/y	19.000
Total	t/y	54.000

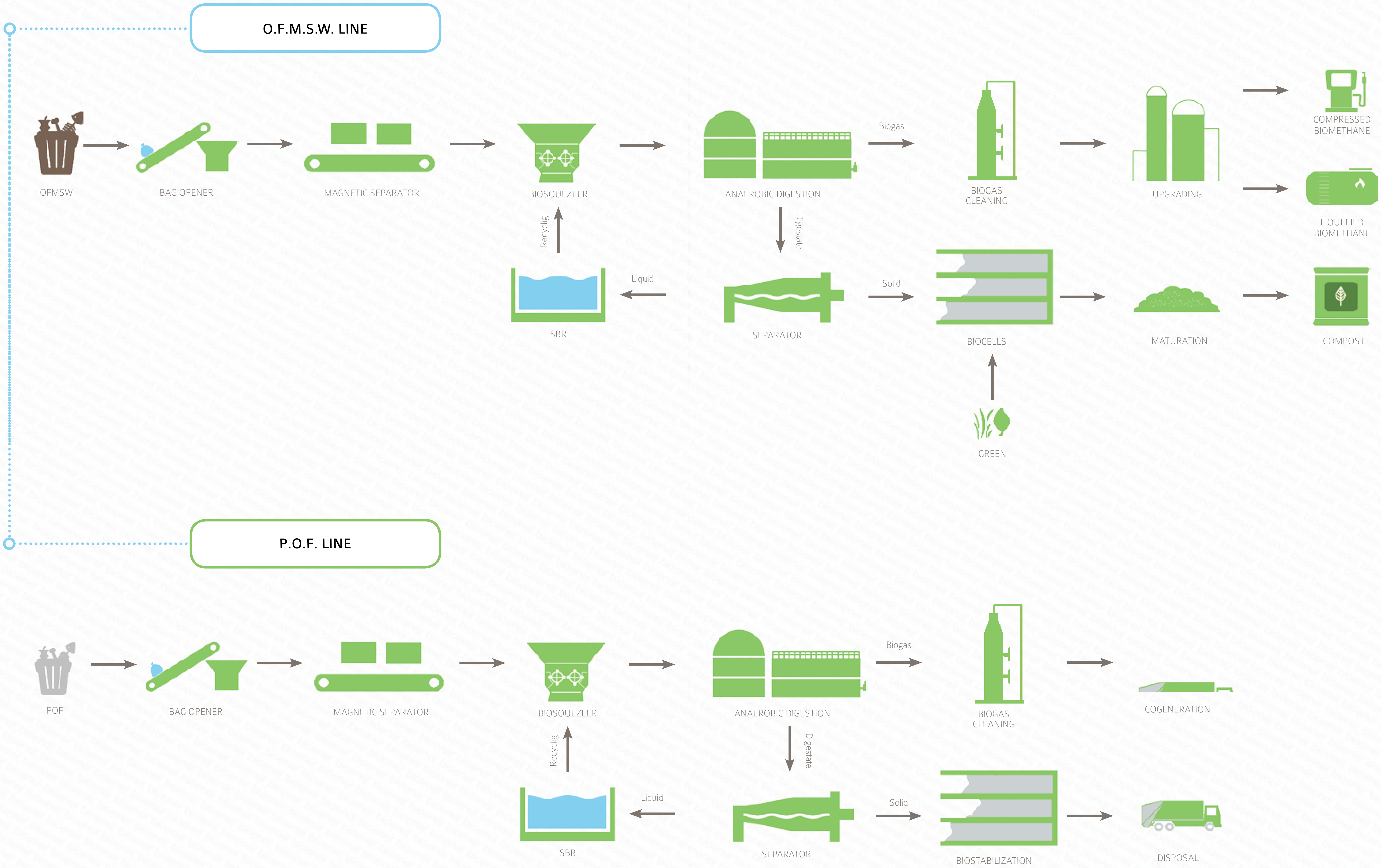
OUTLET FLUX

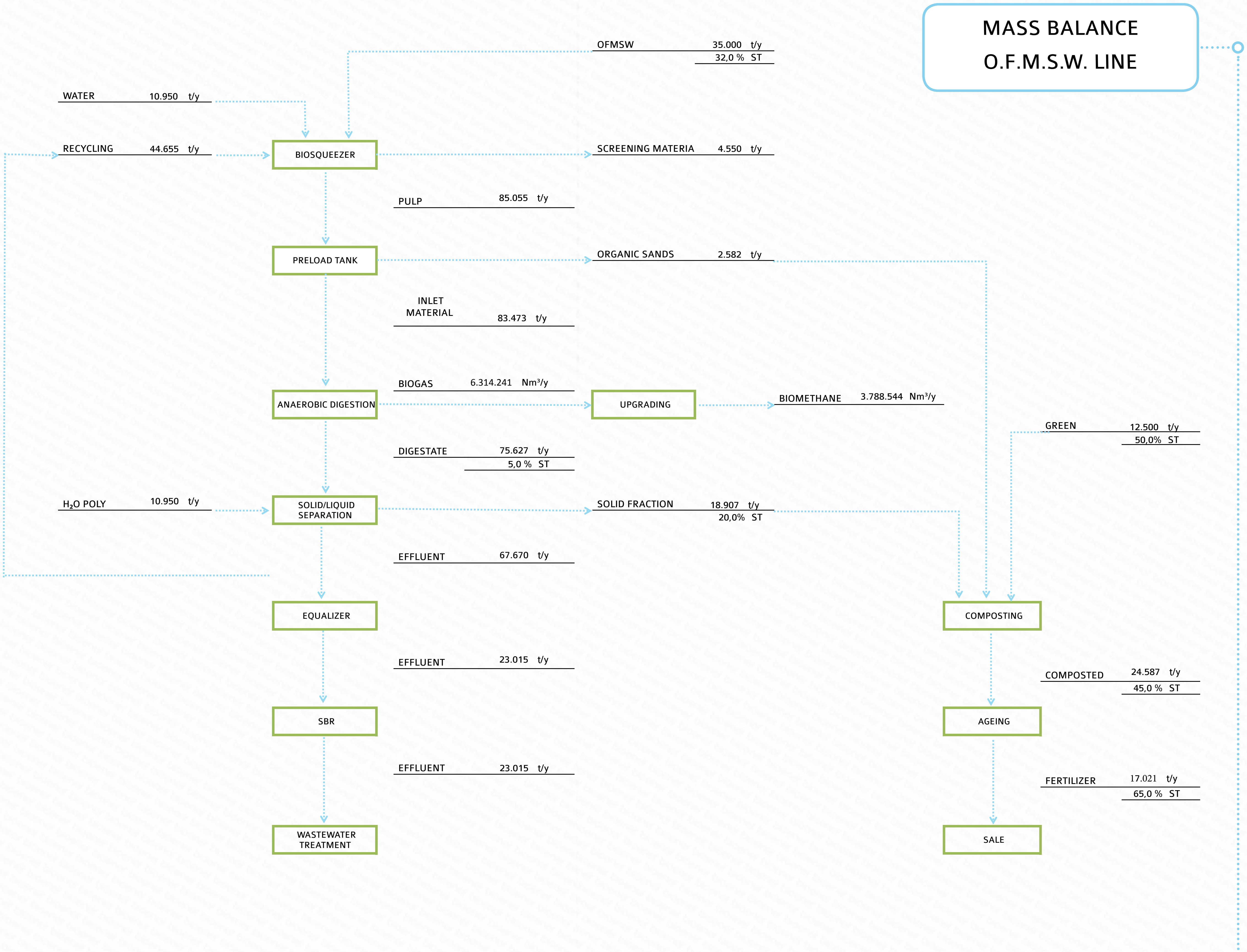
Matrix	Unit	Quantity
Biogas from P.O.F.	Nm^3/y	3.264.505
Biomethane from Biogas Upgrading from O.F.M.S.W.	Nm^3/y	3.788.544
Inert Matrix (oversieve)	t/y	7.020
Compost from O.F.M.S.W.	t/y	17.021
Liquid Manure	t/y	35.400
Biostabilized Digestate from P.O.F. (disposal)	t/y	5.807

