



Lighting Design Lab: **Ecotope's Design For Off™**

Presented by
Jon Heller, Ecotope

October 5, 2023

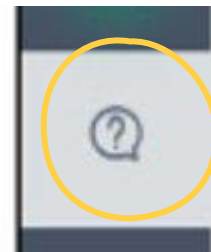
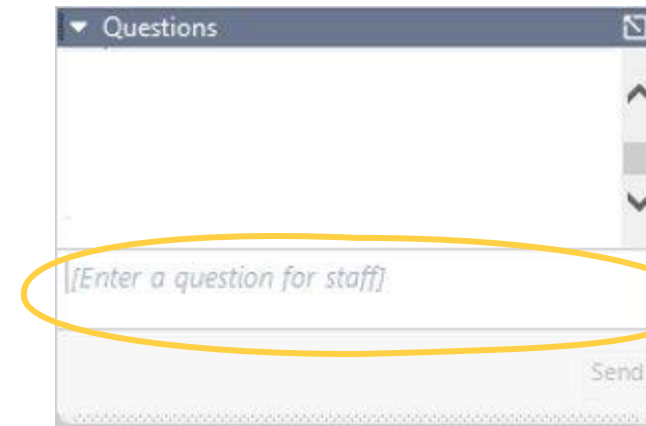


Webinar Procedures

- All attendees are on mute
- Submit questions in Questions tab at any time
- The webinar is being recorded
- Please take the after-class survey!



Click this arrow if you don't see the GoTo toolbar. It might be on your other screen, if you have 2 monitors!



A couple different ways it might look to ask questions

Design for Off™

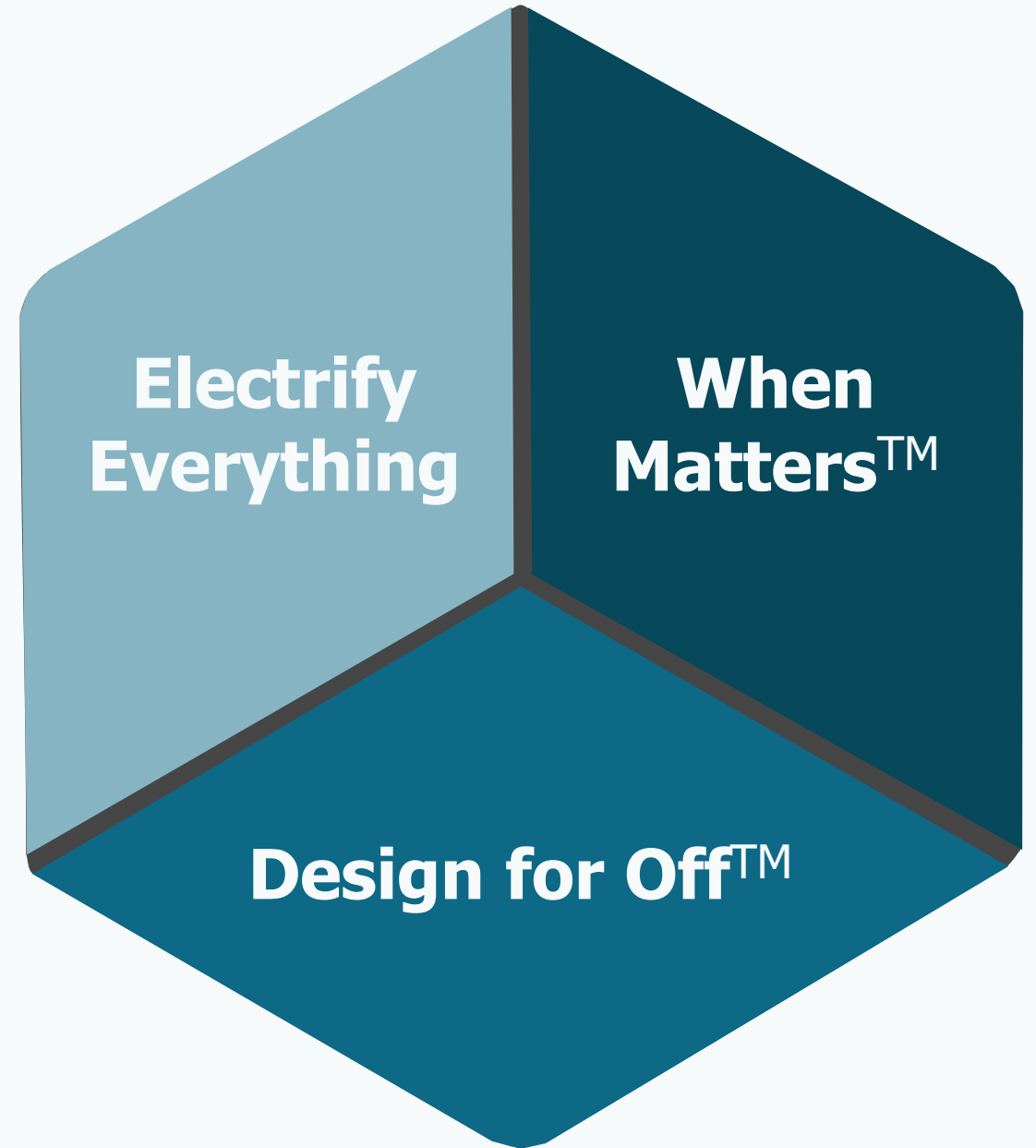
Jon Heller, PE, LEED AP
President

October 5, 2023



Purpose

+ **Leading transformation of the building industry to energy efficient, carbon neutral buildings**



Before and after air conditioning

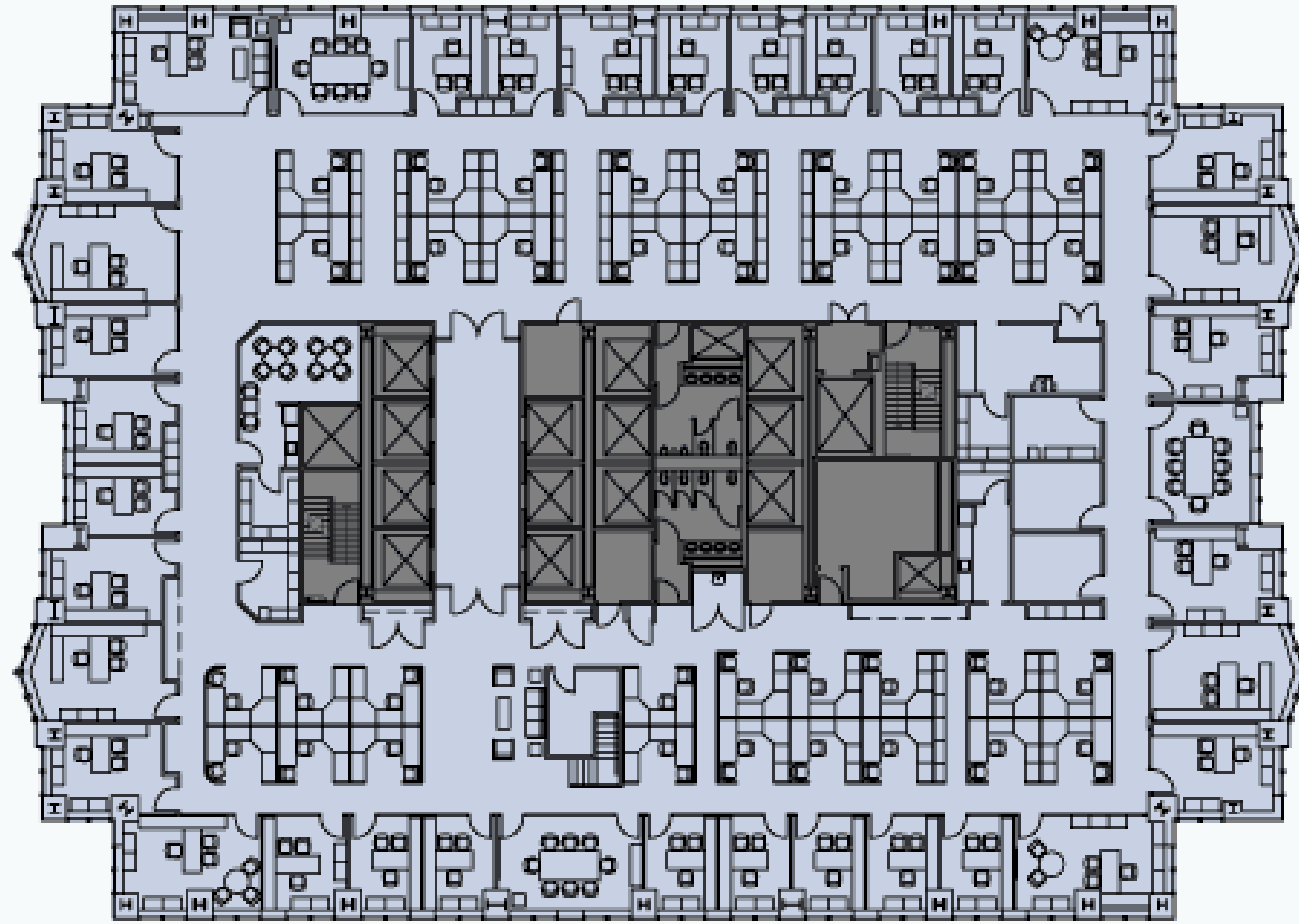


The Arctic Building



The Norton Building

Perimeter offices



SeaFirst Building

+ 1969

+ EUI ~ 100-150 kBtu/sf-yr



Seattle City Hall

+ 2003

+ EUI ~ 75 kBtu/sf-yr



Alley 24

+ 2007

+ EUI \sim 50 kBtu/sf-yr



The Bullitt Center

+ 2013

+ EUI ~ 16 kBtu/sf-yr



The Globe Building

+ 1891

+ EUI ~ 30 kBtu/sf-yr



Lighting progress 1980–2020's



2 W/SF



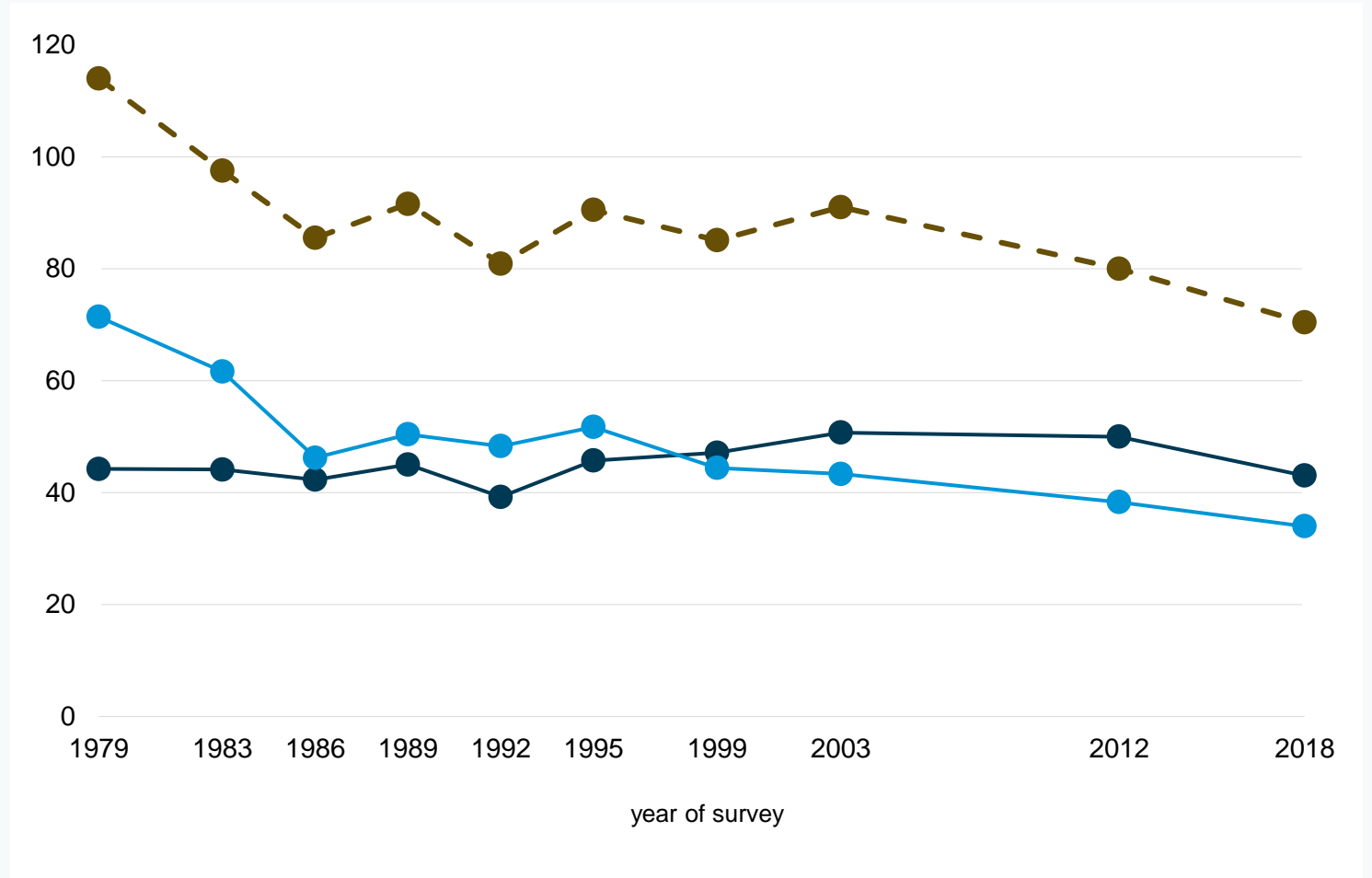
0.5 W/SF

Envelope progress 1980–2020's



Energy intensity in commercial buildings

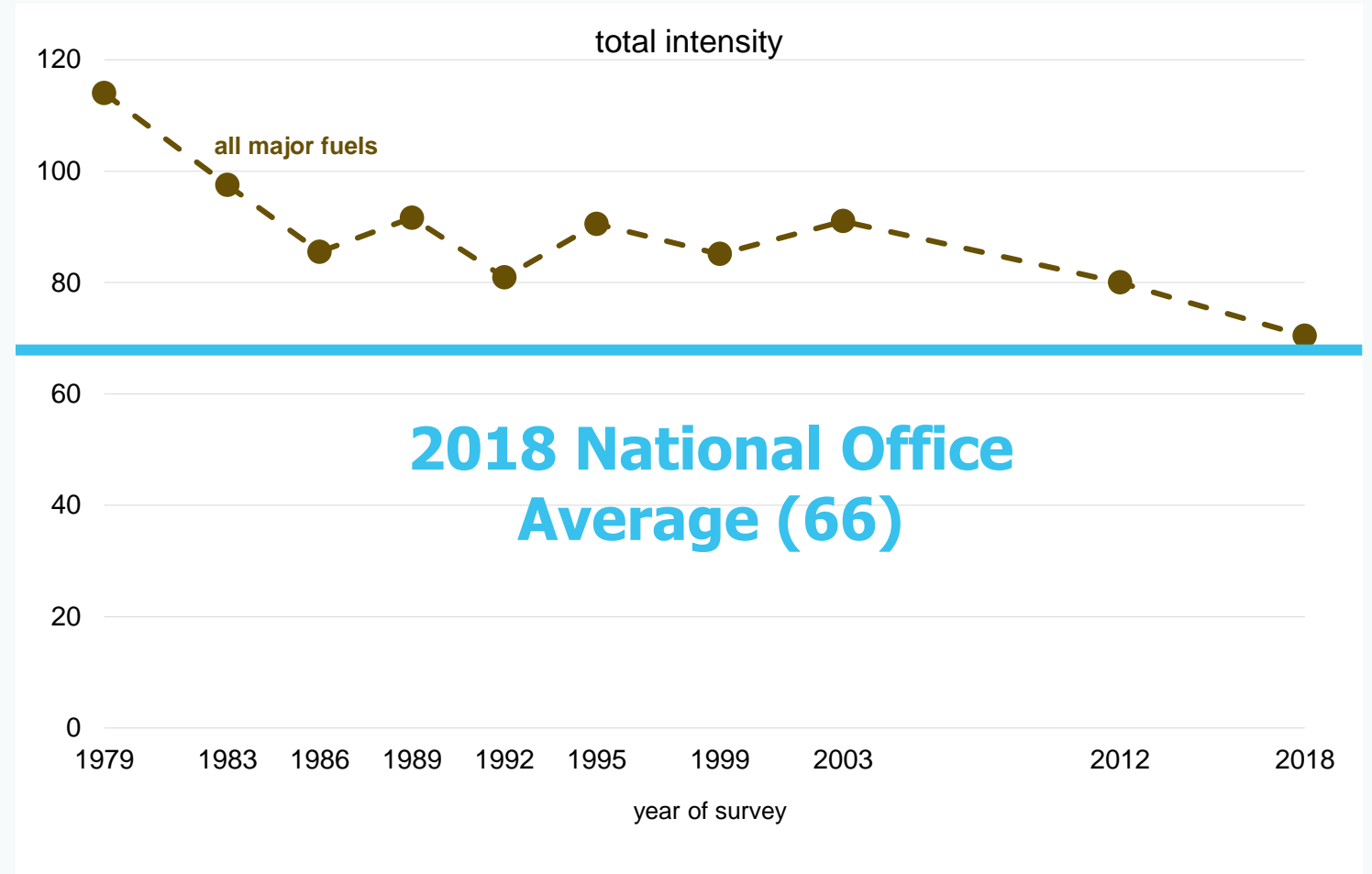
+ **Energy intensity by select fuels, 1979–2018**
thousand British thermal units per square foot



Data source: U.S. Energy Information Administration, *Commercial Buildings Energy Consumption Survey*

Energy intensity in commercial buildings

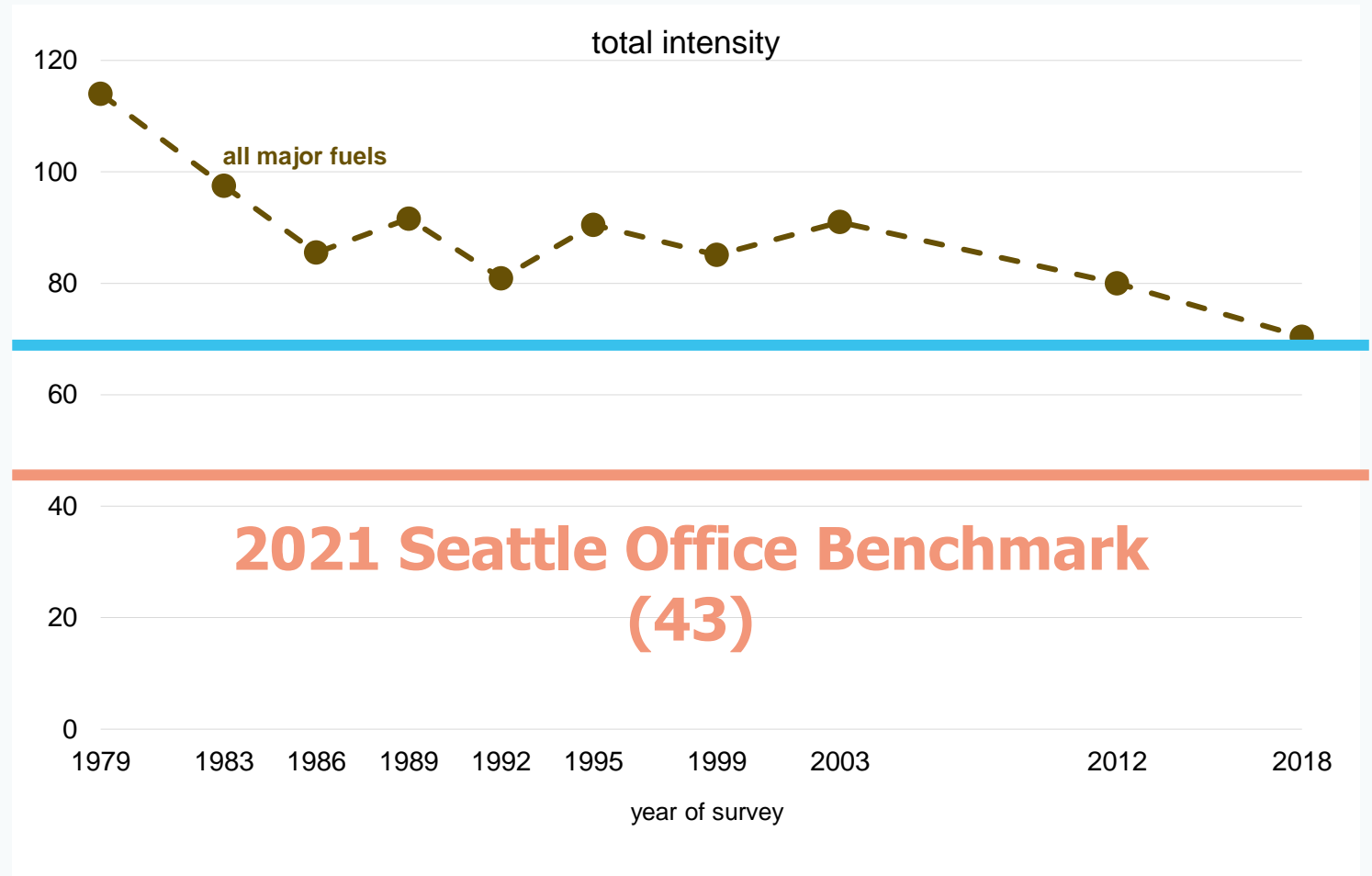
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Energy intensity in commercial buildings

