Biomass Supply Chain

Insights from the 'Sustainable Biofeedstock Supply Chains for Advanced Biofuels in Europe towards 2050' report

16th Evolution of Refiners' & Fuel Manufacturers' Strategic Role in the Energy Transition
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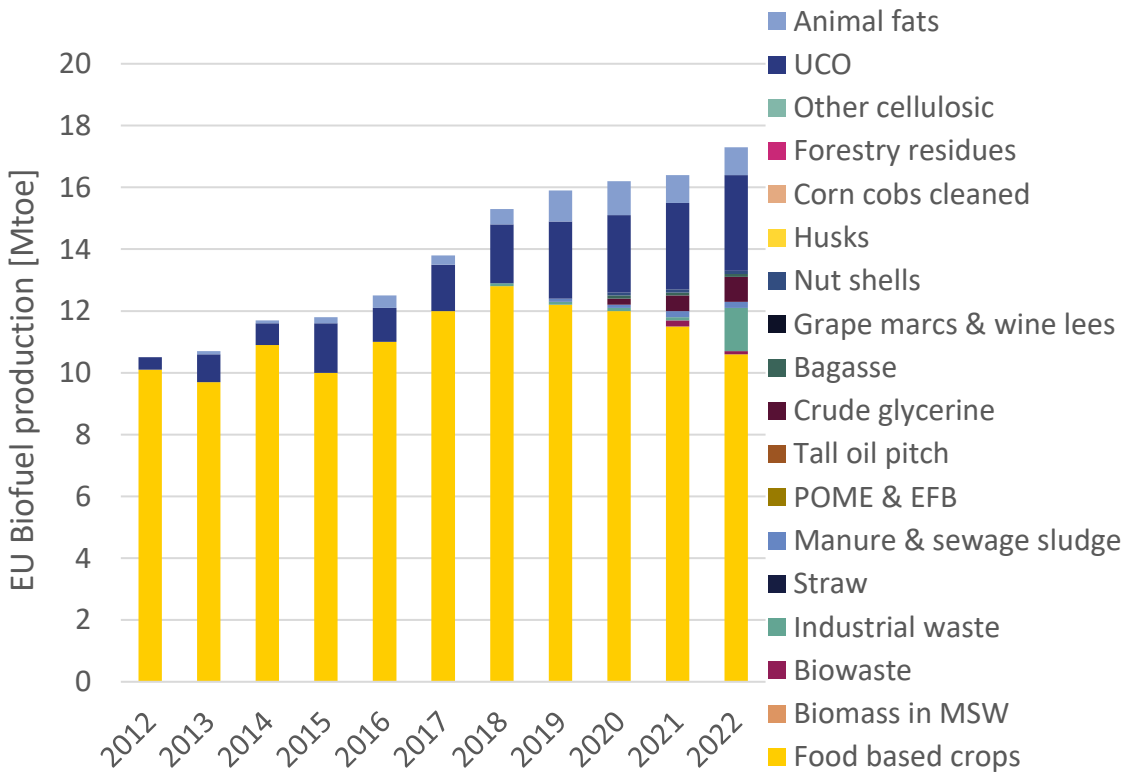


Agenda

- Moving beyond Annex IX-B: the strategic imperative for advanced biofuels from lignocellulosic biomass and waste
- Centralized vs decentralized production: what are economically optimal biomass supply chains for advanced biofuels?
- Greenfield vs brownfield: How can they be integrated with existing industries?
- Geographic patterns: supply chains and trade
- Biomass availability and demand: is there sufficient sustainable biomass?

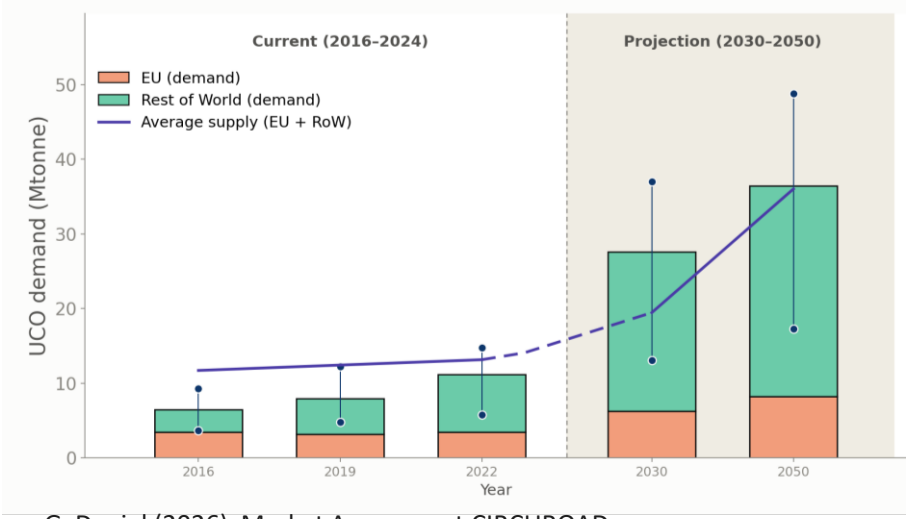
Annex IX-B biofuels have been the main driver for recent growth of biofuels in the EU

- Biofuels are still produced mostly from food and feed crops, but have declined after the implementation of the RED II
- Growth mainly from HVO/HEFA made from UCO, animal fats, etc.
- The EU relies heavily on imports of UCO (up to 80% import reliance)



Source: EU JRC (2025)

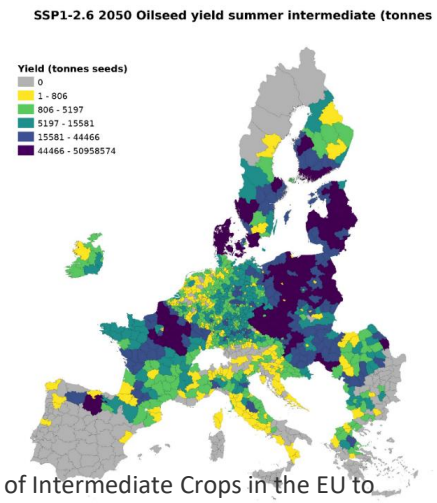
Global Used Cooking Oil (UCO) markets could reach a tipping point soon (before 2030)



Source: G. Daniel (2026). Market Assessment CIRCUROAD

Intermediate oil crops could offer an important relief, but fall short of a full-scale solution considering expected demand.

