# Models for economic assessments of second generation biofuel production

Eirik Jåstad

Bio4fuel lunch meeting – 01.02.19

# My project

- Models for economic assessments of second generation biofuel production
- PhD at MINA
- Work package Energy, Fuels and Economics (WP1.3)

- Working with:
  - Economical aspects of biofuel production in the Nordic countries
  - Working with partial equilibrium models

# Papers

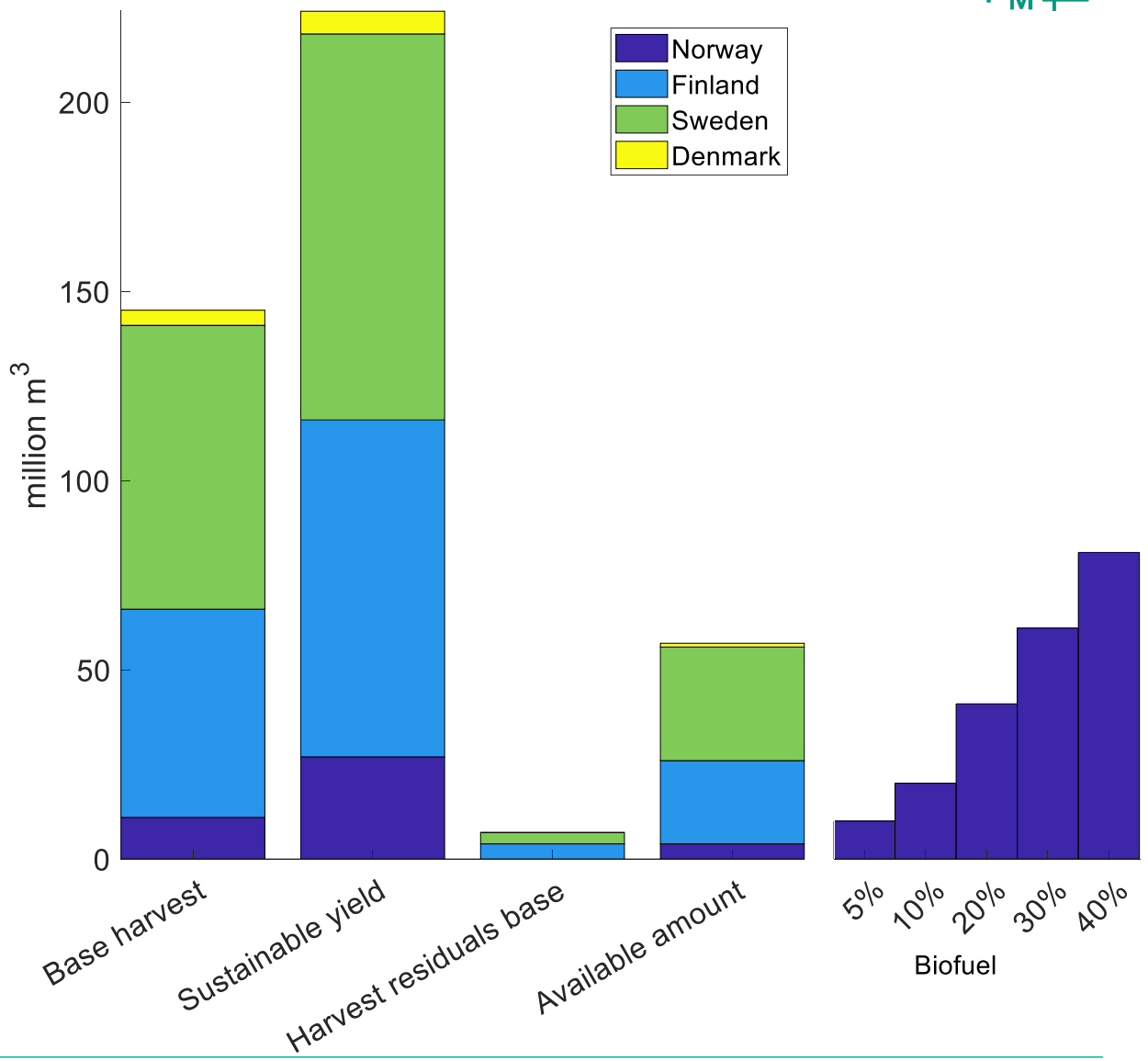
- I am finish with 3 studies.
  - Modelling of uncertainty in the economic development of the Norwegian forest sector (published)
  - Large-scale forest-based biofuel production in the Nordic forest sector: Effects on the economics of forestry and forest industries (published)
  - Modelling effects of policies for increased production of forest-based biofuel in the Nordic countries (submitted)
- Upcoming:
  - Greenhouse gas effects and energy system effects of various bioenergy scenarios
  - Optimal use of Nordic biomass; energy or industrial products?

