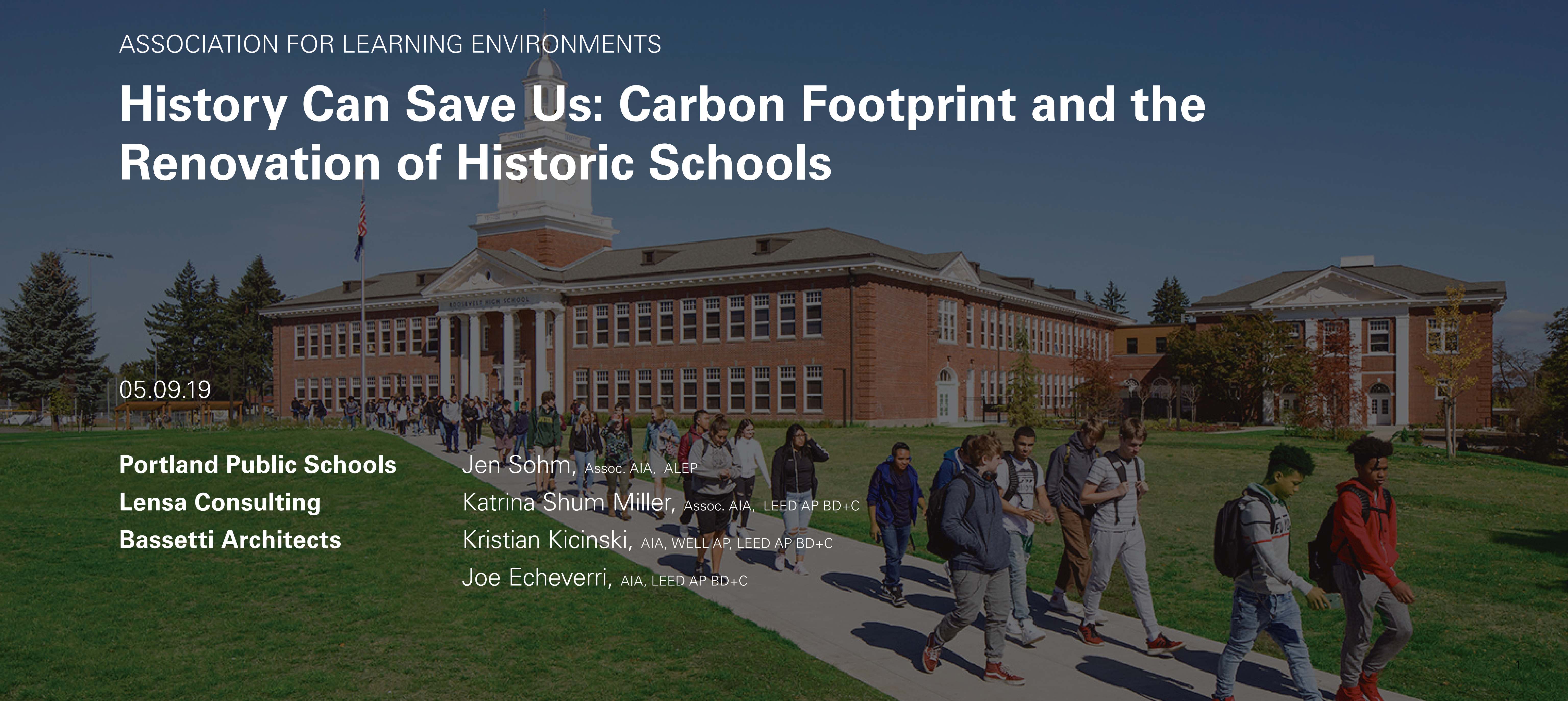


ASSOCIATION FOR LEARNING ENVIRONMENTS

History Can Save Us: Carbon Footprint and the Renovation of Historic Schools

05.09.19

Portland Public Schools
Lensa Consulting
Bassetti Architects

Jen Sohm, Assoc. AIA, ALEP
Katrina Shum Miller, Assoc. AIA, LEED AP BD+C
Kristian Kicinski, AIA, WELL AP, LEED AP BD+C
Joe Echeverri, AIA, LEED AP BD+C

- Identify the potential challenges of reusing historic school structures, and understand strategies for overcoming those challenges.

- Learn strategies for adapting historic school facilities with traditional classrooms into 21st century learning environments.

- Understand the carbon footprint and environmental impacts of new school construction and the potential impact reductions available through the adaptive reuse of historic school structures.

- Understand how the use of Life Cycle Assessment (LCA) methodologies and tools can influence the future planning and design of historic school reuse projects.

The Many Names of "Carbon"

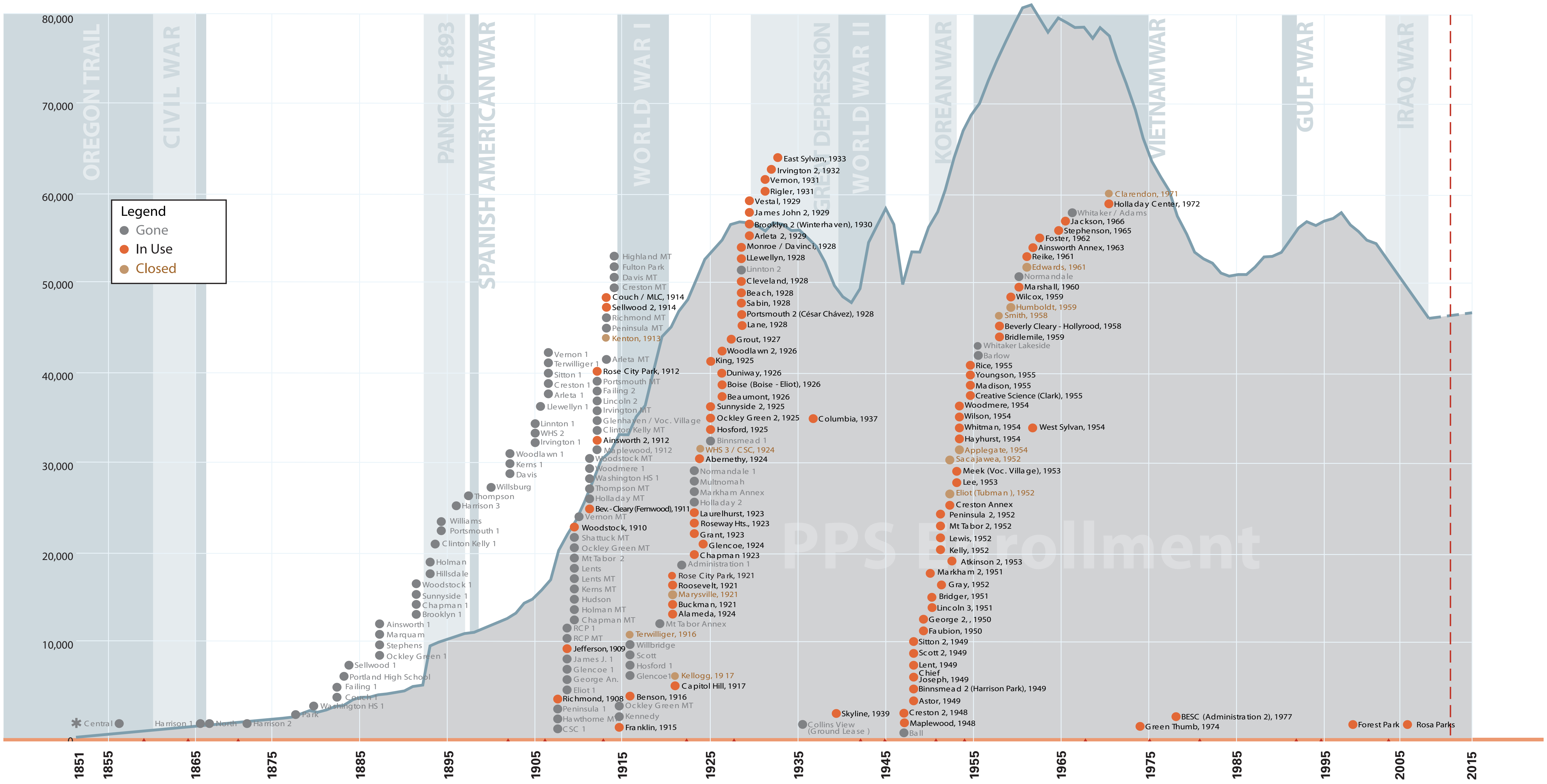
The following is a list of terms that are often used somewhat interchangeably to refer to the emissions associated with climate change or global warming [1]:

- Carbon
- Carbon footprint
- Carbon dioxide (CO2)
- Carbon dioxide equivalent (CO2e or CO2eq)
- Greenhouse gas (GHG) emissions
- Fossil fuel emissions
- Global warming potential (GWP)
- Climate change (CC) potential

[1] Carbon Leadership Forum

Strategies and Challenges for Reusing Historic Structures

Portland Public Schools Construction Timeline



2012 Long Range Facilities Plan

Sustainability Principles of Design

CONSTRUCTION + DESIGN

- Balance potential lifecycle savings of new construction with the embodied energy investment in existing buildings.
- Respect and preserve historic elements unique to neighborhoods.
- Use high quality salvaged or reused materials, limit virgin materials.

ENERGY EFFICIENCY

- Prioritize rehabilitation of original windows.
- Balance heating efficiency, daylighting, environmental impact and lifecycle cost when considering windows.

Franklin High School, Portland (DOWA-IBI)

2012 Long Range Facilities Plan

Principles of Historic Stewardship

RECOGNITION OF HISTORIC CONTEXT + ARCHITECTURAL CHARACTER

- Reuse features of older and historic buildings which cannot be duplicated.
- Prioritize repairing and maintaining original windows to the extent feasible over replacement.

EXISTING IS SUSTAINABLE

- Project teams should evaluate lifecycle savings with embodied energy
- Full feasibility studies, consider demolition debris
- Building reuse conserves energy
- De-construct + Salvage

2012 Long Range Facilities Plan

Principles of Historic Stewardship

TEACHING THE VALUES OF REUSE

- Rehabilitation creates more jobs than new construction
- Neighborhood schools encourage walking and biking
- Study environmental impacts

Importance of Cultural Value

Can't be Overstated / Hard to Calculate

Historic Assessments

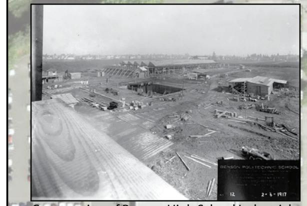
Benson High School

546 NE 12th Ave, Portland OR, 97232

View Site in Google Maps

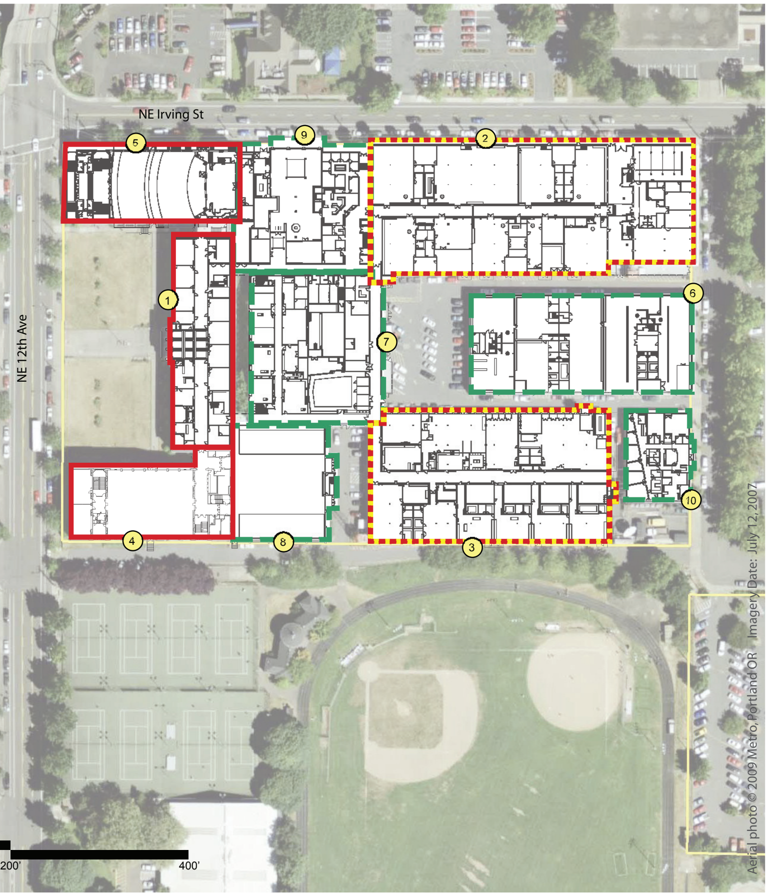
Building Periods

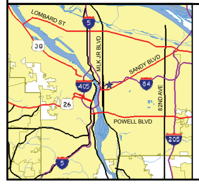
1. Main Building (115A), 1916
2. North Shop Wing (115C), 1917
3. South Shop Wing (115D), 1918
4. Old Gymnasium (115E), 1925
5. Auditorium (115F), 1930
6. Aeronautics/ Automotive Shops (115G), 1953
7. Library Science Addition (115A), 1953
8. New Gymnasium (115H), 1964
9. New Library Addition (115J), 1991
10. KPBS (115K), 1992



Construction of Benson High School Industrial Arts Building from scaffolding of first unit, looking northeast, 1917.

2009 photograph of the front (west) elevation of the Benson High School.





Historical Significance and Building Integrity

- Contributing High Significance
- Contributing Moderate Signif.
- Non-Contributing

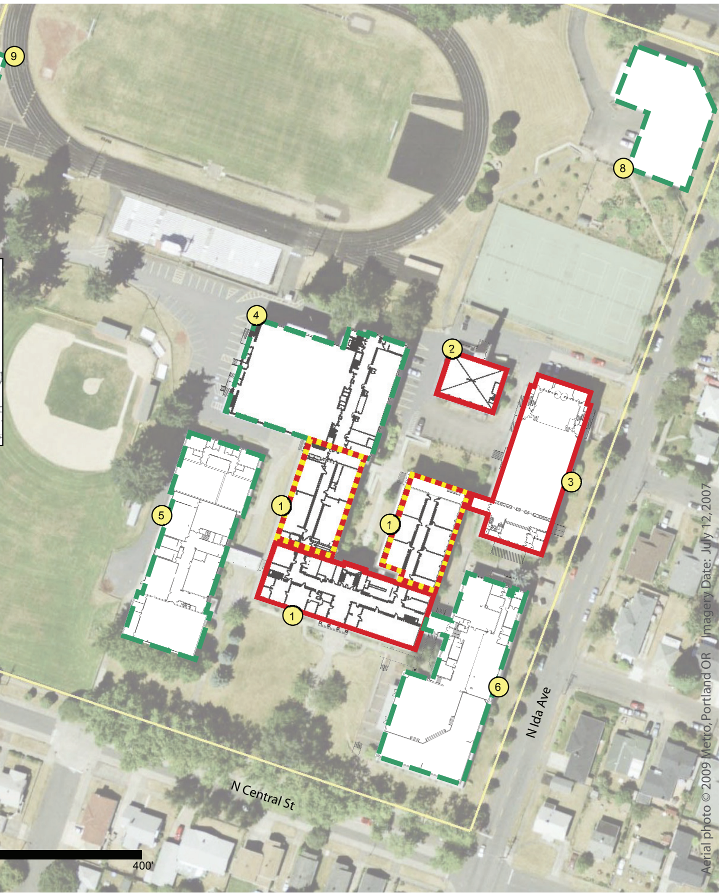
Roosevelt High School

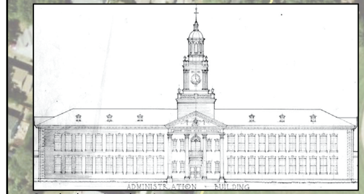
6941 N Central St, Portland OR, 97203

View Site in Google Maps

Building Periods

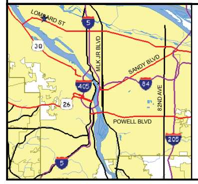
1. Original Building (124A), 1921
2. Boiler Room (124B), 1921
3. Auditorium Addition (124C), 1930
4. Gymnasium Add(124D), 1950
5. Classroom Add (124E), 1960
6. Cafeteria Add (124F), 1964
7. Observatory, 1964
8. Shop Building, 1970
9. Field House, n.d.





South elevation drawing, 1921.

1930s photograph of Roosevelt High School, looking northwest.



Historical Significance and Building Integrity

- Contributing High Significance
- Contributing Moderate Signif.
- Non-Contributing

Challenges

- Historic Significance
- Incorporating Educational Program
- Constrained Urban Sites
- Health and Safety

1. **Water Quality:** Modernization would include replacement of plumbing piping and fixtures.
2. **Fire /Life Safety:** Aged fire alarm and sprinkler systems will be upgraded for improved safety.
3. **Asbestos:** Abatement and removal.
4. **Lead Paint:** Abatement and removal.
5. **Building Envelope:** Modernization would upgrade exterior walls, windows and roof to repair damage, improve energy efficiency and increase durability.
6. **ADA:** Substantial upgrades to make all areas of the school universally accessible and compliant with current codes.
7. **Radon:** Modernization would provide a new radon mitigation system below new foundations.
8. **Seismic:** URM buildings and other structures would receive a complete structural upgrade to meet current building codes.
9. **Security Systems/Fencing:** Secure entry and video surveillance system upgrades to control access. Exterior service access and central plazas to be fenced and secured during school hours.
10. **Auditorium/Stage:** Aging theatrical lighting and rigging systems to be updated for improved safety and maintainability.

Window Replacement

CHALLENGES

- Condition
- Budget
- Heat gain
- Landmark Significance

STRATEGIES

- Prioritize rehabilitation on south and west sides
- Renovate unique windows
- If replacement is necessary, choose original historical profiles
- Use water infiltration and air barrier testing to prioritize most significant issues

