

Environmental Product Declaration
BioBased Tile

BioBased Tile® (BBT®)

According to ISO 14025



Laura Bush Middle School, Lubbock, TX
Parkhill, Smith & Cooper, Inc.

Committed to Sustainability.

Armstrong® is committed to delivering solutions that reduce the environmental impact of the buildings you create, from product design and raw material selection, to how our products are produced and delivered.

This Environmental Product Declaration (EPD) was developed to document the sustainability of our products. Inside this ASTM certified ISO compliant EPD is the following:

- Product application and use
- Product ingredients and their sources
- Information on how BBT flooring is produced
- Life Cycle Assessment (LCA) results including global warming potential and primary energy usage
- Total impacts over the life cycle of the product
- Performance attributes

BBT is designed to be both durable and beautiful, making it a great product for commercial applications.

BioBased Tile

Functional Unit – 1 m² of BBT 1 year service life

| LCA IMPACT* MEASURES | TOTAL |
|--|-----------|
| Primary Energy (MJ) | 103.9 |
| Global Warming Potential (kg CO ₂ equivalent) | 6.22 |
| Acidification Potential (kg SO ₂ equivalent) | 1.56E-02 |
| Eutrophication Potential (kg PO ₄ ³⁻ equivalent) | 2.20E-03 |
| Ozone Depletion Potential (kg R11 equivalent) | 1.97E-08 |
| Photochem Ozone Creation Potential (kg Ethene equivalent) | 3.90E-03 |
| PERFORMANCE ATTRIBUTES | |
| Acoustics NRC (Absorption) | 0.05 |
| Static Load (psi) | 250 |
| Light Reflectance | up to 74% |
| ASTM F2982 | Meets |

Flooring Ingredients: Limestone, Biobased Polyester Resin, Titanium Dioxide, Colored Pigments

* Based on CML2010 Impact Factors

Visit armstrong.com/transparency for further information.

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This document is a Type III Environmental Product Declaration by Armstrong World Industries that is certified by ASTM as conforming to the requirements of ISO 14025. ASTM has assessed that the Life Cycle Assessment (LCA) information fulfills the requirements of ISO 14040 in accordance with the instructions listed in the Product Category Rules (PCR) cited below. The intent of this document is to further the development of environmentally compatible and sustainable construction methods by providing comprehensive environmental information related to potential impacts in accordance with international standards.

| | | |
|-----------------------------------|--|--|
| Declaration Number: | EPD-0003 | |
| Program Operator: | ASTM International - 100 Barr Harbor Drive West Conshohocken, PA, USA www.astm.org | |
| Declaration Holder: | Armstrong World Industries, Inc. 2500 Columbia Avenue Lancaster, PA 17603 | |
| Declared Product | Armstrong® innovative BioBased Tile is a non-PVC tile with 85% limestone and BioStride, a biobased polyester binder. BioBased Tile is available in two visuals including a stylish, linear visual known as Striations. With the same proven, long product life as other resilient flooring materials, BBT has more than 5 times greater resistance to impact and more than 2.5 times greater resistance to cracking than standard composition tile. BioBased Tile is FloorScore® and NSF/ANSI 332 Gold Level Certified. | |
| Declaration Type | Cradle-to-Grave. Intended for Business-to-Business (B-to-B) audiences. Represents Average Performance. | |
| Applicable Countries | U.S. and Canada, consistent with Product Category Rules for Environmental Product Declarations. Flooring: Carpet, Resilient, Laminate, Ceramic, Wood. NSF International. | |
| Product Application | Floor covering choice in commercial spaces: <ul style="list-style-type: none"> • Hospitality • Education • Healthcare • Office • Retail • Assisted Living | |
| Content of the Declaration | This declaration is complete and contains in its full form: <ul style="list-style-type: none"> • Product Definition • Material Content • Production of the Flooring Systems • Installation of Flooring Systems • Use Stage • Extraordinary Effects • End of Life Stage • Life Cycle Assessment • Additional Information, Evidence, Test Certificates • PCR Documentation and Verification • References | |
| PCR Development | <input type="checkbox"/> New or Revised <input checked="" type="checkbox"/> Existing - For details on PCR Review, contact ncss@nsf.org | |
| PCR Reference | 1. Product Category Rules for Environmental Product Declarations. Flooring: Carpet, Resilient, Laminate, Ceramic, Wood. NSF International. Per ISO 14025, environmental declarations from different programs (PCR) may not be comparable. | |

EPD Date of Issue: June 19, 2014

EPD Period of Validity: June 19, 2019

Verification and Authorization of the Declaration

This declaration and the rules on which this EPD is based have been examined by an independent external verifier in accordance with ISO 14025.

| | | | |
|--|------------------------------|--------------------------------------|------------------------------|
| X Tim Brooke Vice President, Certification | Date June 19, 2014 | X Tom Gloria External Verifier | Date June 19, 2014 |
|--|------------------------------|--------------------------------------|------------------------------|

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Summary LCA Results

Scope and Boundaries of the Life Cycle Assessment

The Life Cycle Assessment (LCA) was performed according to ISO 14040 and followed the PCR instructions. The cradle-to-grave LCA encompasses raw material production; transport of raw materials to the production facility; manufacturing of flooring; packaging; transportation to job site; use phase; and end of life including disposal or recycling. Detailed information regarding the LCA is found in Section 10.

