DESERT SUNRISE

UNIVERSITY OF NEVADA, LAS VEGAS

U.S. Department of Energy:
Race to Zero Student Design Competition

Presenters: Nick Inouye, David McCredo III, Ludwing Vaca

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A. TEAM QUALIFICATIONS

DESERT SUNRISE TEAM:

INDUSTRY PARTNERS:

Bombard Electric LLC
www.bombardre.com/

Geotechnical & Environmental Services, Inc.
www.gesnevada.com/

Home Energy Connection: Building Performance Experts
www.homeenergyconnection.com

IntelliChoice Energy
www.iceghp.com/

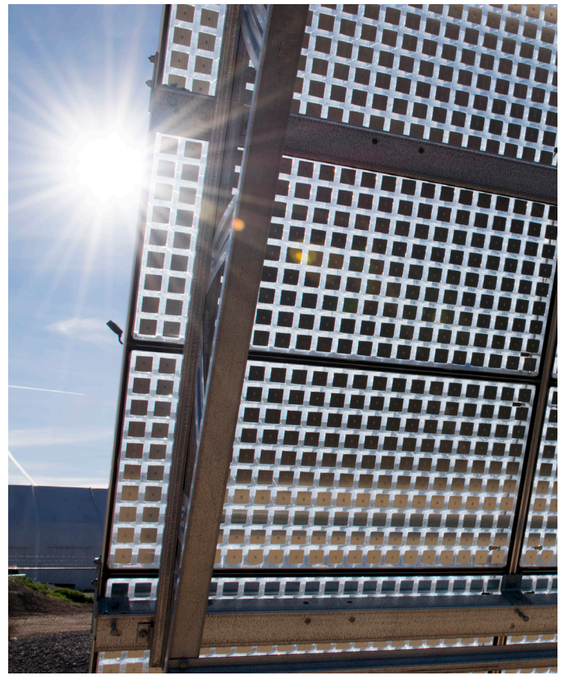
Southwest Gas
www.southwestgas.com/

B. DESIGN GOALS AND PROJECT CONTEXT

“All the homes were one or two room shacks. We put canvas over the windows to keep out the cold. In some there were no floors. We drank the water from the ditch. There was no plumbing, no insulation. We heated with wood. Later there was some electricity. Some homes were very crowded because it is the Indian way to take in the family members who need a place no matter what. We were very poor, but we worked hard to help build the houses and the Community Building.”

Agnes Hanks, Moapa Paiute woman, c. 1970

PAIUTE STORY



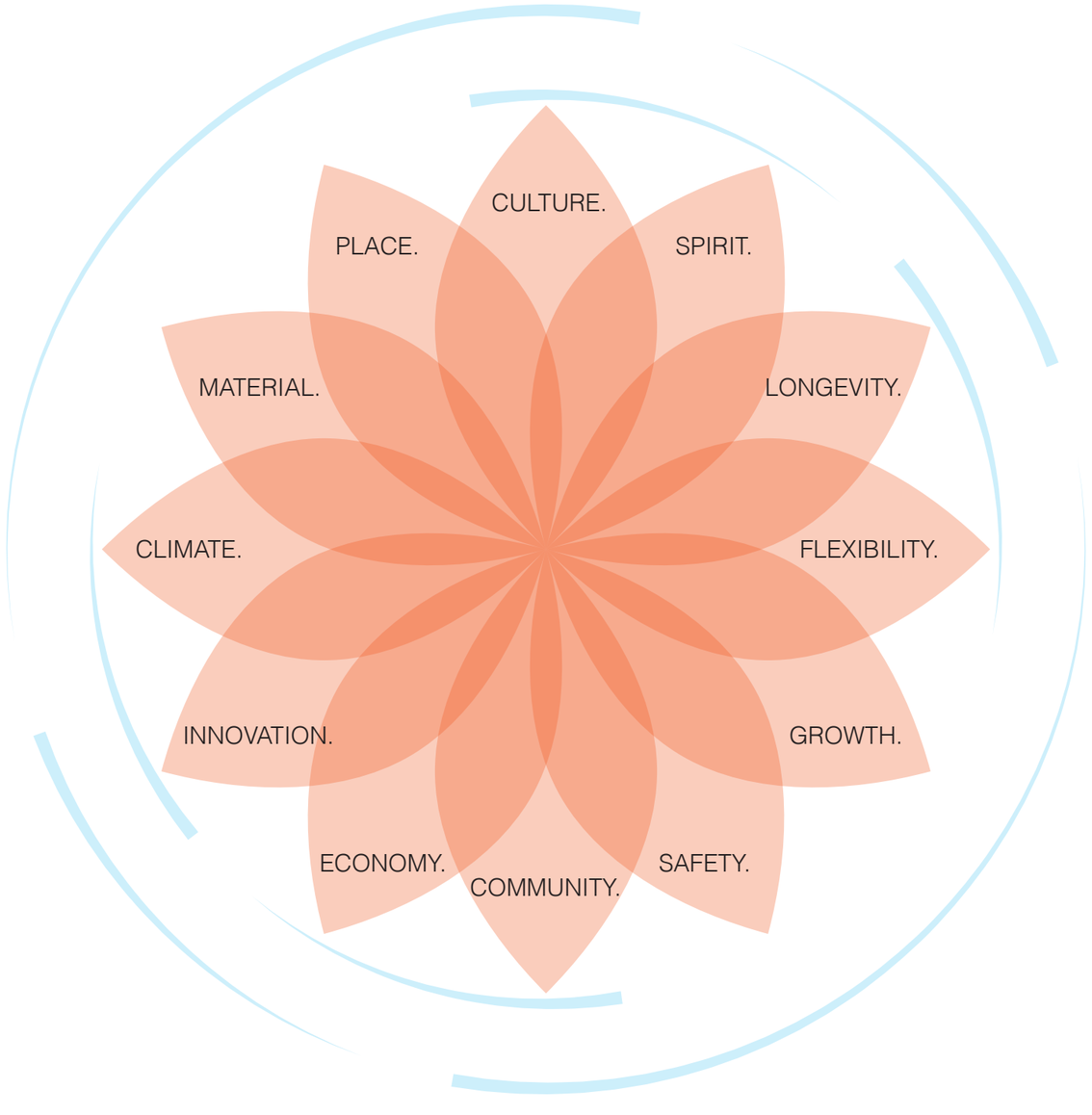
PAIUTE RESOLUTION

WHEREAS, the Tribe has identified culturally significant systems of land boundaries, heritage, housing needs, and technology which would benefit from a **partnership with UNLV's Building Sciences & Sustainability Graduate Concentration to develop a culturally significant net zero solar home on the Moapa tribal reservation**;

DESIGN GOALS

DESIGN GOALS

renewed home.
harnessing the climate extremes of the Mojave, housing needs of the Moapa Paiute.



extended heritage.
multi-generational durability, aging in place

design efficiency.
cost, performance and optimization

spiritual connection.
indigenous culture and lifestyle, economic reality

DESIGN APPROACH

- Parametric analysis of five areas contributing most to the energy use of a residential building:

1. Building Form and Orientation
2. Fenestration and External Shading
3. Roof Assemblies
4. Wall Assemblies
5. Mechanical Equipment for Thermal Comfort and Indoor Air Quality.

- Identify optimal configuration, assemblies, and systems to design a net-zero site energy home.

- Optimized design verified by independent third-party.

RESEARCH — BEopt — NREL

OPTIMIZATION — HEED

THIRD-PARTY VERIFICATION — REM/Rate™

PROJECT SUMMARY

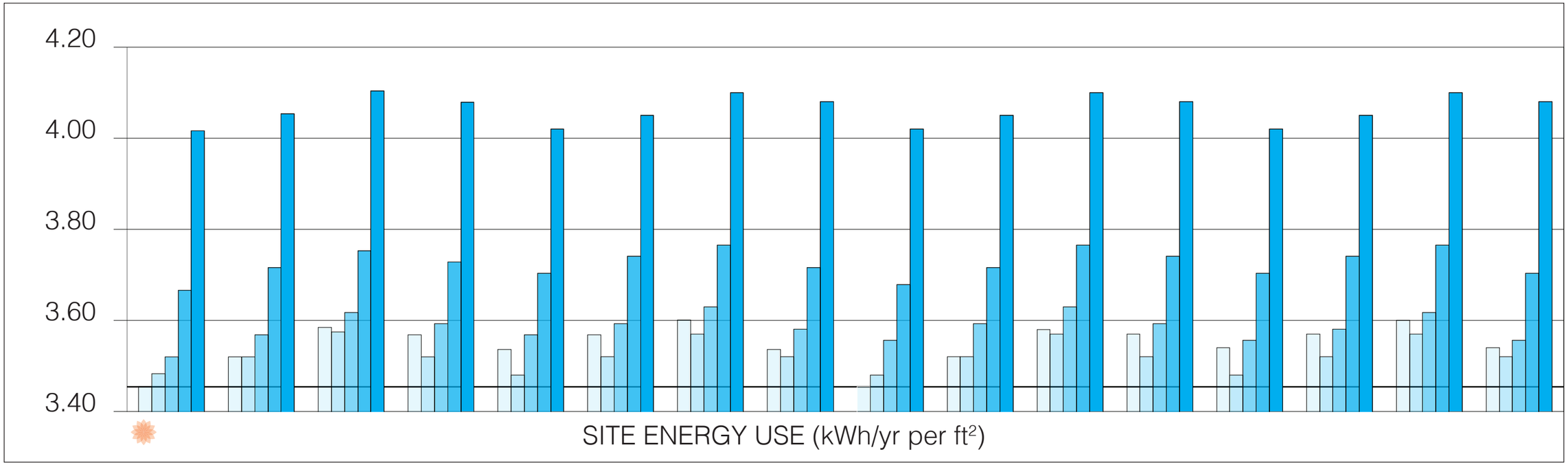
- Moapa Valley, NV
- Climate Zone: **3**
- Square Feet: **1,387**
- Stories: **1**
- Bedrooms: **2**
- Bathrooms: **2**

HERS score: **33**
Energy $/Yr: **$ 989**

with 5.04 kWp PV...

HERS score = **-11**
Energy $/Yr = **$ 0**

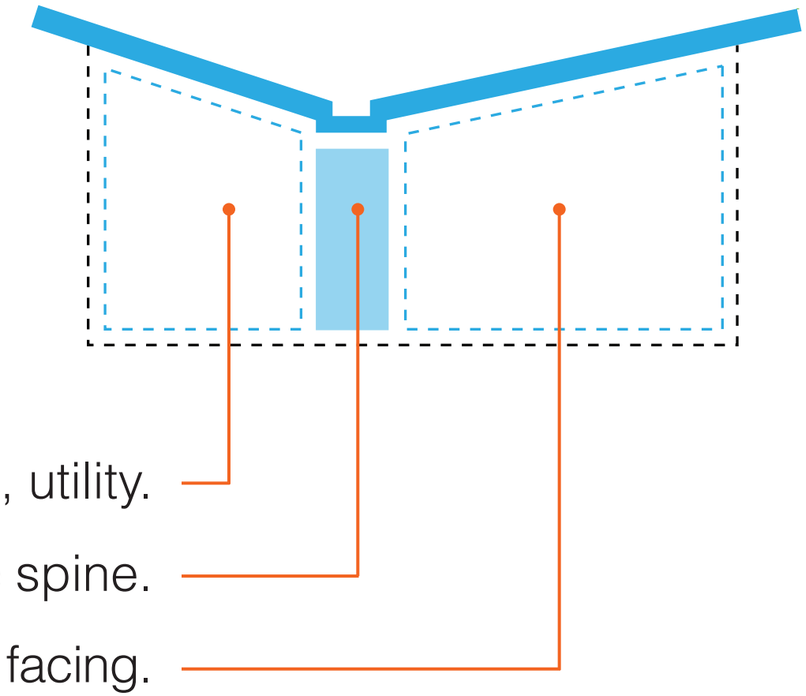
FORM, ORIENTATION & ENERGY: DECISION MAKING MATRIX



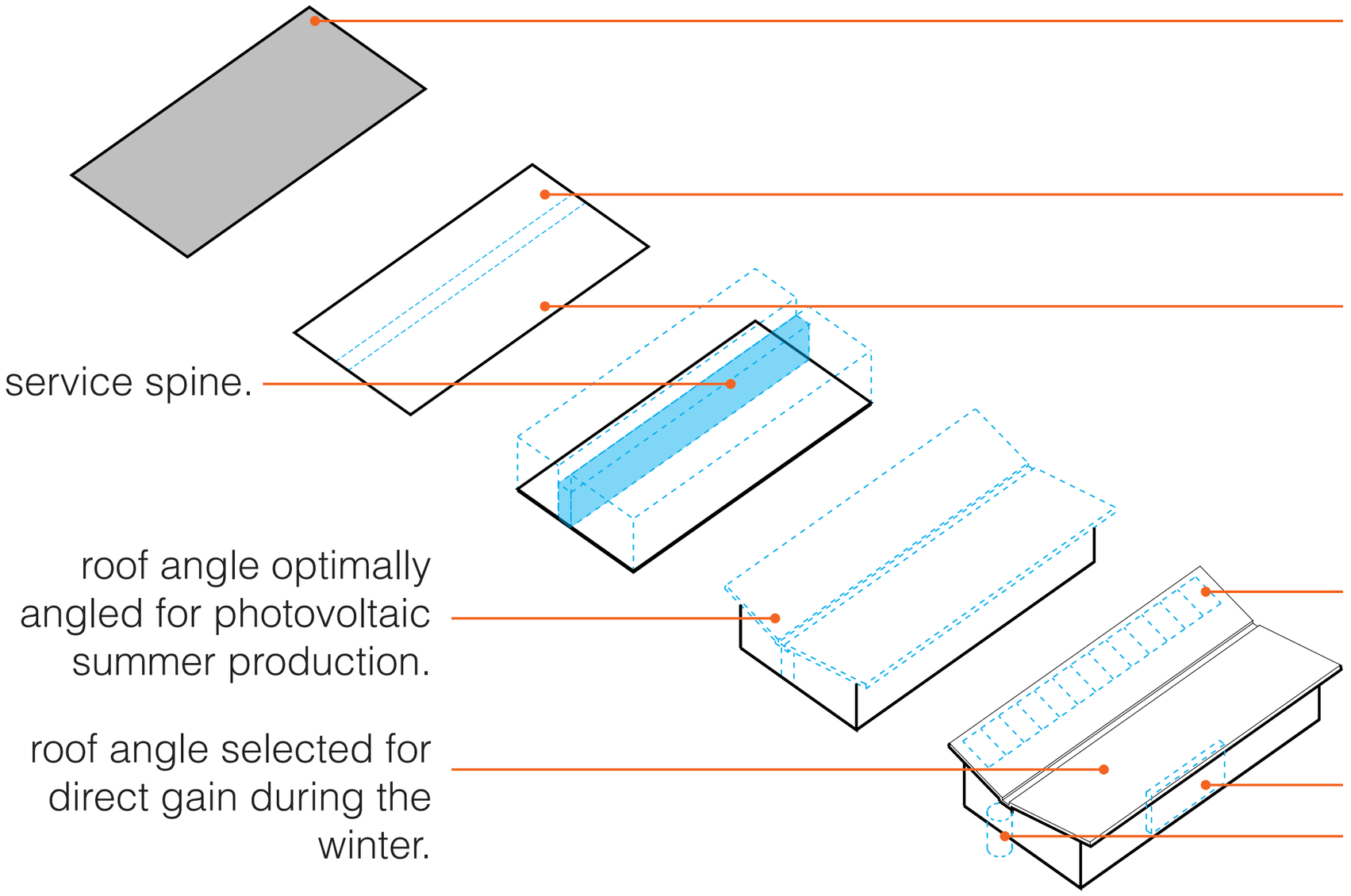
	S 0°	SSW 22.5°	SW 45°	WSW 67.5°	W 90°	WNW 112.5°	NW 135°	NNW 157.5°	N 180°	NNE 202.5°	NE 225°	ENE 247.5°	E 270°	ESE 292.5°	SE 315°	SSE 337.5°
Rectangle																
Square																
L-Shape																
U-Shape																
Courtyard																

CONCEPT

“Shadow of the Eagle” near Moapa Paiute reservation, across Interstate 15.



