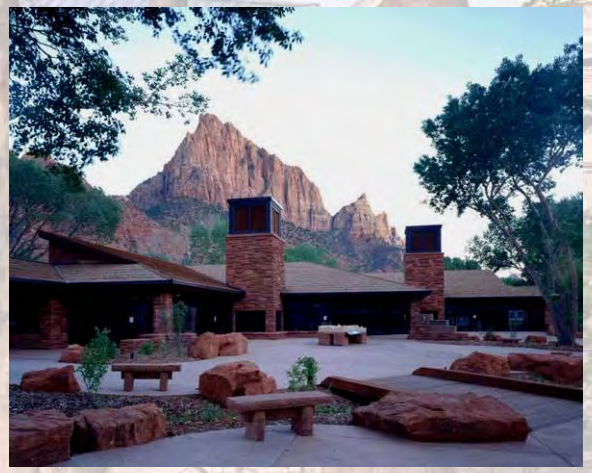
U.S. Department of Energy
Energy Efficiency and Renewable Energy

federal energy management program

RECYCLING BUILDINGS
THE ULTIMATE GREEN STRATEGY

12:15 – 1:15 PM
Wednesday, December 6th 2006

Carl Elefante **AIA, LEED AP**
Principal
Director of Sustainable Design
QUINN EVANS | ARCHITECTS



The Greenest building is….

....one that is *already* built.

Stewardship of the Built Environment

"Built for the Ages"

1910 - 1964

Pennsylvania Station

McKim Meade & White

Stewardship of the Natural Environment

Kenyan proverb:
The earth was not given to us by our parents;
it was lent to us by our children.

What is Sustainable ?

Ecology

Economy

Equity

The Ecology of Commerce
Paul Hawken

Ecology

Atmospheric Change

Nitrogen	78%
Oxygen	21%
	99%
CO_2	0.03%

1850 vs. 2000

CO_2 (40% increase)
< 250 ppm >350 ppm

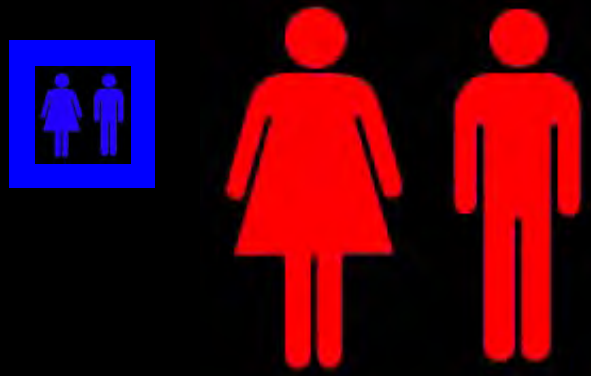
CH_4 (80% increase)
<1.0 ppm >1.8 ppm

N_2O (7% increase)
< 285 ppb >305 ppb

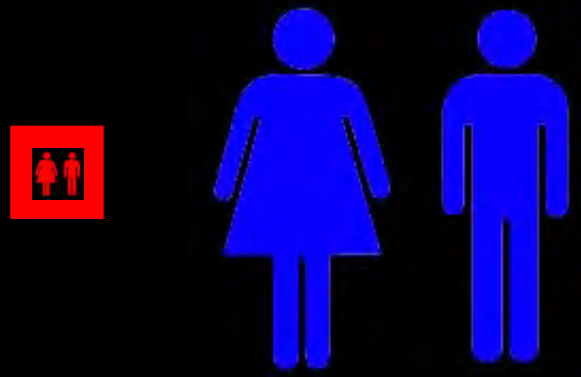
CFC (400% increase)
0.0 ppb >0.4 ppb

Economy

US vs China



Population



Per Capita Energy Use

If (When?)
China consumes
energy like US

Equity
Population

10 Most Populous Nations 2035

India
China
USA
Indonesia
Nigeria
Pakistan
Bangladesh
Brazil
Congo
Ethiopia

World Population 2005
6,466,000,000
World Population 2035
10,000,000,000

U.S. Building Industry Impacts

Energy	Materials	Waste
>35%	>40%	>25%
		58% demolition 36% renovation 6% construction

Market Transformation

Accessibility

1990
Americans with
Disabilities Act

Preservation

1966
National Historic
Preservation Act

Secretary of the Interior's Standards

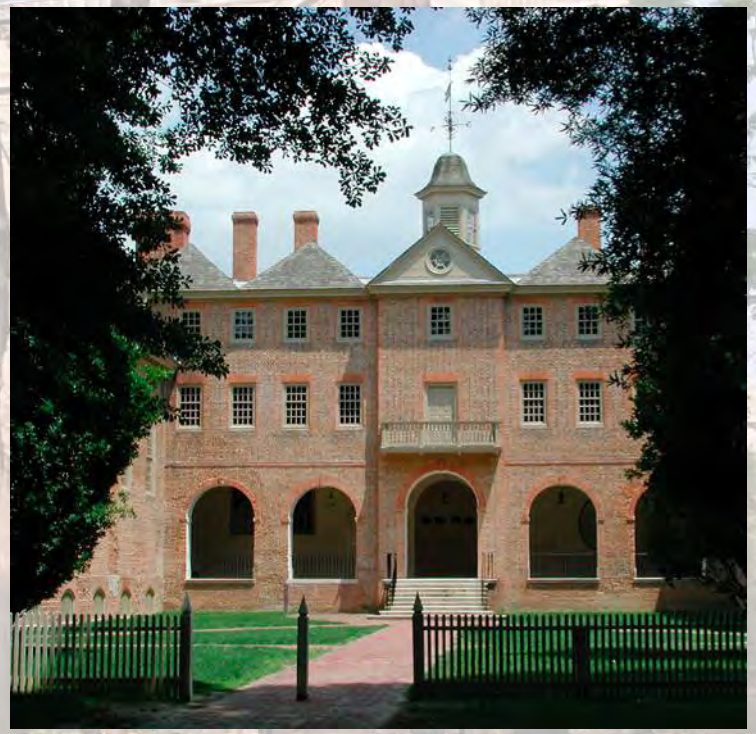
as Green Strategies

Preservation	Retain
Restoration	Replenish
Reconstruction	Replace
Rehabilitation	Renew

Sol's Standards: Preservation

Preservation

focuses on the **maintenance and repair** of existing historic materials and retention of a property's form as it has evolved over time.



Wren Building
College of William & Mary
QUINN EVANS | ARCHITECTS

Sol's Standards: Restoration

Restoration

depicts a property at **a particular period of time** in its history, while removing evidence of other periods.

Calvary Baptist Church
QUINN EVANS | ARCHITECTS

Sol's Standards: Reconstruction

Reconstruction

re-creates vanished or non-surviving portions of a property for interpretive purposes.

Mt. Vernon Treading Barn
QUINN EVANS | ARCHITECTS

Sol's Standards: Rehabilitation

Rehabilitation acknowledges the **need to alter or add** to a historic property to meet continuing or changing uses while retaining the property's historic character.

Cleveland Elementary School
QUINN EVANS | ARCHITECTS

Secretary of the Interior's Standards for Rehabilitation

USE TO RETAIN HISTORIC CHARACTER

1. A property shall be **used for its historic purpose** or be placed in a **new use that requires minimal change** to the defining characteristics of the building and its site and environment.

Secretary of the Interior's Standards for Rehabilitation

RETAIN HISTORIC CHARACTER

2. The **historic character of a property shall be retained** and preserved. The removal of historic materials or alteration of features and spaces that characterize a property shall be avoided.

Secretary of the Interior's Standards for Rehabilitation

AVOID INAPPROPRIATE CHANGES

3. Each property shall be recognized as a physical record of its time, place, and use. Changes that create **a false sense of historical development**, such as adding conjectural features or architectural elements from other buildings, **shall not be undertaken**.

Secretary of the Interior's Standards for Rehabilitation

CHANGE OVER TIME IS HISTORIC

4. Most properties change over time; those **changes** that have acquired historic significance in their own right **shall be** retained and **preserved**.

Secretary of the Interior's Standards for Rehabilitation

VALUE OF CRAFTSMANSHIP

5. Distinctive features, finishes, and construction techniques or **examples of craftsmanship** that characterize a property **shall be preserved**.

Secretary of the Interior's Standards for Rehabilitation

REPAIR INSTEAD OF REPLACE

6. Deteriorated historic features shall be **repaired rather than replaced**. Where the severity of deterioration requires replacement of a distinctive feature, the new feature shall match the old in design, color, texture, and other visual qualities and, where possible, materials. Replacement of missing features shall be substantiated by documentary, physical, or pictorial evidence.

Secretary of the Interior's Standards for Rehabilitation

CAUSE NO HARM

7. Chemical or physical **treatments**, such as sandblasting, **that cause damage** to historic materials **shall not be used**. The surface cleaning of structures, if appropriate, shall be undertaken using the gentlest means possible.

Secretary of the Interior's Standards for Rehabilitation

PROTECT ARCHEOLOGICAL RESOURCES

8. Significant **archeological resources** affected by a project **shall be protected** and preserved. If such resources must be disturbed, mitigation measures shall be undertaken.

Secretary of the Interior's Standards for Rehabilitation

DIFFERENTIATE NEW FROM HISTORIC

9. New additions, exterior alterations, or related new construction shall not destroy historic materials that characterize the property. The **new work shall be differentiated** from the old and shall be compatible with the massing, size, scale, and architectural features to protect the historic integrity of the property and its environment.

Secretary of the Interior's Standards for Rehabilitation

REVERSIBILITY

10. New additions and adjacent or related **new construction shall be** undertaken in such a manner that if **removed in the future**, the essential form and integrity of the historic property and its environment would be unimpaired.

Green Building Assessment
of Existing Buildings

CURRENT PERFORMANCE

CULTURAL VALUE

ENVIRONMENTAL VALUE

RE-USE VALUE

ADAPTABILITY

DECONSTRUCTION IMPACT

Green Building Assessment
of Existing Buildings

CURRENT PERFORMANCE

Meets **intended** performance goals

Meets **contemporary** performance goals

Building Well

Durability & Maintainability

Green Building Assessment
of Existing Buildings

CULTURAL VALUE

Cultural / historical assessment

Original fabric

Representative characteristics

Craftsmanship and other exceptional values

Preservations Economic Benefits

Green Building Assessment
of Existing Buildings

ENVIRONMENTAL VALUE

Inherent Green Value of Traditional and Vernacular Building

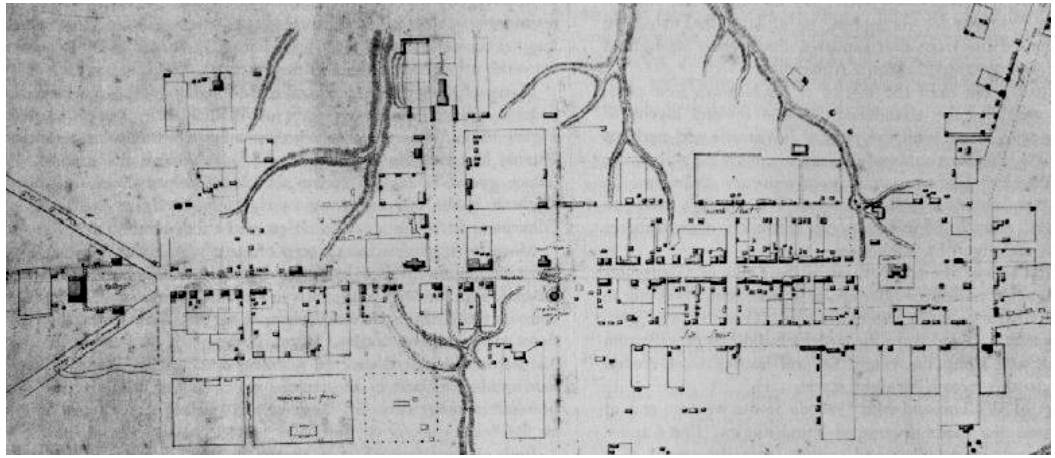
- **Community context**
- Climate-responsive building

Embodied energy

Material resources

Impact avoidance

Building Community



Building Community:

A New Frontier for Architecture Education and Practice

Boyer & Mitgang

www.carnegiefoundation.org

Green Building Assessment
of Existing Buildings

ENVIRONMENTAL VALUE

Inherent Green Value of Traditional and Vernacular Building

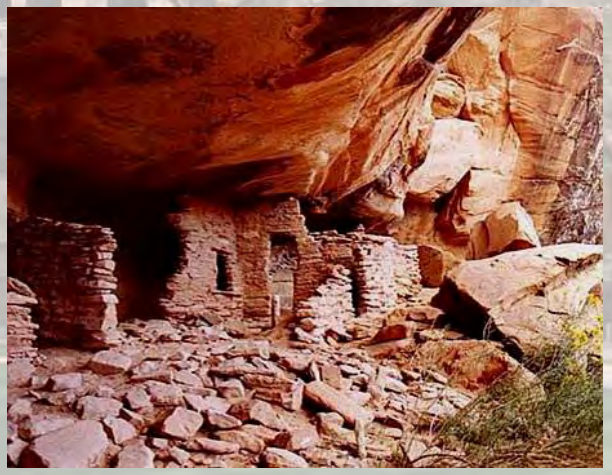
- Community context
- **Climate-responsive building**

