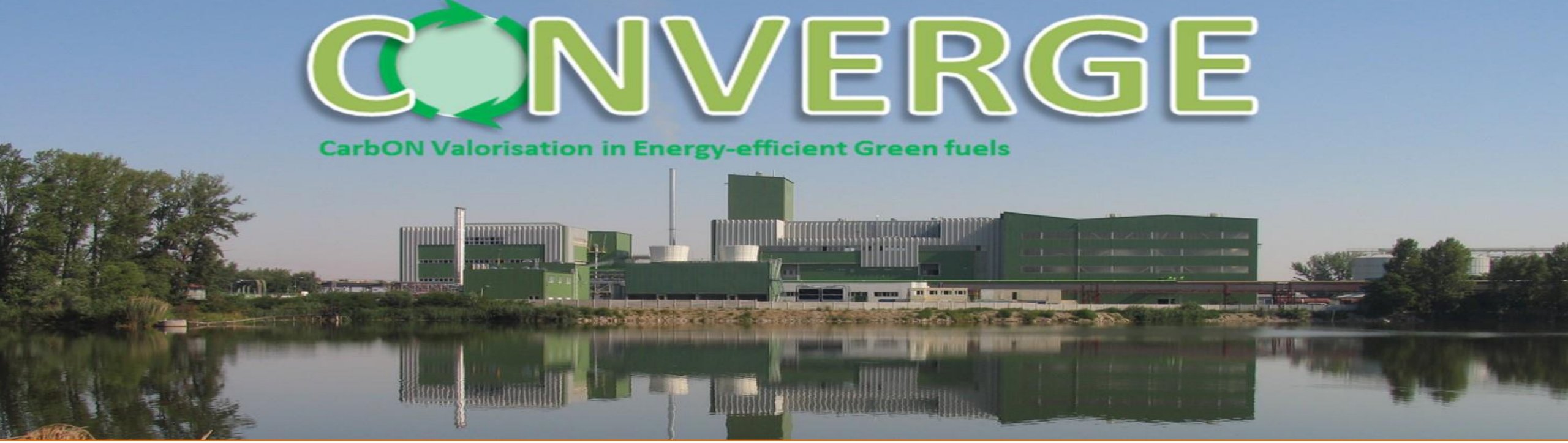

EUROPEAN REGIONS SUITABILITY FOR ADVANCED BIOFUEL PRODUCTION
Case Scenarios for Residual Biomass Supply Chains

Concawe
Environmental Science for European Refining

Concawe STF-3 Group - Meeting
11 January 2021

Dott. Marco Ugolini

CARE FOR
CA.RE. FOR. Engineering
Carbon Reduction & Forestry

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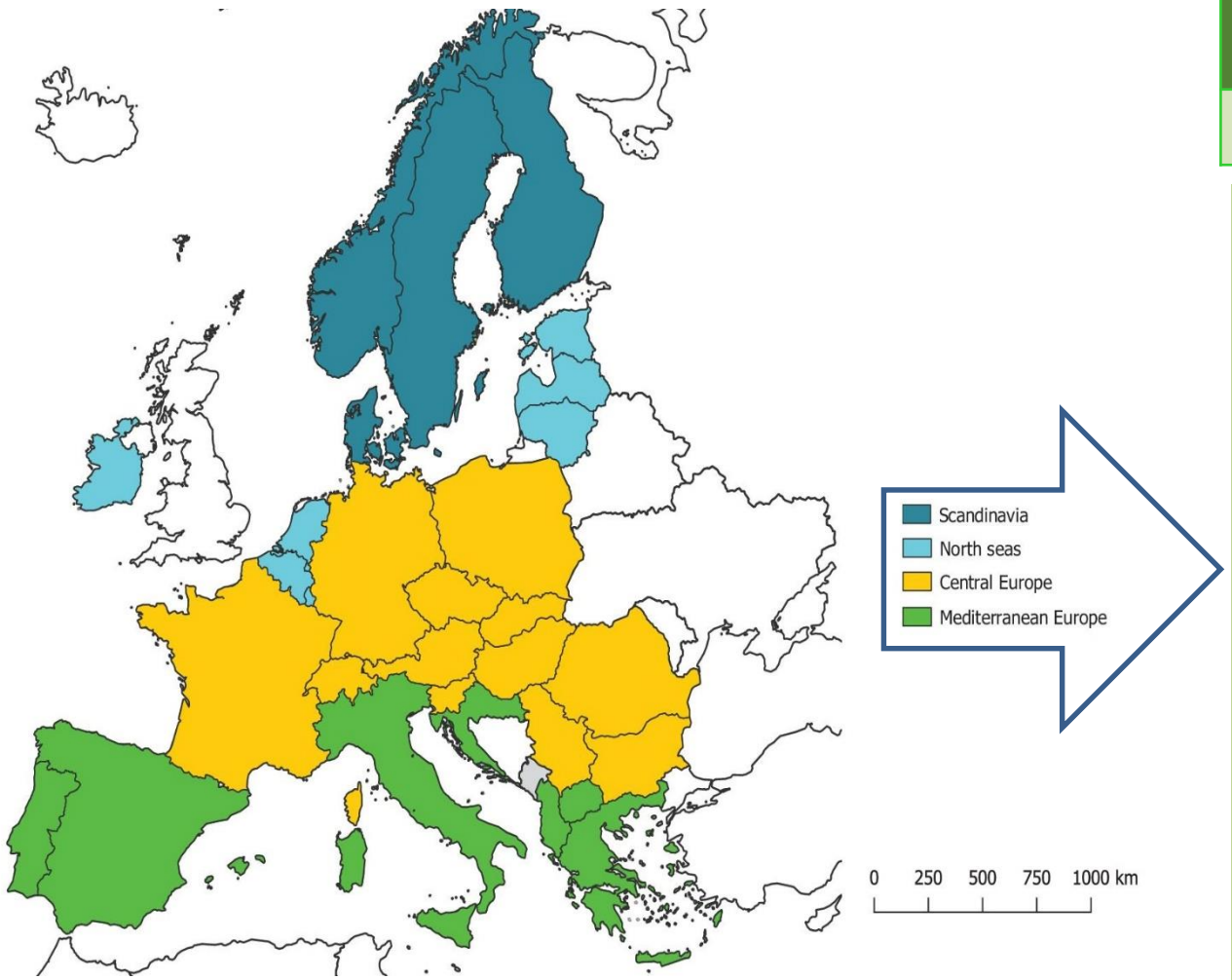
The biomasses in scope

01

Biomasses in scope



Biomass types	Feedstock forms	Biomass supply chains
10	5	16

1. Cereal straw (wheat, spelt, rice, barley, rye, oat)
2. Exhausted grape marc and wine lees
3 Exhausted olive pomace
4 Prunings from tree permanent crops (olive trees, fruit trees, vines, etc.)
5. Residues from forest logging (trunk residues, branch, bark)
6. By-products from primary timber processing (sawmill) and forest-based industries
7. 2G-Lignin
8. Industry beer residues - beer thresher
9. Production of flowers, ornamental plants and nursery plants
10. By-products of the paper and cellulose industry

