JULY 2022

USC Sustainable Design & Construction Guidelines

USC FPM
Facilities Planning and Management

Contents

1 Overview

1.1
Letter from USC

Sustainability is a cornerstone of what we do at USC and is an integral part of our design and construction. The USC Sustainability Design & Construction Guidelines will guide and inform project managers, stakeholders, architects and engineers, and construction contractors in the integration of sustainable measures and methods into our projects. Not optional concerns, they represent core requirements and considerations for the successful advancement and execution of our future sustainable campus development projects.

Prepared in collaboration with key stakeholders across USC—from faculty and staff to student interns - the USC Sustainable Design & Construction Guidelines advance the University's commitment to sustainable strategies for the design and construction of new buildings, renovations, and asset renewal projects with impacts across multiple areas. This document works alongside the USC Facilities Design Guidelines and many of the goals set in Assignment: Earth, USC's 2028 Sustainability Framework such as Zero Waste, Water Reduction and Carbon Neutrality.

The Guidelines feature: a Process Management section to guide the project team on roles and responsibilities, key sustainability activities, and required tracking and reporting; a Life Cycle Cost Analysis section to better understand cost effective design options, over the lifetime of a project; and an Environmental Life Cycle Analysis section to assess the environmental impact of project materials.

These Guidelines are a "living document" and will mature along with the evolution of USC sustainability policies and practices. We at USC Facilities Planning and Management welcome all to use these Guidelines and provide feedback over time. Assignment: Earth is everyone's responsibility!

Christopher J. Toomey

Vice President & Executive Director
USC Facilities Planning & Management

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Acknowledgements

The USC Sustainable Design & Construction Guidelines is the product of the efforts and collaboration of many dedicated and trained USC stakeholders and contributors representing university staff, faculty and students working with building industry sustainability experts to advance and realize the university's commitment to sustainable design, construction and operations of new buildings, renovations, and asset renewal projects. These Guidelines are a "living document" that will be updated over time as lessons are learned by USC through their application and the pathways to improving sustainability evolve.

USC Contributors and Stakeholders:

- Facilities Planning and Management
- Office of Sustainability
- USC Auxiliary Services
- USC Procurement Services
- USC WorkWell Center
- Faculty Advisors
- Student Interns

Consultant Team:

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1.3
Terms & Definitions

Management Process

Life Cycle Cost Assessment — The process of assessing the total cost of obtaining, owning, and disposing of an investment. In this context, LCCA is used to evaluate and compare design options for a project for lifetime cost-effectiveness.

Asset renewal — Projects whose central purpose is to modernize and extend the life expectancy of a building or infrastructure asset (i.e. deferred maintenance or other asset stewardship projects).

Basis of Design (BoD) — The Basis of Design describes the project specific design and technical approach to design, and includes the extended documentation of principles, assumptions, rationale, expectations, variables, and criteria used for calculations during design.

Owner's Project Requirements (OPR) — A foundational document detailing functional requirements and expectations of a project as well as its future operation. The OPR will serve as a guideline that informs design, as well as the Basis of Design (BoD).

Integrated Design Process (IDP) — An interdisciplinary design approach that brings together disciplines that usually work separately. An IDP can help create a more efficient, sustainable building.

Certification Frameworks

Leadership in Energy and Environmental Design (LEED) — A globally recognized 3rd party green building rating system that promotes the sustainable design, construction, and operation of high performance green buildings and communities. The following versions of LEED are referenced in this document: LEED v4.1 BD+C, LEED V4 BD+C, LEED v4 Commercial Interiors. Please refer to these documents as needed.

WELL Building Standard — The WELL Building Standard is a performance-based framework for measuring, certifying, and monitoring the elements of the built environment that impact human health and wellbeing, through air, water, nourishment, light, fitness, comfort, and mind. WELL v2 is referenced in these guidelines.

Envision Framework — An independent, third-party project verification and awards program to promote projects that adhere to the sustainability criteria in the Envision framework. These criteria cover Qualify of Life, Leadership, Resource Allocation, Natural World, and Climate and Resilience.

Living Building Challenge (LBC) — A performance based built environment certification program and sustainable design framework that bases performance on 7 'Petals' – Place, Water, Energy, health & happiness, materials, equity, and beauty. LBC certification differentiates itself through a focus on regenerative design.

Design Process Phases

Concept/Feasibility — Initial project collaboration and research to determine scope, establish goals, develop requirements, evaluate feasibility, select a project team, and assess the proposed location through a site survey or similar analysis.

Schematic Design (SD) — Review project requirements to develop an initial building design that includes the development of a general plan and basic exterior design. The end goal is to develop a basic building design.

Design Development (DD) — Design team revises SD drawings to provide more detail on plumbing, electrical, HVAC, energy usage, and any other project specific systems. This phase includes material, finish, and product selection and concludes when an interior and exterior design is finalized.

Construction Documents (CD) — In the CD phase the architect and design engineers finalize a technical design that includes structural engineering and detailing, heating air conditioning and ventilation systems, plumbing, electrical, gas, energy calculations, and all products and materials selected and scheduled.

Construction Administration (CA) — Construction administration includes administrative tasks performed by an architect (or other governing body) to help oversee the construction of a project. This phase aims to ensure the timely execution of construction.

Site & Landscape

Native vegetation — Regionally indigenous plants that are adapted to the climate and environmental conditions of a given place. At USC University Park and Health Science Campuses, native vegetation should be: 1) indigenous to the South Coast Bioregion of the California Floristic Province; 2) drought tolerant/ climate adaptive; 3) and/or reflective of the cultural histories of the Gabrielino-Tongva people, metropolitan South-Central LA, and the Trojan community.

Biodiversity — The variety of all living things found in a particular place on Earth, or the total variety of life on Earth.

Cool roofs — Roofs constructed of light-colored materials or materials with improved reflectiveness that reflect more sunlight and emit more thermal energy than conventional roofs.

Light pollution — The excessive or improperly designed use of outdoor artificial lighting that adversely impacts human sleep cycles, animal behavior, and astronomical observation.

Stormwater Best Management Practices (BMPs) — Infrastructural, vegetative, and managerial design practices that reduce flooding, pollution, erosion, and structural damage during rain events.

Heat Island Effect — Increased ambient air temperatures in urbanized landscapes, as result of a scarcity of greenspace, an abundance of pavement and other heat-trapping urban surface materials, urban geometry (wind flow, sunlight exposure, etc.), and heat-generating human activities.

Green roofs — Flat or slightly sloped roofs comprised of vegetation, preferably native, planted over a waterproofing system.

Materials & Waste

Life Cycle Assessment (LCA) — A systematic analysis of a product or process that quantifies its environmental impact over the full life cycle and is compliant with LCA standard ISO 14044.

Environmental Product Declaration (EPD) — An independently verified and registered document that communicates transparent and comparable information about the life-cycle environmental impact of products in a credible way and is compliant with ISO 14025.

Embodied Carbon — Carbon dioxide equivalent emissions associated with the manufacture, transportation, installation, maintenance and disposal of materials used in the construction of a building.

Diversion (waste) — The process of minimizing landfill waste by finding opportunities for reusing, recycling, and composting materials in order to find new purpose

Regenerative materials — Building materials that contribute positively to the natural environment, often as a rapidly renewable carbon sink (i.e. bamboo, hemp, wood, etc.)

Zero Waste — A systematic approach to waste management that emphasizes conservation and reuse of materials with the intent to eliminate landfill waste and support a circular economy. Zero waste typically refers to a minimum of 90% diversion rate.

Circular Economy — A circular model of production and consumption where materials are made to be reused and repurposed instead of becoming waste.

Municipal Solid Waste (MSW) — Consists of everyday items such as product packaging, yard trimmings, furniture, clothing, bottles and cans, food, newspapers, appliances, electronics, and batteries.

Construction and Demolition Waste (C&D) — Consists of waste generated during the construction, renovation, and demolition of a building project. This typically includes steel, wood, drywall/plaster, brick, asphalt, concrete, clay, etc.

Health

Volatile Organic Compounds (VOCs) — Substances with a high vapor pressure and low water solubility that evaporate at room temperature and are known to have both short- and long-term human health effects.

Red List Materials (Living Building Challenge Red List) — The LBC Red List identifies the materials that are most dangerous to the health of people and the environment.

Daylighting — The process of controlling how light enters a building through windows and other openings so that indoor spaces can be naturally lit throughout the day.

Biophilic Design A design approach used in the built environment to connect occupants to nature, through naturally inspired shapes, indoor plants and greenery, daylighting, and other space and place conditions.

Energy

Energy Use Intensity (EUI) An indicator used to demonstrate the energy efficiency of a building's design and/or operations, usually expressed in units of energy per square foot per year.

Energy Retrofits Energy retrofits are energy conservation measures applied to existing buildings to improve their energy efficiency.

R-Value The R-value is the capacity of an insulating material to resist heat flow. The higher the R-value, the more effective the material is at insulating.

U-Value The U-value is the rate in which heat is transferred through a building material. When a building is efficiently insulated, the U-value is low.

Solar Heat Gain Coefficient (SHGC) The fraction of solar radiation admitted through a window, door, or skylight, transmitted directly or indirectly and released as heat inside the building. Materials with lower SGHCs transmit less solar radiation.

Shoebox Energy Model A simplified energy model that addresses the basic geometry including, massing, zoning, and seasonal energy consumption trends related to climate.

Water

Potable Water Potable water is water that is treated to levels safe for use as drinking water or food preparation.

Greywater Gently used water from bathroom sinks, showers, tubs, and washing machines that may be reused, with or without treatment, for landscape irrigation.

Rainwater Harvesting The collection of rainwater from roofs or other catchment areas, diverted from storm water drainage systems for irrigation or other use.

Low-Flow / High Efficiency Fixtures Toilets, faucets, shower heads, and other water fixtures that are designed to reduce water consumption by having lower flow rates or smaller volumes of water outputted per use.

Water Budget An accounting of all the water that flows into and out of a project area.

1.4
Sustainability at USC

In 2021, USC articulated its goal to achieve climate neutrality by 2025, an ambitious effort that demonstrates the university's commitment to sustainability. To achieve its commitment, USC is continuing to pursue a multitude of strategies including retrofitting existing buildings, installing new solar panels on campus, electrification of their vehicle fleet, and ensuring new buildings are highly energy efficient. Already, USC has reduced its overall (Scope 1, 2, and 3) greenhouse gas emissions by 19% from 2014 to 2020, earning the university a silver rating in its first Association for the Advancement of Sustainability in Higher Education (AASHE) Sustainability Tracking, Assessment and Ratings System (STARS) report. For direct Scope 1 and 2 emissions, USC has achieved a 35% reduction per square foot in emissions from 2014 to 2020, exceeding the goal set in 2015 for a 20% reduction by 2020. In addition to cutting emissions, USC is pursuing other campus level initiatives related to landscape and waste such as switching to all electric-powered landscaping tools, transitioning to native, drought tolerant/climate adaptive plant species, and expanding their waste collection system to divert recyclables and organics.

In addition to initiatives under way, USC has been working to refresh its campus sustainability goals with Assignment: Earth, USC's 2028 strategic framework for sustainability action, which details the university's vision for sustainability. It has specific commitments and initiatives around greenhouse gas (GHG) emissions, circular economy and waste, water use reduction, healthy ecosystems, transparency, and accountability.

The student perspective is another key element to advancing sustainability at USC, as students are key stakeholders and future leaders of our world. USC has introduced new undergraduate curriculum programs to integrate sustainability and experiential learning into courses and fields of study across the university. USC will also launch an online training program to introduce all students to core sustainability concepts and to familiarize them with USC's pursuit of campus sustainability in its infrastructure, engagement programs, and initiatives. For the development of this document, the USC Sustainable Design & Construction Guidelines, students were asked to share their sustainability priorities and provide feedback on the usability of the guidelines. In terms of priorities, USC students envision a USC community where sustainability is seamlessly integrated into the institutional and cultural fabric of the university, and where sustainability is equally visible and accessible to all stakeholders on campus.

To further support the university in achieving its sustainability goals, the USC Sustainable Design & Construction Guidelines (referred to as USC SDCG or the guidelines) were developed. These guidelines will help USC ensure that sustainability is embedded within the design and construction process, transitioning the university to a more sustainable built environment. These Sustainable Design & Construction Guidelines will be a living document, reflecting changes over time to align with and advance the work already underway at USC, and to create a more sustainable future for USC students, faculty, staff, and the wider city and county of Los Angeles. Given the nature of document, these guidelines will be revisited and updated by USC's Facilities Planning and Management (FPM) Team. It is expected that USC FPM will update the guidelines periodically, in alignment with other facility guidelines, which will ensure strategies remain relevant and continue to advance USC on its sustainability goals.

1.5
Executive Summary

Purpose & Priorities

The USC Sustainable Design & Construction Guidelines (SDCG) serve as a guide for selecting and implementing sustainable design strategies for USC construction-based projects. In alignment with Assignment: Earth, USC defined building scale technical solutions to support sustainable landscapes, emissions reduction, resource conservation, as well as health and wellbeing.

The guidelines are divided into seven topic areas where USC will focus its design and construction efforts. These topic areas are reflective of USC stakeholder priorities as well as numerous third party standards. The intent of each topic area, outlined as follows, serves as an aspirational guide for project teams while designing, renovating, and constructing USC facilities.

- **Site:** Develop sites sustainably, integrating with surrounding ecosystems and built environment
- **Landscape:** Foster native, diverse, and resilient landscapes
- **Energy:** Prioritize efficient, low-carbon design that is electrification ready
- **Water:** Conserve potable water through efficiency, recycling, and reuse
- **Materials:** Prioritize healthy, local, low-carbon materials
- **Waste:** Design facilities to minimize waste during building construction, operation, and end of life
- **Occupant Comfort:** Design healthy and comfortable spaces

Structure & Application

The guidelines contain three sections: management process, technical guidelines, and an appendix. Project teams should review all sections of the USC SDCG to understand potential strategies and ongoing management of the guidelines. To support guidelines execution, a separate USC SDCG checklist (excel) was developed.

USC SDCG

- **Management Process:** Outlines the integrated design process that USC and project teams are to take to design & construct projects, ensuring sustainability is upheld throughout all phases in design. This section also identifies key roles and responsibilities to provide clarity on who is responsible for inputs, analysis, and ultimately reporting on the guidelines. The tracking and reporting section in Management Process outlines what is to be reported at the end of each phase, to ensure that the project is on track to achieve its sustainability goals.
- **Technical Guidelines:** Provides a list of minimum requirements, best practices, and aspirational strategies for selection across project types for site, landscape, energy, water, materials, waste, and occupant comfort. It is expected that for new construction & major renovations, project teams will be able to adhere to all applicable minimum requirements, and pursue best practices and aspirational strategies whenever possible. For Tenant Improvements (TI) and Asset Renewal (AR), it is understood given the varying nature of the projects that not all strategies will apply, and project managers and teams must align on this and obtain approval for exceptions or find alternatives.
- **Appendix:** Includes reference materials and guidance for sustainability activities that require additional technical detail including Life Cycle Analysis (LCA) and Life Cycle Cost Analysis (LCCA) process. Please note the key steps for these two types of analysis are highlighted in the management process section, and the appendix is available for additional technical guidance.

USC SDCG Checklist

- **Sustainable Design & Construction Guidelines Checklist:** The USC SDCG checklist is an excel spreadsheet that contains all potential project strategies. Project managers should use this as a tool for tracking strategies and exceptions.

Project teams engaged in construction-based projects will use the guidelines to select building design strategies across topic areas as applicable for the project types. Project types are defined as follows:

- **New Construction & Major Renovation (NC/MR):** Projects that are new free-standing structures, building additions and/or 'full gut' renovation of existing buildings.
- **Tenant Improvements (TI):** Projects whose central purpose is to accommodate programmatic needs through interior renovation and may include limited HVAC improvements local to the tenant improvement area.
- **Asset Renewal (AR):** Projects whose central purpose is to modernize and extend the life expectancy of a building or infrastructure asset (i.e. deferred maintenance or other asset stewardship projects).

Compliance with the guidelines is required for all projects as feasible that fall under the above definitions, and it is therefore expected that project teams incorporate all minimum and a subset of best practice and aspirational measures into designs. In addition to achieving minimum requirements, USC highly encourages project teams to consider aspirational strategies to accelerate progress toward sustainability goals. If implementation of the guidelines conflicts with any USC standards or if the minimum requirements cannot be achieved due to project constraints, any exceptions made must be identified and tracked. Project teams are responsible for assessing exceptions/conflicts and proposing alternative approaches/resolutions for approval per Section 2: Management Process.

