Fair Cape

PAS2050: Product Carbon Footprint Assessment Report

Bottled Eco-Fresh™ Milk (500ml, 1-Litre, 2-Litre)

Updated on 20 January 2012

FAIR CAPE
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This report was developed by

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Executive Summary

Overview

Fair Cape commissioned Global Carbon Exchange to assess the greenhouse gas (GHG) emissions associated with its bottled Eco-Fresh™ Milk (three sizes). The assessment was undertaken in accordance with PAS2050 (BSI, Carbon Trust and DEFRA, 2008), and followed the business-to-business approach (i.e. not taking into account the emissions associated with consumer use and milk bottle disposal).

Objectives

Fair Cape set out the following key objectives for undertaking this product carbon footprint assessment:

- To understand the emissions embedded within the company's products;
- To be able to accurately offset the emissions associated with the specified bottles of milk with a waste-to-energy project at the Welgegund farm;
- To be in-line with the current company vision of environmental leadership.

Findings

The embedded cradle-to-gate emissions associated with the three sizes of bottled Eco-Fresh™ Milk produced are shown in the figure and table below.

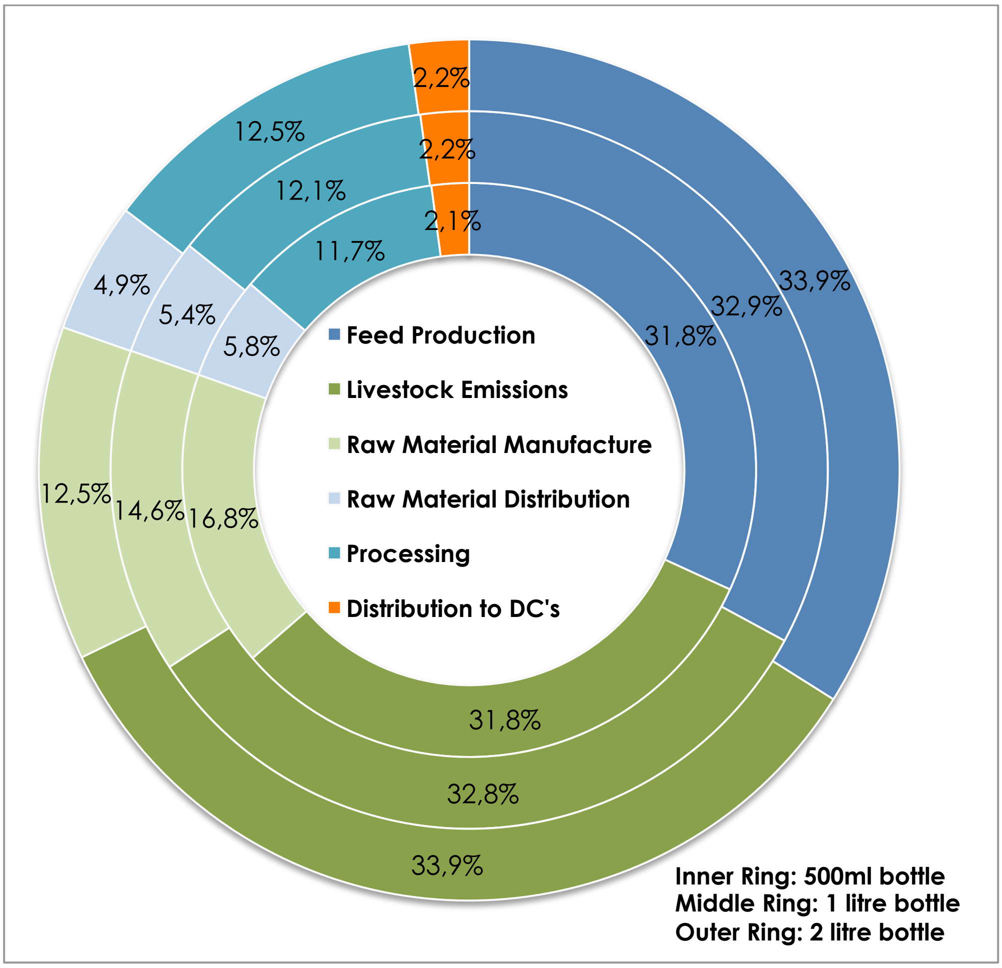

Figure 1: Comparison of emissions profile by source for the three sizes of bottled Eco-Fresh™ Milk produced by Fair Cape.

Emissions per litre	500ml	1 litre	2 litre	Average
Full Cream	1360	1316	1276	1317
Low Fat	1252	1211	1174	1212
Fat Free	NA	1066	1034	1050

Table 1: GHG Emissions, in grams of CO_2e per litre, for the three sizes and three types of bottled Fair Cape Eco-Fresh™ Milk

	500 ml Bottle		1 Litre bottle		2 Litre Bottle	
	CO_2e (grams)	%	CO2e (grams)	%	CO2e (grams)	%
Feed Production	216.4	32%	432.9	33%	865.8	34%
Livestock Emissions	216.1	32%	432.2	33%	864.5	34%
Raw Material Manufacture	114.0	17%	192.7	15%	320.0	13%
Raw Material Distribution	39.6	6%	70.5	5%	125.4	5%
Processing	79.4	12%	158.9	12%	317.8	12%
Distribution to DC's	14.3	2%	28.7	2%	57.3	2%
Total	**679.9**	**100%**	**1 315.8**	**100.0%**	**2 550.7**	**100.0%**

Table 2: GHG emissions, in grams of CO_2e, for the 3 sizes of bottled Full Cream Eco-Fresh™ Milk produced by Fair Cape.

* Includes truck refrigeration

Benchmarking

Fair Cape bottled Eco-Fresh™ Milk has a relatively lower embedded emissions profile per litre of milk than other milk products from around the world, as indicated in the table below. It should be noted that for Fair Cape the production processes are the same for fat free, low fat and full cream milk and therefore the same result applies to all three milk-types.

		CO_2e / litre milk (grams)	Comment
New Zealand Study*	NZ-conventional	1056	• *All data normalized to represent 1 litre. (Original study was on1 kg milk)* • *All data normalized to represent business-to-business approach; (Original data represented only farm emissions –feed and livestock- and was taken as 66% of total.*
	Sweden-conventional	1618	
	Sweden-organic	1397	
	German-conventional Intensive	1912	
	German-conventional Extensive	1471	
	German-organic	1912	
TESCO**	Skimmed milk	1198	*Results normalized to exclude consumer use and disposal.*
	Semi-skimmed milk	1327	
	Whole milk	1551	
Piacere Laggero (Italy)***		1473	*Results normalized to exclude consumer use and disposal.*
Average: All other Milk		**1492**	*Corrected to represent business-to-business approach.*
Fair Cape (Full Cream – 1 litre bottle)		**1316**	

Table 3: GHG Emissions, in grams, per litre of milk produced, by various producers.

Note: *Basset-Mens C et al. 2006.

**TESCO, 2009

***The International EPD System (2010), Granarolo.

Limitations

Fair Cape acknowledges that there are some limitations to this study due to the limited availability of reliable secondary data sources in the South African context, most notably for feed production data. Fair Cape intends to update these results, and to increase the accuracy and credibility of these findings in future publications.

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Glossary

BSI	British Standards Institute
CH_4	Methane
CO_2e	Carbon dioxide equivalent
gCO_2e	Grams carbon dioxide equivalent
DEFRA	Department of Environment. Food and Rural Affairs (UK)
EF	Emission Factor
EG	Ethylene Glycol
EPD	Environmental Product Declaration
FC	Fair Cape
GCX	Global Carbon Exchange
GHG	Greenhouse gases
GWP	Global Warming Potential
HDPE	High Density Polyethylene
IPCC	Intergovernmental Panel on Climate Change
Kg	Kilogram
kL	Kilolitre
kW	kilowatt
kWh	Kilowatt hour
LCA	Life Cycle Assessment / Analysis
LDPE	Low Density Polyethylene
MJ	Megajoule
N	Nitrogen
N_2O	Nitrous Oxide
PAS2050	Publicly Available Specification no 2050
PCR	Product Category Rule
PET	Polyethylene Terephthalate
PTA	Terephthalic Acid
Tonnes	Metric tonnes
UNFCCC	United Nations Framework Convention on Climate Change
VS	Volatile Solid
W	Watts

1. Introduction and Overview

1.1 Introduction

This report presents information about the assessment of the embodied energy and greenhouse gas (GHG) emissions relating to the manufacture and transportation of the three different sizes and three different types of bottled Eco-FreshTM Milk produced at Fair Cape.

This report conforms to the requirements for public disclosure of the life cycle GHG emissions of products laid out in the 'Code of Good Practice for product GHG emissions and reductions' produced by the Carbon Trust in the UK. It aims to provide the basis to publish consistent information for product GHG emissions, and their reduction, assessed in conformity with PAS2050, the Publicly Available Specification for a method for measuring the embodied GHG emissions of products and services jointly developed by the BSI, the Carbon Trust and DEFRA as published in 2008.

1.2 Background

Fair Cape commissioned Global Carbon Exchange (GCX) to undertake an assessment of the greenhouse gases associated with the production of their Eco-FreshTM Milk products. Fair Cape produces three different types of Eco-FreshTM Milk at its dairy facility in Kuiperskraal – Fat Free, Low Fat and Full Cream milk. Each of these is produced in 500 ml, 1 litre or 2 litre bottles.

Fair Cape is concurrently investigating a waste-to-energy facility at its Welgegund Dairy Parlour, and the Company intends to use the emission reductions from this project to offset the embedded emissions associated with the production of its free-range line of milk.

1.3 Objectives

Fair Cape set out the following key objectives for undertaking this product carbon footprint assessment:

- To understand the emissions embedded within the company's products;
- To be able to accurately offset the emissions associated with the specified bottles of milk with a waste-to-energy project at the Welgegund farm;
- To be in-line with the current company vision of environmental leadership.

1.4 Methodology

The method used to compile the data for this report followed the 4 basic steps as laid down in PAS2050:

- Build a Process Map
- Check Boundaries and Prioritisation
- Data Collection

- Footprint Calculation

The process map and boundaries conformed with the Product Category Rules (PCR) for the assessment of the life-cycle environmental performance of "Processed liquid milk" as well as for the declaration of such performance by an Environmental Product Declaration (UN CPC 2211).

In accordance with PAS2050:

- The Cradle to Gate approach was used inclusive of all emissions associated up to the point of the bottle arriving at the Fair Cape Distribution Centres. This excludes emissions associated with external distribution to retailers, retail, consumer use and disposal of the milk bottles.
- Primary data was used for all Fair Cape-owned activity wherever possible.
- Primary data was used for all areas in the value chain where data was readily available, and emissions from such sources were material.
- CH_4 and N_2O emissions associated with livestock were calculated using a Tier 2 methodology as set out in the IPCC Guidelines for National Greenhouse Gas Inventories (Volume 4, Chapter 10, 2006).
- The proportion of farm and feed emissions were allocated at 96% towards the dairy cows, with the remaining emission associated with cows to slaughter, as advised by Fair Cape personnel.
- Feed production emissions for Fair Cape controlled feed growing process (oat and wheat) were calculated using the Cool Farm Tool V1.1, developed by the University of Aberdeen and commissioned by Unilever Plc.
- Emissions associated with water and wastewater (containing low concentrations of milk from losses) were excluded.
- All transportation emissions included the return trips.
- Land use change emissions were omitted from all Fair Cape owned farms, as these have been operational or over 20 years.
- Secondary data was used in areas where primary data was not readily available, and where such emissions represented less than 10% of total emissions of the product.
- Secondary data was consulted for feed emission calculations where these emissions did represent more than 10% of the product emissions.
- Some of the secondary data, from foreign studies used to determine data averages for feed production not occurring on Fair Cape owned farms, do include land use change emissions. These additional emission inclusions err on the conservative side, and may result in an overestimation of feed-based emissions.
- Secondary emission factors used were from DEFRA (2011) or IPCC (2007), unless stated otherwise.
- All secondary emission factors used were LCA based emission factors (based on UK LCA inventories).
- Milk losses (at production) were accounted for.
- All emissions were expressed as CO_2 equivalents (CO_2e), and accounted for carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

- Global Warming Potentials (GWPs) used for calculating fugitive emissions from refrigerant gases were from DEFRA (2010).
- The GWP for methane from cows (from enteric fermentation and manure management systems) was taken at a conservative value of 25. Reduction for biogenic proportion of methane from primary sequestration was not accounted for. This conservative approach may account for an overestimation of emissions from these sources.
- An electricity grid emission factor for South Africa of 1.03kg CO_2e/kWh was applied (Eskom, 2010).
- Allocation of emissions between Full Cream, Low Fat and Fat Free milk was based on economic value of cream.
- All activity data in the report was submitted to GCX by Fair Cape and by Fair Cape's respective suppliers.
- Detailed calculations, assumptions and limitations are detailed in Appendix B.