Study:

# Modelling effects of policies for increased production of forest-based biofuel in the Nordic countries

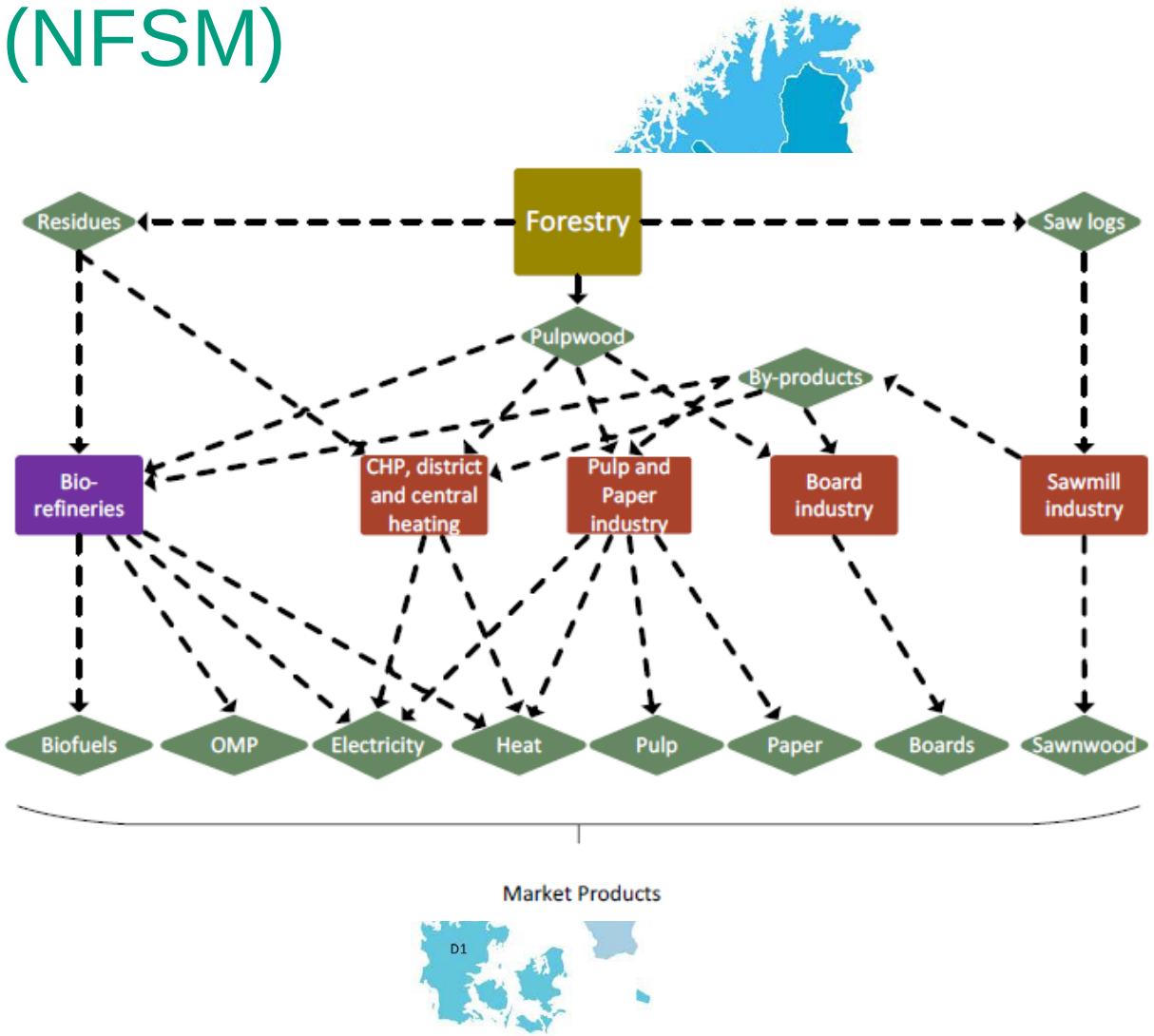
# Raw materials

- The Nordic forest sector harvest less roundwood than the growth
- Harvest less harvest residuals than possible



# Nordic Forest Sector Model (NFSM)

- Spatial, partial equilibrium model
- MILP
- Maximising consumer plus producer surplus
- 29 products:
  - Spruce, pine, and non-coniferous sawlogs and pulpwood
  - Harvest residuals
  - 13 final products




(Mustapha 2016)