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4 layers methodology

02

4 layers

I

1st level availability assessment

Bioeconomic potential

II

2nd level availability assessment

Suitability class allocation

III

spatial distribution at NUTS2 level

Biomass supply regional clusters

IV

Multi Criteria Analysis

Most promising supply chains and locations

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Cereals straw case study

03

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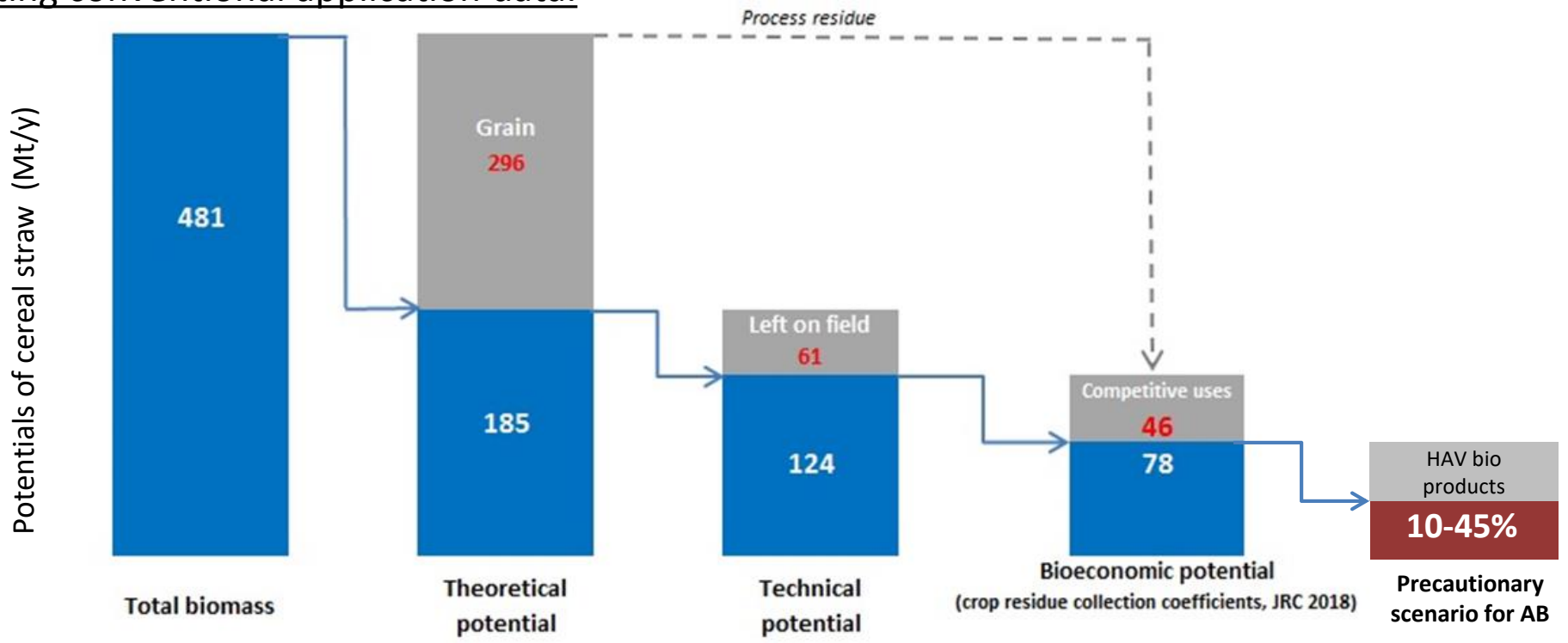
Biomass potential

Biomass potential

THREE DISTINCT LEVELS OF BIOMASS POTENTIAL: theoretical, technical and bioeconomic (according to Vis and van den Berg, 2010 and Thran and Pfeiffer, 2015).

Such approach takes into account the technical accessibility of the biomass, the ecological share of residues to leave in the field and competing conventional application data.



$$TrP = H\text{-}PP \qquad TchP = TrP\text{-}R \qquad BeP = TchP\text{-}Ca \qquad Ps = BeP * Rf$$

Source: Thorenz, 2018, modified

Biomass availability assessmant

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CEREALS STRAW

	Country	Theoretical potential	Technical potential	Bioeconomic potential JRC	Precautional scenario (45%)	Precautional scenario (10%)
CENTRAL EUROPE	France	39.833,85	26.688,68	16.730,22	7.528,60	1.673,02
	Germany	27.794,80	18.622,51	11.673,81	5.253,22	1.167,38
	Poland	17.873,15	11.975,01	7.506,72	3.378,03	750,67
	Romania	15.592,16	10.446,74	6.548,71	2.946,92	654,87
	Hungary	9.308,02	6.236,37	3.909,37	1.759,22	390,94
	Bulgaria	5.862,80	3.928,08	2.462,38	1.108,07	246,24
	Serbia	5.437,14	3.642,88	2.283,60	1.027,62	228,36
	Czechia	4.876,19	3.267,05	2.048,00	921,60	204,80
	Austria	3.145,51	2.107,49	1.321,11	594,50	132,11
	Slovakia	2.532,56	1.696,81	1.063,67	478,65	106,37
	Bosnia and Herz.	901,47	603,98	378,62	170,38	37,86
	Switzerland	549,53	368,19	230,80	103,86	23,08
	Slovenia	375,90	251,85	157,88	71,05	15,79
MEDITERRANEAN EUROPE	Spain	13.794,66	9.242,42	5.793,76	2.607,19	579,38
	Italy	10.652,26	7.137,02	4.473,95	2.013,28	447,40
	Greece	2.129,84	1.426,99	894,53	402,54	89,45
	Croatia	1.905,32	1.276,56	800,23	360,11	80,02
	Portugal	726,38	486,68	305,08	137,29	30,51
	Albania	435,59	291,85	182,95	82,33	18,29
	North Macedonia	339,18	227,25	142,45	64,10	14,25
SCANDINAVIA	Denmark	5.584,18	3.741,40	2.345,35	1.055,41	234,54
	Sweden	3.260,59	2.184,60	1.369,45	616,25	136,94
	Finland	2.120,25	1.420,57	890,51	400,73	89,05
	Norway	803,85	538,58	337,62	151,93	33,76
NORTH SEAS	Lithuania	3.168,68	2.123,02	1.330,85	598,88	133,08
	Latvia	1.636,64	1.096,55	687,39	309,33	68,74
	Belgium	1.630,59	1.092,49	684,85	308,18	68,48
	Ireland	1.363,55	913,58	572,69	257,71	57,27
	Netherlands	884,26	592,45	371,39	167,12	37,14
	Estonia	734,55	492,15	308,51	138,83	30,85
	Luxembourg	97,73	65,48	41,05	18,47	4,10
	TOTAL	185.351,18	124.185,29	77.847,49	35.031,37	7.784,75

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Suitability analysis

SUITABILITY CATEGORIES

Cross check plant feedstock requirements/biomass potential, allows to identify four different **categories of suitability**, as evaluation criteria for a region or a country.

4 CATEGORIES
express the **performances of the biomass potential** in a given region
for scaling up the Converge technology at commercial size.

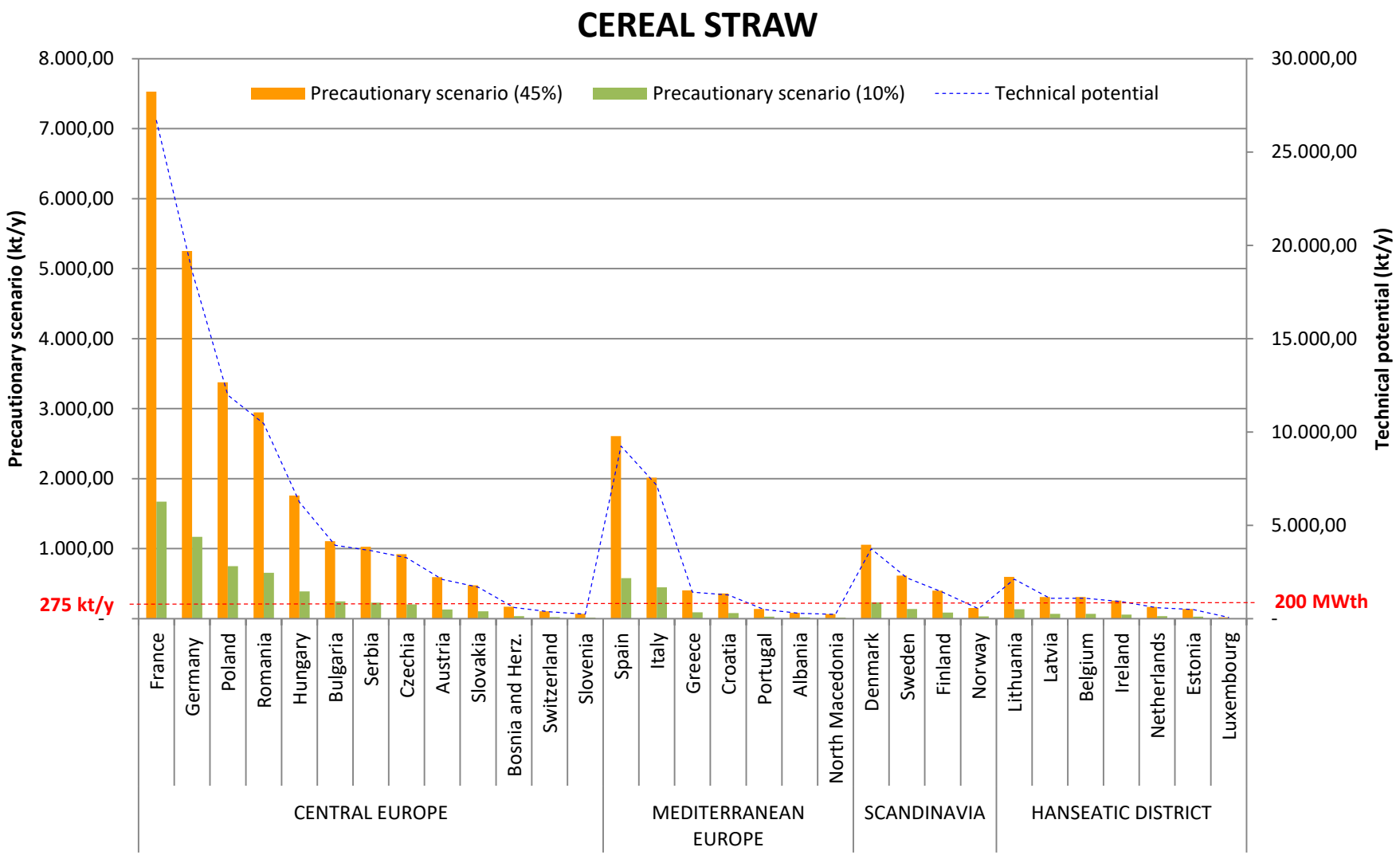
Suitability classification of regions or country

