PART 2 - Introduction to Green Building and Sustainability

Sustainability can be defined as the ability to meet the needs of the present without compromising the ability of future generations to meet their own needs.

Green building is the practice of creating structures and using processes that are environmentally responsible and resource efficient throughout a building's *life cycle*. That life cycle respectfully analyzes and integrates site selection through design, construction, operation, maintenance, renovation and deconstruction. The practice expands and also complements the classical building design concerns of economy, utility, durability, and comfort.

In the natural cycle, there is not any waste.

GREEN BUILDING

GLOBAL WARMING

ENERGY PRICES

BIM
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LEED
Leadership in Energy and Environmental Design

Impacts of built environments

Commercial construction requires the greatest quantity of resources in the building industry. The impacts from buildings in the United States include:

- 72% of electricity consumption
- 39% of energy use
- **38% of all carbon dioxide (CO_2) emissions**
- 40% of raw materials use
- 30% of waste output
- 14% of potable water consumption

The **built environment** is the human-made surroundings that provide the setting for human activity. The built environment contributes **67%** of all greenhouse gas emissions.

Green buildings have:

- 26% energy use reduction
- **27% higher levels of occupant satisfaction**
- 13% lower maintenance costs
- 33% lower carbon dioxide emissions

Benefits of green buildings

Green buildings are specifically designed structures that reduce the overall negative impact of the built environment on human health and the natural environment by:

- Efficiently using energy, water, land, and materials
- Protecting occupant health and improving employee productivity
- Reducing waste and pollution from each green building
- Continuously looking for ways to improve performance

Net-zero energy use
Water balance
Carbon neutrality

→ **Regenerative design**

↓ **Sustainable design**

The Triple Bottom Line

The **key indicator** of true sustainability is the *triple bottom line*.

The bottom line indicates how much money the business/project/investment made.

- Can I hire this prospective employee? How much is it going to cost, and how much money can the employee save the business or add to the business?
- Should we buy this equipment? How much does the equipment cost, and how much can it save the company, or how much new revenue can it generate?

The same decisions are made in development, design, and construction.

- Is this project going to make us money?
- Will we break even, or will we lose money?
- What’s our profit margin going to be?

The Triple Bottom Line

When we think about sustainability we need to look beyond the traditional bottom line.

True sustainability has three key aspects:

1. Economics
2. Environment
3. Social responsibility

These aspects make up the *triple bottom line*. A social or ecological externality is an effect of building that may not be considered in the cost of the project.

Economics -- Economic bottom line of a company that produces a long-term, positive economic impact.