- Potential positive environmental impact
- **Intermediate oil crop potential estimated at ~4.7 Mtoe**
- Biomass availability during winter is significantly restricted
- Strongly constrained by their long growing periods
- Higher potential for lignocellulosic crops



Source: Elbersen et al. (2026). Availability Potential of Intermediate Crops in the EU to 2050. Concawe Reports no. 6/26

Sustainable biofuel scale-up, requires diversification beyond fats and oils

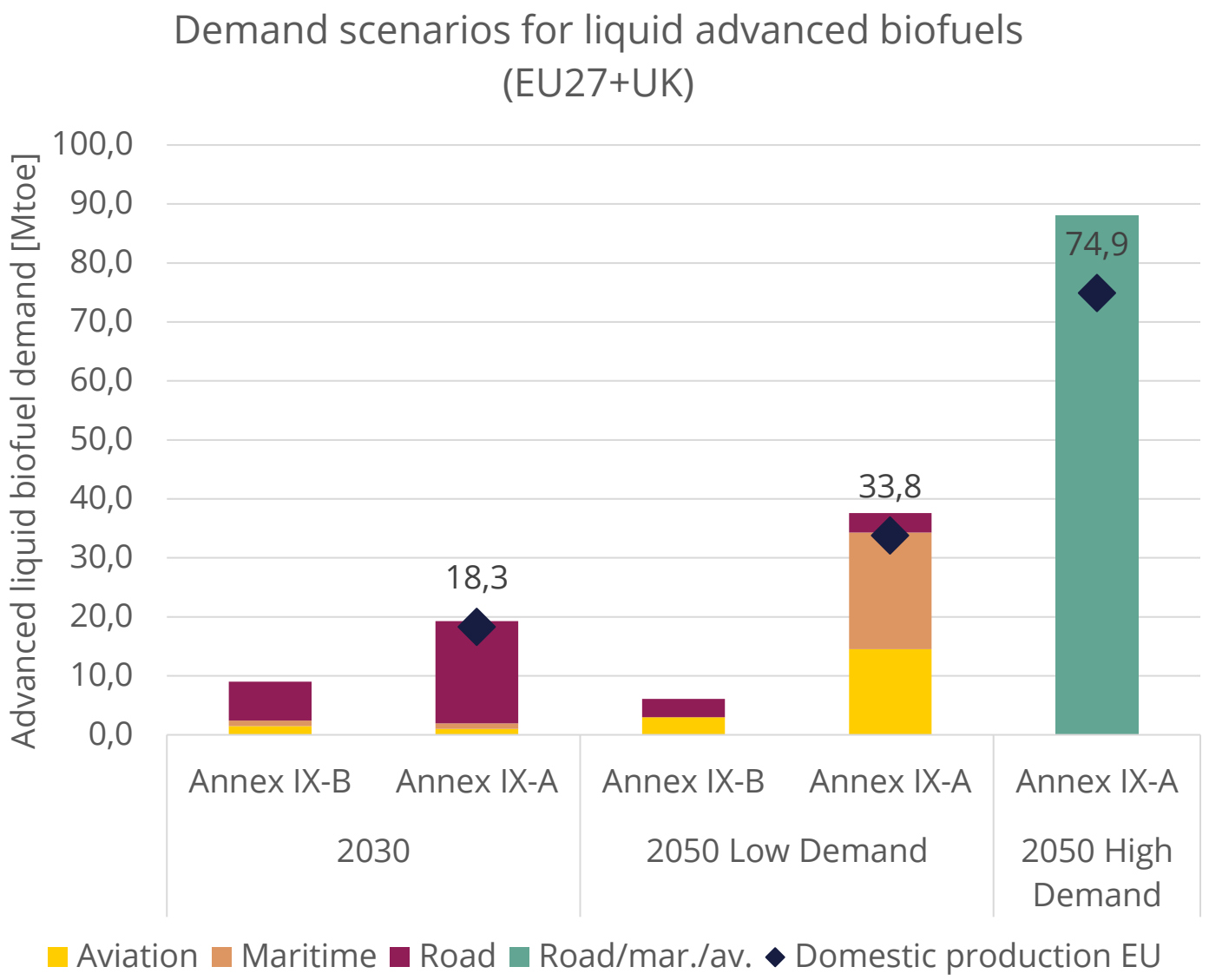
Advanced biofuel demand

- Low Demand **(LD)** scenario: based on DI Fuels (DG RTD, 2024)
- High Demand **(HD)** scenario: based on Concawe S&P study (2025)
- Assuming 85-90% domestic production (2050)
- Annex IX-A: drop-in fuels produced in thermochemical biorefineries: Fischer-Tropsch (GFT), Hydrothermal liquefaction (HTL)
- Demand nodes: existing oil refineries
- Annex IX-B: excluded from study

Competing uses of domestic solid biomass for heat/electricity (primary demand)

- 2030: 70.4 Mtoe
- 2050 LD: 126.1 Mtoe
- 2050 HD: 101.4 Mtoe

Based on DG RTD (2024)
Demand nodes: largest cities NUTS2



- *EC. (2024). Development of outlook for the necessary means to build industrial capacity for drop-in advanced biofuels – Final report (M. Georgiadou, T. Goumas, & D. Chiaramonti, Eds.). Publications Office of the European Union. https://doi.org/doi/10.2777/679307*
- *S&P. (2025). Study on the potential evolution of Refining and Liquid Fuels production in Europe.*

Spatial mapping of advanced biofuel plants

Note: More scenarios, including sensitivity scenarios on feedstock supply available in main CONCAWE report.

Integration strategies

Biomass supply region



Intermodal terminals



Pulp mills



Existing biofuel



Oil refineries



- **Greenfield** (applicable to distributed HTL)
- **Located greenfield** (applicable to centralized HTL and GFT)
- **Co-locating**
  Installed as seperate entity, shared use of infrastucture, utilities, labor, energy.
- **Co-locating**
- **Retro-fitting**
  Added as 'bolt-on' unit, shared processes, utilities, labor, energy, feedstock components

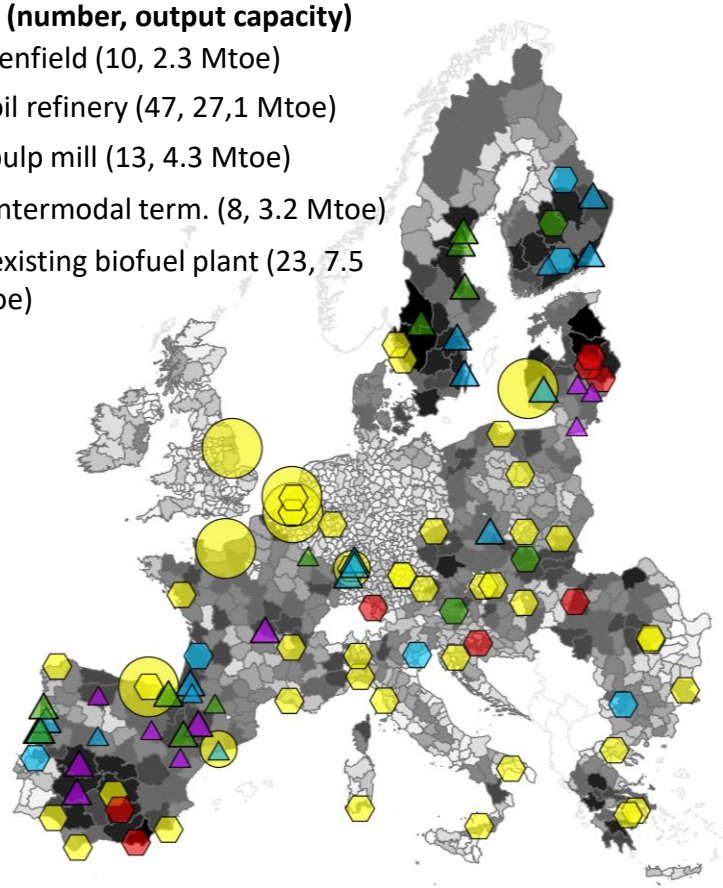
LD scenario 2050 (33.8 Mtoe)

