Analysis Up Front: The Case for Modeling Early and Often

Rendering courtesy of Weber Thompson

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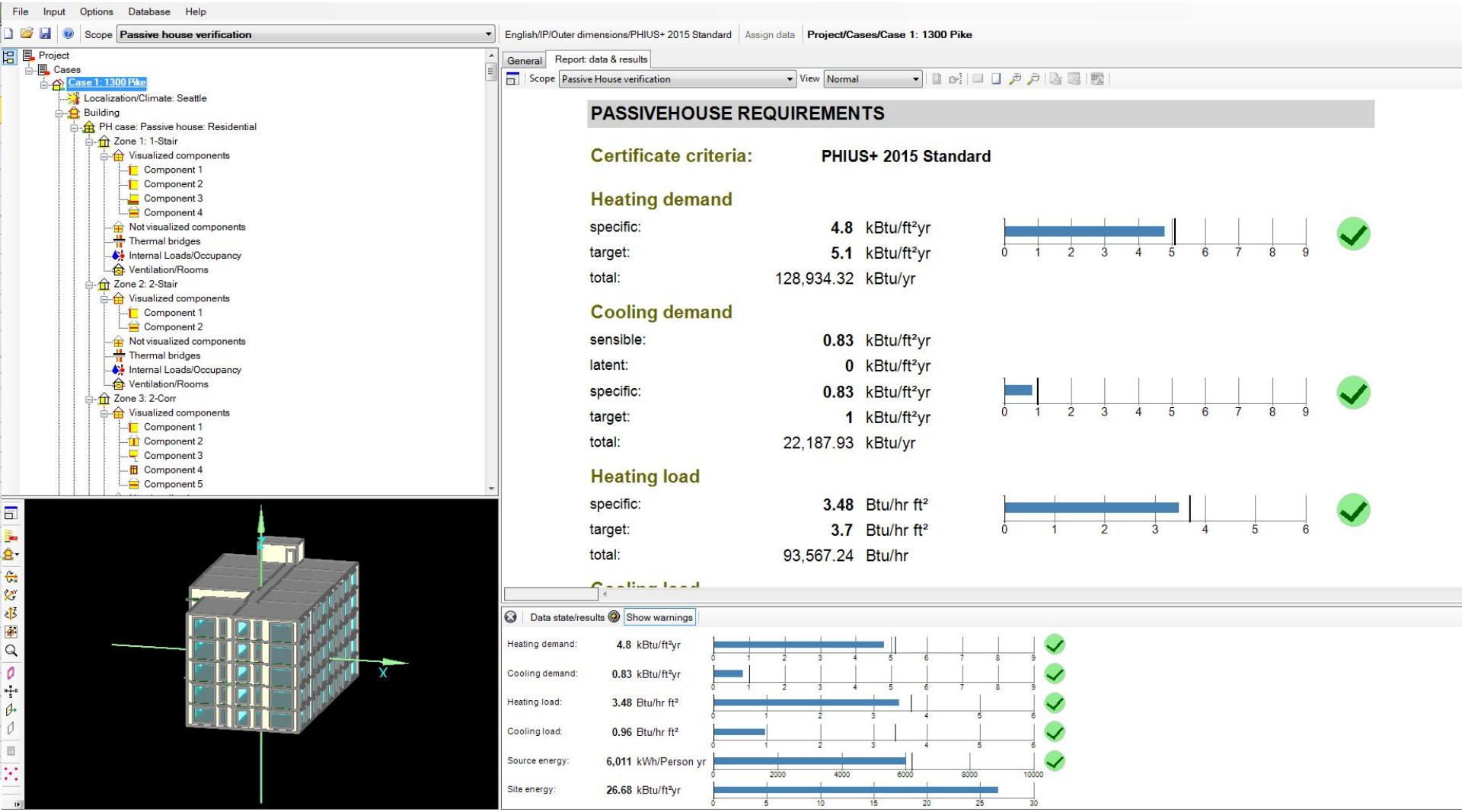
WUFI!


File Input Options Database Help
Scope Passive house verification
English/IP/Outer dimensions/PHIUS+ 2015 Standard
Assign data
Project/Cases/Case 1: 1300 Pike
Project
Cases
Case 1: 1300 Pike
Localization/Climate: Seattle
Building
PH case: Passive house: Residential
Zone 1: 1-Stair
Visualized components
Component 1
Component 2
Component 3
Component 4
Not visualized components
Thermal bridges
Internal Loads/Occupancy
Ventilation/Rooms
Zone 2: 2-Stair
Visualized components
Component 1
Component 2
Not visualized components
Thermal bridges
Internal Loads/Occupancy
Ventilation/Rooms
Zone 3: 2-Corr
Visualized components
Component 1
Component 2
Component 3
Component 4
Component 5
General
Report: data & results
Scope Passive House verification
View Normal
PASSIVEHOUSE REQUIREMENTS
Certificate criteria: PHIUS+ 2015 Standard
Heating demand
specific: 4.8 kBtu/ft²yr
target: 5.1 kBtu/ft²yr
total: 128,934.32 kBtu/yr
Cooling demand
sensible: 0.83 kBtu/ft²yr
latent: 0 kBtu/ft²yr
specific: 0.83 kBtu/ft²yr
target: 1 kBtu/ft²yr
total: 22,187.93 kBtu/yr
Heating load
specific: 3.48 Btu/hr ft²
target: 3.7 Btu/hr ft²
total: 93,567.24 Btu/hr
Data state/results
Show warnings
Heating demand: 4.8 kBtu/ft²yr
Cooling demand: 0.83 kBtu/ft²yr
Heating load: 3.48 Btu/hr ft²
Cooling load: 0.96 Btu/hr ft²
Source energy: 6,011 kWh/Person yr
Site energy: 26.68 kBtu/ft²yr

PHPP/WUFI

- Static analysis
- Deep dive into local conditions
- Hygrothermal and dynamic analysis (WUFI)

