A Streamlined Life Cycle Assessment Comparison for the Premade STANDCAP Pouch in the Sauces and Personal Care Market versus Rigid Packaging Options

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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 based comparing the premade STANDCAP Pouch to a rigid package equivalent across a range of eleven (11) product categories including sauces, salsa, condiments, and personal care. The purpose of the LCA was to use the results as an educational tool and better understand the environmental impacts of the different package options.

For this report, two separate premade STANDCAP Pouch examples are used. The construction of both examples are identical, other than one option uses post-consumer recycled (PCR) content in some film layers. Generally, use of PCR results in lower overall environmental impacts. Note that the fitment does not contain PCR in these assessments, only the flexible portion of the package. The comparisons between the two flexible structures are shown below:

STANDCAP	STANDCAP PCR	
PET	PET (100% PCR)	
Adhesive	Adhesive	
High Barrier PET	High Barrier PET (50% PCR)	
Adhesive	Adhesive	
Nylon	Nylon	
Adhesive	Adhesive	
LLDPE/HDPE Coex	LLDPE/HDPE Coex (42% PCR)	

For the comparisons, the rigid packages were assumed to not contain any PCR, as levels of PCR were not indicated on the packs evaluated.

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.

The study evaluated the premade STANDCAP Pouch and a rigid option across the following product categories (and page number) :

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

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

Other metrics considered include:

- Product:package ratio
- Material discarded (grams of packaging per 1000 kg of product)

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, a number of 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.

Mayonnaise (inverted PET bottle) Packaging Comparison

Mayonnaise is a popular condiment sold in a variety of packaging formats. For this streamlined Life Cycle Assessment study, two inverted packaging formats were evaluated – an inverted PET bottle and the premade STANDCAP Pouch:

Table 1-A. Mayonnaise (inverted PET bottle) Packaging Evaluation Comparison

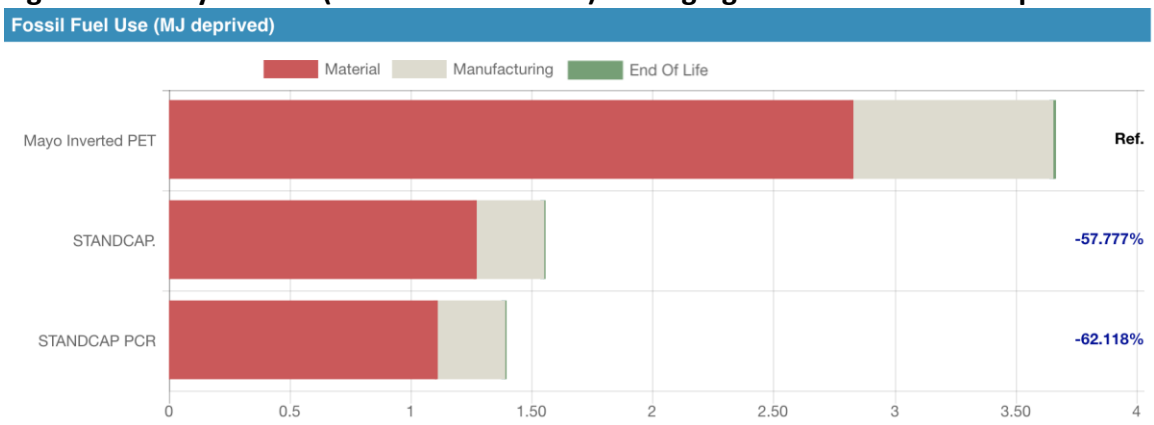
Package Type/Product Weight	Structure (package weight)	Photo
Rigid Inverted Container (11.5 fl oz)		
Bottle & Shrink Label	PET bottle – 25g PET label – 2.1g	
Closure	Fitment – PP – 10.7g Valve – Silicon - .09g Ring – PP - .2g	
Tamper Evident Seal	PET/EPS/Poly/Foil - .2g	
	TOTAL = 38.29g	
Premade STANDCAP Pouch (14 fl oz) – Standard and with PCR		
Pouch – Standard Pouch – PCR	PET/PET/Nylon/LLDPE/HDPE PET (100% PCR)/ PET (50% PCR)/Nylon/ LLDPE-HDPE Coex (42% PCR) 6.72g	
Fitment	Closure – PP – 10.53g Fitment-LDPE/LLDPE-2.7g Ring – PP – .2g Valve – Silicon – .09g	
	TOTAL = 20.24g	

Packages as close as possible in size/volume were selected to make the lifecycle comparison. Not in all cases were packs of identical size/volume available for purchase.

Fossil Fuel Use

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 common 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.

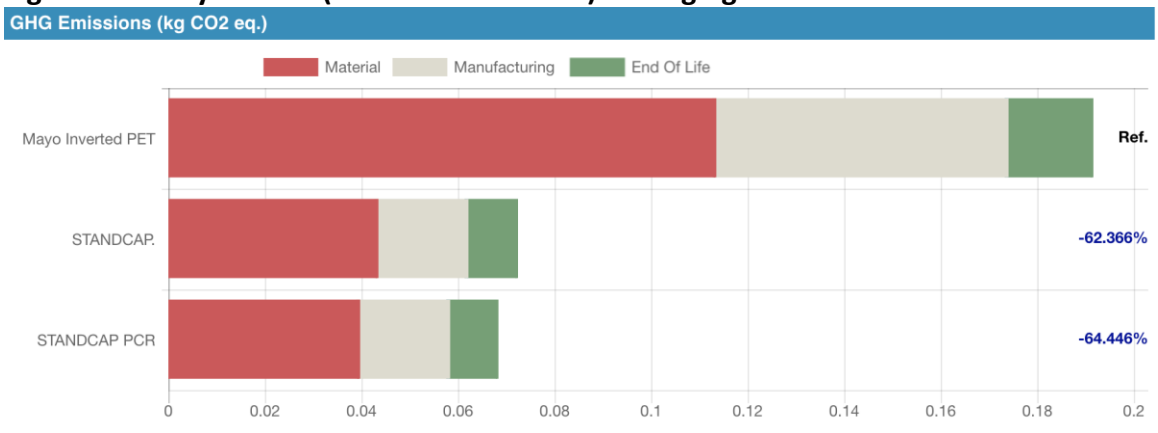
Figure 1-1. Mayonnaise (inverted PET bottle) Packaging – Fossil Fuel Consumption



The fossil fuel use chart shows the premade STANDCAP Pouch uses under half (-58%) the fossil fuel as the rigid PET mayonnaise container. While both packages use plastic for the majority of their construction, the STANDCAP pouch is much lighter (19.54g vs. 38.29g) than the PET bottle, driving the lower fossil fuel use. The use of PCR results in an additional 5% overall fossil fuel reduction when compared to the rigid pack.

Greenhouse Gas (GHG) Emissions

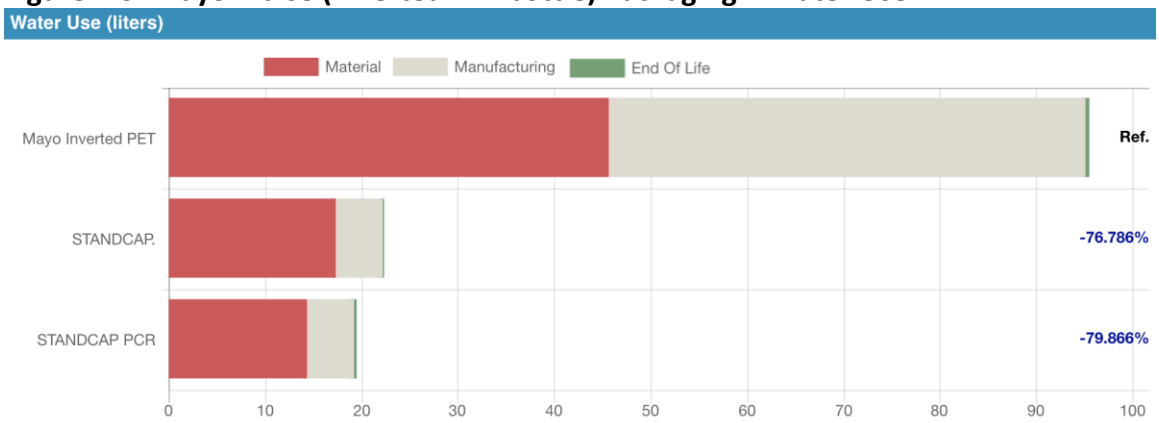
Figure 1-2. Mayonnaise (inverted PET bottle) Packaging – GHG Emissions



For Greenhouse Gas (GHG) emissions, the premade STANDCAP Pouch again shows a large reduction in emissions (-62.4%) vs. the rigid PET container due to it lighter weight material, as well the manufacturing/conversion process (gray part of chart) of laminating/ extruding film layers, which is generally less energy intensive than stretch blow molding and associated heating needed for a rigid container. Both the STANDCAP pouch and inverted PET bottle both had closures made from injection molding and are quite similar in weight (13.52g and 10.99g respectively) which would thus have similar overall impacts. The use of PCR results in an additional emission reduction of about two percent.

Water Use

Figure 1-3. Mayonnaise (inverted PET bottle) Packaging – Water Use



The premade STANDCAP Pouch results in much lower water use (-76.8%) than the rigid PET bottle largely due to the laminating and extrusion process for film layers not requiring nearly the amount of water as need for cooling molds in the manufacturing process for rigid containers. This is shown in the gray area of the chart and is noticeable for the rigid PET container.

End of Use Results

The charts above show that the premade STANDCAP Pouch has lower environmental impacts including fossil fuel usage, GHG emissions, and water usage in this scenario than the inverted PET container. In this section, the impacts of a material recycled or discarded are considered to ensure that the package aligns with Circular Economy or Sustainable Materials Management goals. Table 1-B (below) shows the results when current recycling rates are considered, as well the product-to-package ratio, which is a measure of the resource efficiency of the materials used. For this measure, a high product and a low package number are desired.

Table 1-B. Mayonnaise (inverted PET bottle) Packaging - Recycled and Landfilled Comparison

Format	Pkg Wt. (g)	Product % Wt.	Package % Wt.	Pkg wt. (g)/ 1000 kg mayo	Pkg Recycled (g)/1000 kg mayo	Pkg Landfilled (g)/1000 kg mayo
Rigid Inverted Container	38.29	89.2%	10.8%	120,624	21,109	99,515
STANDCAP	20.24	95.0%	5.0%	52,381	0	52,381
STANDCAP w/PCR	20.24	95.0%	5.0%	52,381	0	52,381

To determine the package recycled and packaging discard rate, the following assumptions were made:

- *PET container recycling rate – 26.8% (per EPA Sustainable Materials Mgmt, published Nov 2020)*
- *All material collected for recycling was assumed to be actually recycled*
- *Package landfilled is amount of packaging not recycled, goes to municipal solid waste*

Wrap up/ Summary

The results in Table 1-B show that the premade STANDCAP Pouch has a higher overall product weight percentage (95.0%) than the rigid PET container (89.2%).

Additionally, the inverted PET container uses nearly more than double the amount of packaging (120,624g vs. 52,381g) to package 1000 kg of mayonnaise. Even when taking into consideration current recycling rates for PET bottles, the premade STANDCAP Pouch results in much less material being disposed at end of life (52,381g vs. 99,515g).

In the end, it is up to the packaging developer and other stakeholders to determine which indictors and other sustainability-based metrics (such as weight of material used, weight of material sent to landfill or recycled), as well as customer needs that must be balanced along with the environmental indicators. Most companies prioritize 2-3 main indicators for their focused sustainability strategy and messaging. This can help companies and package developers concentrate on package formats that most closely align with company goals.

SUMMARY COMPARISON

Table 1-C. Mayonnaise (inverted PET bottle) Packaging Comparison Summary

Format	Fossil Fuel Use (MJ-Equiv)	GHG Emissions (kg-CO2 equiv)	Water Use (l)	Product-to-Package ratio and percent wt.	Pkg Landfilled (g)/1000 kg Mayo
Mayo Rigid Inverted Container	3.66	.1911	95.29	8.3:1 89.2%:10.8%	99,515
STANDCAP	1.54 **(-57.8%)**	.07191 **(-62.4%)**	22.12 **(-76.8%)**	19.1:1 **95.0%:5.0%**	52,381 **(-47.4%)**
STANDCAP w/PCR	1.39 **(-62.1%)**	.06793 **(-64.4%)**	(19.19) **(-79.9%)**	19.1:1 **95.0%:5.0%**	52,381 **(-47.4%)**

Notes:

- *A normalized product weight (common value divisible by all package formats) of 11.5 fl. oz was used for Fossil Fuel, GHG and Water Consumption calculations.*
- *All percentages cited are for other formats compared to the rigid package.*
- *A higher number for product-to-package ratio (first number) cited means a higher percentage of weight is attributed to product, and less to packaging, resulting in more efficient use of packaging resources.*
- *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 mayonnaise used as the basis for both comparisons.*
- *Weight for 14 fl. Oz. of mayonnaise based on mass density of 27.6g/fl. Oz.*

Mayonnaise (PET Jar) Packaging Comparison

Mayonnaise comes in a variety of packaging formats, with a clear plastic (PET) jar being one of the most popular. For this streamlined Life Cycle Assessment study, a comparison was made between a popular mayonnaise container in a PET jar versus the premade STANDCAP Pouch:

Table 10-A. Mayonnaise (PET Jar) Packaging Evaluation Comparison

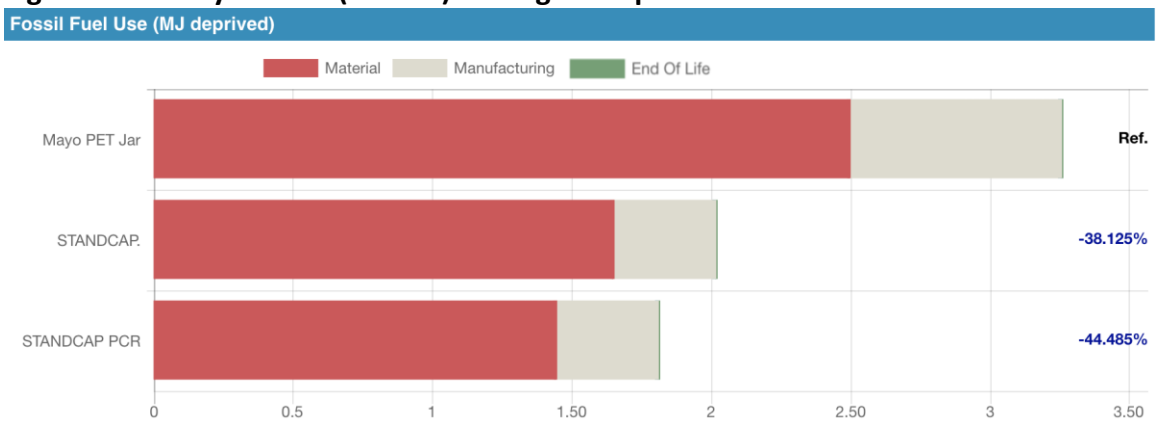
Package Type/Product Weight	Structure (package weight)	Photo
Mayonnaise Rigid Jar (15 fl. oz.)		
Jar	Jar-PET – 25.8g	
Closure	Closure – PP – 7.1g	
Label	Labels – Paper – 1.6g	
Lidstock	Lidstock – Paper/Poly/ Foil – 1.2g	
	TOTAL = 35.7g	
Premade STANDCAP Pouch (14 fl. oz.) – Standard and with PCR		
Pouch – Standard Pouch – PCR	PET/PET/Nylon/LLDPE/HDPE PET (100% PCR)/ PET (50% PCR)/Nylon/ LLDPE-HDPE Coex (42% PCR) 6.72g	
Fitment	Closure – PP – 10.53g Fitment-LDPE/LLDPE-2.7g Ring – PP – .2g Valve – Silicon – .09g	
	TOTAL = 20.24g	

Packages as close as possible in size/volume were selected to make the life cycle comparison. Not in all cases were packs of identical size/volume available for purchase.

<u>Fossil Fuel Consumption, Greenhouse Gas Emissions, and Water Consumption Comparison</u>

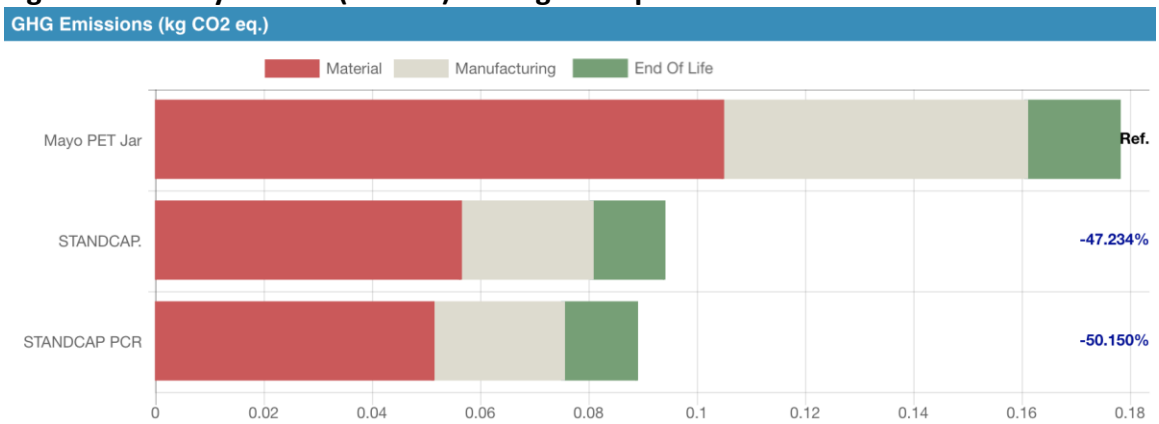
The charts below will highlight results of the fossil fuel usage, greenhouse gas (GHG) emissions, and water use for each of the package formats evaluated. These are some of the primary common indicators that package developers consider when appraising the environmental impacts of a particular package. 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.

