The Independence Heights House

Prairie View A&M University

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5th Year Architecture, Net Zero Energy Design I

THE TEAM

INDUSTRY PARTNERS

INDUSTRY PARTNERS

architend

GreeNexus Consulting

TegrityHomes
BUILDING YOUR FUTURE

ENGLISH + ASSOCIATES ARCHITECTS, INC.

MATRIX
STRUCTURAL
ENGINEERS

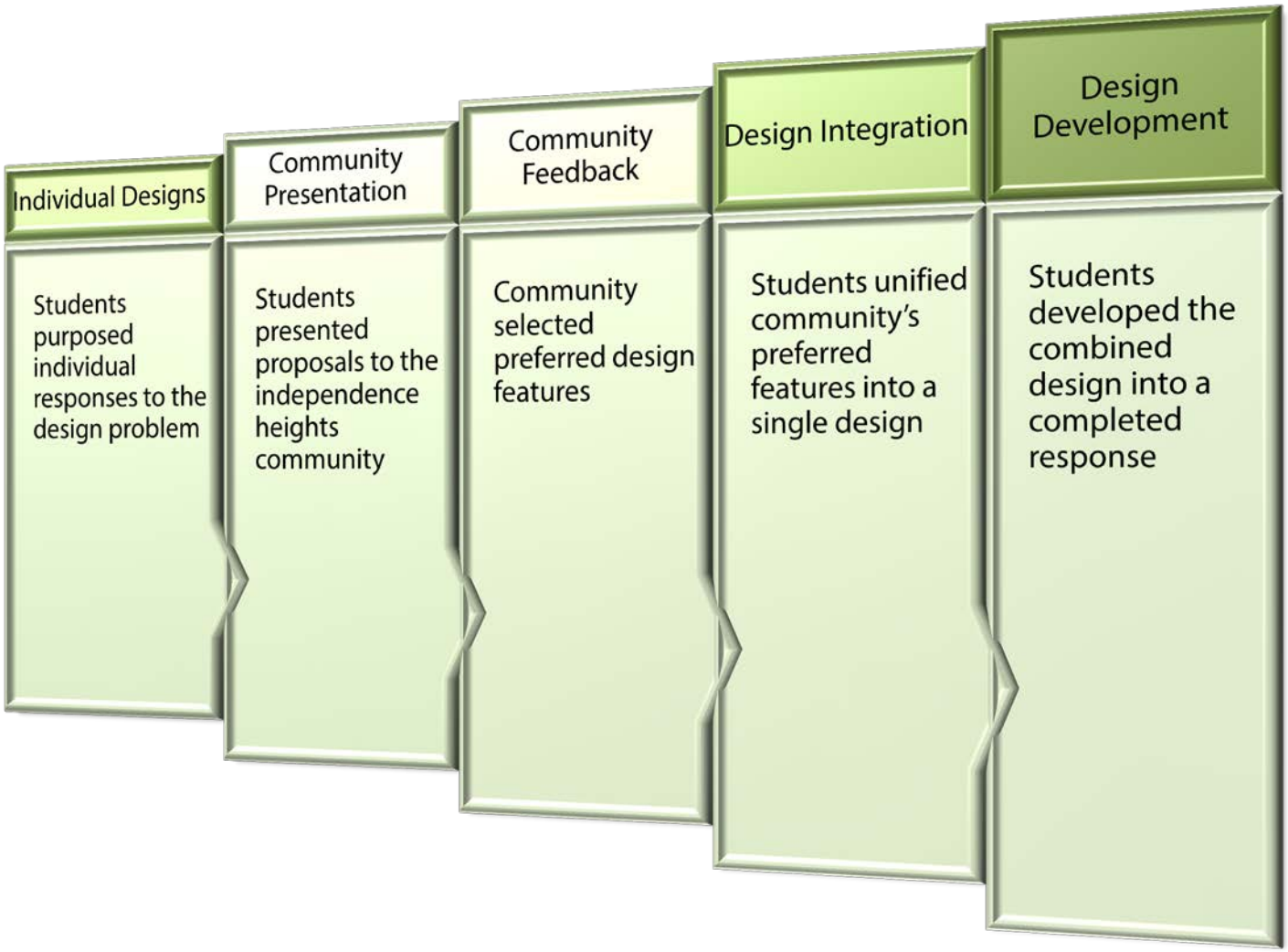
Independence Heights
IHCAC
Collaborative Action Coalition

Integrated PSL olutions

PASSIVSCIENCE
Knowledge saves power

tend
building

DESIGN PROCESS



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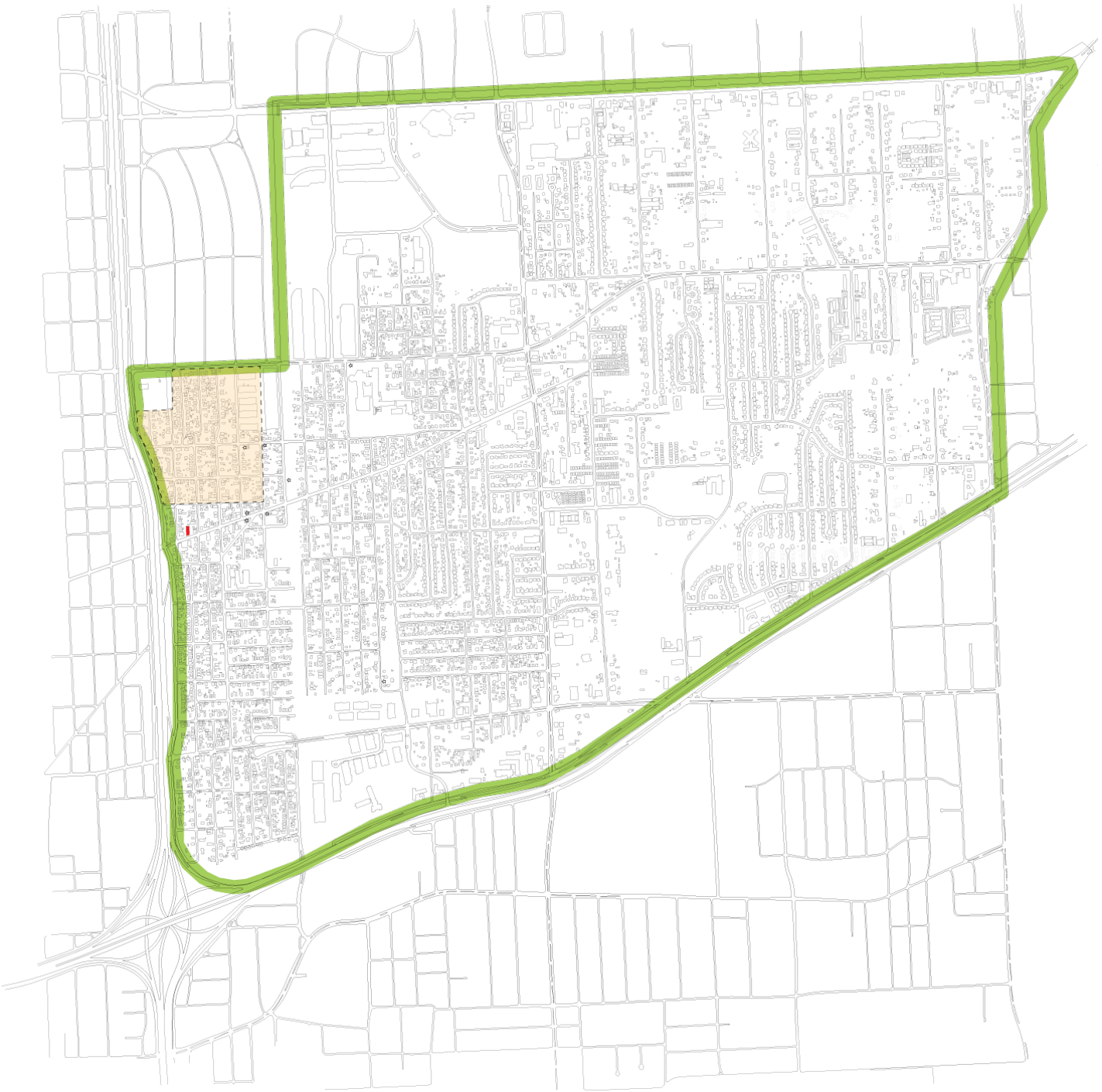