1.5 Limitations

- Primary data for the feed components not owned by Fair Cape was not accessible for this study, and secondary data sources on emissions associated with feed production were therefore used.
- Due to inherent inaccuracies and inconsistencies in the secondary data, based on different methodological techniques, country-specific discrepancies and other issues associated with secondary feed data, data variances were attained.
- Although conservative values were applied in the study, the emissions arising from Feed growing activities are not accurate, and should be investigated further.
- Due to timing constraints, such inaccuracies could not be resolved for this study.
- LCA based emission factors were used for all sources except for SA grid emission factors resulting from electricity consumption. Reliable sources for LCA base emission factors were not available for this study.

2. Product Greenhouse Gas Assessment

2.1 The Process Map

As per the PAS2050 specifications, the assessment of life cycle GHG emissions for products shall be carried out as either:

i. A **Cradle-to-Grave** assessment, which includes the emissions arising from the full life cycle of the product; or

ii. A **Cradle-to-Gate** assessment, which includes the GHG emissions released up to and including the point where the input arrives at a new organization (including all upstream emissions).

For this assessment the cradle-to-gate approach was used.

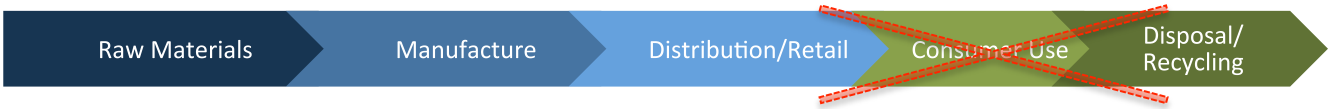

Figure 2: Diagram indicating the difference between the Cradle-to-Grave approach, and the Cradle-to-Gate approach.

Note: Consumer use and disposal/recycling is not included in the Cradle-to-Gate approach.

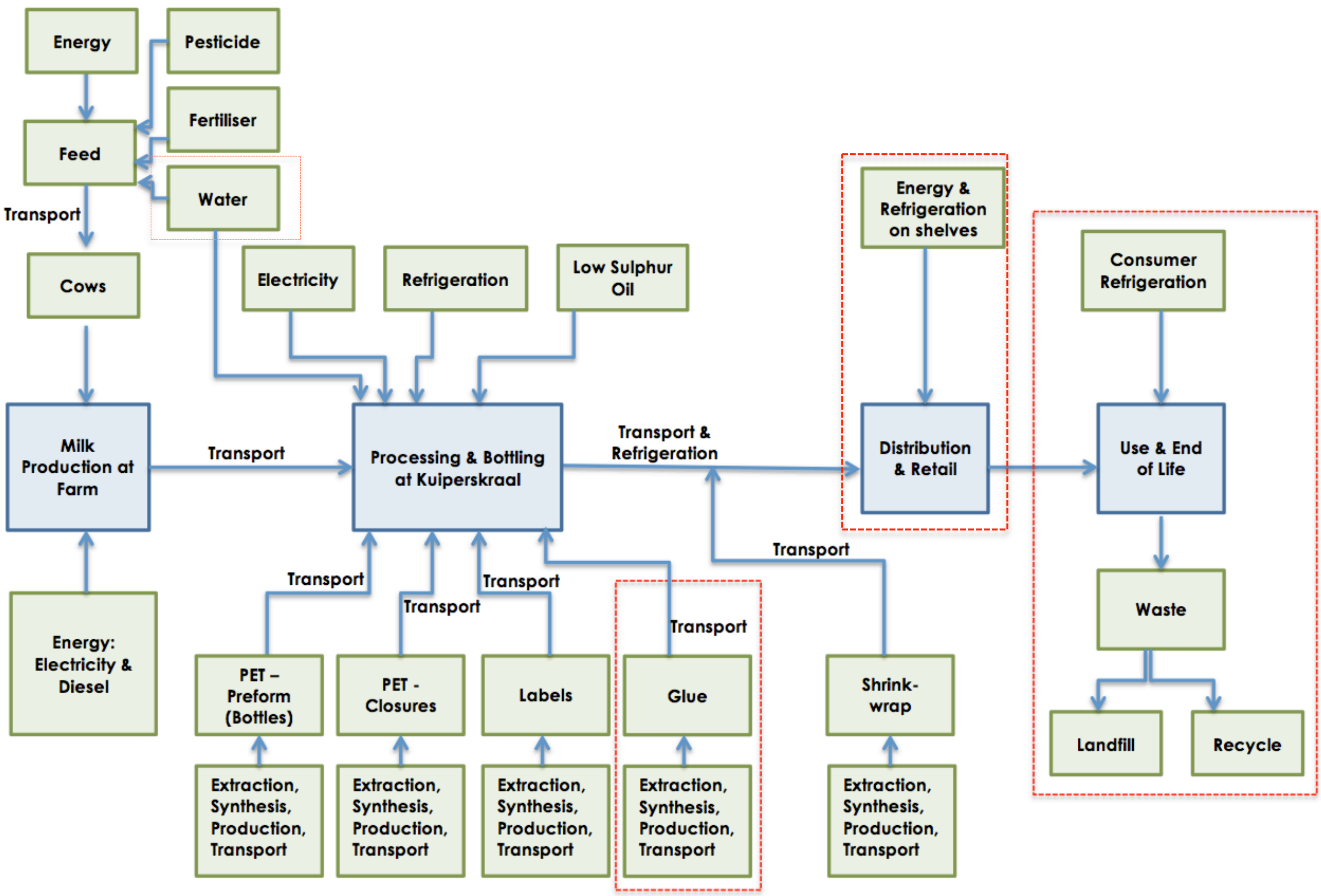

Figure 3: Process Map for the production of Fair Cape Eco-Fresh™ bottled milk.

Note: The process map is the same for the 3 sizes of milk bottles.

Areas indicated with a red boundary were omitted for this assessment due to immateriality, or, in the case of "Use and End of Life" phase, due to the boundary of the assessment.

2.2 Setting Boundaries and Prioritisation

In conformity with PAS2050, and consistent with the Product Category Rule (The International EPD System (2010) *Product Category Rules: CPC Class 2211: Processed Liquid Milk*, PCR201: 12, Version 1.0, 2010-06-24), as outlined in BS ISO 14025, the boundaries of this assessment included all material direct and indirect emissions associated with the production of Fair Cape bottled Eco-Fresh™ Milk.

Fair Cape has measured all cradle-to-gate emissions – from raw material extraction and production up until the retailer's gate. Fair Cape has done this, as it believes that these are boundaries over which it has a strong influence for making future reductions.

Emission sources that were included or excluded are indicated in the process map above (Figure 3), and are listed in the table below.

Emission Source	Included / Excluded	If excluded, reason for exclusion	If Included, activity data source (primary or secondary)
Feed Production	Included		Primary and secondary
Enteric Emissions from cows	Included		Primary and country-specific (Tier 2 of the IPCC guidelines)
Emissions from Manure Management	Included		Primary and country-specific (Tier 1& 2 of the IPCC guidelines)
Energy use at Dairy Farm	Included		Primary
Raw material manufacture of plastic bottles	Included		Primary and some secondary
Raw material manufacture of plastic closures	Included		Primary and some secondary
Raw material manufacture of labels (paper)	Included		Secondary
Raw material manufacture of Shrink-wrap	Included		Secondary
Manufacture and transportation of glue	Excluded	Immaterial	
Transportation of plastic raw materials	Included		Primary
Transportation of paper (labels)	Excluded	Immaterial	
Energy used for processing	Included		Primary
Refrigeration used in processing	Included		Primary
Distribution of finished product (including refrigeration) to FC distribution centers by internal transport networks	Included		Primary
Distribution of finished goods from DCs to retail outlets by 3rd parties	Excluded	Beyond cradle-to-gate scope	
Energy use at retail	Excluded	Beyond cradle-to-gate scope	
Consumer use	Excluded	In line with cradle-to-gate approach	
Disposal of bottle	Excluded	In line with cradle-to-gate approach	

Table 4: Emission sources included and excluded in the carbon footprint analysis of Fair Cape bottled Eco-Fresh™ Milk.

Note: Grey shading indicates excluded emission sources.

2.3 Results

Due to the immaterial variance in energy use in the production process of fat-free, low-fat and full-cream Eco-Fresh™ milk, each of these three types of milk were regarded as the same throughout the study. Allocation based on economic value of cream was applied at the end of the study, so that throughout the report results are presented for three sizes of full cream milk only.

2.3.1 Feed Production

Feed for Fair Cape's cows is made up of various quantities of the following components:

- Oat silage,
- Wheat straw
- Maize
- Concentrate (soybean meal, sunflower meal, minerals and vitamins)
- Lucerne
- Pellets (lucerne, maize, soybean meal, sunflower meal, minerals and vitamins)

These components are mixed in various quantities depending on the cow-type (lactating, dry, heifers, calves). Oat silage and wheat straw are produced on the farm, whereas the remaining components are sourced from international and South African farms.

At Fair Cape, milking cows consume 26kg of dry feed per day, and non-milking cows consume 13 kg dry feed per day.

Oat and wheat straw components were calculated based on energy at farm, fertilizer application and fertilizer production.

Primary data for the remaining feed components was not accessible for this study, and secondary data sources on emissions associated with feed production were therefore used (Wood S and Cowie A, 2004; Flysjö A, 2010; Thoma G et al, 2009, Wang X, 2010). For details on calculations and assumptions please see Appendix B.

Due to inherent inaccuracies in data, based on different methodological techniques, country-specific discrepancies and other issues associated with secondary feed data, data variances were attained. For conservative purposes the upper value of 428.9 grams CO_2e per kg of feed produced was applied for both Dry and Milking cow feed. This included chemical fertiliser production, pesticide production, energy usage (diesel and electricity), deforestation for pasture and feed crops, and pasture degradation (based on external studies).

	500 ml Bottle	1 Litre Bottle	2 Litre Bottle
Total Emissions from Feed Production	**216.4**	**432.9**	**865.8**

Table 5: GHG emissions from feed production, in grams of CO_2e, for the production of Fair Cape Eco-Fresh™ Milk.

Feed production accounted for between 32% and 34% of total emissions. This is a material source, and in order to conform to PAS2050, primary emissions data should be calculated in the future.

Fair Cape intends to improve accuracy and consistency of these emission calculations in future assessments.

2.3.2 Emissions from Livestock

Livestock emissions included methane (CH_4) emissions associated with enteric fermentation and manure management, and direct and indirect nitrous oxide (N_2O) emissions associated with manure management.

The table below summarises the main sources of emissions at the Welgegund farm.

	500 ml Bottle	1 Litre bottle	2 Litre Bottle
Manure Management: Methane CH_4	36.4	72.9	145.8
Enteric Fermentation: Methane CH_4	152.5	305.1	610.1
Manure Management: Direct N_2O	10.9	21.8	43.7
Manure Management: Indirect N_2O	16.2	32.4	64.9
Total Emissions from Livestock	**216.1**	**432.2**	**864.5**

Table 6: Agricultural emissions, in grams of CO_2e, for the 3 sizes of bottled Fair Cape Eco-Fresh™ Milk.

Note: 96% of total livestock emissions were allocated to milk production. The remaining 4% were allocated to cattle for beef production, as advised by Fair Cape.

- Livestock emissions were the most significant emission source for each of the 3 sizes of milk bottles.
- For this emissions source, methane emissions from enteric fermentation were the most significant.
- Please see Appendix B for all calculations and assumptions made.

2.3.3 Emissions from the Manufacture of Raw Materials

Emissions from raw material manufacture included extraction and processing of the raw materials that were used as inputs into the milk bottle production process at Kuiperskraal. Other than for the milk itself, and the energy use on the farm, Fair Cape does not control the value chain of these products.

