Life Cycle Analysis of Plastic Food Storage Products: Avoided Food Waste vs. Recycling

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Executive Summary

In fall of 2018, York University was retained by Clorox to calculate the life cycle impacts for a range of GLAD plastic products being sold in 6 markets around the world. The study covered Glad food storage bags and wraps. All references in the report to GLAD products refer just to this portion of the Glad portfolio.

This report summarizes the results of this analysis, describing the general methodological approach, data assumptions and overall findings.

Quantifying the LCA impacts of GLAD products was done in two stages.

Stage 1 was to quantify emissions impacts associated with the manufacturing and transport of GLAD products in 6 primary markets in which they are made and sold.

Stage 2 was to quantify the emissions savings attributable to GLAD products resulting from avoided food waste.

All modeling was conducted in Eco Invent and Sima Pro, the world's largest commercial life cycle analysis database. Doing so allowed the university to model customized energy grid mixes and transport distances for all of the markets in which Clorox manufactures and sells their products.

Overall emissions impacts associated with the manufacturing and transport of Glad Products equals approximately 105,000 metric tonnes of carbon.

In order to quantify the emissions savings attributable to GLAD products, the study team used a combination of field testing and qualitative surveys to better understand how households use plastic food storage products.

This included:

1) How much food is being stored? (by product type)
2) What types of food are being stored?
3) How long do people store food using GLAD products?
4) How much does plastic food storage avoid food waste?
5) How does using plastic food storage alter purchasing decisions?

The results of our survey testing showed that people use different GLAD products for different purposes. As an example, cling wrap is often used to avoid food spoilage (wrapping a half-eaten apple for later), but not for long term food storage. Conversely, freezer and large food bags were used to store organics (namely meat products) for periods in excess of 2 weeks. Our findings show that avoided food waste can be separated into two categories: 1) avoided landfill (using a GLAD product helps avoid households putting food in the garbage) and 2) source reduction (using GLAD products for long term food storage reduces the need to purchase additional food as a replacement).

Avoided landfill and source reduction estimates were calculated for the full range of GLAD products using the feedback provided by survey participants.

While extensive testing was conducted to estimate how people were using GLAD products, a decision was made to use the “worst case” of the survey responses.

Cognizant of the fact that many stakeholders view LDPE products as being environmentally problematic (due to low levels of recyclability) the study team wanted to present the most conservative estimate possible. This was done in the event that potential critics thought we were overstating how often, or how much people were using GLAD products to avoid food waste.

In every instance, the study team chose the lowest reported value to calculate emissions abatement.

The emissions savings attributable to avoided food waste resulting from the use of GLAD products was in excess of 1.278 million metric tonnes of carbon (based on approximately 32,000T of GLAD products being sold globally).

This is the equivalent of removing 213,000 cars from the road for a year, or planting more than 383 thousand mature trees.

To provide context, Ontario’s Blue Box program abates approximately 2.7 million TCO2e based on 870,000T of material recycled annually.

Phrased alternatively, one tonne of plastic GLAD products abates almost 40T of carbon via avoided food waste, while one tonne of Blue Box materials abates 3.1T of carbon via recycling.

A product made largely of LDPE film (which traditionally has low levels of recyclability) offers an environmental return 12.9x greater relative to Blue Box printed paper and packaging. That does not even take into consideration the 200+ million dollar cost associated with operating the Blue Box program.

In a time where governments are looking to minimize carbon impacts and waste sent to landfill, a potential solution lies in the use of plastic food storage. These findings also speak to the seemingly dichotomous pursuits of avoiding food waste, while maximizing recycling rates. Many of the products that help households avoid food waste (plastic containers, freezer/sandwich bags, cling wrap etc.), cannot be readily recycled in conventional recycling system.

We have to ask ourselves, what is the goal of our system? Is a “successful” system the one that abates the most carbon, or the one that diverts the most material? At one point does cost factor into how we measure success? (Note: While increased diversion and carbon abatement generally go hand in hand, prioritizing the diversion of certain materials can maximize carbon impacts, while diverting less material)

The findings from this report highlight the critical role that plastic products can help in not only avoiding food waste, but achieving preferable environmental outcomes at a lower cost.

Introduction:

In fall of 2018, York University was retained by Clorox to calculate the life cycle impacts for a range of GLAD plastic products being sold in 6 markets around the world.

Some of the products included in this analysis are (not an exhaustive list):

- Glad Cling wrap
- Glad Press'n Seal
- Glad Freezer Bags
- Glad Food Storage
- Glad Zipper Bag Storage
- Glad Microwave Film
- Glad Oven Bag

This report summarizes the results of this analysis, describing the general methodological approach, data assumptions and overall findings.

Quantifying the LCA impacts of GLAD products is was done in two stages.

Stage 1 was to quantify emissions impacts associated with the manufacturing and transport of GLAD products in 6 primary markets in which they are made and sold.

