

Carbon footprint of Good Natured 'from concentrate' and not-from-concentrate fruit juice, post juicing to packing.

Final Report

December 2007


Good Natured Limited

Carbon footprint of Good Natured 'from concentrate' and not-from- concentrate fruit juice, post juicing to packing.

Final Report

December 2007

Prepared by Tom Penny, Michael Collins, and Jonna
Meyhoff Fry

For and on behalf of Environmental Resources Management
Approved by: Paul Fletcher _____
Signed:  _____
Position: Partner _____
Date: 24 December 2007 _____

This report has been prepared by Environmental Resources Management the trading name of Environmental Resources Management Limited, with all reasonable skill, care and diligence within the terms of the Contract with the client, incorporating our General Terms and Conditions of Business and taking account of the resources devoted to it by agreement with the client.

We disclaim any responsibility to the client and others in respect of any matters outside the scope of the above.

This report is confidential to the client and we accept no responsibility of whatsoever nature to third parties to whom this report, or any part thereof, is made known. Any such party relies on the report at their own risk.

CONTENTS

<i>EXECUTIVE SUMMARY</i>	<i>I</i>
<i>1 GOAL AND SCOPE OF THE STUDY</i>	<i>1</i>
<i>1.1 GOAL OF THE STUDY</i>	<i>1</i>
<i>1.2 SCOPE OF THE STUDY</i>	<i>1</i>
<i>2 CARBON FOOTPRINT RESULTS AND CONCLUSIONS</i>	<i>8</i>
<i>3 REFERENCES</i>	<i>9</i>

EXECUTIVE SUMMARY

Climate change and sustainable energy supply issues are receiving increased media coverage and consumer interest. Recent public surveys indicate that climate change is the issue likely to cause most concern in the next 20 years. A raft of climate change and energy policy measures are in place at the UK, European and international level, but to achieve deep cuts in carbon emissions efforts are required from us all, from multi-national to smaller businesses to individuals. Good Natured Limited has taken the, significant, first step by investigating the carbon footprint of its juice products. In this instance, the carbon footprints concentrate on the difference between Good Natured's 'from concentrate' and not-from-concentrate orange juices. This means that only the processes from concentration or pasteurisation to packing and filling is included, not the full life cycle.

ERM was commissioned to assist Good Natured and its suppliers in collecting data to inform the calculation of the carbon footprint of two orange juice products, and in carrying out the calculation itself.

The study was constrained in its timescale in that Good Natured wanted the work completed as quickly as possible. It is important to recognise that the value of the work revolves primarily around the quality of the data supplied by the various parties along the supply chain, and the learning about data availability, data gaps and the significance of the different processes involved. It must be highlighted that, due to shortfalls in data availability over the study timescale and the need to use generic data, the footprints themselves could be improved in accuracy if additional data become available. However, as they are, they still provide good indications of the magnitude of the carbon footprint and of the issues involved in making comparisons.

The carbon footprint of the two orange juices studied is shown in *Table 0.1* below.

Table 0.1 *Total carbon footprint results for Good Natured orange juices*

	Good Natured orange juice, 'from concentrate'	Good Natured orange juice, not-from-concentrate
Carbon footprint kg CO ₂ equivalents per 1,000 litre juice	170	510

As can be seen, the carbon footprint of the not-from-concentrate comes out three times as high as the carbon footprint of the 'from concentrate'. This is partly due to the greenhouse gas emissions from the higher energy consumption for the pasteurisation process as well as the bigger volume of juice being transported.

1 GOAL AND SCOPE OF THE STUDY

1.1 GOAL OF THE STUDY

This project aimed to provide the information to understand the difference in greenhouse gas impacts of the two Good Natured products:

- Good Natured orange juice, 'from concentrate'; and
- Good Natured orange juice, not-from-concentrate.

The objective of the study was to determine the difference in carbon footprint between the two orange juice products. The objective was not to consider the whole life cycle of the two products. This meant that only the processes that differ for the two products are considered.

