Satu Halava

CARBON FOOTPRINT OF THERMOWOOD

Faculty of Technology and Maritime Management
Chemical Engineering

2013

samk
Satakunnan ammattikorkeakoulu
Satakunta University of Applied Sciences

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Degree Programme in Chemical Engineering
January 2013
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Number of pages: 29
Appendices: 2

Key words: carbon footprint, thermowood, carbon dioxide emission, greenhouse gas

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ABSTRACT

Purpose of this Bachelor's Thesis was to study the carbon footprint of Suomen Lämpöpuu thermowood manufacturing process.

Company is going to increase utilization of their own waste sawdust in the process, which means investments on renewable energy. Part of the oil is already replaced. Manufacturing process of thermowood is under development.

This research included the whole production chain from wood raw material growing in forest up to supply to customer. Also transportation and energy consumption were included.

Carbon dioxide emissions calculated were based on the PAS 2050:2011, which is commonly used standard specification for the assessment of the life cycle greenhouse gas emissions of goods and services. PAS 2050:2011 is very suitable for the companies, which evaluate carbon dioxide emission of products lifetime.

According to the results, major emissions originated from the fossil fuel combustion and transportation. Especially, combustion of oil could be even half of the total emissions.
Share of Thermowood own process from total CO_2-emissions was about 50 %, which originates almost entirely from heating of wood by combustion of oil. Replacing oil with renewable wood would lead to almost zero CO_2-emission.

According to the calculations total CO_2-emissions covering the whole chain was about 70 kg CO_2/s-m^3.

LÄMPÖPUUN HIILIJALANJÄLKI

Halava, Satu
Satakunnan ammattikorkeakoulu
Kemiantekniikan koulutusohjelma
Tammikuu 2013
Ohjaaja: Hannelius, Timo (lehtori, SAMK)
Valvoja: Palonen, Juha (toim.joht. Suomen Lämpöpuu Oy)
Sivumäärä: 29
Liitteet: 2

Avainsanat: hiilijalanjälki, lämpöpuu, hiilidioksidipäästöt, kasvihuonekaasu

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TIIVISTELMÄ

Tämän opinäytetyön tarkoituksena oli selvittää Suomen lämpöpuun tuotannon hiilijalanjälki. Suomen Lämpöpuu Oy tulee lisäämään oman jätteen purun hyötykäyttöä prosessissa, mikä tarkoittaa investointia uusiutuvaan energialähteeseen. Osa öljystä on jo korvattu. Lämpöpuun valmistusprosessia kehitetään koko ajan.

Tutkimus sisälsi koko tuotantoketjun raaka-aineen puun kasvamisesta metsästä aina valmiin lämpöpuutuotteen toimittamiseen asiakkaalle. Kuljetukset ja energiankulutus on myös otettu huomioon.

Hiilidioksidipäästöt laskettiin pohjautuen PAS 2050:2011, mikä on yleisesti käytössä oleva standardi määritelty kasvihuonekaasujen arviointiin tuotteista ja palveluista. PAS 2050:2011 on hyvä yrityksille, jotka haluavat tutkia hiilidioksidipäästön tuotteen elinkaaren aikana.

Tuloksien mukaan suurin osa päästöistä muodostuu fossiilisten polttoaineiden poltosta ja kuljetuksista. Varsinkin öljyn polttamisen voidaan sanoa tuottavan puolet koko päästöistä. Lämpöpuun tuotannon osuus koko hiilidioksidipäästöstä oli 50 %, mikä johtui melkein kokonaan puun lämmittämiseen käytettävästä öljyn polttamisesta. Öljyn korvaaminen uusiutuvalla energialla laskisi hiilidioksidipäästön lähes nollaan.

Tulosten mukaan hiilidioksidipäästö koko tuotantoketjussa oli noin 70 kg CO_2/k-m^3.

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1. INTRODUCTION

The global warming is growing problem all over in the world. Reduction of greenhouse gas (CO2) is a huge challenge, which must be faced. Carbon footprint, which is the measure of CO_2-emission, should be evaluated for products and services. Everyone should consider their own carbon footprint to reduce the CO_2-emission.

Knowledge of the environment issues have increased. The customers are more and more aware of environmental impacts of products. It is well known that fossil fuels: oil, coal and earth gas produce CO_2-emissions, which should be decreased and use of environmentally friendly production started leading to considerably less, even zero, CO_2-emissions.

Carbon footprint can be evaluated by using commonly accepted standards, e.g PAS 2050:2011. PAS (Publicly Available Specification) is specification for the assessment of the life cycle greenhouse gas emissions of goods and services.

Suomen lämpöpuu asked to study carbon footprint of their thermowood manufacturing process.

2. SUOMEN LÄMPÖPUU OY

Suomen Lämpöpuu Oy was established in 1999. It is one of the pioneers in thermo wood production in the world. Main product groups are exterior cladding and patio products. They also product cladding, decking, interior wall paneling, flooring, sauna and construction products, see /1/.

Their largest customers are the Europe's hardware store chains, construction wholesalers and floor manufacturers. Also their products are directed to funiture-, vehicle-, and woodworking industry. Significant part of the production is tailored products to architect projects. Small retailers and do-it-yourself constructors are clients ass well.

