Generic Vinyl Siding

Product Selection and Description

Vinyl siding is used as an exterior wall finish on new and renovated construction. Since its introduction in the 1960s, vinyl siding has become the most popular wall finish for new construction.

The product is manufactured in a wide variety of profiles, colors, and thicknesses to meet different market applications. Vinyl siding is commonly produced as double units that have the appearance of two overlapping or adjoining 11.4 cm wide (4.5 in wide) boards. Double 4.5 is the most common profile. The weight of vinyl siding is about 18 kg (40 lb) per 9.29 m^2 (100 ft^2), for a typical 0.102 cm (0.040 in) thickness. For the BEES system, 0.102 cm (0.040 in) thick, 23 cm (9 in) wide horizontal vinyl siding installed with galvanized nail fasteners is studied. The nails are assumed to be placed 41 cm (16 in) on center.

Data were collected in an industry-wide effort and averaged on a production-weighted basis. Vinyl siding is composed of two layers: the substrate and the capstock, which is the surface exposed to the outside and formulated to be more weather resistant. The vinyl siding product in BEES represents 50% siding made with polyvinyl chloride (PVC) capstock and 50% made with acrylonitrile styrene acrylate (ASA) capstock.[1]

Flow Diagram

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

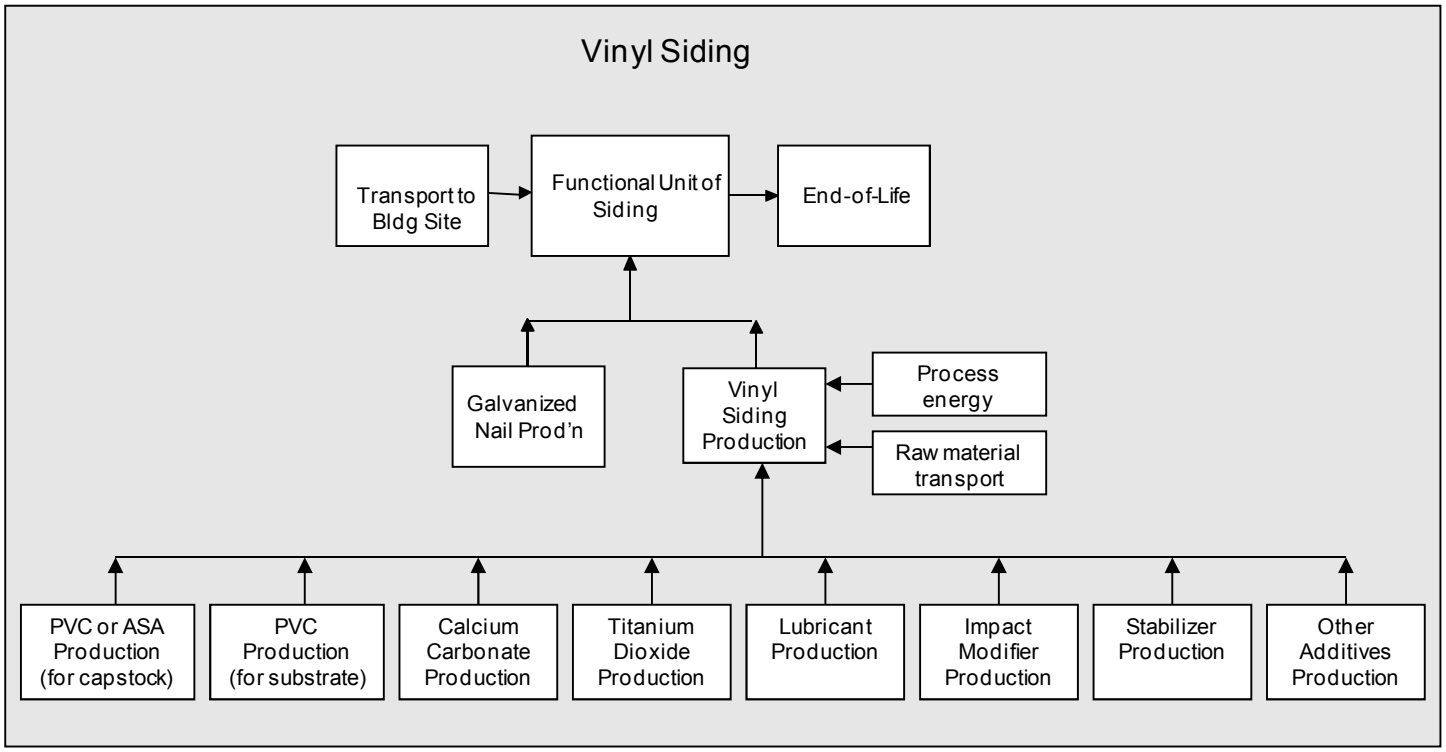

Figure 1: Vinyl Siding System Boundaries

Raw Materials

Both the PVC and ASA capstock vinyl siding formulations by mass percentage are provided in the following table:

[1] While PVC capstock currently has a slightly higher market share, the siding with ASA capstock is expected to become the more dominant product in the coming years.

