International Journal of Environmental Science: Development and Monitoring (IJESDM)
ISSN No. 2231-1289, Volume 4 No. 3 (2013)

# IMPACT OF GLASS INDUSTRIES ON RENEWABLE ENERGY

Sambeet Mishra[1], Dr Sayed Majid Ali[2], Batala Krishna Rao[3], Pratyasha Tripathy[4]
[1,4]School of Electrical Engineering, KIIT University, Bhubaneswar, India,
[2]Professor, School of Electrical Engineering, KIIT University, Bhubaneswar, India
[3]Engineer, National Highways Authority of India

## ABSTRACT

**Having been blessed with the capability of achieving the most transparency, glass is given the most priority in many incidences. It has the ability to be reformed to different forms undergoing different treatments. The most striking use of glass is in the renewable energy conversion process. It is used in photovoltaic modules as layer of protection against the elements. In thin-film technology, glass serves as the substrate upon which the photovoltaic material and other chemicals (such as Transparent Conductive Oxide) are deposited. Glass is also the basis for mirrors used to concentrate sunlight, although new technologies avoiding glass may be visible some time later. As sited in the green rhino energy, for solar applications the main attributes of glass are transmission, mechanical strength and specific weight. Even though a lot of advantages are associated with the glass, it has not been given a second thought by most of us that glass may also put negative effect on the environment. Here we shall discuss some such issues and shall try our best to put limelight on the possible solutions.**

***Keywords: Glass, Renewable energy, Photovoltaics, Obsidian, silica, fenestration applications.***

## 1. INTRODUCTION

May it be coating, heat treating, graving or decorating, glass is one of the most beautiful things which can undergo all these treatments [8], and has the capability of getting itself reformed to a huge variety of items like Aquariums, ornaments including Christmas tree ornaments, engraved glassware, doors, top of the tables and other furniture, different types of mirrors, stained glass for windows, windshields of the cars, and also scientific apparatus such as test tubes. Nature's one of the finest miracles can be well witnessed by taking a view on Obsidian, which is a naturally formed glassy stone. The time when sand shoots out of an erupting volcano, the first step of the formation of Obsidian takes place [8]. Then it melts in the volcanic lava and gets cooled as soon as it comes in contact with water. The glass thus formed is dark green to black. Fulfilling many of the purposes of the ancient people, Obsidian has been used since the Stone Age. It was used as a cutting tool, for tips for spears, and for ceremonial purposes [8], owing to the virtue of possessing a uniform surface with high transparency, glass is usually considered among the most attractive materials [1]. Glass is used in photovoltaic modules as layer of protection against the elements. In thin-film technology, glass also serves as the substrate upon which the photovoltaic material and other chemicals (such as TCO) are deposited. Glass is also the basis for mirrors used to concentrate sunlight, although new technologies avoiding glass are emerging [6]. For solar applications the main attributes of glass are transmission, mechanical strength and specific weight [6]. Even though a lot of advantages are well-extracted from the glass, it has not been given a second thought by most of us that glass may also put negative effect on the environment including living beings. Here some of the important issues have been highlighted which needs to be taken care of by us.

## 2. MAJOR INGREDIENTS

The prime ingredient in passive solar building is the glass. Now let us put limelight to the major ingredients of glass. These ingredients required to manufacture glass include [5]:

- Silica (60-70%)
- Lime (13%)
- Soda ash (12%)
- Some cullet

## 3. PIE-CHART REPRESENTATION OF THE COMPOSITION OF GLASS

The pie chart of the composition is provided below:

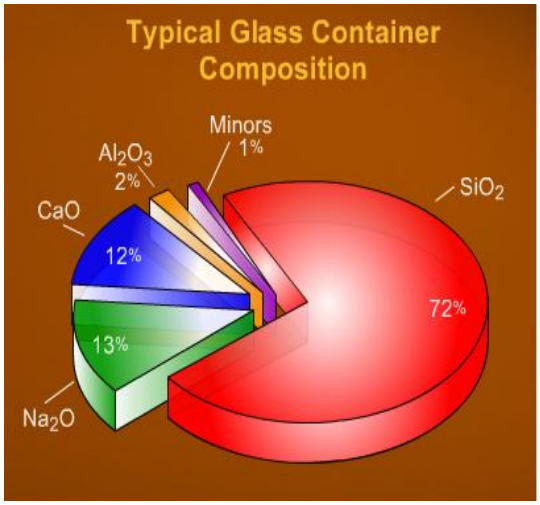


**Fig. 1** : Composition of glass [5]

There are different types of glass made by different methods, with the help of slight modifications in their composition, sometimes along with the addition of other materials [9], e.g. sources for low iron glass majorly

include iron sand and limestone. In order to produce low iron flass, furnaces are designed such that they must handle higher melting and refining temperatures. The thin layers of coating are usually deposited on one side of the glass for depicting the purpose of anti-reflection, improved conductivity or self-cleaning.

## 4. METHOD OF MANUFACTURING GLASS

The ingredients, as already discussed, required to manufacture glass include Silica (sand or silicon dioxide), soda ash, lime, cullets. Silica that comes from white sand or pulverized sandstone gets fused into glass at around 3133° F. Soda ash (sodium carbonate) or caustic soda (sodium hydroxide) lowers the melting point to 2600°F – 2900° F, but the resulting glass is found to be water-soluble. Lime (calcium oxide) makes the water glass insoluble, helps in stabilizing the mixture, makes the glass stronger and water resistant [9]. The addition of cullet (bits of old or broken glass from previous manufacturing [9] otherwise called the waste glass) further helps in lowering the temperature that is required in order to fuse the ingredients [5].

## 5. USES

The introductory part of this article already carries information on the application of glass in our day-to-day life, which is usually taken for granted by almost all of us. An intensive example of the application includes the use of glass in building materials because the functionality of glass as a cost-effective building material is further enhanced by incorporating photovoltaic. Thin film application in glass is gradually being able to hold its place in the market. This type of application has the ability to reduce a building's energy consumption to net-zero. This means that the amount of energy needed for the use of the building is produced by itself [2].
Glass has become an unavoidable part in the incorporation of photovoltaic in the following fenestration products:

- Curtain Walls
- Window Walls
- Sloped Glazing
- Sunscreens
- Skylights
- Related Products

BIPV (building integrated photovoltaic) fenestration applications have begun to grow in almost all the countries of the world with the view of achieving grid parity. Grid parity refers to the point where electricity generated from photovoltaic is equal to or cheaper than grid power from electric utilities [2]. Some areas have already proved the possibility of grid parity, such as California and Japan, Hawaii and some other islands that previously used fossil fuel to produce electricity.
For the applications of photovoltaic, there is a high need of bright clear glass, whose properties are different from the standard glass. The input materials for glass are widely available oxides. However, the resources for low iron raw materials needed for ultra-bright solar glass are limited and expensive. Standard glass may be adequate for some thin-film modules, but for all others, solar grade glass is essential [4].

## 6. DEMERITS and THEIR SOLUTIONS

According to the Green Rhino Energy, in 2007, 138 million tons of glass was produced. Of this, 50 million tons were flat glass, which is used in solar modules and reflectors. The flat glass market is worth €21bn annually. Some glass is further processed by laminating, tempering, coating and silvering, making this a market of $60bn annually [4]. The flat glass market alone is predicted to grow by 5% annually. But there lies some major demerits.
With high transport costs, there is need of the glass that can be produced in the vicinity of the module manufacturer. This glass is otherwise known as the "fresh" glass [4]. Hence, it is advisable that the glass producer and the pv manufacturers must be close to avoid the unnecessary burden of the high transportation costs.

Also, in order to make glass, a high powered oven at a temperature of as high as 1500°C or more is highly needed. The energy required to generate this level of heat usually results in an overpowering amount of CO2 that is being released into the atmosphere [10].