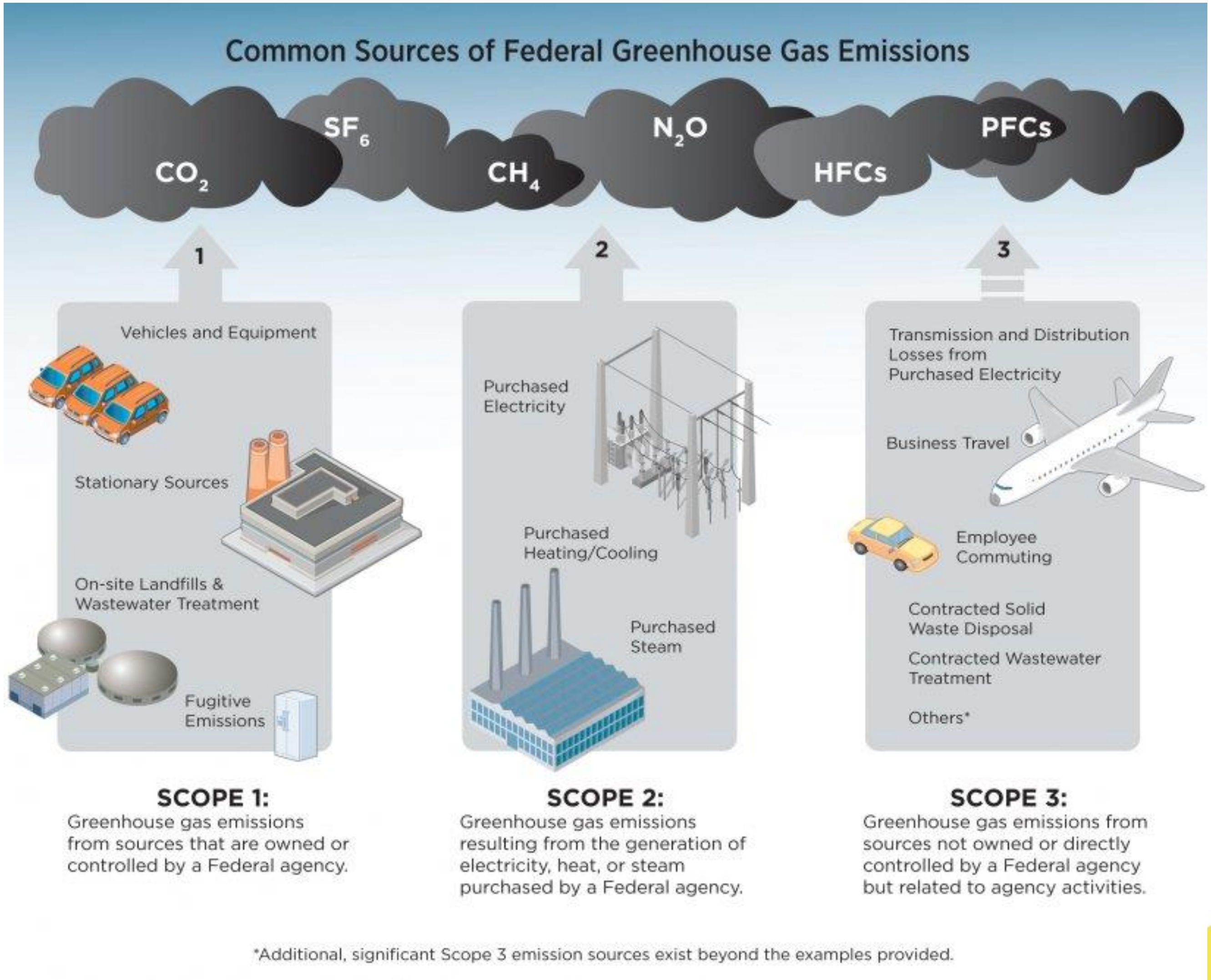
Environment -- Sustainable environmental practices. Organizations should endeavor to benefit the planet as much as possible and consider negative externalities to the environment

Social Responsibility -- Improving the lives of those with whom the building interacts. The well- being of a building’s workers, occupants, community members, neighbors, and other stakeholder interests should be interdependent.

