

CASE STUDY DERs ON THE CUSP:

RMI
July 12, 2022

Mount West
Hano Homes
JFK Elementary School
Fairweather 1, 2, 3, 4



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215.783.5591



BUILDING EVOLUTION CORPORATION
Achieve Performance & Durability Through A Holistic Approach™



DEVELOPERS



FACILITATOR



SOLUTION PROVIDER

**ARCHITECT
ENERGY MODELING
R+D PANELIZATION**



**CONSTRUCTION
MANAGER**



BUILDING EVOLUTION CORPORATION
Achieve Performance & Durability Through A Holistic Approach™

HVAC / ENVELOP ENGINEER

DEVELOPERS



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PANELIZERS

*** NOTE: ALL PROJECTS ARE IN FEASIBILITY PHASE**

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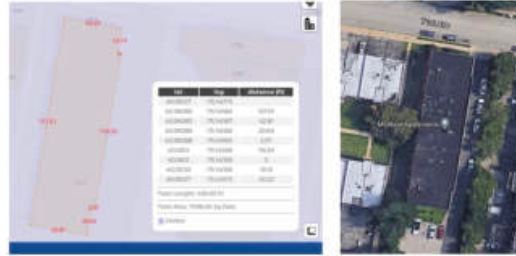
HVAC / ENVELOP ENGINEER



PANELIZERS

Odin affiliates currently own and manage approximately 9,000 apartments and 200,000 square feet of commercial space in 14 US States.

- Mount West 2 1414 71st Ave, Philadelphia, PA 19126



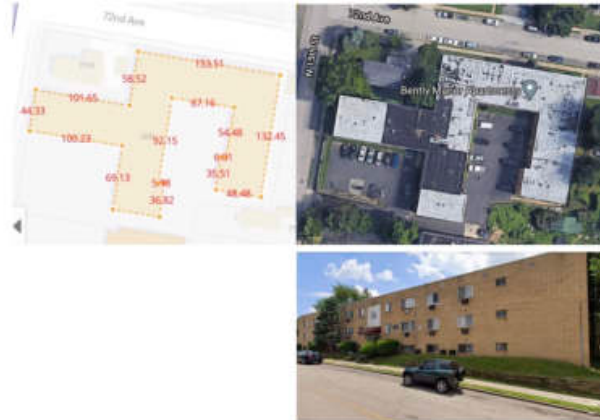
- 7101 N. 15th St 7101 N. 15th St, Philadelphia, PA 19126



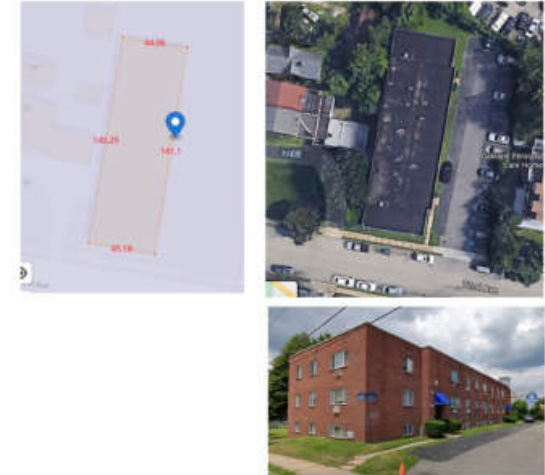
- 1775 Godfrey St, Philadelphia, PA 19126



- Bentley Manor 1410 72nd Ave, Philadelphia, PA 19126



- Mount West 1 1411 76th Ave, Philadelphia, PA 19126





Bldg Info

Mount West

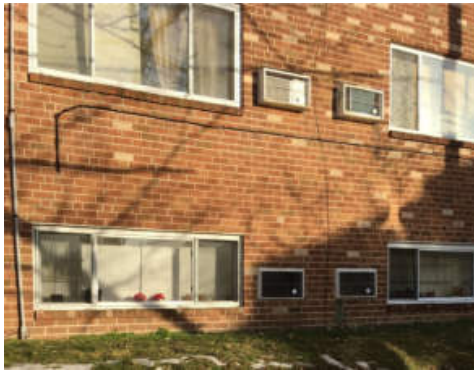
1414 71st Ave, Philadelphia, PA 19126

Year Built - 1950s-1960s

Size - 20,901 GSF

Units - 28 (22 1 Bed, 6 2 Bed)

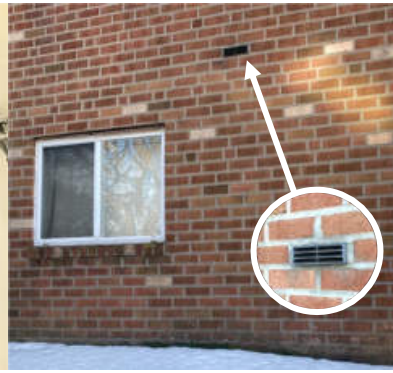
Materials - Brick, CMU, 2x floor framing and roof framing



Existing Thru-wall Air-Conditioning



Existing Hydronic Baseboard Heating



Existing Bath Ventilation

Existing Systems Analysis

Summary of replacement strategy, options, and age of equipment



Existing Gas Water Heating

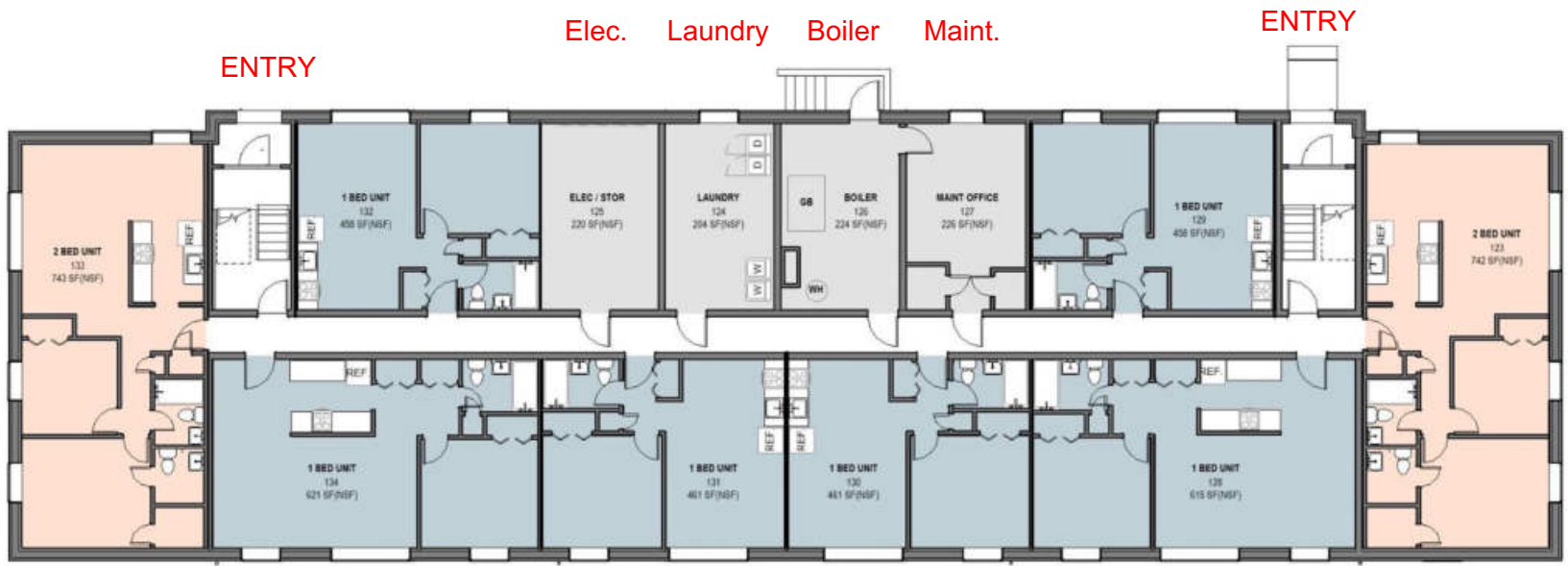


Existing Centralized Gas Boiler for Heating



Existing 40 Amp Panel in Unit

71st Ave



ENTRY

Elec. Laundry Boiler Maint.

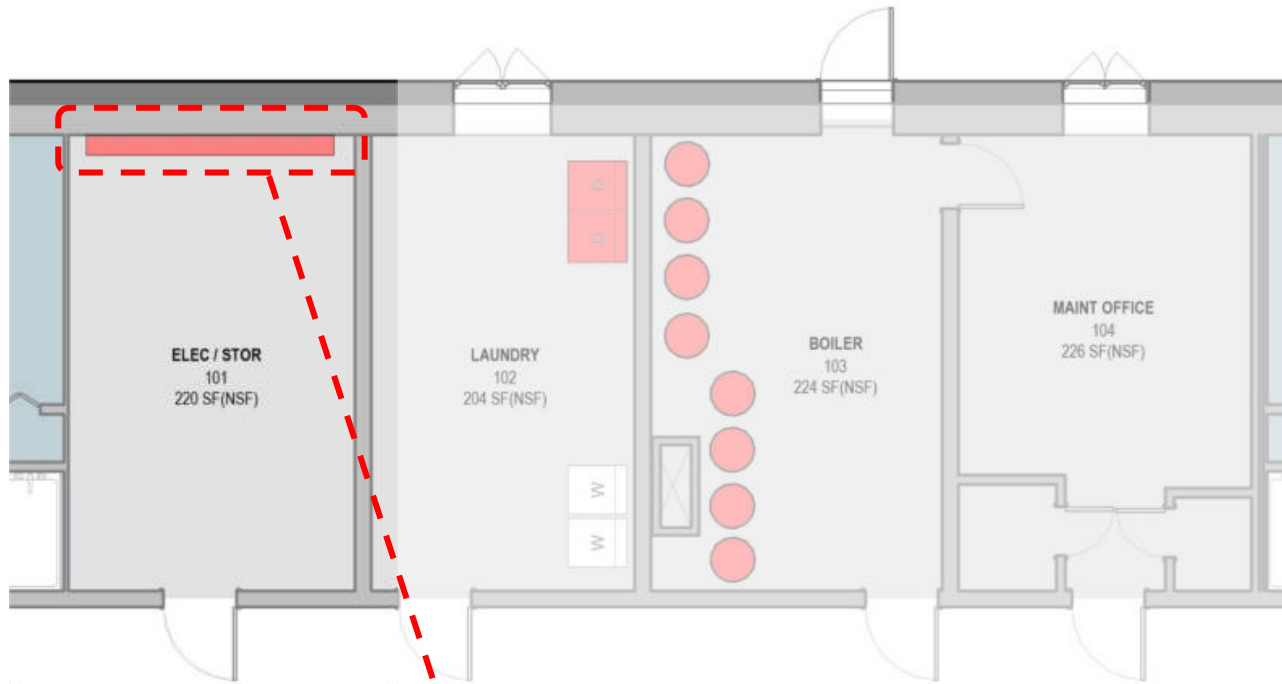
ENTRY

1 BED UNITS: 458 - 615 SF
2 BED UNITS: 742 SF

Department Legend

- 1 BED
- 2 BED
- MECH

Basement Layout

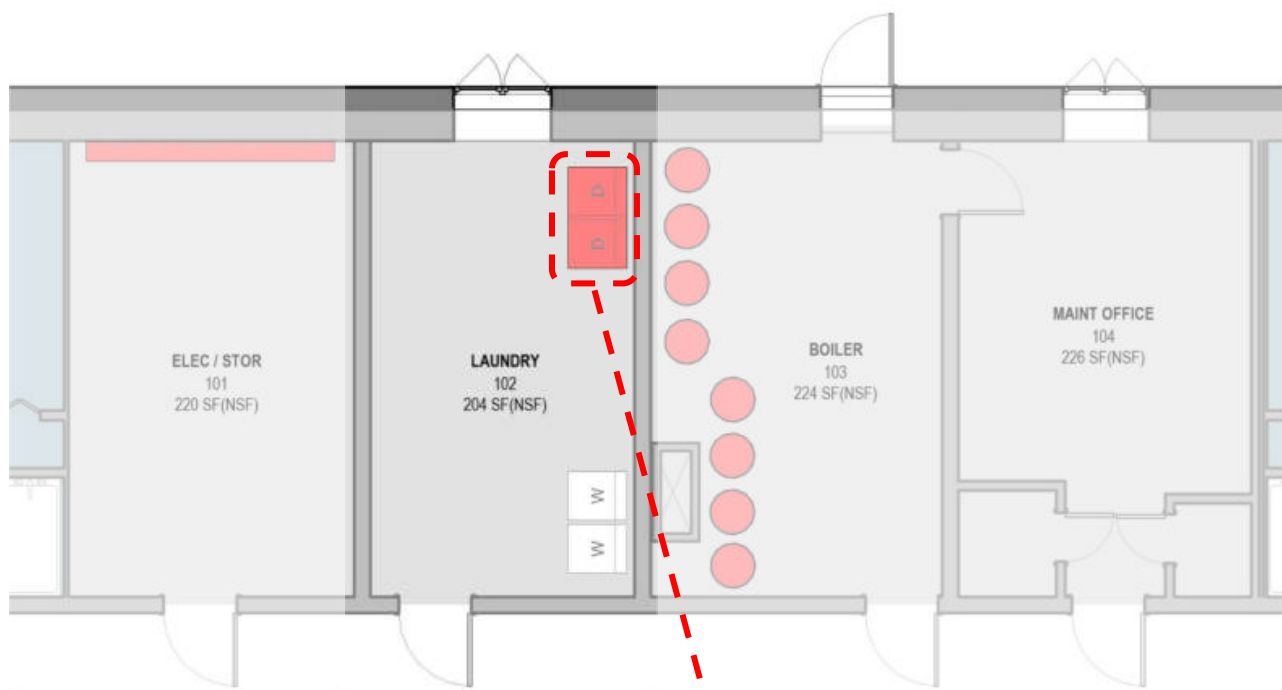


Mechanical Spaces Electrical Meter Room:

- Replace existing 800 amp service with 1200 amp service

Existing elec. panel
and sub-meters



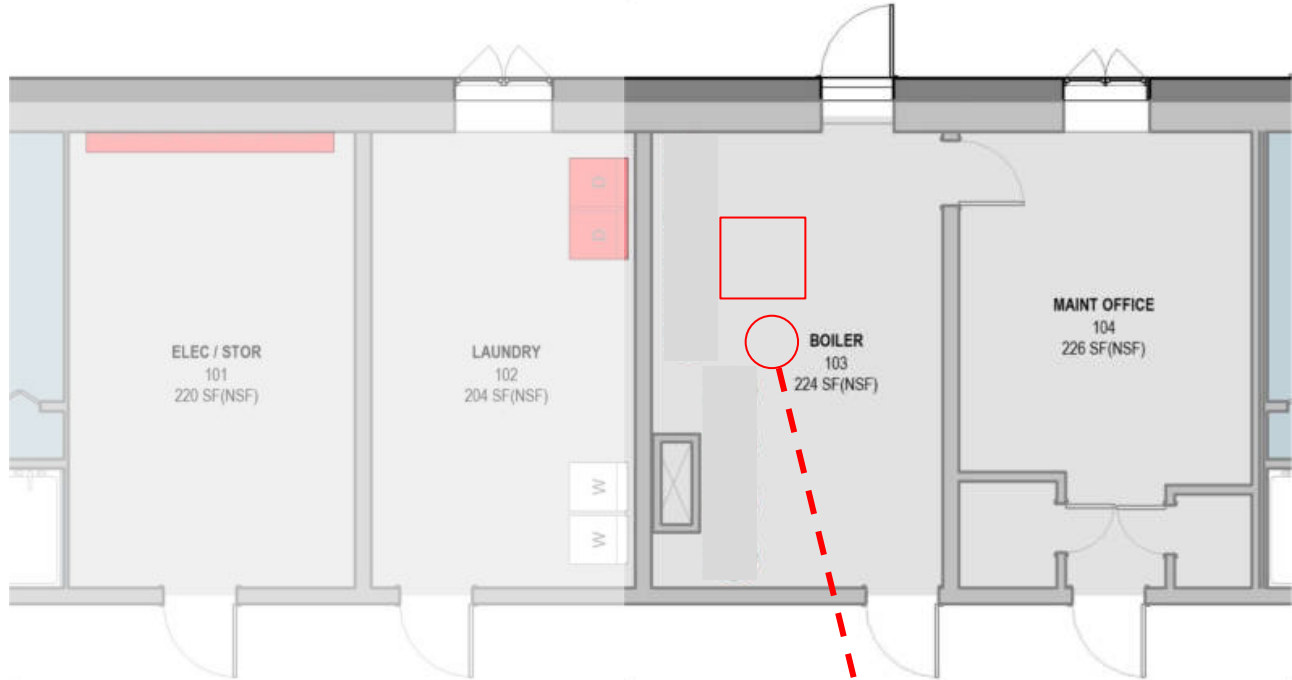


Existing vented
gas dryers

Mechanical Spaces Laundry Room:

- Replace Gas dryers w/ condensing HP dryers
- Eliminate dryer vents



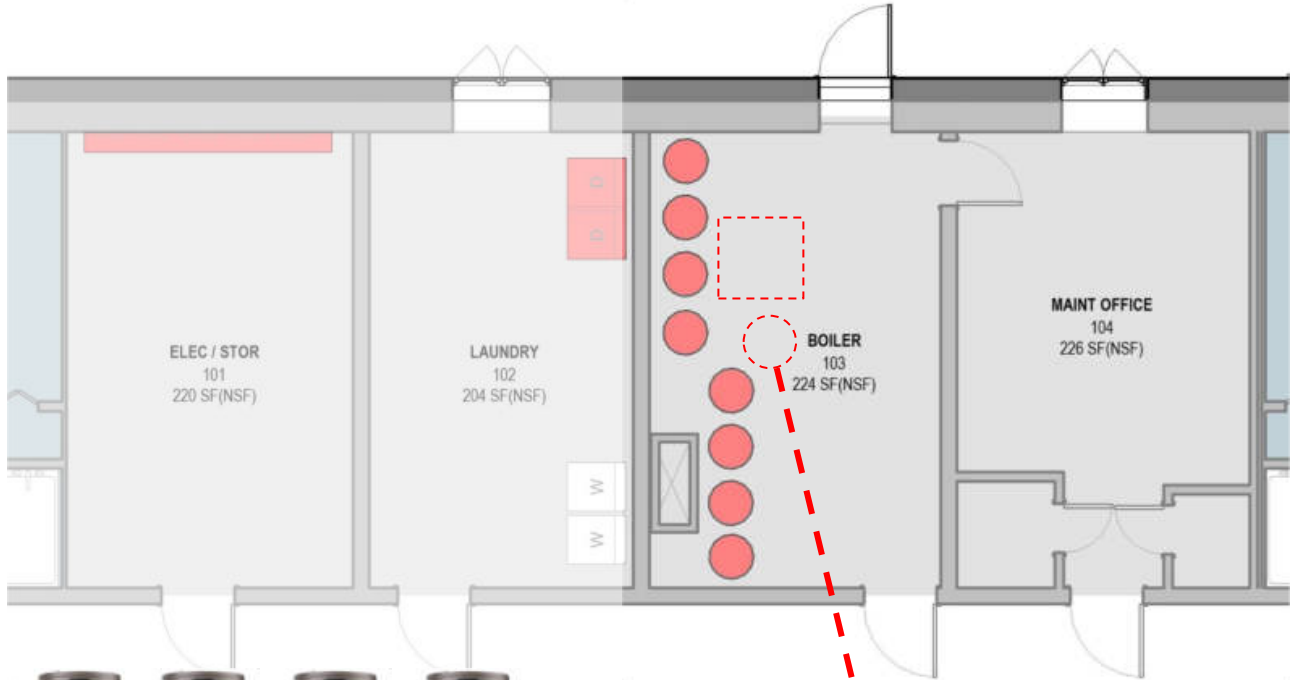


Mechanical Spaces Boiler Room:

- Remove Gas-fired boiler

Existing boiler and gas HW heater





Mechanical Spaces Boiler Room:

- Remove boiler
- Replace with HP water heaters
- Cap & abandon pipes
- Install (8) 80 gal Rheem HP WH



Heat pump Water Heater Cost - \$2000 per unit

Existing boiler and gas HW heater



2 Bed Unit

1 Bed Unit

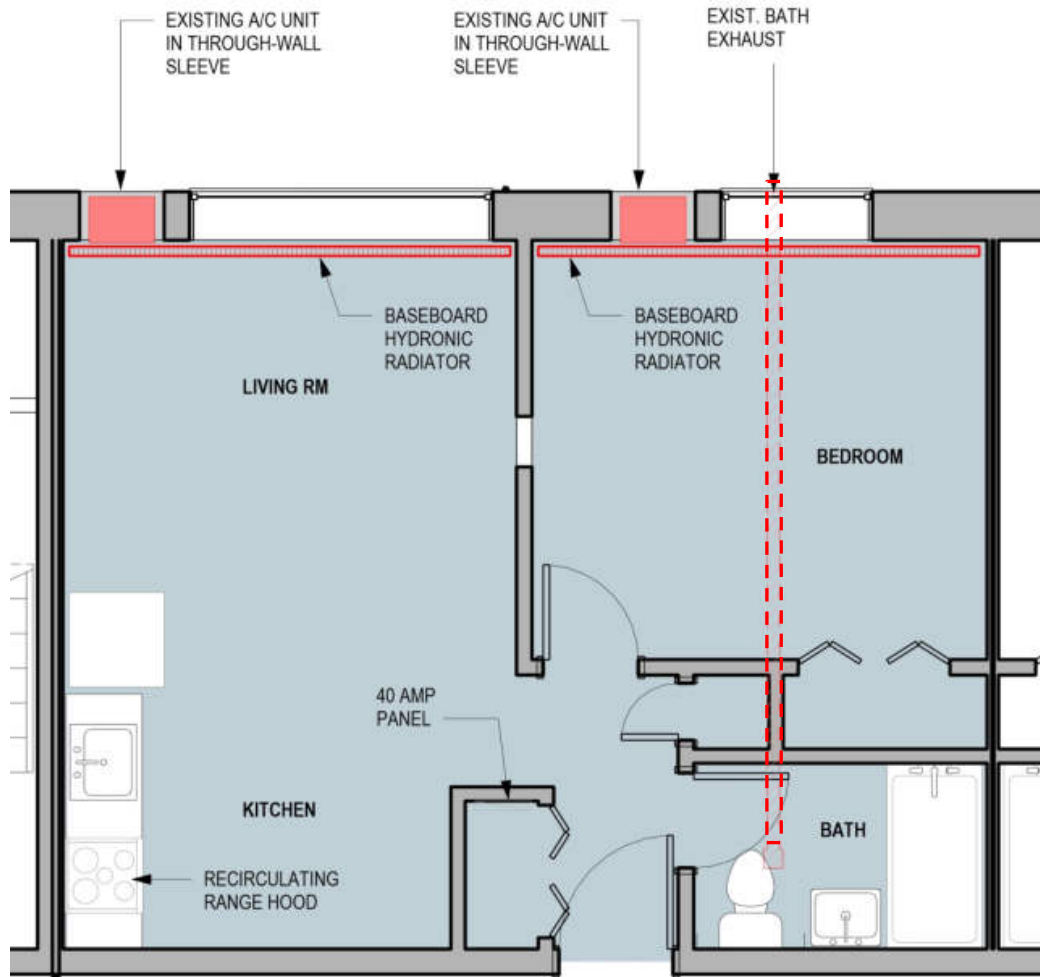


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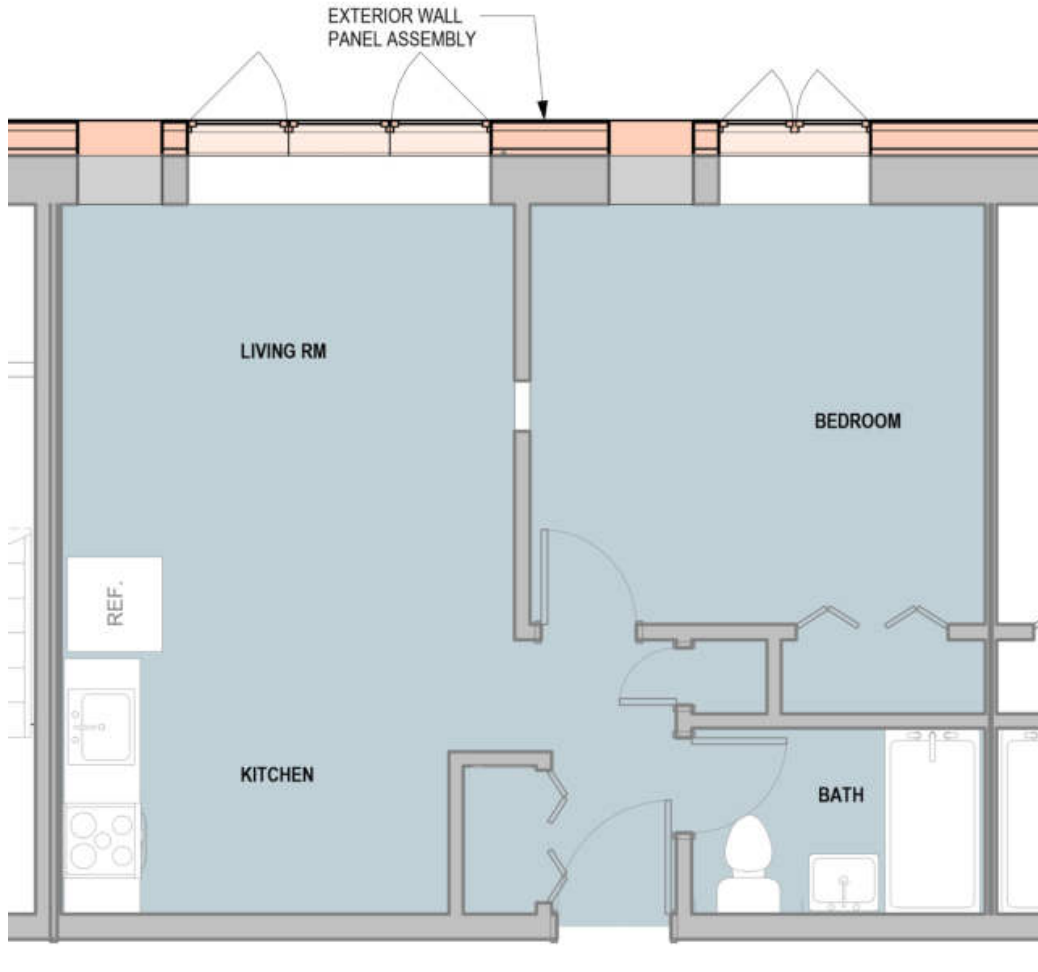
Level 1.5



Typical 1-Bed Unit

EXISTING SYSTEM:

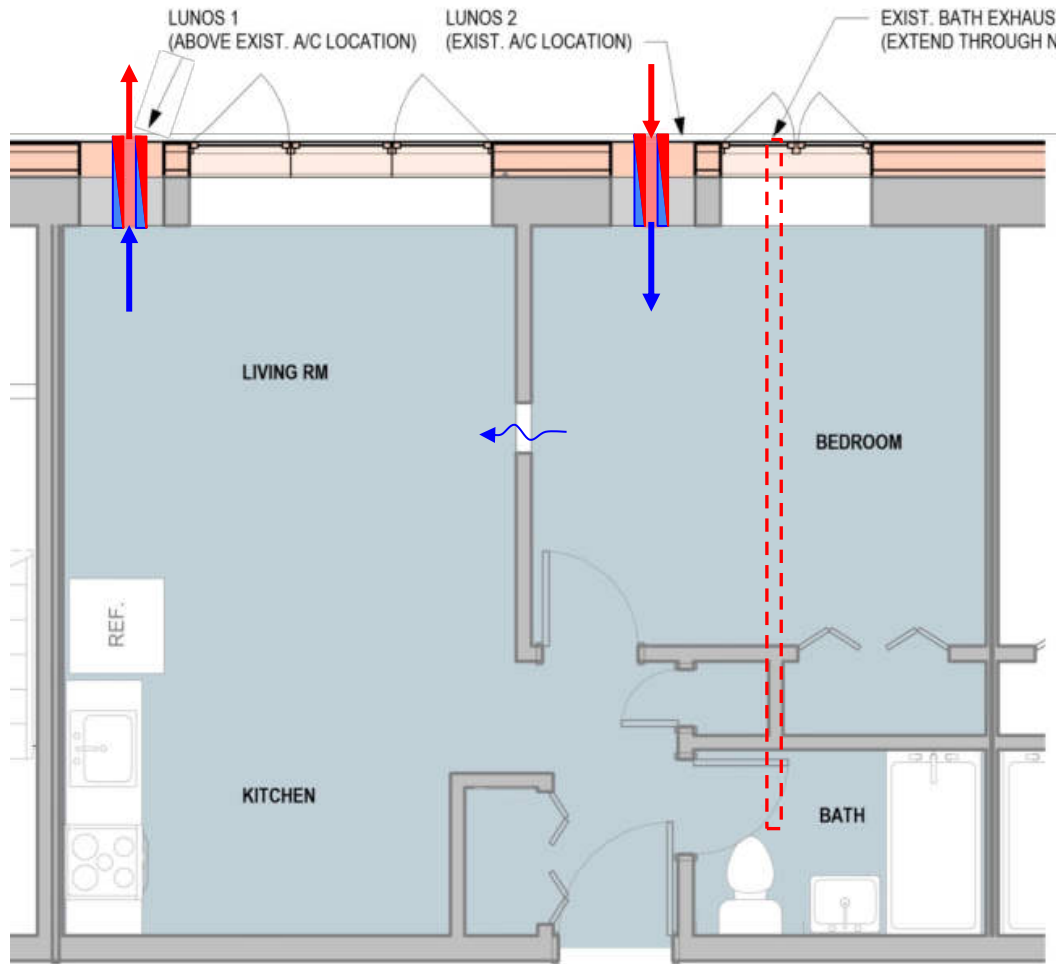
- Plug-in A/C unit in through-wall sleeve
- Centralized hydronic baseboard heating
- Exhaust fan in bathroom ducted to exterior wall
- Recirculating range hood with charcoal filter
- 40 amp elec panel



Typical 1-Bed Unit

New Wall Panel:

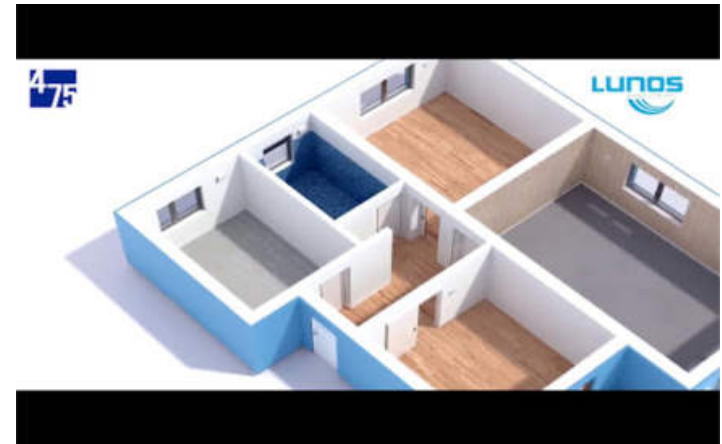
- Prefabricated exterior wall panel system
- Factory-installed windows in existing window locations
- Vapor-open insulated wall assembly