The annual capacity of the heat treatment is 20 000 m^3, which is planned to be increased up to 50 000 m^3. Over 90% of production is exported, see /1/.

3. STRUCTURE OF THE WOOD

In the tree are different cells and components that needs to understant. Into middle section is pith, which is made on ground tissue and dead heartwood. Heartwood and sapwood make up the actual wood. On top of this comes the growth layer, Cambium, which constantly builds up new wood.

The out layer consist of the bast. There happens transportation of nutrients dissolved in water. Bark protects the trunk from the effects of the environment.
Wood's chemical structure consist of cellulose, hemicellulose, lingniin, acetyl and extrativ substance also minerals, see /2/.

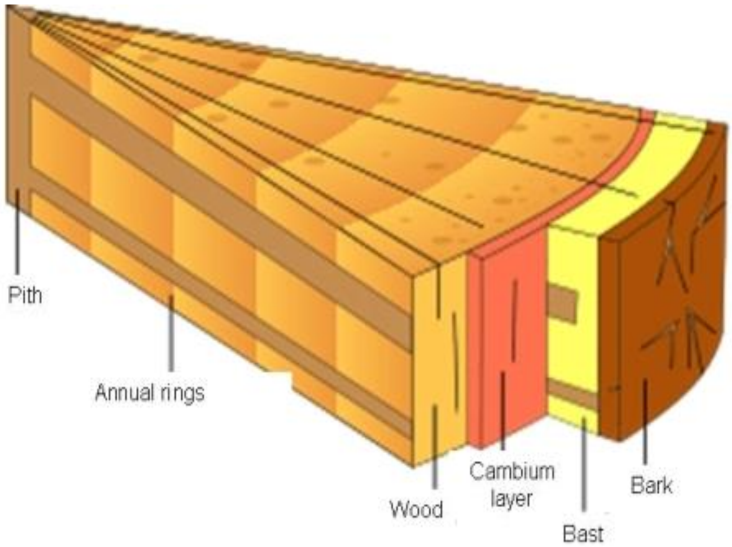


Figure 1.Structure of wood, see /2/.

3.1 Coniferous wood

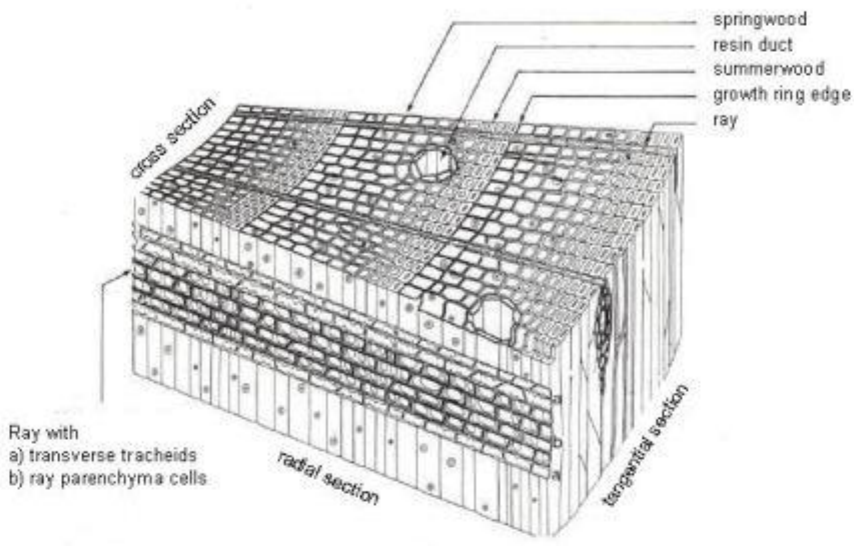


Figure 2.Structure of coniferous wood, see /2/.

3.2 Deciduous wood

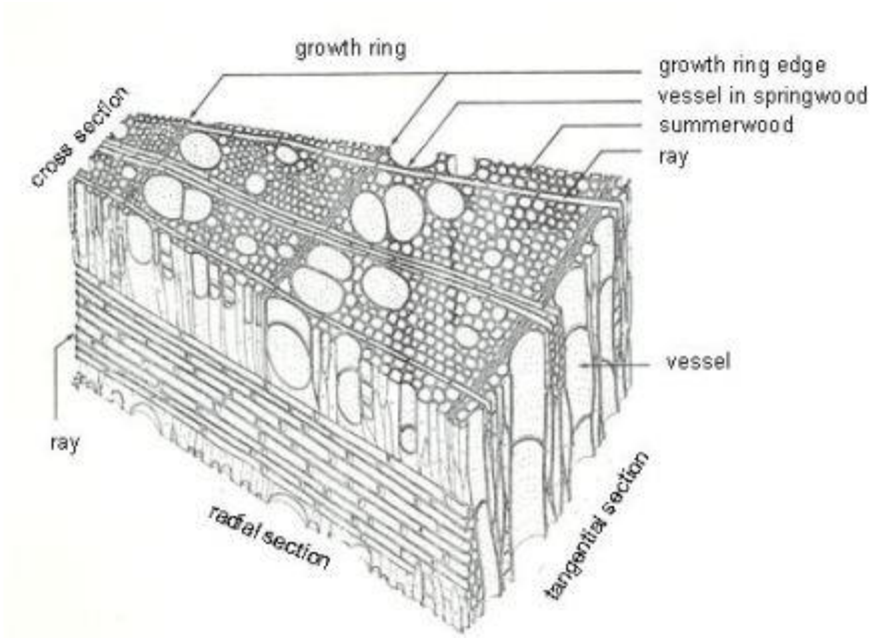


Figure 3.Structure of deciduous wood, see /2/.