Embodied energy

Material resources

Impact avoidance

Building in Nature



Green Heritage

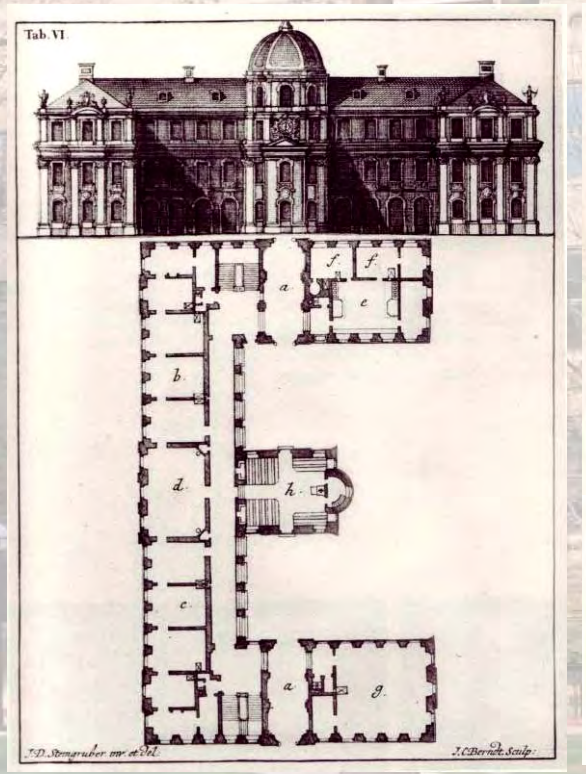
Systems Integration

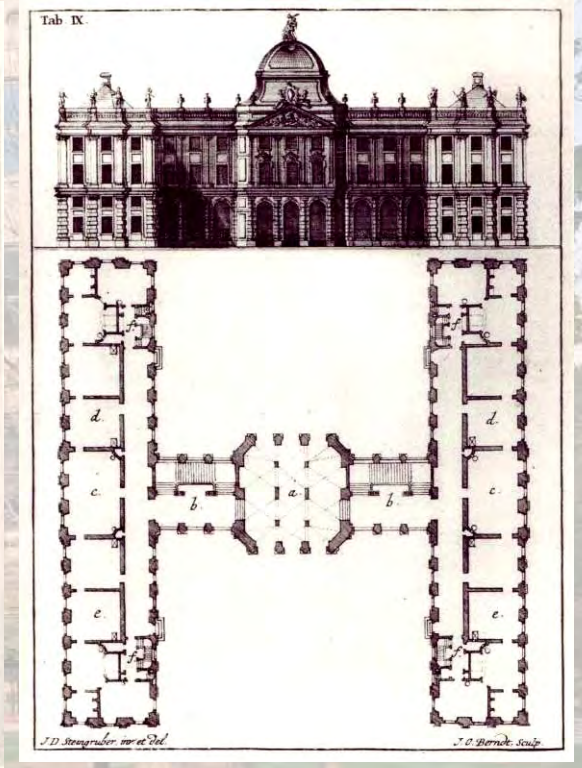
Climate-responsive Design

Building / Site Integration

Build in Nature

Access to Daylight & Ventilation





Architectonisches Alphabeth

Johann David Steingruber

Green Building Assessment
of Existing Buildings

ENVIRONMENTAL VALUE

Inherent Green Value of Traditional and Vernacular Building

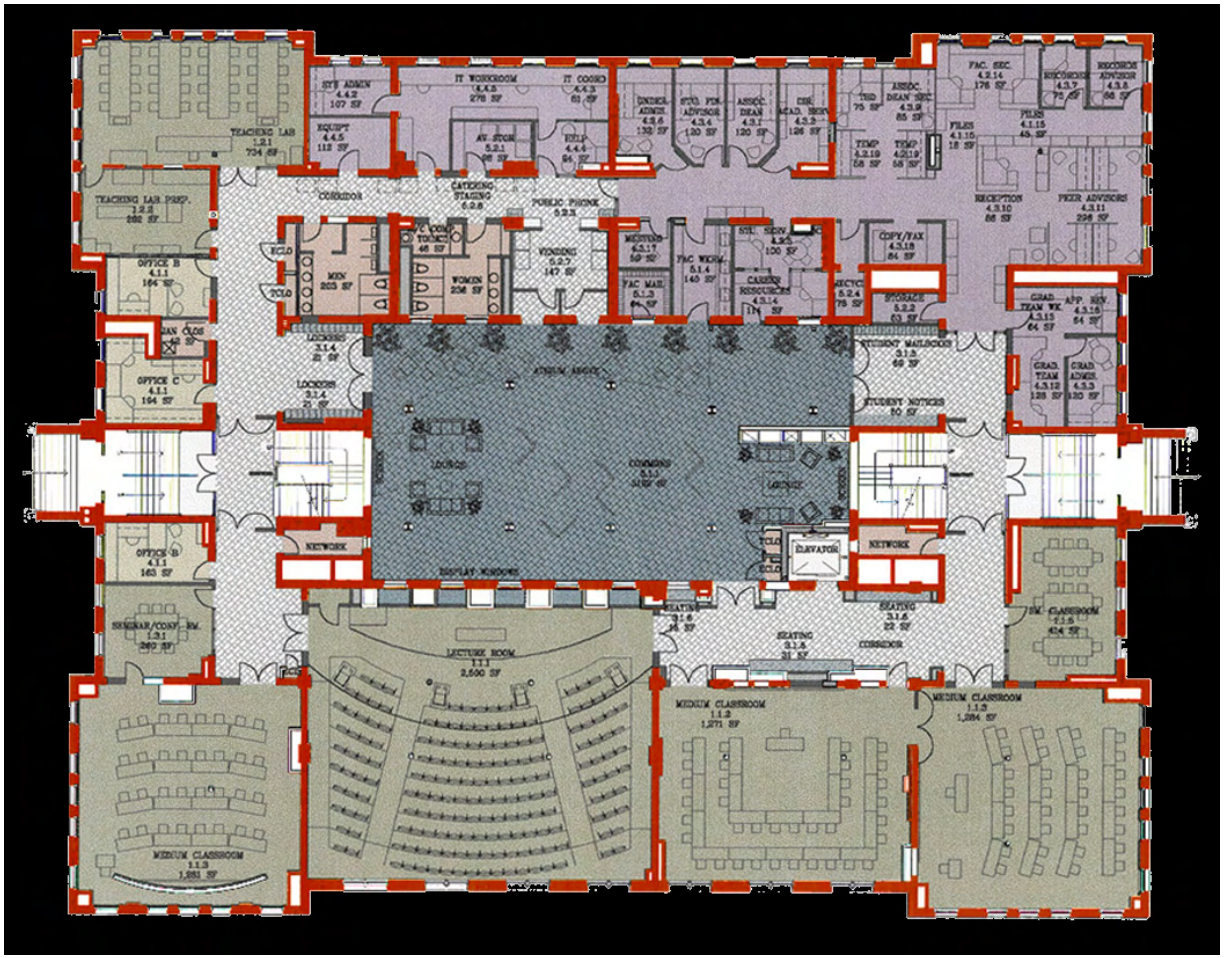
- Community context
- Climate-responsive building

Embodied energy

Material resources

Impact avoidance

Embodied Energy



Green Building Assessment
of Existing Buildings

ENVIRONMENTAL VALUE

Inherent Green Value of Traditional and Vernacular Building

- Community context
- Climate-responsive building

Embodied energy

Material resources

Impact avoidance

Green Building Assessment
of Existing Buildings

RE-USE VALUE

Usable / maintainable

Salvageable

Recyclable / technical nutrients

Renewable

Salvage

Green Building Assessment
of Existing Buildings

RE-USE VALUE

Usable / maintainable

Salvageable

Recyclable / technical nutrients

Renewable

Green Building Assessment
of Existing Buildings

ADAPTABILITY

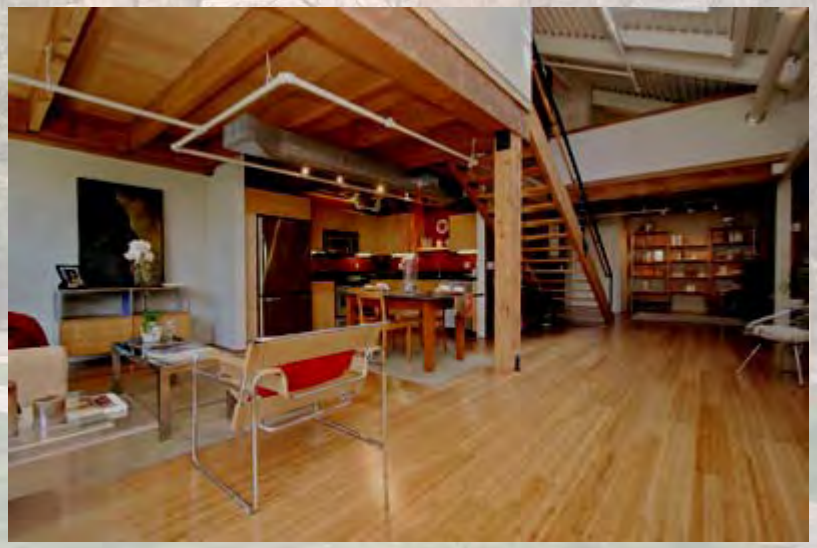
Adaptable

Adaptable with extraordinary cost and effort

Not adaptable

Building Well

Adaptability



Green Building Assessment
of Existing Buildings

DECONSTRUCTION IMPACT

Hazardous materials / brownfield sites / etc.

Non-salvageable materials

Benign waste / biological nutrients

SUBS

Sustainable Use of the Building Stock

Stewardship of Existing Buildings

+

Green Building Practices

=

Recycling Buildings

Green Building Characteristics

Strategies: site micro-climate, water-efficient landscaping, low-impact development

Systems: high efficiency HVAC & controls, low-flow plumbing, energy-efficient lighting

Materials: durability, salvage, recycling, natural materials, non-toxic materials, local materials

Performance: daylighting, natural ventilation, controllability

LEED
LEADERSHIP IN ENERGY & ENVIRONMENTAL DESIGN

USGBC
United States Green Building Council

LEED Green Building Rating System
Leadership In Energy & Environmental Design

LEED Categories

42		27	**Total Project Score**	Possible Points 69

Certified 26 to 32 points Silver 33 to 38 points Gold 39 to 51 points Platinum 52 or more points

7		7	**Sustainable Sites**	Possible Points 14	
Y	?	N			
Y			Prereq 1	**Erosion & Sedimentation Control**	
1			Credit 1	**Site Selection**	1
1			Credit 2	**Urban Redevelopment**	1
		1	Credit 3	**Brownfield Redevelopment**	1
1			Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
		1	Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
		1	Credit 4.3	**Alternative Transportation**, Alternative Fuel Refueling Stations	1
1			Credit 4.4	**Alternative Transportation**, Parking Capacity	1
1			Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1
		1	Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1
		1	Credit 6.1	**Stormwater Management**, Rate and Quantity	1
		1	Credit 6.2	**Stormwater Management**, Treatment	1
1			Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands**, Non-Roof	1
		1	Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands**, Roof	1
1			Credit 8	**Light Pollution Reduction**	1

5			**Water Efficiency**	Possible Points 5	
Y	?	N			
1			Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
1			Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
1			Credit 2	**Innovative Wastewater Technologies**	1
1			Credit 3.1	**Water Use Reduction**, 20% Reduction	1
1			Credit 3.2	**Water Use Reduction**, 30% Reduction	1

7		10	**Energy & Atmosphere**	Possible Points 17	
Y	?	N			
Y			Prereq 1	**Fundamental Building Systems Commissioning**	
Y			Prereq 2	**Minimum Energy Performance**	
Y			Prereq 3	**CFC Reduction in HVAC&R Equipment**	
2			Credit 1.1	**Optimize Energy Performance**, 20% New / 10% Existing	2
2			Credit 1.2	**Optimize Energy Performance**, 30% New / 20% Existing	2
		2	Credit 1.3	**Optimize Energy Performance**, 40% New / 30% Existing	2
		2	Credit 1.4	**Optimize Energy Performance**, 50% New / 40% Existing	2
		2	Credit 1.5	**Optimize Energy Performance**, 60% New / 50% Existing	2
		1	Credit 2.1	**Renewable Energy**, 5%	1
		1	Credit 2.2	**Renewable Energy**, 10%	1
		1	Credit 2.3	**Renewable Energy**, 20%	1
1			Credit 3	**Additional Commissioning**	1
1			Credit 4	**Ozone Depletion**	1
		1	Credit 5	**Measurement & Verification**	1
1			Credit 6	**Green Power**	1

9		4	**Materials & Resources**	Possible Points 13	
Y	?	N			
Y			Prereq 1	**Storage & Collection of Recyclables**	
1			Credit 1.1	**Building Reuse**, Maintain 75% of Existing Shell	1
1			Credit 1.2	**Building Reuse**, Maintain 100% of Existing Shell	1
1			Credit 1.3	**Building Reuse**, Maintain 100% Shell & 50% Non-Shell	1
		1	Credit 2.1	**Construction Waste Management**, Divert 50%	1
		1	Credit 2.2	**Construction Waste Management**, Divert 75%	1
		1	Credit 3.1	**Resource Reuse**, Specify 5%	1
		1	Credit 3.2	**Resource Reuse**, Specify 10%	1
1			Credit 4.1	**Recycled Content**, Specify 25%	1
1			Credit 4.2	**Recycled Content**, Specify 50%	1
1			Credit 5.1	**Local/Regional Materials**, 20% Manufactured Locally	1
1			Credit 5.2	**Local/Regional Materials**, of 20% Above, 50% Harvested Locally	1
1			Credit 6	**Rapidly Renewable Materials**	1
1			Credit 7	**Certified Wood**	1

9		6	**Indoor Environmental Quality**	Possible Points 15	
Y	?	N			
Y			Prereq 1	**Minimum IAQ Performance**	
Y			Prereq 2	**Environmental Tobacco Smoke (ETS) Control**	
1			Credit 1	**Carbon Dioxide (CO_2) Monitoring**	1
1			Credit 2	**Increase Ventilation Effectiveness**	1
		1	Credit 3.1	**Construction IAQ Management Plan**, During Construction	1
		1	Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1
1			Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1
1			Credit 4.2	**Low-Emitting Materials**, Paints	1
1			Credit 4.3	**Low-Emitting Materials**, Carpet	1
		1	Credit 4.4	**Low-Emitting Materials**, Composite Wood	1
1			Credit 5	**Indoor Chemical & Pollutant Source Control**	1
1			Credit 6.1	**Controllability of Systems**, Perimeter	1
		1	Credit 6.2	**Controllability of Systems**, Non-Perimeter	1
1			Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55-1992	1
1			Credit 7.2	**Thermal Comfort**, Permanent Monitoring System	1
		1	Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1
		1	Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1

5			**Innovation & Design Process**	Possible Points 5	
Y	?	N			
1			Credit 1.1	**Innovation in Design**, Chilled Ceiling Panels	1
1			Credit 1.2	**Innovation in Design**, Occupant Handbook / Education	1
1			Credit 1.3	**Innovation in Design**, Preserving Significant Cultural Heritage	1
1			Credit 1.4	**Innovation in Design**, 100% Green Electric Power for 2 years min	1
1			Credit 2	**LEED™ Accredited Professional**	1

