# Sustainable MEP Integration

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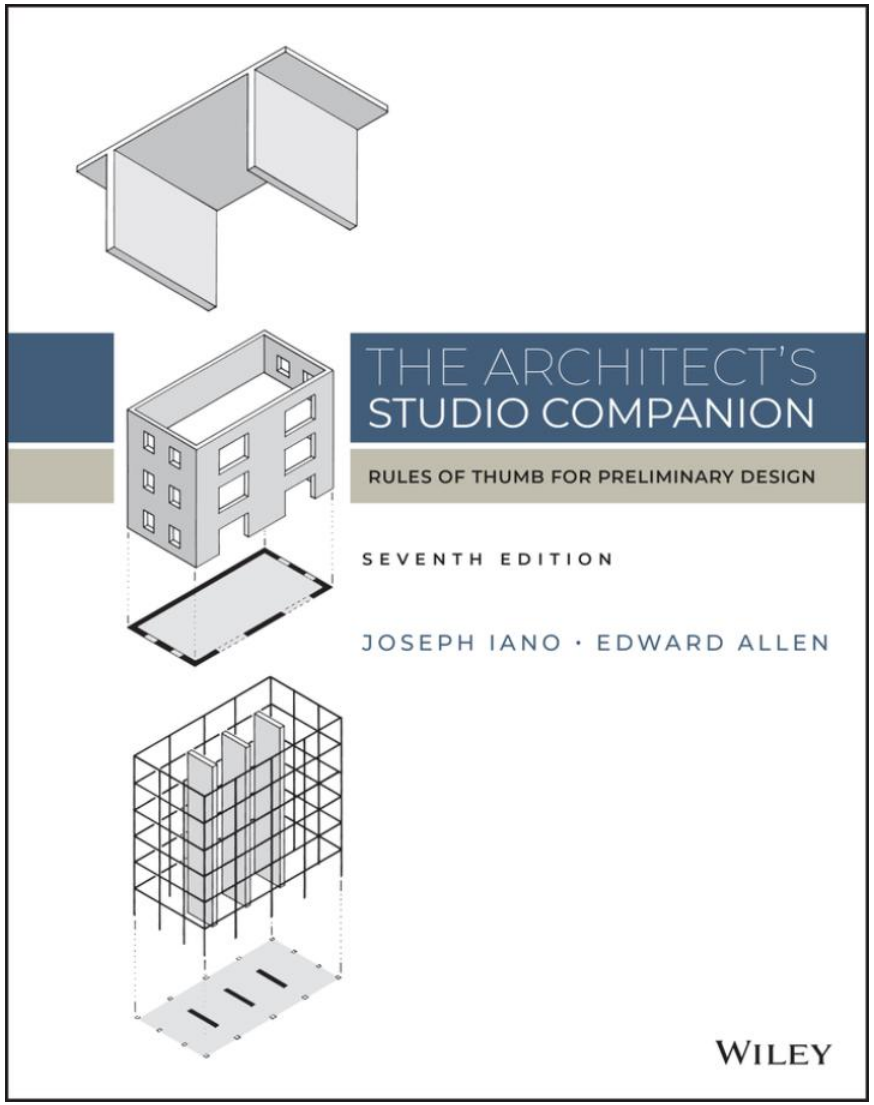
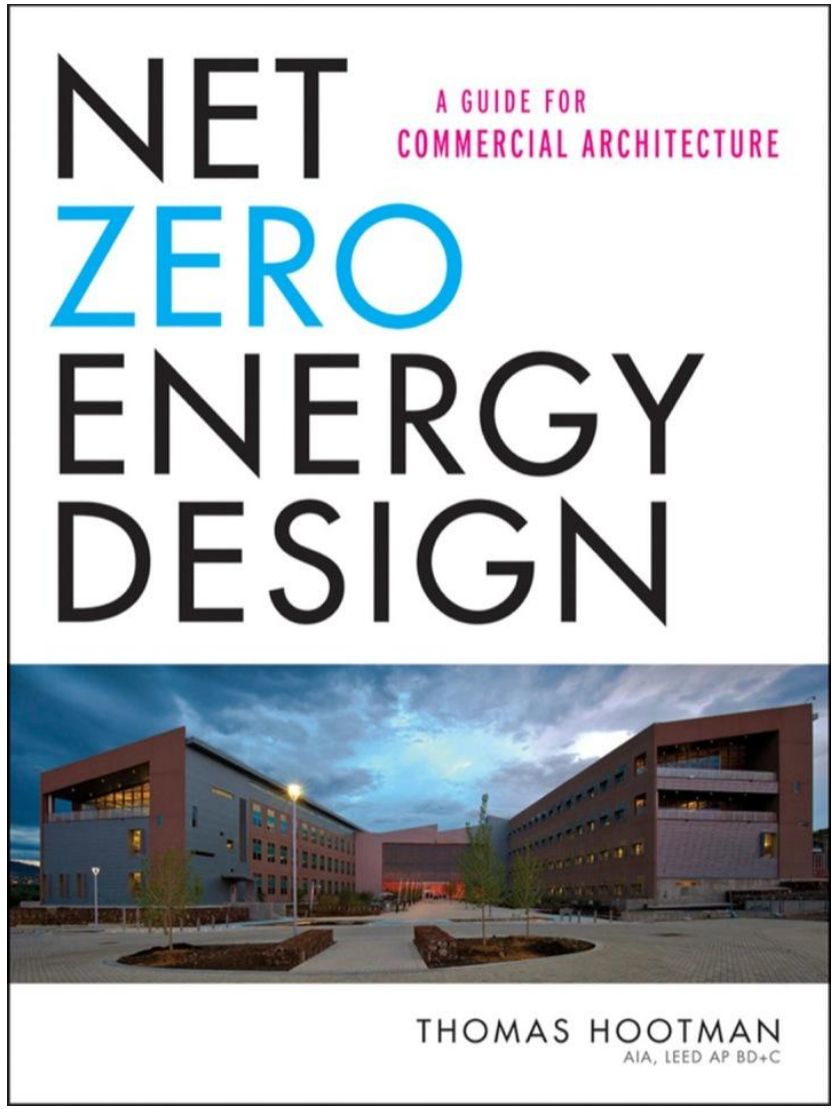
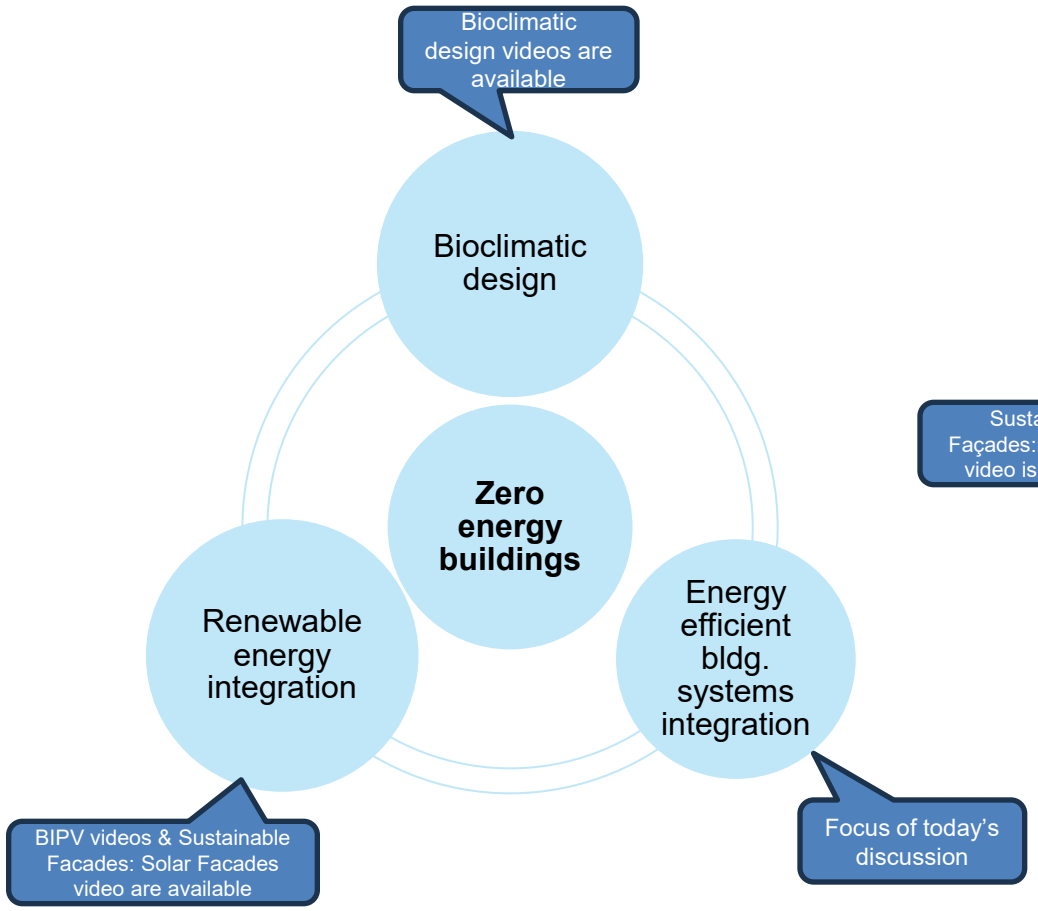
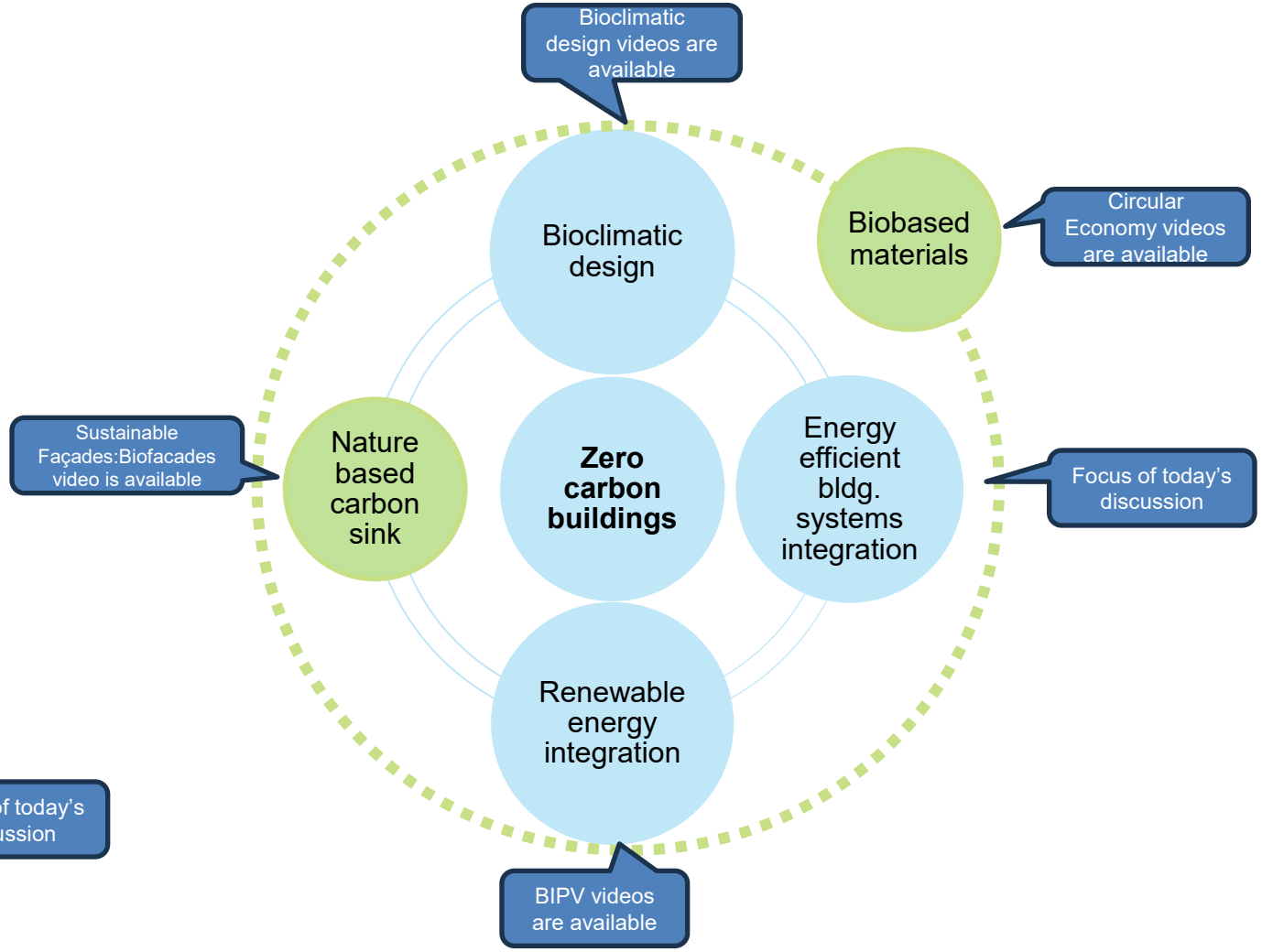

