



Case 5

Glass as a building material

reduce strip mining and landfills, sequester CO₂, get paid for raw materials

This article introduces ways to continuously generate value for glass as one of the 100 innovations that shape The Blue Economy, which is known as ZERI's philosophy in action. This article is of part of a broad effort by the author and the designer of the Blue Economy to stimulate open source entrepreneurship, competitiveness and employment. For more information about the origin of ZERI <www.zeri.org>

Researched, Written and Updated by Gunter Pauli

The Market

The world uses an estimated 3,200 billion containers of all types to package food and drinks each year - and growing. Nearly everything ends up as waste. Glass is a minor component. Each year some 100 billion glass bottles and jars are produced in highly automated facilities that can crunch out up to one million bottles per day with an average value under half a dollar. In addition to packaging glass, flat glass is used at home and in cars representing 44 million tons. The flat glass market is valued at over \$50 billion per year. Glass is a \$100 billion market.

Glass has been produced for 9,000 years and the first bottle appeared 3,500 years ago. Though, recycling bins have only been introduced in the 1970s. Whereas countries like Sweden achieve +90 percent recycling, the US average is under forty, granted that California leads with nearly 80 percent. The UK has a great preference for glass containers using an estimated 8 billion units or 3.6 million tons of which less than one million tons is recycled. The rest finds its way to landfills.

Glass is made out sand rich in silica and could be reused indefinitely. The process of making glass is energy intensive. One ton of virgin glass requires four GigaJoule of energy. Converting used bottles into new containers reduces the carbon emissions with an estimated 17 percent, while avoiding mining. However, recycling is expensive. Members of the European Union and numerous American states impose a deposit



which improves the economics. Charging as little as 5 cents per container in America to 25 cents for a liter bottle in Europe creates a secondary market. Unfortunately, the high cost of collection, transportation, and the requirement to separate according to color, has not been offset by taxes and fees. Even major campaigns by consumers and governments does not seem to improve the glass companies' appetite for more recycled glass. Thus an estimated 65 billion bottles and jars are wasted each year.

The Innovation

Converting bottles back into bottles may seem logical. However asking trees to reprocess leaves back into leaves in the spring does not make sense from a physical, chemical and biological point of view. Just like leaves are converted to soil by micro-organisms, fungi and earthworms, the innovation imagined by Andrew Ungerleider and Gay Dillingham in the USA is to convert un-recyclable blends of white, green and brown glass into a glass foam with a wide range of potential applications, except making bottles. It seems that the bottle itself was the bottleneck to the re-use of this natural resource.

The crushing of used glass into powder, heated up while injecting CO₂ creates a foam, lightweight but abrasive, strong and cheap. Since landfills are keen to reduce their load, the recovery of glass on site and the local conversion into glass foam gives way to a new business model: "entrepreneurs get paid to receive raw materials". The innovation is not limited to cascading of materials whereby the waste of one is an input for the other, the innovation extends to the business model whereby the key ingredients come with cash. In addition, if the factory is located close to (or even on) a landfill, the production facility could benefit from methane gas generated by decomposing organic waste, turning this greenhouse gas into a cheap energy source, cutting costs while further reducing its adverse impact on climate change.

The First Cash Flow

Ungerleider and Dillingham went on to create in 1994 Earthstone. Motivated by their desire to reduce strip mining they turned a known technique into a new business and quickly found a simple market entry in the niche market of physical abrasives. Blocks of recycled glass, with air bubbles and frustules similar to the strong diatom silica, clean a BBQ grill, remove paint, or smoothen fiber boards. Since the handling is limited to cutting blocks of glass foam into easy to handle abrasives, and the competition is expensive with a well documented adverse environmental impact, supply stores like Home Depot started carrying the recycled glass-based product. Once the first sales were confirmed, then production increased and improved moving on the experience curve, shifting from a batch to a continuous system, increasingly using local materials at lower cost, turning more competitive.



The Opportunity

The field of applications is vast. While the US company Pittsburgh Corning, using a similar technique decided to focus on the market of building materials, with their first glass recycling factory in Belgium and a second in the Czech Republic, Ungerleider and Dillingham went on to discover a broad portfolio of applications. Today, Earthstone has eleven applications for recycled glass on the market. The latest opportunity is to provide hydroponic agriculture a growth medium, made from glass foam, that can be permanently recycled eliminating a waste stream that strained this argo-industry.

The Swedish building entrepreneur Åke Mård, located in Sundsvall, Sweden took blocks of glass foam and converted these into pre-fabricated foundations, walls and even roofs for homes. He discovered that glass - filled with tiny air bubbles - serves as a fire proof structural building material, not just as an insulation. This innovative construction technique has been approved by the European Union. No water permeates these blocks, no vermin eats its way through the walls, no fungi grow in the basement and the insulation factor outpaces known alternatives in price and performance. Mård realized that recycled glass performs four functions while serving as a physical structure.

The critical mass required to operate a commercially viable oven is estimated at 5 million bottles annually. By 2009, Earthstone processed 5.3 million bottles annually and is profitable. Considering the consumption of 200 glass bottles per family per year, then approximately 25,000 families are needed to make this business viable. The barrier to entry is relatively low. The main cost is energy, which could be supplied by a company with excess heat clustering activities like natural systems do, or it could be derived from the methane gas from organic waste that usually comes along with glass. The creation of these factories generate jobs, while improving the quality of building materials at competitive prices, unleashing entrepreneurship everywhere, reducing the need for transport and mined material.

Gunter Pauli is the author of the Report to the Club of Rome: "Blue Economy: 100 Innovations - 10 years - 100 million jobs" published in 35 languages worldwide.

For further background on the 100 cases: www.TheBlueEconomy.org



The Blue Economy



A prefabricated house with foundations, walls and roof made from recycled glass. Designed and constructed by Åke Mård in Sundsvall, Sweden. Photo courtesy of Åke Mård of MRD (Sweden)



Grill cleaning with recycled glass produced by Earthstone. Photo courtesy of Earthstone (USA)