



# How Selecting Materials Impacts Our Lives

American Hardwoods and  
Life Cycle Assessment

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Whether you're an architect, designer, materials specifier or homeowner, you make choices every day that not only impact the quality of your life, but impact the environment. Whether selecting hardwood flooring over carpeting, natural materials versus synthetic, or replacing older appliances with energy efficient ones, our choices have long-term effects on the livability of planet Earth. Therefore, we all need to be knowledgeable about our options.

One of the most environmentally friendly building and design materials is American hardwoods. When considered through life cycle assessment (LCA) against other materials, hardwoods are favored for their extremely long service life, low carbon footprint, and eco-friendly disposal or repurposing at the conclusion of their useful lives.

Cover Photo: Mill's Tavern, Providence, RI, features white oak flooring. The interior vertical surfacing is also oak, and the interior of the panels are white oak veneer. The stile and rails are solid white oak and the ceiling beams are oak veneer. Photo credit: Warren Jagger Photography Inc. Above: North American Red Oak is showcased in foyer of Amsterdam Conservatory. Photo courtesy of American Hardwood Export Council.

## What is LCA?

Life cycle assessment, also known as life cycle analysis, eco-balance or cradle-to-grave analysis, is the evaluation of a product's impact through its total existence, from raw material procurement, through manufacturing, through its service life, and ultimate disposal.

It begins with a life cycle inventory, which collects measurable data related to raw materials, energy consumption, and manufacturing processes. It may also include product use, transportation, maintenance, and other factors. Using a system of standardized measurement allows products and processes to be uniformly measured, no matter where they are manufactured. This measurement system also allows one product to be evaluated against another to determine the impact of each on the environment over its useful life.

## Life Cycle Cost Analysis

In addition to measuring the environmental impact of a material over its lifetime, another evaluation factor can be the total costs associated with a material, including initial material costs, installation, and on-going maintenance, commonly known as life cycle cost analysis (LCCA).

Based on manufacturers' published maintenance data/life cycle costs, and conversations with manufacturers' representatives, an architectural firm developed a life cycle cost comparison of a dozen frequently used synthetic and natural flooring products. Their matrix indicates that in facilities with a lifetime use of more than 15 years, hardwood flooring – while it may have higher upfront costs – has significantly lower life cycle costs. (See LCCA chart page 11.) Note that in the chart Engineered Hardwood (made by attaching a layer of hardwood to a softwood base) is evaluated. Solid hardwood flooring has a useable product life of 100+ years for an even longer LCCA.

Average installed costs ranged from \$1.45 to \$12.00 per square foot, with vinyl composition tile on the low end and hardwood on the higher end. When comparing useable product life, replacement, cleaning and labor costs over 15 years, products with the lowest initial costs actually rank among those with the highest total life cycle costs. Hardwood, rubber and bamboo flooring have the lowest total cost at 15 years among the dozen flooring materials compared.

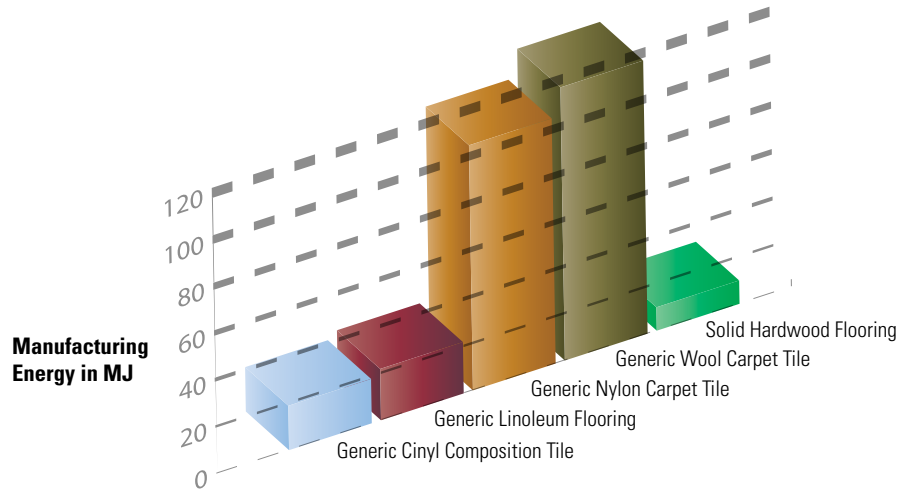
**When considered through LCA, hardwoods are favored.**