Life Cycle Assessment Summary

Declared Unit: 1 m² of installed flooring tiles for use over 1 year, impacts based on CML 2010 Impact Factors

Table 1. Life Cycle Assessment of BioBased Tile

| IMPACT MEASURE ^{1,2} | SOURCING / EXTRACTION | PRODUCTION | INSTALLATION | USE STAGE ³ | END OF LIFE | TOTAL |
|--|-----------------------|------------|--------------|------------------------|-------------|----------|
| Primary Energy (MJ) | 40.2 | 21.6 | 26.5 | 13.6 | 2.0 | 103.9 |
| Global Warming Potential (kg CO ₂ equivalent) | 3.54 | 1.05 | 0.88 | 0.61 | 0.14 | 6.22 |
| Acidification Potential (kg SO ₂ equivalent) | 5.30E-03 | 2.80E-03 | 4.60E-03 | 2.20E-03 | 8.00E-04 | 1.56E-02 |
| Eutrophication Potential (kg PO ₄ ³⁻ equivalent) | 1.00E-03 | 2.00E-04 | 6.00E-04 | 2.00E-04 | 1.00E-04 | 2.20E-03 |
| Ozone Depletion (kg R11 equivalent) | 1.28E-08 | 6.68E-09 | 6.09E-11 | 1.61E-10 | 1.57E-12 | 1.97E-08 |
| Photochem Ozone Creation Potential (kg Ethene equivalent) | 1.70E-03 | 1.60E-03 | 1.00E-04 | 4.00E-04 | 0.00E+00 | 3.90E-03 |

¹ Additional Impact Measures are included in Section 10.

² Impact as based on CML 2001-Nov. 2010.

³ Use stage impacts are based on medium intensity maintenance practices as described in Section 7.

Additional Information

This declaration contains additional information, as listed below, that is outside the scope of the LCA. This additional information, provided by Armstrong®, has not been evaluated by ASTM, but is considered useful for the purpose of comparing this EPD to other EPDs developed from the same PCR. Guidance is recommended in comparing performance data and LCA information for products that perform the same in the areas of Acoustics, Fire Performance, Stain Resistance, Light Reflectance, Durability, Maintenance and End of Life Recyclability. Please refer to page 4 for a summary of performance attributes by item number and note the website references listed below for additional information.

- Resistance to Staining and Reagents: Armstrong.com/stainresistance
- Health, Safety, and Installation Information

BioBased Tile® (BBT®)

According to ISO 14025

Detailed LCA Results

1.0 Product Definition

1.1 Product Definition and Description

Armstrong® BioBased Tile (BBT) is limestone-based flooring tiles with a biobased polyester binder, featuring a through-pattern construction throughout the thickness of the tile. So, after years of foot and rolling load traffic, the pattern of the flooring is preserved; wear is less visible and can be restored using simple maintenance methods. BBT is manufactured by Armstrong World Industries in Jackson, Mississippi (39204).

2.0 Product Application






Armstrong BioBased Tile (BBT) is a commercial interior floor covering. To achieve consistent, high-quality installation of all products in our flooring portfolio, we have created the Armstrong Guaranteed Installation Systems manual, F-5061. This comprehensive guide to Armstrong flooring installation provides all the information needed to properly install Armstrong BBT and ensure it will look great and perform exactly as it should. This document can be referenced at: <http://www.armstrong.com/commflooringna/guaranteed-installation-systems.html>

3.0 Product Performance Attributes

All Armstrong BioBased Tile meets or exceeds the performance requirements of ASTM F 2982, Standard Specification for Polyester Floor Tile. BBT has more than 5 times greater resistance to impact and more than 2.5 times greater resistance to cracking than standard composition tile. Properly installed and maintained, BBT provides a durable, long-lasting resilient flooring option for all commercial market segments.

3.1 Performance Selection

Table 2. Performance of BioBased Tile

| ITEMS INCLUDED IN THIS EPD | ATTRIBUTES | |
|--|---|--|
| Armstrong BioBased Tile |  NRC 0.05 |  PSI - 250 |
| Installation Materials: Armstrong S-525 and S-700 Adhesives |  Light Reflectance up to 74% |  Thermal Resistance - 0.015 |
| Maintenance Materials: Armstrong S-495 Commercial Floor Sealer, S-480 Commercial Floor Finish and S-485 Commercial Floor Cleaner (Neutral Detergent) |  Recyclable | |

3.2 Key Selection Attributes

Armstrong BBT is designed for high traffic areas and durable performance against static load (bookcases, desks, retail product shelving, display racks, etc.) and heavy rolling loads (medical equipment, patient beds, produce carts, inventory, book carts, etc). The durable, through-pattern construction means that even in the highest traffic venues, the wear is less visible. The vibrant colors and stylish pigmentation chips add style to this well-known product brand sold throughout the world. All Armstrong BBT flooring products are FloorScore® certified and are tested and comply with the requirements of the California Department of Public Health Standard Method for the Testing & Evaluation of VOC Emissions (CDPH V1.1., 2010). Armstrong's commitment to the environment includes periodic review of current processes as new technologies become available along with the inclusion of recycled content in all BBT products.

BioBased Tile® (BBT®)

According to ISO 14025

4.0 Product Characteristics

Table 3. Product Characteristics of BioBased Tile

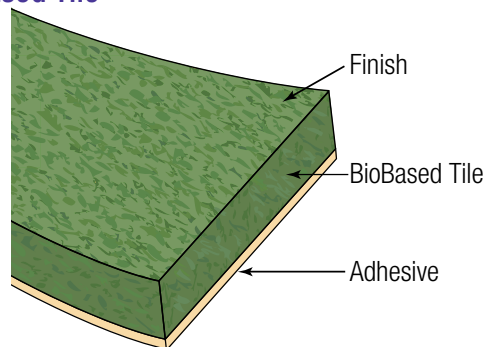
| COMMERCIAL TILE CHARACTERISTICS | | | | | |
|---------------------------------|----------------------|-----------------|------------|---------------------------------------|-------------------------------------|
| PRODUCT | TILE DIMENSION (IN.) | THICKNESS (IN.) | | AVERAGE WEIGHT (LBS/FT ²) | AVERAGE WEIGHT (kg/m ²) |
| | | Overall | Wear Layer | | |
| BioBased Tile | 12 x 12 | 0.125 | 0.125 | 1.44 | 7.03 |
| | 12 x 24 | | | | |

5.0 Material Content

5.1 Definitions

- **Finish** – A field applied finish to protect the flooring.
- **BioBased Tile** – A limestone tile with BioStride®, a biobased polyester resin.
- **Adhesive** – A field applied substance used to fasten the BBT to the subfloor.

Figure 1. Composition of Installed BioBased Tile



5.2 Production of Main Materials

- **Calcium Carbonate** (Limestone) – An abundant mineral used as an inert filler.
- **Biobased Polyester Resin** – A thermoplastic resin derived from petroleum and biobased content.
- **Titanium Dioxide** – An abundant mineral used as a pigment for whitening.
- **Pigments** – Coloring agents.

