Understanding Thermally Modified Wood

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Presented By:

ARBOR WOOD CO
THERMALLY MODIFIED WOOD

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This educational offering is recognized by the Minnesota Department of Labor and Industry as satisfying **1.25 code/energy hours** of credit toward Building Officials and Residential Contractors continuing education requirements.

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The American Institute of Architects
Course No. AWTMT1326
This program qualifies for 1.0 LU/HSW Hour
Course Expiry Date: XX/XX/XX

Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

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IDCEC
INTERNATIONAL DESIGN
CONTINUING EDUCATION COUNCIL

Course Description

This course will explore the process of thermal modification. Thermal modification is a tested and proven process for increasing the dimensional stability, durability, and performance of wood while sustaining the natural beauty and design element all without the use of harsh chemicals. This course examines all aspects of this sustainable wood product and how it can be incorporated into a variety of projects.

Learning Objectives:

- Explain how the thermal modification process increases the durability of wood to provide a material that can be specified for longevity in building projects.
- Identify the ways that thermally modified wood can help contribute to the overall sustainability of a building project.
- Identify appropriate applications for the use of thermally modified wood to maintain aesthetic standards and ensure long-term performance.
- Explain the difference between wood preservation techniques in order to specify those that contribute to a healthier, more sustainable project while maintaining a specific design aesthetic.
- Apply course content to improve the design and performance of their own projects.

INTRODUCTION

Wood In The Built Environment

Wood has been used in construction and infrastructures throughout millennia and it is considered as one of the oldest building materials. The fact that wood is a natural product and aligned with the demand of modern societies for sustainability has boosted its popularity.

- Wood is natural, renewable, easy to work with, and readily available.
- A greater focus on embodied carbon has led to an increase in use.
- Historically, the use of wood has been challenged by its durability, decay, maintenance, inconsistent moisture content, and availability of high-quality wood.
- There have been a variety of processes developed in the last 30+ years that enhance the performance and durability of wood.

Processes To Increase Wood Performance

CHEMICAL TREATMENT
The use of chemicals to impregnate and cure the wood to protect against decay and increase durability. These treatments only work with softwood species.

WOOD BURNING / CHARRING
The Japanese art of Shou Sugi Ban involves charring wood to provide protection from water and other decay.

PAINTING / STAINING
These products provide an additional protective layer that prevents water and UV rays from getting to the wood. They require regular applications to maintain.

THERMAL MODIFICATION
The use of heat to change woods relationship with water, increasing dimensional stability and durability.

Four Approaches to Thermal Modification

1. **PLATO**
   A four-stage process of heating wood in wet conditions, drying, heating again, and curing in dry conditions.

2. **RETIFICATION**
   Heating wood in a nitrogen-rich atmosphere with a maximum 2% of oxygen content.

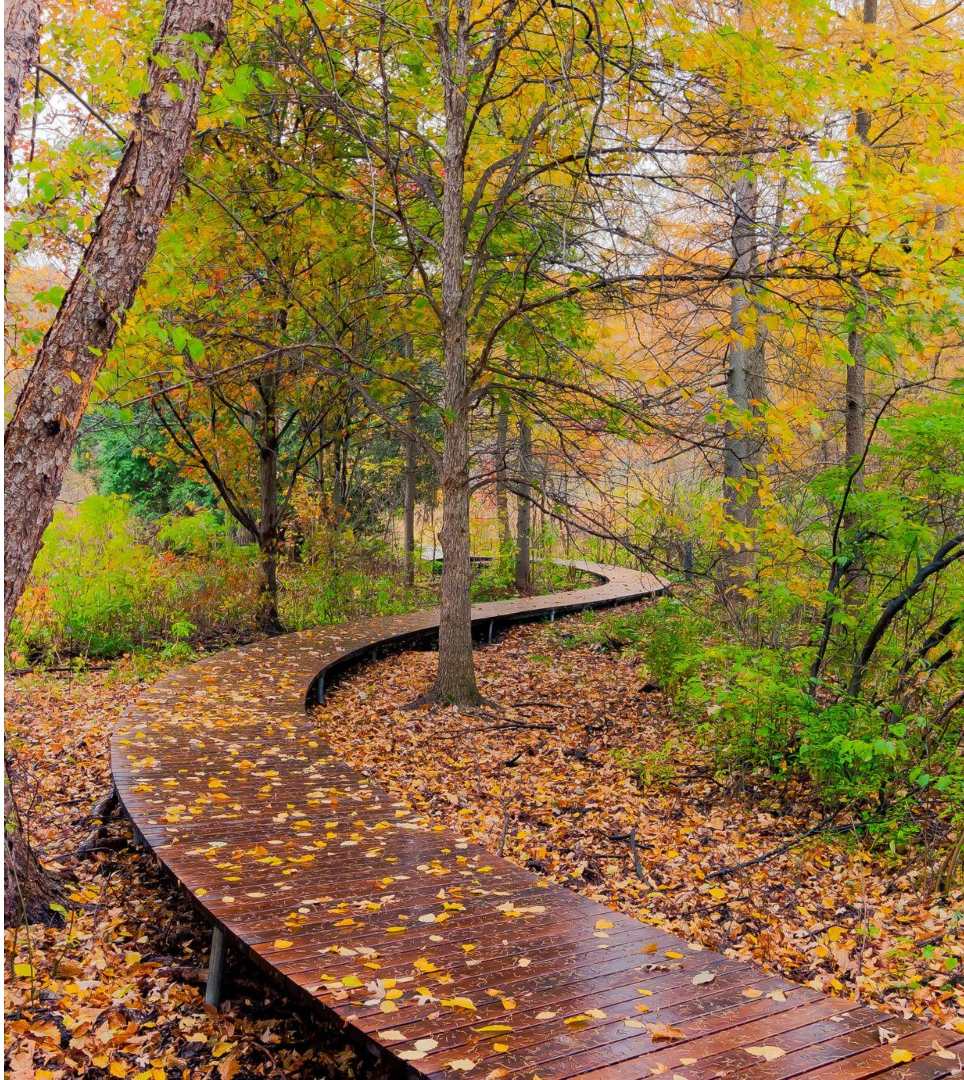
3. **OIL HEAT TREATMENT**
   Heat and oil introduced in an oxygen-starved environment.

