

Introduction to Standards Related to Building Life Cycle & Sustainability

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Lecture Objectives:

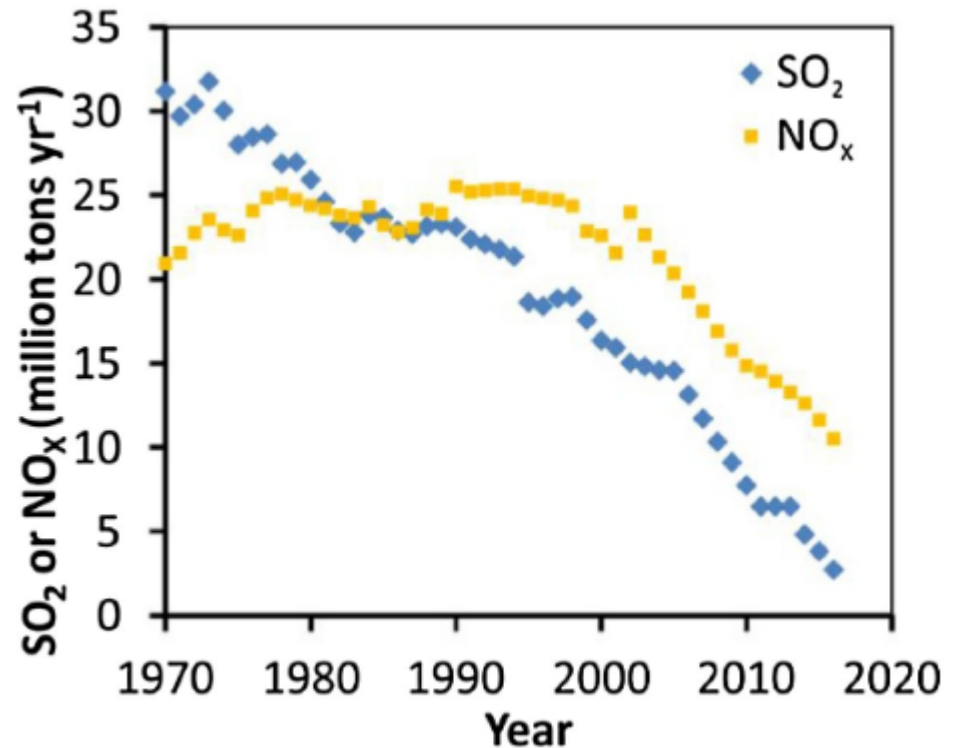
1. Introduce the concept of sustainable development
2. Consider the life cycle of a building
3. Provide a overview of green building standards



- Talley Student Union, NC State University
 - LEED Silver: design and construction
 - LEED Gold: operations and maintenance



Introduction and Historical Perspective:



SO₂ – sulfur dioxide
 NO_x – nitrogen oxides

*<https://www.birdnote.org/show/50th-anniversary-silent-spring>

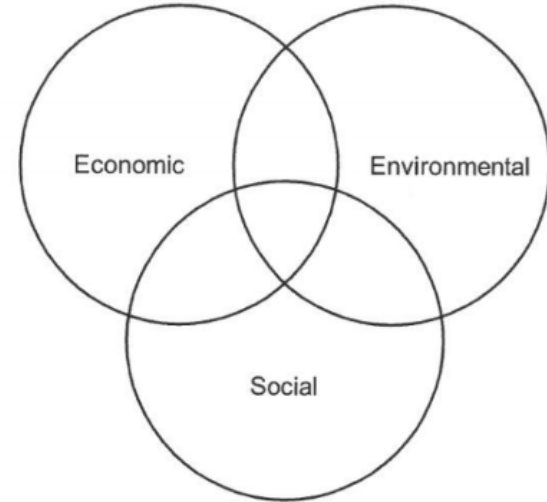
*Sullivan et al. (2018). Air pollution success stories in the United States: the value of long-term observations. Environ Sci Policy. 84: 69-73.



Defining Sustainability:

“Meeting the needs of the present without compromising the ability of future generations to meet their own needs.”