5.0 Material Content (continued)

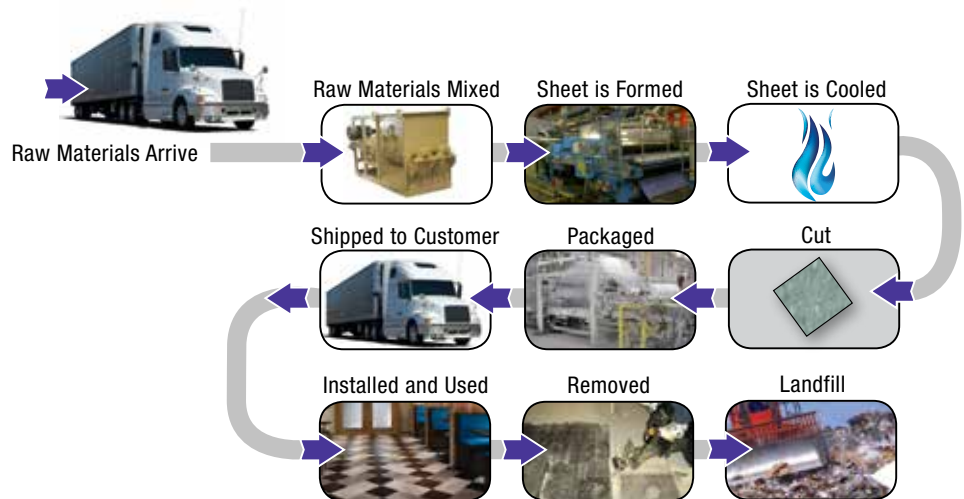
Table 4. Material Content of BioBased Tile to a Concentration of a 1,000 ppm (0.1%)

| COMPONENT | MATERIAL | CASRN | MASS % | AVAILABILITY | | ORIGIN | TRANSPORTATION MODE |
|-----------|-------------------------------|------------|--------|------------------|---------------|--------|---------------------|
| Filler* | Calcium Carbonate (Limestone) | 1317-65-3 | 85-88% | Abundant Mineral | Non-renewable | U.S. | Truck |
| Binder | Biobased Polyester Resin | N/A | 11-14% | Biobased Crop | Renewable | U.S. | Truck |
| | | | | Fossil Limited | Non-renewable | | |
| Pigment | Titanium Dioxide | 13463-67-7 | 0.5% | Abundant Mineral | Non-renewable | U.S. | Truck |
| | Colored Pigments | Various | <0.1% | Abundant Mineral | Non-renewable | U.S. | Various |

*Recycled limestone makes up 10% of this product.

5.2 Production of BioBased Tile

Figure 2. Process for Manufacturing BioBased Tile



BioBased Tile is floor tile primarily used in commercial flooring applications and is comprised mostly of limestone in a biobased polyester matrix. The manufacturing process involves the hot mixing of the raw materials milled and calendered into a hot sheet that is then cooled before cutting into floor tiles. BBT will have a factory applied finish to protect the tile face during packaging and installation.

After packaging, the BBT is shipped and installed.

BioBased Tile® (BBT®)*According to ISO 14025***5.3 Health, Safety, and Environmental Aspects During Production**

Armstrong® has a comprehensive Environmental, Health, and Safety Management Program. Risk reduction begins in the product design process. All products go through a safety, health, and environmental review prior to sale. Armstrong also has a long standing commitment to the safety and health of all our employees. The company's Safety Management Program is considered to be World Class. Our OSHA recordable incident rate is below 1.0, meaning there is less than one injury per 100 employees per year. All employees view safety as a key responsibility of their jobs. In 2010, Armstrong was named one of "America's Safest Companies" by EHS Today.

Armstrong is equally committed to reducing our environmental impact. As with safety goals, each manufacturing facility has annual environmental plans, tailored to meet goals on energy, water, and waste reduction. Armstrong is a registered member with The Climate Registry. This means the company gets third-party verification of our global greenhouse gas (GHG) inventories, which are then made publicly available. As part of this effort, the cumulative energy usage by our facilities is reported in the Armstrong Climate Registry certification.

6.0 Installation of BioBased Flooring Tiles**6.1 Installation Recommendations**

BBT must be installed in strict accordance with the current edition of the Armstrong Guaranteed Installation Systems manual, F-5061. This comprehensive guide to Armstrong flooring installation provides all the information needed to properly install Armstrong BBT and ensure it will look great and perform exactly as it should. You can reference this document at: <http://www.armstrong.com/commflooringna/guaranteed-installation-systems.html>

6.2 Health, Safety, and Environmental Aspects During Installation

There are no recognized systemic hazards associated with installing BBT flooring.

6.3 Waste

Installation waste is minimized by the modular aspect of the BBT flooring. A conservative 3% waste factor was assumed on-site during construction. This value is based on historic internal studies which have documented the quantity of scrap that is generated at the job site due to needed border cuts, penetrations, or installer mistakes. For this study it is assumed that all of the on-site scrap material will be sent to a landfill located within 50 miles of the job site.

6.4 Packaging

Armstrong BioBased Tile is packaged in a recyclable corrugated box. Wooden pallets are used to protect unit loads during shipping.

