Task33
Gasification of Biomass and Waste

IEA Bioenergy
Technology Collaboration Programme

Gasification - a key technology in the energy transition and for the circular economy

energia rinnovabile

A LONCIN COMPANY

ECO20x: from lignocellulosic feedstocks to green hydrogen

2 Dec 2021

CMD - the company

For over 30 years **C.M.D. SpA Costruzioni Motori Diesel** has been involved in design, prototyping and development of engines and solutions for automotive, marine and aeronautical fields.

Safety, innovation, reliability and customization are the 4 keywords to describe our company and our products.

Our highly skilled R&D team constantly works for developing cutting- edge products suitable for both general markets requirements and each single customer.

We work to make performances & design a perfect combination.

CMD headquarters is located in San Nicola La Strada (CE). Plants are all located in Atella (PZ): **here take shape our projects and our goals.**

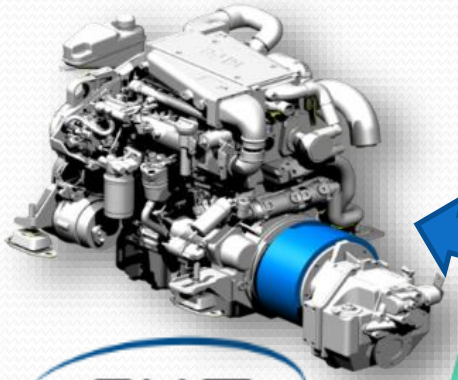
Mariano Negri
CEO CMD SpA

CMD departments [B.U.]

CHP SYSTEMS FOR ENERGY PRODUCTION FROM RENEWABLE SOURCES

ECO20X energia rinnovabile

HYBRID POWERTRAINS

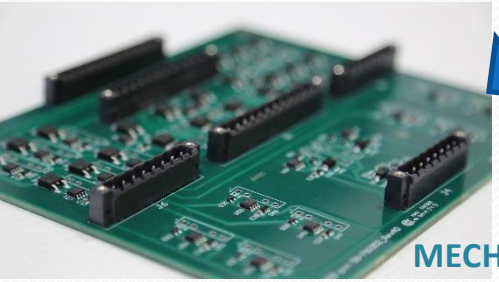


Testing and Facilities

COMPLEX MECHANICAL COMPONENTS

MARINE ENGINE

FNM MARINE DIESEL ENGINES



MECHATRONIC SYSTEMS

AVIO ENGINES

CMD CORE IS THE INTERNAL COMBUSTION ENGINE

Technical aspects related to the use of the CMD ECO20x mCHP system

Eng. Domenico Cirillo

Alternative energy : the biomass

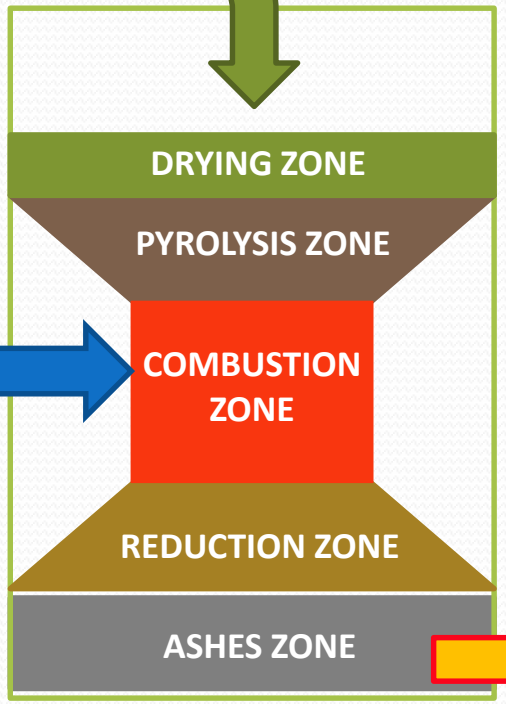
The biomasses are intended like wastes belonging from farms, agricultural residues, forestry, livestock, including civil trash.

All these wastes form Organic Fraction of Urban Solid Waste, today a GARBAGE, a problem. This problem may become a different approach to the environment given by the PYROGASSIFICATION.

The ISO 17225-4 norm states the wooden chips qualities based on humidity and size.

BIOMASSA

AIR



Reattore Downdraft [Imbert]

GAS COMBUSTIBILE

energia rinnovabile

Alternative energy : why

The plant CMD Atella produce 27 tons of woody waste per month, with disposal costs: 4,300 € / month.
Use them for the gasification involves the possibility of producing approximately

21,600 kWh
what does it mean:

Energy Recovery of rejection
Disposal of the waste Savings

Net saving of 3,000 € / month bill.
Disposal Saving: € 4,300 / month

Although it seems a small percentage, in fact, this possibility makes **energetically INDEPENDENT** the Caserta facilities in addition to creating the above savings.

Biomasses as alternative source of energy to the fossils

The use of biomass as fuel requires a system that allows the employment of produced gas and a specific definition of each step of the process, from biomass to energy production.

