

## BUILDING INFORMATION

Category:	<b>Residential</b>
Status:	<b>In planning</b>
Building type:	<b>New construction</b>
Year of construction:	<b>2014-2015</b>
Units:	<b>1</b>
Number of occupants:	<b>3.9 (Verification)</b>



## Boundary conditions

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

## Building geometry

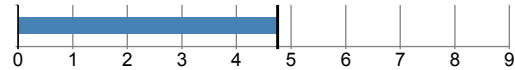
Enclosed volume:	<b>21130.7</b> ft <sup>3</sup>
Total area envelope:	<b>5278.8</b> ft <sup>2</sup>
AV ratio:	<b>0.2</b> 1/ft
Floor area:	<b>1469.6</b> ft <sup>2</sup>

## PASSIVEHOUSE REQUIREMENTS

**Certificate criteria:** Default Standard

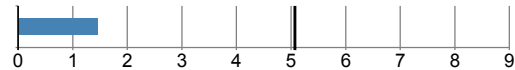
### Heating demand

specific:	<b>4.73</b> kBtu/ft <sup>2</sup> yr
target:	<b>4.75</b> kBtu/ft <sup>2</sup> yr
total:	6950.56 kBtu/yr



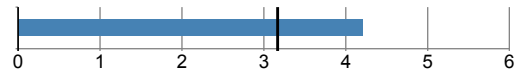
### Cooling demand

specific:	<b>1.46</b> kBtu/ft <sup>2</sup> yr
target:	<b>5.07</b> kBtu/ft <sup>2</sup> yr
total:	2149.3 kBtu/yr
latent:	0.01 kBtu/ft <sup>2</sup> yr



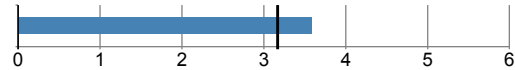
### Heating load

specific:	<b>4.21</b> Btu/hr ft <sup>2</sup>
target:	<b>3.17</b> kBtu/ft <sup>2</sup> yr
total:	6188.54 Btu/hr



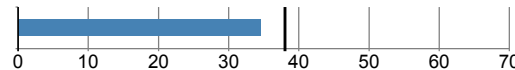
### Cooling load

specific:	<b>3.59</b> Btu/hr ft <sup>2</sup>
target:	<b>3.17</b> kBtu/ft <sup>2</sup> yr
total:	5273.5 Btu/hr



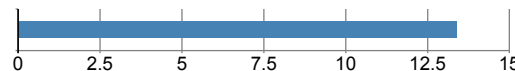
### Primary energy

specific:	<b>34.5</b> kBtu/ft <sup>2</sup> yr
target:	<b>38.04</b> kBtu/ft <sup>2</sup> yr
total:	50692.14 kBtu/yr



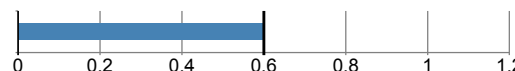
### Site energy

total:	13.39 kBtu/ft <sup>2</sup> yr
building systems:	20.29 kBtu/yr
photovoltaic savings:	0 kBtu/ft <sup>2</sup> yr



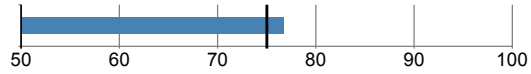
### Air tightness

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



## PASSIVEHOUSE RECOMMENDATIONS

HRV efficiency: **76.7 %**



Frequency of overheating: **7.9 %**  
Cooling system is not required

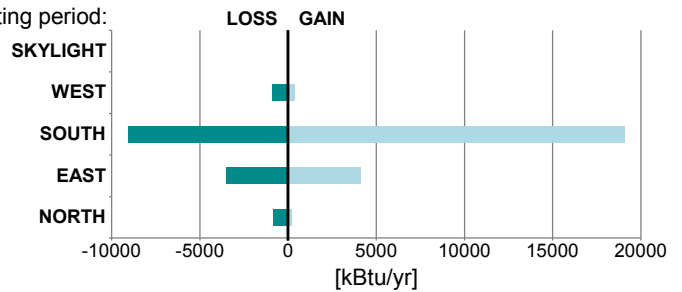


## BUILDING ELEMENTS

### Windows

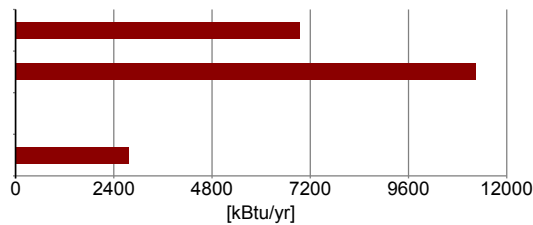
Average SHGC: **0.49**  
Average solar reduction factor heating: **0.42**  
Average solar reduction factor cooling: **0.33**  
Average U-value: **0.15 Btu/hr ft<sup>2</sup> °F**  
Total glazing area: **363.6 ft<sup>2</sup>**

Heat gain/loss heating period:



