



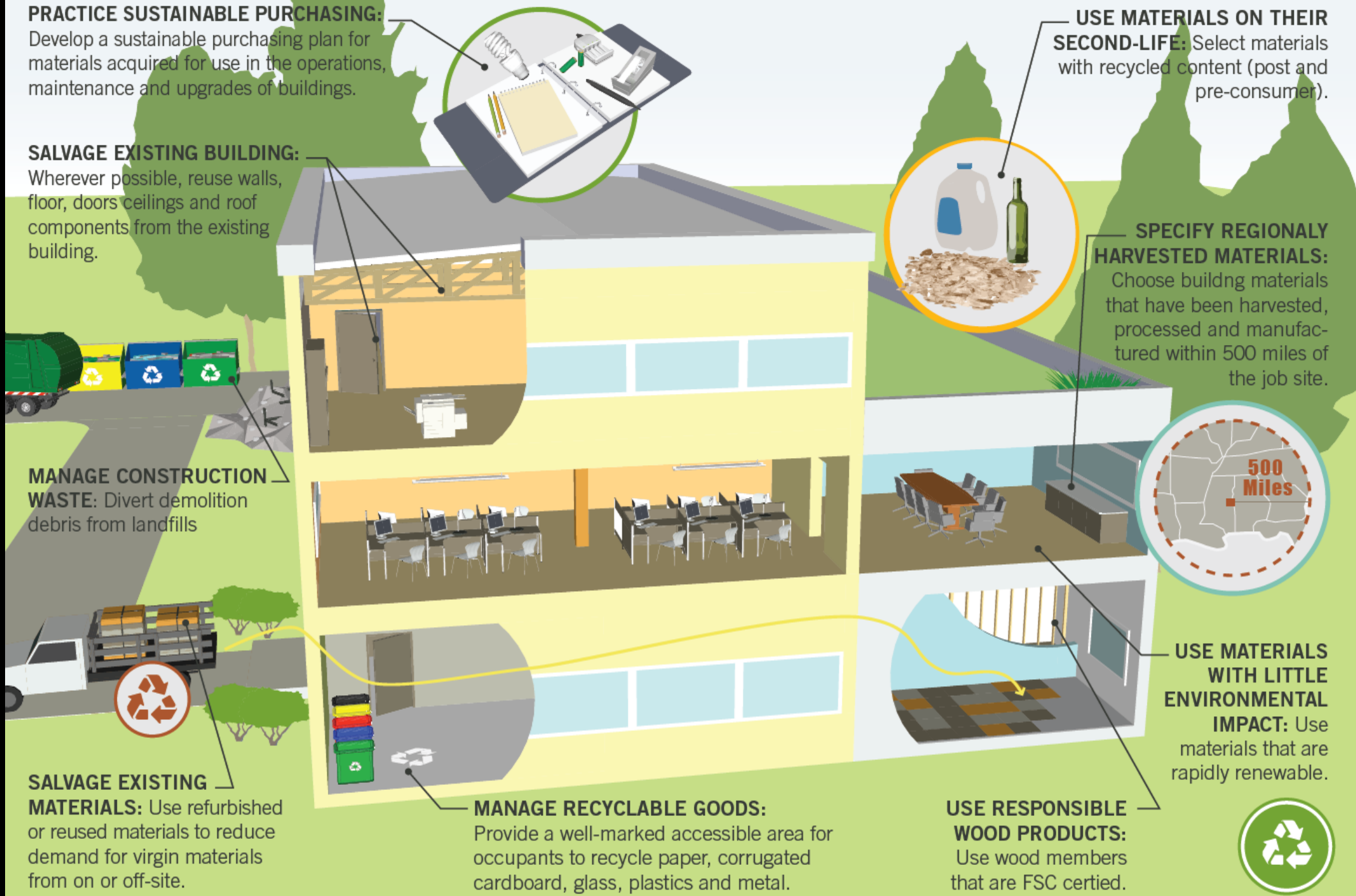
Green Building & Sustainable Construction (TCM 5330)

Materials and Resources



Dr. Tommy Tafazzoli

Where to track materials and resources sustainability



How do you know if a building material is safe and sustainable?

- Determining if a building material is safe and sustainable involves evaluating it across several criteria, including:



its
environmental
impact

health
implications

resource
efficiency

lifecycle
performance

Watch the video

10 Innovative Green Building Materials to Watch in 2023

- Link:

https://www.youtube.com/watch?v=UMxcEQ61gZU&ab_channel=ARCH-Architecture

(you may also click on the YouTube Logo below)

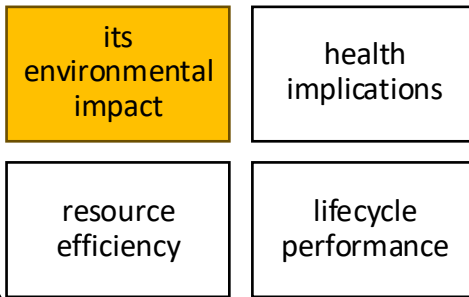


What criteria for environmental impact should we consider to ascertain the safety and sustainability of a building material?