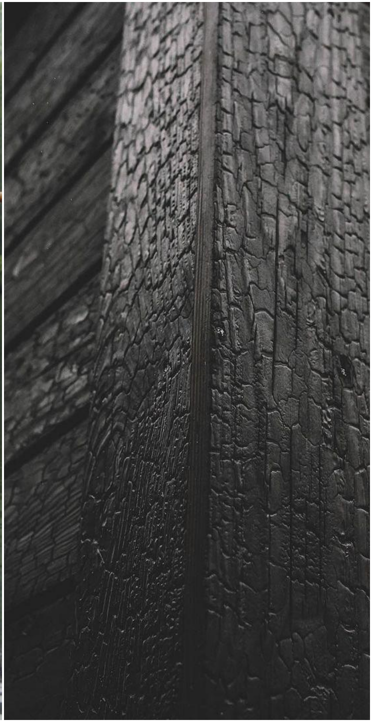
4. **THERMOWOOD MODIFICATION**
   Heat and steam are used in an oxygen-starved environment which is **the process we will focus on in this presentation.**

Thermal Modification

This **chemical-free** process uses nothing but **heat and steam** to modify the cellular structure of the wood and fundamentally changing wood's relationship with water.

- Thermal modification process takes place in a thermo kiln.
- The temperature of the wood is increased to over 400°F, removing all the moisture content from the wood cells, increasing the dimensional stability and overall durability of wood.
- The high heat process renders the wood hydrophobic, meaning it is permanently resistant to water.
- The process also cooks out the food sources for insects, fungi, and mold making it much more resistant to decay.





Origins of Thermal Modification

Evidence of the thermal modification can be traced back to early civilizations.

Vikings were known to use fire to treat their wooden ships for protection against harsh sea conditions.

The Japanese art of wood charring known as Shou Sugi Ban was used to increase the performance and beauty of exterior siding.

VTT

The ThermoWood process was developed in Finland in the early 90’s by VTT Technical Research Centre of Finland, a scientific arm of the Finnish government bringing value add to Finland’s most abundant resource; wood.

