FROM WASTE
TO ENERGY RESOURCE…

innovazione energia ambiente

INNOVATION FOR ENERGY AND ENVIRONMENT

OCTOBER 2015

SUMMARY

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FROM WASTE
TO ENERGY RESOURCE…

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FROM WASTE TO ENERGY RESOURCE PROJECT

Today it is possible to achieve the goal to:

TRANSFORM MUNICIPAL WASTE IN RESOURCES

No longer produced to be **"THROWN IN LANDFILL"**, but resources that allow you to not harm the environment and conserve fossil fuels and raw materials.

With technology it is possible to:

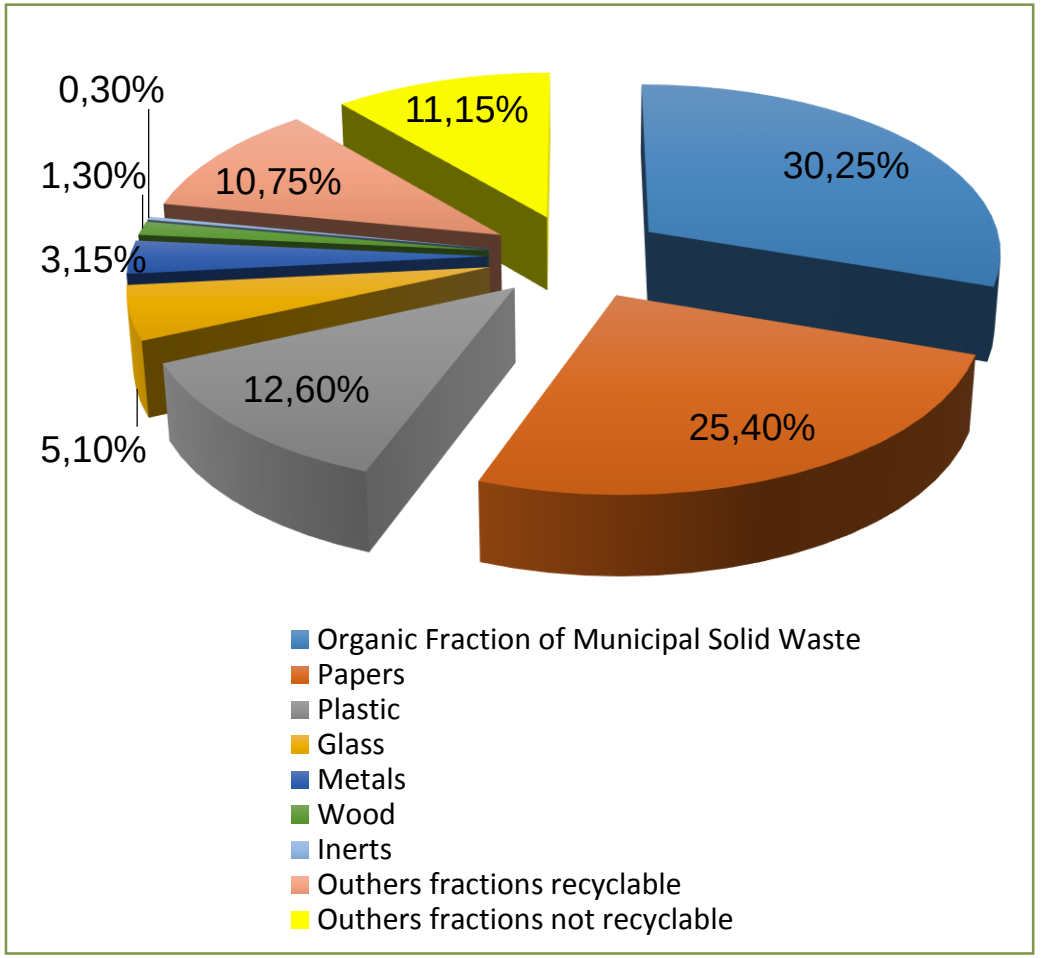
- AVOID INCINERATORS
- 90% REDUCTION IN THE LANDFILLING
- AVOID THE PRACTICE OF COMPOSTING AND THE RESULTING ENERGY CONSUMPTION
- REDUCE THE PRODUCTION OF CARBON DIOXIDE AND ODORS

FROM WASTE TO ENERGY RESOURCES

In recent years, much has been made of positive developments concerning the COLLECTION AND DISPOSAL OF MUNICIPAL WASTE.

TODAY you can do even better by using news technologies:

- Transform into BIO-GAS ORGANIC matter with high-efficiency without waste to landfills, without producing CO_2 and especially without producing foul smells.
- Valuing raw materials, such as reclaimed plastic, ferrous metals, glass, paper, cardboard, etc.
- Implement a process with high index E.R.O.E.I. (*Energy Return on Energy Investment*).
- Finally obtain the relationship between positive operating costs and revenues.
- Reduce management overhead by reorganizing all stages of collection, transport, treatment and recovery.



Example for Italy

FROM WASTE TO ENERGY RESOURCES

ORGANIC SEPARATED FRACTION

PRE-PROCESSING AND HIGH EFFICIENCY ANAEROBIC DIGESTION

- Biogas / Bio-methane
- Organic fertilizer Kemet®
- Water

creation of skilled job

DRY FRACTION

- Ferrous & non-Ferrous metals
- Plastic & Rubber
- Paper & Cardboard
- Glass
- Dry fraction undifferentiated

SEPARATION, RECOVERY AND VALORIZATION OF RECOVERED MATERIALS

- Valuable recyclable and reusable materials

LANDFILLING

INCINERATORS

AEROBIC COMPOSTING

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FROM WASTE
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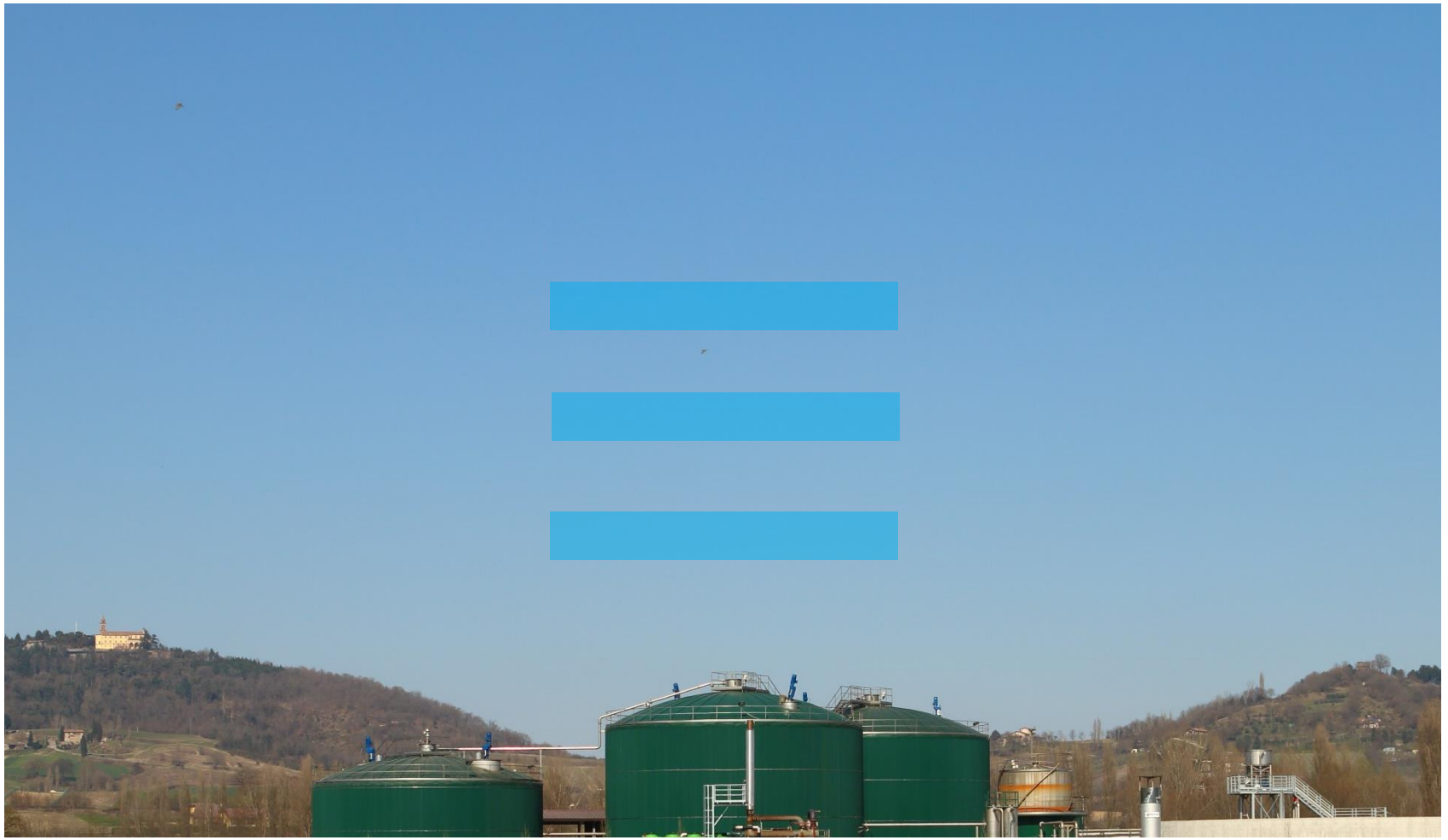

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THE CONSORTIUM INNEA

This "new resource" is able to create skilled jobs and significant economic benefits. All this with technologies and patents developed and owned by Italian companies belonging to the

THE GROUP "INNEA" – INNOVATION FOR ENERGY AND ENVIRONMENT

The staff of INNEA GROUP designs and manufactures equipment for the production of biogas from biomass of agricultural origin and / or livestock since 1978; since then over seventy plants have been made, which are still in full working order.

The adoption of policies to stimulate renewable energy production, the untenable situation of waste management in landfills is now exhausted and the impending environmental collapse brought Eng. Vincenti and his staff to develop the patented technology for the production of BioGas directly from the organic fraction of waste, transforming in fact, the waste in resource.

INNEA GROUP has the duty not only to co-ordinate the implementation of individual projects, but to act as a single corporate entity for the promotion of technology on an international scale.

We believe that the scope of the project, the experience gained in the design, the results obtained so far, combined with the technical expertise of individual companies express, in the medium term, one of the most important businesses in the international scene.

ENGINEERING PROCUREMENT & CONSTRUCTION

INNEA GROUP works within the model **EPC (ENGINEERING PROCUREMENT & CONSTRUCTION)** dealing with an internal staff of engineers and technical experts in the field, the first two phases and giving partners the works to be executed:

- CONSULTING AND FEASIBILITY STUDY OF THE SYSTEM
- FULL DEVELOPMENT OF THE BUSINESS PLAN
- RESEARCH SUPPORT OF FINANCIAL INSTRUMENTS
- PRELIMINARY AND EXECUTIVE PLANNING
- MANAGING CONSTRUCTION PERMITS
- INSTALLATION AND PROJECT MANAGEMENT
- TESTING, STAFF TRAINING AND START-UP FACILITY
- AFTER SALES SERVICES

ENGINEERING PROCUREMENT & CONSTRUCTION

The associated companies, each in their technical skills, realize the individual parts which then will compose the system in its entireness:

- DIGESTERS AND WORKS IN METAL CARPENTRY
- ELECTRICAL, THERMAL-HYDRAULIC AND MECHANICAL SYSTEMS
- SYSTEMS FOR THE MANAGEMENT AND STORAGE OF THE MATERIAL INPUT
- DESIGN AND CONSTRUCTION MANAGEMENT SOFTWARE, MONITORING AND REMOTE CONTROL
- SORTING PLANTS FOR THE INORGANICS RECYCLABLE AND REUSABLE MATERIALS
- UPGRADING BIO-METHAN PLANTS
- DIGESTATE TREATMENT PLANTS

and everything needed for the realization of the planned work.

