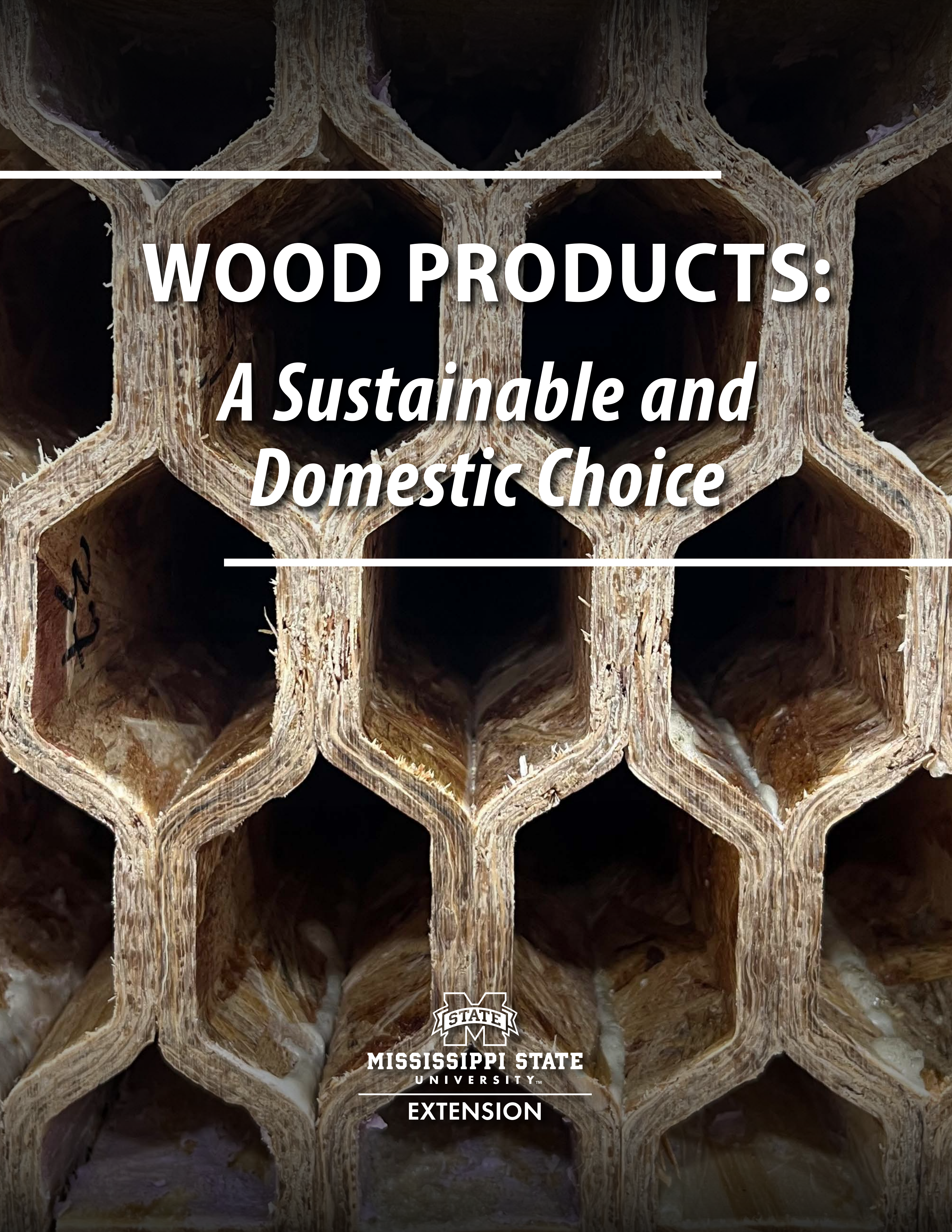

WOOD PRODUCTS:

A Sustainable and Domestic Choice

MISSISSIPPI STATE UNIVERSITY™
EXTENSION

Contents

Lesson 1: Greenhouse Effect

Just as a greenhouse traps heat to keep plants warm, certain gases in the earth's atmosphere, such as water vapor, carbon dioxide (CO_2), and methane, trap heat. During the day, sunlight warms the earth, and these gases help trap that heat, ensuring the earth stays warm even at night. The process of heat retention by these gases is known as the **greenhouse effect**.

Figure 1. The sun's heat is trapped inside the greenhouse by the glass walls and results in a higher temperature inside the greenhouse.

Wavelength and temperature are inversely related, meaning that hotter objects emit radiation at shorter wavelengths, while cooler objects emit radiation at longer wavelengths. With the sun's surface temperature around 5480°C (9896°F), the radiation it emits is primarily short wavelength, including visible light and ultraviolet (UV) radiation.

The earth's atmosphere is largely transparent to this shortwave radiation, allowing much of it to reach the surface. When the earth's surface absorbs this energy, it heats up and re-emits it as longwave radiation (infrared radiation), due to the relatively lower temperature of the earth's surface.

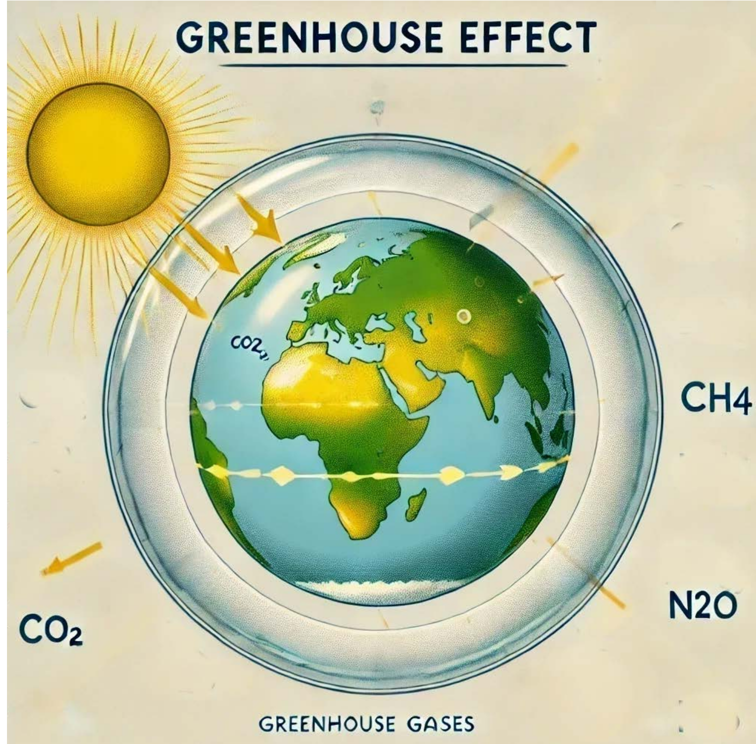

Figure 2. Greenhouse gases (GHG) allow the sun's light to reach the earth's surface, but they re-emit and trap the heat.

Greenhouse gases are transparent to the shortwave energy emitted by the sun but effectively absorb the longwave energy re-emitted by the earth. In simple terms, they function like a blanket, trapping heat within the earth's atmosphere and making the planet warm enough for life. Without the greenhouse effect, the planet would be extremely cold, making life impossible.

Have you ever noticed that cloudy nights tend to be warmer than clear ones? This happens because clouds contain water vapor, which is the most abundant greenhouse gas. Water vapor in the clouds absorbs heat radiating from the earth's surface and then re-emits it back toward the ground, helping to keep the air warmer. On clear nights, without clouds, this heat escapes into space, making the air cooler.