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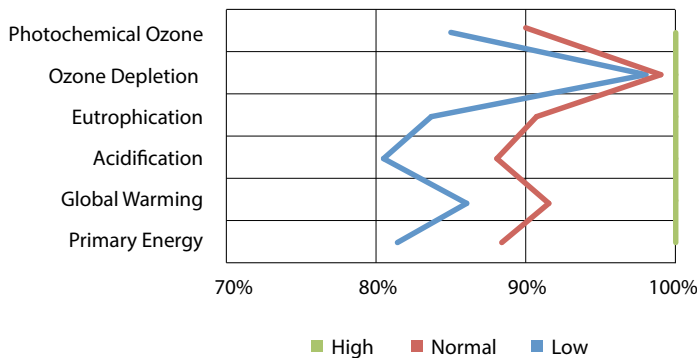
7.0 Use Stage

For this study, it was assumed that BBT would last 25 years and therefore would need to be replaced 2.4 times over the building's useful life if properly installed and maintained. The useful life indicated in the PCR for flooring is 60 years. Recommended maintenance practices are provided in the Armstrong® Installation Guide and required as part of the warranty. Warranty details can be found at <http://www.armstrong.com/commflooringna/technical-downloadcenter.asp>. For BBT, the recommended maintenance is representative of medium intensity maintenance, as shown in Table 5 and Figure 3. Because maintenance procedures often vary depending on the building owner's maintenance practices, level of use, and traffic conditions, Table 5 provides low, medium and high maintenance scenarios. The normalized environmental impacts associated with these hypothetical scenarios are shown in Figure 3. The low intensity maintenance scenario results in lower environmental impacts. For example, less scrubbing means less water consumption and a lower eutrophication potential.

Table 5. Estimated Maintenance Intensity for BioBased Tile

| MAINTENANCE SCHEDULE | NUMBER OF TIMES PERFORMED IN 1 YEAR (365 DAYS) | | |
|--------------------------|--|--------|------|
| | LOW | MEDIUM | HIGH |
| Sweep /Dry Mop | 260 | 260 | 260 |
| Damp Mop | 26 | 52 | 104 |
| Scrubbing | 6 | 12 | 24 |
| Stripping / Floor Finish | 1 | 1 | 2 |

Figure 3. LCA Results for Estimated Maintenance Intensity (1 Year)



7.1 Cleaning and Maintenance

Recommended cleaning and maintenance can be found in Armstrong Installation and Maintenance Guides: <http://www.armstrong.com/assets/commflooringna/literature/downloads/F8663.pdf>

7.2 Health Aspects During Usage

All Armstrong BBT flooring products are FloorScore® certified and are tested and comply with the requirements of the California Department of Public Health Standard Method for the Testing & Evaluation of VOC Emissions (CDPH V1.1., 2010).

8.0 Extraordinary Effects

8.1 Fire Performance

BioBased Tile demonstrates the following fire performance:

- Class 1 when tested in accordance with ASTM E 648/NFPA 253, Standard Test Method for Critical Radiant Flux
- Meets 450 or less when tested in accordance with ASTM E 662/NFPA 258, Standard Test Method for Smoke Density
- Flame Spread Index – 0 and Smoke Developed Index 25 or less when tested in accordance with CAN/ULC S102.2, Standard Test Method for Flame Spread Rating and Smoke Development

8.2 Insulation Value

ASTM C518 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Flow Meter Apparatus
 R-value = 0.07 [ft² F h/Btu] R-value = 0.013 [m² K/W]

9.0 End of Life Stage

9.1 Disposal

Disposal in municipal landfill or commercial incineration facilities is permissible and should be done in accordance with local, state, and federal regulations.

10.0 Life Cycle Assessment

This study provides life cycle inventory and environmental impacts relevant to Armstrong flooring systems. This LCA was conducted to 1) better understand the environmental impacts of the life cycle of flooring systems; 2) learn how the impacts of raw material selection, product formulation, and manufacturing process influence the life cycle impacts of flooring systems, and 3) use innovation to drive reduction in the product.

The methods for conducting the life cycle assessments, upon which this EPD is based, were consistent with ISO 14040 and 14044. This report is intended to fulfill the reporting requirements in Section 5 of ISO 14044 and the Product Category Rules for Flooring: Carpet, Resilient, Laminate, Ceramic, Wood.

10.1 Information on the Product System Definition and Modeling of the Life Cycle

The functional unit for this EPD is 1 m² of BBT for use over 1 year.

Flooring System View: In order to understand the complete view of a flooring system, life cycle information is included for the total flooring system based on 1 square meter (m²) view. This includes the flooring tile, adhesives and finishes applied during the use stage.

10.0 Life Cycle Assessment (continued)

System Boundaries:

The system boundaries studied as part of this life cycle assessment include extraction of primary materials, raw materials manufacture, flooring panel production, installation, and end of life.

The phases below outline a “cradle-to-grave” life cycle assessment for flooring tiles (Figure 4).

Figure 4. Life cycle phases included for the BioBased Tile in study:

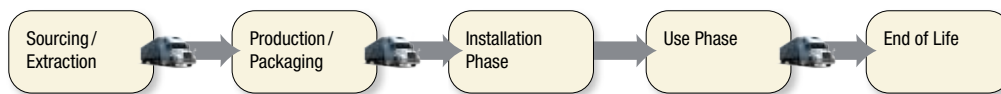
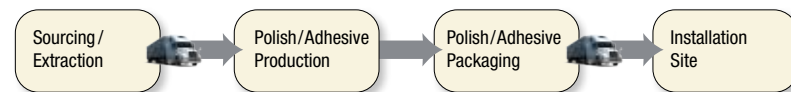


Figure 5. Life cycle phases included in the adhesive and polish used during the use stage of the study:



As Shown in Figures 4 and 5, the Cradle-to-Grave Assessment Includes:

- Raw materials production including raw material and packaging materials for BioBased Tiles, adhesive and polish
- Transportation of raw materials to the manufacturing facility
- Manufacturing of the tiles at the manufacturing facility
- Packaging of finished products including energy to operate packaging equipment
- Transportation from manufacturing facility to distribution centers, retailers, and job site (assumed to be 500 miles by truck)
- Use phase covers a useful life of 60 years as required by the PCR and includes the transportation and installation of the system including adhesive, polish and maintenance
- End of life includes landfill disposal of BioBased Tiles with assumed 50 miles by truck

The Cradle-to-Grave Assessment Excludes:

- Overhead energy usage (heating, lighting) of manufacturing facilities
- Maintenance and operation of support equipment

10.0 Life Cycle Assessment (continued)

Assumptions:

Armstrong World Industries began conducting life cycle assessments in 2006 and completed a baseline LCA of key flooring products in 2012.

This map shows the location of the Armstrong® BBT manufacturing facility. Transportation emissions and fuels throughout the life cycle phases are included. All transportation associated with raw materials reflects the actual modes of transportation and mileage. Disposal transportation at end of life is assumed to be 50 miles.