Plant type (number, output capacity)

- HTL biocrude (37, 10.5 Mtoe)
- Biocrude upgrading (8, 11,6 Mtoe)
- GFT (56, 22.3 Mtoe)

Location (number, output capacity)

- Greenfield (10, 2.3 Mtoe)
- At oil refinery (47, 27,1 Mtoe)
- At pulp mill (13, 4.3 Mtoe)
- At intermodal term. (8, 3.2 Mtoe)
- At existing biofuel plant (23, 7.5 Mtoe)



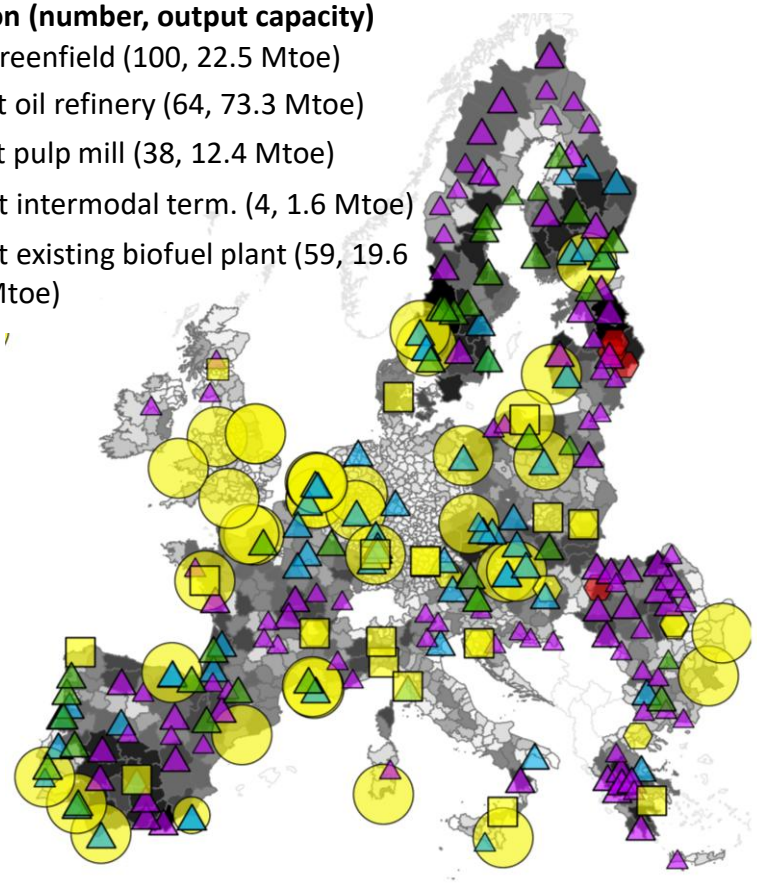
HD scenario 2050 (74.9 Mtoe)

Plant type (number, output capacity)

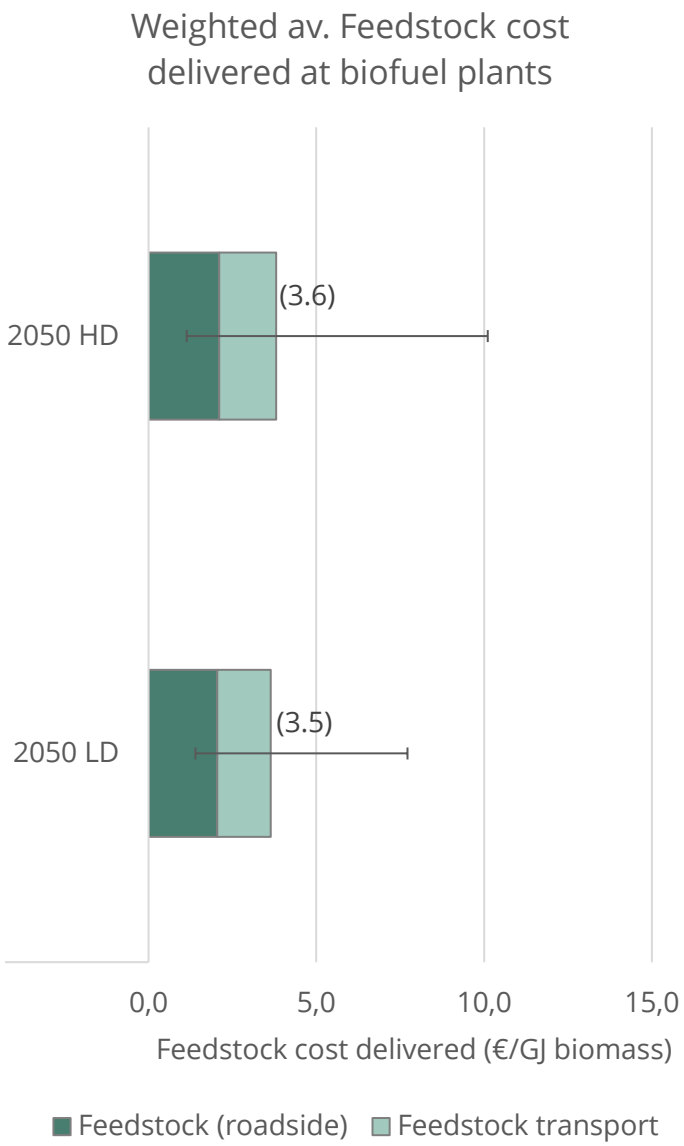
- HTL biocrude (197, 54.4 Mtoe)
- Biocrude upgrading (38, 59.8 Mtoe)
- GFT (12, 4.8 Mtoe)
- HTL centralized (18, 10.3 Mtoe)

