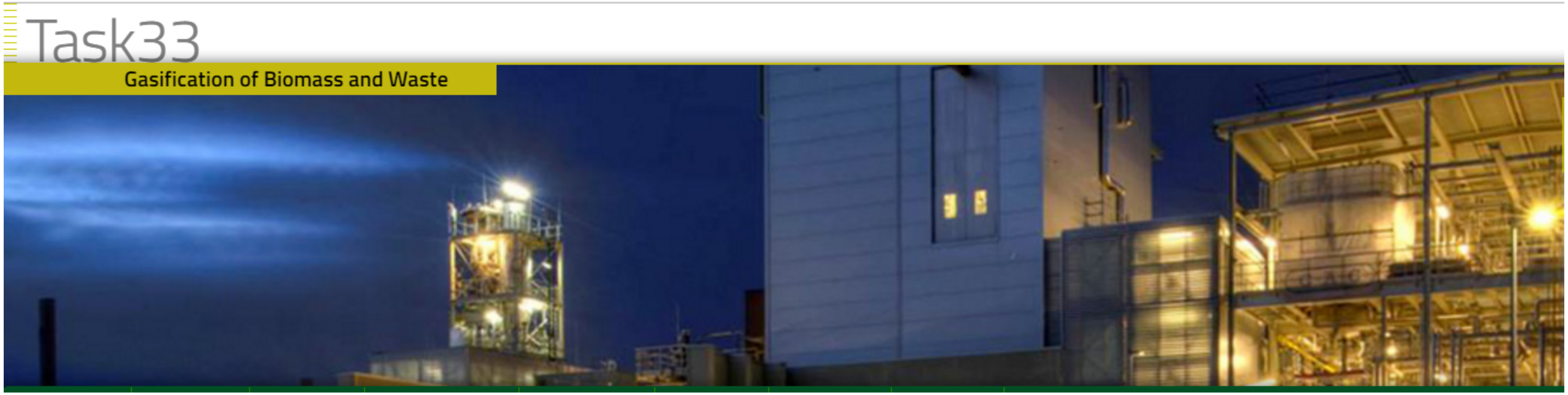
Task 33 Workshop "Small scale gasification for CHP"
02.-04. May, Innsbruck, Austria



CMD ECO20: a small-scale combined heat and power system at early commercialization based on gasification and syngas conversion in an ICE

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A LONCIN COMPANY

Costruzioni Motori Diesel is a dynamic, goal-oriented engineering company

offering a complete range of services

within the internal combustion engine industry

Business Units - Products & Applications

CMD has operated on the market since 1971 providing a full range of engineering, production & commercial services "from concept to market"

Engines

- Diesel Engines
- Marine Propulsion
- Hybrid Engines
- Aeronautic Engines
- Up to 300 Hp

Machining Parts

- Engine blocks
- Cylinder heads
- Automotive Engines
- Camshafts
- Oil Sumps
- Gear box
- Special Parts

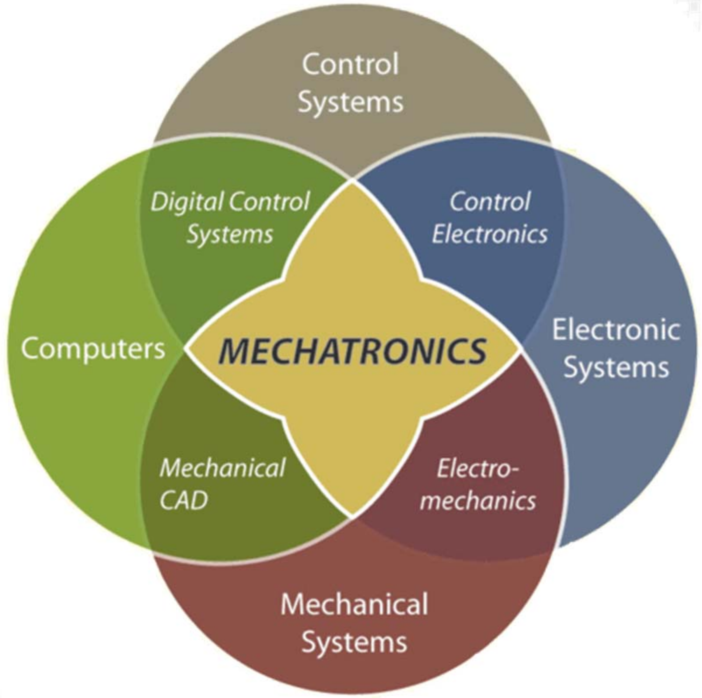
Energy R&D Project

- Aerogest
- Trigenerator
- Avio SeB
- Turbohydrogen
- Microcogeneration
- Range Extender

Electronic

- ECU (gasoline/diesel) – HW, SW
- ECU box
- Engine Management
- Engine design and development
- Ecu data reader
- Harness
- Calibration

CMD within a NETWORK:
Global Engineering Support and Main Clients



CMD today

Via Pacinotti 2
81020 San Nicola La Strada (CE)

Atella 2 Nucleo Industriale Valle di Vitalba Loc. Cartofiche – 85020 Atella PZ

Atella 1 Nucleo Industriale “Valle di Vitalba” 85020 Atella (PZ)

Atella 3 Nucleo Industriale “Valle di Vitalba” 85020 Atella (PZ)

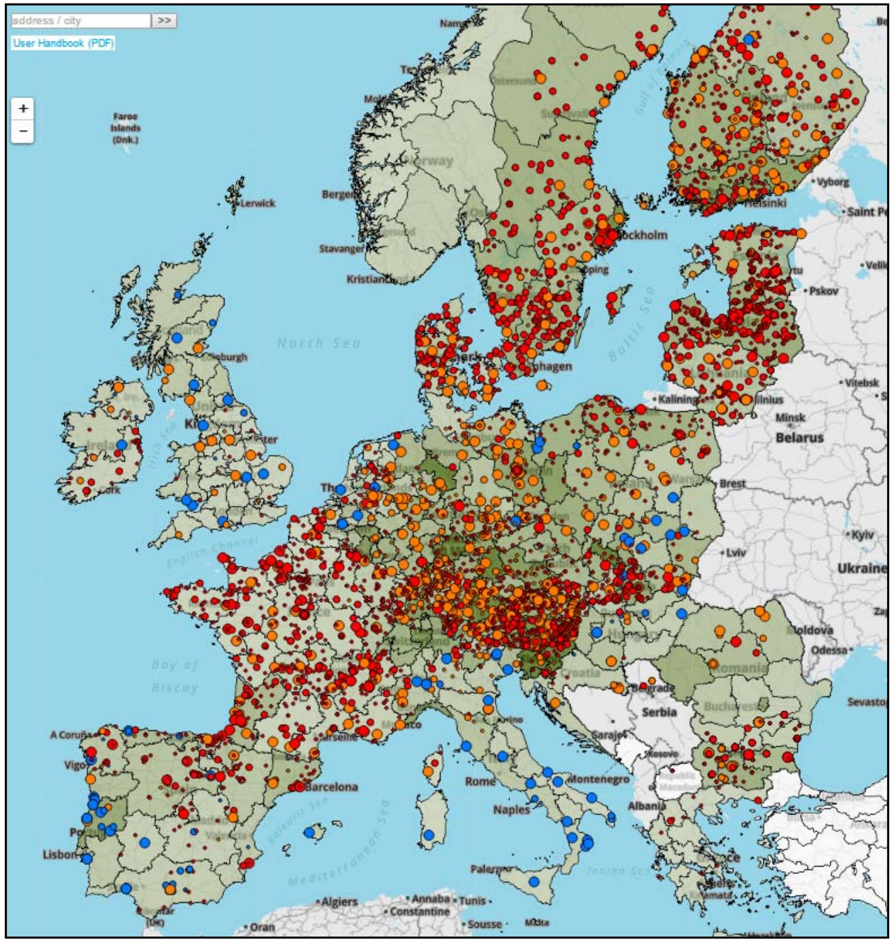
ENERGY

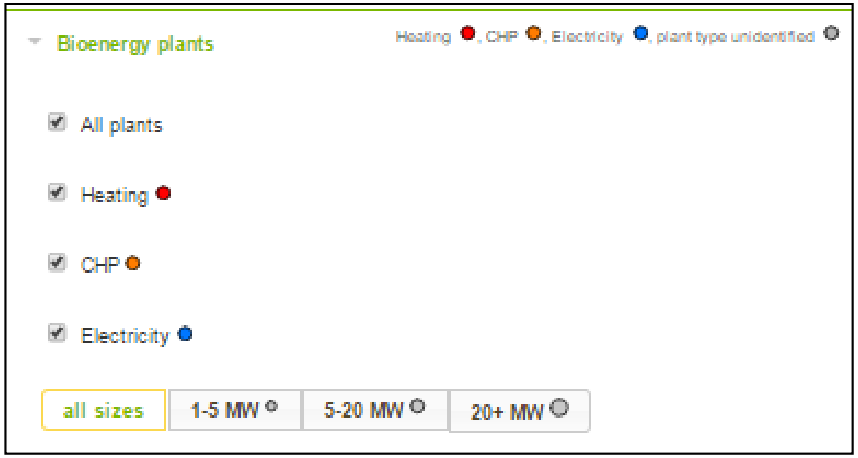
ECO20

energia rinnovabile

Bio-energy plants in EU

In the present energy scenario, bio-energy plants fuelled with biomass are within technologies strongly incentivized in the European Union (EU) to increase the energy supply to remote districts by using locally available renewable sources.



