

# **Green Building and Retrofit Planning for Urban Revitalization and Redevelopment**

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Building Energy  
University of Massachusetts, Amherst

# Unique places

- Municipal goals
- Requirements from higher levels of government
- Historical development
- Unique combination of resources and opportunities

# Principles

- Design with the climate.
- Use local and existing natural resources where possible.
- Protect and preserve aesthetically, historically, and architecturally valuable aspects of buildings while avoiding compromises that fail to sufficiently upgrade building performance or that could lead to future degradation of the building.
- Provide for a high level of indoor environmental quality.
- Use building systems and materials that minimize life-cycle carbon dioxide equivalent emissions.
- Identify and encourage no-regrets investments.
- Make maximum—and creative—use of existing structures and infrastructures.

# Holyoke





# Holyoke

Municipal goals

***Redevelop Center City and Innovation District while moving toward 100% renewable Energy***

Requirements from higher levels of government

***Implement Renewable Energy Development Funds***

Historical development

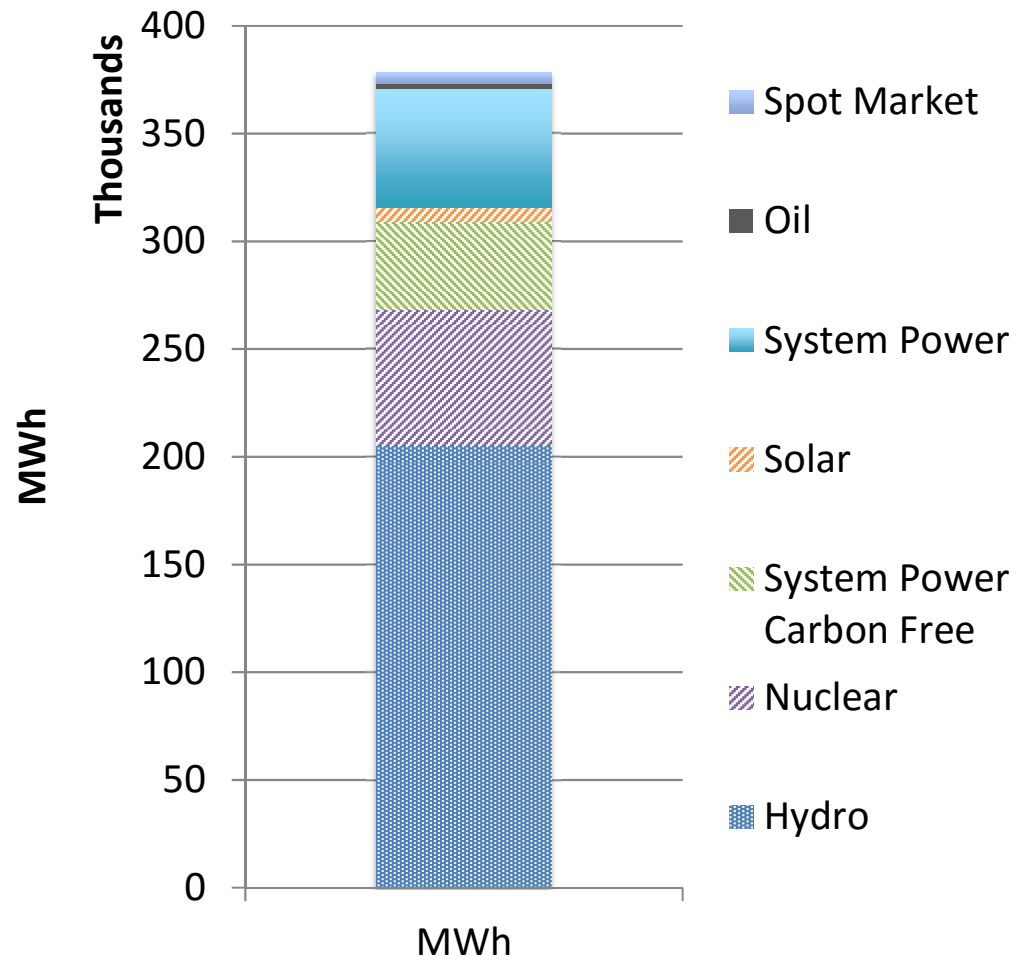
***Mill town, Gateway City, Municipal Utility***

Unique combination of resources and opportunities

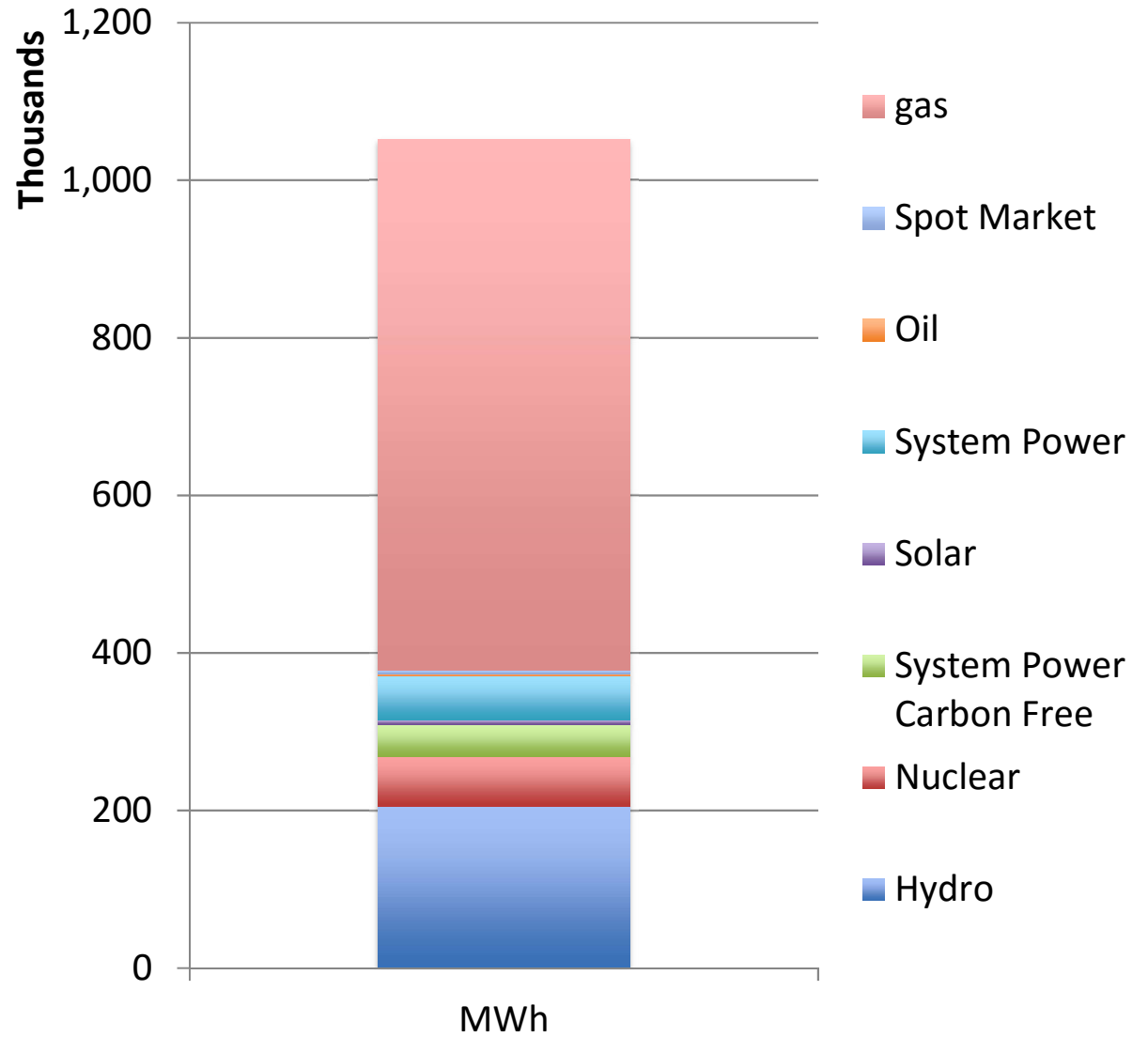
***Canals, HG&E, proximity to R1 Univ., Springfield, Connecticut River, large existing buildings***



# HG&E 2015 Electric Power Mix

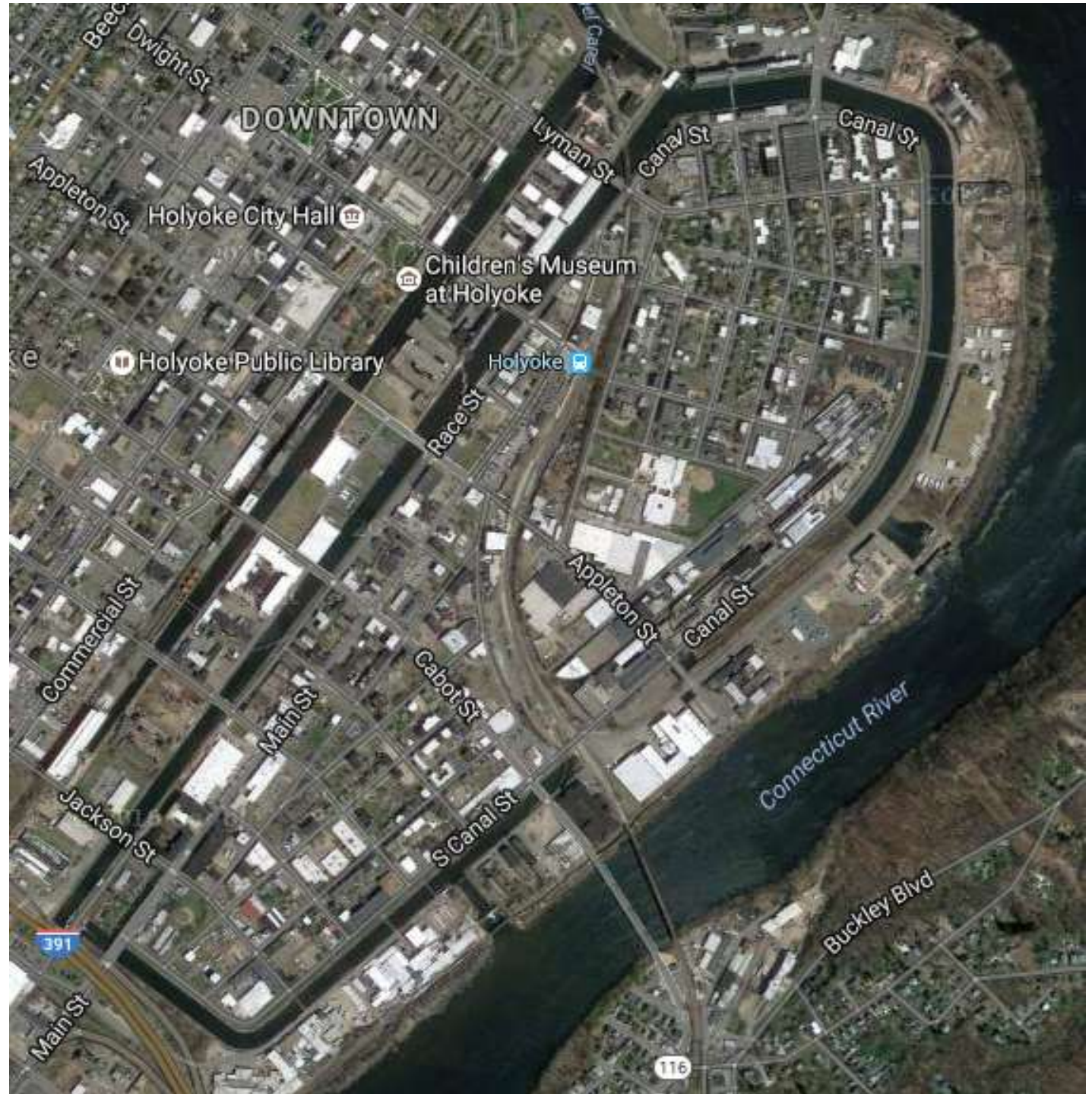


# Holyoke *Gas* & Electric



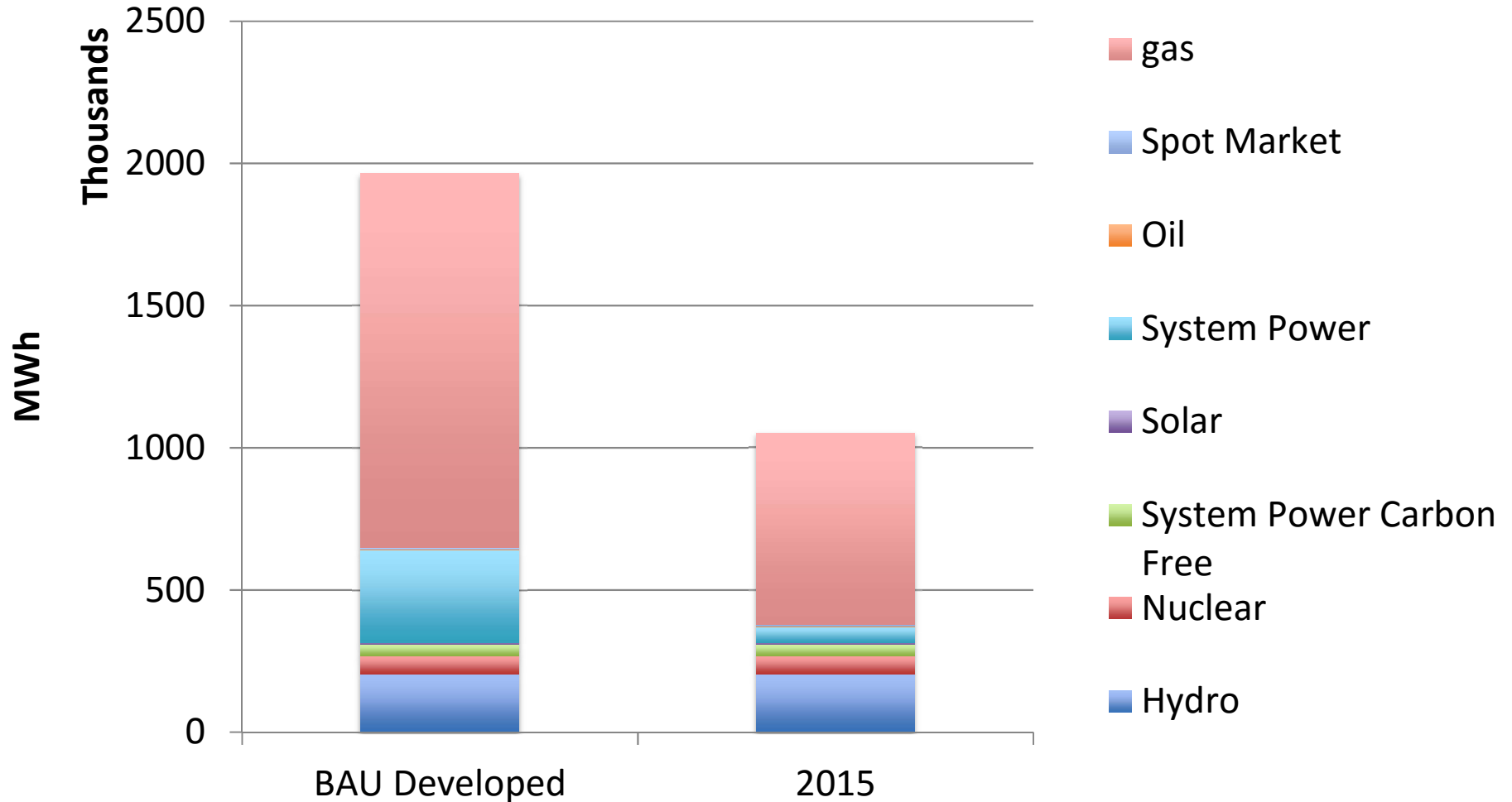
# Holyoke Center City and Innovation District

21,456,623 sf  
developable

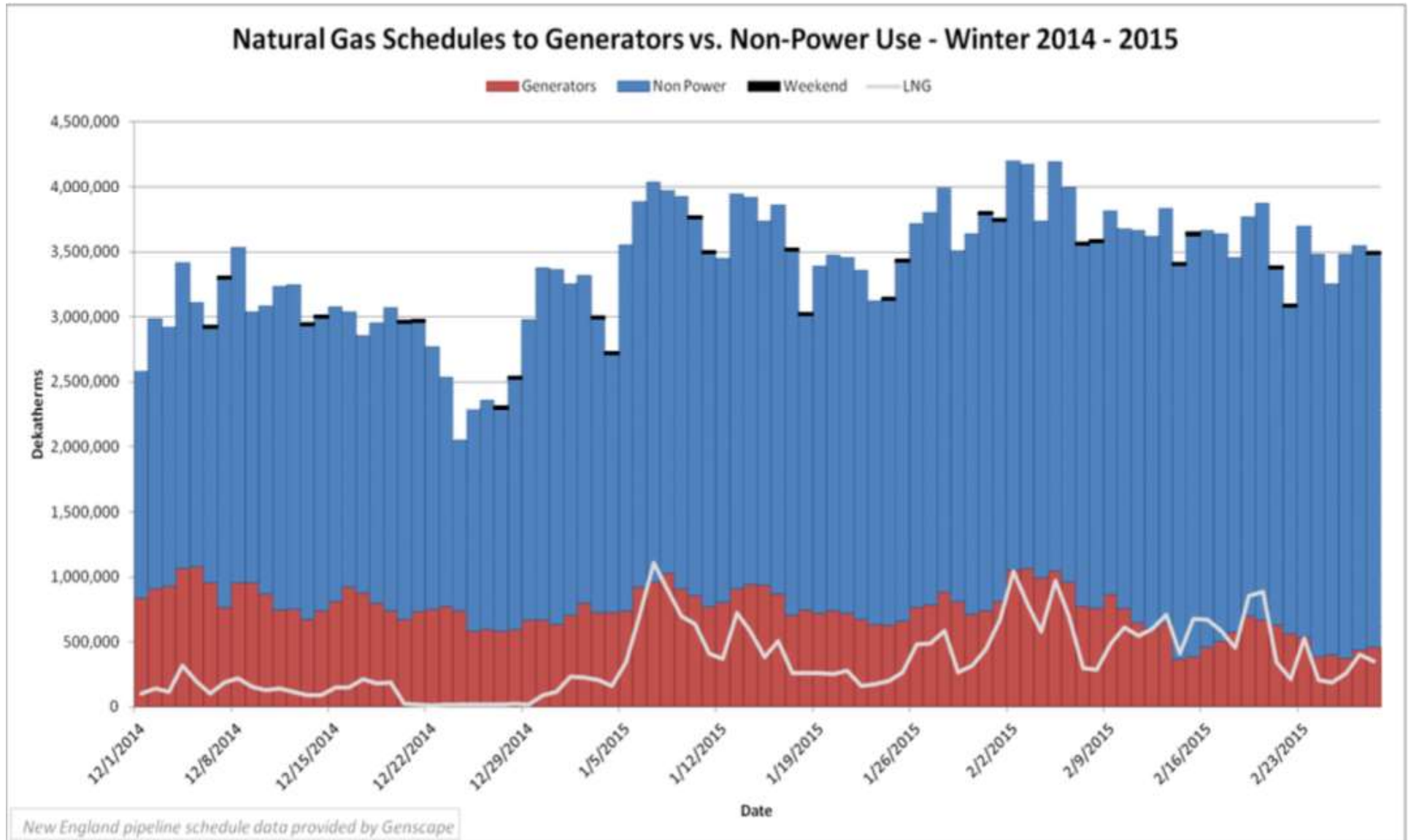




# Code compliant redevelopment of 21 Million sqft existing mill buildings in Innovation District



# Natural gas peaks for heating



# Order of Priorities

1. Favor systems that can be powered by renewable energy. In practice this means favoring electrically driven systems over on-site fuel combustion.
2. Design for peak shaving and off-peak electric use.
3. Use natural forces to supply space conditioning, comfort, indoor health, and lighting.
4. Optimize systems for overall energy efficiency.

