THE ADDED VALUE OF A TOTAL QUALITY-DRIVEN OPTIMAL BIOMASS SUPPLY CHAIN

KEY RESULTS OF A STUDY MADE IN THE CLEANTECH FINLAND BIOENERGY (CFB) DEVELOPMENT PROJECT

15.12.2014

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CONTENT

• Why a total quality-driven optimal biomass supply chain is needed?

• What is a total quality-driven optimal biomass supply chain?

• How much is the benefit / the value added?

• Wrap up - Who to contact?
A TOTAL QUALITY-DRIVEN OPTIMAL BIOMASS SUPPLY CHAIN SAVES MONEY

**Improvement in feedstock caloric value, MWh/ton**

- **Best**
- **Better**
- **Good**
- **Base case**

**Improvement in plant revenues, eur/ton**

- **Best**
- **Better**
- **Good**
- **Base case**

**Decrease in harvested area required, hectares**

- **Best**
- **Better**
- **Good**
- **Base case**

**Decrease in transportation costs, eur (average 50 km legs)**

- **Best**
- **Better**
- **Good**
- **Base case**
## Low Fuel Quality Means Extra Costs for the Plant

<table>
<thead>
<tr>
<th>Quality problem of biofuel (wood chips)</th>
<th>Impact on the handling and storage of fuel</th>
<th>Impact on the operation of the boiler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Too high moisture content</td>
<td>Causes freezing on the equipment. Freezing and sticking form big lumps, which block the equipment. Risk of mould (occupational health). Complicates handling and storage</td>
<td>Lower output (energy). Fuel consumption and emissions increase. Uneven burning. The control of combustion becomes more difficult. In the worst case a break in the boiler operation may occur.</td>
</tr>
<tr>
<td>Too dry fuel (&lt;35%, excl. gasification plant)</td>
<td>The ignition risk increases, especially when the amount of fines is high (logging residues).</td>
<td>Control of the combustion becomes more difficult. The temperatures may rise too high causing boiler damages.</td>
</tr>
<tr>
<td>Too large particle size (branches, sticks etc.)</td>
<td>Sticks cause blocking, bridging and/or wedging in feeding screws etc. Handling problems</td>
<td>Control of the combustion becomes more difficult, chips don’t burn fast enough (grate) or burn too low in the bed and raise the temperature too much (fluidized bed)</td>
</tr>
<tr>
<td>Too small particle size, plenty of fines</td>
<td>Fines prevents air moving in the storage pile and slow down drying. Fines blocks air scoops and causes explosion risk. Dry content losses increase.</td>
<td>Fines can end up with fly ash (grate), chips burn too high in the bed and raise the super heater temperatures too much. Emissions increase.</td>
</tr>
<tr>
<td>Impurities: rocks, sand, metal, soil, dirt, plastics, ice, snow</td>
<td>Impurities wear out conveyance equipment. Impurities cause increase in transportation weights. Risk of melting and refreezing. Overall cause extra requirements in handling.</td>
<td>Impurities cause wearing in boiler surfaces, mechanical damages, fouling of fluidized beds, more frequent change of bed sand and air scoop blocking. Impurities decrease efficiency and effect the amount of and quality of ash.</td>
</tr>
<tr>
<td>Green mass (needles), chemical composition</td>
<td></td>
<td>The alkali metals and chlorine cause deposition and hot corrosion. The amount of ash increases.</td>
</tr>
<tr>
<td>Quality variation of fuel (sudden)</td>
<td>Design and use of receiving, handling and storage structure and equipment becomes more difficult. Extra requirements are needed in storage and handling.</td>
<td>Boiler structure design becomes more difficult. Variations cause sudden temperature changes in combustion and make the control more difficult. Feeding, its adjustment and predictability gets harder, efficiency decreases.</td>
</tr>
</tbody>
</table>

The quality problems of biofuel (wood chips) create extra costs in fuel supply, storage, handling, process, operating and maintenance.
**FUEL QUALITY IS AFFECTED IN VARIOUS STAGES OF THE SUPPLY CHAIN**

Forestry transport can also be considered as a part of the harvesting stage. In this study these stages are analysed separately.