Design Strategies
for Adapting Historic School Facilities

Building Explorations

FINDING BALANCE

- Program
- Community Assets
- Environment
- Cost + Risk

SCENARIO 1B

AREA

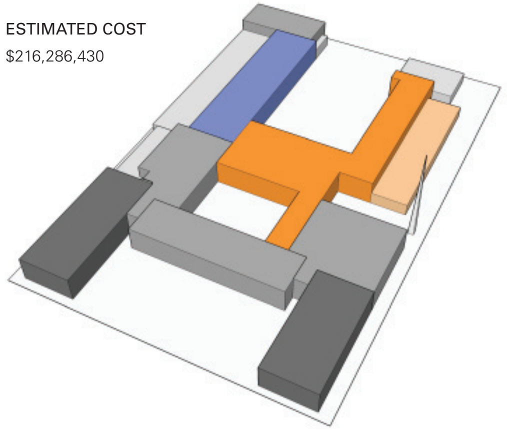
231,200 SF Renovation

118,800 SF New Construction

350,000 SF Total

ESTIMATED COST

$216,286,430



SCENARIO 1C

AREA

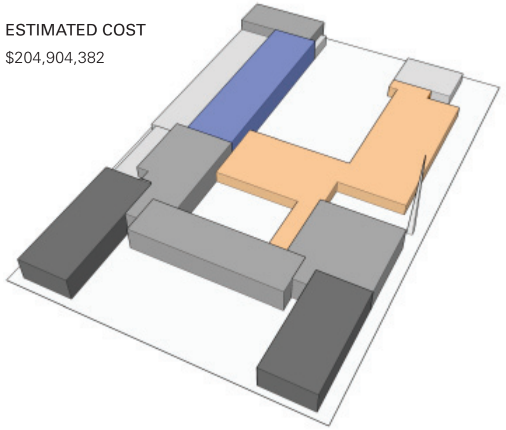
231,200 SF Renovation

93,800 SF New Construction

325,000 SF Total

ESTIMATED COST

$204,904,382



SCENARIO 2B

AREA

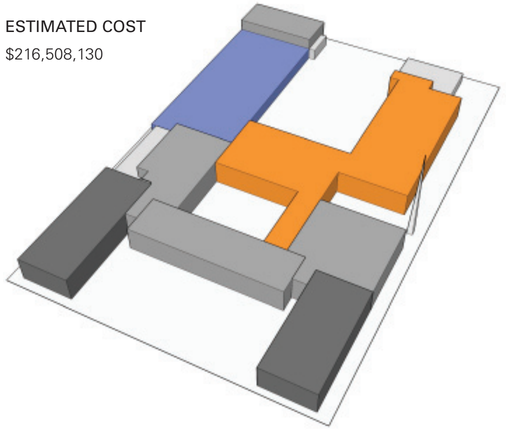
250,600 SF Renovation

99,400 SF New Construction

350,000 SF Total

ESTIMATED COST

$216,508,130



SCENARIO 2C

AREA

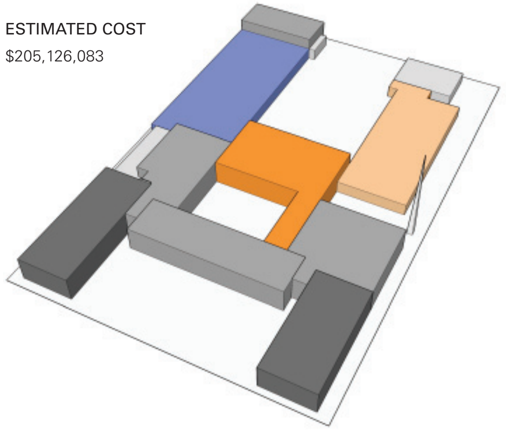
250,600 SF Renovation

74,400 SF New Construction

325,000 SF Total

ESTIMATED COST

$205,126,083



SCENARIO 3B

AREA

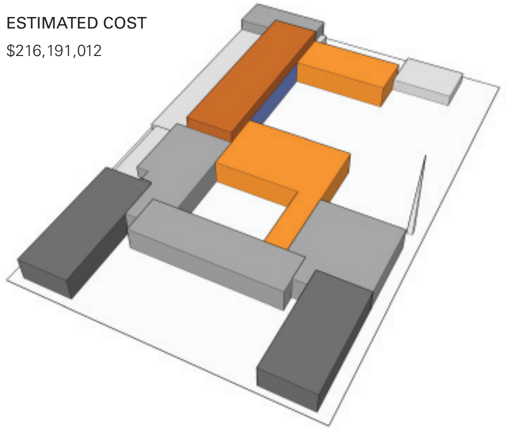
231,200 SF Renovation

118,800 SF New Construction

350,000 SF Total

ESTIMATED COST

$216,191,012



SCENARIO 3C

AREA

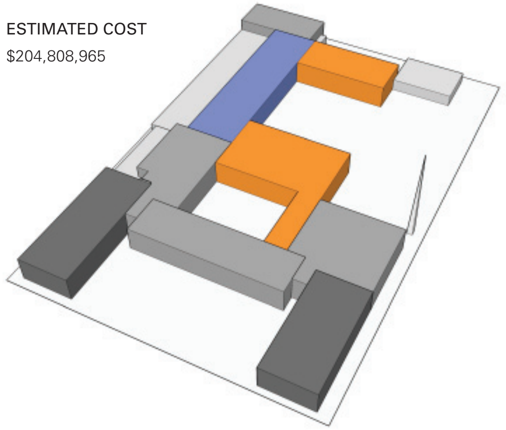
231,200 SF Renovation

93,800 SF New Construction

325,000 SF Total

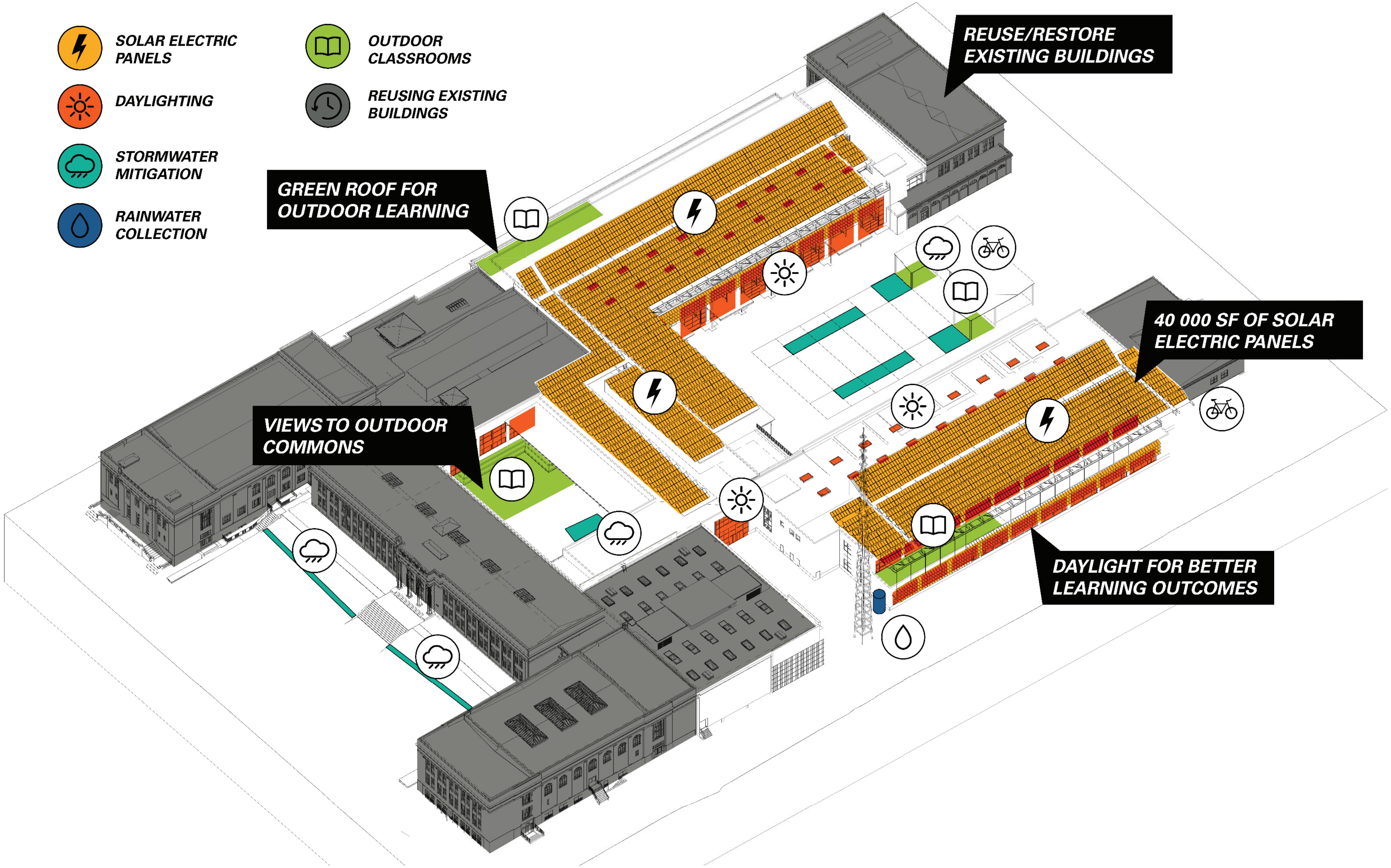
ESTIMATED COST

$204,808,965



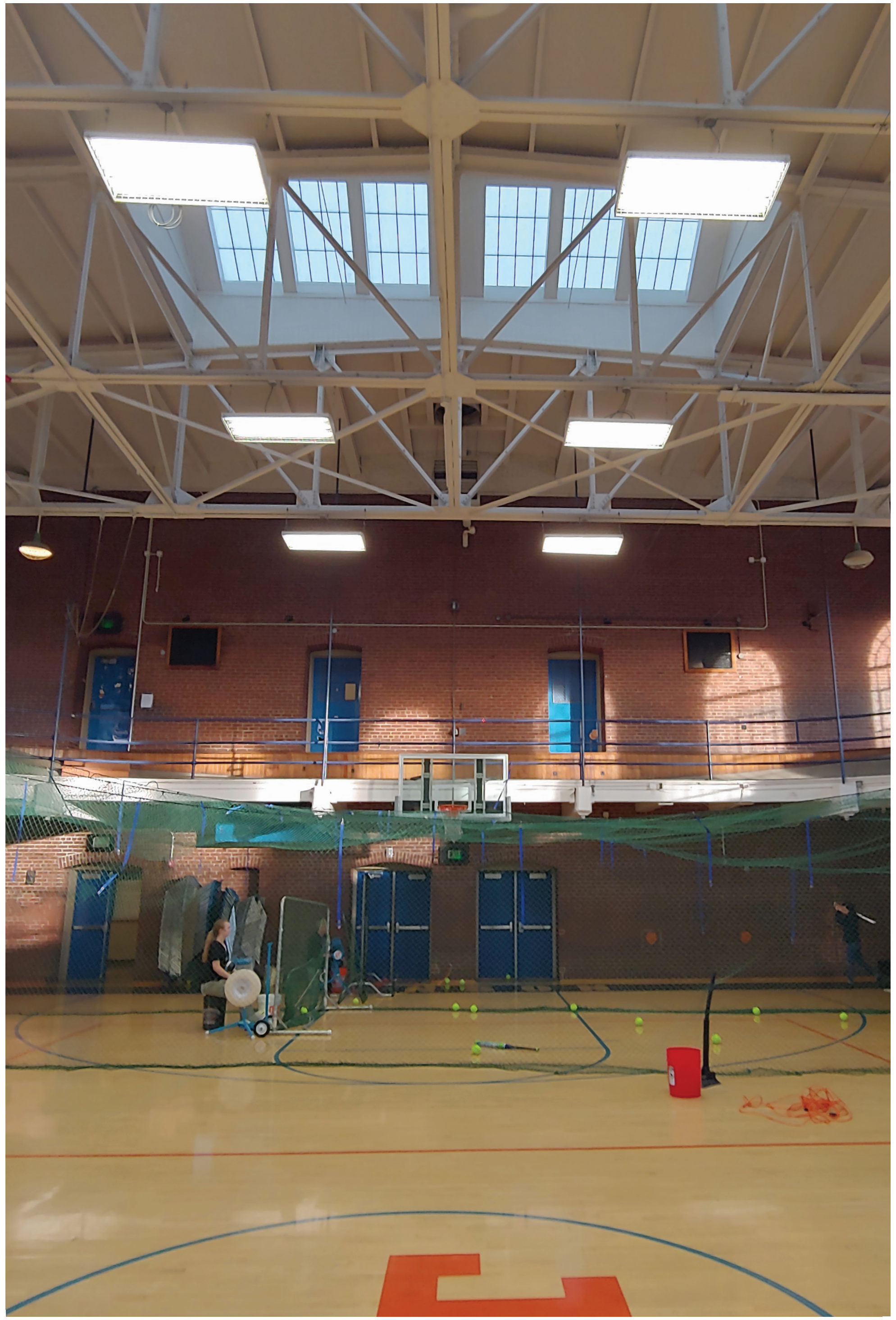
Environment

- Life Cycle Benefit
- New Sustainable Technologies
- Carbon Footprint



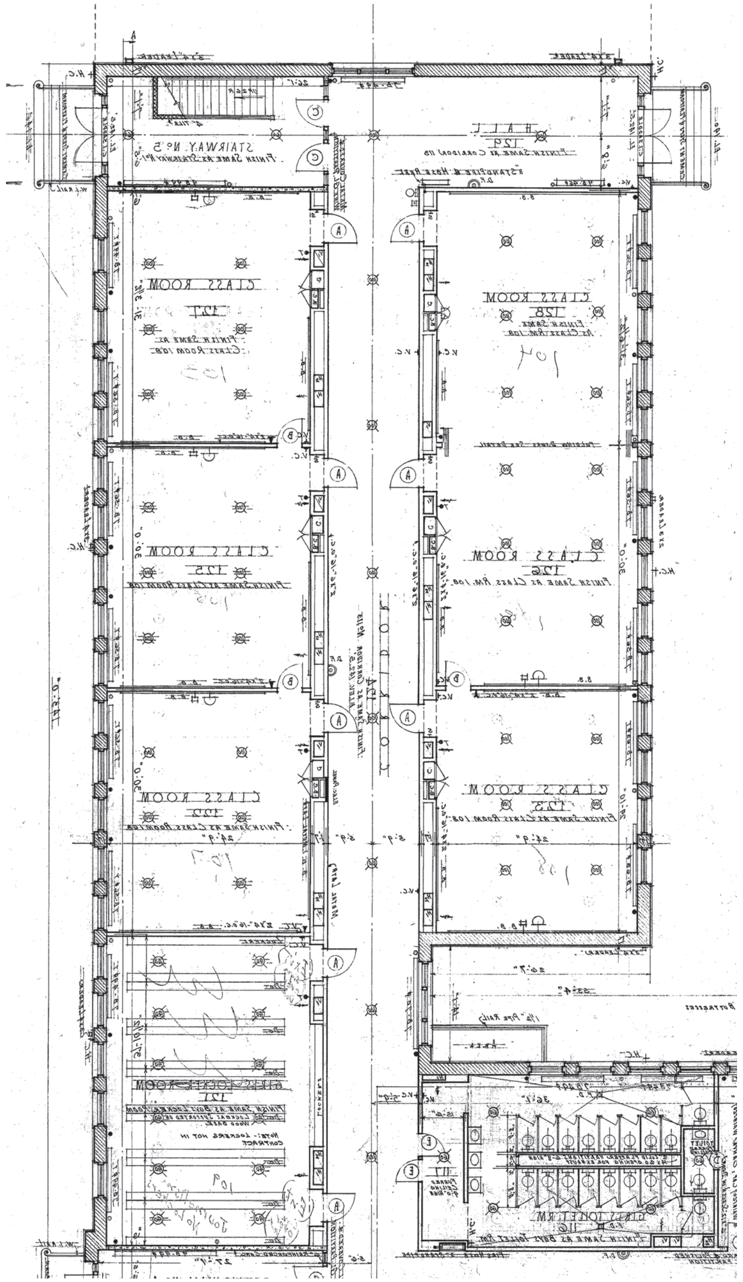
Program

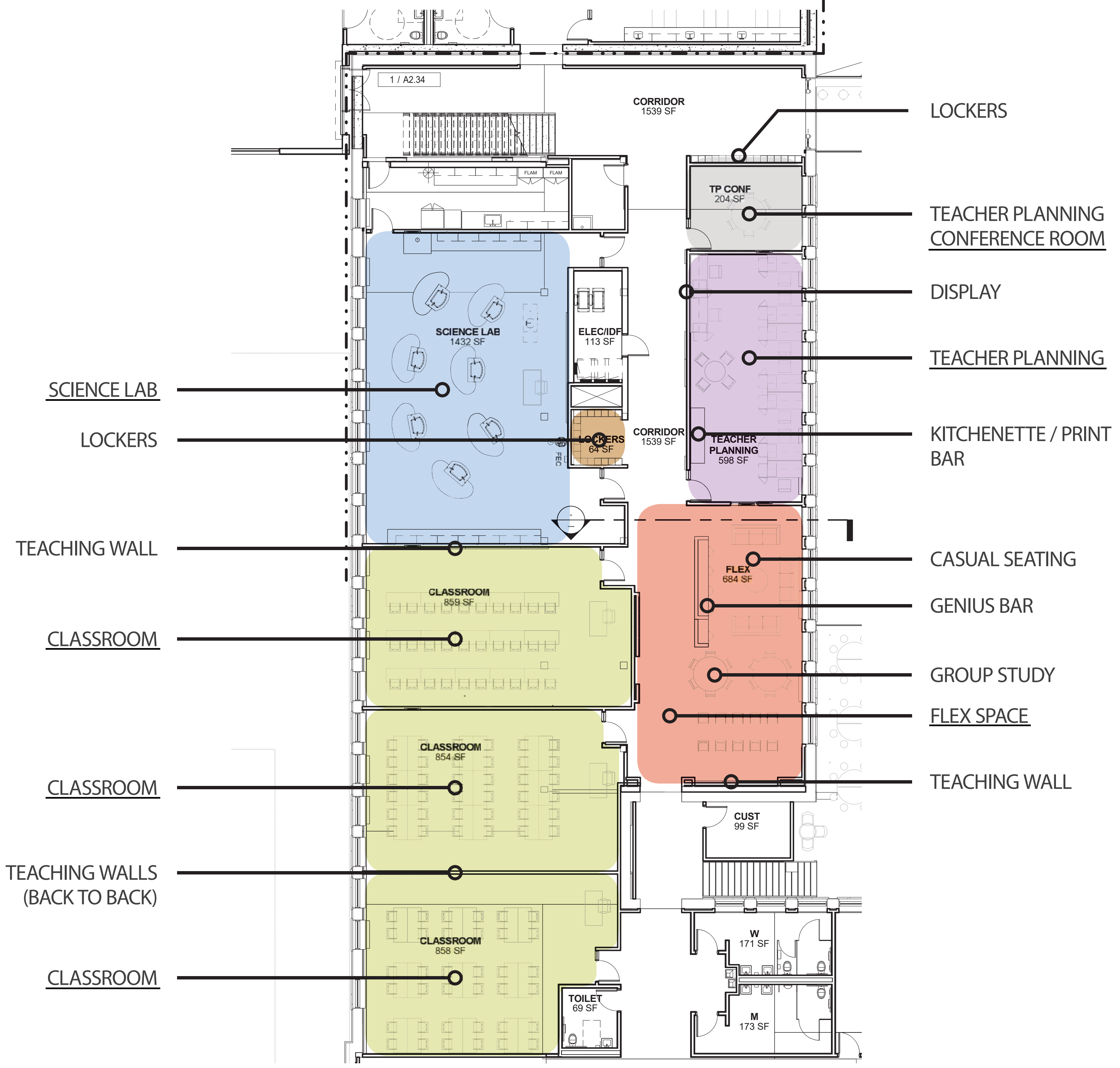
- Size + Capacity
- District Standards
- Safety
  - Accessibility
- Adaptive Reuse Potential
  - Site Specific Requirements



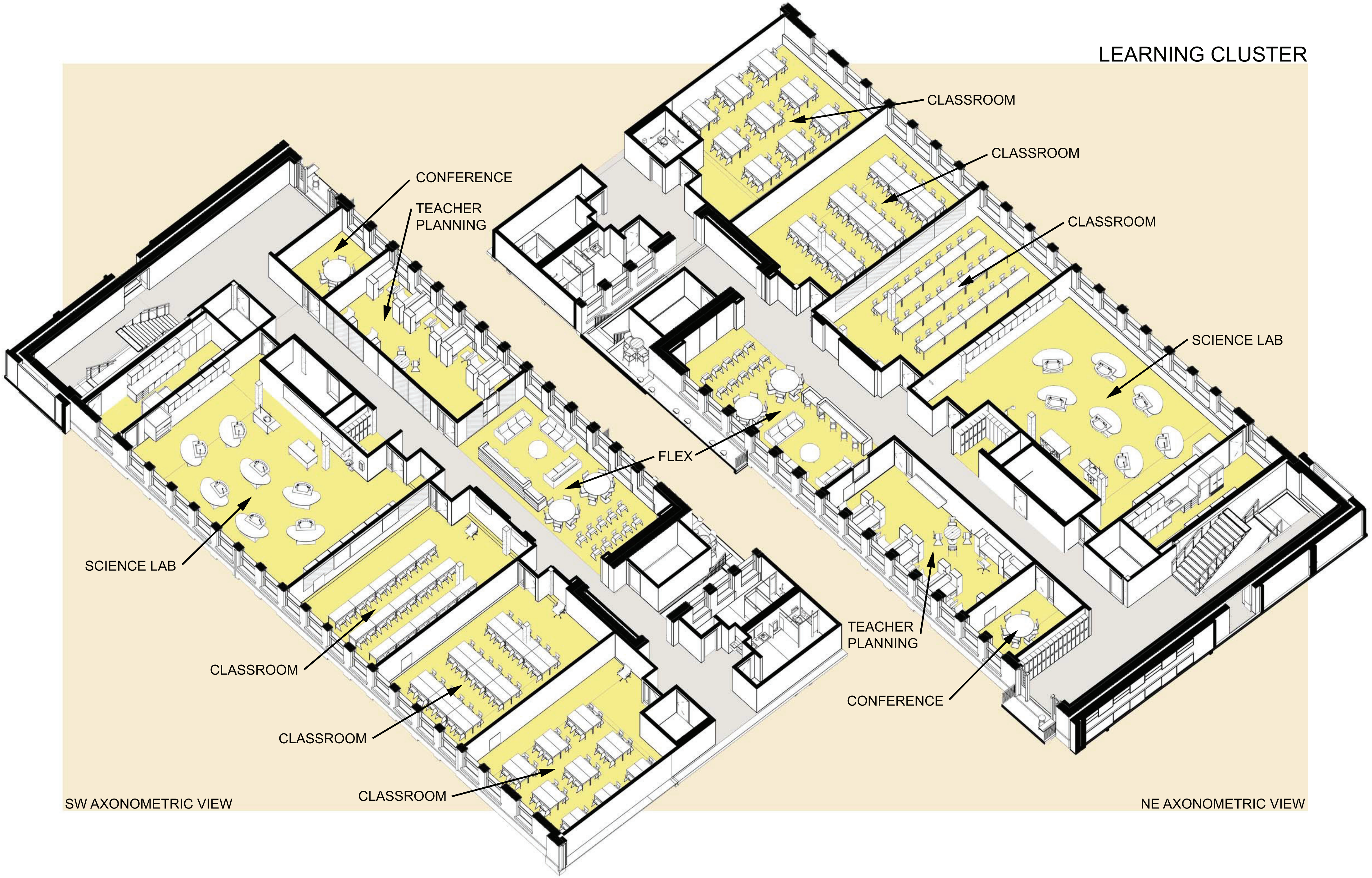
Adaptive Reuse

21st Century Learning in 20th Century Schools





21st Century Learning in 20th Century Schools



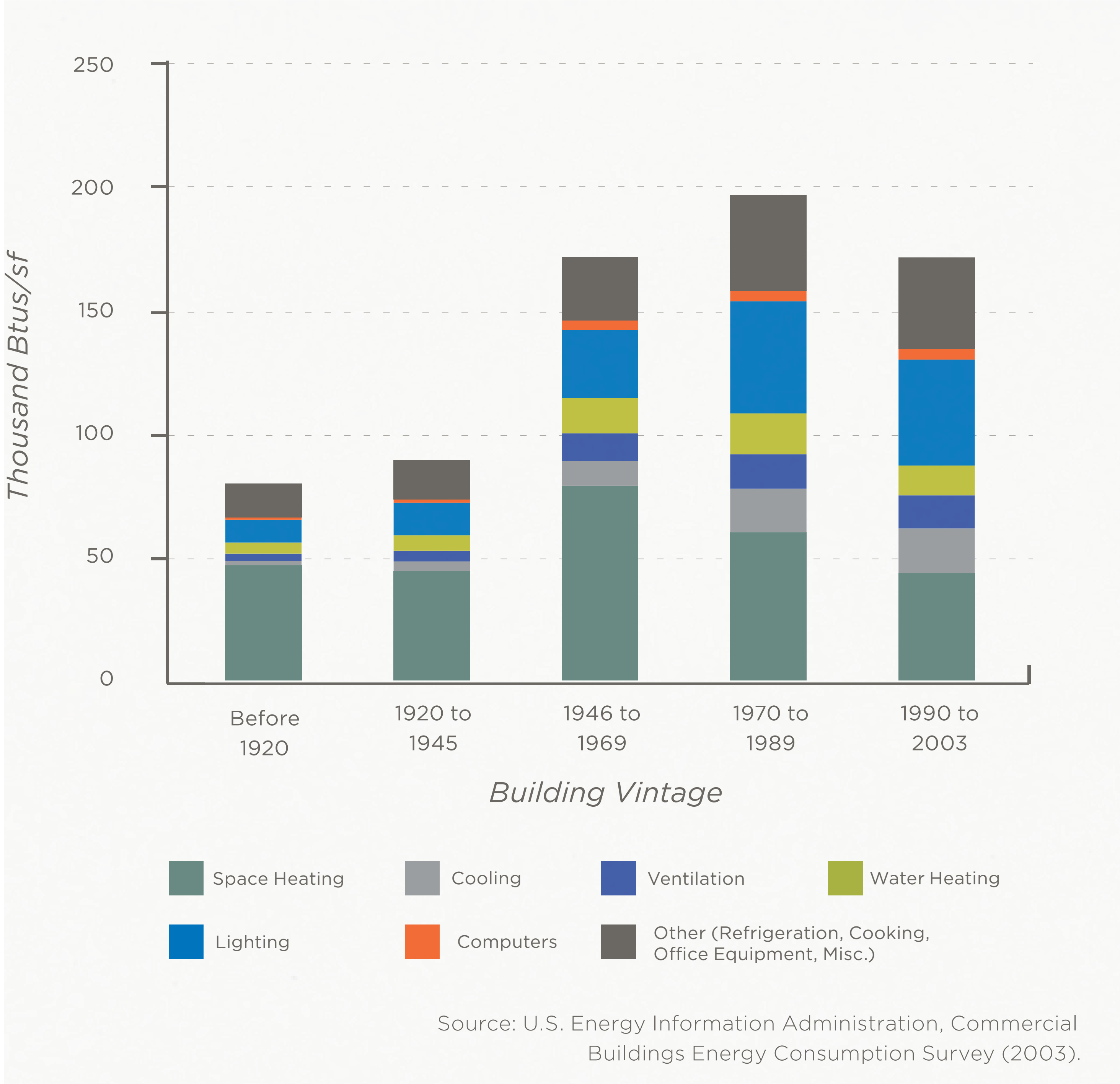
Adaptive Reuse

"Original Green"

Historic buildings are well suited for resource efficiency

"Originally, before the Thermostat Age the places and buildings we built had no choice but to be green, otherwise people would freeze to death in the winter, die of heat stroke by summer, starve to death or other really bad things would happen."