Passive House Beyond Single Family

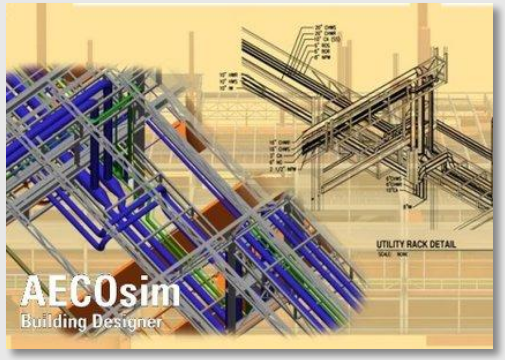
- Inputs across many zones
- Commercial spaces
- Mechanical sizing
- Complex building systems and controls
- Utility costs and incentives

Whole Building Energy Model - Softwares

eQUEST

DOE-2

Carrier Hourly Analysis Program (HAP)



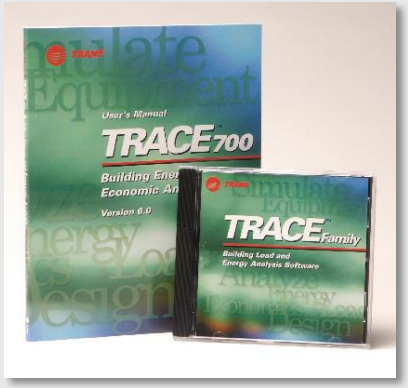
Autodesk Green Building Studio

A whole-building energy analysis web service that helps architects and designers capture early design thinking to support sustainable design.