THE ARCHITECT'S
STUDIO COMPANION
RULES OF THUMB FOR PRELIMINARY DESIGN
SEVENTH EDITION
JOSEPH IANO · EDWARD ALLEN
WILEY


NET ZERO ENERGY DESIGN
A GUIDE FOR
COMMERCIAL ARCHITECTURE
THOMAS HOOTMAN
AIA, LEED AP BD+C

# Net Zero Design Approach



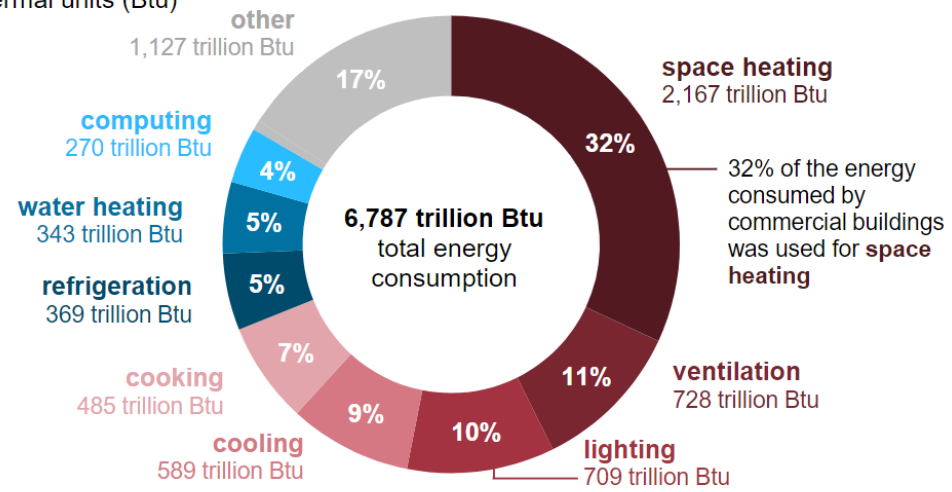

**Net Zero Energy Design Strategy**



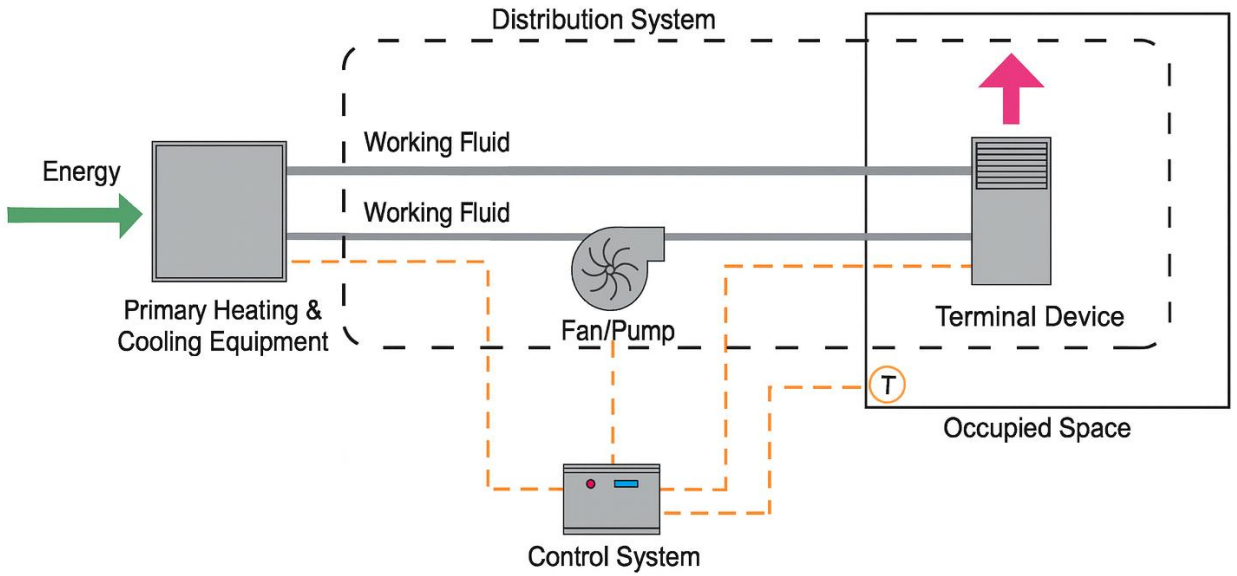

**Net Zero Carbon Design Strategy**

# Energy End User & HVAC Key Component

**End uses of energy consumption by U.S. commercial buildings (2018)**
British thermal units (Btu)

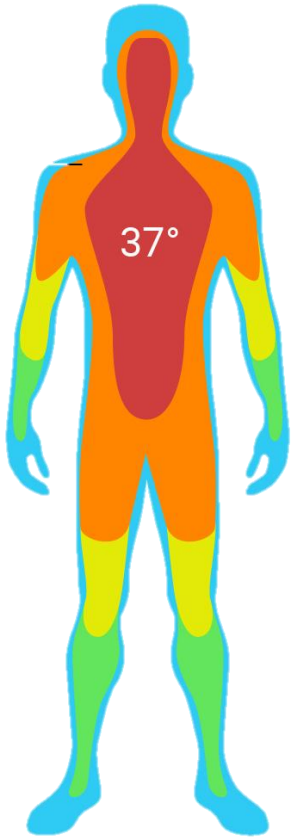



**Data source:** U.S. Energy Information Administration, *Commercial Buildings Energy Consumption Survey*
**Note:** Btu = British thermal units