## CORRIM Favors Hardwood

A number of studies have been done on the environmental impacts of hardwoods. In 2007-2008, the National Wood Flooring Association Industry Research Foundation conducted a life cycle analysis of wood flooring in conjunction with the Consortium for Research on Renewable Materials (CORRIM), in Madison, Wisconsin. The study evaluated solid strip hardwood flooring compared to other flooring alternatives, such as vinyl, linoleum and carpet, with regard to air emissions, energy use, water use, and product service life, finding solid hardwood flooring to be desirable from an environmental impact standpoint, a conclusion that is consistent with previous studies in Europe.

The CORRIM study concluded that wood flooring has the least environmental impact of all other flooring options studied. This was based on several factors:

## Total Primary Energy Required to Manufacture Selected Floor Coverings



- Comparatively benign air emissions. Wood flooring was shown to have no emissions for methane, nitrogen oxide and other particulates, and minimal emissions for carbon dioxide.
- Comparatively less water consumption. Solid hardwood flooring and generic vinyl composition tile use substantially less water than other alternatives, with water use for production of hardwood flooring confined on-site to boilers for facility heating.

- Comparatively less total primary energy use. Of the five floor coverings considered, solid hardwood flooring uses the least amount of primary energy in manufacturing.
- Long service life and desirable end-of-life scenarios. Hardwood flooring may be recycled or combusted as wood fuel, representing an advantage to the environment over other disposal scenarios.
- Renewable nature of the raw wood input.
- Carbon neutral benefits associated with wood as a material.

## Measurement Models

Additionally, other assessment tools have emerged and are under continuous development to further simplify the evaluation process for materials specifiers.

For example, the SimaPro model contains a large database of products, common materials and processes; options for selecting LCA impacts of materials, components, buildings and processes;

and includes seven comprehensive, widely-accepted impact assessment methods.

The Athena™ Environmental Impact Estimator compares the cradle-to-grave ecological footprint of assemblies or completed structures. Using the Athena Model, wood, steel and concrete were compared across the six stages of a material's life expectancy: resource extraction, manufacturing, on-site construction, facility occupancy, and demolition and ultimate reuse or recycling. It found wood to have the lowest environmental impact in each of these categories, and that wood exceeds the other materials in terms of environmental soundness for energy use, production of greenhouse gases, air and water pollution, production of solid waste, and overall ecological resource use.

BEES® (Building for Environmental and Economic Sustainability) helps builders determine environmentally friendly and cost-effective products. And while the BEES database addresses

more than 230 products, only recently has hardwood flooring been included, based upon the findings of a U.S. study of the environmental impacts of producing hardwood lumber. This study (Bergman and Bowe 2008), conducted in hardwood sawmills in northeastern U.S., examined hardwood lumber manufacturing using life cycle inventory methodology and is the first step toward inclusion of hardwood flooring life cycle information in BEES.

## Hardwoods Improve the Environment

Environmentalists agree that hardwood is a carbon neutral substance because, while living, trees sequester substantial amounts of carbon in their cellular structure. In fact, nearly 50 percent of the dry weight of a tree is carbon. Overly mature trees, however, will release carbon into the atmosphere; thus the importance of responsibly managing forests and harvesting mature trees.





Responsibly managing forests and the sustained harvesting and processing of mature trees result in new tree growth and the continued sequestration of carbon. Each year for the last 50 years, American hardwood forests stored nearly 110 million tons of carbon dioxide (excluding all harvested material). This direct contribution of America's hardwood forests to carbon sequestration excludes the carbon held in long-term storage as a component of American hardwood products.

The conversion of wood into products such as flooring, furniture, cabinetry and moulding, contributes to the long-term removal of carbon dioxide from the atmosphere, helping to reduce greenhouse gases and global warming. With useful lives spanning generations, finished products crafted of American hardwoods act as an additional carbon store for many decades.