Stage 2 was to quantify the emissions savings attributable to GLAD products resulting from avoided food waste

This report is organized in the following sections:

- Data Sources
- Defining Model Boundaries
- Stage 1 Modeling: Calculating Emissions Impacts of Manufacturing and Transport
- Summary of Stage 1 Modeling Results
- A note on assumptions
- Stage 2: Modeling Emissions Abatement attributable to GLAD Products
- Survey Methodology
- Survey Results
- Using Survey Results to Model LCA
- Calculating Emissions Savings

- Overall Results and Conclusion

Data Used and Sources

LCA Data

The data used in this life cycle analysis includes the following:

- Sales and tonnage data for various GLAD products (provided by Clorox)
- Primary (manufacturing) and end market (destination) locations (provided by Clorox)
- Distance from manufacturer to end market (calculated using ARC GIS)
- Mode of transportation (assumed – truck for land transport, ship for overseas transport)
- Energy grid mix (EcoInvent)
- Emissions coefficients – all (processing, transport, manufacturing, recycling) (EcoInvent)

Data from product testing

- Average weight of product using micro gram scale (taken by study team)
- Organics weight stored by product (measured by study team)

Data from household surveys

As described in section 3, household surveys were conducted over a four week period to gauge the following:

- Measures surrounding how households use GLAD products, i.e. frequency of use, duration of use etc.
- Measures surrounding household awareness towards waste diversion initiatives and environmental issues
- Measures surrounding why households use GLAD products (it saves money, it saves time etc.)

Stage 1 Modeling: Calculating Emissions Impacts (Manufacturing + Transport)

Defining Model Boundaries

For the purposes of this report, model boundaries include:

- Virgin Material Extraction (Petroleum Extraction)
- Material Processing (Petroleum to Ethylene pellets)
- Manufacturing (Ethylene pellets into final product)
- Virgin Transport (Source to Processing) – distance between where virgin material is being extracted and the processor

- Transport (Processing to Manufacturer) – distance from processor to manufacturing plant
- Transport to End Market – Distance from manufacturing plant to end market

Calculation Steps

To accurately model the emissions impacts associated with the manufacturing and transport of GLAD products, the following steps were taken:

Data Preparation

- Convert all sales and unit data provided by Clorox into metric units (lbs. to kg, kg to metric tonnes)

- Calculate the amount of plastics and paper based product shipped from origin plant location to receiving port. This needs to be done for each unique origin point and destination point,

  i.e. 287.4T Plastics Ningbo China to Port Auckland,
  2.19T Plastics from Rogers AR to Port Auckland
  258.08T Plastics from Bangkok, Thailand to Port Auckland

Calculating Transport Distances

- Calculate the transport distances from Origin Plant Location, to Shipping Port, to Receiving Port. This is done using ARC GIS, which assumes the most common shipping route (by truck if continental travel, and by ship for overseas travel)
- Transport distances must be calculated for each individual plant location and receiving port, i.e. If there are 6 manufacturing plants that manufacture material for New Zealand markets, then 6 individual transport distances must be calculated for the distance between each of those points

Identify Energy Grid Mix

Given that each manufacturing location will use a different energy grid mix (Ontario is different than Thailand, which is different than Virginia), customized energy grid mixes have been used in all modeling to reflect the jurisdictional energy profile of where products are being manufactured.

Table 1 below summarizes the energy grid mix used depending on manufacturing location:

Manufacturing Plant	**Energy Grid Mix**
Rogers AR	Arkansas
Amherst VA	Virginia

Orangeville ON	Ontario
Thailand (All)	Thailand (National)
China (All)	China (National)
Portugal (Benavente)	Portugal (National)

Identify and calculate the emissions coefficients associated with each of the stages highlighted in the model boundaries (virgin material extraction etc.)

Emissions coefficients are taken from the EcoInvent database, which is the world's largest open source repository for life cycle data. Given that this is a high level LCA, we have used data surrogates to approximate for the manufacturing processes used by Clorox (i.e. extruding plastic pellets into LDPE film uses an assumed process taken from Eco Invent, and may not reflect the actual process used by Clorox).

Generally speaking, there is limited variability with respect to the energy intensiveness and LCA impacts associated with various processes. Coefficients are most sensitive to the energy grid mix being used as the inputs for production (which have been accounted for).

Calculate Process Energy Coefficients

Using EcoInvent and the customized energy grid mixes defined above, model the processing energy coefficient (which includes all process energy associated with material extraction, material processing and manufacturing into end product). Each jurisdiction in which GLAD products are manufactured will have a different processing energy coefficient due to differences in the regional energy mix.

Processing energy coefficients will be unique to the material type used in manufacturing GLAD products, i.e. LDPE Film, Corrugated Cardboard, HDPE, Aluminum, Polyethylene wrapper etc. (Note: The data provided by Clorox did not provide a detailed breakdown of the % of material allocated to each material type. As an example, cling wrap packaging often includes serrated aluminum. The model assumes the % of aluminum and HDPE allocated to certain products in the absence of exact data)

Table 2 below provides an example of the process energy coefficients used in our modeling (specific to Rogers Arkansas):

Table 2: Process Energy Coefficients

	Process Energy
LDPE Film	1.4126 tCO2e
Corrugated Cardboard	2.7795 tCO2e
Aluminum	11.6790 tCO2e
HDPE	1.2475 tCO2e

Of note, these coefficients assumes that 100% virgin material is being used. Depending on the energy grid mix applied, process energy coefficients can vary by as much as 20%.