CATEGORY	PLANT CAPACITY	Description
NO OPERATIONAL LIMIT	OVER 200 MWth MONO-FEEDSTOCK SC	Bioeconomic potential of the biomass allows monofeedstock supply chain and plant capacity over 200MW_{th}
OPERATIONAL LIMIT	UP TO 200 MWth OR 100 MWth MONO-FEEDSTOCK SC	Bioeconomic potential of the biomass allows only plant capacities up to 100 or 200 MW_{th} feeded by mono-feedstock supply chain; (if over, two different feedstock are required as maximum)
OPERATIONAL RISK	LESS THEN 100 MWth MULTI-FEEDSTOCK SC	Bioeconomic potential of the biomass NOT allows mono-feedstock supply chain for plant up to 100 MW_{th} ; (if over, more than 2 different kinds of biomass have to be combined in a multi-feedstock supply chain)
NO SUITABILITY	NO SUITABILITY FOR ANY PLANT CAPACITY	There is a not solvable scarcity of bioeconomic potential of the biomass

Second level biomass availability assessmant

PLANT FEEDSTOCK REQUIREMENTS

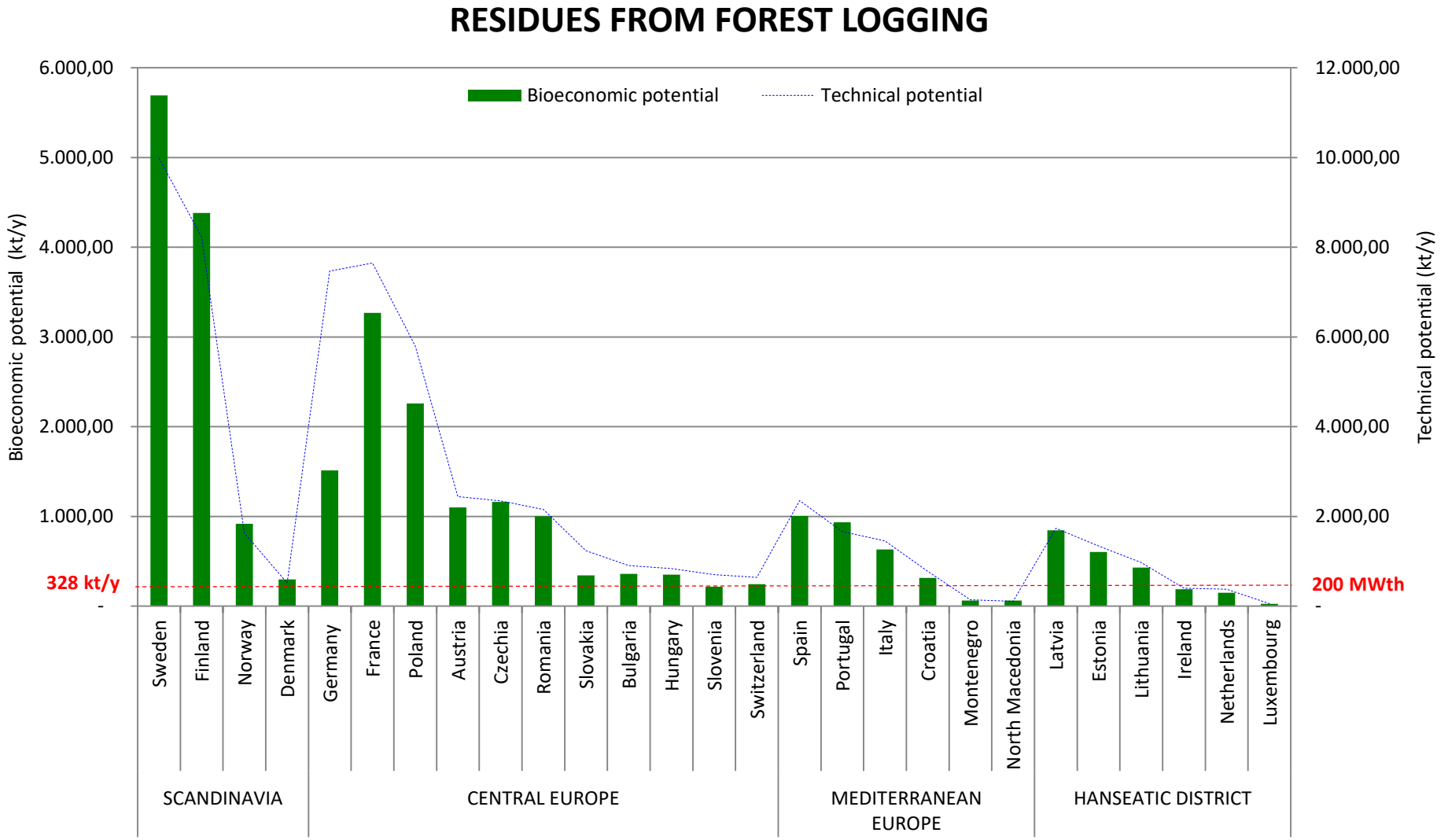
100 MW	200 MW
138 kt/y	275 kt/y



Second level biomass availability assessmant

PLANT FEEDSTOCK REQUIREMENTS

100 MW	200 MW
164 kt/y	328 kt/y



Second level biomass availability assessmant

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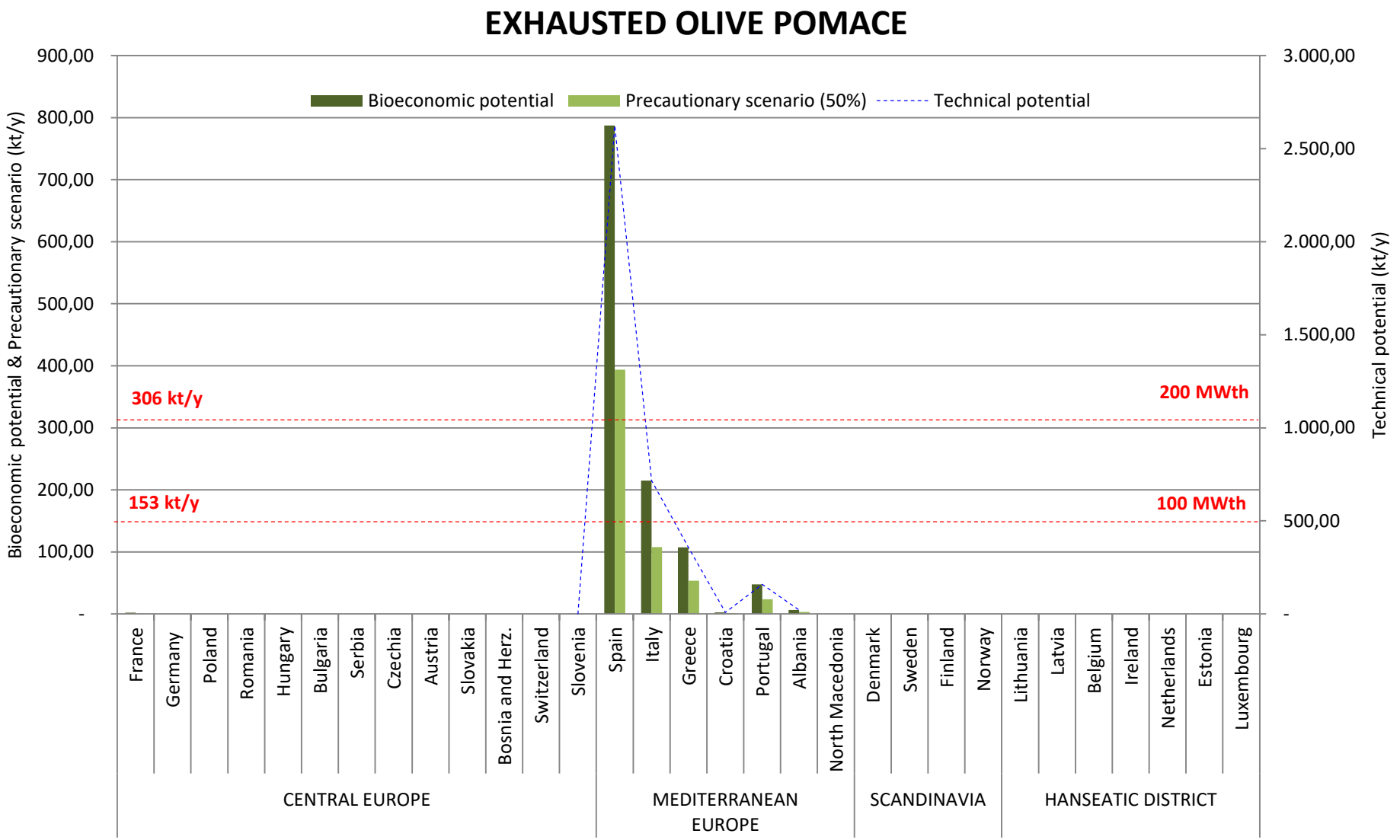
PLANT FEEDSTOCK REQUIREMENTS

