Course content & Intended Learning Outcomes (ILOs)

No	Content	ILO
1	**Introduction to Green Technology** Basic definitions, basic principles, an overview of green technologies	**LO#1:** Explain and elaborate green technology concepts, approaches, tools, methods, technologies, and their importance
2	**Renewable Energy** Concept of Energy, Units and Measurement, Types of energy, Energy and power, Energy demand, History of fossil fuels, Sources of energy, solar, wind, tidal, geothermal, biomass, animal, human, hydrogen and fuel cells.	**LO#2:** Describe, evaluate, and develop different renewable energy technologies
3	**Biomass Energy Technology** Biomass classification, Biomass characteristics, Biomass production techniques, Harvesting of biomass, Gasifier and its process, Bio-ethanol production, bio-diesel production, Electricity generation from biomass Importance of biogas production, Biological process involved in Anaerobic digestion, Uses of biogas, Designing of small biogas digesters, Construction of a digester	**LO#3:** Describe and evaluate techniques of converting biomass to energy
4	**Industrial Green Technology** Bioplastics, green catalysis, green technology development challenges, opportunities for green technology markets	**LO#4:** Conduct case studies for analyzing and evaluating industrial applications of green technology **LO#5:** Describe green technology development challenges, opportunities for green technology markets
5	**Design approaches in green technology** Introduction to green building design	**LO#6:** Describe guiding principles fundamental to design approaches in green technology

Sustainable and Green Technologies (2C)
Introduction to Sustainable Built Environment

Environmental Issues

1.Climate Change

2.Overpopulation

3.Ecosystems & Endangered Species

4.Deforestation

5.Pollution

6.Water Scarcity & Water Pollution

7.Loss of Biodiversity

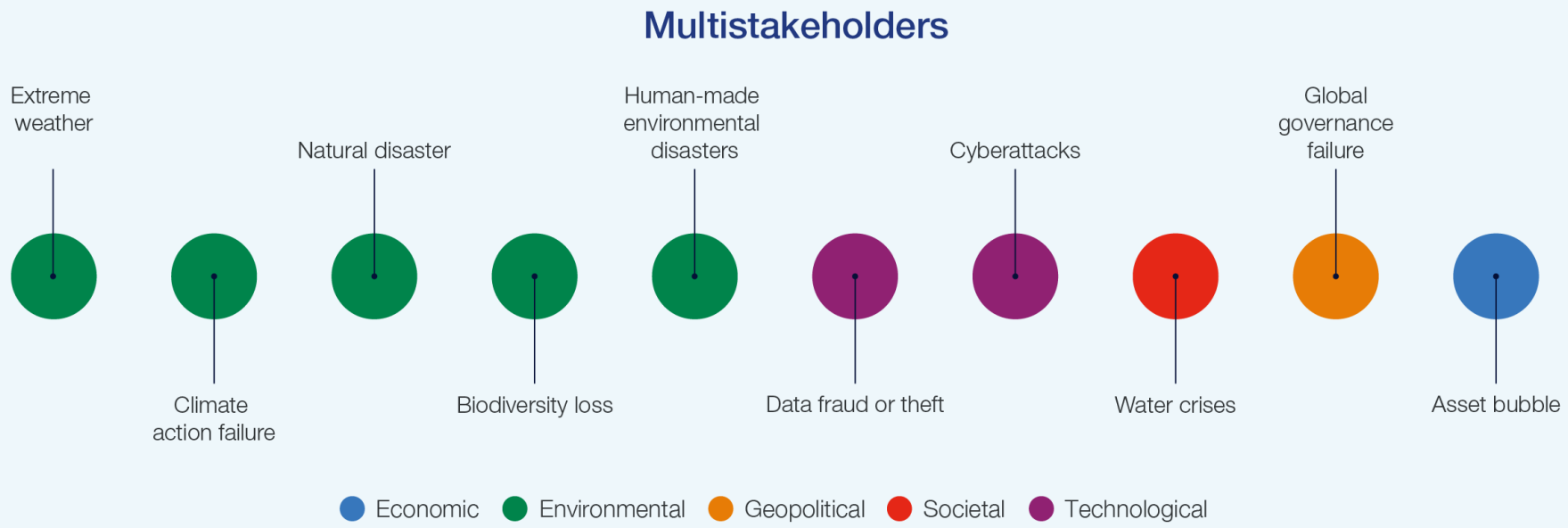
8.Waste Disposal

9.Land Management & Urban Sprawl

10.Public Health

TOP 10 RISKS OVER THE NEXT 10 YEARS

Long-Term Risk Outlook: Likelihood

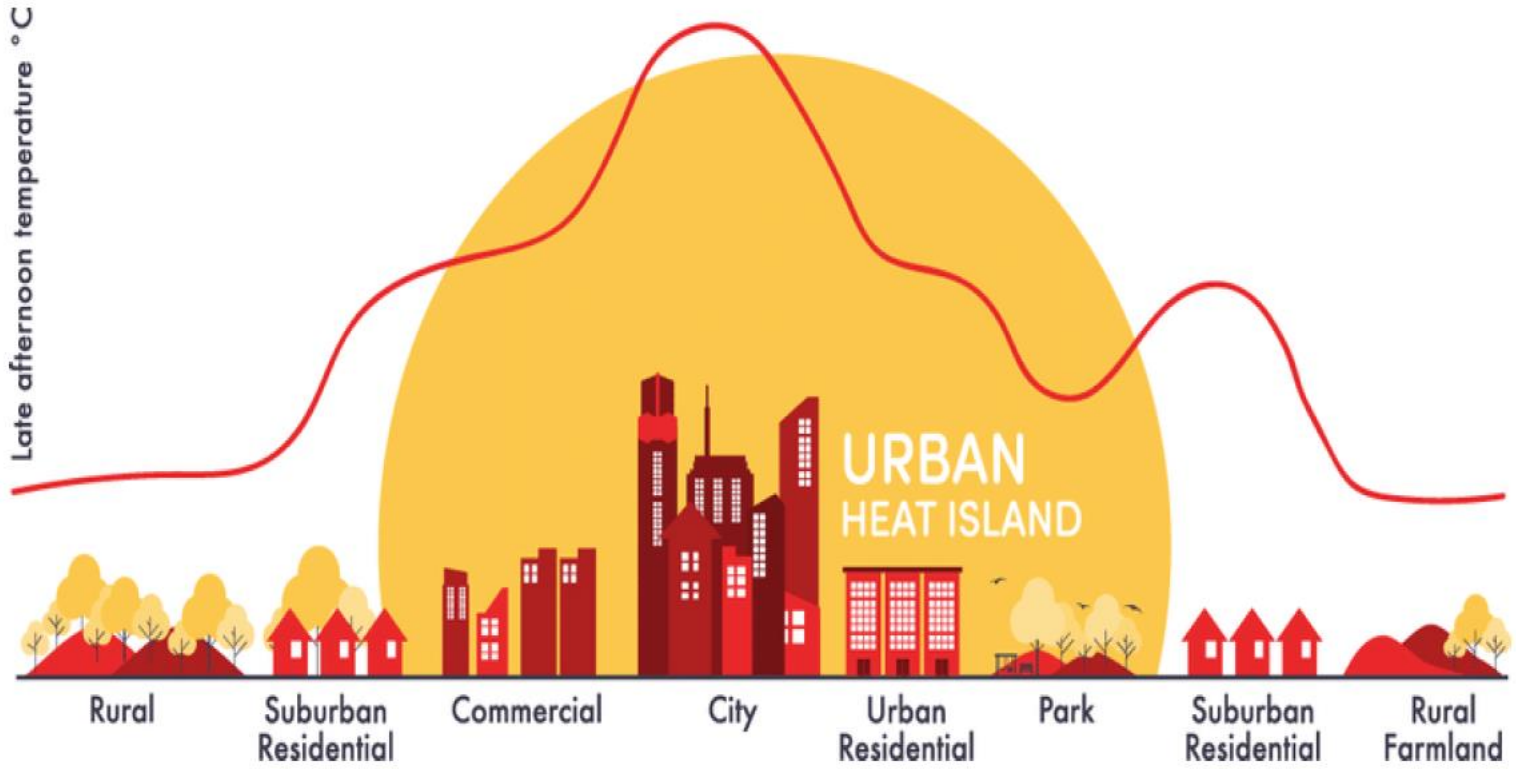


Global Risks Report 2020

Environmental Challenges Created by Construction Industry

https://www.greenbuildingsolutions.org/life-cycle-assessment/environmental-issues-construction/

