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LCA for Setra glulam

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1 General aspects

1.1 Introduction

This study has been conducted according to the requirements of ISO 14044:2006, EN 15804:2012+A1:2013, ISO 14025:2006 and PCR NPCR 015 rev1 Wood and wood-based products for use in construction.

The present LCA study is performed by IVL Swedish Research Institute as an external consultant report in accordance to the requirements in EN15804.

1.2 Goal of the study

The goal of the study has been to provide necessary data and documentation to perform an EPD according to the requirements of PCR NPCR 015 rev1, and to gain insight into the environmental impacts related to glulam production.

The scope is a cradle to gate LCA, why the purpose is to give modular LCA information that can be used as data source for a full LCA on a construction works level if additional life cycle stages are added.

The results from this LCA study will be published in an environmental product declaration type III for the product.

Target audiences of the study are customers and other parties with an interest in the environmental impacts of glulam. The EPD is therefore intended to be used in business-to- business and business-to- consumer communication. The internal use of the LCA is to highlight the relative significance of different manufacturing steps, and is therefore as basis for future improvements.

If the result in this report in future shall be used to support comparative assertions intended to be disclosed to the public, the guidance in ISO 14025 shall be followed. If future changes in the manufacturing, including upstream data, appear that affect the result more than 10% to any impact category, a revised LCA calculation shall be made and the EPD updated. Such changes shall therefore always be communicated to IVL.

1.3 Product description

Glulam are part of the product group “Wood and wood-based products for use in construction” and includes a wide range of products from solid wood to engineered are given in PCR NPCR 015 rev1.

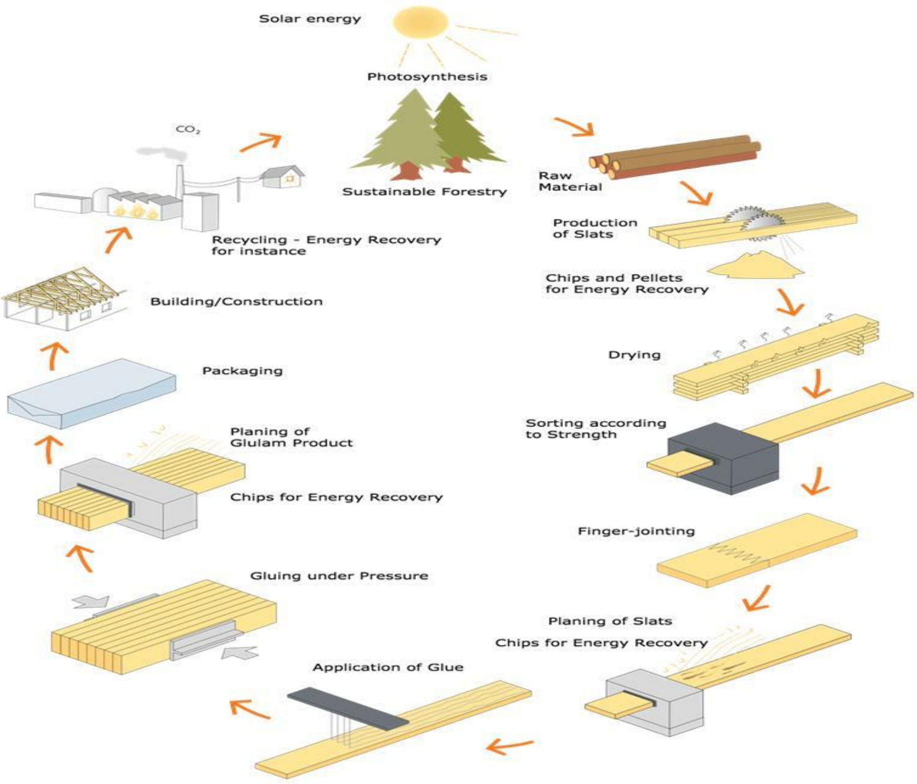

Figure 1 **Detailed description of the manufacturing of the processes for glulam production**

Glulam is made up of wood laminations or lams (pieces of sawn timber named lam when used for glulam production) that are bonded together with adhesives, see Figure 1. In glulam are all lams oriented in the same direction as the beam or pillar.

1.4 Area of application

Glulam is used as beams and pillars.

1.5 Functional unit (FU) and declared unit (DU)

The declaration is; ‘1 m^3 glulam beam or pillar’.

The products will only be attributed to a functional unit when it is a part of any construction works. A functional unit is not relevant for this EPD and therefore not included in the LCA. The same technical classification of glulam is used notwithstanding if it is made of pine or spruce. The glulam in this EPD is made of spruce.

1.6 Product characterisation

The glulam from Setra has a moisture content of about 12 % (weight/ weight) and made of spruce and a density as delivered at 430 kg/m^3 (and a dry density of 384 kg/m^3). The products are not impregnated or treated with any chemicals. The products can be customized designed if asked for.

1.7 Reference service life (RCL)

A reference service life (RCL) is only valid if a full life cycle is accounted for but is commonly reported on in the EPD anyway. Nevertheless, glulam RCL can be set to the same as the construction works design life if protected from weather exposure. This imply normally to a RCL from 50 or 60 years. The service life in practice will be far longer.

1.8 Calculation rules for averaging data

The LCA is representative as an average for glulam beams or pillars from Setra in Långshyttan, including specific data from the two spruce sawn timber suppliers; Setra Heby (67%) and Setra Färila (33%). An assumed average transportation distance to end user from Setra Långshyttan is used (170 km) in the scenario for transportation A4. This distance is given by Setra as an estimate of an average consumer in 2017.

The production at Långshyttan also includes a small amount of treated glulam (made of pine). In the LCI is the manufacturing modeled such as if the only product is non-treated and made of Spruce. This means that Långshyttan have an additional sawmill supplier (Skinnskatteberg), that is not needed to account for (as well as the downstream impregnation).

1.9 System boundaries

The EPD follows the modular structure defined by EN15804. The general scope of the EPD is cradle to gate (module A1 to A4).

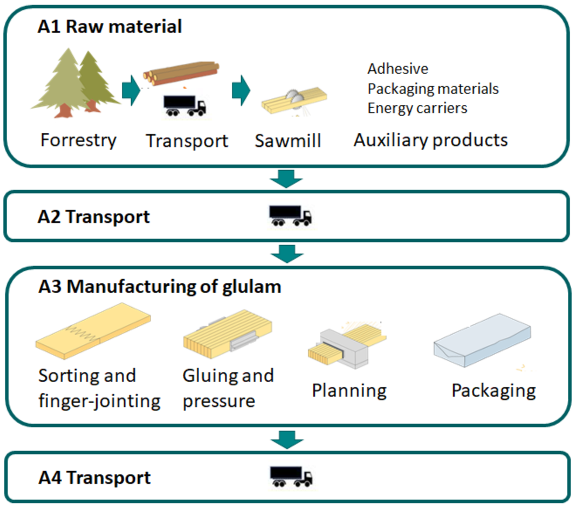

Figure 2 System boundaries for the glulam production

Table 1 describes the life cycle stages, processes, material- and energy flows or data that are included and excluded in the analysis on a general level. System boundaries related to the processes are also given in Figure 2.

Table 1 Scope of EPD with respect to life cycle stages covered and modules for the assessment

Product stage			Constr./ installation stage		Use stage							End of life stage				D
Raw material supply	Transportation	Manufacturing	Transportation	Construction / installation / assembly	Use	Maintenance (incl. transportation)	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-installation / demolition / disassembly	Transportation	Waste procesing	Disposal	Reuse, recove, recycling-potential -
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	X	MND	MND	MND	MNR	MNR	MNR	MNR	MNR	MND	MND	MND	MNR	MND

X above indicates that the modules included in the analysis, MND is used for modules that is not declared but relevant and MNR for modules not relevant.

This LCA follows EN 15804. According to this standard raw material supply and energy in A3 shall be assigned to module A1, why e.g. resource use for electricity used in A3 is declared in A1. Since this in some case is not clear to the LCA consultant how it is implemented in the EPD, the modules A1-3 will be reported as one integrated module (that is in line with EN15804), in order to avoid misinterpretation.

1.9.1 Technical flowchart – product system scheme

The definition and required inclusion to each module is followed and defined in EN15804. No additional specifications are given in the PCR NPCR 015 rev1.
The goal with the inventory is to use (in prioritized order),

1. specific data if possible
2. generic data representative for the specific data
3. other generic data

The main processes included in the LCA and included main processes and the degree of specific data are given in Table 2.

Table 2 Description of product system and its main processes and type of data source

Module	Process	Description of data source
A1	A1:1 Forestry	Swedish average
	A1:2 Electricity (from A3)	Swedish average (for both the glulam plant as the sawmill)
	A1:3Adhesives	Specific recipe and specific core data from Casco included generic upstream sources used as representative for Dynea
	A1:4 Sawn timber	Specific data from the Heby and Färila sawmill (that is the only deliverers)
	A1:4.1 Common parts	Specific data from the actual sawmills
	A1:4.2 Power house	Specific data and measured emission figures are complemented with national applied generic emission figures
	A1:4.3 Log yard	Specific data from the actual sawmills
	A1:4.4 Debarking and saw intake	Specific data from the actual sawmills
	A1:4.5 Raw sorting	Specific data from the actual sawmills
	A1:4.6 Saw house	Specific data from the actual sawmills
	A1:4.7 Thumb station	Specific data from the actual sawmills
	A1:4.8 Drying	Specific data from the actual sawmills
	A1:4.9 Sorting and trimming (justerverk)	Specific data from the actual sawmills
A2	A2:1Transport to of sawn timber to saw mill	Actual transport distance and statistical load factor (half of the returns is empty) for sawn timber, and then a conservative approach for

Module	Process	Description of data source
		all other materials where the actual distance is used combined with an empty return. An average standard diesel (a mix including 7 % biogenic sources) is applied.
A3	A3:1 Glulam house	Specific data from the actual plant at Långshyttan
	A3:2 Heat supply from a district heating plant	Specific data on energy use are from the the actual plant at Långshyttan and combustion figures are the based on national applied generic emission figures
A4	A4:1 Transportation distance to an average costumer	Specific data based on statistical information from Setra valid for 2017

1.9.2 Reproducibility, transparency and potential possibilities for an update (A3)

The main data sources for the core process (A3) are from Setra's yearly environmental report and Key Performance indicators in 2017 (regular updated for all sites in Setra). Also an environmental report is published on early basis and is used for specific emissions to water and is reported to the Långshyttan municipality (2017). Additional information is therefore required to perform and check for updates for the Setra Långshyttan EPD. The data collection and allocation for A3 is made in a separate xls-file where individual figures can be changed and therefore constitute the main source for reproducibility and basis for the reference flow concerning A3. The reference flows are part of the plans and its processes in the LCA software and can be used to reproduce the result.

1.9.3 Scenarios for analyses processes beyond cradle to gate

Not valid here since the EPD coverers only cradle-to-gate.

1.9.4 Assumptions about electricity consumption and other relevant background data

As recommended by EPD Norway the Swedish national electricity grid is used, since no specific electricity with guarantee of the origins is bought, for electricity used at the glulam manufacturing or at the sawmill. This is in line with the PCR and the GPI.

1.9.5 Cut-off criteria for initial inclusion of inputs and outputs

General cut-off criteria as defined in EN15804 are followed. Besides these criteria's omitted processes (or flows) as given below are valid – no cut-off flows from inventory are identified (see Table 3).

Table 3 List of excluded processes

Process excluded from study	**Cut-off criteria**	**Quantified contribution from process**
No processes omitted	—	—
Flows not treated fully are listed in section 2.2.	—	—

1.9.6 Data quality requirements

The data quality for data and background data corresponds to the specifications of EN 15804. IVL Swedish environmental Research Institute performs varieties of checks during the inventory work before entering data to the study.

IVL use GaBi as LCA tool from Thinkstep (former PE International). We therefore preferable use GaBi databases (that is annually updated) since we regard these databases to be more in line with EN15804 than ecoinvent 3.3 (as implemented to GaBi and ecoinvent version 3.0.1 has never been adopted to GaBi). Ecoinvent is mainly used when a data is not found in the GaBi databases, or used in the upstream system (i.e. when a les significant contribution is expected).