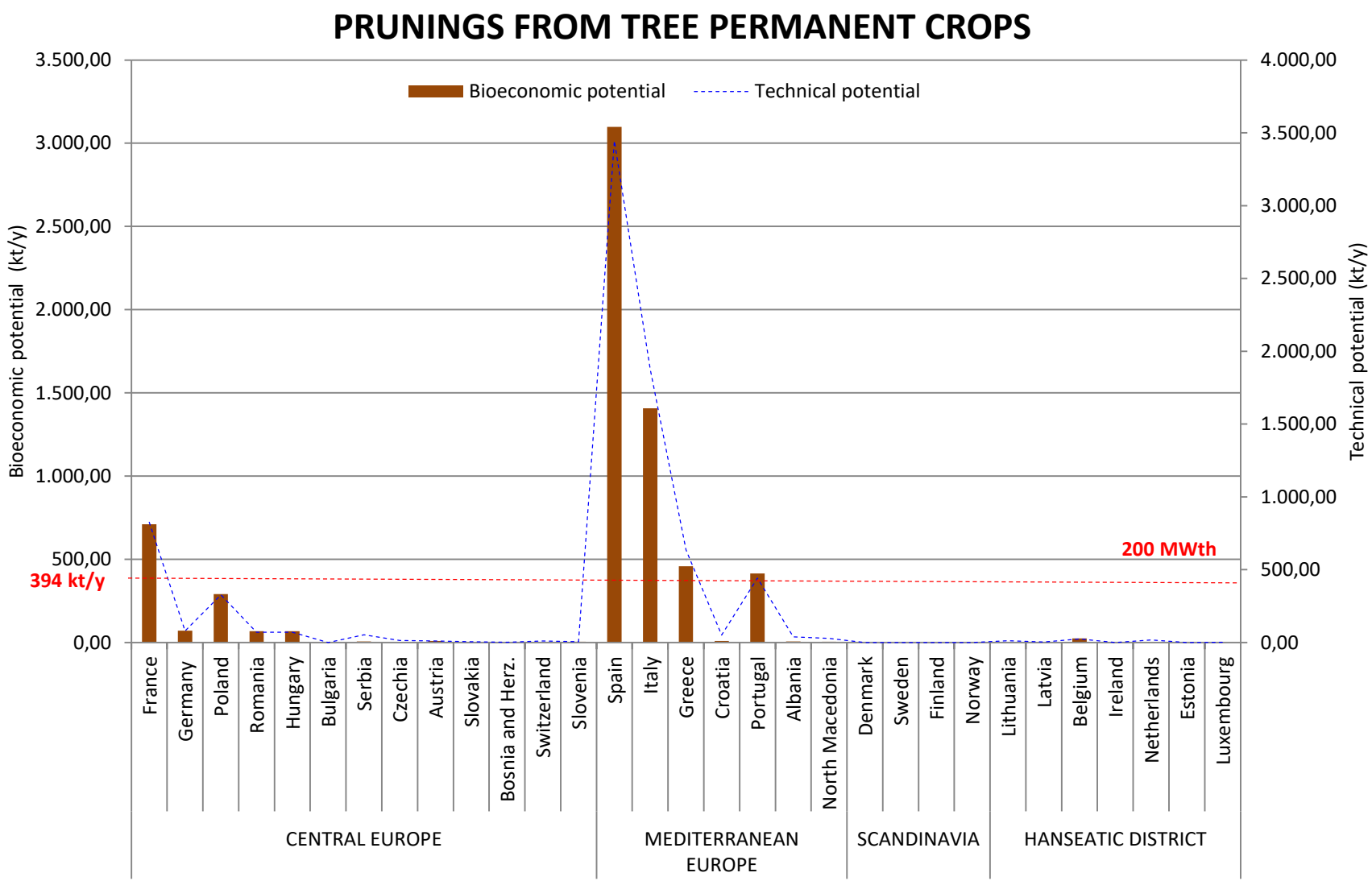
100 MW	200 MW
153 kt/y	306 kt/y



Second level biomass availability assessmant

PLANT FEEDSTOCK REQUIREMENTS

100 MW	200 MW
197 kt/y	394 kt/y



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Data spatial distribution

Biomass spatial distribution at NUTS2 level

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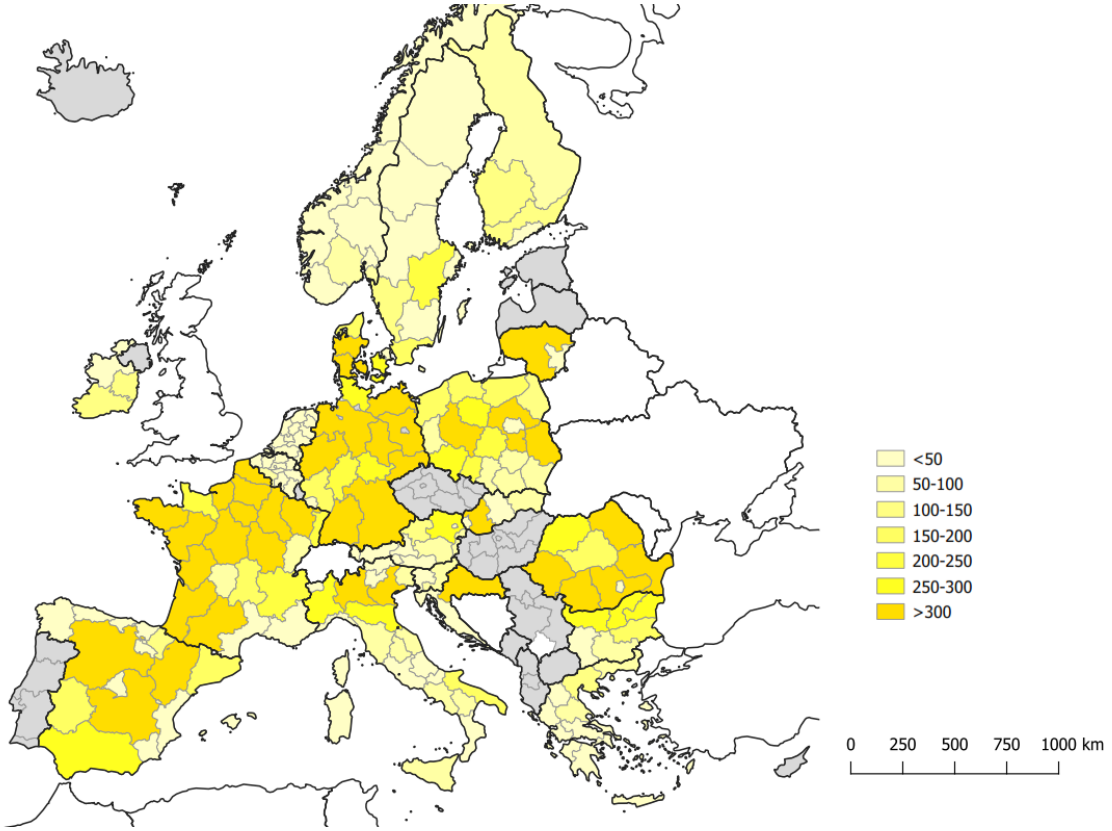