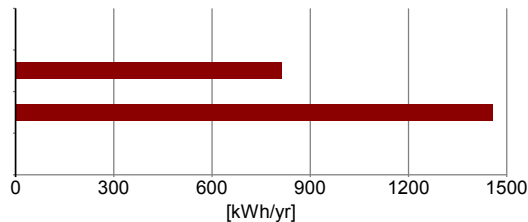
### HVAC

Total heating demand: **6951 kBtu/yr**  
Total DHW energy demand: **11259 kBtu/yr**  
Solar DHW contribution: **0 kBtu/yr**  
Auxiliary electricity: **2770 kBtu/yr**



### Electricity

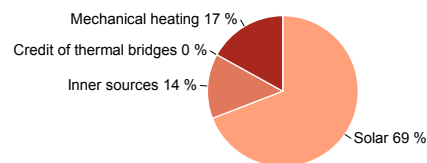
Direct heating / DHW: **0 kWh/yr**  
HVAC auxiliary energy: **812 kWh/yr**  
Appliances: **1458 kWh/yr**  
Output PV system: **0 kWh/yr**  
Total electricity demand: **2270 kWh/yr**



## HEAT FLOW

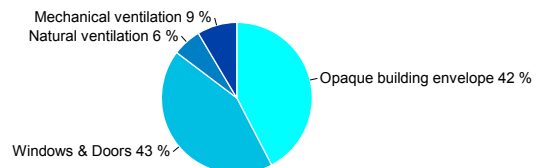
### Heat gains

Solar: **23705 kBtu/yr**  
Inner sources: **4755 kBtu/yr**  
Credit of thermal bridges: **0 kBtu/yr**  
Mechanical heating: **6951 kBtu/yr**



### Heat losses

Opaque building envelope: **15001 kBtu/yr**  
Windows & Doors: **15210 kBtu/yr**  
Natural ventilation: **2179 kBtu/yr**  
Mechanical ventilation: **3021 kBtu/yr**

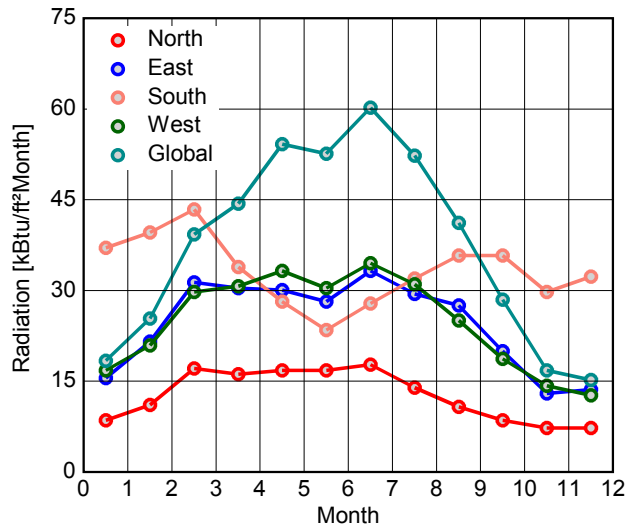
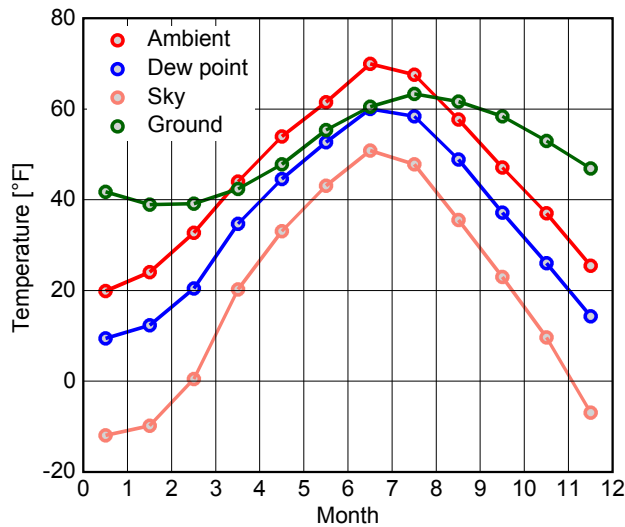


## CLIMATE

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** kWh/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