PLANT LAYOUT

STATE OF AFFAIRS

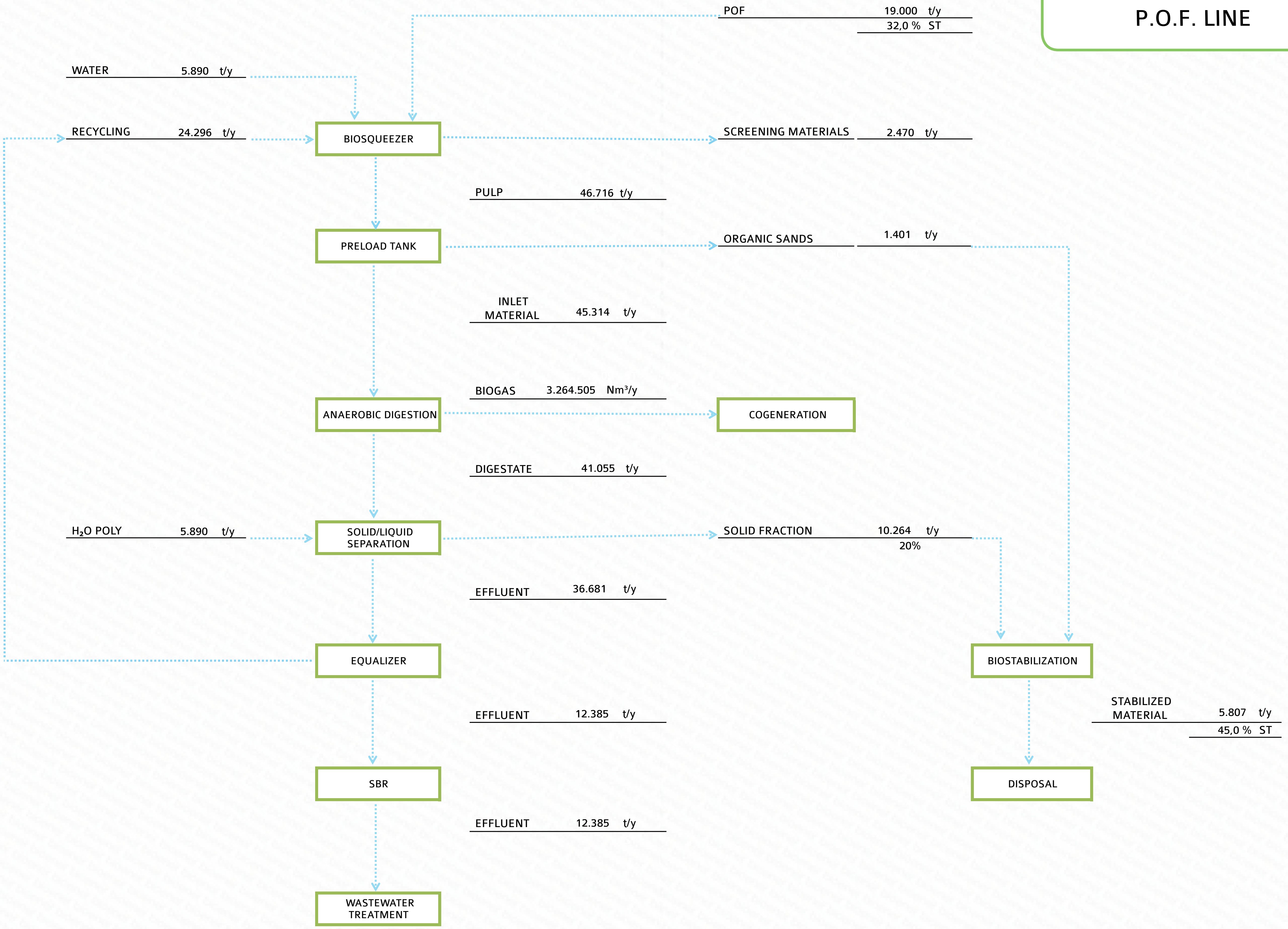
DESIGN STAGE


O.F.M.S.W. LINE
OFMSW
BAG OPENER
MAGNETIC SEPARATOR
BIOSQUEZEER
ANAEROBIC DIGESTION
Biogas
BIOGAS CLEANING
UPGRADING
COMPRESSED BIOMETHANE
LIQUEFIED BIOMETHANE
Recyclig
Digestate
Liquid
SBR
SEPARATOR
Solid
BIOCELLS
MATURATION
COMPOST
GREEN
P.O.F. LINE
POF
BAG OPENER
MAGNETIC SEPARATOR
BIOSQUEZEER
ANAEROBIC DIGESTION
Biogas
BIOGAS CLEANING
COGENERATION
Recyclig
Digestate
Liquid
SBR
SEPARATOR
Solid
BIOSTABILIZATION
DISPOSAL



MASS BALANCE
O.F.M.S.W. LINE
OFMSW 35.000 t/y 32,0 % ST
WATER 10.950 t/y
RECYCLING 44.655 t/y
BIOSQUEEZER
SCREENING MATERIA 4.550 t/y
PULP 85.055 t/y
PRELOAD TANK
ORGANIC SANDS 2.582 t/y
INLET MATERIAL 83.473 t/y
BIOGAS 6.314.241 Nm³/y
ANAEROBIC DIGESTION
UPGRADING
BIOMETHANE 3.788.544 Nm³/y
GREEN 12.500 t/y 50,0% ST
DIGESTATE 75.627 t/y 5,0 % ST
H₂O POLY 10.950 t/y
SOLID/LIQUID SEPARATION
SOLID FRACTION 18.907 t/y 20,0% ST
EFFLUENT 67.670 t/y
EQUALIZER
COMPOSTING
EFFLUENT 23.015 t/y
COMPOSTED 24.587 t/y 45,0 % ST
SBR
AGEING
EFFLUENT 23.015 t/y
FERTILIZER 17.021 t/y 65,0 % ST
WASTEWATER TREATMENT
SALE

