



**CPI Eco-Innovation Pilot and Market Replication  
Project (Call 2009)  
ECO/09/256062/SI2.570220**



**Life cycle product development for a novel green milk bottle  
produced with waste paper from the general recycled paper supply  
stream**

**STORK®**

**MARYBELLE**



# 1. THE OPPORTUNITY

GreenBottle is a major packaging innovation with the potential to replace plastic bottles and laminated carton systems like Tetrapaks in the £multi-billion global liquid packaging market.

GreenBottle has all of the functionality of plastic bottles in terms of its production, supply chain and in-use characteristics but, because the bottle shell is made of compressed, recycled paper (with a thin inner plastic liner to hold the liquid, and a conventional plastic cap), it is significantly better for the environment, with less than a third of the plastic and a significantly smaller carbon footprint than plastic bottles.

Petcore, the European trade association that fosters the collection and recycling of PET, reported that in Europe alone, over 3m tones of PET bottles were used and only 1.45 million tonnes were collected in 2010 – 52% went into landfill or incineration. (Source: PCI for Petcore)

Plastic waste is a major environmental issue in Europe and around the world. The cost to the environment of this form of plastic bottle, let alone the less easily recycled laminated cardboard packaging, is significant.

GreenBottles, by contrast, are made predominantly from paper with just a thin plastic liner to hold the liquid, and so have a significantly lower environmental impact and better carbon footprint than either plastic bottles or tetrapaks. GreenBottles are similarly superior on other measures of environmental impact.

	GreenBottle	HDPE Poly-bottle	Laminated Carton
Global Warming Potential (gCO2 equivalent)	71.82	95.6	93.07
ReCiPe single score (mpts)	6.83	10.44	14.28

(Source : independent Pira Life-Cycle Analysis : Dec 2010)

We would expect PET bottles to be worse than GreenBottle on all these measures.

# 2. The Project

By mid 2010 GreenBottle had been developed and validated in low volume production volumes. In summary, the project set out to transfer the concept to high speed, high volume production and validate the complete supply chain for waste material used to produce a GreenBottle. More specifically the project set out to:

- Develop the moulding process to manufacture bottles at high speed
- Automate the bottle assembly
- Evaluate GreenBottle’s performance on a high speed filling line
- Ensure GreenBottle becomes part of an effective recycling loop
- Prove the commercial benefits of GreenBottle
- Increase awareness of GreenBottle and spread its use to different markets

Throughout the project GreenBottle has focused the project on the development of a successful GreenBottle in the UK retail milk market. We have:

- Proved that consumers love GreenBottle – it is easy to use and recycle
- GreenBottle is a commercial success with sales tripling in our test market
- Demonstrated that our partner Dairy can utilize existing filling lines
- Established that the environmental benefits are clear
- Developed the technology and machinery to automate production



Martin Myerscough, Inventor of the GreenBottle.



Current production GreenBottle



GreenBottle is a paper fibre bottle with a thin plastic liner.



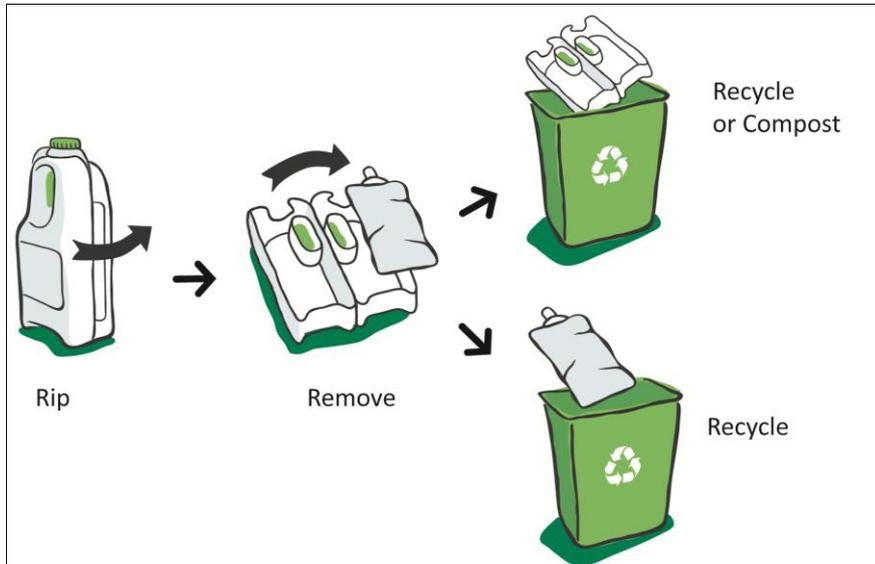
GreenBottle can mould embossed and debossed impressions to visually enhance our packs.