AREA PLAN

CONTEXT

Independence Heights - Demographics	
Area	3.390 Sq. Mi.
Population	13,404
Population Density	3,954
Median Household Income	$55,450
Male Population	6,590
Female Population	6,812
Male Median age	34.8
Female Median Age	36.4
Average Household Size	3.0 Persons
Percentage of Family Households	46.9%
Percentage of Married Couple Families	36.3%
Percentage of Single Mother Households	8.6%
Percentage of Never Married Females 15 yrs. and Older	16.3%
Average number of Cars or Other Vehicles Available in Houses/ Condos	1.7
Percentage of Population Below the Poverty Level	41.6%

Houston- Demographics	
Population Density	3,704
Median Household Income	$63,900
Male Median Age	31.6
Median Female Age	33.2
Average Household Size	2.7 Persons
Percentage of Family Households	50.4%
Percentage of Married Couple Families	38.8%
Percentage of Single Mother Households	11.3%
Percentage of Never Married Females 15 yrs. and Older	18.0%
Average number of Cars or Other Vehicles Available in Houses/ Condos	1.2
Percentage of Population Below the Poverty Level	23.8%

CONTEXT

Design a home that meets the affordability standards in the Independence Heights Area

Incorporate accessibility as an integral part of the design to meet the needs of the community

Create a response that addresses the area's proneness to flooding

Consider the architectural dynamics of the neighborhood and create a home that fits within its architectural fabric

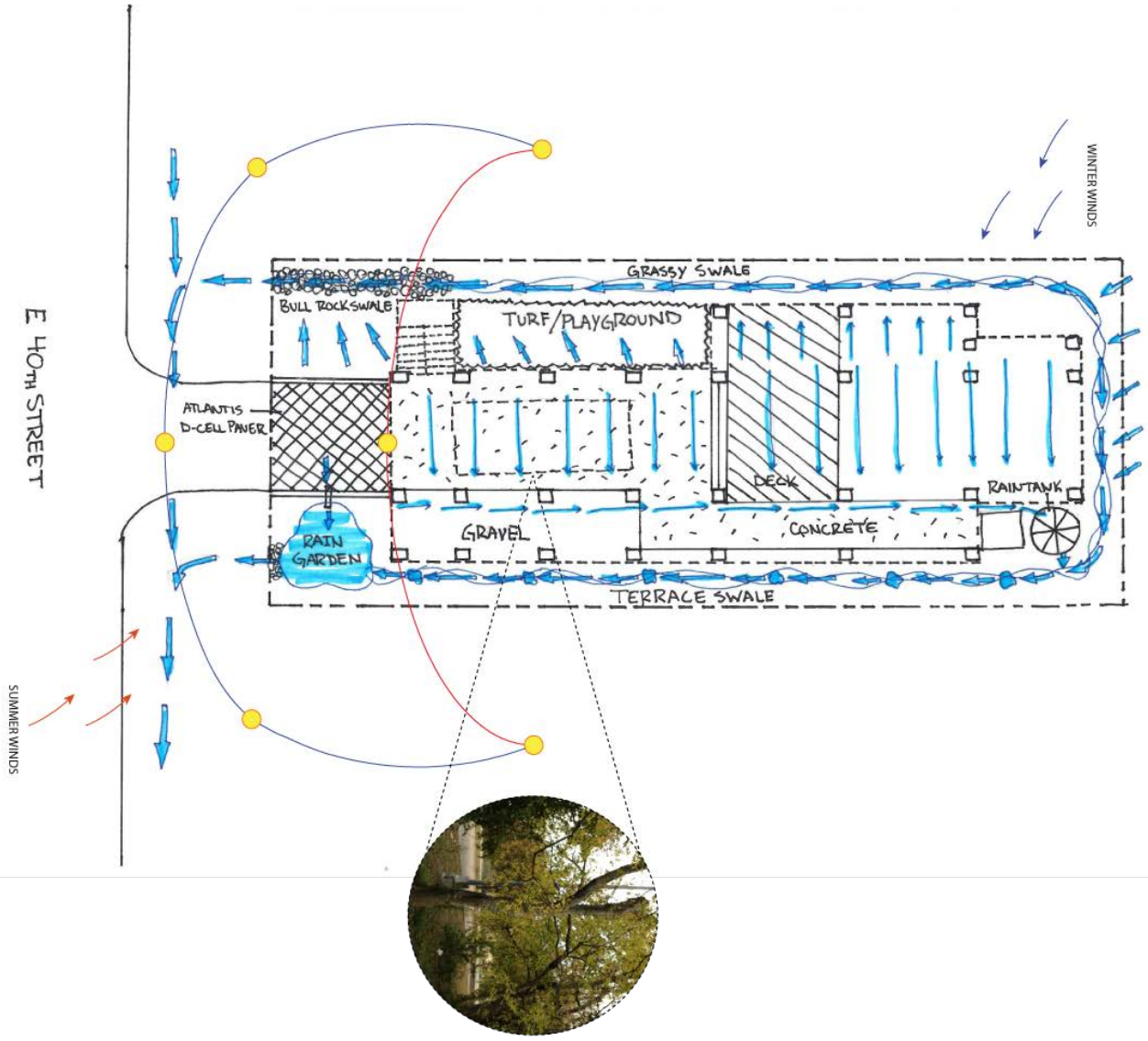
Meet or exceed the requirements to achieve passive House Institute Certification in the United States

Design a Net Zero Energy Ready Home

DESIGN GOALS

PROPOSAL

PROPOSAL


E 40TH STREET
WINTER WINDS
SUMMER WINDS
GRASSY SWALE
BULL ROCK SWALE
TURF/PLAYGROUND
ATLANTIS D-CELL PAVER
DECK
RAINTANK
RAIN GARDEN
GRAVEL
CONCRETE
TERRACE SWALE