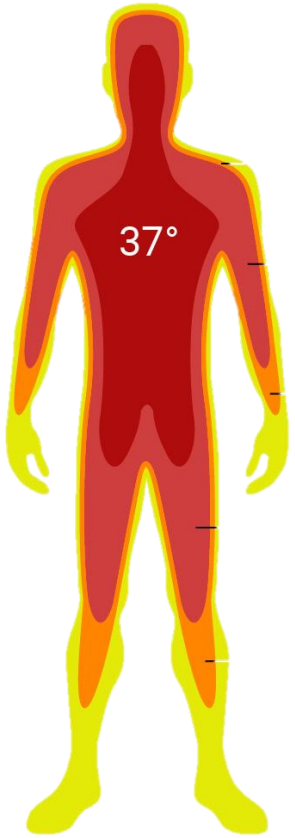



Net Zero Energy Design. Hootman. 2013

**Climate and Bioclimatic Design:**
**Human Body Reactions to Main Climatic Elements**




20°C ambient temp



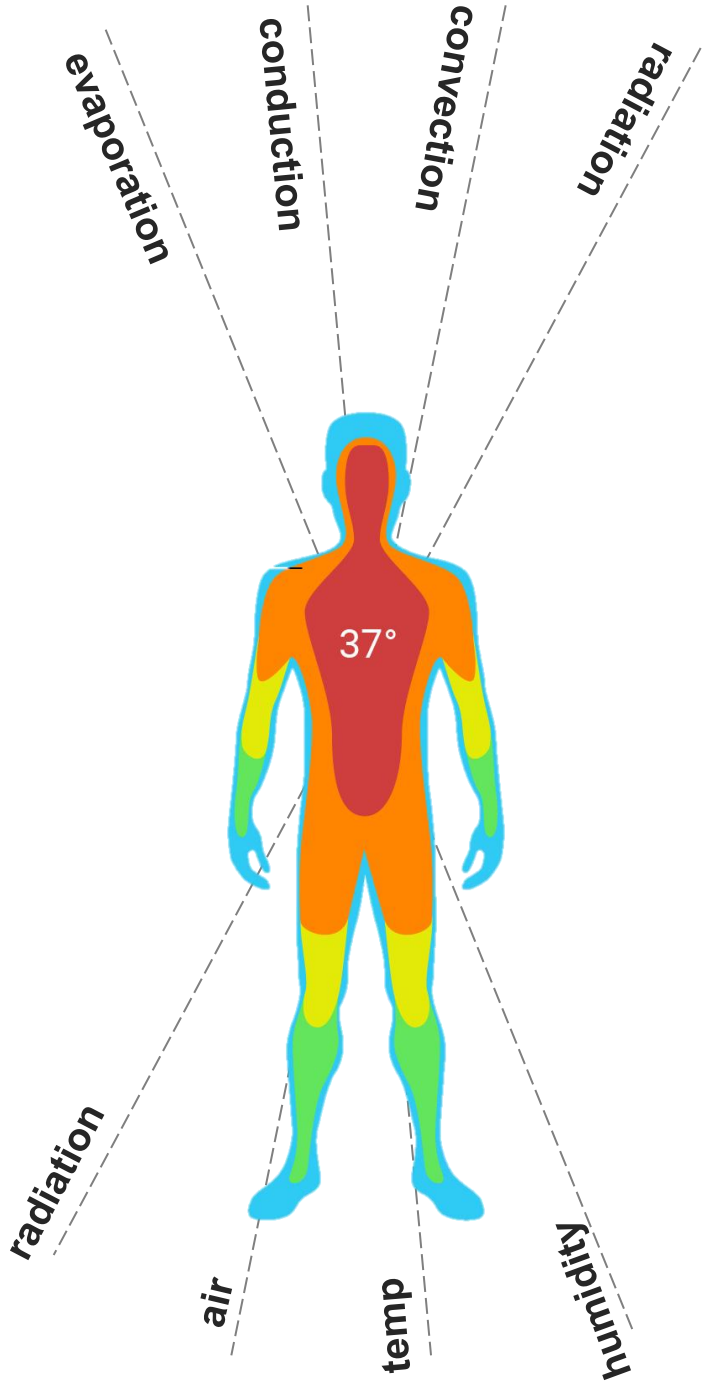

30°C ambient temp

Medical science

Biology

Environmental technology

Meteorology

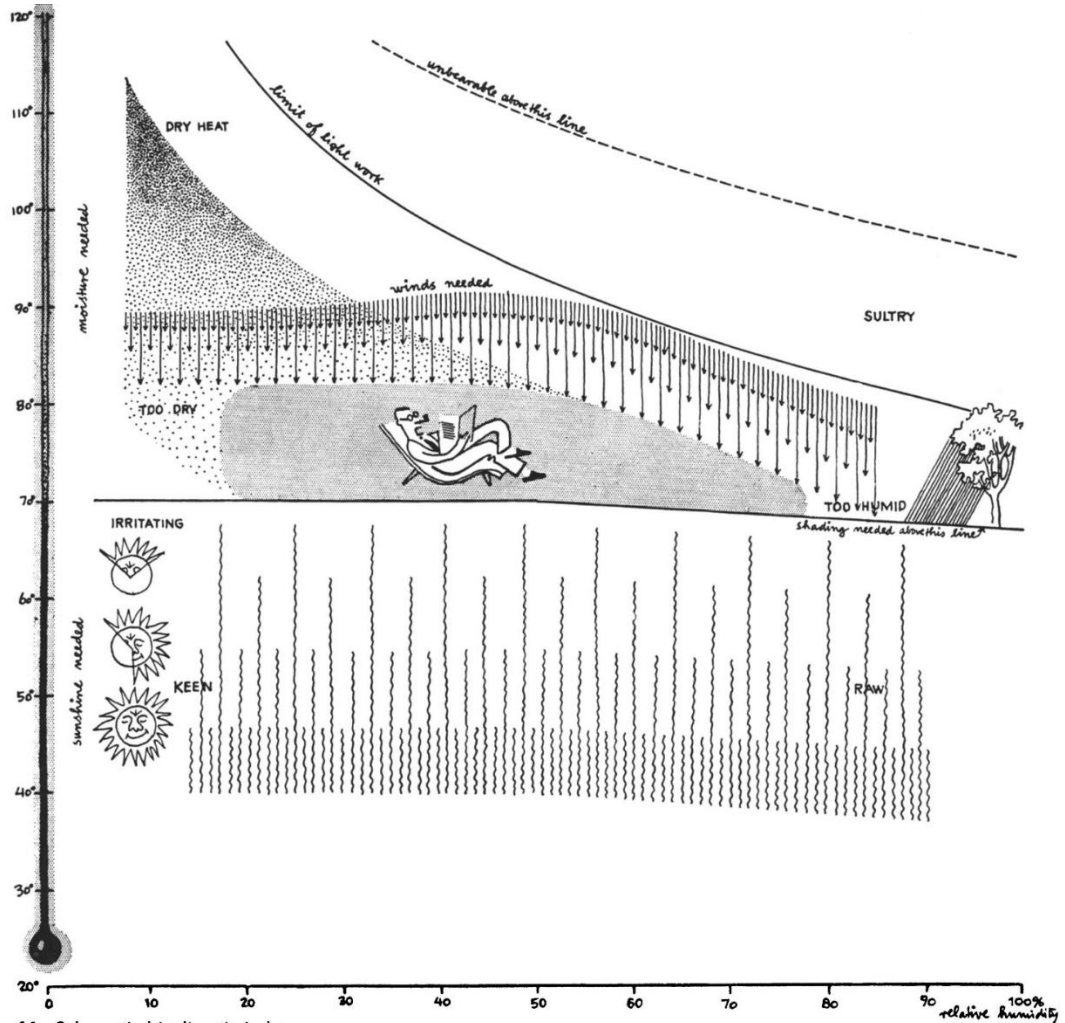



Human reaction

Indices of comfort

Main climatic elements

# Climate and Bioclimatic Design: Psychometric Chart




46. Schematic bioclimatic index.

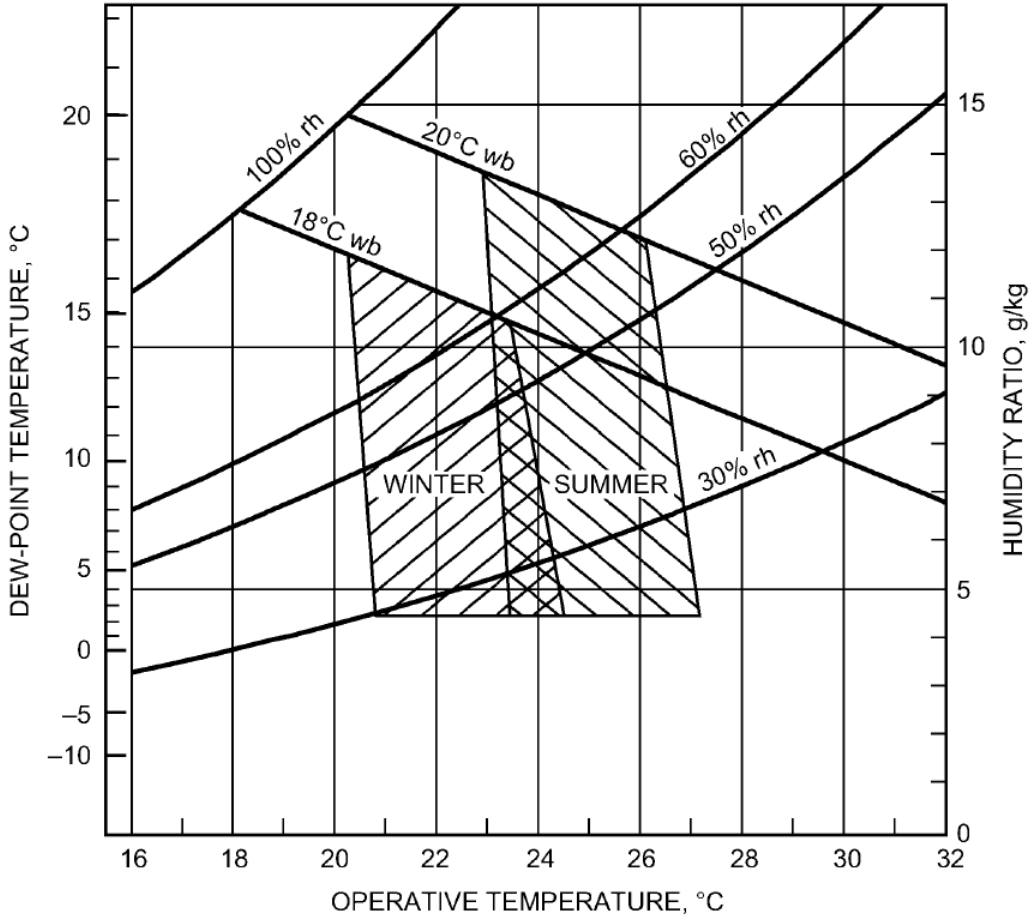



**Fig. 5 ASHRAE Summer and Winter Comfort Zones**
(Acceptable ranges of operative temperature and humidity for people in typical summer and winter clothing during primarily sedentary activity.)

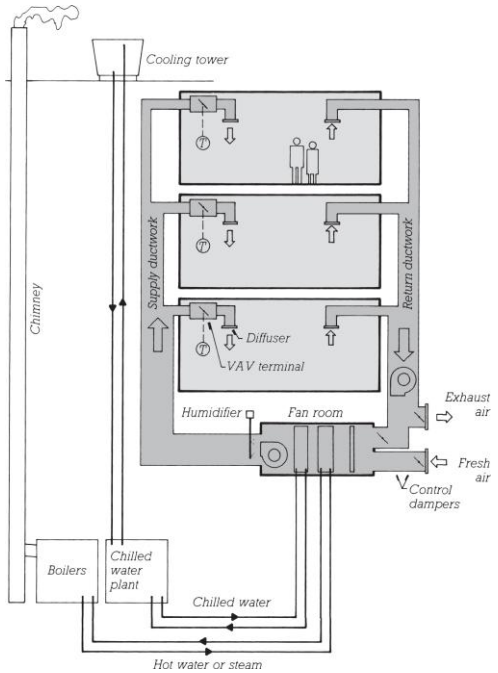
# HVAC System Design Goals and Recommending Systems

## Heating and cooling system for large buildings

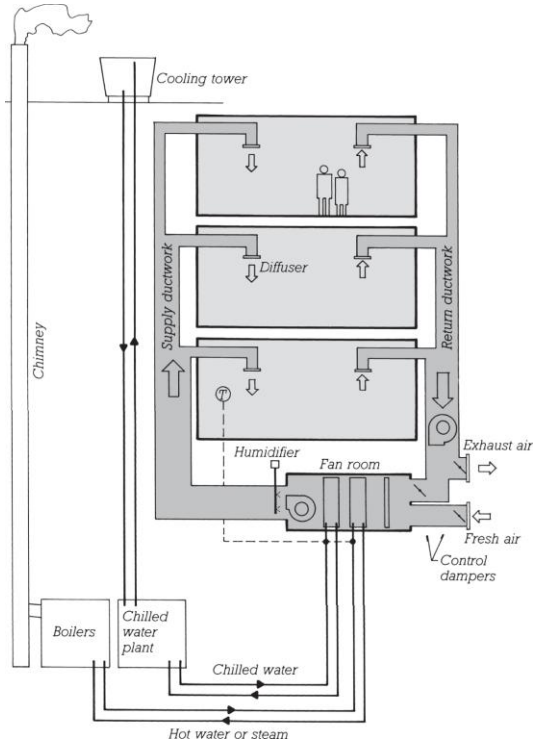
| GIVE SPECIAL CONSIDERATION TO THE SYSTEMS INDICATED IF YOU WANT TO: | Variable Air Volume (VAV) (page 174) | VAV Reheat (page 175) | VAV Induction (page 175) | Fan-Powered VAV (page 175) | Dual-Duct VAV (page 175) | Constant Air Volume (CAV) (page 176) | Multizone CAV (page 177) | Active Chilled Beams (page 178) | Passive Chilled Beams (page 179) | Fan-Coil Terminals (page 180) | Close-Loop Heat Pumps (page 181) | Hydronic Convectors (heating only) (page 182) | Hydronic Radiant Heating and Cooling (page 183) | Central Single-Packaged