Simplifying: CMD ECO20x can entirely substitute fossil fuel

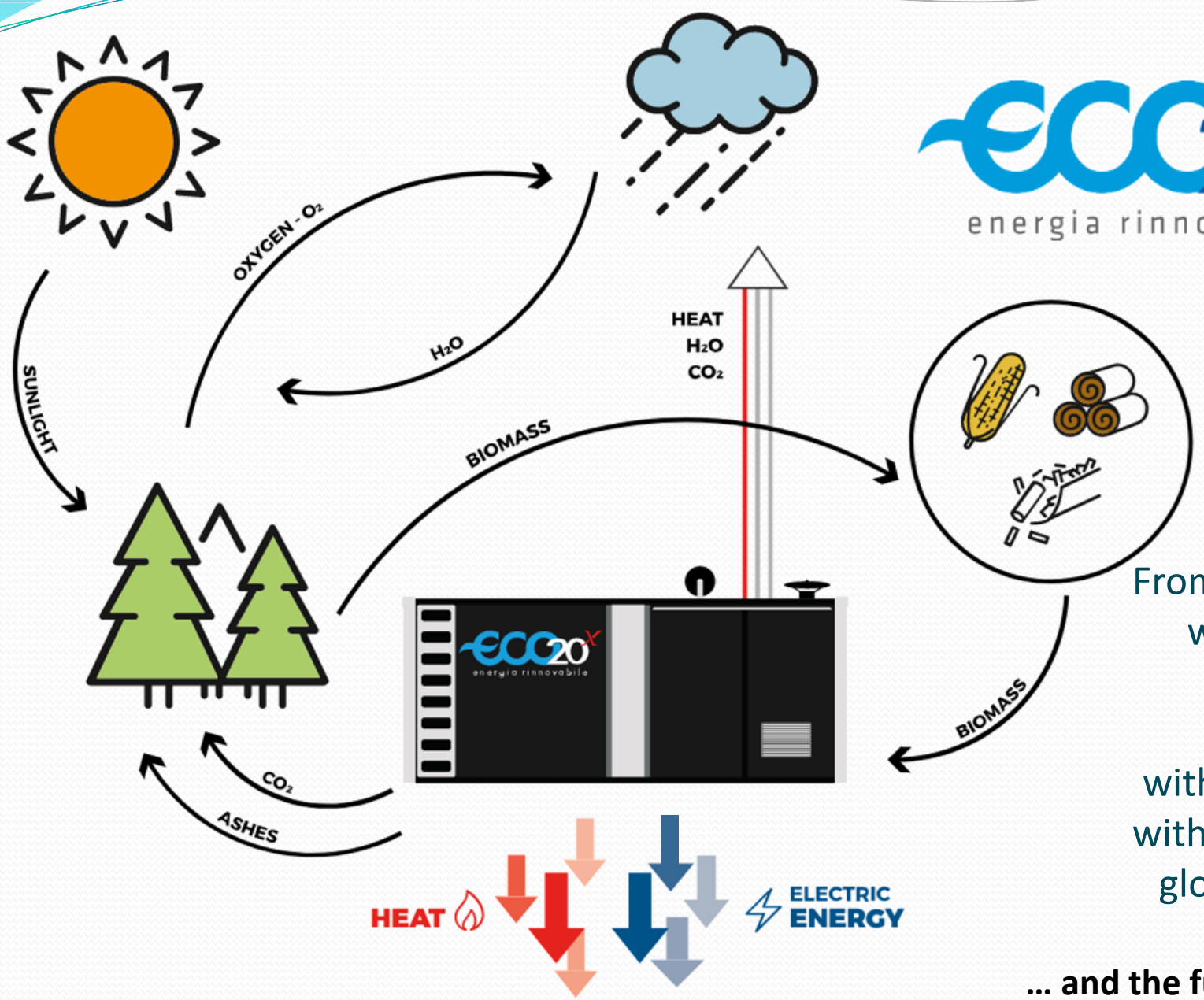
One liter of petrol corresponds to less than 3kg of wooden chips

1 lit gasoline

3 kg biomasses

CMD ECO20x mCHP fed by biomasses

CMD ECO20: a virtuous circle



From residues and waste wood origin:

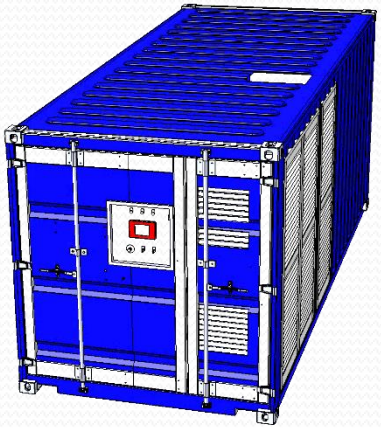
ENERGY

without polluting

without producing global warming gases

… and the fuel is renewable

GENERAL TECHNICAL FEATURES



Technical features ECO20x (dependent quality of biomass)	
Electric power	20 kWp @ 50 Hz
Thermal power	40 kW
Mass flow rate of biomass	25 kg/h
Maximum hours for day	24 h
Specific consumption	1.25 kg/kWh
Features biomass	G10 – G30, U = 20%
Container dimensions	H: 2’560 mm x L: 2’440 mm x W: 6’050 mm
Empty mass	5’500 kg
Equivalent noise level LAeq dB(A)	67 dB(A) - 7 m to the plant

