A techno-economic assessment for optimizing methanol production for maritime transport in Sweden

Davide Conti\textsuperscript{a}, Fumi Harahap\textsuperscript{b}, Semida Silveira\textsuperscript{c}, Annukka Santasalo-Aarnio\textsuperscript{d}

\textsuperscript{a} KTH Royal Institute of Technology, Stockholm, Sweden, conti@kth.se
\textsuperscript{b} KTH Royal Institute of Technology, Stockholm, Sweden, harahap@kth.se
\textsuperscript{c} KTH Royal Institute of Technology, Stockholm, Sweden, semida.silveira@energy.kth.se
\textsuperscript{d} Aalto University, Helsinki, Finland, annukka.santasalo@aalto.fi

Abstract:
The maritime transport sector is currently highly dependent on oil-based fuels. International regulations enforce tight limits regarding NO\textsubscript{x} emissions from the exhaust gases and maximum sulphur content in the fuel, enhancing the sector interest towards the development of cleaner alternative fuels. A transition to biomass-based liquid fuels is of interest as a common solution for reducing pollutant emissions and for CO\textsubscript{2} emissions mitigation. In this paper, a case study on Sweden analyses the potential of methanol production, using gasification of woody residues from sawmills to cover domestic and international maritime energy demand. Methanol seems to be a promising alternative to heavy and light fossil oils as maritime fuel, and sawmills residues are an abundant resource in Sweden. The study considers the entire methanol production chain, starting by assessing the availability of sawmill by-products and ending with the energy demand of final users, identified as the Swedish ports. The analysis considers two scenarios until year 2035, assuming different share of energy demand covered by methanol. When considering the production and use of biofuels, the cost for transportation of the feedstock and the final product have a great impact on the final cost. An optimization model is used to locate the methanol production plants, so to minimize the cost of the production chain. Four possible plant sizes are considered, 100, 200, 300 and 400 MW of biomass fuel thermal input. The production plant is modelled to determine the material and energy streams involved in the process and to obtain the cost and efficiency of producing methanol at the synthesis plant. The results include the final methanol cost and an estimation of the CO\textsubscript{2} emissions reduction potential from replacing oil fuels with methanol for the assumed scenarios.

Keywords:
Gasification, Maritime Transport, Methanol, Sweden, Woody Biomass.

1. Introduction
Reducing the environmental impact of the transport sector is one of the main challenges of the current time. When compared to electricity and heat generation, transport has the lowest penetration of renewable energy sources, which mainly consist of biofuels for road transport [1]. Recently, the European Union (EU) introduced the Renewable Energy Directive (2009/28/EC), aiming to increase
the use of renewable energy sources for the transport sector. Despite the legislation effort made by the EU, transport remains the highest CO₂ emitting sector and the only sector that hasn’t showed a reduction of CO₂ emissions compared to the 1990 level [2]. Since the transport sector was not originally included in the EU Emission Trading System (ETS), in May 2018 the European Parliament and the Council of the European Union approved the Effort Sharing Decision (EU regulation 2018/842), which defined greenhouse gases (GHG) emission targets for those sectors not included in the ETS. For non-ETS sectors, the legislation defines a GHG emissions reduction target of 30% by 2030 compared to 2005 levels [3]. The Swedish Parliament adopted in June 2017 a national climate policy (Govt. Bill 2016/17:146) which set the GHG emission reduction target for non-ETS to 63% by 2030 and an emissions reduction goal of 70% by the same year for domestic transport, compared to 2010 levels [4].

Maritime transport applications must follow the emission standards issued by the International Maritime Organization (IMO). NOₓ and SOₓ emission standards for exhaust gases from ships are regulated by MARPOL Annex VI [5]. Currently, the maximum allowed sulphur content is 3.50% in weight which will be reduced to 0.50% starting from January 2020 [5]. Limitations are stricter for ships navigating through designated sea areas, referred as Emission Control Areas (ECAs). In such case, the maximum allowed sulphur content in the fuel is reduced to 0.10% in weight [5]. Being the Baltic Sea one of the ECAs, Sweden is directly interested in developing low-sulphur alternative fuels for maritime transport through such area.