Urban Heat Islands

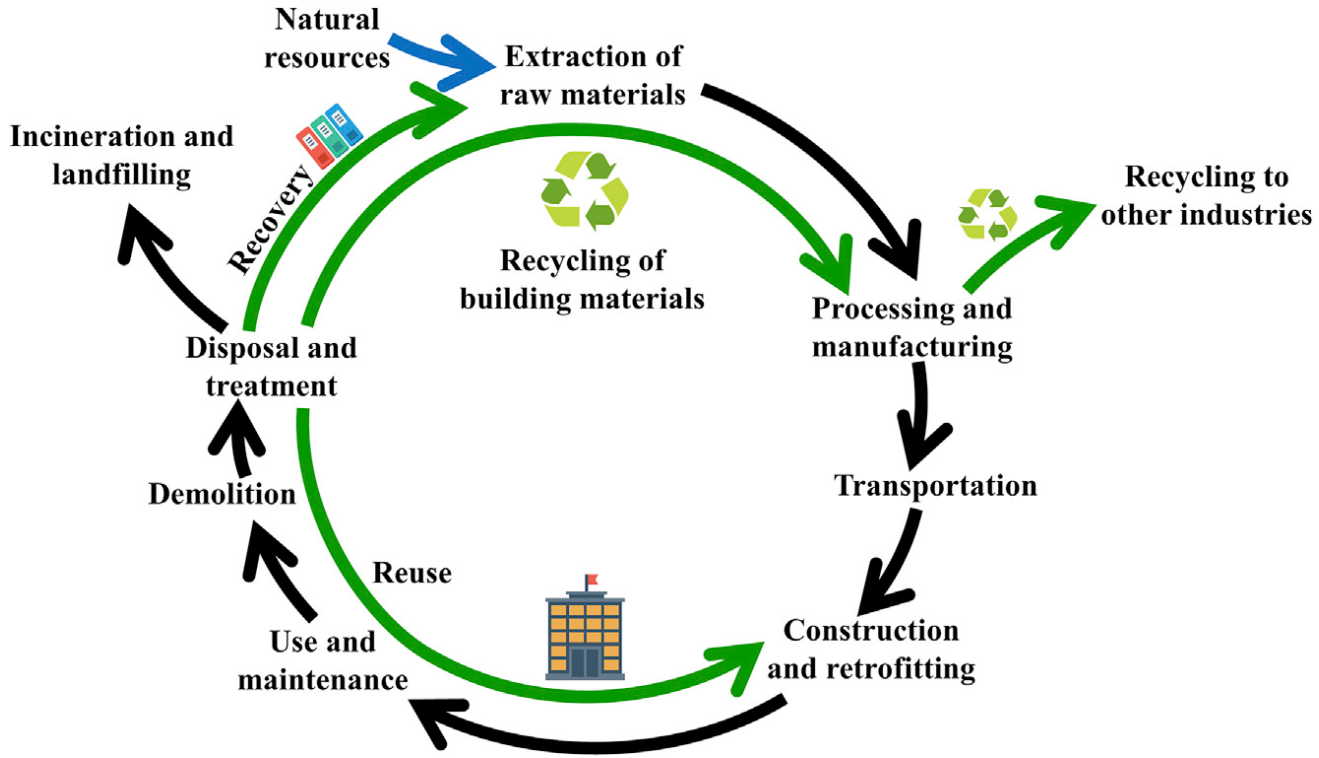


https://www.youtube.com/watch?v=lnBO4vX82Fs

https://www.youtube.com/watch?v=ZMn-bCdThEg

https://www.youtube.com/watch?v=-dvFb2vC7_Y

Transform Built Environment with Sustainability

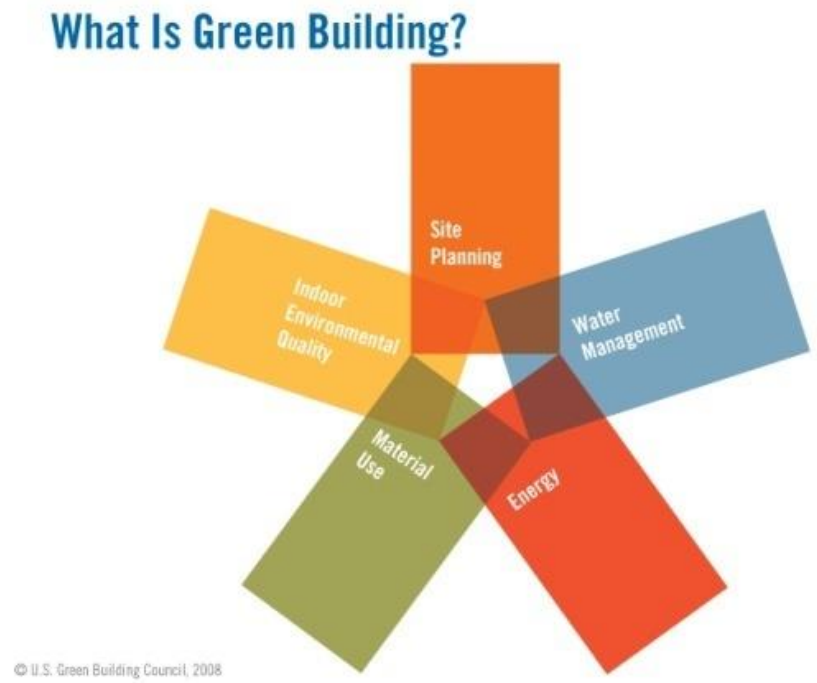


https://en.usst.edu.cn/info/1061/2169.htm

Smart (Green) Design Objective

Adopt practices that significantly reduce or eliminate the negative impact of construction and operations of building on the environment and occupants in five broad areas:

- Sustainable site planning
- Safeguarding water and water efficiency
- Energy efficiency and atmosphere
- Conservation of materials and resources
- Indoor environmental quality



Graphic from USGBC

Anticipated Benefits

Environmental benefits

- **Reduce the impacts of natural resource consumption**

Economic benefits

- **Improve the bottom line**

Health and safety benefits

- **Enhance occupant comfort and health**

Community benefits

- **Minimize strain on local infrastructure and improve quality of life**

Productivity Benefits

Improve occupant performance

- Significant improvements in national productivity in the US
- Student performance is better in daylight schools.

Reduce absenteeism and turnover

- Providing a healthy workplace improves employee satisfaction

Increase retail sales with daylighting

- Studies have shown ~40% improvement

Project Planning

Owner's project requirement (OPR)

Appointment of a project team

- Architect + green /sustainability consultant directly reporting to owner
- Project manager, QS, Engineer to site, MEP consultant

Site selection

Design process

Design Consideration

- Building orientation
- Storm water quality and quantity control
- Heat island effect – non roof and roof
- Light pollution reduction
- Water efficient landscapes
- Waste water treatment and rainwater harvesting & reuse
- Daylight & views for occupants and occupied spaces