Pollutant	Emission limits according to Dlgs 152/2006* (5% oxigen into exaust gas)	Emission limitis ECO20x
Particulate matter (PM)	130 mg/Nm^3	1.5 mg/Nm^3
Nitrogen oxides (NOx)	500 mg/Nm^3	193 mg/Nm^3
Carbon monoxide(CO)	650 mg/Nm^3	96 mg/Nm^3

Emission limits according to ***Dlgs 3 aprile 2006, n. 152, Parte V, Allegato I, Parte III – *Valori di emissione per specifiche tipologie di impianti (sottosezione 3. Motori fissi a combustione interna*).

Alternative energy : the biomass

The biomasses to be used for CMD ECO20x may be choosen from a big range of products and by-products like:

Scraps of wood, vines's waste, pruning branches, shells of coconuts, walnuts, hazelnuts, chestnuts, almonds, hazelnut oil, apricot, peach, tobacco stalks, corn, canes. Several biomass qualities were tested in several mixtures.

The handling systems are designed for biomass size cathegory G30 and density more than 200 kg/m^3

SHELLS


Almond


Hazelnuts


coconut


walnut


pistachio

NUTS


peach


apricot


olive


mango


avocado

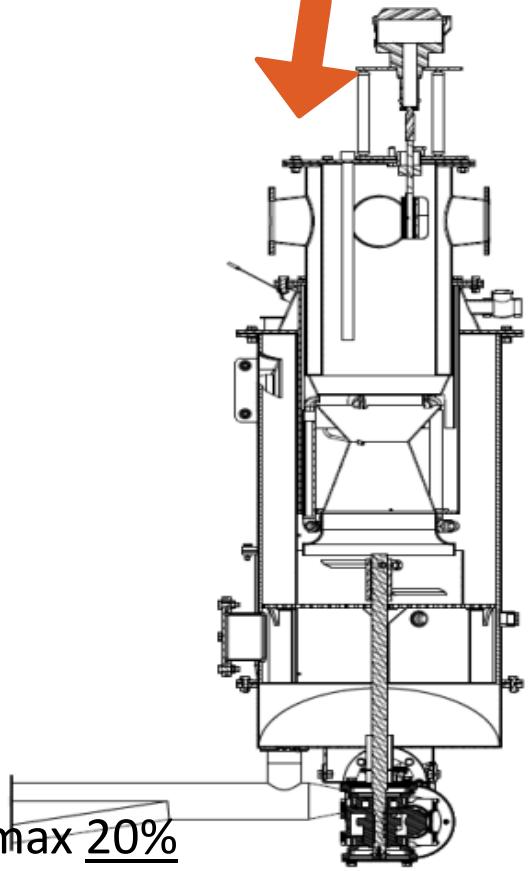
SCRAPS


ground wood


Scraps of wood


vine shoots


stalks of corn, tobacco, cane



The constraint is the humidity degree : max 20%

Automation and remote control

CMD ECO20x is equipped with an electronic control system capable of controlling, interrogating and operating every component of the plant, from the system for collecting, handling and transferring the biomass to the reactor, to managing the ashes and condensates. It allows the automatic start of the pyrogasification reaction for the production of syngas, supplying it into the engine when the gasification parameters comply with its power supply. It is able to start and manage the genset engine, from start-up, to synchronism with the distribution network and up to the transfer of the electricity generated to it, in accordance with CEI-021.

Automation and remote control

The control system allows the management of the machine through the web interface service that assigns an IP address to each machine,
through which it is possible to:
- monitor the operating parameters,
- run data log data,
- clear alarms,
- start / stop the machine,
- test the actuators and measuring devices.

ECO-BURNER

ECO-BURNER is a fully automated system, capable of producing thermal energy from biomass / residual materials. The ECO-BURNER system is essentially a gasification boiler particularly suitable for medium power heating systems.

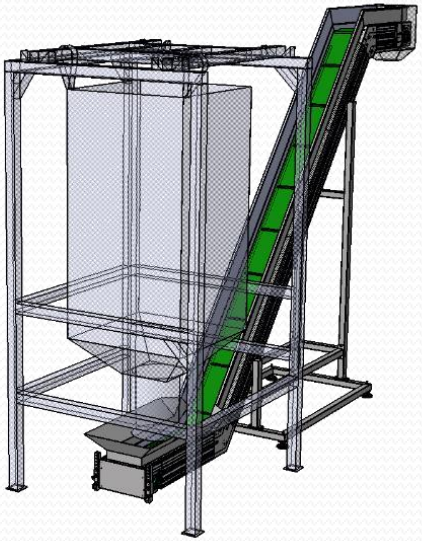
Specifiche tecniche ECO-BURNER	
Potenza termica	100 kW_p (dipendente dalla qualità della biomassa)
Caratteristiche elettriche	50 Hz, 400V, 3 A
Massima operatività giornaliera	24 h
Consumo specifico	0.35 kg/kWh
Startup Time	15-90 min (dipendente dalle condizioni ambientali e dalla qualità della biomassa)
Dimensioni del container	H: 3'000 mm x L: 1'800 mm x W: 1'800 mm
Massa a vuoto	1'400 kg
Livello equivalente L_{Aeq} dB(A)	80 dB(A) - misura effettuata a 7 m dall'impianto