EnergyPlus

sefaira

IES INTEGRATED ENVIRONMENTAL SOLUTIONS



1300 Pike

Weber Thompson - Architect
Cascade Built - Construction

Annual Htg Energy: 5.1 kBtu/ft^{2}yr

Annual Clg Energy: 1.0 kBtu/ft^{2}yr

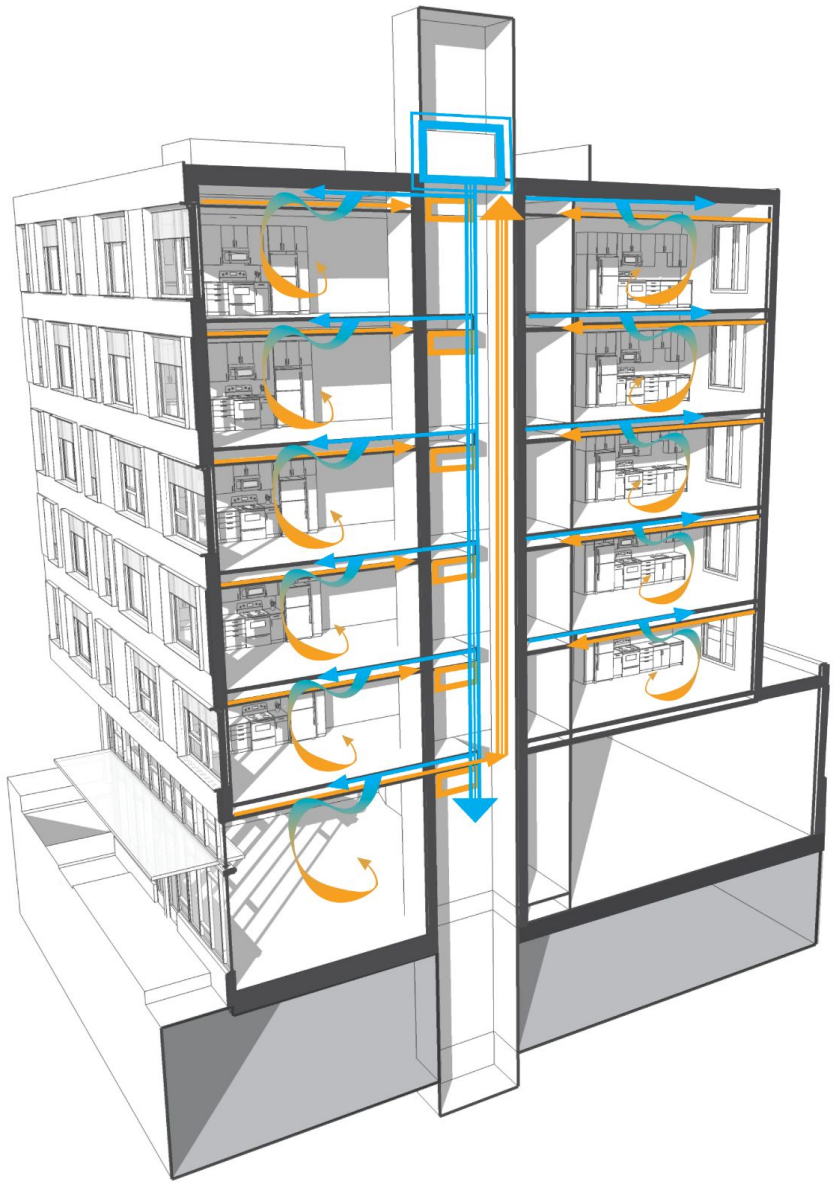
Peak Heating: 3.7 Btu/ft^2

Peak Cooling: 3.4 Btu/ft^2

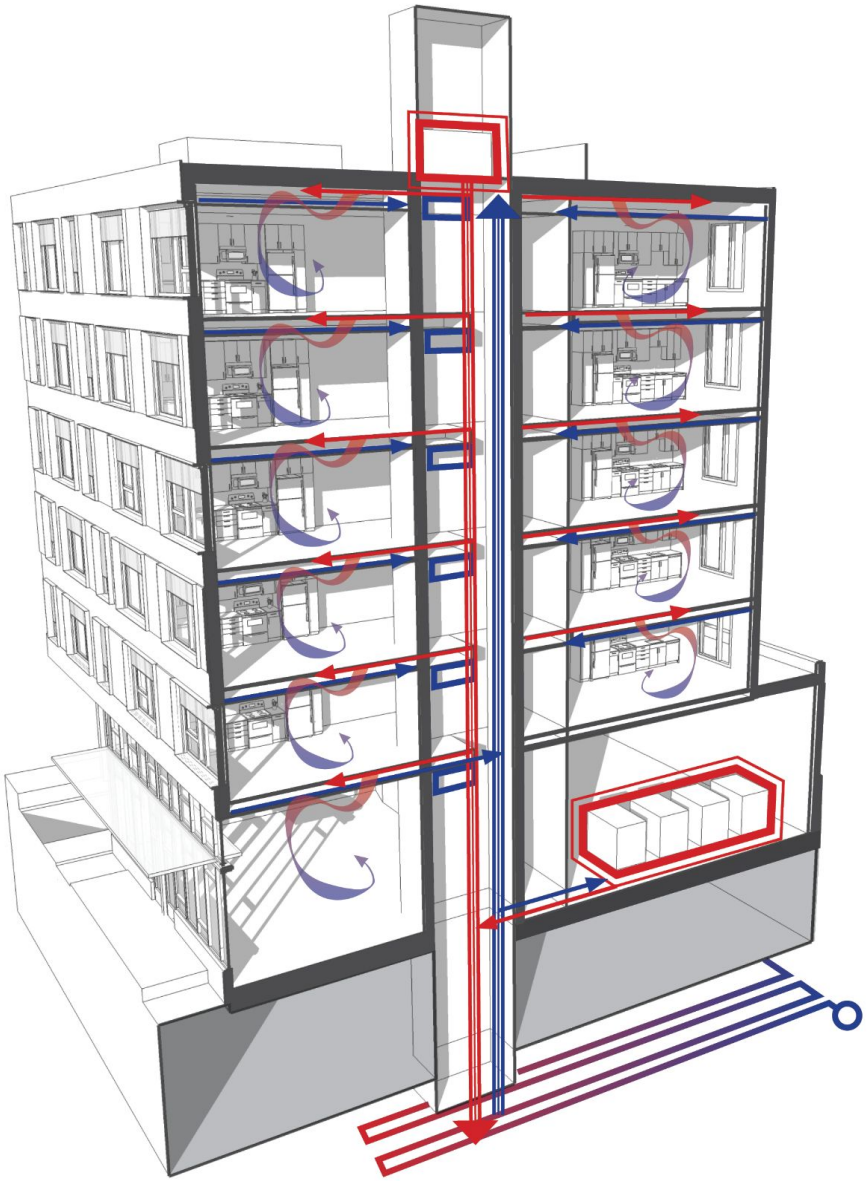
Source Energy: 6,200 kWh/person

- Walls: R-30 insulation
- Roof: R-60 insulation
- Floors: R-30 insulation
- Windows:
  - U-value < 0.15
  - SHGC < 0.25
- Automated Exterior Shades

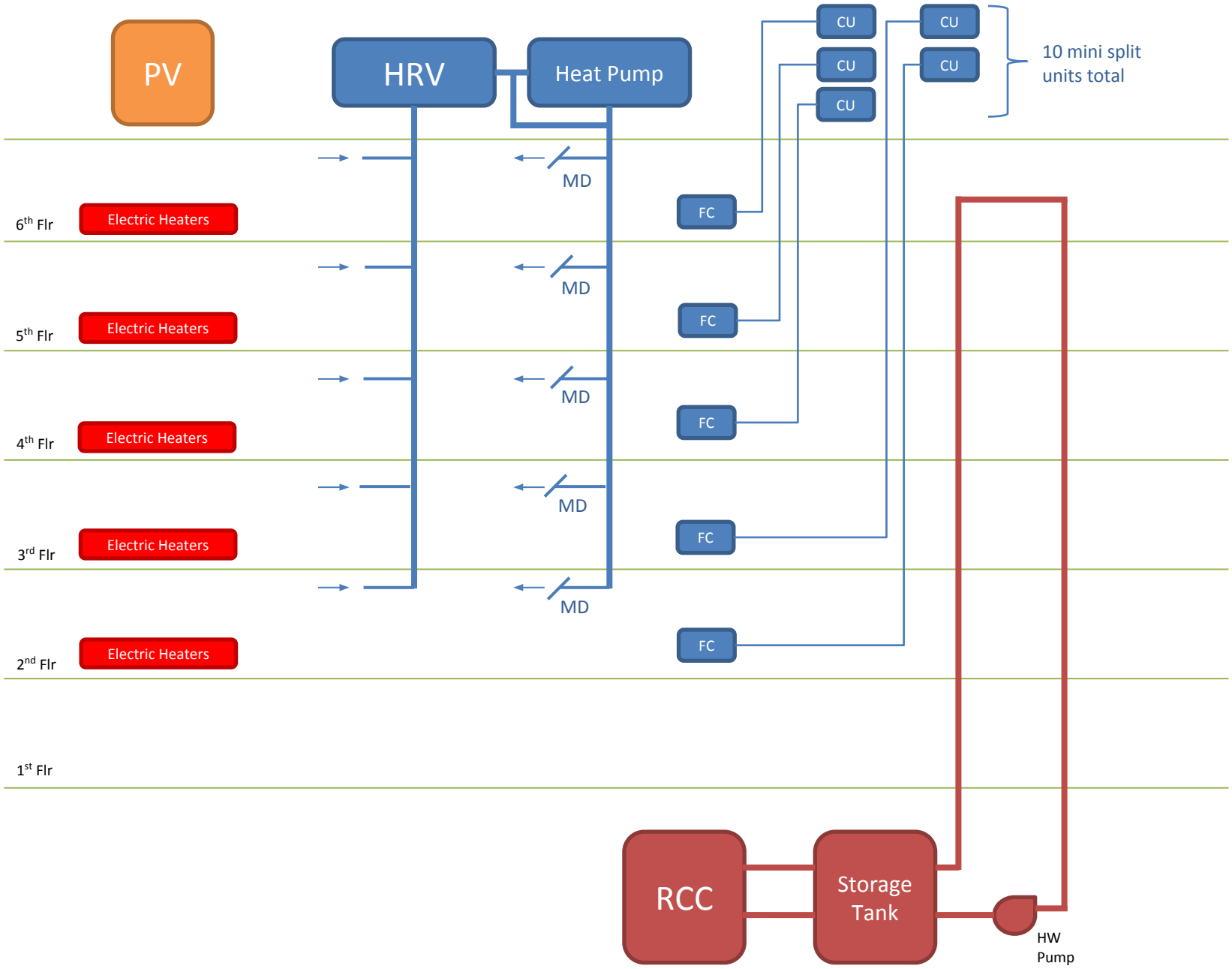
- Ventless dryers
- Recirculating kitchen hood
- High efficiency appliances
- LED lighting



