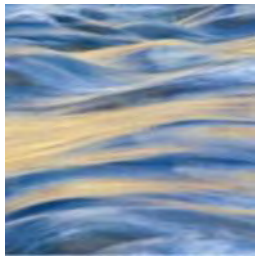




PATRICIA CHEN
ARCHITECTURE



Cold Climate Single-Family Comfort



Design Team

Architect/CPHC

Patricia Chen Architecture, LLC

MEP

Staengl Engineering

Civil

Rapanotti Design

Structural

Eclipse Engineering

Builder

Wright Construction Company, Inc.

Rater

Airtight Energy Consulting, Inc.

Photographer

David Barnum

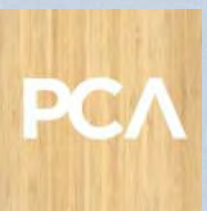


Design

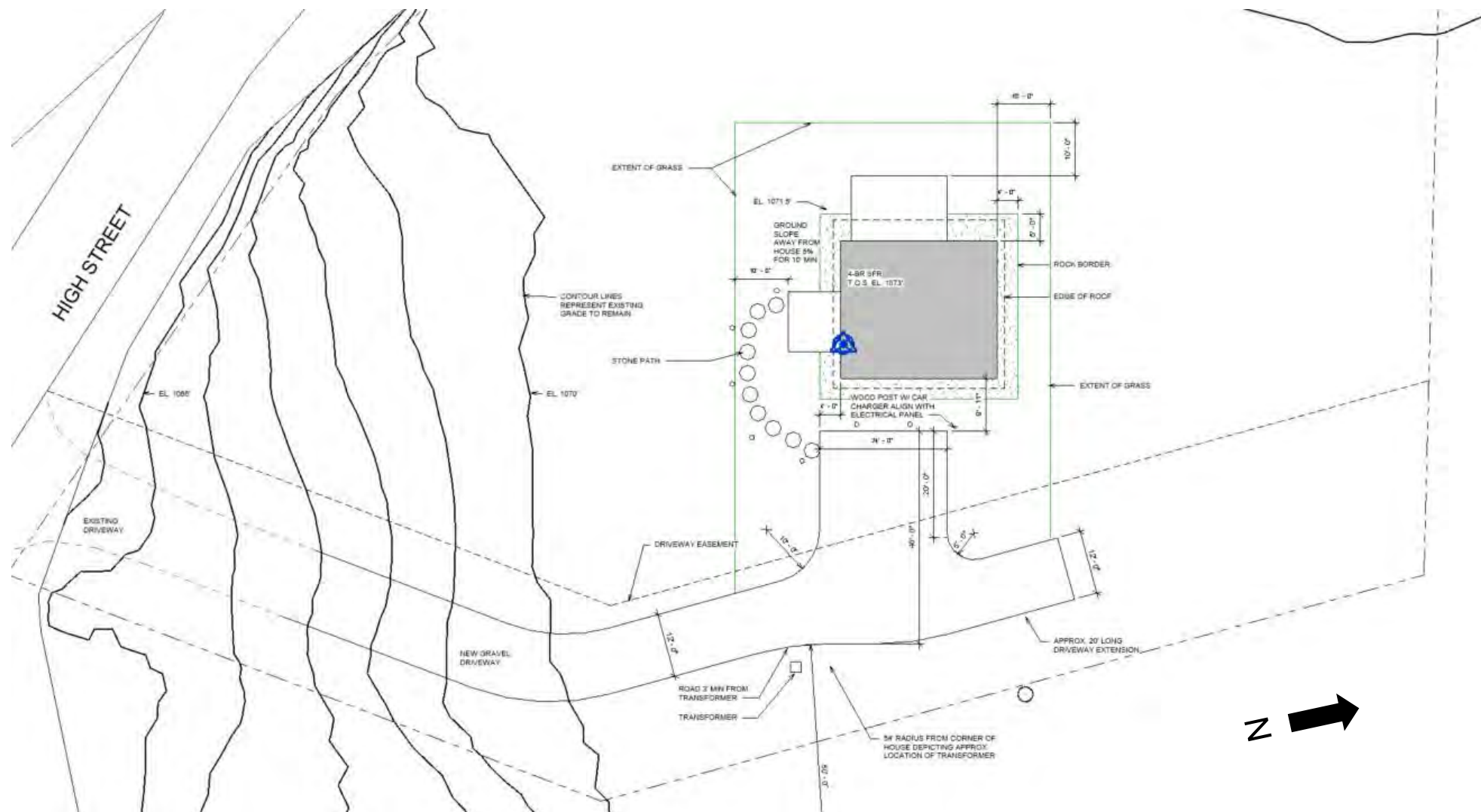


Design Criteria

- Passive House
- No Fuel Burned
- Thermal Comfort

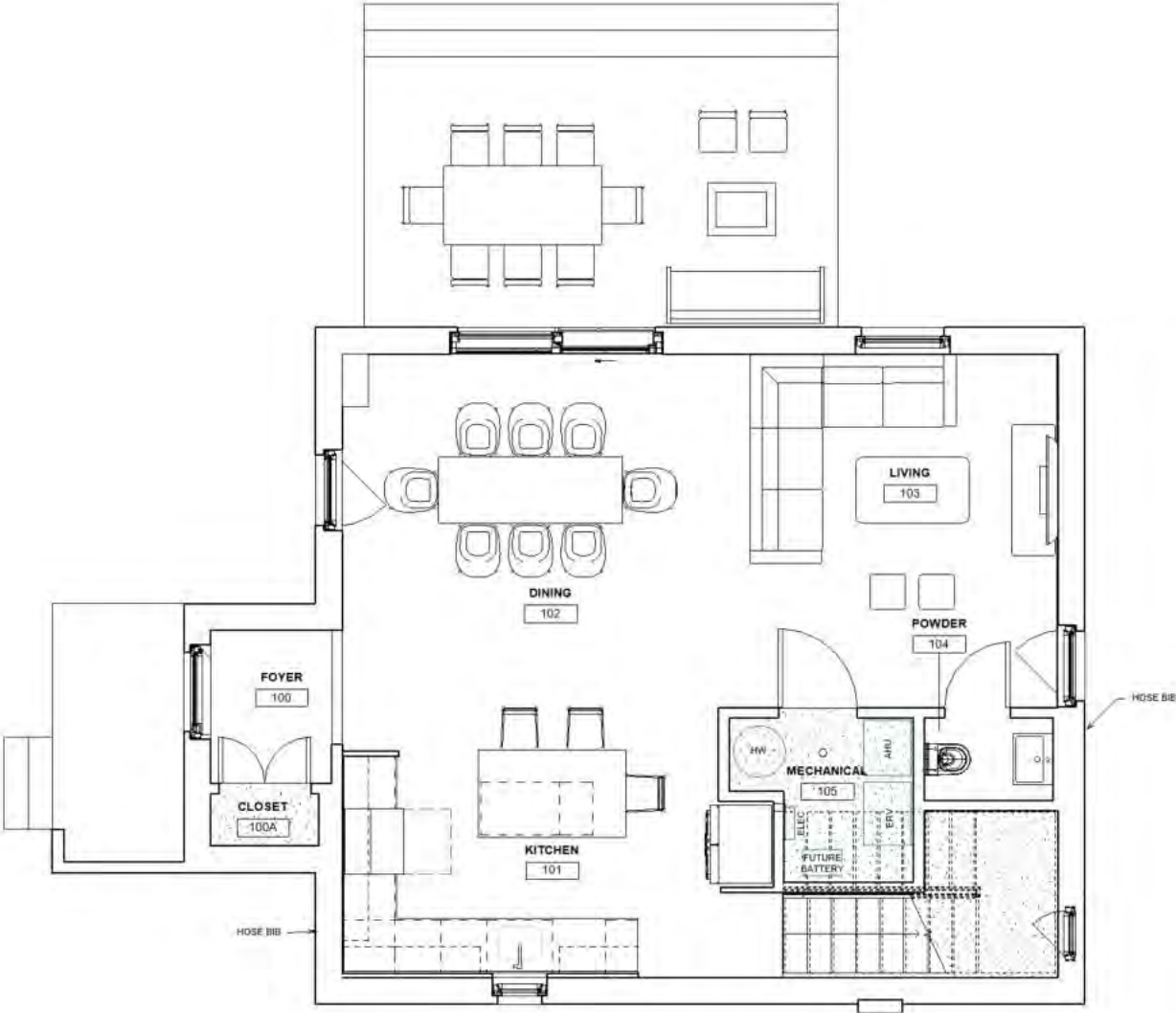


Ludlow, Vermont



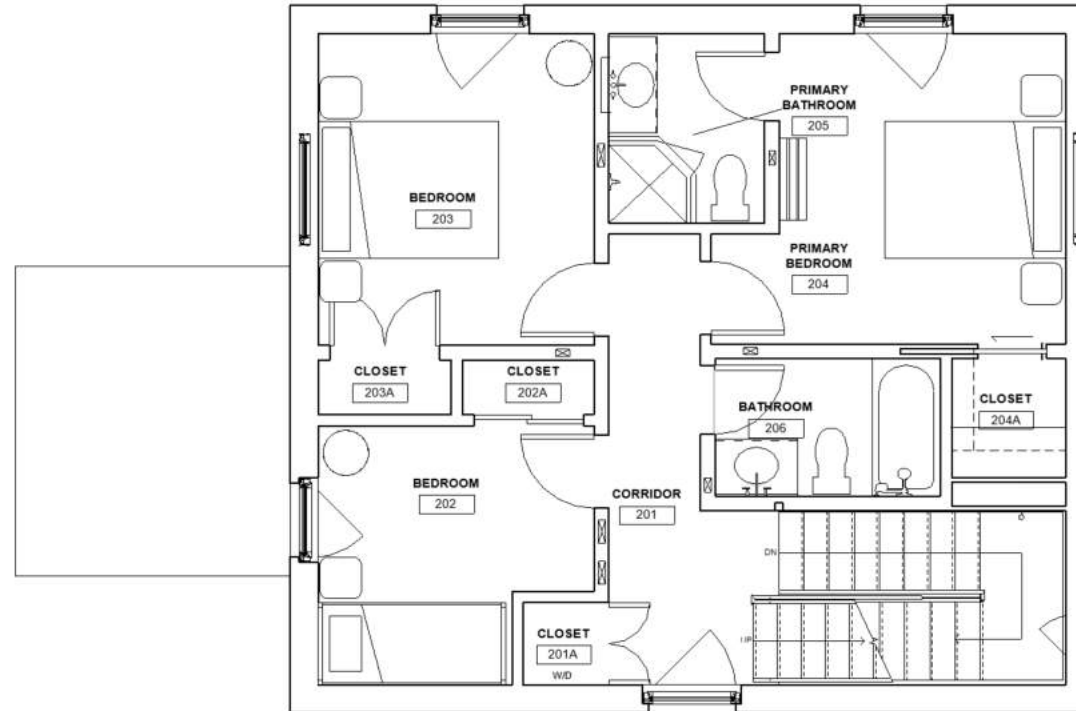


First Floor





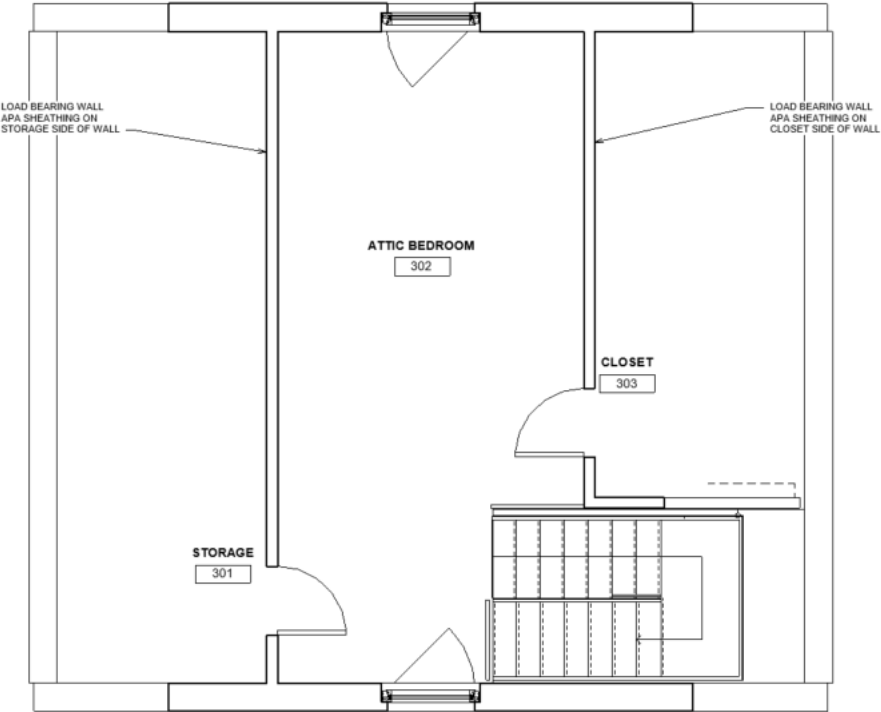
