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## Keeping Glass Recycling Financially Sustainable: A Cost - Benefit Analysis

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**KEEPING GLASS RECYCLING FINANCIALLY SUSTAINABLE:  
A COST - BENEFIT ANALYSIS**

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HONORS PROJECT

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Glass is a premium packaging material typically used for beverages and food stuffs. As a preferred packaging material, 33% of customers would like to see more products packaged in glass (Glass Recycling Coalition, 2017). The desirability of glass is based on its qualities of being nonporous and impermeable, which make it a cleaner and safer packaging material for food and beverages (Glass Packaging Institute, 2017). This paper explores the value chain of recycled glass and the value to manufacturers of glass containers, like Owens - Illinois, Inc., the world's leading glass packaging manufacturer with 2016 revenues near \$6 billion (Owens - Illinois, Inc., 2016).

### How Glass Packaging is Produced

Glass packaging made by Owens - Illinois, Inc. is produced in five steps.

- 1) Sand, limestone, soda ash, and recycled glass, referred to as cullet, are melted in a furnace at over 1500 °C.
- 2) The molten mixture is removed from the furnace and cut into units that will then form individual glass containers.
- 3) The units are then diverted into forming machines where they are molded into individual glass containers.
- 4) Once a container is molded into the desired shape and size, it is then heated back to up be slowly cooled in a lehr, stabilizing the internal pressures of the glass.
- 5) Finally, the glass containers are put through rigorous inspections to ensure the uniformity of each bottle.

## Production Costs

The production costs of creating glass packaging consist of raw materials, labor, and overhead costs, broken down as follows:

1. Raw Material  $\approx$  30%, varies based on raw material versus recycled material
2. Labor  $\approx$  20%, stable
3. Overhead  $\approx$  50%, of which 40% is energy costs, varies based on raw material versus recycled material

Cullet can replace up to 95% of the raw materials needed for production, providing a stabilizing effect on the cost of raw materials (Strategic Materials, 2017). A large component of overhead cost is energy cost, which typically accounts for 40% of overhead costs or 20% of the total manufacturing costs (Owens - Illinois, Inc., 2016). Volatility in market prices for energy affects the breakdown of this cost analysis. This volatility is especially pertinent in the North American region, as prices of natural gas and fuel oil in North America fluctuate (Owens - Illinois, Inc., 2016). Here again, cullet provides a stabilizing effect on cost, as a raw material mix with greater portions of cullet require a lower temperature for manufacturing than a mixture with greater portions of raw material, thus lowering energy costs for the manufacturing facility when cullet is used (Ohio Environmental Protection Agency, 2015).

## Glass as a Preferred Packaging Method

Glass is the preferred packaging by many consumers. According to the Glass Packaging Institute (2017), because glass is nonporous and impermeable, there are no interactions between glass packaging and products that affect the flavor of food and beverages. Additionally, glass has a zero rate of chemical interactions, which is considerably lower than plastic or aluminum (Strategic Materials, 2017). A global study by the European Container Glass Federation (2017)

showed that glass continues to be the reference packaging material for markets such as spirits, wine and beer, and is continuing to gain market share in the food, water and dairy sectors. Because of the absence of interactions between glass packaging and products, many parents have requested that more baby food be packaged in glass, in order to reduce exposure to toxic chemicals in plastic packaging (European Container Glass Federation, 2017).

### Motivation of Glass Recycling

The motivations for glass recycling is an important component of the supply of cullet, these being environmental and economic. On the environmental side, a survey done by the Glass Packaging Institute (2017) indicated the final destination of recovered glass is important to 75% of public sector respondents and 85% of glass industry respondents. Both groups ranked bottle-to-bottle recycling as their preferred end use of recovered glass (Glass Packaging Institute, 2017).