The greenhouse effect is a natural process essential for maintaining temperatures suitable for life on Earth. However, when the concentration of greenhouse gases in the atmosphere rises, more solar energy is trapped and less escapes back into space, leading to an increase in global average surface temperatures. Greenhouse gases make up only a small fraction of the earth's atmosphere; water vapor varies between 0.25% and 4%, while non-water vapor greenhouse gases account for roughly 0.05%. Despite their low concentrations, these gases might contribute to trapping the sun's energy and influence global temperatures. Do you know which greenhouse gases are the most prevalent and where they come from?

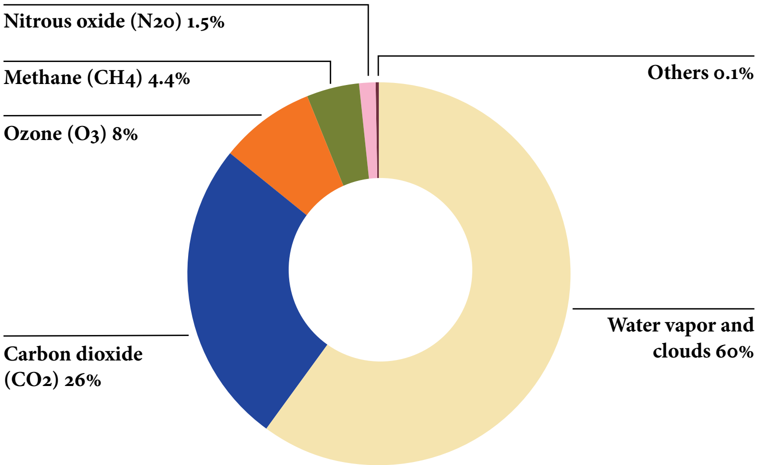

Figure 3. The greenhouse gases that are most important to the earth's atmosphere are water vapor, carbon dioxide, ozone, methane, and nitrous oxide.

Water vapor is the most abundant greenhouse gas in our atmosphere and is responsible for about half of the earth's greenhouse effect. **CO_2** is the second-most prevalent greenhouse gas, and its concentration is more stable and long-lasting in the atmosphere (lasting for centuries). Regardless of water vapor, CO_2 accounts for about 80% of all U.S. greenhouse gas emissions. Human activities can cause increases in greenhouse gas concentrations, especially CO_2.

Figure 4. Human-related sources of non-water vapor greenhouse gas emissions include electricity, agriculture, industry, buildings, transportation, and food waste.

Between 1760 and 1840, the Industrial Revolution marked a significant transition from a handicraft-based economy to one dominated by mechanized manufacturing processes. This revolution was a key contributor to the rise in greenhouse gas concentrations. The extensive combustion of fossil fuels to meet the energy demands of industrial machinery has steadily increased CO_2 levels in our atmosphere, resulting in higher greenhouse gasses. Increasing greenhouse gas, mainly CO_2, concentrations can disrupt the atmospheric balance. A higher concentration of greenhouse gases can trap more of the sun's energy, potentially leading to an increase in global atmospheric temperatures.

Figure 5. The Industrial Revolution transformed lives with power-operated tools and machines.

There are various ways to reduce emissions and mitigate their negative impacts. In the following chapters, we will explore wood-based products as one of these pathways.

Lesson 2: Forests and Humans

Oceans, forests, and soil naturally absorb and store carbon, making them important **carbon sinks**. This process, known as **carbon sequestration**, helps reduce the amount of carbon in the atmosphere. This chapter focuses on forests, exploring their role in reducing carbon concentrations and the actions we can take to protect them. Foresters, the experts who study and manage forests, play a crucial role in ensuring forests continue to serve as valuable natural resources and effective carbon sinks.

Trees obtain their nutrients through a process called **photosynthesis**, which takes place in their leaves. During this process, trees absorb carbon dioxide (CO_2) from the air and water (H_2O) from the soil to produce oxygen (O_2) and carbohydrates (sugars). The carbon dioxide is absorbed from the environment; sunlight provides the energy needed for the reaction; and water is drawn up from the roots to the leaves. Trees use carbohydrates as a food source, distributing them to other parts of their structure, like their trunks and roots.

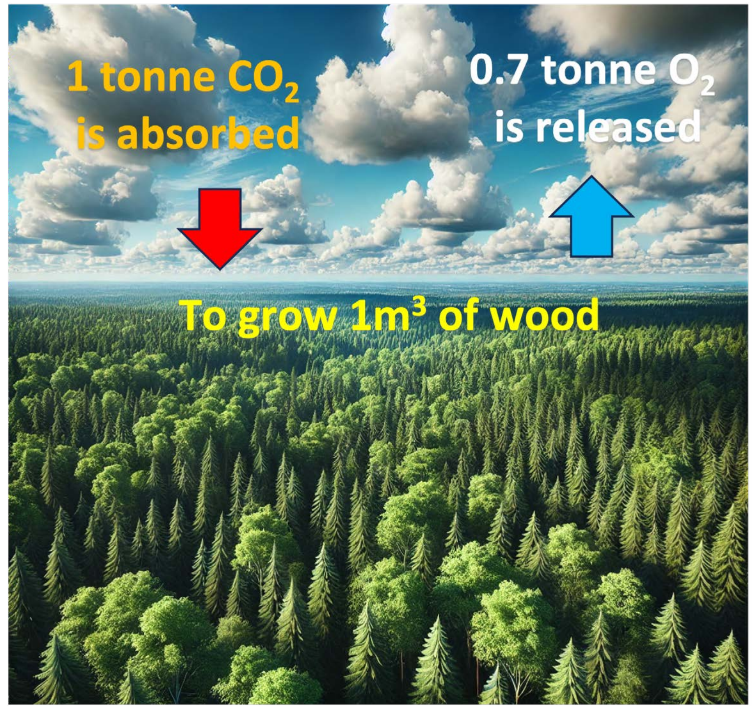

Figure 6. Trees absorb carbon dioxide and produce oxygen.

