A Streamlined Life Cycle Assessment Comparison for Glenroy Stand-Up Pouch with Fitment Options vs. Rigid PET (with pump) and HDPE Bottles for Shampoo

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Prepared for:

GLENROY®

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Project Overview & Goals

Glenroy approached PTIS to look at providing a streamlined life cycle assessment (LCA) and report with descriptions on key environmental indicators comparing three separate Stand-Up Pouches (SUP) with fitment structures to two rigid package equivalents currently on the market for an upscale shampoo.

The purpose of this LCA was to use the results as an educational tool and better understand the environmental impacts of the SUP options when compared to the rigid package options. Two rigid packs served as the benchmark, including a PET bottle with a pump as well as standard HDPE bottle with a flip top closure against a range of spouted pouch options. Both the bottle and SUP options contain 1 liter (33.8 fluid ounces) of shampoo.

The assessment looked at the primary packaging.

For this report, three separate SUP options were compared to the rigid bottles:

- Traditional Spouted Stand-up Pouch
- Post-Consumer Recycled (PCR) Metalized Spouted Stand-up Pouch
- Post-Consumer Recycled (PCR) Non-metalized Spouted Stand-up Pouch

Packaging Options

Traditional (Multi-layer) SUP	**Wt (g)**	
PET	1.84g	
Metalized PET	1.82g	
Nylon	1.87g	
LLDPE	12.66g	
Cap & Fitment – PP	3.31g	
Weight (Primary Pack)	20.73g	
PCR Metalized Spouted SUP	Wt (g)	
PCR PET (100% PCR)	1.82g	
PCR Metalized PET (100% PCR)	1.82g	
Nylon	1.87g	
HPDE/LLDPE Coex (42% PCR)	10.32g	
Cap & Fitment – PP	3.31g	
Weight (Primary Pack)	19.14g	
PCR Non-metalized Spouted SUP	Wt. (g)	
PCR PET (100% PCR)	1.82g	
Nylon	1.87g	
HPDE/LLDPE Coex (42% PCR)	10.32g	
Cap & Fitment – PP	3.31g	
Weight (Primary Pack)	17.32g	

Rigid Bottle – PET w/ pump	**Wt. (g)**	
Bottle – PET (100% PCR)	52.1g	
Pump (diptube, cap, spring, etc.)	23.0g	
Overwrap – LDPE	2.9g	
Weight (Primary Pack)	78.0g (bottle)	

Rigid Bottle – HDPE w/ flip top	Wt. (g)	
Bottle – HDPE	76.2g	
Flip top closure – PP	5.9g	
Overwrap – LDPE	2.9g	
Weight (Primary Pack)	85.0g	

The streamlined LCA software tool used for the project was EcoImpact-COMPASS® from Trayak. The tool was originally developed through the Sustainable Packaging Coalition (SPC) and is widely used and accepted in the packaging industry for quick LCA type of package comparisons. It is now maintained and updated by Trayak.

For the comparison, a product weight of 1 liter (33.8 fl. oz.) was used. This was based on the declared sales weight for the shampoo bottle as well as the different SUP options.

The environmental indicators that were measured through EcoImpact-COMPASS® include:

1. Fossil Fuel Use
2. GHG Emissions
3. Water Use

Other metrics considered include:

- Material efficiency (g of pkg/ fl. oz of product)
- Material discarded

Recycling rate assumptions (based on US EPA data and default in the EcoImpact-COMPASS® software):

- PET bottle – 29%
- HDPE bottle – 18%
- PP closure/ cap – 3%
- PP Pump – 0%
- All stand-up pouches with fitment – 0%

Other assumptions used in the calculations:

- Transportation assumptions for incoming materials were included. These assumptions included:
    - 72km (45 miles) of large truck transport for HDPE and PET bottles (to filling facility)
    - 2,286km (1,421 miles) of a large truck transport for the pump
    - 3,280km (2,038 miles) of a small truck transport for the closure
    - 3,300km (2,070 miles) of a mid-sized truck transport for pouch
- The energy profile for the U.S. was used for all calculations

