# UNIT-I

Green Buildings within the Indian Context, Types of Energy, Energy Efficiency and Pollution, Better Buildings, Reducing energy consumption, Low energy design.

# GREEN BUILDINGS WITHIN THE INDIAN CONTEXT

- The Green Building movement was pioneered in Great Britain with the rating system called BREEAM (which was first launched in 1990.
- This system was later adopted in the U.S when the US Green Building Council was formed.
- LEED (Leadership in Energy and Environmental Design) was loosely adopted from the BREEAM system and came into existence sometime in March 2000.
- In India, this movement was adopted by the Confederation of Indian Industry (CII) in the early part of this decade.
- They formed the Indian Green Building Council which is actively involved in promoting the Green Building concept in India.

- LEED India, also known as Leadership in Energy and Environmental Design India, is a green building rating system developed by the Indian Green Building Council (IGBC) in partnership with the U.S. Green Building Council (USGBC).
- The Leadership in Energy and Environmental Design (LEED-INDIA) Green Building Rating System is a nationally and internationally accepted benchmark for the design, construction and operation of high performance green buildings.
- It promotes a whole-building approach to sustainability by recognizing performance in key areas:
  - Sustainable site
  - Water efficiency
  - Energy efficiency and renewable energy
  - Conservation of materials and resources
  - Indoor environmental quality
  - Regional Priority

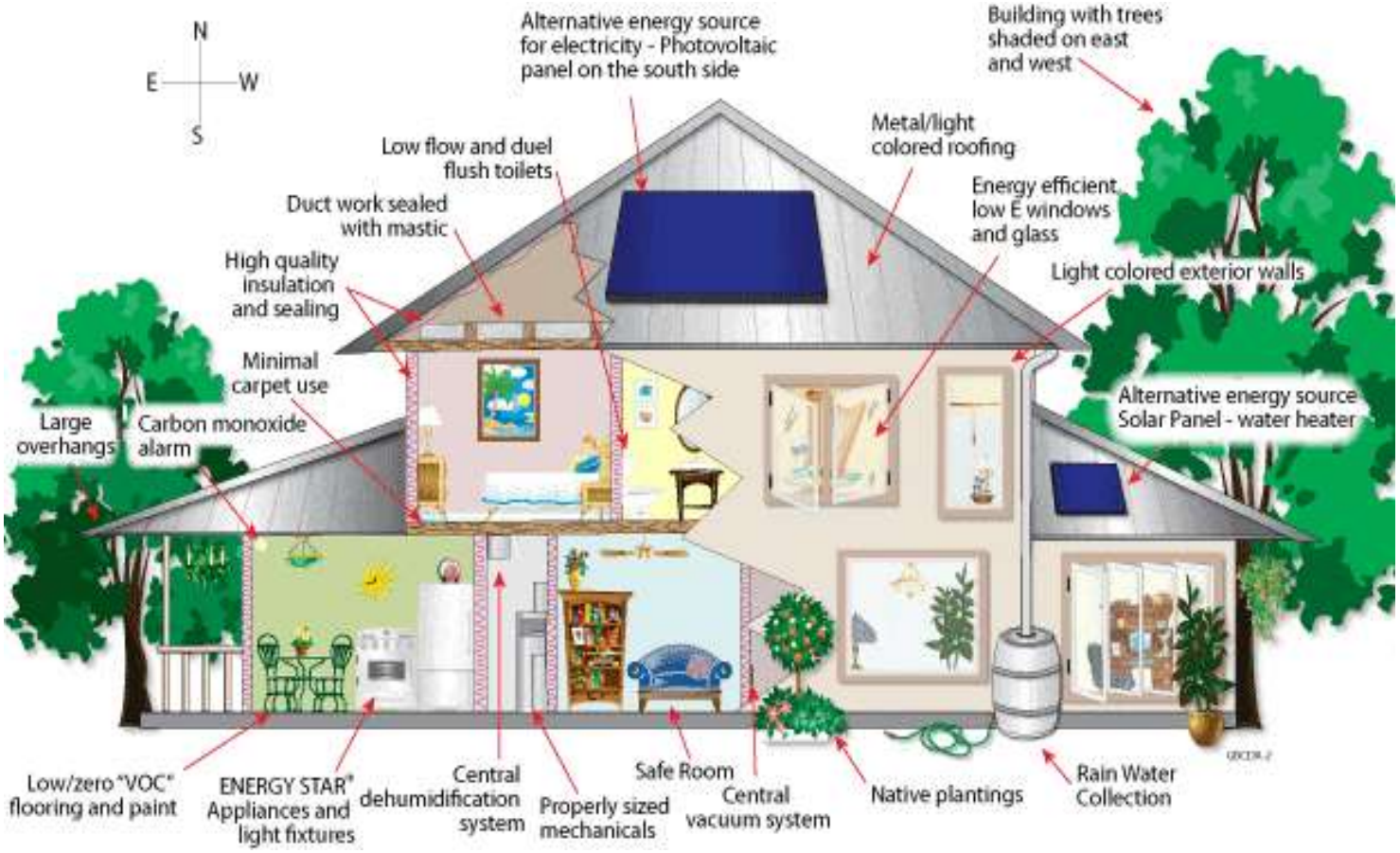
- LEED India was launched in India in 2003 and since then has grown exponentially.
- This has created a large network of smaller stakeholders which includes the construction industry comprising corporate, government & nodal agencies, architects, developers, builders, products manufacturers and most interestingly green building consultants whose profession was almost unheard of a decade ago