Units (page 192) | Packaged Heat Pump Units (page 193) | Ductless Split-Packaged Units (page 193) | Packaged Terminal Units (page 184) | Passive Solar Heating (page 228) | Natural Ventilation Cooling (page 231) | Thermal Mass Cooling (page 234) | Evaporative Cooling (page 237) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimize first costs | ● | ● | | | | ● | | | | | | | | ● | | ● | ● | | | | |
| Minimize operating costs and energy consumption | ● | | ○ | | | | | ● | ● | | ● | | ● | | ● | | | ● | ● | ● | ● |
| Maximize control of air velocity and air quality | | | ○ | ● | ○ | ○ | ○ | ● | | | | | | | | | | | | | |
| Maintain comfort with large heating and cooling load changes | | ● | ○ | ● | ○ | | | | | ● | | | | | | | | | | | |
| Minimize system noise | ● | ● | ○ | | ○ | ● | ○ | ● | ● | | | ● | ● | | | | | ● | | ● | |
| Minimize visual obtrusiveness | ● | ● | ○ | ● | ○ | ● | ○ | ○ | ○ | | | | ● | ● | | | | ● | ● | ● | ● |
| Maximize flexibility of space reconfiguration | ● | ● | ○ | ● | ○ | | | | | ● | | ● | | | | ● | ● | | | | |
| Condition a large, single-story, open space | | | | | | | | | | | | | | ● | | | | | | | |
| Minimize floor space used for the heating and cooling systems | | | | | | | | ● | ● | ○ | | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |

● Frequently use
○ Less frequently used

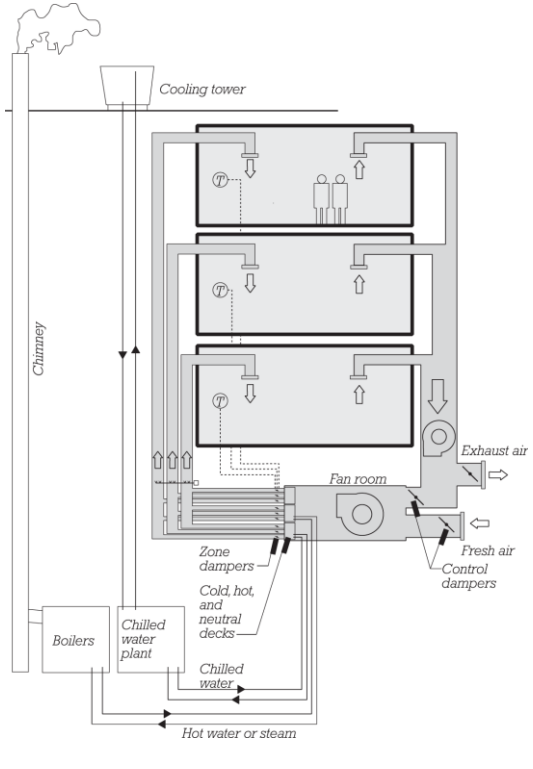
# HVAC Systems and Architectural Space Implications: VAV, CAV, Multizone System & Chilled Beam