Second Floor





PHIUS Core 2021

Single-Family



PHIUS Core 2021 Single-Family

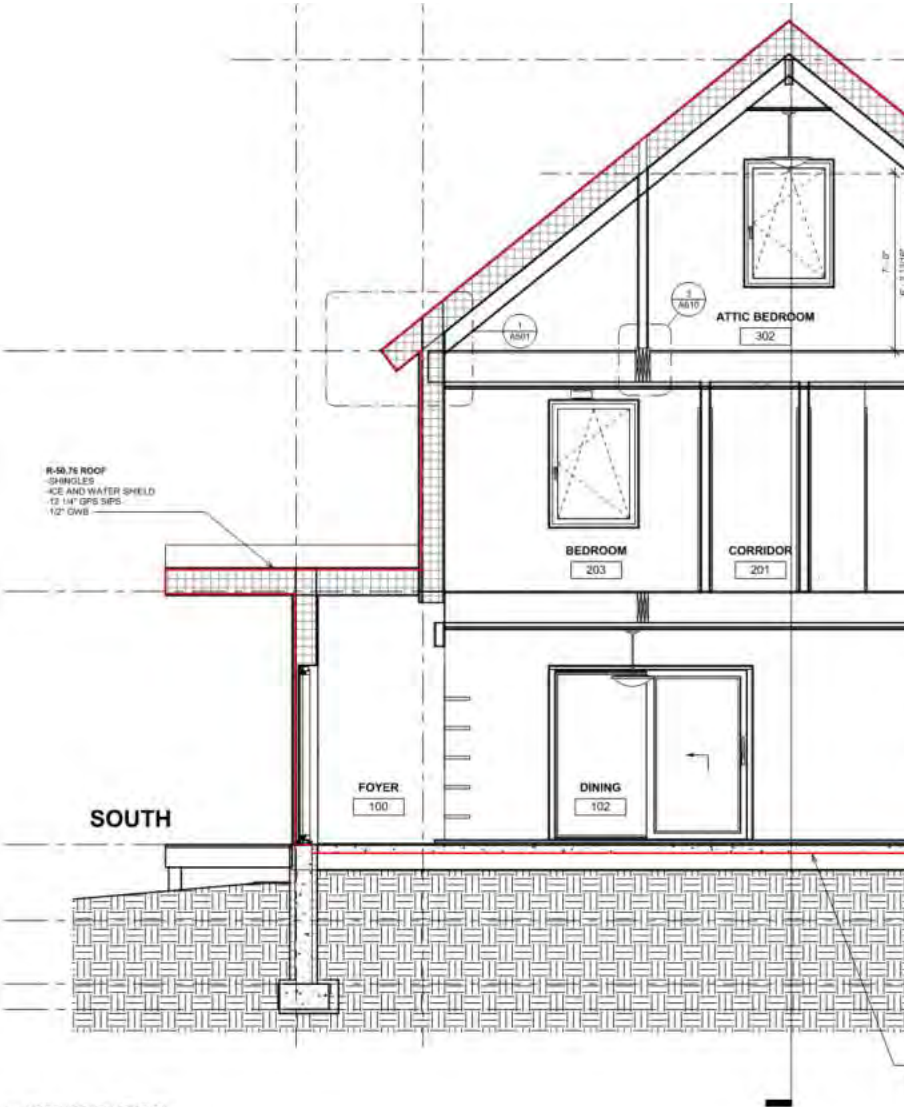


- 4 Bedroom
- 2.5 Bathrooms
- Open Living/Dining/Kitchen

- Floor area: 1,621 sf
- Enclosed Volume: 20,840 cf
- Net Volume: 12,386.5 cf
- Total Area Envelope: 4,594.7 sf
- Envelope area/iCFA: 2.835



Building Section Thermal Performance



Climate Zone	6A
Maximum Window U-value (Btu/hr.sq.ft.)	0.14
Maximum SHGC	NR
Minimum Projection Factor	NR
Minimum SRE for E/HRVs	0.83
Minimum TRE for E/HRVs	NR
Minimum Wall R-value	45
Minimum Roof R-value	77
Minimum Unconditioned Basement / Crawlspace Ceiling R-value	30
Minimum Below-grade walls / floors R-value	25
