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FEBRUARY 2017 | # 3

Characteristics of Sweden's Biomass Terminals

Forest biomass terminals provide diverse services to the forest industry: buffer storage, transfers of material between different modes of transport, raw material upgrading, etc. Terminals' operational costs are highly sensitive to their layout and design. In order to design efficient terminals, it is essential to understand the current state of forest terminals. To this end, a survey was sent out to companies operating forest terminals for energy in Sweden. The respondents were asked to provide information about their terminals' areas, volumes of material handled, equipment, inventory methods and age. Our results provide a detailed overview of the state of Sweden's forest terminals and will be useful in the design of improved biomass terminals in future.

DATA GATHERING AND COMPILATION

In cooperation between Swedish University of Agricultural Sciences (SLU) and Swedish Forest Industry's IT Company (SDC) the forest biomass terminal data were collected from 18 Swedish forest companies and owner's associations, providing information in total on 246 terminals for the years 2010 and 2011.

The number of terminals used in analyses varied depending on provided data. For example terminals with areal data were 246 while terminals used for mass and assortment calculations were 207 and so on. For analyses purposes all terminals were divided in four groups: < 2 ha, 2 ≤ 5 ha, 5 ≤ 10 ha and ≥ 10 ha.

TERMINAL SIZE AND BIOMASS DISTRIBUTION

The total number of terminals were not evenly distributed among terminal size classes and 74 % of all terminals had areas of less than 2 ha and only 8 % of terminal areas had areas of more than 5 ha. The smallest terminal area observed was 0.1 ha while the biggest terminals in Sweden were of 20 ha.

The clustering around smaller terminals is showed in Figure 1, where terminals of < 2 ha, < 5 ha and < 10 ha accounted for 35 %, 64 % and 78 %, respectively, of Sweden's total cumulative terminal area. The total mass of handled biomass fallowed the similar trend where terminals of < 2 ha, < 5 ha, and < 10 ha handled 54 %, 76 % and 91 %, respectively, of the Sweden's total cumulative biomass output at terminals (Figure 1).

MAIN CHARACTERISTICS OF BIOMASS HANDLING AT TERMINALS

In total 14 different energy assortments were handled over 207 forest biomass terminals with the total yearly

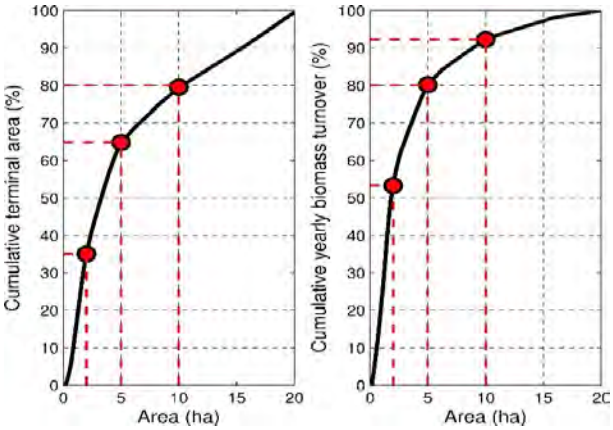

Figure 1. Cumulative terminal area (246 terminals) and yearly inventory turnover of biomass (207 terminals) in Sweden.

turnover at 1.8 million OD t (Table 1). The three main energy assortments were energy wood, logging residue chips and logging residues.

The high amount of uncommuted biomass mean that comminution operations are wide spread at the terminals and in average 90 % of terminals perform such operations.

Smaller terminal usually are delivering smaller amounts of volume to one customers while bigger terminals on average are delivering to 2–5 customers per terminal (Table 2).

Terminals among the two smallest terminal classes (< 5 ha) had a higher share of paved area (% from the total terminal area) as well as the highest share of terminals with completely un-paved areas.

Table 1. Total annual mass handled (OD t) by terminals of different size classes.