Management & Related Initiatives

The SDCG will be managed by USC Facilities Planning Management (FPM), which will take the following steps to ensure the guidelines are consistently executed and maintained:

- Conduct training for project managers on guidelines application and use on projects
- Convene project managers monthly or quarterly to inform updates to guidelines during the first year of SDCG implementation
- Consistently evaluate and update the guidelines to align with campus initiatives and facilities documents, updating the guidelines at least every two years
- Publish date of SDCG last edit in the guidelines for tracking and transparency

In addition to maintaining the guidelines, FPM will inform third party certification discussions and confirm the guidelines remain in alignment with related campus initiatives.

Third Party Certifications

In addition to using the USC SDCG, it is also required that project teams must achieve the following third-party certifications across projects. Certain SDCG strategies already align with LEED credits and are denoted as such in the Technical Guidelines section.

- **Minimum Requirements**
  - **LEED Platinum Certification** for New Construction and major Renovation projects
  - **LEED Gold Certification** for TI projects
- **Aspiration**
  - **WELL Gold** Certification for New Construction & Major Renovation projects over $5M
  - **LBC Petal or Full Certification** for an appropriate project(s)

Note: The certification requirements above will be evaluated and set on a project-by-project basis based on specific project characteristics, sustainability opportunities and available schedule and funding.

Related USC Campus Initiatives

The USC Sustainable Design & Construction Guidelines work in tandem with other campus initiatives and planning guidelines that guide the management of campus facilities, grounds, and operations. These include the following:

- Assignment: Earth
- Stormwater Management
- Waste Management
- Landscape
- Transportation
- Safety
- Utility Service & Infrastructure
- Campus Master Plans
- UPC Specific Plan
- Historic Resources

Project teams and other interested stakeholders should reference these documents during project execution to ensure strategies selected are supporting campus wide goals and activities outlined in these documents. Further, as updates are made to these documents, USC FPM will ensure that any changes in performance criteria or strategies are reflected in the USC SDCG.

2 Management Process

Introduction

The Management Process will guide USC and Project Teams including architect, engineers, specialty consultants, construction contractors, end users, and FPM staff on required roles and responsibilities, key sustainability activities, and required tracking and reporting throughout and post project. Project Teams should take an integrative process approach to ensure sustainability is considered throughout the project, and the management process section is intended to guide them in this effort.

2.1 Roles & Responsibilities

Sustainability Liaison(s)

USC intends to appoint one or multiple Sustainability Liaisons, who will serve as the point(s) of contact for university-wide inquiries from faculty, staff, and students about USC FPM Sustainability Design &Construction Guidelines (SDCG). This role is a link to on-going coordination with the USC Office of Sustainability about the FPM sustainability stewardship efforts in support of the facility related goals of Assignment: Earth. The Sustainability Liaison role will be supported by other stewards for sustainability including FPM Project Managers, Design & Construction Teams and others in FPM support roles.

Project Manager

The FPM project manager for each project is the FPM project lead and accountable for the execution of the Sustainability Design & Construction Guidelines and other project criteria. The Project Manager is the daily point of contact for SDCG applications related to each new building, renovation or assets renewal projects assigned to them. This involves working closely with the entire Project Team ensuring the appropriate strategies are pursued and driving toward completed documentation in alignment with the Sustainability Design & Construction Guidelines and other agreed upon project goals. Further, project managers should share pursued strategies and any lessons learned from guidelines implementation with FPM to inform any needed changes to the management process.

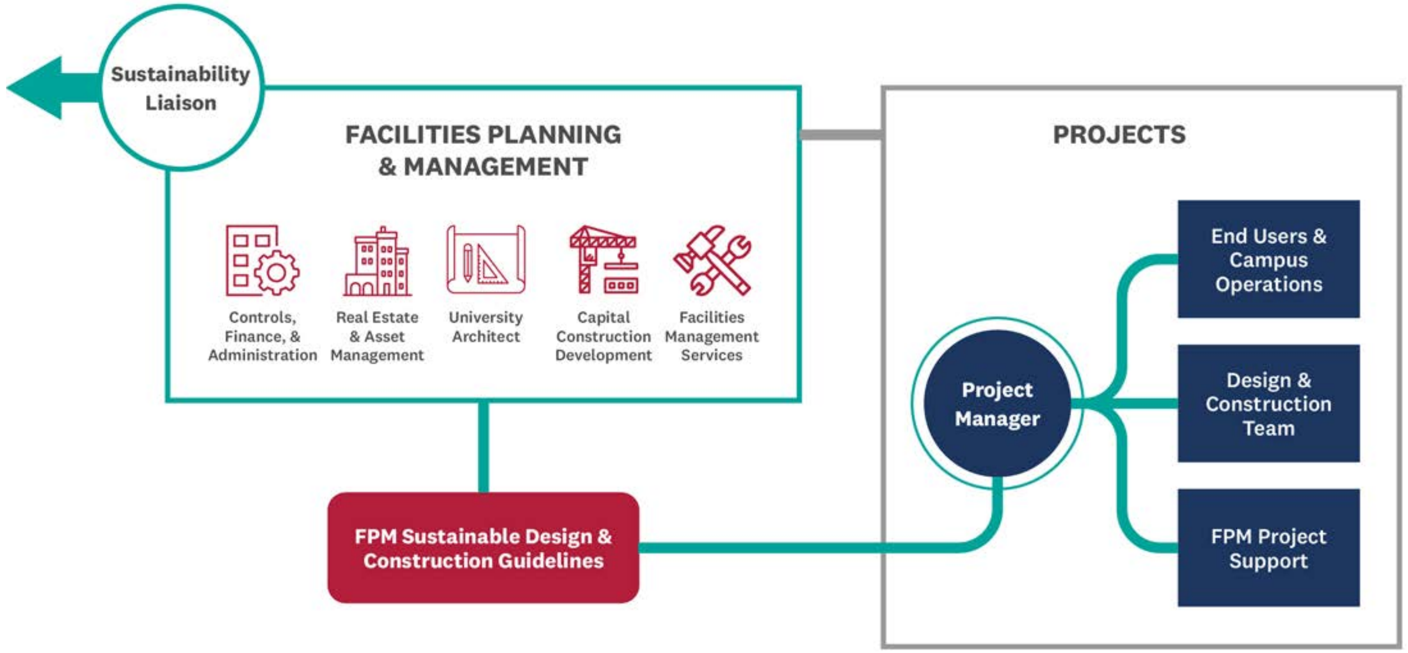

Figure 1: Role of Sustainability Liaison(s)

FPM Project Support

The FPM Project Support are the people, work processes and systems within FPM that provide technical, operational, tracking, reporting and documentation support to each project. The support areas critical to the Sustainability Design & Construction Guidelines include FPM/FMS Engineering Services, FPM/FMS Operations & Maintenance and FPM Controls, Finance & Administration. The involvement and contribution from these areas include FPM business practices and policies, contracts, e-builder project management system, FPM website management, technical operations and maintenance of campus wide utilities, buildings, and grounds.

Design Teams

Design Teams are the architects, engineers and specialty professional service consultants including third party owners' advisor sustainability consultant hired by USC to advise a project in accordance project requirements and who are responsible for evaluation, documentation, integration and execution of these Sustainability Design & Construction Guidelines as part of their professional services. The SDCG will be used to inform the approaches, evaluations and design solutions which will be vetted by the Design Team with the USC Project Manager and broader Project Team through applicable analysis, discussions, and documentation throughout each phase of their work.

Construction Teams

Construction Teams are the general contractor, subcontractors, suppliers, and others hired by USC to construct a project in accordance with project Contact Documents and who are responsible for executing the Sustainability Design & Construction Guidelines as applicable in their work. These Sustainability Design & Construction Guidelines will be used to inform the approaches, evaluations and documentation which will be vetted by the Construction Team with the USC Project Manager and broader Project Team through applicable analysis, discussions, and documentation throughout each phase of their work.

End Users and Campus Operations

The planning, design and construction of USC facility design and construction projects involves a diverse range of project specific operations stakeholder engagements including Project End User Representatives (VP, Dean, Faculty, Staff and Students), USC Finance: Budget & Planning, Campus Administrative Operations including DPS, Fire Safety & Emergency Planning, Environmental Health & Safety, Office of Sustainability, Transportation, Procurement Services, and Information Technology Services.

Responsible	Project Design & Construction Team and Sustainability Liaison(s)
Accountable	FPM Project Manager
Consulted/ Coordinated	End Users and Campus Operations
Informed	Senior University Leadership as Appropriate

2.2 Scoping & Design Process

This section defines the activities required from scoping through project completion to ensure the university embeds sustainability into designs. This process is led by the project manager, with inputs from others as diagrammed above. The following "Guide to Services" figure issued in October 2021 by USC Facilities Planning and Management describes the project phases. This overall process should be maintained for the project. To provide further detail on the sustainability activities within this process, the Project Sustainability Activities Table (pg 15) includes sustainability activities from feasibility/programming/design through closeout phases.

Project Initiation / Preliminary Scoping

Every project, no matter the project type, goes through a pre-project evaluation phase. During this period, the project is defined and scoped for overall parameters and budget, and approved, as described in "Guide to Services".

During this phase it is important that sustainability discussions and activities take place including:

- Communication to project proponents and broader stakeholder groups about USC's FPM Sustainability goals and baseline requirements
- Discussion of any additional sustainability goals or aspirations that align with the Assignment: Earth framework, or beyond
- Initial, high-level review of the prioritization matrix as well as efforts to understand the type of strategies required to meet the goals of these guidelines and the broader goals for each project
- Preliminary assessment of where the potential strategies sit in the high/low effort and high/low impact continuums
- Review of synergistic project opportunities to broaden sustainability impacts, assessing potential to combine efforts on projects if greater impact can be achieved
- Review of any budget and schedule implications related to sustainability
- Execute a Project Specific Sustainability Design & Construction Guidelines checklist for management, tracking and reporting progress
- Assess goals and opportunities related to electrification and any hurdles to being electrification ready

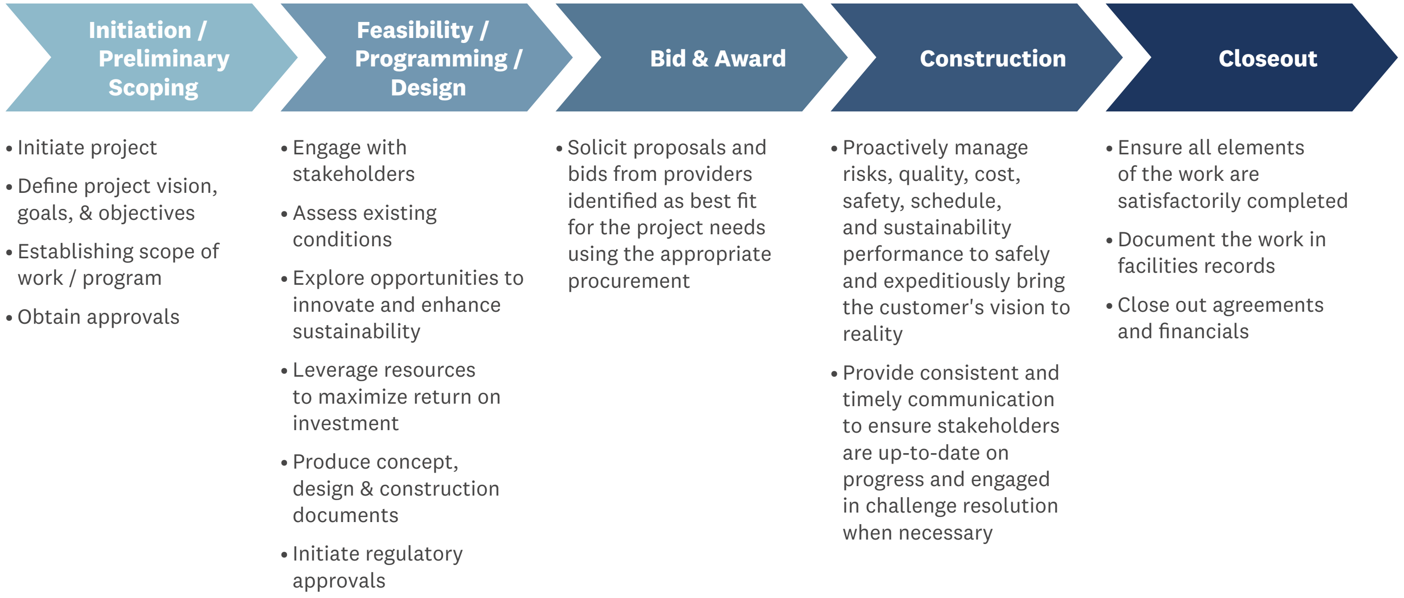

Figure 2: Life of a Project, adapted from USC's "Guide to Services"

Once the project is approved and Project Team selected, a feasibility study is to be conducted to confirm the project's scope, budget, and sustainability goals. If realignment is required within the approved budget, potential strategies may need to be reviewed more closely, with a focus on highest impact/lowest cost.

Project Sustainability Activities

The intent of the Project Sustainability Activities Table on the following pages is to define the key actions to be completed throughout the phases of design (that pertain to sustainability). Please reference the legend to understand how to apply activities to specific project types.

Project Sustainability Activities Table

	Concept	SD	DD	CD	CA	Post Occupancy
General Sustainability Activities	PO PM - - - SL **Set Sustainability Goals** Conduct sustainability goal setting workshop with design teams, FPM PM and Sustainability Liaison. Confirm any goals established in preliminary scoping phase and align on additional performance goals. **Assess Goal Feasibility** Confirm feasibility of meeting Sustainability Goals within approved budget-look for highest impact/lowest effort first.	- PM DT - - - **Review Guidelines** Guidelines and prioritization matrix review. **Identify Preliminary Strategies & Determine Exceptions** Identify / confirm Sustainability strategies and identify any project specific exceptions to achieving USC SDCG requirements.	- PM DT - - - **Finalize Strategies** Confirm Sustainability strategies and review exceptions.	- PM DT - - - **Validate Sustainability strategies and review exceptions** Ensure confirmed strategies are adequately included and that their benefit is validated.	- PM DT - - - **Track/Confirm construction implementation** Ensure strategies are being implemented.	- PM DT CT - - **Ensure all Sustainability strategies are implemented** Confirm all strategies have been implemented in the project. **Document strategies** Develop a record of all strategies included in project and expected benefits. Include a case study report documenting expected benefits/ performance.
OPR / BOD	PO PM - - - - **Outline OPR Sustainability Requirements** Project team develops OPR to capture initial project requirements. This is a living document to be updated throughout the project.	- PM DT - - - **Draft BOD** Document strategies and exceptions. **Update OPR** Project team updates OPR with input from Commissioning Agent.	- PM DT - - - **Finalize BOD** Include strategies and exceptions. **Update OPR** As project teams align on final sustainability strategies, OPR should be updated to reflect requirements.	n/a	n/a	n/a

Legend

Responsible Groups:

PO = Project Owner
PM = Project Manager
DT = Design Team
CT = Construction Team
CA = Commissioning Agent
SL = Sustainability Liaison(s)

Red border:
Applies to all project types

Yellow border:
Only applies to New Construction & Major Renovation projects

Blue border:
Applies to New Construction & Major Renovation projects, and may apply to Tenant Improvement & Asset Renewal projects

Project Sustainability Activities Table (cont.)

	Concept	SD	DD	CD	CA	Post Occupancy
Analysis: Assessments	- PM DT - - - **Site Assessment** Analysis of site and/or confirming building replacement if relevant. Consider broader project opportunities and needs for inclusive design, biophilia, mobility and specific scope options to consider in the RFP process according to project goals and budget.	- PM DT - - - **Renewables Feasibility** Assess opportunities for building or project renewable energy integration. **Electrification Feasibility** Assess full electrification feasibility, and hybrid building options, integrating options into LCCA process.	- PM DT - - - **Triple Bottom Line Analysis** Consider the value of triple bottom line analysis for a more holistic picture of broad life cycle cost benefits from health impacts.	- PM DT - - - **Assess Health of Materials** Consider health material specification choices - and health overlays on top of embodied carbon analysis.	n/a	- PM DT - - - **Post-Occupancy Evaluation** Consider post occupancy evaluations to assess both human comfort and energy performance.
Analysis: Energy Model	- PM DT - - - **Energy Modeling Review** Review project specific energy modeling needs, and recommend tailored approaches for NC, MR and TI projects.	- PM DT - - - **Shoebox Model** Conduct 'shoebox' energy modeling early in SD to inform major envelope decisions. A shoebox model is a simplified energy model that addresses the basic geometry including, massing, zoning, and seasonal energy consumption trends related to climate. **Initial Modeling** Conduct energy modeling at the end of SD following the ASHRAE 90.1-2019 methodology and for the LCCA inputs.	- PM DT - - - **50% Model Update** Update energy modeling at 50% to verify energy performance, optimize system design and inform final specification requirements.	- PM DT - - - **Performance Verification** Verify energy performance and design EUI (kBtu/ft2/yr) at the end of construction documents.	- PM DT - - - **Documentation** Where applicable for LEED, complete documentation for submittal.	n/a

Legend

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Yellow border:
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Project Sustainability Activities Table (cont.)