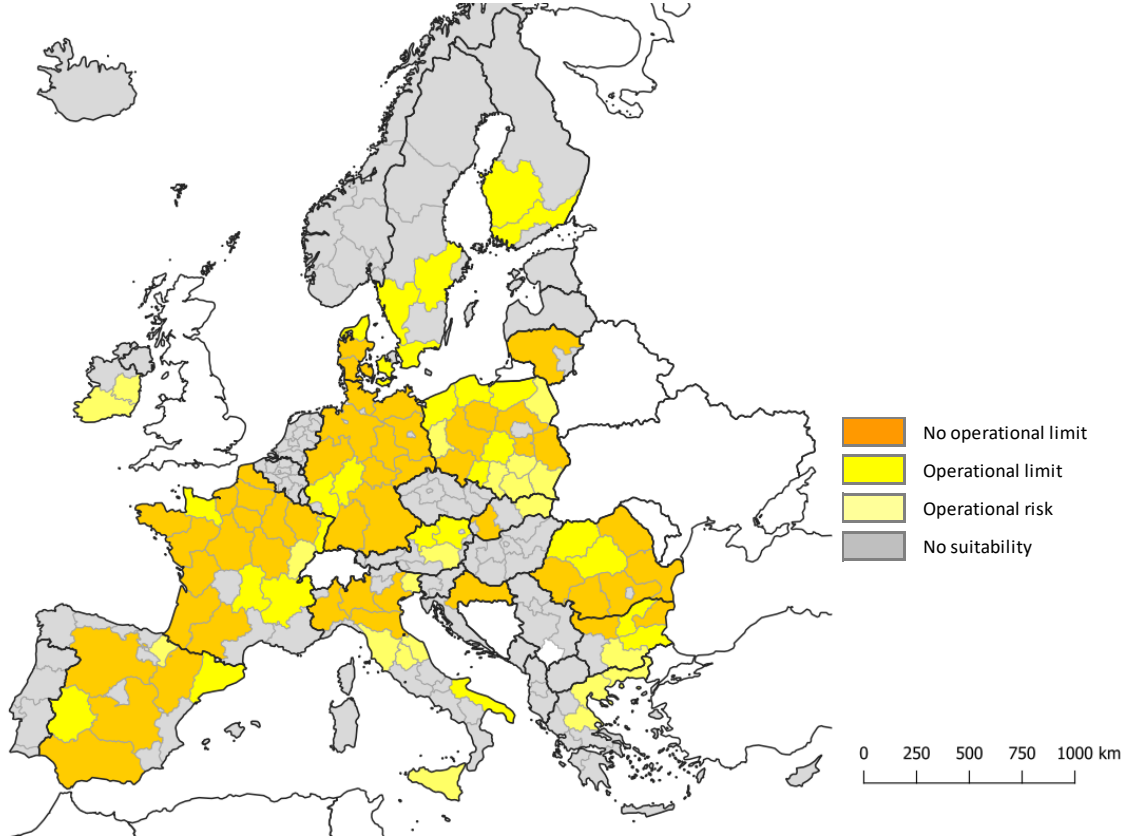
CEREALS STRAW



Biomass availability distribution



Suitability class allocation

Biomass spatial distribution at NUTS2 level

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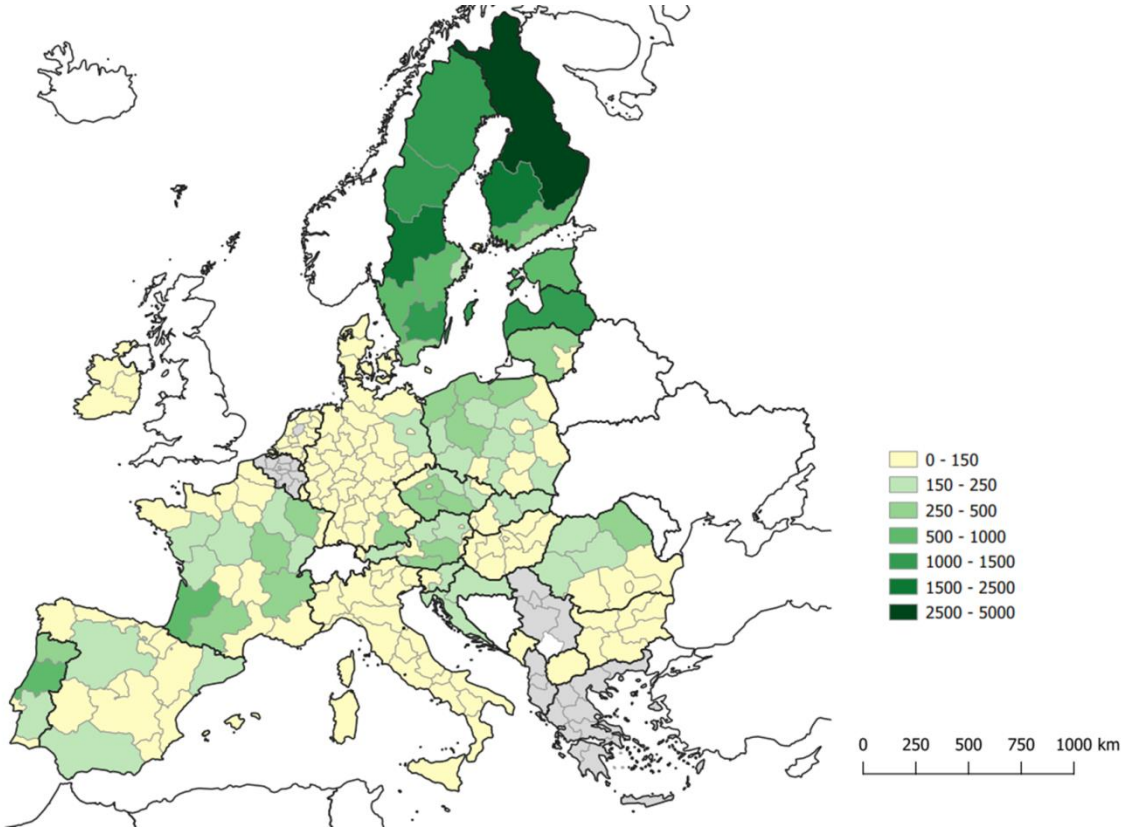
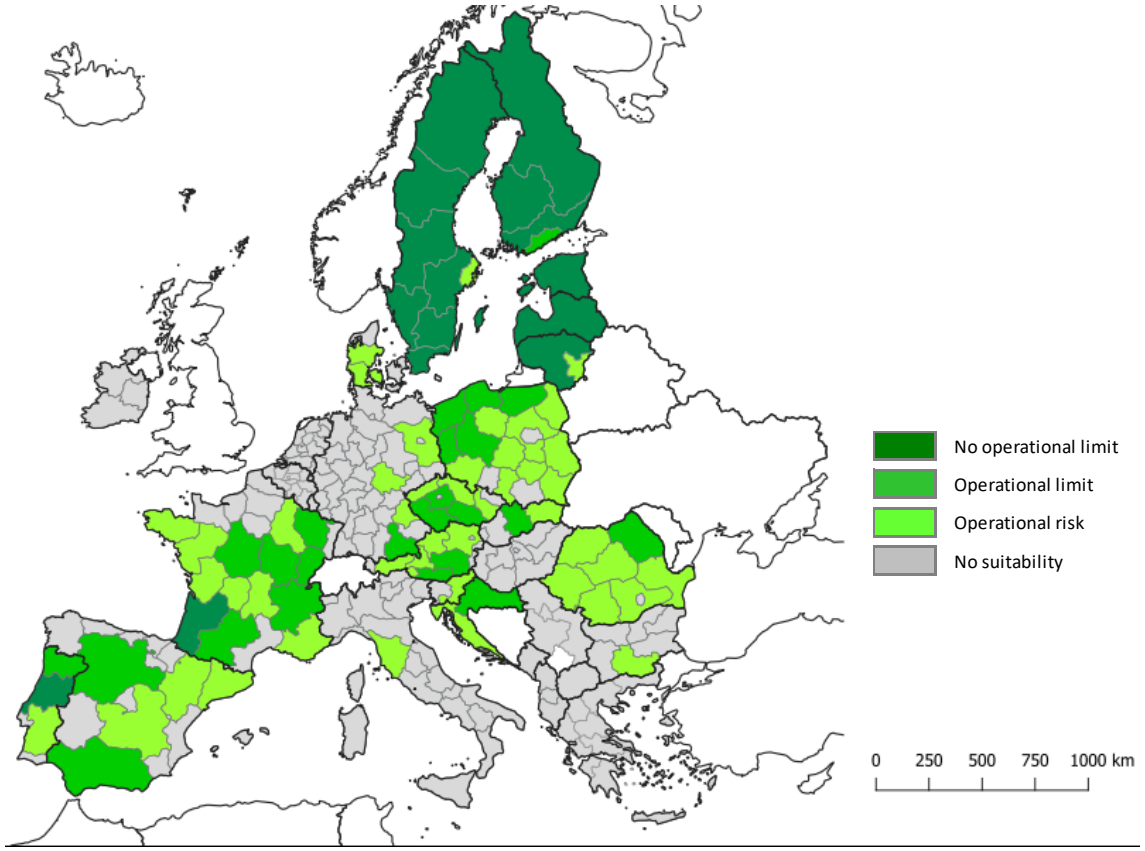
RESIDUES FROM PRODUCTION FORESTS