# Main techno economic assumptions

- 58% efficiency

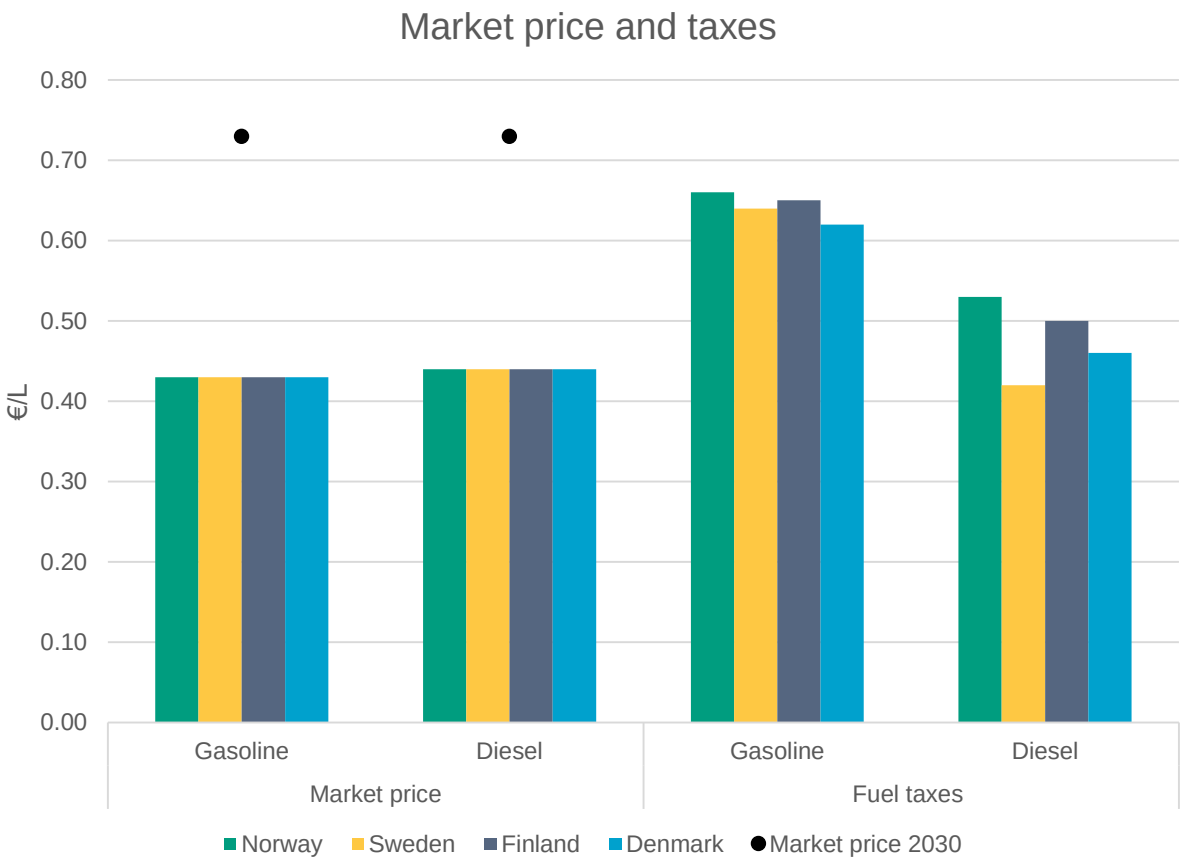
  => 1 m3 pulpwood = 120 L biofuel

- Biofuel can be made from:
  - Spruce, pine, and non-conifers pulpwood, residuals from sawmills, harvest residuals, and a mix of them

Assumed costs of different production units

| Production unit [million L/year] | 79 | 157 | 236 | 315 |
|---|---|---|---|---|
| Labour input [h/1000 L] | 0.57 | 0.44 | 0.38 | 0.42 |
| Fix costs [€/L/year] | 0.56 | 0.49 | 0.45 | 0.42 |
| Investment cost [€/L/year] | 0.40 | 0.34 | 0.31 | 0.29 |
