Carbon Footprint

Nelson Forests Ltd.

Report

Version 6.0

Author: Daniel McCallum

Date: 20 June 2009

Document Control

Author	Daniel McCallum
Project Sponsor	Nelson Forests Ltd.
Project Manager	Daniel McCallum
Project Mentor	Andrew Karalus
Project Supervisor	Bruce Manley

Development History and Status

Version	Date Issued	Reviewed by	Approved by	Date approved	Revision type
1	06/01/2009	Andrew Karalus	Andrew Karalus	8/01/2009	First Draft
2	12/01/2009	Daniel McCallum	Daniel McCallum	15/01/2009	Second Draft
3	26/01/2009	Andrew Karalus Bruce Manley	Andrew Karalus Bruce Manley	3/02/2009 30/01/2009	External Review
4	4/02/2009	Piet Buekman	Piet Buekman	4/02/2009	Final Draft

Executive Summary

Nelson Forests supply chain was analysed from cradle to market using a carbon calculator developed for Nelson Forests. The calculator follows life cycle analysis (LCA) principles and methodologies from leading international standards. Results obtained include carbon emission profiles for log and lumber products produced by Nelson Forests, forest operations and their Kaituna Sawmill, delivered to domestic and export customers.

The carbon footprint of the **domestic log supply chain was 18.7**[1] **kg CO_2e/m^3**, the **export log supply chain was 65.1**[1] **kg CO_2e/m^3**, a break down of emissions sources can be found in table A.

Table A: Source of log supply chain emissions as a percentage of total emissions

Emissions Source	Domestic	Export
Management Activities	1%	0%
Forest Operations	3%	1%
Roading Operations	17%	5%
Harvesting Operations	47%	13%
Log Transport	32%	80%

The carbon emissions of lumber products produced at the Kaituna sawmill range from 27 to 923 kg CO_2e/m^3. Emissions associated with onsite generation of thermal energy (steam) are the largest for kiln dried products (up to 85%). Under internationally recognised LCA and carbon footprint methodologies, thermal energy generation derived from burning woody biomass is considered carbon neutral, and is therefore excluded from the assessment. This reduces the **carbon footprint of lumber products** to **27-148 kg CO_2e/m^3.**

Depending on the product, transportation mode and location of the customer, distribution can account for up to 80% of the total embodied emissions of lumber from cradle to market. Lumber products trucked to Christchurch have a similar emissions profile to products shipped to Australia. This highlights the energy and emissions efficiency of ocean freight over long haul road transport.

Using a conservative service life of lumber products (30 Years), 270 kg CO_2e/m^3 of embodied carbon can be credited toward the assessment as stored carbon. When stored carbon is included in the assessment **all lumber products are net stores of carbon, storing between 6-243 kg CO_2e/m^3**, even after all down stream emissions associated with the production and

[1] Std. Dev. Domestic Supply Chain (σ=4.6 kg CO_2e/m^3). Std. Dev. Export Supply Chain (σ=10 kg CO_2e/m^3)

extraction of raw materials, processing and distribution have been accounted for. If it can be proven that the majority of product is land filled after it's initial use, claiming a stored carbon figure in the order of up to 840 kg $CO_2\boldsymbol{e}/m^3$ could be justified and credited toward the product's assessment accordingly.

Significant reduction opportunities exist in both the log and lumber supply chains. It is calculated that a **combined carbon emissions reduction of 16-25% could be made** across both the log and lumber supply chains (Table B). It is recommended that reduction initiatives are investigated and implemented where feasible. It is also recommended that the carbon calculator developed be integrated into normal business activities, ensuring the measurement and monitoring of Nelson Forests carbon footprint over time.

Table B: Emission Reduction Opportunities in the Log and Lumber Supply Chains.

Priority	Description	CO_2e Reduction	Direct Costs
1	Integrate the carbon calculator developed as part of normal business activities.	N/A	Low
2	Replace waste oil, with biomass as source of heat for drying saw dust.	10-13%	Medium-High
3	Lobby for an increase in the allowable gross vehicle mass of a log truck to at least 50 tonne.	2-3%	Low – Medium
4	Inform log truck drivers on impacts of driver behaviour on fuel consumption.	2-4%	Low – Medium
5	Inform harvesting crews on how operations effect fuel consumption.	<2%	Low - Medium
6	Continue support for mechanisation and higher utilisation rates of harvesting machines.	<1%	Low - Medium
7	Lobby for the creation of a national carbon label or carbon brand specific to forest products.	N/A	Low – Medium.
8	Implement material energy audit recommendations related to kiln fans.	<1%	Medium-High
9	Investigate trans-coastal shipping and rail to Christchurch lumber markets.	<1%	Low - High

Table of Contents

1 Introduction

1.1 Global Perspective

Climate change is now a significant international political issue, it has captured the minds of governments, business and consumers alike and it has drawn attention to the role of reducing Greenhouse Gas (GHG) emissions in abet climate change. There is significant and increasing pressure in domestic and export markets for information on the GHG-intensity of products. GHG footprinting is being used to establish a common approach for measuring the GHG embodied in a product and in subsequent labelling regimes. The GHG "footprint" can not be generic and has to be specific and traceable in order for it to be validated.

Accounting and assessing an organisation's carbon footprint is a relatively new concept. With global awareness of climate change and the amendment of international and national legislation surrounding carbon trading, carbon accounting and carbon footprinting are set to become a regular business activity in many primary industries. However, establishing a carbon footprint for products is still in its infancy on a global and national scale. Early adopters are needed in New Zealand to establish and test protocols for footprinting products which can later be shared with the wider industry.

1.2 Forest and Wood Industry Perspective

The NZ wood industry has been under pressure both in domestic and export markets. In domestic markets wood is losing share to substitute building products and systems. In export markets profitability is under threat from fluctuating freight costs, exchange rate and markets are potentially threatened by attention to GHG emissions associated with "food miles" and "wood miles". Long life building products derived from sustainably managed forests possess attractive GHG credentials relative to competing materials. However timber's sustainability credentials have more often been attacked by reference to forest management practices, particularly those associated with rainforest depletion. Credible and verifiable information was needed to confidently position long life forest products as a sustainable and low GHG emissions material, relative to its competitors. Nelson Forests Ltd sees commercial advantage for its products and for NZ wood products by offering a true representation of the GHG benefits at the product level.

The level of that commercial advantage in the first instance will be to answer questions about carbon footprints to maintain access to markets. However Nelson Forests Ltd also sees opportunity to increase demand for wood as a low carbon footprint building product. More recently the passing of the Emissions Trading Scheme by the New Zealand government has prompted the wood industry to assess their impact on GHG emissions to mitigate the possible risk of future emission liabilities.

1.3 Goals

The goals of this study were to:

1. Measure the carbon footprint of Nelson Forests log and lumber products.
2. Identify the most significant processes which contribute to the carbon footprint of Nelson Forests supply chain to direct resources to reduction initiatives, and to obtain a base line for reduction targets.
3. Provide information to Nelson Forests stakeholders regarding the carbon footprint of Nelson Forests' products.
4. Develop a tool which can monitor Nelson Forests carbon footprint over time, with the vision of sharing the tool with industry.

1.4 Scope

The LCA was conducted over three components of Nelson Forests supply chain.

1. Forest Operations

   The scope includes Nelson Forests' supply chain from seedling production to delivery of processed logs to the customer's gate (both domestic and export customers). Carbon sequestration within the forest is excluded from the assessment.

2. Sawmill Operations

   The scope includes Nelson Forests processing operations at their Kaituna Sawmill from gate to gate. Stored carbon within the product is also included in the scope. Stored carbon is assessed in accordance with PAS 2050:2008 (Appendix 13.1)

3. Lumber Distribution

   The scope includes the delivery of products form the Kaituna mill to the customer's gate (both domestic and export). For export customers the boundary ends at the unload port.

2 Methodology

Carbon footprinting of products and processes is a relatively new concept. However, the framework to assess a carbon footprint, life cycle analysis (LCA), has been used as a research tool to quantity energy consumption and environmental impacts of products and processes since the late 1960s. In the mid 1990s LCA received international recognition as the preferred framework to assess environmental impacts with the inception of the ISO 14040 series in 1997. Subsequent revisions have occurred in 1998, 2000 and 2006 to reflect changes in its application and methodology development. LCA has been used to assess the environmental impact and energy consumption of products and processes in most modern industries, including forestry and forest products. International impetus of carbon footprinting has driven the need for an independent standard. As a result the PAS 2050:2008 was developed. An ISO standard is in its draft form (ISO 14067), when released it will become the governing standard for carbon footprinting. Background information relating to LCA, can be found in Appendix 13.2, a list of governing standards applied in this project can be found in the reference section.

A measurement and monitoring framework accompanied by a specification document was developed using Microsoft excel to ensure Nelson Forests can measure, monitor and manage the carbon footprint of their products. This will enable Nelson forest to track their performance and provide quantifiable reduction measurements over time. The specification document has been developed to ensure that the methodology followed in the project can be repeated by other staff in the business.

2.1 Functional Unit

The functional unit for each component of the supply chain can be found in Table 1.

Table 1: Functional Unit

Supply chain component	**Functional Unit**
Forest Operations	1 m^3 green processed log
Sawmill Operations	1 m^3 processed lumber
Lumber Distribution	1 m^3 processed lumber

2.2 Allocation

The allocation of emissions to products follows the PAS2050:2008 specification 8.1.1a. Unit processes are divided into sub-processes. Input and output data are collected related to these sub-processes and allocated to the products on a mass basis and consumption basis.

3 Results

3.1 Forest Operations

Results were generated using the carbon footprint tool developed for Nelson Forests. Results show that the carbon footprint of the domestic and export log supply chains are 18.7 kg CO_2e/m^3 and 65.1 kg CO_2e/m^3 respectively (Figure 1). The standard deviation of the export log supply chain (σ=11.3) is greater than that of the domestic log supply chain (σ=5.9). This is due to the compounding of the domestic supply chain variation and the export supply chain variation. Variation in domestic supply chain is derived from differing transport distance and harvesting system. The variation of the export supply chain is derived from the complexity of different shipping routes, schedules and vessels to export markets (σ=5.4).

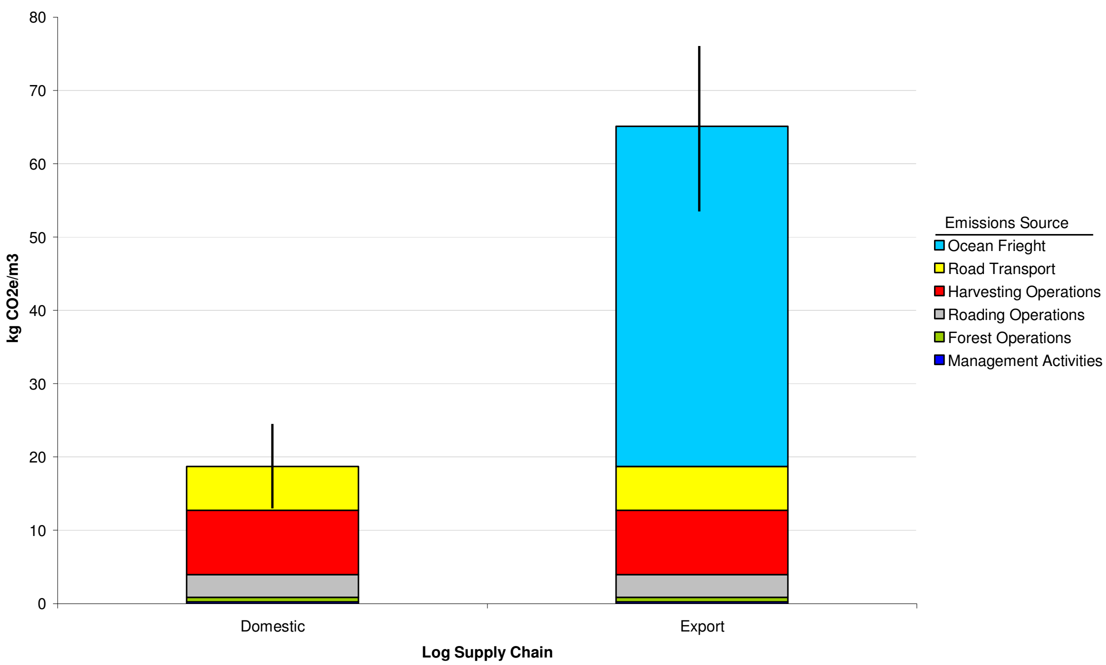

Figure 1: Carbon footprint of domestic and export logs.

