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Possible application and commercial use of the BLAZE concept: Gasification-Fuel Cell CHP plant

Nicola Rovelli

Enereco

BIOCOGEN 2030

Webinar 7th December 2021

http://www.blazeproject.eu/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 815284

OUTLINE

- BLAZE Project
- BLAZE CHP concept (Technology)
- Expected application – BLAZE Objectives
- Biomass potential and selection
- Preliminary Market perspectives

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BLAZE Project

Biomass Low cost Advanced Zero Emission small-to-medium scale integrated gasifier - fuel cell CHP plant

BLAZE is an EU-funded research project under **Horizon 2020** Program.

It involves industry, universities and associations, and is coordinated by Guglielmo Marconi University (USGM)

- 9 WPs
- > 4 years project
- 4.3 M€
- 10 partners

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BLAZE Project Pilot Plant

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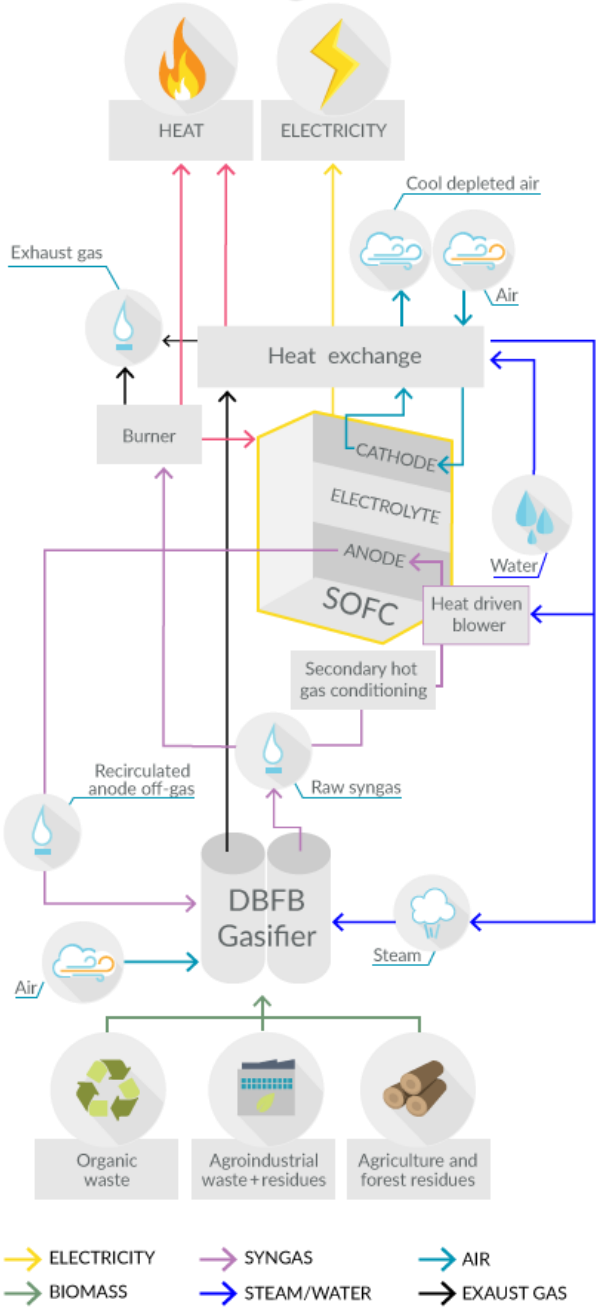
Innovative technologies:

dual bubbling fluidised bed technology integrated with **primary high temperature cleaning & conditioning system**

Secondary high temperature gas cleaning for **HCl and H2S removal**

thermal and chemical **integration of SOFC (Solid Oxide Fuel Cell)**



Feedstock: BIOMASS

- Primary residues from **forest**
- **Agricultural** residues
- Secondary residues from **wood industries**
- Secondary residues of **industry utilizing agricultural products**
- Municipal **organic waste**
- **Waste from wood**
- **Digestate** from biogas production