MASS BALANCE
P.O.F. LINE



PRODUCTION CYCLE

ACCUMULATION AND MATRICES SUPPLY

The O.F.M.S.W. and P.O.F. are transported to the system using the vehicles for the collection that, after a phase of weighing, unload the matrices in a dedicated building to reception. The dimensioning of the two distinct pretreatment lines (P.O.F. and O.F.M.S.W.), is designed for both on data from the one with higher capacity (O.F.M.S.W.), increased by 20%.
The loading of the lines occurs through n.2 overhead traveling cranes equipped with a polyp grab, one for each single line of treatment.

Shredder

The shredder has the function of bag opener, in order to achieve a uniform distribution of the material. The system performs mainly the action of tearing of trash bags and allows the dimensional adjustment of O.F.M.S.W. and P.O.F according to particle sizes of 50 ÷ 70 mm, with the exception of rigid or stringy pollutants, which can attest to an average values on the order of 200mm.

SEPARATION OF THE OVERSIEVE AND BIOSQUEEZING

This phase has two separate lines respectively one for O.F.M.SW. and one for the P.O.F.. and it is characterized by:

Magnetic separator

It is provided an installation of magnetic separators with the use of ferrite permanent magnets, which, compared to the use of electromagnetic separators, eliminate entirely the energy required for generating the magnetic field, while generating the same magnetic field intensity.

Discs sieve

The discs sieve primarily performs the task of separating oversize and not processable materials. The discs sieve AMUT allows to screen each type of material, even the finest and/or filiform, avoiding that this one can twist around the rollers, causing a blockage.

Biosqueezing

The biosqueezing is performed through the use of the biosqueezer. Thanks to the high rotation speed the plastic component separated tends to rise, reaching the top of the cylinder, where it is evacuated. The heaviest organic component is squeezed and collected. This component is fed to a special sands removing system, which provide for a first removal of the inert substances, and finally sent by pumping to the preload tank. Each line of treatment is equipped with n.2 biosqueezers (n.2 for the O.F.M.S.W. line and n.2 for the P.O.F line).

SUBSTRATE PREPARATION

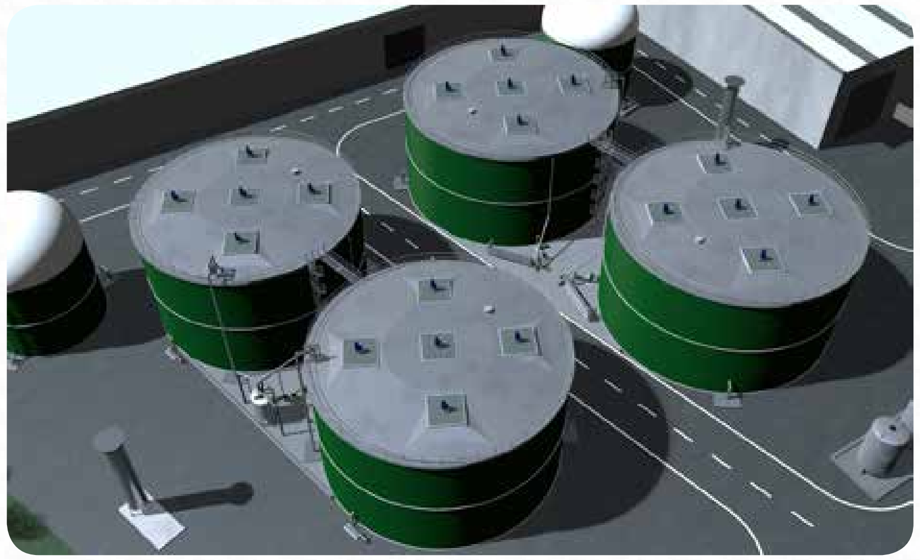
Preload tank and substrate preparation

The preload tank system involves the construction of n. 2 reactors made of steel, one for the O.F.M.S.W. line and one dedicated to P.O.F. line. The system allows a material having right characteristics in terms of dry matter. Moreover, the system allows to optimize the production of biogas. Downstream of the preload tank system there is an additional shredding system, which is used to obtain a better protection of the pumps from fibres. An aliquot of liquid manure is sent to each squeezing unit and then it is treated in the later stages of the process in order to obtain an adeguate percentage of dry in the pulp.

