

Design for Off: Keys to Highly Efficient Commercial Buildings



Jonathan Heller

Utility Energy Forum – May 2017

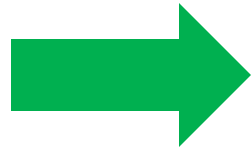
Presentation Objectives

1. **Why aren't we seeing huge improvements in commercial building energy efficiency?**
2. **Direction for HVAC design evolution.**
3. **Program implications.**

Lighting Progress 1980-2016



2 W/SF



0.5 W/SF

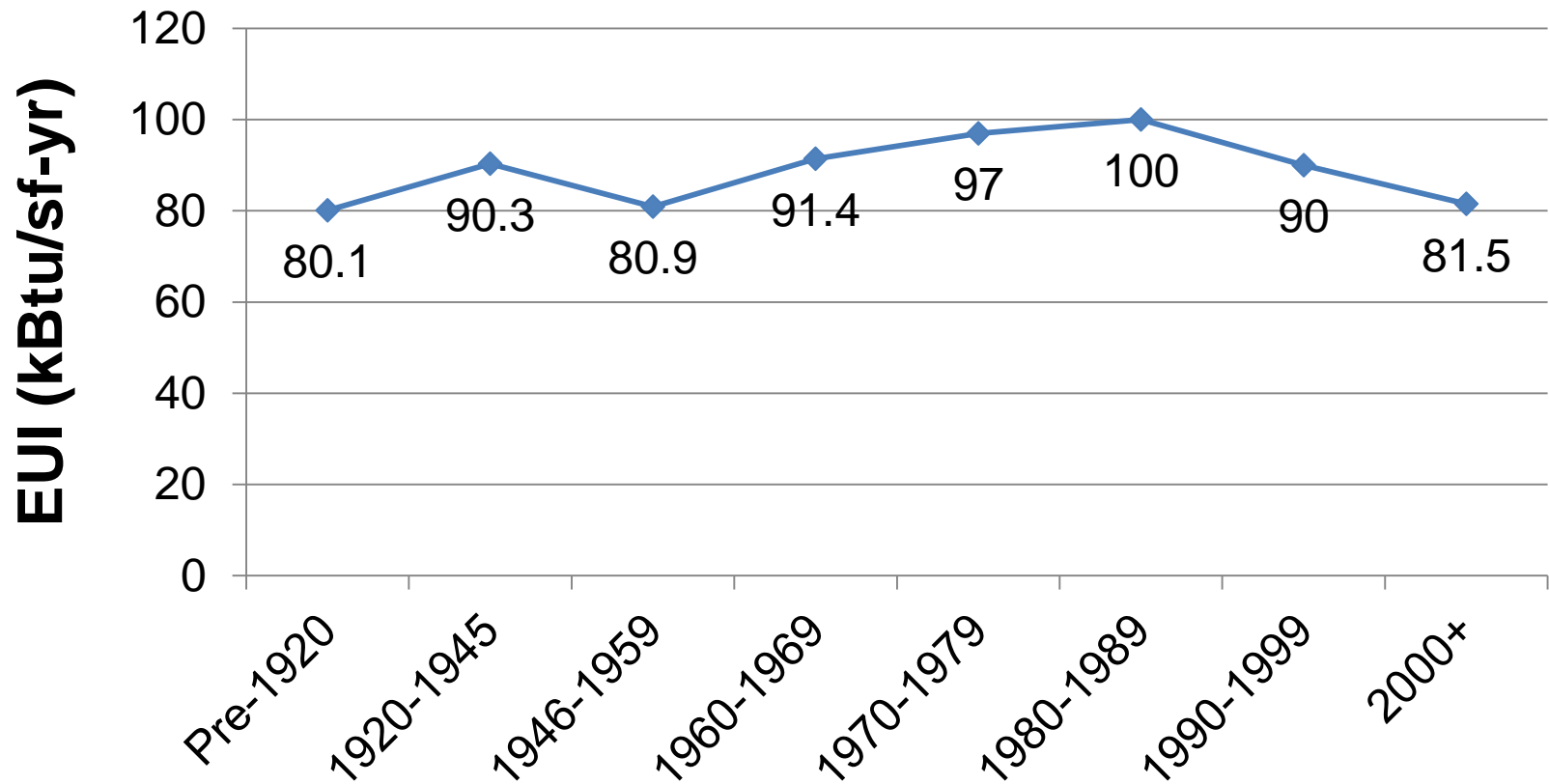
Envelope Progress 1980-2016



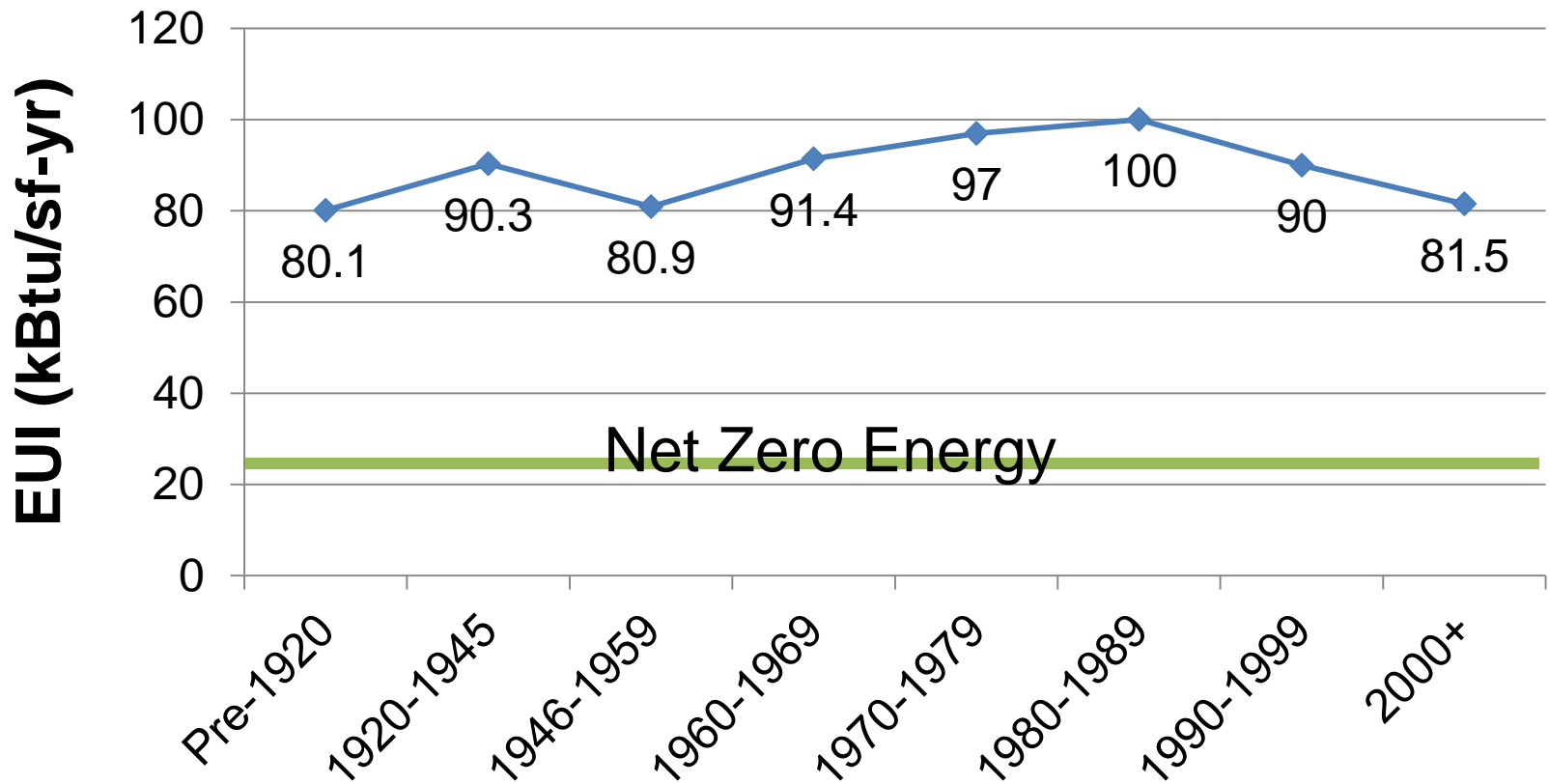
Computer Efficiency



EUI of U.S. Commercial Buildings



EUI of U.S. Commercial Buildings



Offices

1891



30 kBtu / ft²-yr

2003



85 kBtu / ft²-yr

Case Studies: Libraries



109 kBtu/sf-yr



60 kBtu/sf-yr

Case Studies : Fire Stations

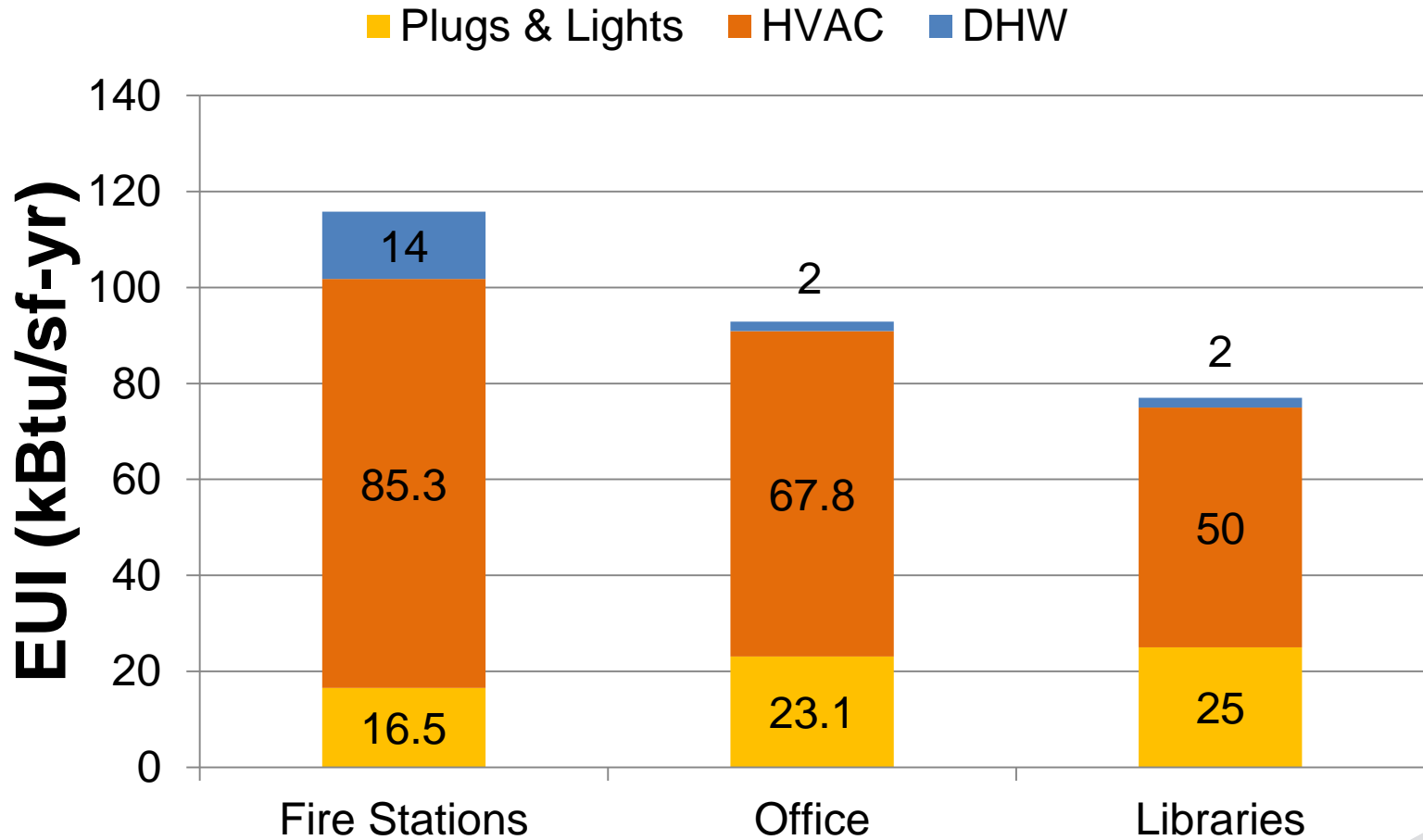