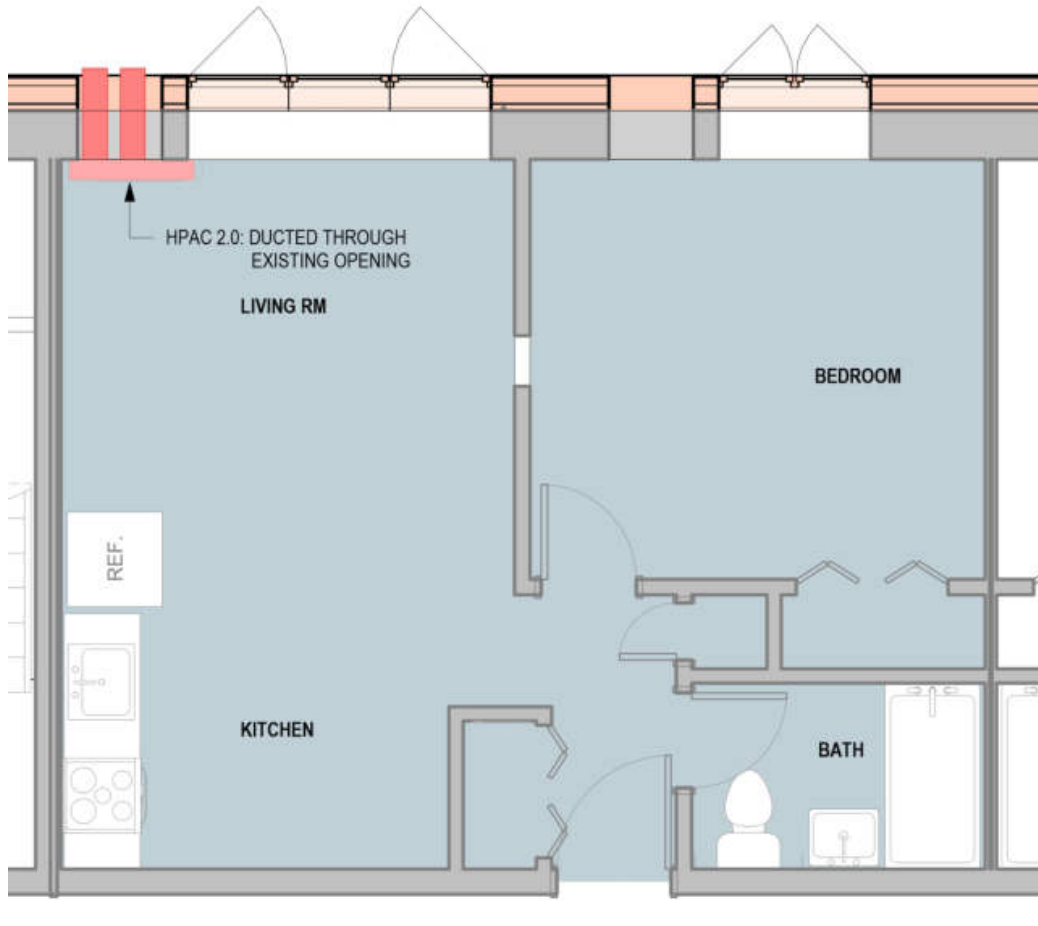


Typical 1-Bed Unit

Ventilation SYSTEM:

- Lunos ET2 HRV pair in Bedroom and Living Room
- Transfer grille installed between Bedroom and Living Room for air circulation through unit
- **Panasonic ERV for Bath exhaust**





Typical 1-Bed Unit

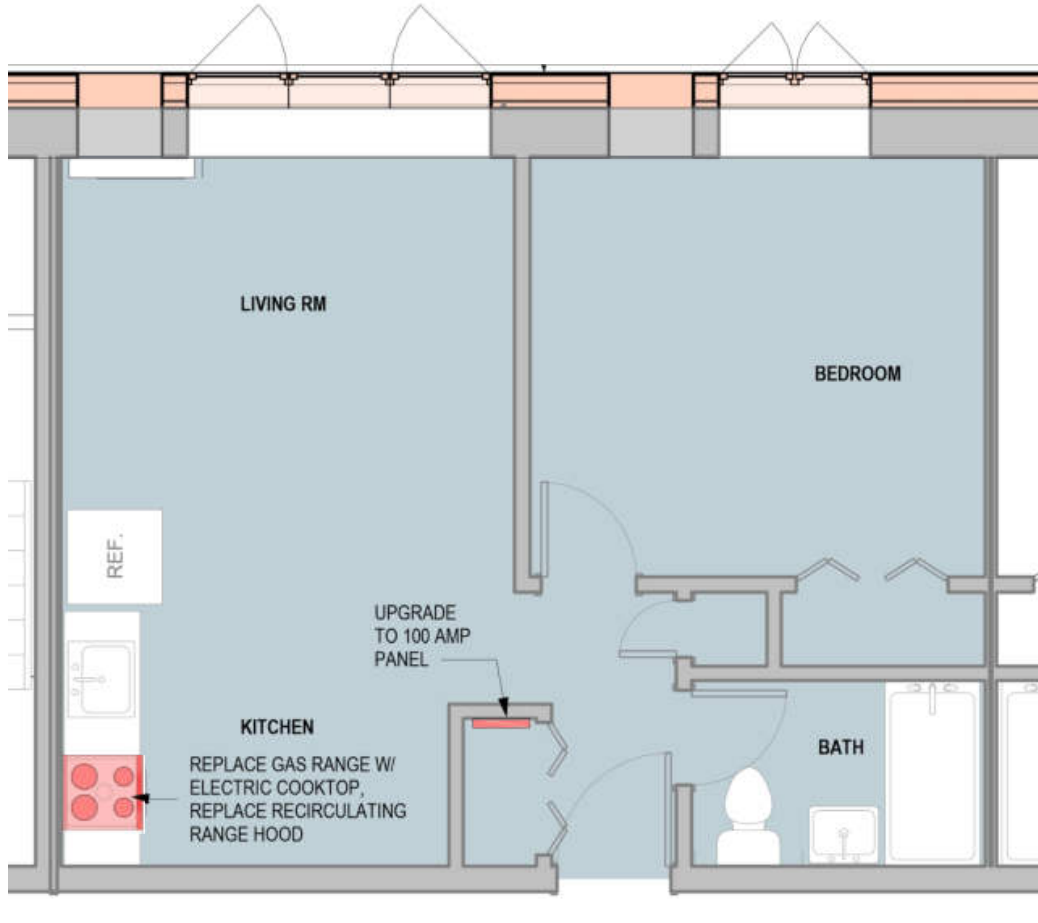
Heating/Cooling SYSTEM:

- Ephoca monoblock heat pump unit provides heat, cooling, and humidity control
- (2) through-wall ducts installed in existing A/C opening in Living room



Cost - \$2,500 per unit

Size - 39.7" W x 21.9" H x 6.5" D

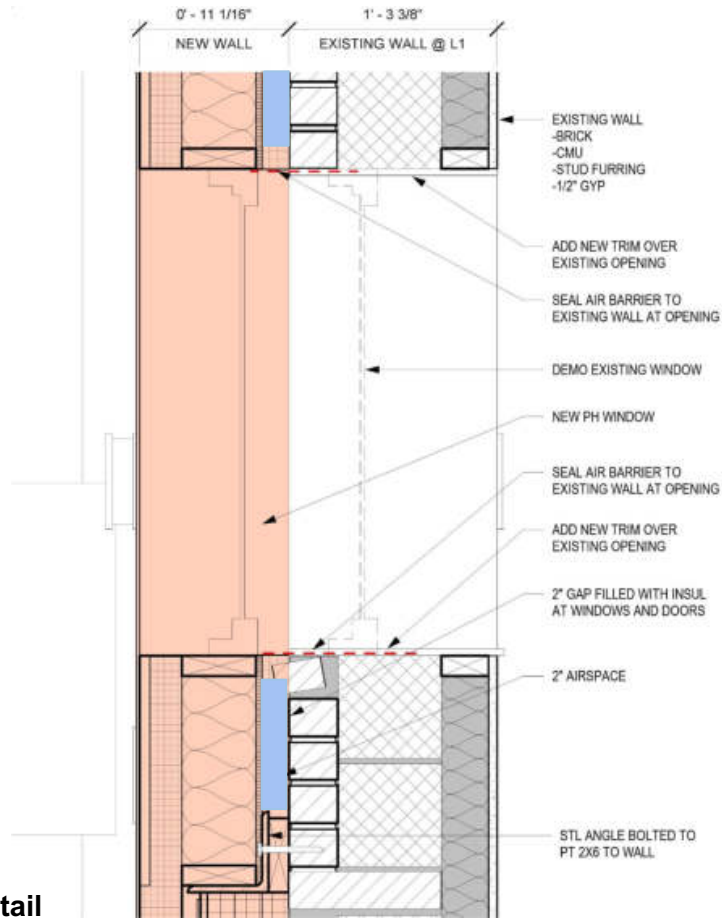


Typical 1-Bed Unit

ALL-ELECTRIC SYSTEM:

- Eliminate gas appliances throughout: replace gas range with electric cooktop
- Replace recirculating range hood
- Upgrade electrical sub-panel in unit to 100 amps

Window/Base Detail



Assembly Details

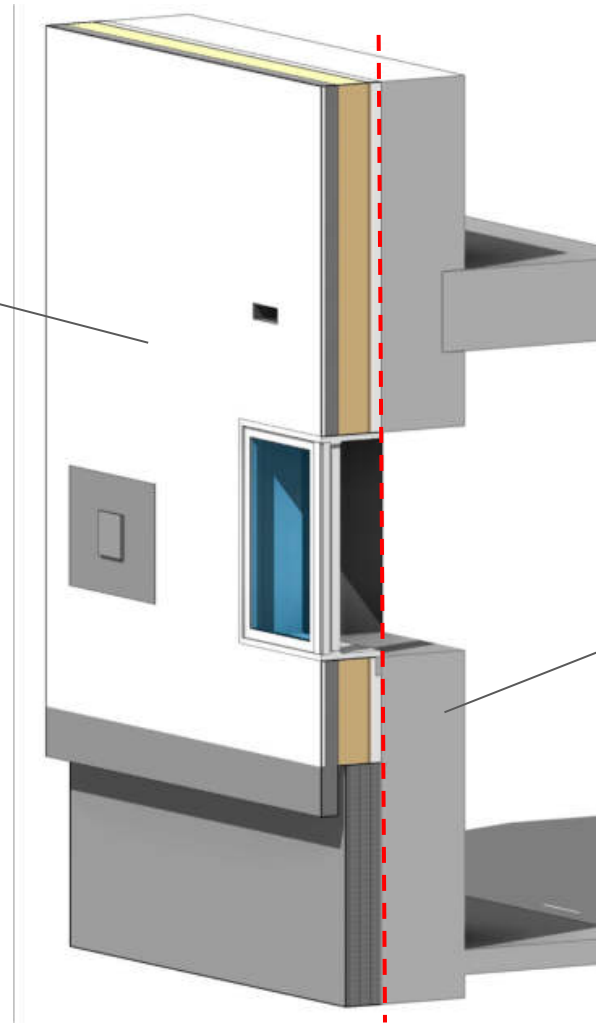
Detail of overall construction approach between existing and new wall at window opening

Wall Details

- Vapor open assembly
- Prefab and Panelized

New Wall Assembly

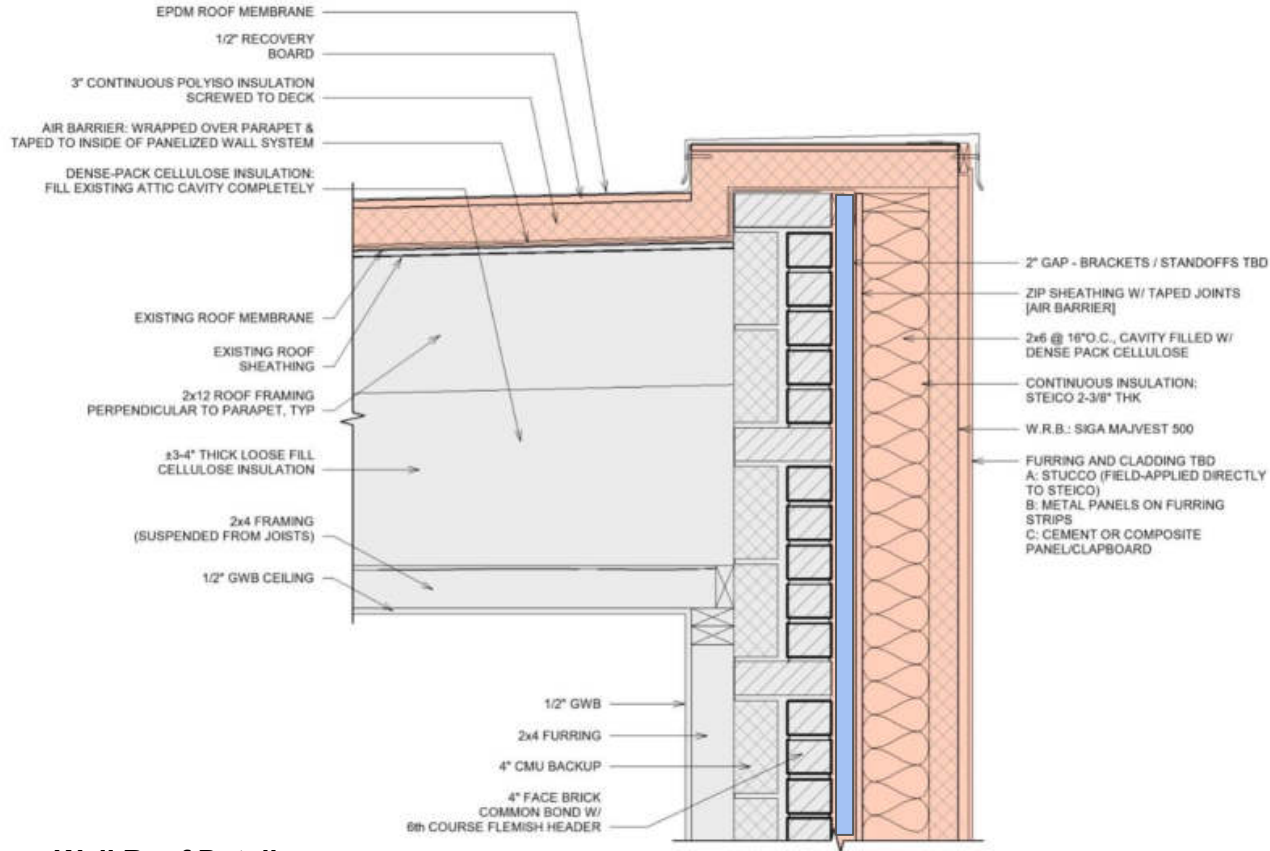
- siding
- 2 1/2" of steico exterior insul
- 2x6 wood framing
- dense pack cellulose Insul
- 7/16" plywood
- 2" air space



Existing Wall
Assembly

Assembly Details

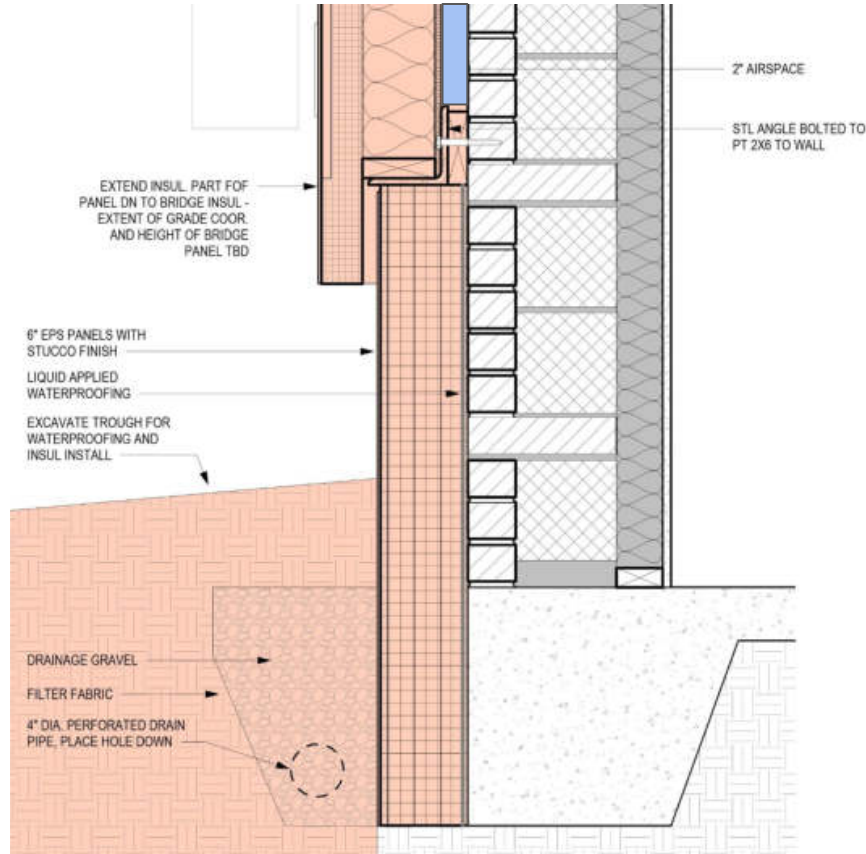
Detail of overall construction approach between wall and roof



Wall Roof Detail

Assembly Details

Detail of overall construction approach at base of wall at perimeter



Foundation Detail



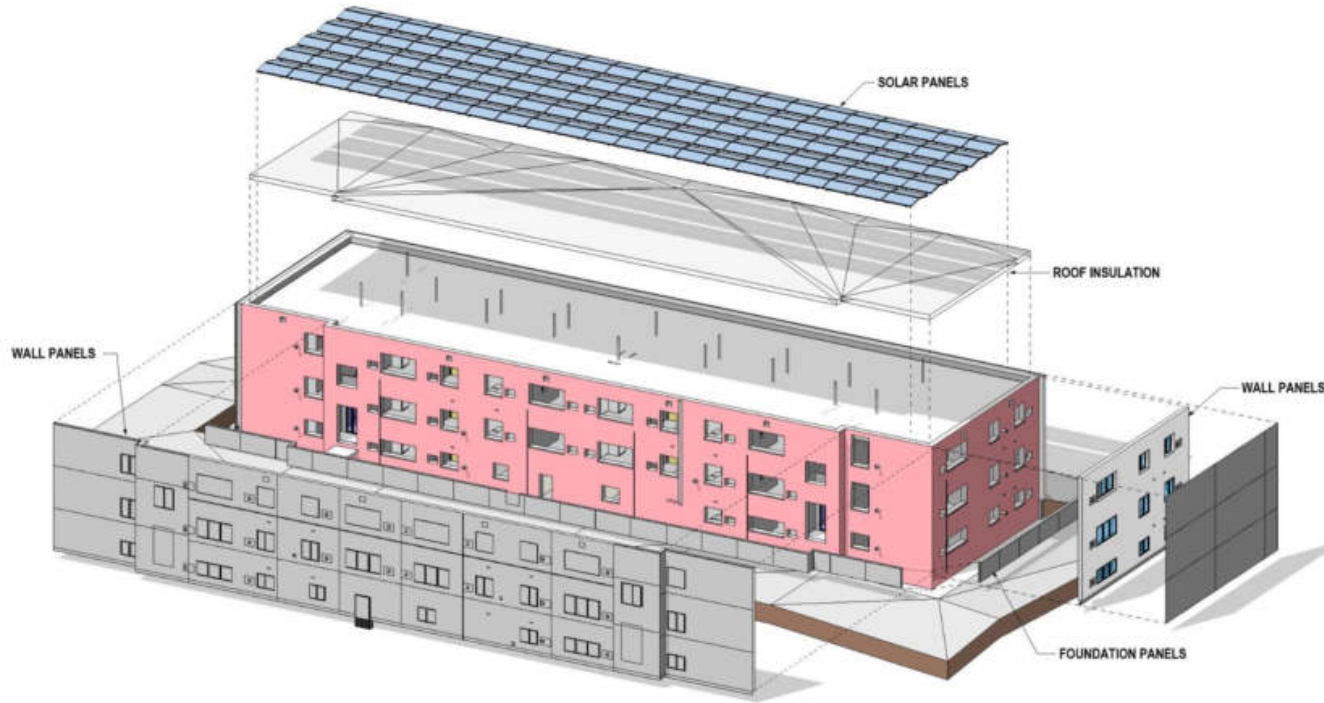
Prefab Fabrication

Costs, construction timeline, and info about blueprint prefab



Thermal Envelope

Exploded axon showing new walls and roof insulation over existing building including perimeter excavations





Rooftop Solar

(220) 300W solar panels on
10 deg east west roof racks
for maximum efficiency

Total Array Size - 66kw
Generates 107,203 kWh/yr
or 70% of total consumption



EUI: Site Energy Use Intensity Comparison (kBtu/SF)

Project Energy Consumption + Production

1414 w/ Solar 8



88% Better than Code building

1414 25



PHL Affordable Passive House 27



PHL Affordable LEED 47



PHL Affordable Code 59



TYPICAL Code kWh

361,403 kWh Total



Project Energy Consumption + Production

88% Better than Code building

PROJECTED Consumption kWh

153,136 kWh Total



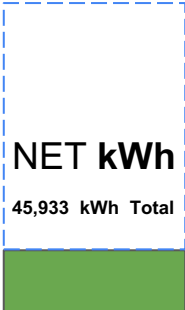
PROJECTED PV Production kWh

107,203 kWh Total



NET kWh

45,933 kWh Total



- Space heating
- Auxiliary energy / fans
- Miscellaneous loads
- Space cooling
- Appliances
- Renewable electricity production
- Hot water
- Lighting

TYPICAL Code kWh

361,403 kWh Total

361,403 kWh x \$.11kWh =
\$39,754/year/building
\$1419/year/unit
\$118/month/unit

Project Energy Consumption + Production

88% Better than Code building

PROJECTED Consumption kWh

153,136 kWh Total



PROJECTED PV Production kWh

107,203 kWh Total



45,933 kWh x \$.11kWh =
\$5052/year/building
\$180/year/unit
\$15/month/unit

NET kWh

45,933 kWh Total



- Space heating
- Auxiliary energy / fans
- Miscellaneous loads
- Space cooling
- Hot water
- Appliances
- Renewable electricity production
- Lighting

71ST AVENUE			
Budget breakdown	sf	\$/sf	TOTAL
BUILDING BUDGET	20901		
Panels (Blueprint Robotics)	11068	\$69.12	\$765,000.00
EPS for foundations (\$1.5/sf material)	1390		\$20,000.00
Miscellaneous Site work (Drainage tiles, waterproofing...)			\$50,000.00
Roof (based on Topline bid)	6967	\$15.30	\$106,595.10
EPHCCA (in BR scope)	28	\$4,000.00	
Excavation			\$50,000.00
Patching interiors/windows (in BR scope)			
Exterior Finish	12458	\$30.00	\$373,740.00
NEW Electrical service upgraded from 800amp to 1200amps			\$20,000.00
NEW 100amp panels and services run to all 28 units		\$4000/unit	\$112,000.00
Demolition: stairs, boilers			\$25,000.00
New Concrete Stairs			\$30,000.00
Dense pack roof insulation	6967	\$6.00	\$41,802.00
220 Line to stove (in BR scope)	28	\$700.00	
New stoves	28	\$600.00	\$16,800.00
Entrance canopy			\$25,000.00
Solar	82800	\$1.50	\$124,200.00
HARDCOST SUBTOTAL		\$84.21	\$1,760,137.10
Hardcost Contingency		6%	\$96,807.54
HARDCOST TOTAL		\$88.84	\$1,856,944.64
SOFT COSTS			
Our Fee: Arch/predevelop		10%	\$176,013.71
Our Fee: GC		6%	\$105,608.23
Admin Management fee		3%	\$52,804.11
Insurance		1%	\$8,800.69
Permitting		1%	\$8,800.69
Contingency		6%	\$96,807.54
General Conditions		10%	\$176,013.71
TOTAL		\$118.74	\$2,481,793.31

Overview of Cost

Construction cost details

\$2,481,793.31

- 868,627.65

- \$500,000

- \$500,000

\$613,165.65

Annual Mortgage

Total Cost

4% LIHTC

Mun. Grant

State Grant

5% MORTGAGE

\$39,492.00

\$88,635.46 per Apartment



Existing Facade

Existing brick facade with exterior applied cooling units, elec conduit and vents



Facade Renderings

Initial facade option
exploring panel divisions
and window shading



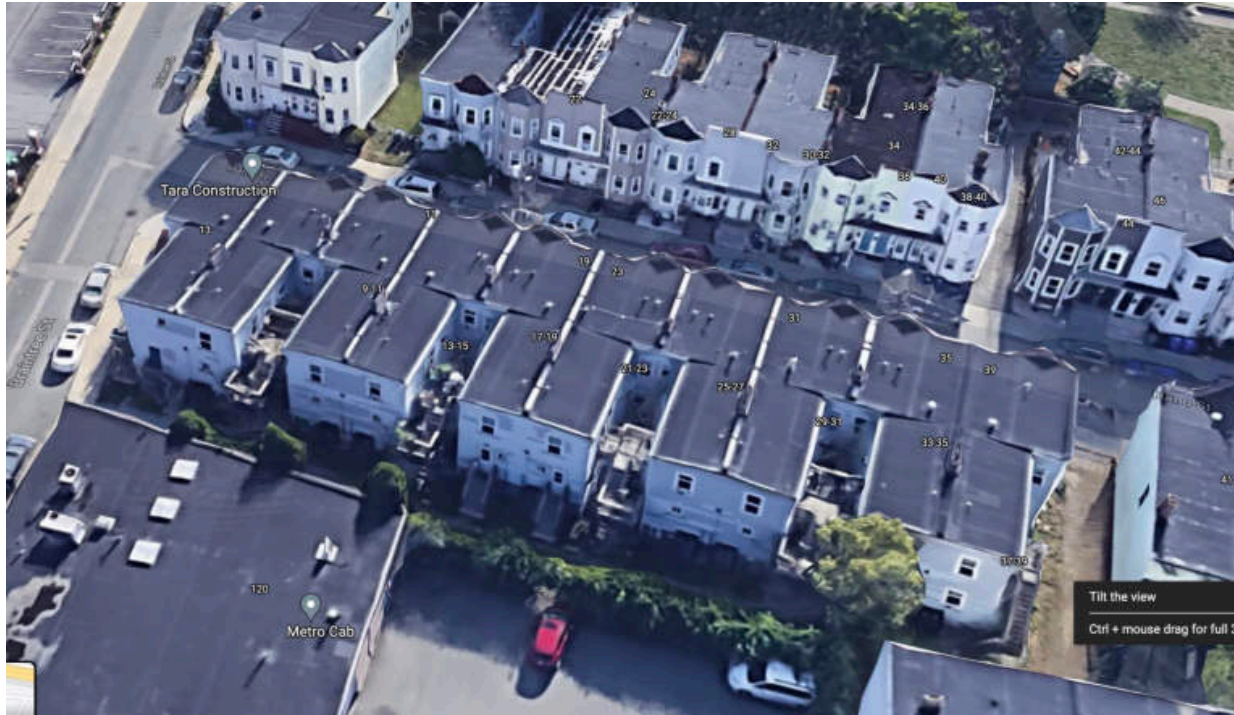
Facade Renderings

Process facade rendering exploring panel divisions and window shading and color



Facade Renderings

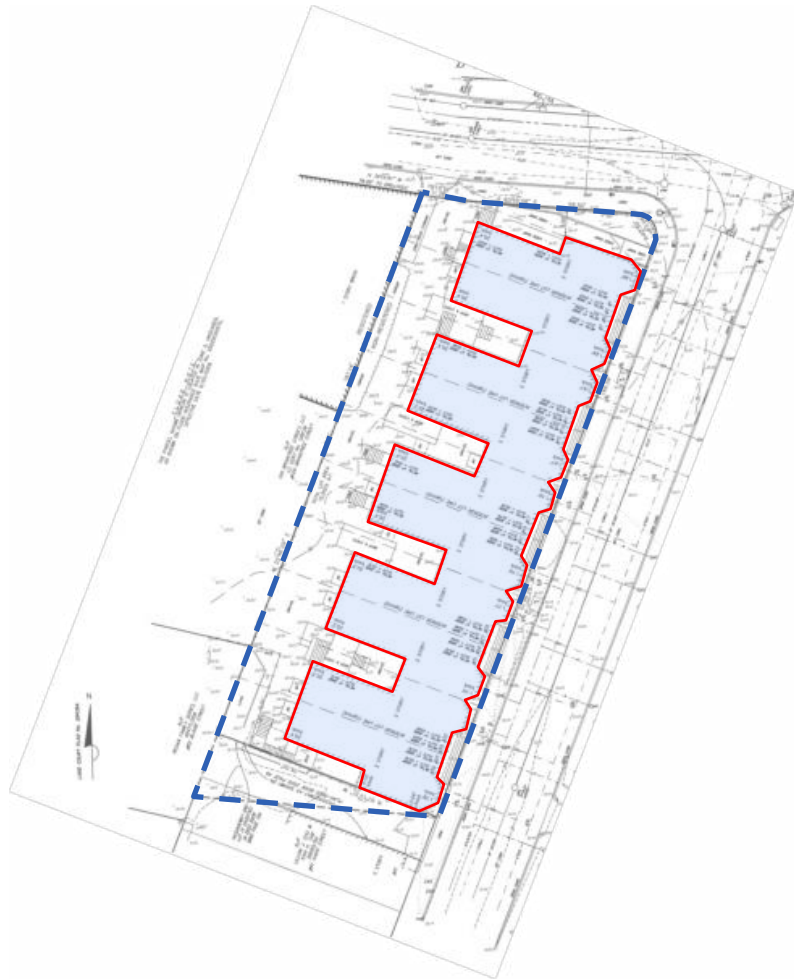
Process facade rendering exploring colors, entry canopy, and planting



Bldg Info

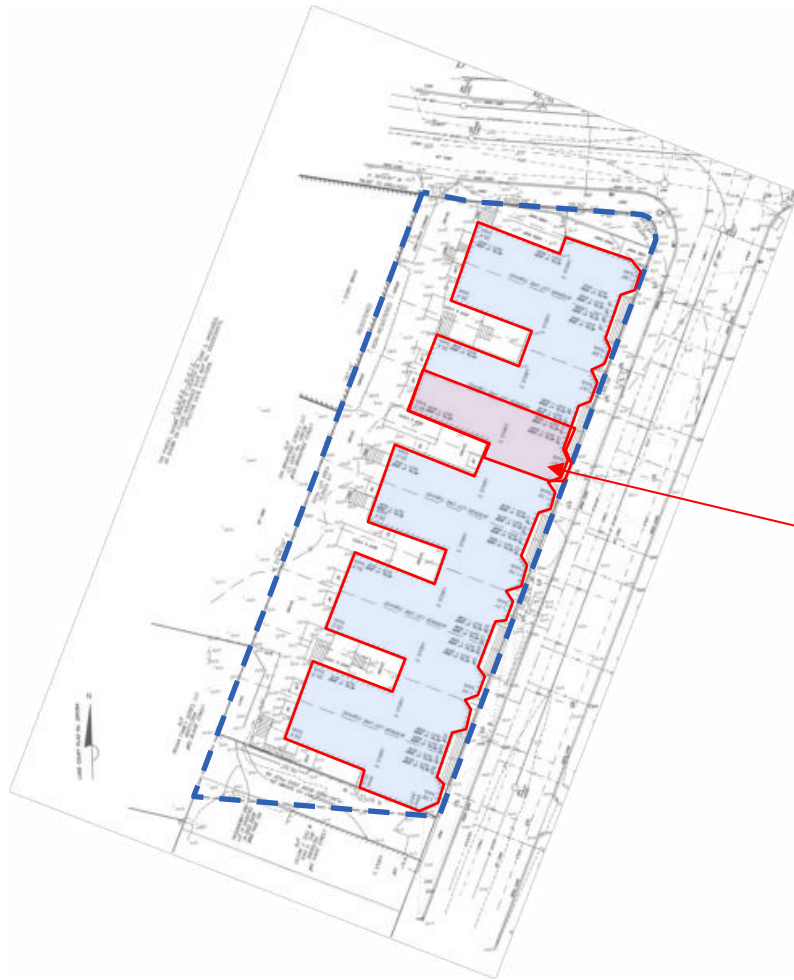
1-39 Hano Street,
Allston Brighton, MA

- Year Built – 1888
- Size – 24,083 GSF
- Zoning: R-3
- 10 Duplexes, 20 Units
- Materials – Wood framed, masonry fire walls



RECENT SURVEY PLAN

- Challenging building form
- Very tight access at street
- Overhead wires make front panelization difficult
- Model as one building or Ten?