Green Rating System

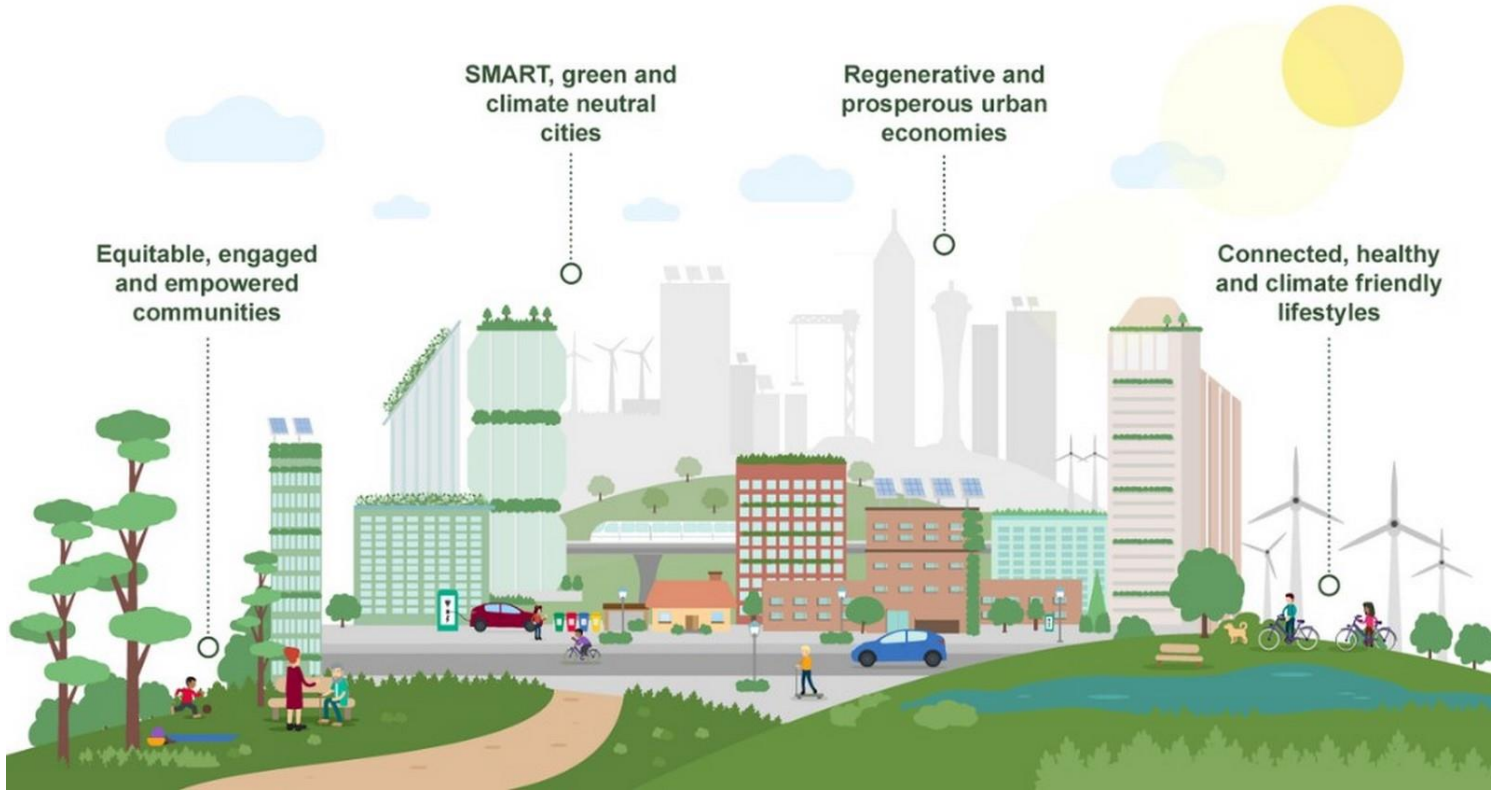
A set of performance standards used to certify the operations and maintenance of in the form of commercial or institutional buildings and residential buildings of all sized, both public and private.

Green Labeling System

Green labeling refers to the accreditation activities of products in line with the specific environmental standards of authority.

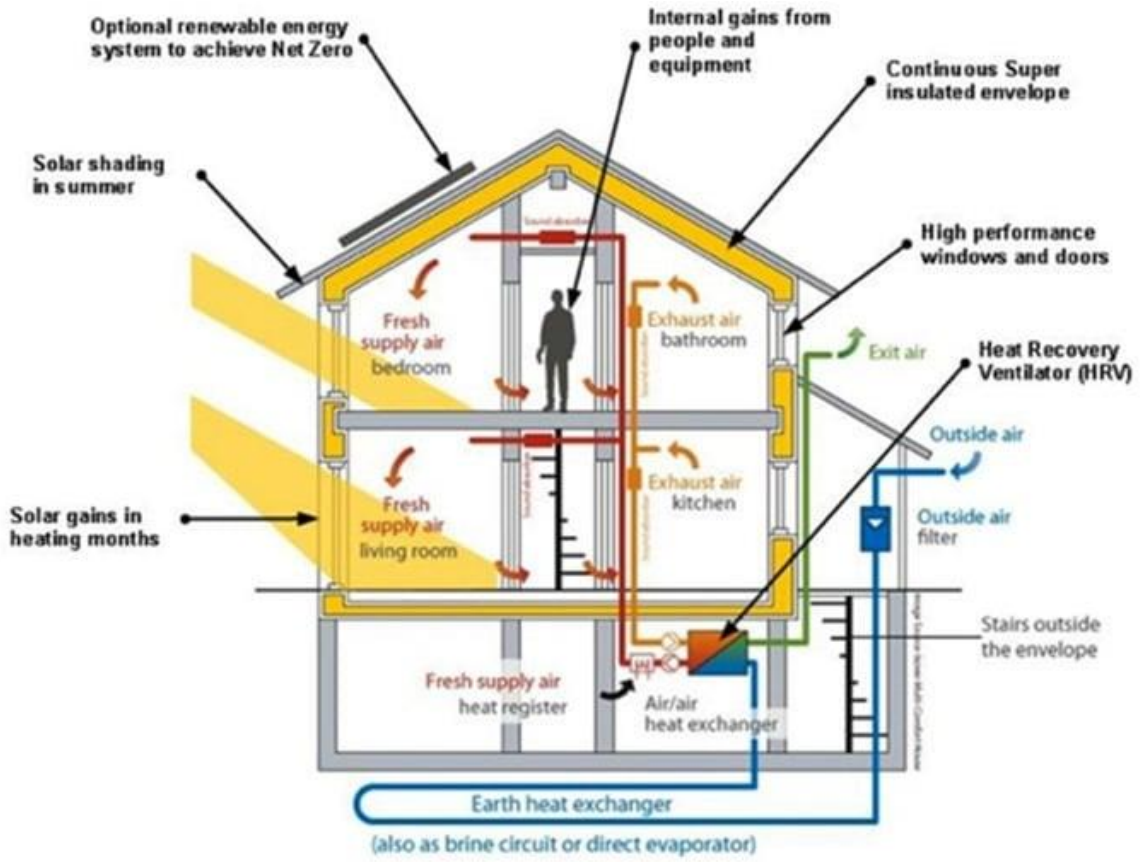
Green labels are also known as environmental labels or eco-labels