- Our Common Future (Brundtland Report), 1987



39% of CO₂ emissions

40% of energy consumption

13% of water consumption

*ASTM International. 2017. E2432: Standard Guide for General Principles of Sustainability Related to Buildings. West Conshohocken, PA. 6 p.

*ISO 15392 – 2008. Sustainability in Building Construction – General Principles

*ANSI/ASHRAE/USGBC/IES 189.1 – 2009. Standard for the Design of High-Performance Green Buildings

Codes, Standards, and Certifications:

Code:

Provides the minimum requirements for a building's design and construction to ensure public safety and structural performance

- Example: The *International Building Code* (IBC)

Standard:

Provides the technical definitions, procedures, and guidelines that specify the minimum requirements for manufacturing or using a product

- Example: *ASTM D5456: Standard Specification for Evaluation of Structural Composite Lumber Products*

Certification:

Having an accredited third-party organization ensure your product or process conforms to criteria specified in a regulation or standard

- Example: Engineered Wood Association (APA)



Green Building Standards:



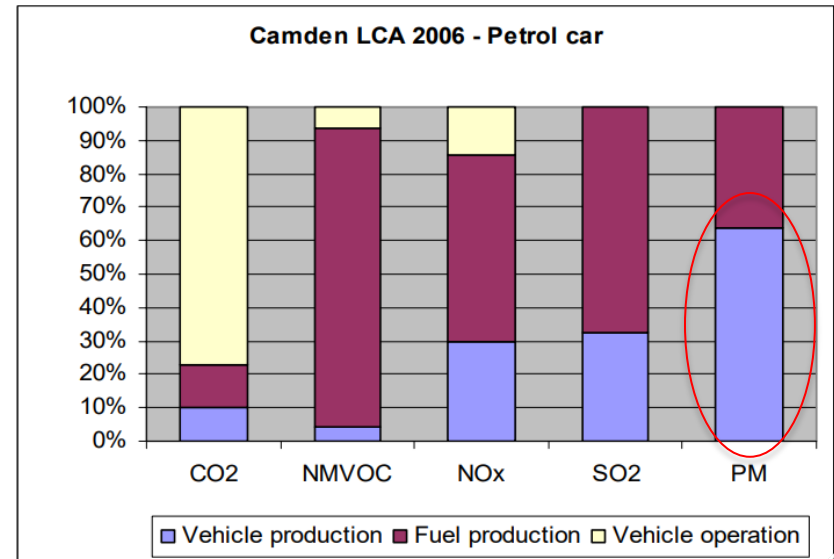
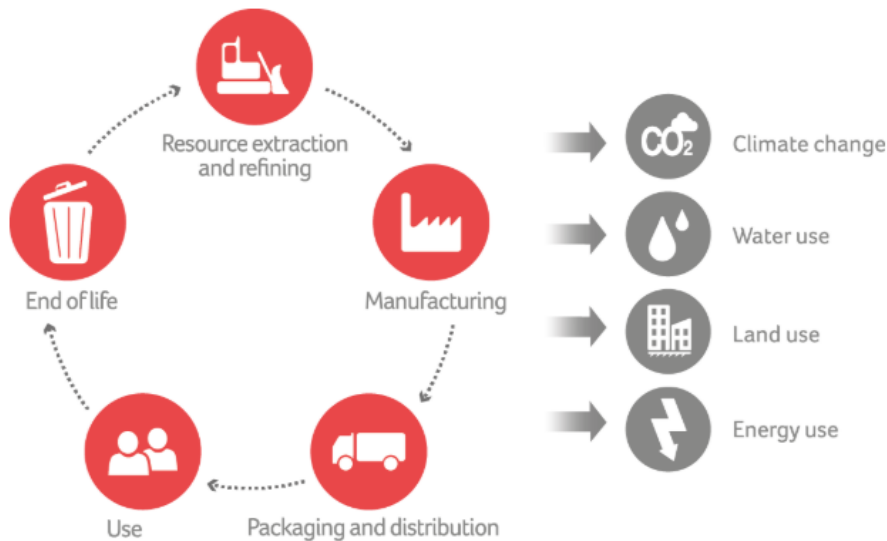
- Net zero energy use
- Closed loop water systems
- Access to fresh air and daylight
- Indoor air quality
- Red List materials (lead, mercury, etc...)
- Using local construction materials
- Material conservation management plan
- Human scaled vs. automobile scaled places
- Raising construction capital through equitable investment
- Incorporate design features based on beauty
- Provide educational materials to the public about the building's operation



Life Cycle Assessment:

Life Cycle Assessment (LCA):

- International Organization for Standardization (ISO): 14040
- Quantifies the inputs and outputs of a product or process throughout life cycle stages
- Assesses the impact of a product or service on a number of impact categories:
 - Climate change, ozone depletion, acidification, resource scarcity, etc.