RECENT SURVEY PLAN

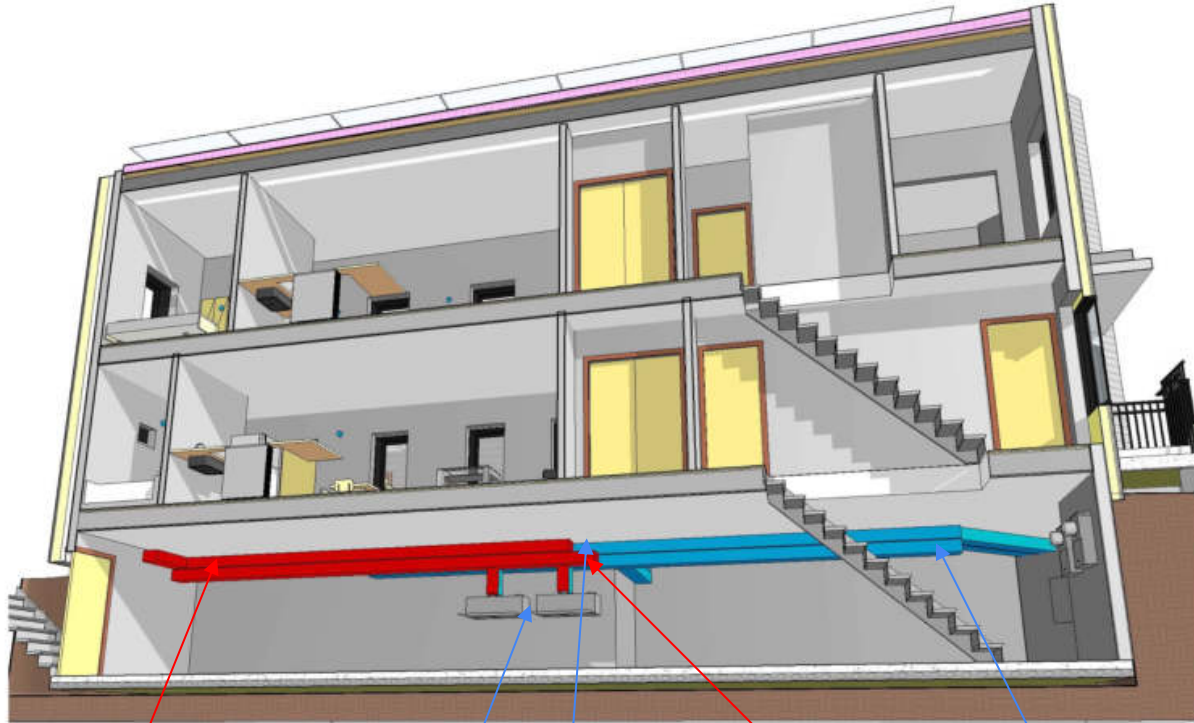
- Challenging building form
- Very tight access at street
- Overhead wires make front panelization difficult
- Model as one building or Ten?
- Chose to model one duplex at a time.



HVAC STRATEGY

EXISTING CONDITIONS

- Eliminate gas and centralized boiler for heating
- Eliminate gas and DHW tanks
- No cooling



Minotair units

1st floor supply/exhaust ducts
Flush to ceiling and feed 1st floor
Through floor registers

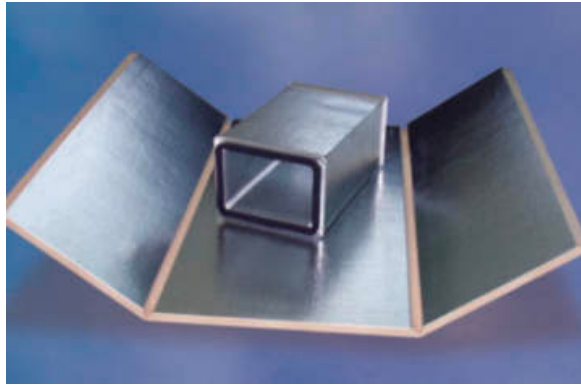
2nd floor supply/exhaust ducts
Sandwiched below 1st floor ducts
feed 2nd floor on outside

HVAC STRATEGY

- Decentralized ventilation, heating, and cooling strategy
- Replace gas water heaters with Heat Pump Water Heaters (HPWH)
- Use Minotair Unit

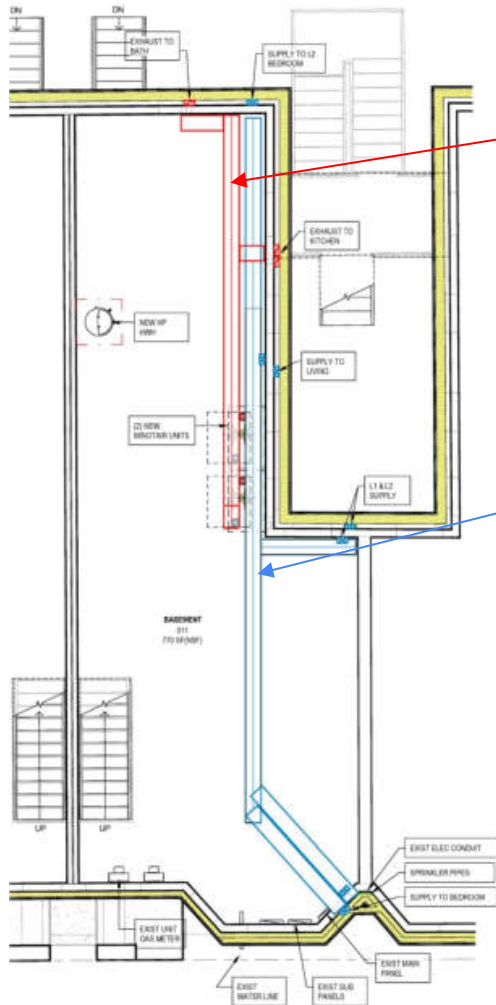


KoolDuct®



HVAC STRATEGY

- Decentralized ventilation, heating, and cooling strategy
- Replace gas water heaters with Heat Pump Water Heaters (HPWH)
- Use Minotair Unit
- Use KOOL DUCT



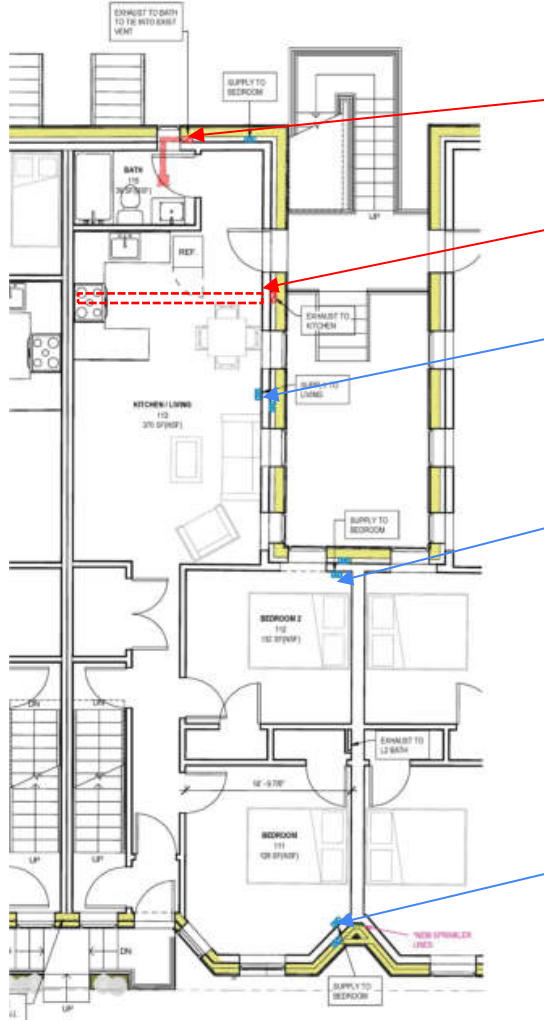
EXHAUST Ducts to
1st + 2nd floor bathrooms
And kitchens.

SUPPLY Ducts to
Bedrooms and living
areas

HVAC STRATEGY

- Decentralized ventilation, heating, and cooling strategy
- Replace gas water heaters with Heat Pump Water Heaters (HPWH)
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BASEMENT PLAN



Exhaust connected to existing
Bath exhaust to exterior

Exhaust connected to existing
Kitchen exhaust to exterior

Supply Floor register

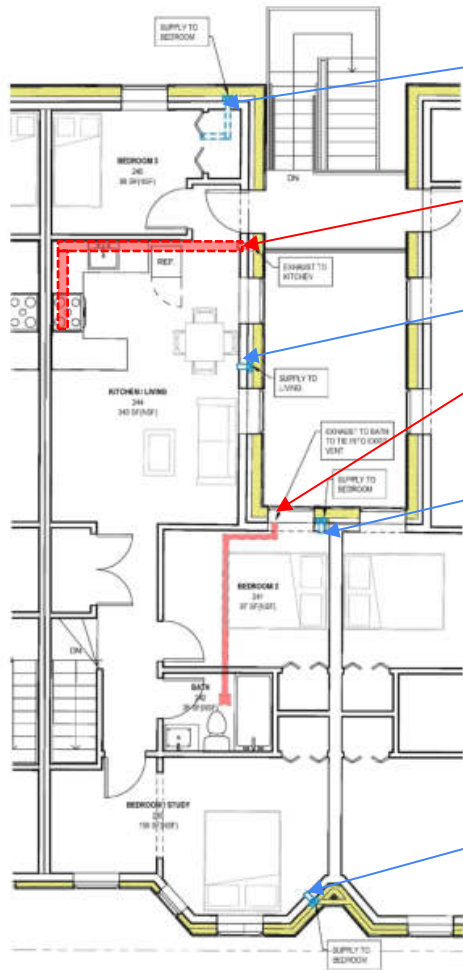
Supply Floor register

Supply Floor register

1st FLOOR PLAN

HVAC STRATEGY

- Decentralized ventilation, heating, and cooling strategy
- Replace gas water heaters with Heat Pump Water Heaters (HPWH)
- Use Minotair Unit
- Use KOOL DUCT
- Service 1st floor unit through floor registers



Supply Wall register

Exhaust connected to existing Kitchen exhaust to exterior

Supply Wall register

Exhaust connected to existing Bath exhaust to exterior

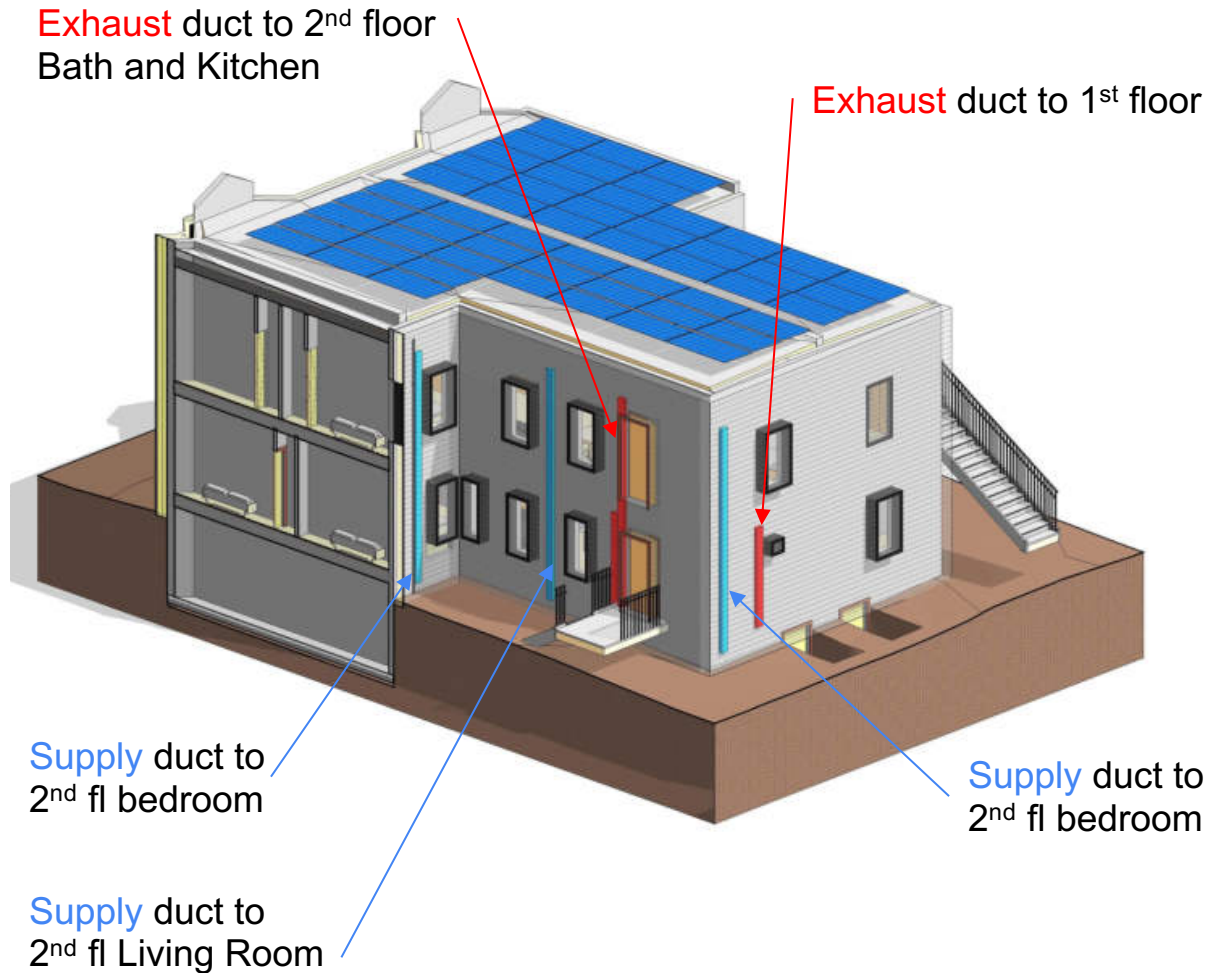
Supply Wall register

Supply Wall register

2nd FLOOR PLAN

HVAC STRATEGY

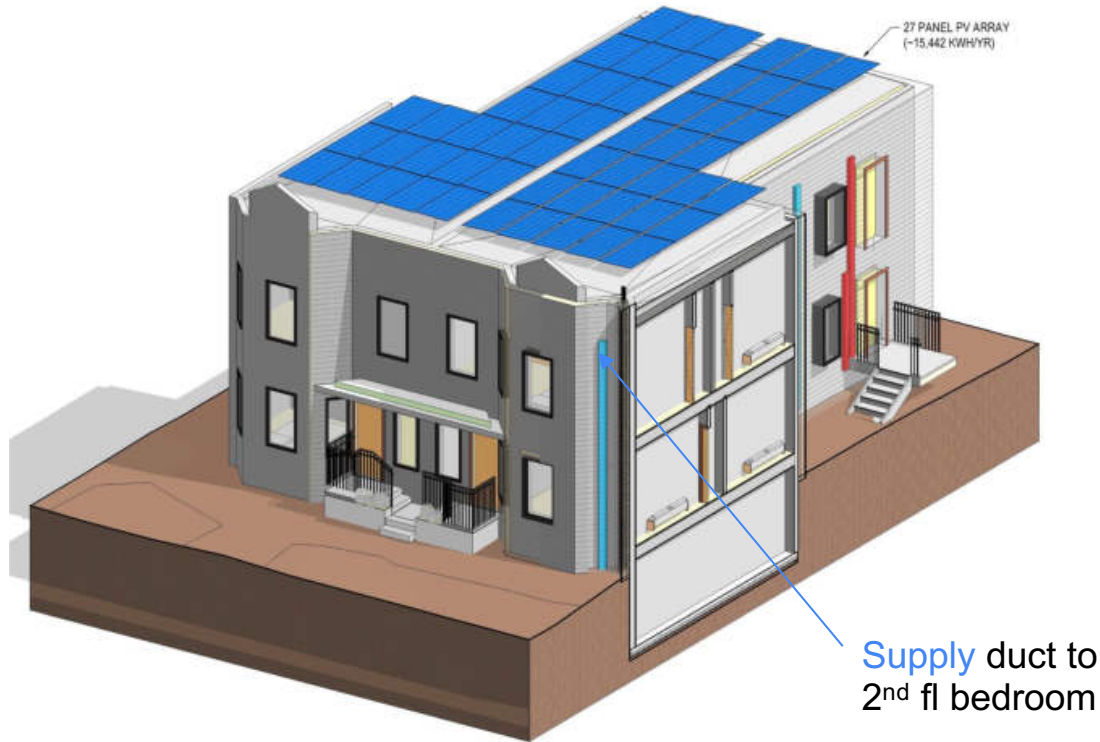
- Decentralized ventilation, heating, and cooling strategy
- Replace gas water heaters with Heat Pump Water Heaters (HPWH)
- Use Minotair Unit
- Use KOOL DUCT
- Service 1st floor unit through floor registers
- Service 2nd floor from outside between new and existing envelop



HVAC STRATEGY

- Decentralized ventilation, heating, and cooling strategy
- Replace gas water heaters with Heat Pump Water Heaters (HPWH)
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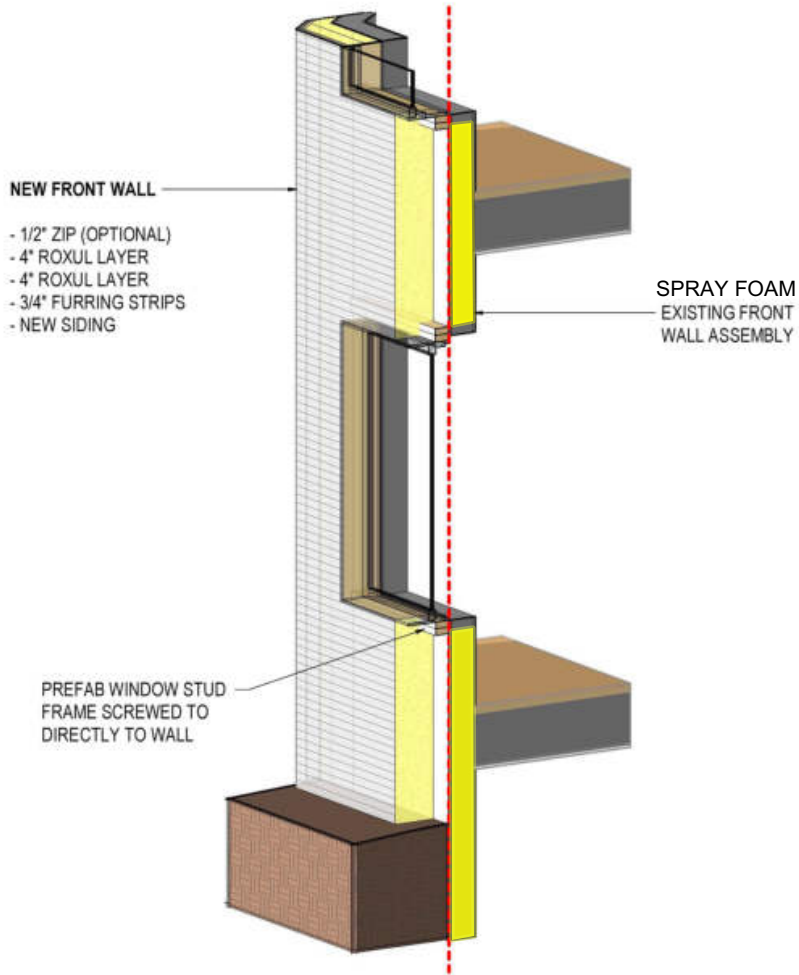
AXONOMETRIC



HVAC STRATEGY

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AXONOMETRIC



ENVELOP STRATEGY

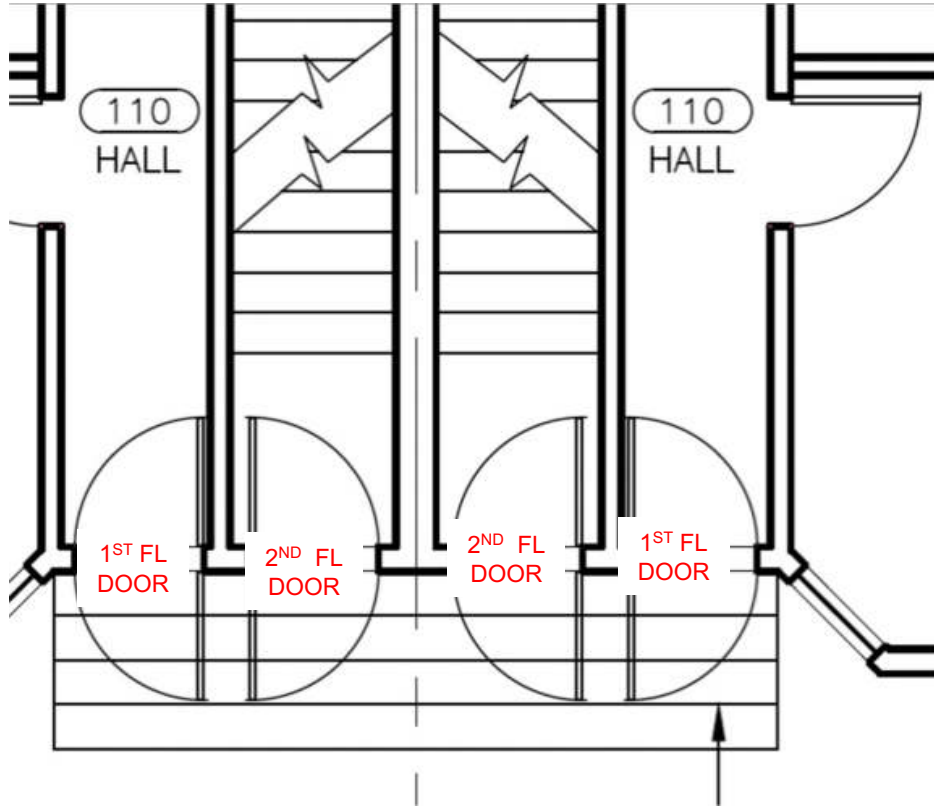
FRONT WALL

- Strip existing skin from building down to studs
- Spray foam EXISTING stud walls
- Install new 1/2" Zip layer as primary AIR BARRIER
- Install PRE-FRAMED window screwed directly to existing wall
- Install 1 layer of 4" RECYCLED polyiso insulation AND 2 - 4" layers of Roxul on bays
- Furring strips and new siding



HANO STREET VIEW

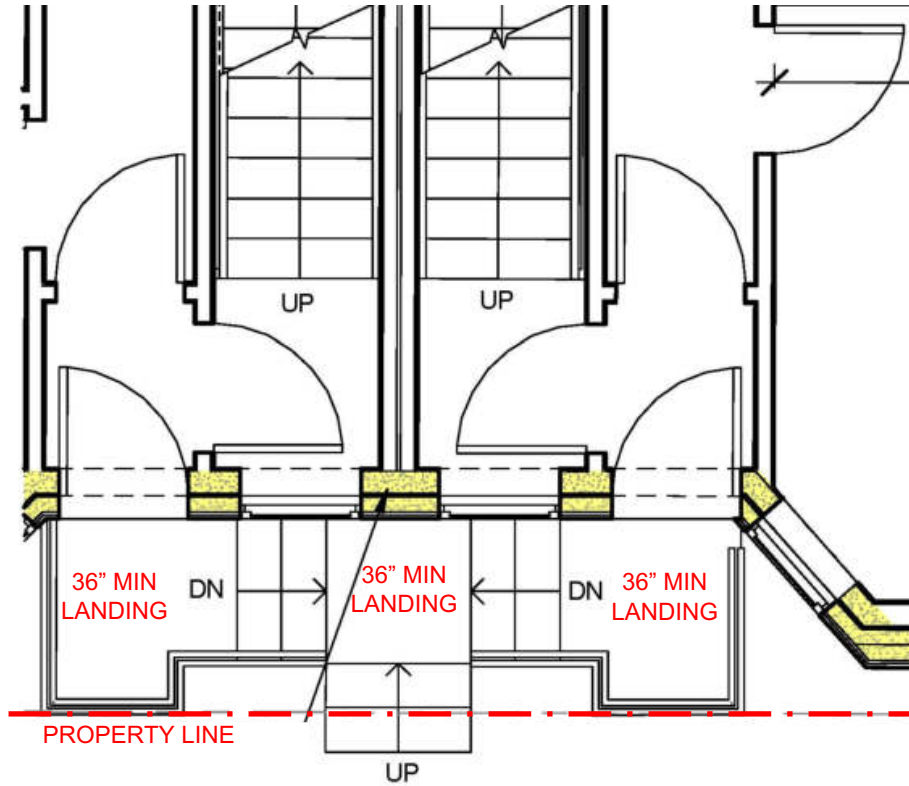
HOW TO MAKE ENTRANCE
CODE COMPLIANT?



ENTRANCE

HOW TO MAKE ENTRANCE CODE COMPLIANT?

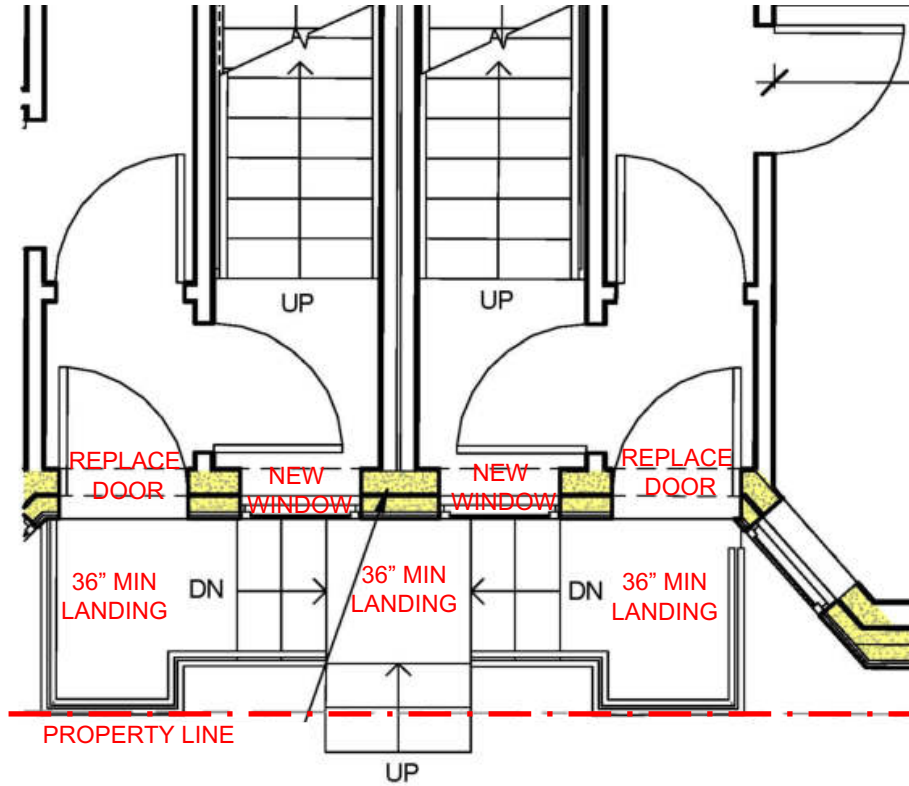
- No 36" landing for steps
- Steps extend into sidewalk
- 32" wide doors



ENTRANCE

HOW TO MAKE ENTRANCE CODE COMPLIANT?

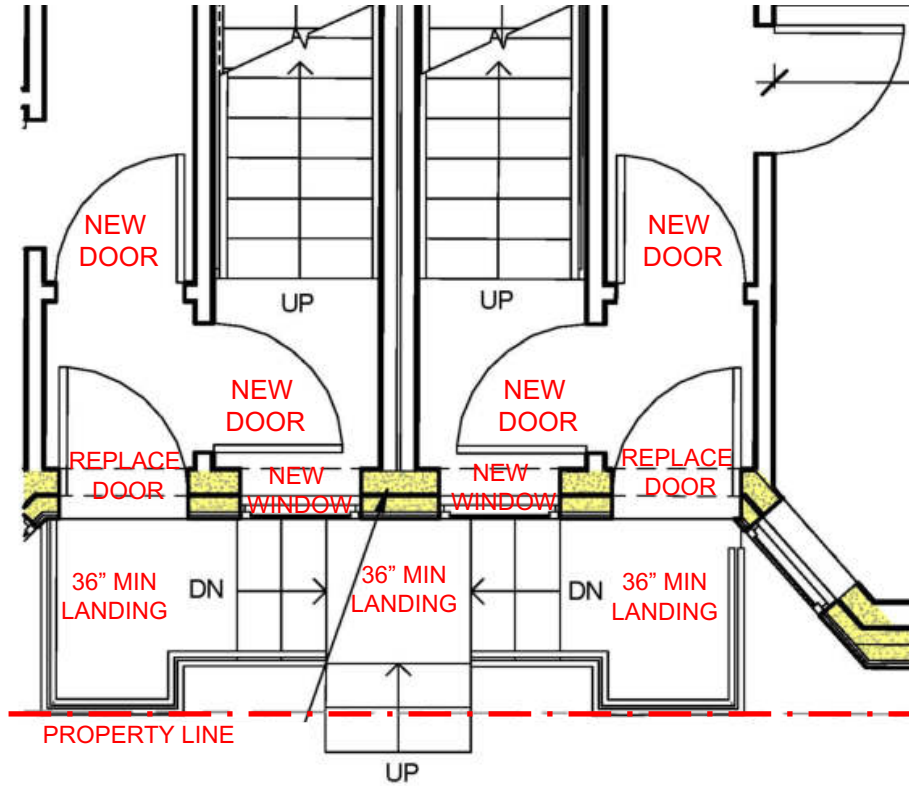
- Min 36" landings for steps



ENTRANCE

HOW TO MAKE ENTRANCE CODE COMPLIANT?