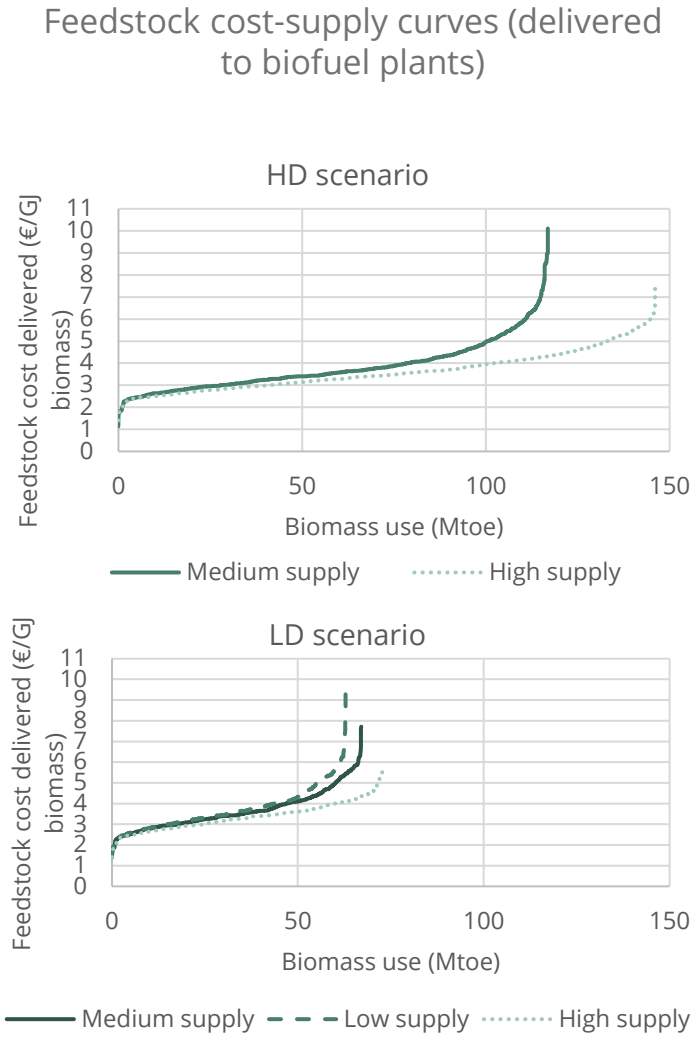
Location (number, output capacity)

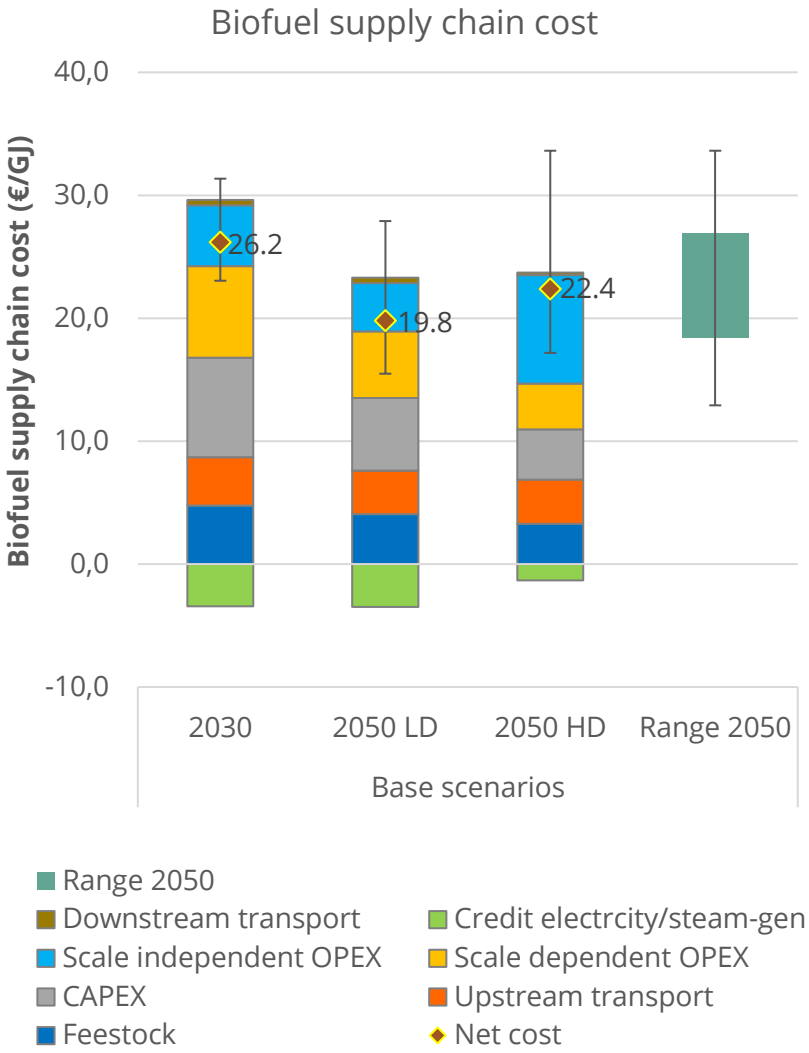
- Greenfield (100, 22.5 Mtoe)
- At oil refinery (64, 73.3 Mtoe)
- At pulp mill (38, 12.4 Mtoe)
- At intermodal term. (4, 1.6 Mtoe)
- At existing biofuel plant (59, 19.6 Mtoe)



