

BUILDING INFORMATION

Category:	Residential
Status:	In planning
Building type:	New construction
Year of construction:	2014
Units:	1
Number of occupants:	3.5 (Verification)



Boundary conditions

Climate:	PORTLAND INTL JETPORT ME
Internal heat gains:	0.7 Btu/hr ft ²
Interior temperature:	68 °F
Overheat temperature:	77 °F

Building geometry

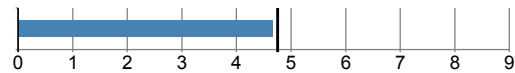
Enclosed volume:	10955.2 ft ³
Total area envelope:	5278.8 ft ²
AV ratio:	0.5 1/ft
Floor area:	1336 ft ²

PASSIVEHOUSE REQUIREMENTS

Certificate criteria: Default Standard

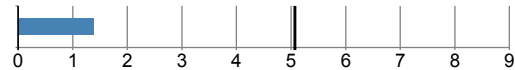
Heating demand

specific:	4.67 kBtu/ft ² yr
target:	4.75 kBtu/ft ² yr
total:	6232.63 kBtu/yr



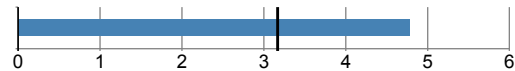
Cooling demand

specific:	1.39 kBtu/ft ² yr
target:	5.07 kBtu/ft ² yr
total:	1852.78 kBtu/yr
latent:	0.01 kBtu/ft ² yr



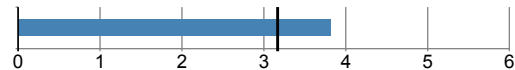
Heating load

specific:	4.78 Btu/hr ft ²
target:	3.17 kBtu/ft ² yr
total:	6379.88 Btu/hr



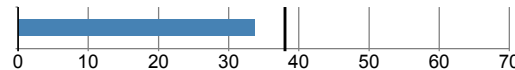
Cooling load

specific:	3.82 Btu/hr ft ²
target:	3.17 kBtu/ft ² yr
total:	5103.05 Btu/hr



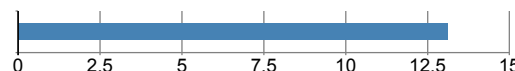
Primary energy

specific:	33.65 kBtu/ft ² yr
target:	38.04 kBtu/ft ² yr
total:	44953.85 kBtu/yr



Site energy

total:	13.12 kBtu/ft ² yr
building systems:	37.3 kBtu/yr
photovoltaic savings:	0 kBtu/ft ² yr



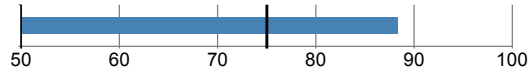
Air tightness

ACH50:	0.6 1/hr
target:	0.6 1/hr
CFM50 per envelope area:	0.02 cfm/ft ²
target:	0.05 cfm/ft ²

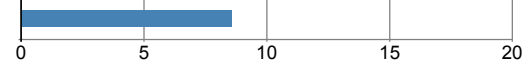


PASSIVEHOUSE RECOMMENDATIONS

HRV efficiency: **88.3 %**



Frequency of overheating: **8.6 %**
Cooling system is not required

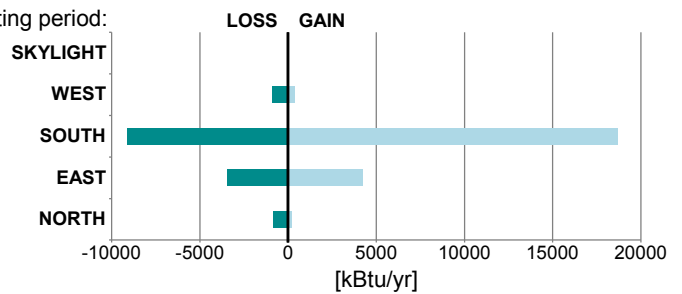


BUILDING ELEMENTS

Windows

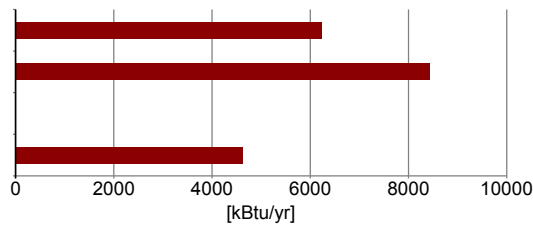
Average SHGC: **0.49**
Average solar reduction factor heating: **0.41**
Average solar reduction factor cooling: **0.33**
Average U-value: **0.151 Btu/hr ft² °F**
Total glazing area: **361.9 ft²**

Heat gain/loss heating period:



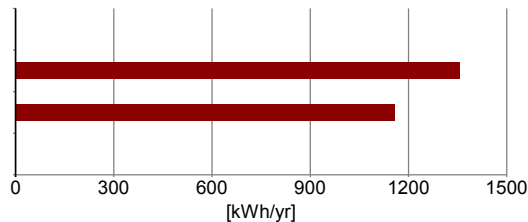
HVAC

Total heating demand: **6233 kBtu/yr**
Total DHW energy demand: **8437 kBtu/yr**
Solar DHW contribution: **0 kBtu/yr**
Auxiliary electricity: **4630 kBtu/yr**