Assortment	Size class (ha)			
	< 2	2≤5	5≤10	≥10
	(n=154)	(n=37)	(n=9)	(n=7)
Energy wood	605 267	268 041	156 800	96 000
Logging residue chips	139 156	42 677	7 123	30 000
Logging residues	61 418	22 855	31 585	15 930
Bark	65 769	29 556	6 300	5 000
Saw dust	30 800	3 696	10 400	12 400
Stem wood chips	19 076	10 200	23 600	-
Tree part chips	17 660	3 471	176	1 371
Stumps	14 098	8 248	17 980	3 720
Tree parts	14 065	16 494	1 445	264
Dry sawmill chips	5 000	-	-	-
Shavings	1 970	-	10 000	1 700
Cut off	1 852	-	-	1 700
Recycle wood	1 395	2 470	-	-
Peat	80	-	-	-
All pooled	977 605	407 710	265 410	168 085

MEASUREMENT AND INVENTORY PRACTICES

Due to the high level of diversity among terminals the degree of paved surface, the number of assortments handled, and the number of customers varied in the wide range.

Most of the inventories at terminals below 5 ha were consequently performed by visual inspection (terminal personnel, including truck drivers working for logistics companies): this method was used at 60 % of all < 2 ha terminals and at 59 % of those in the 2 ≤ 5 ha class (Figure 2).

Inventories at terminals of < 5 ha were conducted by a wider range of individuals, including employees of several third party firms.

Terminals of ≥ 5 ha primarily relied on terminal personal and the Swedish Timber Measurement Association (VMF) while 56% of terminals in the 5 ≤ 10 ha class and 100 % of those in the ≥ 10 ha class used VMF.

Smaller terminals generally used multiple measurement techniques to inventory their stock, including visual inspection and GPS measurements. In addition, physical measurements (length, width and height) were also quite common.

Physical measurements were strongly preferred at terminals of ≥ 5 ha and was the method of choice at all terminals of ≥ 10 ha and 78 % of terminals in the 5 ≤ 10 ha class. Conversely, it was only used at 30 % of 2 ≤ 5 ha terminals and 51 % of the <2 ha terminals.

The clear divide of preferred method of inventory choice between terminal personal and third party performer is shown in the Figure 2.

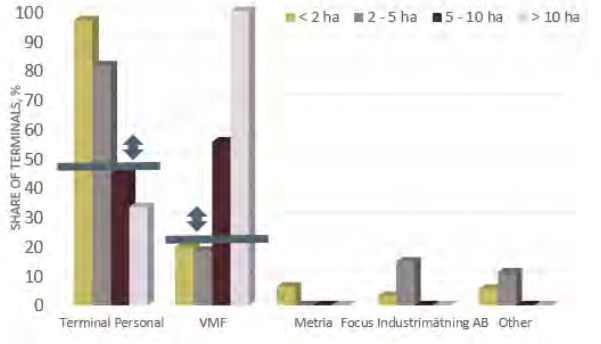

Figure 2. Preferred terminal stock level inventory performer at different terminal size classes.

The most common approaches to inventories were to monitor stock levels once a month or 3–4 times per year. Follow-up intervals between inventories varied widely at terminals of < 2 ha: in some cases inventories were performed annually while in others they were done on an ad hoc basis.

At terminals of ≥ 5 ha, inventories were most commonly performed on a more scheduled basis; biannually, quarterly, or monthly.

Table 2. Preferred terminal stock level inventory performer at different terminal size classes.

