

# Design for Off: Key Mechanical Design Features for Significant Energy Savings



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**July 29, 2014**

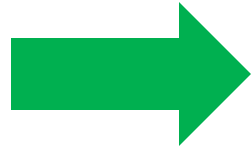
# Presentation Objectives

- Convince you that HVAC System Design is the key to High Performance Building Design
- Identify the key Mechanical Design features needed to deliver high performance buildings.

# 30 years of Energy Code Progress

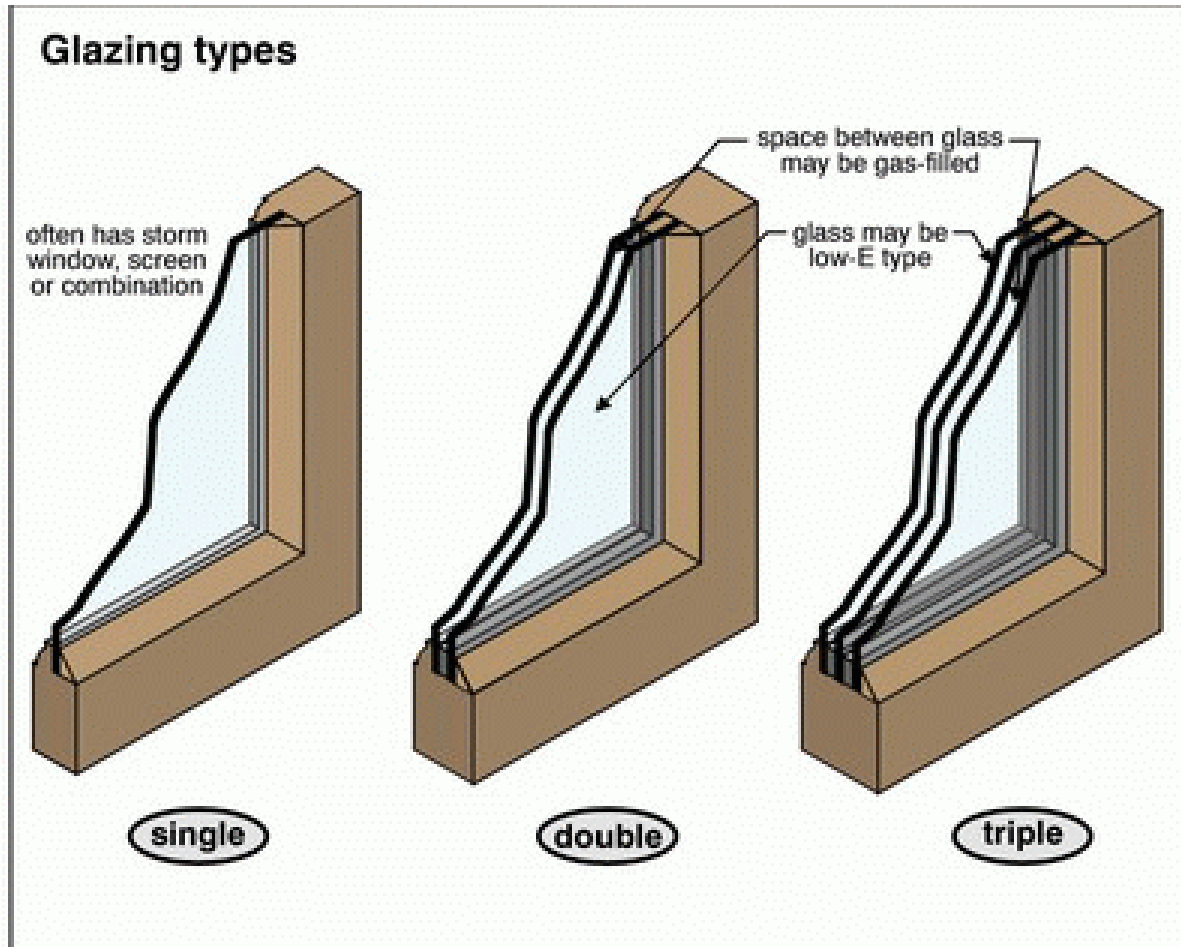


2 W/SF

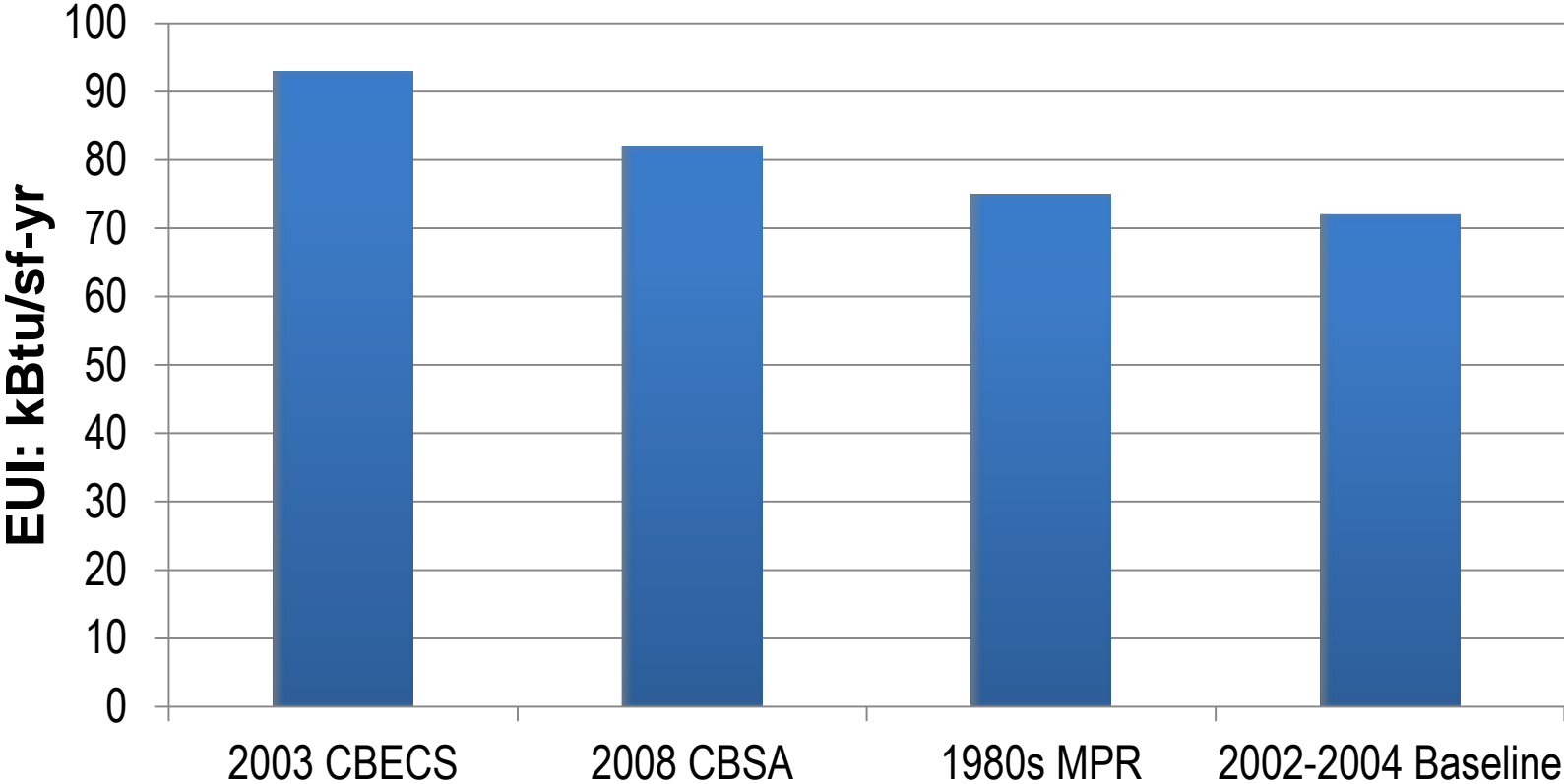


1 W/SF

# 30 years of Energy Code Progress



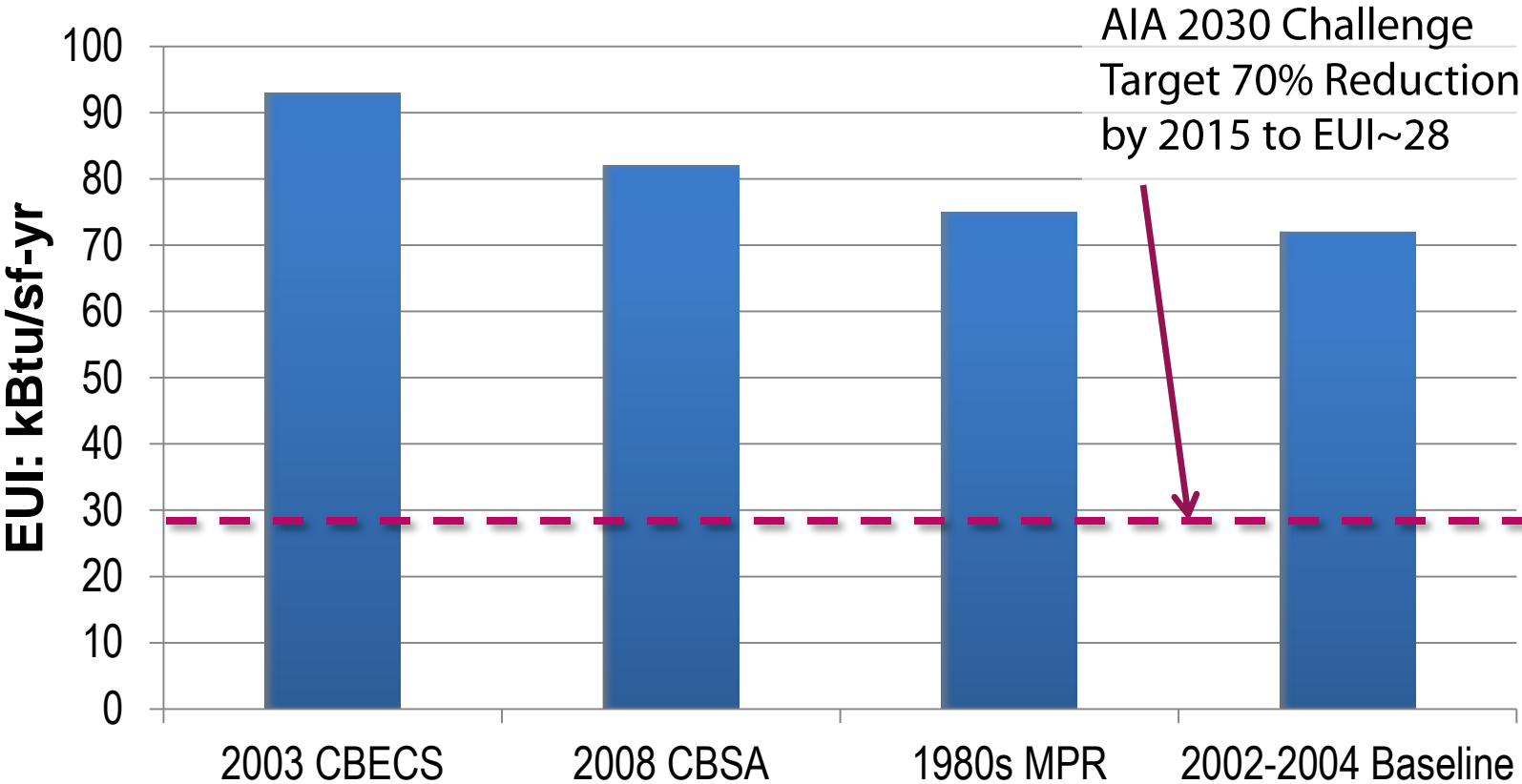
# Office Building EUI



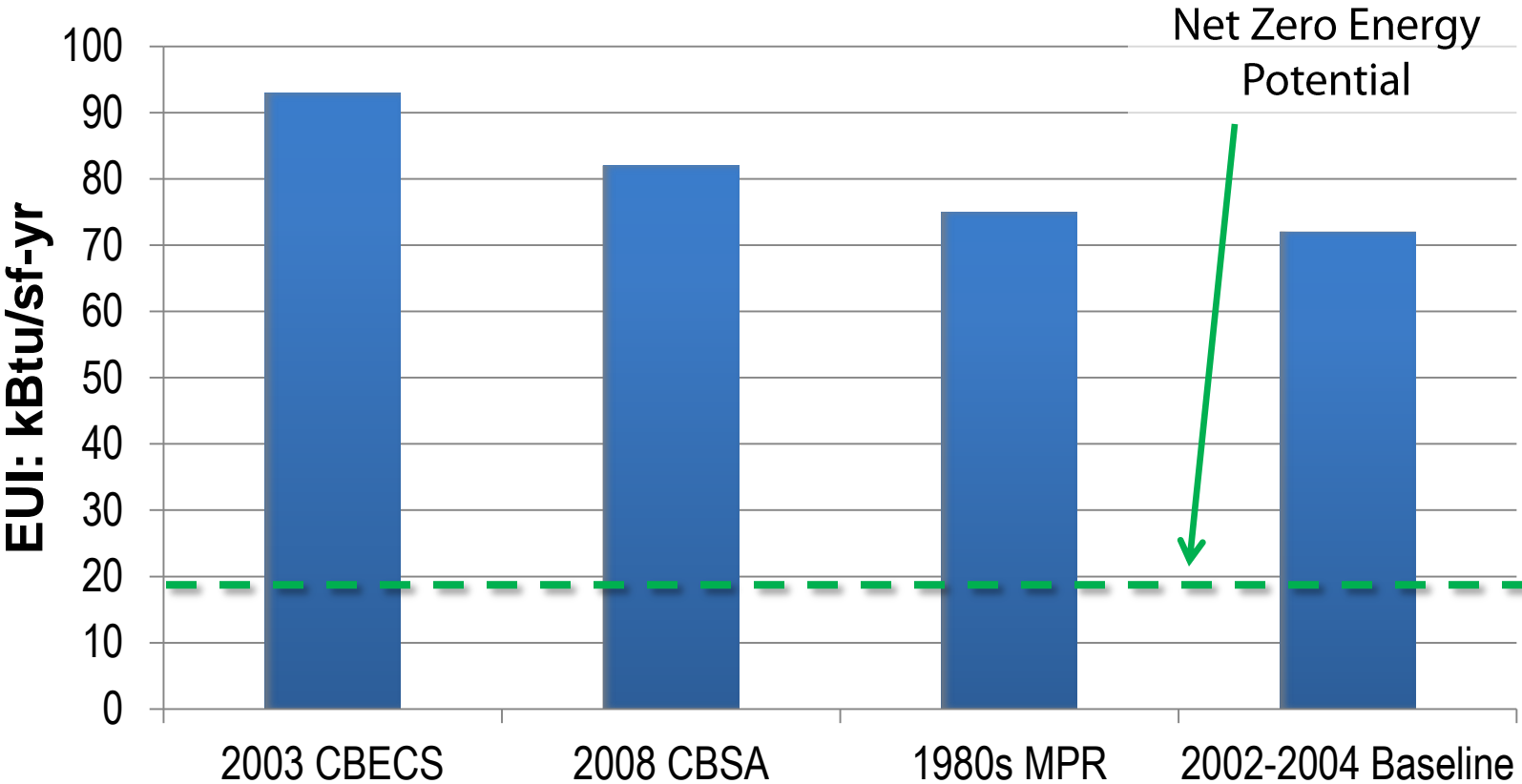
Existing Buildings

New Buildings

# Office Building EUI



# Office Building EUI



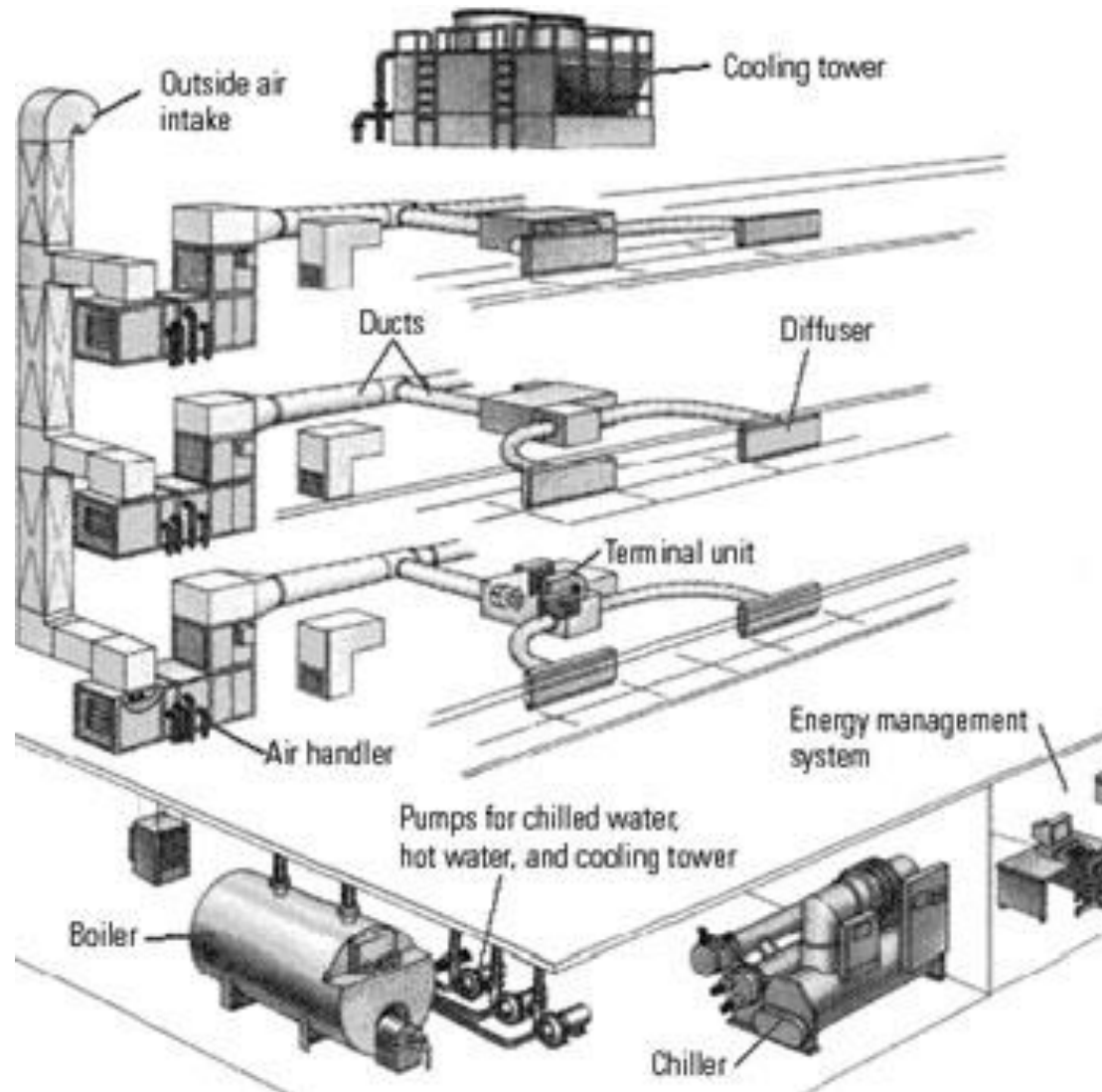
# How Far Have We Really Come?