### ORIGIN OF BIOMASS: FOREST AND WOOD
- The characteristics of the forest and wood material
  - Inapplicable or poor material, tricky field conditions

### HARVESTING AND FOREST STORAGE
- Conditions (weather, field)
- Working proficiency and techniques used
- Timing and deadlines (drying)
  - Extra costs, production losses, low quality and damages, increased moisture and impurities

### FORESTRY TRANSPORT
- Conditions (weather, field)
- Working proficiency and techniques used
- Timing and deadlines
  - Extra costs, damages, increased moisture and impurities

### ROADSIDE STORAGE
- Conditions (weather, field)
- Working proficiency and techniques used
- Timing and deadlines (drying)
  - Extra costs, damages, increased moisture and impurities

### CHIPPING AND LONG-DISTANCE TRANSPORT
- Conditions
- Working proficiency and techniques used
- Timing
- Lack of necessary rejections
- Shaking during chipping
  - The chosen chipping method cf. features of raw materials
  - Impacts on particle size, moisture content, impurities, green mass

### DELIVERY AND RECEIVING
- Management and control
- Transport and site equipment
- Capabilities of receiving stations and feed-in processes
- Timing of deliveries, varying hours of day
  - Quality control process, tolerances, unloading problems, delays, rejections

### CHIPPING AND STORAGE
- General conditions (weather, storages)
- Working proficiency and techniques used
- Timing and deadlines (esp. as for drying)
- Lack of necessary rejections
- Shaking during chipping
- The chosen chipping method cf. features of raw materials
  - Impacts on particle size, moisture content, impurities, green mass

### ENERGY PRODUCTION: PLANT PROCESS AND COMBUSTION
- High moisture content
- Heterogeneity of fuels
- Unwanted particle sizes
- Impurities and contaminations
- Low calorific value
  - Impacts on economy, work problems, combustion process and side-products (emission, ash etc.)

### PROBLEMS WILL MATERIALIZE LATEST IN
- Uncertainties
- Shortage of fuels (in relation to demand)
- Unwanted delivery times
  - Impacts on value chain reliability
Why a total quality-driven optimal biomass supply chain is needed?

What is a total quality-driven optimal biomass supply chain?

How much is the benefit / the value added?

Wrap up - Who to contact?
TOTAL QUALITY-DRIVEN OPTIMAL BIOMASS SUPPLY CHAIN - FROM THE FOREST TO THE BOILER
# VALUE ADDING SOLUTIONS - FROM THE FOREST TO THE BOILER