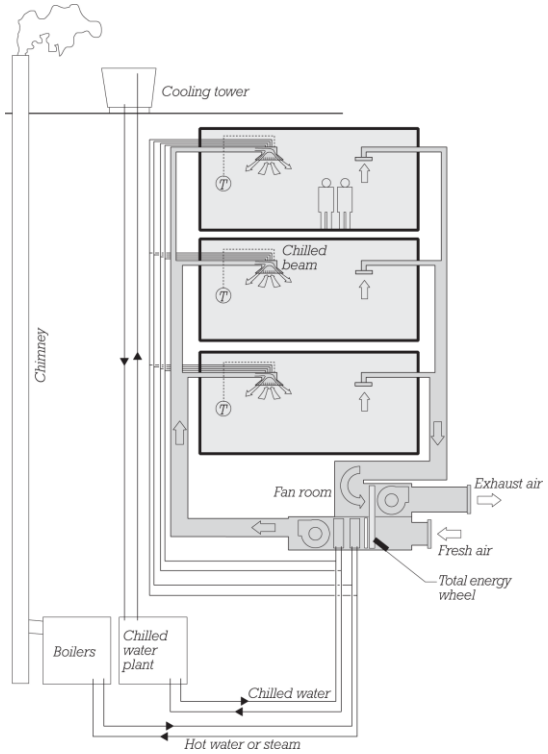

**Variable air volume (VAV)**




**Constant air volume (CAV)**



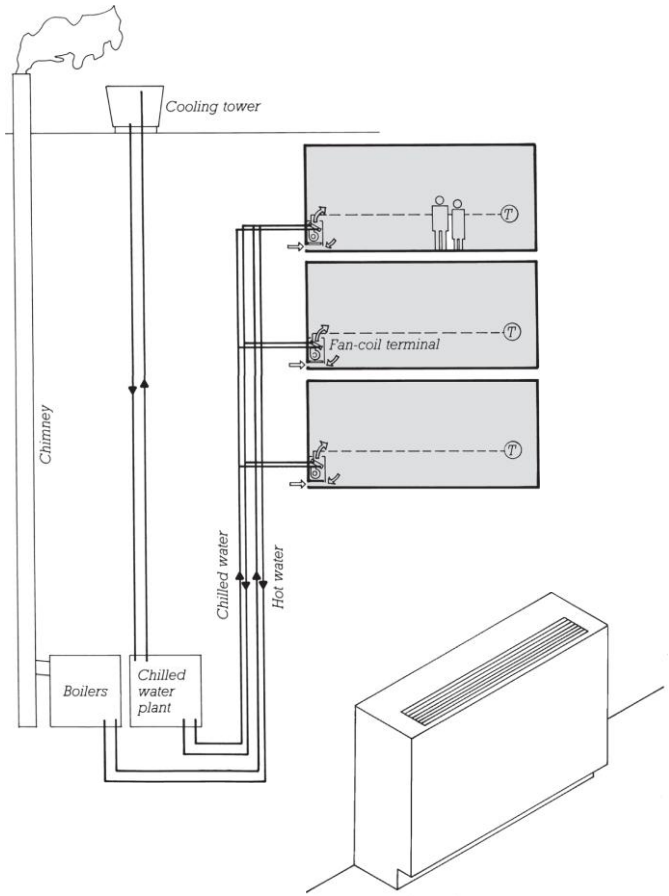

**Multi-zone system**



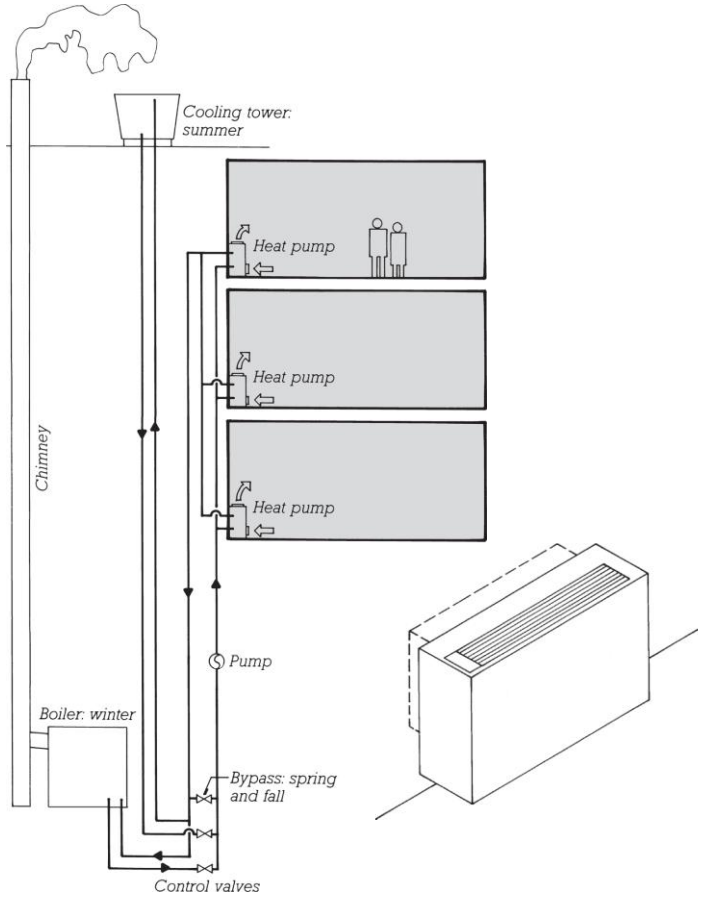

**Active chilled beam system**

The Architect's Studio Companion. Iano & Allen. 2022

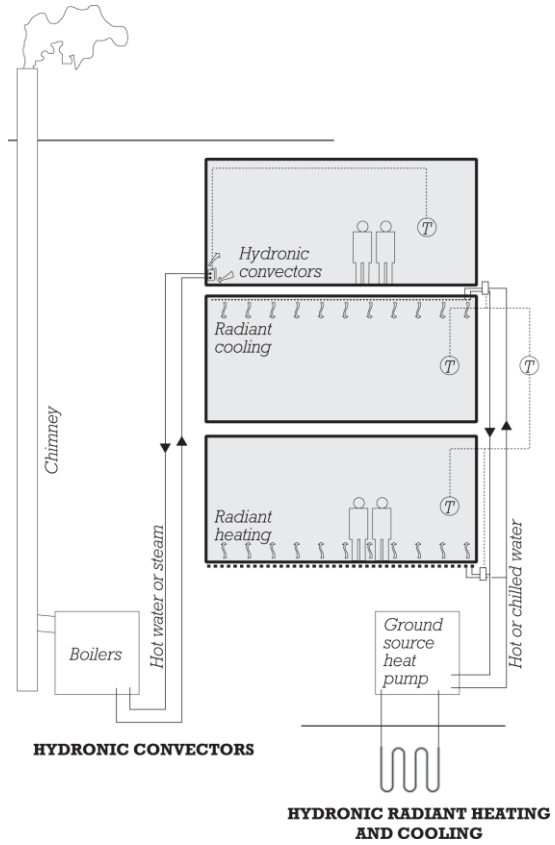
# HVAC Systems and Architectural Space Implications: Fan Coil Unit, Heat-pump, & Radiant Heating



