LCA identifies the environmental impact of products, processes or activities over their entire lifespan. It is a primary tool of the CertainTeed Sustainable Product Design program and integral to our product stewardship initiatives.
CertainTeed is actively pursuing strategies to reduce our environmental impact, while increasing the sustainability of our operations and products.

The CertainTeed Siding Group manufactures vinyl and polymer siding products. CertainTeed has developed a corporate sustainability strategy for reducing energy, water use, and waste. We have conducted Life Cycle Assessments (LCAs) of our products to better understand and reduce their impact.

For full public transparency, CertainTeed submitted its data to the Building for Economic and Environmental Sustainability (BEES) program. BEES Online is a software program designed and managed by the National Institute of Standards and Technology (NIST). It allows the comparison of building products on a life cycle basis. BEES fully reviews and investigates each product LCA to ensure that the data is correct and accurate.

To learn more about BEES visit www.nist.gov/el/economics/BEESSoftware.cfm

**Life Cycle Assessment (LCA)**

The LCA is an analytical tool used to quantify and interpret the flows to-and-from the environment (e.g. emissions, consumption of energy, etc.) over the entire life cycle of a product, process or service. By including the impacts throughout the product life cycle, a LCA provides a comprehensive view of the environmental aspects of the product and an accurate picture of the environmental costs/benefits of product selection.

It starts with determining the scope of the study; functional unit, system boundaries, assumptions and limitations, allocation methods used and impact categories. In the inventory analysis, a flow model of the technical system is constructed using data on inputs and outputs. The input and output data needed for the construction of the model are collected (e.g. resources, energy requirements, emissions to air/water, waste generation) for all activities within the system boundaries. Next, the environmental impacts are calculated and analyzed in relation to the functional unit. Inventory analysis is followed by impact assessment, where the Life Cycle Inventory (LCI) data is characterized in terms of their potential environmental impacts (e.g., acidification, eutrophication, potential global warming effects).

**Functional Unit**

The functional unit is of great importance in an LCA as it provides a unit of analysis and comparison for all environmental impacts. It is based on the use and life of the product. For our purposes, this is expressed in terms of wall coverage (for a given time period). To compare multiple building products, BEES uses a functional unit of 1 square foot of siding over a 50-year lifespan.

**Modeling Software**

SimaPro® software was utilized for modeling the complete cradle to cradle/grave LCI for CertainTeed siding products. All process data including inputs (raw materials, energy and water) and outputs (emissions, waste water, solid waste and final products) are evaluated and modeled to represent each process that contributes to the life cycle of the CertainTeed products being evaluated.

An LCA is conducted in four phases:

1. Goal and scope definition
2. Life cycle inventory
3. Life cycle impact assessment
4. Interpretation
CertainTeed Siding Products

As part of CertainTeed’s commitment to product stewardship, CertainTeed became the first company to develop a post-consumer collection and recycling program.

**Vinyl Siding**

CertainTeed’s vinyl siding product in BEES is modeled as an average of our lines manufactured in our Jackson, MI and Hagerstown, MD plants. Bills of materials and manufacturing data were collected from these two facilities and averaged on a weighted basis (based on vinyl siding output). Our siding has a nominal thickness of 0.11 cm (0.044 in) and a mass ranging from 17.83 – 21.79 kg (39.4 – 48.2 lb.) per 9.29 m² (100 ft²). Consistent with the generic vinyl siding product in BEES, it is typically installed with galvanized nail fasteners placed 41 cm (16 in) on center.

For CertainTeed Vinyl Siding Constituents, refer to the detailed PDF on certainteed.com. “Other additives” include pigment, impact modifiers, stabilizers, and process aids. Data for all of the materials were provided in Material Safety Data Sheets (MSDS); their production data are included in the LCA model. Production data for materials is based on elements of the U.S. LCI database, the EcolInvent® database, and the SimaPro® database.

**CedarBoards™ D6 Insulated Siding**

CedarBoards is a vinyl siding product with expanded polystyrene (EPS) foam backing for added insulation. Containing both post-consumer and pre-consumer recycled content PVC resin, it has the semblance of a rough cedar finish (nominal thickness 0.11 cm/0.044 in). The product’s minimum recycled content is 60% (total recycled content of the overall assembly is 54%). It is produced at CertainTeed’s Jackson, MI plant, and sent to another facility to be laminated onto the insulated foam.

Recycled content CedarBoards are comprised of three main components: EPS foam, vinyl siding, and lamination glue. The foam backing is EPS foam board insulation produced by Progressive Foam. The data for the raw materials and production of this foam can be found in the documentation for Progressive Foam’s insulated siding.

