

## The Performance and Evaluation for Recycling of Waste Glass

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According to the EPA in Taiwan report, 9.05 million metric tons of solid wastes were generated in 1999, and the waste glass was accounted of 4.95 percent. However, with the increasing tonnage of disposal cost and existing disposal sites are reaching full capacity, recycling is currently accepted as a sustainable approach to waste management.

Therefore, it's essential and urgent that the government in Taiwan establish the recycling and recovery framework for the minimization of the solid waste, reduction of materials and energy consumption, and the encouragement for the reuse, recycle and recovery development.

To achieve this goal, Taiwan has been strived for a long period of time in waste glass recovery and recycle. Waste glass, unlike other kinds of resource waste, is 100% recyclable. The EPA in Taiwan now center on a lot of different kinds of waste glass, such as glass container, flat glass, CRT glass, windshields glass, fluorescent lamps, and waste pesticide glass container.

This article will focus on the framework of the recycling market access, and also try to provide some strategies to improve waste glass recycling efficiently.

**Keywords:** sustainable waste glass, market access, recovery

### Introduction

With the hard work of the entire citizenry, Taiwan's economy has been flourishing, and personal income in Taiwan has increased dramatically during the past 30 years. However, with the improvement in economic life, mass production, mass consumption and massive waste disposal have entered our lives. The environment problems that Taiwan faces today, one of the most pressing concerns is the treatment/recycling of waste. With the increasing of disposal cost and existing disposal sites are reaching full capacity, recycling is currently accepted as a sustainable approach to waste management. The recovered materials, such as scrap tires, waste construction materials and plastic parts, actually are not 100 percent recyclable because of problems associated with the recycling techniques or market demand.

According to the EPA in Taiwan reports, glass container holds the largest market in the glass industry. In Taiwan, approximately 0.44 million-metric-tons of glass container are manufactured annually. Also, each year Taiwan generates about 500,000 to 600,000 tons of waste glass. Due to the fact that waste glass is 100% recyclable, the EPA in Taiwan has proclaimed that waste glass is one of the recyclable materials. Some recycling is done, but most of the glass ends up in incinerators and landfills.

Not only for the resource recovery, but also for the environmental protection and energy saving, recycling waste glass has become a general conception to the people in Taiwan. This article will focus on the framework of the recycling market access and the strategies to improve waste glass recycling effectively.

### The Effective of Recycling Waste Glass

Recycling waste glass to produce new container increases energy savings than starting with raw materials. Melting sand, soda, and limestone at temperatures of between 1200 and 1500 degrees Celsius traditionally produces new glass. However, recycled waste glass melt at lower temperatures, furnaces aren't required to operate at the higher levels, thus prolonging furnace life.

Recycling of waste glass can conserve the natural resource. In the past few years, the increased use of waste glass from solid wastes helps the community economically and ecologically. The contents of waste glass recycling initiative include the following.

- 1.Reduction of the usage of natural resources.
- 2.Reduces total energy consumption by 25□32 percent.
- 3.Reduces solid wastes by 75 percent.
- 4.Reduces air pollutant emissions by 14□20 percent.
- 5.Reduces water pollutant production by 50 percent.

### Current Status of Waste Glass Recycling in Taiwan

#### *Waste Glass Recycling Process*

The recycling of waste glass is included in the "Waste Container Resource Recycling Act." in Taiwan, and the recycling flow-chart is shown in Figure 1. In addition, the waste glass recycling process in Taiwan is shown in Figure 2. Generally, glass recycling has involved the collection and sorting by colors for use in the manufacture