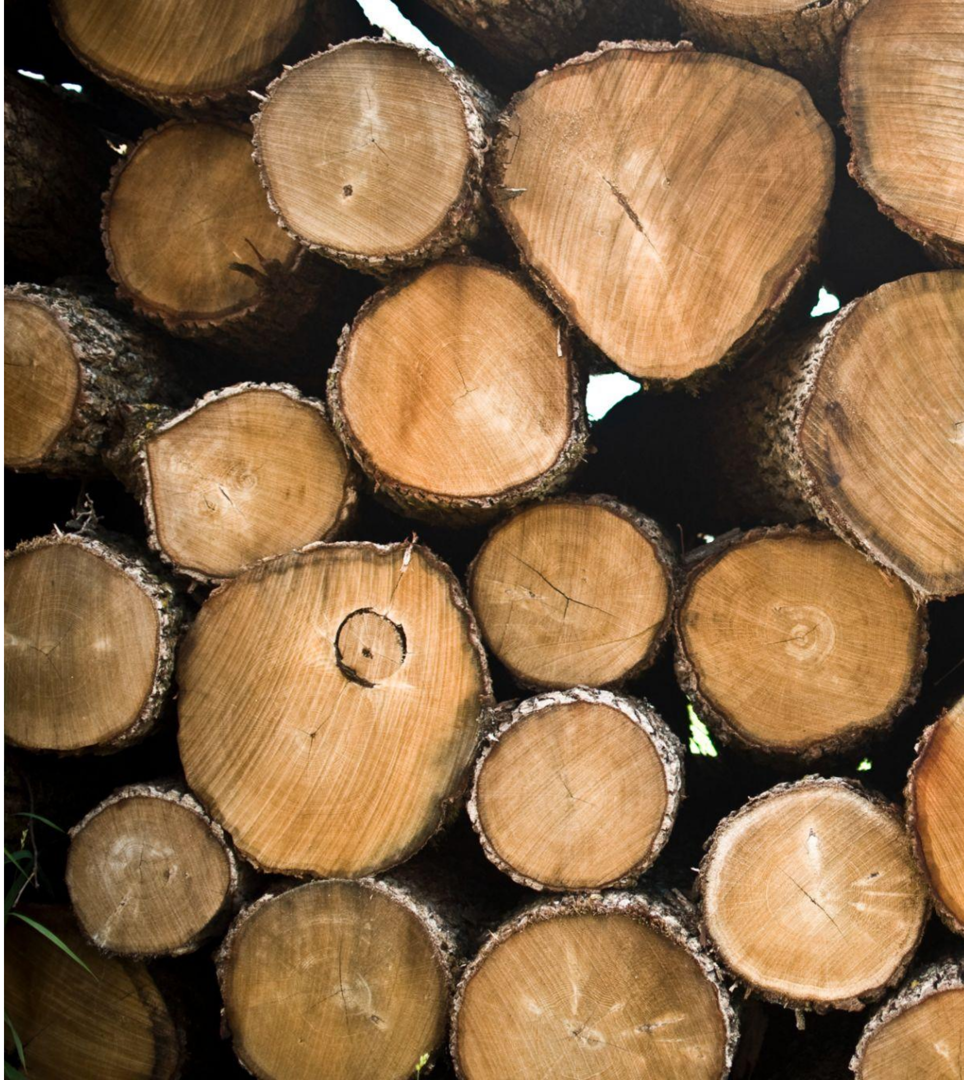
Species

There are a variety of wood species, both hardwoods and softwoods, that are appropriate for thermal modification;

- Red Oak
- White Ash
- Pine
- Spruce
- Hickory
- Hemlock

And many more.

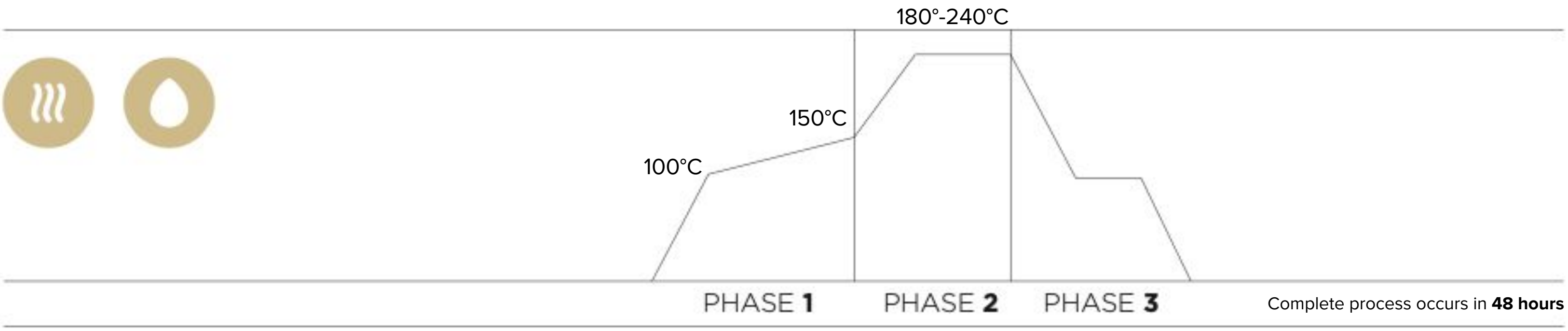
The most popular species for modification are currently Ash and Pine. As pricing and availability shifts, the market has responded. There are a number of new species being tested daily to ensure a sustainable and responsible supply of timber can be sourced for future projects.



Open System Thermowood Process

- Select grade kiln dried wood (12% MC +/-) is subjected to a secondary high heat thermal modification kiln.
- The system modifies the timber by a pyrolysis process at high temperatures and normal atmospheric pressure.
- The high heat causes hydrolysis, breaking up the hydroxyl groups in the hemicellulose of the wood.
- As these systems are easier to manufacture, there are numerous suppliers, making open systems the predominant choice of modification.

Thermal Modification Open System Process



PHASE 1: TEMPERATURE INCREASE
The temperature in the modification kiln begins to increase, removing much of the pitch and sap in the wood. Steam is introduced to prevent the wood from checking in the high heat. The moisture content of the wood is reduced from 15-20% down to nearly zero.

PHASE 2: THERMAL MODIFICATION
Oxygen is removed from the modification kiln and peak temperatures are achieved. This high-heat, oxygen-deprived environment causes hydrolysis - a breaking of the bond between H2O and the wood's hemicellulose. Low oxygen content prevents the wood from burning even at the high temperature.This phase is where thermal modification occurs.

PHASE 3: COOLING & RECONDITIONING
Temperature is reduced by introducing steam. The steam cools and conditions the wood to a moisture content of 4-6% improving dimensional stability. Depending on the environment, acclimation of the wood settles in the 6-7% range

Closed System Thermowood Process

- This system modifies timber by a hydrolysis process at high pressures but lower temperatures, so that pressure acts as a substitute for temperature.
- The wood is **pressurized** in a controlled, oxygen free atmosphere during the heating and cooling phases, and with only a small amount of water steam.
- It requires advanced design and manufacturing capabilities so there are a limited number of these systems in production.
- Thermal modification can be performed on any species of wood, hardwood or softwood, and although the capacity is less, the process takes place in 12 hours or less.