<table>
<thead>
<tr>
<th>Solution provider</th>
<th>Company Solution</th>
<th>Value added / customer benefits (according to studies, interviews and company information)</th>
</tr>
</thead>
</table>
| **Fixteri Oy**    | is a company specialized in the harvesting technologies and the development of a comprehensive logistics chain of small-dimensioned wood. Fixteri is developed for harvesting stem wood at renovation sites of young forests and first thinning sites. The Fixteri baler bundles stem wood into bales. | - As the first company in the world, Fixteri has developed a logistics chain solution for harvesting small-dimensioned wood, as well as the necessary technologies, which simultaneously benefit the forest and energy industries, harvesting entrepreneurs, forest owners, and nature alike. Cost efficient and flexible harvesting and logistics chain are enabled by the Fixteri baler, which is the result of years of product development and testing work, guided by long practical experience.  
- The Fixteri harvesting technology, is intended for first thinning and refining of young forests. The technology is most cost-competitive in and improves profitability most when harvesting small-dimensioned wood.  
- The baling saves harvesting time, makes transportation more cost-efficient and reduces storage space requirements.  
- The Fixteri bales dry well (down to 30 % moisture in good circumstances)  
- The yield per forest hectare can – as a result – be up to 40 % better.  
- The bales are measured and registered automatically in the process.  
- With bales, the savings in long-distance transport are in average 40 %. The entire transportation chain can benefit even from 200-300 % efficiency gains and 50 % smaller storage requirements. |
| **MHG Systems**   | provide companies with an opportunity to renew their business and operation model by means of accurate cost monitoring and real-time enterprise resource planning.  
MHG Biomass Manager is focused on inventory monitoring, managing biomass delivery chains in real-time, feedstock assessment, origin tracking and terminal management | - MHG’s services bring about significant cost savings and environmental benefits to all operators of biofuel supply chains, thus allowing improvement in value chain profitability.  
- Customers can use MHG’s services to monitor and verify the social and environmental impacts of their operations, to match performance reports or voluntary standards.  
- MHG’s solutions facilitate increasing revenues and more complex business models.  
- The materialized benefits from using MHG’s solutions include:  
  - Optimization of working hours, leading to significant manpower cost savings – starting from 10 % savings in the field work up to 50 % savings in the office work.  
  - Savings in transportation costs, from improved efficiency of driver work up to improved utilization of transportation capacity (up to 10 % savings).  
  - Savings related to reduced storage requirements due to the faster supply cycle (savings up to 30 %).  
  - Improved quality of acquired biomaterials due to a significantly better monitoring and control of the value chain.  
  - Environmental benefits arising e.g. from reduction in transportation volumes. |
| **Kärkimurskaus Oy** | produces and supplies solid biomass fuel from wood chips | - The wood chips produced from stumps by Kärkimurskaus technology do not warm up during clamp storing, thus the risk of self ignition is very low. The fuel is very suitable for buffering and back-up storages.  
- The efficiency and speed in the transportation will improve. The residues from chipping and sieving, as well as impurities, will remain in the forest, which means savings in transportation costs and improved efficiency in subsequent handling processes.  
- The quality of the fuel will improve, e.g. the ash content varies typically between 0.4 – 2.3 %. This contributes to a more efficient hand-over at the gate and more efficient production processes at the plant, as well as less equipment breaks. |
# VALUE ADDING SOLUTIONS - FROM THE FOREST TO THE BOILER

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| **INRAY** | The X-ray quality measurement system for biofuels | - In bioenergy production the indicators of the fuel quality, especially moisture content and share of impurities, are the key parameters for the control of the plant process.  
- The water content of the fuel is a parameter used to adjust the settings of a biomass boiler. But it is also essential for verifying the lower calorific value (LCV) of the fuel which is typically used for purchase pricing of the fuel. Solid biofuels often contain impurities such as stones, sand, soil and also metals that lower LCV and increase operation and maintenance costs in the power plant.  
- InrayFuel is a reliable and transparent solid fuel online quality control system that enables remarkable savings for power plants in:  
  - fuel procurement  
  - operation and maintenance costs  
  - sampling and analysing costs  
- The Inray Fuel systems measures online from the fuel flow the moisture content, density, volume and impurity content. It reports on-line the load-specific quality data and related energy content (caloric value).  
- Inray Fuel system recognizes foreign objects, classifies them according to size and materials and transmits the information to main system in less than one second, whereby foreign substances can be removed before further processing and thus avoid problems e.g. in chipping and crushing  
- The key benefits of the Inray Fuel system are  
  - Improved energy efficiency  
  - Less manual work in sampling and analyzing  
  - Better identificatuion of moisture variations inside one load  
  - Less ash  
  - Less problems in the production process, better overall quality of the process. |
| **SAIMATEC ENGINEERING** | The biomass drying system is based on Saimatec's long-term knowledge and technology for bulk material handling in pulp & paper industry. The vertical type dryer is suitable for different types of biomass, like wood bark, all varieties of wood chips, sawdust mixed in other materials and sludges mixed with biomass. | - The system is a self-contained unit including infeed silo and outfeed equipment as well as automation. Drying process is controlled in an energy efficient way.  
- Construction will be easily scaled and dimensioned for different capacity ranges. Biomass flow from few to many hundreds of cubic-meters per hour can be handled.  
- The following beneficial features can be linked to Saimatec’s solution  
  - no need to fine-grind material  
  - drying time is sufficiently long for also coarse particles to dry  
  - low temperature (typically under 150 Celsius) eliminates risk of volatile emissions and fire  
  - low speed of the drying air eliminates the tendency of dust spreading and therefore reduces need for  
  - housekeeping  
  - compact, sealed construction also prevents dust emissions to surroundings  
  - energy efficient 1 to 3-stage drying  
  - vertical construction makes installation easier also when space is limited  
- From the viewpoint of the power plant, the key benefits of Saimatec's system are  
  - Improved energy efficiency due to better fuel quality with lower water content  
  - Less space needed for storing the fuel  
  - Cost savings in the process |
## VALUE ADDING SOLUTIONS – RELATED PLANT TECHNOLOGY

