NESEA 2018

Multifamily Passive House: Controlling Internal Loads

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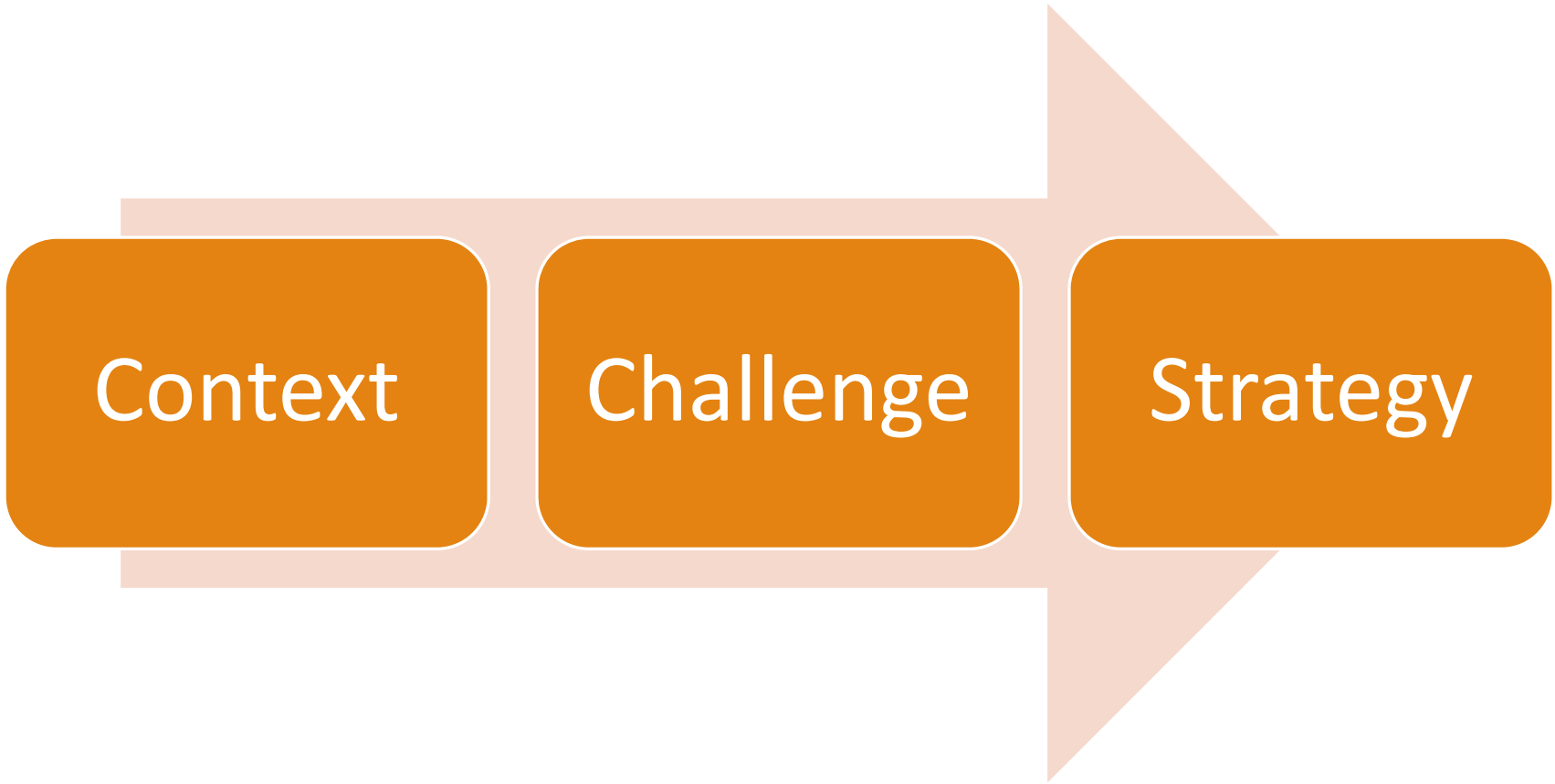
THE LEVY PARTNERSHIP


Context
Challenge
Strategy

URBANIZATION, DENSITY & ENERGY USE INTENSITY

Multifamily PH and Energy Use Intensity

Urban infill site decreases greenfield development

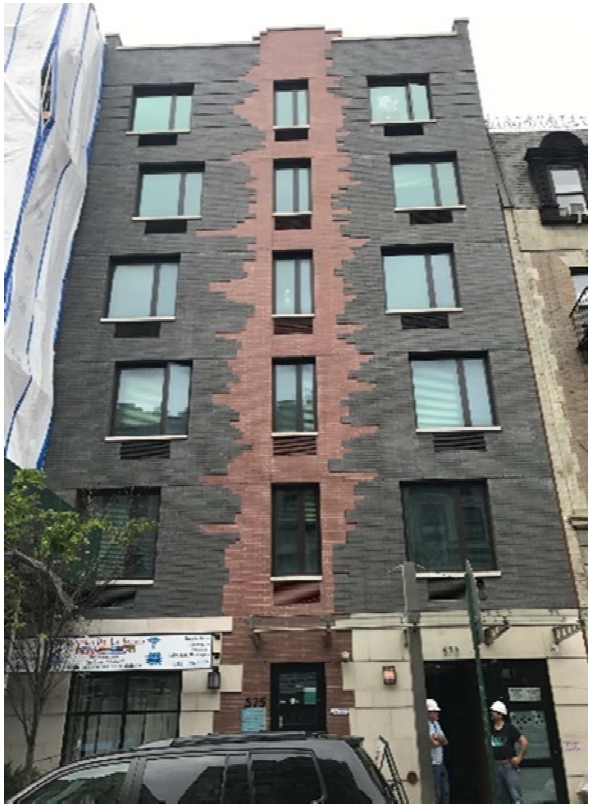
Increased urban density and low EUI are some of the benefits of the urbanization trend

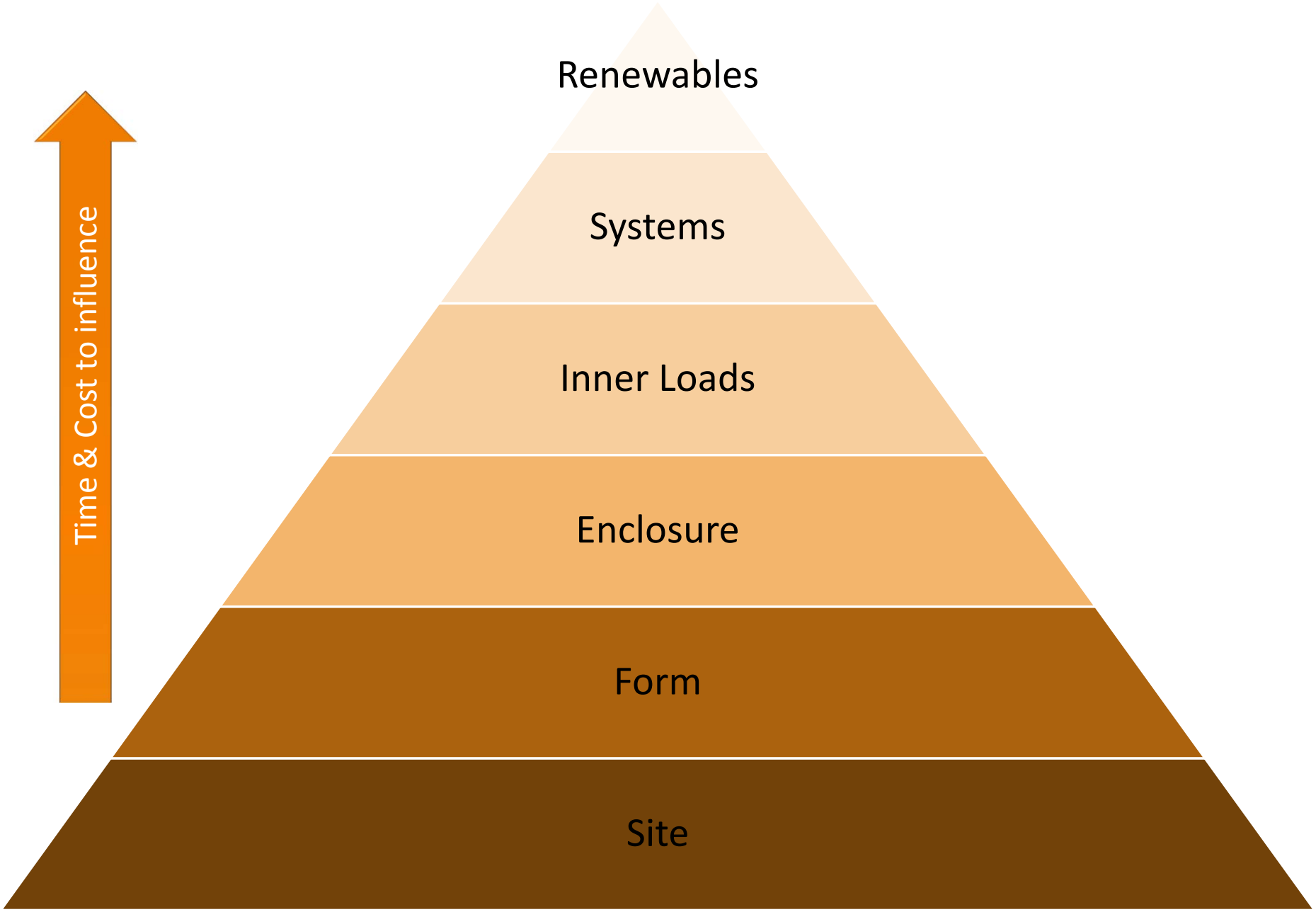
Multifamily PH is an effective means to reduce EUI

Dense multifamily results in some added challenges for balancing heating and cooling loads in Passive House

*"Energy Use Intensity (EUI) is expressed as **energy** per square foot per year. It's calculated by dividing the **energy** consumed by the building in one year (kBtu or kWh) by the total gross floor area of the building."* (Energy Star, 2017)

Archetype

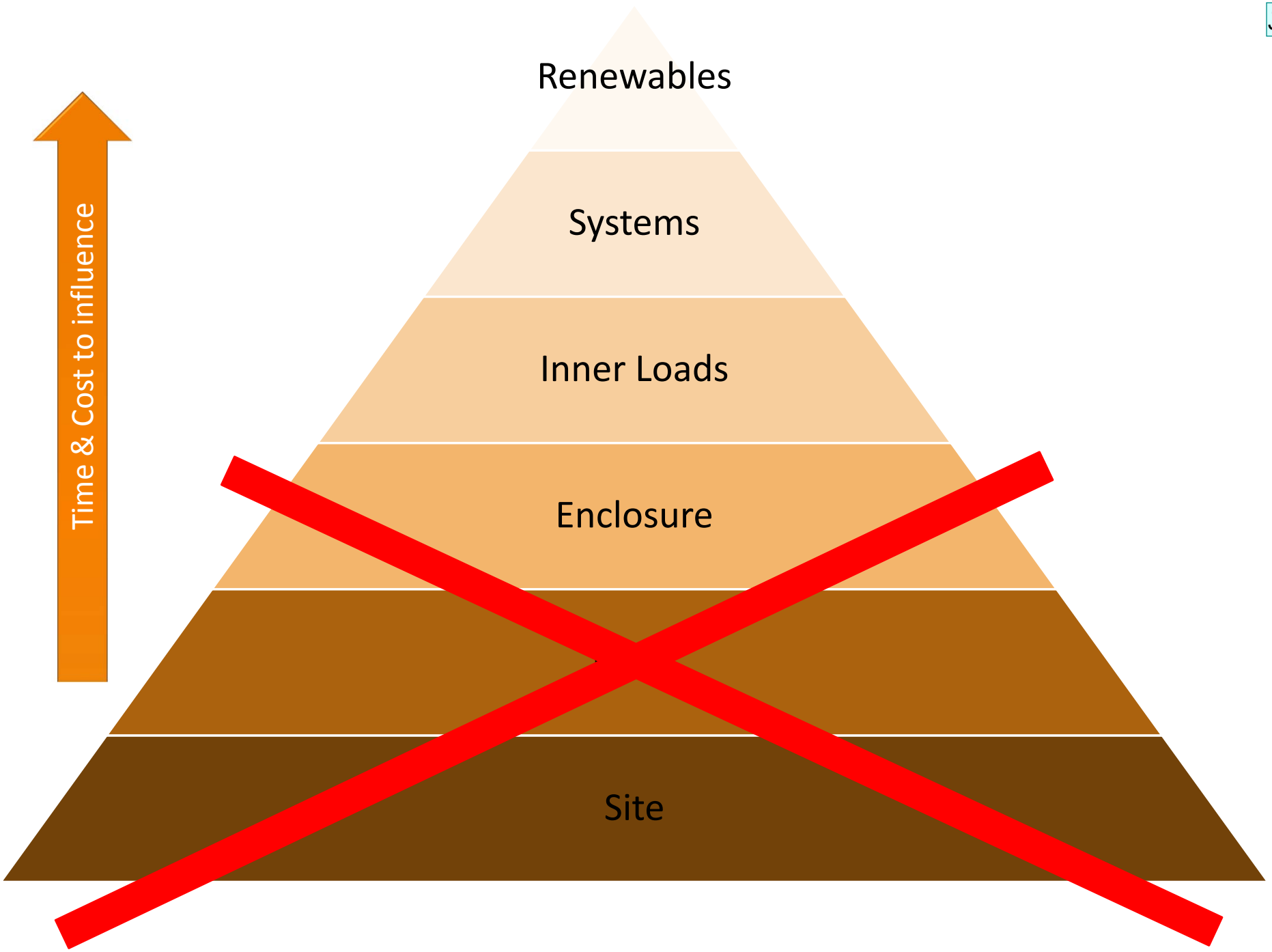



Time & Cost to influence
Renewables
Systems
Inner Loads
Enclosure
Form
Site


NO
PARKING


NO PARKING
ANYTIME

PASSIVE HOUSE SITE CONDITIONS


Renewables
Systems
Inner Loads
Enclosure
Site
Time & Cost to influence

Slide 11

JD2 animate? Andrew?
Jordan Dentz, 2/28/2018

Manage heating load/demand

Adiabatic site conditions make the heating demand and load easy to meet

…until you start tweaking to meet cooling targets

Approximate Ranges for Case Studies:	
Above grade wall	R 24-30
Roof	R 40-68
Slab	R 0-5.5
Below Grade Wall	R 5-18
Window	0.11 - 0.088 Btu/hr ft^2 F
Frame	0.13 - 0.20 Btu/hr ft^2 F
Frame to Wall Psi value	0.023 - 0.030
U-window Installed	0.14 - 0.15 Btu/hr ft^2 F
Solar Heat Gain Coefficient	0.38 - 0.47
Window to Wall ratio	12-20%