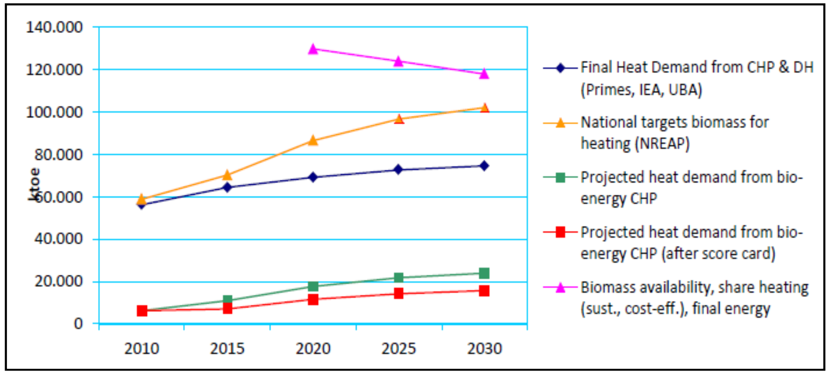


Source: http://www.basisbioenergy.eu/basis-gis.html

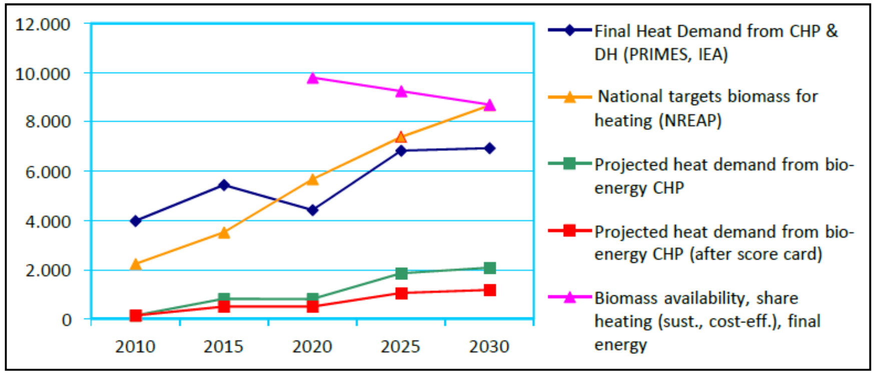
Potential Bionergy scenario

Interesting is the implementation potential for bio-energy CHP in the 27 EU Member States (MS) and in Italy, as well as the sales prospective scenario of mCHP systems in the residential and SME & Collective sector until 2030

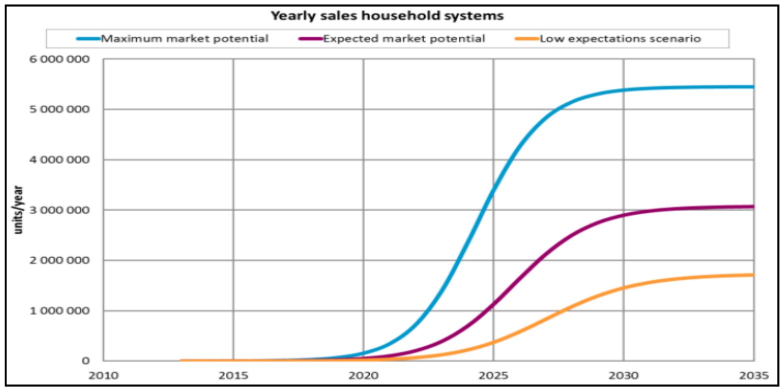
Bio-energy CHP potential analysis EU-27



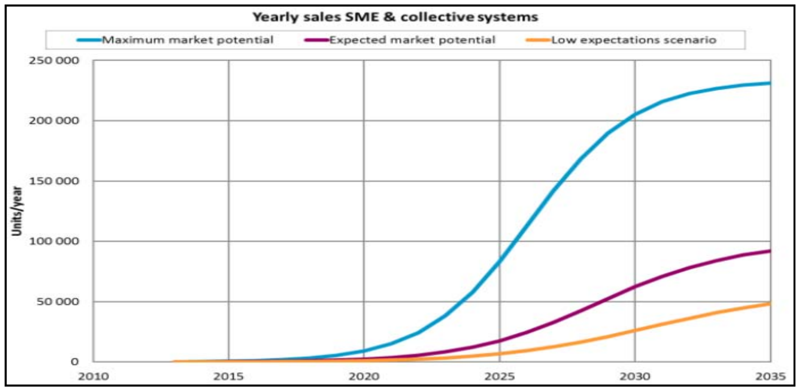
Bio-energy CHP potential analysis in Italy



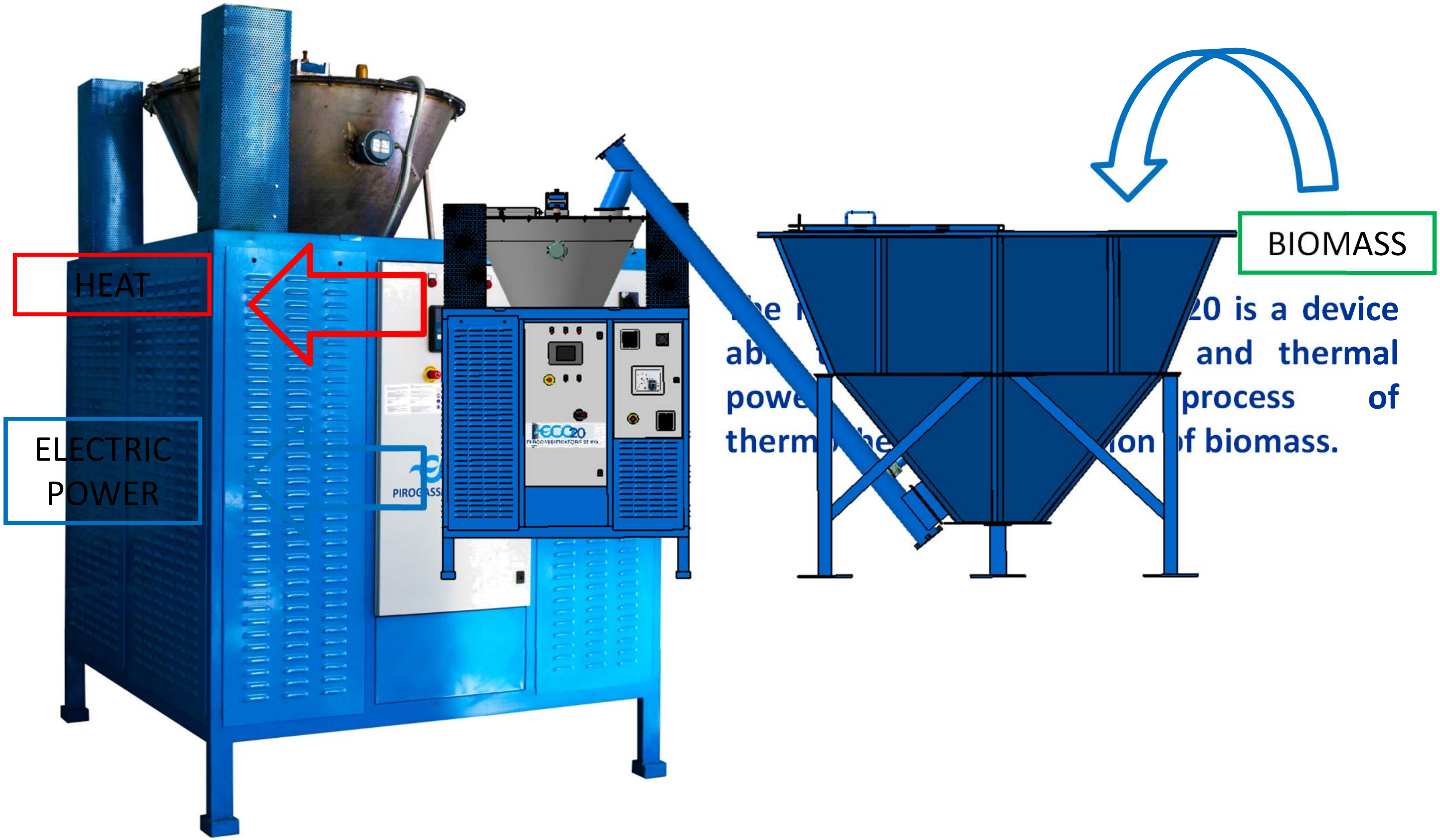
Sales potential scenario of mCHPs in the residential sector in EU



Sales potential scenario of mCHPs in the SME & Collective sector in EU



CMD ECO20



…e … 20 is a device ab… and thermal pow… process of therm… he… ion of biomass.

