



SUSTAINABLE BUILDING WITH MASS TIMBER: Renewable Architecture Solutions for Grades 9-12

Learning Objectives

By the end of this lesson, students will be able to:

- ✓ Analyze how mass timber serves as an eco-friendly alternative to traditional materials like steel and concrete, reducing greenhouse gas emissions and promoting carbon storage through sustainable forestry practices (U.S. Forest Service, 2023).
- ✓ Investigate the benefits and limitations of using mass timber in construction, including its renewable nature, strength, and potential for cost reduction, along with challenges such as sourcing and structural considerations (WoodWorks, 2022).
- ✓ Evaluate the environmental, economic, and social impacts of mass timber use, both locally and globally, including its role in reducing carbon footprints, supporting forest economies, and encouraging responsible land management (American Wood Council, 2023).

Tip: *These objectives connect mass timber to broader sustainability goals, helping students understand its benefits in building a low-carbon future.*

Vocabulary

- ✓ **Mass Timber:** Engineered wood products designed for large-scale construction, such as high-rise buildings, providing a renewable alternative to traditional materials like concrete and steel. Mass timber helps reduce the carbon footprint of buildings by storing carbon within the wood itself (U.S. Forest Service, 2023).
- ✓ **Carbon Sequestration:** The natural process through which trees absorb and store carbon dioxide from the atmosphere, helping to reduce greenhouse gases and mitigate climate change. Using wood from sustainably managed forests in construction extends the carbon storage period (American Wood Council, 2023).
- ✓ **Firewood Bank:** A community-driven program that supplies firewood to families in need, promoting the sustainable and responsible use of local wood resources for heating. Firewood banks help communities reduce



dependence on non-renewable energy sources, particularly in rural areas (U.S. Department of Agriculture, 2023).

- ✓ **Cross-Laminated Timber (CLT):** A type of mass timber created by stacking layers of wood panels in alternating directions, enhancing the structural strength and flexibility of wood for use in larger buildings. CLT's durability and load-bearing capacity make it suitable for multi-story structures (WoodWorks, 2022).
- ✓ **Sustainable Forestry:** The practice of managing forests to meet current wood demands without compromising future forest health. Sustainable forestry ensures a consistent supply of timber while preserving biodiversity and supporting ecosystem services (Forest Stewardship Council, 2023).

Tip: *These terms provide essential knowledge for understanding the ecological and engineering aspects of sustainable timber use.*

Background Information

Mass timber is an innovative building material made from layers of wood laminated together to create strong, durable structures suitable for large-scale construction projects, such as multi-story buildings. Unlike traditional materials like concrete and steel, which require energy-intensive manufacturing processes that release significant carbon emissions, mass timber is a renewable and low-carbon alternative. It offers a substantial environmental advantage by storing carbon within the wood itself, contributing to **carbon sequestration** — the natural process through which trees absorb carbon dioxide from the atmosphere and retain it even after being harvested for construction use (U.S. Forest Service, 2023).

Countries like **Canada and Japan** are leaders in using mass timber, with notable projects like the Brock Commons Tallwood House in Vancouver, a high-rise that demonstrates the material's structural strength and sustainability. Mass timber's versatility, strength, and sustainability have made it increasingly popular in architecture, as it enables architects and engineers to create buildings with a reduced carbon footprint (WoodWorks, 2022). While mass timber is a promising solution, it also presents challenges. Sustainable forestry practices are essential to prevent overharvesting and ensure a continuous wood supply, as deforestation could offset the environmental benefits (Forest Stewardship Council, 2023). Additionally, mass timber construction requires specialized skills,



which may increase building costs and limit its use in some regions. However, with responsible sourcing and appropriate training, mass timber has the potential to transform the construction industry, aligning with global efforts to reduce greenhouse gas emissions and promote renewable resources (American Wood Council, 2023).

Activity Summary

Students will conduct a research-based and hands-on activity comparing traditional building materials (such as steel and concrete) with **mass timber**. They will explore the structural properties, carbon emissions, and environmental impact of each material. Using small samples or images of mass timber products like **Cross-Laminated Timber (CLT)**, students will analyze how its layered design supports strength and flexibility for construction (WoodWorks, 2022). Additionally, they will calculate and compare the carbon footprint of mass timber versus traditional materials, reinforcing mass timber's role in reducing emissions (American Wood Council, 2023).