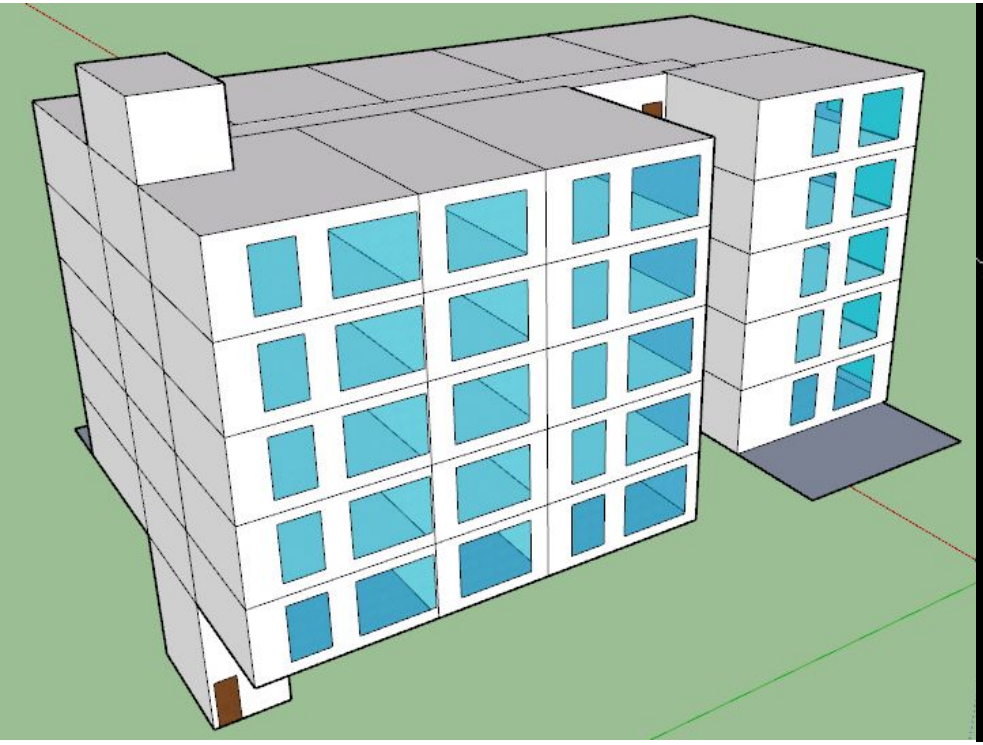
- Centralized HRV
- Efficiency > 82%
- Variable flow
- MERV 13 filtration



- VRF fan coils = too large (> 6,000 Btu/h)
- Chilled water = too complex
- Geothermal HP = too expensive

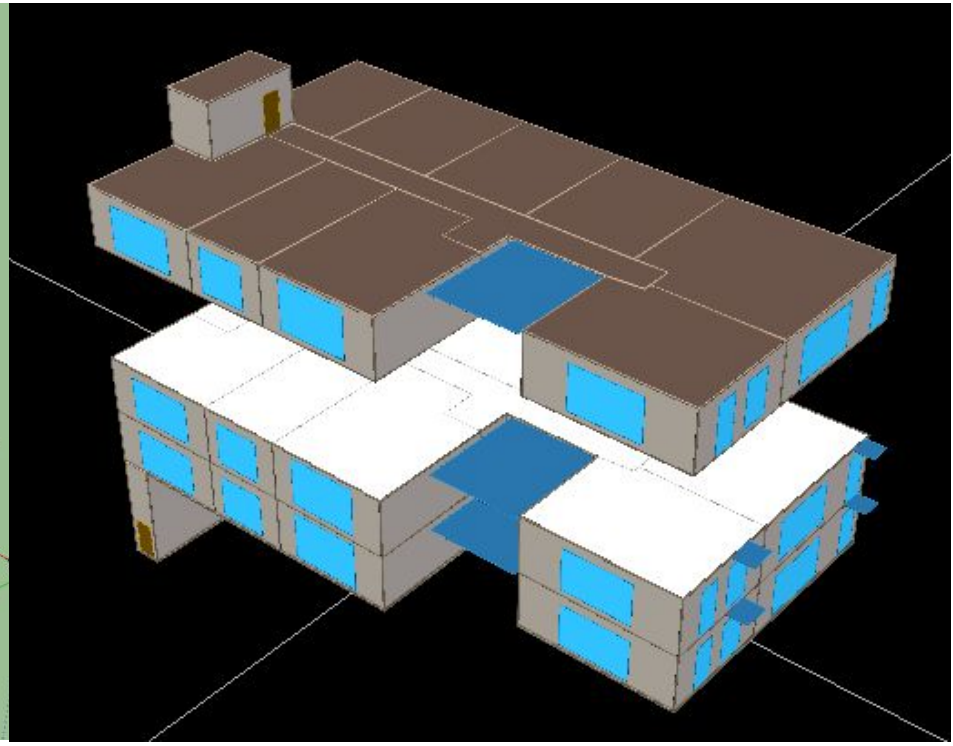

PV
HRV
Heat Pump
CU
CU
CU
CU
CU
10 mini split units total
MD
MD
MD
MD
MD
FC
FC
FC
FC
FC
6th Flr
5th Flr
4th Flr
3rd Flr
2nd Flr
1st Flr
Electric Heaters
Electric Heaters
Electric Heaters
Electric Heaters
Electric Heaters
RCC
Storage Tank
HW Pump

WUFI



- PHIUS+ 2015 compliance
- Hygrothermal analysis

eQUEST



- Zone-level conditions
- Mechanical sizing
- Parametric analysis
- Utility costs