<table>
<thead>
<tr>
<th>Solution provider</th>
<th>Company Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Etteplan</td>
<td>Etteplan has comprehensive competence in electronics and embedded systems development, automation and electrical design, mechanical design as well as technical product information solutions and services.</td>
</tr>
<tr>
<td>Clean Flame</td>
<td>Clean Flame specializes in burner systems for utility companies. Clean Flame is developing a new multifuel burner for liquid and gaseous fuels, which can burn LFO, HFO, pyrolysis oil, waste and bio oils, natural gas, LNG and bio gases clean and efficiently.</td>
</tr>
<tr>
<td>Caverion</td>
<td>Caverion designs, builds, operates and maintains user-friendly and energy efficient technical solutions for buildings and industries. Services from high-pressure pipelines to boiler house ventilation solutions and from valve maintenance to comprehensive maintenance solutions.</td>
</tr>
</tbody>
</table>
| KPA Unicon        | KPA Unicon is specialized in customized and modularized boiler plant turnkey projects. KPA Unicon’s products utilize biomass fuels as well as fossil fuels in a sustainable way. KPA Unicon delivers projects as turnkey basis or process delivery, depending on customer’s need. KPA Unicon can take responsibility of operation and maintenance at the plant. KPA Unicon’s solutions:  
  - Unicon Biograte, capacity range 3 - 150 MWth  
  - Unicon Pellet, capacity range 3-150 MWth  
  - Unicon BFB, capacity range 5-20 MWth  
  - Unicon O& G capacity range 3-600 MWth |
| Nordic Power Service Ltd | Nordic Power Service Ltd specializes in the maintenance and repair of power plant boilers. |
| ANDRITZ           | ANDRITZ delivers complete solutions – from biomass receiving to fuel feeding to combustion (boilers or gasifiers) to ash handling to on-going service. BFB and CFB boilers from ANDRITZ are proven in installations around the world. Rebuild services enable conversion of existing boilers to biomass firing and co-firing. |
SUMMARY: ADDED VALUE FROM A TOTAL QUALITY-DRIVEN OPTIMAL BIOMASS SUPPLY CHAIN

**ORIGIN OF BIOMASS: FOREST & WOODS**
- Relevant data available: raw material, resources and field conditions
- Data available for financial estimates / budgeting
- Availability of raw materials known in real time
- Increased predictability towards next stages

**SUPPLY AND PURCHASE**
- Improved knowledge of feedstock and storage values
- Less errors and misunderstandings, improved co-operation
- Real time information about feedstock (availability, features)
- Enhanced selling-purchasing process

**HARVESTING AND FOREST STORAGE**
- Improved planning and preparation - right technology, right staff, right timing
- Real time measurement and relevant data for the harvesting contractor
- Fixteri bales speed up harvesting process and make transports more efficient

**FORESTRY TRANSPORT**
- Real time tracking of transports (from field to plant)
- Improved predictability, used to plan and prepare next stages
- Efficiency of forestry transports up to 200–300 % (Fixteri bales)

**ROADSIDE STORAGE**
- Improved planning and preparation due to real-time accurate data
- Real time data about storage values
- Improved drying process and reduction in storage volumes with Fixteri bales and related storing models

**CHIPPING/STORAGE**
- Feedstock with less impurities - less equipment damages
- Dry chips improve quality and enable longer storage times (Saimatec drying systems)

**ENERGY PRODUCTION: PLANT PROCESS AND COMBUSTION**
- Improved process economy, a satisfied end-customer
- Efficient process adjustments based on measurements before combustion
- Predictability of fuel quality
- Right plant technology selections - chance for remarkable savings
- Expertise to maximize the opportunities and benefits of high-quality chips

**QUALITY BENEFITS**
- Cost savings in sampling and analysing processes

**PROFITS REALIZED**
- Cost savings in sampling and analysing processes
Why a total quality-driven optimal biomass supply chain is needed?

