Generic Ceramic Tile With Recycled Glass

Product Selection and Description

Ceramic tile flooring consists of clay, or a mixture of clay and other ceramic materials, which is baked in a kiln to a permanent hardness. To improve environmental performance, recycled windshield glass is often added to the ceramic mix.

For the BEES system, a 50-year ceramic tile with 75 % recycled windshield glass content, installed using a latex-cement mortar, is studied. Each tile is 15 cm x 15 cm x 1.3 cm (6 in x 6 in x ½ in) and weighs 632.4 g (22.31 oz).

Flow Diagram

The flow diagram below shows the major elements of the production of this product, as it is currently modeled for BEES.

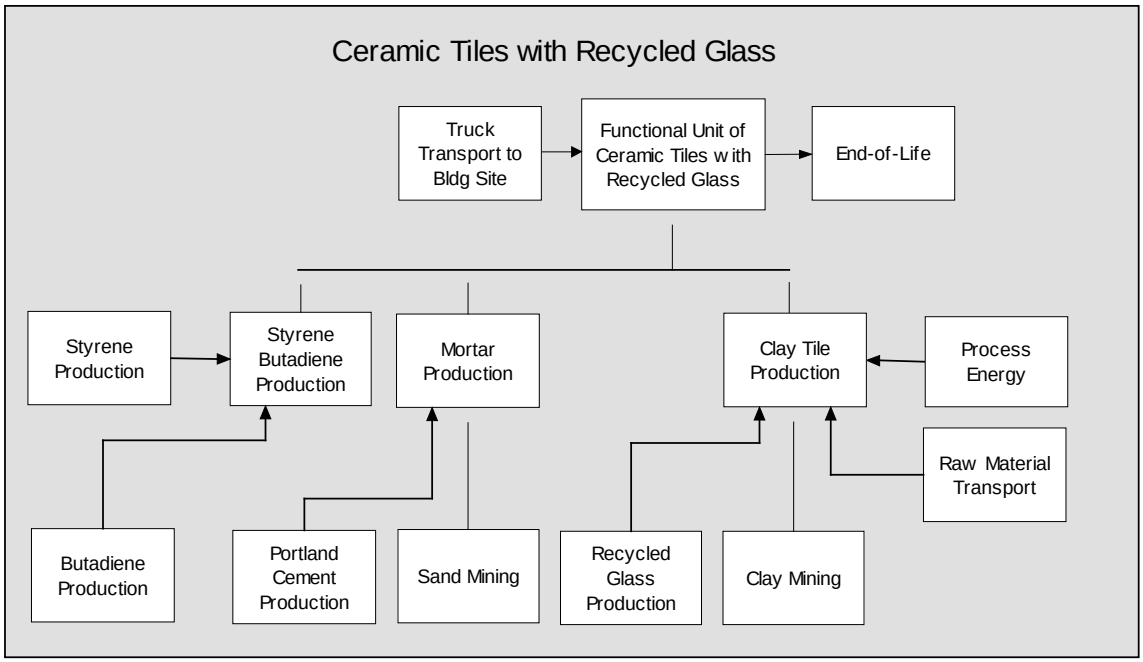

Figure 1: Ceramic Tile System Boundaries

Raw Materials

Clay and recycled glass are the primary constituents of the ceramic tile. The mass of each raw material is provided in the Table below.

Table 1: Ceramic Tile Constituents

Constituent	*Mass Fraction*	*kg/tile (oz/tile)*	*kg/m^2 (oz/ft^2)*
Clay	25 %	0.1581 (5.577)	6.807 (22.31)
Recycled Glass	75 %	0.4743 (16.73)	20.42 (66.92)

The production of clay assumes 50 % common clay, 25 % silica, and 25 % limestone.[1] Data for clay and silica sand come from the EcoInvent database, while data for limestone come from the U.S. LCI Database. Burdens

[1] Assumption based on http://europa.eu.int/comm/environment/ecolabel/pdf/ceramic_tiles/feasibilitystudy.pdf.

associated with glass production are allocated to the application for which the glass is initially produced (vehicle windshields), so the only burdens from recycled glass production are those associated with the collection and reprocessing of windshields.

The ceramic tiles are installed using a latex/mortar blend. The constituents of the latex/mortar blend are provided in the Table below.

Table 2: Latex/Mortar Blend Constituents

Constituent	*Mass Fraction*
Mortar	**69.6 %**
Portland Cement	17 %
Sand	83 %
Styrene-Butadiene Latex	**30.4 %**

Manufacturing

Energy Requirements and Emissions. The energy requirements for the drying and firing processes of ceramic tile production are listed in the Table below.

Table 3: Energy Requirements for Ceramic Tile Manufacturing

Energy Carrier	*Contribution*	*MJ/kg (Btu/lb)*
Coal	9.6 %	0.402 (173)
Natural Gas	71.9 %	3.013 (1 295)
Fuel Oil	7.8 %	0.327 (140)
Wood	10.8 %	0.448 (193)
Total	**100 %**	**4.19 (1 801)**

Emissions for ceramic tile firing and drying are based on U.S. EPA AP-42 data for emissions from the combustion of the specific fuel types.

Transportation. Transportation of the recycled glass to the tile facility is taken into account as 402 km (250 mi) by truck. The clay used to make the tiles is assumed to be shipped by truck 80 km (50 mi).

Waste. The manufacturing process generates no waste materials as all materials are reutilized in the plant.

Transportation

The distance for mortar transport to the end user is assumed to be 241 km (150 mi) by truck. Transportation of tiles by diesel truck to the building site is modeled as a variable of the BEES system.

Installation

Installing ceramic tile requires a layer of latex/mortar approximately 1.3 cm (½ in.) thick, which is equivalent to 0.567 kg (1.25 lb) per ft^2.[2] The relatively small amount of latex/mortar used between the tiles is not included. Installation of tile and mortar is assumed to be a manual process, so no there are no emissions or energy inputs. About 5 % of the installation materials are assumed to go to waste, all of which is disposed of in a landfill.

Use

Ceramic tile with recycled glass is assumed to have a useful life of 50 years. Maintenance of the tile floor during this period – e.g., cleaning, polishing – is not included within the system boundaries.

[2] Average application rate at 0.5 in thickness reported at http://www.texascement.com/mortarcalc.html and http://www.c-cure.com/servref/covcalc/impmort/fimp.htm.

End of Life

All of the ceramic tile and latex/mortar are assumed to be disposed of in a landfill at end of life.

References

Life Cycle Data

National Renewable Energy Laboratory (NREL): *U.S. Life-Cycle Inventory Database*. 2005. Golden, CO. Found at: http://www.nrel.gov/lci/database.

PRé Consultants: *SimaPro 6.0 LCA Software*. 2005. The Netherlands.

EcoInvent Centre: *EcoInvent data v2.0* (Dübendorf: Swiss Centre for Life Cycle Inventories, 2007). Found at: www.ecoinvent.org.

Industry Contacts

National Tile Contractors Association (2005)