# WHAT IS GREEN BUILDING?

- A green building is defined as one which uses less water, optimizes energy efficiency, conserves natural resources, generates less waste and provides healthier space for occupants compared to conventional buildings.
- It is an environmentally sustainable building, designed constructed and operated to minimize total environmental impacts.
- A green building aims to lower environmental impacts, maximize social and economic value over a building life cycle through site selection, design, construction, operation, maintenance, renovation and demolition


# OBJECTIVES OF GREEN BUILDINGS:

- **Reducing Environmental Impact:** Green buildings aim to minimize the consumption of resources such as energy, water, and raw materials. They also strive to reduce greenhouse gas emissions, waste generation, and pollution, thereby contributing to a more sustainable and healthier planet.
- **Energy Efficiency:** One of the primary objectives of green buildings is to enhance energy efficiency. They use innovative design techniques, insulation, energy-efficient appliances, lighting, and HVAC systems to significantly lower energy consumption. This reduces reliance on non-renewable energy sources and helps combat climate change.
- **Water Conservation:** Green buildings incorporate water-efficient fixtures, rainwater harvesting systems, and water recycling technologies to minimize water consumption. This helps conserve a precious resource and reduces the strain on local water supplies.
- **Improved Indoor Air Quality:** Green buildings prioritize indoor air quality by using low-emission materials, proper ventilation systems, and natural lighting. This creates a healthier and more comfortable indoor environment for occupants, leading to increased productivity and well-being.
- **Optimal Site Selection and Land Use:** Sustainable buildings are often located in areas that minimize environmental impact, such as previously developed sites or areas with easy access to public transportation. They also promote responsible land use to preserve green spaces and biodiversity.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Alternative energy source for electricity - Photovoltaic panel on the south side
Building with trees shaded on east and west
Metal/light colored roofing
Low flow and duel flush toilets
Duct work sealed with mastic
Energy efficient low E windows and glass
High quality insulation and sealing
Light colored exterior walls
Minimal carpet use
Alternative energy source Solar Panel - water heater
Large overhangs
Carbon monoxide alarm
Low/zero "VOC" flooring and paint
ENERGY STAR® Appliances and light fixtures
Central dehumidification system
Properly sized mechanicals
Safe Room
Central vacuum system
Native plantings
Rain Water Collection

- **Materials Selection:** Green buildings use eco-friendly and recycled materials whenever possible. The goal is to reduce the demand for new resources, lower waste generation, and decrease the environmental impact of construction and demolition.
- **Waste Reduction:** Through efficient design and construction practices, green buildings aim to minimize construction waste and encourage recycling. This reduces the amount of waste that ends up in landfills.
- **Longevity and Durability:** Green buildings are designed to have a longer lifespan and require less frequent maintenance and repairs. This minimizes the need for replacement materials and reduces the overall environmental impact over the building's lifetime.
- **Renewable Energy Integration:** Many green buildings incorporate renewable energy sources such as solar panels, wind turbines, and geothermal systems. This not only reduces the building's reliance on fossil fuels but also contributes excess energy back to the grid.
- **Occupant Health and Well-being:** Sustainable buildings prioritize the health and well-being of occupants by providing ample natural lighting, good ventilation, and comfortable indoor temperatures. These factors can lead to increased occupant satisfaction, productivity, and overall quality of life.
- **Cost Savings:** While the initial investment in green building technologies and materials can be higher, the long-term operational and maintenance cost savings often outweigh these costs. Energy and water savings, along with potential tax incentives, contribute to financial benefits over time.

