RE SOURCE LAB

PRODUCTION & SUPPLY CHAIN MANAGEMENT

Universität Augsburg University

Rehap

Agroforestry residues potentials for the European Bioeconomy

Moving towards a competitive European Bioeconomy: Emerging biorefinery technologies & pathways to deployment

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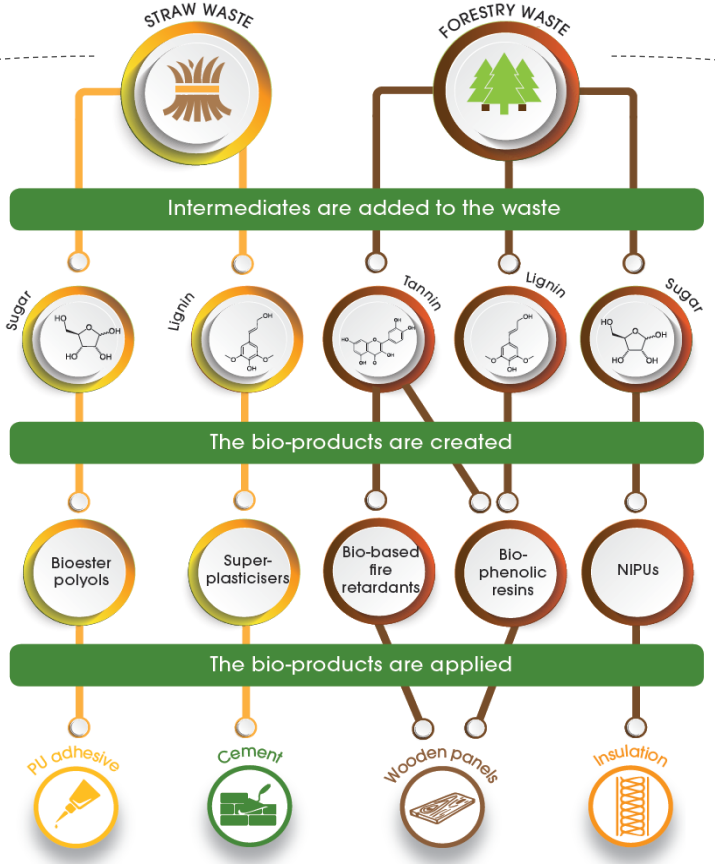
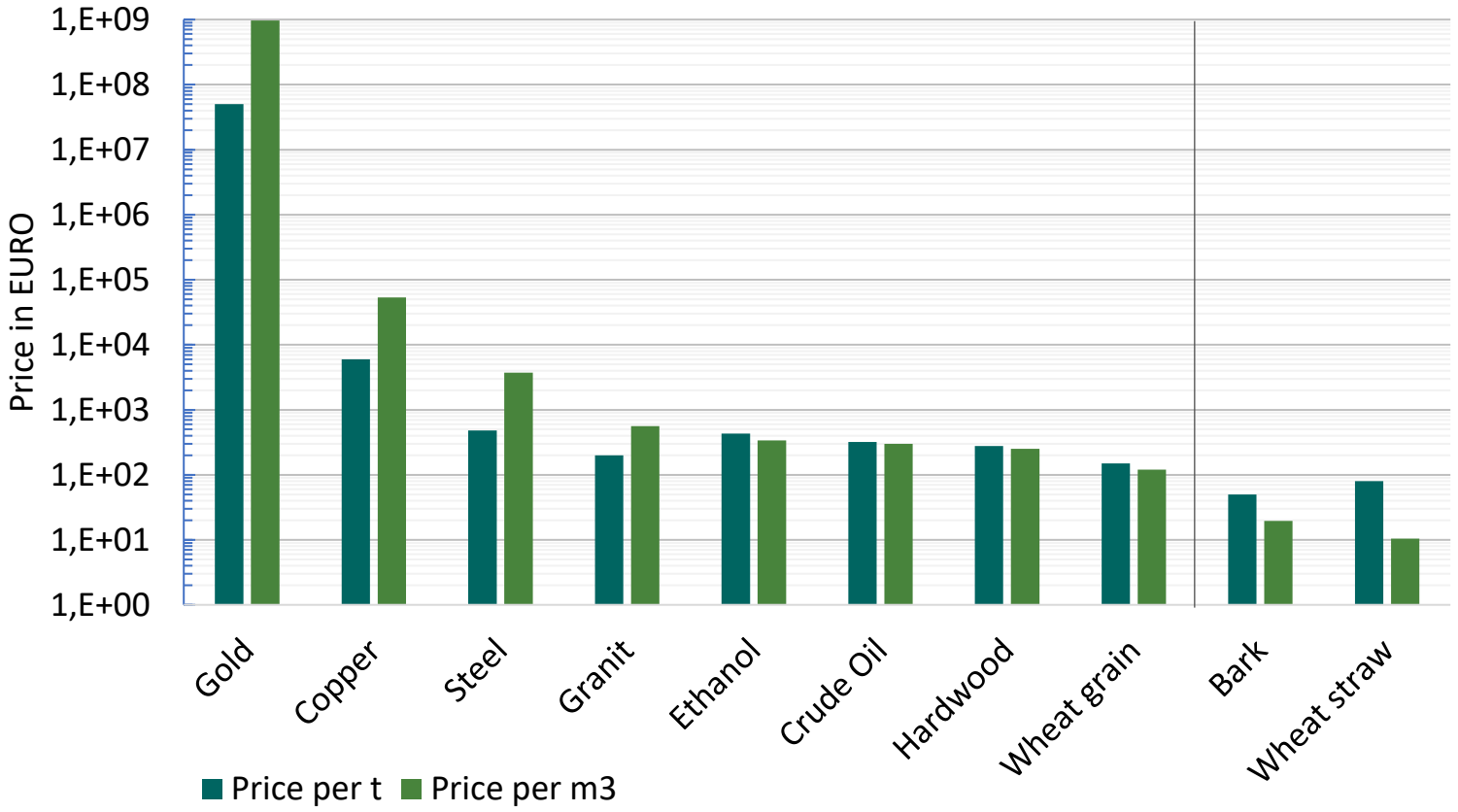
HORIZON 2020