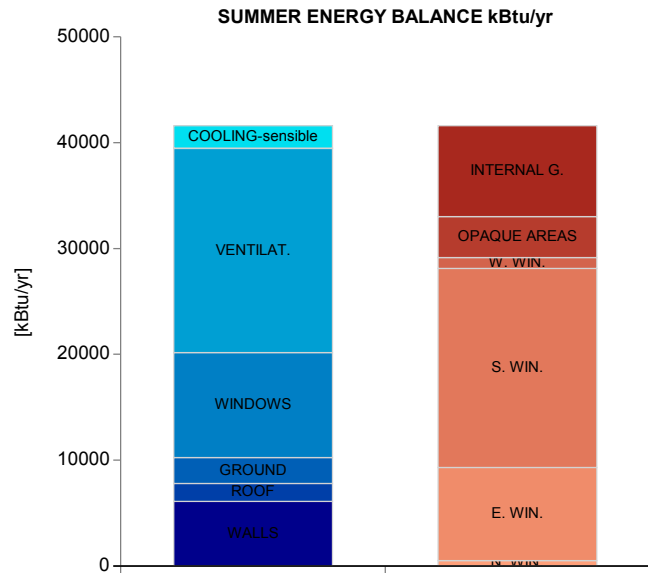
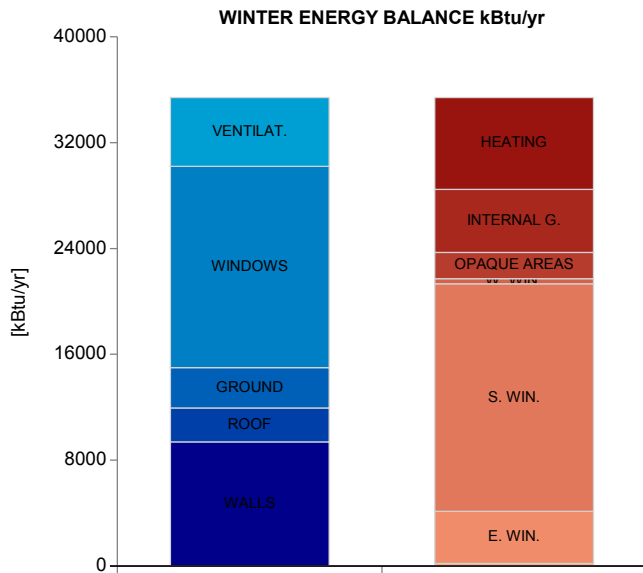
Transmission losses :	<b>30211</b> kBtu/yr
Ventilation losses:	<b>5200</b> kBtu/yr
<b>Total heat losses:</b>	<b>35411</b> kBtu/yr
Solar heat gains:	<b>28440</b> kBtu/yr
Internal heat gains:	<b>5705</b> kBtu/yr
<b>Total heat gains:</b>	<b>34145</b> kBtu/yr
Utilization factor:	<b>83.4</b> %
Useful heat gains:	<b>28460</b> kBtu/yr

Annual heat demand:	<b>6951</b> kBtu/yr
Specific annual heat demand:	<b>4730</b> Btu/ft <sup>2</sup> yr