119 kBtu/sf-yr



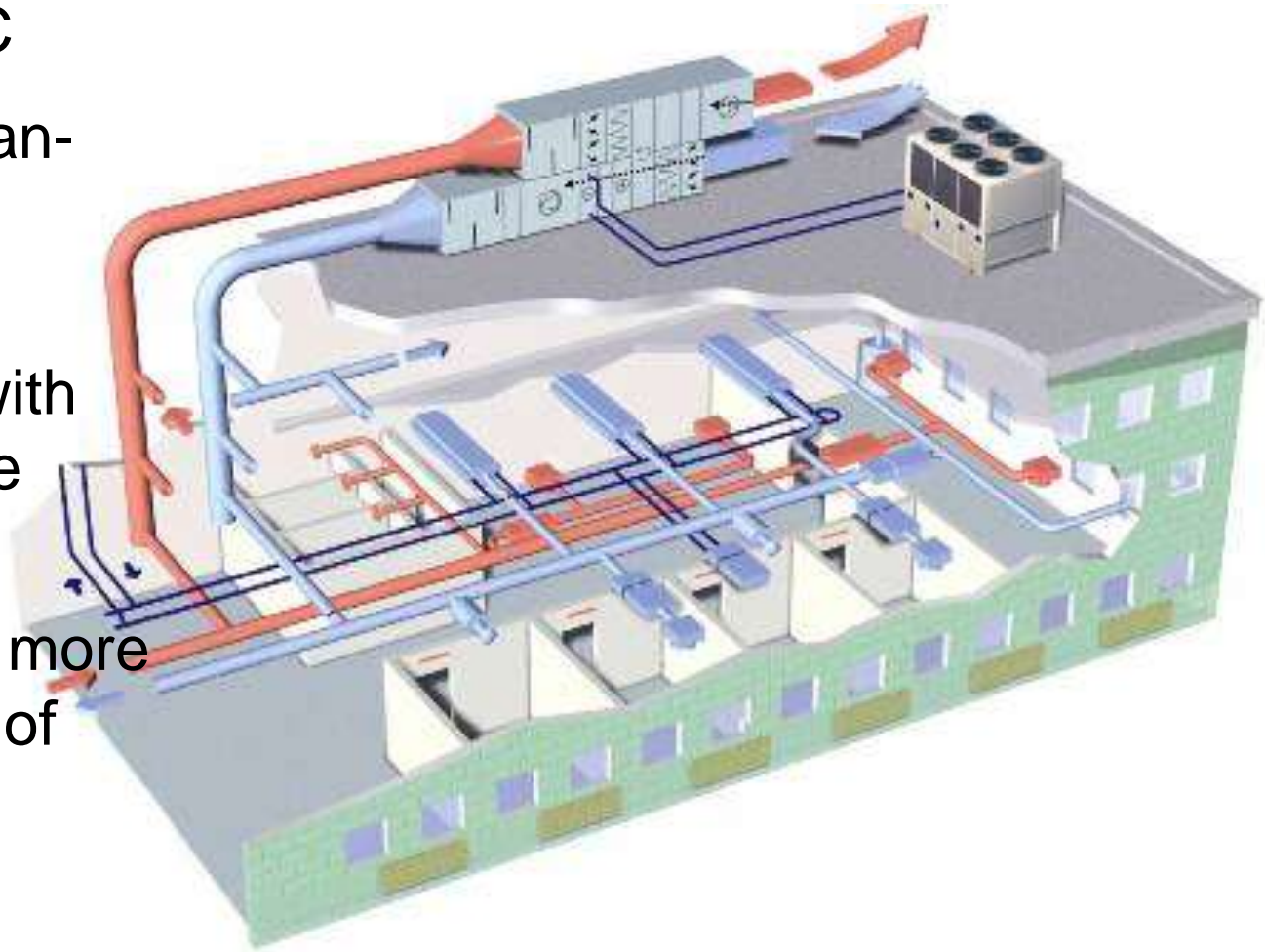
50 kBtu/sf-yr

End Use Breakdown for Average Commercial Buildings

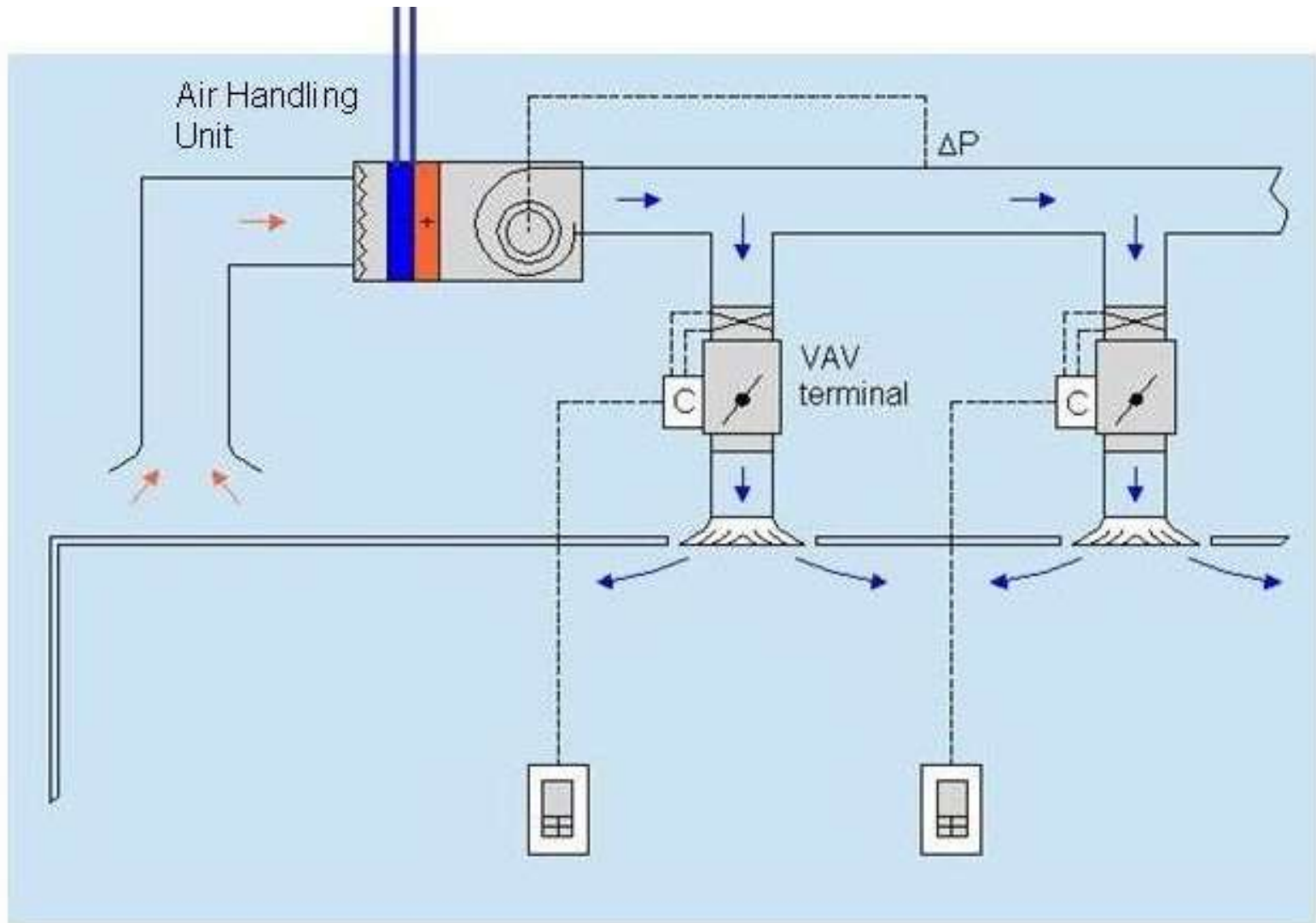


Typical Modern HVAC Design

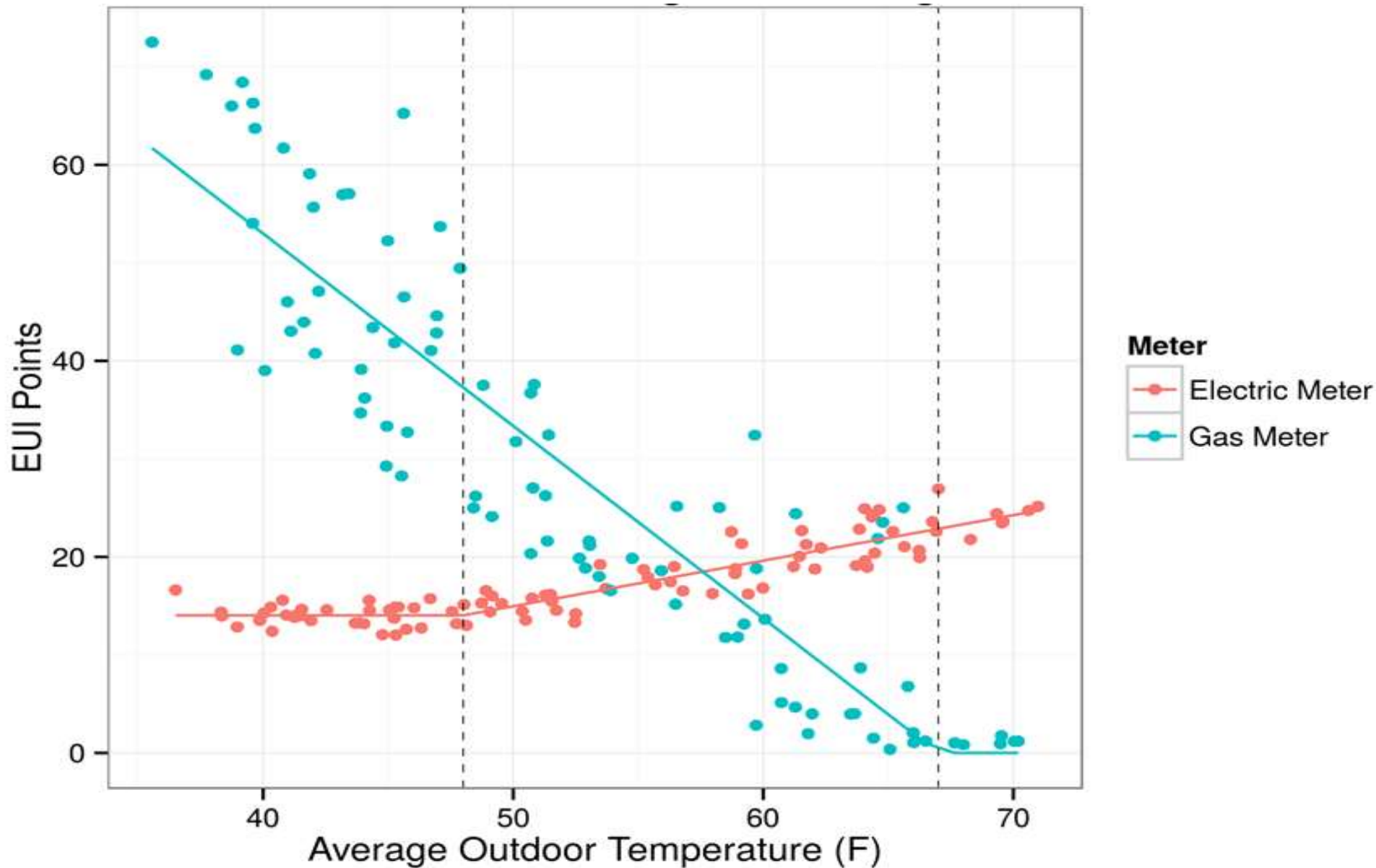
- All-in-One HVAC
- Large Central Fan-forced Rooftop Equipment
- Multiple zones with tight temperature settings
- If some is good, more is better “Factor of Safety”