Stephen Mouzon, The Original Green



- The Greenest Building: Quantifying the Environmental Value of Building Reuse

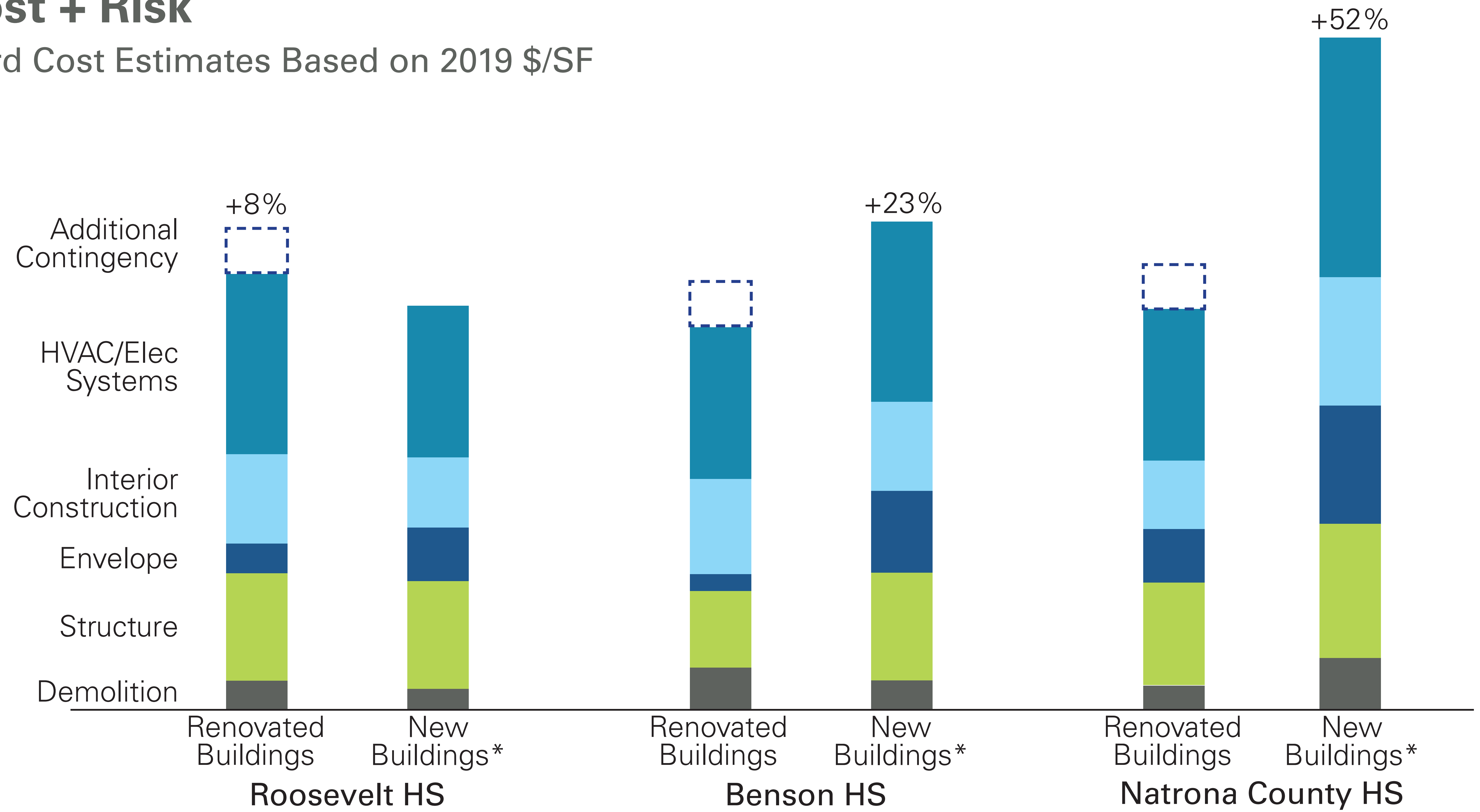
Daylighting

Salvaged Materials

Salvaged Materials

Cost + Risk

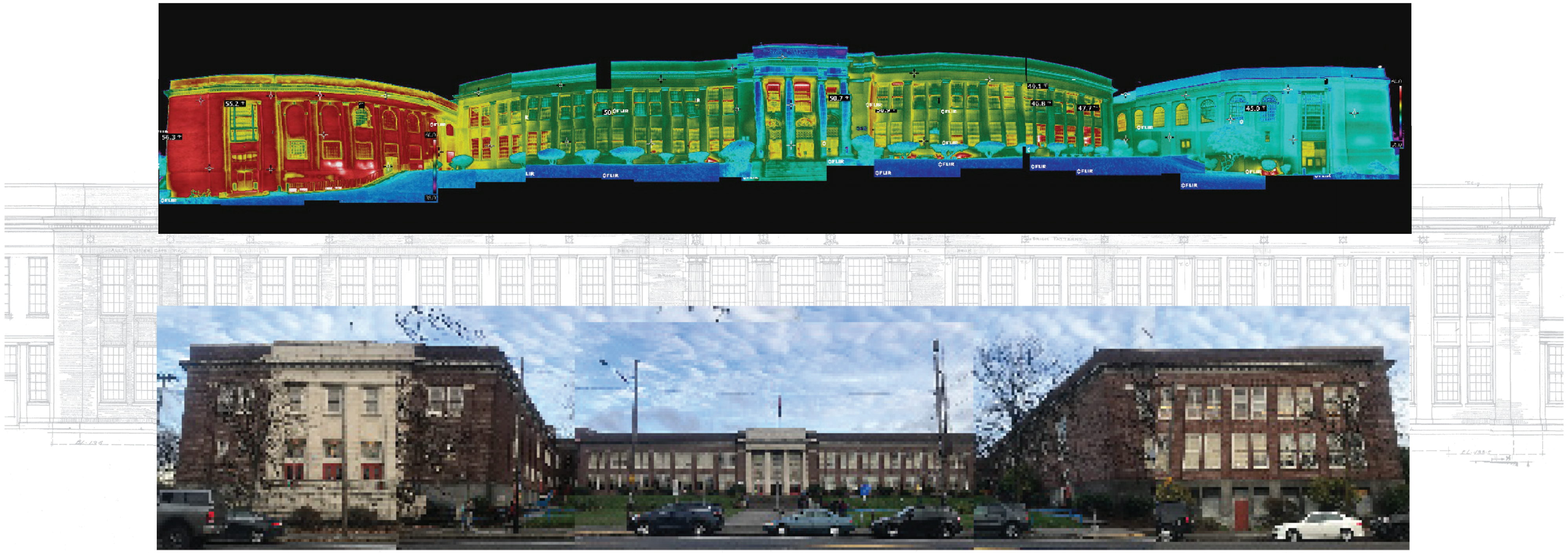
Hard Cost Estimates Based on 2019 $/SF

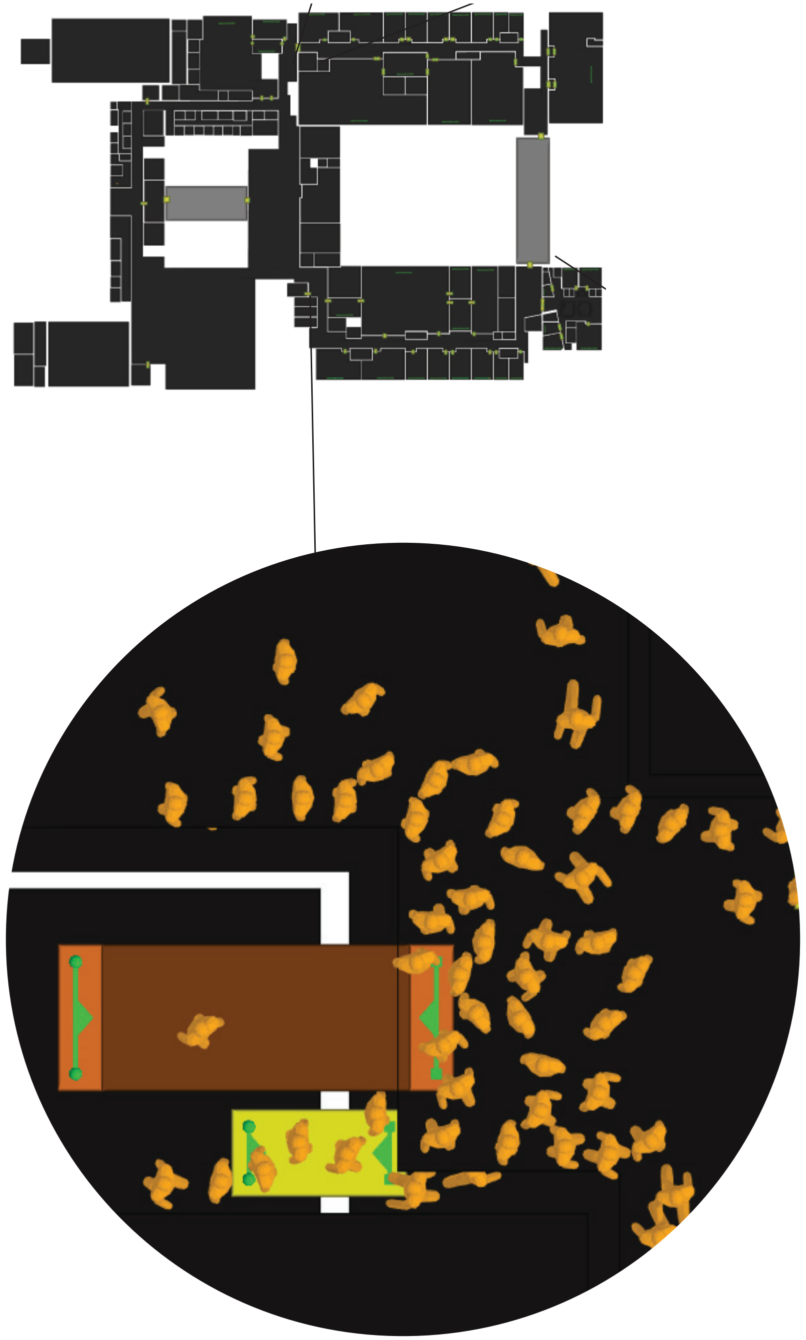


*BASED ON USING CURRENT MATERIALS AND STANDARDS, NOT A 1:1 REPLACEMENT OF SAME HISTORIC COMPONENTS

Data Informed Design

- Due Diligence + Site Investigation
- Micro Climate Study
- Daylight Study
- Energy Model
- Life Cycle Assessment
- Crowd Simulation

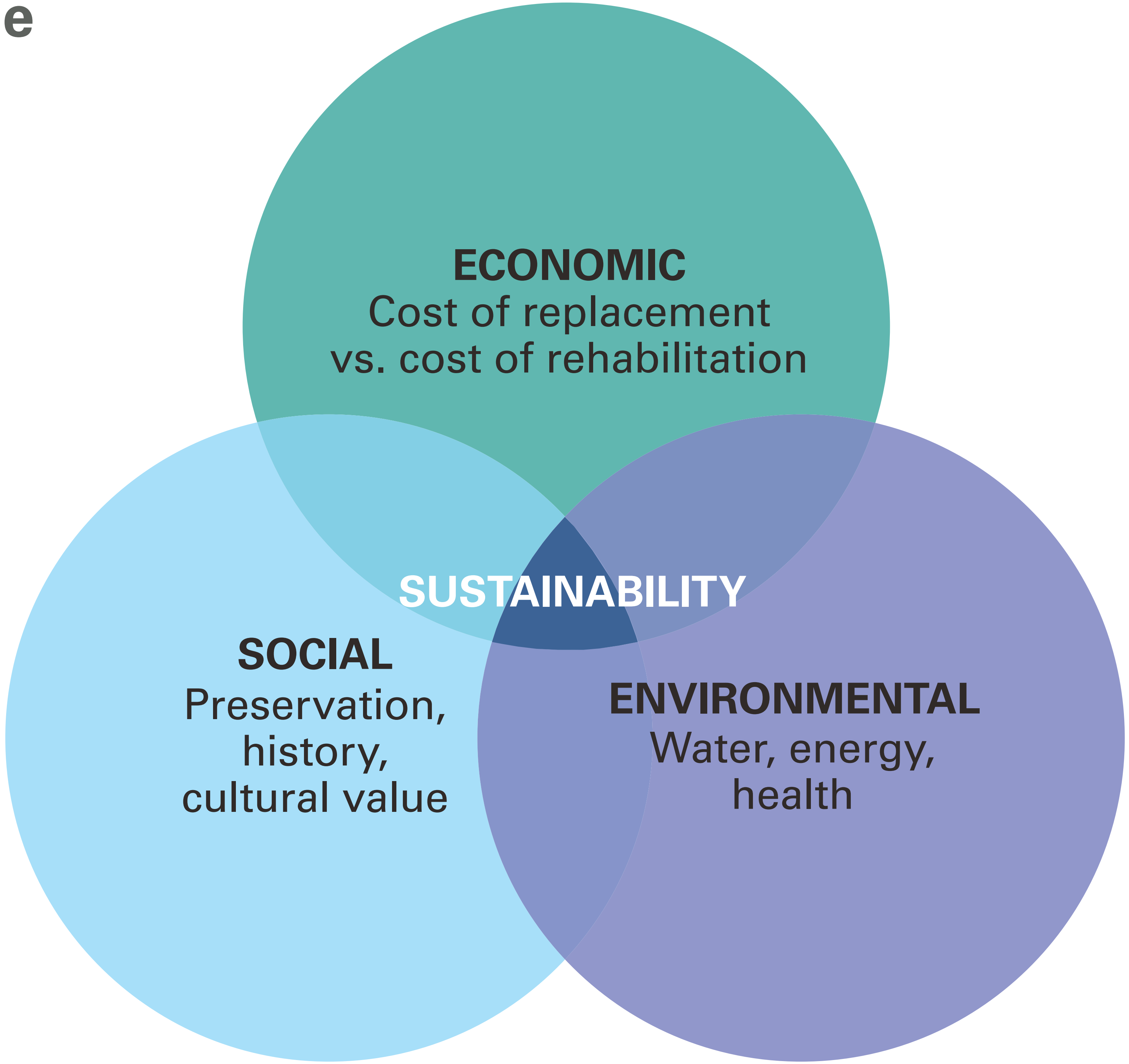




3. Placement of Elements

The Carbon Footprint of New Construction vs. Adaptive Reuse of Historic Structures

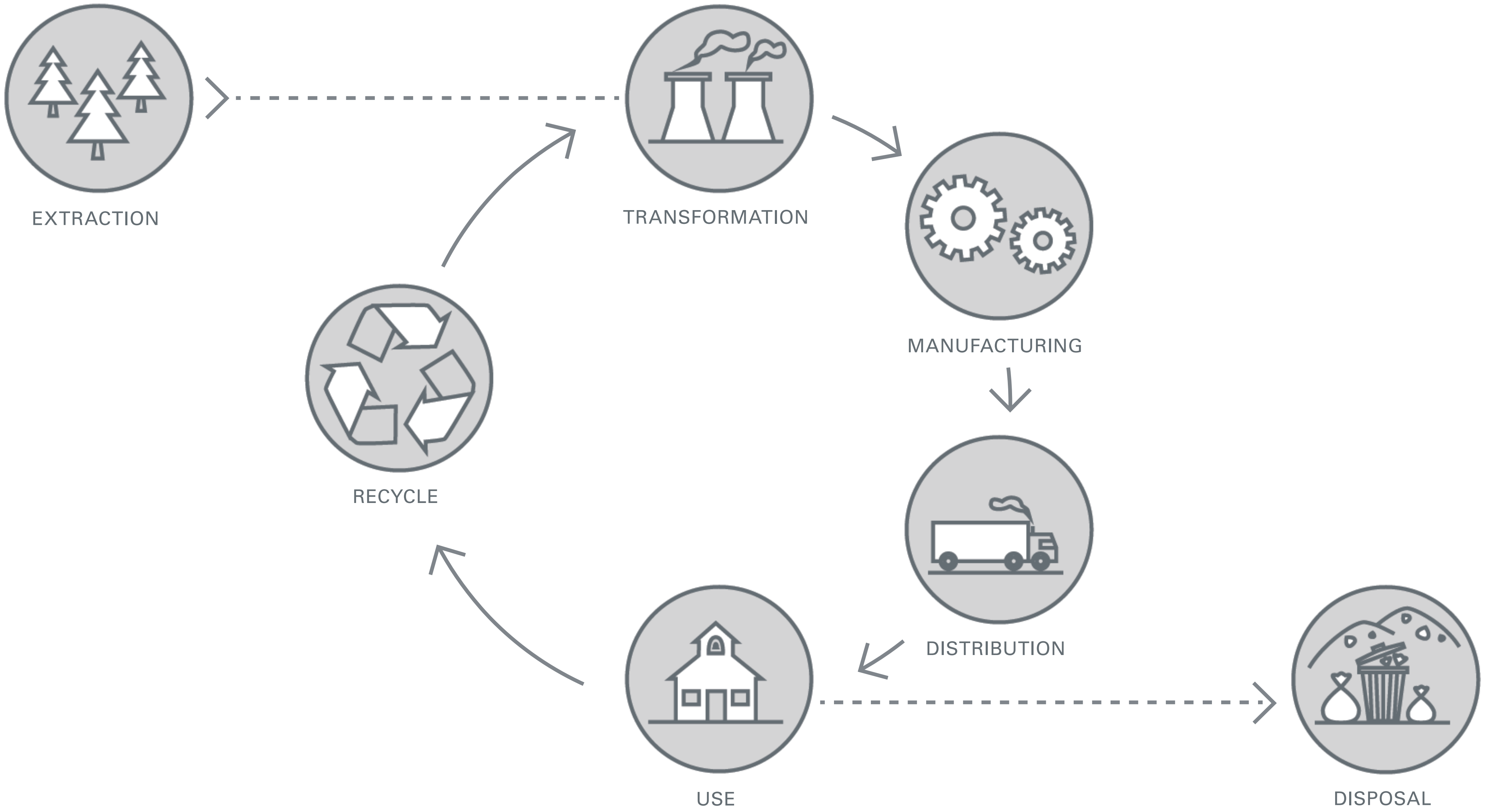
Triple Bottom Line



CARBON IMPACT

What is Life Cycle Assessment?