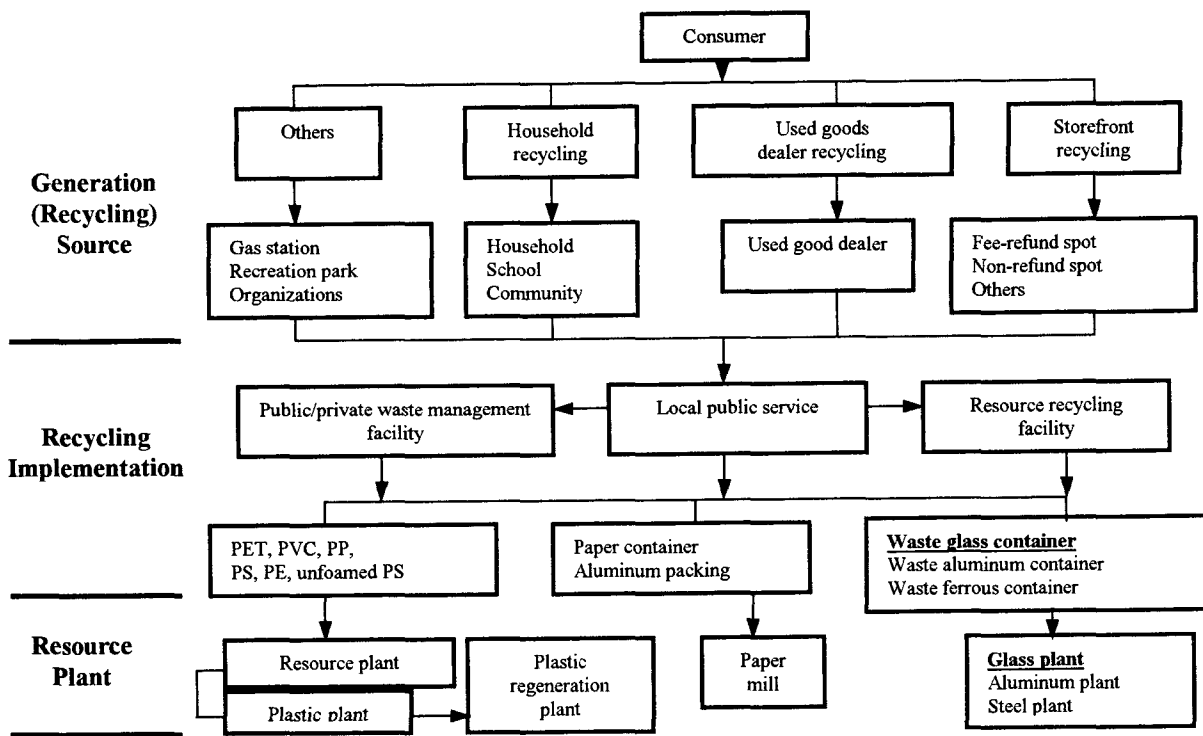


Figure1. Waste Container Resource Recycling flow-chart (Taiwan area)