4 MANUFACTURING THERMOWOOD

The manufacturing process of thermowood is based on the use of high temperature and steam. No chemicals are used in the treatment. The process improves dimensional stability and biological durability of wood. Another improvement is the insulation properties of the final material, the process leads to a reduction in thermal conductivity. Due to the high treatment temperatures the resin is removed from the wood, see /3/.

4.1 Temperature Increase and Kiln Drying

The air temperature is in the kiln is raised at rapid speed using heat and steam to a level of around 100 °C , the wood temperature follows at a similar level. Thereafter the temperature is increased steadily to 130 °C and drying takes place. Either green or ready kiln dried raw material can be used. Steam is used as vapour membrane to prevent craking of the wood. The steam also facilities chemical changes taking place in the wood. At the end of this phase the moisture content is reduced to almost zero, see /3/.

4.2 Intensive Heat Treatment

During the intensive heat treatment phase the air and wood temperature is increased to a level of between 185-225 °C. The peak of temperature depends on the desired end use of the material. When the target level is reached the temperature remains constant for 2-3 hours. Steam is used to prevent the wood burning and craking and it also continues to influence the chemical changes taking place in the wood, see /3/.

4.3 Cooling and Moisture Conditioning

The temperature is reduced using water spray systems. Conditioning and re-moisturising takes place to bring the wood moisture content to a workable level over 4 percent, see /3/.

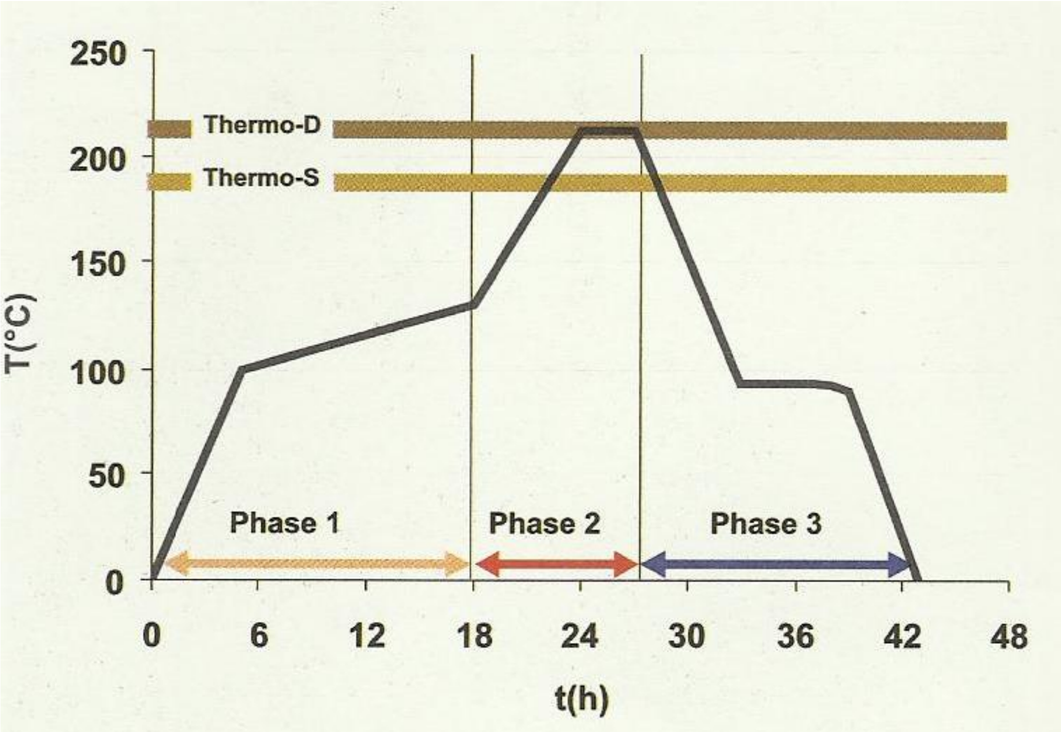


Figure 4.Describtion of thermowood heating process, see /3/.