Alternatively, students could research the role of **firewood banks** in supporting community sustainability by investigating how these programs provide a renewable heating source in rural areas. This activity encourages students to evaluate the environmental and social impacts of renewable resources, emphasizing the real-world relevance of sustainable practices in architecture and community energy solutions (U.S. Department of Agriculture, 2023).

Activity Instructions

Introduction

Begin by introducing the concept of **sustainable building materials** and their importance in reducing the environmental impact of construction. Discuss traditional materials like **steel** and **concrete**, which require high energy for production, resulting in significant **carbon emissions**. Pose questions to the students: "What environmental impacts do you think come from using steel and concrete?" and "How might renewable materials, like wood, help reduce our carbon footprint?" Explain that the construction industry is one of the largest contributors to global carbon emissions, and finding alternative materials is essential for sustainability (American Wood Council, 2023).



Introduce **mass timber** as an innovative solution that stores carbon within the wood, effectively creating buildings that reduce greenhouse gases rather than add to them. Share examples like **Cross-Laminated Timber (CLT)**, a type of engineered wood made by layering timber panels, which is strong enough for multi-story buildings. Alternatively, explain how **firewood banks** provide a renewable heating source in certain communities, particularly rural areas, supporting local needs while reducing dependence on fossil fuels (U.S. Department of Agriculture, 2023). Let students know they will explore one of these options in a hands-on activity today, gaining insights into sustainable material use and community support.

Main Activity

Materials Needed

- Small wood blocks or models of mass timber (for structural comparison)
- Diagrams of mass timber buildings (optional)
- Firewood samples (if exploring firewood banks)
- Handouts or worksheets for research and note-taking

Steps

- 1. Introduction to Mass Timber and Firewood Banks:** Begin by discussing the applications of mass timber in modern architecture. Show examples of buildings made with mass timber, such as the **Brock Commons Tallwood House** in Canada, which demonstrates the strength and sustainability of wood in high-rise construction (WoodWorks, 2022). Explain how mass timber reduces carbon emissions through **carbon sequestration**, storing carbon within the wood structure. Alternatively, introduce firewood banks as a resource that supports sustainable heating, especially for low-income or rural communities.
- 2. Hands-on Material Comparison:** Divide the class into groups, providing each group with both wood blocks (to represent mass timber) and mock samples of traditional materials (or descriptions) like





steel or concrete. Ask students to handle the wood blocks and compare them to traditional materials, observing differences in weight, texture, and eco-friendliness. Have them take notes on each material's properties, discussing how mass timber's lighter weight makes it easier to transport, thus reducing transportation-related emissions, and how it is renewable, unlike steel or concrete (U.S. Forest Service, 2023).

3. Designing Models and Community Planning:

- **For Mass Timber:** Ask students to use the wood blocks to design simple models of structures, such as a small building or tower. Through this exercise, they can understand how mass timber layers enhance strength and support, especially in multi-story constructions. Encourage them to think about the structural benefits of mass timber and its capacity to withstand various stresses, making it a viable alternative in sustainable architecture.
- **For Firewood Banks:** Students focusing on firewood banks will research local tree species suitable for firewood, discussing attributes like burn rate and accessibility. They could then create a mock plan for a sustainable firewood program, identifying potential resources, costs, and environmental considerations, such as choosing fast-growing tree species to prevent deforestation and ensure an ongoing wood supply (U.S. Department of Agriculture, 2023).

Tip: *Through these hands-on exercises, students will gain an understanding of mass timber's applications in sustainable architecture and the social benefits of community firewood banks. They will also be encouraged to analyze each material's sustainability factors and challenges, considering real-world impacts.*

Reflection/Discussion

Conclude the activity with a class discussion to encourage students to reflect on their findings. Pose questions like, "What advantages does mass timber offer over materials like concrete?" and "How does using mass timber support the environment?" Encourage them to think about how mass timber's carbon-sequestering properties and renewable nature contribute to sustainable building practices.

For students who explored firewood banks, ask questions such as "How does a firewood bank benefit the local



community?” and “What considerations would be important for creating a sustainable firewood program?” This discussion reinforces the environmental and social impacts of sustainable practices, helping students connect the practical aspects of mass timber and firewood banks to broader sustainability goals (Forest Stewardship Council, 2023).

