Sustainable forest biomass resources for biofuel production in Latvia

Current and future woody biomass’ for energy
- Monitoring use and understanding technology
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Ministry of Agriculture of Republic of Latvia

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Sustainability criteria for the forest biofuel (if transformed to liquids)

- Biofuel should not be produced from biologically valuable areas:
  - natural forests, where forest management activities are forbidden or very limited;
  - *Natura 2000* and other protected areas, except cases, when biofuel production doesn't affect negatively protected species;
  - unmanaged biologically valuable grasslands.

- Biofuel should not be produced from organic soils:
  - swamps and wetlands, which is saturated with water for a long time;
  - forests on peat soils;

- Reduction of emissions of GHG after replacement of fossil fuel with wood should be at least 35% (*at least 50% after 2017*):
  - emissions from production of biofuel and efficiency of conversion comes into account.
Additional silviculture related sustainability criteria

- Poor mineral soils (mainly pine stands) are excluded from technically available stock of forest biofuel (harvesting residues and stumps).
- Naturally wet mineral soils are excluded as well, (harvesting residues and stumps) because slash is necessary for packing into strip-roads.
- Harvesting losses are taken in account (from 1% for firewood to 40% for stumps).
How sustainability criteria are applied to forest biofuel

- **Criteria corresponding to biologically valuable areas:**
  - protected areas with harvesting (no commercial thinning or clear-cut allowed) limitations are excluded from technically available stock of biofuel;
  - no attempts to produce biofuel from biologically valuable grasslands (while they are grasslands);

- **Criteria corresponding to wetlands and organic soils:**
  - drained and naturally wet organic as well as mineral wet soils are excluded from calculation (also due to silviculture reasons);

- **Reduction of GHG emissions:**
  - calculated taking into account emissions from fuel consumption during the production and supply of biofuel to a customer as well as from utilization of wood ash (compensatory fertilization);
  - average harvesting and supply conditions are used in calculation (terrain transport 500 m, road transport of chips 50 km, stump road transport 5 km), potential of concentration of forest management operations is not taken in account.
Other assumptions

- **Harvesting technologies:**
  - combination of harvester & forwarder for extraction, comminution at a road-side, truck with 2 containers with total capacity of 70 m$^3$ for transport of stumps and wood chips;
  - *Bracke C16.a* head is used for harvesting of small trees;
  - caterpillar excavator and ordinary forwarder are used for stump extraction.

- **Productivity figures:**
  - firewood and slash from clear-cuts – *Extraction of logging residues at LVM (Latvia's State Forests)*, LSFRI Silava & Skogforsk, 2004-2006;
  - small dimension trees and stumps – *Forest energy from small dimension stands, "infrastructure objects" and stumps*, LSFRI Silava & Skogforsk, 2006-2008;

- **Sustainability estimations:**
  - *Implementation of criteria of sustainability of biomass and elaboration of supporting action plan*, Vides projekti, LSFRI Silava, Latvia University of Agriculture.
Input data on forest lands

- Forest area in Latvia according to National statistical forest inventory from the total county area:
  - including forests and other reforested areas with number of trees < 1000 ha\(^{-1}\) – 57.4%;
  - including only forests and reforested areas with number of trees > 1000 ha\(^{-1}\) – 54.7%.

<table>
<thead>
<tr>
<th></th>
<th>forests</th>
<th>non-forest lands</th>
<th>total forested land</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area, th.ha</td>
<td>3535,73</td>
<td>252,17</td>
<td>3787,9</td>
</tr>
<tr>
<td>Stock, mill.(m^3)</td>
<td>650,16</td>
<td>4,06</td>
<td>654,22</td>
</tr>
<tr>
<td>Stock, (m^3) ha(^{-1})</td>
<td>183,88</td>
<td>16,08</td>
<td>172,71</td>
</tr>
</tbody>
</table>

- Distribution of forests according to land use:
Growing stock in the state and other forests

- Average stock in the state forests – **234 m³ ha⁻¹**.
- Average stock in other forests – **187 m³ ha⁻¹**.