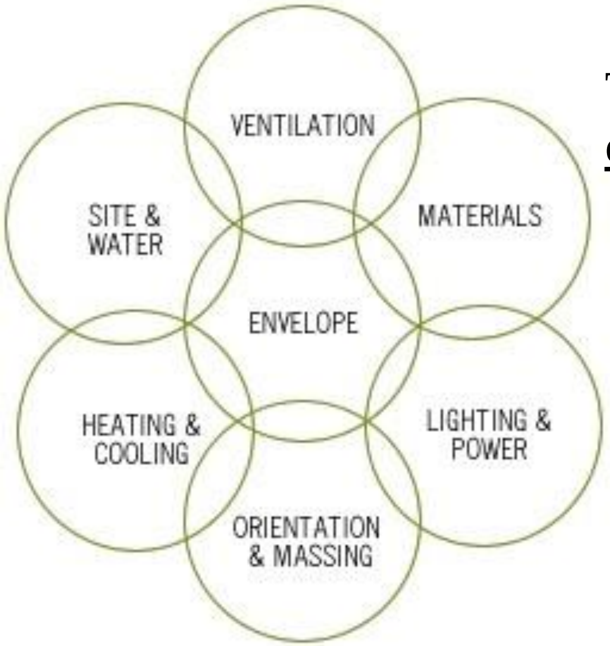
The Triple Bottom Line

Consider the use of *light bulbs* in a building. Looking at just the bottom line for construction, a builder installs conventional and dim light bulbs to maximize the upfront profits of the building. Conventional light bulbs are cheap. When looking at the triple bottom line, however, what sustainable strategy should this builder use to address economic growth, the environment, and social responsibility over the life of the building? The builder should consider the use of brighter, compact florescent light bulbs (CFLs) or LEDs that use a fraction of the energy (but do have higher upfront costs).

Greenhouse gas emissions



Sustainable thinking



To achieve the many benefits of green building, **whole building design** was developed (e.g. insulation level, waterproof membrane)

There are **three major concepts** integral to both green buildings and sustainability that are not part of the conventional building process:

- Systems thinking
- Life-cycle thinking
- Integrated process

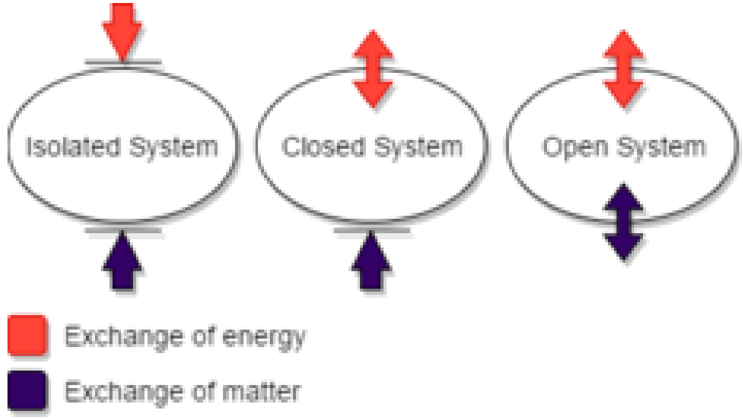
Systems Thinking

In a sense a series of small systems are connected to become a more complex system in which the parts all affect each other.

Open Systems - An open system is a system that constantly takes in items from outside the system, uses them and then released them as waste (e.g. building or city).

Closed Systems - A set of actions/materials with a closed loop. For example, plants growing in a field, grow, produce oxygen, take in water, then die and decay which helps plants grow, or water cycle.

Emergent properties are characteristics of a system that only happen when the system is working and are not a result of the smaller subsystems.



Systems Thinking

Positive Feedback Loop – a system where energy is taken from the output of a system and reapplied to the input, or A produces B which in turn produces more of A (i.e. population growth or interest-earning savings account).

Negative Feedback Loop - a system where the output may signal the system to stop changing, i.e. a thermostat - at a certain point the temperature feedback will tell the system to cut off.

Prius effect – users can respond something only if they have real-time information about it.

Leverage Points - leverage points are a point in a system where a small change can lead to large changes in results. This means small actions that can be free, or a small cost might mean large savings or improvements on a project (a construction site close to a river).

Life-cycle approach

Green buildings need a life-cycle approach, and project teams should always look at the big picture by evaluating *all phases of the project* together rather than merely looking at the snapshots. A life cycle of a building covers from location selection to renovation or demolition (e.g. wood-flooring product).

The practice investigating materials from their extraction to their disposal is called **cradle-to-grave approach**. Differently, **cradle-to-cradle approach** aims to extend the product lifecycle to avoid waste through recycling or reusing.

The total energy consumed in all stages (from extraction to disposal) is called **embodied energy**. The more embodied energy a product contains, the more it will result in damage to the environment (e.g. marble).

A **life-cycle assessment (LCA)**, evaluates all the environmental impacts of a given product or service caused or necessitated by its existence during its whole lifetime.

A **life cycle cost (LCC)** includes the purchase price, installation cost, operating costs, maintenance and upgrade costs, and remaining (residual or salvage) value at the end of ownership or its useful life (e.g. refrigeration system).