Electricity

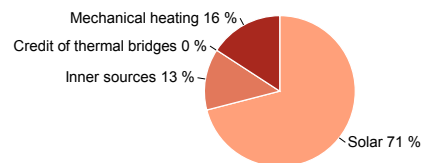
Direct heating / DHW: **0 kWh/yr**
HVAC auxiliary energy: **1357 kWh/yr**
Appliances: **1158 kWh/yr**
Output PV system: **0 kWh/yr**
Total electricity demand: **2515 kWh/yr**



HEAT FLOW

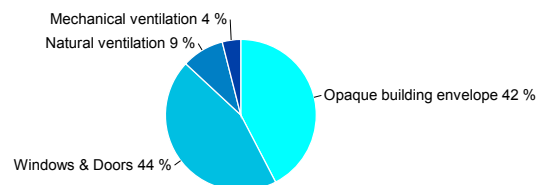
Heat gains

Solar: **23617 kBtu/yr**
Inner sources: **4376 kBtu/yr**
Credit of thermal bridges: **0 kBtu/yr**
Mechanical heating: **6233 kBtu/yr**



Heat losses

Opaque building envelope: **14521 kBtu/yr**
Windows & Doors: **15226 kBtu/yr**
Natural ventilation: **3111 kBtu/yr**
Mechanical ventilation: **1367 kBtu/yr**

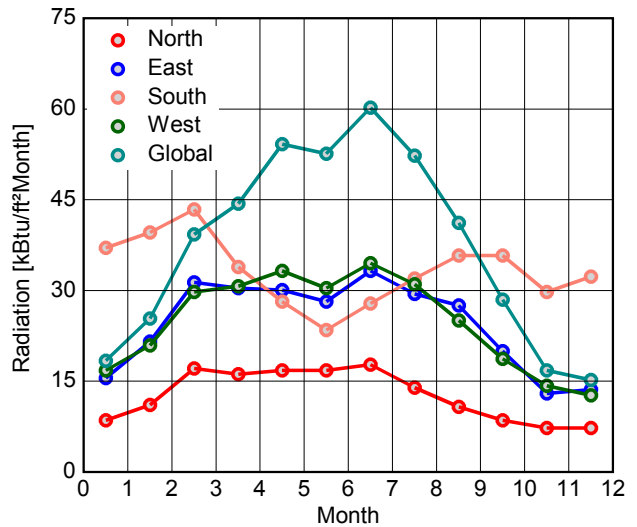
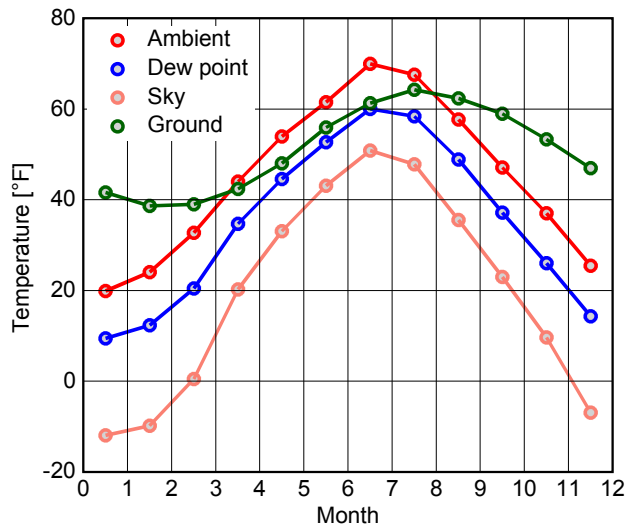


CLIMATE

Latitude: **43.7 °**
 Longitude: **-70.3 °**
 Elevation of weather station: **45.9 ft**
 Elevation of building site: **45.9 ft**
 Heat capacity air: **0.018 Btu/ft³F**
 Daily temperature swing summer: **18.2 °F**
 Average wind speed: **13.1 ft/s**

Ground

Average ground surface temperature: **47 °F**
 Amplitude ground surface temperature: **57 °F**
 Ground thermal conductivity: **1.2 Btu/hr ft °F**
 Ground heat capacity: **29.8 Btu/ft³F**
 Depth below grade of groundwater: **n.def.**
 Flow rate groundwater: **n.def.**



Calculation parameters

Length of heating period: **243 days/yr**
 Heating degree hours: **184.2 kFh/a**
 Phase shift months: **1.4 mths**

Climate for	Heating load 1	Heating load 2	Cooling
Temperature [°F]	5.4	31.1	78.3
Solar radiation North [Btu/hr ft²]	12.7	7.9	26.9
Solar radiation East [Btu/hr ft²]	24.7	12.7	54.5
Solar radiation South [Btu/hr ft²]	58.6	20.9	42.8
Solar radiation West [Btu/hr ft²]	26.3	12	61.8
Solar radiation Global [Btu/hr ft²]	28.5	13.9	103.7

