Dry matter losses and their economic significance in forest energy procurement

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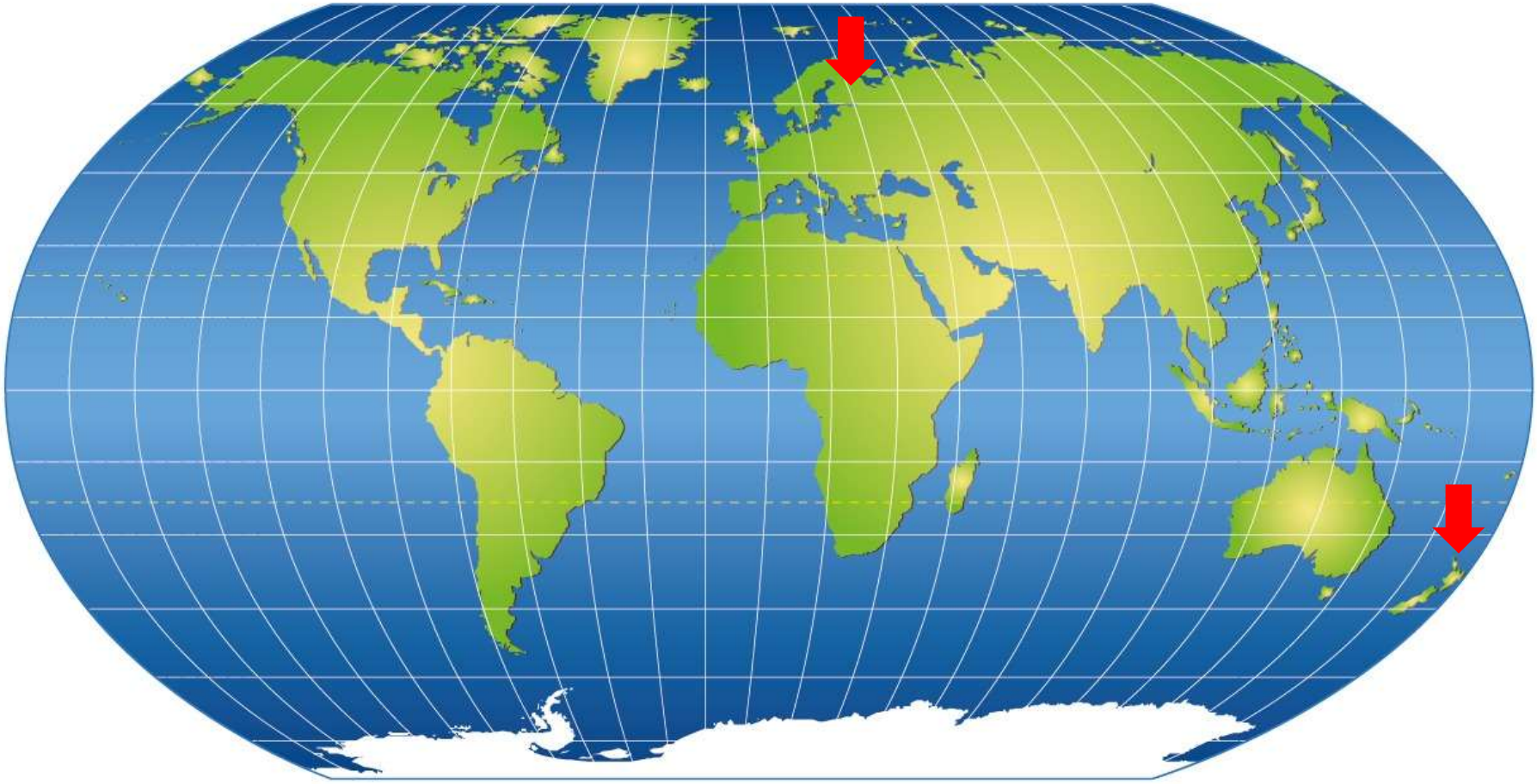

Map: www.shutterstock.com

Content:

- Solid fuel consumption in Finland
- Aim of the study
- Experiment infrastructure
- Dry matter losses
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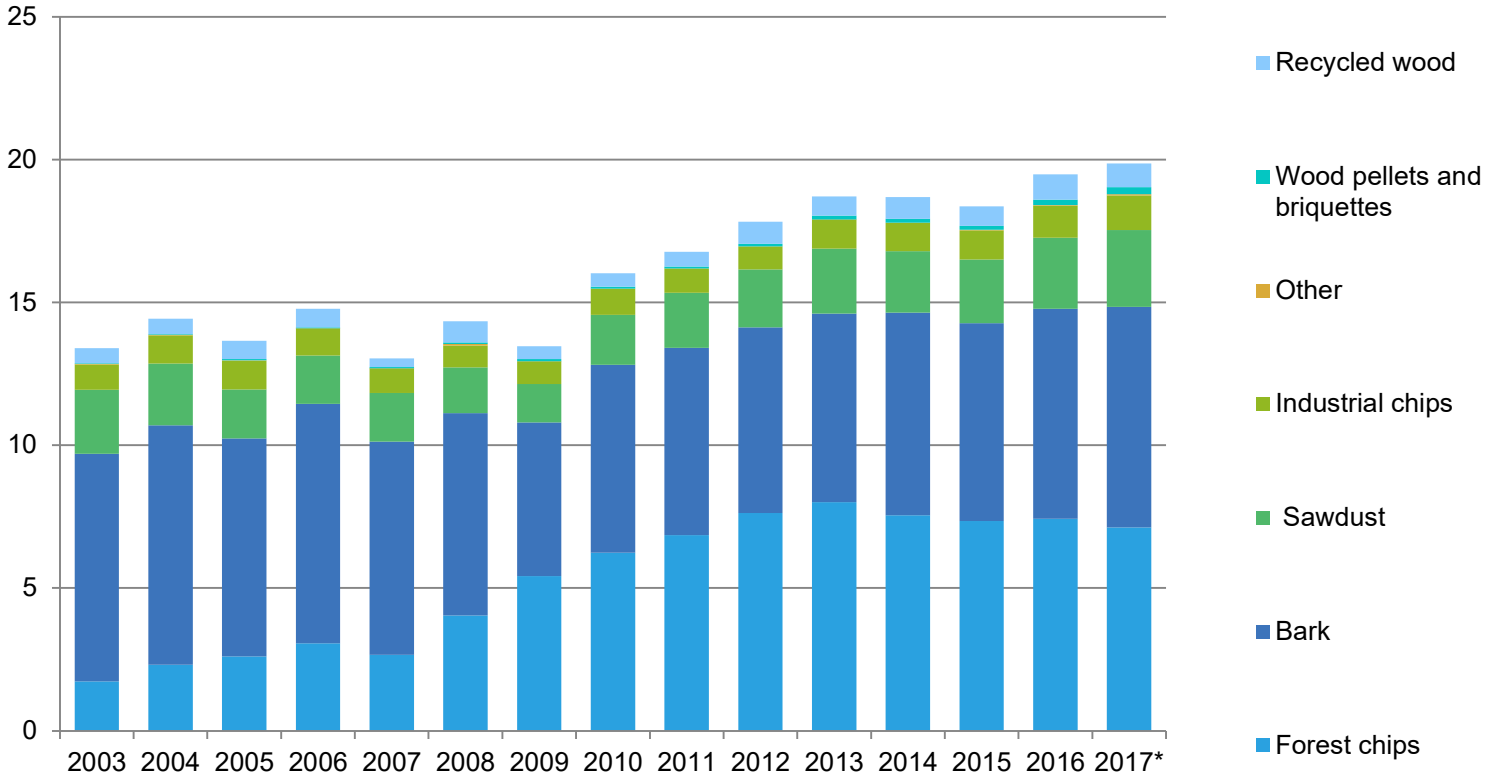
- Conclusion