	500 ml Bottle	1 Litre bottle	2 Litre Bottle
Electricity at Farm	12.7	25.3	50.7
Other energy at farm (diesel)	19.9	39.8	79.7
Bottles: PET Synthesis: (PTA and EG extraction. and synthesis of PET resin)*	56.0	89.5	134.3
Bottles: PET Preform manufacture	5.1	5.1	5.1
Closures: (inclusive of HDPE LDPE	17.9	28.8	43.1

synthesis & lid formation) **			
Labels manufacture***	1.2	1.5	2.1
Shrink wrap manufacture****	1.2	2.5	5.0
Total Emissions from Manufacture of Raw Materials	**114.0**	**192.7**	**320.0**

Table 7: Emissions associated with raw material manufacture, in grams of CO_2e, for the 3 sizes of Fair Cape bottled Eco-Fresh™ Milk.

Note: *Emissions from PET synthesis was based on secondary data (Franklin Associates, 2010), and included transportation upstream of Hosaf.

**Emissions from Closure manufacture were derived from secondary data (Franklin Associates, 2010), and primary data (Polyoak, 2011), and included transportation upstream of Polyoak.

*** Emissions from label manufacture were based on paper production from secondary sources (Mondi, 2010).

****Emissions from shrink-wrap manufacture were derived based on secondary data (Franklin Associates, 2010), and included transportation.

- Electricity was mainly used on the farm for the milking equipment, and diesel was used in vehicles.
- PET is used in the production of bottles. The preform bottles were produced by Polyoak, which procured PET resin from Hosaf. Hosaf in turn obtained the raw materials required – Ethylene Glycol (EG) and Purified Terephthalic Acid (PTA) -from sources in the USA and Dubai. For this study, emissions associated with PET production were determined based on a US study by Franklin Associates (2010). The process map shown in Figure 4 below indicates the boundaries of emissions included in this assessment, including the production activities that occurred at Polyoak.
- It is important to note that the emissions associated with the electricity usage for blowing bottles was not included in this section. Bottle blowing occurred on Fair Cape premises, and the electricity consumption was incorporated into the milk production process instead (see Section 2.3.5 below).
- Plastic closures were manufactured at Polyoak from a mixture of HDPE (81.6%), LDPE (14.4%), Slip Additive (2%) and Master Batch (2%). For this study, emissions associated with the production of Slip Additive and Master Batch was omitted due to immateriality. HDPE was synthesised by Safripol, and LDPE was synthesised by Exxon Mobile. However, due to inaccessible primary data sources, the above-mentioned Franklin Associates study was used to determine the emissions associated with the production of both these plastic resins. The process map shown in Figure 5 below indicates the boundaries of emissions included in this assessment, including the activities occurring at Polyoak.
- Paper and glue were used in label production. The labels were manufactured by Cape Printing, and the glue by Bonstick. Both these emission sources were immaterial, but the emissions associated with the paper production were included based on secondary data sources.
- Plastic shrink-wrap, used for bulk-packaging bundles of milk bottles, was sourced from LT Plastics. The shrink-wrap was made out of LDPE, the emissions of which were also based on the Franklin Associates (2010) study.

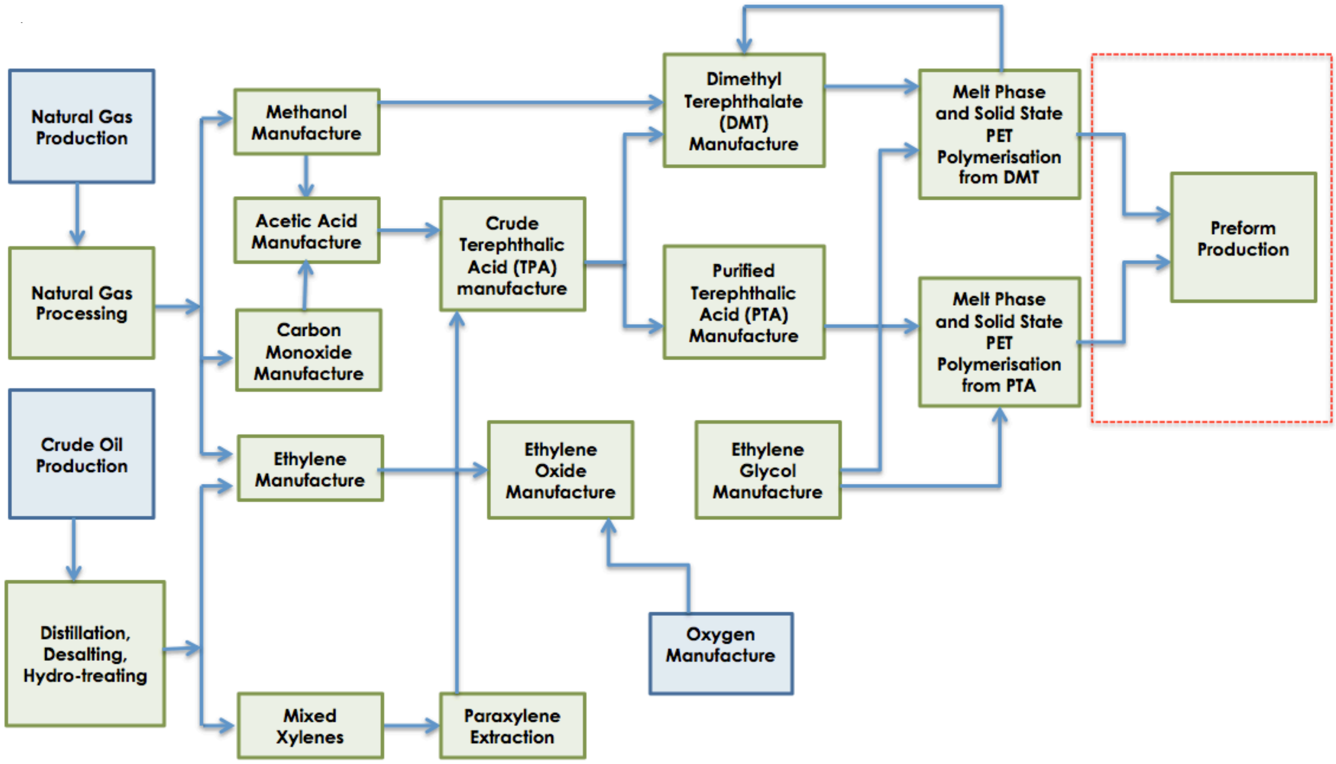

Figure 4: Process map for production of PET resin. (Adapted from Franklin Associates, 2010).
Note: Area indicated with a red boundary indicates preform production at Polyoak, based on primary data sources.

- Emissions associated with PET bottle production, excluding the emissions associated with bottle blowing, accounted for up to 66.6% (in 500ml bottles) of all raw material manufacturing emissions.
- In total, emissions from raw material manufacture accounted for 17%, 14% and 12% of total embedded emissions of a 500ml, 1-litre and 2-litre bottle respectively.

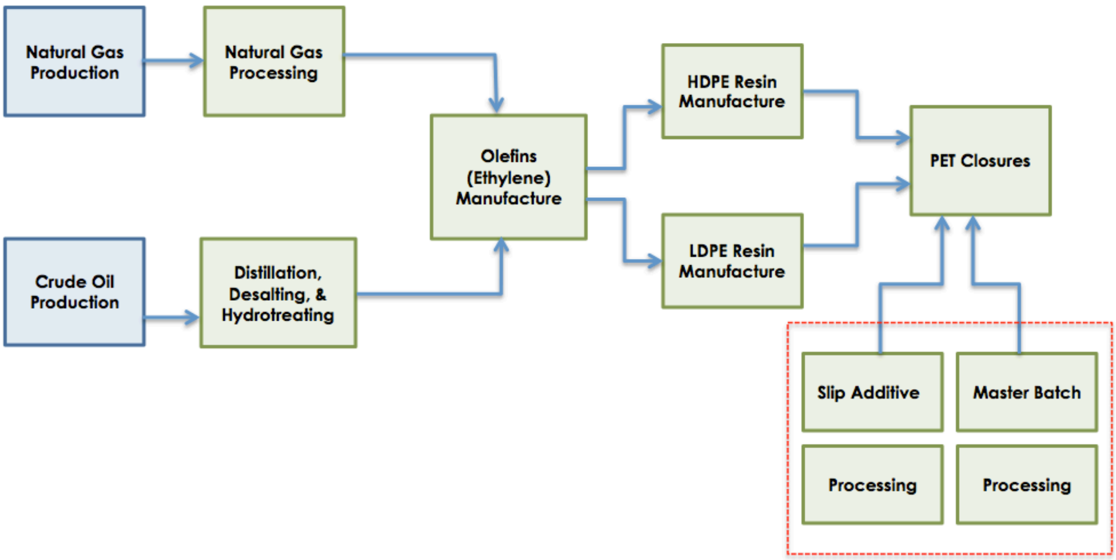

Figure 5: Process Map for the production of PET Closures. (Adapted from Franklin Associates, 2010)
Note: Area indicated with a red boundary indicates raw material products omitted from the assessment due to immateriality.

2.3.4 Emissions from the Transportation of Raw Materials

Emissions associated with the transportation of all raw materials at all stages of the production cycle were included. The emissions are shown in the table below.

	500 ml Bottle	1 Litre bottle	2 Litre Bottle
Distribution of feed into Farm	**20.5**	**41.1**	**82.2**
Transportation of PTA & MEG to Hosaf	5.5	8.8	13.1
Transportation of PET to Polyoak	11.3	18.1	27.1
Transportation of Preforms to Fair Cape	0.1	0.2	0.2
Transportation of LDPE & HDPE to Polyoak	0.4	0.4	0.4
Transportation of Closures to Fair Cape	1.6	1.6	1.6
Transportation of shrink-wrap to Fair Cape	0.0	0.0	0.0
Distribution from Farm to Milk facility	0.2	0.4	0.8
	39.6	**70.5**	**125,4**

Table 8: Emissions associated with raw material transportation, in grams of CO_2e, for the 3 sizes of Fair Cape Eco-Fresh™ bottled milk.

Note: For details of all calculations see Appendix B.

- Emissions associated with the transportation of the feed into the farm were the most significant.
- Of these feed distribution emissions, 58% arise from the transportation of maize from Bloemfontein.
- Fair Cape aim to grow all maize onsite, and therefore cut these emissions entirely.
- The PET resin was transported on large container trucks across the country, from the Hosaf factory in Durban to the Polyoak facility in Cape Town.
- Emissions associated with the transportation of PTA and EG to Hosaf from Dubai and Florida were also significant. These raw materials were transported on large container vessels.

2.3.5 Emissions from the Processing of Milk at Kuiperskraal

The following activities take place at the Kuiperskraal facility:

- Primary milk storage in silos
- Milk transportation throughout the production process
- Separation (of fats into 3 varieties of milk)
- Pasteurisation
- Homogenisation
- Bottle blowing
- Bottle filling
- Bottle labelling
- Shrink-wrapping of parcels
- Refrigerated storage of final product
- Cleaning of all equipment

Fair Cape Eco-Fresh™ milk represented only a portion of all processed milk, and all stored products at the Kuiperskraal facility. Only the proportion of energy required in the production and storage of Eco-Fresh™ milk was accounted for; Energy use was allocated to milk and cream used in the Eco-Fresh™ milk bottle only, according to specific physical processes.

	500 ml Bottle	1 Litre bottle	2 Litre Bottle
Energy Processing & refrigeration	63.1	126.3	252.6
Refrigeration (gases)	4.3	8.5	17.0
Low Sulphur Oil for Boilers	12.0	24.1	48.2
	79.4	**158.9**	**317.8**

Table 9: Emissions associated with Processing and Refrigeration, in grams of CO_2e, for 3 sizes of Fair Cape Eco-Fresh™ bottled milk.

Note: For details of all calculations see Appendix B.

2.3.6 Emissions Associated with Distribution of Final Product to DCs

As reported by Fair Cape, 98.2% of all Fair Cape products were distributed to the various FC distribution centres throughout South Africa by the internal distribution network (including some contractors). The trucks were refrigerated and ran on diesel.

	500 ml Bottle	1 Litre bottle	2 Litre Bottle
Distribution to DCs and retail outlets In FC owned trucks(diesel)	14.0	28.1	56.0
Refrigeration (Truck)	0.3	0.6	1.3
	14.3	**28.7**	**57.3**

Table 10: Emissions associated with Distribution to DCs, in grams of CO_2e, for 3 sizes of Fair Cape Eco-Fresh™ bottled milk.

