Large-scale forest-based biofuel deployment in the Nordic forest sector: Effects to the economics of forestry and forest industries

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My work in Bio4Fuels (WP1.3)

• Modelling and assessments of wood biomass markets and bioenergy policies

• Examples:
  – What are the forest sector value chain implications of large-scale biofuel production?
  – How may learning affect competitiveness?
  – What are the implications to raw material prices?
  – What are the best locations biofuel plants?
  – Impacts of policies
Biofuels in the Nordic countries

• So far, mainly first-generation biofuel
• Small amount of second-generation raw materials
Nordic targets and policies

- **Norway**
  - Quota obligation
    - At least 3.5% (2018), 8% (2020), 16% (2030) advanced biofuel with doublet counting
- **Sweden**
  - Quota obligation
    - CO2 reduction
    - Tax reduction
- **Finland**
  - Quota obligation
- **Denmark**
  - Quota obligation
- **EU**
  - Double counting
  - GHG emission reduction
  - Max 7 % food-based biofuel

### Targets for biofuel in the liquid fuel mix

<table>
<thead>
<tr>
<th></th>
<th>2018</th>
<th>2020</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norway</td>
<td>10%</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td>Sweden – diesel</td>
<td>19.3%</td>
<td>70%</td>
<td></td>
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<tr>
<td>Sweden - gasoline</td>
<td>2.6%</td>
<td>70%</td>
<td></td>
</tr>
<tr>
<td>Finland</td>
<td>15%</td>
<td>20%</td>
<td>30%</td>
</tr>
<tr>
<td>Denmark</td>
<td>5.75%</td>
<td>10%</td>
<td></td>
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<tr>
<td>European Union</td>
<td>10%</td>
<td>14%</td>
<td></td>
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</tbody>
</table>
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
Forest sector

- The Nordic forest sector harvest less roundwood than the growth
- Harvest less harvest residuals than possible
- 40% biofuel production from wood would require about 2/3 of the current harvest
Model study:

Scenarios and main 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

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>0%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production [billion L]</td>
<td>0</td>
<td>2.9</td>
<td>5.8</td>
<td>8.7</td>
<td>11.6</td>
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Model results:
Roundwood consumption

- Slightly increase at the sawmill
- Reduction at pulp and paper mills
  - Up to 33%
- Biofuel production need up to 98 million m³
  - 2/3 of the initial harvest
Model results:
Change in Nordic wood balance and pulpwood prices

- Increased harvest
- Harvest residues
- Increased import
- Reduced consumption
- Pulpwood price

Graph showing changes in million m³ and €/m³ with percentage increases.
Effects to forestry

- Increase in use of
  - Sawlogs 3%
  - Pulpwood 25%
  - Roundwood total 15%
  - Harvest residuals 500%

![Yearly harvest chart showing increase in use of sawlogs, pulpwood, and harvest residuals.](chart.png)
Model results:
Impacts to the net revenues in the forest sector

-4000 -3000 -2000 -1000 0 1000 2000 3000
0 % 10 % 20 % 30 % 40 %
million €

Sawmill Pulp and paper Forest owner Net

Norwegian University of Life Sciences
Model results:
Location of biofuel production (million liter/year)

![Graph showing biofuel production in million liters per year for different percentages across Norway, Finland, Sweden, and Denmark.]

- Norway
- Finland
- Sweden
- Denmark

Norwegian University of Life Sciences
Conclusion

• Implementation of large-scale forest biofuel will influence the forest sector substantially

• Impacts in general
  – Harvest levels (+)
  – Utilization of harvest residues (+)
  – Biomass imports (+)
  – Wood use/production in heating and pulp and paper (-)

• Increasing biomass prices should be accounted for at large deployment levels