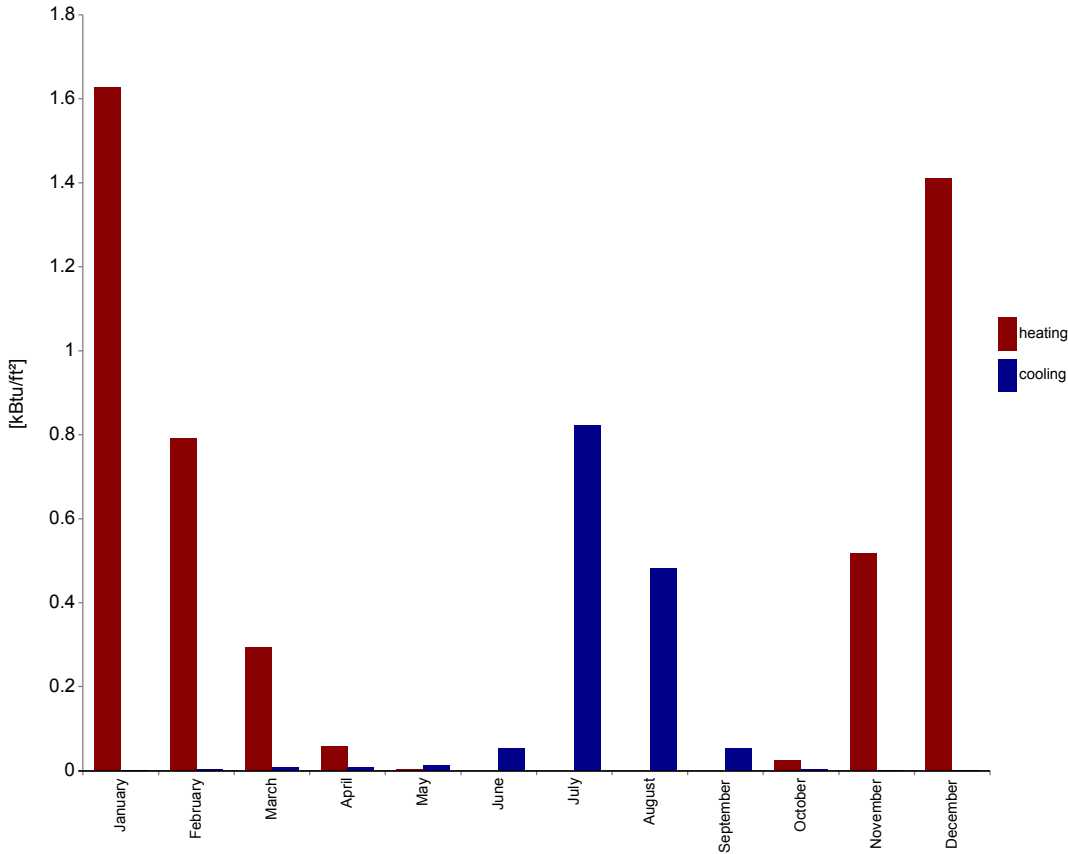
## ANNUAL COOLING DEMAND

Solar heat gains:	<b>33019</b> kBtu/yr
Internal heat gains:	<b>8569</b> kBtu/yr
<b>Total heat gains:</b>	<b>41588</b> kBtu/yr
Transmission losses :	<b>44985</b> kBtu/yr
Ventilation losses:	<b>43094</b> kBtu/yr
<b>Total heat losses:</b>	<b>88079</b> kBtu/yr
Utilization factor:	<b>44.8</b> %
Useful heat losses:	<b>39458</b> kBtu/yr

Cooling demand - sensible:	<b>2130</b> kBtu/yr
Cooling demand - latent:	<b>19</b> kBtu/yr
<b>Annual cooling demand:</b>	<b>2149</b> kBtu/yr
Specific annual cooling demand:	<b>1.5</b> kBtu/ft <sup>2</sup> yr



SPECIFIC HEAT/COOLING DEMAND MONTHLY



Month	Heating [kBtu/ft²]	Cooling [kBtu/ft²]
January	1.6	0
February	0.8	0
March	0.3	0
April	0.1	0
May	0	0
June	0	0.1
July	0	0.8
August	0	0.5
September	0	0.1
October	0	0
November	0.5	0
December	1.4	0

## HEATING LOAD

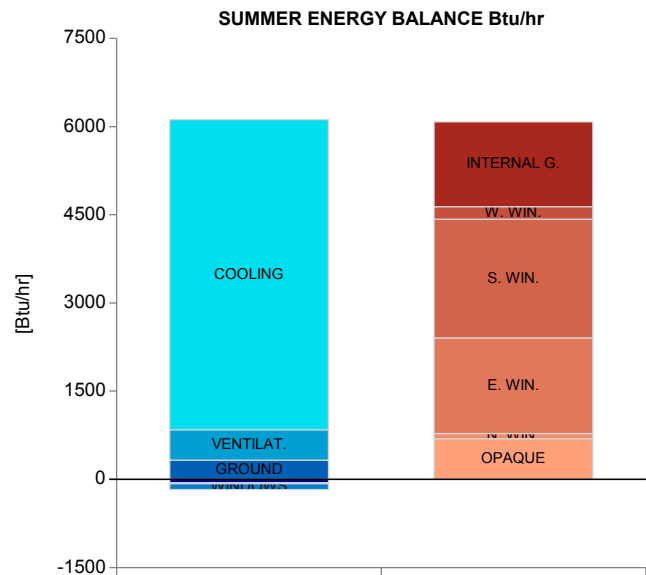
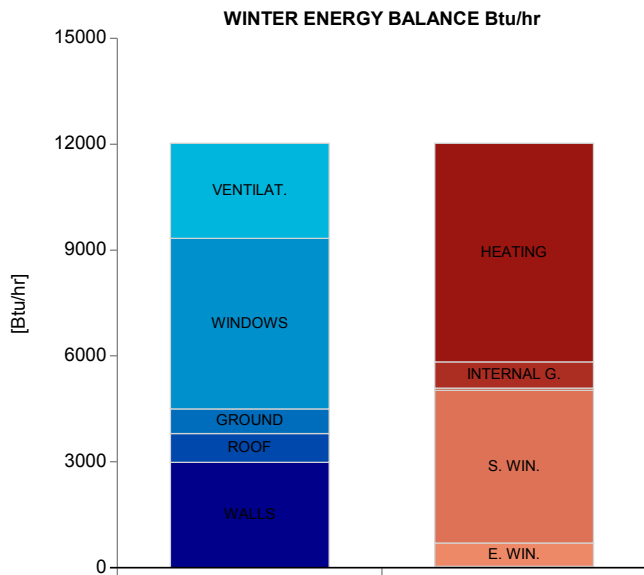
	First climate	Second climate
Transmission heat losses:	<b>9329.1</b> Btu/hr	<b>5782.4</b> Btu/hr
Ventilation heat losses:	<b>2692</b> Btu/hr	<b>1585.8</b> Btu/hr
<b>Total heat loss:</b>	<b>12021.2</b> Btu/hr	<b>7368.3</b> Btu/hr
Solar heat gain:	<b>5087.3</b> Btu/hr	<b>1934</b> Btu/hr
Internal heat gain:	<b>745.4</b> Btu/hr	<b>745.4</b> Btu/hr
<b>Total heat gains heating:</b>	<b>5832.6</b> Btu/hr	<b>2679.3</b> Btu/hr
<b>Heating load:</b>	<b>6188.5</b> Btu/hr	<b>4688.9</b> Btu/hr