PROPOSAL

PROPOSAL

1 10
5

FLOOR PLAN

PROPOSAL

1 10
5

SOUTH ELEVATION

1 10
5

NORTH ELEVATION

PROPOSAL

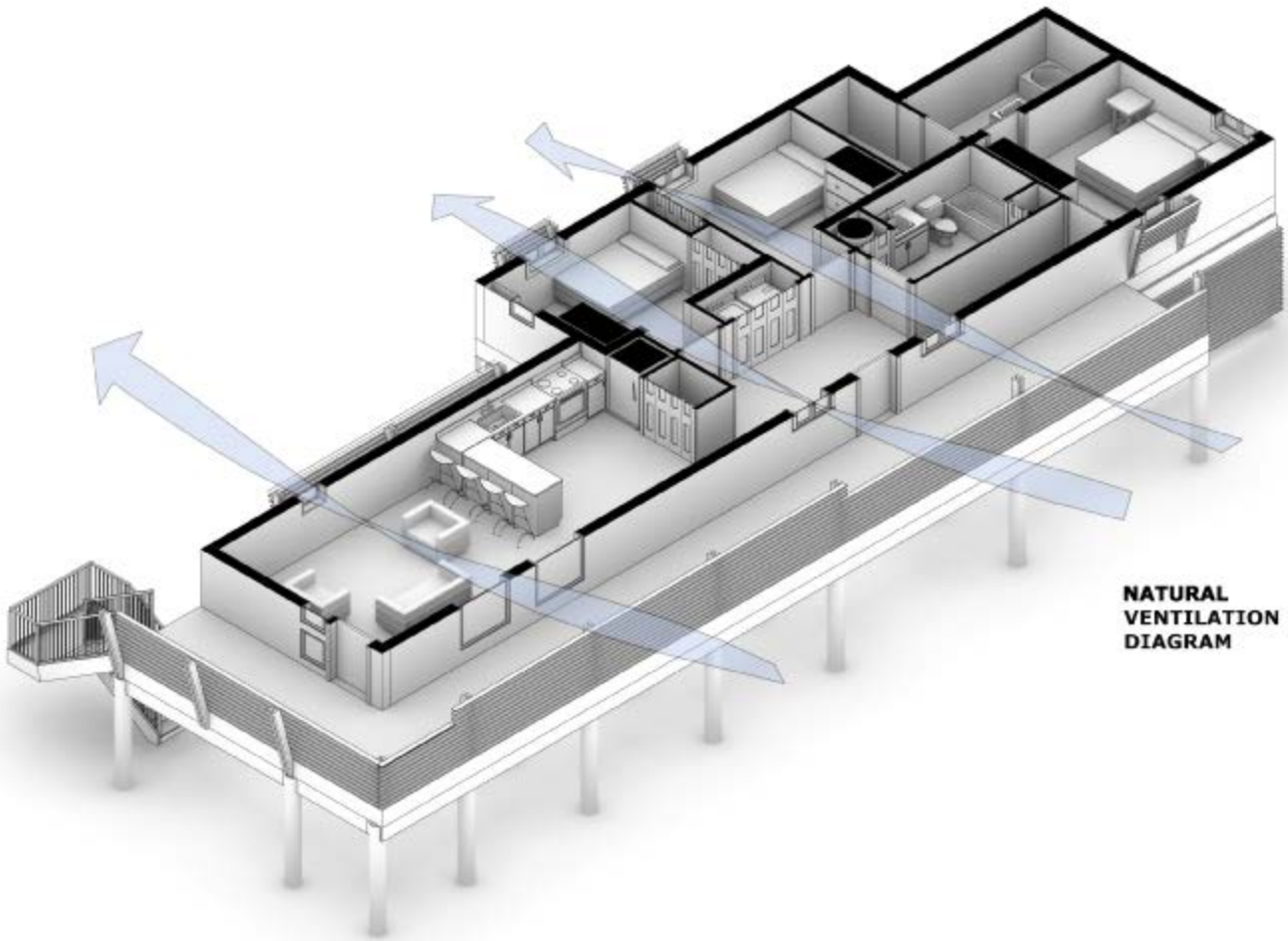
1 10
5

EAST ELEVATION

PROPOSAL

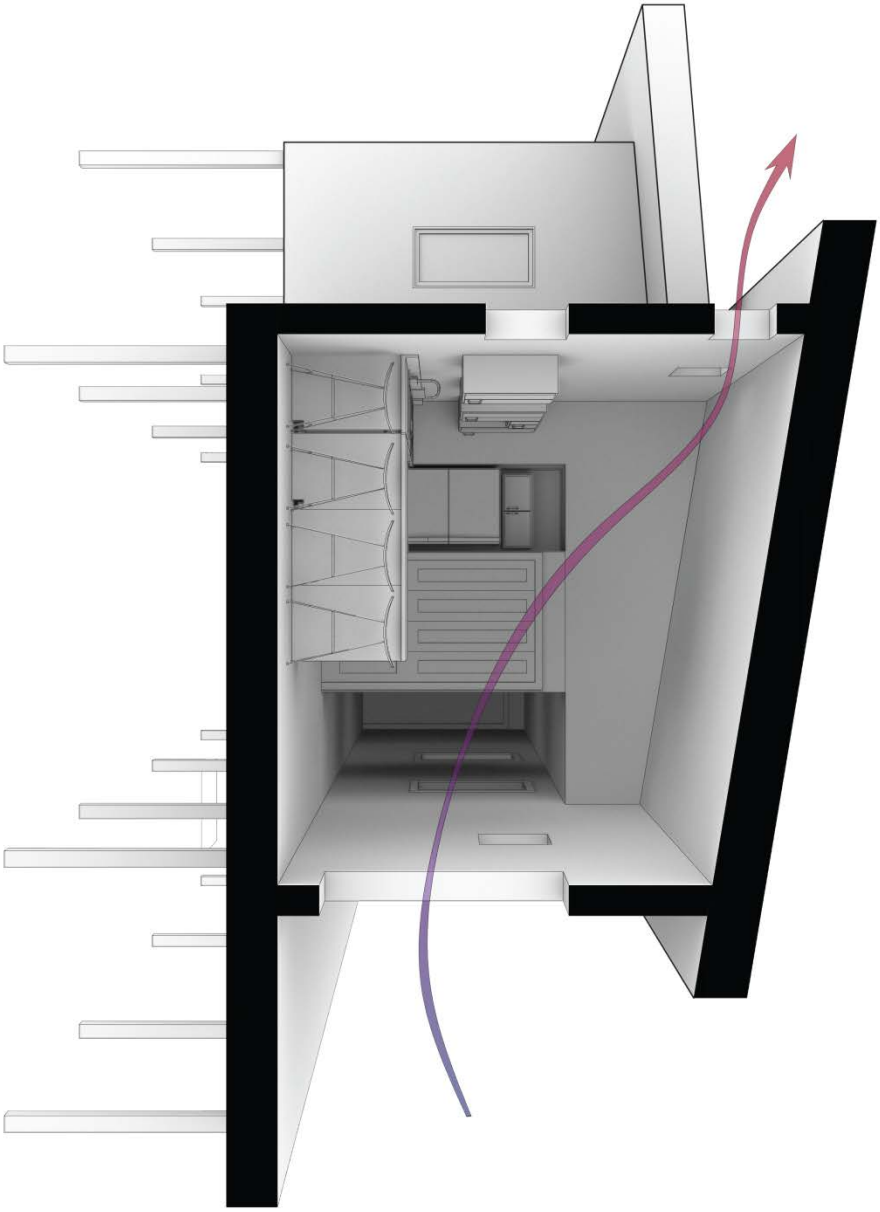