The most significant contributor to GHG emission across Nelson Forest's log supply chain is ocean freight of export logs (41%). The second largest contributor is harvesting emissions (28%), followed by road transport (20%) and forest roading operations (8%), Forestry operations only contribute 2% of total emissions (Figure 2). A full break down of all emission sources can be found in Table 2. A full account of parameters and emission factors used to derive the carbon footprint of the forest operations can be found in Appendix 13.3.

Figure 2: Detailed log supply chain emissions inventory.

Total Emissions: 38,432 t CO_{2e}

	1% Management Activities	0.2 kg CO2e/m3
	2% Forest Operations	0.6 kg CO2e/m3
	8% Roading Operations	3.1 kg CO2e/m3
	28% Harvesting Operations	8.8 kg CO2e/m3
	62% Log Transport	22.4 kg CO2e/m3
	Domestic Log	**18.7** kg CO2e/m3
	Export Log	**65.1** kg CO2e/m3

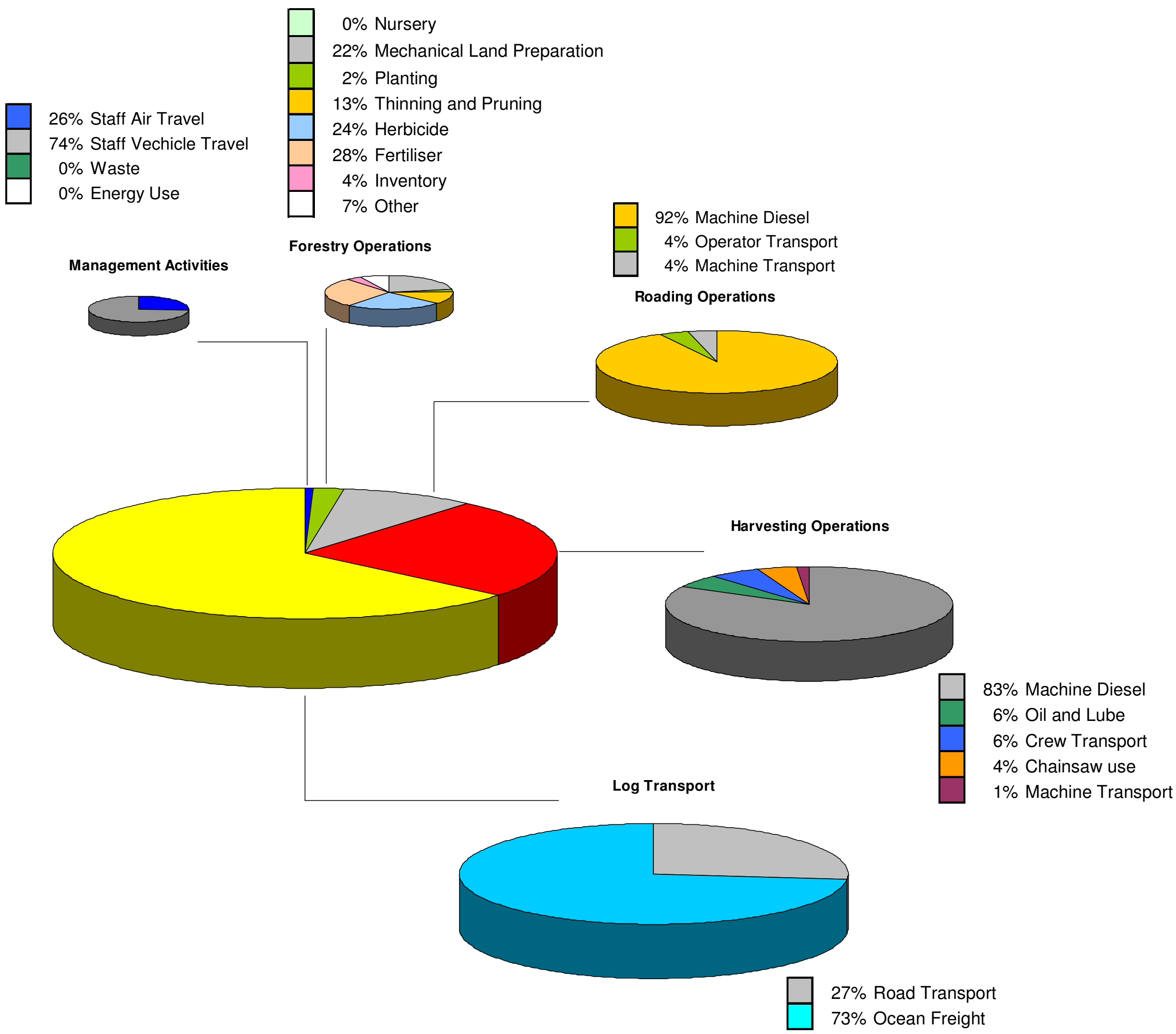

Table 2: Forest operations emissions by unit process, sub unit process and operation

Unit Process	Sub Proccess	Operation	t CO2*e*	kg CO2*e* /m3
Management Activities	Staff Air Travel		67.9	0.06
	Staff Vechicle Travel		194.3	0.18
	Office Waste			
	Office Electrical Energy			
	Total		**262.2**	**0.24**
Forestry Operations	Mechanical Land Prep			
		Machine Diesel	141.2	0.13
		Operator Transport	6.3	0.01
			147.5	0.13
	Fertilise			
		Product	176.7	0.16
		Application	10.7	0.01
			187.4	0.17
	Herbicide			
		Product	122.29	0.11
		Application	35.90	0.03
			158.18	0.14
	Silvicultural Activities			
		Planting	12.6	0.01
		Pruning	18.0	0.02
		Thinning	65.3	0.06
			96.0	0.09
	Other			
		Forest Inventory	25.6	0.02
		Security Patrol	14.7	0.01
		Mowing	18.2	0.02
		Road side spraying	14.8	0.01
			73.3	0.07
	Total		**662.4**	**0.61**
Roading Operations	Machine Diesel			
		Dozers	1,017	0.93
		Excavators	1,207	1.10
		Trucks	468	0.43
		Other	437	0.40
			3,129	2.9
	Operator Transport		126	0.12
	Machine Transport		133	0.12
	Total		**3,388**	**3.1**
Harvesting Operations	Machine Transport		135	0.1
	Ground Based Mechanical		2,224	8.5
	Ground Based Motor Manual		1,302	6.6
	Hauler Mechanical		3,270	9.7
	Hauler Motor Manual		2,663	9.0
	Total		**9,594**	**8.8**
Transport Operations	Road transport	Trucking	6,579	6.0
	Ocean Transport	Bulk Carrier	17,946	46.4
	Total		**24,525**	**22.4**
Total			**38,432**	35.13
	Domestic Log			**18.7**
	Export Log			**65.1**

3.2 Sawmilling Operations and Lumber Distribution

Emissions associated with the generation of thermal energy to supply heat energy in the kilns account for up to 85% of total product emissions at the Kaituna sawmill (Figure 3). Thermal energy at the Kaituna sawmill is generated by burning woody biomass residues from sawmilling operations. Residues are supplied from Kaituna sawmill, and trucked in from external sources. Biomass is regarded as a carbon neutral source of energy (PAS 2050:2008), therefore emissions associated with the generation of thermal energy is not included when assessing the carbon footprint of the products produced at the Kaituna sawmill. However non CO_2 emissions (CH_4, N_2O) generated from burning biomass is included, as is the embodied emission in the log and subsequent processing which the biomass residues are derived from.

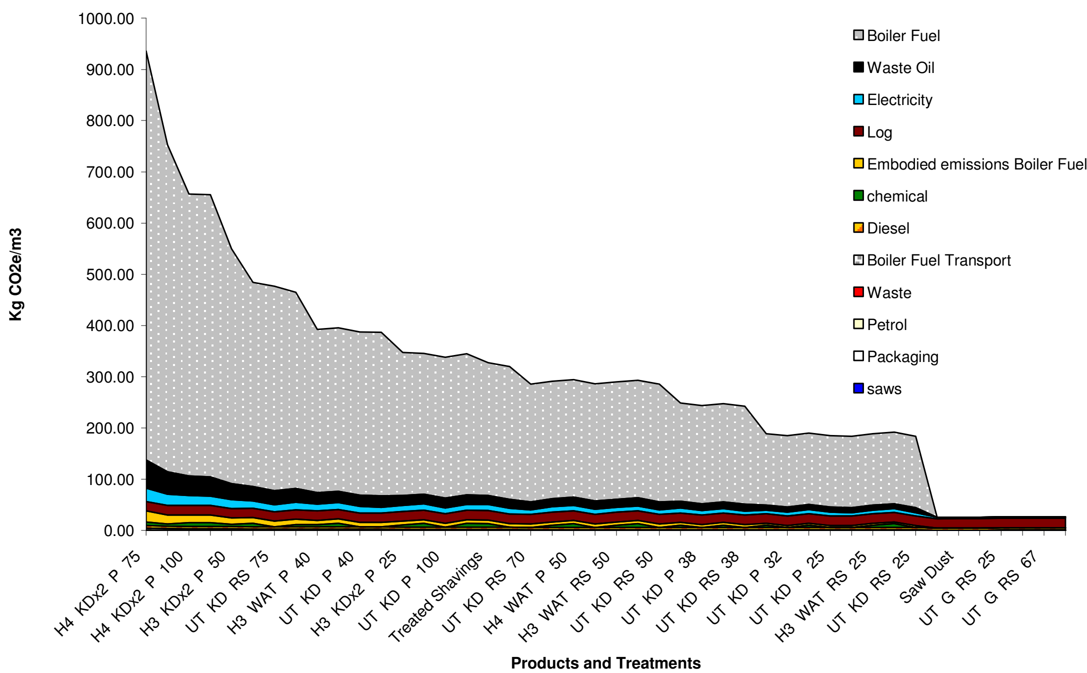

Figure 3: Emission profile including thermal energy emissions associated with burning biomass for products at Kaituna Mill.

Excluding carbon emission associated with thermal energy generation, the emission profile of the products produced at the Kaituna sawmill range from 27 to 148 kg CO_2e/m^3. Waste oil, electrical energy and embodied log emissions account for the largest sources of emission for products which have been kiln dried. Embodied log emissions, mobile plant and electrical energy are the largest sources of emissions for products which are not dried, treated or under go a surface finishing treatment (Figure 4). A full break down of emission sources can be found in Table 3.

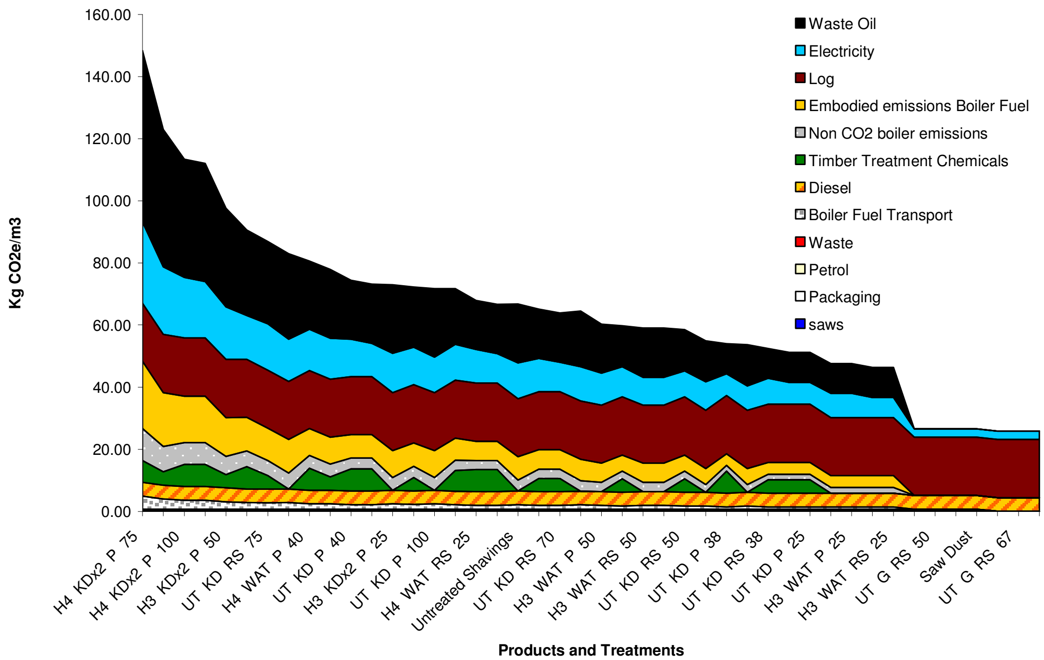

Figure 4: Emission profile excluding thermal energy emissions associated with burning biomass for products at Kaituna mill.