Calculate Transport Energy Coefficients (Source to Processor)

Depending on the locality of the manufacturing facility, EcoInvent will automatically assume the closest distance for virgin material source to processor. As an example, for manufacturing facilities located in the United States, EcoInvent assumes that virgin petroleum is sourced from the Permian Basin in South Texas. These assumptions can be changed assuming the user has access to alternative data.

Transportation Energy (Source to Processor) will be unique for each material used in the manufacturing of GLAD products, as it is assumed virgin material is sourced from different areas.

Calculating Transport Energy (Process to End Markets)

Based on the transport distance calculated earlier, (from origin plant location, to shipping port, to receiving port), and the EcoInvent emissions per truck km (Diesel) and emissions per ship km (Diesel), calculate transport energy (process to end market).

*Equation: (Distance traveled by truck * Emissions per truck km) + (Distance traveled by ship * Emissions per ship km)*

Transportation Energy (Processor to End Market) will be the same for each material used in manufacturing (as the finished product is being transported) from one manufacturing location, to a destination port.

Calculate Overall Emissions Impacts

To calculate the overall emissions impacts of various GLAD products in each market area, we use the following formula:

*Equation: **[**(Material Tonnes * Process Energy Coefficient) + (Material Tonnes * Transport Energy (Source to Processor)) + (Material Tonnes * Transport Energy (Processor to End Market)]*

Summary of Results

Table 3 below summarizes the preliminary results of our carbon impact modeling by market area.

	Plastic, T	Paper, T	Plastic %	Total Product Weight, T	**Total Emissions Impacts from Product Production and Transport**
USA	15,163	10,491	59%	25,655	74,035 tCO2e

CN	2,733	463	86%	3,196	6,691 tCO2e
AUS	1,631	1,005	62%	2,636	7,583 tCO2e
Canada	1,299	1,109	54%	2,408	11,341 tCO2e
HK	1,025	482	68%	1,507	3,539 tCO2e
NZ	589	203	74%	792	2,049 tCO2e

A note on recycling assumptions

This model assumes that all material inputs used in the manufacturing of GLAD products are made from virgin materials, and contain 0% recycled content

This model also assumes that none of the packaging used for GLAD products is recycled.

These assumptions are not consistent with what is actually observed – as an example, much of the paper fiber used in the packaging of GLAD products is both (partially) derived from recycled sources, and can be recycled in most markets.

However, in the absence of having jurisdictional data regarding recycling rates and utilization of recycled content, a conservative assumption was made to not factor recycling into either the manufacturing or end of life stages.

Stage 2: Modeling Emissions Abatement attributable to GLAD Products

In order to calculate the emissions savings attributable to GLAD products, we need to understand how households actually use plastic food storage products.

This includes:

6) How much food is being stored? (by product type)
7) What types of food are being stored?
8) How long do people store food using GLAD products?
9) How much does plastic food storage avoid food waste?
10) How does using plastic food storage alter purchasing decisions?

To date, there is no data (academic or otherwise) that examines this issue. While we intuitively understand that using plastic food storage will help mitigate food waste, the magnitude of this impact has yet to be quantified.

As such, York University developed and conducted a survey to gauge household attitudes and usage of various GLAD products. Note: The survey referred to plastic food storage more generally, and did not specifically make reference to a particular company. The material categories used were consistent with what is commercially available in the Ontario market place. This includes:

- Sandwich Bags
- Freezer Bags
- Cling Wrap
- Food Storage Bags

Survey Methodology

3 geographical regions were targeted to complete questionnaires pertaining to attitudes towards food waste and reusable plastic containers. Geographic regions are defined by population density, geographic location and collection type (curbside collection vs. depot systems).

These groups include:

1. Large Urban (Toronto, Brampton, Mississauga, York Region)
2. Urban Regional (Ajax)
3. Medium Urban (Barrie)

These groups were selected on the basis that they provide an adequate geographic representation of the province, and provide the greatest opportunity to interview the broadest cross section of both sociodemographic and socioeconomic groups.

Survey questions were organized into four main areas: (1) How plastic food storage products are utilized; (2) self-reported awareness and behavior; (3) Motivation for use and (4) demographic information related to age, ethnicity, education and income.

Questionnaires were pre-tested and refined prior to conducting the official survey in collaboration with the Try Council Ethics Committee. The pre-test allowed for wording refinements and changes to the ordering of the questions. The finalized survey was conducted over a four week period beginning in the second week of November 2018 and running through December 2018. Teams of two enumerators and one site supervisor were sent to each municipality for a period of four days each, spending 6 h at each survey site.

Questionnaire “booths” were set up in spaces with high foot traffic (namely malls, arenas and public commons areas). Enumerators were asked to approach members of the public, explain who they were and the purpose of the study, and requested approximately 10–15 min of the participant's time to complete the survey. A five dollar Tim Horton’s Café and Bake shop gift card was used to incent participation.

A mix of convenience and quota sampling was employed to ensure that survey participants reflect the relative proportions of Ontario’s population. Survey responses were recorded by hand and by tape recorder by the enumerator, and later electronically archived and analyzed using Provalis Word Stat, Microsoft Excel and Microsoft Word.