1.2 SCOPE OF THE STUDY

1.2.1 *Functional unit*

When conducting a comparative study it is important that the functions of the different product systems are equivalent in order to allow fair comparison of the carbon footprinting results.

The functional unit for this study was 1,000 litres of orange juice, packaged in one litre consumer packaging.

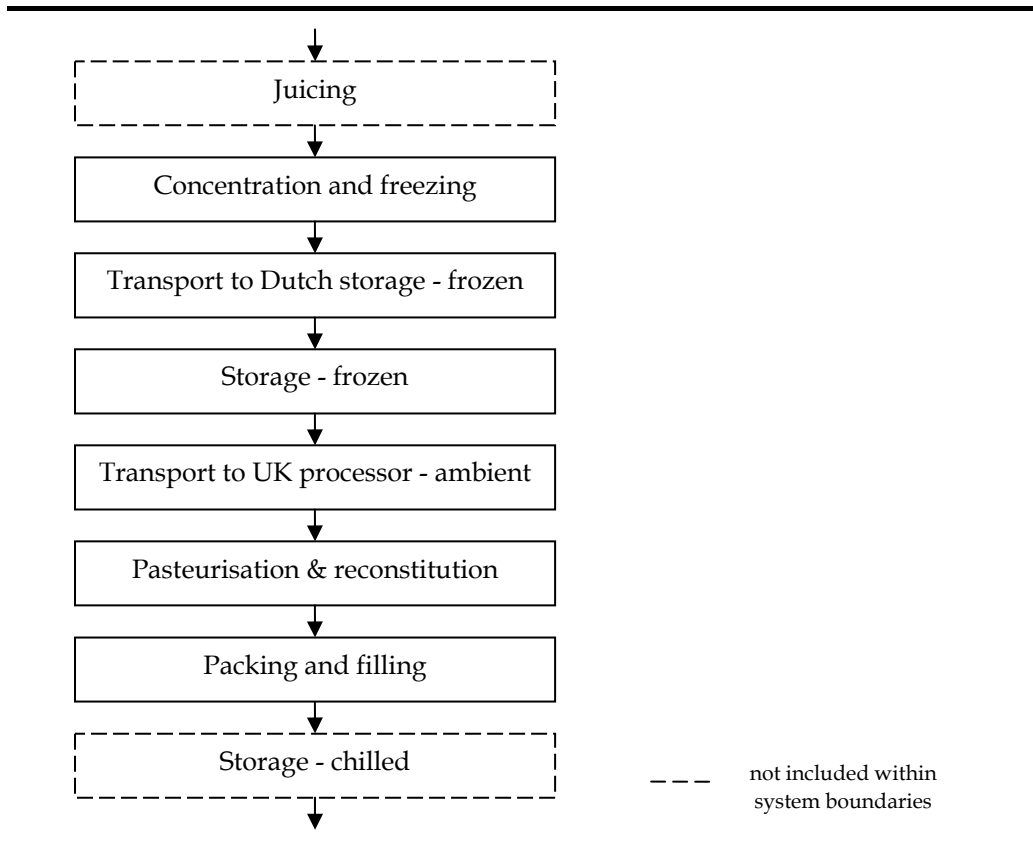
1.2.2 *System boundaries*

This study did not cover the full life cycle of the two products, but instead focused on the difference between the two products due to the different processing methods (ie 'from concentrate' and not-from-concentrate). Therefore, the processes included are post juicing to packing in consumer packaging. This is illustrated in *Figure 1.1* and *Figure 1.2* below.

As can be seen from *Figure 1.1*, the 'from concentrate' juice undergoes concentration at the Costa Rican processor through evaporation of the water content of the juice, reducing the volume of the juice by 86.4%. The concentrate is then filled into 200 litre metal drums with liner and frozen. The drums are transported by lorry to the port of Puerto Limon, loaded onto a transoceanic freight ship and shipped, in freezer units, to the Dutch port of Rotterdam. The drums are offloaded onto lorries and transported to the storage facility where they are stored in freezer units for an estimated average of 30 days. When ready for shipment to the UK, the drums are transported by lorry back to the Rotterdam port, loaded onto a freight ship and transported to the UK. The port is assumed to be Southampton. This shipment is done under ambient conditions, allowing the concentrate to have defrosted by the

time it reaches the UK processor. From Southampton the drums are transported via lorry to the processors, where the concentrate is decanted, pasteurised and reconstituted, and filled into consumer packaging and palletised.