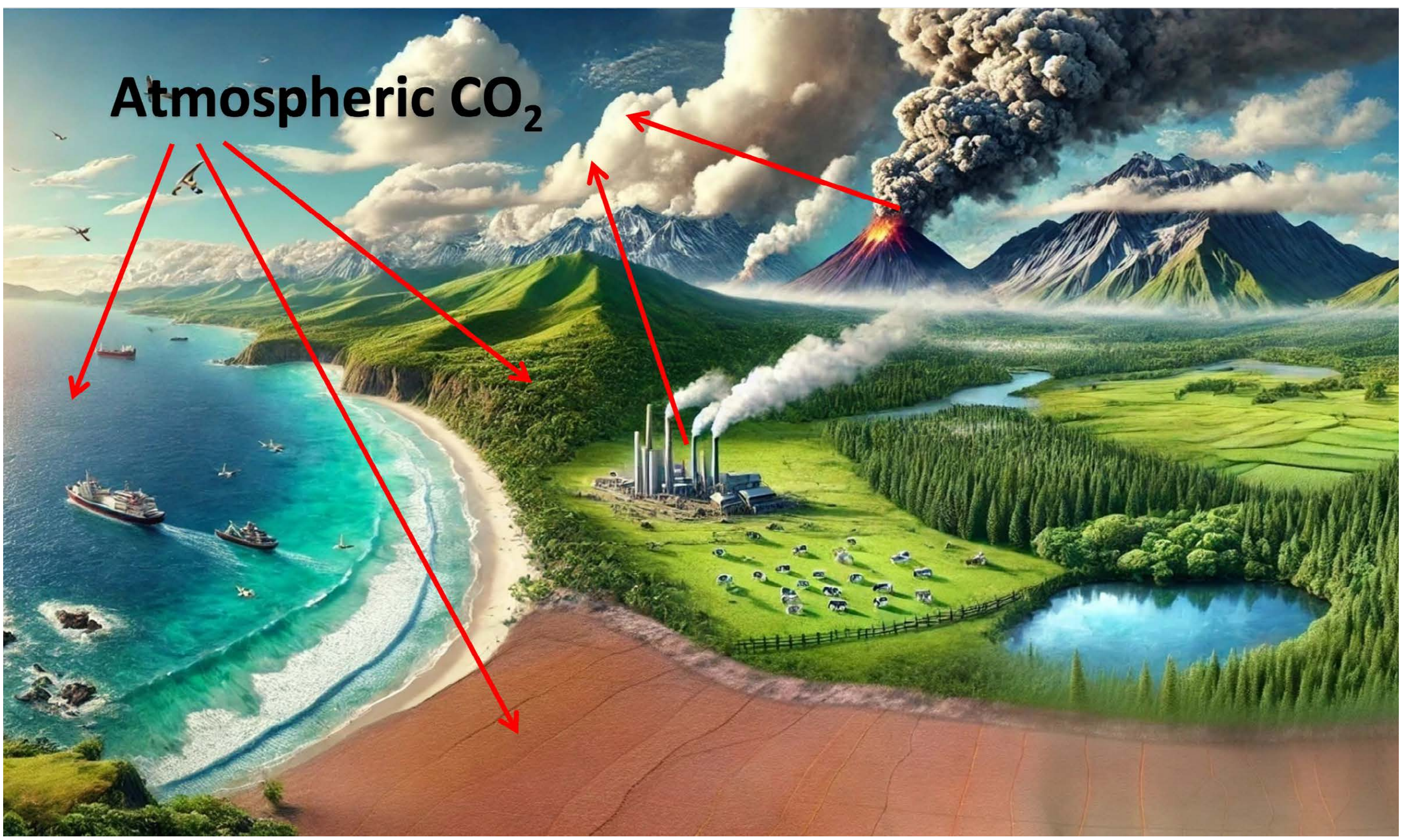

Figure 7. Forests, oceans, and soil absorb carbon, while volcanoes and industrial facilities release carbon.

The oxygen produced during photosynthesis is released back into the atmosphere. In other words, as trees grow, they absorb carbon dioxide from the atmosphere and release oxygen back into it. This natural process makes trees a valuable tool in reducing carbon dioxide levels in the atmosphere. On average, for every cubic meter of wood that grows, 1 metric ton (or *tonne*, 1.102 short tons) of carbon dioxide is absorbed from the atmosphere, while 0.7 tonnes (0.772 short tons) of oxygen is produced and released back into the atmosphere.

Think of forests as the lungs of the earth. It is our responsibility to protect this vital organ. **The carbon captured by forests is stored in the trees**, with half of the weight of dried wood made up of carbon. The importance of trees in reducing greenhouse gas concentrations raises an important question: **Why do we cut them down?** Trees absorb carbon dioxide from the atmosphere to obtain the carbon they need for growth and maintenance. However, as trees age and mature, they capture less carbon dioxide since they do not grow anymore and mainly need carbon to maintain their existing structure.

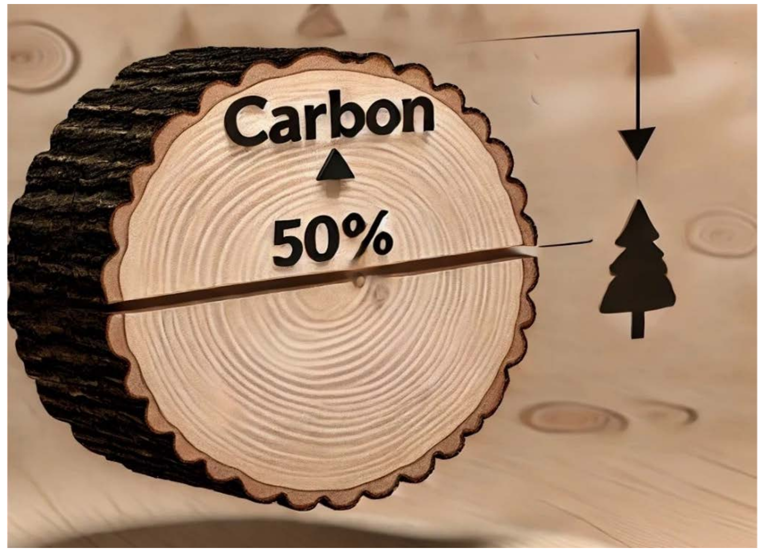

Figure 8. Dry wood is roughly 50% carbon by weight.

As they age, parts of the tree or the entire tree will die, and the stored carbon will be gradually released back into the atmosphere through decomposition. This means older trees can release more carbon than they capture, resulting in a negative or reduced carbon sequestration rate compared to a younger, growing forest. To promote sustainability, maximize carbon sequestration, and get the most benefit from forests, trees are cut down after they reach a certain age, and new trees are planted in their place. We will examine how these trees are used and which industries rely on this renewable resource.

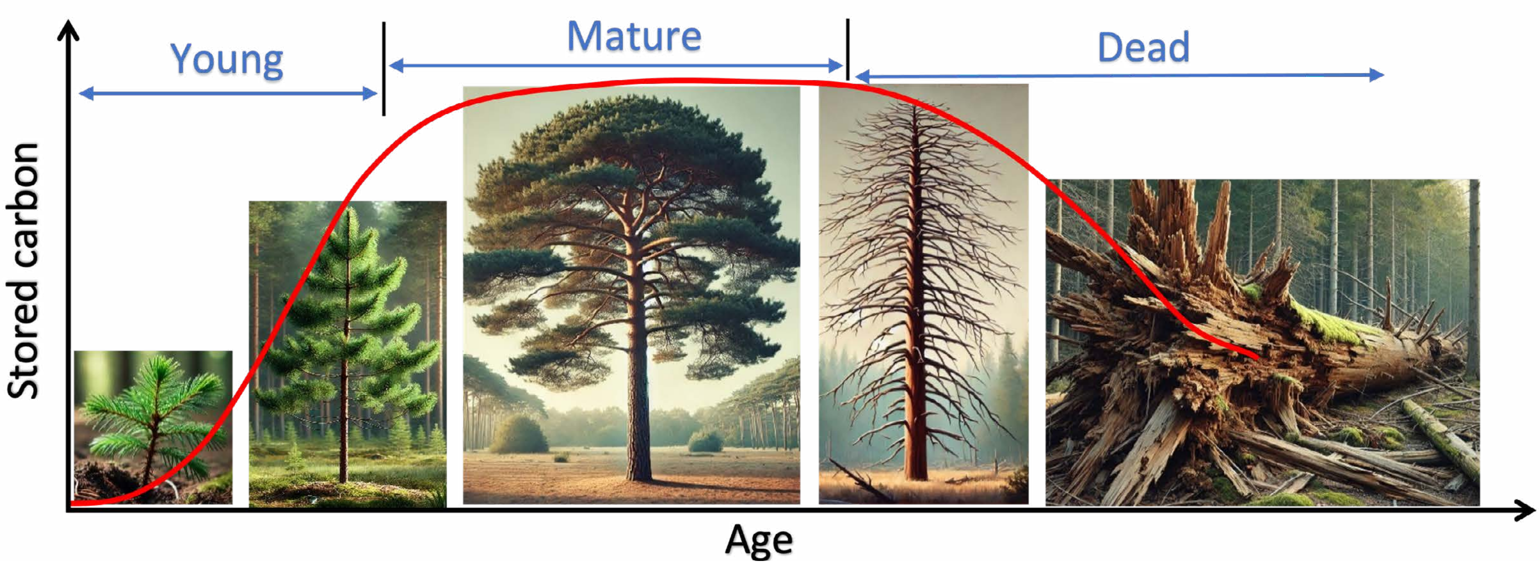

Figure 9. The red curve indicates the carbon sequestered by a tree throughout its life.