- **S.P.I. S.R.L. (SOCIETÀ POLITECNICA ITALIANA)** - Since 1885 specialized in Engineering and Environmental, deals with research and designing in the following sectors: environment, renewable energy, wastewater treatments and solid waste disposal. With over 70 plants built worldwide, deals with the promotion and realization of Waste To Energy plants for the treatment of Municipal Solid Waste through an integrated new technology, using International Patents created by Eng. Enrico Vincenti.
- **FORTINI SERVICE S.R.L.** - More than 50 years in the field of industrial hydraulics.
- **S.E.E.R S.R.L. (SOCIETÀ ELETTRICA ENERGIE RINNOVABILI)** - 40 years in electrical engineering and electronics, have also developed the managing.
- **COMMERCIAL SERVICE AND INTELLIGENCE SERVICE INNOVATION (ISI S.R.L.)** - since 1964 alongside companies with business management consulting and administration. Strongly committed over the last decade in the creation and management of international projects on behalf of major corporations.

ASSOCIATED COMPANIES

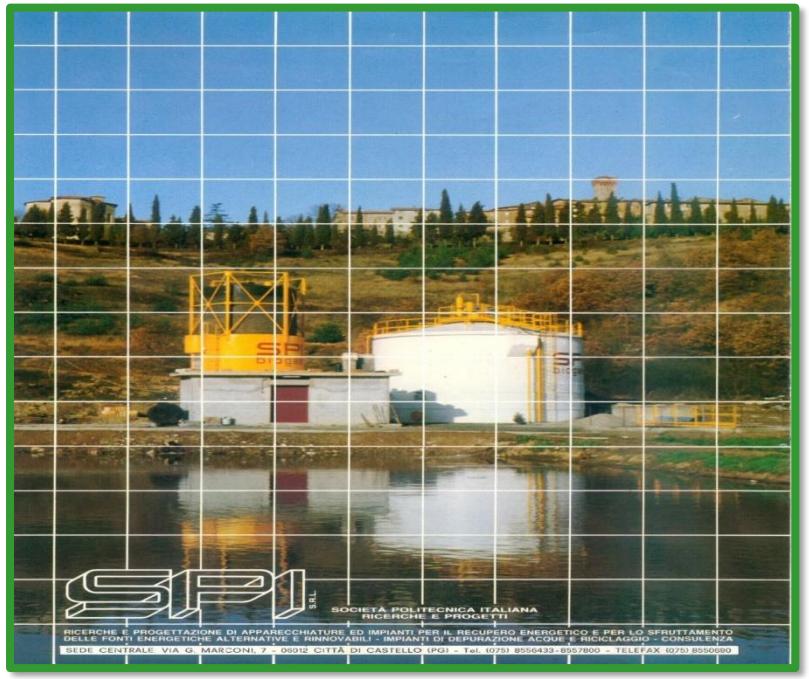
- **E.T.M. S.R.L. (ELECTRIC TRADING MARKETING)** – has forty years' experience in trading and marketing all over the world dealing with renewable energy in the automotive sector.
- **M.I.P. S.R.L. (MONTAGGI INDUSTRIALI PIPELINE)** – Leader in the installation of industrial pipelines ranging from hydro to petrochemical.
- **CONSORZIO ABN** – 42 cooperatives are part of it, with more than 11,000 employees. General contractor (EPC contracts) formally qualified to build and maintain power plants, focuses on the development of innovative business models through community involvement. The Consorzio ABN is an ESCO (Energy Service Company) accredited by GRTN since 2005.
- **ALESSI S.R.L.** – Diversified in various activities in the field of plant engineering, leader in the construction and design of systems for the selection of waste, it is a global supplier of technology selection and recovery of materials undifferentiated as well as a promoter of technology for the production of Bio-Gas from organic waste.

- **GM GREEN METHANE S.P.A.** – Company of the Marchi Industrie Group since 1873 the history of the Italian chemical. GM is the world leader in the purification of Bio-Gas allowing its transformation into Bio-Methane and the consequent injection into the network. It is proposed as a strategic supplier and privileged, as well as a customer, investor and convinced promoter of our technologies.
- **SANDWIK ITALIA DIVISIONE PROCESS SYSTEMS** – Company of the Sandvik Group, a world leader in the production of special steels for over 150 years, project partners for the design and construction of drying plants for bio-digestate.
- **OFFICINE PICCINI** - From a small workshop founded in 1949 to a global reality. Realize private and public infrastructure in different continents, is proposed as a General Contractor in the countries with which it maintains economic relations.
- **VERAGON ITALIA S.R.L.** - Mineral water from the air... a " miraculous" project. Synergy in order to produce mineral water using the energy extracted from the waste. High-tech Government and humanitarian projects.

- **BICARJET SOLVAY** – Solvay Group company is a supplier and partner R&D promoting ecological systems based bicarbonates specifically formulated to control odor emissions and reducing air pollutants.
- **M.P. INOX** – Company specializing in the processing of stainless steel for the construction of digesters, already partner of SPI srl (Studio Vincenti) in the construction of various plants.
- **BIOGEST SERVICE SRL** – Company specializing in the development of an innovative composting system with a method that, through aerobic fermentation induced, transforms the digestate into fertilizer for the soil, eliminating liquids that require expensive transport and storage.
- **WONDERWARE (BY SCHNEIDER ELECTRIC)** – Company market leader in the field of software for the management of industrial activities in real time: Supervisory HMI, GeoSCADA, Mobile Solutions, Production Management, MES, Performance Management, as well as solutions for integration with asset management applications, supply chain and ERP.
- **COPE (CONSORZIO PUNTO EUROPA)** – Information center for planning the EU social and economic policies.

MAIN PLANTS CONSTRUCTED IN ITALY AND ABROAD

- **1978** Landini Farm on **LIPPIANO (PG)**: treatment of 2.000 pigs farm effluent - 70 kWe.
- **1979** Foundation for the agricultural education at the University of Perugia Tenuta di **CASALINA (PG)**: treatment of 2.000 pigs farm effluent - 70 kWe.
- **1980 COOPERATIVA CILA - REGGIO EMILIA**: treatment of 5.000 pigs farm effluent.
- **1981 POLIKOMBINAT SURCIN - BEOGRAD (YUGOSLAVIA)**: treatment of 12.000 pigs farm effluent.



- **1982** Installation of anaerobic digestion of zootechnical effluent in the municipality of **MARSCIANO (PG)**, with net conveyor (36 km) from 86 pig farms and production of 0,7 MWe elettrical, thermal energy for drying agricultural products (tobacco and corn), the heating of 10,000 square meters of greenhouses, the production of agricultural organic fertilizers dried, the irrigation of 3,000 ha with treated water.

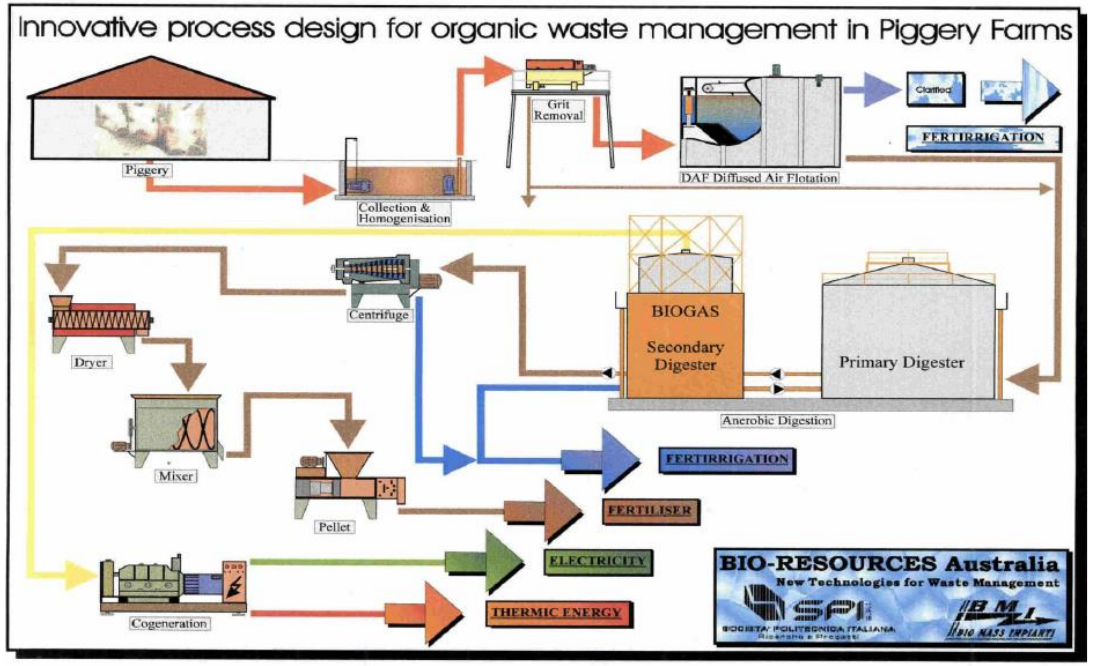
MAIN PLANTS CONSTRUCTED IN ITALY AND ABROAD

- **1984 SIAI AVEZZANO**: treatment of 4.000 pigs farm effluent with complete purification of water and production of 180 kWe.
- **1985 MAMUSA FARM - CAGLIARI**: treatment of 10.000 pigs farm effluent with production of 0,25 MWe.
- **1988 IL PRATO FARM – SASSARI**: Installation of an anaerobic digestion plant to treat poultry farm effluent with a capacity of 100,000 laying hens, production of 230 kWe, thermal energy for heating greenhouses, the irrigation of 50 ha with treated water, production of 200 kWe from wind power, production of organic fertilizers.

- **1989 IMPIANTO CONSORTILE DI VISANO (BS)**: treatment of sewage cattle, pigs, poultry and civilians of the area with conveyance in pipelines and production of 1 MWe.

MAIN PLANTS CONSTRUCTED IN ITALY AND ABROAD

- **1990 CHARLES HILFE FARM - BALLARAT (AUSTRALIA)** integrated plant with treatment of 10.000 pigs farm effluent and production of 0,40 MWe, organic fertilizers, treated water for irrigation and thermal energy.
- **1992 BELICE (SPAGNA)**: Production of biogas plant.
- **1996 CADÈS DE PENEDÈS (SPAGNA)**: Plant for the production of biogas.
- **1996 MAZZARI**: Anaerobic digestion and water treatment.
- **1999 TRAPAS (SPAGNA)**: Production of biogas plant.



- **2003 DISTILLERIE CAVIRO – FAENZA (RA)**: Biogas cogeneration plant powered by borlande from distillery - 2,1 MWe.
- **2004 CADÈS DE PENEDÈS (SPAGNA)**: upgrading of the plant for the production of biogas.

MAIN PLANTS CONSTRUCTED IN ITALY AND ABROAD

- **2006 MANTOVA AGRICOLTURA – MANTOVA**: powered by corn silage and idrobios - 1 MWe e 1,2 MWt.
- **2010 FAT FATTORIA AUTONOMA TABACCHI – CITTÀ DI CASTELLO (PG)**: powered by corn silage and triticale - 1 MWe e 1,2 MWt.
- **2011 SOCIETÀ AGRICOLA POLIZIANA MONTEPULCIANO (SI)**: powered by biomass energy crops (silage cereals) - 1 MWe e 1,2 MWt.

- **2011 AZIENDE AGRICOLE ASSOCIATE GIORGI E TONELLI TORGIANO (PG)**: powered by corn silage and triticale - 0,5 MWt e 0,6 MWt.
- **2011 SOCIETÀ AGRICOLA SEGHIZI – POZZAGLIO (CR)**: powered by silage cereals and sewage cattle - 1 MWe e 1,2 MWt.
- **2012 VIRGINIA TRADE – TRESTINA (PG)**: powered by silage cereals - 1 MWe e 1,3 MWt.

MAIN PLANTS CONSTRUCTED IN ITALY AND ABROAD

- **2012 GREEN WAY S.R.L. LOCALITÀ ACQUAVIVA MONTEPULCIANO (SI)**: powered by biomass energy cultivation (silage cereals) - 1 MWe e 1,2 MWt.
- **2012 DISTILLERIE CAVIRO – FAENZA (RA)**: power by agricultural waste and slaughterhouse waste - 1 MWe e 1,3 MWt.
- **2013 TOZZI ENERGIA S.P.A.- SAN GIOVANNI IN PERSICETO (BO)**: powered by silage cereals - 1 MWe e 1,3 MWt.

