Coca-Cola Amatil Eastern Creek

Proposed Injection Moulding Plant

Life Cycle Benchmarking Study

Report Number 30-2615R4

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Goodman Property Service (Aust) Pty Ltd
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TABLE OF CONTENTS

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

1 INTRODUCTION

Coca-Cola Amatil (CCA) propose to build a PET Preform and Closure Manufacturing Plant to provide preforms and closures to its In-House Blowfill Bottling Operations in Australia, New Zealand, Papua New Guinea and Fiji. The development will be located at the existing CCA Distribution Centre at Roussell Road, within the M7 Business Hub in Eastern Creek, NSW. CCA operates in Australia, New Zealand, Papua New Guinea, Fiji and Indonesia and currently employees more than 1,850 people in NSW.

SLR Heggies (Heggies Pty Ltd) has been commissioned by Goodman Property Services Australia Pty Ltd (Goodman) to conduct a Life Cycle Benchmarking Study to provide detail to the Department of Planning (DoP) on the potential environmental impacts that may result from supply chain step-changes and the move from Merchant Bottle Supply to In-House Blowfill Bottle Manufacture.

1.1 Director General's Requirements

The Director General's requirements applicable to this assessment are:

"*Life Cycle Assessment: Including an evaluation of the potential environmental impacts of each stage of the products lifecycle*."

It is noted that this study is not intended to produce a full life cycle analysis (LCA) of the product, but provide a focussed *benchmarking* study to compare Merchant Bottle Supply and In-House Blowfill Bottle Manufacture processes. This approach will demonstrate the environmental benefits and/or disadvantages of these manufacture processes, providing information necessary for CCA's submission to the DoP.

1.2 Study Objectives

Key aspects of this comparative benchmarking study will include:

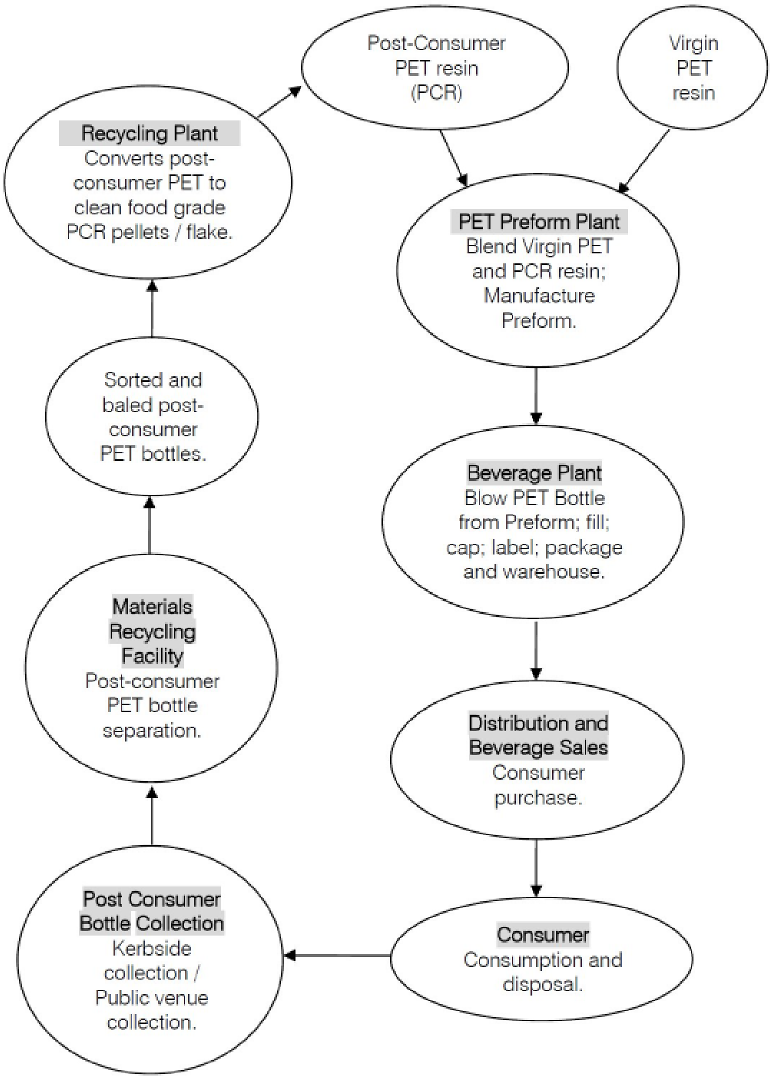
- Definition of a clear study scope, including goal and methodology;
- Preparation of an life cycle inventory including inputs (i.e. energy, water and raw materials) and outputs (i.e. emissions to air, water and land) from comparable processes (within defined parameters);
- Evaluation and discussion of the significance of the potential environmental impacts; and,
- Provision of study limitations, assumptions, uncertainties and conclusion.

The study methodology is explained in full in **Section 3** of this report.

2 PET BEVERAGE BOTTLE MANUFACTURE STAGES

The full life cycle of the PET beverage bottle is illustrated in **Figure 1**. The manufacture phase of the life cycle is described in more detail in the following section.

Figure 1 Full Life Cycle of the PET Beverage Bottle



Source: CCA

The manufacturing process entails converting polyethylene terephthalate (PET) and high density polyethylene (HDPE) resin pellets into preforms (i.e. bottle) and closures (i.e. cap) respectively. The steps of this process are provided in **Table 1**.

Table 1 Manufacture Steps – PET beverage bottle

Step 1) Resin Delivery & Storage
PET and HDPE resin pellets arrive on site in shipping containers. The resin pellets are loaded into a rotary valve located next to silos and an air blower transfers the resin pellets from the rotary valve up to the top of the resin silos where the resin is stored ready for use.
Step 2) Resin Blending
PET resin pellets are transferred via vacuum pipework from the bottom of the silos into the Blending Room where the resin is loaded into Blender. The resin from the silo (Virgin PET) is blended with recycled resin (Regrind) produced from the small amount of plastic waste produced during the start-up of the process. Once the PET resin pellets have been blended, vacuum pipework is then used to transfer the PET resin pellets to the Resin Dryers in the Dryer Room. HDPE Resin pellets are also transferred via vacuum pipework from the bottom of the silos; however the resin is transferred directly to the loading hopper on top of the Closure Injection Machine.
Step 3) Resin Drying
PET resin is loaded into the resin dryers located in the dryer room. Each of the resin dryers holds approximately 6 tonnes of blended PET resin pellets. Inside the dryer the resin is heated up to 170°C for a period of 4 to 6 hours. During this process the air in the dryer is circulated, the moisture in the air is removed by passing the air through a desiccant bed. The drying process is a continuous process as the resin loaded in the top of the dryer takes approximately 4 to 6 hours to reach the bottom of the dryer. At the bottom of the dryer the hot PET resin pellets are fed into the preform injection machine.
Step 4) Injection Moulding
PET resin pellets are fed from the bottom of the resin dryer into the preform injection moulding machine where the pellets are melted with heat and pressure into molten PET. The PET resin is then injected into a steel mould to produce PET preforms. The preforms are then transferred from the preform injection moulding machine where they are packed into bins. Once the bins have been filled, Automatic Guided Vehicles (AGV) take the filled bins to the warehouse conveyor. The bins are then moved via forklift and stacked into the warehouse.
Step 5) Bottle Production and Filling Operations
In the case of Merchant Supply, bins of preforms are transported to Blow Plants where they are unloaded and converted into a bottle. The bottles are then palletised, transported to a warehouse, then loaded for transport to the CCA Beverage Line where the bottles are depalletised, rinsed and sterilised, and filled. For In-House Manufacture, bins of preforms are transported to Blowfill Plants where they are unloaded and converted into a bottle ready for sterilisation and filling within the same facility.
Step 6) HDPE Closures
HDPE resin pellets are fed from the loading hopper located above the closure injection machine where the pellets are melted with heat and pressure into molten HDPE. The HDPE resin is then injected into a steel mould to produce HDPE closures. The HDPE closures are then transferred from the closure injection moulding machine where they are packed into bins and AGV take the filled bins to the warehouse conveyor. Closures requiring printing are transferred directly from the closure injection machine via conveyors to the closure printing machines. Closures are loaded into the closure printing machines where logos are printed onto the surface of the closures. The printed closures are dried and then packed into bins. Once the bins have been filled the AGV take the filled bins to the warehouse conveyor. The bins are then moved via forklift and stacked into the warehouse. The AGV also bring empty bins to the closure injection machine and closure printing machines for filling.
Step 7) Bottle Capping and Labelling
Filled bottles are capped and labelled, then packaged into saleable units and warehoused awaiting distribution.