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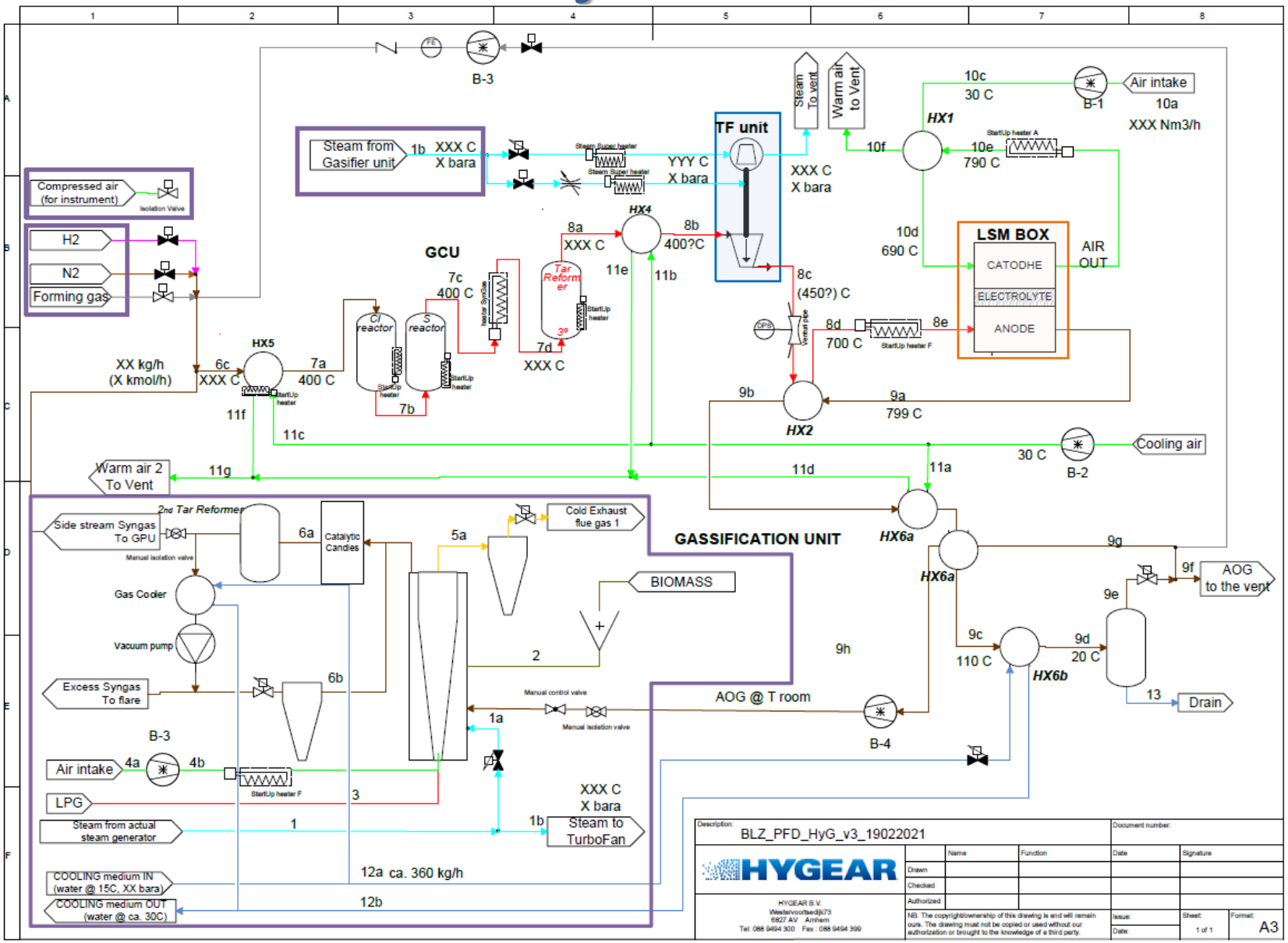
BLAZE Project Pilot Plant



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BLAZE objective

The technology is developed for a **CHP capacity** range from **small (25-100 kWe)** to **medium (0.1-5 MWe)** scale

Parameter	Current	BLAZE
Overall efficiency	≈ 65%	≈ 90%
electrical efficiency	≈ 25%	≈ 50%
investment cost	≈ 10,000 €/kWe	≈ 4,000 €/kWe
operating cost	≈ 0.10 €/kWhe	≈ 0.05 €/kWhe
electricity production cost	≈ 0.20 €/kWh	≈ 0.10 €/kWh
Negligible gaseous and particulate matter emissions		

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WP2- D2.1 Biomass selection & Characterization