Minimum Rating Required for Air-Source Heat Pumps	Minimum COP @ 5°F: 1.75
Minimum SEER Required for Air-Source Heat Pumps	15

- Roof R-84
- Walls R-50
- Foundation R-21
- Floor R-33
- Windows R-10±
 - U_{COG} 0.092
 - U_{Frame} 0.15
- Airtightness 0.05 CFM₅₀/SF



Passive House Requirements

PASSIVEHOUSE REQUIREMENTS

Certificate criteria: Phius CORE 2021

Heating demand



Cooling demand



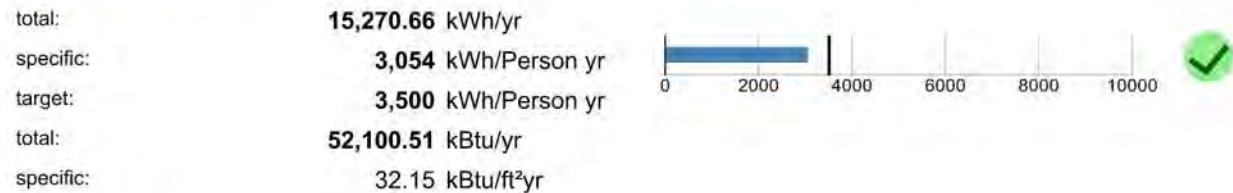
Heating load



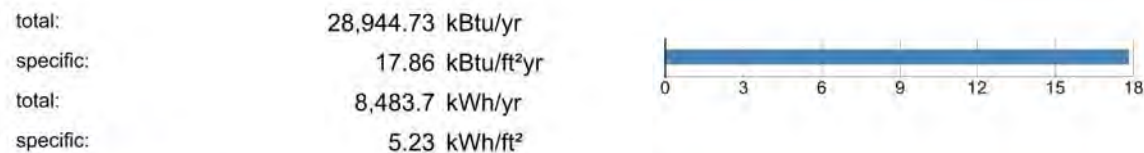
Cooling load



Source energy



Site energy



Air tightness





Total Heating & Cooling Demand

HVAC

Total heating demand:

Total cooling demand:

Total DHW energy demand:

Solar DHW contribution:

Auxiliary electricity:

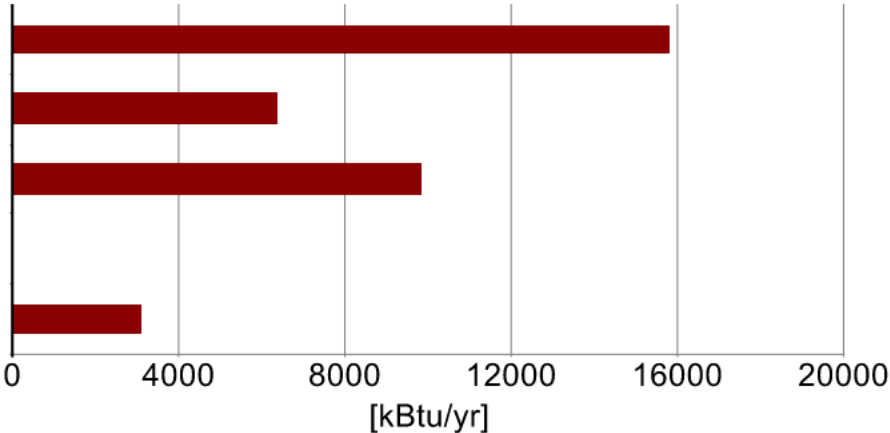
15,837 kBtu/yr

6,329 kBtu/yr

9,850 kBtu/yr

0 kBtu/yr

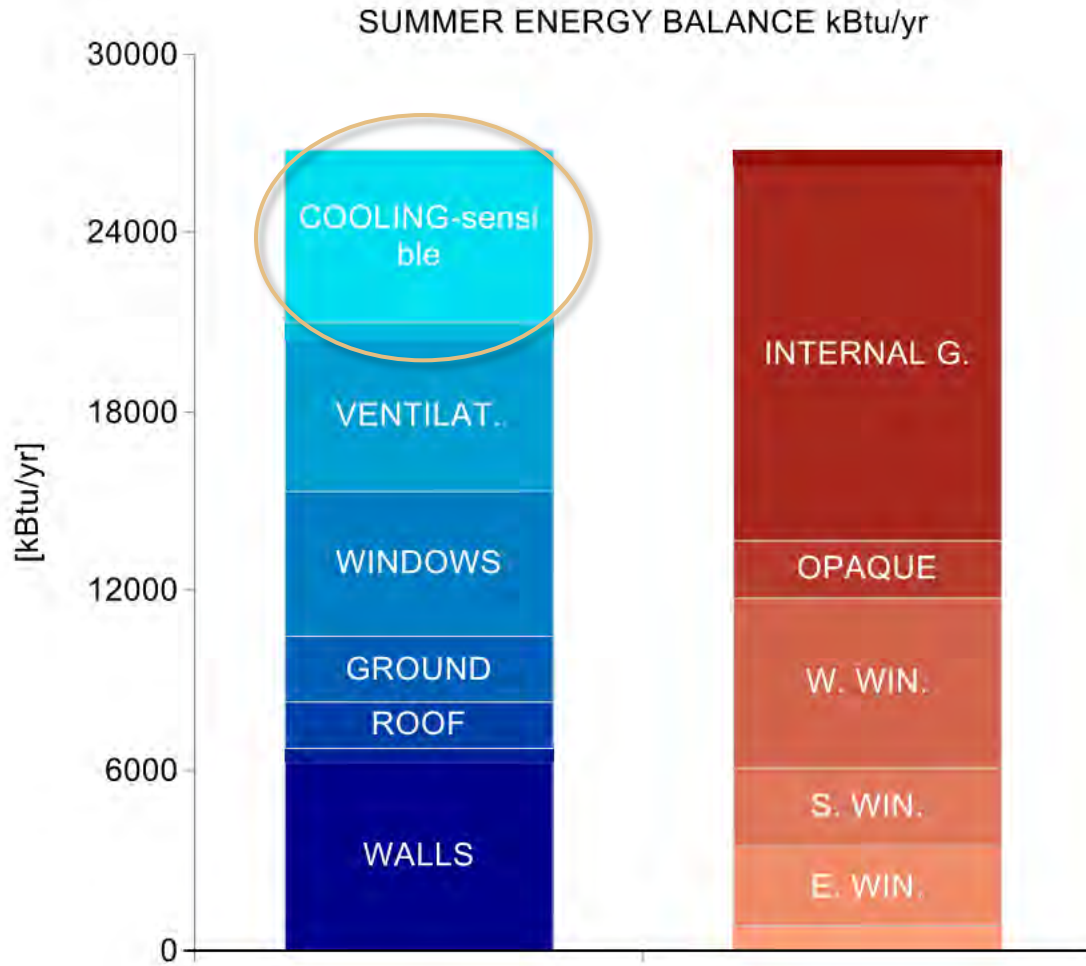
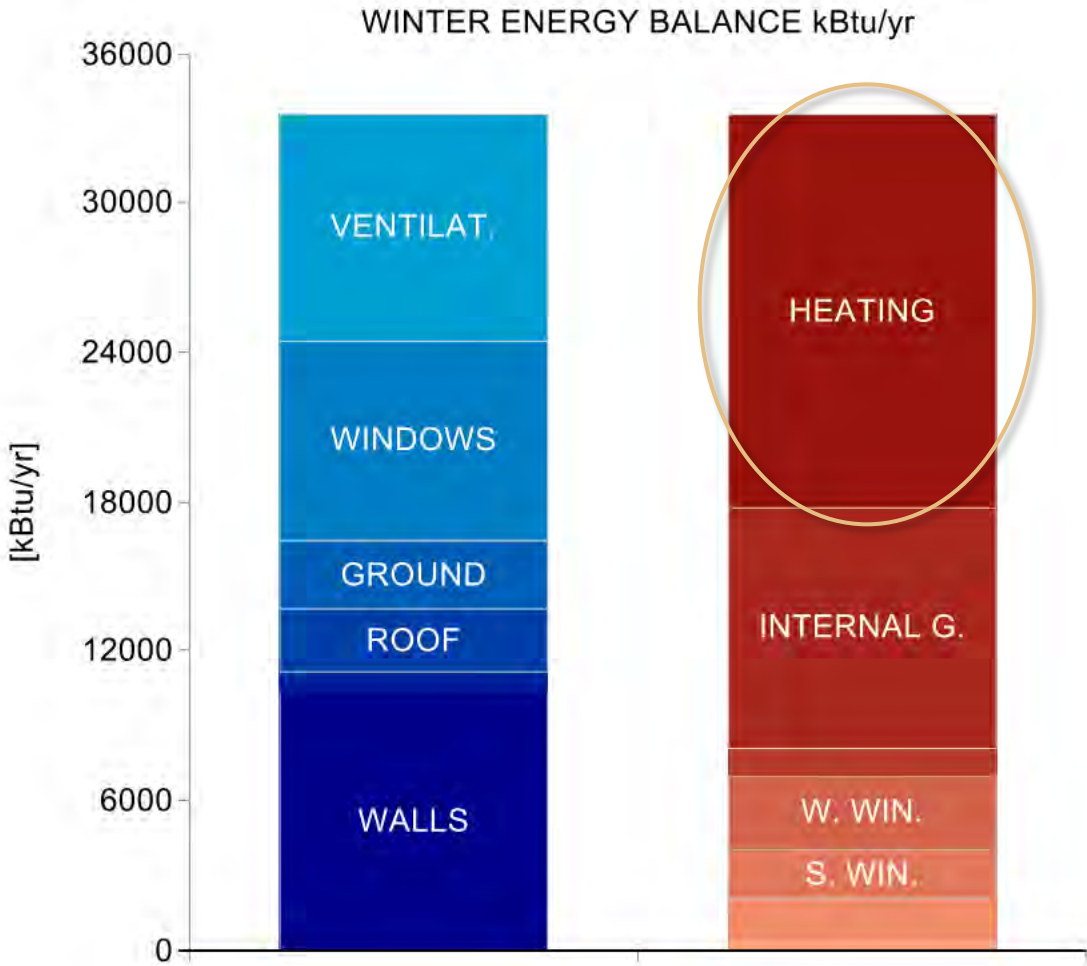
3,084 kBtu/yr





