

**VISVESVARAYA TECHNOLOGICAL UNIVERSITY
BELGAUM**



GREEN BUILDINGS

(Subject Code: BETCK105B)

LECTURE NOTES

(MODULE-3)

I-SEMESTER

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Module -3

Global Warming

Definition

Global warming is the gradual increase in the average temperature of the Earth's atmosphere and oceans, primarily caused by human activities such as burning fossil fuels and deforestation. This increase in temperature causes a wide range of effects on the Earth's climate, including rising sea levels, changes in precipitation patterns, and more extreme weather events. These changes can have negative impacts on ecosystems and human communities, including increased frequency of natural disasters and damage to agriculture and infrastructure.

Causes

The primary cause of global warming is the burning of fossil fuels, such as coal, oil, and natural gas, which releases large amounts of carbon dioxide and other greenhouse gases into the atmosphere. These gases trap heat from the sun, causing the Earth's temperature to rise.

Other human activities that contribute to global warming include:

- Deforestation and other land use changes, which reduce the ability of the land to absorb carbon dioxide
- Industrial processes, such as cement production, that release greenhouse gases
- Agriculture, particularly livestock production, which generates methane and nitrous oxide.
- Fertilizers usage in agriculture, which releases nitrous oxide
- Landfills, waste treatment facilities and sewage treatment plants, which release methane.

It's also worth noting that human activities that decrease the Earth's reflectivity, such as urbanization and deforestation, also contribute to global warming.

Effects

The effects of global warming can be wide-ranging and can have significant impacts on both the natural world and human society. Some of the potential effects of global warming include:

- Rising sea levels: As the Earth's temperature rises, ice and snow melts, causing sea levels to rise. This can lead to coastal flooding, erosion, and saltwater intrusion into freshwater supplies.
- Increased frequency and severity of extreme weather events: Global warming can lead to more frequent and severe heatwaves, droughts, storms, and other extreme weather events.
- Damage to ecosystems: Changes in temperature and precipitation patterns can harm or kill off plant and animal species that are not able to adapt. This can disrupt entire ecosystems, reducing biodiversity and altering food webs.
- Damage to agriculture: Changes in temperature and precipitation patterns can harm crop yields, making it harder to grow food.
- Damage to human health: Global warming can lead to a range of health problems, including heat stroke, respiratory problems, and the spread of disease.
- Displacement of people: Rising sea levels and extreme weather events can force people to leave their homes and communities.
- Economic impacts: The costs associated with the effects of global warming, including damage to infrastructure, decreased crop yields, and increased healthcare costs, can have a significant impact on the economy.

It's important to note that these effects are interrelated and can exacerbate each other, leading to even more severe impacts.

Contribution of Buildings towards Global Warming

Buildings, both residential and commercial, can contribute to global warming in a number of ways. Some of the ways that buildings can contribute to global warming include:

- Energy consumption: Buildings consume a large amount of energy for heating, cooling, lighting, and powering appliances. This energy is often generated from burning fossil fuels, which releases greenhouse gases into the atmosphere.
- Insulation: Poorly insulated buildings can lead to heat loss in winter and heat gain in summer, resulting in increased energy consumption for heating and cooling.
- Lighting: Buildings consume energy for lighting, which contributes to greenhouse gas emissions.
- Materials: Building materials such as cement, steel and aluminum are energy-intensive to produce and contribute to emissions.

- Water consumption: Buildings can consume a significant amount of water, which can lead to the release of methane and other greenhouse gases from treatment and transportation of water.
- Waste: Buildings can generate a significant amount of waste, which can contribute to greenhouse gas emissions if it ends up in landfills.

According to estimates, the building sector is responsible for around 40% of global energy-related carbon emissions. This makes it one of the largest contributors to global warming.

On the other hand, Buildings can also have a positive impact on the environment by being energy-efficient, using renewable energy sources, and being constructed with sustainable materials.

Overall, buildings are responsible for a large portion of global greenhouse gas emissions, and there is a growing interest in making them more energy efficient and sustainable in order to reduce the contribution to global warming.

Carbon Footprint

A carbon footprint is a measure of the total amount of greenhouse gases (including carbon dioxide, methane, nitrous oxide, and others) that are emitted into the atmosphere as a result of human activities. The most common way to measure a carbon footprint is in terms of the amount of carbon dioxide equivalents (CO₂e) that are emitted.