Inquinante	Limiti di emissione secondo Dlgs 152/2006	Limiti di emissione ECO-BURNER
Polveri (PM)	100 mg/Nm^3	0.3 mg/Nm^3
Ossidi di azoto (NOx)	500 mg/Nm^3	0.5 mg/Nm^3
Monossido di carbonio (CO)	350 mg/Nm^3	34 mg/Nm^3
Biossido di zolfo (SO2)	200 mg/Nm^3	132 mg/Nm^3

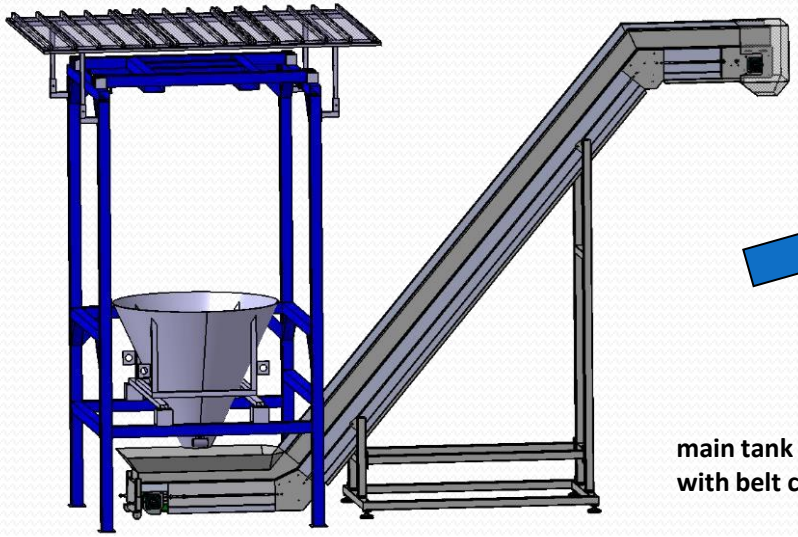
Limiti definiti ***dal Dlgs 3 aprile 2006, n. 152, Parte V, Allegato I, Parte III*** – *Valori di emissione per specifiche tipologie di impianti (sottosezione1.1 Impianti nei quali sono utilizzati combustibili solidi).*

Installation: Packing (Pastorano)

A pallet producer asks for drying system optimization and improvement: ECO Burner



ECO Burner INSTALLATION to change the existing drying system (using LPG) with ECO BURNER fed by same residual wooden from pallet production



main tank low cost
with belt conveyor

ENERGY
FROM
FEEDSTOCKS
OVER - LIGNOCELLULOSIC

Biomass/residuali tested on gas producer development

Each experimentally tested biomass/residual was bound to related Technology Readiness Level for an evaluation of reliability level for gas producer vs specific matter for feeding. Range between 7 (Posidonia) a 9 (lignocellulosic materials).

Cippato di pino 1

Cippato di pino 2

Cippato di abete

Cippato di pioppo 1

Cippato di pioppo 2

Cippato classe A1

Nocciolo di oliva

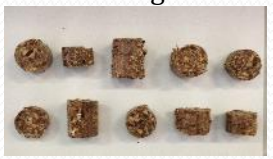
Sansa olearia esausta

Lolla di riso

Lolla di riso bricch.

Gusci di castagne

Gusci di castagne bricch.



Scarti mobilificio

MDF

Formica

Polvere di legno

Polvere di legno bricch.

Fungaia

Gusci di nocciole

Posidonia

Posidonia bricch.

Caffè

Pepe verde e tralci di vite

Sfalci e potature

Plaid

Jeans

Tessuti 1

Tessuti 2

Tessuti 3

Fanghi di depurazione

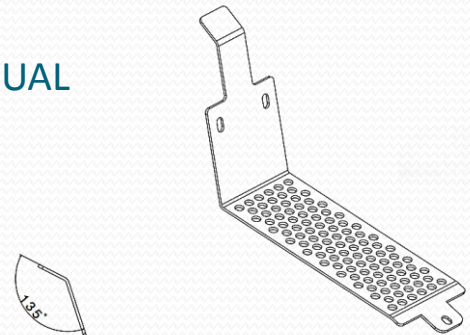
Pine needles material pre-treatment evaluation

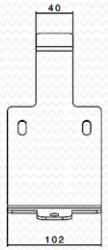
In order to know how pretreatment apply for pine needles, an experimental campaign is started, to define the kind of blade apply on raw material.

