

Sustainable Engineering

Module V

*“We have borrowed the earth from our children
and not inherited it from our forefathers”* Margret Thatcher

Topics Discussed

Sustainability practices:

- ✓ Basic concept of sustainable habitat
- ✓ Methods for increasing energy efficiency in buildings
- ✓ Green Engineering
- ✓ Sustainable Urbanisation
- ✓ Sustainable cities
- ✓ Sustainable transport

Sustainable Habitat – Basic Concepts

- Buildings have huge impacts on our natural environment and these impact need to be reduced dramatically.
- Buildings account for significant part of resource consumption.
- Greenhouse gas emissions and waste generation figures of the world will rise rapidly as construction increases to meet the needs of a growing population.
- By the end of 2030, 250 million new urbanites are expected to join in Indian cities.

- A **sustainable habitat** is an ecosystem that produces food and shelter for people and other organisms, without resource depletion and in such a way that no external waste is produced.
- Proper habitat design has a direct impact on energy and resource consumption.
- Sustainable habitat means achieving a balance between the economic and social development of human habitats together with the protection of the environment, equity in employment, shelter, basic services, social infrastructure and transportation.

National climate change action plan



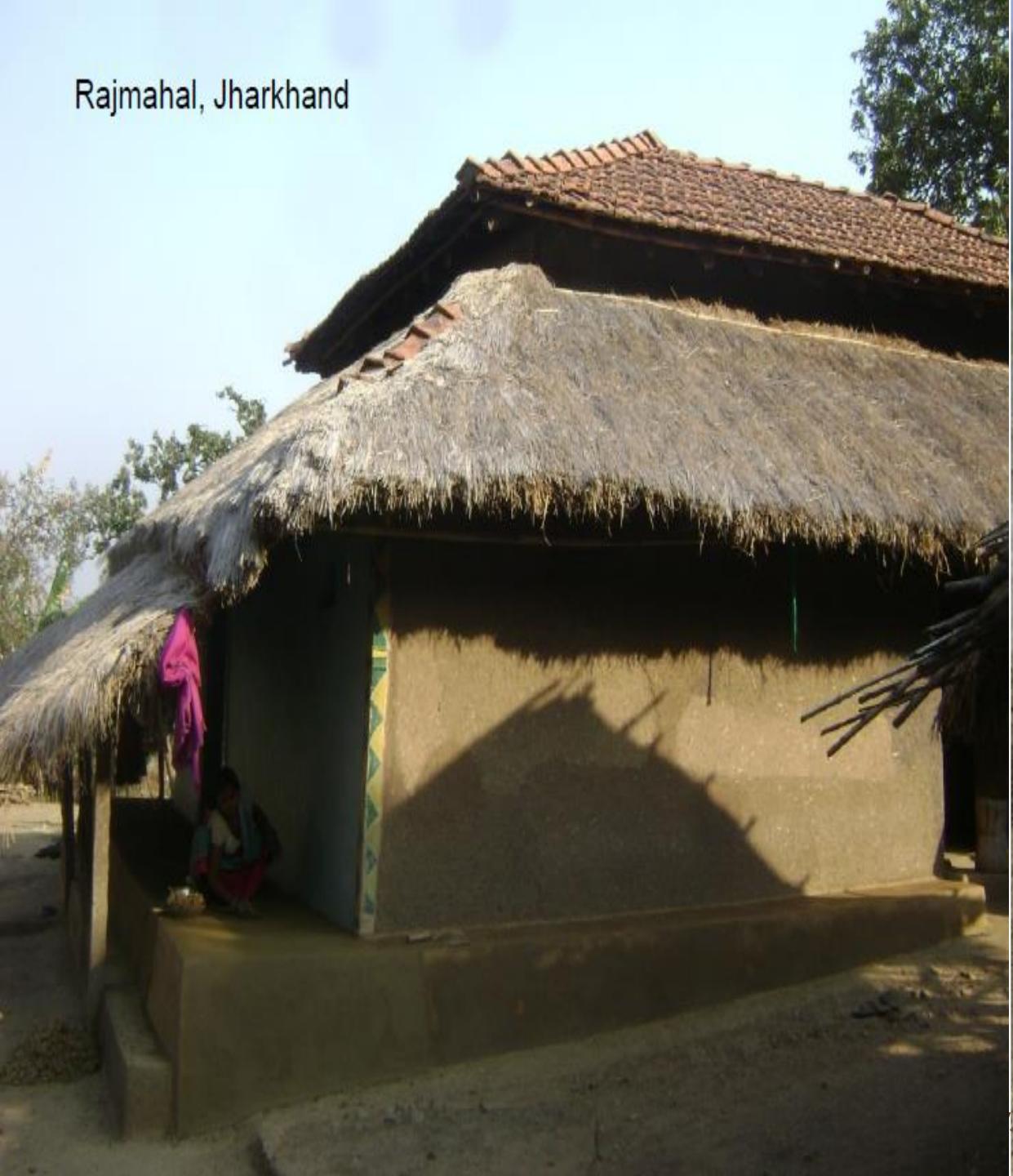
The National Mission for Sustainable Habitat cover the following aspects:

- Extension of the energy conservation building code - which addresses the design of new and large commercial buildings to optimize their energy demand;
- Better urban planning and modal shift to public transport - make long term transport plans to facilitate the growth of medium and small cities in such a way that ensures efficient and convenient public transport;
- Recycling of material and urban waste management - a special areas of focus will be development of technology for producing power form waste.
- Include a major R&D programme, focusing on bio-chemical conversion, waste water use, sewage utilization and recycling options wherever possible.

- Designing a sustainable habitat is a matter of keeping two goals in mind
 1. Incorporate design concepts and materials that minimize resource use, maximize energy and water efficiency, eliminate exposure to toxic chemicals and prioritize human health and safety throughout the construction process
 2. Identify ways and means such that the building and the living can actually help protect the environment through practices that restore nature in specific and meaningful ways

<https://www.youtube.com/watch?v=f1j26Qv1nbg>

Rajmahal, Jharkhand



Energy Efficiency of Buildings

- The International Energy Agency (IEA) recognizes that *buildings are the largest consumers of energy worldwide (40 per cent)* and will continue to be a source of increasing energy demand in the future.
- Globally, the sector's final energy consumption doubled between 1971 and 2010 to reach 2794 million tonnes of oil equivalent (Mtoe), driven primarily by population increase and economic growth.
- Under current policies, the global energy demand of buildings is projected by the IEA experts to grow by an additional 838 Mtoe by 2035 in comparison to 2010.
- The building sector is the largest contributor to global greenhouse gas (GHG) emissions.
- Existing buildings represent significant energy-saving opportunities because their performance level is frequently far below current-efficiency potentials

- For enhancing energy efficiency in buildings in India, Bureau of Energy Efficiency (BEE) notified the Energy Conservation Building Code (ECBC) in 2007 under the provisions of the Energy Conservation Act 2001.
- Residential and commercial buildings account for nearly 30% of total electricity consumption in India today. This share is expected to increase to 48%—nearly half of electricity consumption—by 2042.