Energy Balance

L€





Heat Pump Performance



GE Appliances Connect
Central Air Conditioning Heat Pump (HP)
Singlezone Ducted, Centrally Ducted
AHRI Cert #: **206799410**
Outdoor Unit Model #: **AUH2436ZGDA***
Indoor Model #: **UUY24ZGDAB***

🔥 Maximum Heating Capacity (Btu/h) @5°F: **23,000**
🔥 Rated Heating Capacity (Btu/h) @47°F: **24,000**
❄️ Rated Cooling Capacity (Btu/h) @95°F: **24,000**

Advanced Data – Sizing for Heating

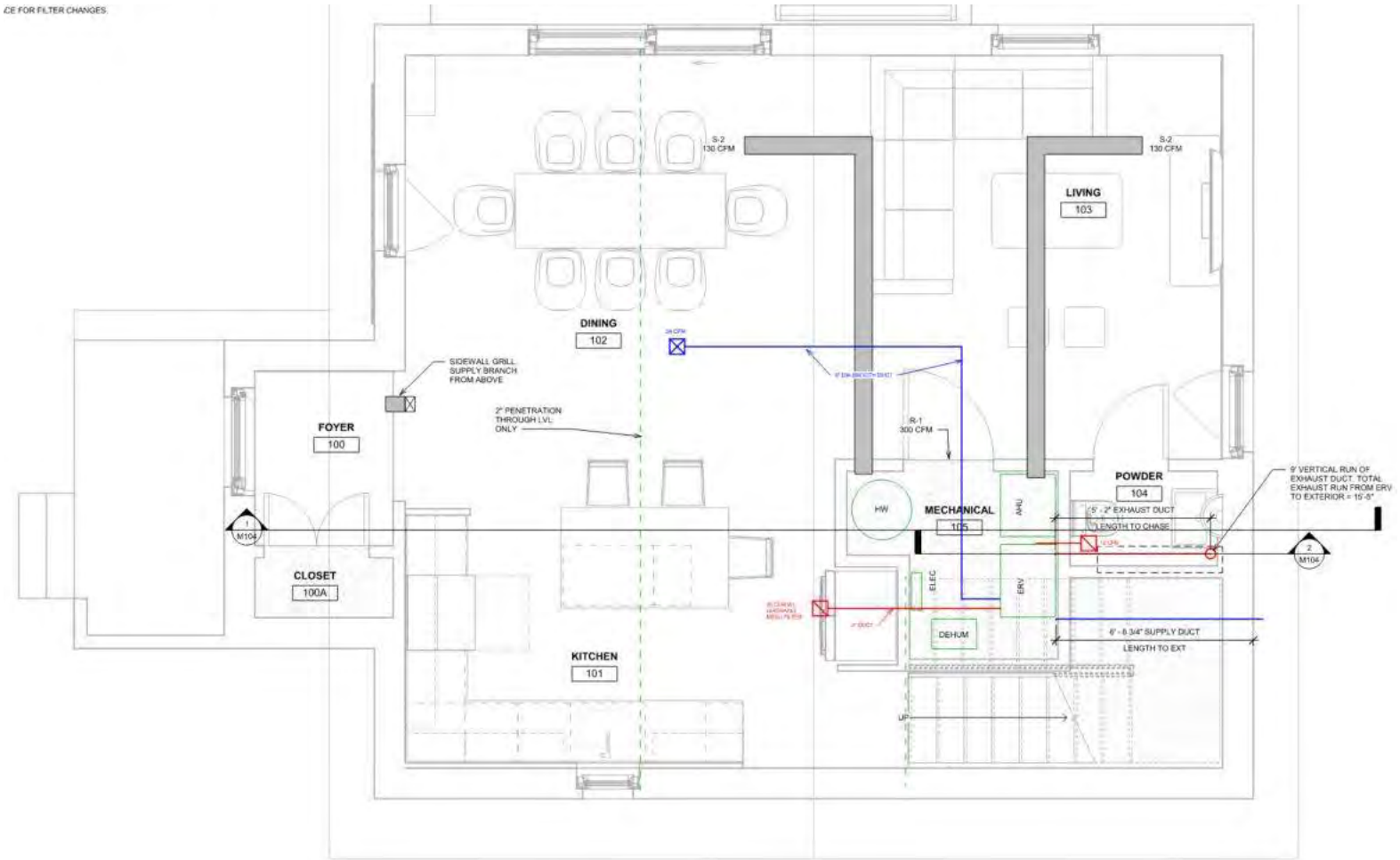
Information Tables		Performance Specs						
Brand	GE Appliances	Heating / Cooling	Outdoor Dry Bulb	Indoor Dry Bulb	Unit	Min	Rated	Max
Series	Connect	Cooling	95°F	80°F	Btu/h	9,000	24,000	24,000
Ducting Configuration	Singlezone Ducted, Centrally Ducted				kW	0.69	2	2
AHRI Certificate #	206799410				COP	3.82	3.52	3.52
Outdoor Unit Model #	AUH2436ZGDA*	Cooling	82°F	80°F	Btu/h	10,500	-	24,400
Indoor Model #	UUY24ZGDAB*				kW	0.56	-	1.6
Indoor Unit Type					COP	5.5	-	4.47
Furnace Model #		Heating	47°F	70°F	Btu/h	9,100	24,000	24,000
EER	12.5				kW	0.61	2.07	2.07
SEER	20				COP	4.37	3.4	3.4
HSPF (Region IV)	10.5	Heating	17°F	70°F	Btu/h	13,400	16,000	16,000
EER2	12				kW	1.49	2.03	2.03
SEER2	17				COP	2.64	2.31	2.31
HSPF2 (Region IV)	9	Heating	5°F	70°F	Btu/h	14,600	22,000	23,000
HSPF2 (Region V)	7				kW	1.94	3.58	3.74
ENERGY STAR V6.1	👍				COP	2.21	1.8	1.8
ENERGY STAR V6.1 Cold Climate	👍	Heating	-22°F	70°F	Btu/h	14,300	-	18,800
ENERGY STAR V5.0					kW	2.76	-	3.91
Capacity Maintenance (Rated 17°F/Rated 47°F)	66%				COP	1.52	-	1.41
Capacity Maintenance (Rated 5°F/Rated 47°F)	91%							
Capacity Maintenance (Max 5°F/Rated 47°F)	95%							