Relevant boundary conditions for heating load calculation: Heating load 1

ANNUAL HEAT DEMAND

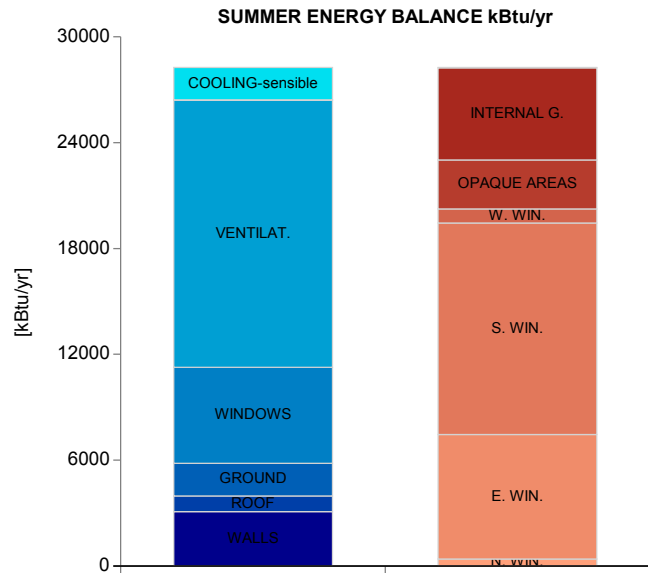
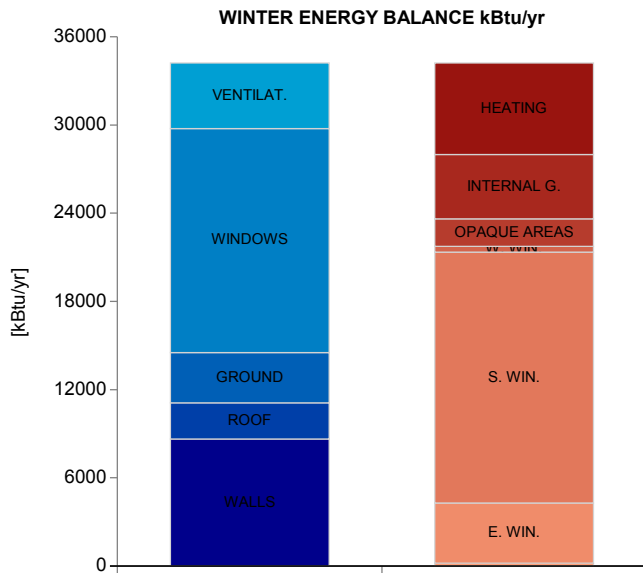
Transmission losses :	29747 kBtu/yr
Ventilation losses:	4478 kBtu/yr
Total heat losses:	34225 kBtu/yr
Solar heat gains:	27989 kBtu/yr
Internal heat gains:	5186 kBtu/yr
Total heat gains:	33176 kBtu/yr
Utilization factor:	84.4 %
Useful heat gains:	27993 kBtu/yr

Annual heat demand:	6233 kBtu/yr
Specific annual heat demand:	4665.6 Btu/ft ² yr

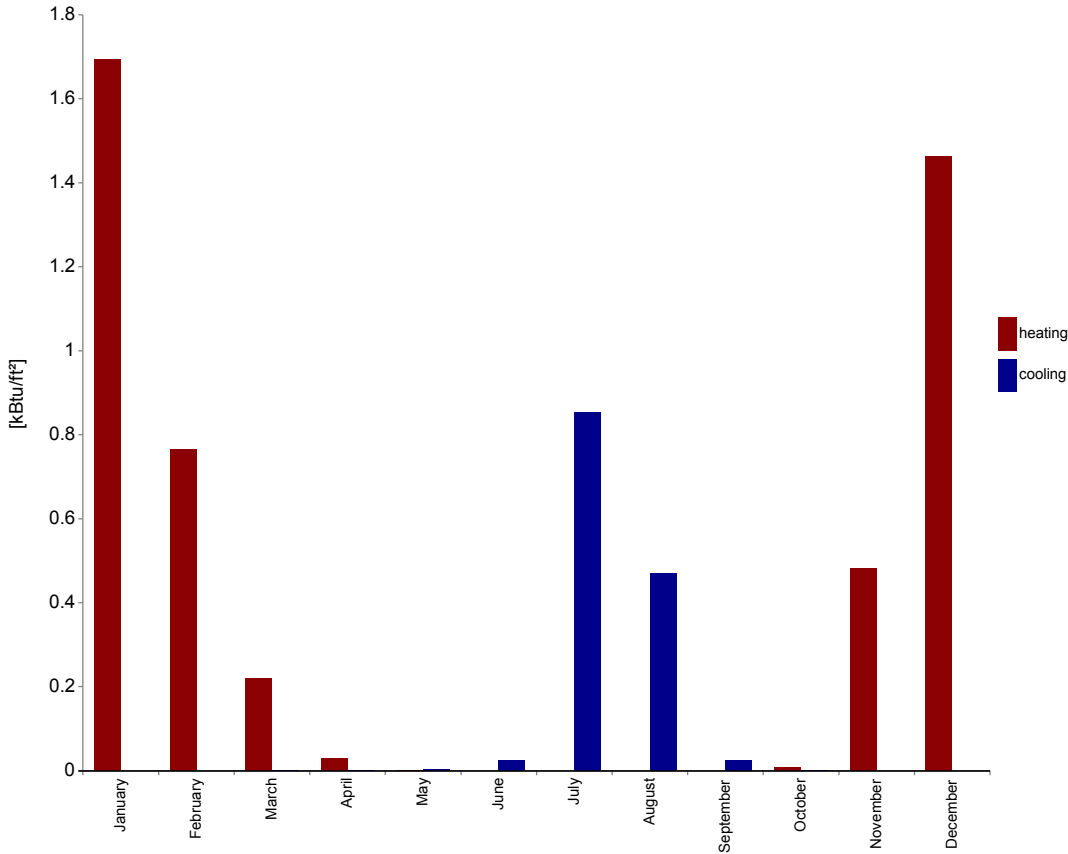
ANNUAL COOLING DEMAND

Solar heat gains:	23022 kBtu/yr
Internal heat gains:	5229 kBtu/yr
Total heat gains:	28251 kBtu/yr
Transmission losses :	22097 kBtu/yr
Ventilation losses:	29715 kBtu/yr
Total heat losses:	51811 kBtu/yr
Utilization factor:	51 %
Useful heat losses:	26412 kBtu/yr