Ongoing Research with NRRI

The Natural Resources Research Institute at the University of Minnesota Duluth is currently researching additional topics to advance the use of thermally modified wood.

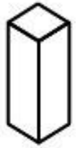
- Simple treatments to improve thermally modified wood color stability.
- Evaluating the use of thermally modified wood waste (e.g., chips, sawdust) to treat wastewater.
- Developing thermally modified strand-based composites for sheathing (similar to OSB), siding, subflooring, and mass timber. (patent pending).

Natural Resources Research Institute

UNIVERSITY OF MINNESOTA DULUTH

Driven to Discover™

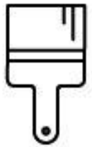
BENEFITS OF THERMALLY MODIFIED WOOD



SOLID & STABLE
Dimensional stability is increased, minimal expansion and contraction ensuring a straight board for life

HIGH PERFORMANCE
Less water absorption makes it less susceptible to mold, rot & fungal decay.

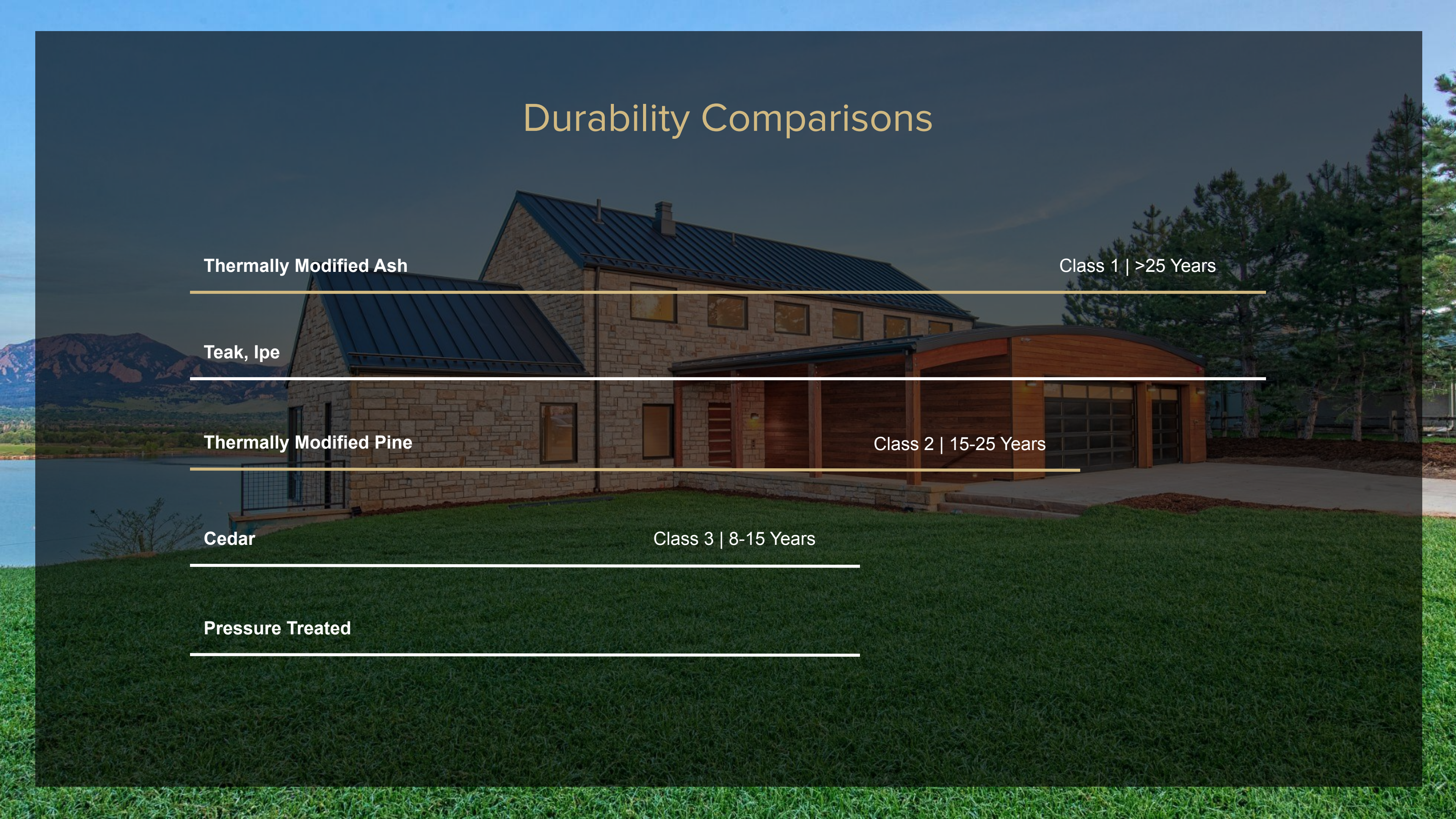
ENHANCED APPEARANCE
A rich, even tone throughout, a quick power wash restores wood back to its original color.