### 3. CONSUMER REACTION: THEY LOVE IT!!

Research and in-market testing has consistently shown that consumers ‘get’ GreenBottle, find it easy to use and, given the choice, prefer GreenBottle over equivalent plastic bottles.

#### i) Easy to Use and Dispose Of

GreenBottles are designed so that after use they can easily be opened, the paper and plastic elements separated, and each disposed of appropriately:

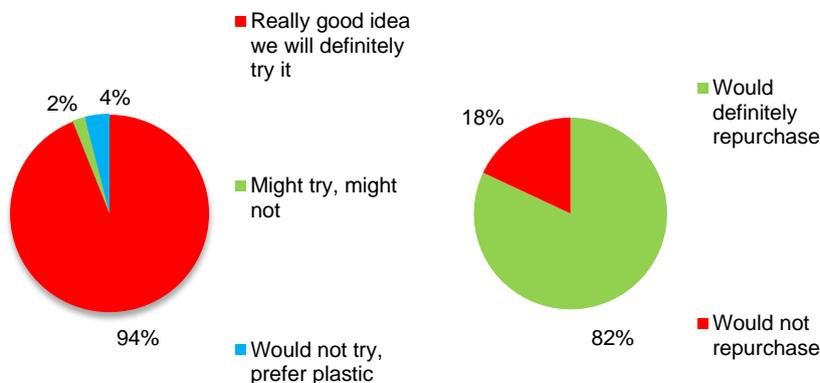


Importantly, consumers ‘get’ GreenBottle, instinctively understand why it is better, and express strong preference compared to plastic bottles.

GreenBottle has consistently been preferred by consumers to conventional plastic bottles in research in the milk, detergent and juice categories. In a Test Market in Asda stores, sales of milk sold in GreenBottles increased significantly.

#### ii) Research consistently shows preference for GreenBottles over plastic

In the milk category, research indicated a positive intention to try of over 90%: and, after use, repurchase intention was 82%.



(Source: GreenBottle Research)



GreenBottle promotional activity generates huge customer interest.



GreenBottle on sale in ASDA.



Customers instinctively understand why it is better.

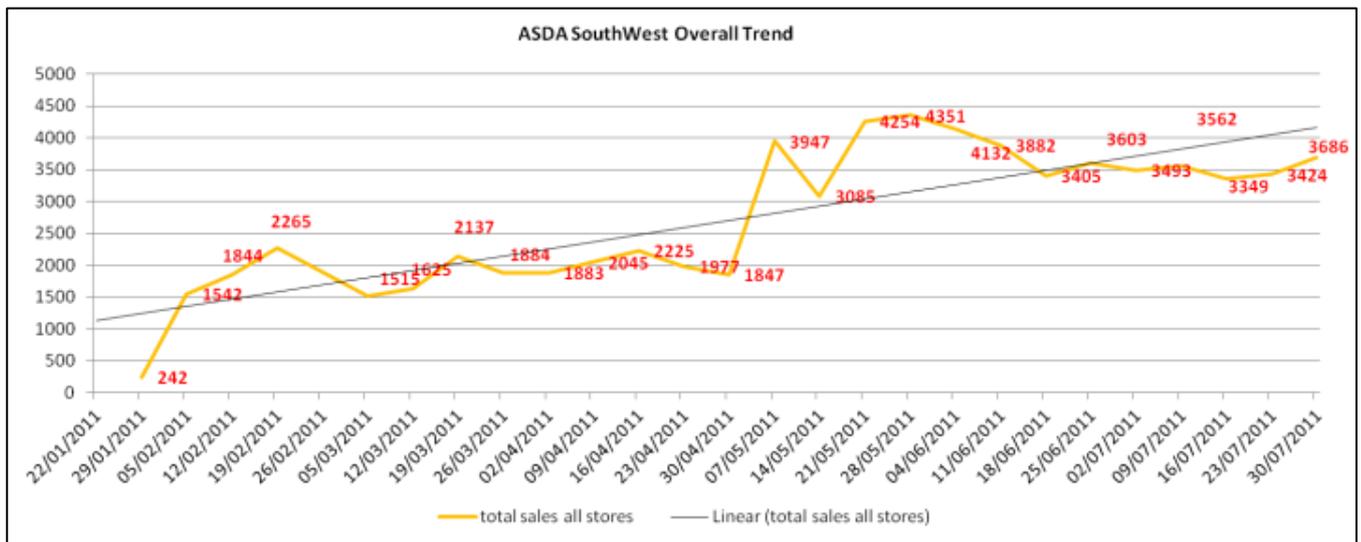


iii) In Test Market, sales of milk sold in GreenBottles more than tripled.