**Current EUI = 30 kBtu / ft<sup>2</sup>-yr**



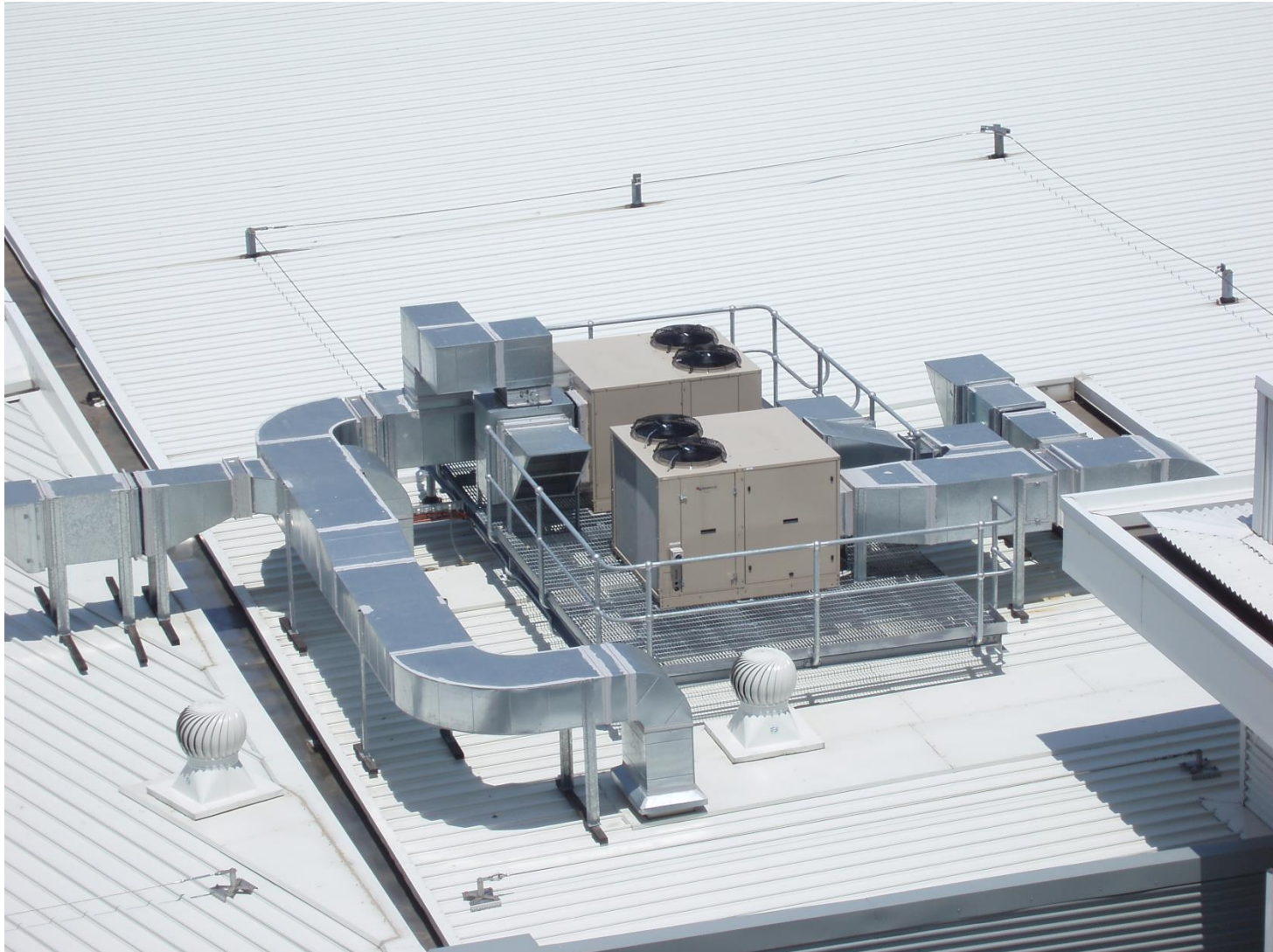
# 1. Move away from large central HVAC systems