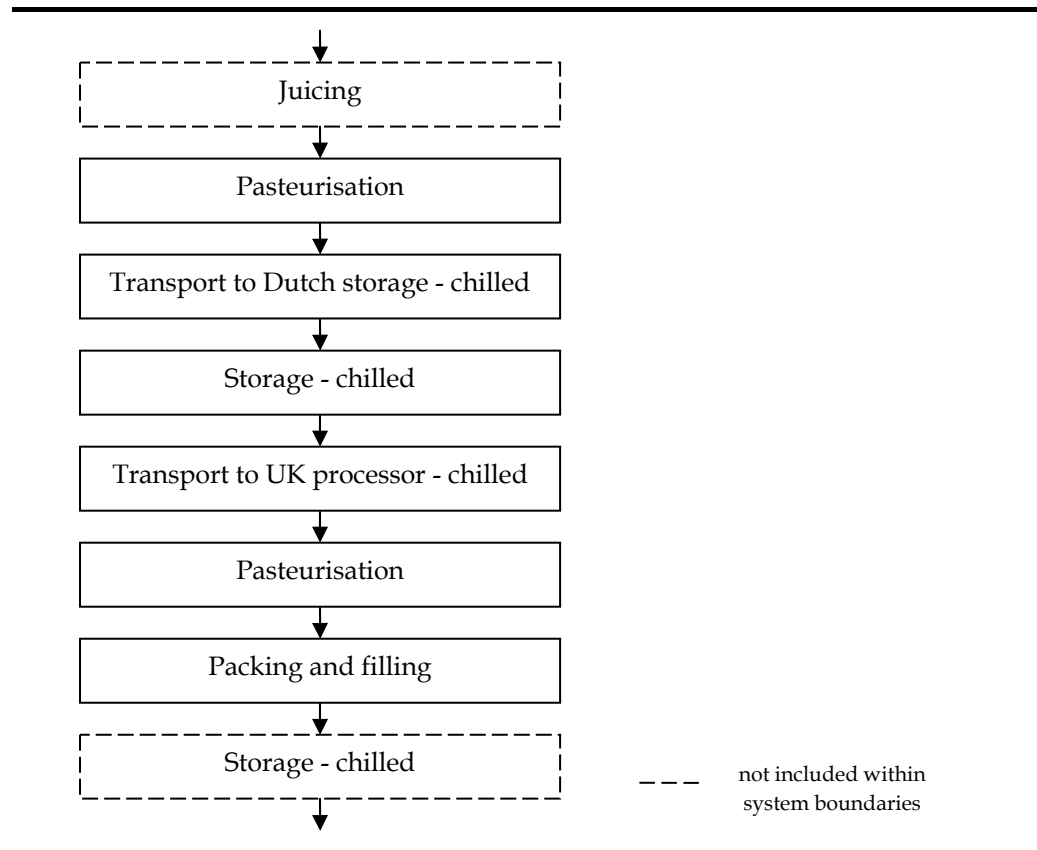
Figure 1.1 *System boundaries for the 'from concentrate' system*



The not-from-concentrate juice is pasteurised at the Costa Rican processor before being filled into 200 litre metal drums with liner and transported by lorry to the port of Puerto Limon. There the drums are loaded onto a transoceanic freight ship and shipped, in chiller units, to the Dutch port of Rotterdam. The drums are offloaded onto lorries and transported to the storage facility where they are stored in chiller units for an estimated average of 30 days. When ready for shipment to the UK, the drums are transported by lorry back to the Rotterdam port, loaded onto a freight ship and transported, in chiller units, to the assumed UK port of Southampton. From Southampton the drums are transported via lorry to the processors, where the juice is decanted, re-pasteurised and filled into consumer packaging and palletised.