The recycled content of CedarBoards D6 consists of both pre-consumer (post-industrial), including materials from vinyl siding and window manufacturers; and post-consumer, from scrap, end-of-life siding and construction tear-down. Recyclers clean and shred incoming material to produce PVC flakes, which are shipped to CertainTeed for manufacturing CedarBoards.

CedarBoards™ D6 contains the highest recycled content of any vinyl siding product currently on the market (min. 54%). This is possible because of CertainTeed Siding’s recycling network partnerships with over 175 distributor branch members, and a workable formula that meets the company’s stringent quality guidelines. Recycled materials (job site scrap, distributors, and other post-consumer sources) are integrated into the manufacturing process and verified by a third-party auditor. The recycled content of CedarBoards has achieved GreenCircle™ Certification. We plan to continue working with customers to expand this true closed-loop program, ensuring that even more old vinyl will be collected and returned to us for recycling.

visit www.certainteed.com/LCA for a detailed PDF
As part of CertainTeed's commitment to product stewardship, a LCA was used to evaluate the environmental benefits of a closed-loop program for vinyl siding (products continuously recycled to make new siding). As a result, CertainTeed became the first company to develop a post-consumer collection and recycling program. CertainTeed has developed a partnership with a network of recyclers to collect end-of-life vinyl siding and installation scrap. The recyclers have recycling containers located at vinyl siding distributors and jobsites, allowing installers to recycle end-of-life product from remodeling/installation scrap.

**Lamination of Recycled Content CedarBoards**

After the product has been manufactured, it is sent to Beach City, OH to be laminated. The vinyl siding sheets and EPS foam board are hand-fed onto a table of rollers. Lines of glue are applied to the foam. Next, the foam and vinyl are run through a compression roller to seal the foam to the vinyl. The whole process relies primarily on manual labor. Only a small amount of electricity is used for the roller machine, and is included as part of the foam production process. Heavy-duty diesel truck transport from Jackson, MI to Beach City, OH (394 km/245 mi) is included in the model.

You can find a list of components of the lamination glue on the Progressive Foam’s LCA.

**CertainTeed Cedar Impressions™ Polypropylene Siding**

Cedar Impressions is manufactured at CertainTeed’s McPherson, KS plant.

Two material mixes are blended together to form Cedar Impressions siding. The polypropylene (PP) resin compound is made up of PP resin, calcium carbonate filler, and other additives. The natural clay color concentrate is made up of approximately 50% inorganic, mineral-based compounds, and 50% organic compounds. The full bills of materials for these compounds have been included in the model, but are not provided in this documentation to protect company-confidential data. Production data for materials is based on elements of the U.S. LCI database, the EcoInvent database, and the SimaPro database.
Manufacturing, Installation, Use Phase and End-of-Life

Below is information on the manufacturing, installation, use phase and end-of-life for all three CertainTeed products.

Manufacturing
 CertainTeed facilities have systems in place to recycle or recover and use all of the floor sweepings and product scrap (no manufacturing/product losses). For example, the Cedar Impressions scrap is recycled into a part of packaging pallets used throughout CertainTeed plants. The solid waste is non-hazardous material composed of unrecyclable packaging, cafeteria trash, and other miscellaneous trash (sent to landfills).

Combustion-related air emissions are accounted for in upstream energy use data sets (e.g., natural gas use in a boiler). No other process-related air emissions are generated from these processes.

Installation
 Installation of CertainTeed products is done primarily by manual labor. These products were modeled as being “installed with nails” to be consistent with other vinyl siding products in BEES. For the vinyl-based sidings, nails are installed 41 cm (16 in) on center. Similar to the generic vinyl siding product in BEES, the nails are modeled as galvanized steel, and for installation 41 cm (16 in) on center, 0.026 kg/m² (0.005 lb./ft²) of siding is used. Cedar Impressions products are installed with galvanized steel nails 26.7 cm (10.5 in) on center. For installation 26.7 cm (10.5 in) on center, 0.04 kg/m² (0.008 lb/ft²) of siding is used. The energy required to operate compressors to power air guns and circular saws for cutting is assumed to be very small and is not included in the analysis.

Use Phase
 We offer homeowners a lifetime warranty for all siding products. However, in BEES all CertainTeed siding products are modeled as having useful lives of 50 years. Therefore, one initial installation and use period is modeled for the functional lifetime. No routine maintenance is required to prolong the lifetime of the product. Cleaning is recommended to maintain appearance and can be done with water and household cleaners.

End-of-Life
 Each of these products was modeled as being disposed in a landfill at end-of-life. As previously described, CertainTeed has a Vinyl Siding Take Back Program. We recommend that vinyl siding be recycled at the end-of-life.