● Manufacturing Location

Cutoff Criteria:

The cutoff criteria for the study are as follows:

- Mass – If a flow is less than 1% of the cumulative mass of the model, it is excluded, providing its environmental relevance is not a concern.
- Energy – If a flow is less than 1% of the cumulative energy of the model, it is excluded, providing its environmental relevance is not a concern.
- Environmental relevance – If a flow meets the above criteria for exclusion, yet is believed to potentially have a significant environmental impact, it is included.

Data Quality:

The LCA model was created using the GaBi 6 Software system for life cycle engineering, developed by PE INTERNATIONAL GmbH. The GaBi database provides the life cycle inventory data for several of the raw and process materials obtained from the background system. The data quality is considered to be good to high quality. With the exception of supplier specific data, all other relevant background data was taken from the GaBi database software. No data set was over 10 years old.

All gate-to-gate, primary foreground data was collected for the flooring manufacturing process. This foreground data was from annual production for the year of 2011. Background data was collected from suppliers or generic data was used. When generic data was used, it was verified and triangulated against several sources.

Allocation:

Co-Product Allocation – No co-product allocation occurs in the product system.

Multi-Input Processes Allocation – No multi-input allocation occurs in the product system.

Reuse, Recycling, and Recovery Allocation – The cut-off allocation approach is adopted in the case of any recycled content, which is assumed to enter the system burden-free. Only environmental impacts from the point of recovery and forward (e.g., collection, sorting, processing, etc.) are considered.

Product and packaging waste is modeled as being disposed in a landfill rather than incinerated or recycled. Plastic and other construction waste is assumed to be inert in landfills so no system expansion or allocation is necessary as landfill gas is not produced. In the case of biobased packaging waste disposed during installation, landfill gas from the decomposition of this waste is assumed to be collected and used to produce electricity. It is assumed that this recovered energy offsets energy produced by the US average grid.

10.0 Life Cycle Assessment (continued)

10.2 Results of the Life Cycle Assessment

The LCA results are documented separately for the following stages:

1. Sourcing/Extraction
2. Production
3. Installation
4. Use Phase
5. End of Life

Table 6 shows the results for 1 m² of BioBased Tile installed and maintained for one year.

Table 6. LCA of BBT for 1 m² of installed BBT flooring including medium intensity maintenance for 1 year

| IMPACT MEASURE ^{1,2} | SOURCING / EXTRACTION | PRODUCTION | INSTALLATION | USE PHASE ³ | END OF LIFE | TOTAL |
|--|-----------------------|------------|--------------|------------------------|-------------|----------|
| 1 Year Use | | | | | | |
| Primary Energy (MJ) | 40.2 | 21.6 | 26.5 | 13.6 | 2.0 | 103.9 |
| Global Warming Potential (kg CO ₂ equivalent) | 3.54 | 1.05 | 0.88 | 0.61 | 0.14 | 6.22 |
| Acidification Potential (kg SO ₂ equivalent) | 5.30E-03 | 2.80E-03 | 4.60E-03 | 2.20E-03 | 8.00E-04 | 1.56E-02 |
| Eutrophication Potential (kg PO ₄ ³⁻ equivalent) | 1.00E-03 | 2.00E-04 | 6.00E-04 | 2.00E-04 | 1.00E-04 | 2.20E-03 |
| Ozone Depletion Potential (kg R11 equivalent) | 1.28E-08 | 6.68E-09 | 6.09E-11 | 1.61E-10 | 1.57E-12 | 1.97E-08 |
| Photochem Ozone Creation Potential (kg Ethene equivalent) | 1.70E-03 | 1.60E-03 | 1.00E-04 | 4.00E-04 | 0.00E+00 | 3.90E-03 |
| 60 Year Use | | | | | | |
| Primary Energy (MJ) | 96.4 | 51.7 | 63.5 | 814.4 | 4.8 | 1030.8 |
| Global Warming Potential (kg CO ₂ equivalent) | 8.50 | 2.50 | 2.10 | 36.80 | 0.30 | 50.20 |
| Acidification Potential (kg SO ₂ equivalent) | 1.27E-02 | 6.70E-03 | 1.11E-02 | 1.29E-01 | 1.80E-03 | 1.62E-01 |
| Eutrophication Potential (kg PO ₄ ³⁻ equivalent) | 2.30E-03 | 5.00E-04 | 1.60E-03 | 1.29E-02 | 3.00E-04 | 1.76E-02 |
| Ozone Depletion Potential (kg R11 equivalent) | 3.07E-08 | 1.60E-08 | 1.46E-10 | 9.69E-09 | 3.77E-12 | 5.66E-08 |
| Photochem Ozone Creation Potential (kg Ethene equivalent) | 4.10E-03 | 3.90E-03 | 3.00E-04 | 2.58E-02 | 0.00E+00 | 3.41E-02 |

¹ Additional Impact Measures are included in Section 10.

² Impact as based on CML 2001-Nov. 2010.

³ Use phase impacts are based on medium intensity maintenance practices as described in Section 7.

10.0 Life Cycle Assessment (continued)

Table 7. Cradle to Gate Life Cycle Assessment Results for 1 m² of BBT for 1 Year

| IMPACT MEASURE (CML 2001-Nov. 2010) | SOURCING / EXTRACTION | PRODUCTION | CRADLE-GATE TOTAL |
|--|-----------------------|------------|-------------------|
| Primary Energy (MJ) | 40.2 | 21.6 | 61.8 |
| Global Warming Potential (kg CO ₂ equivalent) | 3.54 | 1.05 | 4.59 |
| Acidification Potential (kg SO ₂ equivalent) | 5.30E-03 | 2.80E-03 | 8.10E-03 |
| Eutrophication Potential (kg PO ₄ ³⁻ equivalent) | 1.00E-03 | 2.00E-04 | 1.20E-03 |
| Ozone Depletion Potential (kg R11 equivalent) | 1.28E-08 | 6.68E-09 | 1.95E-08 |
| Photochem Ozone Creation Potential (kg Ethene equivalent) | 1.70E-03 | 1.60E-03 | 3.30E-03 |
| Abiotic Depletion, Elements (kg Sb-equivalent) | 2.04E-06 | 2.85E-07 | 2.33E-06 |
| Abiotic Depletion, Fossil (MJ) | 38.0 | 15.0 | 53.0 |