- Heat Pump Criteria - The outdoor unit is to be inverter-driven with at least 18 SEER, capable of providing heat at -13°F
- Solution - Installed a single-zone ducted split system heat pump – 2 ton, 20 SEER, capable of providing heat at -22°F

Implementation

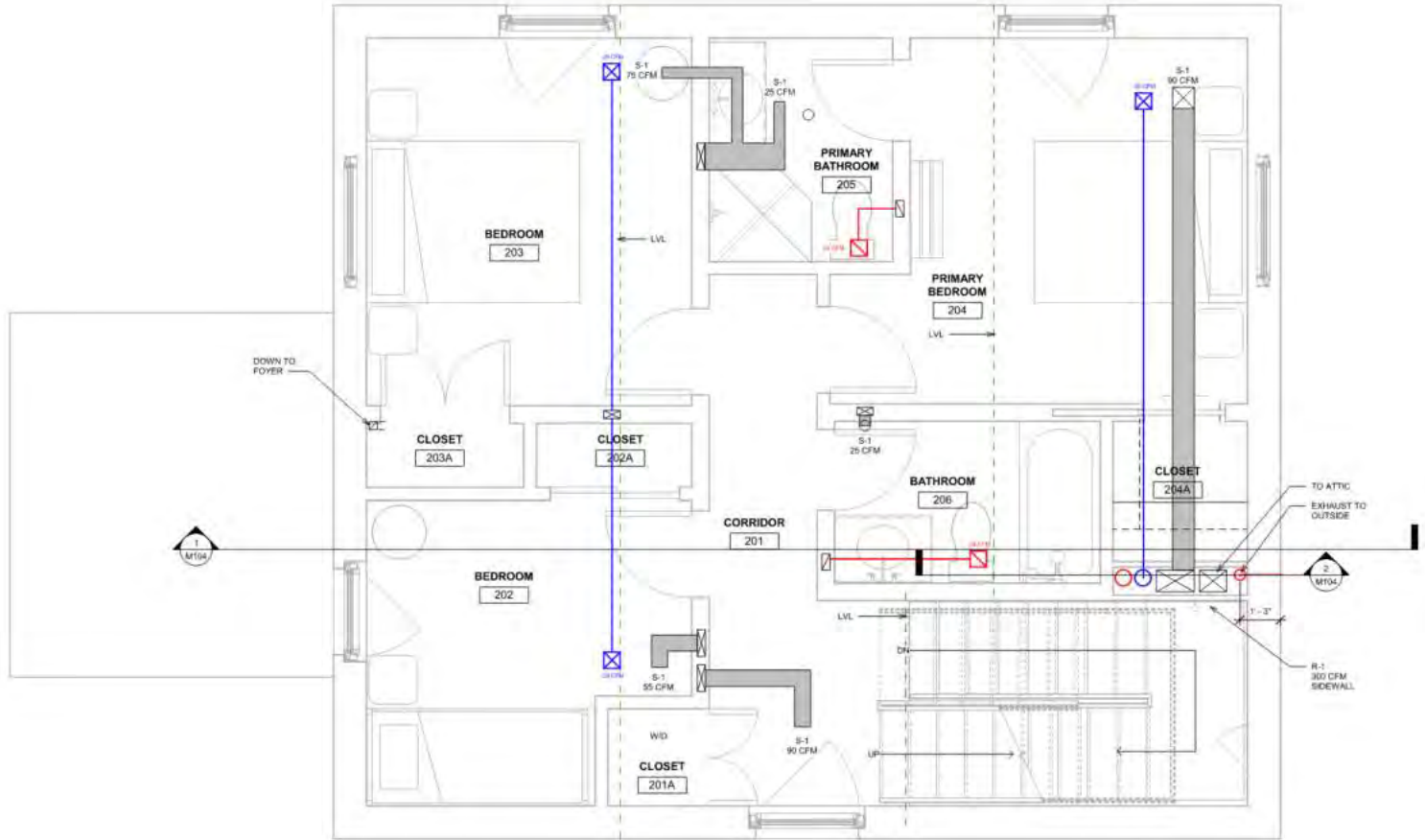


