*Brief Report*

# *Update of Cradle to Cradle:*
# *Complete Life Cycle Assessment of "Container Glass"*

*For, All India Glass Manufacturing Federation, New Delhi, India*

*June 2018*

# ABOUT AIGMF

The All India Glass Manufacturers' Federation (AIGMF) founded in 1944 is the sole representative body of all segments of the Indian glass industry consisting of large, medium and small-scale manufacturers. The federation is made up of five regional associations viz., Western India Glass Manufacturers' Association-Mumbai, Eastern India Glass Manufacturers' Association-Kolkata, U.P. Glass Manufacturers' Syndicate-Firozabad, Northern India Glass Manufacturers' Association-Bahadurgarh (Haryana) and South India Glass Manufacturers' Association-Chennai. The federation consists of a total of 63-member companies engaged in the manufacture of glass and glass articles.

# OBJECTIVE

AIGMF was interested to understand the environmental impacts of container glass in India over the complete life cycle i.e. source to disposal. To accomplish this, AIGMF engaged thinkstep Sustainability Solutions Pvt Ltd, a 100% Indian subsidiary of thinkstep AG, Germany, an independent consulting company with extensive experience in conducting Life Cycle Assessment (LCA) studies according to ISO 14040/44. In the past, thinkstep has already conducted Life Cycle Assessment Study of the environmental performance of container glass production for Glass Packaging Institute (GPI), European Container Glass Federation (FEVE) representing member companies in North America and Europe and AIGMF representing member companies in India (2012) respectively.

This study provides the foundation for meaningful use of LCA results and will also help member companies of AIGMF to project the green image of the product amongst consumers and other stakeholders.

# GOAL

The goal of the study includes:

- Understanding the environmental impact of container glass - focusing on cradle-to-cradle assessment (including raw material extraction to manufacturing and end-of-life recycling).
- To identify and investigate potential improvement opportunities for container glass packaging.

The life cycle assessment is an original ISO 14040/44[1],[2] compliant study. Consistent methodology and modelling has been used for this study which is also specific to India.

[1]ISO 14040: Environmental Management – Life Cycle Assessment – Principles and framework (ISO 14040:2006); German and English version EN ISO 14040:2006

[2] ISO 14044: Environmental Management – Life Cycle Assessment – Requirements and guidelines (ISO 14044:2006); German and English version EN ISO 14044:2006

## SCOPE

The scope of the assessment is explained in the sections below:

### Life cycle stages

The life cycle stages of product systems that were studied included:

- Cradle-to-gate production of raw and relevant ancillary materials needed for the manufacture of container glass.
- Transports of relevance over the life cycle of the glass containers.
- Manufacture of container glass
- End-of-life of glass covering recycling (open and close loop), reuse and disposal.