<table>
<thead>
<tr>
<th>Age group</th>
<th>Other forests</th>
<th>State forests</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–10</td>
<td>10–20</td>
<td>21–30</td>
</tr>
<tr>
<td>31–40</td>
<td>41–50</td>
<td>51–60</td>
</tr>
<tr>
<td>61–70</td>
<td>71–80</td>
<td>81–90</td>
</tr>
<tr>
<td>101–120</td>
<td>111–120</td>
<td>&gt;120</td>
</tr>
</tbody>
</table>

![Bar chart showing growing stock by age group and forest type]
Input data for harvesting in 2007 according to the State Forest Service

- **9,8** mill.m$^3$ (132 th.ha) in total, including 4,4 mill.m$^3$ (67 th.ha) in the state forests and 5,4 milj.m$^3$ in other forests (65 th.ha);
- **8,1** milj.m$^3$ (38 tūkst.ha) harvested in clear-cuts, 1,7 milj.m$^3$ (94 th.ha) in other cuts;
- average harvesting stock 74 m$^3$ ha$^{-1}$ (*66 m$^3$ ha$^{-1}$ in state forests and 82 m$^3$ ha$^{-1}$ in other forests*);
- average harvesting stock in clear-cuts is **211** m$^3$ ha$^{-1}$ (*267 m$^3$ ha$^{-1}$ in state forests and 182 m$^3$ ha$^{-1}$ in other forests*),
- average harvesting stock in other cuts is **18** m$^3$ ha$^{-1}$ (*17 m$^3$ ha$^{-1}$ in state forests and 20 m$^3$ ha$^{-1}$ in other forests*).
Increment of carbon in timber biomass and losses due to harvesting

- Carbon removal and emission in 2007:
  - emission due to harvesting – 2,77 mill.t of carbon;
  - increment of timber biomass – 8,05 mill.t of carbon.
Types of evaluated forest biofuels

- **Already utilized resources:**
  - firewood, both from clear-cuts and other harvesting;
  - harvesting residues from clear-cuts.

- **Easily accessible but not-utilized or partially used resources:**
  - stumps from clear-cuts;
  - small dimension trees from the forest infrastructure (*drainage ditches, road-sides*).

- **Costly and not-utilized resources:**
  - small dimension trees from pre-commercial thinning;
  - small dimension undergrowth trees from commercial thinning and clear-cut;
  - mixed size trees and bushes from woody vegetation on abandoned farmlands (*harvesting takes place, generally, on account of land owners to convert land to something else*).
Forest biomass resources in Latvia, excluding reforested farmlands

- **Potential resources** – 3,8 mill.t yearly:
  - harvesting stock and area in 2007 is taken in account;
- **Sustainable resources** – 3,2 mill.t yearly:
  - excluding wet soils, organic soils and poor sandy soils;
  - all firewood is assumed sustainable as it is side product of roundwood production.
- **Technically available resources** – 2,4 mill.t yearly:
  - excluding harvesting and other losses;
- **Technically available resources is about 75% of sustainable part and 61% of total potential in 2007.**

<table>
<thead>
<tr>
<th>Type of resources</th>
<th>Firewood</th>
<th>Clear-cut</th>
<th>Thinning</th>
<th>Forest infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>undergrowth</td>
<td>stumps</td>
<td>slash</td>
</tr>
<tr>
<td>Potential (t yearly)</td>
<td>550 537</td>
<td>257 548</td>
<td>1 349 572</td>
<td>229 985</td>
</tr>
<tr>
<td>Sustainable resources (t yearly)</td>
<td>550 537</td>
<td>170 211</td>
<td>1 231 979</td>
<td>154 997</td>
</tr>
<tr>
<td>Available amount (t yearly)</td>
<td>545 031</td>
<td>119 148</td>
<td>739 187</td>
<td>108 498</td>
</tr>
<tr>
<td>Harvestable stock (t ha⁻¹)</td>
<td>5</td>
<td>2</td>
<td>24</td>
<td>2</td>
</tr>
</tbody>
</table>
Sustainable forest biomass resources, excluding abandoned farmlands

- Forest infrastructure: 1%
- Slash in thinning: 5%
- Undergrowth: 5%
- Small trees in thinning: 12%
- Stumps in clear-cut: 31%
- Slash in clear-cut: 23%
- Firewood: 23%
Potential of naturally reforested farmlands

- Naturally afforested farmlands in Latvia:
  - total area 353 th.ha, growing stock 3,6 mill.m³;
  - characteristic indicators (high variability of species and density, different size and form of separate fields).