Biomass availability distribution



Suitability class allocation

Biomass spatial distribution at NUTS2 level

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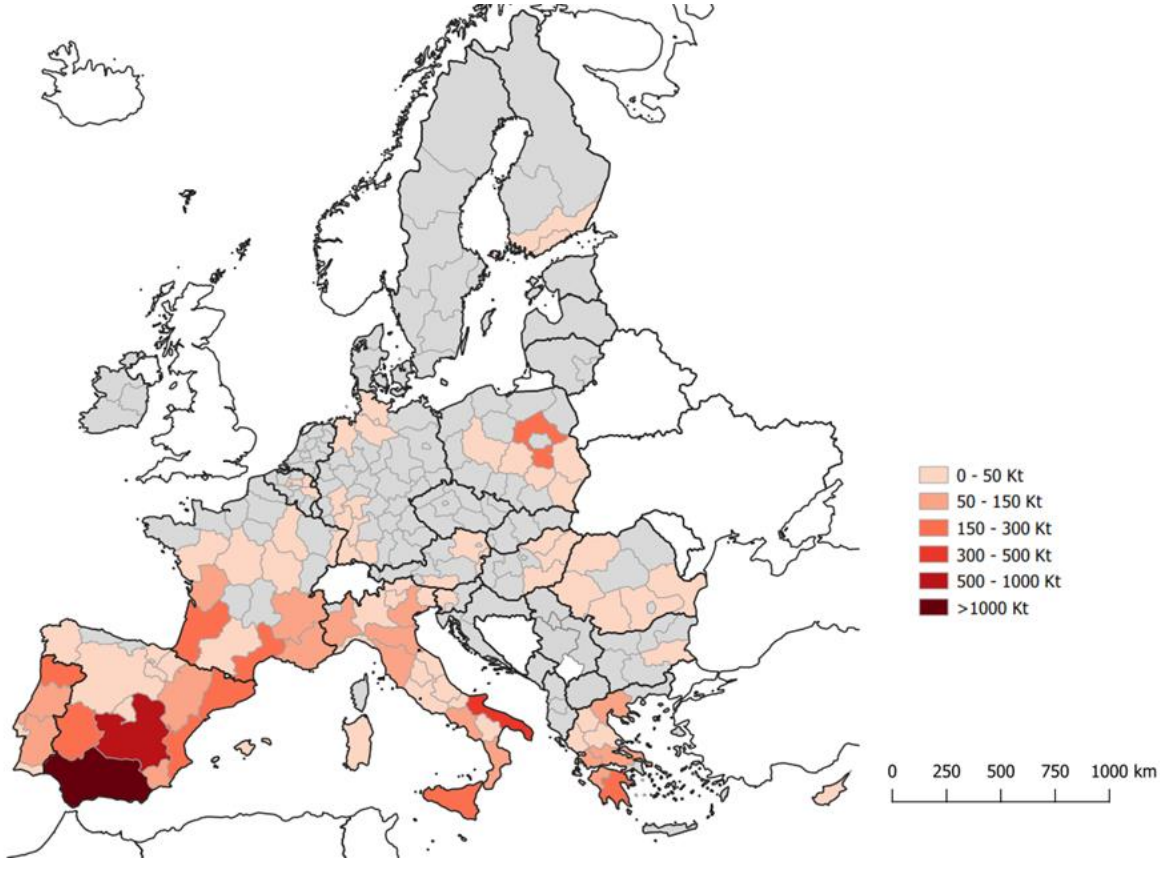
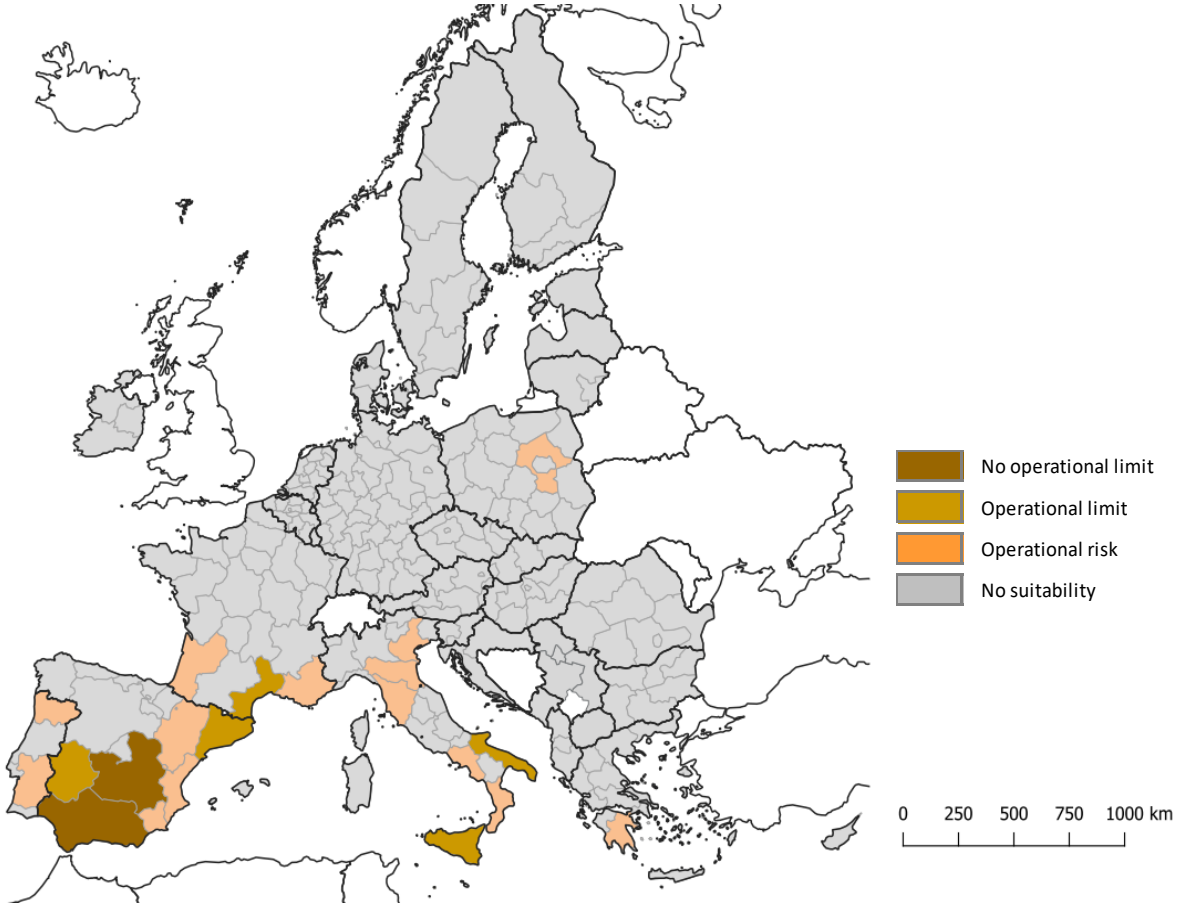
PRUNINGS FROM TREE CROPS



