User Guide

Reusable Beverage Container Advisor

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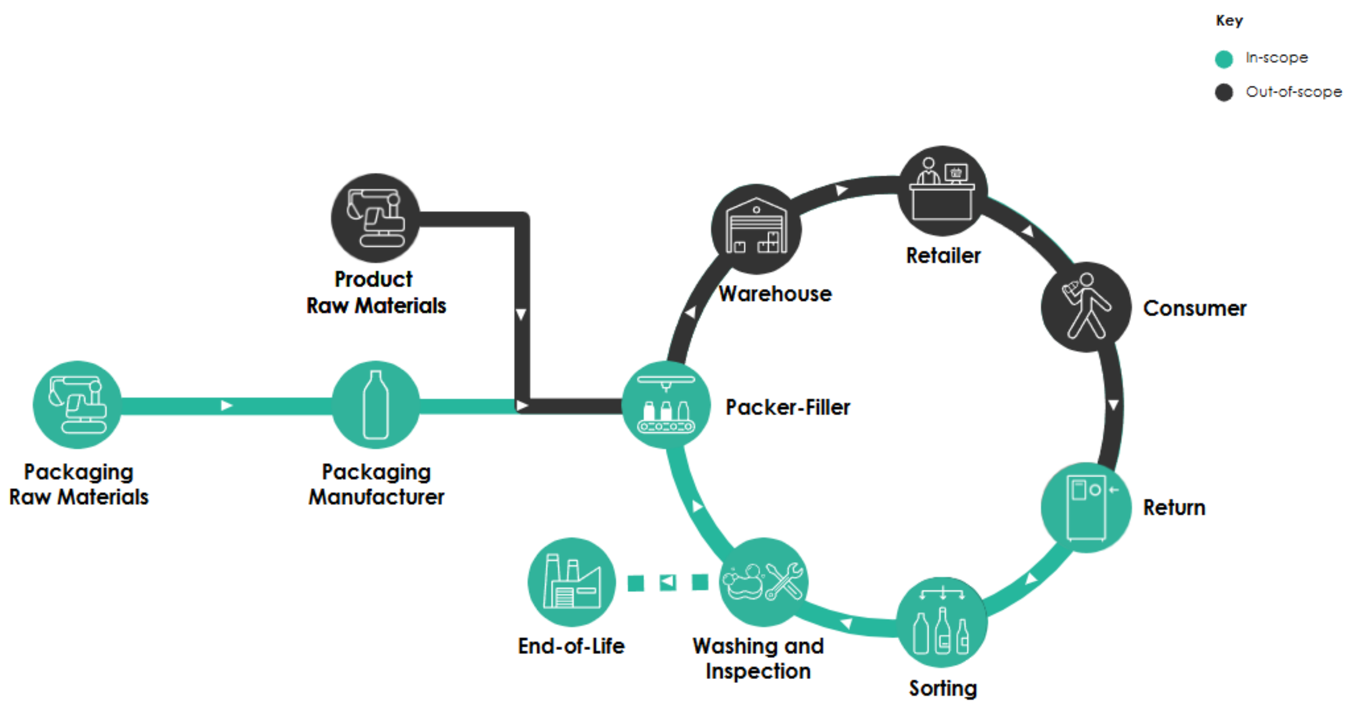
Introduction

This document is supplemental to the online Beverage Container Reuse Advisor Tool (The tool), hosted online by Eunomia Research & Consulting. The tool, developed in partnership with the Meridian Institute, is built to empower Meridian's Reuse & Refill Action Forum members to assess and communicate the environmental and financial impacts of reuse systems via common language and understanding.

The tool is focused on non-alcoholic retail beverages sold in the US. The reuse/refill system that has been modelled is based on a 'pre-filled' retail beverage container reuse system that provides the beverage directly to the consumer. This excludes dispensing with reusable cups or any other 'back-end' reusable vessels that the consumer does not interact with.

The purpose of this User Guide is to provide supplemental data, assumptions and modeling rationale so that users of the tool can understand how the results were calculated. It provides a more detailed description of how the inputs impact the calculations occurring behind the scenes in the tool, the system modelled, and how key assumptions were determined and justified.

Figure 1-1: The stages of the beverage reuse system modeled (grayed out circles show stages not modeled)



This document is structured as follows:

- Section 1.0 User Inputs
- Section 2.0 Return Infrastructure
- Section 3.0 Transportation Logistics

- Section 4.0 Process-Specific Assumptions
- Section 5.0 Further Technical Data Points & Assumptions

1.0 User Inputs

1.1 Boxes A and B: Single-use and reusable set-up

Boxes A and B provide users the ability to select the material, size, and quantity of single-use and reusable containers.