# Towards smaller zonal systems

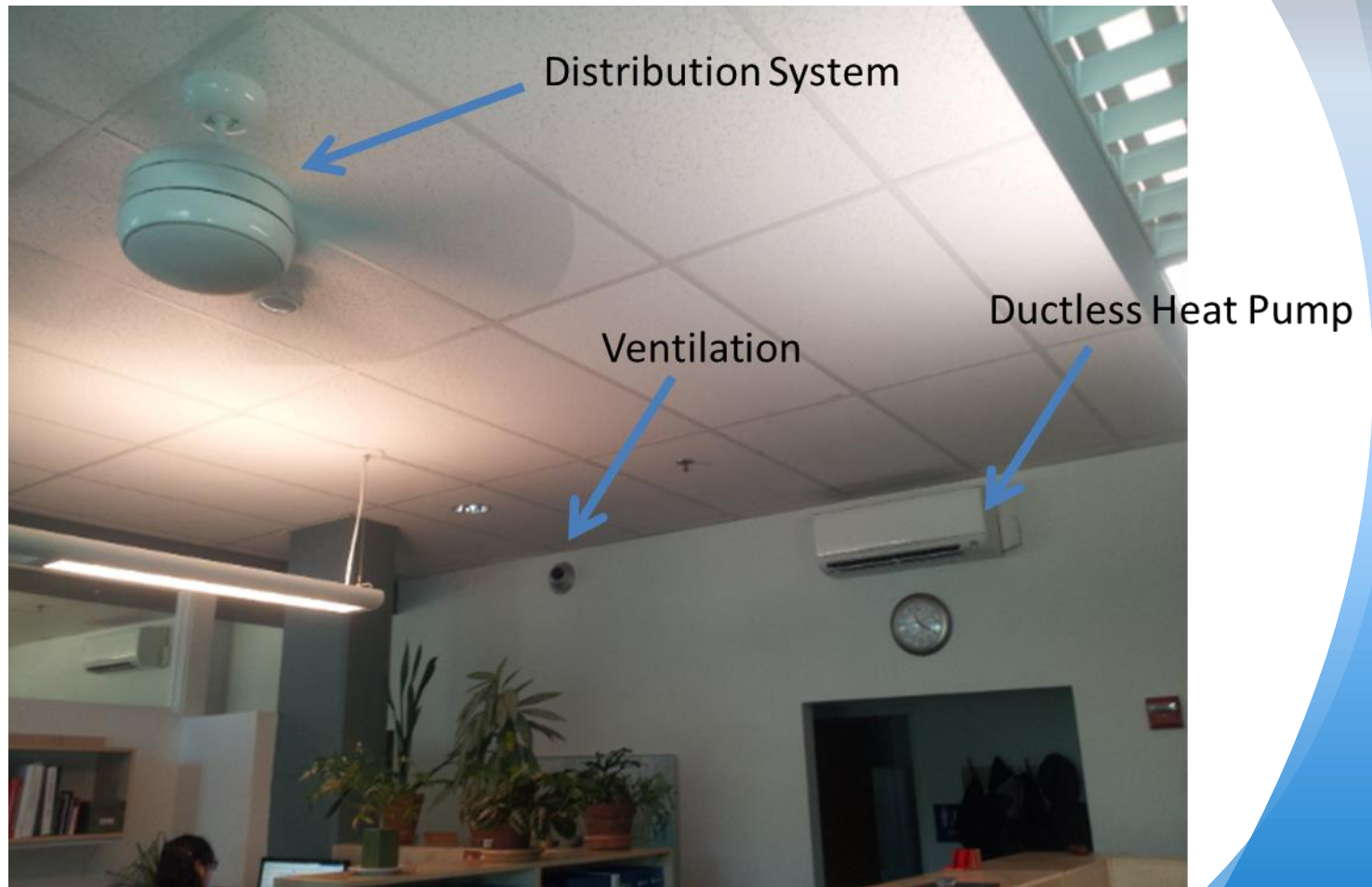


## 2. Move away from All-In-One HVAC systems





# Towards dedicated ventilation systems



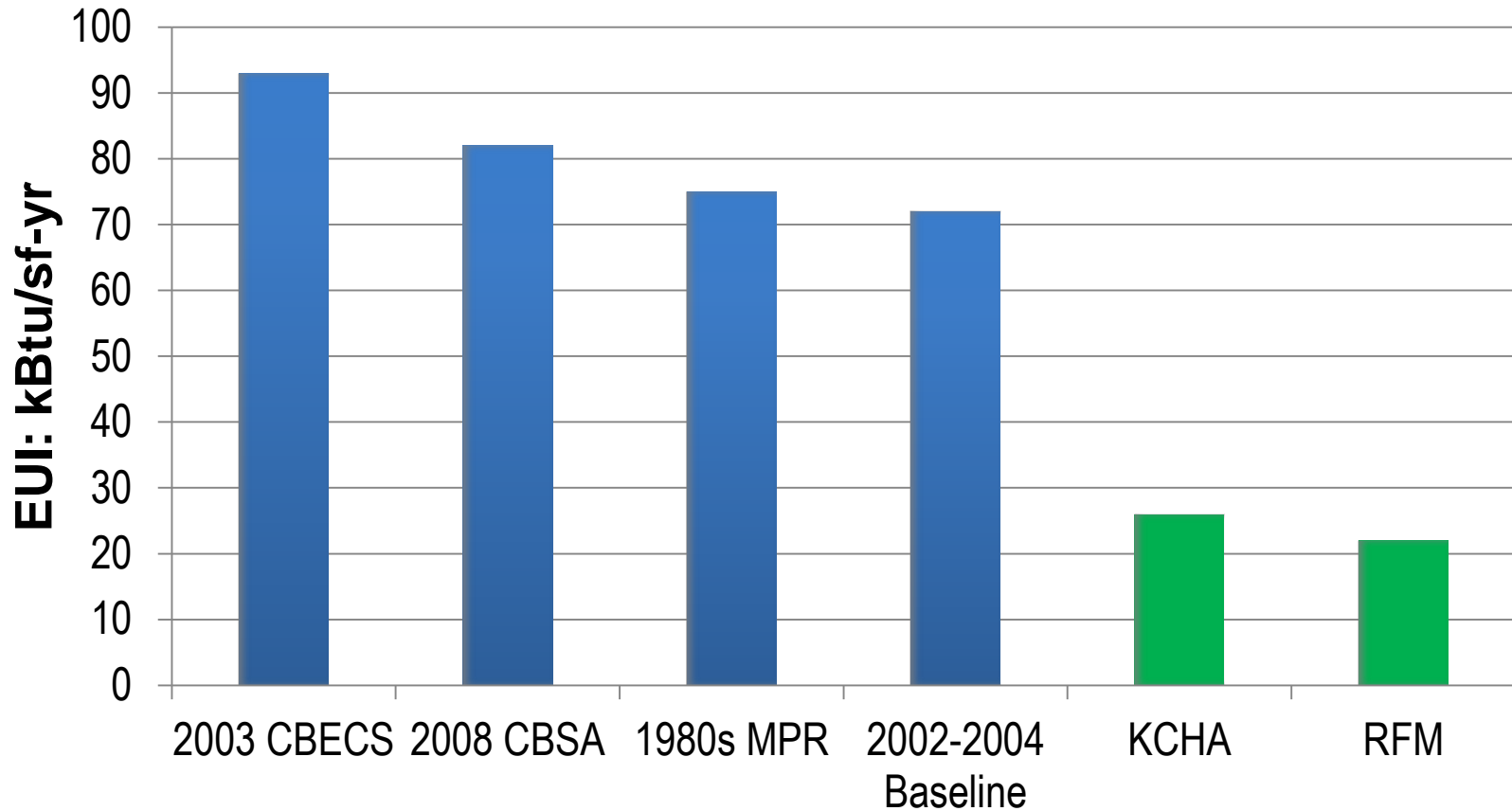
# 3. Right-Size Mechanical Systems



# Believe (Do) the Load Calculations



# Ecotope Case Studies





# Rice Fergus Miller Office: Bremerton, WA



EUI = 22



# Now What?

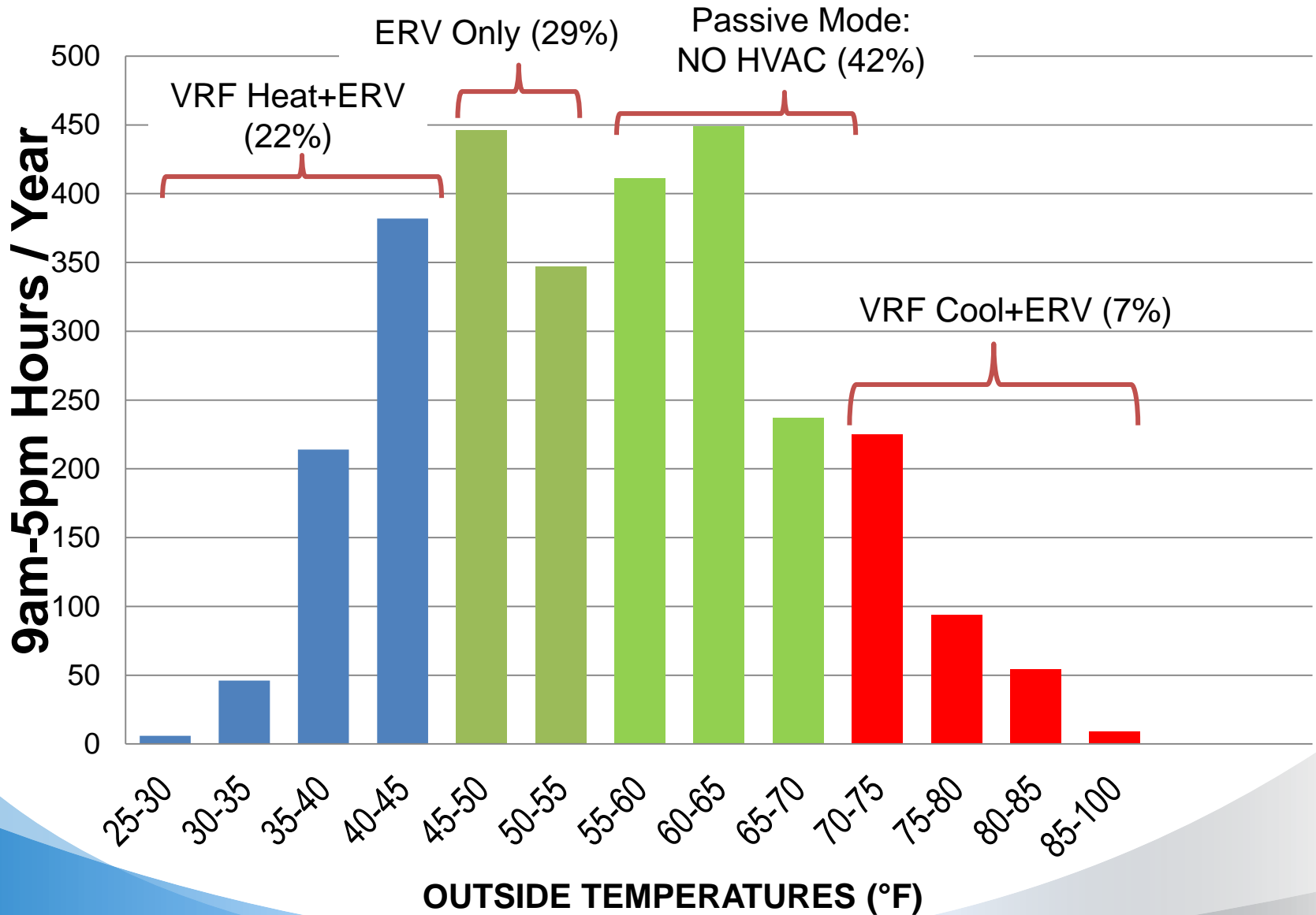


# Load Reduction Measures

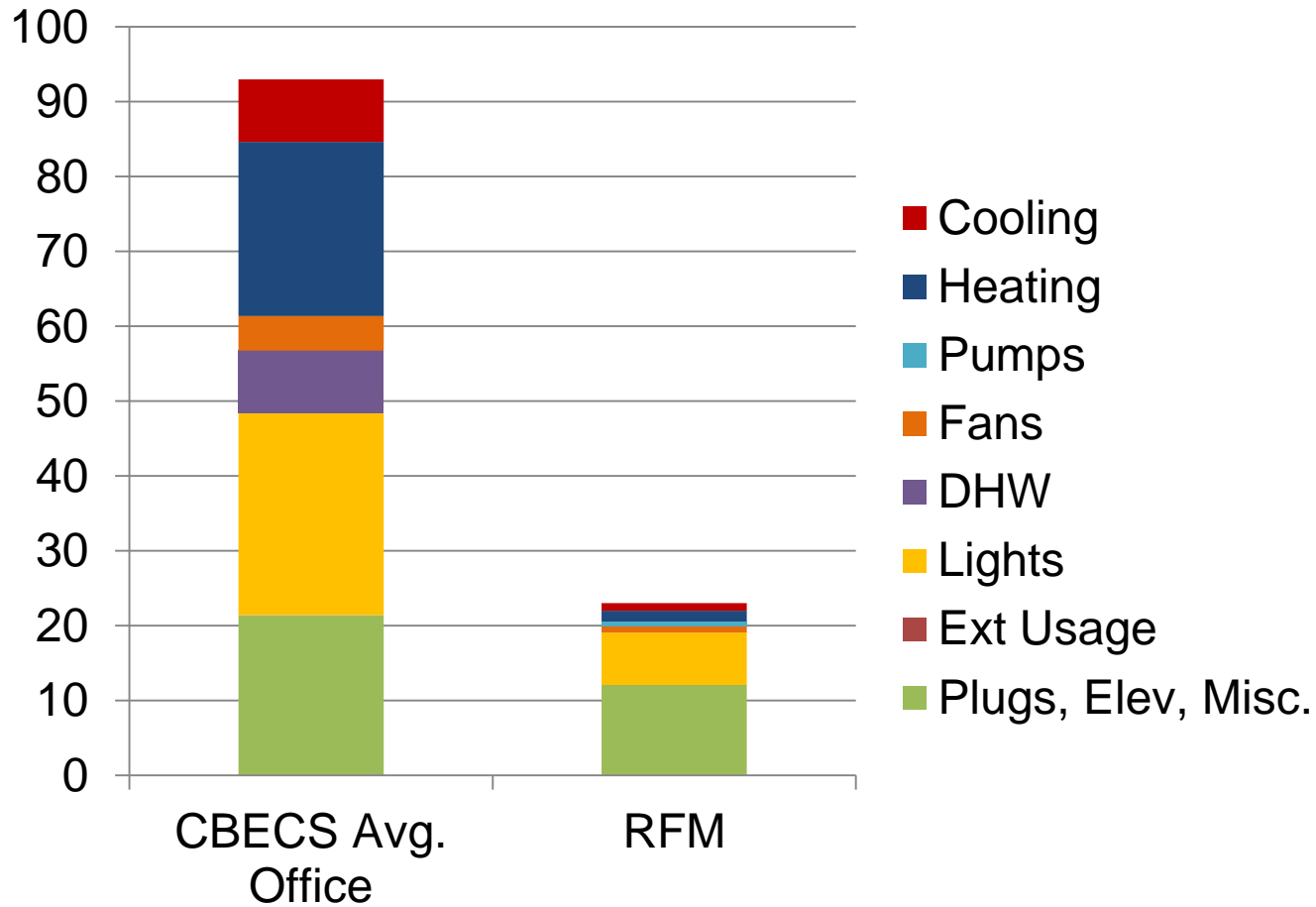
1. Insulation
2. Daylighting
3. VRF Heat Pumps
4. Heat recovery ventilation