Cooling demand - sensible:	1840 kBtu/yr
Cooling demand - latent:	13 kBtu/yr
Annual cooling demand:	1853 kBtu/yr
Specific annual cooling demand:	1.4 kBtu/ft ² yr



SPECIFIC HEAT/COOLING DEMAND MONTHLY



Month	Heating [kBtu/ft²]	Cooling [kBtu/ft²]
January	1.7	0
February	0.8	0
March	0.2	0
April	0	0
May	0	0
June	0	0
July	0	0.9
August	0	0.5
September	0	0
October	0	0
November	0.5	0
December	1.5	0

HEATING LOAD

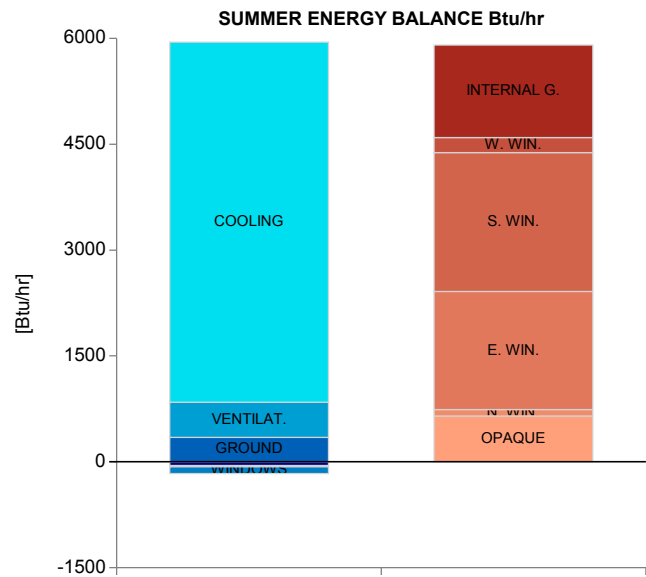
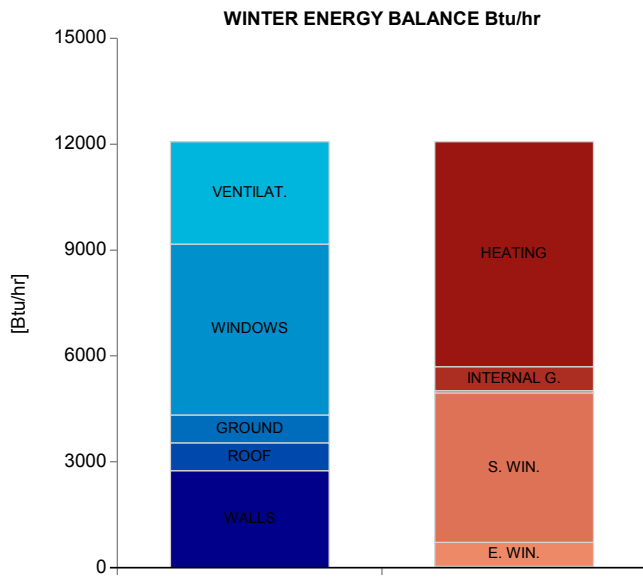
	First climate	Second climate
Transmission heat losses:	9164.6 Btu/hr	5722.4 Btu/hr
Ventilation heat losses:	2909 Btu/hr	1713.6 Btu/hr
Total heat loss:	12073.5 Btu/hr	7436 Btu/hr
Solar heat gain:	5016 Btu/hr	1911.4 Btu/hr
Internal heat gain:	677.6 Btu/hr	677.6 Btu/hr
Total heat gains heating:	5693.7 Btu/hr	2589 Btu/hr
Heating load:	6379.9 Btu/hr	4847 Btu/hr

Relevant heating load: **6379.9** Btu/hr
 Specific heating load: **4.8** Btu/hr ft²

COOLING LOAD

Solar heat gain:	4592.8 Btu/hr
Internal heat gain:	1312.9 Btu/hr
Total heat gains cooling:	5905.6 Btu/hr
Transmission heat losses:	302.7 Btu/hr
Ventilation heat losses:	499.9 Btu/hr
Total heat loss:	802.6 Btu/hr
Cooling load - sensible:	5103 Btu/hr
Cooling load - latent:	0 Btu/hr

Relevant cooling load: **5103** Btu/hr
 Specific maximum cooling load: **3.8** Btu/hr ft²