Figure 10-1. Mayonnaise (PET Jar) Package Comparison – Fossil Fuel Use



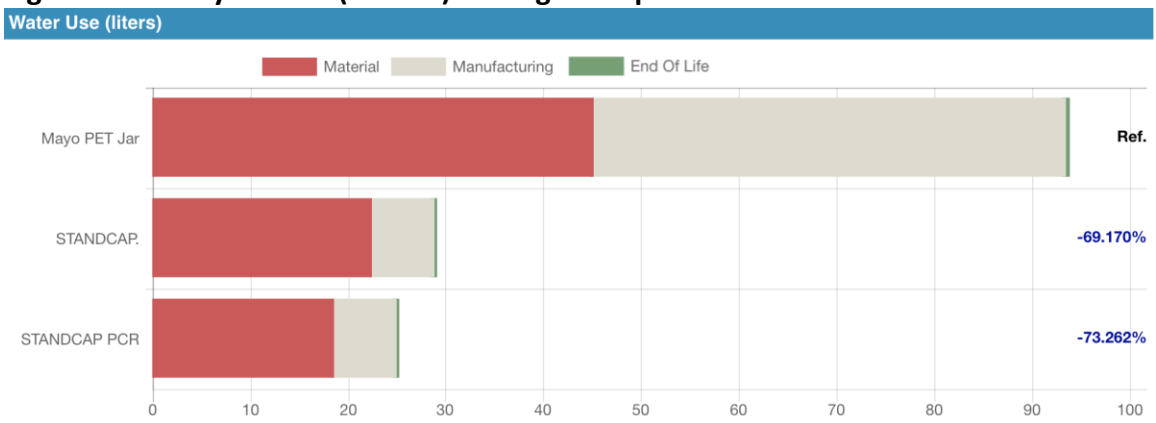
The Fossil Fuel Use chart above shows that the premade STANDCAP Pouch results in over a third less (-38.1%) fossil fuel resources, with additional 6% in fossil fuel reduction to produce the pouch versus the PET jar example. This is largely driven by the PET jar using substantially more material (35.7g vs. 20.24g) to package nearly the same amount of product.

Figure 10-2. Mayonnaise (PET Jar) Package Comparison – GHG Emissions



The GHG emissions chart also shows the reduced impacts of the premade STANDCAP Pouch, which has greenhouse emissions nearly half that of the rigid PET jar. This is again driven by the weight difference between the two package formats, as well as the manufacturing (converting process) difference. The larger manufacturing impact (gray part of graph) is due to the blow molding process for the rigid PET jar, which is more energy intensive, resulting in higher GHG emissions than the laminating and extrusion process used for the multilayer flexible pouch.

Figure 10-3. Mayonnaise (PET Jar) Package Comparison – Water Use



Finally, when looking at water use during the life cycle of the two package formats, the premade STANDCAP Pouch results in nearly 70% lower water use than the PET jar (and 73% when incorporating in the PCR content). This is especially noticeable in the manufacturing phase (gray part of the graph) which results in much larger amount of water required driven by the water that is needed to cool the molds in the blow molding manufacturing process. The water helps to cool the plastic bottle so it can be removed from the mold, speeding up the overall manufacturing process. The stand-up pouch format, which is formed by laminating or extruding multiple thin layers of film together, uses much less water in its manufacturing and conversion process.

End of Use Results

The results above show that the premade STANDCAP Pouch has a much lower usage of fossil fuel and water as well as carbon impact when considering the primary package. Package developers also consider the amount of material that is recycled or sent to landfill, to ensure that the package aligns with Circular Economy or Sustainable Materials Management goals. Table 10-B (below) shows the results when current recycling rates are considered, as well the product-to-package ratio, which is a measure of the resource efficiency of the materials used. For this measure, a high product and a low package number are desired.

Table 10-B. Mayonnaise (PET Jar) Packaging – Recycled and Landfilled Comparison

Format	Pkg Wt. (g)	Product % Wt.	Package % Wt.	Pkg wt. (g)/ 1000 kg mayo	Pkg Recycled (g)/1000 kg mayo	Pkg Landfilled (g)/1000 kg mayo
Mayo Rigid Jar	35.7	92.1%	7.9%	86,232	16,701	69,530
STANDCAP	20.24	95.0%	5.0%	52,381	0	52,381
STANDCAP w/PCR	20.24	95.0%	5.0%	52,381	0	52,381

To determine the package recycled and packaging discard rate, the following assumptions were made:

- *PET bottle recycling rate at 26.8% (US EPA, Sustainable Materials Mgmt- Published Nov. 2020)*
- *Flexible packaging was assumed to have 0% recycling rate*
- *Closures and fitments assumed to have 0% recycling rate*
- *All material collected for recycling was assumed to be actually recycled*
- *Package landfilled is amount of packaging not recycled, goes to municipal solid waste*

End of Use Summary

The U.S. EPA utilizes a Waste Hierarchy which lists source reduction and reuse as the most preferred method to reduce waste. The premade STANDCAP Pouch does very well in this regard when compared to the rigid PET jar for mayonnaise. The PET jar requires considerably more material (86,232g vs. 52,381g) of packaging to contain 1000kg of mayonnaise. Even when considering that the PET bottle is recycled at a rate of 26.8% in the U.S. today, it still results in much more material being discarded at end of life (69,530g vs. 52,381g). The HDPE bottle would need to nearly double its recycling rate to about 54% to reach the same amount of material discarded as the STANDCAP pouch does today.

The examples above highlight that while many multi-material flexible packages are not yet recovered and recycled in any significant amount, they still result in a substantial reduction in the amount of material sent to landfill versus other types of packaging.

Summary/Implications

The results in this scenario show that the premade STANDCAP Pouch has a number of sustainability benefits when compared to a rigid PET jar for packing and shipping mayonnaise. These include lower fossil fuel and water use, greenhouse gas emissions, better product: package ration (efficiency of materials), and considerably less material discarded at end of life.

As with all package decisions, there are other package attributes such as product protection, brand message, ease of use, and other consumer features that must be considered, including the sustainability benefits of each package format, amount and ease of product evacuation, and the total package design using a holistic approach.

Table 10-C summarizes much of the critical data and package comparison discussed for this mayonnaise packaging case study.

Table 10-C. Mayonnaise (PET Jar) Packaging Comparison Summary

Format	Fossil Fuel Use (MJ-Equiv)	GHG Emissions (kg-CO2 equiv)	Water Use (l)	Product-to-Package ratio and percent wt.	Pkg Landfilled (g)/1000 kg mayo
Mayo Rigid Jar	3.26	.1777	93.59	11.6:1 92.1%:7.9%	69,530
STANDCAP	2.01 (-38.1%)	.09379 (-47.2%)	28.85 (-69.2%)	19.1:1 95.0%:5.0%	52,381 (-24.7%)
STANDCAP w/PCR	1.81 (-44.5%)	.08861 (-50.2%)	25.02 (-73.3%)	19.1:1 95.0%:5.0%	52,381 (-24.7%)

Notes:

- *A normalized product weight (common value divisible by all package formats) of 15.0 fl. oz. of product was used for Fossil Fuel, GHG and Water Consumption calculations.*
- *All percentages cited are for other formats compared to the stand-up flexible pouch.*
- *A higher number for product-to-package ratio (first number) cited means a higher percentage of weight is attributed to product, and less to packaging, resulting in more efficient use of packaging resources.*
- *Package landfilled values are based on the of amount of packaging sent to municipal solid waste after recycling, based on 1000 kg of mayonnaise*
- *Used 27.6 g/fl oz. as density for mayonnaise to determine product weight*

Mustard Packaging Comparison

Mustard has traditionally been packaged in an HDPE bottle or glass jars. The comparison below looks at the environmental impacts for mustard packed in an HDPE bottle with the impacts from the premade STANDCAP Pouch. For this streamlined Life Cycle Assessment study, the following formats were evaluated:

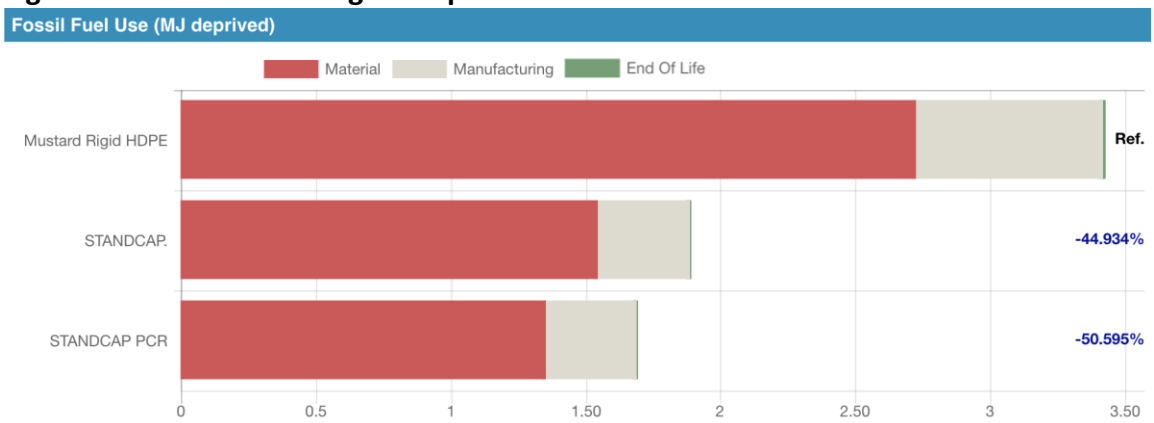
Table 2-A. Mustard Packaging Evaluation Comparison

Package Type/Product Weight	Structure (package weight)	Photo
Mustard Rigid Container (14 oz.)		
Bottle	Bottle – HDPE – 30.7g	
Spout/ Fitment	Spout/Fitment – PP – 4.9g	
Tamper Evident Seal	Seal – EPS/Poly/Foil – .3g	
	TOTAL = 35.9g	
Premade STANDCAP Pouch (14 oz.) – Standard and with PCR		
Pouch – Standard Pouch – PCR	PET/PET/Nylon/LLDPE/HDPE PET (100% PCR)/ PET (50% PCR)/Nylon/ LLDPE-HDPE Coex (42% PCR) 6.72g	
Fitment	Closure – PP – 10.53g Fitment-LDPE/LLDPE-2.7g Ring – PP – .2g Valve – Silicon – .09g	
	TOTAL = 20.54g	

<u>Fossil Fuel Consumption, Greenhouse Gas Emissions, and Water Consumption Comparison</u>

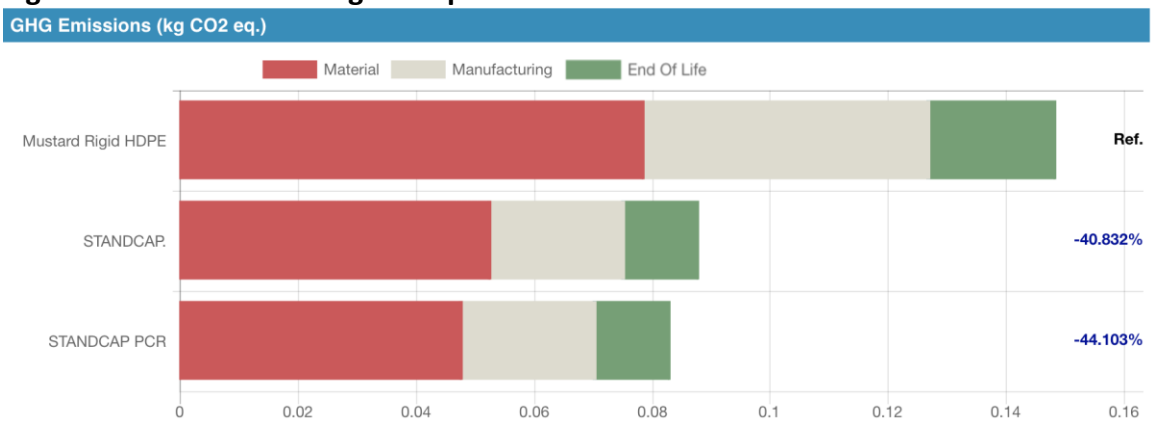
The charts below will highlight results of the fossil fuel usage, greenhouse gas (GHG) emissions, and water use for each of the package formats evaluated. These are some of the primary common indicators that package developers consider when appraising the environmental impacts of a particular package. 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.

Figure 2-1. Mustard Package Comparison – Fossil Fuel Use



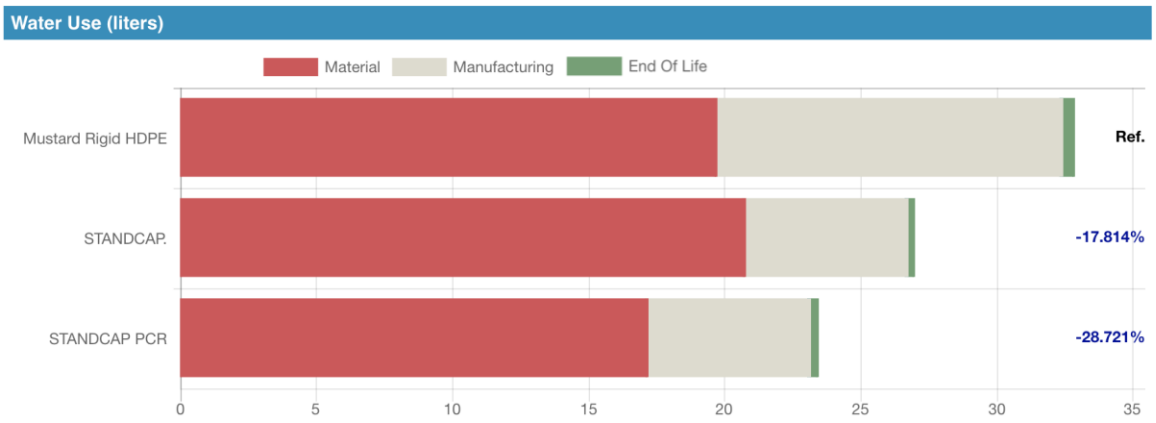
The Fossil Fuel Consumption chart above (Figure 2-1) shows that the premade STANDCAP Pouch has a lower use of fossil fuel sources (-44.9%) vs. the HDPE bottle, driven largely by the additional weight of the bottle (bottle weighs nearly twice as much as the pouch – 35.9g vs. 20.24g) as well as the additional energy/fuel required in the blow molding process for the HDPE bottle. The lighter weight of the inverted pouch shows up in the material (red) part of the graph, with the conversion process for the pouch (adhesive lamination and extrusion process for film layers) versus blow molding heavier material requirements for the HDPE bottle. Therefore, a lighter package with a manufacturing process that is less energy intensive, will often result in lower Fossil Fuel Use, as is the case with the premade STANDCAP Pouch. The use of PCR results in an additional savings of an additional 6%.

Figure 2-2. Mustard Package Comparison – GHG Emissions



The GHG emissions chart above also shows that the premade STANDCAP Pouch has a much lower greenhouse gas emission or carbon impact (-40.8%) than that of the HDPE bottle. Since both package formats are using plastic in their make-up, the package manufacturing (conversion) process in the graph (gray part of graph) can depict the impacts of the different processes between the two pack formats. Again, since the premade STANDCAP Pouch uses much less material (20.24g vs. 35.9g) than the HDPE bottle, it has a reduced carbon impact. The larger end of life impact for the plastic bottle is driven by the fact that even though HDPE bottles are recycled at a rate of 29.1%, there is still a larger impact due to more material ending up as municipal solid waste (see Table 2-B).

Figure 2-3. Mustard Package Comparison – Water Use



Finally, Figure 2-3 shows a comparison of water use during the life cycle of the two package formats. In this case, the premade STANDCAP Pouch has lower water use (-17.8%) than the HDPE bottle, likely driven by the manufacturing (converting) difference between the two packs as water needed to cool the molds for the rigid HDPE bottle, which drives its higher water use in the manufacturing process. The use of PCR further reduces water by 11% over the standard STANDCAP option.