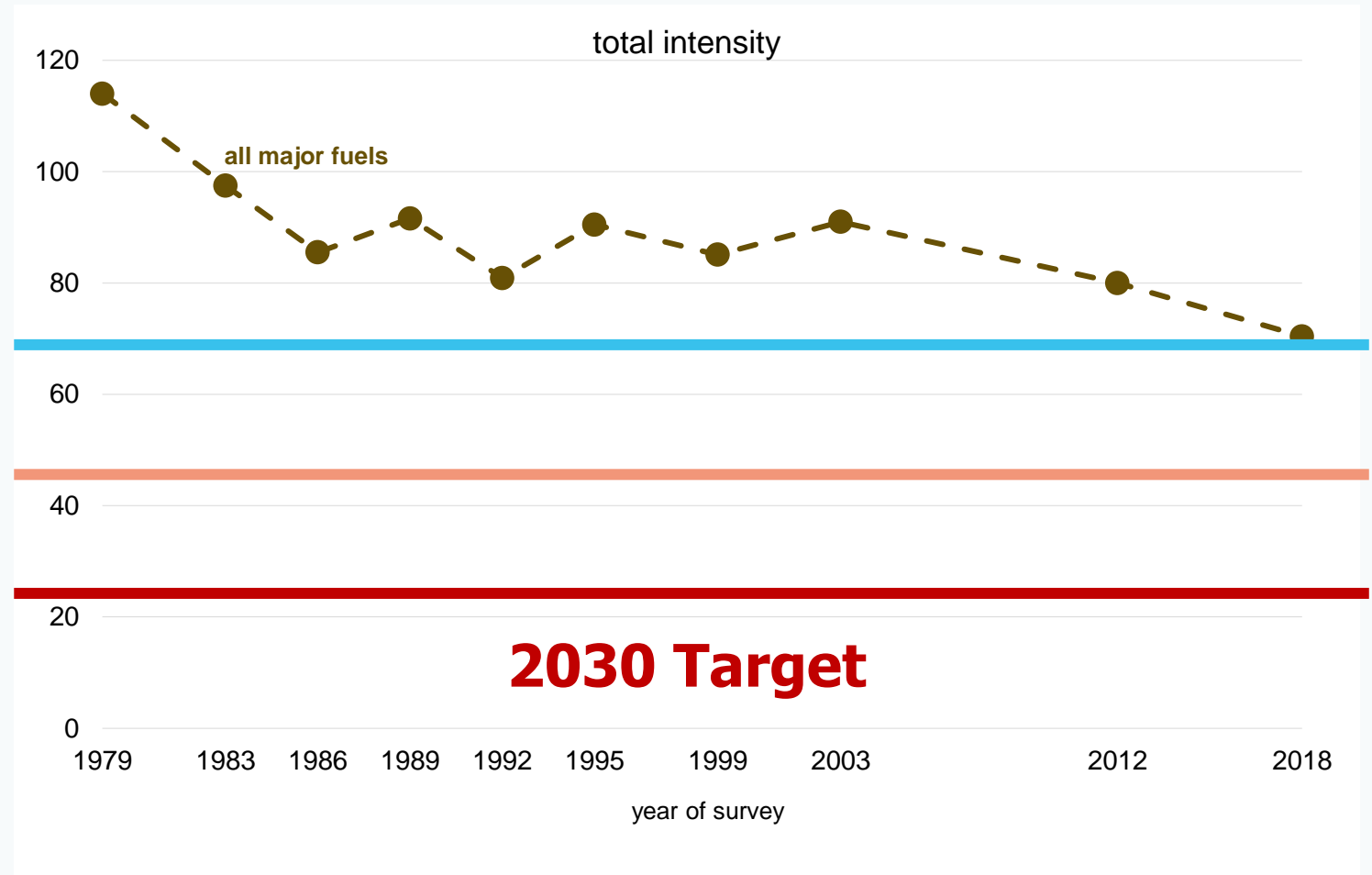
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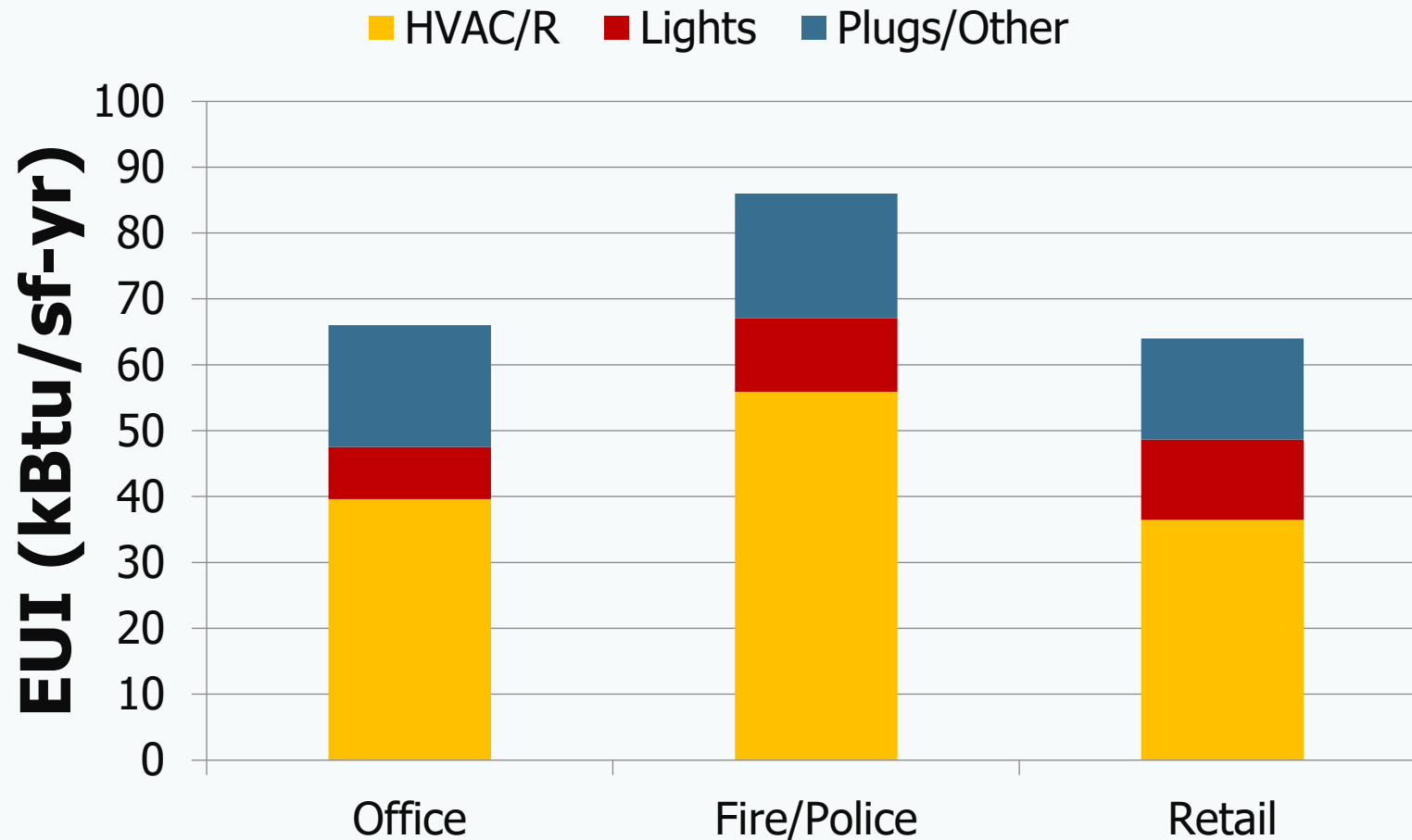
Energy intensity in commercial buildings

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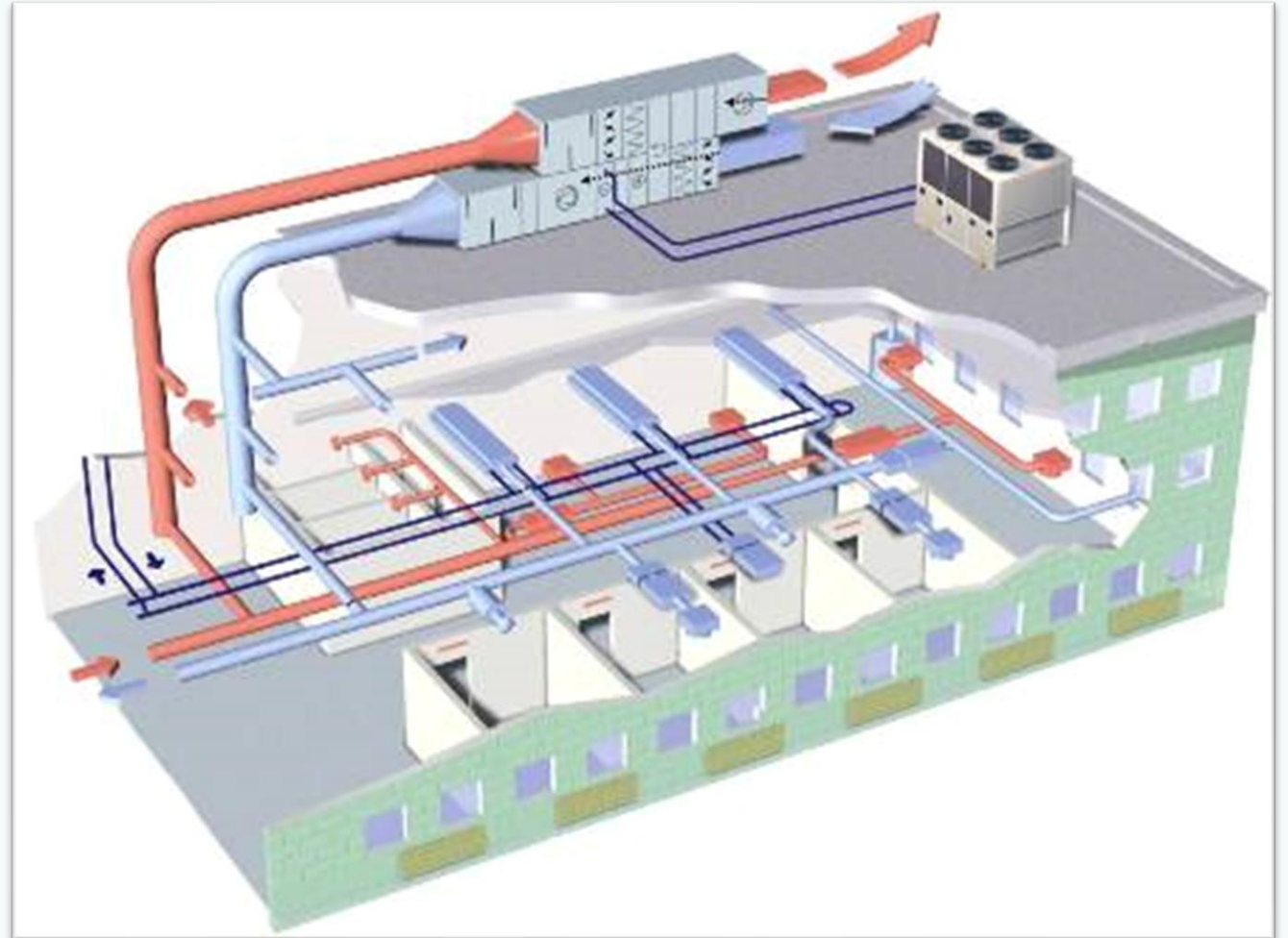
Data source: U.S. Energy Information Administration, *Commercial Buildings Energy Consumption Survey*

End use breakdown for average commercial buildings

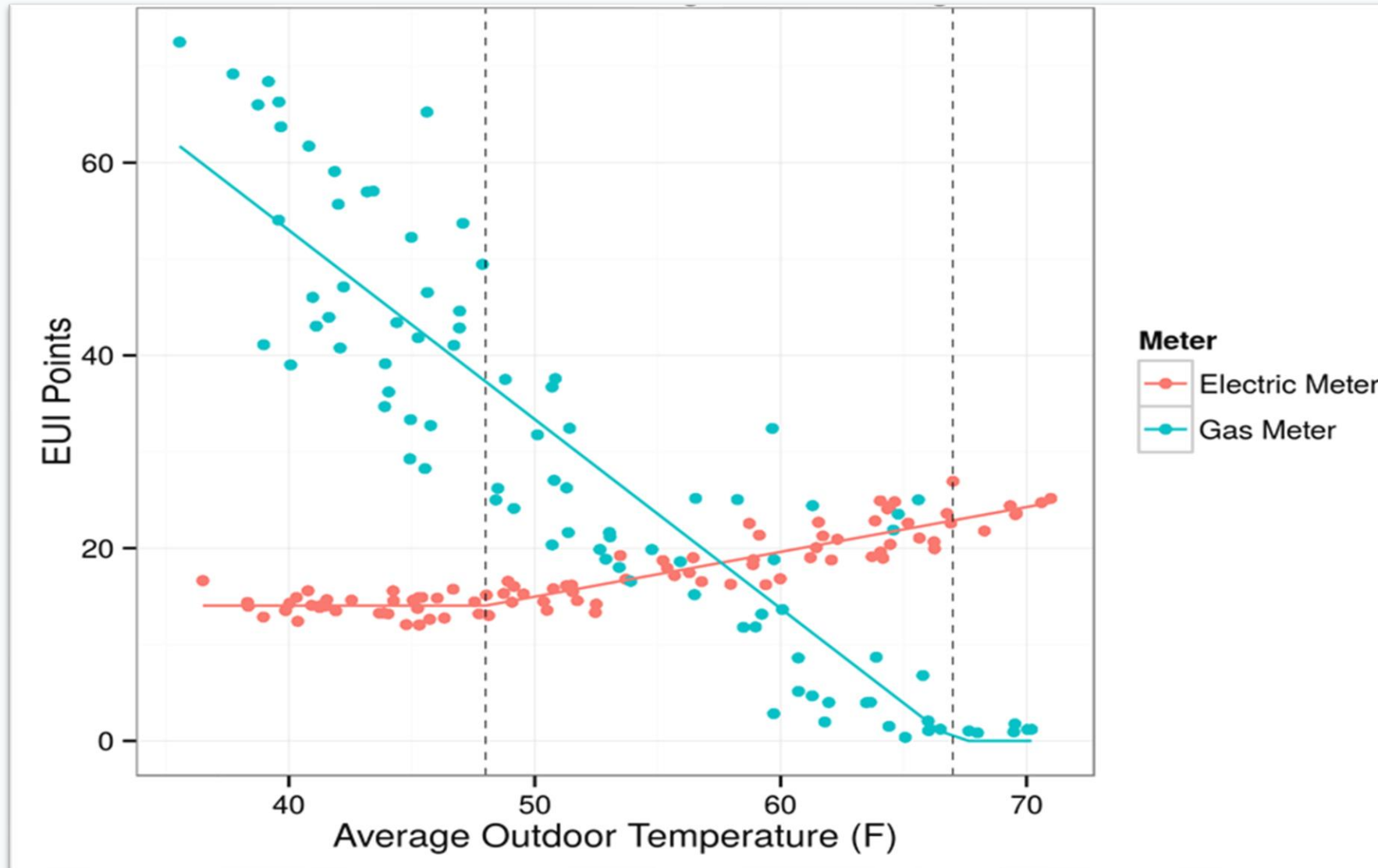


Typical modern HVAC design

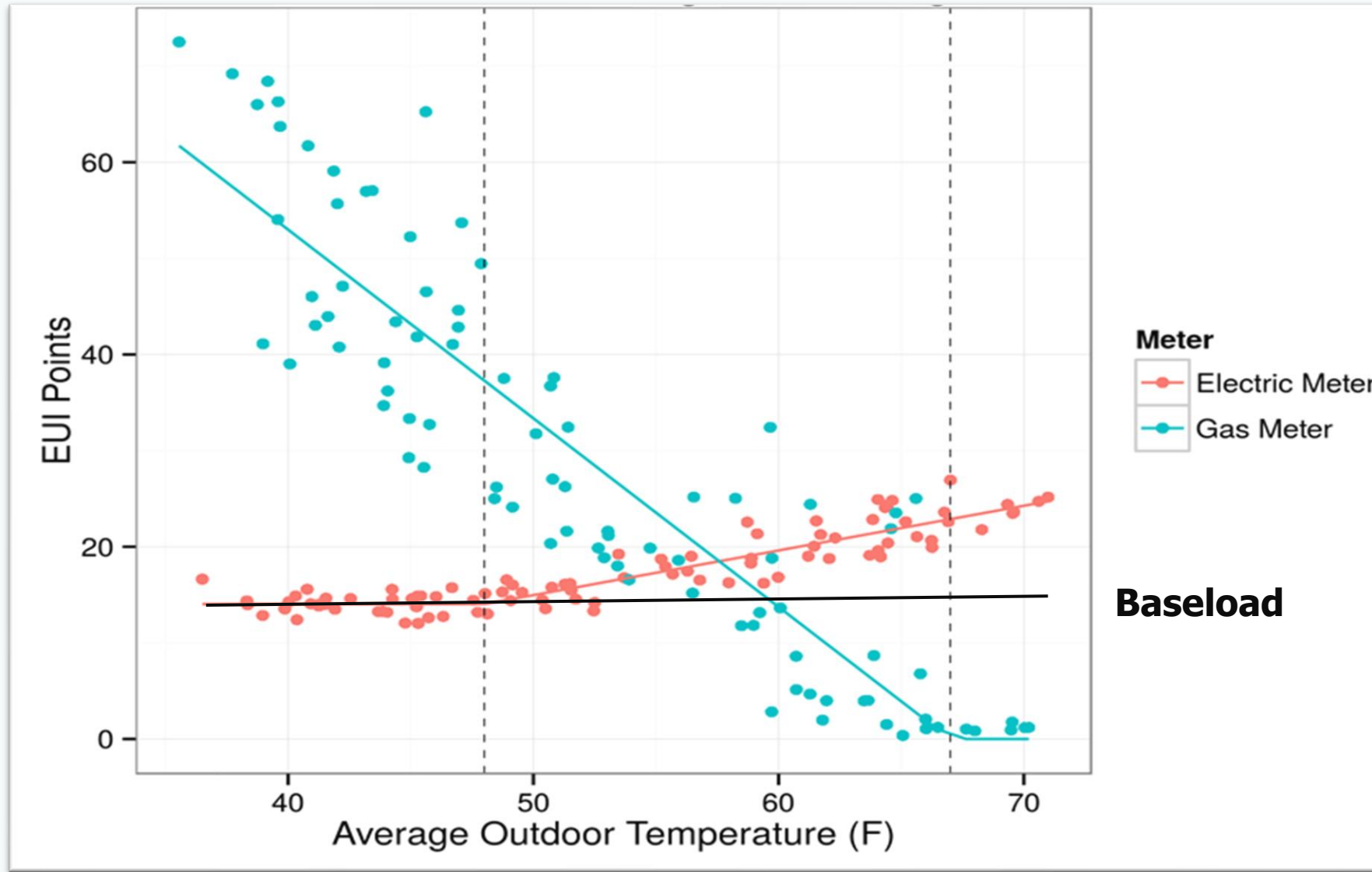
- + **All-in-one HVAC**
- + **Large central fan-forced rooftop equipment**
- + **Multiple zones with tight temperature settings**
- + **Zonal reheat**
- + **If some is good, more is better "Factor of Safety"**