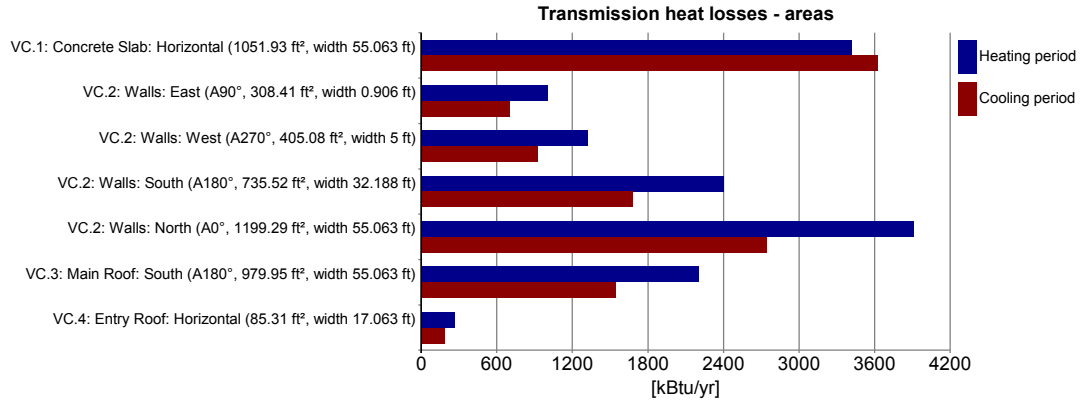


AREAS

Name	Area [ft²]	Average U-value [Btu/hr ft² °F]	Absorption coefficient	Emission coefficient	Reduction factor shading [%]	Transmission losses heating [kBtu/yr]	Transmission losses cooling [kBtu/yr]
VC.1: Concrete Slab: Horizontal (1051.93 ft², width 55.063 ft)	1051.9	0.026	0	0	0	3416.1	3626.7
VC.2: Walls: East (A90°, 308.41 ft², width 0.906 ft)	308.4	0.017	0.7	0.9	100	1005.3	705.2
VC.2: Walls: West (A270°, 405.08 ft², width 5 ft)	405.1	0.017	0.7	0.9	100	1320.4	926.2
VC.2: Walls: South (A180°, 735.52 ft², width 32.188 ft)	735.5	0.017	0.7	0.9	100	2397.4	1681.7
VC.2: Walls: North (A0°, 1199.29 ft², width 55.063 ft)	1199.3	0.017	0.7	0.9	100	3909.1	2742.1
VC.3: Main Roof: South (A180°, 979.95 ft², width 55.063 ft)	979.9	0.011	0.8	0.9	100	2202.9	1545.3
VC.4: Entry Roof: Horizontal (85.31 ft², width 17.063 ft)	85.3	0.016	0.9	0.9	100	269.6	189.1

Degree hours [kFh/a]

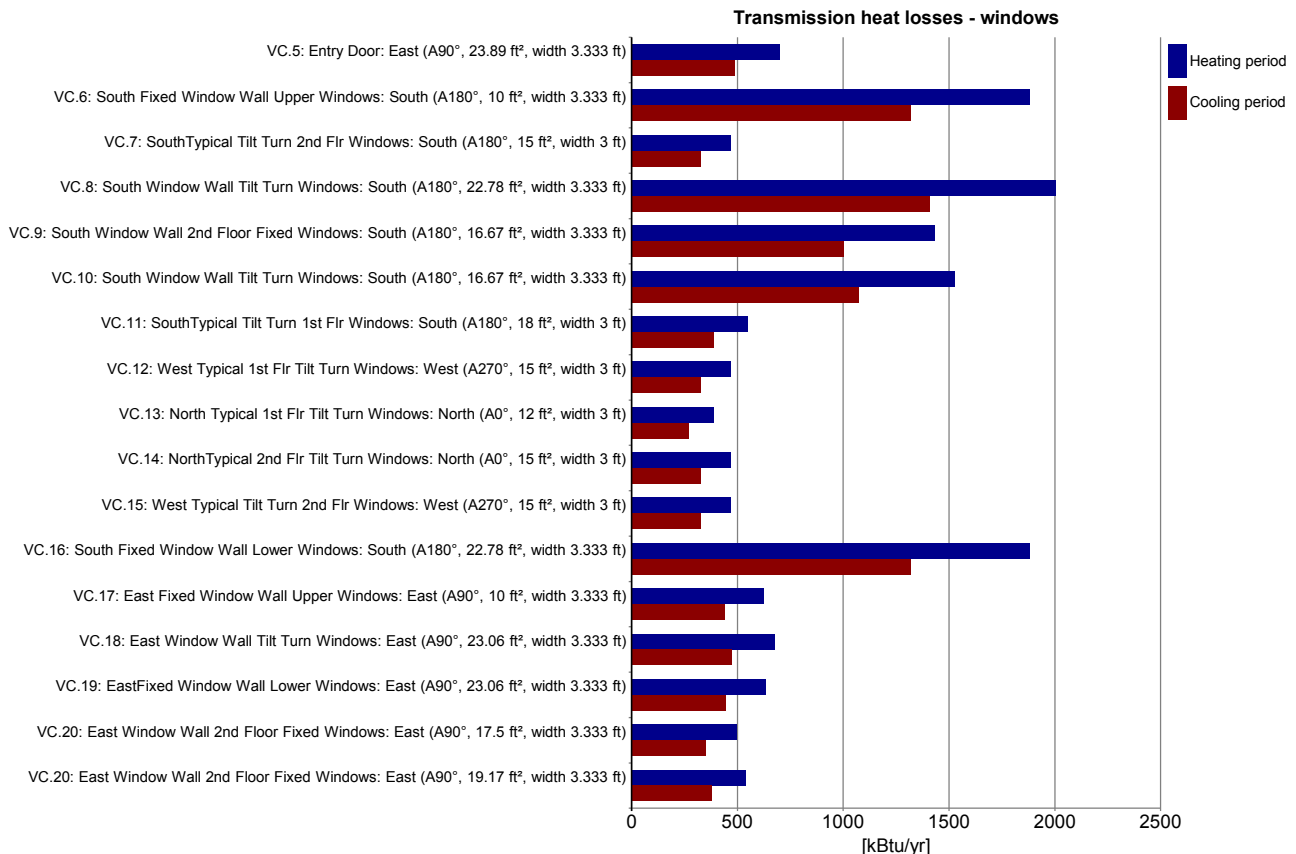
	Heating	Cooling
Ambient heating	109.4	76.7
Ground heating	70.6	74.9