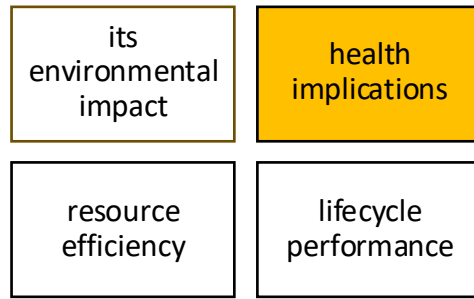
Source: Prefer materials that are locally sourced and also from renewable resources. LEED defines regional materials as those that are extracted, harvested, recovered, or manufactured within 500 miles of the project site.

Energy Consumption: Consider the energy required to extract, manufacture, and transport the material. Materials with lower embodied energy are generally more sustainable.

Carbon Footprint: Assess the greenhouse gas emissions associated with the material throughout its lifecycle. Choosing materials with lower carbon footprints contributes to mitigating climate change.



What criteria for health should we consider to ascertain the safety and sustainability of a building material?



Volatile Organic Compounds (VOCs): Some materials off-gas VOCs, which can affect indoor air quality and health. Look for low-VOC or VOC-free materials.

Toxicity: Avoid materials that contain toxic substances or heavy metals that can leach into the environment or pose health risks to occupants.

Volatile Organic Compounds (VOCs) in buildings refer to a large group of chemicals that can easily become vapors or gases. Along with carbon, they contain elements such as hydrogen, oxygen, fluorine, chlorine, bromine, sulfur, or nitrogen. VOCs are emitted by a wide array of products numbering in the thousands.

Examples of VOCs

- Formaldehyde:** Found in pressed wood products (like particleboard, hardwood plywood paneling), glues, adhesives, and certain types of insulation.
- Benzene:** Present in paints, glues, carpets, emissions from burning coal and oil, and tobacco smoke.
- Toluene:** Used in paint thinners, adhesives, coatings, and some personal care products.
- Ethylene Glycol:** Found in some paints, solvents, and automotive antifreeze.
- Acetone:** Present in nail polish remover, furniture polish and wallpaper.
- Xylene:** Found in printing, rubber, and leather industries.

Watch the video

WHAT ARE VOLATILE ORGANIC COMPOUNDS (VOC'S)?

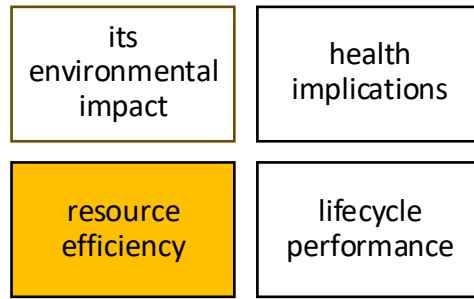
- Link:

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What criteria for health should we consider to ascertain the safety and sustainability of a building material?



Recycled Content: Materials made from recycled content reduce the demand for virgin resources and can lower the environmental footprint.

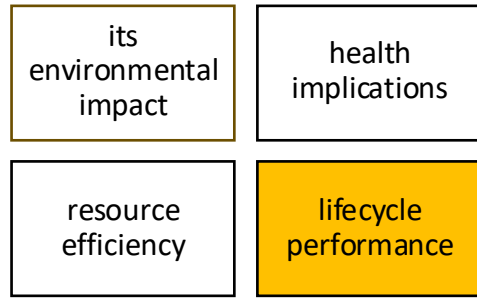
Durability: Durable materials last longer, reducing the need for frequent replacements and the associated environmental impact.

Recyclability: Materials that can be recycled at the end of their use phase prevent waste and support a circular economy.



The recyclability of materials refers to their ability to be collected, processed, and reused to make new products after they have served their original purpose. This process is a key component of waste reduction and is essential to sustainable resource management.

What criteria for health should we consider to ascertain the safety and sustainability of a building material?



Lifecycle Assessment (LCA): Conducting an LCA can help evaluate the comprehensive environmental impacts of a material over its entire life, from extraction through disposal or recycling.

Adaptability and Reusability: Materials that can be adapted to different uses or reused in other projects minimize waste and extend the material's life.



What Certifications and Standards can we rely on?
Environmental Product Declarations (EPD)
Green Building Certifications
Health and Safety Standards