# WHY ARE GREEN BUILDINGS SO RELEVANT NOW?

- There is no debating that the human race is growing faster than the planet earth can sustain.
- This unsustainable growth is clearly causing certain environmental changes that need to be reversed or at least slowed down.
- Now, there are many different things we can do by correcting our ways and by minimizing environmental degradation.
- India is a large country with a large population and big problems.
- We are a water deficient country and the energy crisis seems to be perennial in nature.

- Moreover, the unsustainable energy and water policies are not helping the cause.
- Hence to insulate oneself from the resource crunch and strive towards self-sufficiency and smarter living.
- This realization has contributed immensely to the growth and promotion of green buildings.
- Apart from that, green buildings offer the developers, builders and architects an opportunity to get out of the rut that has come about due to the lack of differentiation in projects.
- Green building has now become “something new” that was not done in the past.
- Developers are trying hard to leverage their green building credentials for branding purposes and tapping into the new niche market

# GREEN BUILDING RATINGS IN INDIA

- ***Green Rating for Integrated Habitat Assessment (GRIHA)***
  - Green Rating for Integrated Habitat Assessment (GRIHA) is India's own rating system jointly developed by **TERI** (The Energy & Resources Institute) and the Ministry of New & Renewable Energy, Government of India.
  - It is a green building design evaluation system where buildings are rated in a three-tier process.
  - The GRIHA Rating System contains 34 evaluation criteria with 100 points.

- These criteria have been categorized into
  - **Site Planning** including conservation and efficient utilization of resources, health and wellbeing during building planning and construction stage
  - **Water Conservation**
  - **Energy Efficiency** including energy embodied & construction and renewable energy
  - **Waste Management** including waste minimization, segregation, storage, disposal and recovery of energy from waste and
  - **Environment for good health** and wellbeing.
- Common wealth Games Village, New Delhi, Fortis Hospital, New Delhi, CESE (Centre for Environmental Sciences & Engineering) Bldg, IIT Kanpur have received GRIHA ratings

– ***Leadership in Energy & Environmental Design India (LEED India)***

- LEED is an internationally recognized green building certification system, providing **third-party verification** that a building or community was designed and built using strategies aimed at improving performance across all the metrics that matter most:
  - Sustainable site
  - Energy savings,
  - Water efficiency,
  - $CO_2$ emissions reduction,
  - Improved indoor environmental quality and
  - Stewardship of resources and sensitivity to their impacts.
- The Indian Green Building Council has adapted LEED system and has launched LEED India version for rating of new construction.

- ***Bureau of Energy Efficiency (BEE)***
  - BEE developed its own rating system for the buildings based on a 1 to 5 star scale. More stars mean more energy efficiency.
  - The ECBC (Energy Conservation Building Code) provides design norms for:
    - **Building envelope**, including thermal performance requirements for walls, roofs, and windows;
    - **Lighting system**, including day lighting, and lamps and luminaire performance requirements;
    - **Air conditioning**, HVAC system, including energy performance of chillers and air distribution systems;
    - **Electrical system**; and
    - Water heating and pumping systems, including requirements for solar hot-water systems.

- BEE has developed the Energy Performance Index (EPI).
- The unit of Kilo watt hours per square meter per year is considered for rating the building and especially targets air conditioned and non-air conditioned office buildings.
- The Reserve Bank of India's buildings in Delhi and Bhubaneshwar, the CII Sohrabji Godrej Green Business Centre and many other buildings has received BEE 5 star ratings.

**Indian Green Building Council (IGBC) Green Building Rating System:**

- The IGBC offers various rating systems for different building types, including Green Homes, Green Building, Green Factory Buildings, Green Schools, Green Townships, and Green Interiors.
- These rating systems evaluate aspects such as
  - Site planning
  - Energy efficiency
  - Water conservation
  - Indoor environmental quality
  - Materials and resources and innovation.

# TYPES OF ENERGY

- The word energy is derived from the Greek en (in) and ergon (work).
- Energy is defined as 'the capacity to do work' – that is, the capacity to move an object against a resisting force.
- The scientific unit of energy is the joule.
- The concept of energy reveals the common features in processes as diverse as burning fuels, propelling machines and charging batteries.