Relevant heating load: **6188.5** Btu/hr  
 Specific heating load: **4.2** Btu/hr ft<sup>2</sup>

## COOLING LOAD

Solar heat gain:	<b>4637.2</b> Btu/hr
Internal heat gain:	<b>1444.2</b> Btu/hr
<b>Total heat gains cooling:</b>	<b>6081.3</b> Btu/hr
Transmission heat losses:	<b>290.7</b> Btu/hr
Ventilation heat losses:	<b>517.2</b> Btu/hr
<b>Total heat loss:</b>	<b>807.8</b> Btu/hr
<b>Cooling load - sensible:</b>	<b>5273.5</b> Btu/hr
<b>Cooling load - latent:</b>	<b>0</b> Btu/hr

Relevant cooling load: **5273.5** Btu/hr  
 Specific maximum cooling load: **3.6** Btu/hr ft<sup>2</sup>

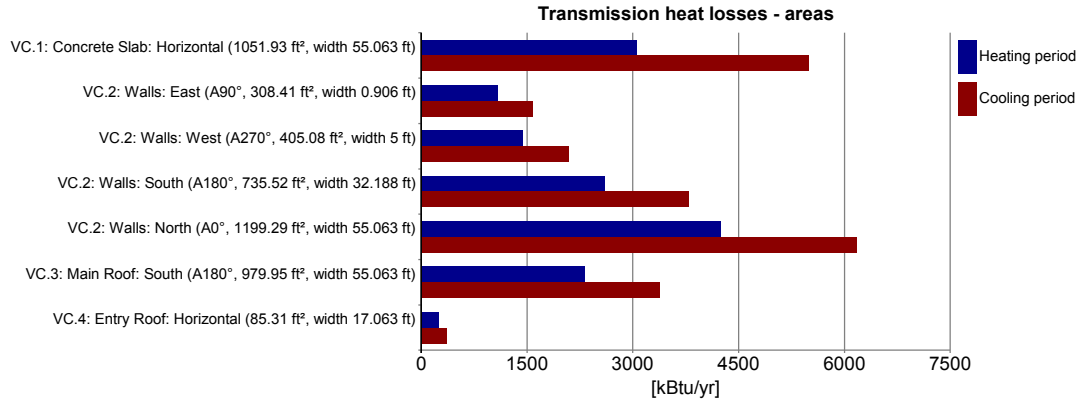


## AREAS

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	0.023	0	0	0	3061.2	5496.1
VC.2: Walls: East (A90°, 308.41 ft², width 0.906 ft)	308.4	0.018	0.7	0.9	100	1091.4	1587.5
VC.2: Walls: West (A270°, 405.08 ft², width 5 ft)	405.1	0.018	0.7	0.9	100	1433.5	2085
VC.2: Walls: South (A180°, 735.52 ft², width 32.188 ft)	735.5	0.018	0.7	0.9	100	2602.9	3785.8
VC.2: Walls: North (A0°, 1199.29 ft², width 55.063 ft)	1199.3	0.018	0.7	0.9	100	4244.1	6172.9
VC.3: Main Roof: South (A180°, 979.95 ft², width 55.063 ft)	979.9	0.012	0.8	0.9	100	2320.3	3374.8
VC.4: Entry Roof: Horizontal (85.31 ft², width 17.063 ft)	85.3	0.015	0.9	0.9	100	247.2	359.6