Steps 1 – 4 are carried out for both In-House Blowfill Bottle Manufacture and Merchant Bottle Supply and describe the manufacture of the PET preform.

Step 5 describes the proposed supply chain step-changes that would be realised with the move from Merchant Supply to In-House Manufacture which comprise bottle production and filling operations.

Steps 6 and 7 are carried out for both In-House Manufacture and Merchant Supply and describe the production of HDPE closures, capping, labelling and warehousing of the finished product.

3 STUDY SCOPE

3.1 Methodology

This comparative product benchmarking study will focus on two (2) cases:

1) Do Nothing (i.e. continue current practices utilising Merchant Bottle Supply); and,
2) Do Something (i.e. move to In-House Blowfill Bottle Manufacture).

Constrained supply chain steps are provided in **Figure 2** for both cases. (Please refer to **Section 2** of this report for a description of the manufacture process of the CCA PET beverage bottle). The system boundary of the study is represented by the dashed line. It has been assumed that all stages lying outside this defined system boundary (i.e. raw materials extraction, distribution, product use and waste management stages, and stages following bottle filling operations) will have like-for-like inputs and outputs and therefore lie outside the scope of this comparative study which is focussed on significant changes to emissions that may be realised.

Parameters considered have been limited to inputs of raw PET material, energy (including transportation) and water. An inventory of inputs and outputs (i.e. emissions to air, water and land) has been quantified on a "per mass unit" basis (a functional unit of 1 tonne) or on a per 1000 bottles basis for comparable steps only, using available data (namely data supplied by CCA and the National Greenhouse Accounts (NGA) Factors Workbook (2010)). (Refer to **Appendix A** for a full inventory.)

The outcome of the study is a weighting of one case against the other in terms of their quantified inputs and outputs, and includes an evaluation of the potential environmental impacts associated with each case.

Note: Merchant Bottle Supply and In-House Blowfill Bottle Manufacture will hereafter be referred to as "Merchant Supply" and "In-House Manufacture" respectively.

3.2 Data Quality

Air emissions data was taken from the CCA supplied Husky Injection Molding Systems ANZ Pty Ltd reports on typical regeneration air composition and the SLR Heggies compiled CCA Air Quality Assessment for the proposal. CCA supplied the remainder of the information including future expected projections of bottle volumes likely to be generated by the proposed new facility and Merchant Supply in the year 2015, including inputs of raw material, water, energy (including transport) and outputs of water and solid wastes.

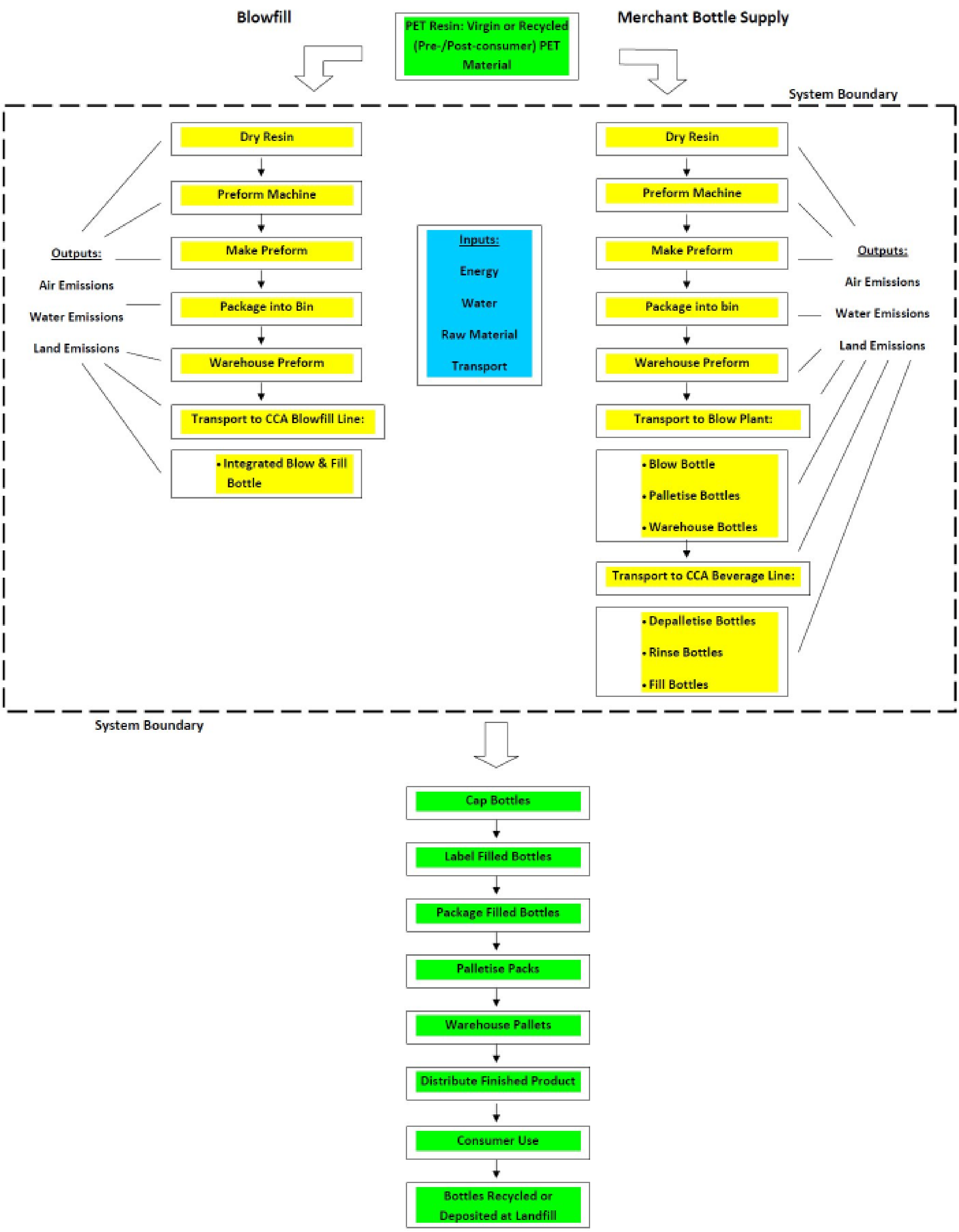
GHG emissions associated with transport and purchased electricity have been calculated using the current NGA Factors Workbook (NGA, 2010). Inventories have been prepared based on the information available and a number of assumptions (outlined in **Section 3.4**).