## 5. DESIGN FOR OFF

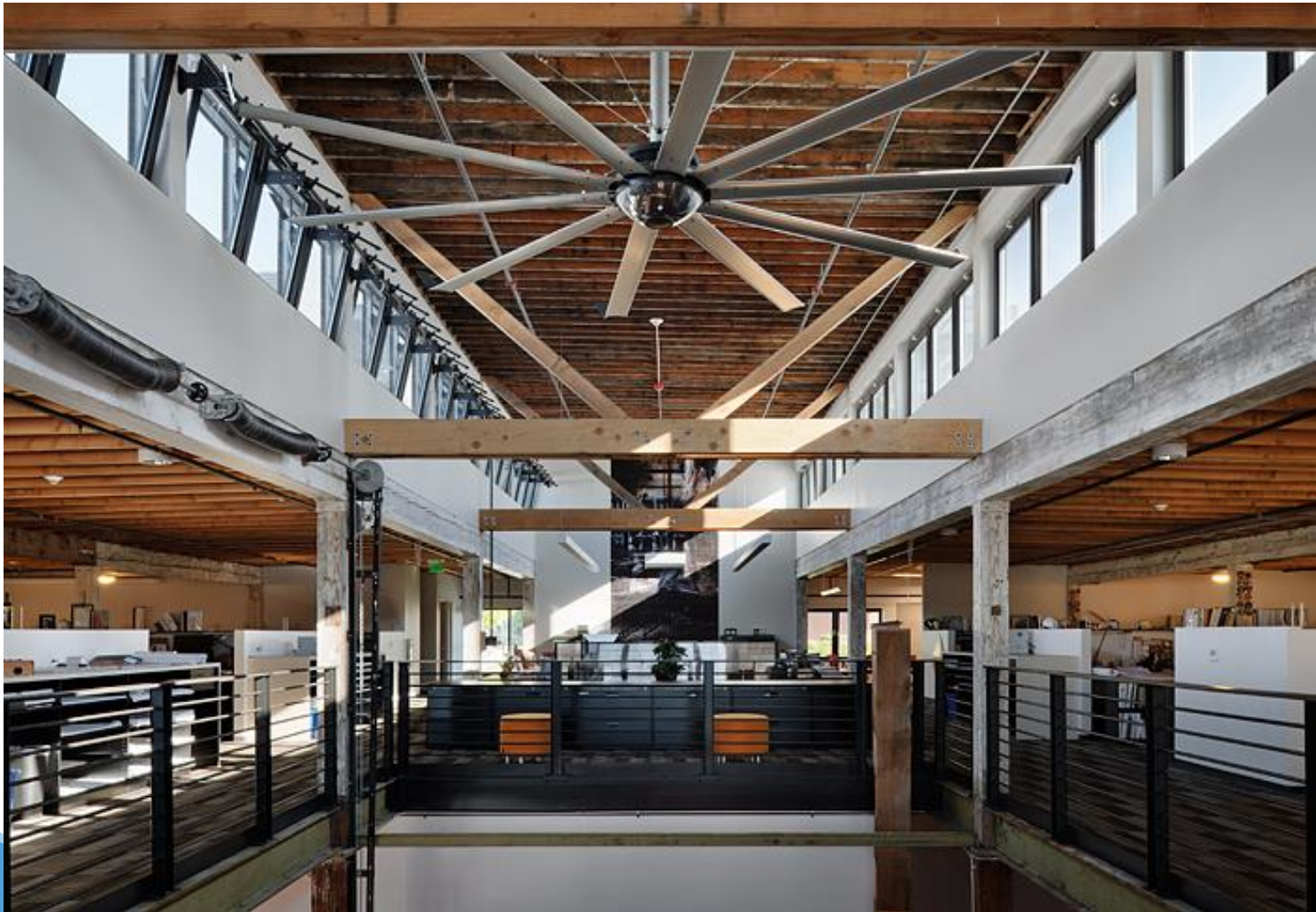
# NO Heat/Cool for 70% of the year!