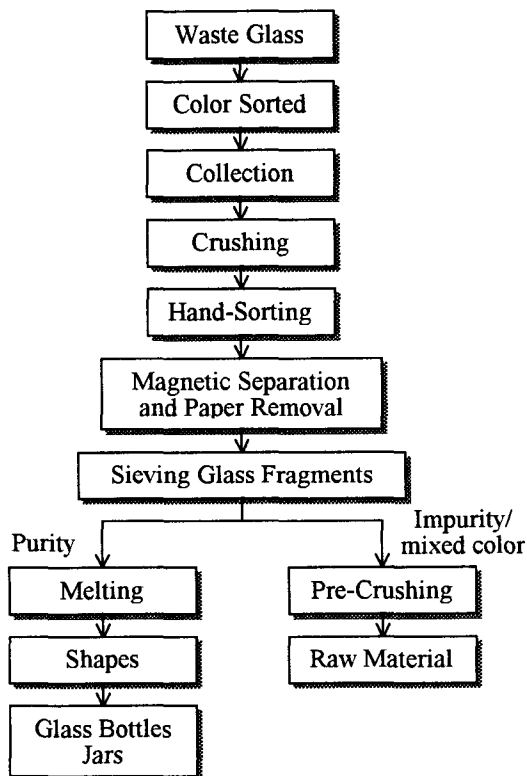


Figure 2. Typical Waste Glass Recycling Flowchart in Taiwan

of new glass containers. Quality is a major concern when dealing with any recycled material. Because cullet replaces raw materials in the glass container manufacturing standards for purity, color and consistency in order to used effectively. To maintain and ensure the quality and color consistency of new glass, containers must be separated by color before recycling—green, white and amber. Metals, stones and ceramics damage glass furnaces and present major problems in the glass manufacturing process in most instances. Therefore, cullet used for recycling must be contaminant free. Colors and contaminants would be sorted out early in the process. Once the cullet gets broken or mixed, contaminants are difficult to remove and can spoil the quality of an entire load. Cullet which has no (or a few) impurities may be made into new glass containers. Other, which has mixed colors or lots of impurities, may become the raw material of construction.

#### Collection Points for Waste Glass

The major collection points for waste glass in Taiwan include :

1. Glass Bottles and jars factory.
2. Beer and soft drink containers factory.
3. Hotel, restaurant and coffee shop.
4. The residential quarter.
5. Municipal solid waste stream.

In fact, the collection point of waste glass was not so popular in Taiwan. In most part of time, people often take the whole recyclable materials, include glass, papers, plastics and others that collected daily, each day at the same time and the same place to the local public service,

then the service would devolve them to the resource plants, like glass plants.

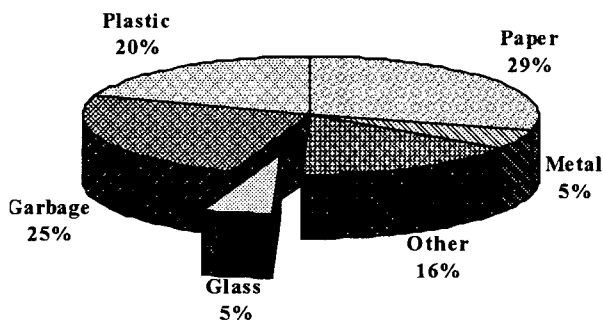


Figure 3. The contents of MSW

#### *The Achievement of Glass Recycling*

In 1993, according to the "Scrap material and container management regulation" enacted by EPA in Taiwan, described of container glass is one of the materials that are difficult to dispose of, and should be recycled. Therefrom waste glass was recycled by the local public service, used good dealer, and glass industries who collected glass from the collection points around the residents. At present, there are 61 agencies to accept and process the recycled glass. The waste glass-recycling rate in Taiwan in current 4 years was shown in Figure 4. The rate of the waste glass recycling rises every single year. This result not only encouraged the people in Taiwan, but also offered an expression of the concept of recycling and environment protection had established in most part of people living in Taiwan. In order to extend the kinds of waste glass recycling, on April this year the EPA in Taiwan has proclaimed that CRT glass is one of the materials that should be recycled. In addition, the government in Taiwan in order to spirit up waste glass recycling and reusing, enacted the subsidy fees about New Taiwan 1 Dollar per kilogram waste glass in 1998.

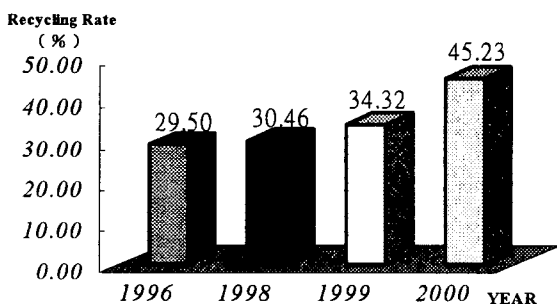


Figure 4. The recycling rate of the current 4 years

#### *The Applications of Waste Glass*

Of the material being recycled today, glass is still one of the most difficult to reuse. Recently, the

applications of recycled glass have been limited to bottle manufacturers and some fiberglass applications with limited success. Nevertheless, alternative use of waste glass is possible in :