CMD ECO20 : general specifications

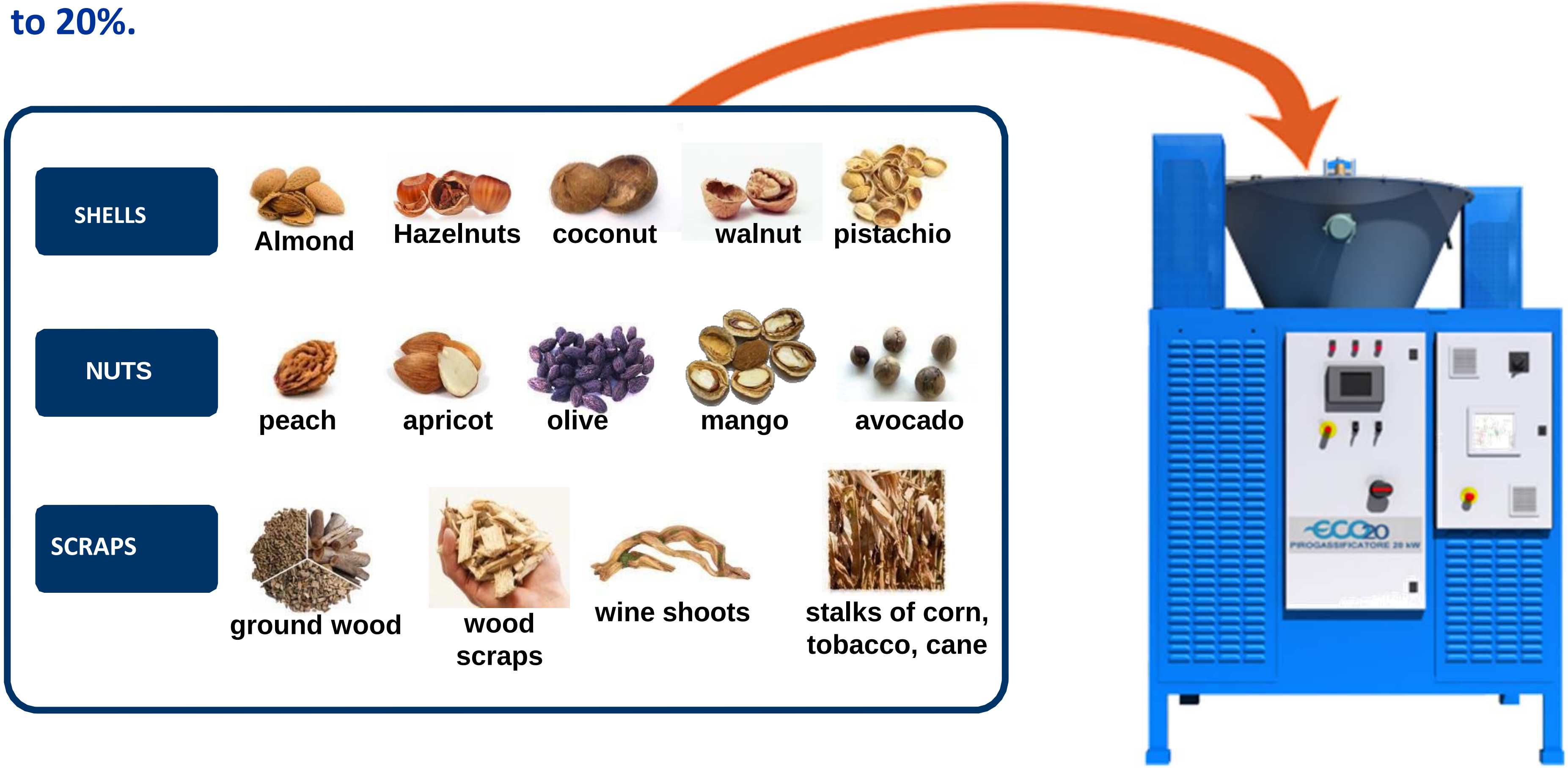
Nominal Electric Power	20 kWe_p
Nominal Thermal Power	40 kWt
Output voltage	400 V
Frequency	Three Phase 50 Hz
Mass flow rate biomass (kg/h)	22
Specific consumption (kg/kWh)	1.1
Volumetric flow rate syngas (Nm^3/h)	54
Height	300 cm
Width	180 cm
Length	180 cm
Weight	1600 Kg
dB a 7m	67dB

CMD ECO20 for a circular economy

Today ECO 20 processes wood chips, but aim of the company is the future use of biomasses to be chosen from a big family of products or by-products of the wood and agro-food industries.

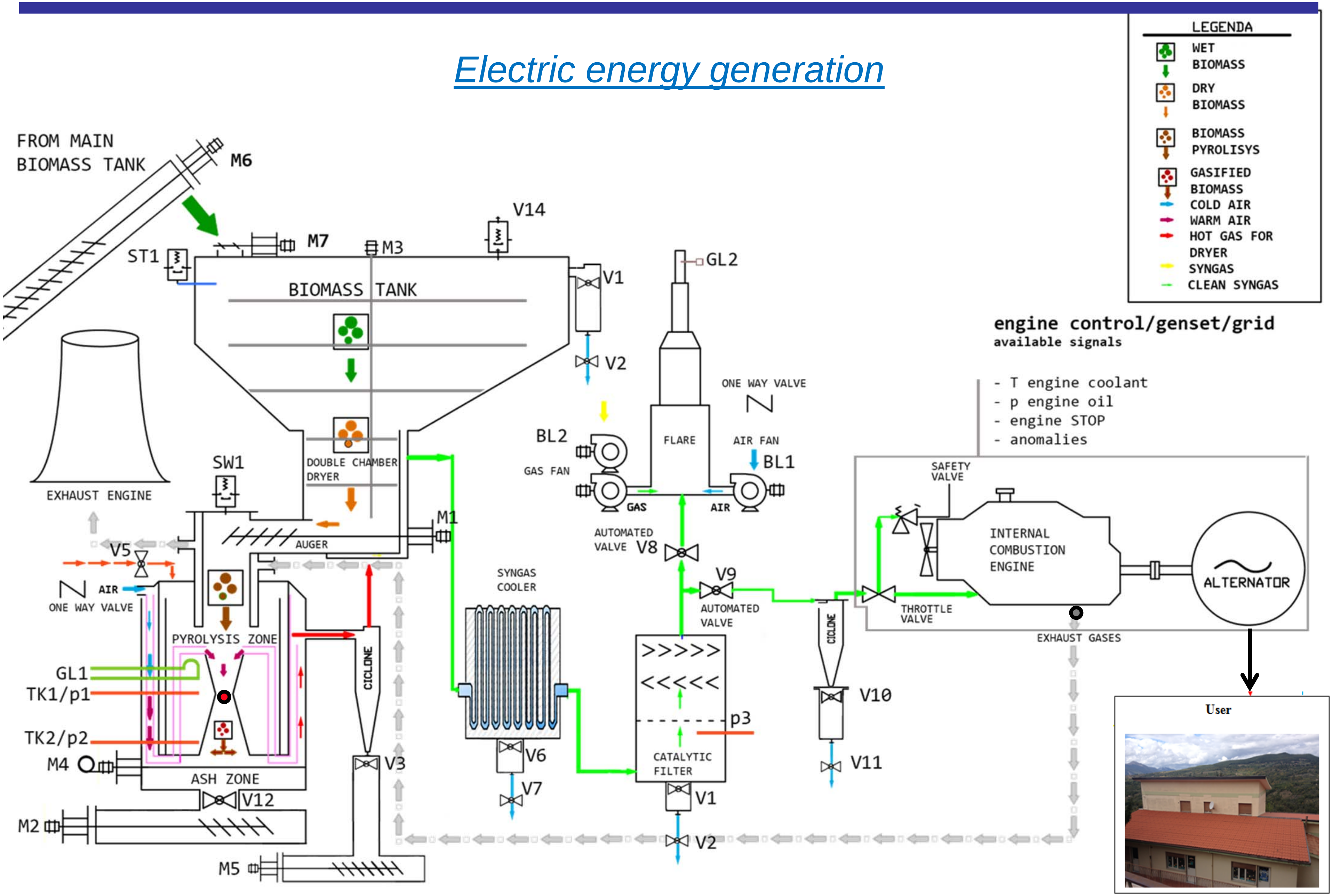
Up to now more than 13 kind of biomasses were tested in several mixtures.