The Kaneko Commons atrium at Willamette University in Salem, OR, features maple acoustical paneling. Photo credit: ©Eckert&Eckert

## What Is A Carbon Footprint?

A carbon footprint is the measurement of greenhouse gases produced from day-to-day living through burning fossil fuels for electricity, heating, transportation and product manufacturing. Measured in tons of carbon dioxide, it is a current concern for many environmentalists who believe greenhouse gases are a contributing source to global warming.

Hardwoods play an important role in reducing America's overall carbon footprint.

- When a young forest is growing, it produces one ton of oxygen and absorbs 1.4 tons of carbon dioxide for every ton of wood.
- Trees actually sequester carbon into the wood, meaning it will not be released into the atmosphere.
- Carbon emissions associated with manufacturing wood products are less than the carbon stored within the wood during its growth cycle.

## How to Reduce Your Carbon Footprint

Being mindful of how energy is used will significantly reduce your carbon footprint. Here are a few simple things you can do as a building professional or homeowner:

### Building Professionals

- Measure choice impact with modeling systems such as LEED®, Green Globes™ and BIM (building information modeling).
- Source materials within a 500-mile radius of installation.
- Choose natural materials that require less processing.
- Specify energy-saving lighting.
- Choose high-efficiency heating and cooling systems.
- Specify materials that are recyclable.
- Recycle construction waste.

### Homeowners

- Use a set-back thermostat on your furnace.
- Reduce your hot water heater temperature a few degrees.
- Replace light bulbs with energy-saving bulbs.
- Do weekly shopping in a single trip.
- Carpool or use public transportation.
- Buy locally grown fruits and vegetables.
- Do full loads when operating dish washers and washing machines.
- Recycle as much as possible.
- Work from home one day per week.

## What to Consider When Selecting a Material

There are many factors to consider when choosing a building or decorating material. Some impact the environment more, while others are a cost consideration. Be a knowledgeable specifier and consumer. When making a selection, compare factors in a product's life cycle with those of American hardwoods:

What to Consider for Material Selection	How American Hardwoods Compare
Is the material natural or man-made?	American hardwoods are an all-natural material.
Is it a healthy material?	With hardwood floors, there is no place to harbor pollen or animal dander, and for mold to grow.
Does it require a lot of processing?	Cutting and drying of lumber is all that is required.
How much of the material is utilized?	Virtually every part of a log is used as lumber or by-products, including bark, sawdust and scrap.
How does importing products impact the environment?	Regionally sourced U.S. hardwoods don't incur burning fossil fuels to transport them across the ocean.
Why is it important to consider a material's origin?	Some foreign countries have no governing agencies to assure quality standards or environmentally safe manufacturing practices. In the U.S., quality standards and safe manufacturing practices are regulated by U.S. agencies and associations.
Are harmful chemicals needed for manufacturing and on-going maintenance?	With the proper finish, hardwood products require minimal maintenance, like dusting or occasional buffing.
What maintenance and repair costs are associated with the material?	Minimal maintenance is required. Typical repair is refinishing.
What is the useful life of the material? How does it compare with other materials?	A solid hardwood floor can last up to 125 years or longer with several refinishings. Museum quality furniture can last centuries.
Can the material be recycled or repurposed?	Finished hardwood products can be repurposed or used as a combustible fuel.
What happens to the material after its useful life?	If in a landfill, hardwoods naturally decay and return to nature, unlike many synthetics and plastics which will remain almost indefinitely.

Right: Tom Sealy Shaker style cherry bedroom by Gat Creek Furniture, [www.gatcreek.com](http://www.gatcreek.com). Inset: Tom Seely oak dining room table by Gat Creek Furniture, [www.gatcreek.com](http://www.gatcreek.com).





### **LCCA for Hardwood Furniture**

Life cycle cost analysis clearly favors the selection of solid hardwood furniture. Inexpensive pressboard furniture has a service life of five to seven years, with the latter being exceptional. Compare that to solid hardwood furniture, which will last a lifetime and beyond.

It can stand up to wear and tear in high traffic areas, as evidenced in schools, libraries and hospitals, and is equally durable in the home, where it can withstand the rigors of raising a family.

Hardwood furniture certainly has a higher initial cost, but like flooring, when considered over its useful life, quality furniture is a better investment.