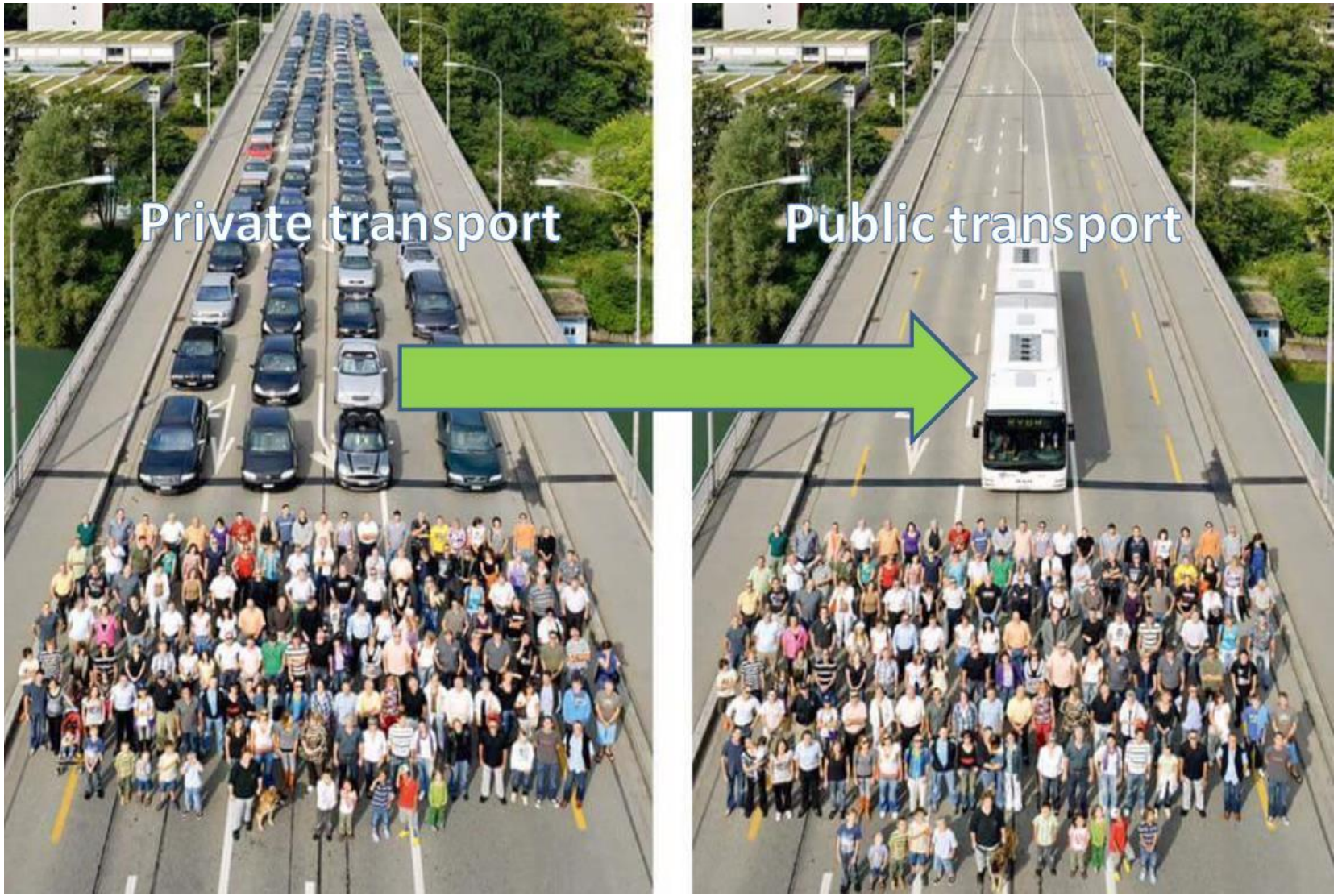
Urban Sustainability



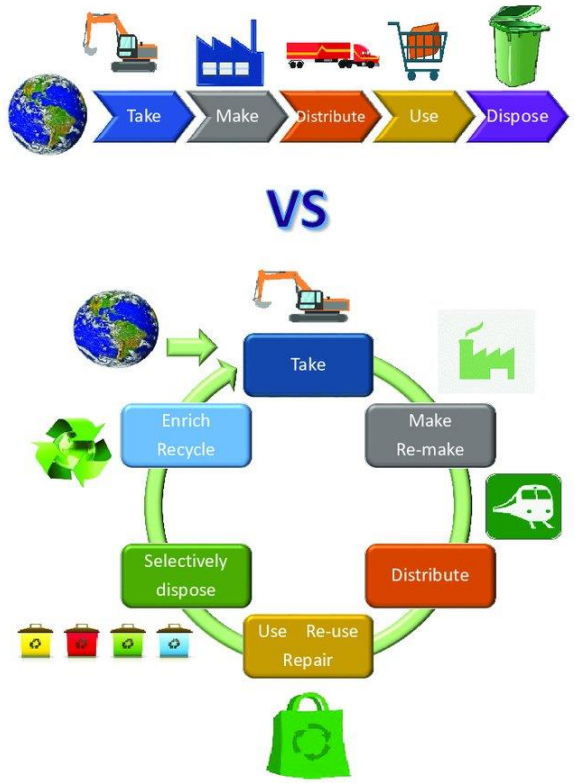
https://www.re-thinkingthefuture.com/sustainable-architecture/a4249-what-are-the-principles-of-urban-sustainability/

Net Zero Energy Building




Private transport
Public transport

Linear economy vs circular economy



https://www.researchgate.net/publication/337435190_e-WASTE_everything_an_ICT_scientist_and_developer_should_know/figures?lo=1

Research

Alternative materials

Secondary materials (from construction and demolition waste)

Rain water harvesting

What is a “Green Building”

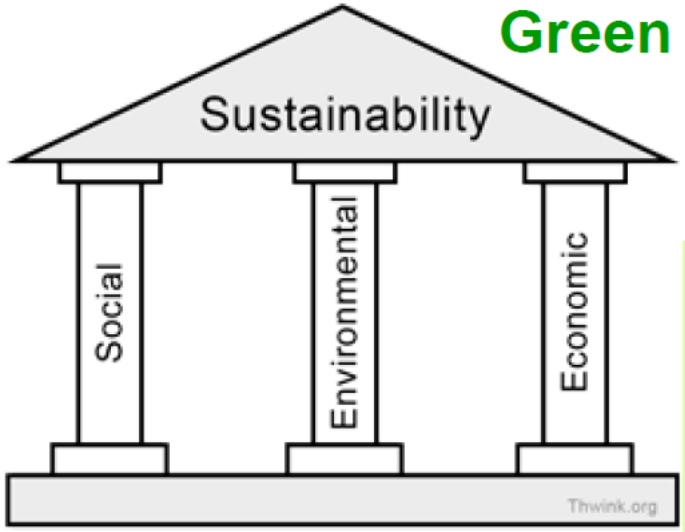
“Green Buildings” are high performance structures that also meet certain standards for reducing natural resource consumption.

Defining Green Buildings :

Design and construction practices that significantly reduce or eliminate the negative impact of buildings on the environment and its occupants with regard to site planning safeguarding water use and water use efficiency promoting energy efficiency and renewable energy conserving materials and resources and promoting indoor environmental quality

- US Green Building Council -

Green Building and Sustainability



ENVIORNMENTAL BENEFITS

- Protect biodiversity and ecosystems
- Improve air and water quality
- Reduce waste streams
- Conserve natural resources

ECONOMIC BENEFITS

- Reduce operating costs
- Create, expand, and shape markets for green product and services
- Improve occupant productivity

SOCIAL BENEFITS

- Enhance occupant comfort and health.
- Heighten aesthetic qualities.
- Minimize strain on local infrastructure.
- Improve overall quality of life.

Through a number of high-tech and low-tech approaches, greenbuildings are designed to meet several goals. These include:

- Reduced water use
- Reduced material use
- Increased human health
- Intelligent use of space
- Working with nature
- Integration within the community

Architectural designs

Definitions

Concept that focuses on the components or elements of a structure or system and unifies them into a coherent and functional whole, according to a particular approach in achieving the objective(s) under the given constraints or limitations.

Architectural Design focuses on a broad range of perspectives linking several common concerns: site and context, use and form, building methods and materials, and the role of the architect. Context is considered in terms of preexisting natural and constructed forms and sociological patterns of use. The architect is seen less as the sole creator of a completed building than as a collaborator in shaping the physical environment.

Different types of habitable structural categories

Technologically advance Modern or traditional vernacular structures

Low, Medium, High or Mega density structures

Residential, Commercial, Entertainment, Transport, Schools and Hospitals or structures aimed at social or religious gatherings

Green Architecture

Definitions

Green architecture, or green design, is an approach to building that minimizes harmful effects on human health and the environment. The "green" architect or designer attempts to safeguard air, water, and earth by choosing eco-friendly building materials and construction practices.

Building and structure design philosophy that aims at minimal use of non-renewable and/or polluting materials and resources in construction and use of a facility. Green architecture uses natural and reclaimed building materials, optimizes natural light, and integrates structures with the insulating earth.

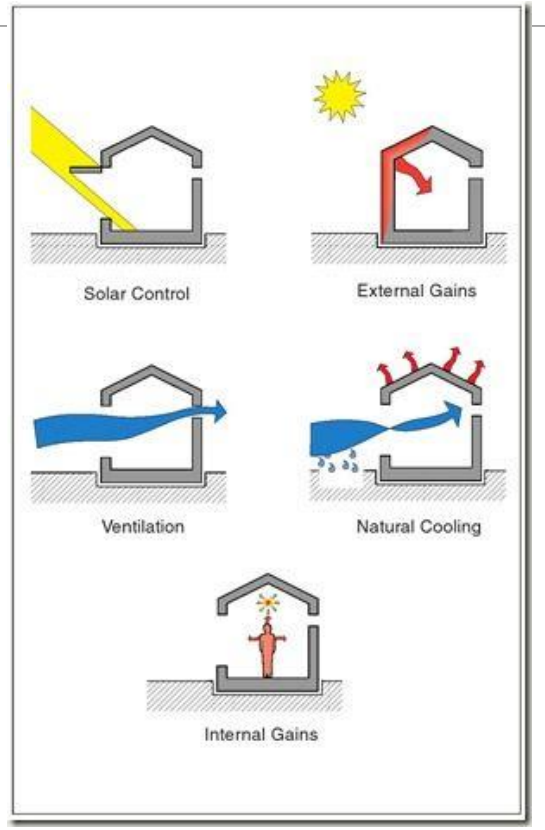
Different Aspects of Green Architecture

- sustainable development
- eco-design
- eco-friendly architecture
- **earth-friendly architecture**
- environmental architecture
- natural architecture