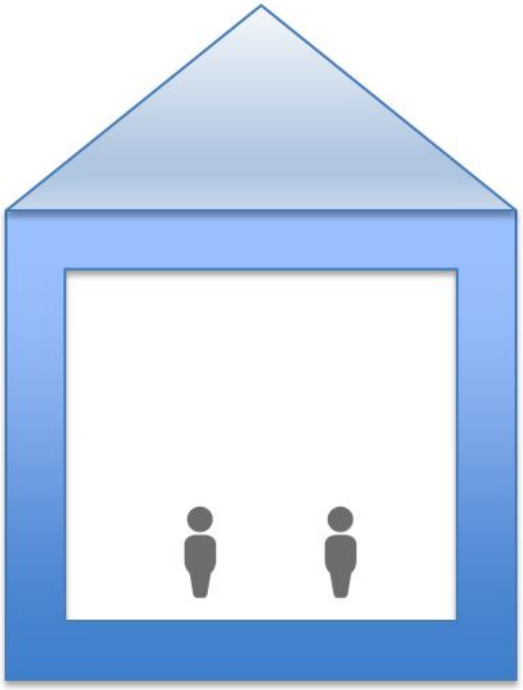
Value Engineering

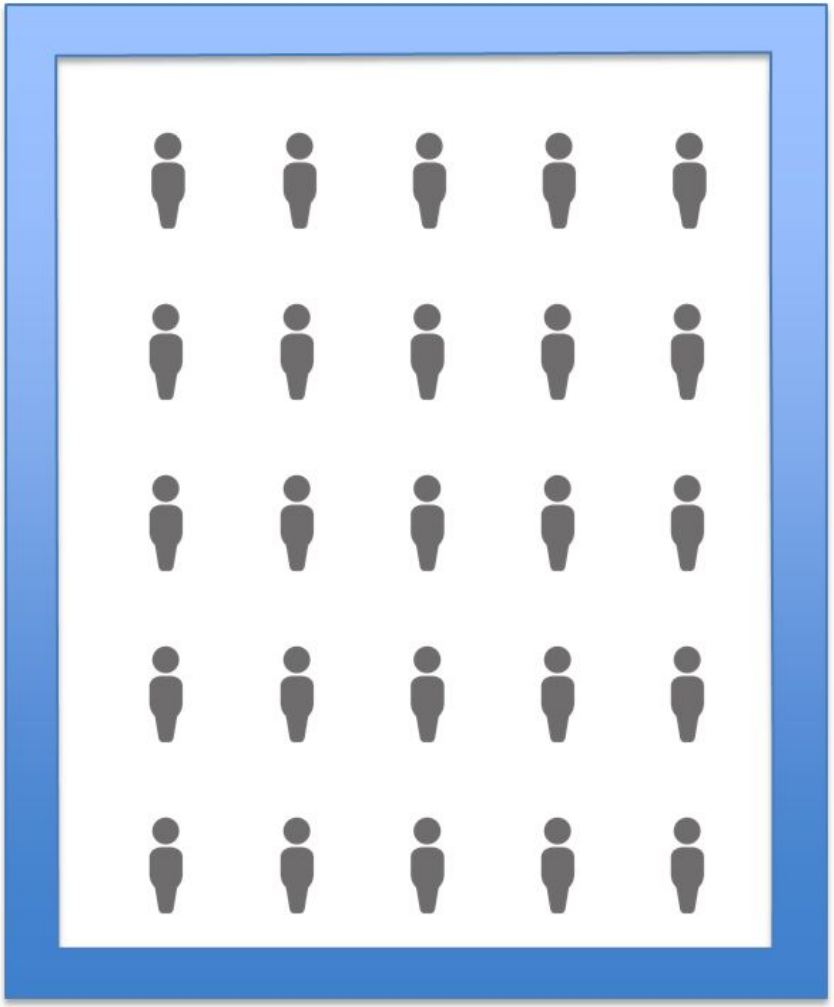
DD Proposed Design	VE Alternates
12x10 walls with R-30 batts	2x8 walls with R-25 batts
Triple pane PH windows	Double pane windows
R-60 roof insulation	R-45 roof insulation
Automated shading system	Manual shades
Balcony thermal break system	Conventional balcony connections
Centralized HRV system	Individual unit HRVs
Integral HP on ventilation system	No integral HP on ventilation
Modulating ventilation flow	Constant ventilation flow
Mini splits for south-facing units	No mini splits for south-facing units
Ventless dryers	Conventional dryers w/ exhaust
Recirculating kitchen hoods	Conventional kitchen hoods
High efficiency appliances	Energy Star appliances
Reverse cycle chiller for DHW	Gas-fired DHW heater
PV system	PV system added later

Envelope to Occupant Ratio

- INT volume to EXT surface area
- Interior loads

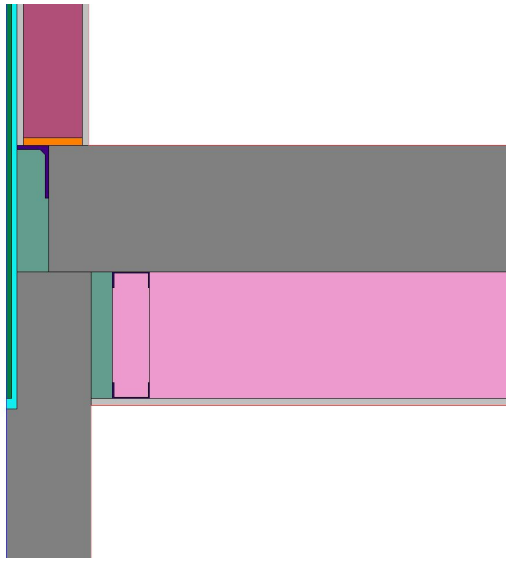
- Insulation requirements
- Overall air leakage