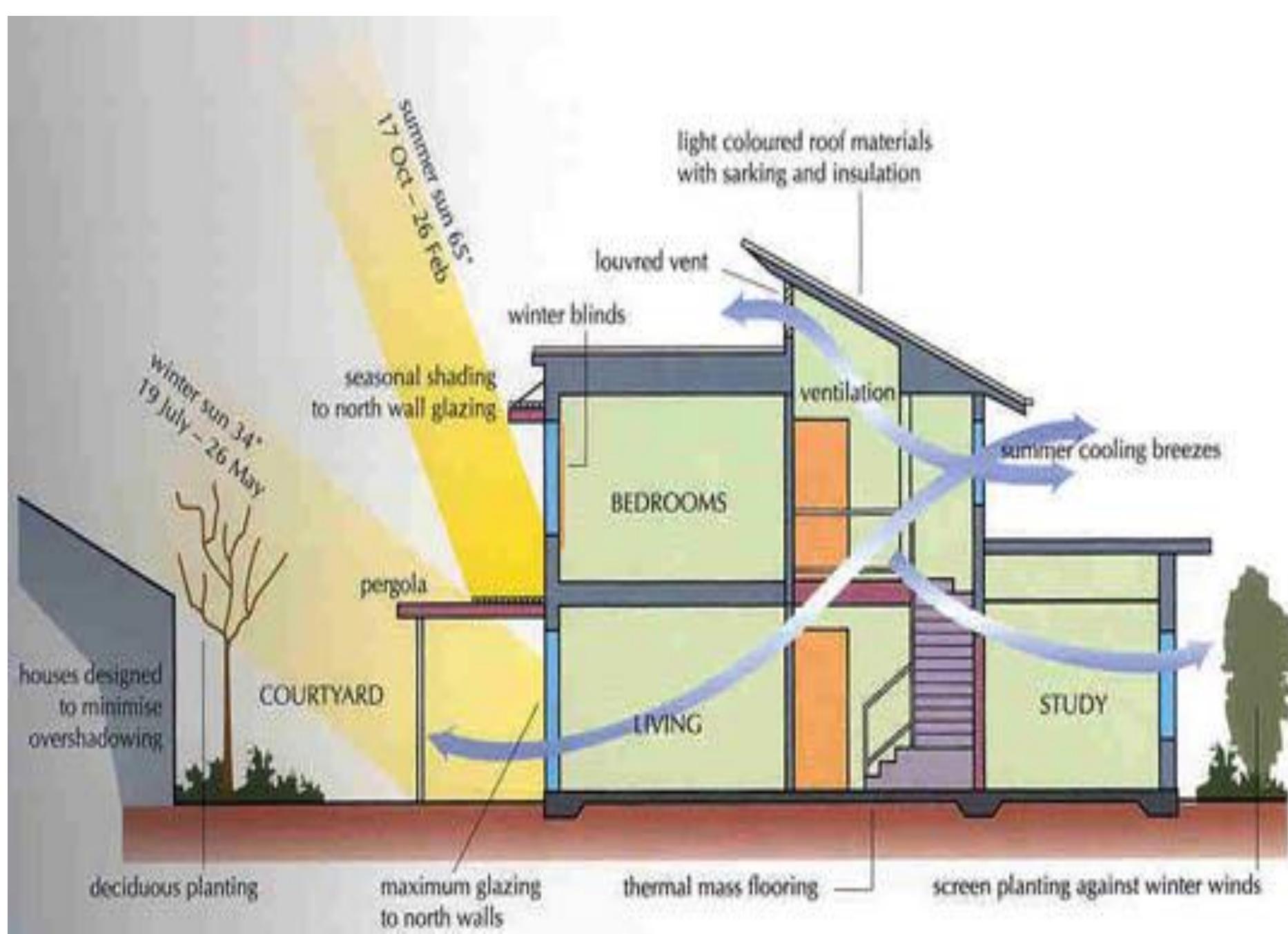
Energy Efficiency of Buildings

- Energy in buildings is categorized into two .types
 - ✓ Energy for the maintenance/servicing of a building during its useful life
 - ✓ Energy capital that goes into production of a building (known as embodied energy) using various building materials

Methods of minimizing energy wastage

- **Standards and Labeling** - provide the consumer an informed choice about the energy saving and thereby the cost saving potential of the relevant marketed product.(19 equipment/appliances, i.e. Room Air Conditioners, Fluorescent Tube Lights, Frost Free Refrigerators, Distribution Transformers, Induction Motors, Direct Cool Refrigerator, electric storage type geyser, Ceiling fans, Color TVs, Agricultural pump sets, LPG stoves, Washing machine, Laptops, ballast, floor standing ACs, office automation products, Diesel Generating sets & Diesel operating pumpsets of which the first 4 products have been notified under mandatory labeling from 7th January, 2010.)
- The Energy Conservation Building Code (ECBC) (was developed by Govt. of India for new commercial buildings on 27th May 2007. ECBC sets minimum energy standards for new commercial buildings having a connected load of 100kW or contract demand of 120 KVA and above.)
- Awareness campaign

- Demand Side Management (DSM) Scheme
- Using sensors
- Maximising the use of windows
- Onsite generation of renewable energy by using solar panels
- Passive design techniques for buildings in warm climate, such as white roof, sun shading and natural ventilation can achieve significant cooling
- Building energy performance label and certificate
- Residential Building orientation



ENERGY CONSERVATION MEASURES AT SJCET

- Water Overflow Indicator
- Bore well Recharging
- 10kW Solar Electric Plant for the Canteen Building
- Hi-Tech Poly House for Vegetable Cultivation
- Construction of a 6 storied building following Green Building Concept
- Steam Cooking
- Solar Water Heaters
- Incinerator for avoiding open burning of waste
- Waste Water Treatment for water recycling
- Vermi Compost Unit
- Automatic optimum switching of stand-by Generators for Energy Efficiency
- Power Factor Improvement
- Energy Auditing
- Use of High Efficiency UPS and LCD Monitors
- Biogas Plant
- Rain Water Harvesting
- Fish Farming Pond
- Demand Side Management
- Energy Efficient Distribution
- Energy Efficient Lighting
- Save Meenachil River Campaign - "My Shore My Water My Life"
- Motivational Talks on Energy Conservation.
- ENCON Week - Quiz Programme, Drawing Competition, Essay Writing Competition & Energy Squad Selection
- Earth Hour Observation
- Energy Conservation Project Exhibition - "EMINEO"
- Seminars on Environmental Protection

SJCET received **Kerala State Energy Conservation Award 2010** from **Energy Management Centre (Govt. of Kerala)**.

SJCET received **Best ENCON Club Award** from **BPCL Kochi Refinery** for the consecutive years **2011, 2012, 2013, 2014 & 2015**.

வெறுதி
ஸங்கஷண்
பிடிக்கல்லின் !!



20% വെള്ളത്തി ലാറിച്ചാൽ
30% വെള്ളത്തി ബിൽ കുറയ്ക്കാം

வெளுத் தாங்களை மாற்றுவதற்காகவில்லையான் என்று. பூசைகள் 20 மத்தொலைகளிலும் வெளுத்தி உரிச்சொன்னது. வெளுத்தி உபயோக நிலை 20 மத்தொல் குடுவது வாய்த் தொழிலில் வருமா குடுவது 30மத்தொலையைதான். குடும்பத் தொழிலில் உபயோகிக்குமாற்றல் நிர்க்கு குடுதலுள்ளதான் என்கூண்டியில் வெளுத்தி குடுவது நிர்க்கி இல்லை என்றிருக்கிறோ.

കേരളത്തിൽ ഏറ്റവും കുടുതൽ വൈദ്യുതി ഉപയോഗിക്കുന്ന പിട്ടോലാസ്റ്റിനാണ്. വിടുകളിൽ വൈദ്യുതി കാഞ്ചീപുരം ശാഖ ഉപയോഗിക്കുന്നതിലും ഏതാണ് 400 മൊഹമാർക്കുന്നിലെ ലഭ്യമായാക്കും. അതിന്റെ ഫലാഭാഗി ഒപ്പകുറുന്നാൽ അതിനു മുകളിൽ ഓല്ലാഡി 10 മണിബേജം ആനുബന്ധമെങ്കുന്ന വൈദ്യുതി മുന്നക്കുറിച്ചിപ്പിക്കുന്നാക്കും.

வாய்மை வழிவுகளின் பகுதி நிலபாலோகம் என்ற பெயரைக்கும் தான் வெளிவுக்கும் உபயோகிக்கூடுக.

உபயோகம் கூடினால் இந்தனை வெறுத்து எடுக்க விரியும் சீர்ப்புகளைவேறு படித்து வாய் வழங்க.

வெளிவூக்கும் முறைகளும் எவ்வியக்களும் தூதய்களிட நடந்து விடுவதினால்கூக வசி குடும்பத்தில் பிரகாங் வரிக்கிழும். பிரகாங்கிடுவதையே வெளிச்சுவூப் காரும் உரிமைகளைப்பிடிய அளவுகள் நடவடிக்கை.

வாழி காலனையிலே விடுவூர் பூரியூட்டு வெற்றுகளே அதுவும் விரும்பும் உபயோகமாகும்.

வெறுதி ஸங்கசிக்குந்த்
உத்பாடினிக்குந்தினக்கால் லாட்கரை!!

பிரபுவன் - விடுதலை நாக்கங்கிலமுடிச் சுற்றுநூல் 50 முறைகள் எண்ணால் ஏவுபூருடி நாக்கங்கூட்டுறை. அதையுள் ஒரு யுள்ளூருட் தலைவருடின் உபதோகமைவிலீடு பகல்வெற்றிக்கூல் குருவன்னுள் 2 முறையில் இன்புகளிலிருக்குமள்ளி வருகோடு.

വൈദ്യുതബന്ധം

କ୍ଷୁଣ୍ଣେବେଳରୁକାର୍ଯ୍ୟ ହୋଇଥିବାକୁ ନେତ୍ରଗମ୍ଭୀର ଲାଗୁ ହେଲାକିମ୍ବୁ (CFL) ରୁଣ୍ଧିକାର୍ଯ୍ୟଗମ୍ଭୀର ଲାଗୁ କରିବାକୁ ପାଇଁ ବେଳେ ବେଳେ କଲାପରିଯୁକ୍ତ ଏବଂ ଆମ୍ବାଲିଲାଗା ଛାନ୍ଦାରେ ଉପରେରୁଥିବା କ୍ଷୁଣ୍ଣେବେଳରୁକାର୍ଯ୍ୟ ହୋଇଥିବାକୁ ନେତ୍ରଗମ୍ଭୀର ଲାଗୁ ହେଲାକିମ୍ବୁ (CFL) ରୁଣ୍ଧିକାର୍ଯ୍ୟଗମ୍ଭୀର ଲାଗୁ କରିବାକୁ ପାଇଁ ବେଳେ ବେଳେ କଲାପରିଯୁକ୍ତ ଏବଂ ଆମ୍ବାଲିଲାଗା ଛାନ୍ଦାରେ ଉପରେରୁଥିବା

**ଓପର୍ବତୀ ପାଂକଜଣା ଶୀଳନାକୁ !
ଓପର୍ବତୀ ବିତି କୁଣ୍ଡଳୀ !!**

60 പാട്ടിന്റെ ബാംഗ് കാറ്റി പകരാണ് 11 പാട്ടിന്റെ CFL ഉപയോഗിക്കുകയാണെങ്കിൽ അതിന്റെ പ്രവർത്തനത് കാലാവധിയിൽ (10000 ഇഞ്ചിക്കുറ) 490 ആളുകൾ വൈദ്യുതി ലാഭിക്കാനുകൂടാണ്. അമൃതാ യൂണിറ്റ് 3 റൂപ പിഎഫ് 1470 രൂപയുടെ ലഭ്യം.