## Degree hours [kFh/a]

	Heating	Cooling
Ambient heating	109.5	159.2
Ground heating	70.8	127.2

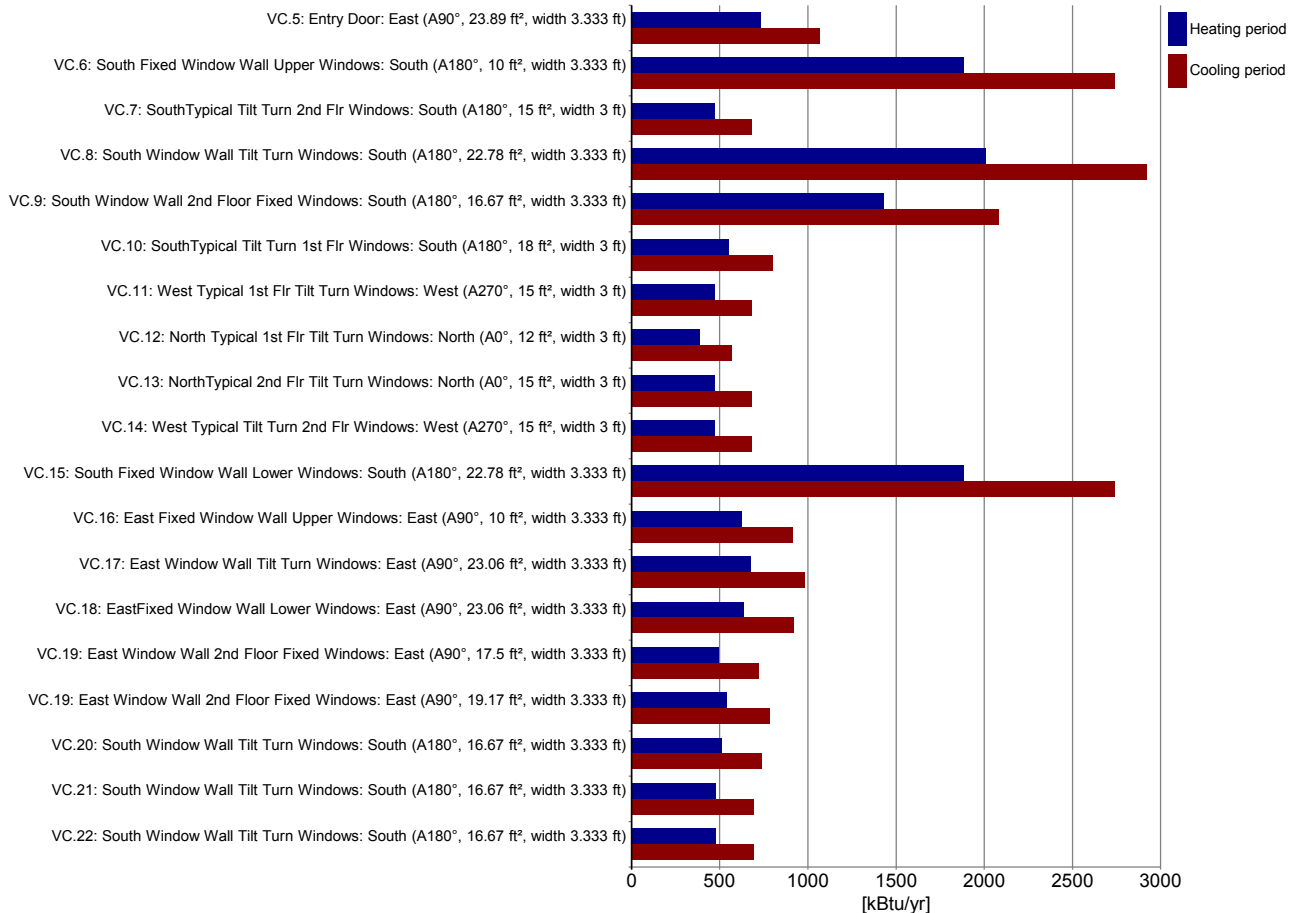


## THERMAL BRIDGES

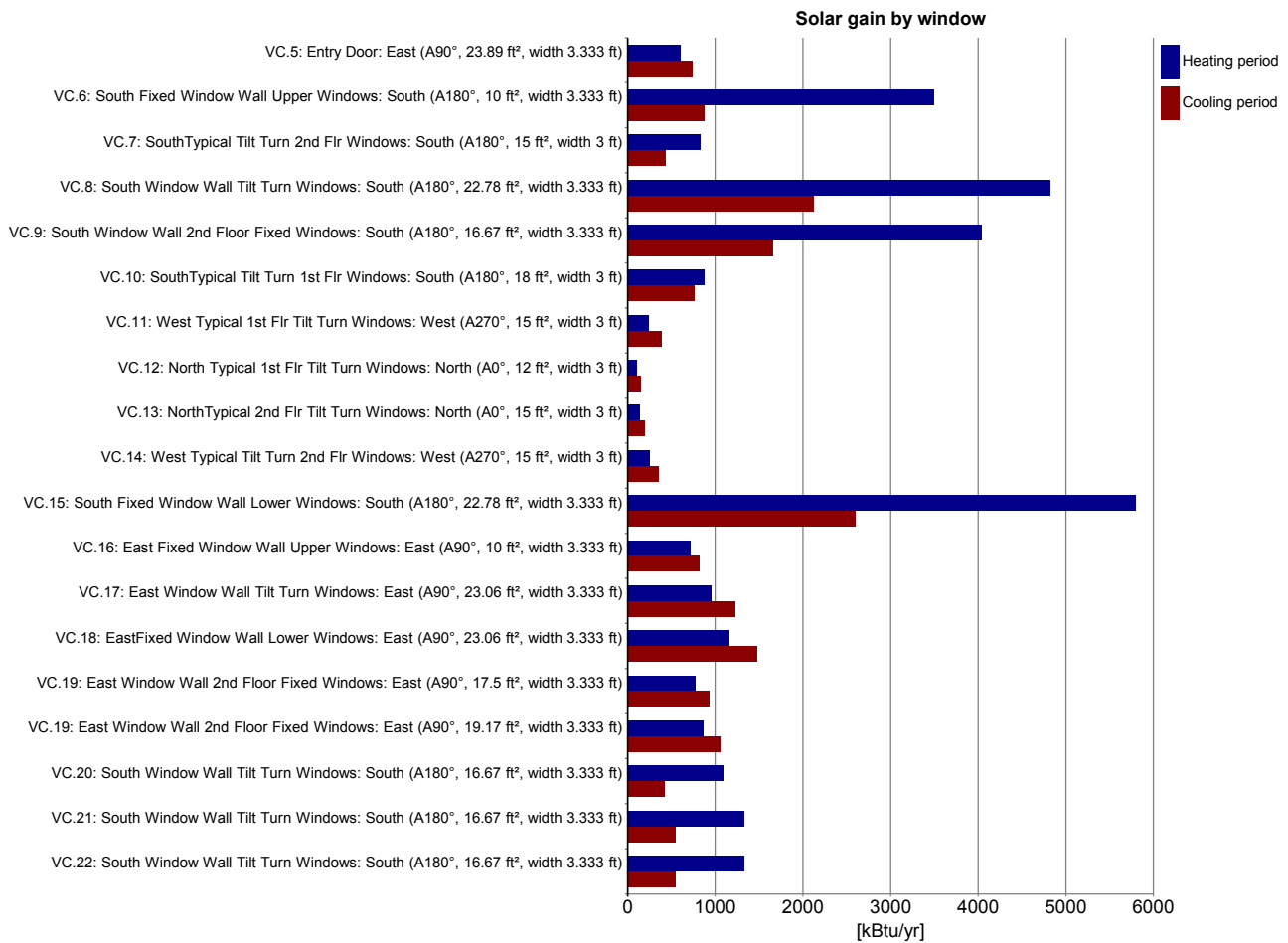
## WINDOWS

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	0.156	0.5	60.3	62.9	611.7	744.9	736	1070.4
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	1883.1	2738.9
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	470.9	685
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	2008.7	2921.6
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	1432.8	2084
VC.10: 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	552.4	803.4
VC.11: 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	470.9	685
VC.12: 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	389.5	566.5
VC.13: 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	470.9	685
VC.14: 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	470.9	685
VC.15: 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	1883.1	2738.9
VC.16: 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	627.7	913
VC.17: 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	676.8	984.4
VC.18: 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	634.5	922.9
VC.19: 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	498.1	724.4
VC.19: 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	539	784
VC.20: South Window Wall Tilt Turn Windows: South (A180°, 16.67 ft², width 3.333 ft)	1	90	0.155	0.5	80.2	45.1	1090	429.6	509.7	741.3