WORKABILITY
May be glued, painted, or finished similar to standard wood to achieve the desired look for your next project.

NATURAL PROCESS
Chemical-free process using only heat and steam.

LIGHTWEIGHT
Due to its low moisture content, Arbor Wood is lighter and easier to work with.



Durability Comparisons

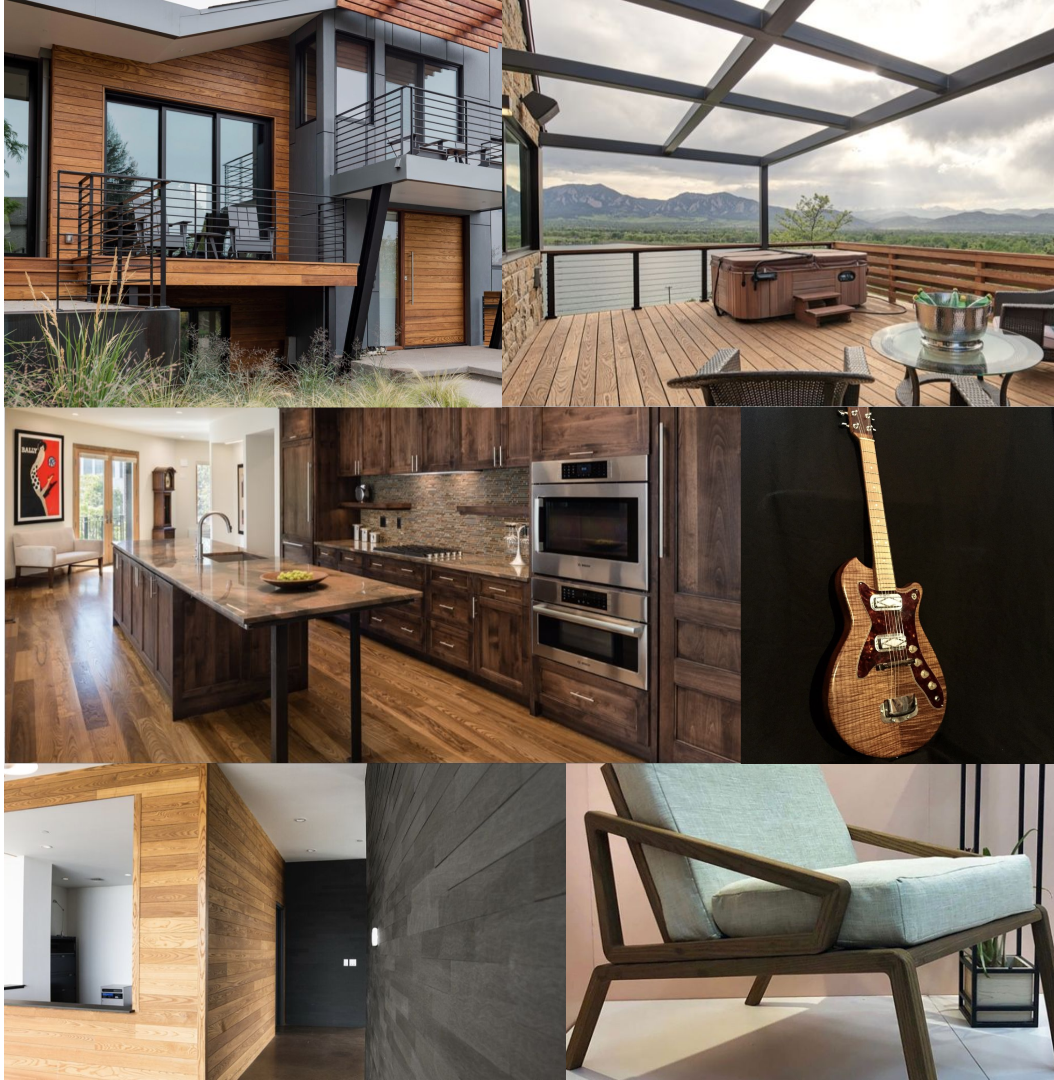
Thermally Modified Ash	Class 1 | >25 Years
Teak, Ipe	
Thermally Modified Pine	Class 2 | 15-25 Years
Cedar	Class 3 | 8-15 Years
Pressure Treated	

APPLICATIONS OF THERMALLY MODIFIED WOOD

Applications for Thermally Modified Wood

- Exterior Cladding
- Soffit & Fascia
- Decking
- Millwork
- Interior Walls & Ceilings
- Flooring
- Furniture
- Site Furnishings & Landscape Elements
- Musical Applications

And many more.



INSTALLATION & MAINTENANCE

Installation

Thermally modified wood is typically used as siding and decking along with traditional trim and millwork.

As it is a real wood product there is no limit to how thermally modified wood can be incorporated into building projects.