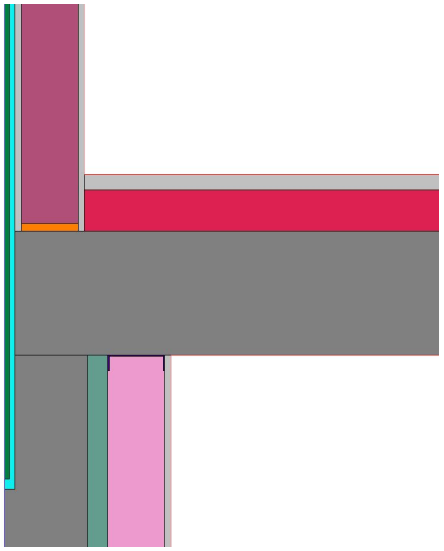


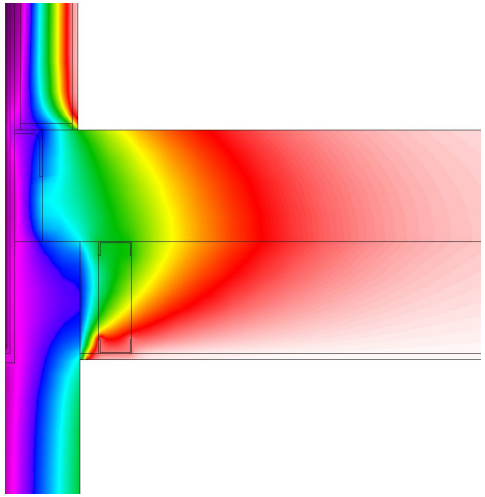


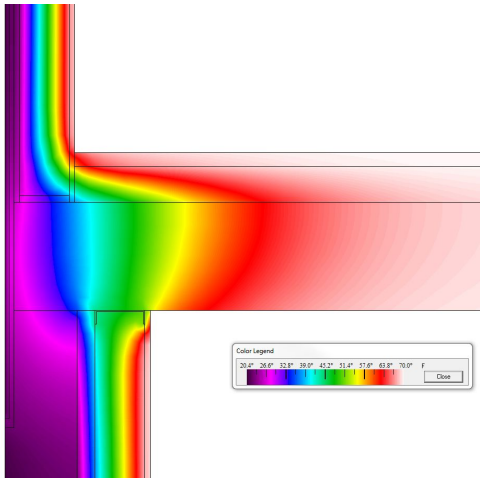
AUTOMATED SUN SHADES | SOUTH AND WEST FACADES

- R-21 walls
- R-50 roof
- U-0.22 windows
- SHGC < 0.25
- Air sealing still critical!