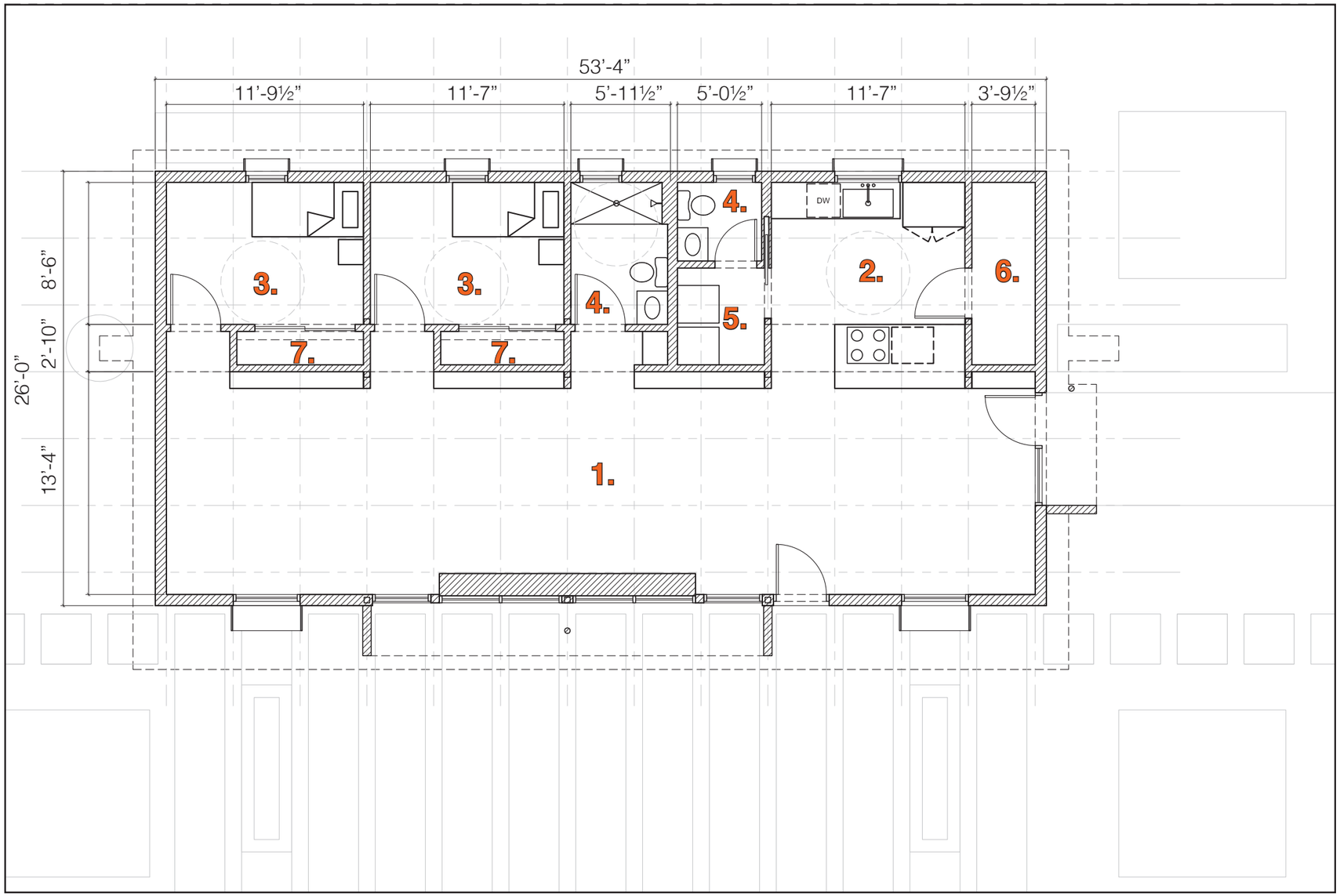
PROJECT CONCEPT



SITE CONTEXT

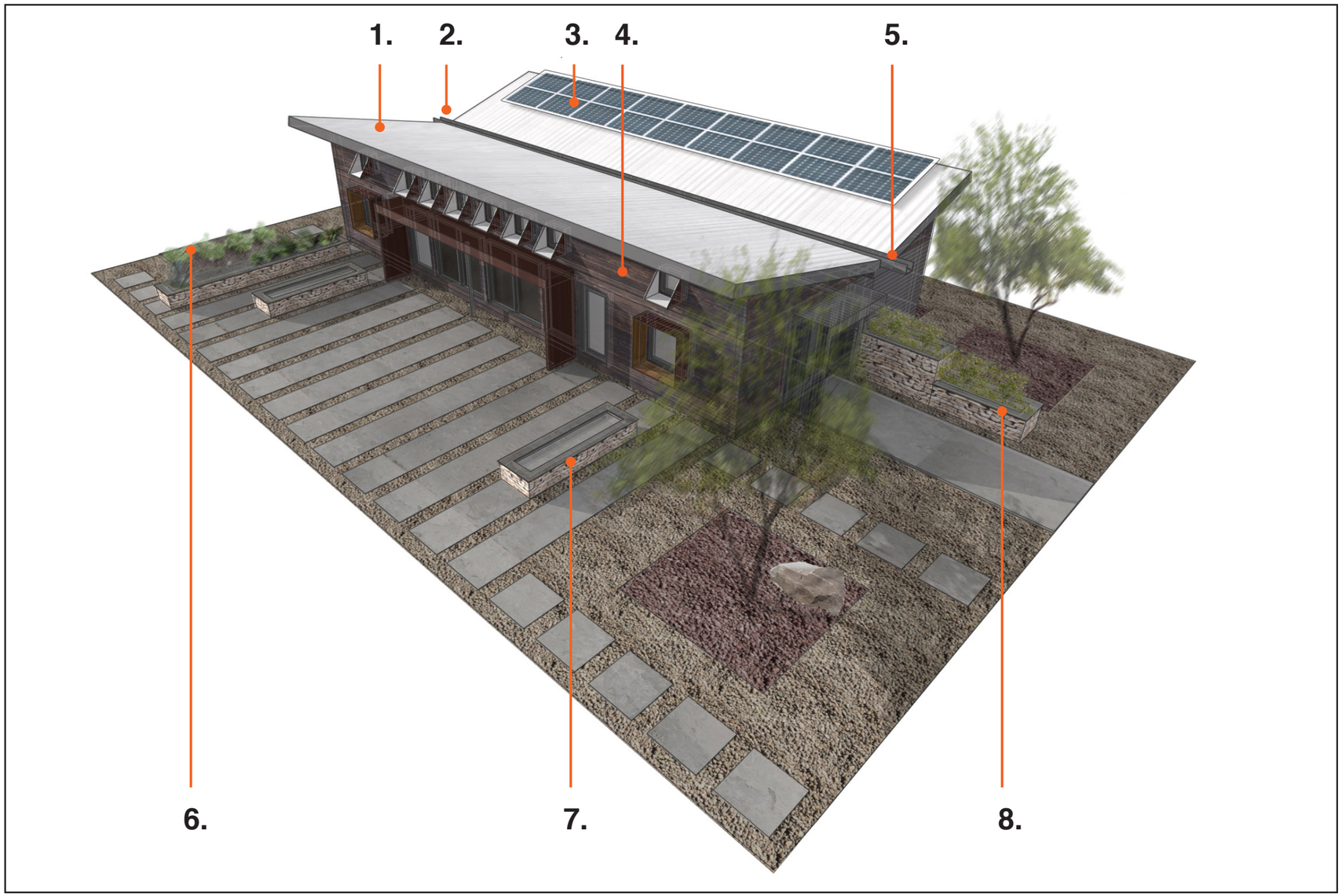
1. Interstate15
2. Moapa Travel Plaza
3. Park
4. PV Array
5. Site
6. Road To Valley Of Fire

FLOOR PLAN



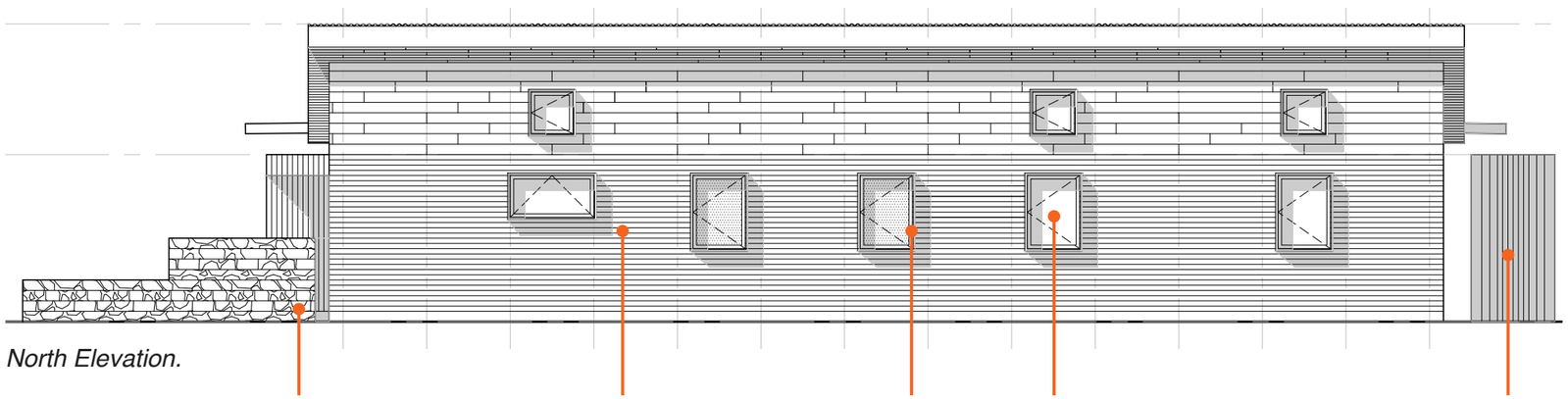
1. Grand Hall
2. Kitchen
3. Bedroom
4. Bathroom
5. Laundry
6. Utility Closet
7. Closet

MATERIALS AND STRATEGIES

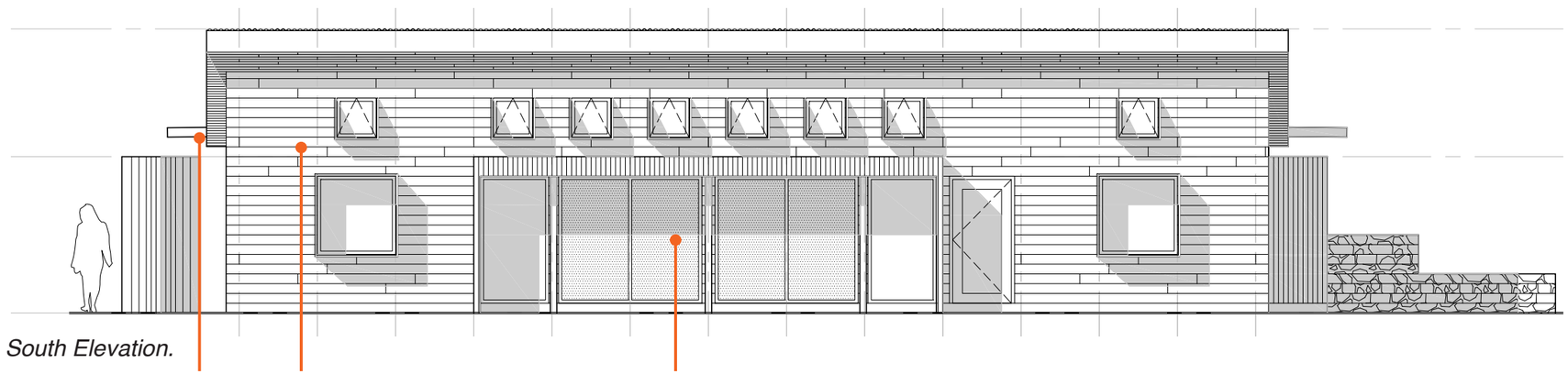


1. Corrugated Metal Roof
2. Rain Catchment Cistern (behind)
3. PV Panels (18x Solar World plus SW 280 Mono)
4. Reclaimed Wood Siding
5. Catchment Scupper
6. Vegetable Garden
7. Fire Pit
8. Herb Planter

ELEVATIONS: NORTH + SOUTH



North Elevation.

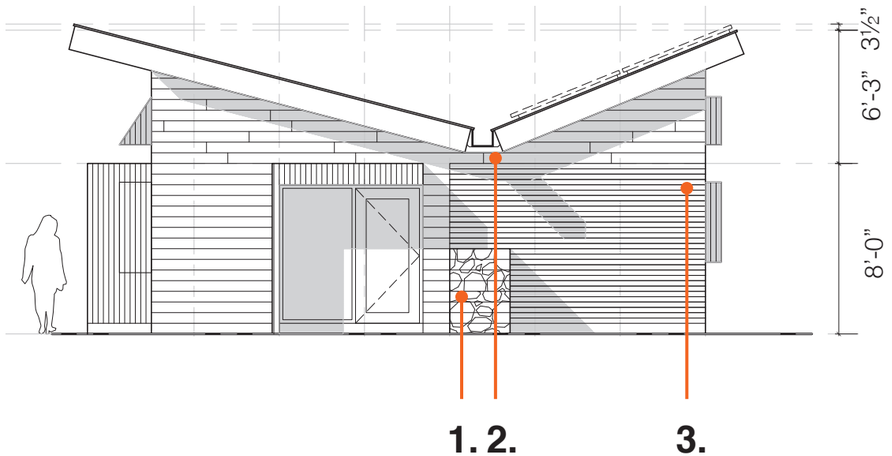


South Elevation.

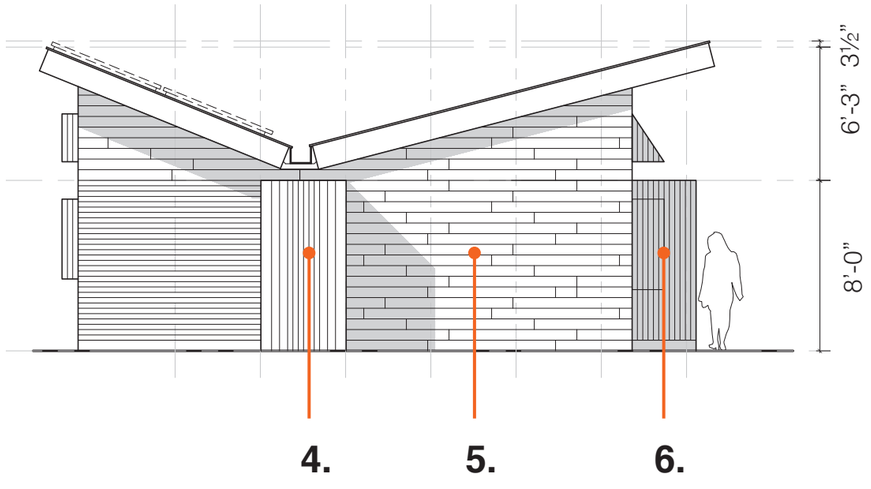
1. Herb Planter
2. Corr. Metal Skin
3. Corr. Metal and Plywood Box Frame
4. Aluminum Clad Wood Frame Windows
5. Rain Catchment Cistern
6. Catchment Scupper
7. Reclaimed Wood Siding
8. CMU Trombe Wall

0 2’ 4’ 8’

ELEVATIONS: EAST + WEST



East Elevation.

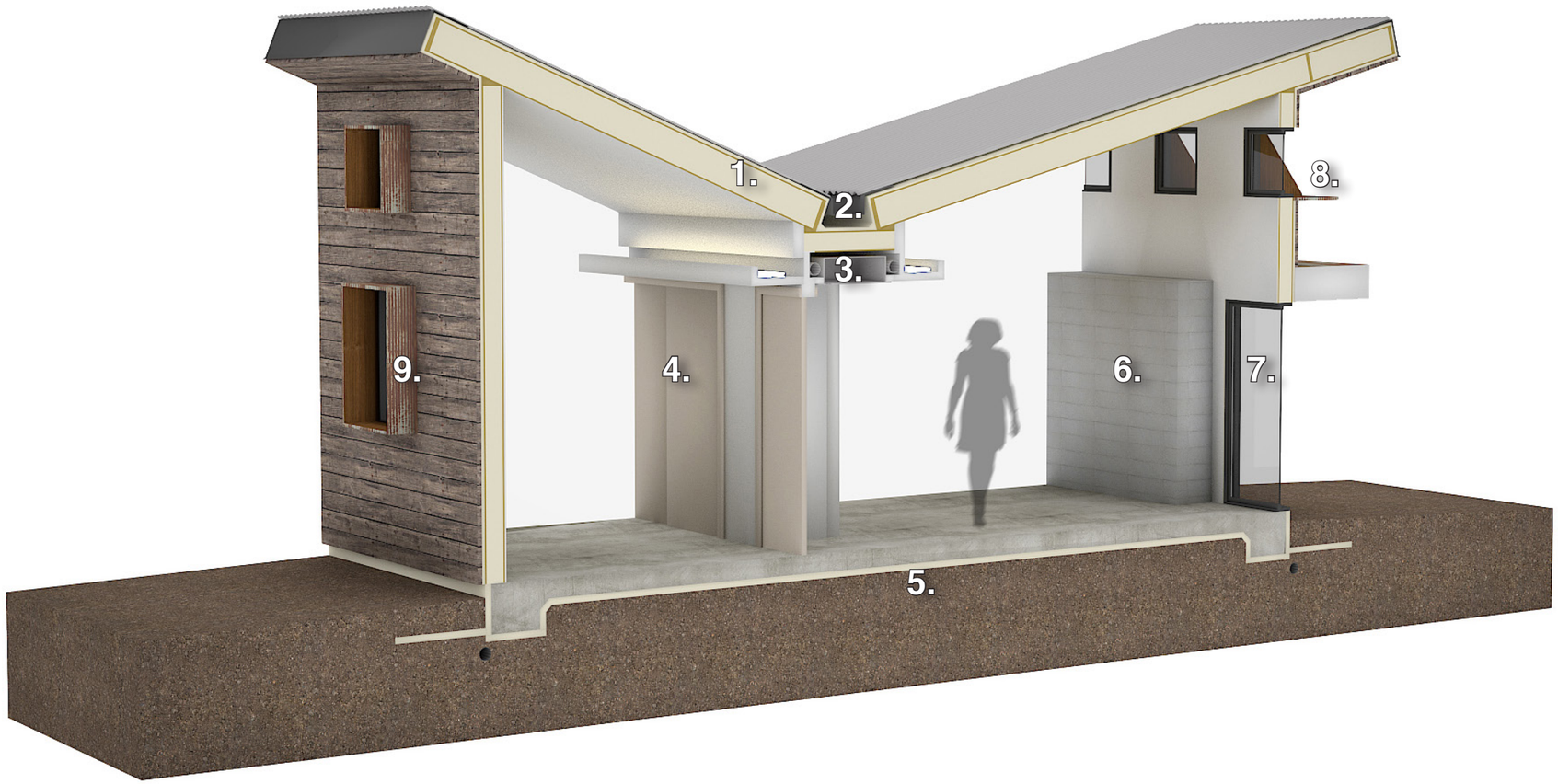


West Elevation.