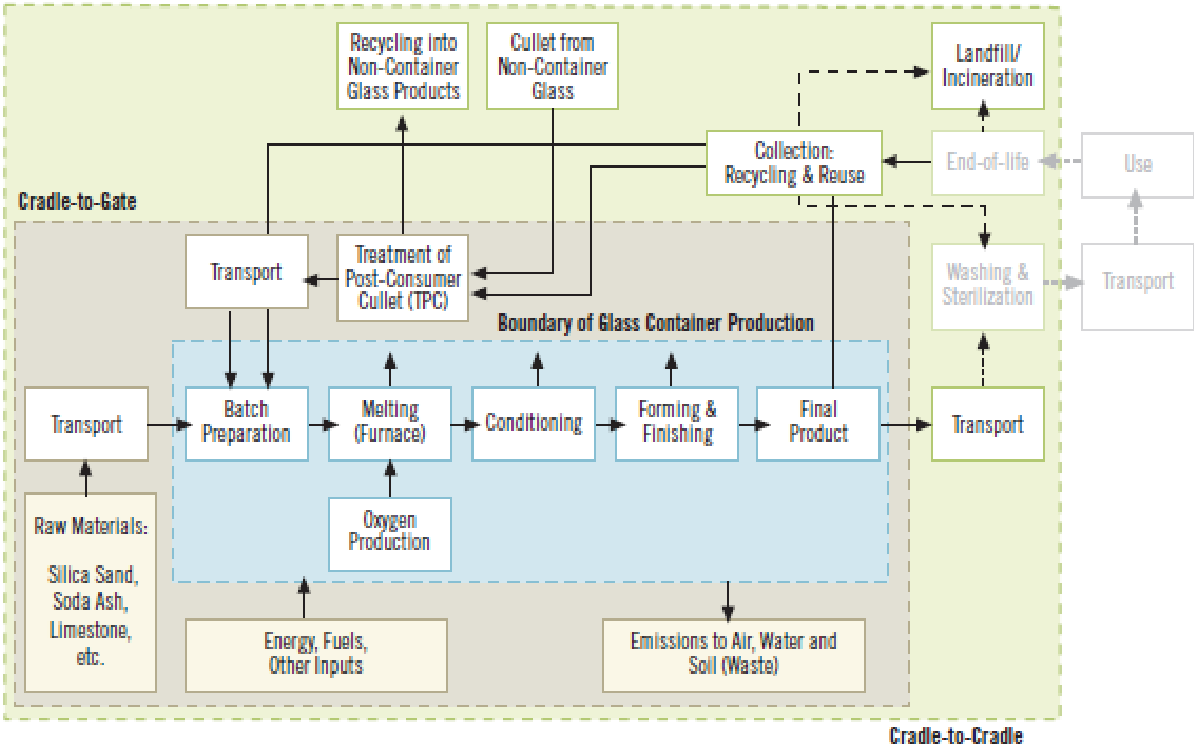


Figure 1: Life cycle flow diagram of container glass

Source : Environment Overview Complete Life Cycle Assessment of North American Container Glass http://www.gpi.org/downloads/lca/N-American_Glass_Container_LCA.pdf

### Functional Unit

The functional unit is a reference for the product whose life cycle impact is being assessed. The functional unit allows quantification of the environmental impacts of container glass over cradle-to-gate life cycle stage. These environmental impacts are calculated on the basis of the functional unit wherein each flow related to material consumption, energy consumption, emissions, effluent and waste is scaled to the reference flow. The functional unit is defined as 1 kg of container glass.

### Data Collection

In the study, site-specific data representative of current technology used in India of reference year 2016-17 were collected and analyzed for container glass. The data has been collected from member companies of AIGMF like Hindustan National Glass and industries Limited, AGI Glasspac Limited, Piramal Glass Limited, Om Glass Works Pvt. Limited, Pankaj Glass Works Pvt. Limited, Farukhi Glass Industries, Durgesh Glass Works Pvt. limited. The representative upstream data (mainly raw materials, energies, fuels, and ancillary materials) were obtained from GaBi 8 database 2016 and are representative of the years 2016 onwards. Overall, the quality of the data used in this study is considered high for glass. They are representative of the described systems of this study.

## Software

The LCA model was created using the GaBi 8 Software system for life cycle assessment, developed by thinkstep AG. The GaBi database provides the life cycle inventory data for several of the raw and process materials obtained from the upstream system.

## End-of-Life

In the end of life phase of the container glass, the below table shows the percentage in old study and new study.

Table 1. End of Life phase scenarios

| End of life phase | During 2012 | During 2017 |
|---|---|---|
| Recycling | 32% | 45% |
| Reuse | 30% | 35% |
| Landfill | 38% | 20% |

## KEY LCIA RESULTS

CML 2001 (Jan 2016) method has been selected for evaluation of environmental impacts developed by Institute of Environmental Sciences, Leiden University, NL. These indicators are scientifically and technically valid. The cradle to cradle environmental impacts for 1 kg of container glass is shown below in the table:

Table 2. Cradle to cradle environmental impacts for 1 kg of container glass in 2012 and 2017 LCA study

| Life Cycle Impact Categories | Glass Life Cycle (Cradle to Cradle) 2012 | Glass Life Cycle (Cradle to Cradle) 2017 |
|---|---|---|
| Acidification Potential (AP) [kg $SO_2$ eq.] | 0.0083 | 0.0056 |
| Eutrophication Potential (EP) [kg Phosphate eq.] | 0.0006 | 0.0003 |
| Global Warming Potential (GWP 100 years) [kg $CO_2$ eq.] | 1.0900 | 0.5811 |
| Human Toxicity Potential (HTP inf.) [kg DCB eq.]* | 0.1900 | 0.0954 |
| Photochemical Ozone Creation Potential (POCP) [kg Ethene eq.] | 0.0003 | 0.0002 |
| Terrestrial Ecotoxicity Potential (TETP inf.) [kg DCB eq.] | 0.0026 | 0.0011 |
| Primary energy demand (net cal. value) [MJ] | 13.600 | 7.7513 |

* Even though the toxicity impact categories are considered to have a low reliability, they have been included in this assessment because they are considered by AIGMF and other stakeholders to be relevant to the material comparison. Nevertheless, results based on these impact categories should be interpreted with appropriate caution.

