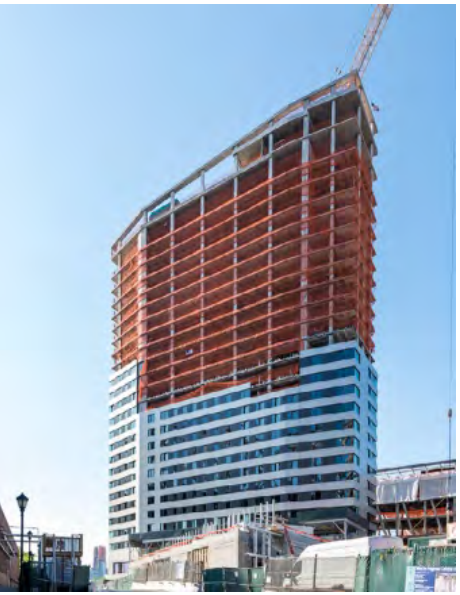
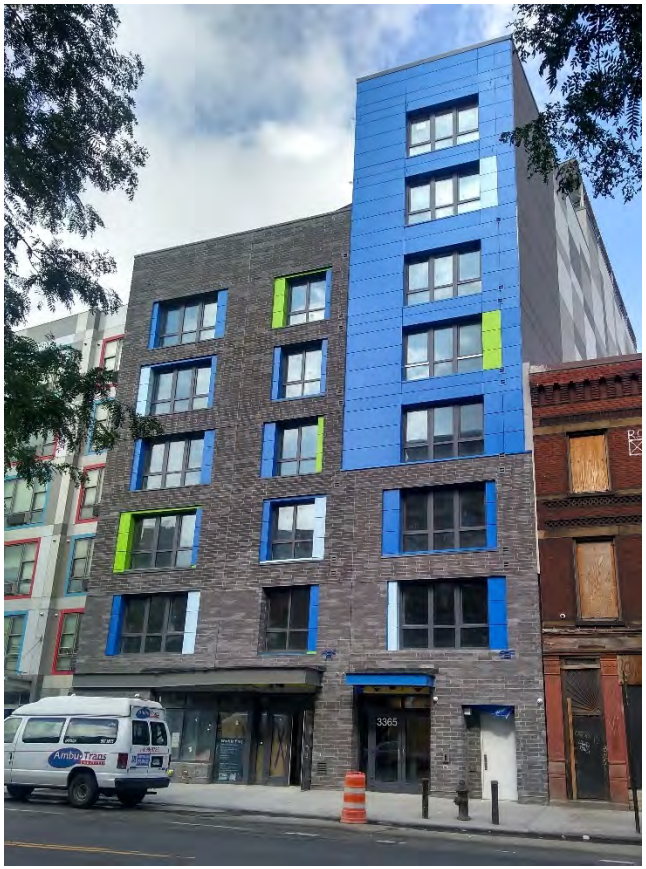
Different Systems of Multifamily Passive House from Design to Operation





Lois B. Arena, PE
Director, Passive House Services

Mark Ginsberg FAIA, LEED^{AP}
Partner

Crystal Ng RA, LEED^{AP}, CPHC
Associate

Justin Stein
Vice President

BRONXPRO GROUP

Steven Winter Associates, Inc.
Improving the Built Environment Since 1972

CURTIS + GINSBERG ARCHITECTS LLP

AIA Statement

Credit(s) earned on completion of this course will be reported to AIA CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request. This course is registered with AIA CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Course Description

Applicable solutions to multi-family passive house certified design for affordability through critical construction details, maintenance considerations, and building end use.

Learning Objectives

1. Understand alternate building systems (Envelope, Heating/ Cooling and Ventilation) that result in compliant Passive House buildings.

2. Understand operational issues, including staff and resident education with Multifamily Passive House buildings.

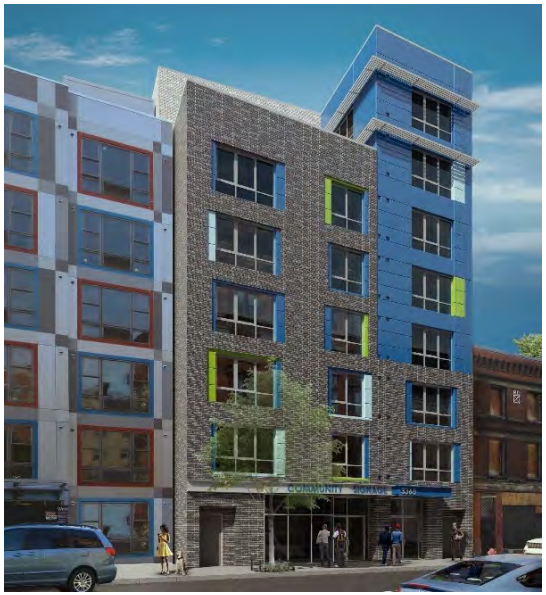
3. Understand critical design issues including thermal breaks building height, shading associated with Multifamily Passive House projects.

4. Plan for key construction issues, including contractor training, testing requirements. that are inherent with Multifamily Passive House development.

Background

Developer/Constructor

BRONXPRO GROUP



Completed PH Projects: 1
In Design: 3

PH Verifier and Consultant

Steven Winter Associates, Inc.
Improving the Built Environment Since 1972

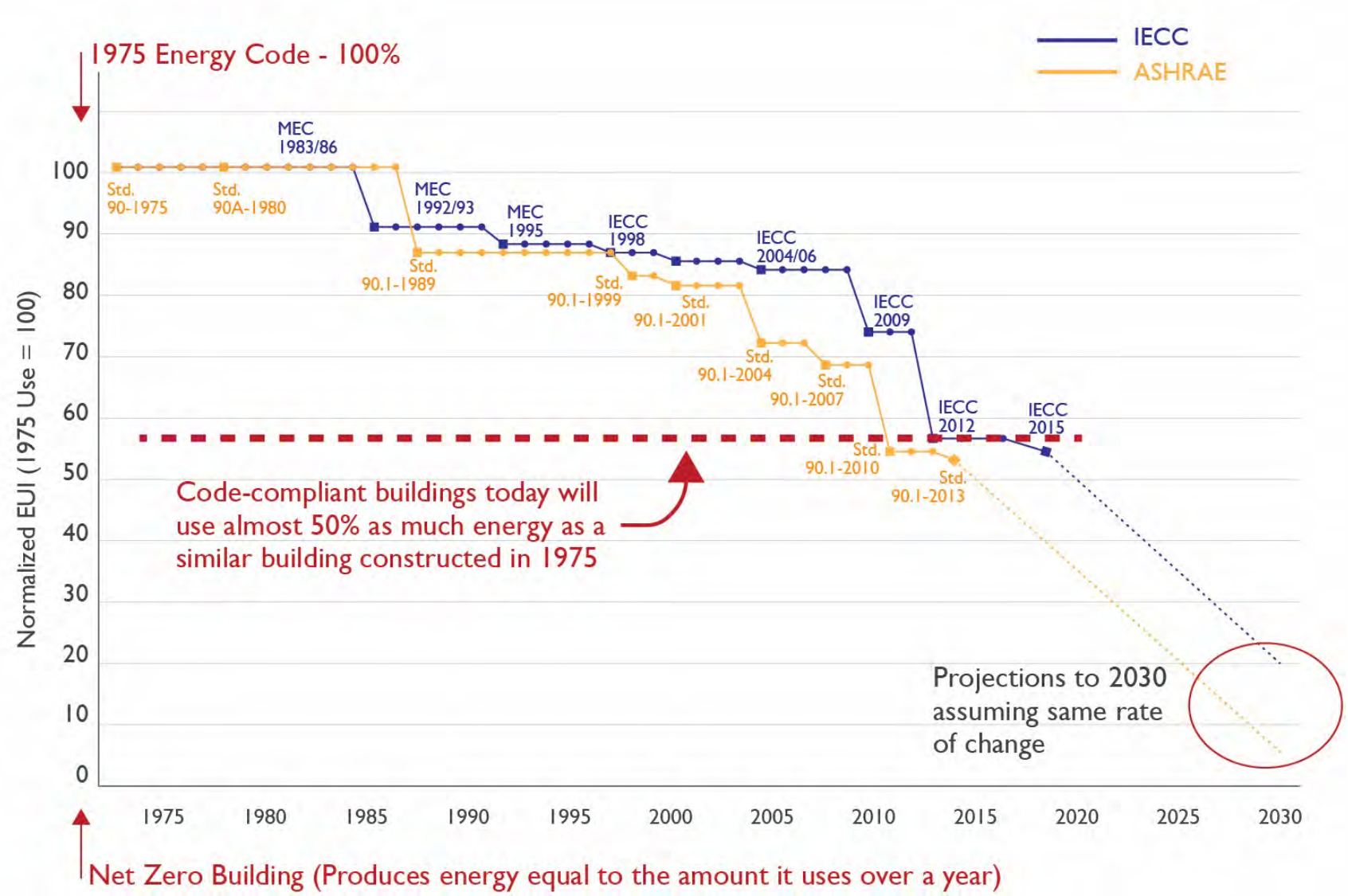
Completed PH Projects: 13
In Construction: 5
In Design: 15