Solid wood fuel consumption in heating and power plants, 2003–2017*



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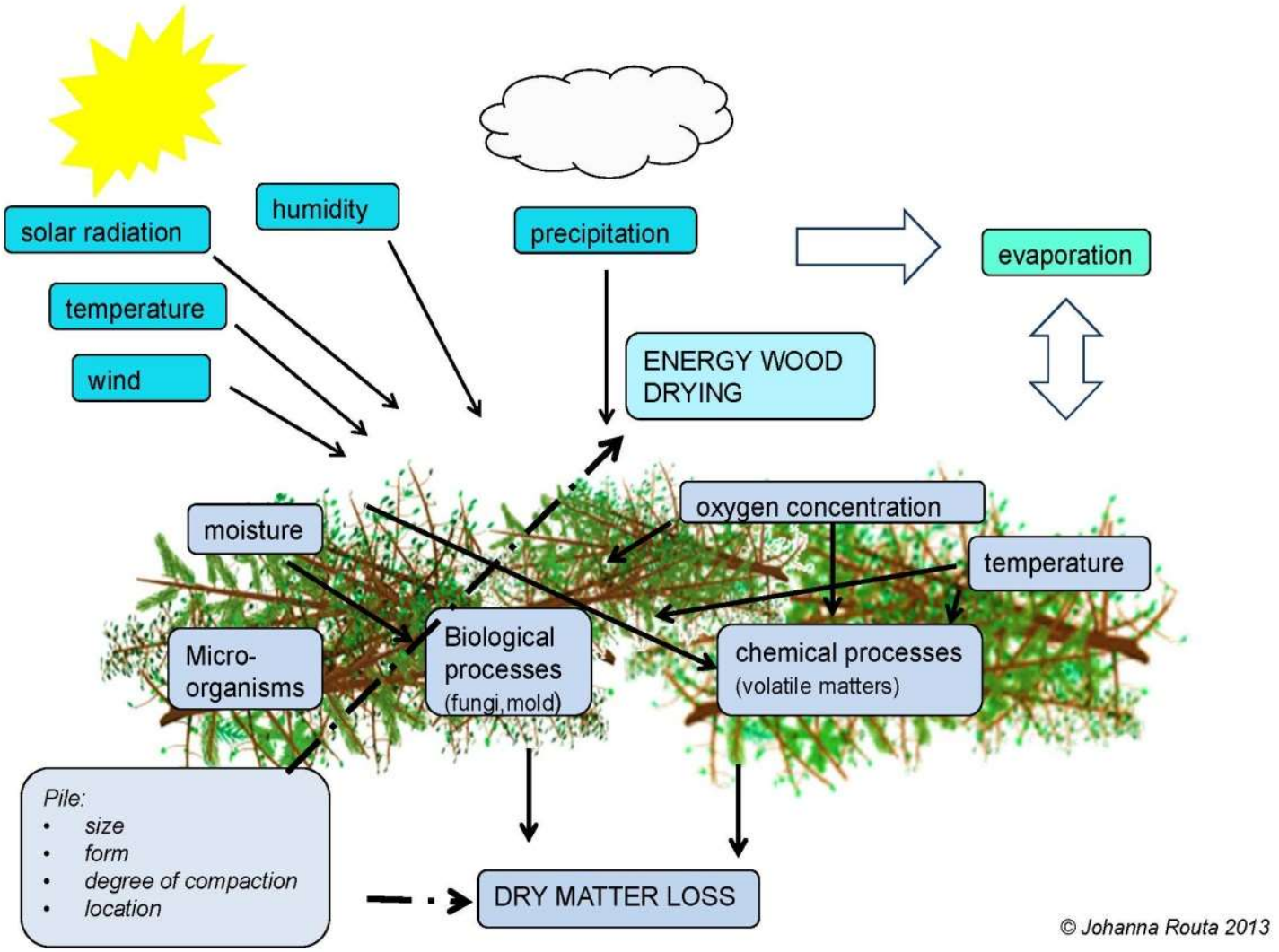
Aim of the study:

- The aim of this study was to analyze the dry matter losses of delimbed small diameter energy wood stems by constant weight monitoring within varying storage times.
- The cost effects of dry matter losses caused by different storing times were calculated to evaluate the importance of the phenomenon.
- In addition the effects of storing on energy content of energy wood were calculated.



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- The amount of dry matter in the energy wood was calculated based on the weight of the pile and its analyzed moisture content.
- Energy content of the study piles was calculated in the beginning and in the end of the experiment based on the measured moisture contents and observed dry matter losses.
- Four different size classes (small, middle, big and large scale; 10,000, 50,000, 100,000 and 300,000 m3- y) were determined, based on used energy wood volumes in power plants in Finland 2015 (Official Statistics Finland 2017).
- Based on the raw material base of forest chips in Finland, the share of stem wood was set to 60% and to 40% logging residues of energy wood volumes.

Routa, J., Kolström, M., Ruotsalainen, J., and Sikanen, L. 2015. Precision Measurement of Forest Harvesting Residue Moisture Change and Dry Matter Losses by Constant Weight Monitoring. International Journal of Forest Engineering, 26:71-83.