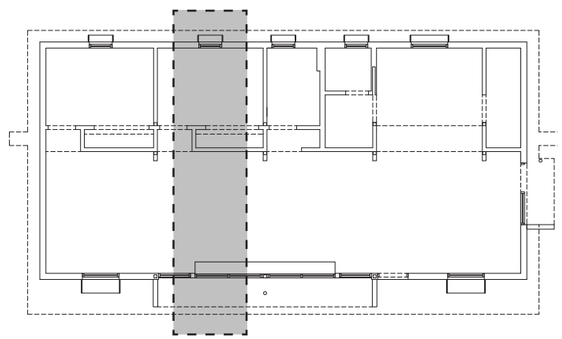
1. Herb Planter
2. Catchment Scupper
3. Corr. Metal Skin
4. Rain Catchment Cistern
5. Reclaimed Wood Siding
6. Corr. Metal and Plywood Box Frame

0 2’ 4’ 8’

SECTION AXONOMETRIC

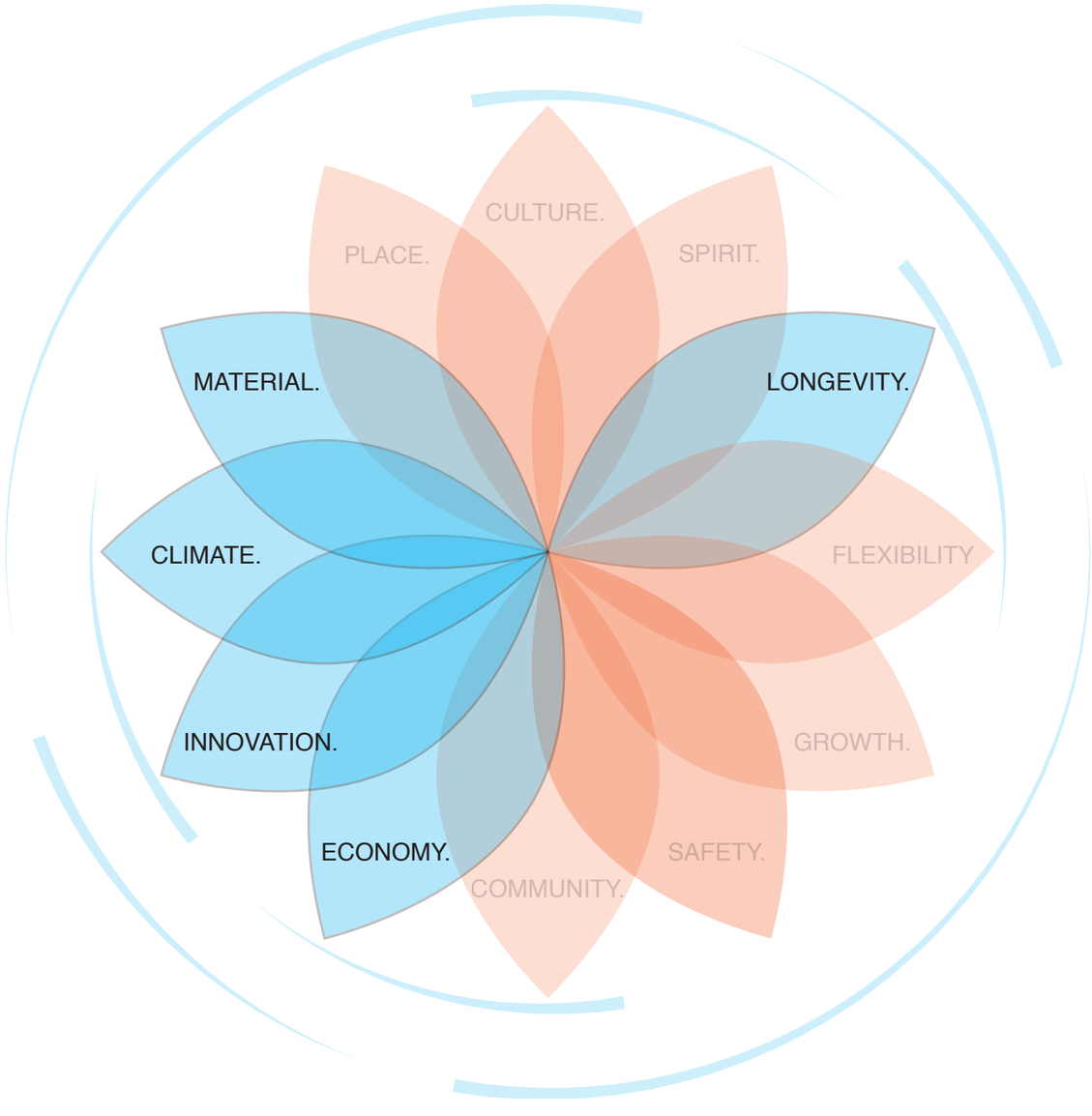


1. SIP Structure
2. Scupper
3. Service Spine
4. Storage
5. Fully Insulated Slab
6. Trombe Wall
7. Alum. Clad Wood Frame Windows
8. Light Shelf/Shade
9. Corr. Metal and Plywood Box Frame



C. ENVELOPE DURABILITY ANALYSIS

DESIGN GOALS: ENVELOPE DURABILITY



longevity. Where applicable, design choices opt for a longer lasting solution, or one less likely to deteriorate over time.

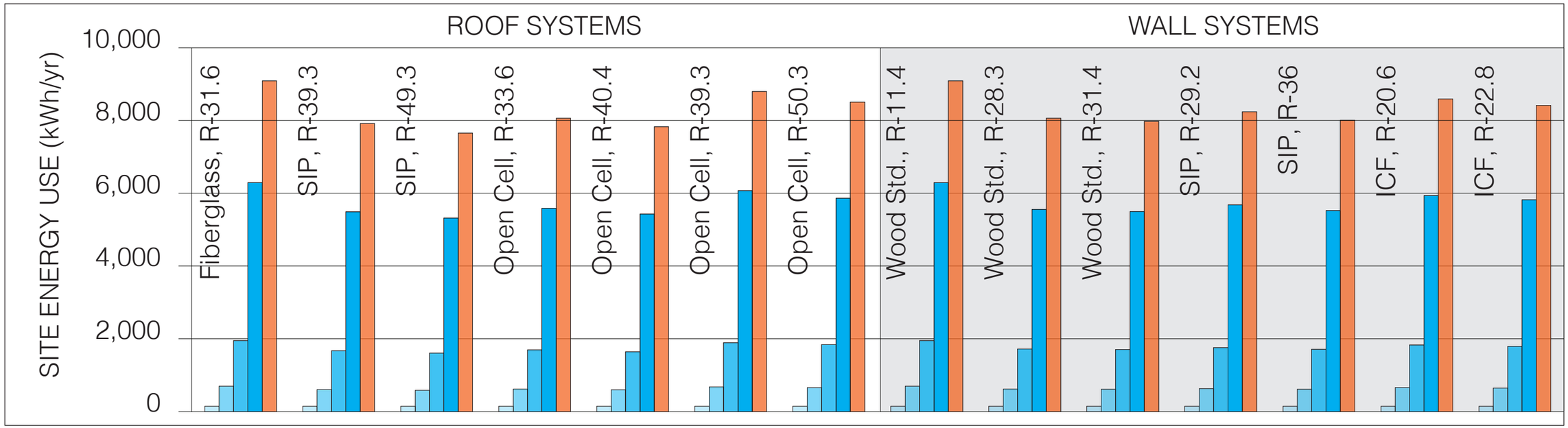
economy. Assemblies specified and sized based on material and labor cost efficiency.

innovation. To complement a tight, well insulated envelope with passive strategies: Trombe Wall and Direct Gain

climate. Thermal, Moisture, and Air Control layers designed and detailed for site conditions.

material. Naturally weathering claddings protect structural and insulative layers while blending into the Mojave landscape

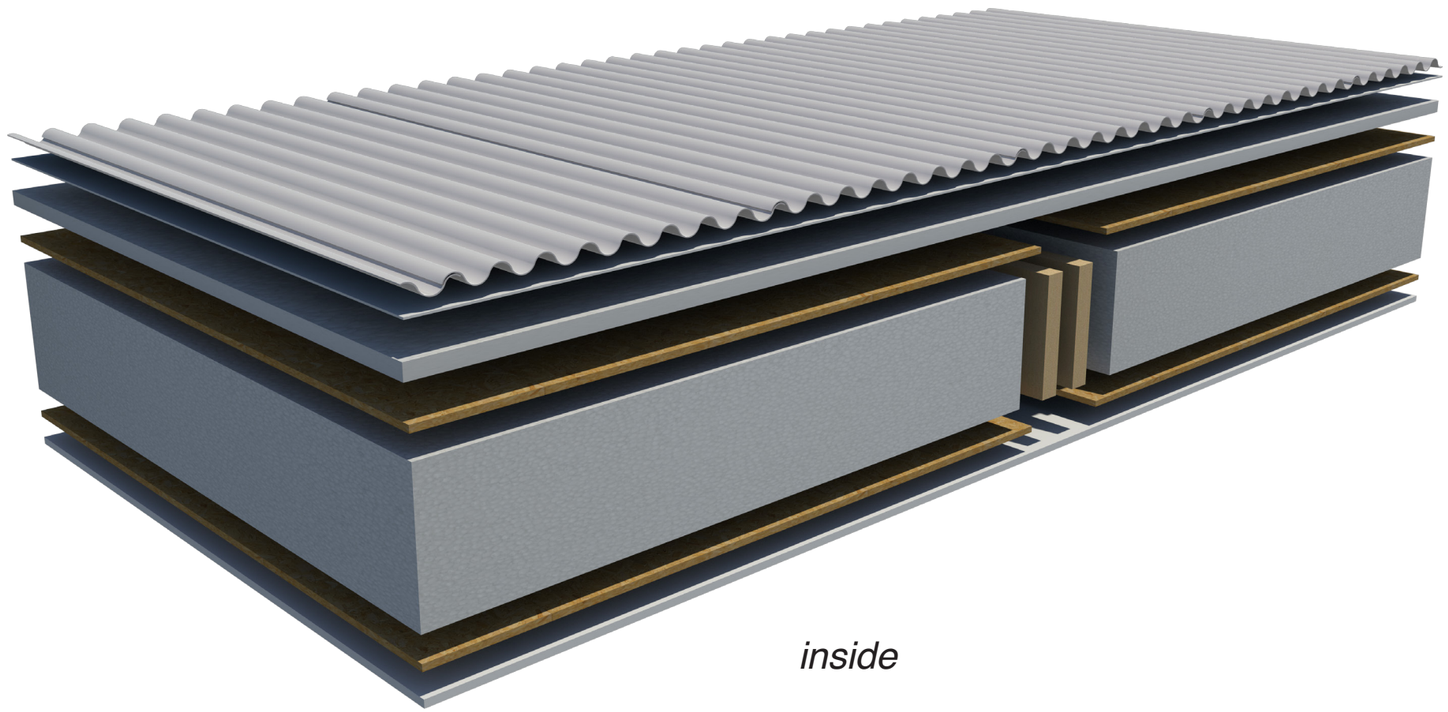
ENVELOPE RESEARCH: DECISION MAKING MATRIX ROOF & WALLS



	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Heating (G)	6,294	5,493	5,320	5,587	5,432	6,074	5,866	6,294	5,558	5,499	5,684	5,526	5,939	5,822
Cooling (E)	1,953	1,675	1,610	1,698	1,645	1,895	1,842	1,953	1,722	1,707	1,760	1,713	1,833	1,795
HVAC Fan (E)	701	607	587	622	601	680	660	701	622	616	634	616	663	648
Vent Fan	150	150	150	150	150	150	150	150	150	150	150	150	150	150
Total	**9,092**	**7,919**	**7,655**	**8,066**	**7,831**	**8,799**	**8,506**	**9,092**	**8,066**	**7,978**	**8,242**	**8,007**	**8,594**	**8,418**
Price ($)	**BASE**	**+5,145**	**+6,435**	**+4,038**	**+5,039**	**+3,651**	**+6,459**	**BASE**	**+4,651**	**+4,861**	**+3,369**	**+2,331**	**+3,779**	**+7,637**

ENVELOPE ANALYSIS: ROOF THERMAL PROPERTIES (h ft^2 °F / Btu)

outside



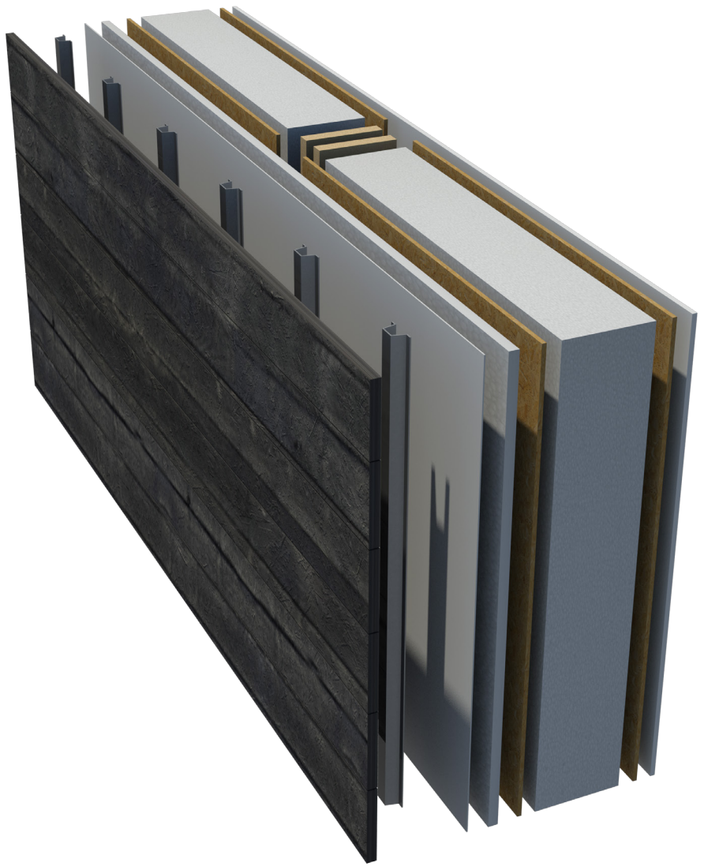
inside

(outside to inside)

- Outside Air Resistance
  R = .170
- 7/8” 26 GA Metal Roof
  R = .667
- 1” Cont. XPS (R-5/in)
  R = 5.000
- OSB (.4375 n.)
  R = .510
- EPS Insulation (R-3.85/in)
  R = 37.056
- 2” x 10” pine wood frame
  R = 8.455
- OSB (.4375 in.)
  R = .510
- Gypsum Board (.0375 in.)
  R = .320
- Inside Air Resistance (horiz-up)
  R = .610

Isothermal Planes Calculation	(h ft^2 °F / Btu)	(h ft^2 °F / Btu)	U (Btu /h ft^2 °F)	R - Total (h ft^2 °F / Btu)
R At Frame And b/t Frame	8.455	37.056		
Area (%ft^2)	.1	.9		
Isothermal Planes (U & R)			.028	**35.476**

ENVELOPE ANALYSIS: WALL THERMAL PROPERTIES (h ft² °F / Btu)



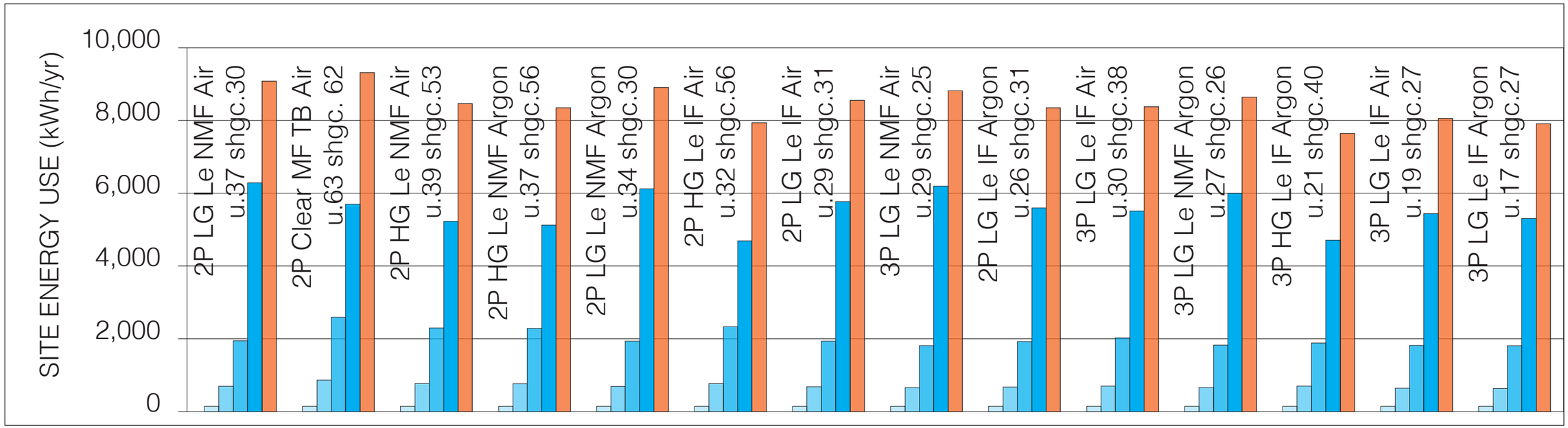
outside *inside*

(outside to inside)

- Outside Air Resistance
  R = .170
- Reclaimed Wood Siding
  R = .800
- 1” Cont. XPS (R-5/in)
  R = 5.000
- OSB (.4375 in.)
  R = .510
- EPS Insulation (R-3.85/in)
  R = 21.656
- 2” x 6” pine wood frame
  R = 4.895
- OSB (.4375 in.)
  R = .510
- Gypsum Board (.0375 in.)
  R = .320
- Inside Air Resistance (horiz-up)
  R = .680

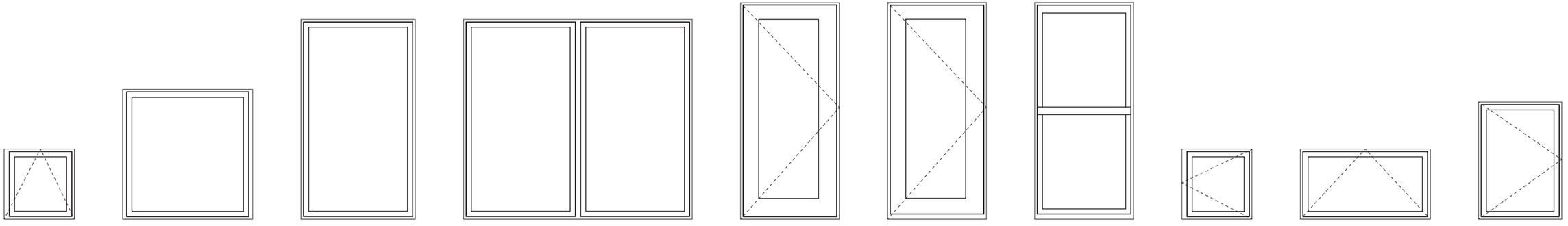
Isothermal Planes Calculation	R @ Frame (h ft² °F / Btu)	R b/t Frame (h ft² °F / Btu)	U (Btu /h ft² °F)	R - Total (h ft² °F / Btu)
R At Frame And b/t Frame	4.895	21.656		
Area (%ft²)	.1	.9		
Isothermal Planes (U & R)			.041	**24.12**

ENVELOPE RESEARCH: DECISION MAKING MATRIX WINDOWS



	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Heating (G/E)	6,294	5,708	5,235	5,133	6,130	4,699	5,781	6,203	5,605	5,517	6,007	4,716	5,447	5,317
Cooling (E)	1,953	2,599	2,302	2,294	1,942	2,338	1,942	1,818	1,930	2,030	1,833	2,097	1,824	1,816
HVAC Fan (E)	701	868	774	768	695	771	686	663	678	704	663	704	645	639
Vent Fan	150	150	150	150	150	150	150	150	150	150	150	150	150	150
Total	**9,092**	**9,327**	**8,476**	**8,359**	**8,916**	**7,948**	**8,564**	**8,828**	**8,359**	**8,388**	**8,652**	**7,655**	**8,066**	**7,919**
Price ($)	**BASE**	**+42**	**+269**	**+143**	**+250**	**+945**	**+195**	**+1,244**	**+2,677**	**+945**	**+1,914**	**+7,997**	**+10,767**	**+17,841**