Is it important to take care of forests? Absolutely. Why? Forests are naturally susceptible to threats like wildfires, disease, and insect infestations. When unmanaged and neglected, forests can become overcrowded, leading to higher tree mortality rates from insect damage and fire. These threats can spread more quickly through the dense tree canopies of unmanaged forests, causing widespread damage.

Overcrowded trees also struggle to grow properly because they have to compete for water and sunlight, and weaker trees eventually die off. When trees die, all the carbon dioxide they absorbed and stored is released back into the atmosphere—either suddenly during wildfires or gradually through decomposition.

Forests need proper care and management to prevent such events and improve the health and resilience of these ecosystems. How do we care for forests? Foresters use various **sustainable forest management practices**, such as **controlled burning** and **mechanical thinning**, to improve forest health.

Controlled burning involves intentionally set small, managed fires under specific weather conditions by a team of fire experts. This reduces the buildup of leaves, branches, and dead trees on the forest floor, lowering the risk of larger wildfires and promoting the growth of new vegetation.

Mechanical thinning involves cutting and removing small-diameter trees to provide more space, reducing competition for resources like water and sunlight, and improving the overall health of the remaining trees. These sustainable forest management techniques reduce wildfire risks, minimize the spread of pests and diseases, promote tree growth, protect forests, and restore vital ecosystems. Mechanical thinning, followed by prescribed burning, is a more effective approach to managing forests.

Figure 10. Threats such as wildfires and insect outbreaks negatively impact forests.

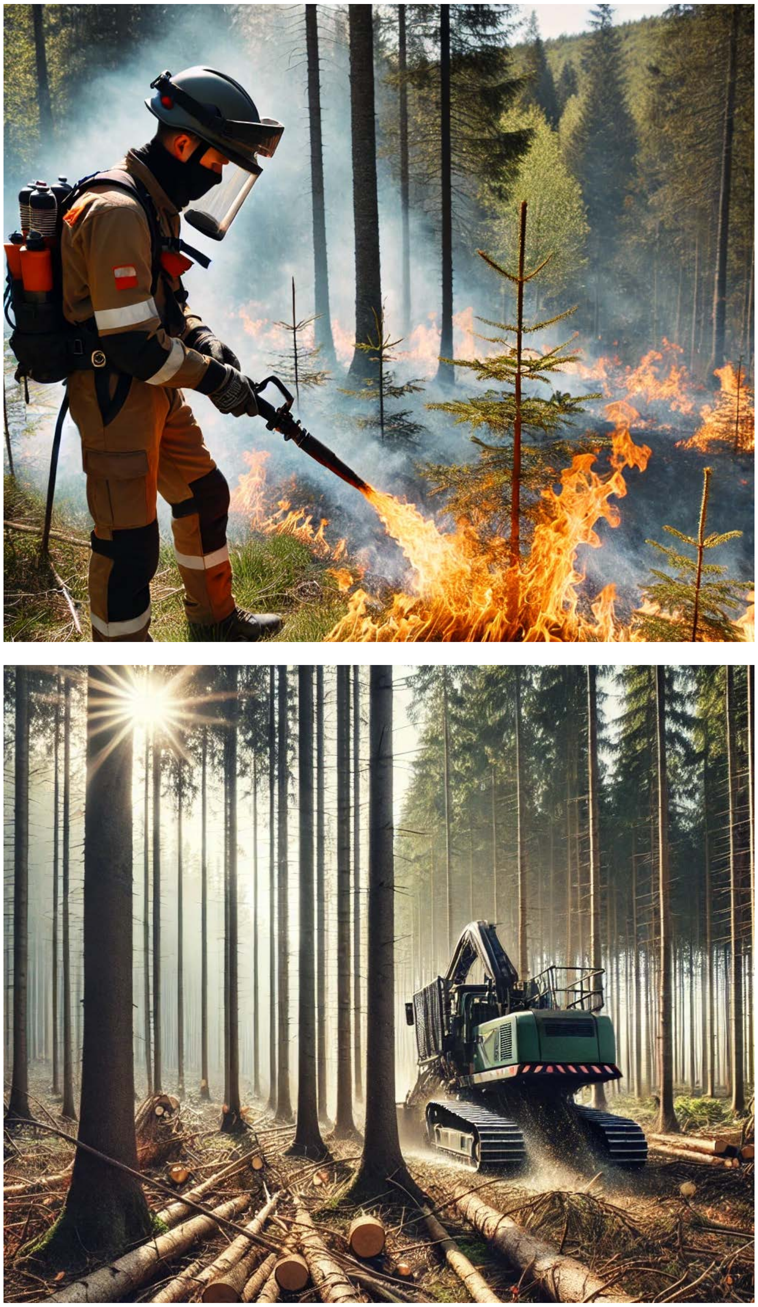

Figure 11. Forest management practices include controlled burning and mechanical thinning.