Material

The tool allows users to select from single-use aluminum cans, plastic (PET) bottles, and glass bottles. There are two separate inputs for PET bottles for carbonated beverages versus still water because the thickness of these bottles is different. This change can be seen in the 'single-use weight container (g)' box as the various inputs are selected.

There are two options for reusable materials: glass and PET as these are the most common solutions for reusable beverage containers currently on the market.

Size

The sizes of beverage containers were estimated based on the US beverage market. Table 1-1displays the ranges of beverage container sizes and the corresponding estimated size used for modeling.

Table 1-1: Approximated container sizes

Range (fl oz)	Modeled Size (fl oz)
<8.5	8.01
8.5 -13.5	12.00
13.5 – 23.7	16.06
23.7 – 33.8	25.36
>33.8	33.81

Quantity

The number of beverage containers per year that users can input ranges from 50,000 to 100,000,000.

This input is only in Box A for single-use because the number of reusable containers is calculated based on the number of single-use containers per year input as well as the size of single-use and reusable containers. For example, if 10,000,000 single-use containers are compared to reusable containers of the same size, then the model assumes 10,000,000 reusable containers. If 10,000,000 single-use containers less than 8.5 oz. are switched to reusable containers 13,5 to 23.7 oz, then the number of reusable containers is calculated as 4,989,474 containers. This ensures that the volume sold remains the same between single-use and reusable to allow for a like-for-like comparison.

Additional Float Pool

In any given reuse system, more containers will be needed than consumed in any given year to account for the time they take to move round the system. This input allow users to approximate the % increase in containers necessary in a given year. In reality, pool size would be linked to return rate, though this model does not dynamically connect the two.

1.2 Box C: Reuse system set-up

Reuse Return Rate

The return rate is the percentage of reusable containers which are returned into the system by consumers. This will influence system performance (environmental and financial).

Bottle Design Harmonization

Harmonized bottle design means you share bottle specifications and designs with other actors in the system and there is therefore potential to share reconditioning infrastructure. This increases the utilization of infrastructure and can reduce transportation distances, reducing environmental impacts and costs.

Fragmented bottle design mean that there is less uniformity and more unique bottle designs require more infrastructure specific to those containers.

Economies of Scale

Low economy of scale means you have not significantly rolled out reuse throughout your supply chain and there is relatively small amount of return, sorting, and washing locations covering your geographic area. These locations tend to be used less efficiently, and bottles must travel longer distances, both of which drive up costs and environmental impacts.

High economy of scale means that reuse makes up a reasonable market share in your supply chain (i.e., >10%) and you have built significant infrastructure to accommodate this. This infrastructure geographically covers your market meaning it is utilized efficiently and transport distances are lower.

Recycling Rates

Recycling rates are higher in 'bottle bill' states. The assumed recycling rates are listed in Table 1-2.

Table 1-2: Recycling Rate Assumptions

Container Type	Bottle Bill Recycling Rate	US Average Recycling Rate
Cans	75%	45%
Glass bottles	64%	25%
PET bottles	71%	29%

Energy System

Energy is used at various stages in the life of a container. Today's energy system assumes there is no decarbonization. Partial decarbonization assumes a reduction in carbon intensity for transport (20%), electricity (50%), and heat (20%).

2.0 Return Infrastructure

2.1 Bottling & Washing Facilities

The quantity of bottling facilities is needed to understand how the beverage industry operates today (e.g., how much energy is used to make plastic bottles), as well as to understand how many bottling/canning lines there are available to transition to reuse. It is also necessary to quantify and locate these facilities, so that transportation distances can be estimated.

The total number and location of bottling/washing facilities was derived from the Beverage Company Database.[1] Any sites relating to out-of-scope beverage types were excluded. Further data cleaning was done to exclude any sites that were just business headquarters or PO boxes, and duplicates were removed.

The total number of reuse filling lines (Table 2-1, Table 2-2, Table 2-3, Table 2-4) is the same as the number of washing/reconditioning lines in this system. This number varies with economies of scale and bottle design harmonization.[2]

Table 2-1: Number of single-use can filling lines switching to reusable filling/washing lines, in a harmonized system, at different economies of scale

Beverage Sector	Low	Medium	High
Soft Drinks	3	3	7
Water	1	2	4
Total	**4**	**5**	**11**

Table 2-2: Number of single-use can filling lines switching to reusable filling/washing lines, in a fragmented system, at different economies of scale

Beverage Sector	Low	Medium	High
Soft Drinks	5	5	8
Water	5	5	5
Total	**10**	**10**	**13**

Table 2-3: Number of single-use bottle filling lines switching to reusable filling/washing lines, in a harmonized system, at different economies of scale

Beverage Sector	Low	Medium	High
Soft Drinks	6	9	19

[1] Beverage Marketing Corporation. 2025. *THE BMC BEVERAGE COMPANY DATABASE*. https://www.beveragemarketing.com/beverage-directory.asp

[2] It was assumed that there is no loss in line annual capacity when switching to reuse.