	Concept	SD	DD	CD	CA	Post Occupancy
Analysis: LCA	- PM DT - - - **LCA Opportunity Review** Review project specific LCA opportunities and set % reduction goals.	- PM DT - - - **Initial LCA** Conduct LCA to inform design options and decisions, concrete mix optimization, general product and assembly selections with embodied carbon and environmental impact in mind. Set baseline.	- PM DT - - - **LCA Update 1** Conduct whole building (or system) LCA to identify high impact materials and system selections for the structure and/or envelope, and identify embodied carbon reduction strategies.	- PM DT - - - **LCA Update 2** Confirm reduction strategies, write material-based strategies into the specs, and identify the best manufacturer options.	- PM DT CT - - **LCA Implementation** Ensure that concrete mixed on site meets embodied carbon targets and ensure that material choices contributing to the % reductions are followed through with during construction.	- PM DT - - - **Final LCA Update** Update final model per submittals, calculate final embodied carbon impact of the building or system along with its impact on the other environmental indicator categories, and calculate the final % reduction from baseline.
Analysis: LCCA	- PM DT - - - **LCCA Opportunity Review** Confirm LCCA adoption on the project based on size, scope and budget and project specific opportunities.	- PM DT - - - **LCCA Scoping** Identify and agree on LCCA analysis, including all energy conservation measures to be modeled. Decide on O&M cost goal and decide which LCCA studies would be most beneficial for the project.	- PM DT - - - **Initial LCCA** Conduct identified LCCA studies, assess results, and select which systems will be chosen for the project. Be sure to include all energy conservation measures to be modeled.	- PM DT - - - **LCCA Update** Update LCCA where required as design develops, and ensure that the project's overall design and specifications conform to LCCA study assumptions and results.	- PM DT - - - **LCCA Implementation** Ensure that the final construction documents conform to LCCA study assumptions and results. Ensure that the systems choces resulting from LCCA study are followed through during construction.	- PM DT - - - **LCCA Operation & Data Collection** Ensure that facilities teams know how to properly operate LCCA-chosen systems and that cost data is collected over the building lifetime, to test LCCA assumptions.
Analysis: Daylight Analysis	- PM DT - - - **Daylight Opportunity Identification** Identify analysis opportunities for the project to balance glare or optimize daylight, and agree analysis needs with USC for future design phases.	- PM DT - - - **Daylight Analysis** Where identified, conduct analysis to inform internal and external shading, glazing ratios and performance criteria.	- PM DT - - - **Daylight Optimization** Where applicable, optimize performance criteria and specifications from adopted strategies.	- PM DT - - - **Spec Verification** Where applicable, verify specifications are appropriately captured.	- PM DT - CA - **Daylight Commissioning** Ensure daylighting and shading systems are appropriately commissioned.	n/a

Legend

Responsible Groups:

PO = Project Owner
PM = Project Manager
DT = Design Team
CT = Construction Team
CA = Commissioning Agent
SL = Sustainability Liaison(s)

Red border:
Applies to all project types

Yellow border:
Only applies to New Construction & Major Renovation projects

Blue border:
Applies to New Construction & Major Renovation projects, and may apply to Tenant Improvement & Asset Renewal projects

Project Sustainability Activities Table (cont.)

	Concept	SD	DD	CD	CA	Post Occupancy
Commissioning	n/a	- PM - - CA - **Commissioning Requirements** Develop project specific requirements for commissioning and envelope commissioning, develop the RFP and interview and select the CxA. **Engage CxA** Engage commissioning agent(s) For alignment with project goals and review of the OPR.	- PM - - CA - **Engage CxA** Engage commissioning agents to Review BOD documents against the project OPR.	- PM - - CA - **1. CxA 50% review** Review and comment on 50% CDs, and provide specifications for commissioning. **2. CxA 90% review** Where beneficial, conduct a 2nd review of 90% CD documents for constructability and to ensure systems can be easily balanced and commissioned.	- PM - - CA - **CxA construction** Review key submittals during construction that impact energy performance. Facilitate the commissioning process and training of operations and maintenance staff.	n/a
Reporting & Deliverables	- PM DT - - SL **Sustainability Goals** **Owners Project Requirements (OPR)** **LEED preliminary checklist**	- PM DT - - SL **Major USC SDCG Strategies being pursued** **Exceptions to the USC SDCG** **Basis of Design (BOD)** **LEED checklist**	- PM DT - - SL **All USC SDCG Strategies pursued** **Exceptions to the USC SDCG** **Basis of Design (BOD) Updates** **LEED checklist**	- PM DT - - SL **USC SDCG Documentation** **LEED Design Documentation**	- PM - CT - SL **USC SDCG Documentation** **LEED Construction Documentation**	- PM DT CT - SL **Final SDCG Checklist** **Case Study**

Legend

Responsible Groups:

PO = Project Owner
PM = Project Manager
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Applies to all project types

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Only applies to New Construction & Major Renovation projects

Blue border:
Applies to New Construction & Major Renovation projects, and may apply to Tenant Improvement & Asset Renewal projects

2.3 Project Tracking & Reporting

Compliance with Guidelines

Design and Construction Teams working through the Project Manager shall work within the process detailed in section 2 to update the FPM Sustainability Liaison(s) on progress toward implementing sustainable design strategies into design. It is suggested the FPM project managers and FPM Sustainability Liaison(s) meet at a regular cadence (i.e. monthly) with Project Teams to review and discuss strategies, exceptions, and deliverables to ensure teams are on track. Inputs for deliverables & reports are provided by the Project Teams, collected & organized by the FPM Project Manager and socialized with the Sustainability Liaison(s) to ensure that the teams comply. The Guidelines Coordination process will be developed to provide guidance and direction to facilitate the FPM Project Manager to course correct as needed to ensure goals are met. If Sustainability Liaison(s) have not yet been appointed by USC, the Project Manager will meet with an interim appointee(s) designated by FPM.

Deliverables & Reports

This section provides directions on the reports to be generated across project types, as referenced in the Project Sustainability Activities table. Please refer back to Project Sustainability Activities table for applicability of report by project type.

Feasibility / Concept

Sustainability Goals

Outline the project's sustainability related goals. This may be built into Owners Project Requirements (OPR). Detail impact areas, and high-level mitigation plans for mitigation.

Owners Project Requirements (OPR)

High-level outline of the goals and requirements of the project (developed by the project owner). Summarize project intent for Design Teams, Construction Teams, O&M staff, future renovation teams, and any other parties that need to understand the original project goals and requirements as it pertains to sustainability.

LEED Preliminary Checklist

Conduct an initial assessment of project plans to identify potential LEED certification path. This should be conducted for all projects, regardless of construction budget threshold to identify project opportunities.

Schematic Design (SD)

USC SDCG Checklist

Complete a preliminary assessment of USC Sustainable Design & Construction Guideline checklist. Identify major (high impact, high cost, etc.) strategies being pursued.

Exceptions to the USC Sustainability Design & Construction Guidelines

Identify any project specific exceptions to be considered in relation to USC SDCG Requirements. Provide an explanation for proposed exemptions to be reviewed with the USC Sustainability Liaison(s)/FPM appointee.

Project Basis of Design (BOD)

Written by the Design Team, this document should provide an explanation of the thought processes and assumptions behind major design choices being made in the project. The intention of the BOD is to provide all project participants with a baseline, narrative, and overview of how the final designs have been selected in alignment with the OPR.

LEED Checklist

Update LEED checklist in accordance with credits being pursued by the project and ensure alignment maintained with project sustainability goals.

Analyses

All applicable analyses should be provided at the end of schematic design with clear recommendations for strategies that can be pursued and to what level of performance.

Detailed Design (DD)

USC SDCG Checklist

Update project specific Sustainability Design & Construction Guidelines checklist for management, tracking, and reporting progress.

Exceptions to the USC Sustainability Design & Construction Guidelines

Identify any project specific exceptions to be considered in relation to USC SDCG Requirements. Provide an explanation for proposed exemptions to be reviewed with the USC Sustainability Liaison(s)/FPM appointee.

Project Basis of Design (BOD) Updates

Provide details on any updates that have been made to the BOD since the previous submission during Schematic Design.

LEED Checklist

Update LEED checklist in accordance with credits being pursued by the project and ensure alignment maintained with project sustainability goals.

Analyses

All applicable analyses should be provided at the end of schematic design with clear recommendations for strategies that can be pursued and to what level of performance.

Construction Documents (CD)

USC SDCG Documentation and Checklist

Update project specific Sustainability Design & Construction Guidelines checklist for management, tracking, and reporting progress. It is expected that Project Teams provide documentation inputs, while Project Managers collect and review with Sustainability Liaison(s). The goal of this effort is to ensure that Project Teams are on track to achieve sustainability goals and give an opportunity to Sustainability Liaisons to course correct teams as needed.

LEED Design Documentation

Provide documentation available at the construction document phase to show how the project design will fulfill the requirements of the LEED credits being pursued. See LEED guidelines for documentation requirement details (note – only applicable for projects pursuing LEED)

Analyses

All applicable analyses should be provided at the end of schematic design with clear recommendations for strategies that can be pursued and to what level of performance.

Construction Administration (CA)

USC SDCG Documentation and Checklist

Collect and review documentation associated with updates to project specific Sustainability Design & Construction Guidelines checklist for management, tracking and reporting progress. It is expected that Project Teams provide documentation inputs, while Project Managers collect and review with Sustainability Liaison(s). The goal of this effort is to ensure that Project Teams are on track to achieve sustainability goals and give an opportunity to Sustainability Liaisons to course correct teams as needed.

LEED Construction Documentation

Provide documentation available at the construction administration phase to show how the project design will fulfill the requirements of the LEED credits being pursued. See LEED guidelines for documentation requirement details (note – only applicable for projects pursuing LEED).

Project Closeout

Final SDCG Checklist

Project managers to finalize the USC Sustainable Design & Construction Guidelines checklist and share with the Sustainability Liaison(s). The intent of this checklist is to demonstrate which strategies were pursued and allow the Sustainability Liaison to enable communication of strategies on a periodic basis.

Case Study

Project Teams to provide inputs for a post closeout review of project, that references the strategies pursued and expected levels of performance (i.e. energy reduction, water reduction, etc.). This can be used as a reference for future projects, occupant education, project publicity, and for USC SDCG updates. Include project successes, shortfalls, and any other relevant details.

3 Technical Guidelines

3.1 Introduction

Technical Guidelines

The USC Sustainable Design & Construction Guidelines (SDCG) should serve as a guide to Project Managers and Project Teams engaging in construction-based projects on USC's campus. The technical guidelines are divided into categories including site, landscape, energy, water, materials, waste and occupant comfort in order to group relevant strategies. Project Managers and Project Teams should review all sections to ensure they capture opportunities to advance USC's goals around carbon, circularity, water reduction, and health & wellbeing (i.e. review materials and waste regarding circularity).

Assignment: Earth

The guidelines were informed by the goals defined by the University's sustainability framework, Assignment: Earth. All relevant goals from this framework are included in each category of the technical guidelines. These goals, as well as the intents defined in section 1.5, should guide project aspirations.

How to Read these Guidelines

Each category (site, landscape, energy, water, materials, waste and occupant comfort in) includes focus areas with a subset of strategies to implement by project type. Project types include the following:

- **NC = New Construction & Major Renovation:** Projects that are new free-standing structures, building additions and/or 'full gut' renovation of existing buildings.
- **TI = Tenant Improvements:** Projects whose central purpose is to accommodate programmatic needs through interior renovation and may include limited HVAC improvements local to the tenant improvement area.
- **AR = Asset Renewal:** Projects whose central purpose is to modernize and extend the life expectancy of a building or infrastructure asset (i.e. deferred maintenance or other asset stewardship projects).

Strategies are defined as either minimum requirement, best practice, or aspirational for a project. The following rules apply for selection of strategies.

- **Minimum Requirements:** All minimum requirements are required for applicable project types
- **Best Practices:** Team should select 1-3 best practices as applicable by project type. If no best practices can be pursued the team must document the exception in alignment with the management process
- **Aspirational:** Ideally Project Teams will choose to implement at least one aspirational strategy as applicable by project type. If an aspirational strategy cannot be selected then the team must document the exception in alignment with the management process

For documentation – one of the following from the Project Team are assigned as the responsible party to complete the documentation for that section:

- **PM = Project Manager**
- **DT = Design Teams**
- **CT = Construction Team**

Related Third Party Certifications

Credits from the following third party certifications are referenced throughout the technical guidelines. Link to these certification frameworks are available here:

- LEED (v4.1 BD+C, V4 BD+C, V4 Commercial Interiors)
- WELL (v2)
- Envision Sustainable Infrastructure Framework (v3)
- Living Building Challenge

Education & Engagement

USC's campus facilities shape how students, faculty, staff and visitors interact with and experience the campus. The strategies outlined in this section enable sustainable design that should be recognized and discussed amongst campus patrons. Therefore, project teams should consider opportunities to provide signage around a project's sustainability strategies and accomplishments (i.e. LEED certification, expected performance metrics, innovative design concepts, etc.). Signage can allow for campus engagement and continue to advance the culture of sustainability at USC.

3.2 Site

Overview

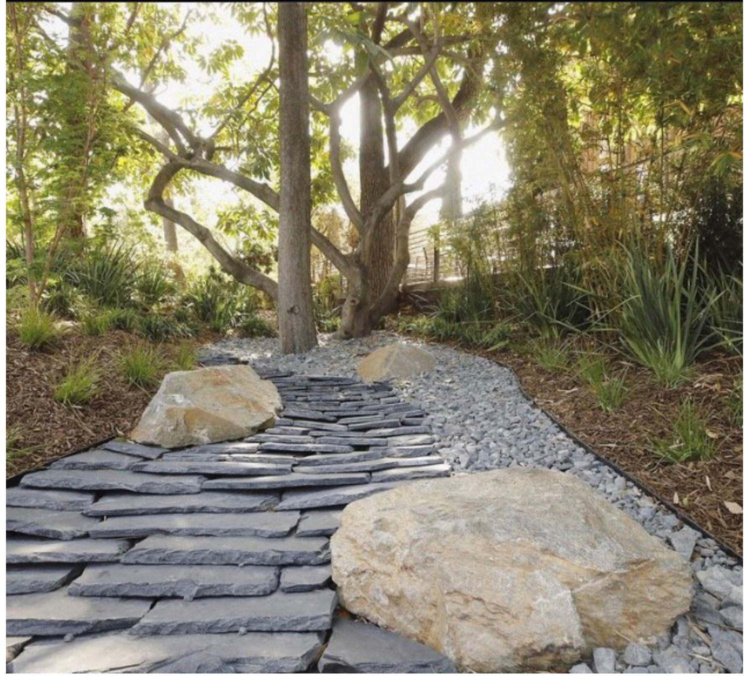
The site of a building project can have a variety of impacts on the overall sustainability of the development. Selecting sites with accessible low-carbon transportation methods, and choosing design solutions that minimize stormwater runoff and heat island effect are just some of the critical components of site selection and development. By selecting locations and design strategies that promote sustainability, USC can better integrate with surrounding ecosystems and minimize the negative impacts of development.

This section provides strategies to minimize USC's impact on surrounding ecosystems, by utilizing best practices in stormwater management and pavement selection. Further, as a part of an effort to support a carbon neutral campus, project teams should consider opportunities for electric vehicle charging infrastructure and encourage access to public transportation. Design strategies are grouped into the following three focus areas: stormwater management, access to alternative transportation, and pavement.

Assignment: Earth Goals

The university has set the following goals from the Assignment: Earth framework related to site and landscape for the USC campus:

- USC will develop and begin implementing a long-term plan for grounds and landscaping and strategic planting standards by FY 2024
- USC will update its Design Guidelines to incorporate health and wellness strategies into facilities designs by FY 2023
- USC will achieve a 20% potable water use reduction per square foot of total campus building space by FY 2028 (FY 2014 baseline)
- USC will establish a publicly accessible online dashboard to track sustainability resource metrics by FY 2023





Required Measures

A Stormwater Management

The University of Southern California relies heavily on stormwater infrastructure to prevent flooding and convey stormwater throughout the campus. In addition to flood control, stormwater Best Management Practices (BMPs) are increasingly valuable as stormwater runoff is one of the largest sources of freshwater pollution in American cities. Weather events involving heavy precipitation can overwhelm existing stormwater infrastructure, leading to increased flooding within the Los Angeles (LA) metropolitan area and increased water pollution in local streams, rivers, and coast lines. Sustainable stormwater systems that are adaptive to changing climate conditions and maintain reliability and efficiency are essential to a functional campus and community.