Integrated Process

In the integrated system, there is a flow of information and collaboration between each member for each phase of the project.

In the **conventional building process** (or design-bid-build), project teams work in isolation and collaborate when problems occurs:

- Design
- Construction plans
- Bidding process
- Construction
- Commissioning and turnover
- Occupancy

The outcome of this process will usually be construction delays and extra project costs (e.g. general contractor was not involved in the design phase).

Integrated Process

The project phases of an **integrated process** are different than the conventional process:

- **Pre-Design** (starting from the project location)
- Design
- Construction plans
- Bidding process
- Construction
- Commission the building
- Occupancy and Recommissioning
- Building end of life reuse or demolition/recycle

The key in the integrated process is to integrate the *whole* project team early. Taking actions late in the process will only result in delays and additional costs.

Project location should assist the project teams rather than creating challenges. Understanding the whole community is essential for successful project integration (single-occupancy vehicles, climate, soil type, underground water, laws, etc.).

Integrated Process

The project phases of an **integrated process** are different than the conventional process:

- **Pre-Design** (starting from the project location)
- Design

Main principles of the integrated process

An integrated process is an approach that integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insights of all participants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication, construction, and ongoing operations.

An *iterative* process need to be developed.

Project location should assist the project teams rather than creating challanges. Understanding the whole community is essential for successful project integration (single-occupancy vehicles, climate, soil type, underground water, laws, etc.).

Iterative process

An iterative process exists that contains lots of feedback loops in order to establish a working system.

Following is a list of stages for the *iterative process*:

- Establish clear goals
- Brainstorm and develop creative and effective solutions
- Research and refine ideas
- Explore synergies between different strategies
- Establish metrics to measure success
- Set new goals based on the work that has been done

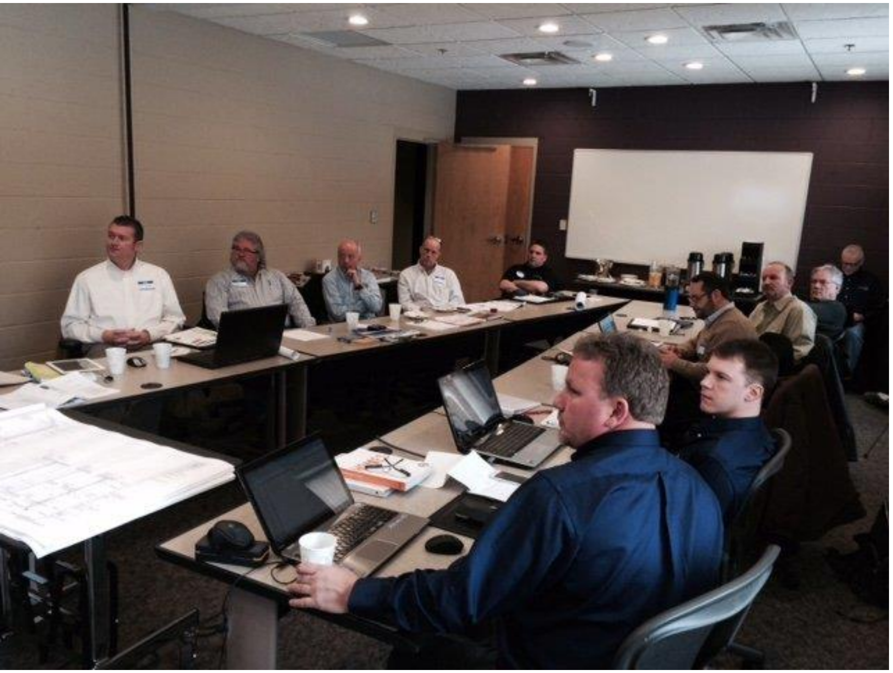
This approach is unlike the conventional building approach (*linear approach*).