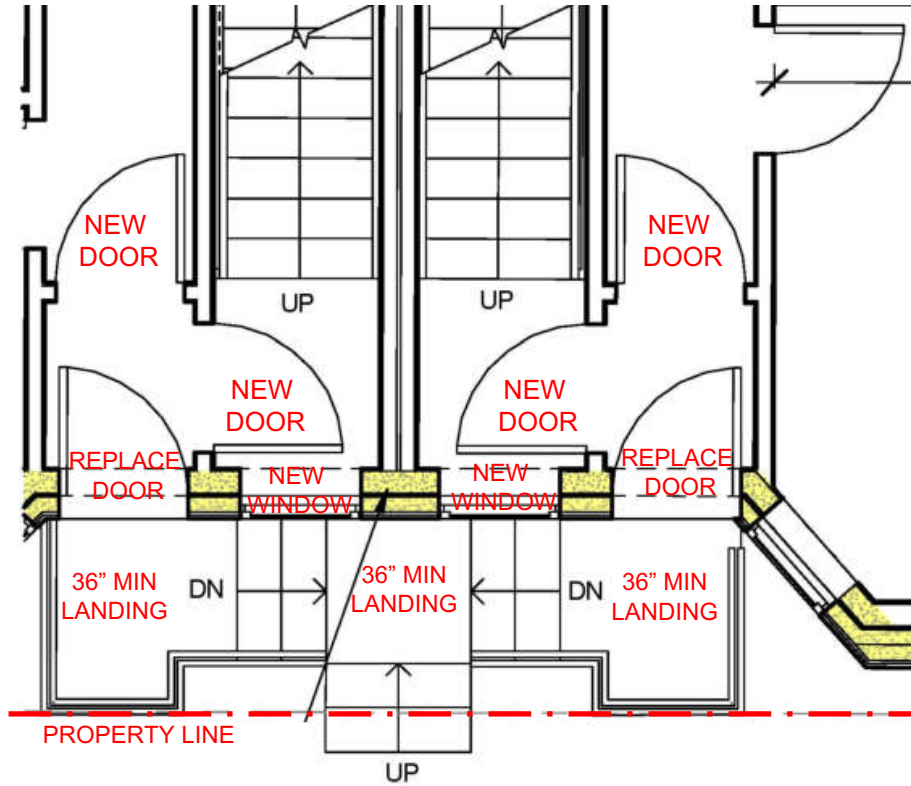
- Min 36" landings for steps
- Replace 1st floor unit doors
- Replace 2nd floor unit doors with windows



ENTRANCE

HOW TO MAKE ENTRANCE CODE COMPLIANT?

- Min 36" landings for steps
- Replace 1st floor unit doors
- Replace 2nd floor unit doors with windows
- Install new interior doors to both units

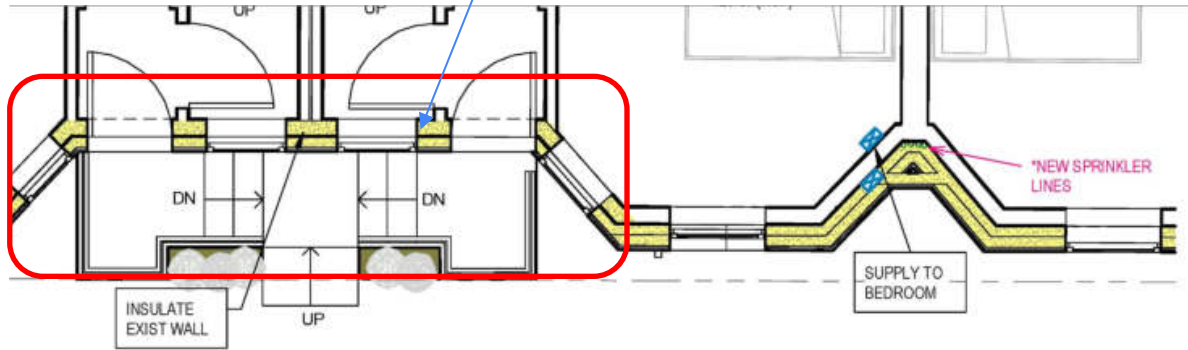


ENTRANCE

HOW TO MAKE ENTRANCE
CODE COMPLIANT?



Insulate existing wall here by filling existing wall cavity with SPRAY FOAM and 4" of used polyiso IN THIS ZONE

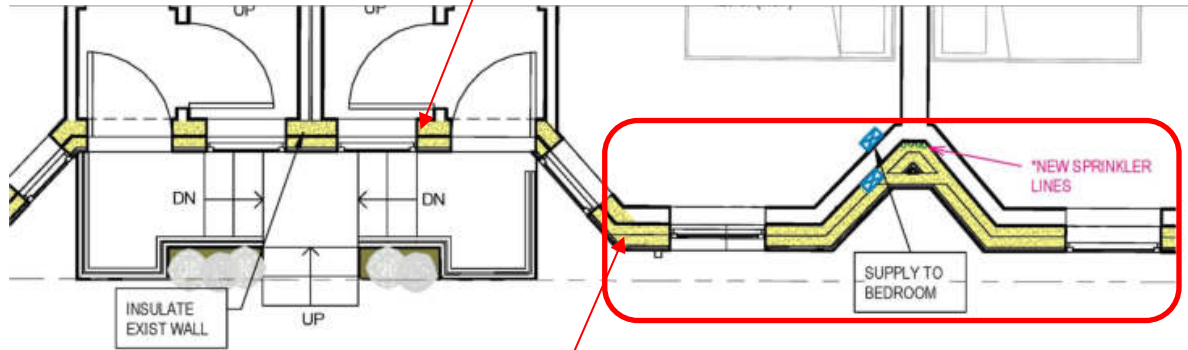


ENVELOP STRATEGY

FRONT WALL

- Strip existing skin from building down to studs
- Spray foam EXISTING stud walls
- Install new ½" Zip layer as primary AIR BARRIER
- Install PRE-FRAMED window screwed directly to existing wall
- Install 1 layer of 4" RECYCLED polyiso insulation AND 2 - 4" layers of Roxul on bays
- Furring strips and new siding

Insulate existing wall here by filling existing wall cavity with SPRAY FOAM and 4" of used polyiso IN THIS ZONE



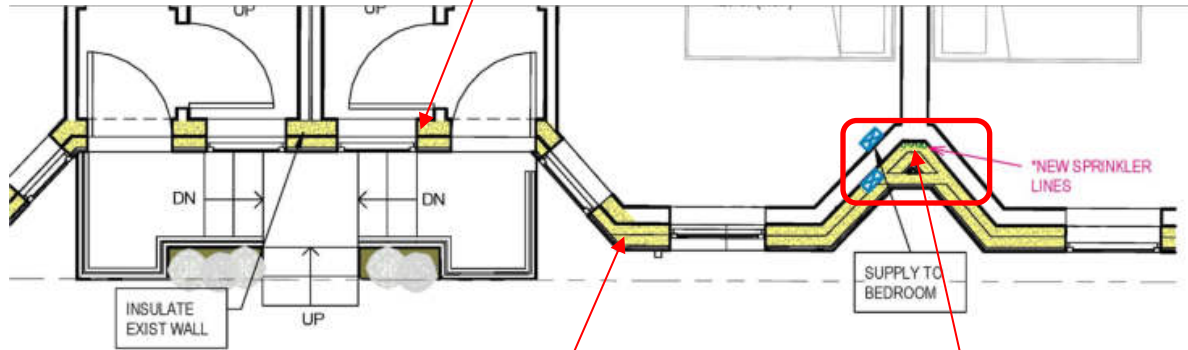
Insulate 2 layers of 4" Roxul IN THIS ZONE

ENVELOP STRATEGY

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Insulate existing wall here by filling existing wall cavity with SPRAY FOAM and 4" of used polyiso IN THIS ZONE



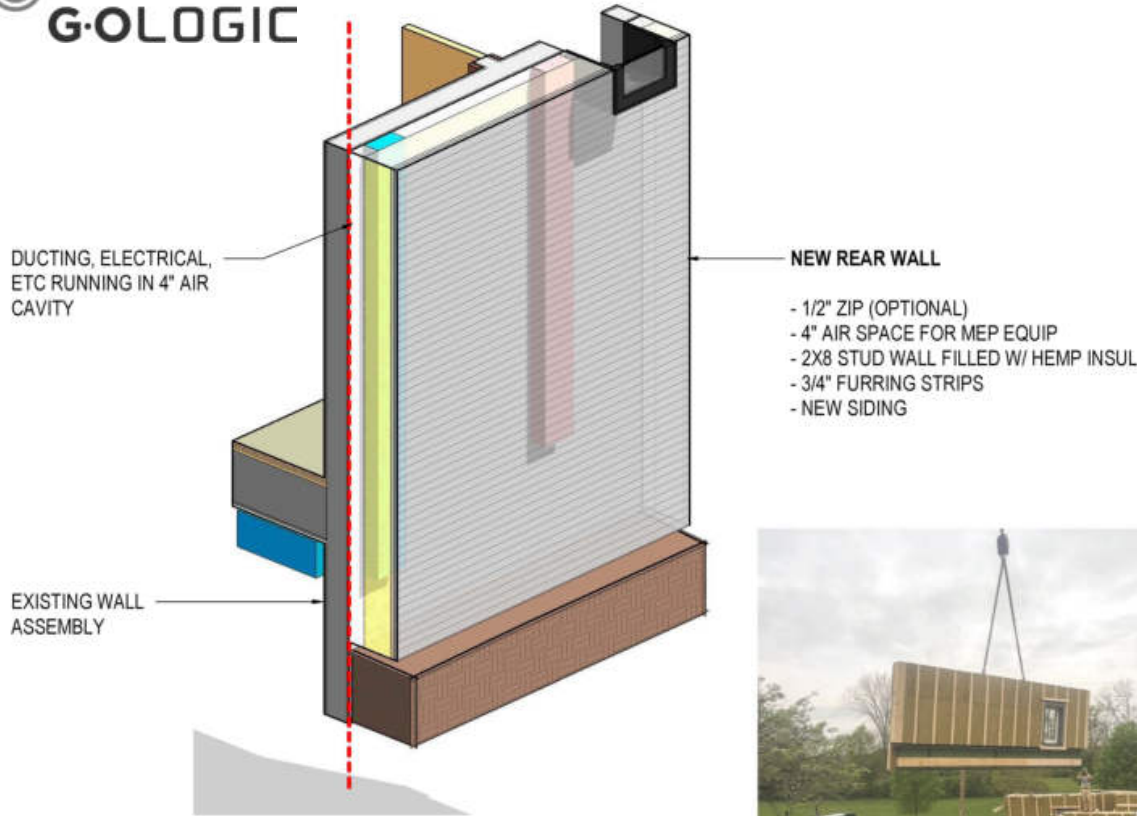
Insulate 2 layers of 4" Roxul IN THIS ZONE

New Sprinkler lines
If necessary

ENVELOP STRATEGY

FRONT WALL

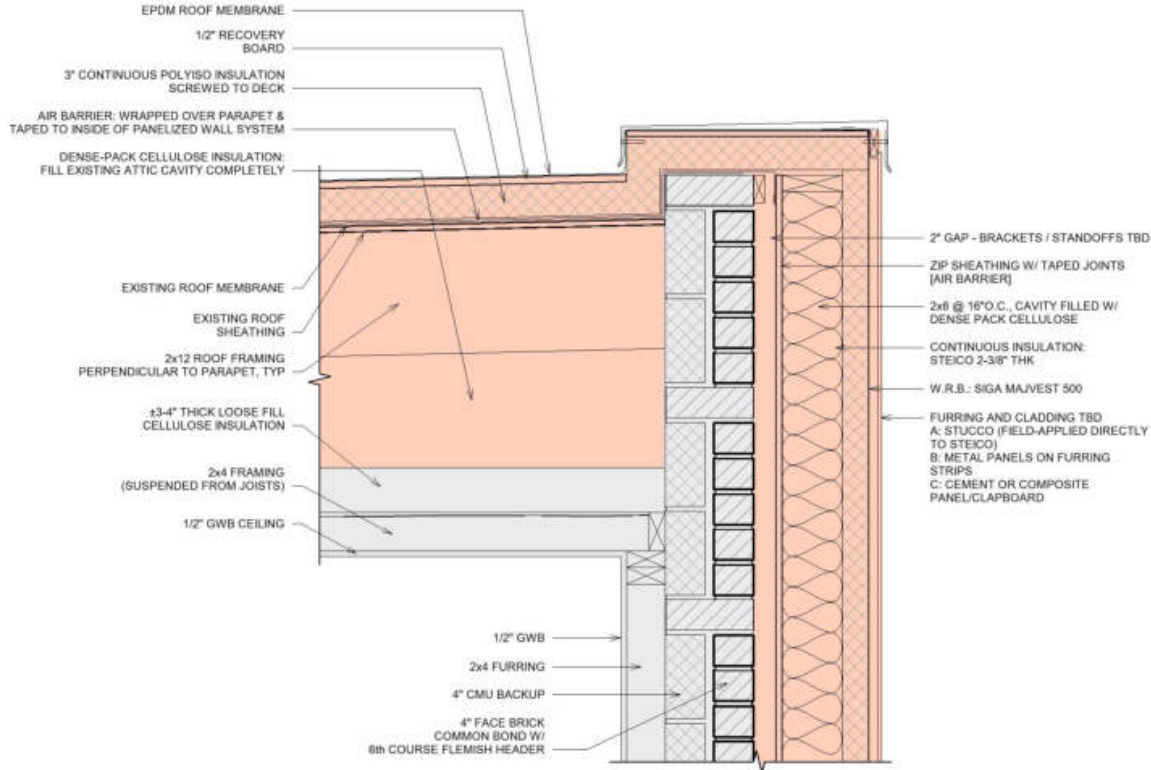
- Strip existing skin from building down to studs
- Spray foam EXISTING stud walls
- Install new ½" Zip layer as primary AIR BARRIER
- Install PRE-FRAMED window screwed directly to existing wall
- Install 1 layer of 4" RECYCLED polyiso insulation AND 2 - 4" layers of Roxul on bays
- Furring strips and new siding
- Run sprinkler lines between old and new envelopes



ENVELOP STRATEGY

ALL OTHER WALLS

- Strip existing skin from building down to studs
- Install new 1/2" Zip layer as primary AIR BARRIER
- Install 2X8 stud wall filled with Hemp Insulation, spaced 4" from existing wall
- Furring strips and new siding
- Run sprinkler lines AND ductwork in 4" air space between old and new envelops



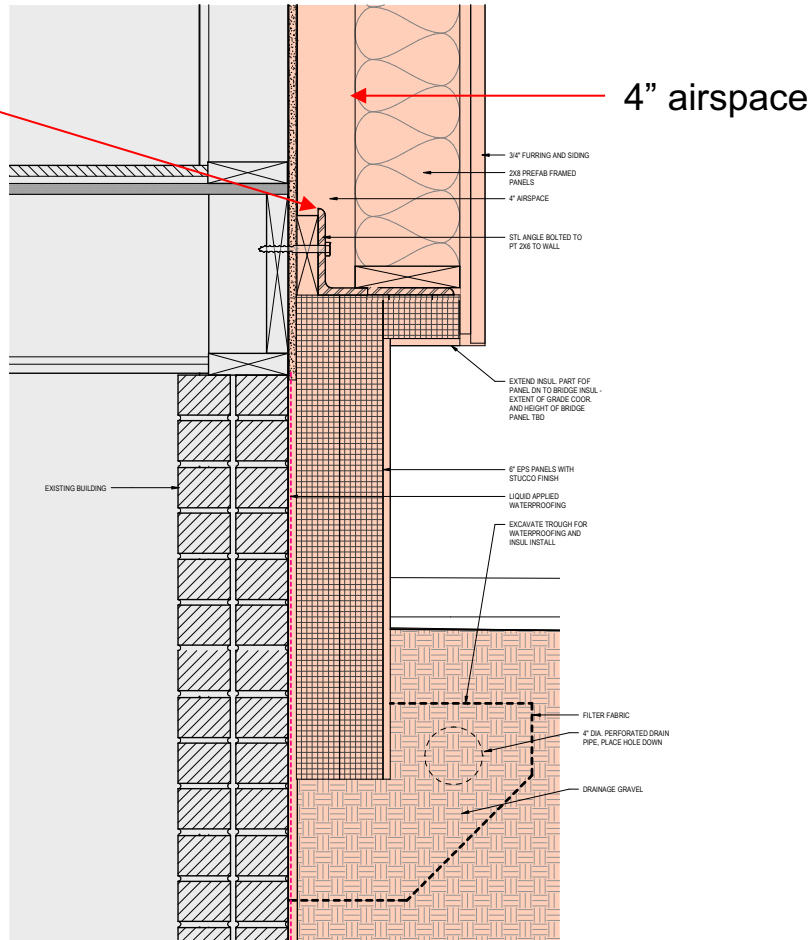
Wall Roof Detail

ENVELOP STRATEGY

ALL OTHER WALLS

- Strip existing skin from building down to studs
- Install new 1/2" Zip layer as primary AIR BARRIER
- Install 2X8 stud wall filled with Hemp Insulation, spaced 4" from existing wall
- Furring strips and new siding
- Run sprinkler lines AND ductwork in 4" air space between old and new envelops
- Wrap parapet and roof

Anchor shelf angle to existing basement leaving 4' space for Ductwork



Foundation Detail

ENVELOP STRATEGY

ALL OTHER WALLS

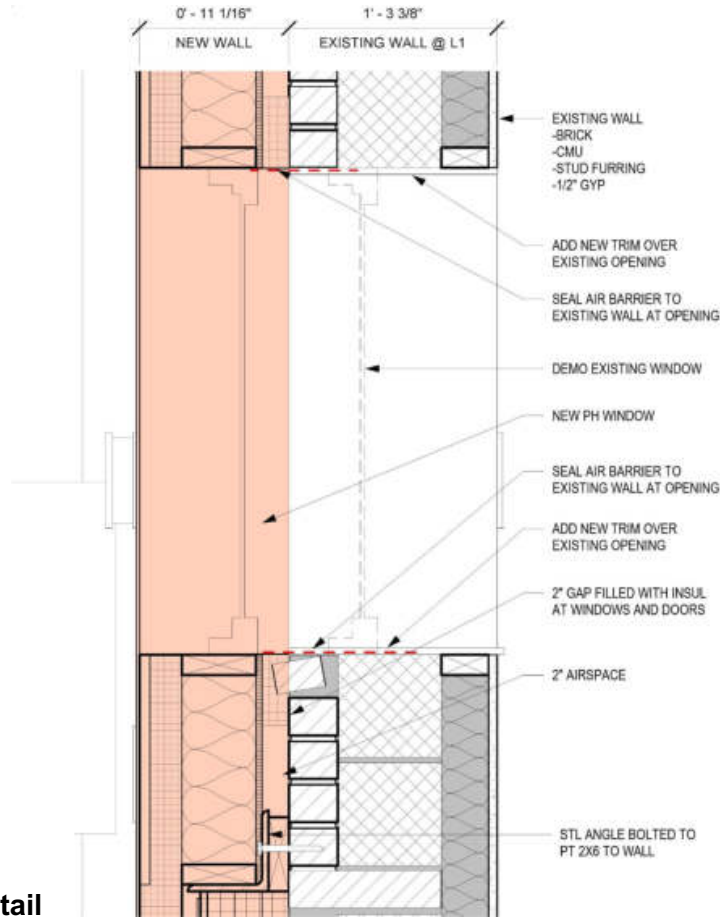
- Strip existing skin from building down to studs
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- Install 2X8 stud wall filled with Hemp Insulation, spaced 4" from existing wall
- Furring strips and new siding
- Run sprinkler lines AND ductwork in 4" air space between old and new envelops
- Wrap parapet and roof
- Stop insulation of basement at grade

ENVELOP STRATEGY

ALL OTHER WALLS

- Strip existing skin from building down to studs
- Install new ½" Zip layer as primary AIR BARRIER
- Install 2X8 stud wall filled with Hemp Insulation, spaced 4" from existing wall
- Furring strips and new siding
- Run sprinkler lines AND ductwork in 4" air space between old and new envelops
- Wrap parapet and roof
- Stop insulation of basement at grade
- Remove and seam exist wind

Window/Base Detail



BUILDING INFORMATION

Category: Residential
 Status: In planning
 Building type: Retrofit
 Year of construction: 1880
 Units: 2
 Number of occupants: 7 (Design)
 Occupant density: 220 ft²/Person

Boundary conditions

Climate: BOSTON LOGAN INT ARPT MA
 Internal heat gains: 1.4 Btu/hr ft²
 Interior temperature: 68 °F
 Overheat temperature: 77 °F

Building geometry

Enclosed volume: 27,014.3 ft³
 Net-volume: 11,440 ft³
 Total area envelope: 3,535.9 ft²
 Area/Volume Ratio: 0.1 1/ft
 Floor area: 1,540 ft²
 Envelope area/CFA: 2.296

PASSIVEHOUSE REQUIREMENTS

Certificate criteria: PHIUS+ 2018

Heating demand

specific: 3.9 kBtu/ft²yr
 target: 8.3 kBtu/ft²yr
 total: 6,011.69 kBtu/yr

Cooling demand

sensible: 2.99 kBtu/ft²yr
 latent: 0.21 kBtu/ft²yr
 specific: 3.2 kBtu/ft²yr
 target: 7 kBtu/ft²yr
 total: 4,921.09 kBtu/yr

Heating load

specific: 5.26 Btu/hr ft²
 target: 6.9 Btu/hr ft²
 total: 8,106.39 Btu/hr

Cooling load

specific: 4.06 Btu/hr ft²
 target: 4.3 Btu/hr ft²
 total: 6,256.84 Btu/hr

Source energy

total: 0 kWh/yr
 specific: 0 kWh/Person yr
 target: 3,840 kWh/Person yr
 total: 0 kBtu/yr
 specific: 0 kBtu/ft²yr

Site energy

total: -2,866.57 kBtu/yr
 specific: -1.86 kBtu/ft²yr
 total: -840.19 kWh/yr
 specific: -0.55 kWh/ft²

Air tightness

ACH50: 1.49 1/hr
 CFM50 per envelope area: 0.05 cfm/ft²
 target: 1.79 1/hr
 target CFM50: 0.06 cfm/ft²

PASSIVEHOUSE RECOMMENDATIONS

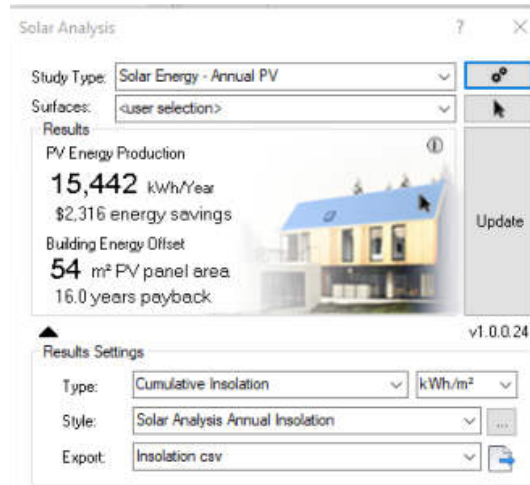
Sensible recovery efficiency: 98 %
 Frequency of overheating: 25.2 %
Cooling system is required
 Frequency of overheating only applies if there is not a [properly sized] cooling system installed.



SOLAR

PER DUPLEX:

- (27) 300W solar panels on 10 deg east west roof racks for maximum efficiency
- Total Array Size – 8.1kw per duplex
- @ \$2/watt = \$16,200 per duplex or \$8100 per unit or **\$162,000.00**



HISTORIC AND PROJECTED ENERGY CONSUMPTION

- Historical data below from the Capital Needs Worksheet shows an average EUI of 75.2 kBTU/sf/yr.

EUI of 75.2

Table 5. Normalized Historical Utility Consumption

Utility	Consumption	Cost (\$)	% Total Cost	Your Building	Index	Unit
Water	1,268,030 Gal.	\$21,907	33.5%	67.8	61.1	Gal./bedroom/day
Electricity	104,423 kWh	\$24,257	37.1%	13.2	10.2	kBtu/ft ²
Gas	13,656 therms	\$19,307	29.5%	62.0	49.3	kBtu/ft ²
TOTAL	1,722 MMBtu	\$65,471	100.0%	75.2	59.5	kBtu/ft²

Existing EUI of 75 kBTU/sf/yr

\$43,566.00 Annual Cost of Utilities

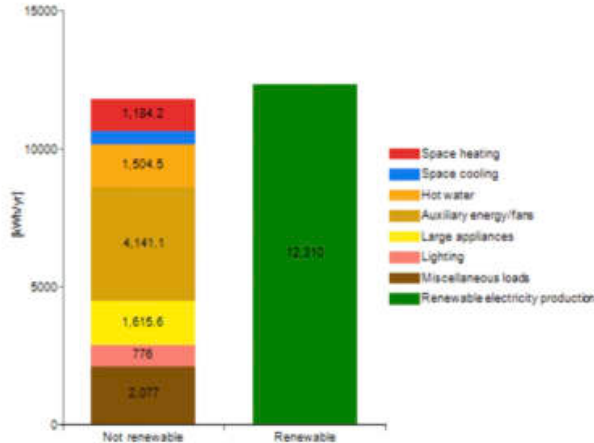
New EUI after DER: 23 kBTU/sf/yr

The chart below summarizes the results of the WUFI Passive model and projected energy consumption, as well as energy generation based on a 11.2 kW PV array **per building** (28,400 watt LG panels). Without the solar, the EUI is projected to be **23 kBTU/sf/yr** (70% better than historical data). With the projected energy generation from the solar, the projected EUI is **0 kBTU/sf/yr**, or Net Zero Energy:

23 kBTU/sf/yr

0 kBTU/sf/yr

NET ZERO ENERGY
\$43,566.00 SAVINGS PER YEAR



WUFI Passive EUI Calculator

Project: Hano Homes

1/10 Units

Gross sf	
L1	890.00
L2	890.00
Total Gross Sf	1,780.00

Total ICFA 1431.00

Total Site Energy Use kBtu/yr 41,213.89

kWh/yr 12079.10

kWh/yr to kBtu/yr 41213.89

Specific Source Energy Use kBtu/sf/yr 19.80

EUI kBtu/sf/yr: 23.15

EUI is expressed as energy per square foot per year.

It is calculated by dividing the total energy consumed by the building in one year by the total gross floor area of the building.