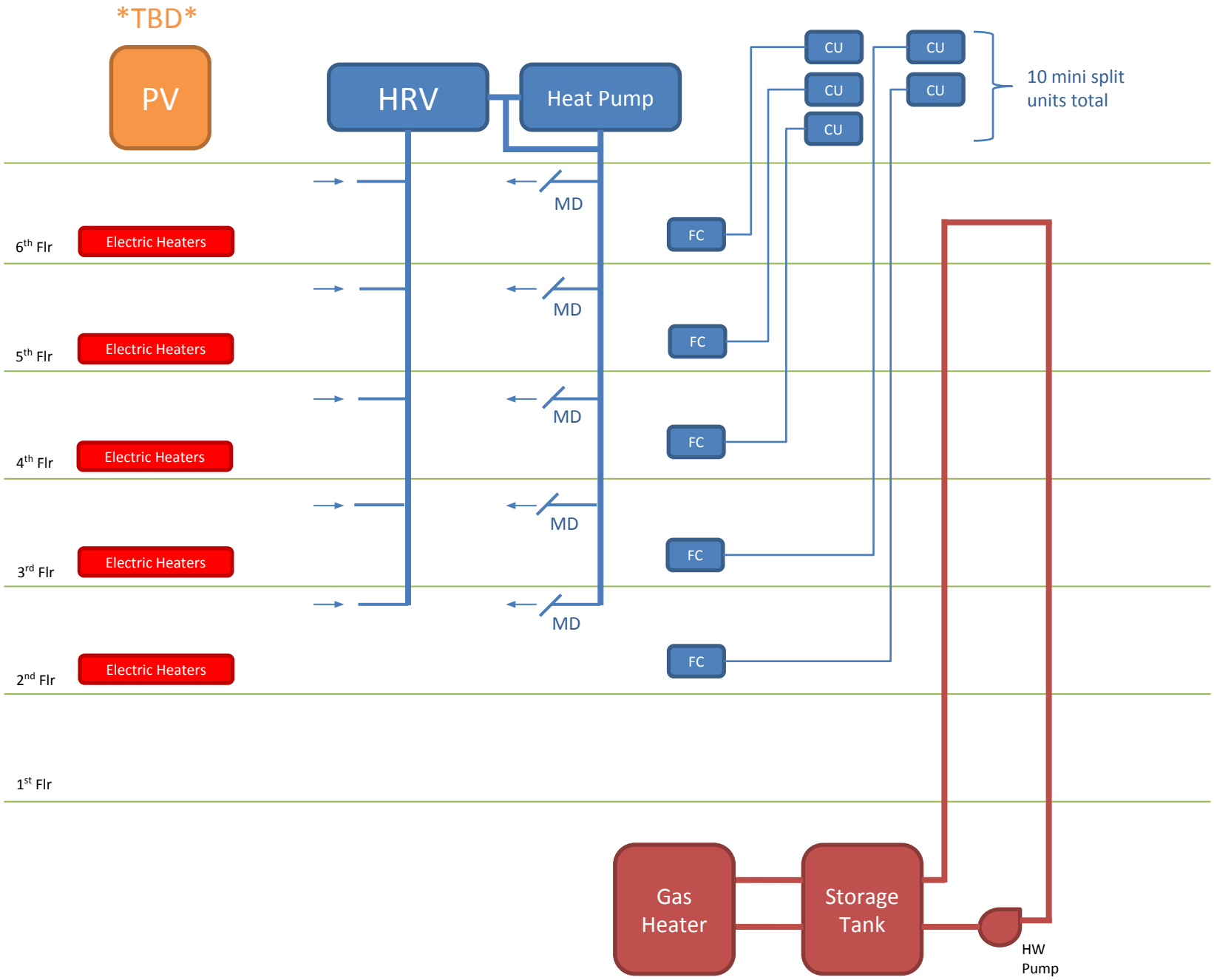






Under Slab Insulation

Above Slab Insulation


TBD
PV
HRV
Heat Pump
CU
CU
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CU
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10 mini split units total
MD
MD
MD
MD
MD
FC
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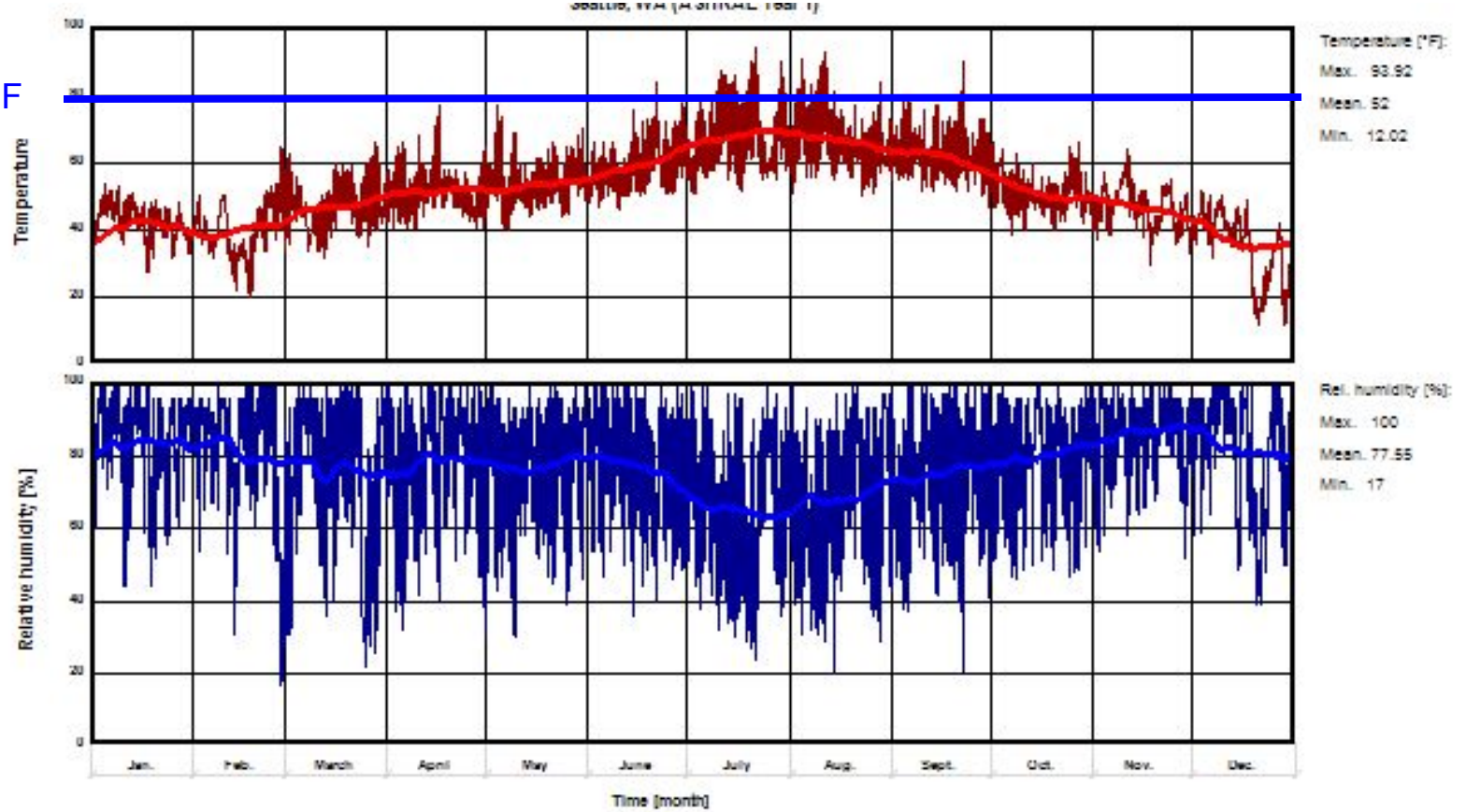
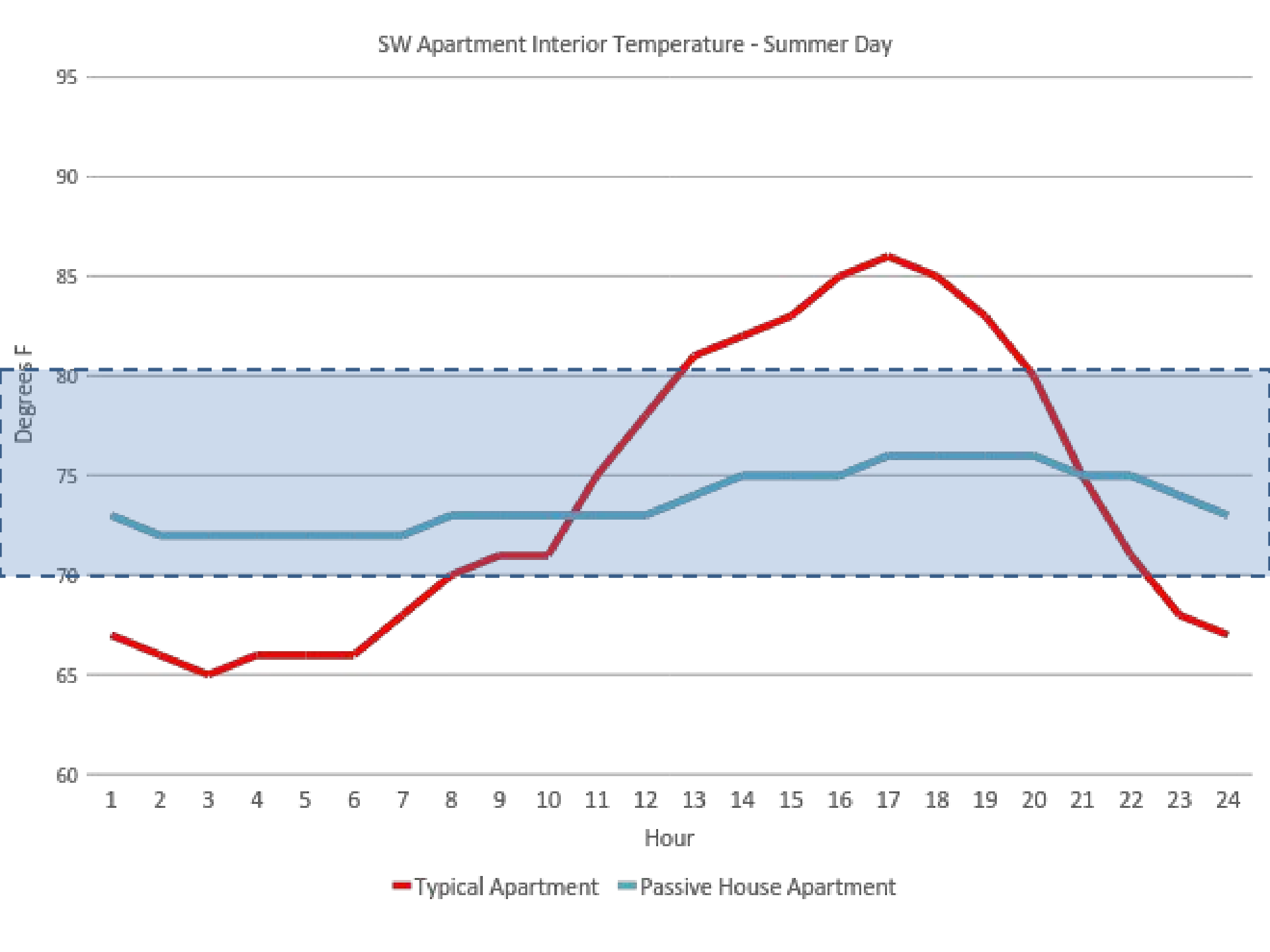
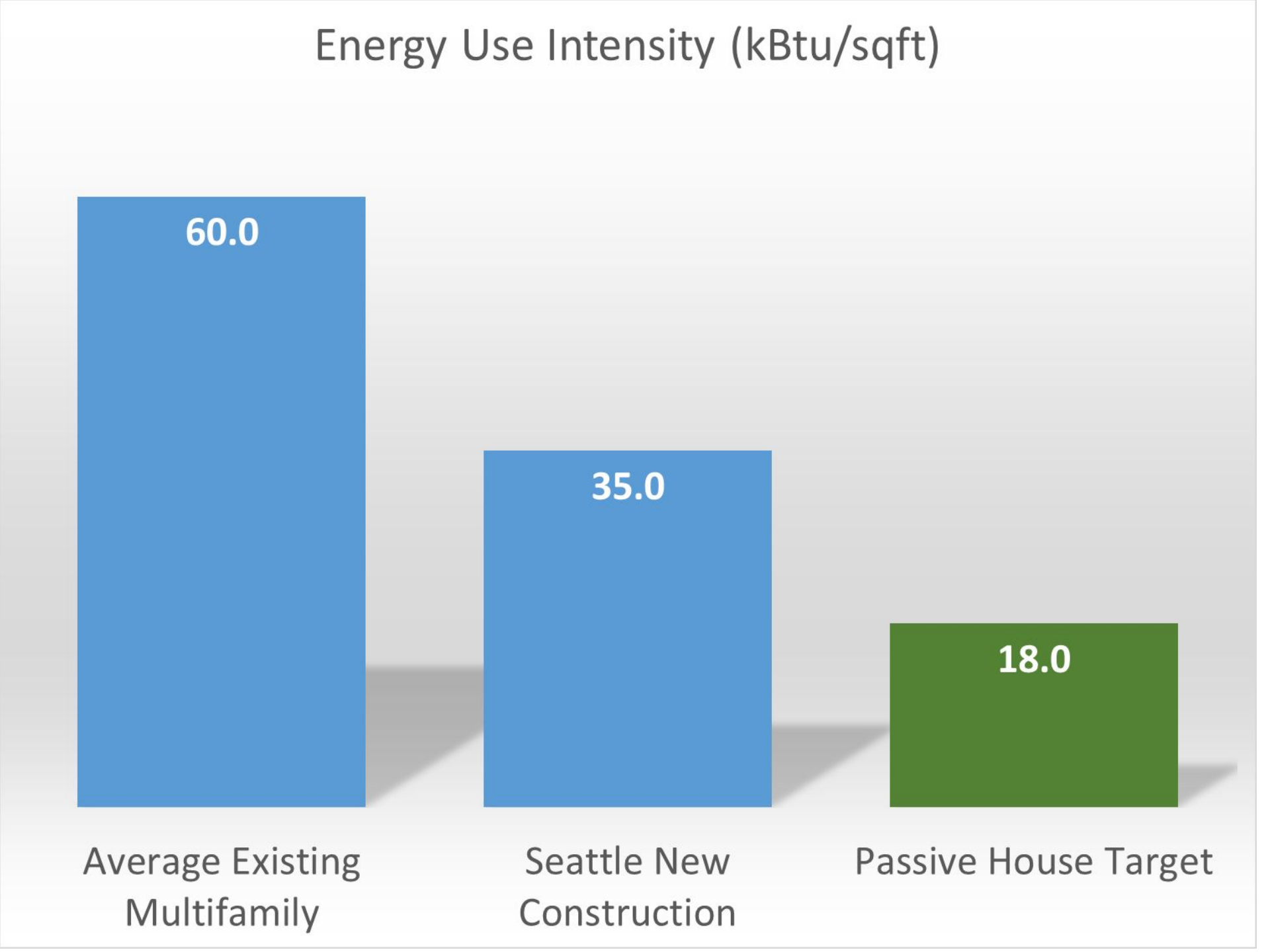
6th Flr
5th Flr
4th Flr
3rd Flr
2nd Flr
1st Flr
Electric Heaters
Electric Heaters
Electric Heaters
Electric Heaters
Electric Heaters
Gas Heater
Storage Tank
HW Pump