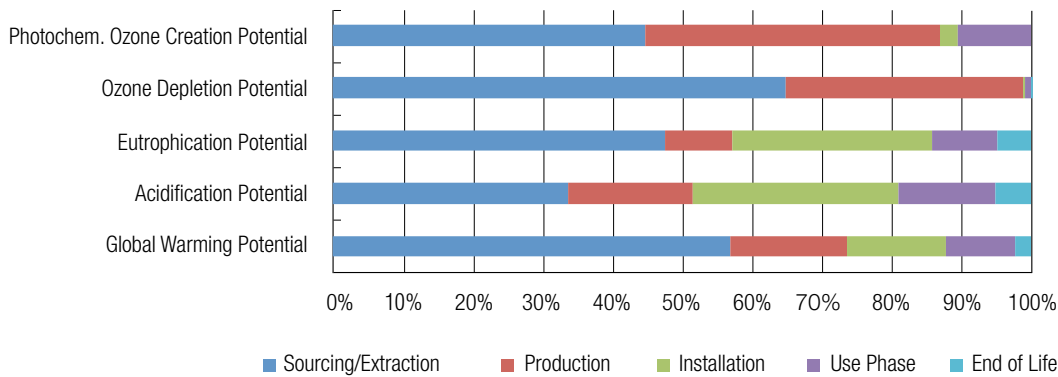
Table 8. Cradle to Grave Life Cycle Assessment Results for 1 m² of BBT for 1 Year

| IMPACT MEASURE (CML 2001-Nov. 2010) | CRADLE-GATE | INSTALLATION | MAINTENANCE INTENSITY | | | END OF LIFE | TOTAL IMPACTS (Cradle-Grave) | | |
|--|-------------|--------------|-----------------------|----------|----------|-------------|------------------------------|----------|----------|
| | | | LOW | MED | HIGH | | LOW | MED | HIGH |
| Primary Energy (MJ) | 61.8 | 26.5 | 6.8 | 13.6 | 27.2 | 2.0 | 97.1 | 103.9 | 117.5 |
| Global Warming Potential (kg CO ₂ equivalent) | 4.59 | 0.88 | 0.31 | 0.61 | 1.22 | 0.14 | 5.92 | 6.22 | 6.83 |
| Acidification Potential (kg SO ₂ equivalent) | 8.10E-03 | 4.60E-03 | 1.10E-03 | 2.20E-03 | 4.40E-03 | 8.00E-04 | 1.46E-02 | 1.57E-02 | 1.79E-02 |
| Eutrophication Potential (kg PO ₄ ³⁻ equivalent) | 1.20E-03 | 6.00E-04 | 1.00E-04 | 2.00E-04 | 4.00E-04 | 1.00E-04 | 2.00E-03 | 2.10E-03 | 2.30E-03 |
| Ozone Depletion Potential (kg R11 equivalent) | 1.95E-08 | 6.09E-11 | 8.05E-11 | 1.61E-10 | 3.22E-10 | 1.57E-12 | 1.96E-08 | 1.97E-08 | 1.99E-08 |
| Photochem Ozone Creation Potential (kg Ethene equivalent) | 3.30E-03 | 1.00E-04 | 2.00E-04 | 4.00E-04 | 8.00E-04 | 0.00E+00 | 3.60E-03 | 3.80E-03 | 4.20E-03 |
| Abiotic Depletion, Elements (kg Sb-equivalent) | 2.33E-06 | 2.86E-07 | 3.47E-07 | 6.93E-07 | 1.39E-06 | 4.14E-08 | 3.00E-06 | 3.35E-06 | 4.04E-06 |
| Abiotic Depletion, Fossil (MJ) | 53.0 | 26.0 | 6.5 | 13.0 | 26.0 | 2.0 | 87.5 | 94.0 | 107.0 |

10.0 Life Cycle Assessment (continued)

Figure 6. Life Cycle Impact Results for BBT (1 year)*

Figure 6 shows the relative importance in percentage terms for the raw material Sourcing/Extraction, Production, Installation, Use, and End of Life stages for BioBased Tile.



*Based on CML 2010 Impact Factors.

Table 9. TRACI 2.0 LCA Results for 1 m² of BBT for 1 year

| IMPACT MEASURE (TRACI 2.0) | SOURCING / EXTRACTION | PRODUCTION | INSTALLATION | USE PHASE (1 yr) | END OF LIFE | TOTAL |
|--|-----------------------|------------|--------------|------------------|-------------|----------|
| Global Warming Potential (kg CO ₂ equivalent) | 3.54 | 1.05 | 0.88 | 0.61 | 0.14 | 6.22 |
| Acidification Potential (kg mol H ⁺ equivalent) | 0.29 | 0.14 | 0.26 | 0.11 | 0.05 | 0.85 |
| Eutrophication Potential (kg PO ₄ ³⁻ equivalent) | 1.40E-03 | 2.00E-04 | 3.00E-04 | 2.00E-04 | 1.00E-04 | 2.10E-03 |
| Ozone Depletion Potential (kg CFC11 equivalent) | 1.28E-08 | 8.05E-09 | 6.31E-11 | 1.91E-10 | 1.68E-12 | 2.11E-08 |
| Smog (kg O ₃ equivalent) | 0.08 | 0.05 | 0.07 | 0.02 | 0.02 | 0.24 |

10.0 Life Cycle Assessment (continued)

Figure 7 shows the sources of primary energy separated into non-renewable and renewable resources. Figures 8 and 9 show the contribution of different resources to renewable and non-renewable primary energy. All figures refer to energy sources used to manufacture BioBased Tile in 2011.