Thematically, survey responses were organized using the following categories:

1) How GLAD products are utilized by households
2) Awareness and participation of households in municipal waste diversion initiatives
3) Why households use GLAD products (and other forms of food storage)

A total of 642 responses were successfully recorded (out of 1841 approached) for a response rate of 34.8%

It is important to note that the data gathered from our surveys is based on self-reported behavior, and not observed behavior. While this is not a particularly important distinction for how and why households use GLAD products, self-reported measures of environmental awareness and participation tend to be overstated. This phenomenon is known as the value action gap.

A summary of select survey results are shown below.

How GLAD products are utilized by households

Survey Statement: Do you use plastic food bags/containers/cling wrap to store food?

- Yes: 618
- No: 24

Fig 1. Survey Statement: How often do you use plastic food bags/containers/cling wrap to store food?

Fig 2. Survey Statement: How long do you keep food before throwing it out? (Based on GLAD product)

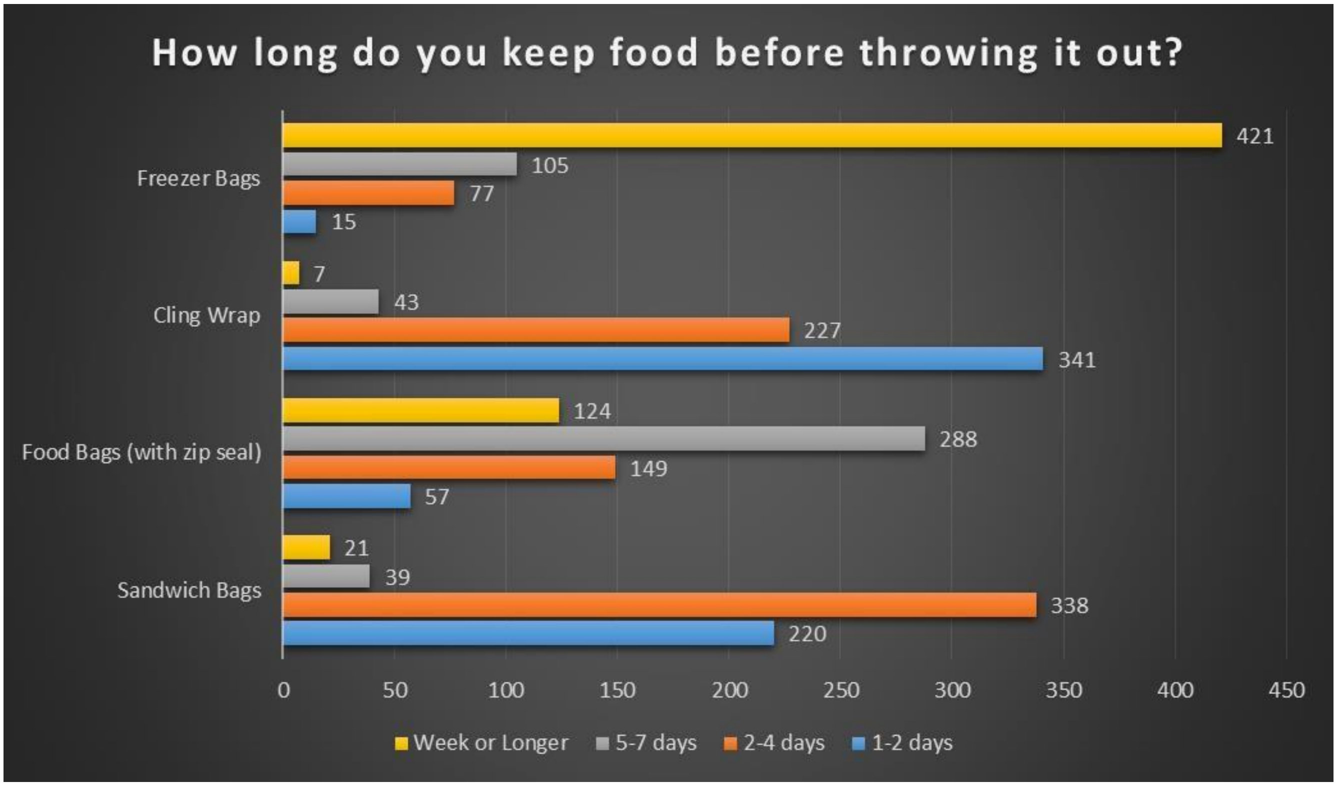
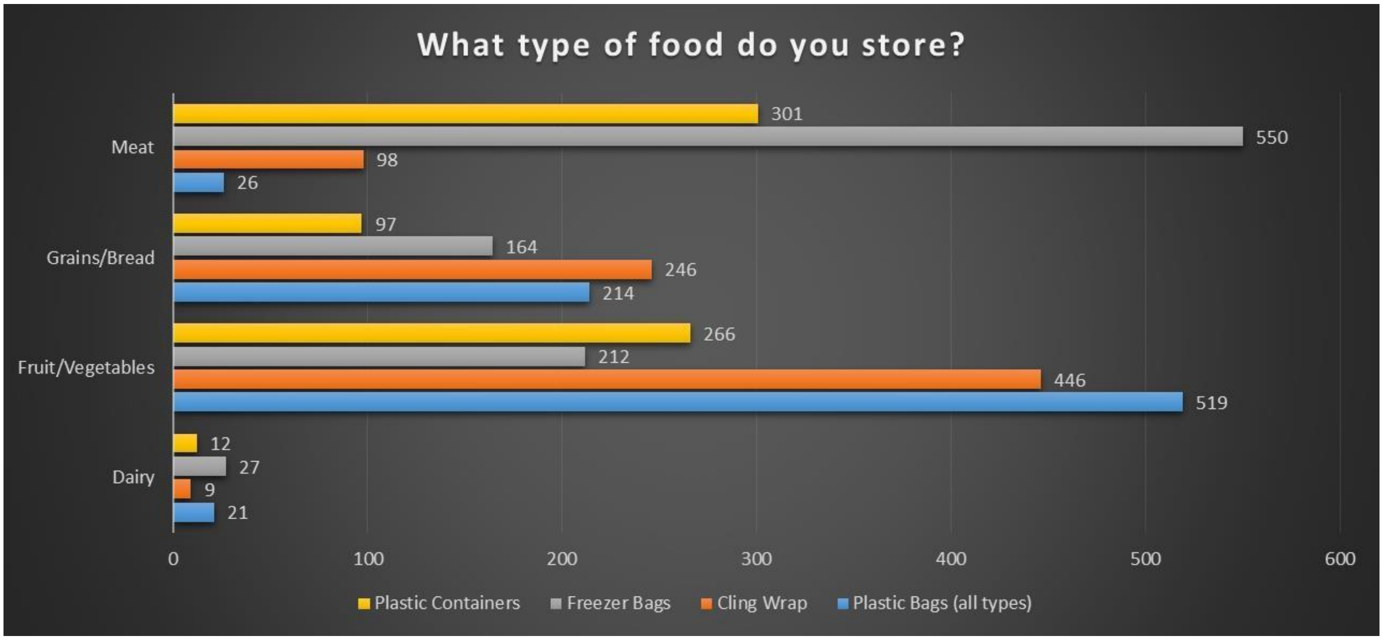