Biomass availability distribution



Suitability class allocation

Biomass spatial distribution at NUTS2 level

CONVERGE
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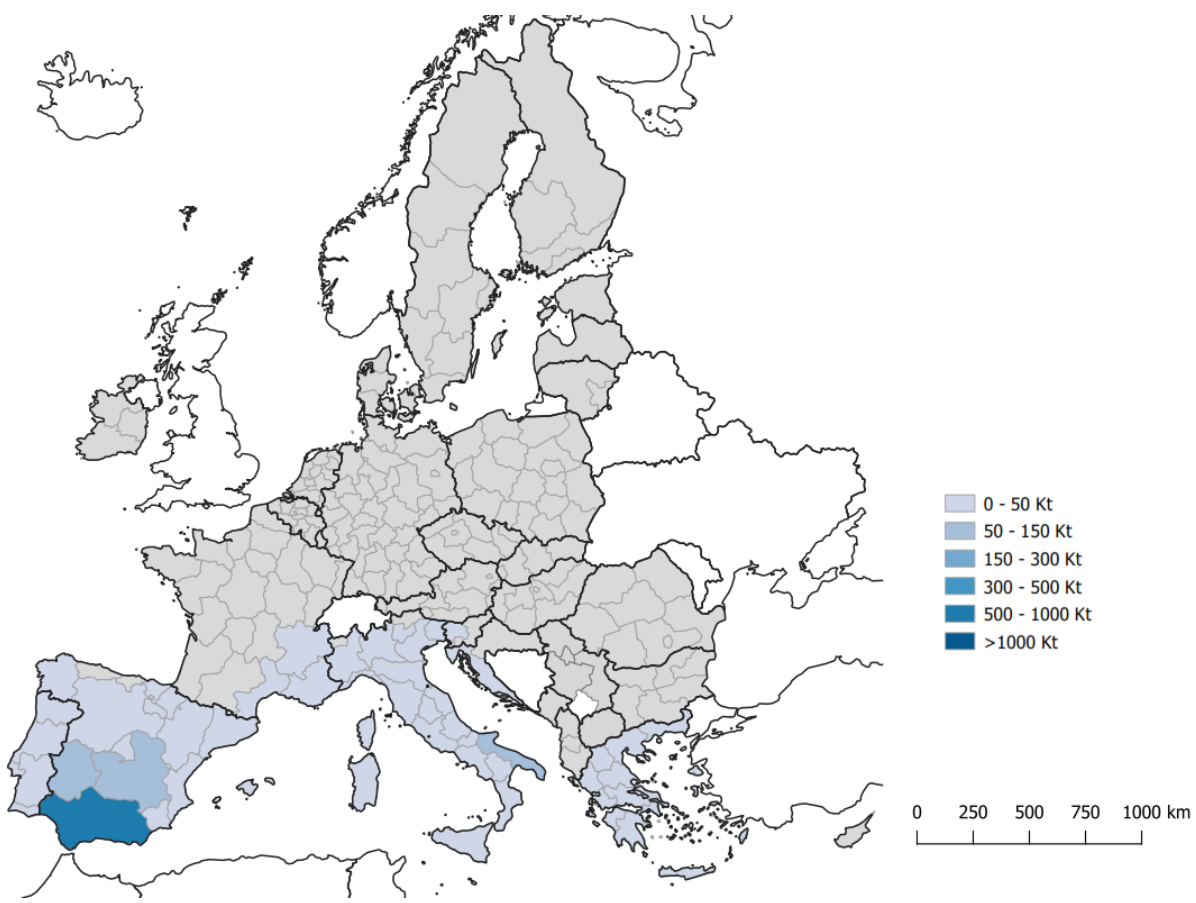
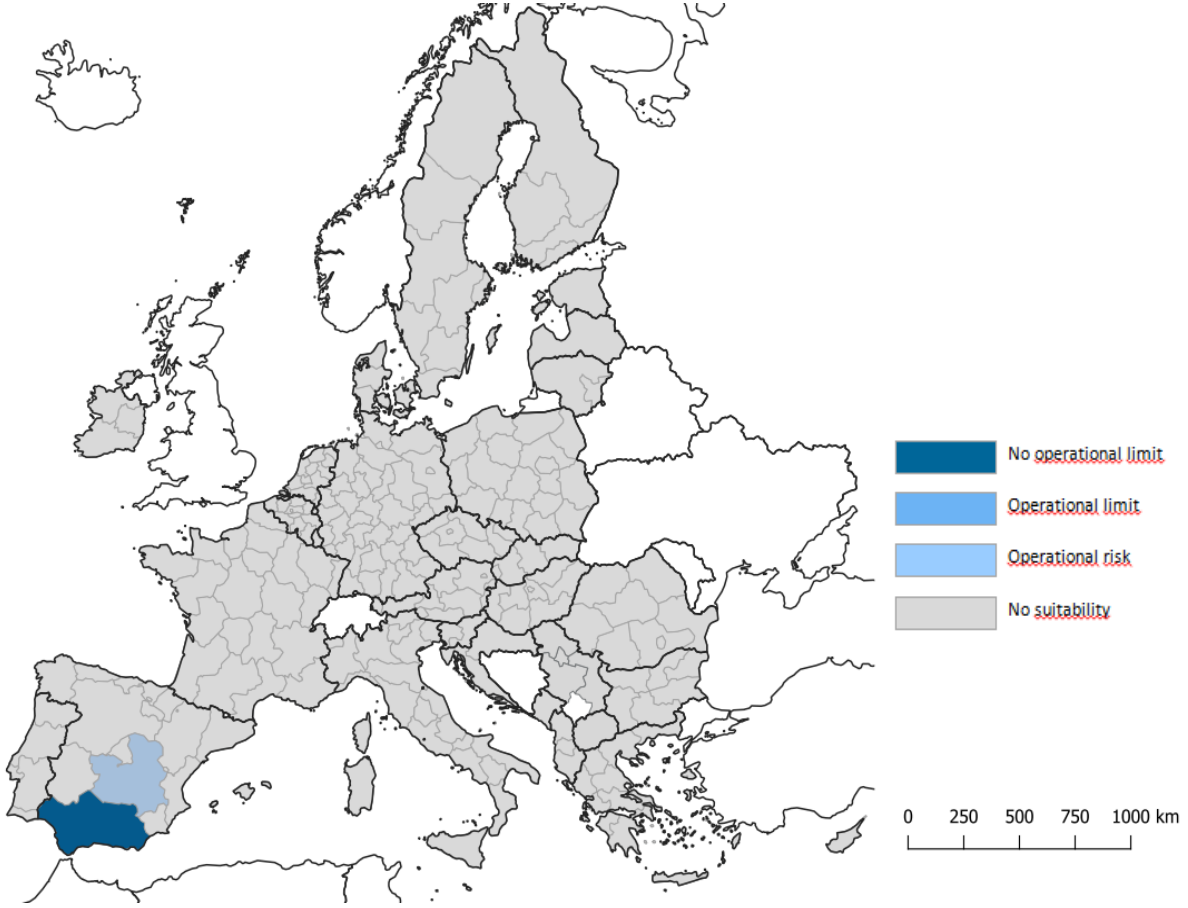
EXHAUSTED OLIVE POMACE