What is a total quality-driven optimal biomass supply chain?

How much is the benefit / the value added?

Wrap up - Who to contact?
SEVERAL ECONOMICAL BENEFITS ARISE FROM THE TOTAL QUALITY-DRIVEN OPTIMAL SUPPLY CHAIN

I. Economical benefits for the companies in the value chain

- Benefits for business and marketing, e.g. online visualization of available storages and their location
- Economical benefits related to improved data, e.g. optimization of fuel storage sizes, storages used as a collateral, ...
- Reduced labor and handling costs throughout the supply chain
- Logistics savings – delivery batch characteristics (moisture), optimized transport chain and vehicle selections

II. Competitive fuel price and availability at the gate; benefits in the procurement process

- Right price: from the plant viewpoint lower cost, from the supply chain viewpoint higher margin
- A predictable and effective procurement process
- Supply reliability: from the plant viewpoint secured availability, from the supply chain viewpoint predictable income
- Reduced investments to backup storages due to secured availability

III. Economical benefits from the good quality for the plant

- Improved/known quality: moisture, particle size, impurities, "green mass" content, homogeneity
- Higher efficiency and energy yield
- Process controllability and forecasting
- Reduction in operation and maintenance costs
- Smaller investments in fuel storage and pre-processing due to even / predictable quality
- Reduced production downtime
- Reduced need of biomass feedstock
- Reduction in harmful emissions
- Ash reduction, easier replacement and boiler sand resistance
FROM THE END CUSTOMER (PLANT) VIEWPOINT THE BENEFITS CAN BE GROUPED IN THREE GROUPS

1. Improved supply chain efficiency reflected to the purchase price
2. Benefits from the secured feedstock availability
3. Benefits from the improved (right) feedstock quality
### The Plant Benefits from the Better Technical and Economical Yield

<table>
<thead>
<tr>
<th>Source</th>
<th>Benefit</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of procured feedstock</strong> (branches, stumps,...)</td>
<td>Better caloric value depending on the feedstock</td>
<td>Variations can be around 40 %: 2,1 kWh/kg harvesting residues 2,4 kWh/kg stem wood 2,9 kWh/kg stumps</td>
</tr>
<tr>
<td><strong>Harvesting method (affecting the yield)</strong></td>
<td>Harvesting small-dimensioned whole-trees instead of stem wood leads 10-40 % better yield per hectare</td>
<td>Compared with 100 m3 of yield from stem wood, the method for the whole-tree gives 110-140 m3</td>
</tr>
<tr>
<td><strong>Moisture content of the harvested feedstock</strong></td>
<td>Less procurement costs per MWh - smaller forest area (hectares) to be procured</td>
<td>Base case - moisture 30 % If moisture 55%, additional 0,002 ha per MWh is required</td>
</tr>
<tr>
<td><strong>Stem wood bales, affecting the yield of the chipping process</strong></td>
<td>The speed (yield, MWh/h) of chipping baled stem wood can be double as compared with chipping other types of raw material</td>
<td>Cost savings in the chipping process</td>
</tr>
<tr>
<td><strong>Storage location / drying circumstances</strong></td>
<td>Lower moisture content with better drying circumstances</td>
<td>The resulting moisture content can vary from 55 % to 30 %. 10 % less moisture leads to 2 % increase in yield</td>
</tr>
<tr>
<td><strong>Amount of rotten wood</strong></td>
<td>Less rotten wood - better caloric value of the feedstock</td>
<td>Rotten wood can lower the caloric value 0 -50 %</td>
</tr>
</tbody>
</table>
## THE PLANT BENEFITS FROM THE BETTER FEEDSTOCK AVAILABILITY

