A full Supply chain optimization model to locate the forest biomass-based bioenergy production plants in Finland

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Contents

- Bioenergy in Finland
- BeWhere Finland
- Model inputs
- Model results – regional and national
- Future dimension

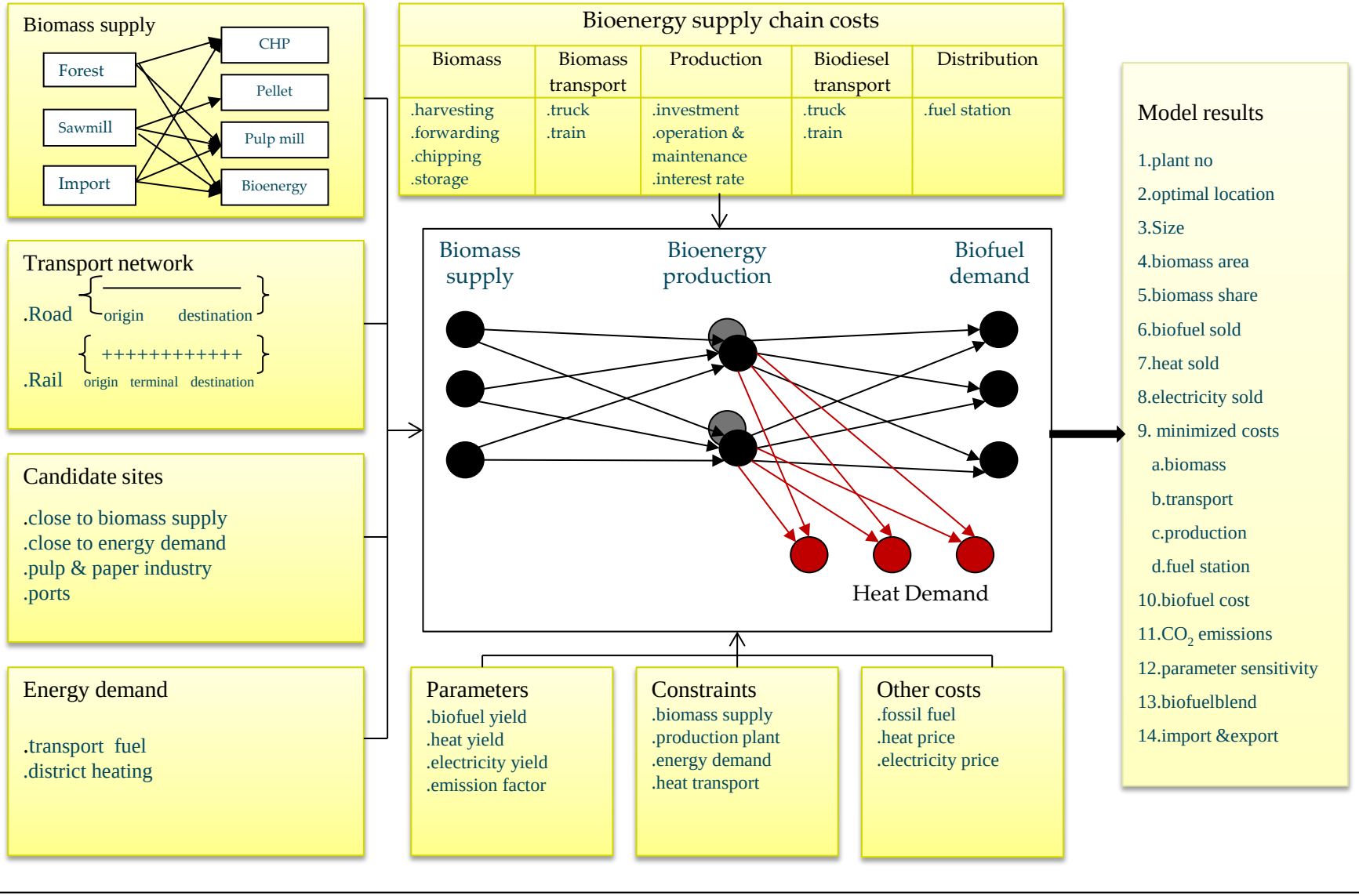
Background

- 2020 Renewable energy targets of Finland:
  - 38% renewable energy share (from 25% 2009)
  - 25.2 PJ / 20% minimum biofuel distribution requirement (double counting)
- National Renewable Energy Action Plan:
  - 13.5 Mm^3 forest chips use (from 6 Mm^3 2009)

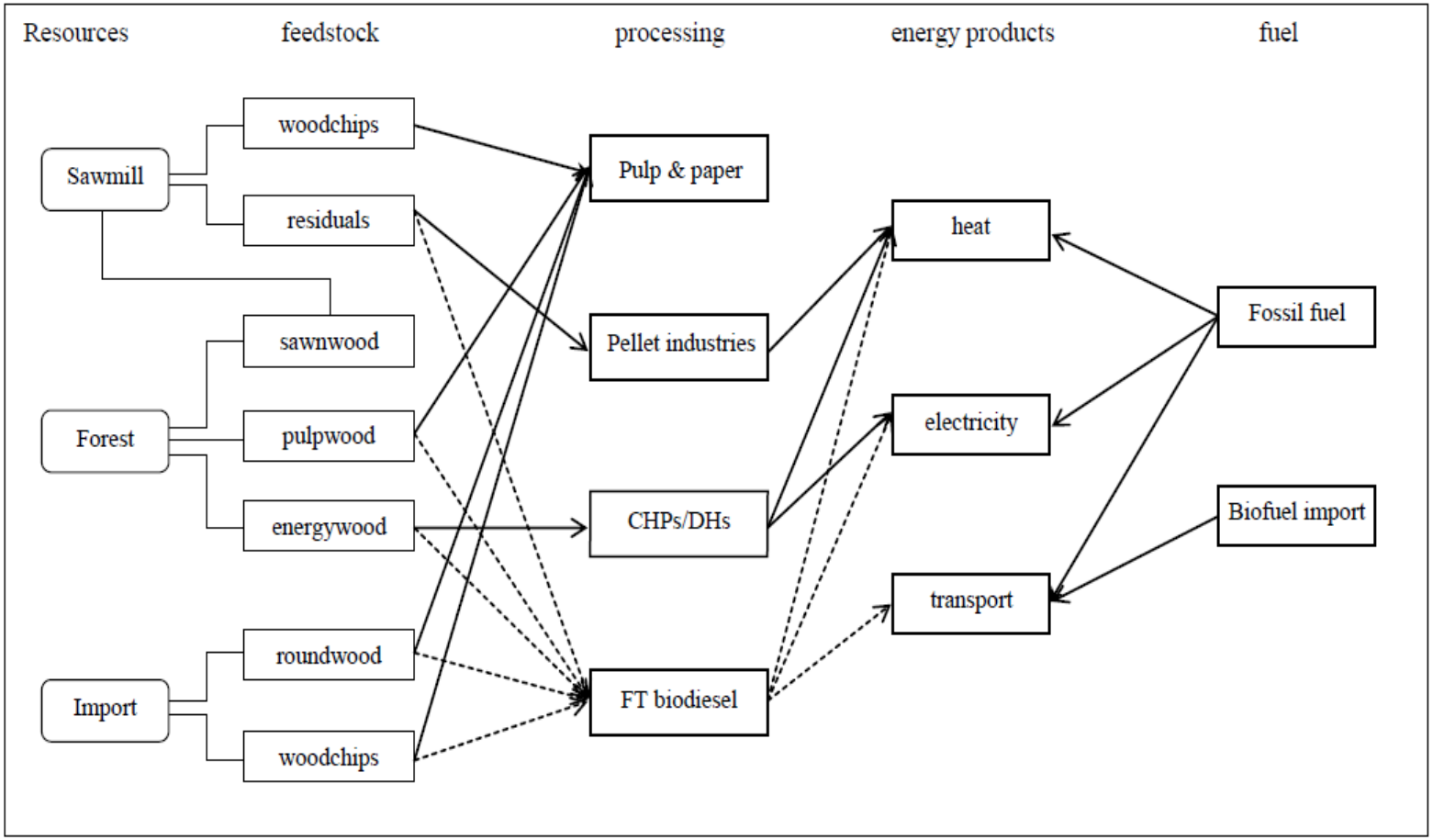
Measures

- Incentives e.g, wood incentive per MWh electricity and linked with CO2 price.
- Subsidies for small wood procurement eg. Thinning
- Mandatory blending % with fossil transport fuels