For details of all assumptions and calculations, please see Appendix B.

2.4 Fair Cape Eco-Fresh™ Bottled Milk Emissions Breakdown

The figure below shows a comparison between the three sizes of bottled Eco-Fresh™ milk produced by Fair Cape.

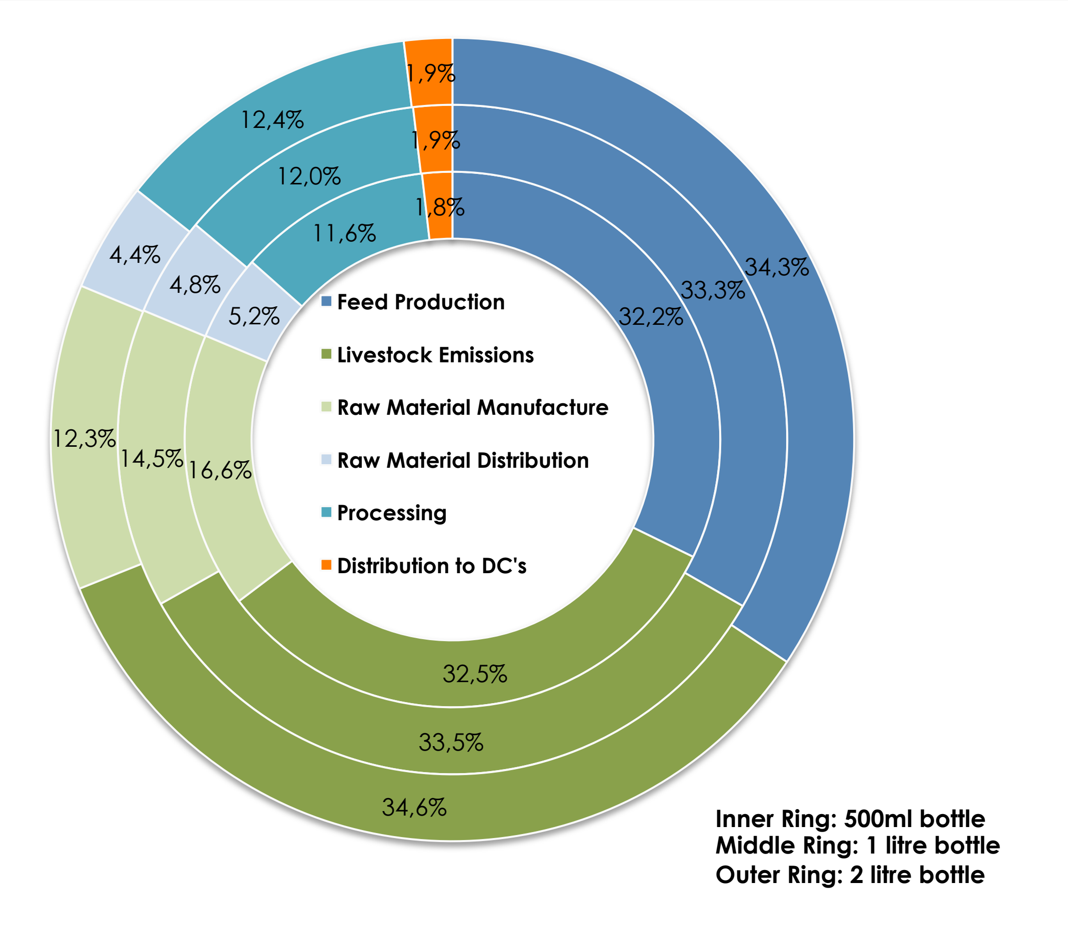

Figure 6: Comparison of emissions profile by source for the three sizes of bottled Eco-Fresh™ milk produced by Fair Cape.

	500 ml Bottle		1 Litre bottle		2 Litre Bottle	
	CO2e (grams)	%	CO2e (grams)	%	CO2e (grams)	%
Feed Production	216.4	32%	432.9	33%	865.8	34%
Livestock Emissions	216.1	32%	432.2	33%	864.5	34%
Raw Material Manufacture	114.0	17%	192.7	15%	320.0	13%
Raw Material Distribution	39.6	6%	70.5	5%	125.4	5%
Processing	79.4	12%	158.9	12%	317.8	12%
Distribution to DC's	14.3	2%	28.7	2%	57.3	2%
Total	679.9	100%	1 315.8	100.0%	2 550.7	100.0%

Table 11: GHG emissions, in grams of CO_2e, for the 3 sizes of Eco-Fresh™ bottled milk produced by Fair Cape.

Although the emissions profiles are very similar across all three products, it is interesting to note the main differences:

- Feed production and livestock emissions collectively made up 64%, 67% and 69% of total emissions for 500ml, 1-litre and 2–litre bottles respectively.
- Emissions from raw material manufacture were also significant and accounted for a further 17%, 14% and 12% of total emissions for 500ml, 1-litre and 2-litre bottles respectively.

2.5 Allocation between Full Cream, Low Fat and Fat Free Milk

Allocation of emissions between Full Cream, Low Fat and Fat Free milk was based on economic value of cream, as follows:

Emissions per litre (g CO2e)	500ml	1 litre	2 litre	Average
Full Cream	1360	1316	1276	1317
Low Fat	1252	1211	1174	1212
Fat Free	NA	1066	1034	1050

Table 12: GHG emissions, in grams of CO_2e per litre, for the three sizes and three types of bottled Fair Cape Eco-Fresh™ Milk.

2.6 Benchmarking Fair Cape Eco-Fresh™ Milk

Fair Cape Eco-Fresh™ Milk had a relatively lower embedded emissions profile per litre of milk than other milk products from around the world, as indicated in the table below.

		Grams CO_2e / litre milk	Comment
New Zealand Study* (LCA)	NZ-conventional	1056	• *All data normalized to represent 1 litre. (Original study was on1 kg milk)* • *All data normalized to represent business-to-business approach; (Original data represented only farm emissions –feed and livestock- and was taken as 66% of total.*
	Sweden-conventional	1618	
	Sweden-organic	1397	
	German-conventional Intensive	1912	
	German-conventional Extensive	1471	
	German-organic	1912	
TESCO (PAS2050)**	Skimmed milk	1198	*Results normalized to exclude consumer use and disposal.*
	Semi-skimmed milk	1327	
	Whole milk	1551	
Piacere Laggero (Italy)* (LCA)**		1473	*Results normalized to exclude consumer use and disposal.*
Average: All other Milk		**1492**	*Corrected to represent business-to-business approach.*
Fair Cape (Full Cream, 1 litre bottle)		**1316**	

Table 13: GHG Emissions, in grams, per litre of milk produced, by various producers, normalised to the business-to-business approach.

Note: *Basset Mens C et al. 2006.

**TESCO, 2009

***The International EPD System (2010), Granarolo.

The comparability of LCA and PAS2050 studies is difficult given the different methodologies and assumptions used for each approach.

3. Conclusions

Fair Cape has successfully measured the embedded emissions associated with its Eco-Fresh™ bottled milk products using the PAS2050 business-to-business model.

- The majority of emissions arose from the production of animal feed and from the methane and nitrous oxide associated with livestock.
- Fair Cape Eco-Fresh™ bottled milk had a below-average rate of emissions per litre of milk produced as compared to other similar studies globally.

The "GCX Assessed" logo is available for use in the labelling of Fair Cape's milk bottles.

This logo should be accompanied by an explanatory note detailing:

- The amount of emissions (dependent on the bottle size);
- The methodology used (PAS2050); and
- The boundary applied (i.e. business-to-business).

Figure 7:"Assessed" Logo – Global Carbon Exchange

Appendix A: References

Basset-Mens C, Ledgard S & Carran A (2006). *First Life Cycle Assessment of Milk Production from New Zealand Dairy Farm Systems*

BSI and The Carbon Trust (2008). PAS 2050:2008: *Specification for the assessment of the life cycle greenhouse gas emissions of goods and services*

BSI and The Carbon Trust (2008). *Guide to PAS 2050: How to assess the carbon footprint of goods and services*

Cederberg et al. (2009), SIK – the Swedish Institute for Food and Biotechnology

Flysjö A *(2010). Greenhouse gas emissions related to dairy production and feeding.* XXV FEFAC Congress, Hamburg (Germany)

Food & Agriculture Organisaation of the United Nations (2010). *Greenhouse Gas Emissions From the Dairy Sector: A Life Cycle Assessment.*

Franklin Associates, A Division of Eastern Research Group Inc, Prairie Village, Kansas (2010). *Cradle to Gate Life Cycle Inventory of Nine Plastic Resins and Four Polyurethane Precursors.* Prepared for the Plastics Division of the American Chemistry Council

Global Carbon Exchange (GCX, 2009). *Fair Cape Milk Production Facility; Carbon Footprint Report (*June 09 – July 09).

IPCC Guidelines for National Greenhouse Gas Inventories (2006). Volume 4: Agriculture, Forestry and Other Land Use. Chapter 10: Emissions from Livestock and Manure Management.

IUFoST Scientific Information Bulletin (SIB) (2010). *Life Cycle Analysis and Carbon Footprinting with respect to Sustainability in the Agri-food sector*

Mangino JM et al (2003), *Development of an Emissions Model to Estimate Methane from Enteric Fermentation in Cattle.*

Sonesson U, Cederberg C & Bertglund M *(2009). Greenhouse Gas Emissions in Animal Feed Production: Decision Support for Climate Certification*

Sustainable Food Labs, University of Aberdeen, Unilever Plc, The Cool Farm Tool, a User's Guide, April 2011.

TESCO, 2009: Quantitative research conducted by FRANK Research Ltd, 2009,. *RRP Tesco pint of milk*

The International EPD System (2010). *Product Category Rules: CPC Class 2211: Processed Liquid Milk*, PCR201:12, Version 1.0, 2010-06-24.

The International EPD System (2010). *Environmental Product Declaration for "Piacere Leggero" Fresh Milk in PET Bottles (1-litre and ½ litre containers*), Granarolo.

Thoma G et al (2009). *Carbon Footprint and the Dairy Industry*. US Dairy Research.

Wang X, (2010). *Greenhouse Gas Emissions of the Agricultural and Livestock Products in China.* College of Resources and Environment, Northwest A&F University, Yangling, China, 712100

Wood S and Cowie A (2004). *A Review of Greenhouse Gas Emission Factors for Fertiliser Production.* Research and Development Division, State Forests of New South Wales. Cooperative Research Centre for Greenhouse Accounting, prepared for IEA Bioenergy Task 38.

Appendix B:
Calculation, Assumptions and Limitations

FEED PRODUCTION

Feed production emissions for Fair Cape controlled feed growing process (oat and wheat) were calculated using the Cool Farm Tool V1.1, developed by the University of Aberdeen and commissioned by Unilever Plc. The tool is in accordance with IPCC tier 2 methodologies for calculating emissions from agricultural practices.

The fertilizer application rate at the Fair Cape growing land was applied using the following assumptions:

Soil texture	Medium
Soil Organic Matter	1.72 < SOM <= 5.16
Soil moisture	Dry
Soil drainage	Good
Soil pH	5.5 < pH <= 7.3

User defined fertilizer application rates and compositions were defined as follows:

Fertilizer used	**Base nutrient**	**Composition (CPK)**
SAAI 210(18)	Ammonium Nitrate	40:0:0
CURA A-44	Ammonium Nitrate	50:0:0
Bob CURA A-44	Ammonium Nitrate	40:4:0
AMILPLUS	Ammonium Nitrate	48:16:0

Application rates were applied as those supplied by Kynoch (Saaiprogram, 2011). Values for each area of land with its corresponding fertilizer application rate was applied, and values were then calculated for the total land area under the particular cultivation process.

Wheat was assumed to have a productivity of 15 tonnes per annum, and oats a productivity of 3.5 tonnes per annum.

Energy used on the farm for other machinery was then added to the totals.

For all other feed types, due to inaccessible primary data, it was necessary to reference other studies to obtain the data required. No country-specific sources were available, and thus international feed production studies were consulted. These included Australia (Wood S and Cowie A, 2004), Sweden (Flysjö A, 2010; Cederberg et al. 2009), the USA (Thoma G et al, 2009), and China (Wang X, 2010).

The feed mix ratio between oat silage, wheat straw, maize, concentrate, pellets and lucerne was determined from the feed situational analysis provided by Fair Cape.