Fig 3. Survey Statement: What type of food do you store in various GLAD Products?



Figures 1 through 3 above summarize the frequency of responses based on how participating households report using GLAD products.

More than 96% of all respondents indicated using a type of food storage (cling wrap, food bags, freezer bags etc.) at some point. Majority of respondents use various GLAD products multiple times per week – the one exception to this is freezer bags, which respondents indicated as using multiple times per month.

Rates of usage is largely a function of what types of foods households store based on product type. As noted in Figure 2, freezer bags are most commonly used to store meat based organics, while cling wrap and plastic bags are most commonly used to store fruits and vegetables. Why this is an important distinction is that rates of disposal vary significantly based on both food type and medium of storage.

Freezer bags and food bags (with zip seal) are most commonly used for longer term food storage (defined as in excess of a week). Cling wrap and plastic sandwich bags are used for shorter term food storage (between 1 and 4 days). These findings are consistent with our general understanding surrounding rates of spoilage for various food types.

Fruits/vegetables/dairy have generally much shorter in home shelf lives when compared to meats (and some grains) which can be stored in a freezer for extended periods. Household's use of GLAD plastic food storage products is heavily correlated with what food items are being stored. There is a clear delineation with respect to which product types are used by households and for what purpose.

Awareness and participation of households in municipal waste diversion initiatives

While the results of this section do not specifically pertain to any of the modeling or calculations used in this study, it provides useful insights into self-reported measures of awareness and concern for food waste. These findings can help provide context for why plastic food storage should be advocated for, given both the efficacy of the product in avoiding food waste, and public concern for the issue.

Table 4 summarizes the results of the survey testing:

	Strongly Agree	Agree	Neither Agree/Nor Disagree	Disagree	Strongly Disagree
I regularly participate in my cities Blue Bin Program	52%	20%	15%	9%	4%
I regularly participate in my cities Green Bin Organics Program	36%	26%	8%	16%	14%
I know what materials are allowed to go into my cities Blue Bin	19%	37%	23%	14%	7%
I know what materials are allowed to go into my cities Green Bin	20%	24%	17%	24%	15%
Recycling is important to me	39%	25%	19%	9%	8%
Avoiding food waste is important to me	37%	30%	10%	12%	11%
Society wastes too much food	41%	31%	14%	7%	7%
I am concerned about waste from plastics	24%	25%	18%	17%	16%

Perhaps the most salient finding from the above results is self-reported concern for food waste. While this is not an entirely unexpected result (given that most people tend to report high levels of concern for environmentally conscionable initiatives), this finding can be used to highlight the role of plastic food storage in ameliorating food waste. These results are elucidated in the next section.

Why households use GLAD products (and other forms of food storage)

Fig 4. Survey Statement: I use plastic food bags/containers/freezer bags/cling wrap to avoid food waste

Fig 5. Survey Statement: I use plastic bags/containers/freezer bags/cling wrap to help me save money.