3.3 Limitations

This study is limited to significant changes in emissions and covers supply chain steps within the manufacture stage of the life cycle. Raw material extraction, transport of virgin PET resin and post-consumer recycled (PCR) resin to Injection Moulding Plants, distribution of the finished product, consumer use and disposal stages are not assessed as these stages are considered like-for-like for both cases and are therefore outside the scope of this study. Similarly, various steps within the manufacture stage of the life cycle have not been assessed as inputs and outputs are considered the same for both cases (e.g. the capping and labelling of filled bottles).

Lighter weight HDPE closures will be produced as part of supply chain step-changes and the move to In-House Manufacture leading to a decrease in the demand for raw HDPE material and less HDPE material deposited at landfill. However, this is outside the study boundary as defined in **Figure 2**. Also, inputs and outputs associated with transport have been calculated for transport in Australia only.

Figure 2 Study Snapshot



3.4 Assumptions List

Inventory Assumptions:

- Volumes of PET bottles based on future projections for the year 2015.
- Variances between forklift annual fuel consumptions and GHG emission outputs are assumed to be insignificant, though it is noted that the move to In-House Manufacture would lead to improved warehouse storage efficiency and reduced forklift movements.
- Diesel fuel and a fuel consumption rate of 30 litres per 100 km assumed for all transport (VTT, 2005).
- B Double (road freight) transports assumed for the transportation of preforms to Western Australia.
- Preform transport distances and the number of loads of performs transported by road freight per annum are assumed the same for In-House Manufacture and Merchant Supply.
- An average of 10,000 preforms per bin, an average of 44 bins per 40’ Pan Truck shipment and an average of 64 bins per B Double shipment is assumed for the transport of preforms.
- An average of 3,000 bottles per pallet and 20 pallets per 40’ Pan Truck is assumed for Merchant Supply additional transportation calculations.
- NGA Emission Factors for greenhouse gas emission calculations.
- Global Warming Potentials according to Kyoto accounting provisions.
- Typical air regeneration composition assumed for air emissions.

General:

- All stages lying outside the system boundary assumed to have like-for-like inputs and outputs.

4 BENCHMARKING ASSESSMENT

4.1 Inputs

Inputs of raw material, water, energy including associated transport are discussed in the following section.

4.1.1 Raw Material

The approximate mass of PET resin used for In-House Manufacture and Merchant Supply are provided in **Table 2**. Estimated amounts are based on future projections of bottle volumes for the year 2015 and were calculated using projected volumes of manufactured bottle types by their respective preform weights. The results indicate that In-House Manufacture will result in a decrease in demand for PET resin by approximately 5,496 tonnes per annum (tpa) due to the development of lighter weight preforms. This represents a reduction of 13 % in raw material demand.

In addition, the finish applied to the PET bottle will be reduced by an average of 1.2 g PET resulting in further reductions of PET resin usage. Whilst this may be noted as an advantage, the bottle finishing is outside the study boundary as defined in **Figure 2**.

Table 2 Estimated Resin Inputs – Preform Manufacture

		In-House Manufacture		Merchant Supply	
Bottle Type	**Volume (000's)**	**Preform Weight (g)**	**Resin (tpa)**	**Preform Weight (g)**	**Resin (tpa)**
600 ml Water	251,236	16.60	4,171	21.50	5,402
600 ml CSD	533,028	23.00	12,260	26.50	14,125
1250 ml CSD	236,100	36.70	8,665	41.00	9,680
1500 ml CSD	93,737	40.70	3,815	44.00	4,124
600ml Hotfill & others	213,357	28.50	6,081	33.00	7,041
700ml Hotfill	26,708	38.00	1,015	40.00	1,068
1000 ml Hotfill	5,616	43.00	241	45.00	253
2000 ml Hotfill	6,841	87.00	595	89.00	609
750 ml Water	8,389	25.20	211	29.50	247
Totals	**1,375,012**		**37,054**		**42,549**

Source: CCA 2010 Board Submission based on 2015 projections.
Note: CSD stands for Carbonated Soft Drink.

4.1.2 Water

In both In-House Manufacture and Merchant Supply cases, water is required for cooling the blow moulds and the injection moulding machine. Water is supplied via a looped recycled water system from which less than 960 L of water per annum is lost from the system due to mould changes (i.e. residual water from water hoses moved from the old mould to the new mould is lost) and other necessary processes.

However, higher fresh water inputs are required by Merchant Supply as this process uses open cooling towers while In-House Manufacture utilises closed cooling towers. Merchant Supply also requires that bottles are rinsed on the filler with treated water to remove contaminants and sterilise the bottles, whereas In-House Manufacture pre-cleans preforms pneumatically and sterilisation of bottles occurs due to process heat.

When compared to In-House Manufacture, these water losses equate to approximately 50,000,000 L per annum (per annum assumed) per filling plant. This equates to approximate water savings of 135,000 L per tonne PET resin, assuming In-House Manufacture uses 37,054 tonnes PET resin per annum.

4.1.3 Energy

Proposed supply chain step-changes leading to energy savings include the following:

- Investment in latest technology drying systems and injection machines will reduce the energy consumption associated with PET resin drying and preform production.
- In-House Manufacture has no requirement for the depalletising and rinsing of bottles as preforms automatically feed into the integrated Blowfill machine, leading to lower energy consumption rates.
- Lighter weight preforms will result in a lower energy requirement for PET bottle manufacture.
- In-House Manufacture will lead to a significant decrease in associated transportation requirements as only preforms will need to be transported to Blowfill Plants. (Merchant Supply requires transportation of preforms to Blow Plants and bottles to CCA beverage lines for filling.)

The estimated energy inputs required by In-House Manufacture and Merchant Supply to produce PET bottle preforms are provided in **Table 3**. Amounts are based on future projections of bottle volumes and preform energy requirements for the year 2015 and assume facilities are operational 24 hours a day, 7 days a week (i.e. 8,760 hours per annum).

The results indicate that a move to In-House Manufacture from Merchant Supply will result in a lower annual energy requirement with estimated energy savings of 3,119,104 kWh per annum. Based on technology developments over the last 10 yrs, CCA estimates show that the energy consumption per annum of Merchant suppliers is approximately 9 % higher when compared to in-House Manufacture.

The amount of energy required per 1,000 bottles is also shown in **Table 3**. The average energy consumption per 1,000 bottles for In-House Manufacture and Merchant Supply was calculated to be 23 kWh and 25 kWh respectively (or a 9 % difference).

Table 3 Estimated Energy Inputs - Preform Manufacture

		In-House Manufacture			Merchant Supply		
Bottle Type	**Volume (000's)**	**Resin (tpa)**	**kWh**	**kWh/1000 bottles**	**Resin (tpa)**	**kWh**	**kWh/1000 bottles**
600 ml Water	251,236	4,171	4,433,497	18	5,402	4,876,847	19
600 ml CSD	533,028	12,260	11,022,393	21	14,125	12,124,632	23
1250 ml CSD	236,100	8,665	4,994,985	21	9,680	5,494,484	23
1500 ml CSD	93,737	3,815	2,447,323	26	4,124	2,692,055	29
600ml Hotfill & others	213,357	6,081	5,570,411	26	7,041	6,127,452	29
700ml Hotfill	26,708	1,015	1,529,014	57	1,068	1,681,915	63
1000 ml Hotfill	5,616	241	321,512	57	253	353,663	63
2000 ml Hotfill	6,841	595	391,642	57	609	430,806	63
750 ml Water	8,389	211	480,264	57	247	528,290	63
Totals		**37,054**	**31,191,041**		**42,549**	**34,310,145**	

Note: CSD stands for Carbonated Soft Drink

Merchant Supply requires both the transport of preforms to Blow Plants for bottle production, and the transport of bottles to CCA beverage lines for filling and finishing. In-House Manufacture requires only the transport of preforms to Blowfill Plants as the process incorporates both blow and fill operations within the one facility. Therefore, freight transportation will be significantly reduced in the move to In-House Manufacture leading to a decrease in the amount of fuel consumed per annum.