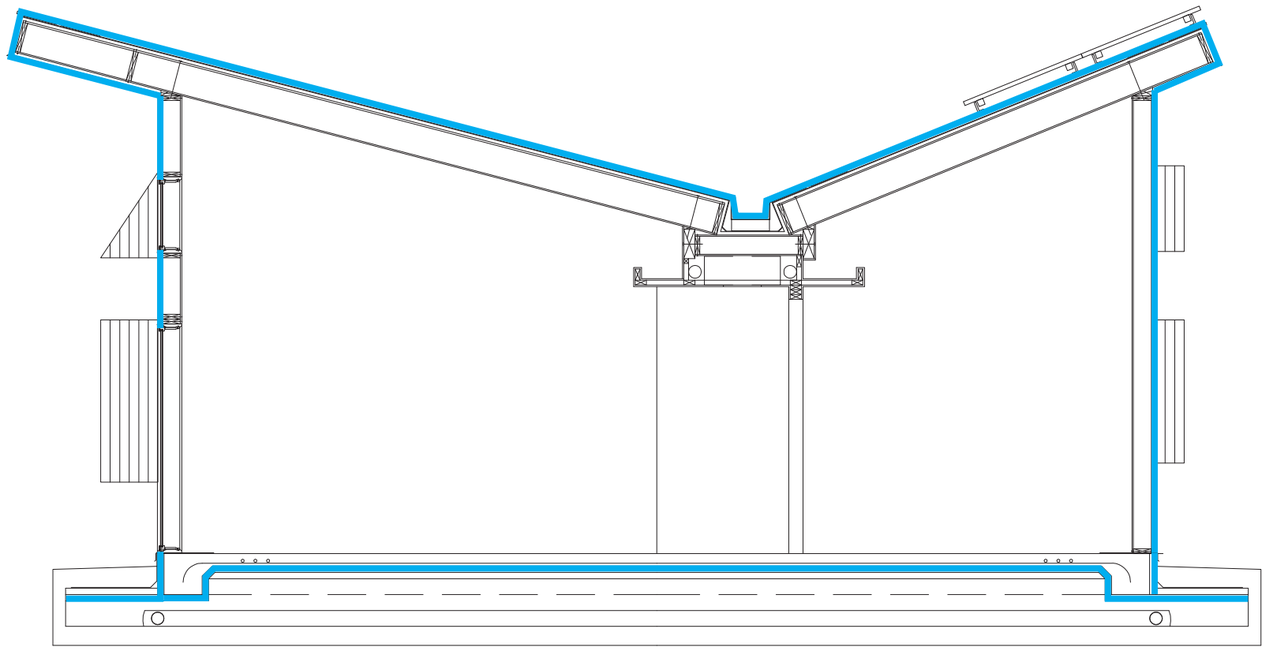
WINDOW AND DOOR SCHEDULE



Type	Dimension (W x H)	Count	Action	U-Value/ SHGC	Frame Type	Glazings
SOUTH						
A	2’-0” x 2’-0”	8	Awning	.26/.24	Aluminum Clad Wood	3/Air
B	4’-0” x 4’-0”	2	Fixed	.24/.26	Aluminum Clad Wood	3/Air
C	3’-6” x 6’-0”	2	Fixed	.24/.26	Aluminum Clad Wood	3/Air
D	7’-4” x 6’-0”	2	Fixed	.34/.58	Aluminum Clad Wood	2/Air
E	3’-0” x 6’-8”	1	Door	.30/.19	Aluminum Clad Wood	2/Air
EAST						
F	3’-0” x 6’-8”	1	Fixed	.30/.23	Insulated Fiberglass	2/Air
G	3’-0” x 6’-8”	1	Door	.30/.19	Insulated Fiberglass	2/Air
NORTH						
H	2’-0” x 2’-0”	3	Casement	.25/.24	Aluminum Clad Wood	3/Air
I	4’-0” x 2’-0”	1	Awning	.26/.24	Aluminum Clad Wood	3/Air
J	2’-6” x 3’-6”	4	Casement	.25/.24	Aluminum Clad Wood	3/Air

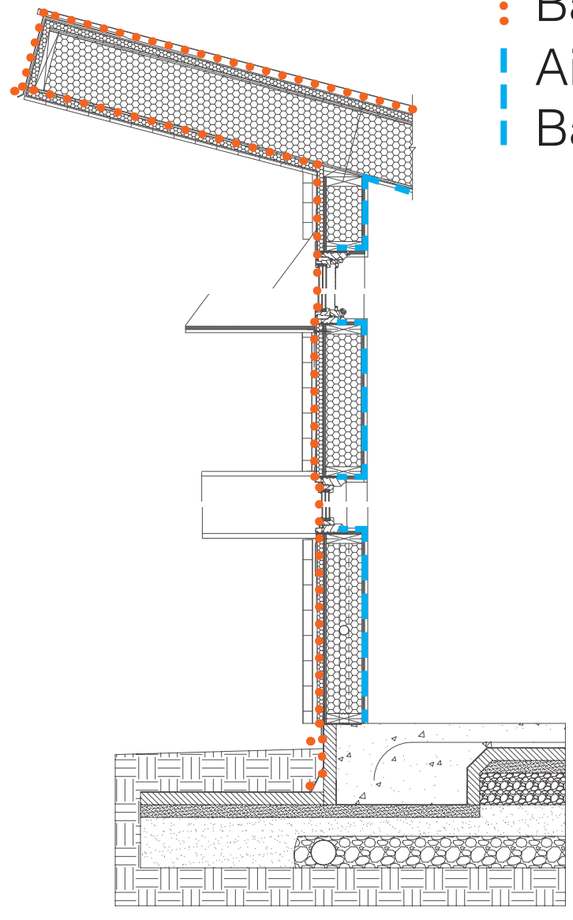
BUILDING SECTION DIAGRAMS

Continuous rigid insulation

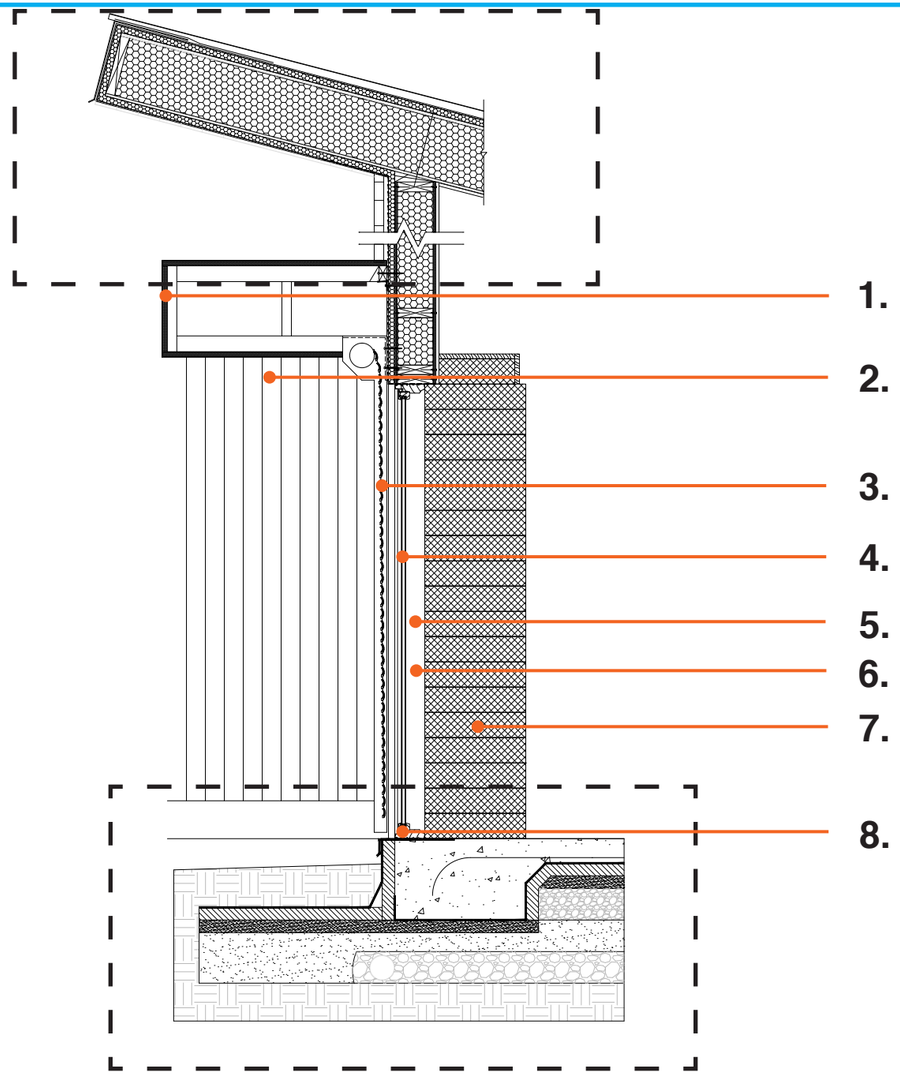


Moisture Barrier

Air Barrier



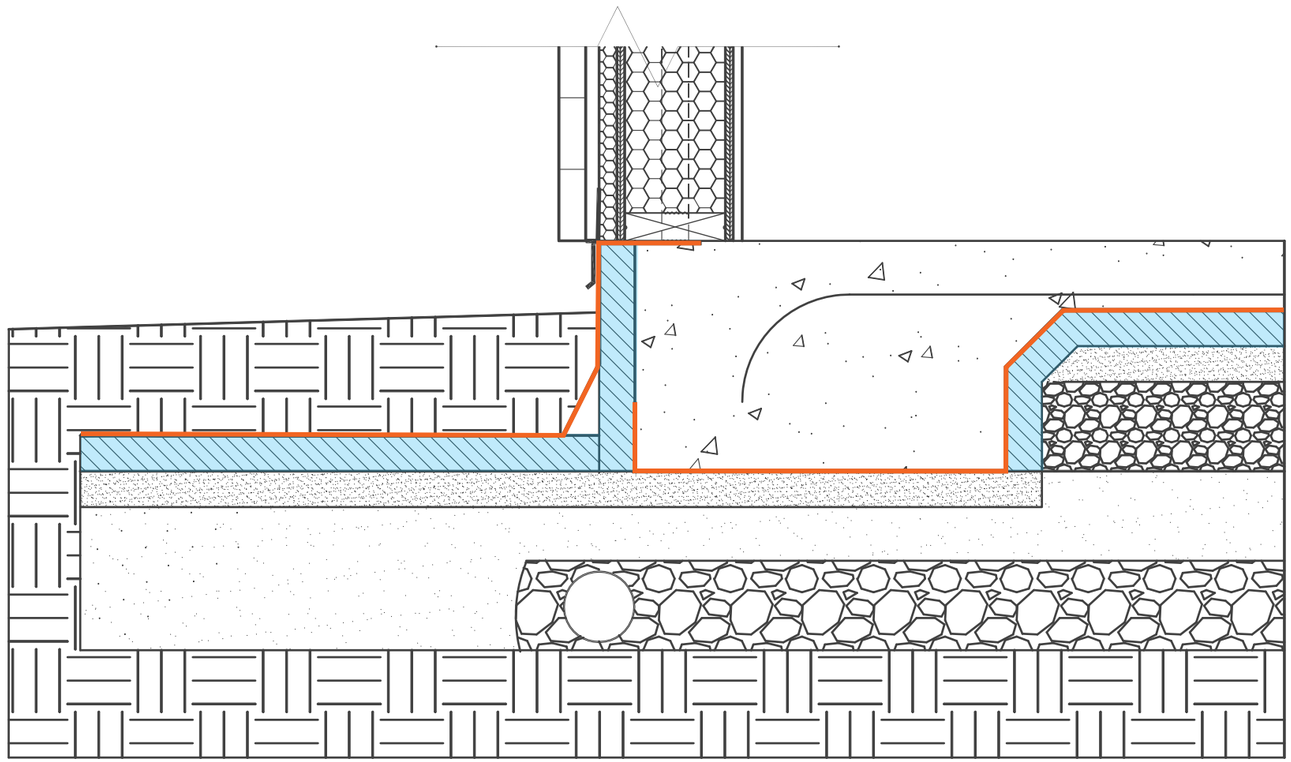
ENVELOPE DETAILS: TROMBE WALL



1. Corrugated and plywood shading device
2. Corrugated metal skin
3. Movable insulation
4. Double glazed high gain window
5. 2” air cavity
6. Solkote-selective solar-coating
7. 4”x 8”x16” solid concrete block
8. Aluminum clad wood frame system

0 3” 6” 1’

ENVELOPE DETAILS: FOUNDATION

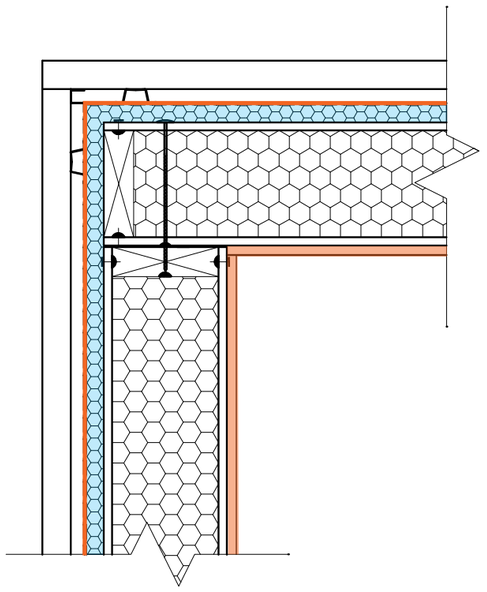


Moisture control system: 10mm **continuous moisture** & **radon barrier**.

2” XPS, R-9.

0 3” 6” 1’

ENVELOPE DETAILS: CORNER

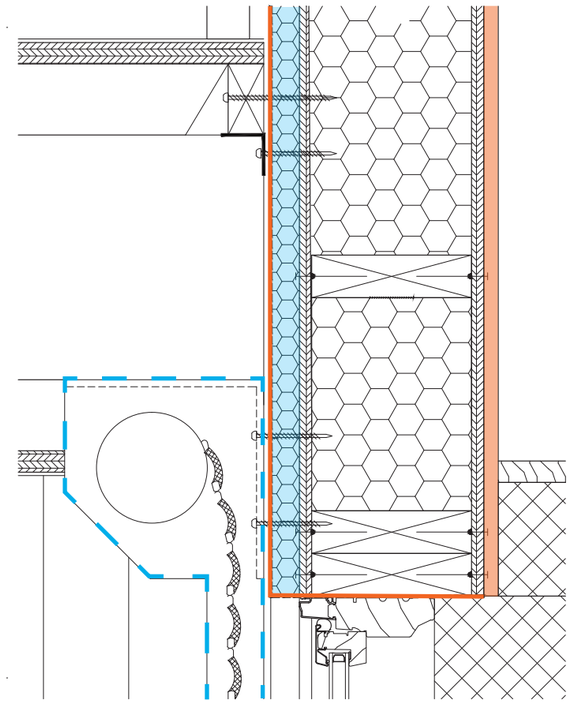


Weather barrier installed shingle fashion.

R-6 **continuous rigid insulation** w/ seams tuck taped.

Air barrier - gypsum board caulked at all joints.

ENVELOPE DETAILS: MOVABLE INSULATION



Movable insulation system.

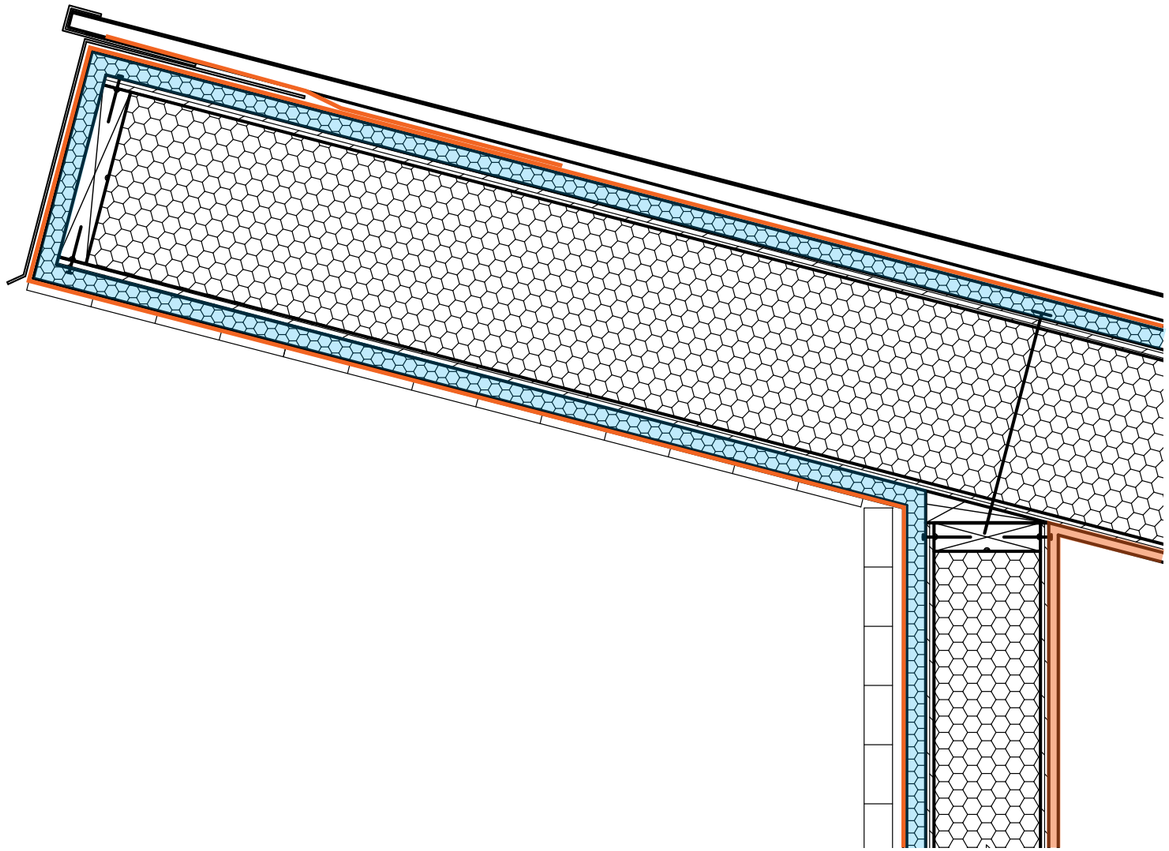
Weather barrier installed shingle fashion.

R-6 **continuous rigid insulation** w/ seams tuck taped.

Air barrier - gypsum board caulked at all joints.