Motivation

„The free energy to which man can have access comes from two distinct sources. The first source is a stock, the stock of free energy of the mineral deposits in the bowels of the earth. The second source is a ***flow****, the* ***flow of solar radiation*** *intercepted by the earth.“* Georgescu Roegen



Motivation



- **Low density** and **economic value** of **lignocellulose** renders feedstock logistics challenging
- Disproportionately **increasing feedstock transportation cost** for large biorefineries
- **Privileged demand** for lignocellulose residues

→ Need for explicit consideration of regionality of feedstock supply in bioeconomic value chains

Assessment of agroforestry residue potentials for the bioeconomy in the European Union

J. of Cleaner Production ***2018***

Which are the most abundant **lignocellulose residues** in the EU?

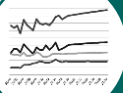
Where are the lignocellulose residues regionally distributed

Spatially explicit forecast of feedstock potentials for second generation bioconversion industry from the EU agricultural sector until the year 2030

J. of Cleaner Production ***2019***

$y_i = ß_0 + ß_1 x_{i1}..$

What are the underlying variables determining the future development of agricultural harvesting residues?



How will the theoretical, technical, and bioeconomic potential of agricultural residues develop in the EU28 until 2030?

Environmental benefits of large-scale second-generation bioethanol production in the EU: An integrated supply chain network optimization and Life Cycle Assessment approach

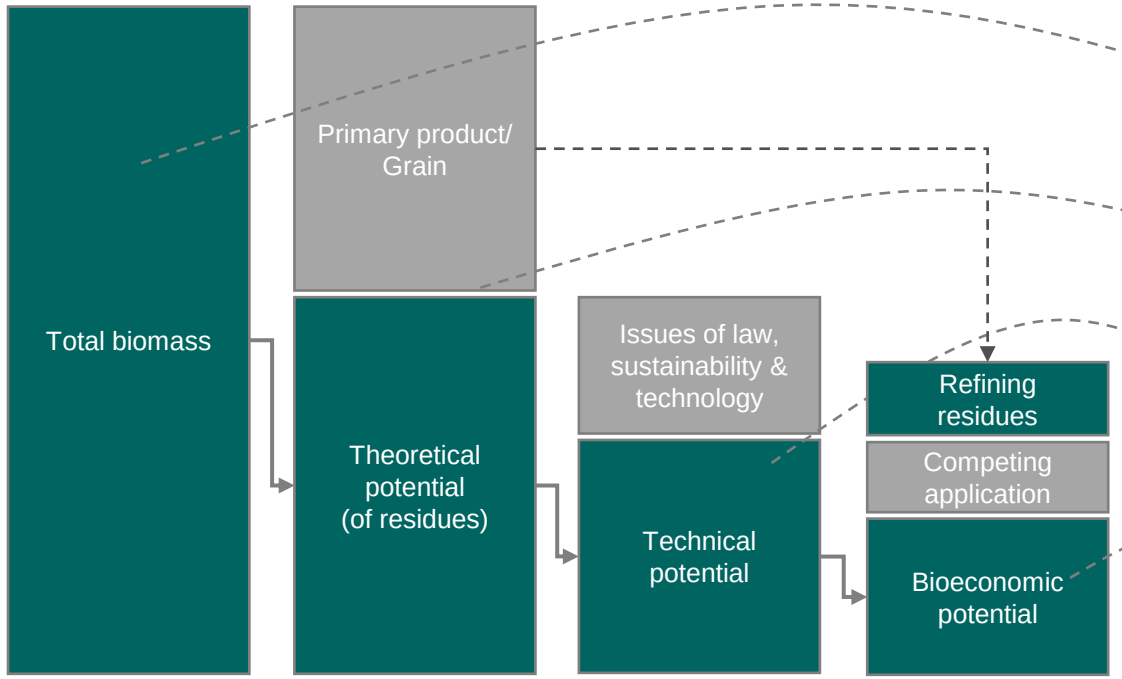
J. of Ind. Ecology ***2020***

What is the optimal supply chain network design under economic and environmental objective functions.

Which environmental objectives are congruent, and which are conflicting in bioeconomic value chains