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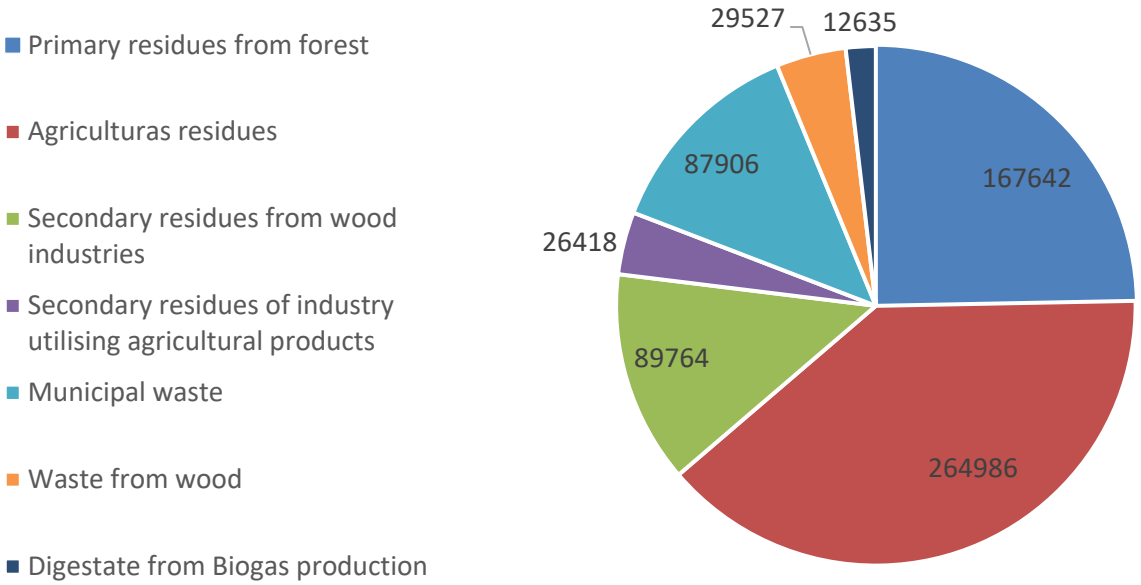
TASK 2.1 - Determination of the actual potential of residual biomass feedstocks

Datasets and the elaborated results provided by the S2Biom project were used (www.s2biom.eu)

The biomass has been divided in 7 categories:



The total biomass potential availability is equal to 678,878 Kton/year (dry mass basis).

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WP2- D2.1 Biomass selection & Characterization

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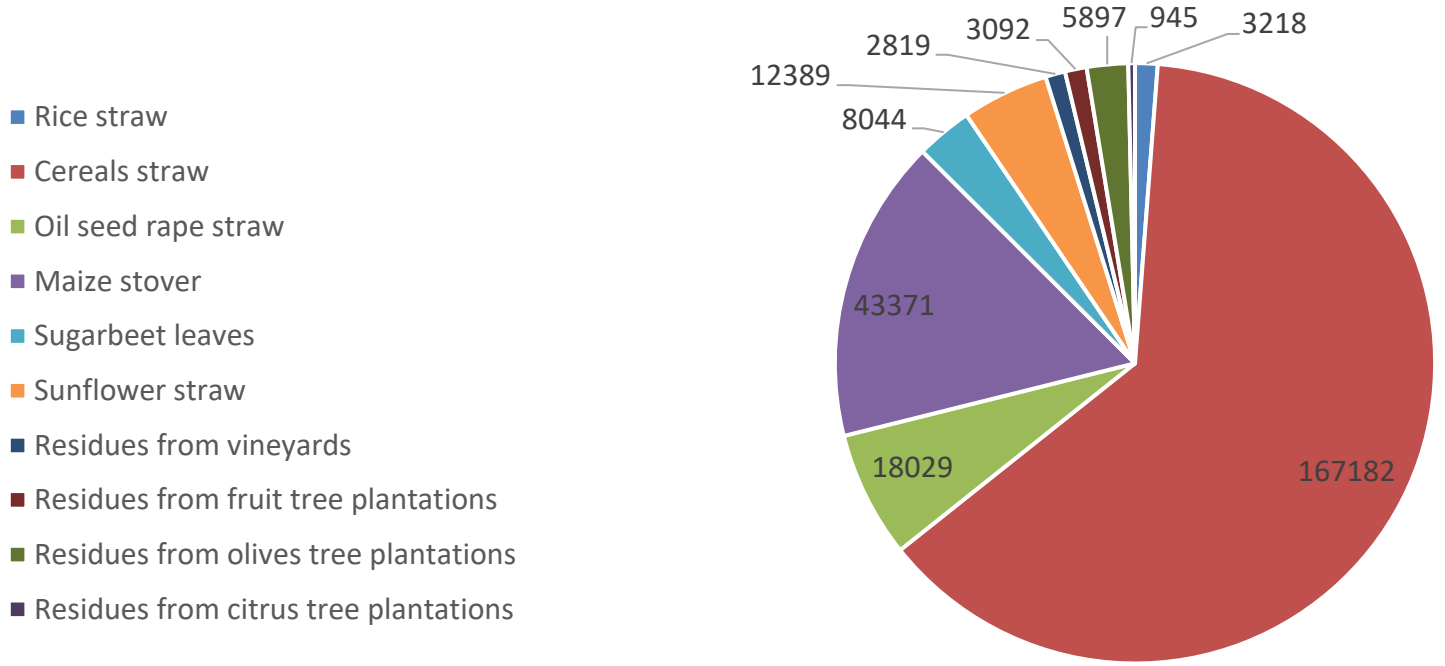
TASK 2.1 - Determination of the actual potential of residual biomass feedstocks