SS

Sustainable Site

WE

Water Efficiency

EA

Energy & Atmosphere

MR

Material Resources

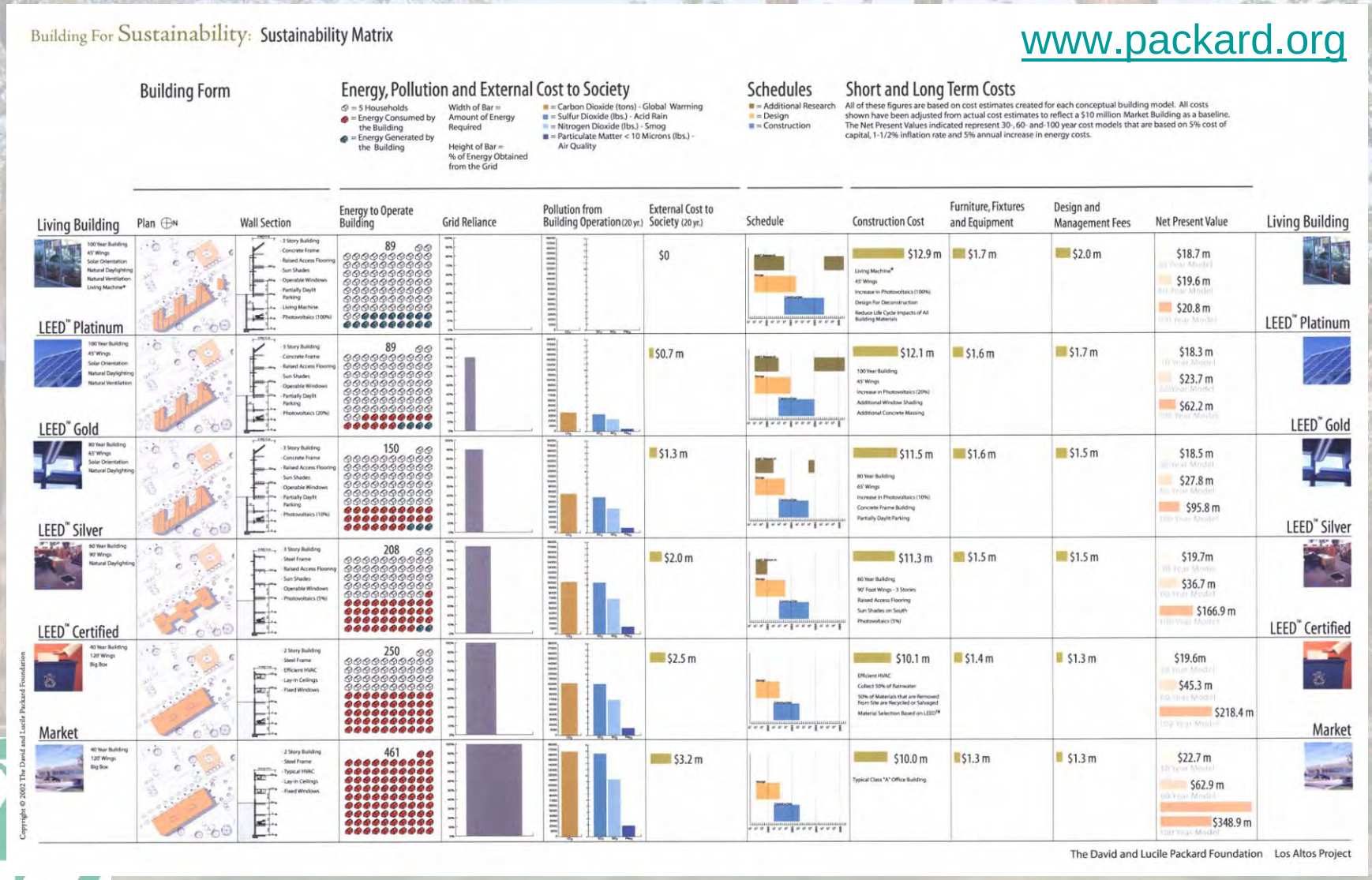
EQ

Environmental Quality

ID

Innovation & Design

Packard LEED Matrix



LEED-NC Scoring

69 total points

Platinum

52 + points

Gold

39 – 51 points

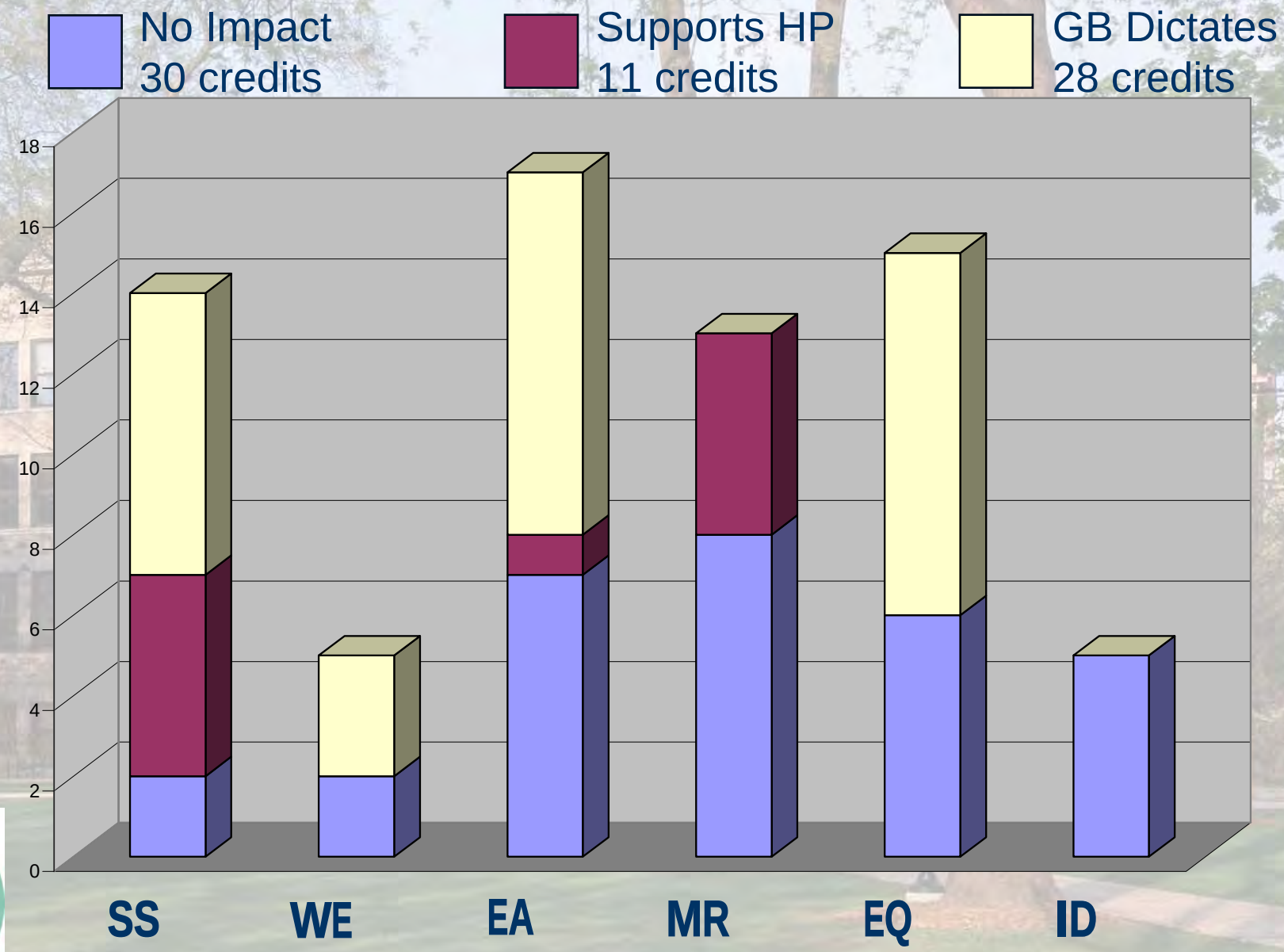
Silver

33 – 38 points

Certified

26 – 32 points

LEED / Preservation Compatibility



ECONOMIC "MODES"

New Development

Maintenance / Conservation

Restorative Development

Green Rehabilitation

AIA Top 10 Green

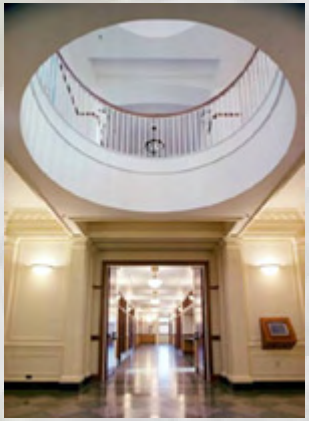
California College of Arts & Crafts
Leddy Maytum Stacy

Pittsburgh Glass Center
Davis Gardner Gannon Pope

Barn at Fallingwater
Bohlin Cywinski Jackson

Denver Dry Building
DURA / AHDC

Green Rehabilitation



Draper Hall
Berea College
Van Der Ryn

Green Rehabilitation

Ecotrust

Green Building Services

Green Rehabilitation

Brown vs
Board of Education
Monroe School NHS
QUINN EVANS

Changing Face of Preservation

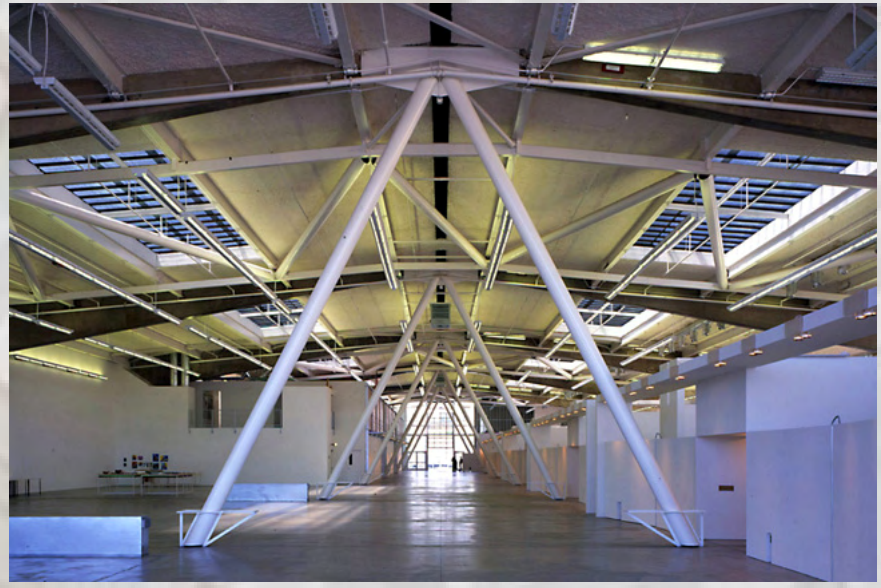
Historic Landmark designation
www.cr.nps.gov/nhl

Secretary of the Interior's Standards

Buildings dating from **1956** and earlier

Preserving the Modern Movement

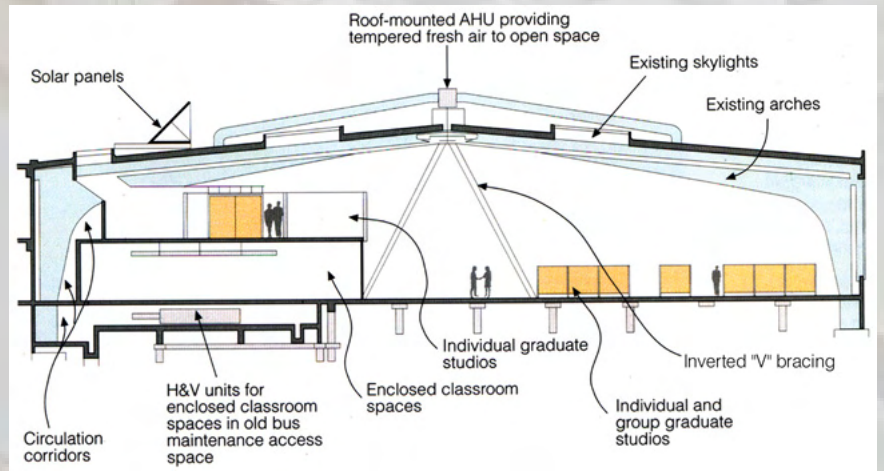
Green Rehabilitation



former Greyhound Bus Maintenance Facility

California College of Arts & Crafts

Leddy Maytum Stacy

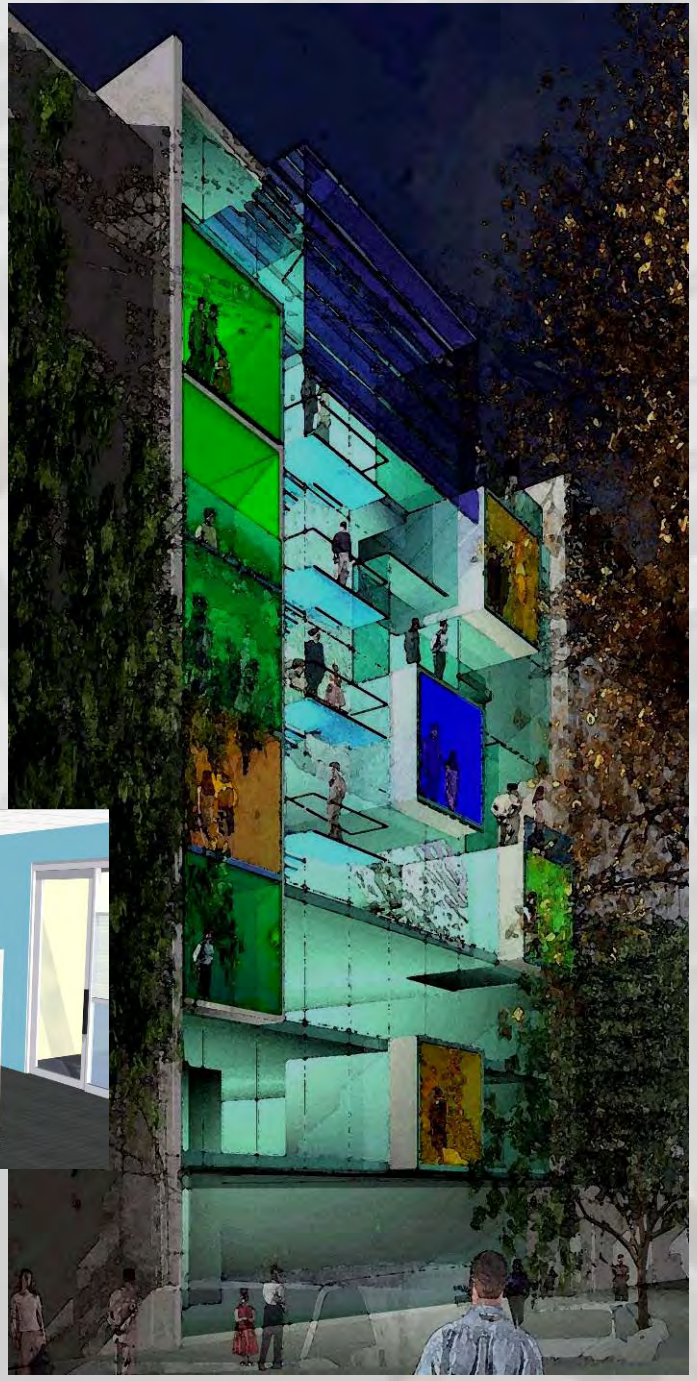


Green Rehabilitation

Chicago Center for Green Technology

Farr Associates

Green Rehabilitation



The Ocean Conservancy

William McDonough + Partners

QUINN EVANS | ARCHITECTS

The Greening of Dana

As part of the process to prepare the School of Natural Resources and Environment (SNRE) for the challenges of the 21st century, the School's administration felt that the building's capacity needed to be increased, and that existing spaces needed to be renovated. Grounded in SNRE's educational mission, we translated our general green-renovation goals into site-specific approaches, searched for similar examples from other institutions, and started keeping track of the decisions made on these issues. They are categorized as follows:

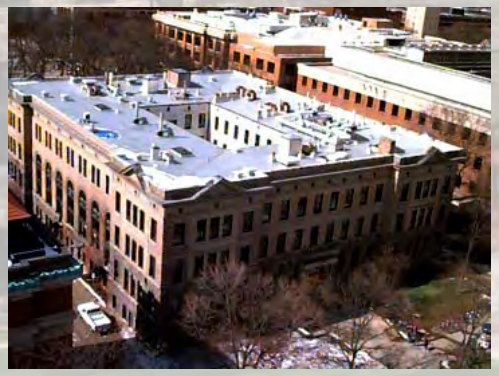
General Issues
Energy Issues
Water Issues
Material and Waste Issues
Human Health Issues