Terminal characteristics	Size class (ha)				
	< 2	2 ≤ 5	5 ≤ 10	≥ 10	All terminals
Area (ha)	0,9 (0,48)	3 (0,81)	6,3 (1,31)	14,3 (4,02)	1,9 (2,74)
Paved area (% of total area)	47 (43)	60 (38)	28 (39)	38 (39)	48 (42)
Biomass turnover per terminal (OD t)	6 307 (10 029)	10 454 (8 335)	29 490 (40 521)	24 012 (21 593)	8 661 (14 289)
Space utilization (OD t/m^2)	0,78 (1,26)	0,37 (0,32)	0,54 (0,79)	0,19 (0,20)	1 (1,12)
Biomass concentration per assortment (OD t)	3 039 (5 384)	4 155 (2 814)	5 596 (4 595)	5 949 (3 533)	3 446 (4 997)
Supply from terminal (OD t / customer)	3 004 (8 374)	3 333 (3 644)	5 223 (4 308)	4 020 (2 349)	3 198 (7 444)
No. of assortments (n)	2,4 (1,14)	2,7 (1,11)	4 (2,26)	3,4 (1,84)	2,5 (1,3)
No. of customers (n)	3 (2,1)	4,5 (4)	4,1 (2,6)	5 (2,1)	3,4 (2,7)

TERMINAL EQUIPMENT

Few clear differences are seeing when considering equipment used at the terminals. The ≥ 5 ha terminals were generally better equipped than smaller ones. The most common piece of equipment across all terminal size classes was a wheel loaders, which ranged from 78 to 92 % (Figure 3). However, the most obvious difference was when looking at measurement equipment. Terminals of ≥ 5 ha had more extensive measuring facilities such as measuring bridges, measuring houses, scales, and drying ovens. In addition, all terminals in the 5 ≤ 10 ha class had on-site scales.

Figure 3. Used equipment at different terminal size classes.

TERMINAL AGE AND LOCATION

The ages of terminals in the < 5 ha class ranged from less than 2 years to more than 20 years. In general bigger terminals tended to be also older. This could be due to more investments over time as terminals have been developed and grew in size. However, all of the ≥ 5 ha terminals were either between 6 and 10 years old or more than 20 years old.

In total, 27 % of the terminals were located within 30 km of the coast. Most of these terminals (23 out of 30; 77 %) were of size less than 2 ha. There were no terminals ≥10 ha within 30 km of the coast.

The closest forest industry sites to the terminals were sawmills: on average, each terminal was 18 km away from the nearest sawmill by road (Table 3).

The average distance between a terminal and the nearest railroad was 5 km (as crow flies), with larger (≥ 5 ha) terminals being situated closer to railroads than smaller ones.

The forest industry sites that were most distant from the terminals were pulp mills; the distance to the nearest pulp mill increased with terminal size.

Table 3. Average distances (km, (sd)) from terminals to nearby forest industry sites (road distance) and railroad, closest terminal (as crow flies).

Facility	Size class (ha)			
	< 2 ha	2-5 ha	5-10 ha	> 10 ha
CHP ≥ 100 GWh annual output	43 (31)	43 (30)	56 (42)	42 (32)
Pulpmill	63 (39)	63 (60)	85 (64)	144 (76)
Sawmill	20 (18)	16 (13)	12 (10)	5 (5)
Railroad	5 (8)	4 (7)	0 (0)	1 (1)
Closest terminal	21 (14)	22 (20)	38 (14)	7 (7)

However, the observed terminal number was limited to just 112 and could affect the overall image of the terminal geographical landscape.

SUMMARY

Most terminals covered < 5 ha; terminals in this class accounted for 65 % of the country's total terminal area. In addition, more than half the country's total forest biomass output was handled at terminals of < 2 ha. The extent of paving at terminal size classes varied widely from 28 to 60 %.

Studied terminals handled 14 different assortments; on average, each individual terminal handled 2.4–4.0 assortments. The most widespread assortment was energy wood which accounted for 63 % of the total volume handled.

Larger terminals were older, often had better measurement equipment than smaller ones and relied more heavily on third parties to perform inventories. Conversely to big terminals, smaller terminals were more likely to have mobile machinery.

More detailed description of Sweden's biomass terminals for energy production can be found in publication "Characteristics of Swedish forest biomass terminals for energy" (Kons.et all. 2014).

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2017.02.14

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