5 CHARACTERISTICS OF THERMOWOOD

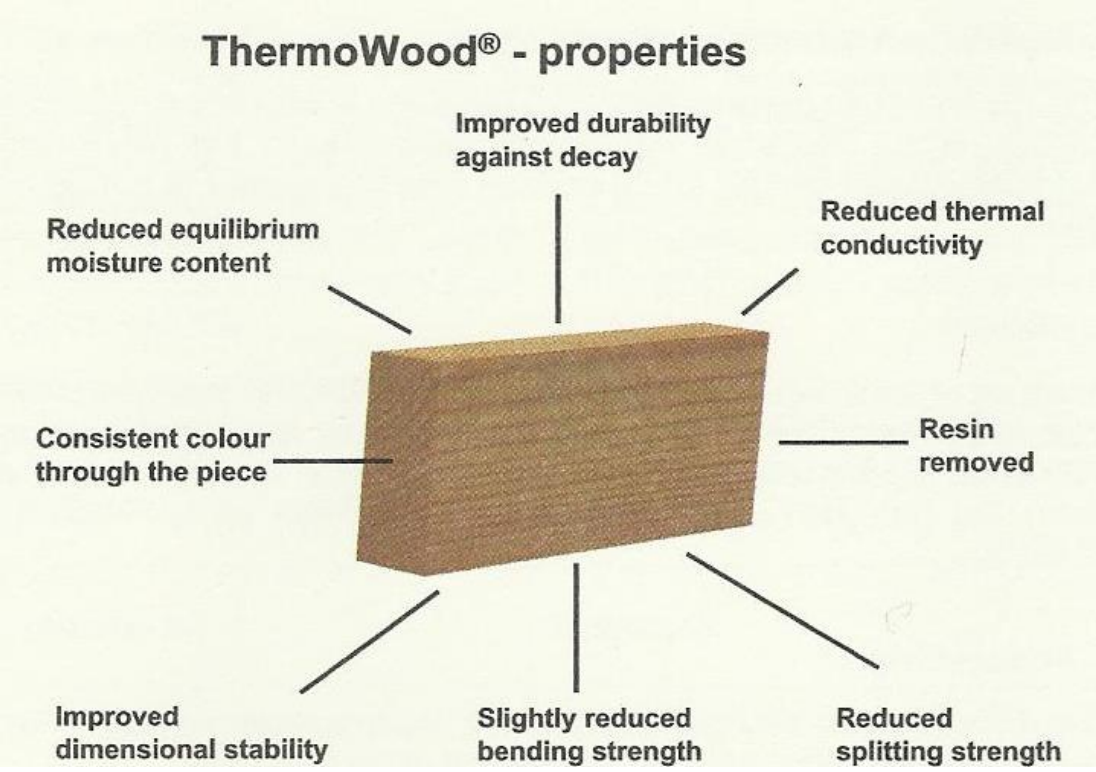


Figure 5.Properties of thermowood, see /3/.

After heating there came eight quality improvements to the thermowood. Permanently the wood changes of chemical and physical properties. Improvements are the density, strength, surface hardness, equilibrium moisture content, stability, permeability, thermal properties, biological durability and weather resistance, see /3/.

5.1 Structure Changes in Thermowood

Pictures simplify understanding the structure changes in the thermowood comparing to untreated wood. Wood is treated only by heat and its make the wood last longer, because of the structure changes.

In the beginning the woods structure is not that organized and make it very weak. When the wood is heat treated wood fibers are organized to straight line, see figure 6. It is not broken easily and is done without any chemicals.

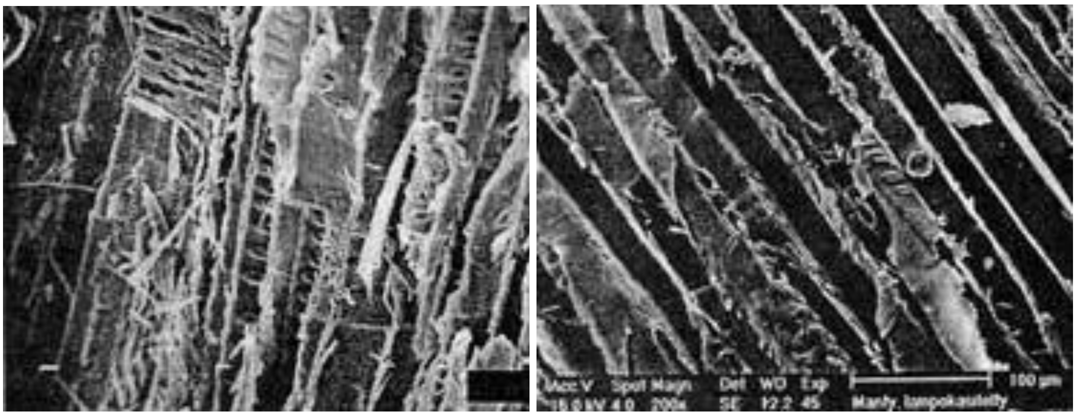


Figure 6.Untreated pine on the left and heat treated pine on the right, see /3/.

Thermowood is good material for cladding. It’s natural product and doesn’t load the environment. At the end of thermowood’s life cycle it can be re-used in the energy production, disposed by burning or placing it into dumping place without any harm to the nature.

6. THERMOWOODS TRAVEL TO THE CUSTOMER

Thermowood's travel to the customer starts from the forest, which is the nearest possible. Transport distances of the wood should be short as possible from logistical reasons. The timber comes from the saw mill in trucks to production in Suomen Lämpöpuu Oy. There the wood is heat treated, planed and part of it painted.

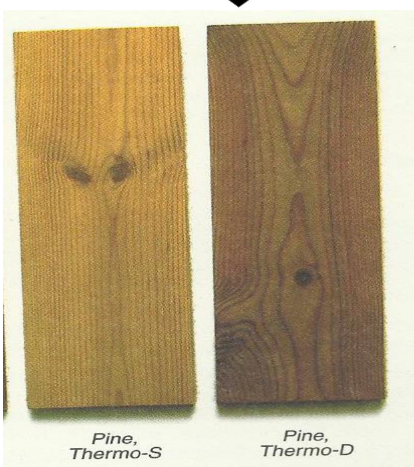
Energy consumption to the planning, packing and band saw comes from the renewable energy sources. The electricity used in the factory is guaranteed produced from the renewable energy sources, verify Appendix 2.