German Federal Government, 2012

Assessment of agroforestry residue potentials



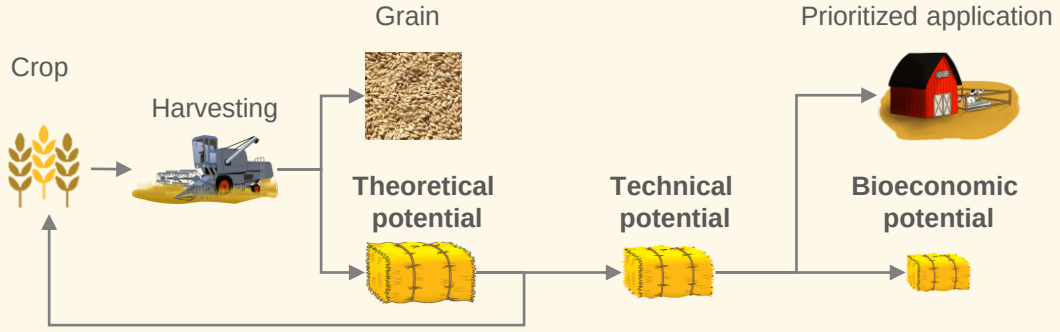
Total biomass = whole plant

Theoretical potential = total residues

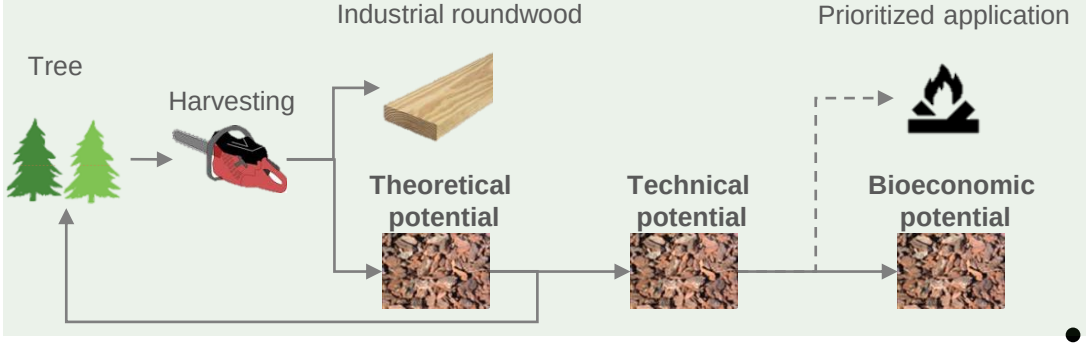
Technical potential = theoretical potential – issues of law, sustainability & technological limitations

Bioeconomic potential = technical potential - competing application

Agricultural sector



Forestry sector



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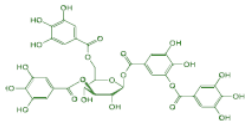
Assessment of agroforestry residue potentials