Biomass to biofuel supply chain costs



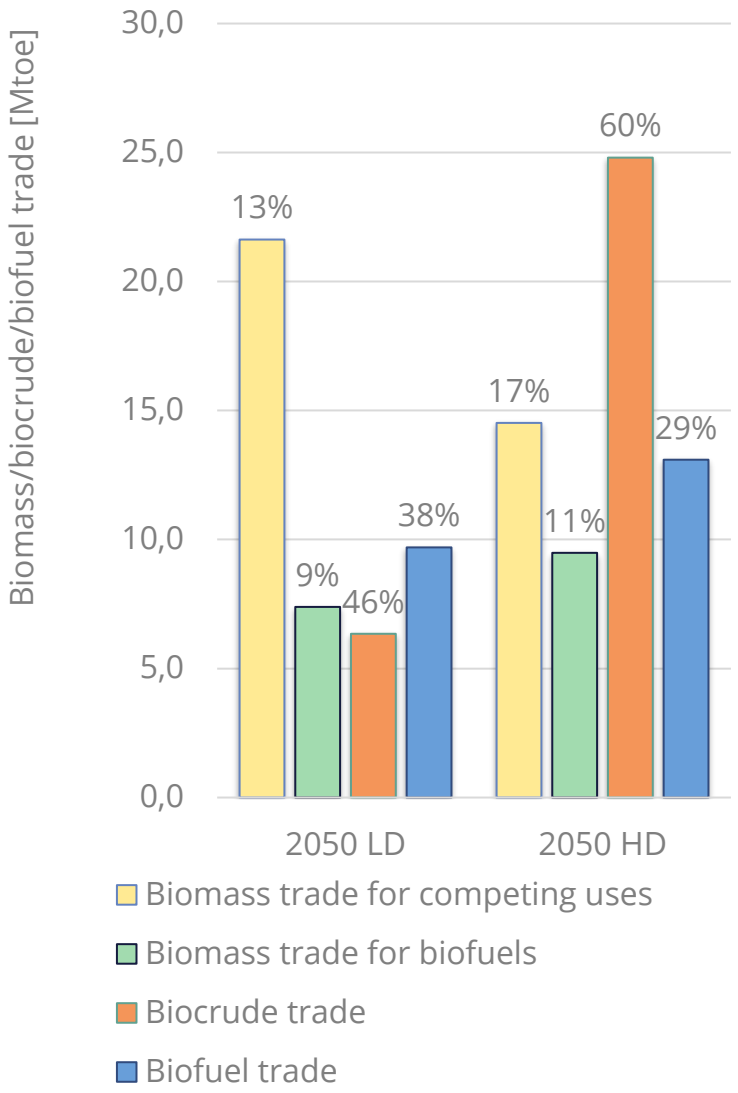


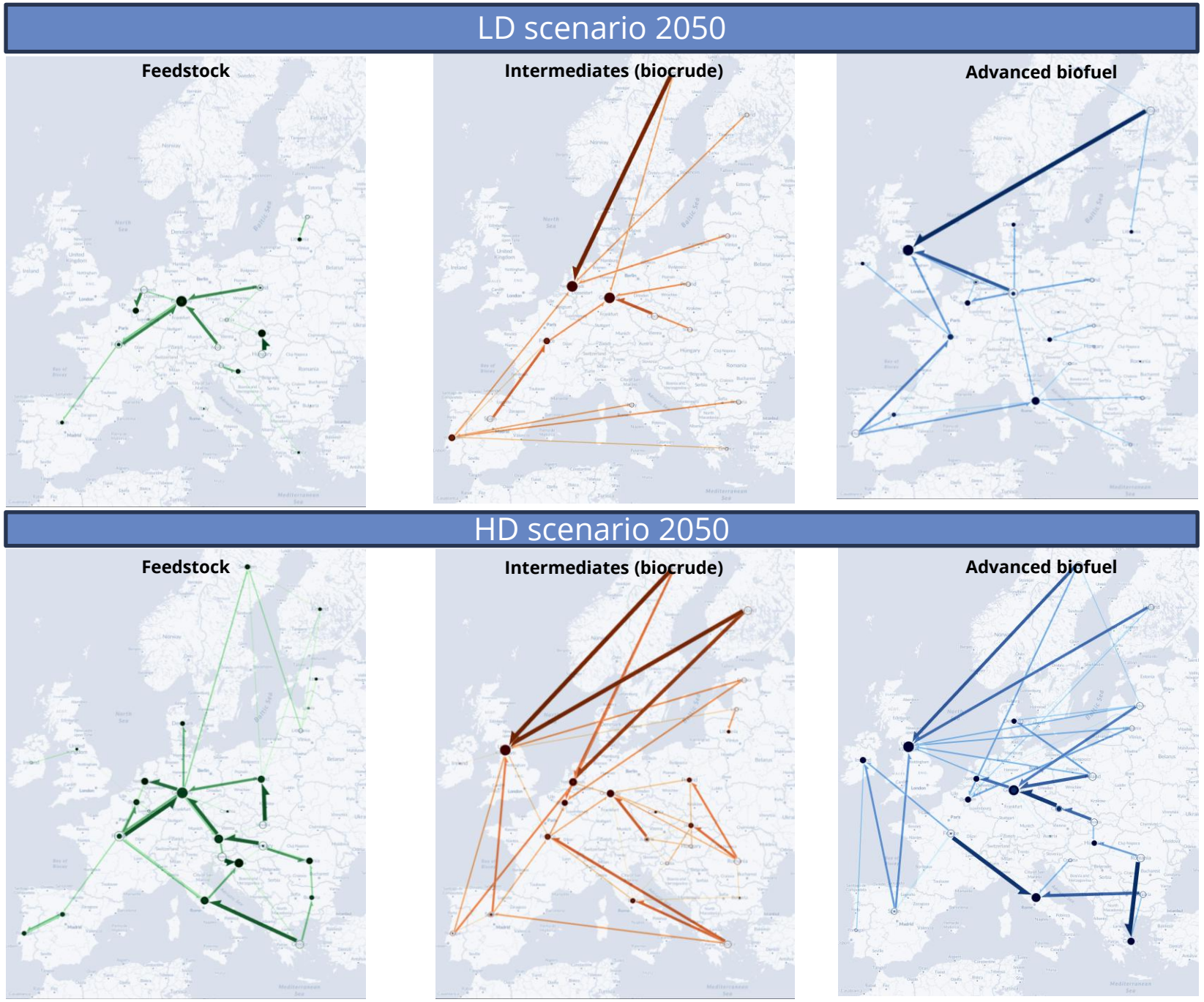


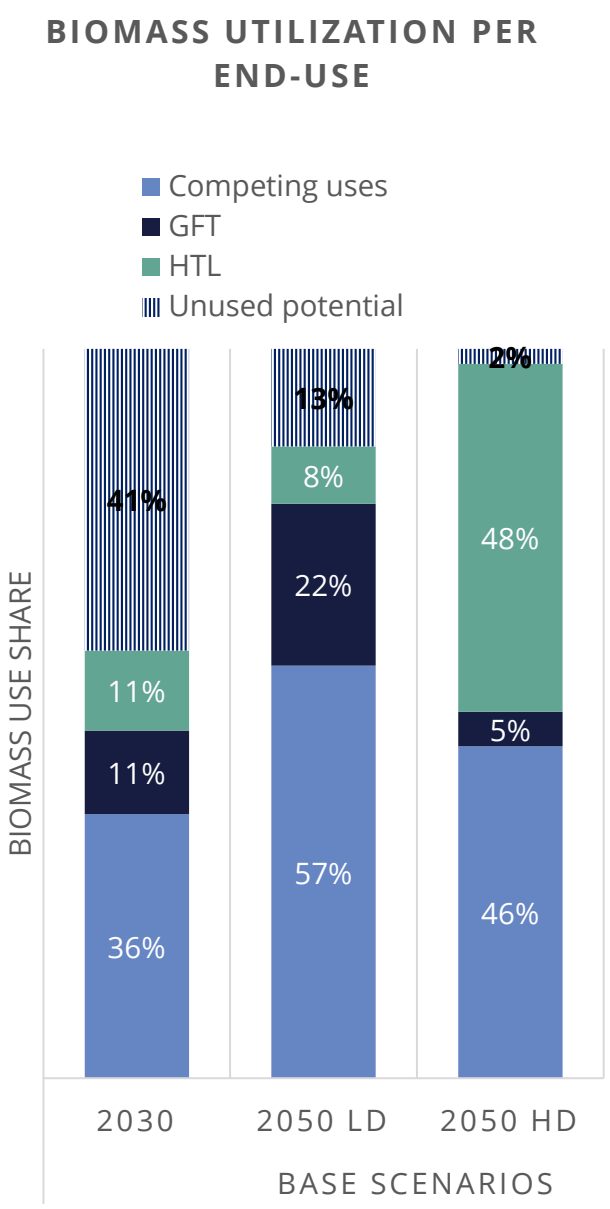
Note: Figures are based on production and delivery costs for biomass. Market prices are typically higher, reflecting profit margins and market demand.