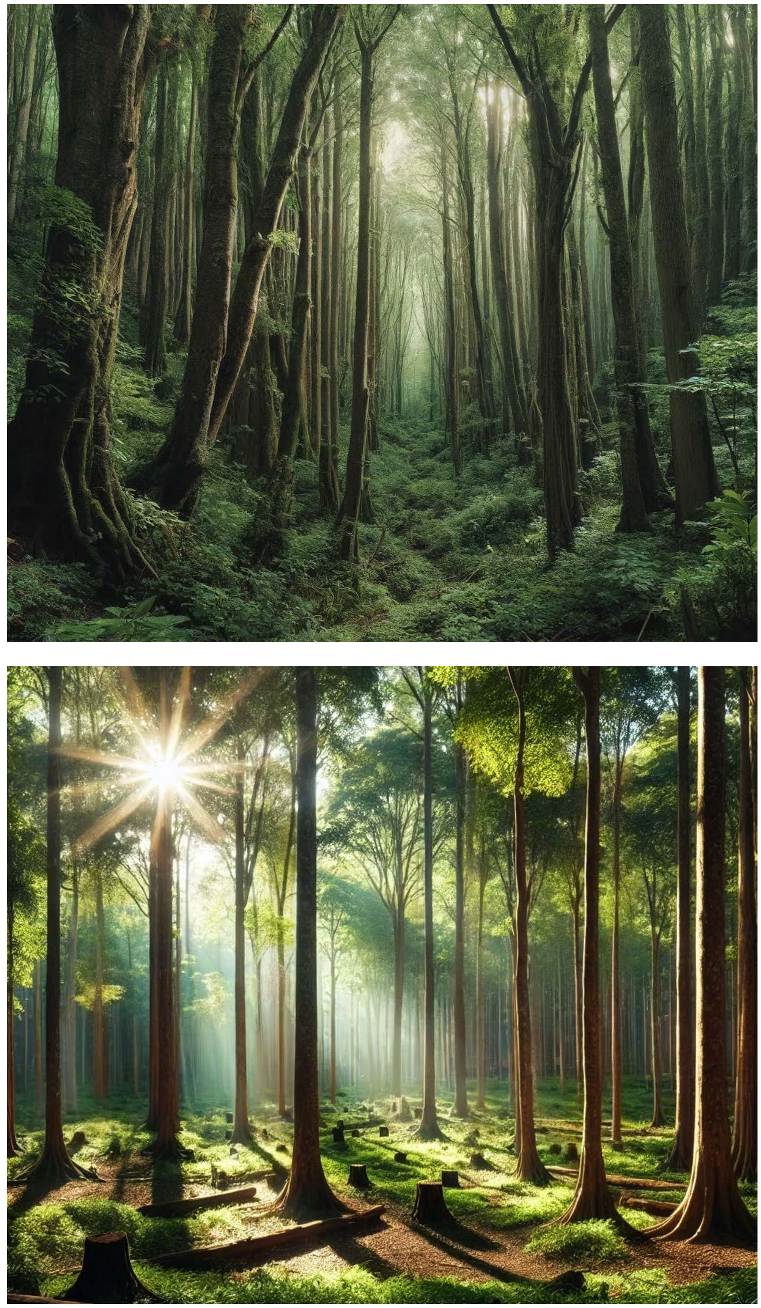

Figure 12. Comparison of two healthy forests—unmanaged on the left and managed on the right.

Sustainable management practices—such as mechanical thinning, prescribed burning, and clear-cutting followed by replanting—are essential to improving the health and resilience of forest ecosystems. Foresters play a crucial role in maintaining healthy forests, which in turn are more productive and effective at capturing and sequestering carbon from the atmosphere.

In the next lesson, we'll see which industries use wood and depend on this renewable resource. Their success—along with the growing markets for wood products—is essential for maintaining the health and sustainability of forests.

Lesson 3: Structural Wood-Based Products

Did you know that forests cover one-third of the land in the U.S.? Thanks to this vast natural resource, wood is widely used in the U.S. as a primary construction material for buildings. The Mississippi Forestry Association reports that forests cover 19.9 million acres in Mississippi—more than 65% of the state's land area.

While steel, concrete, and brick are commonly used building materials worldwide, wood has distinct advantages over them. Unlike steel, concrete, and brick, wood is a renewable resource. Additionally, producing steel, cement, and brick requires high energy, leading to CO_2 emissions. This energy-intensive process makes materials like steel, concrete, and brick carbon-positive, as their production releases CO_2 into the atmosphere. In contrast, dried wood consists of about 50% carbon absorbed from the atmosphere, and it takes less energy to process trees into construction materials. As a result, wood-based products are carbon-negative—they capture rather than release CO_2. By choosing renewable and carbon-negative products like wood, we can support sustainability and help reduce greenhouse gas concentrations.

Wood in the Building and Construction Industries

Trees can be processed in various ways to create wood-based structural products. With minimal processing, they can serve as utility poles in the energy sector. You've likely seen **wood utility poles**, as more than 99% of all distribution lines and a large portion of lower voltage transmission lines are built with wood. Wood utility poles are renewable, carbon-negative, highly practical, and convenient to work with.

Figure 13. Wood utility poles.

Another common form you're likely familiar with is **lumber and timber**. Lumber and timber are long wood-based materials with rectangular or square cross-sections.

Lumber is widely used in the building industry, especially for constructing residential homes. It's used to build the framework of the house, including the walls, roof, and floors. In addition to being renewable and carbon-negative, wood has long been favored for its affordability and ease of use. It's lightweight and can be easily transported, cut on-site with a saw, and fastened together with nails and screws. These benefits make wood a popular construction material in the U.S. Have you ever seen wood framing in new home construction? Did you know it takes around 25 mature trees to frame an average house?

Figure 14. Trees processed into lumber and timber.

Figure 15. Wood framing with lumber as a traditional method for constructing residential houses.

Structural lumber with its smallest dimension at 5 inches or greater is classified as timber and is used for columns, posts, and railroad crossties. **Railroad crossties** have traditionally been made of wood, and wood ties still account for more than 90% of crossties in the North American railway system. The U.S. freight rail network, recognized as the largest, safest, and most cost-efficient freight system, is essential to sustaining the American economy.

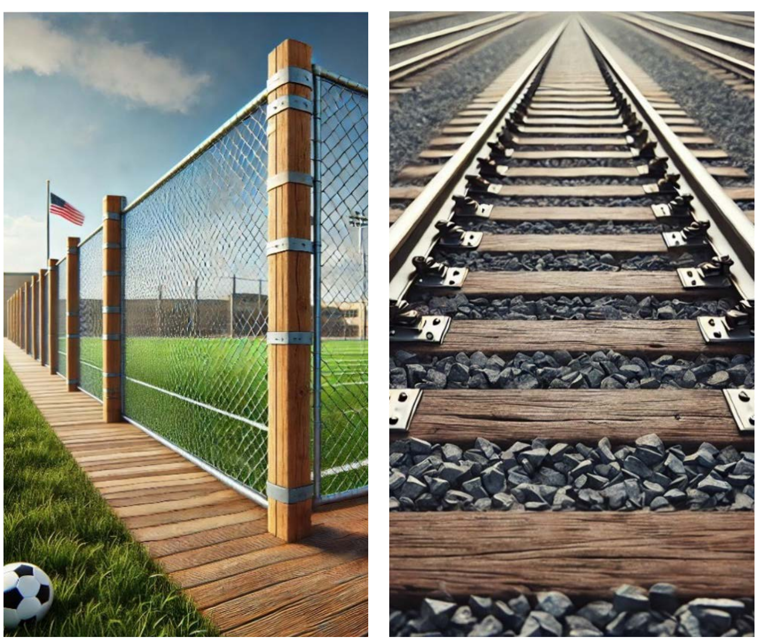

Figure 16. Timber is widely used as posts and crossties.

Tree logs can also be processed into thin layers known as veneers. These thin wood veneers are bonded together to create various products, such as plywood. When trees are too small in diameter to be suitable or cost-effective for producing lumber or veneers, they can be processed into thin pieces called strands or flakes. Wood strands coated with resin are bonded to form products like oriented strand board (OSB). Have you ever seen plywood or OSB? If not, check out the wood panel section next time you're at a building materials store or lumber yard.

Figure 17. Tree logs are processed into veneers and flakes to make plywood and OSB.

Plywood and OSB are primarily sold in standard 4-by-8-foot panels, commonly used in construction to cover the frame of a house. Once the structural frame is built with lumber, these panels, known as sheathing panels, are nailed to the lumber to cover the walls, floors, and roof. **Did you know that building with wood can help save energy?** Wood has a lower thermal conductivity than steel and concrete, giving it natural insulating properties. In winter, wood helps retain heat inside, and in summer, it helps keep heat out, maintaining a comfortable indoor temperature.

Figure 18. OSB is used for roof and wall sheathing to cover this home.

Did you know that traditional wood framing with lumber limits buildings to a maximum height of about six stories? This limitation raises the question: How can we use wood to construct larger structures like tall buildings and bridges, which are typically built with steel and concrete? Engineering concepts have enabled us to develop various **engineered wood products** with high structural performance, making it possible to construct such large structures with wood. **Glue-laminated timber**, known as **glulam**, is one of these advancements. It's made by bonding layers of lumber together, all oriented in the same direction. Glulam can be fabricated in both straight and curved forms.