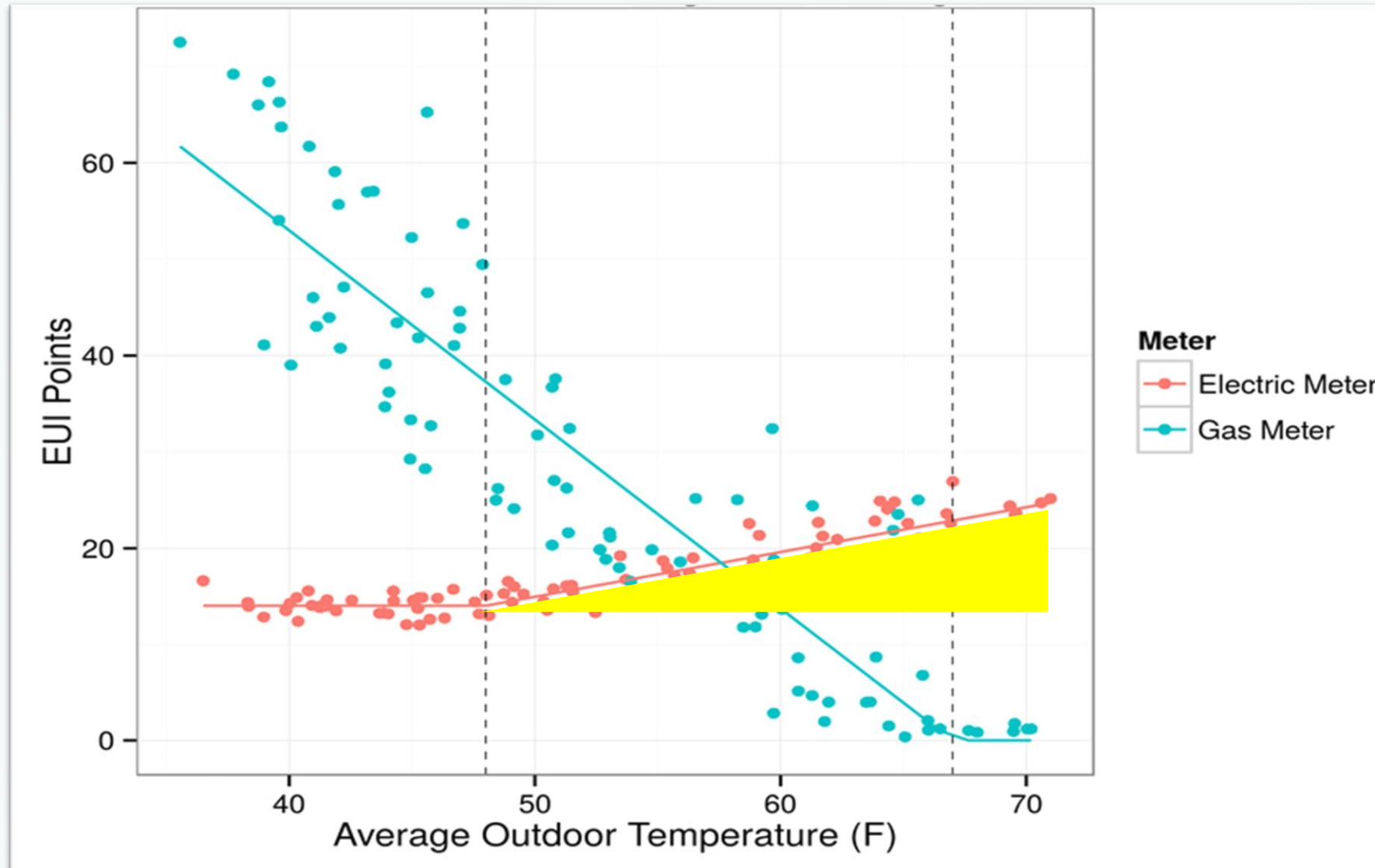
Simultaneous heating and cooling



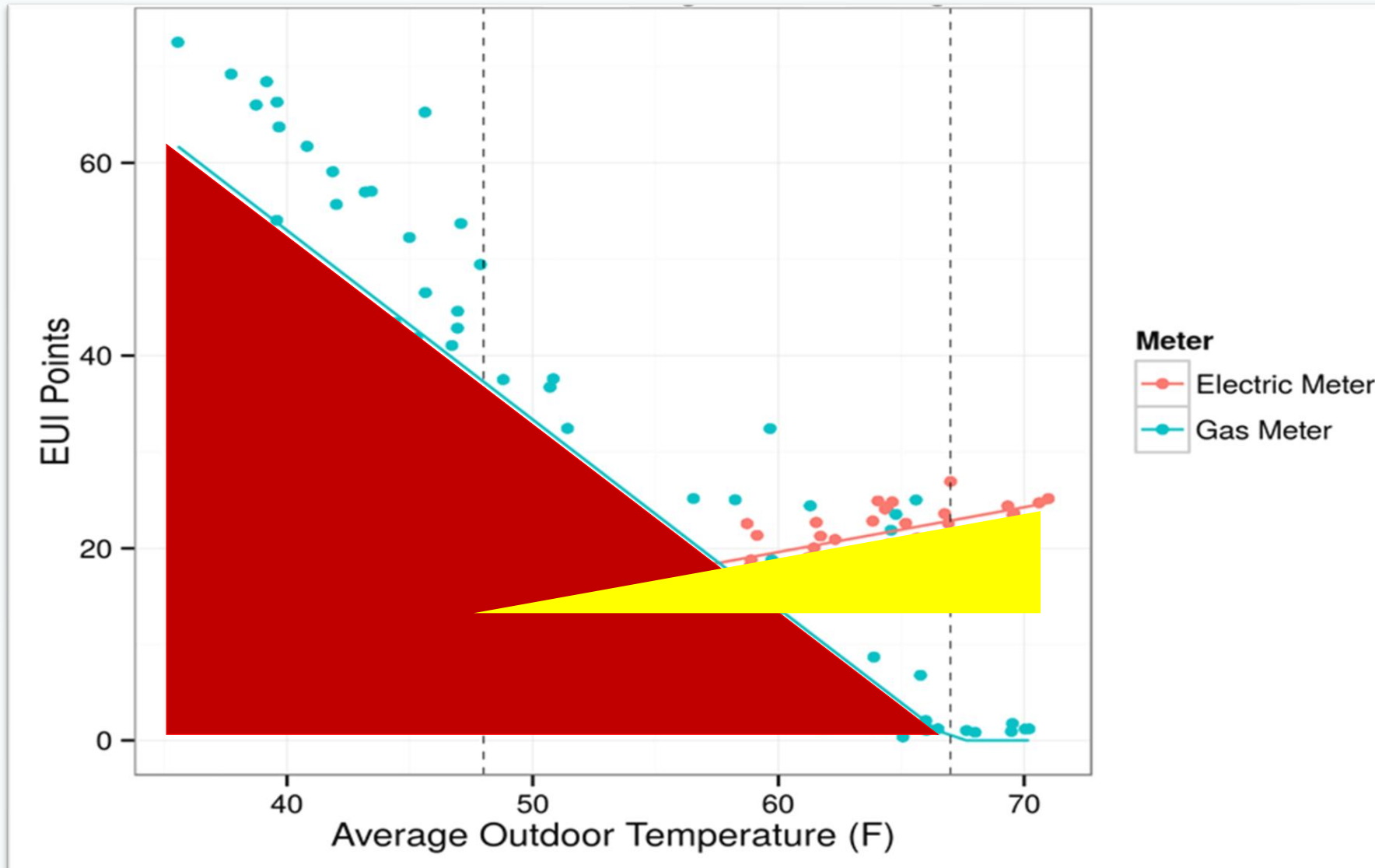
Simultaneous heating and cooling



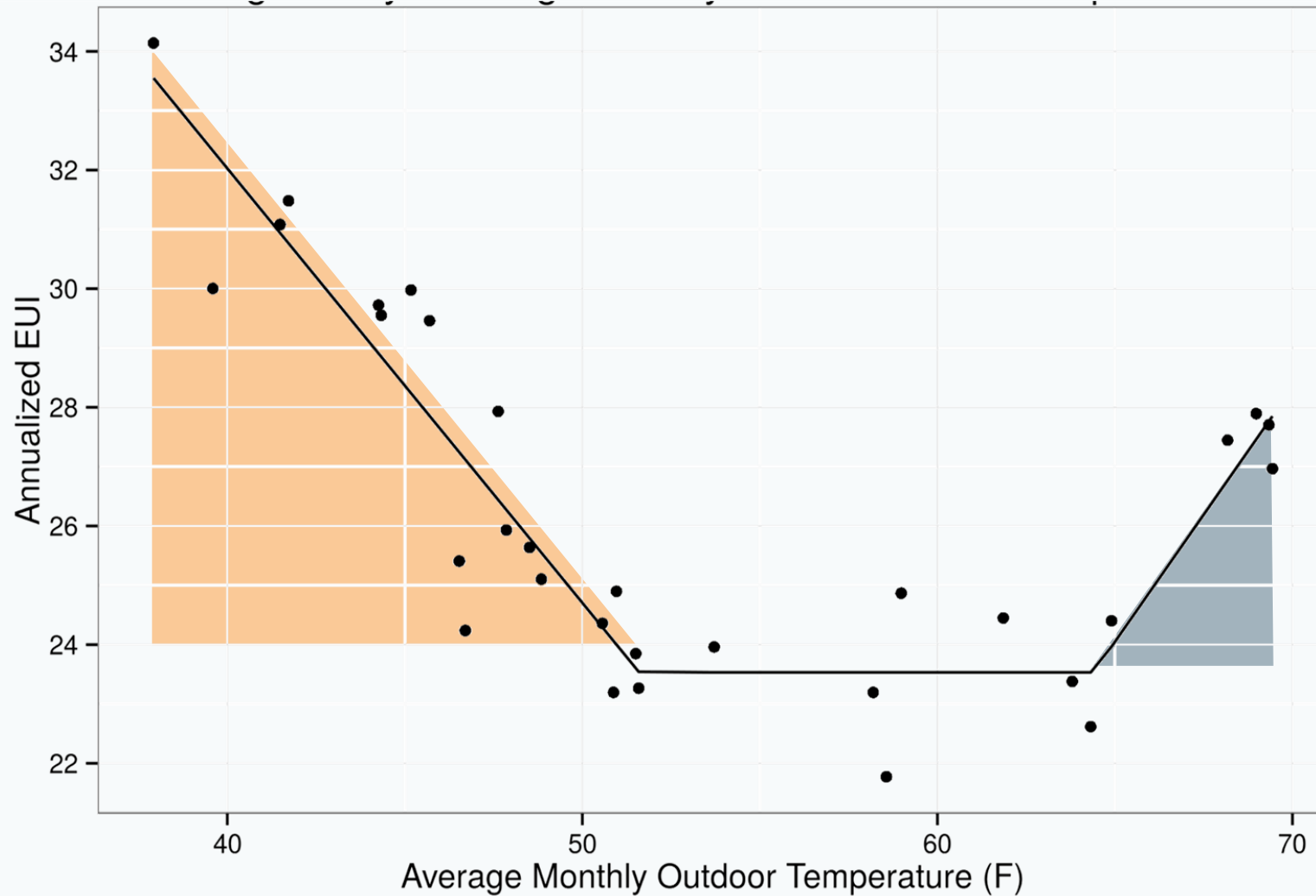
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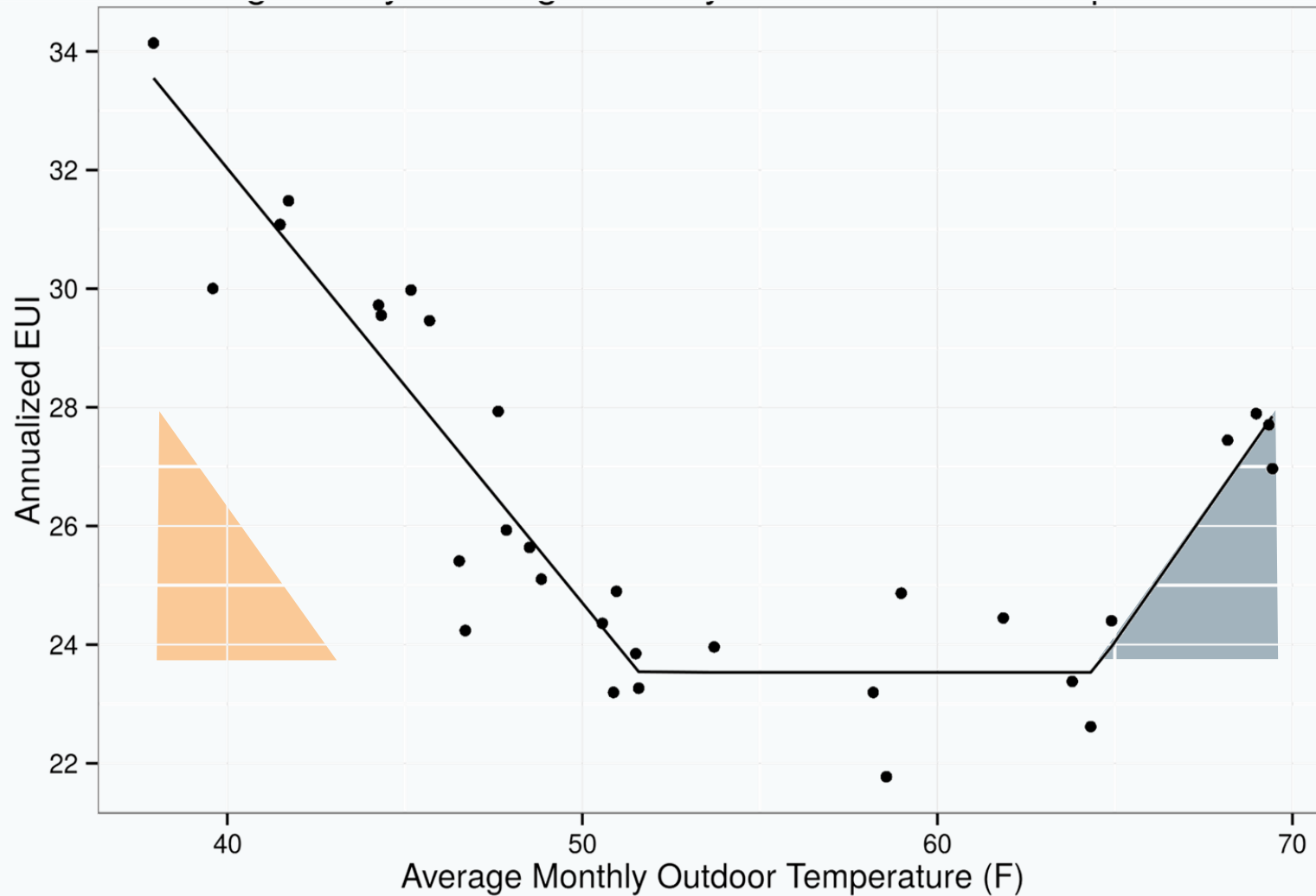
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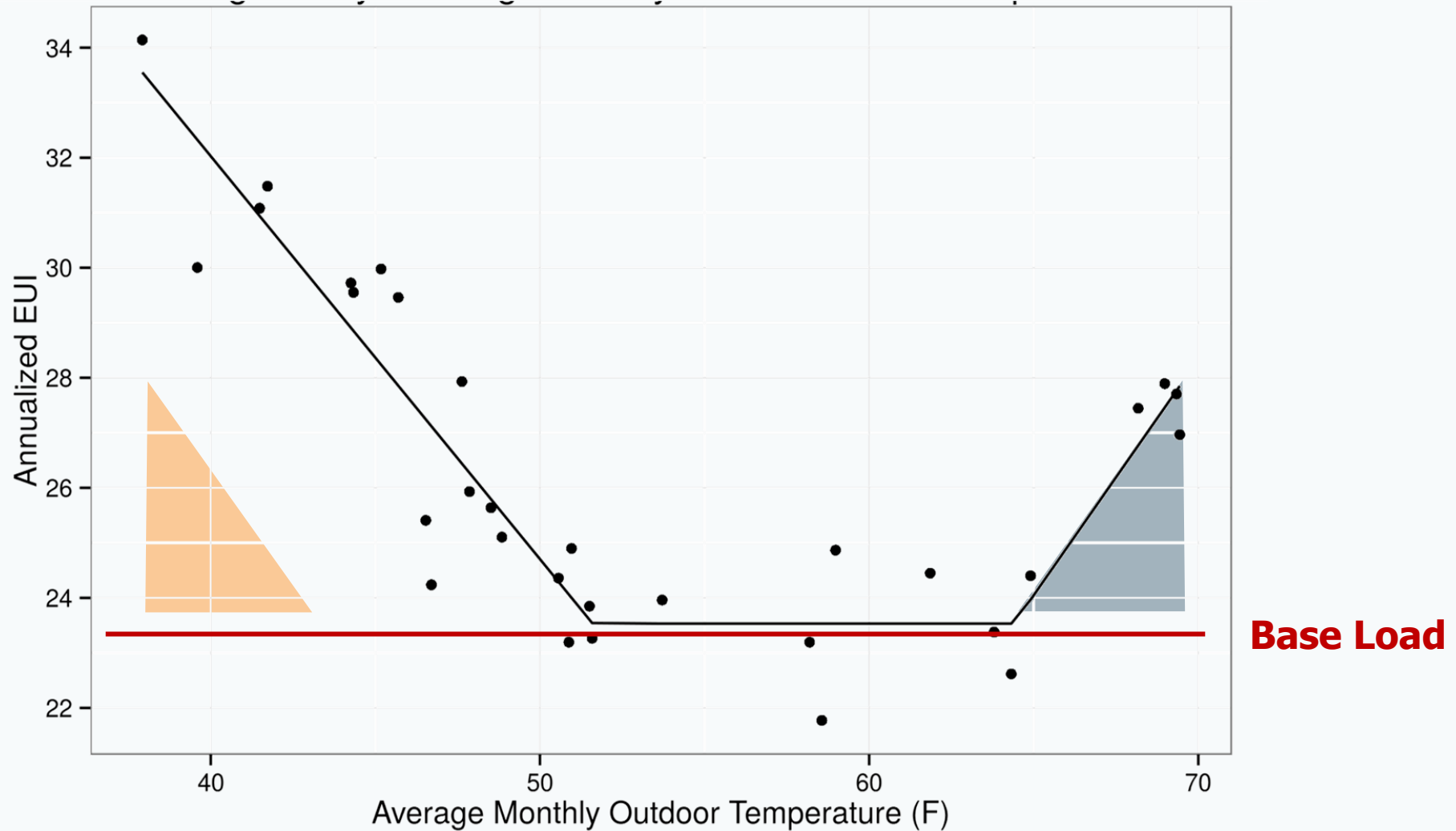
Impact of Design for Off™



