The cost calculators for sustainable procurement of logging residues, thinning wood and stumps for fuel

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- The procurement cost calculators
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The history of the procurement cost calculators

- 2001, "Cost factors and large scale procurement of logging residues" project
- 2004, "Development of chip production from young forests" project
- 2004, "Harvesting of stumps and processing of forest energy wood" project
- 2005, "Harvesting alternatives and cost factors of delimbed energy wood" project
- 2007, "Large-scale forest fuel supply solution through a regional terminal network" project
- 2011, "METKA - Forest energy profitably" project
Forest chips calculators – Simple tools for the stand level cost and sensitive analysis*

The primary aim of the Excel-based cost calculators is to familiarize the user with the various ways different factors affect cost of forest chips. The calculator enables the user to investigate how changes in processed material or in the productivity and hourly cost of machines influence the harvesting cost of the whole system.

**Characteristics of forest stand**

<table>
<thead>
<tr>
<th></th>
<th>Set value</th>
<th>Presumed value</th>
<th>Model uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area, ha</td>
<td>2,0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forwarding, m</td>
<td>150</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transporting, km</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accumulation of small sized energywood, m³/ha</td>
<td>600</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pine, % of accumulation</td>
<td>33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spruce, % of accumulation</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others, % of accumulation</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Birch, % of accumulation</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moisture of fresh whole tree, %</td>
<td>55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moisture of seasoned whole tree, %</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loss of seasoning, %</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seasoning time at roadside storage, months</td>
<td>88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interest of capital, %</td>
<td>6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Set value Presumed value Model uses

**Results**

Quantities of delimbed energy wood on site

<table>
<thead>
<tr>
<th></th>
<th>m³</th>
<th>MWh</th>
<th>m³/ha</th>
<th>MWh/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh energy wood</td>
<td>240</td>
<td>490</td>
<td>40</td>
<td>82</td>
</tr>
<tr>
<td>At roadside storage seasoned energy wood</td>
<td>238</td>
<td>519</td>
<td>40</td>
<td>86</td>
</tr>
</tbody>
</table>

Cost at power plant by different supply chain methods:

<table>
<thead>
<tr>
<th></th>
<th>Fresh wood, €/m³</th>
<th>Fresh wood, €/MWh</th>
<th>Dry wood, €/m³</th>
<th>Dry wood, €/MWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chipping at RS &amp; delivery to plant</td>
<td>16.2</td>
<td>17.7</td>
<td>38.3</td>
<td>17.5</td>
</tr>
<tr>
<td>Chipping at terminal &amp; delivery from terminal to plant</td>
<td>18.6</td>
<td>18.9</td>
<td>40.6</td>
<td>18.6</td>
</tr>
</tbody>
</table>

The main work stages of the procurement cost calculators

Organization of stump and rootwood procurement activities
- Uprooting of stumps
- Forwarding of stumps
- Transportation of chips by truck
- Communion at the landing
- Communion at the use facility

Organization of logging residue procurement activities
- Piling of logging residues integrated into roundwood harvesting
- Forwarding of loose residues
- Transportation of residue logs & loose residues
- Communion at the landing
- Communion in the terrain
- Communion at the use facility

Organization of small-sized thinning wood procurement activities
- Bundling of logging residues
- Forwarding of small-sized energy wood
- Transportation of small-sized energy wood by truck
- Communion at the landing
- Communion at the use facility

Organization of delimbed energywood procurement activities
- Manual felling-bunching of thinning wood
- Forwarding of delimbed energywood
- Transportation of delimbed energywood
- Communion at the landing
- Communion at the terminal
- Transportation of chips by truck

The procurement costs at the end use facility: € per solid cubic meter or € per MWh

Organization of fuel chips procurement activities
- Uprooting of stumps, piling of branches & cutting of trees
- Forwarding of stumps, logging residues & small trees
- Chipping in terrain, at the landing, in the terminal or at the plant
- Transporting of processed & unprocessed material

METLA
Forest Knowledge Expertise Welfare

22.3.2011
Procurement costs on the basis of the stand data*

In the stand data sheet, the user can insert specific information about:

- Forwarding (m) & transporting (km) distances
- Moisture content of fresh/dried energy wood (%)
- Seasoning time (months) & loss at the roadside storage (%)
- Area of the stand (ha)
- Tree and stump size (dm³)
- Accumulation and recovery rate of biomass (m³/ha or %)
- Interest of capital (%)

To help the estimation of the volume of the harvested trees there is a separate cell, where the volume of different tree species can be calculated by the DBH and length.

Forest chips energy content is calculated as a function of moisture content and wood fuels heating values.