| Input roundwood [million m3] | 0.66 | 1.3 | 2.0 | 2.6 |

# Liquid fuel in the Nordic countries




VAT and minimum selling price of diesel and gasoline

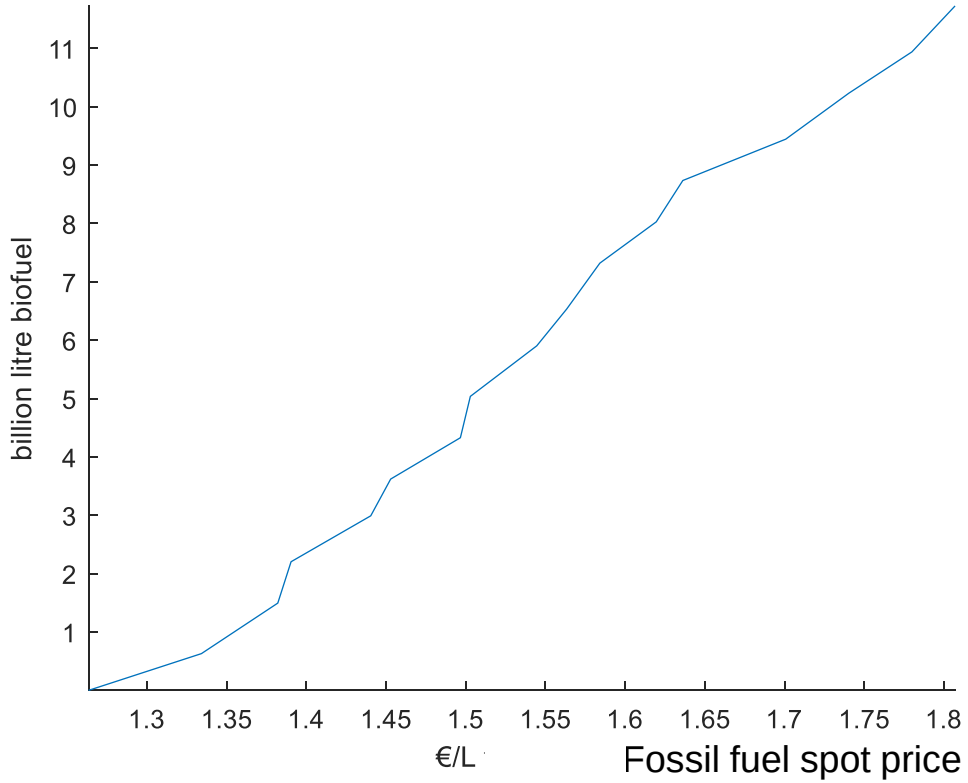
| | Norway | Sweden | Finland | Denmark |
|---|---|---|---|---|
| VAT [%] | 25 | 25 | 24 | 25 |
| | | | | |
| Selling price diesel [€/L] | 1.21 | 1.08 | 1.17 | 1.13 |
| Selling price gasoline [€/L] | 1.36 | 1.34 | 1.34 | 1.31 |
| | | | | |
| Fraction of biofuel today | 13% | ~30% | 7% | |
| Biofuel blending mandate 2020 | 20% | ~30% | 20% | 10% |
| Advanced biofuel (physic amount) | 4% | | | |