Streamlined Life Cycle Assessment and Case Studies

Streamlined Life Cycle Assessment Tool - EcoImpact-COMPASS®

EcoImpact-COMPASS® was used for the life cycle assessment (LCA) package comparison in this report as it is a widely accepted tool within the packaging community. It is known as a streamlined LCA as it uses industry average data, rather than inputs specific for a particular company, and is much quicker than a full LCA. The tool has been continuously revamped as new manufacturing and converting information is available. The EcoImpact-COMPASS® tool also uses data from ecoinvent, U.S. Life Cycle Inventory Database (part of the National Renewable Energy Laboratory), and other LCA databases which are widely used. EcoImpact-COMPASS® allows for a Cradle to Grave boundary as it can also incorporate in transportation and end of life (recycling or landfill) impacts. The tool is administered and updated regularly by software provider, Trayak.

EcoImpact-COMPASS® output includes metrics for several environmental impact categories, which can be used by packaging developers to gain a better understanding of impacts of different materials, conversion processes, and packages, while in the package development phase.

The output from the tool allows for an easy comparison across the environmental impacts, incorporating data from material formation, package manufacturing, transportation, and end of life.

EcoImpact-COMPASS® Limitations:

As with all life cycle assessments, several assumptions are made, using industry averages. As such, the output from the EcoImpact-COMPASS® can help show general comparisons between different flexible package and rigid options. Additionally, it must be understood that in most cases, some package formats and materials will perform better in some environmental indicators (such as greenhouse gas emissions and fossil fuel usage) and may not perform as well around others, such as water-based indicators. There are generally tradeoffs that need to be considered with any package option. This does not mean one package is necessarily better than another but does lead to discussion about which environmental indicators are most important for brands to attempt to minimize their overall impacts.

Environmental Indicator Metrics Results

The charts on the following pages will highlight results across a number of environmental indicators. Package developers may reference these indicators when considering the environmental impact of different package options. Note that there are generally tradeoffs between the different indicators and no one package will typically come out ahead in all indicators. This means that package developers and companies must decide which indicators most reflect their internal goals and balance product protection, consumer usage, brand equity, and environmental indicators among many other factors when selecting a package structure and format.

Shampoo Comparison – Primary Package

Shampoo is often sold in a rigid package, but with more companies looking to find ways to reduce their environmental impacts, some are considering the use of flexible packaging as a way to reduce the amount of packaging material that is used. In this streamlined LCA, three separate SUP samples are presented as an alternative. The difference between the 3 SUPs is based on the materials used and PCR content included in the structure. A product volume of 1 liter (33.8 fl. oz) was used for the comparison. The HDPE bottle is used as the standard to which other options are compared:

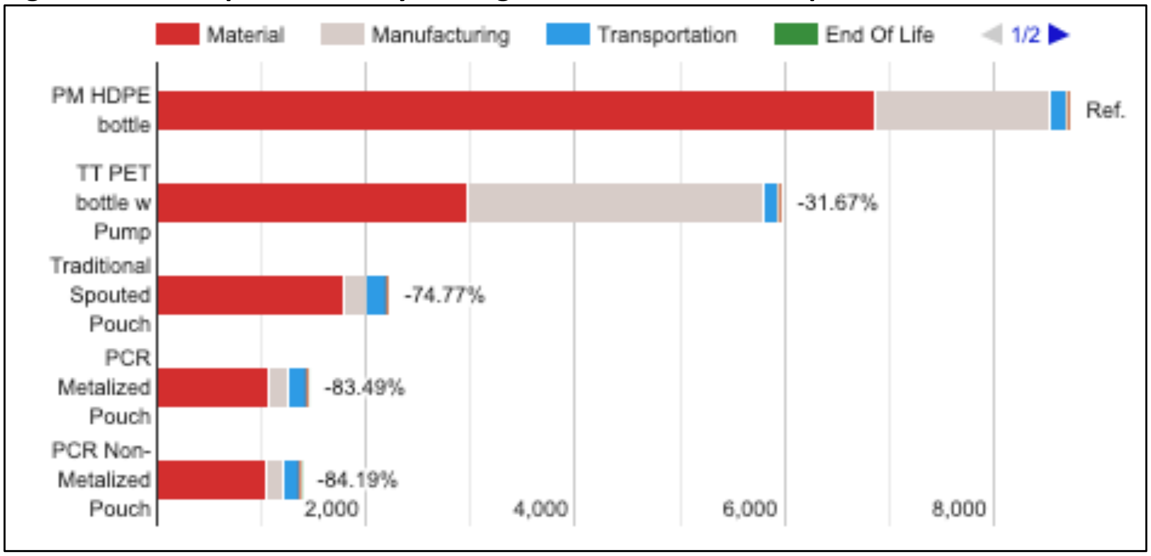
Table 1-A. Shampoo Packaging Evaluation Comparison

Package Type/Product Weight	Structure (package weight)	Photo
Rigid Bottle – HDPE bottle w/ flip top closures		
Bottle	HDPE – 76.2g	
Flip top closure	PP – 5.9g	
Overwrap	LDPE – 2.9g	
	TOTAL = 85.0g	
Rigid Bottle – PET bottle w/ pump		
Bottle	PET – 52.1g	
Pump (diptube, cap, spring, etc.)	PP, steel spring – 23.1g	
Overwrap – LDPE	2.9g	
	TOTAL = 78.0g	
Traditional (Multi-layer) SUP		
Traditional Stand-up Pouch	PET/Met PET/Nylon LLDPE – 18.19g	
Fitment/ cap	PP – 3.31	
	TOTAL = 20.73g	
PCR Metalized spouted SUP		
PCR Metalized spouted SUP	PCR PET/ PCR Metalized PET/ Nylon/ PCR HDPE/LLDPE – 15.83g	
Fitment/ cap	PP – 3.31	
	TOTAL = 19.14g	
PCR Non-metalized spouted SUP		
PCR Non-metalized spouted SUP	PCR PET/ Nylon/ PCR HDPE/LLDPE – 14.01g	
Fitment/ cap	PP – 3.31	
	TOTAL = 17.32g	

The charts on the following pages will highlight results of the fossil fuel usage, greenhouse gas (GHG) emissions, and water use for each of the package formats evaluated. These are some of the primary indicators that package developers consider when appraising the environmental impacts of a particular package. The EcoImpact-COMPASS® software "normalizes" the data based on the functional unit such as weight or number of uses to allow comparison between package formats which may not be the exact same size, though in this case the same product weight of 1 liter (33.8 fl. oz) was used across all package formats evaluated.