To establish an integrative process, it is useful to conduct different *types of meetings*. Such meetings would include:

- Charrettes (all team members, facility manager and stakeholders, project goals)
- Team meetings (different disciplines work collaboratively, e.g. the envelope)
- Small task groups (inside each disciplines)
- Stakeholder meetings (community needs)

Iterative process

The LEED process begins with holding a Charrette.



Anyone involved with the construction or use of the building is a candidate for participation.

The *outcome* of the Charrette should include a first draft of the LEED scorecard, a preliminary rating, and defining the roles of each member of the project team.

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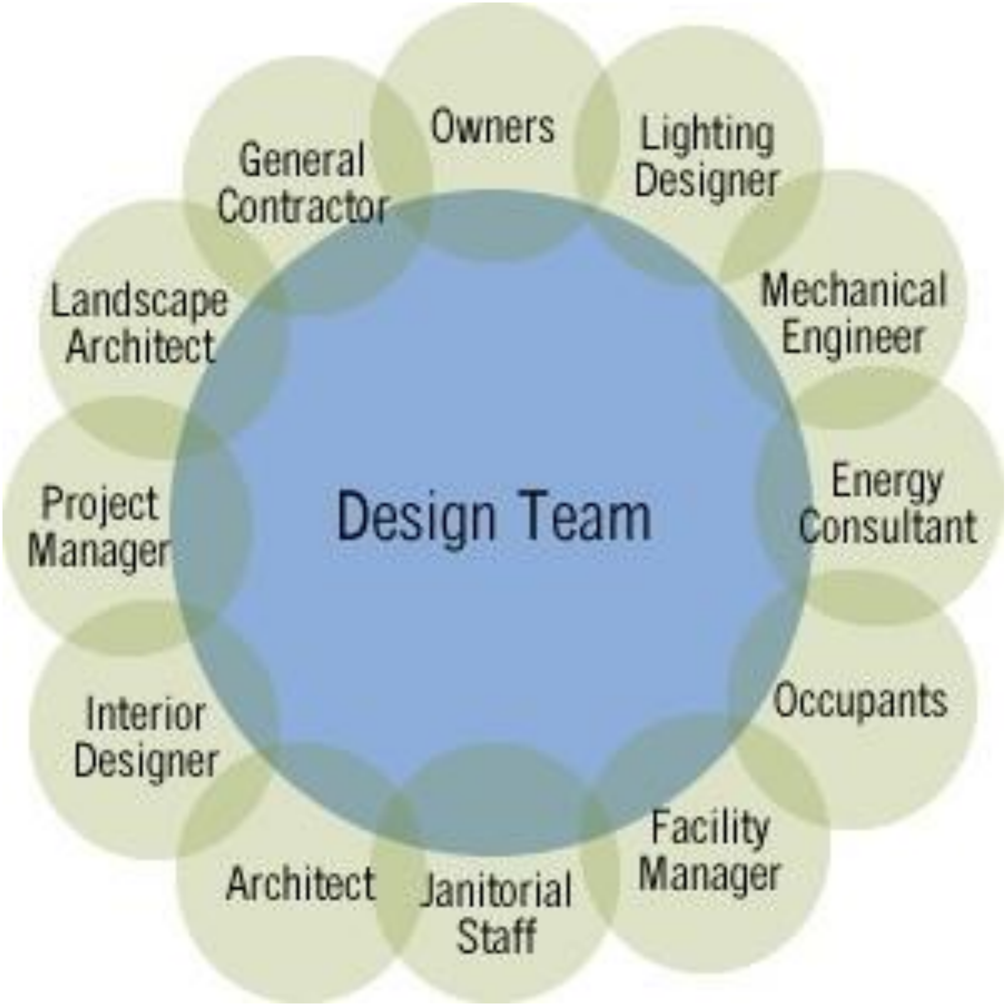
Integrative Process Compared to Traditional Project Delivery

	Traditional Project Delivery	**Integrative Process**
Teams	Hierarchical, working independently only as needed	Collaborative, integrative, assembled as early as possible before any designing
Process/Schedule	Linear, working in silos	Concurrent; shared information, *iterative*
Risk	Individual risk	Shared equally
Compensation	Individually based	Based on team success
Communication	Paper based	Digital and virtual; use of computer models
Materials/Strategies	Least expensive to meet code	Life cycle analysis, life cycle costing
Project phases	Design – occupancy	Predesign phase; green building goals are reviewed at every phase

Team selection



With integrated project delivery, alle the stakeholders, design teams, and constructions teams, who really make up the whole project team, work collaboratively from the beginning of the project. This approach is called *design-build*.