Most common installation solutions:

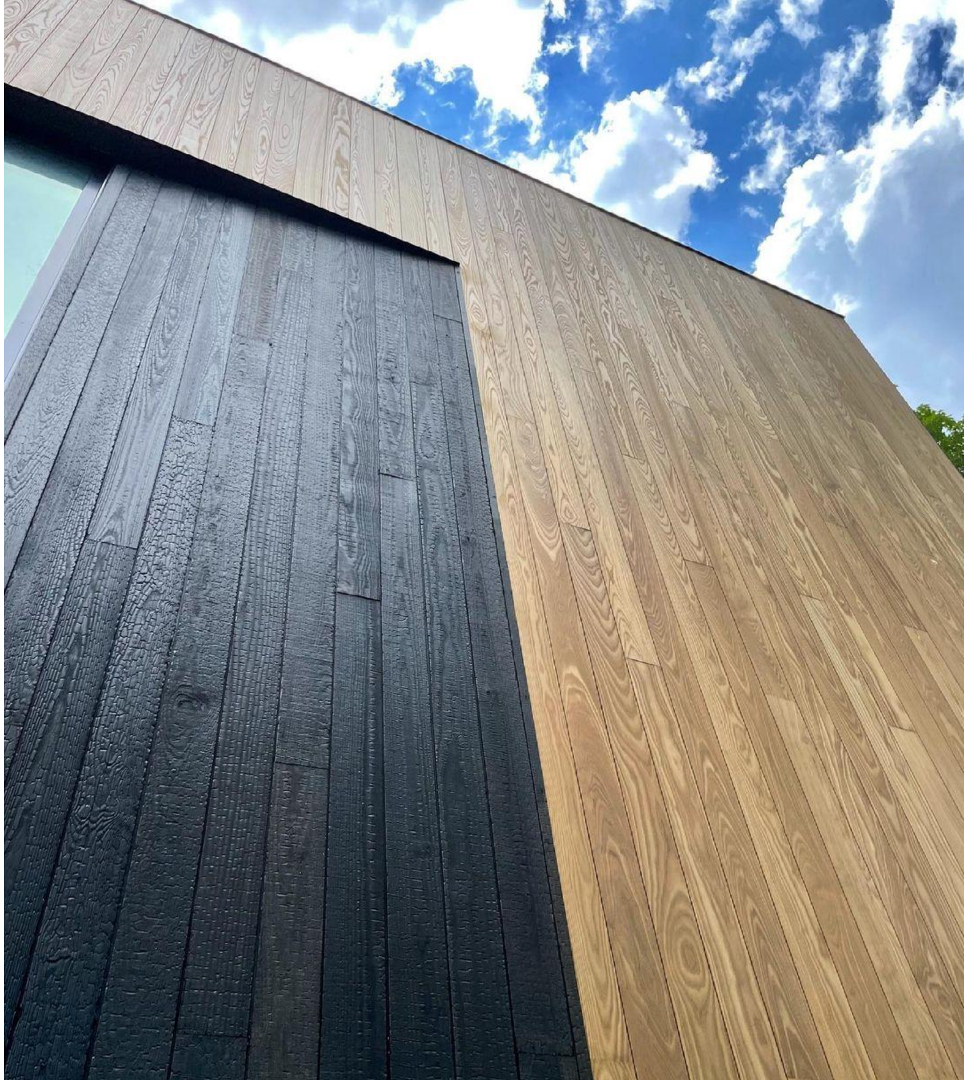
- Hidden fastener system
- Clip in rail systems
- Pre-Drilling and face fastening

Finishes

It is recommended to finish thermally modified wood with an exterior UV protective surface finish.

Factory finishing with a penetrating oil also helps reduce the natural surface checks that occur with wood over time. By conditioning the wood with a penetrating oil, small imperfections that often occur are reduced.

Modified wood will turn a weathered grey color over time when exposed to exterior elements and left untreated.



Color Change

Thermal modification changes the naturally occurring sugars in the wood resulting in beautiful, rich tones which extend through the full thickness of the material. Since it is still a natural product, the grain and unique characteristics of the wood remain. In an exterior environment, thermally modified wood will move to gray when unfinished and the application of a UV inhibitor helps maintain the original color.

SUSTAINABILITY

Sustainability

Thermally modified wood can be assessed in relation to areas of interest including:

- Embodied Carbon
- LEED Certification
- Living Building Challenge (LBC)
- Declare Label
- HPDs and EPDs
- Forest Certification
- Carbon Smart Wood

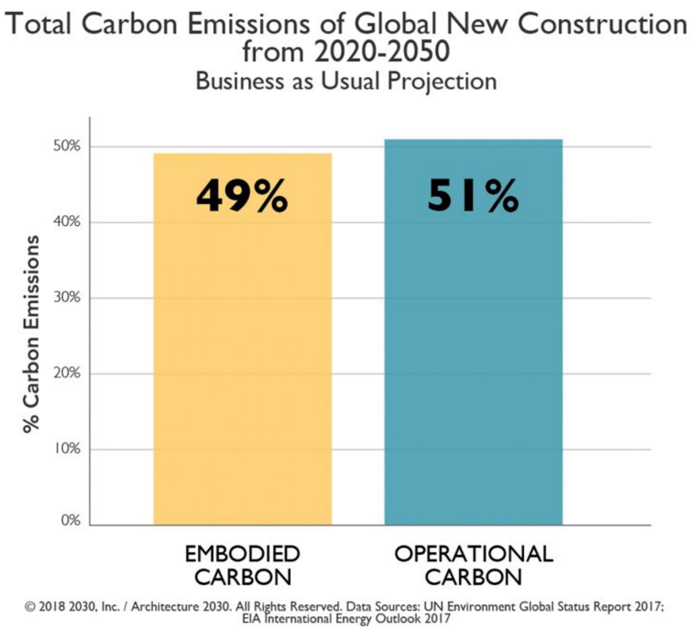
Embodied Carbons

When we transform the wood into a building product, that carbon is locked in and stored in the building for a very long time, preventing that carbon from entering the atmosphere.