The data quality for the utilized data is described under the heading “

The sequestrated biogenic carbon that is used for energy purpose during the processing of wood A1-3 will be equal with the emitted biogenic carbon. However, especially biogenic methane is a GHG and is accounted for (with emissions factors when wood is combusted) in GWP $_{100\ \mathrm{GHG}}$, i.e. the GWP indicator as required by EN15804 The net contribution to biogenic carbon from A1-3 to be reported in the EPD is therefore equal with the biogenic stored in the product in the final product (and if relevant in packaging materials). This amount is calculated as follows 384 kg dry matter * 50% biogenic carbon in wood * 44/12 to go from carbon to CO_2 equal to 704 kg CO_2/m^3. This biogenic carbon dioxide shall according to the PCR NPCR 015 rev1 be treated as CO_2 Bio = 1 kg CO_2e. To allow the EPD to be used for climate declaration by the Swedish Road Administration, the GWP 100 GHG has to be reported separately as outlined in EN15804:2013. We therefore report both the GWP 100 GHG and summed GWP that includes stored biogenic carbon, as the latter part separately.

Life cycle inventory analysis”.

1.10 Additional environmental information

1.10.1 Additional environmental indicator results

PCR NPCR 015 rev1 specifies that the content of biogenic carbon in the product shall be accounted for and added up with the common impact category climate change. To do this the biogenic carbon is transformed to CO_2. Moreover, the PCR NPCR 015 rev1 then stipulate that 1 kg biogenic CO_2 shall be regarded as equal with 1 kg CO_2 (GWP100). Since this is not scientifically correct, this information will be reported separately so the reader that wants to have a scientific sound result shall find the result in the EPD as reported according to EN15804 and supplied with the mixed figure. The contribution to the GWP will therefore be reported twofold as follows:

- GWP (as EN15804:2013)
- GWP derived from content of biogenic CO_2

1.10.2 Additional environmental information in the EPD

The following additional environmental information is reported in the EPDs:

- Declaration concerning potential content of hazardous substances are given in appendix 2.
- VOC material emissions. See appendix 3.

The sequestrated biogenic carbon that is used for energy purpose during the processing of wood A1-3 will be equal with the emitted biogenic carbon. However, especially biogenic methane is a GHG and is accounted for (with emissions factors when wood is combusted) in GWP $_{100\ GHG}$, i.e. the GWP indicator as required by EN15804 The net contribution to biogenic carbon from A1-3 to be reported in the EPD is therefore equal with the biogenic stored in the product in the final product (and if relevant in packaging materials). This amount is calculated as follows 384 kg dry matter * 50% biogenic carbon in wood * 44/12 to go from carbon to CO_2 equal to 704 kg CO_2/m^3. This biogenic carbon dioxide shall according to the PCR NPCR 015 rev1 be treated as CO_2 Bio = 1 kg CO_2e. To allow the EPD to be used for climate declaration by the Swedish Road Administration, the GWP 100 GHG has to be reported separately as outlined in EN15804:2013. We therefore report both the GWP 100 GHG and summed GWP that includes stored biogenic carbon, as the latter part separately.

2 Life cycle inventory analysis

2.1 Data collection procedures

Life cycle inventory have been performed in 2015 and spring 2015 and covers information valid for 2017 from Setra Långshyttan. The reference year for the final LCA is set to 2018.

The inventory work was performed based on the environmental report from Setra and the Key Performance Indicators 2017 gathered by Setra. This information was complemented with several questions and calculations and questions to Setra Långshyttan. The inventory material for the glulam production and the sawmills was collected and stored in separate xls-files. This data also account for the allocation performed. The remaining LCA calculations were then performed in Gabi.

A site specific inventory was also conducted for the supplier for sawn timber namely Färila och Heby (2017). Casco provided information on the MUF adhesives in 2016 and are in larger part based on site specific information (collected by Casco between 2012-2014). This MUF adhesive is assumed to be representative also for the MUF adhesives from Dynea.

2.2 Descriptions of unit processes

The unit processes described in Table 2 is described in detail in this section

2.2.1 A1:1 Forestry

A1:1 Forestry	
Aspect	**Notes**
Precision	Swedish average
Completeness	Data accounts for all known sub-processes
Consistency, allocation method etc.	A conservative approach is used where all forestry activities are allocated to the final product round timber and nothing to forestry by products (GROT). This allocation between round timber and by-products (GROT) are following the economical approach outlined in EN 15804.
Geographical coverage	Data is valid for Swedish average forestry
Time related coverage	Data is valid for 2012. No updated figures are published by Skogforsk. However, Skogforsk publish yearly activity based information that can be used as an indicator of overall efficiency development in the harvesting. According to this information (Figure 4) are figures from 2012 a conservative figure compared to the current situation (see Figure 4), why these figures from 2012 are a conservative approach and therefore used with no limits in this study.[1]
Main data sources (references)	Yvonne Aldentun (2009): Livscykelinventering av fyra plantskolor. Resultat nr 9 1999, Skogforsk, Brunberg T (2009): Bränsleförbrukning i skogsbruket Skogforsk, 7 oktober 1999 Brunberg T 2103: Bränsleförbrukningen hos skogsmaskiner 2012. Fuel consumption in forest machines 2012. Arbetsrapport Från Skogforsk nr. 789–2013.
Validation of data	Data are compared to other data sources, see Figure

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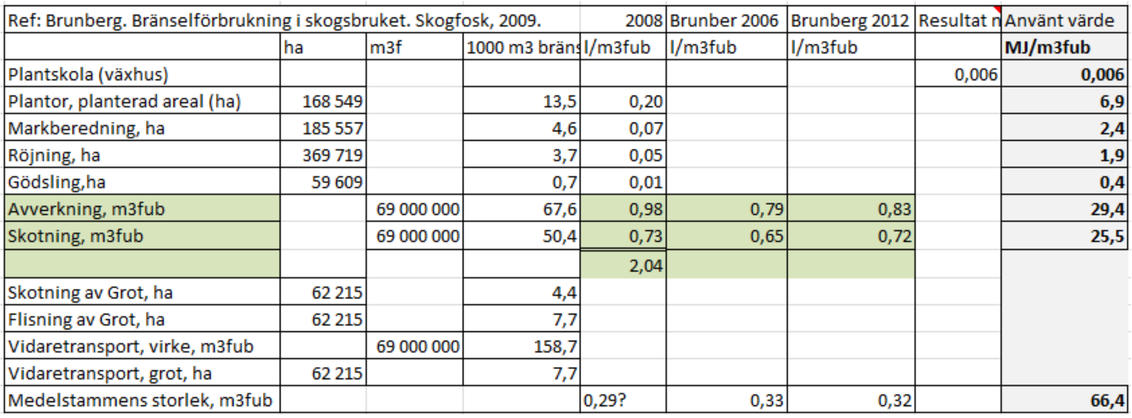
[1] All assumptions made or if older data are used it shall be accepted by the verifier if it is an conservative approach (or representative for the current situation).

A1:1 Forestry	
Aspect	**Notes**
	3. The diesel consumption for harvesting and forwarding (skotning) it the two dominant forestry processes. The different references from other references from the same person are in a range of about +/- 10%. The latest reference is chosen for these two processes harvesting (and is a value in the midle). Data for the planting is from Aldentun 1999. The data are assumed to be the same today and has an insignificant contribution. All other data is found on Brunskog 2009 (valid for the year 2008). See also comment under "Time related cover" above.
Representativeness	Data is set to be representative for the current Swedish situation and valid for the forestry suppliers to Setra Långshyttan.
Treatment of missing data	No data is found missing
Data quality assessment	Data quality as required in EN15804 is met.
Comments	The most up to date data for Swedish available average is used. Data from Gabi and ecoinvent 3.3 are used for some background processes like combustion of diesel in forrestry machines and LCI data for the fuel used.



Ref: Brunberg. Bränselförbrukning i skogsbruket. Skogfosk, 2009.				2008	Brunber 2006	Brunberg 2012	Resultat n	Använt värde
	ha	m3f	1000 m3 bräns	l/m3fub	l/m3fub	l/m3fub		**MJ/m3fub**
Plantskola (växhus)							0,006	**0,006**
Plantor, planterad areal (ha)	168 549		13,5	0,20				**6,9**
Markberedning, ha	185 557		4,6	0,07				**2,4**
Röjning, ha	369 719		3,7	0,05				**1,9**
Gödsling,ha	59 609		0,7	0,01				**0,4**
Avverkning, m3fub		69 000 000	67,6	0,98	0,79	0,83		**29,4**
Skotning, m3fub		69 000 000	50,4	0,73	0,65	0,72		**25,5**
				2,04				
Skotning av Grot, ha	62 215		4,4					
Flisning av Grot, ha	62 215		7,7					
Vidaretransport, virke, m3fub		69 000 000	158,7					
Vidaretransport, grot, ha	62 215		7,7					
Medelstammens storlek, m3fub				0,29?	0,33	0,32		**66,4**

Figure 3 Amount of diesel consumed in different forestry related activities, Swedish average. The dominant contributions are marked in green above and are for final cutting respective forwarding. Reference for these processes is Brunberg 2013, see list below.[2]

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[2] That figure is not used for calculation and just reported as supplement information and the "?" just indicate that the reference was not 100% clear about this matter.

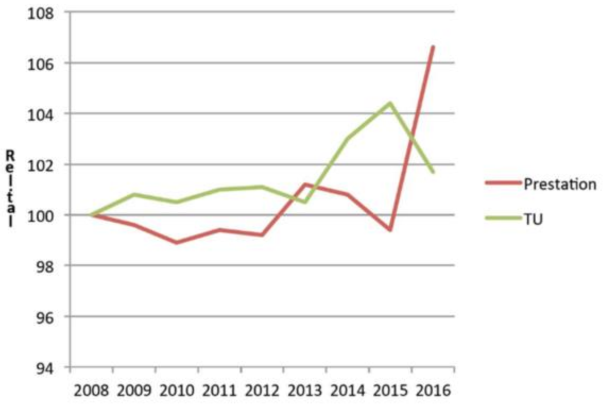

Figure 4 **Resent development in Swedish forrestry. The utility (“TU”) and activity time (“Prestation”) is increased in 2016 compared to 2008 to 2012[3].**

2.2.2 A1:2 Electricity bought in A1:4 and A3

A1:2 Electricity bought in A3	
Aspect	**Notes**
Precision	Country specific grid mix and relevant processed for 2013, assumed to be valid for representative year valid for the latest 3-years period (2012-2015).
Completeness	Data accounts for all known sub-possesses
Consistency, allocation method etc	Allocation follows a physical causality in line with EN 15804.
Geographical coverage	Data is valid for Sweden
Time related coverage	Data is valid for 2013 and compared with latest year that is available in the statistic namely 2016, see Table 4. There is only one minor difference namely 3% increase of wind power and 3% less nuclear power. Therefore LCA data from Gabi from 2013 can be assumed to be representative also for the latest Swedish electricity mix available in statistic.
Main data sources (references)	Gabi
Validation of data	The data from Gabi is given for a single year (2013) and the GWP is 0,043 kg CO_2e/kWh and is accepted as representative for the latest years of electricity production, see below.
Representativeness	Data is assumed to be representative for the current Swedish electricity grid mix (see above)
Treatment of missing data	No data is found missing
Data quality assessment	Data quality as required in EN15804 is met.