Prerequisites of PH Design

- Air-tight envelope

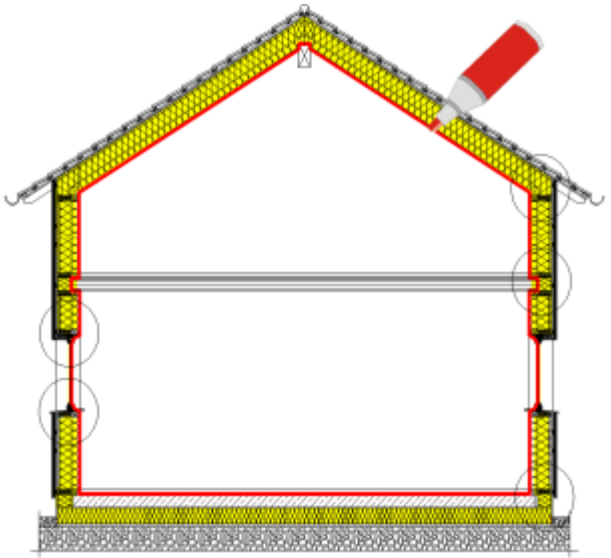


Image source: Passipedia

- Thermal-bridge-free construction

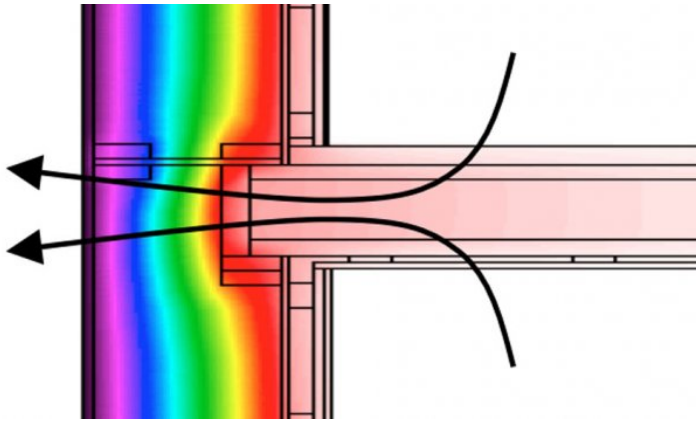


Image source: ecohome

ZK21

Passive House Criteria

PHIUS
Passive House Institute US

Heating Demand

Cooling Demand

Heating Load

Cooling Load

Primary Energy

Air tightness 0.08 CFM/ft^2

Passive House Institute

Heating Load

Cooling Load

OR

Heating Demand

Cooling Demand

Primary Energy

Air tightness 0.6 ACH50

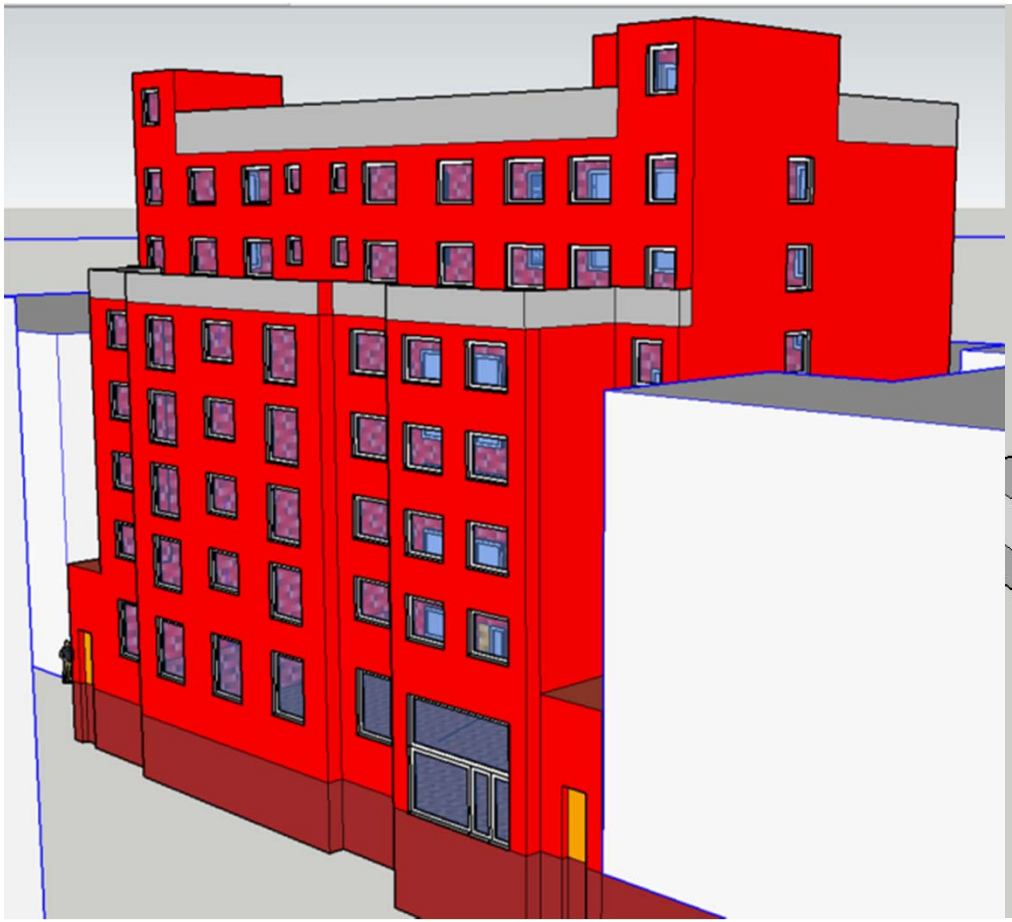
Slide 14

ZK21 Remove slide?
Zoe Kaufman, 3/7/2018

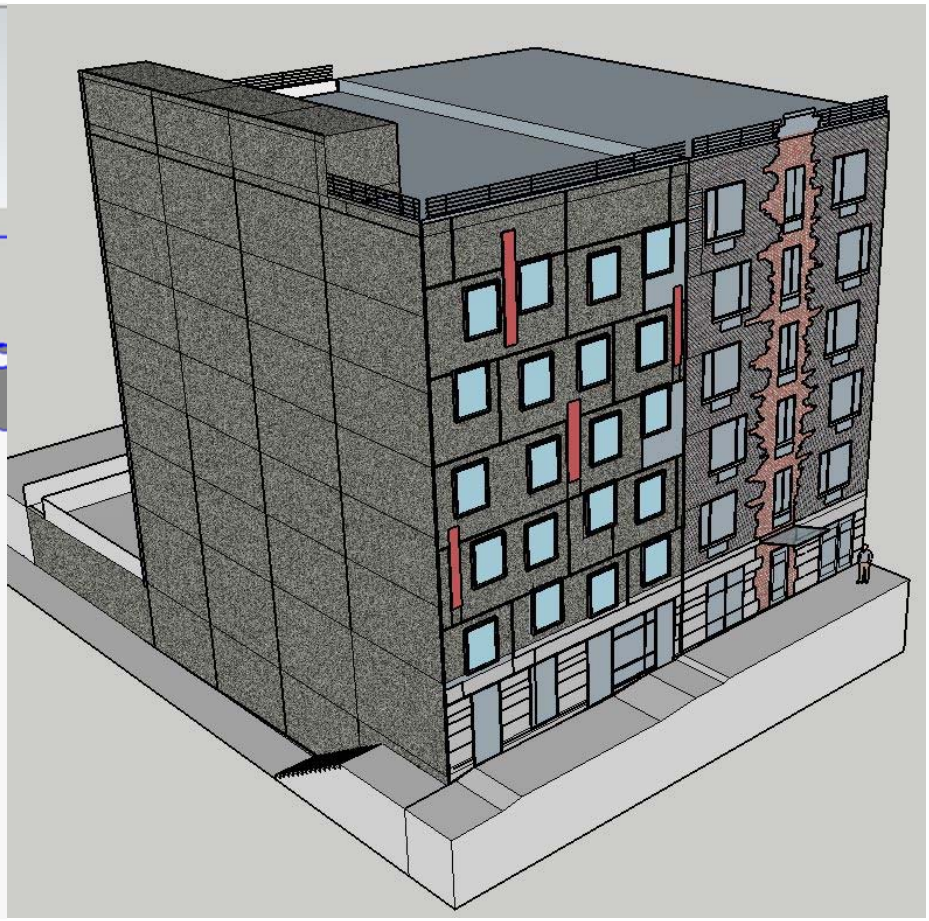

The Challenge
BALANCING HEATING & COOLING DEMAND

Multifamily PH Projects

PHI

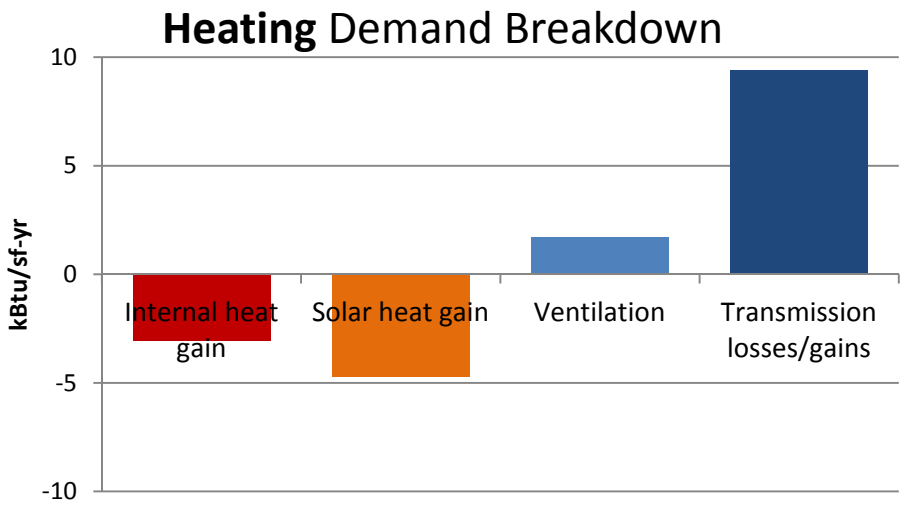


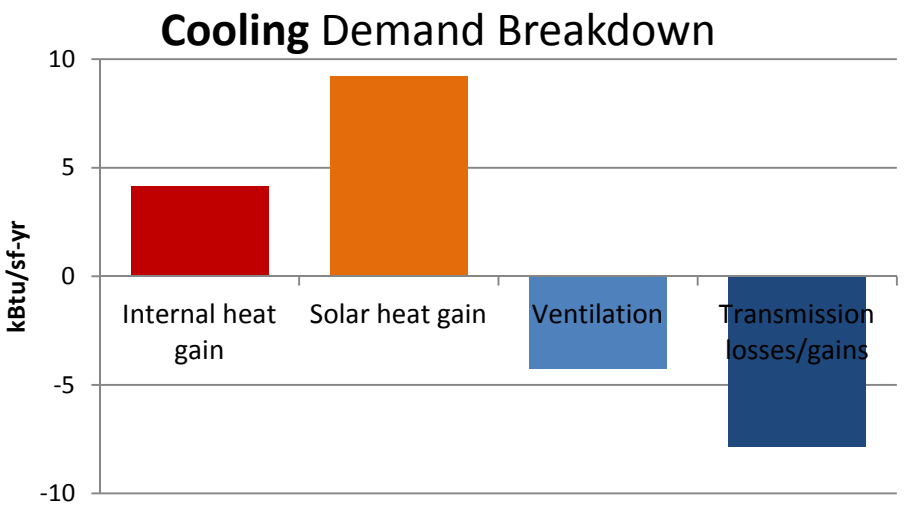
PHIUS



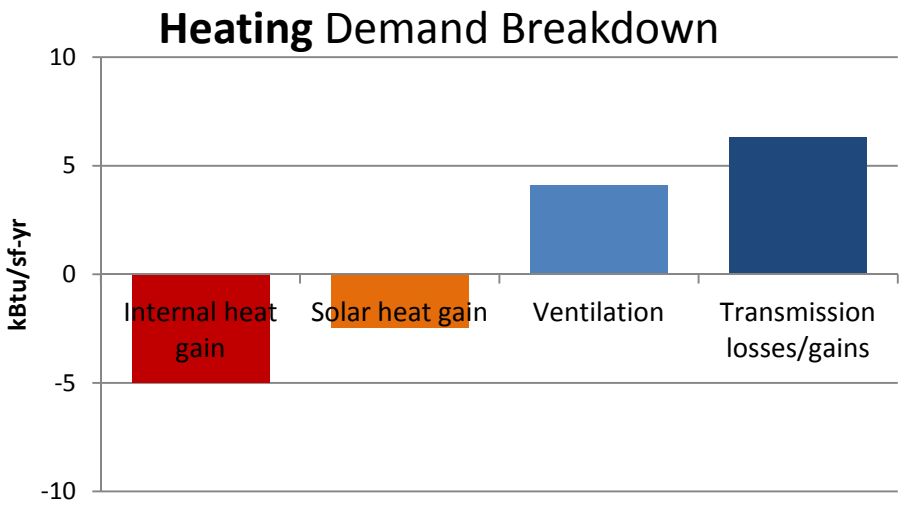
The Role of Internal Gains

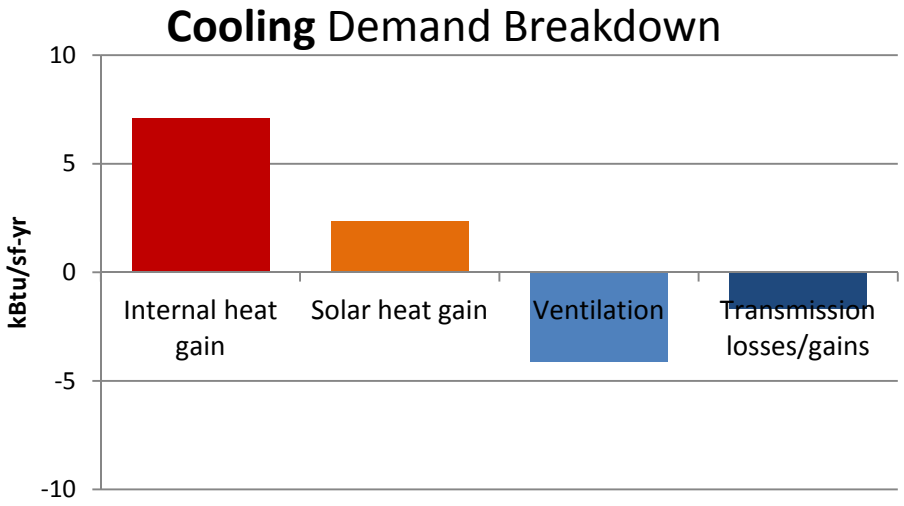
Single-Family Passive





Multifamily Passive

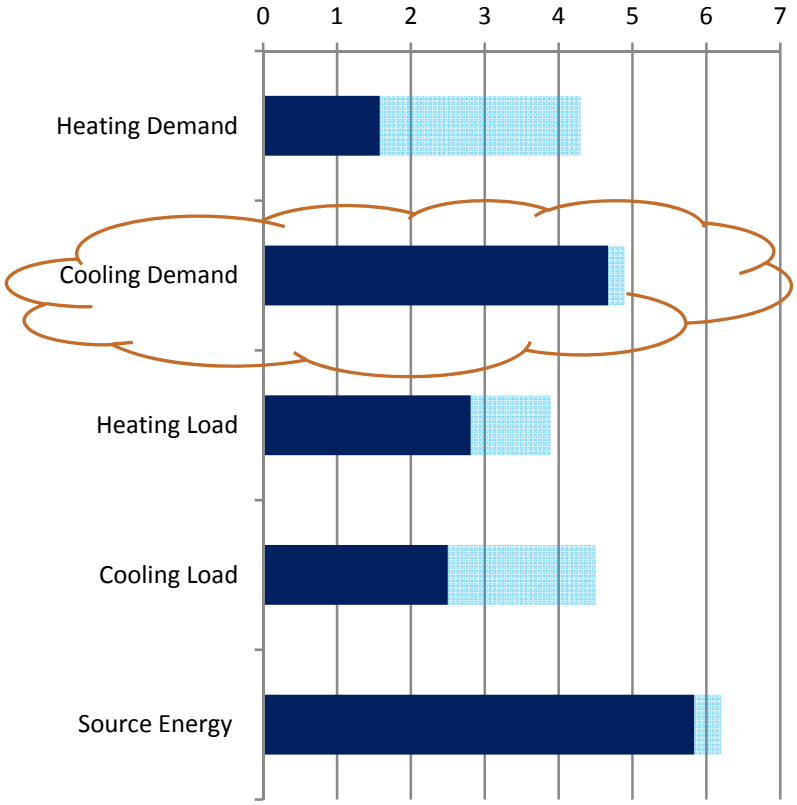




Heating and Cooling Balance: **PHIUS** Small Building Example