The City of Los Angeles requires projects to comply with the stormwater regulations in the City of LA Low Impact Development (LID) Manual. To align with campus sustainability goals and minimize negative environmental impacts, USC strives to implement stormwater BMPs that exceed regional standards, and align with LEED equivalence, at a minimum. Project teams shall also evaluate the feasibility of infiltration, retention, and detention BMPs and prioritize these to enhance flood management, recharge the aquifer, and reduce reliance on the public stormwater system. When feasible, surface-level stormwater BMPs shall be implemented, providing multiple benefits, including functional landscaping and elements to enhance biodiversity.

In addition to the minimum required strategies established by USC, project teams are also encouraged to pursue Envision stormwater equivalence. As an aspirational goal, project teams can implement educational BMP signage in designs to promote pollution awareness. Furthermore, as climate change continues to challenge the availability of water as a resource, an aspirational goal for some larger projects could include a harvest and use feasibility study to identify opportunities to use stormwater to reduce water consumption.

Strategies

Minimum Requirements

1 Stormwater BMPs Consistent with LEED Minimum (90th percentile) for Rainwater Management NC - -

Comprehensive Stormwater Management Plan to reduce runoff volume and improve water quality by replicating the natural hydrology and water balance of sites.

LEED v4 SSc: Rainwater Management

Best Practices

2 Infiltration, Retention and Detention NC - -

Implement volume storage BMPs to the maximum extent possible to minimize campus flooding in extreme weather events.

3 Stormwater BMPs Consistent with Envision Equivalence for Managing Stormwater (Conserving or Restorative Levels of Achievement, 95th percentile) NC - -

In addition to meeting minimum LEED equivalence, project teams can strive to achieve BMP standards set by Envision.

ENVSP v3 NW2.2 Manage Stormwater

4 Prioritize Multi-Benefit Surface Level BMPs NC - -

Utilize multi-benefit surface level BMPs to the maximum extent possible, incorporate functional landscape and increased biodiversity.

Aspirational

5 Incorporate Educational Signage to Promote Awareness of On-Campus BMPs NC - -

Signs can be in the form of diagrams and narrative to educate and promote pollution awareness.

6 Project Specific Harvest and Use Feasibility Study NC - -

Where infiltration of stormwater is not feasible, identify and evaluate any opportunities for rainwater reuse in conjunction with building water efficiency and reuse opportunities. Refer to the water section for additional guidance on recommended reuse applications.

Resources

- *City of LA Planning and Land Development Handbook for Low Impact Development (LID)*
- USC Teams to Engage: Facilities and Planning Management (FPM), Engineering Services

Documentation

- Concept BMP approach prioritizing functional landscape and multi-benefit BMPs. - DT -
- Comprehensive Stormwater Management Plan outlining onsite stormwater management design and BMP volumes/capacities based on storm event. - DT -
- Site plan showing type and locations of permanent stormwater BMPs. - DT -
- Project Specific Harvest and Use Feasibility Study, if applicable. - DT -

Required Measures

B Access to Alternative Transportation

Students, faculty, staff, and visitors at USC use a variety of transportation systems to travel to campus. The school provides services including shuttles, buses, carpools, and bicycle and vehicle parking infrastructure to ensure affordable and equitable campus access to all stakeholders. USC has developed the following design recommendations to promote healthy, low carbon transit alternatives such as increased pedestrian access, improved bicycle circulation and walkability, and electric vehicle charging infrastructure.

Strategies

Minimum Requirements

1 Pedestrian Access — NC TI -

Design the project site with clear, accessible and continuous pedestrian access.

LEED v4.1 Innovation - Walkable project site

2 Include Effective Bicycle Circulation and Parking Systems — NC TI -

Design or locate the project to provide sufficient bicycle access and short-term storage. Additionally, provide long-term bicycle storage for residential facilities.

LEED v4.1 LTc6 - Bicycle Facilities

Best Practices

3 Electric Vehicle Charging Stations — NC TI -

Install electrical vehicle supply equipment (EVSE) within project parking facilities.

LEED v4.1 LTc8 - Electric Vehicles

4 Access to Transit — NC - -

Locate functional entries to buildings within ¼ mile walking distance of bus, streetcar or rideshare stops, and ½ mile of planned bus rapid transit or commuter rail stations (i.e. MetroLink) to promote building occupant use of transit.

Resources

- *California Air Resources Board: Electric Vehicle Supply Equipment (EVSE) Standards*
- *LEED Cities: Plan & Design: Walkability and Bikeability*
- *National Association of City Transportation Officials: Urban Bikeway Design Guide*
- *US Department of Transportation: Bikeway Selection Guide*
- *Caltrans: State Bicycle & Pedestrian Plan*
- USC Teams to Engage: Facilities Planning Management (FPM)

Documentation

- Site plan reflecting bike and EV charging infrastructure — - DT -

C Pavement

The University of Southern California has many large outdoor gathering spaces and functional hardscaped areas throughout campus. Due to the importance and abundance of campus hardscape, future development shall strive to implement sustainable hardscape design on campus to minimize negative environmental effects caused by construction and to create outdoor spaces that are adaptable to increased temperatures. At a minimum, USC requires newly constructed hardscapes to have high solar reflectance (SR) values consistent with LEED equivalency. High solar reflectance values help to decrease the heat island effect and maximize comfort of outdoor spaces during extreme temperatures. Additionally, to minimize construction impacts, projects that include a geotechnical engineer shall include an analysis of material re-use opportunities.

Project teams may also choose to utilize materials that are accredited by the Concrete Sustainability Council (CSC) to ensure minimal negative environmental impacts caused by material sourcing. It is also encouraged that open-grid paving systems, having a perviousness of 50% or more, be used when feasible. Open-grid paving systems help to reduce heat island effect and stormwater runoff. As an aspirational goal, projects that include the addition or replacement of outdoor parking stalls may consider installing covered parking stalls with roofing materials having high SR values, vegetation, or, where feasible, solar PV for energy generation and contribution to carbon neutrality goals.

Strategies

Minimum Requirements

1 Hardscape Finish Materials with High Solar Reflectance (SR) Values Consistent with LEED Strategies for Heat Island Reduction — NC - -

Installing materials with high SR values increases the functionality of outdoor spaces.

LEED v4 SSc4: Heat Island Reduction

Required Measures

2	**Project Geotechnical Engineers to Provide Opportunities for Material Re-use** Maximizing material recycling often conserves resources, lessens the negative environmental impacts of construction, and provides cost savings.	NC - -

Best Practices

3	**Procure Sustainable Sourced Materials** Maximize use of materials accredited by the Concrete Sustainability Council (CSC) and consistent with Envision Equivalence for resource allocation. ENVSP v3 RA1.1 Support Sustainable Procurement Practices	NC - -
4	**Open-Grid Paving Systems** Utilize hardscape with minimum 50% perviousness consistent with LEED credit for Heat Island Reduction. LEED v4 SSc: Heat Island Reduction	NC - -

Aspirational

5	**Covered Parking** Implement covered parking for 75% of exposed stalls consistent with LEED credit for Heat Island Reduction. Roofing material shall have a high SR value, vegetation, or, where feasible, include solar PV for energy generation and contribution to carbon neutrality goals. LEED v4 SSc4: Heat Island Reduction	NC - -

Resources

- *USC Landscape Design Guidelines*
- USC Teams to Engage: Facilities and Planning Management (FPM), USC Transportation (re: parking), Fire Safety and Emergency Management (re: hardscape requirements for emergency vehicle access)

Documentation

• Site plan identifying pavement locations, types, SR values, and perviousness, as well as any covered parking stalls and type of covered parking.	- DT -
• Geotechnical report or letter from geotechnical engineer identifying opportunities for material re-use and subsequent project specifications for application.	- DT -
• Project specifications identifying applicability for materials sourced from manufacturers accredited by the Concrete Sustainability Council (CSC) and subsequent contractor submittals.	- - CT

3.3 Landscape

Overview

Human health and the health of the ecosystem are linked. According to CalEnviroScreen 4.0, the USC campus lies within an area of Los Angeles with a high pollution burden. To mitigate these impacts and stressors associated with pollution, water scarcity, extreme heat, extreme weather events, and a changing climate, the USC campus will transform and adapt to address these challenges over the coming years. The strategies listed in this section outline a pathway to creating a more healthy and resilient campus landscape. The strategies are consolidated around reducing potable water use, maintaining, and enhancing biodiversity, and expanding the health benefits of the landscape. The standards set by The State of California Model Water Efficient Landscape Ordinance (MWELO), which is referenced by Title 24, Part 11 CalGreen Building Code, establishes baseline requirements for reductions in potable water use and minimum requirements. The USC campus community may set more ambitious goals related to outdoor water use reductions to align with local plans such as LA's Sustainable City pLAn. Overall, transitioning to water-efficient landscapes is a high priority. The following recommendations will contribute to leadership in landscape water conservation and help to embed sustainable design principles into USC campus landscape design to deliver measurable results for landscape performance.

Assignment: Earth Goals

The university has set the following goals to reduce dependence on imported water and increase health and wellness strategies in facilities design. Goals from Assignment: Earth related to landscape are as follows:

- USC will develop and begin implementing a long-term plan for grounds and landscaping and strategic planting standards by FY 2024.
- USC will update its Facility Design Guidelines to incorporate health and wellness strategies into facilities designs by FY 2023.
- USC will achieve a 20% potable water use reduction per square foot of building space by FY 2028 (FY 2014 baseline)
- USC will establish a publicly accessible online dashboard to track sustainability resource metrics by FY 2023

Required Measures

A Potable Water Use Reduction

Southern California has a Mediterranean climate characterized by dry summers and wet winters. Southern California native plants, along with plants that have evolved in Mediterranean climate zones, have adapted to survive within this cycle of summer drought and winter rains. Transitioning the campus to a landscape of mostly native and climate adapted plant species is the primary tool for reducing outdoor potable water use on campus. Much of the existing campus is planted with species requiring moderate to high levels of supplemental water. Because the campus uses potable water to irrigate the landscape, lowering the amount of supplemental irrigation required to keep the plants healthy will have a significant impact on reducing overall potable water use.

All new construction projects over 500 s.f. and rehabilitated landscape areas over 2,500 s.f. are required, by the California Model Water Efficient Landscape Ordinance and Los Angeles Green Building Code (Title 24, Part 11 CalGreen Building Code) to substantially reduce demand for supplemental irrigation. Meeting these requirements can be achieved by using Southern California native and climate adapted plants—plants that require low amounts of supplemental irrigation after initial plant establishment period. This code requirement ensures new and rehabilitated landscapes meeting the size requirements will be drought tolerant. However, much of the campus landscape consists of smaller established landscape spaces that are under 2,500 and to achieve campus goals for potable water use reductions, will require transitioning these areas to native and climate adapted planting.

Strategies

Minimum Requirements

1 Outdoor Water Use Reduction (30% reduction over calculated baseline*) NC TI -

Reductions in outdoor water use can be achieved by selecting plants that have water needs matching the climate. In addition to meeting MWELO code requirements, design teams can Align with LEED Outdoor Water Use Reduction

LEED v4 WEpr1: Outdoor Water Use Reduction

2 Drought-Tolerant Landscaping NC TI -

All new and rehabilitated landscapes should incorporate California native and climate adapted plants that thrive in the current climate and are expected to do well with future climate changes.

3 Water-Saving Irrigation Systems NC TI -

Install and maintain high efficiency irrigation equipment including automatic controllers, weather-based sensors, and flow meters for all newly installed and renovated landscapes. In addition, equipment must comply with USC Landscape & Irrigation Standard Guidelines and the Water Efficient Landscape Ordinance MWELO.

4 Prohibit Irrigation Water Runoff onto Adjacent Hardscape NC TI -

Adjust irrigation spacing and coverage angles to prevent runoff or provide non-irrigated buffer between hardscape and landscape areas.

5 Reduce Soil Evapotranspiration NC TI -

Use organic, or mineral mulch to preserve soil moisture levels. 3" of mulch is required by MWELO for new and rehabilitated landscapes except on slopes greater than 2:1, in turf, seeded, and spreading ground cover areas. Place mulch material in a continuous layer, 3" deep adjacent to plant crown in shrub and groundcover areas, and in areas between shrubs.

Best Practices

6 Outdoor Water Use Reduction (50% reduction over calculated baseline*) NC TI -

Follow LEED credit and reduce outdoor water by 50%

LEED v4 WEc1: Outdoor Water Use Reduction

7 Increase Soil Health NC TI -

Increase soil health including capacity for stored carbon. Healthy soil has a higher capacity to sustain plants during periods of drought. For new projects and landscape rehabilitations, soil should be tested for fertility and agricultural suitability (even for non-agricultural landscapes) from a minimum of four locations per acre of planted area. Lab recommendations for soil amendments should be followed and documented.

Required Measures

8	**Alternative Water Sources** Expand alternative sources of water for irrigation to ensure irrigation water supply for campus trees in anticipation of the next extreme drought and possible mandatory restrictions on outdoor potable water use.	NC - -

Aspirational

9	**Outdoor Water Use Reduction (75% reduction over calculated baseline*)** Reduce outdoor water use by 75% over calculated baseline.	NC TI -

*Baseline for outdoor water use should be calculated using EPA WaterSense Water Budget Tool

Resources

- *EPA WaterSense Water Budget Tool*
- *LEED Outdoor Water Use Reduction Calculator*
- *Water Use Classification of Landscape Species (WUCOLS IV)*
- *Model Water Efficient Landscape Ordinance*
- *Urban Forest Ecosystem Institute at Cal Poly SelecTree*
- Teams to engage: USC Facilities Planning and Management (FPM)

Documentation

- *Use the EPA WaterSense Water Budget Tool to calculate baseline. - DT -
- LEED Outdoor Water Use Reduction Calculator to Provide a list of all proposed plants indicating water use needs indicated by the Water Use Classification of Landscape Species (WUCOLS) at the beginning of the design development stage. - DT -
- Submit hydrozone plan at the beginning of the design development stage. - DT -
- Submit water budget calculations for all new and rehabilitated landscapes over 200 s.f. to determine if estimated irrigation demand can be met with current water supply sources. - DT -

B Biodiversity

Biodiversity helps to maintain the balance of nature and cities and USC lies within a globally significant biodiversity hotspot. The USC Health Sciences and University Park campuses provide habitat for many urban adapted species such as the free-tailed bat and the downy woodpecker. The 229-acre University Park Campus has more than 3,700 trees, contributing significant, cooling, air quality improvements and biodiversity benefits in downtown Los Angeles. What the USC campus community does to address steeply declining rates of biodiversity can have a large impact on the region. While USC is a habitat fragment, with focused efforts to maintain and enhance biodiversity, aligning with Sustainable City pLAN and prioritizing "no Net loss," USC can contribute to the ecological uplift of the surrounding city. In addition, because many people visit the campuses each year, there is tremendous opportunity to create timeless experiences supporting meaningful connections with nature.

Much is unknown about urban nature regarding species composition and distribution, and the USC campus community has a unique opportunity to add to the knowledge base as a learning laboratory for urban biodiversity. The first step will be for the campus to create a biodiversity baseline from which to measure change over time. The baseline should include species such as plants, butterflies and moths, reptiles and amphibians, and insects. The USC campus community can help to set an example for the region in adding to current knowledge about urban biodiversity.

Strategies

Minimum Requirements

1	**Habitat Preservation** Identify targeted species and habitats for preservation on project sites.	NC - -
2	**Reduce Turf Areas on Campus** Except for registered historical sites, and recreation fields, do not install new turf areas and remove exiting turf as a part of landscape renovations as feasible.	NC TI -
3	**Native Species Protection** Conserve native species and do not incorporate invasive species in new projects or renovations. Only use plant species that are not listed on the Cal-IPC Invasive Species Inventory.	NC TI -

Best Practices

4	**Pollinator Pathways** Create new pollinator gardens and pathways linking areas with California native plants and prioritize plant species supporting the life-cycle of targeted species.	NC - -

Aspirational

5	**Native Species Transition** Dedicate 25% of new and renovated landscape areas to native Southern California plant species. Composition of native landscape areas should emphasize species diversity and habitat establishment for targeted species.	NC TI -

Required Measures

Resources

- *LA Sanitation & Environment 2020 Biodiversity Report, Biodiversity Atlas of LA.*
- *Natural History Museum Los Angeles County Urban Nature Research Center, Catalina Conservancy Native and Endemic Plant Species List, Las Pilitas Nursery Nature of California*
- Teams to engage: USC Facilities Planning and Management (FPM), including USC arborist

Documentation

- Provide list of native Southern California plant species and diagram indicating location and area calculations of proposed native Southern California landscapes. - **DT** -
- Provide list of all proposed plant species demonstrating no invasive species are used. - **DT** -

C Health Benefits of Landscape

The USC campus landscape is the context for achieving many interrelated goals of the sustainability guidelines. It is also the place where the positive effects of a healthy environment are experienced. Walking through or spending time within landscaped campus areas can be restorative. Taking a 15-minute walk across campus along a tree-lined pathway can help to promote mental health, reduce stress, and lower blood pressure rates. Increasing tree canopy coverage on campus can help to promote healthy and low-carbon transportation choices by encouraging walking and biking to campus, and encourage students, staff and visitors to use the campus as a place for exercise and restoration.