Figure 19. Straight glulam beams.

Considering the application and the applied load, glulam can be fabricated in various depths and lengths, making it suitable for a wide range of uses. This engineered wood product is commonly used as columns and beams in the construction of tall buildings. Additionally, glulam serves as an excellent material for utility poles. Its high-performance characteristics also make it ideal for large-scale structures such as long-span bridges and airplane hangars.

Figure 20. Glulam is used in the construction of tall buildings and long bridges.

Cross-laminated timber, or CLT, is another type of engineered wood product. It is fabricated by bonding layers of lumber together, with each layer oriented at a right angle to the adjacent one. This construction method forms a strong, rigid panel that can be used for walls, floors, and roofs, offering versatility in various building applications, particularly tall buildings.

Figure 21. Cross-laminated timber (CLT).

The development of glulam and CLT has made it possible to compete with steel and concrete in the construction of tall buildings. Structures up to 18 stories high have already been built in Canada and Europe. As of 2022, the tallest wooden building in the world is the 25-story Ascent, located in Wisconsin. Interestingly, the Japanese timber company Sumitomo Forestry has proposed an ambitious project to construct the world's tallest wooden building in Tokyo—a 70-story skyscraper—by 2041.

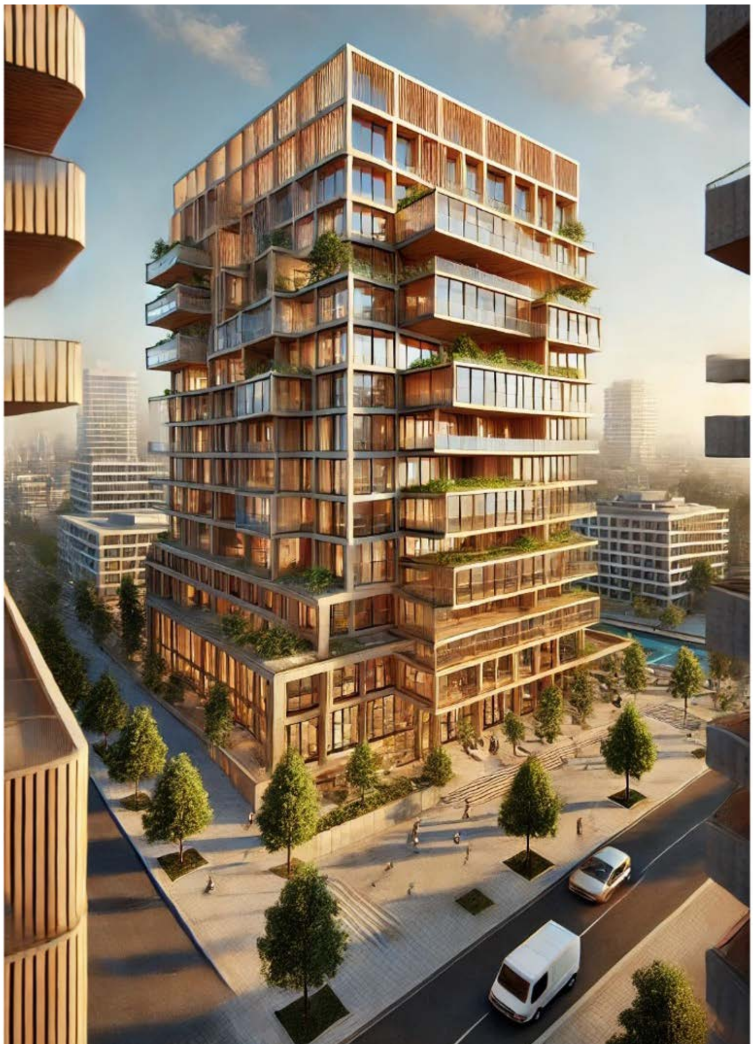

Figure 22. Tall mass timber building constructed using CLT and glulam.

As mentioned, 50% of dried wood consists of carbon. Each ton of carbon stored in wood equates to 3.67 tons of carbon dioxide. To understand how much carbon can be stored by using wood instead of conventional materials like concrete and steel, let's look at El Dorado High School in El Dorado, Arkansas, constructed in 2011. This high school spans 322,500 square feet, and by opting for wood framing instead of steel and masonry, the school saved approximately $2.7 million.

The El Dorado High School construction used 153,140 cubic feet of wood-based products, a volume of wood that U.S. and Canadian forests can regenerate in just 13 minutes. The carbon stored in these wood-based materials was equivalent to 3,660 metric tons of carbon dioxide. Additionally, by using wood instead of steel and masonry, the project avoided the emission of 7,780 metric tons of greenhouse gases.

When combining the stored carbon and avoided emissions, the total carbon benefit of this wood-based building amounted to 11,440 metric tons of carbon dioxide. To put this into perspective, this carbon benefit is equivalent to the emissions generated by operating 2,100 cars for an entire year or the emissions from powering a single home for 970 years. This example underscores the significant environmental advantages of using wood in construction, contributing to sustainability and reducing carbon footprint.

Trees offer a renewable resource for developing high-performance products suited for the construction and building industries. Unlike non-renewable materials like steel and concrete, wood promotes sustainability by preserving natural resources for future generations. More importantly, using wood in construction allows us to sequester carbon stored in trees, keeping it locked away for extended periods. By using and advancing engineered wood products, we can promote sustainable building practices and significantly contribute to a lower-carbon future.

Lesson 4: Non-Structural Wood-Based Products

The **construction** and **building** industries are not the only sectors that rely on wood and wood-based products. Low-quality wood, yard trimmings, and recycled wood—wood that is unsuitable for producing structural materials like lumber, timber, and veneers—are used in various other industries for a wide range of applications. The following sections will highlight some key industries and their associated products.

Pulp and Paper Industry

What is pulp? Pulp is the key ingredient in the paper-making process. Pulp is produced by breaking down the fibrous parts of plants, primarily trees. Various methods, including mechanical and chemical processes, are employed to separate cellulose fibers for pulp production.

The pulp and paper industry is one of the largest industrial sectors globally, with a significant impact on forests. It transforms wood into a wide range of products, such as paper and cardboard. This industry consumes approximately 33 to 40% of the industrial wood traded worldwide. In the U.S., the pulp and paper industry is the second-largest consumer of harvested roundwood, using about 35% of the total. The construction and building industries rank first, consuming roughly 45% of harvested roundwood. **Did you know that the U.S. is the world's second-largest producer and consumer of paper, second only to China?**

Pulp and **high-purity cellulose** are used in a variety of consumer and specialty products, such as these:

- Printer paper
- Receipts
- Post-its
- Envelopes
- Toilet paper rolls
- Napkins
- Paper cups
- Food packaging
- Diapers and baby wipes
- Cardboard
- Filters
- Shoes and handbags
- LCD screens
- Food casings
- Binding agents in food and pharmaceuticals