Architect

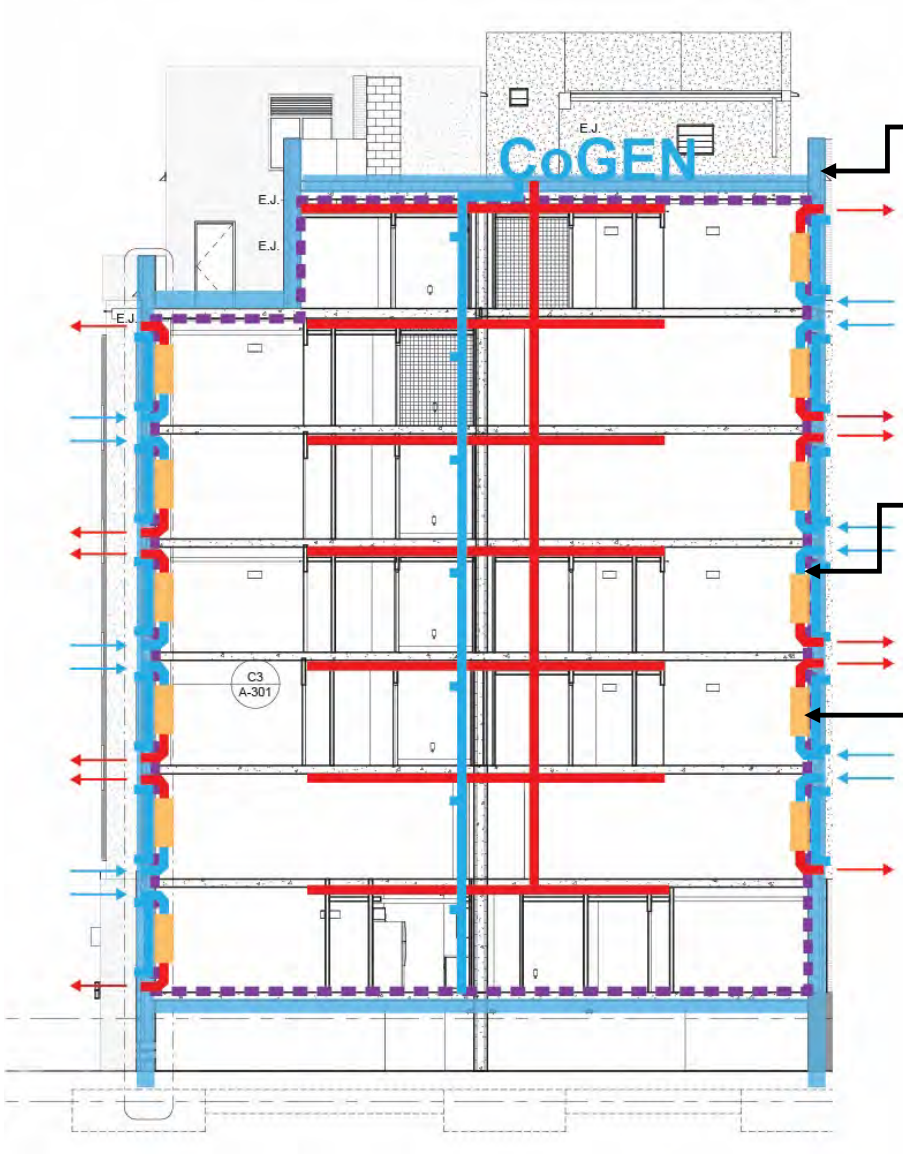
CURTIS + GINSBERG ARCHITECTS LLP

Completed PH Projects: 6
In Construction: 1
In Design: 8

Why Passive House



Passive House Principles



Optimizing Building Envelope

- Continuous Insulation
- Controlling Solar Gain
- Reducing Thermal Bridging

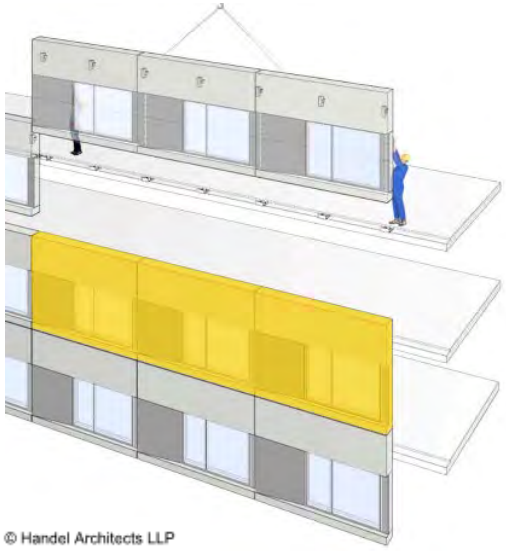
Creating Air/Wind Tightness

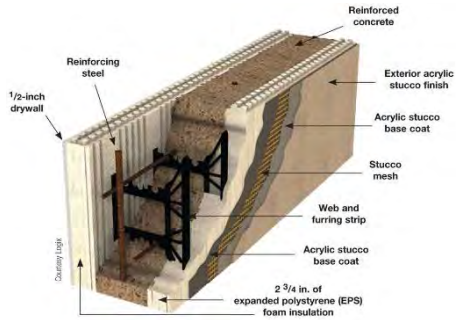
Provide Ventilation w/ Heat/Moisture Recovery