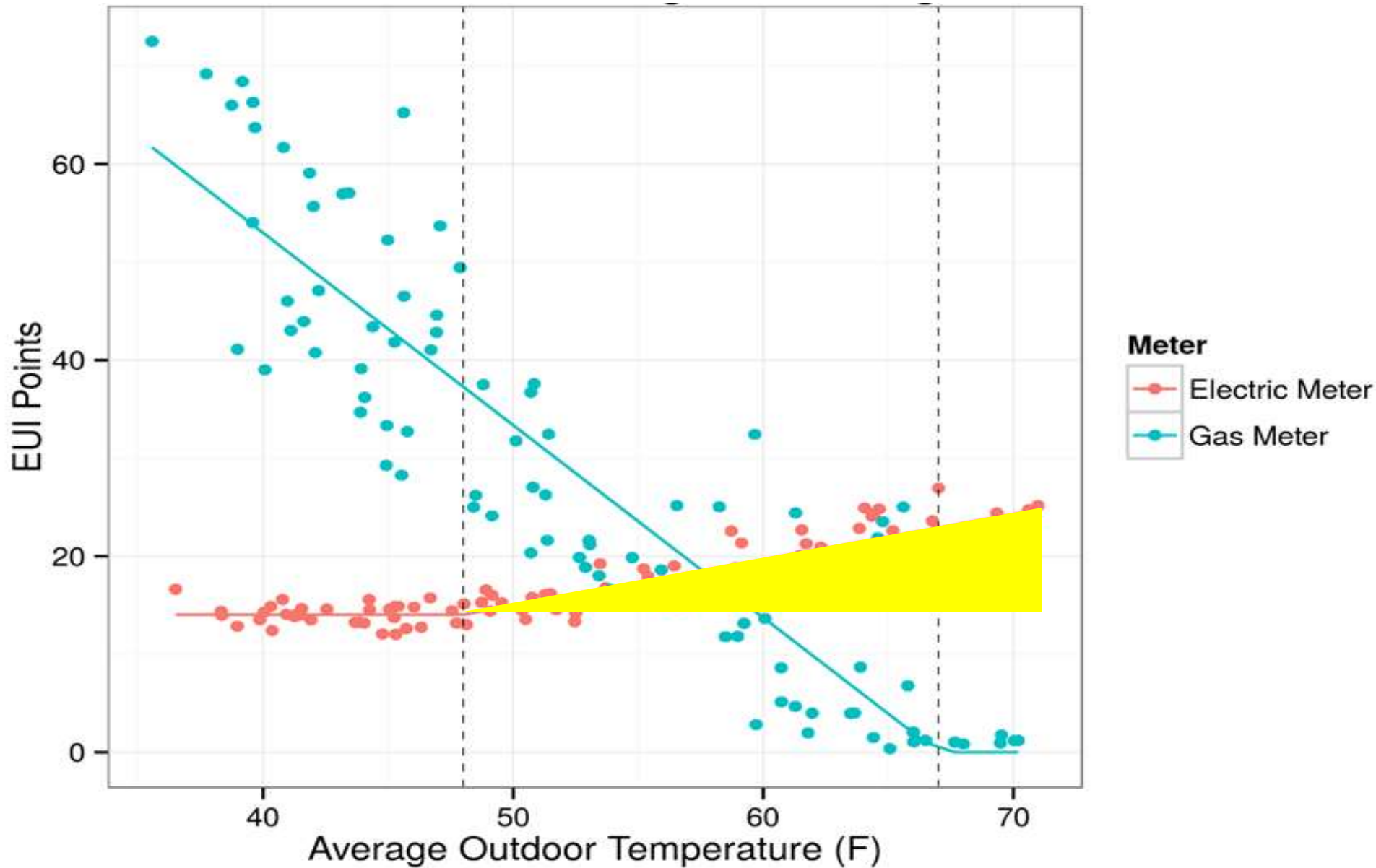
Variable Air Volume



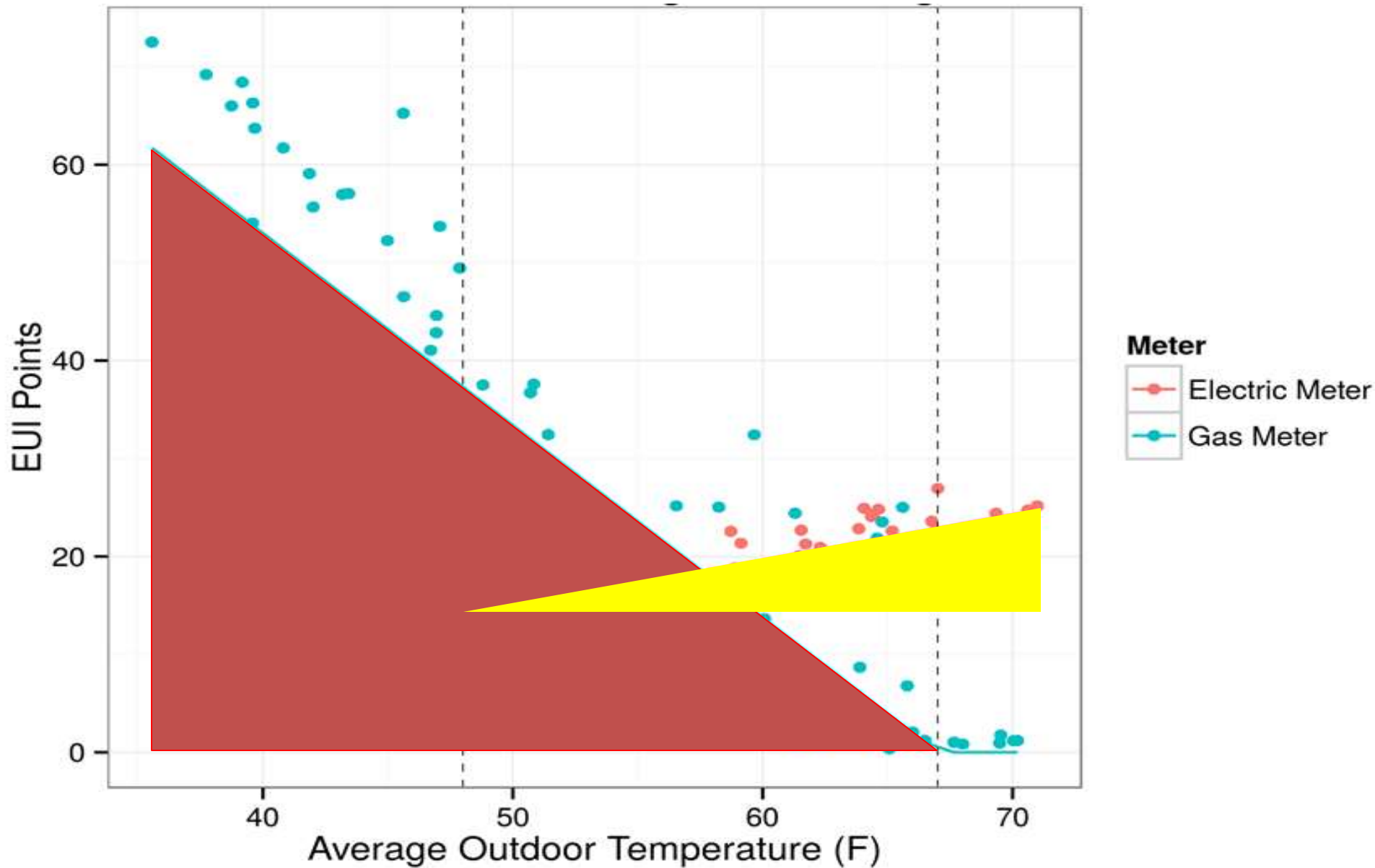
Simultaneous Heating and Cooling



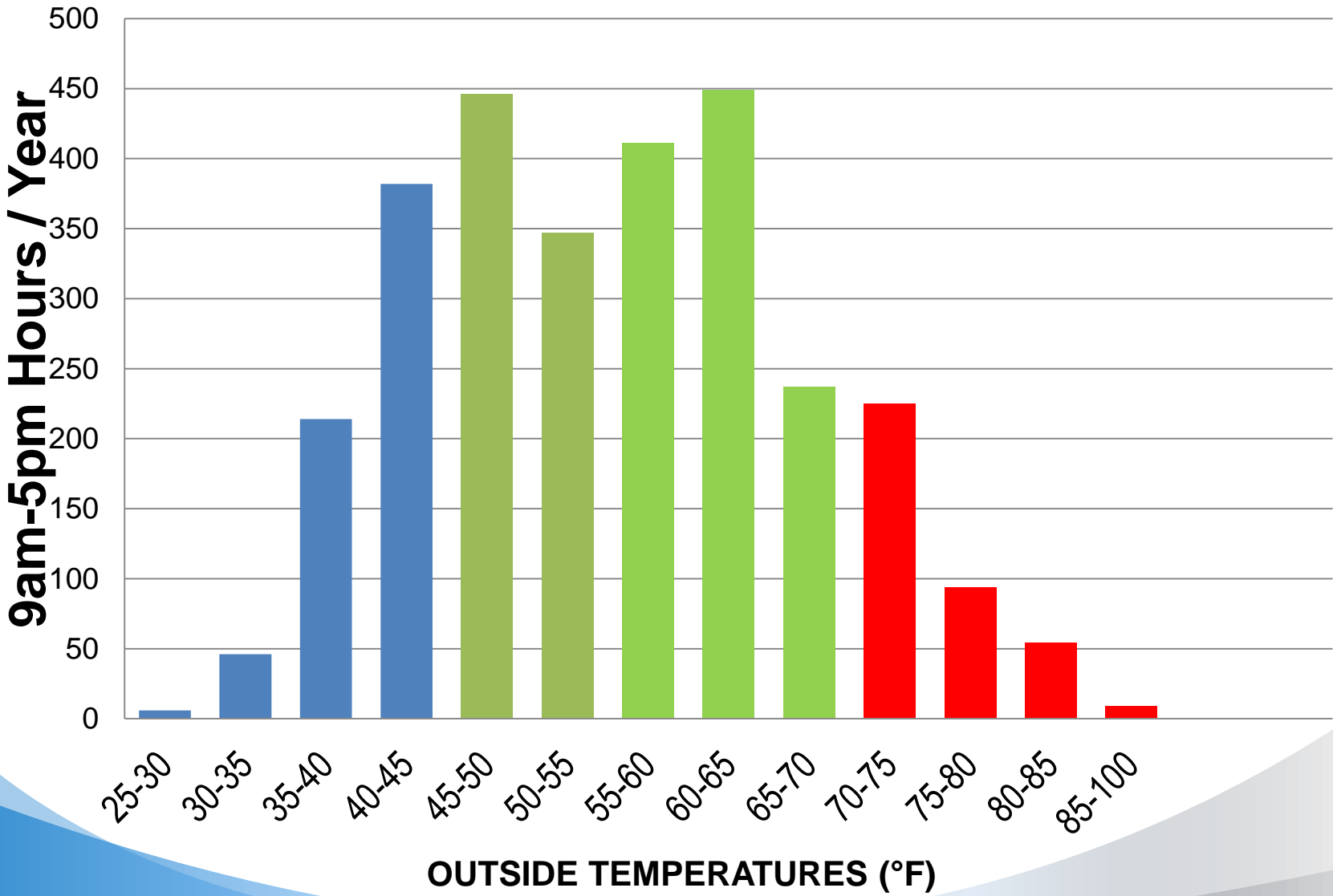
Simultaneous Heating and Cooling