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FROM WASTE
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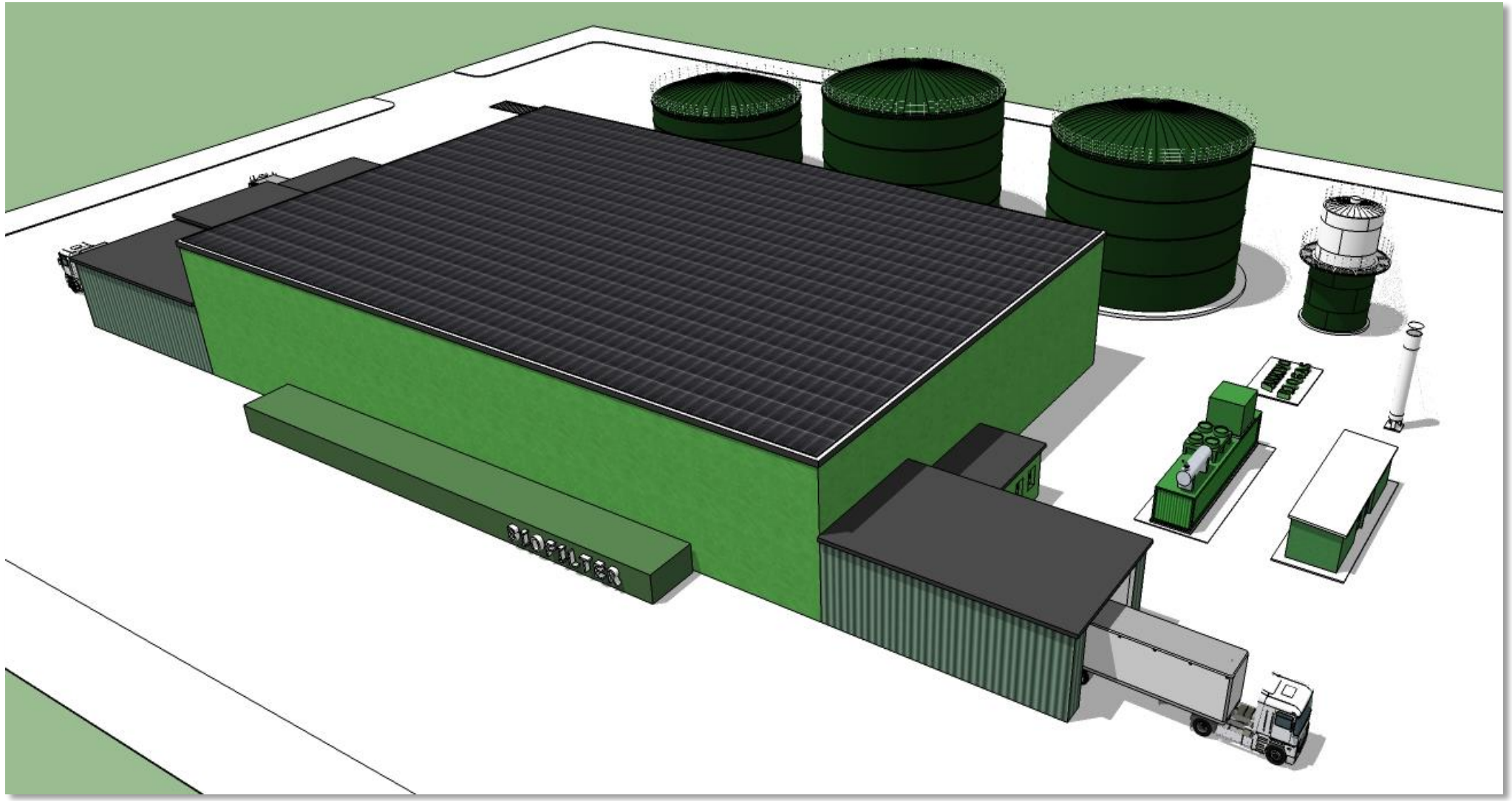
THE FACILITY


BIOFILTER

Our system is conceived and designed as an integrated platform to process the **Organic Fraction of Municipal Solid Waste**, using some of the best available technology to recover the maximum value from waste, minimizing the amount of waste taken to the landfill.

The Organic Urban Fraction and other biomass from agriculture or animals are used to obtain:

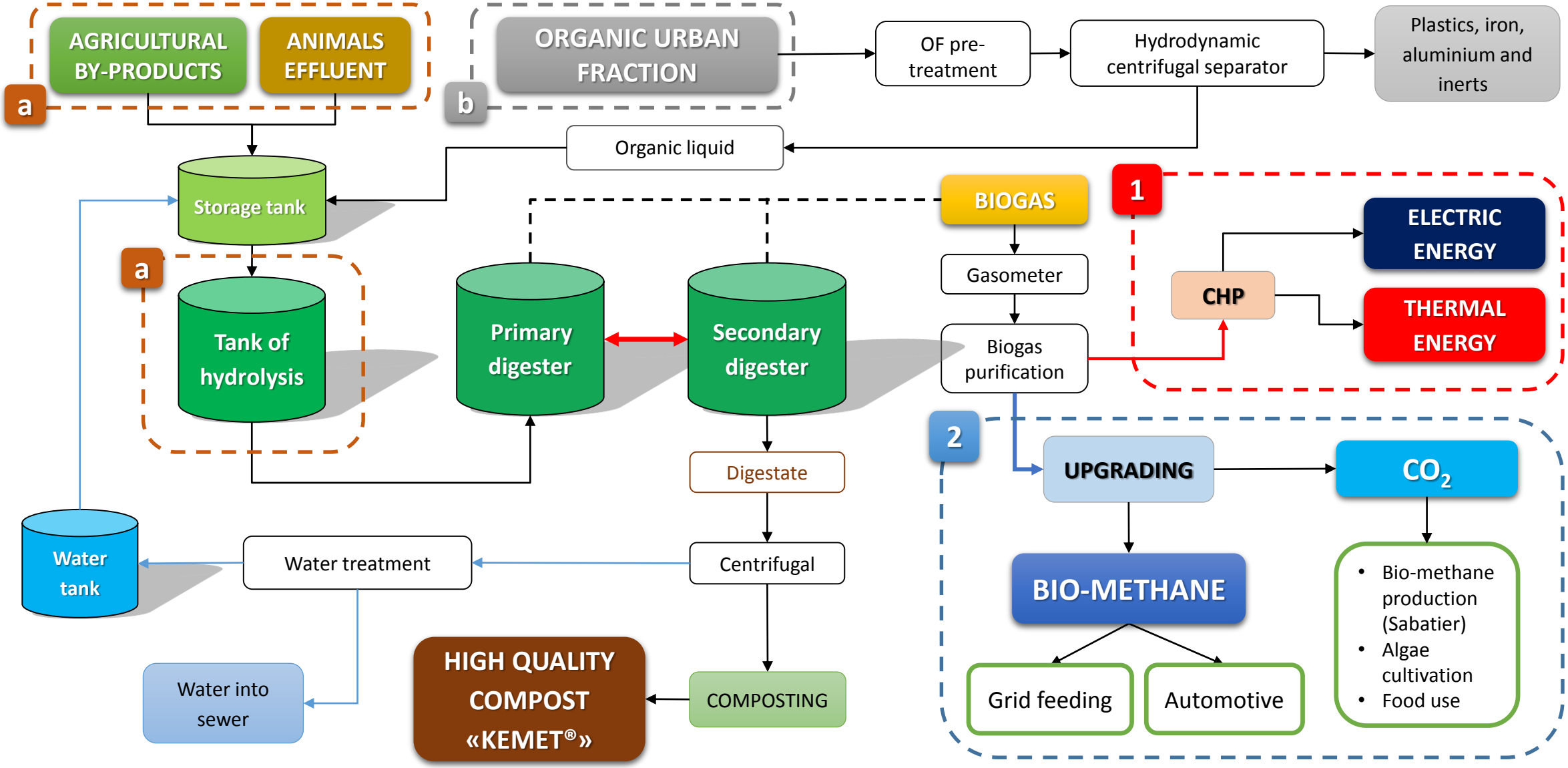
- RENEWABLE ENERGY such as bio-methane, or electricity and heat;
- ORGANIC FERTILIZER (KEMET®);
- CO_2 pure to 99% for different purpose and commercializations;

The system is organized along two main lines:

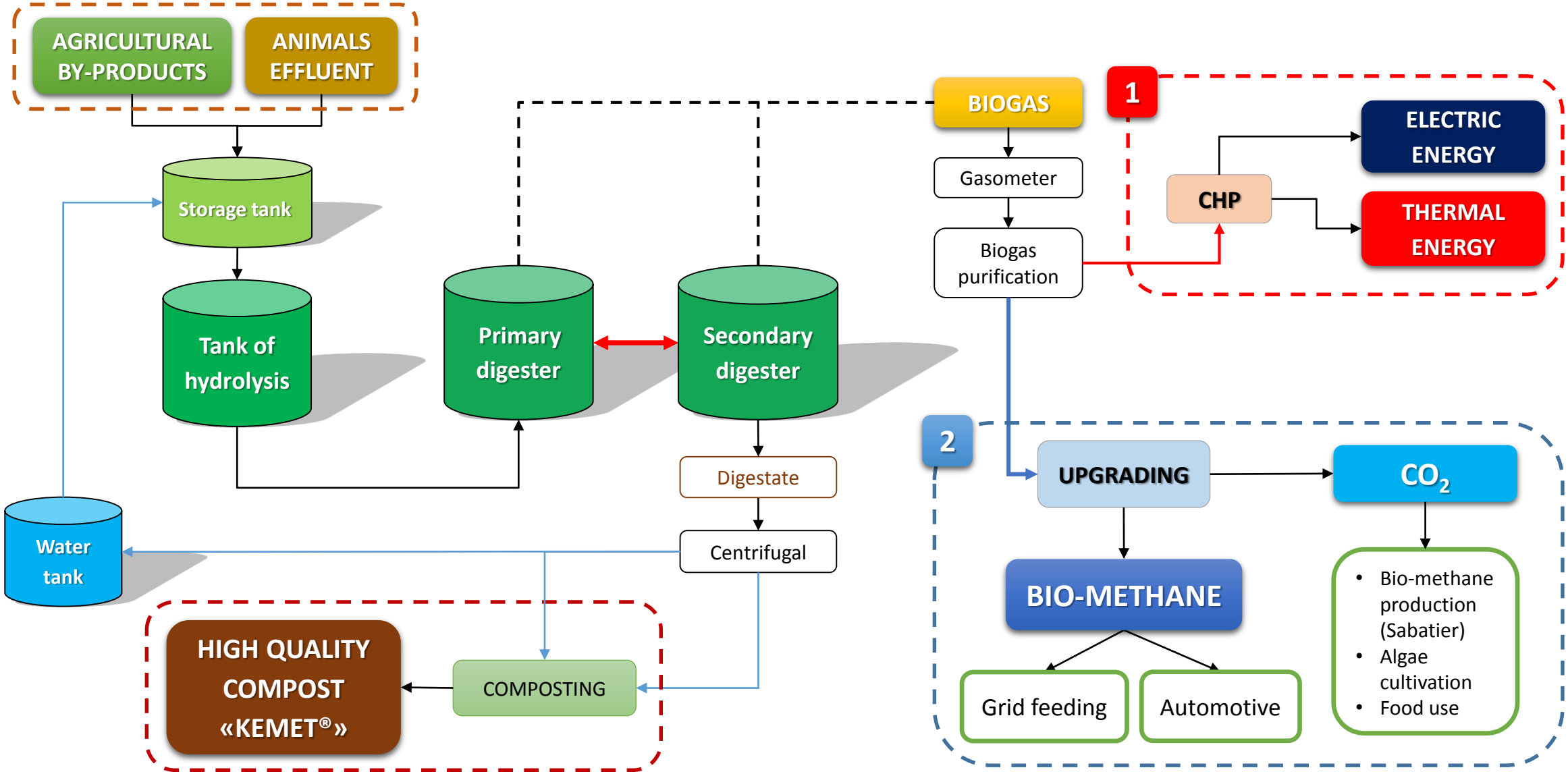
- **THE ORGANIC LINE,** where the biowaste (O.F.M.S.W.) and other biomass is treated and used to feed the digesters producing biogas, organic fertilizer and water;
- **THE BIOMETHANE/COGENERATION LINE,** after the process of purification of the biogas, a section of upgrading remove the CO_2 (recovered and not dispersed in the environment) and we get purified **natural methane**, and/orthe biogas is entered into the co-generator for the production of **electrical** and **thermal energy**.