WEST ELEVATION

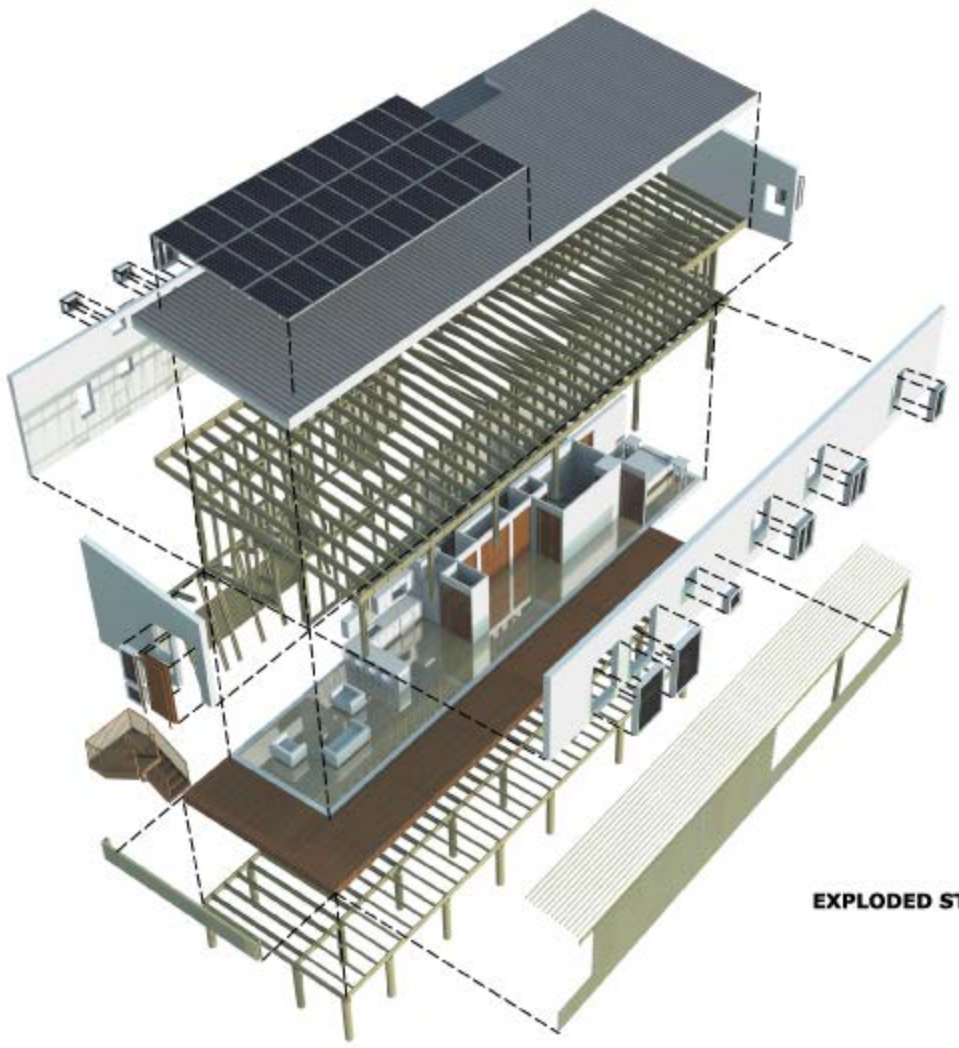
PROPOSAL



NATURAL
VENTILATION
DIAGRAM

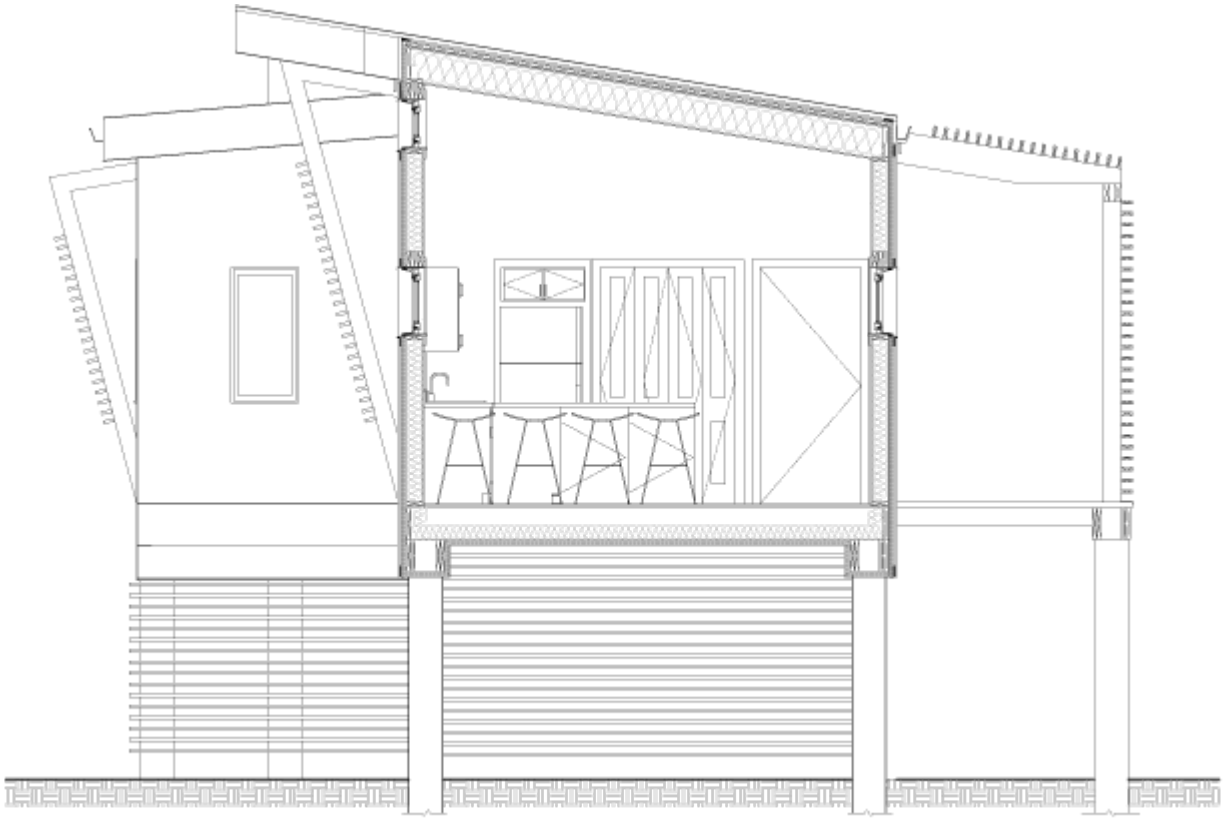
PROPOSAL





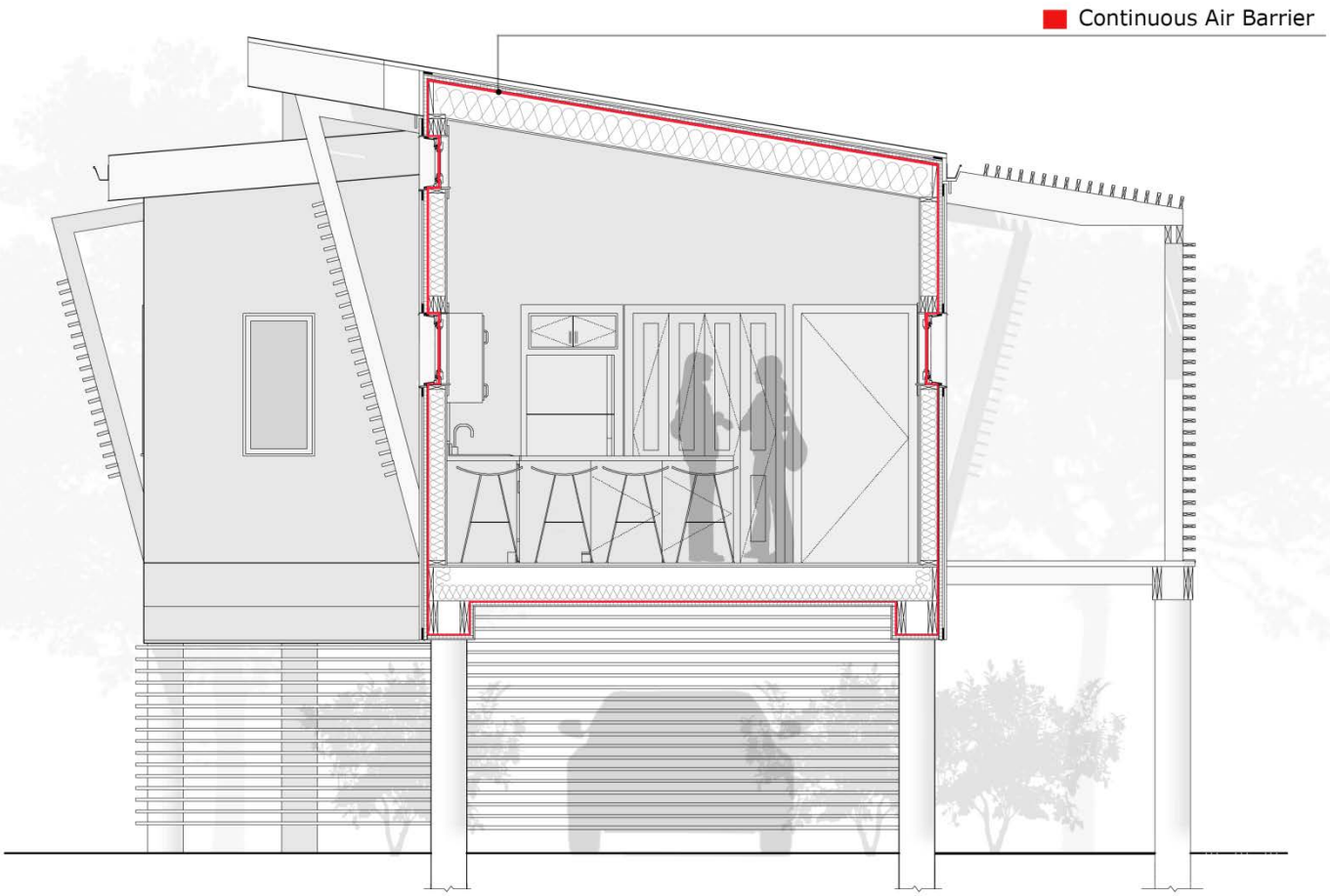