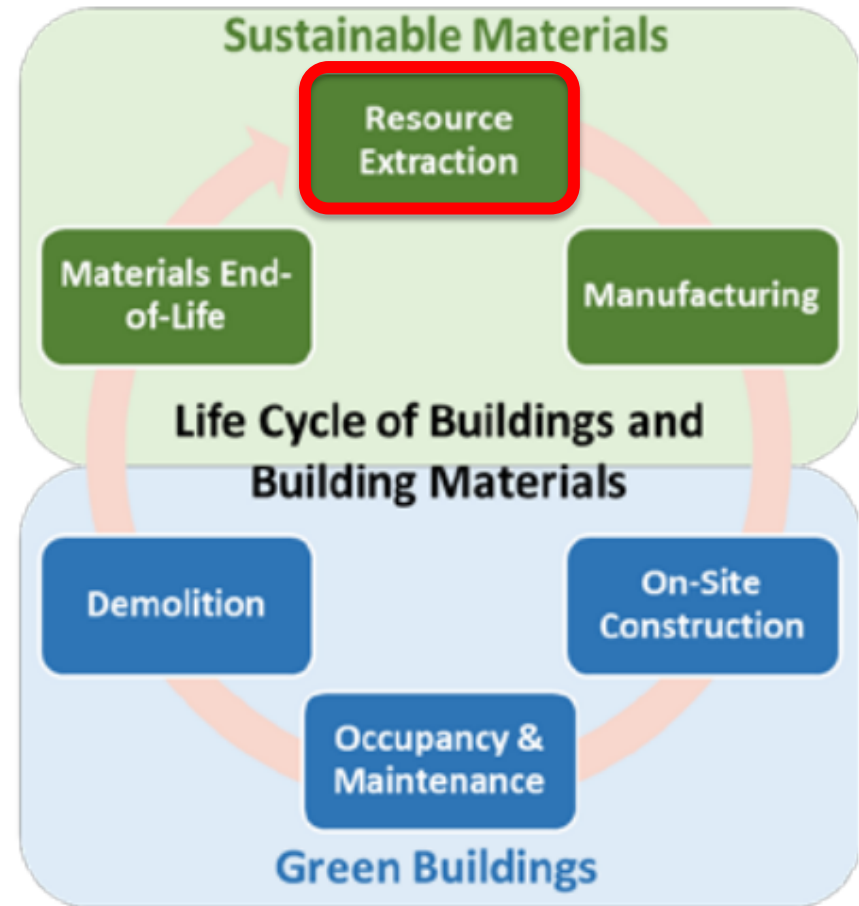
*<https://www.ecoinvent.org>

*Lane. 2006. Life cycle assessment of vehicle fuels and technologies. Report on Behalf of London Borough of Camden, Ecolane Transport Consultancy.

Life Cycle Stages of a Building:

Life cycle stages (ASTM* E2432):

- Raw material extraction
- Product manufacturing
- Transportation Siting
- Construction
- Use and maintenance
- End of initial service
- Renovation
- Demolition
- Disposal



*ASTM – American Society for Testing and Materials

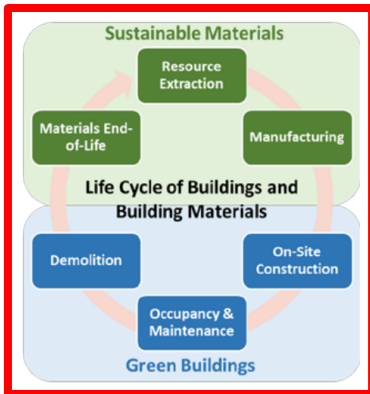


Life-cycle Standards:

- ASTM E2432 – Principles of sustainability relative to buildings
- ASTM E3027 – Making sustainability related chemical selections
- ISO 14040 – Life cycle assessment: principles and framework
- Living Building Challenge v3.1
- ICC*/ASHRAE* 700 – National Green Building Standard:

Table 303
Threshold Point Ratings for Green Buildings

Green Building Categories			Rating Level Points			
			BRONZE	SILVER	GOLD	EMERALD
1.	Chapter 5	Lot Design, Preparation, and Development	50	64	93	121
2.	Chapter 6	Resource Efficiency	43	59	89	119
3.	Chapter 7	Energy Efficiency	30	45	60	70
4.	Chapter 8	Water Efficiency	25	39	67	92
5.	Chapter 9	Indoor Environmental Quality	25	42	69	97
6.	Chapter 10	Operation, Maintenance, and Building Owner Education	8	10	11	12
7.		Additional Points from Any Category	50	75	100	100
Total Points:			231	334	489	611



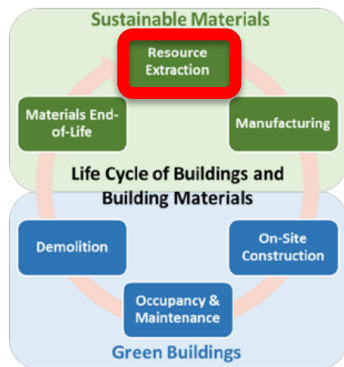
*ICC – International Code Council

*ASHRAE – American Society of Heating, Refrigerating and Air-Conditioning Engineers



Resource Extraction Standards:

- State laws
 - Ex: Oregon Department of Forestry, Administrative Rule 629
 - State of West Virginia Mining Laws, Rules, & Regulations (2007 reference manual)
- Third party verification

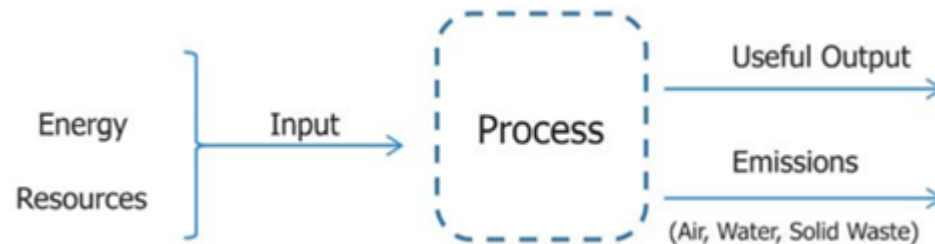
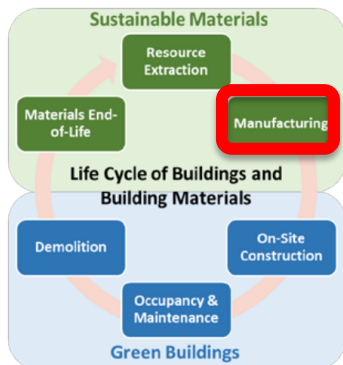


Goals:

- Long term sustainable growth and yields
- Protect riparian zones and biological diversity
- Minimize waste from harvesting
- Ensure forestry practices comply with federal, state, and local laws

Manufacturing Standards:

- ASTM
 - E2986 – Evaluation of environmental aspects of sustainability of manufacturing processes
 - E2987 – Standard terminology for sustainable manufacturing
 - E3096 – Key performance indicators for sustainable manufacturing
- NSF/ANSI 140, 332, 336, 342, 347, 373
 - Sustainability assessments for carpet, flooring, furnishing fabric, wall coverings, roofing products, and dimension stone
- Product Category Rules – Assist in making sustainability assertions for different products that serve a similar function



*NSF – National Sanitation Foundation

*ANSI – American National Standards Institute



Construction Standards:

- ISO 15392 – General principles of sustainability in building construction
- ANSI 189.1 – Design of high-performance green buildings
- LEED v4 – Building design and construction
- IES DG-22 – Design guide for sustainable lighting
- AIA Prescription for Healthier Building Materials
- ASTM E2129 – Data collection for sustainability assessment of building products