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[3] https://www.skogsstyrelsen.se/globalassets/statistik/statistiska-meddelanden/bruttoavverkning-jo0312/2015-bruttoavverkning-sm-jo0312.pdf

A1:2 Electricity bought in A3	
Aspect	**Notes**
Comments	—

Table 4 Electricity production in the Swedish grid mix[4]

	2013	2014	2015	2016	Diff 2016-2013
Vattenkraft	37%	39%	43%	37%	-0.2%
Vindkraft	6%	7%	9%	9%	3%
Solkraft	0.02%	0.03%	0.06%	0.09%	0.1%
Kärnkraft	39%	38%	32%	36%	-3%
Konventionell värmekraft	9%	8%	8%	9%	-0.3%
kraftvärme, industri	3%	3%	3%	3%	-0.1%
kraftvärme, fjärrvärme	5%	4%	4%	5%	-0.1%
kondensproduktion	0.18%	0.25%	0.13%	0.17%	0.0%
Gasturbin- och annan produktion	0.01%	0.01%	0.01%	0.01%	0.0%
Summa produktion	100%	100%	100%	100%	

2.2.3 A1:3 MUF adhesives

A1:3 MUF adhesives	
Aspect	**Notes**
Precision	Specific data concerning recipe and core process are from Casco MUF. These data are assumed to be the same and representative also for Dynea that is the actual deliverer for Setra
Completeness	Data accounts for all known sub-possesses, see Figure 5
Consistency, allocation method etc	Allocation are in line with EN 15804.
Geographical coverage	Data is valid for Casco MUF that are assumed to be representative for Dynea as well
Time related coverage	Data is an average from 2012-2014
Main data sources (references)	Casco 2016-06-30
Validation of data	Data is validated by Casco
Representativeness	Data is set to be representative for the current Swedish situation and valid for the forestry suppliers to Setra Långshyttan.
Treatment of missing data	Downstream treatment of wasted product at the site is not accounted for since it is negligible (0,02 %).

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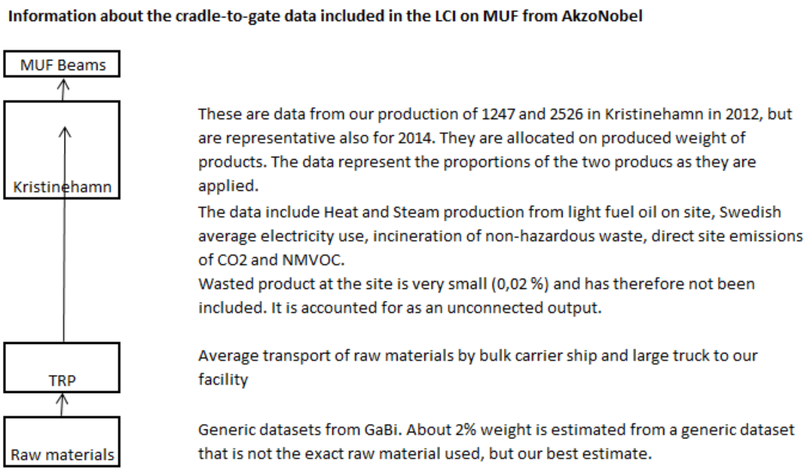
[4] http://www.scb.se/hitta-statistik/statistik-efter-amne/energi/tillforsel-och-anvandning-av-energi/arlig-energistatistik-el-gas-och-fjarrvarme/pong/tabell-och-diagram/tillforsel-och-anvandning-av-el-20012015-gwh/

A1:3 MUF adhesives	
Aspect	**Notes**
Data quality assessment	Data quality as required in EN15804 is met.
Comments	Data received as a Gabi program file (gbx) that means that all LCI result from the original LCA is imported to this LCA calculation



Information about the cradle-to-gate data included in the LCI on MUF from AkzoNobel

These are data from our production of 1247 and 2526 in Kristinehamn in 2012, but are representative also for 2014. They are allocated on produced weight of products. The data represent the proportions of the two producs as they are applied.

The data include Heat and Steam production from light fuel oil on site, Swedish average electricity use, incineration of non-hazardous waste, direct site emissions of CO2 and NMVOC.

Wasted product at the site is very small (0,02 %) and has therefore not been included. It is accounted for as an unconnected output.

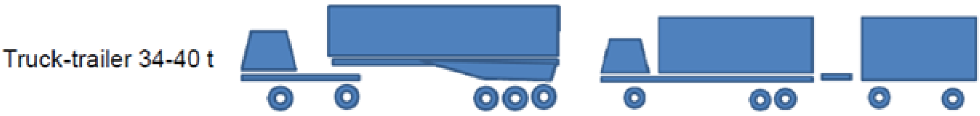
Average transport of raw materials by bulk carrier ship and large truck to our facility

Generic datasets from GaBi. About 2% weight is estimated from a generic dataset that is not the exact raw material used, but our best estimate.

Figure 5 Documentation of dataset received by Casco 2016 (documentation as received from Casco. No 1247 and 2526 is commercial names of the Casco MUF base adhesive and the hardener. 98 % of the contribution to GWP is based on site specific data from Casco, owned by AkzoNobel)

2.2.4 A2:1 Transport of round and sawn timber

A2:1 Transport of round timber	
Aspect	**Notes**
Precision	Specific transport data and fuel mix. Generic upstream data.
Completeness	Data accounts for all known sub-possesses
Consistency, allocation method etc	Allocation follows a physical causality in line with EN 15804.
Geographical coverage	Data is valid for the transportation taken place
Time related coverage	Transport distance is 100 km and valid for 2017 (and the latest years)
Main data sources (references)	Information from transportation companies about transport distance and fuel mix in 2014.
Validation of data	Data for fuel-mix is sensitive for the amount bio components used that is set to 7.23 wt-% and the sulphur content is set to 10 ppm. Note that since July 2018 is GWP contribution from the Swedish standard diesel reduced by 20% (meaning a biodiesel content of about 25%). This is not accounted for in this LCA why all diesel consumption must be regarded as conservative, see https://energimyndigheten.a-w2m.se/Home.mvc?ResourceId=5752.
Representativeness	Data is set to be representative for the current European (EU 27) transport, combustion and fuel mix. The truck is diesel driven, Euro 4, 34 - 40t gross weight and with a 27t payload capacity. The source emissions and driving share rural/urban is from HBEFA 3.1, see http://www.umwelt.sachsen.de/umwelt/download/70675_09_10_Endfassung.pdf.
Treatment of missing data	No data is found missing
Data quality assessment	Data quality as required in EN15804 is met.
Comments	Corrections are made for actual payload, empty return and a weight factor if the reference flow in the LCI differ from the bulk density (relevant for the transportation). See Appendix and figures below.



Round timber, from forestry to sawmill:

The actual distance is 100 km and weight factor of 1,7 caused by a moisture content of 70% (bulk weight compared to dry matter) and results in a virtual transportation distance of 170 km. An empty return gives the following adjusted load factor of 52% (14 t =(120*27+120)/(120+120) and 14/27=0,52)

Sawn timber, from sawmill to glulam plant:
The actual distance is 136 km (weighted average from Heby and Färila) and a weight factor of 1,12 caused by a moisture content of 12% (bulk weight compared to dry matter) and results in a virtual transportation distance of 152 km. An empty return for 50% gives the following adjusted load factor of 74%
(20 t = (120*27+0,5*27*120)/(120+120) and 20/27=0,74)

The equations used in Gabi are explained in the Annex.

2.2.5 Sawmill A1:4.1 to A1:4.9

A sawmill is divided in a number of processes (here defined as A3:1 to A3:10) that generates different co-products. Moreover, the wood drying process energy use dependent on wood moisture content. In addition, it should then be noticed that wood volume change when it is dried beneath a moisture content of 30 %. None of these aspects are handled in the PCR for wood from EPD Norway. The inventory work for the sawmills follows also the specifications given in “Methodology for Environmental Assessment of Wood-Based Product” (Erlandsson M, report No I 9608070, Trätek August 1996) if specifications are missing in the wood PCR. This is valid for the recalculation of the reported average energy use from the sawn timber drying, in order to reflect the actual moisture content (that typically differs from the reported average). Such recalculation of energy use for drying is as minimum required if the reported sawn timber moisture content is lower than the moisture content used in the LCA calculation. This is the case in this LCA, why we need to increase the energy use for drying to give a representative energy use (and its impact) for sawn timber with a moisture content of 12% (that is a lower content than the reported average).

In order to follow EN15804 it is important that the sawmill is divided in different processes, else it will not possible to perform the required economical allocation correctly. Compared to ISO 14044, EN 15804 introduced a revised order where economical allocation shall apply, when a large difference is the case when comparing the main product(s) and low value coproduct. Note that the “note” in EN15804 “that defines this” is only indicative. We use the note as definition when an economical allocation shall be performed “A difference in revenue of more than 25 % is regarded as high” (the part of the overall turnover is thus neglected). To define if an economical allocation the price difference is calculated, see Table 5.

Table 5 Price difference (current products price/price for the sawn timber)of co-products compared to the main product(s) (reference IVL 2015)

Bark	5%
Cellulose chips	32%
Dry by-products	3%
Saw dust (spån)	2%
Shavings (kutterspån)	15%

As given by Table 5 cellulose chips is the co-product with the highest economic value compared to the main products from the same sub-process with about 1/3 of the value of the interim main product. This approach applied follows the allocation procedure given by EN15804 and impact from the sawmill is only allocated to only Cellulose chips and sawn timber. This allocation it then based on price, why almost all impact in practice is allocated to the sawn timber.

The inventory data from the two Setra sawmills are given for the average production mix resulting in a moisture content higher than the 12% that is bought by Setra glulam plant in Långshyttan. The consequence is that the original energy use has to be increased to meet the actual moisture content valid for Långshyttan. This compensation is based on equations equation No 17 from Erlandsson (1996). The result of the compensation is given in Figure 5.

Sawmill A3:1 to A 3:10	
Aspect	**Notes**
Precision	Site specific data from the sawmill in Färila and Heby. The data are weighted in respect to the amount sawn timber bought for the actual glulam production in 2017.
Completeness	Data accounts for all known sub-possesses
Consistency, allocation method etc	Allocation follows a physical causality in line with EN 15804 and an economical allocation if valid as specified in the standard. See general notes above and details below.
Geographical coverage	Data is valid for Färila and Heby that is a typical Swedish spruce sawmill
Time related coverage	Data is valid for 2017
Main data sources (references)	The KPI from 2017 is used for respective sawmill to get the LCI data needed..
Validation of data	Data are compared with data from different years and only a small difference is found according to the KPI.
Representativeness	Data is valid for Färila and Heby that is a typical Swedish spruce sawmills and is the two that deliver spruce sawn timber to Setra Långshyttan, why data is fully representative
Treatment of missing data	No data is found missing
Data quality assessment	Data quality as required in EN15804 is met.

Sawmill A3:1 to A 3:10	
Aspect	**Notes**
Comments	Some upstream data such as internal transport used process data from Gabi and Ecoinvcen 3.3. The energy use reported as a KPI for energy use to the power house combustion use emission figures from the Swedish EPA (2018)**Error! Bookmark not defined.** and lectricity from Gabi (Swedish mix grid, see 2.2.2). Reference: Swedish EPA (2018): Emissionsfaktorer och värmevärden 2018. Underlag till Sveriges växthusgasinventering för utsläppsåren 1990-2016 till UNFCCC. Naturvårdsverket, uppdaterad: 2018-02-15. The xls-file is available here (see https://www.naturvardsverket.se/upload/stod-i-miljoarbetet/vagledning/Luft-klimat/emissionsfaktorer-klimat-2018.xlsx)

Process, further details
A3:1 Common parts
Common parts are; office, lightning internal transportation/diesel, pipe water, grease, lubricants and waste. Common parts that cannot be attributed to a single process at the sawmill concerning is allocated to the total production of sawn product, i.e. the main product sawn timber, as a conservative approach.
A3:2 Power house
The power house generate heat to other processes at the sawmill and is treated as a separate process and is then in the LCA linked to the energy use from the other sub-processes on the site. Emission figure from combustion emission factors from Swedish EPA (2018) [5] for NOx, CO, CH_4, SO_2, N_2O, NMVOC and NH_3.
A3:3 Log yard
Co-product that falls within this process step is not part of the co-product allocation of this individual sub-process (according to the economical allocation procedure given in EN15804 and here defined relative economical values given in Table 5). All impact are allocated to the sawn timber
A3:4 Debarking and saw intake
Co-product that falls within the process step is not part of the co-product allocation of this individual sub-process. All impact are allocated to the sawn timber
A3:5 Raw sorting
Co-product that falls within the process step is not part of the co-product allocation of this individual sub-process. All impact are allocated to the sawn timber
A3:6 Saw house
Co-product that falls within the process step is not part of the co-product allocation of this individual sub-process. All impact are allocated to the sawn timber

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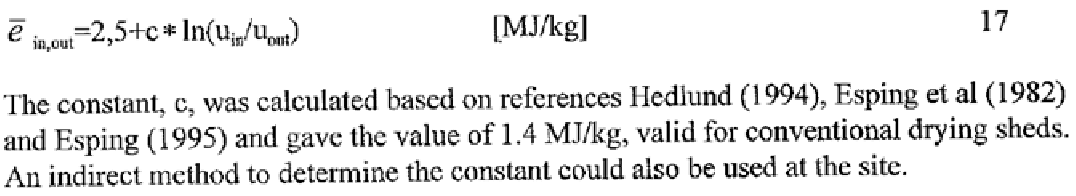
[5] https://www.naturvardsverket.se/upload/stod-i-miljoarbetet/vagledning/Luft-klimat/emissionsfaktorer-klimat-2018.xlsx)

A3:7 Thumb station
Co-product that falls within the process step is not part of the co-product allocation of this individual sub-process. All impact are allocated to the sawn timber
A3:8 Drying
The average thermal energy use in the drying process is recalculated from an average moister content in the final products of 14,0 % to 12 %, and an average density of 384 kg DM/m^3 (only spruce). The calculation is based on equation 17 in Erlandsson (1996)[6], see Figure 6. This calculation gives a correction factor of 1,06 (=318/299 kWh/m^3/kWh/m^3) compared to the average energy use for the drying process, see screen shots from this xls-file calculations and supplementary information given in appendix 6.
A3:9 Sorting and trimming (justerverk)
Allocation is attributed to all sawn timber.