Water	9	17	43
Total	**15**	**16**	**62**

Table 2-4: Number of single-use bottle filling lines switching to reusable filling/washing lines, in a fragmented system, at different economies of scale

Beverage Sector	Low	Medium	High
Soft Drinks	12	13	19
Other Water	9	17	43
Total	**21**	**30**	**62**

2.2 Distribution Centers

In this system, reusable beverage containers returned to retail locations are 'backhauled' to Distribution Centers, where they are sorted before being sent onwards to Bottling & Washing Facilities. It was necessary to estimate the number and location of these Distribution Centers involved in the system, to calculate their infrastructure costs and transportation distances.

According to research previously seen by Eunomia,[3] there are an estimated 590 Distribution Centers in the US. The exact location of these Distribution Centers is not known, and was therefore estimated using the ArcGIS Network Analyst tool. The underlying assumption is that the Distribution Centers are all roughly equally sized to serve approximately the same number of people (i.e., the total contiguous US population divided by the number of Distribution Centers), and are located near to where the demand is, based on the population distribution.

[3] Confidential source.

3.0 Transportation Logistics

Transportation is used throughout the beverage system, in both single-use and reuse models. This transportation has environmental and financial impacts which are a function of transport distance and vehicle types used.

The following subsections describe how transport distances were estimated, based on the number and location of different types of infrastructure discussed in the previous section.

Table 3-1 presents the characteristics of different vehicles used in the modeling of transportation impacts.

Table 3-1: Vehicle data

Characteristic	Class 8 Truck	20' Box Truck	Forklift
Truck inside width (m)	3	3	N/A
Truck inside depth (m)	16	6	N/A
Truck inside height (m)	3	3	N/A
Vehicle haulage limit (lb)	35,000	10,000	N/A
Tractor weight (lb)	17,000	N/A	N/A
Deadhead distance[4]	35%	N/A	N/A
Fuel type	Diesel	Diesel	LPG
Fuel consumption (MPG)	6	9-10	N/A
Fuel consumption – LPG (gal/hour)	N/A	N/A	0.7
Vehicle fill efficiency	80%	80%	N/A
Staff Per Vehicle	1.2	1.2	1.2
Staff Salary and On Costs ($/year)	$92,072	$92,072	N/A5
Vehicle Capex ($)	$140,000	$85,000	$40,000
Maintenance and & Insurance ($/year)	$28,000	$21,250	$8,000
Loading + Unloading time (minutes)	60	30	N/A
Available hours per day (hours)	11	11	11
Lifetime (years)	9	9	5

[4] The amount of distance a vehicle typically has to travel empty between dropping off its previous load and picking up the current one.
[5] See Staff DB

3.1 Distance Calculations

The distance that containers are hauled is a key determinant of the impacts of logistics in a reuse system. Hauling bottles generates GHG emissions, and requires trucks, fuel and staff that contribute to the total cost of the system.

The following subsections describe how the locations of different infrastructure are used to determine transportation distances for the various legs in the reuse system.

The Haversine formula was used to estimate driving distances. The Haversine formula gives the straight-line distance between two sets of X-Y coordinates. The straight-line distance was then scaled by a 'detour index'[6] of 1.3 to get an approximate driving distance. Sources suggest 1.1-1.3 is appropriate – 1.3 was used as a conservative estimate.[7]

The below subsections discuss further key assumptions related to each transportation step.

3.1.1 Empty Containers to Filling Location

It was assumed that empty, newly manufactured containers must travel 300 miles by road from the converter[8] to the filling location,[9] [10] and that this leg is done in a class 8 truck.

3.1.2 Sorting Centers to Filling & Washing Locations

This leg represents the transportation of bottles consumed in the retail sector, from Sorting Centers to Filling & Washing Locations. We assume that this leg is done by a Class 8 truck.

We assume that the truck arrives to pick up the bottles from the Sorting Center when it is nearing capacity – so that the capacity of the Sorting Center is the limiting factor, not the size of the truck or number of truck journeys. In other words, as many trucks can leave a Sorting Center in a week as is necessary.

It was assumed that the drive distance for bottles leaving any given Sorting Center is the average drive distance to the nearest one-fifth of Bottling & Washing Facilities. The weighted averages shown in Table 3-2 are averages across each Sorting Center and bottle design. These distances depend on whether the reuse system is harmonized or fragmented, as the more fragmented the system, the more different Filling & Washing Locations must be online to service the different bottle designs.