The majority of products sold at the Kaituna mill are either appearance grade timbers, used for finishing applications in buildings, or industrial structural products, for both indoor and out door use. A conservative service life of these products of 30 years has been assumed. The implications for products with a longer service life is discussed in section 5. Assuming a conservative 30 year service life, 30% (270 kg CO_2e/m^3) stored carbon can be credited toward the products. Using the storage figure of 270 kg CO_2e/m^3 enables all the products produced at Kaituna to become net stores of carbon after all down stream emissions are accounted for. The addition of distribution emissions reduces the amount of stored carbon, however all products are still net stores of carbon (Figure 5).

Distribution emissions can account for up to 80% of total emissions depending on the product and mode of distribution. Comparing the emissions profile of products delivered to domestic and export destinations highlights the energy and emission efficiency of ocean freight. For example products trucked to Christchurch have a similar emission profile to products shipped to Australia (Figure 5). Parameters and emission factors used to derive the above results can be found in Appendix 13.4.

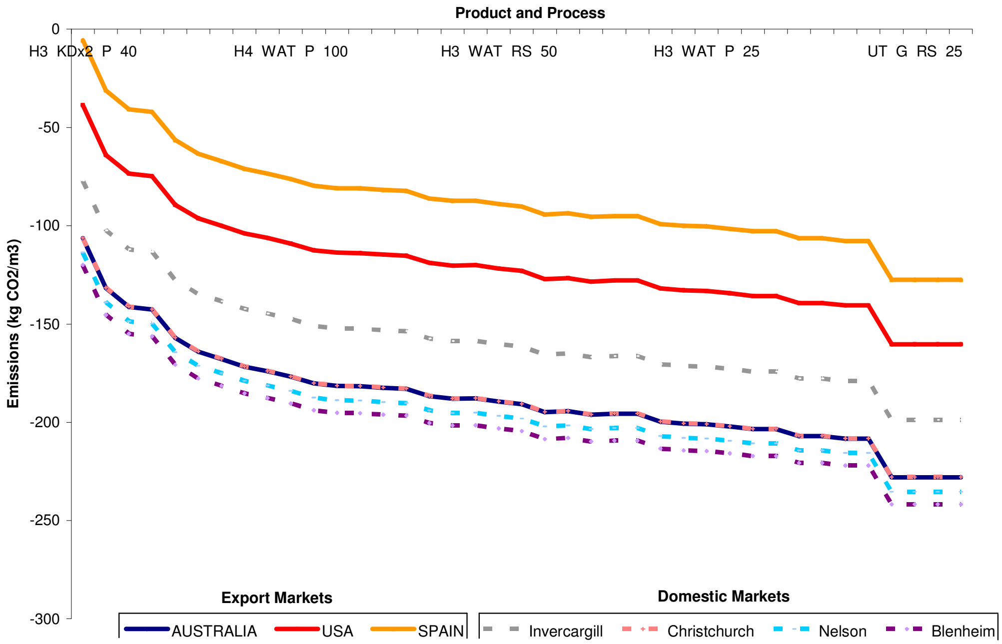

Figure 5: Emission profile excluding thermal energy emissions associated with burning biomass, including distribution emissions and including stored carbon for products at Kaituna mill.

Table 3: Sawmill and lumber distribution emissions.

Unit Process	**Sub Proccess**	**Operation**	**t CO2e**
Energy	Electrical	Sawmill	182
		Plainer	24
		Kilns	366
		Treatment	12
		Other	6
		Transmission Losses	1
			590
	Diesel	Mobile Plant	306
	Thermal	Biomass	13,340
		Embodied Energy	367
		Biomass Transport	71
			13,777
	Petrol	Chainsaw	12
	Waste Oil	Boiler fuel drying	934
	Total		**15,618**
Raw Materials	Logs	Embodied emissions	1,295
	Chemicals	Treatment	144
			1,440
	Total		**1,440**
Consumables	Saws		3
	Packaging		-
			3
	Total		**3**
Waste	Land fill		17
Lumber Distribution	Domestic Road Transport		505
	Ocean Transport		900
			1,405
	Total		1,405
Total			**18,482**

Break Even Analysis (Transport)

Break even analysis was conducted to see how far any given log would have to travel by road to have the same embodied emission as a cubic metre of log shipped to Asia (Japan/Korea), and a cubic metre of lumber shipped to Australia. It was found that a truck carting logs 900 km (roughly Nelson to Southland) would have the same embodied emission as freighting logs to Asia, and a truck carting lumber 225 km would have the same embodied emission as shipping product to Australia (Table 4).

Table 4: Log and lumber road and ocean transport break even analysis

Cargo	Freight Type	kg $CO_2e/m^3/km$	km	kg CO_2e/m^3
Logs	Ocean	0.0044	10,000	44
Logs	Road	0.0490	898	44
Lumber	Ocean	0.0065	1,800	11.2
Lumber	Road	0.0503	222	11.2

4 Comparison with literature

4.1 Forest Operations

Sonne [2006] conducted a LCA quantifying the GHG emissions from forestry operations in the Pacific North West of USA. Another LCA study conducted by Berg and Lindholm [2003] assessed the environmental impacts of forest operations in Sweden. The system boundary in Sonne [2006] was cradle to harvest, while Berg and Lindholm [2003] was from cradle to mill gate. Comparisons of the two studies, with the results from Nelson Forests are shown below in Table 5.0. Emissions associated with harvesting operations account for 8.4 kg CO_2e/m^3 in Sonne [2006]. The largest contributor to the emission profile in Berg and Lindholm [2003] was road transport (8.3 kg CO_2e/m^3). The second largest contributor being harvesting (4.7 kg CO_2e/m^3), followed by silviculture and nursery operations. Silviculture and nursery emissions were significantly higher than those reported by Nelson Forests, with silviculture contributing up to 8% of total emissions. Unfortunately Berg and Lindholm [2003] do not provide enough information to ascertain the reason behind these large differences.

Table 5: Comparison of Forest Operation LCA

Study	Country	System Boundary	Results
Sonne [2006]	USA	Cradle to Harvest	16 kg CO_2e/m^3
Nelson Forests	NZ	Cradle to Harvest	13 kg CO_2e/m^3
Berg and Lindholm [2003]	Sweden	Cradle to Mill Gate	14 kg CO_2e/m^3
Nelson Forests	NZ	Cradle to Mill Gate[2]	19 kg CO_2e/m^3

4.2 Sawmill Operations

Milota *et al.* [2005] conducted a Gate to Gate life cycle inventory of softwood lumber (Douglas fir and Hemlock) production in Southern and Western sawmills in the USA, including emissions associated with the generation of thermal energy. The results from this study are compared to Nelson Forests results in Table 6. Comparisons suggest that Nelson Forests footprint is 12-54% higher than that of Milota *et al.* [2005] depending on locality. However this is to be expected as Milota *et al.* [2005] assessed Douglas Fir and Hemlock species which typically have lighter kiln schedules, and hence require less thermal energy than *Pinus radiata*. However, Nelson forests overall carbon footprint (and that of USA south) is substantially reduced due to the use of woody biomass as the feed stock to produce on site thermal energy.

Table 6: Comparison of Saw Mill LCA

Study	Country	System Boundary	Results
Milota *et al.* [2005]	USA (South)	Gate to Gate	353 kg CO_2e/m^3
	USA (West)	Gate to Gate[3]	258 kg CO_2e/m^3
Nelson Forests	NZ	Gate to Gate[4]	398 kg CO_2e/m^3

[2] Nelson Forests analysed the supply chain from cradle to market (including export logs), however the figure reported above is only representative of the delivery to domestic markets to enable an objective comparison.
[3] Thermal energy generated from propane, which has lower emissions per unit of energy than biomass, however it is not regarded as carbon neutral energy source.
[4] Nelson forests sawmill study is cradle to customer gate, however the results have been adapted to make comparisons between the Milota study objective.

5 End of life Scenarios

End of life scenarios have not been included in this analysis as it was deemed outside the scope of the project. However end of life scenarios have been reviewed to give context to their potential effects on a cradle to grave carbon footprint. There are 6 realistic end of life scenarios of untreated structural lumber, and two for treated lumber.

1. Land Filling (probable option for treated lumber).
2. Burning.
3. Left to rot in the natural environment.
4. Burned with energy recovery.
5. Recycled into new buildings (possible option for treated lumber).
6. Recycled into other engineered wood products (e.g.: chip board).

5.1 Land Filling

Current convention cites that option 1, landfill, would have a negative impact on the carbon footprint of lumber if the analysis boundary was cradle to grave. However recent literature [Micales and Skog, 1996., Ximenes, Gardner and Cowie, 2007] provides evidence to suggest land filled lumber only degrade and release a small fraction (3-6%) of carbon stored in wood after 100 years in a land fill. Based on this knowledge, land filling wood would increase the service life (life of the product storing carbon) of the product. Using the PAS 2050:2008 standard this would equate to the retention of 94% of embodied carbon, enabling a stored figure of 846 kg $CO_2\boldsymbol{e}/m^3$.

5.2 Burning

Burning lumber liberates stored carbon as CO_2 back to the atmosphere. Based on current convention under the PAS 2050:2008 liberation of carbon to the atmosphere lowers the service life of that product. Therefore, if lumber was burned either through a fire in a standing building or after demolition it would reduce the service life of the product. If the service life decreases, the amount of stored carbon credited toward the product reduces increasing the carbon footprint.

5.3 Left to Rot

Lumber can be left to rot in the open environment, as a result of waste cuts in the construction process or through demolition without proper waste disposal. Depending on the climate and preservation treatment, decomposition can be accelerated in an open environment. This would result in the lowering of the service life of the product increasing the carbon footprint.

5.4 Burned With Energy Recovery

Burning untreated woody biomass to recover energy is an end of life scenario that is gaining popularity as the impetus to reduce dependence on fossil fuel energy increases. Due to Kyoto rules and the natural carbon cycle woody biomass is considered carbon neutral. When burned to recover energy as either heat, steam or cogeneration of electricity, additionality could be claimed. Additionality is achieved when reductions are additional to a given base line scenario. For example, a facility considered implementing a boiler to generate steam, and option 1 was a wood fuel stock, and the base line scenario was coal stock. As wood stock is considered carbon neutral, the displacement of the emissions arising form the baseline scenario would be considered additional, and credited toward the end of life scenario, reducing the carbon footprint of wood products.

5.5 Recycling

Used lumber can be recycled into new buildings. It is more common that large dimension lumber, generally used as beams or columns, is recycled into new buildings. Recycling lumber into new buildings increases the service life of the product, reducing the carbon footprint. Untreated lumber of smaller dimension can also be recycled into engineered wood products such as chip board, MDF and OSB. This will effectively increase the service life of the original product reducing the carbon footprint.

5.6 Conclusion

The majority of end of life scenarios increase the service life of the product, enabling carbon embodied within the product to be stored longer, or by providing a non fossil fuel energy source creating additionality. While end of life scenarios have not been considered in this assessment, a conservative estimate of the service life of products has been used (30 year service life). However literature provides strong evidence to suggest that if lumber is land filled it can retains over 90% of it's embodied carbon. If the end of life scenario can be proven that the majority of product is land filled after it's initial use, claiming a stored carbon figure of up to 840 kg $CO_2\boldsymbol{e}/m^3$ could be justified and credited toward the product's assessment accordingly.