The energy use for drying of wood ($e_{in,ut}$) can be calculated as follows:



$$\bar{e}_{in,out}=2{,}5+c*\ln(u_{in}/u_{out}) \qquad \text{[MJ/kg]} \qquad 17$$

The constant, c, was calculated based on references Hedlund (1994), Esping et al (1982) and Esping (1995) and gave the value of 1.4 MJ/kg, valid for conventional drying sheds. An indirect method to determine the constant could also be used at the site.

and where

u_{in}	moister content of the wood in to the drying kiln
u_{ut}	moisture content of the wood out from the drying kiln

Figure 6 Applied equation No 17 from Erlandsson (1996)Error! Bookmark not defined. that is used for the ecalculation of energy use when moisture content differs between the source data and the moisture content asked for.

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[6] Report is available as pdf on request to: martin.erlandsson@ivl.se

2.2.6 Glulam manufacturing A3:1 to A3:2

The glulam manufacturing process in Långshyttan can be divided in the glulam house A3:1; finger jointing, planning, adhesives application, pressing, final planning and packaging. The heat is derived from the local district heating plant A3:2.

Glulam manufacturing A3:1 to A 3:3	
Aspect	**Notes**
Precision	Site specific
Completeness	Data accounts for all known sub-possesses
Consistency, allocation method etc.	Allocation follows a physical causality in line with EN 15804 and an economical allocation if valid as specified in the standard resulting that all impact are allocated to the glulam (and nothing to by-products). See general notes above and details below.
Geographical coverage	Data is valid for Setra that has a national/regional market but has also an export to Europe mainly
Time related coverage	Data is valid for mainly 20147
Main data sources (references)	Setra Långshyttan has a set of Key Performance Indicators (KPI) for 2017 that is used as basis for the inventory.
Validation of data	Data are compared with data from different years and only a small difference is found.
Representativeness	Data is set to be representative for so called “high frequency” manufacturing process applied at Setra Långshyttan.
Treatment of missing data	No data is found missing
Data quality assessment	Data quality as required in EN15804 is met.
Comments	Some upstream data such as internal transport used process data from Gabi and Ecoinvent 3.3 and the power house combustion use figures the Swedish EPA[5] and electricity from Gabi (Swedish mix grid, see 2.2.2).

Process, further details
A3:1 Glulam house
The production includes standard beams and pillars and object beams. All impact are allocated to the glulam produced and nothing to the by-product (wood chips). Since the economical allocation approach from EN15804 is valid it means that the upstream environmental impact for the shaving from the planning is entirely allocated to the glulam (about 20% of the sawn timber is transformed to shavings in the glulam process). The adhesives used are based on KPI in 2017 and is an average used for standard products. Resource use, waste and energy are measured on site and reported as KPI (2017) that is used as data source for the LCI calculations.

Packaging material as follows are accounted for:

Packaging materials	**kg/m^3**	**%**
Straps, nylon	0.11	0.03
Clingwrap, polyethylene	1.1	0.3

A3:2 Heat supply from a district heating plant

The heating supply comes from Långshyttan a combustion plant. This plant only uses bio fuel. Emission figures for combustion is based on emission factors from Swedish EPA (2018)[5] for NOx, CO, SO_2, CH_4, N_2O, NMVOC and NH_3.

2.2.7 A4 Transportation to an average costumer

For general information and data used see 2.2.4 A2:1 Transport of round and sawn timber. An average transport for these end users that is reached by truck is 170 km. This distance is given by Setra as a representative transport distance to the costumers in 2017. An empty return for 50% gives the adjusted load factor of 75%: no weight factor is needed since the reference flow is equal with the declared unit.

(20 t = (170*27+0,5*27*170)/(170+170) and 20,25/27=0,75)

The fuel use is 1,21 kg (given directly as a reference flow in Gabi) that equal to 1,5 l if the density is 0,83 kg/litre or 1,5/170=0,009 litre/km and carrying 1 m3 glulam means 0,009/0,43=0,020 litre/tkm. These figures are reported in the EPD.

See also in Appendix 5 for how this backwards calculation is used to define diesel need for the EPD template.

3 Life cycle impact assessment results

3.1 Characterization models, factors and methods

Characterisation factors from CML as outlined in EN15804 is used as they are implemented in the Gabi software named “CML 2001 – Apr. 2013”. Besides these LCIA result the LCI indicators as specified in EN 15804 are reported and the content of biogenic carbon in wood. This carbon content is reported as CO_2e as outlined in PCR NPCR 015 rev1.

When reporting primary energy used as material the net calorific combustion value is used. This simplified approach is acceptable according to EN15804 and is needed since the data do not report feedstock energy and this word could be defined in different ways. The following combustions values are used[7]:

Cardboard	19,2 MJ/kg dry matter
MUF	18,0 MJ/kg
Nylon	28,8 MJ/kg
Wood	19,2 MJ/kg
PE	42,7 MJ/kg

The estimated impact results are only relative statements which do not indicate the end points of the impact categories, exceeding threshold values, safety margins or risks.

3.2 LCA result for Glulam

The figures below are directly as they are given as a result from the LCA calculations except; 1) primary energy and 2) stored biogenic carbon, where additional calculations have to be done in order to achieve the indicator result asked for.

Table 6 LCA result for parameters describing environmental impacts, EN15804:2012

Impact Category	Parameter	Value per DU A1-3	Value per DU A4
Global Warming	GWP100 + CO_2 biogenic	-660	4.3
	Global warming potential, GWP100	-704	0
	Global warming potential, (in accordance to NPCR 015 rev1)	44	4.3
Ozone Depletion	Depletion potential of the stratospheric ozone layer, ODP20	5.3E-07	1.4E-12

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[7] Reference for fossil polymers is: Heats of combustion of high temperature polymers. Walters R N et al, 200X.

Impact Category	Parameter	Value per DU A1-3	Value per DU A4
Photochemical ozone creation	Potential formation of tropospheric ozone, POCP	0.013*	-0.006*
Acidification for soil and water	Acidification potential of soil and water, AP	0.27	0.018
Eutrophication	Eutrophication potential, EP	0.061	0.004
Abiotic depletion potential	ADP-elements include all non-renewable,	2.0E-05	3.4E-07
Abiotic depletion potential	ADP-fossil fuels include all fossil resources	649	58

*Gabi database separate NOx to NO and NO_2 in combination with a marginal approached characterisation model for POCP that is based on a high polluted ambient air results in a negative characterisation factor for nitrogen monoxide.

Table 7 LCA result for parameters describing resource use

Parameter	Value per declared unit (A1-3)	Value per declared unit (A4)
Use of renewable primary energy excluding renewable primary energy resources used as raw materials, kg	1 707	3
Use of renewable primary energy resources used as raw materials, kg	7 371	0
Total use of renewable primary energy resources (primary energy and primary energy resources used as materials), kg	9 078	3
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials, kg	829	59
Use of non-renewable primary energy resources used as raw materials, kg	169	0
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as materials), kg	998	59
Use of secondary material, kg	0.004	0
Use of renewable secondary fuels, MJ	0	0
Use of non-renewable secondary fuels, MJ	0	0
Net use of fresh water, m^3	0.501	0.0002

Table 8 LCA result for other environmental information describing waste categories

Parameter	**Value per declared unit (A1-3)**	**Value per declared unit (A4)**
Hazardous waste disposed*, kg	0.004	3.08E-06
Non hazardous waste disposed, kg	0.822	0.02
Radioactive waste disposed, kg	0.00573	2.3E-06
Components for re-use, kg	—**	—**
Materials for recycling, kg	—**	—**
Materials for energy recovery, kg	—**	—**
Exported energy, MJ	0 MJ per energy carrier	0 MJ per energy carrier

*The characteristics that render waste hazardous are described in existing applicable legislation, e.g. in the European Waste Framework Directive.

** All usable flows shall be co-product allocated in A1 to A3 why these entries are not possible.

3.3 Characterization models, factors and methods

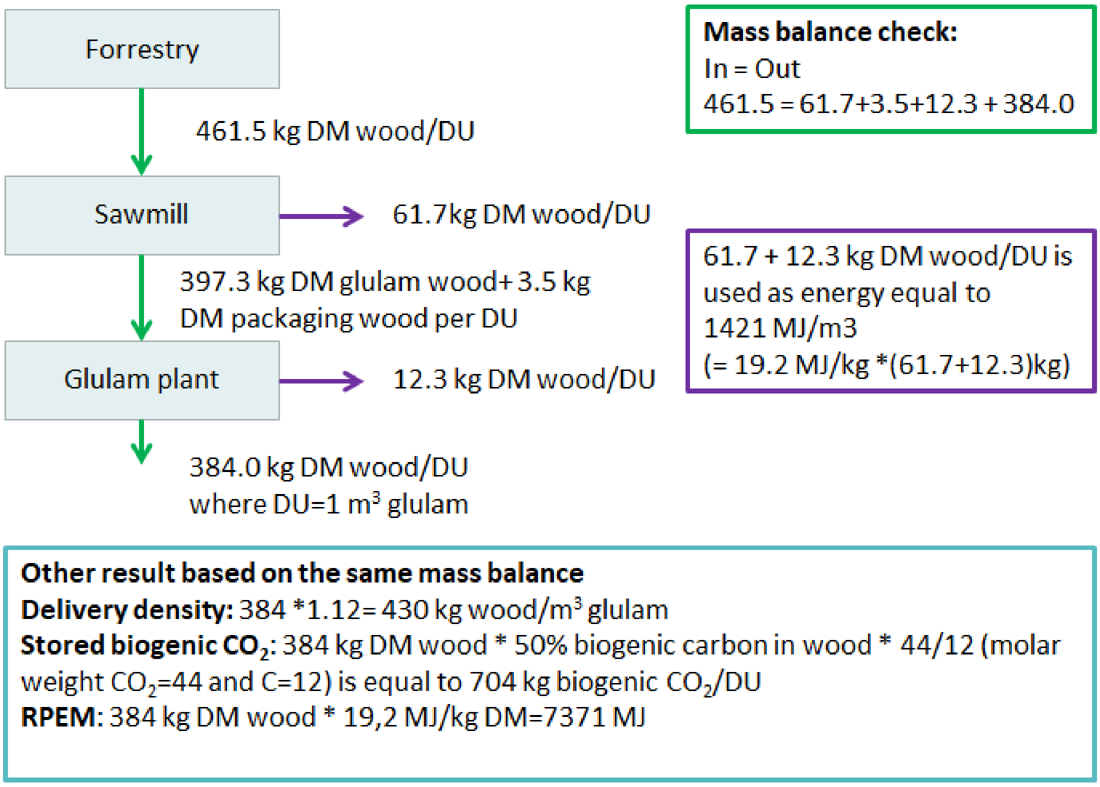
A mass balance is illustrated in this section. All basic flows in the inventory is based on dry matter (DM) in order to avoid problem related to problems that occurs when volume is based for calculations in the LCI. A final recalculation of kg DM to the delivery density is then possible to calculate (and check) by multiply the DM in 1 m^3 wood in kg by the moisture content of 12 %, i.e. 384 kg DM wood/m3 * 1.12= 430 kg 1 m^3 wood including water (see also illustration below).