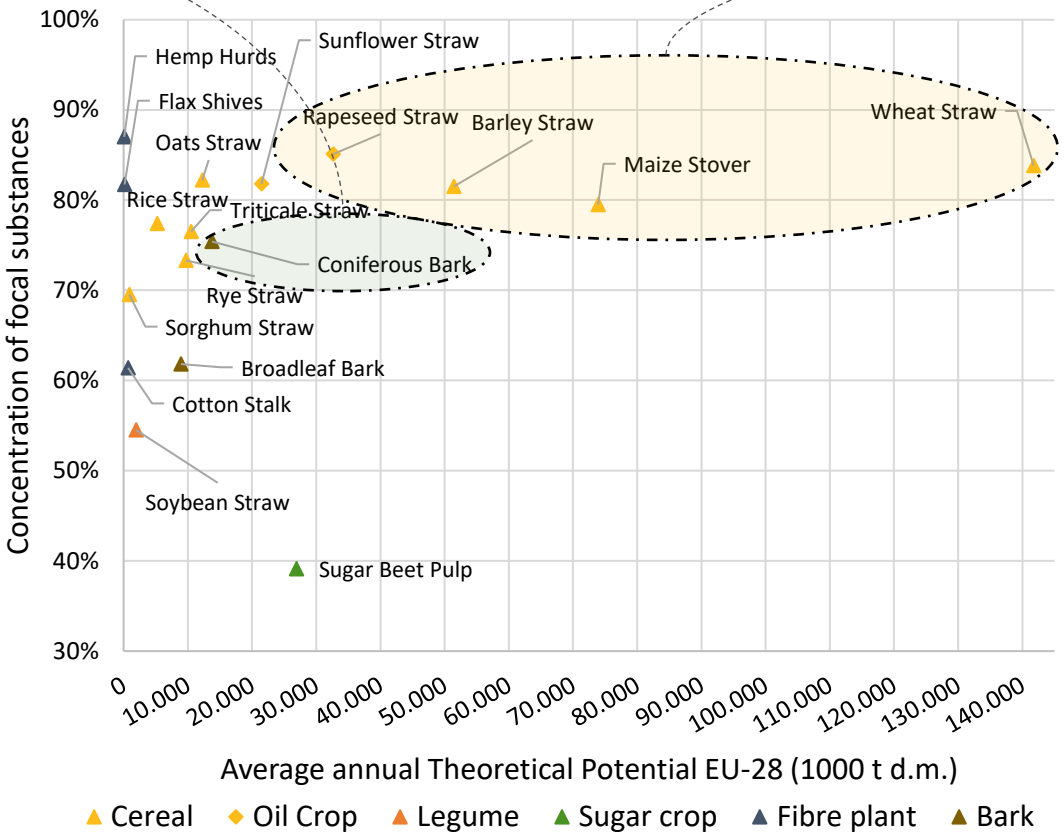
Forestry

Spruce and **pine bark** with appr. **15 Mt** bioeconomic potential

Cellulose	~ 25 %
Hemicellulose	~ 10 %
Lignin	~ 30 %
Tannin	8 – 12 %



Additionally a considerable amount of extractable **tannin**

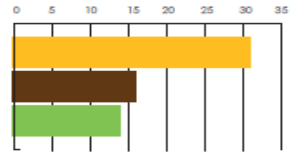


Agriculture

Approx. **110 Mt** of bioeconomic straw potential