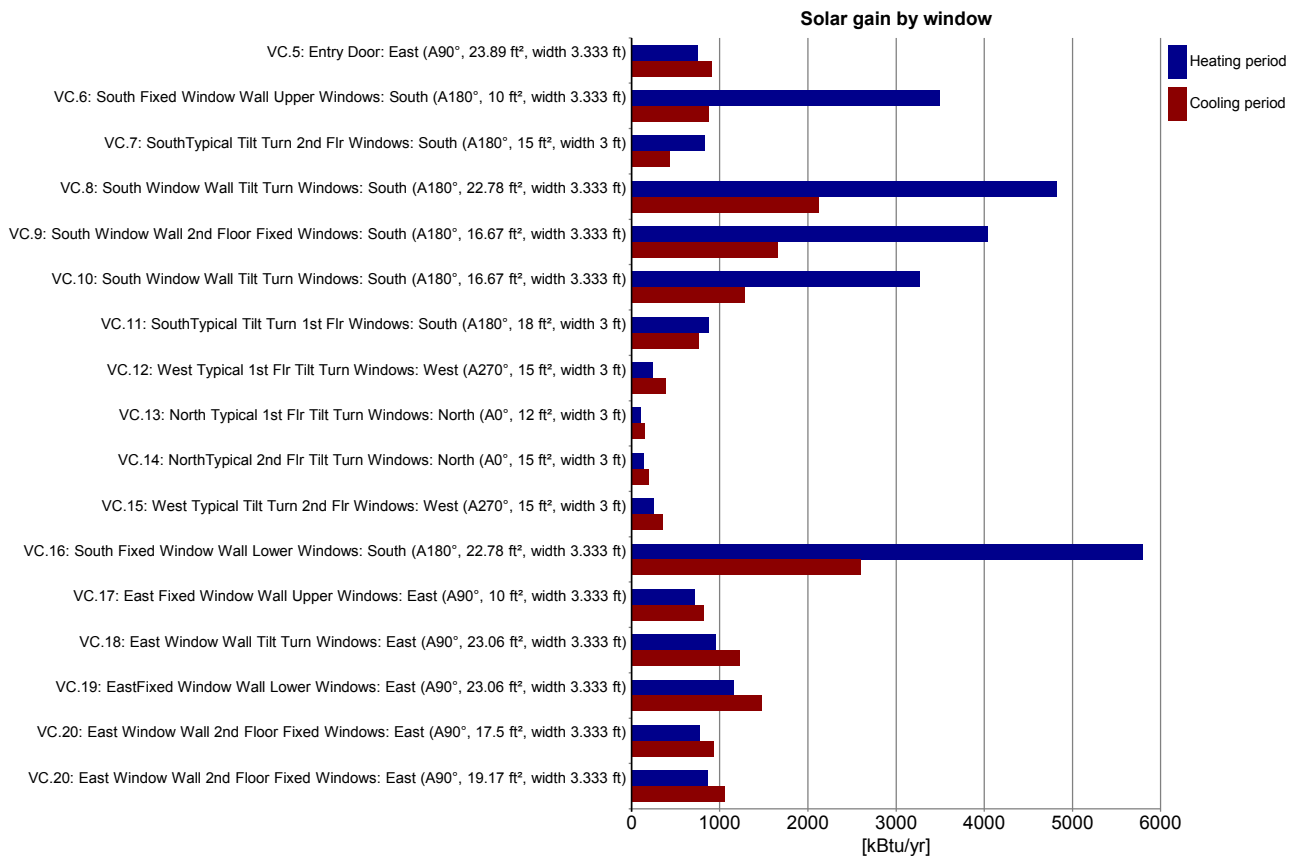


THERMAL BRIDGES

WINDOWS

Name	Quantity	Inclination [°]	U-value total [Btu/hr ft² °F]	SHGC (perpendicular)	Reduction factor shading [%]	Reduction factor shading summer [%]	Solar gain heating [kBtu/yr]	Solar gain cooling [kBtu/yr]	Transmission losses heating [kBtu/yr]	Transmission losses cooling [kBtu/yr]
VC.5: Entry Door: East (A90°, 23.89 ft², width 3.333 ft)	1	90	0.148	0.5	61.6	63.8	752.7	909	698.1	489.7
VC.6: South Fixed Window Wall Upper Windows: South (A180°, 10 ft², width 3.333 ft)	6	90	0.159	0.5	63.6	22.8	3502.3	879.1	1881.8	1320
VC.7: SouthTypical Tilt Turn 2nd Flr Windows: South (A180°, 15 ft², width 3 ft)	1	90	0.159	0.5	70.4	53.3	831.2	440.7	470.6	330.1
VC.8: South Window Wall Tilt Turn Windows: South (A180°, 22.78 ft², width 3.333 ft)	3	90	0.149	0.5	82.3	51.8	4821.1	2125.4	2007.3	1408
VC.9: South Window Wall 2nd Floor Fixed Windows: South (A180°, 16.67 ft², width 3.333 ft)	3	90	0.145	0.5	81.8	47.8	4042.1	1654.8	1431.8	1004.3
VC.10: South Window Wall Tilt Turn Windows: South (A180°, 16.67 ft², width 3.333 ft)	3	90	0.155	0.5	80.2	45.1	3270	1288.9	1527.9	1071.7
VC.11: SouthTypical Tilt Turn 1st Flr Windows: South (A180°, 18 ft², width 3 ft)	1	90	0.156	0.5	60.2	74.5	879.8	762.5	552	387.2
VC.12: West Typical 1st Flr Tilt Turn Windows: West (A270°, 15 ft², width 3 ft)	1	90	0.159	0.5	34.5	46	240.5	388.3	470.6	330.1
VC.13: North Typical 1st Flr Tilt Turn Windows: North (A0°, 12 ft², width 3 ft)	1	90	0.165	0.5	39.5	47.8	110.5	153	389.2	273
VC.14: NorthTypical 2nd Flr Tilt Turn Windows: North (A0°, 15 ft², width 3 ft)	1	90	0.159	0.5	39.4	47.8	144.6	201.1	470.6	330.1
VC.15: West Typical Tilt Turn 2nd Flr Windows: West (A270°, 15 ft², width 3 ft)	1	90	0.159	0.5	36.3	42.4	253.4	358	470.6	330.1
VC.16: South Fixed Window Wall Lower Windows: South (A180°, 22.78 ft², width 3.333 ft)	3	90	0.14	0.5	83.6	53.6	5802.8	2604.1	1881.8	1320
VC.17: East Fixed Window Wall Upper Windows: East (A90°, 10 ft², width 3.333 ft)	2	90	0.159	0.5	66.1	64.5	718.3	819.1	627.3	440