Different individual process flows are reported in Appendix 1 and the same amount is used in the illustration below. The product output from the forrestry is 461.5 kg (DM) wood. This outtake of wood is then used for 3.5 DM kg wood packaging for the sawn timber (and then recycled/energy recovered and according to EN 15804 and allocated to the next product system). Moreover is 61.7 kg DM wood used for energy purpose in the sawmill and 12.3 kg DM wood is used for energy purpose at the glulam plant. The total mass balance is met and no material is missing, see illustration below.

The very same mass balance is also used to report biogenic carbon stored in the delivered product and energy stored, see figures in the illustration below.

3.4 Value based choices related to decisions regarding characterization models, factors and methods

No value choices are made regarding impact categories, characterization models, and characterization factors. Normalization, grouping and weighting are not applied.



Mass balance check:
In = Out
461.5 = 61.7+3.5+12.3 + 384.0

61.7 + 12.3 kg DM wood/DU is used as energy equal to 1421 MJ/m3 (= 19.2 MJ/kg *(61.7+12.3)kg)

Other result based on the same mass balance
Delivery density: 384 *1.12= 430 kg wood/m^3 glulam
Stored biogenic CO_2: 384 kg DM wood * 50% biogenic carbon in wood * 44/12 (molar weight CO_2=44 and C=12) is equal to 704 kg biogenic CO_2/DU
RPEM: 384 kg DM wood * 19,2 MJ/kg DM=7371 MJ

4 Life cycle interpretation

4.1 Interpretation of results

The idea with accounting of processes in EN15804 is that A3 describes the core process and the impact that directly can be attributed to the process owner and the company behind the production. Nevertheless, also the possibility of selecting suppliers (A1-A2) is controlled by the process owner, and therefore, a potential source for environmental improvement. The LCA result separated in A1, A2, A3 and A4 respectively is given in Table 9. The summarised value is the reported in the EPD as shown in Table 6 to Table 8. The contribution to climate change from each individual process can be studied by looking at the process scheme given in appendix "APPENDIX 1: Process scheme from GaBi for glulam". The LCA result indicates that Setra in future for instance can make the following environmental improvements;

- Buy electricity with certificate of origin with green attributes. But also ask the sawn timber suppliers to do the same
- (an integrated manufacturing of glulam and sawn timber would reduce the environmental impact since the transportation between the sites would not be needed, but is not an realistic alternative)
- Increase the amount of diesel with documented reduction in the emission of greenhouse gasses and preferable by using HVO. Data for fuel is sensitive for the amount bio components used that is set to 7.23 wt-% in the current LCA. Note that since July 2018 is GWP contribution from the Swedish standard diesel reduced by 20% (meaning a biodiesel content of about 25%). This is not accounted for in this LCA why all diesel consumption must be regarded as conservative.
- Try to optimize, and thereby decrease, the internal transportations at the Långshyttan manufacturing site
- If possible, reduce the amount plastic folio used, or/and change to an source that use secondary materials
- If possible reduce the amount adhesives used (and in future ask for biobased alternatives)

The use of fossil fuels in the Setra Långshyttan manufacturing process is limited to use of diesel for internal transportations.

The result for different LCIA indicators from the LCA calculations is divided in the different separate modules as given in the tables below.

Table 9 LCIA result divided in stage A1 to A3 for glulam

	Total A1-4	**A1 Raw materials**	**A2 Transport**	**A3 Manu-facturing**	**A4 Tran-sport**
ADP elements, [kg Sb-Equiv.]	1.99E-05	1.90E-05	5.12E-07	3.77E-08	3.40E-07
ADP fossil, [MJ]	708	596	52	0.5	58
AP, [kg SO2-Equiv.]	0.283	0.215	0.016	0.034	0.018
EP, [kg Phosphate-Equiv.]	0.0651	0.0489	0.0040	0.0080	0.0044
GWP 100 excl. biogenic carbon, [kg CO2-Equiv.]	48.3	37.5	3.8	2.8	4.3
ODP, steady state, [kg R11-Equiv.]	5.28E-07	5.10E-07	1.52E-08	2.26E-09	1.42E-12
POCP, [kg Ethene-Equiv.]	0.0070	0.0145	-0.0056	0.0045	-0.0064

When processes are divided according to the specifications given in EN15804 it is clear that the raw material stage and module A1 is significant for GWP, ADP and ODP. The combustion of bio-based fuels in A1 used at the sawmill and the biobased district heating used in the glulam house in A3 affect the contribution to AP, POCP and EP, why the distribution from these processes concerning these impact categories differ from the other ones.

4.2 Comparison with other EPDs

Glulam from Långshyttan is compared with EPD from other Swedish manufacturers found in EPD Norway. GWP is chosen as indicator of the overall environmental performance and comparison compiled here.

Table 10 Comparison of performance reported by different producers concerning contribution to climate change (A1-3).

kg CO_2e/m^3	**Glulam**	**Note**
Martinson (2015)	39	The low figure is in basic related to a combined sawmill including a glulam production
Moelven Töreboda (this study)	62	However, this EPD use more Gabi data for background data than in Martinson.
Setra Långshyttan (this study)	44	IVL is also the LCA consultant as for Martinson and Moelven.

The value for adhesives is about the same as used for Martinson, Töreboda and Setra. The largest difference is found in the transportation from the sawmill to the glulam manufacturing (that is 0 km for Martinson) and a larger distance between the forestry and the sawmill. Another large difference is the internal transportation at Töreboda that is significant higher than expected compared to the two other ones. Since the GWP is sensitive to the amount of adhesive used and fossil energy, the diesel consumption is basically causing the main difference between the environmental performances between the different producers.

5 Critical review

An external critical review is performed by:

Linda Høibye, COWI, LAN@cowi.com

The report from the critical review is published as a separate document

5.1 Responses to critical review

Comments from the review changed the LCA results initially reported concerning the indicator RPEE. Corrective actions on comments given from the review are included in this revised version of the report and the published EPD. The dialogue with the reviewer is published as part of the verification report.

6 References (to be included in the EPD)

Besides the mandatory references given in the EPD template the references below is added:

EPD Norway 2013: Wood and wood-based products for use in construction. Product-category rules, NPCR 015 rev1, Issue date: 30.08.2013, Valid to: 30.08.2018, EPF Norway.

Erlandsson M 1996: Methodology for Environmental Assessment of Wood-Based Product. Report No I 9608070, Trätek Stockholm August 1996.

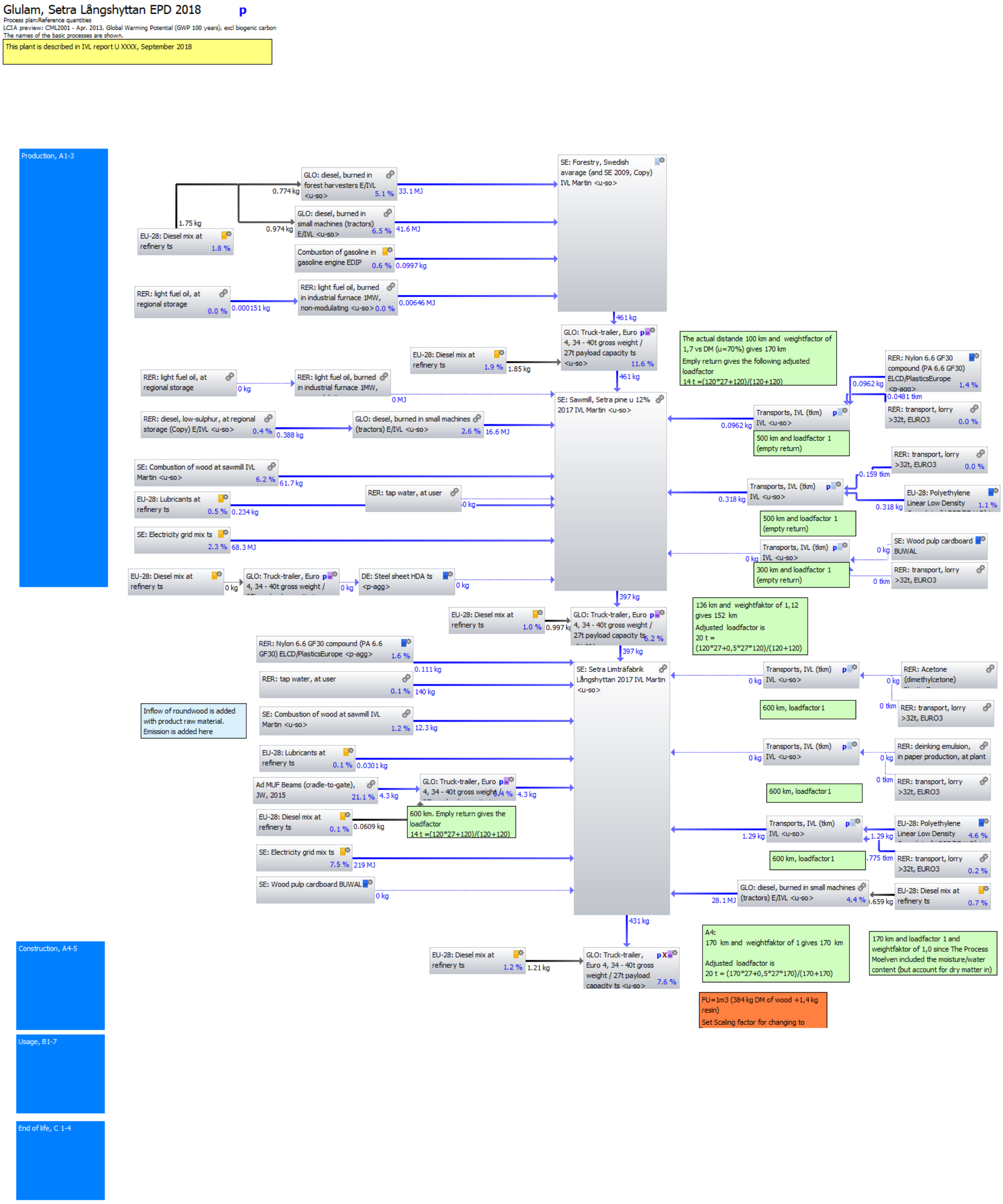
Erlandsson M 2018: LCA for Setra glulam. IVL Swedish Environmental Institute, assignment report, September 2018.

Brunberg T 2103: Bränsleförbrukningen hos skogsmaskiner 2012. Fuel consumption in forest machines 2012. Arbetsrapport Från Skogforsk nr. 789–2013.