Fossil Fuel Use

Figure 1-1. Shampoo – Primary Package – Fossil Fuel Consumption



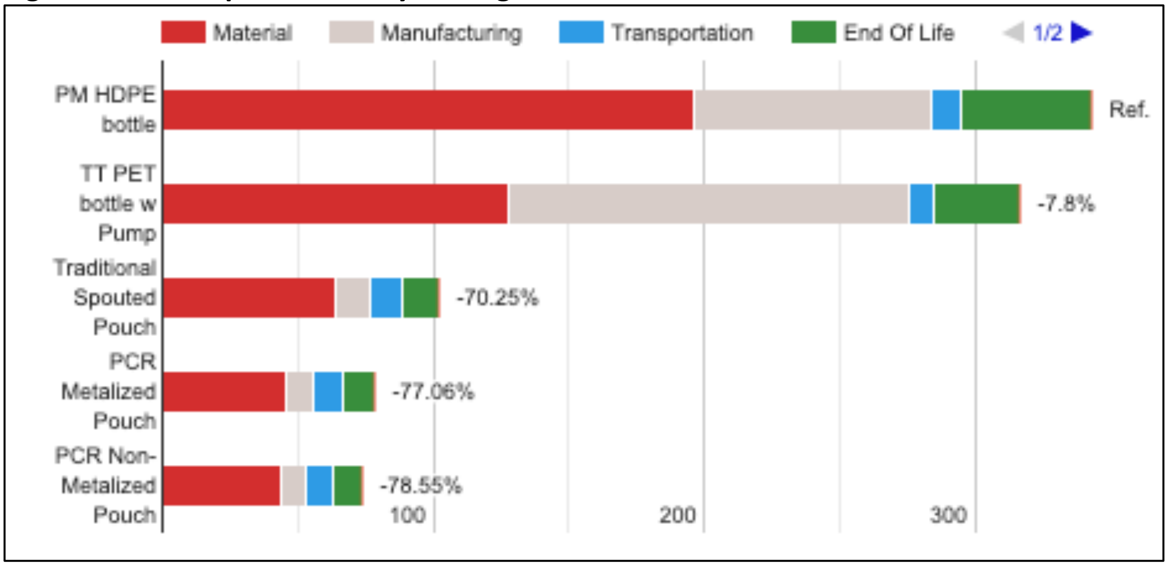
The fossil fuel use chart above shows that the pouch options result in a significant reduction in fossil fuel use compared to the current bottle. The reduction is about 75-85% lower than the HDPE bottle with flip top closure (used as the standard for all comparisons). This is largely driven by the overall package weight, with the HDPE bottle weighing about 4 times (85.0g vs. 17.32g- 20.73g) that of the pouches and all options being primarily made up of plastic. The PET bottle weighs less than the HDPE bottle overall at 78g vs. 85g, even with the more intricate pump system. The PET bottle uses nearly one-third less fossil fuel overall than the HDPE bottle.

Transportation (blue part of the graph) makes up a small overall impact of about 2% of the total for the bottles, with the material and manufacturing phases (red and gray part of graph) making up the majority of the overall impact.

The Traditional Spouted Pouch uses more fossil fuel than the PCR metalized SUP or the PCR non-metalized SUP since it leverages a slightly heavier structure (20.73g vs. 19.14g and 17.32g). Additionally, the two structures that contain PCR have a further reduction over the traditional SUP since they both utilize a large overall percentage of PCR material, which then requires less overall fossil fuel in the material production (red bar) stage.