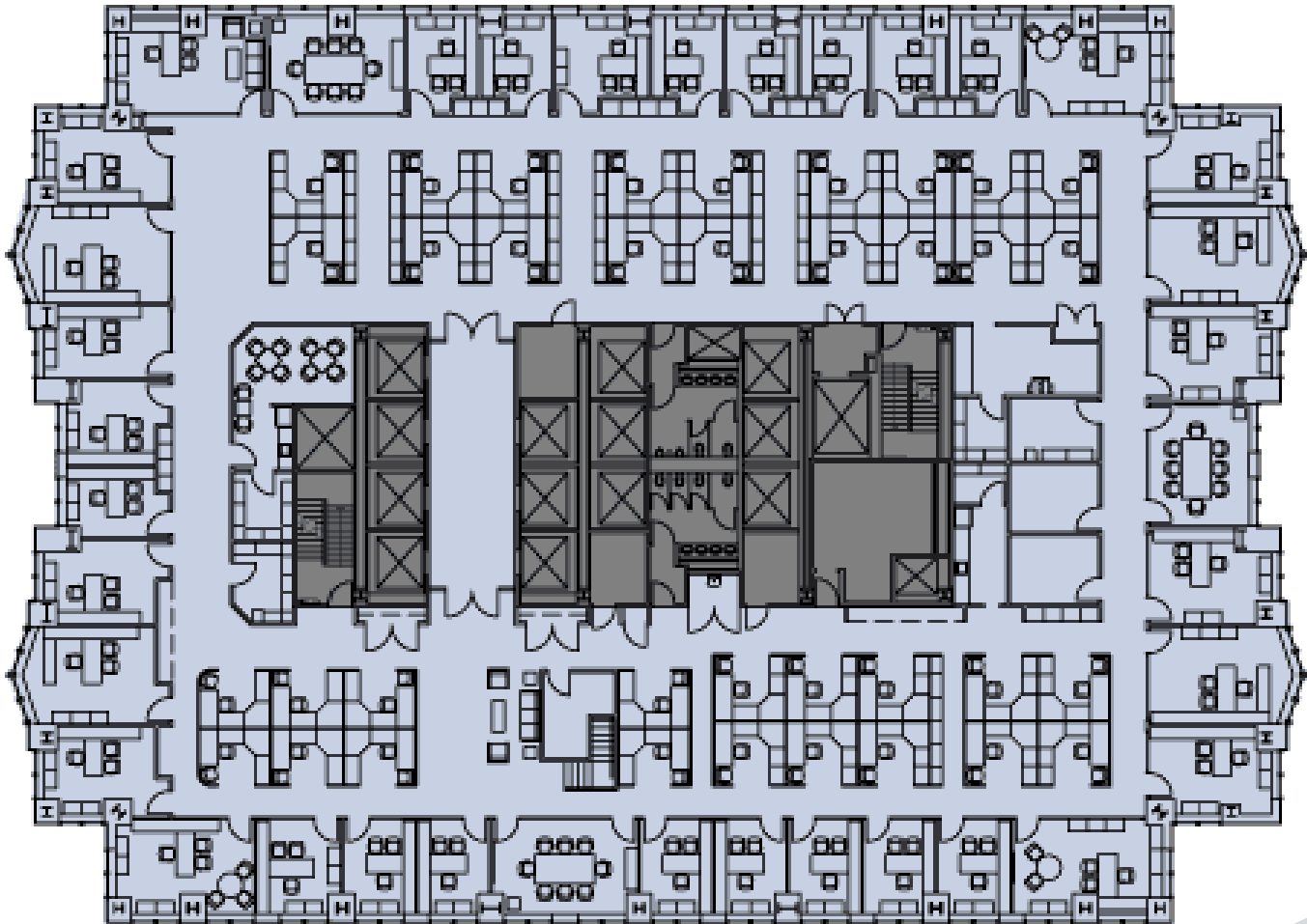
Simultaneous Heating and Cooling



Daytime Temperature Bins in Seattle



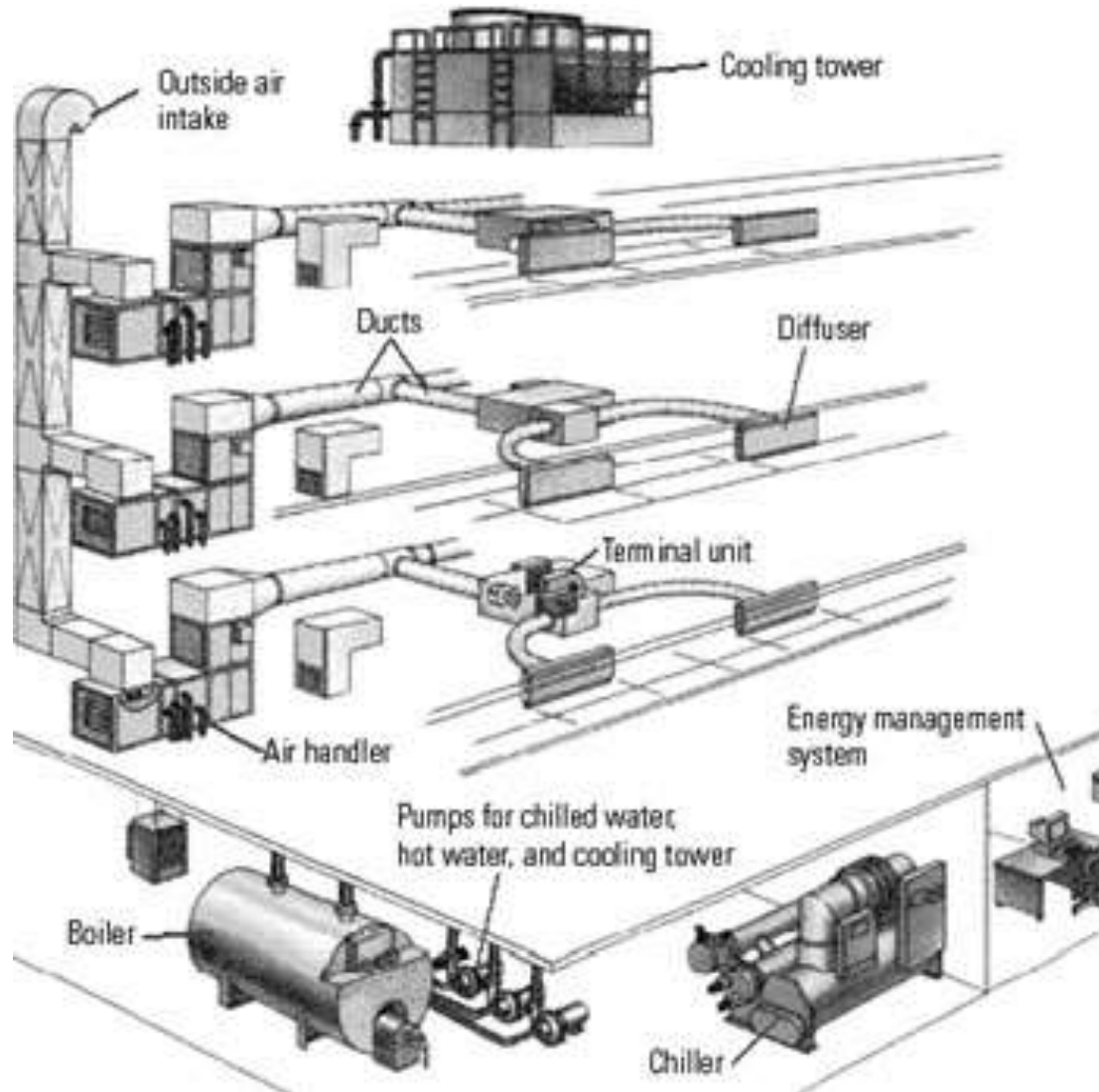
Perimeter Offices



Open Office Floor Plans