ANAEROBIC DIGESTION

Anaerobic Digestion

The section of anaerobic digestion for the treatment of the O.F.M.S.W. is separated from the one for the treatment of the P.O.F.. It is provided for n.4 primary digesters (n.2 for the O.F.M.S.W. line and n.2 for the P.O.F. line) and n.2 cold digesters (n.1 for the O.F.M.S.W. line and n.1 for the P.O.F. line). The degradation of the biomass and the production of biogas occur in the primary digester in thermofilic condition. The heat recovered from the congeneration is used for the heating of the digesters. The cold digester is used for the digestate storage and contextually the biogas accumulation in



the pressostatic accumulator in low pressure. Such component has the function of hydraulic joint allowing discontinuous operation of the following phases. A monitoring system is used to optimize the biogas production.

STORAGE AND BIOGAS TREATMENT

Digesters

The biogas produced in each anaerobic digester rises in the upper part of the tank thanks to the continuous mixing of the organic substances in fermentation in the digester. The upper part of each tank, designed to store a part of the biogas produced, has capacities ranging as a function of an increase/decrease of the liquid level in the tank and it is linked through a special pipeline with the pressure-accumulator.

Pressostatic accumulator at low pressure

The biogas produced is stored in n.2 pressostatic accumulators at low pressure (n.1 for O.F.M.S.W. line a nd n.1 for P.O.F. line) made with double membrane of polyester fibres coated in PVC and installed above the cold digester.

Washing columns and condenser type chiller

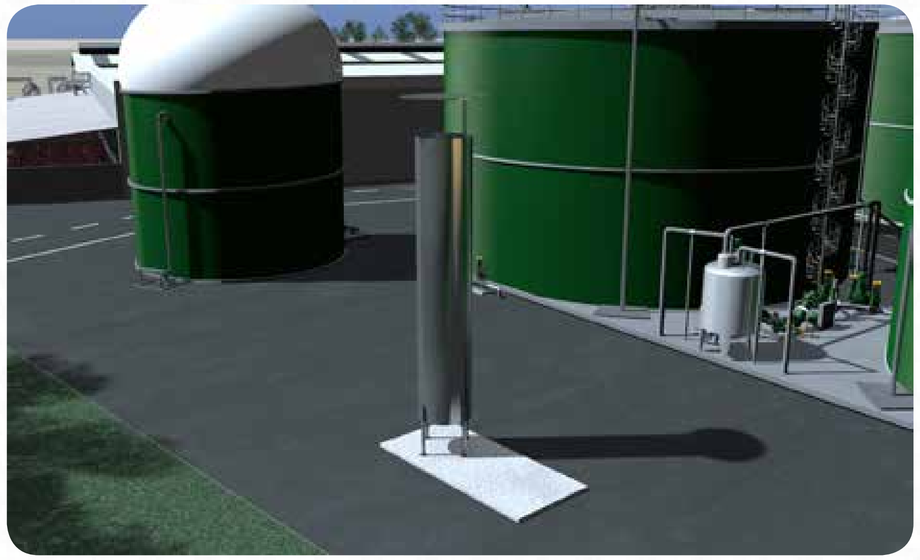
The biogas is generated with impurities such as reduced organic compounds, H_2S and moisture. Before proceeding with the use of biogas for the production of biomethane and for cogeneration it is important to keep in mind the need of gas purification from the compounds listed above to values imposed by upgrading station. The H_2S removal is within two washing towers dual stage (n.1 for the O.F.M.S.W line and n.1 for the P.O.F. line). The biogas is sent to a drying battery for cooling (n.1 for the O.F.M.S.W line and n.1 for the P.O.F. line), composed by a heat exchanger and a refrigeration cycle as cooling unit (chiller).

Compression of biogas

Upstream of the upgrading system (O.F.M.S.W. line) and upstream of the cogenerator (P.O.F line), a centrifugal fan compresses the biogas to bring it under pressure to the next station and the cogeneration engine.

SAFETY TORCH

Any biogas excess that could not be started to the next section or the biogas produced during periods of stop of the system, is burned in a special safety torch (one for each line), equipped with an automatic ignition system linked to the pressure in the gasometer.