<table>
<thead>
<tr>
<th>Source</th>
<th>Benefit</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substitute fuels</td>
<td>Reducing use of more costly substitute fuels (typically oil), avoiding extra costs</td>
<td>Non-availability of 2-3 days can cause extra costs from several thousand euros up to tens of thousand euros, depending on the plant size</td>
</tr>
<tr>
<td>Back-up storages</td>
<td>Avoiding excess back-up storages, reducing related capital and process costs</td>
<td>A back-up storage for e.g. one weekend corresponds in average to 1% of annual feedstock consumption</td>
</tr>
</tbody>
</table>
### THE PLANT BENEFITS FROM REDUCTION IN PROCESS FAILURES AND MAINTENANCE

<table>
<thead>
<tr>
<th>Source</th>
<th>Benefit</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feedstock particle size, amount of sticks</td>
<td>Avoidance of failures from blocking, bridging and/or wedging in feeding screws etc</td>
<td>Problems in particle size cause 0% – 30% of process failures. Example from a 180 MW plant operating 7000 hours/a: low quality can cause extra costs up to 380 000 eur/a (*)</td>
</tr>
<tr>
<td>etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feedstock impurities (rock, sand, ice ..)</td>
<td>Avoidance of wearing and tearing caused by impurities</td>
<td>Impurities cause 0% - 35% of process failures. Example from a 180 MW plant operating 7000 hours/a: low quality can cause extra costs up to 440 000 eur/a (*)</td>
</tr>
<tr>
<td>Caloric value of the feedstock</td>
<td>Low or varying caloric value has a negative effect on the boiler performance, increasing need</td>
<td>Problems in caloric value cause up to 8 % of process failures. Example from a 180 MW plant: low quality can cause extra costs up to 100 000 eur/a (*)</td>
</tr>
<tr>
<td>Green mass (needles etc)</td>
<td>Green mass has a negative effect on the boiler performance</td>
<td>Green mass causes 0% - 7% of process failures. Example from an 180 MW plant: low quality can cause extra costs up to 90 000 eur/a (*)</td>
</tr>
<tr>
<td>Low quality of the fuel</td>
<td>Avoidance of wearing and tearing of the plant equipment, i.e. avoidance of extra maintenance</td>
<td>The costs due to extra maintenance work are highly plant-specific.</td>
</tr>
<tr>
<td>Extra investments</td>
<td>Avoidance of investments in the pre-processing equipment (like extra sieves etc)</td>
<td>The avoided investment costs can vary from thousands up to tens of thousands euro</td>
</tr>
</tbody>
</table>

*The basis of calculations derived from the study: extra costs from process failures can be estimated in average as 1 eur/MWh*
### SIMULATION: ADDED VALUE FROM BETTER QUALITY AND AVAILABILITY

Example 1:
- Annual wood chip combustion **50 000 MWh**
- Using whole-tree chips
- Average storing conditions, moisture **45%**
  - Problematic particle size, impurities
  - Availability problems

Example 2:
- Annual wood chip combustion **50 000 MWh**
- Using whole-tree chips
- Very good storing conditions, moisture **30%**
  - Minor problems with particle size and impurities
  - No availability problems

<table>
<thead>
<tr>
<th></th>
<th>Example 1</th>
<th>Example 2</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Harvesting methodology (stem wood)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forest area needed</td>
<td>219</td>
<td>219</td>
<td>hectares needed</td>
</tr>
<tr>
<td>Harvesting costs</td>
<td>346 136</td>
<td>346 136</td>
<td>eur less</td>
</tr>
<tr>
<td><strong>Impact of harvesting</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calorific value</td>
<td>0.58</td>
<td>1.44</td>
<td>MWh/t</td>
</tr>
<tr>
<td>Efficiency (combustion)</td>
<td>1</td>
<td>3</td>
<td>%</td>
</tr>
<tr>
<td>Plant revenues</td>
<td>0.3</td>
<td>2.6</td>
<td>eur/t</td>
</tr>
<tr>
<td>Price paid</td>
<td>11.5</td>
<td>28.8</td>
<td>eur/t</td>
</tr>
<tr>
<td>Forest area needed</td>
<td>55</td>
<td>100</td>
<td>hectares less</td>
</tr>
<tr>
<td>Annual transportation (50 km)</td>
<td>2 292</td>
<td>4 167</td>
<td>km less</td>
</tr>
<tr>
<td>Emissions (combustion)</td>
<td>90</td>
<td>165</td>
<td>CO2 ton less</td>
</tr>
<tr>
<td>Transportation cost</td>
<td>49 000</td>
<td>91 000</td>
<td>eur less</td>
</tr>
<tr>
<td><strong>Disorders, damages etc.</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant costs</td>
<td>0.80</td>
<td>0.37</td>
<td>eur/MWh</td>
</tr>
<tr>
<td>Plant costs</td>
<td>40 000</td>
<td>18 500</td>
<td>eur/a</td>
</tr>
<tr>
<td><strong>Fuel availability and purchasing</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant costs</td>
<td>294 000</td>
<td>183 750</td>
<td>eur/a</td>
</tr>
</tbody>
</table>