This study aimed to include the entire feed production process inclusive of producing grass, feed crops, crop residues, by- products, and concentrates, including:

- Production of nitrogen (N) fertilizer (CO_2e);
- Application of manure and chemical fertilizers to crops, accounting for both direct and indirect emissions (N_2O);
- Deposition of manure and urine on pasture crops, accounting for both direct and indirect emissions (N_2O);

- Energy used for fertilization, field operations, drying, processing of feed crops and fodder (CO_2e);
- Processing of crops into by-products and concentrates (CO_2e);
- Transport of feed from the production site to the feeding site (CO_2e);
- Changes in carbon stocks as a result of land use change (mostly from deforestation) in the previous 20 years (IPCC, 2006); and
- Nitrogen (N) losses related to changes in carbon stocks (N_2O).

For the Swedish study, an LCA database for conventional feedstuffs had recently been compiled at SIK (Swedish Institute for food and biotechnology. It included the environmental impact, defined as resource use and emissions, in animal feed production up to the feed factory for the most commonly occurring conventional feedstuffs in Sweden at present. GWP calculations from the feed database formed the basis for this chapter. Data for Swedish feedstuffs were calculated using current yield levels according to statistics and fertiliser doses were checked against the most recently published fertilisation data. Emissions of direct and indirect N_2O emissions were calculated according to the latest guidelines from IPCC (2006). Manufacture of machinery and buildings was not included for the agriculture sector. However, this has little significance for GWP calculations, since emissions other than fossil CO_2 dominate this part of the life cycle. Such emissions were included by estimation for this Fair Cape study.

For the study done in China, major cereals, vegetables and some fruits were selected to calculate their GHG emissions, according to the availability of the data. The data for agricultural product yield and for nitrogen fertilizer consumption quantity was from the Compilation of National Costs and Benefits of Agricultural Products (2008). The value of the N_20 emissions factor was based on Chinese Greenhouse Gas Emission Inventory Research. The emissions factor of CO_2 per unit nitrogen fertilizer production was 6KgCO_2/KgN, which was calculated based on the national yield and energy consumption of nitrogen fertilizer in China. The emissions factor of CH_4 of a rice-paddy is a national average value, 22KgCH_4/annum, which was calculated based on the national rice yield and total CH_4 emissions from national paddy. Global warming potential values of N_20 and CH_4 were 298 and 25 respectively.

Due to inherent inaccuracies in data, based on different methodological techniques, country-specific discrepancies and other issues associated with secondary feed data, data variances were attained. For conservative purposes the upper value for each type of feed produced was applied for both Dry and Milking cow feed.

	Gram CO2e per kg Feed Produced	Comments
Wheat (Sweden)	360	• *Data was corrected to include energy emissions* • *Soybean meal emissions normaiised to exclude land use change*
Oat (Sweden)	458	
Grass Ley (Sweden)	310	
Mixed Ley (Sweden)	225	
Soybean Meal (Sweden)	585	
All Feed (US)	300	
Wheat (China)	320	
Corn (China)	270	
Soya Bean (China)	320	
Average	**350**	

The upper and lower emission factor limits as applied to Fair Cape specific feed types used in feed mix, limits were applied as shown below:

	Upper level (Grams CO2e per kg feed produced)	Upper level (Grams CO2e per kg feed produced)
Oat silage (Wet)	198	198
Lucerne (DRY)	400	200
Wheat Straw (W)	752	752
Maize (DRY)	350	200
Cotton Seed	450	200
Dry Apple (DRY)	350	120
Soybean Meal (DRY)	585	320
Concentrate (DRY)	700	135

Due to low confidence level in the emissions data, conservative upper level emissions values were applied.

Only 5% of emissions from wheat straw were applied, as straw is seen as a waste product from wheat growing applications.

96% of all feed emissions were applied and allocated towards the dairy cows for production of milk purposes. The other 4% of emissions were allocated to cattle sent to slaughter.

LIVESTOCK EMISSIONS

All livestock emissions were calculated as per the IPCC Guidelines for National Greenhouse Gas Inventories (2006), Volume 4, Chapter 10. All numbered references to tables and equations below refer to this IPCC document. All methane emissions were calculated by the Tier 2 approach, whereas N2O emissions were calculated by the Tier 1 approach using country-specific data.

Emissions from the following emissions sources were calculated:

- Methane emissions from Manure Management
- Methane emissions from Enteric Fermentation
- Direct and Indirect Nitrogen (N2O) emissions from Manure Management

For all of the above emission sources, 96% of all emissions were applied and allocated towards the dairy cows for production of milk purposes. The other 4% of emissions were allocated to cattle sent to slaughter.

Gross Energy:

As a first step it was necessary to calculate the gross energy required per cow per day.

Animal performance and diet data were used to estimate feed intake, which is the amount of energy (MJ/day) an animal needs for maintenance and for activities such as growth, lactation, and pregnancy. The equations listed in Table 10.3 below were used to derive this estimate.

TABLE 10.3
SUMMARY OF THE EQUATIONS USED TO ESTIMATE DAILY GROSS ENERGY INTAKE FOR CATTLE, BUFFALO AND SHEEP

Metabolic functions and other estimates	Equations for cattle and buffalo	Equations for sheep
Maintenance (NE_m)	Equation 10.3	Equation 10.3
Activity (NE_a)	Equation 10.4	Equation 10.5
Growth (NE_g)	Equation 10.6	Equation 10.7
Lactation (NE_l)*	Equation 10.8	Equations 10.9 and 10.10
Draft Power (NE_{work})	Equation 10.11	NA
Wool Production (NE_{wool})	NA	Equation 10.12
Pregnancy (NE_p)*	Equation 10.13	Equation 10.13
Ratio of net energy available in diet for maintenance to digestible energy consumed (REM)	Equation 10.14	Equation 10.14
Ratio of net energy available for growth in a diet to digestible energy consumed (REG)	Equation 10.15	Equation 10.15
Gross Energy	Equation 10.16	Equation 10.16

Source: Cattle and buffalo equations based on NRC (1996) and sheep based on AFRC (1993).
NA means 'not applicable'.
* Applies only to the proportion of females that give birth.

EQUATION 10.3
NET ENERGY FOR MAINTENANCE

$$NE_m = Cf_i \bullet (Weight)^{0.75}$$

EQUATION 10.4
NET ENERGY FOR ACTIVITY (FOR CATTLE AND BUFFALO)

$$NE_a = C_a \bullet NE_m$$

EQUATION 10.6
NET ENERGY FOR GROWTH (FOR CATTLE AND BUFFALO)

$$NE_g = 22.02 \bullet \left(\frac{BW}{C \bullet MW} \right)^{0.75} \bullet WG^{1.097}$$

EQUATION 10.8
NET ENERGY FOR LACTATION (FOR BEEF CATTLE, DAIRY CATTLE AND BUFFALO)

$$NE_l = Milk \bullet (1.47 + 0.40 \bullet Fat)$$

EQUATION 10.14
RATIO OF NET ENERGY AVAILABLE IN A DIET FOR MAINTENANCE TO DIGESTIBLE ENERGY CONSUMED

$$REM = \left[1.123 - \left(4.092 \bullet 10^{-3} \bullet DE\%\right) + \left[1.126 \bullet 10^{-5} \bullet (DE\%)^2\right] - \left(\frac{25.4}{DE\%}\right)\right]$$

EQUATION 10.15
RATIO OF NET ENERGY AVAILABLE FOR GROWTH IN A DIET TO DIGESTIBLE ENERGY CONSUMED

$$REG = \left[1.164 - \left(5.160 \bullet 10^{-3} \bullet DE\%\right) + \left[1.308 \bullet 10^{-5} \bullet (DE\%)^2\right] - \left(\frac{37.4}{DE\%}\right)\right]$$

EQUATION 10.16
GROSS ENERGY FOR CATTLE/BUFFALO AND SHEEP

$$GE = \left[\frac{\left(\frac{NE_m + NE_a + NE_l + NE_{work} + NE_p}{REM}\right) + \left(\frac{NE_g + NE_{wool}}{REG}\right)}{\frac{DE\%}{100}}\right]$$

Coefficients used:

	Milking Cows	Non -Milking Cows	Source / Comment
Cf_i	0.386	0.322	Lactating vs. non-lactating cows from table 10.4
W	650	325	Average weight of cow (Fair Cape)
C_a	0.17	0.17	Table 10.5: pasture fed cows
BW	650	325	Average weight of cow
C	0.8	1	a coefficient with a value of 0.8 for females, 1.0 for castrates
MW	650	325	
WG	0	0.1	Assumed weight gain of 100g per non-dairy cow, and 0g for dairy cow.
Milk	39	0	From Fair Cape
Fat	0.0355		From Fair Cape
NE_{work}	0	0	Cows do not work
NE_{wool}	0	0	
NE_p	0	0	Proportion of pregnant females unknown
DE%	69%	59%	From Nova Feeds
GE	**319.583**	**110.703**	**Calculated**

Methane Emissions from Manure Management:

This section describes how the CH_4 produced during the storage and trea™ent of manure, and from manure deposited on pasture was estimated. The term 'manure' was used here collectively to include both dung and urine (i.e. the solids and the liquids) produced by livestock. The decomposition of manure under anaerobic conditions (i.e. in the absence of oxygen) during storage and trea™ent produces CH_4. These conditions occur most readily when large numbers of animals are managed in a confined area (e.g. dairy farms, beef feedlots, and swine and poultry farms), and where manure is disposed of in liquid-based systems. Emissions of CH_4 related to manure handling and storage are reported under 'Manure Management'.

The main factors affecting CH_4 emissions are the amount of manure produced and the portion of the manure that decomposes anaerobically. The former depends on the rate of waste production per animal and the number of animals, and the latter on how the manure is managed. When manure is stored or treated as a liquid (e.g., in lagoons, ponds, tanks, or pits), it decomposes anaerobically and can produce a significant quantity of CH_4. The temperature and the retention time of the storage unit greatly affect the amount of methane produced. When manure is handled as a solid (e.g. in stacks or piles), or when it is deposited on pastures and rangelands, it tends to decompose under more aerobic conditions and less CH_4 is produced.

The following classifications of manure management systems were used in Fair Cape:

- Un-aerated/aerated dam or tank (10%)
- Deep beds (50%)
- Composting piles (40%)

The Volatile Solid (VS) Excretion rate per cow was required in order to calculate emissions from manure management:

Calculating the VS Excretion Rate:

EQUATION 10.24
VOLATILE SOLID EXCRETION RATES

$$VS = \left[GE \bullet \left(1 - \frac{DE\%}{100} \right) + \left(UE \bullet GE \right) \right] \bullet \left[\left(\frac{1 - ASH}{18.45} \right) \right]$$

Calculating EF from Manure Management, as per the Tier 2 approach:

EQUATION 10.23
CH_4 EMISSION FACTOR FROM MANURE MANAGEMENT

$$EF_{(T)} = \left(VS_{(T)} \bullet 365 \right) \bullet \left[B_{o(T)} \bullet 0.67\, kg / m^3 \bullet \sum_{S,k} \frac{MCF_{S,k}}{100} \bullet MS_{(T,S,k)} \right]$$

	MS	MCF	Source / Comment

Un-aerated/aerated dam or tank	0.10	77	From table 10.A4 and 10.A5 based on American cows
Deep beds	0.50	4	
Composting piles	0.40	0.50	

Coefficients used:

	Milking Cows	Non-Milking Cows	Source / Comment
DE%	69%	59%	From Nova Feeds
ASH	0.08	0.08	Suggested variable (eq. 10.24)
UE	0.04	0.04	Suggested urinary excretion rate for most ruminants
GE	319.583	110.703	Calculated (above)
Bo	0.24	0.19	From table 10.A4 and 10.A5 based on American cows
VS	**5.5776**	**2.4841**	**Calculated (kg VS per day per cow)**

Calculated Methane Emissions from each manure management system per cow per year:

	Milking Cows	Non-Milking Cows
Un-aerated/aerated dam or tank	25.207	8.887
Deep beds	6.547	2.308
Composting piles	0.655	0.231
TOTAL (CH4)	**32.408**	**11.427**

TOTAL CH_4 (calculated)	43.8351	kg CH_4 per animal per year
TOTAL CO_2e (calculated)	1095.8774	Kg CO_2e per animal per year
Litres of milk per cow per year	14 235	From Fair Cape (based on 39 litres per cow per year)
Embedded Emissions:	***0.076985***	***Kg CO_2e per litre of milk***

Methane Emissions from Enteric Fermentation:

Methane is produced in herbivores as a by-product of enteric fermentation, a digestive process in which carbohydrates are broken down by micro-organisms into simple molecules for absorption into the bloodstream. The amount of methane that is released depends on the type of digestive tract, age, and weight of the animal, and the quality and quantity of the feed consumed. Ruminant livestock (e.g. cattle, sheep) are major sources of methane, as their ruminant gut structure fosters extensive enteric fermentation of their diet. Only moderate amounts of methane are produced by non-ruminant livestock (e.g. pigs, horses).