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[6] Boscoe FP, Henry KA, Zdeb MS. 2012. *A Nationwide Comparison of Driving Distance Versus Straight-Line Distance to Hospitals.* https://pmc.ncbi.nlm.nih.gov/articles/PMC3835347/

[7] Stack Exchange. 2022. *Geographic Information Systems, Is there a relationship between driving distance and straight line distance?* https://gis.stackexchange.com/questions/422572/is-there-a-relationship-between-driving-distance-and-straight-line-distance#:~:text=The%20ratio%20is%20approximately%20pi,general%20orthogonal%20nature%20of%20roads.

[8] The converter is the location where raw materials are converted into empty containers.

[9] Franklin Associates, A Division of ERG (ERG). 2023. *LIFE CYCLE ASSESSMENT OF PREDOMINANT U.S. BEVERAGE CONTAINER SYSTEMS FOR CARBONATED SOFT DRINKS AND DOMESTIC STILL WATER.* https://napcor.com/wp-content/uploads/2023/02/NAPCOR-Beverage-Container-LCA-Report-2023.pdf

[10] Norwegian Institute for Sustainability Research. 2023. Life cycle assessment of the current recycling system and an alternative reuse system for bottles in Norway. PP 46. https://infinitum.no/media/zezjsrvs/report-lca-of-single-use-and-reuse-systems_or2723.pdf

Table 3-2: Drive distances for transporting bottles from Sorting Centers to filling & washing locations

Economies of Scale	Average distance in Harmonized System (mi)	Average distance in Fragmented System (mi)
Low	180	225
Medium	165	212
High	145	200

3.1.3 Distribution Centers to Filling & Washing Locations

This leg represents the transportation of bottles from Distribution Centers[11] to Filling & Washing Locations. We assume that this leg is done by a Class 8 truck.

We assume that the truck arrives to pick up the bottles from the Distribution Center when it is nearing capacity – so that the capacity of the Distribution Center is the limiting factor, not the size of the truck or number of truck journeys. In other words, as many trucks can leave a Distribution Center in a week as is necessary.

It was assumed that the drive distance for bottles leaving any given Distribution Center is the average drive distance to the nearest one-fifth of Bottling & Washing Facilities. The weighted averages shown in Table 3-3 are averages across each Distribution Center and bottle design. These distances depend on whether the reuse system is harmonized or fragmented, as the more fragmented the system, the more different Filling & Washing Locations must be online to service the different bottle designs.

Table 3-3: Average drive distances under different conditions for the Distribution Center to bottling/washing facility leg (mi)

Economies of Scale	Weighted Average distance in Harmonized System (mi)	Weighted Average distance in Fragmented System (mi)
Low	224	261
Medium	126	229
High	93	138

[11] The transport leg previous to this from hospitality locations to Distribution Centers, is assumed to be performed by 'reverse logistics' with no additional impacts, and is therefore not modeled here.

4.0 Process-Specific Assumptions

4.1 Raw Materials, Conversion and End of Life

The embodied GHG emissions and water of raw materials of container bodies and closures are in scope. The embodied impacts of secondary and tertiary packaging are not calculated, as high-level estimates show that these are negligible.

The emissions and water use of using raw materials depend on the relative proportions of primary (virgin) and secondary material used – the recycled content of raw materials. This is shown in Table 4-1.

Table 4-1: Recycled content of packaging materials (US average)

Material	Recycled content
Aluminum	73%
Glass	23%
PET	12%
Steel	80%
HDPE	12%

These recycled content values are used to determine the embodied emissions and water from raw materials in the US, average across the relative proportions of both primary and secondary materials (Table 4-2 and Table 4-3).

Table 4-2: Emissions factors used ($kgCO_2e/kg$ material)[12]

Material	Primary (virgin) material	Secondary material	US average material
Aluminum	10.9	0.9	3.6
Glass	0.7	0.3	0.6
PET	2.2	0.5	1.9
Steel	3.2	1.6	1.9
HDPE	1.6	0.7	1.5

[12] Derived from EPA Warm

Table 4-3: Embodied water factors liters (water/kg material)

Material	Primary (virgin) material	Secondary material	US average material
Aluminum	868.7	2.0	236.0
Glass	4.0	6.0	4.5
PET	9.9	5.6	9.4
Steel	0.0	0.0	0.0
HDPE	0.0	0.0	0.0

Table 4-4 shows the conversion processes involved in turning raw materials into containers (and closures), and the related energy consumption of these processes.