# Aim of the study

- Which subsidy/policy scheme is most economically efficient when introducing large scale biofuel plant

| Scheme | Abbreviation | Min level | Max level |
|---|---|---|---|
| **Feed in premium** | Feed-in | 0 €/L | 1.1 €/L |
| **Increase in fossil fuel tax** | Fossil inc | 0.73 €/L | 1.8 €/L |
| **Investment support** | Invest | 0% | 100% |
| **Quota obligation for all Nordic countries** | Quota | 0% | 50% |
| **Quota obligation each country independently** | Quota 2 | 0% | 50% |
| **Raw material support** | Raw | 0 €/$MWh_{input}$ (0 €/L biofuel) | 75 €/$MWh_{input}$ (1.25 €/L biofuel) |
| **Tax exemption** | Tax | 0% | 100% |

# Biofuel production vs. fuel price

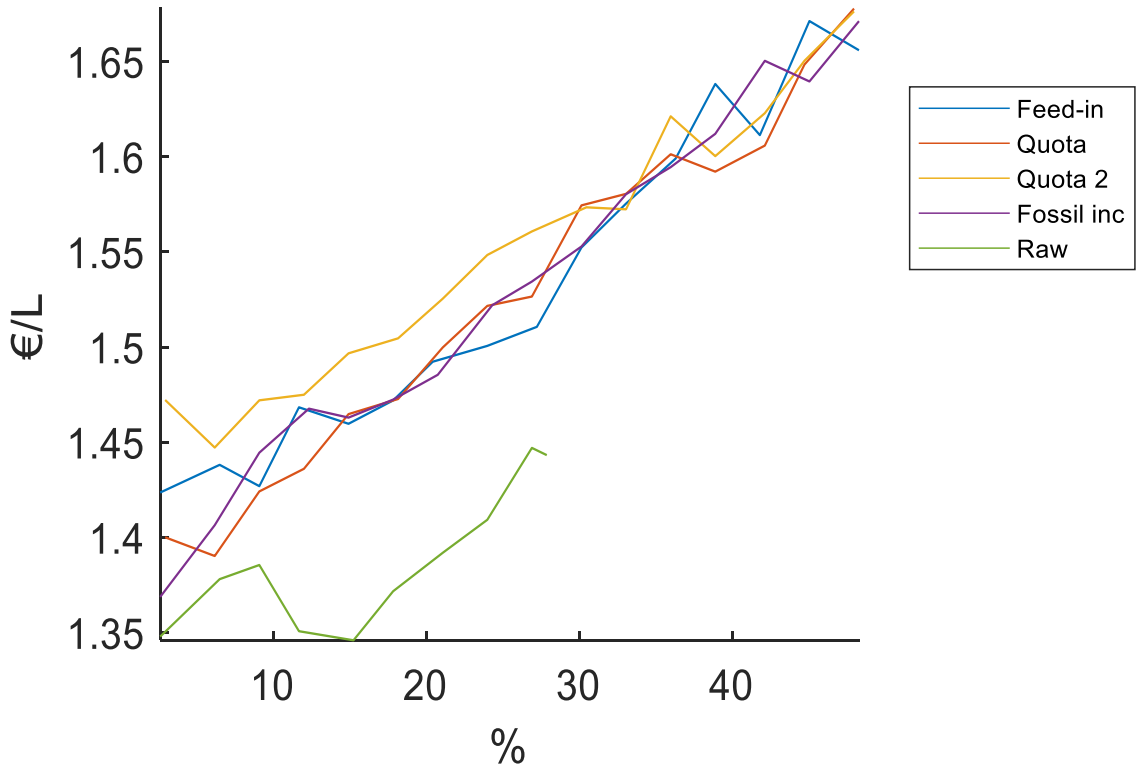



Fossil fuel spot price today: 0.44 €/L
Fossil fuel selling price today: 14 kr/L ~= 1.75 €/L