The Greening of Dana

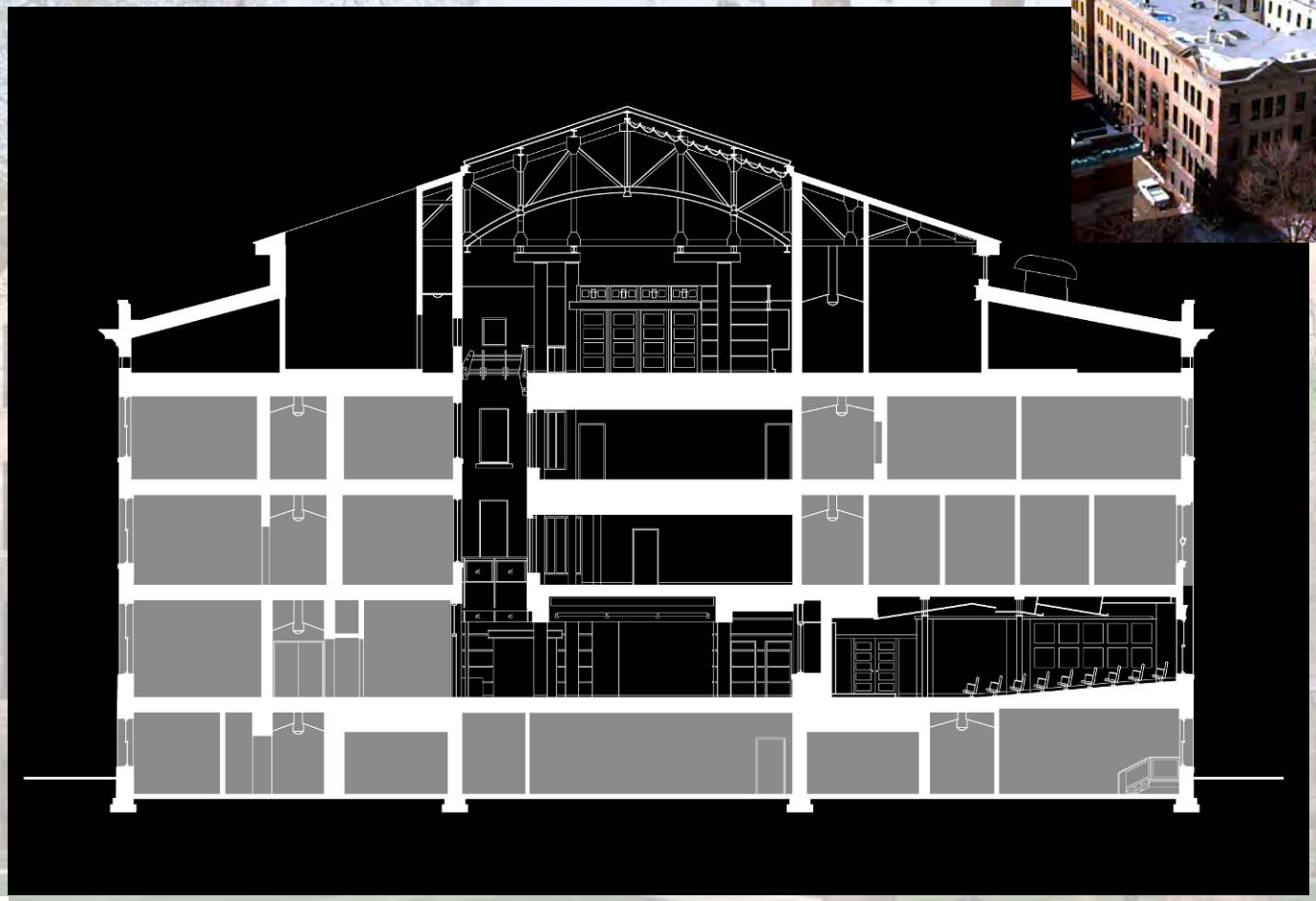
ca. 1910

The Greening of Dana

Before: 84,000sf
After: 107,000 sf



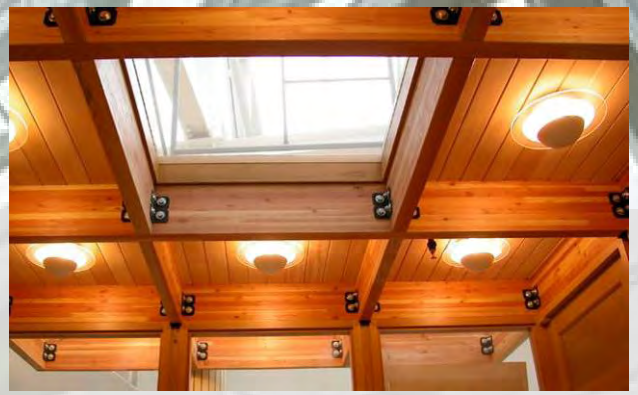
The Greening of Dana



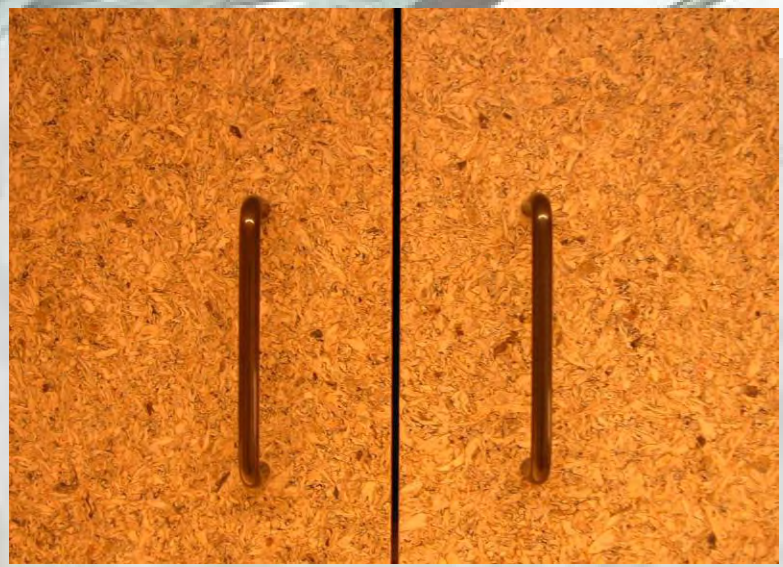
Expanding In Place

Atrium

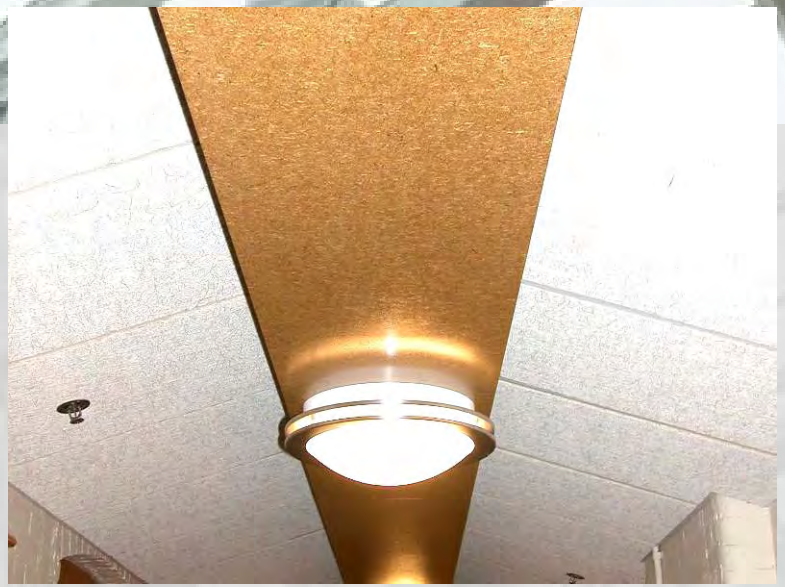
Daylight



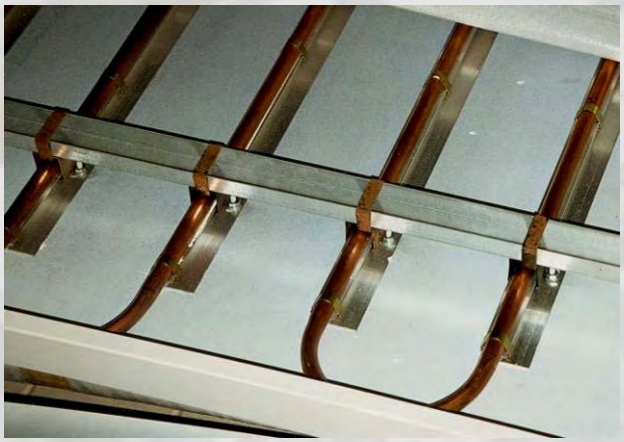
Green Materials

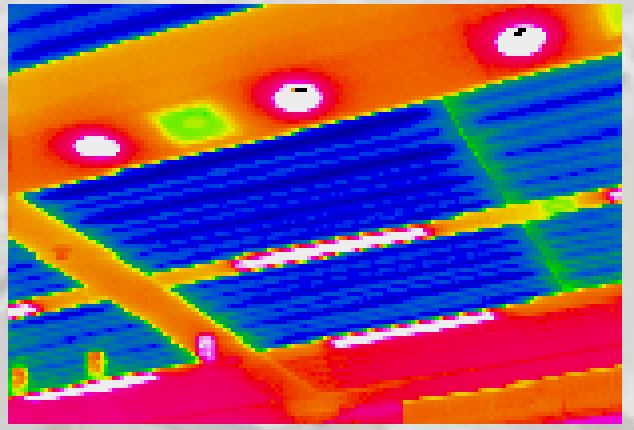


Green Materials

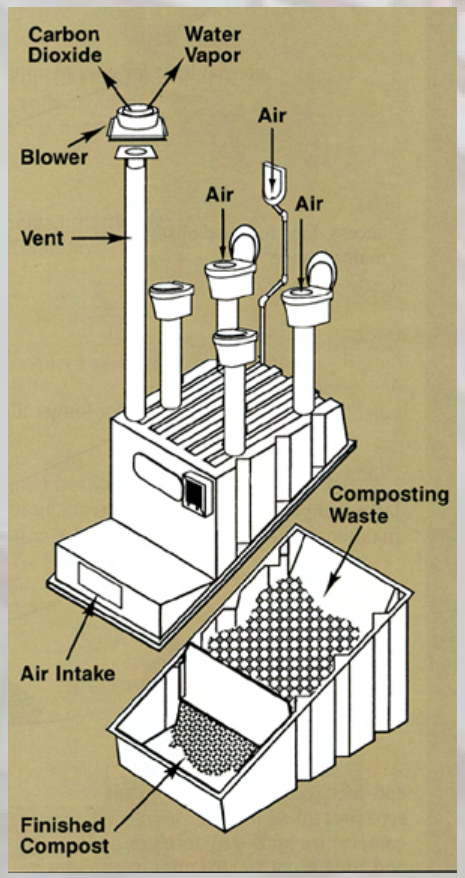


Radiant Cooling



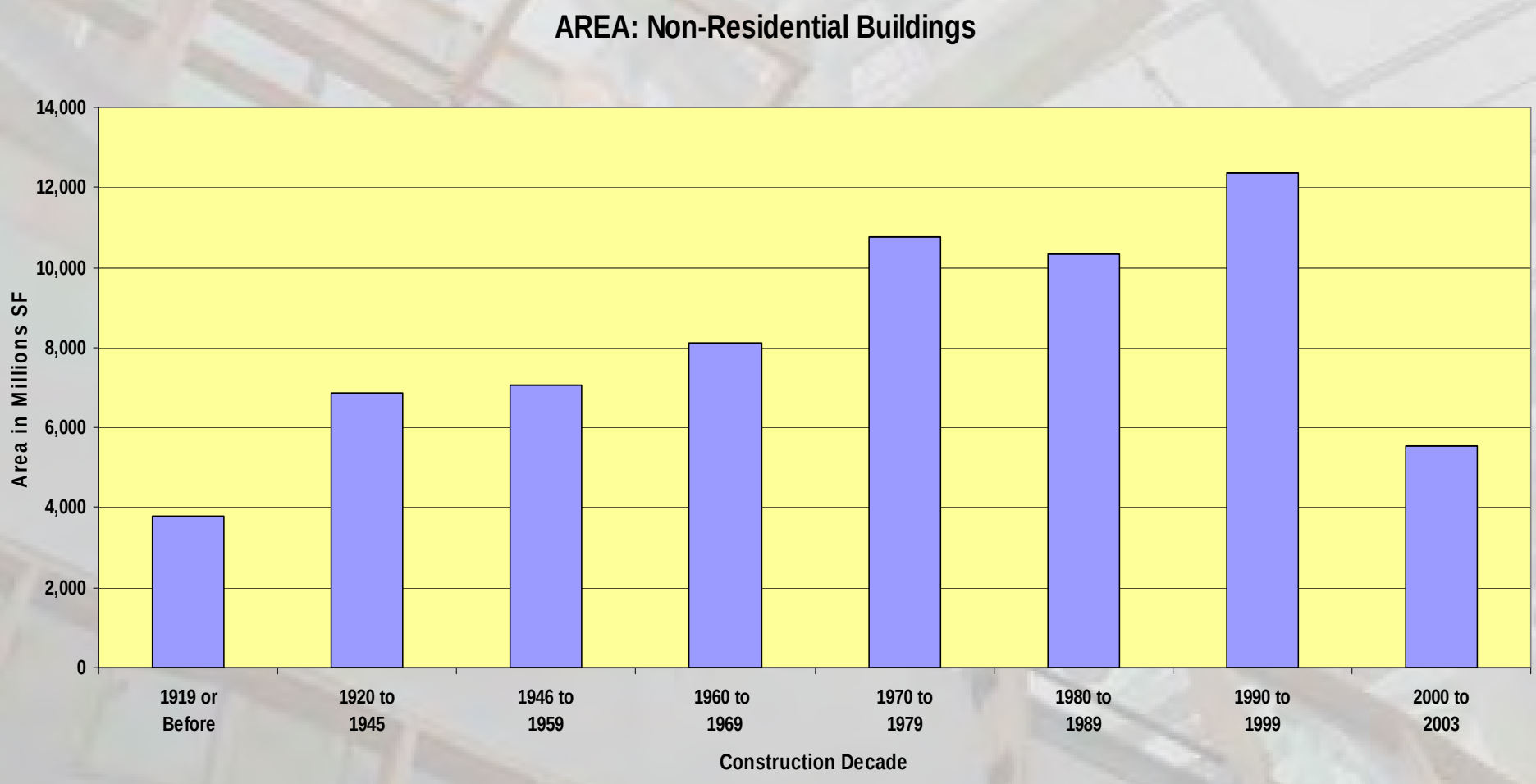


Water Conservation



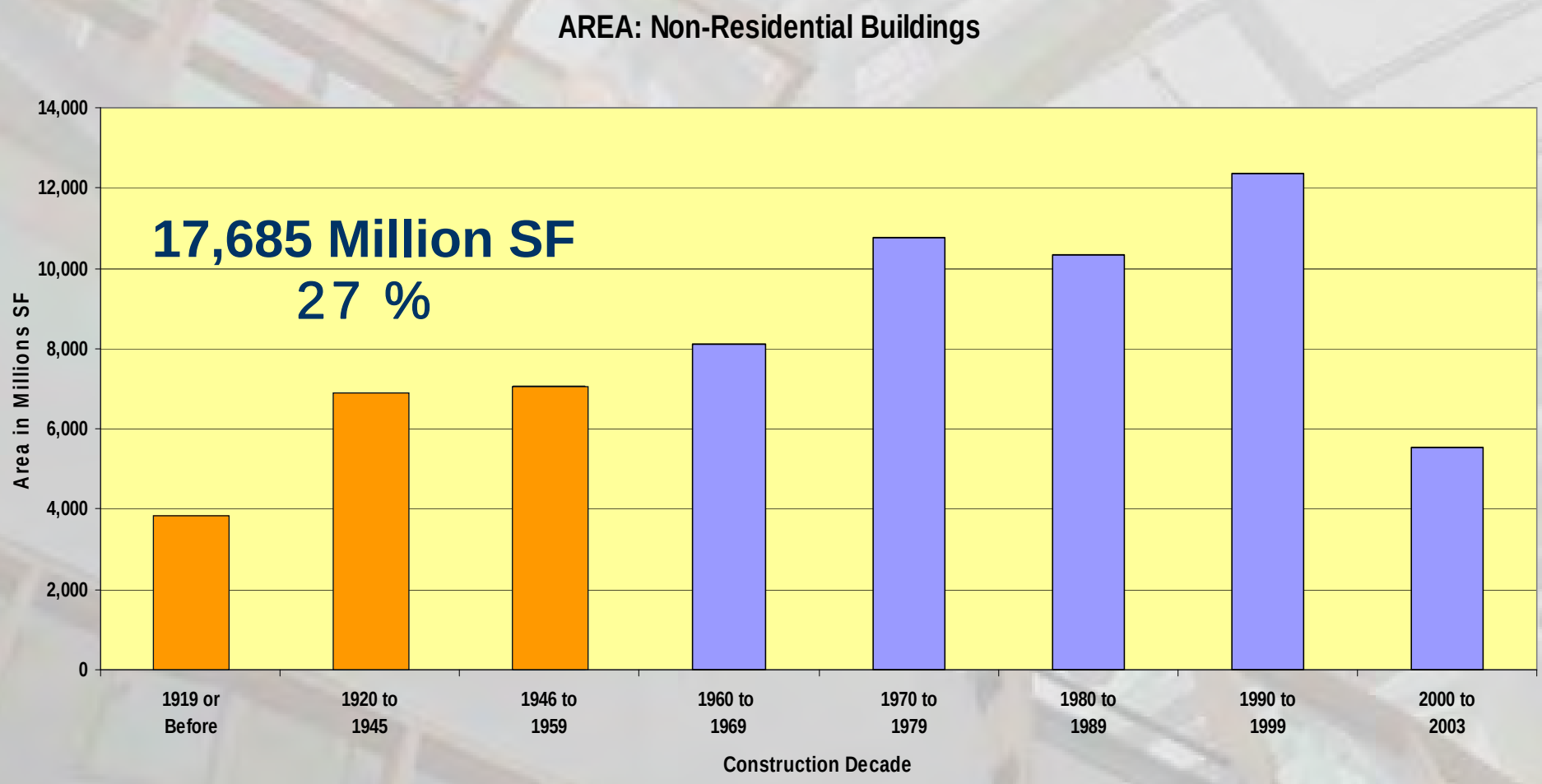
BIPV's

The Changing Building Stock



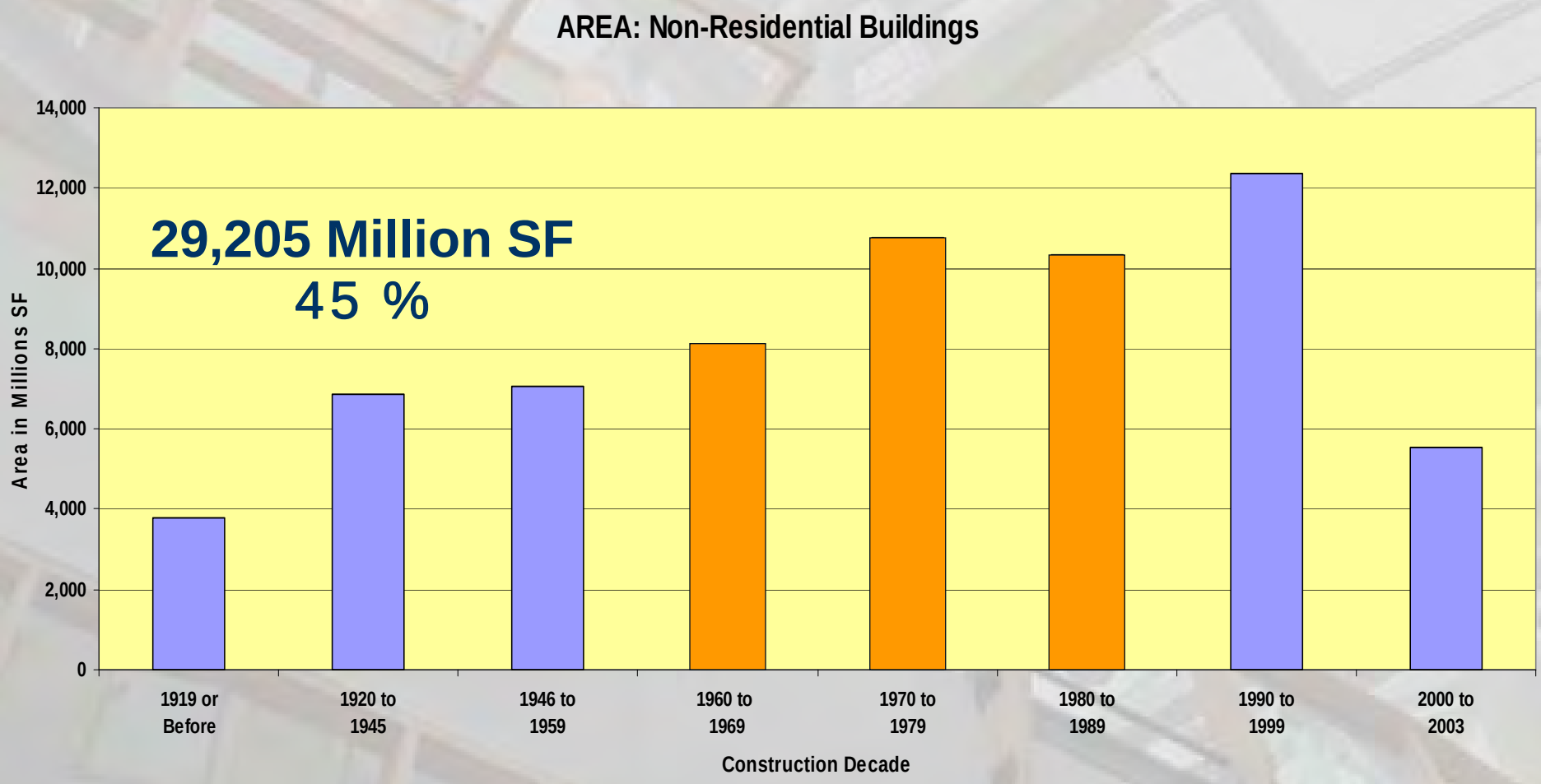
Department of Energy
Commercial Building Inventory