Cellulose	~ 35%
Hemicellulose	~ 30 %
Lignin	~ 15 %

Wheat straw is the most promising source at **46 Mt**

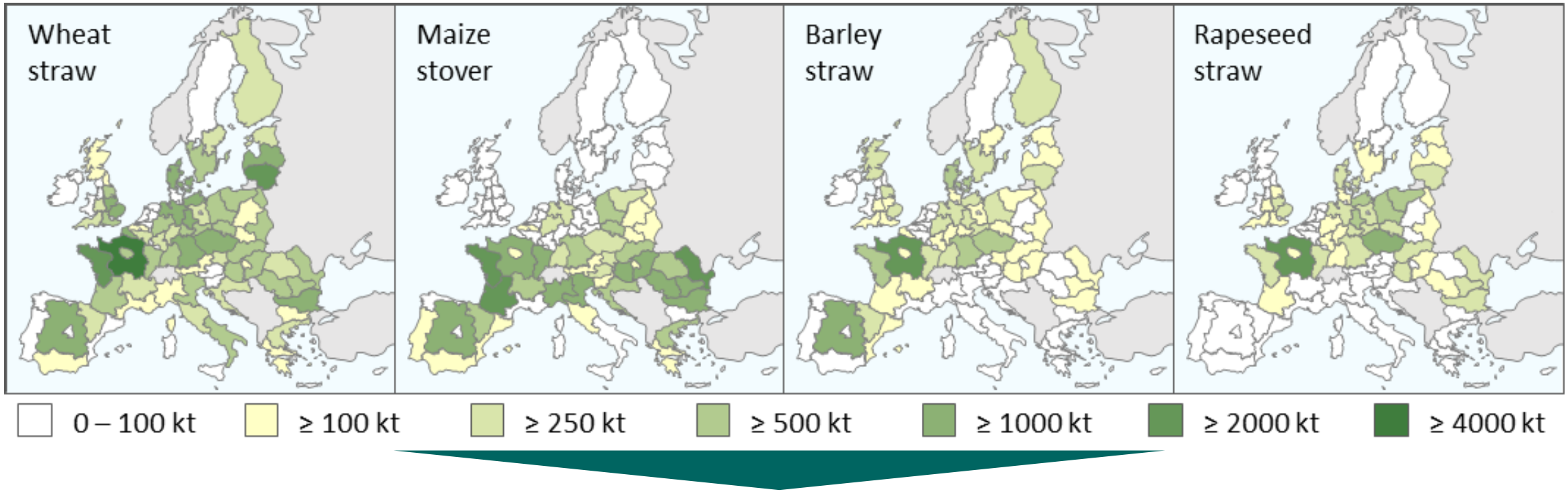


Maize stover	(31 Mt)
Barley straw	(16 Mt)
Rapeseed straw	(14 Mt)

|Source: Thorenz et al., 2018

Assessment of agroforestry residue potentials

Regionalized annual bioeconomic potential (in 2018)