Dry matter losses logging residues

	Pile 1	Pile 2	Pile 3	Pile 4	Pile 5	Pile 6	Pile 7
Cover	P	F	P	P	F	P	NO
Dry matter in the beginning of experiment, kg	1048.8	1508.2	1213.8	1915.5	1548.0	1140.2	1394.7
Moisture in the beginning of experiment, %	54.5	46.8	46.6	35.7	48.0	20.1	53.4
Dry matter in the end of experiment, kg	845.0	1141.7	944.7	1503.2	1439.6	1140	1235.4
Moisture in the end of experiment, % (3 samples, average)	45.5	51.2	36.6	37.8	49.2	35.8	57.5
Change in moisture, % units	- 9	+4.4	-10	+2.1	+1.2	+15.7	+4.1
Dry matter loss, kg	203.8	366.5	269.1	412.3	108.4	0	159.3
Time in storage, months	20.0	8.4	8.4	8.0	8.0	8.0	8.0
Dry matter loss, %	19.4	24.3	22.2	21.5	7.0	0	11.4
Dry matter loss per month, kg	10.2	43.6	32.0	51.5	13.6	0	19.9
Dry matter loss per month, %	1.0	**2.9**	2.6	2.7	0.9	**0**	2.5

Routa, J., Kolström, M. and Sikanen, L. 2018. Dry matter losses and their economic significance in forest energy procurement. International Journal of Forest Engineering 29: 53–62

Dry matter losses small diameter stem wood

	Pile 1	Pile 2	Pile 3	Pile 4	Pile 5	Pile 6	Pile 7	Pile 8	Pile 9	Pile 10	Pile 11
Species: P=pine B=birch S=spruce	P Paper	P No cover	B Paper	B Fibre	S, B, P Fibre	S, B, P Paper	S, B, P No cover	P Fibre	P Fibre	P Fibre	P Fibre
Dry matter at the beginning of the experiment, kg	4833	4511	5422	5428	4555	4344	5242	8423	6997	6896	7903
Moisture at the beginning of the experiment, %	59.7	62	49.7	49.2	44.1	50.1	46.6	54.0	56.7	58.3	54.9
Dry matter at the end of the experiment, kg	4105	4039	5263	5193	4263	3843	4646	8111	6859	6843	7818
Moisture at the end of the experiment, %	37.7	37.8	34.1	34.9	40.6	34.3	42.0	40.5	40.3	40.9	37.4
Dry matter loss, kg	728	472	159	235	292	501	596	312	138	53	85
Time in storage, months	14.5	14.5	6.8	6.8	8.1	8.1	8.1	10.2	10.2	11.6	11.6
Dry matter loss, %	15.1	10.5	2.94	4.33	6.4	11.5	11.4	3.7	2.0	0.8	1.1
Dry matter loss per month, %	**1.04**	**0.72**	**0.43**	**0.64**	**0.79**	**1.42**	**1.40**	**0.36**	**0.19**	**0.07**	**0.09**