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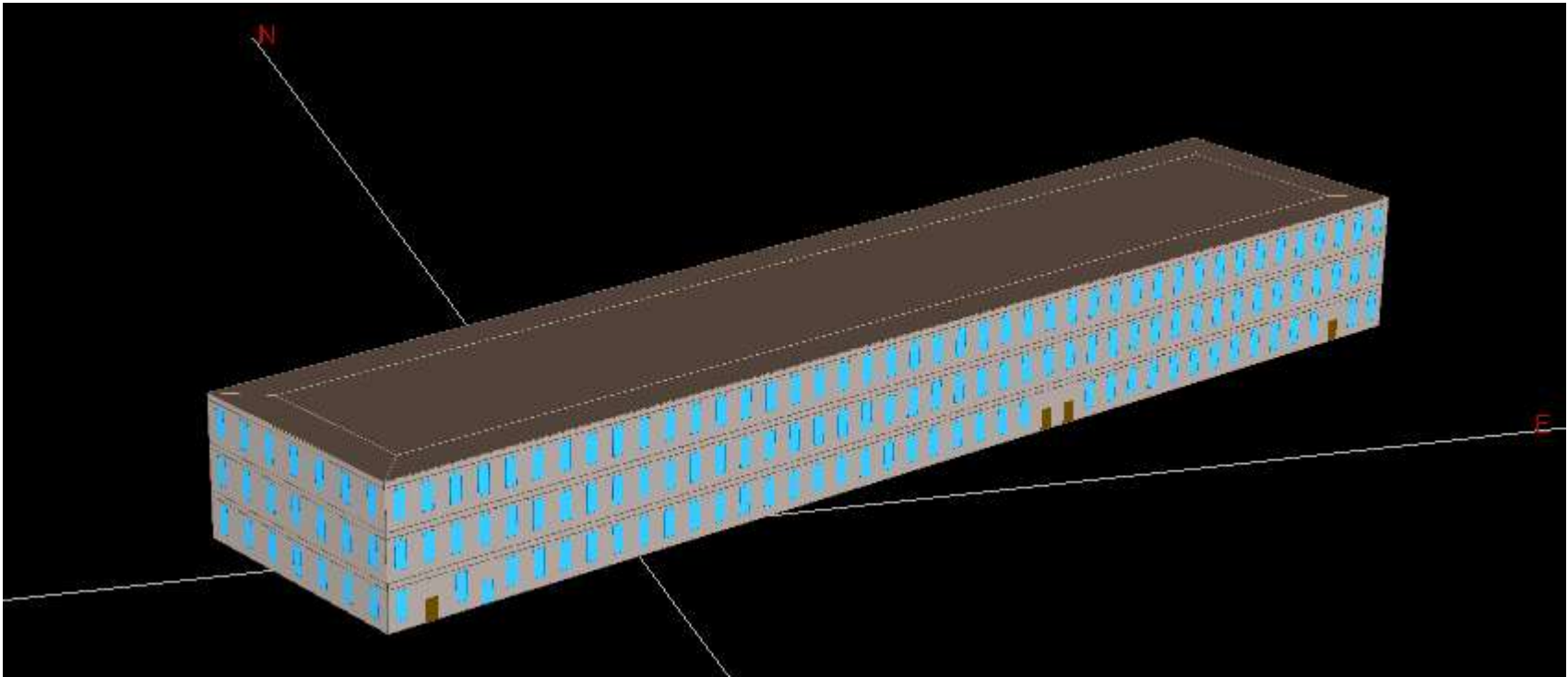
# Office

Address: 532 Main Street



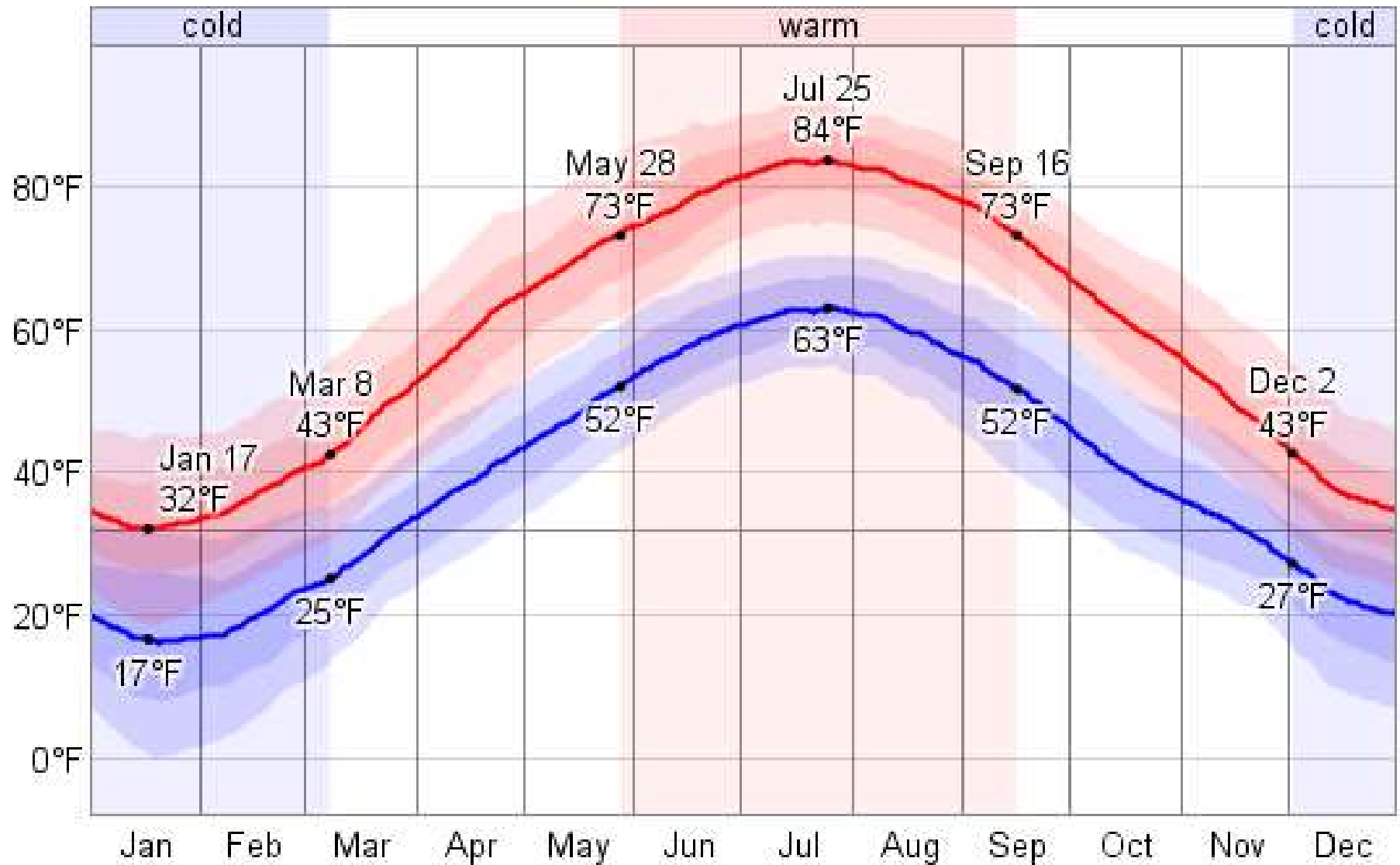
South west view

# Office

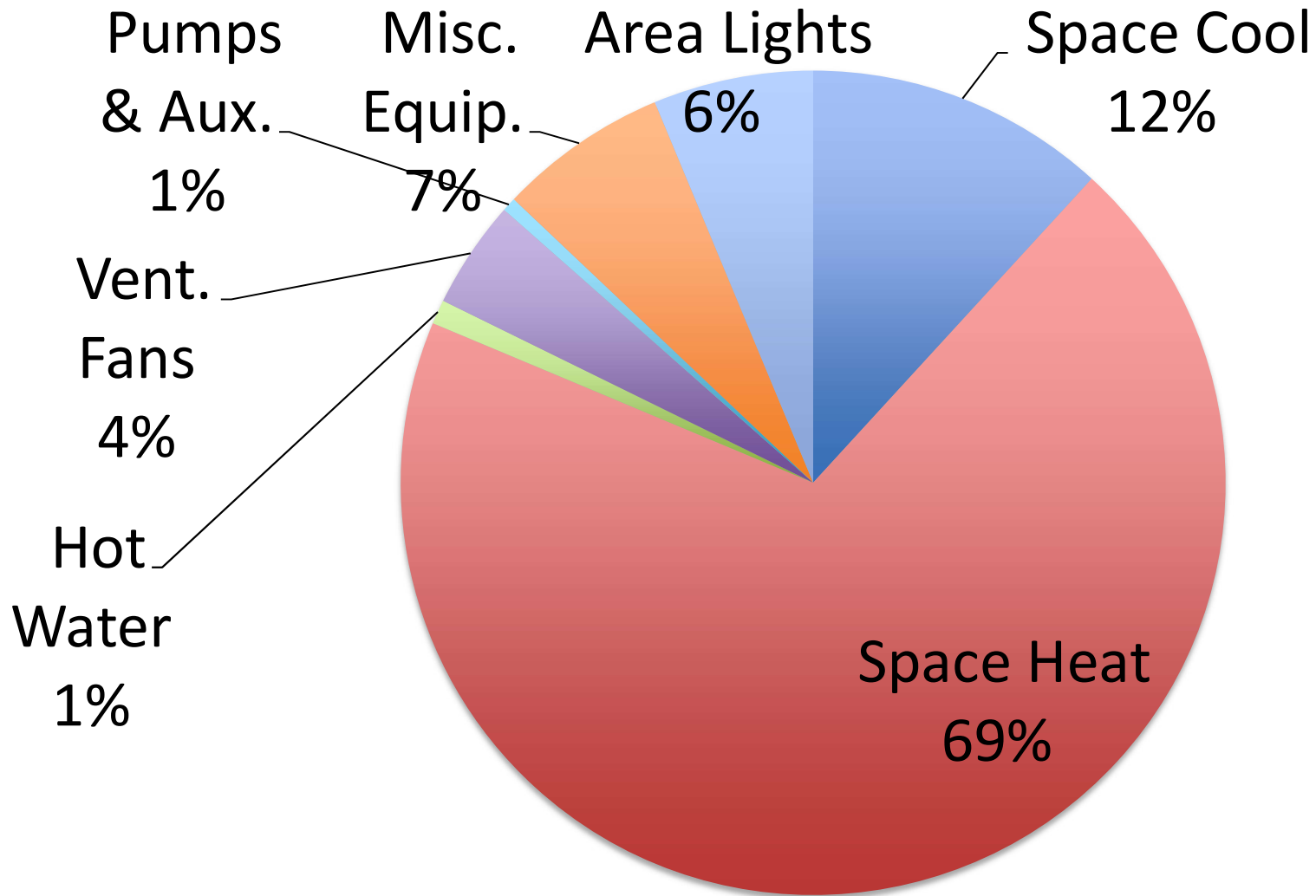


# Holyoke Climate

## Daily High and Low Temperature



# Baseline Office Building





RELATIVE HUMIDITY 100% 80% 60%

DESIGN STRATEGIES: JANUARY through DECEMBER

- 6.8% 1 Comfort(594 hrs)
- 2 Sun Shading of Windows(0 hrs)
- 3 High Thermal Mass(0 hrs)
- 1.4% 4 High Thermal Mass Night Flushed(121 hrs)
- 5 Direct Evaporative Cooling(0 hrs)
- 6 Two-Stage Evaporative Cooling(0 hrs)
- 0.8% 7 Natural Ventilation Cooling(67 hrs)
- 8 Fan-Forced Ventilation Cooling(0 hrs)
- 9 Internal Heat Gain(0 hrs)
- 10 Passive Solar Direct Gain Low Mass(0 hrs)
- 11 Passive Solar Direct Gain High Mass(0 hrs)
- 12 Wind Protection of Outdoor Spaces(0 hrs)
- 13 Humidification Only(0 hrs)
- 8.9% 14 Dehumidification Only(781 hrs)
- 2.2% 15 Cooling, add Dehumidification if needed(193 hrs)
- 16 Heating, add Humidification if needed(0 hrs)

19.3% Comfortable Hours using Selected Strategies  
(1689 out of 8760 hrs)

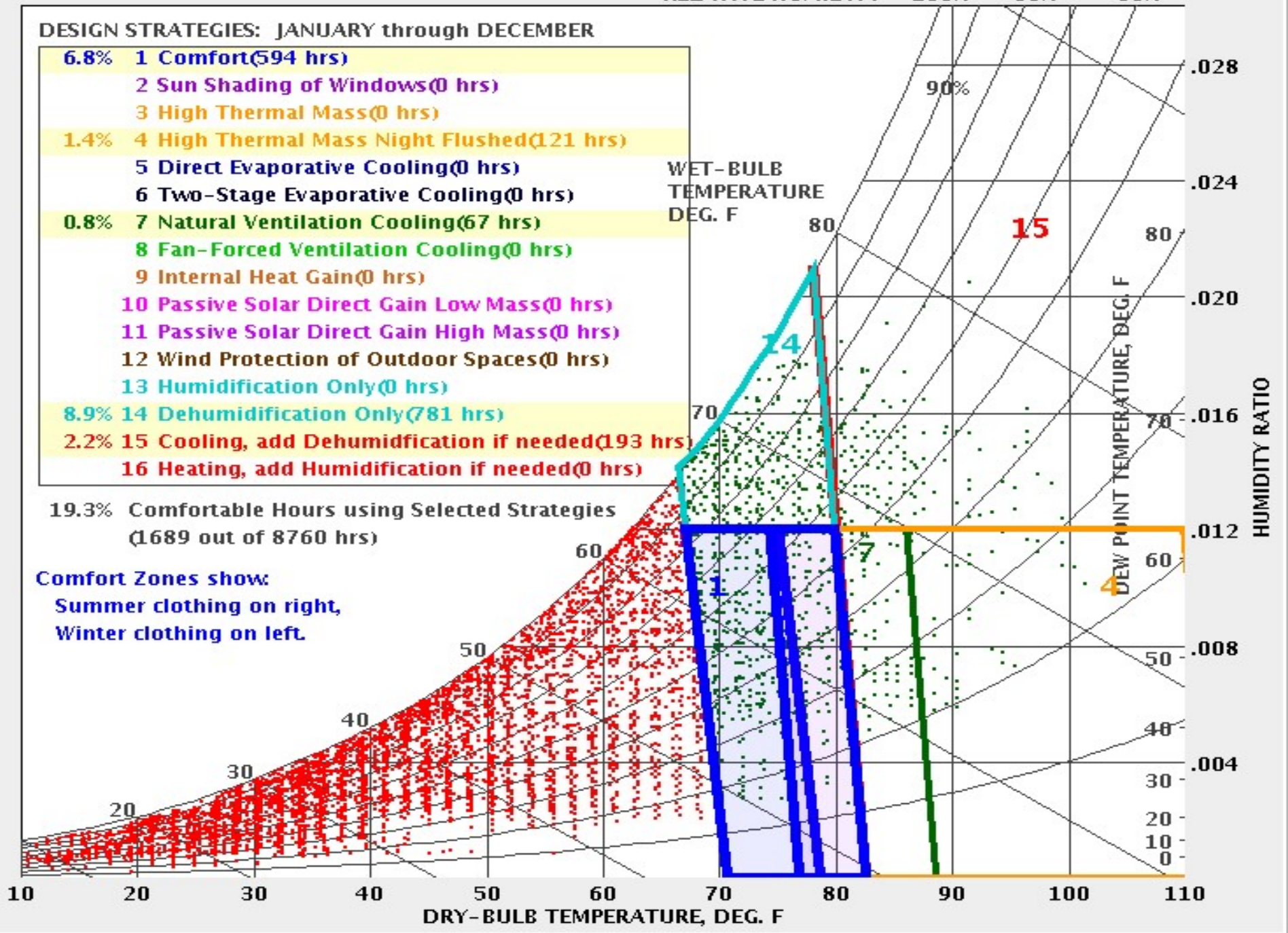
Comfort Zones show:  
Summer clothing on right,  
Winter clothing on left.