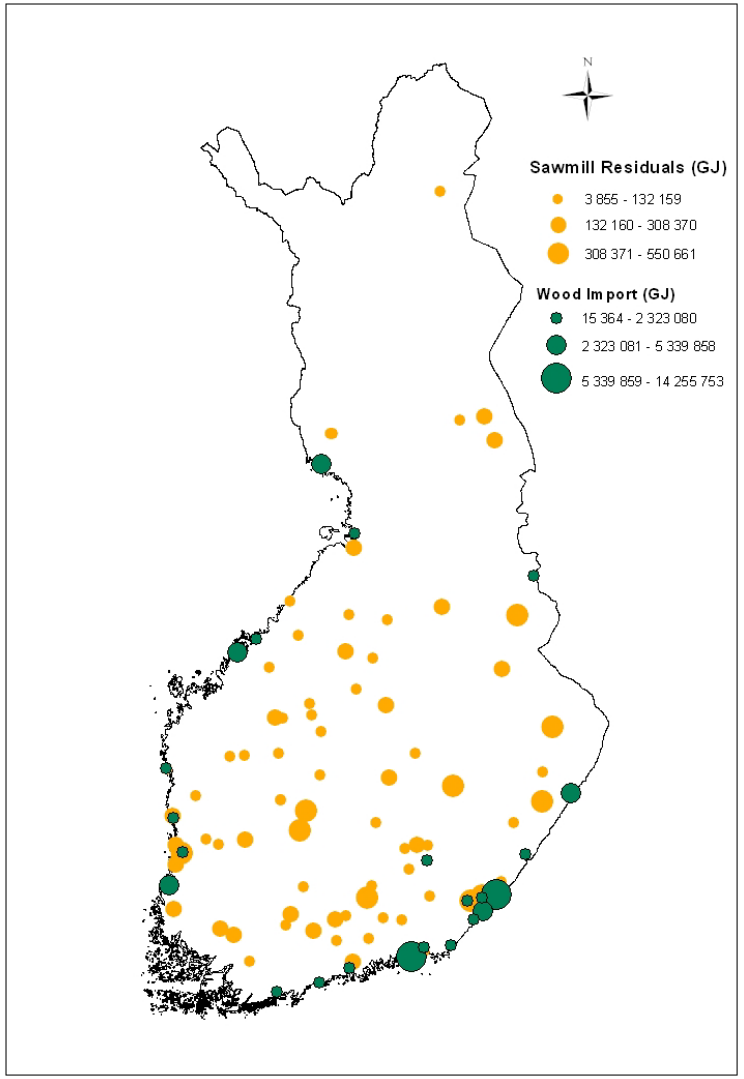
BeWhere Finland

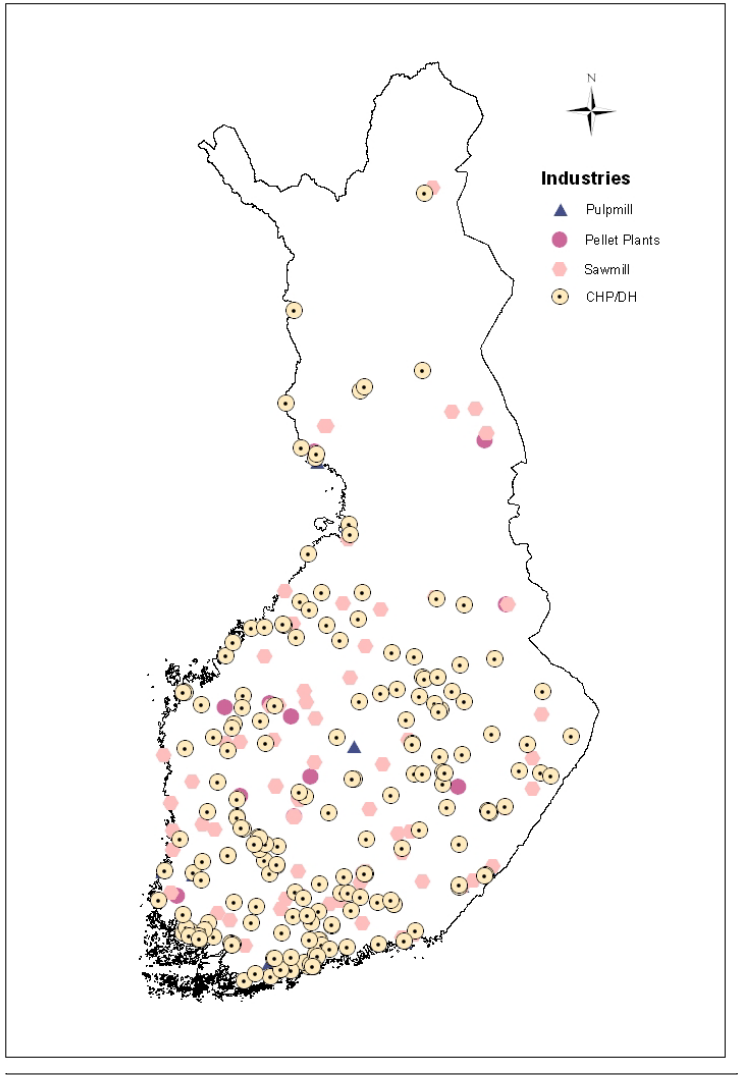


Flow of Feedstock and energy

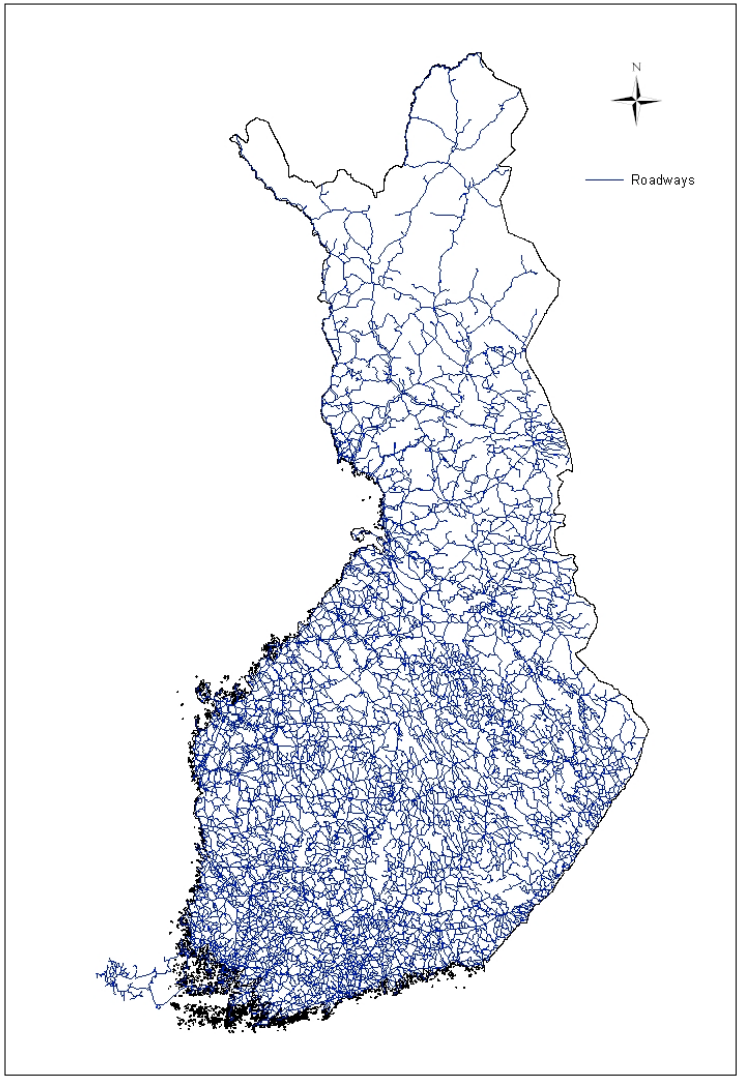


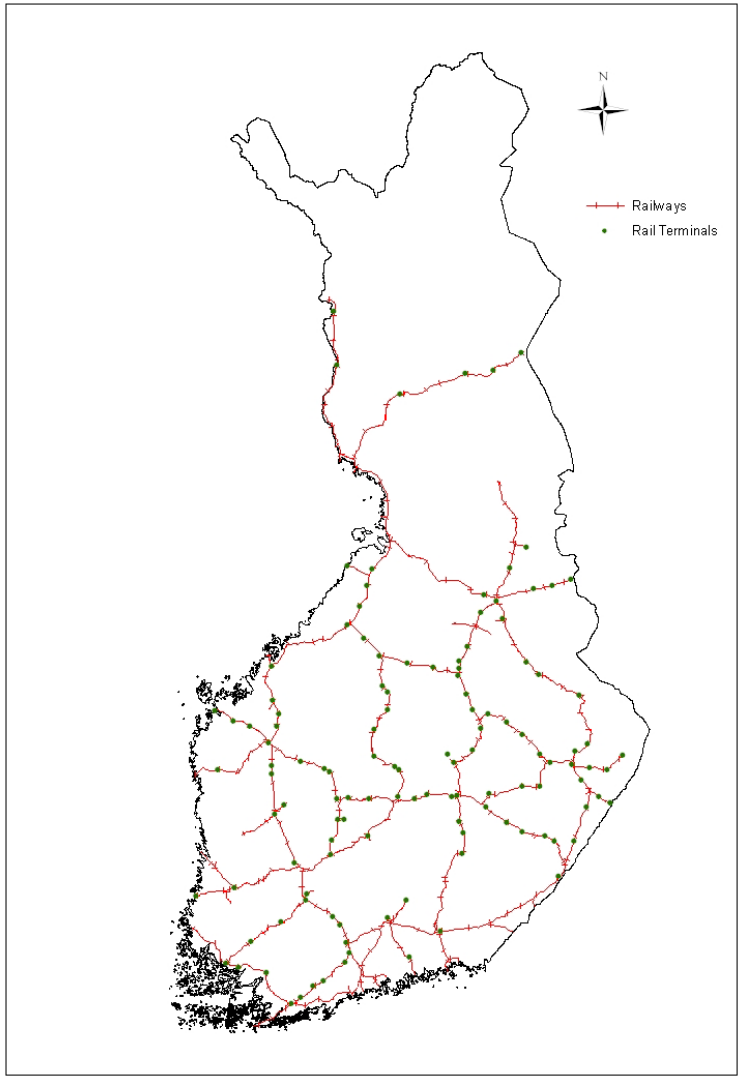
Spatial distribution of feedstock resources