Pre-certified energy model indicates that **cooling demand** is the toughest threshold

- Heating Demand: 4.3 kBtu/ft^{2}yr
- Cooling Demand: 4.9 kBtu/ft^{2}yr*
- Heating Load: 3.9 Btu/hr ft^2
- Cooling Load: 4.5 Btu/hr ft^2
- Source Energy: 6200 kWh/per/yr



Modeled Space Conditioning Energy

Required Space Conditioning Energy

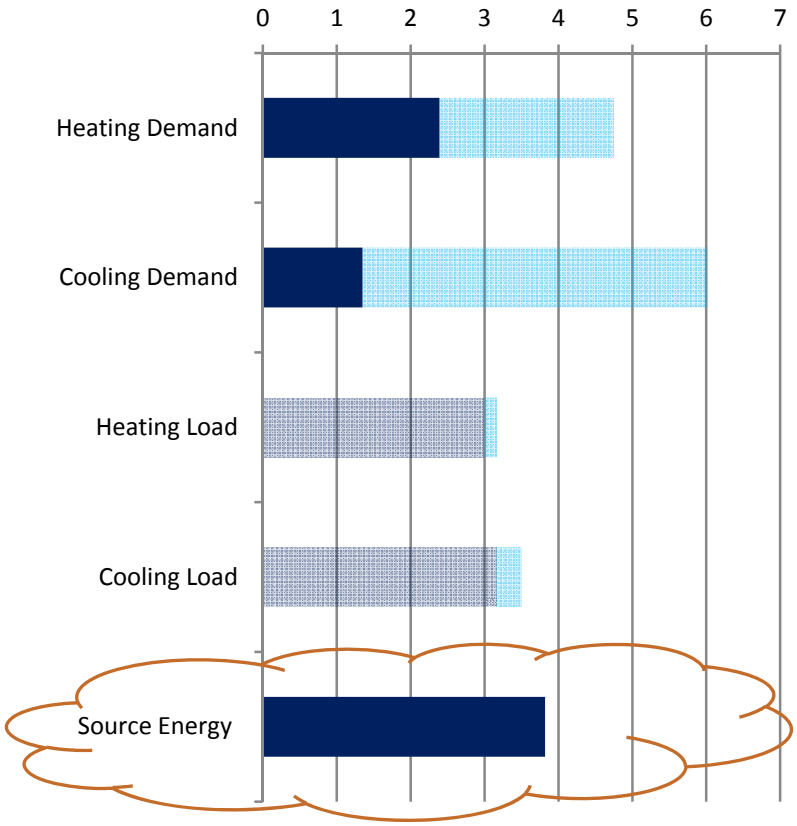
Overage of Space Conditioning Energy

Heating and Cooling Balance: **PHI** Large Building Example

Energy model indicates that **primary energy** is the toughest threshold

- Heating Demand: 4.75 kBtu/ft^{2}yr
- **OR** Heating Load: 3.17 Btu/hr ft^2
- Cooling Demand: 6.02 kBtu/ft^{2}yr
- **OR** Cooling Load: 3.50 Btu/hr ft^2
- Source Energy: 38 kBtu/sf-yr*

*Graphed as Btu/sf-yr * 10^4



Modeled Space Conditioning Energy

Required Space Conditioning Energy

Overage of Space Conditioning Energy


CONCEPT
PLAN
TEAM
innovation
45% is SALE!
idea
plan
activities
analisis
PRODUCT
CONSUMERS
INTERNET
SUCCESS!
THINK OUTSIDE THE BOX
WORK
motivation
75%
Success!
LOADING TO SERVER
MAIN
A. ASIA
B. INDIA
C. USA