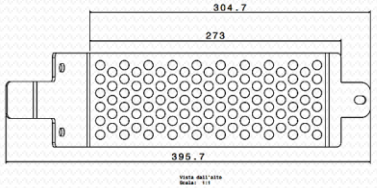
The focus fo campaign is the use pine needles RESIDUAL

min size

pine needles briquettes







new cutting sieve

Starting from biomass as it is, we will finish testing activities

pretreatment based on available tools – choosing between two pretreatment technology –

A New mesh for cutting sieve was designed and tested – it reduces the pretreatment steps at just one, THE CUTTING

Straw material pre-treatment evaluation

Straw material is an other challenge for CMD ENERGY, coming from agriculture and farm, it's a biomass available everywhere and extremely promising

The pretreatment process is been defined on this specific residual.

straw sheave

free straw

densification

CHP feeding

Cloth Waste application

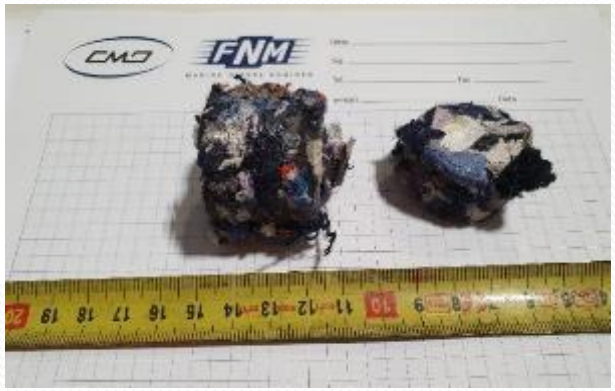
A new material was delivered in CMD to energetic valorisation

In order to test the availability for a plant composed by n°10 devices fed by briquettes

Tests on ECO20x will follow. Design in progress.

From Cloth Waste

New briquetting device – specific for Cloth Waste



Cloth waste briquettes ready for CHP feeding

CHP fed by Cloth Waste is not just a modified version of ECO20x. Pine and Straw have required just some changes in a low number of mechanic components and some electronic software strategies.

The CHP Cloth Waste fed is a NEW device, requiring specific assembly procedure and specific documents for CE compliance

Sewage sludge: a new REACTOR for gasification

From market study, the interest on sewage sludge is deeply pursued. Such a material is a semiliquid waste obtained from the processing of municipal sewage, often sewage sludge is a special waste, hard to be disposed.

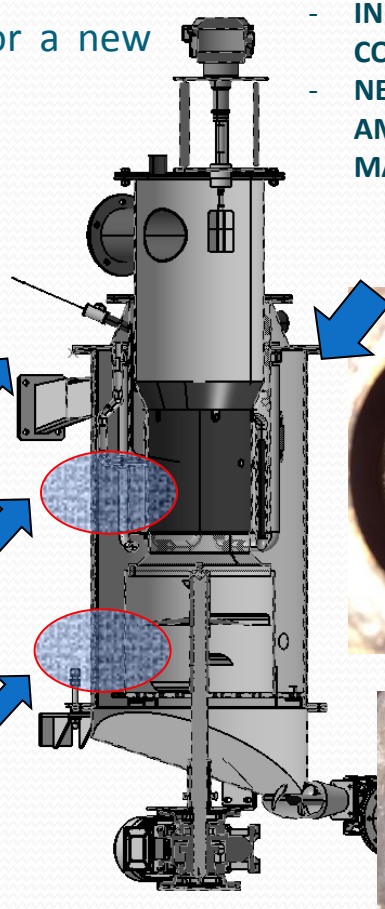
The research and development for this material is started for a new version of gas producer. A new REACTOR.

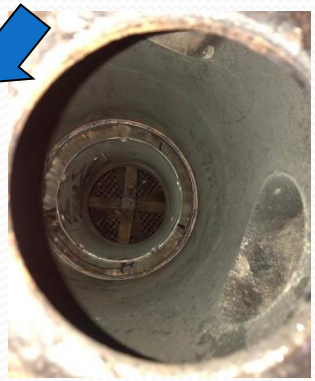
- **NEW EQUIVALENT RATIO**
- **NEW SYSTEM FOR ASHES MANAGEMENT**
- **INNOVATIVE REACTOR CORE**
- **NEW SYSTEM FOR AMORPHOUS STRUCTURES MANAGEMENT**

DRIED SEWAGE SLUDGE – MOISTURE 20%

SPECIAL GAS PRODUCER IS REQUIRED

- **NEW AIR MAINFOLD AND PIPING DESIGN**
- **NEW REACTOR CORE FOR GAS IMPROVEMENT GAS PRODUCTION FROM SEWAGE SLUDGE**
- **NEW SYSTEM FOR AMORPHOUS STRUCTURES MANAGEMENT**