6 Emissions Reduction

6.1 Forest Operations

6.1.1 Harvesting

Emissions associated with harvesting operations account for 47% of total emissions for a given domestic log, and 14% of total emissions for a given export log. Absolute reductions in harvesting operations are limited due to capital and operational restrictions, however intensity measure reductions can be made by increasing productivity.

Absolute reductions

Absolute reductions made at the crew level could be achieved through optimization of machine use to minimise fuel consumption. Operators of equipment that consume large quantities of fuel (Hauler, Mechanised Felling, Processing, Skidders, Excavators and Loaders) should be trained on how to minimise fuel consumption of the machine, and reaffirm the importance of regular preventative maintenance to ensure machines are running efficiently.

Haulers and Skidders

- Minimise idle and down time through planning in advance.
- Optimise haul size, ensure that machines are not under or overloaded.
- Ensure skidder tyres are inflated to the correct level to match operating conditions.

Mechanical Processor

- Increase utility of the machine by creating a buffer ahead of the processing to ensure down time is minimised.

Loaders and Excavators

- Position machines on the skid to reduce movement.
- Where safe to do so, maximise the capacity of the grapple when loading out.
- Ensure adequate training is provided to trainee loader operators.

Productivity Improvement

Increasing the utility of crews will increase absolute emissions but will reduce the intensity measure of the product. Harvesting system improvements at Nelson Forest over the last 5 years has resulted in an increased production capacity of approximately 25,000 tonnes per year. Based on this trend, log supply chain emissions could be reduced by a further 1% every two years if production capacity meets market demand.

6.2 Log Transport

Increased Net Payload and Back loading

Road Transport accounts for 34% of total emissions for a given domestic log, ocean freight accounts of 72% of total emissions for a given export log. Analysis shows that increasing the allowable gross vehicle mass (GMV) from the current 44t to 50t could result in road transport emissions reducing by 17% reducing the domestic log supply chain by 5%, and entire log supply chain emissions by 4%.

Larger trucks will require larger investment per transportation unit. Larger load sizes should see higher return on investment. However, to maximise the return on investment the utility of these larger units will need to increase through back loading, or reducing the average lead distance through network efficiencies. Increasing loaded km from a current 56% to 60%, or reducing the average lead distance from 64km to 60 km through greater network efficiencies could reduce supply chain emissions by a further 1% each respectively. Moving to larger trucks (higher net payload) and increasing their loaded utility or reducing the average lead distance will reduce log supply chain emissions by 5-6%.

Driver Education

Studies have shown that driver education can lead to fuel efficiency improvements of up to 15%[5], reducing log supply chain emissions by 3%. Implementing integrated navigation and diagnostic technology would increase driver insight into their driving behaviour and how it impacts on fuel consumption. This technology would also identify consumption hot spots along common haul routes, enabling drivers to take corrective action to reduce consumption in these areas. A cost benefit analysis would have to be conducted to assess the viability of investing in such technology.

Ocean Freight

Larger vessels are more fuel efficient per unit of cargo (assuming loaded at full capacity) than smaller vessels. Chartering larger bulk vessels is favourable over smaller vessels (assuming it can be loaded to capacity).

[5] Energy Efficient Ways. To improve the economic bottom line of your forest harvesting business. http://www.energyfed.org.nz/Forestry.pdf Visited 9 December 2008.

6.3 Sawmill Operations

Kilns

Waste oil is burnt to generate heat in the saw dust drying process. If heat can be generated from biomass, displacing the need for waste oil, emissions of the lumber supply chain could be reduced by 13%.

Over 60% of total electrical energy use at the Kaituna mill is consumed in the kiln drying process. A kiln assessment conducted in 2001 by Windsor, and an energy audit conducted in 2004 by Energy Management Solutions made several recommendations related to improving electrical and thermal energy efficiency in the kilns. If these recommendations have not been acted on it is suggested that they be considered. Small energy efficiencies in the kiln process could result in large emissions reductions of kiln dried products.

6.4 Distribution

Distribution can account for up to 80% of total product emissions depending on the product and mode of transport. Efficiency gains can be made through better utilisation of fleet capacity.

Road

Trucks should always be loaded to their full capacity even when travelling short distances. Small increases in the utility, and capacity of road transport can result in significant emission reductions at the product level. For example increasing laden capacity from 50% to 100% would result in an emission reduction of 7% across the lumber supply chain.

Ocean

Ocean freight is in the order of 5-10 times more efficient than long haul road transport. The feasibility of trans-coastal shipping, or rail freight between Blenheim and Christchurch should be investigated.

7 Marketing and Promotion

While Nelson Forests may gain short term benefits by being first to market with explicit information surrounding the carbon footprint of their lumber products, others will soon follow creating a wash of information in the market. This could result in confusion and disinterest from consumers, which would be detrimental to the wider industry. 40% of New Zealand's lumber production is exported, and up to 70% of engineered wood products are exported. Therefore it is recommended that Nelson Forests push for a NZ Inc. branding, ideally with a formal association with the NZWood campaign (Figure 6).

Figure 6: Concept carbon labels/brand with an association with the NZWood program.

This will create a consistent message in both domestic and international markets of the carbon benefits of "NZWood". Furthermore, pooling resources will lower the administrative costs (brand management) of individual processors. It is suggested that the brand be promoted in the market through the following mediums:

1. Place the brand (carbon label) on the packaging material of lumber.
2. Display the brand on invoices.
3. Inform local architects in main markets of the work and provide emission factors for grades of timber that are common for domestic and commercial use. This will enable architects to inform their clients on the direct carbon benefits of using "NZWood".
4. Provide customers with information they can supply their customers with at point of sale (brochure). Preferably have the brochure at the location where the lumber is displayed (ie: next to the lumber).
5. Web portal for additional information before and after point of purchase.
6. Develop case study show homes (in conjunction with architects) which are promoted in relevant print media, with an emphasis on the amount of carbon stored in that building by using "NZWood".

8 Conclusions

8.1 Log Supply Chain

Log distribution and harvesting are the largest sources of carbon emissions in Nelson Forests log supply chain. Emission reduction initiatives should focus on distribution and harvesting. Training log truck drivers to become more aware of how their driving and environment effects fuel consumption is seen as a low cost measure to reduce emissions. Increasing the allowable gross vehicle mass of a log truck to 50 tonne to allow a maximum net payload of 34 tonne will result in a 3% reduction in log supply chain emissions. Improvements in the fuel consumption of current harvesting systems are limited by capital and operational constraints. However, optimising crew capacity and productivity to match market demand can reduce the intensity measure of log products.

8.2 Lumber Supply Chain

Thermal energy requirements are the largest source of emissions for kiln dried products at the Kaituna mill. However, at the Kaituna mill, and many of New Zealand's sawmills this energy is generated from the combustion of woody biomass, which is carbon neutral. Therefore, the emissions profile of the products produced at Kaituna is substantially reduced. When stored carbon in products is accounted for all the products produced at Kaituna are net stores of carbon, even when distribution emissions are included. This provides a very strong positioning statement for the products produced at the Kaituna mill, and wood products in general compared to steel, aluminium and concrete. Trans-coastal ocean freight or rail would be favourable over long road hauls (>250km) as the energy requirements and emissions could be substantially reduced.

The promotion of Nelson Forests lumber products through the establishment of a national carbon label or carbon brand specifically for New Zealand produced wood products through a formal association with the NZWood program is desirable. A nation brand is favoured over an individual or private brand to eliminate "green washing" and to provide a consistent message in both domestic and international markets of the carbon benefits of using "NZWood".

9 Recommendations

Based on the finding in this report several initiatives have been identified across both the log and lumber supply chains to measure and reduce the carbon footprint of Nelson Forests (Table 7). It is recommended that these initiatives are followed up and implemented where feasible.

Table 7: Recommended initiatives to improve the carbon footprint of Nelson Forests.

Priority	Supply Chain	Description	Cost	Benefit
1	Log and Lumber	Integrate the carbon calculator developed as part of normal business activities, ensuring the measurement and monitoring of Nelson Forests carbon footprint over time.	In kind time of person in charge of implementing and managing the tool.	Inform customers with latest information, track progress and provide quantifiable reduction improvements.
2	Lumber	Replace waste oil, with biomass as source of heat for drying saw dust.	Capital spend to implement alternative fuel drier will be needed.	Reduction in fuel costs. Reduce supply chain emissions by 10-13%
3	Log	Lobby for an increase in the allowable gross vehicle mass (GMV) of a log truck to at least 50 tonne.	In kind time to support lobby.	Potential cartage savings due to economies of scale. Reduce supply chain emissions by 2-3%
4	Log	Inform log truck drivers on impacts of driver behaviour and the environment on fuel consumption.	2-4 hour presentation (either in kind or external) plus possible driver stand down costs.	Reduction in fuel use which if significant Should be reflected in a reduction in cartage rates. Reduce supply chain emissions by 2-4%
5	Log	Inform harvesting crews on how operational constraints effect fuel consumption, and where and how fuel savings can be made in their operation.	2-4 hour presentation (either in kind or external) plus possible crew stand down costs.	Reduction in fuel use which if significant should be reflected in a reduction in harvesting rates. Reduce supply chain emissions by <2%
6	Log	Continue to support productivity improvements through mechanisation and higher utilisation rates.	Direct costs to Nelson Forests low. Significant capital spend needed by harvesting contractors	An increase in productivity should be reflected in a reduction in harvesting rates. Reduce supply chain emissions by <1%
7	Lumber	Lobby for the creation of a national carbon label or carbon brand specifically for New Zealand produced wood products.	In kind time to support lobby, if initiated brand management fees are likely.	Product awareness and market access should result possibly leading to stronger sales.
8	Lumber	Implement material energy audit recommendations related to kiln fans at the Kaituna sawmill where financially justified.	Refer to Kaituna energy audit.	Refer to Kaituna energy audit. Reduce supply chain emissions by <1%%
9	Lumber	Investigate trans-coastal shipping and rail as an alternative distribution network to Christchurch lumber markets.	Likely to be higher than current road transport.	Cost likely to reduce as capacity grows due to government initiatives to promote rail and trans coastal shipping. Reduce supply chain emissions by <1%

10 Lessons Learnt

10.1 Introduction

I and many others in the industry knew that forest products had strong carbon credentials as sustainably managed forests sequester carbon from the atmosphere, a benefit that could be transferred to the resulting products (PAS 2050:2008). However credible, robust information was needed to defend the position of forest products as a carbon friendly building material that is unrivalled by their competitors. Hence the carbon footprint project of Nelson Forests was born.

I entered this project with a vision and a goal. The vision was to enable the forest industry to map the carbon footprint of their products cost effectively. The goal was to calculate the carbon footprint of Nelson Forests log and lumber products. With this vision and goal I was faced with two issues, [1] what is the problem, and [2] what is the solution.

10.2 The Problem

The problem I was faced with at the start of this project was, how do you calculate a carbon footprint? I knew what a carbon footprint was, but I didn't know the process or methodology involved in calculating a carbon footprint. This problem was emphasised as carbon footprinting is still in its infancy, with few skilled professions resulting in limited knowledge transfer.

10.3 The Solution

The solution was research and networks. The timing of this project could not have been better for me to find a solution to the above problem for two reasons:

1. Access to emerging standards and,
2. access to networks and New Zealand's carbon footprinting community.

An emerging international standard on carbon footprinting (PAS 2050) was in a consultation phase during late 2007 and 2008. This enabled web access to the development of the leading international carbon footprinting standard. The first official release of the PAS 2050 was in late October 2008. As the development of this standard progressed through the consultation phase, I became familiar with and understood the reasoning for the development of the standard and its underlying methodology (LCA). Knowledge learnt through this process was applied when conducting the carbon footprint assessment of Nelson Forests.

New Zealand has a small community of LCA practitioners, the majority of whom reside in Crown Research Institutes (Scion, AgResearch and Landcare research). I was able to gain access to the small network and community through Nelson Forests involvement in MAF's GHG footprinting strategy for New Zealand's primary industry (Appendix 13.5). Early in the project I met with LCA practitioners who had conducted carbon footprint assessments on forest products in the past. This gave me reassurance in the methodology and created a foot in the door to valuable networks in the carbon footprint community. Further networks were created through Nelson Forests association with the GHG footprinting strategy. These networks have enabled Nelson Forests to showcase the carbon footprint work to the wider industry with confidence. Furthermore, I have been involved in New Zealand's commentary on the development of an ISO standard on carbon footprinting (ISO 14067-1), through Nelson Forests established association with the MAF project.