Table 4-4: Conversion assumptions

Material	Conversion Process	Electricity Consumption, kWh/kg	Gas (heat), kWh/kg
Aluminum Cans[13]	Sheet rolling + Can manufacturing	2.6	2.2
Glass Bottles[14]	N/A	0.0	0.0
PET Bottles (Standard)[15]	Injection Molding	4.5	0.0
Steel	Part Forming	0.2	0.0
HDPE[16]	Injection Molding	4.5	0.0

We are using the cut off approach to EoL accounting. Any emissions associated with recycling (credits or impacts) are 'cut-off' therefore assumed zero. Impacts of primary material production are allocated to the product where the primary material is used. Impacts of the recycling process are allocated to the product where the recycled material is used. Impacts of treatment of waste not recycled are allocated to the product generating the waste. Recycling the material at its end of life only credits the product with the avoided impacts of the alternative end of life processes, such as landfilling. See Section 5.0 for the relevant data points.

[13] Sphera. 2021. Life Cycle Assessment of North American Aluminum Cans. https://www.aluminum.org/sites/default/files/2021-10/2021AluminumCanLCAReportFullVersion.pdf
[14] Assumed to happen at raw material production
[15] Rex Materials Group. N,d. *Injection Molding Facility Energy Consumption Summary.* https://www.rexmaterials.com/activek_apps/rmg/assets/tcs/Facility%20Energy%20Use%20Summary%20-%20Overview.pdf
[16] Rex Materials Group. N,d. *Injection Molding Facility Energy Consumption Summary.* https https://www.rexmaterials.com/activek_apps/rmg/assets/tcs/Facility%20Energy%20Use%20Summary%20-%20Overview.pdf

4.2 Bottling

The producer/bottling stage takes containers, or preform containers, as an input and produces filled containers as an output. Note that for cans and glass bottles this is just container filling, whereas for PET bottles these must be blown at the filler which uses a lot of energy.

Note that we assume that this process is basically the same for single-use and reusable containers (apart from blow molding, which is not required for non-new reusable containers). This stage uses the following equipment:

- Container depalletizer;
- Container cleaner;
- Filler;
- Labeler;
- Container packager;
- Container wrapper;
- Blow molding machine.

CAPEX is modeled using the relationship between the capital cost of the site and how many employees work there (estimated from the Beverage Market Company data):[17] Eunomia's research shows that CAPEX for a filling line is approximately $1.7 million for every one person employed at a filling location. This CAPEX includes: machinery, electrical equipment, land purchasing, buildings etc. Equipment is assumed to have a lifetime of 15 years.[18]

The OPEX in scope for the producer stage are staff costs and energy consumption.

Table 4-5: Energy consumption of bottling equipment

Equipment type	Electric power consumption (Wh/1000 containers)[19]
Container de-palletizer	449
Blow molding machine	4,694
Container cleaner	363

[17] It is assumed that, for a given number of containers of a certain size, transitioning to reuse requires no extra filling capacity; that reconditioning is appended to the start of the filling line, and reusable bottles are filled in the same way as single use ones.
[18] PWC. 2022. *Economic study of returnable refillable PET in the EU soft drinks industry.* https://unesda.eu/wp-content/uploads/2024/06/PwC-Economic-study-of-returnable-refillables-PET_2022.pdf
[19] TUM School of Life Sciences. 2023. *Electrical Energy Consumption of Beverage Bottling Plants: Analysis, Modeling, and Forecast.* https://mediatum.ub.tum.de/doc/1712681/document.pdf

Equipment type	Electric power consumption (Wh/1000 containers)[19]
Filler	275
Labeler	621
Container packager	561
Container wrapper	561
Inspector	79

4.3 Washing, Drying and Inspecting

The reuse system considered in this report assumes that washing, drying and inspecting take place at the same sites as (re)filling the containers – i.e., this is done at Bottling & Washing Facilities.

Evidence from real plants suggests there is a relatively consistent relationship between the capital cost of the washing plant and the annual bottle washing capacity.[20] [21] [22] [23] [24]

Section 2.1 describes how we estimated the number of reusable filling lines at each reuse market share and market harmonization. From this we can estimate the reuse bottling and canning annual capacity in terms of bottles-per-minute capacity: the cost of a new reconditioning facility is modeled as $56,152 for every bottle-per-minute (BPM) of capacity the plant has.

We therefore multiply the annual line capacity derived in Section 2.1 (in bottles-per-minute, BPM, assuming that plants run 24-7-365 with 85% utilization) by the $56,152 to get total reconditioning facility CAPEX.