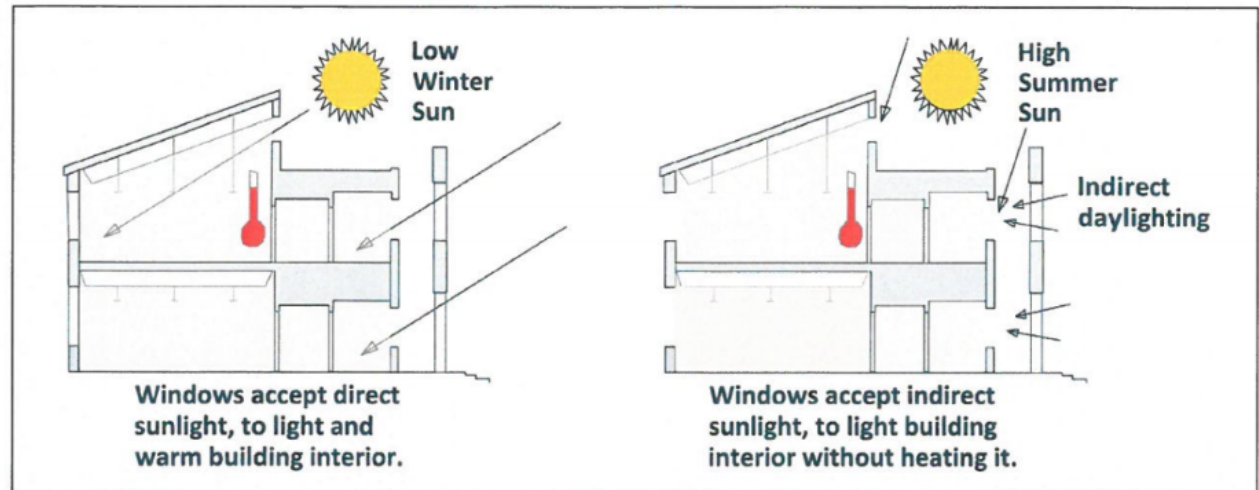
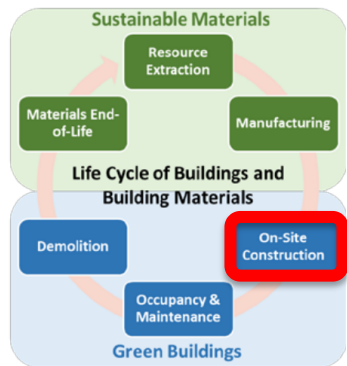
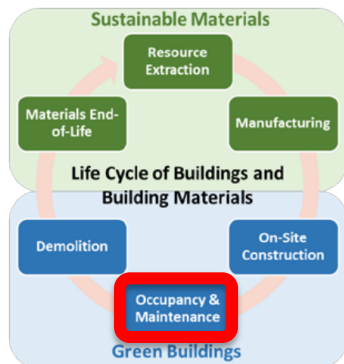


Figure 3 - South facing building fenestration and shade design with passive solar benefit.



Operation/Maintenance Standards:

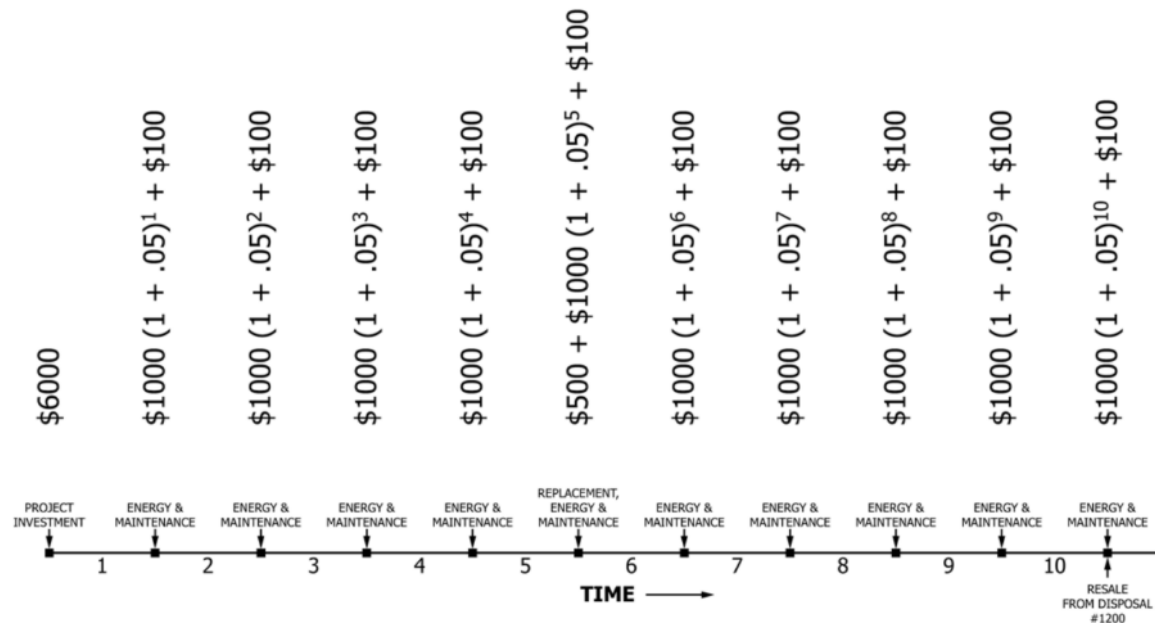
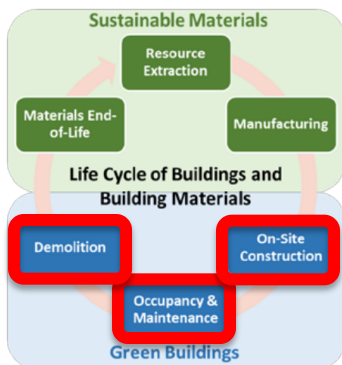
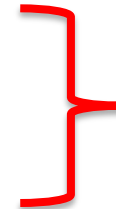
- LEED v4 – Building operation and maintenance
 - Example: clothes washer must have an energy star or performance equivalent rating
- Life cycle costing (LCC):
 - ASTM A1068 – LCC of corrosion protection system on iron/steel products
 - ASTM A930 – LCC of corrugated metal pipe for buried conduits
 - ASTM C1131 – LCC of concrete culvert and sewer systems
 - ASTM F1675 – LCC of plastic pipe for buried conduits
 - ASTM F2687 – LCC of food service equipment



Life Cycle Cost Analysis Summary								
Project Title	Dave's Kitchen							
Supplier	Energy Star							
Equipment Name	High Efficiency Gas Fryer							
Model Number	HEG-1							
	Year	0	1	2	3	4	5	Total
Initial Cost								
1 Purchase Price		\$ 3,500						\$ 3,500
2 Accessory Price		\$ 300						\$ 300
3 Taxes		\$ 228						\$ 228
4 Rebates/Incentives		\$ (500)						\$ (500)
5 Extended Warranty Cost		\$ -						\$ -
6 Freight Charges		\$ 350						\$ 350
7 Installation/Commissioning		\$ 60						\$ 60
8 Training		\$ 150						\$ 150
Initial Cost Subtotal		\$ 4,088						\$ 4,088
Service Costs								
Warranty Term	0 years							
1 Parts		\$ 82	\$ 83	\$ 85	\$ 87	\$ 88		\$ 425
2 Labor		\$ 122	\$ 125	\$ 127	\$ 130	\$ 132		\$ 636
3 Travel		\$ 31	\$ 31	\$ 32	\$ 32	\$ 33		\$ 159
4 Shop Supplies		\$ -	\$ -	\$ -	\$ -	\$ -		\$ -
5 Other		\$ 25	\$ 25	\$ 25	\$ 25	\$ 25		\$ 125
S&R Cost Subtotal		\$ 260	\$ 264	\$ 269	\$ 274	\$ 278		\$ 1,345