Project Name: 1-39 Hana Homes
 Project #
 Title: Feasibility Study Construction Pricing
 Date: 02/10/2022

A	B	C	D	E	F	G	H	I
ITEM	DESCRIPTION OF WORK	Direct Cost	Markup	Material Cost	Material Markup	Sub Contractor	Sub Con. Markup	Total
Division 1: General Requirements			10.00%		13.60%		15%	
01 29 76.00	Project Invoicing	\$5,000	\$500	\$0	\$0	\$0	\$0	\$5,500
01 31 13.00	Project Management	\$20,000	\$2,000	\$0	\$0	\$0	\$0	\$22,000
01 31 19.00	Project Meetings	\$5,000	\$500	\$0	\$0	\$0	\$0	\$5,500
01 32 13.00	Project Scheduling	\$10,000	\$1,000	\$0	\$0	\$0	\$0	\$11,000
01 51 13.02	Temp Electricity	\$1,000	\$100	\$0	\$0	\$0	\$0	\$1,100
01 51 36.02	Temp Water Service	\$750	\$75	\$0	\$0	\$0	\$0	\$825
01 51 40.02	Tool Equipment Rental	\$75,000	\$7,500	\$0	\$0	\$0	\$0	\$82,500
01 52 19.02	Sanitary Facilities	\$2,000	\$200	\$0	\$0	\$0	\$0	\$2,200
01 55 26.02	Traffic Control	\$2,000	\$200	\$0	\$0	\$0	\$0	\$2,200
01 56 26.02	Temporary Fencing	\$1,000	\$100	\$0	\$0	\$0	\$0	\$1,100
01 57 16.02	Temporary Pest Control	\$1,200	\$120	\$0	\$0	\$0	\$0	\$1,320
01 73 00.00	Site Supervision	\$30,000	\$3,000	\$0	\$0	\$0	\$0	\$33,000
01 74 16.00	Site Maintenance	\$10,000	\$1,000	\$0	\$0	\$0	\$0	\$11,000
01 74 19.02	Waste Disposal	\$5,500	\$550	\$0	\$0	\$0	\$0	\$6,050
01 74 23.02	Final Clean	\$2,000	\$200	\$0	\$0	\$0	\$0	\$2,200
01 78 13.00	Punch List	\$15,000	\$1,500	\$0	\$0	\$0	\$0	\$16,500
Division 2 Sitework								
02 22 00.02	Demolition (Included in 03 31 00.02)	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Division 3 Concrete								
03 31 00.02	Structural Concrete Foundations Sub	\$0	\$0	\$0	\$0	\$15,000	\$2,250	\$17,250
Division 4 Wood & Plastics								
06 11 00.00	Wood Framing Demolition	\$0	\$0	\$0	\$0	\$64,500	\$9,675	\$74,175
06 11 00.01	Wood Framing MH	\$3,000	\$300	\$20,000	\$2,720	\$0	\$0	\$24,920
06 11 00.02	Wood Framing Sub	\$0	\$0	\$0	\$0	\$50,000	\$7,500	\$57,500
06 20 43.01	Interior Trim & Base MH	\$500	\$50	\$3,000	\$408	\$0	\$0	\$3,958
06 20 43.02	Interior Trim & Base Sub	\$0	\$0	\$0	\$0	\$17,975	\$2,696	\$20,671
06 43 16.01	Deck & Rolling MH	\$1,000	\$100	\$10,000	\$1,360	\$0	\$0	\$12,460
06 43 16.02	Deck & Rolling Sub	\$0	\$0	\$0	\$0	\$70,000	\$10,500	\$80,500
Division 7 Thermal & Moisture Protection								
07 14 00.02	Fluid-Applied Waterproofing Sub	\$1,200	\$100	\$0	\$0	\$12,000	\$1,800	\$14,900
07 21 13.01	Insulation MH	\$0	\$0	\$48,970	\$4,660	\$0	\$0	\$53,630
07 21 13.03	Insulation Sub	\$2,000	\$200	\$0	\$0	\$35,216	\$5,282	\$42,698
07 27 00.01	Air Barrier MH	\$3,000	\$300	\$25,000	\$3,400	\$0	\$0	\$30,400
07 27 00.02	Air Barrier Sub	\$1,000	\$100	\$0	\$0	\$62,000	\$9,300	\$72,400
07 42 43.01	Fabricated Wall Panel Assemblies MH	\$0	\$0	\$585,617	\$78,944	\$0	\$0	\$664,561
07 42 43.02	FWP Assemblies Sub	\$10,000	\$1,000	\$0	\$0	\$21,029	\$3,129	\$24,258
07 44 00.00	Siding Demolition	\$0	\$0	\$0	\$0	\$43,500	\$6,525	\$50,025
07 46 00.01	Siding MH	\$4,000	\$400	\$55,000	\$7,480	\$0	\$0	\$66,880
07 46 00.02	Siding Sub	\$4,000	\$400	\$0	\$0	\$107,600	\$16,140	\$128,140
07 50 00.00	Membrane Roofing Demolition (Included in 07 50 00.01)	\$0	\$0	\$0	\$0	\$0	\$0	\$0

A	B	C	D	E	F	G	H	I
ITEM	DESCRIPTION OF WORK	Direct Cost	Markup	Material Cost	Material Markup	Sub Contractor	Sub Con. Markup	Total
07 50 00.00	Membrane Roofing Sub	\$4,000	\$400	\$0	\$0	\$185,000	\$27,750	\$217,400
07 55 00.02	Green Roof Systems Sub	\$0	\$0	\$0	\$0	\$37,000	\$5,550	\$43,125
07 71 00.02	Roofing Specialties/Gutter Sub (Included in 07 50 00.01)	\$0	\$0	\$0	\$0	\$0	\$0	\$0
\$20								
Division 8 Doors, Window & Interiors								
08 14 10.01	Exterior Doors MH (Included in 08 50 00.01)	\$0	\$0	\$0	\$0	\$0	\$0	\$0
08 14 10.02	Exterior Doors Sub	\$0	\$0	\$0	\$0	\$63,000	\$9,450	\$72,450
08 50 00.01	Windows MH	\$0	\$0	\$0	\$0	\$200,036	\$27,305	\$227,240
08 50 00.02	Window Sub (Included in 07 42 43.01)	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Division 9 Finishes								
09 21 00.00	Finishes Sub	\$2,000	\$200	\$0	\$0	\$85,450	\$12,768	\$97,248
09 91 13.01	Exterior Painting MH	\$2,000	\$200	\$2,000	\$340	\$0	\$0	\$3,390
09 91 13.02	Exterior Painting Sub	\$2,000	\$200	\$0	\$0	\$47,500	\$7,125	\$56,825
09 91 23.01	Interior Paint MH	\$0	\$0	\$400	\$54	\$0	\$0	\$454
09 91 23.02	Interior Paint Sub (Included in 09 21 00.02)	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Division 11 Equipment								
11 30 13.01	Kitchen Appliances MH	\$1,000	\$100	\$17,000	\$2,312	\$0	\$0	\$20,412
11 30 13.02	Kitchen Appliances Sub	\$0	\$0	\$0	\$0	\$4,636	\$695	\$5,331
Division 12 Furnishings								
Division 21 Fire Suppression								
21 00 00.02	Fire Suppression Sub	\$6,000	\$600	\$0	\$0	\$132,247	\$19,837	\$158,684
Division 22 Plumbing								
22 00 00.00	Plumbing Demolition	\$0	\$0	\$0	\$0	\$0	\$0	\$0
22 00 00.02	Plumbing Sub	\$1,000	\$100	\$0	\$0	\$0	\$0	\$1,100
22 33 00.01	Plumbing Water Heaters MH	\$1,000	\$100	\$57,570	\$7,830	\$0	\$0	\$66,500
Division 23 HVAC								
23 29 00.01	HVAC FDU MH	\$6,000	\$600	\$128,200	\$17,450	\$0	\$0	\$152,250
23 29 00.02	HVAC FDU Sub	\$0	\$0	\$0	\$0	\$124,000	\$18,600	\$142,600
Division 26 Electrical								
26 00 00.00	Electrical Demolition (Included in 26 00 00.02)	\$0	\$0	\$0	\$0	\$0	\$0	\$0
26 00 00.02	Electrical Sub	\$0,000	\$200	\$0	\$0	\$119,000	\$17,260	\$136,460
26 50 00.01	Lighting Fixtures MH	\$0,000	\$100	\$5,000	\$748	\$0	\$0	\$7,248
26 51 00.01	Photovoltaic Sub	\$1,000	\$100	\$0	\$0	\$226,617	\$35,543	\$272,559
Division 28 Electronic Safety and Security								
28 00 00.00	Electronic Security Sub	\$0	\$0	\$0	\$0	\$89,470	\$13,461	\$103,121
Division 31 Earthwork								

A	B	C	D	E	F	G	H	I
ITEM	DESCRIPTION OF WORK	Direct Cost	Markup	Material Cost	Material Markup	Sub Contractor	Sub Con. Markup	Total
Add Alternate - Field Installed Insulation in lieu of panels								
06 11 00.01	Wood Framing MH (1x3 wood cladding) - Add	\$0	\$0	\$12,200	\$1,430	\$0	\$0	\$13,630
07 21 13.01	Insulation MH - Add	\$0	\$0	\$14,739	\$1,668	\$0	\$0	\$16,407
07 21 13.03	Insulation Sub - Add	\$2,000	\$200	\$0	\$0	\$43,760	\$6,562	\$46,562
07 21 13.03	Insulation Sub - Deduct	(\$2,000)	(\$200)	\$0	\$0	(\$31,216)	(\$4,682)	(\$38,100)
07 27 00.01	Air Barrier MH - Deduct	(\$2,000)	(\$200)	(\$25,000)	(\$3,400)	\$0	\$0	(\$30,600)
07 42 43.01	Fabricated Wall Panel Assemblies MH - Deduct	\$0	\$0	(\$585,617)	(\$78,944)	\$0	\$0	(\$664,561)
07 42 43.02	FWP Assemblies Sub - Deduct	(\$10,000)	(\$1,000)	\$0	\$0	(\$21,029)	(\$3,129)	(\$34,258)
08 50 00.02	Window Sub - Add	\$0	\$0	\$0	\$0	(\$9,205)	(\$1,380)	(\$10,585)
Add Total: 148175								
Adjusted Total: \$3,040,392.00								
Cost by MH: \$ 152,014.08								
SQFT cost by GSF: \$ 121.42								
SQFT cost by GSF of Envelope: \$ 145.91								

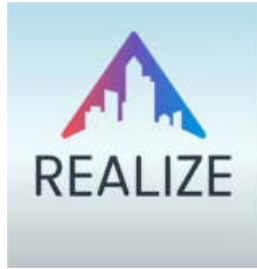


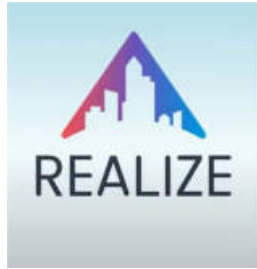
PANELIZED
\$149.00/SF
TOTAL: \$3,726,000.00

\$186,000.00 per Apartment

SITE BUILT
\$121.00/SF
TOTAL: \$3,040,392.00

\$152,019.00 per Apartment

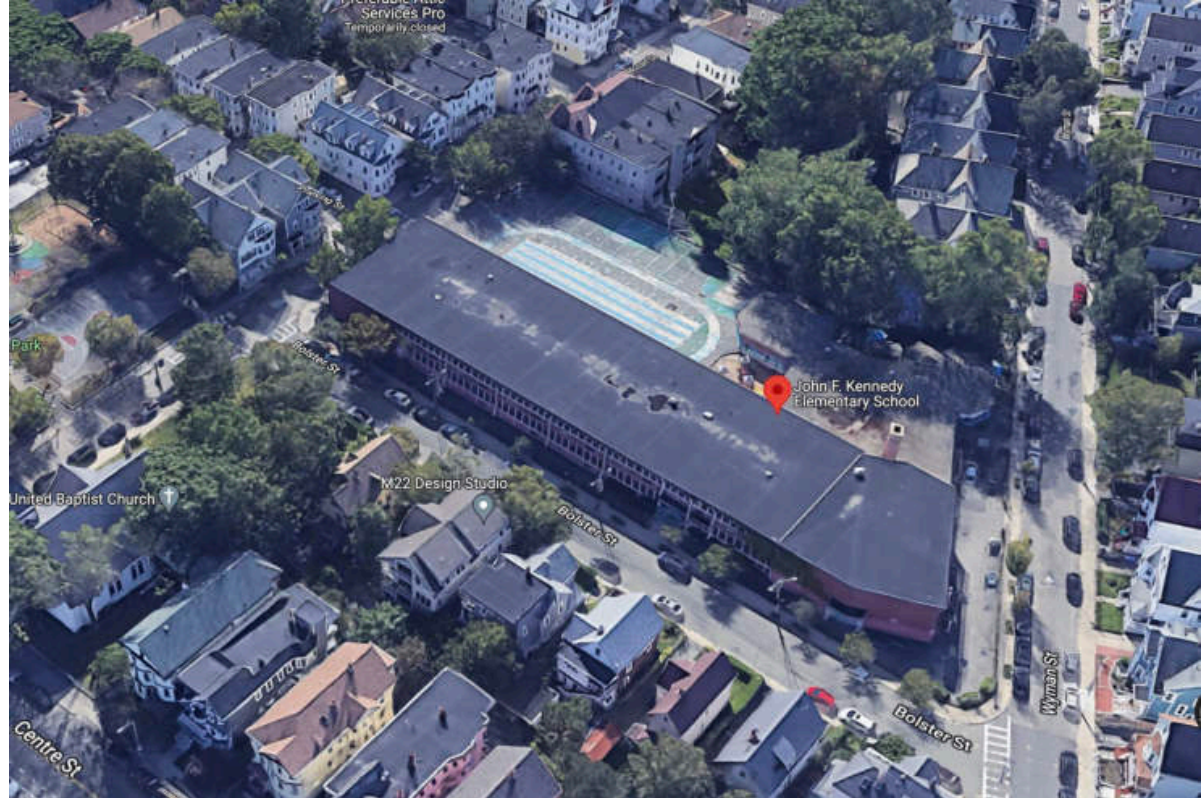






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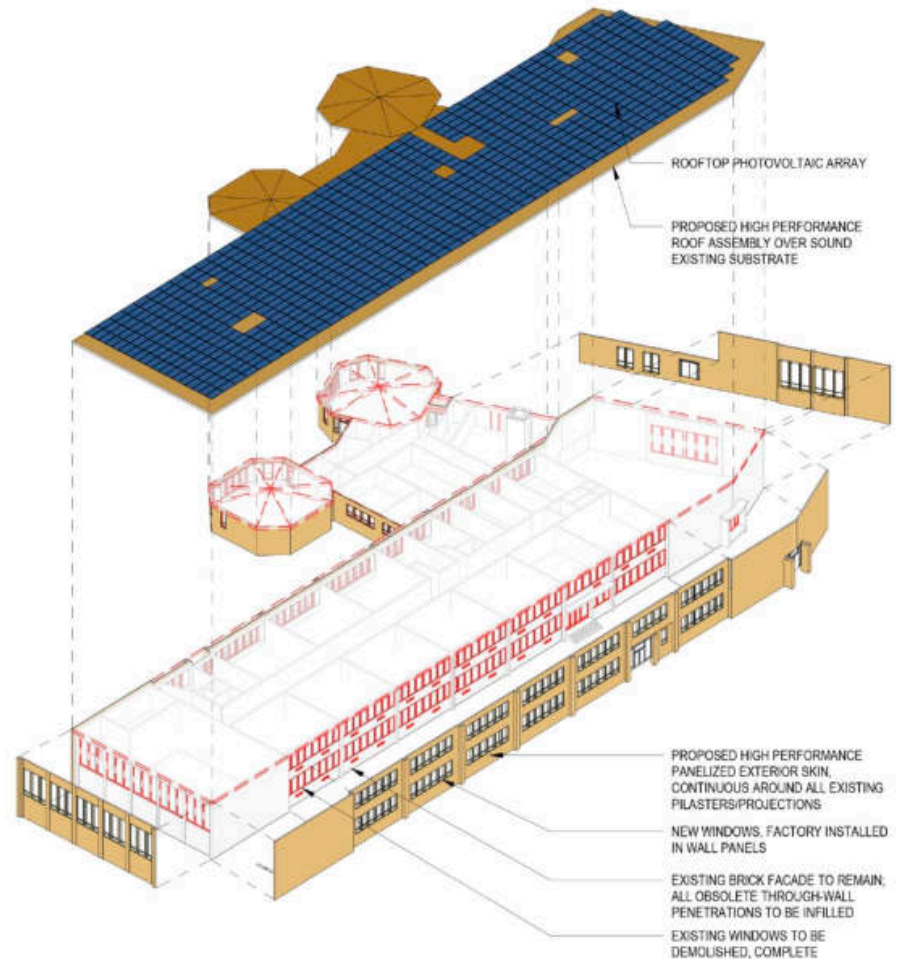
- High level DER Feasibility study
- School District was planning on limited Retrofit with a robust geothermal system for heating/cooling
- We proposed a DER to radically reduce energy consumption, with panelized system, all-electric building, new HVAC and Domestic hot water
- No WUFI model but used average **25 kBTU/sf/yr** as target EUI (*65% utility savings from baseline*)
- Existing utility data says the baseline EUI is **71 kBTU/sf/yr**
- Explored 3 HVAC strategies, looking for most appropriate and cost-effective.
- High level pricing exercise to determine if this is the more cost-effective approach to this retrofit





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- 2 story structure
- Prefabricated exterior wall panels cladding the entirety of the above-grade building enclosure.
- Given the limited extents of this study and the limited existing documentation available, the Project Team has assumed a panel thickness of 6" with an Rvalue of 35 as a placeholder.
- Given the limited extents of this study and the limited existing documentation available, the Project Team has assumed a roof assembly thickness of 12" (Rvalue of 72) as a placeholder.



(Exploded axonometric diagram depicting proposed high performance panelized skin)



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VENTILATION STRATEGY #1: UNITARY ERVS

PROS

- Reduced cross-contamination between spaces
- Minimized ductwork, coring, smoke dampers, etc.
- Occupancy based ventilation rates for each space are much easier to implement
- Preserves roof area for solar array
- May be most energy efficient option (depending on equipment selection)

CONS

- Added maintenance costs due to individual unit filters
- Large number of individual ERVs may be more expensive than a central ERV
- Need to run electrical to each unit
- Added penetrations to building exterior

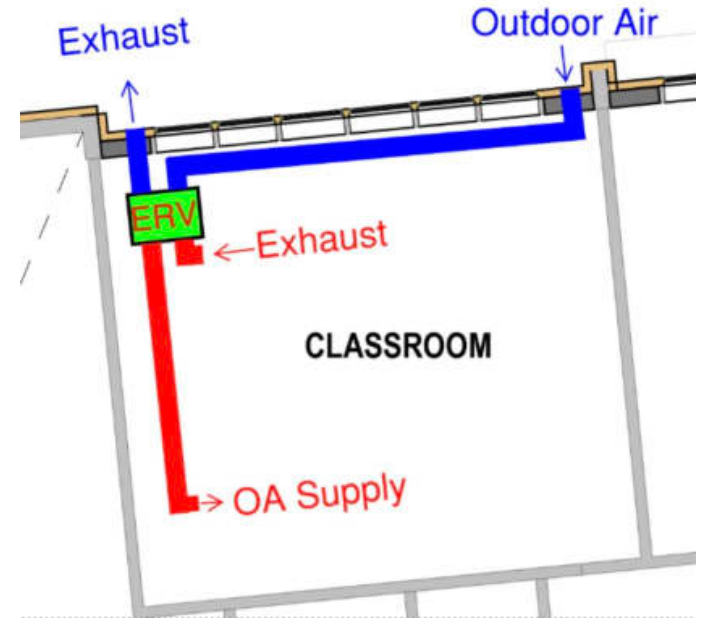


Figure 1 – Example Unitary ERV Layout



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VENTILATION STRATEGY #2: CENTRALIZED ERVS

PROS

- Fewer ERV's may have less upfront and maintenance costs, depending on ductwork, dampers and coring costs.
- Maintenance has fewer units to maintain (such as changing filters)
- Can incorporate post-ERV conditioning of air to control moisture load and comfort.

CONS

- Reduces roof space availability for solar array
- More ductwork
- Limited ability to turn down ventilation rates in specific spaces when not occupied

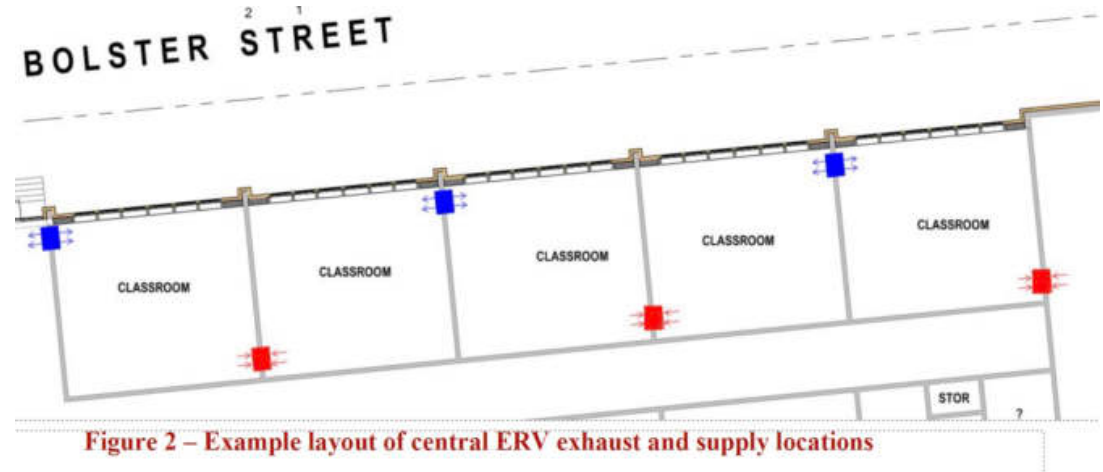


Figure 2 – Example layout of central ERV exhaust and supply locations



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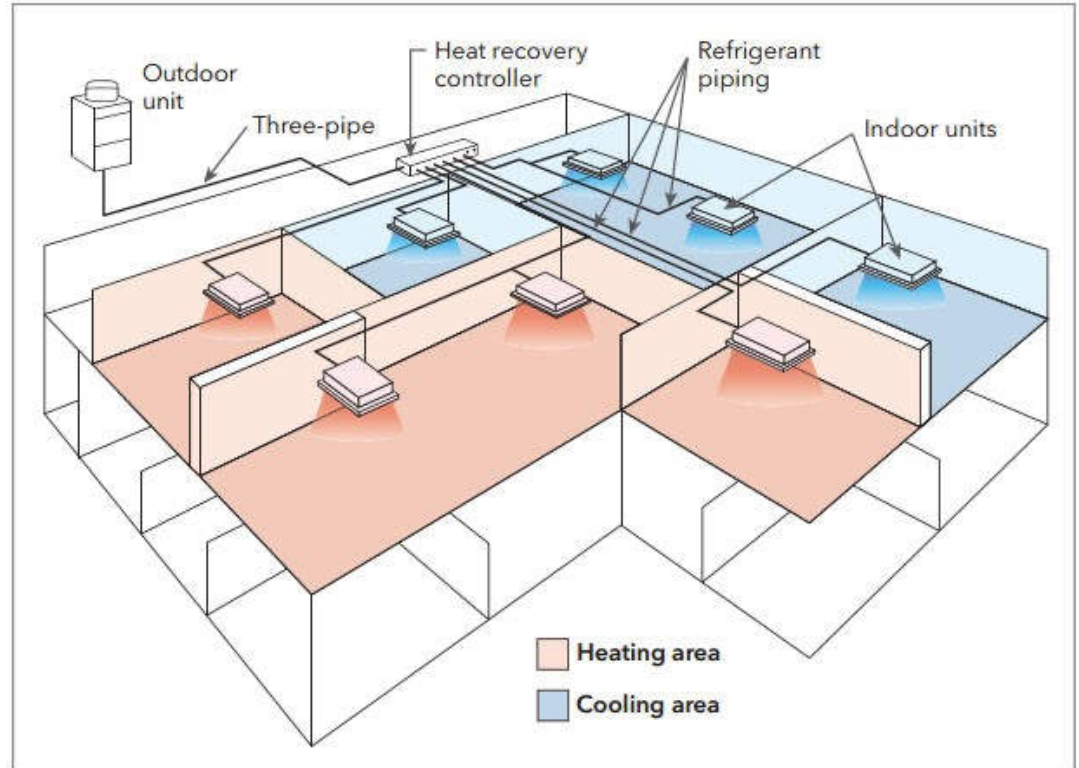
HEATING/COOLING STRATEGY #1: VRF (RECOMMENDED)

PROS

- Minimal footprint of outdoor equipment
- Efficient system minimizes operating costs
- Simultaneous heating and cooling with energy recovery
- Refrigerant lines, branch controllers and terminal units are relatively low impact additions to the interior

CONS

- Upfront costs may be high
- Depending on installation contractor, a poor install quality can result in refrigerant leaks and inefficient operation



Variable refrigerant flow systems can deliver cooling to some zones and heating to others, with no reheat needed (an air-source system is shown here).



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HEATING/COOLING STRATEGY #2: CENTRAL HEX SYSTEM

PROS

- Utilizes standard hydronic distribution
- Reduces refrigerant and potential leakage points
- Simultaneous heating and cooling with energy recovery
- Minimal footprint of outdoor equipment
- Efficient system minimizes operating costs
- Conducive to future refrigerants or heat pump technology upgrades

CONS

- Slightly less efficient than standard VRF
- WSHPs are single speed and may be noisy when kicking on

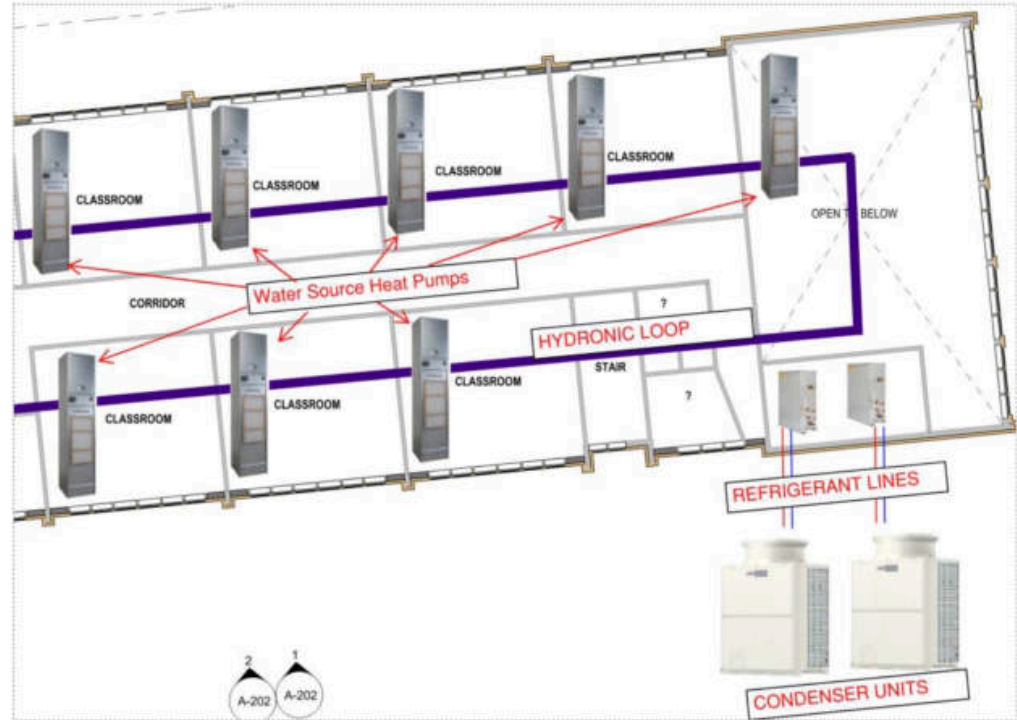


Figure 3 – Example HEX System Layout



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HVAC/DHW SYSTEMS: BUILDING EVOLUTION CORPORATION
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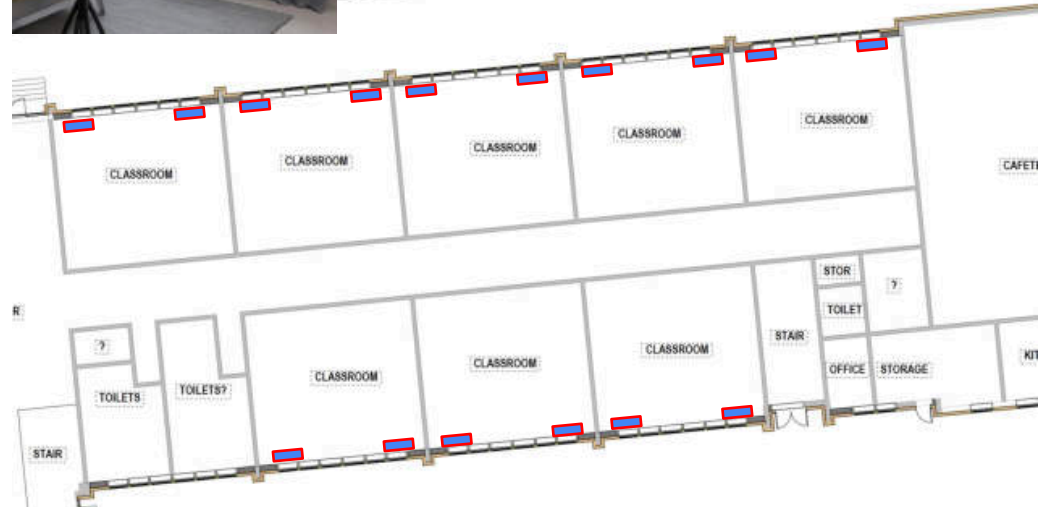
HEATING/COOLING STRATEGY #3: EPHOCA

PROS

- Relatively efficient units
- Low upfront costs due to inexpensive units and limited distribution required
- Preserves roof space for solar panels
- Install is minimally invasive and can utilize existing wall penetrations

CONS

- Limited heating capacity at cold temperatures
- Would need multiple units per space to meet load.
- Not suitable for large spaces with moderate to high heating/cooling load.