"Historic" Buildings



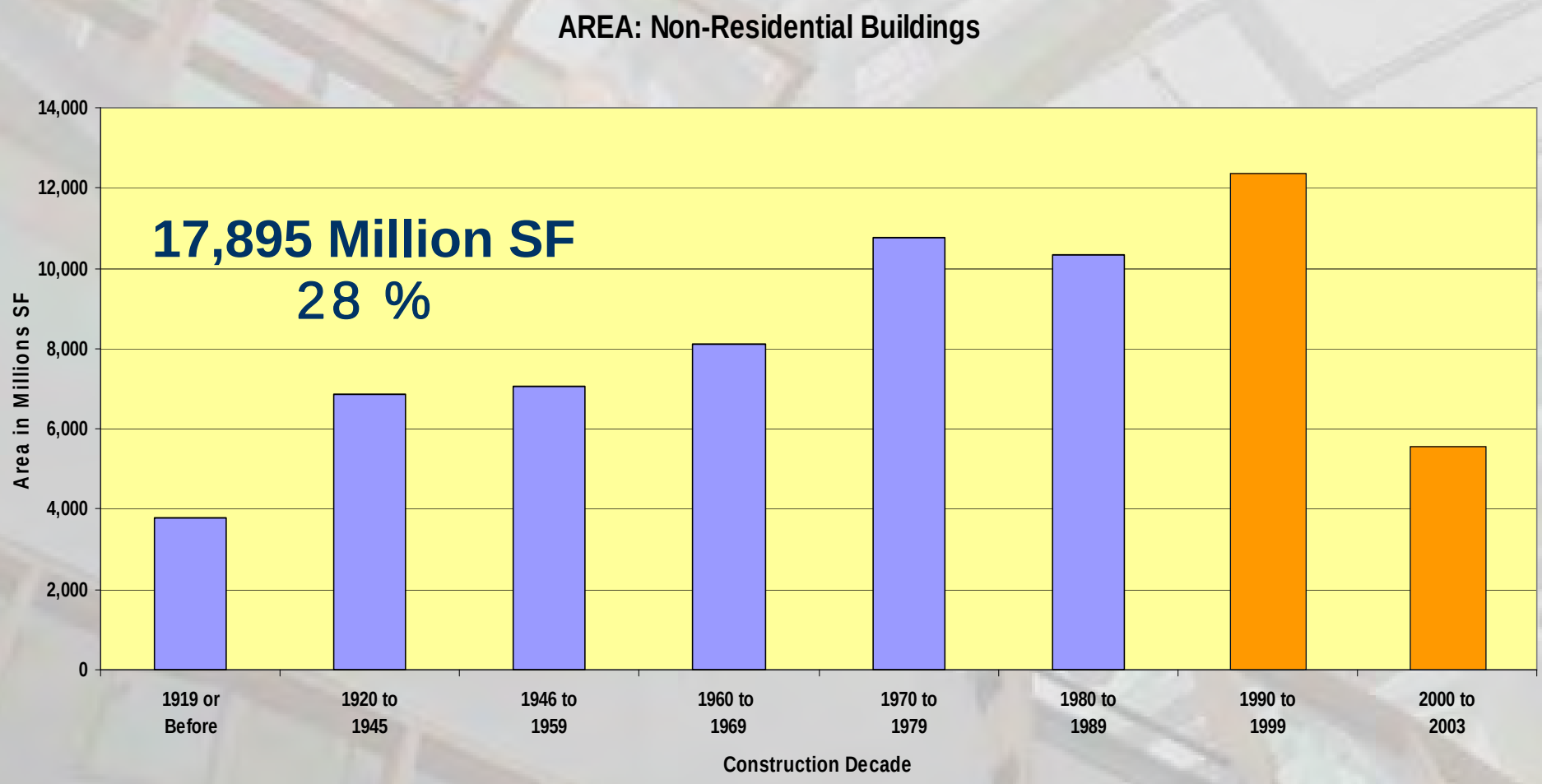
Department of Energy
Commercial Building Inventory

Modern-Era Buildings



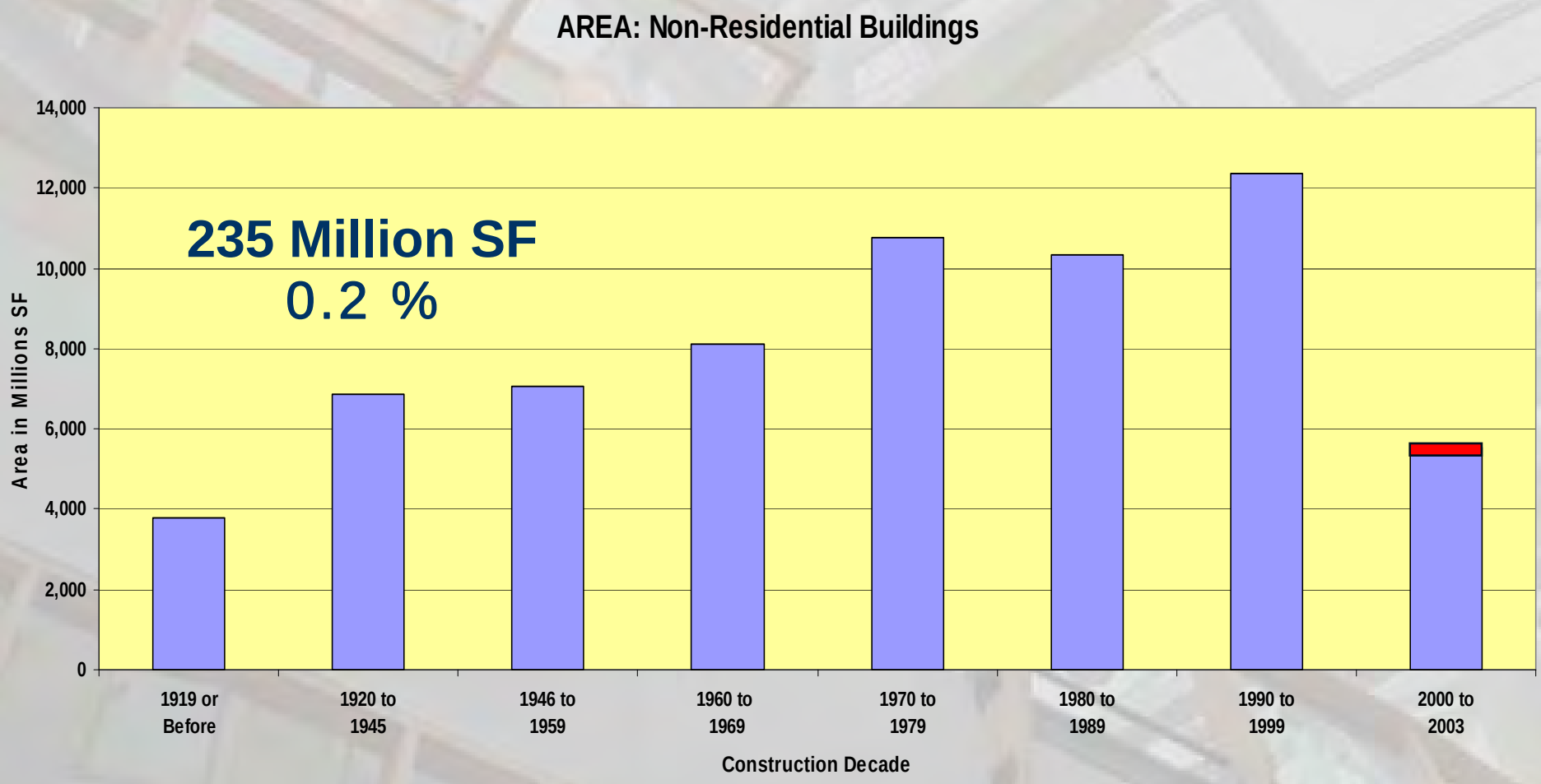
Department of Energy
Commercial Building Inventory

High-Performance Era



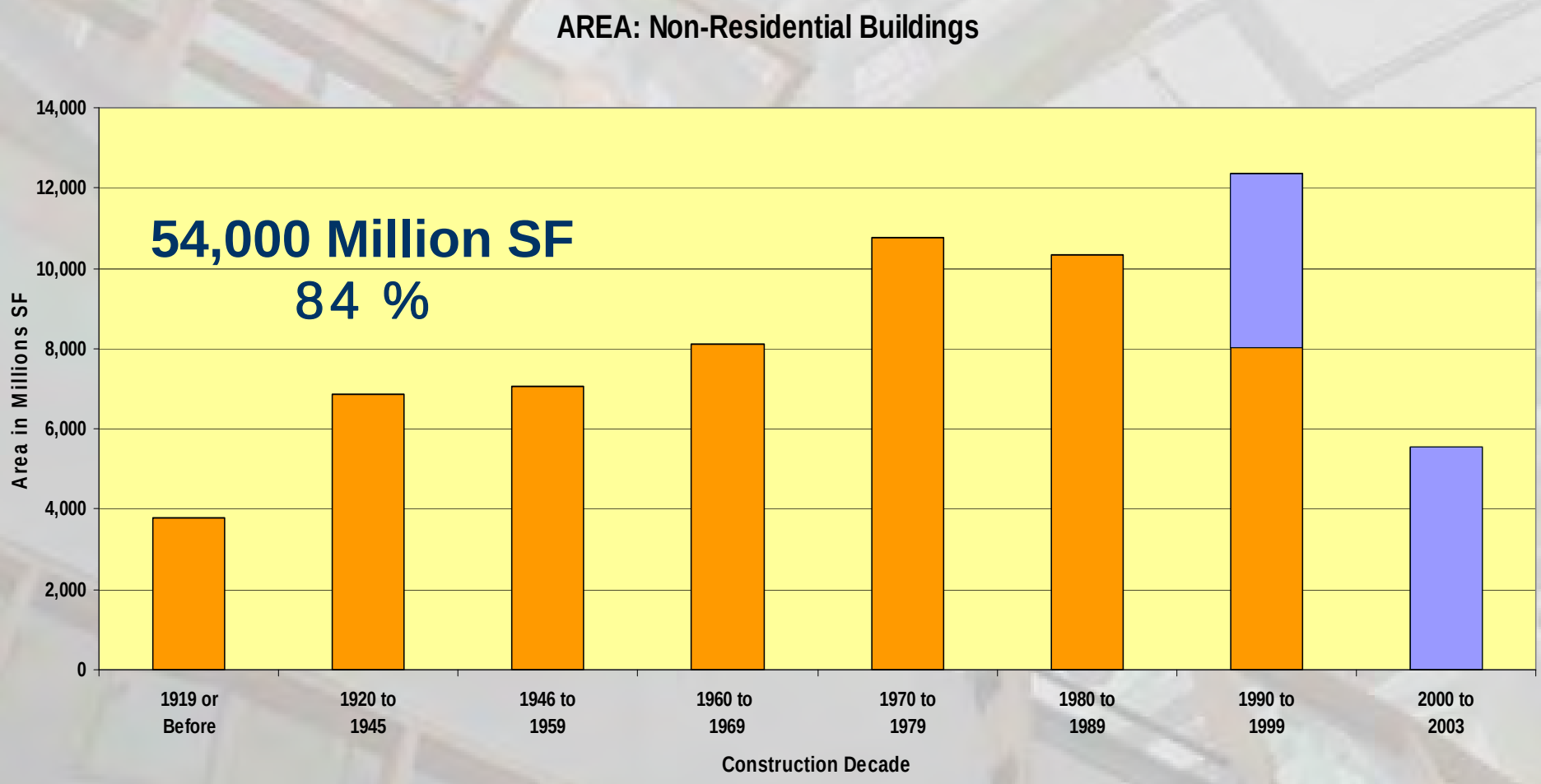
Department of Energy
Commercial Building Inventory

LEED Buildings



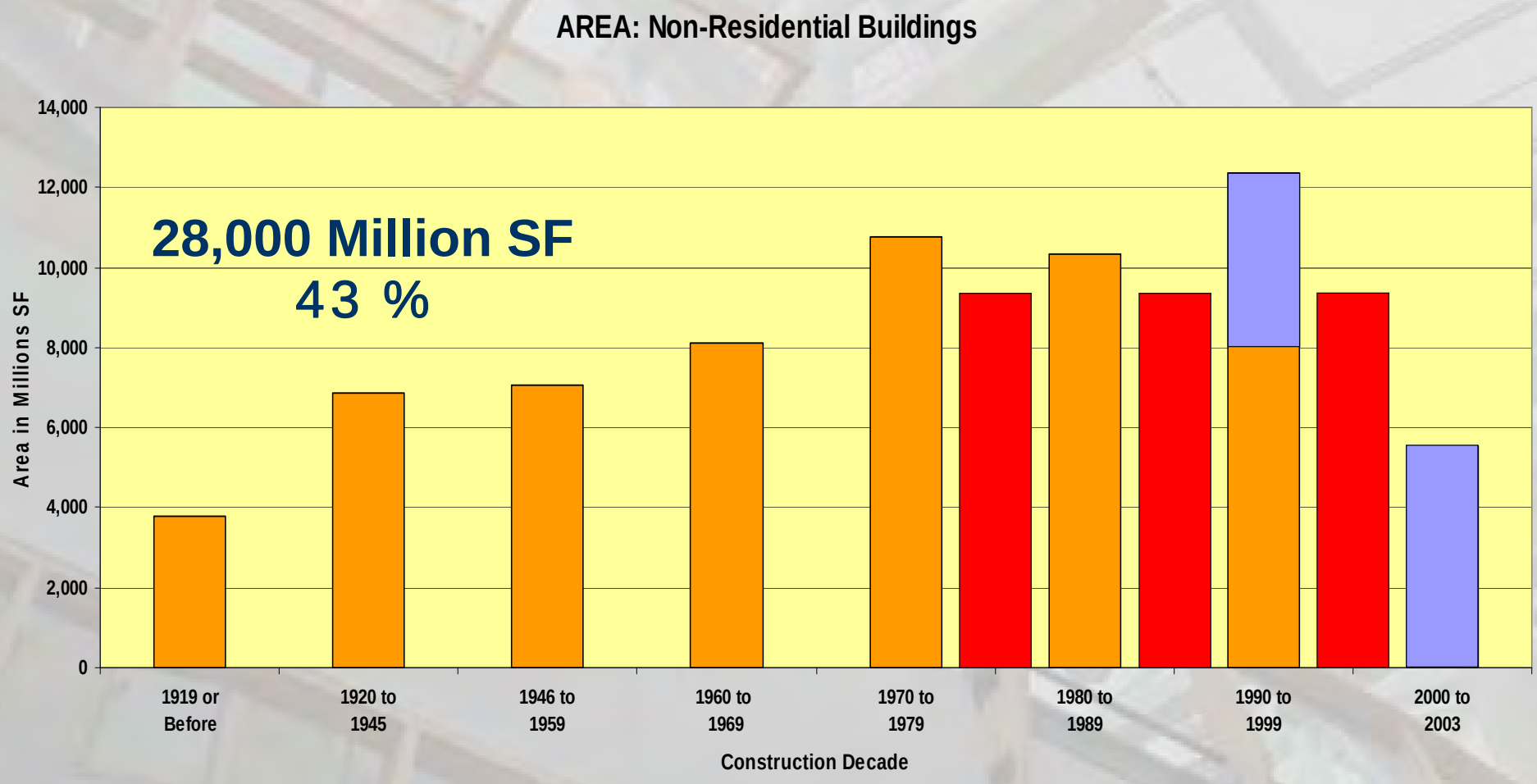
Department of Energy
Commercial Building Inventory