7 Appendixes

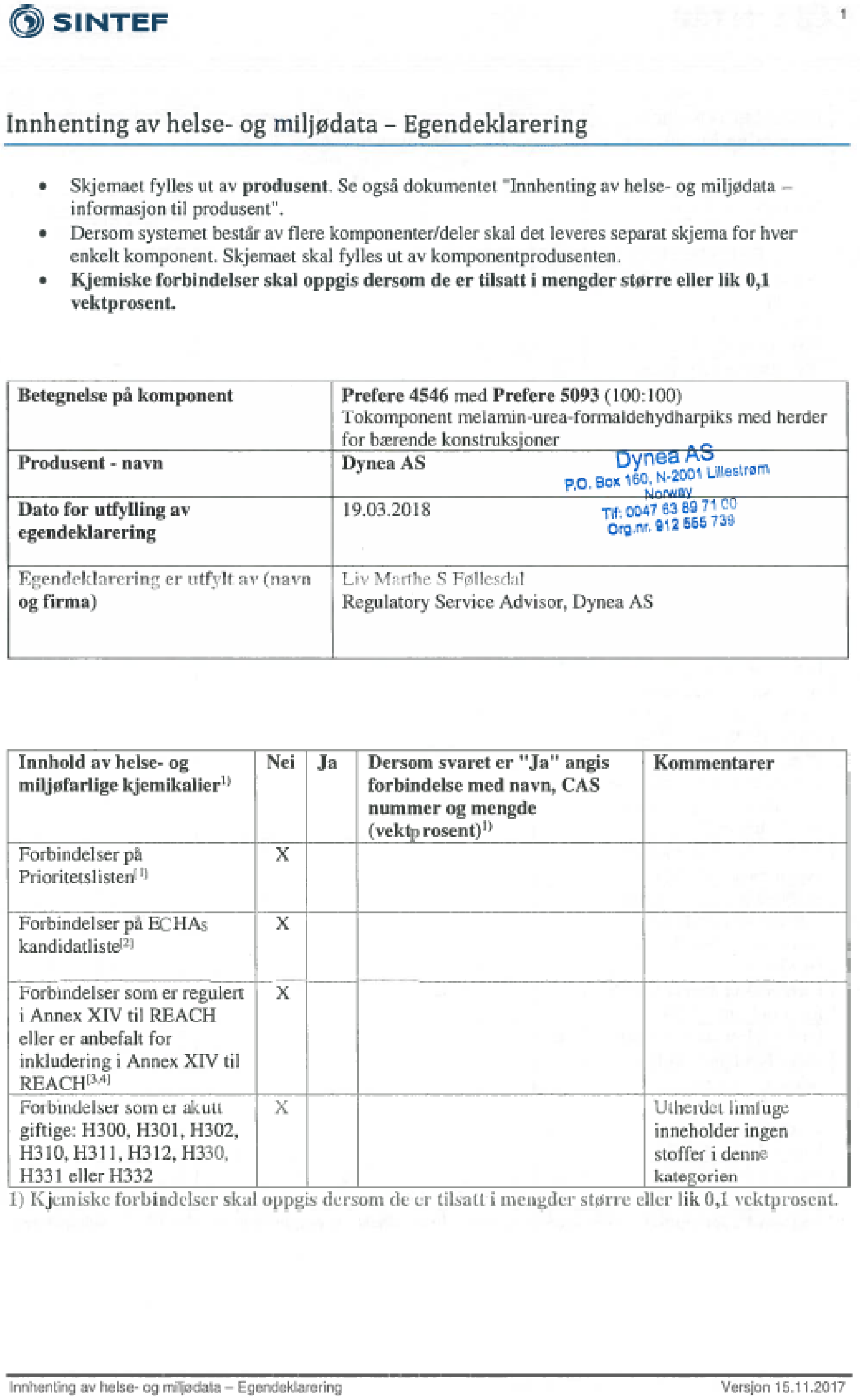
APPENDIX 1: Process scheme from GaBi for glulam

The % given below is equal with the contribution to GWP A1-A4.



APPENDIX 2: Content declaration and dangerous substances related to MUF from Dynea

Page 1 to 3 from SINTEF.



SINTEF 1

Innhenting av helse- og miljødata – Egendeklarering

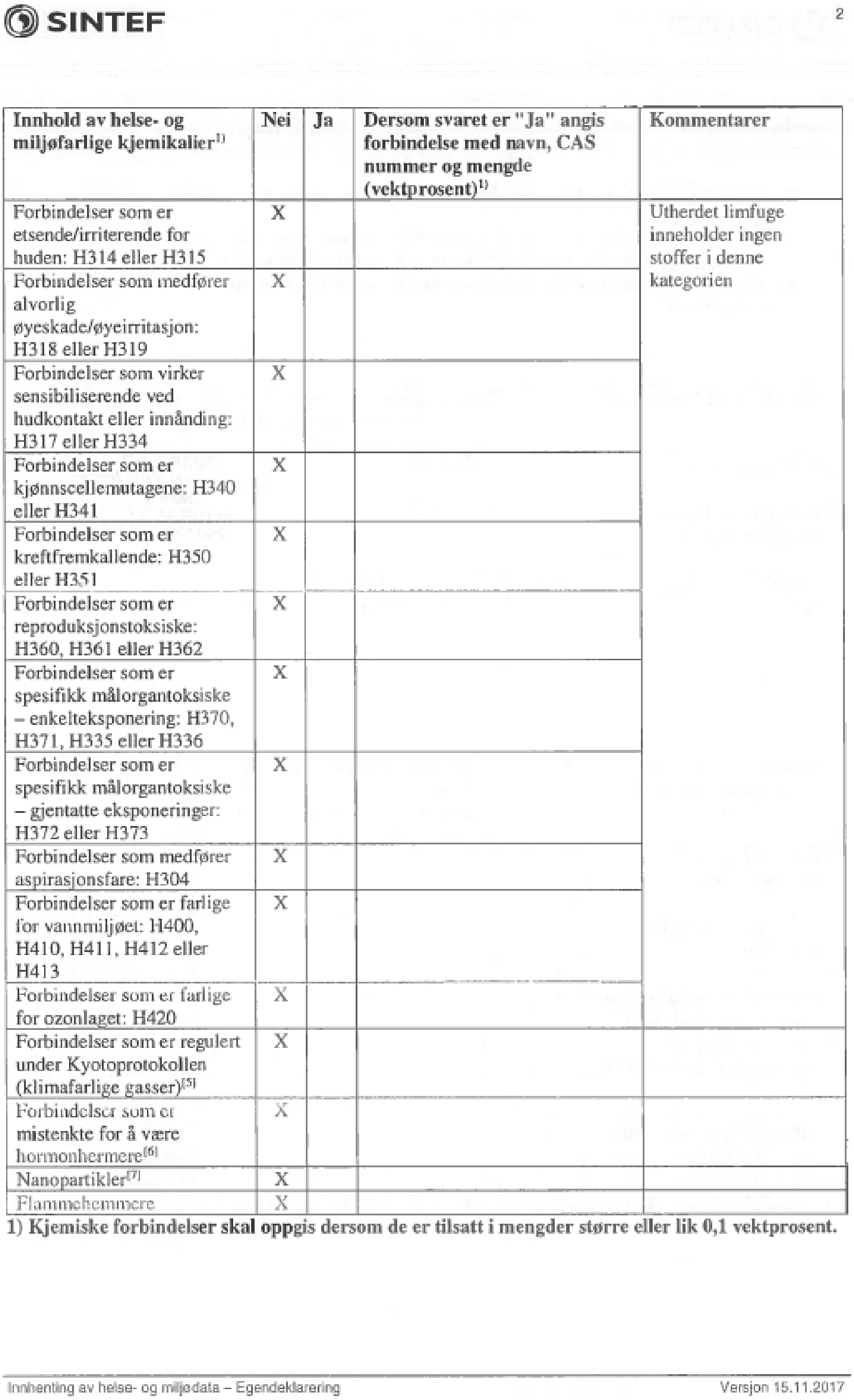
- Skjemaet fylles ut av **produsent**. Se også dokumentet "Innhenting av helse- og miljødata – informasjon til produsent".
- Dersom systemet består av flere komponenter/deler skal det leveres separat skjema for hver enkelt komponent. Skjemaet skal fylles ut av komponentprodusenten.
- **Kjemiske forbindelser skal oppgis dersom de er tilsatt i mengder større eller lik 0,1 vektprosent.**

Betegnelse på komponent	**Prefere 4546** med **Prefere 5093** (100:100) Tokomponent melamin-urea-formaldehydharpiks med herder for bærende konstruksjoner
Produsent - navn	**Dynea AS** Dynea AS P.O. Box 160, N-2001 Lillestrøm Norway Tlf: 0047 63 89 71 00 Org.nr. 912 555 739
Dato for utfylling av egendeklarering	19.03.2018
Egendeklarering er utfylt av (navn og firma)	Liv Marthe S Føllesdal Regulatory Service Advisor, Dynea AS

Innhold av helse- og miljøfarlige kjemikalier[1]	**Nei**	**Ja**	**Dersom svaret er "Ja" angis forbindelse med navn, CAS nummer og mengde (vektprosent)**[1]	**Kommentarer**
Forbindelser på Prioritetslisten[1]	X			
Forbindelser på ECHAs kandidatliste[2]	X			
Forbindelser som er regulert i Annex XIV til REACH eller er anbefalt for inkludering i Annex XIV til REACH[3,4]	X			
Forbindelser som er akutt giftige: H300, H301, H302, H310, H311, H312, H330, H331 eller H332	X			Utherdet limfuge inneholder ingen stoffer i denne kategorien

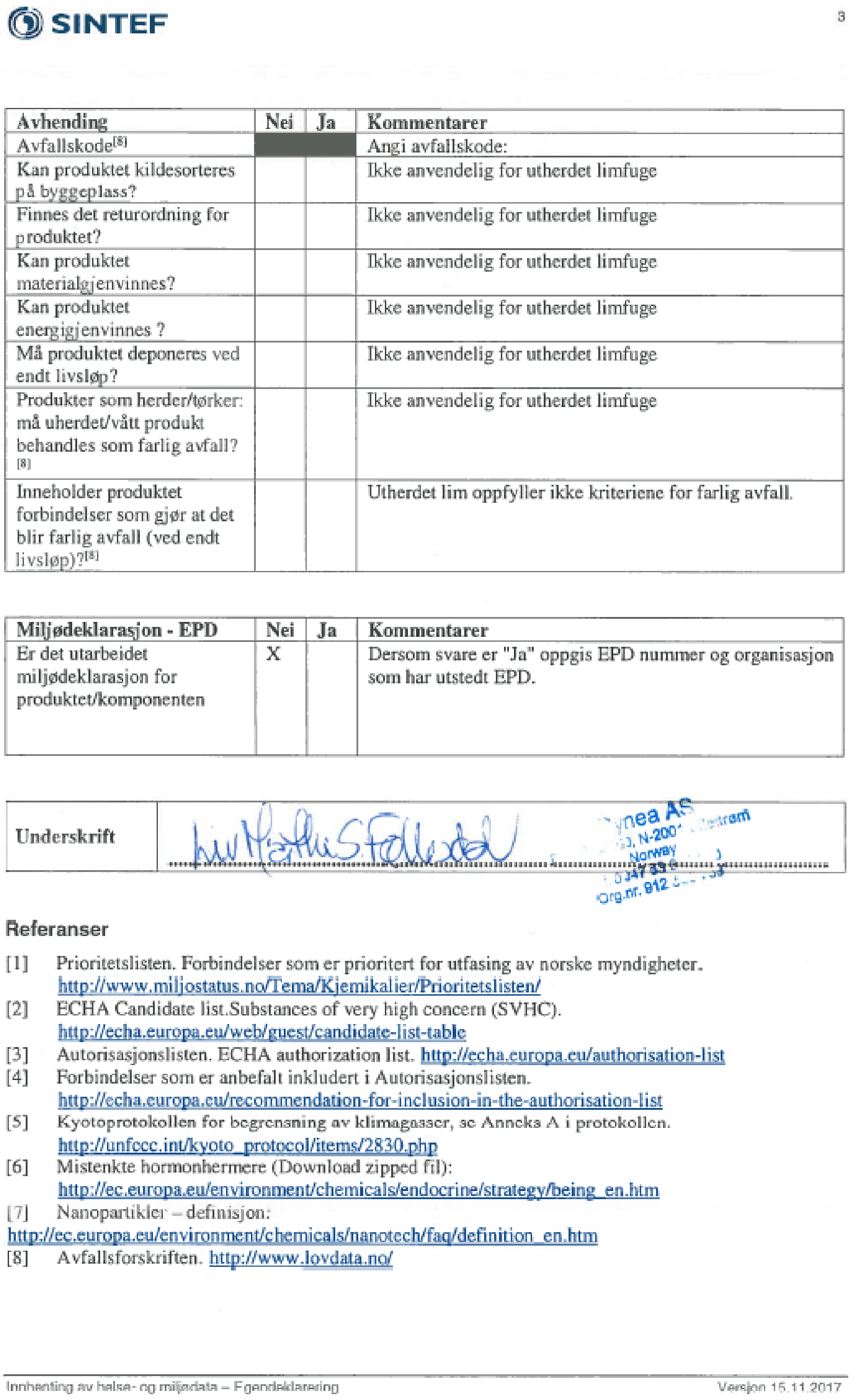
1) Kjemiske forbindelser skal oppgis dersom de er tilsatt i mengder større eller lik 0,1 vektprosent.