Greenhouse Gas (GHG) Emissions

Figure 1-2. Shampoo – Primary Package – GHG Emissions

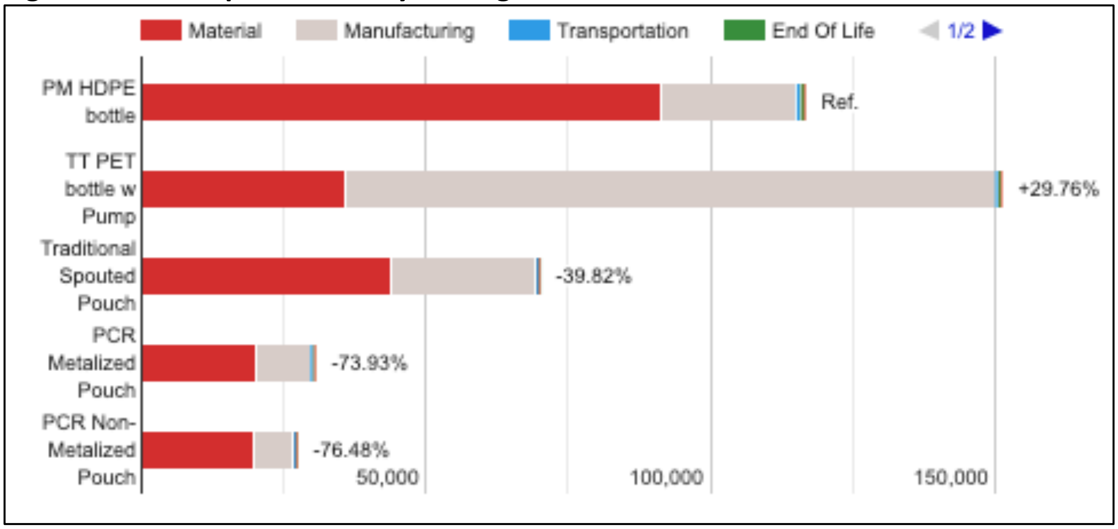


The values for Greenhouse Gas (GHG) emissions again show a major overall reduction for the different SUP options, with emissions lower than the HDPE bottle by anywhere from 70-78%.

The two bottles are much closer in overall GHG emissions than in fossil fuel usage with the two stages of injection molding for the PET preform and the subsequent stretch blow molding process, along with injection molding process for the pump components having a larger impact. The PET is still a lighter overall structure than the HDPE bottle, which uses a flip top closure. The HDPE bottle is produced through extrusion blow molding, and injection molding for the flip top closure. The SUP options all utilize layers of materials that are adhesively laminated with an injection molded spout. Again, the lower weight of the pouches is the main driver in overall emissions reductions, with the PCR pouch options having lower emissions than the traditional pouch.

Water Use

Figure 1-3. Shampoo – Primary Package – Water Use



The SUP options again have considerably lower water usage for holding 33.8 fl. oz. of shampoo than the two rigid options. Both bottles use more material as well as blow molding which uses water to cool molds, leading to the higher overall water use. The PET bottle option actually has higher water usage than the HDPE bottle, likely driven by the injection molding process for the preform, followed by the stretch blow molding process to form the bottle, while the HDPE bottle just uses extrusion blow molding.

It should be noted that the water usage in the material phase is considerably higher for LLDPE (which the pouches utilize in their structure) than PET, which is why the traditional spouted pouch appears to have more water usage proportionally in the material phase than the PET bottle with pump.

The PCR options result in nearly half the water usage as the traditional spouted pouch, since even though the flakes are washed, the overall water usage for PCR is less than the water needed in the polymerization in the production of virgin plastic.

<u>End of Use Results and Wrap-up / Summary – Primary Package</u>

The charts previously shown indicate that the SUP variations all have lower environmental impacts including fossil fuel usage, GHG emissions, and water usage in this scenario than both the rigid PET and HDPE bottles, when considering the primary package. Table 1-B (next page) considers the impacts of a material that is recycled or discarded as well to ensure that the package aligns with Circular Economy or Sustainable Materials Management goals. The table shows the results when current recycling rates are considered, as well as the material efficiency ratio, which is a measure of the resource efficiency of the materials to package a fluid ounce of product.

The results in Table 1-B show that the Sup options have a considerably better material efficiency value. This is largely driven by the pouches utilizing about 20-25% of the amount of material as the rigid bottle options.

Additionally, the bottle options result in substantially more material being discarded at the end of life when taking into consideration estimated current recycling rates for PET bottles (29%) and HDPE bottle (18%) vs. the PE-based SUP options, where no recycling credit was given for the pouches, since they are multi-material. The PET bottle would theoretically result in about 12% less material discarded based on currently recycling rates than the HDPE bottle, while the pouch options result in about 70-75% less material discarded.

The table on the next page summarizes a variety of environmental attributes for the SUP options. In all of the attributes evaluated below, the SUP variables hold an advantage vs. the rigid HDPE package.