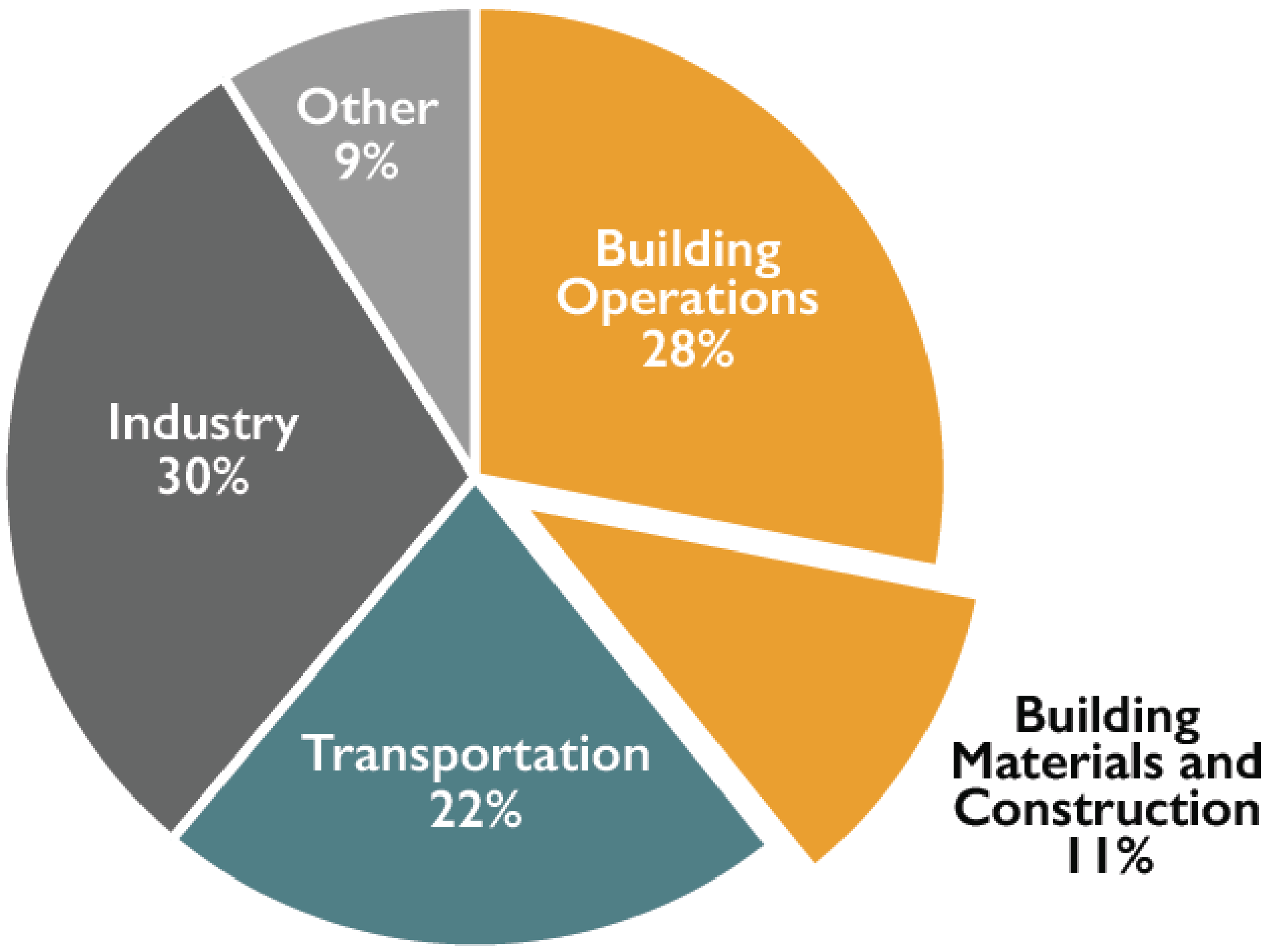
Life Cycle Stages



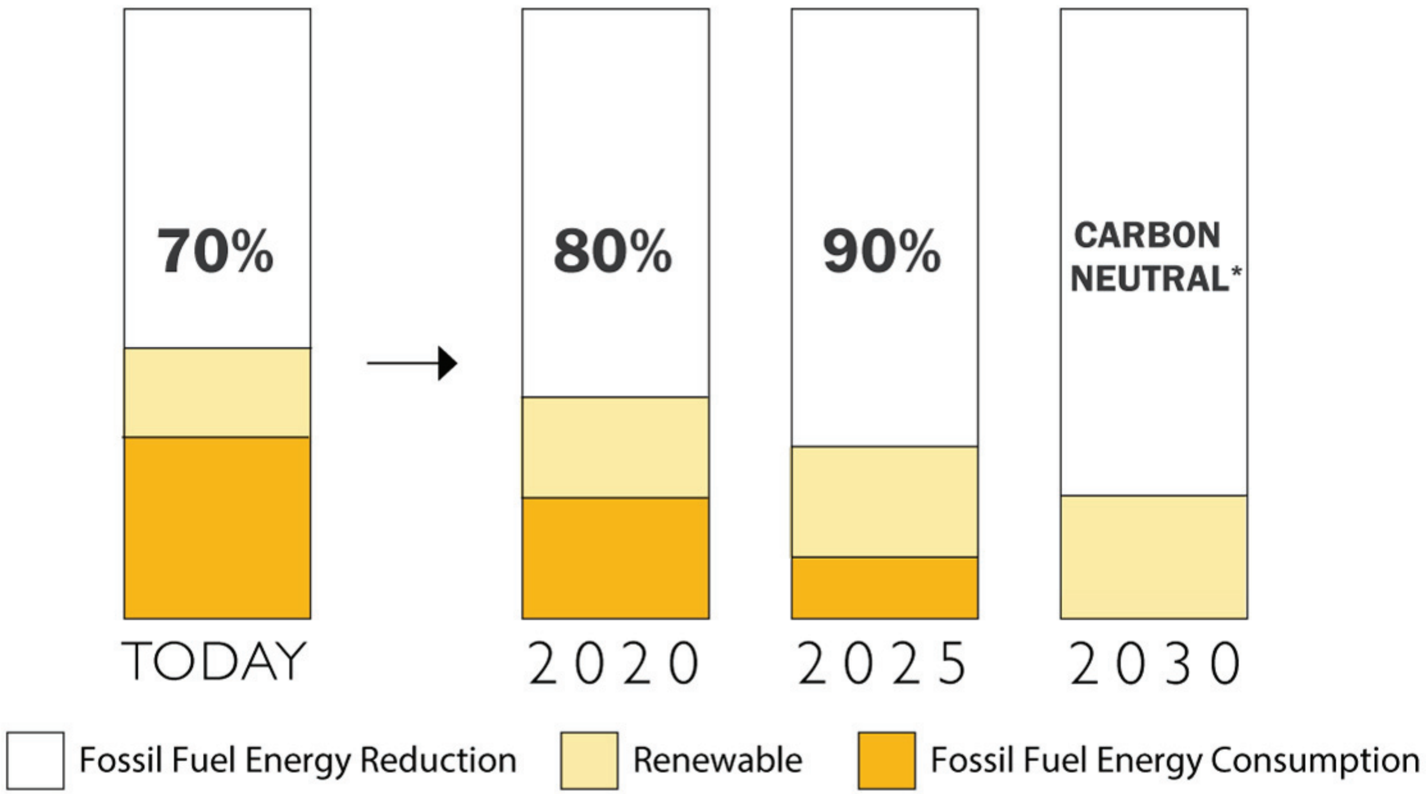
Why Carbon Lifecycle Assessment is Gaining Traction

As operational energy shrinks and buildings approach net zero, embodied carbon becomes more important

Global CO_2 Emission by Sector



Source: © 2018 2030, Inc. / Architecture 2030. All Rights Reserved. Data Sources: UN Environment Global Status Report 2017; EIA International Energy Outlook 2017



The 2030 Challenge

Source: ©2015 2030, Inc. / Architecture 2030. All Rights Reserved.
*Using no fossil fuel GHG-emitting energy to operate.

New Updates to AIA Code of Ethics

At the recommendation of the National Ethics Council and the New England Committee on the Environment, new rules and ethical standards were also added to the Code of Ethics to address sustainability:

- Members should promote fai
  advise their clients and empl
  sunlight and energy for all; s
  environment that equitably s
  restoring degraded or deplet
- When performing profession
  potential environmental imp
  performed on behalf of the c
- Energy conservation: membe
  with their clients for each project (Ethical Standard 6.1).
- Water use: members should optimize water conservation in each project to reduce water use and protect water supply, water quality, and watershed resources (Ethical Standard 6.2).
- Building materials: members should select and use building materials to minimize exposure to toxins and pollutants in the environment to promote environmental and human health and to reduce waste and pollution (Ethical Standard 6.3).
- Ecosystems: members should consider with their clients the impact of each project on the natural habitat and ecosystem to promote environmental and human health (Ethical Standard 6.4).
- Climate change: members should incorporate adaptation strategies with their clients to anticipate extreme weather events and minimize adverse effects on the environment, economy and public health (Ethical Standard 6.5).
- Members shall consider with their clients the environmental effects of their project decisions (Rule 6.501).

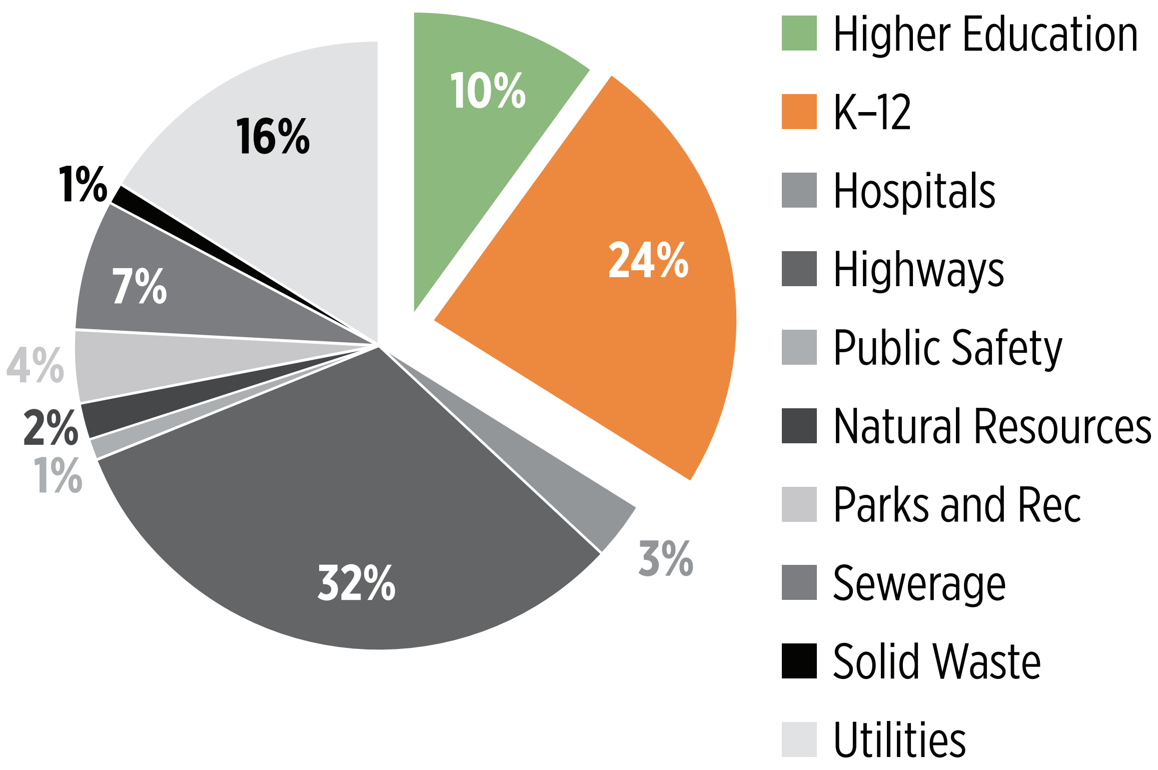
An updated copy of the Code of Ethics and more information on the National Ethics Council can be reviewed on AIA's website.

When performing professional services, members shall make reasonable efforts to inform their clients of the potential environmental impacts or consequences the member reasonably believes may occur as a result of work performed on behalf of the clients (Rule 2.401).

State and Local Capital Outlay

K–12 Facilities Account for About One-Quarter of State and Local Infrastructure Investments

Percent of total state and local capital outlay, 1995–2012

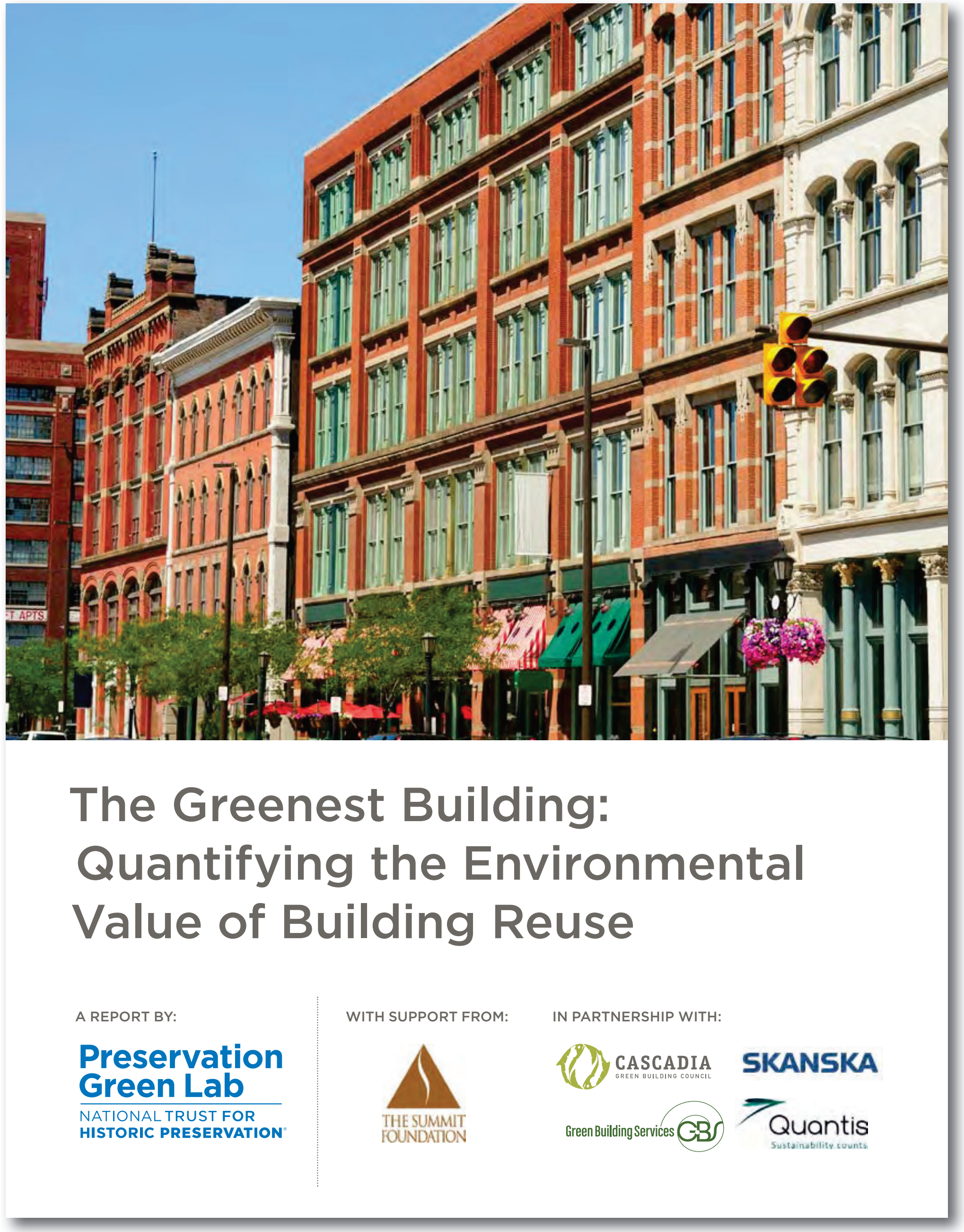


Source: U.S. Census of Governments, State and Local Government F-13 Fiscal Survey, FY 1995–2012, omitting 1997, 2001, 2003

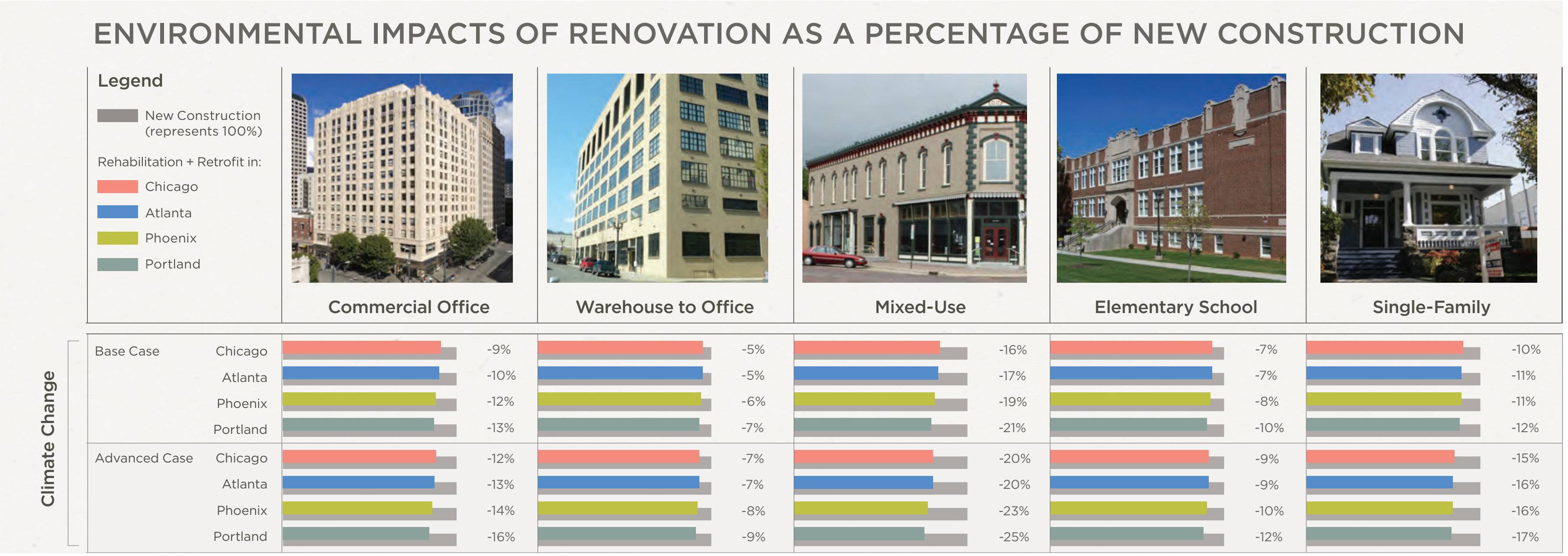
Building Reuse

Under what conditions is building reuse environmentally favorable compared to demolition and new construction?

Quantifying Environmental Impacts



Summary of Results – The Greenest Building: Quantifying the Environmental Value of Building Reuse



Climate Change		Commercial Office	Warehouse to Office	Mixed-Use	Elementary School	Single-Family
Base Case	Chicago	-9%	-5%	-16%	-7%	-10%
	Atlanta	-10%	-5%	-17%	-7%	-11%
	Phoenix	-12%	-6%	-19%	-8%	-11%
	Portland	-13%	-7%	-21%	-10%	-12%
Advanced Case	Chicago	-12%	-7%	-20%	-9%	-15%
	Atlanta	-13%	-7%	-20%	-9%	-16%
	Phoenix	-14%	-8%	-23%	-10%	-16%
	Portland	-16%	-9%	-25%	-12%	-17%

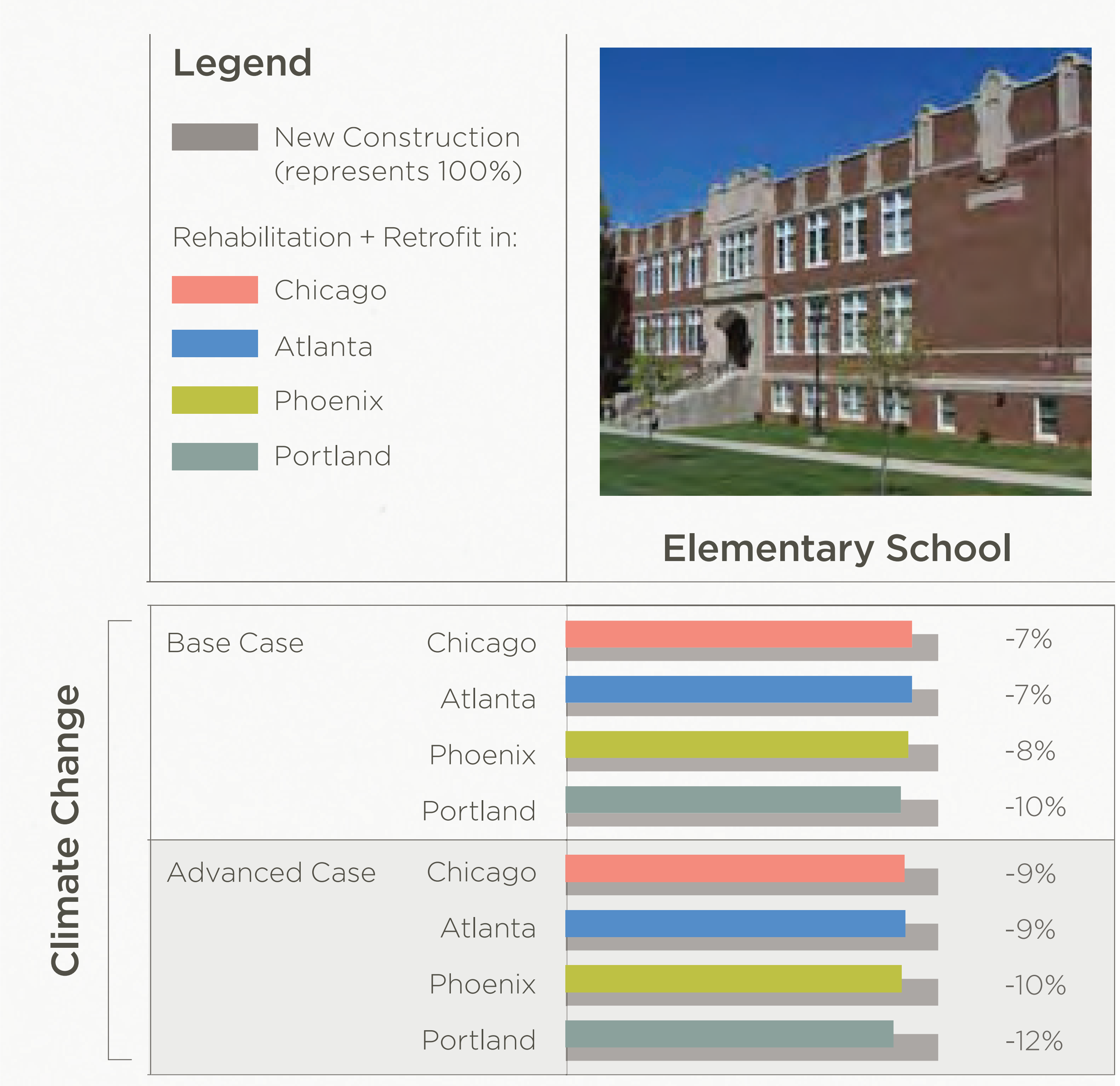
Year of Carbon "Equivalency"

Building Type	Chicago	Portland
Urban Village Mixed Use	42 Years	80 Years
Single-Family Residential	38 Years	50 Years
Commercial Office	25 Years	42 Years
Warehouse-to-Office Conversion	12 Years	19 Years
Multifamily Residential	16 Years	20 Years
Elementary School	10 Years	16 Years
Warehouse-to-Residential Conversion	Never	Never