In-House Manufacture transportation requirements of preforms from the proposed Eastern Creek facility to Blowfill Plants (including the return trip back to Eastern Creek) are provided in **Table 4** below. Please note that Merchant Supply preform transport distances and the number of preform loads transported via road freight per annum are assumed the same as those for In-House Manufacture. Calculations assume an average of 10,000 preforms per bin, an average of 44 bins per 40' Pan Truck shipment and an average of 64 bins per B Double shipment. Fuel required for the return trip

Table 4 Transportation of Preforms – In-House Manufacture

State / Country	Type of transport (Road Freight)	Approx. transport distances (return trip) (km)	No. of loads / annum	Total kms travelled
New South Wales	40' Pan Truck	20	795	15,900
New South Wales	40' Pan Truck	20	68	1,360
Queensland	B Double	1900	516	980,400
Victoria	B Double	1800	344	619,200
Victoria	B Double	1800	47	84,600
South Australia	B Double	2770	141	390,570
Western Australia	B Double*	7800	188	1,466,400
Totals			**2,099**	**3,558,430**

*B Double assumed for transports.
Note: Australian transports only.

Table 5 shows the additional transportation requirements of Merchant Supply (i.e. trucks freighting bottles from Preform Blow Moulding Plants to CCA Beverage Lines, including the return trip). Calculations for the number of loads per annum were based on the total estimated number of bottles produced in 2015 (refer to **Table 2**) and an average of 60,000 bottles per 40' Pan Truck (i.e. 3,000 bottles per pallet and an average of 20 pallets per Truck).

Table 5 Additional Transportation – Merchant Supply of Bottles to CCA Beverage Lines

Type of transport (Road Freight)	Average approx. transport distance (return trip) (km)	No. of loads / annum	Total kms travelled
40' Pan Truck	20.8	22,917	476,674

Note: Australian transports only.

Assuming a fuel consumption rate of 30 L per 100km, the total amount of fuel consumed per annum for In-House Manufacture and Merchant Supply is approximately 1,067,529 L and 1,210,531 L respectively, with a difference of 12 % (or 143,002 L per annum due to the additional transportation).

4.2 Outputs

4.2.1 Solid Waste Emissions

Volumes of wastes generated during the manufacture stage of the PET beverage bottle are similar for both In-House Manufacture and Merchant Supply. Solid waste emissions include reject PET preforms, PET dust, PET closures (also HDPE closures and purge blocks), waste hydraulic oil and empty ink and colorant drums. (Refer to **Table 6** for approximate waste volumes generated.) Reject PET preforms (near 100 %) are reused in the Injection Moulding Process and all other plastic waste (approximately 0.1 % of raw material) is recycled by Plastic Recyclers for reuse in other applications. Waste hydraulic oil is collected and recycled by appropriately licensed oil recyclers while the remainder of waste types are collected and disposed of by licensed waste disposal companies.

Table 6 Operational Waste Generation Rates

Waste Material	Waste Processing	Rate
Reject PET Preforms	Reused in the Injection Moulding Process.	321 tpa
PET Dust	Stored in bulker bags and sold to Plastic Recyclers.	15 tpa
PET Purge Blocks	Stored in large steel bins and sold to Plastic Recyclers.	18 tpa
Waste Hydraulic Oil	Waste Hydraulic Oil sent to Oil Recyclers.	2 kL
Empty Ink Drums	Removal from site by a Waste Disposal Company.	7 kL
Empty Colourant Drums	Removal from site by a Waste Disposal Company.	7 kL

Packaging requirements are higher for Merchant Supply than for In-House Manufacture due to the additional freight requirements of Merchant Supply. Merchant shipment of bottles requires a plastic pallet and plastic layer pads, a top board and PET strapping (typically 18.5 m / full height of pallet) for stabilisation of the pallet. Stretch wrap is also used (approximately 45 m / full height of pallet) for hygiene (dust proofing). Packaging is reused where possible and PET strapping are chipped into pieces and sold to Plastic Recyclers.

Collapsible returnable bins containing pallets and including a hygienic lined woven bag are required for the shipment of preforms for both In-House Manufacture and Merchant Supply.

It is noted that the development of a lighter weight PET bottle will result in less PET material disposed at landfill.

4.2.2 Water Emissions

Waste water generation rates (e.g. water used to clean facility floors etc) are considered similar for In-House Manufacture and Merchant Supply and are approximated at 18,000 L per annum. Waste water is collected by contractors and is disposed of by appropriately licensed waste disposal companies.

Water discharges to sewer or stormwater drains are considered the same for both cases. Water discharges occur when the moulds are changed (up to 4 times per month) and equal approximately less than 960 L per annum.

4.2.3 Air Emissions – Greenhouse Gases

A quantitative greenhouse gas (GHG) assessment has been undertaken to estimate potential GHG emissions associated with In-House Manufacture and Merchant Supply.

Direct and Indirect Emissions (Emission Scopes)

Direct or Scope 1 emissions of GHG are produced from sources within the boundary of an organisation and as a result of the organisation's activities. These direct emissions mainly arise from the generation of electricity and heat, manufacturing processes, the transportation of materials, products or waste, fugitive emissions, and on site waste management.

Indirect or Scope 2 and Scope 3 emissions are generated outside the boundary of an organisation as a consequence of an organisation's activities (i.e. emissions result from the activities of another organisation). Indirect emissions can arise from the consumption of purchased electricity, upstream and downstream activities such as the extraction of fossil fuels, the transport of an organisation's product to customers or contracted activities.

For the purposes of this report, Scope 1 emissions (i.e. associated transportation) and Scope 2 emissions (i.e. purchased electricity) have been calculated using emission factors from the NGA Factors Workbook (2010) for diesel oil fuel combustion and NSW energy consumption. Scope 1 emissions resulting from forklift activities are regarded as minimal and are therefore not been assessed. Scope 3 emissions have not been calculated and are outside the scope of this study.

It is noted that the CCA Air Quality and Greenhouse Gas Assessment document (CCA AQA) prepared for the Eastern Creek Proposed Injection Moulding Plant (dated 26 November and compiled by SLR Heggies), focuses on Scope 2 emissions due to energy consumption and Scope 1 emissions due to the transport of imported resin from Port Botany and PCR from Recycling Centres to Eastern Creek, based on estimations made for the year 2017. These results vary from those provided in the following sections as CCA AQA transports are outside the scope of this study and energy consumption totals for In-House Manufacture are based on estimations for the year 2015.

Greenhouse Gas Calculation Methodology

Quantification of potential Project emissions has been undertaken in relation to both carbon dioxide (CO_2) and other non-CO_2 greenhouse gas emissions.

For comparative purposes, non-CO_2 greenhouse gases are awarded a "CO_2-equivalence" (CO_2-e) based on their contribution to the enhancement of the greenhouse effect. The CO_2-e of a gas is calculated using an index developed by the Intergovernmental Panel on Climate Change (IPCC) called the Global Warming Potential (GWP). The GWPs of relevance to this assessment are presented in **Table 7**.