***<<<< For Classification of Energy Refer UNIT-II >>>>***

- These and other processes can be described in terms of diverse forms of energy, including:
  - Thermal Energy (Heat),
  - Chemical Energy (In Fuels Or Batteries)
  - Kinetic Energy (In Moving Substances)
  - Electrical Energy
  - Gravitational Energy
  - Nuclear Energy

- Solar power, both in the form of **direct solar radiation** and in **indirect** forms such as **bioenergy, water or wind power**, was the energy source upon which early human societies were based.
- When our ancestors first used fire fuelled by burning wood, they were **harnessing** the **power of photosynthesis**, the solar-driven process by which **plants materials** such as **wood** are created from **water** and **atmospheric carbon dioxide**.
- Societies went on to develop ways of harnessing the movements of water and wind, both caused by solar heating of the oceans and atmosphere respectively.
- As civilizations became more sophisticated, **architects** began to design buildings to take **advantage** of the **Sun's energy** by enhancing their **natural use** of its **heat** and **light**, so reducing the need for artificial sources of warmth and illumination.

- Technologies for harnessing the power of the Sun, firewood, water and wind continued to improve right up to the early years of the Industrial Revolution, but by then, the **advantages of coal**, the first of the *fossil fuels to be exploited on a large scale, had become* ***apparent***.

- These highly concentrated energy sources soon **displaced wood, wind and water** in the homes, industries and transport systems of the industrial nations.
- Today the fossil fuel trio of **coal, oil and natural gas** provides around **80% of the world's energy.**
- Concerns about the adverse environmental and social consequences of fossil fuel use have been voiced intermittently for several centuries, but it was not until the 1970s that humanity began to take more seriously the prospect of **fossil fuels 'running out'**, and that their continued use could be **affecting** the planet's **natural ecosystems** and **global climate**.

- The development of **nuclear energy** following the Second World War raised hopes of a **cheap, plentiful and clean alternative to fossil fuels.**
- But **nuclear power's** contribution to electricity supply has in some countries stalled in recent years, due to concerns about **safety, cost, waste disposal and weapons proliferation.**
- In other nations nuclear power supplies continue to expand
- These concerns have been a major **catalyst** of renewed interest in the **renewable energy sources in recent decades.**

- Renewable energy can take a variety of these forms, and can be defined as: energy obtained from the continuous or repetitive currents of energy recurring in the natural environment (Twidell and Weir, 1986) or as energy flows which are replenished at the same rate as they are 'used' (Sorensen, 2000)
- sustainable energy source can be defined as
  - one that is not substantially depleted by continued use
  - does not produce significant pollution or other environmental problems
  - does not cause health hazards or social injustices.

- In practice, few energy sources come close to these ideals, but **renewable energy** sources are generally **more sustainable** than fossil or nuclear fuels
- They are essentially **inexhaustible**, and their use usually involves **fewer health hazards** and much **lower emissions** of **greenhouse gases** and **other pollutants**.
- Renewable energy sources are **derived** principally from the **enormous power** radiated by the **Sun**. principal source is solar radiation
- The **Sun's radiation** comes from **nuclear fusion** reactions between **hydrogen atoms** in its very hot interior. However, this **very high temperature** is **not** due to **nuclear fusion**
- Rather, the **radiation pressure** from **nuclear fusion prevents** the **Sun** from getting **hotter**
- The Sun should continue to radiate in this way for another five billion years

- Two non-solar renewable energy sources are
  - **Motion of the ocean tides**, principally driven by the gravitational pull of the Moon, the source of *tidal energy.*
  - The other is ***Geothermal energy*** *from the Earth's interior, which manifests itself in heat emerging from volcanoes and hot springs, and in heat from hot rocks.*

# ENRGY EFFIECINCY AND POLLUTION CONTROL:

1. Design and Orientation:
   - ❑ Optimize the building's design and orientation to maximize natural light and reduce the need for artificial lighting.
   - ❑ Consider passive solar design principles to harness natural heat and ventilation.
   - ❑ Use shading devices, such as awnings or louvers, to minimize direct sunlight and reduce cooling loads.
2. Energy-Efficient Lighting:
   - ❑ Install energy-efficient lighting systems, such as light
   - ❑ LEDs, which consume less energy and have a longer lifespan than traditional bulbs.
   - ❑ Incorporate occupancy sensors and daylight sensors to automatically adjust lighting levels based on occupancy and natural light availability.
3. HVAC Systems:
   - ❑ Use high-efficiency HVAC (heating, ventilation, and air conditioning) systems that meet or exceed energy efficiency standards.
   - ❑ Implement zoned heating and cooling systems to optimize energy use in different areas of the building.
   - ❑ Regularly maintain and clean HVAC systems to ensure optimal performance.