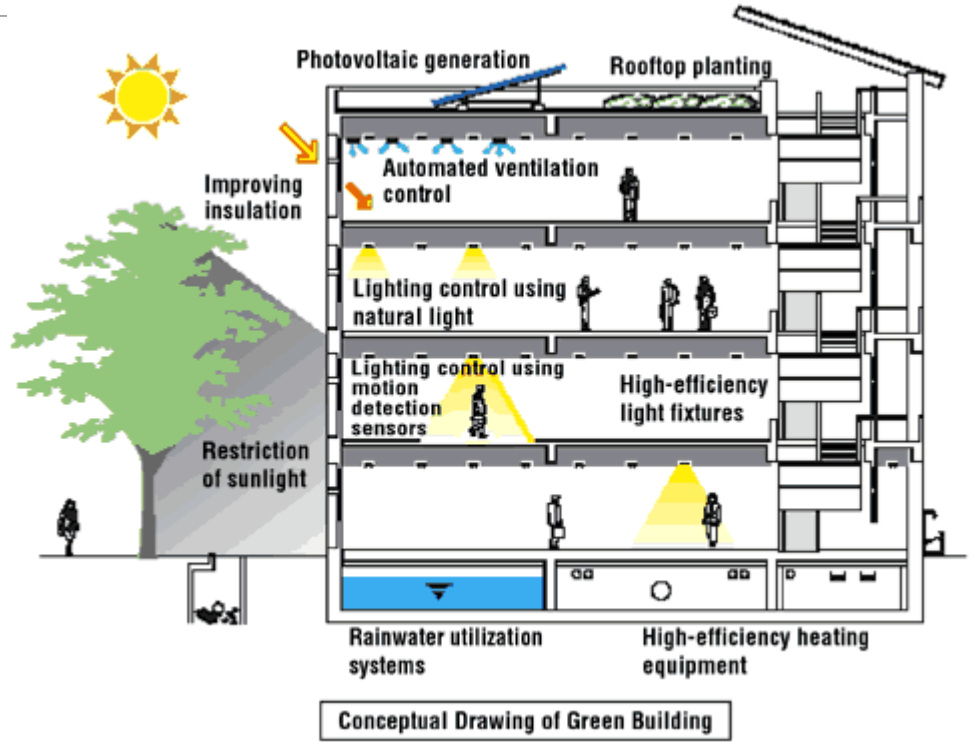
Sustainable design principles

- Optimize the use of the sun
- Improve indoor air quality
- Responsible land usage
- Creation of high-performance and moisture-resistant houses
- Wise and innovative usage of the Earth’s natural resources

Aspects of a passive bioclimatic building design

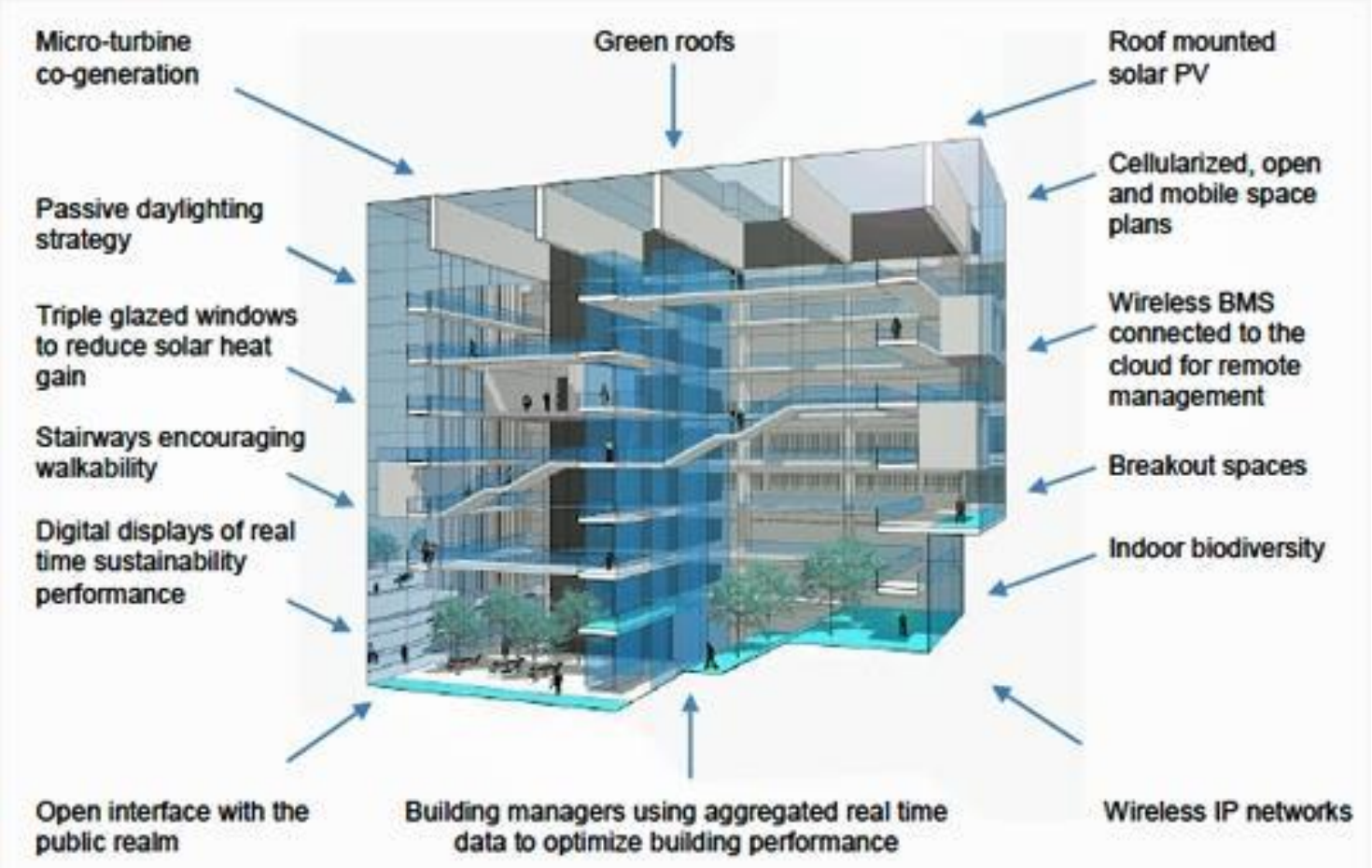


Features of a Green Building



https://www.ecomena.org/salient-features-of-a-green-building/

Major components of a Green Building



Features of Green Architecture

- Selection of the optimal location on the land, maximizing sunlight, winds, and natural sheltering
- Orientation of the building to maximize natural thermal comforts via proper influx or shading of the sunrays
- Allow for the maximum possible air movement throughout the structure
- Protect interior from the rains and moisture
- Maximize the views where necessary

Ventilation systems designed for efficient heating and cooling

- Use of louvered windows and doors that allows natural ventilation
- Allow for a central chimney where rising columns of hot air could escape

Energy-efficient lighting and appliances

- Use of LED or CFL light bulbs and energy saving fixtures where necessary
- Purchase of appliance with a better rating system for energy
- Ergonomically designed interiors and furniture that increase efficiency and effectiveness

Water-saving initiatives

- Re use of sewer water as fertilizer in gardening
- Re use of grey water for gardening or vehicle washing purposes
- Install specific water saving plumbing and toilet fixtures such as better manufactured tap and faucet settings, cistern with dual flush systems, smart sensor where water activated through movement of the user

Landscapes planned to maximum use of passive solar energy and a buffer for excessive light penetration in

Roof top gardens where the slab gets shaded from the harsh sun and could generate more food items

Wall gardens and hanging gardens

Ground cover with shade planting and wind screening

Minimal harm to the natural habitat

Less cut and fill of sloping sites and use existing natural features as part of the structure, wherever it's possible

Use of absolute minimum building foot print

Re grow the possible vegetation where locally be found

Provide and facilitate the cohabitation of useful insects and wild life

Use of sewer and bio waste in generating bio gas

Different Energy Sources Available

- Solar energy converted into electricity or heat
- Wind energy
- Hydro energy
- Wave energy
- Tidal energy
- **By burning fossilized remains of organisms such as fossil fuel**
- Geo thermal energy
- Bio mass energy
- Hydrogen energy

Use of alternate power sources

Use of solar panels on roof structures

Installation of small scale wind turbine power generators where sufficient wind power exists such as high elevations or coastal areas

Non-synthetic, non-toxic materials

- Organic herbicides and pesticides such as Marigold, Garlic, Neem(Kohomba) concoctions to spray
- Use of Inginiseed, natural charcoal, sand for water purification
- Mud and cow dung mixture as a floor and oven top finish
- Various tree sap as adhesives and tree sap as colour, various soils as colour or textures

Locally-obtained building material such as woods and stone, eliminating long-haul transportation

- **Use of locally harvested timber, various stones of granite as finishes**
- Mud & clay from the site as a building material
- Locally harvested reed or bamboo roofing material

Responsibly-harvested woods

- Timber from timber plantations

Efficient use of space

- Sticking to the standards and safety guide lines
- Design using ergonomic fundamentals

Identify and use of underutilised areas such as under the stairways, Over the cupboards, roof attic spaces for various uses such as storage or even as studio spaces, pantry spaces.