ପ୍ରକାଶ ଲେଖନୀକଙ୍କ ନିମ୍ନଲିଖିତ ଲେଖକଙ୍କାଣିକ ପାଇଁ 36/28 ବାଟିଲେଣ୍ଟ ଟ୍ରୂପ୍ ଏଥିରୁ ଉପଯୋଗିକ ହେବାକିମ୍ବାଳିକିମ୍ବା 30 ଅଧିକାନ୍ଦିତଙ୍କାଙ୍କ ବୈଷ୍ଣବୀ ଲାଭିକାଣାକିମ୍ବା

ଶ୍ରୀଲକ୍ଷ୍ମୀପ୍ରତିକ୍ରିଯା ମାଗର

- സാധാരണ ഗ്രാവലറ്റുകൾക്ക് പകരം റിലവാർമ്മേഷ്ട് തുല കെട്ടാൻിക് ബന്ധുവയറ്റുകൾ ഉപയോഗിച്ച് അഭാരി വാഹ തയിൽ ഫാൻ പ്രവർത്തിപ്പിക്കുകയാണെങ്കിൽ ഉംഖാ ഉപയോഗം പക്ഷേമില്ലാതെ കുറയ്ക്കാനുകൂം.
 - ഫാനിന് ദാരം കുടുമ്പന്നു ചുലം മോട്ടാറിന് അധികം താഡാവ് വരികയും കാരുക്കണ്ണ കുറയ്ക്കയും ചെയ്യുന്നു. ബൈററിനീൽക്കും ശബ്ദം ഉണ്ടാക്കിൽ ഉംഖാ നാജ്ദം ഉണ്ടാണ് മനസ്ത്വിലാക്കുക.
 - സീലിംഗ് ഫാൻ ഉറവിക്കുന്നൊഴി ആവധ്യത ലിഫ്റ്റ് സീലിംഗ്രൂപ്പായി ഒരടിയൈക്കില്ലെം അകലെയുള്ളൊന്നു ഉറപ്പു വരുത്തണാണ്. ലിഫ്റ്റുകൾ ഒരിയായ ചരിവിൽ എടി നിക്ഷണം ഫാൻ ലിഫ്റ്റ് അനുസരിച്ചിരിക്കും ഉണ്ടായിൽ കേണ്ട സ്വരൂപമിന്നും അകലും 2.75 ശ്രീഘടാണ്.



விலா குருவையுடைய வழிகள் பாசிக்கும் வெள்ளுத்தொலை நூற்றுக்கணக்கான வழிகளுக்குத்தான் வெவ்வேறுபடி உபயோகிக்குமானால் சிரியான வெவ்வேறுத் தொலை நூற்களைப்படுத்து.

സ്വീകരണ (സ്വിഡ്)

- സാമ്പത്തിക അനുഭവങ്ങളായ വലിപ്പവും റഫ്രിഞ്ചറുൾ നിന്ന് കൈമാറുക.
 - ട്രോളി ഫോറ്മിൽഡാറ്റുകളുടെ വൈവരണി ഉപഭോഗം നില തുച്ഛന കൃത്യതലാണ്.
 - റഫ്രിഞ്ചറുറിനക്ക് അനുപാതികവും ദാനാക്കുന്ന പ്രവർത്തനങ്ങൾക്കും കൊഡിലിലുള്ളത്താണ് പ്രസിദ്ധമായി പിടിക്കപ്പെട്ടത്. അതിനാൽ റഫ്രിഞ്ചറുറിന്റെ പ്രവർത്തിലും വശശാലിലും ദിനപിഡിയുടുത്തി 15 സെ ഫുട്ടിലും അകലും കൊടുക്കുകയും ക്ഷണങ്ങൾക്കും കൊഡിലിൽ പറ്റിയിരിക്കുന്ന പൊടി തുടക്കപ്പെടുത്തിയാക്കുകയും വേണം.
 - റഫ്രിഞ്ചറുറിന്റെ വാഹിൽ ദ്രോഗി അടഞ്ഞിക്കണം. ഇതിനായി വശശാലിലെ ഗ്രൂപ്പ് ബോർഡിംഗ് കാലാകാലം പരിശോധിച്ച് പാശ്ചാത്യ ചെന്നാരാജാക്കിൽ ഓട്ടുക.
 - റഫ്രിഞ്ചറുർഗ്ഗും പാശ്ചാത്യ ചെന്നാരാജാരാജാക്കണ്ണൻ വായ്ക്കുകയും വായ്ക്കുകയും വെള്ളുക. അടിക്കടി നൂറുക്കും മാത്രം വെള്ളുത്തി ഉപഭോഗം കുറുക്കാം.
 - റഫ്രിഞ്ചറുറിൽ നിന്ന് ഏറ്റുക്കുന്ന ആപ്പാരാജായനാഡി അനുപാതിക മാത്രം നീന്തുകയും ചുരുക്കുകയും ചുരുക്കുകയും ചുരുക്കുക.
 - കൈശാപാർശവാശർ ചുടാവിയന്നിനുംബും ചുരുക്കം റഫ്രിഞ്ചറുറിനുകൾ ചെയ്യുക.
 - സൗഖ്യാട്ടക്സ് കുറവുള്ള സെക്കുണ്ടും 6 മിനിറുത്തിൽ 10 മിനിറു വശശാലി സംബന്ധിച്ചിൽ റഫ്രിഞ്ചറുർഗ്ഗും സ്പിച്ച് എല്ലാ ചെയ്യിന്ന് ടാബ്സാന്താണ്. ഇതുമുഖ്യം റഫ്രിഞ്ചറുറിന് നിക്കലാണെന്നുമില്ല.
 - ഉപഭോഗാർത്ഥിക്കുന്നുസിച്ച് 165 പിസ്റ്റ റഫ്രിഞ്ചറുറിന്റെ പ്രതിശീലത വൈവരിച്ച ത്രാവാഗം കാരം യൂണിറ്റുവാലാണ്.

മുസ്ലിമുൾക്കുടി (മുലക്ട്രിക് അയാൾ)

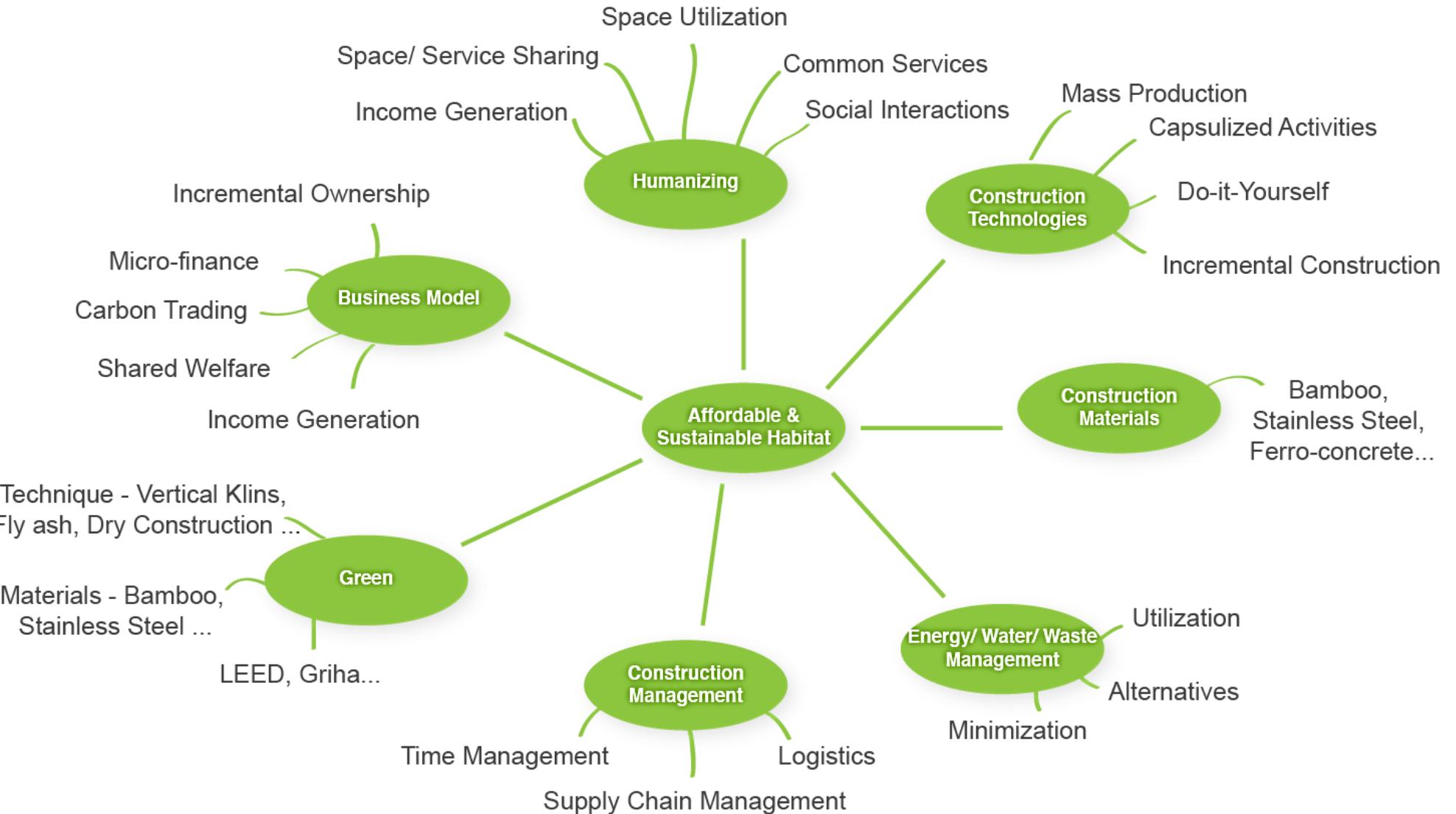
- ഓട്ടോമാറ്റിക് നല്പര്.
 - സുപ്രസിദ്ധമായ ശരിയാക്കി ഒപ്പുവിന്നിന്നുണ്ടാക്കുന്ന ഇനംതിലിന്തർക്ക് വാൻ ചെയ്യുക.
 - സൗഖ്യവിന്റെ ഏറ്റവും കാര്യം ഇനംതിലി ഇടുക.¹⁸