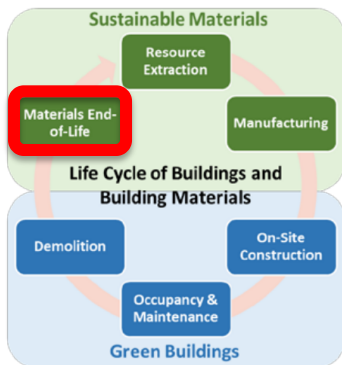
Design/Construction/Operation Standards:

- ANSI/ASHRAE 189.3 – Design, construction, and operation of sustainable high-performance health care facilities
- WELL v2 – ensures high levels of indoor air quality over building lifetime
- ASTM E2150 – Environmental cost element structure
- ASTM E2637 – Utilizing environmental cost element structure
- ASTM E917 – LLC of building and building systems



End-of-Life Standards:

- State Regulations: North Carolina Administration Code - Chapter 13
- Federal Regulations
- ASTM E2979 – Classification of discarded materials from manufacturing and associated support facilities

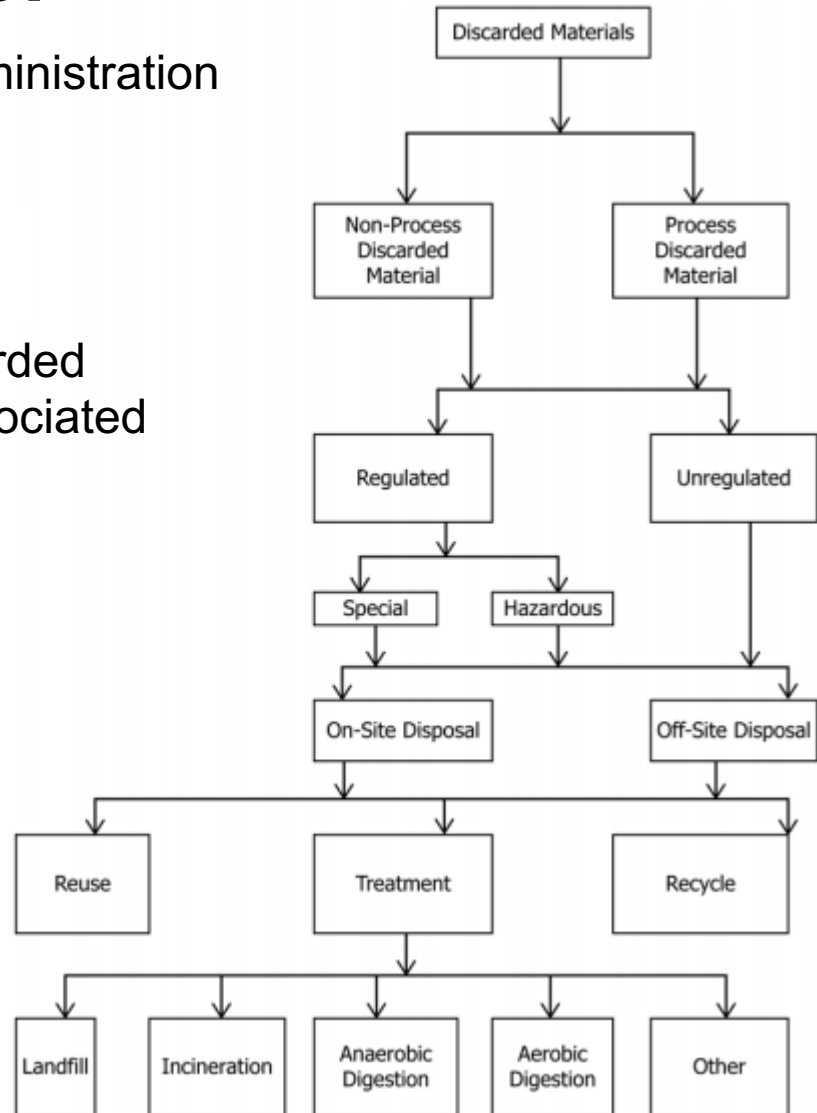


CLASSIFICATION

LOCATION

DISPOSITION

TREATMENT



Visit Our Project Website

<https://faculty.cnr.ncsu.edu/yuanyao/green-buildings-and-sustainable-materials/>

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