Digestive system

The type of digestive system has a significant influence on the rate of methane emission. Ruminant livestock have an expansive chamber, the rumen, at the forepart of their digestive tract that supports intensive microbial fermentation of their diet, which yields several nutritional advantages including the capacity to digest cellulose. The main ruminant livestock are cattle, buffalo, goats, sheep, deer and camelids. Non-ruminant livestock (horses, mules, asses) and monogastric livestock (swine) have relatively lower methane emissions because much less methane-producing fermentation takes place in their digestive systems.

Feed intake

Methane is produced by the fermentation of feed within the animal's digestive system. Generally, the higher the feed intake, the higher the level of methane emissions. However, the extent of methane production may also be affected by the composition of the diet. Feed intake is positively related to animal size, growth rate, and production (e.g. milk production, wool growth, or pregnancy).

Calculating Methane from enteric fermentation, as per the Tier 2 approach:

EQUATION 10.21
CH_4 EMISSION FACTORS FOR ENTERIC FERMENTATION FROM A LIVESTOCK CATEGORY

$$EF = \left[\frac{GE \bullet \left(\frac{Y_m}{100} \right) \bullet 365}{55.65} \right]$$

Coefficients used:

	Milking Cows	Non -Milking Cows	Source / Comment
GE	319.583	110.703	Calculated (above)
$\boldsymbol{Y_M}$	6.5%	6.%	Given in table 10.12 pg 10.30 of IPCC document
EF	**136.2464**	**47.1955**	**Calculated (kg CH_4 per cow per year)**

Direct and Indirect Nitrogen (N_2O) Emissions from Manure Management:

Direct N_2O

Direct N_2O emissions occur via combined nitrification and de-nitrification of nitrogen contained in the manure. The emission of N_2O from manure during storage and treatment depends on the nitrogen and carbon content of manure, and on the duration of the storage and type of treatment. Nitrification is the oxidation of ammonia nitrogen to nitrate nitrogen.

Nitrification is a necessary prerequisite for the emission of N_2O from stored animal manures. Nitrification is likely to occur in stored animal manures provided there is a sufficient supply of oxygen. Nitrification does not occur under anaerobic conditions. Nitrites and nitrates are transformed to N_2O and dinitrogen (N_2) during the naturally occurring process of de-nitrification, an anaerobic process. There is general agreement in the scientific literature that the ratio of N_2O to N_2 increases with increasing acidity, nitrate concentration, and reduced moisture.

In summary, the production and emission of N_2O from managed manures requires the presence of either nitrites or nitrates in an anaerobic environment preceded by aerobic conditions necessary for the formation of these oxidized forms of nitrogen. In addition, conditions preventing reduction of N_2O to N_2, such as a low pH or limited moisture, must be present.

Indirect N_2O

Indirect N_2O emissions result from volatile nitrogen losses that occur primarily in the forms of ammonia and nitrogen oxides (NOx). The fraction of excreted organic nitrogen that is mineralized to ammonia nitrogen during manure collection and storage depends primarily on time, and to a lesser degree temperature. Simple forms of organic nitrogen such as urea (mammals) and uric acid (poultry) are rapidly mineralized to ammonia nitrogen, which is highly volatile and easily diffused into the surrounding air (Asman et al., 1998; Monteny and Erisman, 1998). Nitrogen losses begin at the point of excretion in houses and other animal production areas (e.g. milk parlors) and continue through on-site management in storage and treatment systems (i.e. manure management systems). Nitrogen is also lost through runoff and leaching into soils from the solid storage of manure at outdoor areas, in feedlots and where animals are grazing in pastures.

Calculating **Direct Nitrogen** emissions:

EQUATION 10.30
ANNUAL N EXCRETION RATES

$$Nex_{(T)} = N_{rate(T)} \bullet \frac{TAM}{1000} \bullet 365$$

EQUATION 10.25
DIRECT N_2O EMISSIONS FROM MANURE MANAGEMENT

$$N_2O_{D(mm)} = \left[\sum_S \left[\sum_T \left(N_{(T)} \bullet Nex_{(T)} \bullet MS_{(T,S)} \right) \right] \bullet EF_{3(S)} \right] \bullet \frac{44}{28}$$

Coefficients used:

	Milking Cows	Non-Milking Cows	Source / Comment
$N_{Rate(T)}$	0.44	0.31	North American Dairy Cattle default (Table 19, pg 10.59)
TAM	650	350	Weight of cows (average)
$N_{ex(T)}$	104.39	36.77	Calculated (kg N per cow per year)
MS	As above	As above	
$N_{(T)}$	1400	1400	Number of each type of cows
$N_2O_{D(mm)}$	**1125.32**	**396.42**	**Calculated (kg N_2O per year)**

Calculating **Indirect Nitrogen** emissions:

EQUATION 10.26
N LOSSES DUE TO VOLATILISATION FROM MANURE MANAGEMENT

$$N_{volatilization-MMS} = \sum_S \left[\sum_T \left[\left(N_{(T)} \bullet Nex_{(T)} \bullet MS_{(T,S)} \right) \bullet \left(\frac{Frac_{GasMS}}{100} \right)_{(T,S)} \right] \right]$$

EQUATION 10.27
INDIRECT N_2O EMISSIONS DUE TO VOLATILISATION OF N FROM MANURE MANAGEMENT

$$N_2O_{G(mm)} = \left(N_{volatilization-MMS} \bullet EF_4 \right) \bullet \frac{44}{28}$$

Coefficients used:

	Milking Cows	Non-Milking Cows	Source / Comment
$Frac_{GasMS}$	See below	See below	From Table 10.22, pg 10.65
TAM	650	350	Weight of cows (average)
$N_{ex(T)}$	104.39	36.77	Calculated (kg N per cow per year)
MS	As above	As above	
$N_{(T)}$	1400	1400	Number of each type of cows
EF_4	0.01	0.01	Efault value
$N_{volatisation-MMS}$	**43113.07**	**18533.97**	**Calculated (kg N per year)**
$N_2O_{G(mm)}$	**1580.813**	**679.579**	**Calculated (kg N_2O per year)**

Frac$_{GasMS}$

	Milking Cows	Non-Milking Cows
Un-aerated/aerated dam or tank	35	30
Deep beds	28	30
Composting piles	30	45

RAW MATERIAL MANUFACTURE

All emissions associated with the manufacture of plastics used in the production of bottles, closures and shrink-wrap were derived from Life Cycle Inventory studies (Franklin Associates, 2010).

The three primary atmospheric emissions reported in this analysis that contribute to global warming are fossil fuel-derived carbon dioxide, methane, and nitrous oxide. (Non-fossil carbon dioxide emissions, such as those from the burning of wood, are considered part of the natural carbon cycle and are not considered a net contributor to global warming.) The 100-year global warming potential for each of these substances as reported in the Intergovernmental Panel on Climate Change (IPCC) 2007 report are represented.

Discrepancies in using this data arose primarily from the grid (electricity) emission factor, specifically in activities of the Fair Cape value chain controlled by Hosaf and Sasol. These could not be corrected, due to the cumulative nature of LCA.

PET Resin Manufacture:

The PET resin used in preforms was produced at Hosaf. Due to primary data inaccessibility, secondary data was used for this study. It was assumed that the general production and synthesis process of PET is uniform across the globe. As all raw materials used by Hosaf were supplied by the US and Dubai, the Franklin Associates study (US-based) was assumed to be an acceptable source of secondary data.

This section presents LCA results for the production of polyethylene terephthalate (PET) resin (cradle-to-resin). The results are given on the bases of 1,000 pounds and 1,000 kilograms of PET resin.

Primary data was collected for olefins, acetic acid, PTA and PET resin production.

Olefins: A weighted average was calculated using production quantities from the olefins production data collected from three leading producers (8 thermal cracking units) in North America. As of 2003, there were 16 olefin producers and at least 29 olefin plants in the U.S. The captured production amount was approximately 30 percent of the available capacity for olefin production. Numerous co-product streams are produced from the olefins hydrocracker. Fuel gas and off-gas were two of the co-products produced that were exported to another process for fuel. When these fuel co-products are exported from the hydrocracker, they carry with them the allocated share of the inputs and outputs for their production. A mass basis was used to allocate the credit to the remaining material co-products.

Acetic Acid: Only one company provided 2003 data for acetic acid. This dataset was arithmetically averaged with a confidential dataset from 1994. Mixed acid and off-gas are co-products of acetic acid. A mass basis was used to allocate the credit for the acid, while the energy amount for the off-gas was reported separately as recovered energy.

TPA/PTA and PET Resin: The data included an aggregation of TPA, PTA, DMT, and PET production. New data was collected for DMT, PTA (including TPA), and PET production. A weighted average using production amounts was calculated from the PTA production data from two plants collected from two leading producers in North America. A weighted average using production amounts was also calculated from the PET production data from two plants collected from two leading producers in North America. Data from primary sources in the early 1990's was used for PET from DMT production. The two PET technologies were weighted accordingly at 15 percent PET from DMT and 85 percent PET from PTA.

As of 2003, there were 16 PET producers and 29 PET plants in the U.S. The captured production amount is approximately 15 percent of the 2003 production amount for PET production from PTA in the U.S. and Canada. Scrap resin (e.g. off-spec) and steam are produced as co-products during the production of PET from PTA. A mass basis was used to allocate the credit for scrap, while the energy amount for the steam was reported separately as recovered energy.

Greenhouse Gas Summary for the Production of PET Resin
(lb carbon dioxide equivalents per 1,000 lb PET or kg carbon dioxide equivalents per 1,000 kg PET)

	Fuel-related CO2 Equiv.	Process CO2 Equiv.	Total CO2 Equiv.
Carbon dioxide (fossil)	2,159	296	2,455
Methane	169	159	328
Nitrous oxide	15.0	0	15.0
Methyl bromide	1.4E-05	0	1.4E-05
Methyl chloride	1.5E-04	0	1.5E-04
Trichloroethane	5.2E-05	7.7E-06	6.0E-05
Chloroform	3.2E-05	0	3.2E-05
Methylene chloride	0.0012	0	0.0012
Carbon tetrachloride	0.0040	9.5E-06	0.0040
CFC-012	1.7E-04	0	1.7E-04
HCFC-22	0	3.6E-04	3.6E-04
Total	2,343	455	2,798

Note: The 100 year global warming potentials used in this table are as follows: fossil carbon dioxide--1, methane--25, nitrous oxide--298, methyl bromide--5, methyl chloride--16, trichloroethane--140, chloroform--30, methylene chloride--10, carbon tetrachloride--1400, CFC-012--10,900, HCFC-22--1810, HCFC-123--77, and HFC-134a--1430.

Source: Franklin Associates, A Division of ERG

HDPE & LDPE Resin Manufacture:

Both HDPE (81.6%) and LDPE resin (14.4%) were used in the manufacture of the milk bottle closures. Polyoak sourced the HDPE from Safripol, and the LDPE from Exxon Mobile. Sasol was the only supplier of the feedstock (ethylene gas) for producing HDPE polymer. They produced the ethylene from natural gas extracted from the Mozambican coast as well as from coal mined at Secunda, and converted the natural gas and coal into synthetic fuels using the Fischer-Tropsch technology. The secondary data (described below) was therefore not an accurate depiction of the primary emissions associated with the production of the closures.

HDPE Resin Manufacture

This section presents LCI results for the production of high-density polyethylene (HDPE) resin (cradle-to-resin). The results are given on the bases of 1,000 pounds and 1,000 kilograms of HDPE resin.

Primary data was collected for olefins and HDPE resin production.