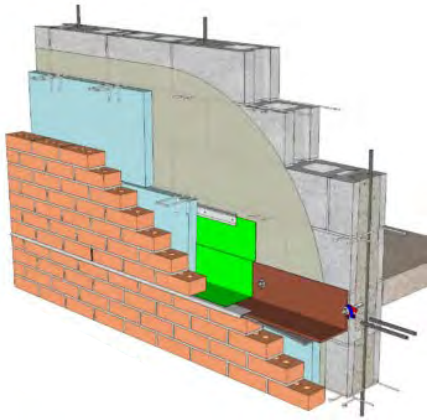
= Minimal Mechanical / Minimal Energy Consumption

Evaluating Different Envelopes

Thermal Performance / Air Barrier and Sealing







Prefabricated Panels

Fabricated Stud Frame Wall panel offset with water vapor barrier installed with window

Insulated Concrete Form

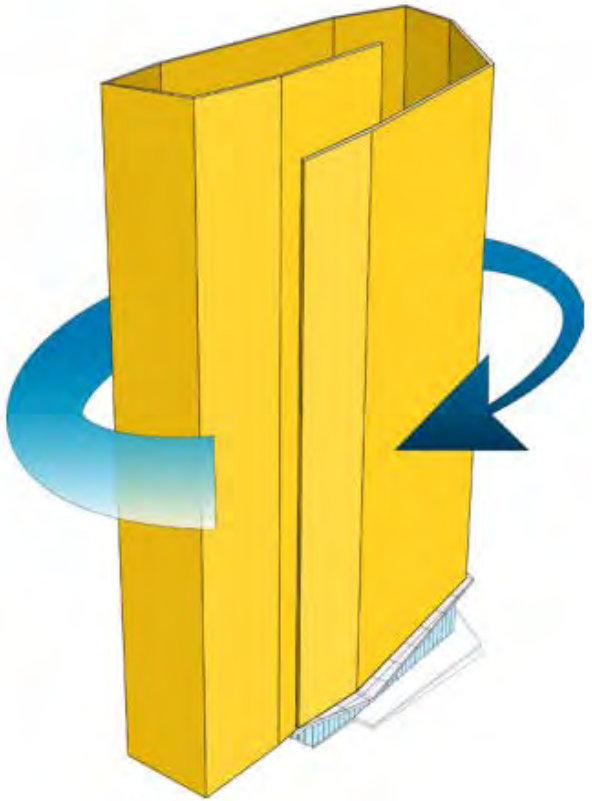
Stay in place concrete form with integral straps for attachment

CMU

Concrete masonry wall with rigid insulation

Prefabricated Panels

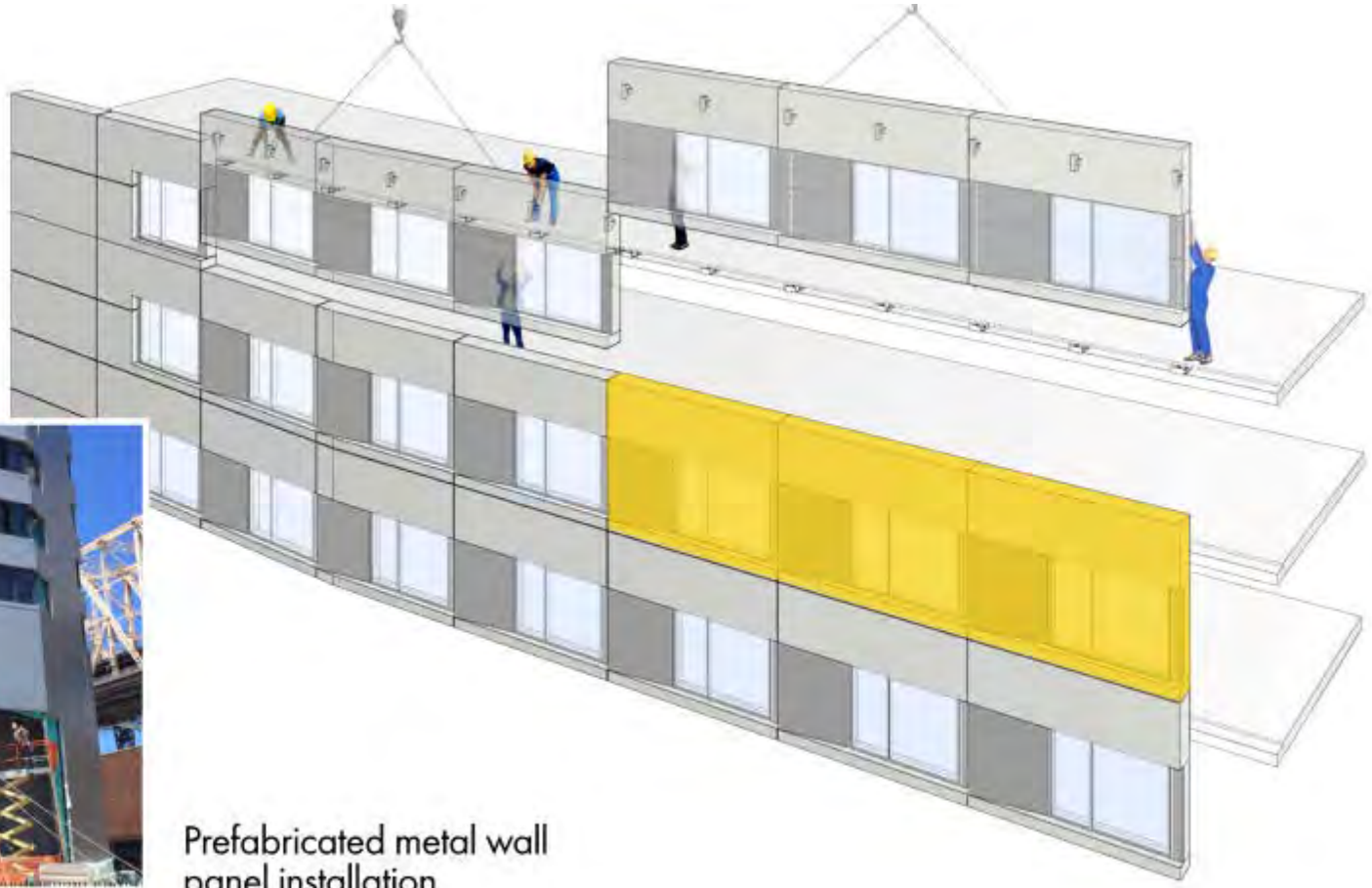
Thermal Performance



© Handel Architects LLP

Prefabricated Panels

Air Barrier and Sealing



Prefabricated metal wall panel installation

Prefabricated Panels

Air Barrier and Sealing

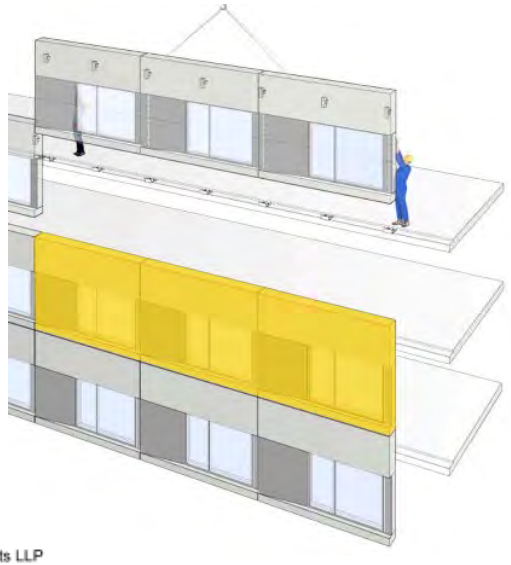
Prefabricated Panels

Air Barrier and Sealing

BEFORE PANEL SUPPORTS SEALED

AFTER PANEL SUPPORTS SEALED

Prefabricated Panels Pros and Cons



Pros

- Speed of construction
- Quality control in the factory
- Can be extremely efficient and air tight