0 3” 6” 1’

ENVELOPE DETAILS: ROOF



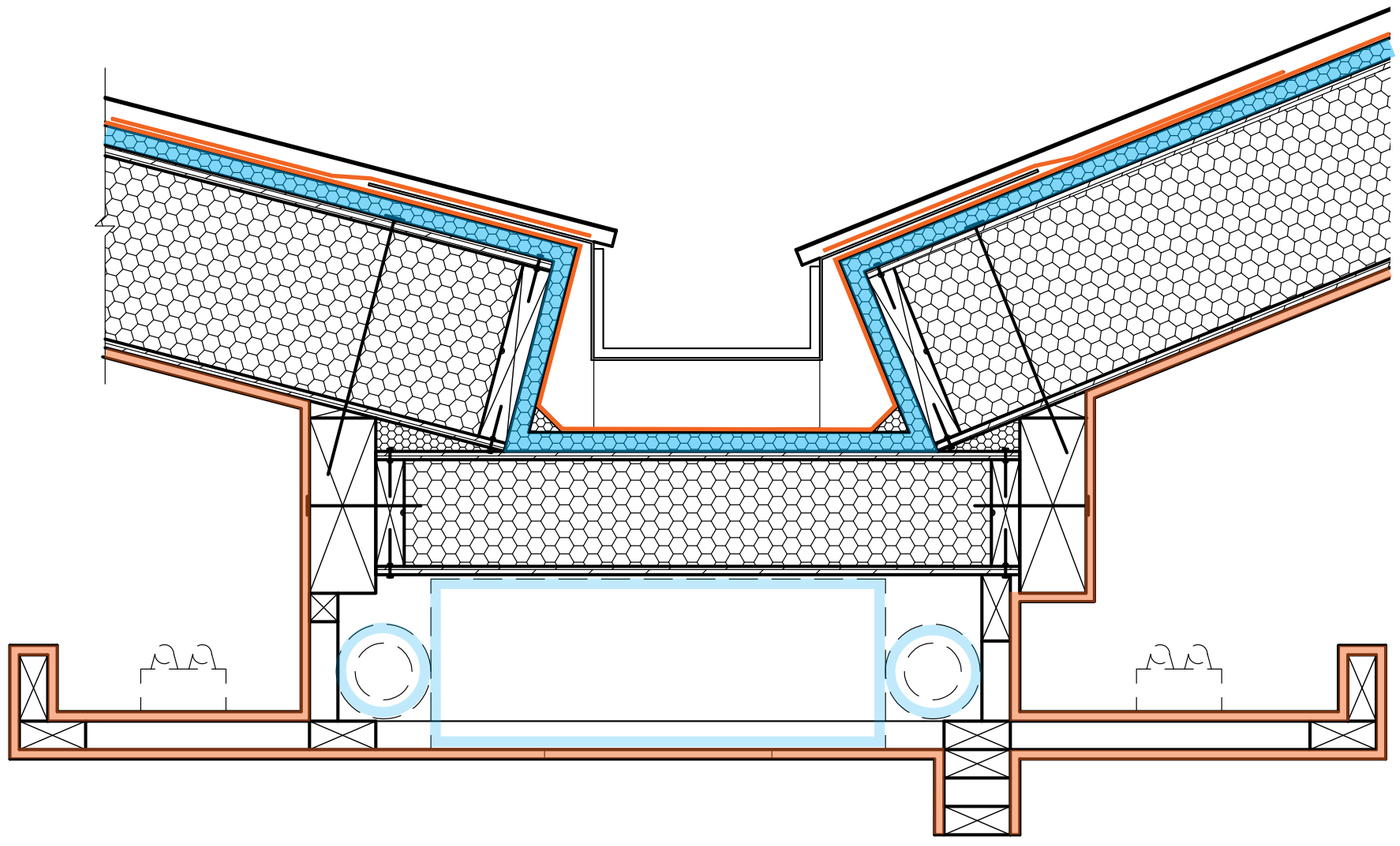
40 mil **waterproofing membrane** - overlap over flashing and weather barrier.

R-6 **continuous rigid insulation** panel w/ seams tuck taped.

Air barrier - gypsum board caulked at all joints.

0 3” 6” 1’

ENVELOPE DETAILS: CENTRAL SCUPPER/SERVICE SPINE



40 mil **waterproofing membrane** - overlap over flashing

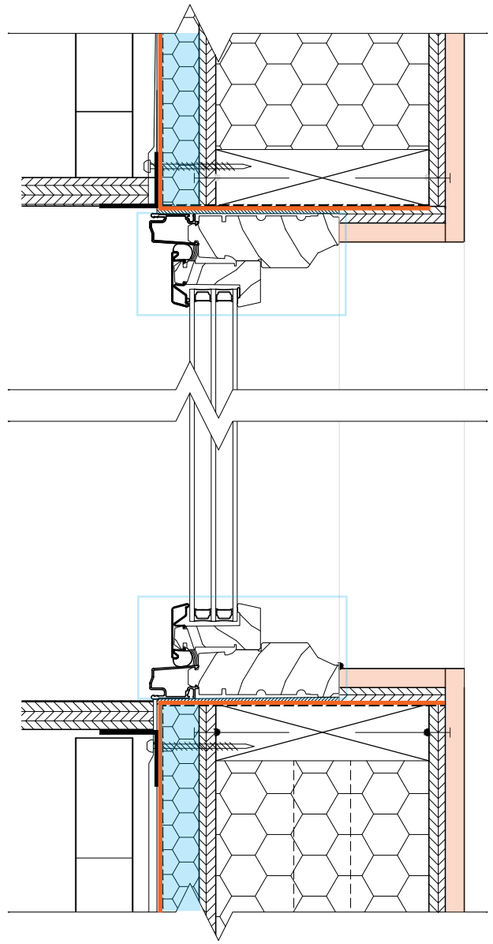
R-6 **continuous rigid insulation** panel w/ seams tuck taped.

Air barrier - gypsum board caulked at all joints.

Mechanical equipment and ducting.

0 3” 6” 1’

ENVELOPE DETAILS: WINDOW DETAIL



40 mil **waterproofing membrane** - overlap over flashing

R-6 **continuous rigid insulation** panel w/ seams tuck taped.

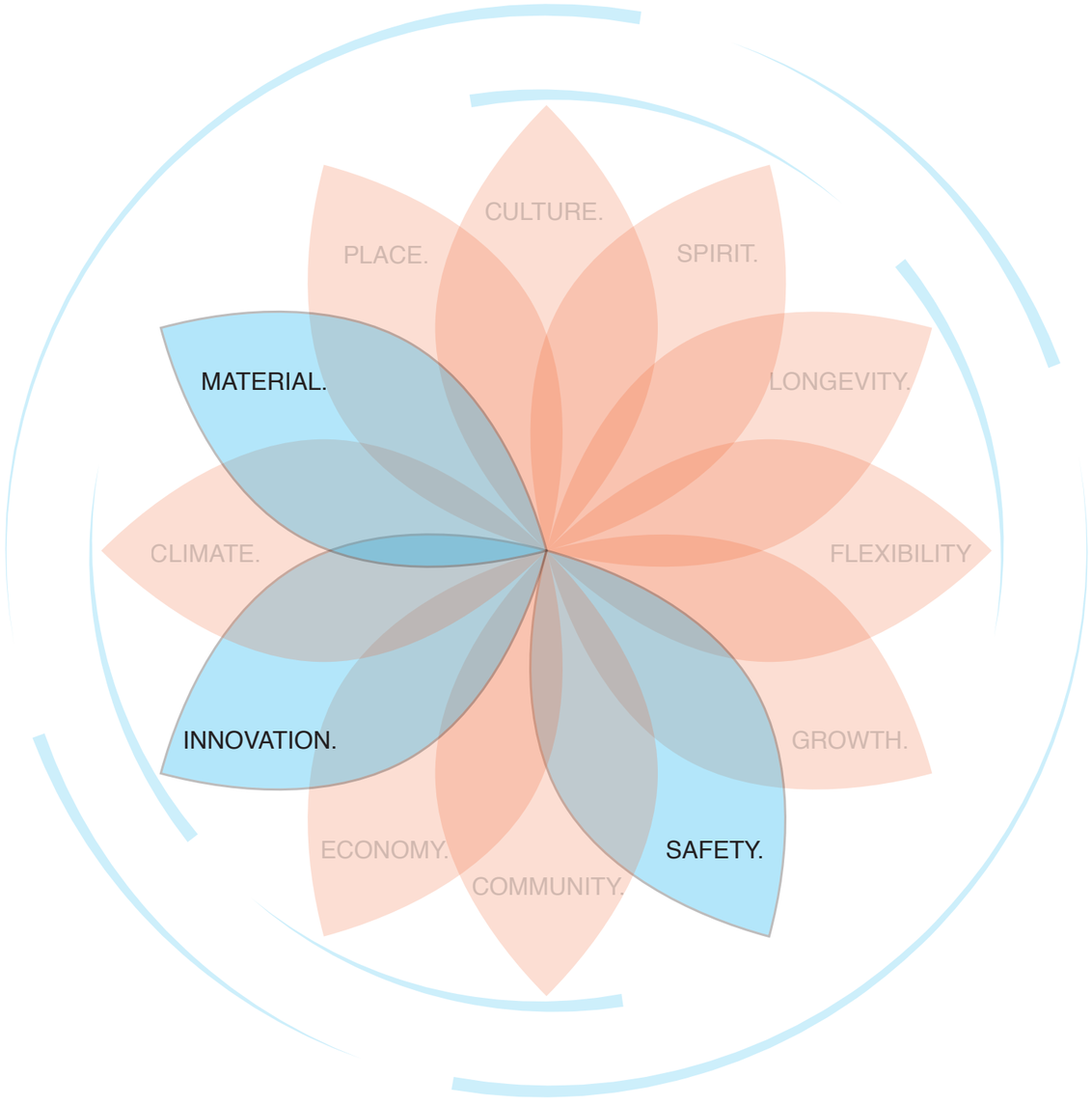
Air barrier - gypsum board caulked at all joints.

Aluminum clad wood windows

0 3” 6” 1’

D. INDOOR AIR QUALITY EVALUATION

DESIGN GOALS: INDOOR AIR QUALITY



safety. Integration of appropriate radon barrier according to Indoor airPlus standards.

innovation. HRV unit coupled with ductless conditioning minimizes energy consumption while providing adequate ventilation.

material. Specification of low-VOC materials and interior finishes.

IAQ ANALYSIS

Building Envelope

- Proper placement water and vapor control layers, prevents mold growth, thus preventing harmful exposure.
- Rodent/pest screens placed in any building opening that couldn't be fully sealed to avert unwanted guests.
- Radon Zone 3 (low-potential for radon exposure) requires a 6-mil radon barrier in the foundation slab, but constructability persuaded us to select a 10-mil radon barrier.

Interior Components

- Ultra-low VOC paint and finishes selected
- No formaldehyde used on exposed elements
- Carbon Monoxide sensors near bedrooms
- HRV unit provides the necessary ventilation to meet ASHRAE 62.2-2010 Standards

IAQ ANALYSIS (CALCULATIONS)

Required continuous CFM = (7.5 CFM × number of occupants) + $\left[\frac{\text{floor area}}{100}\right]$ cfm

= (7.5 CFM x 4) + $\left[\frac{1,387}{100}\right]$

= 30 CFM + 13.87 CFM

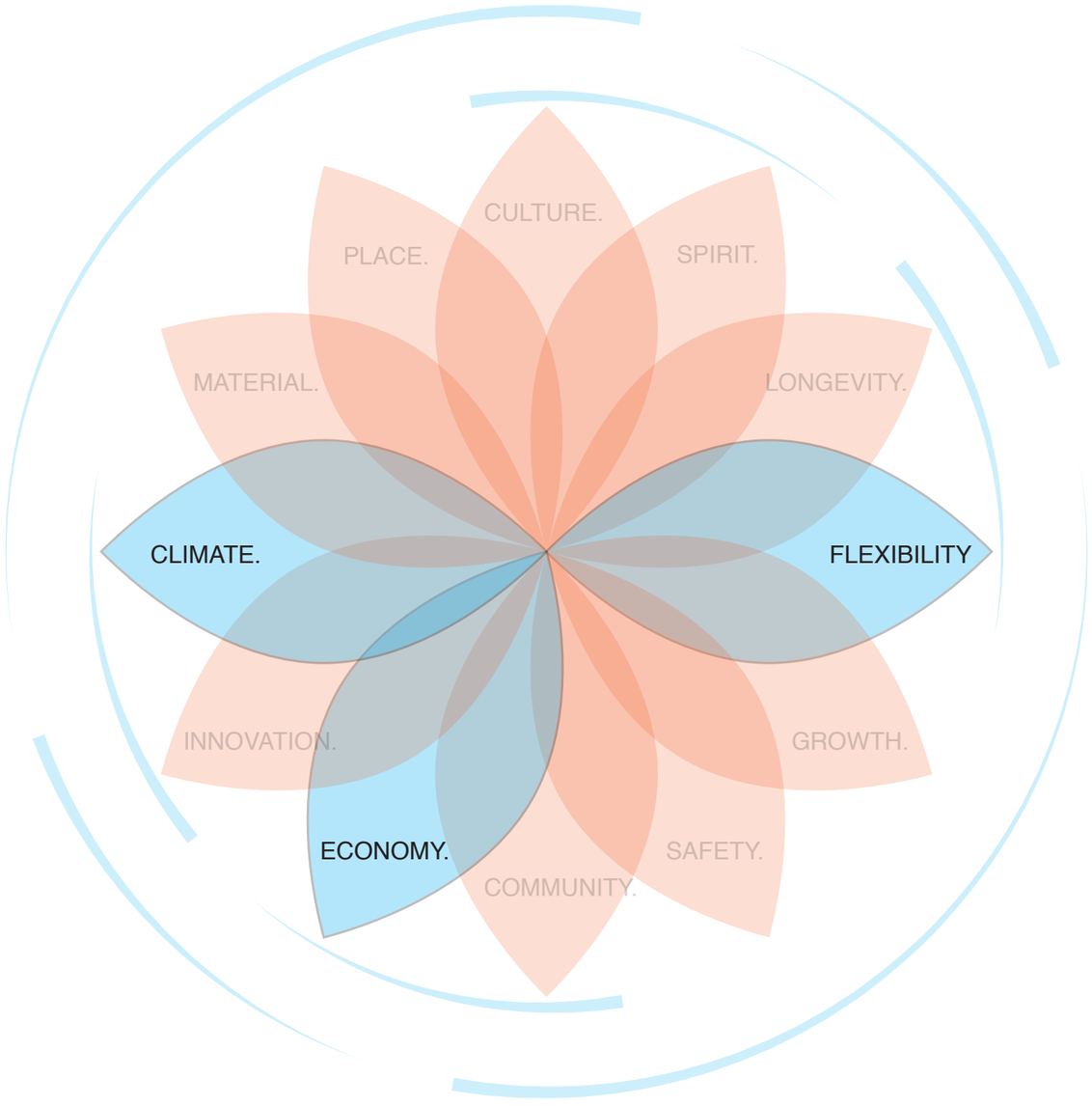
= **43.87 CFM**

HRV Ventilation Performance:

External Static Pressure		Net Supply Air Flow			Gross Air Flow					
					Supply			Exhaust		
PA	IN. W.G.	L/S	CFM	M^3/H	L/S	CFM	M^3/H	L/S	CFM	M^3/H
25	0.1	40	84	143	40	85	144	40	85	144
50	0.2	38	**80**	136	38	81	138	38	81	138
75	0.3	36	77	131	37	78	133	37	79	134
100	0.4	34	73	124	35	73	124	35	74	126
125	0.5	33	**70**	117	33	71	121	34	71	121
150	0.6	31	65	110	31	66	112	32	68	116
175	0.7	29	60	102	29	61	104	29	62	105
200	0.8	26	56	95	27	57	97	27	57	97
225	0.9	25	52	88	25	53	90	25	52	88

E. SPACE CONDITIONING DESIGN AND ANALYSIS

DESIGN GOALS: SPACE CONDITIONING

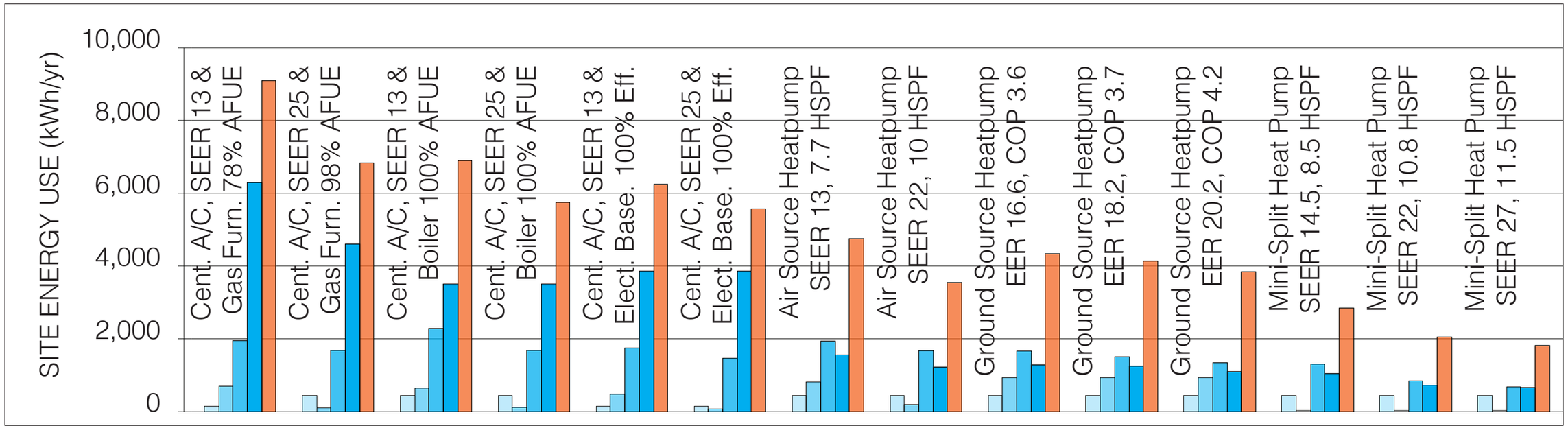


flexibility. Appropriately sized outdoor units allow for multiple, strategically positioned ceiling recessed cassettes of mini-split system.

economy. Selection factors included initial cost of system and annual energy savings.

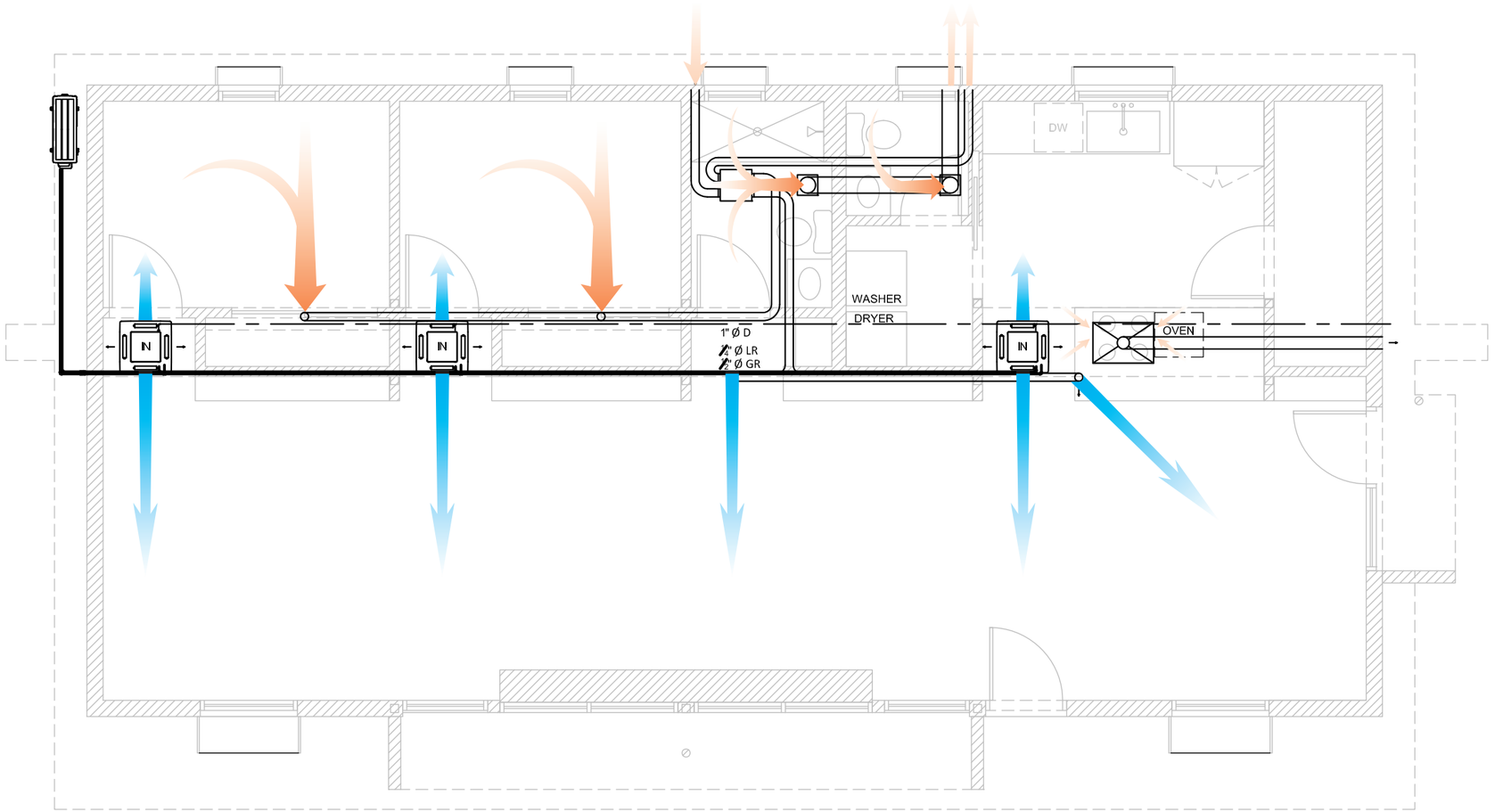
climate. System chosen based on adequate operational efficiency for the Moapa valley temperature range.