## The Natural Choice

The information age has moved material selection well beyond form, function, style and cost. As more sophisticated measurement and assessment processes emerge, savvy designers, architects, builders and homeowners can weigh short-term monetary concerns against long-

term environmental concerns. Factors such as initial cost, useful life, healthy materials, energy consumption, cleaning and maintenance are all part of the new equation. So are global warming, water pollution, air and waste pollutants, habitat destruction, land misuse and destruction, as well as depletion of minerals and fossil fuels.

American hardwood is one of just a few all-natural choices for building materials and components. While some believe American hardwoods are a limited resource, they actually are abundant in supply and sustainable. The volume of hardwoods in American forests today is 90 percent larger than it was 50 years ago. And the U.S. Forest Service forecasts indicate that further increases of 15 to 20 percent are expected in the hardwood growing inventory through 2030.

We simply need to be knowledgeable about our options. With hardwood growth well exceeding removal, the U.S. supply of hardwoods for flooring, furniture, cabinetry and millwork is, by definition, sustainable - now and for future generations. Choose U.S. hardwoods - one of the most environmentally friendly building and design materials available.



Left: Art gallery featuring cherry floor, Shamrock Plank Flooring, [www.shamrockplankflooring.com](http://www.shamrockplankflooring.com).



Interior designer Sue Tartaglio developed this life cycle cost comparison of a dozen frequently used synthetic and natural flooring products. Despite its upfront costs, engineered hardwood flooring has one of the lowest total costs over a lifetime use of 15 years or more.

MATERIAL	ARCHITECTURAL REMARKS	USEABLE PRODUCT LIFE <sup>2</sup>	INST. COST (PER SQ. FT.) <sup>1</sup>	TIMES REPLACED IN 15 YEARS	MATERIAL COST AFTER 15 YEARS	CLEANING/LABOR AFTER 15 YEARS <sup>2</sup> (PER 1,000 SQ. FT.)	TOTAL COST IN 15 YEARS
<b>Vinyl Comp. Tile</b>	Requires at least five coats of finish	15 years	\$1.45	0	\$1,450	\$45,000	<b>\$46,450</b>
<b>Sheet Vinyl</b>	Requires some finish	20 years	\$4.23	0	\$4,230	\$58,500	<b>\$62,730</b>
<b>NF Sheet Vinyl</b>	No additional finish required <sup>4</sup>	20 years	\$4.23	0	\$4,230	\$18,000	<b>\$22,230</b>
<b>Linoleum</b>	Requires some finish <sup>4</sup>	40 years	\$4.75	0	\$4,750	\$18,000	<b>\$22,750</b>
<b>Cork</b>	Requires some finish	50+ years	\$11.00	0	\$11,000	\$7,500	<b>\$18,500</b>
<b>Rubber</b>	No additional finish required	20+ years	\$6.00	0	\$6,000	\$9,000	<b>\$15,000</b>
<b>Medium-Quality Broadloom Carpet</b>	Organic pat.; 6–6 nylon yarn	4–6 years	\$2.77	3	\$8,310	\$24,750	<b>\$33,060</b>
<b>High-Quality Broadloom Carpet</b>	Organic pat.; 6–6 nylon yarn	4–6 years	\$4.45	3	\$13,350	\$24,750	<b>\$38,100</b>
<b>Carpet Tile</b>	Ease of replacement	10 years	\$3.89	1	\$3,890	\$24,750	<b>\$28,640</b>
<b>Bamboo</b>	Readily renewable product	25+ years	\$12.00	0	\$12,000	\$1,500	<b>\$13,500</b>
<b>Ceramic Tile</b>	Bumpy ride; grout lines stain	15–20+ years	\$8.00	0	\$8,000	\$27,000	<b>\$35,000</b>
<b>Hardwood</b>	Engineered product evaluated	25 years <sup>5</sup>	\$12.00	0	\$12,000	\$3,000	<b>\$15,000</b>

Notes:

1. Basic installation—no angles or patterns.
2. Includes materials and labor. Based on number of cleanings required per year.
3. This life depends on proper maintenance.
4. With the factory applied urethane finish, no additional wax or sealer is required after installation. However, depending on the location, some additional finish will be necessary to augment the original finish, due to wear and tear on the product.
5. Solid hardwood floors can last 100+ years.

Above Right: Solid maple flooring is showcased in a custom-built LEED Platinum home in Sarasota County, FL. Photo courtesy of Josh Wynne Construction.





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