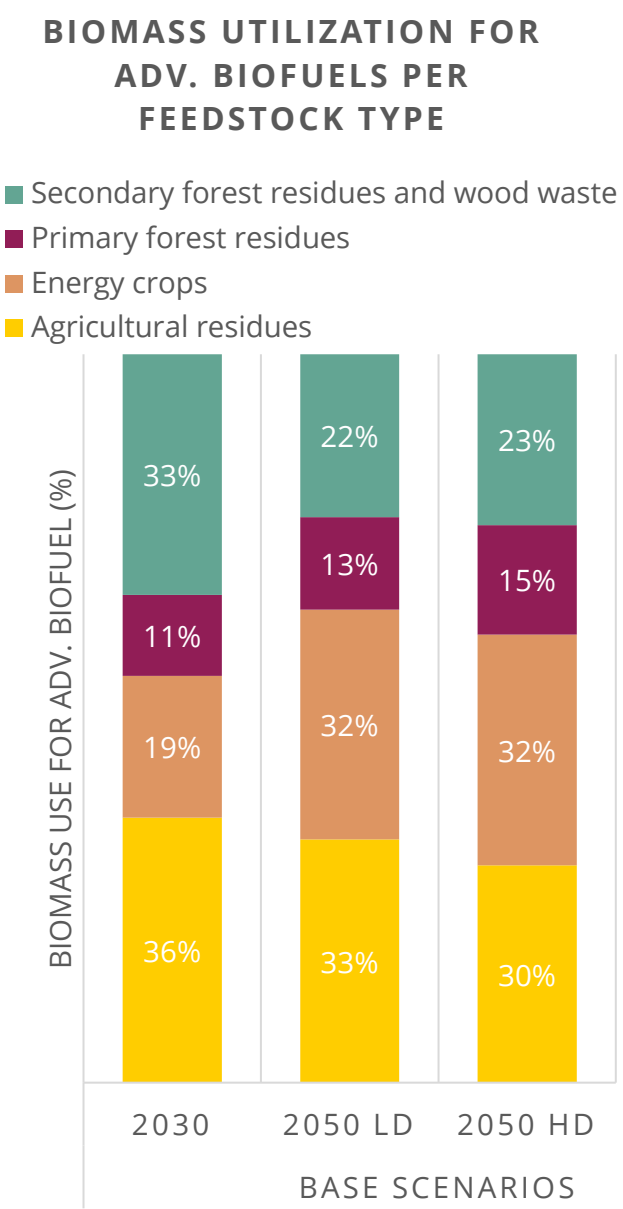
Note: Process technology cost data are based on scientific literature data. According to industrial practice, the costs are significantly higher