RESEARCH: DECISION MAKING MATRIX SPACE CONDITIONING



	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Heating (G/E)	6,294	4,602	3,508	3,508	3,863	3,863	1,560	1,226	1,288	1,252	1,103	1,047	727	666
Cooling (E)	1,953	1,684	2,288	1,684	1,748	1,469	1,939	1,675	1,666	1,508	1,346	1,308	848	683
HVAC Fan (E)	701	106	648	117	481	76	815	197	936	936	936	32	32	32
Vent Fan	150	150	150	150	150	150	150	150	150	150	150	150	150	150
Total	**9,092**	**6,834**	**6,892**	**5,749**	**6,247**	**5,573**	**4,751**	**3,549**	**4,341**	**4,135**	**3,842**	**2,845**	**2,053**	**1,818**
Price ($)	**BASE**	**+5,226**	**+1,453**	**+3,660**	**-795**	**+1,432**	**-467**	**+1,679**	**+19,140**	**+19,685**	**+20,336**	**-2,588**	**-1,263**	**-377**

DIAGRAM FOR AIRFLOW / MECHANICAL PLAN



Results

- The three ceiling recessed cassettes deliver conditioned air for the home.
- HRV system provides the exhaust and fresh air supply.
- In January, the TW and DG passive solar heating strategies produce an indoor temperature range of **67.6-77.2°F**

F. ENERGY ANALYSIS

PROCESS

Material Efficiency.

Exterior wall heights determine roof pitch angle and thus affecting PV system.

16 ft SIP Panels = Maximum annual energy production (↑$)
vs.
12 ft SIP Panels = Optimal summer energy production (↓$)

Heating loads for Desert Sunrise Home are one-third to one-half of cooling loads.

PV system should be optimized for summer energy production.

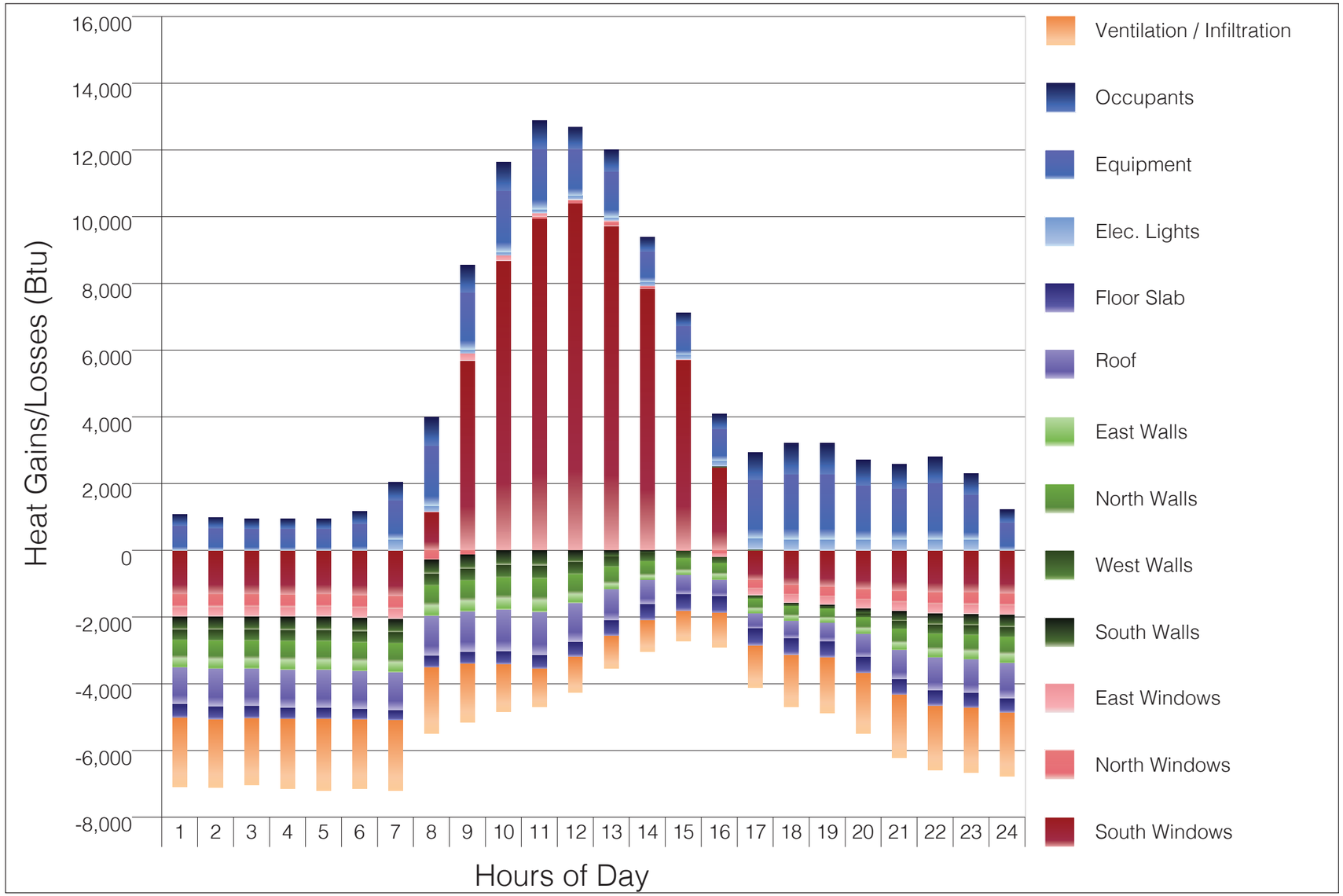
While passive cooling may be done, our team felt that passive solar heating would be easier to accomplish.

Conclusion

1. North and south exterior walls utilize 12 ft SIP panels, which result in a roof angle of 18 degrees, maximizing energy production in summer months.

2. Passive solar heating strategies reduce energy consumption from active heating system.

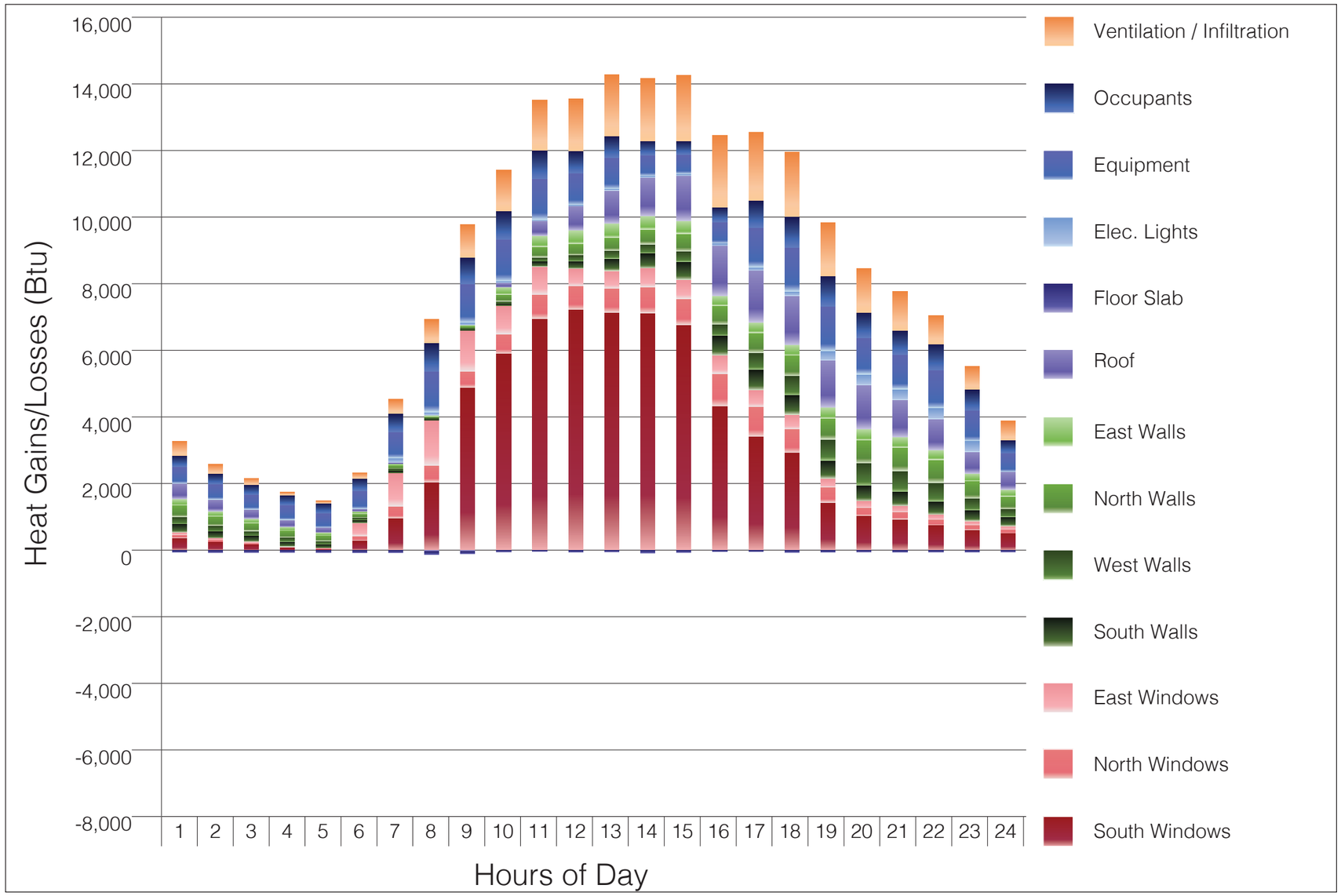
HEED v.4 BUILDING THERMAL LOADS FOR DECEMBER (Btu)



Results

- Trombé wall and direct gain strategies provide significant gains between 8am-4pm, thus reducing reliance on our active heating system.
- SSF = 60.45%
- Continuous ventilation (HRV) and infiltration are the largest sources of heat loss.

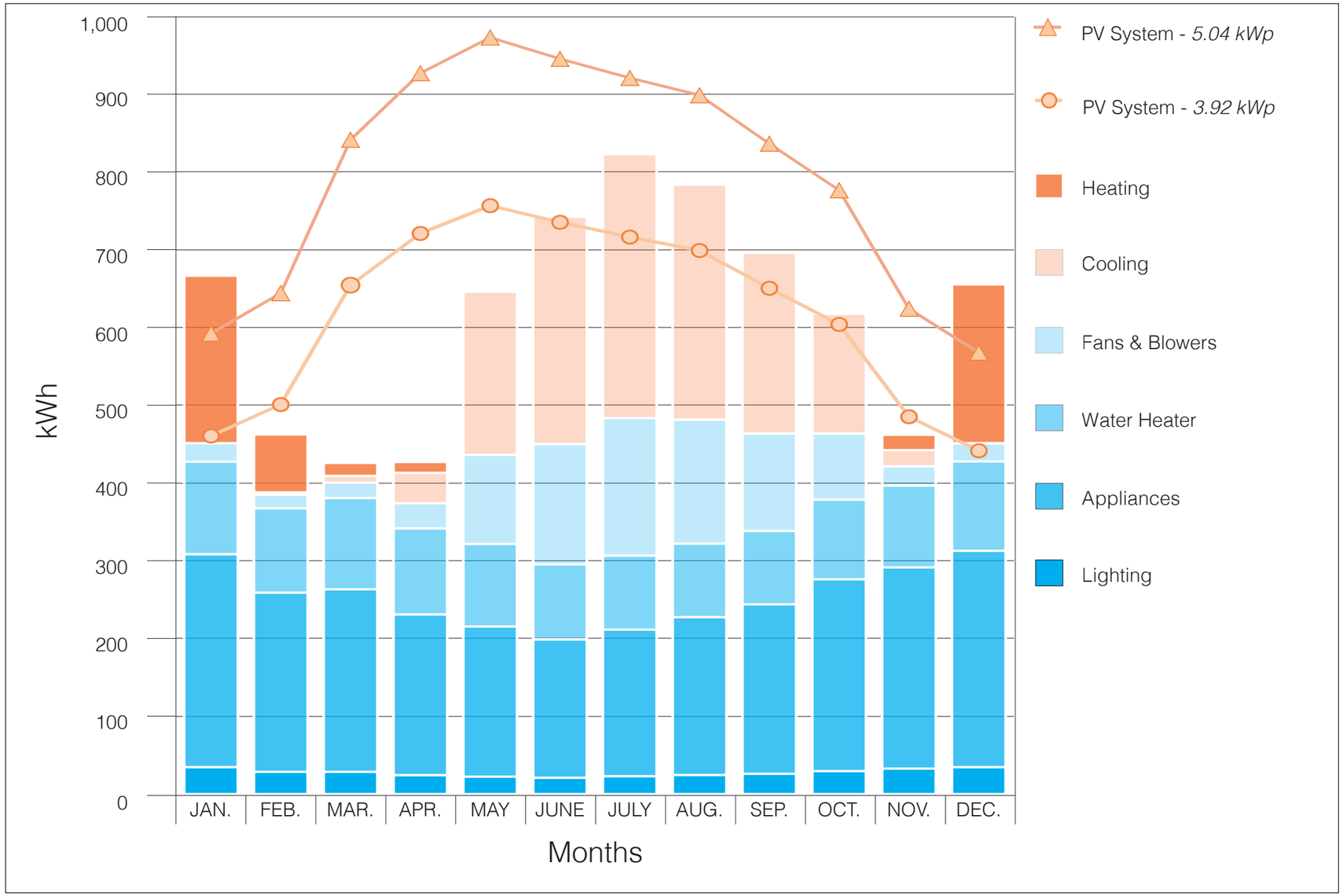
HEED v.4 BUILDING THERMAL LOADS FOR JUNE (Btu)



Results

- The movable insulation provided for the Trombe-Wall and some of the Direct-Gain windows is likely to reduce these solar gains (HEED v.4 did not account for the effects of movable insulation during the summer).

MONTHLY PV OUTPUT vs. ENERGY CONSUMPTION (PVsyst v.6.34 & HEED v.4)