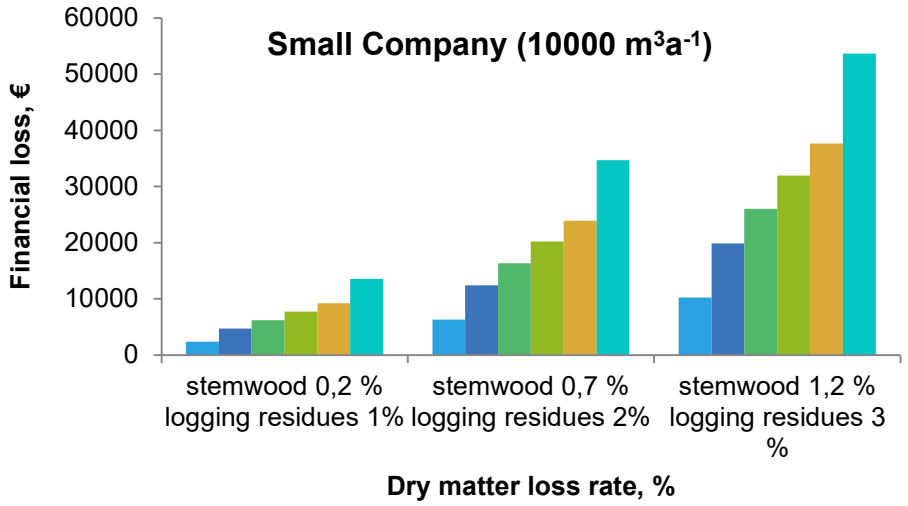
Dry matter loss rates in calculation

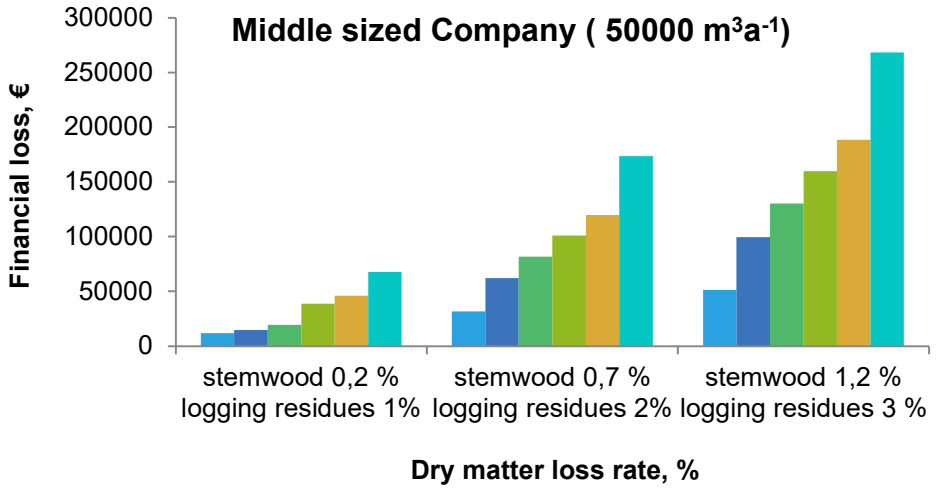
Low	stem wood 0.2%, logging residues 1% per month
Middle	stem wood 0.7%, logging residues 2% per month
High	stem wood 1.2%, logging residues 3% per month

Results:

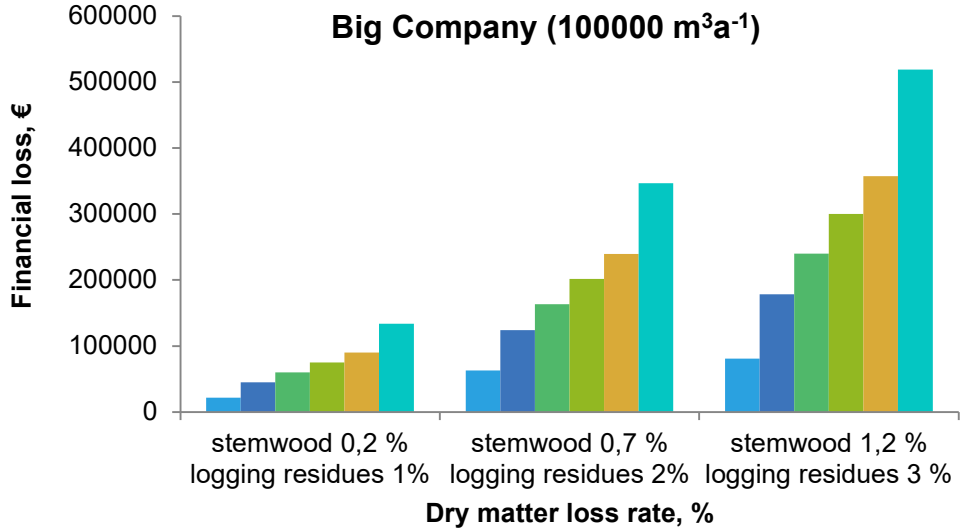
- Dry matter losses cause substantial economic losses to forest energy procurement. Economic losses can be hundred thoudsands euros per year, depending on the procurement amounts, storage times and dry matter loss rates.
- Energy content of the stored small diameter stem wood increased during the storing (3, 6, 8, 10, 12 and 18 months), if dry matter loss rates were low (stem wood 0.2% per month), but with logging residues energy content decreased with long storage periods even with low dry matter loss rates, logging residues (1% per month) .
- With middle (stem wood 0.7%, logging residues 2% per month) and high (stem wood 1.2%, logging residues 3% per month) level dry matter loss rates, the energy content of stem wood increased during the storage period with 3, 6, 8 and 10 months.