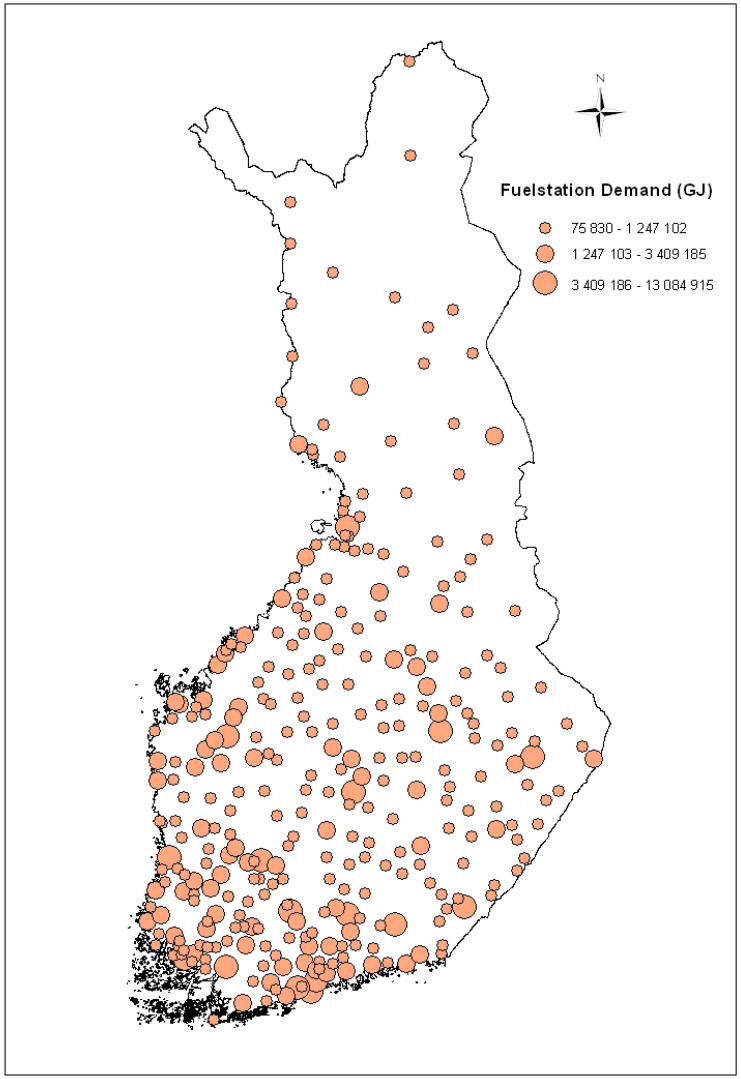


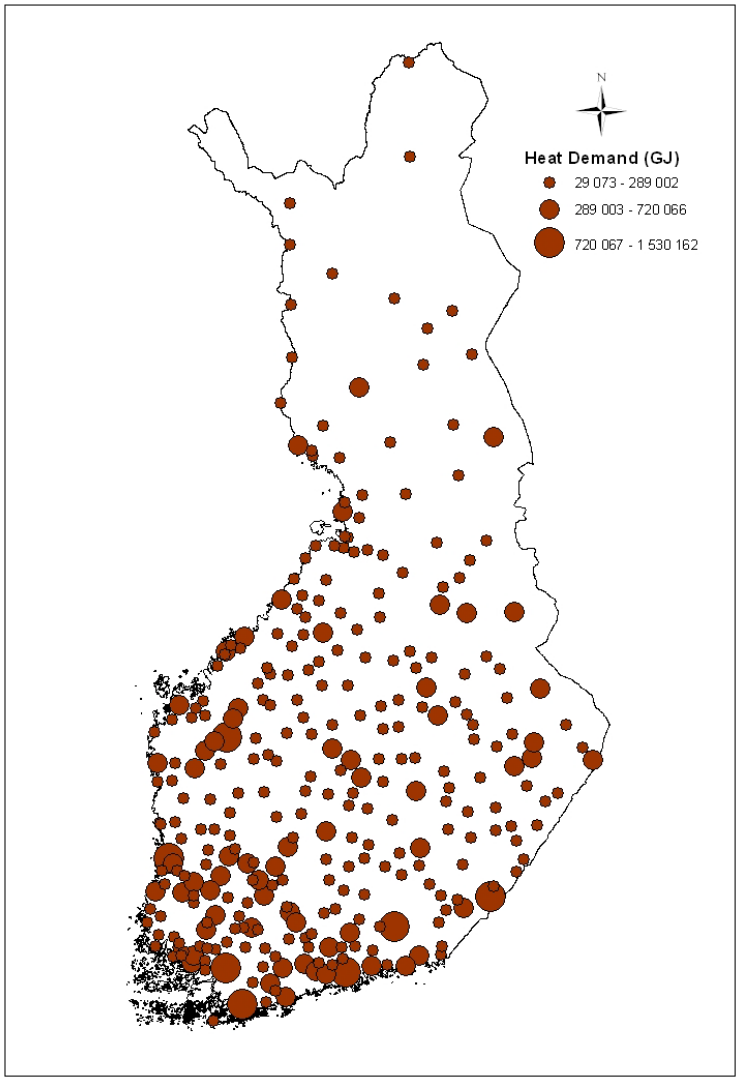
Transport Network





Energy demand



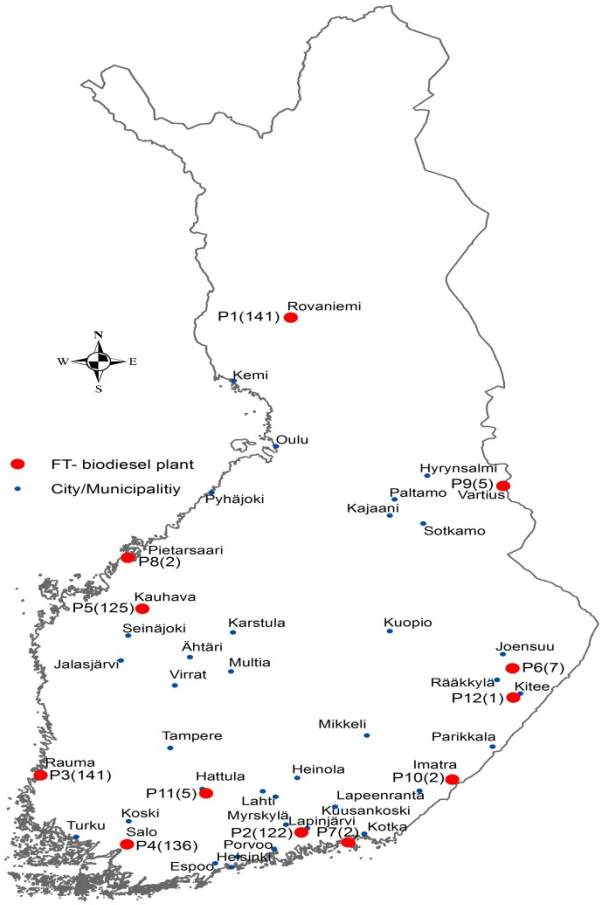


Scenarios for 2020 biofuel target

- Base Scenario
- Feedstock availability
- Industrial competition
- Parameter costs and energy price

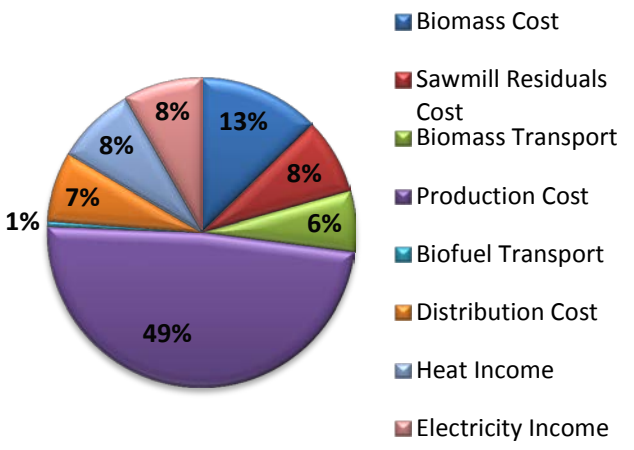