1. Garden architecture.
2. Construction and building industry.
3. Road construction industry.

Waste glass can also be used to make colorful sand and to decorate parks. Furthermore, the recycled waste glass used as road-paving materials has been widely utilized in the United States, Japan, and some European countries over the past decade. In Taiwan, Su Nan, a professor of civil engineering at National Yunlin University of Science and Technology, has finished the experiment of waste glass used in the road-paving material last year. Preliminary results show that most of the waste glass collected in Taiwan may be suitable for incorporation into cement. Further trials and detailed investigations on the cement properties are in progress. Also, in order to increase glass recycling rate and identify more outlets for waste glass in Taiwan, the Highway Bureau of Taiwan Government has drafted a guide on the use of waste glass as a raw material for cement production and road-paving. In the nearly future, most people believe that waste glass would be soon used on road and structure constructions some day in Taiwan.

#### **The Problems of Waste Glass Recycling**

As the mention before of the materials being recycled today in Taiwan, waste glass is one of the most difficult to reuse. One of the major problems in glass recycling is the separation of clear and colored glass. Also, there are few takers for refuse glass not presorted by color. The collection points in Taiwan set one tub, or place, for the inhabitants not only to put glass bottles or jars but also other materials that could be recycled and recovered. In other words, there are no other tubs or places to separate the colors of glass. On the other hand, the costs to sort, transport, process and dispose of glass waste can very significantly. Nevertheless, these costs have a major impact on municipal budgets and private sector disposal extent of waste glass recovery and recycling activities in Taiwan. These include :

1. Shortage of outlets and markets for the used glass bottles collected.
2. Extensive use of "one-way" bottles by imported and local beverage manufactures hinders the use of "recoverable" bottles.
3. The environmental awareness of the general public is relatively low.
4. As costs for collection and disposal services are not linked directly with the quantity of wastes generated through charging, there is no financial incentive for waste producers to reduce waste.

## Waste Glass Recycling Strategies in Taiwan

The recycling and recovering of waste glass have encountered some problems and difficulties in Taiwan. In order to solve the problems and to provide essential information for implementation of recycling polices and improve the recycling status, The EPA in Taiwan not only refers to the relative experiences in Japan, United States and Europeans, but also implements strategies for local governments, private industries and consumers. These include :

1. Provides and researches on development status of further technical innovations in the glass recycling. In other words, provides free delivering and guidance of recycling treatment technologies for reusing factories, and establishes reward methods for factories to use waste glass materials.
2. Enact tax subsidy on enterprises of utilizing recycled products, including investing substitute incoming and speeding up the depreciation of facilities, and applying for tax-free of single taxation.
3. Amends wastes management legislation for promoting recycling markets, including considering the differences of transportation cost in each district and making various subvention of recycling administrations of districts, and encouragement of environmental planning throughout the products or technologies.
4. Establishes educational courses for consumers and private industries and holds exhibitions in connection with reusing and recycling of wastes glass technologies.

While the glass container industry would cooperate with national recycling legislation, most people believe that decisions about solid waste management should remain under the jurisdiction of local and regional authorities. Meanwhile the industry would look forward to working with such authorities to ensure the viability of glass container recycling.

## Conclusion

In the past years, the concept of "recycling" has been educated and accepted to the people in Taiwan. To be one member of "Global Village", the government in Taiwan devotes waste management and recycling to the aim of protecting the environment and improving the life quality.

This paper describes current status of glass recycling in Taiwan, also provides the strategies to promote the waste glass recycling rate. The current status of waste glass recycling still suffers from the handicaps from the economic point of view, and technologies used to be further development to consume more waste glass, Leading to a great future, the government should keep encouraging reuses and developing relative technologies

to offer opportunities for wiser management of solid waste and better conservation of natural resources.

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