Finished thermowood is placed in to the warehouse waiting for the transportation. Trucks transport the thermowood to the customer or harbor where it is shipped. After shipping the wood is transported by truck to the customer, see /4/. In the next page you can see the thermowood travel to the customers.

harvesting

transportation of the wood from forest to saw mill

Processing thermowood (Battening, Heat Treatment, Planing)



90% transportation to the customer by truck

Figure 7.Manufacturing chain of thermowood.

Biggest amount of thermowood is going to the Europe. Countries you can see in the figure below. Finland and other countries in Skandinavia are the second highest location of Slp's customers. Rest of thermowood is going to the Southern Europe, Middle East and Japan.

Figure 8.Location of the main customers.

7 CALCULATING CARBON FOOTPRINT

7.1 PAS 2050:2011

The development of this PAS was co-sponsored by Defra (Department for Environment, Food and Rural Affairs, UK), DECC (Department of Energy and Climate Change, UK) and BIS (Department for Business, Innovation and Skills, UK).

PAS 2050 is a publicly available specification that provides a method for assessing the life cycle greenhouse gas emission of goods and services. It can be used by organizations of all sizes and types, in any location, to asses the climate change impact of the products they offer.

PAS 2050 builds on existing life cycle assessment methods established through BS EN ISO 14040 and BS EN ISO 14044 by giving requirements specifically for the assessment of GHG emissions within the life cycle of goods and services, see /5/.

8 CARBON DIOXIDE EMISSIONS

8.1 Combustion of Wood

Carbon dioxide is produced in combustion of wood, which contains about 50 w-% elemental carbon, see below. Also for example harvesting and transportation emit CO_2.

As an example in wood combustion the following amount of CO_2 is formed.

Wood Composition Based on Dry Wood

Carbon (C) 50 w-%

Oxygen (O) 44 w-%

Hydrogen (H) 6 w-%

Approximately 700 kg/s-m^3 ➔ dry wood 350 kg ➔ 175 kg C ➔ 642 kg CO_2.

This is amount of CO2 produced per 1 solid cubic meter of fresh wood. One solid cubic meter wood corresponds the real physical volume and is denoted as symbol s-m^3.

All productional stages, where CO_2- emissions originate, can be seen in the next page.

8.2 Work Stages

Thermowood's calculation of carbon dioxide emission started when phases of work were listed. In this Bachelor thesis the carbon footprint calculation is bored on the following stages. Slp's Carbon dioxide emission of thermowood is tried to taking consider to the beginning to the end use.

1. Harvesting
2. Wood transfer into forest to side of the road
3. Transportation of the wood to the saw mill
4. Sawing and the after treatments of the wood in saw mill
5. Transportation the board from sawmill to the Slp
6. Unload and battening
7. Heat treatment
8. Planing
9. Painting
10. Packaging
11. Transfers inside Spl
12. Transportation to harbor
13. Shipping
14. Continental transportation to customers

,see /4/.

8.3 Carbon Dioxide Emission Calculations

It is assumed that oil contains 85 w-% elemental carbon.

1 kg Oil → 3.113 kg CO_2

1 kWh= 3.6 MJ

1 MWh = 3600 MJ

ρ (density of diesel oil) = 850 kg/m^3

1. Harvesting

Fuel consumption (diesel): 10 l/h → mass flow is 8.5 kg/h

It is assumed that 250 s-m^3 wood is treated per 8 h working shift. This corresponds 31.3 s-m^3/h.

Specific Diesel Consumption

$$SDC= \frac{8.5\ kg/h}{31.3\ s\text{-}m^3/h} = 0.272\ kg\ diesel/s\text{-}m^3$$

Combustion of Diesel

Diesel oil is combusted according to the reaction formula (1):

$$C_{12}H_{23} + 17.75\ O_2 \rightarrow 12\ CO_2 + 11.5\ H_2O \quad (1)$$

1mol 12mol

$M_{Diesel} =$ 167 g/mol

$m_{Diesel}=$ 272g

$$n_{Diesel}= \frac{m_{Diesel}}{M_{Diesel}} = \frac{272\ g}{167 g/mol} = 1.63\ mol$$

Diesel Consumption is 1.63 mol D/s-m^3

Substance amount of CO_2 , see eq. (1) is 12 *1.63 mol = 19.54 mol CO_2/ s-m^3

$M_{CO_2} =$ 44 g/mol

Mass of CO_2 is 19.54 mol*0.044 kg/mol = 0.860 kg CO_2 / s-m^3

Specific CO_2 emission: **0.86 kg CO_2 / s-m^3**

2. Truck Transportation from Forest to Isojoki Saw Mill

Fulltrailer consumption is 50 l/ 100km, see /6/.