SUMMARY COMPARISON

Table 1-B. Shampoo – Primary Packaging Comparison Summary

Format	Weight	Fossil Fuel Use (MJ-Equiv)	GHG Emissions (kg-CO2 equiv)	Water Use (l)	Material efficiency (g of pkg/fl. oz.)	End of Life Total Mass discarded
HDPE Bottle w/ flip top closure	85g	8720.3 ----	343.33 ----	116,549 ----	2.51g/ fl. oz.	64,428 kg
PET bottle w/ pump	78g	5958.91 (-31.67%)	316.54 (-7.8%)	151,240 (+29.76%)	2.31g/ fl. oz.	56,862 kg (-11.7%)
Traditional Spouted SUP	20.73g	2200.36 (-74.77%)	102.15 (-70.25%)	70,142 (-39.82%)	0.6359g/ fl. oz.	19,495 kg (-69.7%)
PCR Metalized spouted SUP	19.14g	1439.43 (-83.49%)	78.75 (-77.06%)	30,385 (-73.93%)	0.5662 g/ fl. oz.	17,363g (-73.1%)
PCR Non-metalized spouted SUP	17.32g	**1378.71 (-84.19%)**	**73.64 (-78.55%)**	**27,415 (-76.48%)**	**0.5123 g/ fl. oz.**	**15,712g (-75.6%)**

Notes:

- *A normalized product weight (common value divisible by all package formats) of 1 liter (33.8 fl. oz) was used for Fossil Fuel, GHG and Water Consumption calculations. The values shown above are for 1MM primary packs*
- *All percentages cited are for other formats compared to the rigid package.*
- *For all percentage comparisons in EcoImpact-COMPASS®, the tool uses percent change. The formula is: ((Rigid pkg value – flexible pkg value)/ rigid pkg value) *100 = percent change.*
- *Package landfilled values are based on the of amount of packaging sent to municipal solid waste after recycling, based on 1000 kg of shampoo used as the basis for all comparisons.*
- *For recycling rates: PET modeled at 29%, HDPE bottle – 18%, PP caps – 3%,*
  Stand-up Pouches – 0%, Pump – 0%

APPENDIX

Fossil Fuel Use

Fossil Fuel Use measures the total quantity of fossil fuel consumed throughout the life cycle, reported in mega joules (MJ) equivalent deprived. This calculation uses the IMPACT World+ method and assumes fossil resources are used for energy purposes. Fossil fuels include coal, petroleum, and natural gas. Inputs for nuclear fuel as uranium are accounted for in the Mineral Consumption metric.

GHG Emissions

GHG Emissions measure the total quantity of greenhouse gases (GHG) emitted throughout the lifecycle reported in kilogram CO2 equivalents. This calculation follows the latest IPCC 2013 method and considers climate feedback loops.

Water Use

Water Use measures the relative water remaining per area in a watershed after the demand of humans, aquatic ecosystems and manufacturing processes have been met. This metric accounts for water scarcity and the result represents the relative value in comparison to the average liters consumed in the world. Essentially, the total water consumed to make the package is multiplied by the regions scarcity factor which with either increase or decrease the water usage value based on the scarcity or excess availability of water in a specific region, respectively. This metric uses the AWARE (Available Water Remaining) methodology.

Acronyms

Coex:	Coextruded film
HDPE:	High Density Polyethylene
MDPE:	Medium Density Polyethylene
LLDPE:	Linear Low-Density Polypropylene
OPP:	Oriented Polypropylene
PE:	Polyethylene
PCR:	Post-Consumer Recycled
PET:	Polyethylene Terephthalate
PP:	Polypropylene
SUP:	Stand-up Pouch

Glenroy, Inc. is a leading sustainable flexible packaging company and the exclusive converter of the premade STANDCAP Pouch, an eco-friendly, recyclable, and award-winning inverted pouch. Headquartered in suburban Milwaukee, WI since 1965, Glenroy is the authority in sustainable flexible packaging films and stand-up pouches for a variety of end uses, including personal care, food & beverage, household products, pharmaceutical, pet food & treats, nutritional, cosmetic, medical device, and industrial.

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