Table 7 Global Warming Potentials

Gas	Chemical Formula	IPCC 1996 Global Warming Potential
Carbon Dioxide	CO_2	1
Methane	CH_4	21
Nitrous Oxide	N_2O	310

Source: IPCC document *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*

The short-lived gases such as carbon monoxide (CO), nitrogen dioxide (NO_2), and non-methane volatile organic compounds (NMVOCs) vary spatially and it is consequently difficult to quantify their global radiative forcing impacts. For this reason, GWP values are generally not attributed to these gases nor have they been considered further as part of this assessment.

Scope 1 Direct Emissions: Transport

Total estimated transport emissions were calculated for Merchant Supply transport in Australia only using an assumed fuel consumption rate of 30 L / 100 km (for freight transport by 40 tonne Pan Trucks and B Doubles), a diesel oil energy content factor of 38.6 GJ/kL, and diesel oil NGA emission factors applicable to emissions of CO_2 (69.2 kg CO_2-e/GJ), CH_4 (0.2 kg CO_2-e/GJ) and 0.5 kg CO_2-e/GJ N_2O.

Calculated Scope 1 emissions of GHG resulting from total transportation for both cases are presented in **Table 8**.

Table 8 Predicted Scope 1 GHG Emissions

Manufacture Process	Total Emission Factor (t CO_2-e/kL)	Total Diesel Consumption (L/annum)	Total Emission (t CO_2-e)
In-House Manufacture	2.70	1,067,529	2,882
Merchant Supply		1,210,531	3,268

Calculated Scope 1 emissions of GHG resulting from additional Merchant Supply transportation requirements are presented in **Table 9**.

Table 9 Predicted Scope 1 GHG Emissions: Additional Merchant Supply Transport

Emission Factor (t CO_2-e/kL)	Diesel Consumption (kL)	Emission (t CO_2-e)
2.70	143,002	386

The results indicate that an additional 386 tonnes CO_2-e will be emitted to the air in the case of Merchant Supply. This equates to a 12 % decrease in GHGs with the move to In-House Manufacture.

Scope 2 Indirect Emissions: Consumption of Purchased Electricity

Indirect emissions due to the consumption of purchased electricity were calculated for in-House Manufacture and Merchant Supply using estimated energy consumption rates and a Scope 2 emission factor of 0.90 kg CO2-e per kWh for NSW.

Calculated Scope 2 emissions of GHG resulting from the consumption of purchased electricity are presented in **Table 10**.

Table 10 Predicted Scope 2 GHG Emissions: Purchase of Electricity

Manufacture Process	Emission Factor (kg CO2-e /kWh)	Energy Consumption (kWh)	Emission (t CO_2-e)
In-House Manufacture	0.90	31,191,041	28,072
Merchant Supply		34,310,145	30,879

The results indicate Scope 2 emissions associated with energy consumption will be reduced in the move to In-House Manufacture by approximately 2,807 tonnes CO_2-e (or approximately 9 %).

4.2.4 Air Emissions - Other

According to information supplied by Husky Injection Moulding Systems, typical air composition reports there are no stack sources emitting anything other than hot air. Hot air only is emitted from the resin dryers, the mould dehumidifier and air compressor units. This is consistent with the CCA Air Quality and Greenhouse Gas Assessment report. CCA supplied information considers air emissions to be the same for both cases.

5 SUMMARY OF THE RESULTS

The results of the assessment are summarised in the following section. Comparisons of the calculated inputs and outputs for In-House Manufacture and Merchant Supply are illustrated in **Figure 3** to **Figure 8**.

5.1 Inputs

Raw material savings due to the development of lighter weight preforms and the move to In-House Manufacture were calculated to be approximately 5,496 tonnes of PET resin per annum (13 % reduction) based on future bottle volume projections. **Figure 3** and **Figure 4** below illustrate the relative preform weights and PET resin requirements of each PET bottle type for In-House Manufacture and Merchant Supply.

Figure 3 Preform Weight of PET Bottle Types

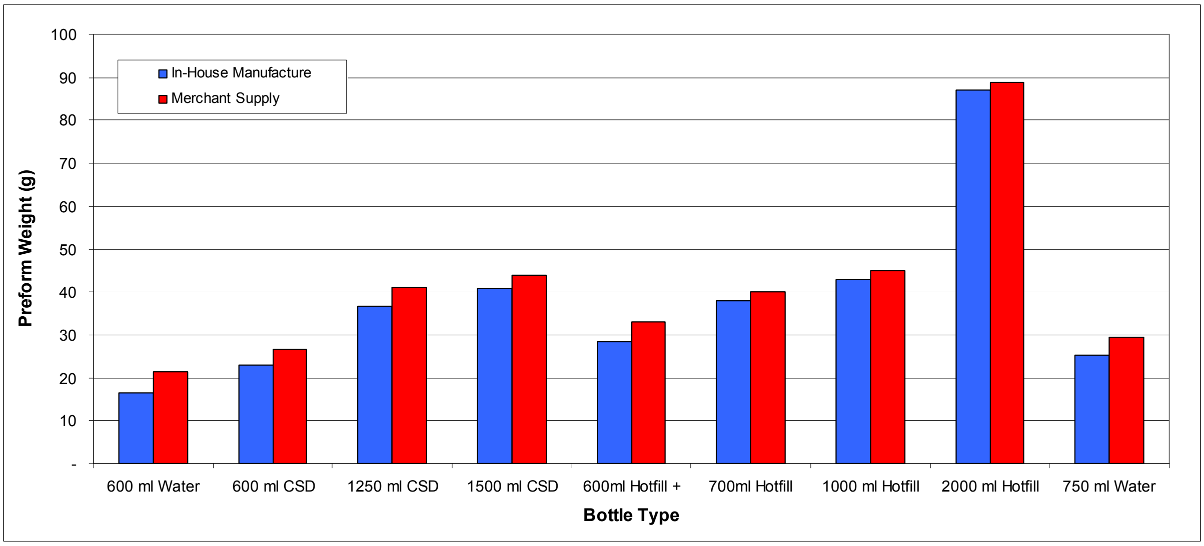
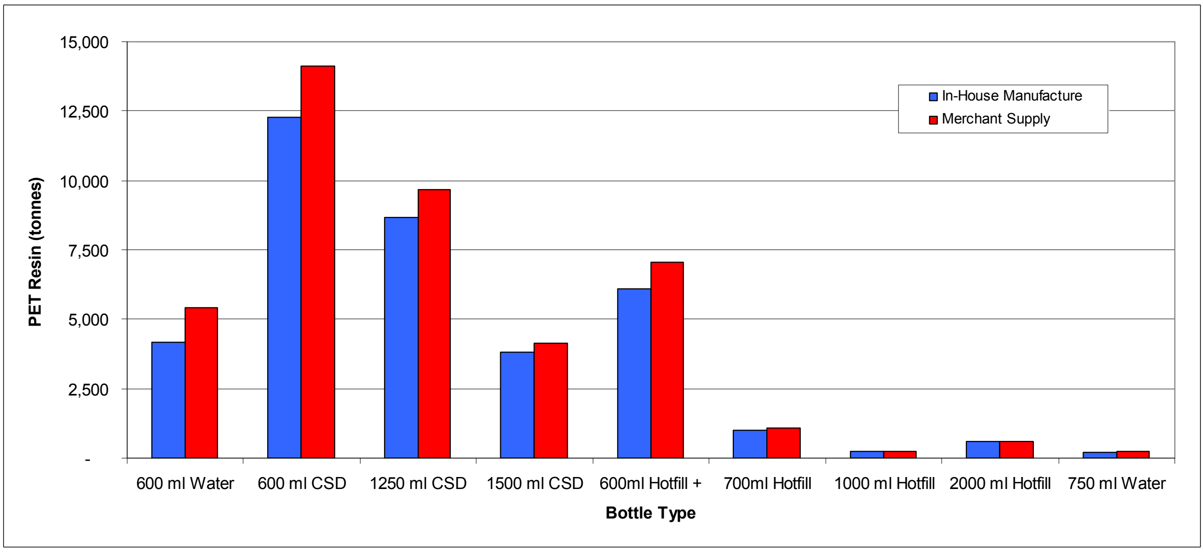


Figure 4 Tonnes PET Resin per PET Bottle Type (based on 2015 bottle volume estimations)



Water savings of approximately 50,000,000 L per annum will be realised in the move to In-House Manufacture. This equates to water savings of 135,000 L per tonne of PET resin according to future projections.