Data Collection and Analysis

In this activity, students will gather and analyze data to understand the environmental and economic impacts of mass timber and firewood as sustainable resources. Depending on the chosen focus, students can examine **carbon emissions** from mass timber compared to traditional construction materials or explore the **energy efficiency** of firewood relative to other fuels commonly used in heating (American Wood Council, 2023).

1. Mass Timber Carbon Footprint Analysis:

- Students working on mass timber will create a comparative data table, listing materials such as mass timber, steel, and concrete. They’ll record information on **carbon emissions** generated during production, **costs**, and **sustainability** factors. For example, they might find that mass timber sequesters carbon while concrete and steel contribute significantly to greenhouse gas emissions (U.S. Forest Service, 2023). By comparing these metrics, students can conclude how mass timber’s renewable nature and lower carbon footprint make it a more eco-friendly choice in construction.

2. Firewood Energy Efficiency and Sustainability:

- Students focusing on firewood banks will analyze the **energy efficiency** of firewood compared to fossil fuels like propane or natural gas. Using online resources or hypothetical data, students will calculate the **BTU output** (energy produced) per unit of each fuel type and compare it to the **cost** and **availability** in rural areas (U.S. Department of Agriculture, 2023). They may find that while firewood has a lower energy output per unit, it is renewable and can be sustainably harvested, unlike fossil fuels. This analysis can include data on community reliance on firewood banks, especially in areas where access to other fuels is limited, underscoring the social and environmental benefits of firewood banks (Forest Stewardship Council, 2023).



After collecting and organizing their data in tables or charts, students will present their findings, discussing the trade-offs of each resource. This data analysis reinforces concepts of sustainability and carbon reduction, helping students understand how choices in materials and fuels impact both communities and the environment.

Discussion and Reflection Questions

To deepen students' understanding of sustainability and renewable resources, lead a discussion using these thought-provoking questions:

- 1. "What environmental advantages does mass timber offer compared to traditional materials like concrete and steel?"**
 - Encourage students to reflect on how mass timber stores carbon, reducing greenhouse gas emissions, whereas concrete and steel have high carbon footprints due to energy-intensive manufacturing (American Wood Council, 2023). Ask students to consider how these differences impact the environment over the lifespan of a building.
- 2. "How might firewood banks support communities in need, and what challenges could they face?"**
 - Guide students to think about the role of firewood banks in providing a renewable heating source, especially for rural and low-income families with limited access to fossil fuels (U.S. Department of Agriculture, 2023). Discuss potential challenges, like maintaining sustainable tree harvesting practices and ensuring an adequate wood supply for future needs.
- 3. "How does using renewable resources like timber help achieve long-term sustainability goals?"**
 - Prompt students to consider how choosing renewable resources like mass timber promotes sustainable development. Discuss how sustainably managed forests can provide ongoing resources without depleting the ecosystem, contributing to long-term environmental stability and resource availability (Forest Stewardship Council, 2023).

Tip: *These questions connect the lesson to real-world sustainability efforts, allowing students to explore the benefits and complexities of using renewable resources in both construction and community heating. Through this reflection, students will gain a holistic view of how sustainable practices can benefit both the environment and society.*



Standards Alignment

This lesson aligns with the following **NGSS** standards, emphasizing sustainability, environmental impact, and the use of renewable resources:

- **NGSS HS-ESS3-4:** Evaluate or refine a technological solution that reduces the impact of human activities on natural systems. This standard applies to the exploration of mass timber as a low-carbon building material that helps reduce greenhouse gas emissions compared to traditional materials like steel and concrete (American Wood Council, 2023).
- **NGSS HS-LS2-7:** Design, evaluate, and refine a solution for reducing environmental impacts of resource use, such as firewood banks, which provide sustainable heating options for communities while promoting responsible forestry practices (U.S. Department of Agriculture, 2023).
- **NGSS HS-ESS3-3:** Create a computational simulation to illustrate the relationships among resource availability, human populations, and biodiversity. In this context, students can consider how sustainable timber practices support long-term biodiversity by preventing deforestation and promoting healthy forest ecosystems (Forest Stewardship Council, 2023).