Cost-optimal locations

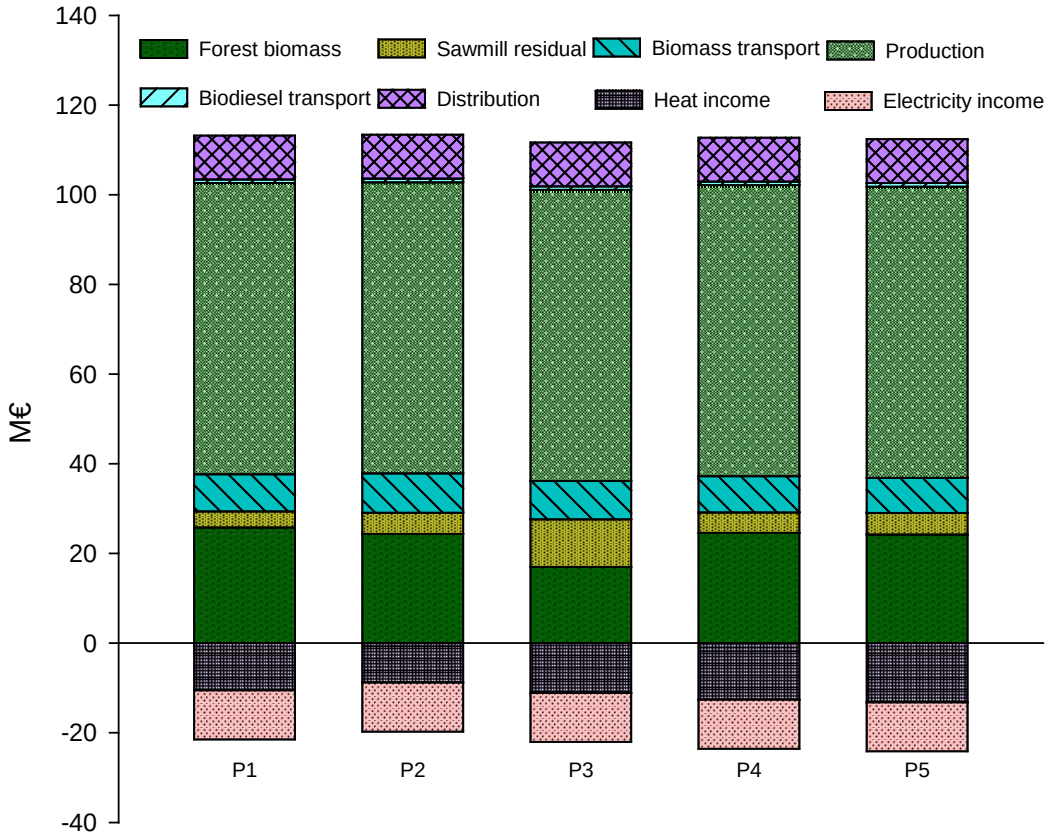
- Five FTplants : Rovaniemi, Lapinjärvi, Rauma, Salo, Kauhava >90 times
- Minimised transportation costs means abundant feedstock supply and high energy demand
- Max heat transport distance



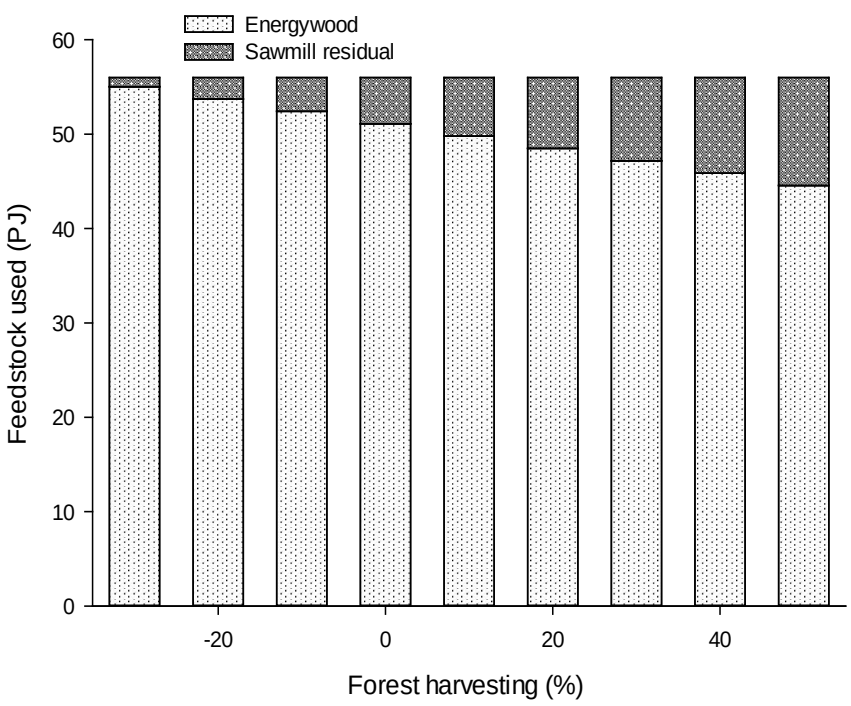
Cost breakdown of biodiesel production supply chain