Wood also acts as a carbon sink. What this means is that wood uses and absorbs carbon from the atmosphere as it grows.

There has been a shift in the sustainability conversation in recent years from a focus on operational carbon to embodied carbon.

- Operational carbon is the carbon related to operating a building.
- Embodied carbon is the carbon used to harvest, transport, and manufacture the materials used to build a building.



LEED Credits

Leadership in Energy and Environmental Design

POSSIBLE 3 POINTS

- Low-emitting materials

POSSIBLE 2 POINTS

- Building product disclosure and optimization - *environmental product declarations*

- Building product disclosure and optimization- *material ingredients*

- Building product disclosure and optimization- *sourcing of raw materials*

Living Building Challenge

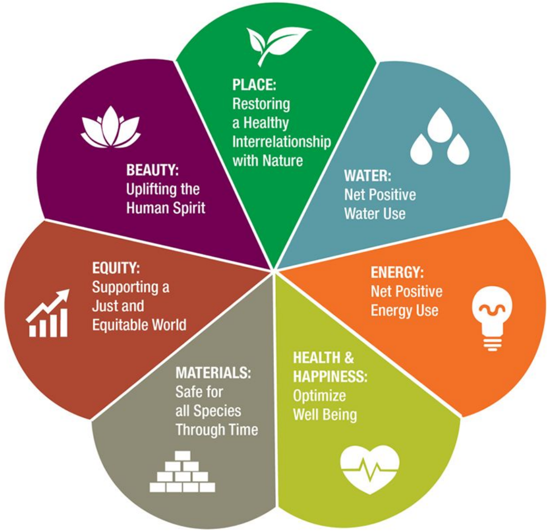
Green building products and practices as well as a well-being aspect

Seven petals such as health and happiness, materials, energy, beauty

Regenerative buildings connect occupants to light, air, food, nature, and community

Benefits human and natural systems

Thermally modified wood can also help contribute to LBC certification.



Declare.

Health Product Declaration (HPD)

Health Product Declaration (HPD) provides a chemical inventory of a building product and characterizes the level of concern about each ingredient.

Most, if not all, of the chemicals in the product are disclosed by the manufacturer, providing greater transparency in selecting products for buildings.

HPD's are helpful in the documentation and compliance of many certifications including:

- LEED
- Living Building Challenge / Declare
- WELL Building

Environmental Product Declaration (EPD)

An EPD (Environmental Product Declaration) is based on specific rules and requirements for each product type which is verified by a third party panel.

EPD's includes Life Cycle Environmental Inventory and Life Cycle Environmental Impact Analysis from material extraction through disposal.

Forest Stewardship Council (FSC)

- FSC is the Gold standard for sustainably managed forests providing a chain of custody from harvesting through to manufacture.

- Raw material extraction can result in:
    - Loss of habitat
    - Deforestation
    - Water pollution
    - Threats to endangered species

This is particularly true in the illegal harvesting of tropical hardwoods.

Carbon Smart Wood™

Carbon Smart Wood™ is a new category of sustainable wood that goes beyond conventional timber harvest and certification. Carbon Smart Wood™ diverts waste, creates jobs, and plants new trees.

- On average, a single board foot of Carbon Smart Wood™ stores 5.2 lbs of CO2e.
- That $100,000 flooring project you're bidding on could store up to 537,640 lbs of CO2e… equivalent to driving over 600,000 miles!

CARBON SMART WOOD™

WOOD REUSE IMPACT	
CSW™ board feet	150,000
Species Type	Thermally Modified Red Oak
Species Count	1
Emissions stored in CSW™ (MT CO_2e)	465.4
TREE PLANTING IMPACT	
Total trees planted estimate	5,652.0
Urban trees	252.0
Peri-urban/rural trees	5,400.0
Lifetime (25-yr) tree sequestration (MT CO_2e)	5,361.5
TOTAL LIFETIME IMPACT	
Estimated lifetime carbon storage (MT CO_2e)	5,827
GHG Equivalencies	
Tanker trucks of gasoline	77
Car trips around the earth	581
Homes' energy use for 1 year	733
Million smartphones charged	708.9
Propane cylinders used to BBQ	242,786

CAMBIUM CARBON

150,000 board feet of Carbon Smart Wood™

in this project funded the planting of up to:

5,652 trees

and provided an estimated total carbon storage benefit of:

5,826.9 MT CO_2e

That's equivalent to:

77 tanker trucks of gasoline

or

581 car trips around the earth

or

733 homes' energy use for 1 year

Notes: wood carbon is based upon analysis of the USFS FIA database, tree carbon is based on a 25 year timeline from City Forest Credits, and the EPA GHG Equivalencies Calculator provides estimated conversions

Summary

- Thermally modified wood is a stable, durable, sustainable, and beautiful option.
- More stable and less expensive than tropical woods with a similar durability.
- Sustainable solution for a natural aesthetic.
- Remember to ask the right questions when specifying thermally modified wood.