Evidence from one plant suggests that for every $600,000 of CAPEX spent, one person is employed.[25]

Section 2.1 describes how the total throughput of reusable containers is calculated at different reuse market shares. We assume active drying which uses electricity at 5.3 kWh per 1,000 containers. We assume this does not vary with container size.

Table 4-6 and Table 4-7 are used to calculate the energy, caustic, sanitizer and water used to wash these bottles. OPEX is calculated based on the amount of inputs and the staff required.

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[20] Peter, A. 2022. *Refillable soda bottles used to be the norm. Can they come back?.* Fast Company. https://www.fastcompany.com/90721672/refillable-soda-bottles-coca-cola

[21] Packaging Europe. 2020. *Reuse: a closer look a Coca-Cola Brazil's unique returnable bottle initiative*. https://packagingeurope.com/reuse-a-closer-look-at-coca-cola-brazils-unique-returnable-bottle-initiative/1583.article

[22] Ruland Engineering & Consulting. 2025. *Plant piping of the new filling line and bottle sorting system. https*://rulandec.com/en/references/piping-rothaus/

[23] Reynolds, P. 2019. *Optimizing the sorting and filling of returnable glass*. Packaging WORLD. https://www.packworld.com/leaders-new/machinery/conveying-accumulation/article/13377141/optimizing-the-sorting-and-filling-of-returnable-glass

[24] Asia Food Journal. 2022. Coca-Cola Europacific Partners Germany invests in a state-of-the-art returnable glass line from KHS. https://asiafoodjournal.com/coca-cola-europacific-partners-germany-invests-returnable-glass-line/

[25] Demorest, A. 2024. *Eco in Pack investment to process 7 million wine & spirits bottles annually for reuse*. FORMES DE LUXE. https://www.formesdeluxe.com/article/eco-in-pack-investment-to-process-7-million-wine-spirits-bottles-annually-for-reuse.64576

We assume active drying which uses electricity at 5.3 kWh per 1,000 containers.[26] We assume this does not vary with container size.

Table 4-6: Washing material data

Material	Emissions Factor	Emissions Factor Unit	Price	Price Unit
Water	1.74E-03[27]	kgCO2e/gallon	$3.83[28]	$/100 cubic feet
Caustic	6.48E-01[29]	kgCO2e/kg	$1.14[30]	$/kg
Sanitizer	5.00E-01[31]	kgCO2e/kg	$1.14[32]	$/kg

Table 4-7: Washing assumptions

Assumption	Unit	Value
Electric power consumption	kWh/L	0.003
Heat consumption	kWh/L	0.05
Heat fuel		Natural gas
Water consumption	Liters/Liter	0.453
Caustic for washing	g/container	7.1
Sanitizer for washing	g/container	0.7

4.4 Return and Sorting Infrastructure

The return location is where the consumer brings the empty packaging back. This model assumes consumers return to retail locations.

The below subsections describe how the costs and environmental impacts of this infrastructure are modeled, based on the quantity of sites. Table 4-8 contains generic cost data used in this modeling.

[26] Propietary data provided by a manufacturer.
[27] Louis Zib, Diana M. Byrne, et Al. 2021. *Operational carbon footprint of the U.S. water and wastewater sector's energy consumption.* Journal of Cleaner Production, Volume 321. https://www.sciencedirect.com/science/article/abs/pii/S0959652621030110
[28] South Cost Water District. 2024. *Commercial Rates and Charges.* https://www.scwd.org/open_government/rates/commercial_rates.php
[29] EcoInvent 3.7.1, APOS, IPCC
[30] Univar Solutions. 2025. *Caustic Soda 50%, Membrane Grade, Liquid, 680 ld Drum.* https://www.univarsolutions.com/caustic-soda-50-mem-3150040?v=16141148&srsltid=AfmBOooGWfBpk5vNE69BPIfLly_6GDqnCeYV5z-_w1mdJRQv66-jkVj8Xo4
[31] EcoInvent 3.7.1, APOS, IPCC
[32] Find source

Table 4-8: Land use data

Land Type	Annual Rent ($/m²)	Installation/Refit Cost ($/m²)
Retail Space (Return infrastructure)	276[33]	N/A

4.4.1 Return

Land costs are included (see Table 4-8), assuming that requirements are the size of the containers (8 ft x 40 ft) plus some space around (50 m²) for queuing and parking.

4.4.2 Sorting

Sorting is assumed to be done at Distribution Centers.