The supply chain information sheets are included default values, for example for the:

- Overhead costs for each supply system (€/m³)
- Covering costs of energy wood at the roadside storage (€/m³)
- Stumpage price of the energy wood (€/m³)
- Hourly cost of machines and trucks (€/h)
- Load capacity for forwarding and transporting (m³)
- Transferring cost of machines (€/turn)
- Loading and unloading time for transporting (h)
- Chippers productivity and chipping costs (m³/h & €/m³)

In the supply chain information sheet the user can, if needed, change the default values. This is because in reality the machines and procurement systems calculation basics and situations can vary significantly.
The sheet of the results

- The cost of each step of the procurement chain and the total cost at end use facility are expressed as either €/m³ (solid cubic meter) or €/MWh

Overview from the result sheet in the cost calculator for roundwood chips procurement

Results

<table>
<thead>
<tr>
<th>Quantities of harvested stump wood on site</th>
<th>Stumps, m³</th>
<th>Stumps, MWh</th>
<th>m³/ha</th>
<th>MWh/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stumps, m³</td>
<td>120</td>
<td>260</td>
<td>60</td>
<td>130</td>
</tr>
</tbody>
</table>

Cost of the chips at the plant:

<table>
<thead>
<tr>
<th>Supply chain based on comminution at the terminal</th>
<th>Chips, €/m³</th>
<th>Chips, €/MWh</th>
<th>Harvesting time consumption per hectare:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stump extraction</td>
<td>14.4</td>
<td>823.1</td>
<td></td>
</tr>
<tr>
<td>Stump forwarding</td>
<td>8.8</td>
<td>517.1</td>
<td></td>
</tr>
</tbody>
</table>

Overview from the result sheet in the cost calculator for stumpwood chips procurement
The supply chains of the cost calculators: Stumps*

The supply chains of the calculators: Logging residues*

The supply chains of the calculators: Whole-trees*

The supply chains of the calculators: Delimbed longwood*

Photos: E.Salo, J.Heikkilä & J.Laitila


Internet applications of the cost calculators:
http://www.afo.eu.com/

Cost calculator for wood chip procurement from thinnings
Copyright: Juha Laitila, Finnish Forest Research Institute

This calculator enables you to examine and demonstrate, how the quality of the woodfuel or productivity and hourly costs of machines influence the total costs of the whole supply chain.

With the calculator, you are able to compare the procurement costs of wood chips produced by four different harvesting chains:
- whole tree harvesting with harwarder
- whole tree harvesting with feller-buncher
- manual whole-tree harvesting with chain saw
- delimbed energy wood harvesting with feller-buncher

Instructions:
Set values into the boxes with light green background. The calculator applies the values in boxes with dark green background. As you insert digits in light green boxes, the dark green boxes will be updated upon your action.

Choose country (This affects the default values of costs and productivity):
English, users guide (pdf)
Deutsch
Francais
Latvija
Slovensko
Suomi, käyttöohje (pdf)

Cost calculator for wood chip procurement from regeneration felling sites
Copyright: Juha Laitila, Finnish Forest Research Institute

This calculator enables you to investigate how the changes in processed material or in the productivity and hourly costs of machines influence the procurement cost of the whole chain.

You are able to compare the procurement costs of wood chips produced by three different harvesting chains:
1. loose logging residue harvesting with forwarder
2. loose logging residue harvesting with farm tractor
3. logging residue bundling and forwarding with forwarder

For each chain there are three versions for the organisation of harvesting:
1. Forwarding and delivery of fresh, green logging residues straight to combustion
2. Drying of logging residues at the stand before (bundling) forwarding and combustion
3. Seasoning of green residues at the road side storage prior to combustion

Set values into the boxes with light green background. The calculator applies the values in boxes with dark green background. In case you insert digits in light green boxes, the dark green boxes will be updated upon your action.
Internet applications of the cost calculators:

http://www.pelletime.fi

Designing of Fuel Supply-Chains

FINNISH FOREST RESEARCH INSTITUTE

- Cost calculations to demonstrate the costs for fuel supply chains.
- Depending on the raw material used, costs of fuel supply to the end using facility can be estimated and calculated according to the input data.
- Small and medium scale wood fuel supply chains can be designed according to the needs of the user.
- Advice for the production of high quality raw material.

“One of the major benefits is that some of the uncertainty of forest based raw material costs delivered to the plant can be minimized. Furthermore this service gives information about the availability of raw material in a given area and the most economic suitable technical solution to bring the raw material from the forest to the plant”. 
Conclusions

• The productivity functions of different harvesting methods, gained from the several work & field studies, are revised into an easy-to-use form in the cost calculators.

• The cost calculators are very useful tool to transfer valuable research and development knowledge into practice.

• The cost calculators were originally developed to serve research needs, but they are also suitable for companies, contractors and teaching purposes. The feedback from the users has been positive.
Conclusions

• In the calculators the analysis is made at the stand level, which thus limits the amounts of cost factors and variables

• Matching the right type of supply chain to the right site requires careful GIS-based availability studies and cost analysis

• The cost calculators are available for free in Finnish, French & English
Thank you for your attention!!!

The cost calculators are available for free in Finnish, French & English at by contacting e-mail: juha.laitila@metla.fi