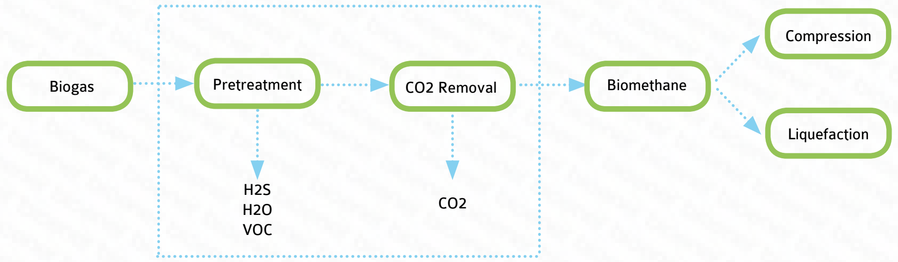
COGENERATION

The cogeneration systems have the purpose of producing electricity and thermal energy, using the biogas produced from P.O.F. line; in this case, the electricity produced by cogeneration is used primarily for self-consumption

and fed into the grid when not needed, while all the recovered heat is used to satisfy internal consumption. The cogeneration group adopted is an engine MTU Biogas Series 1 MW electrical, technically advanced and highly efficiency (electrical efficiency of 43.3%).

UPGRADING SYSTEM

The biogas produces in the O.F.M.S.W. line outgoing from the cooling unit (chiller), previously filtered/dried, enters into a desulfurization system to -90 °C where the H_2S and H_2O is removed. Subsequently, the biogas undergos a CO_2 removal process at a temperature of -120 °C.

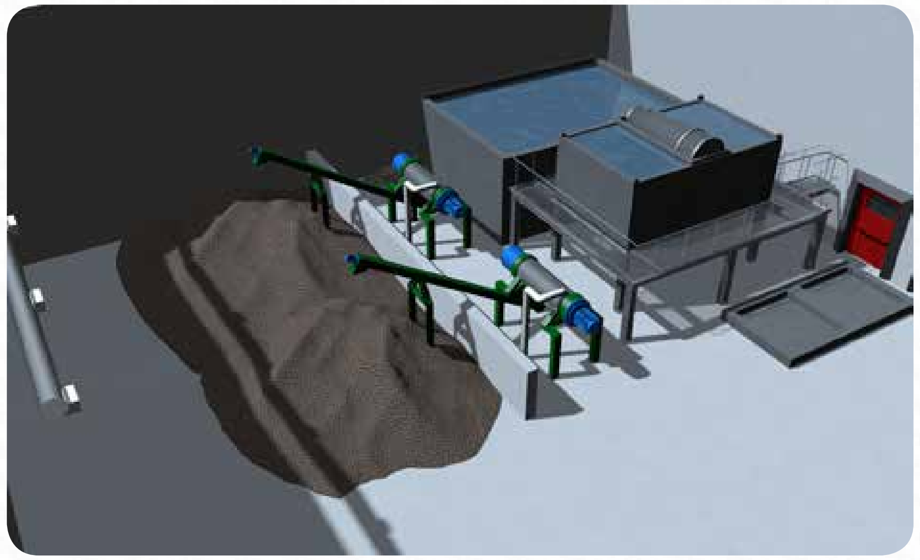


Using biomethane

The biomethane producted is partially compressed and made available in a natural gas distributor for motor vehicles and partially liquefied at a temperature between -120 and -160 ° C using a cryogenic cycle. The plant will be able to supply daily the collection vehicles of NET S.p.A. In a first phase, the biomethane feed conversion is planned for 50 vehicles. The liquefied biomethane instead is transported to third-party distributors through carts.

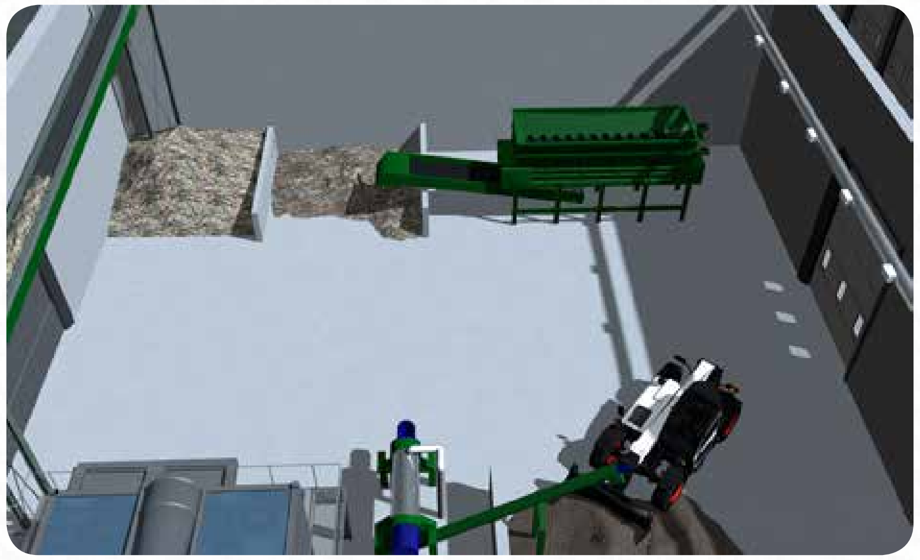
DIGESTATE SEPARATION

The digestate outgoing from the cold digesters is sent separately to a separation stage of the solid fraction from the liquid fraction obtained with a centrifuge (n. 2 for the O.F.M.S.W. and n.2 for the P.O.F.).