[33] AVERAGE OF: Speed Commercial Real Estate. 2025. *How Much Does It Cost to Rent a Retail Space?* https://speeDistribution Centerres.com/blog/how-much-cost-rent-retail-space/#:~:text=Location%20is%20Vital%20to%20Rent%20a%20Retail%20Space%20Successfully&text=For%20a%20space%20of%20around,%241%2C250%20to%20%243%2C500%20per%20month. , and, Fast White Cat. 2024. Understanding the Costs of Launching an e-commerce Retail Business. https://fastwhitecat.com/en/understanding-the-costs-of-launching-an-ecommerce-retail-business/https://www.statista.com/statistics/1379047/retail-real-estate-rent-by-property-type-usa/. , and, Statista. 2024. *Average rent of real real estate in the United States in 4th quarter 2023, by property type.* https://www.statista.com/statistics/1379047/retail-real-estate-rent-by-property-type-usa/
average of the above

5.0 Further Technical Data Points & Assumptions

Table 5-1 contain general assumptions and data points used throughout the model. Table 5-1's energy data is used to calculate the emissions impacts and costs of each type of energy consumption. For example, as discussed in Section 3.0 discusses transportation logistics. Trucks require diesel fuel, whose emissions and cost use data in Table 5-1.

Table 5-1: Energy data

Fuel	Emissions Factor	Emissions Factor Unit	Price	Price Unit
Diesel	12.55[34]	kgCO2e/gallon	$3.08[35]	$/gallon
Electricity	0.28[36]	kgCO2e/kWh	$0.08[37]	$/kWh
Gas	0.21[38]	kgCO2e/kWh	$0.02[39]	$/kWh
LPG	8.03[40]	kgCO2e/gallon	$1.98[41]	$/gallon

The assumptions in Table 5-2 are the proportion of reusable containers entering a process (e.g., conversion) that are ultimately lost (e.g., broken during processing or rejected after inspection). When lost, this material is assumed to be recycled.

[34] Direct: U.S. Environmental Protection Agency. 2023. *Emission Factors for Greenhous Gas Inventories.* https://www.epa.gov/system/files/documents/2023-03/ghg_emission_factors_hub.pdf
WTT: Department for Energy Security and Net Zero. 2024. *Greenhouse Gas Reporting: Conversion Factors 2024. GOV*.UK. https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2024
[35] U.S. Energy Information Administration. 2025. *Petroleum and Other Liquids*. 5-year average: https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=emm_epmr_pte_nus_dpg&f=m
[36] Direct: U.S. Environmental Protection Agency. 2022. *eGRID Summary Tables, Table 2: Subregion Resource Mix (eGRID 2022)* https://www.epa.gov/system/files/documents/2024-01/egrid2022_summary_tables.pdf
T&D: U.S. Environmental Protection Agency. 2024. *THE EMISSIONS & GENERATION RESOUCRE INTEGRATE DATABASE, Egrid Technical Guide with Year 2022 Data.* https://www.epa.gov/system/files/documents/2024-01/egrid2022_technical_guide.pdf
WTT: Department for Energy Security and Net Zero. 2024. *Greenhouse Gas Reporting: Conversion Factors 2024. GOV*.UK. https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2024
[37] https://www.eia.gov/tools/faqs/faq.php?id=74&t=11
[38] Direct: U.S. Environmental Protection Agency. 2023. *Emission Factors for Greenhouse Gas Inventories.* https://www.epa.gov/system/files/documents/2023-03/ghg_emission_factors_hub.pdf
WTT: Department for Energy Security and Net Zero. 2024. *Greenhouse Gas Reporting: Conversion Factors 2024. GOV*.UK. https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2024
[39] U.S. Energy Information Administration. 2025. *Electricity Monthly Update*. https://www.eia.gov/electricity/monthly/update/print-version.php
[40] Direct: Cabrera, G. 2023. *What Is the Carbon Footprint of LPG? A Life-Cycle Assessment.* https://impactful.ninja/the-carbon-footprint-of-lpg/#:~:text=LPG%20has%20a%20lower%20carbon,source%20must%20also%20be%20considered.
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[41] my LPG.eu. 2025. What Is the Carbon Footprint of LGP? A Life-Cycle Assessment https://www.mylpg.eu/stations/united-states-of-america/prices/

Table 5-2: Assumed process and transportation loss rates

Loss rate		Converter	Converter to Producer	Producer	Washing/Drying/ Inspection
Aluminum Cans	Single-use	3%	5%	1%	N/A
Glass Bottles	Single-use	3%	2%	1%	N/A
PET Bottles (Standard)	Single-use	0%	0%	1%	N/A
PET Bottles (Still Water)	Single-use	0%	0%	1%	N/A
Glass Bottles	Reusable	3%	2%	1%	2%
PET Bottles (Standard)	Reusable	0%	0%	1%	5%

Table 5-3 shows the dimensions (size and weight) of all single-use and reusable containers modeled. Container weights are relevant when calculating the impacts embodied in raw materials and transport impacts. The sizes are also relevant when modeling transport.