Intra-EU trade of biomass, intermediates and fuels





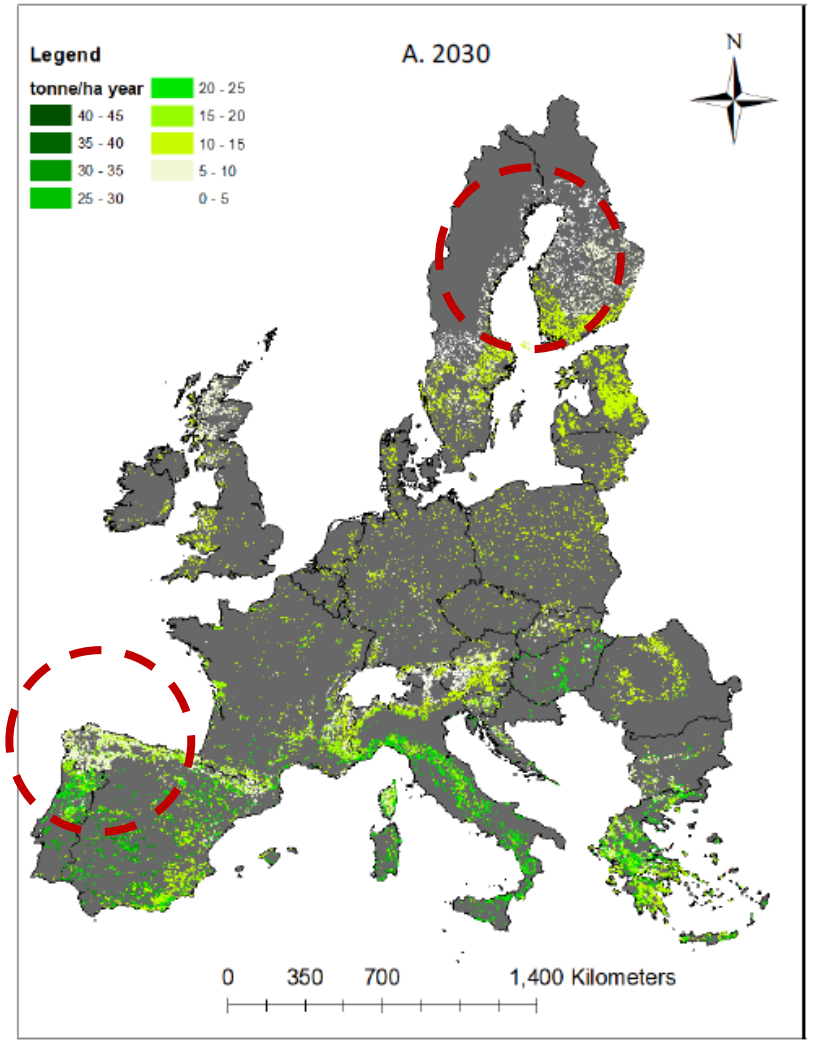


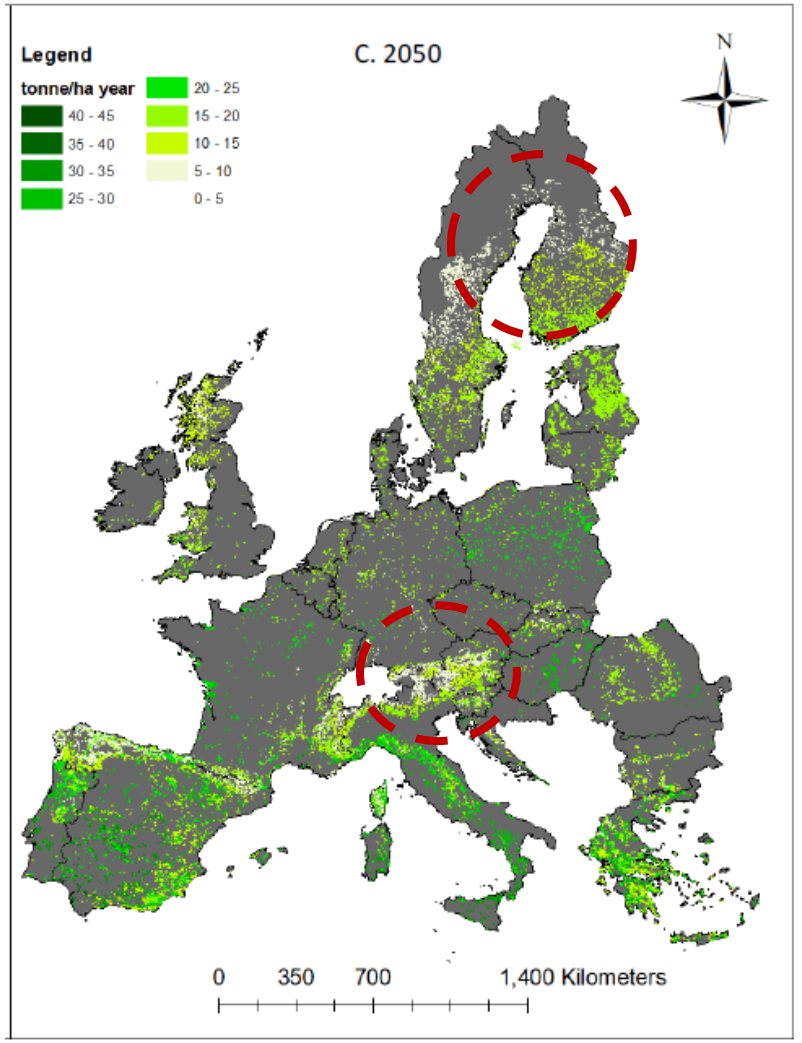


Biomass utilization and opportunities

- Lignocellulosic energy crops present a high potential to support the deployment of domestic advanced biofuels production in the EU.
- The production of lignocellulosic energy crops domestically can reduce reliance on imported fossil fuels and alternatives and buffer the EU from external supply chain shocks.
- Uses marginal land to avoid food conflict while potentially creating new revenue streams for rural economies.

There are still challenges that need attention – Part I

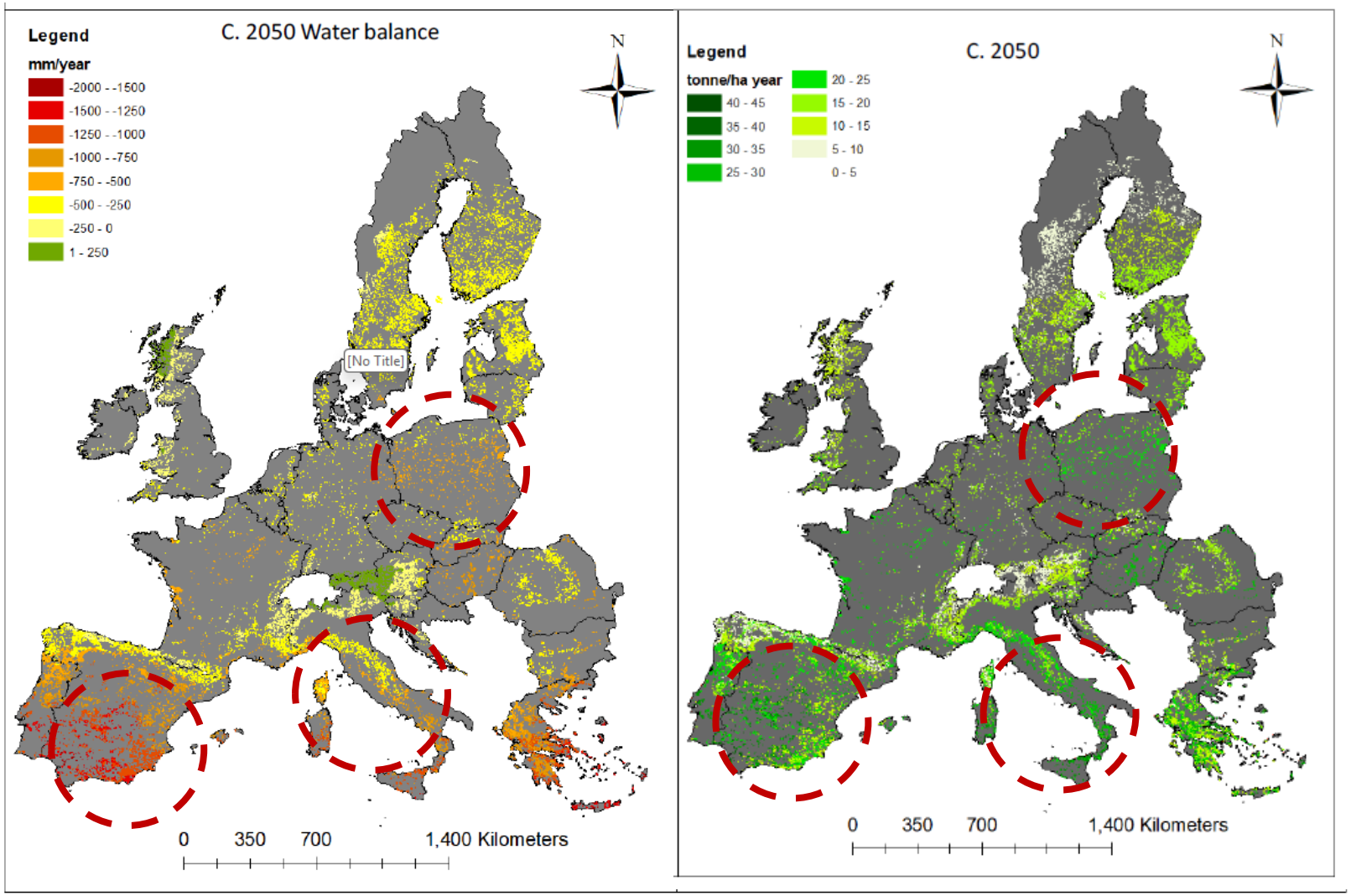




Spatial distribution of lignocellulosic energy crops potential over time (tdry/ha year) in the High availability scenario. The pixel size is enhanced for displaying purposes.