End of Use Results

The results above show that the premade STANDCAP Pouch with fitment package has a lower usage of fossil fuel and water as well as carbon impact when considering the primary package. Package developers also consider the amount of material that is recycled or sent to landfill, to ensure that the package aligns with Circular Economy or Sustainable Materials Management goals. Table 2-B shows the results when current U.S. recycling rates are considered, as well the product-to-package ratio, which is a measure of the resource efficiency of the materials used. For this measure, a high product and a low package weight value are desired.

Table 2-B. Mustard Packaging – Recycled and Landfilled Comparison

Format	Pkg Wt. (g)	Product % Wt.	Package % Wt.	Pkg wt. (g)/ 1000 kg mustard	Pkg Recycled (g)/1000 kg mustard	Pkg Landfilled (g)/1000 kg mustard
Mustard Rigid Bottle	35.9	91.7%	8.3%	90,453	22,664	67,789
STANDCAP	20.54	95.1%	4.9%	50,996	0	50,996
STANDCAP w/PCR	20.54	95.1%	4.9%	50,996	0	50,996

To determine the package recycled and packaging discard rate, the following assumptions were made:

- *HDPE bottle recycling rate at 29.3% (EPA Sustainable Materials Mgmt, published Nov 2020)*
- *Flexible packaging was assumed to have 0% recycling rate*
- *Closures and fitments assumed to have 0% recycling rate*
- *All material collected for recycling was assumed to be actually recycled*
- *Package landfilled is amount of packaging not recycled, goes to municipal solid waste*

End of Use Summary

According to the U.S. EPA Waste Hierarchy, the most preferred method for waste management is Source Reduction and Reuse. A major benefit of flexible packaging is the high product-to-package ratio which flexible packaging tends to offer.

As shown in Table 2-B, the premade STANDCAP Pouch has more weight of the product on shelf attributed to the product (95.1%) and less material to landfill, even though the current STANDCAP pouch is not considered recyclable. The HDPE bottle was given recycling credit of 29.3% based on the latest U.S. recycling statistics for HDPE bottles.

The examples above highlight that while many multi-material flexible packages are not yet recovered and recycled in any significant amount, they still result in an overall reduction in the amount of material sent to landfill versus other types of packaging.

Summary/Implications

The results show that when the premade STANDCAP Pouch and traditional HDPE bottle are used for mustard, the flexible structure will generally have a favorable outcome from a fossil fuel usage, water usage, greenhouse gas (GHG) emissions, and material discarded position. This is largely driven by the flexible pouch using less material than the rigid bottle, which results in less energy used in manufacturing and transporting of the package materials and associated environmental impacts.

As with all package decisions, there are other package attributes such as product protection, brand message, ease of use, and other consumer features that must be considered, including the sustainability benefits of each package format, amount and ease of product evacuation, and the total package design using a holistic approach.

Table 2-C summarizes much of the critical data and package comparison discussed for this mustard packaging case study.

Table 2-C. Mustard Packaging Comparison Summary

Format	Fossil Fuel Consumption (MJ-Equiv)	GHG Emissions (kg-CO2 equiv)	Water Consumption (l)	Product-to-Package ratio and percent wt.	Pkg Landfilled (g)/1000 kg mustard
Mustard Rigid Bottle	3.41	.148	32.77	11.1:1 91.7%:8.3%	67,789
STANDCAP	1.88 (-44.9%)	.08754 (-40.8%)	26.93 (-17.8%)	19.6:1 **95.1%:4.9%**	50,996 **(-24.8%)**
STANDCAP w/PCR	1.69 **(-50.6%)**	.0827 **(-44.1%)**	23.36 **(-28.7%)**	19.6:1 **95.1%:4.9%**	50,996 **(-24.8%)**

Notes:

- *A normalized product weight (common value divisible by all package formats) of 14 oz. of product was used for Fossil Fuel, GHG and Water Consumption calculations.*
- *All percentages cited are for other formats compared to the stand-up flexible pouch.*
- *A higher number for product-to-package ratio (first number) cited means a higher percentage of weight is attributed to product, and less to packaging, resulting in more efficient use of packaging resources.*
- *Package landfilled values are based on the of amount of packaging sent to municipal solid waste after recycling, based on 1000 kg of mustard.*

Honey Packaging Comparison

Honey has been packaged in a PET bottles in a variety of shapes for a number of years. For this streamlined Life Cycle Assessment scenario, we looked at a comparison of a popular honey package versus the premade STANDCAP Pouch:

Table 3-A. Honey Packaging Evaluation Comparison

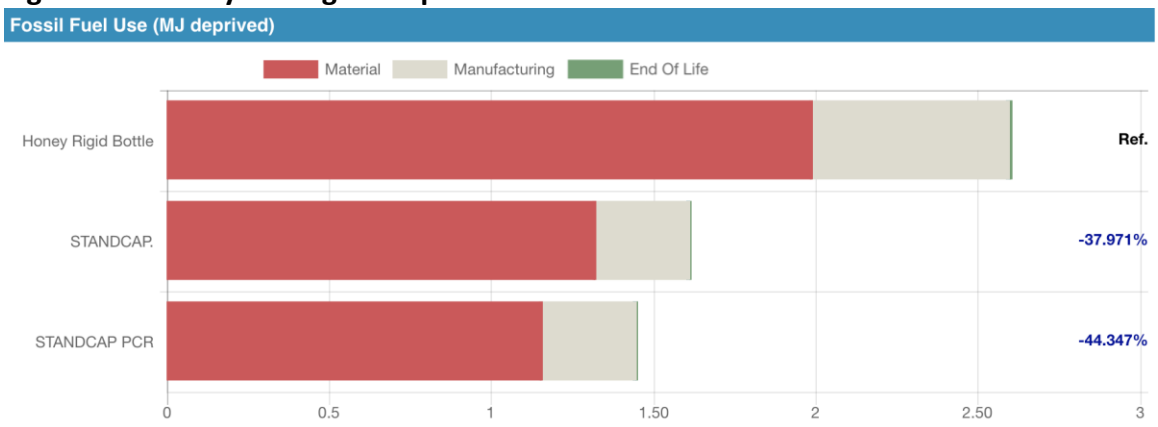
Package Type/Product Weight	Structure (package weight)	Photo
Honey Rigid Container (12 oz.)		
Bottle	Bottle – PET – 21.5g	
Closure	Closure – PP – 4.9g	
Tamper Evident Seal	Seal – Poly/Foil – .3g	
Labels (Front & Back)	Labels – PP – .2g	
	TOTAL = 26.9g	
Premade STANDCAP Pouch (14 oz.) – Standard and with PCR		
Pouch – Standard Pouch – PCR	PET/PET/Nylon/LLDPE/HDPE PET (100% PCR)/ PET (50% PCR)/Nylon/ LLDPE-HDPE Coex (42% PCR) 6.72g	
Fitment	Closure – PP – 10.53g Fitment-LDPE/LLDPE-2.7g Ring – PP – .2g Valve – Silicon – .09g	
	TOTAL = 20.24g	

Packages as close as possible in size/volume were selected to make the life cycle comparison. Not in all cases were packs of identical size/volume available for purchase.

Fossil Fuel Consumption, Greenhouse Gas Emissions, and Water Consumption Comparison

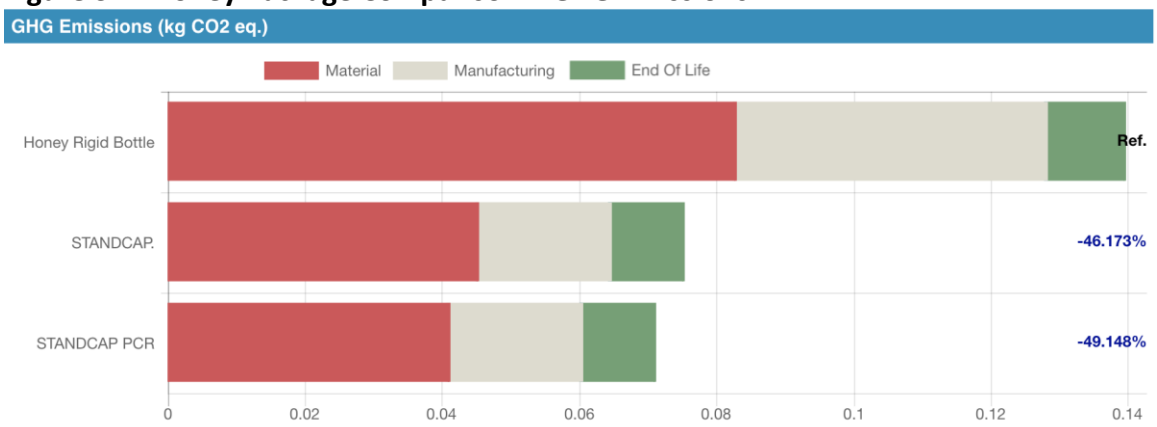
The charts below will highlight results of the fossil fuel usage, greenhouse gas (GHG) emissions, and water use for each of the package formats evaluated. These are some of the primary common indicators that package developers consider when appraising the environmental impacts of a particular package. 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.

Figure 3-1. Honey Package Comparison – Fossil Fuel Use



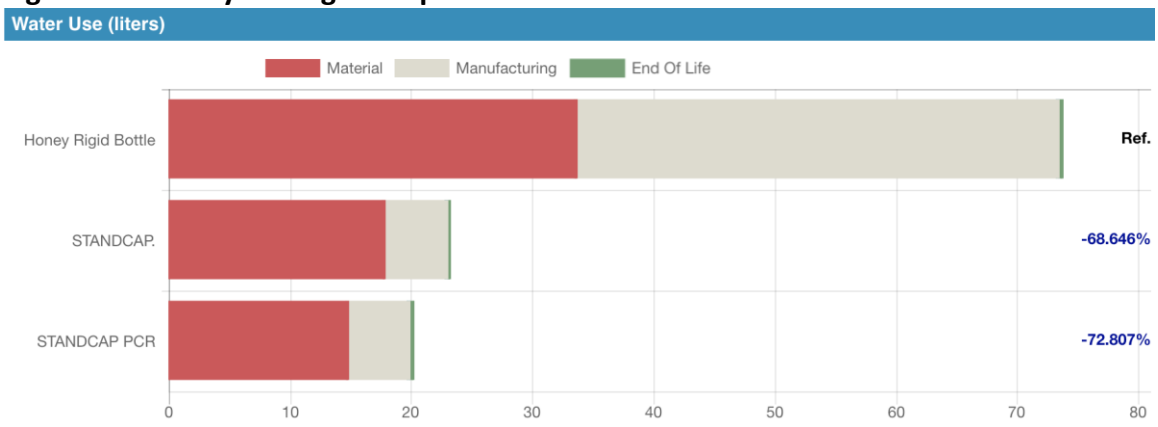
The Fossil Fuel Use chart above (Figure 3-1) shows that the premade STANDCAP Pouch uses over a third less fossil fuel (38.0%) than the rigid PET bottle. This is due to the rigid container being heavier than the STANDCAP pouch and using more overall plastic (26.9g for PET bottle vs. 20.24g for pouch). As a further driver of fossil fuel use, the honey bottle only contains 12 oz. of honey, while the flexible pouch contains 14 oz. The use of PCR results in additional fossil fuel reduction of about 6% as recycled materials are reincorporated back into a package.

Figure 3-2. Honey Package Comparison – GHG Emissions



When considering Greenhouse Gas (GHG) emissions, the premade STANDCAP Pouch results in a reduction of nearly half (-46.2%) the emissions of the rigid bottle. This is due to the pouch using less overall material, as well as the process of laminating and extruding layers of flexible material which results in lower emission than the manufacturing process for the rigid bottle, which requires more energy and heat. This can be seen in the manufacturing (converting) phase, which is represented in gray part of the chart. PCR utilization results in additional GHG reduction of three percent.

Figure 3-3. Honey Package Comparison – Water Use



Finally, Figure 3-3 shows a comparison of water use during the life cycle of the two package formats. In this case, the larger water consumption for the PET bottle is driven by the water that is needed to cool the molds in the stretch blow molding manufacturing process. The water helps to cool the plastic bottle so it can be removed from the mold, speeding up the overall manufacturing process. The stand-up pouch format, which is formed by laminating multiple thin layers of film together, uses about two-thirds less water (-68.6%) in its manufacturing and conversion process.

End of Use Results

The results above show that the premade STANDCAP Pouch with fitment package has lower usage of fossil fuel as well as carbon and water impact when considering the primary package. Package developers also consider the amount of material that is recycled or sent to landfill, to ensure that the package aligns with Circular Economy or Sustainable Materials Management goals. Table 3-B (below) shows the results when current recycling rates are considered, as well the product-to-package ratio, which is a measure of the resource efficiency of the materials used. For this measure, a high product and a low package weight value are desired.

Table 3-B. Honey Packaging – Recycled and Landfilled Comparison

Format	Pkg Wt. (g)	Product % Wt.	Package % Wt.	Pkg wt. (g)/ 1000 kg honey	Pkg Recycled (g)/1000 kg honey	Pkg Landfilled (g)/1000 kg honey
Honey Rigid Bottle	26.9	92.7%	7.3%	78,192	19,938	62,136
STANDCAP	20.24	95.1%	4.9%	50,996	0	50,996
STANDCAP w/PCR	20.24	95.1%	4.9%	50,996	0	50,996

To determine the package recycled and packaging discard rate, the following assumptions were made:

- *PET container recycling rate – 26.8% (per EPA Sustainable Materials Mgmt, published Nov 2020)*
- *Flexible packaging was assumed to have 0% recycling rate*
- *Closures and fitments assumed to have 0% recycling rate*
- *All material collected for recycling was assumed to be actually recycled*
- *Package landfilled is amount of packaging not recycled, goes to municipal solid waste*

End of Use Summary

The results in Table 3-B show that the premade STANDCAP Pouch as a slight advantage in percent of product weight to the rigid PET bottle (95.1% vs. 92.7%). It also has an advantage when looking at amount of material discarded (50,996g vs. 62,136g for 1000 kg of honey) when considering current U.S. recycling rates.

(Note the recycling rate of 26.8% is for PET water bottles and may be inflated for honey bottles which need additional cleaning by consumers. Readily available data for non-beverage bottle recycling rates for PET were not found, so the 26.8% rate was used for the honey bottle).

Summary/Implications

The results show that when the flexible premade STANDCAP Pouch has a number of positive sustainability attributes when compared to a rigid PET bottle for honey. These include lower fossil fuel use, greenhouse gas emissions, water use, discarded material, as well as a higher overall product: package ratio.

Currently, most multilayer pouches are not recyclable, but can still result in less overall material to landfill due to the lightweight nature of multilayer pouches such as the premade STANDCAP Pouch.

As with all package decisions, there are other package attributes such as product protection, brand message, ease of use, and other consumer features that must be considered, including the sustainability benefits of each package format, amount and ease of product evacuation, and the total package design using a holistic approach when determining the most appropriate package.

Table 3-C summarizes much of the critical data and package comparison discussed for this honey packaging case study.