Now, more than ever, we understand that health infrastructure is not just hospitals, but green open spaces, tree-lined walkways, and gardens, places where people can gather, learn, and build social connections. It will be important to create healthy, resilient landscape spaces for the USC community and the larger surrounding community.

Strategies

Minimum Requirements

1	**Tree Canopy** Increase tree canopy coverage in line with campus objectives. Increasing tree biomass can help to improve air quality, store carbon, and increase outdoor thermal comfort. Use native, low water using, and climate adapted species and tree species expected to remain healthy within anticipated climate shifts during the tree's average lifespan.	**NC**	-	-

Best Practices

2	**Open Spaces** Preserve and create open, green space equivalent to a minimum of 30% of project sites, in alignment with LEED. Opportunities for new open green spaces may be found in converting inefficient surface parking lots. LEED credit SSc3: Open Space	**NC**	-	-

Aspirational

3	**Meditation Gardens** Create meditation gardens. Gardens should reduce noise and mitigate distractions, be accessible, provide appropriate seating options, and create a comfortable micro-climate	**NC**	-	-
4	**Community Gardens** Create community gardens with herbs and medicinal plants. On-site food production may require shared-use agreements but has the added benefits of maintaining and enhancing campus biodiversity and helping to provide food security for students and adjacent community members	**NC**	-	-

Resources

- *Living Building Challenge Place Petal*
- *SITES Certification and Precertification, Section 6 – Site Design Human Health + Well Being*
- Teams to engage: USC Facilities Planning and Management (FPM)

Documentation

- Provide documentation of existing tree canopies covering new and rehabilitated landscapes and diagram and area calculations for new tree canopy coverage 5-7 years after installation. - **DT** -
- Provide a diagram indicating open green spaces and area calculations demonstrating alignment with minimum requirement for project sites. - **DT** -
- Provide narrative describing how proposed mediation gardens will mitigate noise and other distractions and create comfortable micro-climate. - **DT** -

3.4 Energy

Overview

To avert the worst impacts of climate change, global emissions must fall rapidly, with full decarbonization of the built environment and the global economy by 2050.[i] The built environment is responsible for 40% of global emissions, 28% of which is operational energy used to heat, cool, light, power, and ventilate buildings. Combustion of fossil fuels also has adverse health impacts on the surrounding community. The State of California, Los Angeles County, and the City of Los Angeles have all set aggressive targets to reduce carbon emissions and target energy use reduction in the built environment. California Senate Bill 100, for example, mandates that the state will target generating 50% of its electricity from renewables by 2026, 60% by 2030, and 100% by 2045 and that the energy efficiency of all existing buildings in the state be doubled. The LA County Sustainability Plan and the City of LA Green New Deal set specific targets around increasing renewable energy supply, achieving carbon neutrality, and reducing EUI targets for buildings. The City of LA Existing Buildings Energy and Water Efficiency (EBEWE) Ordinance also requires annual energy consumption benchmarking for existing buildings over 20k square feet. The City of LA and LA County have both passed motions calling for the development of ordinances eliminating fossil fuels in new construction as early as 2023.

As the grid becomes decarbonized, it's important that buildings on the USC campuses are equipped to take advantage of clean electricity to achieve state, county, city, and campus carbon reduction goals. The guidelines set the groundwork for full electrification of all buildings as the central plant is decarbonized, which will be subject to a future in-depth study. The guidelines prioritize electrification to reduce reliance on carbon offsets over time as the University works toward carbon neutrality by 2025. The strategies in this section cover both design strategies as well as the design process which includes the needed studies, goals and other activities that will lead to a low carbon and efficient design. All teams should refer to the process section to understand specific studies to be completed to determine electrification feasibility.

Assignment: Earth Goals

The university has set the following goals to reduce energy use and fossil fuel reliance on campus. Project teams should consider all opportunities to incorporate energy efficient design, construction, and operation of facilities. Goals from Assignment: Earth are as follows:

- USC will achieve climate neutrality for annual scopes 1 & 2 emissions for fiscal year 2025 and beyond, while seeking to minimize the use of carbon offsets.
- USC will establish a publicly accessible online dashboard to track sustainability resource metrics by FY 2023

Required Measures

A Process

The process to design all electric buildings requires a different mindset. For new construction and major renovation this means designing for how projects operate and for TI projects a longer-term view is required to facilitate future electrification. Individual projects will also have to consider if the building is stand-alone or on the campus central plant, and the challenge of the availability of roof space given the existing architecture on campus. The process outlined below sets direction, and projects should account for central plant electrification plans when available.

Strategies that reduce peak heating loads to lesson space impacts, or strategies that take advantage of diurnal load shift through thermal storage should be incorporated into designs as these are critical for success. A conceptual approach that leverages high Coefficients of Performance (CoP) involves using passive design and carbon-free electricity to extract, move, concentrate, and store thermal energy from where it is not wanted to where and when it is needed, rather than the less efficient approach of using fuel to directly generate thermal energy. Further, the following strategies also address the importance of commissioning through the project life which is essential to ensuring the building envelope and system perform as intended.

Strategies

Minimum Requirements

1 Peak Load Analysis and Reduction Strategy — NC - -

Conduct a peak load analysis, projecting both peak and real-world heating needs through design measures such as: internal gains, reduced set-backs, heat recovery and enhanced building envelope. Target peak heating load reductions of up to 30% from California Title 24 current code baseline envelop values.

2 Load Duration Analysis — NC - -

Develop load duration curves for heating, reheat and cooling to identify opportunities for reversible air source heat pumps or water source heat pumps and to inform electrification feasibility analysis. Incorporate load durations for each peak load measure.

3 Electrification Feasibility & Hybrid Buildings — NC TI -

For all NC & MR projects, complete a feasibility study for electrification, detailing up to three different options for pricing and LCCA. For TI projects where base building systems prevent immediate electrification, conduct a high-level review of electrification pathways for the building where the project represents modifications to more than 25% of the gross floor area.

4 Electrification Potential Score — NC - -

Calculate the annual energy consumption met by electric means for all electrification concepts. A buildings electrification score represents the amount of energy met entirely through electric means – represented out of 100. For electrification and hybrid schemes, calculate the annual energy consumption met by electric means.

5 Renewable Energy Potential Score — NC - -

Conduct a PV analysis and estimate the amount of energy that can be met by renewable energy deployed on the roof or adjacent grade.

6 Life Cycle Cost Analysis (LCCA) — NC TI -

Conduct an LCCA for relevant energy and building envelope components of the project. For details on LCCA, refer to appendix in USC SDCG. This should be applied to all projects above $5 M in construction value, and for TI projects only as opportunities are available.

Best Practices

7 EUI Reduction Goal — NC TI -

Reduce annual energy consumption by 20% compared to ASHRAE 90.1 baseline (using the current version referenced by LEED), utilizing a mix of the passive and active design strategies detailed within this report and best practice industry guidelines.

LEED v4 EAc2: Optimize Energy Performance

8 Enhanced Commissioning — NC - -

Conduct enhanced commissioning and carefully consider the scope and approach to optimize controls for energy efficiency.

LEED v4 EAc1: Enhanced Commissioning

9 Envelope Commissioning — NC - -

Conduct envelope commissioning and blower door testing to minimize infiltration and conduction gains.

LEED v4 EAc1: Enhanced Commissioning

10 Resilience Strategy — NC - -

Where electrification is deployed, consider resilience strategies for critical process cooling systems (freezer farms, process cooling etc.), heating needs or meeting peak heating demands. Strategies could include back-up electric boilers, or gas boilers intended only for design day conditions or equipment failure.

Required Measures

Aspirational

11 Continuous Commissioning — NC - -

Deploy continuous commissioning and fault diagnostic tools to optimize operations and maintenance and minimize energy consumption.

LEED v4 EApr1: Enhanced Commissioning

12 Aggressive EUI Reduction Goal — NC TI -

Reduce annual energy consumption by 50% compared to ASHRAE 90.1 baseline (using the current version referenced by LEED), utilizing a mix of the passive and active design strategies detailed within this report and best practice industry guidelines.

LEED v4 EAc2: Optimize Energy Performance

Resources

- *ASHRAE 90.1 2019*
- *ASHRAE Advanced Energy Design Guide*
- *ASHRAE Commissioning Guidelines*
- *COMNET Commercial Buildings Energy Modeling Guidelines*
- *California Title 24 – Building Energy Efficiency Standards*
- USC Teams to Engage: Facilities & Planning Management (FPM), FPM University Architect, FPM CCD, FPM FMS

Documentation

- Peak load analysis — - DT -
- Load duration analysis — - DT -
- Electrification feasibility study — - DT -
- Electrification score and renewable energy potential scores — - DT -
- EUI reduction pathway — - DT -

B Passive Design Strategies

Passive design measures seek to minimize peak and annual heating and cooling loads, and allow for the use of natural light, natural ventilation, or an optimized economizer function for free cooling. Effective passive design measures are important as they will typically be an integral part of the building design and will outlive tenant improvements over the life of the building. Given the long-term goals of electrification on campus, priority should be given to strategies that support this goal and should take priority over all other strategies. This would typically prioritize strategies that minimize peak heating loads.

The strategies listed below are part of a toolbox to minimize heating and cooling loads, and, where possible, application should be informed by whole-building energy analysis and an electrification feasibility and peak load reduction study.

Strategies

Minimum Requirements

1 Optimized Program / Layout — NC TI -

The layout of all program elements should be carefully considered, grouping HVAC zones onto AHUs to minimize reheat demands and optimize temperature resets.

2 High Performance Façade — NC TI -

Optimize façade performance to reduce peak heating and cooling loads to facilitate electrification. For new construction, optimize Solar Heat Gain Co-Efficient (SHGC) values and total assembly U-factors on each façade. This may include utilization of vertical and/or horizontal fixed or mechanical shading to optimize passive solar design for diurnal and/or annual climate cycles. Consider envelope upgrades on TI projects as applicable.

3 Transfer Air — NC TI -

For non-regularly occupied and transient spaces, use exhaust and transfer air to minimize reheat needs on interior spaces or design out active conditioning, considering supplemental phase change material to further extend passive operation.

Best Practices

4 Phase Change Material or Exposed Thermal Mass — NC TI -

Apply phase change material in light weight construction above ceilings and in walls to help regulate peak heating and cooling loads. Alternatively, use exposed thermal mass in combination with natural ventilation and night cooling strategies.

5 Expanded Comfort Criteria — NC - -

Employ expanded comfort criteria in naturally ventilated spaces to leverage adaptive thermal comfort and consider opportunities in transient spaces for expanded set-points.

Aspirational

6 Heat Recovery from IT Rooms — NC TI AR

IT rooms have large 24/7 air conditioning requirements. Use heat pumps to provide free heating in lobbies and other areas with high infiltration gains or envelope losses to reduce winter heating.

7	**Ventilated Electrical Rooms** Ventilate electrical rooms with smaller transformers with transfer air, using exhaust with make-up air from adjacent conditioned spaces. Combine this strategy with phase change material in walls to further extend the application to larger electrical rooms.	NC TI -
8	**Natural Ventilation and Mixed Mode** Employ natural ventilation in spaces with low internal gains such as office areas to effectively reduce annual energy consumption.	NC - -
9	**Automated Internal Shading** Use automated internal shading on South and West facades to improve day light utilization, programming them to raise shade levels when spaces are not in direct sun.	NC TI -

Resources

- *ASHRAE 55 (2022 edition), Thermal Environmental Conditions for Human Comfort*
- *Center for the Build Environment Thermal Comfort Tool: CBE Thermal Comfort Tool for ASHRAE-55 (berkley.edu)*
- USC Teams to Engage: Facilities & Planning Management (FPM)

Documentation

- Document expected thermal comfort for any spaces adopting adaptive criteria or deviating from Facilities Design Guidelines. - DT -

C Efficient Systems

Efficient systems are critical to reducing energy consumption and meeting campus goals for decarbonization and carbon neutrality. When combined with electrification, efficient systems will reduce the university's overall carbon footprint and reduce the need for carbon offsets.

Over time, it will also become more important to consider when energy is used to best align with renewable energy production, reduce carbon emissions from peaking power plants, increase resilience of the grid during peak demand events, and understand the need for energy storage.

The strategies in this section focus on planning considerations to support electrification goals rather than specific strategies. This works in unison with the process and passive strategies sections and the primary goal to adopt a process and system choices that facilitate electrification.

Strategies

Minimum Requirements

1	**HVAC Zoning** Optimize the zoning and number of AHUs to minimize reheat and maximize the economizer function. Coordinate the approach with programming efforts.	NC TI -
2	**Economizer Optimization and Temperature Resets** Carefully review multi-occupant spaces with high solar gain and ensure terminal box sizing allows for effective temperature reset of the AHU and ensure designs are optimized for effective deployment of supply air temperature and heating hot water temperature reset strategies.	NC TI -

Best Practices

3	**Efficient HVAC Systems** Where applicable consider alternate HVAC systems (central and terminal unit options), focusing on system choices to minimize peak heat loads to achieve electrification, and incorporate best practice such as low fan power design and heat recovery on outside air (OSA).	NC TI -
4	**Minimize Domestic Hot Water Recirculation Losses** Provide optimum recirculation design adjacent to fixtures to minimize water waste and dead legs and consider PEX piping, pipe insulation, point-of-use electric tankless water heaters, or other alternative materials to limit heat loss.	NC TI -
5	**Optimized Daylighting and Lighting Design** Complete daylight analysis to optimize glass selection, internal and external shade options and specifications and to maximize daylight dimming potential. LEED v4 IEQc7: Daylight	NC TI -
6	**Performance Based IAQ Approach** In conjunction with indoor air quality monitoring, provide control strategies or filtration and air treatment options to best balance indoor air quality, peak loads and annual energy consumption. LEED v4 IEQc4: Indoor Air Quality Assessment	NC TI -

Required Measures

Resources

- *ENERGY STAR Guide to Energy-Efficient Heating and Cooling*
- USC Teams to Engage: Facilities & Planning Management (FPM)

Documentation

• Provide a space by space load summary summarizing occupant and solar gains along with VAV terminal oversizing factor for solar driven spaces	-	DT	-

D Plug Loads, Controls, and Performance

Minimizing plug loads, providing adaptive demand response, and occupancy-based controls allows for optimization of passive demand strategies and can help manage peak loads. When combined with sub-metering and energy dashboards, this can help optimize controls and set-points, ensure buildings operate as intended, and safeguard that energy performance goals are maintained over time.

Strategies

Minimum Requirements

1	**Demand Response** Provide demand response capability to dim lighting and adjust temperature set-points in response to a utility or campus demand response action.	NC	TI	-
2	**Occupant-Based Controls** Provide vacancy-based controls for HVAC systems to turn off VAV terminals when spaces are vacant, and temperature set-points are met. Provide occupancy-based controls for lighting.	NC	TI	-
3	**Lab Measures** Specify only ultra-low temperature freezers that are high-efficiency. Provide visual indicators for occupants regarding optimal sash hood opening height settings to maximize safety and minimize unnecessary air exchanges. Build sterilization autoclaves into energy modeling to determine if optimal solution is self-contained autoclaves or autoclaves connected to building domestic hot water or recovered heat.	NC	TI	-

Best Practices

4	**Sub-Metering of Energy** Provide electrical and thermal BTU meters to sub-meter 80% of energy by end use. LEED v4 EAc3: Advanced Energy Metering	NC	-	-

Resources

- *California Public Utilities Commission Demand Response website*
- *California Energy Commission 2019 Nonresidential Compliance Manual - Appendix D Demand Response*
- *ENERGY STAR Submetering Energy Use in Colleges and Universities*
- USC Teams to Engage: Facilities & Planning Management (FPM), Environmental Health & Safety (for labs)

Documentation

• Document demand response strategies in control strategies and summarize on the project lead sheet.	-	DT	-
• Ensure an update to date sub-meter list is provided within the electrical contract documents and final as-designed and as-built documentation.	-	DT	-

E Electrification, Decarbonization and Renewables

Decarbonization of the university's building stock is part of broader campus climate goals, and important to reduce local pollution impacts and avert a climate emergency. In 2021, LADWP collaborated with the National Renewable Energy Laboratory (NREL) to explore pathways for the city to achieve a 100% clean energy future. The results of this assessment (LA100) show that meeting LA's goal of 100% renewable electricity by 2035/45 is achievable and would require rapid deployment of wind, solar, and storage technologies.[ii] USC has considered the findings of this study while developing these Sustainable Design & Construction Guidelines.