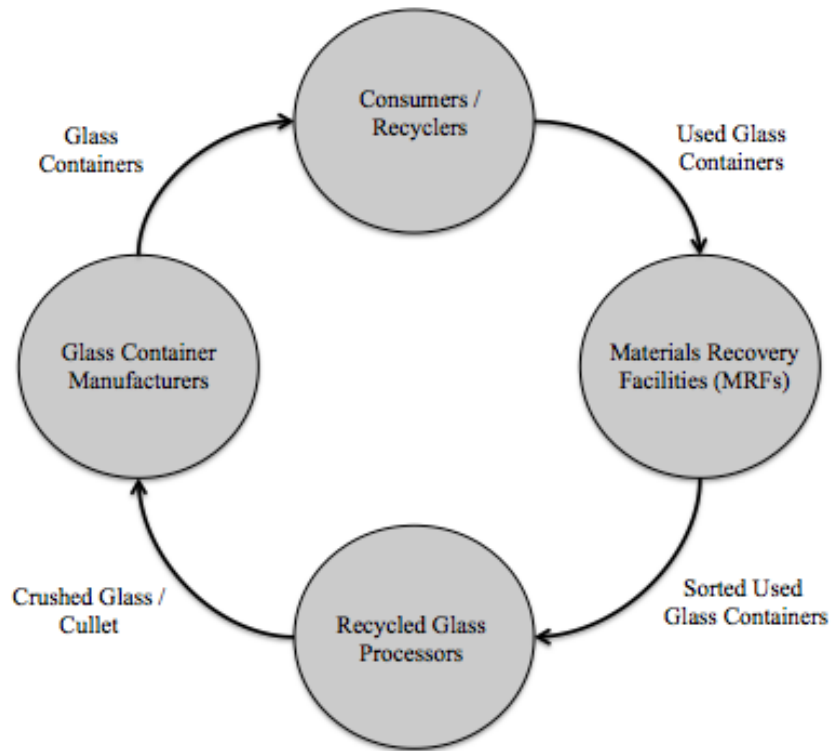
To elaborate, glass has a 1:1 recycling ratio, meaning that when one glass bottle is recycled, a full glass bottle can be recreated, generally in less than 30 days (Glass Packaging Institute, 2017). Consumers are motivated by the high efficiency of glass recycling as compared to plastic. When plastic bottles are recycled, the process is much less efficient, as the composition of plastics vary from container to container, making producing consistent plastic pellets from recycled goods a challenge (Hopewell et al., 2009).

### Glass Recycling Statistics

According to the annual survey done by the Glass Recycling Coalition (2017), the respondents are concerned about recycling glass. More than half of respondents of the survey have glass collection available through a drop-off program, and just under 50% of respondents collect glass through a single stream curbside program (Glass Recycling Coalition, 2017). About

half of the respondents believe the cost of collecting and processing recyclables should be shared among various members of the recycling chain (Glass Recycling Coalition, 2017).

The recycling chain of glass contains consumers / recyclers, materials recovery facilities, recycled glass processors and glass container manufacturers. Consumers purchase items in glass containers, and when recycled, they are collected by a materials recovery facility. Once the materials recovery facilities sort the glass by color, it is sold by the ton to recycled glass processors. Recycled glass processors prepare the material for further use and sell it to various customers, but most frequently to glass container manufacturers.



### Wood County, OH

In July 2017, the Wood County Recycling Center announced that it was going to stop accepting glass as a recyclable material (Fine, 2017). With Owens - Illinois, Inc. operating their

world headquarters in Wood County, there was backlash from the company, as well as environmentally conscious residents of the county. Community members and the Owens - Illinois, Inc. sustainability team began communications with Wood County over the change in policy. After discussions between Wood County and Owens - Illinois, Inc., there was a resolution that collected glass will now be transported to Rumpke Recycling in Dayton, OH (Fine, 2017). Previously, the county had been paying \$40 per ton in shipping costs while collecting only \$10 per ton in the market for the recycled materials (net cost \$30 per ton). The revised cost is \$30 per ton in shipping costs while collecting the same \$10 per ton in the market for recycled materials (net cost \$20 per ton) (Fine, 2017). As of July, Wood County Solid Waste had been paying \$30 per ton net cost for over 5 years and had then declined to continue to pay the net cost (Tao, 2017).

### Similar Occurrences

Similar occurrences are happening around the United States. In April 2016, Cobb County, Georgia declined to accept glass in their single stream recycling program (Lindstrom, 2016). Other municipalities adopting this policy include Spartanburg, South Carolina, Greenville, South Carolina, and Harrisburg, Pennsylvania, as the cost per ton of glass recycling begins to outweigh the benefit (Henricks, 2017).