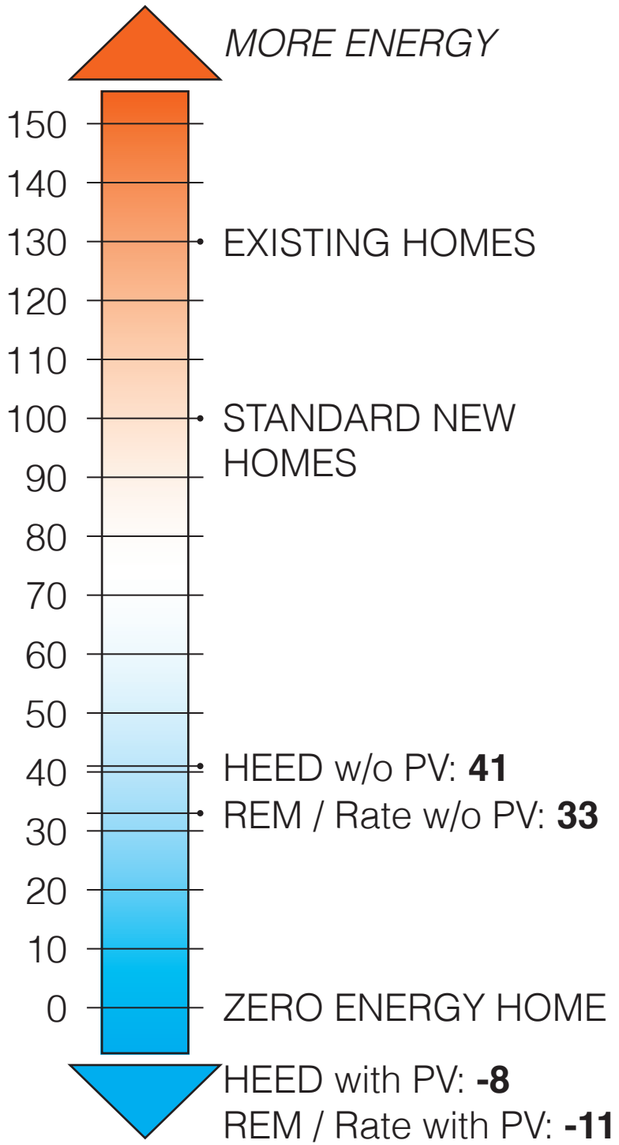


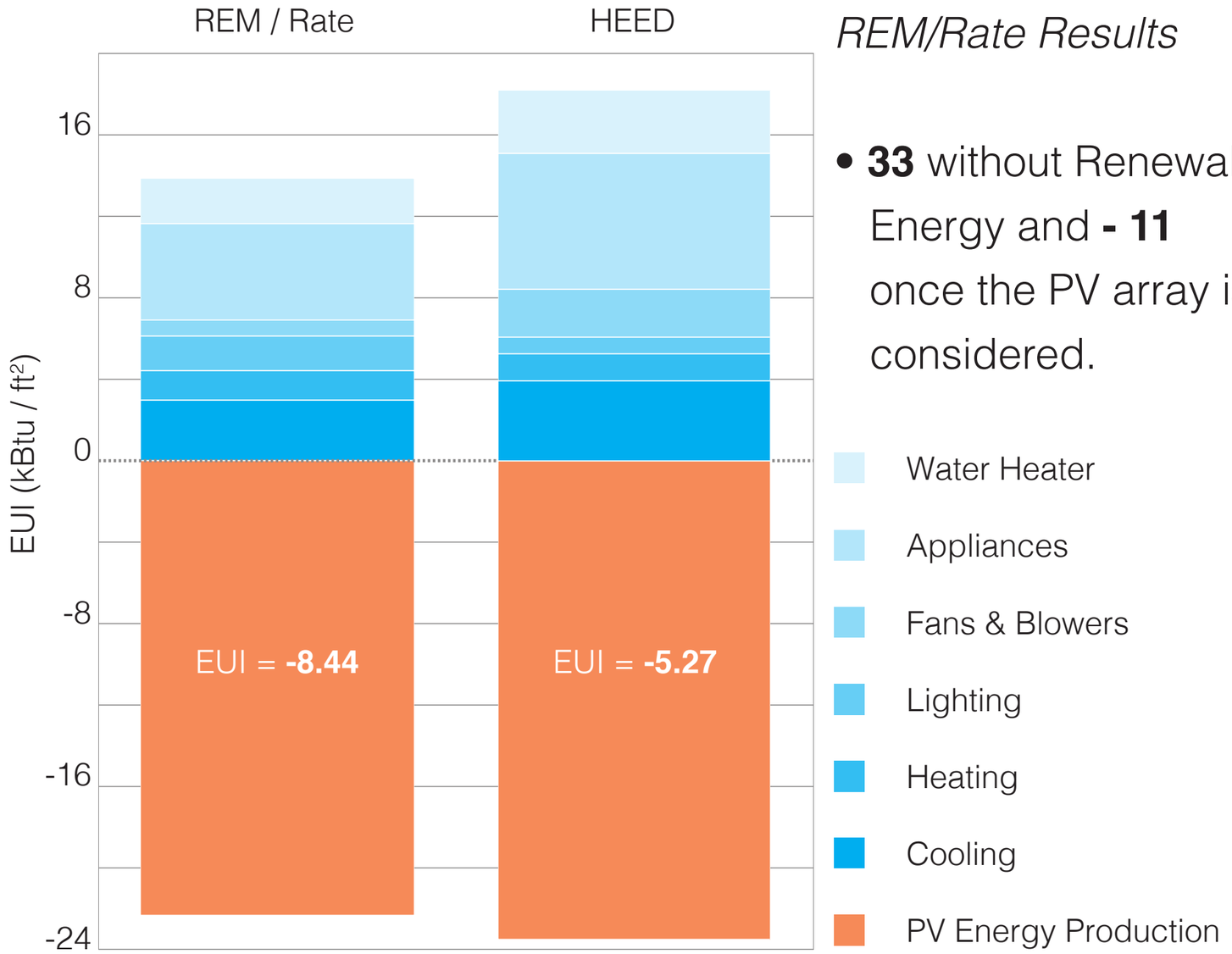
Results

- However, since the home would be tied to a micro-grid, we selected a 5.04 KWp array that would produce 9,546.2 KWh per year.

- The 5.04 KWp array fully satisfies summer demand.

HOME ENERGY RATING SYSTEM (HERS)





REM/Rate Results

- **33** without Renewable Energy and **- 11** once the PV array is considered.

G. FINANCIAL ANALYSIS

FINANCIAL ANALYSIS

TABLE G.1: Direct Construction Cost of “Desert Sunrise Building” using UniFormat

ITEM	DIVISION	MATERIAL COST	LABOR COST	TOTAL COST ($)
A10	Foundation	$7,824.93	$1,173.74	$8,998.67
B10	Superstructure	$11,325.03	$2,517.68	$13,842.71
B20	Exterior Enclosure	$27,590.48	$8,814.78	$36,405.25
C10	Interior Construction	$4,493.34	$837.25	$5,330.59
C30	Interior Finishes	$7,977.05	$1,196.56	$9,173.60
D20	Plumbing	$5,244.07	$2,948.31	$8,192.38
D30	HVAC	$4,456.00	$1,114.00	$5,570.00
D50	Electrical	$2150.00	$1,160.00	$3,310.00
E10	Equipment	$6,609.00	$991.35	$7,600.35
	Total Cost	**$77,669.90**	**$20,753.67**	**$98,423.57**

TABLE G.2: Calculation of House Sales Price

	COST ITEMS	TOTAL COST ($)	TOTAL COST WITH PV ($)
1	Site/ Lot Costs	$5,000	$5,000
2	House Construction Cost (Direct)	$98,423.57	$98,423.57
3	Builder Costs (Financing/Overhead/ General Expenses/ Marketing/Commissions/Profit) 40% of Direct Cost	39,369.43	39,369.43
4	PV Cost Estimate (per Table G.7)	0	$20,337.48
	Total House Sale Price	**$142,793**	**+ $20,337** **$163,130**

FINANCIAL ANALYSIS

Table G.3: Calculation of Annual Homeowner's Cost

	Cost Items	Total Cost ($)	Total Cost with PV ($)
1	Down Payment Cost	$28,559	$32,626
2	Total Loan Amount	$114,234	$130,504
3	Monthly Mortgage Principal and Interest (30 Yrs./4.5%)	$579	$661
4	Annual Mortgage Principal and Interest (12 x Monthly MPI)	$6,948	$7,932
5	Annual Property Taxes	$0	$0
6	Annual Homeowner's Insurance	$500	$500
7	Annual Total Utility Cost Including Connection Charges	$1,027	$144
	Total Annual Homeowners Cost	**$8,475**	**+ $101** **$8,576**

*Using house sale price of $142,793 & $163,130 with and without PV respectively

Table G.5: Calculation of Total Annual Costs

	Cost Items	Total Cost ($)	Total Cost with PV ($)
1	Annual Homeowner Cost	$8,475	$8,576
2	Annual Other Household Debt	$1,896	$1,896
	Total Annual Expenditure	**$10,371**	**+ $101** **$10,472**

FINANCIAL ANALYSIS

Table G.6: Determination of Required Household Income

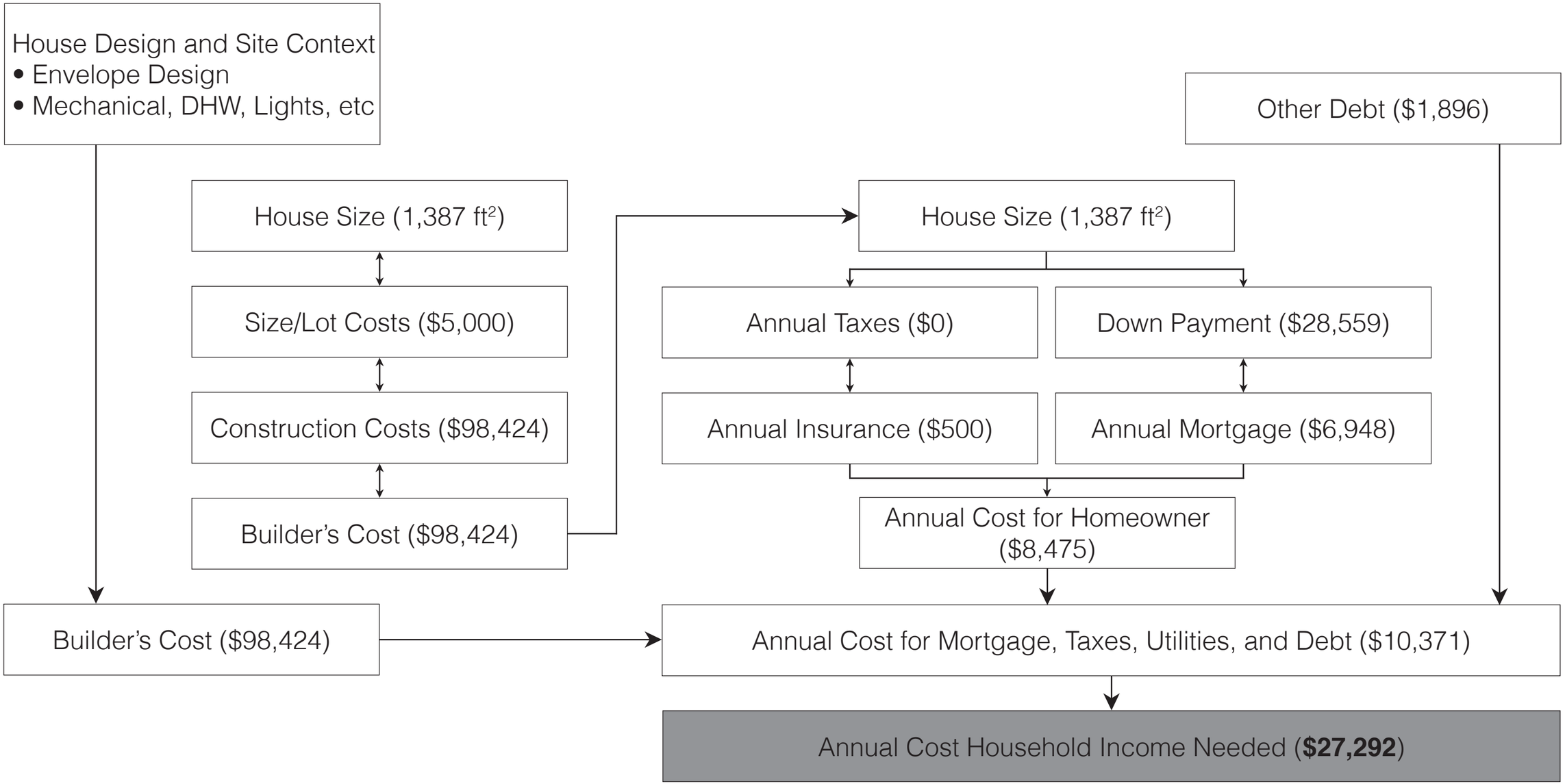
	Cost Items	Total Cost ($)	Total Cost with PV ($)
1	Total Annual Cost (38% of the total income)	$10,371	$10,472
	Annual Household Income ($10,371/ 0.38)	**$27,292**	**+ $266** **$27,558**

Table G.7: PV System Installation Price Breakdown

Unit	Quantity	Price	Total
Panel	18	$249.20	$4,485.60
Inverter*	1	$2,774.44	$2,774.44
Racking (s5 clip)	18	$39.00	$1,000.00
Balance of system(BOS)**	1	$1,220.30	$1,220.30
Install Labor	1	$5,150.00	$5,150.00
Permitting & Engineering	1	$385.83	$550.00
Commission & Other Fee	1	$1,767.56	$1,767.56
Subtotal:			$16,947.90
Contingency 20%	1	0.20	$3,389.58
		Total	**$20,337.48**

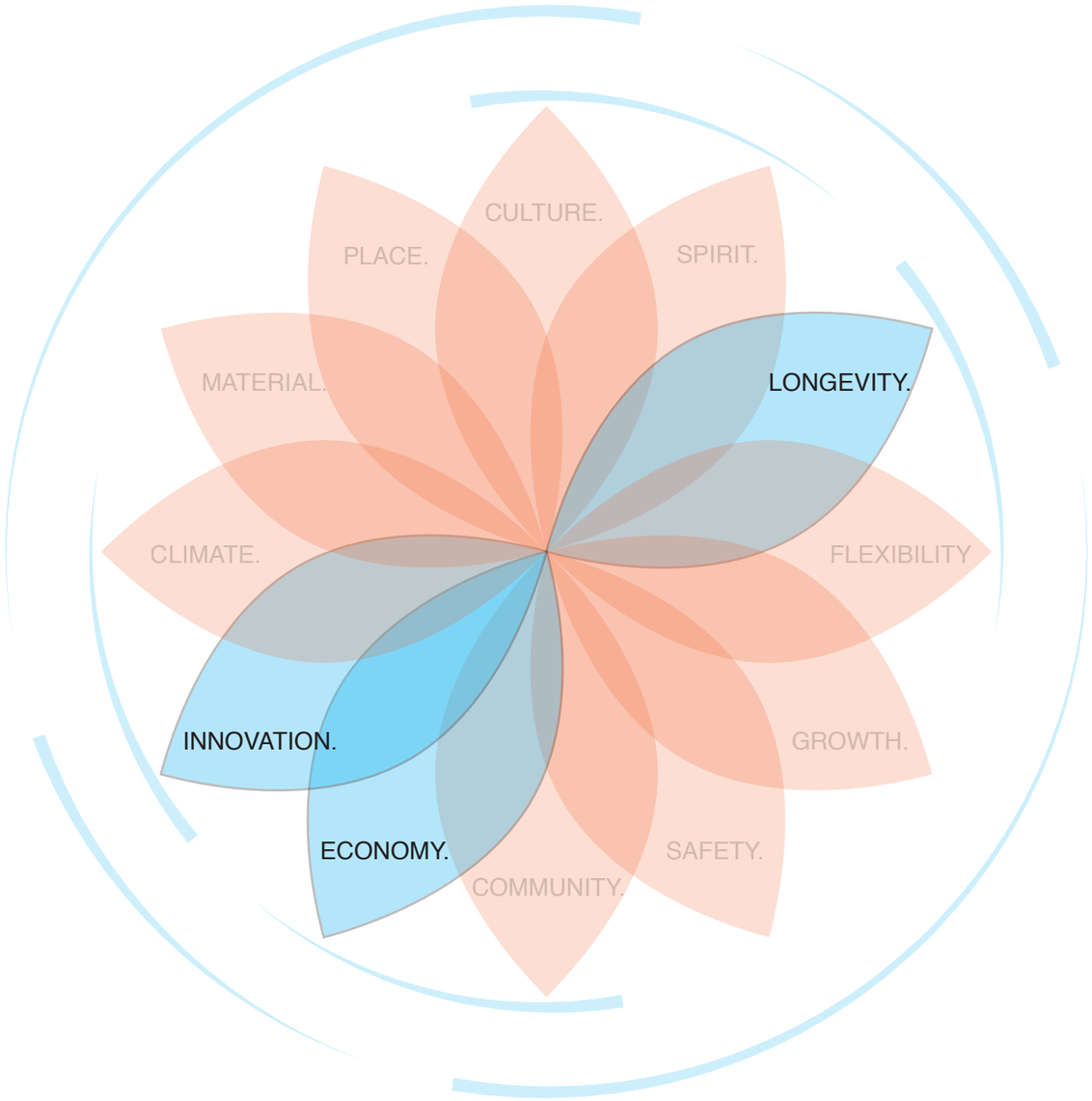
*Pricing of inverter includes monitoring system & 10 additional warranty (10 standard + 10 years= 20 years)
**BOS include DC & AC disconnects, Emergency outlet feature for the TL inverter, wires, conduit, and electrical equipment

FINANCIAL ANALYSIS



H. DOMESTIC HOT WATER, LIGHTING, AND APPLIANCES ANALYSIS

DESIGN GOALS: DOMESTIC HOT WATER, LIGHTING, APPLIANCES



longevity. Appliance efficiency contributes to reduced consumption and therefore resource conservation.

economy. Selection factors included initial cost of appliance and annual energy savings.

innovation. Wherever appropriate, WaterSense and Energy Star rated items were specified to the most current standard.

PEAK DOMESTIC HOT WATER USAGE

Estimating Peak Hour/First Hour Rating				
Use	Average gallons of hot water per use	x	Times used in 1 hour	Gallons used in 1 hour
Shower	5 min x 2 gpm =10 gal	x	4+	50
Shaving	1 min x 1.5 gpm = 1.5 gpm	x	2	3
Automatic Dishwasher	6 gal	x	1	6
Clothes Washer	7 gal	x	1	7
			Total Peak Hour Demand	**66**

ENERGY STAR

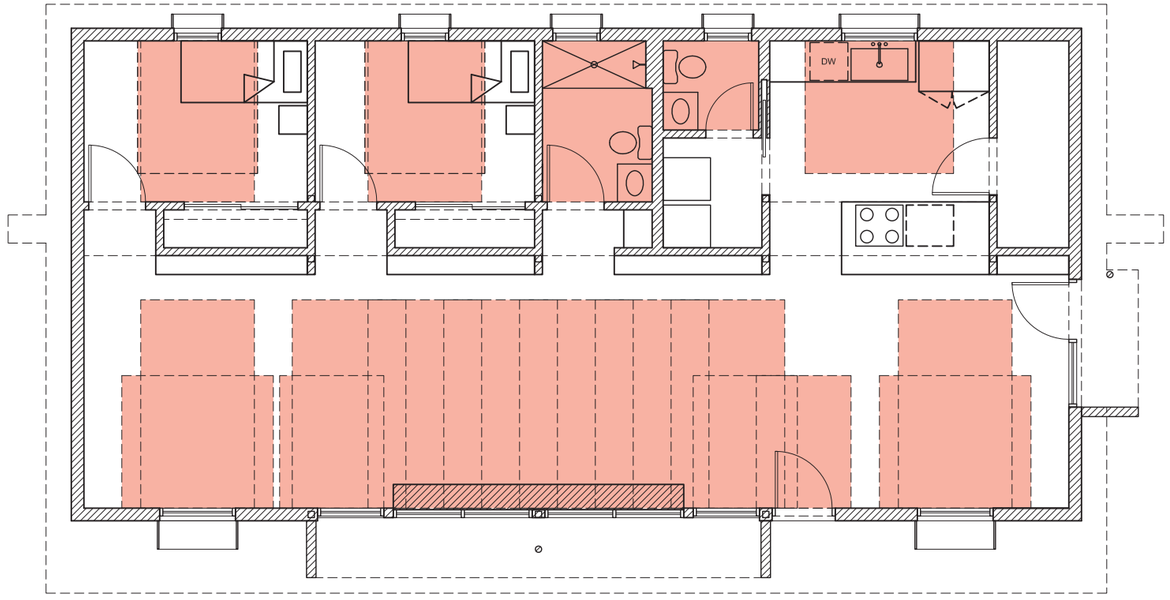
ENERGYGUIDE
Annual Cost
$192

Results

- Our Whirlpool, 50 GAL Hybrid (**heat pump**) water heater has a first-hour rating of 67 gallons, thus meeting our peak loads.

Since this product is a heat pump and remains in our conditioned space, it benefits our home by **reducing** the cooling loads in the summer.

DAYLIGHTING DIAGRAM



Approach

- Provide adequate daylighting.
- Establish an indoor to outdoor connection without increasing unnecessary heat gains.
- Maintain cultural sensitivity.

Results

- **ASHRAE 189.1 - 2014**
- A **4% Daylight Factor** achieved.
- No glazing on the west facade.
- East facade has minimal glazing that is coupled with the main entrance to allow for **traditional** alignment to the sun's solstice.