The following strategies will move the campus towards carbon free operation, implementing quick wins and ensuring buildings are electrification ready for future conversion. While USC is prioritizing electrification, applicability for a given project will need to be addressed on a project-by-project basis. Please refer to the process section above to review required feasibility studies for determining if electrification is the appropriate for specific projects.

Strategies

Minimum Requirements

1	**All Electric Cooking** All kitchenettes and commercial kitchens shall use electric or induction cooking.	NC	TI	AR
2	**All Electric Domestic and Industrial Hot Water** All projects shall use either point of use electric water heaters, storage type electric water heaters or heat pump water heaters for domestic hot water production.	NC	TI	AR

Required Measures

3 Renewable Energy Ready — NC TI -

All projects shall allow sufficient space for switches, empty conduit and PV controllers and provide adequate sizing of bus bars based on available space for PV and document a PV attachment strategy.

4 Electrification — NC TI AR

For NC & MR projects that are not connected to the central plant heating systems, design for full electrification.

For NC & MR projects fed from the central heating plant, ensure buildings are design to be electrification ready.

For TI or Asset renewable projects, ensure electrification ready requirements are followed.

5 Electrification Ready — MR TI -

Where electrification is not feasible, size local heating coils suitable for 115°F entering water temperature and distribution pipework for suitable delta T's to accommodate future electrification and don't take any actions that would preclude electrification.

Best Practices

6 Low Global Warming Potential (GWP) Refrigerants — NC - -

Where technology is available, specify low GWP refrigerants for local split units, hot water heat pumps, packaged HVAC equipment or heat pumps.

LEED v4 EAc6: Enhanced Refrigerant Management

Aspirational

7 On-Site Renewable Energy — NC TI -

Deploy solar PV on building rooftops and parking lot arrays, maximizing solar production.

LEED v4 EAc5: Renewable Energy Production

8 Thermal Energy Storage — NC - -

Where load profiles and HVAC strategies align, consider hot water, chilled water and condenser water storage to balance loads, or plan for installation as part of a future electrification approach.

9 Battery Energy Storage — NC - -

Where there are broader resilience benefits, consider battery energy storage solutions, and balance operation between economic benefits, carbon reduction and peak load shaving.

Resources

- *Lawrence Berkely National Labratory Paper (2018): Electrification of buildings and industry in the United States*
- *TRANE Next Generation Refrigerants*
- USC Teams to Engage: Facilities & Planning Management (FPM)

Documentation

- Document renewable energy ready strategies in construction documents — - DT -
- Document electrification ready strategies — - DT -

Endnotes

- i. IPCC, 2022: Summary for Policymakers. In: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdaji
- ii. NREL, 2021, LA100: The Los Angeles 100% Renewable Energy Study, https://maps.nrel.gov/la100/report

3.5 Water

Overview

Water conservation is critical for USC given the water stress and frequent droughts within the State of California. California and the City and County of Los Angeles have adopted legislation to address the water crisis, including California Assembly Bill 1668 which aims to reduce indoor residential water use through supplier limitations. LA County's Sustainability Plan also sets per capita water demand limits starting in 2025 and continuing through 2045. The City of LA Existing Buildings Energy and Water Efficiency (EBEWE) Ordinance requires annual water consumption benchmarking for existing buildings over 20k square feet. Lastly, the City of LA has set various targets for 2035, including sourcing 70% of LA's water locally and recycling 100% of wastewater. When developing these guidelines, the university aimed to support the state and city in is potable water use reduction goals.

Currently, water conservation and sustainability efforts at USC are focused on landscaping & irrigation, high efficiency fixtures, and improved data collection. In 2021, USC's FPM team launched a landscape & grounds advisory committee to coordinate input into development of university landscape guidelines that will address reduced irrigation-based water use through efficiency improvements and drought tolerant landscaping.

Amongst other efforts, FPM is also undertaking a water sub-metering program with the goal of collecting local data at the UPC campus to better track and reduce usage. This section of the guidelines should be considered alongside the site and landscape section, which provides further opportunities for reducing potable water use.

Assignment: Earth Goals

The university has set the following goals to reduce water demand on campus. Project teams should consider all opportunities to minimize water use in the design, construction, and operation of facilities. Goals from the Assignment: Earth are as follows:

- USC will achieve a 20% potable water use reduction per square foot of total campus building space by FY 2028 (FY 2014 baseline)
- USC will establish a publicly accessible online dashboard to track sustainability resource metrics by FY 2023

Required Measures

A Process, Efficiency, Recycling and Reuse

The strategies below address minimum fixture design standards, outline the process for assessing and applying reuse on projects that may have significant gray water available, and requirements for sub-metering. Building scale water recycling beyond the recommendations outlined in this section are currently not being considered due to space constraints on projects, operation, and maintenance challenges with distributed systems.

Strategies

Minimum Requirements

1 LEED v4 Integrative Process Requirement — NC - -

For residential & recreational buildings or where there are more than 8 showers complete a water budget to inform water recycling opportunities.

LEED IPc1: Integrative Process

2 Water Metering — NC - AR

Implement water sub-meters by major end use (irrigation, process, potable water) and tie into the BMS and where applicable dashboard systems for monitoring.

LEED WEpr3: Building-Level Water Metering & LEED WEc4: Water Metering

3 Reduce Indoor Water Use (20%) — NC - -

Reduce indoor water use 20% from calculated baseline* for all new construction projects.

4 Low Flow Fixture Standards — NC TI AR

Do not exceed maximum flow rates per the following USC design standards:

- Lavatories (commercial): 0.35 GPM aerating faucet
- Water Closets: 1.28 GPF
- Showers: 1.8 GPM
- Urinals: 0.125 GPF

LEED WEpr2 & WEc3: Indoor Water Use Reduction

5 Alternatives to Single Pass Cooling — NC TI -

Design for alternatives to single pass cooling in wet labs and discourage or eliminate all single pass cooling.

Best Practices

6 Gray Water in Residential, Recreational, or Athletic Facilities — NC - -

Use water budgets to inform graywater recycling opportunities and evaluate reuse for irrigation or toilet flushing.

Aspirational

7 Passive Condensate Re-Use with Xeriscaping — NC - -

For buildings with large condensate generation, consider opportunities to discharge into external planters to reduce permanent irrigation needs.

8 Water Recycling within Laboratories — NC - -

Evaluate opportunities to capture and recycle reverse osmosis (RO) and deionization (DI) discharge with condensate and graywater for reuse for irrigation or other non-potable demands.

9 Rooftop Water Capture — NC - -

Evaluate opportunities to capture rooftop rainwater for reuse and implement such systems where feasible.

*Baseline for indoor water use should be calculated using LEED indoor water use calculator

Resources

- *LEED Indoor Water Use Calculator*
- *GBCI Water Use Reduction Additional Guidance*
- *WaterSense Water Budget Tool*
- USC Teams to Engage: Facilities & Planning Management (FPM)

Documentation

- Water budget — - DT -
- Plumbing fixture cutsheets demonstrating flow rates — - DT -

3.6 Materials

Overview

Materials and their lifecycles have an incredible impact on the health of our planet, as well as the people who inhabit it. USC already knows the importance of quality material selection, as evidenced by the commitment to building with durable, long-lasting exterior materials as well as an Adaptive Mitigation Management Approach that sets the stage for building conservation, adaptation, and reuse of its historic resources. Additionally, the City of Los Angeles Green Building Code establishes a high baseline for VOC levels and recycled content.

The material strategies outlined in this section highlight high impact opportunities for FPM to work with USC colleagues as well as project teams to reach institutional goals within project budgets and resources. Many strategies are complimentary either in anticipated outcomes, documentation requirements, or evaluation processes. Project teams should also review the waste section of the guidelines for further guidance on promoting circularity.

Assignment: Earth Goals

The university has set the following goals to reduce the carbon footprint of the campus and its buildings and support the health of the campus community. Project teams should consider all opportunities to minimize carbon in the design, construction, and operation of facilities, and to select healthy materials. Goals from the Assignment: Earth framework are as follows:

- Complete an assessment of scope 3 embodied carbon in all new major construction projects, and pursue design and construction strategies for reducing that embodied carbon
- Model the embodied carbon of the existing physical campuses
- Facilities Design Guidelines to incorporate health and wellness strategies into facilities designs by FY 2023
- USC will establish a publicly accessible online dashboard to track sustainability resource metrics by FY 2023

Required Measures

A Human Health

Chemicals enter our bodies through inhalation (through the lungs), ingestion (through the mouth), and absorption (through the skin). The connection between building materials and finishes and the chemicals included in them is becoming ever clearer, especially those impacting air quality in interior environments. For project teams to best be able to select, specify and install healthy materials, transparent chemical data is needed from manufacturers, yet this information is only beginning to be provided. Institutions like USC can help create the industry demand for this data transparency.

The strategies listed below focus on avoiding known materials and chemicals of concern, then on increasing the chemical transparency of common building materials, and finally on optimizing the actual materials selected for a project as well as supporting the development of new healthy, sustainable materials.

Strategies

Minimum Requirements

1 Install Reflective or Vegetated Roofs — NC - AR

Minimize urban heat island effect on and around campus by using cool roofing materials aligned with LEED Credit criteria when project scope and location within campus allows. This strategy would work in tandem with the specification of non-roof areas listed in the Site Strategies section of this document.

LEED v4.1 SS Heat Island Reduction

2 Specify Low-Emitting Materials — NC TI AR

Specify VOC limits (emissions, content and/or threshold) in alignment with LEED Credit criteria for a minimum of four key product categories including paints and coatings, adhesives and sealants, composite wood, and at least one additional category

LEED v4.1 EQc Low Emitting Materials

Best Practices

3 Report Material Ingredients — NC TI AR

Require project teams to submit chemical ingredient transparency data from manufacturers using programs recognized by LEED Credit criteria, such as Healthy Product Declaration (HPD), Declare, or Cradle to Cradle, for a minimum of twenty products from at least five manufacturers.

LEED v4.1 MRc Material Ingredients

Aspirational

4 Avoid Living Building Challenge (LBC) Red List Materials: — NC TI AR

Avoid LBC Red List materials, chemicals and elements for architectural products included in MasterFormat Specification Sections 03 – 12 in alignment with the LBC Materials Petal requirements.

5 Optimize Material Ingredients — NC TI -

Incorporate at least five materials from three different manufacturers that have a compliant material ingredient optimization report, in alignment with LEED v4.1 MRc Material Ingredient Credit.

LEED v4.1 MRc Material Ingredients

6 Research and Develop — NC TI AR

Partner with faculty, staff, researchers and/or industry partners to pilot a new sustainable material, then track and share its performance.

Resources

- *LBC Red List*
- *LBC Materials Petal*
- *Healthy Building Network*
- *Healthy Building Network's "Home Free" site*
- *Mindful Materials for Compliant Products*
- *Sustainable Minds Transparency Catalog for Compliant Products*
- *LEED v4.1 Building Products Calculator*
- USC teams to engage: USC Facilities Planning & Management (FPM), Procurement

Documentation

Location and identification of cool roof areas and calculation demonstrating percent of total roof area.	-	DT	-
Manufacturer documentation indicating product's chemical inventory, and optimization report where applicable.	-	-	CT
Statements of product compliance with stated VOC limits.	-	-	CT
HPD, Declare, or Cradle to Cradle documentation (Best Practices and Aspirational)	-	-	CT

B Social Health & Equity

Human rights abuses and violations of decent work conditions including, but not limited to, child labor, discrimination, barriers to freedom of association, and disregard for worker health and safety occur globally in the supply chains of many goods, including building products. A supply chain begins at the point of extraction and ends at the location of final manufacture or assembly, in this case, in the densely populated metropolis of Los Angeles that USC calls home.

Required Measures

USC plays a significant role in the health of its local, regional, and state communities and economies. As primary decision-makers on material and product selection, FPM and its project teams therefore also have a major role, and hence opportunity, in supporting economic and community health both near and far by incorporating strategies that prioritize equitable, healthy supply chain and procurement policies.

Strategies

Best Practices

1 Support the Local Economy — NC TI AR

Prioritize and specify materials sourced from within 100 miles of the project site as recognized by LEED Credit criteria for Location Valuation Factor.

LEED v4.1 MRc Sourcing of Raw Materials

2 Reinforce State Priorities — NC - -

Specify materials with Global Warming Potentials (GWP) that do not exceed the limits set by the Buy Clean California Act. Eligible materials currently include structural steel, concrete reinforcing steel, flat glass, and mineral wool board insulation.

Aspirational

3 Expand the Regional Economy — NC TI AR

Utilize materials and consulting services that meet requirements of LBC's Material Petal Living Economy Sourcing Imperative.

4 Support Social Equity within the Supply Chain — NC TI -

Track sustainable resource extraction and/or fair labor practices within the supply chain for at least 3 products or companies using criteria defined by LEED Pilot Credit and/or LBC's Material Petal Responsible Industry Imperative.

LEED v4.1 IPpc144 Social Equity within the Supply Chain

5 Promote Diverse Suppliers — NC TI AR

Source, procure, and set requirements for builders to procure a minimum of 15% of their subcontractors from diverse and/or small suppliers to support USC's university-wide Goal to Procure with Diverse Suppliers and Small, Local Suppliers.

Resources

- USC Small Business Diversity Office
- Buy Clean California Act
- LBC Material Petal Living Economy Sourcing Imperative
- LEED v4.1 Building Products Calculator
- USC teams to engage: USC Facilities Planning & Management, Procurement, USC Small Business Diversity Office

Documentation

- Manufacturer documentation indicating expanded product data, as applicable based on chosen strategy(ies) — - - CT
- Sub-contractor list, also indicating which subcontractors meet USC's Goal to Procure with Diverse Suppliers and Small, Local Suppliers. — - - CT

C Climate & Environmental Health

Building and construction materials generate over 11% of annual global CO_2 emissions, and a significant portion the emissions from new construction will come from the CO_2 emitted in production of just three materials: concrete, steel, and aluminium.[i] Additionally, the extraction, manufacture, and assembly of building materials often negatively impact the environment by causing air and water pollution, soil degradation, and habitat destruction along the supply chain.

The strategies below focus on two main goals: the immediate need to reduce carbon emissions and ultimately sequester more carbon than emitted, and the importance of using building materials which restore environmental health through the responsible use of natural resources. To do either of those things, the industry must increase the demand for product transparency and factor in the true long-term costs of the material choices made – one project at a time.

Strategies

Minimum Requirements

1 Request Environmental Product Declarations (EPDs) — NC TI AR

Request EPDs for at least twenty different products sourced from at least five different manufacturers. For Asset Renewal projects with less than twenty products, request EPDs for all products.

LEED v4.1 MRc Environmental Product Declarations

2 Conduct a Life Cycle Analysis (LCA) — NC - -

Conduct an LCA for structure and envelope components of the project scope to quantify the project's baseline and proposed embodied carbon demonstrating some reduction between baseline and proposed.

LEED v4.1 MRc Building Life-Cycle Impact Reduction

For details on LCA, refer to appendix in USC SDCG.

Required Measures

3	**Specify Low Carbon Materials** Incorporate materials that minimize embodied carbon by having one or more of the following characteristics: salvaged, reused, refurbished, recycled, biobased as recognized by LEED Credit criteria. LEED v4.1 MRc Sourcing of Raw Materials	NC TI AR	

Best Practices

4	**Select Materials Using EPDs** Require EPDs for at least twenty different products sourced from at least five different manufacturers. LEED v4.1 MRc Environmental Product Declarations	NC TI AR
5	**Demonstrate Embodied Carbon Reduction in Structure and Envelope** Conduct an LCA for structure and envelope components of the project scope to quantify the project's baseline and demonstrate a minimum 15% reduction in the proposed design's embodied carbon for these building elements. LEED v4.1 MRc Building Life-Cycle Impact Reduction For details on LCA, refer to appendix in USC SDCG.	NC - -
6	**Life Cycle Cost Analysis (LCCA)** Conduct an LCCA for energy and water components of the project. For details on LCCA, refer to appendix in USC SDCG.	NC TI AR
7	**Specify 30% Low Carbon Materials** Incorporate materials that minimize embodied carbon by having one or more of the following characteristics: salvaged, reused, refurbished, recycled, biobased as recognized by LEED Credit criteria. LEED v4.1 MRc Sourcing of Raw Materials	NC TI AR

Aspirational

8	**Optimize Materials Using EPDs** Collect and compare EPDs to optimize final product selection for at least five products from at least three manufacturers. LEED v4.1 MRc Environmental Product Declarations	NC TI AR
9	**Demonstrate Project Embodied Carbon Reduction** Expand LCA to include components listed in LEED Pilot Credit criteria, in addition to the structure and envelope. Demonstrate a minimum 15% reduction in the proposed design's embodied carbon. LEED v4.1 MRpc132 Procurement of Low Carbon Construction Materials For details on LCA, refer to appendix in USC SDCG.	NC TI -
10	**Life Cycle Cost Analysis (LCCA)** Expand on the baseline LCCA to include structural and building envelope components. For details on LCCA, refer to appendix in USC SDCG.	NC - -
11	**Sequester Carbon** Incorporate at least one material or design strategy that sequesters carbon.	NC - -

Resources

- *AIA Guide to LCA*
- *Tally, LCA Tool Resource*
- *Building Transparency and EC3, Embodied Carbon Resource*
- *LEED v4.1 Building Products Calculator*
- USC teams to engage: USC Facilities Planning & Management

Documentation

LCA Preliminary and Final Reports	- DT -
LCCA Summary Report	- DT -
Manufacturer documentation indicating expanded product data, as applicable based on chosen strategy(ies)	- - CT
Environmental Product Declarations	- - CT

Endnotes

- i. International Energy Agency. 2019 global status report for buildings and construction: towards a zero-emission, efficient and resilient buildings and construction sector. (2019).

