EUBCE
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Biomass Low cost Advanced Zero Emission small-to-medium scale integrated gasifier-fuel cell combined heat and power plant (GA No. 815284)

Biomass availability and suitability for the plant

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The BLAZE Project Approach

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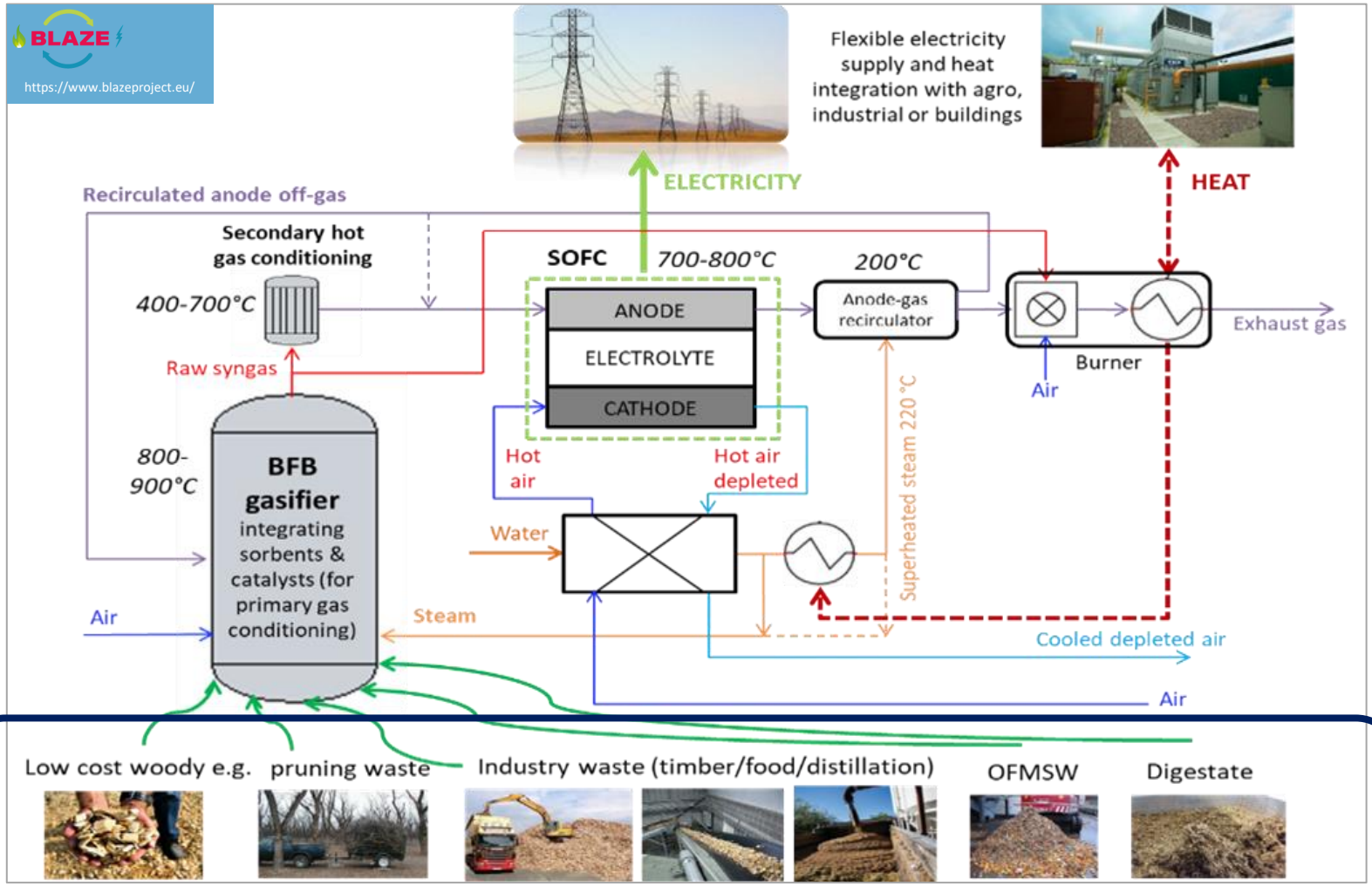

➢ Feedstocks Availability

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Assessment on biomass availability in EU