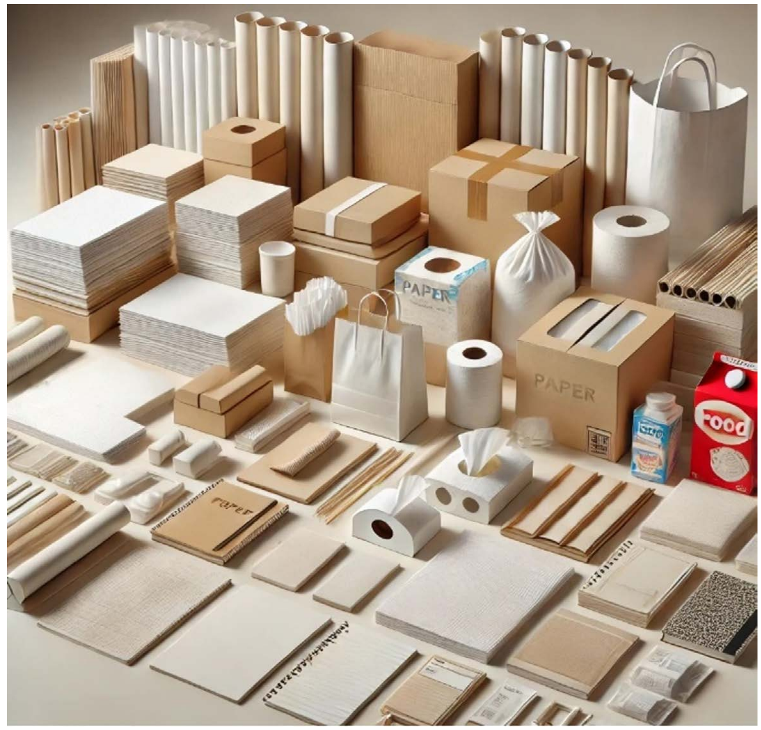

Figure 23. Products made from pulp and paper extracted from wood.

Furniture and Cabinetry Industry

Unlike traditional furniture manufacturing, which primarily relied on solid wood and the craftsmanship of skilled artisans, modern furniture production leverages advanced technology, machinery, and a variety of wood-based products. These advancements have enabled mass production, making the furniture industry the third-largest consumer of wood, following the construction and paper industries. Did you know that the U.S. is the second-largest furniture producer in the world? The top three furniture-producing countries are China (39%), the U.S. (12%), and Germany (5%). Additionally, the U.S., followed by Germany and the United Kingdom, is a leading importer of furniture from around the globe.

Did you know that the U.S. is the largest producer and consumer of forest products, with Americans using timber at a rate five times greater than the global average? This leadership in forest product production and consumption reflects its vast forest resources, advanced forestry management practices, and a strong demand for timber-based products across industries. This also underscores the importance of sustainable forestry practices, ensuring these resources are managed responsibly for long-term environmental and economic health. This balance is critical for supporting global ecosystems and maintaining biodiversity while meeting industrial and consumer needs.

Figure 24. Essential wooden furniture for our homes.

Energy Industry

Wood has served as an energy source, primarily for heating, for thousands of years. Even today, billions of people worldwide rely on wood for cooking and heating. Additionally, wood is used as an energy source in certain electric power plants to produce electricity. Charcoal, produced by a thermo-chemical process called pyrolysis, has a higher energy density and is also used for cooking and industrial applications.

Figure 25. Wood as a source of energy for heating.

Wood and charcoal are commonly burned, much like coal and fuel oil, to generate heat or convert water into steam for spinning turbines and producing electricity. However, it is important to emphasize that wood is a renewable resource, whereas coal and fuel oil are not.

Did you know that nearly half of the wood harvested worldwide is used as fuel, highlighting its critical role in meeting energy needs. In the U.S., approximately 15% of harvested roundwood serves as fuelwood. Advancements in technology have introduced more efficient ways to process and use wood as an energy source, maximizing its potential while minimizing waste. The following sections outline some of these innovative methods and their benefits.

Wood Pellets

Low-quality logs and wood waste are processed into fine dust and compressed into small, dense cylinders called pellets. Essentially, wood pellets are compressed wood with a density 2.5 to 3 times higher than regular wood. They have an average moisture content of just 7%, compared to firewood's typical 20%. This lower moisture content, combined with their higher density, makes wood pellets easier to burn and more efficient at producing heat than firewood. **Did you know that the U.S. is not only a leading producer of wood pellets but also the largest exporter in the world?**

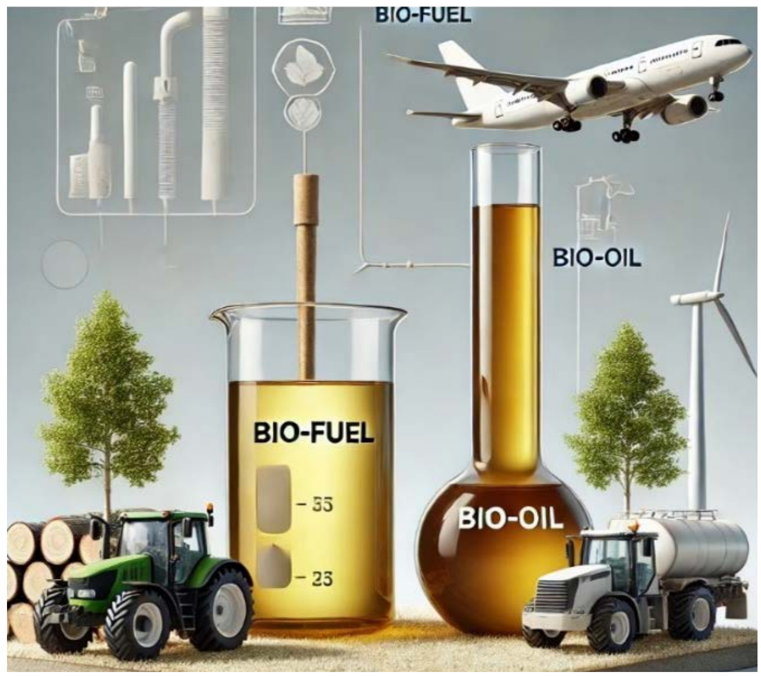

Figure 26. Wood fuel pellets.

Figure 27. Biochar and bio-oil, with various applications, can be derived from wood.

Bio-oil

Wood can be transformed into bio-oil through pyrolysis. This dark, viscous liquid, also known as pyrolysis oil or bio-crude, has a range of applications. It is a raw material for producing adhesives like phenol formaldehyde, commonly used in manufacturing engineered wood products such as plywood and oriented strand board (OSB). The pyrolysis process also produces **biochar**, a carbon-rich material with multiple uses. Biochar can be applied as a soil amendment to sequester carbon, improve soil structure and porosity, enhance water retention, and boost microbial activity, ultimately promoting plant health. Additionally, biochar is widely used in water treatment processes.

Wood-Plastic Composite Industry

In this industry, low-quality wood is processed into sawdust and combined with various polymers to create an innovative class of wood-based materials known as wood-plastic composites (WPCs). To produce these composites, the wood particles are thoroughly mixed with plastic and heated until the plastic melts. The mixture is then shaped using an extruder to form products with either solid or hollow cross-sections. These composites typically consist of 50 to 60% wood flour and 40 to 50% polymer. Unlike wood, which is hydrophilic and prone to dimensional changes from absorbing or losing moisture, wood-plastic composites are water-resistant due to the hydrophobic nature of the plastic component. This water resistance makes WPCs ideal for various exterior applications, including decking and cladding in the construction industry, boat decks in the marine sector, and pallets and crates for industrial use.

Figure 28. Wood-plastic composites, produced with solid and hollow cross-sections, are water resistant.

The combination of wood and plastic can also be extruded into thin filaments. With the rapid advancements in **3D printing** and additive manufacturing, these filaments can be used to produce wood-based products through 3D printing technology. **Did you know researchers have successfully 3D-printed a 600-square-foot, one-bedroom home using wood-based filaments? This innovative approach demonstrates the potential to construct entire houses within 48 hours, offering a rapid and sustainable solution to housing needs.**

It is important to emphasize that all these 3D-printed items, including furniture and homes, can be recycled at the end of their service life. Instead of ending up in landfills and contributing to environmental pollution, they can be reprocessed and reprinted into new products, promoting a sustainable and circular approach to material use.