STRATEGIES

Manage heat gains through building envelope

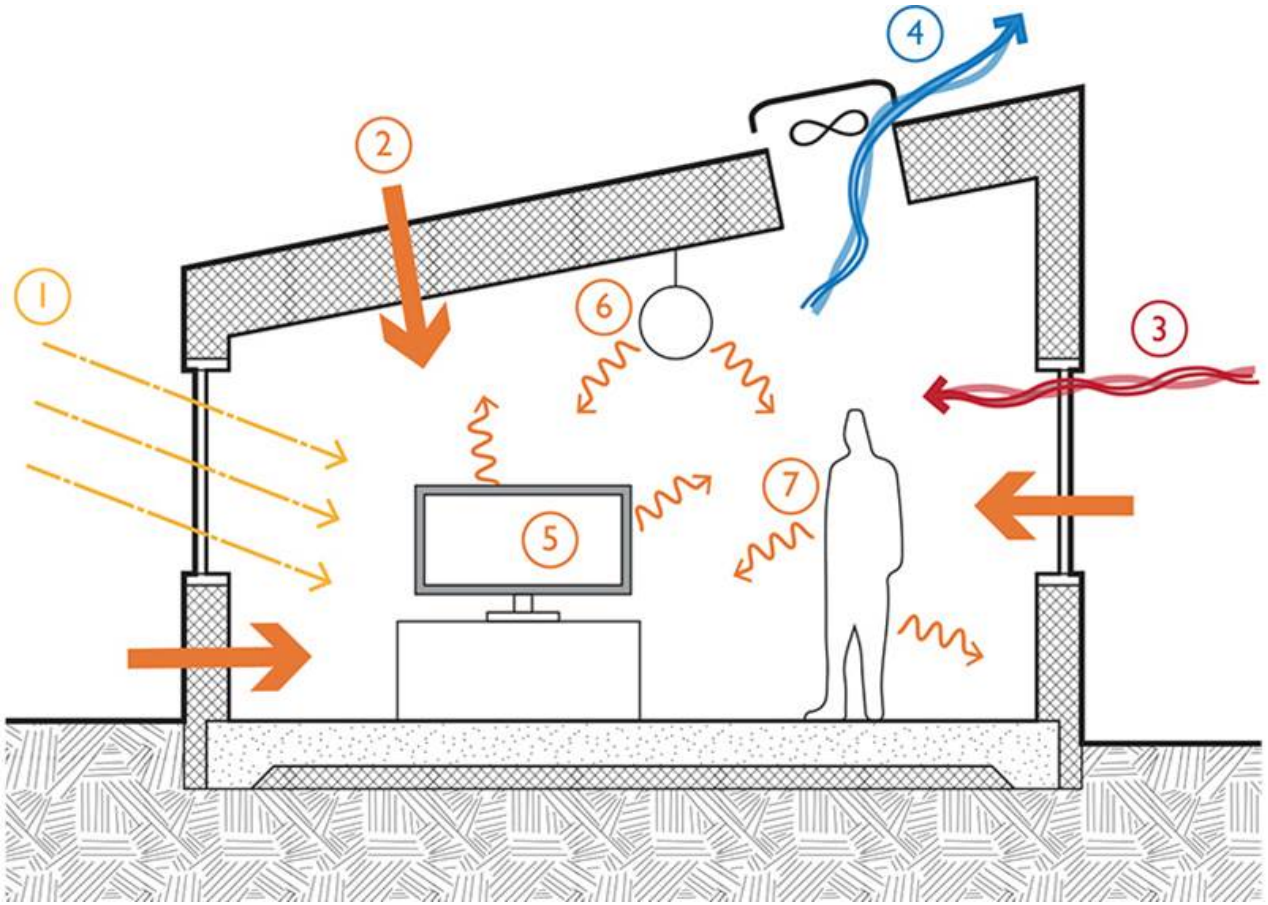
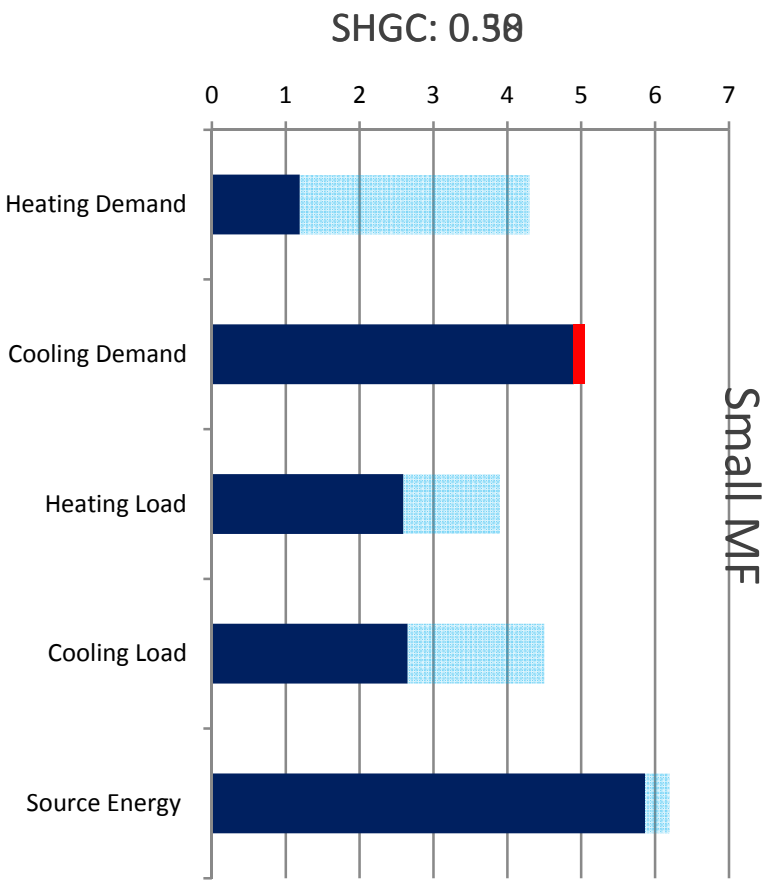
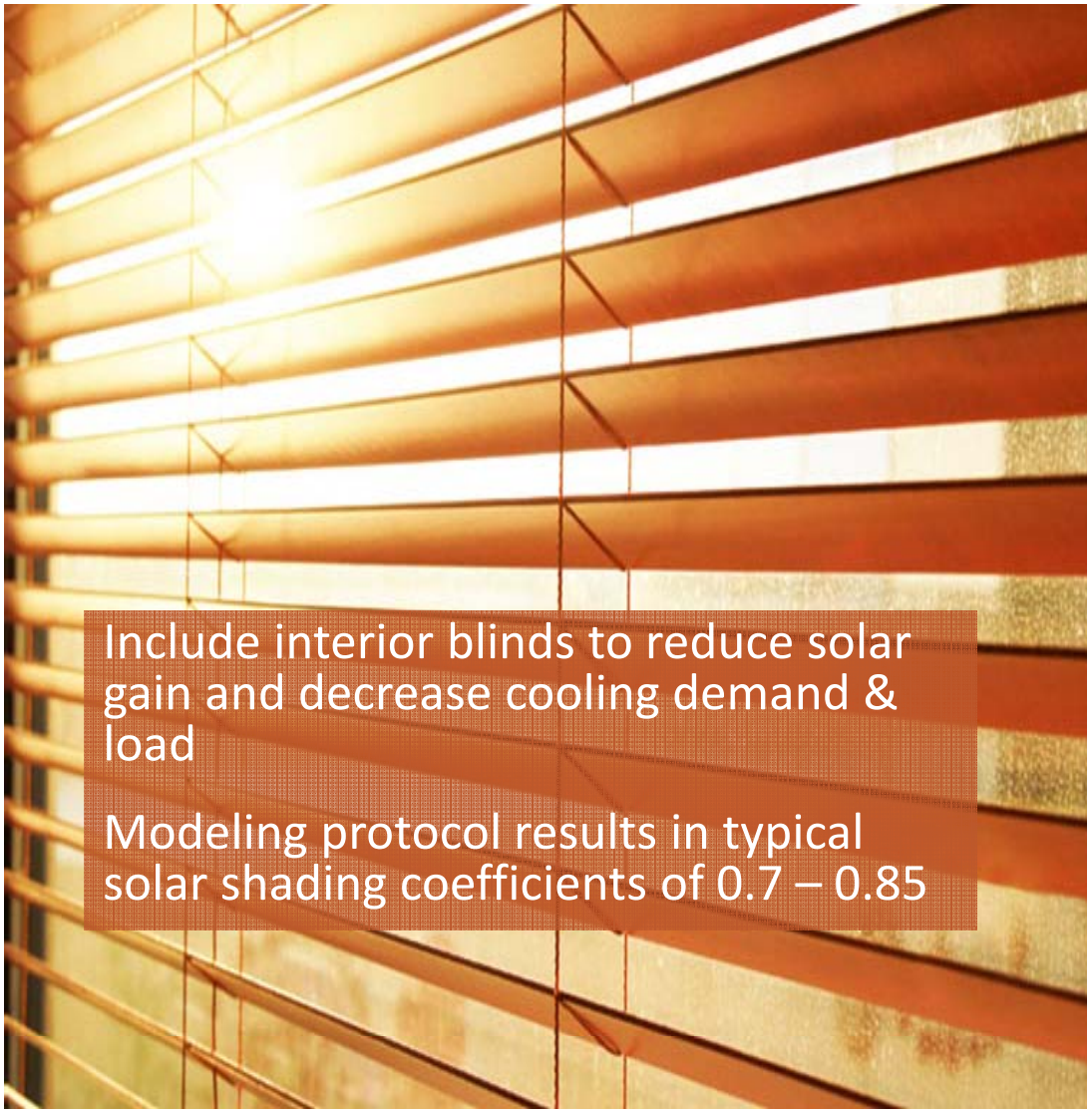