EXPLODED STRUCTURE

PROPOSAL



BULDING SECTION

ENVELOPE



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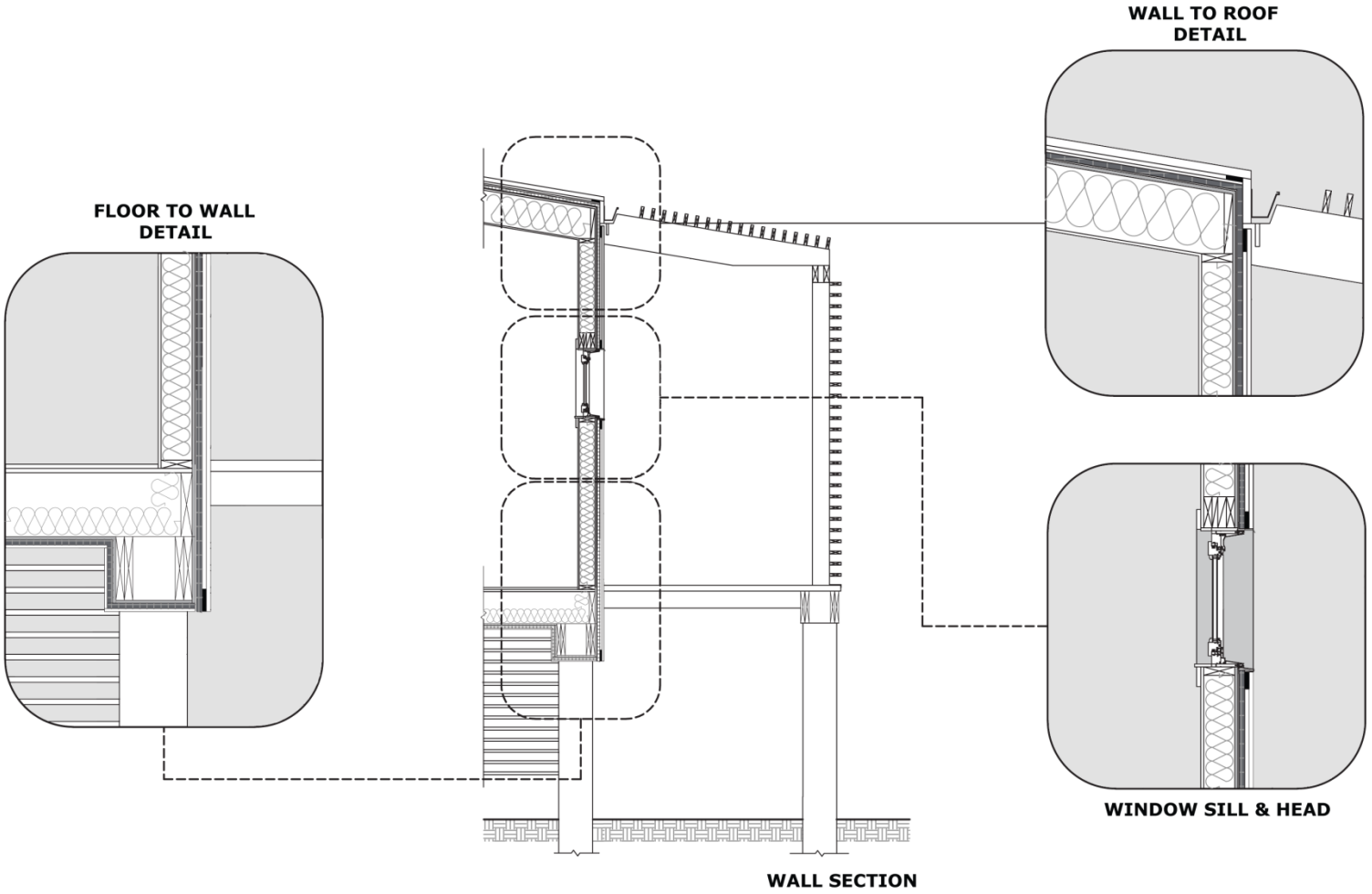
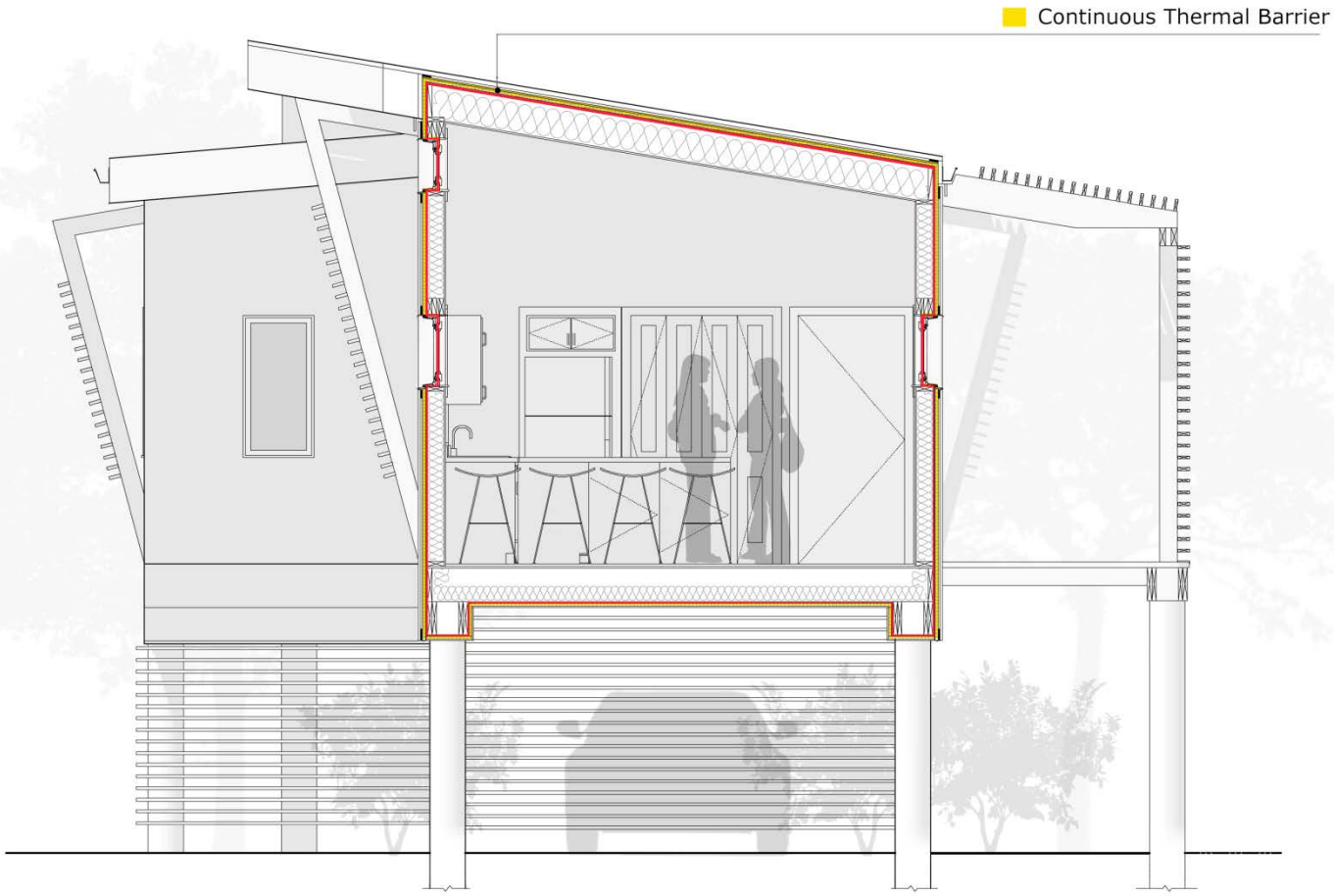
ENVELOPE