Each category has been furtherly divided into different biomass type:



Example: agricultural residues divided per biomass type (Kton/year on dry mass basis)

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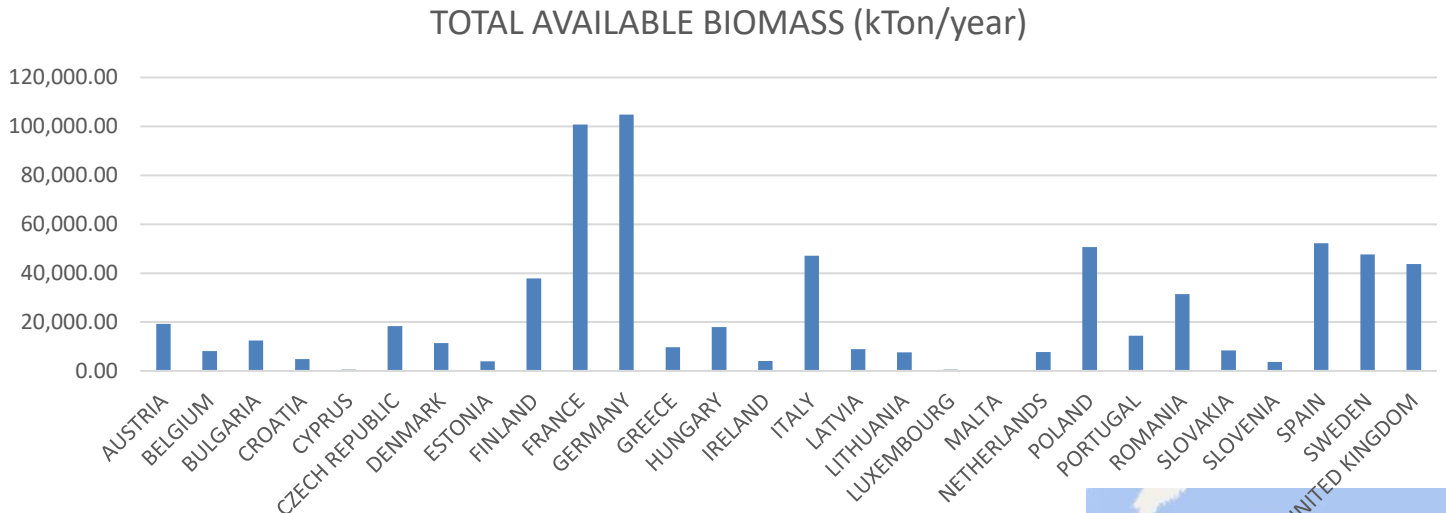
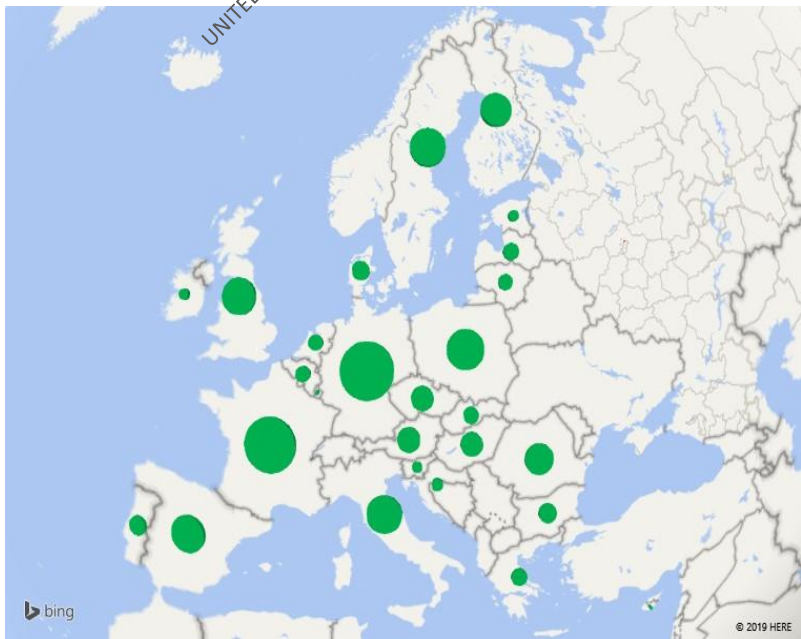