# End Use Reductions

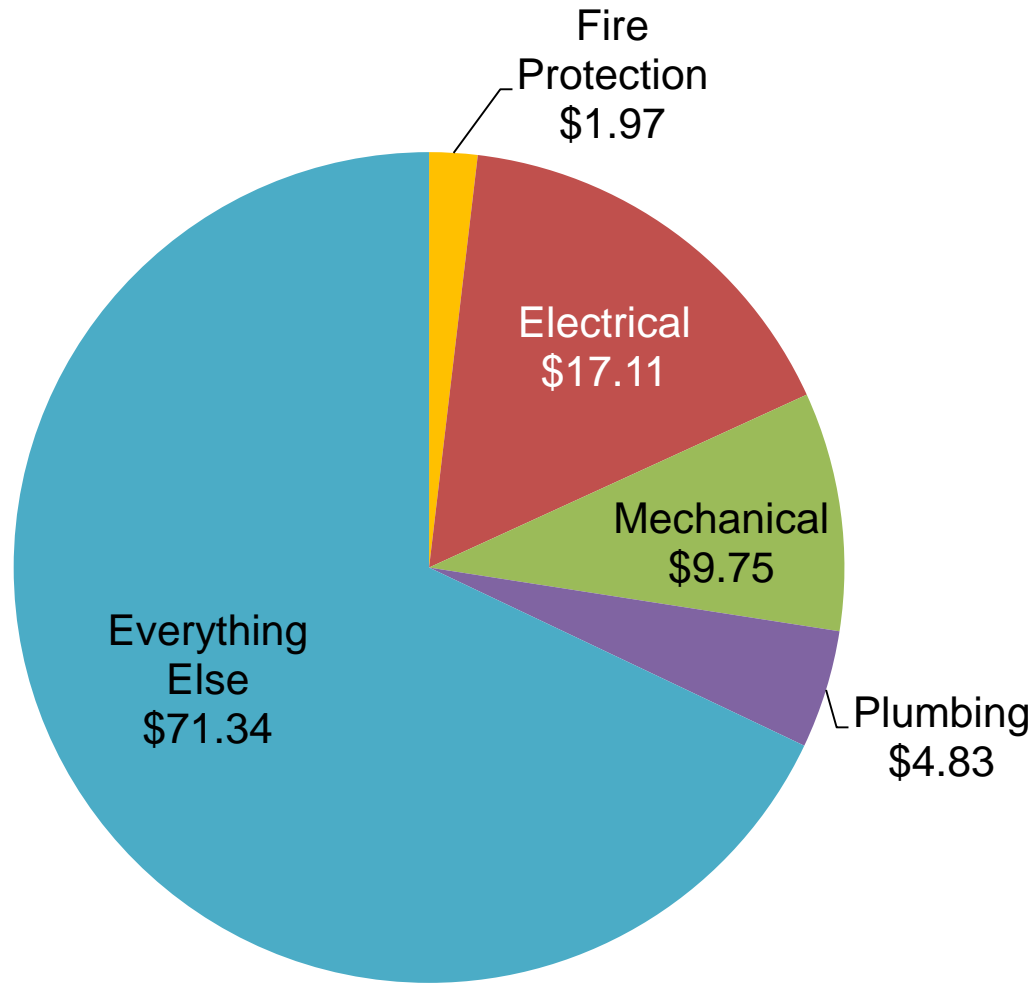


# Fan Energy Load Reduction: Ceiling Fans vs. Ducts to Move Air





# Construction Costs breakdown (\$/sf)



# King County Housing Authority: Tukwila, WA



EUI = 27

# 1980's Level Envelope



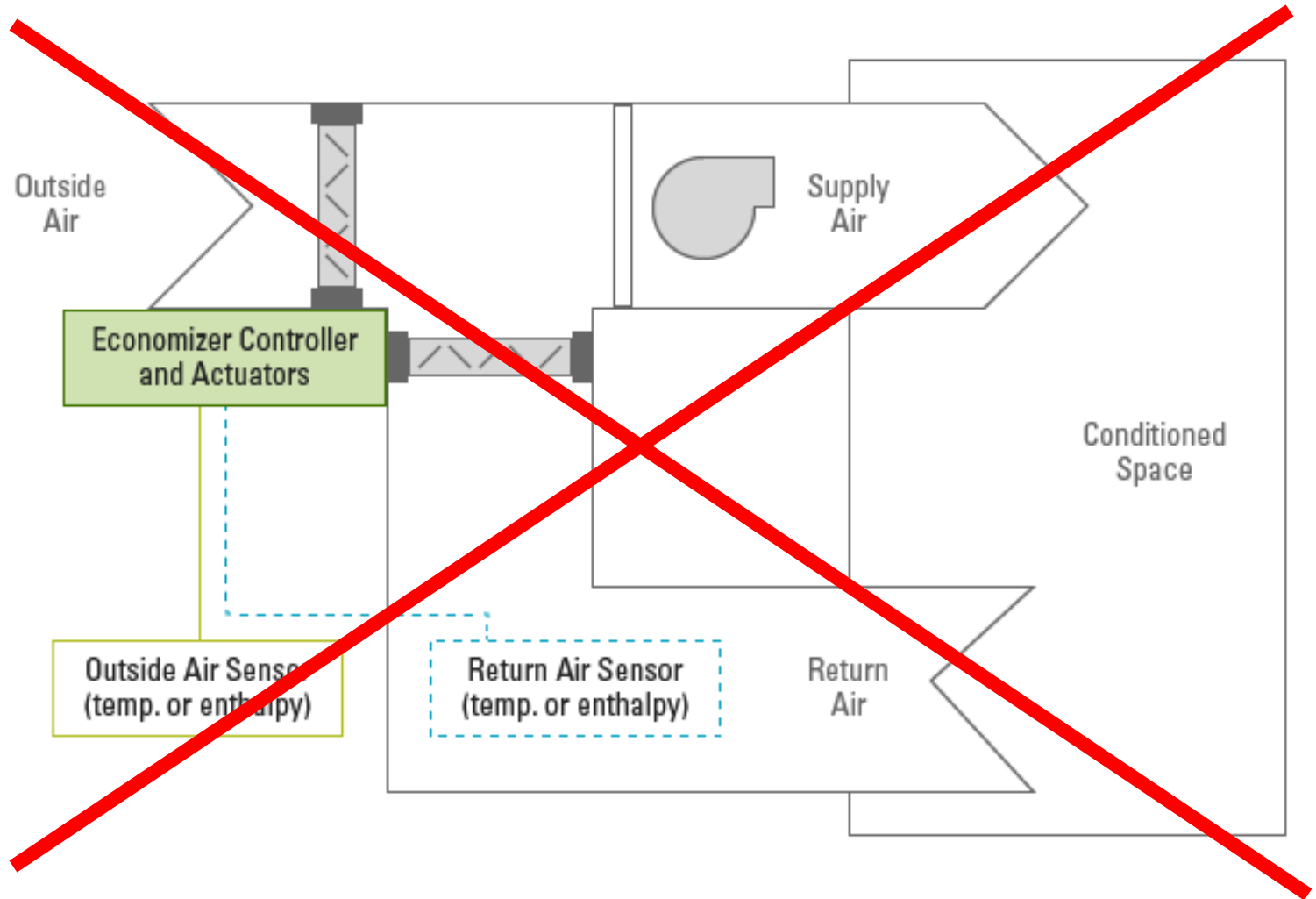
- R-11 Walls
- R-20 Roof

- Uninsulated Slab
- U-0.4 Double Glaze

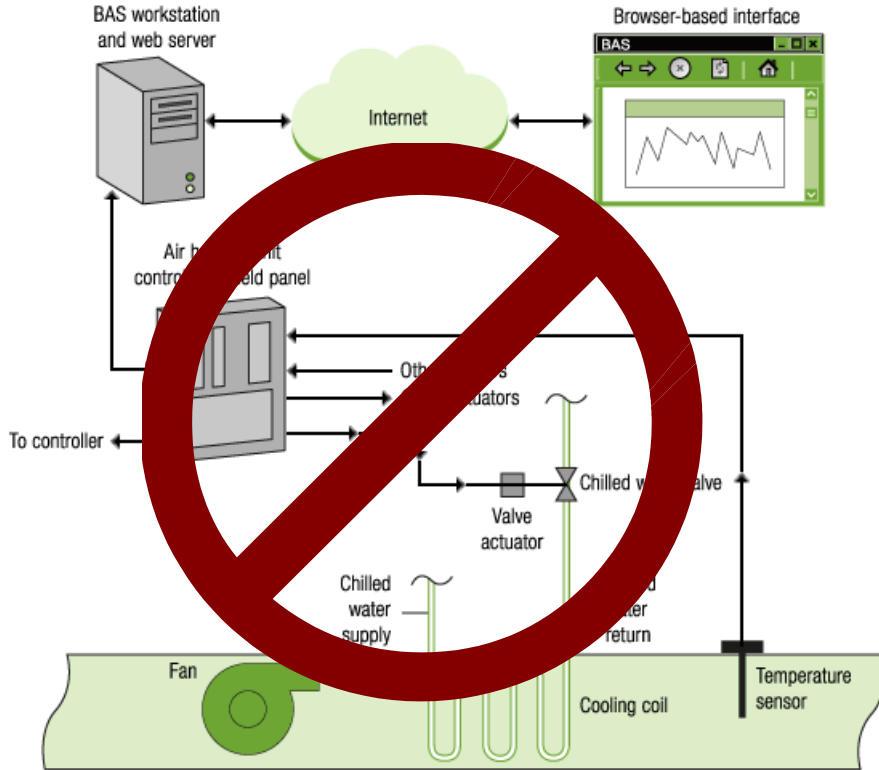




# No Economizers



# No Direct Digital Controls



# High Efficiency Lights & Plugs

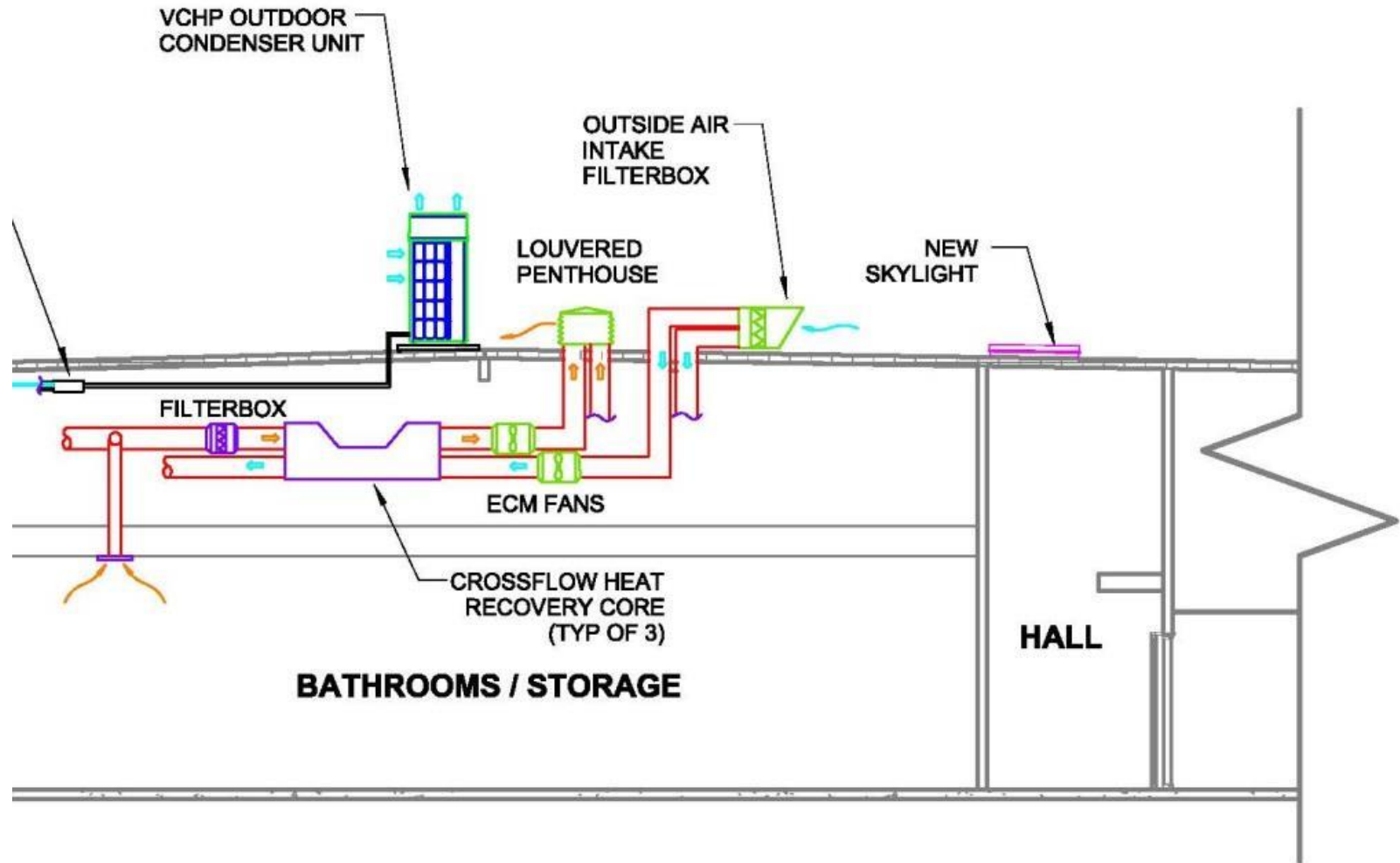


# VRF with Heat Recovery



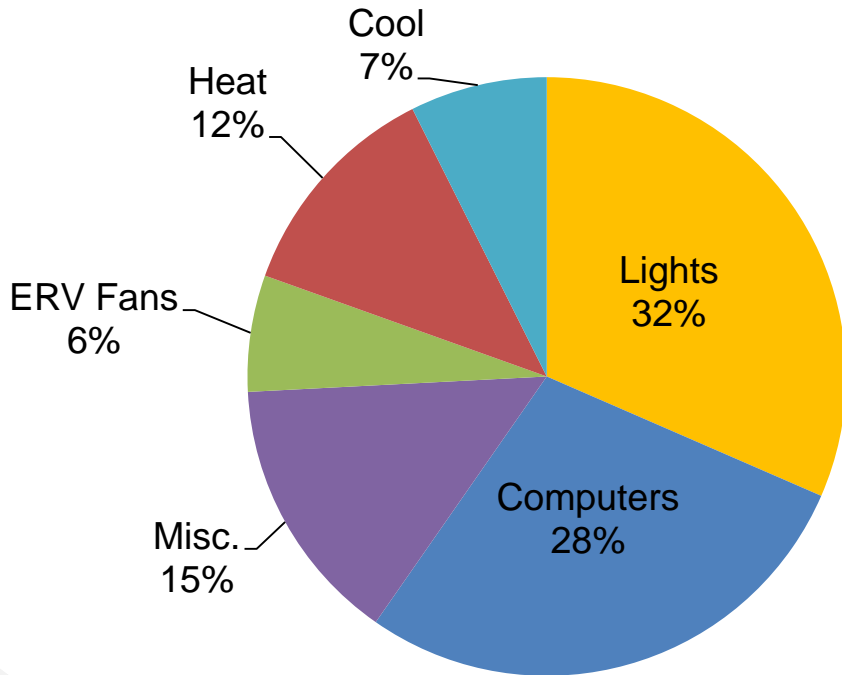
- 48 Tons
- 3 Outdoor Units
- 36 Ductless Units
- 14 Ducted Units
- 50 Zones Total
- 1.33 Ratio Indoor/Outdoor Units