Tip: *These standards guide students in exploring real-world applications of sustainability, helping them understand how renewable resources like mass timber and firewood banks contribute to environmental and community well-being.*

Optional Extensions

1. **Mass Timber Case Study Research:** Encourage students to select a case study of an innovative mass timber building, such as the **Brock Commons Tallwood House** in Canada. Ask them to research the building's design, materials, and the carbon footprint reduction achieved by using mass timber instead of steel or concrete (WoodWorks, 2022). Students could present their findings in a report or presentation, focusing on the environmental benefits and challenges of mass timber in high-rise construction.
2. **Firewood Bank Community Impact Project:** Have students investigate the role of firewood banks in supporting rural or low-income communities. They could conduct interviews with local community



members, firewood bank volunteers, or forestry professionals to learn about the benefits and limitations of firewood as a sustainable fuel source. Alternatively, students could create informational brochures or posters to raise awareness about responsible firewood harvesting and sustainable heating practices, including tips on selecting fast-growing tree species to maintain forest health (U.S. Department of Agriculture, 2023).

- 3. Comparative Environmental Impact Analysis:** Guide students in conducting a comparative analysis of mass timber and traditional construction materials in terms of their environmental impact. They can evaluate factors such as **carbon emissions**, **energy consumption**, and **resource renewability** for each material. This extension allows students to apply critical thinking as they weigh the pros and cons of renewable versus non-renewable materials in construction, fostering a comprehensive understanding of sustainability in architecture (American Wood Council, 2023).

Tip: *These advanced activities encourage students to engage with real-world sustainability challenges, enhancing their understanding of renewable resources, environmental impact, and community support initiatives.*

Assessment

- 1. Research Report:** Students can write a detailed report analyzing either the **environmental impact of mass timber** in construction or the **social benefits of firewood banks**. For mass timber, the report should explore topics such as carbon footprint reduction, sustainability, and potential challenges. For firewood banks, students can examine the role of these programs in providing renewable heating sources, especially in rural or low-income areas (American Wood Council, 2023).
- 2. Comparative Presentation:** Students present a comparative analysis of mass timber versus traditional materials like steel and concrete. This presentation should highlight the environmental advantages of mass timber, such as carbon sequestration and renewability, and the challenges, such as cost and sourcing limitations. Alternatively, students could present on the benefits of firewood banks for community support, emphasizing sustainable fuel use and social impact (U.S. Forest Service, 2023).
- 3. Community Proposal:** For a hands-on project, students can design a proposal for establishing a **local**



firewood bank. The proposal should include sustainable practices, such as selecting fast-growing tree species and promoting responsible harvesting. Students could also outline resource management strategies and ideas for community outreach, such as informational brochures to raise awareness about sustainable firewood use (U.S. Department of Agriculture, 2023).

Tip: *These assessment options allow students to explore sustainability concepts in depth, helping them apply their knowledge to real-world environmental and community issues.*

References and Resources

1. **Video:** *Mass Timber in Modern Architecture* – A detailed video exploring the environmental and structural benefits of mass timber as a sustainable alternative to steel and concrete. Available on YouTube or educational video platforms.
2. **Article:** *The Role of Firewood Banks in Rural Sustainability* – This article discusses the social, economic, and environmental impacts of firewood banks in supporting low-income and rural communities. Available on the U.S. Department of Agriculture website ([usda.gov](https://www.usda.gov)).
3. **Case Study:** *Brock Commons Tallwood House: A Mass Timber High-Rise* – A case study on Canada’s Tallwood House, illustrating carbon footprint reduction and construction innovations in mass timber (WoodWorks, 2022).
4. **Research Database:** **JSTOR** or **Google Scholar** – These databases provide access to academic research articles on sustainable forestry, renewable resources, and eco-friendly building materials.
5. U.S. Forest Service. (2023). Mass Timber in Sustainable Construction. Retrieved from <https://www.fs.usda.gov>
6. WoodWorks. (2022). Benefits and Challenges of Mass Timber Construction. Retrieved from <https://www.woodworks.org>
7. American Wood Council. (2023). Mass Timber and Carbon Reduction. Retrieved from <https://www.awc.org>



8. U.S. Department of Agriculture. (2023). Community Firewood Banks and Sustainable Fuel. Retrieved from <https://www.usda.gov>
9. Forest Stewardship Council. (2023). Sustainable Forestry Practices and Resource Management. Retrieved from <https://us.fsc.org>
10. WoodWorks. (2022). Cross-Laminated Timber in Modern Architecture. Retrieved from <https://www.woodworks.org>

Tip: *These resources provide students with in-depth insights into sustainable building materials and community energy solutions, supporting further exploration of renewable resources in real-world applications.*