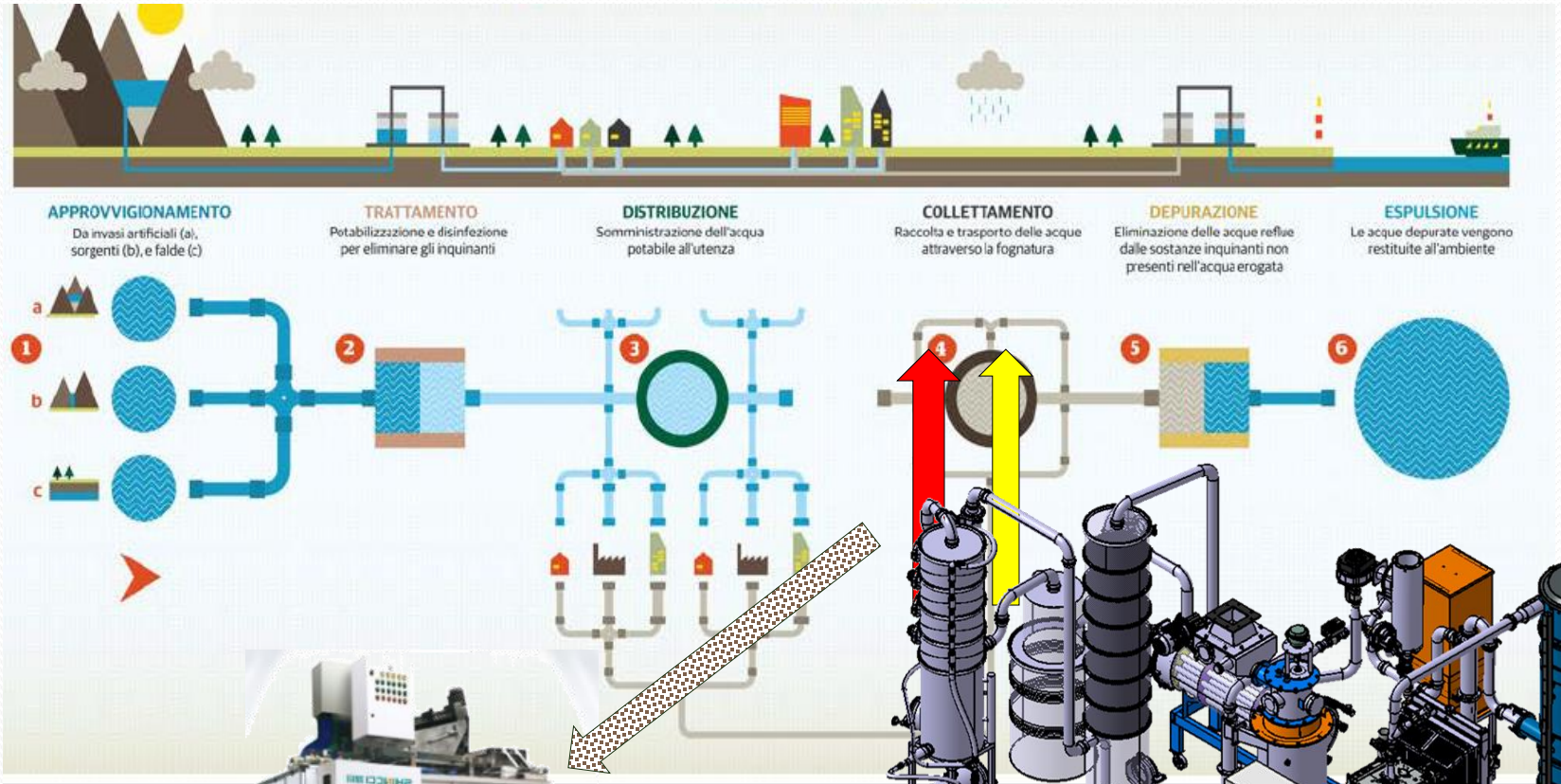




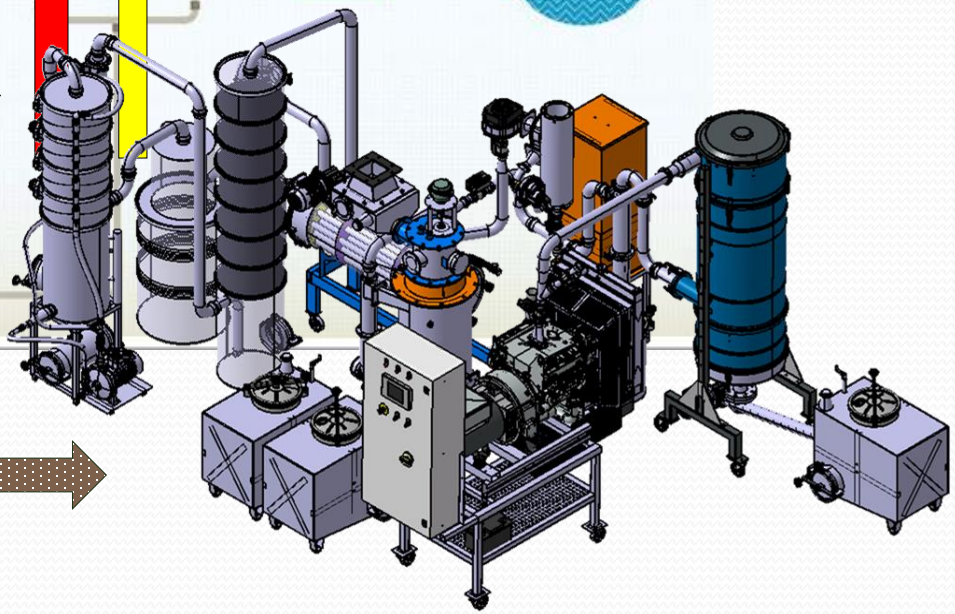
First NEW reactor core prototype details

Sewage sludge: a new whole system

For this NEW CHP system – SLUDGE FED development, a special location was requested.
In september we have definedfor permission in a special AREA in which a waste water filtration system is installed.