Team members with green building knowledge and experience will make a big impact on result.

LEED credentials:

- LEED Green Associate
- LEED AP

LEED Project Administrator

USGBC

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Bio | Courses | Articles

Stefano Cascone graduated from the High School "Principe Umberto di Savoia", in Catania, in 2010, with 100/100 and graduated in Building Engineering and Architecture at the University of Catania, in 2015, with 110/110 cum laude. In December 2019, he received a Ph.D in "Assessment and mitigation of urban and

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Evaluation and selection of strategies and technologies

BIM → Energy simulation

Implementation

Some of the main factors that should not be overlooked during construction are:

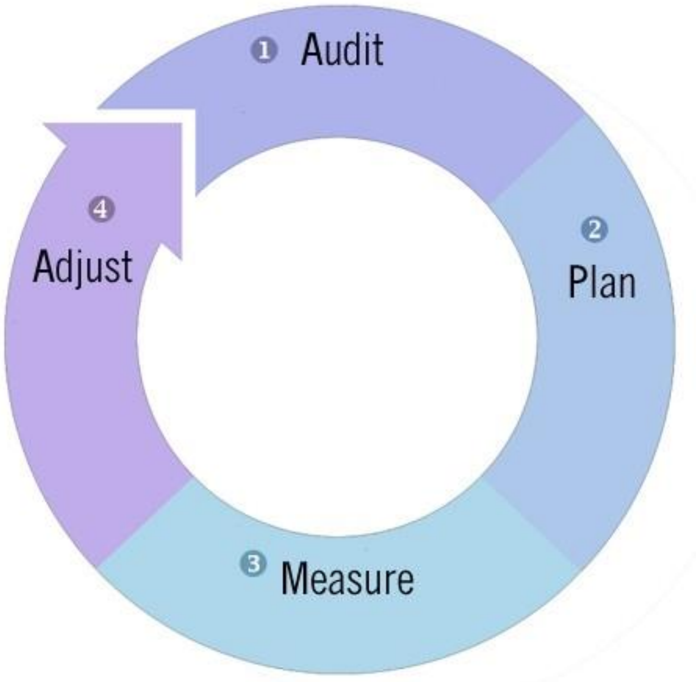
- Erosion and sedimentation control (ESC) plan
- Indoor air quality management plan
- Waste management plan

The costs during the construction phase will be classified either as *soft costs* or *hard costs*.

Even if construction is completed, the integrative process should continue throughout the whole lifetime of a buildings.

Ongoing Operations and Maintenance

The ongoing operations and maintenance of a high-performance building is a *continuous process* that needs to follow a plan that identifies and corrects building system problems to maintain peak building performance over time. This process is a continuous cycle of planning, auditing, measuring, analyzing, and correcting.



The key to understanding whether the building is performing sustainably is to track and evaluate **data** that the building systems provide.

Education and *training* and continuous *feedback* from the building personnel and users are needed to discover potentials for improvements.

Phases of the integrated process

The whole integrated process can be summarized by three main phases:

- **Discovery phase**: predesign, green goals, triple bottom line, participant collaboration, project location, level of certification, LCA, LCC, BIM

- **Design and construction phase**: charrettes, team meetings, small task groups, stakeholders meetings, actions to protect health and environment, green goals into reality, LEED documentation, orientation and training

- **Occupancy, operations, and performance feedback phase**: performance check, data monitoring and evaluation, orientation and training, continuous feedback