## 7. AFFECTS

The harmful effects of glass to the environment are quite tough to be ignored. These effects include:

### 7.1 HARM CAUSED DURING MANUFACTURING

Although the final material called the glass, is 100% recyclable and can be used to yield new glass but some environmental organizations and rules, such as the federal Clean Air Act, are not so content with the way it is made. Upon the glass manufacture process, air-polluting compounds like nitrogen oxides, sulfur dioxide and particulates are previously proved to be released. These are of a great health concern since the particles of metals, chemicals, acids and dust are so tiny (10 micrometers or even smaller) that they are able to enter the nose and throat and reach the lungs, where they produce damage to the body [11].

### 7.2 COST

For the production of float glass, energy and raw materials make up to almost 70% of the cost of goods sold. At 30 €/m2, pv glass is already a high cost for a module, especially thin-film modules. In addition to this the transportation costs, if glass is not produced near the vicinity of the pv industry, may prove to be as high as 25% of the total cost for glass. This puts enormous cost pressure on manufacturers and hence favours that the glass manufacturers be close to their customers [4].

It can also be added to this article that if the glass is not recycled, cost of making new glass becomes very expensive.

### 7.3 UNAVAILABILITY

Although sand is the major ingredient during the manufacture of glass and is easily available in the environment, but other minerals are very scarce [12].

### 7.4 PILED UP

When not recycled, the glass gets it path directly to the garbage, where it gets piled up since it may take around a millions of years to get degraded. Also, overfilled landfills can contaminate the ground and the groundwater [12].

**Acknowledgement**

The authors would like to raise the vote of thanks to KIIT University for providing a learning atmosphere to accomplish the needs of this paper & also Dr C. K. Panigrahi whose contribution is inspiring in the preparation of the paper in each step.

## 8. REFERENCES

[1] C. Hoyle, The Shining Inferno - A Symposium on Glass Raw Materials, Presented by the Glass Manufacturing Industry Council, Available on 25 March, 2013 from the website http://www.gmic.org/pubs.html

[2] R. D. Voreis, Building Integrated Photovoltaics Impacts the Glass and Glazing Industry, Available on 27 March, 2013 from the website http://www.altenergymag.com/emagazine/2011/12/building-integrated-photovoltaics-impacts-the-glass-and-glazing-industry/1832

[3] C. Hoyle, A shining inferno – A Symposium on glass raw materials, Glass manufacturing industry council, Available on 25 March, 2013 from the website http://www.gmic.org/pubs.html

[4] Value chain activity: Manufacturing solar glass, Solar Power, Available on 28 March, 2013 from the website http://www.greenrhinoenergy.com/solar/industry/ind_15_solarglass.php

[5] Glass, Double-hung window restoration, Available from the http://doublehungwindowrestoration.com/glass.html
[6] Solar Glass and Mirrors, Solar Power, Available on 29 March, 2013 from the website http://www.greenrhinoenergy.com/solar/technologies/solar_glass.php
[7] Glass, Wikipedia, Available on 29 March, 2013 from the website http://en.wikipedia.org/wiki/Glass
[8] R. Thomas., S. Sydenham, *Glass*. [Online], Available from the http://www.kidcyber.com.au/topics/glass.htm
[9] How glass is made, GLASSTOPSDIRECT.com, Available on 29 March, 2013 from the website http http://www.glasstopsdirect.com/how-glass-made.php
[10] Available on 29 March, 2013 from the website http://greenanswers.com/q/3923/pollution-toxins/production-glass-bad-environment-and-if-it-are-there-any
[11] D. Talpalariu, Glass making damages environment, softpedia, Available on 29 March, 2013 from the website http://news.softpedia.com/news/Glass-Making-Damages-Environment-94821.shtml
[12] eHow contributor, How does glass recycling affect the environment?, Available on 29 March, 2013 from the website http://www.ehow.com/about_6292669_glass-recycling-effect-environment_.html