Table 5-3: Container dimensions

Container Material	Container Size (L)	Single-Use/ Reusable	Width (mm)	Depth (mm)	Height (mm)	Weight (g)
Aluminum Cans	0.237	SU	57	57	115	11
Aluminum Cans	0.355	SU	66	66	122	12
Aluminum Cans	0.475	SU	66	66	160	13
Aluminum Cans	0.75	SU	82	82	153	15
Aluminum Cans	1	SU	82	82	196	17
Glass Bottles	0.237	SU	56	56	188	193
Glass Bottles	0.355	SU	63	63	218	255
Glass Bottles	0.475	SU	70	70	245	360
Glass Bottles	0.75	SU	75	75	300	458
Glass Bottles	1	SU	80	80	320	594
PET Bottles (Standard)	0.237	SU	64	64	125	18
PET Bottles (Standard)	0.355	SU	67	67	173	20
PET Bottles (Standard)	0.475	SU	64	64	203	24
PET Bottles (Standard)	0.75	SU	73	73	242	35
PET Bottles (Standard)	1	SU	86	86	262	42
PET Bottles (Still Water)	0.237	SU	50	50	155	9

Container Material	Container Size (L)	Single-Use/ Reusable	Width (mm)	Depth (mm)	Height (mm)	Weight (g)
PET Bottles (Still Water)	0.355	SU	53	53	173	11
PET Bottles (Still Water)	0.475	SU	57	57	192	12
PET Bottles (Still Water)	0.75	SU	65	65	235	16
PET Bottles (Still Water)	1	SU	73	73	274	19
Glass Bottles	0.237	RU	56	56	180	180
Glass Bottles	0.355	RU	62	62	228	285
Glass Bottles	0.475	RU	70	70	224	315
Glass Bottles	0.75	RU	80	80	290	570
Glass Bottles	1	RU	85	85	302	610
PET Bottles (Standard)	0.237	RU	58	58	203	34
PET Bottles (Standard)	0.355	RU	62	62	216	39
PET Bottles (Standard)	0.475	RU	65	65	230	43
PET Bottles (Standard)	0.75	RU	70	70	285	57
PET Bottles (Standard)	1	RU	80	80	290	62

The data shown in Table 5-4 are used to calculate the costs of staff working in the reusable beverage system. The number of staff required in the processes are described throughout Sections 3.0 and 4.0.

Table 5-4: Staff financial data (USD)

Staff Grade	Factory Worker	Operative[42]	Sorting Center Manager[43]	Small Return Point Manager[44]	Retail Staff[45]
Annual Salary	50,000	37,024	105,000	65,000	32,510
NI/SS	0%	6.2%	6.2%	6.2%	6.2%
Pension	0%	0%	0%	0%	0%

[42] Indeed. 2025. Warehouse worker salary in the United States. https://www.indeed.com/career/warehouse-worker/salaries
[43] Salary.com. 2025. *Distribution Center Manager Salary in the United States.* https://www.salary.com/research/salary/benchmark/distribution-center-manager-salary
[44] Estimated
[45] Talent.com. 2025. *Retail average salary in the USA, 2025.* https://www.talent.com/salary?job=retail#:~:text=The%20average%20retail%20salary%20in,up%20to%20%2446%2C545%20per%20year.

Staff Grade	Factory Worker	Operative[42]	Sorting Center Manager[43]	Small Return Point Manager[44]	Retail Staff[45]
Health Insurance	0%	18%	6%	10%	20%
Other On-costs	20%	13%	13%	13%	13%
Overtime	0%	14%	0%	0%	0%
Bonus; Other Benefits	0%	0%	0%	0%	0%
NI/SS	0	2,295	6,510	4,030	2,016
Pension	0	0	0	0	0
Health Insurance	0	6,500	6,500	6,500	6,500
Other On-costs	10,000	4,702	13,335	8,255	4,129
Overtime	0	5,000	0	0	0
Bonus; Other Benefits	0	0	0	0	0
Total Unit Cost	60,000	55,522	131,345	83,785	45,155

A 10% program management cost (i.e., to represent system administration, education etc.) was applied to the total net OPEX of the reuse system.[46] [47]

[46] Return It. 2024. *2023 Annual Report, Encorp Pacific (Canada)*. https://ar.return-it.ca/ar2023/pdf/Return-It_2023_Annual_Report.pdf
[47] Recycle BC. 2024. *2023 Annual Report*. https://recyclebc.ca/wp-content/uploads/2024/06/Recycle-BC_Annual-Report_2023_F.pdf