Average Distance: s= 50 km

Load: 50s-m^3

Consumption: 25 l

SDC: 25 l/ 50s-m^3 = 0.5 l/s-m^3

Density of diesel ρ = 850 kg/m^3

0.5 l/s-m^3 * 0.850 kg/m^3 = 0.425 kg/s-m^3

Specific CO_2 emission: **1.32 kg CO_2/ s-m^3**

3. Energy Consumption in Isojoki Sawmill

Energy comes to in sawmill from Savon voima. They use Oil (12%), Wood (34%), Peat (43%) and other (11%) to produce energy, see /7/.

Fuel	%	Heat value
Oil	12	38 MJ/kg
Wood	34	20 MJ/kg Renewable bio fuel
Peat	43	18 MJ/kg
Other	11	

Annual energy consumption in sawmill E_{tot} =7900 MWh.

$$\text{Specific Energy Consumption} = \frac{7900\ \text{MWh}}{120\ 000\ \text{s-m}^3} = 65.8\ \text{kWh / s-m}^3$$

Oil and peat is only taken to account in calculation.

Oil 0.12*66 kWh / s-m^3 =7.92 kWh/ s-m^3

Peat 28.38 kWh/ s-m^3

Total amount of fossil based electricity is 36.3 kWh/ s-m^3.

Calculated CO_2 emissions from different fuels. Heat loss in power generation is not included in the numbers, see /8/.

Oil 0.26 kg CO_2/kWh

Peat 0.38 kg CO_2/kWh

Wood 0.39 kg CO_2/ kWh

Efficiency of back- pressure power plant assumed 80%. 1 kWh electricity consumed 1.25 kWh heat.

Oil (1/0.8) x 0.26 kg (CO_2)/kWh * 7.92 kWh/s-m^3 = 2.574 kg CO_2/s-m^3

Peat (1/0.8) x 0.38 kg CO_2/kWh x 23.38 kWh/s-m^3 = 11.106 kg CO_2/s-m^3.

Specific CO_2 emission: **13.68 kg CO_2/s-m^3**

4. Transport from Isojoki saw mill to Teuva Slp

Distance: s = 60 km

Specific CO_2 emission: **1.6 kgCO_2/ s-m^3**

5. Thermowood Process

Energy used in the Slp is produced from renewable energy sources.

Slp- consumption of light oil is 110000 l / a.

110000 l* 0.840 kg/l = 92400 kg/a

(3.113 kg CO_2 * 92400 kg) / 9000 s-m^3 = 31.96 kg CO_2/s-m^3

Specific CO_2 emission: **32.0 kg CO_2/s-m^3**

6. Transports in Slp

Fluid gas: 17500 l/a

Density ρ = 0.5 kg/l

17500 l*0.5 kg/l = 8750 kg/a

It is assumed that liquefied gas is butane.

C_4H_{10} n= 150862 mol

C_4H_{10} (g) + 3/2 O_2 (g) → 4 CO_2(g) + 5 H_20 (g)

1 mol 4 mol

CO_2 n = 4*150862.07 mol = 603448 mol

CO_2 m = 26 551.7 kg

Total in the year 26 552 kg CO_2

Production: 9000 s-m^3

Specific CO_2 emission:

26 552 kg CO_2/ 9000 s-m^3 = **2.95 kg CO_2/ s-m^3**

7. Painting of thermowood

s: 10km

Production: 9000 s-m^3/a of which only 1000 s-m^3 is painted!

0.26 kg CO_2 / s-m^3 (painted wood) = 0.03 kg CO_2/ s-m^3 (all wood)

Specific CO_2 emission: **0.03 kg CO_2/ s-m^3**

8. Transport to harbor

Distance: 150 km

Consumption 50 l / 100 km

Consumption: 75 l

SDC: 75 l / 50 s-m^3 = 1.5 l / s-m^3

1.5 l /s-m^3* 0.850 kg/m^3 =1.275 kg/s-m^3

Specific CO_2 emission: **4.0 kg CO2 / s-m^3**

9. Shipping

It is assumed that 20g CO_2 is produced per one kilometer of transport of one ton of freight (= 20g CO_2/tkm). One solid cubic meter wood corresponds 740 kg, hence one ton wood corresponds 1.35 s-m^3.

$\frac{1000\ kg}{740\ kg}$ = 1.351 s-m^3

Specific CO_2 Emission= 20g/ 1.351 s-m^3 km

= 14.80 g CO_2/s-m^3 km

700km * 14.8 g CO_2/s-m^3 km = **10.4 kg CO_2/ s-m^3**

10. Transport from harbor to customer

Distance: 100 km

Specific CO_2 emission: **2.7 kg CO_2/ s-m^3**

TOTAL 69.5 kg CO_2/s-m^3

8.4 Absorption of CO_2 by a Wood

It is well known that growing biomass, e.g. wood, absorbs atmospheric carbon dioxide. Especially in Finland, where forests are growing more than they are cut, there exists significant carbon sink, see figure 9.

Figure 9.Carbon dioxide cycle of a biomass.

Example carbon Absorption of a Growing Wood

Composition of wood is seen in page 18. The following calculations are based on 1 s-m^3 fresh wood.

One s-m^3 fresh wood has average density of 700-800 kg/ s-m^3 and water content of 55 w-%. Amount of dry material (= dry wood) lies between 315 up to 360 kg/s-m^3.

Dry wood contains 50 w-% carbon (C), i.e. amount of carbon is 170 kg C/s-m^3.