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HVAC/DHW SYSTEMS: BUILDING EVOLUTION CORPORATION
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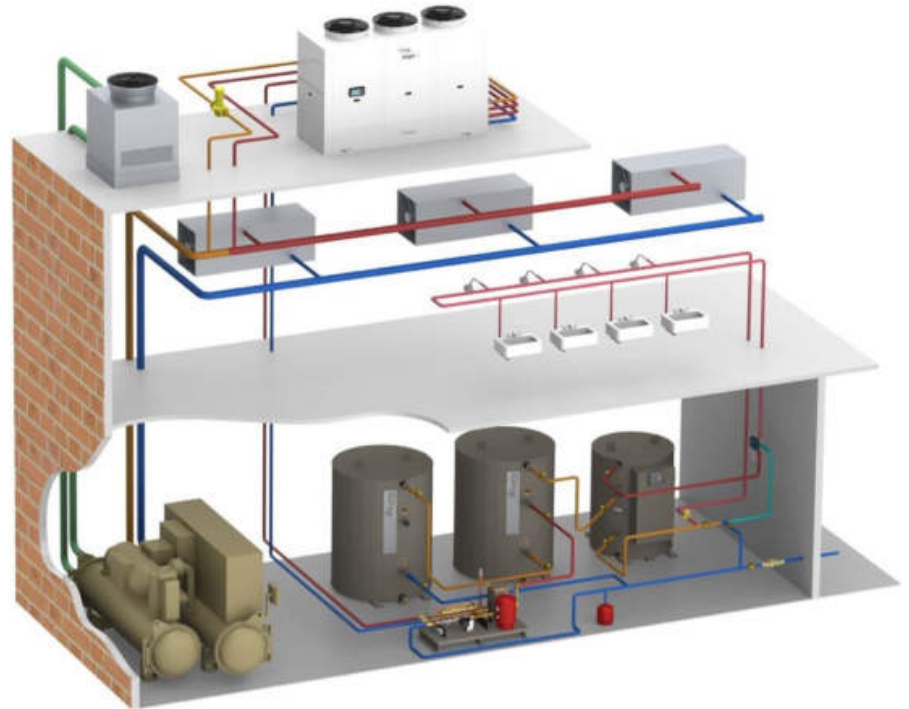
**HOT WATER STRATEGY : Air-to-Water Heat pump
(Aegis, Mitsubishi Q-Mark, LG Hydrokit)**

PROS

- Efficient, all-electric systems
- Can produce hot water even during cold outdoor temperatures
- Can potentially piggyback off of heating/ cooling equipment

CONS

- Requires large amounts of storage to meet peak loads
- Upfront costs typically higher than fossil fuel systems



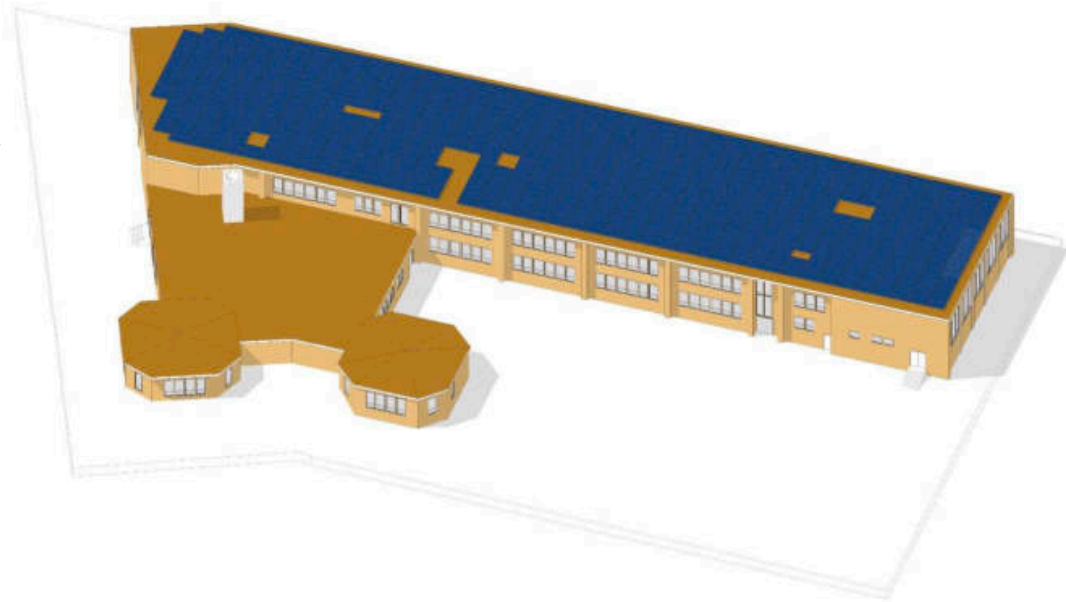


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HVAC/DHW SYSTEMS: BUILDING EVOLUTION CORPORATION
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Renewable Energy Generation

- For the purposes of this study, the Project Team has developed a preliminary plan depicting a rooftop photovoltaic array consisting of approximately 823 - 400W panels. The equivalent system output of an array of this size is approximately **378,264 kWh/yr.**
- The proposed post-DER, pre-solar Energy Usage Intensity (EUI) goal is 25 kBtu/sf yr. Based on the gross area of the building, a site EUI of 25 is equivalent to a site energy use of 376,414 kWh/yr; therefore, with the implementation of a 378,264 kWh/yr solar array, the resulting site EUI drops to - 0.12, projecting a **Net Positive Energy building.**
- *If the utility/cost data provided to us is correct this would translate into approximate utility savings of **\$51,000/year.***





JFK Elementary School
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BUDGET:



- BOD :**
1. **Decentralized Ventilation**
 2. **Centralized VRF**
 3. **Panelized envelop \$254/sf (Union Labor)**

ITEM	DESCRIPTION OF WORK	Unit Price Estimate	Direct Cost	Markup	Material Cost	Subcontractor	Sub-Cost Markup	Total
24 00 00 01	Lighting Release Arm		\$0	\$0	\$0	\$1,000	\$0	\$1,000
48 14 00	Total Storage Mechanical Floor Demolition Equipment Sub.	\$100	\$0	\$0	\$0	\$1,400,000	\$0	\$1,400,100
Division 32 Exterior Improvements								
32 10 00 00	Paving Sub.		\$0	\$0	\$0	\$0	\$3,400	\$3,400
32 14 00 00	Stairwells Sub.		\$0	\$0	\$0	\$0	\$700	\$6,000
32 40 00 00	Landscaping Sub.	\$1,000	\$100	\$0	\$0	\$0	\$400	\$4,000
Incltd \$10,839,889								
Cost by Classroom \$617,767								
SGF Cost by GSF \$214								
SGF Cost by GSF of Envelope \$254								
Add Alternative 001 - Centralized VRF/Boiler System								
23 72 00 00	Centralized VRF System Sub - Add	\$400	\$1,000	\$197,400	\$0	\$0	\$1,479,200	\$2,479,200
23 72 00 01	Unlabeled HVAC RFF Sub - Default		\$0	\$0	\$0	\$0	\$0	\$0
23 72 00 02	Unlabeled HVAC RFF Sub - Default		\$10,000	\$0	\$0	\$0	\$0	\$10,000
Adjusted Incltd \$2,489,200								
Cost by Classroom \$489,639								
SGF Cost by GSF \$214								
SGF Cost by GSF of Envelope \$254								
Add Alternative 002 - Central Water Source Heat Exchangers System								
23 01 48	Centralized Water Source Heat System - Add	\$800	\$10,000	\$207,710	\$0	\$0	\$2,877,000	\$4,477,000
23 72 28 VRF	Air-Conditioning System Sub - Default	\$700	\$10,000	\$1,000	\$0	\$0	\$5,400,000	\$11,500,000
Adjusted Incltd \$1,000,000								
Cost by Classroom \$611,673								
SGF Cost by GSF \$214								
SGF Cost by GSF of Envelope \$254								
Default Alternative 003 - Zoned Air - Decentralized Roof Pumps								
23 01 48	Zoned Air-Conditioning System Sub - Add	\$8,000	\$10,000	\$1,000	\$0	\$0	\$2,200,000	\$4,100,000
23 72 28 VRF	Air-Conditioning System Sub - Add (Major update)	\$10,000	\$10,000	\$1,000	\$0	\$0	\$1,700,000	\$1,700,000
23 72 28 VRF	Air-Conditioning System Sub - Default	\$700	\$10,000	\$1,000	\$0	\$0	\$5,400,000	\$11,500,000
Adjusted Incltd \$1,000,000								
Cost by Classroom \$688,617								
SGF Cost by GSF \$214								
SGF Cost by GSF of Envelope \$198								



Project Name: JFK Elementary School, Jamaica Plain, MA
Project #: [Redacted]
Site Feasibility Study Construction Pricing - Sheet 2
Date: 10/24/2022

ITEM	DESCRIPTION OF WORK	Unit Price Estimate	Direct Cost	Markup	Material Cost	Subcontractor	Sub-Cost Markup	Total
Division 3 - General Requirements								
03 00 00 00	Project Inception		\$1,000	\$0	\$0	\$0	\$0	\$1,000
03 01 10	Project Management	\$20,000	\$2,000	\$0	\$0	\$0	\$0	\$22,000
03 01 19	Project Meetings	\$5,000	\$500	\$0	\$0	\$0	\$0	\$5,500
03 02 10	Project Scheduling	\$10,000	\$1,000	\$0	\$0	\$0	\$0	\$11,000
03 01 13	Temp Electricity	\$1,000	\$100	\$0	\$0	\$0	\$0	\$1,100
03 01 28	Temp Work Partitions	\$700	\$70	\$0	\$0	\$0	\$0	\$770
03 01 48	Temp Equipment Setup	\$75,000	\$7,500	\$0	\$0	\$0	\$0	\$82,500
03 02 18	Sanitary Facilities	\$2,000	\$200	\$0	\$0	\$0	\$0	\$2,200
03 09 24	Traffic Control	\$8,000	\$800	\$0	\$0	\$0	\$0	\$8,800
03 09 24 00	Temporary Fencing	\$6,000	\$600	\$0	\$0	\$0	\$0	\$6,600
03 01 14	Temporary Pest Control	\$1,200	\$120	\$0	\$0	\$0	\$0	\$1,320
03 01 00	Site Supervision	\$40,000	\$4,000	\$0	\$0	\$0	\$0	\$44,000
03 74 14	Site Mobilization	\$10,000	\$1,000	\$0	\$0	\$0	\$0	\$11,000
03 74 18	Waste Disposal	\$18,000	\$1,800	\$0	\$0	\$0	\$0	\$19,800
03 74 23	Hot Clean	\$10,000	\$1,000	\$0	\$0	\$0	\$0	\$11,000
03 78 13	Final Clean	\$18,000	\$1,800	\$0	\$0	\$0	\$0	\$19,800
\$200,740								
Division 2 - Masonry								
02 02 00 00	Demolition (Included in 03 31 00 00)		\$0	\$0	\$0	\$0	\$0	\$0
Division 4 - Masonry								
04 21 13	Block Masonry Repair	\$0	\$0	\$0	\$0	\$0	\$4,000	\$4,000
Division 5 - Wood & Plastics								
04 41 10	Millwork Sub.		\$0	\$0	\$40,000	\$1,000	\$0	\$41,000
04 41 10 00	Millwork Sub.		\$0	\$0	\$0	\$0	\$20,000	\$20,000
Division 7 - Thermal & Moisture Protection								
07 14 00 00	Fluid Applied Waterproofing Sub.	\$1,000	\$100	\$0	\$0	\$0	\$1,000	\$1,100
07 01 10	Insulation (Included in 07 21 10 00)		\$0	\$0	\$0	\$0	\$0	\$0
07 21 10	Insulation Sub.	\$2,800	\$0	\$0	\$0	\$0	\$0	\$2,800
07 07 00 01	Air Barrier Mem.		\$0	\$0	\$10,000	\$1,000	\$0	\$11,000
07 07 00 02	Air Barrier Mem. (Included in 07 07 40 00)		\$0	\$0	\$0	\$0	\$0	\$0
07 40 40 01	Insulated Wall Panel Assemblies MM	\$40,000	\$0	\$0	\$1,400,000	\$29,700	\$0	\$1,769,700
07 42 40 00	TRAP Assemblies Sub.	\$10,000	\$1,000	\$0	\$0	\$0	\$0	\$11,000
07 00 00 00	Aluminum Roofing (Included in 07 20 00 00)		\$0	\$0	\$0	\$0	\$0	\$0
07 00 00 00	Aluminum Roofing Sub.	\$10,000	\$7,000	\$700	\$0	\$0	\$44,100	\$61,800
07 01 00 00	Roofing Specialties	\$29,000	\$7,000	\$700	\$33,000	\$4,000	\$0	\$44,700
Division 8 - Doors, Windows & Partitions								
08 14 10 01	Sliding Glass Door (Included in 07 42 40 01)		\$0	\$0	\$0	\$0	\$0	\$0
08 14 10 02	Sliding Glass Door Sub (Included in 07 42 40 01)		\$0	\$0	\$0	\$0	\$0	\$0
08 41 10 00	Operating Doors		\$0	\$0	\$0	\$13,000	\$0	\$13,000
08 50 00 01	Windows MM (Included in 07 42 40 01)		\$0	\$0	\$0	\$0	\$0	\$0
08 50 00 02	Windows Sub (Included in 07 42 40 01)		\$0	\$0	\$0	\$0	\$0	\$0
Division 9 - Paints								
09 01 20 00	Interior Paint Sub (Included in 09 01 20 00)		\$1,000	\$100	\$0	\$0	\$3,000	\$4,100
Division 22 - Finishing								
22 00 00 00	Plumbing (Included in 22 00 00 00)		\$0	\$0	\$0	\$0	\$0	\$0
22 00 00 01	Plumbing MM (Included in 22 00 00 00)		\$0	\$0	\$0	\$0	\$0	\$0
22 00 00 02	Plumbing Sub	\$20,000	\$8,000	\$400	\$0	\$1,200,000	\$16,000	\$1,424,400
Division 23 - HVAC								
23 72 00 01	Unlabeled HVAC RFF MM		\$14,000	\$1,400	\$250,400	\$30,400	\$0	\$296,200
23 72 00 02	Unlabeled HVAC RFF Sub		\$0	\$0	\$0	\$0	\$0	\$0
23 72 28 VRF	Air-Conditioning System Sub.	\$700	\$10,000	\$1,000	\$0	\$0	\$5,400,000	\$11,500,000
Division 24 - Electrical								
24 00 00 00	Electrical (Included in 24 00 00 00)		\$0	\$0	\$0	\$0	\$0	\$0
24 00 00 01	Electrical MM (Included in 24 00 00 00)		\$0	\$0	\$0	\$0	\$0	\$0
24 00 00 02	Electrical Sub	\$80,000	\$18,000	\$1,000	\$0	\$0	\$2,470,000	\$2,669,000



JFK Elementary School
7 Bolster St, Jamaica Plain, MA 02130

BUDGET:



Preliminary Pricing Narrative

Project Name: JFK Elementary DER	Date: 06/24/2022
Project #:	Revision: 0
Project Address: 7 Bolster St, Jamaica Plain, MA 02130	

Basis of Design Scope of Work

HVAC basis of design is a decentralized ventilation system and a centralized VRF system as recommended in BOD Mechanical Report provided by BEC. Ventilation would be provided by unitary ERVs. Heating and Cooling would be provided by a Central VRF System.

Electrical basis of design scope is to provide power to the new electric VRF and ERV systems and install photovoltaic panels on the new roof.

Plumbing basis of design scope is to provide new hookups and distribution for new VRF and ERV systems

Envelope basis of design scope is to install a prefabricated panelized exterior insulation system to enclose the building as well as a new TPO roofing membrane system. Panel components include windows and exterior doors installed in the factory and an integrated air and vapor barrier to seal the existing facades minimizing heat loss.

Major BOD Pricing Line Items

HVAC	\$4,572,700.00
Plumbing	\$1,425,900.00
Electrical	\$2,851,800.00
Solar Energy	\$175,900.00
Envelope	\$2,806,700.00
Overhead	\$444,500.00
Associated project costs	\$261,500.00
TOTAL	\$12,539,000.00

Add Alternates

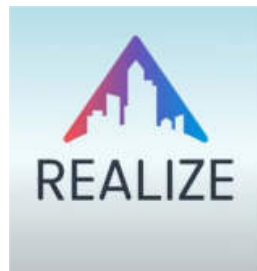
Add Alternate 001 - Centralized Ventilation System - Central rooftop ERV providing ventilation to whole building	\$2,157,800.00
Add Alternate 002 - Central Water Source Heat Exchanger System - HEX heating/cooling system serving whole building	\$1,005,200.00
Add Alternate 003 - Ephoca Pro - Decentralized Air-to-Air Heat Pumps for heating/cooling with reduced, semi-centralized VRF heating/cooling system for the larger spaces.	-\$1,474,500.00

This is preliminary pricing based on the feasibility study provided Building Evolution Corp and Orion Flats.

- **NOTE: WE WERE TOLD A BUDGET HAS YET TO BE CREATED FOR THE PROJECT**
- **WAITING ON FEEDBACK FROM RENEW BOSTON TRUST**

\$12,539,000.00 Total Budget





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FAIRWEATHER BEVERLY



FAIRWEATHER DANVERS



FAIRWEATHER PEABODY



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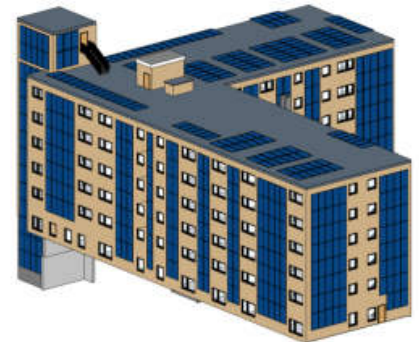
127 unit, 73,920 sf, 6 stories

Feasibility Study

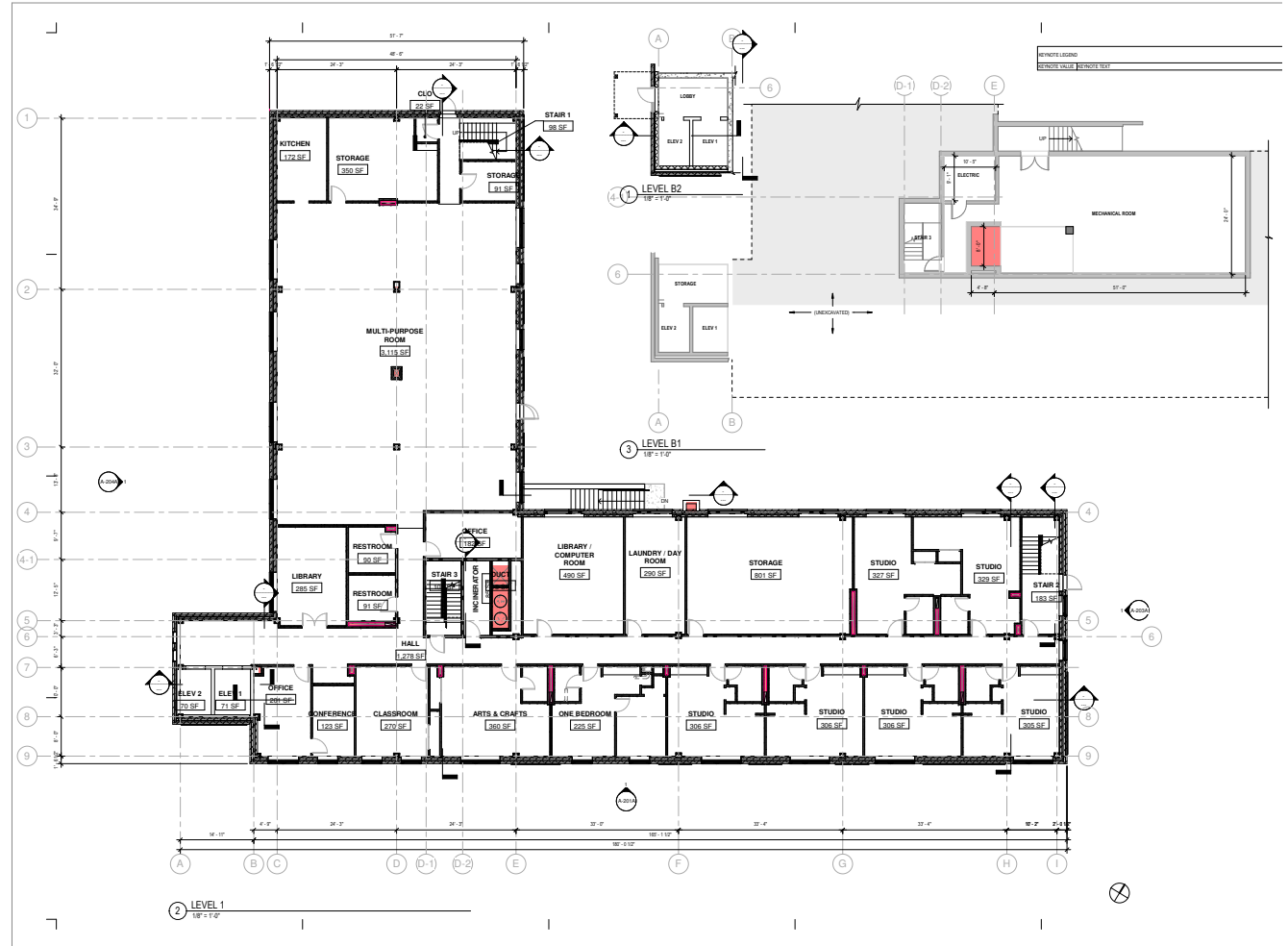
Deep Energy Retrofit

Goals:

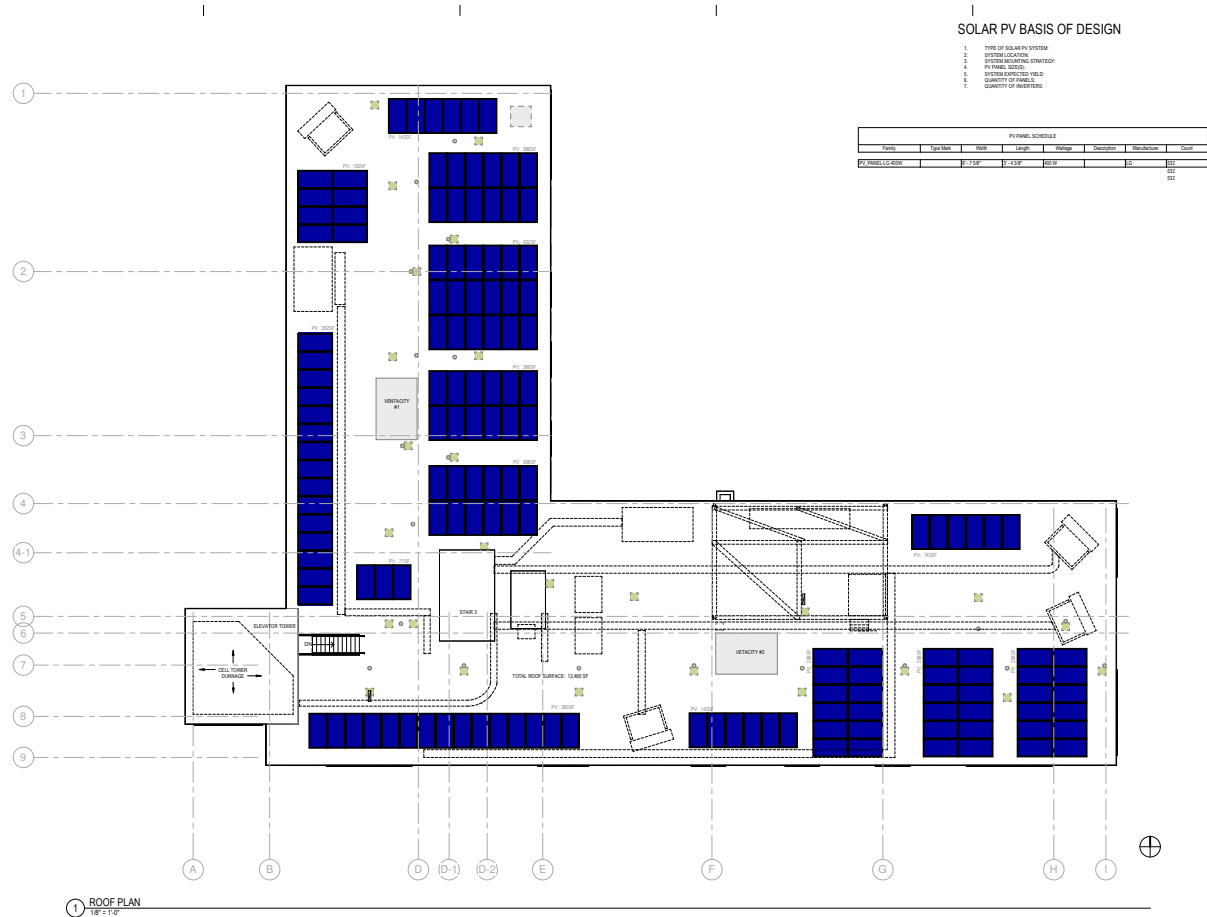
- 1. Research 7 Panelized manufacturers for most cost-effective, factory-built, high performance envelop, including new roof**
- 2. Research 3-4 HVAC strategies for most cost-effective approach to bringing heating, cooling and ventilation to every apartment and communal space**
- 3. Research all-electric centralized Domestic Hot Water Systems to replace gas boiler**
- 4. Eliminate all gas equipment and appliances from building for all-electric building**
- 5. Create WUFI model of proposed design to meet the Passive House standard.**
- 6. Incorporate as much PV renewable energy as possible with goal of Net Zero Energy.**
- 7. Create preliminary budget for DER**



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REMARK LEGEND
REMARK VALUE REFINANCE TEXT

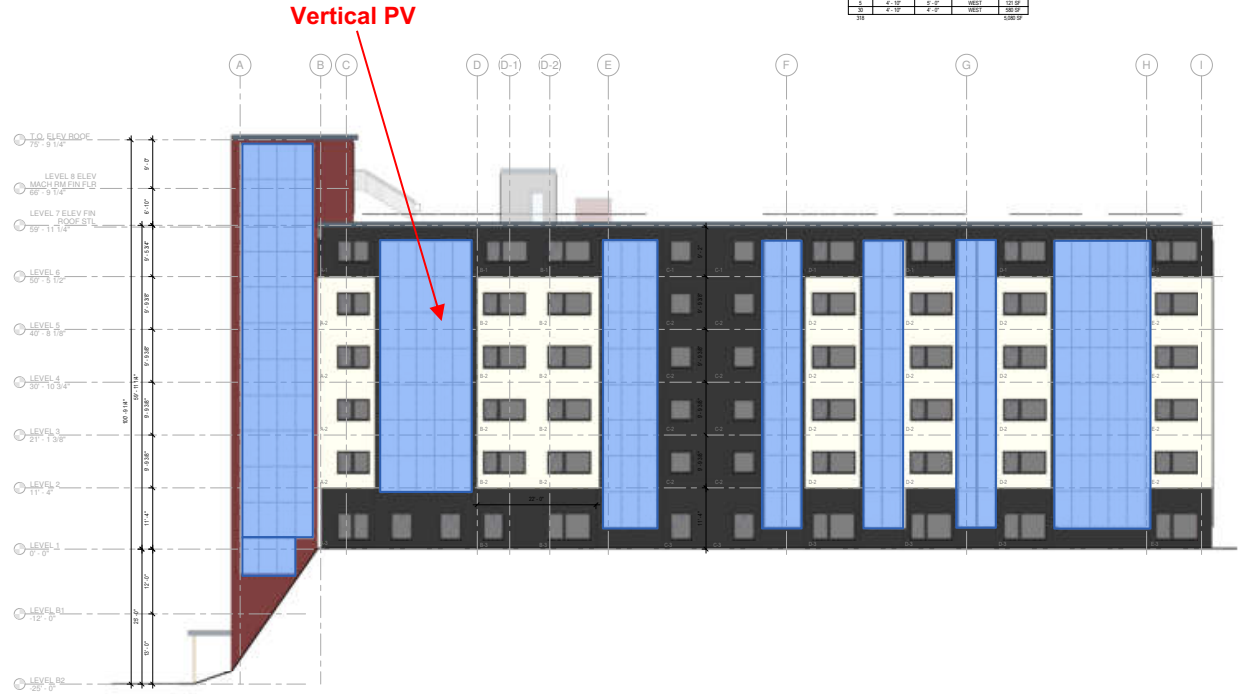
FAIRWEATHER SALEM



WINDOW AREA & COUNTS				
QTY	WINDOW WIDTH	WINDOW HEIGHT	WINDOW ORIENTATION	AREA
85	3'-0"	4'-0"	WEST	108 SF
5	3'-0"	4'-0"	EAST	60 SF
13	3'-0"	5'-0"	WEST	180 SF
5	4'-0"	5'-0"	WEST	100 SF
10	4'-0"	4'-0"	WEST	160 SF
11	4'-10"	5'-0"	WEST	268 SF
87	4'-10"	4'-0"	WEST	1380 SF
2	3'-0"	2'-0"	WEST	12 SF
15	3'-0"	4'-0"	EAST	180 SF
10	3'-0"	4'-0"	EAST	120 SF
7	3'-0"	5'-0"	EAST	105 SF
1	3'-0"	5'-0"	EAST	15 SF
4	4'-0"	5'-0"	EAST	80 SF
26	4'-0"	4'-0"	EAST	384 SF
1	4'-10"	5'-0"	EAST	24 SF
5	4'-10"	4'-0"	EAST	190 SF
10	4'-0"	4'-0"	NORTH	160 SF
5	2'-0"	2'-0"	WEST	60 SF
30	3'-0"	4'-0"	WEST	360 SF
5	3'-0"	5'-0"	WEST	75 SF
5	4'-10"	5'-0"	WEST	240 SF
318	4'-10"	4'-0"	WEST	5180 SF

WINDOW AREA-BY ORIENTATION		
QTY	WINDOW ORIENTATION	AREA
117	WEST	2738 SF
16	EAST	488 SF
10	NORTH	160 SF
12	WEST	132 SF
318		5180 SF

WALL AREA LESS DOORS AND WINDOWS		
QTY	Orientation	Area
1	EAST	1610 SF
1	WEST	1610 SF
1	South	1610 SF
1	North	1610 SF
4		6440 SF

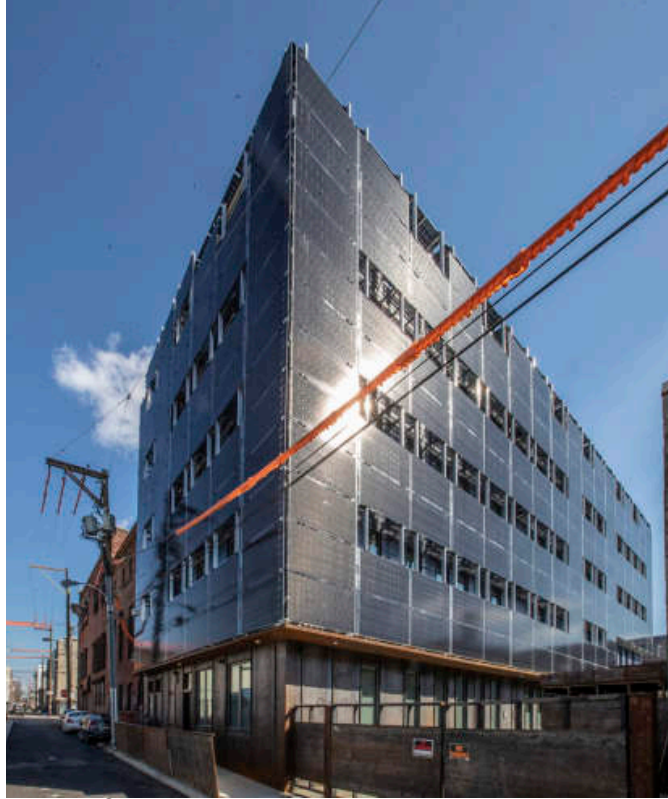


1 SOUTH ELEVATION
1/8" = 1'-0"

REMOTE LEGEND
REMOTE VALUE REFERENCE TEXT

FAIRWEATHER SALEM

Front Flats, 174 kW array, Phila, Onion Flats



WINDOW AREA & COUNTS				
QTY	WINDOW WIDTH	WINDOW HEIGHT	WINDOW ORIENTATION	AREA
85	3'-0"	4'-0"		180 SF
5	3'-0"	4'-0"		120 SF
13	3'-0"	5'-0"		180 SF
5	4'-0"	5'-0"		100 SF
10	4'-0"	4'-0"		160 SF
11	4'-10"	5'-0"		260 SF
87	4'-10"	4'-0"		1,100 SF
4	3'-0"	2'-0"		120 SF
15	3'-0"	4'-0"	EAST	180 SF
10	3'-0"	4'-0"	EAST	120 SF
7	3'-0"	5'-0"	EAST	105 SF
1	3'-0"	5'-0"	EAST	150 SF
4	4'-0"	5'-0"	EAST	80 SF
26	4'-0"	4'-0"	EAST	384 SF
1	4'-10"	5'-0"	EAST	245 SF
5	4'-10"	4'-0"	EAST	210 SF
10	4'-0"	4'-0"	WEST	160 SF
5	4'-0"	5'-0"	WEST	100 SF
30	3'-0"	4'-0"	WEST	360 SF
5	3'-0"	5'-0"	WEST	75 SF
5	4'-10"	5'-0"	WEST	245 SF
15	4'-10"	4'-0"	WEST	630 SF
318				5,580 SF

WINDOW AREA-BY ORIENTATION		
QTY	WINDOW ORIENTATION	AREA
187		2,730 SF
15	EAST	480 SF
10	WEST	180 SF
15	WEST	135 SF
318		5,580 SF

WALL AREA LESS DOORS AND WINDOWS		
Wall Orientation	Area	
EAST	16,530 SF	
WEST	16,530 SF	
South	13,500 SF	
North	13,500 SF	
Grand Total	60,090 SF	