# DOAS via High Efficiency ERV

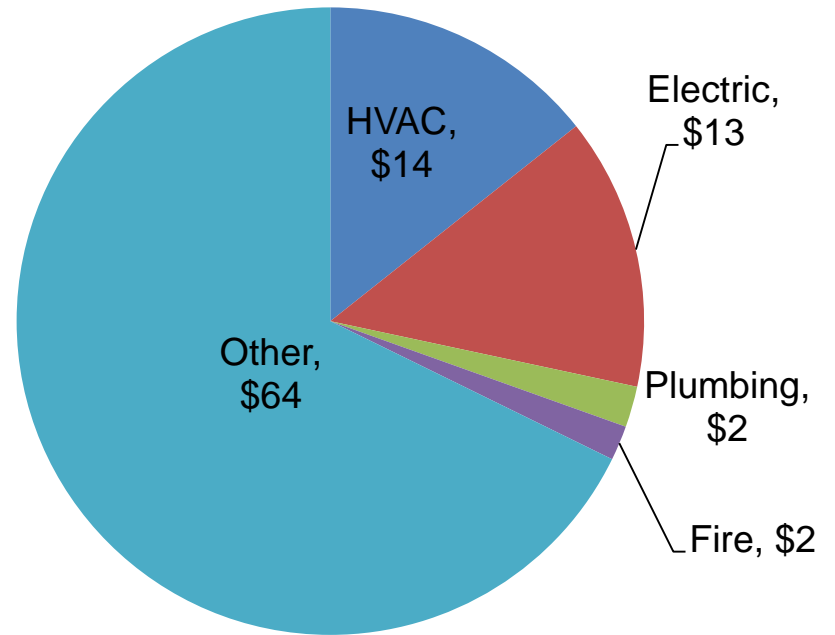


# The Biggest Bang for the Buck

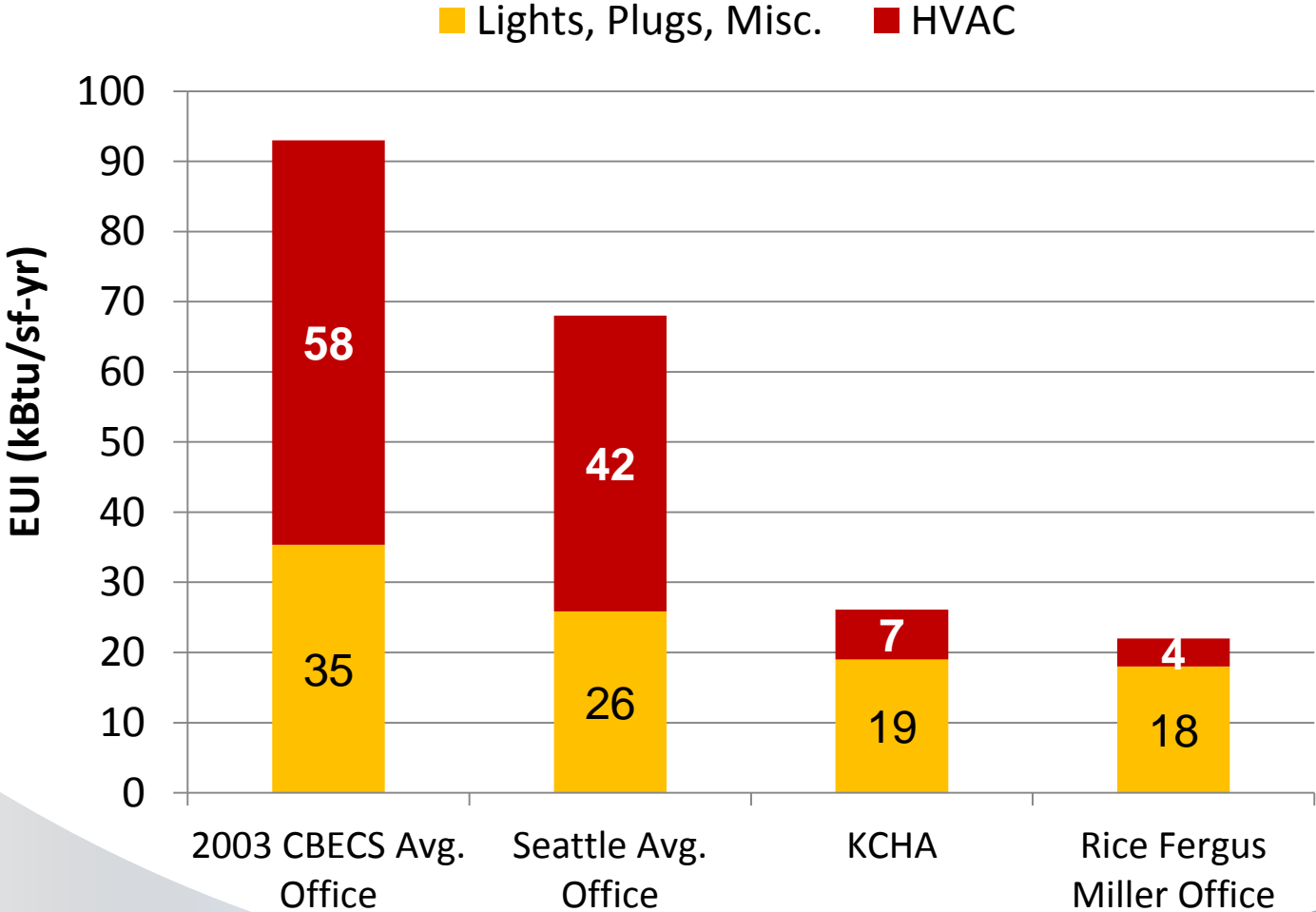
Energy End Use (EUI 27 kBtu/sf-yr)



KCHA Construction Budget (\$95/sf)

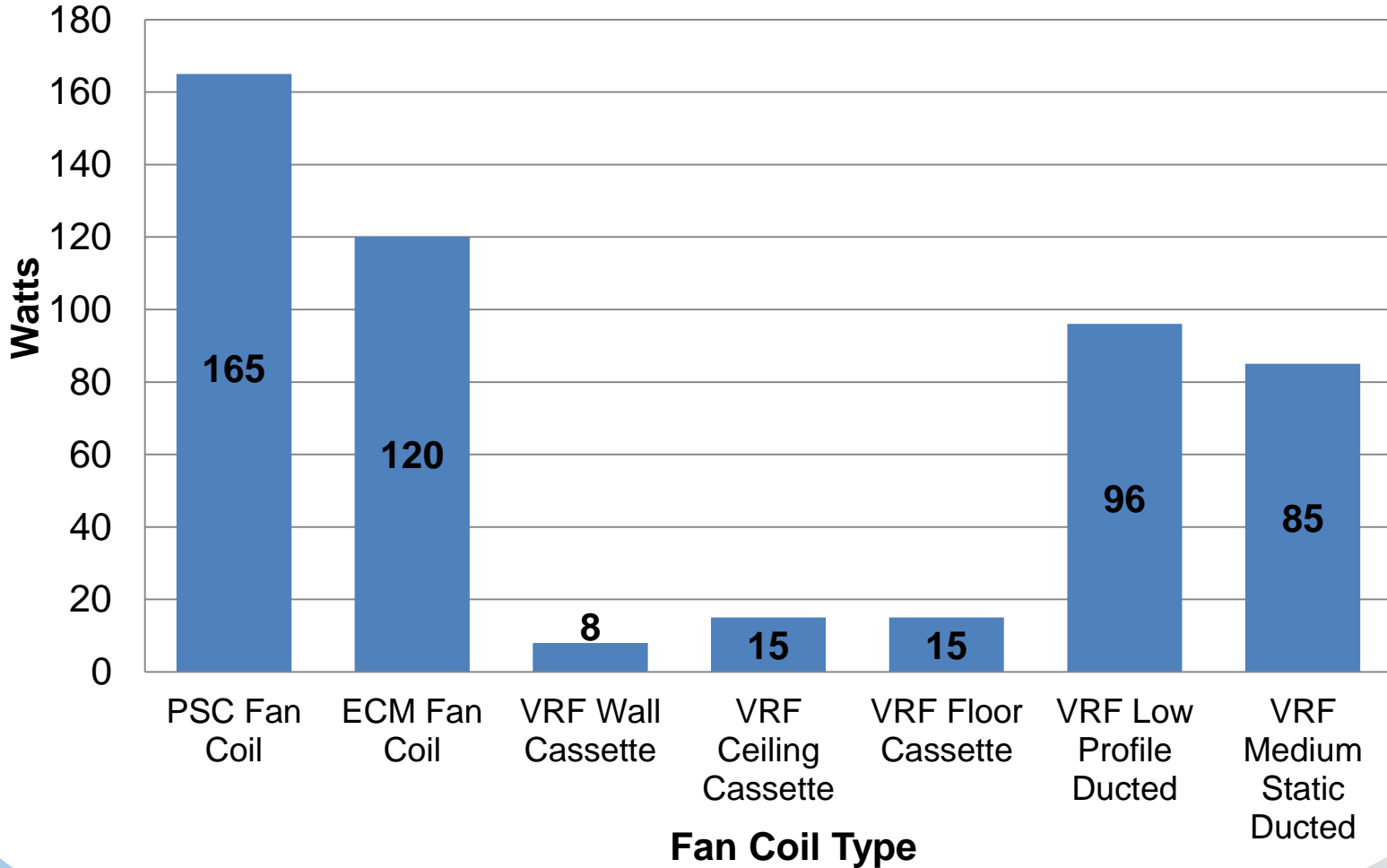


# Why HVAC Matters



# Fan Coil Energy Use

(Fan Watts for delivery of 8000 Btuh cooling)