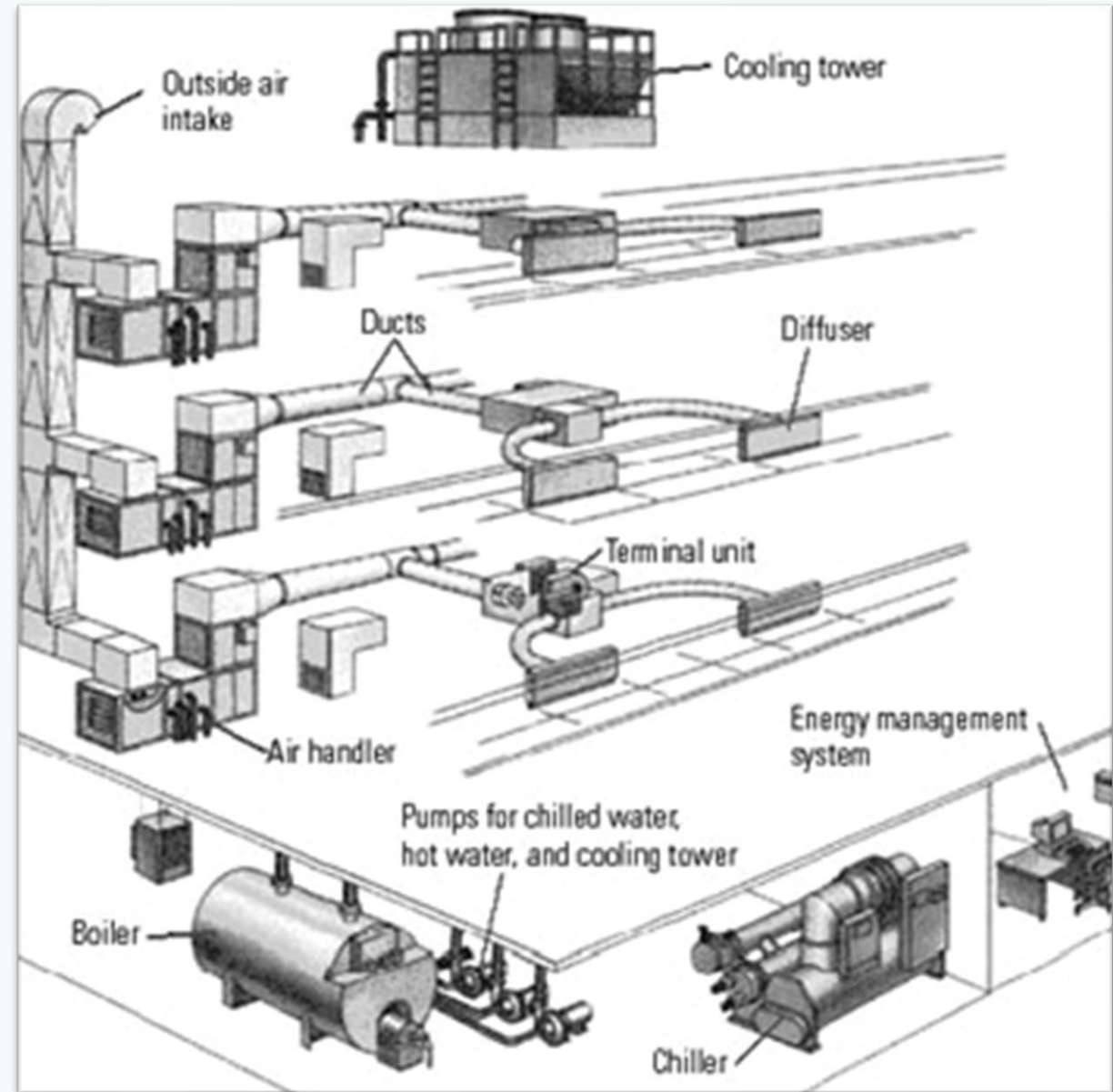
Design for Off™ w/super insulation



Design for Off™ w/super insulation



1 – move away from large central HVAC systems



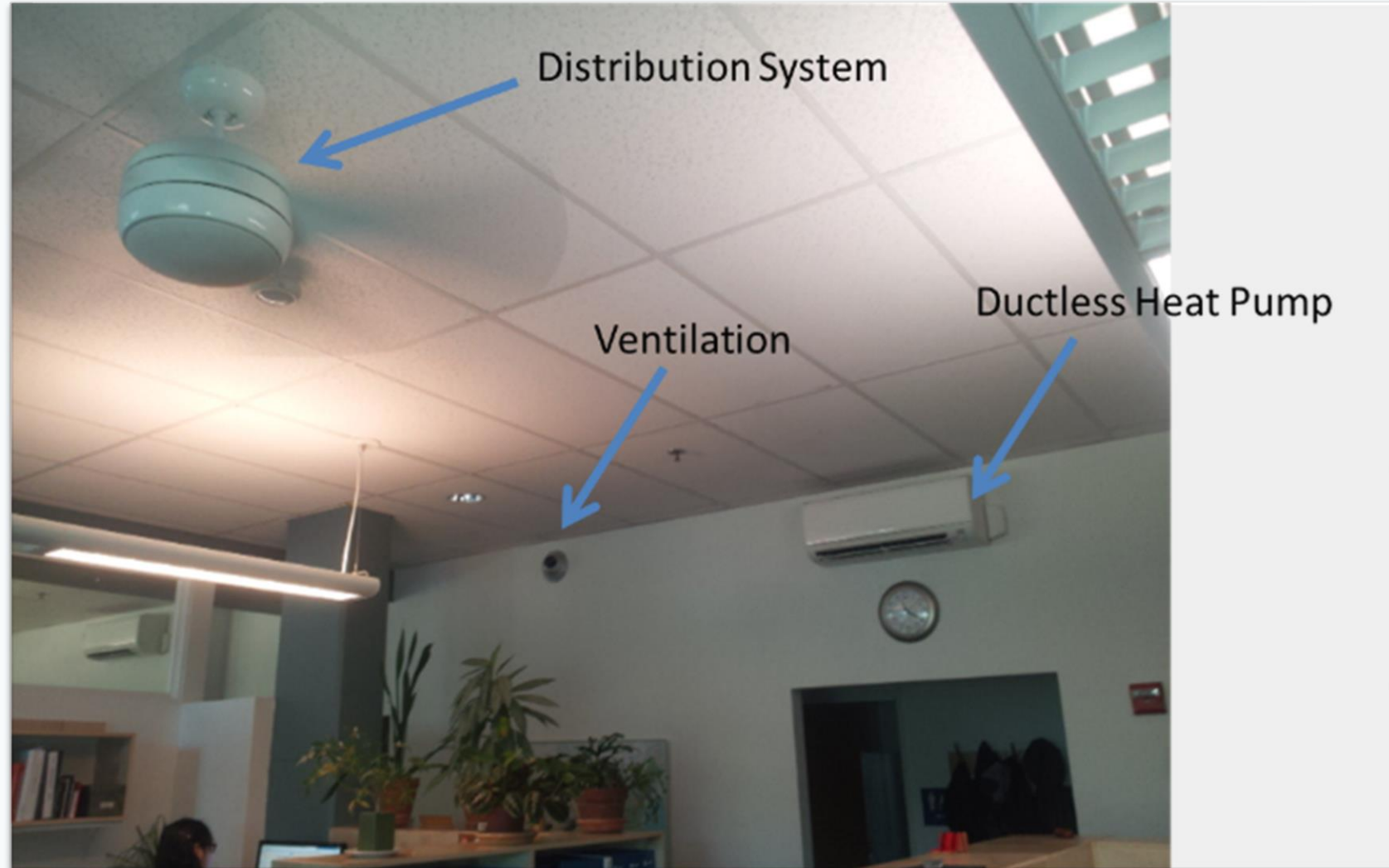
Towards smaller zonal systems



2 – move away from all-in-one HVAC systems



Towards dedicated ventilation systems (DOAS)



3 – right-size mechanical systems



Believe (do) the load calculations



Design for Off™

Design for Off™

**1.
Separate
ventilation
from heating
and cooling
(provide
ventilation
with HRV)**

**2.
Zonal heating
and cooling
equipment
(cycling on
load)**

**3.
Right sizing of
equipment
(ventilation
and heat/cool)**

A building design approach focused to turn systems off by design

High performance envelopes

Drive down the balance point to turn off heating and cooling for most of the year; improve comfort with stable temperatures

High performance ERV's/HRV's

Turn off heating or cooling equipment

Smaller zonal systems

For heating and cooling, cycle heating and cooling systems on a call from a thermostat; do not run fans continuous

5-10°F deadband

Between heating and cooling setpoints; this will turn off excessive simultaneous heating and cooling

Right size equipment

Reduces excessive energy usage due to short cycling and excessive fan energy

Demand control ventilation

Based on CO2 levels, turns off excessive fan energy

Daylighting controls

Use to turns off lights



Rice Fergus Miller, Inc.

**“We put a down
jacket on it and
turned it off”**

-Greg Belding, Principal
Architect, RFM



**Electrify Buildings
+ Design for Off**



EUI: 18.2 kBtu/sf/yr

- + **30,000 SF, 3-story office building**
- + **Located in Bremerton, WA.**
- + **Existing Sears warehouse**
- + **Deep green retrofit**
- + **Net zero energy ready**
- + **\$105/SF costs to renovate**
- + **LEED Platinum**
- + **Rainwater harvesting**



RFM Office
Bremerton, WA



Accomplishments through innovation

- + #1 energy performance in the PNW
- + Energy consumption reduced by 78% below CBEC standard (\$24K savings/yr)
- + Top 4 U.S. highest scoring LEED Platinum NC v2009
- + Harnessed embodied energy (saved 58% in construction costs)
- + Most passive building in the PNW
- + 1st U.S. renovation highest scoring LEED Platinum NC v2009 (92 points)
- + Extreme sustainability at \$105/SF
- + Net zero ready
- + Water consumption reduced by 70%
- + 95% construction waste diverted from landfill

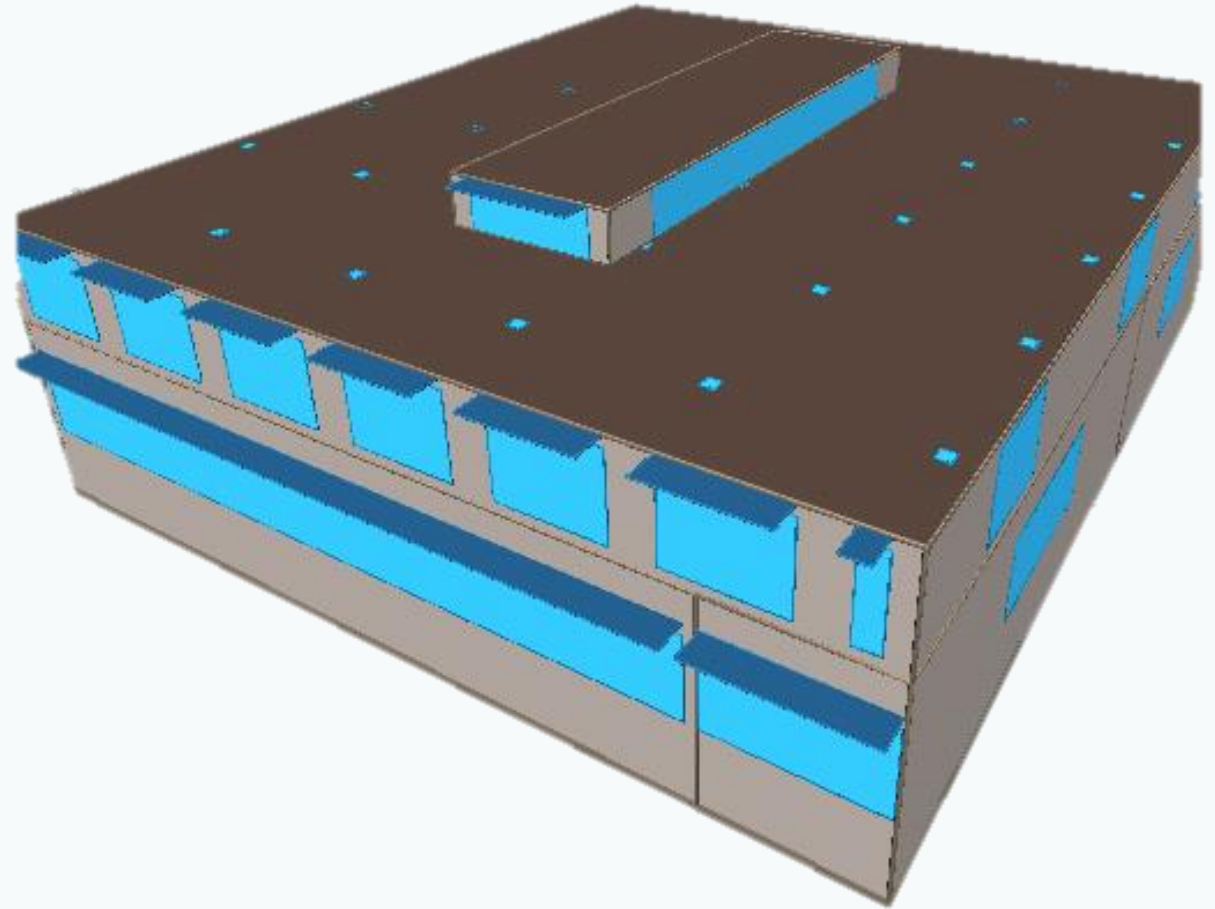


+ **Load reduction measures**

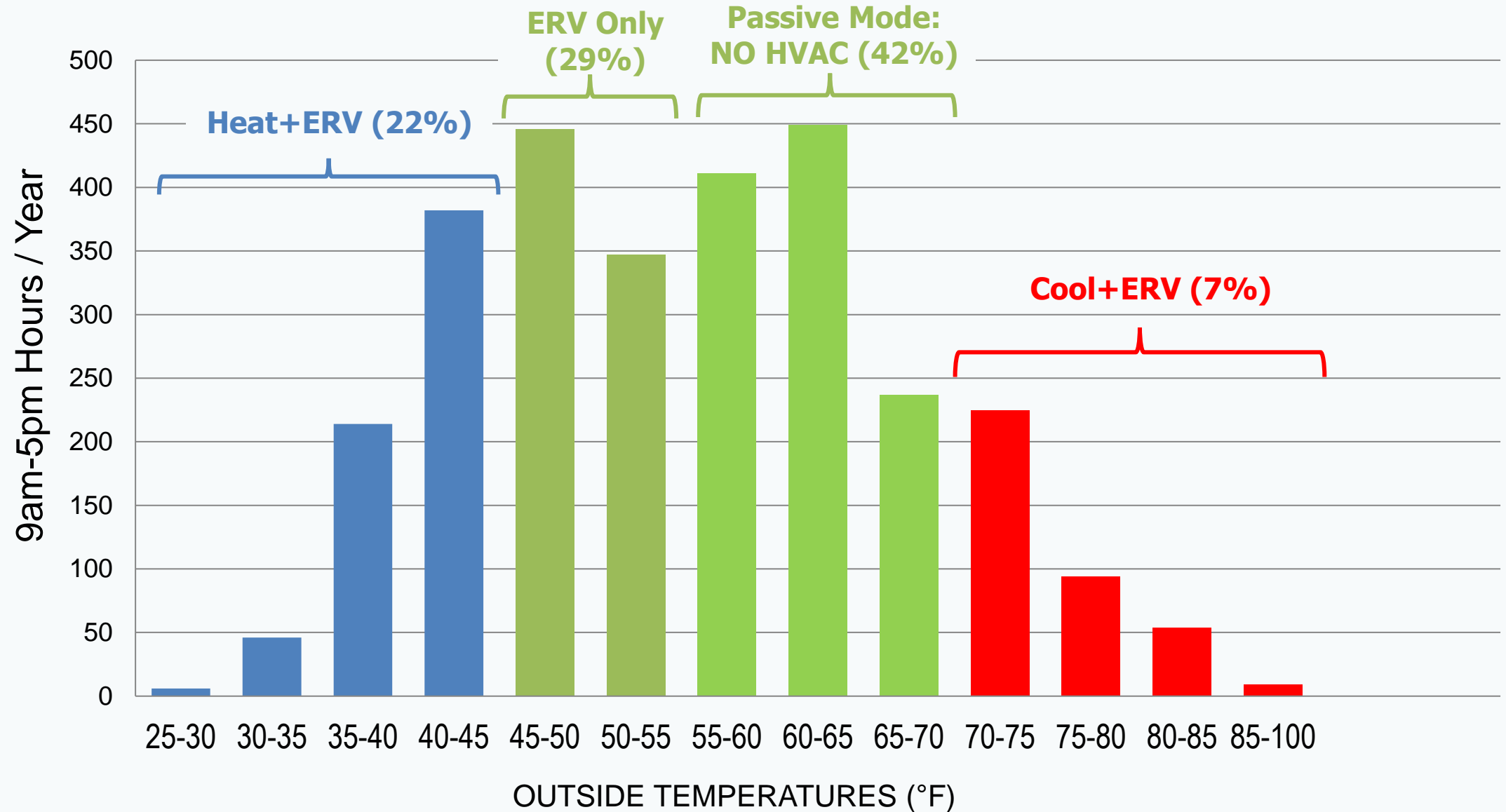
- **Super-insulation**
- **20% glazed (WWR)**
- **Heat recovery ventilation**

+ **HVAC systems**

- **Zonal heat pumps**
- **Energy recovery ventilators**
- **14 FT Big Ass Fan**
- **Natural ventilation (passive mode)**
- **Red/green lights for window operation**