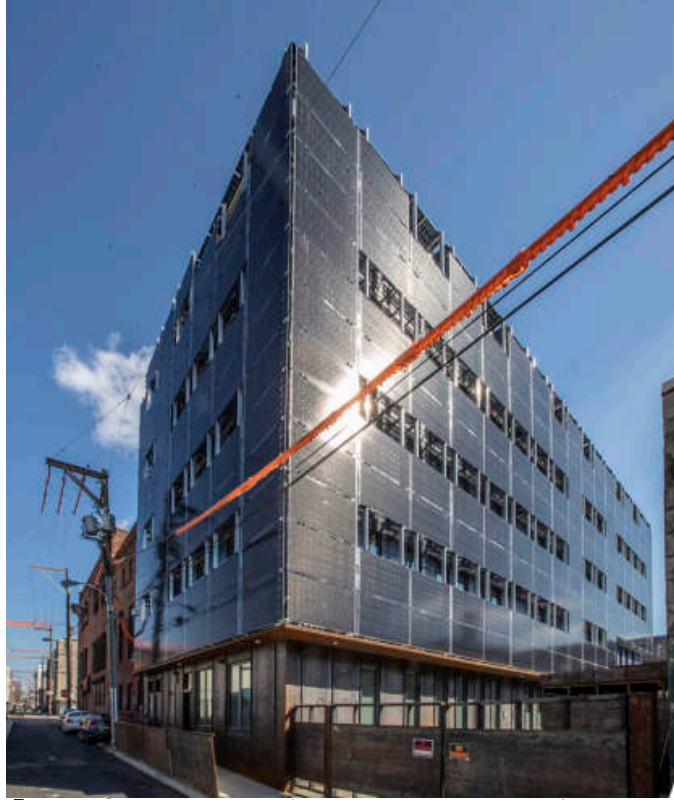


REMOTE LEGEND
REMOTE VALUE REFERENCE TEXT

FAIRWEATHER SALEM



Front Flats, 174 kW array, Phila, Onion Flats



WINDOW AREA & COUNTS				
QTY	WINDOW WIDTH	WINDOW HEIGHT	WINDOW ORIENTATION	AREA
85	3'-0"	4'-0"	EAST	1050 SF
8	3'-0"	4'-0"	EAST	105 SF
13	3'-0"	5'-0"	EAST	150 SF
5	4'-0"	5'-0"	EAST	100 SF
10	4'-0"	4'-0"	EAST	160 SF
11	4'-10"	5'-0"	EAST	260 SF
87	4'-10"	4'-0"	EAST	1380 SF
4	3'-0"	2'-0"	EAST	120 SF
15	3'-0"	4'-0"	EAST	180 SF
10	3'-0"	4'-0"	EAST	120 SF
7	3'-0"	5'-0"	EAST	105 SF
1	3'-0"	5'-0"	EAST	15 SF
4	4'-0"	5'-0"	EAST	80 SF
26	4'-0"	4'-0"	EAST	360 SF
1	4'-10"	5'-0"	EAST	245 SF
5	4'-10"	4'-0"	EAST	200 SF
10	4'-0"	4'-0"	WEST	160 SF
5	4'-0"	5'-0"	WEST	100 SF
30	3'-0"	4'-0"	WEST	360 SF
5	3'-0"	5'-0"	WEST	75 SF
3	4'-10"	5'-0"	WEST	240 SF
3	4'-10"	4'-0"	WEST	160 SF
318				5380 SF

WINDOW AREA-BY ORIENTATION		
QTY	WINDOW ORIENTATION	AREA
18	EAST	2730 SF
18	WEST	1000 SF
10	WEST	180 SF
10	WEST	130 SF
318		5380 SF

WALL AREA LESS DOORS AND WINDOWS		
Wall Orientation	Area	
EAST	16300 SF	
WEST	16300 SF	
WEST	16300 SF	
WEST	13300 SF	
WEST	13300 SF	
Grand Total (4)	65300 SF	

F G H I Salem Heights, Salem, MA, POAH



FAIRWEATHER SALEM



WINDOW AREA ORIENTATION		SOUTH WALL AREA EXCLUDING OPENINGS	
QTY	WINDOW ORIENTATION	AREA	USE Orientation Area
101	SOUTH	2,117 SF	SOUTH
18	EAST	682 SF	SOUTH
0	WEST	0 SF	SOUTH
0	NORTH	1,017 SF	EAST
			Openings: 1,028 SF
119			1,028 SF



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1 EAST ELEVATION
18' x 110'



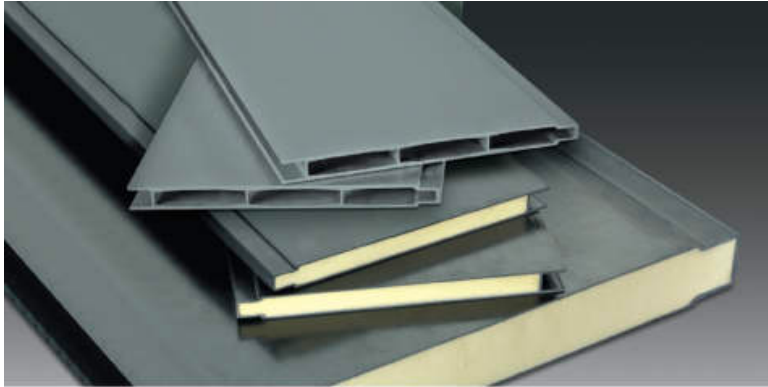
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FRP (Fiberglass Reinforced Panel)

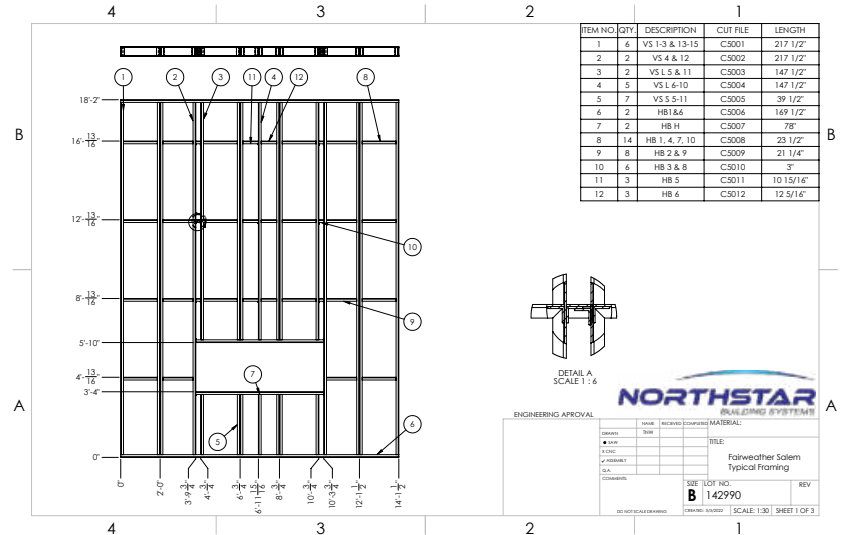
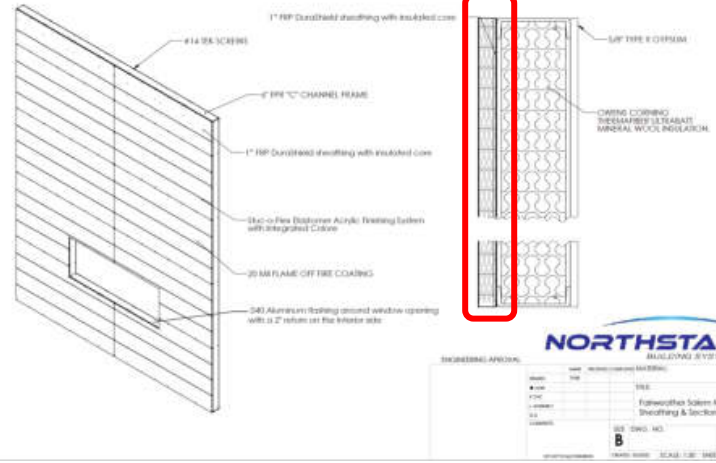


STRONGWELL

EXCLUSIVELY
MADE IN THE
USA

DURASHIELD® & DURASHIELD HC®

FIBERGLASS FOAM CORE/HOLLOW CORE BUILDING PANELS



DETAIL A
SCALE: 1:6

NORTHSTAR
BUILDING SYSTEMS

ENGINEERING APPROVAL

DESIGN: [] DATE: []
 CHECK: []
 APPROVAL: []
 DATE: []

PROJECT: Fairweather Salem
 TYPICAL FRAMING

DATE: 02/15/16
 DRAWING NO: **B 142990**
 SCALE: 1:30 SHEET 1 OF 3

System	DEXTALL	D Wall 2000 (prefab panels with 8" mineral wool insulation)
Energy Performance		Code compliant for climate zone 4
Windows (Factory Installed)	INTUS	CW50 System Triple Pane
Cladding (Factory Applied)		Aluminum
Subtotal		
Tax	SALEM, MA	6.250%
Total Price (Furnish Only)		

INCLUDED

- Structural Brackets – wall panel to slab connection
- Shop Drawings w/ bracket & anchoring details
- Factory installed windows
- Factory applied exterior cladding
- Engineering Verification- Licensed PE
- Pre-Delivery Meeting
- Installation Training
- FOB Delivery to Job Site

NOT INCLUDED:

- Installation
- Mock-ups (available upon request)
- Anchors securing panels to slab
- Local Storage (available upon request)
- Storefront & Public Access Doors



NOTES:

- Prefabricated Exterior Wall Systems are Non-Load Bearing
- Lead Time 18-22 weeks (after contract requirements fulfilled)
- Offer is valid for 14 days

System	DEXTALL	D Wall 2500 (prefab panels with 10" mineral wool insulation)
Energy Performance		Code compliant for climate zone 4
Windows (Factory Installed)	INTUS	Supera 83 Passive System
Cladding (Factory Applied)		Aluminum
Subtotal		
Tax	SALEM, MA	6.250%
Total Price (Furnish Only)		

INCLUDED

- Structural Brackets – wall panel to slab connection
- Shop Drawings w/ bracket & anchoring details
- Factory installed windows
- Factory applied exterior cladding
- Engineering Verification- Licensed PE
- Pre-Delivery Meeting
- Installation Training
- FOB Delivery to Job Site

NOT INCLUDED:

- Installation
- Mock-ups (available upon request)
- Anchors securing panels to slab
- Local Storage (available upon request)
- Storefront & Public Access Doors



NOTES:

- Prefabricated Exterior Wall Systems are Non-Load Bearing
- Lead Time 18-22 weeks (after contract requirements fulfilled)
- Offer is valid for 14 days



Building with conscience.

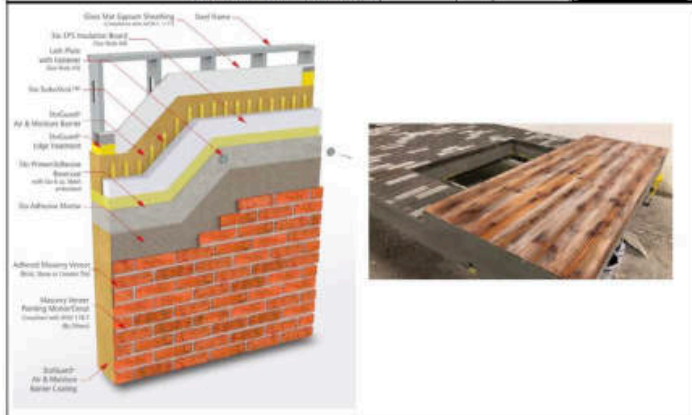
Preservation of Affordable Housing
Fairweather Apartments - Salem
Unit Price Budget Range - Exterior Panel System
Panel Type #3

StoPanel MVES ci with StoCast Brick/Wood (Exterior CFMF NLB Bypass)



PANEL TYPE #3 SCOPE DESCRIPTION	
Panel Design: Engineering, Modeling (LOD 350), Fabrication Tickets, Erection Plans	
CFM Panel Frames: FrameCAD Fabricated 6005162.54 (600) Slats (18"o.c.), Track, Bridging and Strapping	
Exterior Sheathing: 1/2" Glass Mat Gypsum Sheathing, also included at back of panel frame	
AWB: StoGuard Air & Moisture Barrier, Sto Gold Coat	
Finish Substrate: Sto EPS Insulation, Sto Primer, Sto Basecoat, Sto Bonding & Pointing Mortar	
Finish: Applied StoCast Brick or StoCast Wood (Gloss Cast Units, 2x4 maximum selection - field/accents)	
Panel Accessories: Angle with DTSL6 Connectors, ASLign Alignment Pins at Multi-Floor Vertical Span Panels, Esmual compressed gasket paths	
Panel Accessories: Knauf window receivers (pilot installed at perimeter of RC's Window Casework (not included) to be I-I by others on site	
Panel QA/QC: At Each Fabrication Station	
Shipping: Packaging (damage), Loading, Trucking to Jobsite	

PANEL TYPE #3 Square Foot Cost Range
Onsite Panel Erection Range



Standard Clarifications

- 1) Unit Price Ranges are budgetary only and based upon current market pricing (no escalation is currently factored)
- 2) CLP does not include Panel Erection services in Massachusetts, but can recommend Sto Affiliate installers for onsite labor.
- 3) Budget Unit Price Ranges presume a Bypass Panel condition and is contingent upon review and acceptance of final design details.
- 4) Standard CLP inclusions, exclusions, clarifications, terms and conditions apply.
- 5) Budget Unit Price Ranges presume standard sizes, finishes, textures, etc. including any special shapes, special patterns, radius conditions, etc.
- 6) Budget presumes that existing building shell is adequate to support an exterior panel system.
- 7) Firestopping systems are excluded.

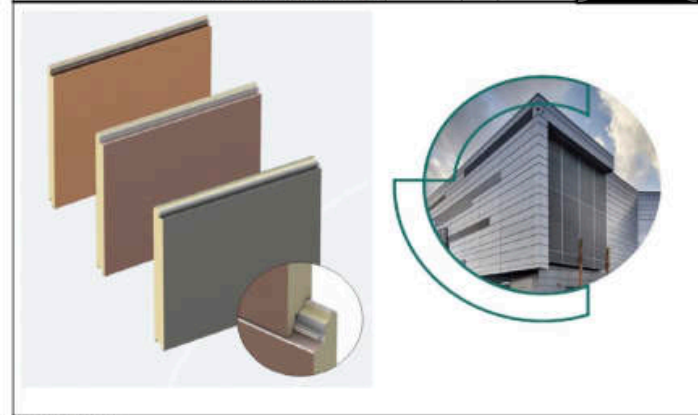
Preservation of Affordable Housing
Fairweather Apartments - Salem
Unit Price Budget Range - Exterior Panel System
Panel Type #4

StoPanel IMP Metal ci (Exterior CFMF NLB Bypass)



PANEL TYPE #4 SCOPE DESCRIPTION	
Panel Design: Engineering, Modeling (LOD 350), Fabrication Tickets, Erection Plans	
CFM Panel Frames: FrameCAD Fabricated 6005162.54 (600) Slats (18"o.c.), Track, Bridging and Strapping	
Exterior Sheathing: 1/2" Glass Mat Gypsum Sheathing, also included at back of panel frame	
AWB: StoGuard Air & Moisture Barrier, Sto Gold Coat	
Finish Substrate: 3/8x4 Hat Track (600), gasketed fasteners	
Finish: Applied 2-T Coating Formawall FWD5 Smooth Metal Panels	
Panel Accessories: Angle with DTSL6 Connectors, ASLign Alignment Pins at Multi-Floor Vertical Span Panels, Esmual compressed gasket paths	
Panel Accessories: Knauf window receivers (pilot installed at perimeter of RC's Window Casework (not included) to be I-I by others on site	
Panel QA/QC: At Each Fabrication Station	
Shipping: Packaging (damage), Loading, Trucking to Jobsite	

PANEL TYPE #1 Square Foot Cost Range
Onsite Panel Erection Range



Standard Clarifications

- 1) Unit Price Ranges are budgetary only and based upon current market pricing (no escalation is currently factored)
- 2) CLP does not include Panel Erection services in Massachusetts, but can recommend Sto Affiliate installers for onsite labor.
- 3) Budget Unit Price Ranges presume a Bypass Panel condition and is contingent upon review and acceptance of final design details.
- 4) Standard CLP inclusions, exclusions, clarifications, terms and conditions apply.
- 5) Budget Unit Price Ranges presume standard sizes, finishes, textures, etc. including any special shapes, special patterns, radius conditions, etc.
- 6) Budget presumes that existing building shell is adequate to support an exterior panel system.
- 7) Firestopping systems are excluded.



RC PANELS

European company brought to us by RMI
Using Sto panels
They were one of the companies that did
Energiesprong in Netherlands.

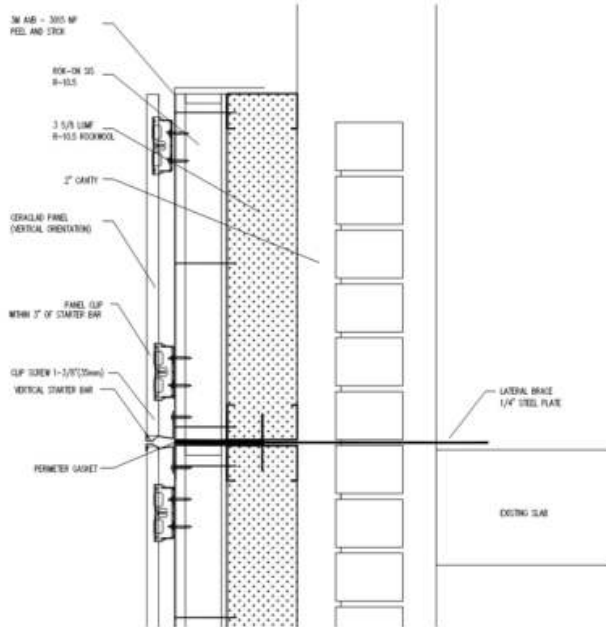
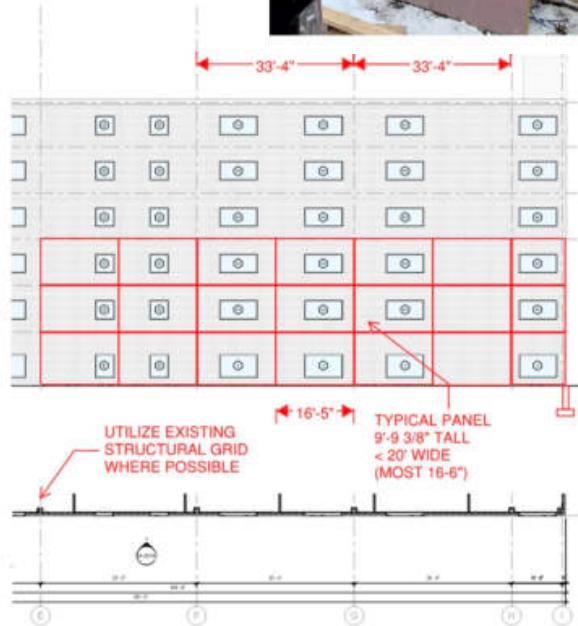
<i>Material Pricing/SF</i>	<i>Labor Pricing/SF</i>	<i>TOTAL INSTALLED</i>

Advanced Building Solutions
188 Warren Street
Brooklyn, NY 11201
Peter Bonte
plabonte@advanced-build.com
mobile 917.509.2200

1. We can produce it on an outsourced basis although before we commit to anything we need get a better understanding of your timeline.
 2. The cost per sqft would be XXXXXX assuming no unforeseen issues arise to do w/material cost .
 3. We can meet the 6 story fire code requirement at the price above.
 4. If Placetailer is going to be your GC we can train their people in the installation and will bring over someone from the Netherlands to assist with training and the first insulation.
- Moving forward we'd like to be able to have few crews in each metro area that is trained on the installation so Placetailer could be a good starting point.
There is work being done that will allow the architect to do the design and load it directly to our platform, we'll then do the layout the engineering and the pricing on the platform.



Typical Panel alignment @ South facade



CERACLAP Triple Coated Color Coating
 Concrete Coating
 Photocatalytic Coating
20 Year Performance Guarantee 90 Year Durability Air Purifying

CERACLAP™ enables color program in available in this section. Custom color samples can be requested at: <https://www.metalleve.com/custom-color>

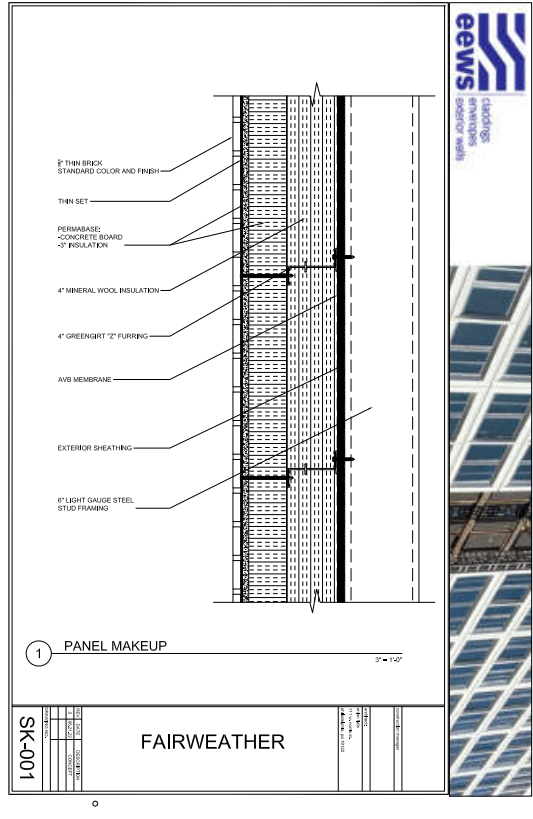


Panel Information	
Panel Type	Exterior
Application Method	Machine Applied
Coating Options	Triple Coated (CerACLAP™) System (Color)
Dimensions	48 1/2" x 96 1/2" x 1 1/2" (Thickness)
Coverage	200 sq. ft. per 100 lbs.
Weight	48 lb. (11 kg)
The Triple Coating is a spin-on finish system, non-solvent, and backed by a 20-year limited warranty.	
Please visit our website for additional CERACLAP product information including:	
- Product literature	
- Custom color samples	
- Specifications	
- CAD details	
- Product performance and approval documents	
- MSDS	



Sienna Orange MMW1221

1. Please contact us at 800-822-8222 for more information on our products and services. We are a leading manufacturer of exterior wall panels.
2. Please contact us at 800-822-8222 for more information on our products and services. We are a leading manufacturer of exterior wall panels.
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Salvation Army



eastern exterior wall systems, inc.

The House – Worlds Tallest Passive House Building



eastern exterior wall systems, inc.

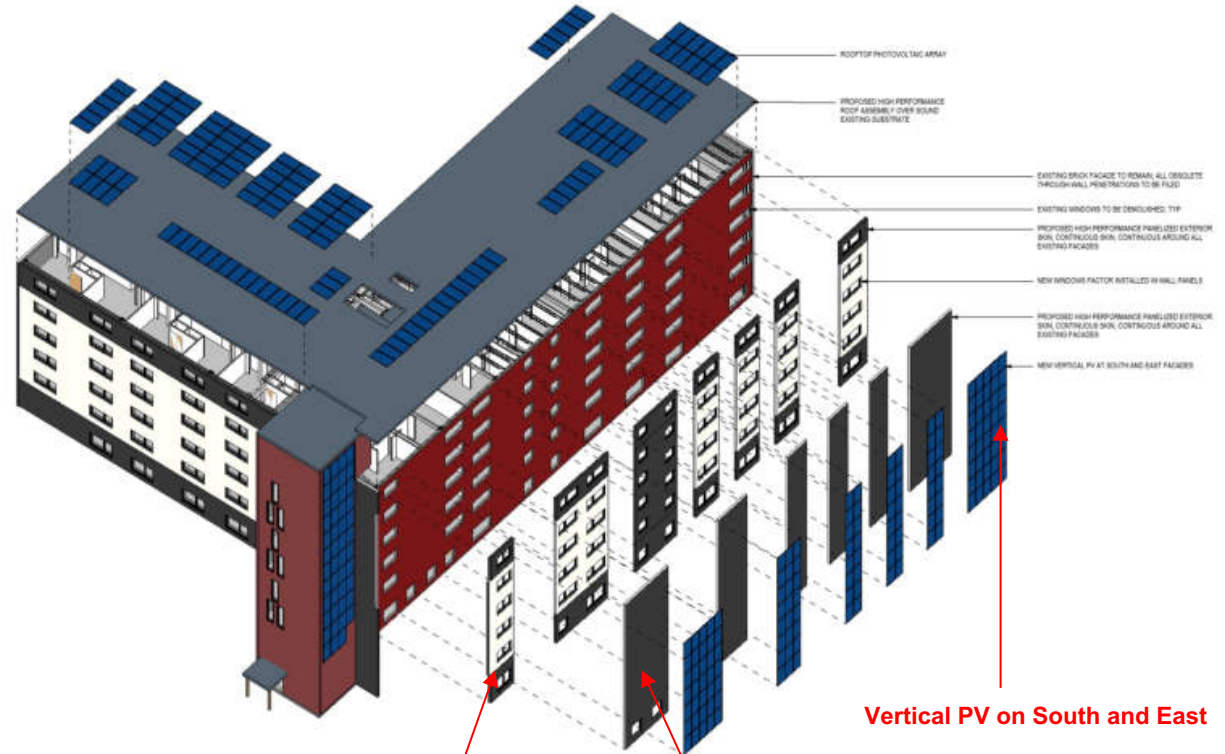


* NOTE: NO UPDATED PRICING

TREMCO			
Insulated metal panel with EPS foam, integrated 3-pane windows, EIFS finish Been buying companies and solidifying pricing Formaliozing installer training program in Cleveland.....extended warranties....	*Based on Heather's cost data analysis on Eva White		
	<i>Material Pricing/SF</i>	<i>Labor Pricing/SF</i>	<i>TOTAL INSTALLED</i>
	XXXX	XXXX	XXXX

David Hutchinson
DBHutchinson@tremcoinc.com
Steven Mort
SMort@tremcoinc.com

FAIRWEATHER SALEM



1 AXONOMETRIC

Areas with windows are to be panelized in factory

Areas with no windows maybe Less expensive to site-build



HVAC/DHW SYSTEMS

BUILDING EVOLUTION CORPORATION
Achieve Performance & Durability Through A Holistic Approach™



Vertical stack

1.    

2.  +   +  or 

3.  +  or 

4.  +  or 

5.  +  or 

Heating, Cooling, & Ventilation

Heating & Cooling Options	Ventilation Options	Ventilation & Ducting Requirement
1. Ephoca Vertical Stack: all-in-one. Requires supplemental electric duct heaters during winter.		Through wall ventilation; horizontal exhaust bathroom and kitchen, supply at Ephoca unit
2. Ephoca Through-Wall, no integral ventilation. Requires supplemental electric heaters during winter.	a. Central Rooftop ERV	i. Vertical duct riser cored internally in units ii. Vertical duct riser external to building, within enclosure
	b. Unitary ERV	i. Through wall ventilation; horizontal exhaust bathroom and kitchen, supply at ERV
3. VRF with Heat Recovery, branch controllers, and wall hung FCUs	a. Central Rooftop ERV	i. Vertical duct riser cored internally in units ii. Vertical duct riser external, within enclosure
	b. Unitary ERV	i. Through wall ventilation; horizontal exhaust bathroom and kitchen, supply at ERV
4. VRF without Heat Recovery and wall hung FCUs	a. Central Rooftop ERV	i. Vertical duct riser cored internally in units ii. Vertical duct riser external, within enclosure
	b. Unitary ERV	i. Through wall ventilation; horizontal exhaust bathroom and kitchen, supply at ERV
5. HEX, Condenser Loop, WSHP/Bulldog	a. Central Rooftop ERV	i. Vertical duct riser cored internally in units ii. Vertical duct riser external, within enclosure
	b. Unitary ERV	i. Through wall ventilation; horizontal exhaust bathroom and kitchen, supply at ERV

Domestic Hot Water

Option	Equipment
1. Central Heat Pump DHW	Outdoor CO2-based condenser, storage and swing tanks, recirculation pump(s)

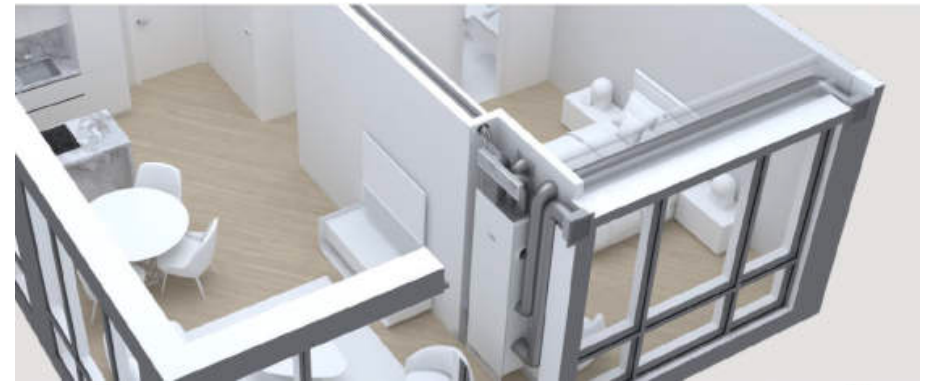
1. Ephoca Vertical Stack

PROS

- Single heating/cooling/ventilation solution
- Easy to schedule installation
- Can exhaust bathroom and kitchen area
- Does not require fire-stopping and smoke dampers
- Reduced risk of refrigerant leak in apartments

CONS

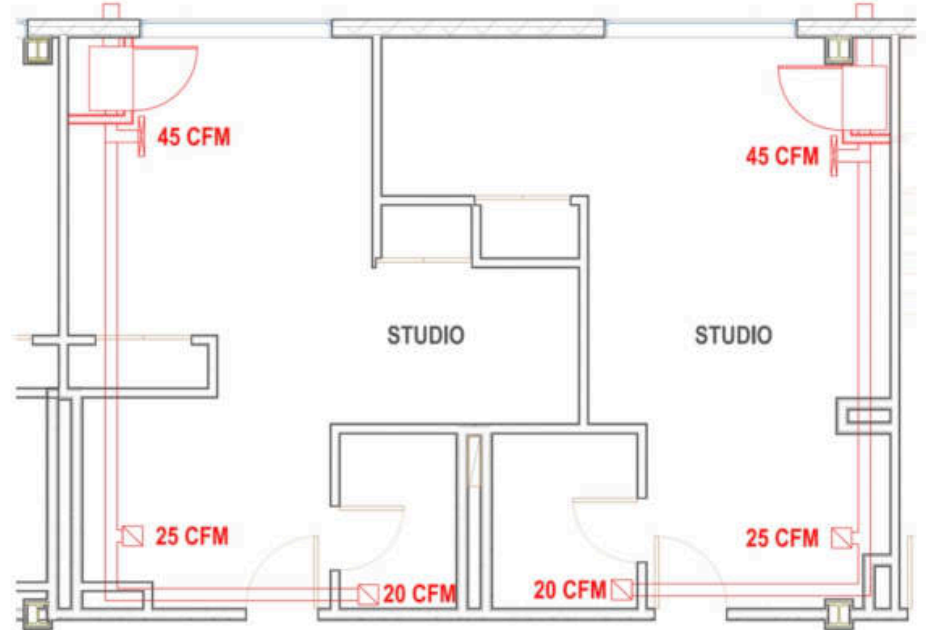
- Added maintenance costs due to individual unit filters
- Higher operating cost compared to centralized heat recovery VRF system
- Requires two penetrations through enclosure per apartment
- More work in occupied rehab compared to wall hung FCUs and central ventilation system
- Lower ERV efficiency compared to central ventilation system
- Will require electric resistance heating for winter design conditions