Watch the video

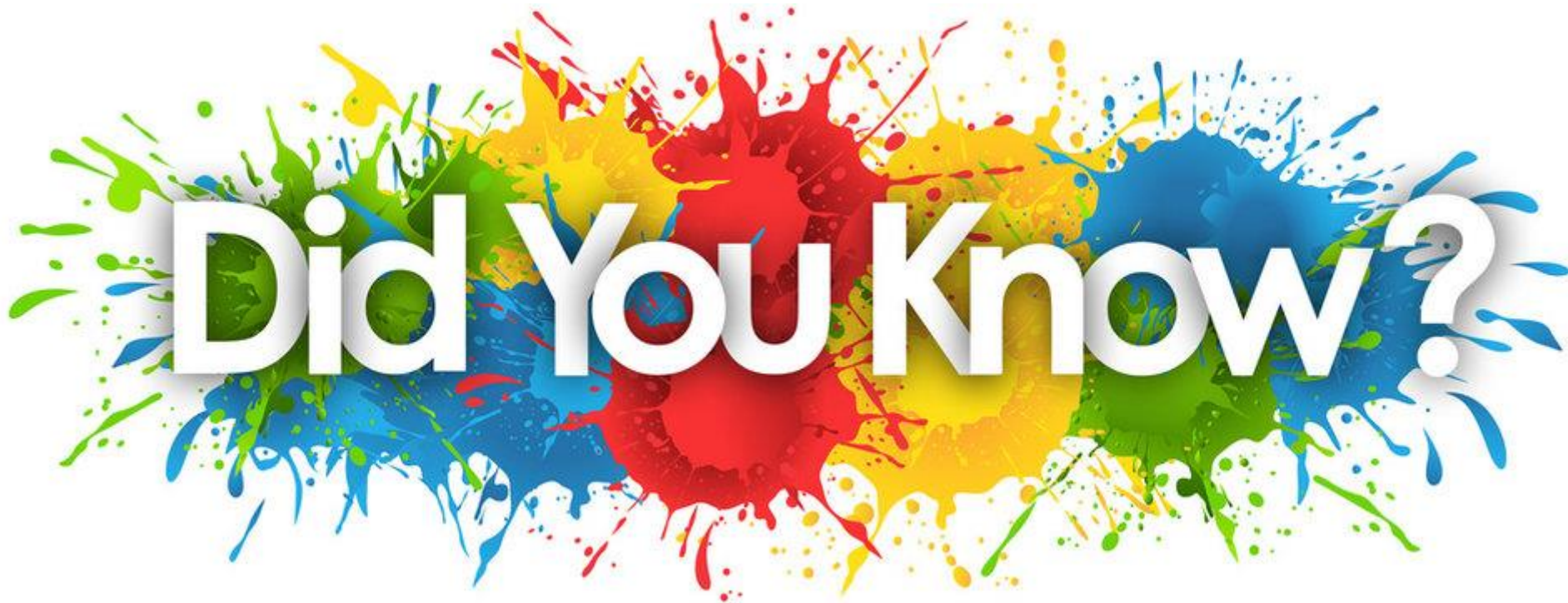
Life Cycle Assessment: Quantifying Environmental Impacts (Course Overview)

- Link:

https://www.youtube.com/watch?v=V7kyG8LxFlo&ab_channel=MITProfessionalEducation

(you may also click on the YouTube Logo below)





**40% of raw stone gravel, and sand and
25% of all virgin wood that is extracted
is used for the construction of buildings?**



Two primary categories when considering materials and resources

- Factor 1. Selection of sustainable materials (life-cycle impacts)
- Factor 2. Waste management.



What are the impacts of using materials on environment, economy, and community?

Environment

- Given the sheer amount of resources that go into buildings, it is easy to see the environmental consequences of their use, including air and water pollution, destruction of native habitats, and depletion of natural resources.

Economy

- Many of the readily available materials used in the construction industry are extracted or manufactured in a way that historically has focused solely on economic profit. In this model, the environment and people are completely left out of the picture.

Community

- The extraction, manufacturing, application, and disposal of many of today's materials pose serious health risks to the human population, many of which are not clearly understood.

Factors Related to Materials and Resources

Factor 1. Material Selection—Considering Life-Cycle Impacts



Factor 1. Material Selection—Considering Life-Cycle Impacts

Develop a construction purchasing policy.

Define Clear Sustainability Goals:	• Establish what sustainability means for the organization, such as waste reduction or using renewable resources.
Assess Current Purchasing Practices	• Review and identify where improvements can be made in the procurement process.
Prioritize Sustainable Materials	• Set guidelines for the use of materials that are eco-friendly, durable, recyclable, have low embodied energy, and are non-toxic.
Engage Stakeholders	• Involve suppliers, contractors, and end-users in developing the policy to ensure practicality and support.
Streamline Procurement Processes	• Evaluate suppliers' sustainability credentials, prefer certified products, and promote bulk purchasing to reduce impacts.
Incorporate Waste Reduction	• Reuse materials where possible, reduce packaging, and plan for material optimization.
Provide Training and Communication	• Make sure all parties involved understand the policy and are trained in its implementation.
Monitor and Review	• Set up metrics for monitoring compliance and regularly update the policy to incorporate new insights and technologies.
Encourage Innovation	• Motivate suppliers and contractors to offer sustainable alternatives.
Transparent Reporting	• Create accountability by reporting sustainability performance internally and externally.
Align with Standards	• Ensure the policy meets recognized sustainability benchmarks like LEED or BREEAM.

Factor 1. Material Selection—Considering Life-Cycle Impacts

Specify green materials



- Specifications are the written documents that an architect issues along with drawings to describe the quality of materials to be used on a project.
- It is in the specifications that you can let the contractor know to buy wood from the region or not to use PVC, for example.
- The specifications are a legally binding document, so it is the most solid way to ensure that green materials make it into the project.

Watch the video

7 Sustainable Architecture Materials

- Link:

https://www.youtube.com/watch?v=aKqNbTo2PFM&ab_channel=EcoMasteryProject

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Factor 1. Material Selection—Considering Life-Cycle Impacts

Specify green interiors.