We ran a 6-month Test Market in Asda stores in the south-west (Cornwall, Devon, Somerset, Dorset). Local milk from a Cornish dairy was sold in GreenBottles alongside the equivalent milk sold in plastic bottles. Over the course of the 6 months milk sold in GreenBottles increased by over 300%

TOTAL TEST MARKET	Av. daily sales pre GB	Av. daily sales post GB	Index
Cornwall	95	257	270%
Devon	40	119	297%
Somerset	19	151	975%
<b>TOTAL</b>	<b>154</b>	<b>527</b>	<b>342%</b>

This delivered consistent and sustained growth for milk in GreenBottles over the full test market period:



Notably, these results were achieved despite the GreenBottle milk being sold at a significant premium versus Own Label milk – a further underlining of the concept’s consumer appeal:

	Trewhiten Milk in GreenBottles	Asda Own Label 4pt	Index (%)	Asda 4pt	Index (%)
Unit Price	£1-53	£1-25	122%	£1-25	122%
Price per litre	76.5p	56p	137%	56p	137%

## **4. THE ENVIRONMENT: WHY GREENBOTTLE IS BETTER**

### **The Problem:**

Packaging waste is a huge and growing problem for modern society, with efficient 'green' disposal of plastic waste a particular issue.

Every day the UK throws away around 15 million plastic bottles. While recycling rates are increasing they are still a long way away from 100% and, even when plastic is recycled once or twice, it will soon end up in a form that cannot be recycled, and will find its way to landfill. Once there, because plastic does not biodegrade, it will persist for hundreds of years. Disposal of laminated cartons, the other predominant form of packaging for liquid consumer products, faces similar problems.

GreenBottle Limited was formed to tackle the environmental issues associated with the manufacture and subsequent disposal of plastic bottles and laminated cartons.

- a) Plastic bottles – made from a non renewable resource. Have a high carbon footprint – the carbon footprint of a PET bottle is approximately 4.4 times that of an equivalent GreenBottle. Approximately 50% of PET bottles are recycled across Europe so the rest are either incinerated or go to landfill. About 22% of recycled PET goes back into packaging. In just a few cycles all the PET will be incinerated or landfilled.
- b) Laminated cartons – the carbon footprint of laminated cartons is about 1.3 times greater than the equivalent GreenBottle. The big problem with laminated cartons is that they require specific recycling facilities. This requires a separate recycling stream (not very appealing in the kerb side collection system) and transportation to the dedicated plant. Across Europe only 33% of laminated cartons are recycled. The remainder are burnt or landfilled.

It is against these quite stark figures that GreenBottle was designed.

### **The Solution**

GreenBottle is made from 2 components:

- a) A moulded outer shell made from either virgin or preferably recycled paper / cardboard. The bottles can be moulded to the same shape as most plastic equivalents which gives excellent shelf stand out in categories where laminated cartons predominate.
- b) A loose plastic inner liner that the consumer separates from the cardboard outer to recycle separately.

The environmental benefits of this approach are:

- c) The cardboard outer can go into the mainstream recycling streams and can then be used to make other recycled cardboard products.
- d) The outer shell can itself be made from 100% recycled material.
- e) Cardboard recycling rates across Europe are about 69% and cardboard can be recycled as much as 6 times.
- f) The cardboard shell is made from a renewable and sustainable source.
- g) The carbon footprint is lower than the competition – in the case of PET significantly lower.
- h) The inner liner uses 70% less plastic than a plastic bottle and this figure is set to increase to nearly 80% with our recent technology advances.
- i) If the product does end up at landfill, then the outer shell will decompose and leave only the thin inner liner which uses far less space.



Every day the UK throws away around 15 million plastic bottles.



GreenBottle has been invented to help solve the problem of plastic waste.



Unlike plastic bottles, the GreenBottle's paper shell is biodegradable.



Switching to GreenBottle reduces the amount of plastic going into landfill.