In summary the solution to the problem, how do you calculate a carbon footprint, was desk research and networking. While desk research proved difficult due to limited knowledge transfer in an emerging carbon footprinting field, access to networks was critical in the success of this project. Networks provided credibility, robustness, knowledge of different industry motivations, involvement in standards development and a peer review process.

10.4 Knowledge Transfer

To fulfil the vision, to enable the forest industry to map the carbon footprint of their products cost effectively, transfer of knowledge is essential. Knowledge transfer to the wider industry was not included in the scope of this project. However, work has been conducted throughout the duration of the project to lay the foundations for transferring knowledge gained in the project to the wider industry. Using knowledge gained and the tools developed carbon footprint assessments have been conducted for two of Nelson Forests domestic log customers. These assessments have been offered free of charge as a customer service and to test the tools developed. The learnings from these assessments were:

- Participants already capture the majority of the data required to conduct a carbon footprint assessment. This information relates to productivity and costs which are routinely tracked and reported.

- The data is easily transferred into the tools developed. Some customising of the tools was needed (1 day).
- Participants were supportive of the assessment and understood and valued the benefits it could bring.

The most efficient means of knowledge transfer would be using a web based collaboration tool. Where industry representatives can learn, manage their data, benchmark, correspond and suggest reduction improvements with others. Furthermore, data from participants in the supply chain can be linked to one another creating a self governed map of the supply chain, and resulting carbon footprint.

There has been preliminary support from both industry and government (MAF) in developing a framework or process to ensure this knowledge is transferred cost effectively. Work on knowledge transfer to the wider industry has been a dominant focus in the closing weeks of this project, with meetings and correspondence with industry and government have taken place to gain further support to enable the work conducted in the project to progress to an industry level.

11 References

Berg, S., and Lindholm, E. 2003 Energy use and environmental impacts of forest operations in Sweden. Journal of cleaner production. 13

Henningsen, R., F. 2000. Study of greenhouse gas emissions from ships. International maritime organization. Issue 2.

IPCC, 2006. Guidelines for National Greenhouse Gas Inventories. Chapter 4, Metal Industry Emissions.

ISO 14040:2006 Environmental management – life cycle assessment – principles and frame work

ISO 14044:2006 Environmental management – life cycle assessment – requirements and guidelines

ISO 14064-1:2006 greenhouse gases – part 1: specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals.

Lal, R. 2004: Carbon emissions from farm operations Environment International 30 (2004) 981– 990

Milota, M., West, C.D., and Hartley, I.D. 2005. Gate to gate life cycle inventory of softwood lumber production. Wood and fibre science. 37.

Ministry for the Environment. 2006. National greenhouse gas inventory data.

Ministry for the Environment. 2008. Voluntary greenhouse gas reporting guidelines for 2007.

PAS 2050:2008 Specification for the measurement of embodied greenhouse gas emissions in products and services. British Standards Institue.

Sonne, E. 2006. Greenhouse gas emission from forestry operations: A life cycle assessment. Journal of environmental quality. 35(4)

The Greenhouse Gas Protocol. Measure to Manage: A Guide to designing GHG Accounting and Reporting Programs. World Resources Institute.

The Greenhouse Gas Protocol. Designing a Customised Greenhouse Gas Calculation Tool. World Resources Institute.

Wood, S., and Cowie, A. 2004. A review of Greenhouse Gas Emission Factors for Fertiliser Production. Research and Development Division, State Forests of NSW. Cooperative Research Centre for Greenhouse Accounting. IEA Bioenergy Tas 38.

12 Glossary

Direct GHG Emissions:	Emissions from sources that are owned or controlled by the reporting company.
Indirect GHG Emissions:	Emissions that are a consequence of the activities of the reporting company, but that occur at sources owned or controlled by another company.
MDF	Medium density fibreboard.
OSB	Oriented strand board.
PAS:	Publicly Available Specification.
GHG:	Green House Gases (CO_2, CH_4, N_2O, HFC's, PFC's, SF_6).
Carbon Footprint:	A measure of the GHG emitted/sequestered measured in CO_2 equivalents (CO_2 eq) generated by a human activity, accumulated over the specified life cycle of the functional unit (product or service).

13 Appendix

13.1 PAS2050:2008 Assessing Stored Carbon

Calculation of the weighted average impact of carbon storage in products (normative)

Where carbon storage, or the uptake of atmospheric carbon, over the life cycle of the product occur within the 100-year assessment period, the impact of this storage or uptake emissions shall reflect the weighted average time of storage during the 100-year assessment period.

C.1.1 Specific case: biogenic carbon storage following product formation

Where the full carbon storage benefit of a product exists for between 2 and 25 years after the formation of the product (and no carbon storage benefit exists after that time), the weighting factor to be applied to the CO2 storage benefit over the 100-year assessment period shall be calculated according to:

$$\text{Weighting factor} = \frac{(0.76 \times t_o)}{100}$$

where

***to* =** the number of years the full carbon storage benefit of a product exists following the formation of the product.

C.1.2 General case: biogenic carbon storage or atmospheric carbon take-up

In cases not covered in **C.1.1**, the weighting factor to be applied to the CO2 storage benefit over the 100-year assessment period shall be calculated according to:

$$\text{Weighting factor} = \frac{\sum_{i=1}^{100} x_i}{100}$$

where

***i* =** each year in which storage occurs,

***x* =** the proportion of total storage remaining in any year i.

Note For example, if a product were to store biogenic carbon over a period of five years following formation of the product, and the amount of carbon stored were to then decrease evenly across the following five years, the weighting factor that represents the weighted average time of carbon storage in the product would be:

$$\frac{(1 + 1 + 1 + 1 + 1 + 0.8 + 0.6 + 0.4 + 0.2 + 0)}{100}$$
$$= 0.07$$

In this example, 100% of the carbon storage benefit occurs over the first five years; this then decreases 20% (0.2) per year over the next five years. Therefore, the total amount of biogenic carbon, expressed as CO2e, stored in the product would be multiplied by a factor of 0.07 to reflect the weighted average impact of biogenic carbon stored in this product over the 100-year assessment period.

13.2 Life Cycle Assessment

Life cycle assessment (LCA) is based on the concept of integrating consumption and production strategies over the whole lifecycle. LCA is an analytical tool for the systematic evaluation of the environmental impacts of a product or service through all stages of its life. It extends from extraction and processing of raw materials through to manufacture, delivery, and use, and finally on to waste management. This is often referred to as "cradle to grave". A number of other environmental assessment tools are restricted to the production process, which is sometimes called "gate to gate" or, in the case of embodied energy, cover the lifecycle, from "cradle to gate", without taking the end of life into account.

Definition of Life Cycle Assessment

ISO 14040 defines LCA as

"… a technique for assessing the environmental aspects and potential impacts associated with a product, by;

- compiling an inventory of relevant inputs and outputs of a product system;
- evaluating the potential environmental impacts associated with those inputs and outputs;
- interpreting the results of the inventory analysis and impact assessment phases in relation to the objectives of the study.

LCA studies quantify the environmental aspects and potential impacts throughout a product's life (i.e. 'cradle-to-grave') from raw material acquisition through production, use and disposal. The general categories of environmental impacts needing consideration include resource use, human health, and ecological consequences."

Elements of a Life Cycle Assessment

An internationally accepted framework for LCA methodology is defined in AS/NZS ISO 14040 and 14044. These standards define the generic steps which have to be taken when conducting an LCA.

Four different phases can be distinguished:

1. *Goal and Scope Definition:* The goal and scope of the LCA study are clearly defined in relation to the intended application.

2. *Inventory Analysis:* The inventory analysis involves the actual collection of data and the calculation procedures. The relevant inputs and outputs of the analysed product system are quantified and produced as a table.

3. *Impact Assessment:* The impact assessment translates the results of the inventory analysis into environmental impacts (e.g. global warming, ozone depletion). The aim of this phase is to evaluate the significance of potential environmental impacts.

4. *Interpretation:* In this phase conclusions and recommendations for decision-makers are drawn from the inventory analysis and the impact assessment.

These four phases are represented in Figure 1. In practice, LCA involves a series of iterations as its scope is redefined on the basis of insights gained throughout the study.

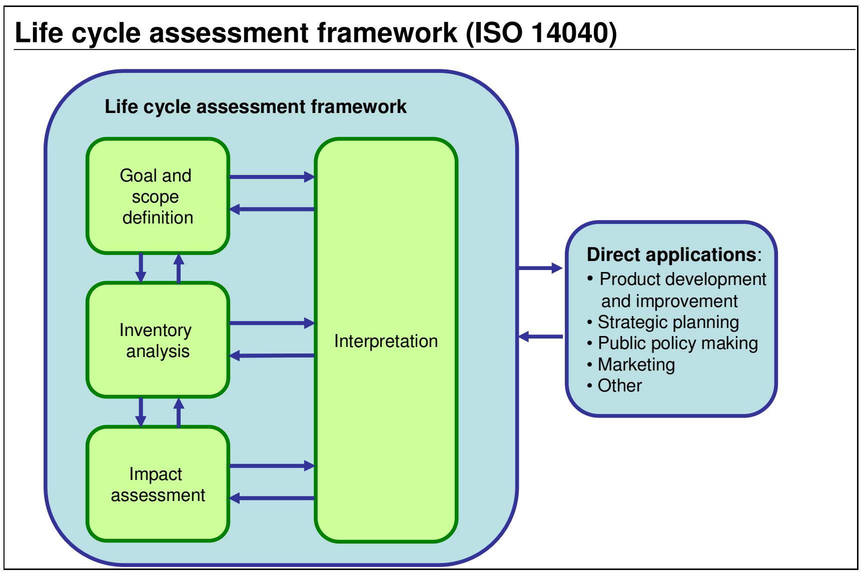

Figure 1: LCA framework (ISO 14040)

13.3 Forest Operations

Management Activities Parameters and Emission Factors

Activity	Parameters	Source	Emission Factor	Source	Emissions t CO2e	kg CO2e/m3
Staff Air Travel						
Domestic	54932 km	1	0.00028 t CO2e/km	A	15.7	0.011
International	250057 km		0.00021 t CO2e/km	A	52.3	0.038
Staff Vechicle Travel						
Diesel Utes	20 vechicles × 33,500 km/yr/vechicle × 0.1 L/km	2	0.00268 t CO2e/L	B	179.6	0.129
Diesel Fire Engines	4 vechicles × 6875 km/yr/vechicle × 0.20 L/km	2	0.00268 t CO2e/L	B	14.74	0.011
Waste						
Landfill Waste						
	Wood kg	3	0.00189 t CO2e/kg	B		
	Paper kg		0.00253 t CO2e/kg			
	Mixed Waste kg		0.00095 t CO2e/kg			
Electrical Energy						
	Electricity Consumption kWh	4	0.000165 t CO2e/kWh	B		
	Losses kWh		0.000014 t CO2e/kWh			