Innhenting av helse- og miljødata – Egendeklarering   Versjon 15.11.2017



Innhold av helse- og miljøfarlige kjemikalier[1]	Nei	Ja	Dersom svaret er "Ja" angis forbindelse med navn, CAS nummer og mengde (vektprosent)[1]	Kommentarer
Forbindelser som er etsende/irriterende for huden: H314 eller H315	X			Utherdet limfuge inneholder ingen stoffer i denne kategorien
Forbindelser som medfører alvorlig øyeskade/øyeirritasjon: H318 eller H319	X			
Forbindelser som virker sensibiliserende ved hudkontakt eller innånding: H317 eller H334	X			
Forbindelser som er kjønnscellemutagene: H340 eller H341	X			
Forbindelser som er kreftfremkallende: H350 eller H351	X			
Forbindelser som er reproduksjonstoksiske: H360, H361 eller H362	X			
Forbindelser som er spesifikk målorgantoksiske – enkelteksponering: H370, H371, H335 eller H336	X			
Forbindelser som er spesifikk målorgantoksiske – gjentatte eksponeringer: H372 eller H373	X			
Forbindelser som medfører aspirasjonsfare: H304	X			
Forbindelser som er farlige for vannmiljøet: H400, H410, H411, H412 eller H413	X			
Forbindelser som er farlige for ozonlaget: H420	X			
Forbindelser som er regulert under Kyotoprotokollen (klimafarlige gasser)[5]	X			
Forbindelser som er mistenkte for å være hormonhermere[6]	X			
Nanopartikler[7]	X			
Flammehemmere	X			

1) Kjemiske forbindelser skal oppgis dersom de er tilsatt i mengder større eller lik 0,1 vektprosent.



SINTEF 3

Avhending	Nei	Ja	Kommentarer
Avfallskode[8]			Angi avfallskode:
Kan produktet kildesorteres på byggeplass?			Ikke anvendelig for utherdet limfuge
Finnes det returordning for produktet?			Ikke anvendelig for utherdet limfuge
Kan produktet materialgjenvinnes?			Ikke anvendelig for utherdet limfuge
Kan produktet energigjenvinnes ?			Ikke anvendelig for utherdet limfuge
Må produktet deponeres ved endt livsløp?			Ikke anvendelig for utherdet limfuge
Produkter som herder/tørker: må uherdet/vått produkt behandles som farlig avfall? [8]			Ikke anvendelig for utherdet limfuge
Inneholder produktet forbindelser som gjør at det blir farlig avfall (ved endt livsløp)?[8]			Utherdet lim oppfyller ikke kriteriene for farlig avfall.

Miljødeklarasjon - EPD	Nei	Ja	Kommentarer
Er det utarbeidet miljødeklarasjon for produktet/komponenten	X		Dersom svare er "Ja" oppgis EPD nummer og organisasjon som har utstedt EPD.

Underskrift	ynea AS N-200 Norway Org.nr. 912

Referanser

[1] Prioritetslisten. Forbindelser som er prioritert for utfasing av norske myndigheter. http://www.miljostatus.no/Tema/Kjemikalier/Prioritetslisten/

[2] ECHA Candidate list.Substances of very high concern (SVHC). http://echa.europa.eu/web/guest/candidate-list-table

[3] Autorisasjonslisten. ECHA authorization list. http://echa.europa.eu/authorisation-list

[4] Forbindelser som er anbefalt inkludert i Autorisasjonslisten. http://echa.europa.eu/recommendation-for-inclusion-in-the-authorisation-list

[5] Kyotoprotokollen for begrensning av klimagasser, se Anneks A i protokollen. http://unfccc.int/kyoto_protocol/items/2830.php

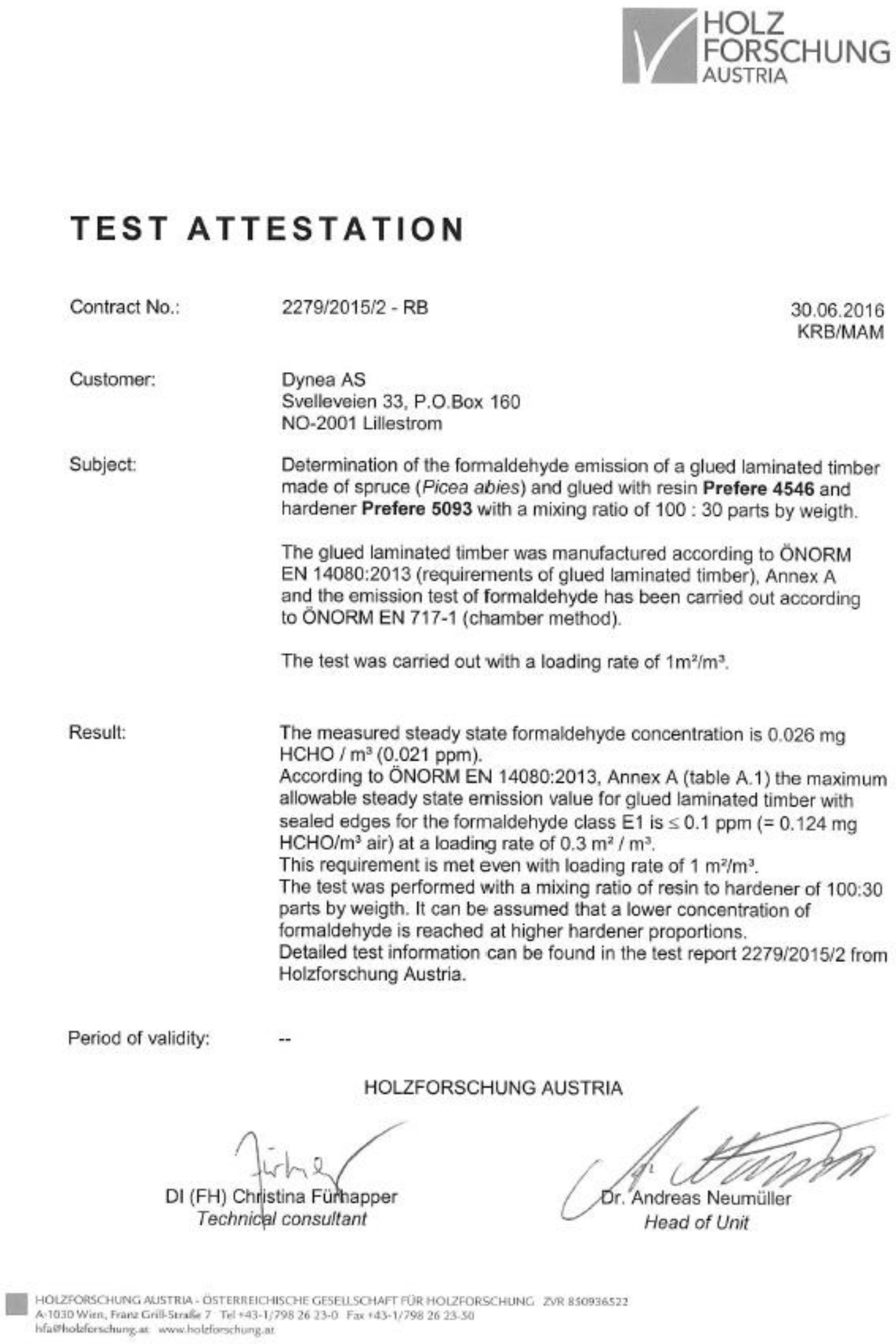
[6] Mistenkte hormonhermere (Download zipped fil): http://ec.europa.eu/environment/chemicals/endocrine/strategy/being_en.htm

[7] Nanopartikler – definisjon: http://ec.europa.eu/environment/chemicals/nanotech/faq/definition_en.htm

[8] Avfallsforskriften. http://www.lovdata.no/

Innhenting av helse- og miljødata – Egendeklarering Versjon 15.11.2017

APPENDIX 3: VOC values for glulam



HOLZ
FORSCHUNG
AUSTRIA

TEST ATTESTATION

Contract No.: 2279/2015/2 - RB

30.06.2016
KRB/MAM

Customer:
Dynea AS
Svelleveien 33, P.O.Box 160
NO-2001 Lillestrom

Subject: Determination of the formaldehyde emission of a glued laminated timber made of spruce (*Picea abies*) and glued with resin **Prefere 4546** and hardener **Prefere 5093** with a mixing ratio of 100 : 30 parts by weigth.

The glued laminated timber was manufactured according to ÖNORM EN 14080:2013 (requirements of glued laminated timber), Annex A and the emission test of formaldehyde has been carried out according to ÖNORM EN 717-1 (chamber method).

The test was carried out with a loading rate of $1 m^2/m^3$.

Result: The measured steady state formaldehyde concentration is 0.026 mg HCHO / m^3 (0.021 ppm).
According to ÖNORM EN 14080:2013, Annex A (table A.1) the maximum allowable steady state emission value for glued laminated timber with sealed edges for the formaldehyde class E1 is $\leq$ 0.1 ppm (= 0.124 mg HCHO/m^3 air) at a loading rate of 0.3 m^2 / m^3.
This requirement is met even with loading rate of 1 m^2/m^3.
The test was performed with a mixing ratio of resin to hardener of 100:30 parts by weigth. It can be assumed that a lower concentration of formaldehyde is reached at higher hardener proportions.
Detailed test information can be found in the test report 2279/2015/2 from Holzforschung Austria.

Period of validity: --

HOLZFORSCHUNG AUSTRIA

DI (FH) Christina Fürhapper
Technical consultant

Dr. Andreas Neumüller
Head of Unit

HOLZFORSCHUNG AUSTRIA - ÖSTERREICHISCHE GESELLSCHAFT FÜR HOLZFORSCHUNG ZVR 850936522
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hfa@holzforschung.at www.holzforschung.at

APPENDIX 4: Transportation processes

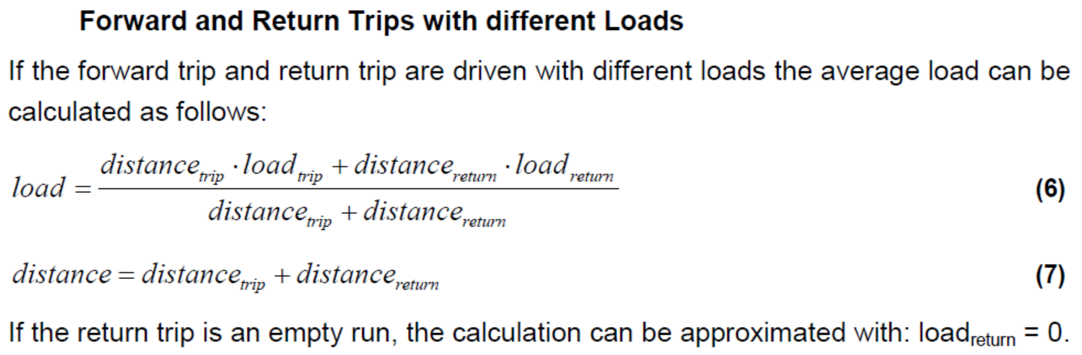
The transportation processes are described in detail in the Gabi documentation:

http://www.gabi-software.com/fileadmin/gabi/documentation5/Documentation_GaBi_Transport_Processes_Truck.pdf

or more in general

http://www.gabi-software.com/index.php?id=8375

The returns and lightweight goods has to be manually calculated before entering the data in the software. Besides these factors a manually modification has to be made if the reference flow weight is not representative for bulk weight. This is often the case since the author prefer to calculate the LCA based on dry matter to get the mass balance correct.