Table 3-C. Honey Packaging Comparison Summary

Format	Fossil Fuel Consumption (MJ-Equiv)	GHG Emissions (kg-CO2 equiv)	Water Consumption (l)	Product-to-Package ratio and percent wt.	Pkg Landfilled (g)/1000 kg honey
Honey Rigid Bottle	2.60	.1394	73.82	12.7:1 92.7%:7.3%	62,136
STANDCAP	1.61 (-38.0%)	.07503 (-46.2%)	23.08 (-68.6%)	19.6:1 **95.1%:4.9%**	50,996 **(-17.9%)**
STANDCAP w/PCR	1.45 **(-44.3%)**	.07089 **(-49.1%)**	20.02 **(-72.8%)**	19.6:1 **95.1%:4.9%**	50,996 **(-17.9%)**

Notes:

- *A normalized product weight (common value divisible by all package formats) of 12. Oz. of product was used for Fossil Fuel, GHG and Water Consumption calculations.*
- *All percentages cited are for other formats compared to the stand-up flexible pouch.*
- *A higher number for product-to-package ratio (first number) cited means a higher percentage of weight is attributed to product, and less to packaging, resulting in more efficient use of packaging resources.*
- *Package landfilled values are based on the of amount of packaging sent to municipal solid waste after recycling, based on 1000 kg of honey.*

Ketchup Packaging Comparison

Ketchup is a popular condiment that is often packaged in a PET bottle or a glass bottle. For this streamlined Life Cycle Assessment study, a comparison between a popular PET bottle and the premade STANDCAP Pouch were evaluated:

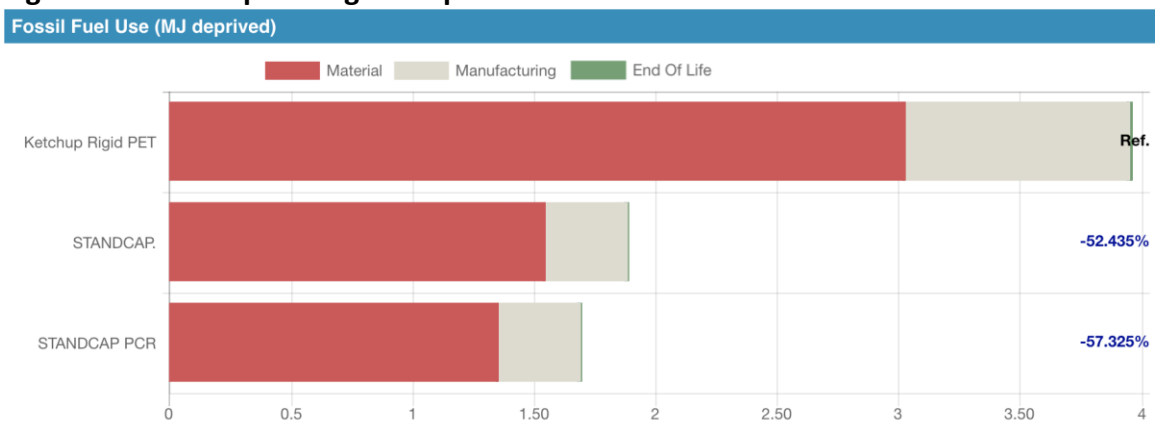
Table 4-A. Ketchup Packaging Evaluation Comparison

Package Type/Product Weight	Structure (package weight)	Photo
Ketchup Rigid Container (14 oz.)		
Bottle	Bottle – PET – 30.3g	
Closure	Closure – PP – 10.3 Valve – Silicon – .09g	
Tamper Evident Seal	Seal – Paper/Poly/Foil – .2g	
Labels (Front & Back)	Labels – Paper – .9g	
	TOTAL = 41.79g	
Premade STANDCAP Pouch (14 oz.) – Standard and with PCR		
Pouch – Standard Pouch – PCR	PET/PET/Nylon/LLDPE/HDPE PET (100% PCR)/ PET (50% PCR)/Nylon/ LLDPE-HDPE Coex (42% PCR) 6.72g	
Fitment	Closure – PP – 10.53g Fitment-LDPE/LLDPE-2.7g Ring- PP - .2g Valve – Silicon - .09g	
	TOTAL = 20.24g	

<u>Fossil Fuel Consumption, Greenhouse Gas Emissions, and Water Consumption Comparison</u>

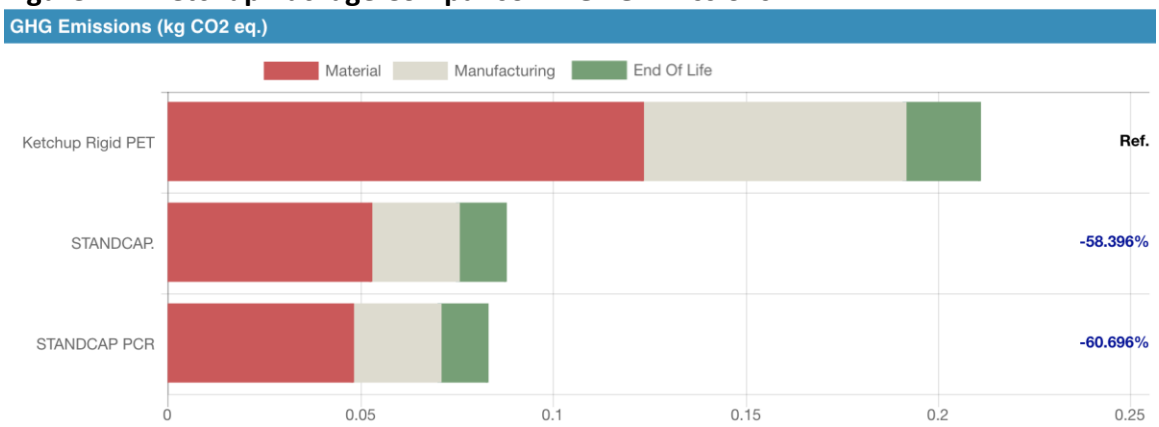
The charts below will highlight results of the fossil fuel usage, greenhouse gas (GHG) emissions, and water use for each of the package formats evaluated. These are some of the primary common indicators that package developers consider when appraising the environmental impacts of a particular package. 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.

Figure 4-1. Ketchup Package Comparison – Fossil Fuel Use



The Fossil Fuel Consumption chart above (Figure 4-1) shows that the premade STANDCAP Pouch results in 52.4% lower fossil fuel use. Both use plastic for nearly the entire package, but the premade STANDCAP pouch uses considerably less material (20.24g vs. 41.79g) than the PET bottle. Additionally, the manufacturing process (gray bar) uses more fossil fuel for stretch blow molding than the laminating and extruding process for the pouch. In most cases, a lighter package where both packs are made of plastics will result in lower fossil fuel use for the lighter package. Note the use of PCR results in an additional 5% reduction in fossil fuel use.

Figure 4-2. Ketchup Package Comparison – GHG Emissions



The GHG emissions chart also shows a large reduction in emissions from use of the premade STANDCAP Pouch (-58.4%). As can be seen above, the lighter weight pouch has a lower overall total for emissions than just the material part for the rigid option (red part of graph). Additionally, the stretch blow molding manufacturing (gray part of graph) process for the bottle results in much higher overall emissions, driven by energy and heat needed to form the plastic in a mold.

Figure 4-3. Ketchup Package Comparison – Water Use

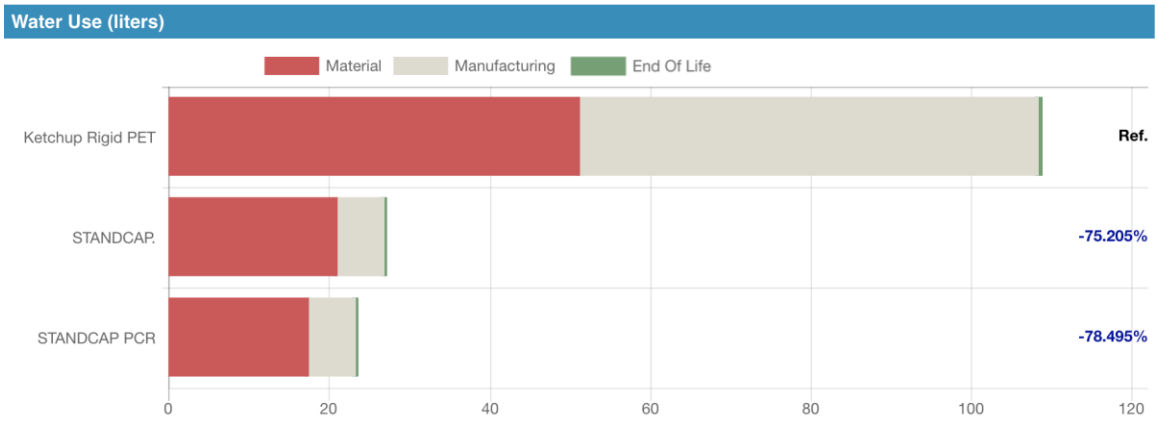


Figure 4-3 shows a comparison of water use between the two options. Again, the premade STANDCAP Pouch comes in with much about three-quarters less water use (-75.2%) than the rigid container and (-78.5%) when PCR is incorporated into the pouch. This would be driven by the water needed to cool the molds in the stretch blow molding process which is much more water intensive than the laminating and extrusion process for multilayer pouches such as the premade STANDCAP Pouch.

End of Use Results

The results above show that the premade STANDCAP Pouch has a much lower usage of fossil fuel and water as well as carbon impact when considering the primary package. Package developers also consider the amount of material that is recycled or sent to landfill, to ensure that the package aligns with Circular Economy or Sustainable Materials Management goals. Table 4-B (below) shows the results when current recycling rates are considered, as well the product-to-package ratio, which is a measure of the resource efficiency of the materials used. For this measure, a high product and a low package weight value are desired.

Table 4-B. Ketchup Packaging – Recycled and Landfilled Comparison

Format	Pkg Wt. (g)	Product % Wt.	Package % Wt.	Pkg wt. (g)/ 1000 kg ketchup	Pkg Recycled (g)/1000 kg ketchup	Pkg Landfilled (g)/1000 kg ketchup
Ketchup Rigid Bottle	41.79	90.5%	9.5%	105,284	20,460	84,824
STANDCAP	20.24	95.1%	4.9%	50,996	0	50,996
STANDCAP w/ PCR	20.24	95.1%	4.9%	50,996	0	50,996

To determine the package recycled and packaging discard rate, the following assumptions were made:

- *PET bottle recycling rate at 26.8% (US EPA Sustainable Materials Mgmt – published Nov. 2020)*
- *Flexible packaging was assumed to have 0% recycling rate*
- *Closures and fitments assumed to have 0% recycling rate*
- *All material collected for recycling was assumed to be actually recycled*
- *Package landfilled is amount of packaging not recycled, goes to municipal solid waste*

End of Use Summary

According to the U.S. EPA Waste Hierarchy, the most preferred method for waste management is Source Reduction and Reuse. A major benefit of flexible packaging is the high product-to-package ratio which flexible packaging tends to offer. The premade STANDCAP Pouch results in over 95% of weight being attributed to the product, while the PET bottle results in just over 90% of weight attributed to ketchup.

When considering how much of a package ends up in municipal solid waste, the PET bottle results in about 40% more material that ends up at a landfill, even considering a recycling rate of 26.8% for PET bottles and no credit for the flexible pouch for recovery.

The examples above highlight that while many multi-material flexible packages are not yet recovered and recycled in any significant amount, they still result in a substantial reduction in the amount of material sent to landfill versus other types of packaging.

Summary/Implications

The results show that the STANDCAP pouch results in lower impacts across a wide range of environmental metrics including fossil fuel and water use, greenhouse gas emissions, and material discarded. This driven by the efficient material usage of the flexible pouch which uses less than half the amount of material needed to package the same amount of ketchup.

As with all package decisions, there are other package attributes such as product protection, brand message, ease of use, and other consumer features that must be considered, including the sustainability benefits of each package format, amount and ease of product evacuation, and the total package design using a holistic approach.

Table 4-C summarizes much of the critical data and package comparison discussed for this ketchup packaging case study.

Table 4-C. Ketchup Packaging Comparison Summary

Format	Fossil Fuel Consumption (MJ-Equiv)	GHG Emissions (kg-CO2 equiv)	Water Consumption (l)	Product-to-Package ratio and percent wt.	Pkg Landfilled (g)/1000 kg ketchup
Ketchup Rigid Bottle	3.95	.2104	108.61	9.5:1 90.5%:9.5%	84,824
STANDCAP	1.88 (-52.4%)	.08754 (-58.4%)	26.93 (-75.2%)	19.6:1 **95.1%:4.9%**	50,996 **(-39.9%)**
STANDCAP w/PCR	1.69 **(-57.3%)**	.0827 **(-60.7%)**	23.36 **(-78.5%)**	19.6:1 **95.1%:4.9%**	50,996 **(-39.9%)**

Notes:

- *A normalized product weight (common value divisible by all package formats) of 14. oz. of product was used for Fossil Fuel, GHG and Water Consumption calculations.*
- *All percentages cited are for other formats compared to the stand-up flexible pouch.*
- *A higher number for product-to-package ratio (first number) cited means a higher percentage of weight is attributed to product, and less to packaging, resulting in more efficient use of packaging resources.*
- *Package landfilled values are based on the of amount of packaging sent to municipal solid waste after recycling, based on 1000 kg of ketchup.*

Chocolate Syrup Packaging Comparison

Most chocolate syrup available today is packaged in an HDPE bottle or glass jar. For this streamlined Life Cycle Assessment study, a comparison was made between a popular syrup in an HDPE bottle vs. the premade STANDCAP Pouch:

Table 5-A. Ketchup Packaging Evaluation Comparison

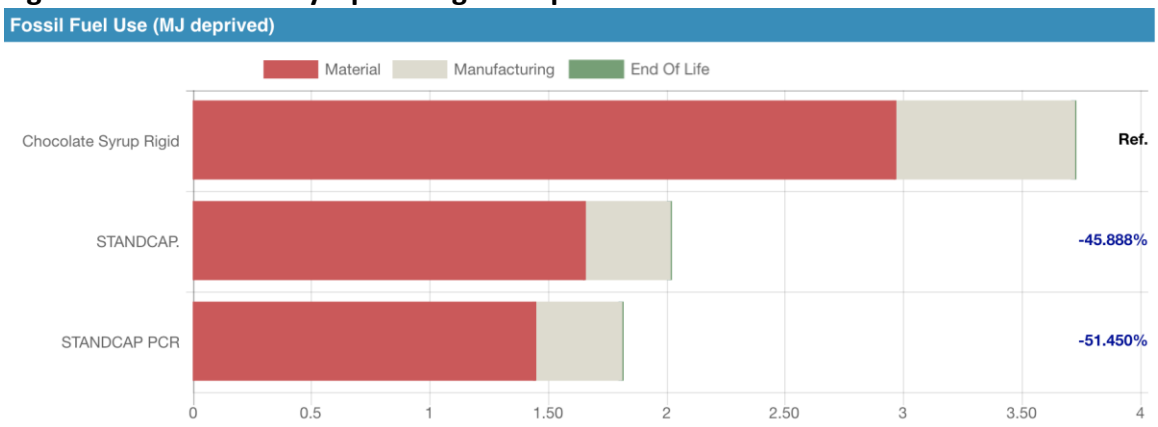
Package Type/Product Weight	Structure (package weight)	Photo
Chocolate Syrup Rigid Container (15 oz.)		
Bottle	Bottle – HDPE – 33.4g	
Closure	Closure – PP – 5.4g	
Tamper Evident Band	Shrink Sleeve – PET – .4g	
	TOTAL = 39.2g	
Premade STANDCAP Pouch (14 oz.) – Standard and with PCR		
Pouch – Standard Pouch – PCR	PET/PET/Nylon/LLDPE/HDPE PET (100% PCR)/ PET (50% PCR)/Nylon/ LLDPE-HDPE Coex (42% PCR) 6.72g	
Fitment	Closure – PP – 10.53g Fitment-LDPE/LLDPE-2.7g Ring – PP – .2g Valve – Silicon – .09g	
	TOTAL = 20.24g	

Packages as close as possible in size/volume were selected to make the life cycle comparison. Not in all cases were packs of identical size/volume available for purchase.

Fossil Fuel Consumption, Greenhouse Gas Emissions, and Water Consumption Comparison

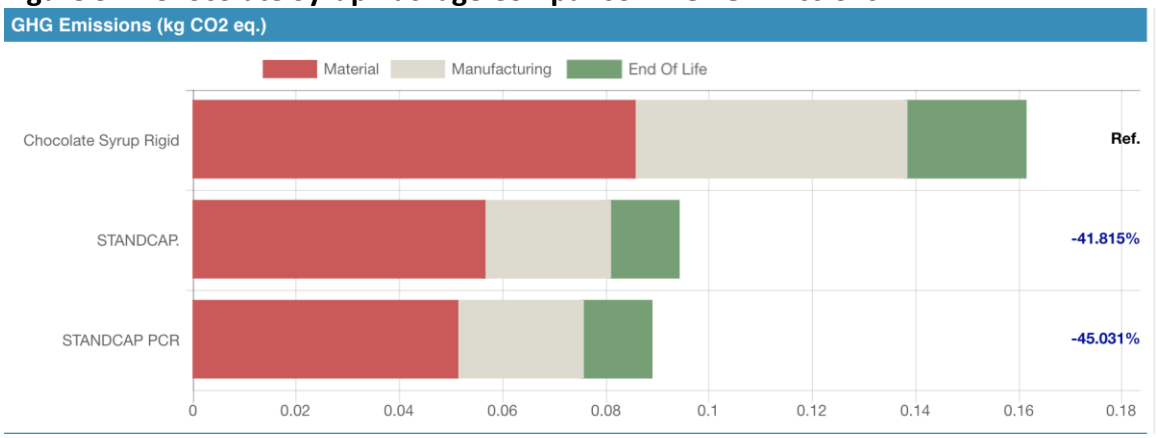
The charts on the following pages will highlight results of the fossil fuel usage, greenhouse gas (GHG) emissions, and water use for each of the package formats evaluated. These are some of the primary common indicators that package developers consider when appraising the environmental impacts of a particular 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.

Figure 5-1. Chocolate Syrup Package Comparison – Fossil Fuel Use



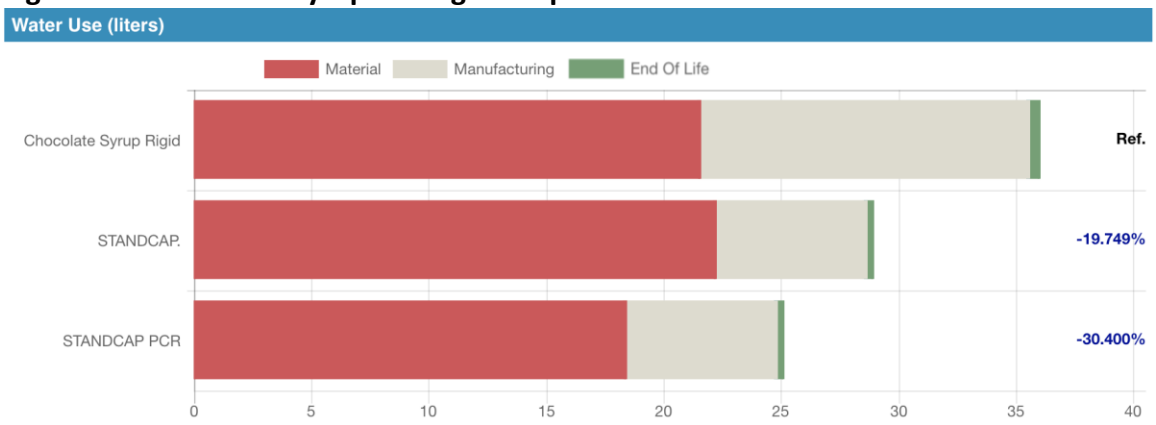
When comparing fossil fuel use between the two packages, the premade STANDCAP Pouch results in a decrease of nearly half (-45.9%) when compared to the rigid HDPE bottle, while use of PCR results in an additional reduction of over 5%. This is driven by the rigid bottle using about double the amount of packaging material (39.2g vs. 20.24g) to hold similar amounts of chocolate syrup. In most cases where both packs are both using plastic as the main material, the lighter weight structure will have the lower fossil fuel use.