Forestry Operations Parameters and Emission Factors

Activity	Parameters		Source	Emission Factor	Source	Emissions t CO2e	kg CO2e/m3
Nursery	Diesel use L		5	0.00268 t CO2e/L	B		
	Petrol use L			0.00232 t CO2e/L	B		
	Herbicide use kg			0.00630 t CO2e/kg	C		
	Pesticide use kg			0.00510 t CO2e/kg	C		
	Fungacide use kg			0.00390 t CO2e/kg	C		
	Fertiliser kg			Dependant on fert application	D		
	Chiller size m3			Dependant on chiller size	B		
Mechanical Land Prep							
Machine Diesel	2,431.0 hr ×	21.7 L/hr	6	0.00268 t CO2e/L	B	141.2	0.102
Operator Transport	235.0 Days × 0.1 L/km	100.0 km ×		0.00268 t CO2e/L	B	6.3	0.005
Fertiliser Application							
Product							
Dothistroma (CuO)	286.0 ha ×	1.2 kg/ha	6	0.00390 t CO2e/kg	C	3.0	0.002
TSP	249.4 ha ×	290.0 kg/ha		0.00069 t CO2e/kg	C	49.9	0.036
DAP	213.4 ha ×	350.0 kg/ha		0.00108 t CO2e/kg	C	80.5	0.058
Boron	1,083.0 ha ×	40.0 kg/ha		0.00100 t CO2e/kg	?	43.3	0.031
Urea	0.0 ha ×	0.0 kg/ha					
Application							
Dothistroma (CuO)	286.0 ha ÷	54.0 ha/hr					
TSP	249.4 ha ÷	25.6 ha/hr					
DAP	213.4 ha ÷	21.2 ha/hr					
Boron	1,083.0 ha ÷	72.0 ha/hr					
Heli fuel use (Jet A1)	100.0 L/hr		7	0.002671 t CO2e/L	E	10.7	0.008
Herbicide Application							
Product							
Spot Spray	580.0 ha ×	2.0 kg/ha	6	0.00630 t CO2e/kg	C	122.3	0.088
Pre Plant	3,169.0 ha ×	4.9 kg/ha					
Broom & Gorse	418.6 ha ×	5.5 kg/ha					
Bracken	26.6 ha ×	3.0 kg/ha					
Fresh Cutover	14.0 ha ×	25.0 kg/ha					
Application							
Pre Plant	3,169.0 ha ÷	30.0 ha/hr					
Post Plant	459.2 ha ÷	20.0 ha/hr					
Heli fuel use (Jet A1)	100.0 L/hr		7	0.002671 t CO2e/L	E	34.3	0.025
Spot Spray	2.0 crews ×	29.0 Days ×	6	0.00268 t CO2e/L	B	1.6	0.001
Diesel Fuel use	100.0 km ×	0.1 L/km					

Activity	Parameters		Source	Emission Factor	Source	Emissions t CO2e	kg CO2e/m3
Silvicultural Activities							
Planting	8.0 crews ×	59.0 Days ×	6	0.00268 t CO2e/L	B	12.6	0.009
Diesel Fuel use	100.0 km ×	0.1 L/km					
Pruning	4.0 crews ×	168.0 Days ×	6	0.00268 t CO2e/L	B	18.0	0.013
Diesel Fuel use	100.0 km ×	0.1 L/km					
Thinning	3.0 crews ×	157.0 Days ×	6	0.00268 t CO2e/L	B	12.6	0.009
Diesel Fuel use	100.0 km ×	0.1 L/km					
Chainsaw Fuel use	5.0 saws/crew ×	157.0 Days ×	6,8	0.00294 t CO2e/L Oil	B		
	5.39 L/saw/day +	3.36 L Oil/saw/day				52.7	0.038
Other							
Inventory	4.0 crews ×	238.9 Days ×	6	0.00268 t CO2e/L	B	25.6	0.018
Diesel Fuel use	100.0 km ×	0.1 L/km					
Security Patrol	1.0 crews ×	54,750.0 km ×	6	0.00268 t CO2e/L	B	14.7	0.011
Diesel Fuel use	0.1 L/km						
Mowing	1.0 crews ×	567.0 hr ×	6	0.00268 t CO2e/L	B	18.2	0.013
	12.0 L/hr						
Road side spraying	1.0 crews ×	1,103.0 hr ×	6	0.00268 t CO2e/L	B	14.8	0.011
	5.0 L/hr						

Roading Operations Parameters and Emission Factors

Activity	Parameters					Source	Emission Factor		Source	Emissions t CO2e	kg CO2e/m3
Plant Hours											
Dozers	8,044	hr	×	47.2	L/hr	9	0.00268	t CO2e/L	B	3,129	2.86
Excavators	17,009	hr	×	26.5	L/hr						
Trucks	4,865	hr	×	35.9	L/hr						
Other	6,155	hr	×	26.5	L/hr						
Operator Transport											
Diesel ute	470,000	km	×	0.1	L/km	9	0.00268	t CO2e/kg	B	126	0.12
Petrol ute	0.0	km	×	0.1	L/km		0.00232	t CO2e/kg	B		
Machine Transport											
Total Spend	337,054	$				9	0.00268	t CO2e/L	B	133	0.12
Average cost	3.66	$/km									
Fuel Consumption	1.85	km/L									

Harvesting Operations Parameters and Emission Factors

Activity	Parameters				Source	Emission Factor		Source	Emissions t CO2e	kg CO2e/m3
Machine Transport										
Total Spend	339,957 $				9	0.00268	t CO2e/L	B	135	0.5
Average cost	3.66 $/km									
Fuel Consumption	1.85 km/L									
System										
Ground Based Mechanical			262,128 m3	24%	10					
Machine Diesel	246,431 L/year ×	2.95 crews		15%		0.00268	t CO2e/L	B	1,945	7.4
Machine Oil+Lube	15,054 L/year ×	2.95 crews				0.00294	t CO2e/L	B	130	0.5
Vehicle Diesel	11,925 L/year ×	2.95 crews				0.00268	t CO2e/L	B	94	0.4
Chainsaw Petrol	5,062 L/year ×	2.95 crews				0.00232	t CO2e/L	B	35	0.1
Chainsaw 2 Stroke	190 L/year ×	2.95 crews				0.00294	t CO2e/L	B	2	0.0
Chainsaw Bar Oil	2,095 L/year ×	2.95 crews				0.00294	t CO2e/L	B	18	0.1
									2,224	**8.5**
Ground Based Motor Manual			196,373 m3	18%	10					
Machine Diesel	83,041 L/year ×	4.66 crews		24%		0.00268	t CO2e/L	B	1,038	5.3
Machine Oil+Lube	5,073 L/year ×	4.66 crews				0.00294	t CO2e/L	B	70	0.4
Vehicle Diesel	8,745 L/year ×	4.66 crews				0.00268	t CO2e/L	B	109	0.6
Chainsaw Petrol	5,062 L/year ×	4.66 crews				0.00232	t CO2e/L	B	55	0.3
Chainsaw 2 Stroke	140 L/year ×	4.66 crews				0.00294	t CO2e/L	B	2	0.0
Chainsaw Bar Oil	2,095 L/year ×	4.66 crews				0.00294	t CO2e/L	B	29	0.1
									1,302	**6.6**
Hauler Mechanical			338,366 m3	31%	10					
Machine Diesel	169,528 L/year ×	6.09 crews		31%		0.00268	t CO2e/L	B	2,767	8.2
Machine Oil+Lube	10,356 L/year ×	6.09 crews				0.00294	t CO2e/L	B	185	0.5
Vehicle Diesel	11,925 L/year ×	6.09 crews				0.00268	t CO2e/L	B	195	0.6
Chainsaw Petrol	5,544 L/year ×	6.09 crews				0.00232	t CO2e/L	B	78	0.2
Chainsaw 2 Stroke	190 L/year ×	6.09 crews				0.00294	t CO2e/L	B	3	0.0
Chainsaw Bar Oil	2,295 L/year ×	6.09 crews				0.00294	t CO2e/L	B	41	0.1
									3,270	**9.7**
Hauler Motor Manual			297,063 m3	27%	10					
Machine Diesel	144,095 L/year ×	5.66 crews		29%		0.00268	t CO2e/L	B	2,184	7.4
Machine Oil+Lube	8,802 L/year ×	5.66 crews				0.00294	t CO2e/L	B	146	0.5
Vehicle Diesel	11,925 L/year ×	5.66 crews				0.00268	t CO2e/L	B	181	0.6
Chainsaw Petrol	7,424 L/year ×	5.66 crews				0.00232	t CO2e/L	B	97	0.3
Chainsaw 2 Stroke	190 L/year ×	5.66 crews				0.00294	t CO2e/L	B	3	0.0
Chainsaw Bar Oil	3,073 L/year ×	5.66 crews				0.00294	t CO2e/L	B	51	0.2
									2,663	**9.0**

Transport Operations Parameters and Emission Factors

Activity	Parameters	Source	Emission Factor	Source	Emissions t CO2e	kg CO2e/m3
Road						
Number of Loads	1,093,930 m3 Transported ÷ 27.8 m3/load	11				
	= 39,350 loads					
Lead distance	63.6 km					
Percentage Loaded	56 % Loaded					
Loaded Km	64 km ÷ 1.65 km/L +					
Unloaded Km	55 km ÷ 2.35 km/L					
	=62.38 L/Load					
Total L	39,350 Loads × 62.4 L/Load					
	=3,124,614 L		0.00268 t CO2e/L	B	6,579	6.0
Road Sensitivity						
Net payload 40m3						
Number of Loads	1,093,930 m3 Transported ÷ 34 m3/load					
	32,174					
Percentage Loaded	56 % Loaded					
Loaded Km	64 km ÷ 1.60 km/L +					
Unloaded Km	55 km ÷ 2.28 km/L					
	=71.1 L/Load					
Total L	32,174 Loads × 64.3 L/Load					
	=2,069364 L		0.00268 t CO2e/L	B	5,546	5.1
Ocean						
Fuel use	23,949 L/day × 16.7 Transit days	11	0.00320 t CO2e/L	F	17,946	46.4
	=399,953 L ÷ 27,545 m3/vessel					
	=14.52 L/m3					
Distance Travelled	10,021 km (Given 13.5 knots)					
Volume carried	386,730 m3					
Ocean Sensitivity						
50% empty back load						
Fuel use	23,949 L/day × 25.0 Transit days	11	0.00320 t CO2e/L	F	26,813	69.3
	=598,731 L ÷ 27,545 m3/vessel					
	=21.7 L/m3					
Distance Travelled	15,032 km (Given 13.5 knots)					
Volume carried	386,730 m3					

Parameter Source

Reference	Parameters
1	Orbit travel annual travel account.
2	Internal vehicle fleet details.
3	Information from cleaning contractor and waste disposal invoicing.
4	Information from energy invoicing.
5	Information from Nursery contractor.
6	Information from Forest operations staff within NFL.
7	Information from Heli contractor.
8	FORME hand book and consultation with Forest operations staff and contractors.
9	Information collected in consultation with Roading Engineer and Roading contractors.
10	Derived from contract harvesting rate data which included a detailed inventory of crew machines, machine use and fuel use rates.
11	Derived from consultation with transportation planner and cartage contractor.

Emission Factor Source

Reference	Emission Factors
A	Carbon Zero online calculator
B	Mfe 2007: Voluntary GHG reporting guidelines. Note does not include extraction and processing of the fuel
C	Lal 2004: Carbon emissions from farm operations
D	Wood and Cowie 2004: A review of Greenhouse gas emission factors for Fertiliser Production.
E	Mfe: 2006 national GHG inventory data.
F	Study of Greenhouse gas emissions from ships, 2000: Final report to the International maritime organization.