Olefins: A weighted average using production quantities was calculated from the olefins production data collected from three leading producers (8 thermal cracking units) in North America. As of 2003, there were 16 olefin producers and at least 29 olefin plants in the U.S. The captured production amount is approximately 30 percent of the available capacity for olefin production. Numerous co-product streams are produced from the olefins hydrocracker. Fuel gas and off-gas were two of the co-products produced that were exported to another process for fuel. When these fuel co-products are exported from the hydrocracker, they carry with them the allocated share of the inputs and outputs for their production. A mass basis was used to allocate the credit to the remaining material co-products.

HDPE resin: A weighted average using production amounts was calculated from the HDPE production data from five plants collected from three leading producers in North America. As of 2003, there were 10 HDPE producers and 23 HDPE plants in the U.S. The captured production amount was approximately 20 percent of the available capacity for HDPE production in the U.S. and Canada. Scrap resin (e.g. off-spec) is produced as a co-product during this process. A mass basis was used to allocate the credit for each co-product.

Greenhouse Gas Summary for the Production of HDPE Resin
(lb carbon dioxide equivalents per 1,000 lb HDPE or kg carbon dioxide equivalents per 1,000 kg HDPE)

	Fuel-related CO2 Equiv.	Process CO2 Equiv.	Total CO2 Equiv.
Carbon dioxide (fossil)	1,377	76.9	1,454
Methane	107	323	430
Nitrous oxide	6.06	0	6.06
Methyl bromide	1.9E-08	0	1.9E-08
Methyl chloride	2.1E-07	0	2.1E-07
Trichloroethane	4.4E-07	4.1E-06	4.6E-06
Chloroform	4.3E-08	0	4.3E-08
Methylene chloride	3.4E-04	0	3.4E-04
Carbon tetrachloride	0.0016	5.1E-06	0.0016
CFC-012	3.4E-05	0	3.4E-05
HCFC-22	0	0.0018	0.0018
Total	1,490	400	1,890

Note: The 100 year global warming potentials used in this table are as follows: fossil carbon dioxide--1, methane--25, nitrous oxide--298, methyl bromide--5, methyl chloride--16, trichloroethane--140, chloroform--30, methylene chloride--10, carbon tetrachloride--1400, CFC-012--10,900, HCFC-22--1810, HCFC-123--77, and HFC-134a--1430.

Source: Franklin Associates, A Division of ERG

LDPE Resin Manufacture

This chapter presents LCI results for the production of low-density polyethylene (LDPE) resin (cradle-to-resin). The results are given on the bases of 1,000 pounds and 1,000 kilograms of LDPE resin.

Primary data was collected for olefins and LDPE resin production.

Olefins: A weighted average using production quantities was calculated from the olefins production data collected from three leading producers (8 thermal cracking units) in North America. As of 2003, there were 16 olefin producers and at least 29 olefin plants in the U.S. The captured production amount is approximately 30 percent of the available capacity for olefin production. Numerous co-product streams are produced from the olefins hydrocracker. Fuel gas and off-gas were two of the co-products produced that were exported to another process for fuel. When these fuel co-products are exported from the hydrocracker, they carry with them the allocated share of the inputs and outputs for their production. A mass basis was used to allocate the credit to the remaining material co-products.

LDPE resin: A weighted average using production amounts was calculated from the LDPE production data from seven plants collected from three leading producers in North America. As of 2003, there were 8 LDPE producers and 15 LDPE plants in the U.S. The captured production amount was approximately 30 percent of the 2003 production amount for LDPE production in the U.S. and Canada. Scrap resin (e.g. off-spec) and steam are produced as co-products during this process. A mass basis was used to allocate the credit for scrap, while the energy amount for the steam was reported separately as recovered energy.

Greenhouse Gas Summary for the Production of LDPE Resin
(lb carbon dioxide equivalents per 1,000 lb LDPE or kg carbon dioxide equivalents per 1,000 kg LDPE)

	Fuel-related CO2 Equiv.	Process CO2 Equiv.	Total CO2 Equiv.
Carbon dioxide (fossil)	1,617	88.3	1,705
Methane	137	358	495
Nitrous oxide	7.42	0.30	7.72
Methyl bromide	2.0E-08	0	2.0E-08
Methyl chloride	2.2E-07	0	2.2E-07
Trichloroethane	3.9E-07	2.9E-06	3.3E-06
Chloroform	4.5E-08	0	4.5E-08
Methylene chloride	3.2E-04	0	3.2E-04
Carbon tetrachloride	0.0017	3.6E-06	0.0017
CFC-012	2.9E-05	0	2.9E-05
HCFC-22	0	1.81	1.81
Total	1,762	448	2,210

Note: The 100 year global warming potentials used in this table are as follows: fossil carbon dioxide--1, methane--25, nitrous oxide--298, methyl bromide--5, methyl chloride--16, trichloroethane--140, chloroform--30, methylene chloride--10, carbon tetrachloride--1400, CFC-012--10,900, HCFC-22--1810, HCFC-123--77, and HFC-134a--1430.

Source: Franklin Associates, A Division of ERG

Preform Manufacture at Polyoak:

Only electricity was used at Polyoak in the production of preform bottles.

	500ml	1 litre	2 litre
Weight (grams)	20	32	48
Electricity per 1000 units (kWh)	17.4	28	41.8
Electricity per unit	0.0174	0.028	0.0418
Electricity per gram	0.000870	0.000875	0.000871
Emissions per gram	0.0008961	0.00090125	0.000896958
Emissions per unit (at Polyoak)	0.017922	0.02884	0.043054

An additional additive – UV stabiliser – is added to the PET at 150g per tonne. The manufacture of this additive was omitted as it was considered to be immaterial.

Closure Manufacture at Polyoak:

Only electricity was used at Polyoak in the manufacture of closures.

Type	Energy requirement (MJ/1000 closures)	kWh/1000 closures	EF (kg CO_2e / 1000 closures)
Closures	4.86	1.350	1.392

Additional additives – Slip Additive and Master Batch - were omitted from this study as they were considered immaterial emission sources.

Shrink-Wrap Manufacture and use at LT Plastics

As mentioned above, all LDPE was sourced from Sasol, but the data used was based on a US-based study (Franklin Associates, 2010). Accuracy was reduced due to the different process used as compared to the Fischer-Tropsch technology primarily used by Sasol.

4 tonnes of shrink-wrap was used by Fair Cape per month. 50.1% of all products distributed were Milk Products, and 44.8% of all Milk products were Fair Cape Eco-Fresh™ Milk. 0.9 tonnes of plastic shrink-wrap was therefore used for the Eco-Fresh™ milk products.

Paper Use in Labels

Mondi-specific emission factors were used to determine emissions from the paper used in the labels (930kg per tonne of paper).

The following assumptions were made:

	500ml	1 litre	2 litre
Paper use (proportion of A4)	**25%**	**33.33%**	**50%**

Emissions associated with printing, ink and glue production, were not calculated due to immateriality.

RAW MATERIAL DISTRIBUTION

Emissions associated with the transportation of supplies included the following:

- Distribution of feed into Farm
- Transportation of PTA & EG to Hosaf
- Transportation of PET to Polyoak
- Transportation of Preforms to Fair Cape
- Transportation of LDPE & HDPE to Polyoak
- Transportation of Closures to Fair Cape
- Transportation of shrink-wrap to Fair Cape
- Distribution from Farm to Milk facility

Distribution of feed to Farm:

Data was based on the 2009 Fair Cape Dairy Parlour Carbon Footprint Report, as follows.

Type	Origin	Trips per month	Tonnes	Km	Truck type	EF (kg CO_2e / tonne.km)
Maize:	Bloemfontein	9	34	1058	Large articulated	0,08778
Lucerne:	Douglas	5	34	861	Large articulated	0,08778
High Protein concentrate	Malmesbury	18	14	48	Medium articulated	0,15438
Other	Wellington	30	6	44	Small truck	0,66666
Other	Cape Town	5	34	26	Large articulated	0,08778
Other	Cape Town	2	20	26	Large articulated	0,08778

Transportation of PTA & MEG to Hosaf:

Type	Tonnes	Origin	km	EF (kg CO_2e / tonne.km)
MEG	28	UAE (Dubai)	7936.6	0.0126
PTA	26	USA (Florida)	14890	0.0126

Transportation of PET to Polyoak (from Hosaf):

Type	Tonnes	Origin	km	EF (kg CO_2e / tonne.km)
PET Pellets	33	Hosaf (durban)	1600 (each way)	0.15438

Transportation of Preforms to Fair Cape:

Type	Fuel consumption (litres of diesel/100km)	km	EF (kg CO_2e litre)
Preform (bottles)	25 (500ml bottles) 26 (1-litre bottles) 27 (2-litre bottles)	90km (return trip)	2.672

Transportation of LDPE & HDPE to Polyoak:

Type	Tonnes	Origin	km	EF (kg CO_2e / tonne.km)
HDPE	33	Mozambique	1200 (each way)	0.08778

Transportation of Closures to Fair Cape

Type	Tonnes	Origin	km	EF (kg CO2e / tonne.km)
Closures	33	Polyoak (Cape Town)	90km (return trip)	0.15438

Transportation of shrink-wrap to Fair Cape

Type	Tonnes	Origin	km	EF (kg CO_2e / tonne.km)
Shrink-wrap	10	LT Plastics (Breckenfell	30km (return trip)	0.41693

Distribution from Farm to Milk facility

Type	Fuel Consumption (litres diesel/ month)	Litres of milk produced annually	EF (kg CO_2e litre)
Milk	221.5	19 929 000	2.672

PROCESSING

Emissions from processing at the Kuiperskraal facility included emissions from:

- Electricity consumption;
- Low sulphur oil used in boilers; and
- Refrigeration gases.

Electricity Consumption

The following production figures at Kuiperskraal were used:

	Total Milk packed	Total Eco-Fresh™ packed	Total litres pasteurized	Total Juice packed	Total (kWh)
Oct-09	1811333.00	867425.00	1882085.00	171945.00	244 074.00
Nov-09	1770980.00	806771.00	1839042.00	176384.00	260 168.00
Dec-09	1629671.00	755237.00	1744832.00	205512.00	281 737.00
Jan-10	1674906.00	818142.00	1745244.00	214312.00	291 760.00
Feb-10	1732413.00	804352.00	1806539.00	150524.00	306 685.00
Mar-10	1839144.00	847239.00	2132056.00	194828.00	278 011.00
Apr-10	1938458.00	791613.00	2265056.00	195148.00	284 256.00
May-10	1828809.00	791317.00	2216714.00	125568.00	266 498.00
Jun-10	1826066.00	811597.00	2215244.00	134060.00	261 469.00
Jul-10	1768869.00	774994.00	2030878.00	133572.00	252 724.00
Aug-10	1821012.00	785727.00	2211128.00	105360.00	254 620.00
Sep-10	1689637.00	700536.00	2000783.00	116412.00	275 673.00

It is important to account for shared refrigeration between milk and all other products, and for shared energy used in the processing of milk between the Eco-Fresh™ milk and other milk.