COD	BIOMASS TYPE	QUANTITY (Kton db)	BIOMASS CATEGORY	POTENTIAL QUANTITY (Kton db/year)
1211	Logging residues from final fellings from nonconifer trees	23348	Primary residues from forest	167642
1212	Logging residues from final fellings from conifer trees	35758		
1213	Logging residues from thinnings from nonconifer trees	11960		
1214	Logging residues from thinnings from conifer trees	24245		
1221	Stumps from final fellings from nonconifer trees	27797		
1222	Stumps from final fellings from conifer trees	44533		
2211	Rice straw	3218	Agriculturas residues	264986
2212	Cereals straw	167182		
2213	Oil seed rape straw	18029		
2214	Maize stover	43371		
2215	Sugarbeet leaves	8044		
2216	Sunflower straw	12389		
2221	Residues from vineyards	2819		
2222	Residues from fruit tree plantations	3092		
2223	Residues from olives tree plantations	5897		
2224	Residues from citrus tree plantations	945		
4111	Sawdust (conifers)	11302	Secondary residues from wood industries	87906
4112	Sawdust (nonconifers)	1579		
4113	Other residues (conifers)	21041		
4114	Other residues (nonconifers)	3274		
4121	Residues from industries of semi finished wood based panels	3504		
4122	Residues from further wood processing	16068		
4131	Bark	5466		
4132	Black liquor	25672		
4211	Olive-stones	1187	Secondary residues from agricultural	29527
4213	Rice husk	631		
4214	Pressed grapes dregs	485		
4215	Cereal bran	27225		
5111	Biowaste non-separately collected	54101	Municipal waste	89764
5112	Biowaste separately collected	35662		
5211	Hazardous post consumer wood	4045	Waste from wood	26418
5212	Non hazardous post consumer wood	22373		
X	Digestate from Biogas production	12635	Digestate from Biogas	12635

Source: https://www.s2biom.eu/

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Assessment on biomass availability in EU

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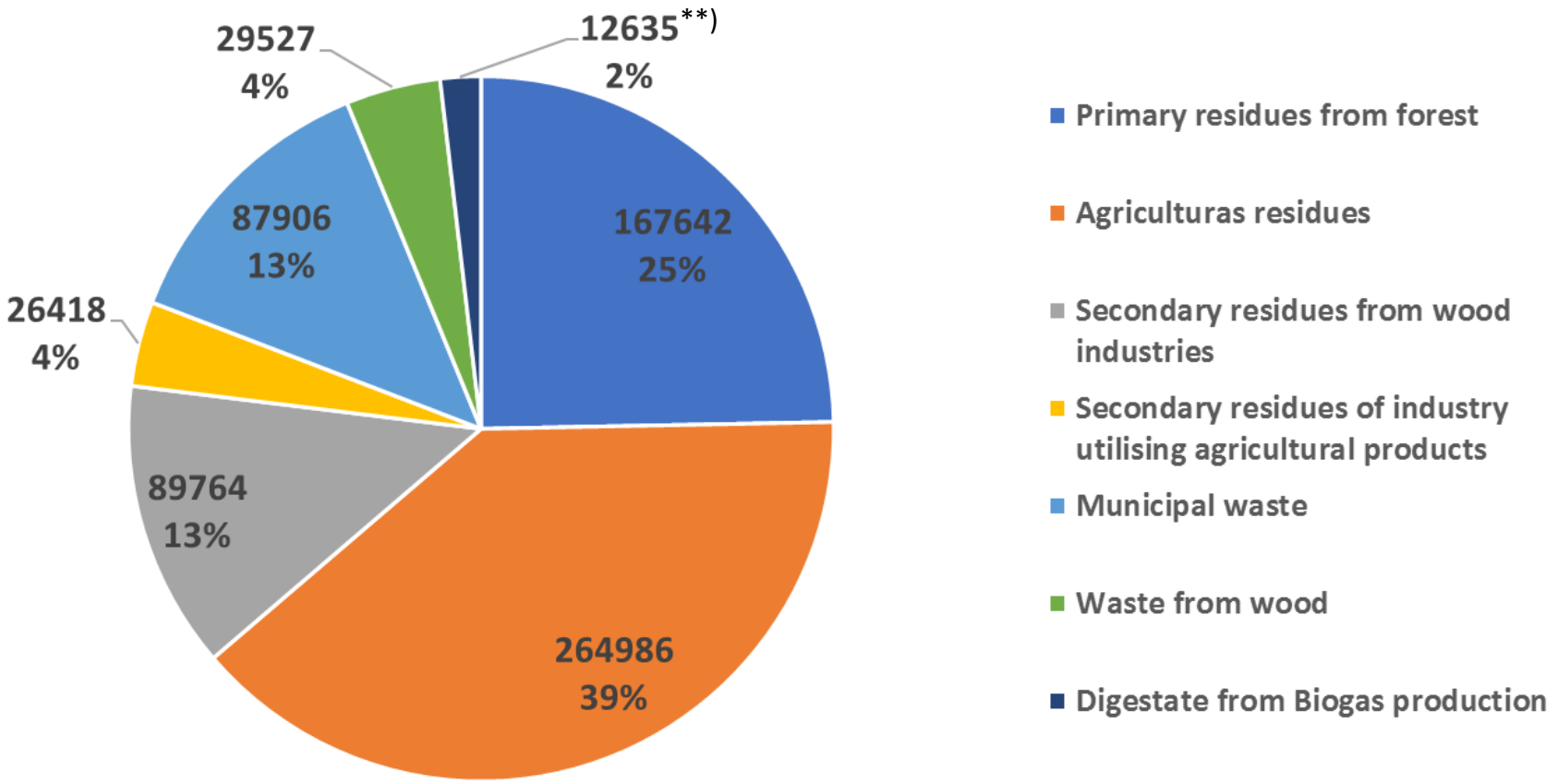
Considered feedstocks*)