Comparison - New Construction vs. Re-use

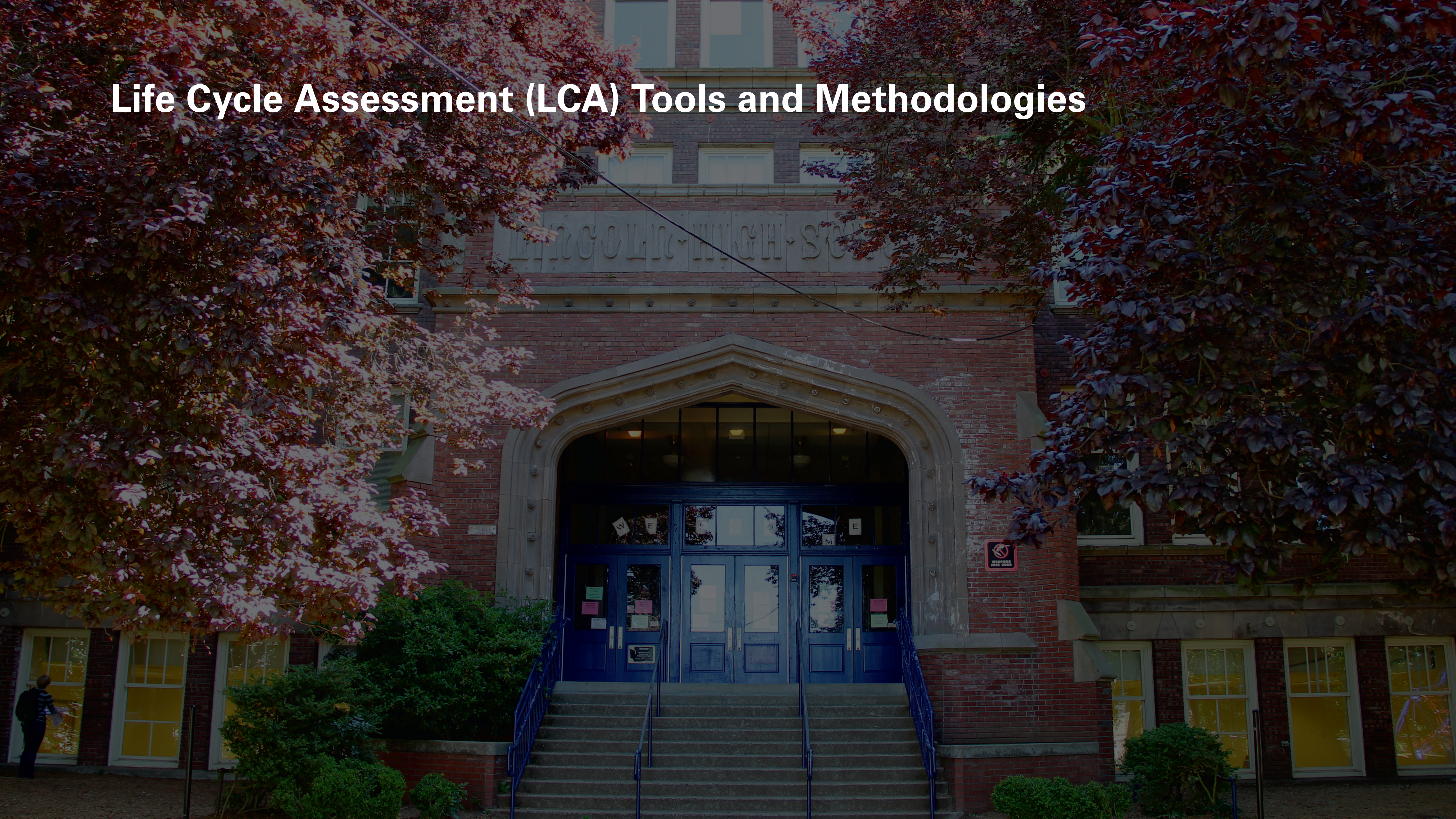
This study finds that it takes 10 to 80 years for a new building that is 30 percent more efficient than an average-performing existing building to overcome, through efficient operations, the negative climate change impacts related to the construction process.

The Greenest Building: Quantifying the Environmental Value of Building Reuse



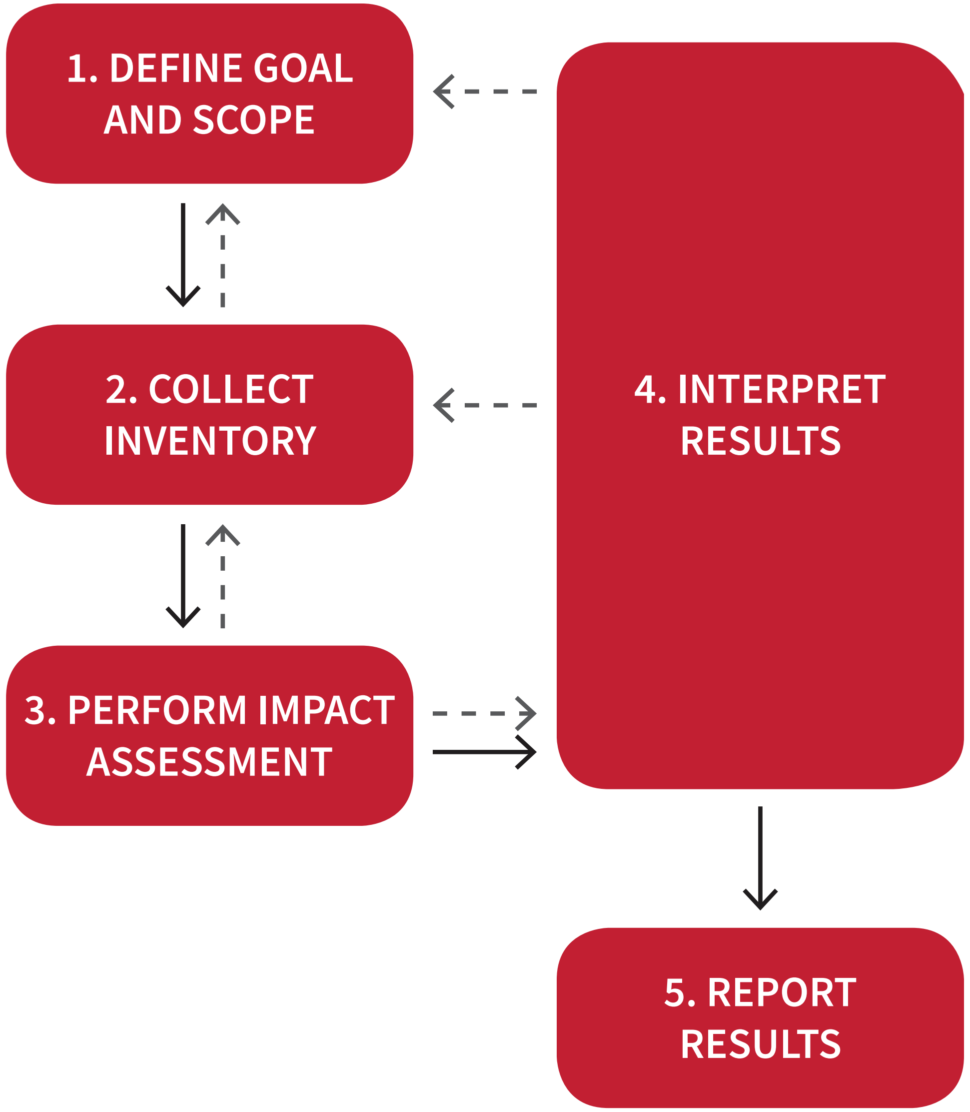
- The Greenest Building: Quantifying the Environmental Value of Building Reuse

Life Cycle Assessment (LCA) Tools and Methodologies

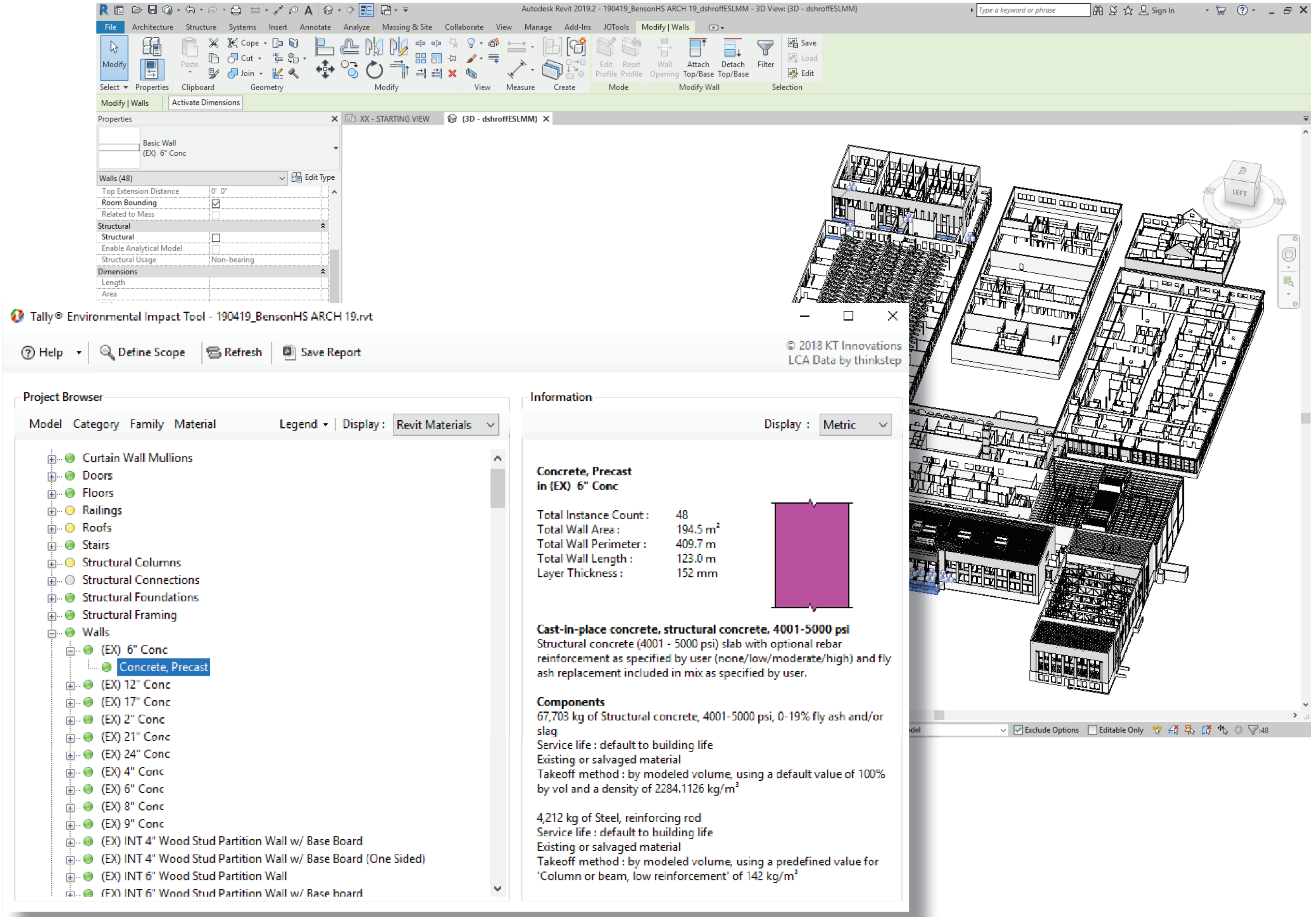


The Life Cycle Assessment Process

Our Goal: Calculate the Carbon Impact of the Proposed Design Against Other Scenarios

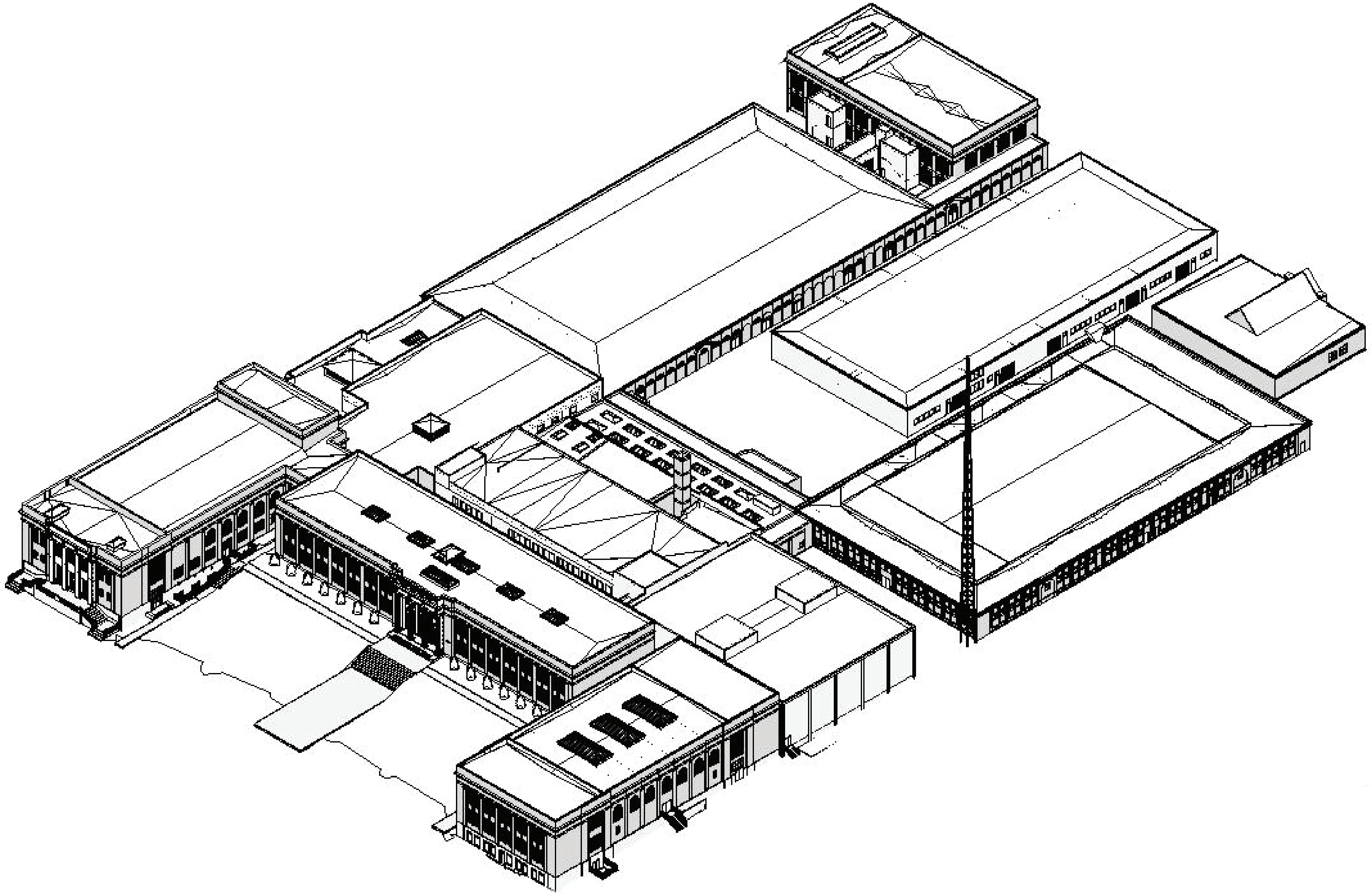


- Life Cycle Assessment of Buildings: *A Practice Guide*



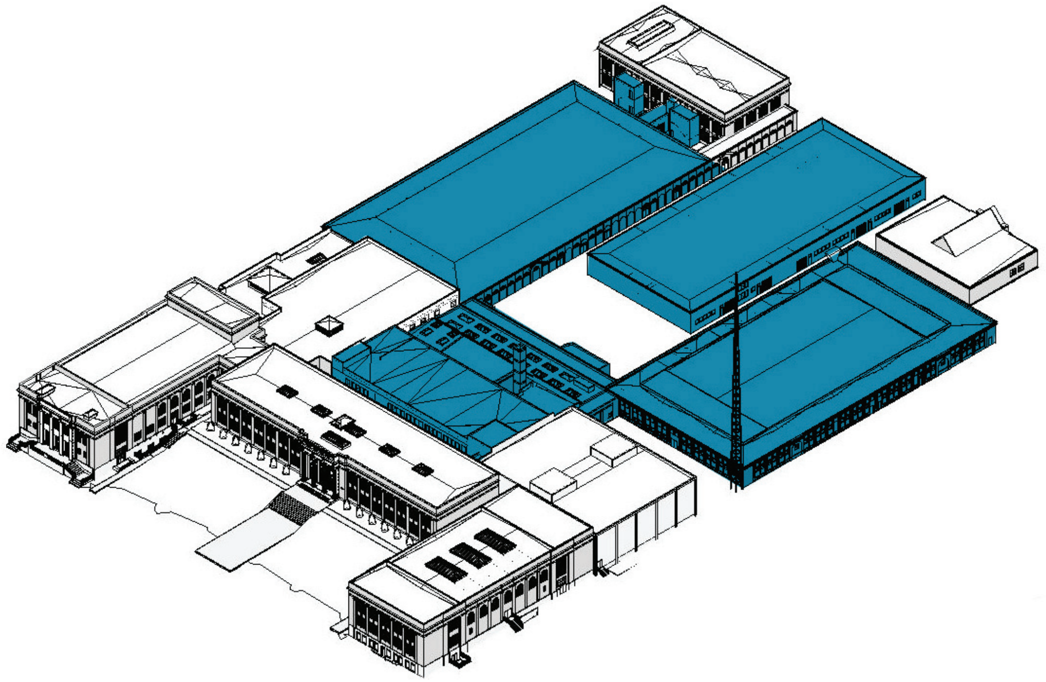
Life Cycle Assessment of Benson Polytechnic High School