Projected Renovation to 2030



The Boom To Come – America Circa 2030
Architect Magazine, October 2006

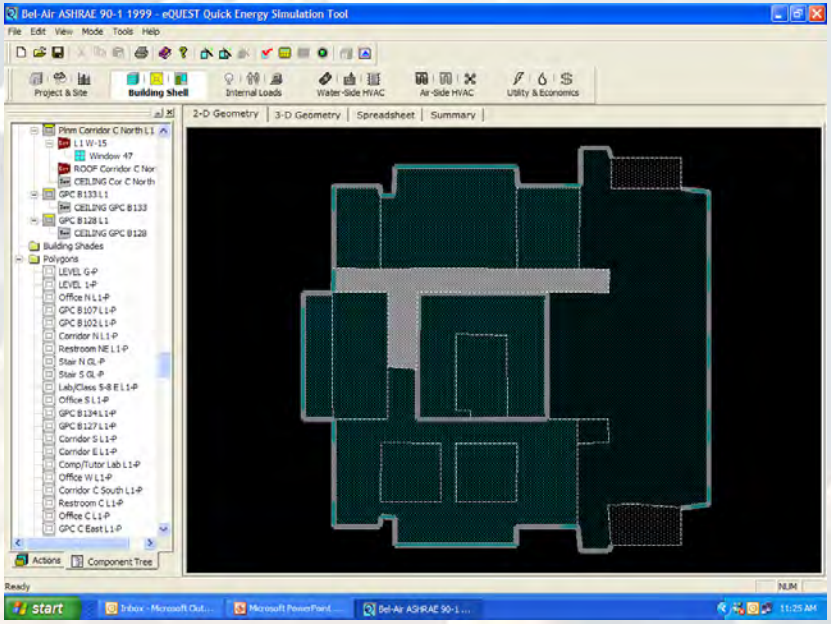
New Construction to 2030



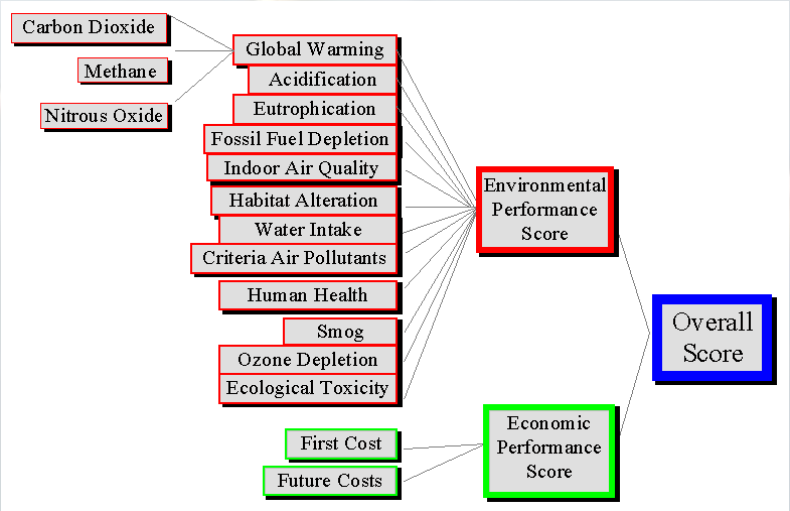
The Boom To Come – America Circa 2030
Architect Magazine, October 2006