* = compared with harvesting stem wood ** = compared with 55 % moisture content
## SIMULATION: ADDED VALUE FROM BETTER QUALITY AND AVAILABILITY

**Example 3:**
- Annual wood chip combustion **500 000 MWh**
- Using whole-tree chips
- Average storing conditions, **moisture 45%**
- Problematic particle size, impurities
- Availability problems

**Example 4:**
- Annual wood chip combustion **500 000 MWh**
- Using whole-tree chips
- Very good storing conditions, **moisture 30%**
- Minor problems with particle size and impurities
- No availability problems

<table>
<thead>
<tr>
<th></th>
<th>Example 3</th>
<th>Example 4</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvesting methodology (stem wood)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forest area needed</td>
<td>2 190</td>
<td>2 190</td>
<td>hectares needed</td>
</tr>
<tr>
<td>Harvesting costs</td>
<td>3 461 360</td>
<td>3 461 360</td>
<td>eur less</td>
</tr>
<tr>
<td>Impact of harvesting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calorific value</td>
<td>0.58</td>
<td>1.44</td>
<td>MWh/t</td>
</tr>
<tr>
<td>Efficiency (combustion)</td>
<td>1</td>
<td>3</td>
<td>%</td>
</tr>
<tr>
<td>Plant revenues</td>
<td>0.3</td>
<td>2.6</td>
<td>eur/t</td>
</tr>
<tr>
<td>Price paid</td>
<td>11.5</td>
<td>28.8</td>
<td>eur/t</td>
</tr>
<tr>
<td>Forest area needed</td>
<td>550</td>
<td>1 000</td>
<td>hectares less</td>
</tr>
<tr>
<td>Annual transportation (50 km)</td>
<td>22 920</td>
<td>41 667</td>
<td>km less</td>
</tr>
<tr>
<td>Emissions (combustion)</td>
<td>900</td>
<td>1 650</td>
<td>CO2 ton less</td>
</tr>
<tr>
<td>Transportation cost</td>
<td>490 000</td>
<td>910 000</td>
<td>eur less</td>
</tr>
<tr>
<td>Disorders, damages etc.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant costs</td>
<td>0.80</td>
<td>0.37</td>
<td>eur/MWh</td>
</tr>
<tr>
<td>Plant costs</td>
<td>400 000</td>
<td>185 000</td>
<td>eur/a</td>
</tr>
<tr>
<td>Fuel availability and purchasing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant costs</td>
<td>2 940 000</td>
<td>1 837 500</td>
<td>eur/a</td>
</tr>
</tbody>
</table>

* = compared with harvesting stem wood  ** = compared with 55 % moisture content
Why a total quality-driven optimal biomass supply chain is needed?

What is a total quality-driven optimal biomass supply chain?

How much is the benefit / the value added?

Wrap up - Who to contact?
A total quality-driven optimal biomass supply chain results to a better quality of the feedstock, a better performance in the supply chain and a more efficient procurement process. Both the end customer (power / heat plant) and the various players in the supply chain benefit economically, and a real win-win situation can be created. The benefits can be estimated in euros via a special-purpose simulation model created in the study.
CONTACT US

- www.fixteri.fi
- www.karkimurskaus.fi
- www.mhgsystems.com
- www.saimatec.fi
- www.inray.fi

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