The handling systems are designed for biomass size category G30 and moisture content up to 20%.



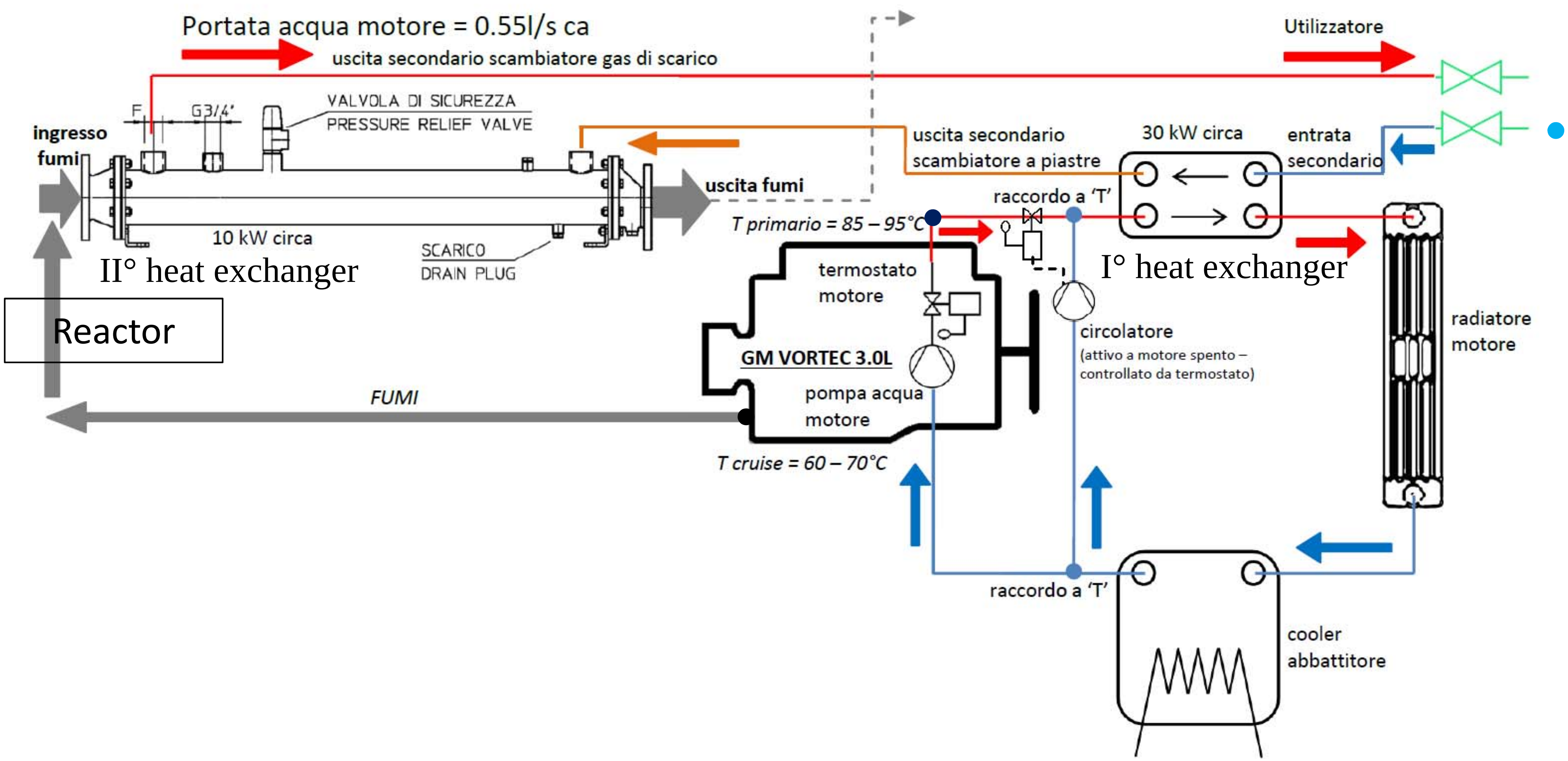
CMD ECO20

CMD ECO20: system layout



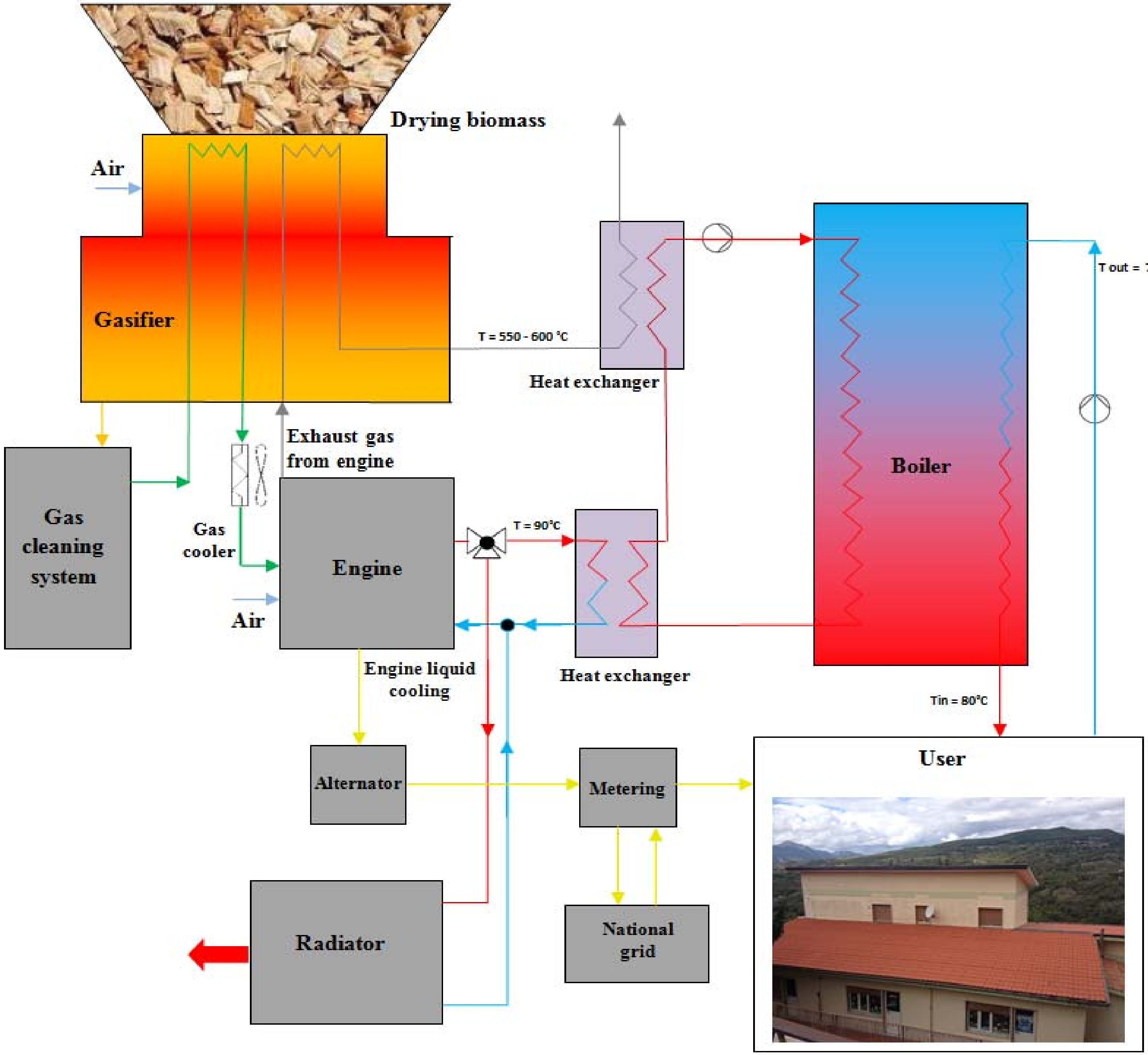
CMD ECO20

Waste heat recovery for thermal energy generation



CMD ECO20

Typical configuration for electrical and thermal energy supply



CMD ECO20 System: experimental characterisation

Proximate and ultimate analyses of woodchip

Proximate analysis (% w/w d.b.)	Moisture content	Volatile Matter	Fixed Carbon	Ash content		
	13.74	78.69	20.80	0.51		
Ultimate analysis (% w/w d.b.)	**C**	**H**	**O**	**N**	**S**	**Cl**
	46.60	5.08	47.76	0.04	0.015	0.009