- use the specifications to make sure only low- or no-VOC paints are used or bamboo floors, for example, are installed.



Factor 1. Material Selection—Considering Life-Cycle Impacts

Develop a sustainable purchasing policy.

Identify Sustainable Materials and Practices

- Choose construction materials that are sourced sustainably, have lower environmental impacts, and are durable and recyclable. Also, consider the sustainability practices of potential suppliers.

Engage Stakeholders

- Include input from all parties involved in the building process, from architects and contractors to end users.

Set Procurement Criteria

- Establish clear criteria for selecting materials and suppliers, such as requiring certifications (e.g., FSC for wood, Energy Star for appliances).

*Factor 1. Material Selection—
Considering Life-Cycle Impacts*
**Specify green electronic
equipment.**

Find electronics and accessories that:

1. use less energy
2. are made with recyclable and recycled materials
3. are easier to upgrade,
4. are easier to fix,
5. are easier to recycle.



Factors Related to Materials and Resources

Factor 2. Waste Management



What are the impacts of waste management on environment, economy, and community?

Environment

- Current construction and disposal practices introduce highly hazardous toxic materials into the soil, air, and water when such materials are disposed of in landfills. Landfills fail and leak contaminants into ground and surface water.

Economy

- The cost of building and maintaining landfills is astronomical. Because landfills have the potential to substantially harm the environment, they are highly regulated and therefore costly. Even after a landfill is “closed,” it must be monitored and tested for decades to determine its impact on local air, soil, and water resources.

Community

- Landfill gas emissions and contaminated groundwater sources have the potential for devastating impacts on human health.

What's the hierarchy of waste management?

Most favoured option



Least favoured option

Or let's make it even simpler



Watch the video

Reduce, Reuse, Recycle Household Waste

- Link:

[https://www.youtube.com/watch?v=EGzg77rx7Uo&ab_channel=MM
SB%28Multi-MaterialsStewardshipBoard%29](https://www.youtube.com/watch?v=EGzg77rx7Uo&ab_channel=MM%28Multi-MaterialsStewardshipBoard%29)

(you may also click on the YouTube Logo below)



Factor 2. Waste Management

Size the building appropriately.

- Bigger buildings often produce more waste compared to smaller ones due to several factors:

Scale of
Construction

Complex
mechanical,
electrical, and
plumbing systems

Renovations and
Updates

More operational
Waste

More Furniture
and Equipment

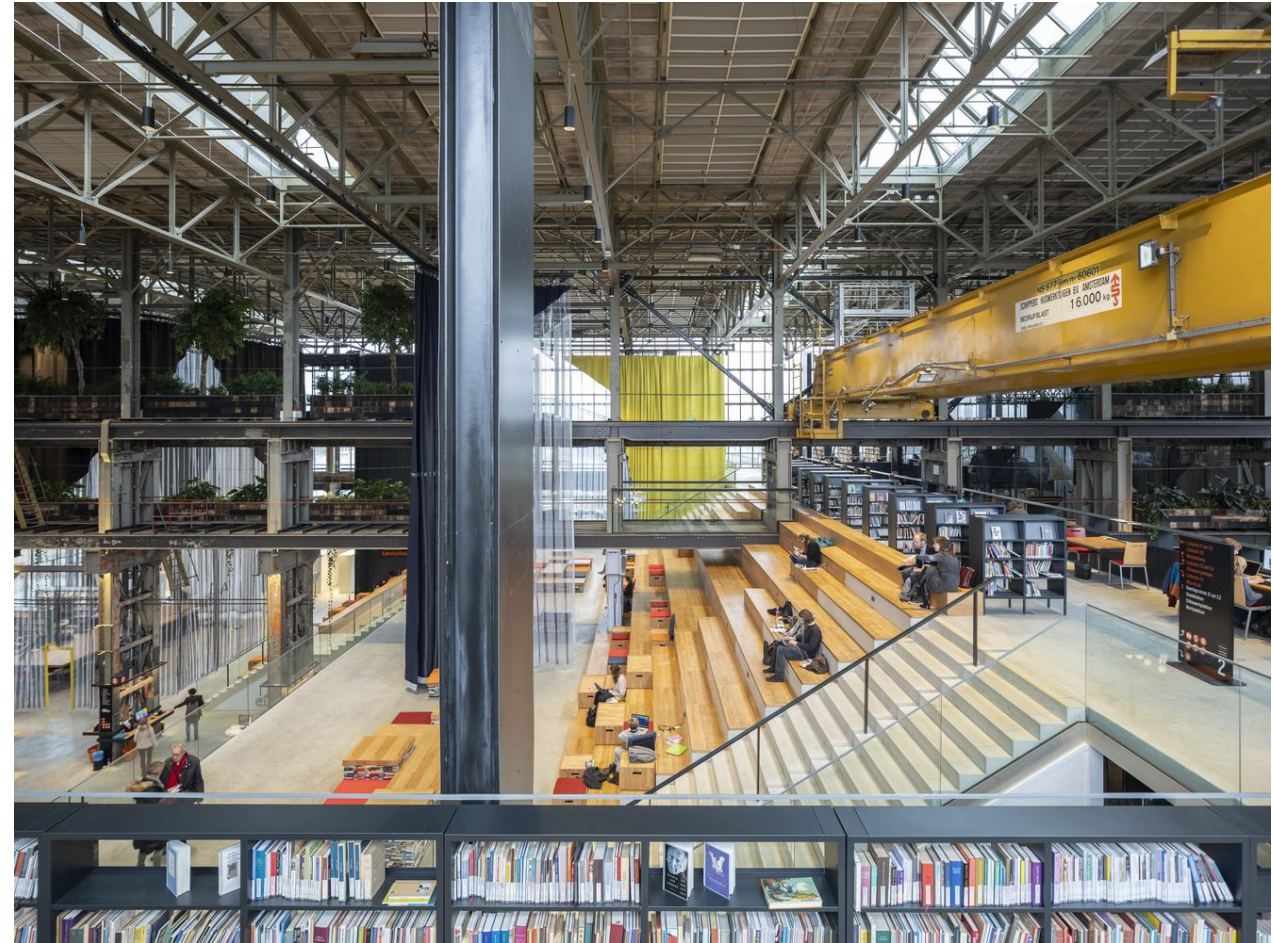
Higher Energy
Consumption



Factor 2. Waste Management

Reuse existing buildings or portions of existing buildings.

- Reusing existing buildings, or portions of them, to promote sustainability is a practice often referred to as "adaptive reuse."
- This approach can significantly reduce environmental impacts by conserving resources and reducing waste.



Factor 2. Waste Management

Reuse building materials.

- Certain salvaged materials simply cannot be duplicated in today's manufacturing system.
- Looking for architectural gems or repurposing a product such as old lockers is a great way to keep materials out of the landfill and give a space character.



Watch the video

Turning wood into recycled materials

- Link:

https://www.youtube.com/watch?v=FJYs12OvBaU&ab_channel=KTVB

(you may also click on the YouTube Logo below)



Factor 2. Waste Management

Develop a construction waste management policy.

Identify Waste Streams and Opportunities for Minimization

- **Map Out Waste Streams:** Identify all potential waste streams in construction projects, including materials like concrete, wood, metal, and packaging.
- **Opportunities for Reduction:** Look for opportunities to minimize waste at the source through design choices, material selection, and procurement practices.

Develop Strategies for Waste Reduction, Reuse, and Recycling

- **Waste Reduction:** Implement strategies to reduce waste generation, such as ordering materials to exact specifications or using prefabricated components.
- **Reuse:** Encourage the reuse of materials and components within the project or in other projects.
- **Recycling:** Identify materials that can be recycled and set up systems for separating and collecting recyclable waste on-site.

Monitor, Report, and Review

- **Track Progress:** Monitor and track waste generation and diversion rates throughout the construction process.
- **Reporting:** Regularly report on waste management performance against the set targets.
- **Review and Adjust Policies:** Review the effectiveness of the waste management policy periodically and make adjustments as necessary to improve outcomes.

Factor 2. Waste Management

Consider new technology, design, and construction decisions.

New Technology

- Energy Efficiency
- Renewable Energy
- Water Conservation
- Material Efficiency

Innovative Design

- Passive Design Strategies
- Green Roofs and Walls
- Flexible Space Usage
- Site-Specific Design

Construction Decisions

- Sustainable Material Selection
- Waste Reduction Plans
- Minimizing Site Disturbance
- Sustainable Construction Practices





Factor 2. Waste Management

Compost.

Promoting composting within the context of a building's operation can significantly enhance its sustainability in several ways:

Waste Reduction

- Composting organic waste reduces the volume of waste sent to landfills and incinerators. This diminishes the environmental impact associated with waste management, such as methane emissions from landfills and the energy consumption of waste transportation.

Soil Improvement

- The compost produced can be used to enrich the soil in gardens and landscaping around the building. This improves soil health by adding nutrients, enhancing soil structure, and increasing water retention, reducing the need for chemical fertilizers and extensive irrigation.

Greenhouse Gas Emissions Reduction

- By diverting organic waste from landfills, composting helps reduce methane emissions. Methane is a potent greenhouse gas, and its reduction is crucial in combating climate change. Composting instead turns organic waste into a resource, contributing to a circular economy.

Factor 2. Waste Management

Encourage recycling.

Effective strategies to promote recycling:

Provide Clear Signage and Instructions

- Install clear, easy-to-understand signs near recycling bins to guide what can and cannot be recycled. Use visuals to overcome language barriers and ensure everyone can participate.

Make Recycling Bins Accessible and Convenient

- Place recycling bins in strategic, high-traffic areas, ensuring they are as accessible as general waste bins. Consider different spaces like kitchens, offices, hallways, and near elevators.

Educate Building Occupants

- Organize workshops or seminars on the importance of recycling and how to recycle properly. Information could cover the environmental benefits of recycling and the specific recycling procedures for the building.
- Distribute educational materials, such as flyers or emails, with recycling tips and facts.

Implement a Recycling Program

- Develop a comprehensive recycling program that includes paper, plastics, glass, and metals. Ensure the program is well communicated to all building occupants.
- Include special recycling streams for e-waste, batteries, and other hazardous materials, providing information on how and where to recycle these items safely.