### Challenging Cost Structure

High freight costs per ton are the major reason municipalities have begun refusing to accept glass in their recycling programs. If there is no local processor for the cullet, the freight costs become prohibitive. Smaller municipalities are forced to bear the cost, and beyond a certain cost level can no longer accept glass. Examples of this include Wood County, Ohio, Cobb County, Georgia, and Harrisburg, Pennsylvania (Henricks, 2017). These and many other

municipalities have determined that the cash outlay cost of landfill is lower than the cash outlay cost of recycling glass. A concern of many is the limited space in landfills. A glass bottle takes approximately 1,000,000 years to biodegrade, as compared to the 450 years it takes a similar sized plastic bottle to decompose (Csanyi, 2014).

An important issue is consumer awareness regarding glass recycling and the nuances associated with glass recycling, as compared to plastic or aluminum, which are more broadly accepted recyclable materials. While some municipalities collect glass with other recyclables, others find that only collecting glass at drop-off sites is sustainable for their community (Glass Packaging Institute, 2017). Many consumers have no knowledge of their communities recycling policies as they evolve to remain fiscally sustainable (Carpenter, 2016) .

### Incentives

Major environmental incentives for keeping recycling programs in municipalities include the prevention of litter, limiting landfill cover, and concern for future generations (Glass Packaging Institute, 2017). These environmental concerns must be weighed against economic limitations. Municipalities bear economic costs when they accept glass because of its cash outlay cost, but must be forward thinking as landfills become overly filled with easily recyclable glass. The cost of landfill will likely increase as more rural areas continue be developed, and preparation for such a cost increase would benefit smaller communities for years to come (Hopewell et al., 2009).

## **Materials Recovery Facilities**

### Cost Structure

The first step in the process of recycling glass is materials recovery facilities. Some materials recovery facilities only accept glass, others collect a variety of recycled materials.



Their revenues come from sales of the recycled materials and tax incentives, if they are provided by tax policy (Mastellone et al., 2017). The major expenses of these facilities are transportation and labor, depending on the level of automation of the facility. Contamination costs, which occur when materials are mixed with non-recyclable materials, can greatly impact the revenue and costs of the facility (Mastellone et al., 2017).

### Business Cycle

Materials recovery facilities typically collect a large variety of recyclable materials because many recycling programs have converted to single stream recycling (Shi et al., 2014). Single stream recycling makes recycling much simpler as all recyclables are put in one bin, and are then sorted at a later date (McKenna, 2014). The motivation behind single-stream recycling is that it makes it as easy to use the recycling bin as it is to use the trash can. Currently, more than  $\frac{2}{3}$  of the recycling programs in the United States use single stream recycling (McKenna, 2014). Materials recovery facilities sort the material as a value added process. Once the sorting process is complete, the materials are sold and shipped to various processors.

### Incentives

Some states have economic incentives for materials recovery facilities, while facilities in other states are ignored by local legislation. In 2008, North Carolina passed a law requiring all Alcohol Beverage Permit holders to recycle their beverage containers (Glass Packaging Institute, 2017). Since then, North Carolina has boosted the amount of glass bottles recovered for recycling from approximately 45,000 tons per year before 2008 to more than 86,000 tons in 2011 (Glass Packaging Institute). Materials recovery facilities would benefit directly if this policy were to be expanded beyond North Carolina. Materials recovery facility lobbyists cite that

recycling 1,000 tons of glass creates about 8 jobs, and would compensate for an lost jobs associated with trash haulers and landfill workers (Glass Packaging Institute).

## **Recycled Glass Processors**

### Cost Structure and Cycle of Business

An example of a recycled glass processor is Strategic Materials. “Strategic Materials processes recycled glass and plastic for use in a wide array of products, creating efficiencies for our customers while conserving earth's natural resources” (Strategic Materials, 2017). The cost structure of recycled glass processors is relatively simple. Recycled glass processors purchase sorted recycled glass from materials recovery facilities, such as municipalities and private glass collectors and sell the refined product to glass manufacturers, such as Owens - Illinois, Inc. (Strategic Materials, 2017). The refining process includes grinding down the material to prepare it for the manufacturing process (Strategic Materials, 2017). The finished material can include cullet to create new bottles, as well as construction materials, water filtration systems, sandblasting, road building, fiberglass insulation and landscaping (Henricks 2016). The finished product usually sells between \$85 and \$150 per ton (McKenna 2017) (Glass Recycling Coalition, 2017).