Identification and analysis of underlying variables & consideration of market forecasts

→ Time series and literature based forecast of the most important agricultural residues in the EU until 2030

 |Source: Wietschel et al., 2019

Forecasting of agroforestry residue potentials

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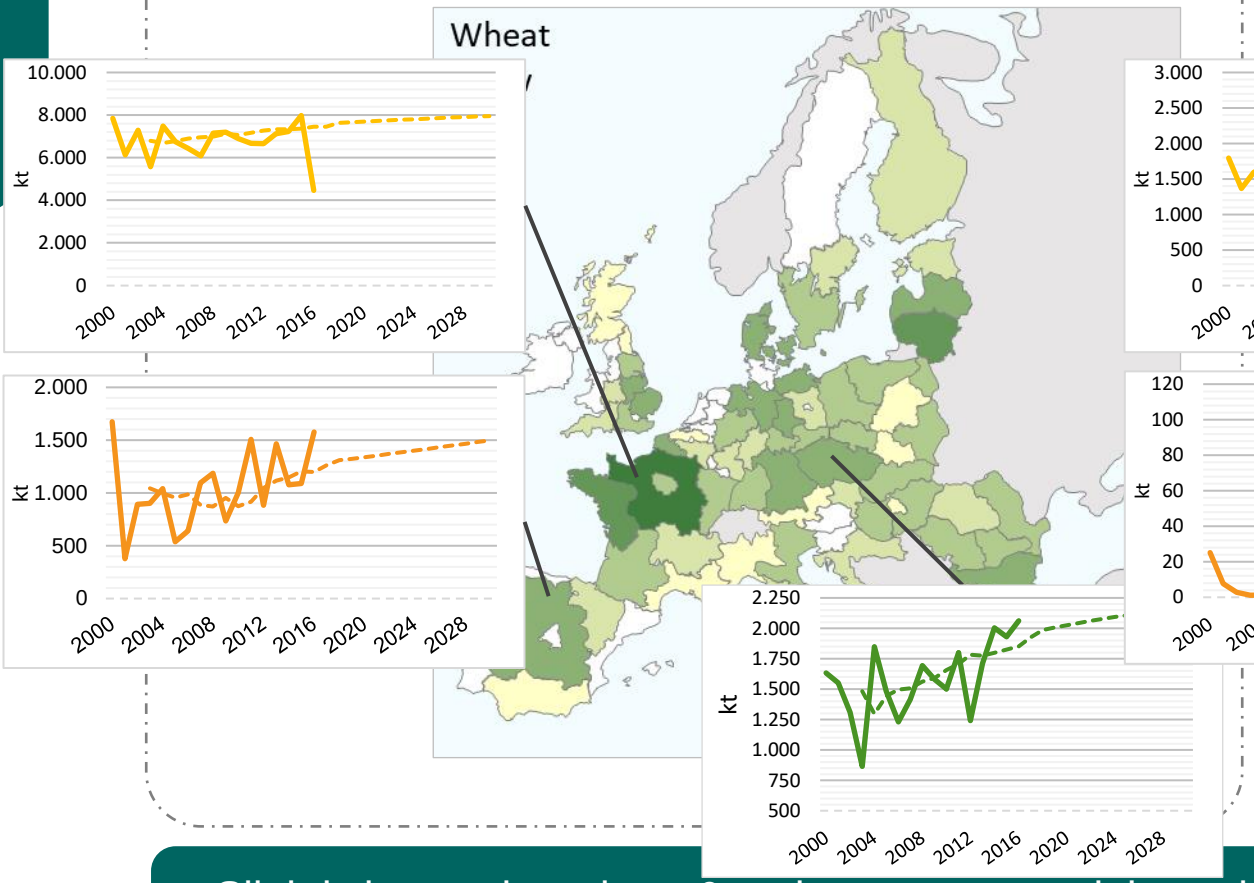
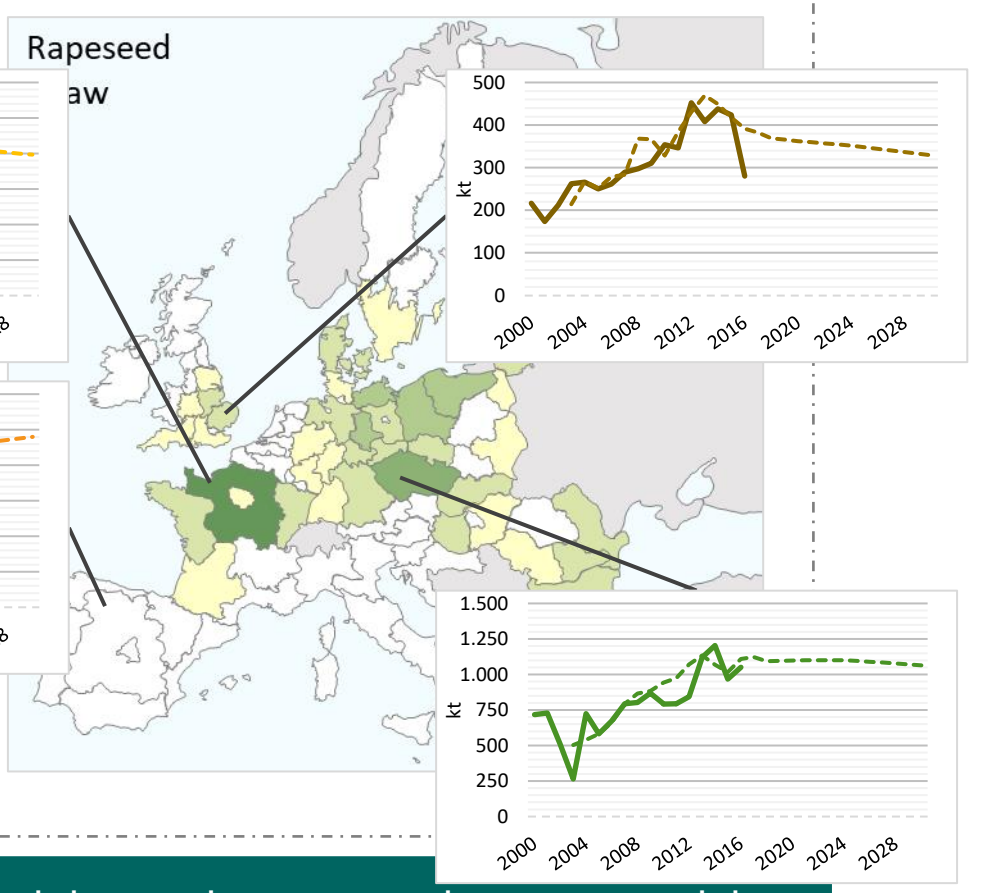
Bioeconomic Potential **wheat straw**