Absorption of carbon dioxide

$44\ g_{/mol} / 12\ g_{/mol} * 170\ kg/\ s\text{-}m^3 = 623\ kgCO_2/s\text{-}m^3$(fresh wood).

Growing wood absorbs 623 kg CO_2 / s-m3. Net emission of CO_2 in thermowood's final product was about 70 kg CO_2 / s-m3. This means that wood take much more CO_2 back to growing process.

For instance, annual average net growth of the forest in Etelä- Pohjanmaa area is 4.5 s-m^3/ha, see /9/. This corresponds absorption of 4.5 s-m3/ha x 623 kg CO2 = 2803 kg CO_2/ha. Hence, in order to compensate CO_2-emissions of thermowood product, area of 225 ha forest would be required.

Thermowood annual production is 9000 s-m^3, which means 630 000 kg CO_2:

9000 s-m^3/a * 70 kgCO_2/s-m^3 = 630000 kgCO_2

Finally, required forest area is:

$$A = \frac{630\,000 \text{ kg } CO_2}{2\,803 \text{ kg } CO_2/\text{ha}} = 225 \text{ hectar}$$

9 RESULTS

The whole production and transport chain of thermowood produces 69.5 kg CO_2/ s-m^3. Consumption of fossil fuel, energy consumption in the saw mill and transportation makes huge part of the carbon dioxide emission on process of thermowood.

Table 1.CO_2 emission from different energy sources, see /10/.

Energy source	CO_2 Emission
Coal Plant	825 g CO_2/kwh
Nuclear/ Wind	5 g CO_2/kwh
Water (Hydro Power)	5-30 g CO_2/kwh
Wood	25 g CO_2/kwh

Slp consumption of fossil fuel makes almost half of the whole CO_2 emission, see figure next page.

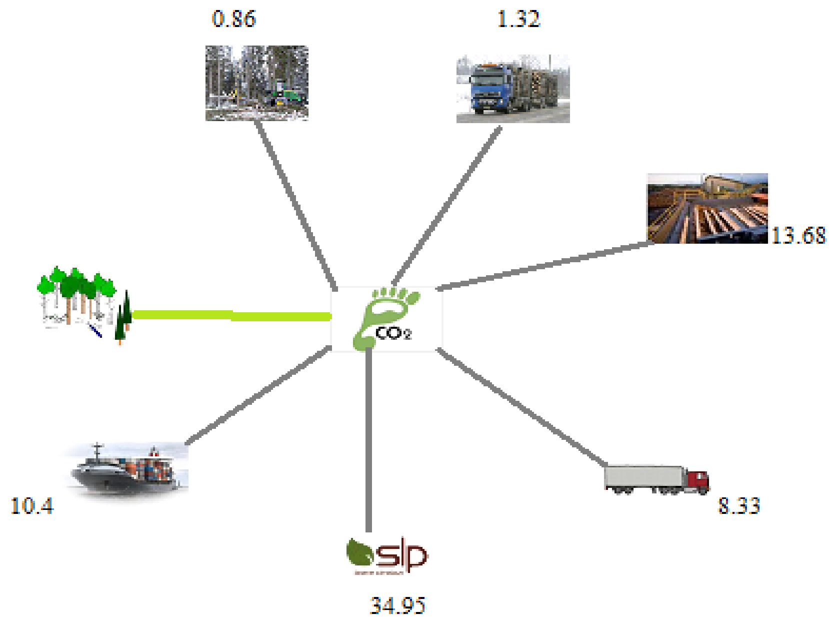


Figure 10.Division of CO_2 emissions (kg CO_2/s-m^3) in the process.

10 CONCLUSIONS

Thermowood process doesn't induce remarkable amount of carbon dioxide. According to the calculations made, the CO_2-emissions are about 50 % from total emission. Carbon dioxide emission of Slp originates mainly from the light oil consumption used to heat the wood. However, even 40% of the oil has been substituted with Slp own renewable waste energy. The transportations by trucks and shipping produce high carbon dioxide emission corresponding almost 30 % of the total emissions.

Oil consumption in the Isojoki sawmill is very small leading to negligible carbon dioxide emission, see /11/. Part of the produced energy goes into heat for district heating. But electrical energy used in the saw mill is produced using fossil fuel, which makes considerable carbon dioxide emission. This should be taken to account in calculations.

Thermowood is much better choice comparing to the metal or concrete products what comes to the CO_2-emissions, see Appendix 1. The carbon dioxide is stored in the thermowood when it is used as exterior cladding. The service life of the thermowood is predicted to be longer than untreated wood.

It is generally known that CO_2 emitted in combustion or degradation of the wood is absorbed back to the growing trees, which means zero net CO_2-emisssion. That fact is the one reason, why carbon dioxide emission comes low from the thermowood process.

In the calculations the net CO_2- emission in thermowood process showed that wood takes back to growing much more than is produced, see page 25.

Thermowood uses no toxic or hazardous chemicals in the process, so no harmful chemicals are released to the environment. The process is continuously developed. Slp makes all efforts to supply most environmentally friendly exterior cladding products to customers.