TOT biomass potential availability: 678,878 $kton_{db}$/year

*) Based on S2biom database (www.s2biom.eu)

**) Estimation based on data of digestate from rural biogas plants in Italy and rural biogas plants available in Europe.

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Assessment about biomass availability in EU

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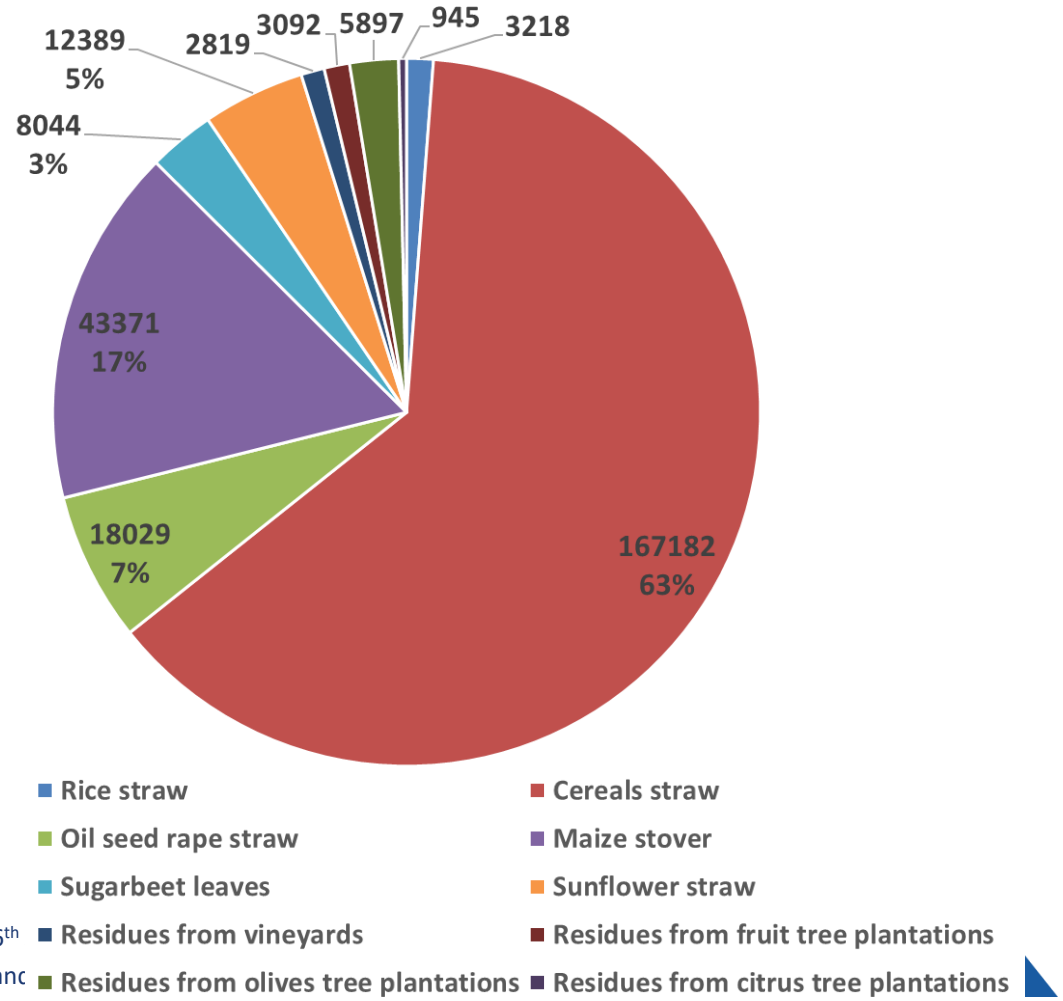
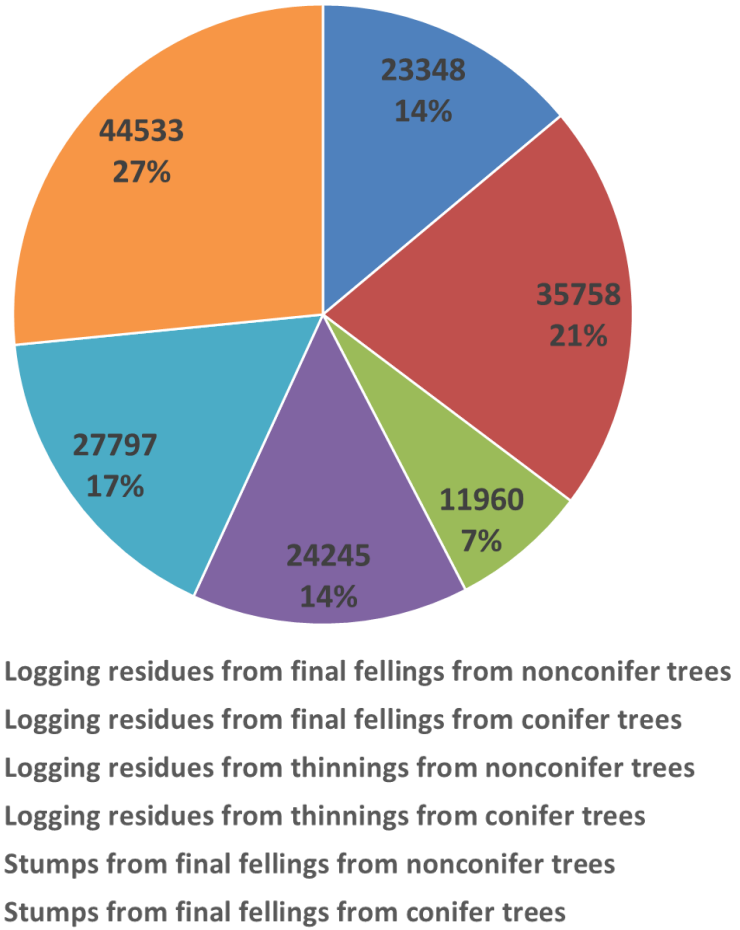
Major biomass availability: **agricultural residues** (265 Mt/y), **primary residues from forest** (168 Mt/y), secondary residues from wood industries (90 Mt/y) and MSW (88 Mt/y).