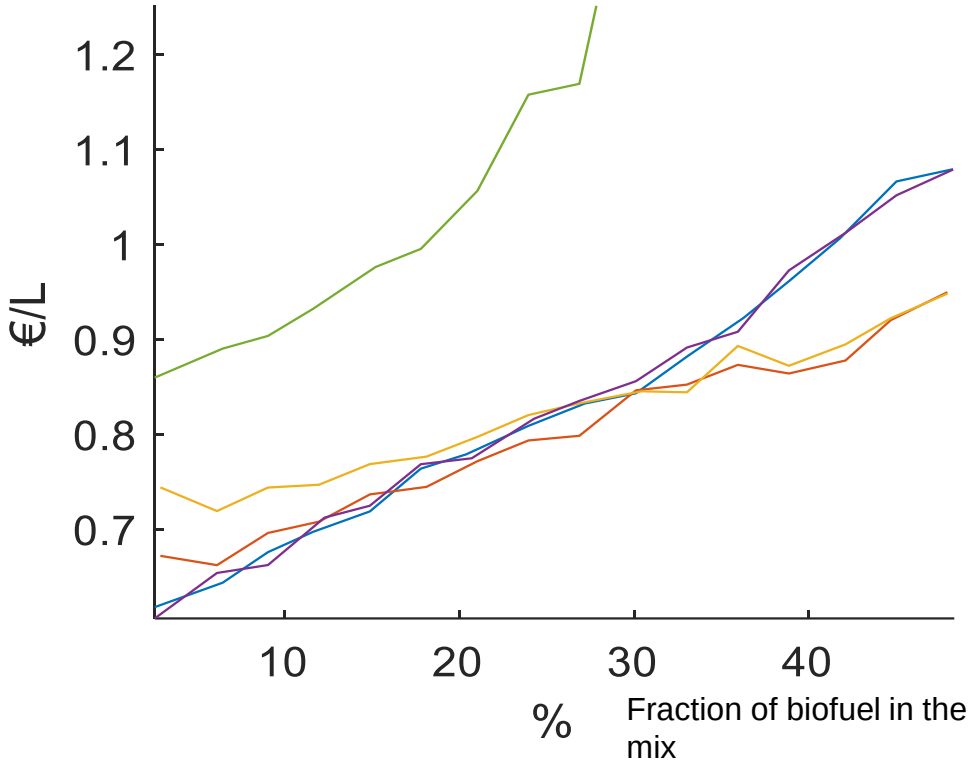
Annually Nordic fuel consumption: ~20 billion L

# Production costs and subsidy level

Modelled unit production costs




Modelled unit subsidy level




Fraction of biofuel in the Nordic fuel mix

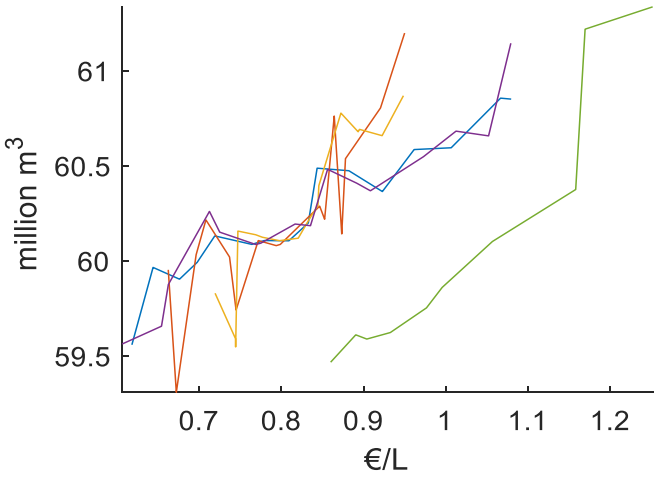
Fossil fuel reference price in 2030: 0.73 €/L