WET-BULB  
TEMPERATURE  
DEG. F

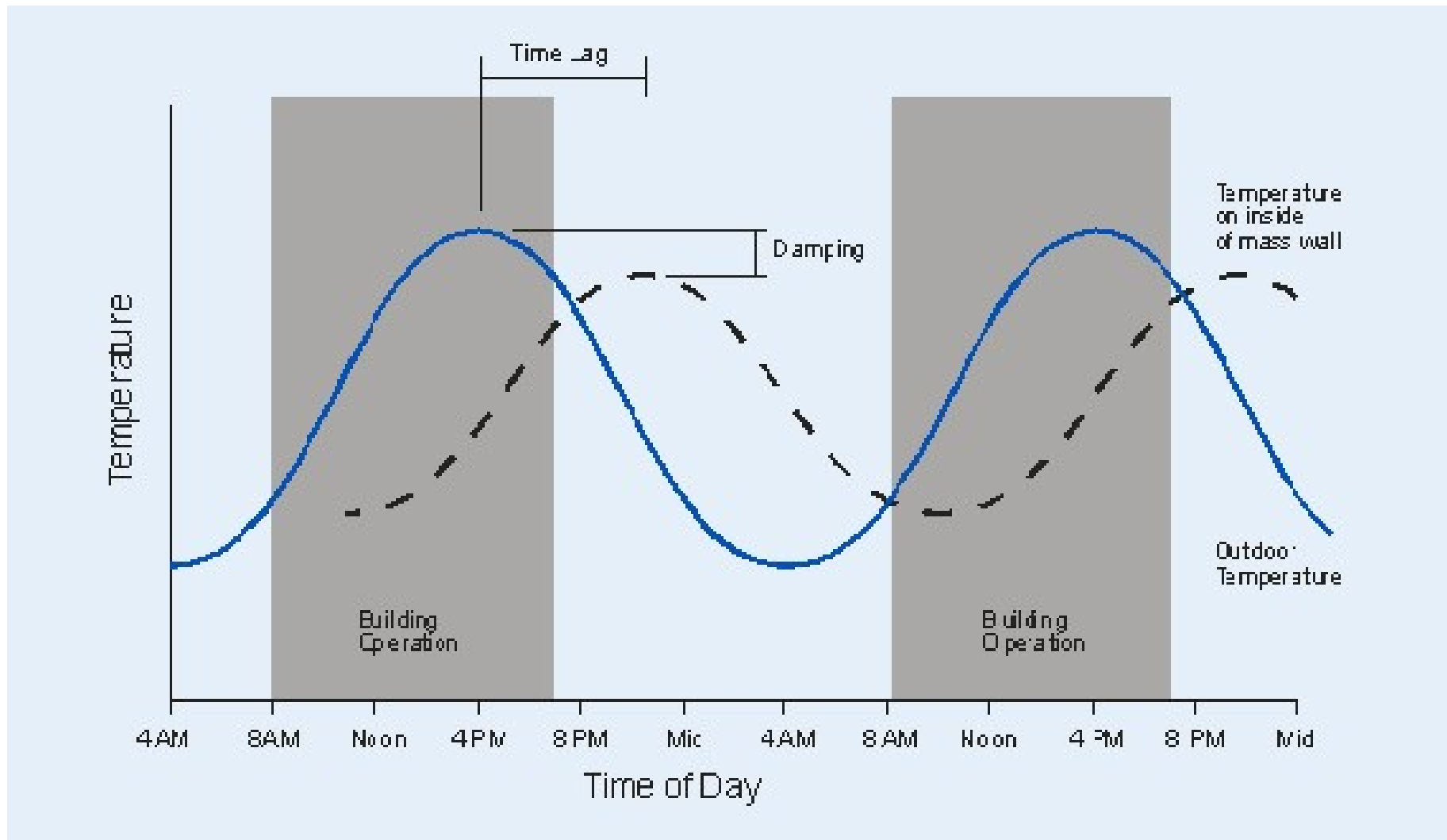
DEW POINT TEMPERATURE, DEG. F

HUMIDITY RATIO

10 20 30 40 50 60 70 80 90 100 110  
DRY-BULB TEMPERATURE, DEG. F

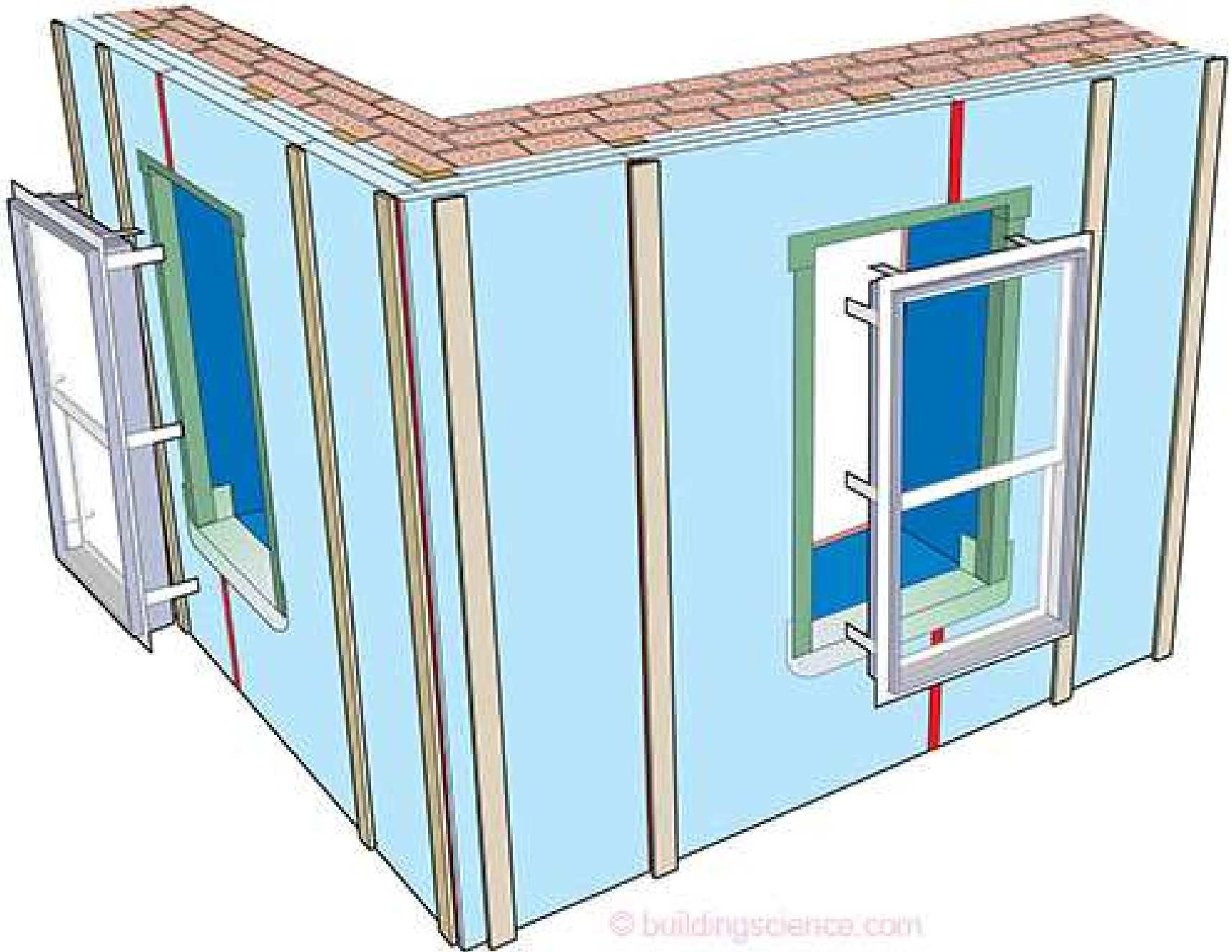


# Thermal Mass and Night Flush Cooling



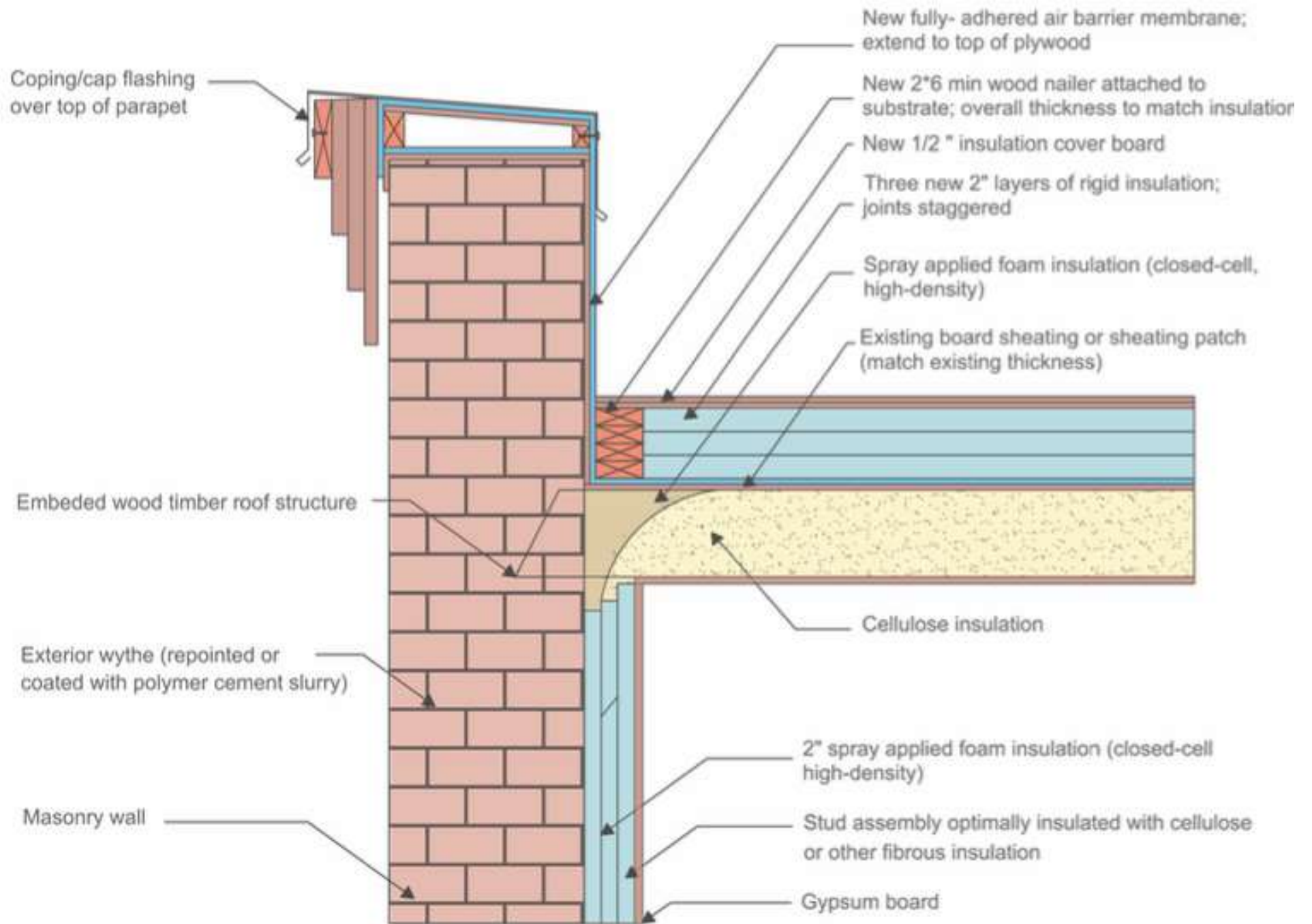






# Trombe Wall Façade Rendering





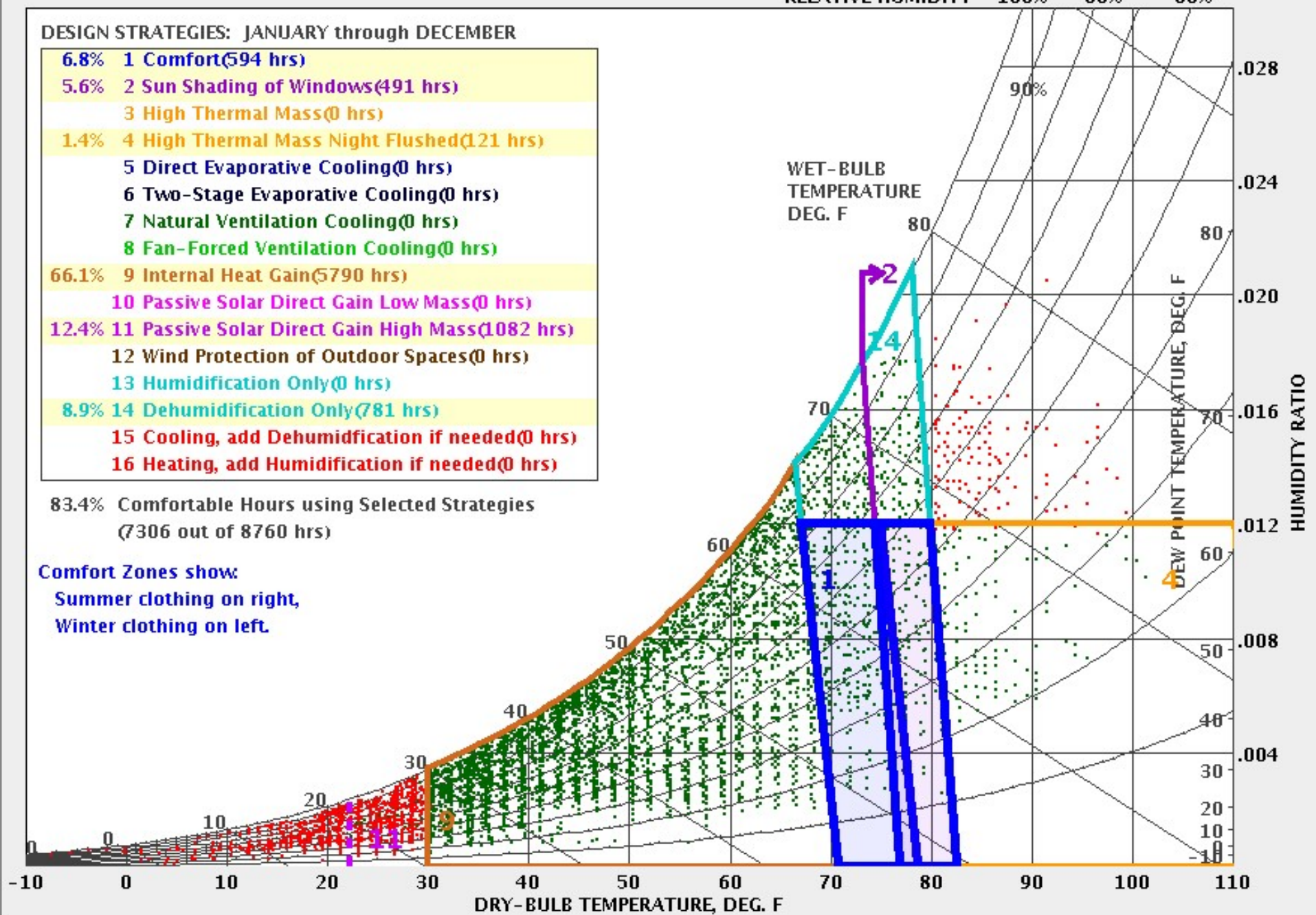
RELATIVE HUMIDITY 100% 80% 60%

DESIGN STRATEGIES: JANUARY through DECEMBER

- 6.8% 1 Comfort(594 hrs)
- 5.6% 2 Sun Shading of Windows(491 hrs)
- 3 High Thermal Mass(0 hrs)
- 1.4% 4 High Thermal Mass Night Flushed(121 hrs)
- 5 Direct Evaporative Cooling(0 hrs)
- 6 Two-Stage Evaporative Cooling(0 hrs)
- 7 Natural Ventilation Cooling(0 hrs)
- 8 Fan-Forced Ventilation Cooling(0 hrs)
- 66.1% 9 Internal Heat Gain(5790 hrs)
- 10 Passive Solar Direct Gain Low Mass(0 hrs)
- 12.4% 11 Passive Solar Direct Gain High Mass(1082 hrs)
- 12 Wind Protection of Outdoor Spaces(0 hrs)
- 13 Humidification Only(0 hrs)
- 8.9% 14 Dehumidification Only(781 hrs)
- 15 Cooling, add Dehumidification if needed(0 hrs)
- 16 Heating, add Humidification if needed(0 hrs)

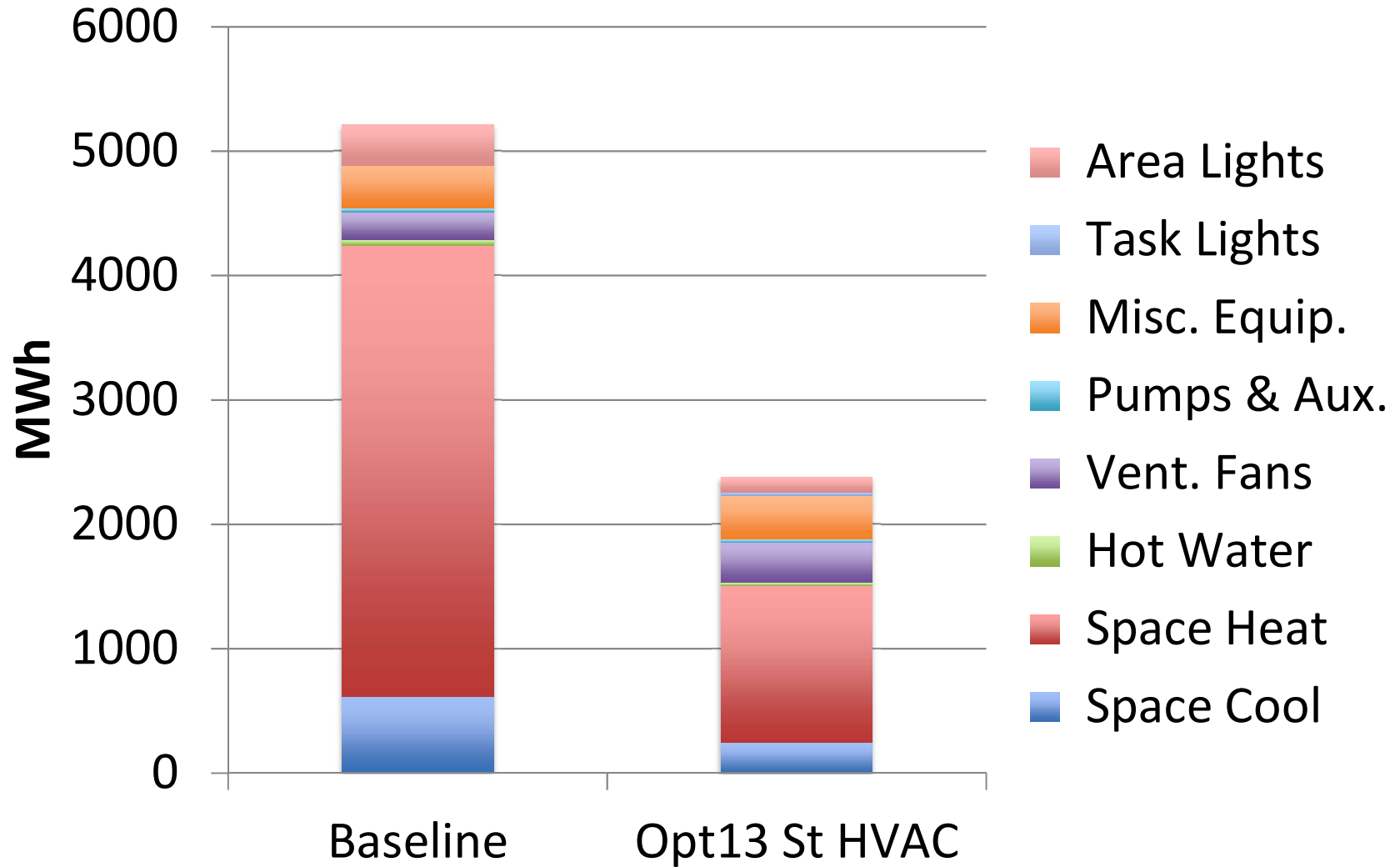
83.4% Comfortable Hours using Selected Strategies  
(7306 out of 8760 hrs)

Comfort Zones show:  
Summer clothing on right,  
Winter clothing on left.