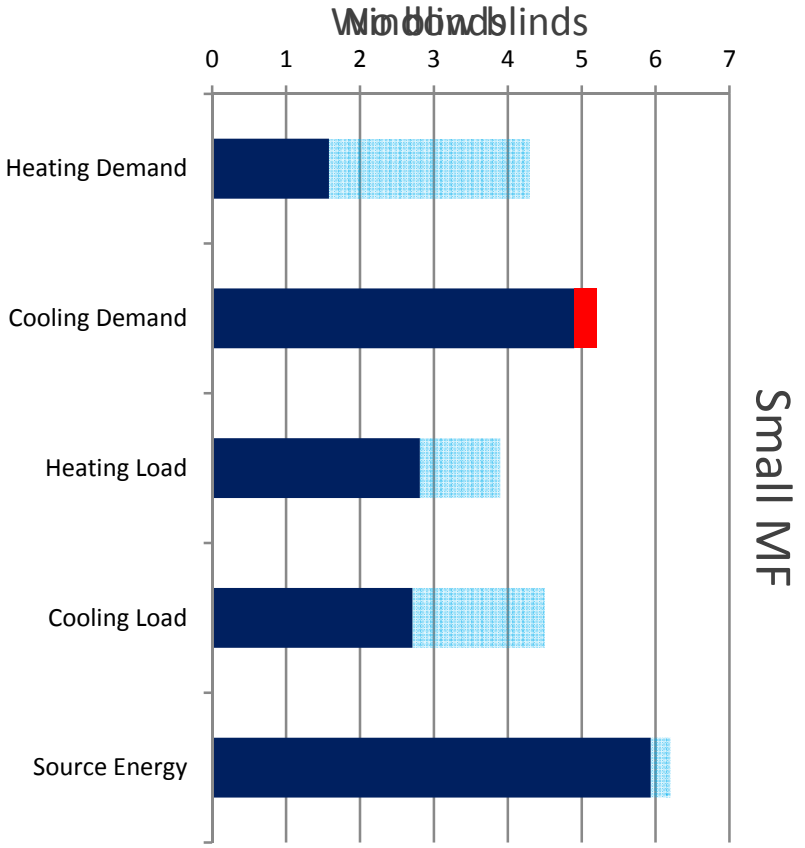
Image source: sefaira

Solar Heat Gain Coefficient



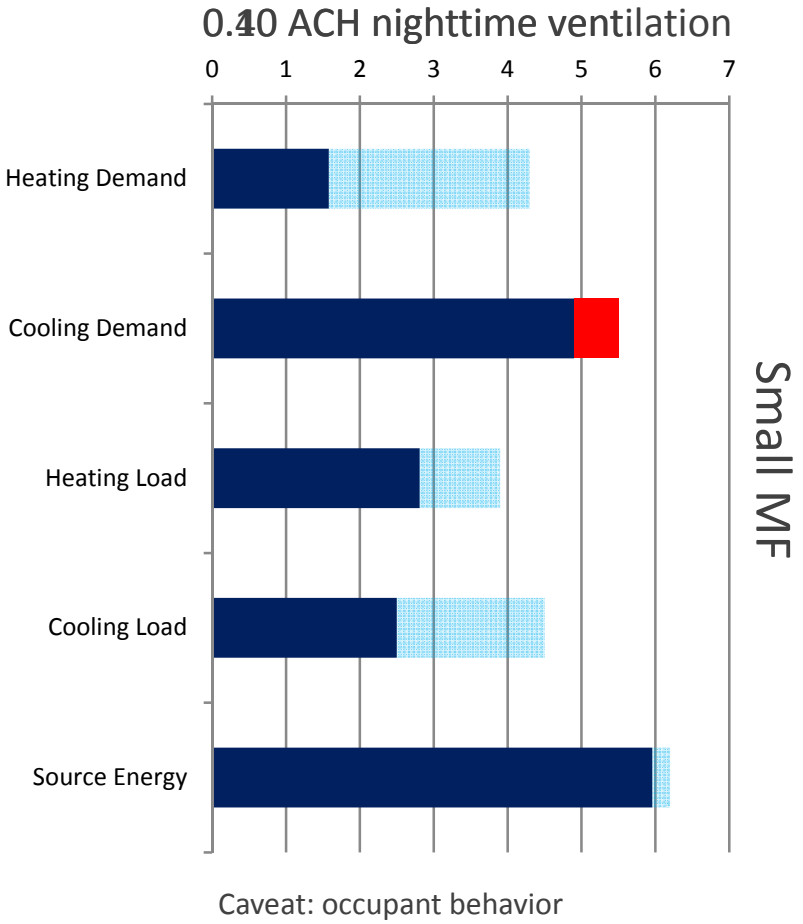
Window Blinds





Nighttime Natural Ventilation

Nighttime natural ventilation through operable windows reduces cooling demand



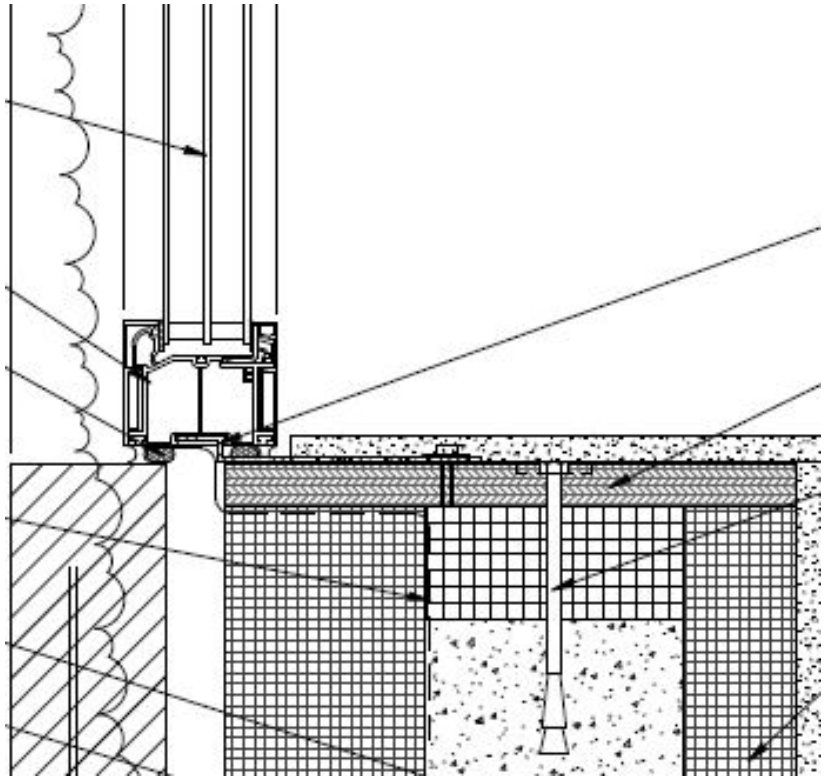
Caveat: occupant behavior

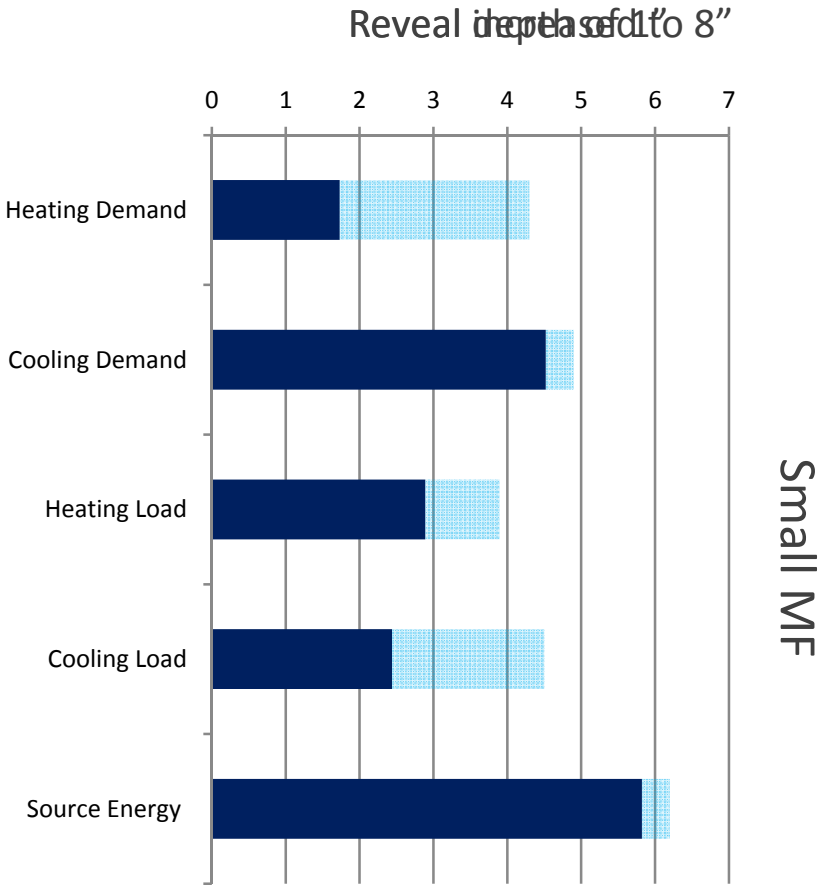
ZK14

Window Reveal Depth

Increased window reveal depth maintains views, daylighting, but reduces solar gain

Subtle but impactful to cooling demand



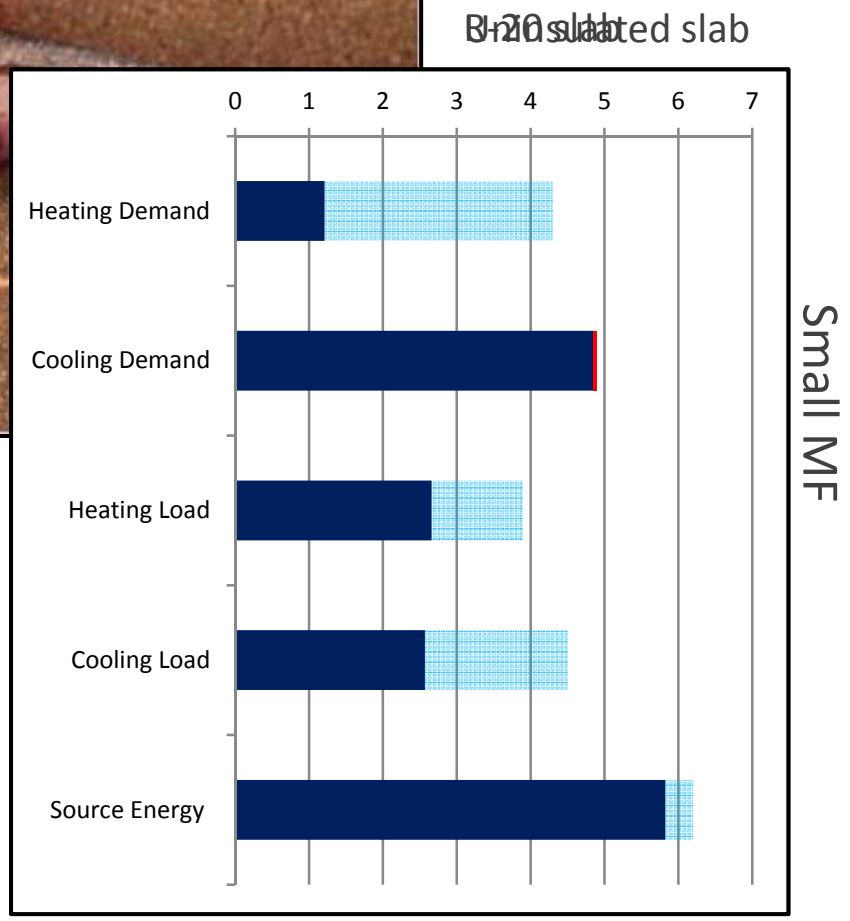


Caveat: thermal-bridge implications based on wall assembly

Slide 25

ZK14 Remove slide?
Zoe Kaufman, 2/28/2018

Below-Grade Conditions – Small Bldg



What does a multifamily Passive House have in common with a naked mole rat?

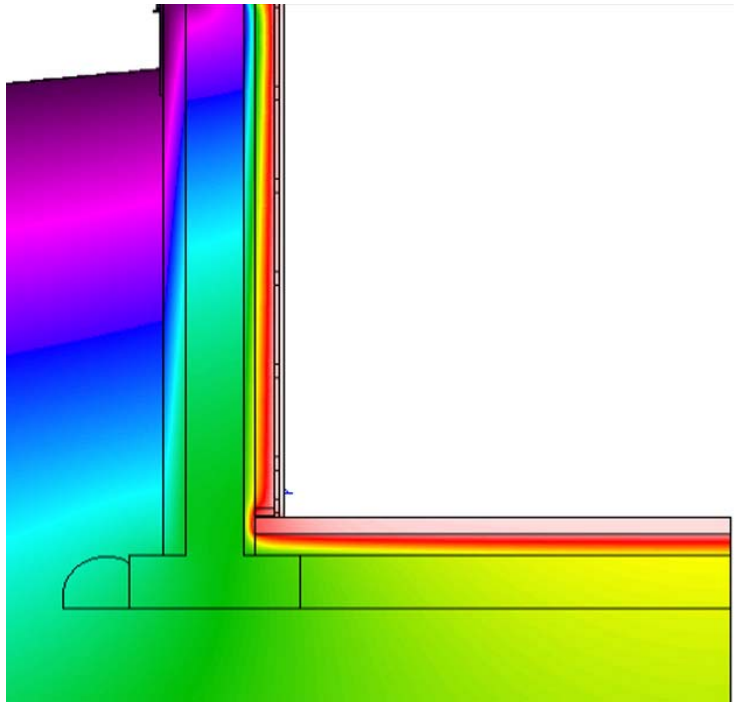
- Reduce below grade insulation, use ground as heat sink in summer, reduce cooling demand

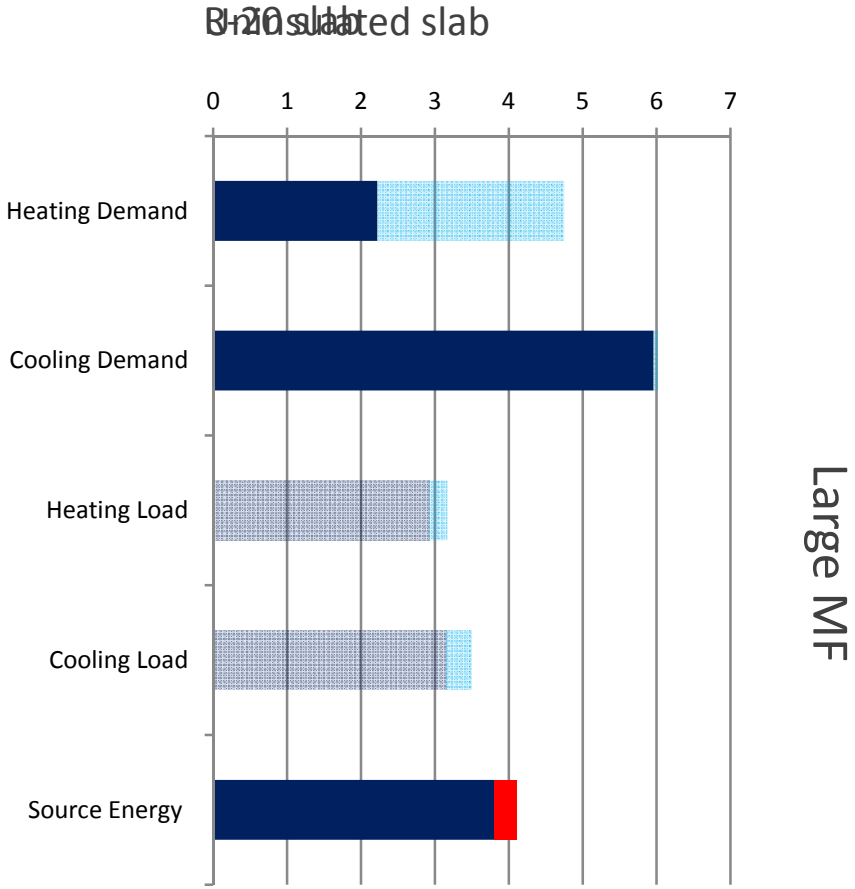
- Reductions in above-grade insulation assemblies have minimal impact on cooling demand