Figure 5-2. Chocolate Syrup Package Comparison – GHG Emissions



The GHG emissions chart also shows that the premade STANDCAP Pouch results in about 41.8% lower emissions, with an additional 4% reduction through the incorporation of PCR. This is also driven by the pouch having about half the amount of material as the bottle. Additionally, the HDPE bottle manufacturing process of blow molding requires heating which results in additional emissions when compared to the extrusion and laminating process of multilayer pouches which are typically less energy intensive.

Figure 5-3. Chocolate Syrup Package Comparison – Water Use



Finally, Figure 5-3 shows a comparison of water use during the life cycle of the two packages. In this case, the premade STANDCAP Pouch again has a lower water use, along with an additional water use reduction of 10% with PCR usage. The stand-up pouch format, which is formed by laminating multiple thin layers of film together, uses much less water in its manufacturing process than the blow molding process for a rigid bottle, which uses water for cooling the molds.

End of Use Results

The results above show that the premade STANDCAP Pouch has a much lower usage of fossil fuel and water as well as carbon impact when considering the primary package. Package developers also consider the amount of material that is recycled or sent to landfill, to ensure that the package aligns with Circular Economy or Sustainable Materials Management goals. Table 5-B (below) shows the results when current recycling rates are considered, as well the product-to-package ratio, which is a measure of the resource efficiency of the materials used. For this measure, a high product and a low package weight value are desired.

Table 5-B. Chocolate Syrup Packaging – Recycled and Landfilled Comparison

Format	Pkg Wt. (g)	Product % Wt.	Package % Wt.	Pkg wt. (g)/ 1000 kg Syrup	Pkg Recycled (g)/1000 kg syrup	Pkg Landfilled (g)/1000 kg syrup
Chocolate Syrup Rigid Bottle	39.2	91.6%	8.4%	92,183	23,013	69,170
STANDCAP	20.24	95.1%	4.9%	50,996	0	50,996
STANDCAP w/PCR	20.24	95.1%	4.9%	50,996	0	50,996

To determine the package recycled and packaging discard rate, the following assumptions were made:

- *HDPE bottle recycling rate at 29.3% (EPA, Published November 2020)*
- *Flexible packaging was assumed to have 0% recycling rate*
- *Closures and fitments assumed to have 0% recycling rate*
- *All material collected for recycling was assumed to be actually recycled*
- *Package landfilled is amount of packaging not recycled, goes to municipal solid waste*

End of Use Summary

According to the U.S. EPA Waste Hierarchy, the most preferred method for waste management is Source Reduction and Reuse. A major benefit of flexible packaging is the high product-to-package ratio which flexible packaging tends to offer and very efficient use of materials.

The rigid HDPE bottle requires considerably more material (92,183g vs. 50,996g) to package 1000kg of chocolate syrup. Even when accounting for the HDPE bottle recycling rate of 29.3%, the rigid bottle still results in over 25% more material ending up landfill vs. the STANDCAP pouch. The HDPE bottle would need to get to a recovery rate of over 54% in order to have the same amount of material discarded as the inverted pouch has today.

The examples highlight that while many multi-material flexible packages are not yet recovered and recycled in any significant amount, they still result in a substantial reduction in the amount of material sent to landfill versus other types of packaging.

Summary/Implications

The results show that the premade STANDCAP Pouch has a number of sustainability benefits when compared to an HDPE bottle for packing and shipping chocolate syrup. These include lower fossil fuel and water use, greenhouse gas emissions, better product: package ratio (efficiency of materials), and considerably less material discarded at end of life.

As with all package decisions, there are other package attributes such as product protection, brand message, ease of use, and other consumer features that must be considered, including the sustainability benefits of each package format, amount and ease of product evacuation, and the total package design using a holistic approach.

Table 5-C summarizes much of the critical data and package comparison discussed for this chocolate syrup packaging case study.

Table 5-C. Chocolate Syrup Packaging Comparison Summary

Format	Fossil Fuel Use (MJ-Equiv)	GHG Emissions (kg-CO2 equiv)	Water Use (l)	Product-to-Package ratio and percent wt.	Pkg Landfilled (g)/1000 kg syrup
Chocolate Syrup Rigid Bottle	3.72	.1612	35.95	10.9:1 91.6%:8.4%	69,170
STANDCAP	2.01 (-45.9%)	.09379 (-41.8%)	28.85 (-19.7%)	19.6:1 **95.1%:4.9%**	50,996 **(-26.3%)**
STANDCAP w/PCR	1.81 **(-51.5%)**	.08861 **(-45.0%)**	25.02 **(-30.4%)**	19.6:1 **95.1%:4.9%**	50,996 **(-26.3%)**

Notes:

- *A normalized product weight (common value divisible by all package formats) of 15 oz. of product was used for Fossil Fuel, GHG and Water Consumption calculations.*
- *All percentages cited are for other formats compared to the stand-up flexible pouch.*
- *A higher number for product-to-package ratio (first number) cited means a higher percentage of weight is attributed to product, and less to packaging, resulting in more efficient use of packaging resources.*
- *Package landfilled values are based on the of amount of packaging sent to municipal solid waste after recycling, based on 1000 kg of chocolate syrup.*

Salad Dressing Packaging Comparison

For this scenario, a comparison between salad dressing in a PET bottle was compared to dressing in a premade STANDCAP Pouch.

Table 6-A. Salad Dressing Packaging Evaluation Comparison

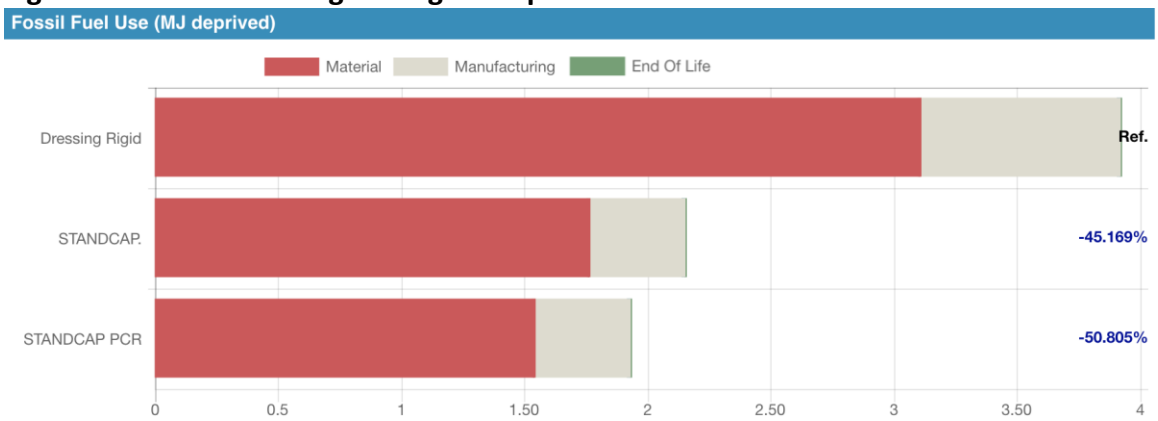
Package Type/Product Weight	Structure (package weight)	Photo
Salad Dressing Rigid Container (16 fl. oz.)		
Bottle	Bottle – PET – 37.9g	
Closure	Closure – PP – 3.8g	
Labels (Front, back, neck)	Labels – Paper – 2.5g	
	TOTAL = 44.2g	
Premade STANDCAP Pouch (14 fl. oz.) – Standard and with PCR		
Pouch – Standard Pouch – PCR	PET/PET/Nylon/LLDPE/HDPE PET (100% PCR)/ PET (50% PCR)/Nylon/ LLDPE-HDPE Coex (42% PCR) 6.72g	
Fitment	Closure – PP – 10.53g Fitment-LDPE/LLDPE-2.7g Ring – PP – .2g Valve – Silicon – .09g	
	TOTAL = 20.24g	

Packages as close as possible in size/volume were selected to make the life cycle comparison. Not in all cases were packs of identical size/volume available for purchase.

Fossil Fuel Consumption, Greenhouse Gas Emissions, and Water Consumption Comparison

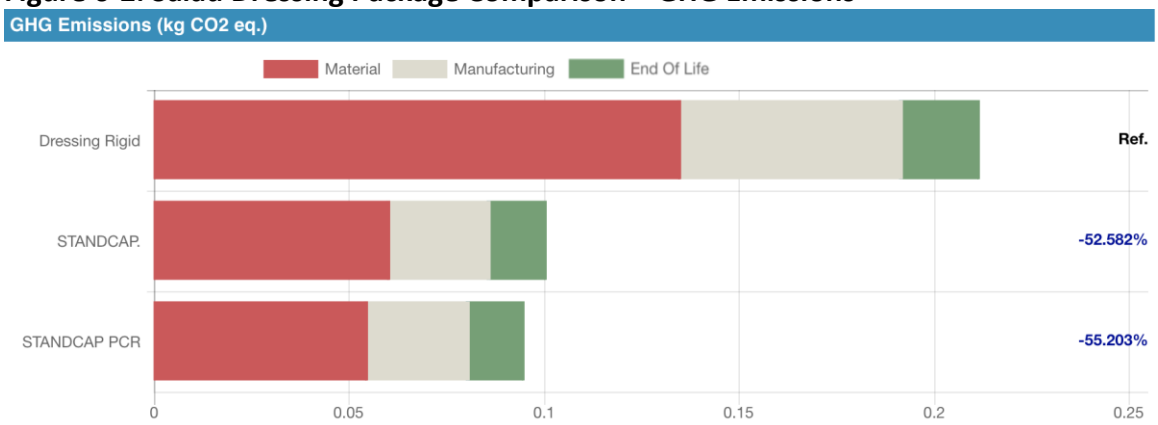
The charts below will highlight results of the fossil fuel usage, greenhouse gas (GHG) emissions, and water use for each of the package formats evaluated. These are some of the primary common indicators that package developers consider when appraising the environmental impacts of a particular package. 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.

Figure 6-1. Salad Dressing Package Comparison – Fossil Fuel Use



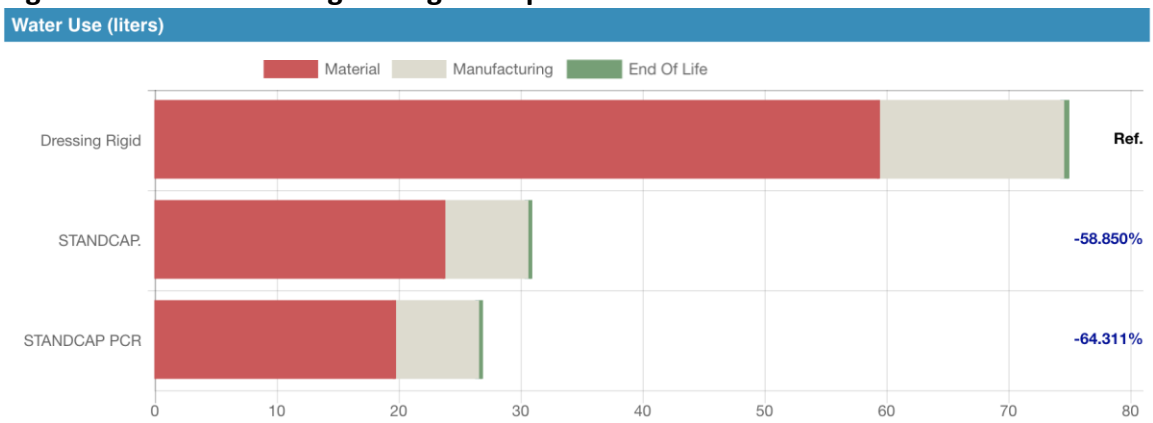
When considering fossil fuel use, the premade STANDCAP Pouch uses just about half (-45.2%) the amount of fossil fuel as the PET bottle, with an additional reduction of 5% through the use of PCR. These reductions are largely driven by the amount of material used, with the PET bottle weighing in at 44.2g (for 16 fl. oz) vs. only 20.24g (for 14 fl. oz) for the premade STANDCAP pouch.

Figure 6-2. Salad Dressing Package Comparison – GHG Emissions



The GHG emissions chart also shows that the premade STANDCAP pouch results in about half the amount of emissions (-52.6%) as the rigid bottle. This would be attributed to a couple of reasons. First, the rigid bottle using about the double the amount of material as the pouch. Secondly, for the manufacturing process, the rigid container requires additional heat (energy) in the stretch blow molding process when compared to the lamination and extrusion steps for the flexible pouch, which drives higher overall emissions.

Figure 6-3. Salad Dressing Package Comparison – Water Use



Finally, Figure 6-3 shows a comparison of water use during the life cycle of the two package formats. In this case, the larger water consumption for the PET bottle is driven by the water that is needed to cool the molds in the stretch blow molding manufacturing process. The water helps to cool the plastic bottle so it can be removed from the mold, speeding up the overall manufacturing process. The premade STANDCAP Pouch format, which is formed by laminating multiple thin layers of film together, uses much less water in its manufacturing process. The use of PCR further reduces water use an additional 5%.

End of Use Results

The results above show that the premade STANDCAP Pouch has a much lower usage of fossil fuel as well as carbon and water impact when considering the primary package. Package developers also consider the amount of material that is recycled or sent to landfill, to ensure that the package aligns with Circular Economy or Sustainable Materials Management goals. Table 6-B (below) shows the results when current recycling rates are considered, as well the product-to-package ratio, which is a measure of the resource efficiency of the materials used. For this measure, a high product and a low package weight value are desired.

Table 6-B. Salad Dressing Packaging – Recycled and Landfilled Comparison

Format	Pkg Wt. (g)	Product % Wt.	Package % Wt.	Pkg wt. (g)/ 1000 kg dressing	Pkg Recycled (g)/1000 kg dressing	Pkg Landfilled (g)/1000 kg dressing
Salad Dressing Rigid Bottle	44.2	91.5%	8.5%	92,486	21,253	71,233
STANDCAP	20.24	95.4%	4.6%	48,401	0	48,401
STANDCAP w/PCR	20.24	95.4%	4.6%	48,401	0	48,401

To determine the package recycled and packaging discard rate, the following assumptions were made:

- *PET bottle recycling rate at 26.8% (EPA Sustainable Materials Management, Published Nov. 2020)*
- *Flexible packaging was assumed to have 0% recycling rate*
- *Closures and fitments assumed to have 0% recycling rate*
- *All material collected for recycling was assumed to be actually recycled*
- *Package landfilled is amount of packaging not recycled, goes to municipal solid waste*

End of Use Summary

Source reduction and efficient use of materials at the top of the EPA Waste Hierarchy as a way to reduce environmental impact of packaging. The STANDCAP pouch highlights this by using about half the amount of material and having a very high weight of product (95.4% vs. only 4.6% for package weight).

Additionally, when considering how much material ends up in municipal solid waste, the premade STANDCAP Pouch results in far less material discarded (48,401g vs. 71,223g to package 1000kg of salad dressing).

The examples above highlight that while many multi-material flexible packages are not yet recovered and recycled in any significant amount, they still result in a substantial reduction in the amount of material sent to landfill versus other types of packaging.

Summary/Implications

The results show that the premade STANDCAP Pouch has a number of environmental benefits when compared to a PET bottle for packing and salad dressing. These include lower fossil fuel and water use, greenhouse gas emissions, better product: package ration (efficiency of materials), and considerably less material discarded at end of life. The flexible pouch aligns very well with Sustainable Materials Management principles.

As with all package decisions, there are other package attributes such as product protection, brand message, ease of use, and other consumer features that must be considered, including the sustainability benefits of each package format, amount and ease of product evacuation, and the total package design using a holistic approach.

Table 6-C summarizes much of the critical data and package comparison discussed for this salad dressing packaging case study.