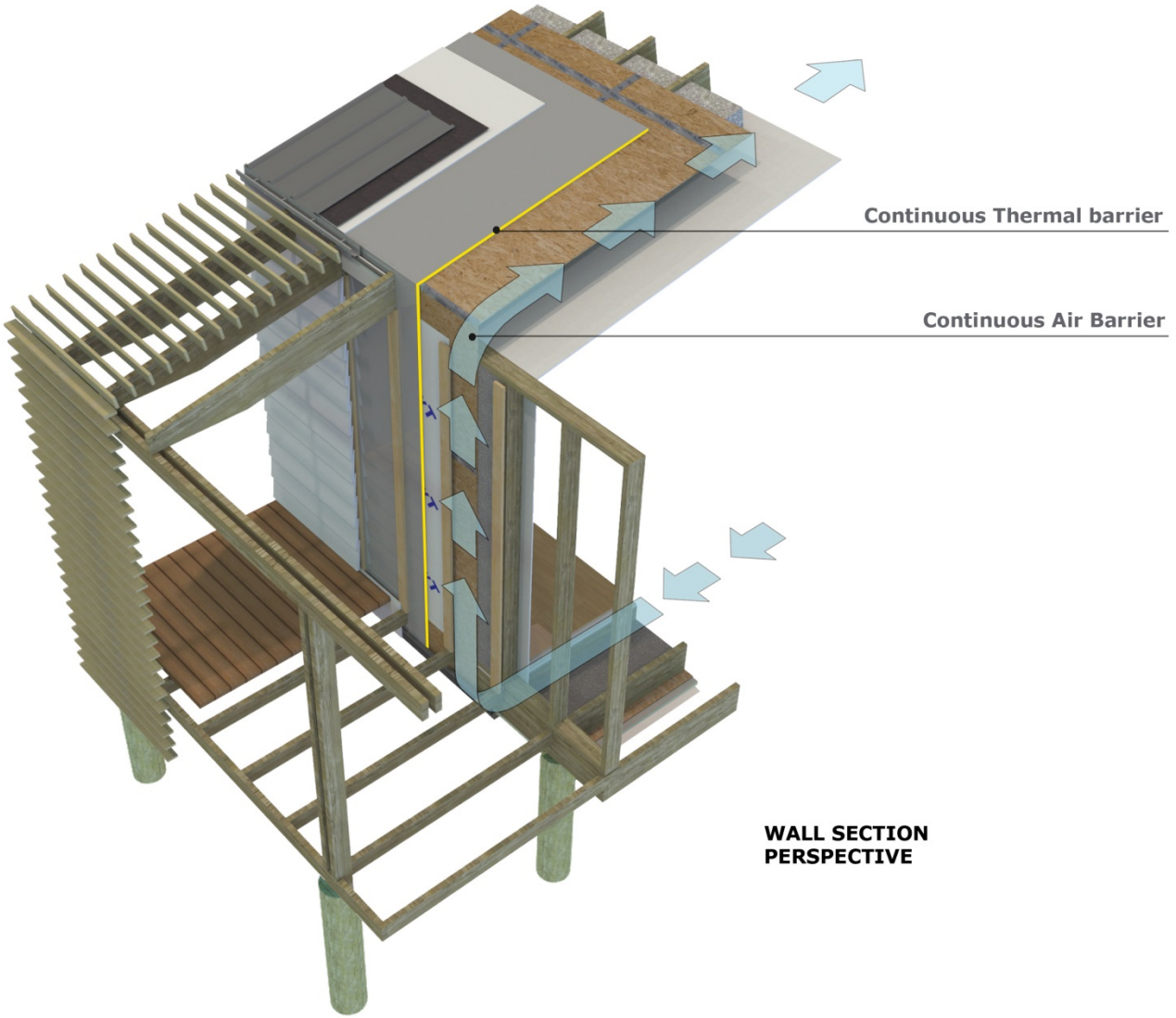

WALL TO ROOF
DETAIL
FLOOR TO WALL
DETAIL
WINDOW SILL & HEAD
WALL SECTION

ENVELOPE



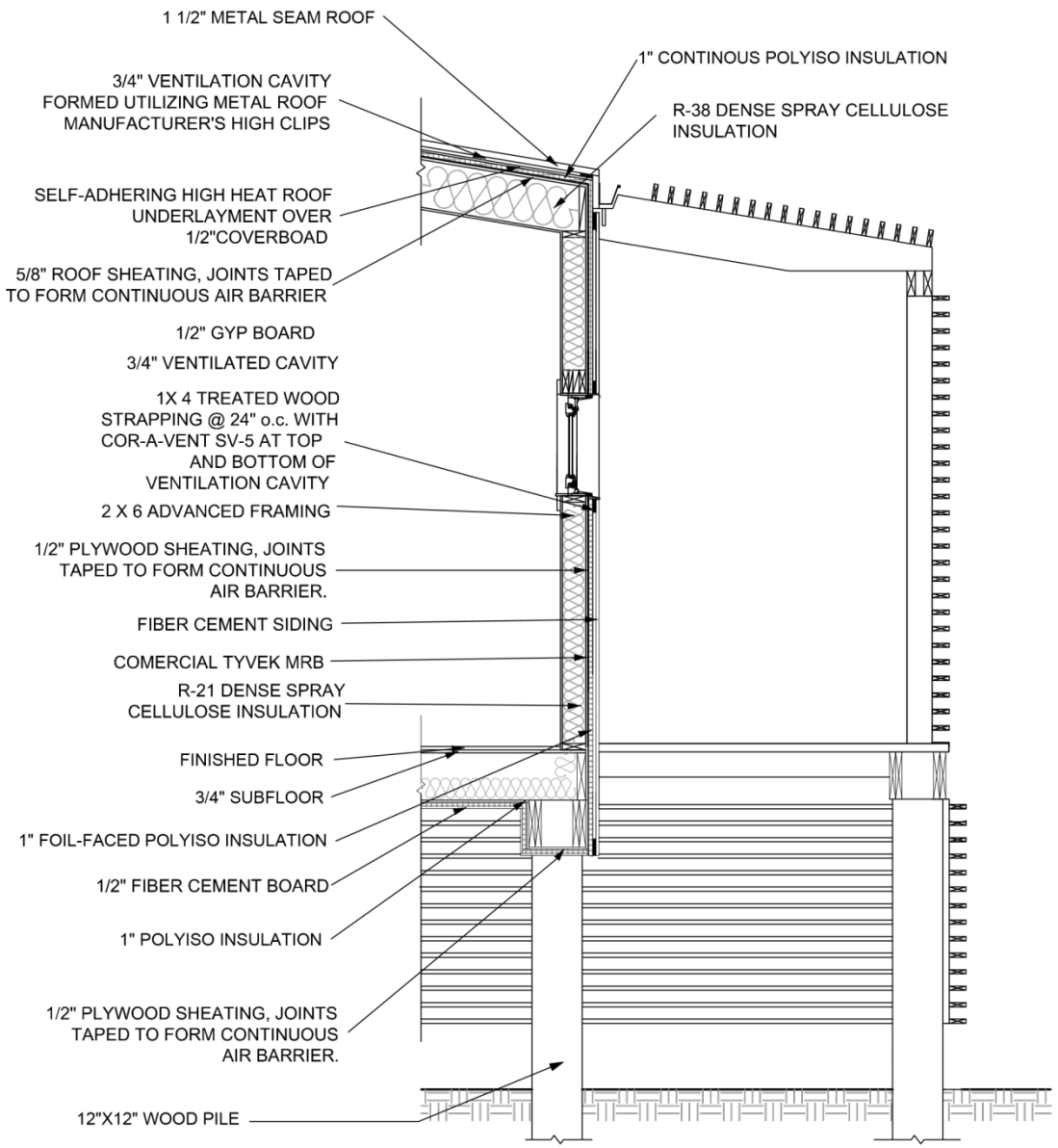
BULDING SECTION

ENVELOPE



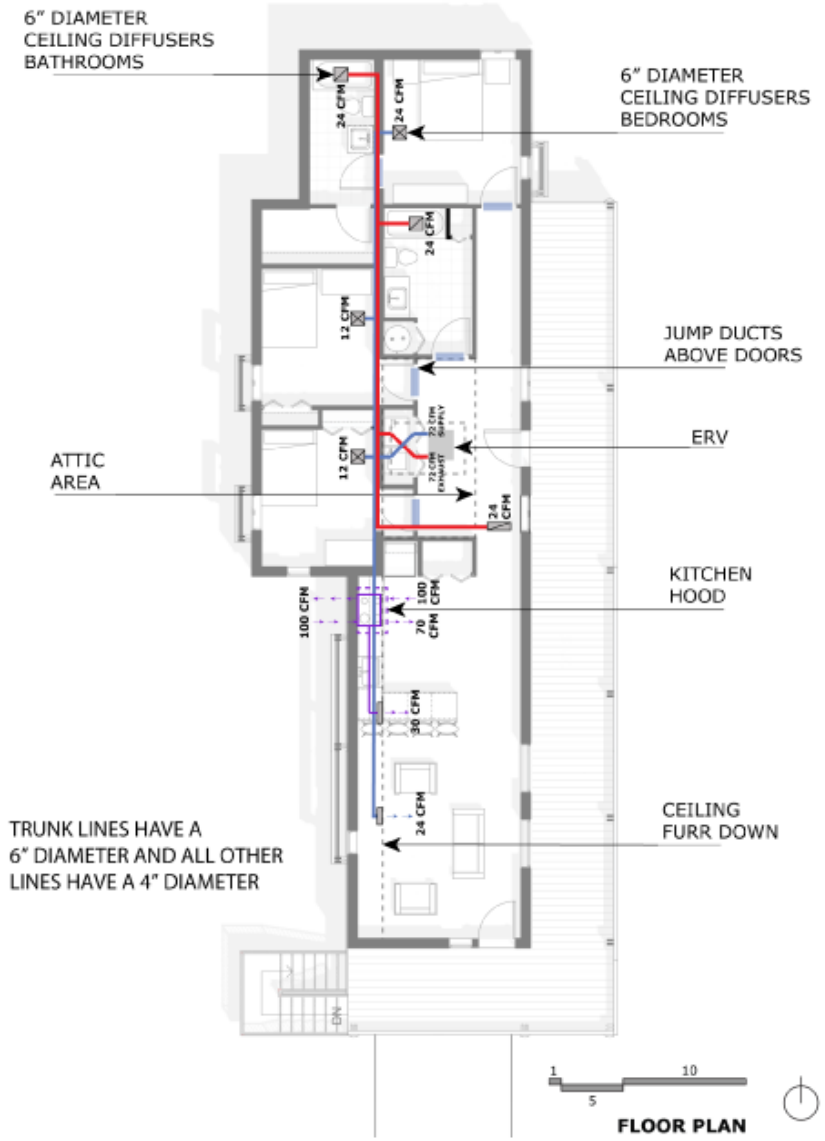