A carbon footprint is usually measured in terms of the amount of greenhouse gases produced over a specific period of time, such as a year, and is expressed in terms of metric tonnes of CO₂e.

Individuals, organizations, and even countries can have carbon footprints. The carbon footprint of an individual can be calculated by assessing the emissions that result from their daily activities, such as driving, heating and cooling their home, and consuming goods and services. The carbon footprint of an organization or company can be calculated by assessing the emissions that result from their operations and supply chain.

Measuring a carbon footprint is the first step in understanding and reducing your greenhouse gas emissions and making more informed decisions about how to take action to combat climate change.

Global Efforts to reduce carbon Emissions

There are a number of efforts underway at the global level to reduce carbon emissions and mitigate the effects of global warming. Some of the key efforts include:

- **The Paris Agreement:** This international agreement, adopted by the United Nations Framework Convention on Climate Change (UNFCCC) in 2015, aims to limit global warming to well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit warming to 1.5 degrees Celsius. Under the Paris Agreement, countries pledge to reduce their greenhouse gas emissions and to report on their progress in doing so.
- **Nationally Determined Contributions (NDCs):** Under the Paris Agreement, countries pledge to reduce their greenhouse gas emissions and to report on their progress in doing so. These pledges are known as Nationally Determined Contributions (NDCs)
- **The Clean Energy for All Europeans package:** This package of EU legislation aims to increase the share of renewable energy and energy efficiency in the EU, to improve the security of the energy supply and to reduce greenhouse gas emissions.
- **The Energy Efficiency Directive:** This EU directive sets binding targets for energy efficiency and requires member states to take a range of measures to improve the energy efficiency of buildings, industry, and transport.
- **The Renewable Energy Directive:** This EU directive sets targets for the share of renewable energy in the EU's final energy consumption and requires member states to take a range of measures to support the deployment of renewable energy.
- **Carbon pricing:** Some countries and regions have implemented carbon pricing mechanisms, such as carbon taxes or cap-and-trade systems, to create an economic incentive for reducing emissions.
- **R&D on clean technologies:** Investing in research and development of new clean technologies, such as carbon capture and storage, can also help to reduce emissions.
- **Sustainable transportation:** Encouraging sustainable transportation options such as electric vehicles, public transportation, and active transportation can help to reduce emissions from the transportation sector.

Green Buildings

Definition

Green buildings, also known as sustainable buildings, are buildings that are designed, constructed, and operated in an environmentally responsible manner. The goal of green building is to reduce the overall environmental impact of a building throughout its lifecycle, from the initial design and construction, to its operation and eventual demolition.

Green buildings typically incorporate a variety of features that help to reduce their environmental impact, such as:

- **Energy efficiency:** Green buildings are designed to use less energy for heating, cooling, and lighting. This can be achieved through a variety of means, such as using energy-efficient appliances and lighting, incorporating renewable energy sources, and using insulation and other building materials that help to reduce heat loss.
- **Water efficiency:** Green buildings are designed to use less water, through the use of low-flow fixtures, rainwater harvesting, and greywater systems.
- **Materials:** Green buildings typically use materials that are sustainable, such as reclaimed or rapidly renewable materials, and materials that have a low environmental impact, such as low VOC (volatile organic compounds) emitting materials.
- **Indoor air quality:** Green buildings are designed to improve indoor air quality, through the use of materials and practices that reduce the amount of pollutants in the air, and through the incorporation of natural ventilation and daylighting.
- **Site impact:** Green buildings are designed to have a minimal impact on the surrounding site, through practices such as preserving natural habitats, reducing the amount of impervious surface, and incorporating green roofs and walls.

Green buildings can have a number of benefits, such as reducing energy and water consumption, improving indoor air quality, and reducing the overall environmental impact of a building throughout its lifecycle.

Features

Green buildings typically incorporate a variety of features that help to reduce their environmental impact, some of these features include:

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- **Site impact:** Green buildings are designed to have a minimal impact on the surrounding site, through practices such as preserving natural habitats, reducing the amount of impervious surface, and incorporating green roofs and walls.
- **Resource Conservation:** Green buildings are designed to conserve resources, through the use of efficient systems, such as geothermal heating and cooling, and through the use of alternative energy sources such as solar and wind power.
- **Recycling and Waste reduction:** Green buildings often have systems in place for recycling and waste reduction, such as composting and recycling stations.
- **Smart building technology:** Green buildings often incorporate technology that enables the building to automatically.