As evident from Table 2, the values of most of the environmental impact indicators for 1 kg of container glass have reduced in 2017 as compared to that in 2012. These reductions are due to following reasons:

1. Reduction in electricity and fuel consumption
   In the melting process, the specific consumption of fuels like heavy fuel oil, liquefied petroleum gas and natural gas has reduced by 20.5%, 14.3% and 19.1% respectively from 2012 to 2017. Also, the specific electricity consumption in melting process has reduced from 2012 to 2017 by 29.0%.
   In non-melting process, the specific consumption of propane, diesel and natural gas has reduced by 16.4%, 17.8% and 16.6% respectively from 2012 to 2017. The specific electricity consumption in non-melting process reduced from 2012 to 2017 by 6.0%.

2. Increased recycling rate
   The recycling rate of the container glass increased from 32% in 2012 to 45% in 2017. Increased recycling rate of post-consumer cullet resulted in substitution of virgin batch materials. Consequently, this indirectly resulted in reduced energy consumption in the melting furnace as identified in the first point above.

3. Increased reuse rate
   The rate of reuse of the container glass increased from 30% in 2012 to 35% in 2017. This increase resulted in reduction of production impacts which would have been due to manufacturing new container glasses.

The Figure **2** below shows the cradle to cradle analysis of 1 kg of container glass for the new study of year 2017.