- Below-grade heat sink can benefit both PHIUS and PHI projects

Below-Grade Conditions – Large Bldg

Dissipating heat from excess internal loads



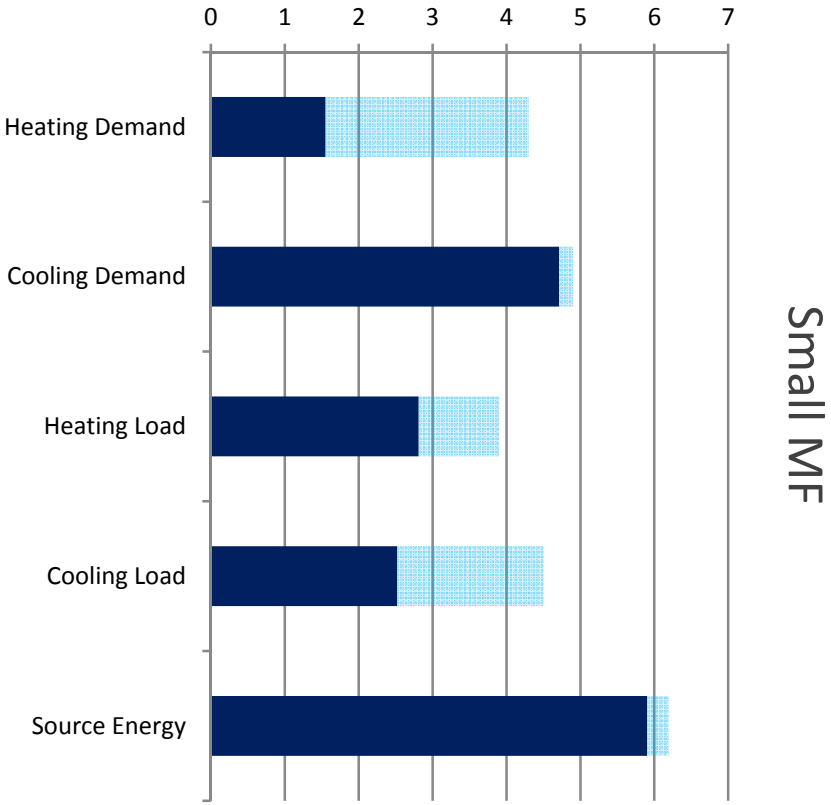


Caveat: zoning and heat flow vs. simulated heat flow

Reduce interior equipment loads

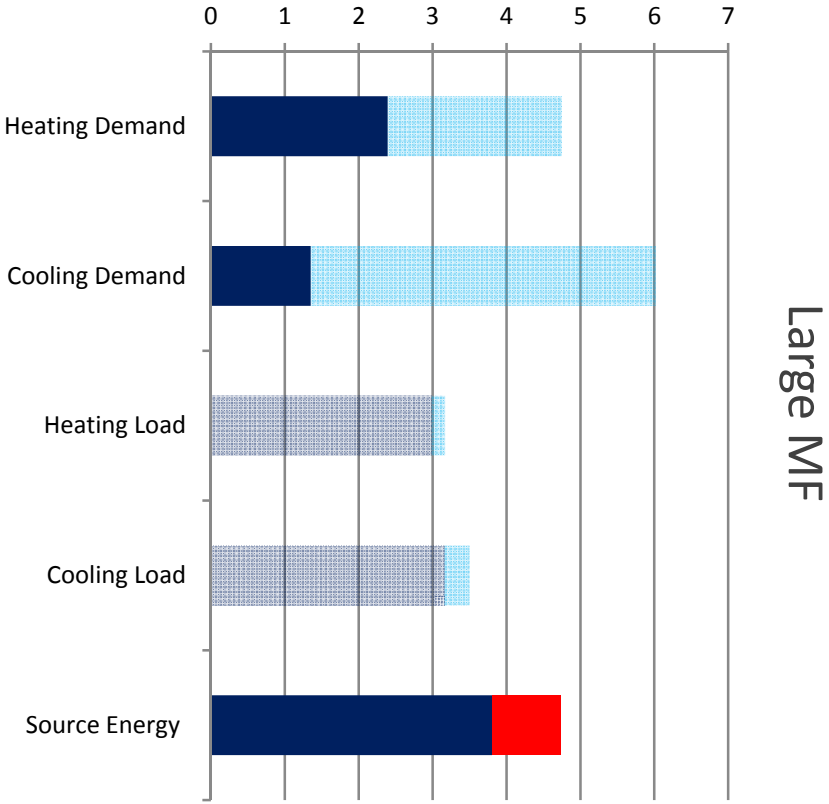
Appliances – Smaller Bldg

ENERGY STAR vs. federal-minimum-efficiency appliances



Appliances – High-Density Living

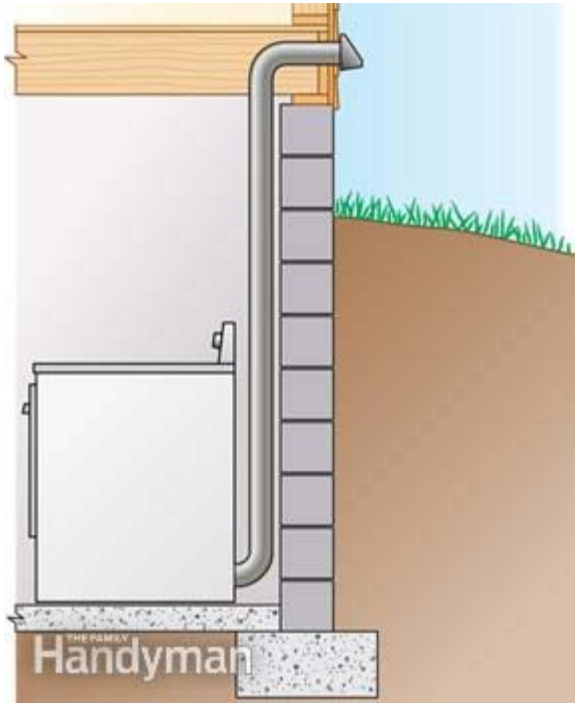
ENERGY STAR vs. federal-minimum-efficiency appliances

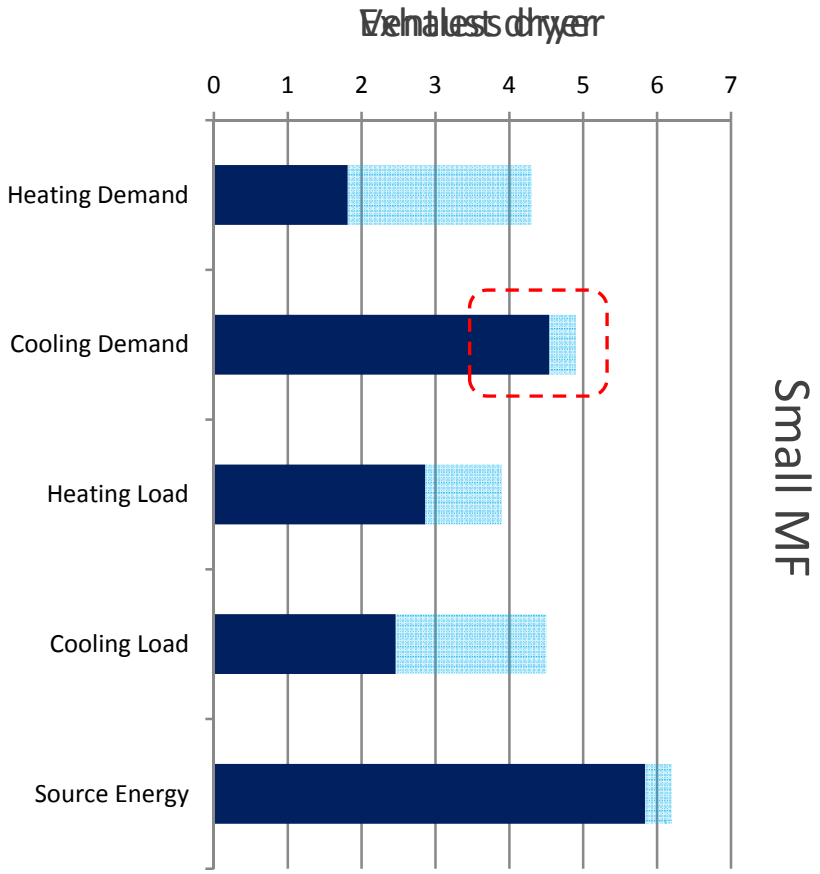


Clothes dryers

Exhaust dryers get a bum rap.

They increase heating demand and heating load, BUT they also reduce cooling demand!

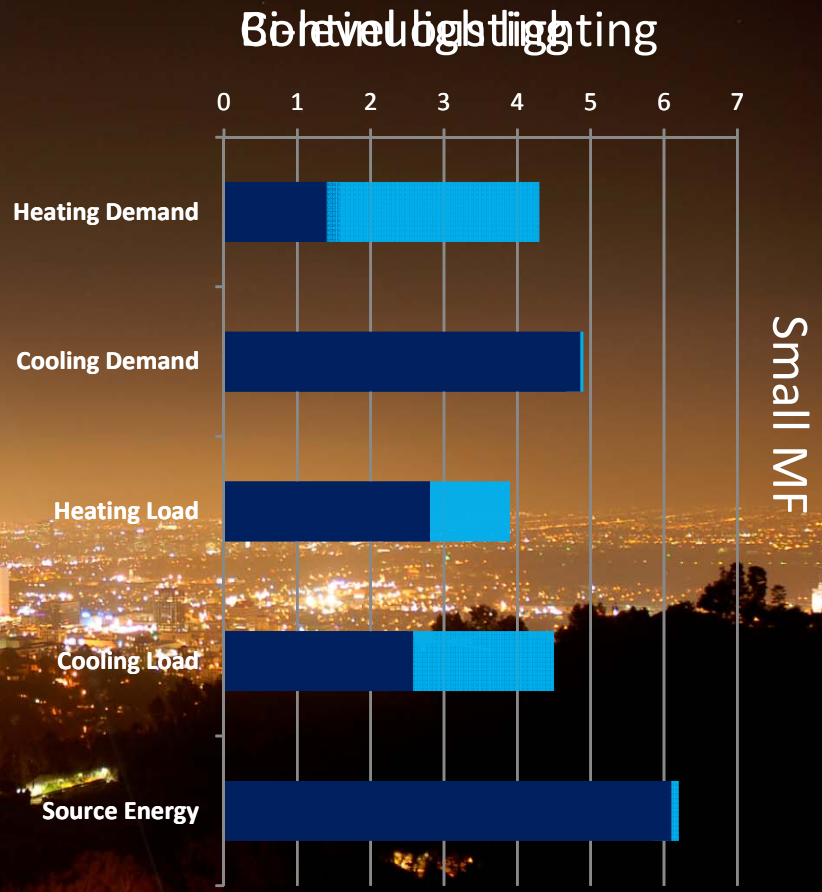




Lighting

Bi-level lighting with occupancy sensors in common spaces reduces internal gains

- **Original LPD 0.6 W/ft²**
- **Target LPD 0.3 W/ft²**
- **Final LPD 0.39 W/ft²**

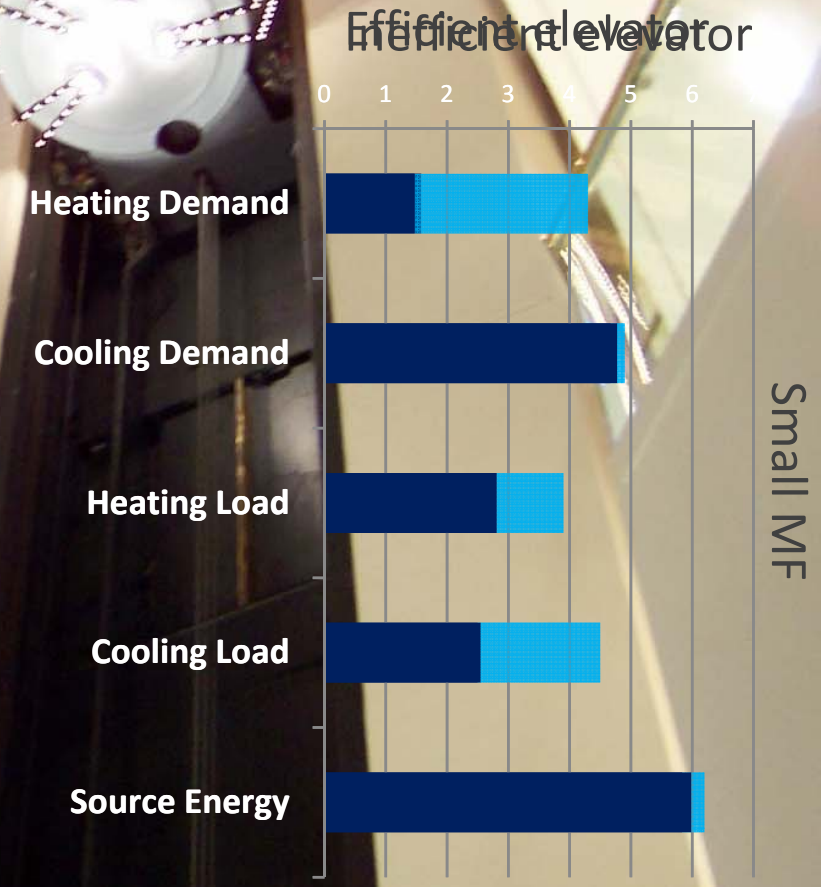


Elevator

An efficient elevator will reduce internal gains and cooling demand

- LED cab lighting with occupancy sensors
- Auto fan shut off
- Regen Power back elevator drive

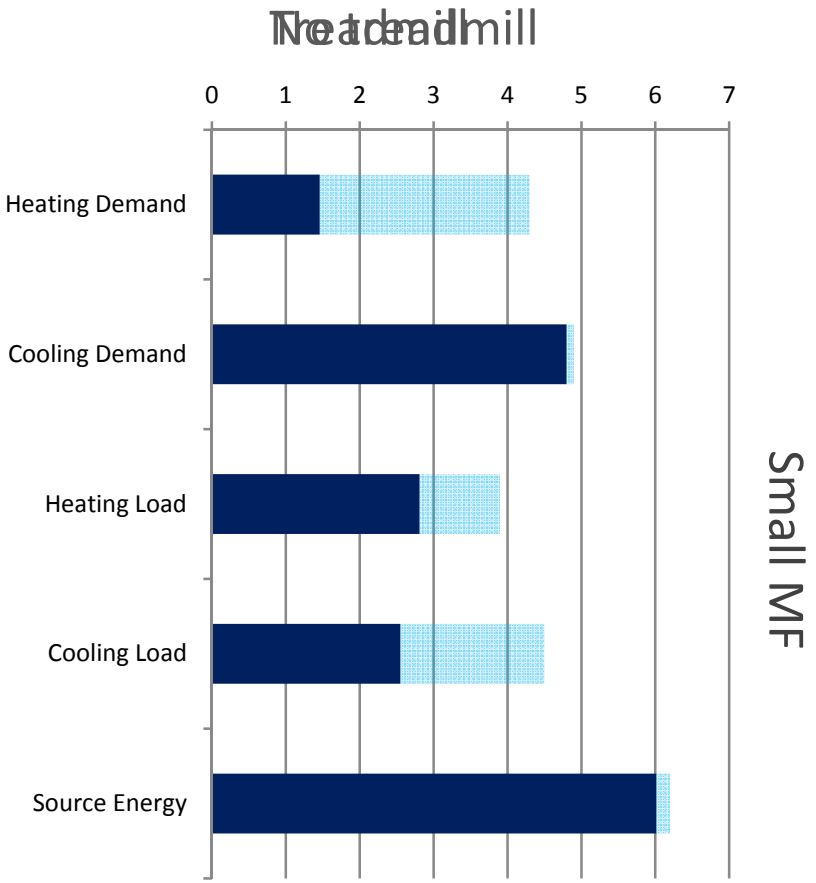
Efficient elevator equipment helps with cooling demand and source energy



Exercise equipment

Self powered exercise equipment (i.e., no treadmills) will reduce miscellaneous electrical loads, internal gains and cooling demand