Zero Energy Building

A **zero-energy building**

is a building with zero net energy consumption, meaning the total amount of energy used by the building on an annual basis is roughly equal to the amount of renewable energy created on the site

Affordable Habitat - A system View



Green Buildings

- Green building

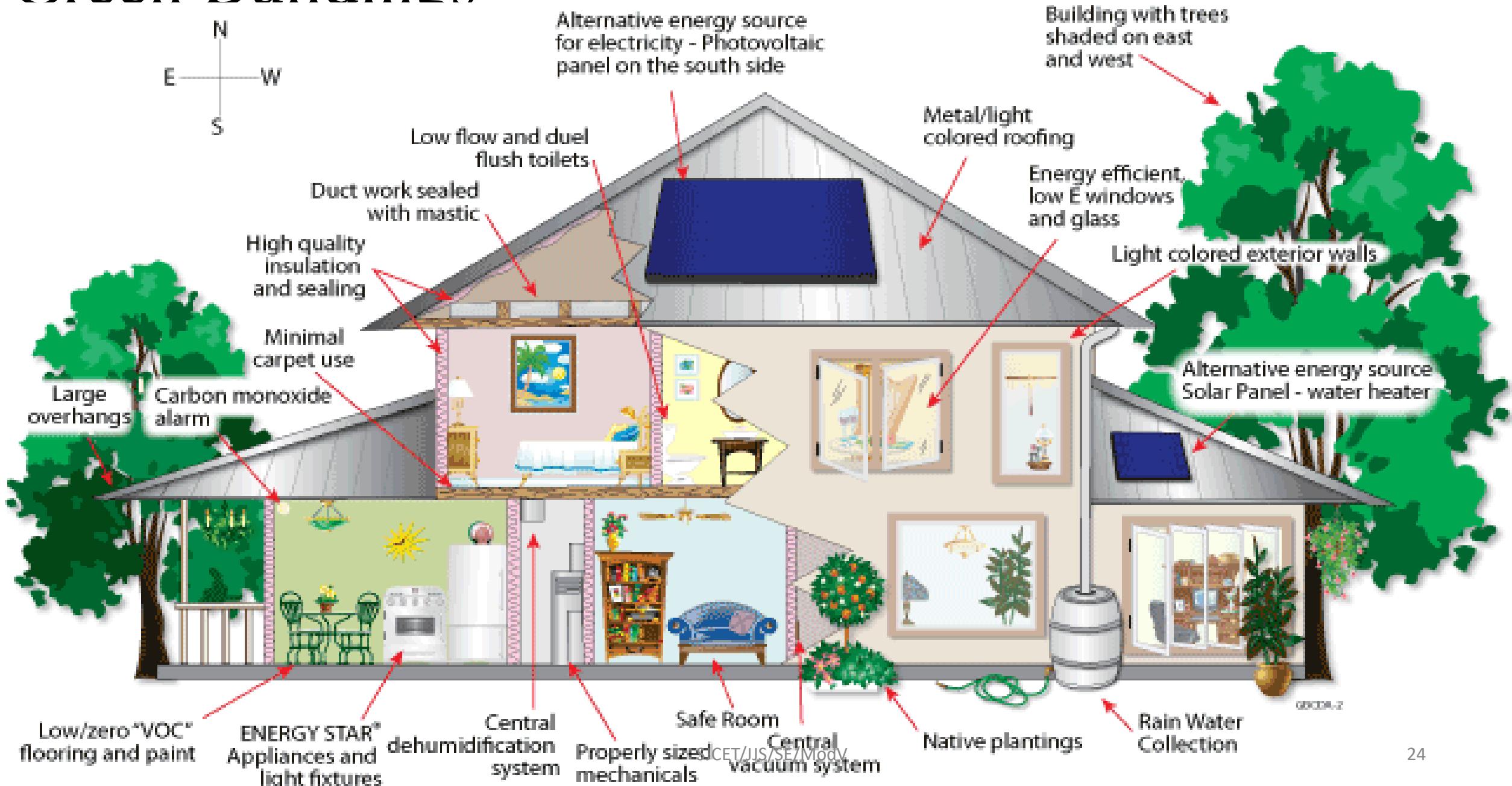
(also known as green construction or sustainable building)

refers to both a structure and the using of processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation, and demolition

- It is described as a structure that ensures efficient use of materials, water, energy and other resources without depletion of nature and minimal generation of non-degradable waste
- Recently newer technologies-developed-to create greener buildings-objective is to reduce the overall impact to the built environment on human health and the natural environment

- Green building brings together a vast array of practices and techniques to reduce and ultimately eliminate the impacts of buildings on the environment and human health.
- It often emphasizes taking advantage of renewable resources, e.g., using sunlight through passive solar, active solar, and photovoltaic techniques and using plants and trees through green roofs, rain gardens, and for reduction of rainwater run-off.
- Techniques, such as using packed gravel or permeable concrete instead of conventional concrete or asphalt to enhance replenishment of ground water, are used as well.
- Fundamental principles : Structure Design Efficiency, Energy Efficiency, Water Efficiency, Materials Efficiency, Indoor Environmental Quality Enhancement, Operations and Maintenance Optimization, and Waste and Toxics Reduction

Green Buildings



Characteristics of Green Buildings

- Although new technologies are constantly being developed to complement current practices in creating greener structures, the common objective is that green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment by:
 1. Efficiently using energy, water, and other resources
 2. Protecting occupant health and improving employee productivity
 3. Reducing waste, pollution and environmental degradation

Objectives of Green Building concept

- Saving energy
- Saving water
- Reducing waste
- Improving health and productivity
- Reduced pollution loads
- Reduced destruction of natural areas, habitats and biodiversity
and reduced soil loss from erosion etc...

Taipei 101, the tallest and largest green building of LEED (Leadership in Energy and Environmental Design) Platinum certification in the world since 2011

URL - <https://www.youtube.com/watch?v=B031ebdzRvc>





An eco-house at Findhorn Ecovillage with a turf roof and solar panels



Hanging gardens of One Central Park, Sydney

Ingredients & Benefits of Green Buildings



Save energy

Produce energy

Save water

Capture rainwater

Create open space

Produce local food

Building insulation or thermal mass leads to energy and cost **savings**

Improved/water quality, open spaces and fresh local food promotes **health**

Reduces burden on City's electrical grid and sewer **infrastructure**

Reduced pollution & increased biodiversity connects people to **nature**

Green materials for building construction

Examples for sustainable materials

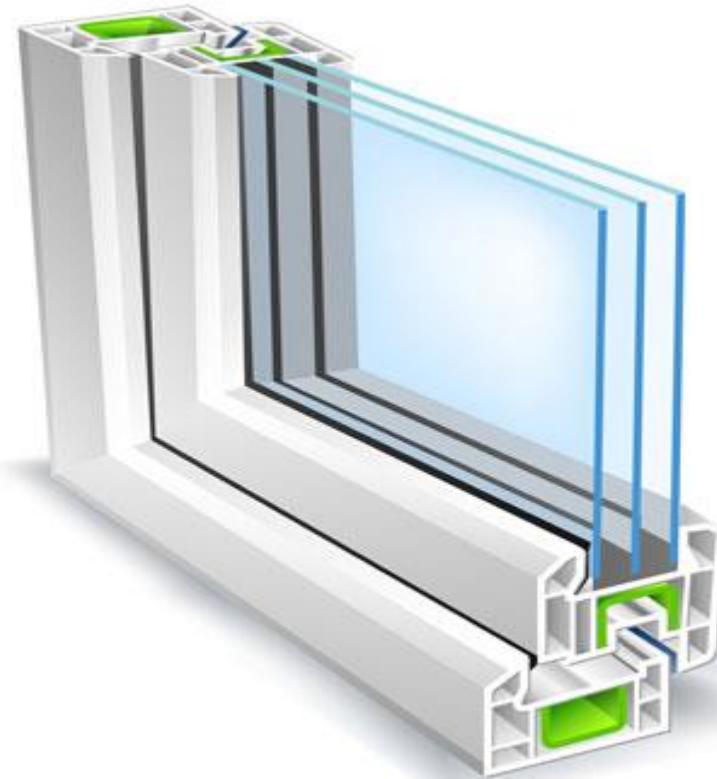
- Renewable sources: solar power
- Reuse from waste: old plumbing, doors etc...
- Wool brick: obtained by adding wool and natural polymer found in seaweed to the clay of the brick. It has around 37% more strength than burnt bricks and is resistant for cold and wet climate
- Sustainable concrete: crushed glass, wood chips or slag, a by product of steel manufacturing. It reduces the emission of carbon dioxide
- Solar tiles: exist to simply protect the building (it absorbs energy from the sun during day time)

Green materials for building construction

- Paper insulation: made from recycled newspapers and card boards
- Insect resistant and fire retardant
- Triple-glazed windows- super efficient windows. Stops heat to enter the building & from direct sunlight
- Using bamboo replacing the steel bars

Green materials for building construction

Examples for sustainable materials



Green materials for building construction

Examples for sustainable materials



Materials Selection Criteria

- Green building materials are composed of renewable, rather than nonrenewable resources.
- Green materials are environmentally responsible because impacts are considered over the life of the product.
- Depending upon project-specific goals, an assessment of green materials may involve an evaluation of one or more of the criteria listed below.
- **Green building material/product selection criteria :**
 - ✓ Resource efficiency
 - ✓ Indoor air quality
 - ✓ Energy efficiency
 - ✓ Water conservation
 - ✓ Affordability



Resource Efficiency

- **Recycled Content:** Products with identifiable recycled content, including postindustrial content with a preference for post consumer content.
- **Resource efficient manufacturing process:** Products manufactured with resource-efficient processes including reducing energy consumption, minimizing waste (recycled, recyclable and or source reduced product packaging), and reducing greenhouse gases.
- **Locally available:** Building materials, components, and systems found locally or regionally saving energy and resources in transportation to the project site.
- **Durable:** Materials that are longer lasting or are comparable to conventional products with long life expectancies.