Figure 7. Sources of Primary Energy

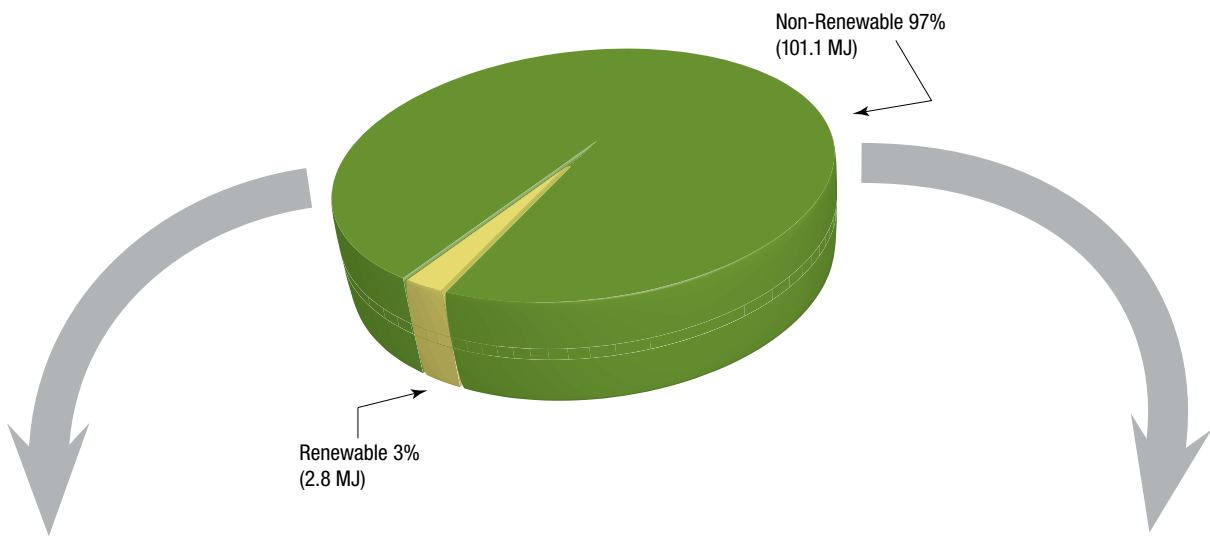


Figure 8. Renewable Energy by Source

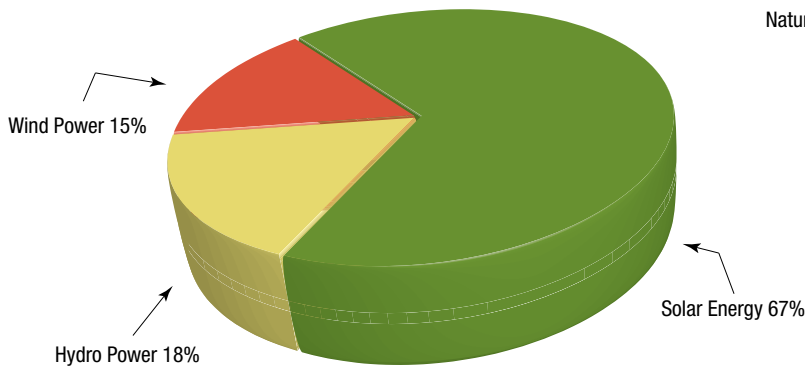
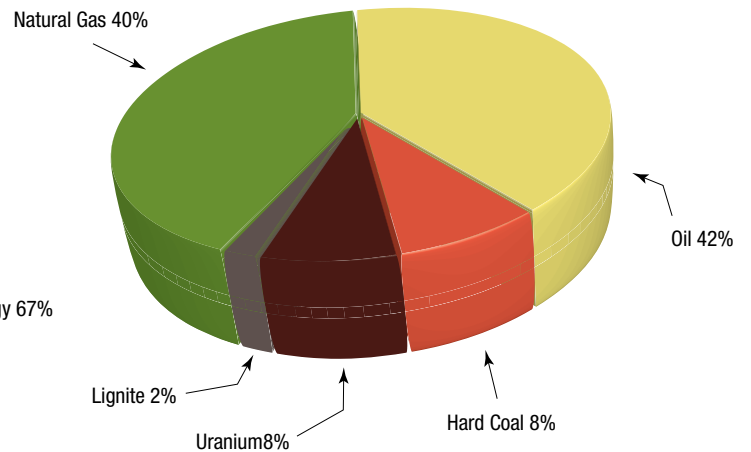


Figure 9. Non-Renewable Energy by Source



10.0 Life Cycle Assessment (continued)

Waste and Water Consumption

The waste shown in Table 10 accounts for the waste generated at Armstrong® manufacturing facilities (“Production”). The “Use” phase waste accounts for the disposal of the packaging and scrap materials generated during installation; the quantity of flooring disposed of following removal from a building is shown in the “End of Life” phase. These waste values do not include the waste generated in the upstream processes. Other waste categories specified in the PCR were excluded due to data quality.

The life cycle of this product consumes water during production while producing non-hazardous wastes. The quantities are separated into contribution per life cycle stage as shown in Table 10 for 1 m² of BioBased Tile.

Table 10. Resources and Wastes for BioBased Tile (1 m²)

| RESOURCES AND WASTES | UNIT | SOURCING / EXTRACTION | PRODUCTION | INSTALLATION | USE PHASE (1 YR) | END-OF-LIFE | TOTAL |
|--------------------------------|------|-----------------------|------------|--------------|------------------|-------------|--------|
| Non Renewable Material Sources | kg | 7.80 | 1.00 | 0.50 | 0.50 | 0.80 | 10.60 |
| Water Use | kg | 791.0 | 229.0 | 178.0 | 138.0 | 69.0 | 1405.0 |
| Hazardous Waste Production | kg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Non Hazardous Waste Production | kg | 1.66 | 1.02 | 0.45 | 0.40 | 7.47 | 11.00 |
| Secondary Fuels (Net) | MJ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

10.3 Interpretation of Life Cycle Assessment

From the results of the flooring system life cycle covered in this study, it was concluded that the flooring manufacturing process and raw materials – specifically, polyester in the binder – have the greatest impact on Primary Energy Demand (PED) and “carbon footprint” (represented by Global Warming Potential [GWP]).