13.4 Processing

Product Emissions (kg CO_2e/m^3)

		Electrical Energy						Follil Energy			Thermal				Log	Chemicals, Consumables and Waste				**Total Kg CO2e/m3 SWE**	
Products	**m3**	Mill	Plainer	Kilns	Treatment	Other	Losses	Diesel	Waste Oil	Petrol	Boiler Fuel	Fuel Transport	Non CO2 emissions	Down Stream	Log	Packaging	Waste	Chemical	Saws	**Inc. Biomass**	**Excl. Biomass**
Bark	2,085.96	2.6	0.0	0.0	0.0	0.1	0.0	4.4	0.0	0.0	0.0	0.0	0.0	0.0	18.7	0.0	0.0	0.0	0.0	25.8	25.8
Saw Dust	5,562.56	2.6	0.0	0.0	0.0	0.1	0.0	4.4	0.0	0.0	0.0	0.0	0.0	0.0	18.7	0.0	0.0	0.0	0.0	25.9	25.9
Chip	20,164.28	2.6	0.0	0.0	0.0	0.1	0.0	4.4	0.0	0.0	0.0	0.0	0.0	0.0	18.7	0.0	0.0	0.0	0.0	25.9	25.9
Treated Shavings	208.60	2.6	1.3	7.0	0.6	0.1	0.0	4.4	17.9	0.3	255.6	1.4	3.3	5.7	18.7	0.0	0.4	6.7	0.0	322.6	70.4
Untreated Shavings	2,433.62	2.6	1.3	7.0	0.0	0.1	0.0	4.4	17.9	0.3	255.6	1.4	3.3	5.7	18.7	0.0	0.4	0.0	0.0	315.4	63.2
H4 KDx2 P 75	378.55	2.6	1.3	21.6	0.6	0.1	0.0	4.4	55.1	0.3	787.3	4.2	10.2	17.6	18.7	0.0	0.4	7.1	0.0	921.3	144.2
H3 KDx2 P 40	2.69	2.6	1.3	17.3	0.6	0.1	0.0	4.4	44.1	0.3	629.9	3.3	8.2	14.1	18.7	0.0	0.4	4.3	0.0	741.4	119.7
H4 KDx2 P 100	6,881.30	2.6	1.3	14.9	0.6	0.1	0.0	4.4	38.0	0.3	543.3	2.9	7.1	12.1	18.7	0.0	0.4	7.1	0.0	646.7	110.5
H4 KDx2 RS 100	8,895.00	2.6	0.0	14.9	0.6	0.1	0.0	4.4	38.0	0.3	543.3	2.9	7.1	12.1	18.7	0.0	0.4	7.1	0.0	645.4	109.2
H3 KDx2 P 50	1.73	2.6	1.3	12.4	0.6	0.1	0.0	4.4	31.7	0.3	452.7	2.4	5.9	10.1	18.7	0.0	0.4	4.3	0.0	542.1	95.2
H3 KDx2 P 38	1,041.39	2.6	1.3	10.4	0.6	0.1	0.0	4.4	26.5	0.3	377.9	2.0	4.9	8.4	18.7	0.0	0.4	4.3	0.0	457.9	84.9
H3 KDx2 P 25	15.39	2.6	1.3	7.6	0.6	0.1	0.0	4.4	19.3	0.3	275.6	1.5	3.6	6.1	18.7	0.0	0.4	4.3	0.0	342.8	70.8
H3 KDx2 RS 25	0.61	2.6	0.0	3.8	0.6	0.1	0.0	4.4	9.7	0.3	137.8	0.7	1.8	3.1	18.7	0.0	0.4	4.3	0.0	186.4	50.5
H4 WAT RS 75	543.84	2.6	0.0	10.8	0.6	0.1	0.0	4.4	27.6	0.3	393.7	2.1	5.1	8.8	18.7	0.0	0.4	7.1	0.0	477.1	88.6
UT KD RS 70	170.51	2.6	0.0	6.2	0.0	0.1	0.0	4.4	15.9	0.3	226.4	1.2	2.9	5.1	18.7	0.0	0.4	0.0	0.0	281.2	57.8
UT KD RS 75	57.76	2.6	0.0	10.8	0.0	0.1	0.0	4.4	27.6	0.3	393.7	2.1	5.1	8.8	18.7	0.0	0.4	0.0	0.0	469.5	80.9
H3 WAT P 40	482.88	2.6	1.3	8.6	0.6	0.1	0.0	4.4	22.1	0.3	314.9	1.7	4.1	7.0	18.7	0.0	0.4	4.3	0.0	387.0	76.2
H4 WAT P 40	107.85	2.6	1.3	8.6	0.6	0.1	0.0	4.4	22.1	0.3	314.9	1.7	4.1	7.0	18.7	0.0	0.4	7.1	0.0	389.8	79.0
UT KD P 40	143.86	2.6	1.3	8.6	0.0	0.1	0.0	4.4	22.1	0.3	314.9	1.7	4.1	7.0	18.7	0.0	0.4	0.0	0.0	382.2	71.4
UT KD RS 40	16.63	2.6	0.0	8.6	0.0	0.1	0.0	4.4	22.1	0.3	314.9	1.7	4.1	7.0	18.7	0.0	0.4	0.0	0.0	380.9	70.1
H4 WAT P 100	2.11	2.6	1.3	7.4	0.6	0.1	0.0	4.4	19.0	0.3	271.6	1.4	3.5	6.1	18.7	0.0	0.4	7.1	0.0	341.1	73.0
UT KD P 100	637.97	2.6	1.3	7.4	0.0	0.1	0.0	4.4	19.0	0.3	271.6	1.4	3.5	6.1	18.7	0.0	0.4	0.0	0.0	333.5	65.4
H3 WAT P 50	15.88	2.6	1.3	6.2	0.6	0.1	0.0	4.4	15.9	0.3	226.4	1.2	2.9	5.1	18.7	0.0	0.4	4.3	0.0	287.4	64.0
H4 WAT P 50	1.58	2.6	1.3	6.2	0.6	0.1	0.0	4.4	15.9	0.3	226.4	1.2	2.9	5.1	18.7	0.0	0.4	7.1	0.0	290.2	66.8
H4 WAT RS 100	74.03	2.6	0.0	7.4	0.6	0.1	0.0	4.4	19.0	0.3	271.6	1.4	3.5	6.1	18.7	0.0	0.4	7.1	0.0	339.8	71.7
UT KD P 50	269.30	2.6	1.3	6.2	0.0	0.1	0.0	4.4	15.9	0.3	226.4	1.2	2.9	5.1	18.7	0.0	0.4	0.0	0.0	282.5	59.1
H3 WAT P 38	12.14	2.6	1.3	5.2	0.6	0.1	0.0	4.4	13.2	0.3	189.0	1.0	2.5	4.2	18.7	0.0	0.4	4.3	0.0	245.3	58.8
H3 WAT RS 50	103.59	2.6	0.0	6.2	0.6	0.1	0.0	4.4	15.9	0.3	226.4	1.2	2.9	5.1	18.7	0.0	0.4	4.3	0.0	286.1	62.7
H4 WAT RS 50	1,971.16	2.6	0.0	6.2	0.6	0.1	0.0	4.4	15.9	0.3	226.4	1.2	2.9	5.1	18.7	0.0	0.4	7.1	0.0	288.9	65.5
UT KD P 32	937.09	2.6	1.3	3.8	0.0	0.1	0.0	4.4	9.7	0.3	137.8	0.7	1.8	3.1	18.7	0.0	0.4	0.0	0.0	182.9	46.9
UT KD P 38	0.82	2.6	1.3	5.2	0.0	0.1	0.0	4.4	13.2	0.3	189.0	1.0	2.5	4.2	18.7	0.0	0.4	0.0	0.0	240.5	54.0
H3 WAT RS 38	6.82	2.6	0.0	5.2	0.6	0.1	0.0	4.4	13.2	0.3	189.0	1.0	2.5	4.2	18.7	0.0	0.4	4.3	0.0	244.0	57.5
UT KD RS 50	1,284.61	2.6	0.0	6.2	0.0	0.1	0.0	4.4	15.9	0.3	226.4	1.2	2.9	5.1	18.7	0.0	0.4	0.0	0.0	281.2	57.8
H3 WAT P 25	22.00	2.6	1.3	3.8	0.6	0.1	0.0	4.4	9.7	0.3	137.8	0.7	1.8	3.1	18.7	0.0	0.4	4.3	0.0	187.7	51.7
UT KD P 25	4,618.32	2.6	1.3	3.8	0.0	0.1	0.0	4.4	9.7	0.3	137.8	0.7	1.8	3.1	18.7	0.0	0.4	0.0	0.0	182.9	46.9
UT KD RS 32	2,996.35	2.6	0.0	3.8	0.0	0.1	0.0	4.4	9.7	0.3	137.8	0.7	1.8	3.1	18.7	0.0	0.4	0.0	0.0	181.6	45.6
UT KD RS 38	409.70	2.6	0.0	5.2	0.0	0.1	0.0	4.4	13.2	0.3	189.0	1.0	2.5	4.2	18.7	0.0	0.4	0.0	0.0	239.2	52.7
H3 WAT RS 25	256.85	2.6	0.0	3.8	0.6	0.1	0.0	4.4	9.7	0.3	137.8	0.7	1.8	3.1	18.7	0.0	0.4	4.3	0.0	186.4	50.5
H4 WAT RS 25	102.17	2.6	0.0	3.8	0.6	0.1	0.0	4.4	9.7	0.3	137.8	0.7	1.8	3.1	18.7	0.0	0.4	7.1	0.0	189.2	53.3
UT KD RS 25	4,007.87	2.6	0.0	3.8	0.0	0.1	0.0	4.4	9.7	0.3	137.8	0.7	1.8	3.1	18.7	0.0	0.4	0.0	0.0	181.6	45.6
UT G RS 25	290.84	2.6	0.0	0.0	0.0	0.1	0.0	4.4	0.0	0.3	0.0	0.0	0.0	0.0	0.0	18.7	0.0	0.4	0.0	0.0	26.6
UT G RS 50	49.32	2.6	0.0	0.0	0.0	0.1	0.0	4.4	0.0	0.3	0.0	0.0	0.0	0.0	0.0	18.7	0.0	0.4	0.0	0.0	26.6
UT G RS 67	951.78	2.6	0.0	0.0	0.0	0.1	0.0	4.4	0.0	0.3	0.0	0.0	0.0	0.0	0.0	18.7	0.0	0.4	0.0	0.0	26.6
UT G RS 75	1,044.36	2.6	0.0	0.0	0.0	0.1	0.0	4.4	0.0	0.3	0.0	0.0	0.0	0.0	0.0	18.7	0.0	0.4	0.0	0.0	26.6

Energy Use Parameters and Emissions Factors

Activity	Parameters			Source	Emission Factor	Source	Emissions t CO2e	kg CO2e/m3
Electrical Energy Use	Total	3,574,616	kWh	1	0.00017 t CO2*e* /kWh	A		
	Sawmill	31%					183	
	Plainer	4%					24	
	Kilns	62%					366	
	Treatment	2%					12	
	Other	1%					6	
	Transmission Losses	1%			0.00001 t CO2*e* /kWh	A	1	
Fossil Fuels	Diesel (mobile plant)	114,519	L	1	0.00268 t CO2*e* /L	A	307	
	Waste Oil	312,479	L	1	0.00299 t CO2*e* /L	A	934	
	Petrol	5,024		1	0.00232 t CO2*e* /L	A	12	
Biomass Energy (thermal)	Imported	9,045,767	kWh	1	0.00038 t CO2*e* /kWh	B	3,394	
	Embodied Emissions							
	Fuel Preparation*			2	0.00902 kg CO2*e* /kWh	D	82	
	Fuel Transport**			2	0.00291 kg CO2*e* /kWh	D	26	
	Internal	26,508,801	kWh	1	0.00038 t CO2*e* /kWh	B	9,946	
	Embodied Emissions							
	Fuel Preparation*			2	0.00902 kg CO2*e* /m3	D	239	

* Fuel preparation includes all the emissions associated with the creation and preparation of bio mass boiler fuel (mix of dry shavings and wet saw dust).
** Emissions associated with the delivery of imported biomass boiler fuel.

Chemicals, Waste and Consumables Parameters and Emission Factors.