Indoor environmental quality enhancement

- Indoor Air Quality (IAQ) seeks to reduce volatile organic compounds, or VOCs, and other air impurities such as microbial contaminants. Buildings rely on a properly designed ventilation system (passively/naturally- or mechanically-powered) to provide adequate ventilation of cleaner air from outdoors or re-circulated, filtered air as well as isolated operations (kitchens, dry cleaners, etc.) from other occupancies.
- **Low or non-toxic:** Materials that emit few or no carcinogens, reproductive toxicants, or irritants as demonstrated by the manufacturer through appropriate testing.
- **Moisture resistant:** Products and systems that resist moisture or inhibit the growth of biological contaminants in buildings.
- **Systems or equipment:** Products that promote healthy IAQ by identifying indoor air pollutants or enhancing the air quality.

Energy efficiency

- To reduce operating energy use, **high-efficiency windows and insulation in walls, ceilings, and floors increase the efficiency of the building envelope**, (the barrier between conditioned and unconditioned space).
- Another strategy, **passive solar building design**, is often implemented in low-energy homes. Designers orient windows and walls and place awnings, porches, and trees to shade windows and roofs during the summer while maximizing solar gain in the winter.
- In addition, effective window placement (day lighting) can provide more natural light and lessen the need for electric lighting during the day.
- **Solar water heating** further reduces energy costs.
- Onsite generation of renewable energy through **solar power, wind power, hydro power, or biomass** can significantly reduce the environmental impact of the building.
- Power generation is generally the most expensive feature to add to a building.

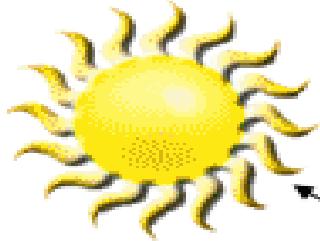
- Encourage use of ecofriendly refrigerants
- Maximise the use of windows and full glass exterior walls
- The lighting power density to be reduced by 10%
- Demonstrate the use of onsite renewable technologies
- Air conditioners fan pumps & motors installed in the building shall have an efficiency equivalent to BEE (Bureau of Energy Efficiency) 3-star rating

Water efficiency

- Reducing water consumption and protecting water quality are key objectives in sustainable building.
- **To the maximum extent feasible, facilities should increase their dependence on water that is collected, used, purified, and reused on-site.** The protection and conservation of water throughout the life of a building may be accomplished by designing for dual plumbing that recycles water in toilet flushing.
- Waste-water may be minimized by utilizing water conserving fixtures such as **ultra-low flush toilets and low-flow shower heads.**
- Bidets help eliminate the use of toilet paper, reducing sewer traffic and increasing possibilities of re-using water on-site.
- Point of use water treatment and heating improves both water quality and energy efficiency while reducing the amount of water in circulation.
- **The use of non-sewage and greywater for on-site use such as site-irrigation will minimize demands on the local aquifer.**

- Recharge groundwater table
- Water efficient fixtures, faucets, fittings....
- Design of landscape with drought tolerant species ensuring minimum consumption of water
- Reduce water demand for irrigation (water management system like drip irrigation)
- Wastewater treatment and reuse

HOW TO MAKE GREEN HOMES



Green Building with Heartland Builders, LLC.
www.heartlandbuilders.com

High Efficiency Low E
insulated glass windows reduce energy use and protect your homes interior

Exposure to the sun Consider your homes orientation to the sun to harness energy or to shield it from heat and UV light

Other Considerations – Low VOC paints, "green" flooring, energy efficient lighting. Conduct a "blower door" test on your home to determine performance.

Insulation Air sealing a home, using a blown insulation and minimizing thermal bridging lowers utility bills. Consider SIPS or ICF's

Rain Gardens
Help reduce storm water run off

Native Landscaping
Requires less maintenance and irrigation

Conserve Water with duo-flush toilets, water saving faucets and rain sensors for lawn sprinkling

High Efficiency Mechanical Systems reduce your energy bills. Consider a Geothermal Heating System. Always seal your duct work.

Recycled Deck Materials utilize sustainable resources and reduce maintenance costs

Recycled Framing Materials such as finger jointed studs and an I joist floor system help reduce new lumber use

Insulated Foundation Walls
Improves the comfort of your home and reduces utility costs. Consider ICF's.

Energy Efficient Appliances
reduce utility costs

Insulated Basement Floors
helps eliminate dampness and reduces utility costs

HOW TO MAKE YOUR BUILDING GREEN

Rainwater harvesting systems on the roof can collect water to be used to flush toilets

Solar panels can heat bath water

Wind turbines on the roof can be used to generate electricity

Consider your home's orientation to the sun to harness energy or to shield it from heat

Rainwater channelled into water butts can be used to water plants or wash cars

Use composting to reduce waste and help your garden at the same time. Most food scraps and biodegradable material produce nutrient-rich fertiliser

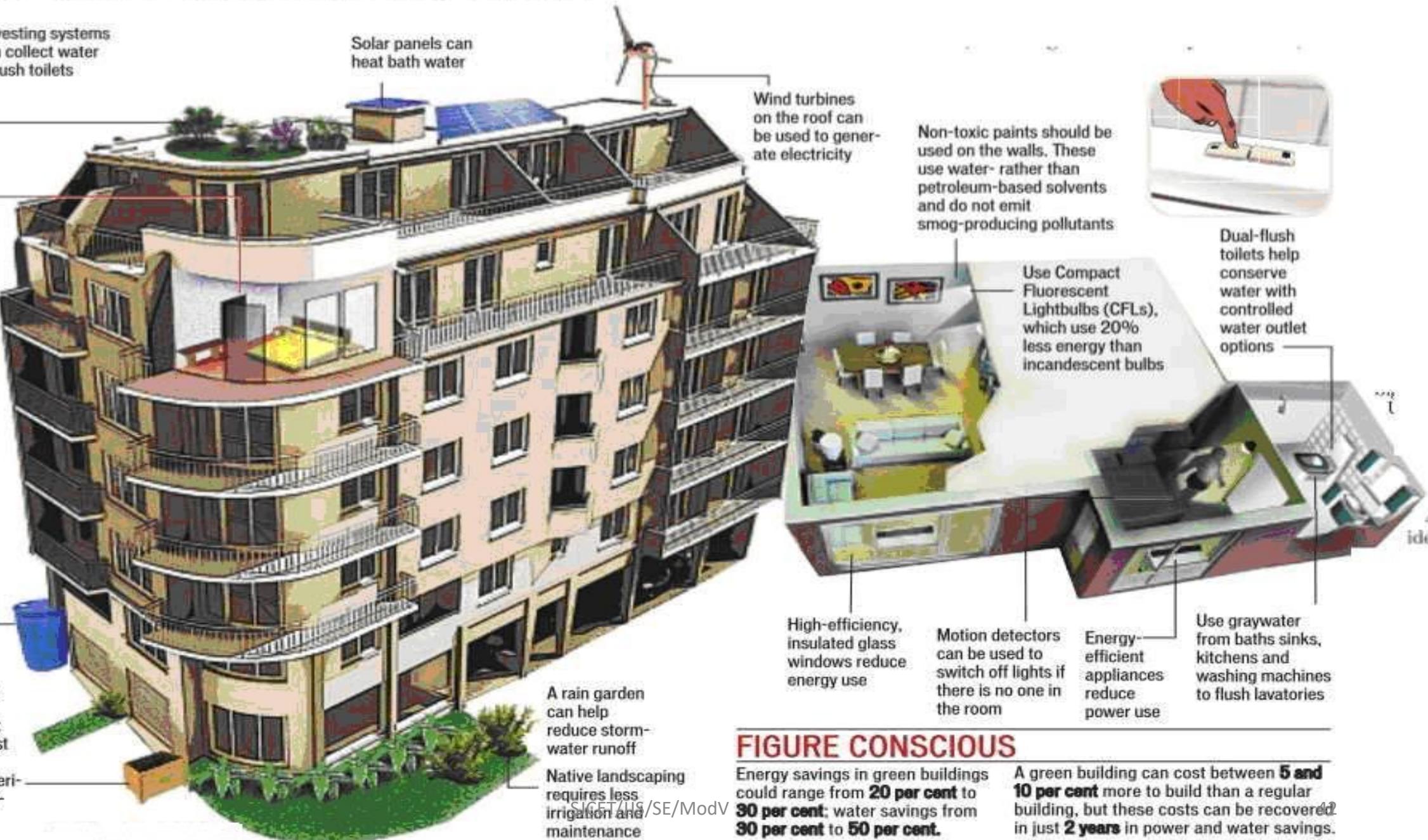


FIGURE CONSCIOUS

Energy savings in green buildings could range from **20 per cent** to **30 per cent**; water savings from **30 per cent** to **50 per cent**.