Total biomass availability and map distribution in EU28 (kton/year)



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WP2- D2.1 Biomass selection & Characterization

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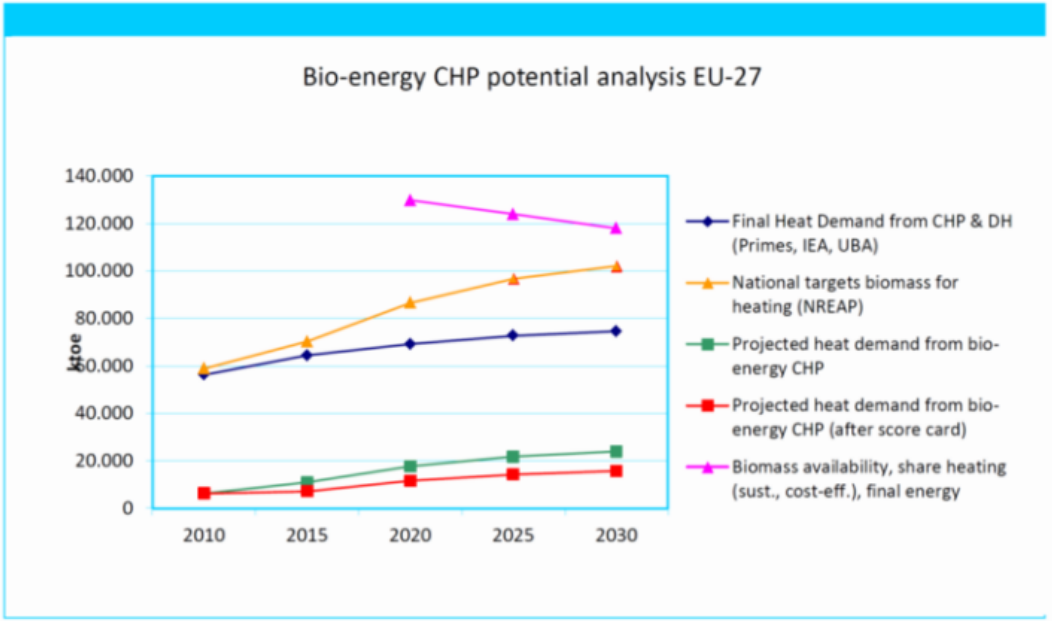
TASK 2.1 - Determination of the actual potential of residual biomass feedstocks

It was considered theoretical potential for applying BLAZE technology as 100% fuel switch to bio-fuels in existing CHP systems – in district heating (DH) as well as in industry.