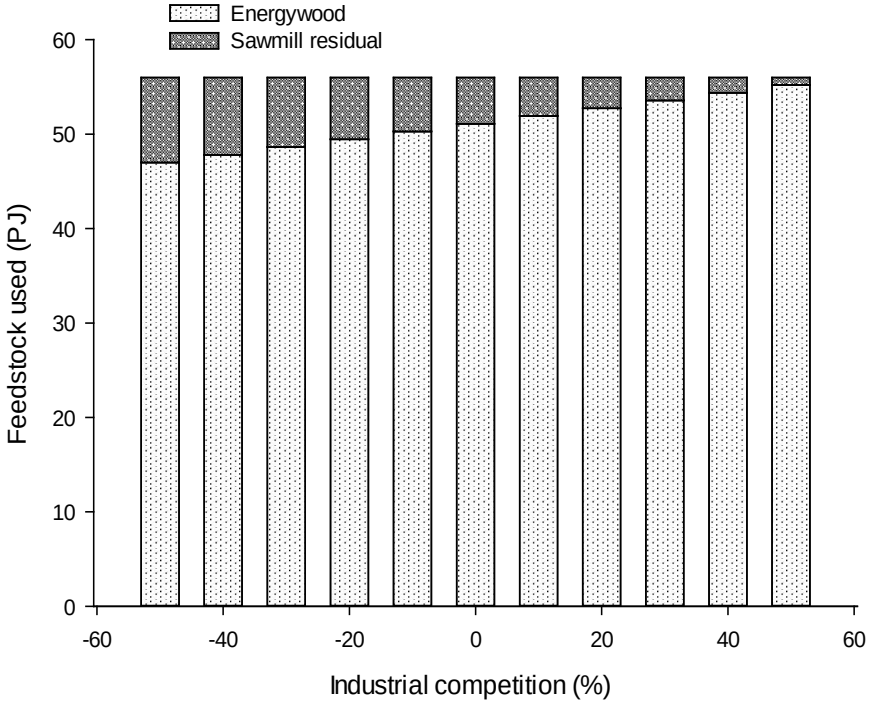
- P3 produces the cheapest biodiesel.
- Unit cost varied between 22.15€/GJ and 22.49€/GJ without any by-product sales.





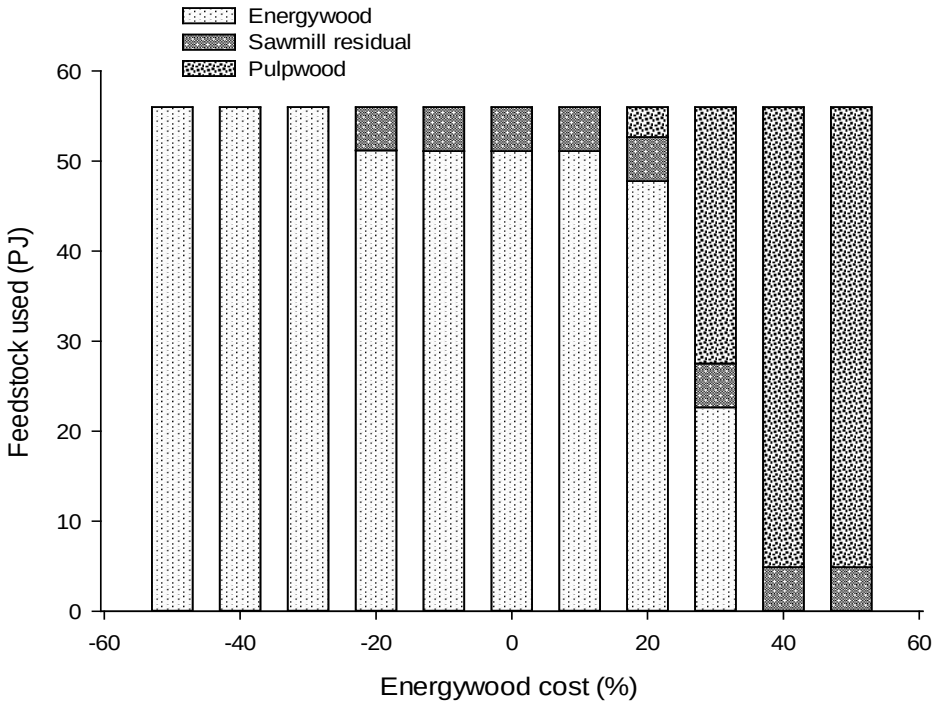
Biomass supply and feedstock resource allocation