- Biofuel potential:
  - thinning and reconstruction of the stands would lead to production of at least 0,6 mill.t of biofuel in short term and 5 mill.t in long term during clear-cut;
  - grey alder and aspen may be used as a coppice crops for direct solid biofuel production in 15-30 years rotation cycle.
Costs and emissions of the forest biofuel production

- **C emissions from biofuel production:**
  - max. 46 th.t yearly (12,5 kg t of biomass),
  - 0,4-14,6% (3,6% in average) from carbon stock in biofuel.

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<tr>
<td></td>
<td>undergrowth</td>
<td>slash</td>
<td>stumps</td>
<td>slash</td>
</tr>
<tr>
<td>t C yearly</td>
<td>272 516</td>
<td>59 574</td>
<td>268 600</td>
<td>369 594</td>
</tr>
<tr>
<td>MWh yearly</td>
<td>2 888 665</td>
<td>631 485</td>
<td>2 847 163</td>
<td>3 917 692</td>
</tr>
<tr>
<td>Time consumption for production and supply (E0 hours per ton)</td>
<td>0,25</td>
<td>9,69</td>
<td>0,98</td>
<td>1,38</td>
</tr>
<tr>
<td>Carbon emissions during production (kg per ton)</td>
<td>1,78</td>
<td>50,97</td>
<td>8,54</td>
<td>17,26</td>
</tr>
<tr>
<td>Production topics (EUR per ton)</td>
<td>10,7</td>
<td>-</td>
<td>43,1</td>
<td>61,9</td>
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<tr>
<td><strong>Sum of carbon emissions:</strong></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>tons yearly</td>
<td>979</td>
<td>8 676</td>
<td>6 555</td>
<td>21 265</td>
</tr>
<tr>
<td>kg per ton of C in biofuel</td>
<td>3,59</td>
<td>145,64</td>
<td>24,41</td>
<td>57,54</td>
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<tr>
<td>kg MWh⁻¹</td>
<td>0,34</td>
<td>13,74</td>
<td>2,30</td>
<td>5,43</td>
</tr>
<tr>
<td>Carbon in biofuel and consumed fossil fuel (C_in / C_out)</td>
<td>0,36%</td>
<td>14,56%</td>
<td>2,44%</td>
<td>5,75%</td>
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Utilization of wood ash

- Maximal amount of wood ash production – 124 th.t yearly (0,9 t ha\(^{-1}\) of harvested area in average);
- Area necessary for utilization of wood ash:
  - according to regulations of Cabinet of Ministers No 362 on utilization of wastewater sludge 87 th.ha of forests or plantations are necessary to utilize all amount of wood ash (area of clearcuts in 2007 38 th.ha, area of selective cuts and thinnings – 94 th.ha),
  - dosage of wood ash – 7,5 t ha\(^{-1}\) (once per 5 years), limiting element – cadmium (Cd),
- Costs – max. 3,1 mill.EUR yearly (1,2 EUR t of biomass);
- Additional carbon emissions – max. 269 t yearly (0,1 kg t of biomass).
Potential of intensification of forest biomass production

- Total sustainable potential of intensification of production of forest biomass is 5 mill. MWh yearly:
  - there is no need to increase harvesting stock or forest management approach to reach that target;
- The most significant potential resources:
  - stumps (44%);
  - small trees in early thinning (15%);
  - slash in clear-cut (14%);
  - management of abandoned farmlands (13%).
Forest industry is an important guaranty for sustainability

- Traditional forestry with biofuel production
- Production of only biofuel

<table>
<thead>
<tr>
<th>Selling of biofuel, EUR ha⁻¹</th>
<th>Selling of roundwood, EUR ha⁻¹</th>
<th>Total management costs, EUR ha⁻¹</th>
<th>Profit before taxes</th>
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<tr>
<td></td>
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<td>Traditional forestry with biofuel production</td>
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Age structure of Latvian forests

Area of pine, spruce and birch stands

- State forests
- Other forests
Consequences of carbon removal and coming Copenhagen decisions

Sum of removal and emission 1990-2007 according different accounting methods

- Gross – net method
- Net – net method
- Bar – max. emissions
- Bar – min. emissions
- Bar – 20% of increment is artificial

Gg CO₂
Research and development as guarantee of sustainability

- Identified problems in Latvia:
  - too many laud voice based (non-forestry) expert assumptions;
  - too few long sustainability targeted forest research;
  - too few international cooperation in forest research to evaluate climatic and other trans-boundary issues.

- Model of role of R&D in biofuel sustainability:
Thank you for attention!

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