Use Technology

- Consider using apps or building management systems that can remind occupants to recycle, inform them of recycling days, or update them on the impact their recycling efforts are making.



Engage and Motivate

- Create a recycling committee or green team to lead initiatives and engage occupants.
- Organize challenges or competitions with rewards for departments or floors that recycle the most.

Provide Feedback and Recognition

- Share regular updates on the amount of waste the building has recycled and how this contributes to environmental goals. This feedback can motivate continued participation.
- Recognize and reward consistent recyclers or departments that show significant improvement in their recycling efforts.

Incorporate Recycling into Lease Agreements and Building Policies

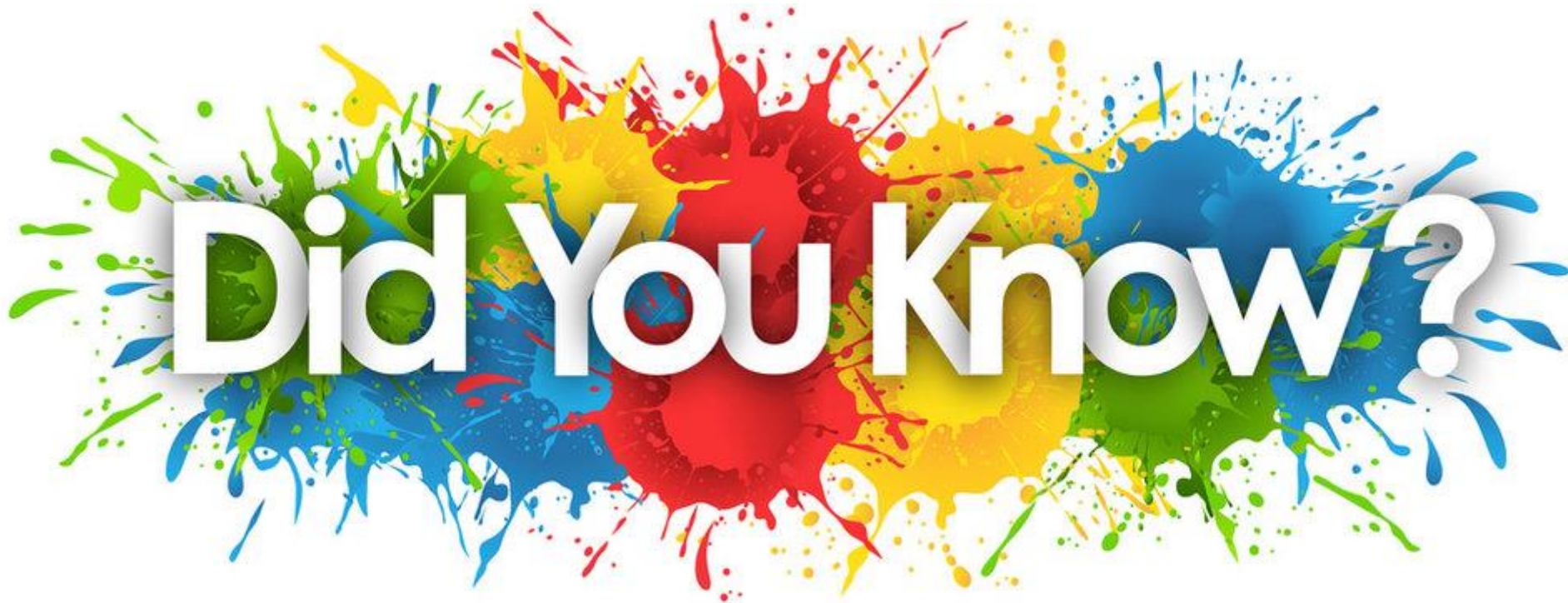
- For commercial buildings, include recycling policies in lease agreements to ensure tenant participation.
- Implement building-wide policies that emphasize sustainability and recycling as core values.

Collaborate with Local Recycling Services

- Work with local waste management and recycling services to ensure recyclable materials are processed correctly. They may also offer additional resources or services to enhance your recycling program.

Make Recycling Part of the Building's Culture

- Encourage a culture of sustainability by integrating recycling and other green practices into the daily routine of building occupants. Leadership should lead by example, participating actively in recycling initiatives.



According to the EPA, 32% of solid waste is currently recycled in the United States.



As of 2022, South Korea holds the record for the highest rate of recycling in the world, having recycled 67.1% of its waste.