TOT Agricultural Residue: 265 Mton$_{db}$/year



TOT Forest residues: 168 Mton$_{db}$/year



Biomass Feedstock Selection

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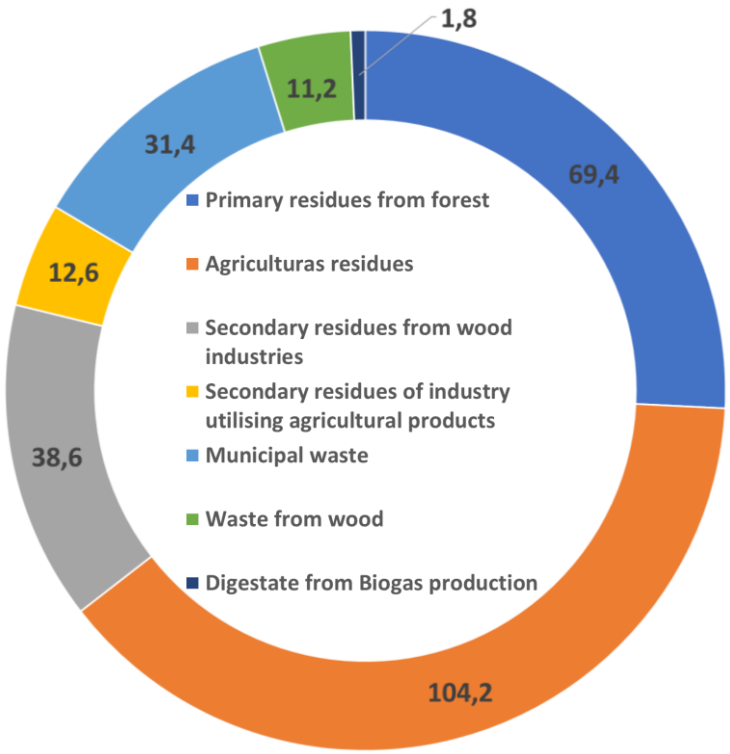
10 sample and 5 mix representative of the biomass species most available in EU suitable for gasification.

3 main criteria:

- Biomass availability;
- Biomass breakdown by type vs. available energy;
- Biomass cost



Biomass breakdown per available energy (Mtoe)

Main classification groups:

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

CATEGORY	Cost (€/ton)
Waste from wood	15
Agricultural residues	28
Primary residues from forest	35
Secondary residues from wood industries	35
Secondary residues of industry utilising agricultural products	55
Municipal waste*	60
Digestate from biogas production *	66

*) For MSW and digestate the cost was set considering the collection and not the raw material, that can be considered 0 as it is a waste.

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10 single residual biomass and 5 mixes

Type of feedstock			Sector of production	Main Group
1	Single Material	Olive pomace pitted	Food Industry	Secondary residues of industry utilising agricultural products
2	Single Material	Almond shells	Food Industry	Secondary residues of industry utilising agricultural products
3	Single Material	Corn cobs	Agricultural	Agricultural residues
4[a)]	Single Material	1- Wheat Straw (pellets 10 mm) 2- Wheat Straw (pellets 6 mm)	Agricultural	Agricultural residues
5	Single Material	Rice husk	Agricultural	Secondary residues of industry utilising agricultural products
6	Single Material	Olive pruning	Agricultural	Agricultural residues
7	Single Material	Arundo donax	Wild crops	Primary residues from forest
8	Single Material	Wood chips	Forestry management	Primary residues from forest
9	Single Material	Sawmill waste	Joinery	Secondary residues from wood industries
10	Single material	Black Liquor	Paper mills	Secondary residues from wood industries
1	Mix	Swarf and sawdust	Wood industries	Secondary residues from wood industries
2	Mix	Multi-essence wood chips	Forestry management	Waste from wood
3	Mix	Subcoal	Waste management	Municipal waste
4	Mix	Municipal solid waste	Waste management	Municipal waste
5	Mix	Digestate	Waste management	Digestate from biogas production

a) For this type of residues, samples of two different pellet diameters were supplied for characterization.