Adaptive reuse of older buildings

Older houses convert into accommodation or office buildings

Older barns, ware houses convert into service industry business or house holds

Use of recycled architectural salvage

Salvaged Building materials such bricks, stones, timber and roof tiles could be reused

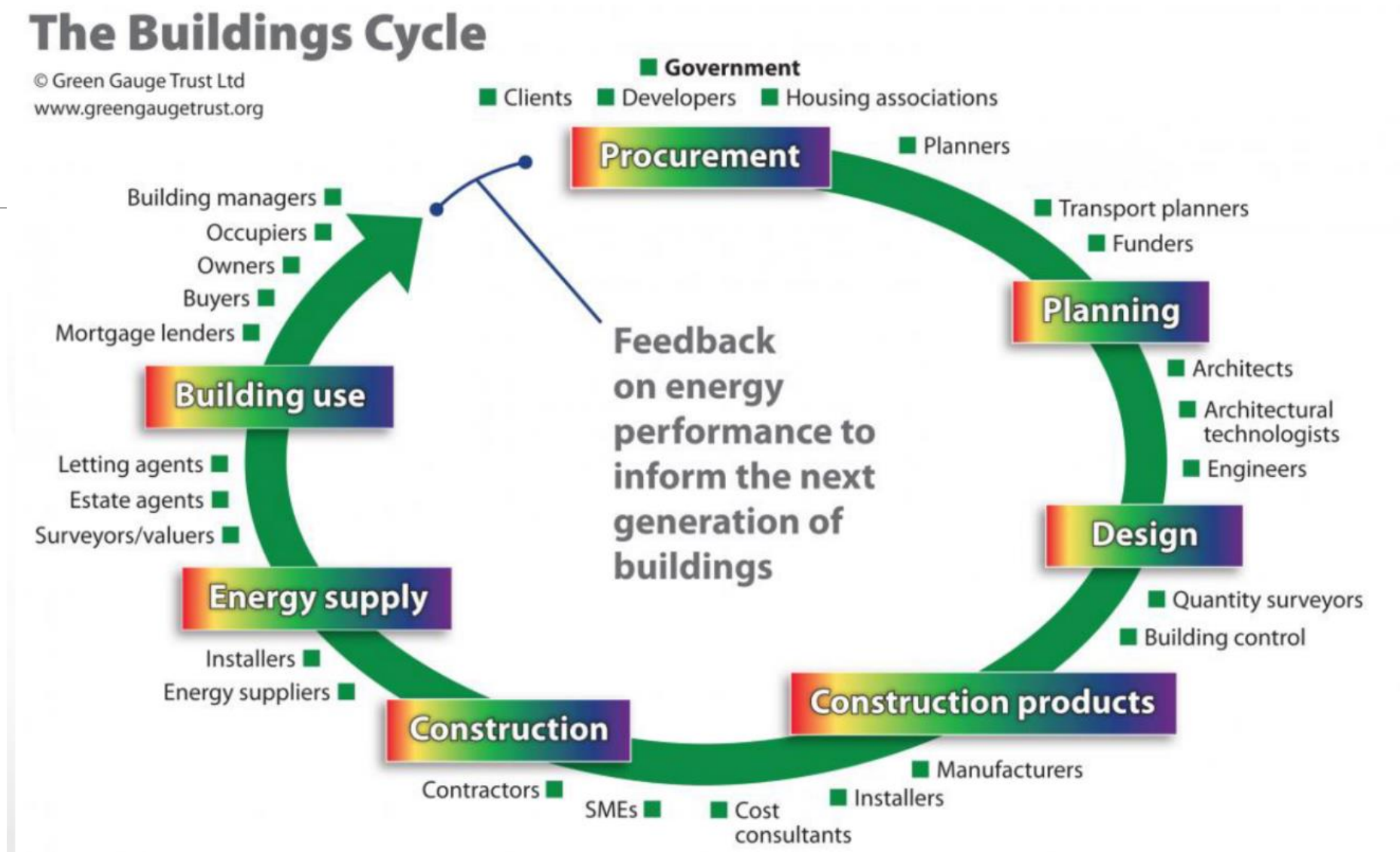
Use of salvaged Door and windows with frames as well as timber posts

Use of traditional construction know how & methodologies

Timber joinery knowledge in both the supporting and roof structures and home furniture

Traditional organic methodologies in timber preservation

Traditional knowledge and methodologies such as wattle and daub construction



The Buildings Cycle involves many players – all of whom have a role in delivering low energy low carbon

Barriers to Green initiatives

Lack of political as well as economic will

Lack of funds

Lack of infrastructure

Lack of knowledgeable personals

Geographical features and climatic conditions

Inhabitants either not being informed properly or not being able to understand

Green design tools

LEEDs guide lines and standards

Local government standards

Various publications and websites that promotes green architecture as well as ecologically responsible building materials

Various energy consumption and waste generation evaluation tools

Product brochures

Benefits of Green Architecture

Reduced building costs

Reduced living costs

Sustainable living standards

Improved health benefits and reduced health related expenses

Less waste and least or no environmental pollution through excessive waste buildups