Table 6-C. Salad Dressing Packaging Comparison Summary

Format	Fossil Fuel Use (MJ-Equiv)	GHG Emissions (kg-CO2 equiv)	Water Use (l)	Product-to-Package ratio and percent wt.	Pkg Landfilled (g)/1000 kg dressing
Salad Dressing Rigid Bottle	3.92	.211	74.79	10.8:1 91.5%:8.5%	71,223
STANDCAP	2.15 (-45.2%)	.100 (-52.6%)	30.78 (-58.9%)	20.7:1 **95.4%:4.6%**	48,401 **(-32.1%)**
STANDCAP w/PCR	1.93 **(-50.8%)**	.09451 **(-55.2%)**	26.69 **(-64.3%)**	20.7:1 **95.4%:4.6%**	48,401 **(-32.1%)**

Notes:

- *A normalized product weight (common value divisible by all package formats) of 16 fl. oz. of product was used for Fossil Fuel, GHG and Water Consumption calculations.*
- *All percentages cited are for other formats compared to the stand-up flexible pouch.*
- *A higher number for product-to-package ratio (first number) cited means a higher percentage of weight is attributed to product, and less to packaging, resulting in more efficient use of packaging resources.*
- *Package landfilled values are based on the of amount of packaging sent to municipal solid waste after recycling, based on 1000 kg of salad dressing.*
- *Used 1.01 g/ml as density for ranch dressing to determine product weight.*

Hummus Packaging Comparison

Hummus is a popular dip often packaged in a PET plastic tub. For this Life Cycle Assessment study, a comparison was made between a popular hummus brand in a PET as well as the premade STANDCAP Pouch. Two separate sizes of hummus packages were considered in this scenario:

Table 8-A. Hummus Packaging Evaluation Comparison

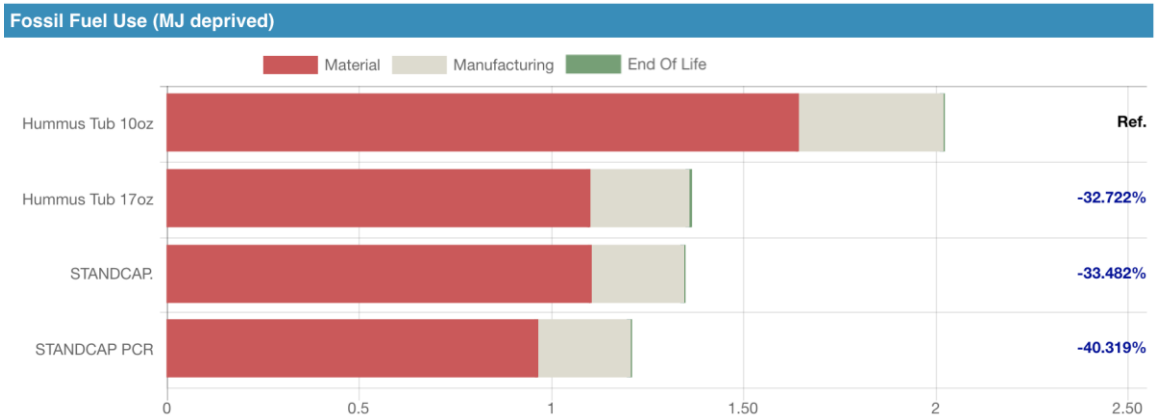
Package Type/Product Weight	Structure (package weight)	Photo
Hummus Tub (10 oz.)		
Tub	Tub – PET– 15.2g	
Lid	Lid – PET – 10.2g	
Lidding	Lidding – PET/LLDPE – 1.1g	
Tub label	Label – OPP – 0.2g	
Lid label	Label – OPP – 0.2g	
	TOTAL = 26.9g	
Hummus Tub (17 oz.)		
Tub	Tub – PET– 19.5g	
Lid	Lid – PET – 10.2g	
Lidding	Lidding – PET/LLDPE – 1.1g	
Tub label	Label – OPP – 0.3g	
Lid label	Label – OPP – 0.2g	
	TOTAL = 31.3g	
Premade STANDCAP Pouch (14 fl. oz.) – Standard and with PCR		
Pouch – Standard Pouch – PCR	PET/PET/Nylon/LLDPE/HDPE PET (100% PCR)/ PET (50% PCR)/Nylon/ LLDPE-HDPE Coex (42% PCR) 6.72g	
Fitment	Closure – PP – 10.53g Fitment-LDPE/LLDPE-2.7g Ring – PP – .2g Valve – Silicon – .09g	
	TOTAL = 20.24g	

Packages as close as possible in size/volume were selected to make the life cycle comparison. Not in all cases were packs of identical size/volume available for purchase.

Fossil Fuel Consumption, Greenhouse Gas Emissions, and Water Consumption Comparison

The charts below 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 common 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.

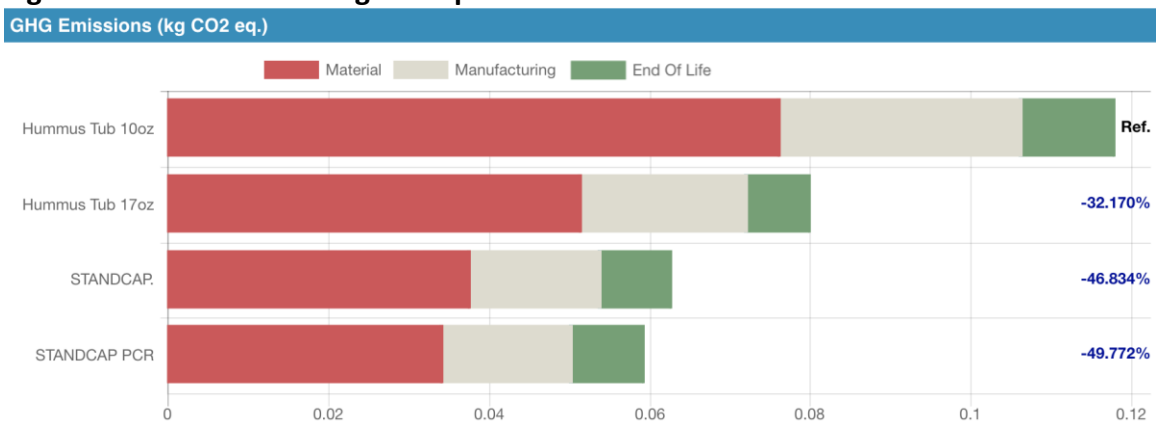
Figure 8-1. Hummus Package Comparison – Fossil Fuel Use



Fossil Fuel Use shows that the both the premade STANDCAP Pouch and the 17 oz. version of the hummus tub are very similar and result in about one-third less fossil fuel than the 10 oz. tub. The use of PCR reduced the premade STANDCAP Pouch fossil fuel use by an additional 7%. The 10 oz. tub would use the most fossil fuel as when normalized for comparison to the other packages. The 10 oz. tub uses 26.9g for 10 oz. of product and for just an additional 4.4g, the 17 oz. tub provides containment of another 7 oz. of product. Larger packs in general are more efficient than smaller packs.

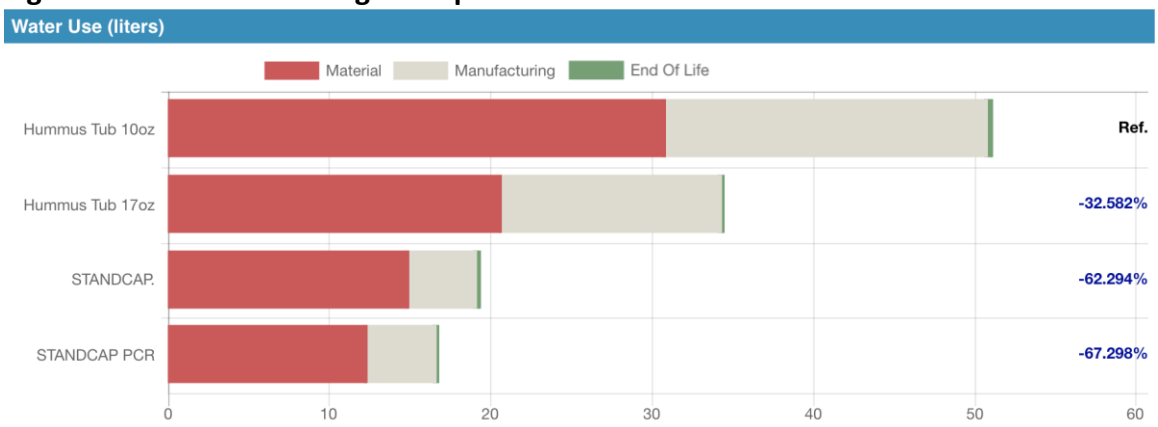
The premade STANDCAP Pouch comes in at just 20.24g of material for 14 oz. of hummus.

Figure 8-2. Hummus Package Comparison – GHG Emissions



The GHG emissions chart also shows that the premade STANDCAP Pouch results in greenhouse gas emissions nearly half (-46.8%) and the premade STANDCAP Pouch with PCR coming in with a reduction of 49.8% that of the 10 oz. rigid tub. This is driven by the lightweight of the flexible pouch, as well as the process of extruding and laminating a multilayer pouch, which can have lower emissions than the thermoforming of the tub.

Figure 8-3. Hummus Package Comparison – Water Use



When considering water use, the premade STANDCAP Pouch again comes in with the lowest amount used by a wide margin (-62.3% vs. the 10 oz. rigid tub). This is again driven by the lower weight as well as the laminating and extrusion process which uses less water than thermoforming for the rigid tubs, which uses water for cooling for the molds.

End of Use Results

The results above show that the premade STANDCAP Pouch has a lower usage of water and carbon emissions when considering the primary package. It also had a much lower fossil fuel use compared to the 10 oz. hummus tub (and similar to the 17 oz. tub). Package developers also consider the amount of material that is recycled or sent to landfill, to ensure that the package aligns with Circular Economy or Sustainable Materials Management goals. Table 8-B (below) shows the results when current recycling rates are considered, as well the product-to-package ratio, which is a measure of the resource efficiency of the materials used. For this measure, a high product and a low package number are desired.

Note: For the recycling rate of the PET tubs, a rate of 18.6% was used, which is the default value in the EcoImpact-COMPASS® tool since other sources for PET recycling rates for tubs were not found.

Table 8-B. Hummus Packaging – Recycled and Landfilled Comparison

Format	Pkg Wt. (g)	Product % Wt.	Package % Wt.	Pkg wt. (g)/ 1000 kg hummus	Pkg Recycled (g)/1000 kg hummus	Pkg Landfilled (g)/1000 kg hummus
Hummus 10 oz. tub	26.9	91.3%	8.7%	94,885	9,972	84,913
Hummus 17 oz. tub	31.3	93.9%	6.1%	64,946	7,526	57,420
STANDCAP	20.24	95.1%	4.9%	50,996	0	50,996
STANDCAP w/PCR	20.24	95.1%	4.9%	50,996	0	50,996

To determine the package recycled and packaging discard rate, the following assumptions were made:

- *PET tub recycling rate at 18.6% (Default rate in COMPASS tool for PET, other packaging container)*
- *Flexible packaging was assumed to have 0% recycling rate*
- *Closures and fitments assumed to have 0% recycling rate*
- *All material collected for recycling was assumed to be actually recycled*
- *Package landfilled is amount of packaging not recycled, goes to municipal solid waste*

End of Use Summary

The U.S. EPA utilized a Waste Hierarchy lists source reduction and reuse as the most preferred method to reduce waste. The hummus scenario shows that the premade STANDCAP Pouch follows this protocol through using the least amount of material, having the best product/package weight efficiency values, as well as the least amount of material discarded at the end of life.

The examples in the case study highlight that while many multi-material flexible packages are not yet recovered and recycled in any significant amount, they still result in a substantial reduction in the amount of material sent to landfill versus other types of packaging.

Summary/Implications

The results of this scenario show that the premade STANDCAP Pouch results in lower impacts across a wide range of environmental metrics including water use, greenhouse gas emissions, and material discarded. The inclusion of PCR drives all of environmental indicators lower – fossil fuel, greenhouse gas emissions and water use. Fossil fuel use was similar to the 17 oz. hummus tub and lower than the 10 oz. tub. This driven by the efficient material usage of the flexible pouch which uses considerably less packaging material to package the same amount of hummus. The scenario also shows that larger packs are more preferable from an environmental impact perspective (17 oz. tub vs. 10 oz. tub) as they generally allow a more efficient use of packaging (weight of product: weight of packaging). However, food waste is an important consideration that can be limited through smaller packaging including portion control packaging.

As with all package decisions, there are other package attributes such as product protection, brand message, ease of use, and other consumer features that must be considered, including the sustainability benefits of each package format, amount and ease of product evacuation, and the total package design using a holistic approach.

Table 8-C summarizes much of the critical data and package comparison discussed for this hummus packaging case study.

Table 8-C. Hummus Packaging Comparison Summary

Format	Fossil Fuel Use (MJ-Equiv)	GHG Emissions (kg-CO2 equiv)	Water Use (l)	Product-to-Package ratio and percent wt.	Pkg Landfilled (g)/1000 kg hummus
Hummus 10 oz. tub	2.02	.1176	51.02	10.5:1 91.3%:8.7%	84,913
Hummus 17 oz. tub	1.36 (-32.7%)	.07977 (-32.2%)	34.39 (-32.6%)	15.4:1 93.9%:6.1%	57,420 (-32.4%)
STANDCAP	1.34 (-33.5%)	.06253 (-46.8%)	19.24 (-62.3%)	19.6:1 **95.1%:4.9%**	50,996 **(-39.9%)**
STANDCAP w/PCR	1.21 **(-40.3%)**	.05907 **(-49.8%)**	16.68 **(-67.3%)**	19.6:1 **95.1%:4.9%**	50,996 **(-39.9%)**

Notes:

- *A normalized product weight (common value divisible by all package formats) of 10 oz. of product was used for Fossil Fuel, GHG and Water Consumption calculations.*
- *All percentages cited are for other formats compared to the stand-up flexible pouch.*
- *A higher number for product-to-package ratio (first number) cited means a higher percentage of weight is attributed to product, and less to packaging, resulting in more efficient use of packaging resources.*
- *Package landfilled values are based on the of amount of packaging sent to municipal solid waste after recycling, based on 1000 kg of hummus.*

Shampoo Packaging Comparison

Many types of shampoo are available today packaged in an HDPE plastic bottle. For this streamlined Life Cycle Assessment study, a comparison was made between a popular shampoo brand in an HDPE bottle vs. the premade STANDCAP Pouch:

Table 7-A. Shampoo Packaging Evaluation Comparison

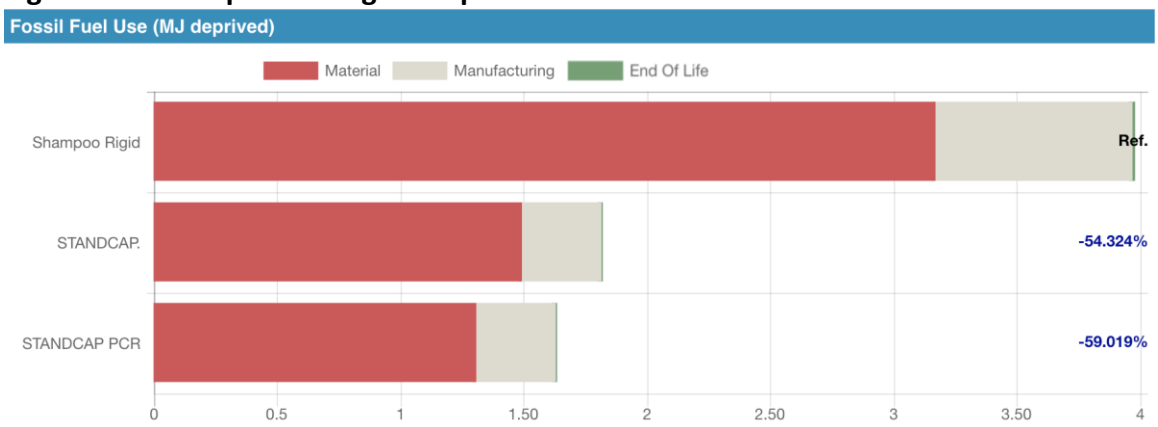
Package Type/Product Weight	Structure (package weight)	Photo
Shampoo Rigid Container (13.5 fl. oz.)		
Bottle	Bottle – HDPE – 31.1g	
Closure	Closure – PP – 9.7g	
Labels (Front & back)	Labels – PP – 1.0g	
	TOTAL = 41.8g	
Premade STANDCAP Pouch (14 fl. oz.) – Standard and with PCR		
Pouch – Standard Pouch – PCR	PET/PET/Nylon/LLDPE/HDPE PET (100% PCR)/ PET (50% PCR)/Nylon/ LLDPE-HDPE Coex (42% PCR) 6.72g	
Fitment	Closure – PP – 10.53g Fitment-LDPE/LLDPE-2.7g Ring – PP – .2g Valve – Silicon – .09g	
	TOTAL = 20.24g	

Packages as close as possible in size/volume were selected to make the life cycle comparison. Not in all cases were packs of identical size/volume available for purchase.