As shown in figure 4, 75% of survey respondents agreed (or strongly agreed) with the statement that using various types of GLAD products helped them avoid food waste. Tying this back to our earlier findings, utilizing some form of plastic food storage allows households to save and store waste, subsequently preventing disposal or spoilage.

Households also readily recognize that this translates into actual monetary savings. What remains less clear is the actual quantity of food waste avoided. During the initial survey pre-test, enumerators were unable to calculate how much food waste is avoided by using plastic food storage. While we knew that using certain GLAD products helped households avoid throwing out food (i.e. freezer bags and meat), follow up question were required to help estimate disposal rates and potential impact on purchasing decisions. These questions were left semi structured, as respondents were asked to estimate the following:

1) For every kilogram of food stored, amount of food waste avoided (i.e. half of the food I wrap in cling wrap I end up eating, the other half I throw away)
2) For every kilogram of food stored, changes in purchasing decisions (i.e. freezing 2lbs of extra chicken breast means I don't have to buy it the next time I go to the store)

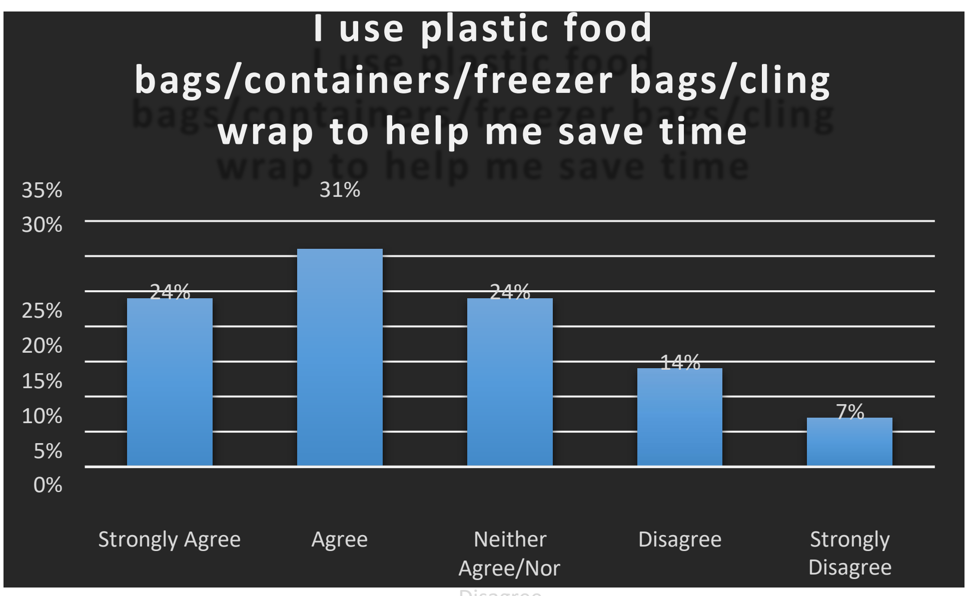
It is important to note that given the open ended nature in which the questions were posed, enumerators were required to code participant responses and estimate the impact on disposal rates and purchasing. This required a degree of interpretation, i.e. ("wrapping my unfinished apple allowed me to eat it later", would be coded as "avoided spoilage").

To communicate these results, enumerators were asked to estimate avoided spoilage and avoided purchases for each of the GLAD product types that were identified in the survey.

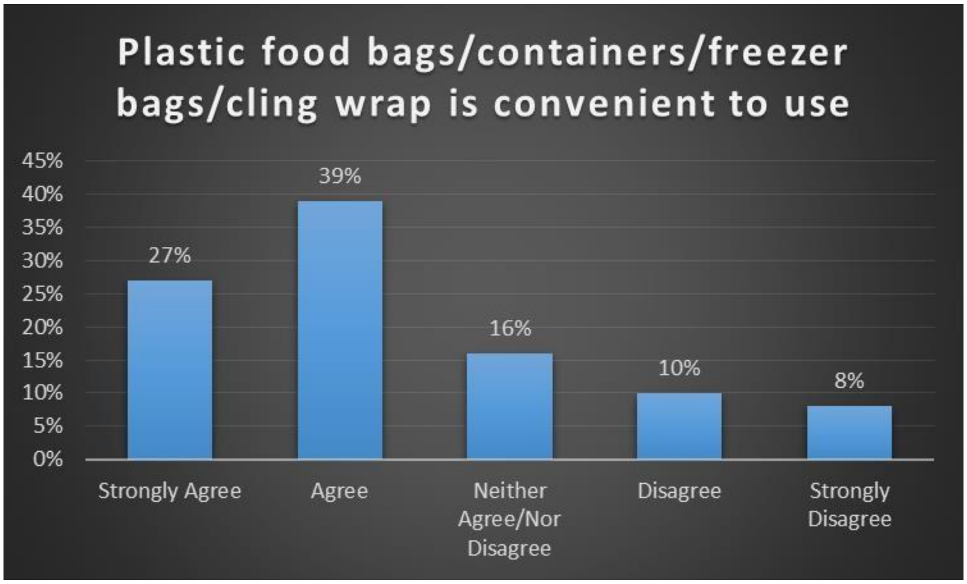
Table 4: Avoided Spoilage and Avoided Purchase

Product Type	Mean Avoided Spoilage	Mean Avoided Purchase
Cling Wrap	33%	10%
Freezer Bag	90%	50%
Sandwich Bag	33%	10%
Food Storage Bag	50%	25%

Survey Statement: I use plastic food bags/containers/freezer bags/cling wrap to help me save time



Survey Statement: Plastic food bags/containers/freezer bags/cling wrap is convenient to use



Based on the final two survey statements, households also use plastic GLAD products because they are convenient, and save time.