A green building can cost between **5 and 10 per cent** more to build than a regular building, but these costs can be recovered in just **2 years** in power and water savings.

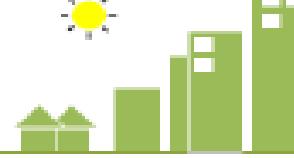
Growth of Green Building in India

ALL TYPES OF BUILDINGS, ALL OVER THE COUNTRY :

- IT PARKS
- OFFICES
- BANKS
- AIRPORT
- CONVENTION CENTRES
- EDUCATIONAL INSTITUTIONS
- HOTELS
- RESIDENTIAL
- FACTORIES



Green Building Evaluation systems



Are developed to evaluate the performance of buildings (new and existing) during design, construction and operation

- LEED (Leadership in Energy and Environmental Design)
- BREEAM, Green Globes, CASBEE
- GRIHA (Green Rating for Integrated Habitat Assessment)
- IGBC (Indian Green Building Council)
- Living Building Challenge
- Life Cycle Analysis

What is LEED?

Leadership in Energy & Environmental Design

- Developed by the United States Green Building Council (USGBC)
- Voluntary, Consensus-based, Market driven for developing high performance, sustainable buildings
- Benchmarks standards such as NBC, ASHRAE, ECBC etc.

CERTIFICATION		50-59
SILVER		60-69
GOLD		70-79
PLATINUM		80-100

Green Building Certification

- There are three primary Rating systems in India.

➤ GRIHA

➤ IGBC

➤ BEE

Green Rating for Integrated Habitat Assessment (GRIHA)

- India's own rating system jointly developed by TERI and the Ministry of New and Renewable Energy, Government of India.
- It is a green building design evaluation system where buildings are rated in a three-tier process.
- The process initiates with the online submission of documents as per the prescribed criteria followed by on site visit and evaluation of the building by a team of professionals and experts from GRIHA Secretariat.
- The GRIHA rating system consists of 34 criteria categorised in four different sections.
- Some of them are –
 - (1) Site selection and site planning, (2) Conservation and efficient utilization of resources, (3) Building operation and maintenance, and (4) Innovation

GRIHA v.2019

Section	Criterion No.	Criterion Name	Maximum Points
1. Sustainable Site Planning	1	Green Infrastructure	5
	2	Low Impact Design	5
	3	Design to Mitigate UHIE	2
2. Construction Management	4	Air and Soil Pollution Control	1
	5	Top Soil Preservation	1
	6	Construction Management Practices	2
3. Energy Efficiency	7	Energy Optimization	12
	8	Renewable Energy Utilization	5
	9	Low ODP and GWP Materials	1
4. Occupant Comfort	10	Visual Comfort	4
	11	Thermal and Acoustic Comfort	2
	12	Maintaining Good IAQ	6
5. Water Management	13	Water Demand Reduction	3
	14	Wastewater Treatment	3
	15	Rainwater Management	5
	16	Water Quality and Self-Sufficiency	5

6. Solid Waste Management	17	Waste Management-Post Occupancy	4
	18	Organic Waste Treatment On-Site	2
7. Sustainable Building Materials	19	Utilization of Alternative Materials in Building	5
	20	Reduction in GWP through Life Cycle Assessment	5
	21	Alternative Materials for External Site Development	2
8. Life Cycle Costing	22	Life Cycle Cost Analysis	5
9. Socio-Economic Strategies	23	Safety and Sanitation for Construction Workers	1
	24	Universal Accessibility	2
	25	Dedicated Facilities for Service Staff	2
	26	Positive Social Impact	3
10. Performance Metering and Monitoring	27	Commissioning for Final Rating	7
	28	Smart Metering and Monitoring	0
	29	Operation and Maintenance Protocol	0
Total Points			100
11. Innovation	30	Innovation	5
Grand Total Points			100 + 5

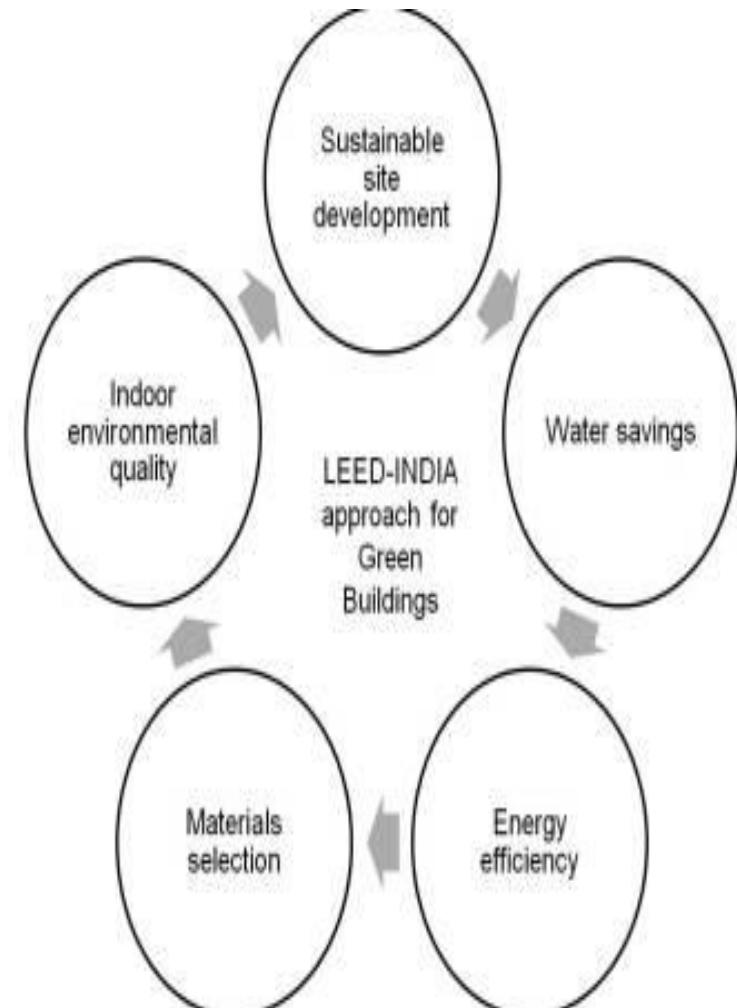
Rating Threshold

GRIHA V 2019 Rating Thresholds	GRIHA Rating
25-40	★
41-55	★★
56-70	★★★
71-85	★★★★
86 or more	★★★★★

<https://www.grihaindia.org/griha-rating>

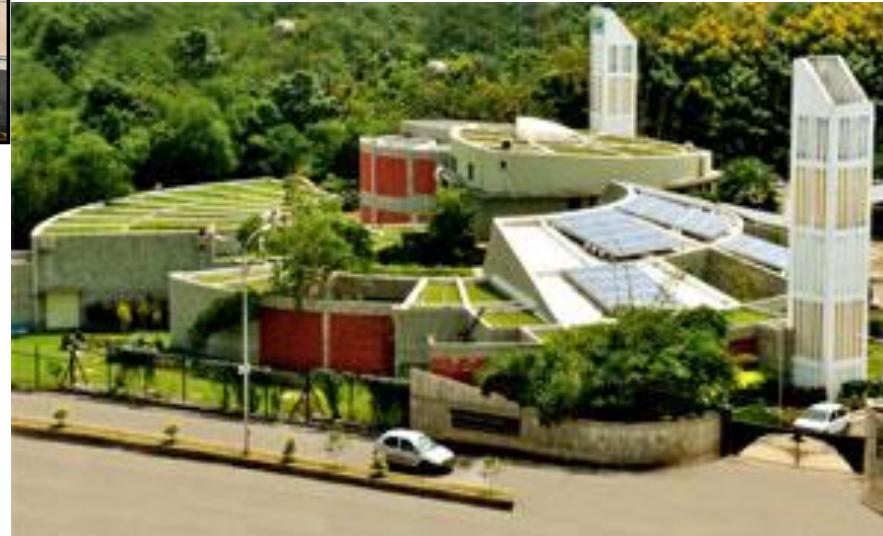
Indian Green Building Council (IGBC)

- LEED is developed by the U.S. Green Building Council (USGBC), the organization promoting sustainability through Green Buildings. LEED is a framework for assessing building performance against set criteria and standard points of references
- Confederation of Indian Industry (CII) formed the Indian Green Building Council (IGBC) in year 2001.
- IGBC is the non profit research institution having its offices in CII-Sohrabji Godrej Green Business Centre, which is itself a LEED certified Green building.
- Indian Green Building Council (IGBC) has licensed the LEED Green Building Standard from the USGBC. IGBC facilitates Indian green structures to become one of the green buildings.