0 2' 4' 8'

PRODUCT SELECTION

Product	Product Type & Compliance	Manufacturer & Model Number	Dimensions (W x D x H)	Cost	Rated & Annual Power Consumption
	Refrigerator / Freezer (CSA, UL Listed, ADA, ETL, Energy Star)	Samsung & RF260BEAESR	35-3/4” x 35” x 70”	$1,600.00	120V / 15A & 620 kWh per year
	Recessed LED Light (IECC, T24, Energy Star)	Halo, 4 in. & TL402WHS	5” x 5” x 2”	4 @ $30.41 = $121.64	120V
	Mini-Split System (AHRI Certified, ETL Listed, Energy Star)	Fujitsu, SEER 18, HSPF 9.5, 24,000 BTU/H Capacity & AOU24RLXFZ / (2) AUU7RLF & AUU9RLF (1)	Outdoor Unit: (31-1/2” x 11-1/4” x 21-5/8”) Indoor Unit: (22-7/16” x 22-7/16” x 9-1/4”)	$3,235.40 (1 Outdoor Unit & 3 Indoor Ceiling Cassettes)	208 / 240V, 1-Phase, 60 Hz 240V

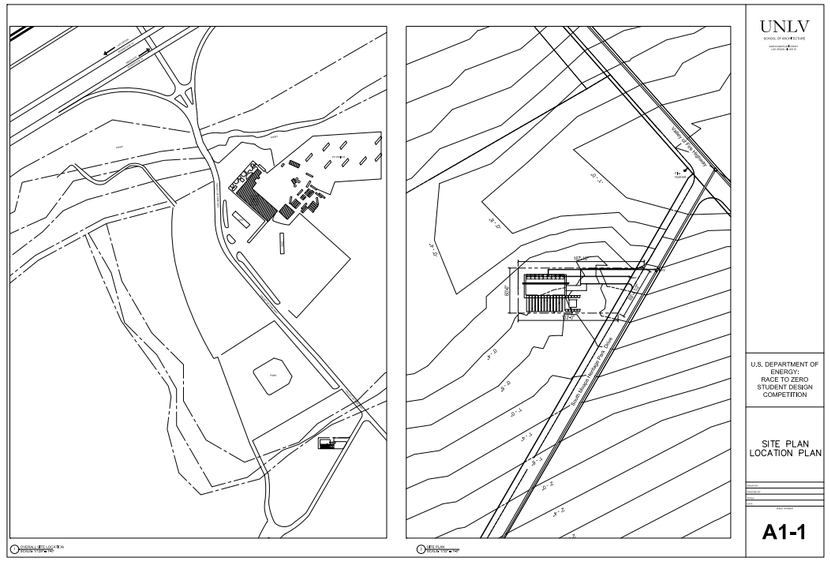
Product	Product Type & Compliance	Manufacturer & Model Number	Dimensions (W x D x H)	Cost	Water Efficiency
	Toilet (Water Sense, ADA)	American Standard & 3381-216-020	29-3/4” x 15” x 31”	2 @ $199.00 = $398.00	1.6 GPF

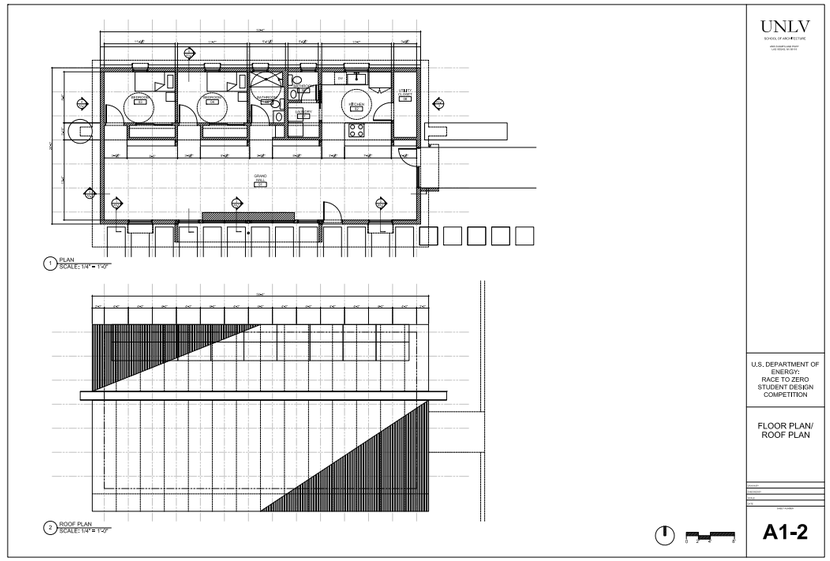
PV SYSTEM COMPONENTS

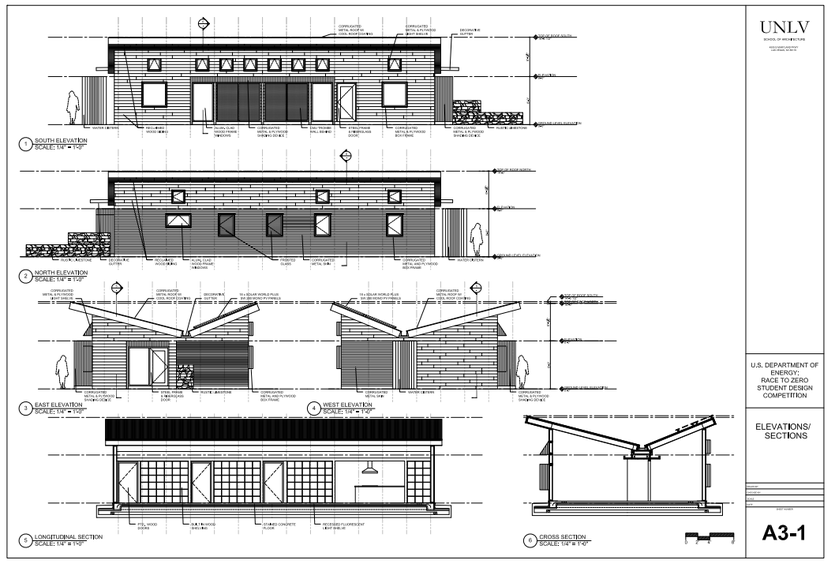
Product	Product Type & Compiance	Manufacturer & Model Number	Dimensions (W x D x H)	Cost (in US Dollars)	Power Delivery
	PV Panel	Solar World Plus SW & 280 Mono	65-15/16” x 1-7/32” x 39-13/32”	18 @ $300.00 = $5,400.00	280 WP, 39.5V
	Power Inverter (UL Listed, AFCI)	SMA Sunny Boy & 6000TL-US	19-3/10” x 7-3/10” x 20-1/2”	$2,391.00	6,300W max DC, 5,200W max AC

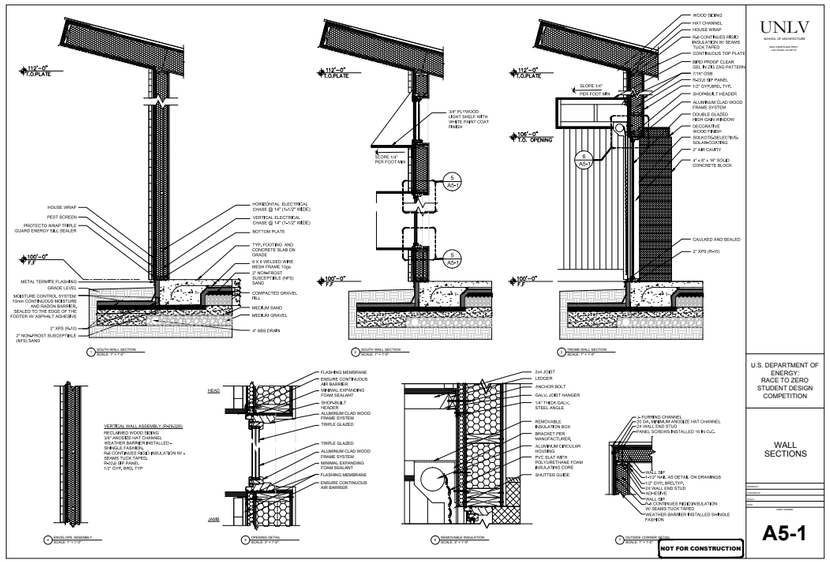
I. CONSTRUCTION DOCUMENTATION

CONSTRUCTION DOCUMENTATION

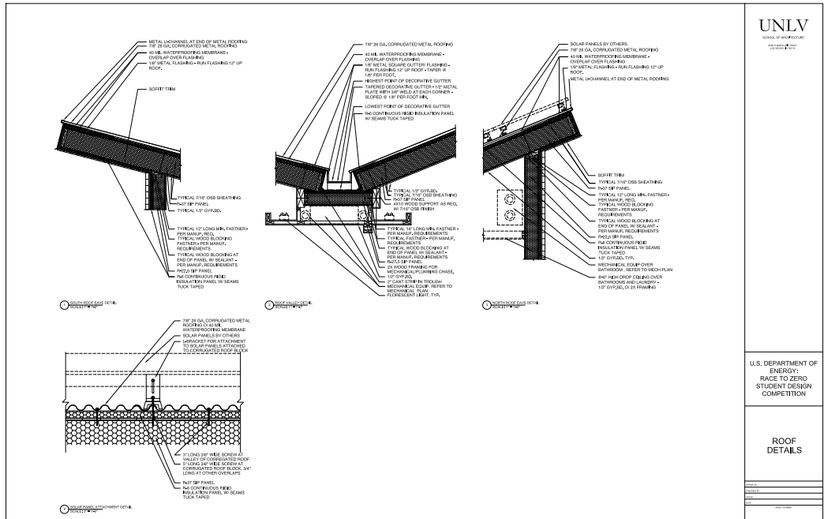








CONSTRUCTION DOCUMENTATION

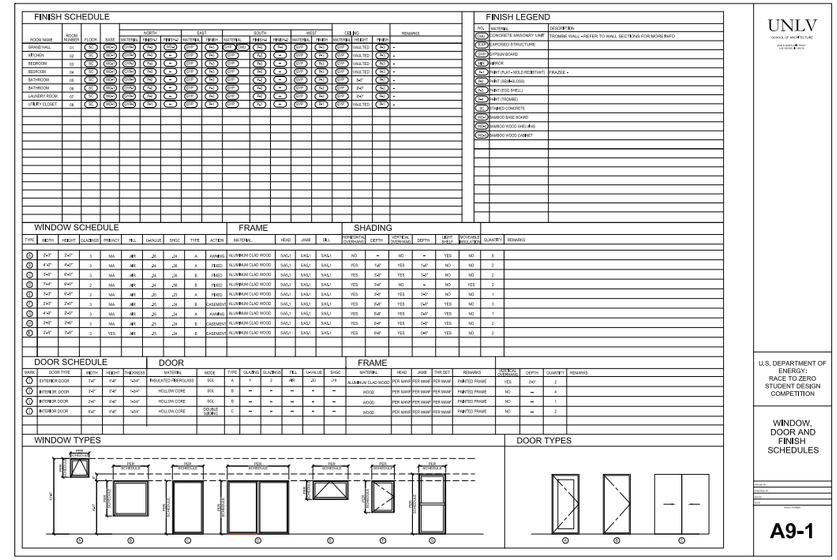


UNLV SCHOOL OF ARCHITECTURE

U.S. DEPARTMENT OF ENERGY: RACE TO ZERO STUDENT DESIGN COMPETITION

ROOF DETAILS

A5-2

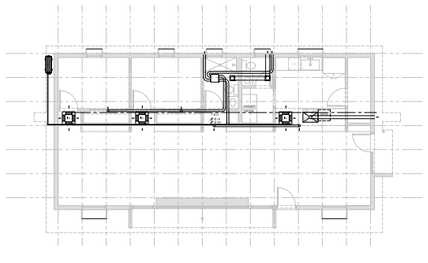


UNLV SCHOOL OF ARCHITECTURE

U.S. DEPARTMENT OF ENERGY: RACE TO ZERO STUDENT DESIGN COMPETITION

WINDOW, DOOR AND FINISH SCHEDULES

A9-1

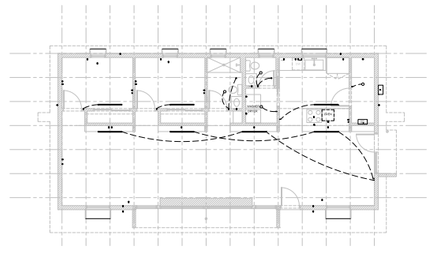


UNLV SCHOOL OF ARCHITECTURE

U.S. DEPARTMENT OF ENERGY: RACE TO ZERO STUDENT DESIGN COMPETITION

MECHANICAL PLAN

M1-1



UNLV SCHOOL OF ARCHITECTURE

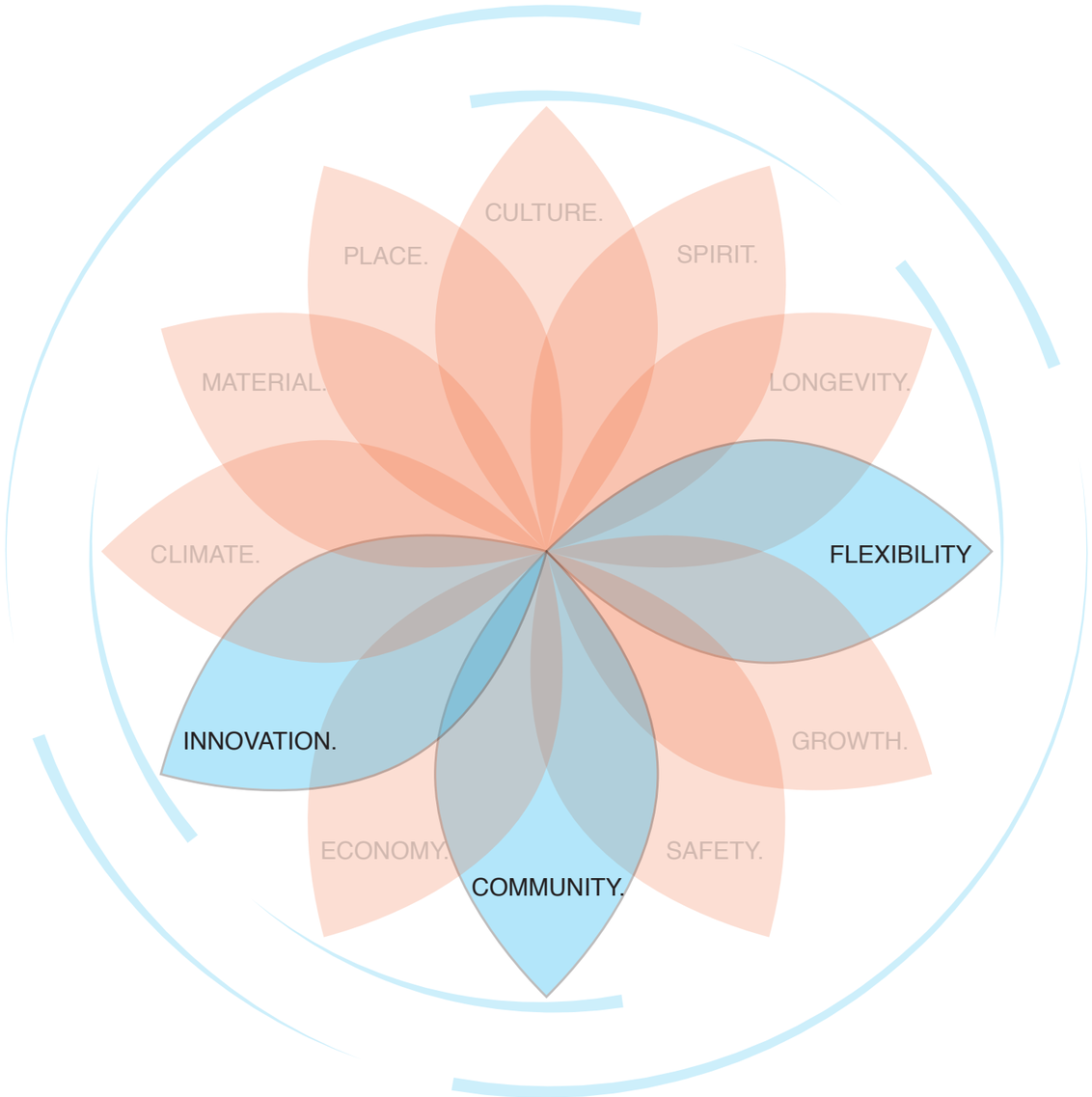
U.S. DEPARTMENT OF ENERGY: RACE TO ZERO STUDENT DESIGN COMPETITION

ELECTRICAL PLAN

E1-1

J. INDUSTRY PARTNERSHIPS

DESIGN GOALS: INDUSTRY PARTNERS



flexibility. Our industry partners allowed us to explore multiple pathways towards our design goals.

community. We sought out local companies or their local branch, because they are most fit to help with climate specific design.

innovation. Consulting with our partners did not always lead to choosing their typically prescibed system, but always informed subsequent design decisions.

INDUSTRY PARTNERS

At the beginning of the design process our team explored several high-efficiency natural gas appliances and technologies. Southwest Gas offered basic engineering support and introduced our team to IntelliChoice Energy.

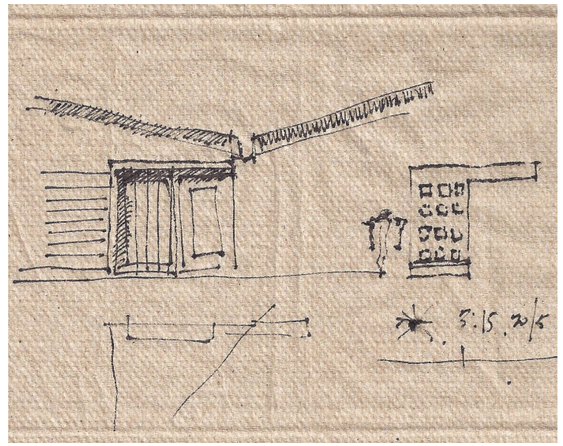
Our project considered a Packaged Gas Heat Pump unit. Among the benefits of this system are that it provides heating and cooling energy as well as domestic hot water. Ultimately, the system was not selected due to the inaccessibility of natural gas to our site (and using propane was deemed to be cost ineffective).

During schematic design, our team explored the feasibility of using a ground-source heat pump (GSHP) to satisfy the heating and cooling needs of the project. Through this collaboration we learned that GSHP systems are not viable at our site location due to the fact that ground temperatures for geothermal use are in the range of 80.6-87.8 °F.

INDUSTRY PARTNERS

With assistance from Bombard Renewable Energy, our team optimized the design of the photovoltaic system specified in this project. Bombard Renewable Energy also provided the cost estimate to install the adopted PV system.

To ensure compliance with all the energy and performance provisions of DOE's Race to Zero Student Housing Competition, and in particular, with the IECC 2012 and Energy Star's Renewable Energy Ready Homes (RERH) requirements, our team sought a third party evaluation from a qualified, licensed expert. With assistance from Home Energy Connection, our home was evaluated using REM Rate v.14.6 to obtain its Home Energy Rating System (HERS) Rating with and without PV and also to ensure compliance with other stipulated competition requirements.



DESERT SUNRISE

THANK YOU.