As shown in Figure 6, End of Life impacts are minimal when compared to other life cycle stages.

10.4 Flooring Impacts:

As shown in Table 6 on page 12, the majority of the environmental impacts for this product occurs during the extraction and processing of raw materials detailed in the Production Stage. For most flooring, the opportunity for reduction is in the manufacturing process as well as reductions associated with raw materials.

10.5 Use Stage:

The use stage is defined in the PCR at 60 years and this is what was used in the LCA. The assumption is that the flooring requires normal maintenance as shown in Table 5. Additional details regarding the assumptions and details of how the use phase was modeled in this study can be found in Section 7. Impacts associated with the Use Stage vary depending on the building owner’s maintenance practices, level of use, and traffic conditions. Figure 5 provides details of three (3) maintenance scenarios and the impacts resulting from the scenarios are provided in Table 8. The low intensity maintenance scenario results in lower environmental impacts. For example, less scrubbing means less water consumption and a lower eutrophication potential.

10.6 End of Life Impacts:

End of Life Impacts associated with landfilling of BioBased Tile flooring had the greatest impact on eutrophication and acidification potential.

BioBased Tile® (BBT®)

According to ISO 14025

11.0 Additional Information, Evidence, Test Certificates

11.1 VOC Emissions

All Armstrong® BBT flooring products are FloorScore® certified and are tested and comply with the requirements of the California Department of Public Health Standard Method for the Testing & Evaluation of VOC Emissions (CDPH V1.1., 2010).

11.2 Sustainability Certifications

Armstrong BioBased Tile has been certified by ULE at the Gold Level per the NSF/ANSI 332 Standard for Sustainability Assessment for Resilient Floor Coverings.

12.0 References

12.1 PCR

Product Category Rules for Environmental Product Declarations. Flooring: Carpet, Resilient, Laminate, Ceramic, Wood. NSF International. (2012)

12.2 Standards

ISO 14025:2006 Environmental labels and declarations – Type III – environmental declarations - Principles and procedures
 ISO 14040:2006 Environmental management – Life cycle assessment – Principles and framework
 ISO 14044:2006 Environmental management – Life cycle assessment – Requirements and guidelines
 ASTM E648-10 Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
 ASTM E662-13 Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials
 ASTM C518-10 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
 ASTM C423-09a Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
 ASTM F 2982-Standard Specification for Polyester Floor Tile
 CAN/ULC-S102, 2010-2017. Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies and Miscellaneous Material and Assemblies
 2010 Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers – Version 1.1 – California

13.0 Third Party Evaluations

- Certificate of Compliance for VOC Emissions: Berkeley Analytical and FloorScore
- Climate Registry certification of our greenhouse gas (GHG) inventories
- Certificate for NSF-332 Gold



BioBased Tile® (BBT®)

According to ISO 14025

14.0 Quality Assurance

Armstrong has a robust internal Quality Assurance process that is based on industry-accepted best practices and is led by a team of quality professionals who have been certified by the American Society for Quality. The process involves several hundred different measures made throughout the manufacturing processes. All Armstrong BioBased Tiles are manufactured in ISO 9001 certified plants.

15.0 References

Table 11. Life Cycle Impact Assessment Categories, Indicators of Contribution to Environmental Issues, Units of Measure, and Brief Descriptions

| IMPACT CATEGORY | INDICATOR | DESCRIPTION | UNIT | REFERENCE |
|-----------------|---|---|-------------------------------|--|
| Acidification | Acidification Potential (AP) | A measure of emissions that cause acidifying effects to the environment. The acidification potential is assigned by relating the existing S, N, and halogen atoms to the molecular weight. | mol H ⁺ equivalent | J. Bare, TRACI: The Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts 2.0, 2011. |
| Climate Change | Global Warming Potential (GWP) | A measure of greenhouse gas emissions, such as CO ₂ and methane. These emissions are causing an increase in the absorption of radiation emitted by the earth, magnifying the natural greenhouse effect. | kg CO ₂ equivalent | Intergovernmental Panel on Climate Change (IPCC). IPCC Guidelines for National Greenhouse Gas Inventories 2006. |
| Eutrophication | Eutrophication Potential (EP) | An indicator of the potential to cause an increase in biomass production. In water, this can lead to algal blooms resulting in oxygen depletion that affects higher species such as fish. Undesirable shifts in numbers of species can also occur, resulting in a threat to biodiversity. | kg Nitrogen equivalent | J. Bare, TRACI: The Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts 2.0, 2011. |
| Ozone Creation | Photochemical Oxidant Potential (POCP)/Smog Potential | A measure of emissions of precursors that contribute to low level smog, produced by the reaction of nitrogen oxides and VOC's under the influence of UV light. | kg NO _x equivalent | J. Bare, TRACI: The Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts 2.0, 2011. |
| | Primary Energy Demand | A measure of the total amount of primary energy extracted from the earth. PED is expressed in energy demand from non-renewable resources (e.g., petroleum, natural gas, etc.) and energy demand from renewable resources (e.g., hydropower, wind energy, solar, etc.). Efficiencies in energy conversion (e.g., power, heat, steam, etc.) are taken into account. | MJ | |
| | Water Consumed | Water consumption is the sum of all water inputs to the life cycle. Includes water required for production of raw materials, upstream datasets, and manufacturing processes. Does not capture the end of life of the water consumed. | gal/ft ² | |
| | Waste Disposed | Waste disposed is the sum of all waste outputs from the life cycle. This includes hazardous and non-hazardous wastes and does not capture end of life of the waste generated. | lbs/ft ² | |

15.1 Definitions

GaBi 6.0 – LCA Modeling Software

CML-2010 – is an impact assessment tool developed by the Center of Environmental Science of Leiden University (CML). The CML methodology groups the LCI results into midpoint categories, according to themes. These themes are common mechanisms (e.g. climate change) or groupings. The impact categories used in this report are Global Warming Potential (GWP), Acidification Potential (AP), Eutrophication Potential (EP), Ozone Depletion Potential (ODP), Photochemical Ozone Creation Potential (POCP), Abiotic Depletion Elements (ADE) and Abiotic Depletion Fossil (ADF).