Sweden is a country largely covered by forests, and where the forestry industry holds an important position in the national economy, providing 10% of the globally traded sawn timber, pulp and paper [6]. Therefore, woody biomass is widely available over the territory and so are the waste products remaining from the industrial processes involving wood. Solid waste material like woodchips, sawdust and bark can be converted into a renewable liquid fuel to use for transport. One of such fuels is methanol. Methanol represents a valid option as clean alternative fuel for maritime transport, since it can be used in DF engines along with heavy fuel oil (HFO) or blended with the conventional fossil fuel for direct injection in a conventional compression ignition (CI) engine. NOₓ and PM emissions from a CI engine decline when a portion of the conventional fossil fuel is replaced by methanol, allowing greater emission reductions when the methanol fraction is increased [7]. Other than reducing NOₓ and particulate emissions, replacing the currently used HFO with bio-methanol produced from woody biomass will also contribute towards mitigating the CO₂ emissions of the maritime transport sector. Maritime transport companies Stena Line and Waterfront Shipping Company Ltd have already introduced some methanol vessels in their fleet [8],[9].

1.1. Research objectives

This study evaluates the potential of producing bio-methanol from gasification of woody biomass in Sweden, to cover part of the demand for maritime transport. The investigation refers to the international and domestic maritime energy demand registered in Sweden during 2016. The report presents results related to two scenarios.

1. M5 considers a low fraction of methanol blended with heavy fuel oil. The mixture is burnt in existing conventional CI engines, without need of retrofitting. The methanol volumetric fraction is limited to 10%, around 5% on energy basis, to avoid phase separation problems in the mixture.

2. M40 covers 40% of the Swedish maritime final energy demand with methanol. The scenario assumes that some of the vessels will be retrofitted DF operation, making feasible the operation with high shares of methanol in the fuel mix.

The considered feedstock materials are wood chips and sawdust by-products generated by Swedish sawmills. It is assumed that large surfaces of free land are available nearby the sawmill, so every sawmill included in the study is considered as potential site where installing a new methanol production plant. The following outcomes will be provided for each proposed scenario:

- optimal location of methanol production sites;
- size of the large-scale methanol synthesis plants, chosen among four different options: 100, 200, 300 or 400 MW of biomass thermal input;
- amount of bio-methanol produced to meet the specified demand;
- final production cost of bio-methanol.

2. Methods
Due to the low bulk and energy densities, transporting wood chips and sawdust results rather expensive, since the transport capacity is not limited by the weight of the transported load but by the volume [10]. Thus, the final production cost of bio-methanol is strongly influenced by the location of the production plants. Therefore, the problem is identified as a Facility Location Problem, which is solved using a Mixed Integer Linear Programming (MILP) optimization model. Solving the model provides the optimal location and the size of the methanol plants that minimize the cost of the production system. The mainland boundaries of Sweden are set as the geographical boundaries of the model.

2.1. Biomass supply
Figure 1 shows the distribution of sawmills across the Swedish territory [11].

![Map of Swedish sawmills](image)

*Figure 1. Geographic position and classification per annual production capacity of Swedish sawmills*

Of the 179 existing Swedish sawmills, only twelve are considered in this study. The selection includes the biggest sawmills for annual production capacity, which are assumed to be the most likely to have the investment capacity required for the construction of a large-scale methanol production plant. Information regarding the identified sawmills are listed in Annex A.

The availability of raw material is assessed by applying a material balance on the products obtained after the sawmilling process. Along with the sawn timber, a substantial part of the raw material remains as by-products, which include barks, wood chips and sawdust. In a typical Swedish sawmill, only 47% of the incoming timber is converted into the desired final product [12]. Table 1 contains the material balance for products obtained in a typical Swedish sawmill.
Table 1. Materials obtained after sawmilling in a typical Swedish sawmill [12]

<table>
<thead>
<tr>
<th>Product</th>
<th>Mass fraction %_{dry}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sawn wood</td>
<td>47</td>
</tr>
<tr>
<td>Sawdust</td>
<td>8</td>
</tr>
<tr>
<td>Wood chips</td>
<td>26</td>
</tr>
<tr>
<td>Barks</td>
<td>19</td>
</tr>
</tbody>
</table>

A portion of the generated by-products is burnt on site in a biomass furnace to cover the internal heat energy demand of the sawmill, which consists of sawn wood drying and room heating. Bark is the main component of the mixture of biomass used as fuel, smaller quantities of sawdust and wood chips are added to facilitate the combustion process [13]. Therefore, the availability of wood chips and sawdust reduces respectively of 0.6 and 1.1 compared to the value showed in Table 1 [12]. The residual wood chips and sawdust that are not used for on-site heating purposes already represent an additional source of income for the sawmill. The latter are usually sold to pulp and paper mills, while the former is sold to plants that produce pellets used for heat and electricity generation [13]. It was assumed that all the sawmill sawdust and wood chips are available for methanol production, not considering any limitations regarding the interest of competing industries in using these resources. Therefore, a cost for wood chips and sawdust is included in the analysis.