A **MANAGEMENT SOFTWARE** automates the operation of all operating components of the system and the **REMOTE CONTROL SYSTEM** allows the **supervision** and the **teleservice.**

FLOW SYSTEM SCHEME – O.F.M.S.W. PLANT



FLOW SYSTEM SCHEME – AGRICULTURAL AND ANIMALS BY-PRODUCTS



BUILDING CONFERRING BIOWASTE

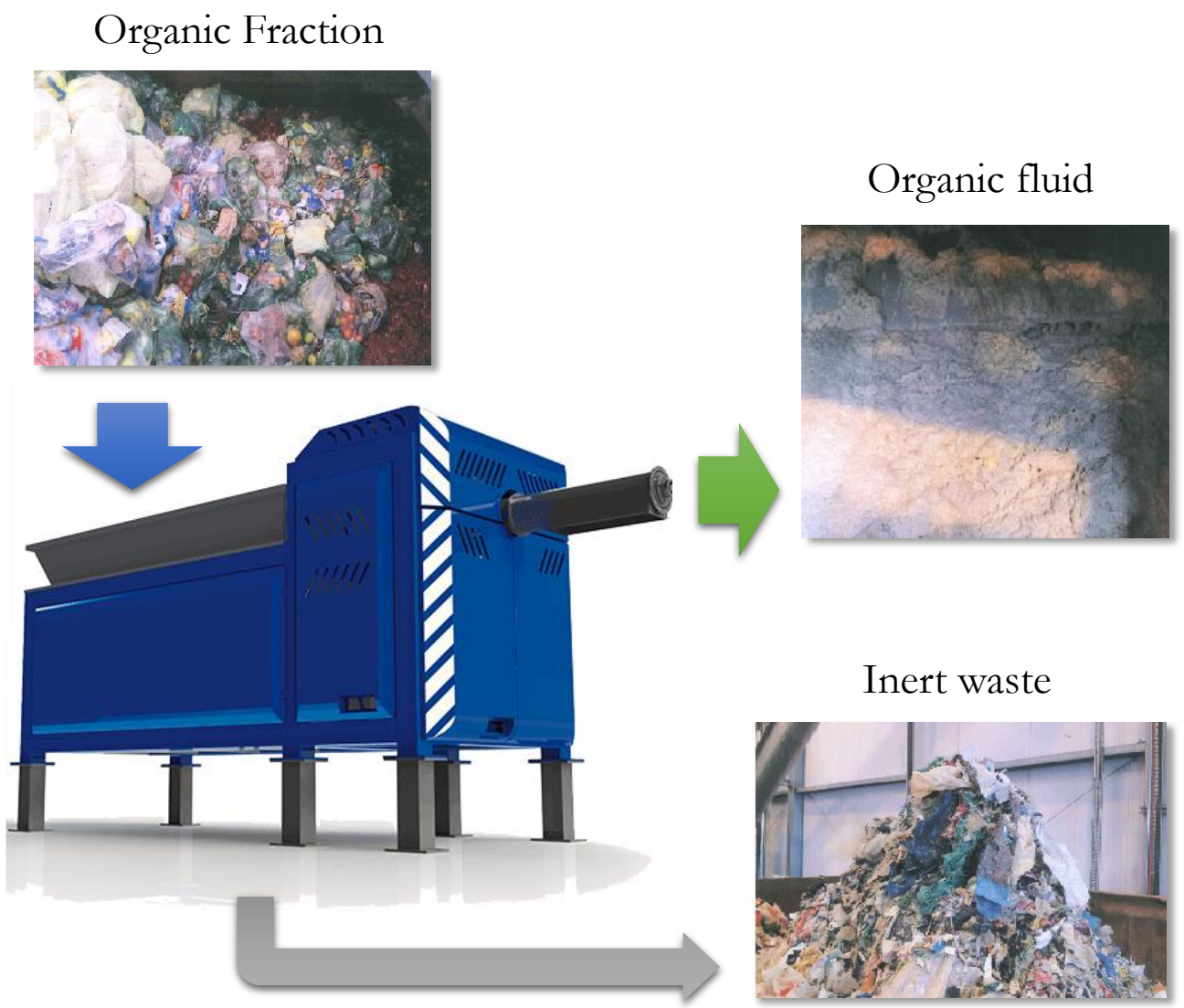
The **building conferring biowaste (O.F.M.S.W.)** is kept in depression and the air is cleaned with **BIOFILTERS** before being released into the atmosphere which prevents odor emissions. Inside they find housing in two separate and distinct areas that could be called pre and post treatment:

- **TRENCH CONFERRING**
- **OVERHEAD CRANE** fully automated with spider for moving the materials
- **BAGS-BREAKER SYSTEM** with loading hopper
- **SIEVE WITH DISCS**
- **IRON REMOVER** for the selection of ferrous and non-ferrous
- **HYDRODYNAMIC CENTRIFUGAL SEPARATOR** with integrated isolating system of plastics and inert
- **PUMPS AND PIPELINING**
- **CENTRUFUGAL SYSTEM** for solid-liquid separation of the digestate

THE ORGANIC LINE: HYDRODYNAMIC CENTRIFUGAL SEPARATOR

The first step of the organic line is constituted by the separation: dry, inert and other fractions are expelled by a centrifugal machine and fed-back to the sorting line. The **organic fluid** obtained has a very good homogeneity which allow to reach a very high efficiency in the anaerobic digestion process.

The machine is produced in various types and size, with metal body, easy to maintain and use.



THE ORG. LINE: PREPARATION OF RAW MATERIALS (case a)

The amount of **raw material**, in the period from collection to full use, is stored on the surface of land available for storages.

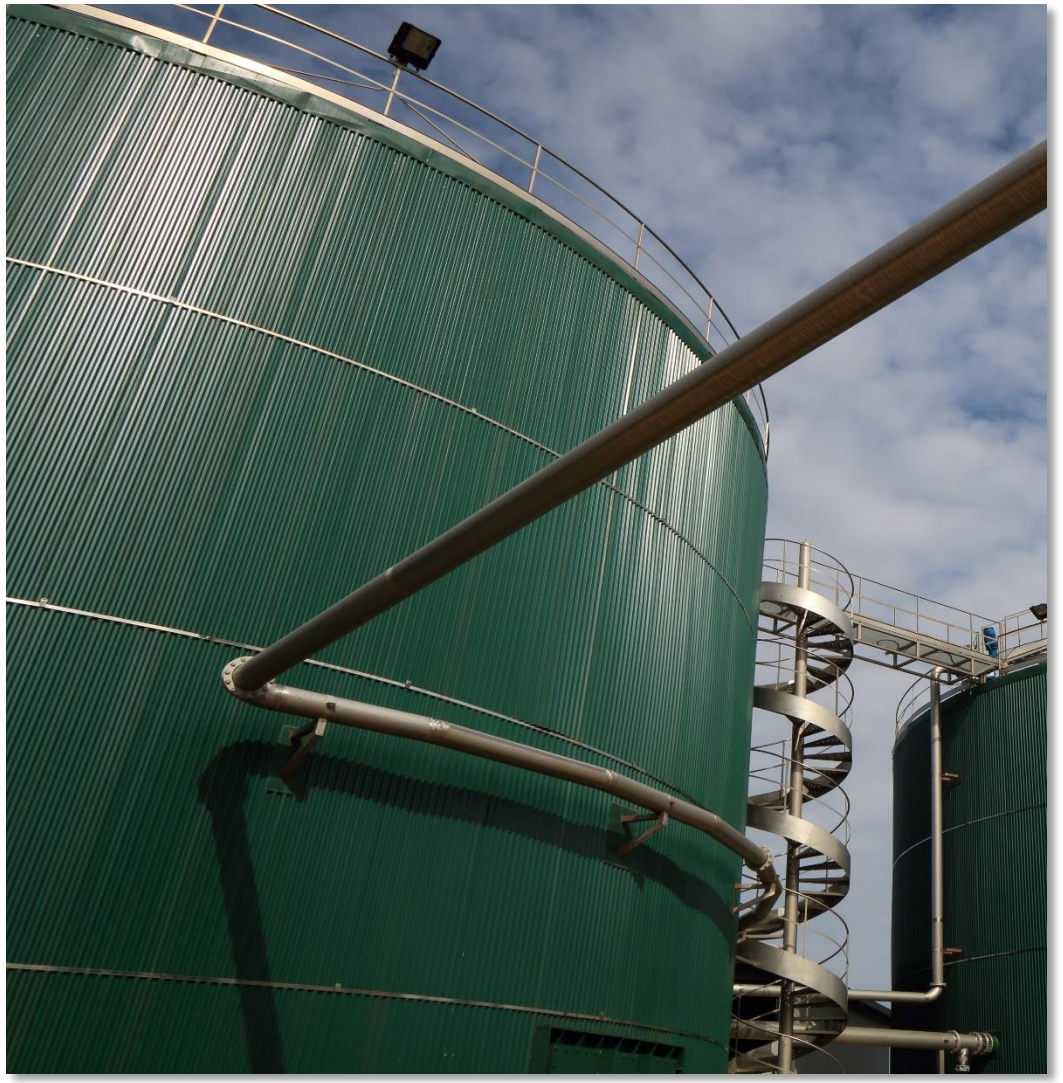
The **by-product** and the **O.F.M.S.W.**, are entered into the alimentation and **MIXING TANK** equipped with a conical bottom from which, by means of a screw driven by an electric motor, are extracted aggregates (stones and sand) that may be contained in other biomass. The tank is hermetically closed by a steel cover and stirred by agitators helix with an external motor.

THE ORGANIC LINE: THE STORAGE TANK (case b)

The **STORAGE AND HOMOGENIZATION TANK** is made of stainless steel.

The organic liquid from the hydrodynamic centrifugal separator is pumped into the tank with the addition of water recirculated from the process. The liquid should be diluted to bring the dry matter content up to 10% to optimize the digestion process.

The digesters will be powered by a pump system by a liquid, well homogenized and heated that it will improve **yield biomethane**, the **digestibility** and **speed reaction**.



THE ORGANIC LINE: THE HYDROLYSIS (case a)

The **TANK OF HYDROLYSIS** is made of stainless steel. The hydrolyzation prior to anaerobic digestion allows to obtain a product of excellent quality to digest which determines an important increase in the quantity and quality of biogas produced.

The loading system of the mixing tank and preparation of the raw material will be of the mechanical type, whereas the product will pass into the hydrolyser, well mixed and added with a suitable amount of recirculation water extracted from the digestate.

The digesters will be fed through a system of pumps with a liquid product well homogenized, heated and hydrolyzed which will improve the yield of biogas, the digestibility and the speed of reaction.

Our **Anaerobic Digestion process** is specifically designed to optimize, in qualitative and quantitative terms, the biogas yield from the digestion of press extruded organic liquid.

The section of anaerobic digestion for production of biogas is constituted by :

- **PRIMARY DIGESTER**
- **SECONDARY DIGESTER**
- **INTERNAL SYSTEM OF MIXING OF THE RAW MATERIAL**
- **RECIRCULATION AND CONTROL PUMPS**

The digesters are built above ground

ENTIRELY OF STAINLESS STEEL

(body and roof) to ensure a safe service life **for at least 30 years** and a simple and cheap maintenance.

They are built in order to have **sealed** for both liquids and gases, which are completely recovered and used.

The digesters will be equipped with **heating coils** in which circulate the hot water recovered by the cogenerator, where present.

The shape coefficient of the digesters, which develop prevalently in height, allows effective stirring of the microbubbles of biogas, which date back upward, assisted by **MIXERS WITH EXTERNAL INSPECTION**, installed externally to the digesters.

The mixing system adopted allows the total maintenance of the digesters exclusively from the outside, avoiding, in this way, their emptying in case of intervention.

To avoid loss of important heat in the digesters, the insulation of the digester will occur with the use of a layer of rock wool of 15 cm. The digesters are heated by heat recovered from the cogenerator, dall'upgrading or by a natural gas boiler.

THE ORGANIC LINE: RECIRCULATION AND CONTROL PUMPS

Central in the high efficiency operation of the plant is the **REDUNDANT SYSTEM PUMPING** for recirculation and flow control which allows not to interrupt the process of digestion and biogas production even for the necessary routine maintenance and keep the production plant for over **8,500 hours/year** .