REFERENCES

1. Suomen Lämpöpuu Oy:n website. Refer to 10.3.2012 http://www.suomenlampopuu.fi/in_english/info_about_thermowood/

2. Dr. Wolman's wood website. Refer to 7.3.2012. http://www.wolman.de/en/infocenter_wood/from_tree_to_wood/wood_properties/aufbau_der_laubhoelzer/index.php

3. Members of the Finnish Thermowood Association. 2003. Thermowood handbook. http://www.thermowood.fi/data.php/200312/795460200312311156_tw_handbook.pdf

4. Palonen, J. 2012. Managing Director of Suomen Lämpöpuu Oy. Teuva. Personal information 10.4.2012, 14.8.2012.

5. Guide to PAS 2050. 2008. How to assess the carbon footprint of goods and services. Brit-ish Standards Institution. Iso-Britannia: British Standards Institution. 59. ISBN 978-0-580-64636-2

6. Kuljetusala website. Refer to 6.9.2012. http://www.kuljetusala.com/oppilaitokset/ukk

7. Savon voima. 2011. Environment report. http://www.savonvoima.fi/SiteCollectionDocuments/Konserni/SV_ymparistoraportti_2011.pdf

8. The Engineering toolbox website. Refer to 4.12.2012 http://engineeringtoolbox.com/co2-emission-fuels-d_1085.html

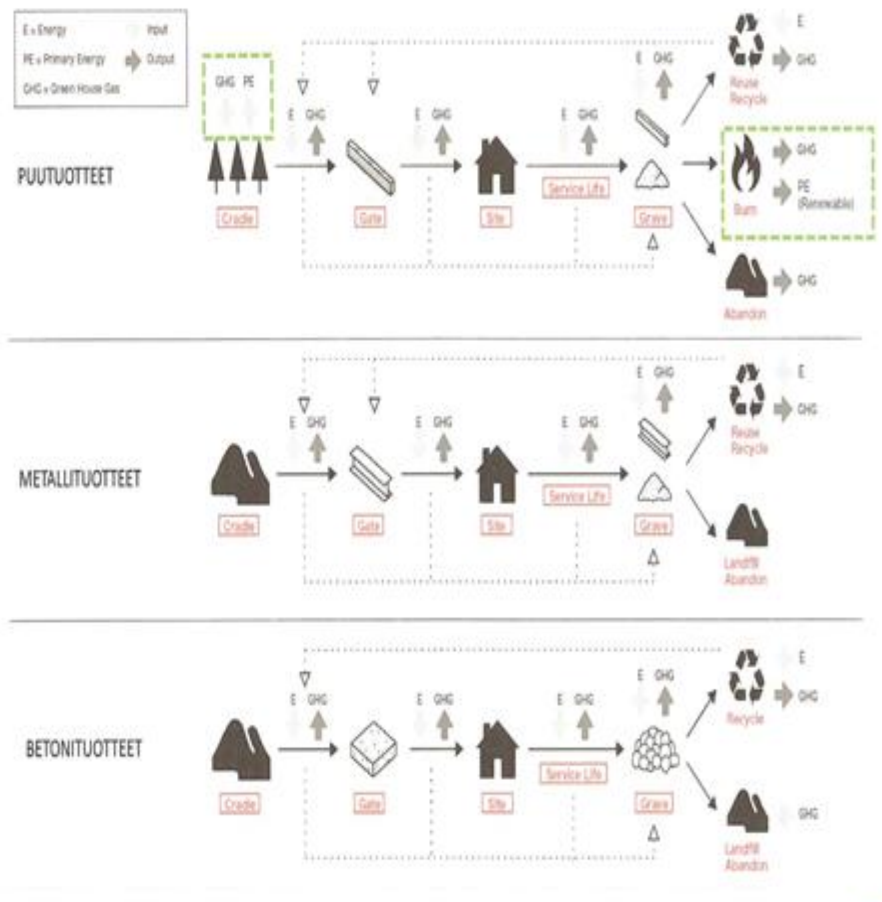
9. Admin. 2012. Metsätilan ostaminen – Vihjeitä tilan etsimiseen ja arviointiin. Puuntuottaja website 2012. http://www.puuntuottaja.com/metsatilan-ostaminen-vihjeita-tilan-etsimiseen-ja-arviointiin/

10. Halonen, M. 2010. Energiantuotantomuotojen elinkaaren päästöt vertailussa. Sinivihreät website 2012. http://www.sinivihreat.fi/?p=500#more-500

11. Mikkola, R. 2012. Production Manager of Isojoki saw mill. Information from visit 28.9.2012.

APPENDIX 1

COMPARING PRODUCT CYCLES: WOOD, METAL AND CONCRETE FROM KUITTINEN, M. 2012. PUUKARENTAMISEN HIILIJALANJÄLKI JA ALUEELLISET HIILIVIRRAT PRESENTATION IN PUUAKATEMIASEMINAARI



APPENDIX 2

CERTIFICATION OF USE RENEWABLE ENERCY SOURCES IN SLP

KRAFT&KULTUR

TODISTUS
2012-2014

TAKAAMME, ETTÄ KAIKKI NÄISSÄ TOIMITILOISSA KÄYTETTY SÄHKÖ ON TUOTETTU AINOASTAAN UUSIUTUVISTA ENERGIALÄHTEISTÄ

Me kannamme vastuuta ympäristöstämme. Sen vuoksi ostamme vain alkuperämerkittyä sähköä Kraft&Kulturilta.

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Suomen Lämpöpuu Oy

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