Cons

- Cost
- Coordination and design assistance needed very early on
- Logistics/shipping to site
- Ability to perform air leakage testing on site/sequencing
- Detailing at panel edges is crucial

ICF

Thermal Performance

2 5/8” EPS each side + thermal mass of concrete for effective R-24.1
Additional insert at 2” increments up to R-48

ICF

Air Barrier and Sealing

Integral cast insulated jamb are cleanest tightest detail

Avoid Panel Joint at Opening, which allow water/air infiltration

Min. Thermal bridge of Brick Angle

Coordination of Min. Penetration Sleeve

Provide reinforcement at floor edge to prevent gaps

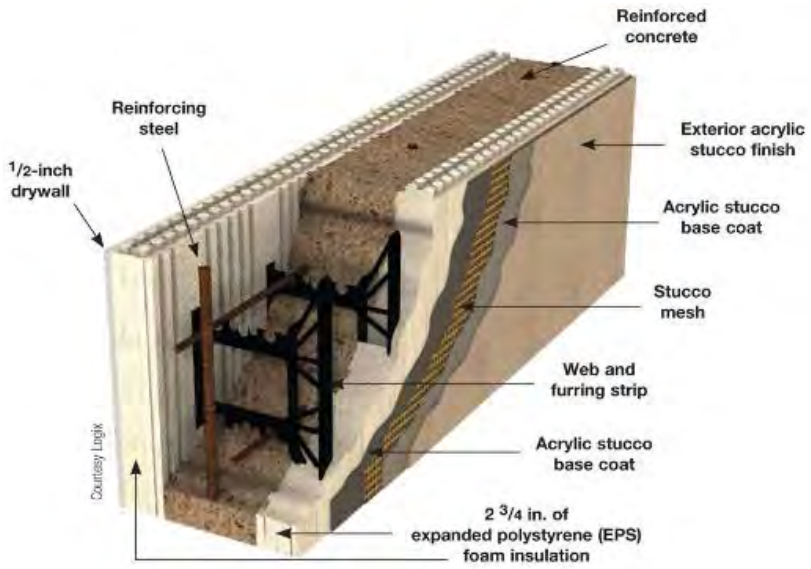
Interlocking EPS form is Class 1 vapor barrier

ICF

Air Barrier and Sealing

Joint of ICF allow air pathway. Gyp bd finish adds to the air tightness

ICF Pros and Cons



Pros

- Reduces Trades/More done with one system
- Watertight Quickly
- Greater Design Flexibility
- Great Sound Isolation (OITC 41 to 65)
- Energy Efficiency System with high R-value and integrated air barrier

Cons

- Unfamiliar construction technology and limited sub contractor
- Implementation crucial to maintain vapor/air barrier continuity

CMU Backup

Thermal Performance

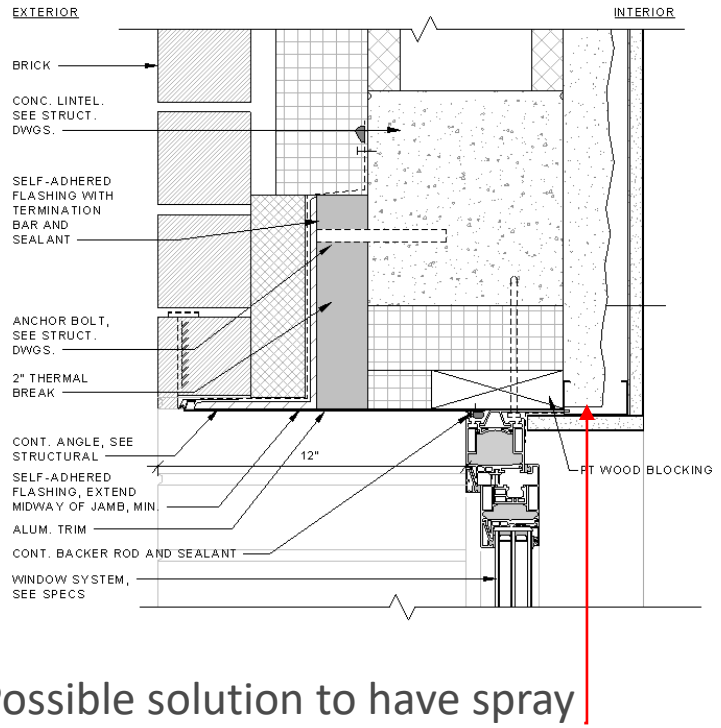
Structural Thermal Break at
Individual ERV opening

Exterior continuous rigid insulation +
Thermal mass of grouted masonry

CMU Backup

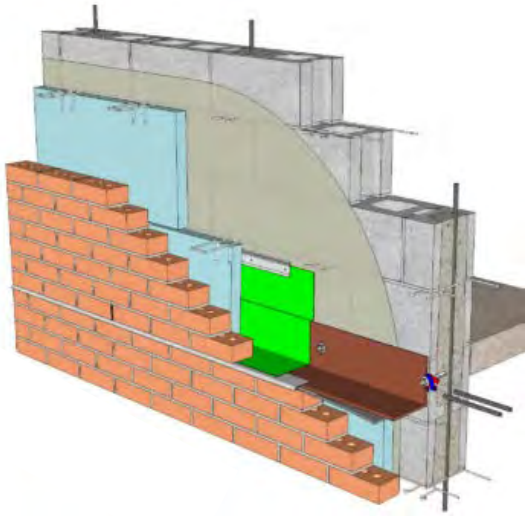
Air Barrier and Sealing

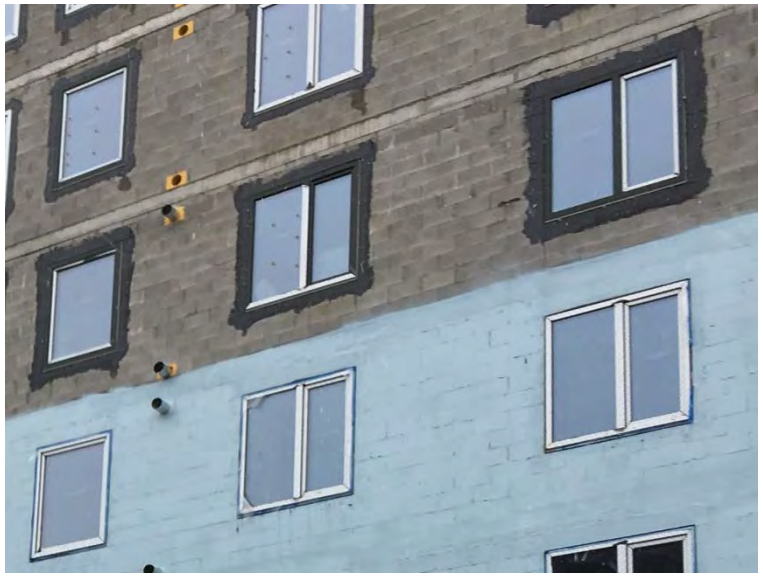
CMU wall not as tight as Concrete wall



Possible solution to have spray foam on the interior

CMU Pros and Cons





Pros

- Ease and knowledge of construction method

Cons

- Need more diligence on air tightness
- May require more structural thermal break for façade elements