The feedstock is transported by truck from the sawmill of origin $i$ to the production plant $k$ at a cost $t_{b_{ik}}$ (in €/TJ biomass). De Jong et al. [14] determined the cost of transporting wood chips and sawdust by truck, as described in (1):

$$t_{b_{ik}} = 320 + 9.7d_{ik}$$

where $d_{ik}$ is the actual distance (in km) between sawmill $k$ and plant $k$, defined as the air distance multiplied by an increasing factor of 1.4, which is the assumed ratio of actual road distance to air distance for Sweden.

2.2. Methanol production

To be converted into methanol, solid biomass is first reduced into gaseous form through a gasification process. Given its high content of water, solid wood must be dried to reduce the moisture content to approximately 15% before entering the gasifier reactor. The gasification reactors that have been primarily investigated for production of bio-syngas are the pressurized direct oxygen fired gasifier and the atmospheric indirect steam-blown gasifier[15]. Heyne et al. [15] developed a model based on the exergy efficiency of the gasification process, showing that pressurized direct gasification guarantees slightly higher efficiencies than indirect gasification [15]. However, direct gasification leads to larger amount of CO$_2$ in the product gas, which represent a disadvantage for the methanol synthesis process, which requires low CO$_2$ concentration in the processed gas to avoid catalyst poisoning [15]. Indirect gasification allows better carbon conversion, which makes it a preferable technology when methanol production is the final purpose of the process [15].

The syngas produced by the gasification process contains contaminants, such as particulate, tars, nitrogen and sulphur compounds, that must be removed to avoid complications with the downstream methanol synthesis equipment. After removing the impurities, the chemical composition of the syngas must be adjusted to meet the requirements needed by the methanol synthesis process. The hydrocarbons in the syngas are converted to H$_2$ and CO through a steam reforming step. Then, the hydrogen to carbon monoxide ratio (H$_2$/CO) is adjusted by converting CO into H$_2$ and CO$_2$ with a high-temperature water-gas-shift (WGS) process. The syngas stream is split before the WGS reactor, so only part of the syngas is processed in order to obtain the desired H$_2$/CO. Lastly, the syngas undergoes another upgrading step to partially remove CO$_2$ before being sent to the methanol synthesis unit.

The upgraded syngas is converted into methanol in a low-pressure isothermal reactor. After leaving the reactor, the product stream is cooled to separate the unreacted gas from the obtained crude
methanol. Part of the unreacted syngas is recirculated to the reactor to increase the conversion efficiency of the process. Then, hydrogen is partially recovered from the remaining purge gas and mixed with the syngas stream leaving the CO$_2$ separation step.

The methanol production plant is modelled with Aspen+ to obtain the material and energy streams involved in the conversion process, which are considered to determine the methanol synthesis cost and the biomass-to-methanol conversion efficiency of the plant. The plant efficiency is used to describe the synthesis plant in the optimization model.

The investment cost per unit capacity of building a methanol synthesis plant is strongly influenced by scaling effects, meaning that increasing the size of the plant leads to a lower unit cost [16]. Thus, the choice of the plant size will eventually influence the unit cost of methanol production, so the total plant investment cost is added to the optimization model.

The cost of the methanol plant is obtained with a bottom-up approach, summing the cost of the different plant components. The scaling function (2) is applied to calculate the cost of each component for the desired plant size:

$$\frac{C_a}{C_b} = \left(\frac{Q_a}{Q_b}\right)^R$$

where $R$ is the scaling factor, $Q_a$ and $Q_b$ are the size of the methanol synthesis plant $a$ and $b$, and $C_a$ and $C_b$ are the costs of the biofuel plant components for size $a$ and $b$.