## Environmental Comparisons

i) Summary of Liquid Packaging alternatives:

	Made from Renewable resources	Made from Recycled Materials	Recycling Rate	GLOBAL WARMING POTENTIAL (Compared to GB)
PET	No	22%	50%	4.38
Laminated Carton	Yes	No	33%	1.3
GreenBottle	Yes	Yes (100% cardboard)	69%	1.0

Source: Pira Analysis; Published Data

ii) Data from Lifecycle Analysis:

In December 2010 we commissioned Pira, the independent research and testing institute, to conduct a Lifecycle Analysis, comparing the environmental impact of GreenBottles to HDPE plastic bottles and laminated cartons. Note that, whilst this analysis did not include PET bottles, our expectation is that their environmental profile would be significantly worse than that of HDPE milk bottles. Key data from the Pira report is:

### Overall Results Summary

	Units	GreenBottle	HDPE Polybottle	Laminated Carton
Global Warming Potential	g CO2 equiv	71.82	95.6	93.07
Abiotic Depletion	g Sb equiv	0.56	0.95	0.65
Acidification	g SO2 equiv	0.22	0.32	0.31
Eutrophication	mg PO4 equiv	37.31	39.66	65.59
Ozone Layer Depletion	mg CFC-11 eq	0.01	0.01	0.18
Human Toxicity	g 1.4-DB equiv	17.12	17.33	23.59
Fresh Water Aquatic Toxicity	g 1.4-DB equiv	0.43	0.59	0.80
Marine Aquatic Toxicity	g 1.4-DB equiv	3.33	3.69	4.73
Terrestrial Ecotoxicity	mg 1.4-DB eq	136.64	166.74	251.31
Photochemical Oxidation	mg C2H4	11.07	18.35	17.68

Source: Pira Analysis

### ReCiPe Weighted Measure

	Units	<u>GreenBottle</u>	HDPE Polybottle	Laminated Carton
ReCiPe single Score	mpts	6.83	10.44	14.28

Source: Pira Analysis

### Conclusion

On every measure – carbon footprint, made from renewable resources, percentage of plastic used, biodegradability at landfill, recycle rates – the GreenBottle is better than the existing technology. This is achieved without any compromise in the ability to make a bottle that has all the characteristics (more in some cases) of existing packaging at a competitive price.

## 5. THE TECHNOLOGY – HOW WE MAKE GREENBOTTLE

GreenBottle is made of an outer shell comprising two half shells of moulded paper pulp, surrounding a vacuum formed plastic inner liner welded to a plastic insert which forms the neck of the bottle including the thread:

There are two key manufacturing operations: production of the outer shell, and vacuum forming of the inner liner and assembly of the finished bottle. Both processes are novel and proprietary.

### Outer shell production

**The outer shell** is made of moulded paper from a slurry of paper fibres in water which is drawn onto a mould and dried. Sizing and water resisting chemicals are added to aid water resistance without detracting from the material's ability to compost or be recycled post use. The paper "felt" is dried on tool to ensure dimensional conformity piece to piece (+/- 0.1mm, ie similar to blown HDPE), and also to strengthen the shell.

To date we have used commercially available machinery to produce test market quantities of paper shells. However, this is too slow and energy inefficient to produce shells at the scale and cost needed for large-scale production, and its high energy usage gives it a relatively poor carbon footprint.

With the help of the EACI grant, we have therefore developed our own technology to produce shells with a novel design in the water removal process through the tooling, which can produce at a scale and a cost comparable to plastic bottles/tetrapaks, and with a significantly better carbon footprint. We have built a prototype to prove that the process works, and are now building production machines to install near the dairy filling the milk for our first national expansion.

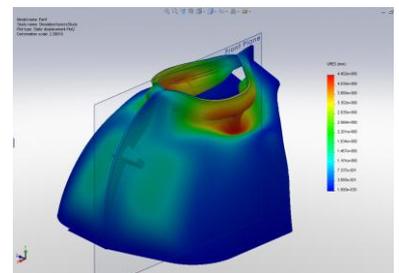
**Material input** to the process is baled fibre pulp which is macerated and slurried in the first tank to produce a 1% slurry. Fibres can be virgin or recycled paper or cardboard, or even vegetable material like corn or palm waste. We have produced GreenBottles from a variety of source materials, and have a method of using low cost recycled cardboard for most of the mix whilst still having a premium surface on the outside of the bottle. Sizing and water resisting chemicals are added at this stage.

**Utilities** are normal electricity and air supply, and the water side is closed loop without special need for waste treatment. Finished shells can be stacked and wrapped for shipment onto distant location, or in line supply onto the assembly line.