VC.21: South Window Wall Tilt Turn Windows: South (A180°, 16.67 ft², width 3.333 ft)	1	90	0.145	0.5	81.1	47.3	1334.9	544.9	477.6	694.7
VC.22: South Window Wall Tilt Turn Windows: South (A180°, 16.67 ft², width 3.333 ft)	1	90	0.145	0.5	81.1	47.3	1334.9	544.9	477.6	694.7

Transmission heat losses - windows







## Summary building envelope

	Total area / length	Average U-value / Psi value	Transmission losses
Exterior wall ambient:	<b>2648.3</b> ft²	<b>0.02</b> Btu/hr ft² °F	<b>9372</b> kBtu/yr
Exterior wall ground:	<b>0</b> ft²	<b>0</b> Btu/hr ft² °F	<b>0</b> kBtu/yr
Basement:	<b>1051.9</b> ft²	<b>0.02</b> Btu/hr ft² °F	<b>3061.2</b> kBtu/yr
Roof:	<b>1065.3</b> ft²	<b>0.01</b> Btu/hr ft² °F	<b>2567.6</b> kBtu/yr
Windows:	<b>513.3</b> ft²	<b>0.15</b> Btu/hr ft² °F	<b>15210.3</b> kBtu/yr
Doors:	<b>0</b> ft²	<b>0</b> Btu/hr ft² °F	<b>0</b> kBtu/yr
Thermal bridge ambient:	<b>0</b> ft	<b>0</b> Btu/hr ft °F	<b>0</b> kBtu/yr
Thermal bridge perimeter:	<b>0</b> ft	<b>0</b> Btu/hr ft °F	<b>0</b> kBtu/yr
Thermal bridge floor slab:	<b>0</b> ft	<b>0</b> Btu/hr ft °F	<b>0</b> kBtu/yr

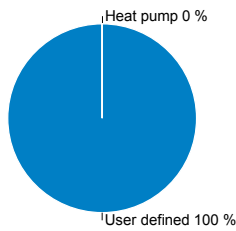
## Shading

	Heating	Cooling
Reduction factor North:	<b>39.4</b> %	<b>47.8</b> %
Reduction factor East:	<b>74.5</b> %	<b>78.5</b> %
Reduction factor South:	<b>77.4</b> %	<b>46.7</b> %
Reduction factor West:	<b>35.4</b> %	<b>44.2</b> %
Reduction factor Horizontal:	<b>100</b> %	<b>100</b> %