Supply chain step-changes (such as investment in latest technology) and the move to In-House Manufacture will decrease energy consumption by approximately 3,119,104 kWh per annum (energy savings of approximately 9 %) based on future projections of PET bottle volumes for the first full year of In-House Manufacture. The average energy consumption per 1000 PET bottles was calculated to be 23 kWh and 25 kWh for In-House Manufacture and Merchant Supply respectively. **Figure 5** and **Figure 6** illustrate energy input requirements for In-House Manufacture and Merchant Supply according to PET bottle type.

In addition, transportation will be reduced significantly in the move to In-House Manufacture. Diesel fuel savings of 143,002 L per annum may be realised in the move to In-House Manufacture (a difference of 12 %).

Figure 5 Estimated Energy Consumption per PET Bottle Type

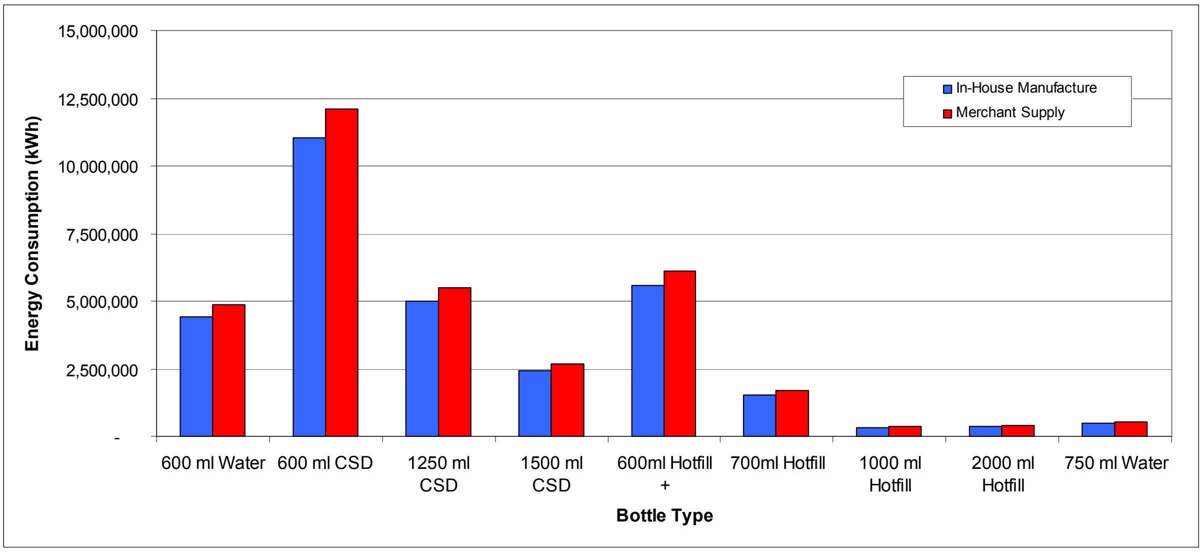


Figure 6 Estimated Energy Consumption per 1,000 bottles of PET Bottle Type

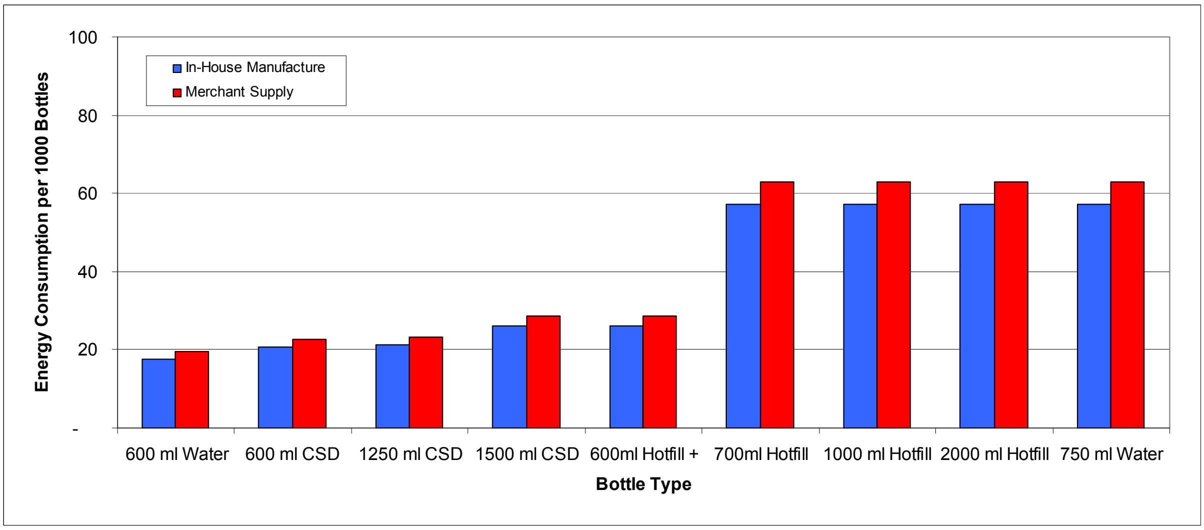


Figure 7 below compares total PET resin inputs and energy consumption inputs for In-House Manufacture and Merchant Supply while **Figure 8** illustrates the fuel consumption inputs of both cases.