(Projected) Heat demand from bio-energy CHP and DH in 2030 is equal to 17.664 ktoe or 205.432 GWhth. (According to "European report on potential of BIO-ENERGY CHP in EU27") *to be updated with latest report*

Figures (projections)	2010	2020	2030
Final heat demand from CHP and DH (PRIMES, IEA, UBA), ktoe	56.233	69.056	74.465
(Projected) heat demand from bio-energy CHP and DH (after score card), ktoe	10.967	14.015	17.664
Bio-energy penetration rate in CHP markets (2009: EEA, Eurostat)	19,5% (2009)	20,3%	23,7%
Biomass availability, share heating (sust., cost-eff.), final energy (Biom. Futures), ktoe		129.756	117.868



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WP2- D2.1 Biomass selection & Characterization

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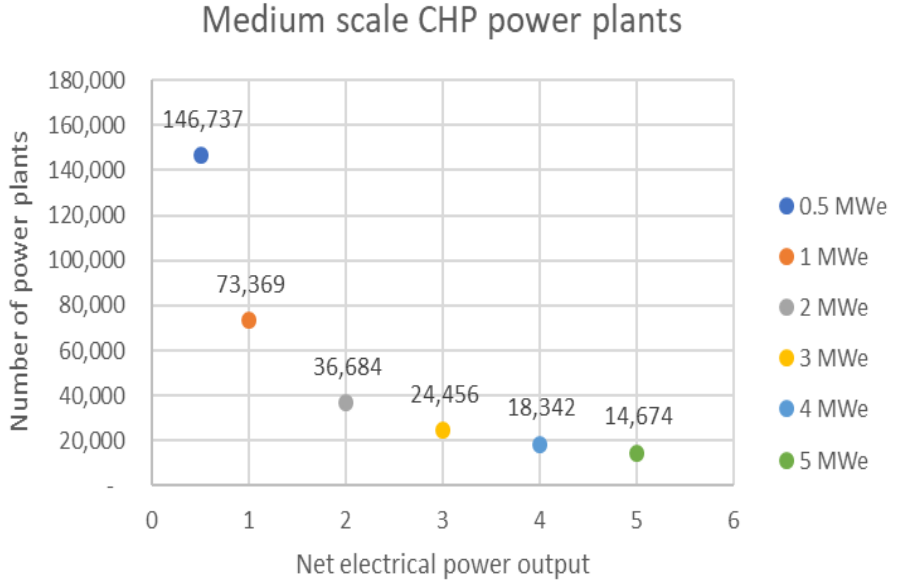
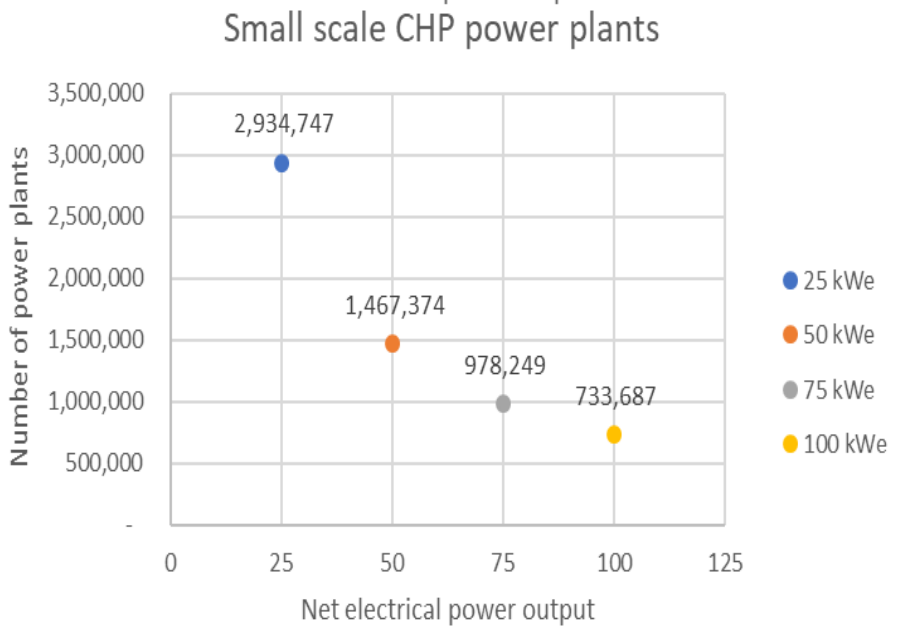
TASK 2.1 - Determination of the actual potential of residual biomass feedstocks

Assuming Blaze technology thermal conversion efficiency equal to 40% and a medium value of 3.500 working hours of the plant we estimated the number of CHP power plants based on BLAZE technology for different capacity range and scale





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BIOMASS CONCLUSION
MARKET ANALYSIS STARTING POINT

Biomass Potential

Considering the technical and economic aspects (availability and costs), the following biomasses have been selected for testing :

- Agricultural residues: Arundo Donax or similar.
- Primary residues from forest: Sawmill, Wood Chips.
- Secondary residues from wood industry: Sawdust.
- Secondary residues of industry utilizing agricultural products: almond shell or similar.
- Waste from wood: Wood Chips.