The kW rating of each item of machinery was therefore sourced:

Electric Equipment (non refrigeration)

Cost Centre	Overall Description	Description	Manufacturer	Model	Specs
Prep	Milk reception	Milk reception pump- Motor	Inoxpa	SE-26E	4kW
Prep	Milk reception	Milk Silo 1- Motor	WEG		4kW
Prep	Milk reception	Milk Silo 2- Motor	WEG		3kW
Prep	Milk reception	Milk Silo 3- Motor		145011	7kW
Prep	Milk reception	Milk Silo 4- Motor	Motoreli	1L90L-4 B3	1.5kW
Prep	Milk reception	Pump from PHE to UV unit-	Sew	DFV100M4	2.2kW;

		Motor			IP55
Prep	Prep	Milk preparation	Homogeniser	APV	6,47kw
Prep	Prep	Separator			15kw
Proc	CIP- outside	CIP return pump from silo's- Motor	Inoxpa	A-150	4kW
Proc	CIP- outside	CIP supply pump to Holing tanks- Motor	Inoxpa		1.1kW
Proc	Fresh water unit outside	Pump from green water tanks- Motor	ABB		4kW
Proc	Ground floor Holding silo 1	Motor 1			0.1kW
Proc	Ground floor Holding silo 1	Motor 2			0.1kW
Proc	Ground floor Holding silo 2	Motor	Mueller		0.37kW
Proc	Ground floor Holding silo 3	Motor	Mueller		0.37kW
Proc	Holding silo ground floor area	Pump from outside- Motor			0.37kW
Proc	Holding silo ground floor area	Pump from holding silo 1- Motor	Leroy Somer	LS80 P	0.55kW
Proc	Holding silo ground floor area	Pump from holding silo 2 & 3- Motor	Bonfiglioli		3kW
Proc	Holding silo- Low fat milk	Motor	Fenner	63	0.18kW
Proc	Holding silo- Low fat milk	Pump from low fat milk silo- Motor	Inoxpa	SE-35C	2.2kW
Proc	Holding silo- Full Cream Milk	Motor	Bonfiglioli		0.37kW
Proc	Holding silo- Full Cream Milk	Pump from Full cream silo- Motor	Inoxpa	SE-35C	2.2kW
Prep	Milk preparation	Pump from receive tank to PHE- Motor			3kW
Prep	Milk preparation	Warm water pump- Motor			1.5kW
Prep	Milk preparation	Cream receive tank- Motor	Leroy Somer	LS80LT	0.55kW
Prep	Milk preparation	Pump from cream tank- Motor			1.1kW
Proc	Holding tank 1	Motor	Leroy Somer	LS90L	1.1kW
Proc	Holding tank 2	Motor	CMG	SLA905 6	0.75kW
Proc	Holding tank 3	Motor	SEW		3kW
Proc	Holding tank 4	Motor	Leroy Somer	LS90L	2.2kW
Proc	Holding tank 5	Motor			2.2kW
Proc	Holding tank 6	Motor	Leroy Somer	LS9D5	2.2kW
Proc	Holding tank 7	Motor	Leroy Somer	LS90L	2.2kW
Proc	CIP- inside	Tank 1- Motor	Leroy Somer	LS80L2	1.1kW
Proc	CIP- inside	CIP supply pump between CIP tanks to holding tanks- Motor	Inoxpa	SE-26E	5.5kW
Proc	CIP- inside	CIP pump behind holding tank 4- Motor	Inoxpa	A-150	5.5kW
Proc	Holding tank area	Pump to PHE- Motor	Inoxpa	SE-15A	1.1kW
Proc	Holding tank area	Mobile pump- Motor	Electra Rewinding		2.2kW
Pack	Packing machine- 2L	Feeder- Motor	Bonfiglioli	BN71B4	0.37kW
Pack	Packing machine- 2L	Filling and capping machine	FOGG		2,2kw
Pack	Packing machine- 2L	Label machine	GERNEP	Rollina 6-480	2,75kw

Pack	Packing machine- 2L	Sleeving machine	Acepak	650 SCF	36kw
Pack	Sachet packing	Sachet machine 1- Left			2kw
Pack	Sachet packing	Sachet machine 2- Right			0,37kw
		One way packaging	Acepak		27kw
Pack	Pack	Cream Packing- 250ml	machine		0,55kw
LAB	Laboratory equipment	Auto clave			900W
LAB	Laboratory equipment	Milk analyser	Ecomilk	KAM 98-20	30W; 50Hz
Service	Water cooling system	Chiller	Climaveneta	HPAT/B1204	162kw
Service	Water cooling system	Pump 1 from Chiller- Motor	Vertrix	VMN 160A	4kw
Service	Water cooling system	Pump 2 from Chiller- Motor	Vertrix	VMN40 160A	4kw
Service	Water cooling system	Pump to PHE- Motor	Calpeda	NM 25/160BE	1.1kw
Service	Water cooling system	Pump from PHE to Sement water tank- Motor	Femco	1502315	0.75kw
Service	Water cooling system	Pump from sement water tank- Motor	Leroy Somer	LS80L	0.75kw
Service	high/Low pressure system	Compressor 1- Standby	Kaeser	N 501-G	55kw
Service	high/Low pressure system	Compressor 2- Links	Kaeser	N 501-G	15kw
Service	high/Low pressure system	Compressor 3- Regs	Kaeser	N 501-G	15kw
Service	Boiler	Pump to hotwell- Motor			2.2kw
Service	PET plant chiller	System pump for chiller- Motor	EBARA	MD/A40-200/7.5	7.5kw
Service	Service	Compressor 1	GA55		55kw
Service	Service	Ysbank	Compressor + fan unit	A3370BC0900	820W
Service	Service	Ysbank	Compressor + fan unit	A3370BC0901	820W
Service	Service	high/Low pressure system	Air Dryer	Kaeser	3kw
Service	Service	high/Low pressure system	Air dryer	HIROSS	3kw
Service	Service	Boiler			27,75kw
Service	Service	Generator 1	Generator- Left	500G6	
Service	Service	Generator 2	Generator- Right	500G6	
Prep	PET bottle blower 1	Bottle foarming	UROLA	URBL 2	48kw
Building	Aircon	Cooling unit + Outdoor unit	Samsung	SH09ZWB	2.6kw
Building	Aircon	Cooling unit + Outdoor unit	Vatley	KPR-230W/Y	230W
Building	Aircon	Cooling unit + Outdoor unit	Samsung	AQ12A2MEA	1,17kw

Refrigeration Equipment

Cost Centre	Overall Description	Description	Manufacturer	Model	Specs
FCF					
Coldroom	Refridgeration	Compressor and fan unit- Links			11,19kw
Coldroom	Refridgeration	Compressor and fan unit			8,39kw
Coldroom	Refridgeration	Compressor and fan unit			8,39kw
Coldroom	Refridgeration	Compressor and fan unit			8,39kw
Coldroom	Refridgeration	Compressor and fan unit-			17,34

		Regs			
Coldroom	Coldroom- Big	Compressor 5	Carrier		14,89kw
Coldroom	Cold room- FCF	Blower (2)	Recam	RLT 3900	610W
Coldroom	Cold room- FCF	Blower (2)	Recam	RST 4100	610W
Coldroom	Cold room- FCF	Blower (3)	Recoil	RST 7000	1015W
Coldroom	Cold room- FCF	Blower (3)	Recoil		1015W
Coldroom	Cold room- FCF	Blower (3)	Recoil	RST 7001	1015W
Coldroom	Cold room- FCF	Blower (3)	Recoil		1015W
Coldroom	Cold room- FCF	Blower (5)	VUCON		75W
Coldroom	Cold room- FCF	Blower (5)	VUCON		75W
Coldroom	Cold room- FCF	Blower (5)	VUCON		45W
Coldroom	Cold room- FCF	Blower (5)	VUCON		45W
DC0					
Coldroom	Coldroom- Big	Compressor 1	Carrier		14,89kw
Coldroom	Coldroom- Big	Compressor 2	Carrier		14,89kw
Coldroom	Coldroom- Big	Compressor 3	Carrier		14,89kw
Coldroom	Coldroom- Big	Compressor 4	Carrier		14,89kw
Coldroom	Cold room- DC0	Blower(3)- From compressor 1	Recoil		1015W
Coldroom	Cold room- DC0	Blower(3)- From compressor 1	Recoil		1015W
Coldroom	Cold room- DC0	Blower(3)- From compressor 1	Recoil		1015W
Coldroom	Cold room- DC0	Blower(3)- From compressor 1	Recoil		1015W
Coldroom	Cold room- DC0	Blower(3)- From compressor 2	Recoil		1015W
Coldroom	Cold room- DC0	Blower(3)- From compressor 2	Recoil		1015W
Coldroom	Cold room- DC0	Blower(3)- From compressor 2	Recoil		1015W
Coldroom	Cold room- DC0	Blower(3)- From compressor 2	Recoil		1015W
Coldroom	Cold room- DC0	Blower(3)- From compressor 3	Recoil		1015W
Coldroom	Cold room- DC0	Blower(3)- From compressor 3	Recoil		1015W
Coldroom	Cold room- DC0	Blower(3)- From compressor 3	Recoil		1015W
Coldroom	Cold room- DC0	Blower(3)- From compressor 3	Recoil		1015W
Coldroom	Cold room- DC1	Blower(3)- From compressor 4	Recoil		1015W
Coldroom	Cold room- DC2	Blower(3)- From compressor 4	Recoil		1015W
Coldroom	Cold room- DC3	Blower(3)- From compressor 4	Recoil		1015W
Coldroom	Cold room- DC4	Blower(3)- From compressor 4	Recoil		1015W

Electricity Consumption was allocated as follows:

Where Eco-Fresh™ Milk represented 41% of total milk, and 45% of total refrigeration.

Low Sulphur Oil

The table below shows the emissions associated with low sulphur oil used in the boilers.

		Steam produced	Fuel (litres)	Emissions (kg CO2e)	Total litres pasteurised	Emissions per litre pasteurised
Oct	2009	220.00	15 840.00	42324.48	1882085.00	0.022488
Nov	2009	236.32	17 015.04	45464.19	1839042.00	0.024722
Dec	2009	251.75	18 126.00	48432.67	1744832.00	0.027758
Jan	2010	237.50	17 100.00	45691.20	1745244.00	0.026180
Feb	2010	181.50	13 068.00	34917.70	1806539.00	0.019329
Mar	2010	220.50	15 876.00	42420.67	2132056.00	0.019897
Apr	2010	205.00	14 760.00	39438.72	2265056.00	0.017412
May	2010	189.90	13 672.80	36533.72	2216714.00	0.016481
Jun	2010	165.40	11 908.80	31820.31	2215244.00	0.014364
Jul	2010	186.41	13 421.52	35862.30	2030878.00	0.017659
Aug	2010	223.50	16 092.00	42997.82	2211128.00	0.019446
Sep	2010	218.40	15 724.80	42016.67	2000783.00	0.021000
TOTAL				**487920.45**	**24089601.00**	**0.020254**

Refrigeration Gases

A total of 90kg of R22 gas was used in the reporting year for the refrigeration of milk.

Area	Cost Centre	Total (kW)	Electricity Proportion	kWh	Fair Cape Eco-Fresh™ Elec (kWh)
Common	Building	4	0.57%	18580.77855	7634.444115
	LAB	0.93	0.13%	4320.031014	1775.008257
	Pack	71.24	10.16%	330923.666	135969.4497
	Prep	97.32	13.88%	452070.3422	185746.0253
	Proc	47.96	6.84%	222783.5349	91536.98494
	Service	329.94	47.05%	1532635.519	629727.1228
Common Total		551.39	78.62%	2561313.872	1052389.035
FCF Refrigeration	Coldroom	74.11	10.57%	344255.3747	154202.66
FCF Refrigeration Total		74.11	10.57%	344255.3747	154202.66
DC0 Refrigeration	Coldroom	75.8	10.81%	352105.7536	0
DC0 Refrigeration Total		75.8	10.81%	352105.7536	0
Grand Total		**701.3**	**100.00%**	**3257675**	**1206591.695**

DISTRIBUTION

98.2% of all fresh milk processed and packaged through the Kuiperskraal facility was transported and delivered through Fair Cape's internal distribution network to distribution centres. The balance was send to Johannesburg and George respectively and was delivered to the various retailers by a sub-contractor. All trucks are refrigerated.

In total 41.719 million litres of product was transported nationally. This included milk and value added products. The internal local distribution network handled 61% of this total volume. Fresh milk constituted ±50.1% of the total volume.

The Fair Cape delivery fleet's average fuel yield was 3.04km/litre. This covered 98.2% of all fresh milk delivery. The fleet travelled an average of 21 523km per week and used 30 680 litres of fuel per month.

Each refrigerated trucks cooling unit contained 1.97kg of R404A (HFC) gas. During an annual period, 4 leakages were detected and approximately 8kg of gas was replaced. Dry nitrogen was used during pressure tests to detect gas leakages thereby minimizing R404A exposure to the atmosphere.

ALLOCATION

Allocation of emissions between full cream, low fat and fat free milk products was done on an economic basis. This was based on cream values as supplied by Fair Cape in table below:

	Total	Skim	Cream	%
Full cream		97,0%	3,0%	
R/l	R 6,78			
	1000,00	970,00	30,00	
Low Fat		98,0%	2,0%	
R/l	R 6,78			
	1000,00	980,00	20,00	
Cream skimmed off	25	15	10	
Value of cream	R 0,52			8%
Skim (Fat Free)		99,5%	0,5%	
R/l	R 6,94			
	1000,00	995,00	5,00	
Cream skimmed off	62,5	37,50	25,00	
Value of cream	R 1,30			19%
cream (1l)	R 16,51			
(250g)	R 25,00			
Ave	R 20,76	60,0%	40,0%	
	1000,00	600	400	