The processes of filling and packing are similar for both products. These have nevertheless been included due to the way energy is measured at the UK processor's facility.

Figure 1.2 System boundaries for the not-from-concentrate system



For each process, the energy and material use is quantified and traced back to the consumption of natural resources. In addition, all outputs to air, water and land are quantified. The main source for such data has been the life cycle inventory database, ecoinvent.

The following paragraphs details the data used for the different processes.

Costa Rican processes (concentration, freezing, and pasteurisation)

Electricity, heavy fuel oil and water consumption data have been provided by the Costa Rican processor. The Costa Rican electricity mix has been modelled based on the statistical data provided by the International Energy Agency. Heat generated from heavy fuel oil is modelled based on generic data for an industrial furnace. Water consumption during the process is based upon UK data for energy spent in supplying a specific volume of water (Water UK 2003). The electricity mix has in this case been converted to the Costa Rican mix.

Due to lack of information, it is assumed that the density of the frozen concentrate is the same as the specific gravity of the unfrozen concentrate. Any inaccuracy in this assumption is considered to have minimal effect on the final result.

In addition, packaging in the form of 200 litre metal drums with plastic liner is included.

A small proportion of waste is produced from the process. This waste is in the form of caustic soda used for cleaning. This has not been included due to lack of data relating to the generation, use and disposal of caustic soda.

No loss of juice during the concentration, freezing and pasteurisation processes has been reported by the Costa Rican processor.

Costa Rican electricity mix

The Costa Rican electricity mix was modelled based on data from the International Energy Agency's (IEA) 2004 statistics (IEA 2007). The electricity mix as used for this study is as shown in *Table 1.1* below. The electricity model also accounts for losses from the electricity distribution network. A net loss of 12.47% has been assumed based on IEA data (IEA 2007).

Table 1.1 *Costa Rican electricity mix used in this study*

Fuel source	IEA mix	Mix modelled	Comments
Oil	2%	2%	
Biomass	4%	8%	Wood co-generation is assumed.
Hydro	79%	91%	
Geothermal	12%		Due to lack of data for geothermal electricity this is modelled as hydro.
Other	4%		Due to lack of information about what this is, this is modelled as wood co-generation.

Transport to Costa Rican Port

Truck transportation is used to deliver the filled drums to the port of Puerto Limon for further shipping. Diesel consumption of the trucks has been specified and is assumed to include the fuel consumed in maintaining the juice as frozen and chilled, respectively, during transit. This assumption was based on the diesel fuel consumption varying between the 'from concentrate' and not-from-concentrate transportation.

Shipping from Costa Rica to the Netherlands

The distance travelled by transoceanic freight ship from the port of Puerto Limon to Rotterdam, the Netherlands, was specified by the Costa Rican processor. The distance is 5,500 nautical miles, which has been verified using Internet tools for sea transport (World Ports Distances 2007, International Freight Exchange 2007).

It was not possible to obtain data for the fuel consumption required for maintaining the drum content chilled or frozen. It was therefore assumed that the energy consumption was similar to that of the chiller and freezer unit of the Dutch storage facility. The electricity for the units is assumed to be generated by fuel oil.

Transport from the Dutch port to the storage facility

It is assumed that the filled drums are transported from the port of Rotterdam to the storage facility nearby by lorry. A transport distance was calculated based upon a location map on the web site of the storage facility and Internet road maps (Googlemap 2007). Data for transport by a 40 tonne articulated lorry were used to model the transportation.

It is assumed, due to the short distance of transportation between the port and the storage facility, that the lorry is not equipped with a temperature control unit. Should this assumption be wrong, the additional energy consumed during transport for such a short distance would have minimal impact on the final results.

Storage in the Netherlands

Energy consumption for storage has been provided by the Dutch storage facility as electricity consumption per tonne per day. It is assumed that the frozen concentrate is stored in Holland for an average of 30 days as specified by Good Natured (Greg Boyle 2007).