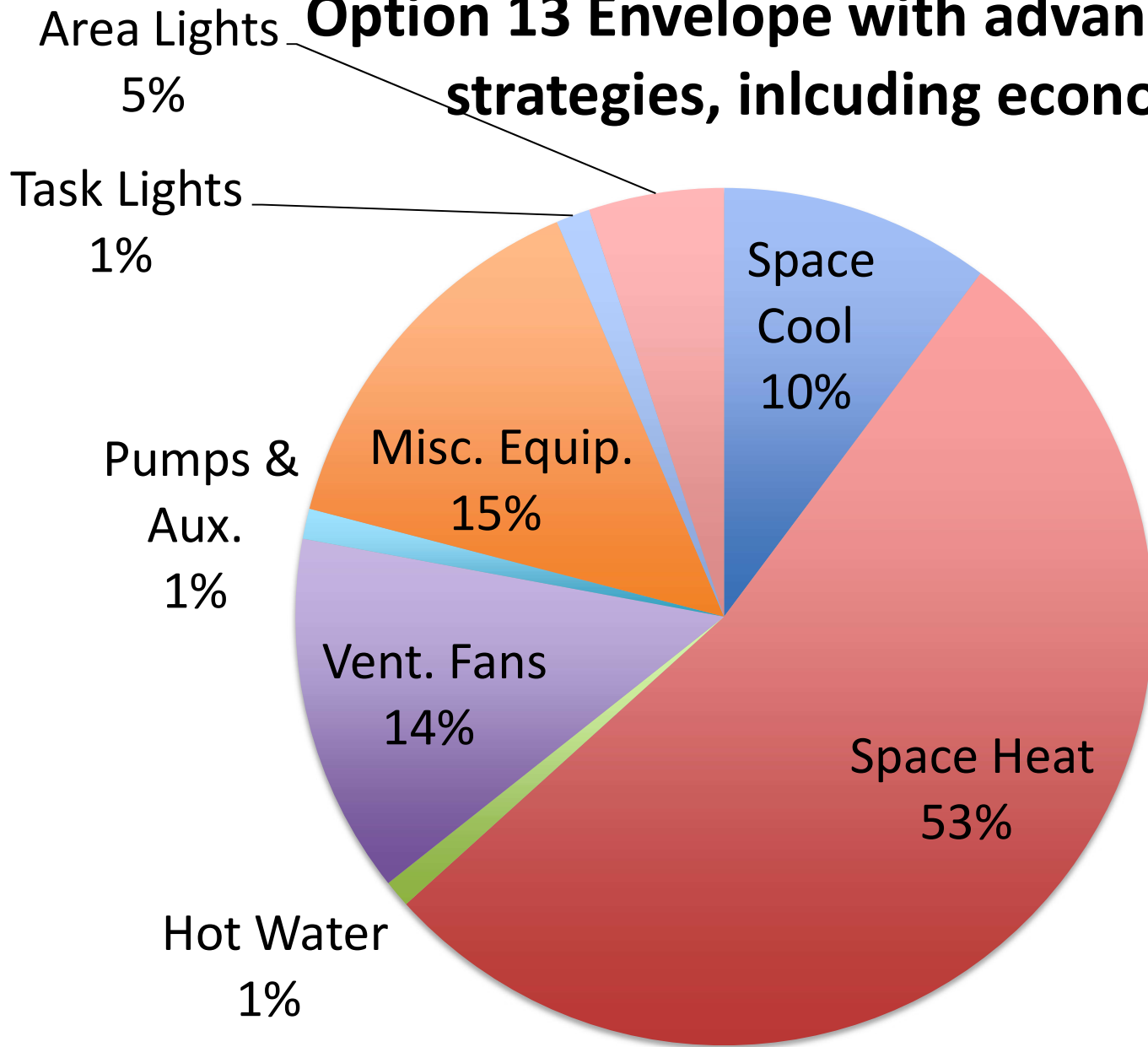




# Baseline vs. Advanced Option (Std. HVAC)



# Option 13 Envelope with advanced cooling strategies, including economizer



# Air Source VRF. High COP but decline with outdoor temperature

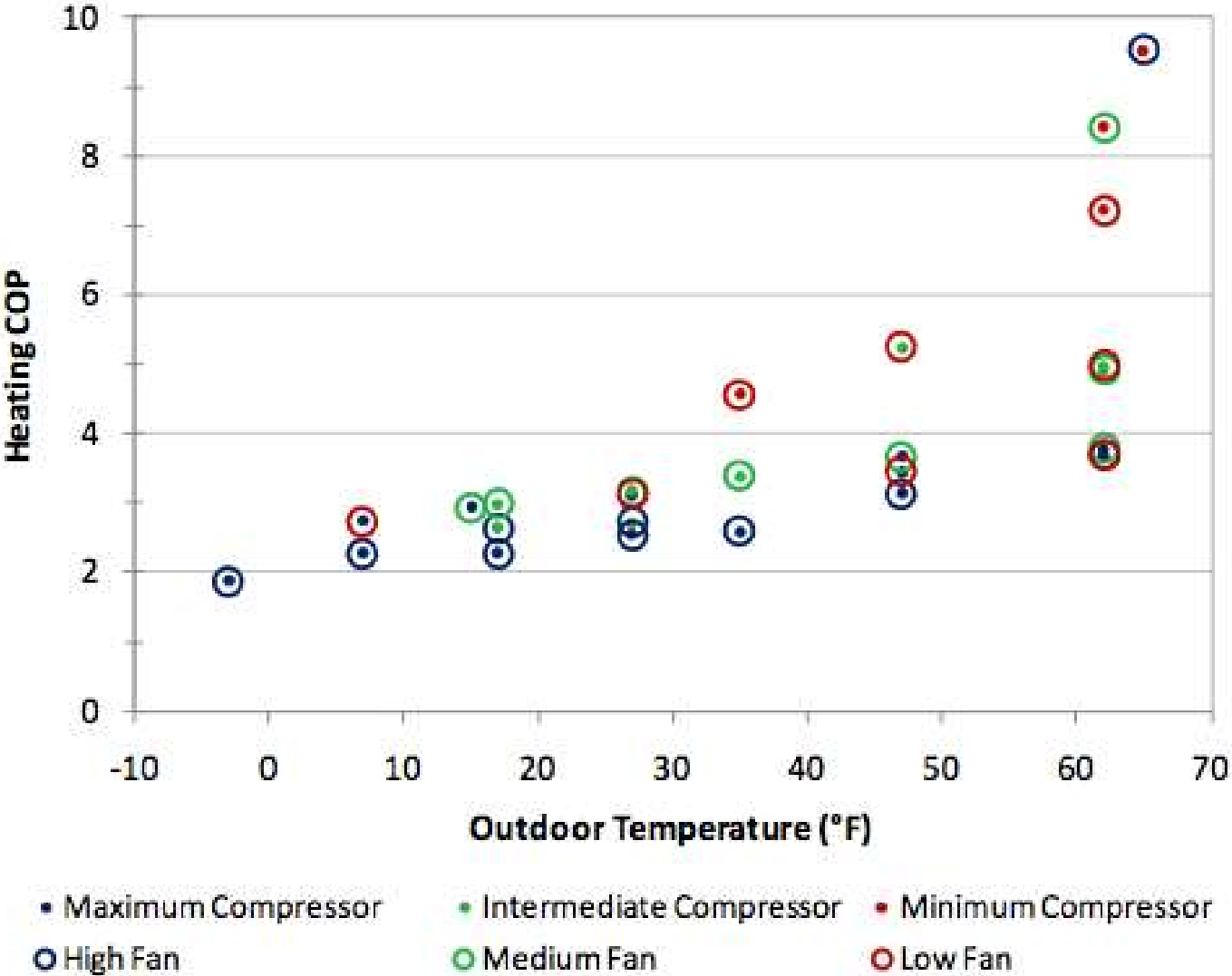


Figure 5. Fujitsu 12RLS steady-state heating COP (70°F return temperature)

heating capacity declines with Low temp reservoir temperature

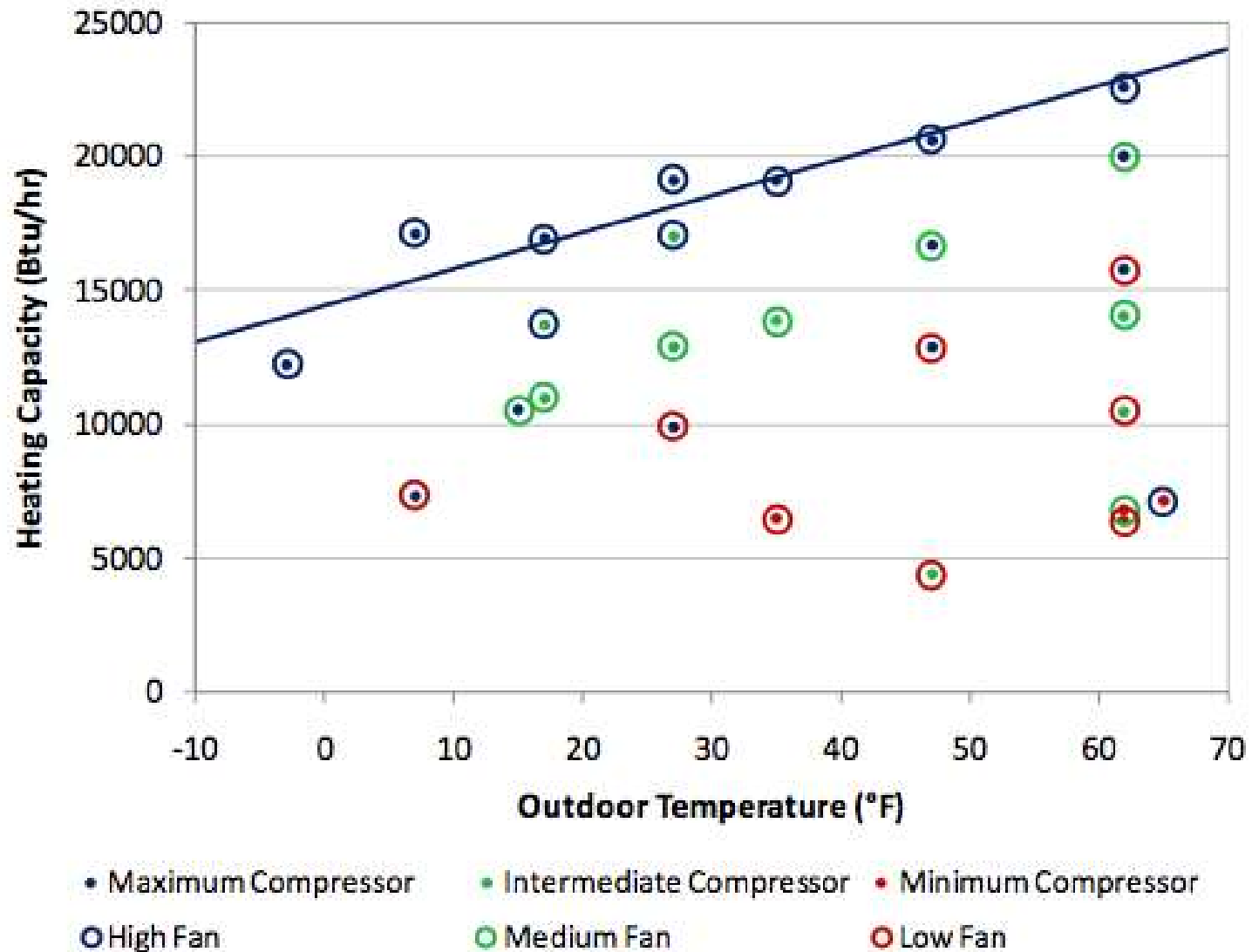
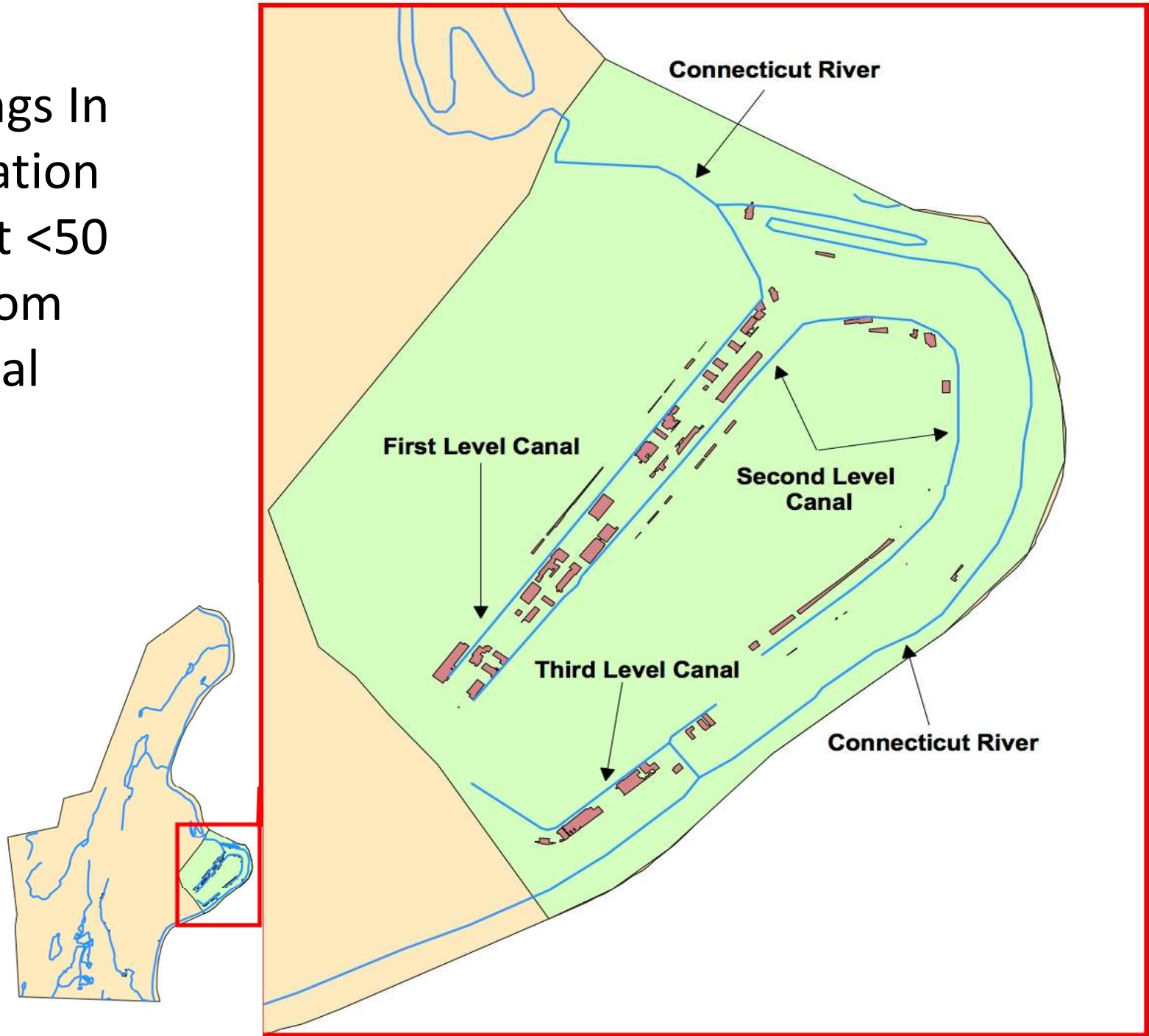