Bioeconomic Potential **rapeseed straw**



- Slightly increasing wheat & maize straw potentials, stable barley straw and decreasing rapeseed straw potential
- Weather events regularly lead to supply disruptions. Climate change might increases probability of disruptions

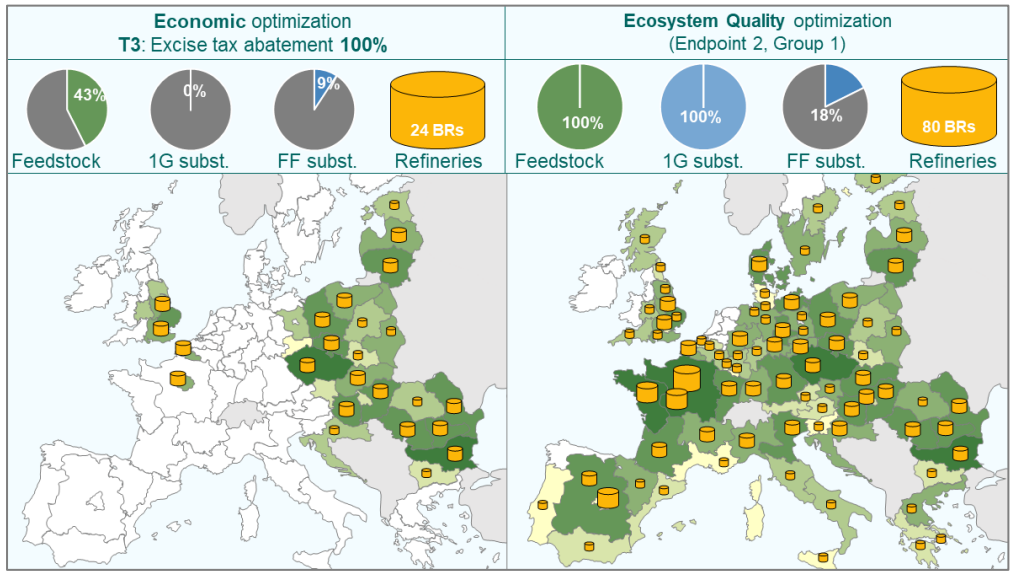
 |Source: Wietschel et al., 2019

UNA

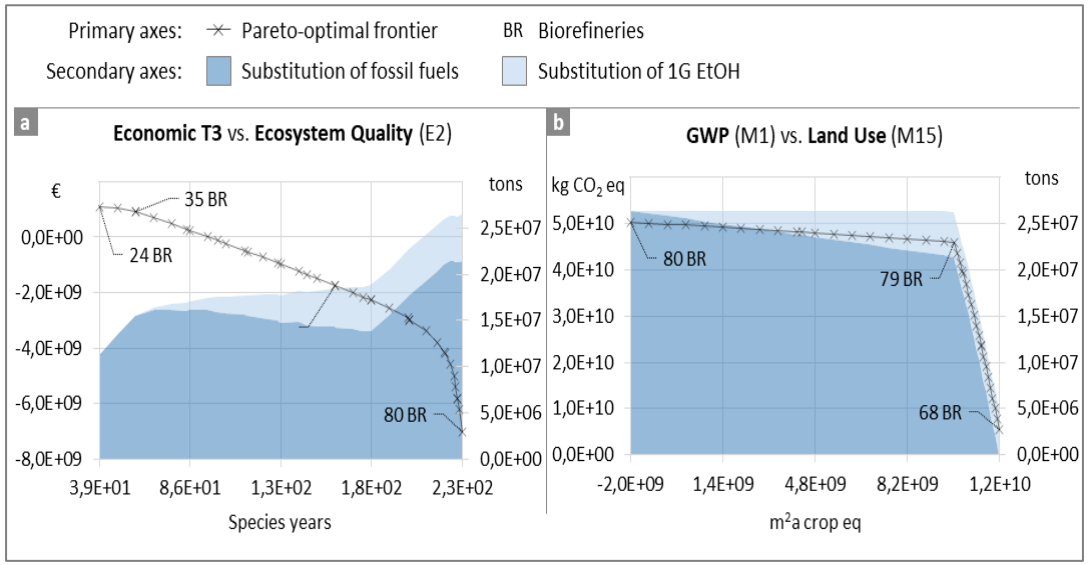
Bioeconomic supply chain network design

Bioeconomic supply network planning based on regionalized feedstock potential – case of EtOH

Single-objective optimization results
Environmental and economical efficient production and distribution network for second-generation bioethanol in the EU:



Multi-objective optimization results
Pareto-optimization between two objectives (by ε-constraint method) to find optimal tradeoffs between economic and environmental dimension:



- Decentralized supply network: sustainable feedstock potentials are site-specific/low distances feedstock sourcing
- Results largely depend on selected objective function: different environmental objectives can be conflictory

 |Source: Wietschel et al., 2020

Thank you for your attention!

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