1. Move away from large central HVAC systems



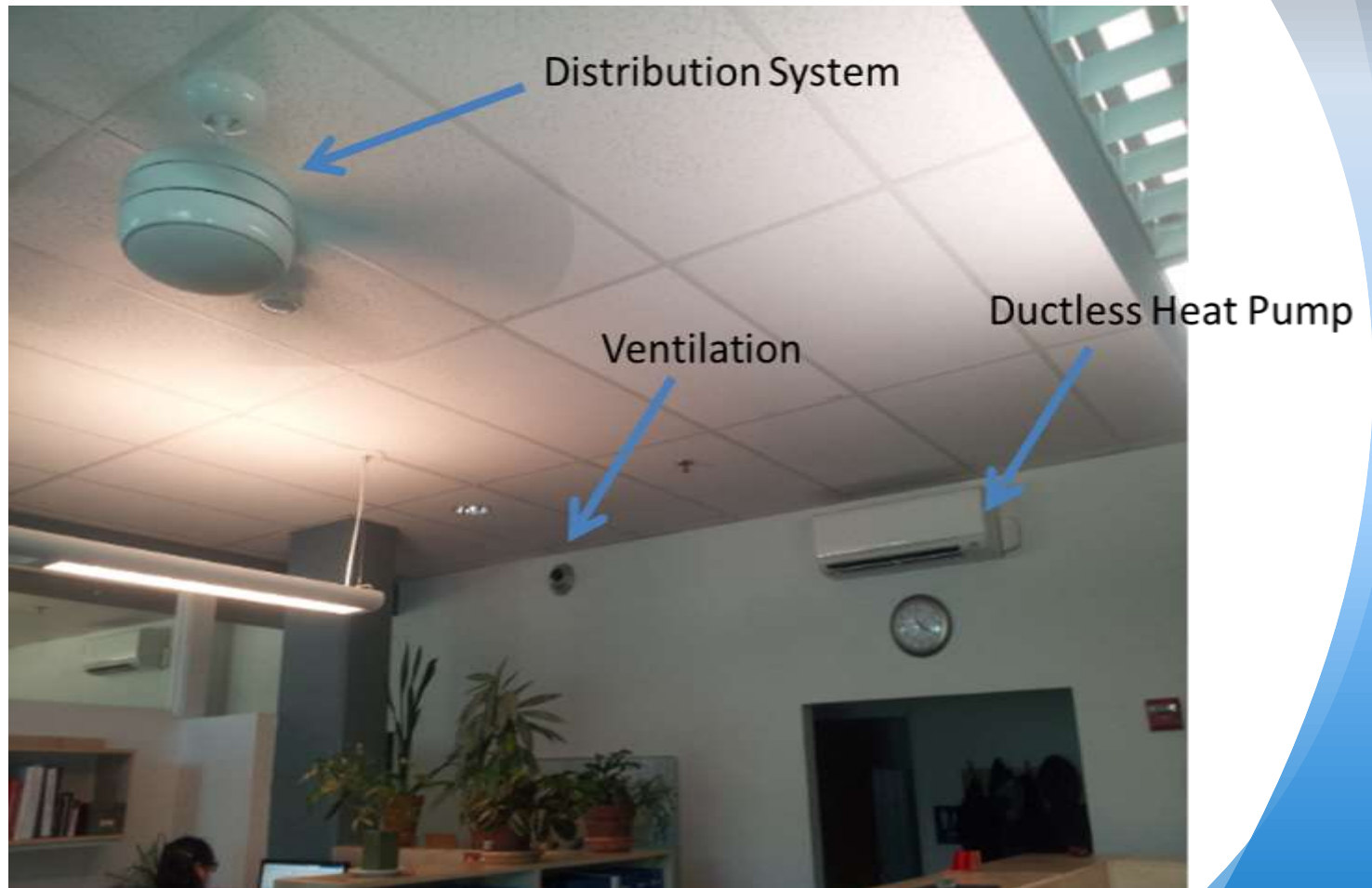
Towards smaller zonal systems



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



Towards dedicated ventilation systems (DOAS)