WALL SECTION PERSPECTIVE

ENVELOPE

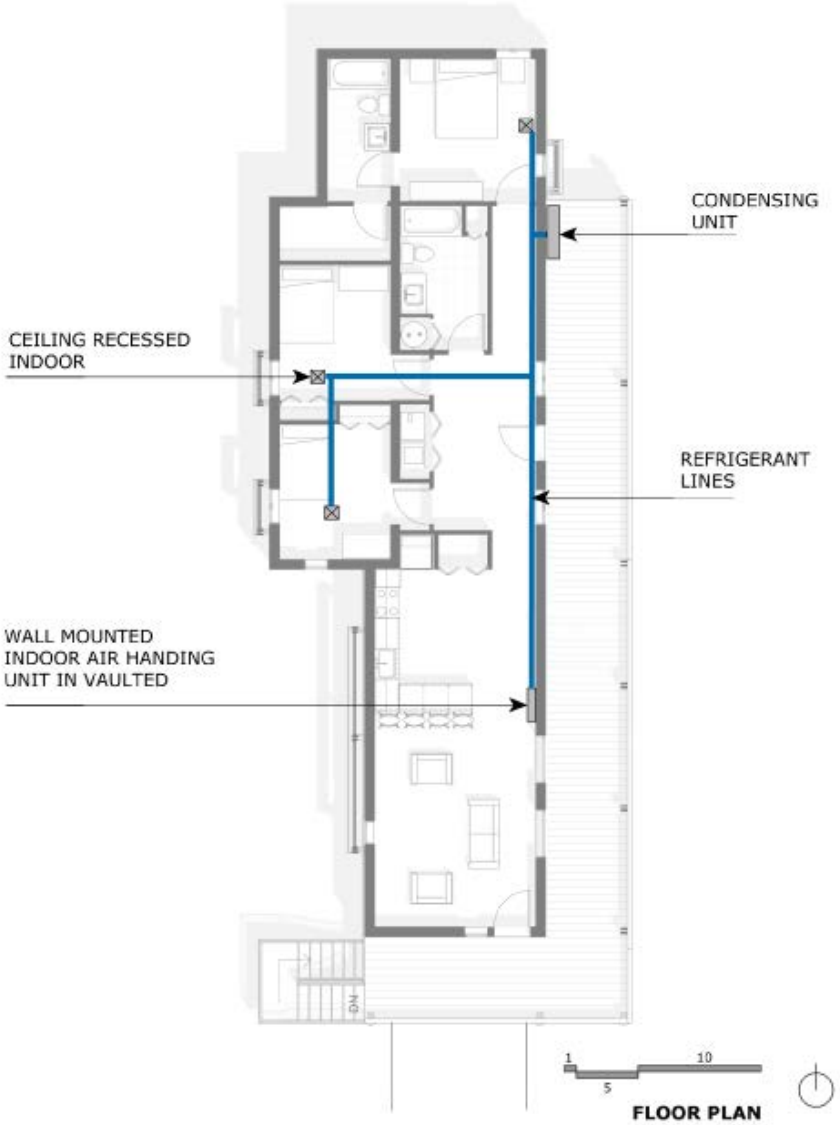


WALL SECTION

ENVELOPE



MECHANICAL VENTILATION


CONDENSING
UNIT
CEILING RECESSED
INDOOR
REFRIGERANT
LINES
WALL MOUNTED
INDOOR AIR HANDING
UNIT IN VAULTED
DN
1
10
5
FLOOR PLAN