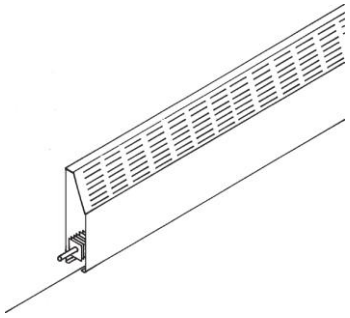

Fan Coil terminal unit system




Closed-loop heat pump system



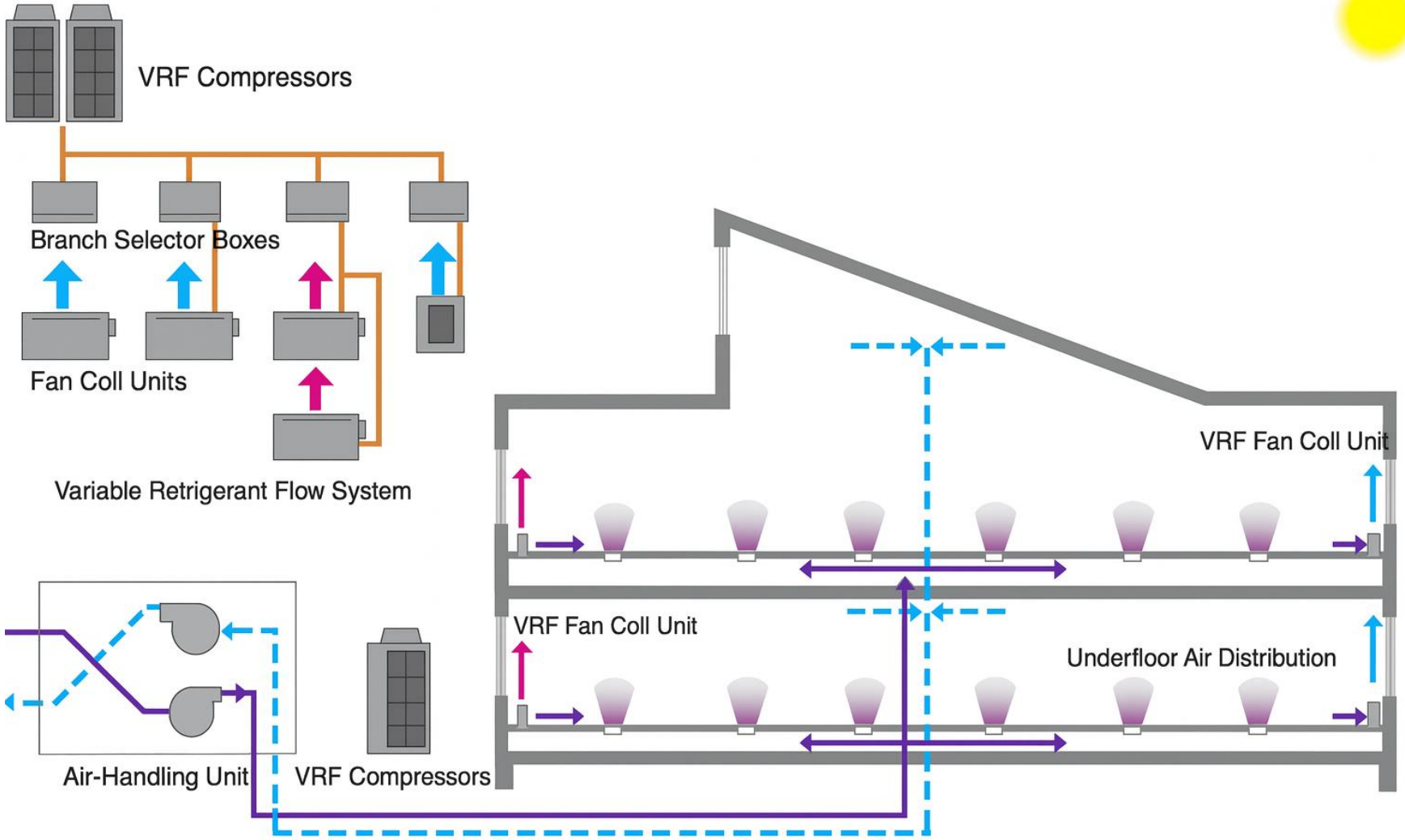

Radiant heating system



Fan tube convector

The Architect's Studio Companion. Iano & Allen. 2022

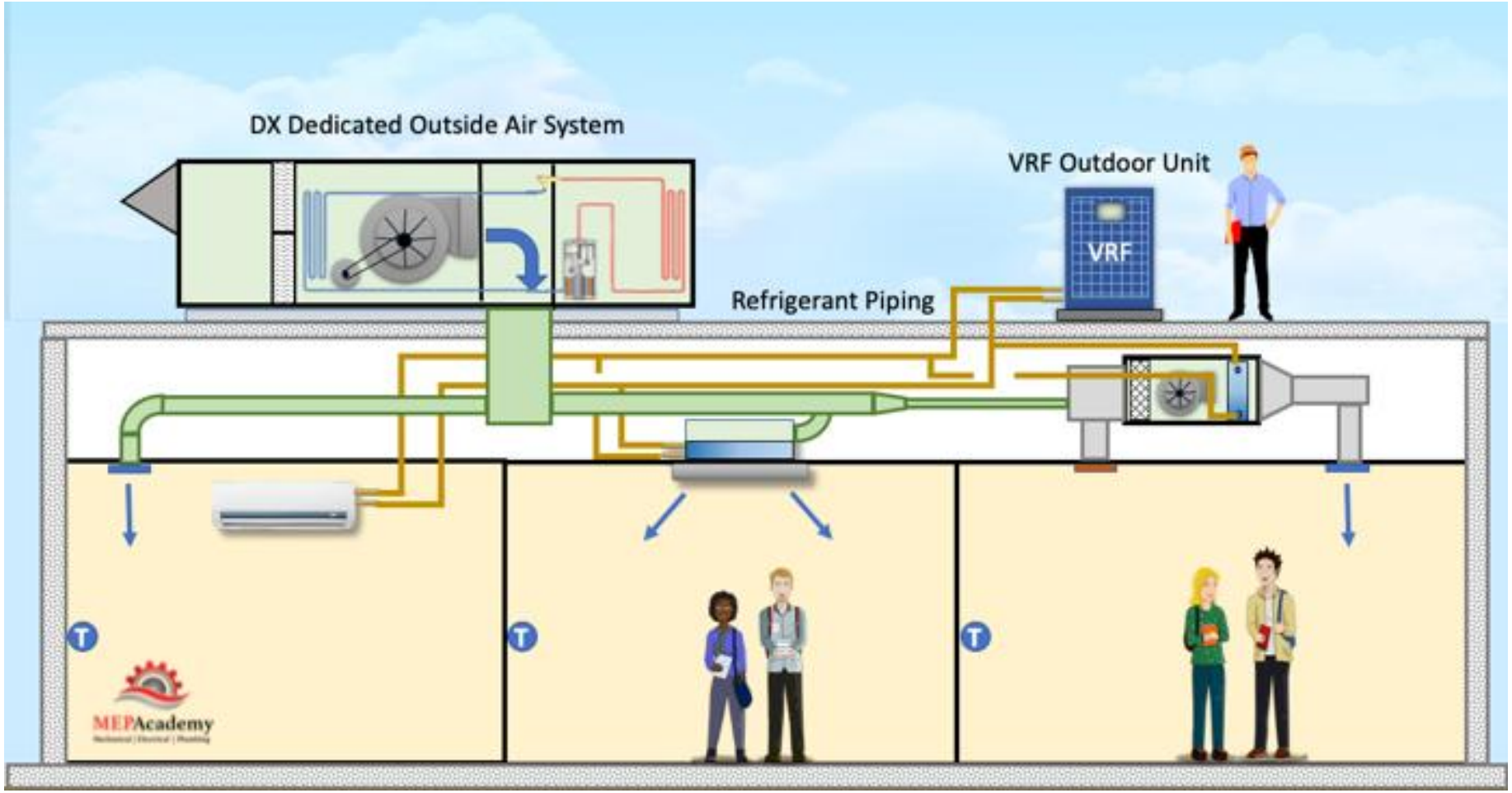
# HVAC Systems and Architectural Space Implications: VRF + Fan Coil + Underfloor Air Distribution