4. Insulation and Sealing:
   - ❑ Insulate the building's envelope, including walls, roof, and windows, to minimize heat transfer and improve energy efficiency.
   - ❑ Seal air leaks and use weather stripping to prevent drafts and enhance thermal comfort.
5. Energy-Efficient Appliances and Equipment:
   - ❑ Install energy-efficient appliances, such as refrigerators, dishwashers, and washing machines, that carry the ENERGY STAR label.
   - ❑ Use energy-efficient office equipment and electronics, including computers and printers
6. Renewable Energy Sources:
   - ❑ Install renewable energy systems like solar panels or wind turbines to generate electricity.
   - ❑ Consider incorporating geothermal systems for heating and cooling, utilizing the constant temperature of the earth.
7. Water Conservation:
   - ❑ Implement water-efficient fixtures and appliances, such as low-flow faucets, showerheads, and toilets. Capture and reuse rainwater for landscaping or non-potable uses like flushing toilets or irrigation.
8. Indoor Air Quality (IAQ):
   - ❑ Use low-VOC (volatile organic compounds) materials, paints, and furniture to improve indoor air quality. Install effective ventilation systems to provide fresh air circulation and reduce the concentration of pollutants indoors.

## Pollution Prevention methods for Energy Efficiency

Opportunities for substantial reduction of energy use, and cost savings, abound across all building systems, and energy-efficiency technologies are continually improving, ensuring a steady flow of viable alternatives.

**Heating and Cooling Systems:**

- HVAC performance, for example, can be improved by replacement or repair of worn-out or inefficient equipment with energy-efficient components.
- Many new, highly efficient HVAC technologies are continually being introduced.
- Occupancy sensors, variable-speed drives, automated ventilation control, heat exchangers, and efficient motors—can reduce energy consumption by adjusting the levels of heating and cooling to maintain a healthy and comfortable environment.

## Energy Efficient Appliances and Equipments:

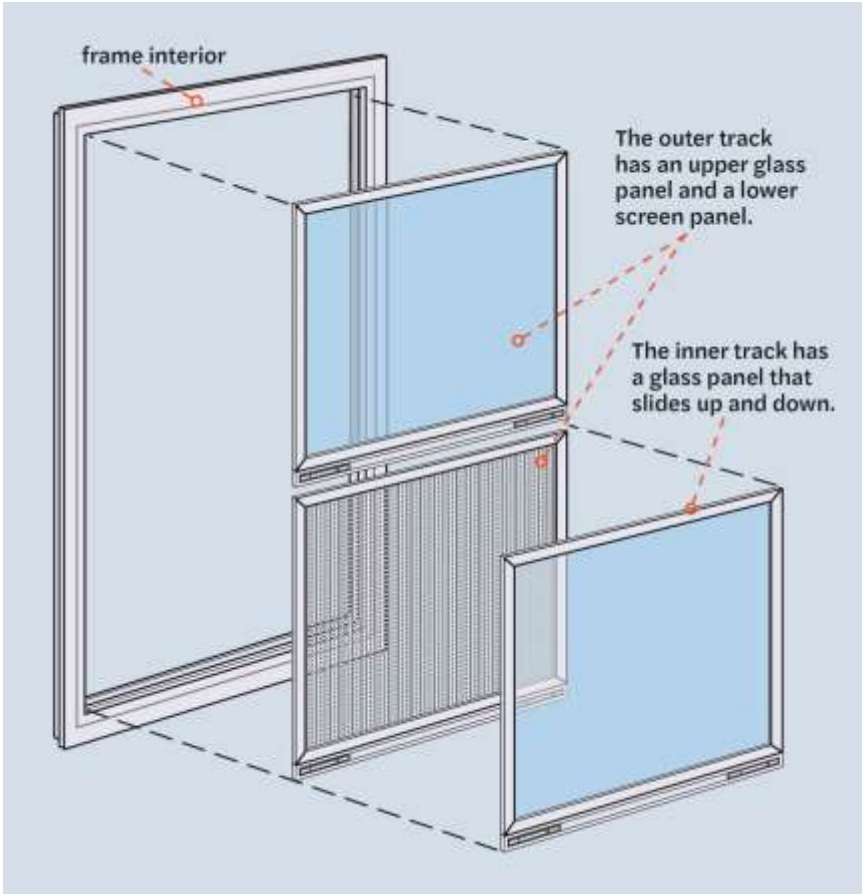
- Lighting also offers numerous opportunities for energy conservation. In some office buildings, it can represent **40 to 60 percent** of total energy **costs**.
- Use natural daylight whenever possible, reduce excessive illumination levels, limit hours of operation, and increase lighting efficiency.
- **Use ENERGY STAR certified compact fluorescent lighting (CFL)**.
- By replacing your light fixtures with **energy conserving compact fluorescent bulbs**, you will save **75 percent** of the energy used with incandescent bulbs.
- LED lighting differs from incandescent and compact fluorescent lighting in several ways.
- When designed well, **LED lighting can be more efficient, durable, versatile and longer lasting.** Use ENERGY STAR certified LED light bulbs.