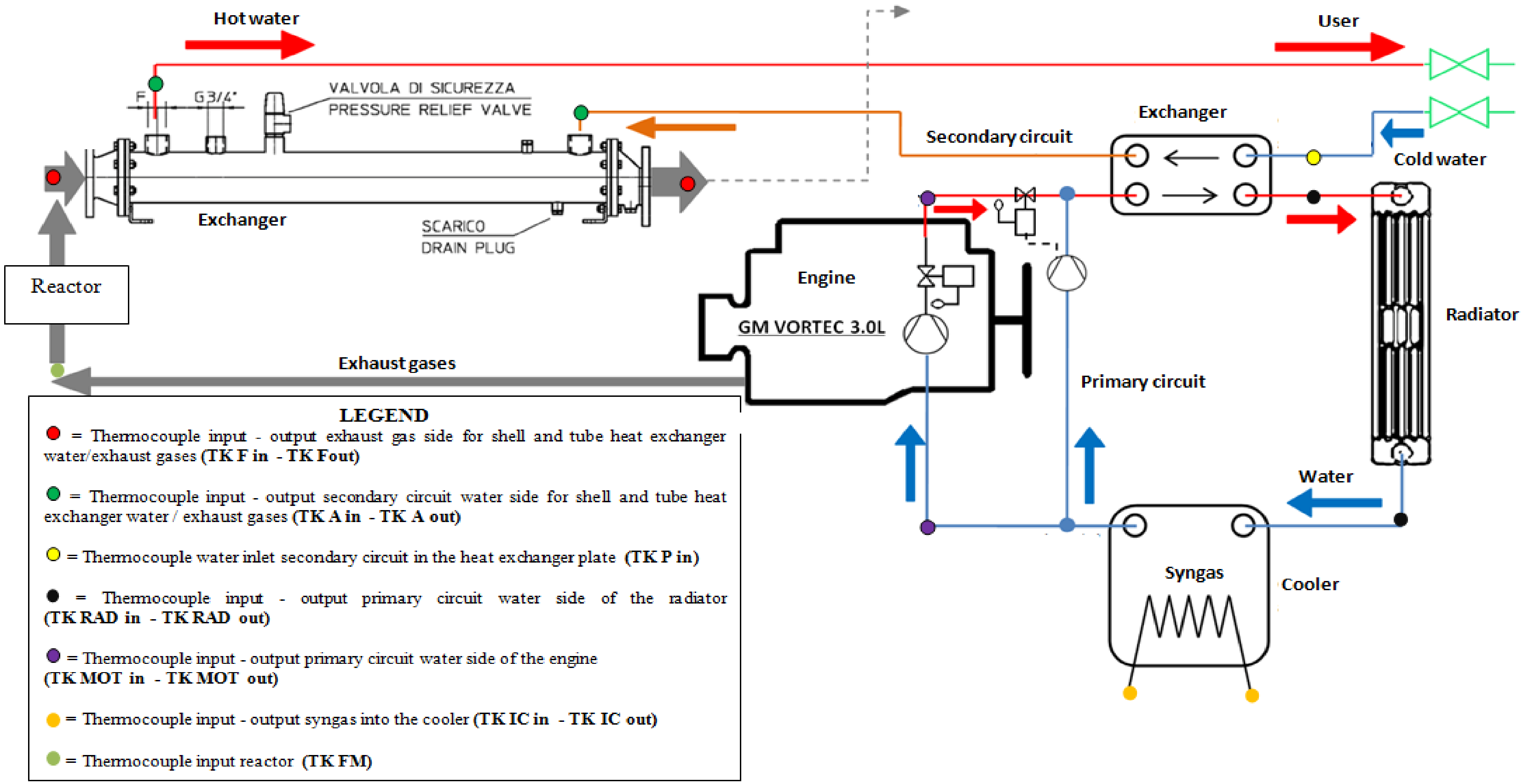
The analysis of the syngas samples was performed by a gas chromatograph HP 5890 Series II using a capillary column PLOT CARBOXEN 1006 (30 m x 0.53 mm x 0.5 mm).

Syngas composition for 4 collected samples

	Test 1	Test 2	Test 3	Test 4	Mean value
H_2 %	11.8	13.4	14.0	14.1	13.32
N_2 %	66.1	61.7	59.8	59.1	61.67
CO %	12.5	14.1	14.2	15.1	13.97
CH_4 %	1.0	1.2	1.5	1.5	1.3
CO_2 %	8.5	9.5	10.4	10.2	9.65
C_2H_6 %	0.1	0.1	0.1	0.1	0.1

CMD ECO20 System: experimental characterisation

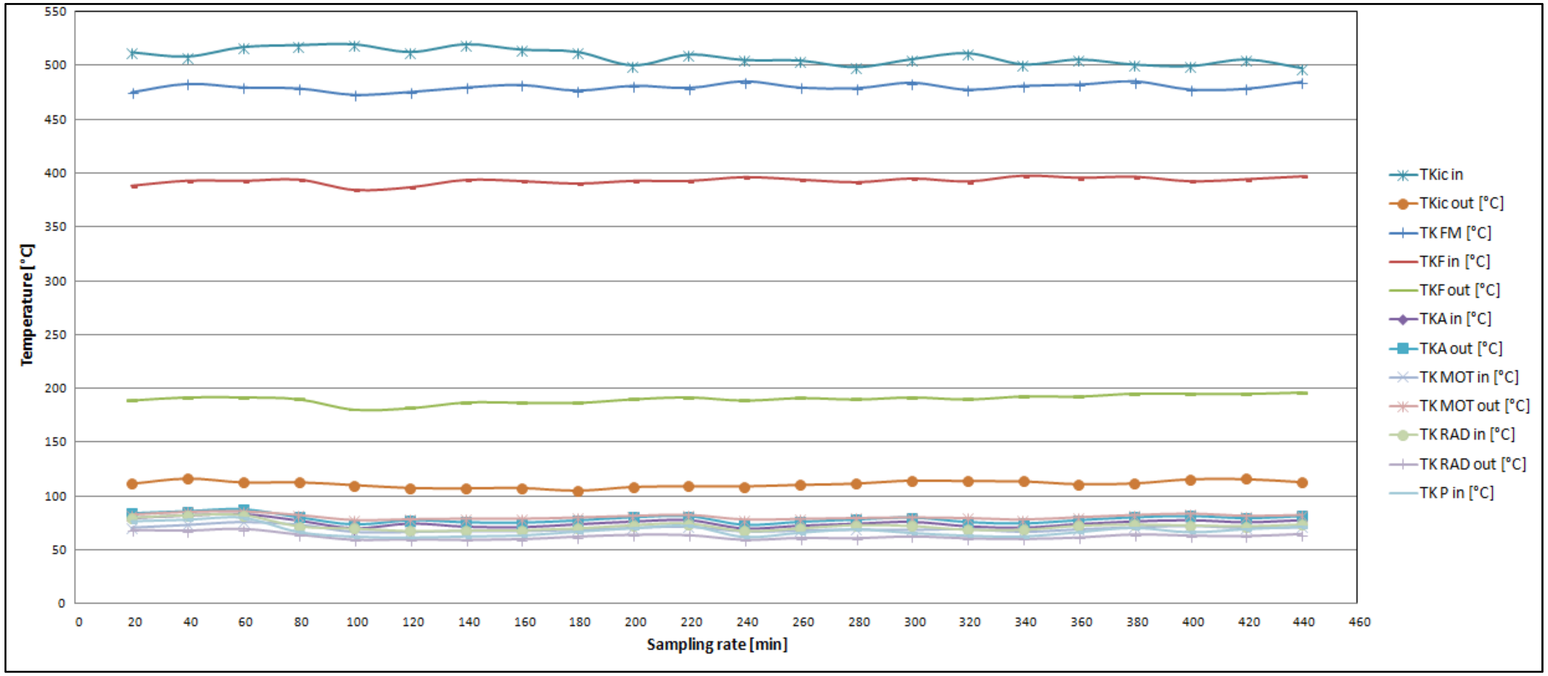
With reference to the thermal layout, 12 thermocouples were mounted to measure temperature in various sections and to evaluate the thermal energy fluxes through the shell and tube and plate heat exchangers, the radiator, the cooler and the engine



Thermocouples type 12-K-600-114-1,5-2I-3P2LD/X1295-1 Mad mineral insulation and Digital thermometer (Two K-type) were used.
The accuracy of Digital thermometer in the range 0°C - 1000°C is ± (0.4% reading value +2°C).