Scenario 1: Keep Existing Building

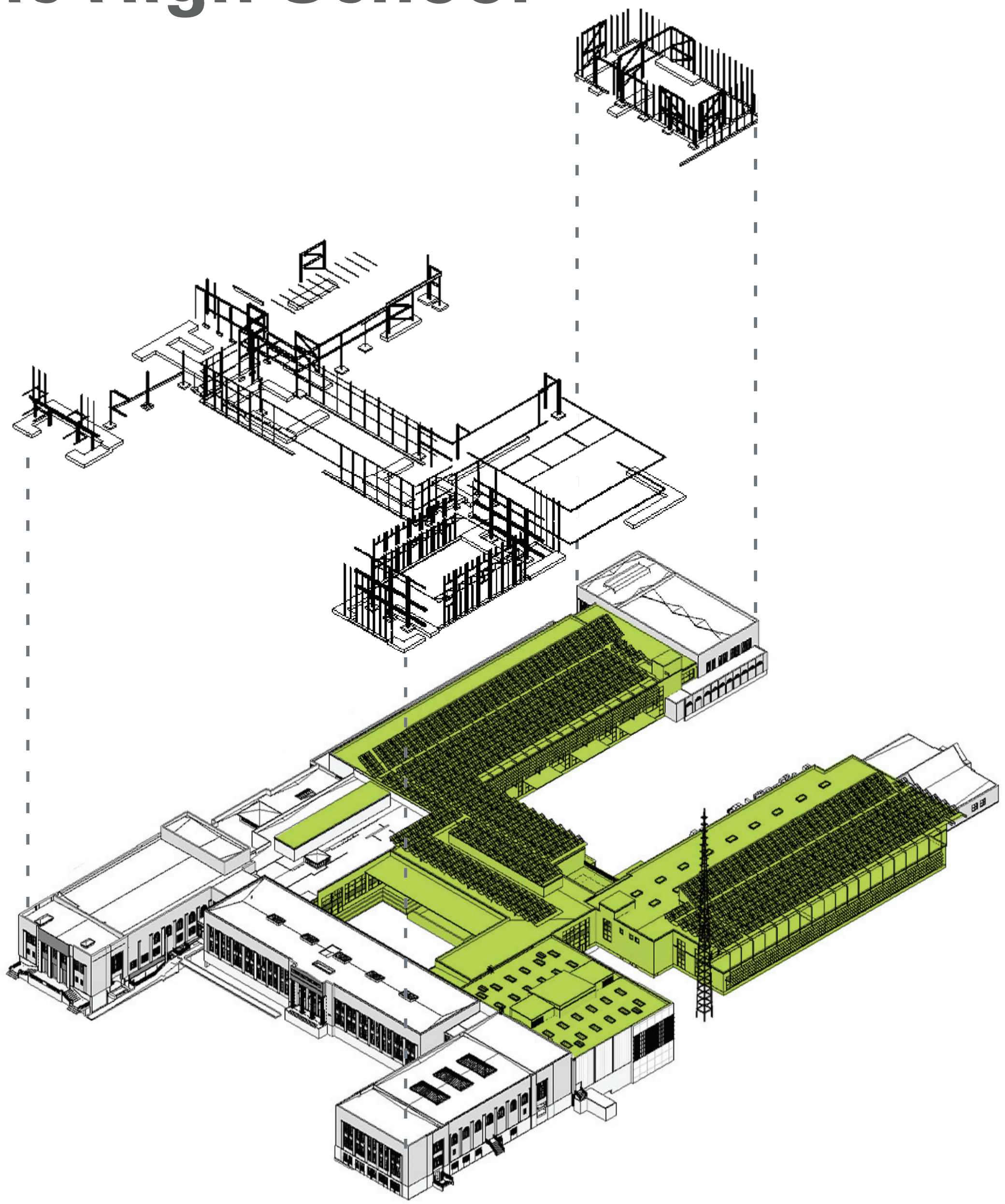


Life Cycle Assessment of Benson Polytechnic High School

Scenario 2: Proposed Design



EXISTING BUILDING
Demolish 155,100 sf of Existing

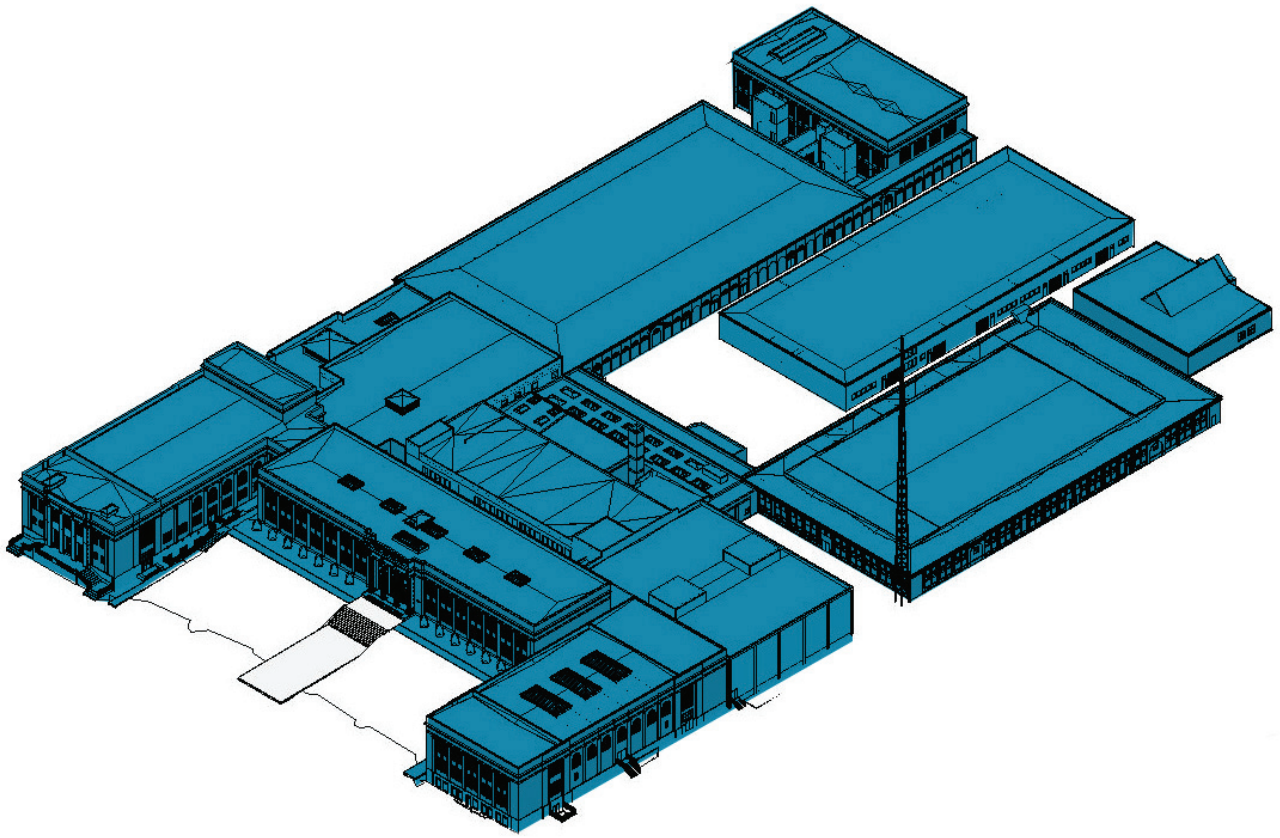


PROPOSED DESIGN
Build 136,800 sf of New Building

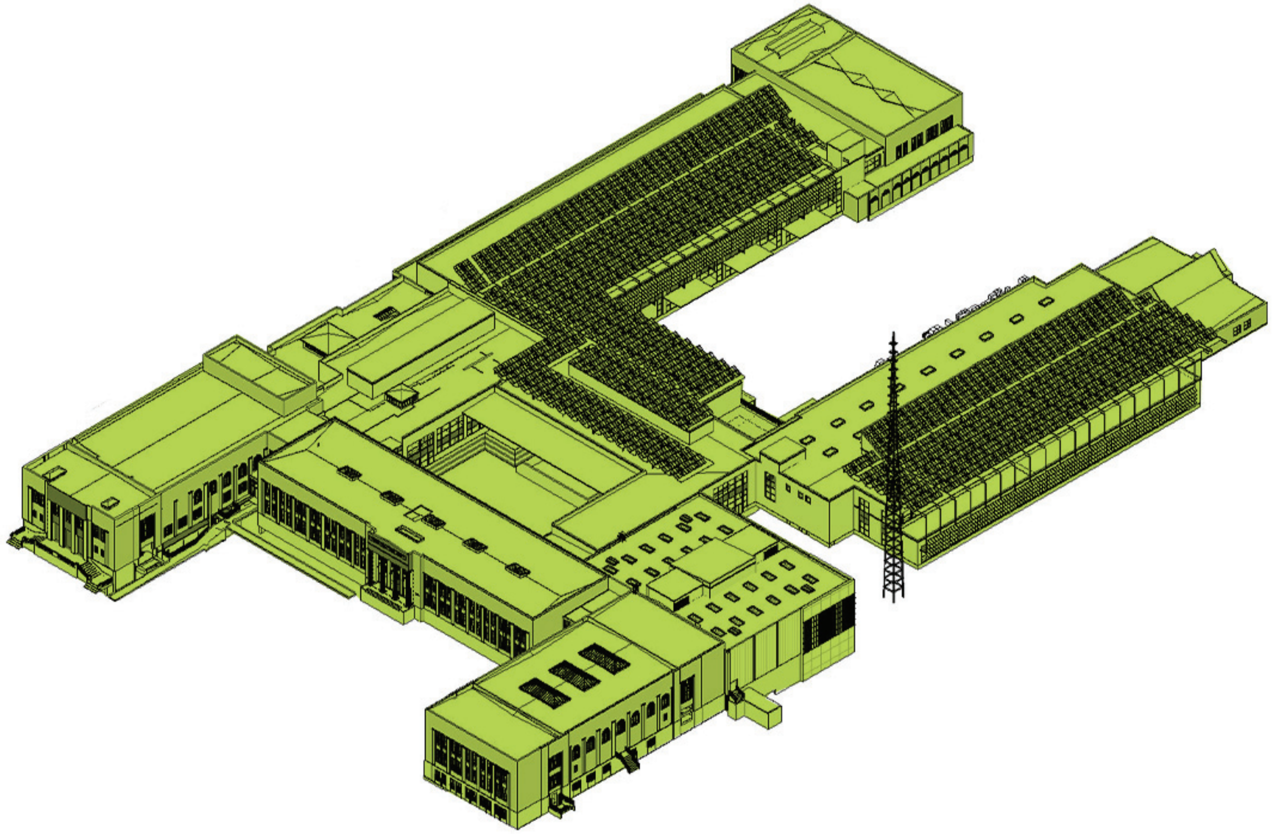
Life Cycle Assessment of Benson Polytechnic High School

Scenario 3: Replace Entire Building with High-Performance Design

Scenario 4: Replace Entire Building with Baseline Code-Compliant Design



EXISTING BUILDING
Demolish 370,000 sf of Existing Building



COMPLETE REPLACEMENT
Build 368,000 sf of New Building

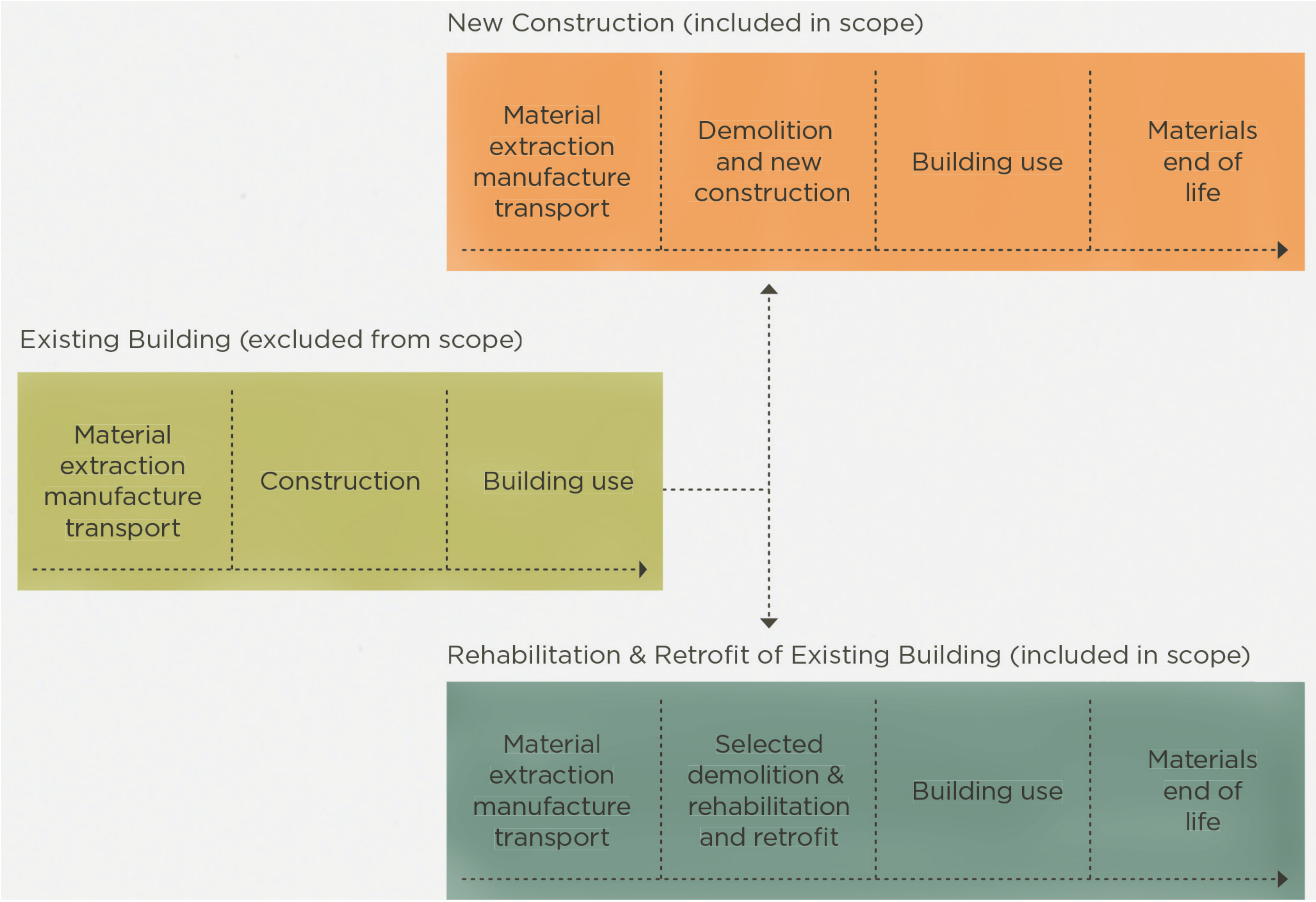
Defining Scope for the Benson Case Study

SCOPE INCLUDES

- Structure
- Foundations
- Enclosure
- Interiors

NOT INCLUDED

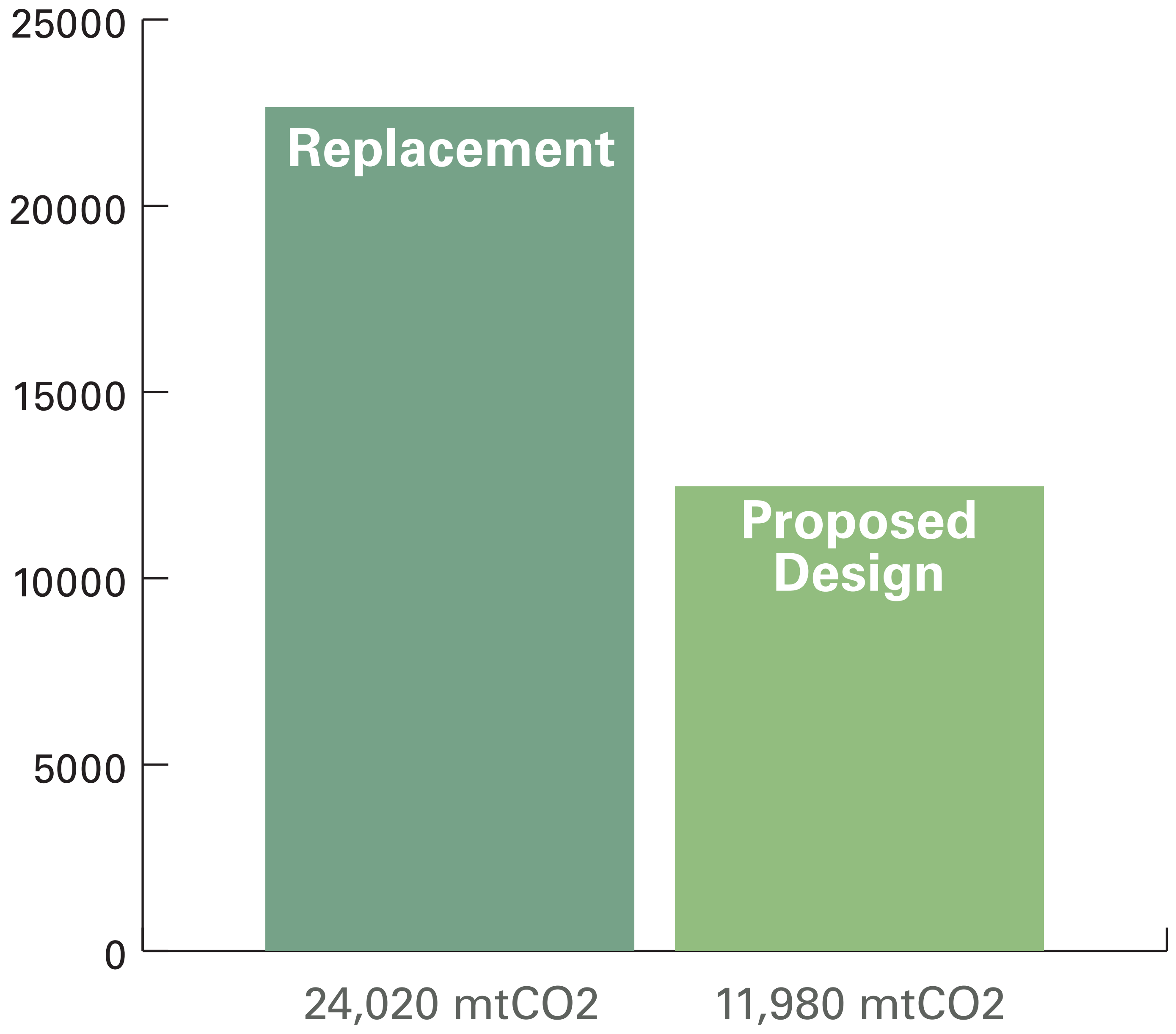
- Mechanical Systems
- Plumbing
- Electrical Systems
- Site Improvements



- The Greenest Building: Quantifying the Environmental Value of Building Reuse

Initial Results

Proposed Design vs. Replacement

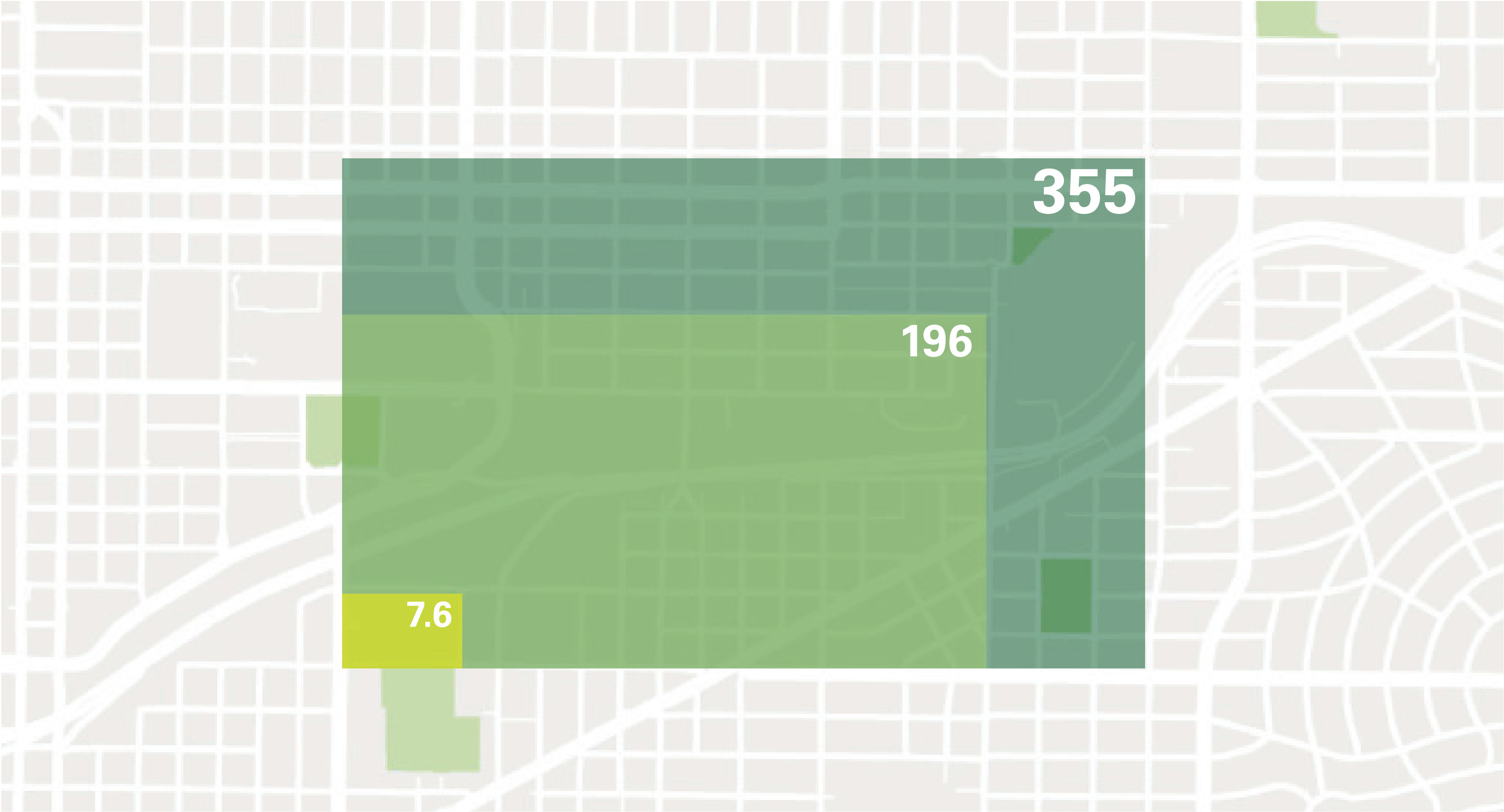


Initial Results

Proposed Design vs. Replacement

ACRES OF FOREST GROWTH OVER 75 YEARS

- Benson Polytechnic High School Site = 7.6 acres
- Proposed Design = 11,980 mtCO2 196 acres
- Replacement Construction = 24,020 mtCO2 / 355 acres