Distribution First Floor



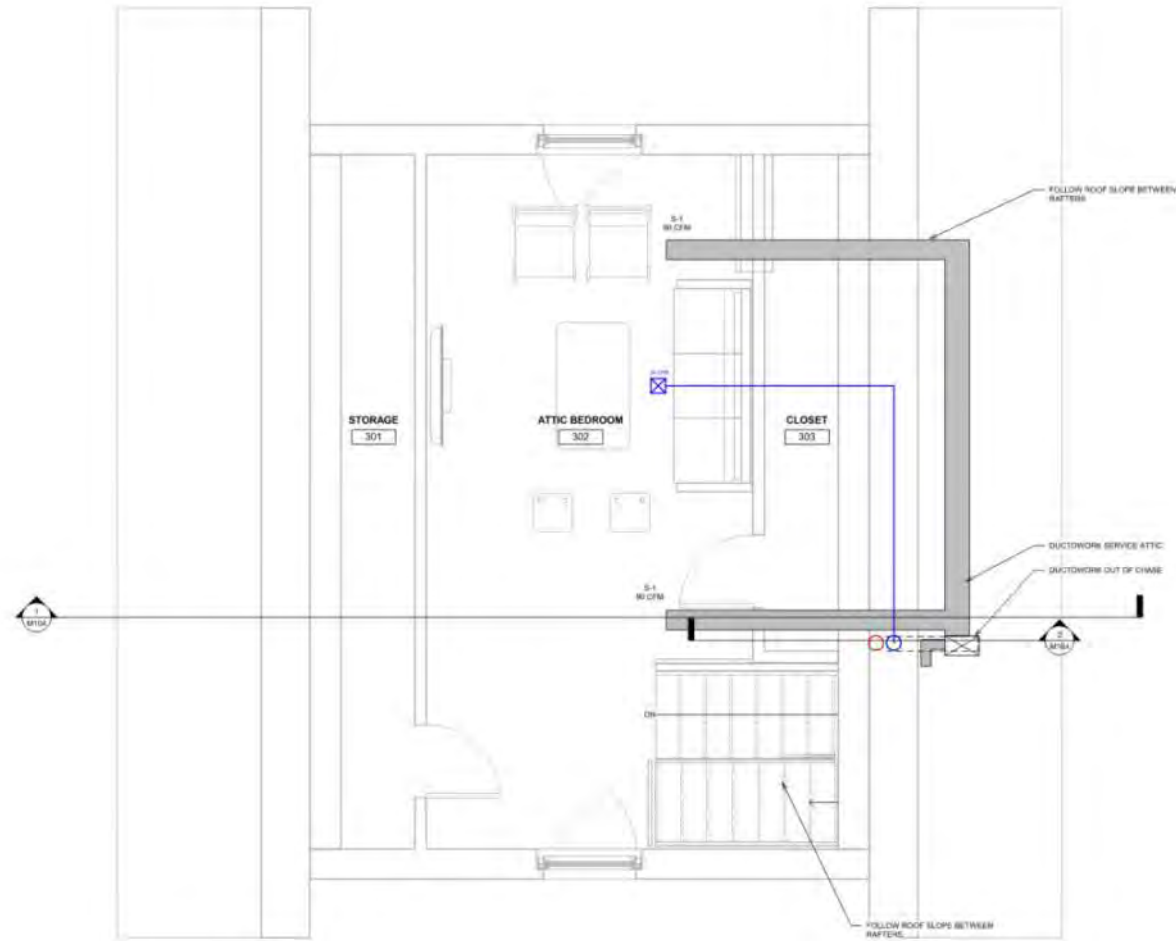


Distribution Second Floor





Distribution Attic





Distribution Section





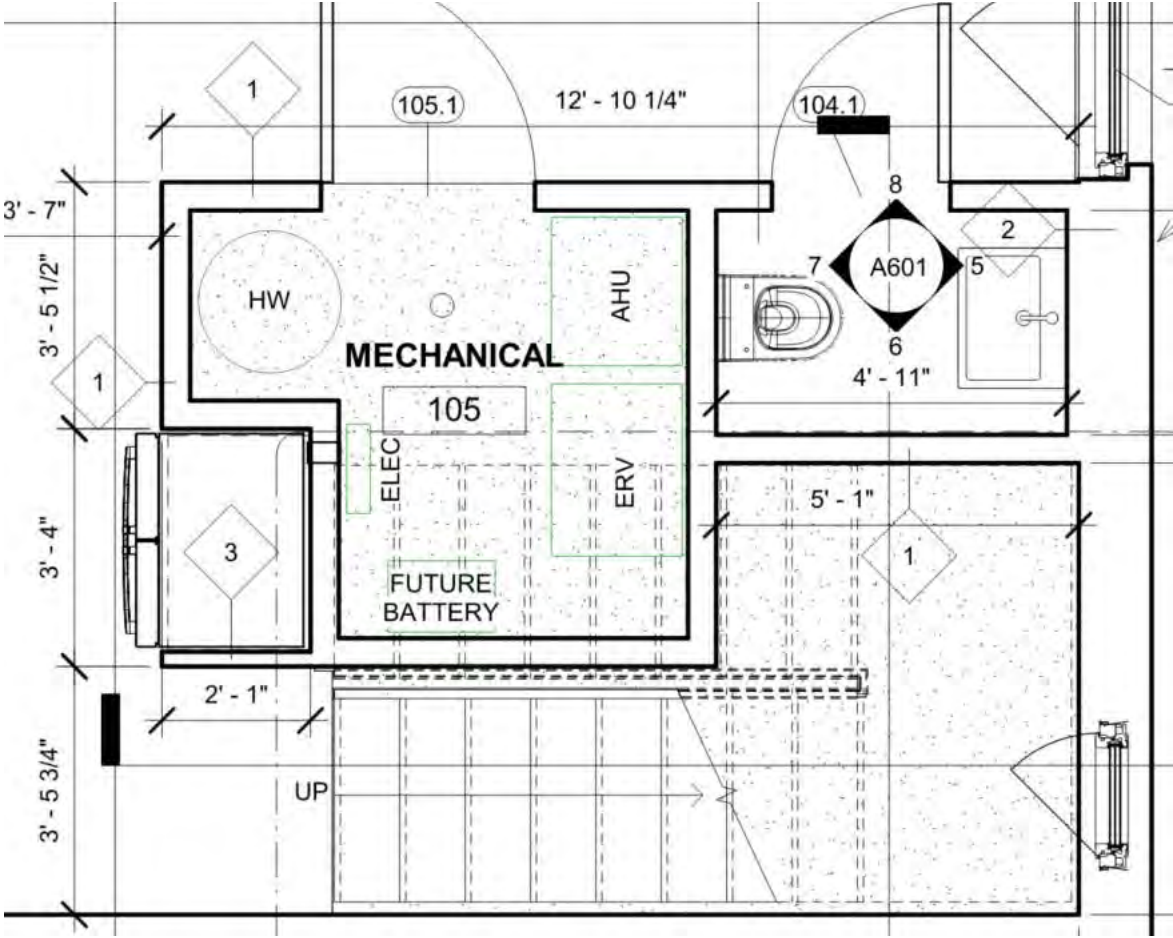


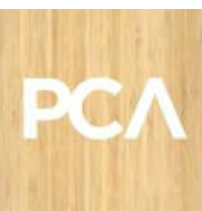
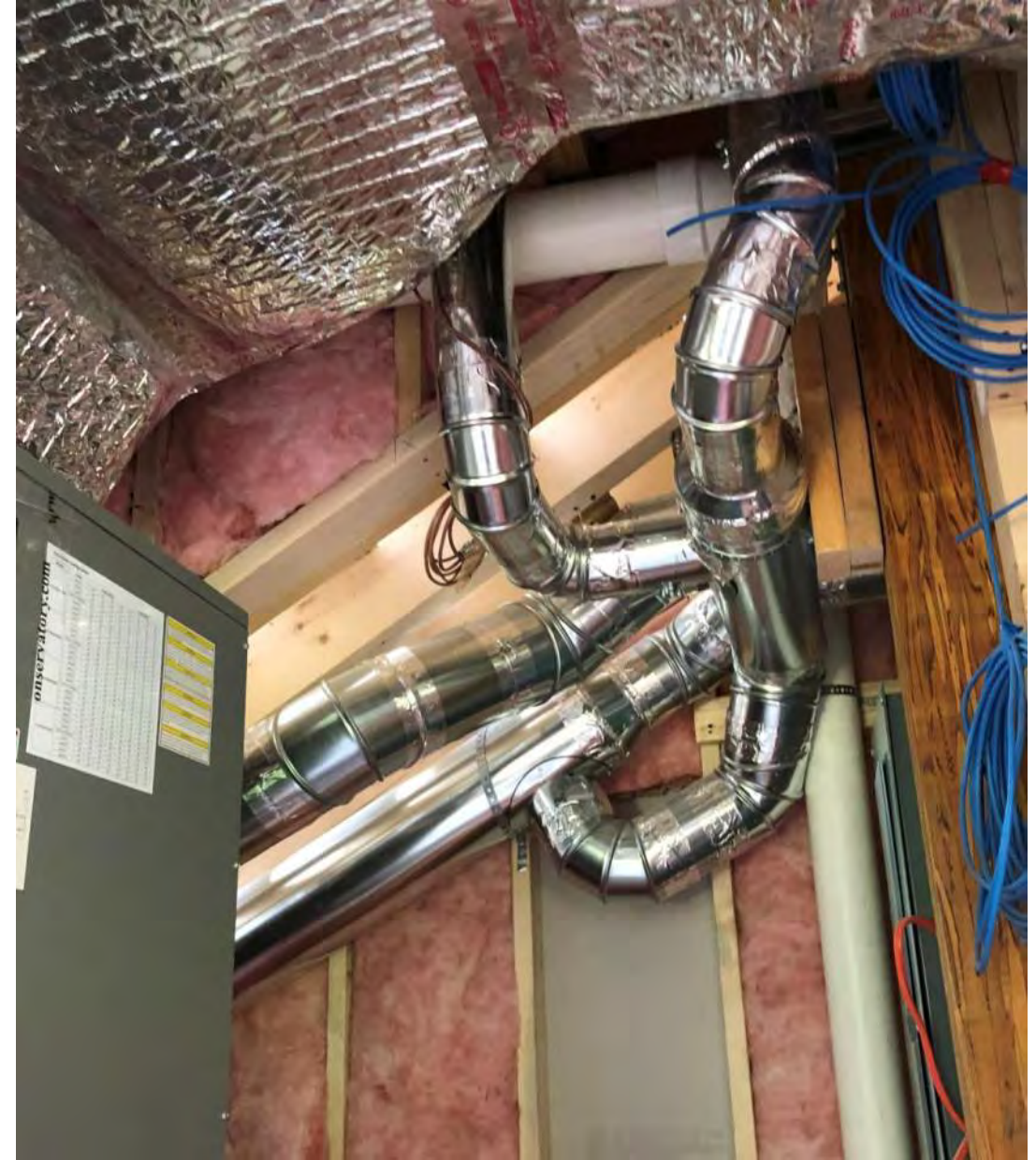
Challenges