Evaluating Different Envelopes

Thermal Bridging - Cladding

Stainless Steel Clips
Thermal Efficiency
63% Steel Backup
74% CMU Backup

Fiberglass Clips
Thermal Efficiency
64% for Steel Backup
79% for CMU backup

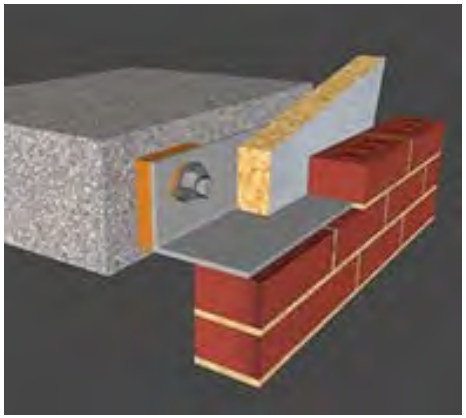
Thermal Stop Clips
Thermal Efficiency
67% for Steel Backup
80% for CMU Backup

Evaluating Different Envelopes

Thermal Bridging – Shelf Angle

Typical Shelf Angle
Thermal Efficiency
55% Steel Backup
67% CMU Backup

Stand-off Angle
Thermal Efficiency
72% Steel Backup
81% CMU Backup



Angle with 1" Thermal Break
Thermal Efficiency
80% Steel Backup
86% CMU Backup

Evaluating Different Envelopes

Thermal Bridging – Brick Ties

Galvanized Steel Brick Ties
Thermal Efficiency
75% Steel Backup
84% CMU Backup

Stainless Steel Brick Ties
Thermal Efficiency
87% Steel Backup
93% CMU Backup

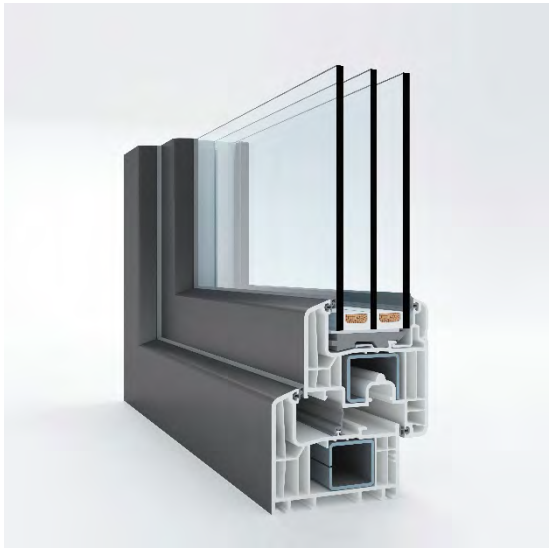
Thermal Break Brick Ties
Thermal Efficiency
88% Steel Backup
94% CMU Backup

Evaluating Different Envelopes

Windows

Thermally Broken Aluminum
U-value:~.1
U-Frame: ~.211
Greatest Structural Capacity
$$$

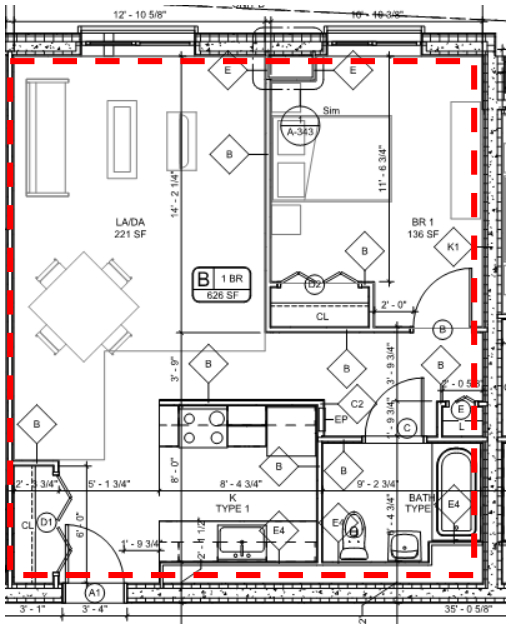
Fiberglass
U-value: ~.17
U-Frame: ~.2
$$



uPVC
U-value: ~.12
U-Frame:~.167
Reinforced with Steel
$

Heat/Energy Recovery Ventilator

Centralized
One ERV ventilates several apartments



Decentralized
Each unit has their own ERV

Heat/Energy Recovery Ventilator

Performance

Centralized

Benefits

- Easier to precondition Supply Air

Challenges

- Little to no control for individual apartment boast
- Balancing is more challenging

Decentralize

Benefits

- Boost flow more easily achievable in apartments
- Better heat recover efficiency, in general
- Better compartmentalization of apartments

Challenges

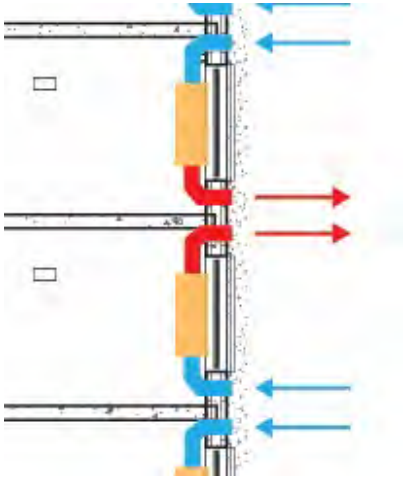
- Preheater recommended in cold climates
- Conditioning supply air more difficult
- UL approved units not readily available

Heat/Energy Recovery Ventilator

Design / Constructability

When we arrived,
YOUR DUCTS HAD:
339.4 CFM of Leakage, equivalent to a
42.3 Square Inch Hole

After we finished,
YOUR DUCTS HAVE:
5 CFM of Leakage, equivalent to a
0.6 Square Inch Hole
This corresponds to a 98.5% Reduction in Duct Leakage.



Centralized

Benefits

- Less horizontal duct > Less ceiling depth
- No exterior through wall penetration

Challenges

- Loss of floor space for vertical shafts
- Large floor and roof penetrations
- Fire rated shafts & dampers needed
- Critical to seal duct
- Higher floor to floor at horizontal distribution floor requires coordination

Decentralized

Benefits

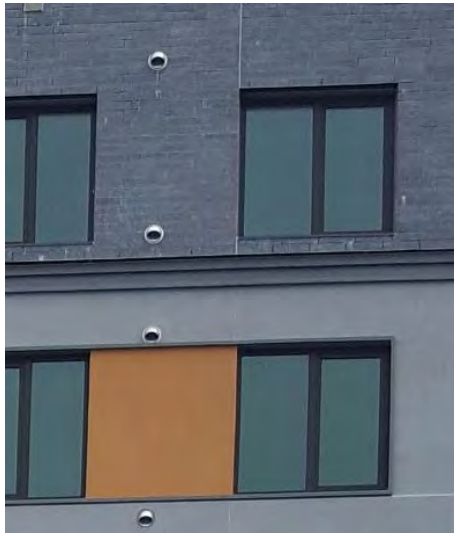
- No floor and roof penetrations
- Better apartment compartmentalization