Biomass availability distribution



Suitability class allocation

BIOMASS SUPPLY REGIONAL CLUSTERS

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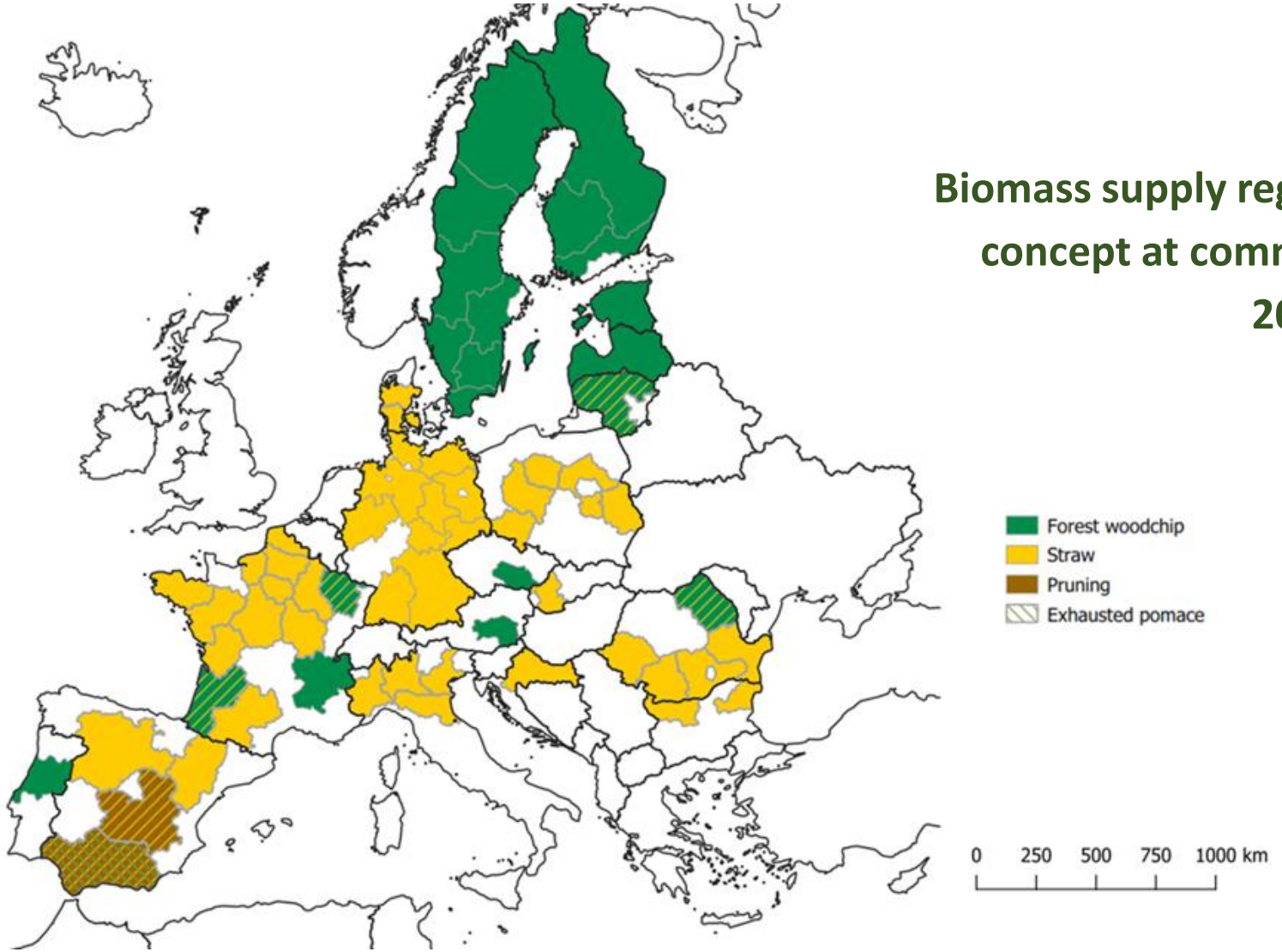

Biomass supply regional clusters suitable for CONVERGE concept at commercial scale for a capacity plant of 200MW$_{th}$ and beyond.

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IV

Multi-criteria analysis

MCA Multicriteria analysis results: best scenarios for CONVERGE concept

The MCA has been implemented for each typology of supply chain considering the following steps:

1. decision criteria identification (12);
2. criteria weights definition;
3 MCA results interpretation.

Selection of the most promising biomass supply chains for further studying in depth:
- LCA
- BUSINESS CASES

District	Biomass supply chains	MCA Scores	
		Total score	Weighted score
Scandinavia	**Residues from forest logging**	**28**	**15,40**
	Cereal Straw	26	13,40
	2G-Lignin	28	12,80
Central EU	**Cereal Straw**	**29**	**15,70**
	Residues from forest logging	24	11,90
	Tree Prunings	24	12,20
Hanseatic	**Cereal Straw**	**25**	**12,50**
	Residues from forest logging	24	11,50
	Multifeedstock (cereal straw, wood chips, broweries spent grain)	18	9,00
Mediterranean EU	**Exhausted olive pomace**	**30**	**14,70**
	Cereal straw	**28**	**15,00**
	Tree Prunings	21	11,60
	Residues from forest logging	21	10,60
	Multifeedstock (e. olive pomace, e. grape marc, prunings)	18	9,40

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Results

04

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Biomass supply chain regional clusters in the category «no operational limit [1]»

District	Biomass supply chain	Country	Regions	Cluster	BeP	
		N	N	N	kt/y	TJ/y
Scandinavia	Residues from forest logging	2	10	2	9.695	116.441
	Cereal straw	1	2	1	639	9.136
	2G-Lignin [2]	1	2	1	303	4.027
Hanseatic	Residues from forest logging	3	3	3	1.786	21.449
	Cereal straw	1	1	1	556	7.948
Central EU	Residues from forest logging	1	1	1	722	8.676
	Cereal straw	6	36	12	16.249	232.359
Mediterranean	Residues from forest logging	1	1	1	551	6.613
	Cereal straw	3	9	4	3.541	50.630
	Tree crops prunings	2	3	2	2.395	23.950
	Exhausted olive pomace	1	1	1	507	6.520

1- NO OPERATIONAL LIMITS =Bioeconomic potential of the biomass allows supply chain monofeedstock and plant power > 200MW_{th}
2 - scenario at 2024

Case scenarios of the most promising biomass supply chains in the four EU districts.

Biomass supply chain regional cluster.
BEP (bioeconomic potential) concerns the total amount of the biomass in the category “no operational limit”.

N. of regions: 69
N. of clusters: 27

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Conclusions

06

CONCLUSIONS

1. **Scandinavia** and **Central Europe** have regions with the **highest bioeconomic potentials** (productive forest residues and cereal straw respectively) which allow mono-feedstock supply chains and higher capacity of the Converge technology than in Mediterranean and North Seas districts.
2. The **Mediterranean and Hanseatic regions** should rely more on **not-feedstock-specific conversion plants**, feedstock imports, or **switching feedstock use from heat/power to biofuel applications** even if for multi-feedstock supply chains complexity in terms of storage and transport and the pre-treatment necessity imply **low level of logistic, economic and enviromental optimisation.**
3 Given the continuously increasing consumption of wood feedstock for energy production **non-forestry ligno-cellulosic materials**, as **straws and exhausted olive pomace**, could be properly used to satisfy the demand for biomass, respectively in Central EU and Mediterranean districts.
4 Assumed the strong competition from today up to 2030, **the industrial plant should be focused to small and medium scale and not-feedstock specific**: distributed production, small selected production sites vs big centralized.

Acknowledgments

Get in touch with us

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