Protection of traditional knowledge and culture

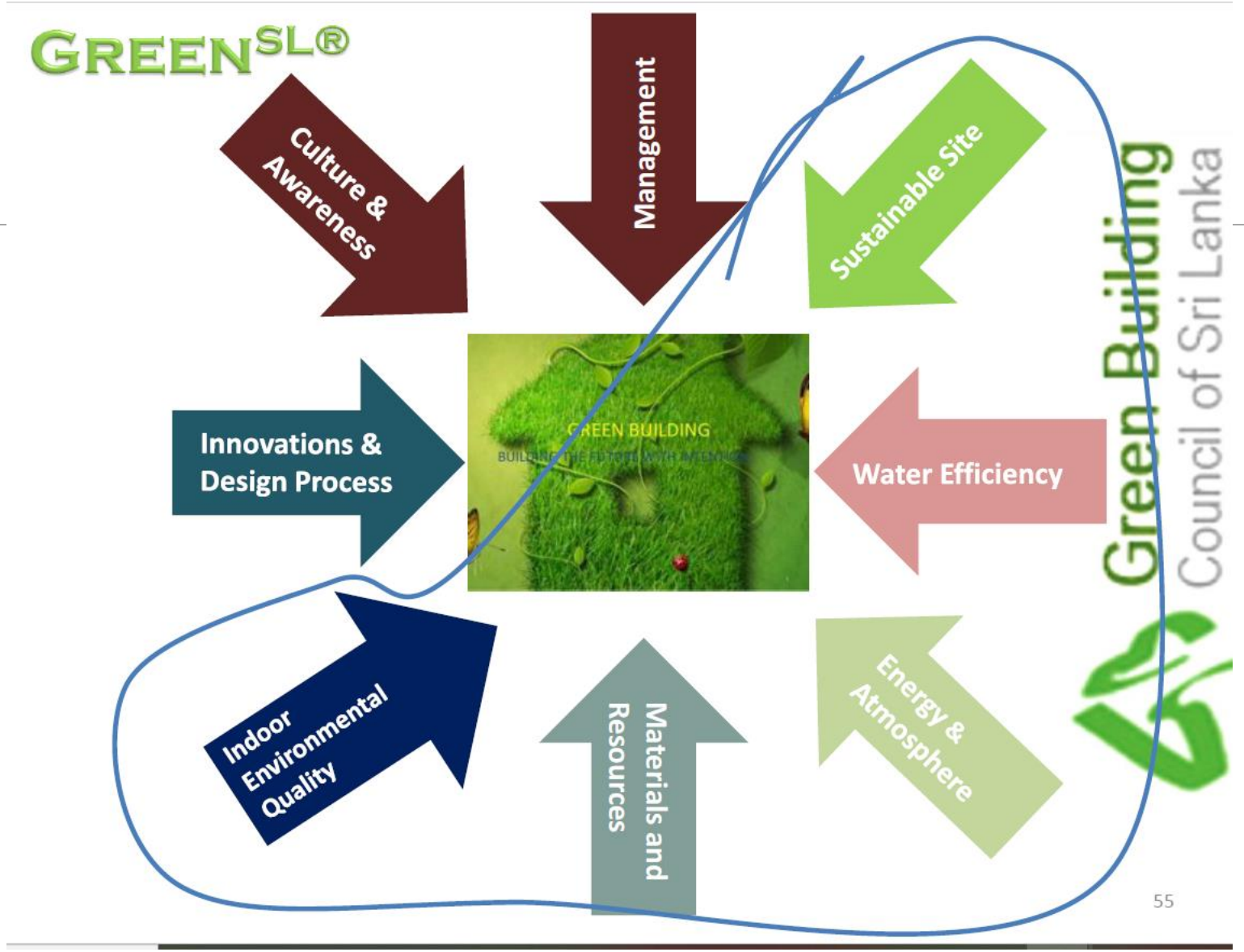
Reduced environmental damage

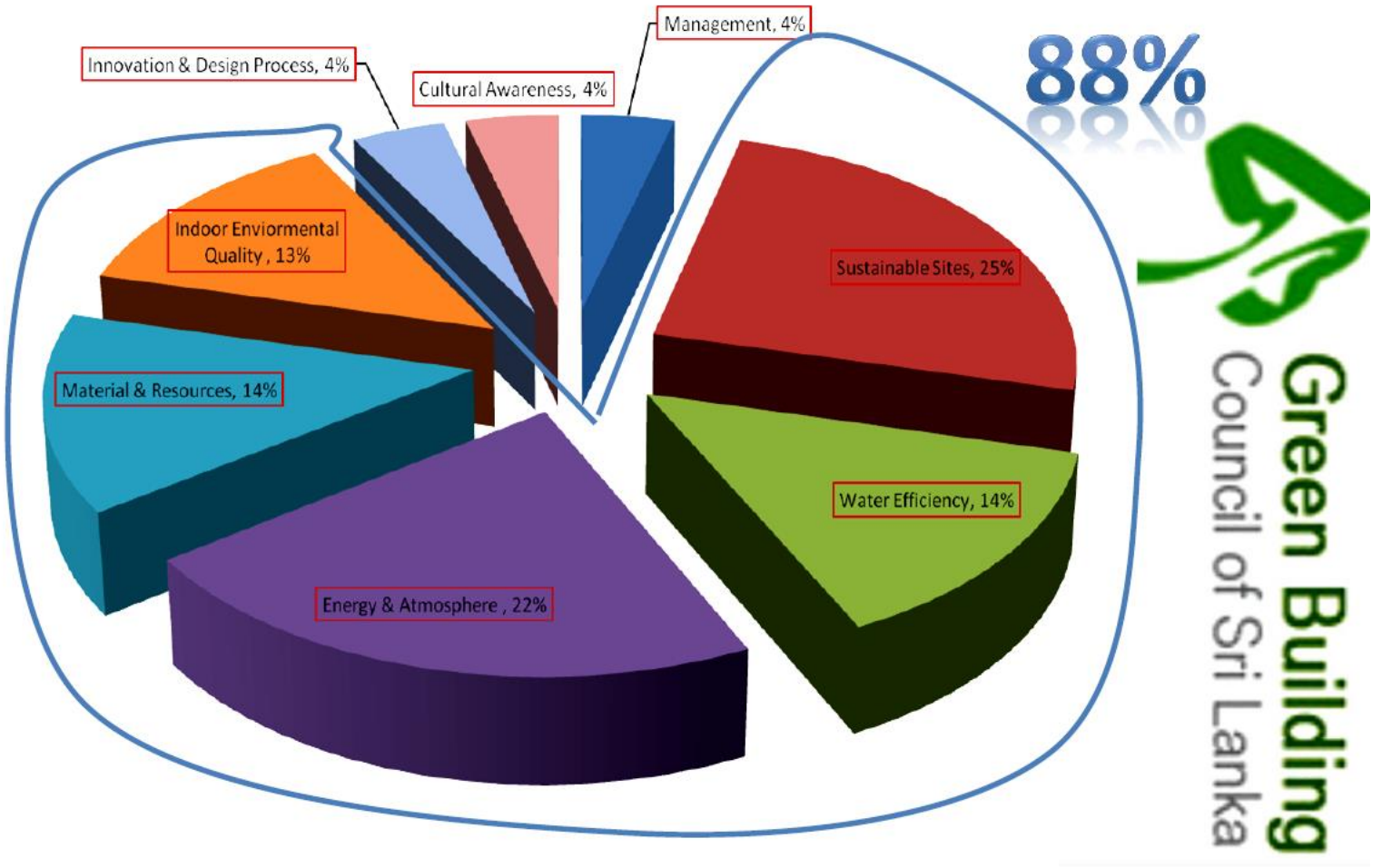
Reduction in carbon footprint

Green building certification

There are many programs available. Listed below are the most commonly used and respected ones

- **LEED** https://new.usgbc.org/leed
- **Green Globes** https://www.thegbi.org/green-globes-certification
- **ENERGY STAR** https://www.energystar.gov
- Living Building Challenge https://living-future.org/lbc/certification/
- NZEB https://living-future.org/net-zero
- Passive House http://www.phius.org/home-page
- SITES http://www.sustainablesites.org
- WELL Building Standards https://www.wellcertified.com/en/start-a-project
- Enterprise Green Communities https://www.enterprisecommunity.org/solutions-and-innovation/green-communities/certification
- There are several other international programs that won't be covered here but are worth a mention: BCA Green Mark (Singapore), Beam (Hong Kong), BREEAM (UK, EU EFTA member states, EU candidates, as well as the Persian Gulf), CASBEE (Japan), Green Star SA (South Africa), Pearl Rating System for Estidama (UAE).


GREENSL®
Culture & Awareness
Management
Sustainable Site
Innovations & Design Process
GREEN BUILDING
Water Efficiency
Indoor Environmental Quality
Materials and Resources
Energy & Atmosphere
Green Building
Council of Sri Lanka
55


Management, 4%
Innovation & Design Process, 4%
Cultural Awareness, 4%
Indoor Enviormental Quality , 13%
Sustainable Sites, 25%
Material & Resources, 14%
Water Efficiency, 14%
Energy & Atmosphere , 22%
88%
Green Building
Council of Sri Lanka

GREENSL® Project Certification

Green Building Council of Sri Lanka


GREEN[SL®] Rating System
For Built Environment
GREEN[SL®] RATING SYSTEM
FOR BUILT ENVIRONMENT
January 2015
Green Building Council Sri Lanka

Management (MN)

Sustainable Sites (SS)

Water Efficiency (WE)

Energy and Atmosphere (EA)