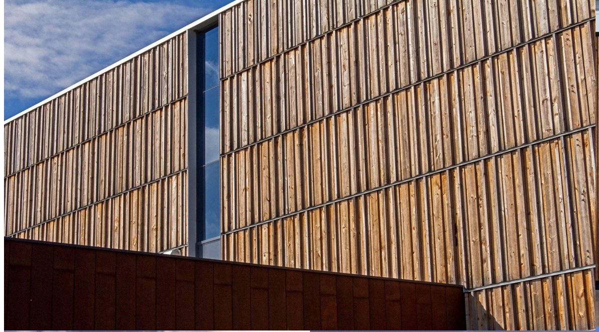
CASE STUDIES

Bell Museum

St. Paul, MN
Architect: Perkins + Will
Product: Thermally Modified White Pine

The Bell Museum in St. Paul is Minnesota's official natural history museum and planetarium. This 3 level building is 90,000 square feet and built to showcase and enhance the University of Minnesota's reputation for innovative research, education, and public engagement.

Arbor Wood was used to clad the buildings exterior as well as some interior embellishments. The Pine used in this project was locally sourced, modified and installed.






Epicurean HQ

Superior, WI
Architect: Paul Stankey & Bryan Meyer
Product: Thermally Modified Ash

When it came time to move to a new building, Epicurean was focused on using sustainable materials that would naturally age over time.

The building in Superior, Wisconsin features Arbor Wood Co. thermally modified ash, inside and out.

From wall cladding to custom cabinetry, the space has a beautiful and natural appeal that will get better with time.

The Historic Modern

Venice, CA
Architect: Abramson Architects
Product: Thermally Modified Ash & Pine

As seen on the Netflix series: Buying Beverly Hills, this Historic Modern is a house like no other. The front portion of a 1907 one-story craftsman bungalow was relocated from an adjacent site and paired with a respectful two-story addition that introduces modern materials, including Arbor Wood thermally modified Ash + Pine.

With the utmost attention to detail, the architecture and interior design embrace modernity without disrespecting the cottages historic roots and neighborhood character.




Del Rey Campus

Los Angeles, CA
Architect: Gensler
Product: Thermally Modified Ash

In this project, Arbor Wood Co. thermally modified ash is used in a variety of applications such as benches, sunscreens & fascia.

The Del Rey Campus, located in sunny Northwest Los Angeles, is a unique office campus where amenities and aesthetics create a life-enhancing experience for creative workers.

Blurring the line between workplace and habitat, the design draws from industrial and residential cues.

Wetland Boardwalk

Minneapolis, MN
Architect: Cunningham Group
Product: Thermally Modified Ash

The Eloise Butler Wildflower Garden, established in 1907, was the first public wildflower garden in the United States.

The much needed and newly designed boardwalk features a unique curved modular system that allows for ease of assembly and quick directional changes.

Additional pieces include benches, bridge railings and camera posts, and future interpretive signage, all designed for easy assemblage into the existing boardwalk frame. The entire assembly rests easy on the land, as to not disturb the gentle ecosystem embedded within the Garden.

Braemar Field

Edina, MN
Architect: Cunningham Group
Product: Thermally Modified Ash

Arbor Wood Co. thermally modified ash was used in a variety of installations at “The Backyard”, an environmentally friendly skating rink designed to help meet the demand for youth ice time. It features a landscaped outdoor area featuring bench tops made of Arbor Wood Co. ash. This gathering space provides warm, elevated seating around a fire pit beside the new Braemar Field. It’s the perfect place for parents to cheer on their young hockey stars.

Sandra Rolph, landscape architect with the project’s architecture firm Cunningham Group, says she’s always excited to try new, sustainable alternatives to traditional building materials. In this project, Arbor Wood was an alternative to imported tropical hardwoods.

LOCUS Architecture

Minneapolis, MN
Architect: LOCUS
Product: Thermally Modified Red Oak

LOCUS Architecture designs sustainable buildings and renovations for residential and commercial clients who value the arts and the environment.

After moving to a new building, the team at LOCUS identified Arbor Wood for a variety of applications including the main entry of the office as well as a walkout deck area.

Justin Merkovich of Locus Architecture says they chose Arbor Wood because it is a real, domestic wood species that is durable and, importantly, beautiful.

Thank You For Your Time!

ARBOR WOOD CO

THERMALLY MODIFIED WOOD

Arbor Wood Co. is a Minnesota-based manufacturer of thermally modified wood products for architectural application. Our process uses domestically sourced, responsibly harvested timber which is modified using heat, pressure, and steam. The result is a high-quality, performance drive material which sustains the natural beauty and design element of wood all without the use of harsh chemicals.

This concludes The American Institute of Architects Continuing Education Systems Course

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