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Reference methods for feedstocks characterizations

Characterization	Parameter	Reference Method
Humidity	Amount of water in the «as received» sample	UNI EN 14774-1 (ASTM E203)
Proximate Analysis	Ash content	UNI EN 14775 – TAPPI T211 om93
	Volatile Matter (VM)	UNI EN 15148, mod. ASTM modif. D3175
	Fixed Carbon (FC)	
Ultimate Analysis	Elemental analysis (C, H, N, O)	UNI EN 15104
	Sulfur (S), Chlorine (Cl)	UNI EN 15289
Major metal elements	Content of Al, Ca, Fe, Mg, K, Si, Na, Ti	UNI EN 15290
Minor metal elements	Content of Cd, Cr, Cu, Mn, Ni, Pb, V, Zn	UNI EN 15297
Calorific value	Higher Heating Value (HHV) Lower Heating Value (LHV)	UNI EN 14918, ISO 1928 DIN 51900 – TAPPI Test T684
Ash TGA	Range of decomposition of carbonate and salts volatilization	Procedure in accordance with bibliography
Combustion of feedstocks	Temperature of ignition and burn-out (TGA)	Procedure in accordance with bibliography
Ash melting	Melting Temperatures	CEN/TS 15370-1, ISO 540: 1995 and DIN 51730: 1998.

Sample preparation	Size of particles, after representative sample grinding	UNI EN 14780
Bulk density	Mass of sample per occupied volume by the «as received» sample	UNI EN 15103

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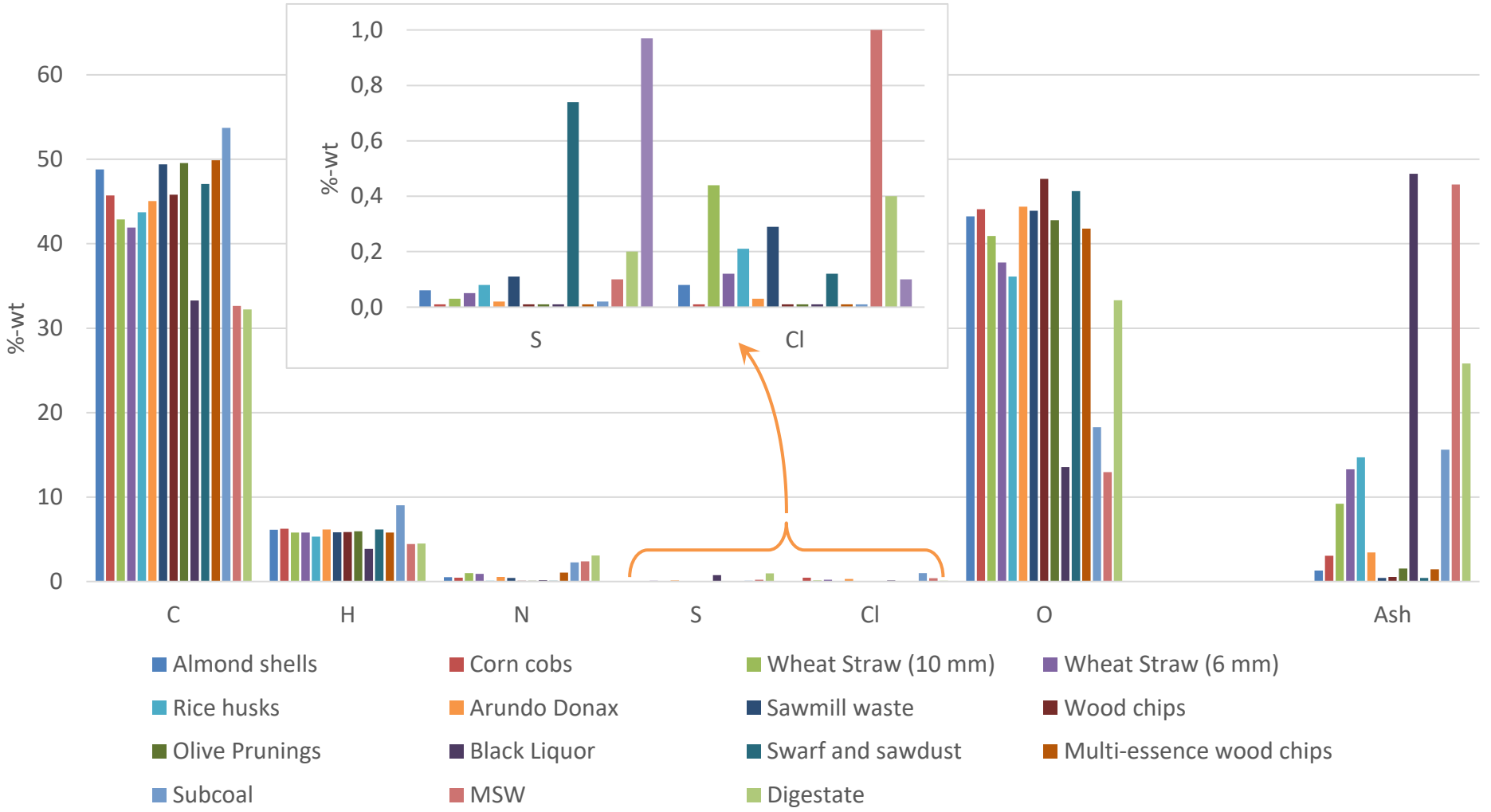