**Variable Refrigerant Flow System**

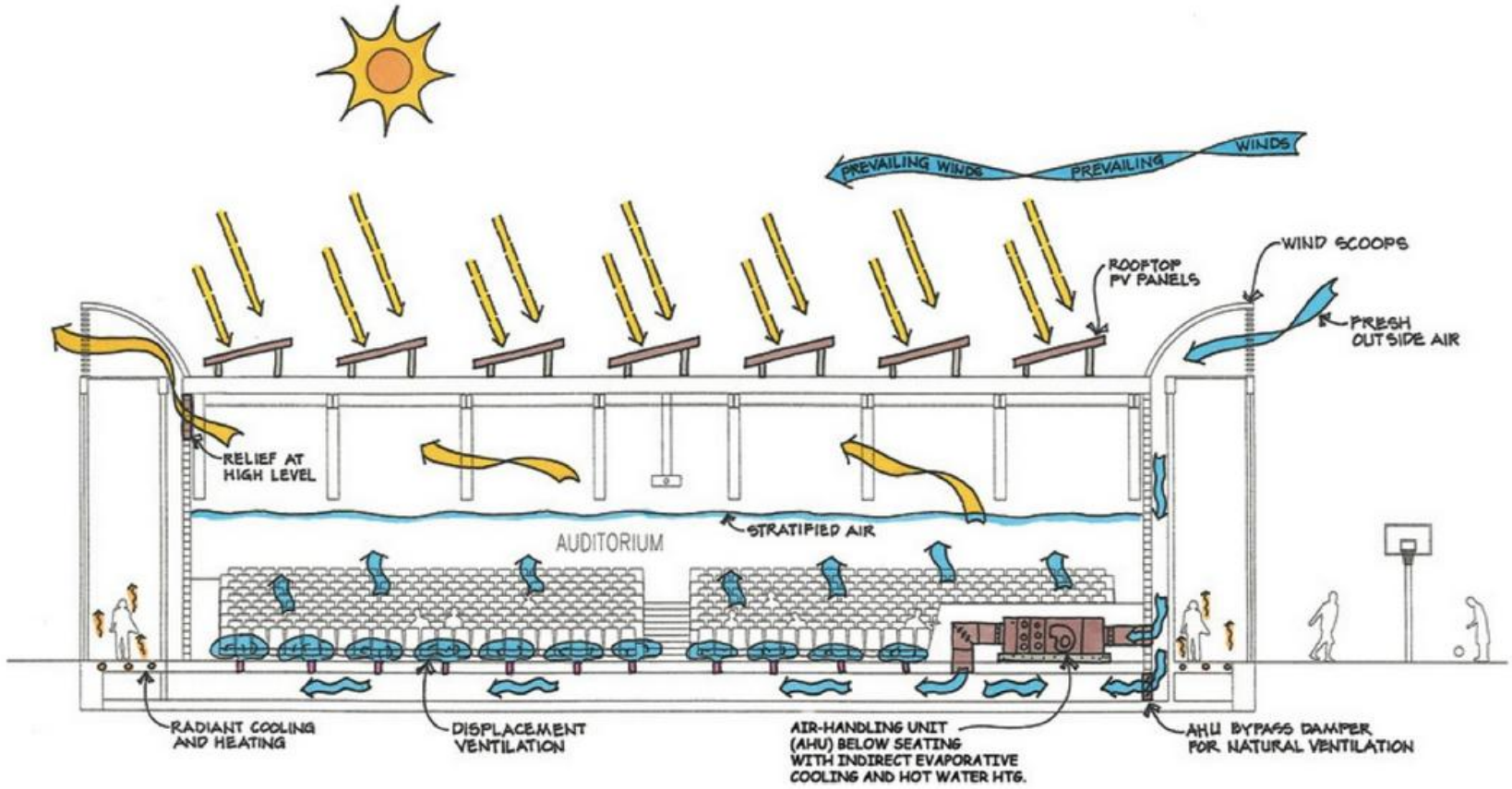
Net Zero Energy Design. Hootman. 2013

# HVAC Systems and Architectural Space Implications: VRF + DOAS




**Dedicated Outdoor Air System (DOAS)**

# HVAC Systems and Architectural Space Implications: Displacement Ventilation + Perimeter Heating




■ **FIGURE 7.7** Displacement ventilation diagram for an auditorium at the Science & Student Life Center at Sacred Heart School in Atherton, California. *Image courtesy of Stantec Consulting Services, Inc.*

**Displacement Ventilation with Perimeter Heating**

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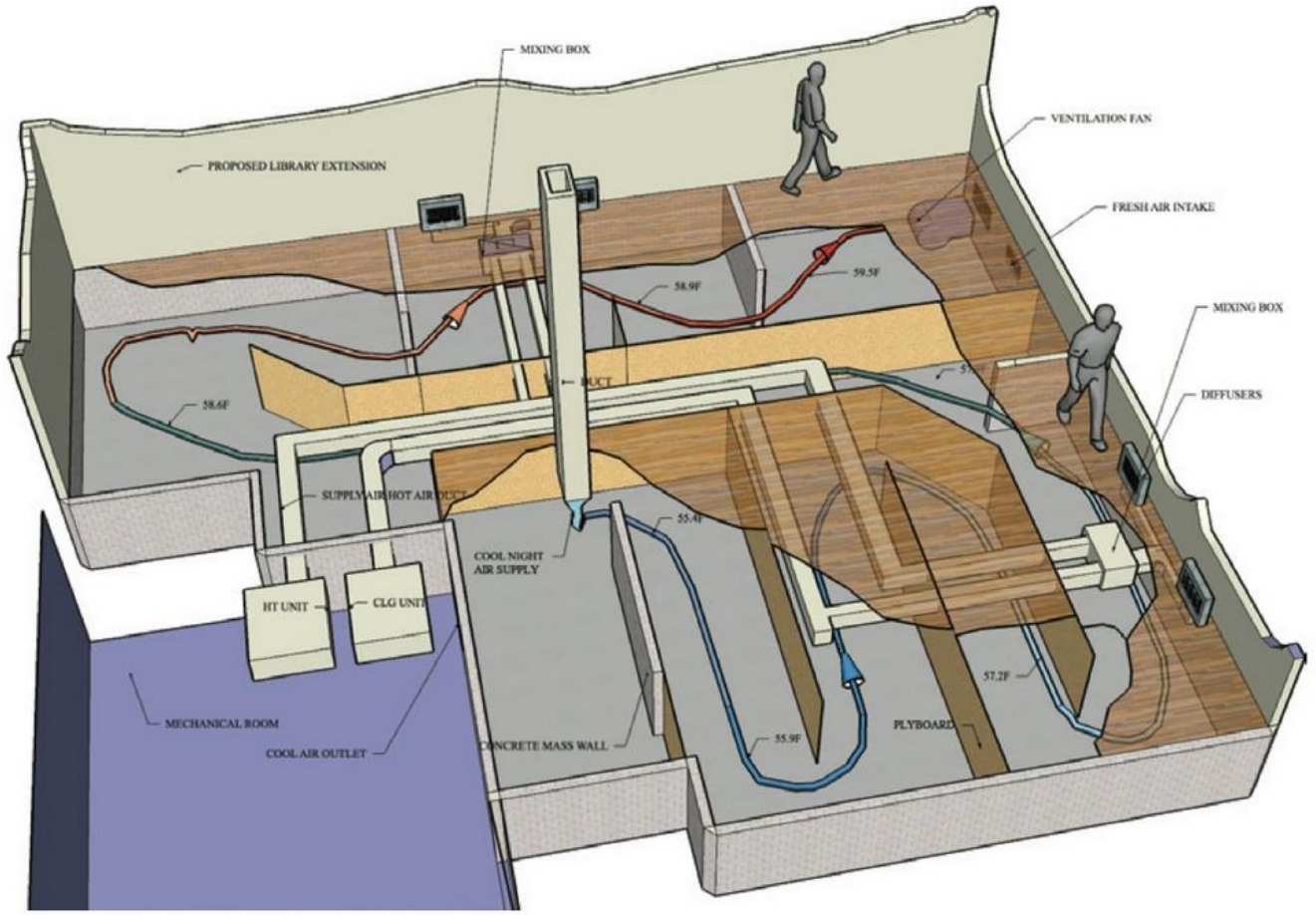
# HVAC Systems and Architectural Space Implications: Precooling




■ **FIGURE 7.13** The East San Jose Carnegie Library addition features a remote thermal mass for precooling ventilation air. *Image courtesy of Stantec Consulting Services Inc.; image by Porus Antia.*

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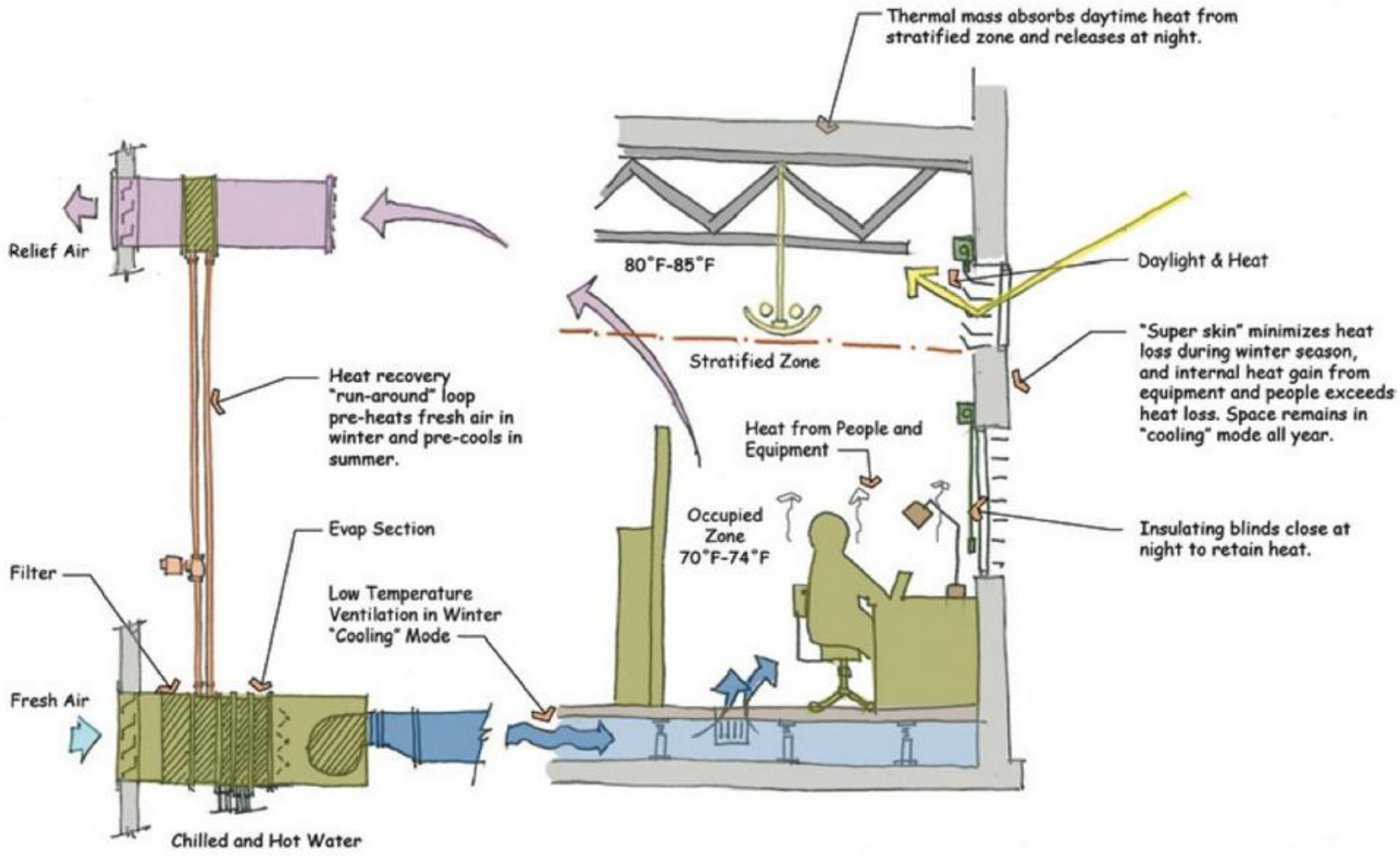
# HVAC Systems and Architectural Space Implications: Heat Recovery System