Commitment to Environmental and Operational Excellence
 Our Certavin resin plant is the only PVC manufacturing facility to use the bulk polymerization process. This patented process uses significantly less energy and water than the suspension process used by other PVC manufacturers. Additionally, our proximity to our vendors and rail spurs allows us to transport our raw materials and finished product by pipeline and rail, reducing the environmental impact and risks of transporting material by truck.
This project considers the life cycle activities from resource extraction through product use, inclusive of maintenance/replacement and end-of-life effects.

**Cut-off Criteria**

The cut-off criteria for input flows to be considered within each system boundary were as follows:

**Mass:** If a flow is less than 1% of the cumulative mass of the model flows it may be excluded, providing its environmental relevance is minor.

**Energy:** If a flow is less than 1% of the cumulative energy of the system model it may be excluded (based on minor environmental relevance).

**Environmental Relevance:** If a flow meets the above two criteria, but is determined (via secondary data analysis) to contribute 2% or more to a product life cycle impact category, it is included within the system boundary.

The study system boundary includes transportation of major inputs to (and within) each activity stage. Shipping final products to the building site (by common modes) as well as transportation to landfills at the end of service life was factored in. Any/all site-generated energy and purchased electricity is included.

The extraction, processing and delivery of purchased primary fuels (e.g., natural gas and primary fuels used to generate purchased electricity) were also included. Purchased electricity consumed at various sites is modeled based on US grid averages (Ref. NREL US LCI database). Ancillary material use (e.g., nails for installation) is also included within the system boundary.
LCA Results

BEES Impact Methodology was used for all environmental impact calculations.

BEES Impact Methodology

BEES was developed by the National Institute of Standards and Technology (NIST) as a tool for selecting cost-effective, environmentally-preferable building products. The specific impact categories included in BEES are described on the following pages.

Overall Environmental Impact

Refer to the detailed PDF on certainteed.com/LCA for the tables and graphs that were generated using the BEES Online Software. They display the overall environmental impact of siding products including: CedarBoards D6, Cedar Impressions, and CertainTeed Vinyl Siding.

The results are a composite score based on all of the impact categories described earlier. The overall score is unit less and useful only for comparing products. It is important to remember that the lower the score, the lower the environmental impact. In comparison to other siding options, all three CertainTeed products have very low impacts across all life cycle stages, when compared to other cladding options.
Global Warming Potential: Carbon dioxide and other greenhouse gasses are emitted at every stage in the life cycle. These gasses can trap heat close to the Earth, contributing to global warming.

Acidification: Acidification is a more regional versus global impact affecting fresh water and forests as well as human health (when high concentrations of SO2 are attained). It is a result of processes that contribute to increased acidity of water and soil systems.
BEES Impact Methodology was used for all environmental impact calculations.

**Human Health, Cancer & Non-Cancer:** This category assesses the potential health impacts of more than 200 chemicals. These are general, based on emissions from the various life cycle stages; increased exposure that may take place in manufacturing facilities is not accounted for. In measuring possible cancer risk, the toxic equivalency potential for each chemical is determined and displayed in terms of benzene equivalents. For health impacts other than cancer, the toxic equivalency potential for each chemical is determined and displayed in terms of toluene equivalents.
**Criteria Air Pollutants:** This impact measures the amounts of criteria air pollutants: nitrogen oxides, sulfur oxides, and particulate matter.

**Eutrophication:** This is the fertilization of surface waters by previously scarce nutrients. When these previously scarce or limiting nutrients are added to a water body, proliferation of aquatic photosynthetic plant life is the result. This may lead to the water body becoming hypoxic, eventually causing the death of fish and other aquatic life.
CertainTeed products have very low impacts across all life cycle stages

Ecotoxicity: The ecological toxicity impact measures the potential of a chemical released into the environment to harm terrestrial and aquatic ecosystems.

Smog: Under certain climatic conditions, air emissions from industry and transportation can be trapped at ground level where, in the presence of sunlight, they produce photochemical smog. This is a symptom of photochemical Ozone Creation Potential (POCP). While ozone is not emitted directly, it is a product of interactions of Volatile Organic Compounds (VOCs) and Nitrogen Oxides (NOx).
Economic Performance: The evaluation begins at product purchase and installation since this is when out-of-pocket costs begin to be incurred. Investment decisions are made based upon out-of-pocket costs. In the BEES model, economic performance is measured over a 50-year study period. Life Cycle Costing (LCC) is the method used for economic analysis. This method sums all relevant costs associated with a product over the study period. Categories typically include: costs for purchase, installation, operation, maintenance, repair, and replacement. A negative cost item is the residual value (product value remaining at end of the 50-year study period). Therefore, negative future cost values represent the value left in the siding product after 50 years.
Conclusions

Lowering energy consumption reduces fossil fuel use and greenhouse gas emissions, as well as the impacts of extracting, processing and distributing the fossil fuels.