Using Survey Results to Inform LCA Modeling

As noted earlier, in order to quantify the carbon abated attributable to GLAD products, we need to estimate the amount of food being stored, the amount of food that is being kept out of the landfill, and how using GLAD products affects purchasing decisions.

Modeling the "Worst Case"

While extensive testing was conducted to estimate how people were using GLAD products, and the results from our survey represent a range of findings, a decision was made to use the "worst case" of the survey responses.

Cognizant of the fact that many stakeholders view LDPE products as being environmentally problematic (due to low levels of recyclability) the study team wanted to present the most conservative estimate possible. This was done in the event that potential critics thought we were overstating how often, or how much people were using GLAD products to avoid food waste.

In every instance, we chose the lowest reported value to calculate emissions abatement. Given that these are user defined variables, the study team can always re-run the model to reflect a range of usage scenarios (all of which would be more favorable towards avoided food waste estimates)

Food Storage Multiplier

In order to calculate avoided food waste attributable to the use of GLAD Products, the study team had to estimate the ratio of food weight relative to the size/weight of the product, i.e. a sandwich bag that weighs 1 gram (per unit), can hold, on average 150g of stored food.

Given that there is no clear guidance in the either the academic or broader literature regarding how much food can be stored for each (GLAD) product, a range of real world examples were weighed and recorded. A summary of the min-max for each of the product types tested is shown in table 5 below.

A total of 89 samples were weighed and tested.

	Weight of Product	Min Stored	Max Stored
Glad Sandwich Bag	1g	100g	350g
Glad Large Zipper Bag	2.3g	200g	680g
Glad Cling wrap	<1g (12" square)	50g	183g
Glad Freezer Bag (medium)	2.02g	100g	720g
Glad Freezer Bag (large)	2.7g	385g	1200g

It should be noted that the study team did not have access to all GLAD product types, and as such, the values collected during sampling were used as a proxy for other GLAD products.

The food storage multiplier for the range of GLAD products modeled in our LCA are listed below:

Table 6: Food Storage Multiplier

Product Type	Ratio of Food Storage to Weight of Product
Gland Cling wrap All	50 X
Glad Press'n Seal All*	100 X
Glad Freezer All	100 X
Glad Food Storage All	100 X
Glad Zipper Clear All	100 X
Glad Microwave Film*	0 X
Glad Oven Bag*	0 X

*****No data available. It is assumed that Press'n Seal is analogous to Cling Wrap. Microwave Film and Oven Bags do not have a food storage multiplier associated with it (as it is assumed that it is not used for food storage)

Usage Assumptions

As noted earlier, an issue encountered by the study team during a review of supplementary literature/data was that there was no data pertaining to how households used GLAD products (or other plastic food storage). The quantities of food waste avoided and the impact on purchasing decisions based on our survey results are summarized in Table 4.

However, consistent with our “worst case scenario” approach – the study team chose the lowest avoided spoilage and avoided purchase values reported from our surveys. These results are summarized in Table 7

Table 7: Avoided Landfill and Avoided Purchase (Source Reduction)

Product Type	Avoided Landfill	Source Reduction
Gland Clingwrap All	10%	5%
Glad Press'n Seal All	10%	5%
Glad Freezer All	75%	25%
Glad Food Storage All	20%	10%
Glad Zipper Clear All	20%	10%
Glad Microwave Film	0%	0%
Glad Oven Bag	0%	0%

Calculating Emissions Abatement

To calculate emissions abatement attributable to GLAD products, we need to calculate the following:

1) Max food stored by product type
2) Amount of avoided landfill waste (by product type)
3) Amount of source reduced waste (by product type)
4) Avoided emissions associated with avoided landfill waste
5) Avoided emissions associated with source reduction
6) Sum all values

Step 1: Calculate Max Food Storage

Max Food Storage is calculated by taking total Poly Weight (as reported by Clorox), and multiplying it by the Food Storage Multiplier shown in Table 6.

This calculation needs to be done for each product type (matching the appropriate food storage multiplier with the correct product type).

Step 2: Amount of avoided landfill waste (by product type)

Avoided landfill waste is calculated by multiplying the max food storage from Step 1, by the avoided landfill % for that particular product type (i.e. 45,000T of organics waste stored by cling wrap keeps 4,500T of organics out of a landfill)

Step 3: Amount of source reduced waste (by product type)

Source Reduction (Avoided purchase) is calculated by multiplying the max food storage from Step 1, by the source reduction % for that particular product type (i.e. 45,000T of organics waste stored by cling wrap avoids the need to purchase 2,250T of new organics)

Step 4: Avoided emissions associated with avoided landfill waste

Using EcoInvent, find an appropriate landfill emissions coefficient for mixed organics waste. While there are a range of values to choose from (depending on topography, infrastructure, landfill design, technology etc.), the 0.77TCO2e chosen for our modeling represents a conservative estimate for a mixed organics load in a North American MSW landfill. This is a customizable variable.