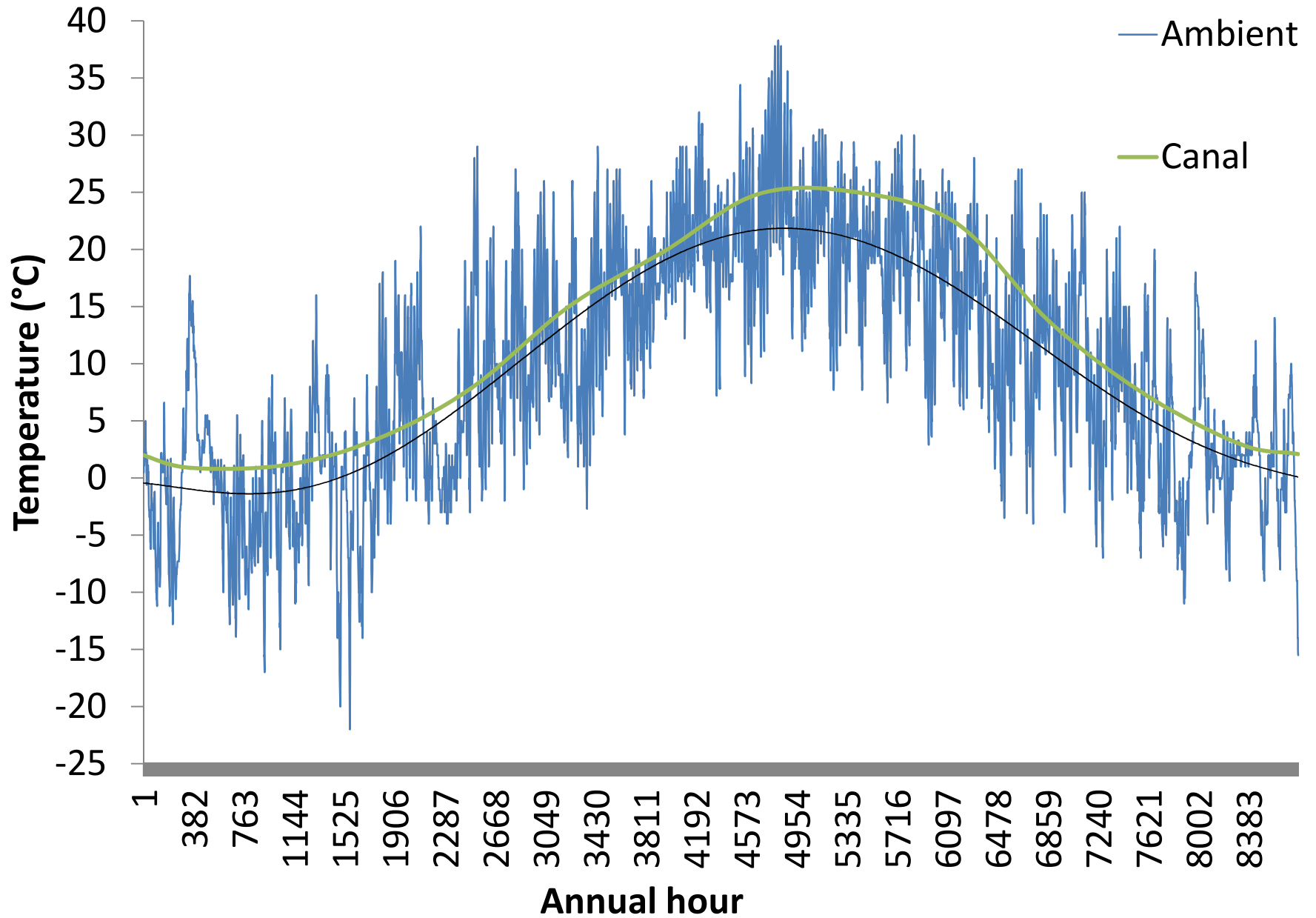
Figure 3. Fujitsu 12RLS steady-state heating capacities (70°F return temperature)



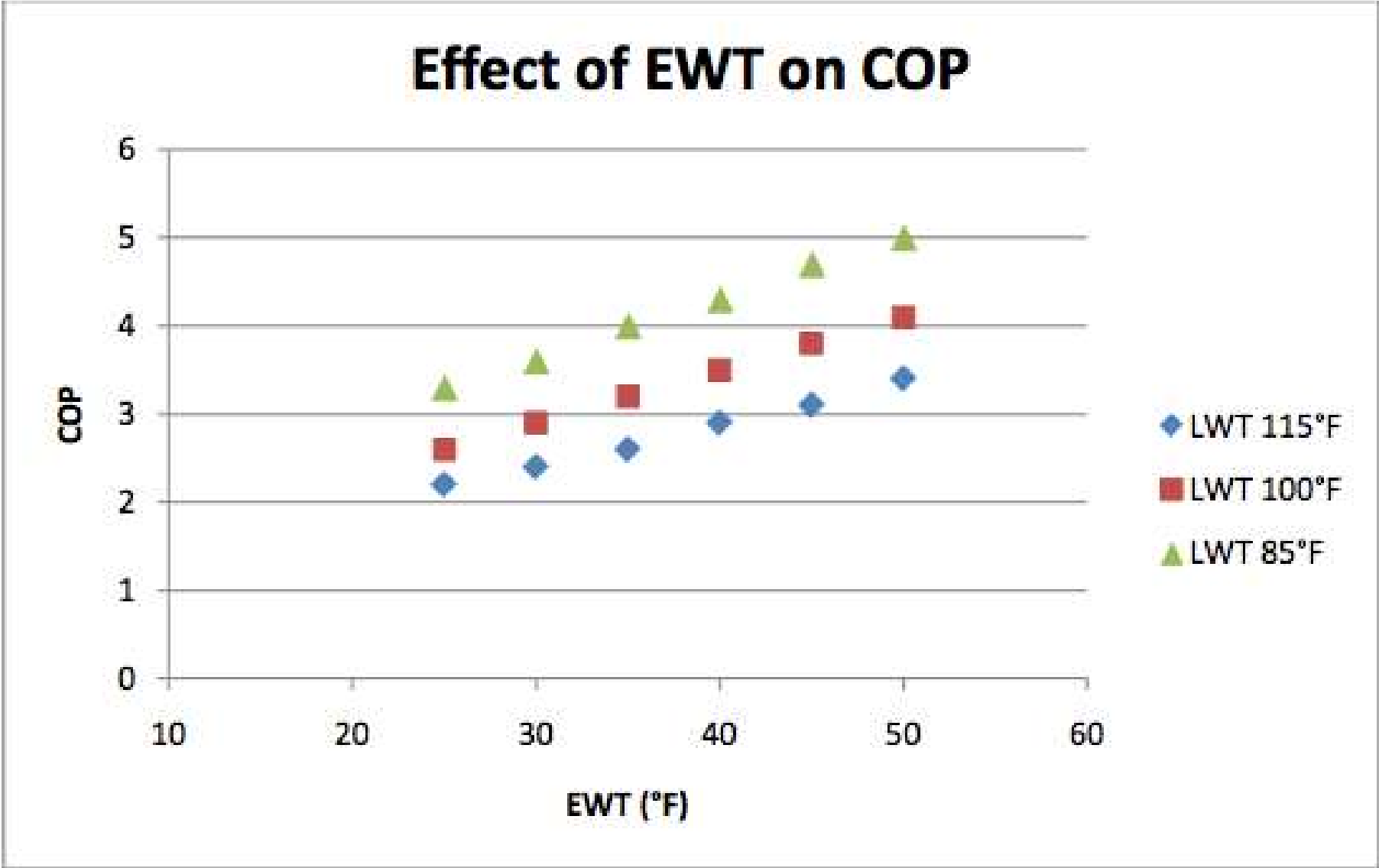
Buildings In  
Innovation  
District <50  
m from  
canal