Figure 29. 3D printing of wood-based filament.

Lesson 5: Preservation

Wood and wood-based products are inherently **hydrophilic**, meaning they readily absorb water. Their dimensions and mechanical properties are sensitive to changes in moisture content. As wood absorbs water, it **swells**, and as it dries, it **shrinks**. Moreover, the load-carrying capacity of wood and wood-based products diminishes when they absorb water, compromising their structural performance.

Figure 30. Thickness swelling of oriented strand board (OSB) after water absorption.

It is important to note that water also negatively impacts other building materials. In steel structures, exposure to air and water leads to **corrosion**, compromising their strength and durability. Similarly, improper drying and curing or freeze-thaw cycles in concrete can result in **flaking**, **spalling**, and **cracking**, undermining its structural integrity.

Figure 31. Corrosion in a steel structure and flaking and cracking in concrete.

Decay is another significant issue affecting wood and wood-based products. Biological agents, such as **fungi** and **termites**, can degrade and break down the structure of wood. These biological agents require a food source and a warm and humid environment to grow. Since wood itself acts as their food, wood with high moisture content creates an ideal environment for their growth and activity. The deterioration caused by decay not only reduces the load-carrying capacity of wood but also contributes to environmental impacts, such as the release of carbon dioxide during the decomposition process.

Figure 32. Comparison between non-decayed and decayed wood.

Considering the adverse effects of water on wood and wood based products—such as swelling, shrinking, and decay—a key question arises: How can we effectively use these materials in our homes and infrastructure? The answer lies in preservation and maintenance.

Proper preservation techniques can significantly extend the lifespan and functionality of wood products. **Preservation** and **maintenance** are necessary for many other materials, as well. For instance, steel is protected against corrosion by applying anti-corrosive coatings or paints. Did you know the iconic Golden Gate Bridge in California is continuously painted as part of its ongoing maintenance? This painting process is a vital, never-ending task to shield the steel from corrosion caused by exposure to the elements. Similarly, concrete is maintained using sealers that fill cracks or cover the top surface to protect it from water infiltration.

Figure 33. Steel and concrete structures *require regular maintenance.*

Based on our discussion, improving wood's water resistance is essential to enhance its longevity and ensure its dimensions and load-carrying capacity remain stable and less affected by moisture. Various protective materials are applied to the wood surface, including stains, synthetic sealants like varnish and lacquer, natural oils such as linseed and tung, and paint.

These coatings form a thin barrier that prevents water from penetrating the wood, thereby minimizing dimensional changes and preserving its structural strength. This coat is mainly used for indoor applications, such as furniture and cabinetry, providing moderate protection against water and environmental factors.

Figure 34. Applying stain to make wood water resistant.

To thoroughly protect wood and wood-based products, particularly those used in exterior applications such as utility poles, against termites and fungi, it is essential to safeguard the inner structure of the wood itself rather than relying solely on a thin coating applied to its outer surfaces. To this end, they are treated with chemical materials designed to prevent or slow down deterioration.

To better understand this preservation process, knowing about the wood microstructure is essential. **Did you know that wood has tubular-shaped cells arranged in a honeycomb-like microstructure?** This structure allows trees to transport water from the roots to the leaves and distribute food from the leaves to other parts of the tree. Under a microscope, wood anatomists can observe these intricate microstructures, including the cells and cavities, to identify the wood species.

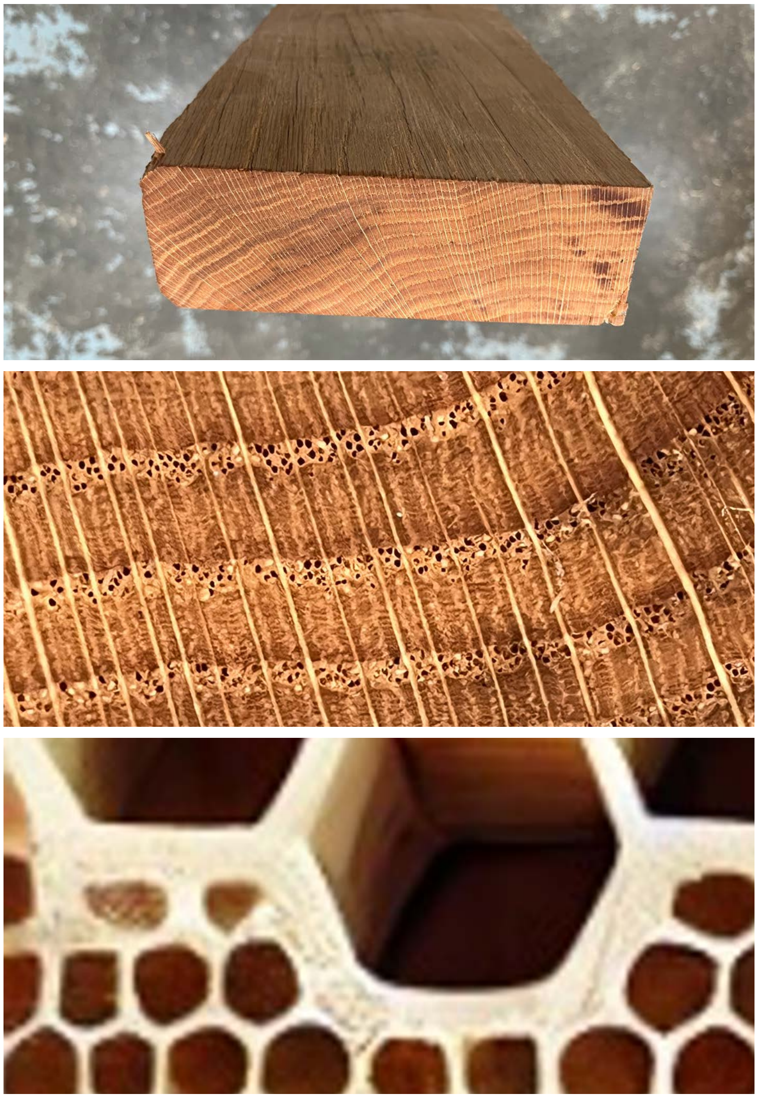

Figure 35. The honeycomb-like microstructure of wood.

The tubular cells within the wood microstructure naturally contain water. In the pressure treatment process, this water is replaced with chemical preservatives such as creosote, chromated copper arsenate (CCA), and DCOI to protect the wood from decay, fungi, and termites. During this process, wood products are placed inside a sealed cylinder, and high-pressure systems force the chemical preservatives deep into the cavities. The pressure displaces the water from the cells and ensures the chemicals penetrate thoroughly, enhancing the durability and longevity of the wood. This treatment makes the wood more suitable for exterior applications where environments are prone to moisture and biological threats.

Figure 36. A high-pressure cylinder is used to treat wood products with chemical materials to protect them from biological agents.

Properly preserving wood can significantly extend the lifespan of wooden structures. For example, the Horyuji Temple in Japan, which is over 1,300 years old, is recognized as the world's oldest surviving wooden structure. This remarkable longevity demonstrates not only the durability of the wood products used but also their ability to sequester carbon over a long time, contributing to environmental sustainability.

Figure 37. Japan's Horyuji Temple, a 1,300-year-old wooden structure.

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