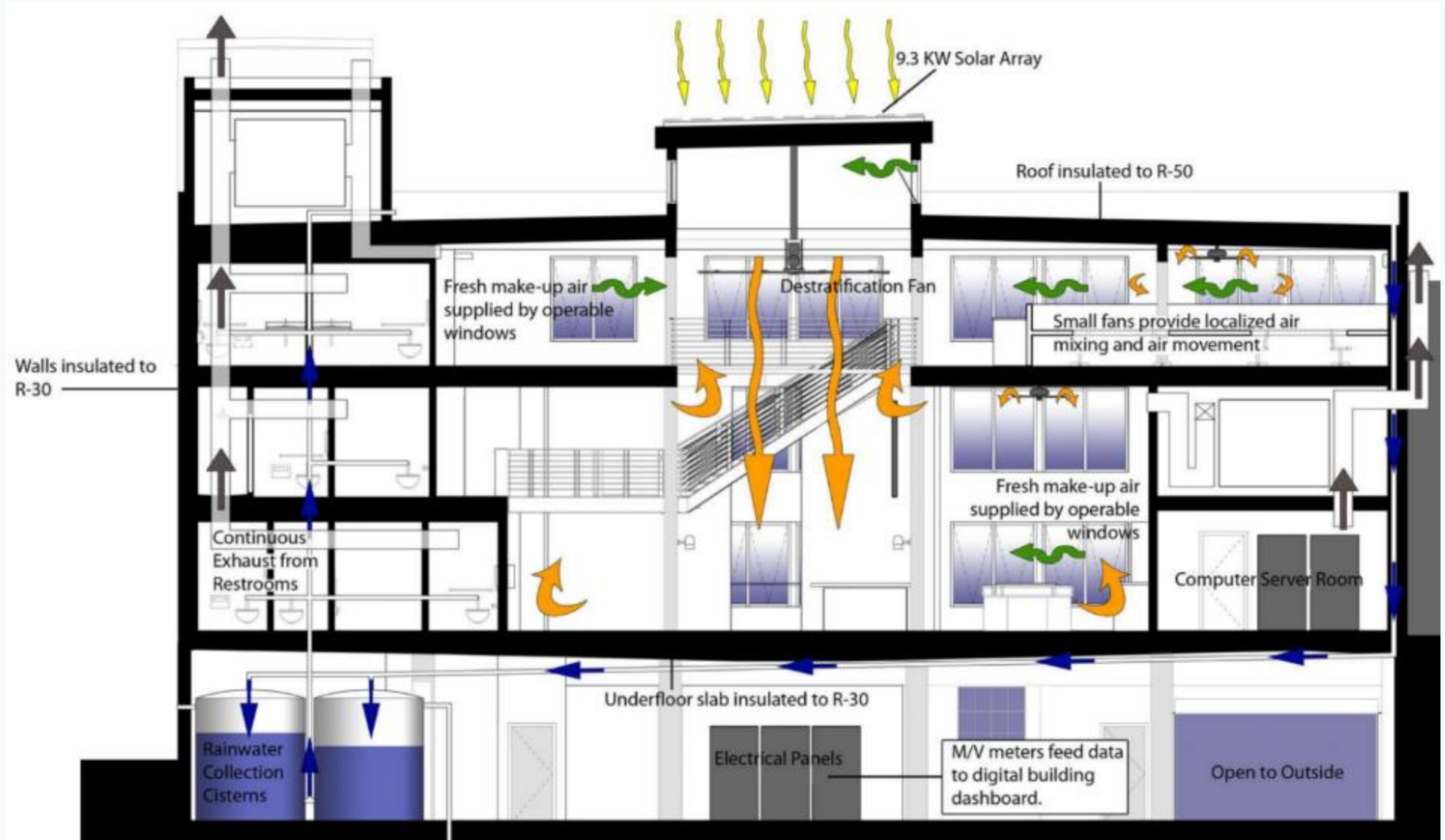
Heat pumps off for 70% of the year

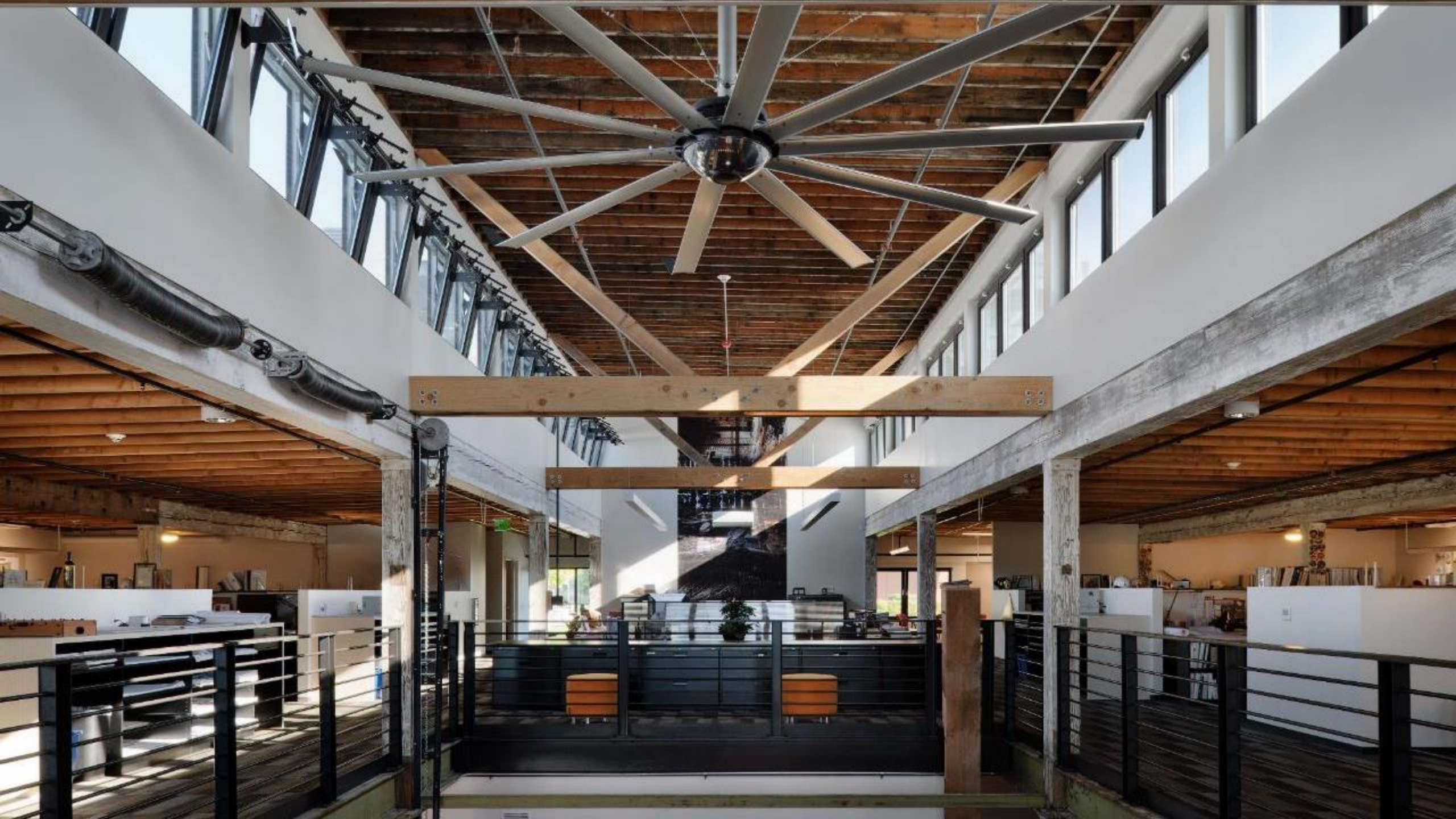




Passive Mode

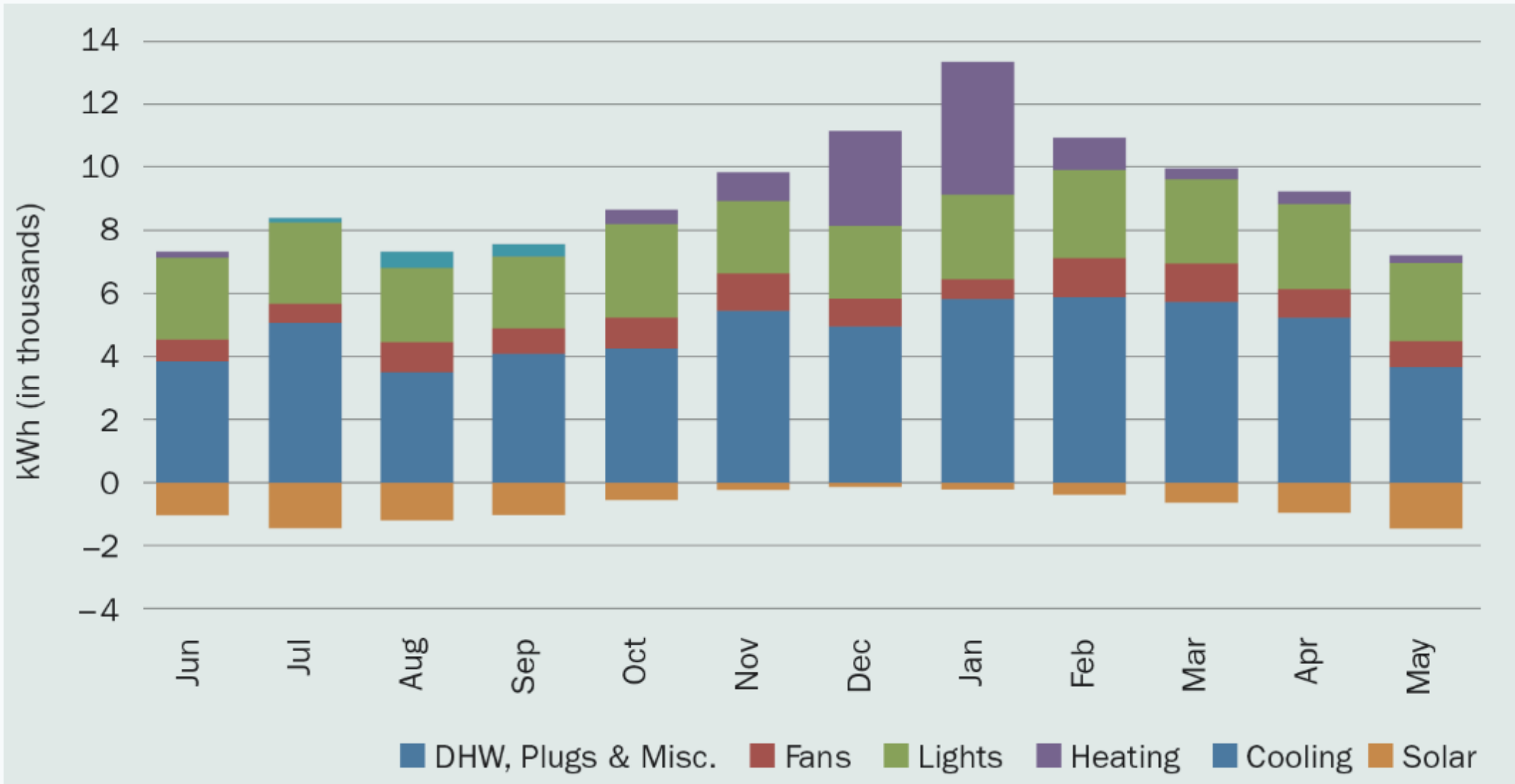
Outdoor temp between 55° and 75°



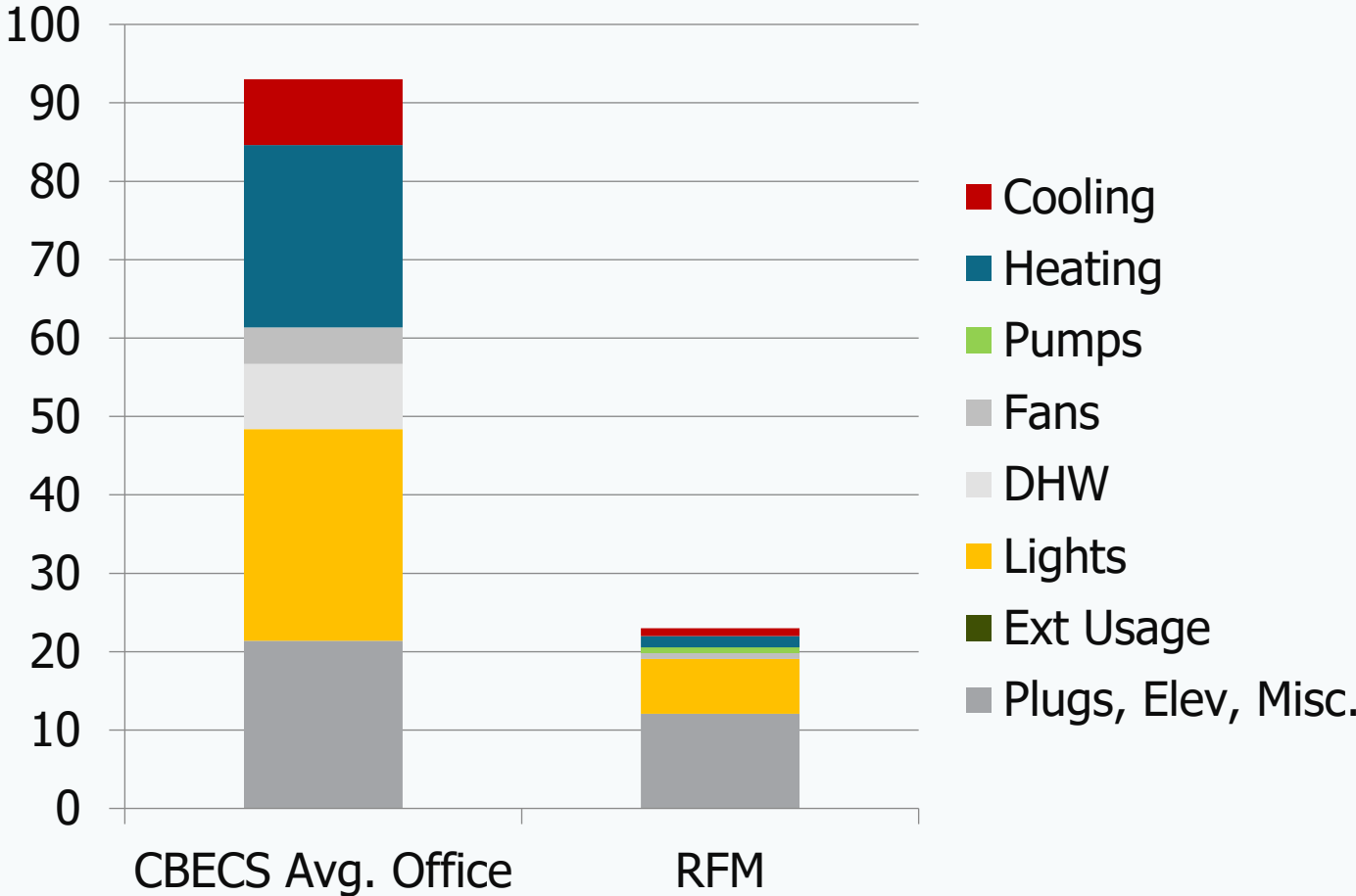


Monthly energy end use breakout

June 2011–May 2012



End use reductions



Smaller mechanical systems

Heating Load

~12 tons

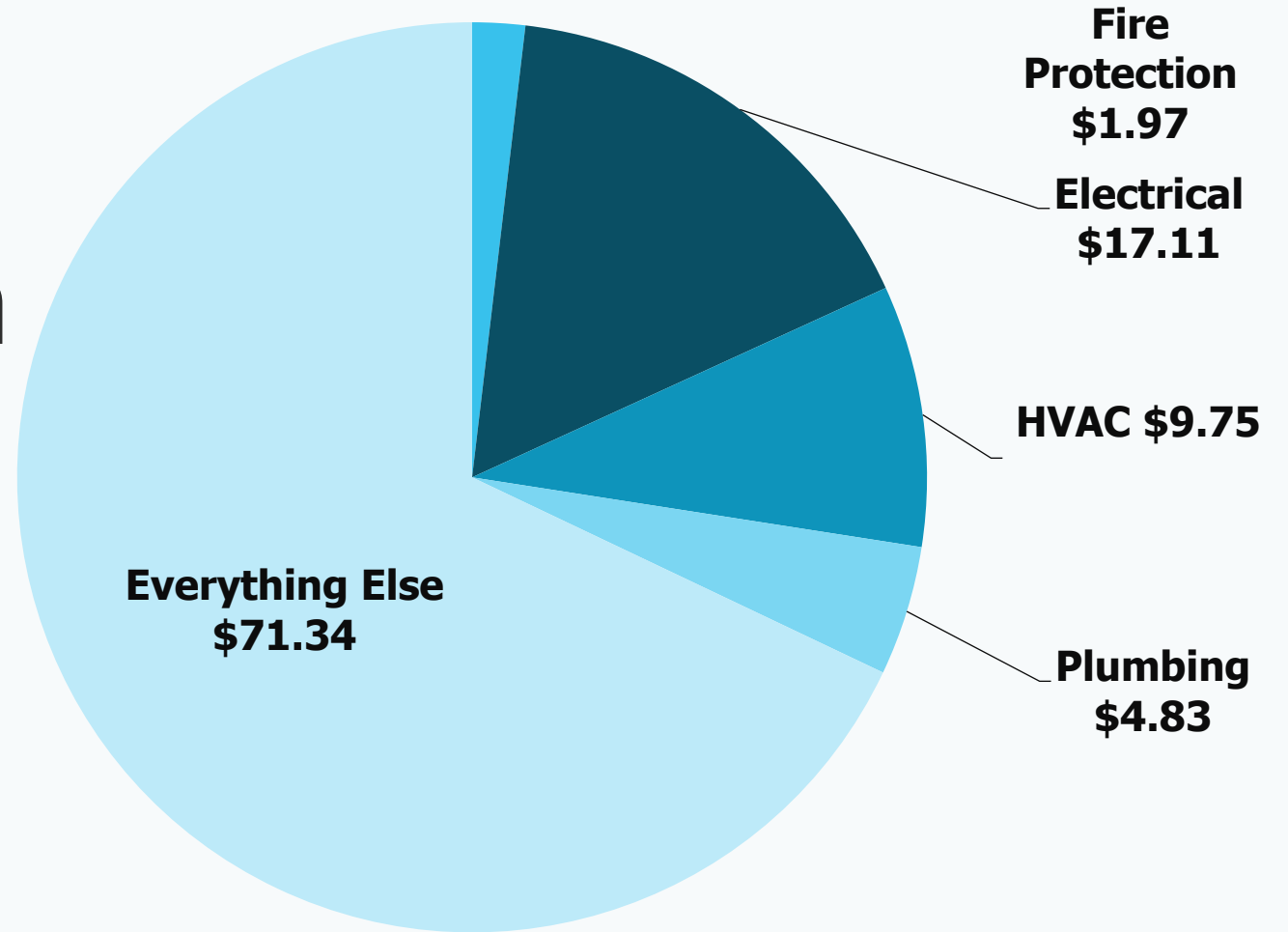
(1,350 SF/ton)

Cooling Load

~22 tons

(850 SF/ton)

Construction costs breakdown (\$/SF)



**Occupant
feedback:**

Priceless





Fire Station #72

The most efficient
fire station in the
United States



Electrify Buildings
+ Design for Off
+ When Matters



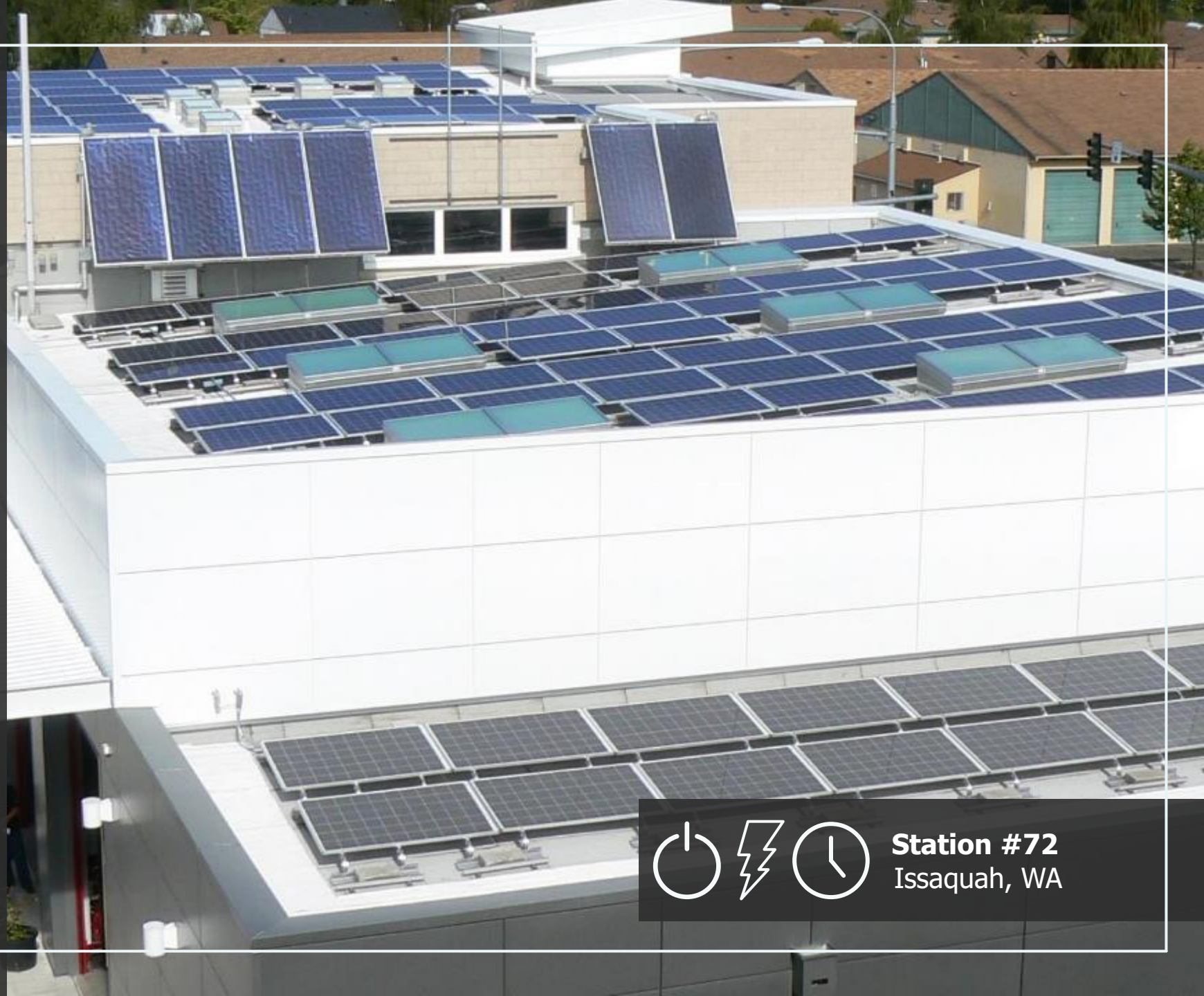
EUI: 23 kBtu/sf/yr

Project Highlights

- + **Super insulation**
- + **Energy recovery ventilation**
- + **Ground-source heat pump system for space and domestic water heating with solar preheat**
- + **Solar thermal + PV (30kW)**
- + **Rain-water cistern for toilet, laundry, irrigation and truck washing to reduce standard potable water use by 60%**

And...