The Dutch electricity mix has been modelled based on the statistical data for 2004 by the International Energy Agency.

No waste is reported by the Dutch storage facility.

Dutch electricity mix

The Dutch electricity mix was modelled based on data from the International Energy Agency's (IEA) 2004 statistics (IEA 2007). The electricity mix as used for this study is as shown in *Table 1.1* below. The electricity model also accounts for losses from the electricity distribution network, which has been assumed to be 15.69% based on IEA data.

Table 1.2 *Dutch electricity mix used in this study*

Fuel source	IEA mix	Mix modelled	Comments
Coal	26%	26%	
Oil	3%	3%	
Gas	61%	61%	
Biomass	2%	7%	Wood co-generation is assumed.
Waste	3%		Due to lack of data for electricity generated from waste incineration this is modelled as wood co-generation.
Nuclear	4%	4%	
Hydro	<1%		
Solar PV	<1%		
Other	2%		Due to lack of information about what this is, this is modelled as wood co-generation.

Transport from storage facility to Dutch port

This transport stage is similar to the transportation on arrival in the Netherlands, ie from the port to the storage facility. Upon leaving the storage facility, the frozen concentrate is allowed to thaw for the remainder of the journey and therefore not maintained as frozen from this point on.

Shipping from the Dutch port to the UK port

The distance travelled by freight ship to the port of Southampton has been estimated using an Internet port distance tool (World Ports Distances 2007). The distance is estimated to be 252 nautical miles.

As the concentrate is allowed to thaw, no energy consumption for maintaining the juice as frozen was included in this shipping stage. For the chilled not-from-concentrate, energy consumption similar to that of the chilling unit of the Dutch storage facility has been assumed.

Transport from the UK port to UK processor

The filled drums are transported from the port of Southampton to the UK processor in Somerset by lorry. A transport distance was calculated based upon an Internet road distance tool (The AA 2007). Data for transport by a 40 tonne articulated lorry were used to model the transportation.

For the chilled not-from-concentrate, energy consumption similar to that of the chilling unit of the Dutch storage facility has been assumed.

UK processing (reconstitution, pasteurisation, packing and filling)

The final processing stage involves, for the 'from concentrate' juice, reconstitution of the juice, pasteurisation, filling and packing, and for the not-from-concentrate juice, pasteurisation, filling and packing. Since the facility does not yet process orange juice for Good Natured, the data provided were based on the facility's typical production figures per litre of processed juice.

The data provided include reconstitution ratio, electricity and natural gas consumption and packaging waste handling. The reconstitution requires approximately one fifth concentrate to produce the final juice product. Data for electricity and natural gas usage was provided separated into three distinct stages based on the processes it required. Stage one includes the receiving of drums, decanting and disposing of the drums and plastic liners. It was estimated by the processor that this component accounts for 20% of the energy usage of the plant. Stage two was estimated to account for 60% of the plants energy usage and includes heat treatment of the juice, cooling, filling, palletisation and loading the product onto transport. Although not specified it is assumed that reconstitution occurs at the beginning of this stage. Stage three includes chilled storage of the final product at the plant as well as administrative, technical and engineering services. Stage three has been excluded as this is beyond the system boundaries of this study.

The allocation of the processor's electricity consumption by splitting it into stages means that, for the 'from concentrate' juice, stage one is only considered for one fifth of the final juice product as this is the volume of concentrate used. Stage two involves the entire final juice product as the juice has been reconstituted at this point.

The UK processor has reported that they purchase green electricity. They allow their customers to make use of the low CO₂ emissions of the production facilities by paying an extra 0.07 pence per kilo or litre of product. The purchase of green electricity presents an interesting issue for carbon footprint practitioners, in that the processing facility consumes electricity from the public electricity network, but has engaged in a contract for purchasing green electricity. There is little or no guidance on the correct way of dealing with this situation, although there can be no doubt that financing and supporting renewable energy schemes is a worthy undertaking. Without categorical guidance from the carbon footprint community, and without evidence as to whether Good Natured intend to contribute towards the green electricity, it has been decided to use the UK electricity mix for electricity consumed in the UK.