Challenges

- Sealing of 2 penetration per apartment
- Horizontal duct at every apartment required detail coordination and increase ceiling depth

Heat/Energy Recovery Ventilator

Maintenance and Operation



Centralized

Benefits

- Fewer units to maintain
- ERV more accessible to maintenance

Challenges

- Cost of ventilation on owner

Decentralize

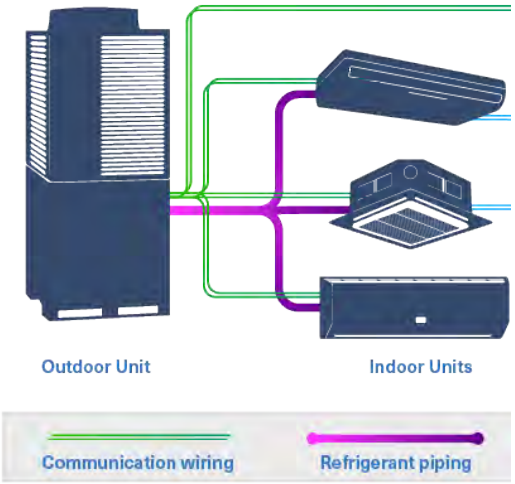
Benefits

- Power for ERV on tenant panel

Challenges

- Filters need to be replaced in every apartment every 3 months
- Requires access to exterior louvers for cleaning

Heating and Cooling



Source: Cool Automation

Air source Heat Pump (VRF)

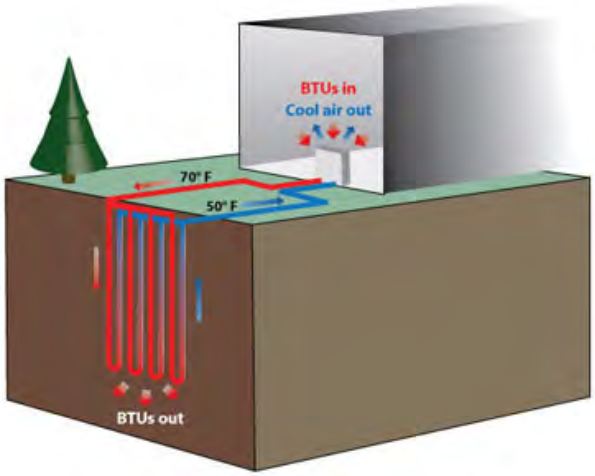
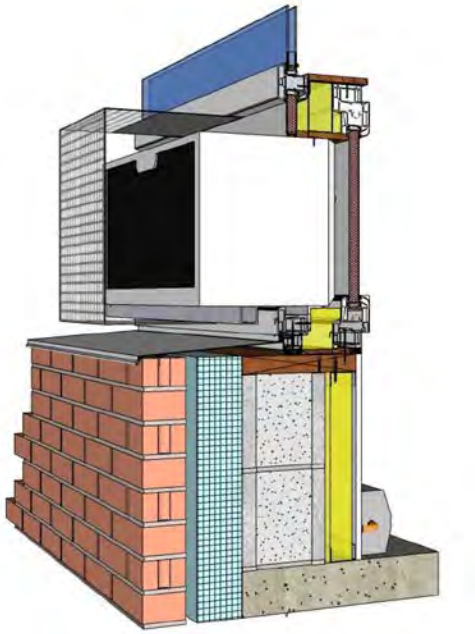


Image: NYSERDA

Water/Geothermal Heat Pump



Hydronic Baseboard

VRF

Wall unit

Ducted Ceiling Units

Performance

+ Ventilation ductwork minimized
+ Heat recovery option allows for simultaneous heating and cooling

Design

- Extra piping required

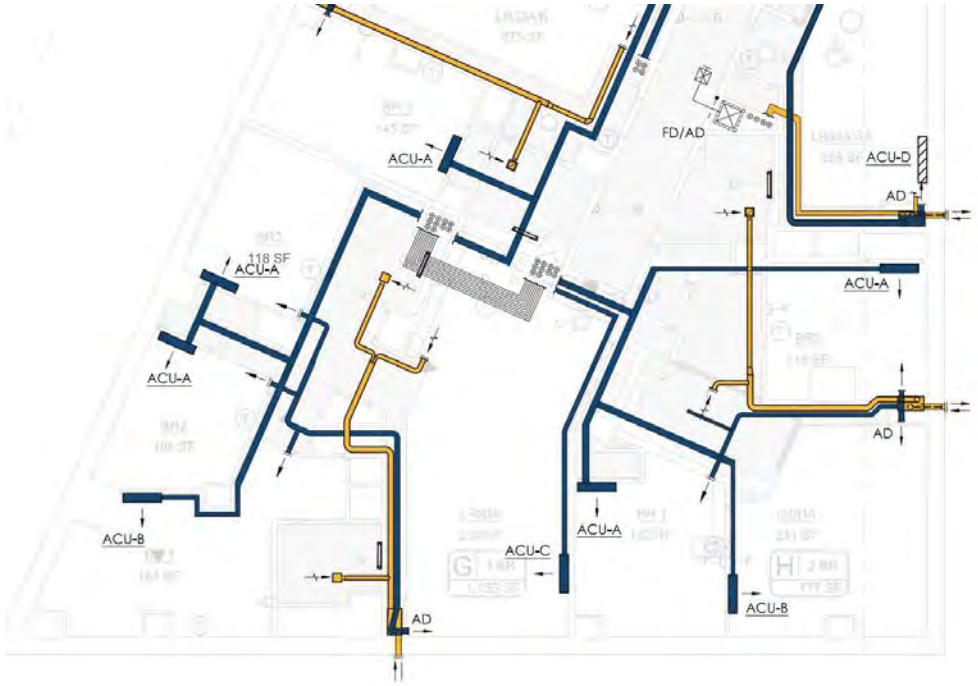
Wall Units

+ No additional ceiling space required
- Additional power for individual unit per room one unit per room
- No current units on market so such small loads