■ **FIGURE 7.10** Heat Recovery of a Return Airstream. *Image courtesy of Stantec Consulting Services Inc.; Drawing by Jim Burns*

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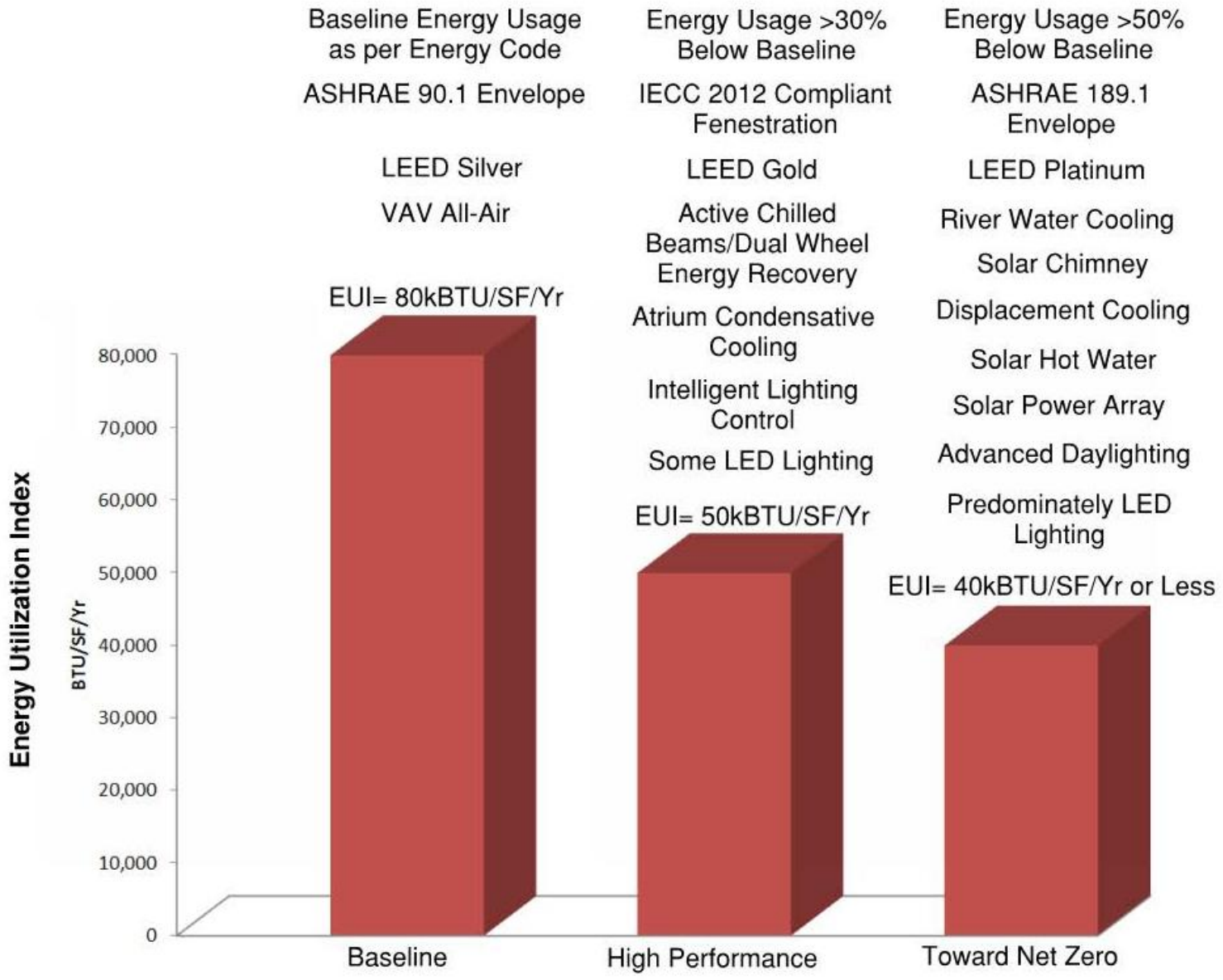
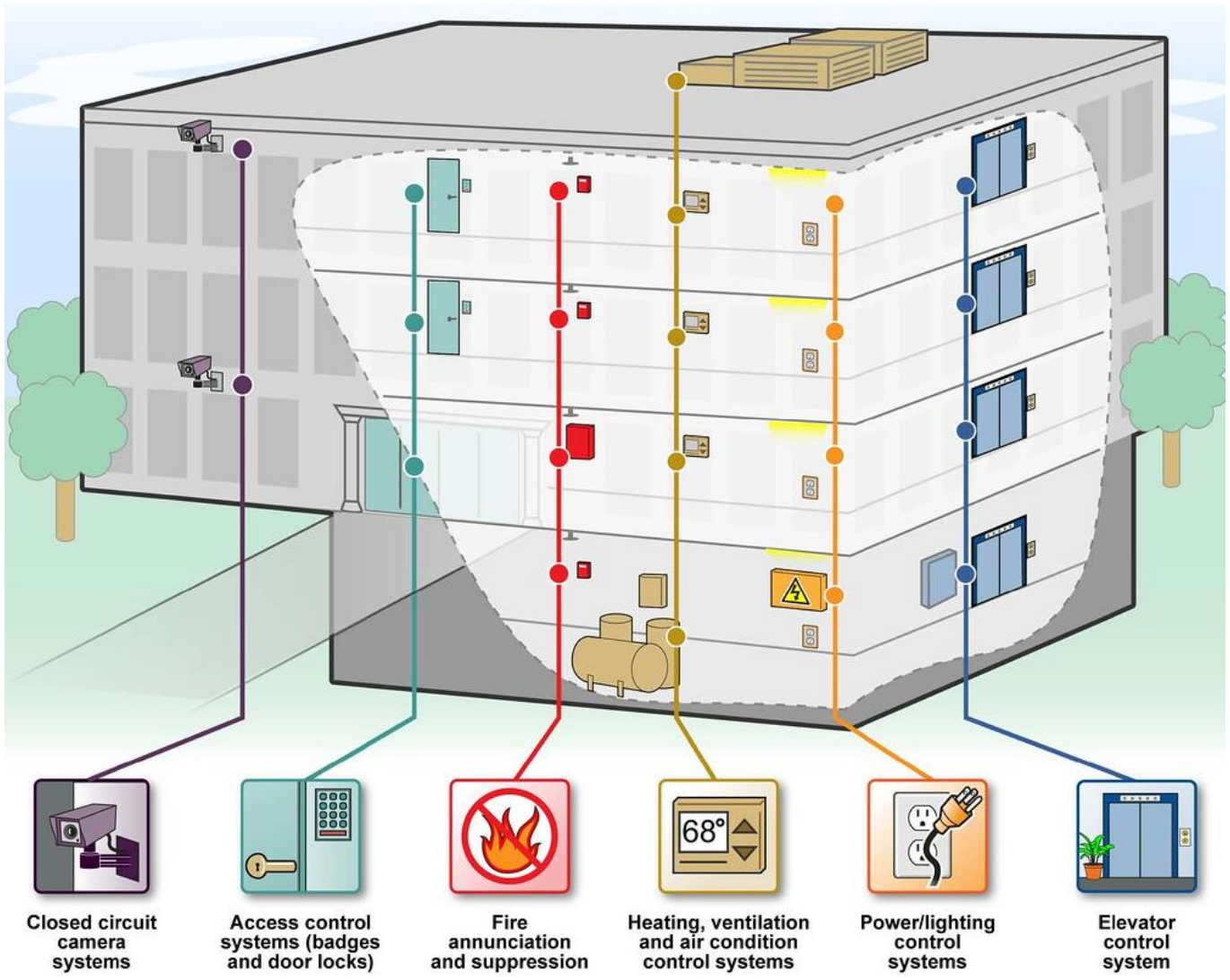
## Example of Zero Design Approach



# Systems Integration: Building Management System



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