Activity	Parameters				Source	Emission Factor	Source	Emissions t CO2e	kg CO2e/m3
Chemicals		m3	L/m3	L					
	H3	1,962	4	8,436	3	0.001 t CO2/L		143	
	H4	18,958	7	134,599	3				
Waste									
Untreated Land Fill		2,536 m3			4				
	Wood	10%	600 kg/m3			0.00100 t CO2/kg			
	Paper and Textiles	7%	250 kg/m3			0.00100 t CO2/kg			
	General	40%	150 kg/m3			0.00100 t CO2/kg			
Treated Land Fill		837 m3			4				
	Treated Wood	98%	600 kg/m3			0.00100 t CO2/kg			
	Treated Sluge	2%	1,000 kg/m3			0.00100 t CO2/kg			
Consumables									
Packaging	Plastic Wrap	14,400 kg			5				
	Strapping	31,500 kg							
	Spray Paint fluoro	4 box							
	Staples	144 box							
	Staples	40 box							
	Plastic Corners	137 box							
	Marker Pens	64 box							
	Chalk	130 box							
	Pack Tags	39 roll							
	Packing Tape	27 box							
		Quantity	Mass (kg)						
Saws	Headrig Bandsaw	24	53.7		6	0.00106 t CO2/kg steel	E	1	
	Edger circular	64	4.5			0.00106 t CO2/kg steel	E	0	
	Band Resaw's	34	30.0			0.00106 t CO2/kg steel	E	1	
	Chipper Knives	32	2.5			0.00106 t CO2/kg steel	E	0	
	Serrated Back Knives	78	0.8			0.00106 t CO2/kg steel	E	0	

Distribution Emission Parameters and Emissions Factors

Activity		Parameters										Source	Emission Factor	Source	Emissions t CO2e	kg CO2e/m3
Road			m3	m3/load	% NFL/trip	% Laden	% loaded km	number of carts	km/trip	km/L Loaded	km/L Empty	7				
	Domestic	Blenheim	1,043	20	100%	100%	80%	52	10	1.85	2.31		0.00268 t CO2/L	A	1.7	1.7
		Pick up	3,097	21	100%	100%	80%	147	10	1.85	2.31		0.00268 t CO2/L		4.9	10.3
		Nelson	383	25	70%	100%	80%	15	110	1.85	2.31		0.00268 t CO2/L		4.0	10.1
		Kaikoura	70	30	70%	100%	80%	2	129	1.85	2.31		0.00268 t CO2/L		0.7	24.1
		Christchurch	6,891	30	70%	100%	80%	230	308	1.85	2.31		0.00268 t CO2/L		165.9	30.8
		Ashburton	595	30	70%	100%	80%	20	394	1.85	2.31		0.00268 t CO2/L		18.3	69.3
		Invercargil	18	30	70%	100%	80%	1	887	1.85	2.31					
			m3	m3/load	% NFL/trip	% Laden	% loaded km	number of carts	km/trip	km/L Loaded	km/L Empty	7				
	Export	Australia	18,050	40	100%	100%	80%	451	110	1.85	2.31		0.00268 t CO2/L		166	9.2
		Asia	1,135	40	100%	100%	80%	28	110	1.85	2.31		0.00268 t CO2/L		10	9.2
		Spain	1,487	40	100%	100%	80%	37	110	1.85	2.31		0.00268 t CO2/L		14	9.2
		USA	5,999	40	100%	100%	80%	150	234	1.85	2.31		0.00268 t CO2/L		118	19.6
		Ex Christchurch	41%	40	100%	100%	80%	0	110	1.85	2.31		0.00268 t CO2/L		0	9.2
		Ex Nelson/Picton	59%	40	100%	100%	80%	0	320	1.85	2.31		0.00268 t CO2/L		0	26.8
Ocean			Vessels	days/trip	Vessel capacity (TEU)	% Loaded	L Fuel/Day									
		Australia	30	3	1,200	75%	42,000					8	0.00320 t CO2/t Fuel	F	202	11.2
		Asia	9	20	4,010	75%	140,350						0.00320 t CO2/t Fuel	F	85	74.6
		Spain	10	30	1,200	75%	42,000						0.00320 t CO2/t Fuel	F	166	111.8
		USA	29	20	2,200	75%	77,000						0.00320 t CO2/t Fuel	F	447	74.6

Parameter Source

Reference	Parameters
1	Nelson Forests Kaituna mill energy use monitoring data.
2	Derivative from NFL carbon footprint analysis, see product emissions matrix.
3	Treatment plant supervision, Kaituna sawmill
4	Operations manager, financial records and waste disposal contractor, Kaituna sawmill.
5	Adam? Despatch
6	Saw doctor, Kaituna sawmill.
7	Sales and dispatch co-coordinator Kaituna sawmill.
8	Sales, dispatch co-coordinator and shipping merchant for Kaituna sawmill.

Emission Factor Source

Reference	Emission Factors
A	Mfe 2007: Voluntary GHG reporting guidelines. Note does not include extraction and processing of the fuel
B	Mfe: 2006 national GHG inventory data.
D	Derivative from NFL carbon footprint analysis.
E	IPCC global average
F	Study of Greenhouse gas emissions from ships, 2000: Final report to the International maritime organization.

13.5 Greenhouse Gas (GHG) Footprinting Strategy

July 2008

http://www.maf.govt.nz/climatechange/slm/ghg-strategy/

Description

The New Zealand Greenhouse Gas (GHG) Footprinting Strategy for the Land-Based Primary Sectors was an initiative developed in partnership with the primary sector at the end of 2007.

The strategy seeks to position New Zealand's land-based primary sectors to respond to significant and increasing pressure by key export markets for information on the GHG-intensity for primary products.

It also responds to a growing need in New Zealand for:

- more proactive involvement in international efforts determining international 'rules' for measuring GHG embodied in a product and in any subsequent labelling regimes;
- a means by which primary producers can measure and validate their GHG footprints;
- addressing gaps in current research and information on GHG emissions;
- identifying weaknesses and threats regarding New Zealand's GHG product and production profiles; and
- capitalising on business opportunities for low carbon-intensity products.

Background

Changes in consumer and retailer demands in some markets are driving substantial changes in the value chains that New Zealand's primary industries participate in. There is an increasing expectation that products have sustainability credentials, and that these can be verified.

Over the last 18 months there has been growing international interest in GHG footprinting of products and services. Governments are also becoming increasingly involved, for example, the UK Government's work on developing a standardised methodology for measuring embodied GHGs in products and services. The International Standards organisation has also recently announced its intention to develop an international standard for GHG footprinting as well as the World Resources Institute who developed the GHG Protocol – the most widely used standard for corporate accounting of GHG emissions.

GHG footprinting (also referred to as carbon footprinting)

GHG footprinting uses a life-cycle analysis approach to determine the total emissions of greenhouse gases (in carbon equivalents) across the entire life-cycle of a product or service. It is a more valid comparison then just food miles (or distance travelled) because it includes all the inputs and outputs of GHGs in the production, supply, use and disposal of a product.

Goal and outcomes of the NZ Strategy for the Land-Based Primary Sectors

The goal for the New Zealand GHG Footprinting Strategy for the Land-Based Primary Sectors is:

> *New Zealand primary industries can operate in markets with credibility and where necessary use internationally recognised, transparent and validated GHG footprinting methodologies ('rules').*

There are three overall outcomes for the strategy:

- international rules to verify GHG footprinting are fair and transparent;
- rules are applied fairly and without discrimination internationally; and
- New Zealand primary producers participate in GHG measurement and enhance their GHG performance.
-

Six additional intermediate outcomes support these:

- methodologies for GHG footprinting of New Zealand primary products are developed;
- companies can access information and tools to improve GHG product performance;
- New Zealand producers can do the calculations, or have them done by a third party at reasonable cost;
- transaction costs for multiple requirements are minimised;
- New Zealand engages effectively in the development of international standards; and
- a process exists for the robust verification of compliance with standards.

Potential benefits of GHG footprinting

- Developing a broader understanding of the environmental impacts, risks and liabilities associated with a product, process or service;
- identifying key areas for product and process improvements;
- developing indicators for the potential environmental impacts of a product or service;
- identifying potential efficiency gains;
- reducing GHG emissions and demonstrating commitment to tackling climate change;
- maintaining and/or enhancing market access; and
- improving relationships with suppliers and customers.

Initiatives

The Strategy includes work in two main areas:

International engagement

International engagement will be aimed at positioning New Zealand at the forefront of international work around GHG footprinting of primary products by:

- ensuring that New Zealand is an influential leader in developing robust, transparent and pragmatic GHG footprinting methodologies for primary products;
- contributing world-class analysis and research input into the development of overarching international standards for GHG footprinting;
- telling a wider story around New Zealand's desire to reduce GHG emissions and backing this up with case studies that demonstrate robust practices of measuring, managing and mitigating GHG emissions across the primary sector supply chain; and
- advocating for collaboration across countries and markets to ensure consistent and fair approaches are taken on GHG footprinting issues.

Sector-led initiatives to establish GHG footprints for primary sector supply chains

The development of sector-specific approaches ('sector methodologies') to GHG footprinting are activities that work with primary sector 'early adopters' to develop comprehensive methodologies for measuring GHG emissions across the supply chain of a primary product.

The methodology developed for a specific industry (e.g. kiwifruit) can then be used to leverage learning to the wider sector (e.g. horticulture). This approach aims to facilitate sectors to measure, manage and (if desired) mitigate GHG emissions across the supply chain.

The successful projects for the 2007/08 funding round were: Dairy, Lamb, Kiwifruit, Wine, Forestry, Onions and Berryfruit.

Sector	Project leader	Other project members
Berry-fruit	Landcare Research	TBC
Dairy	Fonterra	AgResearch, University of New South Wales, Scion
Forestry	Scion	Landcare Research, Wood Processors Association; Nelson Forests, Tenon, Laminex, Earnslaw Bioenergy
Kiwifruit	Landcare Research	Zespri, HortResearch, AgriLink NZ Ltd, Massey University
Lamb	AgResearch	Meat Industry Association, Balance AgriNutrients, Landcorp, Meat & Wool New Zealand, Institute of Environmental Science and Research Limited
Onions	AgriLink	TBC

Wine	Landcare Research	New Zealand Winegrowers, HortResearch

The following criteria apply to all projects:

- any methodology developed has to be a practical and feasible option for New Zealand producers to use to calculate a GHG footprint for primary products;
- the development of a methodology must be industry/sector led in conjunction with research providers. Industry must contribute financially to the development of the methodology;
- any methodology must be aligned with ISO GHG emissions inventory and reporting standards and New Zealand's national GHG emission inventory and be consistent with international best-practice;
- the Crown owns intellectual property, copyright or merchandising rights in or arising from such work. The methodology developed will be freely available to New Zealand primary industries; and
- options and guidance for GHG footprinting must be developed for the sector, including industry strategies for uptake, promotion and leveraging of learning to the wider primary sector.

International Standards

Three of the most influential processes currently underway in the development of international standards for the GHG footprinting of products and services are:

- UK DEFRA/British Standards/Carbon Trust draft standard (PAS 2050);
- an International Standards Organisation (ISO) proposal to develop an international standard for GHG footprinting and communication; and
- a World Resources Institute (WRI) proposal to establish an international standard for product accounting of GHG emissions.

Publicly Available Specification on GHG Footprinting for Products and Services (PAS 2050)

In April 2008, MAF coordinated a New Zealand primary sector view on the second draft of the Publicly Available Specification on GHG Footprinting for Products and Services (PAS 2050) being developed by British Standards, DEFRA and the Carbon Trust.

Update

- There will be no more formal consultation on the draft standard. The final version will be released in October 2008. for more information on this please see:

http://www.bsi-global.com/en/Standards-and-Publications/How-we-can-help-you/Professional-Standards-Service/PAS-2050/Executive-Overview/

- The Carbon Trust is developing two independent standards directly related to the PAS 2050, which will specify the requirements for making credible claims (and labels) regarding reduction commitments and achievements when using the PAS 2050. For more information on this please see: http://www.carbontrust.co.uk/carbon/briefing/developing_the_standard.htm

International Standards Organisation (ISO)

Earlier this year, ISO announced its intention to develop an international standard on GHG footprinting of products and services and an accompanying communication standard.

New Zealand secured an opportunity to present to the relevant ISO Committee on the lessons learnt under the GHG Footprinting Strategy. MAF sent one official and funded a Standards New Zealand representative to attend the most recent meeting, in Bogota, Colombia in June 2008.

Officials are currently evaluating options for future engagement in this forum. Information on this work will be posted shortly.

World Resources Institute (WRI)

The other main international standard-maker in GHG footprinting, the World Resources Institute (WRI) has also recently announced its intention to develop a product level GHG footprint standard. The WRI (and the World Business Council for Sustainable Development) developed the Greenhouse Gas Protocol (GHG Protocol) which is the most widely used international accounting tool to measure and manage greenhouse gas emissions at firm level. It is therefore likely that a WRI standard for product accounting would have widespread international uptake.

Officials are monitoring this development carefully. For more information see: http://www.ghgprotocol.org/standards/product-and-supply-chain-standard

Government investment

Initiative	2007/08 $million	2008/09 $million	2009/10 $million	2010/11 $million	2011/12 $million	Total to 2012 $million	From 2013 annually $million
Greenhouse-Gas Footprinting Strategy	1.469	1.250	1.250	1.100	1.200	5.869	1.150

Links to other government initiatives

The programme is linked to other initiatives, including:

- initiatives within the Sustainable Land Management and Climate Change Plan of Action;
- the Government's Eco-verification Initiative, one of six sustainability initiatives;
- the Government's ongoing response to "food miles" and sustainable exporting issues.

New Zealand Workshop on GHG Footprinting for the Primary Sectors

MAF
Pastoral House
25 The Terrace
PO Box 2526, Wellington
Tel: 0800 CLIMATE (254 628)