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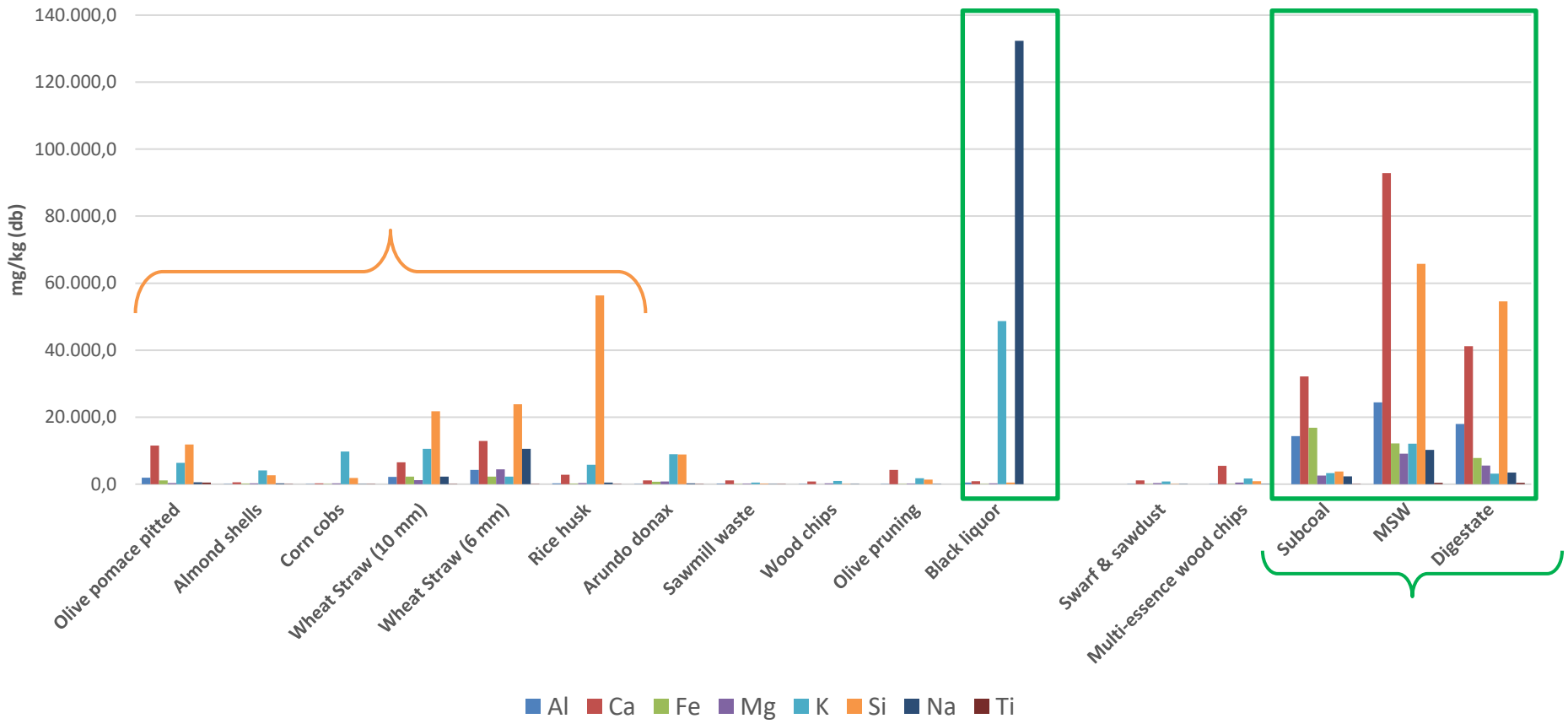
Main inorganic elements