3. Right-Size Mechanical Systems



Believe (Do) the Load Calculations



Disruption of the HVAC Industry

- Designers
 - Installers
 - Manufacturers
 - Distributors
 - Owners
 - Facilities Operators
- 

King County Housing Authority: Tukwila, WA



EUI = 26

1980's Level Envelope

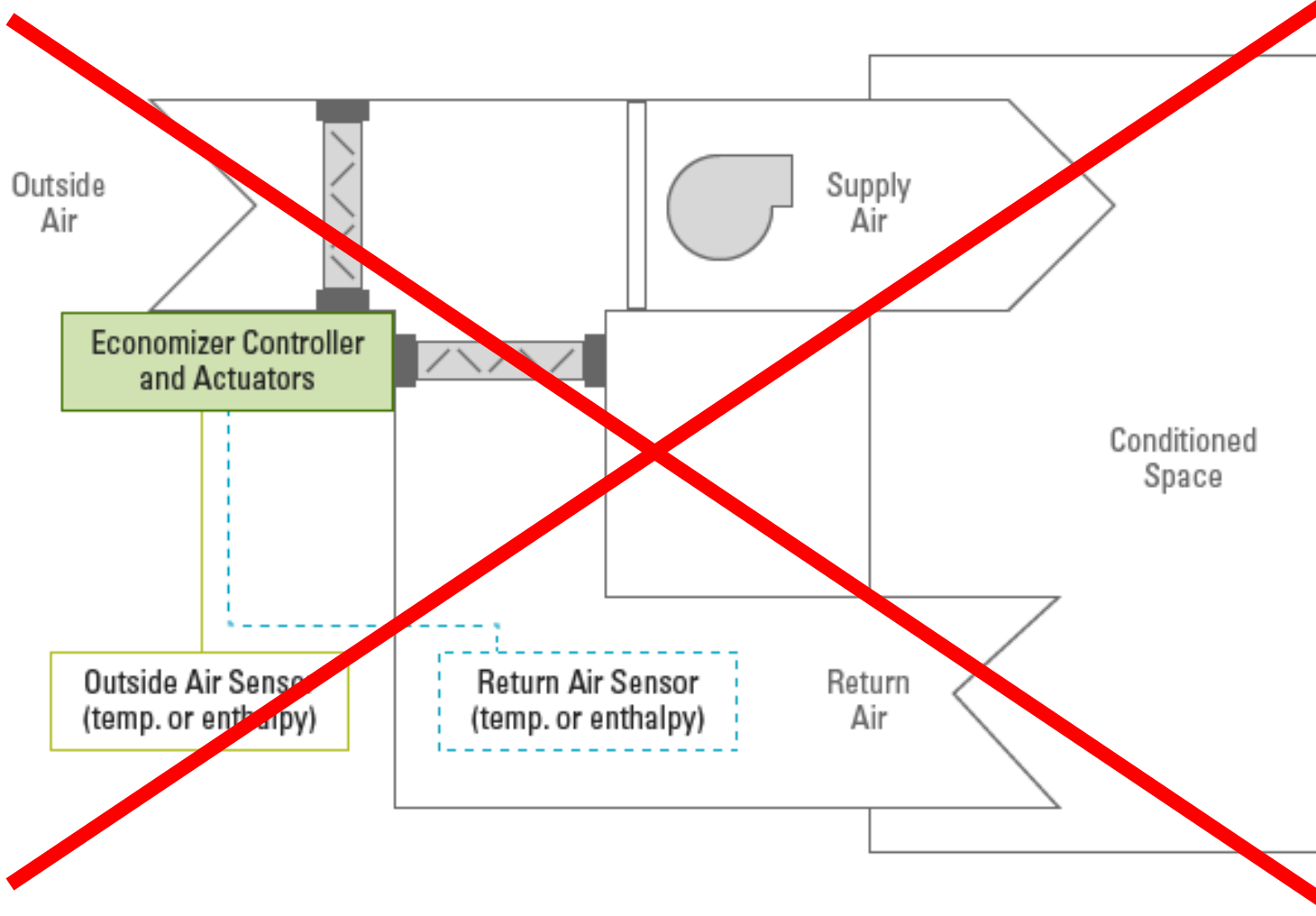


- R-11 Walls
- R-20 Roof

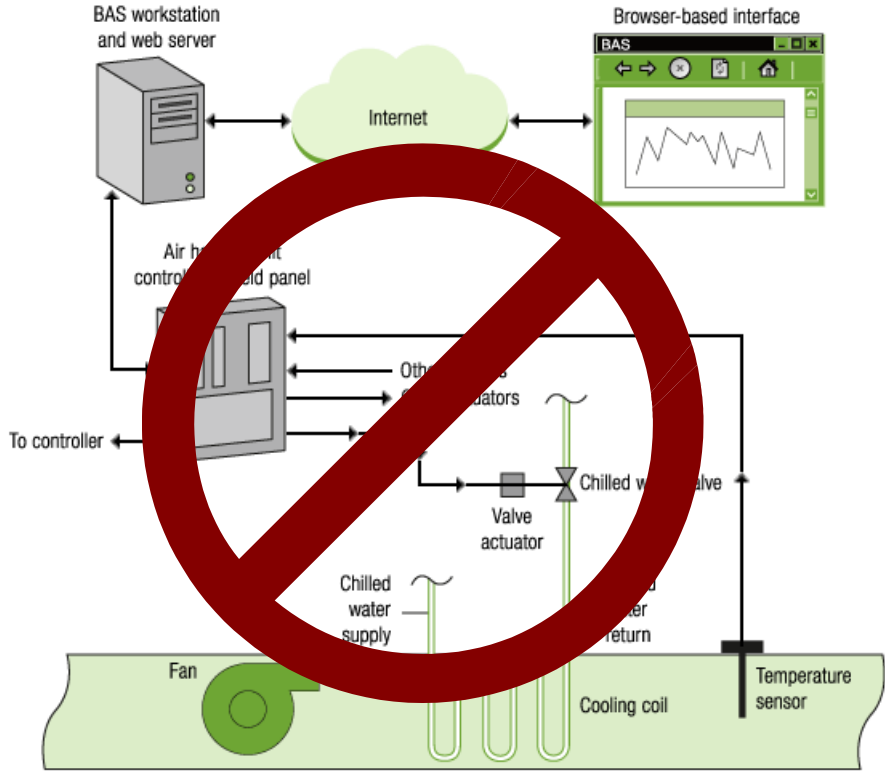
- Uninsulated Slab
- U-0.4 Double Glaze



No Economizers



No Direct Digital Controls



Fluorescent Lights – No Auto Plug Management

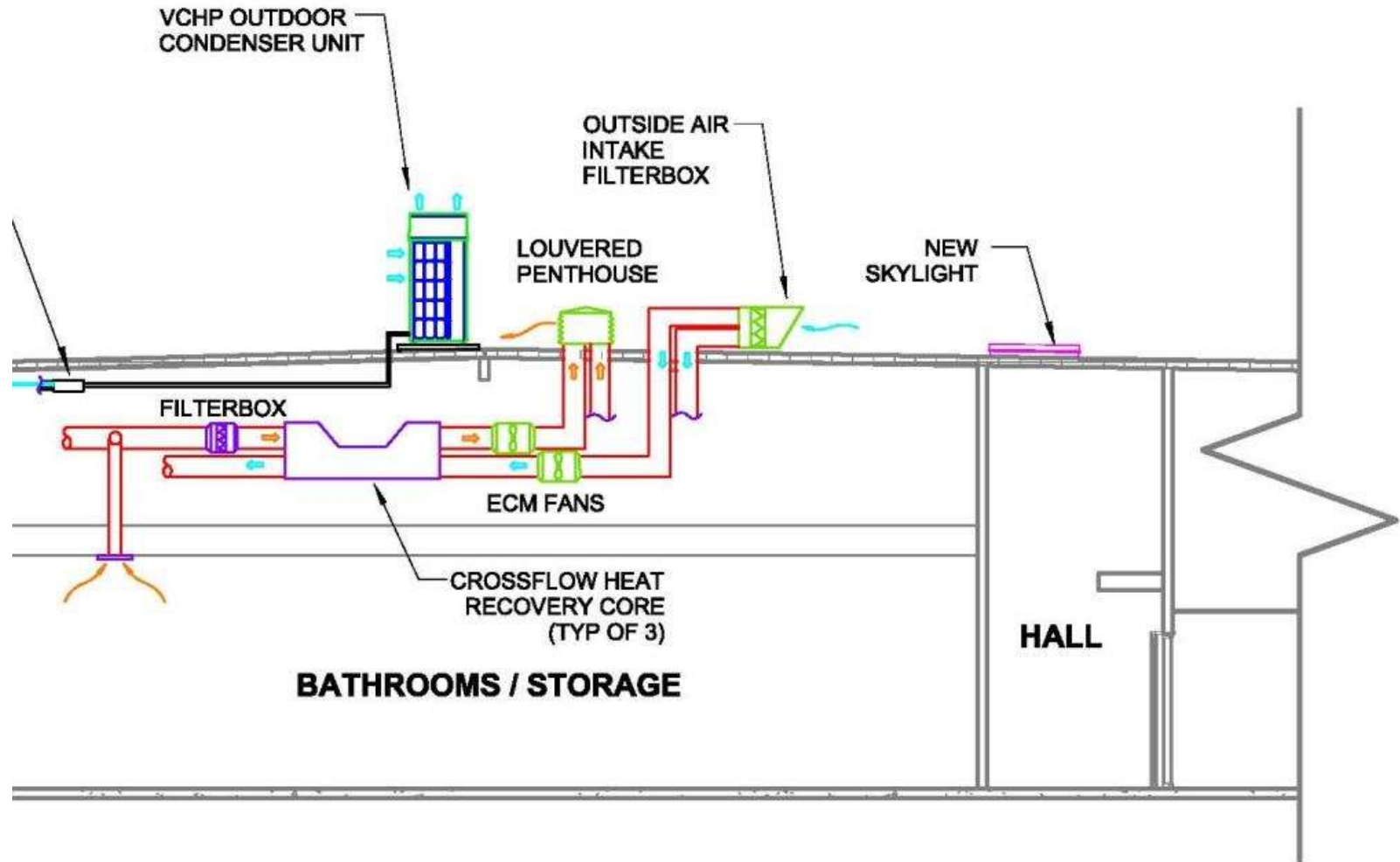


Zonal Variable Refrigerant Flow (VRF)



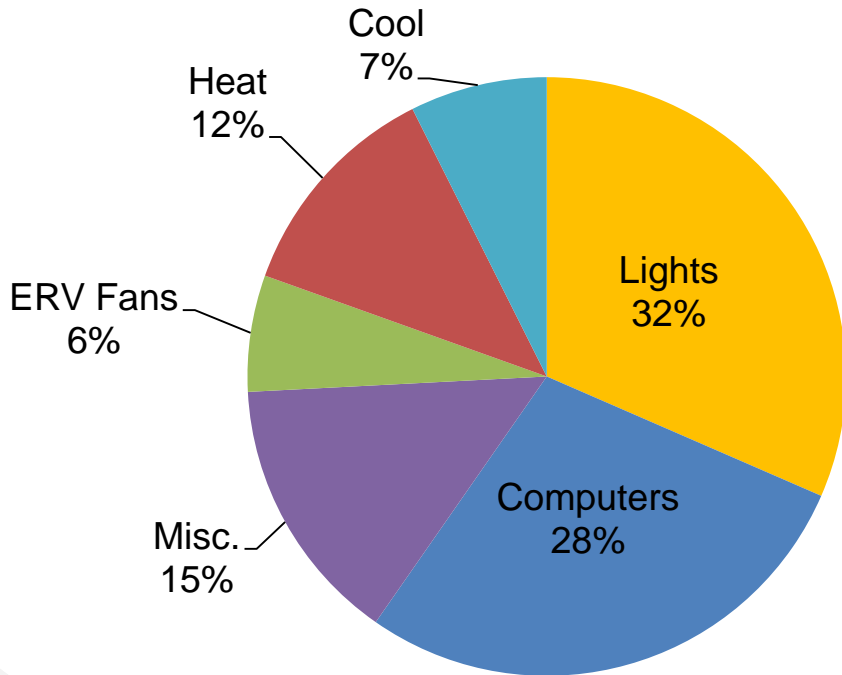
- 48 Tons
- 36 Ductless Units
- 14 Ducted Units
- 50 Zones Total
- 700SF/ton