### 2.3. Methanol distribution

In 2016, the energy use for the transport sector in Sweden amounted to 121.1 TWh, of which 20% was dedicated to domestic and international shipping [17]. Historical data about the energy demand for international and domestic marine transport registered in Sweden have been analysed to obtain a projection of the final energy demand over the considered timespan. Then, the national energy consumption is partitioned among the principal ports in Sweden, considering the gross cargo weight loaded on departing vessels at each port. Transportföretagen, the Swedish confederation of transport enterprises, provides information concerning the loaded cargo for both international and domestic marine transport [18]. Let $P$ be the number of ports considered in the study, let $D_{jy}$ be the energy demand of port $j$ in year $y$, let $D_{inty}$ and $D_{domy}$ be respectively the international and the domestic energy demand for maritime transport in Sweden in year $y$, and let $l_{int}$ and $l_{dom}$ be the gross weight of loaded cargo for international and domestic shipping in 2016. Equation (3) defines the allocation of energy demand to each port.

$$D_{jy} = D_{inty} \frac{l_{intj}}{\sum_{j=1}^{P} l_{intj}} + D_{domy} \frac{l_{domj}}{\sum_{j=1}^{P} l_{domj}}$$

Helsinborg and Trellborg ports in south Sweden are selected for the study. Table 2 reports the necessary information regarding the chosen ports.

<table>
<thead>
<tr>
<th>Port</th>
<th>Latitude °N</th>
<th>Longitude °E</th>
<th>Loaded cargo kton</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>International shipping</td>
</tr>
<tr>
<td>Helsinborg</td>
<td>56.019918</td>
<td>12.70763</td>
<td>3114</td>
</tr>
<tr>
<td>Trellborg</td>
<td>55.37245</td>
<td>13.14982</td>
<td>5528.2</td>
</tr>
</tbody>
</table>

Methanol is transported by truck from the production plant $k$ to the end-user $j$ at a cost $t_{mkj}$ (in €/TJ$_{methanol}$). Börjesson and Gustavsson [19] determined the cost of transporting methanol by truck, as described in (4):

$$t_{mkj} = 138 + 3.05d_{kj}$$
where \(d_{kj}\) is the actual distance (in km) between plant \(k\) and port \(j\), defined as the air distance multiplied by an increasing factor of 1.4, which is the assumed ratio of actual road distance to air distance for Sweden.

### 2.4. Optimization model

This section describes the variables and the constraints that define the optimization model. Let \(S\) be the number of sawmills included in the study, let \(P\) be the number of considered ports, let \(N\) be the number of possible plant sizes assumed, let \(Y\) be the number of years in the projected timespan. The corresponding sets are defined: \(\mathcal{S} = \{1, ..., S\}\), \(\mathcal{P} = \{1, ..., P\}\), \(\mathcal{N} = \{1, ..., N\}\) and \(\mathcal{Y} = \{1, ..., Y\}\). The vector \(Q = \{100, 200, 300, 400\}\) contains the assumed possible sizes of the methanol synthesis plant.

The variables \(b_{i,k,y}\) and \(x_{k,j,y}\) are defined as continuous non-negative variables. Let \(b_{i,k,y}\) be the amount of biomass (in TJ) supplied from sawmill \(i\) to plant \(k\) in year \(y\), and let \(x_{k,j,y}\) be the methanol produced in plant \(k\) (in TJ) and delivered to port \(j\) in year \(y\). Lastly, the binary variable \(u_{k,z,y}\) defines if plant \(k\) of size \(z\) is operating in year \(y\).

Let \(c_{w,y}\) and \(c_{s,y}\) be respectively the cost of wood chips the cost of sawdust in year \(y\), and let \(\bar{b}_i\) be the maximum amount of biomass available at sawmill \(i\). The biomass supplied by each sawmill is limited by (5).

\[
\sum_{k=1}^{S} b_{i,k,y} \leq \bar{b}_i \quad i \in \mathcal{S}, y \in \mathcal{Y} \tag{5}
\]

The delivery of methanol to each port is controlled with constraint (6), which limits the delivered amount to the energy demand of port \(j\) in year \(y\).

\[
\sum_{k=1}^{S} x_{k,j,y} = s \, D_{j,y} \quad j \in \mathcal{P}, y \in \mathcal{Y} \tag{6}
\]

where \(s\) is the share of energy demand covered by methanol, set according to the considered scenario.