CII – Sohrabji Godrej Green Business Centre

**A unique Public – Private Partnership
(CII, Govt of Andhra Pradesh, USAID and Pirojsha Godrej Foundation)**



**“Centre of Excellence” for Energy, Environment, Green Buildings,
Renewable energy, Water & Climate change activities in India**

- <https://www.youtube.com/watch?v=vh4gZdFhGjc>

Suzlon Energy Limited - Pune

Several accolades continue to shower upon Suzlon's global headquarter in Pune - "One Earth" - ever since the facility has been LEED 'Platinum' rated and certified as an eco-friendly building by the Green Building Council.

Built to perfection on an area of 41,000 square meters (10.13 acres), One Earth can be counted as among the largest green building projects in India and is living proof that our world can be replenished with a little green effort, everyday.



- RAJIV GANDHI INTERNATIONAL AIRPORT-HYDERABAD:

- India's first Greenfield airport is undeniably among the top 10 green buildings in India.
- First airport in asia to be certified with 'SILVER' rating.
- This green building ensures optimal use of natural light and minimal wastage of electricity or energy consumption.



Biodiversity Conservation India Ltd (BCIL) - Bangalore

The company's TZed homes in Whitefield, Bangalore has been certified as the first residential apartment in the world to be rated 'Platinum' under LEED.

TZed, which means "Towards Zero Energy Development" is a 2,49,000 sq.ft. green project spread across 5.5 acres and is designed to reduce lighting and energy by nearly 70 per cent.



No home at BCIL TZed Homes uses incandescent lamps, halogens and fluorescent tubelights

ITC Green Centre - Gurgaon

Renowned as one of the early adopters of the green building movement in India, the ITC Green Centre is still considered a benchmark for green buildings. It was 'Platinum' rated building and has endeavored to adopt green practices that go beyond recycled waste and day-lit offices.

Within a built-in area of 180,000 sq.ft., **the building features alternative transportation facilities, storm water management system, solar thermal technology, reflective high-albedo roof paint, minimal exterior lighting, separate smoking rooms with exhaust system and zero-water discharge**



More than 10% of the building materials are refurbished from other sites and 40% are from within 500 miles of the project site

La Cuisine Solaire - Auroville

One of the most innovative green buildings in the country is the **solar kitchen** at Auroville that best demonstrates the use of solar energy to produce steam.

This 1700 sq. m. kitchen is named thus because of the huge 15 diameter solar bowl that has been fixed at the top of the structure to harvest solar energy. On a clear day, this green structure can generate enough steam at a temperature of 150°C that can be used to cook meals for 1000 people, three times a day.



This building puts to use appropriate technologies and passive solar concepts to achieve energy-efficiency

Raintree Hotels - Chennai

Here is an eco-sensitive hotel for the eco-savvy traveler. The entire chain of Raintree business hotels across Chennai city are the first eco-sensitive hotels in South India.

Everything about this hospitality range is green: **right from the rubber wood, bamboo and medium-density fiber used for construction down to the Portland Pozzalana cement containing 15 to 20 per cent fly ash. The George Fisher concealed cistern installed at the hotel controls the water used in toilet flushes and the sewage treatment plant recycles water for use in air conditioners.**



Setting new standards of environmental responsibility without compromising on guest experience

Rating Programme to Suit Different Building Types

One single rating cannot be applied to suit all building types

- **Programmes launched**

- LEED India New Construction (NC)
- LEED India Core & Shell (CS)
- IGBC Green Homes
- IGBC Green Factory Buildings

- **Other Programmes**

- Commercial Interiors (USGBC)
- Existing Buildings (USGBC)
- IGBC Green SEZ's
- IGBC Green Townships (pilot version)
- IGBC Existing Buildings

- **Other Programmes on the anvil**

- IGBC Green Schools*
- IGBC Green Cities *
- IGBC Green Landscape *

* *Rating under development*

IGBC Rating Systems Certification Levels

IGBC GREEN HOMES (Individual Residential Unit)

10 Prerequisites

Certified	38-44
Silver	45-51
Gold	52-59
Platinum	60-75

IGBC GREEN FACTORIES

11 Prerequisites

Certified	51-60
Silver	61-70
Gold	71-80
Platinum	81-100

LEED INDIA-NC

8 Prerequisites

Certified	40 to 49
Silver	50 to 59
Gold	60 to 79
Platinum	80 to 110

LEED INDIA-CS

8 Prerequisites

Certified	40 to 49
Silver	50 to 59
Gold	60 to 79
Platinum	80 to 110

Sustainable Cities

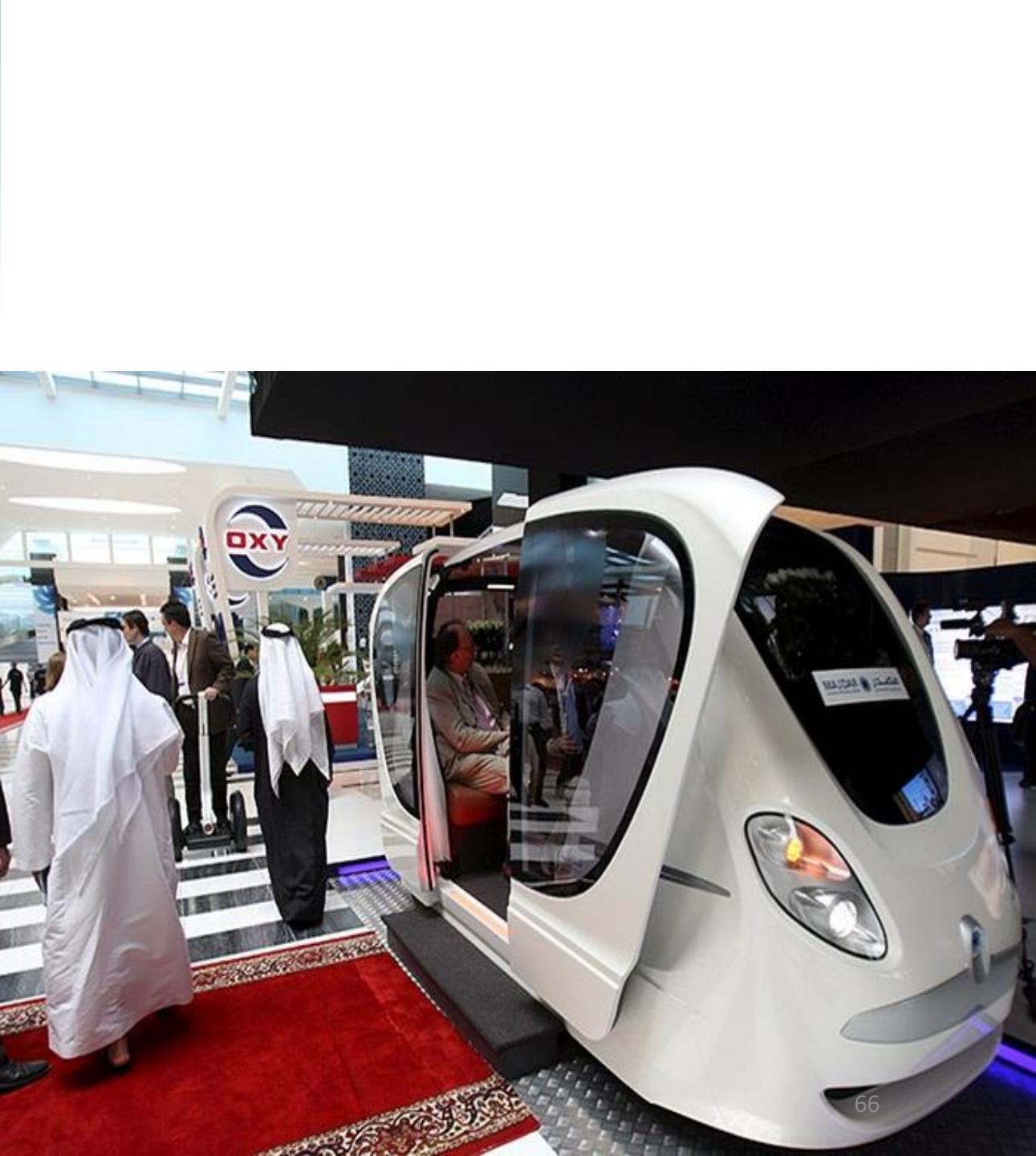
A sustainable city or an eco-city is a city designed with a consideration of environmental impact, inhabited by people, dedicated to minimization of required inputs of energy, water and food, waste output of heat, air pollution, carbon dioxide, methane ,water pollution

Masdar City





url - https://en.wikipedia.org/wiki/Masdar_City



Results of Urbanization



<http://www.thinkindia.net.in>

- By 2050, more than 80% of the world population (9.3 billion) will be in urban areas
- India will add 497 million in next 37 years = 38 Mumbai cities!

Electricity consumption in India is expected to rise to ~ 2280 BkWh (Billion Kilowatt-hour) by 2021-22 and ~4500 BkWh by 2031⁶⁷-32.

Sustainable Cities

B. Sustainable human settlements

42. We commit ourselves to the goal of sustainable human settlements in an urbanizing world by developing societies that will make efficient use of resources within the carrying capacity of ecosystems and take into account the precautionary principle approach, and by providing all people, in particular those belonging to vulnerable and disadvantaged groups, with equal opportunities for a healthy, safe and productive life in harmony with nature and their cultural heritage and spiritual and cultural values, and which ensures economic and social development and environmental protection, thereby contributing to the achievement of national sustainable development goals.