- + **LEED Platinum**
- + **1st place, ASHRAE Technology Award**
- + **Top Engineering Projects of 2012, Plumbing Engineer**



Station #72
Issaquah, WA

Right-sized geothermal for heating, cooling, and domestic hot water

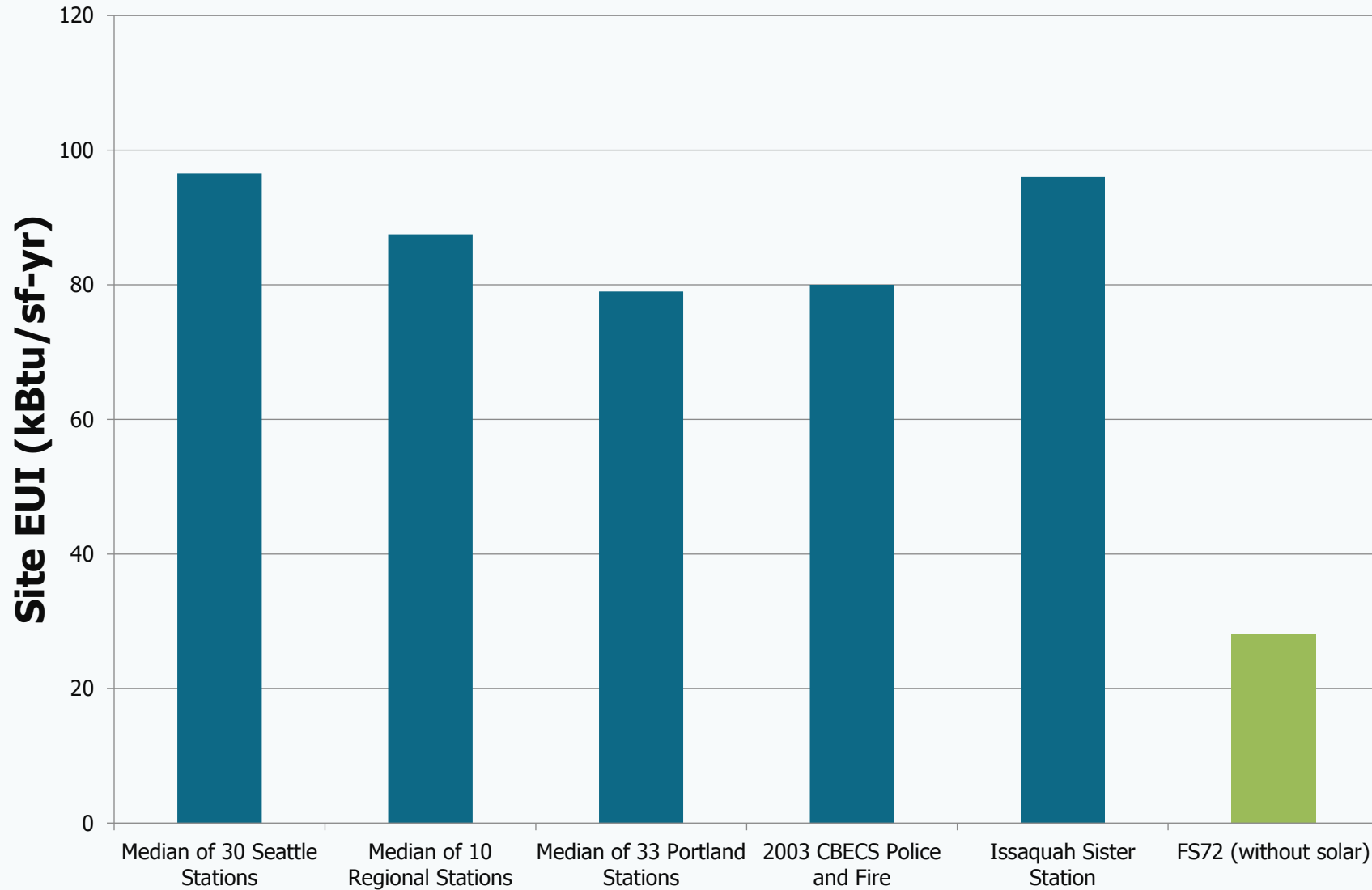
- + **Only 8 geo bores easily fit in parking lot**
- + **3 identical 5-ton heat pumps, loop sized for only 10 tons**
- + **1 ton per 1,140 SF for heating and cooling**
- + **Zoned radiant slabs (seasonal switch-over)**
- + **4-pipe fan coils in sleeping rooms**
- + **Heat recovery ventilation**







EUI of regional fire stations



Why are most 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



Sitka Public Library

**Making the shift
from fuel oil to
clean electricity**



**Electrify Buildings
+ Design for Off
+ When Matters**

EUI: 99 > 32 kBtu/sf/yr

Project Highlights

- + **Reno Added 50% more space and cut EUI by 2/3.**
- + **Super insulation**
- + **Variable refrigerant flow heat pump (VRF) Hydronic**
- + **Radiant flooring**
- + **Very High Efficiency (VHE) Dedicated Outdoor Air System (DOAS)**
- + **Heat pump water heater server room sourced**
- + **Low-flow plumbing fixtures**
- + **Energy usage one-third of the national average**

And...

- + **1st place, ASHRAE Puget Sound Chapter Technology Award, Existing, Commercial, 2020**



Sitka Public Library
Sitka, Alaska



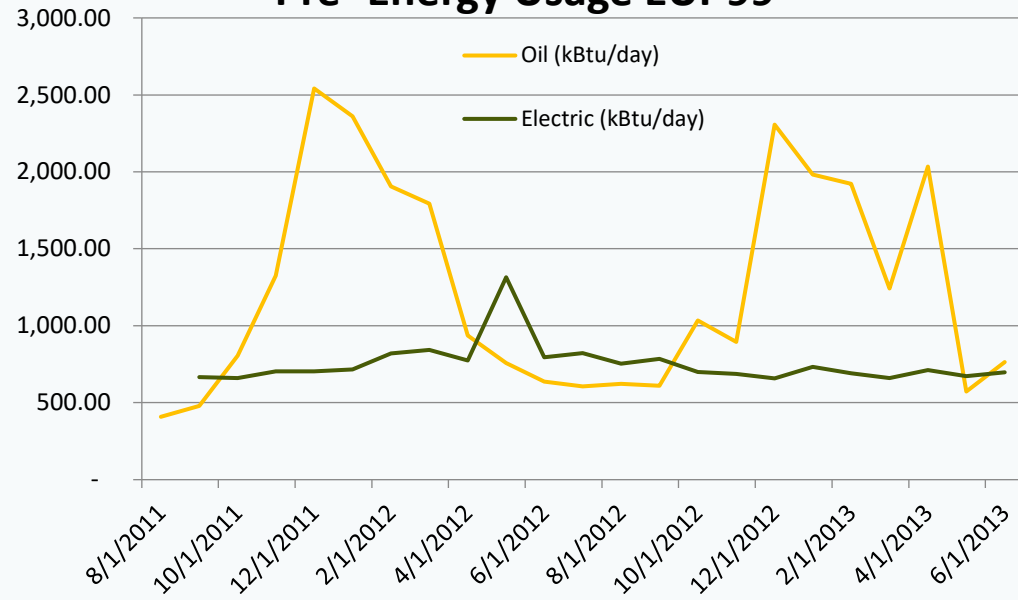


SITKA
PUBLIC
LIBRARY

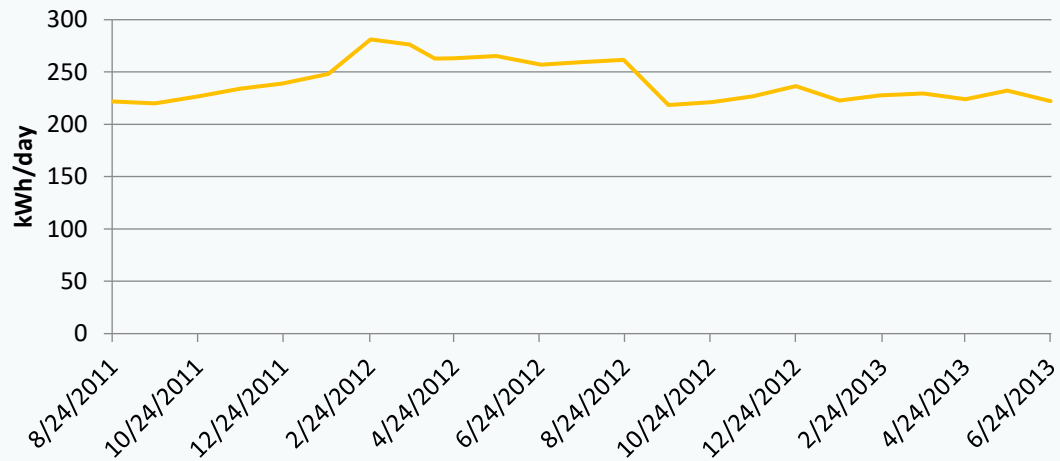
BIKE ONLY



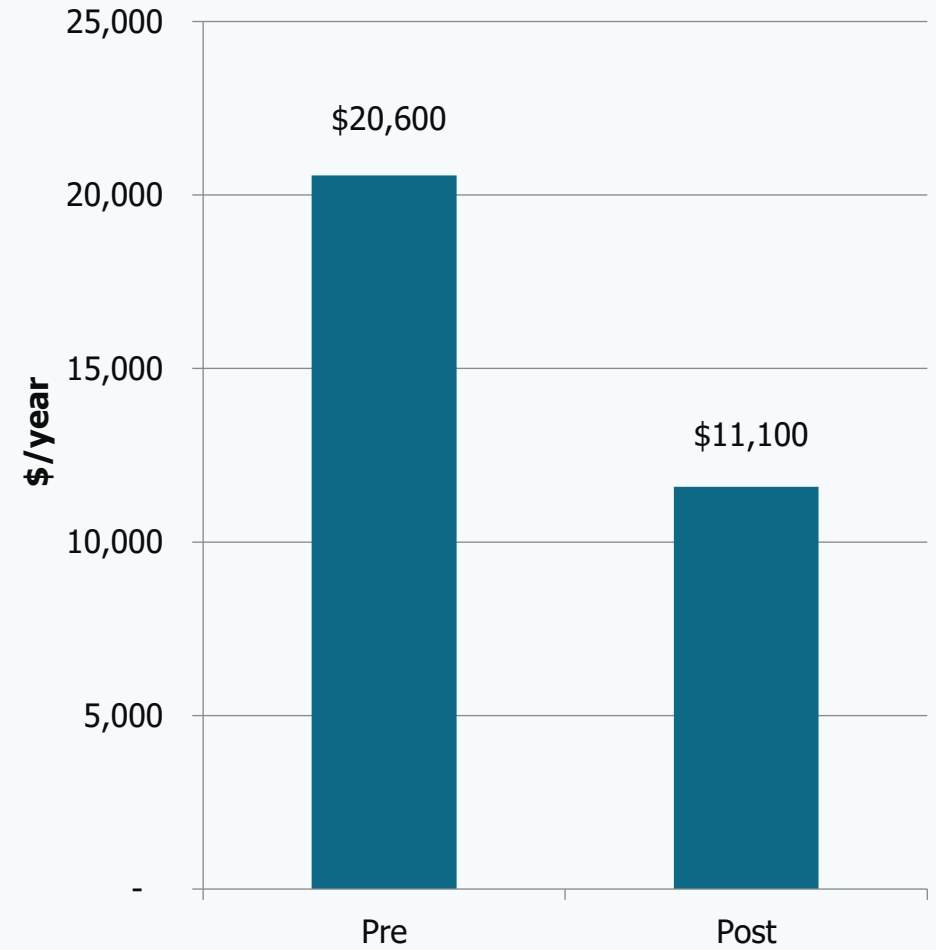
Pre- Energy Usage EUI-99



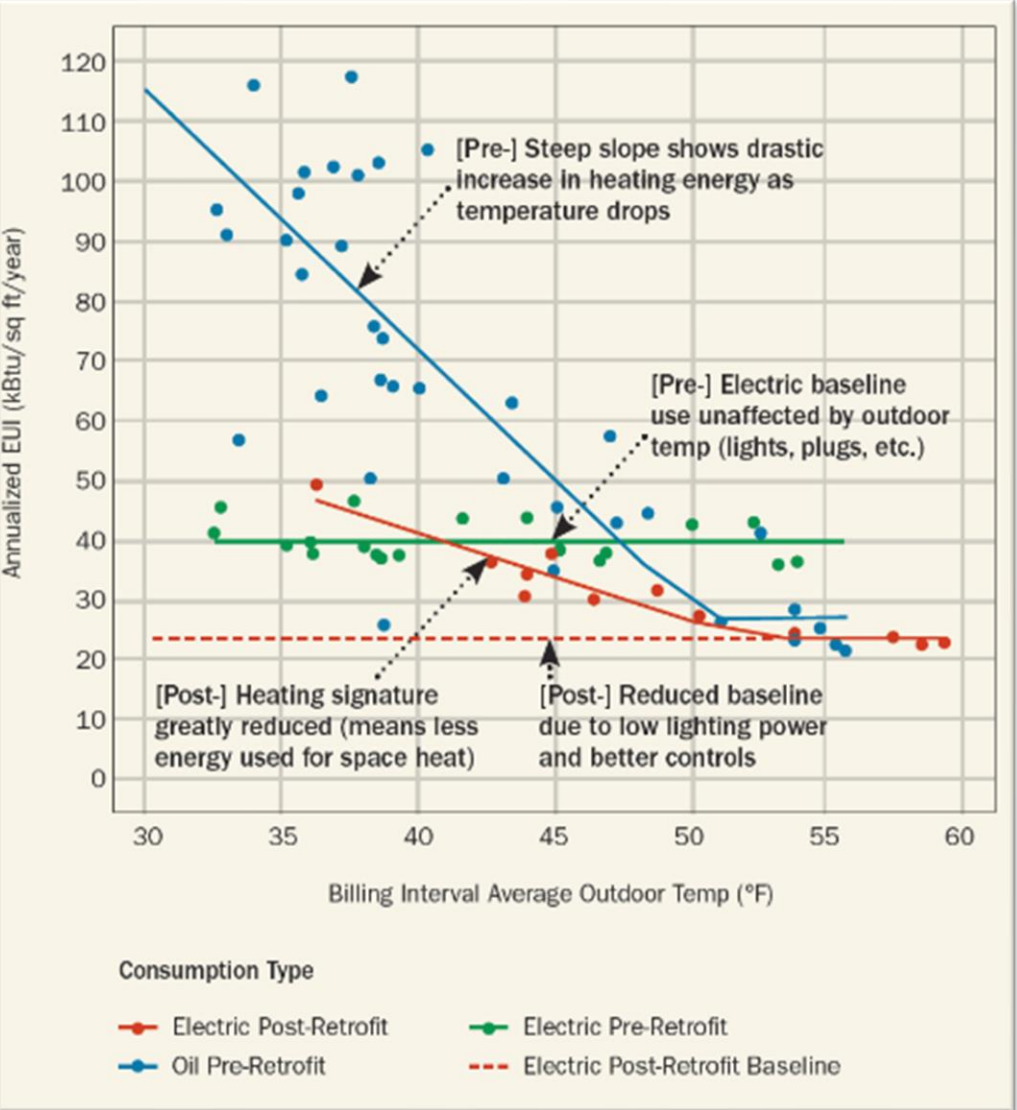
Post Electric Use – EUI-32



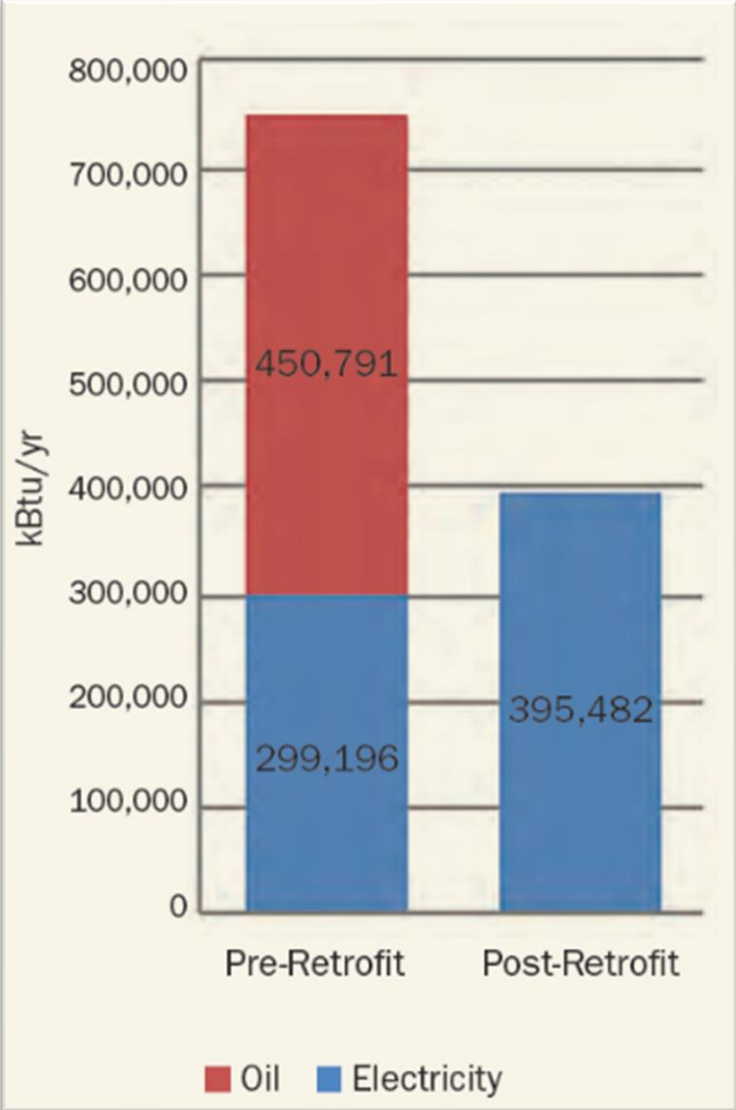
Operational Costs (\$/yr) (Pre is 8000 SF, Post is 12,500 SF)