Necessity

Green buildings are necessary for a number of reasons, including:

1. **Environmental protection:** Green buildings are designed to reduce their environmental impact throughout their lifecycle, from the initial design and construction, to their operation and eventual demolition. This helps to conserve natural resources, reduce greenhouse gas emissions, and protect the environment.
2. **Energy and water conservation:** Green buildings are designed to be highly energy and water efficient, which helps to reduce the overall consumption of these resources. This can lead to cost savings for building owners and tenants, as well as reducing the strain on the environment.
3. **Indoor air quality:** Green buildings are designed to improve indoor air quality, which can lead to improved health and productivity for building occupants.

4. Adaptation to Climate change: Green buildings are designed to be more resilient to climate change, through the use of sustainable materials, energy-efficient systems, and better overall design.
5. Economic benefits: Green buildings can provide economic benefits to building owners and tenants through energy and water cost savings, improved indoor air quality, and better overall building performance.
6. Social benefits: Green buildings can promote social well-being by providing healthy indoor and outdoor environments for building occupants, and by encouraging the use of sustainable transportation options.

The global population is increasing, and urbanization is projected to continue. This means that the number of buildings will continue to grow, and it is therefore essential that these buildings are designed and constructed in an environmentally responsible manner to reduce their overall impact on the planet.

Environmental benefit

Green buildings offer a number of environmental benefits, including:

1. Reduced greenhouse gas emissions: Green buildings are designed to be highly energy and water efficient, which helps to reduce the overall consumption of these resources and reduces the emissions of greenhouse gases.
2. Conservation of natural resources: Green buildings are designed to conserve natural resources, such as water and energy, by using efficient systems and incorporating renewable energy sources.
3. Reduced waste and pollution: Green buildings often include systems for recycling and waste reduction, which helps to reduce the amount of waste that is sent to landfills and reduces the pollution caused by disposal of waste.
4. Improved air and water quality: Green buildings are designed to improve indoor air and water quality, which can lead to improved health and productivity for building occupants and reduced pollution of the surrounding area.
5. Protection of biodiversity: Green buildings are designed to have minimal impact on the surrounding site, through practices such as preserving natural habitats, reducing the amount of impervious surface, and incorporating green roofs and walls.

6. Adaptation to Climate change: Green buildings are designed to be more resilient to climate change, through the use of sustainable materials, energy-efficient systems, and better overall design.
7. Increased energy independence: Green buildings can often generate their own energy through the use of renewable energy sources like solar, wind and geothermal, which helps to reduce the building's dependence on fossil fuels, and decrease the carbon emissions.

All of these environmental benefits contribute to a more sustainable future and help to address the challenges of climate change and environmental degradation.

Economical benefits

Green buildings offer a number of economic benefits, including:

1. Energy and water cost savings: Green buildings are designed to be highly energy and water efficient, which can lead to significant cost savings for building owners and tenants.
2. Improved building performance: Green buildings are designed to be better performing overall, which can lead to increased productivity for building occupants and reduced maintenance costs for building owners.
3. Increased property value: Green buildings are becoming more popular and in-demand, and research has shown that they can command higher rental rates and have higher resale values.
4. Tax incentives and rebates: Many governments offer tax incentives and rebates for building owners who construct or retrofit green buildings, which can help to offset the initial cost of construction.
5. Cost savings on operating and maintenance: Green buildings can have lower operating and maintenance costs, which can be beneficial for the building owner and tenants.
6. Increased occupancy rates: Green buildings can have increased occupancy rates due to their positive reputation, and the desire of tenants to be in a sustainable environment.
7. Increased worker productivity: Green buildings can improve indoor air quality and provide better lighting, which can lead to increased worker productivity, which can have a positive economic impact.

Overall, green buildings can provide economic benefits to building owners, tenants, and the community through cost savings, improved building performance, and increased property values. These benefits can help to justify the initial investment in green building construction or retrofitting and make it a financially viable option.