Vertical stack



- 1 Condenser and fresh air intake (left, right or rear)
- 2 Non-refrigerant compressor
- 3 ECM condenser fan
- 4 High efficiency outdoor heat exchanger
- 5 Condenser + static air exhaust (left, right or rear)
- 6 Return vents
- 7 Motor filter
- 8 EC supply fans
- 9 High-efficiency indoor heat exchanger
- 10 Supply air vent (top or front)
- 11 Static air exhaust
- 12 Condensate meter system
- 13 Hybrid recovery coil
- 14 Static air ECM exhaust fan
- 15 Fresh air ECM supply fan
- 16 Touch controller
- 17 Electronic controls
- 18 Condensate drain



2. Ephoca Wall mounted + De-coupled ventilation

PROS

- Re-use existing enclosure penetration locations
- Does not require fire-stopping and smoke dampers
- Easy to schedule installation
- Reduced risk of refrigerant leak in apartments

CONS

- Added maintenance costs due to individual unit filters
- Higher operating cost compared to centralized heat recovery VRF system
- Requires two penetrations through enclosure per unit without benefit of ventilation
- May not be adequately sized for common spaces
- May require electric resistance heating for winter design conditions
- Does not address ventilation needs

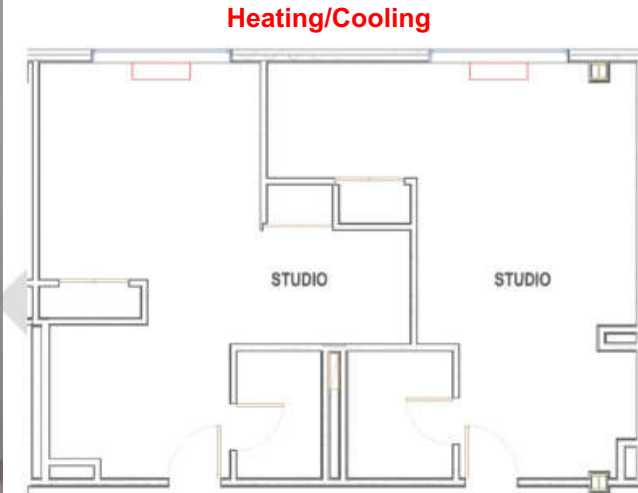


Figure 2: Through wall unit apartment layout

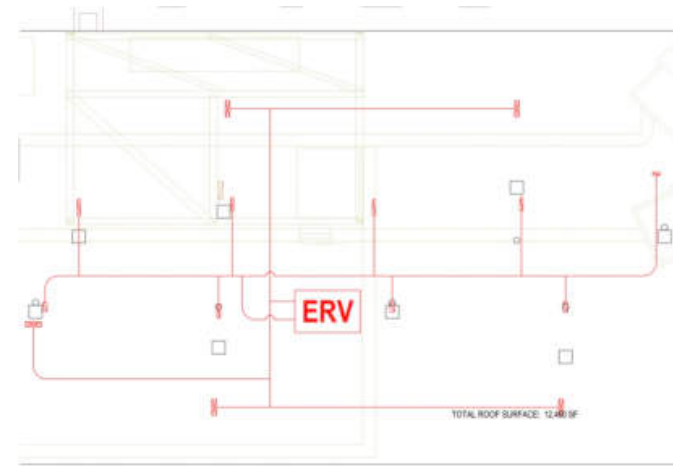
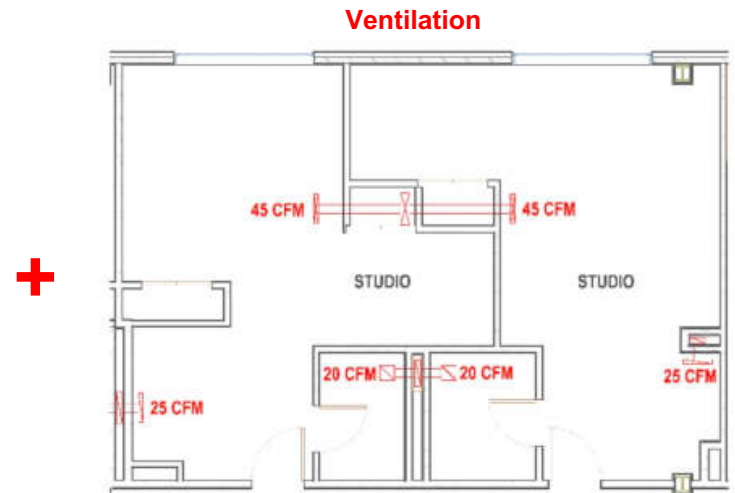


Figure 6: Rooftop layout with internal supply duct risers



Ventilation

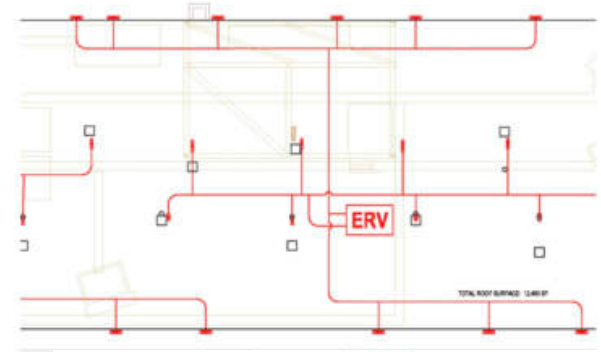
3. VRF w/Heat Recovery and wall hung FCUs + De-coupled ventilation

PROS

- Lowest overall operating cost with heat recovery benefit
- Wall-mounting FCUs does not take away real estate in apartments
- Improved comfort with independent control of heating and cooling
- System can scale to heating/cooling load requirements
- Central maintenance (condensers, controls)

CONS

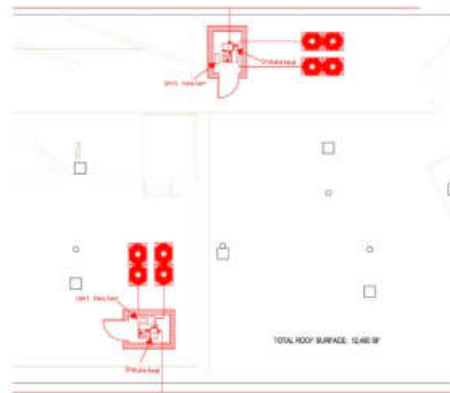
- Reduces roof space availability for solar array
- Limited space within building to mount branch controllers, may have to be installed on roof in purpose built semi-conditioned space
- Vertical chases for refrigerant lines may still require fire-stopping
- Externally run refrigerant lines will still require maintenance access



Heating/Cooling



+



+

Ventilation

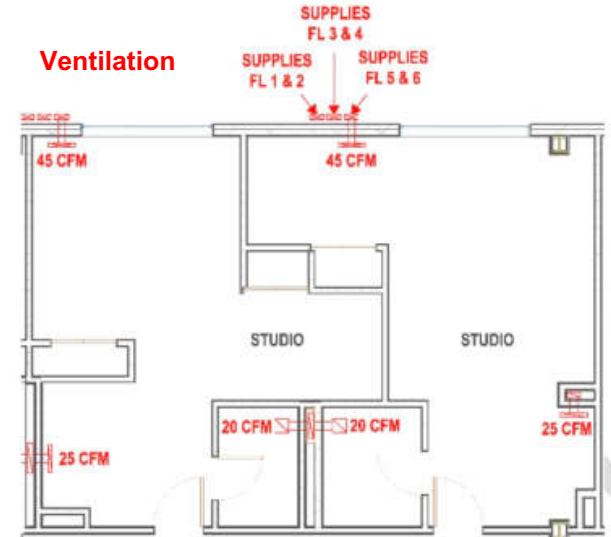


Figure 10: External ductwork staggered.

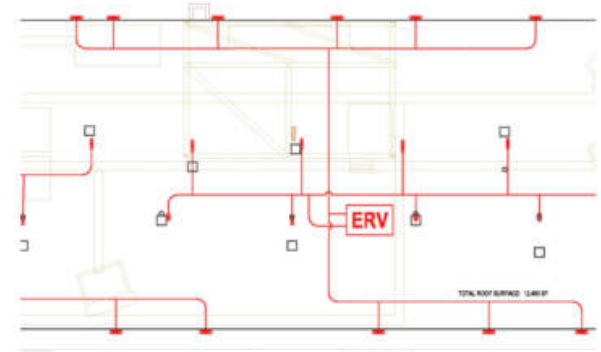
4. VRF WITHOUT Heat Recovery and wall hung FCUs + De-coupled ventilation

PROS

- Lower cost compared to heat recovery VRF option
- Does not require branch controllers
- Wall-mounting FCUs does not take away real estate in apartments
- System can scale to heating/cooling load requirements
- Central maintenance (condensers, controls)

CONS

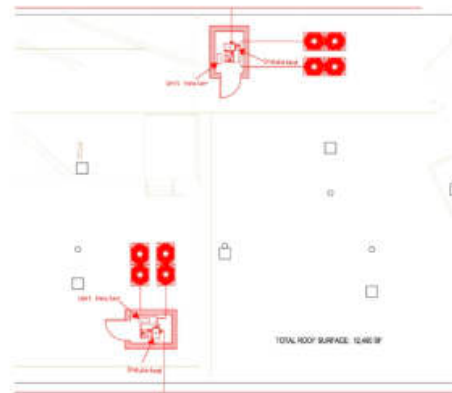
- Higher operating cost compared to heat recovery VRF option
- Reduces roof space availability for solar array
- Reduced comfort without independent control of heating and cooling
- Vertical chases for refrigerant lines may still require fire-stopping
- Externally run refrigerant lines will still require maintenance access



Heating/Cooling



+



+

Ventilation

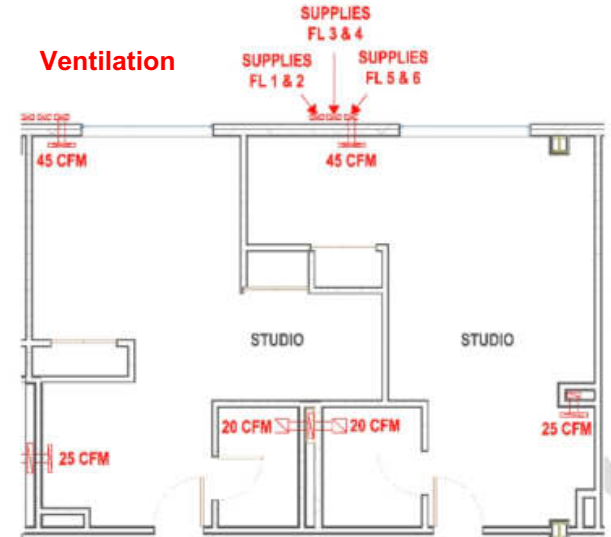


Figure 10: External ductwork staggered.

5. HEX, Condenser Loop, WSHP/Bulldog + De-coupled ventilation

PROS

- Simultaneous heating and cooling with heat recovery
- Reduced refrigerant running through occupied space
- CUs can be located at grade in a central location to serve the entire building.
- May be less expensive than other central options as contractors are familiar with WSHPs, and two pipe hydronic systems

CONS

- Lower efficiency compared to VRF system
- Loss of real estate in apartments

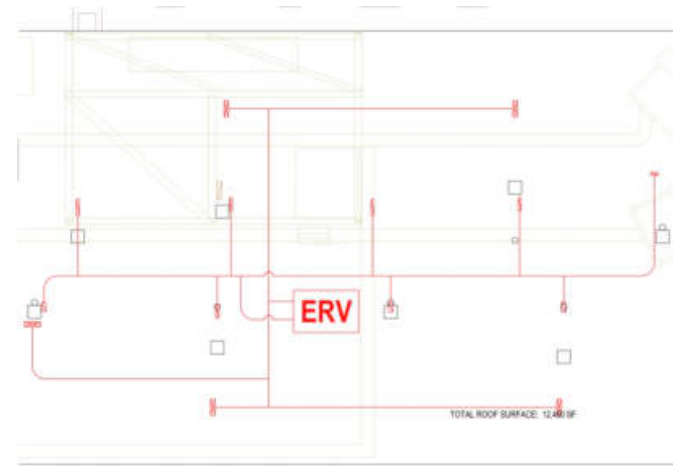
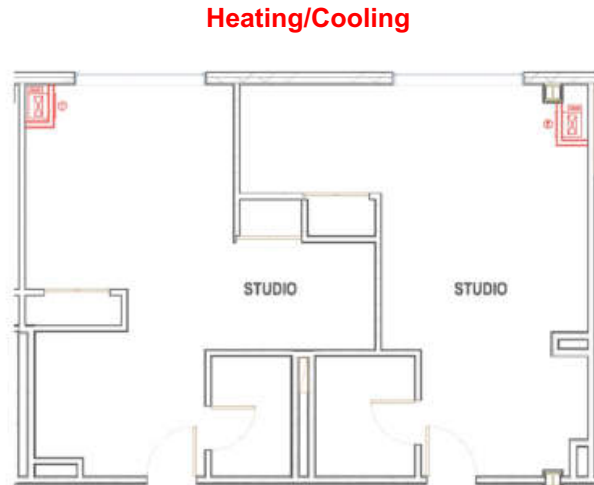
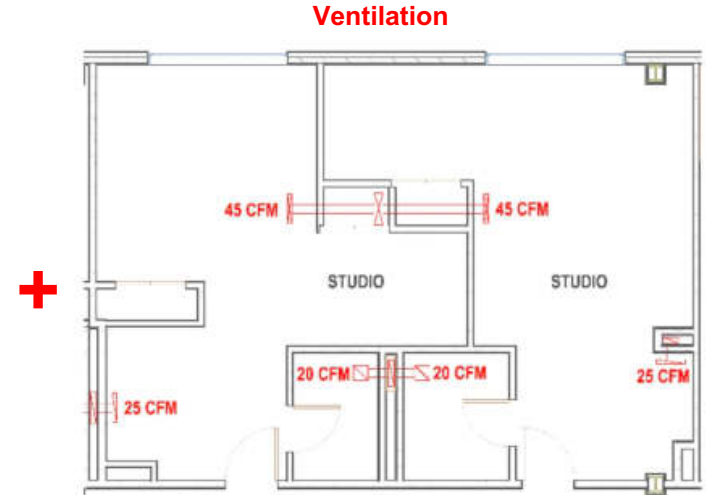


Figure 6: Rooftop layout with internal supply duct risers



HVAC/DHW SYSTEMS: BUILDING EVOLUTION CORPORATION

Achieve Performance & Durability Through A Relaxed Approach™

WUFI + SOLAR

MEETING THE PASSIVE HOUSE STANDARD

SITE ENERGY: 284,635 kWh/yr

SOLAR GENERATION: 179,228 kWh/yr

SITE EUI WITH SOLAR: 13 kBtu/sf/yr

The screenshot shows the PHius software interface for a 'Passive house verification' project. The left sidebar lists components and systems. The main panel shows the configuration for 'Device 1 (Photovoltaic / renewable energy) RoofTop PV'. The 'Required data' section is highlighted in yellow, showing 'Photovoltaic / renewable energy [kWh/yr]' set to 179228 and 'Onsite utilization [H]' set to 1.

BUILDING INFORMATION

Category: Residential
 Status: In planning
 Building type: Retrofit
 Year of construction:
 Units: 127
 Number of occupants: 138 (Design)
 Occupant density: 541.2 ft²/Person

Boundary conditions

Climate: MA - BEVERLY MUNI (Monthly)
 Internal heat gains: 1.5 Btu/hr ft²
 Interior temperature: 68 °F
 Overheat temperature: 77 °F

Building geometry

Enclosed volume: 1,047,013 ft³
 Net volume: 294,690 ft³
 Total area envelope: 76,372.8 ft²
 Area/Volume Ratio: 0.1 1/ft
 Floor area: 74,692 ft²
 Envelope area/CFA: 1.023

PASSIVEHOUSE REQUIREMENTS

Certificate criteria: PHIUS+ 2018

Heating demand

specific: 4.39 kBtu/ft²yr
 target: 6.4 kBtu/ft²yr
 total: 328,065.99 kBtu/yr



Cooling demand

sensible: 2.5 kBtu/ft²yr
 latent: 0.34 kBtu/ft²yr
 specific: 2.84 kBtu/ft²yr
 target: 7.2 kBtu/ft²yr
 total: 212,436.65 kBtu/yr



Heating load

specific: 4.32 Btu/hr ft²
 target: 5.6 Btu/hr ft²
 total: 322,769.73 Btu/hr



Cooling load

specific: 2.52 Btu/hr ft²
 target: 3 Btu/hr ft²
 total: 188,026.41 Btu/hr



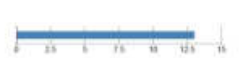
Source energy

total: 912,343.3 kWh/yr
 specific: 3,713 kWh/Person yr
 target: 3,840 kWh/Person yr
 total: 1,748,015.36 kBtu/yr
 specific: 23.41 kBtu/ft²yr



Site energy

total: 971,119.65 kBtu/yr
 specific: 13 kBtu/ft²yr
 total: 284,635.17 kWh/yr
 specific: 3.87 kWh/sf



Air tightness

ACH50: 0.97 1/hr
 CFM50 per envelope area: 0.06 cfm/ft²
 target: 0.97 1/hr
 target CFM50: 0.06 cfm/ft²



WUFI + SOLAR

MEETING THE PASSIVE HOUSE STANDARD

SITE ENERGY: 284,635 kWh/yr

SOLAR GENERATION: 179,228 kWh/yr

SITE EUI WITH SOLAR: 13 kBtu/sf/yr

BUILDING INFORMATION		
Category:	Residential	
Status:	In planning	
Building type:	Retrofit	
Year of construction:		
Units:	127	
Number of occupants:	138 (Design)	
Occupant density:	541.2 ft ² /Person	

Boundary conditions	Building geometry
Climate: MA - BEVERLY MUNI (Monthly)	Enclosed volume: 1,047,013 ft ³
Internal heat gains: 1.5 Btu/hr ft ²	Net-volume: 294,690 ft ³
Interior temperature: 68 °F	Total area envelope: 76,372.8 ft ²
Overheat temperature: 77 °F	Area/Volume Ratio: 0.1 1/ft
	Floor area: 74,692 ft ²
	Envelope area/CA: 1.023

PASSIVEHOUSE REQUIREMENTS	
Certificate criteria:	PHIUS+ 2018
Heating demand	
specific:	4.39 kBtu/ft ² yr
target:	6.4 kBtu/ft ² yr
total:	328,065.99 kBtu/yr
Cooling demand	
sensible:	2.5 kBtu/ft ² yr
latent:	0.34 kBtu/ft ² yr
specific:	2.84 kBtu/ft ² yr
target:	7.2 kBtu/ft ² yr
total:	212,438.65 kBtu/yr
Heating load	
specific:	4.32 Btu/hr ft ²
target:	5.6 Btu/hr ft ²
total:	322,769.73 Btu/hr
Cooling load	
specific:	2.52 Btu/hr ft ²
target:	3 Btu/hr ft ²
total:	188,096.41 Btu/hr
Source energy	
total:	912,343.3 kWh/yr
specific:	3,713 kWh/Person yr
target:	3,840 kWh/Person yr
total:	1,748,019.36 kBtu/yr
specific:	23.41 kBtu/ft ² yr
Site energy	
total:	971,119.65 kBtu/yr
specific:	13 kBtu/ft ² yr
total:	284,635.17 kWh/yr
specific:	3.81 kWh/ft ² yr
Air tightness	
ACH50:	0.97 1/hr
CFM50 per envelope area:	0.06 cfm/ft ²
target:	0.97 1/hr
target CFM50:	0.06 cfm/ft ²

WUFI + SOLAR

MEETING THE PASSIVE HOUSE STANDARD

SITE EUI WITH SOLAR: 13 kBtu/sf/yr

BASELINE EUI: 150 kBtu/sf/yr

92% BETTER THAN BASELINE

Scenario	Source Energy (kBtu/yr)	Site Energy (kBtu/yr)	EUI (kBtu/sq.ft./yr)
As Built	15,467,548	11,128,557	150 ¹

BUILDING INFORMATION

Category:	Residential
Status:	In planning
Building type:	Retrofit
Year of construction:	
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Floor area:	74,692 ft ²
Envelope area/CA:	1.023

PASSIVEHOUSE REQUIREMENTS

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Heating demand

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Cooling load

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total:	188,026.41 Btu/hr	

Source energy

total:	912,343.3 kWh/yr	
specific:	3.713 kWh/Person yr	
target:	3,840 kWh/Person yr	
total:	1,748,015.36 kBtu/yr	
specific:	23.41 kBtu/ft ² yr	

Site energy

total:	971,119.65 kBtu/yr	
specific:	13 kBtu/ft ² yr	
total:	284,635.17 kWh/yr	
specific:	3.81 kWh/ft ²	

Air tightness

ACH50:	0.97 1/hr	
CFM50 per envelope area:	0.06 cfm/ft ²	
target:	0.97 1/hr	
target CFM50:	0.06 cfm/ft ²	

PRICING:



ITEM	A	B	C	D	E	F	G	H	I	J															
	DESCRIPTION OF WORK	Unit Price Estimate	Direct Cost	Markup	Material Cost	Material Markup	Sub Contractor	Sub Con. Markup	Total																
			10.00%			20.0%																			
Division 1 - General Requirements																									
01-29-0000	Project Protection	\$3.00	\$7,500	\$750	\$0	\$0	\$0	\$0	\$0	\$8,250															
01-31-0000	Project Closeout	\$0.40	\$1,000	\$100	\$0	\$0	\$0	\$0	\$0	\$1,100															
01-31-0000	Project Meeting	\$0.70	\$7,400	\$740	\$0	\$0	\$0	\$0	\$0	\$8,140															
01-31-0000	Project Scheduling	\$0.20	\$14,800	\$1,480	\$0	\$0	\$0	\$0	\$0	\$16,280															
01-31-0000	Temporary Security	\$0.10	\$1,100	\$110	\$0	\$0	\$0	\$0	\$0	\$1,210															
01-31-0000	Temporary Utility Service	\$0.02	\$1,500	\$150	\$0	\$0	\$0	\$0	\$0	\$1,650															
01-31-0000	Tool Equipment Rental	\$1.32	\$12,400	\$1,240	\$0	\$0	\$0	\$0	\$0	\$13,640															
01-31-0000	Temporary Fuel Expenses	\$0.04	\$3,000	\$300	\$0	\$0	\$0	\$0	\$0	\$3,300															
01-31-0000	Traffic Control	\$4.40	\$440	\$44	\$0	\$0	\$0	\$0	\$0	\$484															
01-31-0000	Temporary Fencing	\$0.10	\$7,400	\$740	\$0	\$0	\$0	\$0	\$0	\$8,140															
01-31-0000	Temporary Fuel Control	\$0.02	\$1,500	\$150	\$0	\$0	\$0	\$0	\$0	\$1,650															
01-74-0000	Site Supervision	\$40.00	\$4,000	\$400	\$0	\$0	\$0	\$0	\$0	\$4,400															
01-74-0000	Site Maintenance	\$0.20	\$14,800	\$1,480	\$0	\$0	\$0	\$0	\$0	\$16,280															
01-74-0000	Water Drainoff	\$0.50	\$22,200	\$2,220	\$0	\$0	\$0	\$0	\$0	\$24,420															
01-74-0000	Final Clean	\$0.20	\$14,800	\$1,480	\$0	\$0	\$0	\$0	\$0	\$16,280															
01-74-0000	Punch List	\$0.30	\$22,200	\$2,220	\$0	\$0	\$0	\$0	\$0	\$24,420															
Division 2 - Mosaic																									
02-20-0000	Installation	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0															
Division 4 - Masonry																									
04-10-0000	Block Masonry Finish	\$0	\$0	\$0	\$0	\$0	\$0	\$50,000	\$7,500	\$57,500															
Division 6 - Wood & Plastics																									
06-01-0000	Hardwood Unit	\$177.00	\$0	\$0	\$40,000	\$8,000	\$0	\$0	\$0	\$48,000															
06-43-0000	Hardwood Sub.	\$1,540.00	\$00	\$0	\$0	\$0	\$990,000	\$45,500	\$534,200	\$534,200															
Division 7 - Thermal & Mechanical Protection																									
07-14-0000	Application of Insulating Sub.	\$1,000	\$100	\$0	\$0	\$0	\$0	\$3,800	\$510	\$1,510															
07-21-1300	Insulation Installation in DT 13.000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0															
07-21-1300	Insulation Sub.	\$0.50	\$0	\$0	\$0	\$0	\$0	\$3,000	\$400	\$3,400															
07-27-0000	Air Barrier Mem.	\$0	\$0	\$0	\$10,000	\$2,000	\$0	\$0	\$0	\$12,000															
07-27-0000	Air Barrier Sub. Installation in DT 43.000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0															
07-27-0000	Air Barrier Sub. Installation in DT 43.000	\$40.00	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$40,000															
07-43-0000	Exposed Steel Framing Assembly Mem.	\$40.00	\$0	\$0	\$0	\$47,200	\$0	\$0	\$0	\$47,200															
07-43-0000	Exposed Steel Framing Sub.	\$15.00	\$15,000	\$1,500	\$0	\$0	\$401,000	\$80,200	\$481,200	\$496,200															
Division 8 - Windows & Doors																									
08-14-0000	Exterior Glass Unit Installation in DT 43.000	\$1	\$1	\$0	\$0	\$0	\$0	\$0	\$0	\$1															
08-14-0000	Exterior Glass Sub. Installation in DT 43.000	\$1	\$1	\$0	\$0	\$0	\$0	\$0	\$0	\$1															
08-14-0000	Window Unit Installation in DT 43.000	\$100	\$0	\$0	\$0	\$0	\$10,000	\$1,000	\$1,100	\$11,100															
08-30-0000	Window Mem. Installation in DT 43.000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0															
08-30-0000	Window Sub. Installation in DT 43.000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0															
Division 9 - Finishes																									
09-19-2300	Interior Paint Sub. Installation in DT 21.0000	\$1,000	\$100	\$0	\$0	\$0	\$0	\$20,000	\$3,000	\$24,000															
Division 22 - Plumbing																									
22-00-0000	Plumbing Installation in DT 22.0000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0															
22-00-0000	Plumbing Unit Installation in DT 22.0000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0															
22-00-0000	Plumbing Sub. Installation in DT 22.0000	\$20,000	\$0,000	\$0,000	\$0	\$0	\$1,400,000	\$277,000	\$2,104,000	\$2,124,000															
Division 23 - HVAC																									
23-00-0000	Installation of Variable Air Volume Units and RRV	\$14,000.00	\$10,000	\$1,000	\$0	\$0	\$2,000,000	\$300,000	\$2,301,000	\$2,301,000															
23-00-0000	Installation of Units	\$44,000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$44,000															
Division 24 - Electrical																									
24-00-0000	Electrical Installation in DT 24.0000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0															
24-00-0000	Electrical Unit Installation in DT 24.0000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0															
24-00-0000	Electrical Sub. Installation in DT 24.0000	\$10,000	\$10,000	\$1,000	\$0	\$0	\$3,700,000	\$55,000	\$4,256,000	\$4,266,000															
24-00-0000	Lighting Installation	\$1,000	\$1,000	\$100	\$0	\$0	\$0	\$0	\$0	\$1,100															
44-14-0000	Energy Efficient Power Generation Equipment Sub.	\$3,00	\$3,000	\$300	\$0	\$0	\$222,000	\$33,500	\$225,500	\$228,500															
Division 25 - Exterior Improvements																									
25-10-0000	Painting Sub.	\$0	\$0	\$0	\$0	\$0	\$0	\$3,400	\$510	\$4,000															
25-12-2300	Sidewalk Sub.	\$0	\$0	\$0	\$0	\$0	\$0	\$6,300	\$750	\$7,050															
25-40-0000	Landscape Sub.	\$1,000	\$100	\$0	\$0	\$0	\$0	\$2,800	\$420	\$3,220															
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 80%;"></td> <td style="text-align: right;">Total</td> <td>\$13,641,000</td> </tr> <tr> <td></td> <td style="text-align: right;">Cost by Unit</td> <td>\$107,409</td> </tr> <tr> <td></td> <td style="text-align: right;">SQFT cost by GSF</td> <td>\$184</td> </tr> <tr> <td></td> <td style="text-align: right;">SQFT cost by GSF of Envelope</td> <td>\$283</td> </tr> </table>												Total	\$13,641,000		Cost by Unit	\$107,409		SQFT cost by GSF	\$184		SQFT cost by GSF of Envelope	\$283			
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	SQFT cost by GSF	\$184																							
	SQFT cost by GSF of Envelope	\$283																							
Add Alternative 001 - Centralized Ventilation System																									
33-22-0000	Centralized RRV System Sub.- Add	\$45,000	\$10,000	\$1,000	\$0	\$0	\$1,200,000	\$184,000	\$1,385,000	\$1,430,000															
Add Alternative 002 - Through-wall RRV																									
23-00-0000	Installation of Through-wall RRV Units - Add	\$4,000.00	\$0	\$0	\$0	\$0	\$0	\$870,400	\$131,000	\$1,001,400															
23-00-0000	Installation of Through-wall RRV Units - Add	\$12,000.00	\$1,000	\$1,000	\$0	\$0	\$0	\$120,000	\$18,000	\$139,000															
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	Cost by Unit	\$110,723																							
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	SQFT cost by GSF of Envelope	\$283																							
Add Alternative 003 - Through-wall RRV																									
23-00-0000	Installation of Through-wall RRV Units - Add	\$4,000.00	\$0	\$0	\$0	\$0	\$0	\$870,400	\$131,000	\$1,001,400															
23-00-0000	Installation of Through-wall RRV Units - Add	\$12,000.00	\$1,000	\$1,000	\$0	\$0	\$0	\$120,000	\$18,000	\$139,000															
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	Add Total	\$13,666,796																							
	Adjusted Total	\$13,666,796																							
	Cost by Unit	\$112,409																							
	SQFT cost by GSF	\$171																							
	SQFT cost by GSF of Envelope	\$257																							

Basis Of Design:

1. Ephoca Vertical Stack
2. Panelized System: \$60/sf installed

\$13,641,000.00
\$184/sf (GFA)

\$107,409.00 per unit



LESSONS LEARNED.....so far

1. Most panelized manufacturers are very new to this space of Deep Exterior Energy Retrofits, so, many are not yet prepared for scaling up.
2. Many panelized manufacturers are not vertically integrated between the factory and the site installation, and so we are getting a wide range of installation costs. Need to work toward more vertically integrated solutions.
3. Pipelines matter. Several manufacturers became interested only when we could demonstrate to them that there was a pipeline of work which was at a scale that justified their R+D and attention.
4. None of our projects have established budgets so we are designing these strategies in a vacuum. This is not sustainable. While each building is unique, with unique climates, unique labor costs, etc, we need to establish a range of baseline costs that can guide all Solution Providers, Building Owners and Manufacturers.
5. Along with a lack of baseline budget information that has all DERs make sense financially, we also have no replicable strategy to finance these projects. We need a replicable financing strategy for DERs.
6. Have not even begun to think about a Solution Provider offering a GUARANTEE on energy consumption/maintenance as was done with Energiesprong. Need to understand how this could be possible.