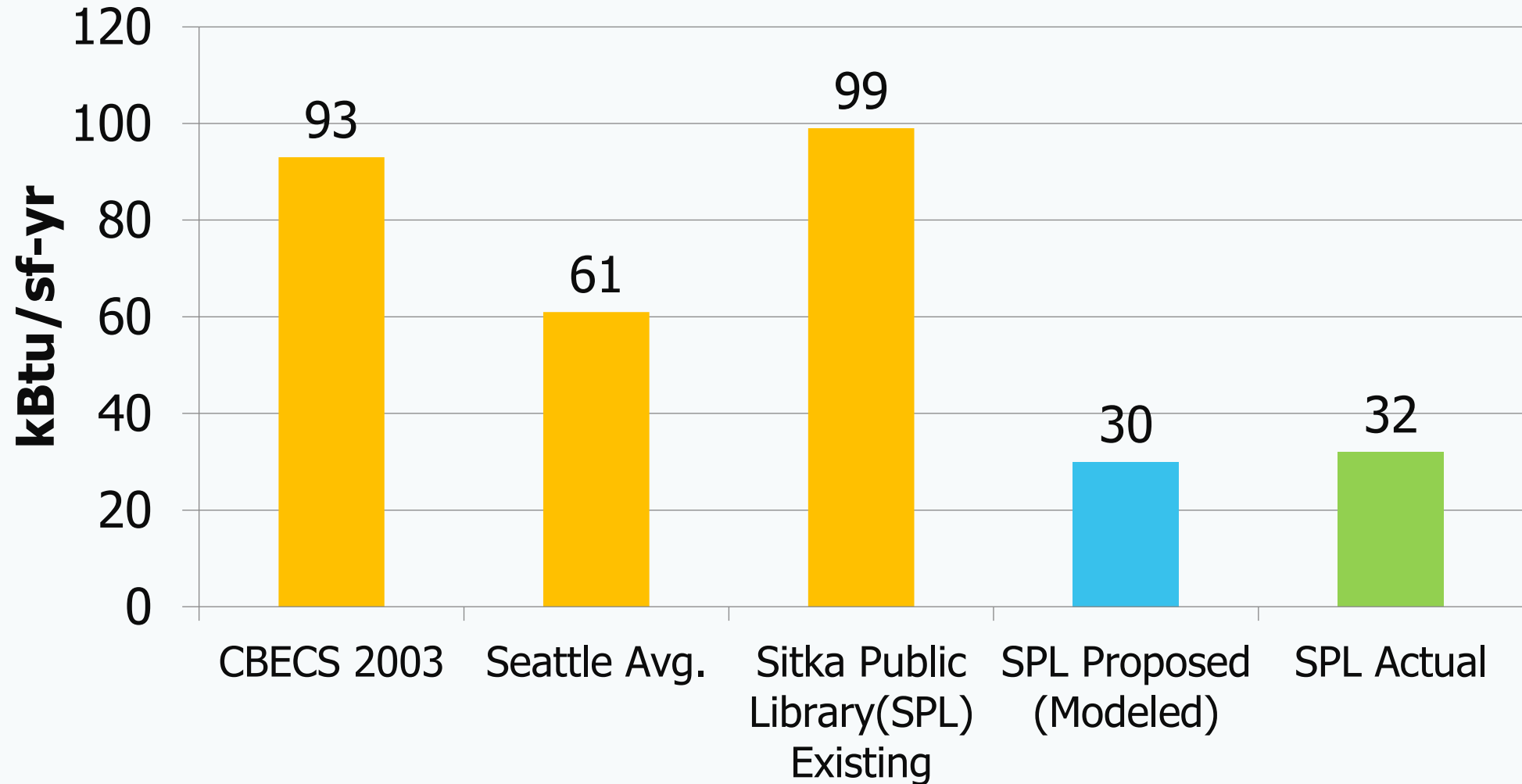
Sitka Public Library energy use by outdoor temperature



Sitka Public Library billed energy use



Library energy use index comparison





King County Housing Authority

EUI = 26 kBtu/sf/yr



**Electrify Buildings
+ Design for Off
+ When Matters**



1980s level envelope

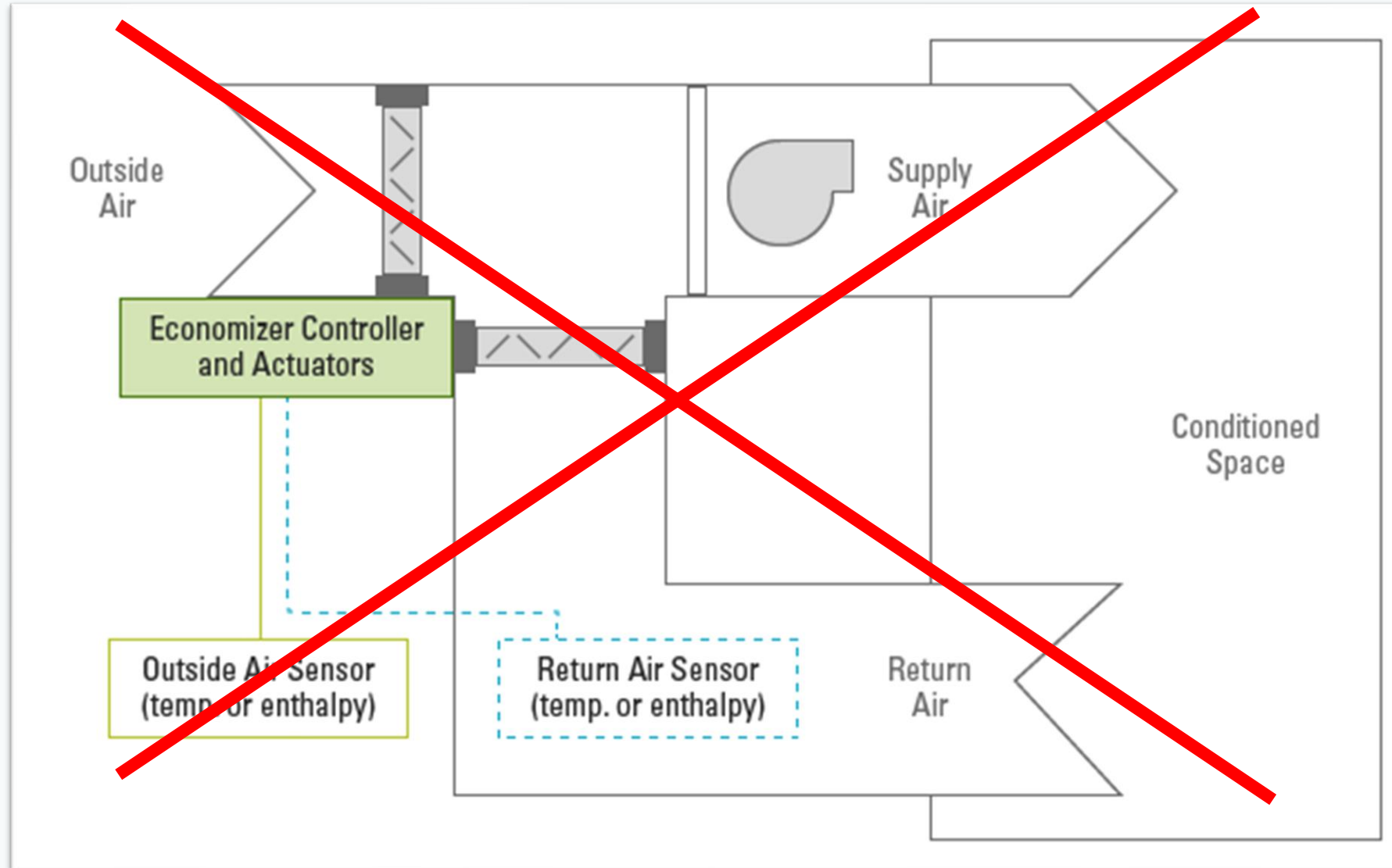


- + **Uninsulated slab**
- + **U-0.4 double glaze**

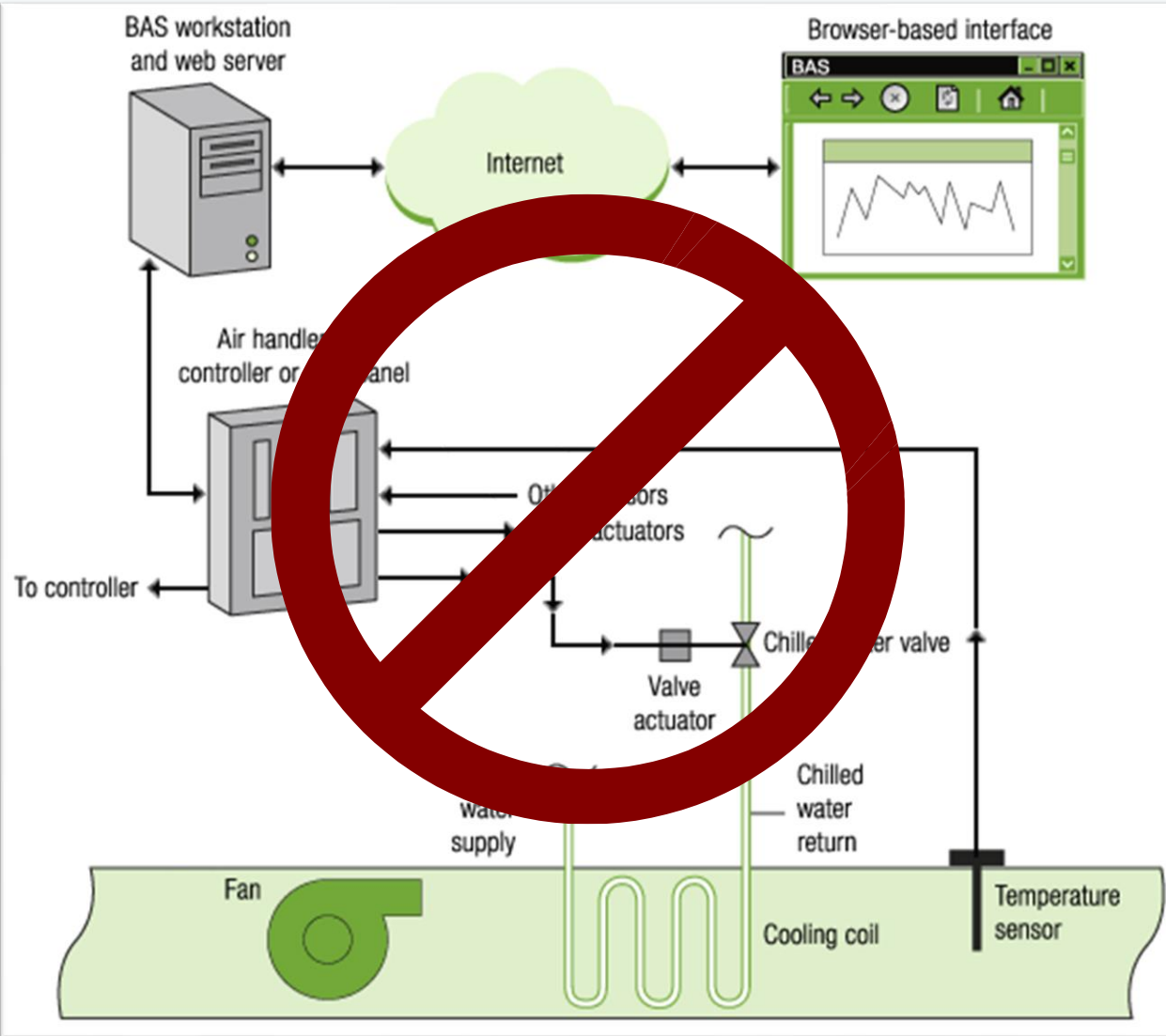


- + **R-11 walls**
- + **R-20 roof**

No economizers



No direct digital controls

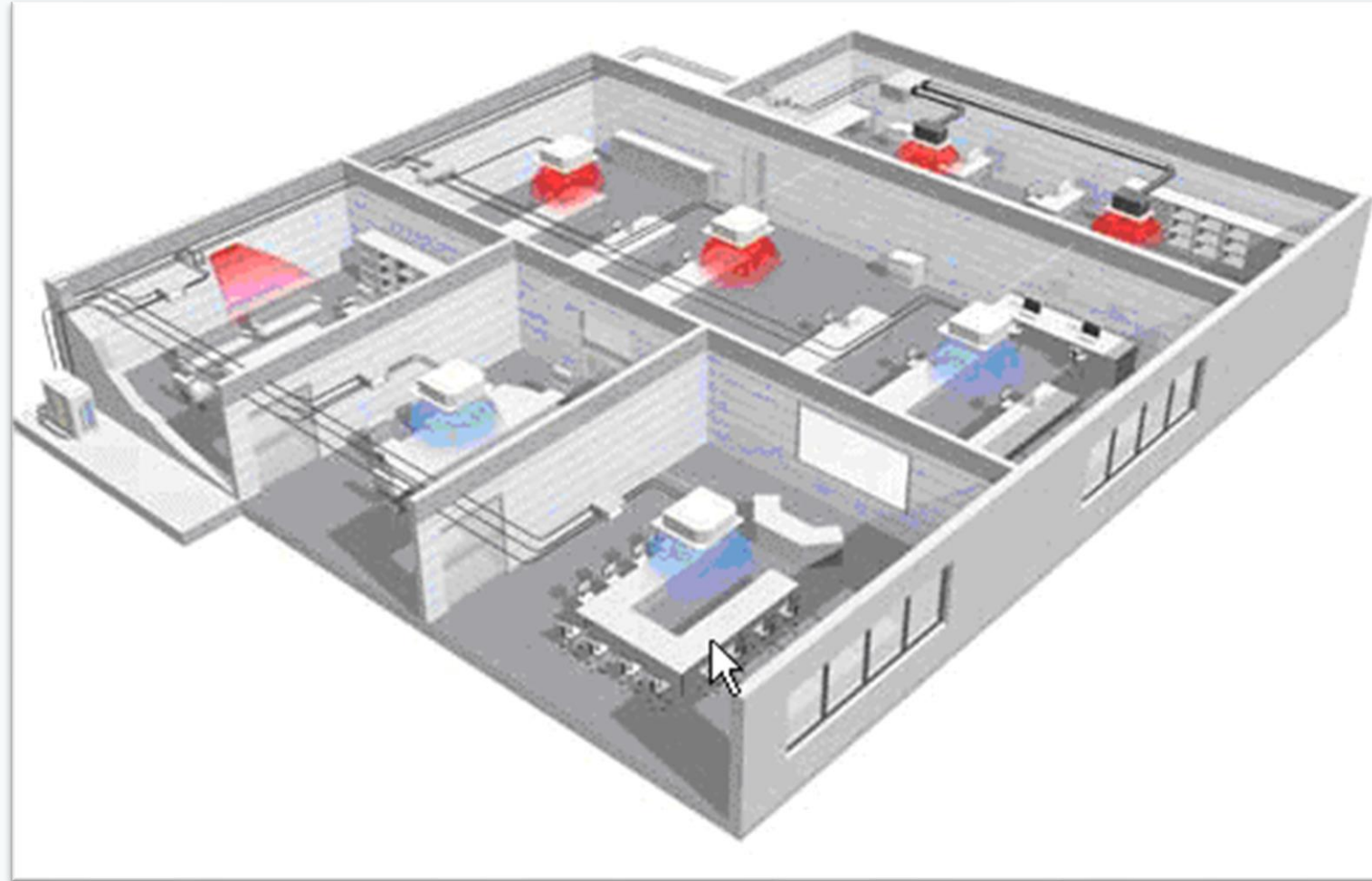


High efficiency lights and plugs

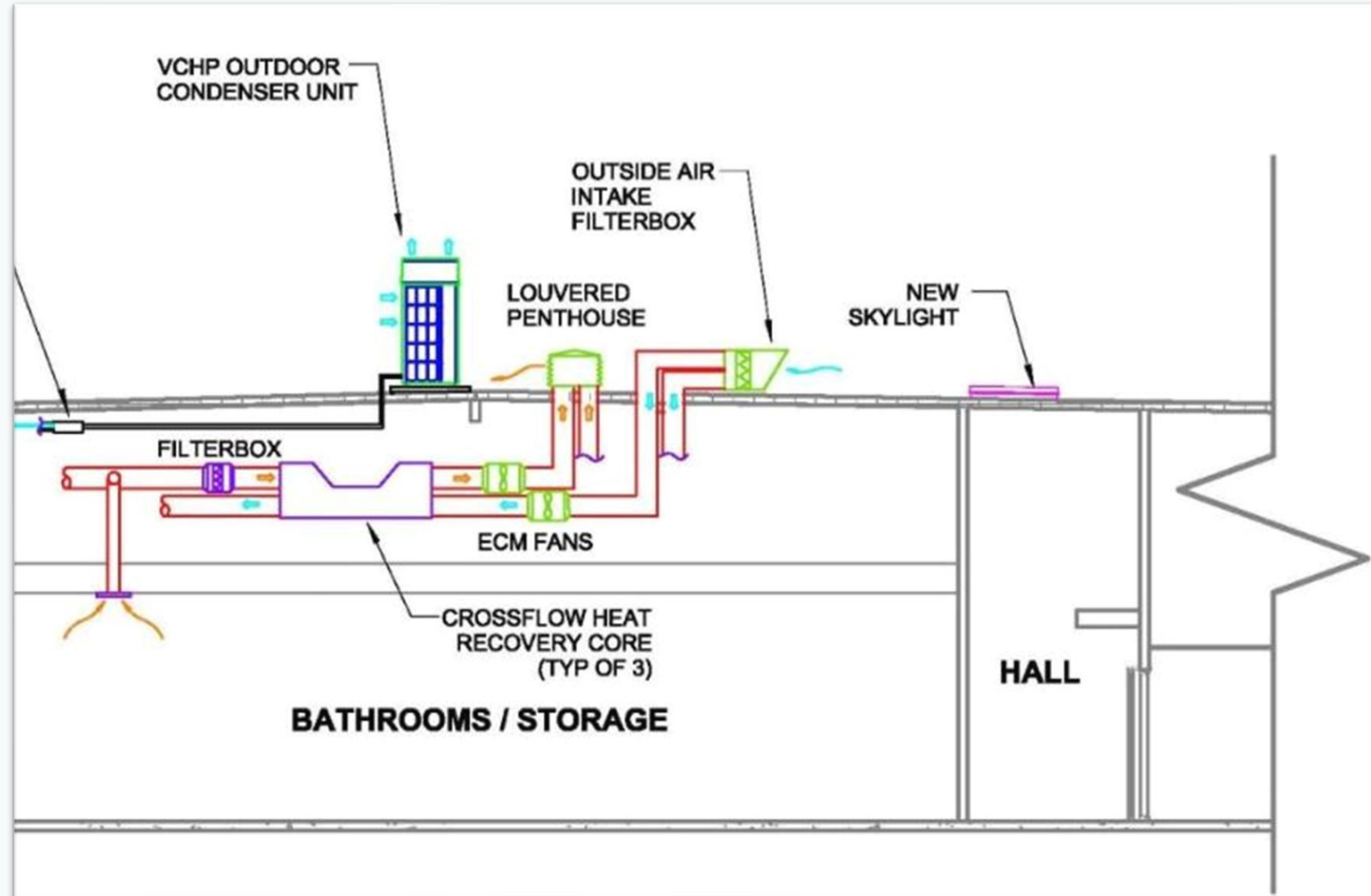


VRF with heat recovery

- + 48 tons
- + 3 outdoor units
- + 36 ductless units
- + 14 ducted units
- + 50 zones total
- + 1.33 ratio indoor /
outdoor units