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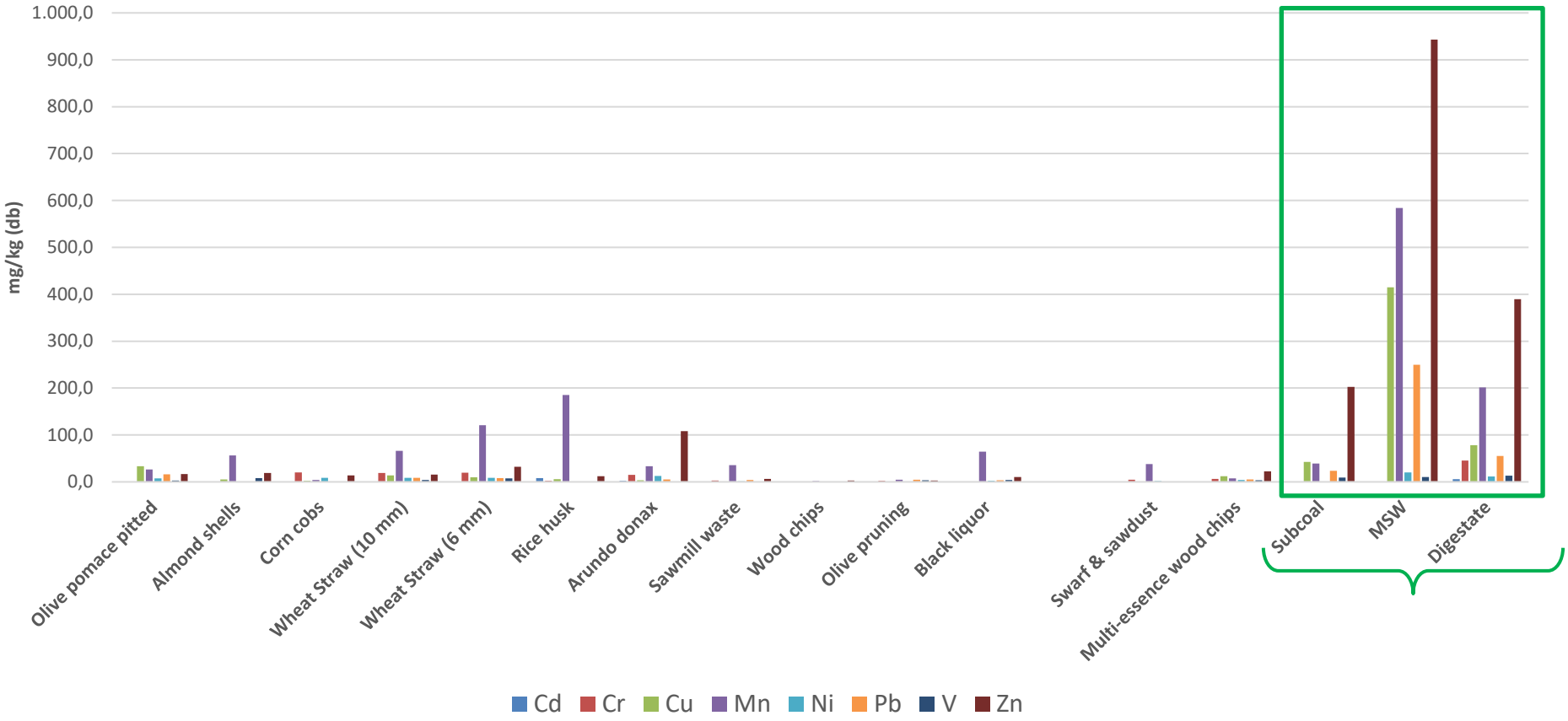
Mainor inorganic elements