Greening Preservation

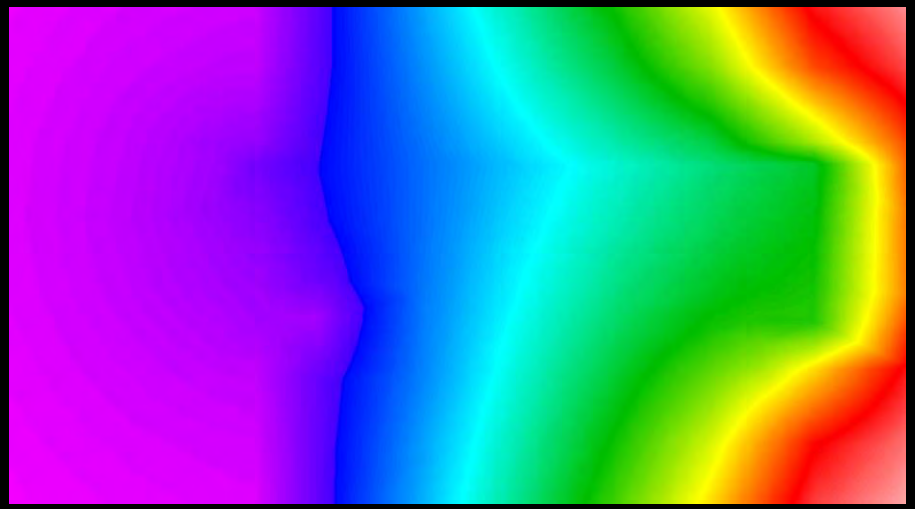
Energy Modeling



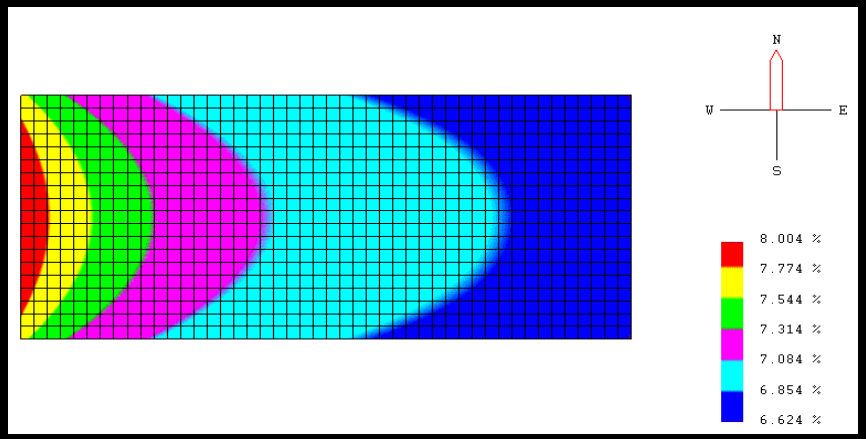
Building Life-Cycles



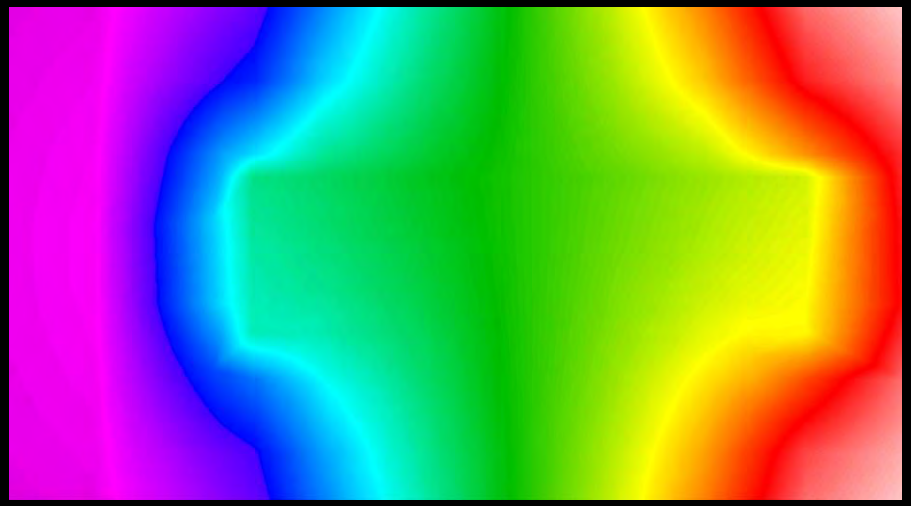
Un-insulated Wall



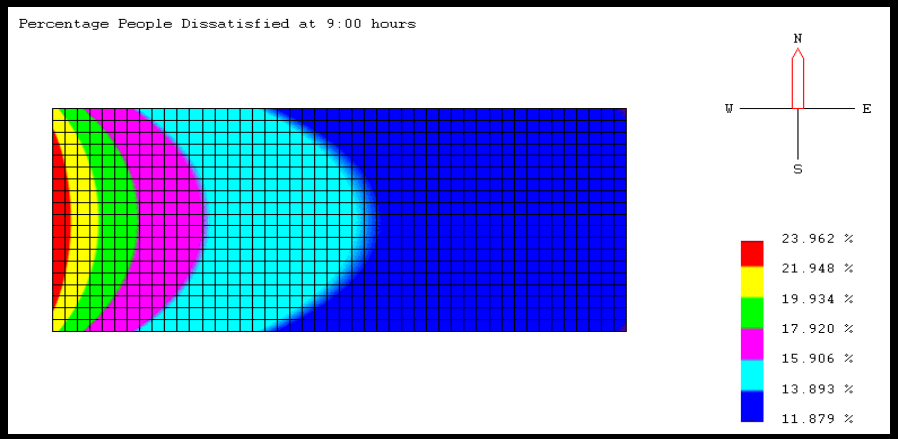
Single Glazing



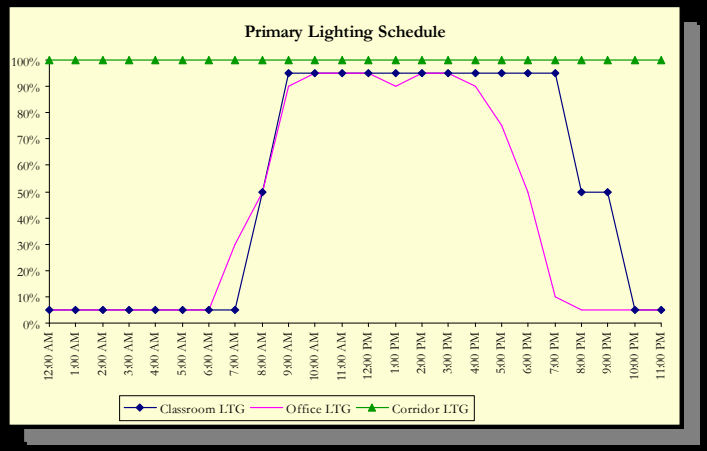
Insulated Wall

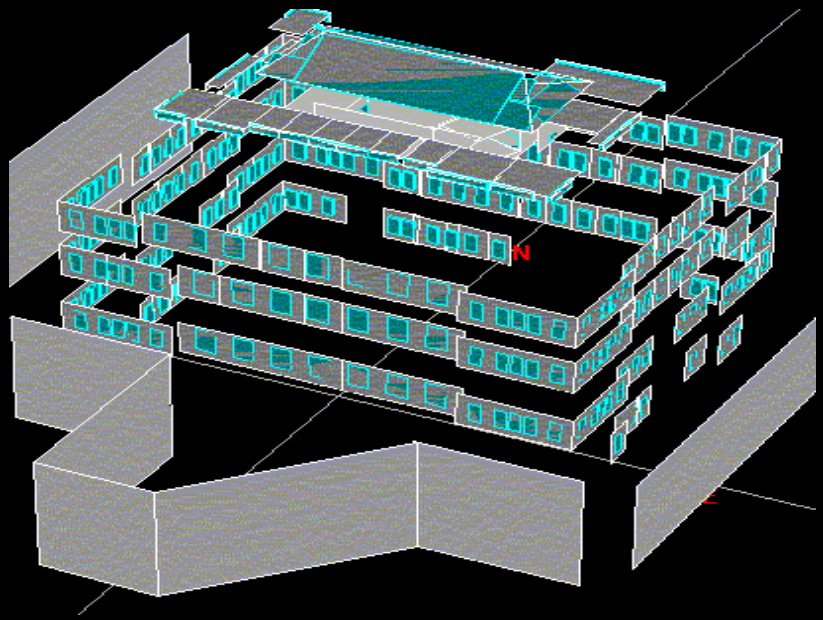


Double Glazing



Energy Modeling





INPUTS

Building Configuration

Envelope Details

Equipment & Controls

Occupancy Patterns

IAQ Settings

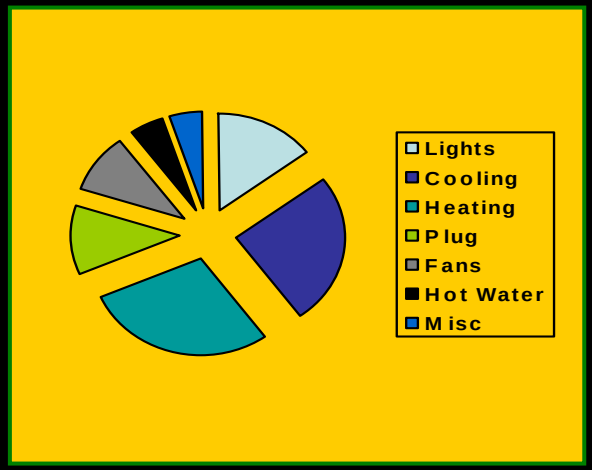
Energy Modeling

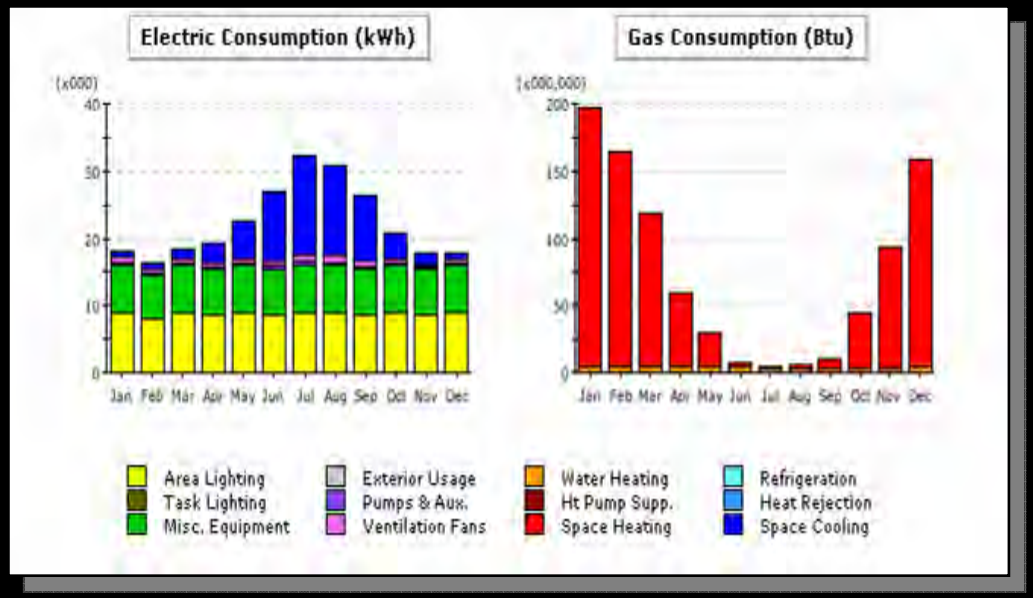
OUTPUTS

Energy Use

Peak Demand

Energy Trade-offs





ENERGY MODEL CASE STUDY

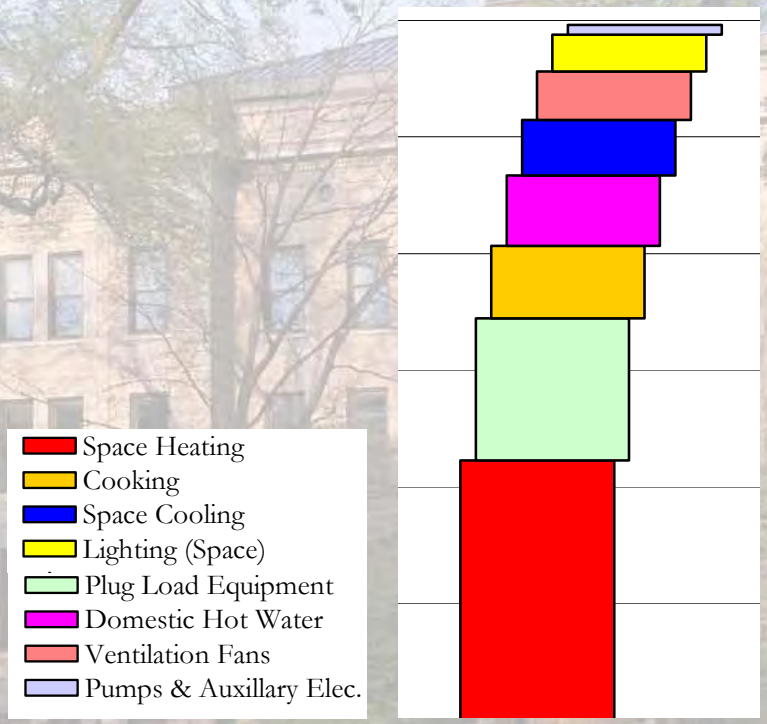
EASTERN MARKET

South Hall 1873
Adolf Cluss
North & Center Halls 1908
Snowden Ashford

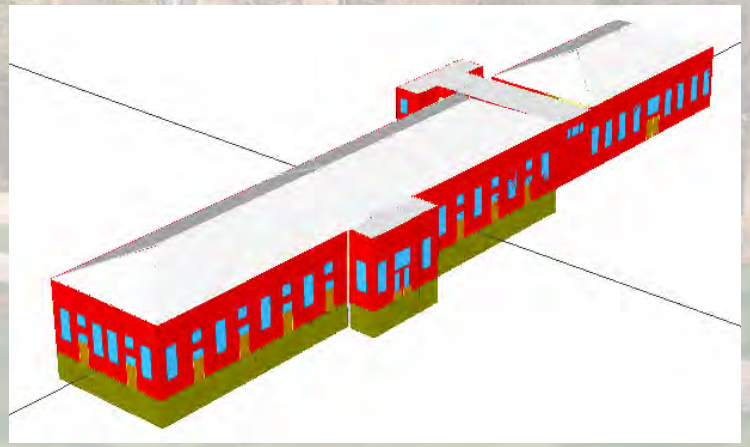
ENERGY MODEL CASE STUDY

EASTERN MARKET

BASELINE



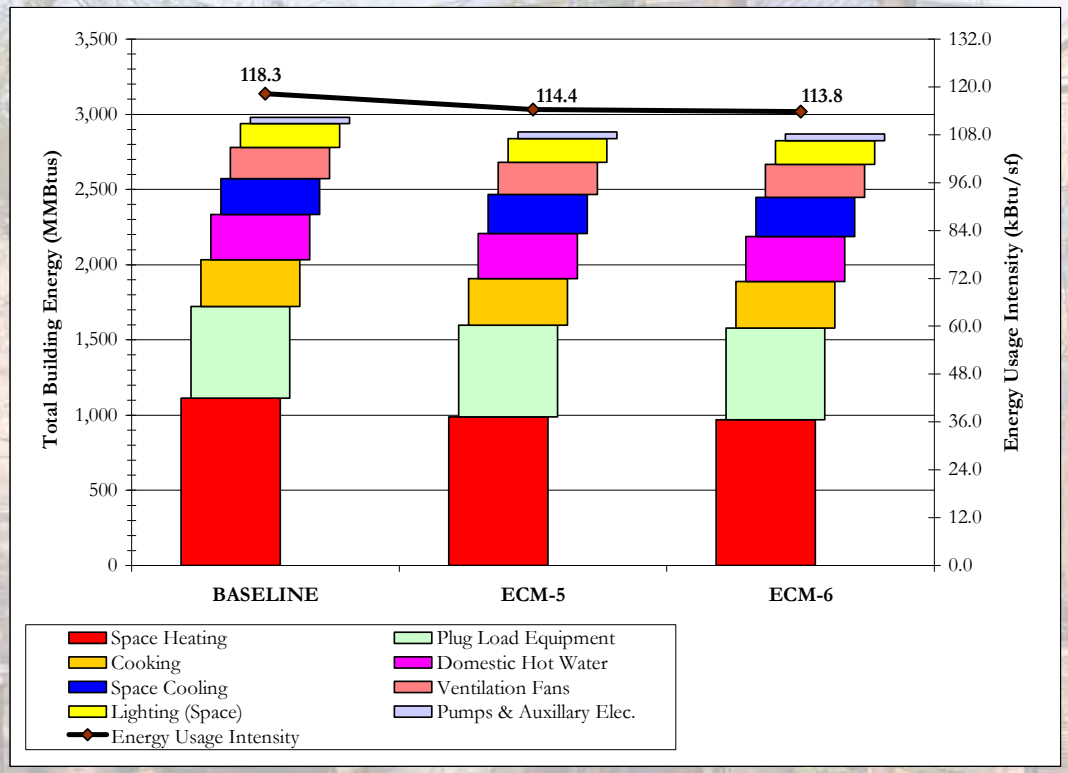
	Existing Building Renovations	
	21 %	6
31.5 %	24.5 %	7
35 %	28 %	8
38.5 %	31.5 %	9
42 %	35 %	10



ENERGY MODEL CASE STUDY

EASTERN MARKET

WINDOW REPLACEMENT



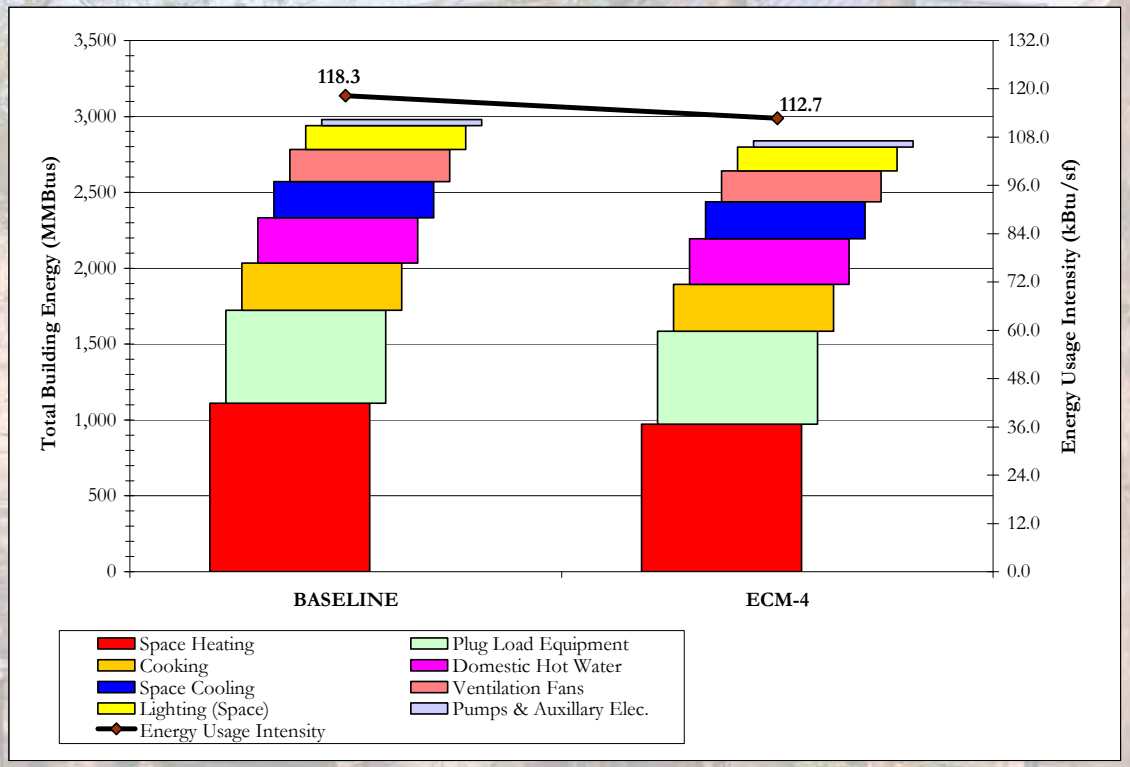
from:
118.3 Btuh/sf
to:
113.8 Btuh/sf
net:
4.5 Btuh/sf

BASELINE: Assumed single pane glazing
ECM-5: Single pane low-e coated glazing
ECM-6: Double-pane glazing

ENERGY MODEL CASE STUDY

EASTERN MARKET

WALL INSULATION



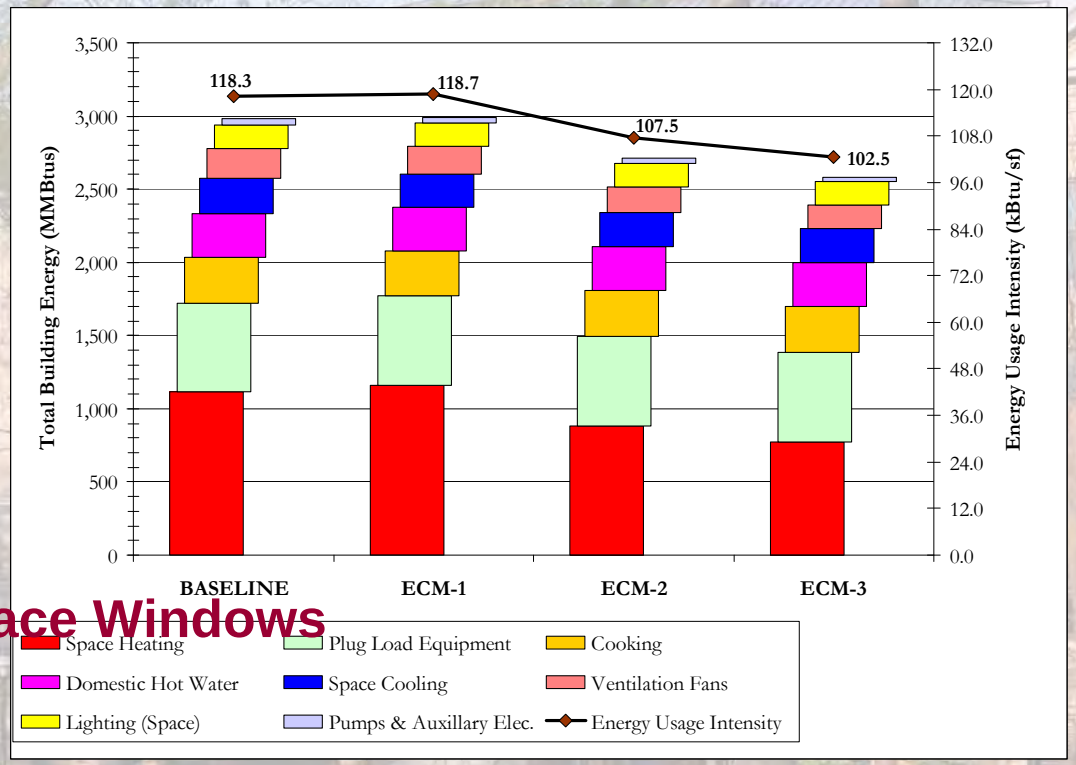
from:
118.3 Btuh/sf
to:
112.7 Btuh/sf
net:
5.6 Btuh/sf

BASELINE:
1'-10" thick load bearing brick
ECM-4: 2" rigid insulation
(furred out with air layer) (R-3.5/in)

ENERGY MODEL CASE STUDY

EASTERN MARKET

ROOF INSULATION



Replace Windows

from:
118.3 Btuh/sf
to:
102.5 Btuh/sf
net:
15.8 Btuh/sf

BASELINE: Dark slate roof on wood deck
ECM-1: High reflective roof skin
ECM-2: 2” rigid roof insulation (R-3.5/in)
ECM-3: 4” polyisocyanurate roof insulation (R-31)

LCA Life-cycle Analysis

BEFORE USE	DURING USE	AFTER USE
Extraction	Construction	Renewal
Manufacture	Operation	Removal
Fabrication	Maintenance	Re-use
Transportation		Disposal

Building Life-cycles

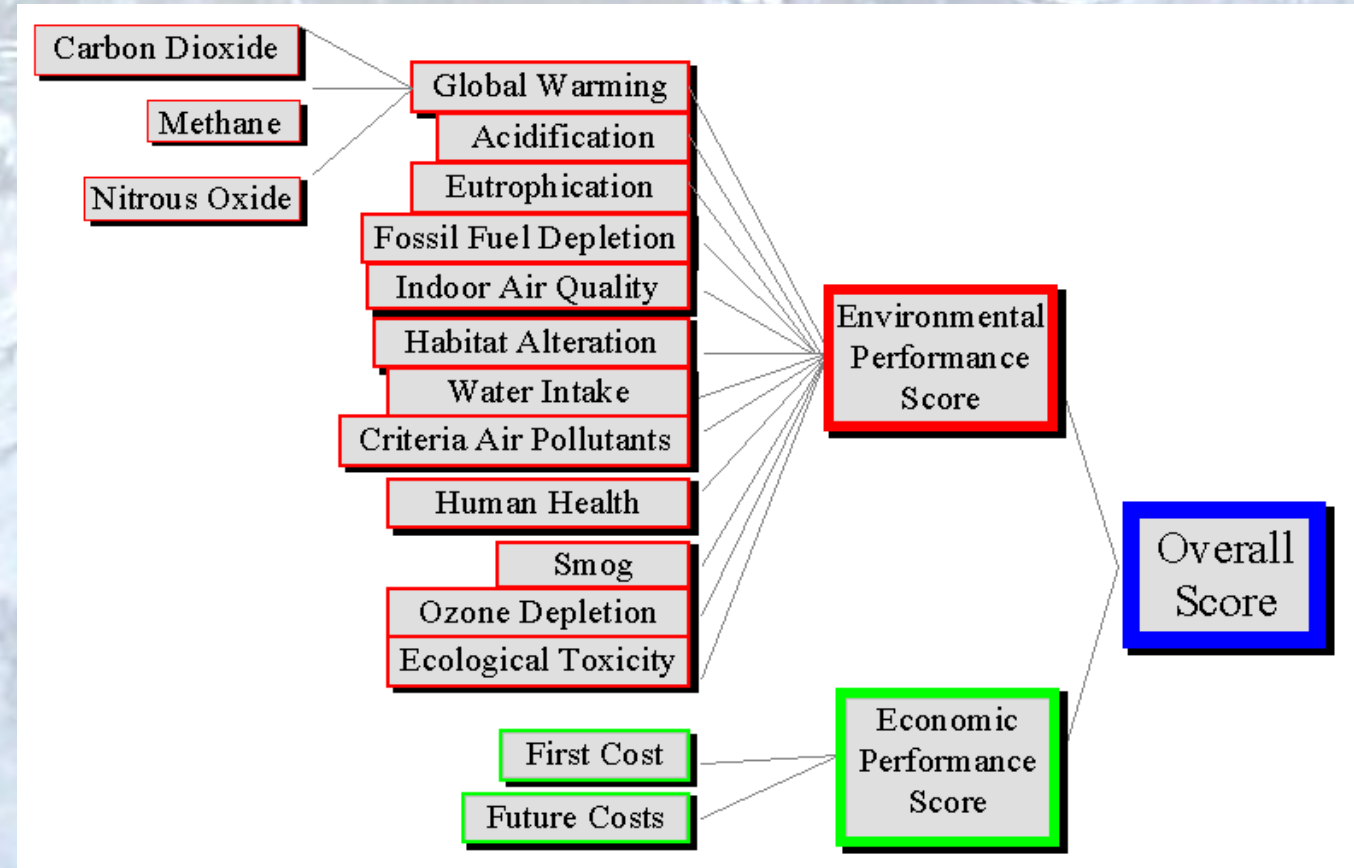
Structure | Shell | Interiors | Systems

How Buildings Learn
Stewart Brand

LCA Life-cycle Analysis

US EPA & NIST BEES 3.0

Building for **E**nvironmental and **E**conomic **S**ustainability

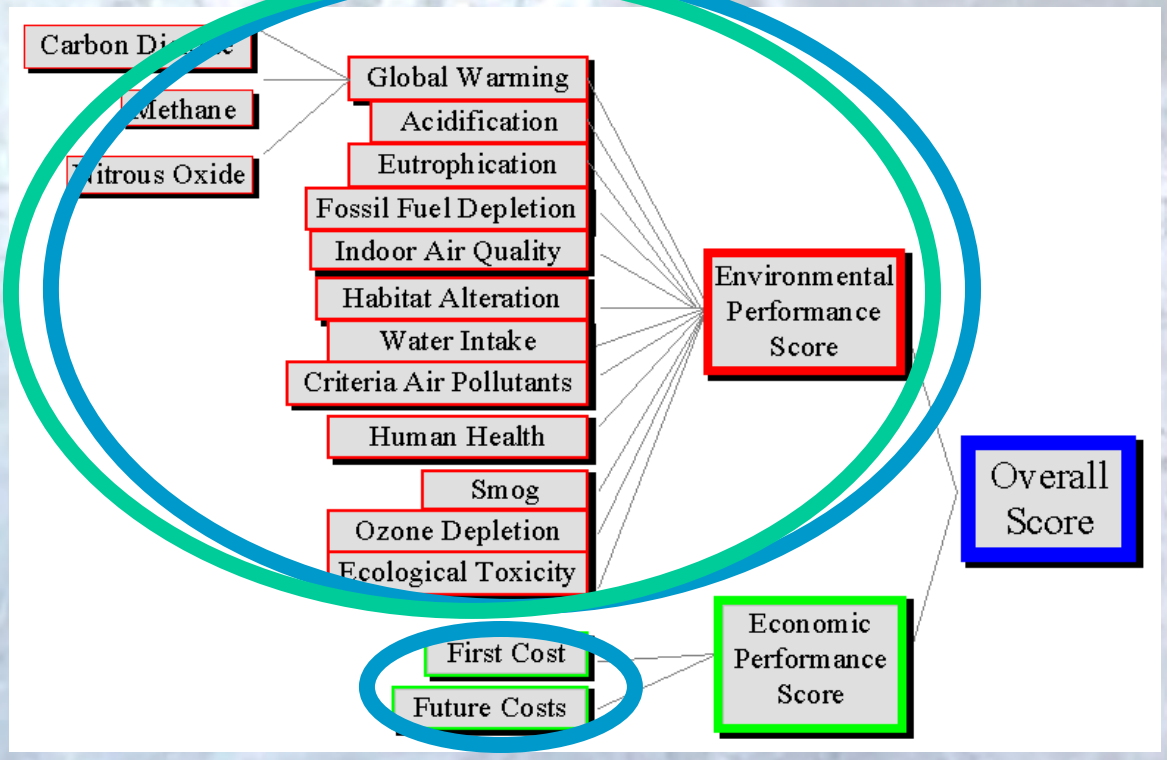


US EPA & NIST BEES 3.0

BEFORE USE
Extraction
Manufacture
Fabrication
Transportation

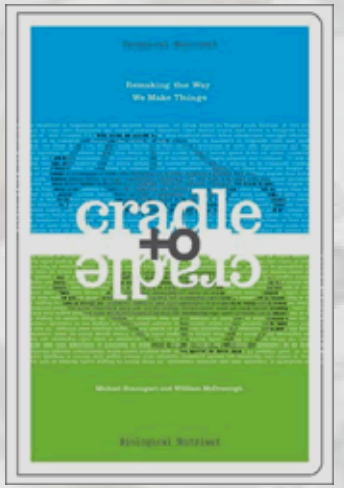
DURING USE
Construction
Operation
Maintenance

