

Introduction to Sustainable Architecture

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1. What Is Sustainable Architecture?

- **Definition:** Design and construction of buildings that minimize environmental impact, promote resource efficiency, and enhance occupant well-being throughout the building's life cycle.
- **Key Goals**
 - Reduce energy and water consumption
 - Lower greenhouse gas emissions
 - Use renewable and locally sourced materials
 - Create healthy, comfortable indoor environments
 - Ensure economic viability and social equity

2. Core Principles

Principle	Description	Typical Strategies
Site Responsiveness	Align the building with its natural context.	Passive solar orientation, preserving existing vegetation, using topography for natural ventilation.
Energy Efficiency	Minimize energy demand and source it renewably.	High-performance insulation, triple-glazed windows, LED lighting, building-integrated photovoltaics (BIPV), heat-recovery ventilation.
Water Conservation	Reduce potable water use and manage stormwater.	Low-flow fixtures, rainwater harvesting, grey-water recycling, permeable paving.
Material Stewardship	Choose materials with low embodied carbon and high durability.	Recycled steel, reclaimed wood, low-VOC finishes, timber from certified forests, modular prefabrication.
Indoor Environmental Quality (IEQ)	Provide healthy, comfortable spaces.	Daylighting, operable windows, non-toxic finishes, acoustic control, ergonomic layouts.

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Principle	Description	Typical Strategies
Lifecycle Thinking	Consider impacts from design to demolition.	Design for adaptability, deconstruction, material reuse, life-cycle assessment (LCA).
Community & Cultural Integration	Respect local culture and promote social equity.	Community participation, affordable housing, public spaces, use of local craftsmanship.

3. Design Process Overview

1. Site Analysis

- Climate data (temperature, solar angles, wind patterns)
- Topography, vegetation, water bodies
- Local infrastructure and transportation

2. Goal Setting & Metrics

- Set performance targets (e.g., Net-Zero Energy, 30% water reduction)
- Choose certification framework (LEED, BREEAM, Passive House, WELL)

3. Concept Development

- Massing that maximizes daylight and natural ventilation
- Orientation for passive heating/cooling

4. Simulation & Modeling

- Energy modeling (e.g., EnergyPlus, IES VE)
- Daylighting analysis (Radiance, DIVA)
- Thermal comfort (PMV/PPD)

5. Material & Systems Selection

- Compare embodied carbon of structural options
- Select HVAC, renewable energy, and water systems

6. Detailed Design & Documentation

- Integrated design documents (BIM with sustainability data)

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- Construction sequencing to minimize waste

7. Construction & Commissioning

- On-site waste management plan
- Performance testing (blower door, IAQ monitoring)

8. Operation & Post-Occupancy

- Ongoing monitoring (energy dashboards)
 - Maintenance plan for longevity
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4. Key Performance Metrics

- **Energy Use Intensity (EUI)** – kWh/m²·yr
- **Carbon Footprint** – kg CO₂eq/m²·yr (operational & embodied)
- **Water Use Intensity (WUI)** – L/m²·yr
- **Indoor Air Quality (IAQ)** – CO₂ levels, VOC concentrations
- **Thermal Comfort** – PMV (Predicted Mean