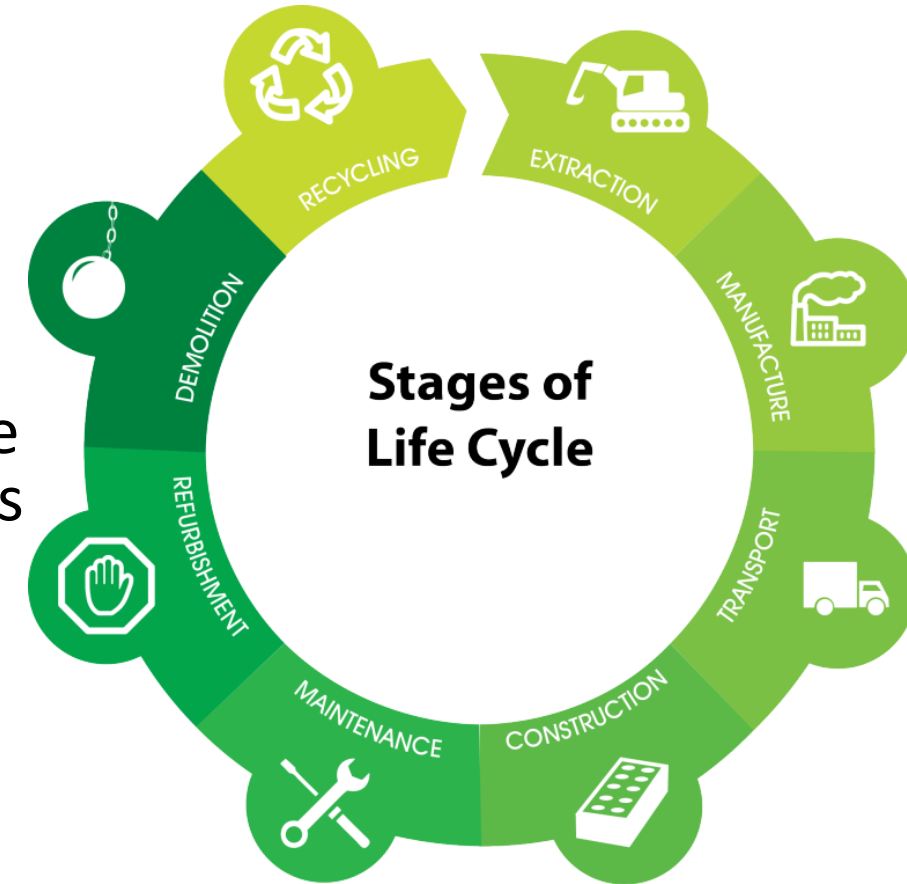
What is **upcycling** materials?



- Upcycling materials refers to the process of transforming by-products, waste materials, useless, or unwanted products into new materials or products of better quality or for better environmental value. It's about creative reuse - converting old or discarded materials into something useful and often beautiful.
- Unlike recycling, which breaks down products into raw materials, upcycling repurposes items without degrading the material quality, thereby extending the life cycle of the material. Examples of upcycling include turning old tires into playground equipment, repurposing glass bottles into decorative lampshades, or transforming worn clothing into quilts or bags.
- Upcycling not only reduces the amount of waste ending up in landfills but also decreases the need for production using new or raw materials, thus saving energy and reducing carbon footprints.

What do we mean by material embodied energy?

- Material embodied energy refers to the total amount of energy required to produce a material.
- This includes the extraction of raw materials, transportation, manufacturing, processing, and delivery.
- It is the sum of all the energy consumed during the entire lifecycle of the material up to the point of its use in a product or construction.
- Understanding embodied energy is critical in assessing the overall environmental impact of materials and can guide choices towards more sustainable options in construction and product design.



What do we mean by **rapidly renewable material**?

- Rapidly renewable materials are those derived from resources that are quickly replenished naturally within a short time frame.
- These materials stand in contrast to non-renewable resources like metals and minerals, which can take thousands or millions of years to form.
- For a material to be considered rapidly renewable by LEED, it must be made from plants that are typically harvested within a ten-year cycle.



What is **recycled content**?

- The percentage of material in a product that is recycled from the manufacturing waste stream (pre-consumer waste) or the consumer waste stream (postconsumer waste) and used to make new materials.
- For LEED, recycled content is typically expressed as a percentage of the total material volume or weight.



What is **pre-consumer recycled content**?

- The percentage of material in a product that was recycled from manufacturing waste.
- Pre-consumer content was formerly known as postindustrial content.
- Examples include planer shavings, sawdust, bagasse, walnut shells, culls, trimmed materials, overissue publications, and obsolete inventories.
- Excluded are rework, regrind, or scrap materials capable of being reclaimed within the same process that generated them.

Watch the video

What is Pre-Consumer Waste?

- Link:

https://www.youtube.com/watch?v=QvuWFiuyWyg&ab_channel=Timbuk2

(you may also click on the YouTube Logo below)



What is **post-consumer recycled content**?

- Post-consumer recycled content refers to materials that have been used and discarded by consumers and are then collected for recycling.
- This is different from pre-consumer or post-industrial recycled content, which comes from the manufacturing process before the product reaches the consumer.
- Post-consumer content is important because it helps close the recycling loop by reusing consumer waste products, thereby reducing the need for virgin materials and decreasing waste sent to landfills.