VC.18: East Window Wall Tilt Turn Windows: East (A90°, 23.06 ft², width 3.333 ft)	1	90	0.149	0.5	81.9	90	961.3	1232	676.4	474.4
VC.19: EastFixed Window Wall Lower Windows: East (A90°, 23.06 ft², width 3.333 ft)	1	90	0.14	0.5	83.9	90.9	1165.2	1474.3	634.1	444.8
VC.20: East Window Wall 2nd Floor Fixed Windows: East (A90°, 17.5 ft², width 3.333 ft)	1	90	0.144	0.5	74.9	77.8	770.7	935.2	497.7	349.1
VC.20: East Window Wall 2nd Floor Fixed Windows: East (A90°, 19.17 ft², width 3.333 ft)	1	90	0.143	0.5	76	79.6	864.9	1057.5	538.6	377.8





Summary building envelope

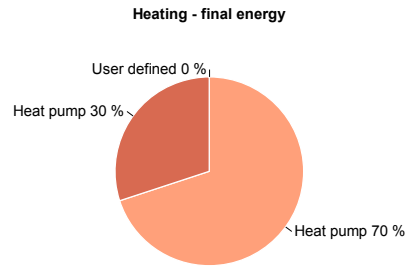
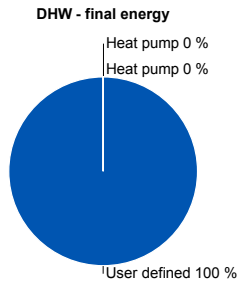
	Total area / length	Average U-value / Psi value	Transmission losses
Exterior wall ambient:	2648.3 ft²	0.02 Btu/hr ft² °F	8632.2 kBtu/yr
Exterior wall ground:	0 ft²	0 Btu/hr ft² °F	0 kBtu/yr
Basement:	1051.9 ft²	0.03 Btu/hr ft² °F	3416.1 kBtu/yr
Roof:	1065.3 ft²	0.01 Btu/hr ft² °F	2472.6 kBtu/yr
Windows:	513.3 ft²	0.15 Btu/hr ft² °F	15226.3 kBtu/yr
Doors:	0 ft²	0 Btu/hr ft² °F	0 kBtu/yr
Thermal bridge ambient:	0 ft	0 Btu/hr ft °F	0 kBtu/yr
Thermal bridge perimeter:	0 ft	0 Btu/hr ft °F	0 kBtu/yr
Thermal bridge floor slab:	0 ft	0 Btu/hr ft °F	0 kBtu/yr

Shading

	Heating	Cooling
Reduction factor North:	39.4 %	47.8 %
Reduction factor East:	74.4 %	78.2 %
Reduction factor South:	77.2 %	46.5 %
Reduction factor West:	35.4 %	44.2 %
Reduction factor Horizontal:	100 %	100 %

HVAC SYSTEMS

System	DHW			Heating			Total		
	Covered DHW demand [%]	Estimated solar fraction [%]	Final energy demand [kBtu/yr]	Covered heating demand [%]	Estimated solar fraction [%]	Final energy demand [kBtu/yr]	Performance ratio	CO2 equivalent emissions [lb/yr]	Primary energy demand [kBtu/yr]
Heat pump	0	0	0	70	0	2757.3	0	1211.6	7444.8
Heat pump	0	0	0	30	0	1181.7	0	519.2	3190.6
User defined	100	0	8069.6	0	0	0	1.1	3739.6	21787.9
Σ	100	0	8069.6	100	0	3939		5470.5	32423.2



COOLING UNITS

	sensible	latent
Air cooling:	0 kBtu/ft²yr	0 kBtu/ft²yr
Recirculation cooling:	0 kBtu/ft²yr	0 kBtu/ft²yr
Additional dehumidification:	0 kBtu/ft²yr	0 kBtu/ft²yr
Panel cooling:	0 kBtu/ft²yr	0 kBtu/ft²yr
Sum:	0 kBtu/ft²yr	0 kBtu/ft²yr