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WP2- D2.1 Biomass selection & Characterization

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TASK 2.2 – Bio-syngas composition and contaminants that affect SOFC operation, and related gasifier parameters and bed materials to reduce SOFC hazardous effects

According to indication coming from Task 2.1 «Biomass supply», the following feedstocks were ultimately considered for characterization:

Feedstock	CATEGORY	Humidity (%-wt, as received)	LHV MJ/kg	Ash %wt, dry basis	S %wt, dry basis	Cl %wt, dry basis	Ash melting T (DT) (°C)
Subcoal	Municipal waste	3,20	21,68	**15,60**	**0,10**	**1,00**	1250,00
Olive pomace pitted	Secondary residues of industry utilising agricultural products	**36,30**	19,79	5,95	**0,06**	**0,08**	1290,00
Sawmill waste	Primary residues from forest	11,20	18,89	0,41	<0.01	<0.01	1300,00
Multi-essence wood chips	Waste from wood	24,50	17,88	1,45	0,02	<0,01	1370,00
Olive Prunings	Secondary residues from wood industries	14,90	17,76	1,55	<0.01	<0.01	1380,00
Almond shells	Secondary residues of industry utilising agricultural products	10,00	17,68	1,31	<0.01	<0.01	1000,00
Swarf and sawdust	Secondary residues from wood industries	6,60	17,14	0,43	<0.01	<0.01	>1385
Wood chips	Primary residues from forest	8,90	16,74	0,54	<0.01	<0.01	>1385
Corn cobs	Agricultural residues	9,00	16,62	3,04	0,03	0,44	645,00
Arundo Donax	Agricultural residues	10,10	16,25	3,43	0,11	0,29	1185,00
1- Wheat Straw (pellets 10 mm)	Agricultural residues	7,60	15,98	9,22	0,05	0,12	1065,00
2- Wheat Straw (pellets 6 mm)	Agricultural residues	7,60	15,40	13,29	0,08	0,21	1135,00
Rice husks	Secondary residues of industry utilising agricultural products	5,20	15,19	**14,70**	0,02	0,03	**990,00**
Digestate	Digestate from biogas production	**71,20**	12,69	**25,81**	**0,97**	0,10	1245,00
Black Liquor	Secondary residues from wood industries	20,60	11,20	**48,28**	0,74	0,12	**680,00**
Municipal solid waste	Municipal waste	23,00	10,22	**47,01**	0,20	0,40	1220,00

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BIOMASS CONCLUSION MARKET ANALYSIS STARTING POINT

Biomass Caractherization

- ENEA analysed a wide selection of Biomass residues to find the most suited fuel for a BLAZE type plant.
- With exception made for corn cobs, black liquor and digestate, **all the feedstocks analysed** (woody or herbaceous) **present no special issues with regards to their use as feedstocks** in a process of gasification in a BFB reactor.
- The only issue would be the release of relatively high content of S and Cl that could be noxious to any catalytic downstream equipment and to the SOFC unit. However this can be fixed with utilisation of specific chemical solutions.
- These results confirm the high fuel flexibility of BLAZE, thus making it suitable for a wider geographical application. The same study, based on the results of previous

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BIOMASS CONCLUSION MARKET ANALYSIS STARTING POINT

General outcomes of BLAZE pilot plant design:

- increased complexity of the system arisen during the project mainly due to high purity of syngas required by SOFC
- Uncertainties related to final commercial cost of SOFC
- Custom made equipment for pilot scale since not available on the market at small scale

These outcomes could lead to an increase of CAPEX and also OPEX that may become critical for small CHP capacity (25-100 kWe).

Hence **BLAZE concept is more likely to be economically viable for medium CHP capacity (0.5-5 MWe)** more focused to **small/medium industries** and **large public/commercial areas, o**ff course in regions where the identified category of biomass is available

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www.blazeproject.eu
@BlazeH2020
info@blazeproject.eu

ENERECO S.p.A.
Nicola Rovelli
Tel. +39 340 5979624
E-mail: nicola.rovelli@enereco.com
www.enereco.com

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