3.7 Waste

Overview

The supply chain economy today is linear: natural resources are extracted, processed, sold, used by consumers, and eventually disposed of – usually in a landfill. This model cannot be sustained in a world with finite resources and an ever-increasing urgency to protect and regenerate earth's natural and social capital.

In 2018 the United States generated close to 300 million tons of municipal solid waste (MSW).[i] Of this, only 31% was recycled or composted. In 2020 California achieved a 42% recycling/composting rate. Although above average, this was a significant shortfall compared to the statewide target of 75% diversion.

USC has been working to reduce waste generation on campus through the expansion of waste diverting infrastructure, behavioral campaigns, and the development of an integrated Zero Waste Management Plan. This effort is now being expanded through the integration of waste minimization best practices into our SDCG. These guidelines aim to align the university with California's waste targets and move USC toward Zero Waste. The recommendations that follow pertain to the circular economy, construction & demolition (C&D waste), and operational waste.

Assignment: Earth Goals

The university has set the following goals to reduce Municipal Solid Waste (MSW) on campus. Project teams should consider all opportunities to minimize waste in the design, construction, and operation of facilities. Goals from Assignment: Earth are as follows:

- Achieve Zero Waste (90% diversion rate) by 2028
- Achieve 30% aversion (reduction in total waste generated)
- Convert at least two additional material streams annually to more circular or closed loop systems
- USC will establish a publicly accessible online dashboard to track sustainability resource metrics by FY 2023

Required Measures

A Circular Economy

The current linear economic model must be transitioned into a circular flow to preserve earth's natural resources and prevent the negative economic, environmental, and social impacts of waste. This requires reusing, repairing, refurbishing, and recycling wherever feasible to keep products in circulation and reduce the need for new raw material. To be successful, we must design our facilities and the products and systems within them with circularity in mind.

In the context of these guidelines, USC should prioritize circular material flows, adaptive reuse, and design for deconstruction principles within the design and construction process.

Strategies

Minimum Requirements

1	**Furniture, Fixture & Equipment (FF&E) Standardization** Until such time that USC develops and adopts standard FF&E specifications, include furniture, fixtures, and equipment in project FF&E specifications and analyses that promote reuse, recycled content, and the ability to repair, refabricate, and/or recycle/compost at end of life.	NC TI -
2	**Product & Material Reuse** Prioritize products, materials, equipment, and other interior / non-structural elements that are durable, can be easily repaired, and, if needed, readily recycled. Minimize custom FF&E. For demolition projects, recover any standardized hardware that can be used as stock for maintaining other buildings. LEED v4 Commercial Interiors MR – Interiors Life Cycle Impact Reduction	NC TI AR

Aspirational

3	**Structural Adaptability & Reuse** Design for flexibility, modularity, and ease of future adaptation. Prioritize and celebrate renovation, retrofits, and reuse of existing building structures or structural elements. LEED v4.1 Innovation – Design for Flexibility, LEED v4 MRc5 – Building Life-Cycle Impact Reduction	NC TI AR
4	**Design for Deconstruction** Design with end life of building and circularity in mind, selecting materials with potential for deconstruction and ultimate reuse in future facilities. Minimize the use of parts, glues, fasteners and consider how disassembly instructions and reuse pathways can be provided for newly constructed and/or renovated facilities.	NC TI AR

Resources

- *Circular Economy Practitioners Guide: Design for Flexibility*
- *Ellen Macarthur Foundation: Circulytics Tools and Resources*
- USC teams to engage: USC Facilities Planning & Management (FPM), Procurement, Surplus, Environmental Health & Safety (EHS)

Documentation

List of products/materials planned for use that can be recycled or reused	- DT -
List of structures/structural elements that were repurposed for the project	- DT -

B Construction & Demolition Waste

When addressing building related waste generation we must consider the full life-cycle of a building. In 2018, 600 million tons of C&D debris was generated in the United States[i]. This is more than twice the amount of Municipal Solid Waste produced in the same year.

CALGreen has established a minimum of 65% C&D waste diversion in the state of California. The USC campus guidelines require 75% diversion as a minimum target for C&D waste, and the campus overall is aiming for 90% waste diversion (i.e. Zero waste). The following sustainable design recommendations provide best practices for mitigating C&D waste at USC. These include the diversion rate requirement as well as strategies such as waste stream identification & separation and the use of manufacturer take back programs.

Strategies

Minimum Requirements

1	**Divert 75% of C&D Waste** Divert at least 75% of non-hazardous construction and demolition material by weight or volume.	NC TI AR
2	**Source Separate 3 Construction Waste Streams** These material streams may include concrete, wood, asphalt, gypsum, metals, brick, glass, plastics, salvaged building components (doors, windows, fixtures, etc.), landscaping items (trees, stumps, soil, rock, etc.). LEED v4 MRc5 – Construction & Demolition Waste Management, LEED v4 MRp2 – Construction and Waste Management Planning	NC TI AR
3	**Source Separate Municipal Solid Waste** Require the collection and separation of recycling and organics waste generated by construction crew	NC TI AR

Required Measures

Best Practices

4	**Source Separate 4 or more Construction Waste Streams** These material streams may include concrete, wood, asphalt, gypsum, metals, brick, glass, plastics, salvaged building components (doors, windows, fixtures, etc.), landscaping elements (trees, stumps, soil, rock, etc), etc. LEED v4 MRc5 – Construction & Demolition Waste Management, LEED v4 MRp2 – Construction and Waste Management Planning	NC TI AR	
5	**Manufacturer Take-Back Programs** Leverage manufacturer/supplier sponsored takeback programs prior to demolition to mitigate waste generation at building end-of-life. For example: Mohawk Group Carpeting and Armstrong Ceiling Tiles. Additionally, require take-back of packaging from materials suppliers during construction.	NC TI -	

Aspirational

6	**Divert 90% of C&D Waste** Divert at least 90% of non-hazardous Construction and Demolition (C&D) material by weight or volume.	NC TI AR
7	**Divert 90% of MSW Waste** Divert at least 90% of non-hazardous Municipal Solid Waste (MSW) by weight or volume during construction activities.	NC TI AR

Resources

- *CALGreen Construction Waste Management Requirements*
- *USGBC: Guide to Defining Waste Streams*
- *Example manufacturers with takeback programs:*
  - *Ceiling tiles: Armstrong, USG, CertainTeed*
  - *Carpet: Mohawk, Interface, Starnet*
  - *Flooring: Tarkett*
- USC teams to engage: USC Facilities Planning & Management (FPM), Procurement, Surplus, Environmental Health & Safety (EHS)

Documentation

- C&D Waste Management Plan - - CT
- Final project C&D and MSW waste diversion rate - - CT

C Operational Waste

USC's ambition of Zero Waste will require changes in materials consumed on-site, occupant behavior, and the infrastructure used for collection and processing of recycled, composted, or landfilled waste streams. USC has had the opportunity to build on its existing diversion efforts, such as organics and liquids collection, while considering new opportunities for reduction within its facilities.

Strategies in this section focus on opportunities to divert and reduce waste as a part of facility design. These include allocating dedicated space within facilities to collect and store waste including recycling and organics, providing consistent and informational signage to promote sustainable occupant behavior, and using technology to make the most of limited space and resources.

Strategies

Minimum Requirements

1	**Recycling & Organics Collection** Provide recycling and organics collection, storage, and adequate ingress/egress space for hauler activities at all facilities. This may include space that is allocated to improve on-site waste management. This strategy is required by law in California, through SB 1383 for organics and AB 341 & 939 for recycling. LEED V4.1 MRp1 - Storage and Collection of Recyclables	NC TI -
2	**Waste Signage** Provide consistent and educational waste signage throughout the site to inform occupants about facility waste management best practices and improve waste disposal behaviors.	NC TI -

Required Measures

Best Practices

3	**Liquids Collection** Provide indoor and outdoor liquids collection equipment such as bins to allow for proper disposal of used oil, liquids, fats, sludges, etc., particularly near food service and residential facilities	NC TI -

Aspirational

4	**On-Site / Demonstrative Composting** Provide appropriate space and equipment (i.e. dehydrators) to allow for and promote on-site composting. Design allocated indoor/outdoor space to demonstrate composting best practices to occupants and visitors. LEED v4.1 Pilot – Comprehensive Composting	NC TI -
5	**Smart Bins** Consider utilizing waste bins with integrated technology elements such as waste compression and/or waste tracking systems. This strategy is best suited for areas with high traffic and higher waste volumes (i.e. food service)	NC TI -

Resources

- *Relevant policy requirements:*
  - *CA Senate Bill 1383: Mandatory Organics Recycling*
  - *CA Assembly Bill 939: 50% Diversion Requirement*
  - *CA Assembly Bill 341: Mandatory Recycling Services & Goal of 75% Diversion*
- *AIA New York Zero Waste Design Guidelines: Zero Waste Calculator*
- USC teams to engage: USC Facilities Planning & Management (FPM), Environmental Health & Safety (EHS)

Documentation

• Verification of material types to be recycled or composted	- DT -
• Description of recycling/composting storage and collection strategies (including the use of smart bins)	- DT -
• Floor plans indicating recycling/composting storage and collection areas.	- DT -
• Site plans indicating adequate ingress/egress for hauler activities related to emptying and/or replacing bins, compactors.	- DT -
• Copy of signage for recycling, liquids, and compost	- DT -

Endnotes

- i. "Advancing Sustainable Materials Management - Epa.gov." Advancing Sustainable Materials Management: 2018 Fact Sheet, US EPA, Dec. 2020, https://www.epa.gov/sites/default/files/2021-01/documents/2018_ff_fact_sheet_dec_2020_fnl_508.pdf.

3.8 Occupant Comfort

Overview

Designing, building, and maintaining healthy & comfortable buildings is essential to creating sustainable campuses at USC. Given humans spend over 90% of their time indoors[i], there is an evident link between human health and the indoor environment. Project teams must consider the health impacts of USC facilities on current and future students, staff, and faculty. By implementing design strategies focused on creating healthy and comfortable indoor spaces, USC can strive to improve mental health, physical health, and productivity for these building occupants. In addition to designing healthy and comfortable indoor spaces, USC must also mitigate potential exposure to chemicals, dust and other pollutants during building construction, renovation, and operation.

This section is intended to give minimum requirements, best practice, and aspirational design strategies that can help the campus meet its "Assignment: Earth" goal of incorporating health and wellness strategies into its facilities designs. The recommendations that follow aim to create healthy and comfortable indoor environments by requiring a focus on health and wellbeing in the design, construction, or renovation of facilities on campus. It should be noted that other strategies that improve health, wellbeing and comfort are addressed throughout the guidelines in applicable sections (e.g. landscape, energy, etc.). This section encompasses the strategies the university wants considered that do not slot into the other topic areas.

Assignment: Earth Goals

The university has set a university goal to improve health and wellness on campus. Project teams should consider all opportunities for related improvements in the design, construction, and operation of facilities. The Assignment: Earth goal is as follows:

- USC will update its Facility Design Guidelines to incorporate health and wellness strategies into facilities designs by FY 2023
- USC will establish a publicly accessible online dashboard to track sustainability resource metrics by FY 2023

Required Measures

A Occupant Health & Wellbeing

The following design recommendations intend to contribute to student, faculty, staff, and visitor health & wellbeing. Strategies include promoting physical and mental health through active and restorative design and improved Indoor Air Quality (IAQ) during construction and building operation. Please reference the existing FPM design guidelines to ensure compliance with accessibility requirements under ADA.

Strategies

Minimum Requirements

1 Construction Indoor Air Quality (IAQ) Management — NC TI AR

Develop a Construction IAQ Management plan and implement control measures to meet or exceed SMACNA's guideline recommendations.

LEED v4.1 IEQc3 – Construction Indoor Air Quality Management Plan

Best Practices

2 Active Design — NC TI -

Design buildings to encourage physical movement and social connection. Provide visibility and access to stairwells and incorporate inviting elements into these spaces (e.g. art, music/acoustics, etc.) and provide active and social work and recreation areas (e.g. standing desks, communal areas, etc).

LEED v4.1 Innovation – Design for active occupants

3 Biophilic Design — NC TI -

Incorporate elements of nature into the indoor environment as (e.g. green features, water features, biophilic artwork). Provide occupant access to "Nature in the Space" or "Natural Analogues" as defined in 14 Patterns of Biophilic Design. Conduct at least one design session focused on identifying such biophilic opportunities.

LEED v4.1 EQpc123 - Designing with Nature, Biophilic Design for the Indoor Environment

4 Permanent IAQ monitors — NC TI -

Install monitors that test the air quality for temperature, relative humidity, particulate matter (PPM2.5), CO2, and VOCs. Prioritize PPM and VOC monitors in open plan office areas, ensuring each AHU system is covered. Develop a remediation plan if any of the WELL precondition thresholds are exceeded.

WELL v2: Air FA01 – Air Quality

5 Operable Windows — NC TI -

Incorporate operable windows into design to increase natural ventilation and provide occupant controls in every regularly occupied space.

WELL v2: Air F07 – Operable Windows

6 Maintenance Staff Health and Wellbeing: — NC TI -

Consider maintenance staff health and wellbeing in the design of facilities so as to maximize comfort and wellbeing during waste management, cleaning, equipment maintenance, and more. This may include providing adequate service space, and ensuring access and sufficient lighting in equipment rooms

Aspirational

7 Restorative Spaces — NC TI -

Provide restorative environments that promote relief from mental fatigue and stress. These spaces could be dedicated single or multipurpose rooms or courtyards in alignment with the WELL certification framework.

WELL v2: Mind M07 – Restorative Spaces

Resources

- *Sheet Metal and Air Conditioning National Contractors Association (SMACNA): IAQ Guidelines for Occupied Buildings under Construction, 2nd edition, 2007, ANSI/SMACNA 008-2008, Chapter 3*
- *ANSI/ASHRAE Standard 62.1 Ventilation for Acceptable Indoor Air Quality*
- *Terrapin - 14 Patterns of Biophilic Design*
- *Living Future - Biophilic Design Guidebook*
- *Confluence Builders: Denver School of Science & Technology - Example Construction IAQ Management Plan*
- USC Teams to Engage: USC Healthy Campus Program, FPM University Architect, FPM CCD and FPM FMS

Documentation

Floor Plans indicating location of relevant features (e.g. IAQ monitors, stairwells, restorative spaces, operable windows, etc.)	-	DT	-
Control diagrams for IAQ monitors	-	DT	-
Construction IAQ Management Plan	-	-	CT

Endnotes

- Environmental Protection Agency. (n.d.). Report on the Environment: Indoor Air Quality. EPA. Retrieved May 13, 2022, from https://www.epa.gov/report-environment/indoor-air-quality

4 Appendices

4.1
Life Cycle Cost Analysis

Introduction

Life Cycle Cost Analysis (LCCA) is the process of assessing the total cost of owning, operating, maintaining, and disposing of a building or building system. LCCA is useful for comparing design alternatives that have different initial and operating costs, to assess which option is most cost effective over the lifetime of the project. It is important for an LCCA to be completed early in design, ideally during Schematic Design (SD) or prior to the start of Design Development (DD), to compare alternatives and choose the best option before the design is too far along.

