Swedish forest biomass logistics

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Outline

• District heating in Sweden
• Forest biomass logistic
  – Assortments
  – Production system
  – Logistic systems
• Case studies and results
• Data collection
• Concluding remarks
District heating

Heating plants & district heating:
Cogeneration of electricity and district heating
City of Linköping – 130,000 inhabitants 550 km of pipes with hot water

Left: Daily temperatures during one year (Linköping, 2008-2009, Data from Swedish Meteorological and Hydrological Institute).
Right: Demand for forest biomass (in MWh) for one supplier.
Swedish situation

- The use of renewable energy resources (water, forest biomass, wind and sun) contribute to more than 47% of the total energy use in 2009.
- District heating accounts for providing heating and electricity for more than 50% of the households.
- Of Sweden's 290 municipalities 270 are using district heating.
- More than half of all residential and commercial buildings are heated with district heating. Among the apartment block, the proportion is about 90 percent, while it is slightly lower for the premises and lowest for single-family homes.

Production of energy in district heating between 1955 and 2010
Proportion of fuel for district heating in 2010.

How we use the wood…

Source: Skogsindustrierna, 2003 & Skogstatistisk årsbok 2004
Woodfuels increase + 7% / year

...of which primary forest fuels (residues, stumps, small trees)

Forest biomass
Underutilized sources

- Heterogenous, low quality, low value
- Bulky and scattered over large areas
- Seasonality demands storage
- Efficient procurement systems needed

Economy of operations

In total 20.8 M m³ chips (18 TWh)

Total value; 3 536 M SEK

Total direct prod. cost 2 847 M SEK

Average margin 24 % (2 – 32 %) for
- forest owner compensation
- basic investments
- development
Technological learning

Cost reduction of unrefined woodresidues in Sweden 1975-2003

\[ y = 38.588x^{-0.226} \]
\[ R^2 = 0.9756 \]

Common techno/economic properties

- Available over landscape areas
- Demand cyclic, annually variable, supply stable
- Scattered over the sites
- Heterogeneous
- Contaminations
- Low heating value
- Unwieldy
- Bulky
- Excessive terminal points

<table>
<thead>
<tr>
<th>Transports &amp; logistics</th>
<th>Storing</th>
<th>Concentration</th>
<th>Mixing, Fractioning, Seasoning</th>
<th>Improved operations, Mechanical rinsing</th>
<th>Drying</th>
<th>(Pre)processing, bundling, special tools</th>
<th>Processing, compaction, bundling</th>
<th>Integration, process flow</th>
</tr>
</thead>
</table>

... some examples of how they are addressed
Residue
Concentration, operation

Drying

Storage

Concentration
Spec tools

Comminution, integration
Compromises are needed
Location of comminution

Terminals
System choices - Residues
System – truck mounted chipper, 90 m³ cargo

Concentration
Mech. rinsing

Preprocessing
Rinsing

Stumps

Conc., Trp

Drying
Small trees

Concentration

Compaction

Continuous felling/accumulation?

Heterogeneity

Mixing

Sorting

Probably the most important to increase feedstock value
Train transport

System – train 1600 tons
Forest biomass in Sweden 2010

20 million cubic meters, 18.5 TWh
450 000 000 tonkm transport work
Increase with 65 000 000 tonkm 2009-2010

Potential increase
- Residues – 2x
- Small trees – 5x
- Stubs – 50x
- Fuel logs - balance

Piggy-backing on forestry

Resources freed through rationalization of conventional forestry may be employed in biofuel production

Planning and logistics system of conventional forestry applied to supply bioenergy market
Logistic system for forest biomass
Case studies and results

Decision Support System FuelOpt model

• Decision variables:
  – Flows (transportation mode), purchase, sales, inventory, chipping use (different system)

• Objective:
  – Maximize profit (revenues – costs)

• Constraints
  – Supply, Demand
  – Flow and conversion balances
  – Capacity restrictions on: transportation mode, chipping system, inventory
Case study Sveaskog

- 400 supply points
- 800 GWh
- 8 assortments
- 21 customers
- 15 terminals
- 21 train routes
- 7 machine types
- 4 truck types

1 ton of e.g. tops and thinnings provide 2.5 MWh
\[\rightarrow\] demand is about 350,000 tons
Case study with Stora Enso Bioenergi

- 1256 supply points
- 3600 GWh (approx 1.5 million metric tons)
- 6 assortments (+ 4 group)
- 86 customers
- 72 terminals (8 train)
- 27 train system
- 5 different chipping systems
- 6 different truck types
Flows from aggregated areas of assortment tops and branches to heating plants

Actual flows

Optimized flows

Chipping on terminal
Truck transport capacity usage

Case 2011: Result per customer

<table>
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<tr>
<th>Industry</th>
<th>Quantity</th>
<th>Cost (SEK)</th>
<th>Revenue (SEK)</th>
<th>Profit (kr)</th>
<th>Profit (SEK/MWh)</th>
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Total revenue about 550 million SEK (60 million Euro)
Data collection for forest biomass operations
Biomass areas?
Biomass areas?

Not profitable

Profitable

Trails need enforcement

Best for team #2
Stand - 5428
Concluding remarks

• The forest bioenergy problem is becoming more important and a significantly increased harvest of forest biomass is possible in Sweden’s boreal forests

• Economy of operations may be significantly improved through improved organisation, planning and development of technology and methods

• DSS FuelOpt is efficient and well suited for industrial use as illustrated by case studies

• Collaboration between companies can be very useful.

• Coordination between value chains is becoming more interesting