The methanol synthesis plant is modelled with the energy balance (7), which includes the biomass-to-methanol conversion efficiency of the plant \(\eta_k\) obtained from the plant modelling.

\[
\eta_k \sum_{i=1}^{S} b_{i,k,y} = \sum_{j=1}^{P} x_{k,j,y} \quad k \in \mathcal{S}, y \in \mathcal{Y} \tag{7}
\]

Then, the plant size is defined according to the received amount of biomass, as described in (8).

\[
\sum_{z=1}^{N} u_{k,z,y} \, h \, Q_z \geq \sum_{i=1}^{S} b_{i,k,y} \quad z \in \mathcal{N}, k \in \mathcal{S}, y \in \mathcal{Y} \tag{8}
\]

Where \(h\) indicates the plant operating hours during a year, assumed equal to 8000. The cost for building a plant of size \(z\) is \(c_{pz}\), and \(c_{opz,y}\) is the cost of operating the plant in year \(y\). Equation (9) is introduced to limit the chosen size to no more than one of the available options.

\[
\sum_{z=1}^{N} u_{k,z,y} \leq 1 \quad k \in \mathcal{S}, y \in \mathcal{Y} \tag{9}
\]

Lastly, constraint (10) maintains the size of the plant constant after the plant is built.

\[
\sum_{z=1}^{N} u_{k,z,y} = 1 \quad z \in \mathcal{N}, k \in \mathcal{S}, y \in \mathcal{Y} \tag{10}
\]

Considering the mentioned costs, the objective function is (11).
\[
\begin{align*}
\mathbf{f}(b, x, u) &= \sum_{y=1}^{S} \sum_{i=1}^{\bar{S}} \sum_{k=1}^{S} b_{i,k,y} (t_{b_{i,k}} + 0.786 c_{x_{i,k,y}} + 0.214 c_{z_{i,k,y}}) \\
&\quad + \sum_{y=1}^{S} \sum_{i=1}^{\bar{S}} \sum_{j=1}^{P} x_{k,j,y} (c_{op_{k,j,y}} + t_{m_{k,j}}) \\
&\quad + \sum_{y=1}^{S} \sum_{i=1}^{\bar{S}} \sum_{z=1}^{N} Q_z c_{p_{k,z}} (u_{k,z,y} - u_{k,z,y-1})
\end{align*}
\]

The Facility Location Problem is defined as in (12).
\[
\begin{align*}
\min_{b,x,u} & \mathbf{f}(b, x, u) \\
\text{s. t.} & \quad (5) - (11) \\
& \quad b_{i,k,y}, x_{k,j,y} \geq 0, \quad i \in \bar{S}, k \in \bar{S}, j \in P, y \in \bar{Y} \\
& \quad u_{k,z,y} \in \{0; 1\}, \quad k \in \bar{S}, z \in \bar{N}, y \in \bar{Y}
\end{align*}
\]

### 3. Preliminary results

The optimization model was tested considering the ports Helsinborg and Trellborg in south Sweden. Figure 2 shows the location of the considered ports and the identified positions of the bio-methanol production sites for both scenarios.

![Figure 2](image)

**Figure 2.** Identified locations of methanol production sites for M5 (left) and M40 (right), positions of the considered ports and of the other sawmills included in the simulation.

The model results regarding the methanol production plant are reported in Table 3.

<table>
<thead>
<tr>
<th>Results</th>
<th>Unit</th>
<th>M5</th>
<th>M40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant location</td>
<td>-</td>
<td>S12</td>
<td>S10</td>
</tr>
<tr>
<td>Plant size</td>
<td>MWbiomass</td>
<td>100</td>
<td>400</td>
</tr>
<tr>
<td>Received biomass</td>
<td>tonwet/hour</td>
<td>30.8</td>
<td>168.4</td>
</tr>
<tr>
<td>Radius of received biomass</td>
<td>km</td>
<td>0</td>
<td>162.8</td>
</tr>
<tr>
<td>Produced methanol</td>
<td>kton/year</td>
<td>36.2</td>
<td>198.6</td>
</tr>
<tr>
<td>Radius of delivered methanol</td>
<td>km</td>
<td>214.8</td>
<td>821.5</td>
</tr>
</tbody>
</table>

Since the simulation was conducted for only one year, the investment cost for building the plant was annualized, assuming an interest rate of 2\% and 20 years lifetime for the plant. The obtained final
cost of methanol equals to 104.50 €/MWh\textsubscript{methanol} for scenario M40 and 101.03 €/MWh\textsubscript{methanol} for M5. Table 4 shows the contribution of the different cost components to the final cost of methanol.