CANDLE LIGHT
EFFICIENCY
LIFESPAN
COLOR RENDERING
INCANDESCENT
EFFICIENCY
LIFESPAN
COLOR RENDERING
CFL
EFFICIENCY
LIFESPAN
COLOR RENDERING
VIRIBRIGHT
LED
EFFICIENCY
LIFESPAN
COLOR RENDERING

- Additional energy savings can be found in a building's water treatment and distribution systems.
- In general, water-heating energy is conserved by reducing load requirements and distribution losses and improving the performance of water-heating equipment.
- Conserve energy by encouraging occupants to select appliances and office equipment with high energy-efficiency ratings.
- Purchase Energy Efficient Products and Equipment. By looking for the Energy Star label on products and equipment, you can reduce your energy bill by 30 percent and your electric lighting charges by 40 percent while cutting pollution.

**Insulation and Sealing:**

- Insulate the house. Make sure your house is well insulated and, if heated or cooled, never leave windows or doors open.
- Raise shades on winter days; lower them in the summer.
- Seal all leaks.
- Block windows and doors with weatherstrip tape and inexpensive door sweeps and install blinds to reduce outside heat transfer.
- Install storm windows—they are added insulation for your home.


frame interior
The outer track has an upper glass panel and a lower screen panel.
The inner track has a glass panel that slides up and down.

- Insulate pipes and fixtures.
- **Insulate** the hot water heater and **heating** and **cooling pipes**.
- An insulation blanket for a water heater will pay for itself in a year or less and will reduce **heat loss by 25-40 percent.**
- Seal little holes around water pipes and stuff insulation into big holes around plumbing fixtures.
- Replace your showerhead. By using a low-flow showerhead, you reduce water consumption and energy usage to heat the water.

## Cut down your 9 minutes shower to a quick 6.

The standard shower head uses 2.5 gallons per minute. Your 6 minute shower just used 15 gallons of water!

*versus*

## Buy a low-flow shower head and stick with your 9 minute shower.

The typical low-flow shower head uses 1.5 gallons per minute. Your 9 minute shower used 13.5 gallons.

**You're saving almost 550 gallons per year!**

# Really Being Green!

**Miscellaneous:**

- Turn unused appliances and equipment off. Turn off equipment and lights at night and on the weekend, unplug appliances when they are not in use
- Clean or replace filters regularly. Be sure to check furnace, air conditioner and heat pump filters regularly.
- By cleaning your heating, ventilation and air-conditioning equipment, your units will last longer, avoid costly down time and improve indoor air quality.
- Increase natural light. Paint your exterior and interior walls in a light color so more light is reflected.
- Paint the edges of the window in white so more light reflected inside.

- During the day, open blinds to bring in natural light instead of turning on lights.
- Reduce paper usage. By double siding on copiers, reusing single-sided paper, using electronic mail and circulating documents with routing slips, an organization can save a significant amount of energy and natural resource
- Use public transportation or carpool. Not only does this save energy costs, but it extends the life of your vehicle.

# BETTER BUILDING

When it comes to better building, several factors play a crucial role in ensuring the quality, efficiency, and sustainability of the construction. Some key factors to consider are:

1. **Planning and Design:** Thorough planning and thoughtful design are essential for a successful building project. This includes understanding the purpose of the building, its intended use, and the needs of the occupants. Consider factors such as functionality, aesthetics, space utilization, and energy efficiency during the design phase.
2. **Quality Materials:** Using high-quality materials is vital for the durability and longevity of a building. Quality materials not only enhance the structural integrity but also reduce maintenance costs over time. Choose materials that are resistant to weathering, fire, pests, and other potential hazards.
3. **Energy Efficiency:** Building energy-efficient structures is not only environmentally friendly but also helps reduce long-term operating costs. Incorporate energy-efficient design elements such as proper insulation, efficient HVAC systems, energy-saving lighting, and the use of renewable energy sources like solar panels.
4. **Sustainable Construction:** Sustainable building practices aim to minimize the environmental impact throughout the entire construction process. Consider using eco-friendly materials, incorporating green building techniques, recycling and reusing materials, and implementing water-saving measures.