DRYING SLUDGE



ENERGY
FOR
HYDROGEN
BIOMASS to GAS [H_2]

RENEWABLE ENERGY for HYDROGEN PRODUCTION

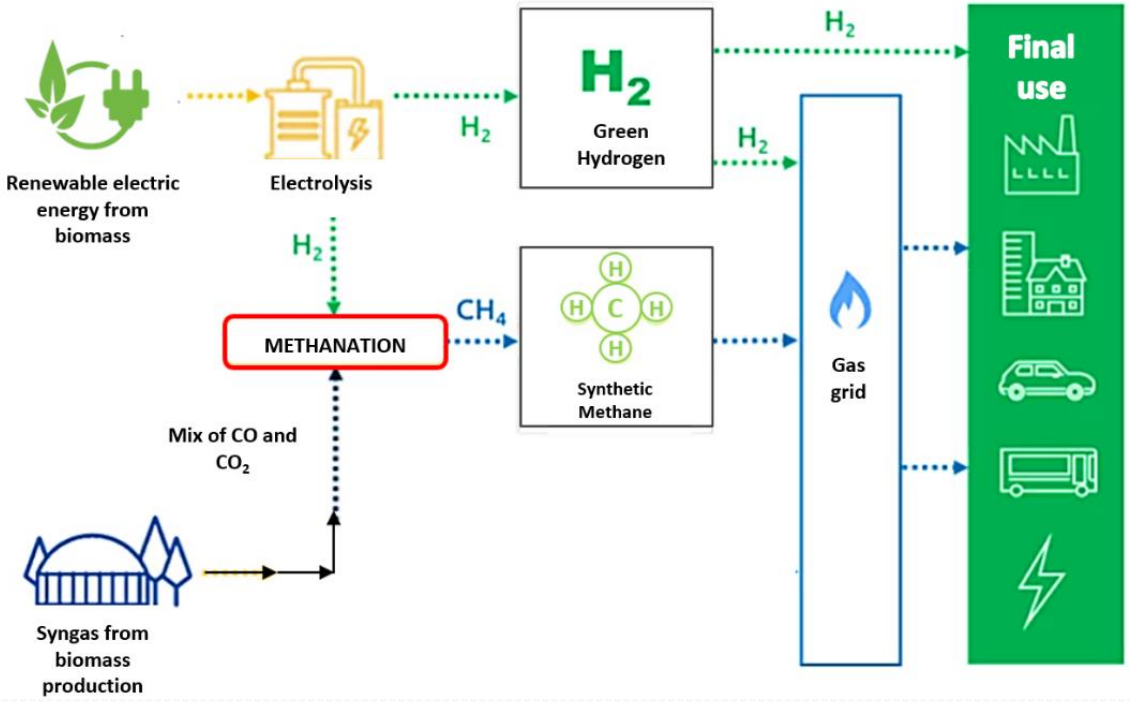
ECO20x is IMMEDIATELY ready for RENEWABLE ENERGY PRODUCTION through BIOMASS valorization. It can be integrated with other renewable resources as SOLAR power and EOLIC power. This GREEN POWER amount must be used to supply electrolizer to convert water into gas hydrogen. A plant using these devices is defined

HYDROGEN VALLEY

a totally GREEN system to produce an energetic carrier REALLY ZERO CARBON: HYDROGEN