Figure 7 Totals for Merchant Supply and In-House Manufacture

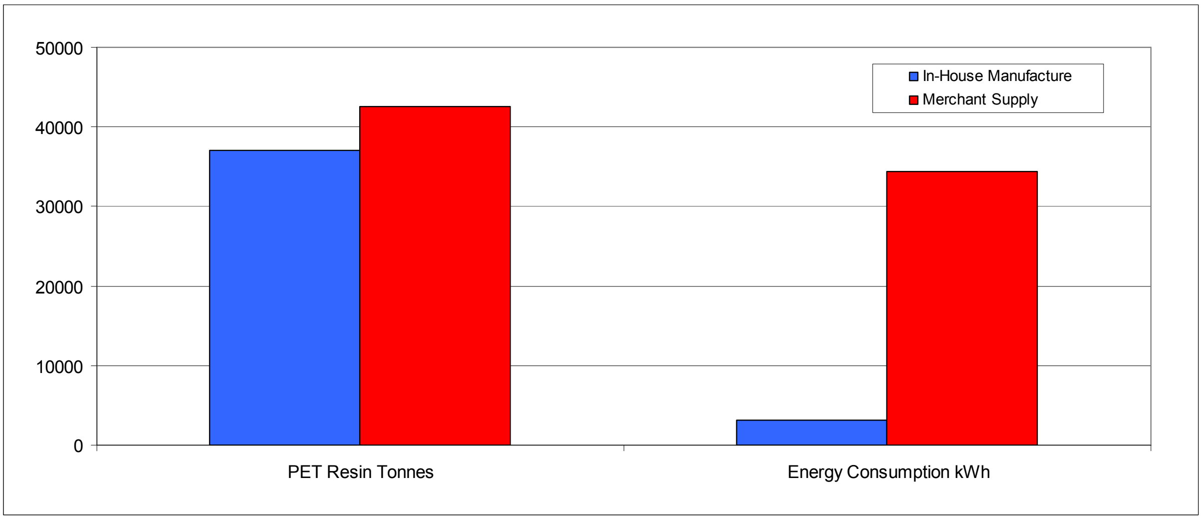
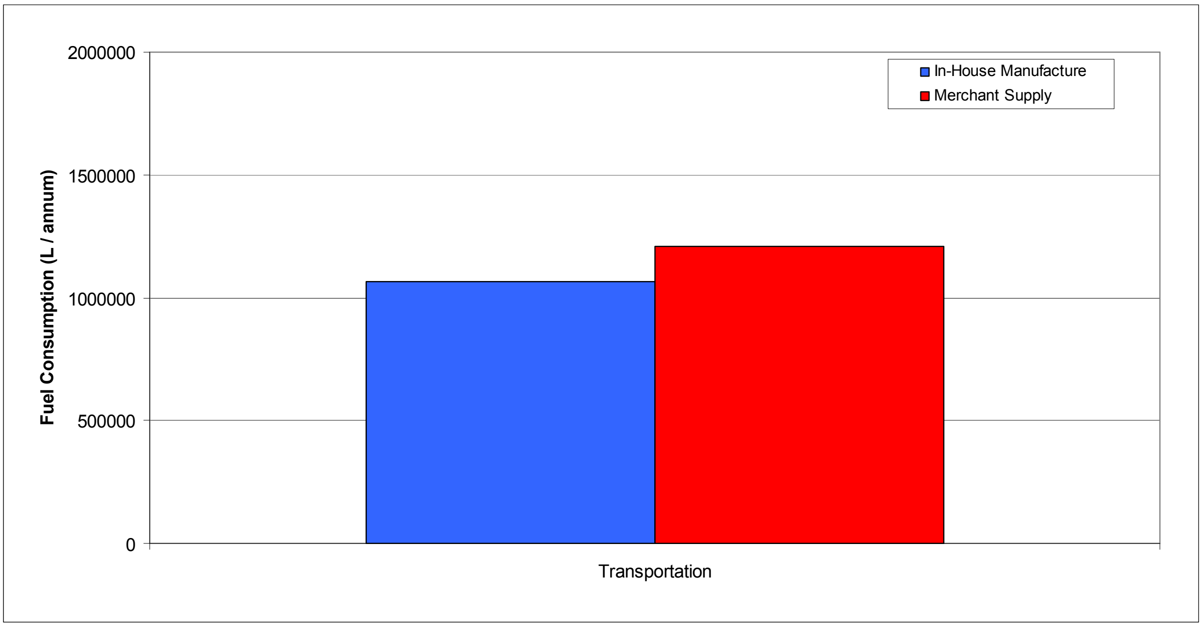


Figure 8 Transport Totals for Merchant Supply and In-House Manufacture



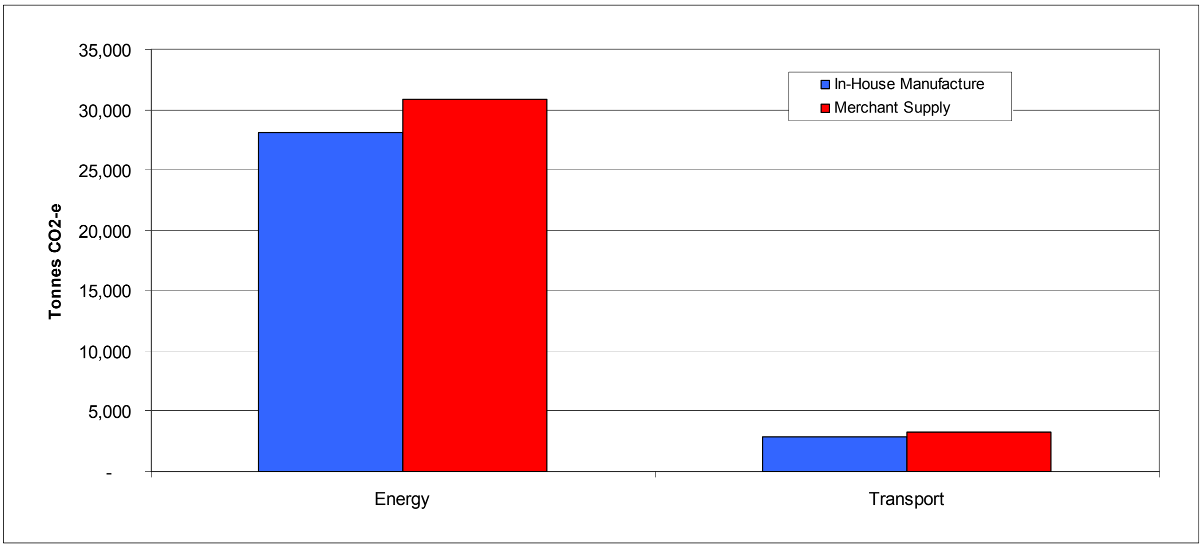
5.2 Outputs

Solid waste emissions are considered the same for both cases. Plastic waste material is recycled back into the manufacturing process where possible or is sold to Plastic Recyclers. Other solid wastes are collected by licensed disposal or recycling companies. Packaging demands for freight stabilisation and hygiene purposes will be much larger for Merchant Supply due to the associated transportation requirements.

Waste water emissions are considered similar for both cases and have been calculated at approximately 18,000 L per annum. Waste water is collected by licensed disposal companies. Water discharges to the sewer or stormwater drain occur in both cases when moulds require changing and are approximated at approximately less than 960 L per annum.

Air emissions include GHGs associated with the purchase of electricity and transportation. The total estimated GHG emission reduction that may be realised in the move to In-House Manufacture was calculated to be approximately 386 t CO_2-e (a 12 % decrease) while the total estimated GHG emission reduction due to the consumption of energy was calculated to be approximately 2,807 t CO_2-e (a 9 % decrease).

Figure 9 GHG Emissions for Merchant Supply and In-House Manufacture



Other air emissions are minimal (hot air is emitted from resin dryers, mould dehumidifiers and air compressor units) and are considered the same for both cases.

5.3 Sensitivity Analysis

The results of the benchmarking assessment are suitable for meeting the goal and scope of the study. The methodology is considered to be reproducible.

6 CONCLUSION

SLR Heggies has been commissioned by Goodman to conduct a Life Cycle Benchmarking Study to provide detail to the Department of Planning on the potential environmental impacts that may result from supply chain step-changes and the move from Merchant Bottle Supply to In-House Blowfill Bottle Manufacture.

The results of the study show that supply chain step-changes and the move to In-House Manufacture will generate the following benefits:

- Raw material savings of approximately 5,496 tonnes per annum (or approximately 13 %) (and bottle PET finish reductions of approximately 1.2 g per bottle);
- Water savings of approximately 50,000,000 L per annum;
- Energy savings of approximately 3,119,104 kWh per annum (or approximately 9 %);
- A reduction in diesel consumption of 143,002 L per annum (or approximately 12 %);
- Solid waste reductions due to a decrease in packaging required for transportation;
- A reduction in PET material deposited at landfill (and less HDPE material deposited at landfill); and,
- GHG emission reductions of 3,193 tonnes CO_2-e overall per annum due to a decrease in fuel consumption and energy consumption (or approximately 9 %).