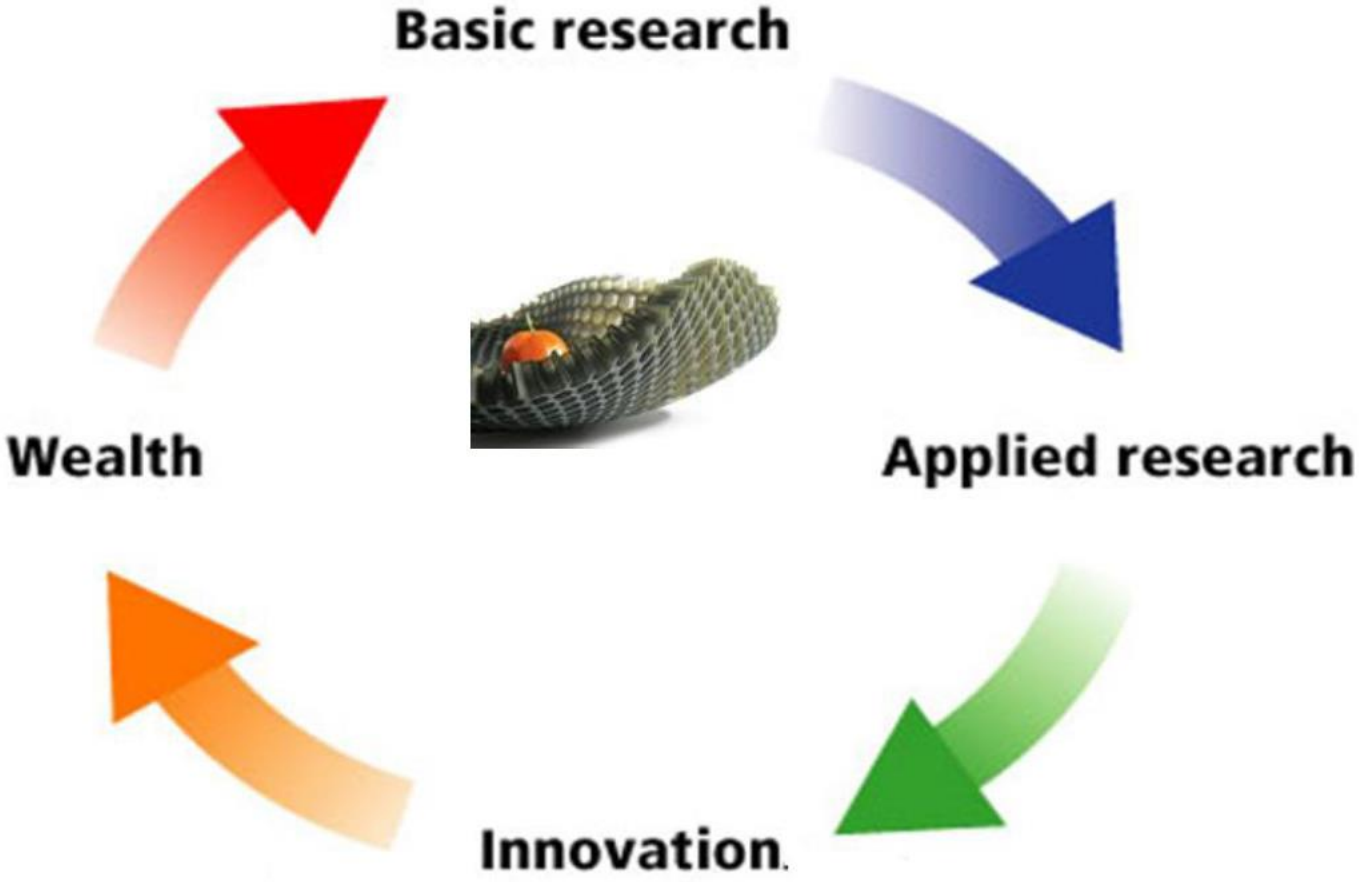
Materials and Resources (MR)

Indoor Environmental Quality (EQ)

Innovation and Design Process (ID)

Social and Cultural Awareness (SC)

Research : Green Innovative Economy (Green Innovation & Entrepreneurship)



Green city concept

GREENSL® Green City Certification

1.0 Management (4)
2.0 Cityscape & Spatial Structuring (13)
3.0 Preservation & Protection of Eco-systems (14)
4.0 Promoting Sustainability in Economic Development (8)

5.0 Provision of Sustainable Infrastructure (27)
6.0 Resource Management (8)
7.0 Provision of Social Infrastructure (4)

8.0 Provision of Cultural Integration (6)
9.0 Global Impact on Local Initiatives (6)
10.0 Innovation in Sustainability & Resilience (10)
11.0 Management & Monitoring of The Transformation of City Profile (4)

GREENSL® Green City Certification

Green Building Council of Sri Lanka

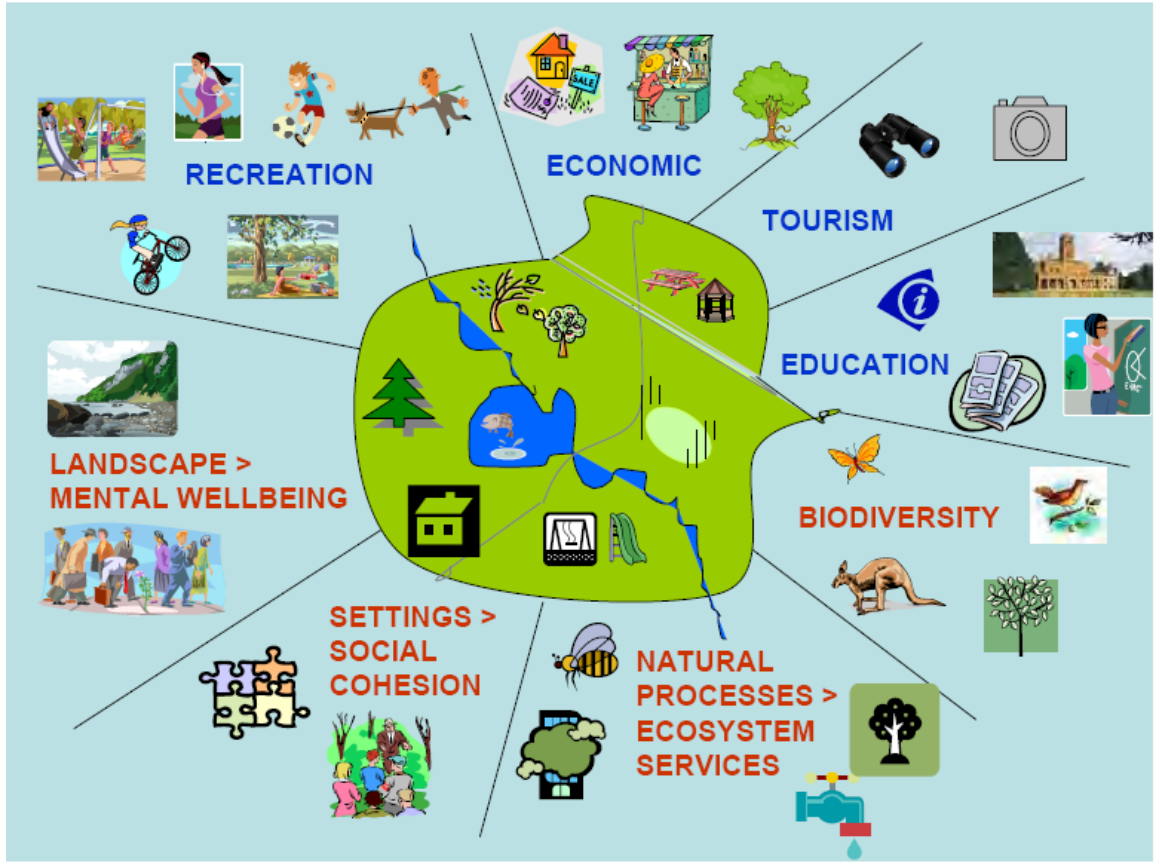
Disaster Risk Reduction


SUSTAINABLE DEVELOPMENT GOALS
17 GOALS TO TRANSFORM OUR WORLD
WORLD GREEN BUILDING COUNCIL
SUSTAINABLE DEVELOPMENT GOALS
Green buildings can improve people's health & wellbeing
Green buildings can use renewable energy, becoming cheaper to run
Building green infrastructure creates jobs & boosts the economy
Green building design can spur innovation & contribute to climate resilient infrastructure
Green buildings are the fabric of sustainable communities & cities
Green buildings use 'circular' principles, where resources aren't wasted
Green buildings produce fewer emissions, helping to combat climate change
Green buildings can improve biodiversity, save water resources & help to protect forests
Through building green we create strong, global partnerships
3 GOOD HEALTH AND WELL-BEING
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
15 LIFE ON LAND
17 PARTNERSHIPS FOR THE GOALS

These four goals are:

- Reduce building energy consumption
- Decarbonize buildings by eliminating the use of on-site fossil fuels
- Encourage renewable energy generation
- Work to decarbonize the electric grid

A new paradigm for the built environment



A paradigm needs to occur between the built and natural environments. This includes rethinking what we build, how we build it, and if it is even necessary in the first place

The urban built environment is responsible for 75% of annual global GHG emissions: buildings alone account for 39%. Eliminating these emissions is the key to addressing climate change and meeting Paris Climate Agreement targets.

In order to heal our planet in the twenty-first century, we need to build less, conserve more, and regreen our existing “gray” infrastructure

https://www.youtube.com/watch?v=-dvFb2vC7_Y