Ducted Units

- Requires additional ceiling space
- Required sealing of ducts

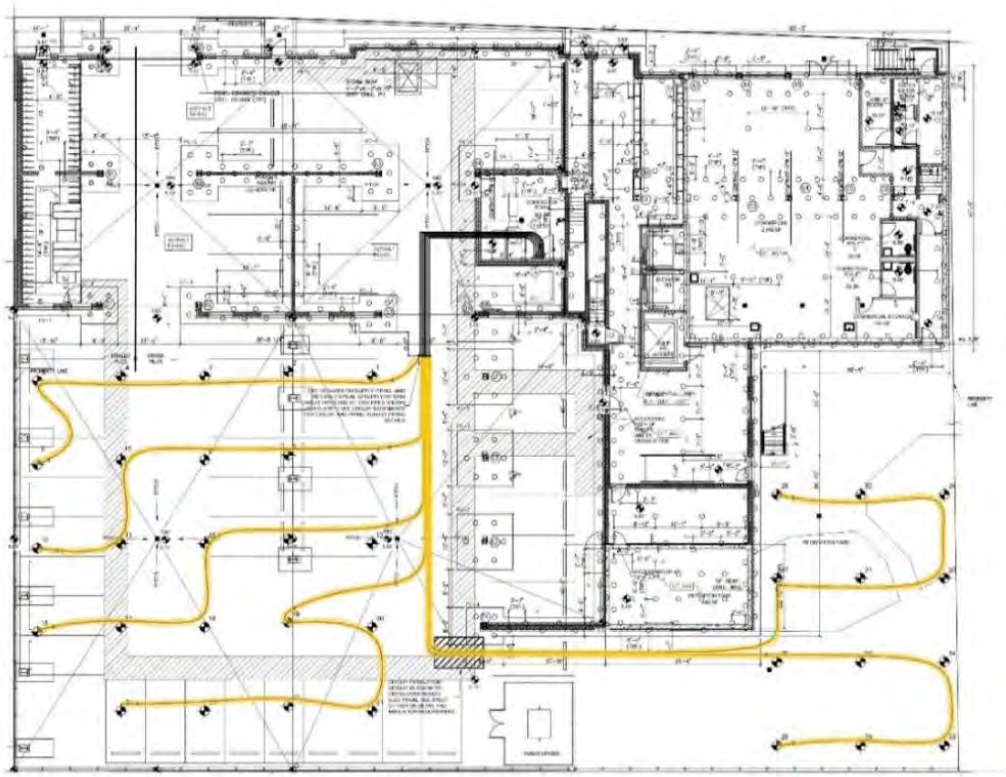
VRF



Maintenance Operation

- Refrigerant leaks = high green house gas emissions
- Cost
- Refrigerant types becoming obsolete with new policy
- Without heat recovery, occupants could be uncomfortable

Water Source Heat Pump



Performance

+ Very efficient when pared with geothermal
- Pumping energy for water loops

Design

+ Flexibility in terminal units (floor units, ceiling mounted, vertical units in cabinets)
- Simultaneous heating-cooling option would require 4-pipe system

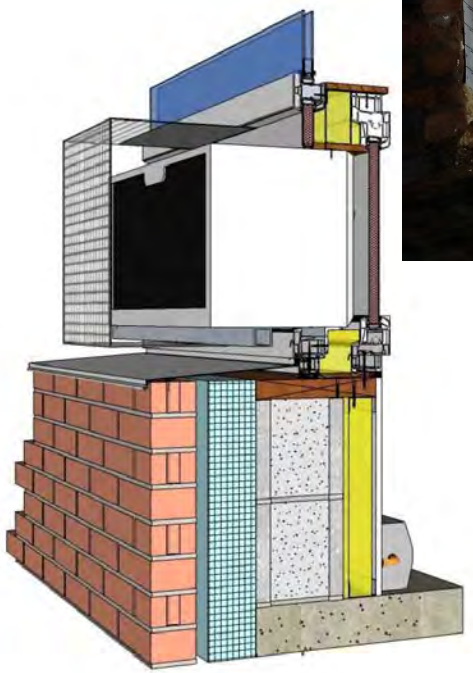
Geothermal can only be in suitable location with multiple wells

Ground Source Heat Pump

Maintenance Operation

- Potential for noise from compressor and fans
- Without 4-pipe system, occupants could be uncomfortable during swing seasons if cooling is desired

Hydronic Heating and Window AC



Performance

+ Boiler/radiator sizing better matched to load
+ Heat recovery option allows for simultaneous heating and cooling
- Pumping power for hydronic can be high
- Least efficient cooling option

Design

+ Less riser and ceiling space
- Need rigorous system to prevent air leakage through window A/C during winter months

Maintenance Operation

+ Cooling on tenant meter
+ Price of Gas
+ Occupants can turn on cooling whenever they want

Domestic Hot Water – Individual

Benefits

- On tenant meter
- If unit is down, only one apartment is affected
- Minimized piping losses

Challenges

- loss of floor space
- Maintenance
- Gas options not viable due to venting issues
- Heat pump water heaters require large volume of air for proper operation
- Storage tank losses

Domestic Hot Water – Central / Recirc

Benefits

- No loss of floor space
- Can use gas boilers which are widely used & gas is inexpensive
- Potential to switch to heat pumps in the future

Challenges

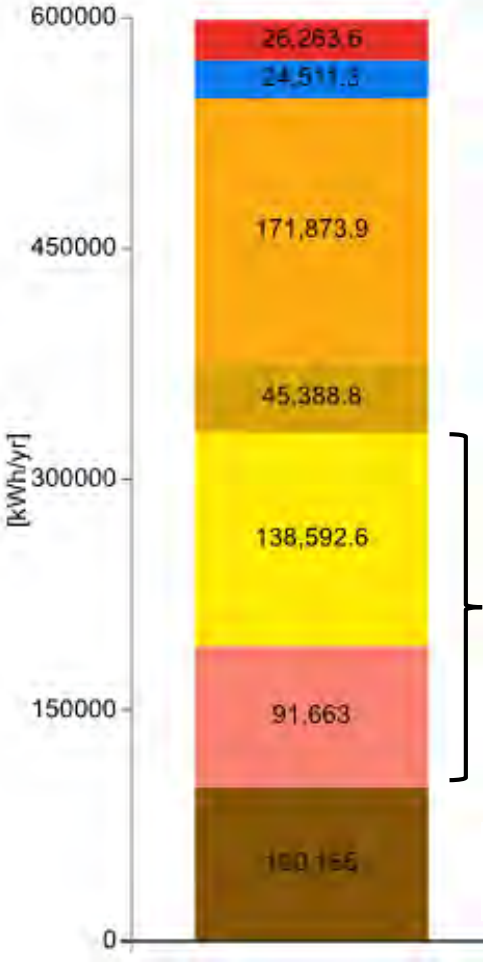
- Extensive energy losses in recirc lines
- Cost of plumbing lines
- Pumping power is very high (24/7 operation)
- On owner's meter

Domestic Hot Water – Semi-Central
Per Floor

Benefits
- Reduced pumping power
- Can use gas boilers
- Potential to switch to HP in future
- Could utilize demand controlled to reduce recirc loop losses

Challenges
- Loss of floor space
- On owner's meter

Plug Loads / Appliances



~37% Building consumption

- Electric Stoves – Required for to meet ventilation
- Dishwasher – water saving vs electrical consumption
- Lighting – common spaces

Renewables

Combined Heat and Power

- Provide emergency power
- Utilize Generated Heat for domestic hot wall
- Reduces demand of domestic hot water heater