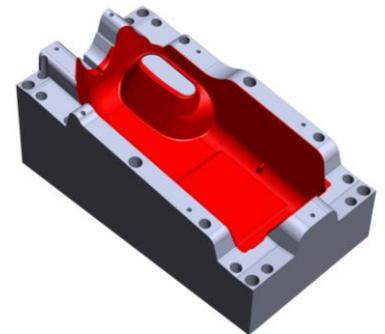
Key to the design is the tooling. This not only removes water from the pulp quickly and very energy efficiently, but also allows a light weight design of the machine's frame because of the way pressure is applied through the tooling. Patents are applied for.



GreenBottle is made of an outer shell comprising of two half shells, and a plastic liner.



GreenBottle uses the latest design software to ensure bottles withstand top loads and internal pressures.



GreenBottle not only design the bottles but are also heavily involved in tooling design and construction.

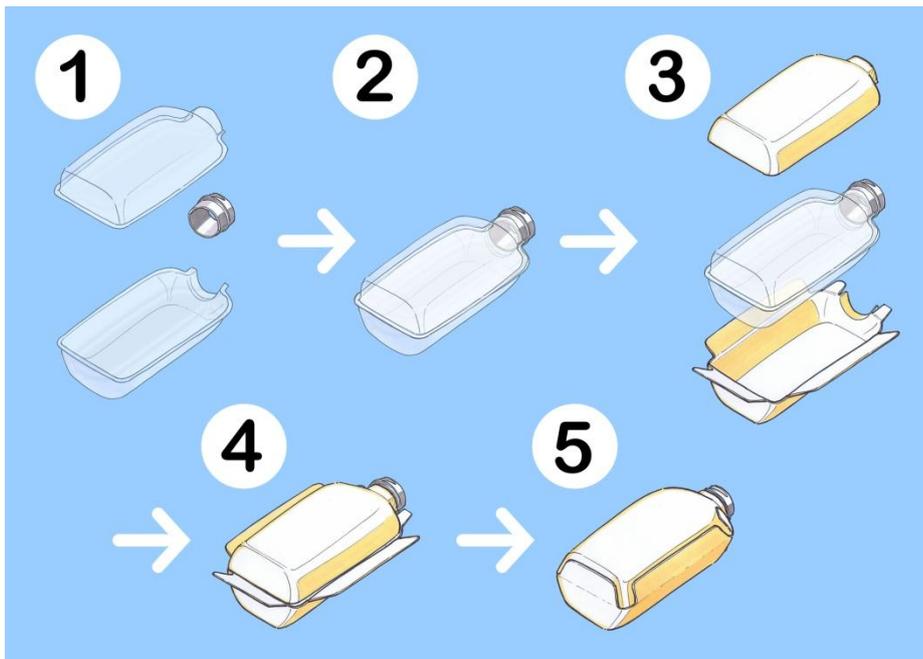


GreenBottle have a method of using low cost recycled cardboard while maintaining a high quality surface finish.

## Vacuum Forming and Assembly

The second process starts with the forming of an **inner plastic liner**. This is welded to a plastic insert that forms the neck of the bottle, the finished “bag” is placed in one half shell, the other shell is placed on top and glued into place to produce the finished bottle.

The vacuum forming is from rolls of film, which can be of a variety of materials, and is an intrinsically hygienic process. We have gained experience in using laminate films to form the bag and can develop this to provide an effective barrier required for different liquids. We have successfully trialled shelf life tests using orange juice. In simple terms the bottle assembly is a five stage process. This is an area for future development:



Step 1 : plastic liners vacuum-formed onto bottle mould. Neck insert placed in bottle.

Step 2: plastic ‘bag’ formed by welding two halves of liner and neck insert together.

Step 3 : formed ‘bag’ placed inside one half paper shell ; second half placed on top.

Step 4 : bottle glued together utilising bottle flaps.

Step 5 : final bottle is ready for collation/dispatch.

The technologies used throughout this process are common to other packaging applications (including food), but no-one has used them using thin film in this sort of application, and again we have patents applied for.



Image 1: Light weight plastic insert



Image 2: Female half shell



Image 3: Bag placed in female half shell



Image 4: Male half shell fully encloses inner bag



Image 5: Female half shell glued onto male half

## Machinery

Our EU grant has substantially helped us to design and build the machinery that automates the processes required to make a GreenBottle.

### GreenBottle Moulding Machine



This machine is about 3m long by 1.5m wide (per lane). A five lane machine is capable of 20 million units/annum.

### GreenBottle Assembly Machine



The machine is 11.5m long by 2.53m wide.