Cedar Impressions:
• The results of the Cedar Impressions LCA reinforces the need to use a LCA to choose green building products.
• Despite not having any recycled content, Cedar Impressions products have a lower environmental impact compared to other cladding options like brick and stucco.
• Polypropylene siding products have slightly higher environmental impact than vinyl plastic products; however, both are significantly lower than other cladding options.
• Based on recent scientific publications, plastic cladding options have significantly lower environmental impacts than previously thought.

CedarBoards Double 6” Insulated Vinyl Siding:
• Including recycled PVC in vinyl siding can significantly reduce its environmental impact. This relationship is so strong because a majority of the environmental impact of vinyl siding comes from the impacts associated with manufacturing virgin PVC.
• Insulated siding significantly improves the environmental impact and argument for vinyl siding. The energy savings (and durability improvements) of insulated siding make it a superior product from a sustainability perspective.
• The energy savings associated with manufacturing and installing EPS-backed siding easily outweigh the environmental impacts associated with its manufacture.
• The energy savings associated with CedarBoards, while important, are not included in the BEES LCA analysis.

Energy Use
In addition to the life cycle impacts addressed in this brief and measured in BEES, installing insulated vinyl siding can contribute to significant energy savings. To estimate the energy efficiency impact of insulated siding, energy models were created for typical homes in a variety of climate zones.

Energy modeling involves the creation of a digital representation of the building: envelope and construction, location and climate, heating/cooling settings, HVAC equipment, scheduled lighting, appliances and other energy uses.

Climate has a significant impact on home energy use. To address this issue, each of the energy models was run in multiple climate zones. These zones represent the variation in temperature and moisture around the country.

Two of the most popular energy efficiency programs for residential builders—EPA’s ENERGY STAR® Qualified Homes and DOE’s Builder’s Challenge—use a Home Energy Rating System (HERS) to develop a score (Ref. HERS Index). This serves as the metric for ranking and rating home energy performance. It is developed by creating a building energy simulation model of the home, taking the thermal performance of the building (envelope and other factors) into account.

visit www.certainteed.com/LCA for a detailed PDF
The HERS Index is a scoring system in which a home built to meet the specifications of the HERS Reference Home scores a HERS Index of 100, while a net zero energy home scores a HERS Index of 0. The lower a home’s HERS Index, the more energy efficient it is in comparison to the HERS Reference Home.

Each 1-point decrease in the HERS Index corresponds to a 1% reduction in energy consumption (compared to HERS Reference Home). Designers and builders can improve a home’s energy performance and lower its HERS Index with insulated vinyl siding. There are added benefits if homes qualify for these programs and any appropriate energy-efficiency incentives.

Energy modeling was also conducted to analyze the impact of installing insulated vinyl siding on both a home representing typical 1950’s to 1970’s construction with R-9 insulation in the walls, and a modern home (meeting minimum requirements of the 2009 International Energy Conservation Code). Home types were modeled in eight climate zones with an insulated vinyl siding value of approximately R-2.5.

The homes modeled for this analysis consisted of two-story homes with 2,400 square feet of above-grade conditioned floor area, basement foundation in northern climates and slab-on grade in southern climates, etc. The prototypical home was modeled in each IECC climate zone, using one representative city for each zone. The HERS Index and projected heating/cooling and water heating energy use were recorded.

Based on the modeling data, the installation of insulated siding on an existing home can save anywhere from 2% to 8% and HERS index improvements of up to 6 points (based on location and insulated siding R-value). Even on a home built to meet the strict requirements of IECC 2009, the installation of insulated vinyl siding can result in energy savings (from 1% to 4%, 1 to 3 points improvement in HERS Index).

To place that in context, consider that replacing a refrigerator from 1993 or later with a new, ENERGY STAR® qualified model saves approximately 1 million British Thermal Units (BTUs) of energy per year. Retrofitting a home with insulated siding (R-2.5) is expected to save an average of four times this amount of energy (averaging across climate zones).

Reducing energy consumption during the life of a building not only saves building owners money, it also reduces the life cycle impacts of the building throughout its lifetime.

Lowering energy consumption reduces fossil fuel use and greenhouse gas emissions, as well as the impacts of extracting, processing and distributing the fossil fuels. The graphs below compare the amount of energy required to produce the CedarBoards D6 insulated siding, to the expected energy savings for an existing and new home. When retrofitting an older home, insulated siding can pay for itself within five years in most climate zones. When using CedarBoards D6 on new homes, the energy savings within ten years can be more than double the energy used to produce the insulated siding.