VENTILATION

Infiltration pressure test ACH50: **0.6** 1/hr
 Room ventilation volume: **10958** ft³
 Total extract air demand: **82.9** cfm
 Supply air per person: **18** cfm
 Occupancy: **3.5**

Average air flow rate: **55.98** cfm
 Average air change rate: **0.31** 1/hr
 Effective ACH ambient: **0.12** 1/hr
 Effective ACH ground: **0** 1/hr
 Energetically effective air exchange: **0.12** 1/hr
 Infiltration air change rate: **0.08** 1/hr
 Infiltration air change rate (heating load): **0.2** 1/hr

Type of ventilation system: **Balanced PH ventilation**
 Wind screening coefficient (e): **0.1**
 Wind exposure factor: **15**
 Wind shield factor: **0.1**

Ventilation heat losses: **4188.11** kBtu/yr

Devices

Name	HRV / ERV efficiency [-]	Electric efficiency [Btu/ft ³]	Heat recovery efficiency SHX [-]	Effective recovery efficiency [-]
Air Pohoda Ultima 240e	0.9	0	0	0.9
Altogether	0.9	0	0	0.9

Ducts

Name	Length (total) [ft]	Clear cross-section [ft ²]	U-value [Btu/hr ft ² °F]	Assigned ventilation units
Supply / outdoor air duct	6	0.1963	0.43	Air Pohoda Ultima 240e
Extract / Exhaust air duct	2	0.1963	0.44	Air Pohoda Ultima 240e
Σ	8			

*length * quantity

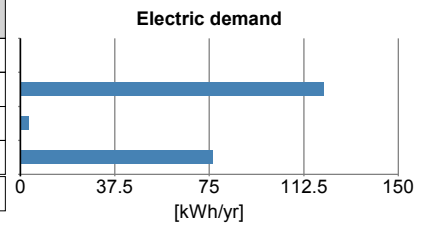
** thermal conductivity / thickness

SUMMER VENTILATION

ACH night ventilation: **0.3** 1/hr
 ACH natural summer: **0.1** 1/hr
 Mechanical ventilation summer: **0.3** 1/hr
 Mechanical ventilation summer with HR: **no**
 Preferred minimum indoor temperature for night ventilation: **68** °F
 Overheating temperature: **77** °F

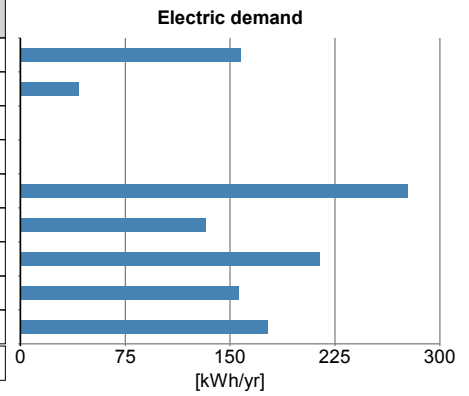
ELECTRICITY DEMAND - AUXILIARY ELECTRICITY

Type	Quantity	Indoor	Norm demand	Electric demand [kWh/yr]	Primary energy [kBtu/yr]
Other	1	yes	0 W	0	0
Ventilation winter	1	yes	0.4 W/cfm	120.4	1109.5
Defroster HX	1	yes	95.7 W	3.3	30.6
Ventilation summer	1	yes	0.4 W/cfm	76.6	705.4
Σ				200.3	1845.5



ELECTRICITY DEMAND RESIDENTIAL BUILDING

Type	Quantity	Indoor	Norm demand	Electric demand [kWh/yr]	Primary energy [kBtu/yr]
Kitchen dishwasher	1	yes	1.4 kWh/Use	157.9	1454.5
Laundry - washer	1	yes	0.4 kWh/Use	42.2	389.2
Laundry - dryer	1	no	3.5 kWh/Use	0	0
Energy consumed by evaporation	1	no	0 kWh	0	0
Kitchen fridge/freeze combo	1	yes	0.8 kWh/d	277.4	2555.4
Kitchen cooktop	1	yes	0.1 kWh/Use	133	1225
Lighting	1	yes	20.8 W	213.9	1970.5
Plug loads	1	yes	80 W	156	1437.4
Small applications per person	1	yes	50 kWh/yr	177.3	1633.4
Σ	9			1157.8	10665.3



INTERNAL HEAT GAINS

Internal heat gains: **0.7 Btu/hr ft²**
 (Default value)

DHW AND DISTRIBUTION

DHW consumption per person per day:	6.6 gal/Person/day
Average cold water temperature supply:	50 °F
Useful heat DHW:	7223.4 kBtu/yr
Specific useful heat DHW:	5407.3 Btu/ft ² yr
Total heat losses of the DHW system:	1213.6 kBtu/yr
Specific losses of the DHW system:	908.4 Btu/ft ² yr
Performance ratio DHW distribution system and storage:	1.2
Utilization ratio DHW distribution system and storage:	0.9
Total heat demand of DHW system:	8437 kBtu/yr
Total specific heat demand of DHW system:	6315.7 Btu/ft ² yr
Total heat losses of the hydronic heating distribution:	0 kBtu/yr
Specific losses of the hydronic heating distribution:	0 Btu/ft ² yr
Performance ratio of heat distribution:	100 %

Region	Length [ft]	Annual heat loss [kBtu/yr]
Hydronic heating distribution pipes		
Σ	0	0
DHW circulation pipes		
Warm region	0	0
Σ	0	0
Individual pipes		
Warm region	90.5	1213.6
Σ	90.5	1213.6
Water storage		
Σ		0