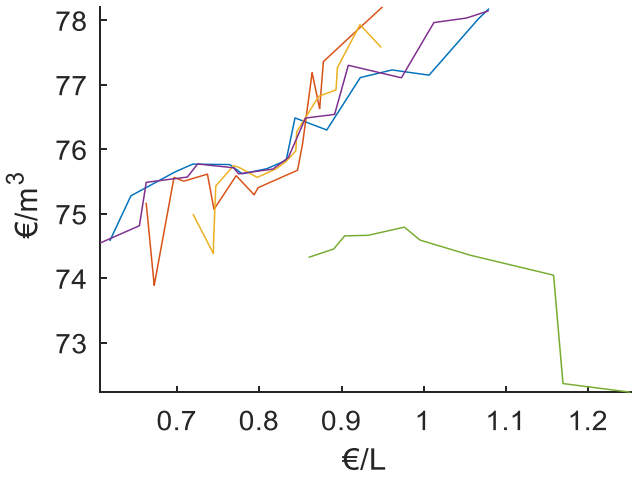
# Forest sector implications

Harvest

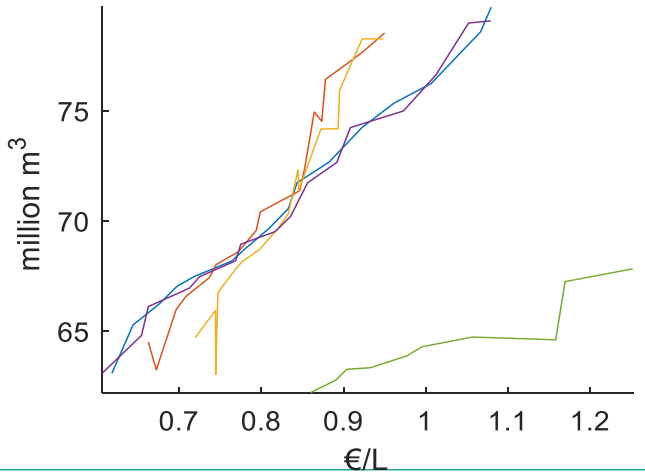
Price

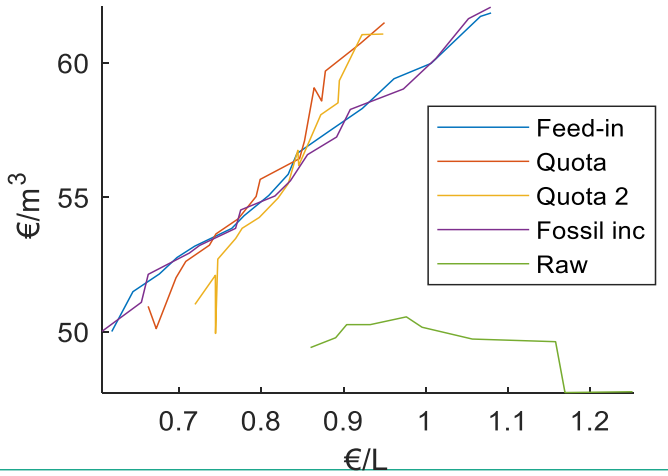
Sawlogs




Pulpwood




Subsidy level

# Conclusion

- Implementation of large-scale forest biofuel will influence the forest sector substantially and will be costly
- Impacts in general
  - Harvest levels (+)
  - Utilization of harvest residues (+)
  - Biomass imports (+)
  - Wood use/production in heating and pulp and paper (-)
- Breakeven price for forest based biofuel: 1.3 €/L
- Public support needed producing 2.4 billion L biofuel: 0.67-0.91 €/L