DOAS via High Efficiency ERV

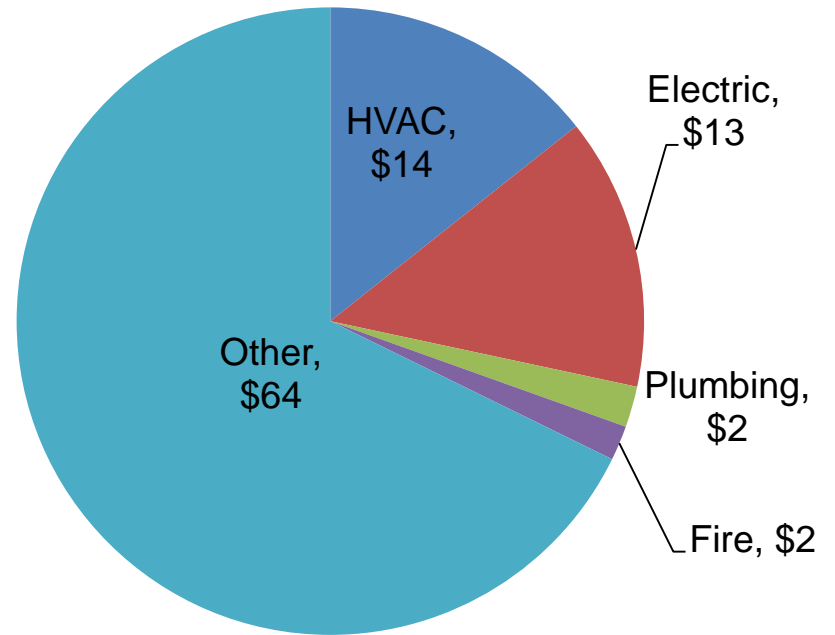


High Performance, Low Cost

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



KCHA Construction Budget (\$95/sf)



From Widgets to Design

1. Provide Ventilation with HRV and Separate Ventilation from Heating and Cooling
2. Zonal Heating and Cooling
Equipment Cycling on Load
3. Right Sizing of Equipment
(Ventilation and Heat/Cool)

2015 WA State Energy Code Changes

1. Dedicated Outdoor Air System with Heat Recovery for Office, Education, Retail, Library, Fire Stations
2. Zoned Heating and Cooling Equipment - Cycling on Load.
3. Ventilation Volumes Limited to 150% of ASHRAE Standards (62.1)

Questions?



Jonathan Heller
jheller@ecotope.com