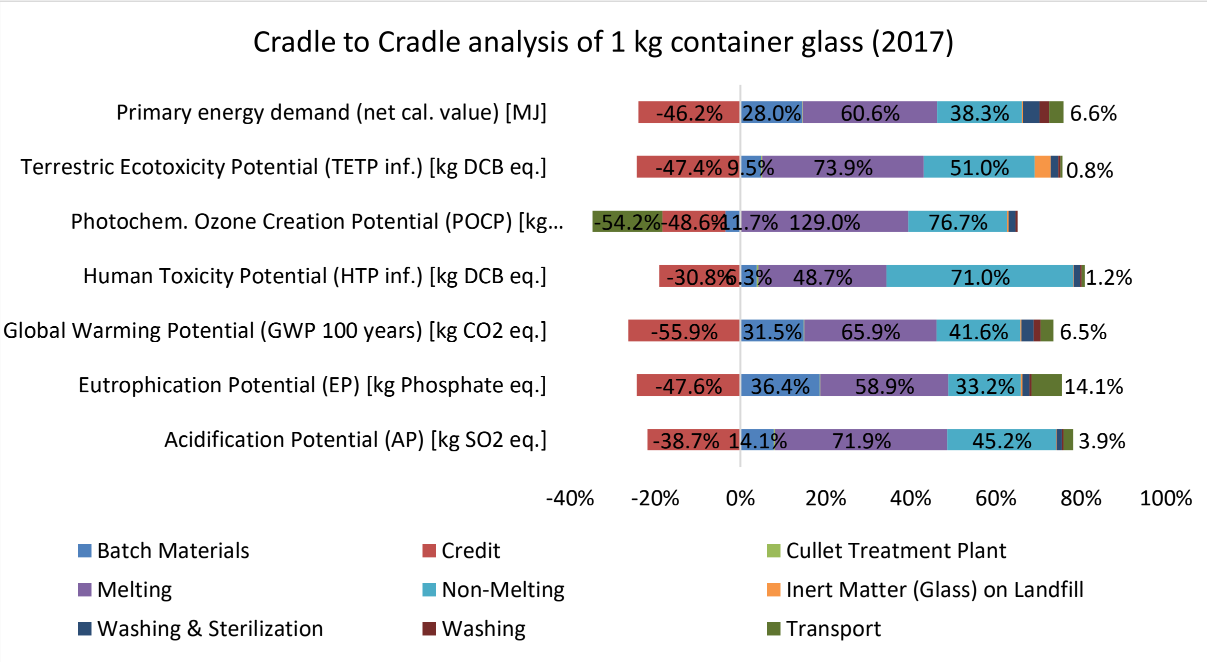


Figure 2. Cradle to cradle analysis of 1 kg of container glass

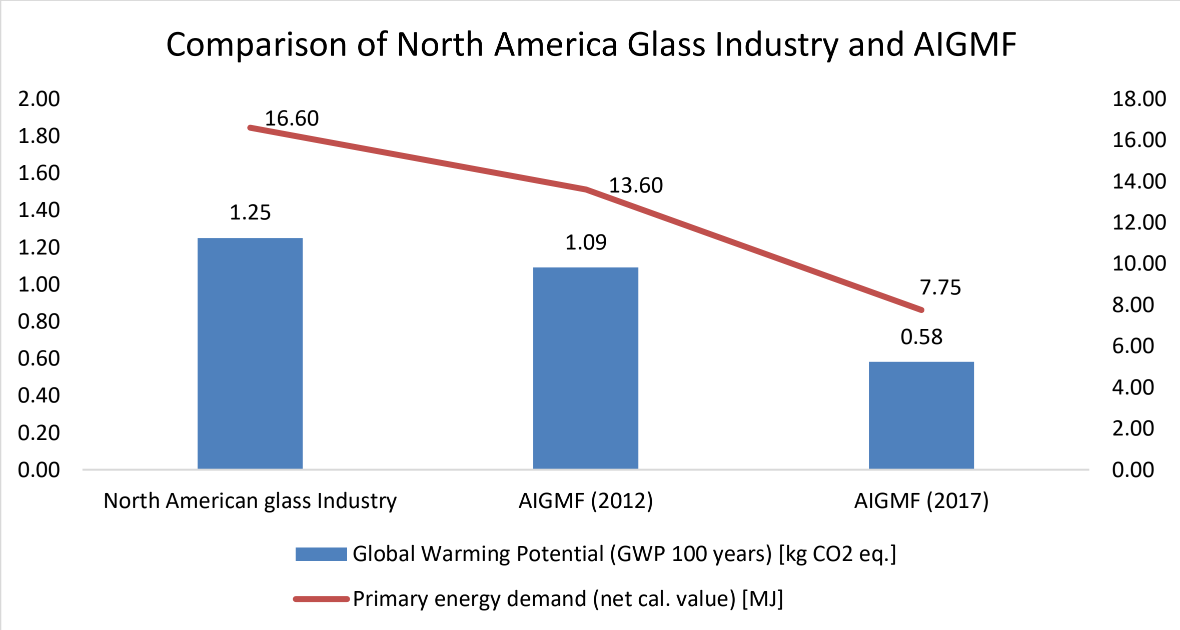


Figure 3. Comparison of North America Glass Industry and India Glass Industry

The above Figure 3 represents the comparison of results for 1 kg of container glass of North American Glass Industry, results of old study of AIGMF and results of new study of AIGMF. The data for North America Glass Industry has been taken from source- http://www.gpi.org/sites/default/files/N-American_Glass_Container_LCA.pdf

## CONCLUSION

- This assessment reflects the existing technical situation for the year 2016-17 representing both large and small manufactures. Conditions of furnaces, due to the increasing use of abatement systems, efficiencies, rebuilds, and cleaner technologies, etc. will change over time affecting the energy and material inputs.
- Glass industry may look for ways to strengthen glass through new surface treatment and better design without sacrificing improvement in material reduction. New technologies such as Narrow Neck Press and Bow (NNPB) forming process can help in such light-weighting efforts. Reduction in weight of glass will reduce material consumption and melting energy needed during the production stage. It will also reduce fuel consumption during transportation stage and increase in strength of glass increase number of reuse.
- Increase in cullet recycling rate will reduce direct material consumption and melting energy hence the overall LCI profile of glass. Better waste management for improvement of collection and segregation of glass and increase in number of cullet treatment plants (CTP) across the country will help in this.
- To improve the overall waste management system, it is important to involve all the stakeholders and create awareness. Partnership with various NGO to conduct training and create awareness for all the stakeholders may be considered.