# Air and Canal Water Temperatures

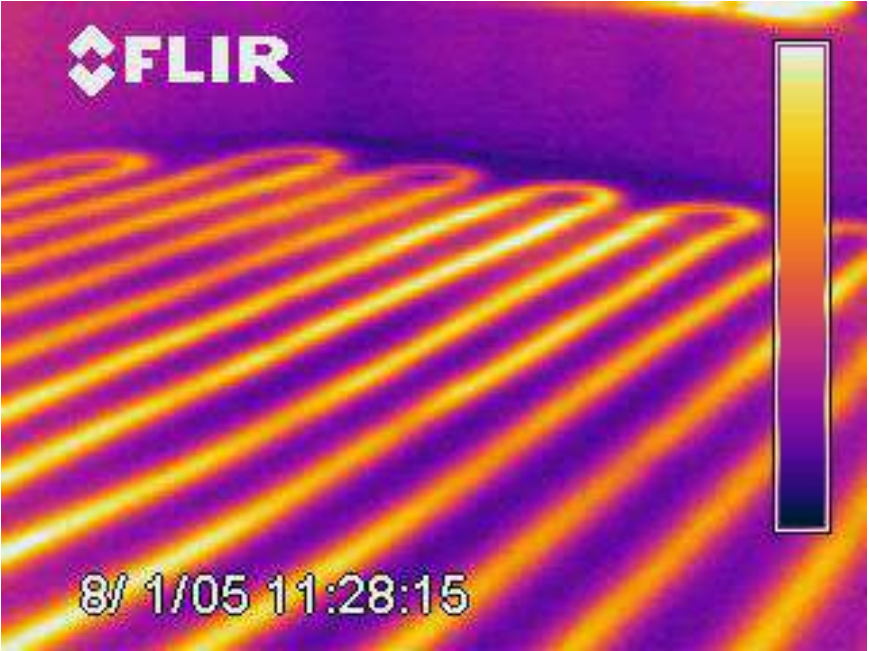


# Benefit of low temperature emitters

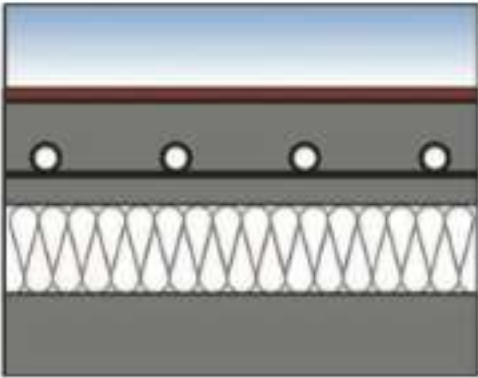




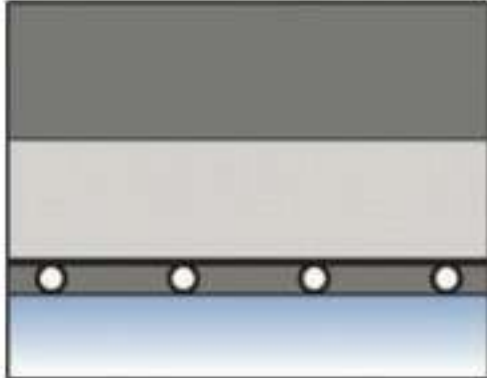
# Hydronic Low Temp Radiant Emitters



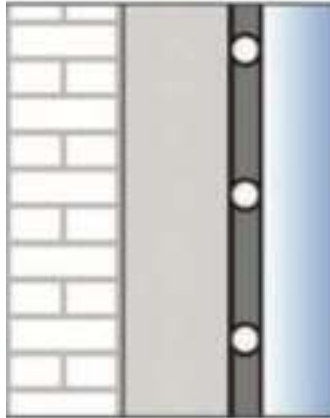
Floor



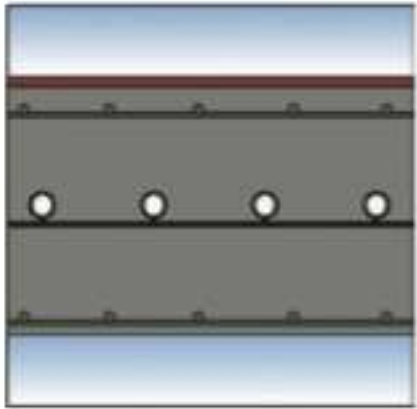
Ceiling



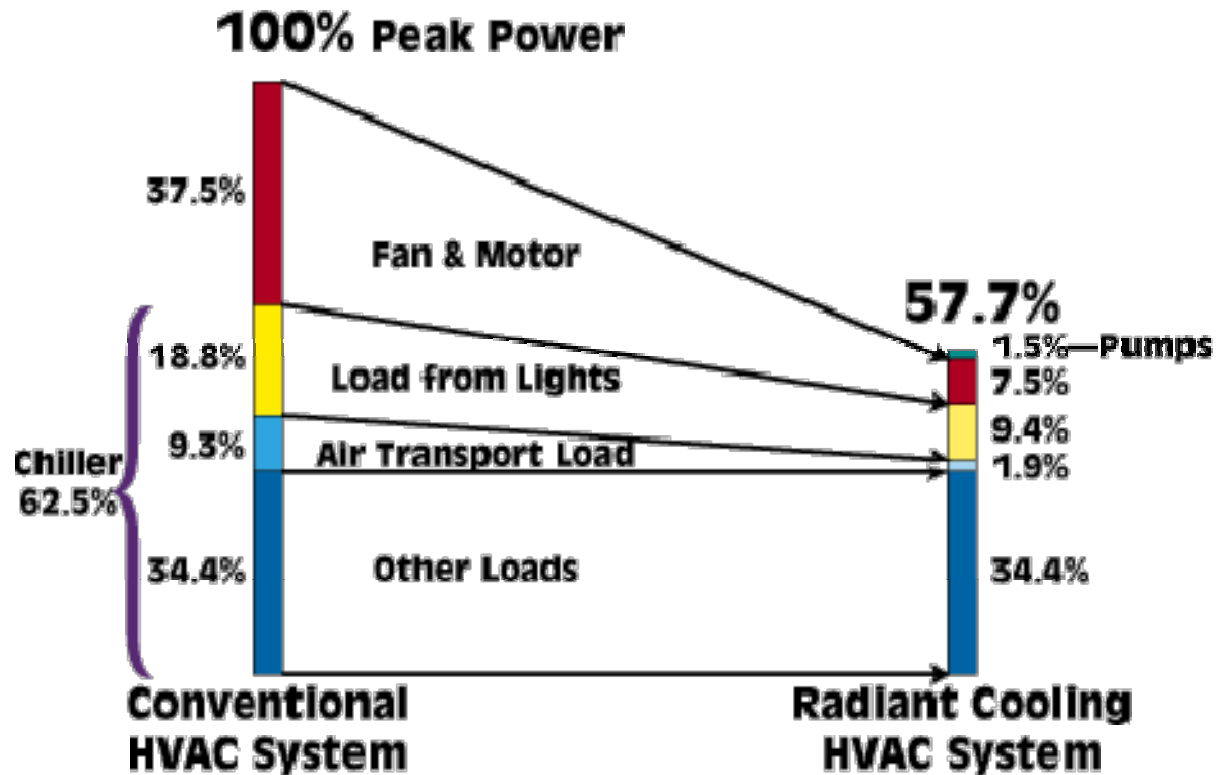
Wall



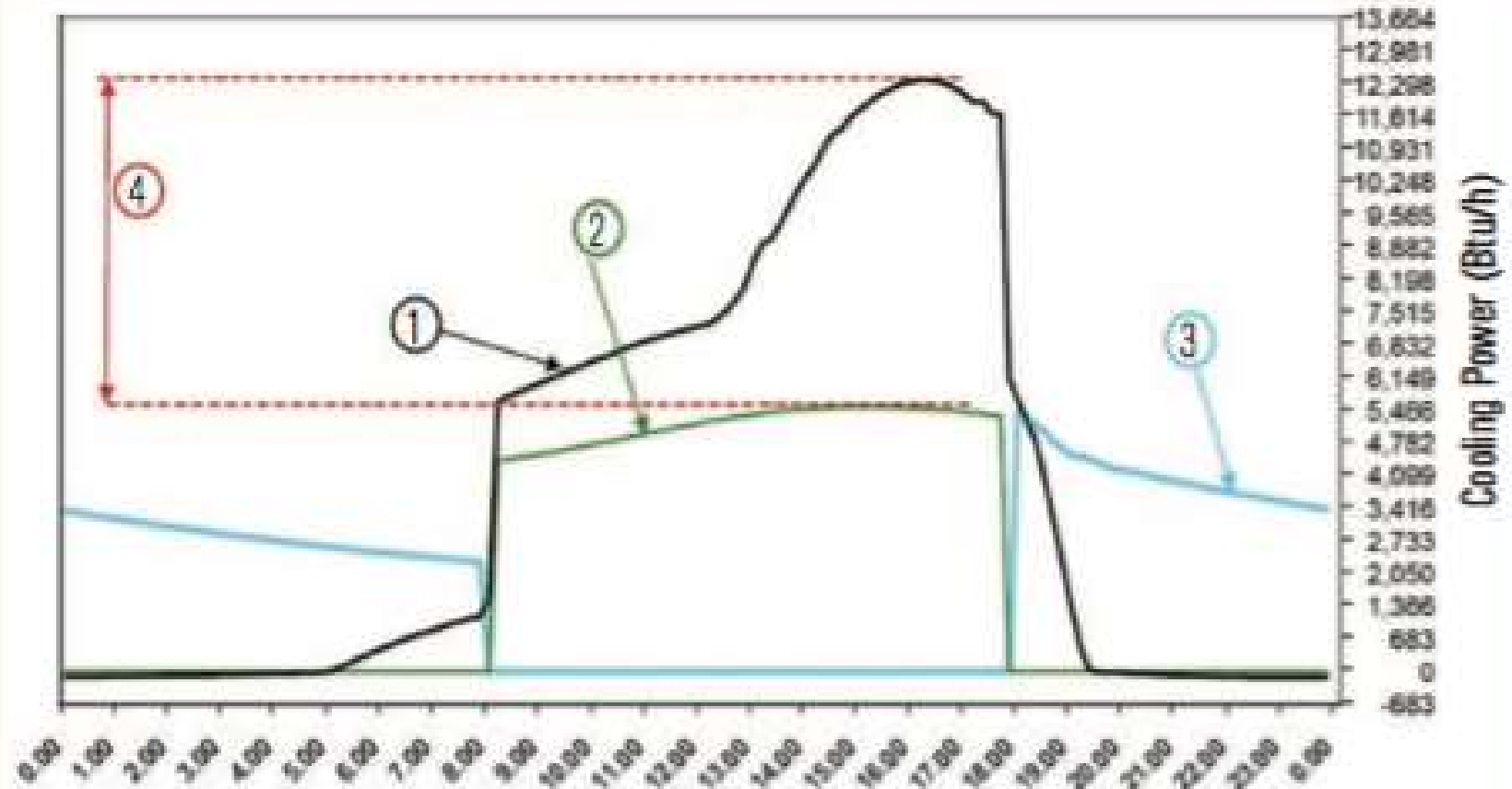
TABS



# Radiant cooling offers savings too



# Peak-shaving with TABS



1 = Heat Gain

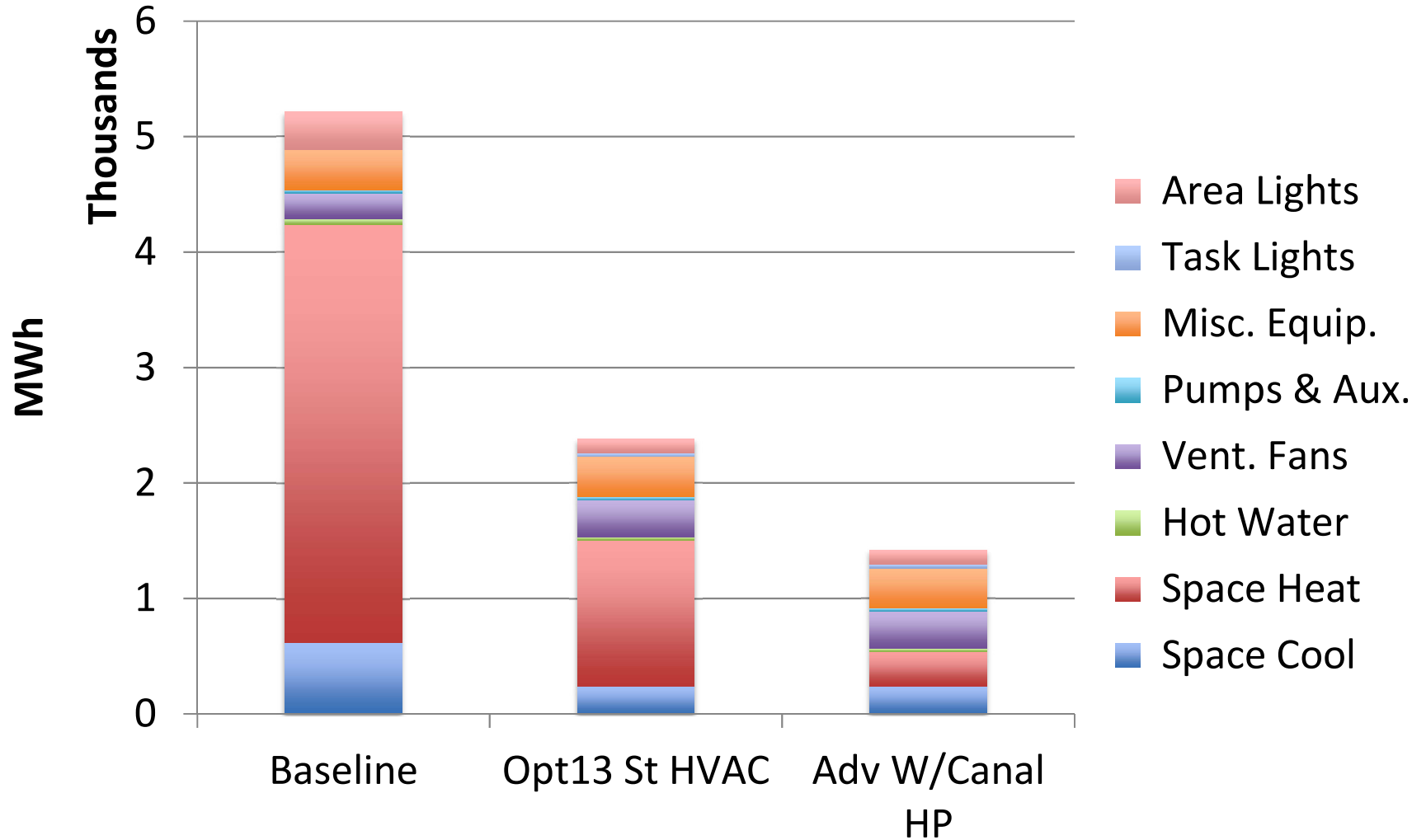
2 = Power Needed for Conditioning the Ventilation Air

3 = Power Needed on Water Side

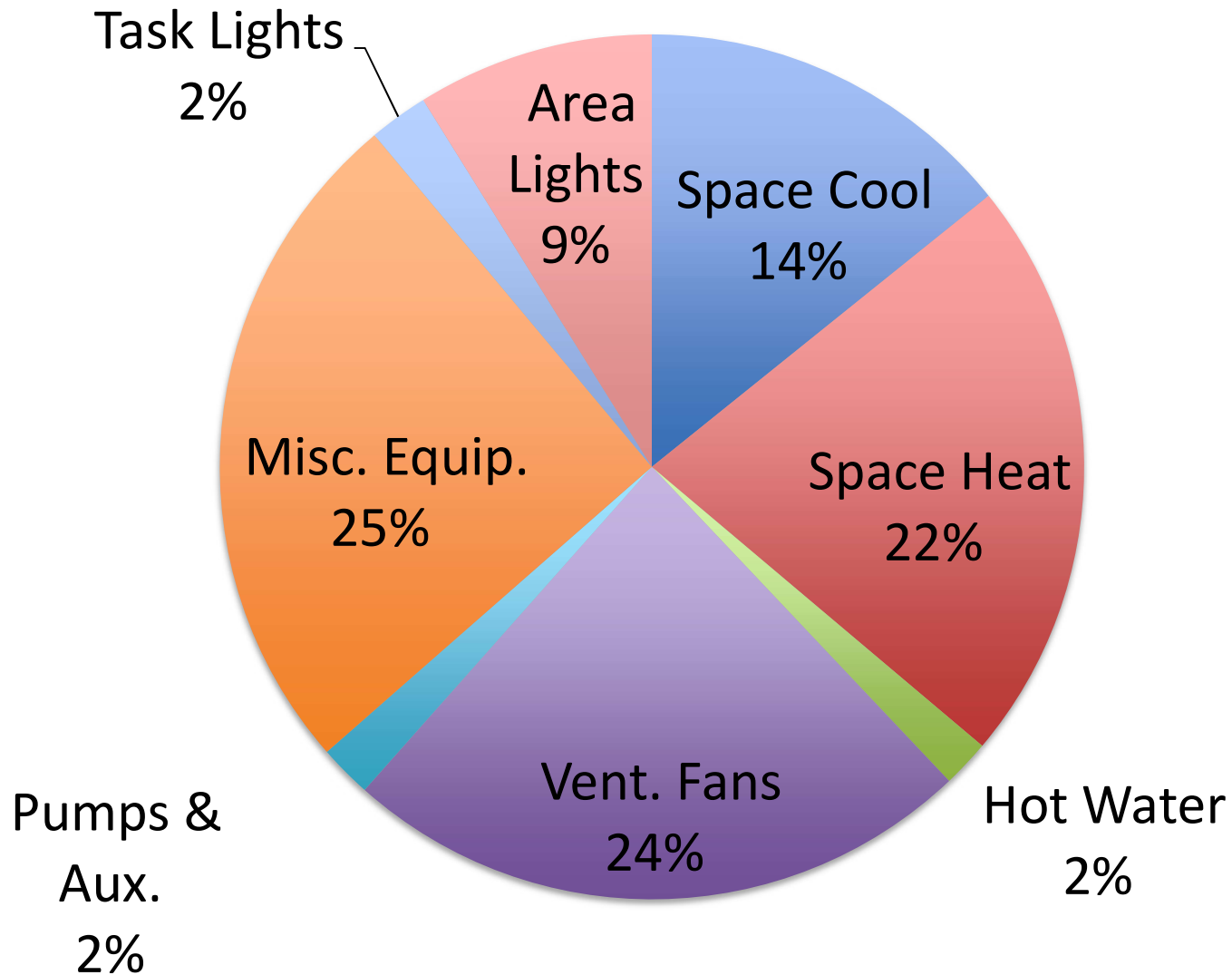
4 = Peak Heat Gain Reduction

FIGURE 8 Example of peak-shaving (reducing the peak load) effect (time vs. cooling power).<sup>17</sup>

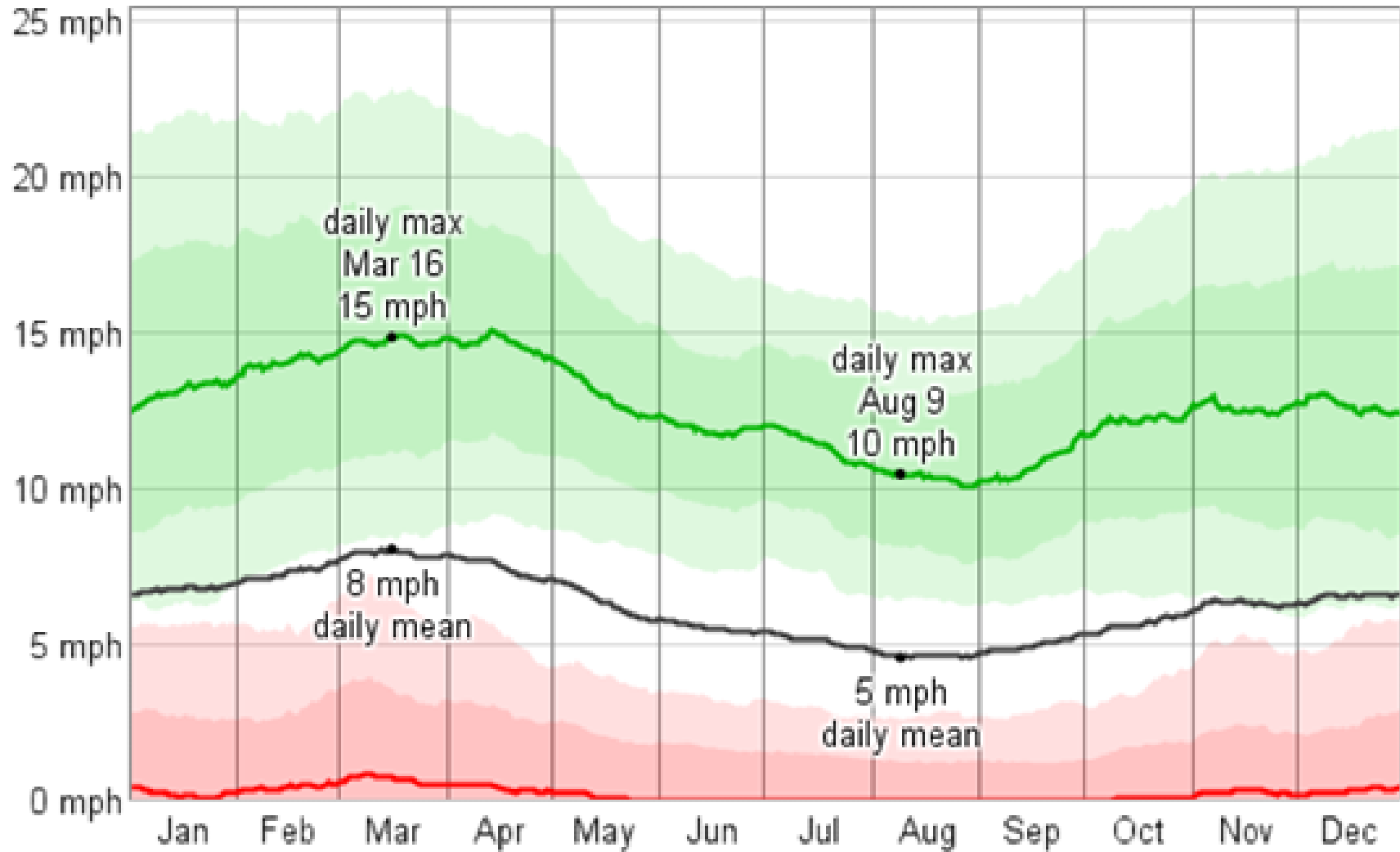
# Baseline, vs. conventional HVAC advanced envelope, vs. canal heat exchange



## Option 13 envelope, economizer, night flush, canal heat exchange



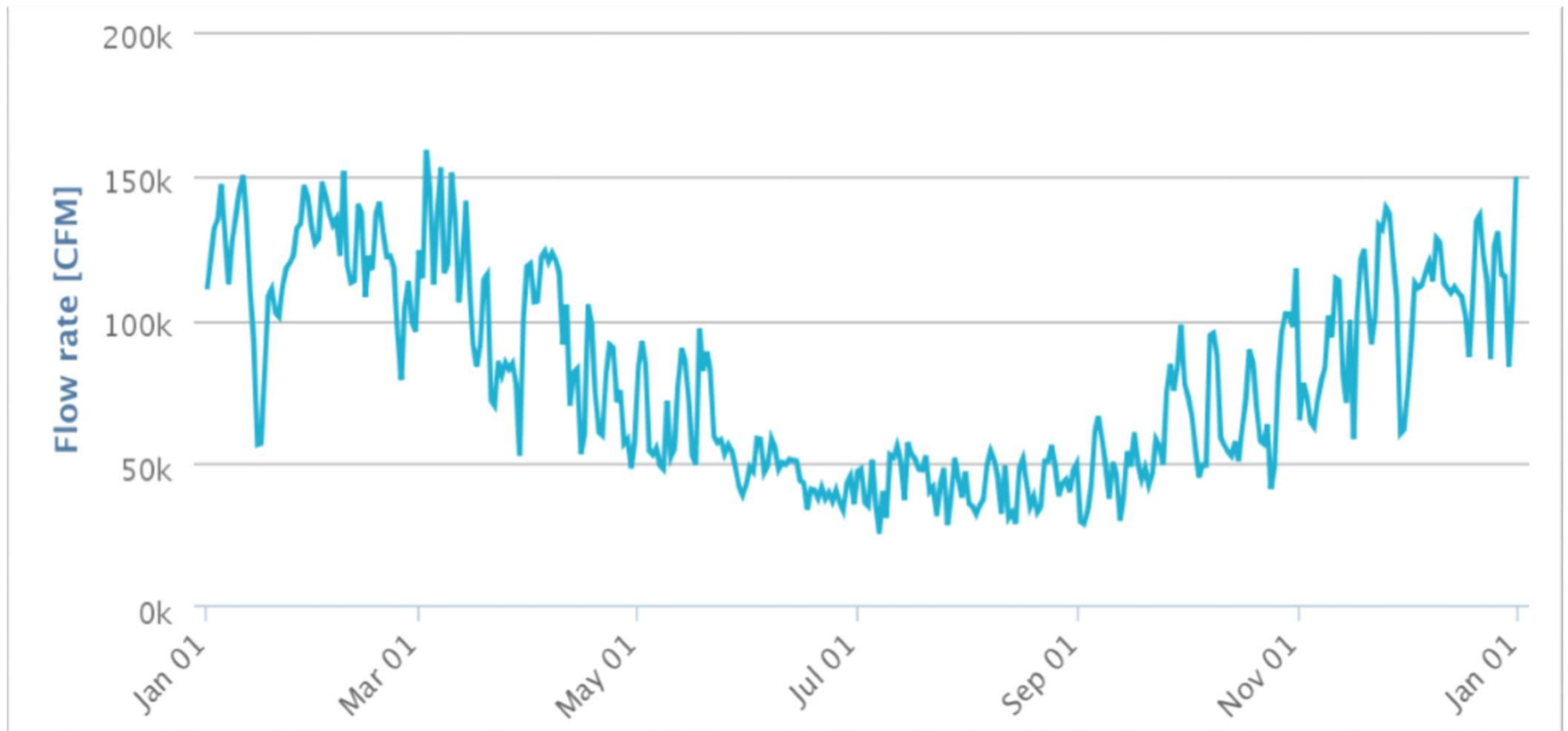
# Wind speeds in Holyoke



smoke  
stacks



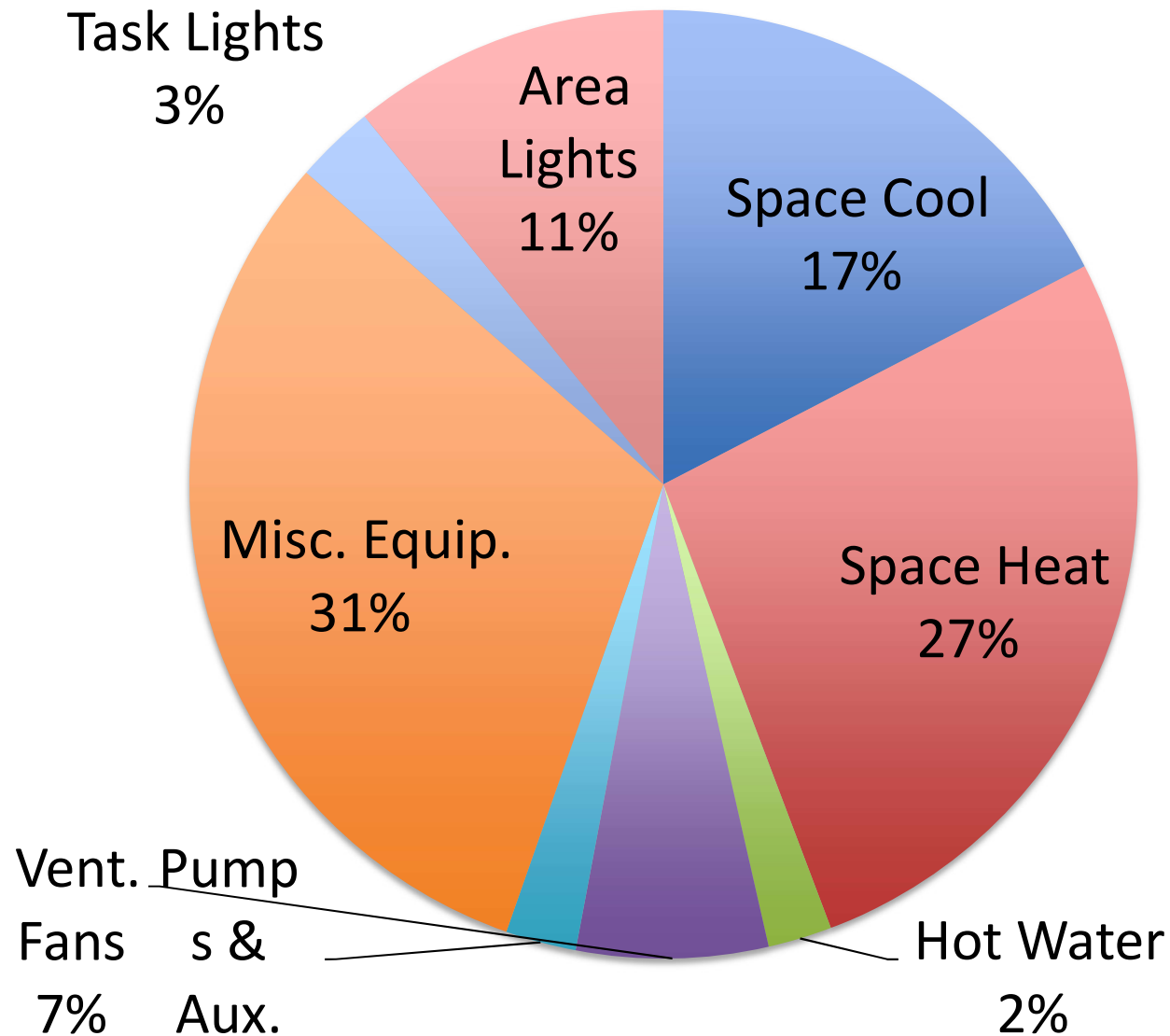
# Stack effect generated ventilation potential