CMD ECO20 System: experimental characterisation

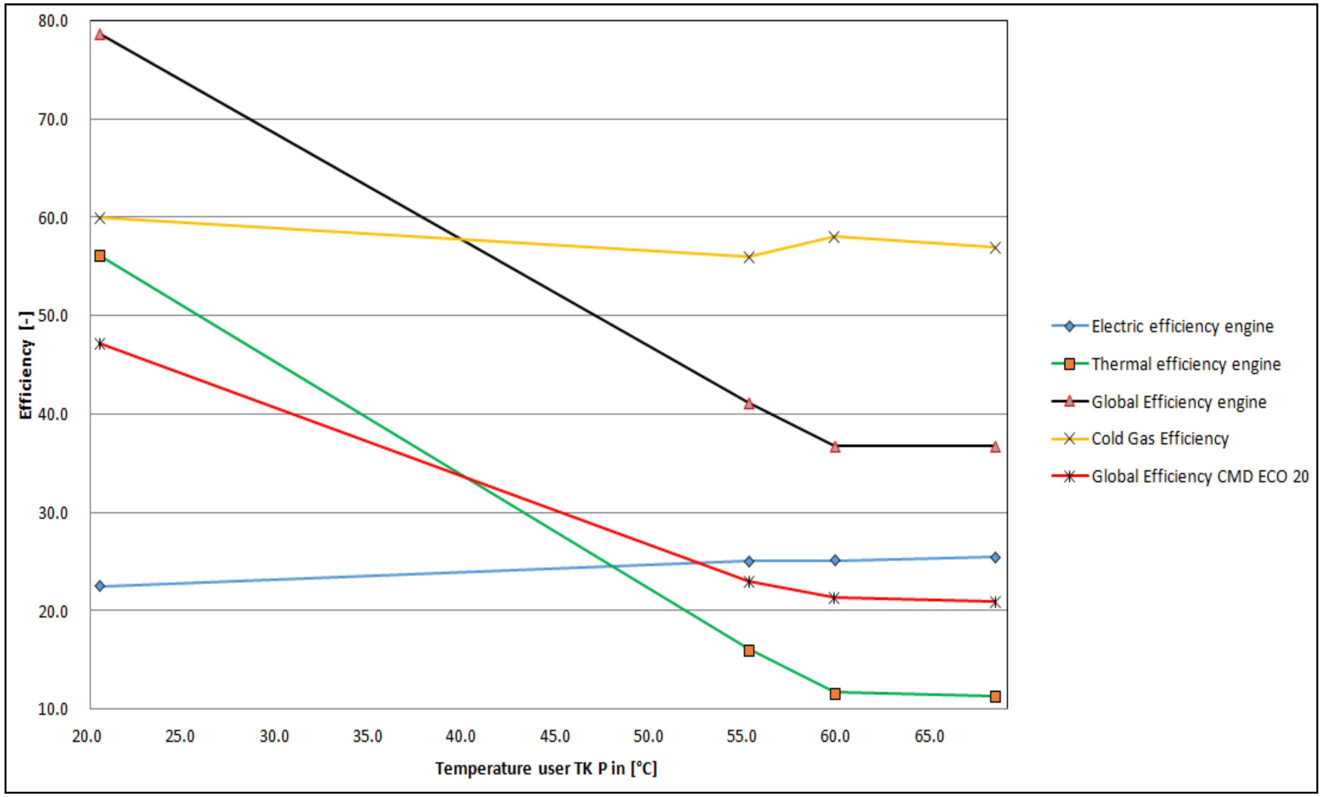
Temperatures in a typical campaign of measurements



	$T_{Kic\ in}$ [°C]	$T_{Kic\ out}$ [°C]	$T_{K\ FM}$ [°C]	$T_{KF\ in}$ [°C]	$T_{KF\ out}$ [°C]	$T_{K\ A\ in}$ [°C]	$T_{KA\ out}$ [°C]	$T_{K\ MOT\ in}$ [°C]	$T_{K\ MOT\ out}$ [°C]	$T_{K\ RAD\ in}$ [°C]	$T_{K\ RAD\ out}$ [°C]	$T_{K\ P\ in}$ [°C]
Max value	519.60	179.00	507.00	423.50	212.40	83.20	90.80	76.50	86.10	82.10	69.50	80.20
Avarage value	470.20	111.03	480.56	390.42	184.91	70.67	75.87	63.17	75.61	67.68	55.33	63.22
Min value	388	39.20	440	352.80	61.10	31.30	35.20	41.80	63.50	25.10	25.70	20.10
Uncertainty	2.08	2.58	0.85	0.92	1.32	0.45	0.48	0.58	0.34	0.78	0.66	0.85

CMD ECO20 experimental characterisation

When the user's temperature decreases, the Global Efficiency of CMD ECO 20 increases because the Cold Gas Efficiency of the reactor and the Electric Efficiency of the engine remain approximately constant while the Thermal Efficiency of the engine increases.



The effect of different users' condition on electrical and thermal efficiency was investigated.

4 cases were studied:

a) $T_{K\,P\,in} = 68.35\ [°C]$

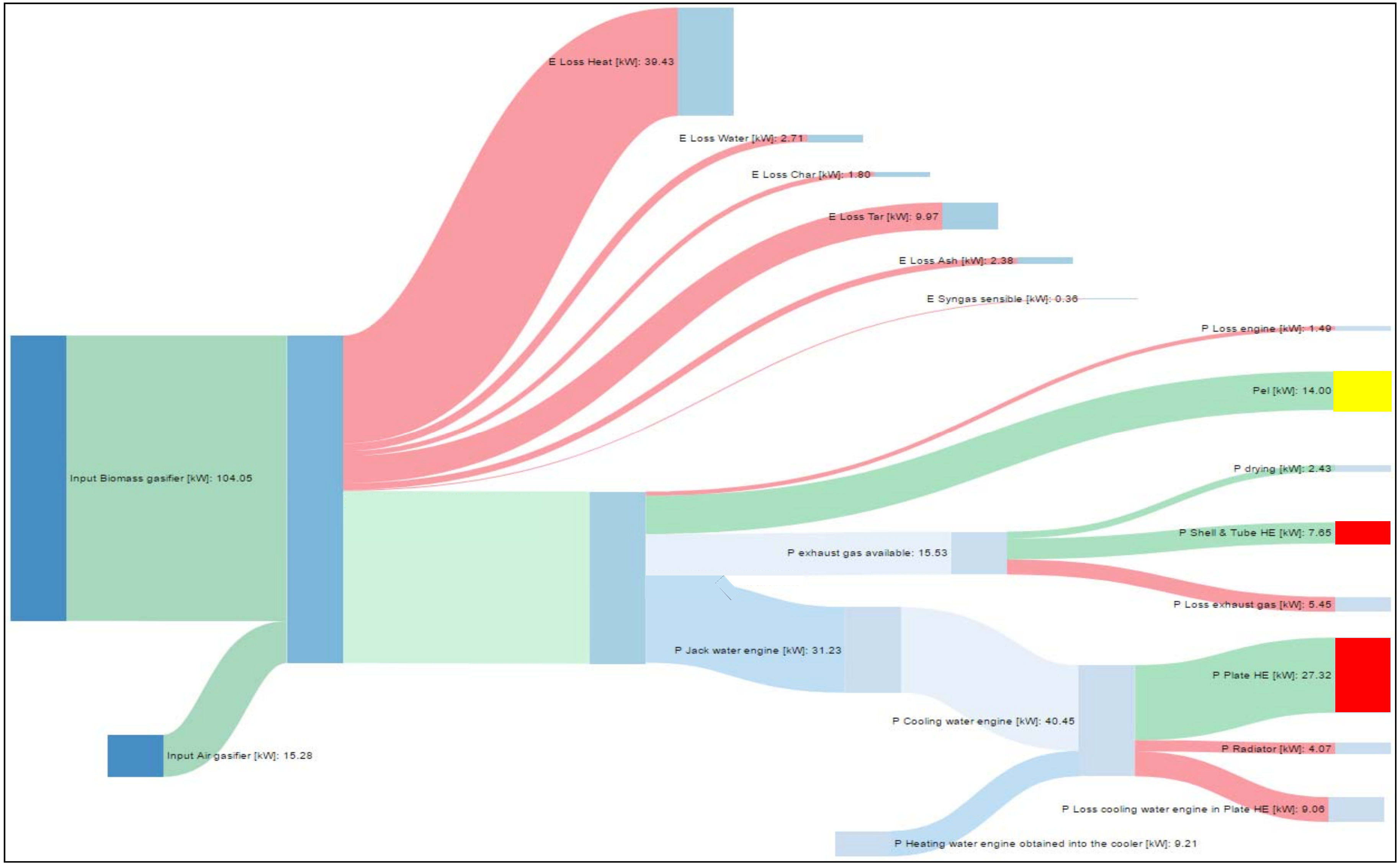
b) $T_{K\,P\,in} = 59.76\ [°C]$

c) $T_{K\,P\,in} = 55.20\ [°C]$

d) $T_{K\,P\,in} = 20.50\ [°C]$

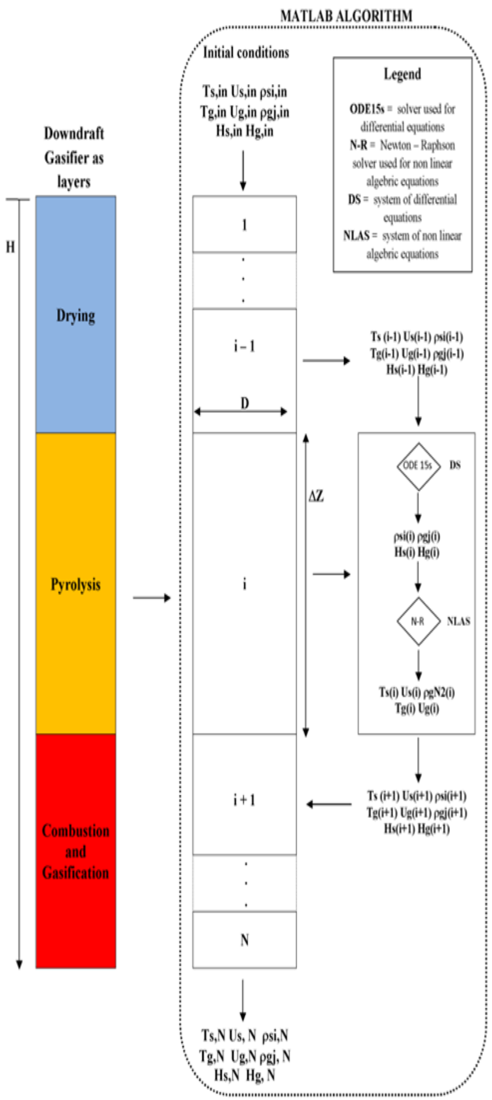
CMD ECO20 System: experimental investigation

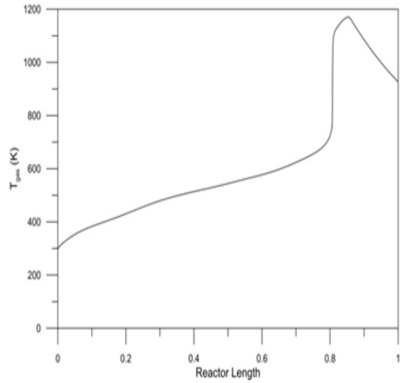
In conclusion, on the basis of the performed measurements, the overall energy balance of the system was derived as reported in the Sankey diagramm of Figure below (case d).

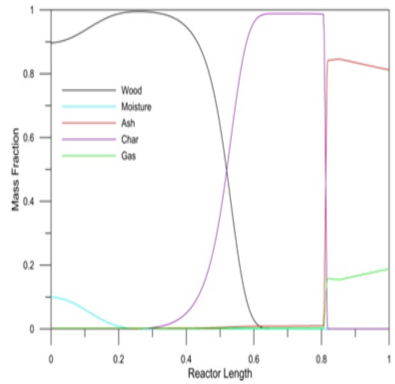


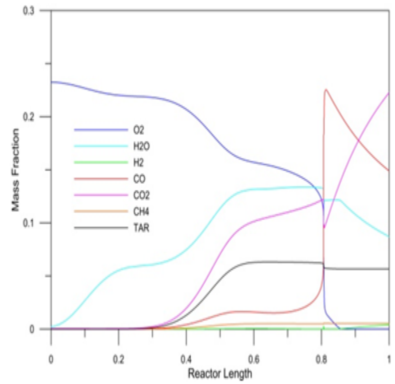
CMD ECO20 System: numerical model

A 1D phenomenological model of the gasifier was developed and validated on experiments

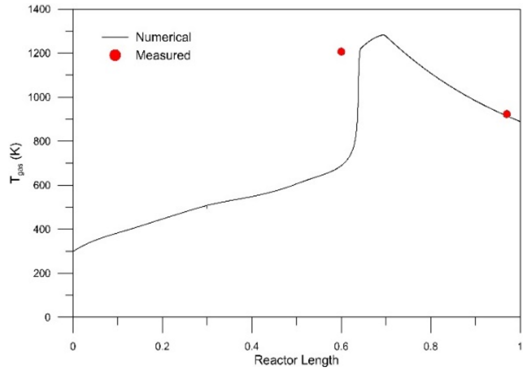


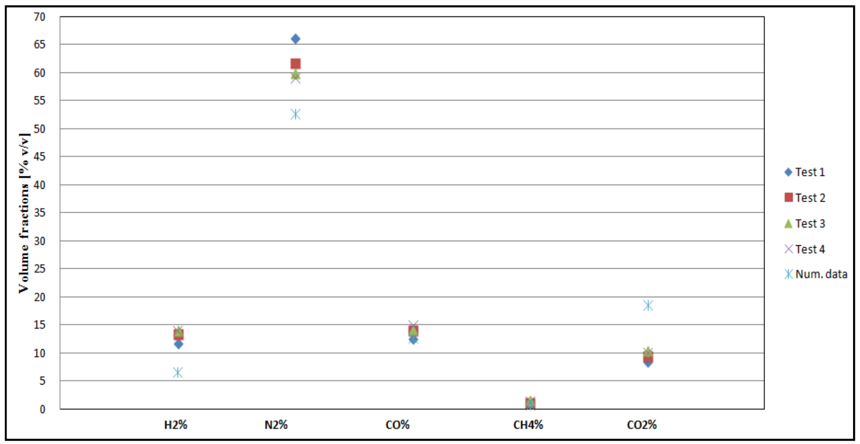






Reactor Diameter	0.3 m
Gasifier Length	0.825 m
Biomass flow rate at inlet	22 kg/h
Equivalence ratio	0.35
1st Thermocouple position - Temperature	0.49 m – 1206.5 K
2nd Thermocouple position - Temperature	0.8 m – 923.15 K





Conclusions (1)

Actual

Pel = 15 kW (avarage value)

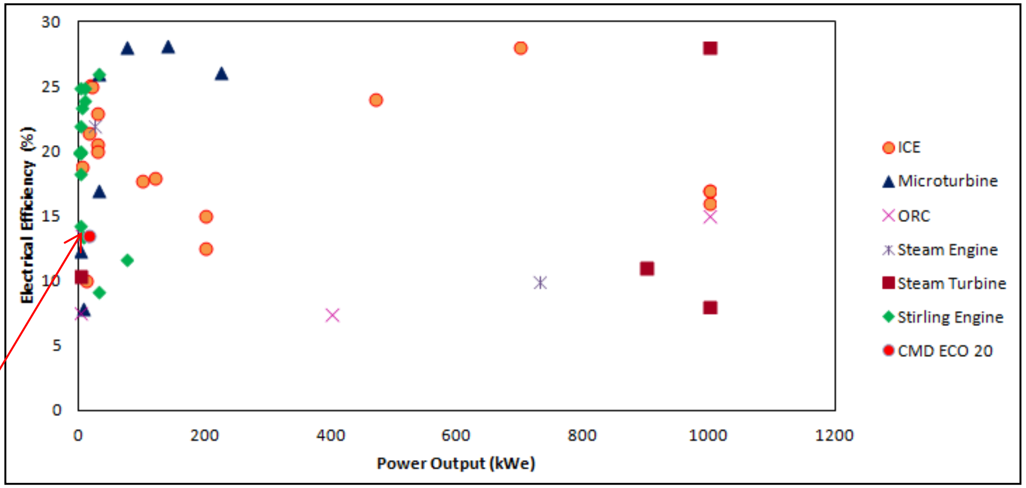
Pth = 35 kW (avarage value)

CGE = 60 % (avarage value)