Key features of a sustainable city

- Resources and services in the city are accessible to all.
- Public transport is seen as a viable alternative to cars.
- Public transport is safe and reliable.
- Walking and cycling is safe.
- Areas of open space are safe, accessible and enjoyable.

- Wherever possible, renewable resources are used instead of non-renewable resources.
- Waste is seen as a resource and is recycled wherever possible.
- New homes are energy efficient.
- There is access to affordable housing.
- Community links are strong and communities work together to deal with issues such as crime and security.
- Cultural and social amenities are accessible to all.

- Whitehill Bordon is an example of an Ecotown in the UK
- Masdar City in Abu Dhabi is an example of a sustainably planned city.

Measures to be taken for a city to move towards sustainability

- Monitoring & Improving air quality
- Maximize waste recycling
- Energy efficient/low/zero carbon buildings
- Smart energy generation
- Proper regulations and legislations
- City transport – innovative smart transport methods
- Water harvesting

Top 10 cities leading in urban sustainability

- Bogota: Urban Transportation
- Melbourne: Energy Efficient built Environment
- Copenhagen: Carbon Measurement and Planning
- Mexico : Air Quality
- Munich : Green Energy
- Rio de Janeiro : Sustainable Communities
- New York: Adaptation and resilience
- San Francisco: Waste Management
- Singapore: Intelligent City Infrastructure
- Tokyo: Finance and Economic Development

Copenhagen

- The city's airport, rail and suburbs are all connected to the centre by the metro system.
- In the city centre, a combination of measures has encouraged an increase in walking and cycling and a decrease in private car use.
- 90% of all construction waste is recycled and 75 per cent of all household garbage used for heating.
- Many public squares and streets are pedestrianised.
- The city has a programme to gradually reduce the number of car parking spaces by 3 per cent per year and further develop cycle lanes and a free cycle hire scheme.



Copenhagen goals

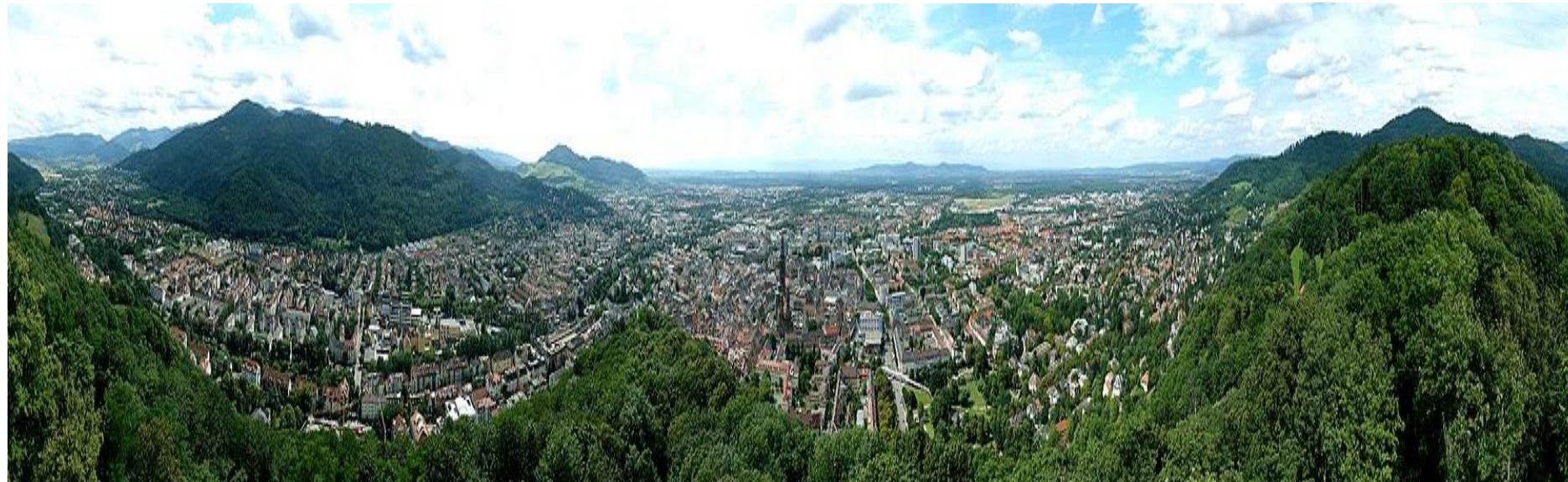
- 90% of citizens will be no more than 15 minutes' walk from a park or one of Copenhagen harbour's two swimming facilities.
- Creation of green cycle routes with Government ministers leading by example. Currently 37km out of proposed 110 have been completed

"Our main goal is to be the world's first carbon neutral city by 2025" Klaus Bondam – Mayor Of Copenhagen
(March 2009)



FREIBURG GREEN CITY

Approaches to Sustainability



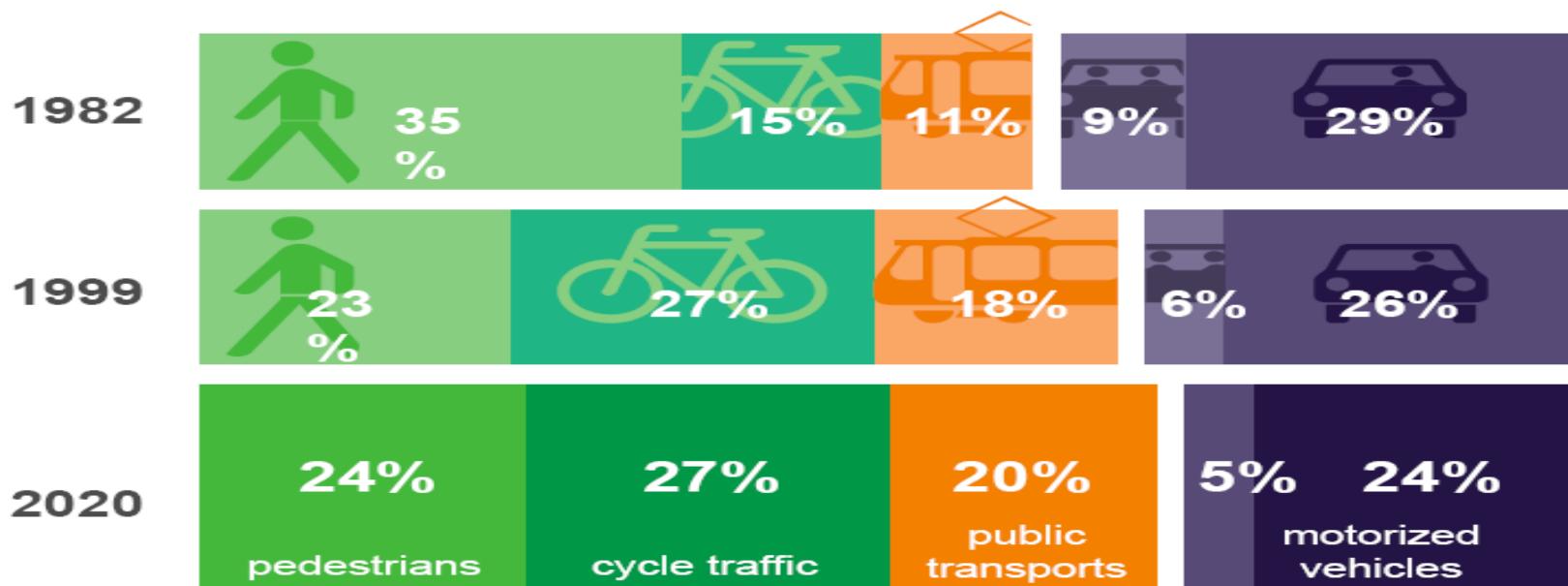
Eco housing, car-free streets and socially conscious neighbours have made the German city of Freiburg a shining example of sustainability. The Observer 23rd March 2008

SJCET/JJS/SE/ModV



- After devastation of WW2, planners rebuilt the city for people not cars.
- Pedestrianised streets, bike lanes and excellent trams were at the heart of the city's development. Plus the unique Freiburg Bächle, small canals that run down each central street.

Modal Split



Sustainable Transport



Sustainable Transport

- **Sustainable Transport** is sometimes known as **Green Transport** and it is any form of transport that does not use non renewable resources.
- It depends on renewable energy rather than fossil fuels that have a finite life expectancy

Unsustainable transport

Economic	Social	Environmental
Traffic congestion	Inequity of impacts	Air pollution
Mobility barriers	Mobility disadvantaged	Climate change
Crash damages	Human health impacts	Habitat loss
Transportation facility costs	Community cohesion	Water pollution
Consumer transportation costs	Aesthetics	Hydrologic impacts
Depletion of non-renewable resources		Noise pollution

Sustainable transport

- Efficient Transportation
- Walking and Cycling Improvements
- Transit Improvements
- Ridesharing
- Commute Trip Reduction

Sustainable Transport

Use of hybrid vehicles

Natural gas and biofuel as transport fuel

Transport choices with very low environmental impact are

Cycling

Use of human powered vehicles

Animal powered transport

The most green transport choice with the least environmental impact is walking.

Hybrid Vehicle

- Conventional vehicles use gasoline or diesel to power an internal combustion engine.
- Hybrids also use an internal combustion engine — and can be fueled like normal cars—but have an electric motor and battery, and can be partially or wholly powered by electricity.
- Hybrids use combinations of gas and electric engines.
- Fewer toxic emissions leak into our air, because of the electric power supplementing the gasoline.
- This creates a cleaner environment for now and the future.



CHEVROLET VOLT