SHREDDING OF MATRICES

In a part of the building two special areas are made to accumulate the output matrices from the anaerobic plant that will be sent to the aerobic process. A nearby storage area is used for the reception of the green fraction. The stored matrices is sent through the mechanical means to a shredding and mixing system.



COMPOSTING PROCESS

To avoid the contamination between the digestate from the O.F.M.S.W. digestion and the one from the P.O.F. digestion, we decided to operate a total separation between the two processes, giving priority in dimension to the O.F.M.S.W. line that produces compost of high quality.

After the solid/liquid separation, the solid digestate is stored in confined stalls, inside the pre-processing areas where the air aspiration system guarantees a depression to avoid odour leakage.

The biomass arrives in the mixing area with a conveyor belt and it is loaded in the biocells for the maturation process.

At the end of the accelerated maturation, the material is taken out the biocells and sent to disposal (for the P.O.F.) and to the final maturation/refinement (for O.F.M.S.W.). The refinement is done with a rotating sieve. The obtained compost is sent to maturation building to be packed.

The oversieve is stored in box and is utilized for the stabilization process of P.O.F..

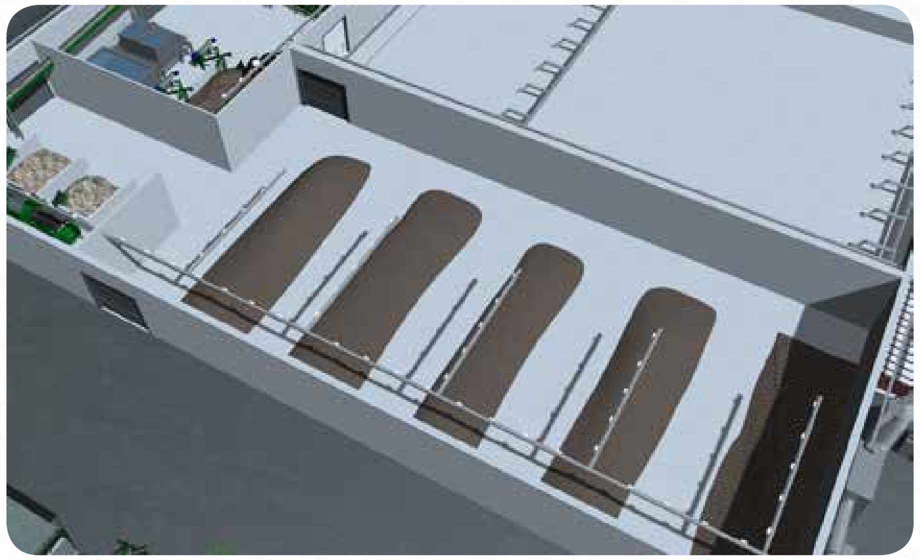
A part of composted coming from the O.F.M.S.W. line, after maturation, is sent

to the pyrolytic system in order to produce charcoal to be placed on market as soil improver. The proposed system is based on the pyrolysis process in which the material to be treated is indirectly converted under the effect of heat in a gaseous fuel (pyrogas) and in vegetable pyrolysis coal (biochar).

The pyrogas product is burned, providing the heat necessary to the maintenance of the pyrolysis process. The material to be processed is internally pyrolyzed to a rotating barrel externally heated by the pyrogas combustion fumes, generated in the combustor that pass through the interspace between outer and rotating barrel muffle. The pyrolysis is carried out in complete absence of oxygen and at temperatures in the range from 450 to 550 ° C.