The **GASOMETER** is used to maintain, in the event of fluctuations of the biogas production, a constant pressure to the biomethane upgrading system and to allow the cogenerator to always work at maximum speed.

The gasometer to service the plant has a **capacity less than 100 m^3** and is made entirely of stainless steel, against the 1.000 m^3 of a typical installation made with plasticized PVC tarpaulins (tarpaulins are not resistant to winds, snow and last for a few years, against 30 years of minimum duration of the gasometers in stainless steel). It is also **not subject to regulation of the deposits of combustible gases in fixed tanks,** or in hazardous activities according to CEI 64-2. Therefore the system will not need to appropriate storage tanks of water for fire protection with the **SIMPLIFIED AUTHORIZATION OF THE FIRE DEPARTMENT**.

THE BIOGAS LINE: BIOGAS PURIFICATION

Biogas produced in the anaerobic digestion process should be **dehumidified**, **desulfurized** prior to be dispatched to the next unit of upgrading, for the conversion into biomethane. In this section we find the following items:

- **SAFETY TORCH**: if operating problems should occur in the cogeneration plant, the torch will burn the biogas produced;
- **CARBON FILTERS** for hydrogen sulphide (H2S) removal;
- **BIOGAS DEHUMIDIFICATION SYSTEM**
- **BLOWER FOR PRESSURIZATION** of biogas for the feeding of upgrading.

THE BIOGAS LINE: CHP GROUP (case 1)

At the end of the biogas line, the **CO-GENERATOR HEAT AND POWER (CHP)** group can be installed in a soundproof container, with all the electrical and electronic devices for an easy and remote control.

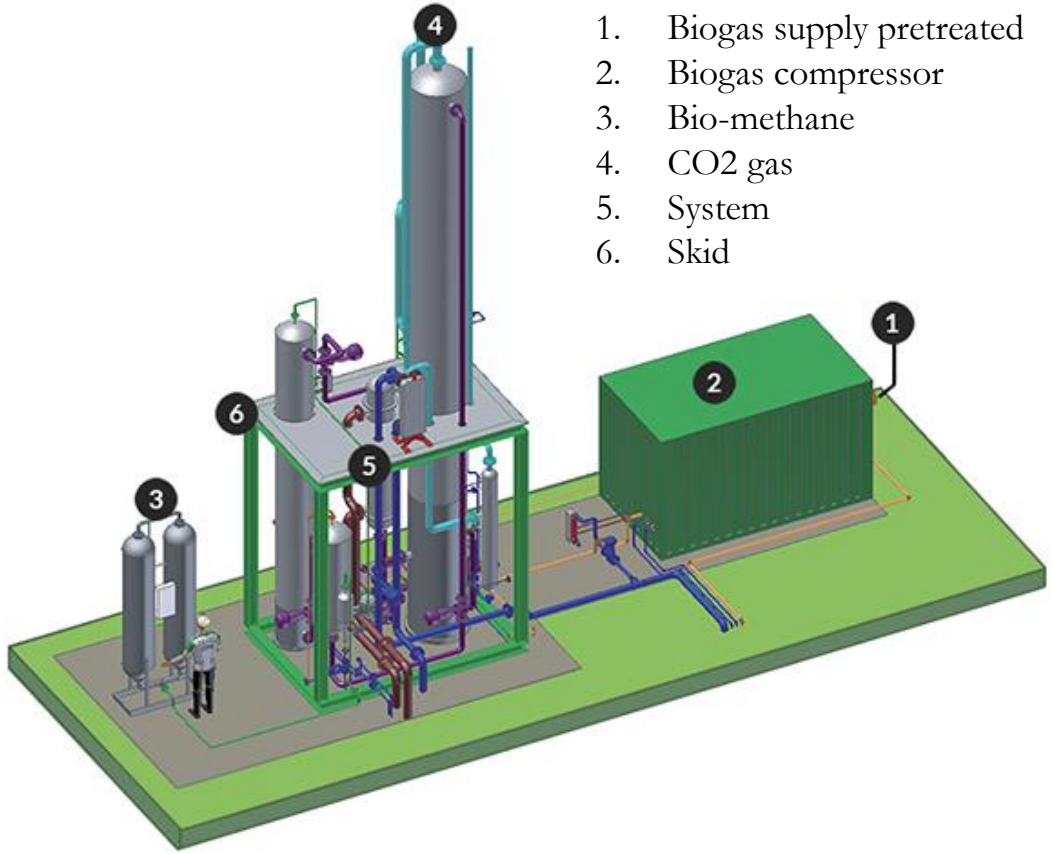
The CHP unit can be used to produce electricity and thermal energy for own consumption of the plant.

The **UPGRADING SYSTEM OF THE BIOGAS** is composed of the following units:

- Units of biogas upgrading, comprehensive of services and electrical panels and control;
- Drying unit of biomethane.

The unit of upgrading and accessory units require little intervention for the management of the process.

The units operate fully automatically and the control systems guarantee full security and the eventual stop in case of a fault.



1. Biogas supply pretreated
2. Biogas compressor
3. Bio-methane
4. CO2 gas
5. System
6. Skid

The **CO2 RECOVERY AND PURIFICATION PLANTS** supply **FOOD GRADE CO2** starting from biogas.

Thanks to the innovative purification process of activated carbons, the technology used removes any kind of impurities and smells, to make a CO2 ISBT/EIGA compliant.

This technology incorporates in the liquefaction unit a stripper column where uncondensable impurities are reduced to acceptable levels. This innovative technical solution enhances the plant recovery capacity up to 99,99 % of the delivered CO2.

This unit consists of:

- a compression part
- a section of drying and purification
- a section of liquefaction and of a cryogenic tank for storage of liquid CO2

The **CENTRIFUGAL** involves a separation of organic substances in suspension and not in solution in the slurry leaving the digestion. It is a process that operates to difference in specific weight between the substances to be separated. The centrifugation is carried out inside a cylindrical-conical container, called a drum, which is rotated at high speed by an electric motor to raise thousands of times the force of gravity.

Inside the drum there is the cochlea, the function of which is to transport to the outside the solid product, which will then be downloaded from an evacuation system.

The **solid part** is extracted completely devoid of odors; the biodigestion in fact has characteristics to stabilize the organic material.

The **separated water** are in part recirculated head of the plant for the dilution of the organic liquid inlet.

DIGESTATE MANAGEMENT AND COMPOSTING

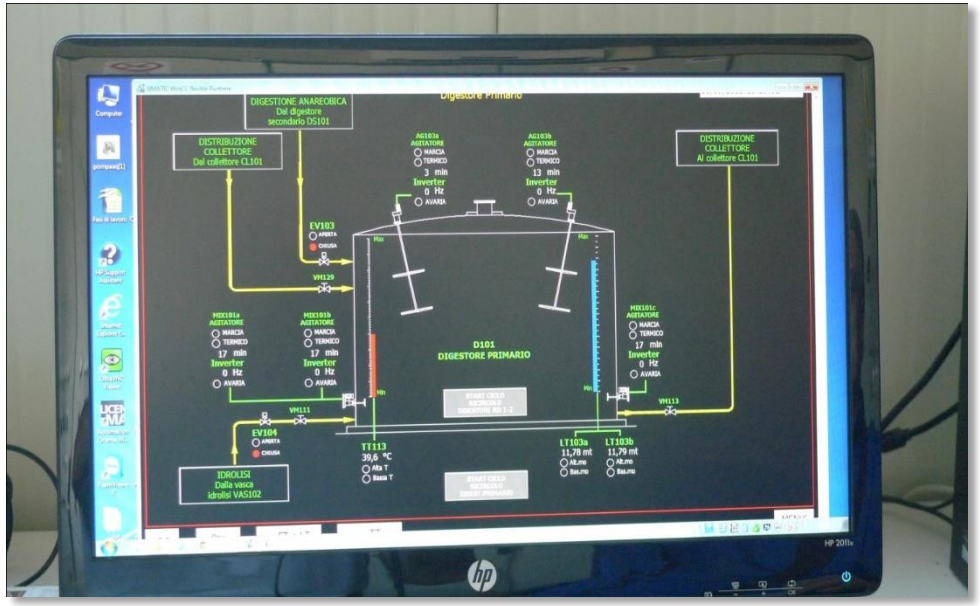
The **DIGESTATE** is the remaining part of the process of anaerobic biodigestion and consists of the indigestible parts of biomass. It's very valuable material as fertilizer soil, reducing the need for the cultivation of exogenous inputs of chemical fertilizers. It's reuse on soil that produced the biomass is therefore very useful in order to ensure sustainability over time of production and maintain a good level of organic matter in soils, essential for agronomic fertility and reducing erosion risks.

The bio-digestate to be treated is poured onto a bed of ligno-cellulosic material of particle size and functional characteristics. The fermentation bed, after months of work, is replaced with fresh material. The composition of this exhausted material is such as to make it suitable as **HIGHEST QUALITY COMPOST** (**KEMET®**).

Was called Kemet, the fertile land of the Nile River, in contrast to the red desert land Decheret.

REMOTE CONTROL SYSTEM

The facility is equipped with a **REMOTE CONTROL SYSTEM** that, using the Internet, allows the operator to monitor the operation of all operating parameters also from their own home and our technicians to intervene at the software level in real time, in telecontrol, without requiring continuous supervision.



Our company guarantees **urgent intervention** in case of malfunction of equipment and systems with the replacement of faulty components for the warranty period

EXAMPLE OF LOCATION

The plant capacity of **100 tons/day** of treatment, then modular expandable, is shown in the figure below, and can be inserted into the landscape with a suitable **GREEN FURNITURE**.

TOTAL ABSENCE OF ODORS

The building that receives the organic fraction is kept in **depression** and the air is cleaned with **BIO-FILTERS** before being released into the atmosphere.
Even the part used for the treatment of the dry fraction is equipped with air extraction and filtering the dust, to **optimize the workplace**.

- **LONG EXPECTED LIFE**

  Plant is made with **stainless steel body and aluminum covering**; all pipe system, pumps and mixers are easily accessible from the outside (for inspection and maintenance activities).

- **HIGH EFFICIENCY IN BIOGAS PRODUCTION**

  The shape of digester allows a very efficient mixing of the liquid, as it promotes a natural mixing effect due to the increase of the biogas microbubbles, with a consequent low power consumption.

- **MAINTENANCE LOW COSTS**

  The fully steel digesters and pipes, minimize the need for ordinary and extraordinary maintenance operations.

- **RELIABILITY**

  The many plants, which have been operating worldwide for over thirty years, reported no major damage or unplanned stops.

- **LOW COST AND EASY MANAGEMENT**

  Around the world, there are plants which have been working over many years: maintenance has been limited to the change of end-of-life motors, consumables and lubricants. The stainless steel body will keep a good value at the end of the plant's life.

COMPETITORS ANALYSIS

This document aims to summarize the **INNEA'S TECHNOLOGICAL INNOVATIONS** in the field of biogas / bio-methane production and underline **main differences versus the standard technology** of the competitors in the Italian market.