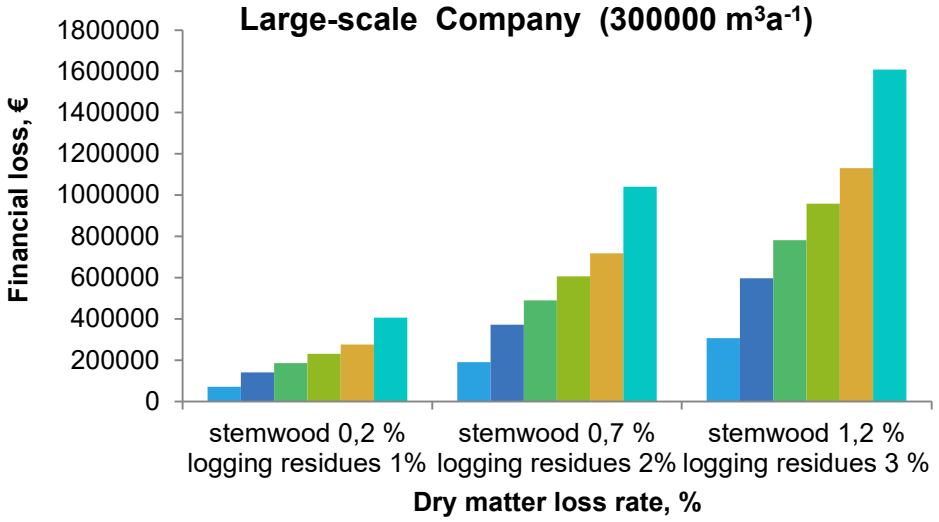
- With low dry matter loss rates, the energy content of the different sized companies storages will increase during even a 12-month storage period, but with middle and high rates, the energy content decreased remarkably.
- The reduced profits caused by dry matter losses with high loss rates (1.2% stem wood, 3% logging residues) were 16–17% of the energy wood procurement costs
- With average loss rates (0.7% stem wood, 2% logging residues), the reduction in profitability was 11% of wood procurement costs, and with small rates (0.2% stem wood, 1% logging residues) 4%.
- Raw material base of companies may varied


Small Company (10000 m³a⁻¹)
Financial loss, €
60000
50000
40000
30000
20000
10000
0
stemwood 0,2 % logging residues 1%
stemwood 0,7 % logging residues 2%
stemwood 1,2 % logging residues 3 %
Dry matter loss rate, %


Middle sized Company (50000 m³a⁻¹)
Financial loss, €
300000
250000
200000
150000
100000
50000
0
stemwood 0,2 % logging residues 1%
stemwood 0,7 % logging residues 2%
stemwood 1,2 % logging residues 3 %
Dry matter loss rate, %


storage time 3 months
storage time 6 months
storage time 8 months
storage time 10 months
storage time 12 months
storage time 18 months


Big Company (100000 m³a⁻¹)
Financial loss, €
600000
500000
400000
300000
200000
100000
0
stemwood 0,2 % logging residues 1%
stemwood 0,7 % logging residues 2%
stemwood 1,2 % logging residues 3 %
Dry matter loss rate, %


Large-scale Company (300000 m³a⁻¹)
Financial loss, €
1800000
1600000
1400000
1200000
1000000
800000
600000
400000
200000
0
stemwood 0,2 % logging residues 1%
stemwood 0,7 % logging residues 2%
stemwood 1,2 % logging residues 3 %
Dry matter loss rate, %

		Energy content in the beginning, MWh	Energy content in the end MWh	increasing + decreasing – during the storage period 12 months, MWh	Value, € + increasing during storing -decreasing during storing
Small sized company	Low level dry matter losses	18598	18647	+49	+1004€
	Middle level dry matter losses		17154	-1444	-29801€
	High level dry matter losses		15795	-2803	-57863€
Middle sized company	Low level dry matter losses	92990	93234	+243	+5022€
	Middle level dry matter losses		85771	-7219	-149005€
	High level dry matter losses		78973	-14017	-289316€
Big company	Low level dry matter losses	185981	186467	+487	+10043€
	Middle level dry matter losses		171542	-14438	-298009€
	High level dry matter losses		157946	-28034	-578631€
Large-scale company	Low level dry matter losses	557943	559402	+1460	+30130€
	Middle level dry matter losses		514627	-43315	-894027€
	High level dry matter losses		473839	-84103	-1735896€

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Conclusions

- In conclusion, attention needs to be paid to handling and management of biomass storage to avoid high dry matter losses.
- Places to store biomass on roadsides need to be chosen carefully, preferably in sunny, open places.
- Logging residues should be dried on site before piling to roadside storage.
- Storage periods should be kept as short as possible, and too long storing should be avoided.
- With proper management, it is possible that the energy content of the energy wood piles increases during the storing.
- However, with negligent handling and poor conditions, the energy content losses and economic losses during the storing can be remarkable.

Thank you!

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