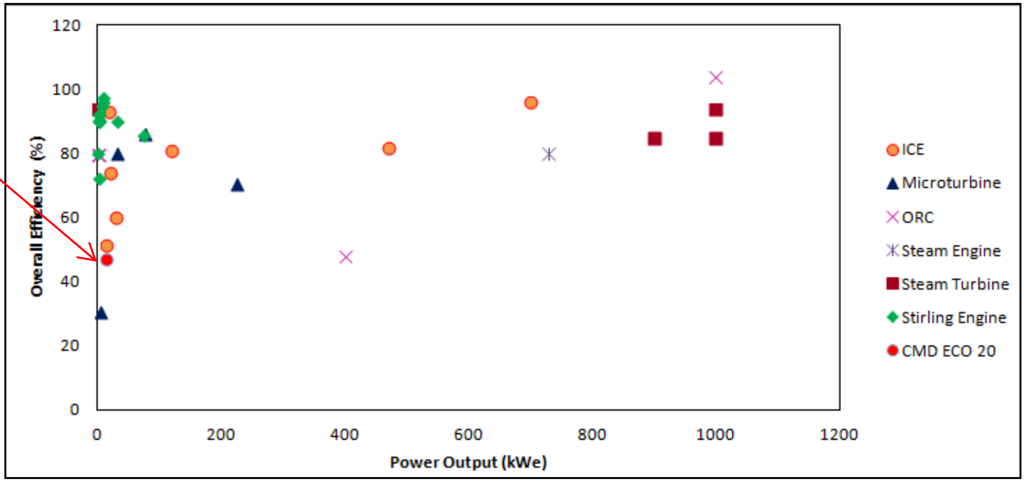
ηel =13.5 % (avarage value)

ηth =33.72 % (avarage value)

ηglob = 47.22 % (avarage value)



CMD ECO 20



Conclusions (2)

After improvements

Pel = 20 kW (avarage value)

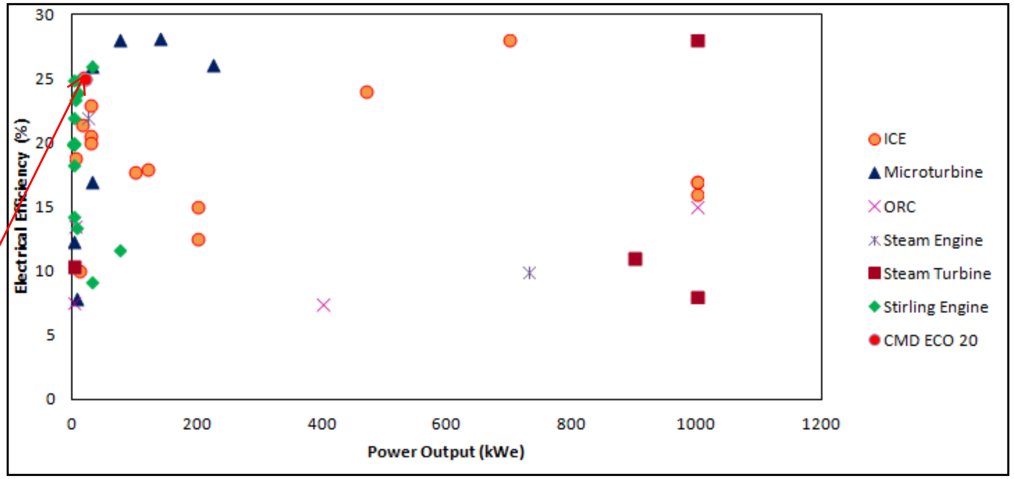
Pth = 40 kW (avarage value)

CGE = 85 % (avarage value)

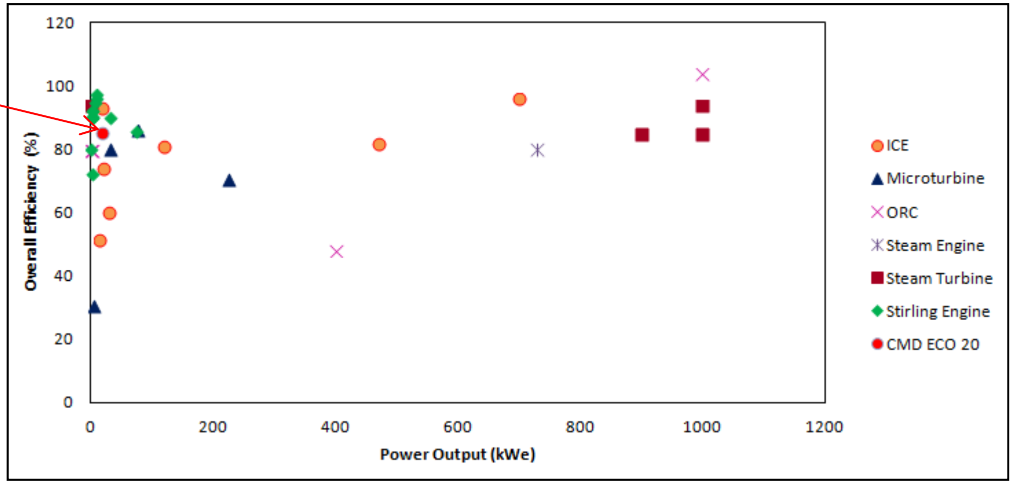
ηel =25 % (avarage value)

ηth =60 % (avarage value)

ηglob = 85 % (avarage value)



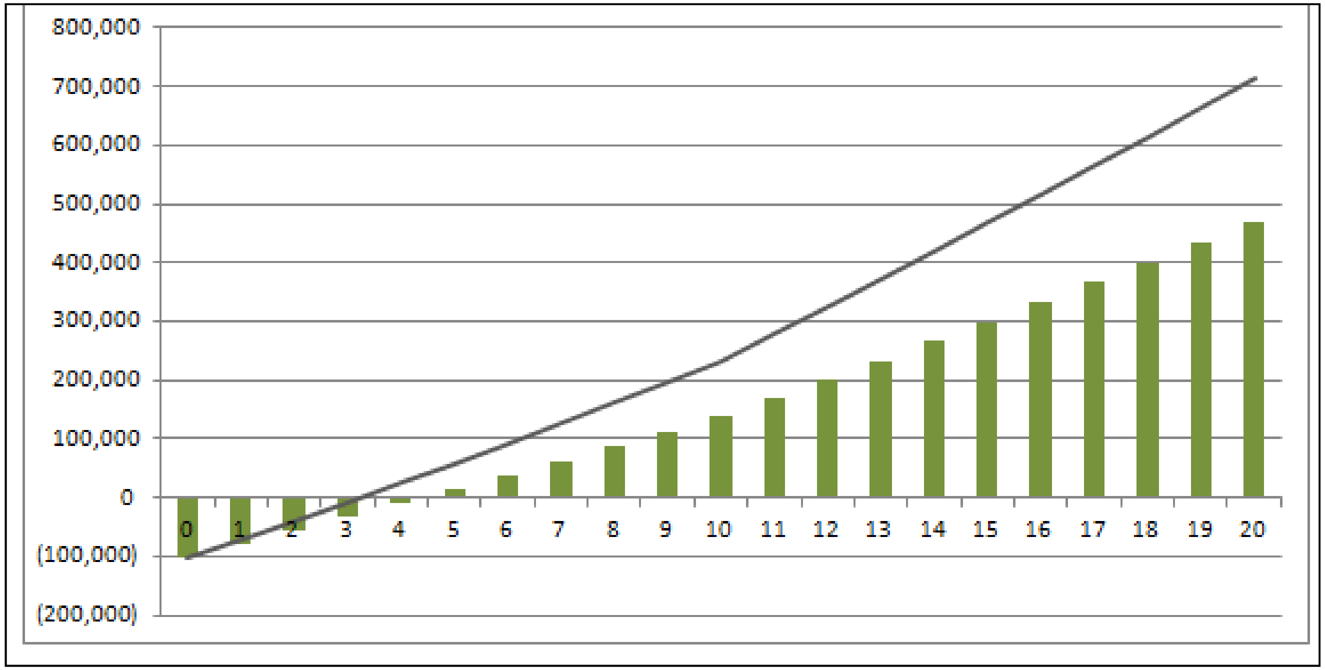
CMD ECO 20



Conclusions (3)

Work hypothesis:

- **Avarage production Pel = 15 kWe and Pth = 35 kWth;**
- **Cost of investiment 100’000 €;**
- **Operating time 6500 h/year;**
- **Woodchip requirement 22 kg/h;**
- **On the basis of Italian incentive, revenue 0.247 €/kWhel (DM 6 luglio 2012 and DM 23 giugno 2016);**
- **Self-consumption thermal energy produced (100%);**
- **Return Of Investiment 5 years.**



Conclusions (4)

Though the system is in a first phase of development research, it is ready to be marketed.

The system installation has several advantages, including:

- to be used in mountain and rural areas where electrical supply is difficult;

- modular units (2 units can produce 40 kWe and 80 kWth);

- different types of biomass can be exploited.

THANK YOU

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