Forward and Return Trips with different Loads

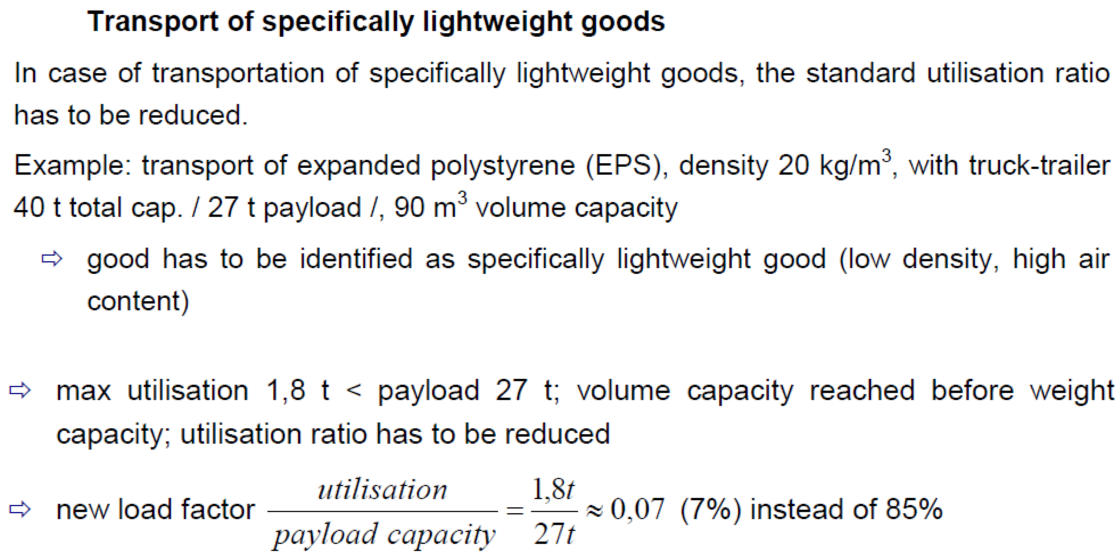
If the forward trip and return trip are driven with different loads the average load can be calculated as follows:

$$load = \frac{distance_{trip} \cdot load_{trip} + distance_{return} \cdot load_{return}}{distance_{trip} + distance_{return}} \quad \textbf{(6)}$$

$$distance = distance_{trip} + distance_{return} \quad \textbf{(7)}$$

If the return trip is an empty run, the calculation can be approximated with: $load_{return} = 0$.

Wood is not a lightweight product. However, for suck products are the following calculation made.



Transport of specifically lightweight goods

In case of transportation of specifically lightweight goods, the standard utilisation ratio has to be reduced.

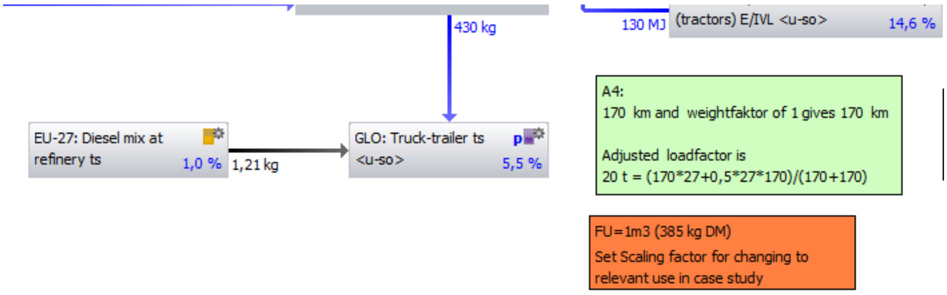
Example: transport of expanded polystyrene (EPS), density 20 kg/m^3, with truck-trailer 40 t total cap. / 27 t payload /, 90 m^3 volume capacity

- ⇨ good has to be identified as specifically lightweight good (low density, high air content)

- ⇨ max utilisation 1,8 t < payload 27 t; volume capacity reached before weight capacity; utilisation ratio has to be reduced
- ⇨ new load factor $\frac{utilisation}{payload\ capacity} = \frac{1{,}8t}{27t} \approx 0{,}07$ (7%) instead of 85%

APPENDIX 5: Calculation of A4 Transportation

Basis for the transportation is described in 2.2.7. However, the EPD requires information that is not directly possible to export from Gabi and requires additional backwards calculations to define. These calculations are given here. The starting point is the use of energy used for the transport operation, See figure below:



A4:
170 km and weightfaktor of 1 gives 170 km

Adjusted loadfactor is
20 t = (170*27+0,5*27*170)/(170+170)

FU=1m3 (385 kg DM)
Set Scaling factor for changing to relevant use in case study

Gabi räknar rätt, men jag har gjort fel när jag skulle räkna om för det som ska redovisas för A4 i själva EPD. Indata för drivmedelsåtgången framgår av figuren nedan (dvs = bilaga 1 i LCA-rapporten, men bilden är förstorad här). Här kommer en riktig beräkning baserat på Gabis transportmodul (se bilaga 4):

When the load factor is 50% becomes the diesel use 1,21 kg diesel divided with; 170 km and wood with a weight of 0,43 kg. We than have to add that Gabi use the lower heat value 42,7 MJ/kg diesel. It is now possible to calculate the needed figure:

1,21/(170·0,43·42,7)=0,7068 MJ/tkm,

i.e running diesel consumption;

0,7068/36 MJ/l=0,020 l/tkm

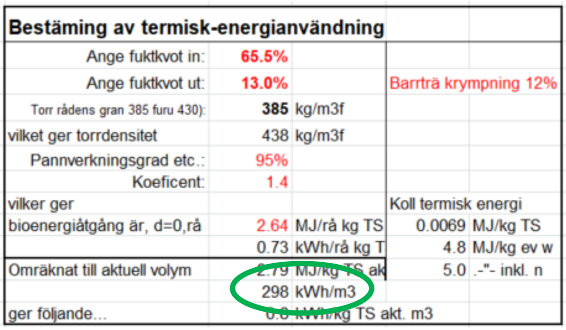
and the total fuel consumption;

0,02 l/tkm*170km= 3,4 l.

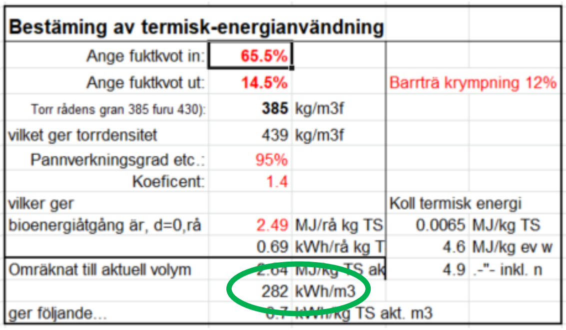
APPENDIX 6: Ralculation of energy used for drying at the sawmills

The recalculation of the energy use from the KPI for respective sawmill are made in a separate xls-file. Here are screen shots from this xls-file reported. Resulting calculation for compensation for increased energy fo the lower moisture content in the wood to Setra (12%) compared to the average production (14,0%).

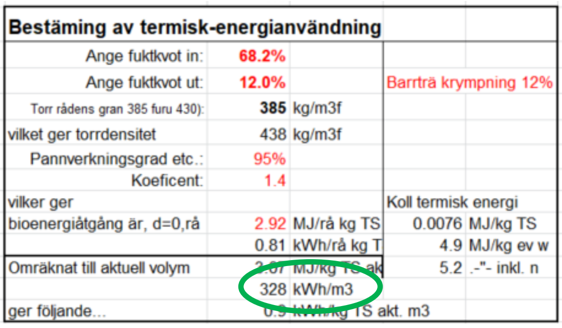
The average thermal energy use in the drying process is recalculated from an average moister content in the final products of 14,0 % to 12 %, and an average density of 384 kg DM/m^3. This calculation gives a correction factor of 1,06 (=318/299 kWh/m^3/kWh/m^3) compared to the average energy use for the drying process. The calculation is based on equation 17 in Erlandsson (1996)[8]



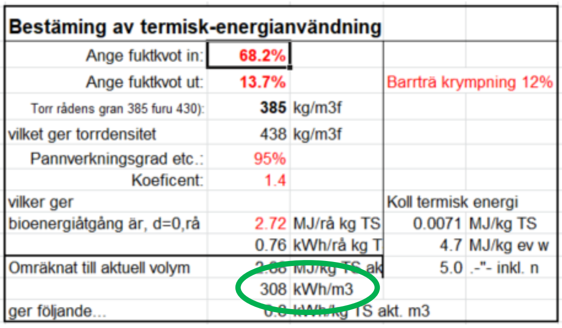
Bestäming av termisk-energianvändning				
Ange fuktkvot in:	**65.5%**			
Ange fuktkvot ut:	**13.0%**		Barrträ krympning 12%	
Torr rådens gran 385 furu 430):	**385**	kg/m3f		
vilket ger torrdensitet	438	kg/m3f		
Pannverkningsgrad etc.:	95%			
Koeficent:	1.4			
vilker ger			Koll termisk energi	
bioenergiåtgång är, d=0,rå	2.64	MJ/rå kg TS	0.0069	MJ/kg TS
	0.73	kWh/rå kg T	4.8	MJ/kg ev w
Omräknat till aktuell volym	2.79	MJ/kg TS ak	5.0	.-"- inkl. n
	298	kWh/m3		
ger följande...	0.8	kWh/kg TS akt. m3		



Bestäming av termisk-energianvändning				
Ange fuktkvot in:	**65.5%**			
Ange fuktkvot ut:	**14.5%**		Barrträ krympning 12%	
Torr rådens gran 385 furu 430):	**385**	kg/m3f		
vilket ger torrdensitet	439	kg/m3f		
Pannverkningsgrad etc.:	95%			
Koeficent:	1.4			
vilker ger			Koll termisk energi	
bioenergiåtgång är, d=0,rå	2.49	MJ/rå kg TS	0.0065	MJ/kg TS
	0.69	kWh/rå kg T	4.6	MJ/kg ev w
Omräknat till aktuell volym	2.64	MJ/kg TS ak	4.9	.-"- inkl. n
	282	kWh/m3		
ger följande...	0.7	kWh/kg TS akt. m3		



Bestäming av termisk-energianvändning				
Ange fuktkvot in:	**68.2%**			
Ange fuktkvot ut:	**12.0%**		Barrträ krympning 12%	
Torr rådens gran 385 furu 430):	**385**	kg/m3f		
vilket ger torrdensitet	438	kg/m3f		
Pannverkningsgrad etc.:	95%			
Koeficent:	1.4			
vilker ger			Koll termisk energi	
bioenergiåtgång är, d=0,rå	2.92	MJ/rå kg TS	0.0076	MJ/kg TS
	0.81	kWh/rå kg T	4.9	MJ/kg ev w
Omräknat till aktuell volym	3.07	MJ/kg TS ak	5.2	.-"- inkl. n
	328	kWh/m3		
ger följande...	0.9	kWh/kg TS akt. m3		



Bestäming av termisk-energianvändning				
Ange fuktkvot in:	**68.2%**			
Ange fuktkvot ut:	**13.7%**		Barrträ krympning 12%	
Torr rådens gran 385 furu 430):	**385**	kg/m3f		
vilket ger torrdensitet	438	kg/m3f		
Pannverkningsgrad etc.:	95%			
Koeficent:	1.4			
vilker ger			Koll termisk energi	
bioenergiåtgång är, d=0,rå	2.72	MJ/rå kg TS	0.0071	MJ/kg TS
	0.76	kWh/rå kg T	4.7	MJ/kg ev w
Omräknat till aktuell volym	2.88	MJ/kg TS ak	5.0	.-"- inkl. n
	308	kWh/m3		
ger följande...	0.8	kWh/kg TS akt. m3		

kWh/m^3	Färila	Heby	Avarage, wighted
Before	282	308	299
After	298	328	318

Resulting compensation factor 1.06 (=318/299)

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[8] Report is available as pdf on request to: martin.erlandsson@ivl.se

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