Fossil Fuel Consumption, Greenhouse Gas Emissions, and Water Consumption Comparison

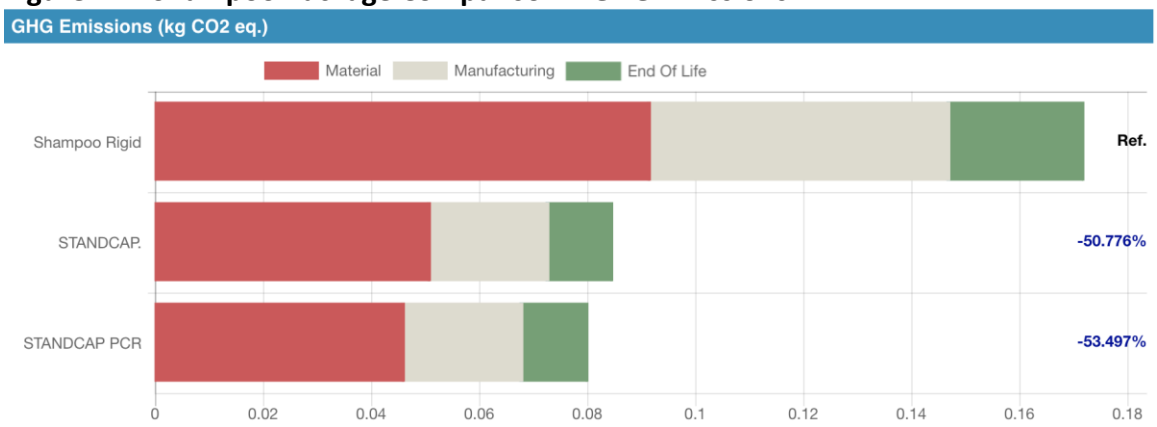
The charts below will highlight results of the fossil fuel usage, greenhouse gas (GHG) emissions, and water use for each of the package formats evaluated. These are some of the primary common indicators that package developers consider when appraising the environmental impacts of a particular package. 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.

Figure 7-1. Shampoo Package Comparison – Fossil Fuel Use



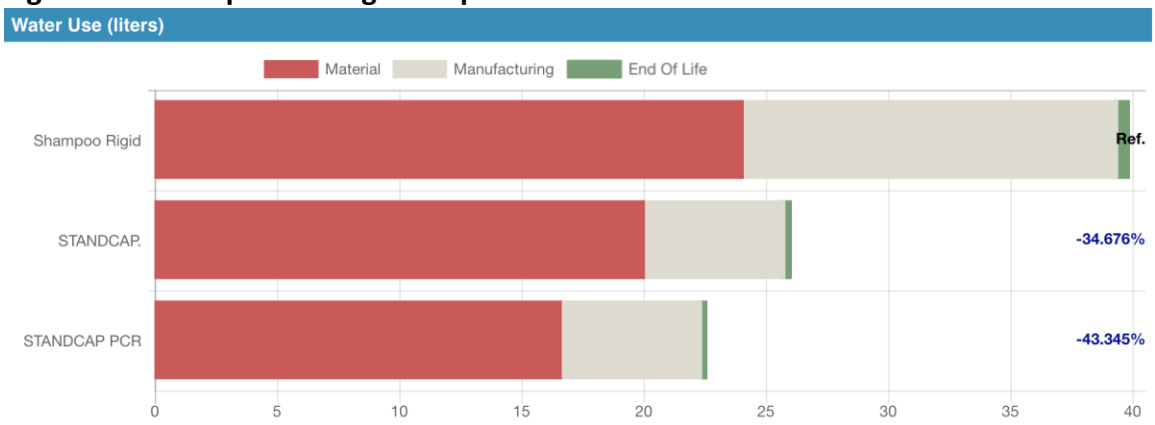
The Fossil Fuel Use chart above shows that the premade STANDCAP Pouch results in about 54.3% less fossil fuel resources (and an additional 5% reduction through the use of PCR) to produce the pouch versus an HDPE bottle. This is largely driven by the HDPE bottle using over twice as much material (41.8g vs. 20.24g). This can be observed in the material portion of the graph (shown in red) which depicts much higher impacts for the rigid HDPE bottle just from material selection and the weight of the bottle.

Figure 7-2. Shampoo Package Comparison – GHG Emissions



The GHG emissions chart also shows that the HDPE bottle has a greenhouse gas emission or carbon impact much larger than the premade STANDCAP Pouch. The pouch has emissions impacts that are just half of those with the HDPE bottle. Since both package formats are using plastic in their make-up, the package manufacturing (conversion) process and amount of material plays a key role. Again, since the flexible stand-up pouch uses much less material than the HDPE bottle, it has a much-reduced carbon impact. The larger end of life impact for the plastic bottle is driven by the fact that even though HDPE bottles are recycled at a rate of 29.3%, there is still a larger impact due to about forty percent more material ending up as municipal solid waste based on current U.S. recycling rates.

Figure 7-3. Shampoo Package Comparison – Water Use



Finally, when looking at water use during the life cycle of the two package formats, the premade STANDCAP Pouch results in about one-third less water being used. This is especially noticeable in the manufacturing phase (gray part of the graph) which shows a much larger amount of water required, largely driven by the water that is needed to cool the molds in the blow molding manufacturing process for the rigid bottle. The water helps to cool the plastic bottle so it can be removed from the mold, speeding up the overall manufacturing process. The stand-up pouch format, which is formed by laminating multiple thin layers of film together, uses much less water in its manufacturing and conversion process. The use of PCR also reduces water use an additional 8%.

End of Use Results

The results above show that the premade STANDCAP Pouch has a much lower usage of fossil fuel as well as carbon and water impact when considering the primary package. Package developers also consider the amount of material that is recycled or sent to landfill, to ensure that the package aligns with Circular Economy or Sustainable Materials Management goals. Table 7-B (below) shows the results when current recycling rates are considered, as well the product-to-package ratio, which is a measure of the resource efficiency of the materials used. For this measure, a high product and a low package weight value are desired.

Table 7-B. Shampoo Packaging – Recycled and Landfilled Comparison

Format	Pkg Wt. (g)	Product % Wt.	Package % Wt.	Pkg wt. (g)/ 1000 kg shampoo	Pkg Recycled (g)/1000 kg shampoo	Pkg Landfilled (g)/1000 kg shampoo
Shampoo Rigid Bottle	41.8	91.0%	9.0%	98,774	21,532	77,241
STANDCAP	20.24	95.6%	4.4%	46,118	0	46,118
STANDCAP w/PCR	20.24	95.6%	4.4%	46,118	0	46,118

To determine the package recycled and packaging discard rate, the following assumptions were made:

- *HDPE bottle recycling rate at 29.3% (EPA Sustainable Materials Management, published Nov 2020)*
- *Flexible packaging was assumed to have 0% recycling rate*
- *Closures and fitments assumed to have 0% recycling rate*
- *All material collected for recycling was assumed to be actually recycled*
- *Package landfilled is amount of packaging not recycled, goes to municipal solid waste*

End of Use Summary

The U.S. EPA utilized a Waste Hierarchy graphic (Figure 7-4), lists source reduction and reuse as the most preferred methods to reduce waste. The benefits of the premade STANDCAP Pouch are especially evident when compared to the rigid HDPE shampoo bottle. The HDPE bottle requires more than twice the amount of material (98,775g vs. 46,118g) of packaging to contain 1000kg of shampoo. Even when considering that the HDPE bottle is recycled at a rate of 29.3% in the U.S. today, it still results in considerably more material being discarded at end of life (77,241g vs. 46,118g).

Additionally, the premade STANDCAP Pouch is very efficient in its use of materials, with over 95% of the total shelf weight being attributed to the shampoo, compared to 91% for the rigid bottle example.

Figure 7-4. EPA Waste Hierarchy

The examples above highlight that while many multi-material flexible packages are not yet recovered and recycled in any significant amount, they still result in a substantial reduction in the amount of material sent to landfill versus other types of packaging.

Summary/Implications

The results in this scenario show that the premade STANDCAP Pouch has a number of sustainability benefits when compared to a rigid HDPE bottle for packing and shipping shampoo. These include lower fossil fuel and water use, greenhouse gas emissions, better product: package ration (efficiency of materials), and considerably less material discarded at end of life.

As with all package decisions, there are other package attributes such as product protection, brand message, ease of use, and other consumer features that must be considered, including the sustainability benefits of each package format, amount and ease of product evacuation, and the total package design using a holistic approach.

Table 7-C below summarizes much of the critical data and package comparison discussed for this shampoo packaging case study.

Table 7-C. Shampoo Packaging Comparison Summary

Format	Fossil Fuel Use (MJ-Equiv)	GHG Emissions (kg-CO2 equiv)	Water Use (l)	Product-to-Package ratio and percent wt.	Pkg Landfilled (g)/1000 kg shampoo
Shampoo Rigid Bottle	3.97	.1715	39.75	10.1:1 91.0%:9.0%	77,241
STANDCAP	1.81 (-54.3%)	.08441 (-50.8%)	25.97 (-34.7%)	21.7:1 **95.6%:4.4%**	46,118 **(-40.3%)**
STANDCAP w/PCR	1.63 **(-59.0%)**	.07975 **(-53.5%)**	22.52 **(-43.3%)**	21.7:1 **95.6%:4.4%**	46,118 **(-40.3%)**

Notes:

- *A normalized product weight (common value divisible by all package formats) of 13.5 fl. oz. of product was used for Fossil Fuel, GHG and Water Consumption calculations.*
- *All percentages cited are for other formats compared to the stand-up flexible pouch.*
- *A higher number for product-to-package ratio (first number) cited means a higher percentage of weight is attributed to product, and less to packaging, resulting in more efficient use of packaging resources.*
- *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 1.06 g/ml as density for shampoo (based on dish detergent density) to determine product weight.*

Lotion Packaging Comparison

Lotion comes in a variety of packs, including an HDPE bottle with a pump mechanism. For the following streamlined Life Cycle Assessment scenario, lotion packed with an HDPE bottle and pump are compared to the premade STANDCAP Pouch:

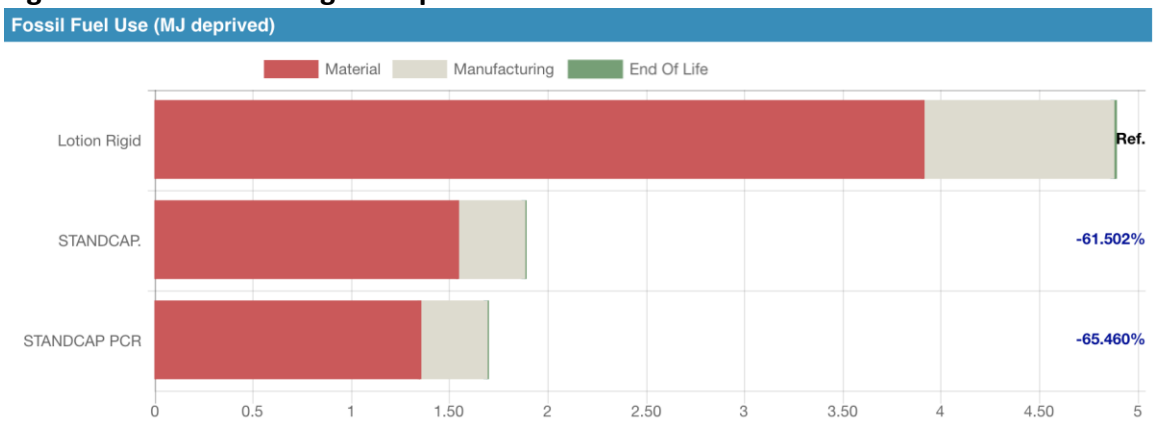
Table 9-A. Lotion Packaging Evaluation Comparison

Package Type/Product Weight	Structure (package weight)	Photo
Lotion Rigid Container (14 oz.)		
Bottle	Bottle – HDPE – 36.3g	
Pump	Ring- Rubber – 0.1g Dip Tube – PP – 1.6g Housing – PP – 5.1g Stem/ Ball – PP – 7.1g Piston – Steel – 0.5g	
Labels (Front & back)	Labels – PP – 1.4g	
	TOTAL = 52.1g	
Premade STANDCAP Pouch (14 oz.) – Standard and with PCR		
Pouch – Standard Pouch – PCR	PET/PET/Nylon/LLDPE/HDPE PET (100% PCR)/ PET (50% PCR)/Nylon/ LLDPE-HDPE Coex (42% PCR) 6.72g	
Fitment	Closure – PP – 10.53g Fitment-LDPE/LLDPE-2.7g Ring – PP – .2g Valve – Silicon – .09g	
	TOTAL = 20.24g	

<u>Fossil Fuel Consumption, Greenhouse Gas Emissions, and Water Consumption Comparison</u>

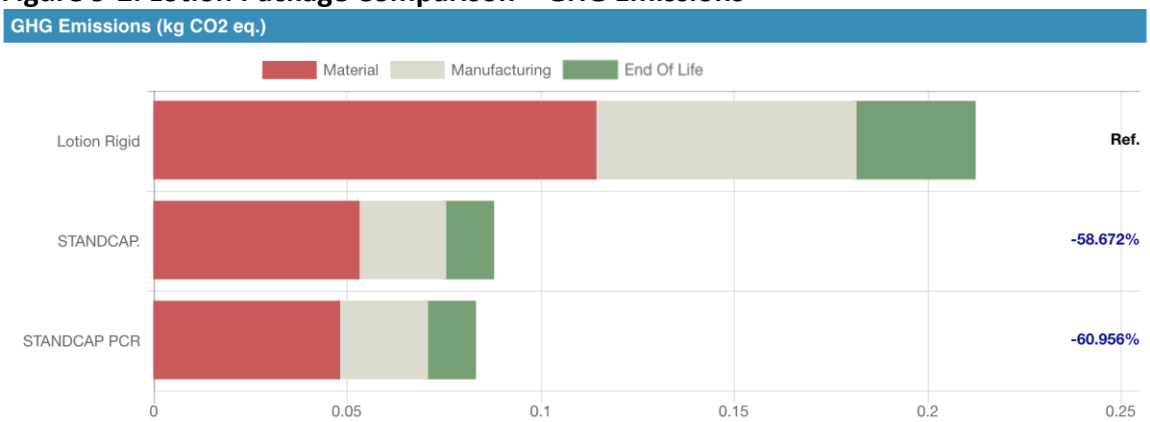
The charts below will highlight results of the fossil fuel usage, greenhouse gas (GHG) emissions, and water use for each of the package formats evaluated. These are some of the primary common indicators that package developers consider when appraising the environmental impacts of a particular package. 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.

Figure 9-1. Lotion Package Comparison – Fossil Fuel Use



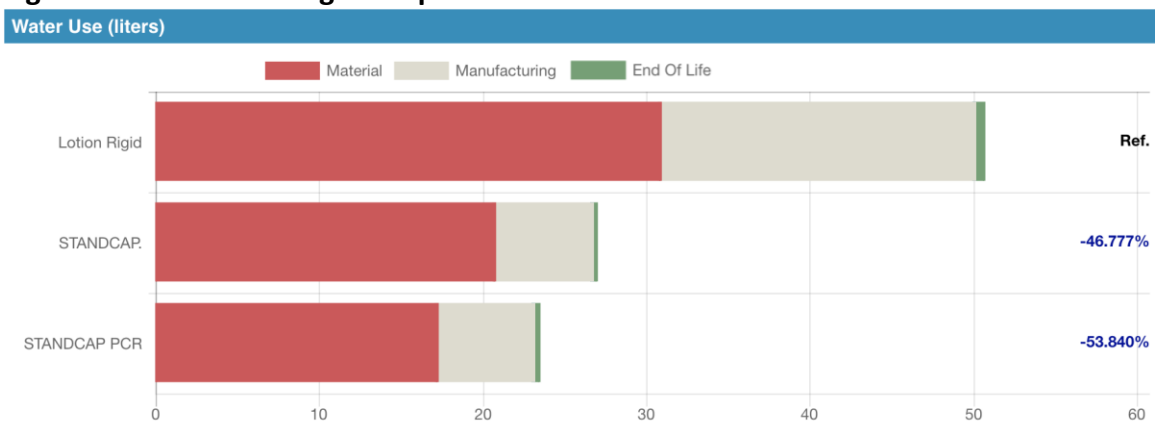
Fossil Fuel Use for the premade STANDCAP Pouch results in a reduction of over half (-61.5%) the use of the rigid bottle. Much of the difference comes from the material impact side (red part of graph), where the rigid bottle of lotion uses 52.1g of material, including parts for the pump, compared to only 20.24g for the premade STANDCAP pouch.

Figure 9-2. Lotion Package Comparison – GHG Emissions



Similar to the fossil fuel results, the premade STANDCAP Pouch results in a reduction of over half (-58.7%), with additional emission reduction through the use of PCR, in greenhouse gas emissions versus the rigid bottle. Again, much of this is driven by the weight difference (52.1g vs. 20.24g) as well as the manufacturing (converting) process advantages for the pouch, which is comprised largely of multiple layers of thin films that are adhered or extruded together, which is less energy intensive than blow molding the HDPE bottle.