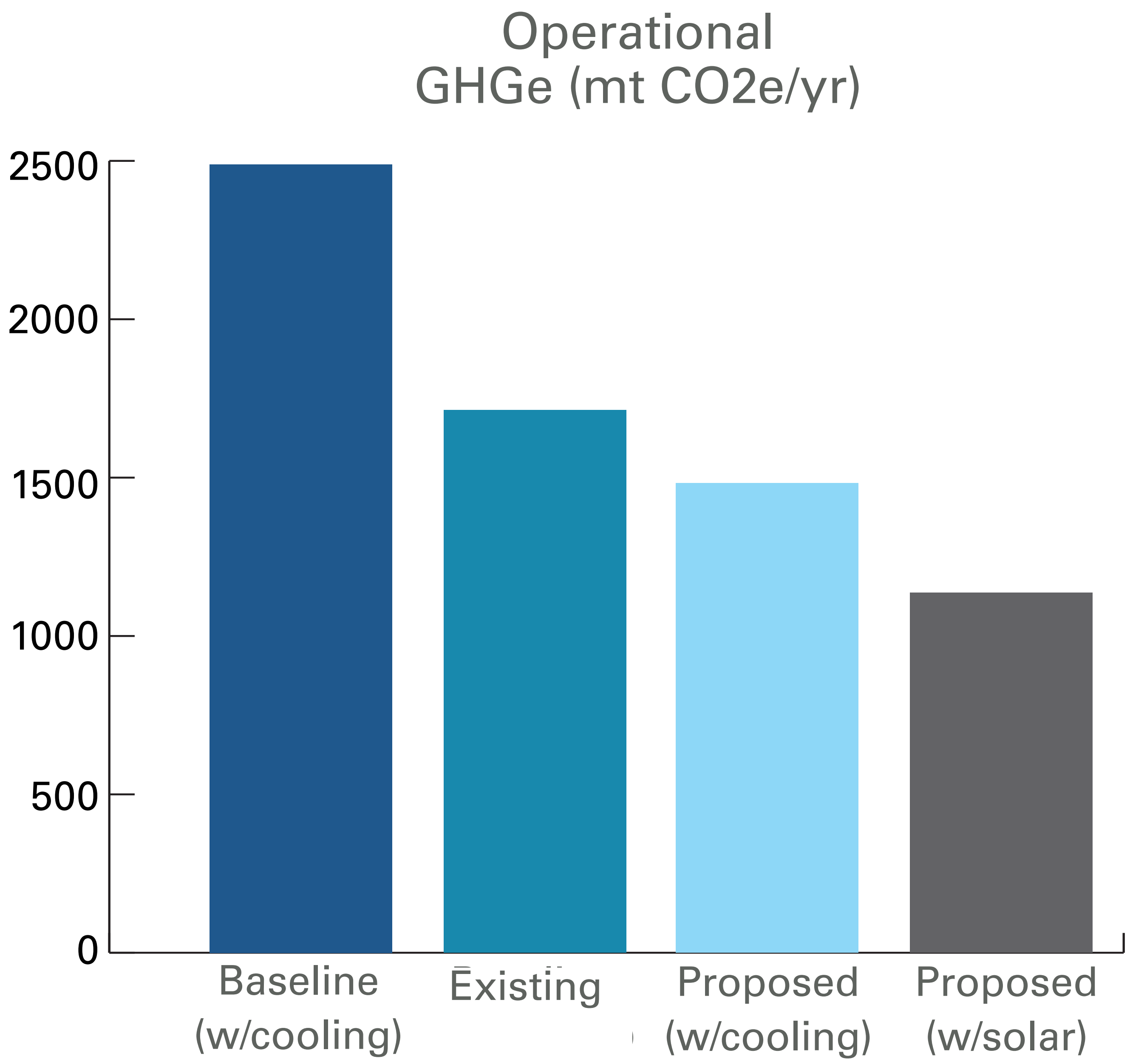


Benson Polytechnic High School

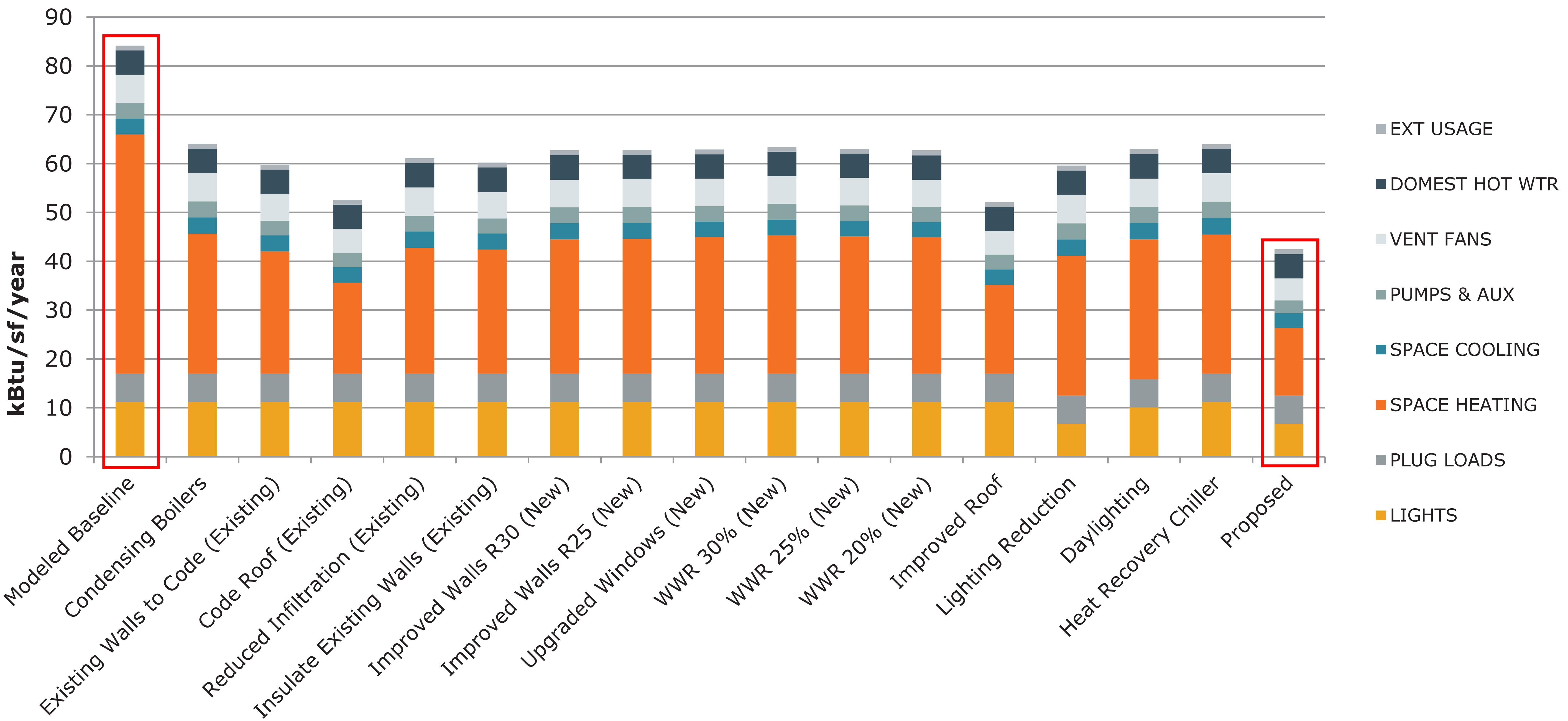
Historic buildings are well suited for resource efficiency

"We cannot build our way to sustainability. We must conserve our way to it."

- Elefante



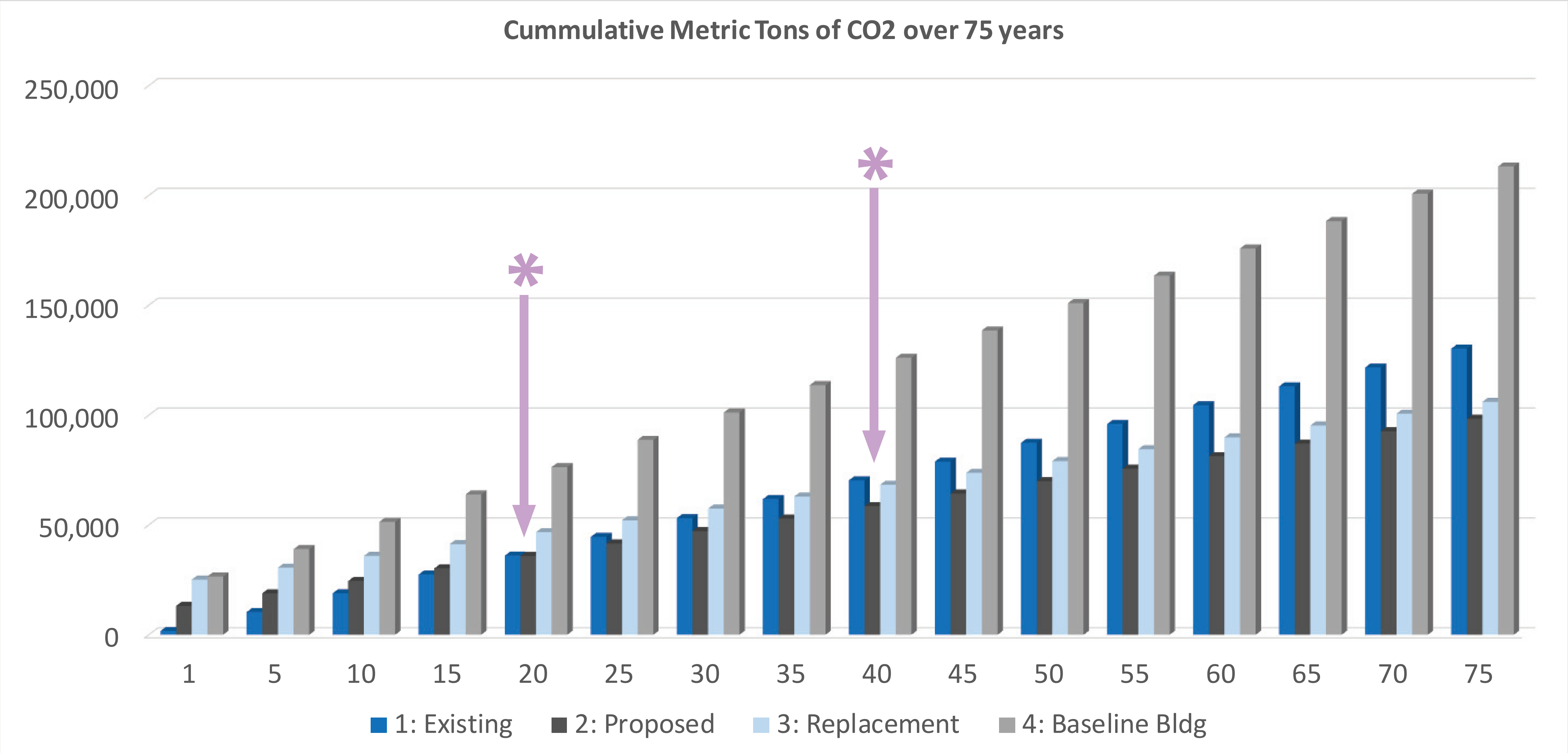
Energy Use



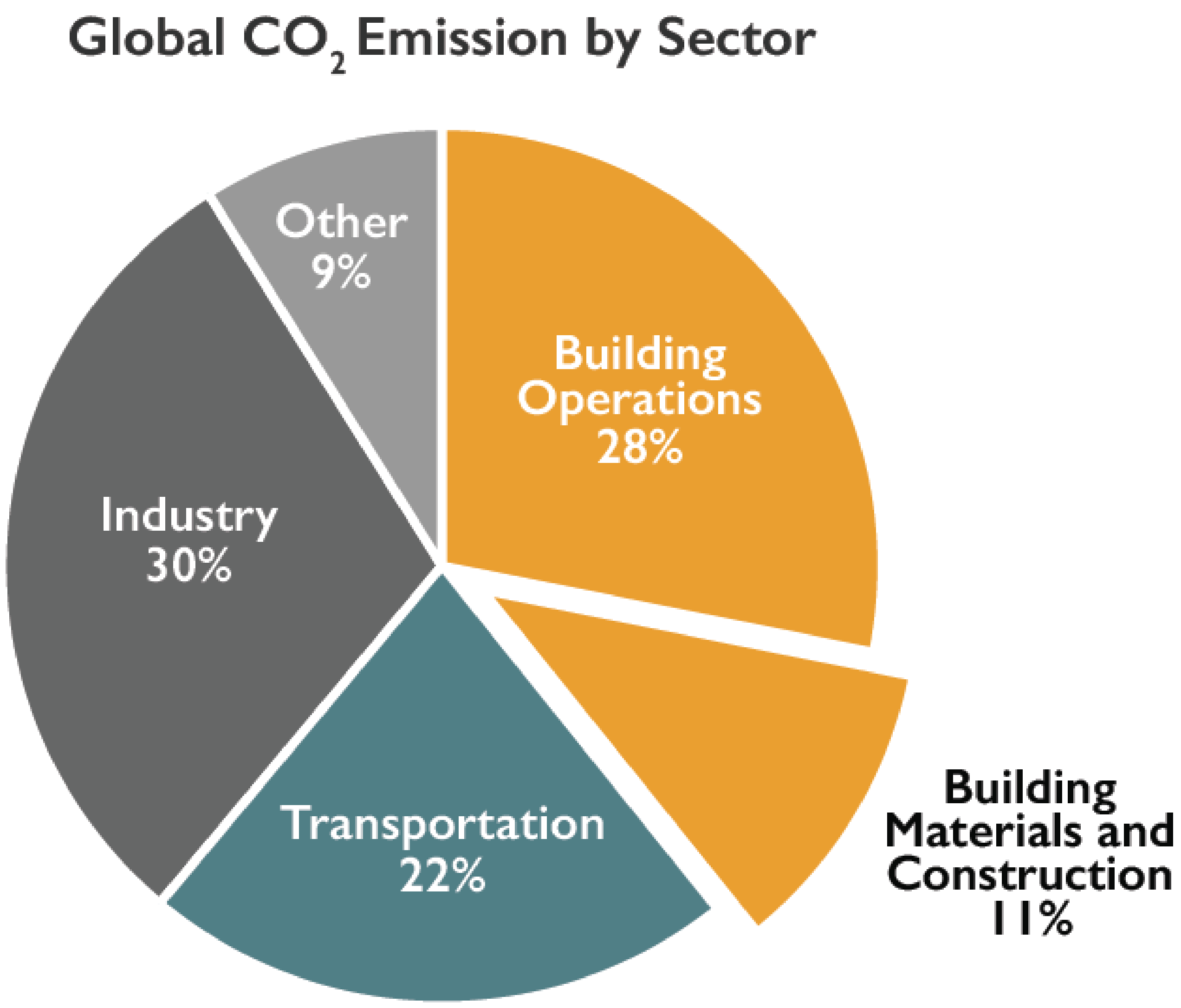
90
80
70
60
50
40
30
20
10
0
kBtu/sf/year
Modeled Baseline
Condensing Boilers
Existing Walls to Code (Existing)
Code Roof (Existing)
Reduced Infiltration (Existing)
Insulate Existing Walls (Existing)
Improved Walls R30 (New)
Improved Walls R25 (New)
Upgraded Windows (New)
WWR 30% (New)
WWR 25% (New)
WWR 20% (New)
Improved Roof
Lighting Reduction
Daylighting
Heat Recovery Chiller
Proposed
EXT USAGE
DOMEST HOT WTR
VENT FANS
PUMPS & AUX
SPACE COOLING
SPACE HEATING
PLUG LOADS
LIGHTS

Initial Results

Building Re-use Reduces Lifetime Carbon Footprint

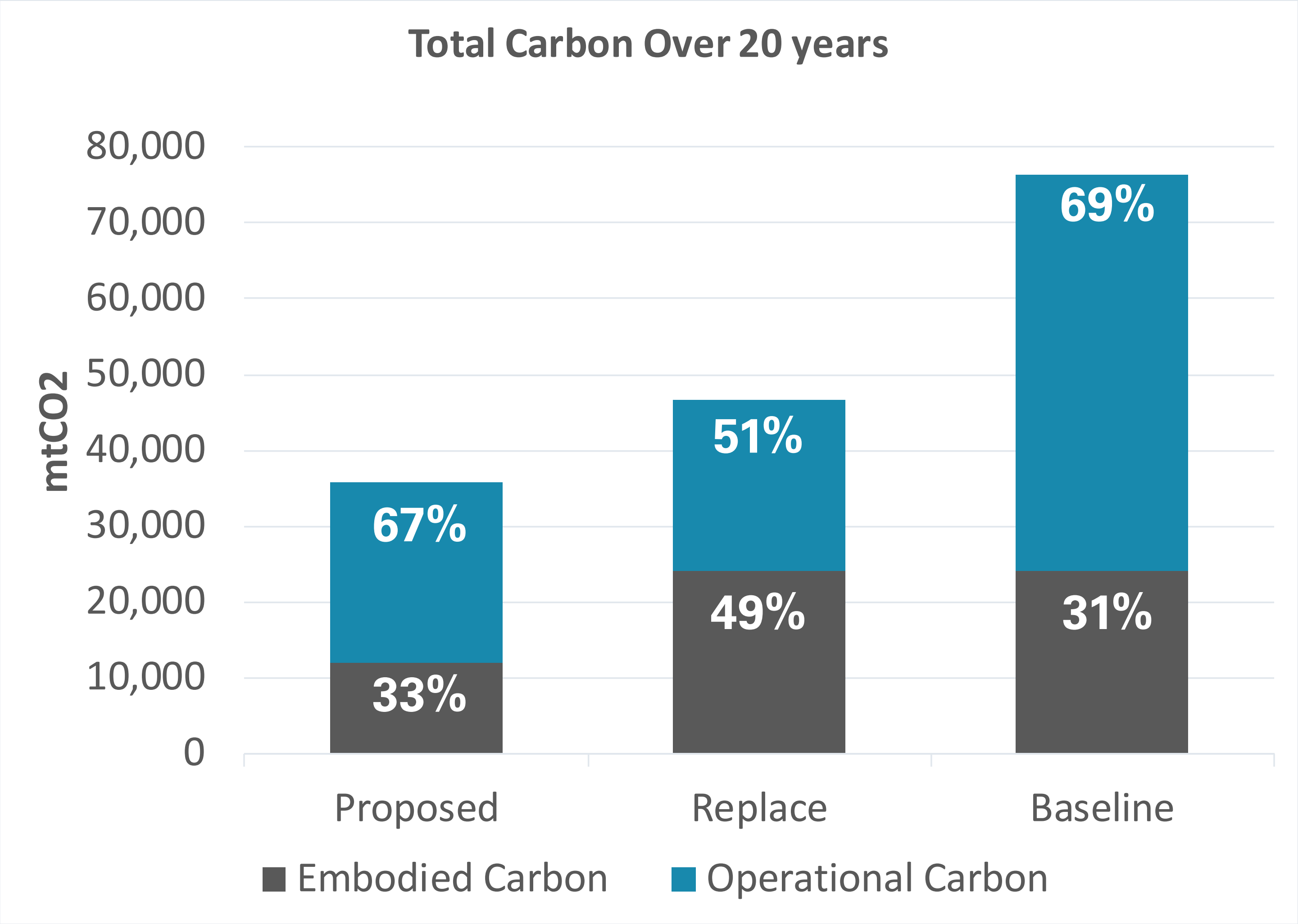


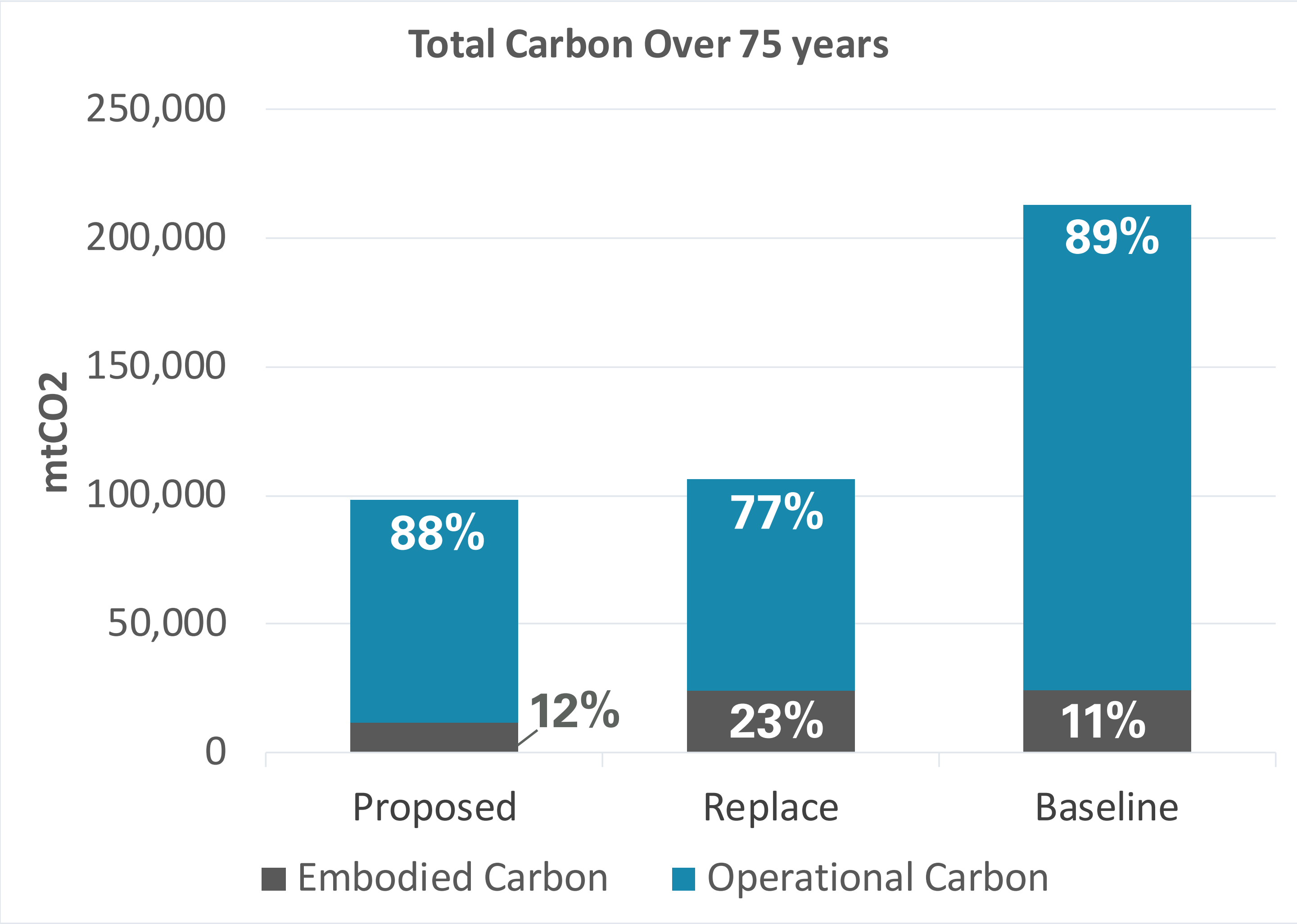
As Operational Energy Shrinks and Buildings Approach Net Zero, Embodied Carbon Becomes More Important



Source: © 2018 2030, Inc. / Architecture 2030. All Rights Reserved. Data Sources: UN Environment Global Status Report 2017; EIA International Energy Outlook 2017

Embodied Carbon as a Percentage of Total Carbon Footprint





Tally Analysis of Benson Proposed Design

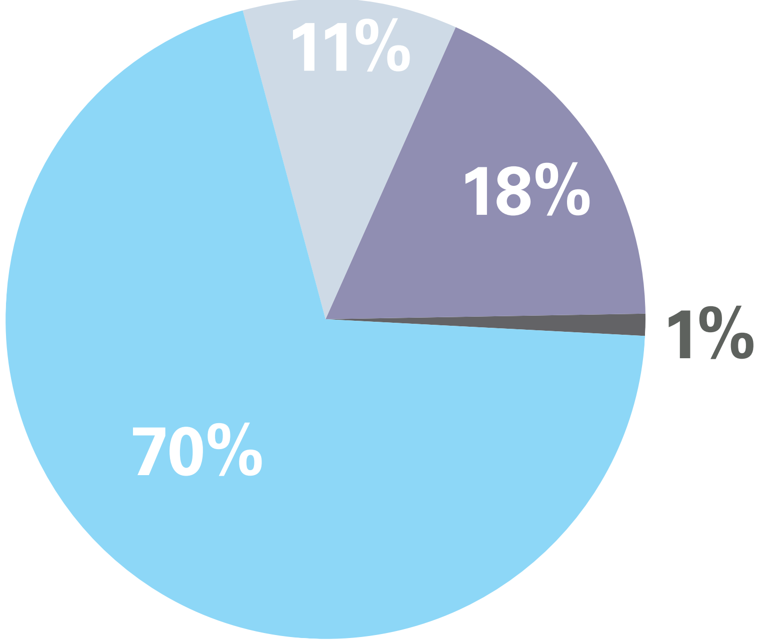
Carbon Footprint / Embodied Carbon

- Product
- End of Life
- Maintenance + Replacement
- Transportation

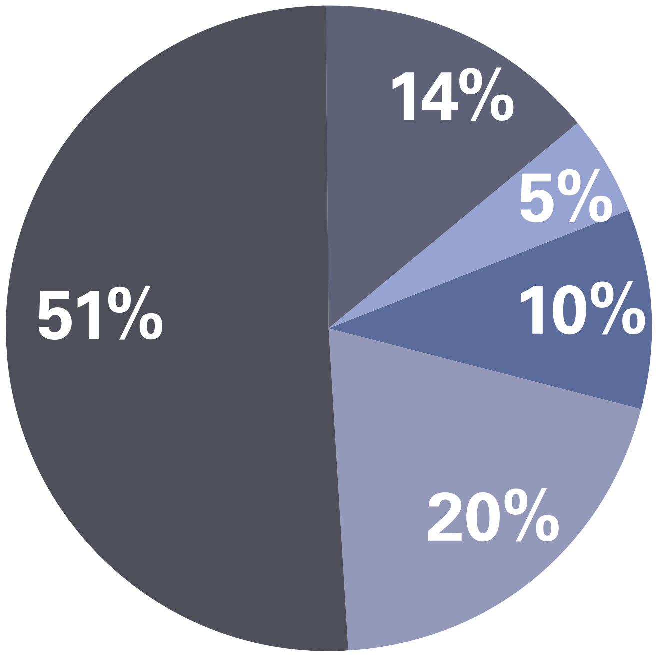
- Concrete
- Metals
- Finishes
- Thermal and Moisture Protection
- Openings and Glazing