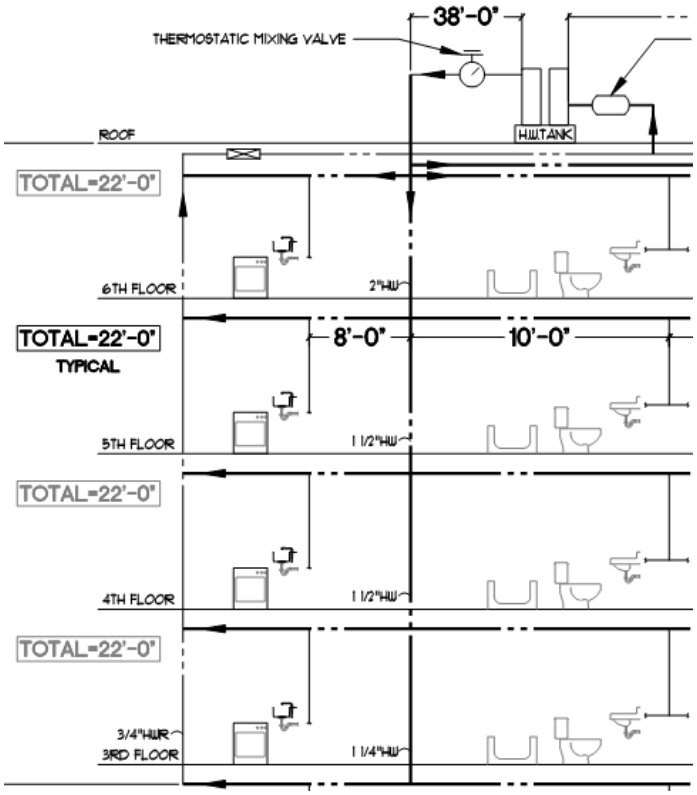
- Elliptical
- Stationary bike
- Weights

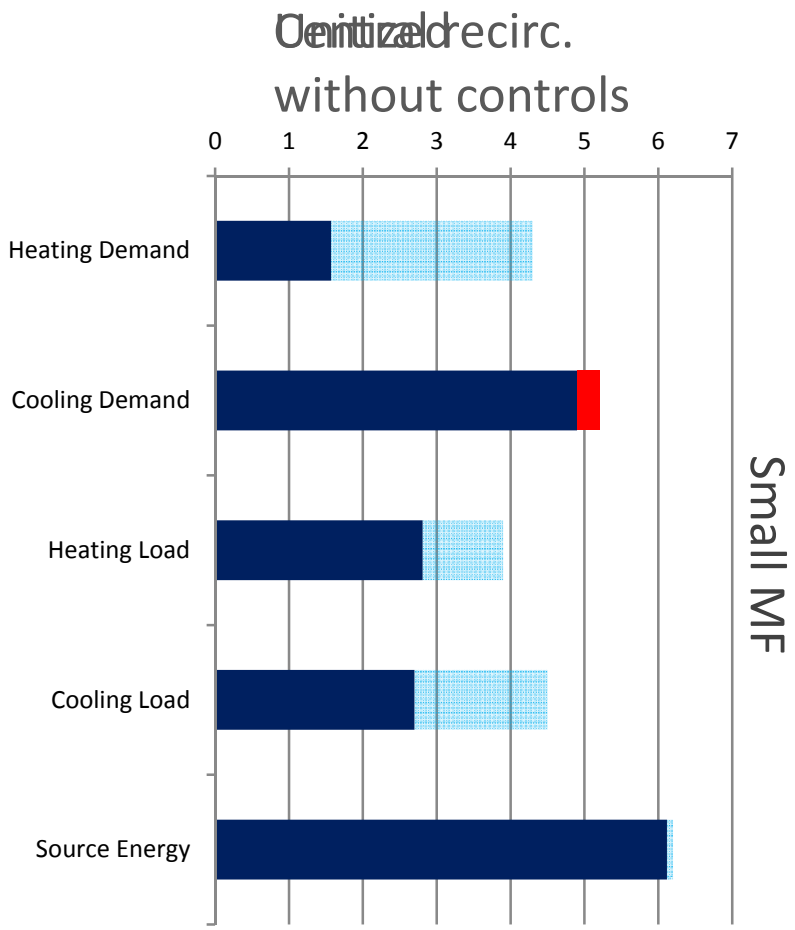


Carefully design HVAC systems

Domestic Hot Water – Small Bldg

Reducing DHW recirculation pipe length will deliver less heat to the building

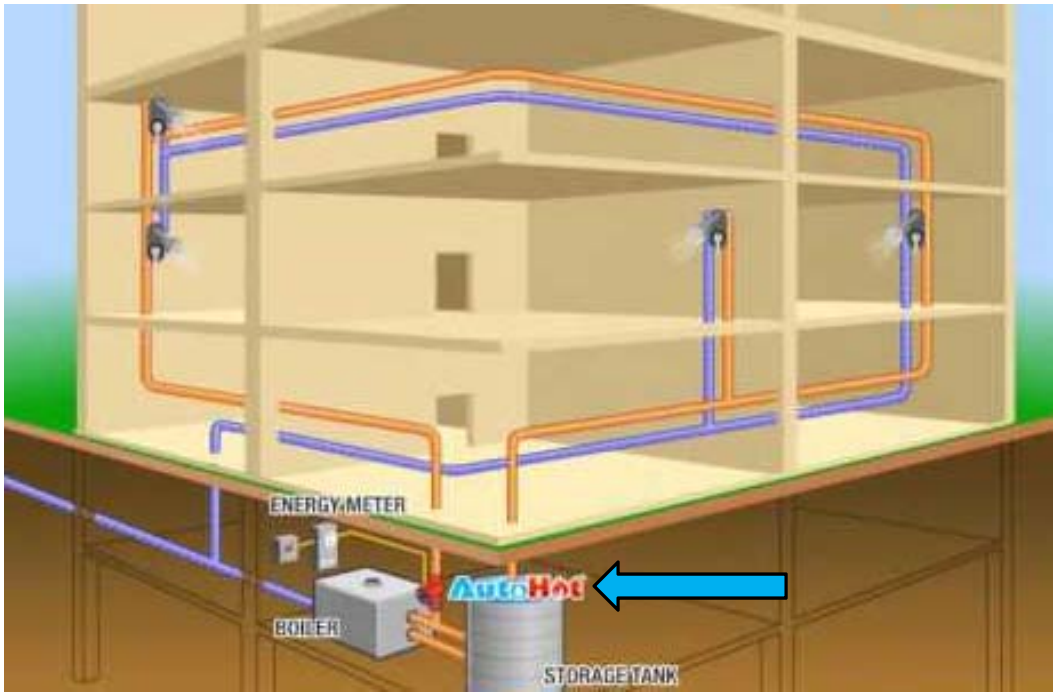


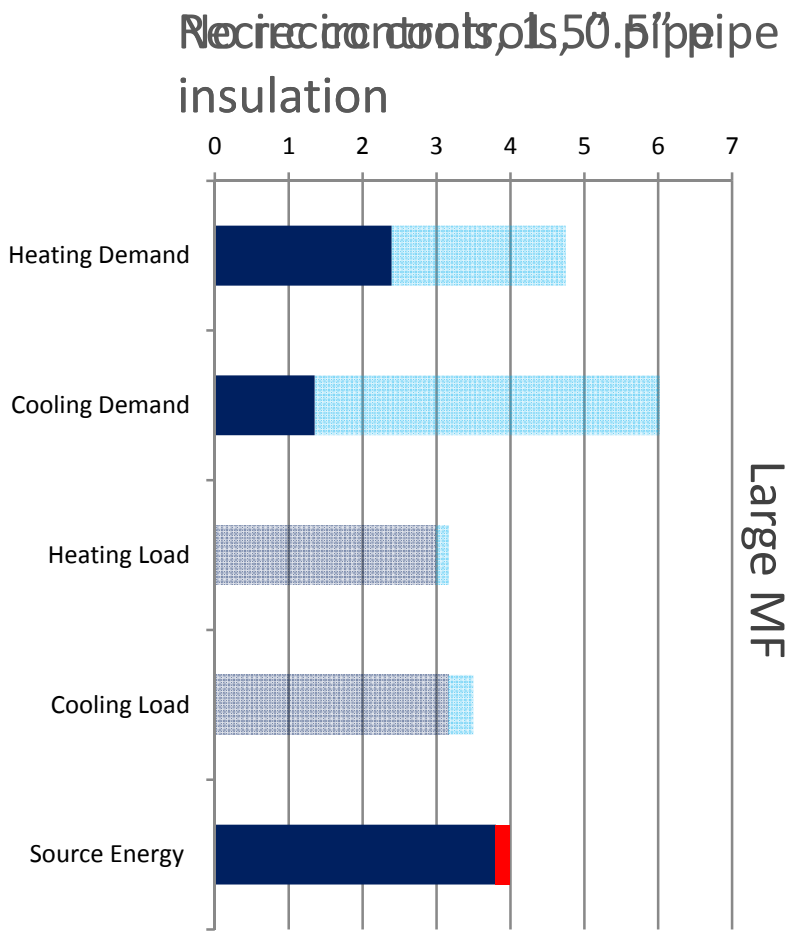


Domestic Hot Water – Large Bldg

DHW pipe insulation reduces unmanaged heat transfer from pipes to living space

Recirculation controls for central system





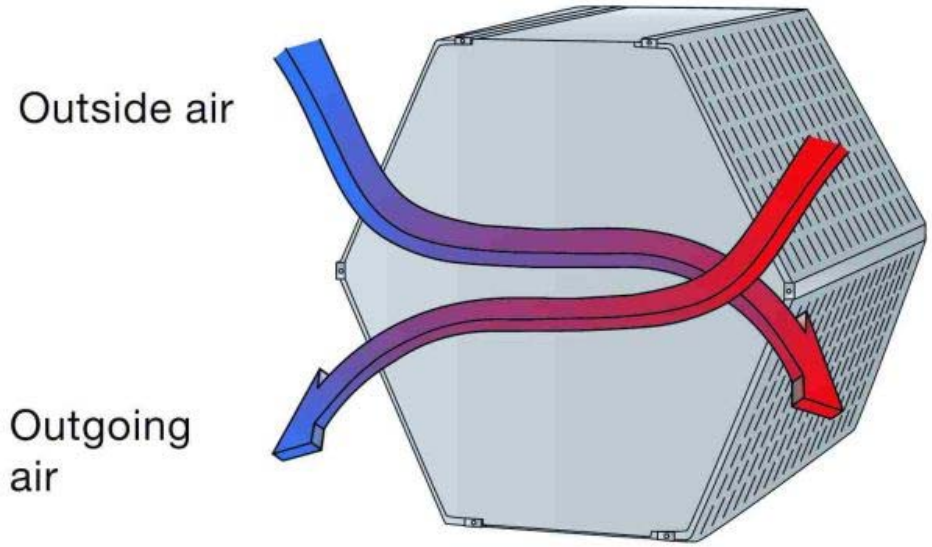
Mechanical Ventilation Efficiency

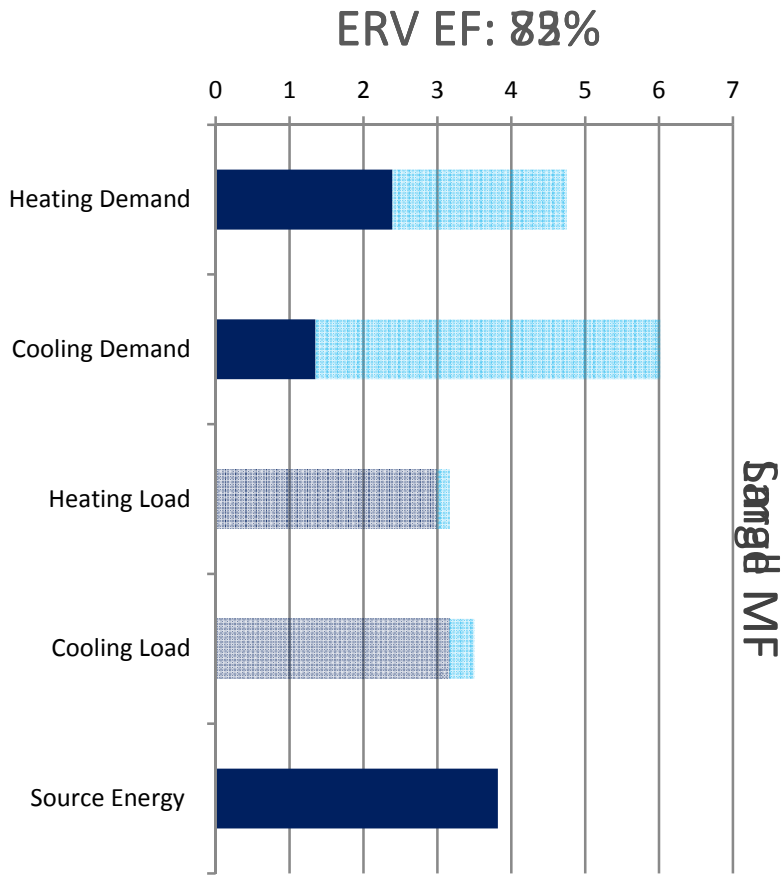
Higher energy recovery efficiency:

- decreases the heating demand

- decreases source-energy usage

- negligible impact on cooling demand





Mechanical Ventilation Rate – Smaller Bldg

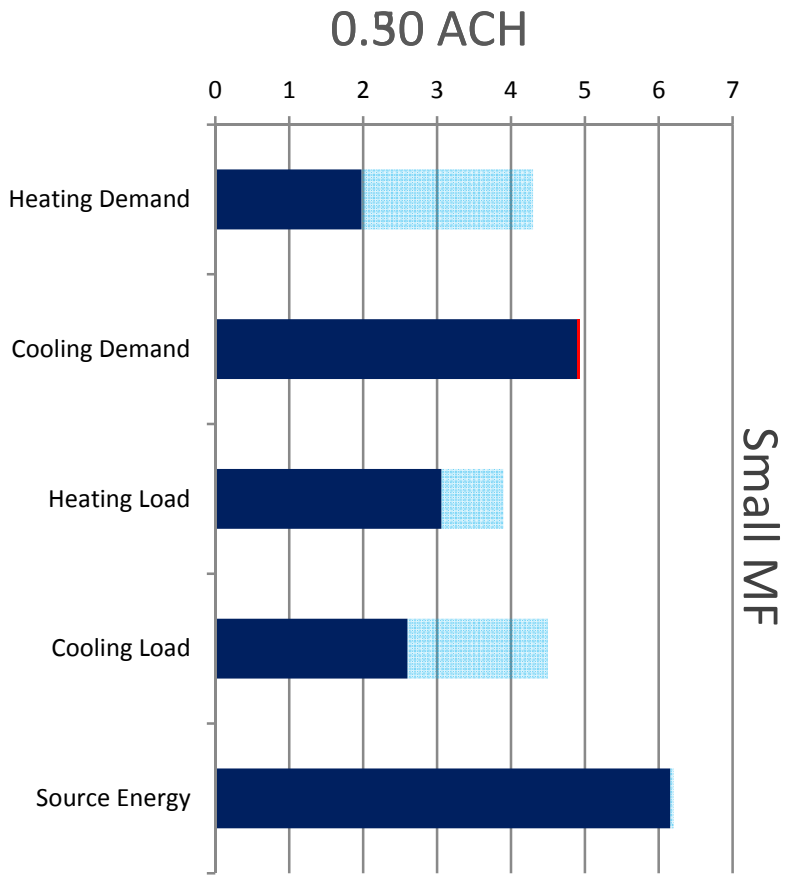
Increasing ventilation rate beyond code requirements:

- increases heating demand & load

- increases cooling demand

- increases source-energy usage

→ Use a properly sized and commissioned ERV



Mechanical Ventilation Rate – Larger Bldg

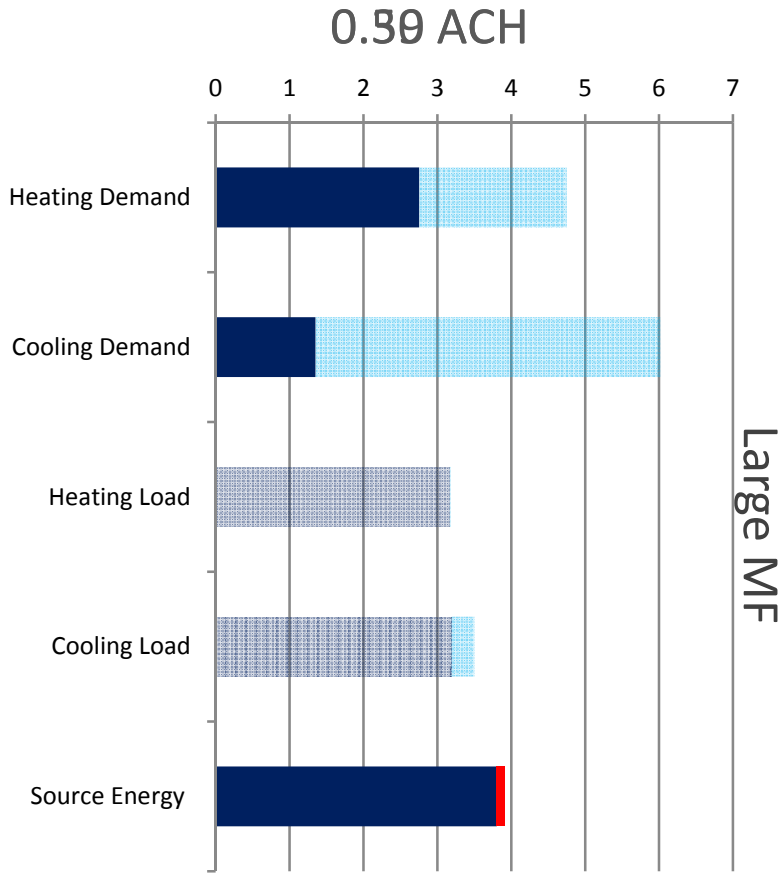
Increasing ventilation rate beyond code requirements:

- increases heating demand & load

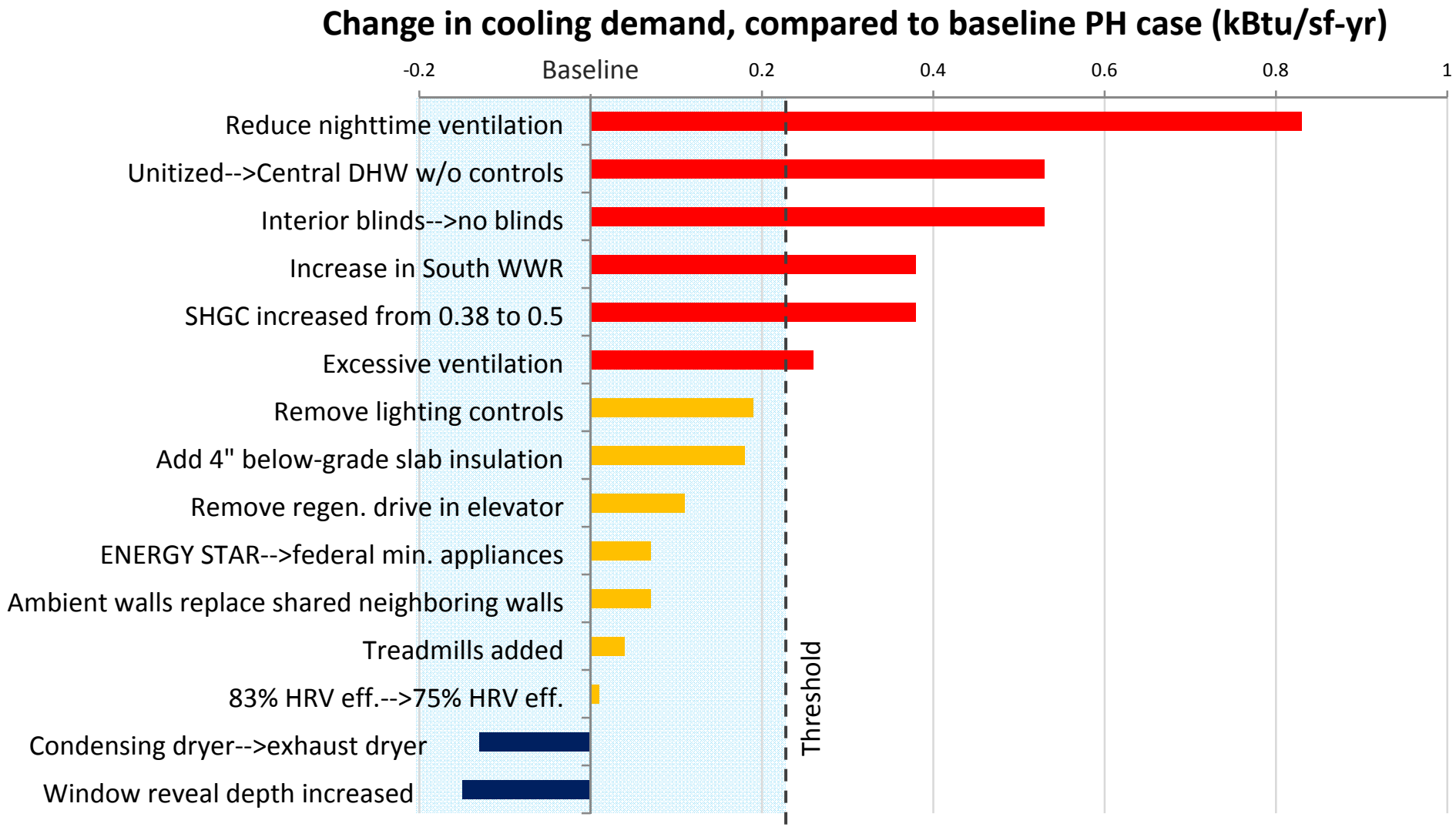
- slight increase in cooling demand

- increases source-energy usage

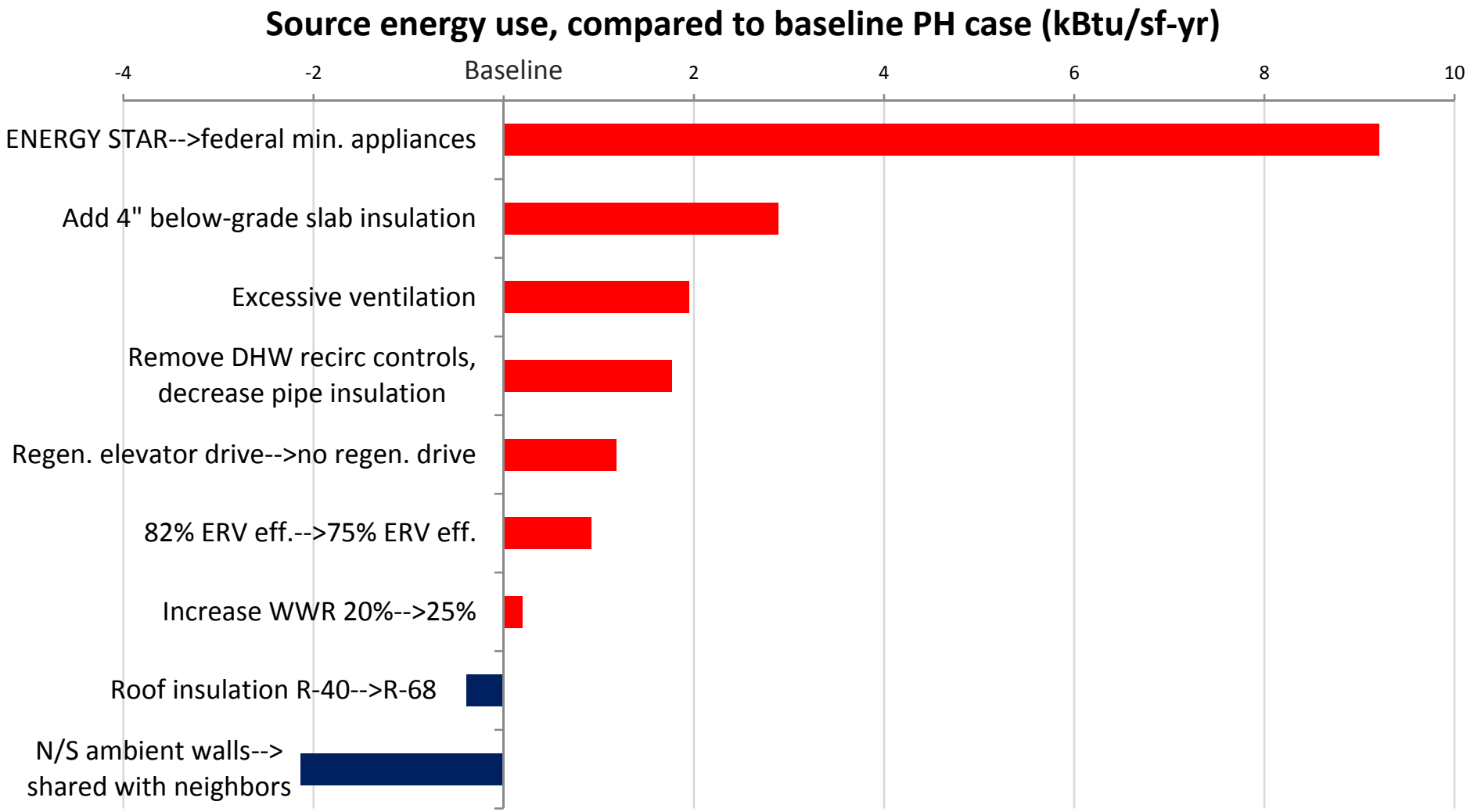
→ Use a properly sized and commissioned ERV



Impact on Cooling Demand (small MF)



Impact on Source Energy (large MF)



THE LEVY PARTNERSHIP

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