	Process/Phase	InnEA Technology	Traditional Technology
1	DIGESTION	Mesophilic	Mesophilic / thermophilic
2	PRE-TREATMENT	Presence of the hydrolyser	Absence of the hydrolyser
3	TREATMENT	Two stages	Mono stage
4	HEATING	Internal integrated classic	Internal classic
5	AGITATION SYSTEMS	External	Internal
6	VIDEO INSPECTION SYSTEMS	Present	Absent
7	BIOGAS STORAGE SYSTEM	By gasometer (100 m^3)	By gasometric dome
8	SYSTEMS MAINTENANCE	Inspection hatches present	No inspection hatches
9	CONSTRUCTION METHODS DIGESTERS	Steel	Concrete
10	MATRIX POWER PLANT	Matrix flexible and variable	Mono fixed matrix
11	PIPING CONSTRUCTION TYPE	Steel	PVC
12	PUMPING SYSTEM	Redundant	No redundant
13	RECIRCULATION MATRIX ORGANIC	Yes	No

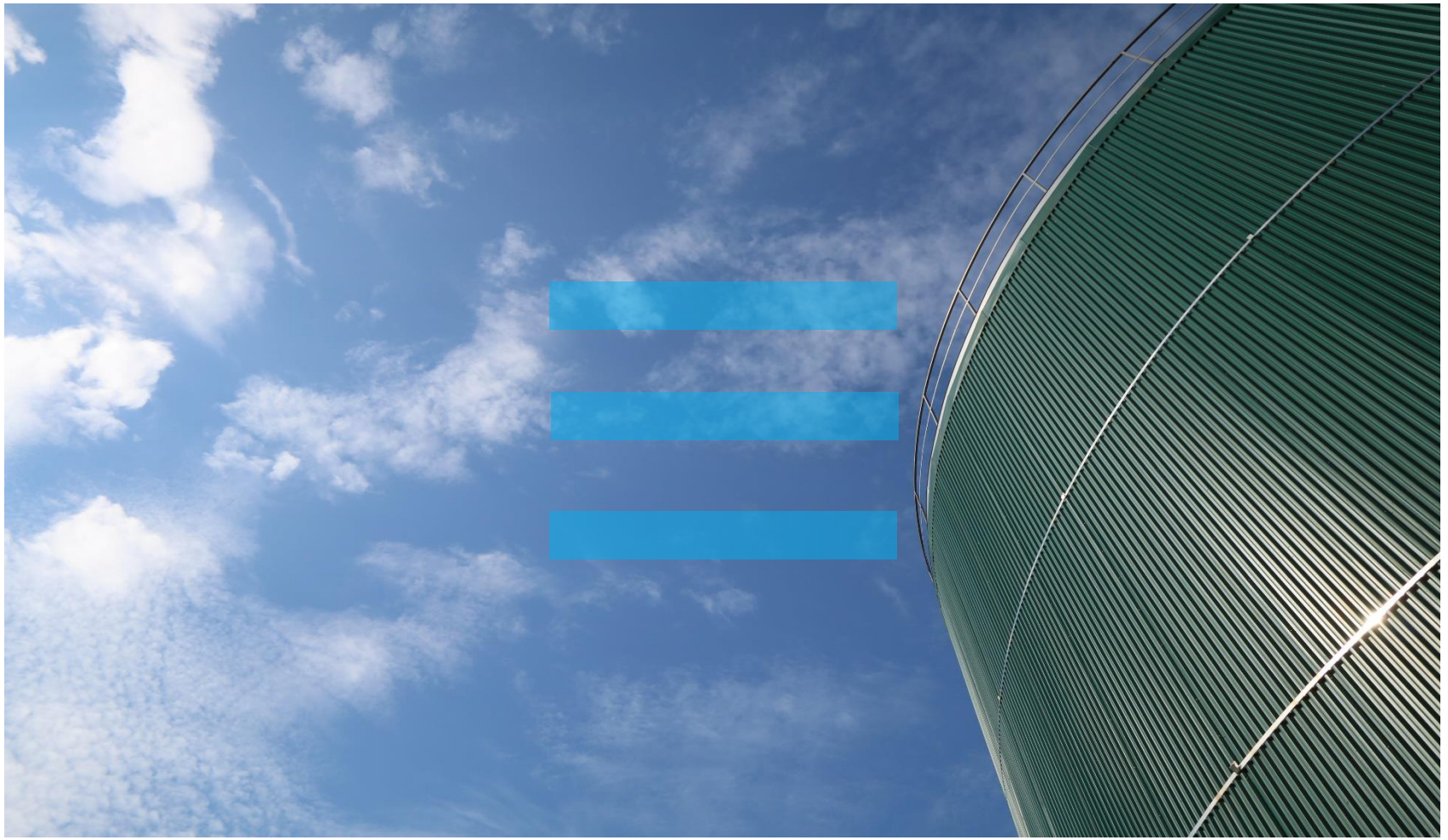
The 13 differentiating features are described below:

1. **DIGESTION.** The advantage of operating in mesophilic stage compared to the thermophilic stage consists in managing a simplified digestion process and reducing the disintegration time of organic substance.
2. **PRE-TREATMENT.** There are multiple benefits of having a hydrolyser stage of the digestive process:
   a) Greater efficiency in the use of organic materials, especially in the presence of components of cellulose.
   b) Through a lower PH there is an abatement of the bacteriological component which improves the digestive process.
   c) Keep storage of the raw material already predigested that can enter directly in the digestive process by improving considerably the response times.
3. **TREATMENT.** The dual stage system allows a better bio digestion by increasing by at least a 15% the biogas production.
4. **HEATING.** The heating system is of a conventional type, but equipped with control systems related to the parameters measured in the pre-treatment and treatment stages.
5. **AGITATION SYSTEMS.** Systems of external agitation can be maintained without stopping the digestive process and the integration within the control system is designed to increase the production flexibility of the plant.
6. **SYSTEMS OF VIDEO INSPECTION.** In addition to a chemical and physical control of the digestion parameters through electronic probes, within the stages of treatment and pre-treatment, there are cameras that allow a visual control of the digestive process.

7. **BIOGAS STORAGE.** Use of the gasometer (much less amount of gas storage than a dome) has the dual advantage of increasing the responsiveness time of the system and to simplify the administrative procedures for the management of the gas storage.
8. **MAINTENANCE SYSTEMS.** The presence of inspection doors improves the system maintenance.
9. **CONSTRUCTION METHODS DIGESTERS.** There are many advantages of having the blocks made of steel instead of concrete:
    a) Life span.
    b) Sealing and reliability.
    c) Building material recycling (steel can be recycled at premium instead of the concrete cost of disposal).
10. **MATRIX POWER PLANT.** A flexible and variable matrix allow the recipe to be adapted to the biological variation of the environment.
11. **TYPE CONSTRUCTION PIPING.** The advantage of having a stronger mechanical resistance and a longer duration
12. **PUMPING SYSTEM.** A pumping system redundancy can reduce production stops and allow a better maintenance program.
13. **RECIRCULATION MATRIX ORGANIC.** The advantage of having a recirculation system between the primary and secondary digester allows to vary the speed of the fermentation process and to fully exploit the organic matter fed.

4

FROM WASTE
TO ENERGY RESOURCE...



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PRODUCTIVITY ANALYSIS

PRODUCTION FOR A PLANT OF 100 TON/DAY OF O.F.M.S.W.

Organic Fraction
100 tons/day
(300.000 habitantes)

Waste
20 t/day

1

ELECTRIC ENERGY
1 MWe

THERMAL ENERGY
1.2 MWt

BIOGAS
15.000
mc/day

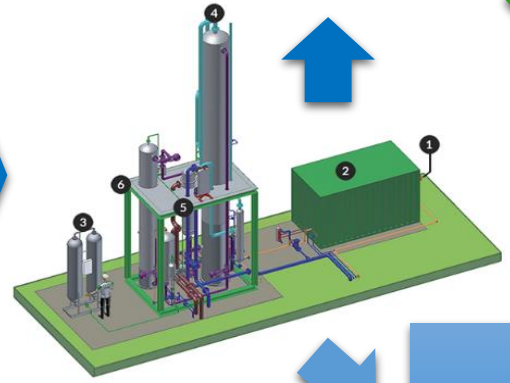
Water
85 mc/day

KEMET®
18 ton/day

2

BIO-METHANE
9.000 mc/day
(3.000.000 mc/years)

Automotive



Grid feeding

CO_2
5.500 mc/day

SolarGas
WindGas

Photobioreactors

Food use

Considering **36.500** tons of **O.F.M.S.W.** per year (**300.000** citizens), our technology is able to provide the following results:

OUTPUT		U.M
Daily biogas	15.000	[m3/day]
Yearly biogas	4.950.000	[m3/year]
Daily methane	9.000	[m3/day]
Yearly methane	3.000.000	[m3/year]
Installed electric power	1	[MWe]
Installed thermal power	1,2	[MWt]
Daily soil fertilizer (Kemet®)	18	[t/day]
Yearly soil fertilizer (Kemet®)	6.300	[t/year]
Daily water	85	[m3/day]
Yearly water	29.000	[m3/year]
Daily CO_2	5.500	[m3/day]
Yearly CO_2	1.900.000	[m3/year]
Daily inert waste	20	[t/day]

PRODUCTION FOR A PLANT OF 130 TON/DAY OF BY-PRODUCTS

ELECTRIC ENERGY 1 MWe

THERMAL ENERGY 1.2 MWt

1

Agricultural And Animals By-products 130(*) tons/day

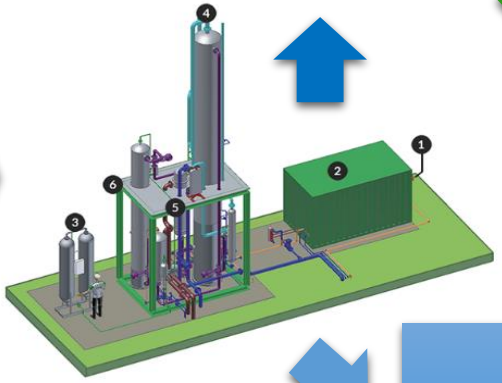
BIOGAS *15.000 mc/day*

Water 85 mc/day

KEMET® 18 ton/day

2

BIO-METHANE 9.000 mc/day (3.000.000 mc/years)



Automotive

Grid feeding

CO_2 5.500 mc/day

SolarGas WindGas

Photobioreactors

Food use

(*) tons/day average amount based on the products available

Considering **50.000** tons of **BY-PRODUCTS** per year, our technology is able to provide the following results:

OUTPUT		U.M
Daily biogas	15.000	[m3/g]
Yearly biogas	5.000.000	[m3/anno]
Daily methane	9.000	[m3/g]
Yearly methane	3.000.000	[m3/anno]
Installed electric power	1.000	[KWe]
Installed thermal power	1.200	[KWt]
Yearly Pelletized Compost Kemet®	6.500	[t/anno]
Daily CO_2	5.500	[m3/g]
Yearly CO_2	1.900.000	[m3/anno]

INNEA'S PLANT PRODUCTIVITY

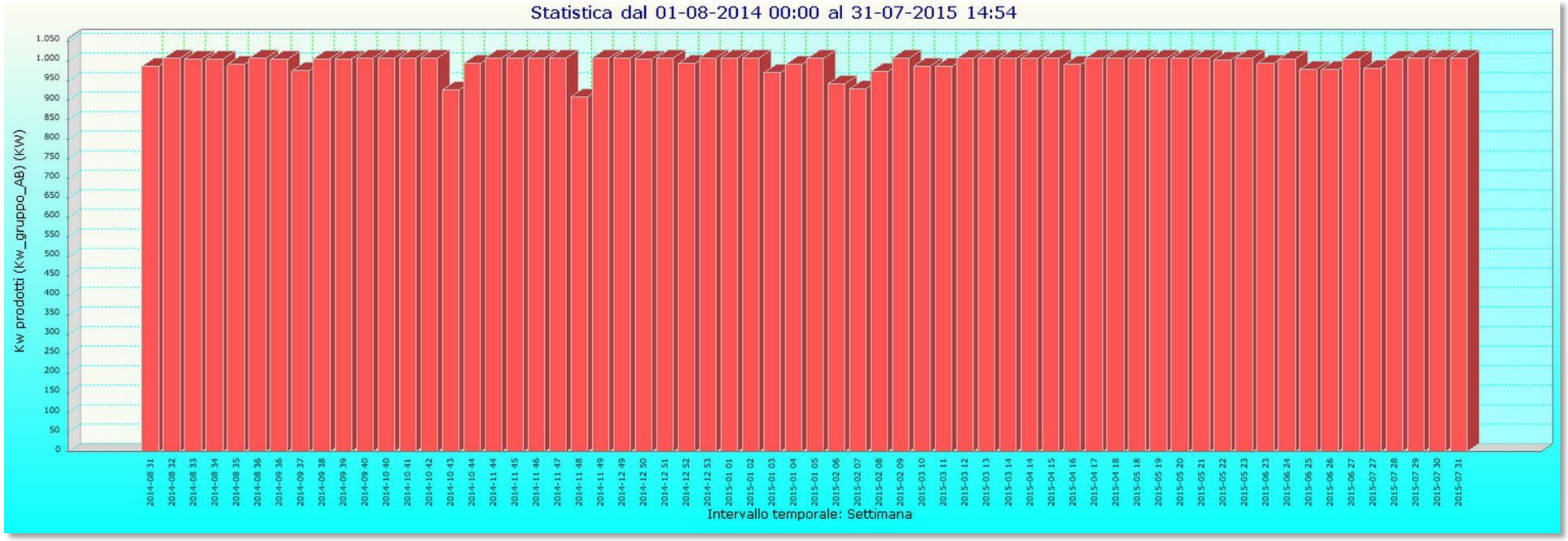
The **SURVEY SHEET OF FUNCTIONALITY AND EFFICIENCY OF THE SYSTEM**(*) made with technology InnEA and signed by our customers shows the following results in productivity:

CUSTOMER SURVEY SHEET

- Location: **Lombardia**
- Supply: **Agricultural by-products and slurry / manure cattle**
- Installed electric power: **999 kW**
- Energy produced in 2014: **8.637.686 KWh**
- Operating hours in 2014: **8700 h**
- Internal power consumption in 2014 : **11,7%**

(*) The original documentation is available at the Consortium InnEA

With management software, we can display the **GRAPH OF PLANT PRODUCTIVITY**:



The graph shows that the average power in the range considered (12 months) is still around to the maximum of 1,000 kW and the average energy produced in a year is more than **8.600.000 kWh** which is equivalent to a maximum production of over **8.700 h** of operating.