- Low-yield areas are generally located in regions characterized by challenging climatic conditions.
- Low-yield areas can present challenges for the overall carbon balance of these locations when accounting for the different carbon pools, such as soil organic carbon and above- and below-ground biomass.
- High carbon stock change differences can lead to non-compliance with REDIII criteria for advanced biofuels.
  Additional research is required

There are still challenges that need attention – Part II



Spatial distribution of lignocellulosic energy crops water balance over time (mm/year). The pixel size is enhanced for displaying purposes.

- High-yield areas can be characterized by additional water requirements; this can lead to the use of irrigation.
- Several of the regions with a large water deficit (water required to be supplied to meet expected biomass potentials) for lignocellulosic energy production overlap in 2030 and 2050 with areas expected to undergo very high water stress.
- As extreme weather events will probably increase over time, future production will increasingly depend on adopting adaptative management strategies

Conclusions

- Biofuels will continue to experience substantial growth driven by aviation and maritime sectors, despite the ongoing electrification of road transport.
- Scaling up advanced biofuels sustainably requires moving beyond fats and oils.
- Sustainability extends beyond the choice of feedstock; it demands an end-to-end supply chain perspective that ensures sustainability at every stage and location of the supply chain.
- Lignocellulosic energy crops offer a pathway to enhance the EU's domestic energy security and can effectively buffer Europe against external supply chain shocks. However, fully realizing this potential requires overcoming and acknowledging hurdles like extreme weather and water limitations.



Thank you

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Hoefnagels, R., Kwakernaak, S., van der Hilst, F., Junginger, M., Vera, I., & Neokosmidis, T. (2025). Sustainable biofeedstock supply chains for advanced biofuels in Europe towards 2050. *CONCAWE Reports*, *25*(10), 1-110.

https://www.concawe.eu/publication/sustainable-biofeedstock-supply-chains-for-advanced-biofuels-in-europe-towards-2050/

Biomass Supply Chains for Advanced Biofuels and competing bioenergy demand in the EU towards 2050

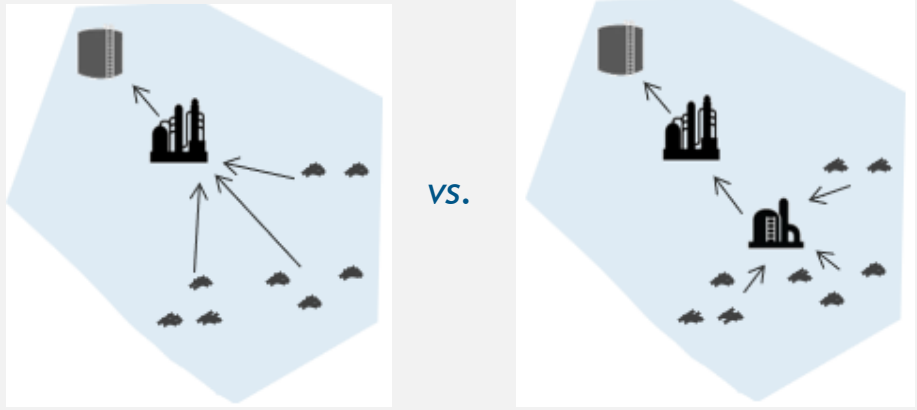
Objective: **Determine economically optimal biomass supply chains** for advanced biofuels (EU-27+UK, 2030 & 2050) under different availability and demand scenarios

Method: Detailed GIS mapping of biomass **feedstock supply (1)** and logistic **infrastructure (4)**, **co-location benefits (2)** at brownfield locations, MILP supply chain optimization for advanced biofuel and competing **bioenergy demand scenarios (6)**.

Supply Chain Strategies

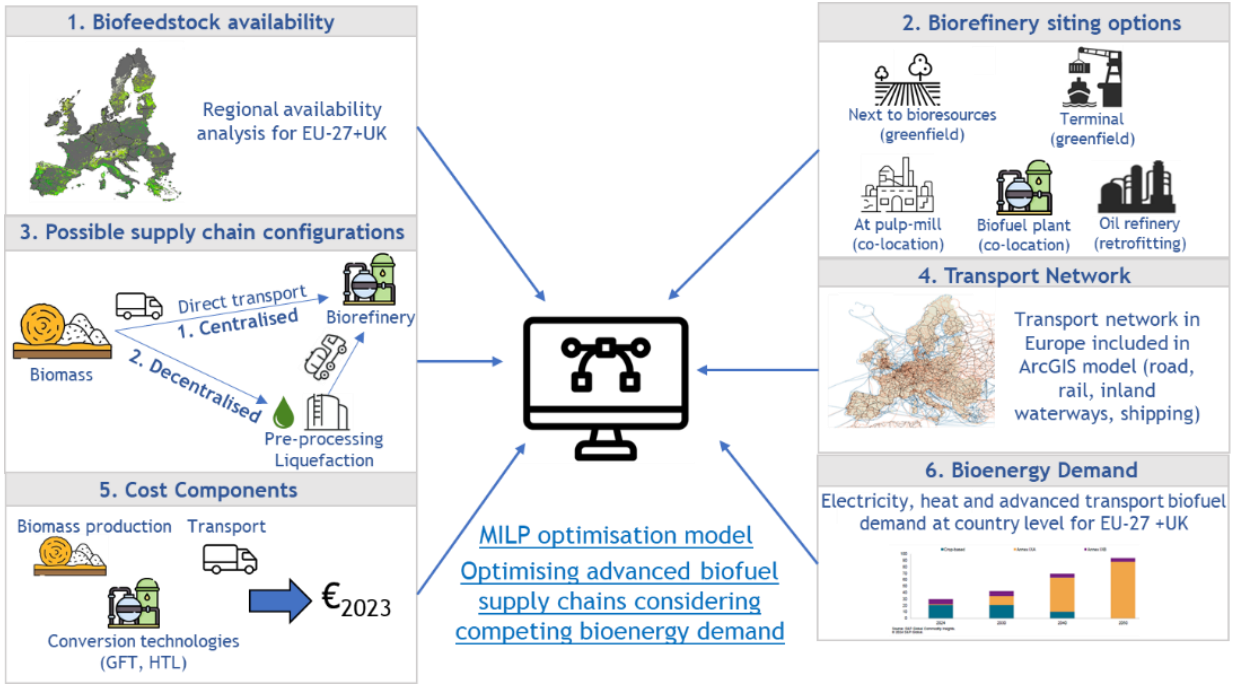
Centralized (GFT or HTL)

Decentralized (HTL biocrude → upgrading)



vs.

Developing optimal supply chain strategies will be key to successful biomass mobilisation



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CONCAWE study (CONCAWE, UU, TNO): https://www.concawe.eu/publication/sustainable-biofeedstock-supply-chains-for-advanced-biofuels-in-europe-towards-2050/



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