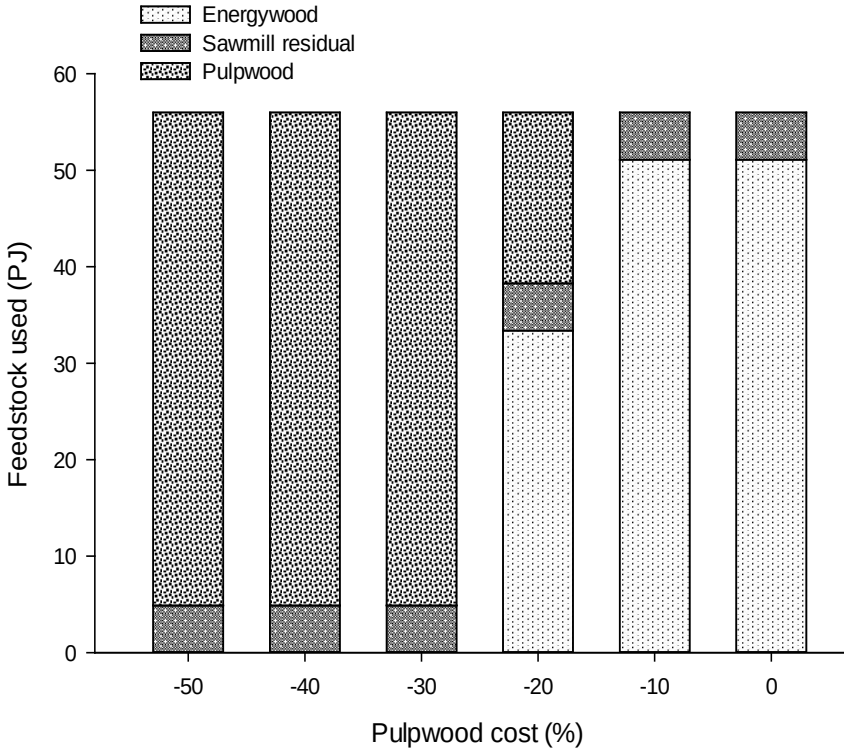
Costs and feedstock resource allocation

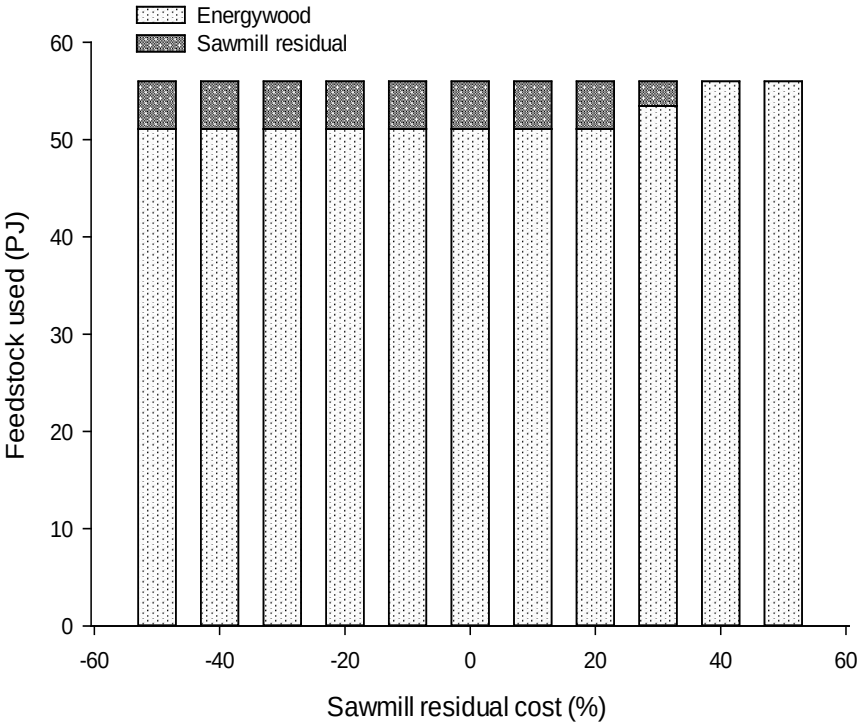
- 30% decrease would completely substitute sawmill residuals
- 30% increase = 40% energy wood + 51% pulpwood + 9% sawmill residuals
- 40% increase = pulpwood replace energywood completely



Cost (€/GJ)	-30%	-20%	-10%	0 %	10 %	20 %	30 %
Feedstock cost	21.20	24.23	26.55	28.88	31.20	33.61	33.84
Feedstock transport	4.27	4.10	4.14	4.14	4.14	3.70	**3.62**
FTbiodiesel cost	75.20	78.06	80.41	82.73	85.05	87.02	87.18

Costs and feedstock resource allocation



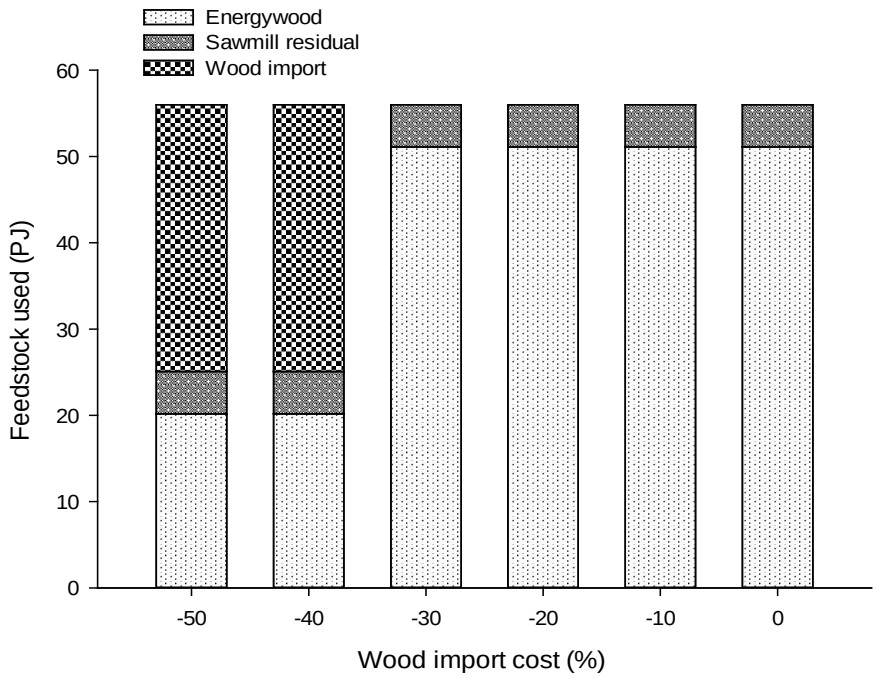


Maximum pulpwood utilization potential at -30%

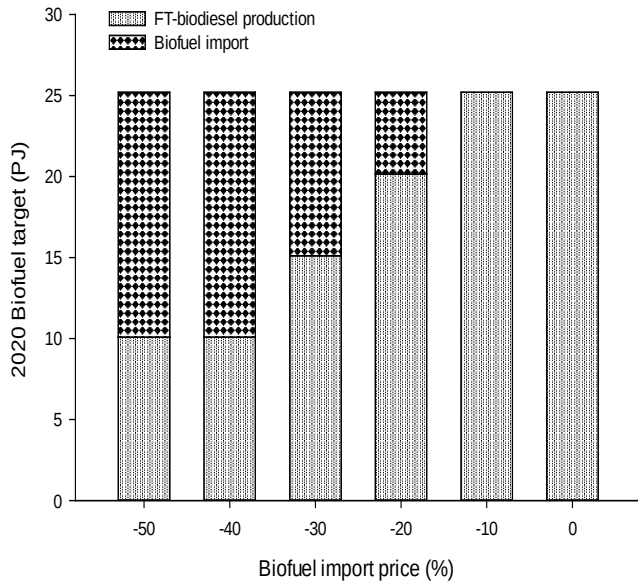
SMR price no influence as maximum utilization potential is reached

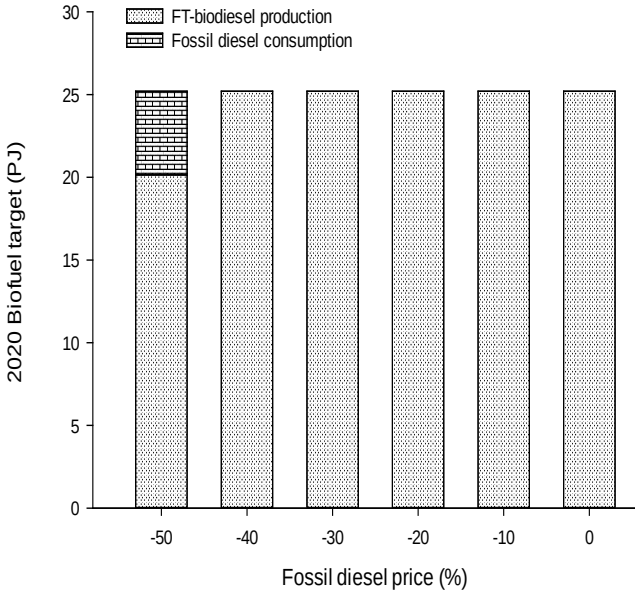
Costs and feedstock resource allocation

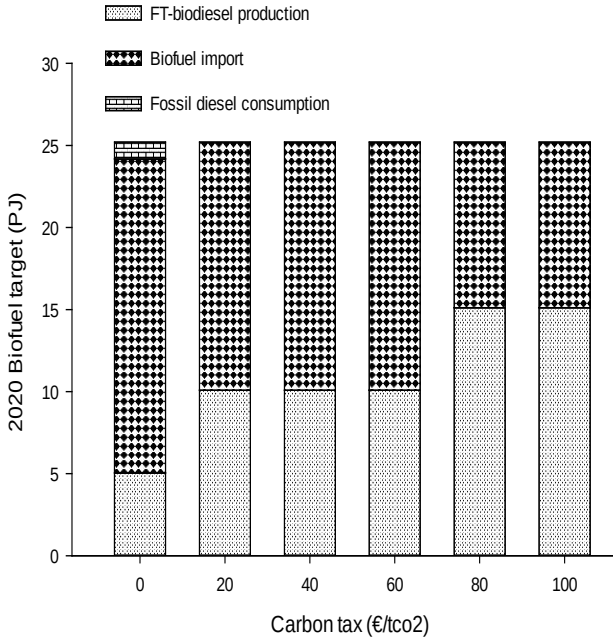
- 31 PJ of wood imports used when 40% decrease in cost
- Cost changes in energywood, pulpwood and sawmill residuals did not influence
- Because:
  - Expensive
  - Longer transport distance