Multiply the landfill emissions coefficient by the avoided landfill waste figure calculated in Step 2. The final value is the emissions savings attributable to avoided landfill waste.

Step 5: Avoided emissions associated with source reduction

Using EcoInvent, find an appropriate source reduction coefficient for mixed organics (grain, meat, dairy, vegetables/fruit). Depending on what types of food people choose to store, this value can vary significantly. Using green bin audit data collected from municipalities across the Greater Toronto Area, a weighted average organics coefficient was used to reflect the mix of organics that households generate (3.15TCO2e). It is important to note that the model is highly sensitive to changes in this value, and it can range quite significantly depending on the type of food that is being source reduced, i.e. meat is 13.48TCO2e, and grain is 0.69TCO2e.

Once an appropriate mixed organics source reduction coefficient is chosen, multiply that by the source reduced tonnes calculated in Step 3.

Step 6: Sum all values

The sum of the avoided landfill emissions and avoided source reduction emissions represents the emissions abated resulting from the use of Glad Products. These results are summarized in Table 8.

Table 8: Emissions Savings Resulting from the use of Glad Products

	Plastic, T	Paper, T	Plastic %	Total Product Weight, T	**Avoided Landfill Emissions from Organics Reduction**	**Avoided Source Emissions from Organics Reduction (Displacing the need to purchase new food)**
USA	15,163	10,491	59%	25,655	334,447 tCO2e	829,281 tCO2e
CN	2,733	463	86%	3,196	3,210 tCO2e	13,132 tCO2e
AUS	1,631	1,005	62%	2,636	9,762 tCO2e	12,132 tCO2e
Canada	1,299	1,109	54%	2,408	46,318 tCO2e	76,724 tCO2e
HK	1,025	482	68%	1,507	10,264 tCO2e	20,994 tCO2e
NZ	589	203	74%	792	6,599 tCO2e	12,574 tCO2e

Results and Conclusion

Table 9 summarizes the total emissions impacts attributable to GLAD products (including both manufacturing and transportation, as well as abated carbon from avoided food waste)

Table 9: Total Emissions Impacts Glad Products

	Total Emissions Impacts from Product Production and Transport	**Avoided Landfill Emissions from Organics Reduction**	**Avoided Source Emissions from Organics Reduction (Displacing the need to purchase new food)**	**Net Emissions Impacts of GLAD Products in Market**
USA	74,035 tCO2e	334,447 tCO2e	829,281 tCO2e	**-1,089,693 tCO2e**
CN	6,691 tCO2e	3,210 tCO2e	13,132 tCO2e	**-9,650 tCO2e**
AUS	7,583 tCO2e	9,762 tCO2e	12,132 tCO2e	**-14,312 tCO2e**
Canada	11,341 tCO2e	46,318 tCO2e	76,724 tCO2e	**-111,701 tCO2e**
HK	3,539 tCO2e	10,264 tCO2e	20,994 tCO2e	**-27,719 tCO2e**
NZ	2,049 tCO2e	6,599 tCO2e	12,574 tCO2e	**-17,123 tCO2e**

Referring to Table 9 – we observe some eye opening results.

Using a conservative "worst case" scenario, the modeled emissions abatement attributable to GLAD products in our 6 markets is approximately 1.27 million TCO2E – that is based on approximately 32,000T of products being sold globally.

To provide context, Ontario's Blue Box program abates approximately 2.7 million TCO2e based on 870,000T of material recycled annually. Phrased alternatively, one tonne of plastic GLAD products abates almost 40T of carbon via avoided food waste, while one tonne of Blue Box materials abates 3.1T of carbon via recycling.

Let that sink in for a second – a product made largely of LDPE film (the scourge of the recycling industry) offers an environmental return 12.9x greater relative to Blue Box printed paper and packaging. That does not even take into consideration the 200+ million dollar cost associated with operating the Blue Box program.

In a time where governments are looking to minimize carbon impacts and waste sent to landfill, a potential solution lies in the use of plastic food storage. These findings also speak to the seemingly dichotomous pursuits of avoiding food waste, while maximizing recycling rates. Many of the products that help households avoid food waste (plastic containers, freezer/sandwich bags, cling wrap etc.), cannot be readily recycled in conventional recycling system.

We have to ask ourselves, what is the goal of our system? Is a “successful” system the one that abates the most carbon, or the one that diverts the most material? At one point does cost factor into how we measure success? (Note: While increased diversion and carbon abatement generally go hand in hand, prioritizing the diversion of certain materials can maximize carbon impacts, while diverting less material)

The findings from this report highlight the critical role that plastic products can help in not only avoiding food waste, but achieving preferable environmental outcomes at a lower cost. The extreme negative sentiment surrounding plastics is creating a potentially dangerous narrative, and ignores life cycle thinking that should be employed when designing an efficient waste management system.