Solar

- Provides supplemental power
- Required significant Battery for emergency power

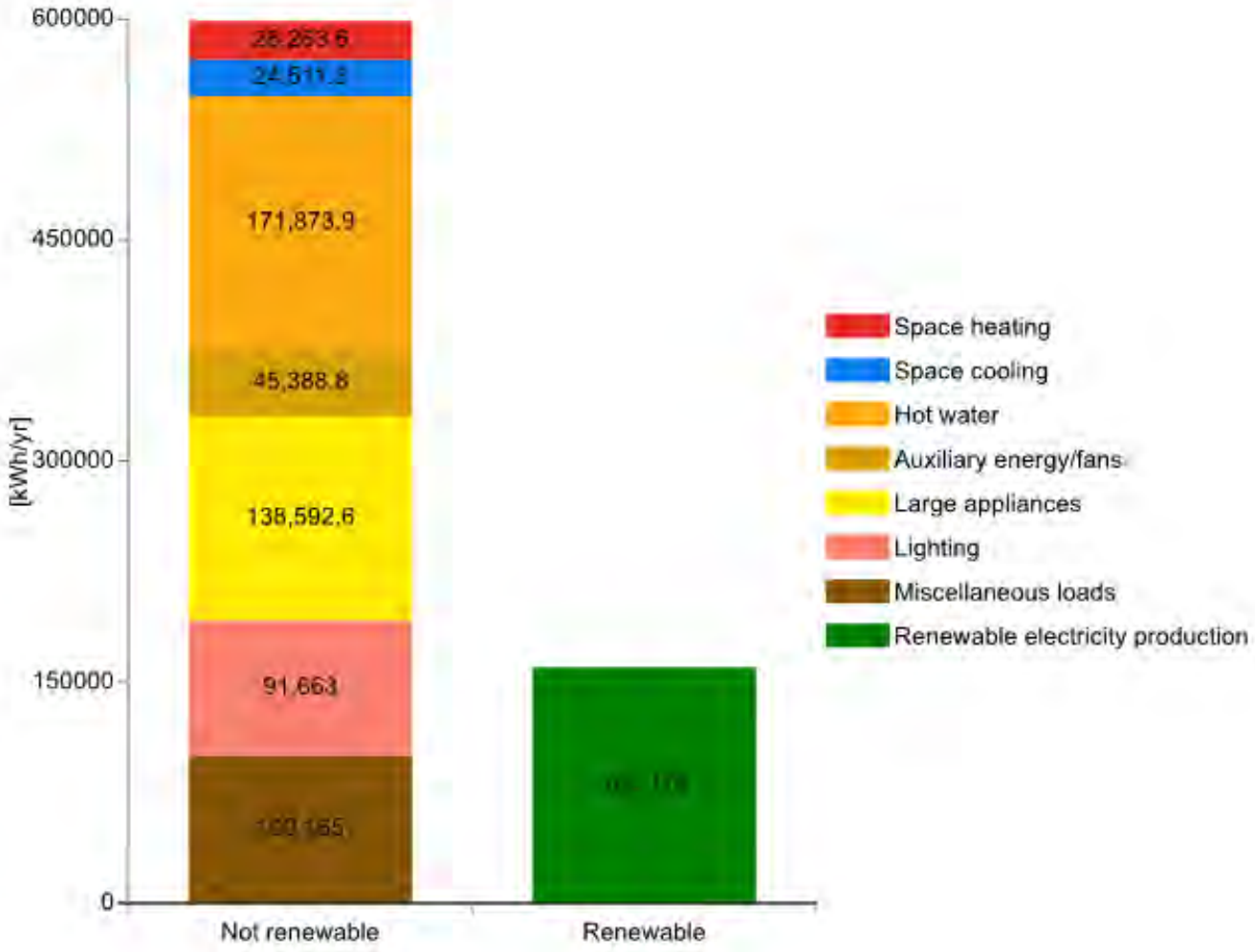
Other Considerations

- Non residential spaces
- Commissioning
- Quality Control / Work crew
- User habits
- Operation

Results – Beach Green Dunes I

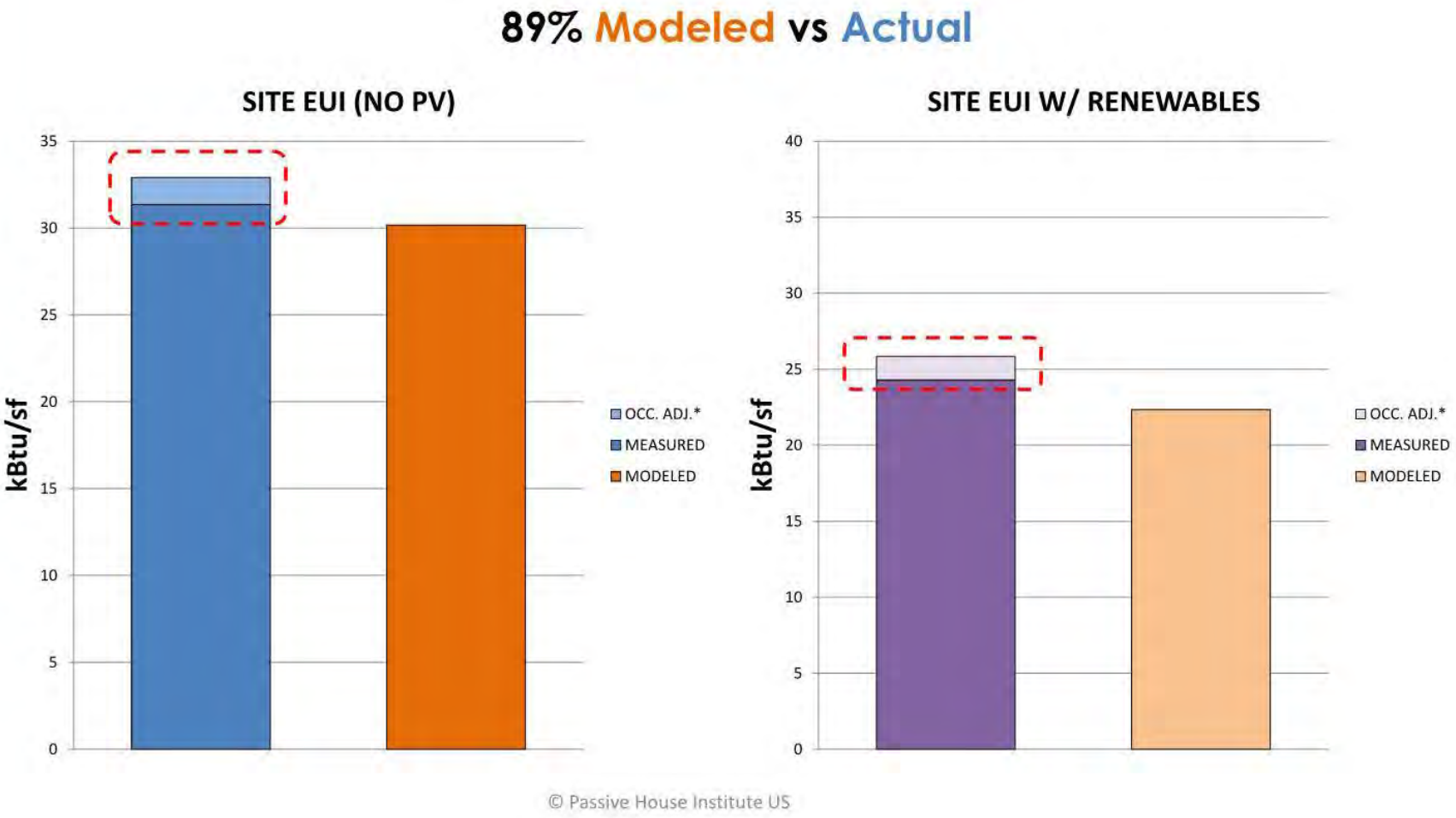
Results

BEACH GREEN DUNES



Results

BEACH GREEN DUNES



Results

Thermostat Settings / Tenant Habitats

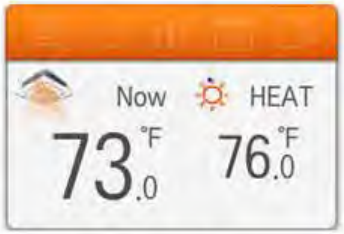
BEACH GREEN DUNES

APT 2D

APT 2E

APT 2H

APT 3D



APT 3E

APT 3H

APT 4D

APT 4E

APT 4H

APT 5D

APT 5E

APT 5H

Results

Co-Gen Valve

BEACH GREEN DUNES

Thank You!