LCCA Study Categories

Life Cycle Cost Analyses can be conducted for a variety of systems, technologies, and material choices. Project teams should consider conducting an LCCA for items in the following study categories:

- **Mechanical systems:** air distribution systems, water distribution systems, central plant equipment and piping, heating and cooling systems (chilled beams, boilers, radiant systems, heat exchangers, etc.)
- **Energy systems:** renewable energy infrastructure, microgrid options, all-electric equipment options
- **Electrical systems:** lighting sources and controls, electricity distribution systems, submetering options
- **Building envelope:** insulation options, glazing/daylighting/shading options, roofing systems

LCCA Project Scopes

Life Cycle Cost Analyses can be applied to any of the following project scopes:

- **Individual building systems**
- **New construction building designs**
- Major or minor **building renovation designs**
- Campus **"neighborhood" infrastructure decisions**
- Facility and campus **development and renovation master plans**

Objectives for an LCCA

Life Cycle Cost Analyses can have different objectives, depending on what the project team is using the LCCA to decide:

- **Accept or reject** a single project or system option
- Select an **optimal performance level** for a building system
- Select an **optimal system type** from competing alternatives
- Select an **optimal combination and/or phasing** of interdependent systems
- Select an **optimal scale** for a system that provides a service (floor, building, campus "neighborhood", or campus)
- **Rank competing projects** to allocate a limited budget

Conducting an LCCA

It is recommended that project teams follow the National Institute of Standards and Technology's Life Cycle Costing Manual for the Federal Energy Management Program (NIST Handbook 135, 2020 Edition) for conducting an LCCA. The manual details the LCCA process from start to finish, and includes guidance on evaluating energy efficiency, water conservation, and renewable energy projects (Chapter 11) and on evaluating sustainability (Chapter 12) and resilience (Chapter 13) projects. Some of the key steps included in the NIST Handbook are listed below:

1 LCCA Set-up

a. **Preliminary considerations:** As LCCAs can range widely in complexity, it is important to define the timeline, level of detail, and the quantity and type of documentation for the analysis upfront, so that all parties are on the same page about how to conduct the LCCA and what type of results it will generate.

b. Define the project scope and objective: Choose between options within the LCCA Project Scopes section above to define the scope for analysis, and choose between objectives, or desired outcomes of the LCCA, from the Objectives for an LCCA section.

c. Identify feasible alternatives: For each system being evaluated with an LCCA, there should be at least one alternative option chosen for comparison that meets the same technical and performance-based requirements.

d. Set the study time horizon: The study time horizon is the length of time for which life-cycle costs are evaluated.

2 Estimating Costs for LCCA

Only costs that vary between project alternatives and are significant in amount should be in included in the LCCA, and sunk costs that have already incurred should not be included. There are different categories of cost that are important to include and distinguish between during analysis:

- Investment/initial costs
- Operational costs (including labor, insurance, etc.)
- Energy/fuel costs (including carbon offset costs)
- Water costs
- Maintenance & repair costs
- Replacement costs
- Residual values
- Opportunity costs (such as changes to assignable space)
- Non-monetary benefits or costs (such as risk considerations, aesthetics, contributions towards sustainability goals, implementation timelines, dependencies, down-time, regulatory hurdles or compliance requirements, staff capacity and skills, technology trends, leadership implications, mission-related benefits to research or education or local community, resilience, etc. Risk considerations can include liability, supply, manufacturer track-record, public relations, repair parts availability, sub-contractor, and technology maturity risks.) Non-monetary benefits or costs should be documented for qualitative evaluation.

It is also important to discount future costs to present value, use constant dollars to adjust for inflation, and adjust future costs for real price escalation. The mathematics of compound interest can be used for discounting and are detailed further in Chapter 3 of the NIST Handbook. The approach and mathematics for using constant dollars and adjusting for price escalation are also included in the handbook.

3 Calculating the Total Life Cycle Cost (LCC)

Though there are other approaches to accounting for the lifetime costs of a project or system, the basic LCC method is the most straightforward. It consists of computing the life cycle cost for each system option, comparing them, and choosing the option with the lowest life cycle cost. Two life cycle costs can only be compared when they have the same economic assumptions, study time horizon, base date, and service date. Project teams should also conduct sensitivity analysis on any variable assumptions for which there is a reasonable amount of uncertainty in order to see how changes in those assumptions affect the LCC of the alternatives being evaluated. Examples include assumptions about utility and fuel cost escalation rates or expected regulatory effective dates. The general LCC formula from the NIST Handbook is as follows:

$$LCC = I + Repl - Res + E + W + OMR + X$$

where:

- LCC = Total LCC in present-value dollars of a given alternative
- I = Present-value investment costs
- Repl = Present-value capital replacement costs
- Res = Present-value residual value (resale value, scrap value, salvage value) less disposal costs
- E = Present-value energy costs
- W = Present-value water costs
- OMR = Present-value non-fuel operating, maintenance, and repair costs
- X = Present-value other costs (benefits treated as negative costs)

If project teams need further economic performance evaluation for the systems under consideration, it is possible to calculate supplementary measures such as net savings, savings-to-investment-ratio, adjusted internal rate of return, discounted payback, and simple payback. The relevant mathematics and approach are included in Chapter 7 of the NIST handbook. Project teams should aim to, at minimum, complete the general LCC approach outlined in this section and utilize the LCCA Documentation Spreadsheet to be provided by FPM.

Project Phases

Life Cycle Cost Analysis is most relevant at the beginning of design, and hence most actions will occur during Scoping, Feasibility/Programming, and Schematic Design. Schematic Design is when the LCCA studies are performed and decisions are consequently made about which system options will be carried through the rest of the design phases. The most relevant tasks for LCCA during each design phase are as follows:

- **Concept/Feasibility:** Assess whether LCCA is applicable for the project size, scope, and budget. Decide on Operation and Maintenance (O&M) cost goal and decide which LCCA studies would be most beneficial for the project.
- **Schematic Design (SD):** Perform LCCA studies, assess results, and select which systems will be chosen for the project.
- **Design Development (DD) & Construction Documents (CD):** Ensure DD & CD design and specifications documents conform to LCCA study assumptions.
- **Closeout & Ownership:** Ensure that facilities teams know how to properly operate LCCA-chosen systems and that cost data is collected over the building lifetime, to test LCCA assumptions.

LCCA and LCA in Collaboration

LCCA can be used in parallel with Environmental Life Cycle Analysis (Section 4.3) to achieve the most sustainable design for a project. An LCCA may reveal that a given sustainable design option saves the project more money over its lifetime than the alternative – the LCCA can then be leveraged to inform implementation of the sustainable design option. If instead the sustainable option is more expensive, the LCCA and Environmental LCA results can be evaluated in parallel to help teams decide what outcome is most important to the project.

4.2
Environmental Life Cycle Analysis (LCA)

Introduction

Environmental Life Cycle Analysis (LCA) is a "method used to evaluate the environmental impact of a product through its life cycle encompassing extraction and processing of raw materials, manufacturing, distribution, use, recycling, and final disposal ". In the context of the Design and Construction industry, LCA is used to assess the environmental footprint of the building materials used to construct a project, such as concrete, steel, glazing, or insulation. Most LCAs focus primarily on Embodied Carbon, or carbon dioxide emissions created throughout the material's life cycle, but environmental LCAs can also include impact categories such as ozone depletion, acidification of land and water resources, and eutrophication.

Figure 3 outlines the broad categories included in a Life Cycle Assessment, and denotes which phases are included in a cradle-to-gate (extraction through manufacturing) and cradle-to-cradle (extraction through recycling) assessment. It also illustrates which phases include embodied carbon, as defined above, and which phases include emissions from the operation of the building, or operational carbon. The phases of life are detailed further in Figure 4 in the Conducting an LCA section below.

LCA Study Categories

The main categories of materials included in an Environmental Life Cycle Analysis for a building are as follows:

- Structural materials: steel (structural, metal deck, reinforcing bar, etc.), concrete, mass timber, or other relevant structural materials
- Enclosure materials: glazing, spandrel, insulation, roofing, mullions/framing, gypsum sheathing, masonry, air/water/vapor membranes, or other relevant enclosure materials

Scales of Study & Associated Objectives

LCA can be utilized at various scales within the building project, depending on what the Project Team is looking to accomplish:

- **Material scale:** to compare properties of one material (SCM content in concrete, recycled content of steel)
  - **Objective:** choose % composition of material that maximizes embodied carbon savings (higher % SCMs, higher % recycled steel)
- **Manufacturer scale:** to compare different manufacturers of the same product
  - **Objective:** choose manufacturer with the lowest global warming potential or other environmental impact category from its production process
- **Building scale:** to compare design options for an entire building (concrete vs. steel structure vs. mass timber)
  - **Objective:** choose an overall design strategy that reduces embodied carbon from the onset of the project as compared to a baseline building (reuse of existing structures, reducing material volumes where possible through design optimization)

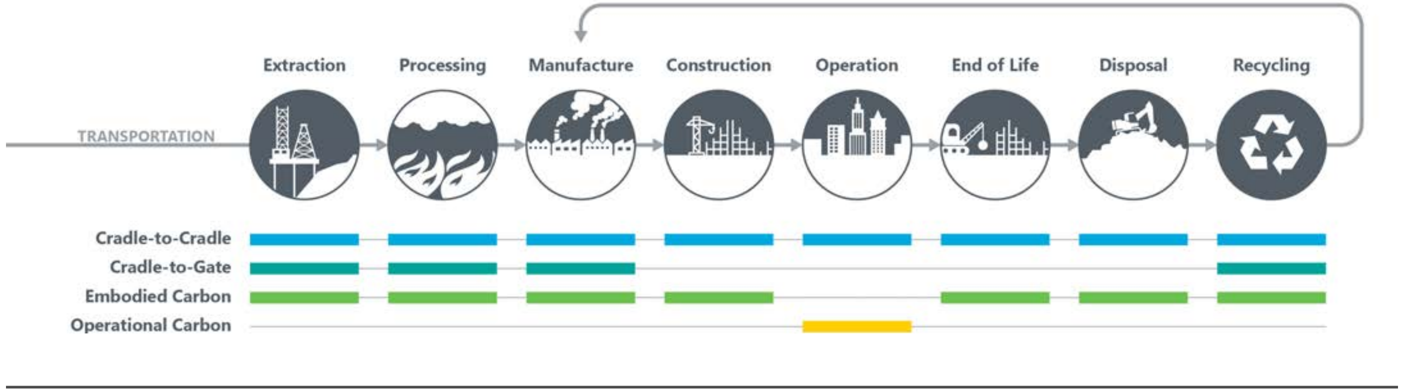


Figure 3: Life Cycle Analysis Accounting Methodology

Conducting an LCA

The most accurate way to conduct a whole building LCA is to utilize one of the many eligible software that have been created specifically for Life Cycle Analysis of building materials, such as EC3 , OneClick LCA , Tally , or Athena EcoCalculator . Each program calculates a total global warming potential (GWP) for the building based on material quantities specific to the building's design, along with manufacturer or industry wide Environmental Product Declarations (EPDs) for each material. Some software also pull information from their own private databases or from Life Cycle Inventory databases, to help characterize the full life cycle impact of a material through all phases of life. Most LCA certification frameworks, including LEED, require a full cradle-to-grave assessment for each material, which includes the Product Stage (A1-A3), Construction Stage (A4-A5), Use Stage (B1-B7), and End of Life Stage (C1-C4) as detailed in the diagram below.

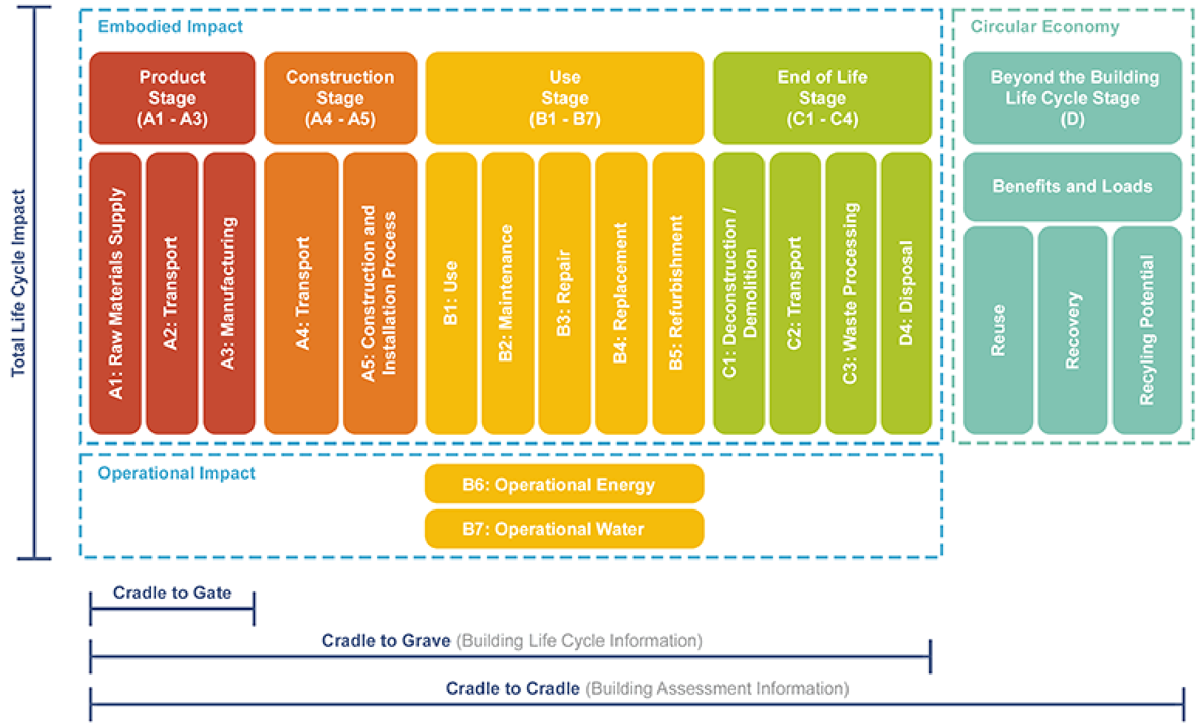


Figure 4: Life Cycle Assessment Phases of Life

Source: Browning Day (https://browningday.com/news/lca-stages-matter-when-tracking-embodied-carbon/)

Key Needs for LCA

- Material quantity takeoffs for all relevant building materials (e.g. sourced from building information model)
- Industry-wide or manufacturer-specific EPDs
- Drawings & specifications for the project to assess material details (finishes, paints, wall types, etc.)

Approach to LCA and Embodied Carbon Reductions

It is recommended that project teams follow the structure of LEED's Life Cycle Impact Reduction credit for conducting an LCA and targeting reductions. LEEDv4 requires that the embodied impacts of a proposed building design are evaluated in comparison to a baseline building across six environmental impact categories:

AP Acidification of land and water sources, in moles H+ or kg SO

EP Eutrophication, in kg nitrogen or kg phosphate

GWP Global warming potential (greenhouse gases), in CO2e (i.e. embodied carbon)

ODP Depletion of the stratospheric ozone layer, in kg CFC-11

SFP Formation of tropospheric ozone, in kg NOx or kg ethene

NRE Depletion of nonrenewable energy resources, in MJ

As seen in Table 1 below, there are tiered thresholds for compliance, through LEED v4 and v4.1. LEED v4.1 will award 1 point for completing an LCA, and then denotes higher point values for increasing percent reductions.

Table 1: Thresholds for LEED Life-Cycle Impact Reduction Credit Compliance

Threshold for Compliance	LEED v4	LEED v4.1
Running the LCA	-	1 pt
5% reduction in GWP & two other indicators, no adverse impacts (>5% increase)	-	2 pts
10% reduction in GWP & two other indicators, no adverse impacts (>5% increase)	3 pts	3 pts
20% reduction or more in GWP, and 10% in other indicators, incorporate reuse into the structure and enclosure, no adverse impacts (>5% increase)	3 pts	4 pts

Detailed LCA Activities

	PRE-DESIGN	EARLY SD	50% SD	100% SD	EARLY DD	50% DD	100% DD	EARLY CD	50% CD	100% CD	BIDDING	CONSTRUCTION
WHOLE BUILDING	**SET GOALS** - % reduction - kgCO2e/m2 - rating system metrics	**LCA: Massing Comparison**	Understand regulation and rating system requirements	Set kgCO2e/m2 baseline	LCA: WHOLE BUILDING Identify top material impacts	Identify reduction strategies	Update LCA model	**LCA: CONFIRM REDUCTION STRATEGIES**	Write reduction strategies into specs, identify material options	Update LCA model per CD changes	Include reduction requirements in bid	Review Submittals Identify reduction strategies **LCA: FINAL ASSESMENT** - Update LCA models per submittals - Calculate GHG emissions - Calculate % below baseline
STRUCTURE			**LCA: Structural Comparison**	Structure System Fixed	**LCA: Structure Analysis** Identify top material impacts	Reduce volume of structure as much as posible	Finalize EC reduction strategies	Write reduction strategies into specs, identify material options			Include reduction requirements in bid	Collaborate to ensure final concrete mixtures meet EC targets
ENVELOPE & INTERIORS		Envelope by set through code, energy modeling, and daylighting		**LCA: ENVELOPE ANALYSIS** Test assemblies	Identify high impact materials (insulation, glazing)	Review industry-wide EPDs and select low impact design options	Explore EC3 and advocate for product-specific data	Write reduction strategies into specs, identify material options			Include reduction requirements in bid	GC to ensure % reductions are met throughout construction

Figure 5: Carbon Leadership Forum LCA Timeline Diagram