The UK electricity mix has been modelled, similarly to the Costa Rican and Dutch electricity mixes, based on the statistical data for 2004 by the International Energy Agency.

UK electricity mix

The UK electricity mix was modelled based on data from the International Energy Agency's (IEA) 2004 statistics (IEA 2007). The electricity mix as used for this study is as shown in *Table 1.3* below. The electricity model also accounts for losses from the electricity distribution network, which has been assumed to be 15.69% based on IEA data.

Table 1.3 *UK electricity mix used in this study*

Fuel source	IEA mix	Mix modelled	Comments
Coal	34%	34%	
Oil	1%	1%	
Gas	40%	40%	
Biomass	2%	2%	Wood co-generation is assumed.
Waste	<1%		
Nuclear	20%	20%	
Hydro	2%	2%	
Solar PV	<1%		
Other	<1%		

A breakdown of the carbon footprints calculated for each juice product is shown in *Table 2.1*. The carbon footprints are calculated as kg CO₂ equivalents per 1,000 litre of ready-to-sell orange juice allowing a direct comparison between the juices.

Table 2.1 *Carbon footprint results for Good Natured juices*

Geographical area	Process	Good Natured orange juice, 'from concentrate' kg CO ₂ eq. / 1,000 litre juice	Good Natured orange juice, not-from-concentrate kg CO ₂ eq. / 1,000 litre juice
Costa Rica	Concentration	16.0	n/a
	Freezing	24.4	n/a
	Pasteurisation	n/a	185.0
Costa Rica to the Netherlands	Transport to port	12.2	60.4
	Shipping to the Netherlands	19.1	109.0
	Transport to storage facility	0.5	3.0
The Netherlands	Storage	1.4	7.7
The Netherlands to the UK	Transport to port	0.5	3.0
	Shipping to the UK	0.8	5.8
	Transport to processor	3.7	21.9
The UK	Pasteurisation & reconstitution	91.4	n/a
	Pasteurisation		114.0
	TOTAL	170.0	510.0

As can be seen, the carbon footprint of the not-from-concentrate comes out three times as high as the carbon footprint of the 'from concentrate'. This is partly due to the greenhouse gas emissions from the higher energy consumption for the pasteurisation process as well as the bigger volume of juice being transported.

The processing of the juice in Costa Rica shows greenhouse gas emissions four and a half times higher for the pasteurisation of the not-from-concentrate juice compared to the concentration and the freezing of the 'from concentrate' juice. At the UK processor's the difference is significantly smaller, pasteurisation of the not-from-concentrate juice emits only 25% more greenhouse gases than the pasteurisation and reconstitution of the 'from concentrate' juice.

Transportation of the not-from-concentrate results in greenhouse gas emissions five and a half times higher than those of the 'from concentrate' juice. The large difference is due to the higher volume being transported for the not-from-concentrate juice and the energy required in maintaining it chilled.

The AA (2007) **Route Planner**. Available at http://www.theaa.com/travelwatch/planner_main.jsp [accessed December 2007].

Greg Boyle, Good Natured Limited, personal communication, email dated 27th November 2007.

Googlemap (2007). Available at <http://maps.google.co.uk/maps?hl=en&tab=wl> [accessed December 2007].

International Energy Agency (2007) **Electricity/heat in Costa Rica in 2004** IEA. Available at <http://www.iea.org/Textbase/stats/prodresult.asp?PRODUCT=Electricity/Heat> [accessed December 2007].

International Freight Exchange (2007) **Port Distances**. Available at <http://www.searates.com> [accessed December 2007].

Water UK (2003) **Towards Sustainability 2003-2004** Water UK. Available at <http://www.water.org.uk/home/news/press-releases/water-industry-facing-up-to-the-challeng/final-report-03-04.pdf?s1=activated> [accessed December 2007].

World Ports Distances (2007) **World Ports Distances Calculator**. Available at <http://www.distances.com> [accessed December 2007].