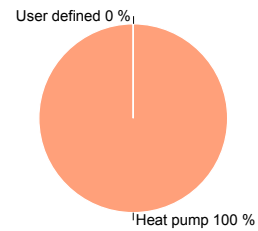
## HVAC SYSTEMS

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	100	0	2015.7	0	885.7	5442.3
User defined	100	0	11030.8	0	0	0	1.1	5570.4	29783.3
<b>Σ</b>	<b>100</b>	<b>0</b>	<b>11030.8</b>	<b>100</b>	<b>0</b>	<b>2015.7</b>		<b>6456.1</b>	<b>35225.5</b>

DHW - final energy



Heating - final energy



## 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
Panel cooling:	0 kBtu/ft²yr	
<b>Sum:</b>	<b>0 kBtu/ft²yr</b>	<b>0 kBtu/ft²yr</b>

## VENTILATION

Infiltration pressure test ACH50: **0.6** 1/hr  
 Room ventilation volume: **12053.8** ft<sup>3</sup>  
 Total extract air demand: **82.9** cfm  
 Supply air per person: **18** cfm  
 Occupancy: **3.9**

Average air flow rate: **61.86** 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: **0.05** 1/hr  
 Infiltration air change rate (heating load): **0.13** 1/hr

Type of ventilation system: **Balanced PH ventilation**  
 Wind screening coefficient (e): **0.07**  
 Wind exposure factor: **15**  
 Wind shield factor: **0.05**

Ventilation heat losses: **4859.52** kBtu/yr

### Devices

Name	HRV / ERV efficiency [-]	Electric efficiency [Btu/ft <sup>3</sup> ]	Heat recovery efficiency SHX [-]	Effective recovery efficiency [-]
Air Pohoda Ultima 240e	0.8	0	0	0.8
Altogether	0.8	0	0	0.8

### Ducts

Name	Length (total) [ft]	Clear cross-section [ft <sup>2</sup> ]	U-value [Btu/hr ft <sup>2</sup> °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

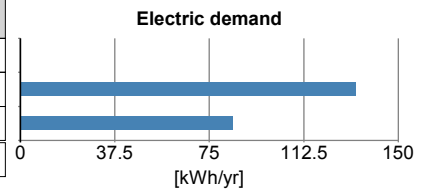
\*\* thermal conductivity / thickness

## 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

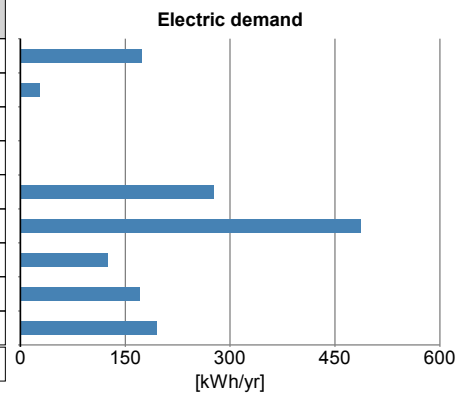
## ELECTRICITY DEMAND - AUXILIARY ELECTRICITY

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	133.1	1226
Ventilation summer	1	yes	0.4 W/cfm	84.2	776
<b>Σ</b>				217.3	2001.9



## 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	173.7	1600
Laundry - washer	1	yes	0.2 kWh/Use	28.1	259.1
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	0.3 kWh/Use	487.6	4491.8
Lighting	1	yes	11 W	124.4	1146.3
Plug loads	1	yes	80 W	171.6	1581.1
Small applications per person	1	yes	50 kWh/yr	195	1796.7
<b>Σ</b>	9			1457.9	13430.4



## INTERNAL HEAT GAINS

Internal heat gains: **0.7 Btu/hr ft<sup>2</sup>**  
 (Default value)

## DHW AND DISTRIBUTION

DHW consumption per person per day:	<b>6.6</b> gal/Person/day
Average cold water temperature supply:	<b>50</b> °F
Useful heat DHW:	<b>7892</b> kBtu/yr
Specific useful heat DHW:	<b>5370.7</b> Btu/ft <sup>2</sup> yr
Total heat losses of the DHW system:	<b>3367.3</b> kBtu/yr
Specific losses of the DHW system:	<b>2291.5</b> Btu/ft <sup>2</sup> yr
Performance ratio DHW distribution system and storage:	<b>1.4</b>
Utilization ratio DHW distribution system and storage:	<b>0.7</b>
Total heat demand of DHW system:	<b>11259.2</b> kBtu/yr
Total specific heat demand of DHW system:	<b>7662.2</b> Btu/ft <sup>2</sup> yr
Total heat losses of the hydronic heating distribution:	<b>0</b> kBtu/yr
Specific losses of the hydronic heating distribution:	<b>0</b> Btu/ft <sup>2</sup> yr
Performance ratio of heat distribution:	<b>100</b> %

Region	Length [ft]	Annual heat loss [kBtu/yr]
Hydronic heating distribution pipes		
Σ	0	0
DHW circulation pipes		
Warm region	0	0
Cold region1	0	0
Σ	0	0
Individual pipes		
Warm region		0
Cold region1	90.5	3367.3
Σ		3367.3
Water storage		
Σ		0