Health and Social benefits

Green buildings offer a number of health and social benefits, including:

1. Improved indoor air quality: Green buildings are designed to improve indoor air quality, which can lead to improved health and productivity for building occupants.
2. Increased natural light: Green buildings often incorporate natural light, which can help to reduce eye strain, headaches, and fatigue, and also improve mood and productivity.
3. Improved thermal comfort: Green buildings are designed to provide better thermal comfort, which can help to reduce the incidence of heat-related illness and improve overall comfort for building occupants.
4. Increased physical activity: Green buildings are often designed to encourage physical activity, through the incorporation of amenities such as bike storage and showers, and through the provision of green spaces for building occupants to use.
5. Improved mental health: Green buildings can improve mental health by providing access to nature and natural light, and by promoting a sense of well-being among building occupants.
6. Increased social interaction: Green buildings can encourage social interaction by providing amenities such as shared spaces, community gardens, and other communal areas, which can help to foster a sense of community among building occupants.
7. Encouragement of sustainable transportation: Green buildings are often located near public transportation, walking and biking paths, and other sustainable transportation options, which can encourage building occupants to use these options instead of driving, which can improve air quality and reduce traffic congestion.

Overall, green buildings can provide health and social benefits to building occupants and the community through improved indoor air quality, increased natural light, improved thermal comfort, increased physical activity, improved mental health, increased social interaction, and encouragement of sustainable transportation. These benefits can contribute to a better quality of life for the building occupants, and foster a sense of community within the building.

Major Energy efficient areas for buildings

There are several major areas for buildings to focus on to improve energy efficiency, including:

1. **Insulation:** Insulating a building's walls, roof, and floors can help to reduce heat loss in the winter and heat gain in the summer, which can lead to significant energy savings.
2. **Lighting:** Incorporating energy-efficient lighting, such as LED or CFL bulbs, and using daylighting techniques can help to reduce energy consumption for lighting.
3. **Heating, Ventilation, and Air Conditioning (HVAC):** Installing high-efficiency HVAC systems, and incorporating techniques such as geothermal heating and cooling, can help to reduce energy consumption for heating and cooling.
4. **Windows and Glazing:** Installing energy-efficient windows and glazing can help to reduce heat loss in the winter and heat gain in the summer, which can lead to significant energy savings.
5. **Building Automation:** Installing building automation systems, such as smart thermostats and lighting controls, can help to improve energy efficiency by automating lighting and HVAC systems, and allowing for real-time monitoring and control.
6. **Renewable energy:** Incorporating renewable energy sources, such as solar panels or wind turbines, can help to reduce a building's dependence on fossil fuels, and decrease the carbon emissions.
7. **Water efficiency:** Incorporating water-efficient fixtures, such as low-flow toilets and showerheads, can help to reduce water consumption and costs.

By focusing on these major energy efficient areas, buildings can significantly reduce their energy consumption and associated costs, and also reduce their environmental impact.

Embodied Energy in Materials

Embodied energy in materials is an important consideration for green buildings because it can have a significant impact on the building's overall environmental impact. The embodied energy of a material is the energy required to extract, process, manufacture, transport, and install it. It includes all the energy used to create a product, from raw materials extraction to disposal.

Green buildings aim to minimize their environmental impact by using materials with lower embodied energy. This can be done by choosing materials that are renewable, such as wood or bamboo, or by specifying materials that can be locally sourced, which reduces the energy required for transportation. Additionally, using materials that can be reused or recycled at the end of the building's life can also help to reduce embodied energy.

For example, materials like brick and concrete have a relatively high embodied energy because they require a lot of energy to produce, whereas materials like wood, bamboo, and straw bales have a relatively low embodied energy because they are renewable and require less energy to produce. Similarly, using reclaimed wood or recycled steel instead of virgin materials can also help to reduce embodied energy.

Another strategy is to use materials with high recycled content, or that can be easily recycled at the end of the building's life. This helps to conserve resources, reduce the environmental impact of extraction, and reduce the energy required for disposal.

In summary, embodied energy in materials is an important consideration for green buildings because it can have a significant impact on the building's overall environmental impact. Green buildings aim to minimize their environmental impact by using materials with lower embodied energy, such as renewable materials, locally sourced materials, or materials that can be reused or recycled. This helps to conserve resources, reduce the environmental impact of extraction.

Green Materials

Green materials, also known as sustainable or eco-friendly materials, are materials that are produced, extracted, processed, and disposed of in a way that has minimal environmental impact. These materials are chosen for their low embodied energy, renewable properties, and ability to be recycled or reused.