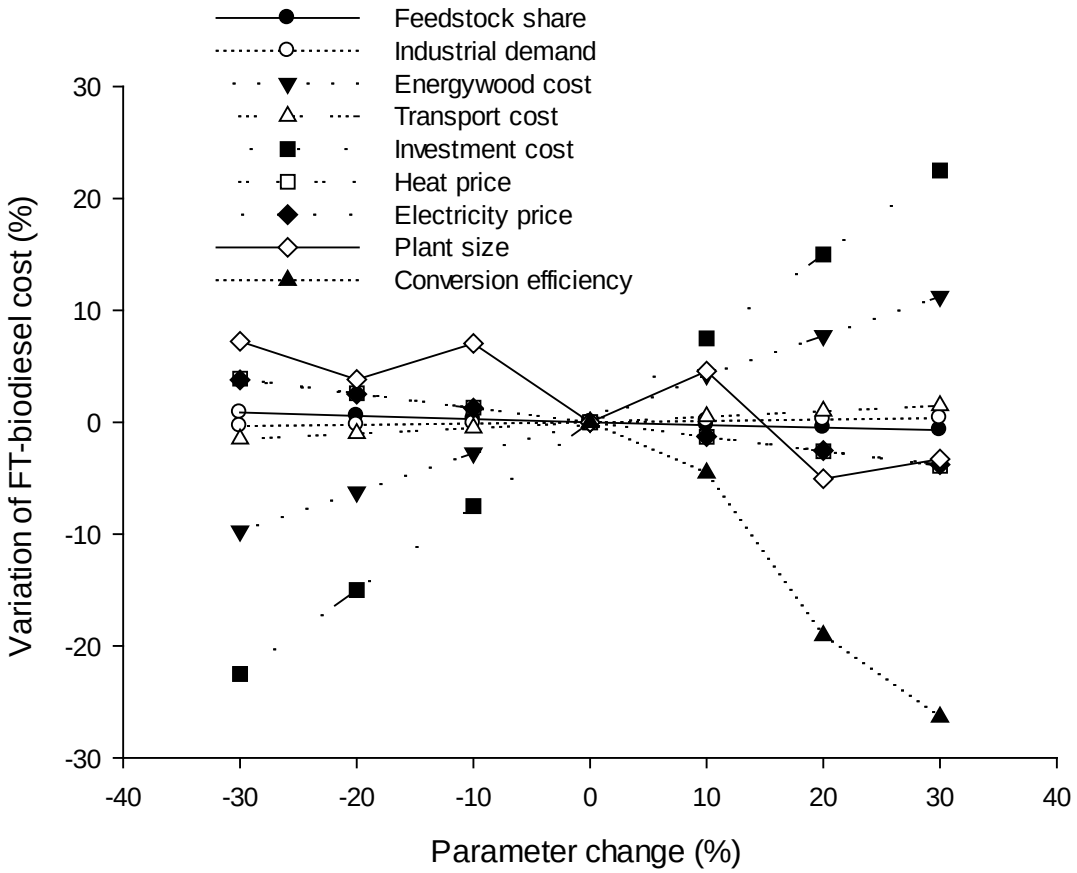
Influence of biofuel import price, fossil diesel price and carbon tax on the 2020 biofuel target