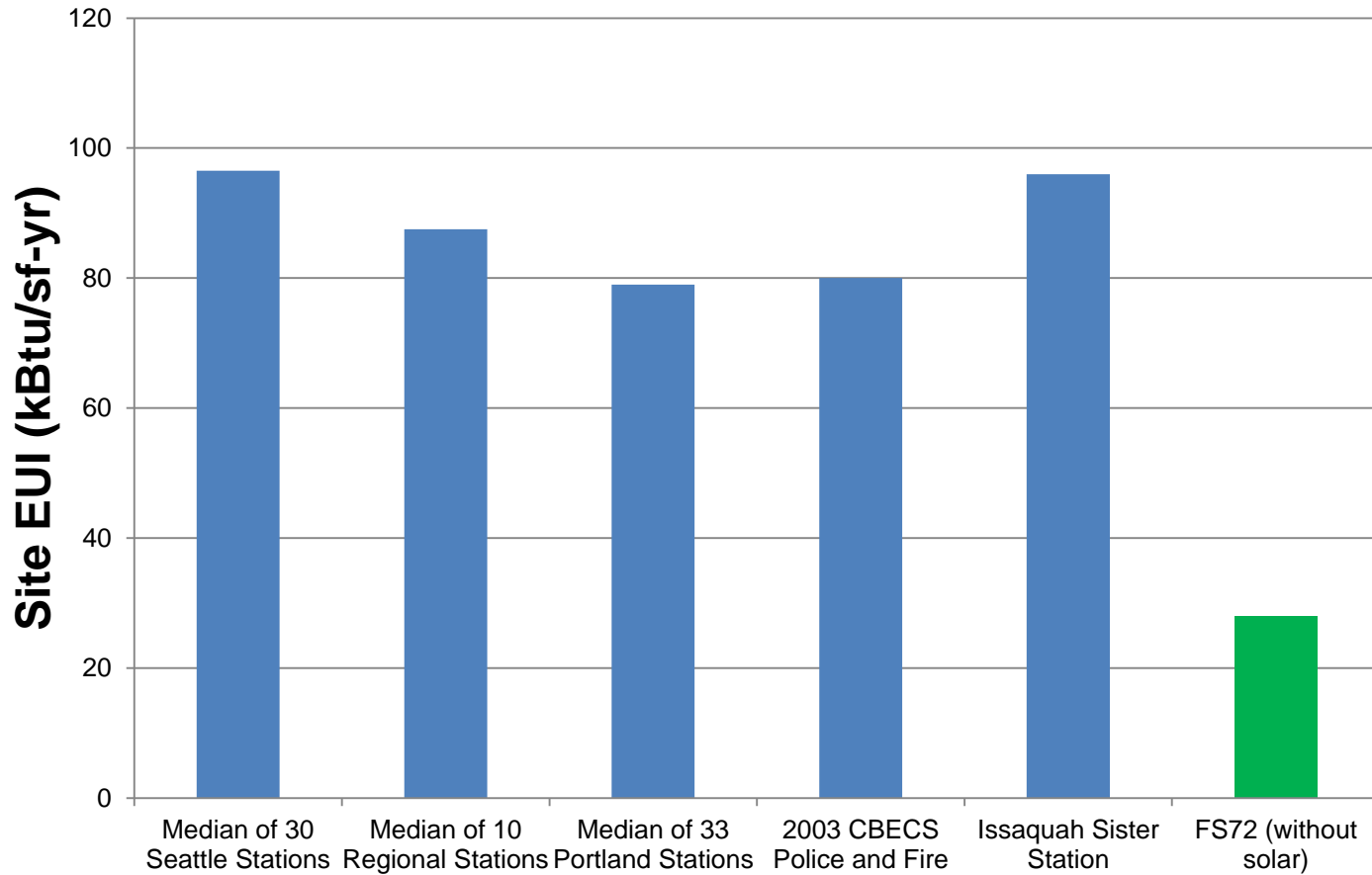


# Fire Station 72. Issaquah, WA



EUI = 29

# EUI of Regional Fire Stations



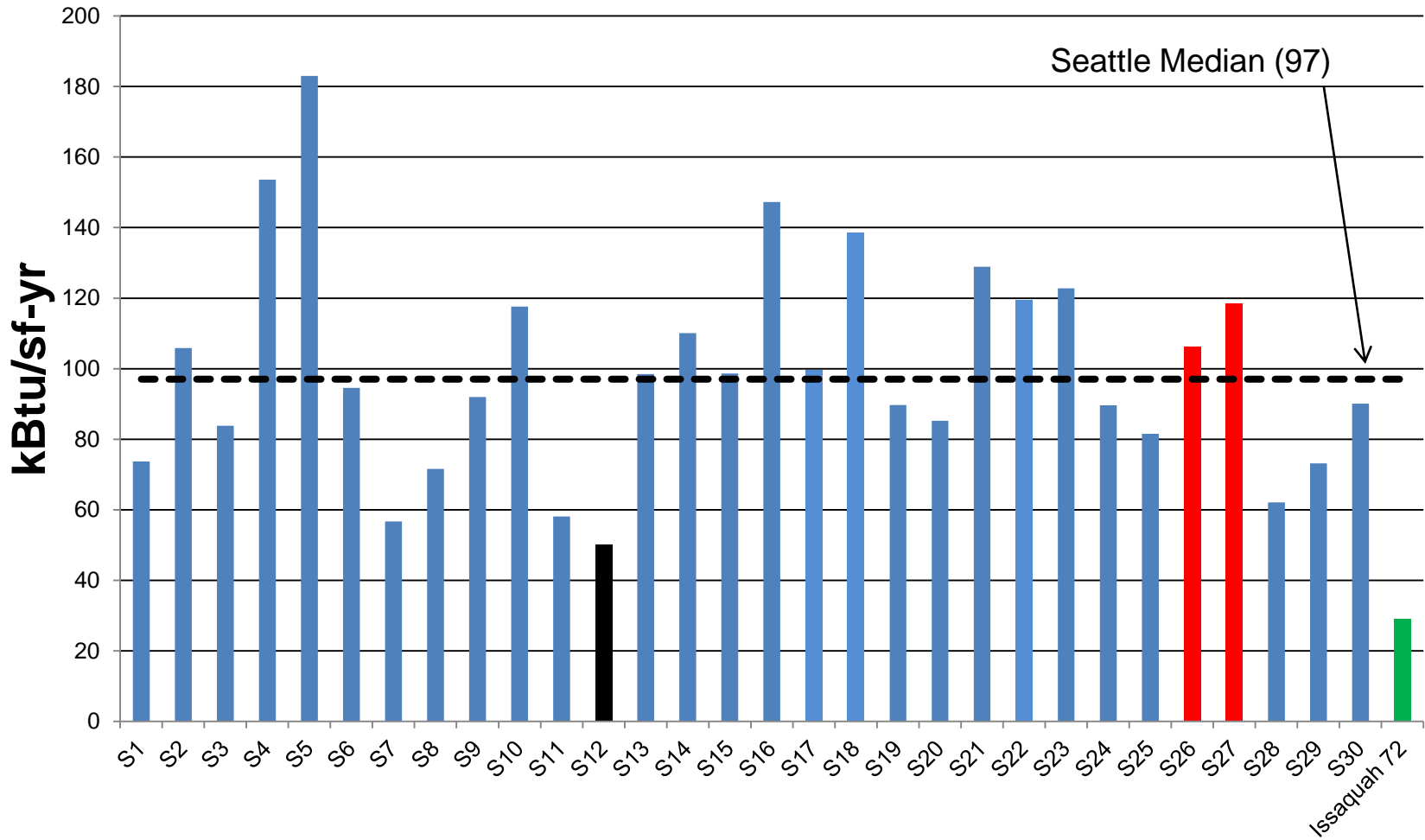
# Right-Sized Geothermal for Space Heating, Cooling, and DHW



Photo: Shawn Oram

- Only 8 geo bores easily fit in parking lot.
- Three identical 5-ton heat pumps
- 1 ton per 1,140 sf for Heating and Cooling
- Zoned Radiant Slabs
- 4-pipe fancoils in sleeping rooms
- DOAS w/ Heat Recovery Ventilation

# EUI of Seattle Fire Stations



# Why are New Stations so Inefficient?

- Continuous ducted central fan systems
- Ventilation at 3x ASHRAE 62
- No heat recovery, electric heat on ventilation air
- Over lit with no occupancy sensors on the lights

# Design for Off

1. Dedicated Outdoor Air System with Energy Recovery or Demand Controlled Ventilation

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DOAS w/ ERV or DCV

# Design for Off

1. Dedicated Outdoor Air System with Energy Recovery or Demand Controlled Ventilation
2. Zoned Heating and Cooling Equipment - Cycling on Load.
3. Limit Ventilation Volumes and HVAC Equipment Sizing to 130% of ASHRAE Standards and Load Calculations



**Questions?**

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