Figure 9-3. Lotion Package Comparison – Water Use



Finally, water use for the flexible premade STANDCAP Pouch is nearly a 50% reduction versus the rigid bottle, with nearly 54% reduction when using PCR content. This is due to the manufacturing process (gray part of graph) for the bottle requiring water for the cooling of molds to make the HDPE bottle, whereas the laminating and extruding process for the multilayer pouch is less water intensive.

End of Use Results

The results above show that the premade STANDCAP Pouch has a lower usage of fossil fuel and water, as well as a reduced carbon impact when considering the primary package. Package developers also consider the amount of material that is recycled or sent to landfill, to ensure that the package aligns with Circular Economy or Sustainable Materials Management goals. Table 9-B (below) shows the results when current recycling rates are considered, as well the product-to-package ratio, which is a measure of the resource efficiency of the materials used. For this measure, a high product and a low package number are desired.

Table 9-B. Lotion Packaging – Recycled and Landfilled Comparison

Format	Pkg Wt. (g)	Product % Wt.	Package % Wt.	Pkg wt. (g)/ 1000 kg lotion	Pkg Recycled (g)/1000 kg lotion	Pkg Landfilled (g)/1000 kg lotion
Lotion Rigid Bottle	52.1	88.4%	11.6%	131,271	26,798	104,473
STANDCAP	20.24	95.1%	4.9%	50,996	0	50,996
STANDCAP w/PCR	20.24	95.1%	4.9%	50,996	0	50,996

To determine the package recycled and packaging discard rate, the following assumptions were made:

- *HDPE bottle recycling rate at 29.3% (EPA Sustainable Materials Mgmt, published Nov. 2020)*
- *Flexible packaging was assumed to have 0% recycling rate*
- *Closures and fitments assumed to have 0% recycling rate*
- *All material collected for recycling was assumed to be actually recycled*
- *Package landfilled is amount of packaging not recycled, goes to municipal solid waste*

End of Use Summary

The U.S. EPA utilizes a Waste Hierarchy, which lists source reduction and reuse as the most preferred method to reduce waste. This lotion scenario shows that the premade STANDCAP Pouch follows this protocol through using the least amount of material (20.24g vs. 52.1g), having the best product/package weight efficiency values (95.1% vs. 88.4%), as well as the least amount of material discarded (50,996 vs. 104,473g) of packaging for 1000kg of lotion) at the end of life.

The examples above highlight that while many multi-material flexible packages are not yet recovered and recycled in any significant amount, they still result in a substantial reduction in the amount of material sent to landfill versus other types of packaging.

Summary/Implications

The results of this scenario show that the premade STANDCAP pouch results in lower impacts across a wide range of environmental metrics including fossil fuel and water use, greenhouse gas emissions, and material discarded. These values are further improved through incorporating PCR into the flexible pouch. This is driven by the efficient material usage of the flexible pouch which uses less than half the amount of material needed to package the same amount of lotion.

As with all package decisions, there are other package attributes such as product protection, brand message, ease of use, and other consumer features that must be considered, including the sustainability benefits of each package format, amount and ease of product evacuation, and the total package design using a holistic approach.

Table 9-C below summarizes much of the critical data and package comparison discussed for this lotions packaging case study.

Table 9-C. Lotion Packaging Comparison Summary

Format	Fossil Fuel Use (MJ-Equiv)	GHG Emissions (kg-CO2 equiv)	Water Use (l)	Product-to-Package ratio and percent wt.	Pkg Landfilled (g)/1000 kg lotion
Lotion Rigid Bottle	4.88	.2118	50.60	7.6:1 88.4%:11.6%	104,473
STANDCAP	1.88 (-61.5%)	.08754 (-58.7%)	26.93 (-46.8%)	19.6:1 **95.1%:4.9%**	50,996 **(-51.2%)**
STANDCAP w/PCR	1.69 **(-65.5%)**	.0827 **(-61.0%)**	23.36 **(-53.8%)**	19.6:1 **95.1%:4.9%**	50,996 **(-51.2%)**

Notes:

- *A normalized product weight (common value divisible by all package formats) of 14 oz. of product was used for Fossil Fuel, GHG and Water Consumption calculations.*
- *All percentages cited are for other formats compared to the stand-up flexible pouch.*
- *A higher number for product-to-package ratio (first number) cited means a higher percentage of weight is attributed to product, and less to packaging, resulting in more efficient use of packaging resources.*
- *Package landfilled values are based on the of amount of packaging sent to municipal solid waste after recycling, based on 1000 kg of lotion.*

Salsa Glass Jar

Salsa generally is packaged in a clear glass jar. For this streamlined Life Cycle Assessment study, a comparison was made between a salsa container in a glass jar versus the premade STANDCAP Pouch:

Table 11-A. Salsa Packaging Evaluation Comparison

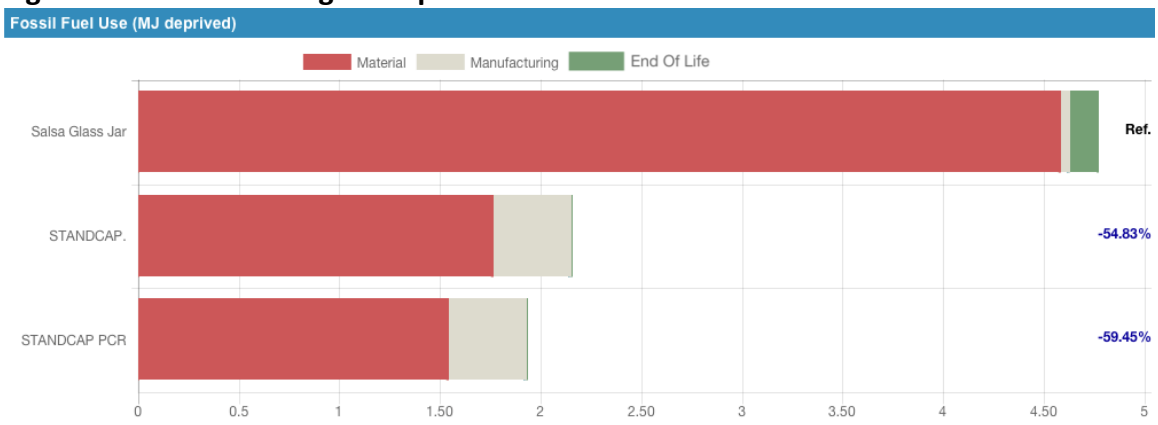
Package Type/Product Weight	Structure (package weight)	Photo
Salsa Glass Jar (16 oz.)		
Jar	Jar – Glass – 286.1g	
Closure	Closure – Steel – 7.1g Rubber gasket – rubber – 1g	
Label	Labels – Paper – 1.1g	
	TOTAL = 295.3g	
Premade STANDCAP Pouch (14 fl. oz.) – Standard and with PCR		
Pouch – Standard Pouch – PCR	PET/PET/Nylon/LLDPE/HDPE PET (100% PCR)/ PET (50% PCR)/Nylon/ LLDPE-HDPE Coex (42%) PCR 6.72g	
Fitment	Closure – PP – 10.53g Fitment-LDPE/LLDPE-2.7g Ring – PP – .2g Valve – Silicon – .09g	
	TOTAL = 20.24g	

Packages as close as possible in size/volume were selected to make the life cycle comparison. Not in all cases were packs of identical size/volume available for purchase.

Fossil Fuel Consumption, Greenhouse Gas Emissions, and Water Consumption Comparison

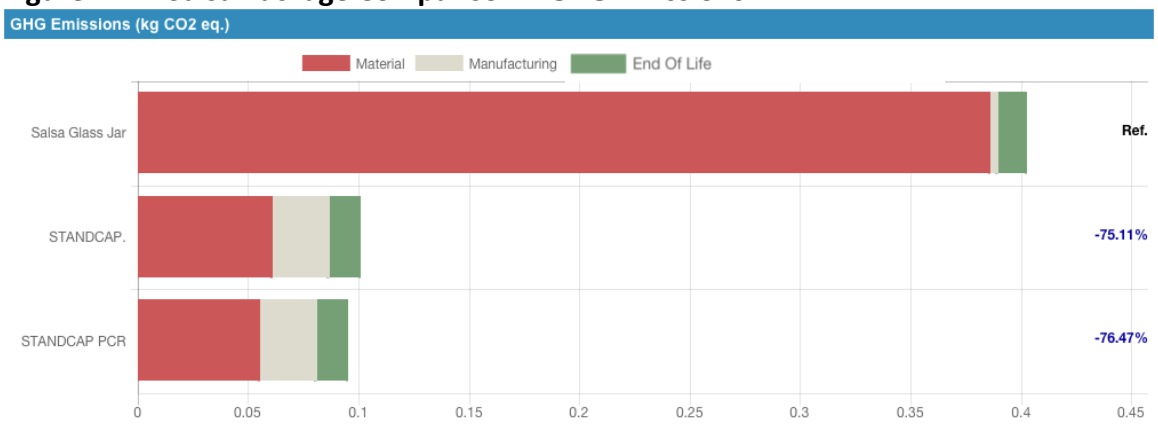
The charts below will highlight results of the fossil fuel usage, greenhouse gas (GHG) emissions, and water use for each of the package formats evaluated. These are some of the primary common indicators that package developers consider when appraising the environmental impacts of a particular package. 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.

Figure 11-1. Salsa Package Comparison – Fossil Fuel Use



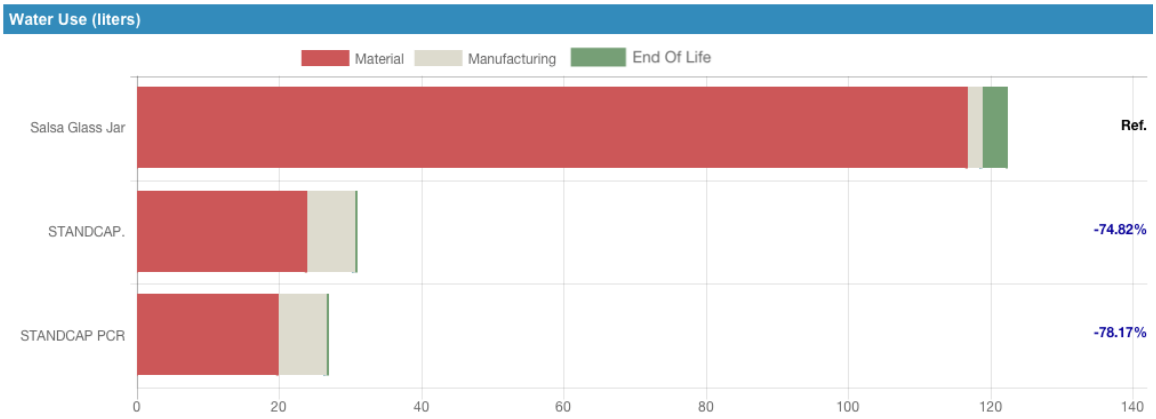
The Fossil Fuel Use chart above shows that the premade STANDCAP Pouch results over half the fossil fuel resources, with an additional 5% in fossil fuel reduction to produce the PCR pouch, versus the glass jar example. This is largely driven by the glass jar using about twelve times as much material (295.3g vs. 20.24g) to package nearly the same amount of product.

Figure 11-2. Salsa Package Comparison – GHG Emissions



The GHG emissions chart also shows a significant reduction in impacts of the premade STANDCAP Pouch, which has greenhouse emissions more than 75% lower than the glass jar. This is again driven by the weight difference between the two package formats. The glass manufacturing process is very energy intensive to reach the heat necessary to mold glass, resulting in significantly higher GHG emissions than the laminating and extrusion process used for the multilayer flexible pouch.

Figure 11-3. Salsa Package Comparison – Water Use



Finally, when looking at water use during the life cycle of the different package formats, the premade STANDCAP Pouch results in over 74% lower water use than the glass jar (and 78% when incorporating in the PCR content). This is especially largely driven by the large amount of water used to cool the molds in the glass making process. The premade STANDCAP Pouch, which is formed by laminating or extruding multiple thin layers of film together, uses significantly less water in its manufacturing and conversion process.

End of Use Results

The results above show that the premade STANDCAP Pouch has a much lower usage of fossil fuel and water as well as carbon impact when considering the primary package. Package developers also consider the amount of material that is recycled or sent to landfill, to ensure that the package aligns with Circular Economy or Sustainable Materials Management goals. Table 10-B (below) shows the results when current recycling rates are considered, as well the product-to-package ratio, which is a measure of the resource efficiency of the materials used. For this measure, a high product and a low package number are desired.

Table 11-B. Salsa Packaging – Recycled and Landfilled Comparison

Format	Pkg Wt. (g)	Product % Wt.	Package % Wt.	Pkg wt. (g)/ 1000 kg salsa	Pkg Recycled (g)/1000 kg salsa	Pkg Landfilled (g)/1000 kg salsa
Salsa Glass Jar	295.3	60.6%	39.4%	651,014	209,336	441,678
STANDCAP	20.24	94.6%	5.4%	57,115	0	57,115
STANDCAP w/ PCR	20.24	94.6%	5.4%	57,115	0	57,115

To determine the package recycled and packaging discard rate, the following assumptions were made:

- *Glass bottle recycling rate at 31.1% (US EPA, Sustainable Materials Mgmt- Published Nov. 2020)*
- *Flexible packaging was assumed to have 0% recycling rate*
- *Plastic closures and fitments assumed to have 0% recycling rate*
- *Steel closures recycling rate estimated at 73.8% (US EPA)*
- *All material collected for recycling was assumed to be actually recycled*
- *Package landfilled is amount of packaging not recycled, goes to municipal solid waste*

End of Use Summary

The U.S. EPA utilizes a Waste Hierarchy which lists source reduction and reuse as the most preferred method to reduce waste. The premade STANDCAP Pouch does extremely well in this regard when compared to the salsa glass jar. The jar uses over twelve times as much material (651,014g vs. 57,115g) of packaging to contain 1000kg of salsa as the pouch. Even when considering that the glass recycling rate of 31.1% in the U.S. today, it still results in much more material being discarded at end of life (441,678g vs. 57,115g). The glass jar and steel lid would need to achieve a recycling rate of over 90% to reach the same amount of material discarded as the premade STANDCAP Pouch does today.

The examples above highlight that while many multi-material flexible packages are not yet recovered and recycled in any significant amount, they still result in a substantial reduction in the amount of material sent to landfill versus other types of packaging.

Summary/Implications

The results in this scenario show that the premade STANDCAP Pouch has a number of sustainability benefits when compared to a glass jar for packing and shipping salsa. These include lower fossil fuel and water use, greenhouse gas emissions, better product: package ratio (efficiency of materials), and considerably less material discarded at end of life.

As with all package decisions, there are other package attributes such as product protection, brand message, ease of use, and other consumer features that must be considered, including the sustainability benefits of each package format, amount and ease of product evacuation, and the total package design using a holistic approach.

Table 10-C summarizes much of the critical data and package comparison discussed for this salsa packaging case study.

Table 10-C. Salsa Packaging Comparison Summary

Format	Fossil Fuel Use (MJ-Equiv)	GHG Emissions (kg-CO2 equiv)	Water Use (l)	Product-to-Package ratio and percent wt.	Pkg Landfilled (g)/1000 kg salsa
Salsa Glass Jar	4.76	.4017	122.24	1.5:1 60.6%:39.4%	441,678
STANDCAP	2.15 (-54.8%)	.100 (-75.1%)	30.78 (-74.8%)	17.5:1 **94.6%:5.4%**	57,115 **(-87.1%)**
STANDCAP w/ PCR	1.93 **(-59.5%)**	.0945 **(-76.5%)**	26.69 **(-78.2%)**	17.5:1 **94.6%:5.4%**	57,115 **(-87.1%)**

Notes:

- *A normalized product weight (common value divisible by all package formats) of 16 oz. of product was used for Fossil Fuel, GHG and Water Consumption calculations.*
- *All percentages cited are for other formats compared to the stand-up flexible pouch.*
- *A higher number for product-to-package ratio (first number) cited means a higher percentage of weight is attributed to product, and less to packaging, resulting in more efficient use of packaging resources.*
- *Package landfilled values are based on the of amount of packaging sent to municipal solid waste after recycling, based on 1000 kg of salsa.*

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 assumes fossil resources used mainly for energy purposes. Fossil fuels include coal, petroleum and natural gas. (Inputs for nuclear fuel such as uranium are accounted for in the mineral consumption metric.) Since it requires different quantities of these fossil fuels to generate one unit MJ, this measure uses MJ-eq to aggregate them.

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
LLDPE:	Linear Low-Density Polypropylene
OPP:	Oriented Polypropylene
PE:	Polyethylene
PCR:	Post-consumer Recycled
PET:	Polyethylene Terephthalate
PP:	Polypropylene

Glenroy is the exclusive converter of the premade STANDCAP Pouch, an innovative, eco-friendly, and award winning inverted flexible pouch. Since 1965, Glenroy Inc. has been a trusted converter and printer of flexible packaging. A privately-held company headquartered in suburban Milwaukee, Glenroy manufactures high-quality, high-barrier, sustainable flexible packaging films and stand-up pouches for a variety of end uses, including food and beverage, household and personal care, pharmaceutical, nutritional, cosmetic, medical device, pet food and treats, and industrial.

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