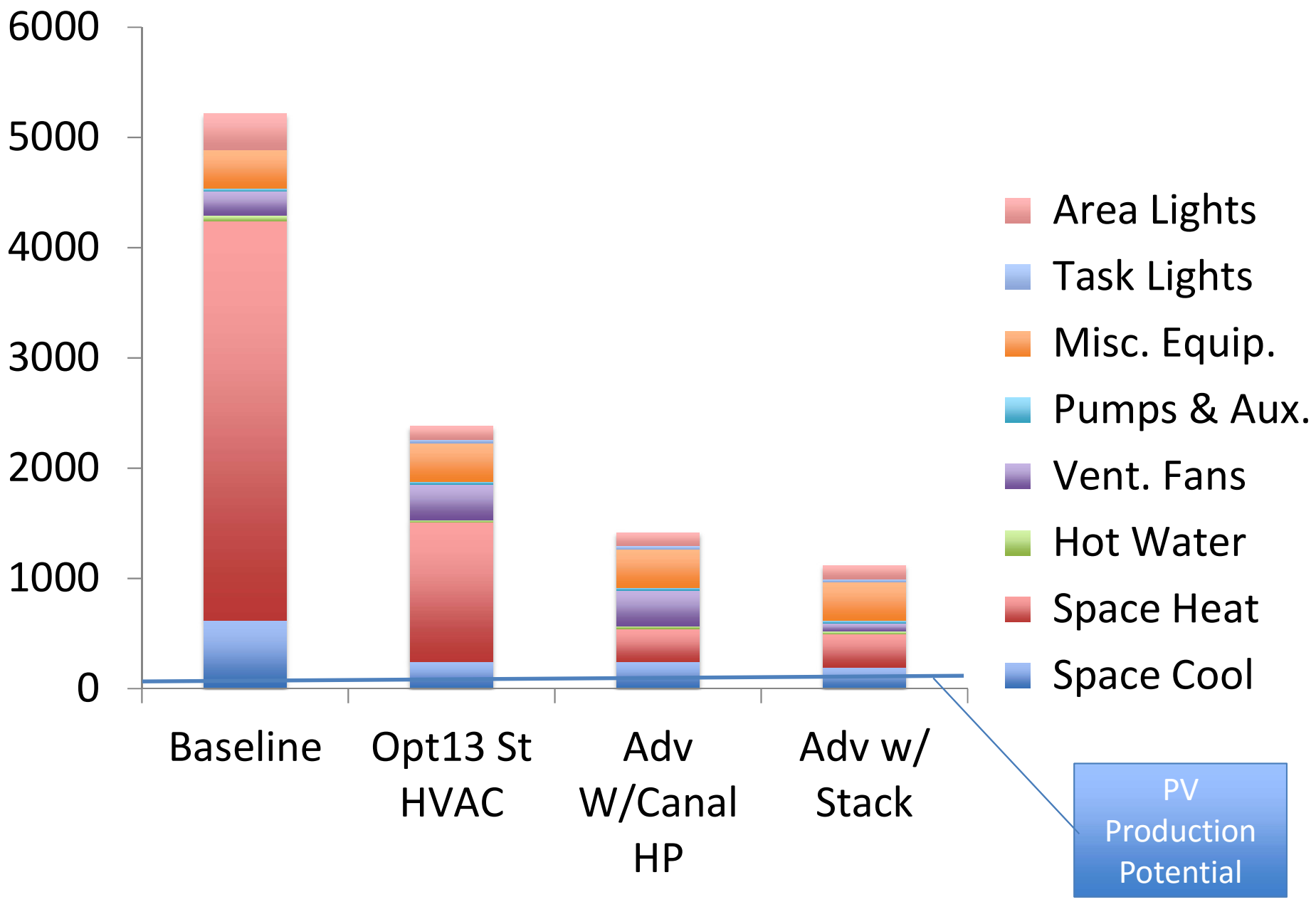


*Image generated with Residential Energy Dynamics, 2016*



# Option 13 envelope, economizer, night flush, canal heat exchange, stack vent





# Historical Commission

- Design waivers
- Pre-approved designs
- Clarity about acceptable exteriors
- Definition of “visible from a public way”

**recessed  
windows  
with  
vertical fin  
solar  
defense for  
Northwest  
facing  
windows.**



# Trombe Wall Façade Rendering



# Exterior Insulation and new claddings



# Thanks

- Marcos Marrero
- Sarah LaRose
- Jim Lavalle

**WoodWorks™**



**Providing Market Education  
and Design Resources  
for Wood Construction**





# Resources For You

- Education Events
- Design Tools
- Case Studies
- Help Desk



Woodworks provides education, resources and technical support related to the design of the non-residential and multi-family wood buildings.

Technical Support

Events

Design Tools

Design with Wood

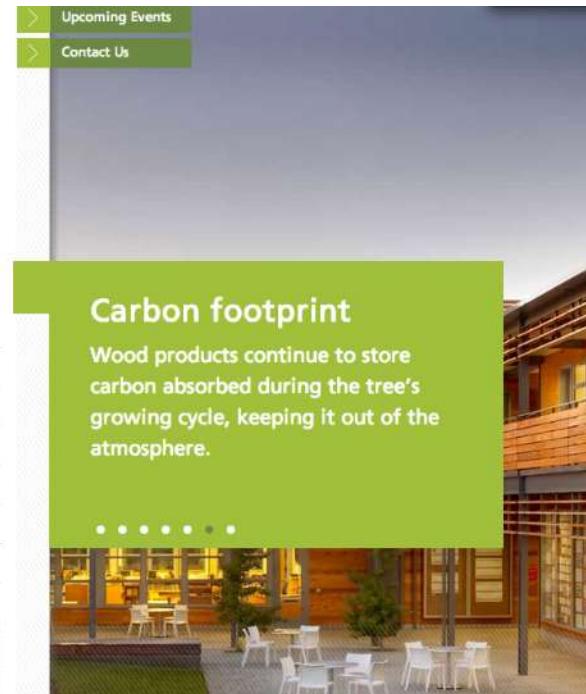
Why Wood?

US Wood Design Awards

Education & Publications

About WoodWorks

Google™ Custom Search



[www.woodworks.org](http://www.woodworks.org)

# Project Support and Technical Assistance

- Schools
- Mid-rise/multi-family
- Commercial
- Corporate
- Franchise
- Retail
- Institutional
- Recreational
- Healthcare





# Why Wood?

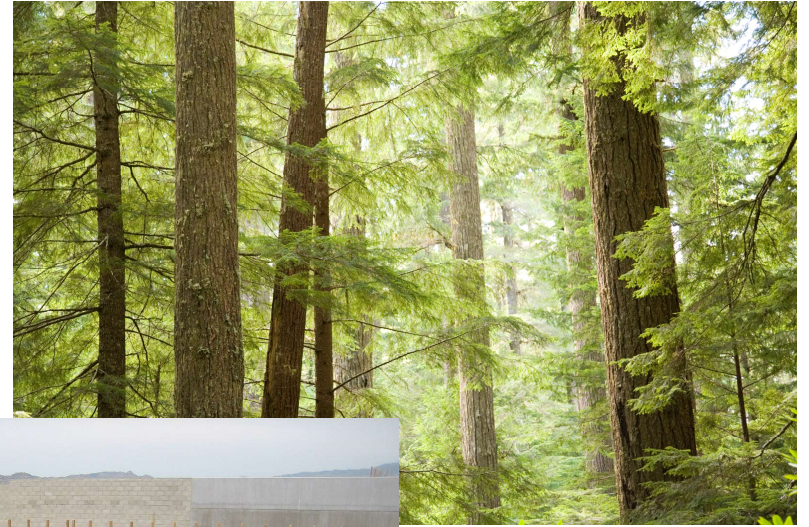
Wood Costs Less

Wood is Versatile

Wood Meets Code

Wood is Durable

Wood is Renewable



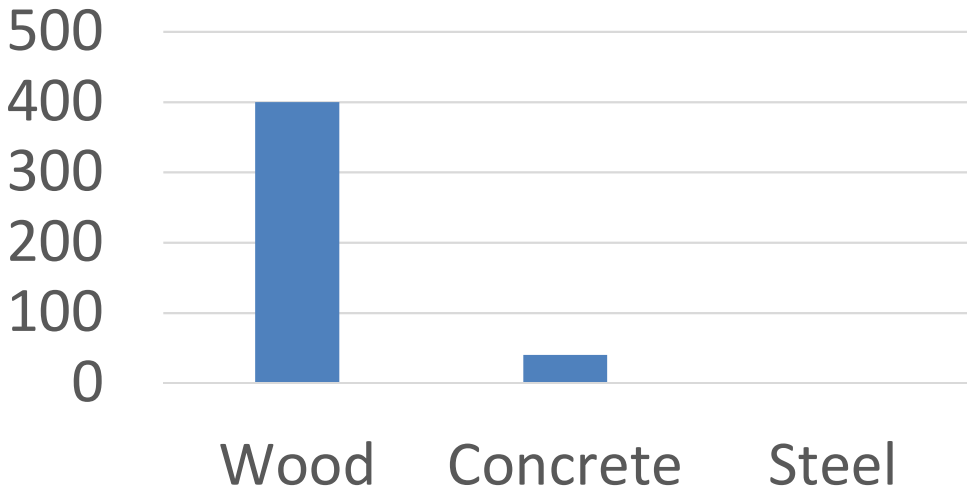
Using Wood Helps Reduce Your Environmental Impact

Wood Products Play a Significant Role in Modern Economy

# Energy Performance

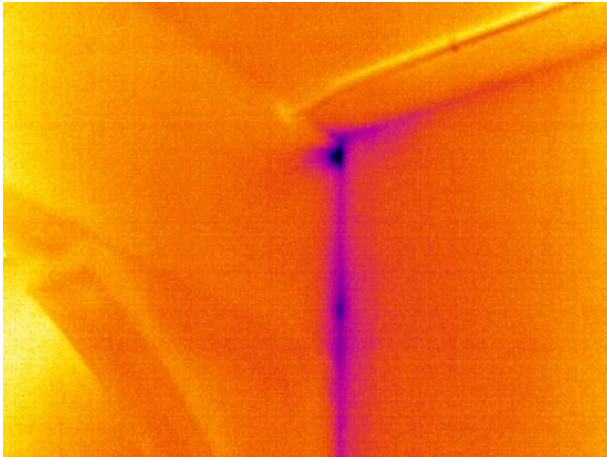
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## Thermal Resistance



\*Normalized Comparison

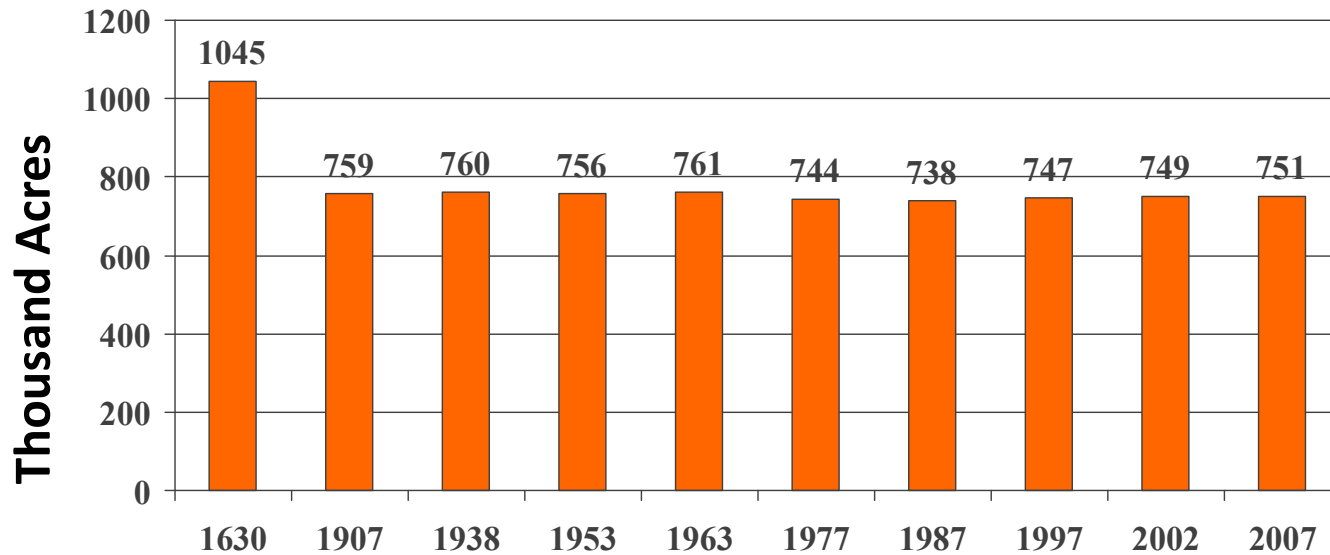
Source: *Thermal Performance of Light framed Systems, CWC*



# US Forest Land

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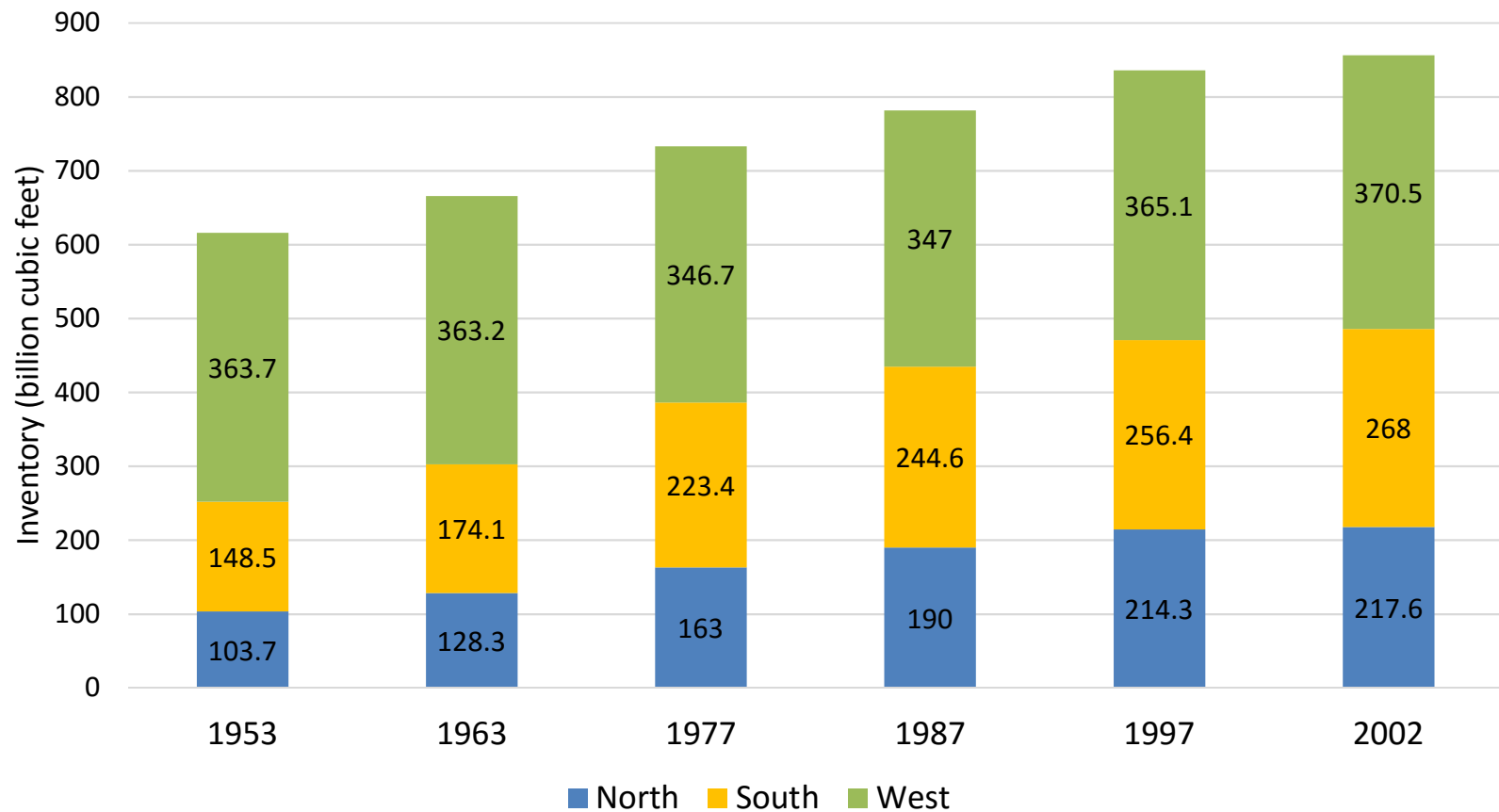
## Forest Area in the United States 1630-2007



Source: USDA-Forest Service, General Technical Report WO-78. (2009).