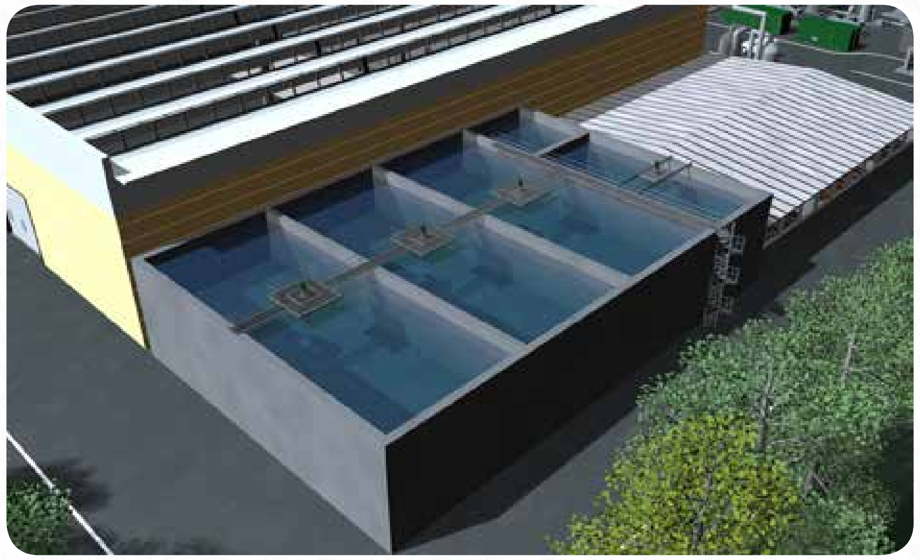
BIODRYING PROCESS

The non-biodegradable fraction is treated with a biodrying system in biocells for the allowing compaction and sending to energy recovery systems.



TREATMENT OF LIQUID EFFLUENT

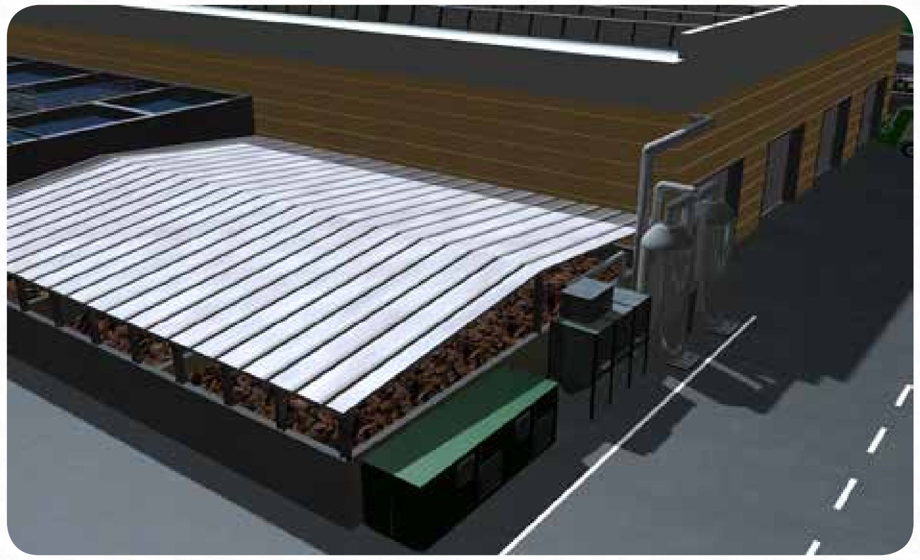
The liquid fraction of the digestate is sent to an equalization tank used for the following biological treatment section where SBR (Sequencing Batch Reactors) technology is used to treat the liquid effluent.
The working phases of the SBR technology can be divided into load, oxidation, denitrification, sedimentation and discharge. The SBR reactor allows the reduction of nitrogen loads present in the liquid fraction of the digestate. The decanted sludge is collected from the bottom of the tank and sent to the system of solid/liquid separation.
It is expected to treat the liquid fraction exiting from SBR by a treatment in membranes (ultrafiltration and reverse osmosis) allowing to meet the



depurator limits.

ODOURS TREATMENT

The entire complex, used as treatment of waste materials, for what concerns the closed sites, is maintained in depression and the intake air is conveyed to an abatement system of odorous emissions and powders consisting of suction lines, scrubber and biofilters. The biofiltration of the air is a treatment of purification from gassous emission based on an oxidation process done by aerobic microorganisms on the pollutant that are often odourous.



EMISSION IN ATMOSPHERE

The project design includes the adoption of the best available theologies, complying with the legislation that provides the reduction and control pollutant emission in atmosphere.
Abatement systems are used for cogenerative engine emission, such as the regulation of lenox combustion for NOx removal and the oxidant catalyst for CO removal.
The pyrolisis process takes place in condition to avoid the dioxin formation, resolving the problem of organic micro-pollution. The pyrolisis gas lacks of organic chlorinated compound (PCDD-PCDF).
The technical equipment, where possible, are positioned in aspired closed space and the air is sent to biofilter, to avoid olfactory emission.

ACUSTIC IMPACT

At the design phase a noise impact investigation will be done. This study will highlight a situation, both during the daytime and the night, comply with limit values (input and output) set by the acoustic classification of the city.

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