Table 1: Vinyl Siding Constituents

Constituent	*% in the Siding with PVC Capstock*	*% in the Siding with ASA Capstock*
PVC	80 %	73 %
ASA	--	7.0 %
Calcium carbonate	12 %	11 %
Impact modifier	1.0 %	5.0 %
Titanium dioxide	2.0 %	1.0 %
Acrylic filler	1.5 %	0.5 %
Other additives	3.5 %	2.5 %
Total	**100 %**	**100 %**

The PVC resin and calcium carbonate data come from the U.S. LCI database. The impact modifier, chlorinated polyethylene, is produced from the chlorination of polyethylene. Data for both chlorine and polyethylene come from the U.S. LCI database. ASA data are from the EcoInvent data sets styrene-acrylonitrile (SAN) copolymer and acrylic acid. Titanium dioxide and the acrylic filler also come from EcoInvent. "Other additives" include pigment, stabilizer, process aids, and lubricants; production data for these are based on the U.S. LCI and EcoInvent databases.

Manufacturing

Energy and other inputs. Manufacturing energy is presented in the table below.

Table 2: Energy Requirements for Vinyl Siding

Energy source	*Quantity per functional unit*[2]
Electricity (kWh)	0.060
Natural Gas (MJ)	0.057
Propane (MJ)	0.004

The electricity is used for raw materials mixing, extrusion, machining, lighting, air compressors, cooling water pumps, grinding operations, and other miscellaneous equipment. The natural gas usage is used for space heating, and the propane is used in mobile equipment at facilities. Electricity production fuels, natural gas, and propane production and combustion come from the U.S. LCI database. In addition to the energy described, the facilities use 0.0197 gal (0.074 l) of water per 0.09 m^2 (per ft^2) of siding mainly for process cooling. A small percentage of this water use is for domestic uses and cleaning.

Manufacturing outputs. Wastewater, 3.4 E-4 gal (1.27 E-3 l) of water per 0.09 m^2 (per ft^2) of siding, comes primarily from domestic and cleaning use; the difference between the reported water in and out is mainly due to evaporation losses in the closed loop cooling water systems utilized by most of the plants. The BEES model includes treatment with water treatment chemicals so this water is assumed to be uncontaminated. A small quantity of inert waste which includes some PVC, 5.0 E-4 lb (2.3 E-4 kg) per 0.09 m^2 (per ft^2) of siding, is generated. This is landfilled. Combustion-related air emissions are accounted for in upstream energy use data sets (e.g., natural gas use in a boiler). Process-related air emissions reported for BEES are as follows:

Table 3: Air Emissions Data for Vinyl Siding

Emission	*Quantity (kg per functional unit)*
Dichloroethene	1.31 E-10

Vinyl Chloride	1.24 E-05

Transportation of vinyl siding constituents. Transportation of the raw materials in the vinyl siding has been accounted for. On average materials are transported 840 kg-mi by train, 917 kg-mi by truck, and 110 kg-mi[2] by ocean freighter. All transportation modes are modeled based on the U.S. LCI database.

Transportation of Product to Installation

The finished product is transported an average of 1 381 km (858 mi) by diesel truck to the building site. The nails used at installation are assumed to be transported 241 km (150 mi) by diesel truck. The BEES user is free to change the assumed transport distances for the main product.

Installation

Installation of siding is done primarily by manual labor. Nails or screws can be used to install the siding; nails are more common and would typically be the type installed with a gun. The energy required to operate compressors to power air guns is assumed to be small and is not included in the analysis. Installation is modeled for nails placed 41 cm (16 in) on center; nail use is 0.0024 kg (0.0053 lb) per 0.09 m^2 (per ft^2) of siding. Installation waste with a mass fraction of 5 % is assumed, and this waste is assumed to go to a landfill.

While sheathing, weather resistive barriers, and other ancillary materials may be required to complete the exterior wall system, these materials are not included in the system boundaries for BEES exterior wall finishes.

Use

The product is assumed to have a useful life of 50 years. No routine maintenance is required to prolong the lifetime of the product, although cleaning is recommended to maintain appearance. Cleaning would normally be done with water and household cleaners. Information on typical cleaning practices (e.g., frequency of cleaning, types and quantities of cleaning solutions used) was not available; maintenance was not included in the system boundaries.

End of Life

Vinyl siding at end of life is assumed to be disposed of in a landfill. The product can be recycled but the quantity actually being recovered and recycled is unknown.

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 7.0 LCA Software*. 2005. The Netherlands.

Ecoinvent Centre, *Ecoinvent data v2.0* (Dübendorf: Swiss Centre for Life Cycle Inventories, 2007), retrieved from: www.ecoinvent.org.

Industry Contacts

Jim Mellentine and Cara Watson, Sustainable Solutions Corporation, on behalf of the Vinyl Siding Institute (June 2012)

[2] Note: this small quantity represents a very small percentage of the overall product raw materials being purchased abroad.