In-House Manufacture and Merchant Supply processes have the following similar outputs:

- Solid wastes are either recycled back into the manufacture process or collected by appropriately licensed disposal contractors and recyclers. Solid wastes (other than packaging) are considered the same for both cases.
- Discharge water is released to the sewer or stormwater drain during mould changes and waste water generated is collected by appropriately licensed disposal contractors. Water emissions are considered the same for both cases.
- Air emissions (other than GHG emissions) are considered insignificant and similar for both cases.

Table 11 Summary Table – In-House Manufacture vs Merchant Supply

Item	Unit	In-House Manufacture	Merchant Supply	Beneficial / Adverse
PET Resin Inputs	tonnes / annum	37,054	42,549	Beneficial
Water Inputs	L / annum	0	50,000,000	Beneficial
Energy Inputs	kWh / annum	31,191,041	34,310,145	Beneficial
Av. Energy Inputs	kWh / 1000 / annum	23	25	Beneficial
Fuel Inputs	L / annum	1,067,529	1,210,531	Beneficial
Packaging Inputs	tonnes / annum	Less	More	Beneficial
Solid Waste Emissions	landfill tonnes / annum	Less	More	Beneficial
Solid Waste Emissions	tonnes / annum (other)	Same	Same	Neutral
Water Emissions	L / annum	Same	Same	Neutral
Scope 1 GHG Emissions	tonnes CO_2-e / annum	2,882	3,268	Beneficial
Scope 2 GHG Emissions	tonnes CO_2-e / annum	28,072	30,879	Beneficial
Other Air Emissions	volume / annum	Same	Same	Neutral

7 REFERENCES

- VTT (2005), VTT Technical Research Centre of Finland - Heavy-Duty Truck Emissions and Fuel Consumption Simulating Real-World Driving in Laboratory Conditions – 2005 DEER Conference.
- Department of Climate Change and Energy Efficiency, National Greenhouse Accounts (NGA) Factors Workbook (2010)
- Coca-Cola Amatil (CCA) Board Submission data (2010)
- Husky Injection Moulding Systems, letter dated September 15, 2010.
- SLR Heggies (2010) CCA Air Quality and Greenhouse Gas Assessment

8 CLOSURE

This report has been prepared by Heggies Pty Ltd with all reasonable skill, care and diligence, and taking account of the manpower and resources devoted to it by agreement with the client. Information reported herein is based on the interpretation of data collected and has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of Goodman Property Service (Aust) Pty Ltd. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR Heggies.

SLR Heggies disclaims any responsibility to the client and others in respect of any matters outside the agreed scope of the work.

Data Inventory

CCA Data Inventory - Benchmarking Study

Raw Material and Energy Inputs

		In-House Manufacture				Merchant Supply			
Bottle	**2015 Volume 000's**	**Preform Weight (g)**	**Tonnes**	**kWh**	**kWh / 1000 bottles**	**Preform Weight (g)**	**Tonnes**	**kWh**	**kWh / 1000 bottles**
600 ml Water	251,236	16.60	4,171	4,433,497	18	21.50	5,402	4,876,847	**19**
600 ml CSD	533,028	23.00	12,260	11,022,393	21	26.50	14,125	12,124,632	**23**
1250 ml CSD	236,100	36.70	8,665	4,994,985	21	41.00	9,680	5,494,484	**23**
1500 ml CSD	93,737	40.70	3,815	2,447,323	26	44.00	4,124	2,692,055	**29**
600ml Hotfill & others	213,357	28.50	6,081	5,570,411	26	33.00	7,041	6,127,452	**29**
700ml Hotfill	26,708	38.00	1,015	1,529,014	57	40.00	1,068	1,681,915	**63**
1000 ml Hotfill	5,616	43.00	241	321,512	57	45.00	253	353,663	**63**
2000 ml Hotfill	6,841	87.00	595	391,642	57	89.00	609	430,806	**63**
750 ml Water	8,389	25.20	211	480,264	57	29.50	247	528,290	**63**
Totals	**1,375,012**		**37,054**				**42,549**		
Total kwh				**31,191,041**				**34,310,145**	
Av. energy consumption					**23**				**25**

Source -2010 CCA Board Submission

Volumes - based on first full year of In-House Manufacture

Based on machine developments over the last 10 years it is estimated that the energy consumption of Merchant suppliers is 10%+ higher than with the new proposed Plant

Raw Material

Total Number of Bottles	1,375,012,000
Balance of Resin Inputs (t)	5,496
% Difference	13%

Energy

NSW Emission factor (kg CO2-e/kWh)		0.90	
Energy Consumption (kWh)	Merchant		34,310,145
	In-House		31,191,041
Energy x EF/1000	Merchant		30,879
	In-House		28,072
Difference (Energy)		2,807	
Difference %		9%	

Difference Energy Consumption (kWh) 3,119,104

Preform Transports

	State/Country	Location	Approx Volumes per Site 000's	Transport Distances Kms	Mode of Transport	Type of Transport	Bins per Shipment	Average Preforms per Bin	No Loads/annum	Total No of kms travelled
Blowing Operations	NSW	Northmead	350000	20	Road	40' Pantechnicon	44	10000	795	15,900
	NSW	Smithfield	30000	20	Road	40' Pantechnicon	44	10000	68	1,360
	Queensland	Richlands	330000	1900	Road	B Double	64	10000	516	980,400
	Victoria	Moorabbin	220000	1800	Road	B Double	64	10000	344	619,200
	Victoria	Bayswater	30000	1800	Road	B Double	64	10000	47	84,600
	South Australia	Thebarton	90000	2770	Road	B Double	64	10000	141	390,570
	Western Australia	Welshpool	120000	7800	Road/Rail/Sea	B Double	64	10000	188	1,466,400
								Total	**2099**	**3,558,430**

Note: Transport from Eastern Creek facility to Blowfill Plants.

Merchant Supply - Additional Transports

Transport States	**Type of Transport (assumed)**	**Approx Transport Distances**	**Pallets / Truck**	**Av No of bottles / pallet**	**Bottles / Truck**
NSW	40' Pan Truck	13	20	3000	60000
Queensland	40' Pan Truck	10	20	3000	60000
Victoria	40' Pan Truck	8	20	3000	60000
South Australia	40' Pan Truck	12	20	3000	60000
Western Australia	40' Pan Truck	9	20	3000	60000
	Average Distance Travelled	**10.4**			
	Return Trip Average Kms	**20.8**			

Number of Trucks	22,917
Total number of kms travelled	476,674.00

NGA Workbook Factors for Road Transport

Energy Content (GJ/kL)	38.6	0.02
Emission Factors (kg CO2-e/GJ)		NGA Calculations
CO2 emissions	69.2	2.67
CH4 emissions	0.2	0.01
NO2 emissions	0.5	0.02
Emission Factor Total		**2.70**

Transport

Assume 30 L / 100 km fuel consumption rate

Preform Transports (incl return trips)

Total Diesel Consumed (L)	1,067,529
Total Diesel Consumed (kL)	1068
Emission Factor Total	2.70
Diesel Consumptn Total (kL)	1068
Emission Factor x Diesel Consumption	2,882

Additional Merchant Supply Transports (incl return trips)

Total Diesel Consumed (L)	143,002
Total Diesel Consumed (kL)	143
Diesel Litres per Tonne Resin (Merchant)	3.36
Emission Factor Total	2.70
Diesel Consumptn Total (kL)	143
Emission Factor x Diesel Consumption	386
Total Fuel Consumption (Merchant)	1,210,531
Emission Factor x Total Diesel Consumption	3,268
% Difference t CO2-e	12%
Difference (Fuel Consumption)	143,002
% Difference	12%