Watch the video

Post-Consumer Recycled Content: From Consumer Waste to Resource

- Link:

https://www.youtube.com/watch?v=DoFrTpjG95c&ab_channel=Pregis

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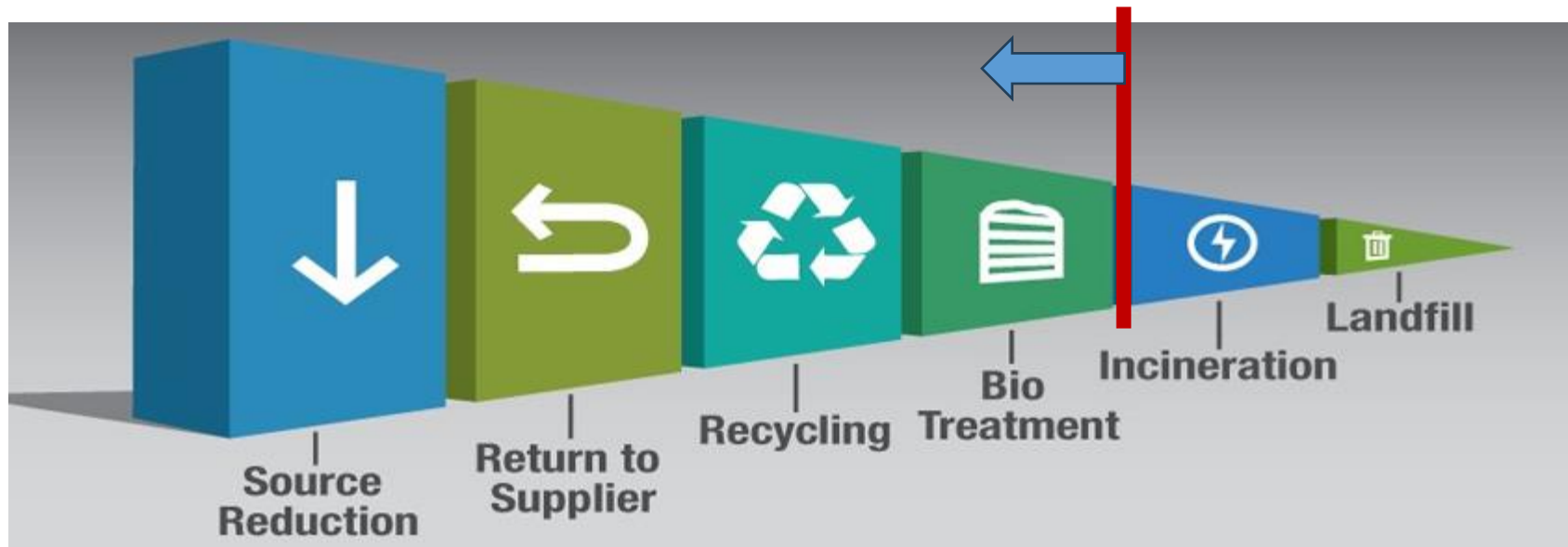
What are **ongoing consumables** ?

- Ongoing consumables are products that are used and replaced over the course of a building's occupancy.
- These include items like office supplies, cleaning products, and food.
- They do not encompass materials used during construction or those that are part of the building's structure and systems.



What is **waste diversion**?

- The amount of waste disposed of other than through incineration or in landfills, expressed in tons.
- Examples of waste diversion include reuse and recycling.



What is **sustained-yield forestry**?

- Sustained-yield forestry is a management practice that aims to achieve a balance between the amount of wood harvested and the forest's natural capacity to regenerate.
- This approach ensures that forest exploitation does not exceed growth over a specified period, typically aiming for continuous production without depleting the forest resources.
- It supports long-term ecological balance, preserving biodiversity and ecosystem services while also providing a steady supply of timber, fiber, and other forest products.



Watch the video

Sustainable Forest Management 101

- Link:

https://www.youtube.com/watch?v=ZeJwlZZbCaI&ab_channel=EUSTAFORBrussels

(you may also click on the YouTube Logo below)



What is a **construction waste management plan**?

- A plan that diverts construction debris from landfills through recycling, salvaging, and reuse.

Class	Definition	Example	Destination
Class A	Reusable or recyclable waste	- Waste from infrastructure works - Recyclable waste, such as: metals, glass, cardboard, etc. - Waste from the manufacturing process and/or demolition of precast concrete parts	They must be reused or recycled as aggregates, or sent to landfill sites for civil construction waste, and must be disposed of in such a way that they can be used or recycled in the future.
Class B	Recyclable waste for other purposes.	Plastics, paper, cardboard, metals, glass, wood, empty packaging of real estate paints (whose container has only dry film of ink in its internal coating,).	They must be reused, recycled or sent to temporary storage sites and must be disposed in such a way that they can be used or recycled in the future.
Class C	Waste for which no economically viable technologies or applications have been developed to enable its recycling.	Gypsum waste.	They must be stored, transported and destined in accordance with the specific technical standards.
Class D	Hazardous waste from the construction process.	Waste such as: paints, solvents, oils and others, or those contaminated from demolitions, refurbishments and repairs of radiology clinics, industrial facilities, etc.	They must be stored, transported, reused and disposed of in accordance with specific technical standards.

Figure 1: Classification of Civil Construction Waste

What is **certified** **wood**?

- Wood that has been issued a certificate from an independent organization with developed standards of good forest management.
- This certificate verifies that wood products come from responsibly managed forests.



What do we mean by **by-product**?

- A material, other than the principal product, generated as a consequence of an industrial process or as a breakdown product in a living system. (EPA)