5. **Structural Integrity:** A structurally sound building is essential for the safety of its occupants. Ensure that the building adheres to local building codes and regulations. Qualified architects and engineers to design and oversee the construction to guarantee its structural integrity.
6. **Proper Ventilation:** Good indoor air quality is crucial for occupant health and comfort. Incorporate proper ventilation systems that provide fresh air circulation and minimize the buildup of pollutants and moisture, which can lead to mold and other issues.
7. **Accessibility:** Design the building to be accessible to people of all abilities. Incorporate features such as ramps, elevators, wider doorways, and accessible restrooms to ensure easy access for individuals with disabilities.
8. **Safety and Security:** Adequate safety measures throughout the building, including fire safety systems, emergency exits, smoke detectors, and security systems. Ensure compliance with safety regulations and consider factors like slip-resistant surfaces and proper lighting.
9. **Maintenance and Durability:** Plan for ease of maintenance and longevity of the building. Incorporate durable materials that require minimal upkeep and select systems and components that are easily accessible for repairs and replacements.
10. **Environmental Considerations:** Evaluate the environmental impact of the building throughout its lifecycle, including construction, operation, and eventual demolition. Aim to minimize waste generation, water usage, and energy consumption while maximizing recycling and sustainability practices.

# BETTER BUILDINGS

- United States Department of Energy (DOE) started the Better Buildings Initiative in 2011.
- Improving the energy efficiency of the nation's commercial buildings, responsible for 20% of the United States' energy use at that time.
- The program is part of DOE's Office Energy Efficiency and Renewable Energy.
- Better Buildings aims to make commercial, public, industrial, and residential buildings 20 percent more energy efficient over the next decade.
- This means saving billions of dollars on energy bills, reducing greenhouse gas emissions, and creating thousands of jobs.
- Through Better Buildings, public and private sector organizations across the country are working together to share and replicate positive gains in energy efficiency.

- The Energy Department is currently pursuing strategies within 4 interrelated key areas to catalyze change and investment in energy efficiency.
  - Developing innovative, replicable solutions with market leaders
  - Making energy efficiency investment easier
  - Developing a skilled clean energy workforce
  - Leading by example in government.

# REDUCING ENERGY CONSUPMTION

Reducing energy consumption is an important step towards sustainability and cost savings. Here are some effective ways to reduce energy consumption:

1. **Improve insulation:** Properly insulate your home or office to prevent heat transfer, especially in walls, windows, and roofs. This helps maintain a consistent temperature indoors and reduces the need for heating or cooling systems.
2. **Upgrade to energy-efficient appliances:** Replace old appliances, such as refrigerators, air conditioners, heaters, and light bulbs, with energy-efficient models. Check the Energy Star label, as these products meet strict energy efficiency guidelines.
3. **Use natural lighting:** Take advantage of natural daylight by opening curtains or blinds during the day instead of relying on artificial lighting. Use lighter colors for walls and furniture to reflect more light and reduce the need for artificial lighting.
4. **Adjust thermostat settings:** Lower your heating thermostat by a few degrees in winter and raise it by a few degrees in summer. This small change can significantly reduce energy consumption without sacrificing comfort.
5. **Unplug electronics when not in use:** Many devices and appliances continue to consume energy even when they are turned off but still plugged in. Unplug chargers, TVs, computers, and other electronics when they are not in use, or use power strips with switches to easily turn off multiple devices at once.

7. **Use energy-efficient lighting:** Replace traditional incandescent light bulbs with energy-efficient options such as compact fluorescent lamps (CFLs) or light-emitting diodes (LEDs). These bulbs consume significantly less energy and last longer.
8. **Reduce phantom loads:** Many electronic devices and appliances draw power even when not in use, known as phantom loads. Use power strips with switches to completely disconnect power supply when devices are not in use.
9. **Optimize water heating:** Lower the temperature of your water heater to around 120 degrees Fahrenheit (49 degrees Celsius) to save energy. Insulate your water heater and the hot water pipes to reduce heat loss.
10. **Practice efficient cooking and laundry:** Use the microwave or toaster oven instead of the oven whenever possible, as they consume less energy. Wash laundry in cold water and hang dry when feasible. Only run full loads in the dishwasher and air dry the dishes.
11. **Install programmable thermostats:** Programmable thermostats allow you to set specific temperature settings for different times of the day, adjusting the temperature automatically. This ensures efficient energy usage when you are away or asleep.
12. **Educate and involve occupants:** Raise awareness about energy conservation among family members, coworkers, or employees. Encourage them to adopt energy-saving habits, such as turning off lights, using natural light, and unplugging devices.