AFTER USE
Renewal
Removal
Re-use
Disposal



LCA Life-cycle Analysis

William McDonough
Michael Braungart



Cradle to Cradle

Waste = Food

Biological Nutrients

Industrial Nutrients

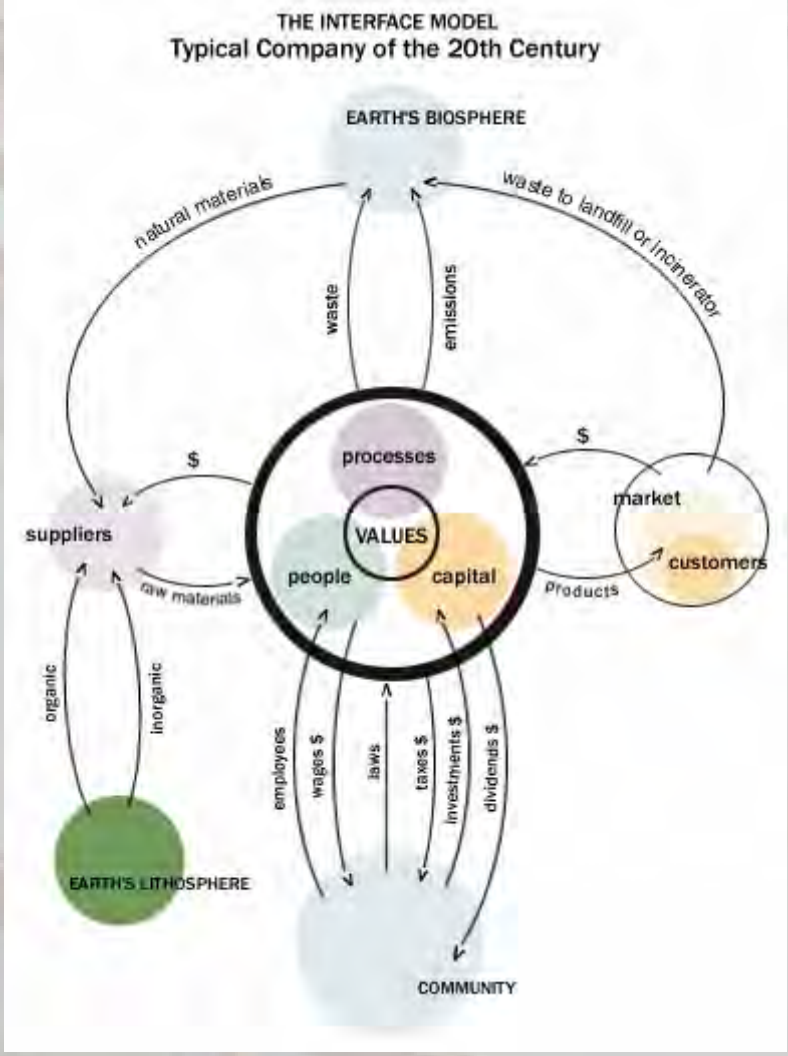
LCA Life-cycle Analysis

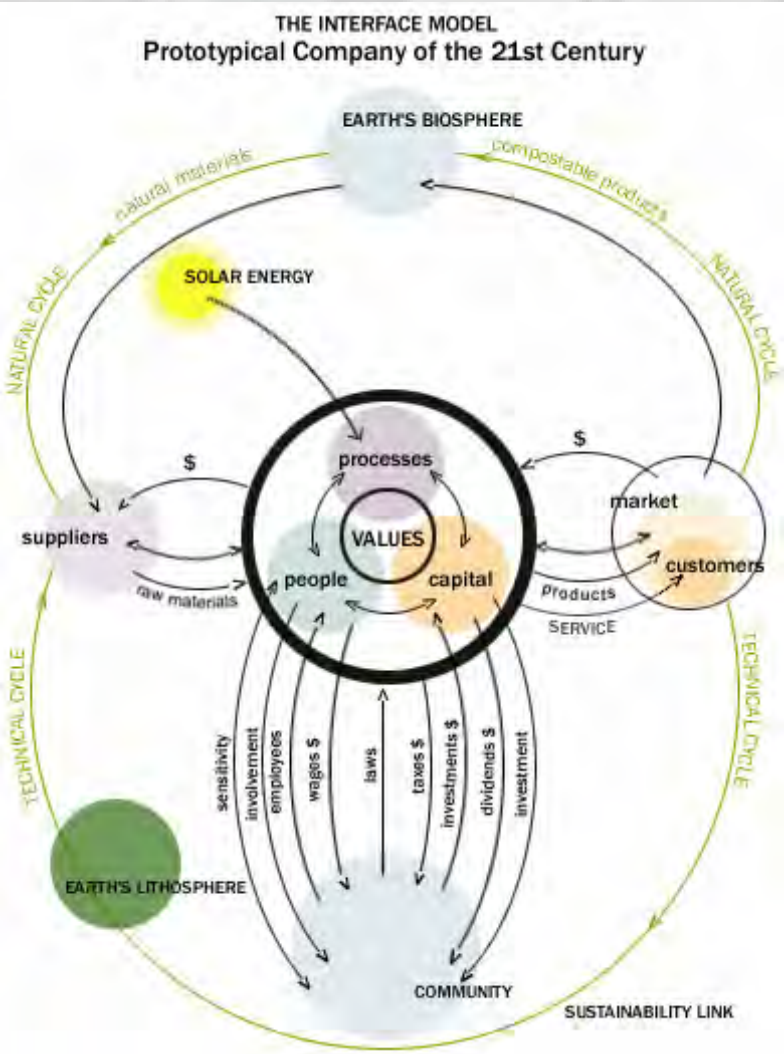
In a sustainable society, nature is NOT subject to systematically increasing:			and in that society...
(1) concentrations of substances extracted from earth's crust	(2) concentrations of substances produced by society	(3) degradation by physical means	(4) human needs are met worldwide

TNS

The Natural Step

LCA Life-cycle Analysis





Interface Carpets

Renewal – Windows

Traditional Wood Window

Modern Aluminum Window

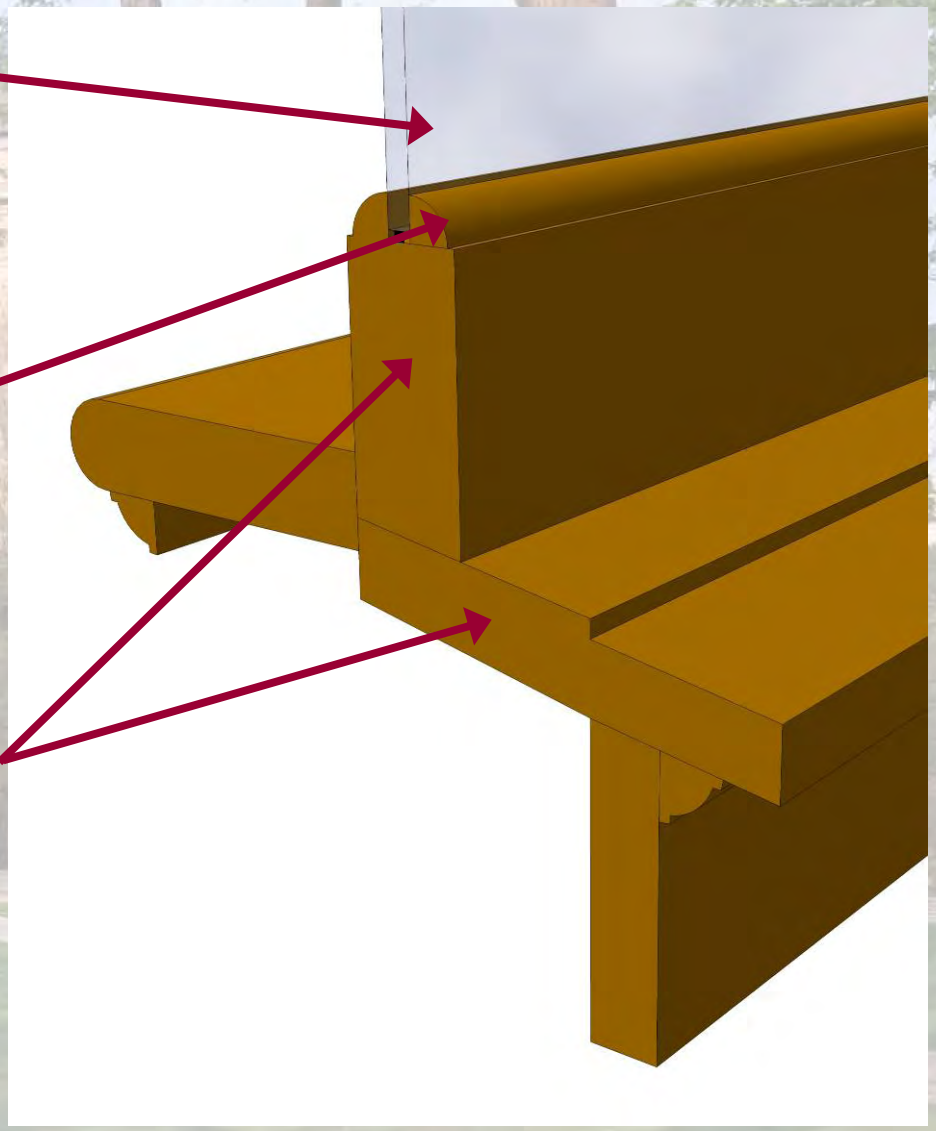
Renewal

Traditional Wood Windows

Single-pane glazing
Replacement
Recyclable

Glazing compound
Repair

Field painted wood sash & frame
Repair
Renew



Renewal

Modern Aluminum Windows

Double-pane glazing
with desiccant-filled metal spacer
and edge sealant

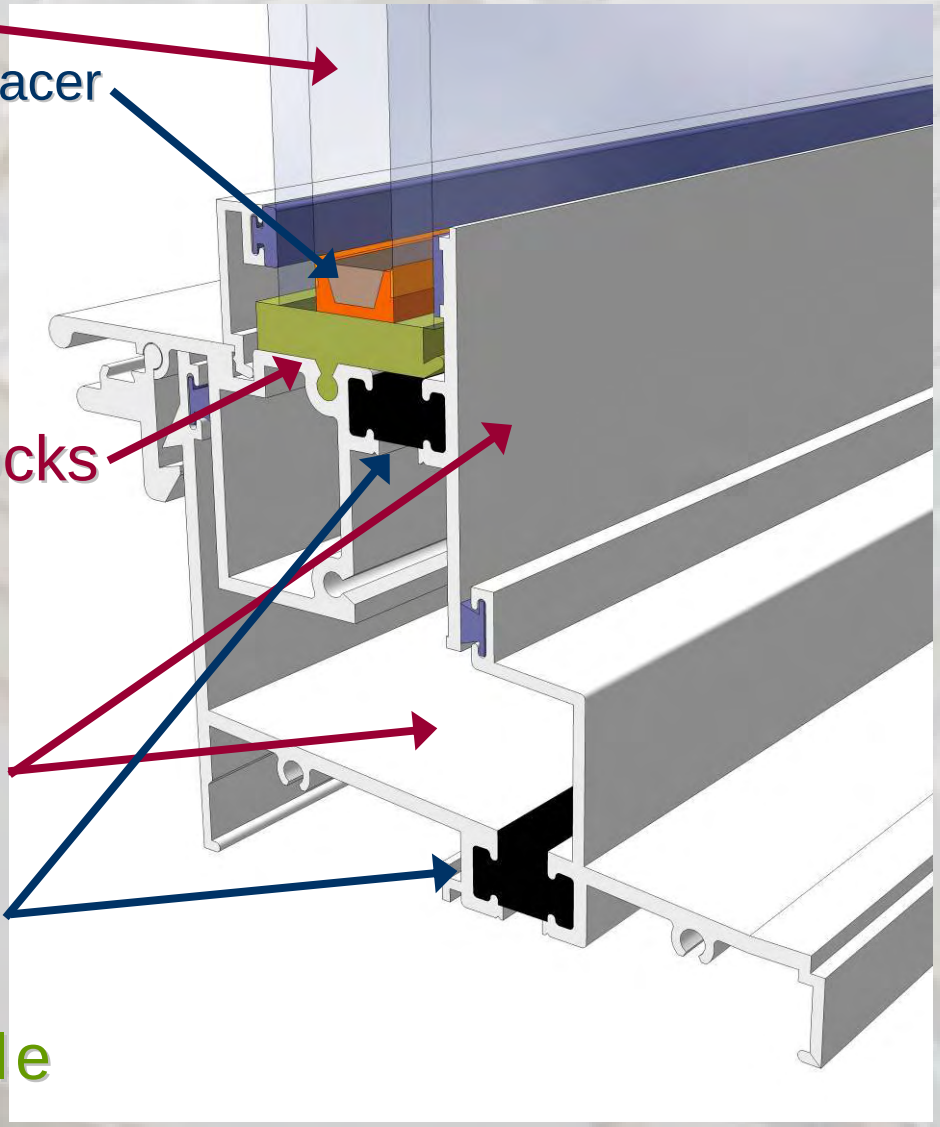
Replacement
Not Recyclable

Glazing gaskets and blocks

Replacement
Not Recyclable

Shop painted aluminum
sash & frame
with thermal isolation gasket

Replacement
Mostly Recyclable



Life-cycle Impacts

Buying a Toyota Prius

vs.

Keeping a Ford Torus

Life-cycle Impacts

Buying a Toyota Prius

vs.

Keeping a Ford Torus

Recaptures Energy Use in

3.5 years

Life-cycle Impacts

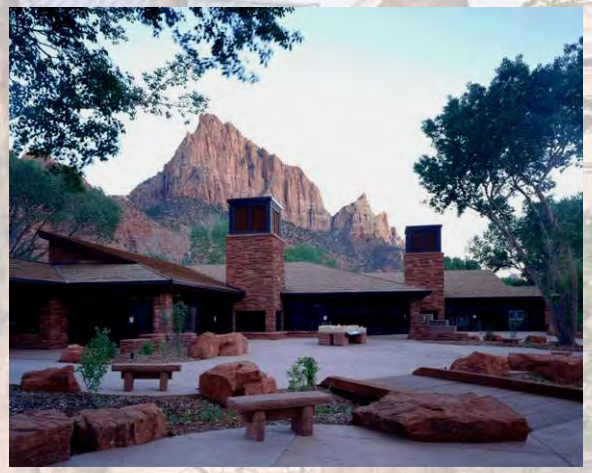
Buying a Toyota Prius

vs.

Keeping a Ford Torus

Recaptures Toxic Emissions in

22 years



The Greenest building is….

....one that is *already* built.