5

FROM WASTE
TO ENERGY RESOURCE...

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TREATMENT OF DRY FRACTION

The revenues of the system may also allow a significant reduction of the fee for waste disposal, or a relapse in services/works

FULL ADVANTAGE OF THE TERRITORY AND THE COMMUNITY

… ONCE YOU REACH THE OBJECTIVE OF

TRANSFORMING waste into a RESOURCE

is it possible **to reinvest the profits generated**

in systems for the

TREATMENT OF THE DRY FRACTION

in order to separate

AUTOMATICALLY MATERIALS REUSABLE

generating more income from their sale as raw materials

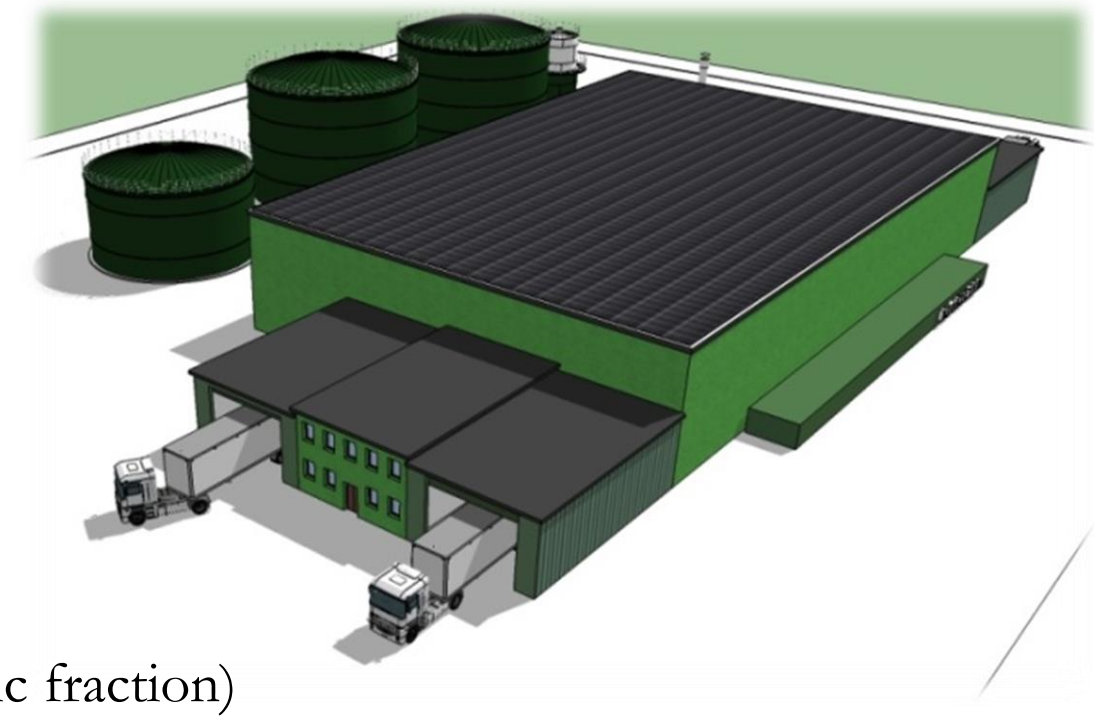
SEPARATION, RECOVERY AND VALORIZATION OF RECOVERED MATERIALS

Our system conceived, designed and presented is an integrated platform for the treatment of municipal unsorted solid waste allows to have:

- The separation of the different fractions of waste.
- The treatment of organic fraction with the production of BioGas to convert in electricity, bio-methane (CO_2) and organic fertilizers (Compost Kemet®).
- Prepare recoverable fraction for their selling.
- Convert some fractions in final products.
- Minimize the quantity of final waste to landfill.

It is a progressive selection plant based on series of conveyors and specific separators, supported also by manual controls:

- Cabin for management and control system.
- Pit for material reception working in vacuum atmosphere.
- Bags opener.
- Magnetic separators.
- Induction separators.
- Drums screen.
- Disk screen.
- Aeraulic system.
- Ballistic separators.
- Optical and Rx Separators.
- Hydrodynamic centrifugal separator (for organic fraction)

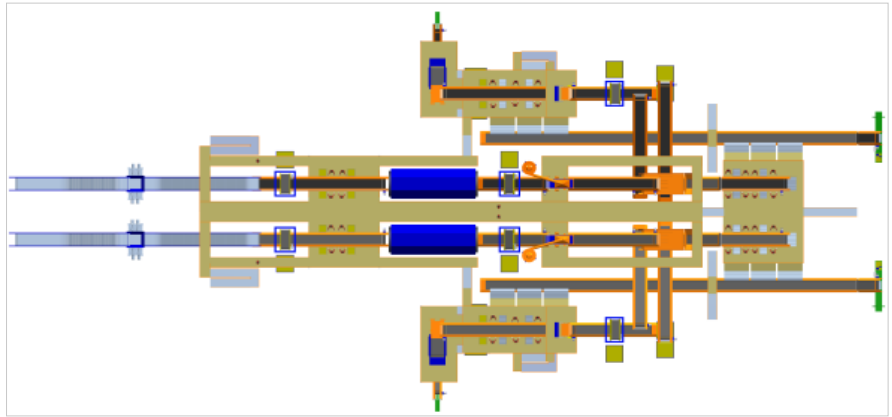


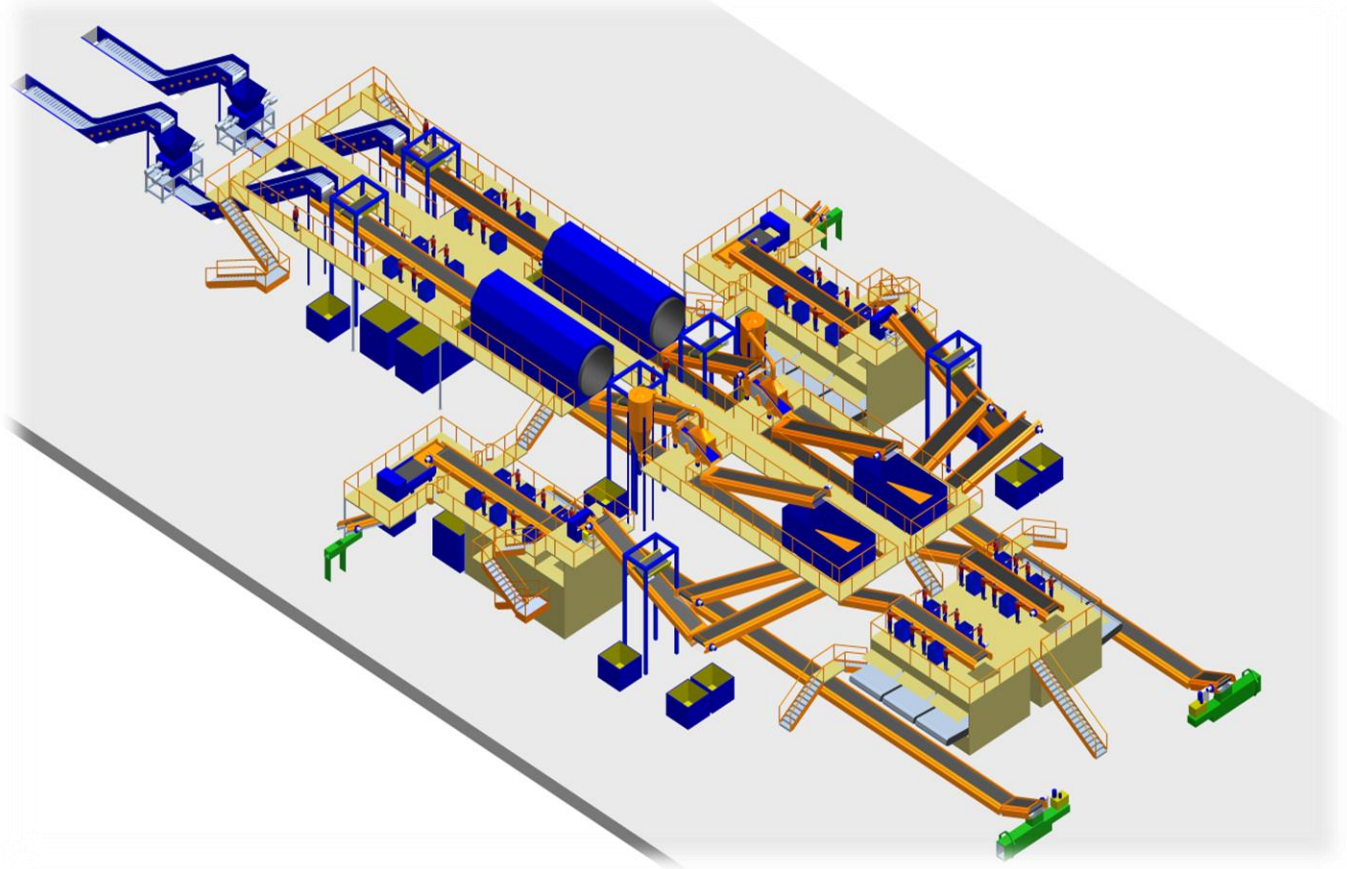
THE TREATMENT LINE

The perspective drawing below shows a modern TREATMENT LINE which can be more or less AUTOMATIZED, from which come out materials already ready for sale and the recovery. This line will receive the unsorted Municipal Solid Waste, as collected, to be here submitted to a progressive sorting process.

In the first sorting step, organics are separated by the bulk MSW, while inorganics continue to be further sorted by type: plastic, glass, paper, metal, etc…

Lay-out and automation level of the line is highly flexible to meet local resources and needs.





THE SORTING LINE: EQUIPMENTS

The cost of a modern system of selection and recovery of dry fraction of MSW is dependent on treatment capacity, but is also cost-effective, even in economic terms, as well as in the environment and energy.

Recovery of ferrous metals, aluminum, plastics, glass and aggregates is almost complete and become increasingly **profitable** with the growth of their value / price.

THE VALORIZATION OF VARIOUS DRY FRACTIONS

All the valuable recyclables coming from the sorting line could be processed into new products, by means specifically tailored, industrial or craft, recycling chains, where the first steps is always consisting in cleaning the dirty raw materials coming from the sorting lines.

In the following pictures is shown an innovative technology (Made in Italy) for plastic recycling, able to directly process heterogeneous plastics coming from the sorting lines.

Different configuration of recycling chains, tailored on local needs, can be designed and supplied, for any type of material coming from the sorting line.

… ONCE YOU REACH THE OBJECTIVE OF

TRANSFORMING waste into a RESOURCE

automatically separating reusable materials

you could evaluate **the mode for the waste collection,** because maybe…

DOOR-TO-DOOR COLLECTION

IS NOT THE OPTIMAL SOLUTION because…

- REQUIRES HIGH COSTS IN TERMS OF:
  time, energy, personnel, transportation, fuel, materials, etc.
- OCCUPIES CONSIDERABLE SPACE:
  both domestic urban and not least creates a stunning visual pollution in our cities.
- CREATE HYGIENE PROBLEMS AND DISCOMFORTS:
  even odor related for citizens.