12 kg
wooden biomass

0,18 kg H_2
green hydrogen



EVEN IMMEDIATELY READY, THIS APPLICATION HAS A **TOO LOW CONVERSION EFFICIENCY**

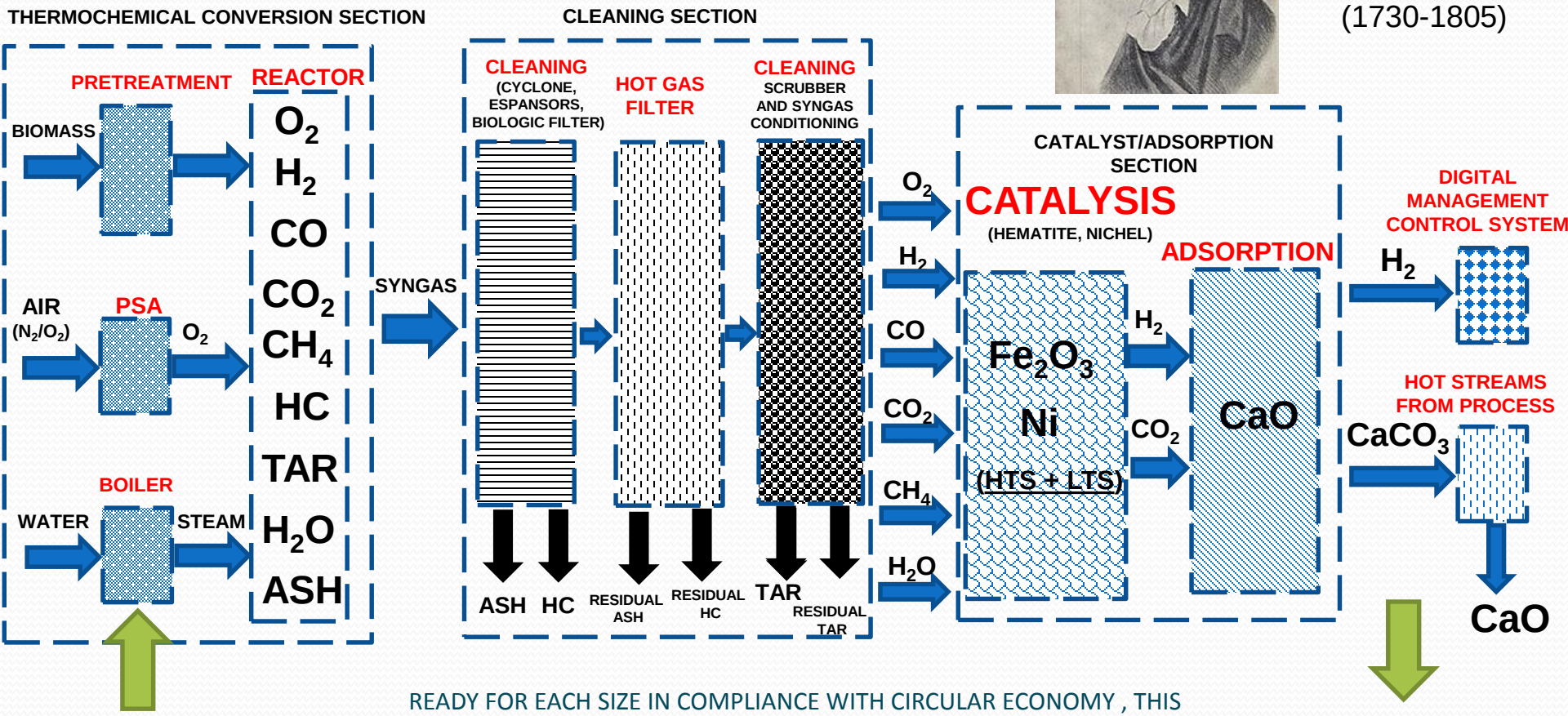
DIRECT HYDROGEN PRODUCTION FROM BIOMASS

GREEN HYDROGEN gas production over electrolysis process an its limited efficiency, for more efficient process.
New challenge is an innovative reactor, able to produce Hydrogen. Through the **WGS reaction (Water Gas Reaction)**, improving process conversion efficiency

WGS (SIMPLIFIED)

$$CO + H_2O \rightarrow CO_2 + H_2$$

Felice Fontana
(1730-1805)



READY FOR EACH SIZE IN COMPLIANCE WITH CIRCULAR ECONOMY , THIS APPLICATION HAS THE **HIGHER CONVERSION EFFICIENCY**

12 kg
wooden biomass

1 kg H_2
green hydrogen

Projects on Gasification funded by National Programmes: Updates

Italian Region	Name	Funding	Aim	Reactor design	Present Status	Note
Basilicata & Campania	RECOVERY	MISE	Energy valorization of residual materials coming from the agro-food industry through syngas from gasification for self-production and self-consumption of **electricity**.	Downdraft	Next start (January 2022)	**CMD S.p.A**, Giaguaro S.p.A, ENEA
Campania	PROMETEO	MISE	**PROMETEO** represents an important opportunity for industrialization and market diffusion of a product capable of responding to multiple needs, susceptible of integration in different contexts such as bio-waste energy recovery technology, otherwise destined for disposal. Through the use of the gasification process, the aim of the project is to become a renewal model for the management and disposal of waste from green areas or from the agri-food industry for the reduction of costs and the environmental impact linked to possible direct combustion.	Downdraft	In progress (2017-2021)	**CMD S.p.A**, EPM
Campania	SMART MOBILITY HUB	MISE	**SMH** intends to favor the decentralized and customized production of electricity from renewable sources only by proposing integrated hybrid generation and storage platforms. Depending onof the availability of local sources between solar and biomass energy, production, storage and energy supply are managed in a flexible and efficient manner, achieving optimal integration, capable of ensuring a continuous service.	Downdraft	In progress (2020-2023)	EPM, GAIA Energy, CNR-STEMS, **CMD S.p.A (consultant)**
Basilicata & Campania	EMERA	Regional	Efficient Micro Energy networks powered by only renewable sources for the autonomy and independence of rural areas from the centralized system.	Downdraft	Next start (January 2022)	**CMD S.p.A**, DIGIMAT, EES, ESA, ENEA, CNR
Campania & Basilicata	GREEN FARM	MISE	**GREEN FARM** intends to propose a model for increasing sustainability in agriculture that combines the production, management and use of energy from renewable sources only, in cultivation and food processing systems, with the enhancement of biomass deriving from the same agricultural operations through the use of the gasification process.	Downdraft	In progress (2020-2023)	UniNA, **CMD S.p.A**, CNR, Graded SpA

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Thanks