- Walls
- Structure
- Floors
- Roofs
- Curtain Wall Mullions
- Doors and Windows

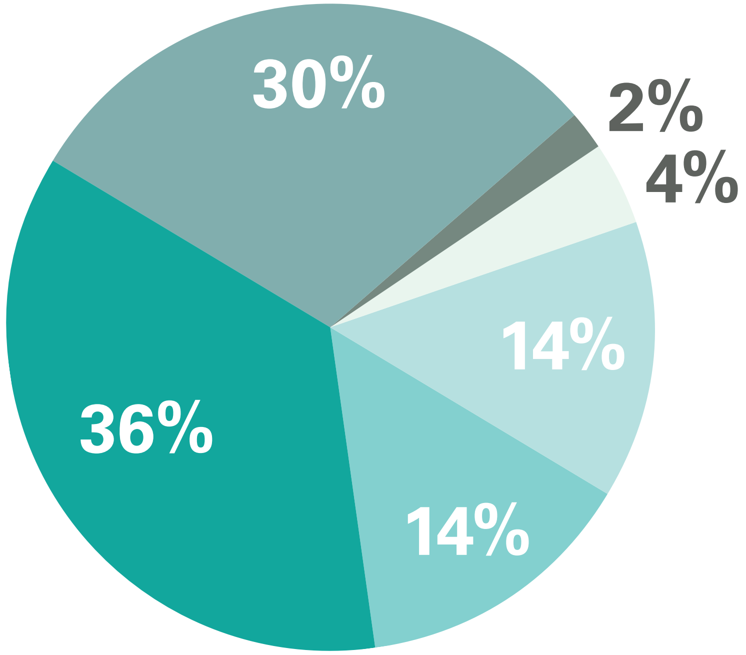
Global Warming Potential
Life Cycle Stages



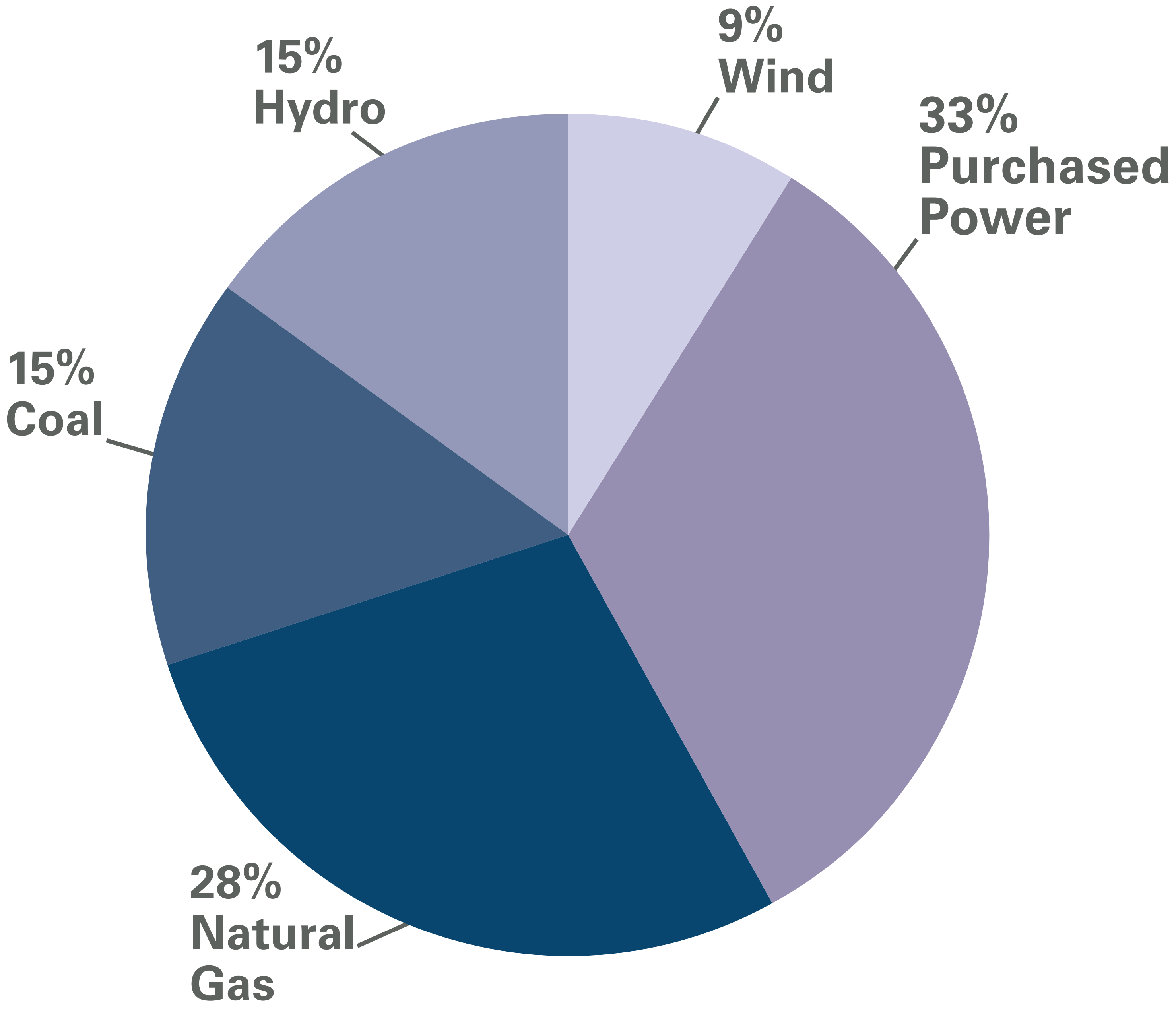
Global Warming Potential
Divisions

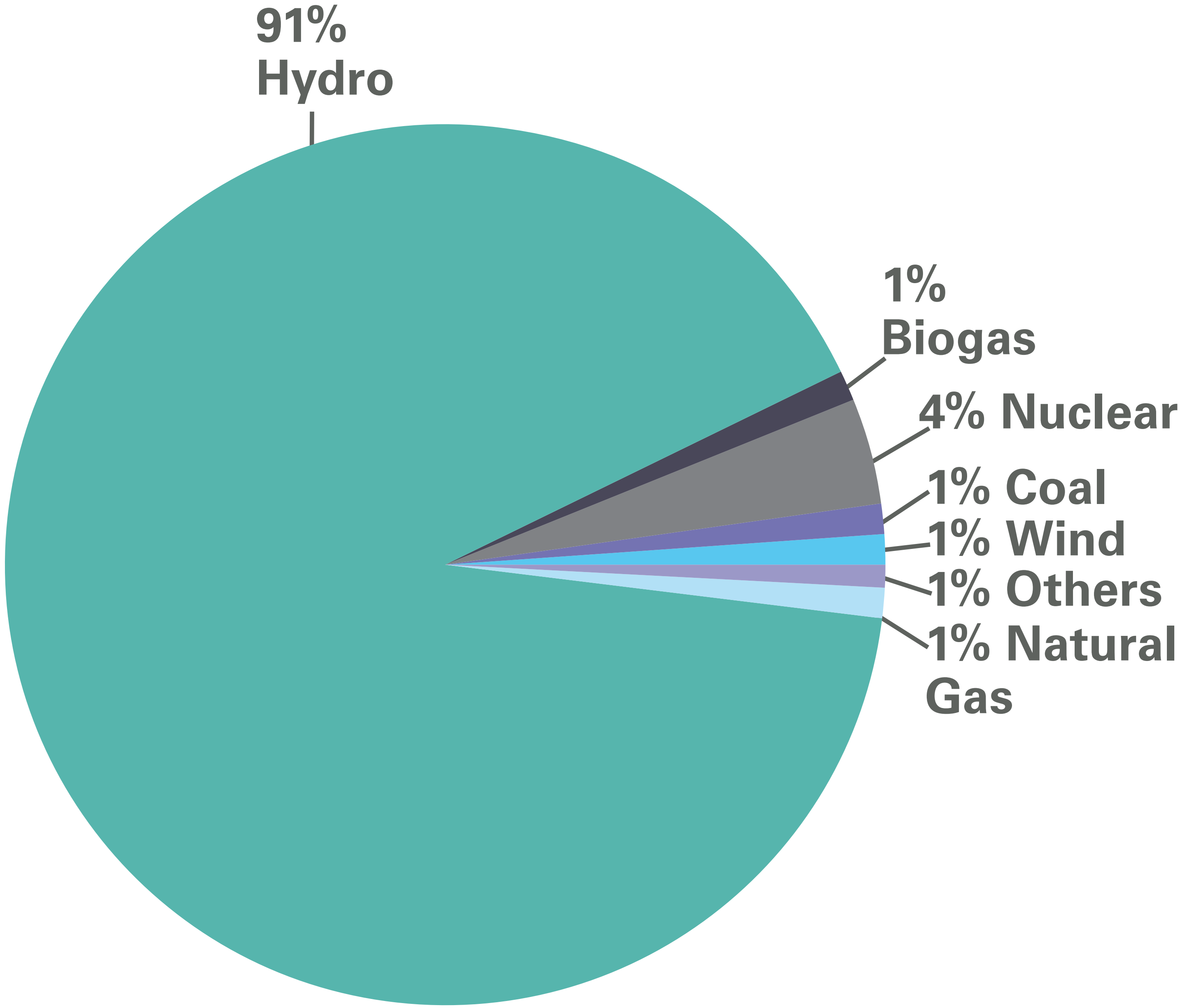


Global Warming Potential
Building Elements

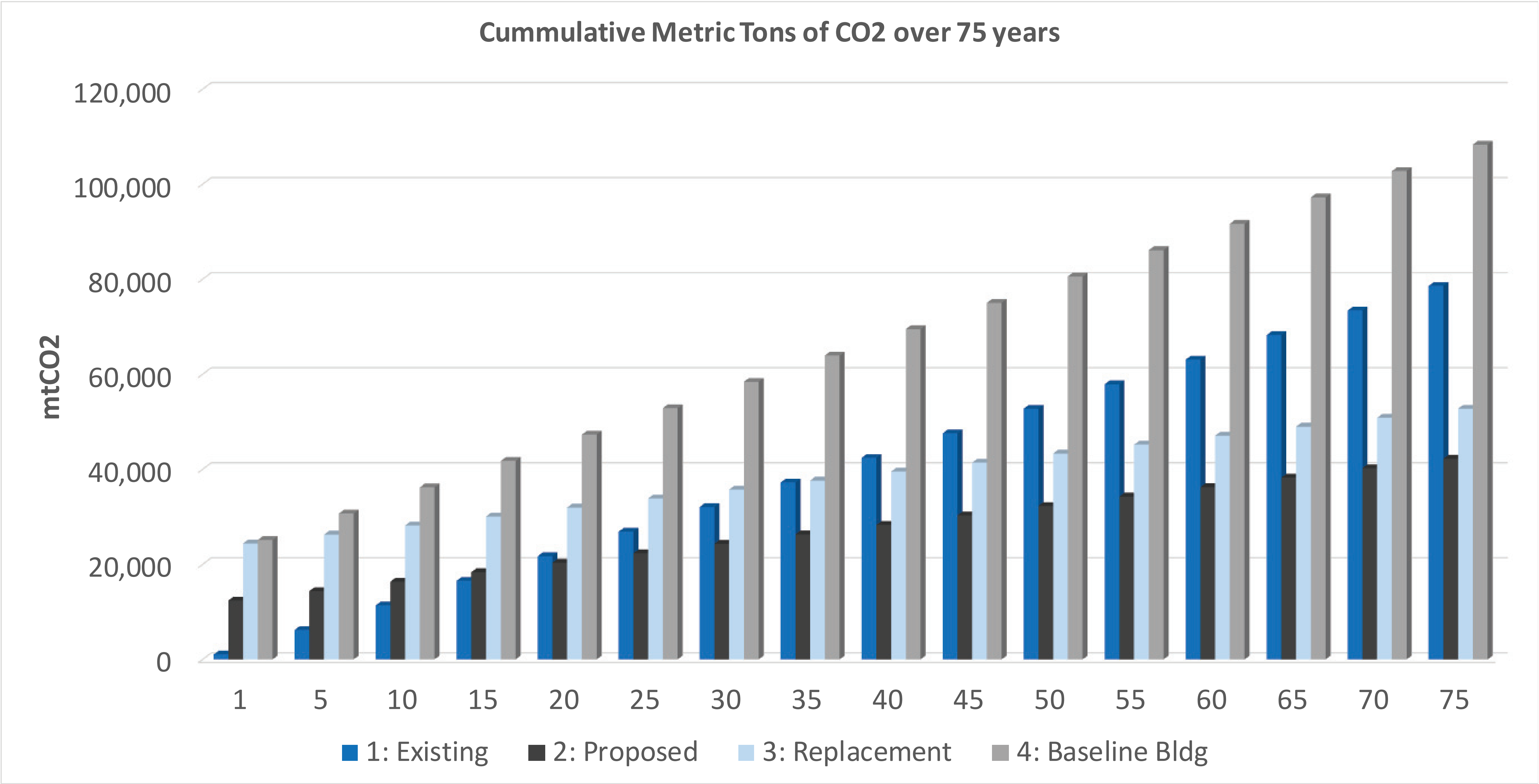


Portland Power Use and Seattle Power Mix



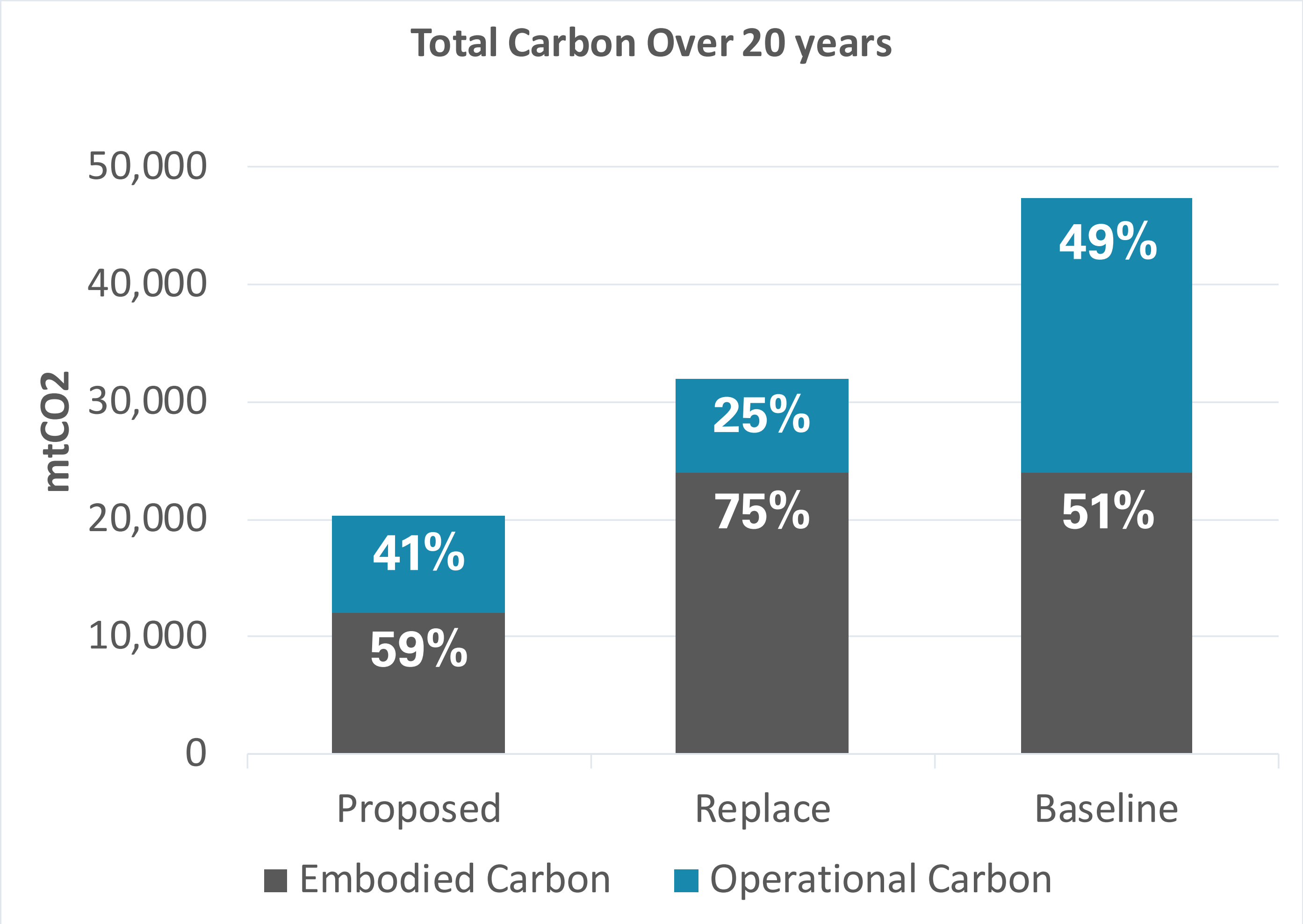


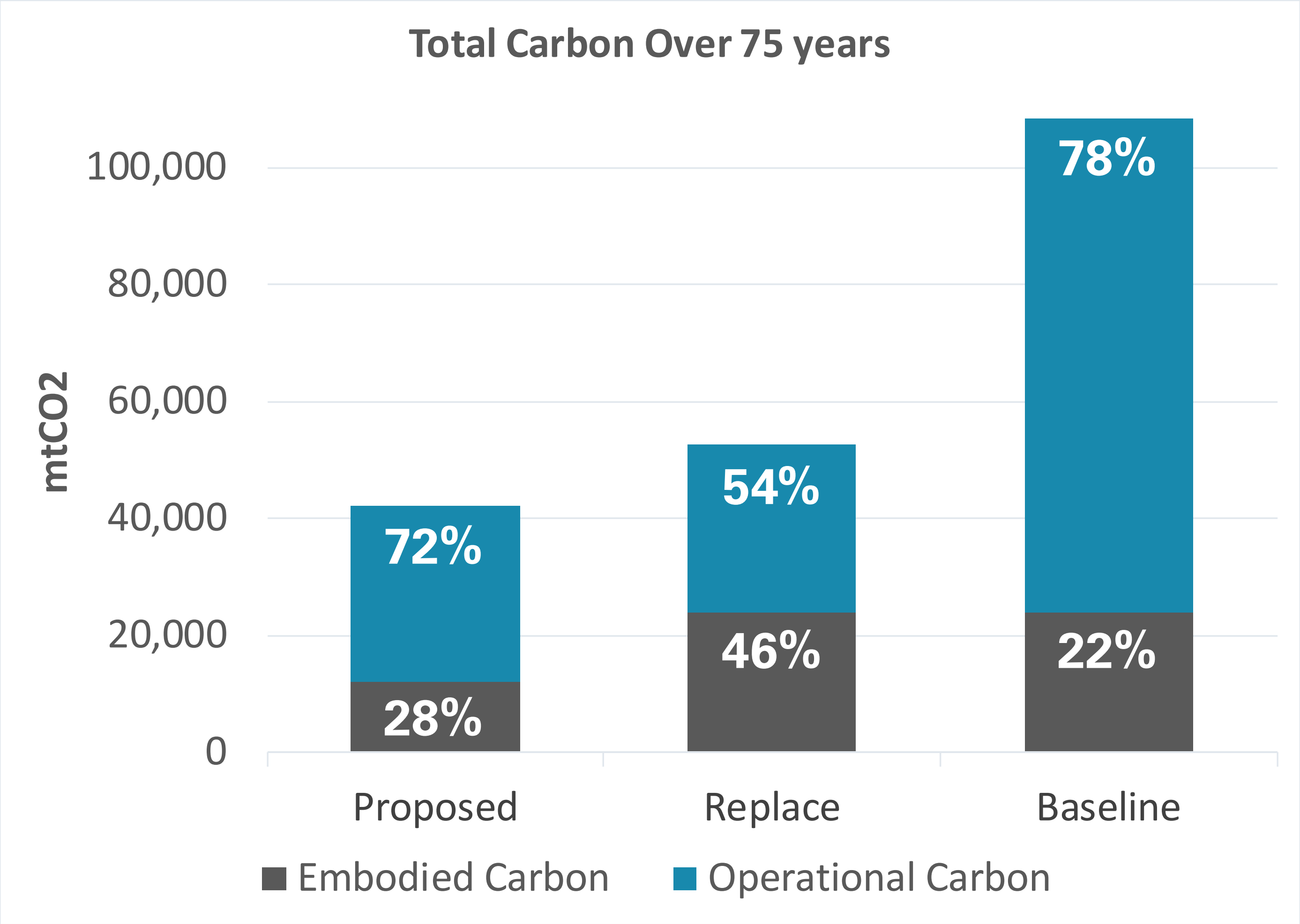
Initial Results - Seattle Utility Source



Embodied Carbon as a Percentage of Total Carbon Footprint

Seattle Utility Source





Next Steps: Reducing Embodied Carbon in New Construction

Wood Construction - Mass Timber and CLT

1st INTERNATIONAL CONFERENCE ON
INNOVATION IN
LOW-CARBON
CEMENT & CONCRETE
TECHNOLOGY
LONDON 24-26 JUNE 2019

Conclusions

- It can take decades for a new building to offset the carbon embodied in its construction.
- Building re-use and renovation offer significant reductions in embodied carbon – 55% in the case of Benson Polytechnic High School.
- Reducing the carbon footprint of our buildings requires not just energy use reductions but reductions in embodied energy.
- Adaptive reuse of historic schools helps meet the triple bottom line (social, economic, and environmental) while also creating successful 21st learning environments.

Questions & Answers

Thank You.

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