ADOPTING THE PROJECT COLLECTION SYSTEMS could be so organized

In just TWO CONTAINERS:

1°- for ORGANIC FRACTION

2°- for UNDIFFERENTIATED FRACTION + PAPER + ALUMINUM + STEEL + PLASTIC + GLASS

With the following **ADVANTAGES:**

- **ADAPTED FOR THE COLLECTION:** it only takes TWO containers placed in easily accessible places to means of mechanical harvesting and comfortable for the award by the citizens.
- **ADAPTED FOR CITIZENS:** this avoids keeping at home several containers, which are bulky and awkward to clean and maintain.
- **LOW VISUAL IMPACT:** there are systems of burial containers that disappear to be installed in areas most valuable monumental.

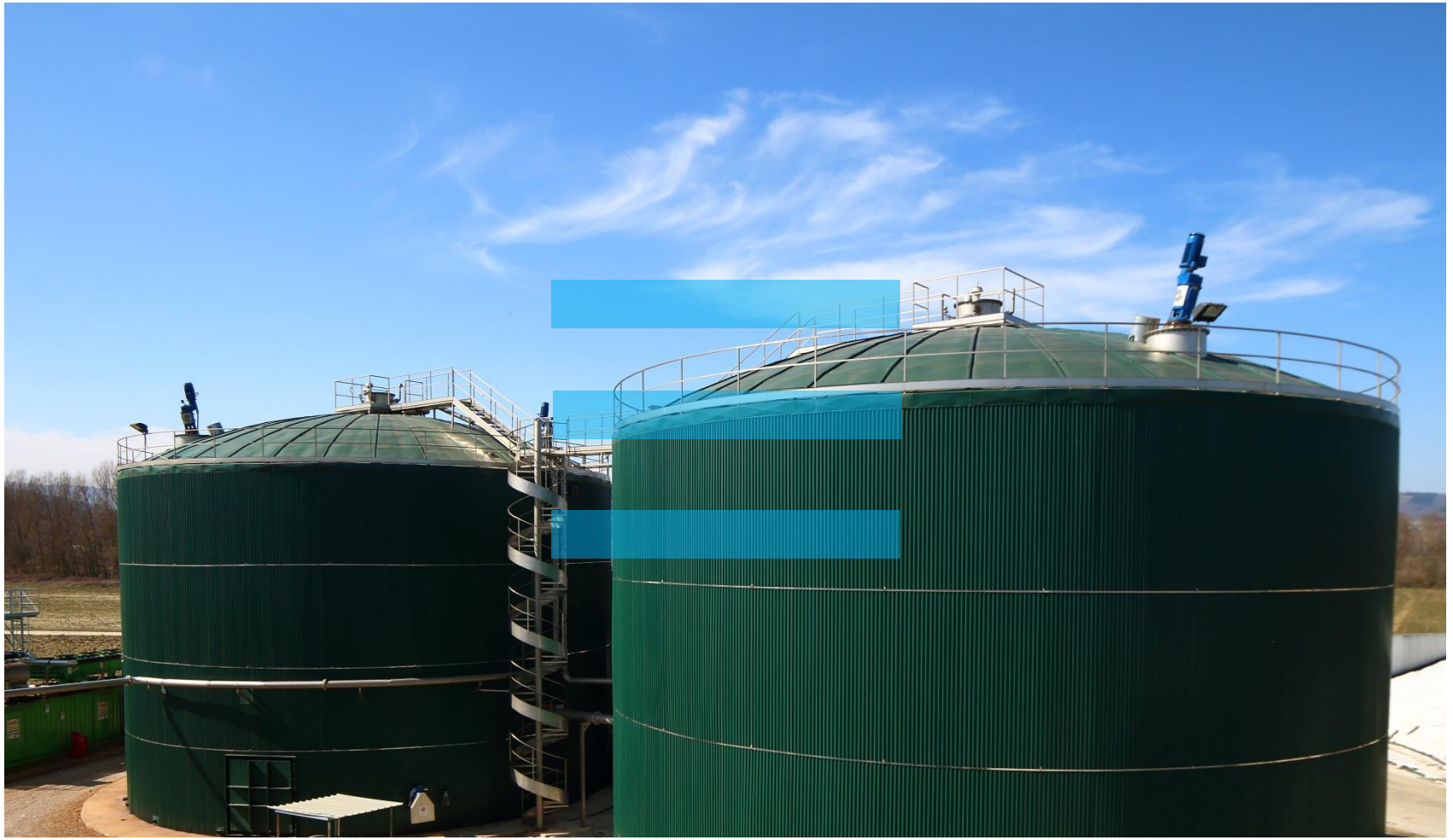
- **ENHANCEMENT**: waste is a resource both from the point of view of energy, both from the point of view of recovery of recyclable material (iron, copper, glass, aluminum, plastic, paper, cardboard, etc.).
- **BUILDING TIME**: the time of construction of the plant is approximately 6-10 months.
- **CREATION OF SKILLED JOBS** for the region and for our country.
- **DECREASE IN THE COST OF COLLECTION AND TRANSPORT**: the collection allows reorganized transport reduced proportionately affecting the overall cost of ownership.
- **USING ON-SITE PRODUCT**: the total fuel savings is using the bio methane in the means of collection and cancel the atmospheric emissions of fossil CO2 and particulate matter.
- **SIMPLIFICATION**: The collection is greatly simplified with a strong decrease in costs, inconvenience to citizens and improved hygiene and urban PICTURE.
- **LOWERING COSTS**: The cost of treatment is not just fully covered by revenues but profits are achieved very significant turning waste into resource.

WE BELIEVE IN THE IMPORTANCE OF THIS PROJECT AND ITS IMPACT ON CIVIL SOCIETY, WE BELIEVE IN ITS DISSEMINATION ON A GLOBAL SCALE, AND FOR THIS REASON WE DECIDED TO JOIN FORCES TO TACKLE THIS NEW CHALLENGE OF THE MARKET:

« introduce to the market the initiative, directly implement the plants designed and also give direct support to the individual projects with dedicated financial or cofinanced programs»

6

WE HAVE A DREAM



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RESEARCH AND DEVELOPMENT

2015

INNEA GROUP supports various Italian universities for the research of new projects to be interfaced with a typical installation for the treatment of OFMWS and biomethane production.
An important resource, often overlooked, is represented by the CO_2 that can be used for various applications.
Following are the important projects, of which the consortium is a supporter.

PHOTOBIOREACTOR

The project proposes the **reuse of CO2 to enter it in photobioreactors** in which algae with a high content oleic are grown.

The algae metabolize CO_2 to synthesize the molecules of which they are made.

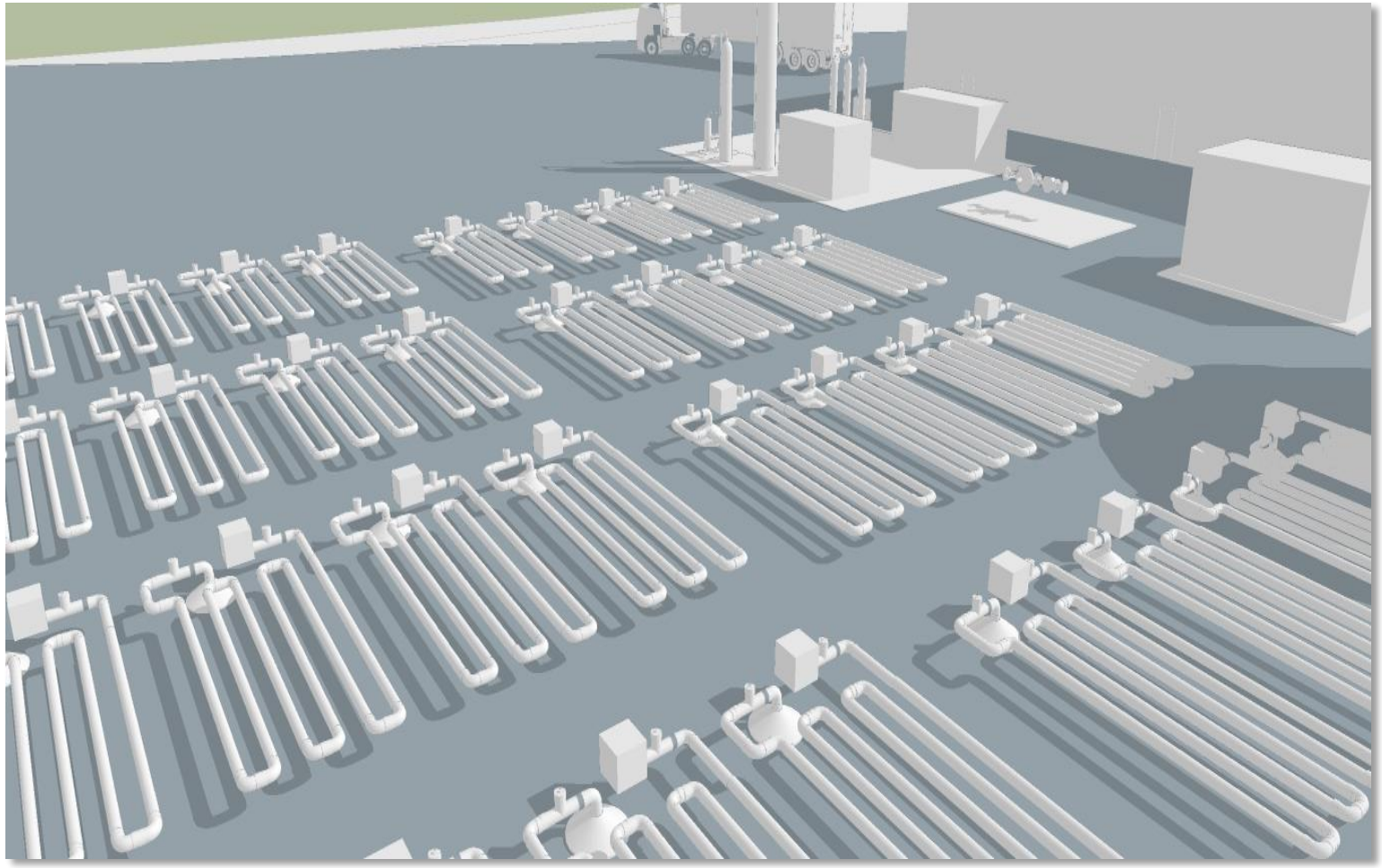
Photobioreactors are cheap, have an important productivity per hectare, much more than allocate soil to specific oleic crops.

R&D - PHOTOBIOREACTOR

Algae do not need nutrients but only of CO_2 recovered from upgrading and sunlight.

From algae vegetable oils can be extracted that can be turned into bio-diesel by transesterification, or by entering them in the digesters, are derived considerable amount of biogas to be allocated to the production of biomethane.

This will close the cycle of matter and energy.



SOLARGAS-WINDGAS PROJECT - UNIVERSITY OF PERUGIA

The project proposes the **reuse of CO2 (capture and storage)** from fossil sources, output from CHP or as in the case study, from the system for upgrading of the methane.

It has the direct production of methane by use of CO_2 and hydrogen (H_2) by the **reaction of Sabatier**:

$$\mathbf{CO_2 + 4H_2 \Rightarrow CH_4 + 2H_2O}$$

The reaction takes place in T between 250-400°C and using a metal catalyst, is lightly exothermic and therefore easily sustainable from the thermal point of view. The central point is the supply source for hydrogen. The technology in question uses the surplus of renewable electricity (solar photovoltaic or wind power) in the hours of low demand to split water (electrolysis) and produce electrolytic H_2.

Once the hydrogen product, it is used for the reaction of Sabatier that provides CH_4 and H_2O. The methane is purified and, for example, injected into the network.

Interfacing the biomethane system with the production and utilization of hydrogen allows increase yields in methane and use the CO_2 removed from the biogas, making the project even more sustainable.

These are examples of projects that show the potential of a Research and Development department interfaced to a plant producing biomethane from MWS.

It is important to emphasize that the installation of laboratories for chemical analysis, laboratory demonstrative and informative will be essential to raise public awareness, through the University, but also politicians, who can understand the magnitude of the field that we risk to throw in landfills.

FROM WASTE
TO ENERGY RESOURCE…

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THANKS FOR YOUR ATTENTION…

…TO THE ENVIRONMENT