# US Forest Land

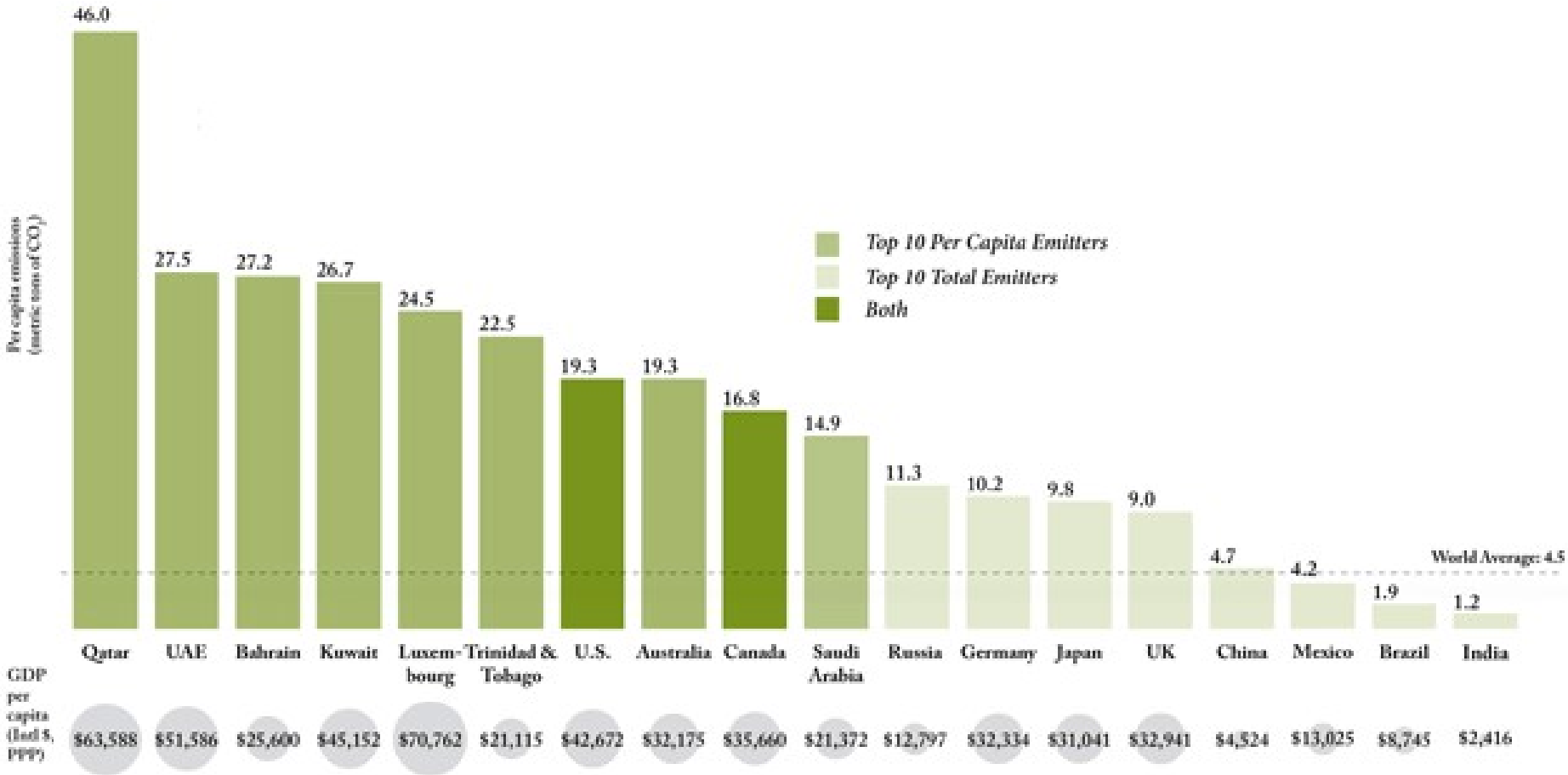
## US Timber **Volume** on Timber Land



Source: USDA-Forest Service, *US Forest Resource Facts and Historical Trends FS-801*. (2004).

# US Contributes Highly to World Emissions

Per Capita CO<sub>2</sub> Emissions and Per Capita GDP for the Top Ten Total Emitters and Top Ten Per Capita Emitters, 2006



Data Source & Notes: WRI, CAIT (2009). Qatar GDP per capita estimate is for 2005; all other data presented are for 2006.

# Sustainable Forestry Carbon Cycle





# LCA of Materials: Carbon Emissions

	USEPA (2006)	USEPA (2006)
Material	Process Emissions (kg CO <sub>2</sub> e/ kg of product)	Process Emissions Including Carbon Storage within Material (kg CO <sub>2</sub> e/ kg of product)
Framing lumber	0.12*	-1.68
Concrete	0.12	0.12
Concrete block	0.14	0.14
Brick	0.32	0.32
Medium density fiberboard (MDF)	0.32	-1.47
Recycled steel (avg recy content)	0.81	0.81
Glass (not including primary mfg.)	0.57	0.57
Cement (Portland, masonry)	0.97	0.97
Recycled aluminum (100% recycled content)	1.13	1.13
Vinyl	--	1.00
Steel (virgin)	2.55	2.55
Aluminum (virgin)	16.60	16.60

Carbon content of 49% assumed for wood. (measured values range from about 47-52%)

Source: 2006 US EPA Database

# Mass timber products

Nail-Laminated Timber (NLT)



Cross-Laminated Timber (CLT)



horizontal framing

Glue-Laminated Timber (GLT)



Tongue & groove decking (T&G)



Timber concrete composite



Structural composite Lumber



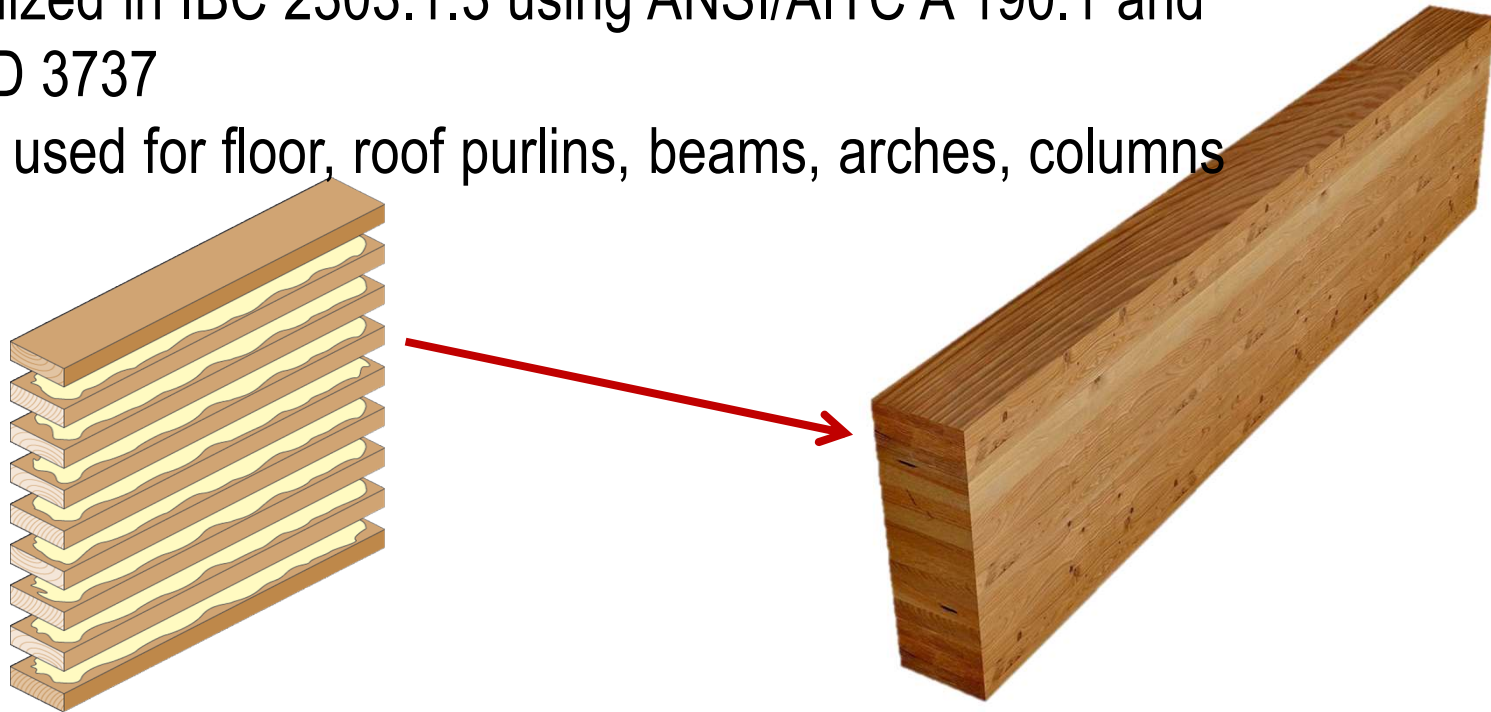
Image source: structurecraft

# Mass timber products

glulam

**Glulam** = a structural composite of lumber and adhesives

- Recognized in IBC 2303.1.3 using ANSI/AITC A 190.1 and ASTM D 3737
- Can be used for floor, roof purlins, beams, arches, columns



# Flexibility of spans and shapes



Richmond Olympic Oval, Richmond, BC, Canada

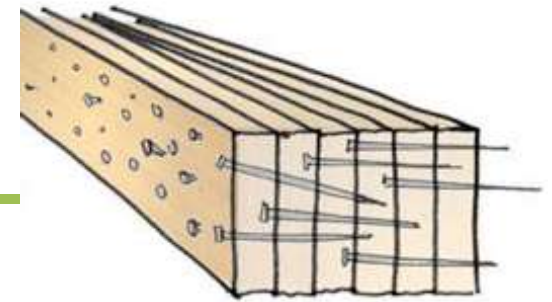
Design Team: Cannon Design Architecture, Fast + Epp, Glotman Simpson

Photo Credit: Stephanie Tracey, Craig Carmichael, Jon Pesochin, KK Law

Creative, Ziggy Welsch

# Solid Timber Panel Products

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## Considerations:

Requires accommodation for dimensional change

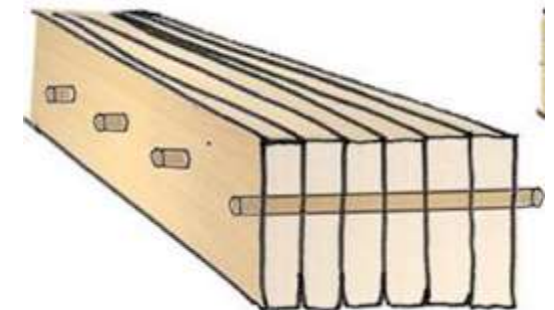
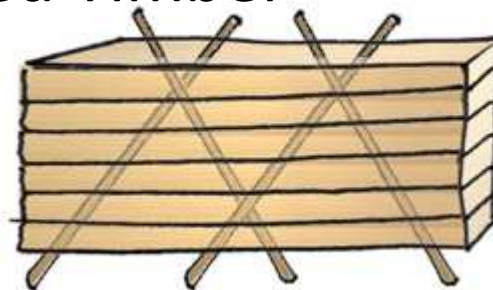
Need wood structural panel for diaphragm capacity

Recognized as a heavy timber floor system

- Long history of use



## Nail Laminated Timber



# Bullitt center

Seattle, wa



Photo Credit: bullitt center

# Solid Timber Panel Products

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Cross Laminated Timber

## Considerations:

- Span usually governed by vibrations
- Dimensionally stable
- Recognized by 2015 codes and standards
- High in plane shear capacity
- Dual Directional span capabilities

# Umass design building

Amherst, ma



Image Credit: Leers Weinzapfel Associates



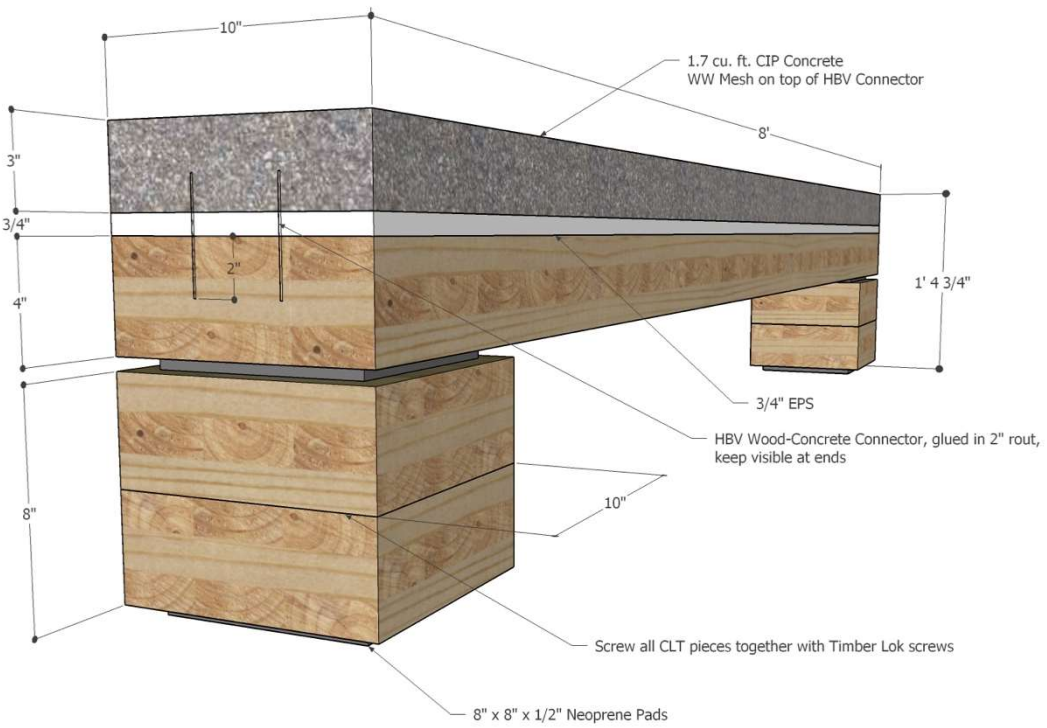
# Umass design building

Amherst, ma

Currently under construction, expected  
opening date: January 2017.

Photo Credit: alex schreyer





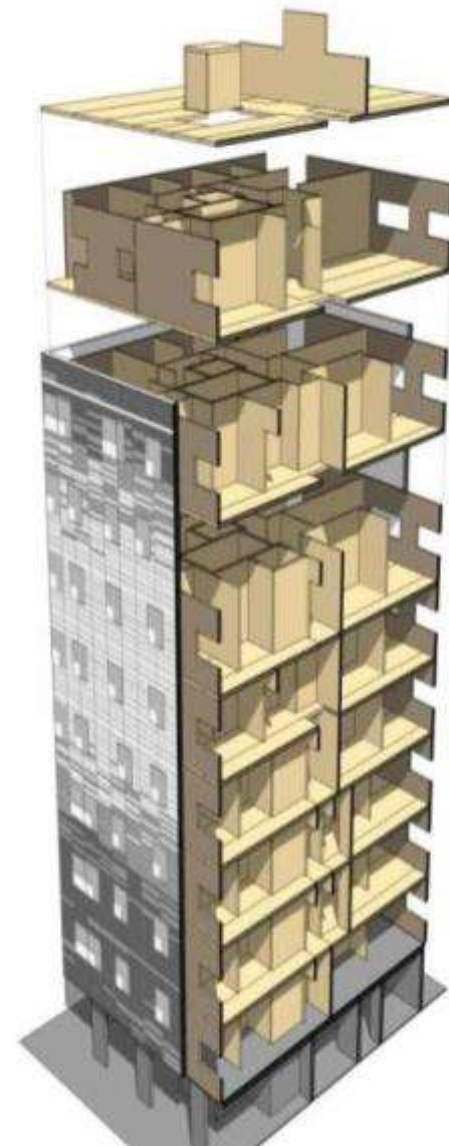
CLT Panels utilized in floor systems with composite concrete topping slab



UMASS Integrated Building Design Image: [UMASS Building and Construction Technology](#)

# Carbon Reduction

<b>Volume of wood used</b>	950 m <sup>3</sup>
<b>Carbon sequestered and stored (CO<sub>2</sub>e)</b>	660 metric tons
<b>Avoided greenhouse gases (CO<sub>2</sub>e)</b>	225 metric tons
<b>Total potential carbon benefit (CO<sub>2</sub>e)</b>	915 metric tons



**Carbon savings from the choice of wood in this one building are equivalent to:**



175 passenger vehicles off the road for a year



Enough energy to operate a home for 79 years

Stadhaus, London, UK

Architect: Waugh Thistleton Architects

Photo credit: Waugh Thistleton Architects

# Government Support

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- “Building stronger markets for innovative wood products will
  - **support sustainable forestry,**
  - **reduce green house gas emissions, and**
  - **put rural America at the forefront of an emerging industry”**
    - *Tom Vilsack – Agriculture Secretary*