1. Not enough space
2. Stratification
3. Electric Back-up



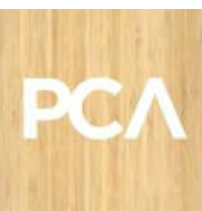
Floor Plan Mechanical Room



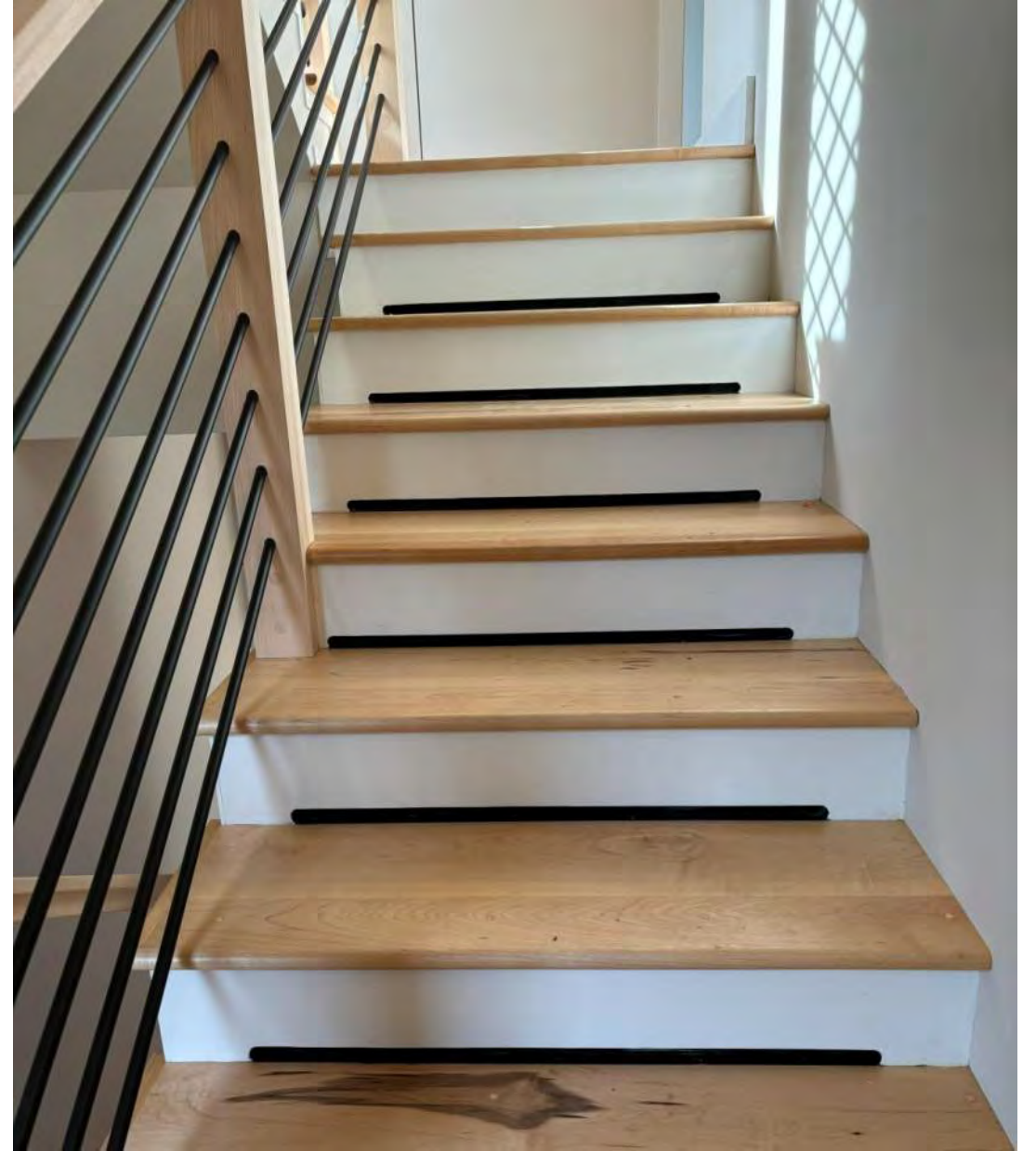


Ductwork





Ductwork



Heat Pump Hot Water Heater



ACCESSORIES

Electric Heat Kit

8kW Heater with 45A breaker (Model# UAZEHO8W)



Electrical Requirement	
Power Supply	208/230V, 1 Phase, 60 HZ
Operating Voltage Range	187-253 VAC
Control Voltage	24VAC
Recommended Fuse/Breaker Size	Indoor: 15A Electric Heater: 8kW: 45A
Outdoor MCA/MOP	25A/37A

Operating Range	
Cooling	5-129°F (-5-54°C)
Heating	-22-75°F (-30-24°C)

Cooling Performance	
Rated Cooling Capacity	24,000 BTU
SEER	20
EER	12.5
Moisture Removal	6.03 Pt./Hr

Heating Performance	
Rated Heating Capacity	24,000 BTU
HSFP	10.5
Supplemental Electric Heat (optional)	8kW

Piping	
Maximum Pipe Length	164 ft
Maximum Pipe Height Difference	50 ft
Connections	3/8"(Discharge) 3/4"(Suction)
The outdoor unit ships with flared soft copper adapters that are swaged for a brazed connection on the exterior of the outdoor unit.	



Electric Back-up

Completion











































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Thank you