### Incentives

Glass processors are organized as corporations or privately held companies, limiting their access to tax incentives. However, some of the same regulations from materials recovery facilities apply, dependant on the equipment used in the process. Iowa, Louisiana, North Carolina and Nevada, offer property tax exemptions for machinery and equipment used for recycling (Evans, 2016). The Iowa program offers a tax exemption for computers, machinery and equipment used in processes that recycle wood, plastic, glass or paperboard (Evans, 2016).

Eligibility for property tax exemptions vary from state to state. While the Iowa program extends eligibility primarily to recycling companies, the Nevada program offers a property tax credit to recycling businesses and manufacturing companies (Csanyi, 2014).

### **Value of Recycled Glass to Owens - Illinois, Inc.**

According to Strategic Materials (2017), “Energy costs drop about 2-3% for every 10% of cullet used in the manufacturing process”. In addition, this lowered temperature puts less stress on furnaces, extending the life of the machinery (Glass Packaging Institute, 2017). With the use of cullet, less water is used in the batching process, which offers an additional cost savings (Strategic Materials, 2017).

An additional value that cullet offers is the environmental advantages, and attached goodwill by customers. A recent study by Harris Poll, on behalf of the Institute of Scrap Recycling Industries (ISRI), reported that many consumers would be willing to pay more to buy products created from recycled material (Carpenter, 2016).

### Cost Range

The cost range that makes it fiscally sustainable to purchase cullet, as opposed to purchasing raw materials and related energy costs, is between \$85 and \$145 dollars per ton. At a cost greater than \$145 per ton, there is no benefit to purchasing cullet. The average cost of cullet in 2015 was \$95 dollars per ton, and has been between \$85 and \$155 dollars on average since 2016 (McKenna, 2016).

### Ideal Outcome

The ideal outcome for Owens - Illinois, Inc. is to have the cost of cullet remain steadily below the cost of raw materials production. As stated above, as more cullet is used, manufacturing costs are minimized. Owens - Illinois, Inc. must find creative ways to incentivize

consumers to increase glass recycling so that the supply of cullet can approach European levels, where cullet is approximately 70% of the batch mix (Owens - Illinois, Inc., 2016). In 2017, glass was recycled at a rate of approximately 33% in the United States (Fine, 2017). An increase to 70% cullet would reduce the energy costs of Owens - Illinois, Inc. by approximately 15%, as well as reducing water and raw material costs.

### Recommendations to Owens - Illinois, Inc.

#### Recommendation I

One recommendation would be lobbying for incentives for recycling and against landfill. Political awareness regarding landfill size is essential to the future of the recycling market. As political conditions change, having a consistent voice as a manufacturer would allow Owens - Illinois, Inc. to position themselves economically. Additionally, the environmental benefits associated with recycled products enhance consumer goodwill for Owens - Illinois, Inc., which could possibly increase their market share.

#### Recommendation II

Another recommendation would include monitoring the supply chain for cullet. When the global supply chain of cullet is threatened, there should be a predetermined plan of action to address the situation. A plan might include an employee in the supply chain department being responsible for monitoring cullet purchases and availability of cullet in the market. When changes, such as the one that occurred in Wood County happen, an employee would have a chain of command in order to alert organizational personnel of the upcoming issue so that appropriate actions can be taken.

### Recommendation III

Although not conventional, there may be a possibility for a tradeable market for cullet futures, similar to the one that exists for aluminum. A market for cullet futures would provide long term stability in the demand for cullet, likely stabilizing its price and allowing for enhanced organizational planning. The success of a tradable market for cullet future would be highly reliant on market conditions.

### Conclusions

Glass is a desirable, sustainable packaging material. So long as recycled glass is made available, the business model of Owens - Illinois, Inc remains sustainable. Breakeven cullet prices appear to be about \$145 per ton. Owens - Illinois, Inc. should invest into the stability of the market for recycled glass. The financial benefits of using cullet are the primary consideration of Owens - Illinois, Inc. however, environmental sustainability should be considered as well. If Owens - Illinois, Inc. were to implement the recommendations, the economic benefits coupled with the environmental benefits, and resulting consumer goodwill, will allow them to sustain business prosperity.

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