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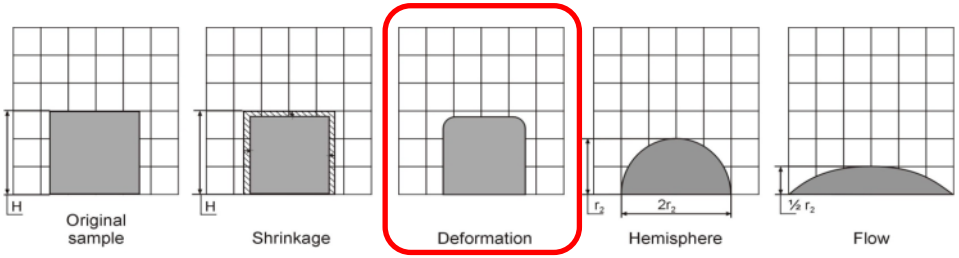
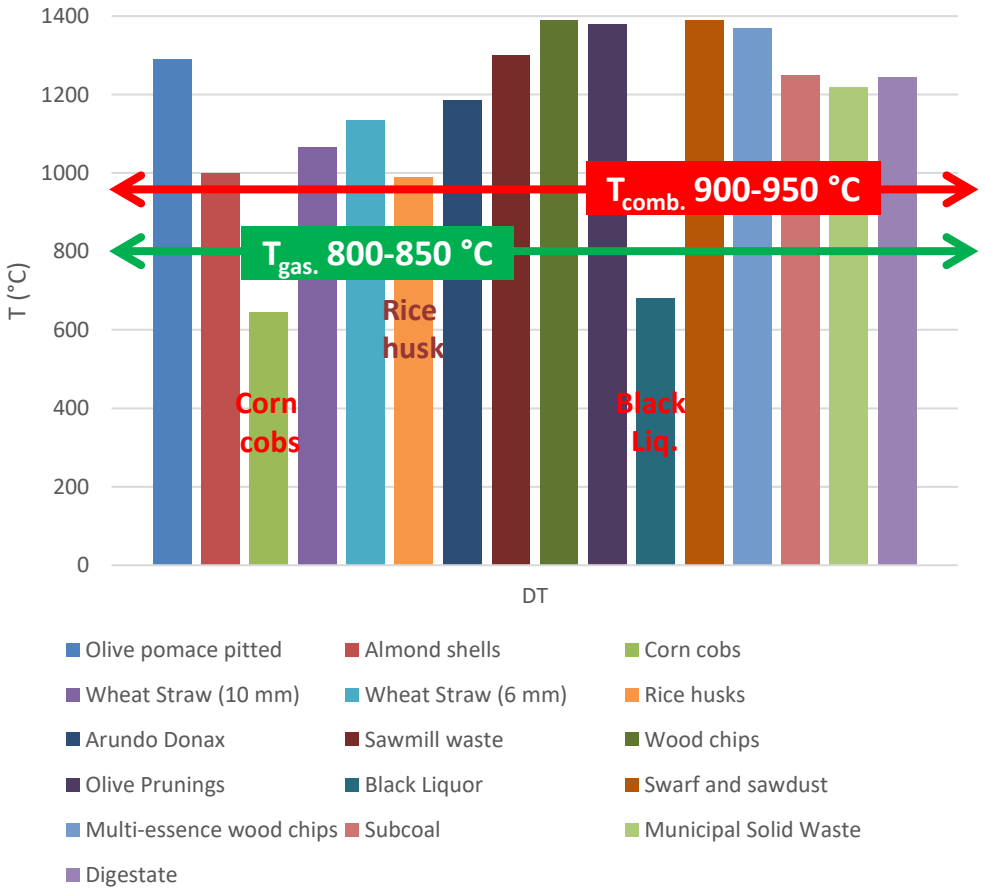
Ash melting behaviour



Feedstock	SST (°C)	DT (°C)	HT (°C)	FT (°C)
Olive pomace pitted	1280	1290	1300	1345
Almond shells	915	1000	1180	1210
Corn cobs	625	645	760	995
Wheat Straw (10 mm)	1030	1065	1195	1315
Wheat Straw (6 mm)	1100	1135	1185	1300
Rice husks	920	990	>1385	>1385
Arundo Donax	1005	1185	1290	>1385
Sawmill waste	1250	1300	>1385	>1385
Wood chips	1110	>1385	>1385	>1385
Olive Prunings	1360	1380	>1385	>1385
Black Liquor	675	680	705	730
Swarf & sawdust	1225	>1385	>1385	>1385
Multi-essence wood chips	1335	1370	>1385	>1385
Subcoal	1240	1250	1254	1300
MSW	1210	1220	1240	1300
Digestate	1020	1245	1260	1300



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Results overview

Feedstock	Category	Humidity (%-wt, ar)	LHV (MJ/kg)	Ash	S	Cl	Ash melting (DT, °C)
Black Liquor	Secondary residues from wood industries	20,6	11,2	48,3	0,74	0,12	680
Corn cobs	Agricultural residues	9	16,6	3,0	0,03	0,44	645
Rice husk	Secondary residues of industry utilising agricultural products	5,2	15,2	14,7	0,02	0,03	990
Almond shells	Secondary residues of industry utilising agricultural products	10	17,7	1,3	< 0,01	< 0,01	1000
Digestate	Digestate from biogas production	71,2	12,7	25,8	0,97	0,1	1245
Municipal solid waste	Municipal waste	23	10,2	47,0	0,2	0,4	1220
Subcoal	Municipal waste	3,2	21,7	15,6	0,1	1,0	1250
Olive pruning	Agricultural residues	10,1	16,3	3,4	0,11	0,29	1185
Wheat Straw (6 mm)	Agricultural residues	7,6	15,4	13,3	0,08	0,21	1135
Wheat Straw (10 mm)	Agricultural residues	7,6	16,0	9,2	0,05	0,12	1065
Olive pomace pitted	Secondary residues of industry utilising agricultural products	36,3	19,8	6,0	0,06	0,08	1290
Arundo donax	Primary residues from forest	11,2	18,9	0,4	< 0,01	< 0,01	1300
Wood chips	Primary residues from forest	8,9	16,7	0,5	< 0,01	< 0,01	>1385
Sawmill waste	Secondary residues from wood industries	14,9	17,8	1,6	< 0,01	< 0,01	1380
Swarf & sawdust	Secondary residues from wood industries	6,6	17,1	0,4	< 0,01	< 0,01	>1385
Multi-essence wood chips	Waste from wood	24,5	17,9	1,5	0,02	< 0,01	1370

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Thank you for your attention

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