<table>
<thead>
<tr>
<th>Results</th>
<th>Share of the final cost %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario</td>
<td>M5</td>
</tr>
<tr>
<td>Annualized plant investment cost</td>
<td>23.1</td>
</tr>
<tr>
<td>Cost of feedstock</td>
<td>51.9</td>
</tr>
<tr>
<td>Cost of transporting biomass to the plant</td>
<td>3.4</td>
</tr>
<tr>
<td>Cost of plant operation</td>
<td>18.2</td>
</tr>
<tr>
<td>Cost of transporting methanol to the ports</td>
<td>3.3</td>
</tr>
</tbody>
</table>

### 4. Conclusions

The preliminary results show that the cost of the selected biomass have a large impact on the production cost of methanol, counting for approximately 50% of the final cost. Therefore, an increase of the plant conversion efficiency seems likely to reduce the final cost of methanol production.

The cost of transporting biomass is considerably higher than the cost of transporting methanol, due to the greater transported quantities. Therefore, the lowest production cost can be obtained by reducing the biomass transport distance. The study reveals the optimal plant location around areas with high availability of feedstock, as showed in Figure 1.

The results reveal small variation of the methanol production cost between the two proposed scenarios. The unit cost of methanol is lower for scenario M5, which assumes smaller amounts of produced methanol. Since the contribution of the feedstock cost is similar for both scenarios, the study reveals that reducing the cost related to transporting materials results in a greater benefit in terms of decreasing the cost per energy unit of produced methanol when compared to economies of scale related to the investment cost for the methanol plant.

### 5. Future work

The presented paper represents an extract of a broader study, which has yet to be concluded. The complete research considers all the 116 sawmills with annual production capacity higher than 30 000 m$^3$/year and 34 Swedish ports.

The research will be continued performing a sensitivity analysis, to analyse the response of the final cost of methanol to the variation of the plant conversion efficiency.

Considering the presented preliminary results, the optimization model will be integrated by limiting the maximum delivery distance of methanol. This will prevent to obtain unrealistic delivery distances for transport of goods by truck, as observed for plant S10 in scenario M40. A sensitivity analysis on this parameter will be integrated to study the response of the system and the variation of the methanol production cost.

Lastly, the final report will include an estimation of the CO$_2$ emission reduction potential from replacing HFO with bio-methanol.
Annex A

Table A.1. List of sawmills included in the study

<table>
<thead>
<tr>
<th>ID</th>
<th>Sawmill</th>
<th>Latitude °N</th>
<th>Longitude °E</th>
<th>Production capacity m³/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>Ala sågverk</td>
<td>61.21748</td>
<td>17.15594</td>
<td>360000</td>
</tr>
<tr>
<td>S2</td>
<td>Bergkvist-Insjön AB</td>
<td>60.68886</td>
<td>15.10482</td>
<td>345000</td>
</tr>
<tr>
<td>S3</td>
<td>SCA Wood – Bollsta sågverk</td>
<td>62.99336</td>
<td>17.68226</td>
<td>550000</td>
</tr>
<tr>
<td>S4</td>
<td>Holmen Timber AB Braviken Sawmill</td>
<td>58.6377</td>
<td>16.23108</td>
<td>400000</td>
</tr>
<tr>
<td>S5</td>
<td>Holmen Timber Iggensunds Sågverk</td>
<td>61.06862</td>
<td>13.32603</td>
<td>335000</td>
</tr>
<tr>
<td>S6</td>
<td>Södra Wood Mönsterås</td>
<td>61.64402</td>
<td>17.09337</td>
<td>340000</td>
</tr>
<tr>
<td>S7</td>
<td>Södra Wood Mönsterås</td>
<td>57.09283</td>
<td>16.53884</td>
<td>420000</td>
</tr>
<tr>
<td>S8</td>
<td>SCA Timber AB Munksunds Sågverk</td>
<td>65.28132</td>
<td>19.44908</td>
<td>332000</td>
</tr>
<tr>
<td>S9</td>
<td>SCA Wood – Rundvik sågverk</td>
<td>59.31622</td>
<td>14.58353</td>
<td>320000</td>
</tr>
<tr>
<td>S10</td>
<td>SCA WOOD AB Tunadals Sågverk</td>
<td>57.22398</td>
<td>12.17577</td>
<td>590000</td>
</tr>
</tbody>
</table>

References