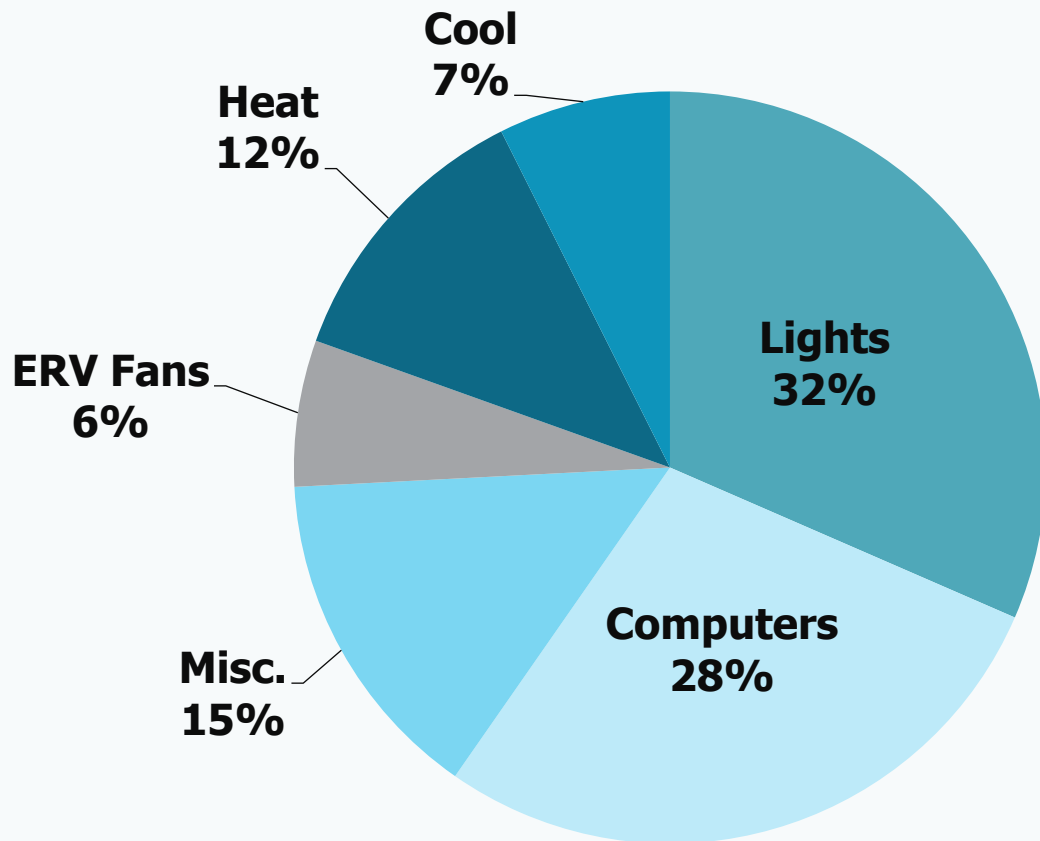


DOAS via high efficiency ERV

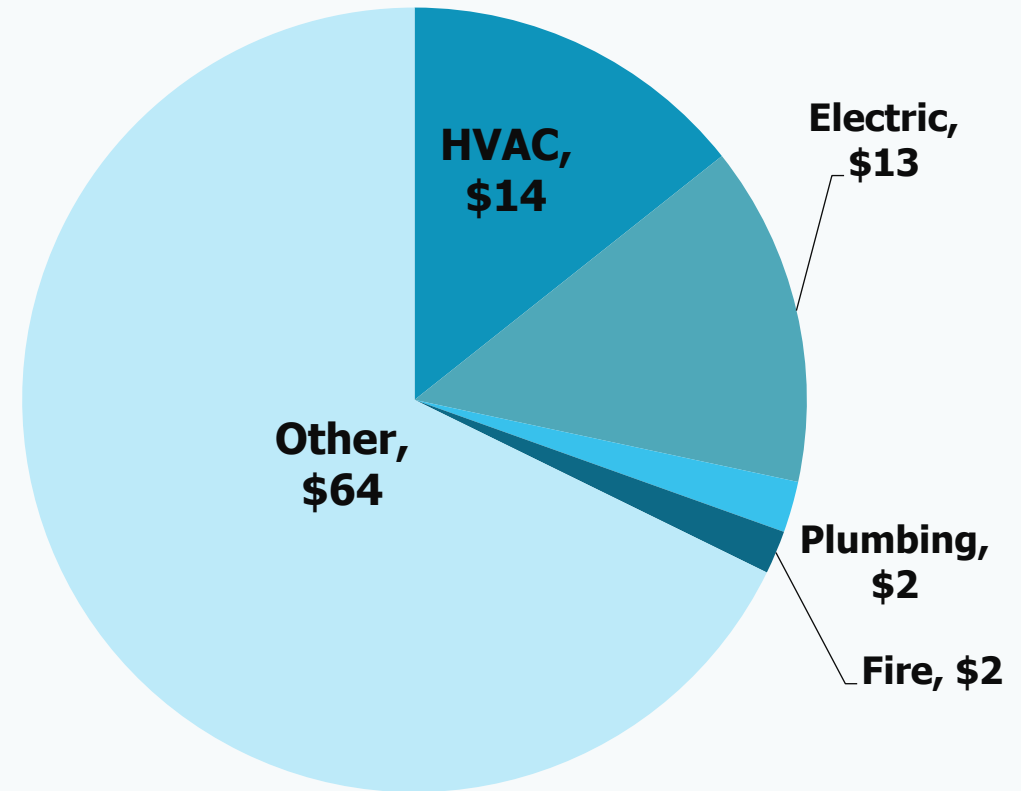


High performance, low cost

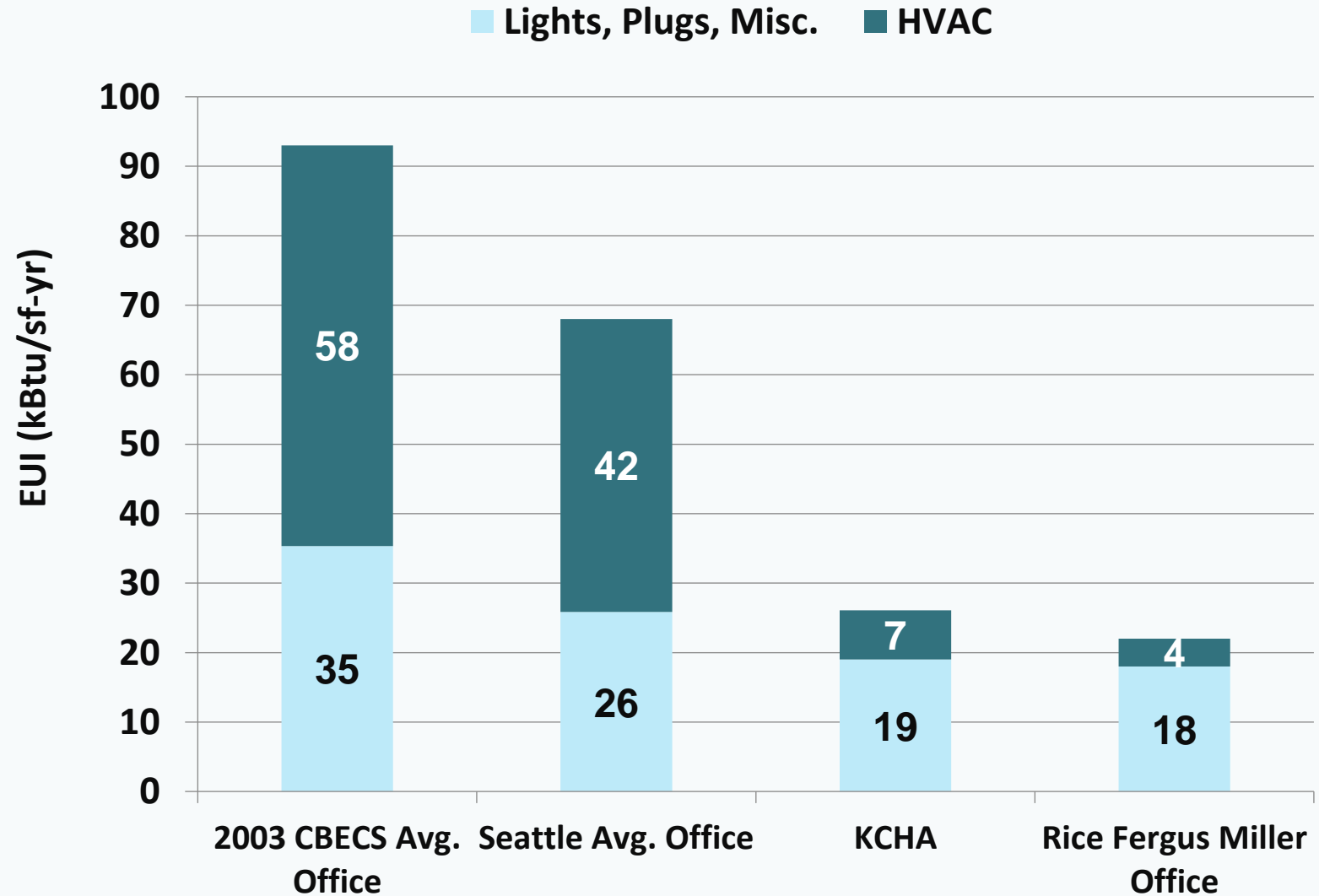
Energy End Use (EUI 26 kBtu/sf-yr)



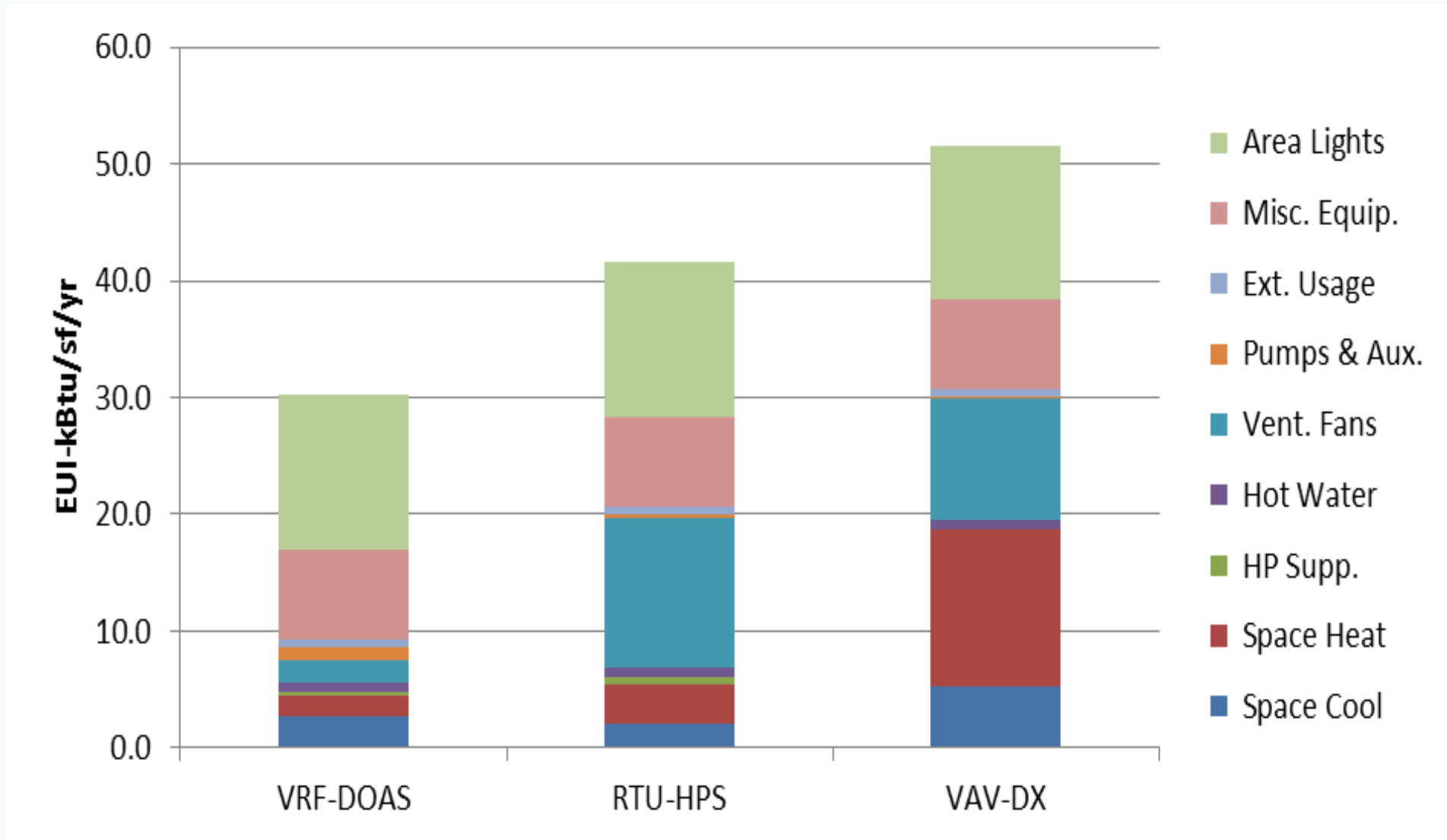
KCHA Construction Budget (\$95/sf)



Why HVAC matters



System comparison (KCHA)





Westside School

Leveraging the old
to create a new
high-performance
space for students
and their teachers



Electrify Buildings
+ Design for Off



Remodeling for efficiency

Client goals

- + **Low cost**
- + **Student comfort**
- + **Energy Efficiency**

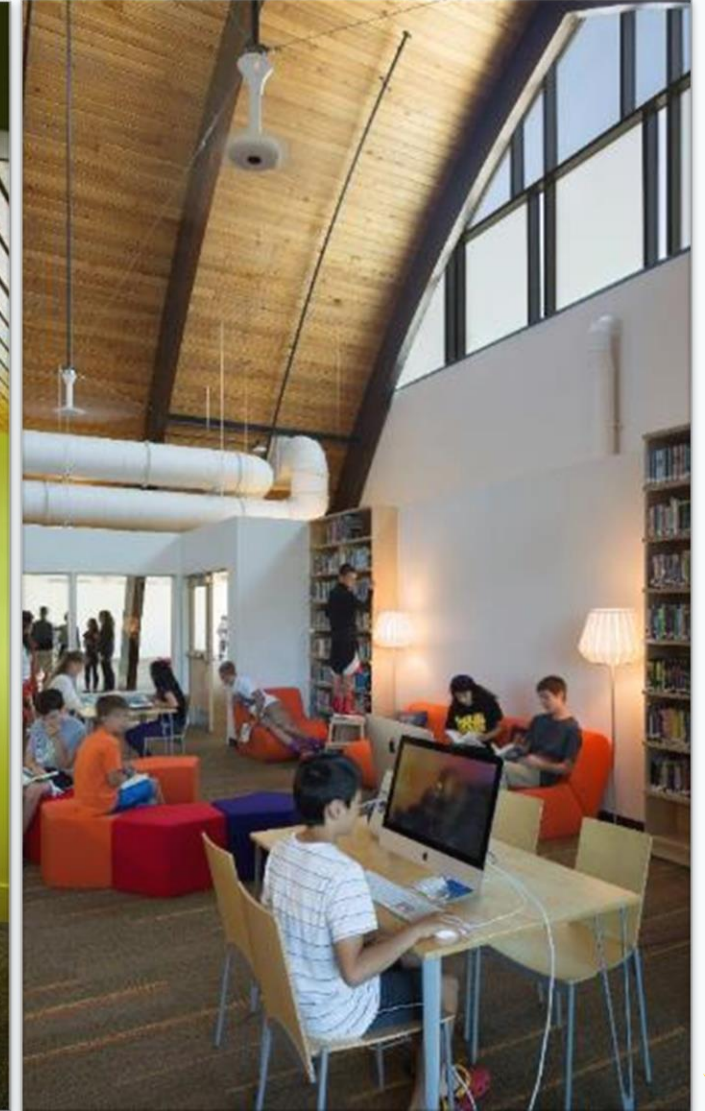
Challenges

- + **Remodel of existing building**
- + **Tight budget**



System selection

- + **Distributed dedicated outdoor air systems (DOAS)**
- + **Demand controlled ventilation (CO2)**
- + **Variable capacity air-source split system heat pumps (ductless)**
- + **Heat pump domestic hot water**



Innovation

- + Classroom ERVs
- + Ductless indoor units
- + Ceiling fans for distribution
- + Occupant based control
- + Hybrid ventilation



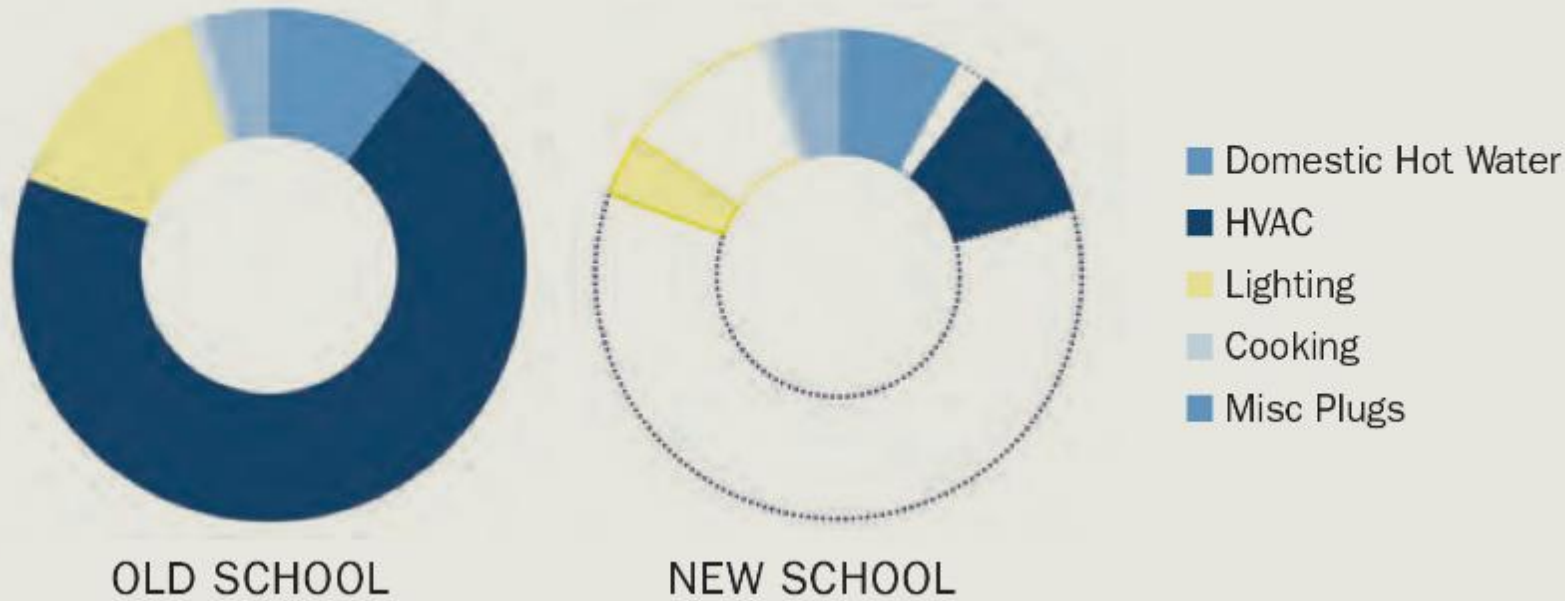




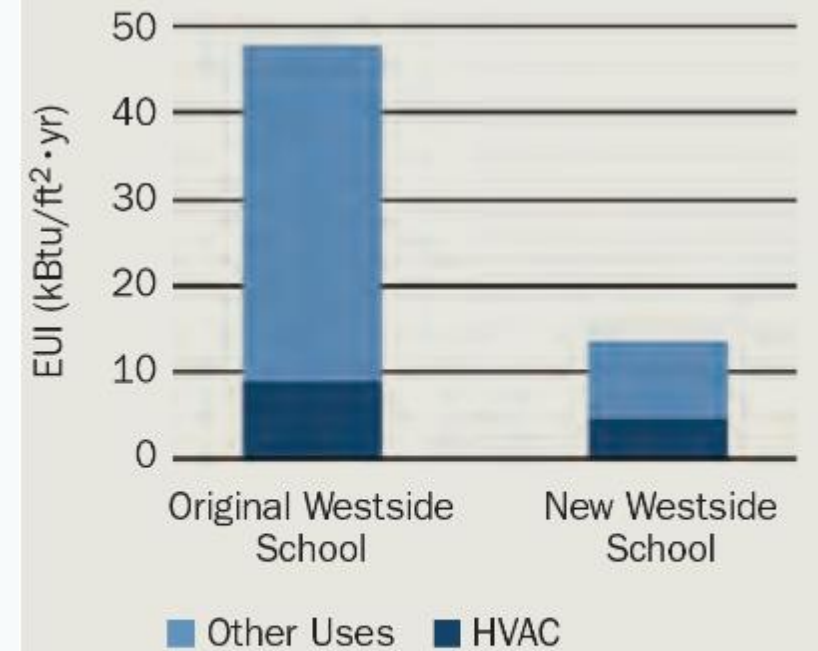
Energy performance

Energy use comparison old school vs. new school

The new school uses just 30% of the energy of Westside's previous facility. The majority of these savings are in HVAC.



Energy performance



Actual energy use of Westside school's leased city of Seattle building and the newly completed Westside school.

Take aways

- + Envelopes are important, but HVAC is where the energy is
- + Select a system that can be turned off
- + “Right-size”
- + Net-zero ready can be cheap
- + Heat pump DHW heating can be implemented cost effectively
- + DOAS systems do not require tempering if careful attention is paid to HX selection



Design for Off™

**1.
Separate
ventilation
from heating
and cooling
(provide
ventilation
with HRV)**

**2.
Zonal heating
and cooling
equipment
(cycling on
load)**

**3.
Right sizing of
equipment
(ventilation
and heat/cool)**

Design for Off™

Jon Heller, PE, LEED AP
President

October 5, 2023



City Light Increased Incentives & New Offerings

- Some incentives increased as much as 60%
 - Lighting
 - Lighting controls
 - Insulation
 - Advanced rooftop controls
 - Package terminal heat pumps
- Energy Project Manager – new!
- Project Development Incentive – new!

Contact an Energy Advisor today to find out if your projects qualify!
Call **(206) 684-3800** or email **SCLEnergyAdvisor@seattle.gov** to get started.

THANK YOU



lightingdesignlab.com | ✉ lightingdesignlab@seattle.gov
