Wood resources for bioenergy

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NIBIO’s main areas of expertise:

Agriculture and plant health, environment and climate, surveys, land use, genetics, forestry, economics and social sciences
Covering Norway
Bioenergy in Norway from Forest

- Total Bioenergy Consumption
- Pellets and Briquettes
- Chips
- Biofuel
- Bioenergy in the Industry
- Firewood

TWh/year

2012
2020
2030

Skog, 22
Volume, Growth and Harvest – Forest in Norway

- **Volume**: The green line shows the accumulation of forest volume over time, increasing steadily from 1920 to 2010.
- **Annual growth**: The light green line indicates the annual growth rate, which also shows a steady increase.
- **Annual harvest**: The brown line represents the annual harvest, fluctuating around the 100 million m³ mark for most of the period, with a notable increase towards 2010.
Rogaland, Hordaland, Sogn og Fjordane and Møre og Romsdal Harvest 21 % of the growth, while Østlandet harvet 56 %.
Skogsbrensel sortimenter

- Stammeved
- Heltre
- GROT (greiner og topper)
- Stubber
Supply chain configuration
25% of forest in Norway in steep terrain

- The trees are harvested at the landing
- A lot of residues at the landing
- Handling of the residues is a challenge
- Storage and drying of residues is a challenge - it rains a lot in West-Norway
- No heating plants in Norway can utilize only forest residues
GROT

Forest residues (grot) is utilized to a very limited extent today.
- The subsidies has been removed
- Only from construction sites
- No heating plants can use only forest residues.
- The chips includes a lot fines
- High energy content
- Difficult to store

To much fines in grot!
Forest road & chipping

Forest road terminals is not built for chipping!
Whole tree harvesting

The production is reduced to about 0.

• However some production from roadsides and to keep the landscape open
• Storage and drying of whole tree materials is ok!
• Good quality chips
Terminals are important

- Most of the forest chips has been on a terminal
- The terminal has a covered storage
- Increases the chip quality
- More secure supply
- Efficient chipping and transport
Wood fuel quality, from forest to the oven

- Inherent properties of the tree
  - Spruce, Pine and Birch
  - Stem, bark, branches
- Moisture content
- Density
- Particle size distribution (Fines)
- Heating value
- Ash (amount, chemical content, melting point)
- Chemical content

Photo: Leif Kjøstelsen
Fin fraksjonen

Grotflis viste større variasjon i mengden av finstoff i forhold til stammevedflis.
Fuktighet i flismaterialet

<table>
<thead>
<tr>
<th>Råstoff</th>
<th>Fuktighet (vekt-%)</th>
<th>sd</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stammeved</td>
<td>39.0</td>
<td>8.9</td>
<td>37</td>
</tr>
<tr>
<td>Heltre</td>
<td>39.9</td>
<td>9.5</td>
<td>46</td>
</tr>
<tr>
<td>Grot</td>
<td>49.8</td>
<td>8.0</td>
<td>19</td>
</tr>
<tr>
<td>Bakhon</td>
<td>39.3</td>
<td>9.8</td>
<td>4</td>
</tr>
<tr>
<td>Bark</td>
<td>69.9</td>
<td>NA</td>
<td>1</td>
</tr>
<tr>
<td>Stubber</td>
<td>50.6</td>
<td>NA</td>
<td>1</td>
</tr>
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</table>

Grot fuktigere enn heltre og stammeved.
**Energitetthet**

<table>
<thead>
<tr>
<th>Råstoff</th>
<th>Energitetthet (kWh/lm³)</th>
<th>sd</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stammeved</td>
<td>753</td>
<td>47</td>
<td>25</td>
</tr>
<tr>
<td>Heltre</td>
<td>791</td>
<td>77</td>
<td>40</td>
</tr>
<tr>
<td>Grot</td>
<td>826</td>
<td>89</td>
<td>15</td>
</tr>
<tr>
<td>Bakhon</td>
<td>801</td>
<td>86</td>
<td>3</td>
</tr>
<tr>
<td>Bark</td>
<td>490</td>
<td>NA</td>
<td>1</td>
</tr>
</tbody>
</table>

Høyeste energettetthet (1048 kWh/lm³) ble beregnet på grot med en fuktighet på 39,8 %.
Askeinnhold

- Grot inneholdt mer aske enn heltre- og stammevedflis. Stammevedflis inneholdt minst aske.
- Det var en større variasjon i askeinnhold i grot enn i stammevedflis.
Annual utilization of grot in Norway

Costs for production of chips from GROT: ≥ 16 øre/kWh

Harvest of grot: costs ≤ 30 øre/kWh:
- 12 mill m³ → ca 7 TWh/år
- 17 mill m³ → ca 10 TWh/år
Energy prices

Sammenlikning energipriser til næringsmarkedet

Gjennomsnitt september 2017 (Uke 36 - 39)
Energiforbruk ved høsting av skogsbrønsel

<table>
<thead>
<tr>
<th></th>
<th>Stammeved</th>
<th>Heltre</th>
<th>GROT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input</td>
<td>66</td>
<td>63</td>
<td>52</td>
</tr>
<tr>
<td>Output</td>
<td>2 035</td>
<td>2 298</td>
<td>2 035</td>
</tr>
</tbody>
</table>

Stammeved: 3,2 %
Heltre: 2,8 %
GROT: 2,5 %
Some thoughts...

- The last ten years more than 2 mill m³ with chips annualy to heating plants.
- Woodresources have changed from grot and whole trees to stemwood.
- In the future biofuel from wood (and heat and power).
Næringsfordeling i treet

Kjersti H. Hanssen

45 år gammelt furubestand. Etter E. Målkönen (1976)
Askeegenskaper

– Elementsammensammensetning
  – Næringsstoffer (Ca, Mg, K, P, Na)
  – Tungmetaller (Cu, Pb, Cd, Hg,...)
– Partikkelstørrelse og tetthet
– Innhold av organisk karbon og forurensende organiske forbindelser
– Utlakingsegenskaper
– pH