To promote energy efficiency at building level and at city level the following aspects need to be considered

- Day light design of building with natural ventilation, green roof and passive climate design
- Adoption of BEE Guidelines, EC building code, Standards and specifications for buildings, energy and equipments
- Promoting the utilization of exhaust heat from incinerations plants and sewerage treatment
- Unser renewable energy for buildings, street lighting, hoardings, mass cooking, climate controls
- Replace coal based power generation to natural gas/non polluting alternative fuels

- Observe strictly safety controls and instructions
- Check transmission and distribution losses
- Incentive decentralized power generation and energy conservation
- Various passive techniques have been put in perspective, and energy saving passive strategies can be seen to reduce interior temperature and increase thermal comfort, reducing air conditioning loads.
- In regions where heating is important during winter months, the use of top-light solar passive strategies for spaces without an equator-facing façade can efficiently reduce energy consumption for heating, lighting and ventilation.

***Passive techniques***

- High levels of insulation and air tightness are used to reduce heat loss from the building, and hence the need for heating during winter.
- Using dense materials in the building construction creates ‘thermal mass’, which reduces temperature fluctuations by storing heat and releasing it later in the day, helping limit overheating during hot weather or times when there are a lot of people in the building.
- Buildings can be designed to make the best use of sunlight by orientating them relative to south and arranging windows to maximize daylight and allow sunlight in during winter, but to limit direct sunlight penetration during summer when it can cause overheating.

- The use of high efficiency, low emissivity glazing allows high levels of daylight in whist reducing heat losses through windows.
- Passive design can use wind-driven and stack-driven natural ventilation to provide cooling in summer without the need for air conditioning.
- To minimize heat losses during cold weather, airflow is reduced to the minimum needed to provide fresh air.

***Renewables***

- Renewable heating systems including biomass boilers, active solar water heating and ground source heat pumps can be used to supply heating and hot water needs with reduced greenhouse gas emissions

- Solar photovoltaics can be mounted on or integrated in the building roof, to provide renewable electricity.
- Wind turbines can be included within the site as another means of providing renewable electricity.
- Energy efficiency brings health, productivity, safety, comfort and savings to homeowner, as well as local and global environmental benefits.

# LOW ENERGY DESIGN

- “Energy-Efficient Building” or “Low-Energy Building” refer to the building’s energy performance.
- These terms put an emphasis on the building’s envelope and its technical installations, underlining thermal insulation, energy-efficient windows, and technical schemes (e.g., a heat-recovery ventilation system, solar panels, etc.).
- Also, in order to provide good indoor comfort, a proper ventilation scheme must be installed
- A low-energy building is defined as “a building that uses 25% less energy for space heating1 than stipulated in the building code, while a very low-energy building must use 50% less energy for space heating than stipulated in the building code

- Energy is used in buildings to deliver comfortable conditions for occupants and to power appliances: this is known as ‘energy-in-use’. Energy is also used in the production of building materials and during construction: this is known as ‘embodied energy’
- Low energy buildings use a mixture of passive techniques and active systems to deliver a comfortable environment with low energy use and low greenhouse gas emissions.
- Passive techniques relate to the shape of the building and the materials that it is built with, while active systems use machinery to provide services to the building which minimize energy use.

- Incorporating renewable energy generation on site can reduce emissions further.
- However, low energy use should be the first priority, since this is the cheapest way to cut greenhouse gas emissions.
- In addition, low energy use makes the adoption of renewable energy technologies more viable because less capacity is required to meet the building demand.
- It's possible to reach the point where a building produces net zero greenhouse gas emissions in use, known as 'zero carbon in use'.
- Embodied energy can also be reduced by using low-carbon building materials and construction methods.

- Natural ventilation is rapidly becoming a significant part in the design strategy for non-domestic buildings because of its potential to reduce the environmental impact of building operation, due to lower energy demand for cooling.
- Naturally ventilated building can readily provide a high ventilation rate. On the other hand, the mechanical ventilation systems are very expensive.
- However, a comprehensive ecological concept can be developed to achieve a reduction of electrical and heating energy consumption, optimise natural air condition and ventilation, improve the use of daylight and choose environmentally adequate building materials.
- The use of renewable energy resources could play an important role in this context, especially with regard to responsible and sustainable development.

- General principles of energy efficient building design or low energy design comprise the following:
  - Integration of energy concept from project outset, demand and management
  - Compact shape, minimize power requirement
  - Day light design
  - Energy efficient lighting, ventilation and space conditioning, site planning and landscape design
  - Shading, green roof, building envelop
  - Fenestration and window/ openings design , glazing design
  - Efficient use of passive solar energy, renewable energy

- Energy efficient and easy to use technical systems
- Low water use sanitary ware
- Low energy electrical appliances
- Use of low embodied energy, recyclable construction materials
- Increased insulation, elimination of thermal bridges wherever possible
- Safety against fire and other hazards