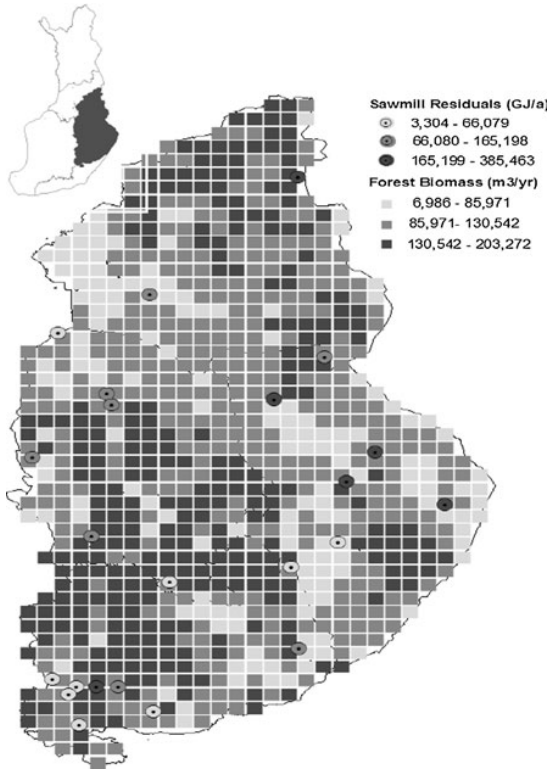


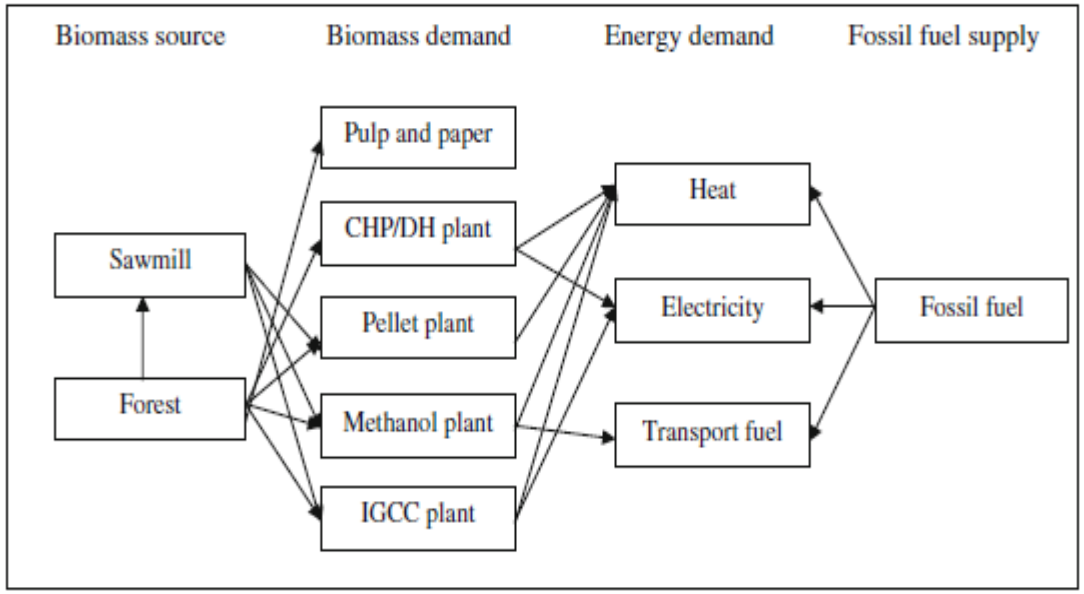


Parameter sensitivity analysis

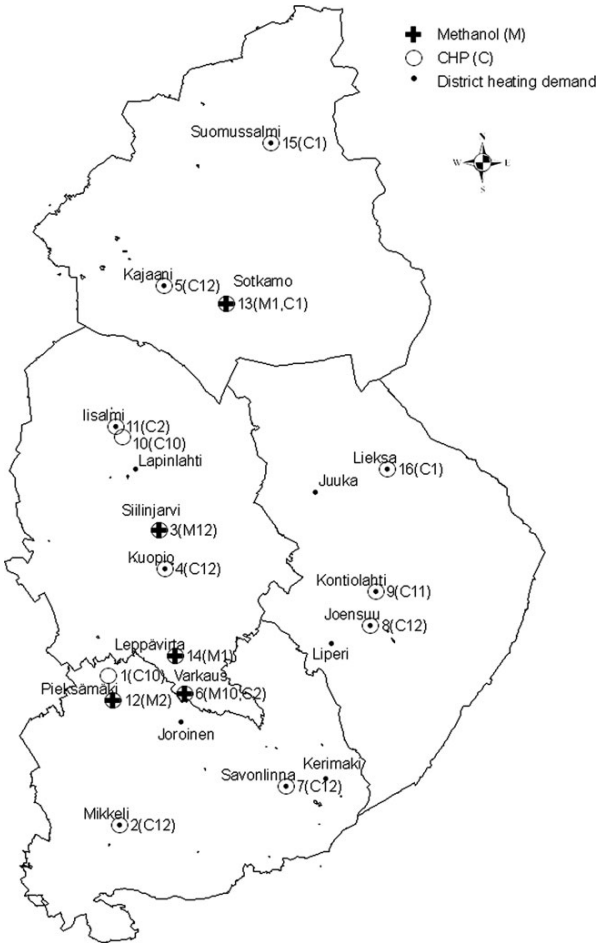


Eastern Finland - Model Scheme

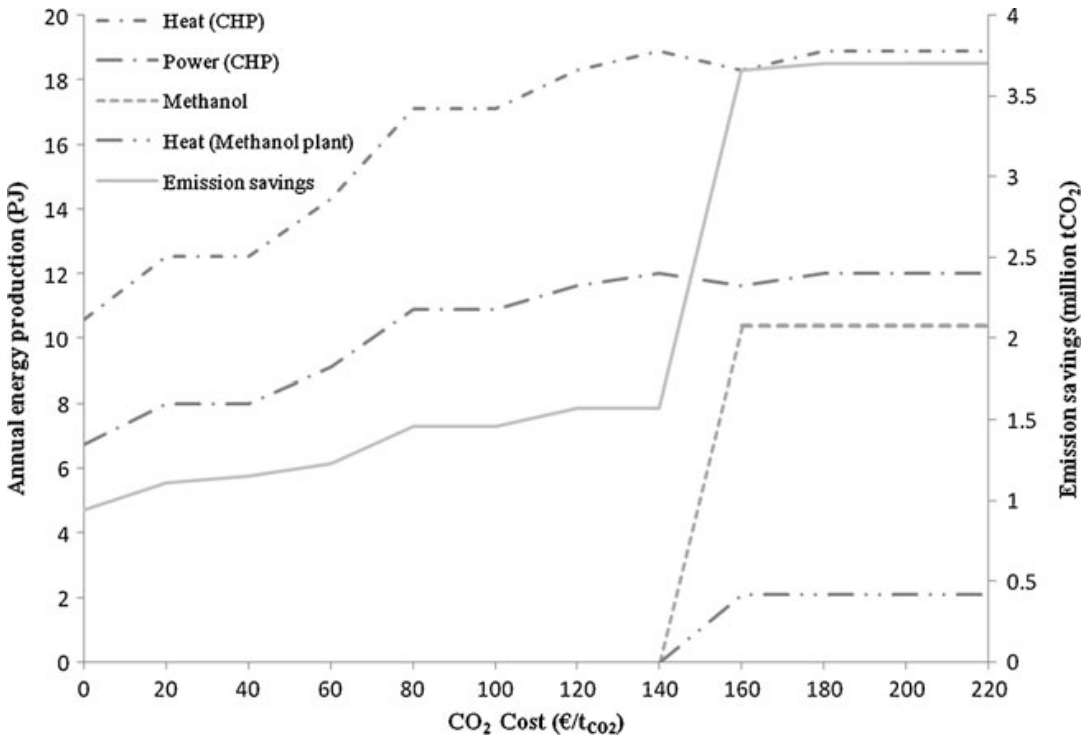




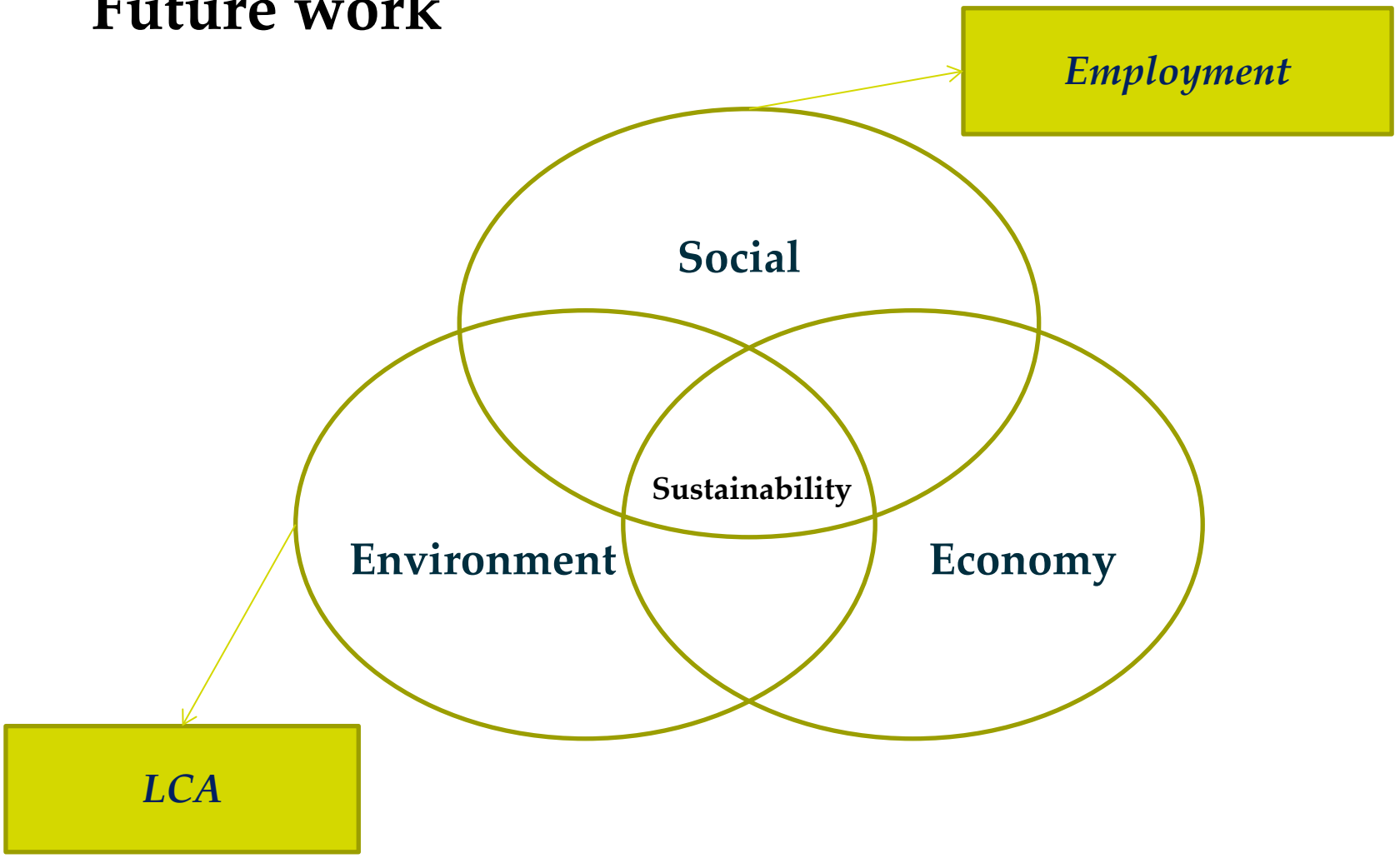
Optimal plant locations



Influence of CO_2 cost on technology diffusion and emission savings



Future work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