Examples of green materials include:

- Wood and bamboo, which are renewable and require less energy to produce than other materials like concrete or steel.
- Recycled materials, such as reclaimed wood or recycled steel, which conserve resources and reduce the environmental impact of extracting and processing virgin materials.

- Low-emitting materials, such as low-VOC paints, adhesives, and carpets, which can help to improve indoor air quality and reduce the environmental impact of off-gassing.
- Natural materials, such as straw bales, cob, and adobe, which are renewable, low-impact and can provide insulation.
- Green certifications materials, such as FSC certified wood and LEED certified products, which are independently verified to meet certain environmental standards.

In summary, Green materials also known as sustainable or eco-friendly materials, are materials that are produced, extracted, processed, and disposed of in a way that has minimal environmental impact. These materials are chosen for their low embodied energy, renewable properties, and ability to be recycled or reused. Examples of green materials include wood and bamboo, recycled materials, low-emitting materials, natural materials, and green certifications materials.

Comparison of Initial cost of Green V/s Conventional Building

The initial cost of a green building versus a conventional building can vary depending on a number of factors, including the type of materials used, the level of energy efficiency and sustainability features incorporated, and the location of the building.

In general, building a green building can be more expensive than building a conventional building because it requires the use of more expensive, sustainable materials and technologies. For example, incorporating energy-efficient systems and equipment, such as geothermal heating and cooling or solar panels, can add significant upfront costs. Similarly, using green materials like reclaimed wood or recycled steel can also be more expensive than using conventional materials.

However, despite the initial cost difference, there is a long-term cost savings in green buildings. Green buildings are designed to be more energy efficient, which can lead to significant long-term energy savings. Additionally, green buildings often have a longer lifespan than conventional buildings, which can further offset the initial cost difference.

It's worth noting that many governments and organizations offer financial incentives to encourage the construction of green buildings. These incentives can include tax breaks, grants, and loan programs that can help to offset the initial cost of building a green building.

It's also important to consider that green buildings are not only cost-effective but also have many environmental, social, and health benefits. It may cost more initially but it can lead to cost savings in the long-term, and also make a positive impact on the environment, human health and well-being.

In summary, building a green building can be more expensive than building a conventional building due to the use of more expensive, sustainable materials and technologies.

Life cycle cost of Buildings

Life cycle cost (LCC) of buildings is a financial analysis method that looks at all the costs associated with a building over its entire lifetime, including the initial construction costs, ongoing operating costs, and end-of-life costs. It helps to identify the most cost-effective options for a building over time, taking into account all the costs and benefits associated with different building systems and materials.

The life cycle cost of a building can be divided into three main categories:

- **Initial costs:** These include the costs of design, permitting, and construction, as well as the costs of any equipment or systems that are included in the building.
- **Operating costs:** These include the costs of energy, maintenance, repairs, and replacements that are required to keep the building running over its lifetime.
- **End-of-life costs:** These include the costs of decommissioning, demolition, and disposal of the building and its components.

When comparing the life cycle cost of a conventional building versus a green building, it is important to consider the long-term energy and maintenance savings that can be achieved through the use of energy-efficient systems and sustainable materials. Green buildings are often more energy efficient than conventional buildings, which can lead to significant long-term energy savings. Additionally, the use of sustainable materials can reduce the need for costly repairs and replacements over time.

Green buildings may have a higher initial cost but they tend to have a longer lifespan and therefore, have a lower life cycle cost. This means that the savings made on energy and maintenance over the lifetime of the building, can offset the initial higher cost.

In summary, Life cycle cost (LCC) of buildings is a financial analysis method that looks at all the costs associated with a building over its entire lifetime, including the initial construction

costs, ongoing operating costs, and end-of-life costs. It helps to identify the most cost-effective options for a building over time. Green buildings may have a higher initial cost but they tend to have a longer lifespan and therefore, have a lower life cycle cost. This means that the savings made on energy and maintenance over the lifetime of the building, can offset the initial higher cost.

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REVIEW QUESTIONS

1. What is global warming? Explain the causes and effects of global warming.
2. What is carbon footprint and how to reduce the carbon emissions?
3. Define green buildings and explain its necessity.
4. Explain the environmental, economical and health and social benefits of green buildings.
5. Explain the energy efficient areas for buildings.
6. Compare the initial cost of green v/s conventional buildings.
7. What is life cycle cost of buildings?

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