- Optimal climate to utilize summer venting
- Requires tenant participation


SW Apartment Interior Temperature - Summer Day
95
90
85
80
75
70
65
60
Degrees F
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
Hour
Typical Apartment
Passive House Apartment


Energy Use Intensity (kBtu/sqft)
60.0
35.0
18.0
Average Existing Multifamily
Seattle New Construction
Passive House Target


REMINGTON


KEEP WARM
BAGEL
DEFROST
CANCEL
Hamilton Beach

What Does This Mean For Bigger Projects?

- 17 story high rise
- 209 dwelling units
- Ground level restaurant
- 45% glazing
- Code constructions
- Whole house fan & trickle vents
- Water source heat pumps w/ fluid cooler and gas-fired boiler
- Gas-fired HW heaters
- 2012 Seattle Energy Code
- LEED Silver v2009 targeted

What Does This Mean For Bigger Projects?

- Triple pane windows*
- Improved air sealing*
- Replace whole house fans with HRV units > 80% efficient
- Downsize heat pumps
- Appliance upgrades

helps meet 2015 Seattle Energy Code C406

Benefits of Early Energy Analysis

- Simplify the design
- Invest in components with greatest impact
- Prevent future cost overruns
- Broaden understanding of performance in complex buildings

Next Steps

- Start building!
- WUFI Passive Dynamic modeling comparison to eQUEST
- Ventilation system optimization
- Mechanical control setpoints

Questions?

Rendering courtesy of Weber Thompson

Celebrating 10 Years of Sustainable Building

ArchEcology LLC