WUFI-Passive Energy Modeling Results	PHIUS+ European Certification Criteria	PHIUS+ European, Base Design	PHIUS + European Optimized Design [1]	PHIUS+ 2015, Certification Criteria	PHIUS+ 2015, Base Design [2]	PHIUS+ 2015 Optimized Design [3]
Heating Demand	4.75 kBTU/ft ^{2}yr	3.2 kBTU/ft ^{2}yr	2 kBTU/ft ^{2}yr	1.9 kBTU/ft ^{2}yr	2.5 kBTU/ft ^{2}yr	1.2 kBTU/ft ^{2}yr
Cooling Demand	4.75 kBTU/ft ^{2}yr	12.6 kBTU/ft ^{2}yr	11.5 kBTU/ft ^{2}yr	13.3 kBTU/ft ^{2}yr	14.6 kBTU/ft ^{2}yr	13.8 kBTU/ft ^{2}yr
Heating Load	3.17 BTU/hr ft ^{2}	4.1 BTU/hr ft ^{2}	3.2 BTU/hr ft ^{2}	3.4 BTU/hr ft ^{2}	4.6 BTU/hr ft ^{2}	3.1 BTU/hr ft ^{2}
Cooling Load	2.54 BTU/hr ft ^{2}	3 BTU/hr ft ^{2}	2.5 BTU/hr ft ^{2}	5.8 BTU/hr ft ^{2}	3.4 BTU/hr ft ^{2}	2.9 BTU/hr ft ^{2}
Primary Energy	38 kBTU/ft ^{2}yr	35.8 kBTU/ft ^{2}yr	34.2 kBTU/ft ^{2}yr	67.56 kBTU/ft ^{2}yr	51.6 kBTU/ft ^{2}yr	49.8 kBTU/ft ^{2}yr
Notes	1. An extra 3" of polyiso insulation is added to the walls and an extra 1" is added to the roof and floor.					
	2. Although the new airtightness standard allows 1.19 ACH50, we cannot exceed 0.60 ACH50 to meet the criteria.					
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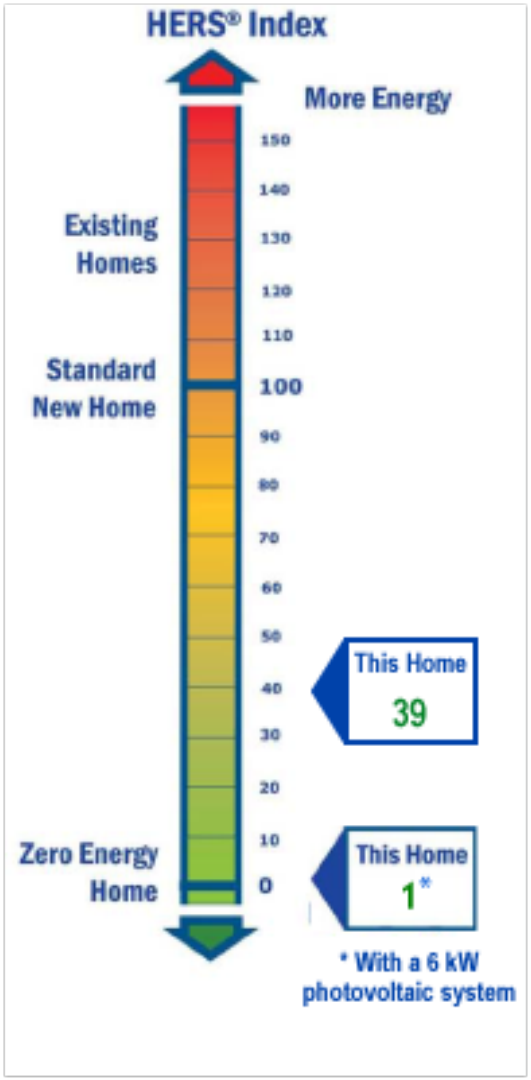
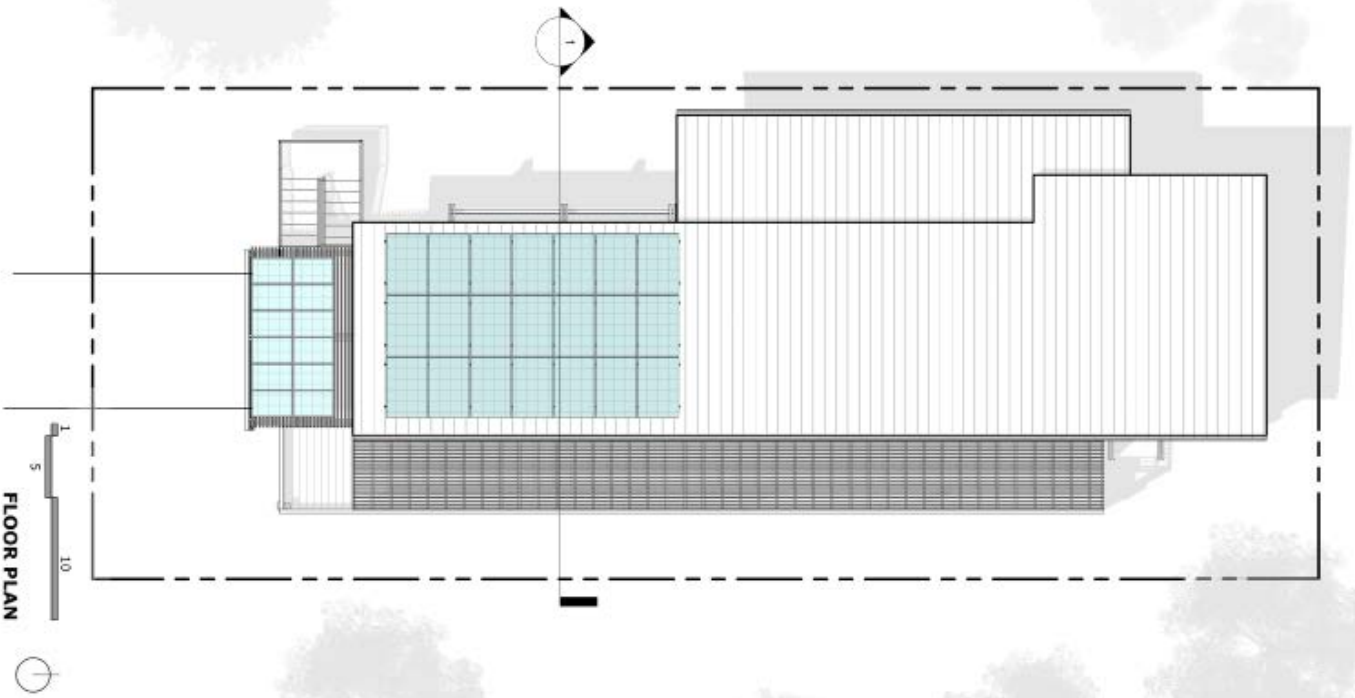
ENERGY ANALYSIS

	BEopt Base	Prairie View Design	Notes
House Type	3 Bedroom	3 Bedroom	
House Size	2,080 SF	1,200 SF	We designed a smaller footprint home in order to meet affordability objectives. Note that this smaller footprint works against us in meeting Passive House criteria.
Wall Insulation	R-13 cavity + R-12 c.i.	R-21 cavity + R-6 c.i.	We utilized advanced framing and added a ventilated rainscreen w/ a radiant barrier.
Roof Insulation	R-49 @ ceiling	R-38 cavity + R-6 c.i.	We moved the thermal plane to the roof to bring the attic into the conditioned space.
Roof Finish	Composite Shingles, medium color	Standing Seam Metal, galvalume finish	We selected a standing seam metal roof for durability. We are holding the roof 3/4" off of the underlayment with high clips to provide a ventilation cavity and radiant barrier.
Floor Insulation	None- slab on grade	R-21 cavity + R-6 c.i.	We raised the floor on piles to address being in the 100 yr. flood plain.
Windows	15%; Double Pane, Low-E, Insul. Frame	15%, Triple Pane, SHGC-0.26, U-0.15	We selected Passive House certified windows for our climate.
Window Shading	2 ft overhangs	7 ft porch; trellises	We have provided fixed shading horizontal and vertical devices to completely shade all windows. The full effect of this is not accounted for in the energy models.
Airtightness	0.60 ACH50	0.60 ACH50	Although PHIUS+2015 requirements are not as tight, we elected to comply with the old standard.
Ventilation	Exhaust	Balanced- ERV	We selected a Passive House certified ERV, but have isolated the kitchen exhaust.
Space Conditioning	SEER 27 Mini-Split	SEER 17.5 Mini-Split	A lower SEER mini-split was selected as an affordability measure.
Water Heater	80 gal Heat Pump	80 gal Heat Pump	
Hot Water Distribution	R-2, Trunk Branch	R-2, Trunk Branch	The delivery system is designed such that no more than 0.5 gallons of hot water will remain in any line.
Lighting	767 kWh	241 kWh	80% of Fixtures are Energy Star qualified.
Appliances	Energy Star, Electric	Energy Star, Electric	We selected a high performance ventless clothes dryer.
Annual Energy Cost	$1,788	$801	We believe the BEopt cost includes a 2kW PV system, whereas ours is prior to inclusion of a 6kW PV system that zeros out energy costs.

ENERGY ANALYSIS



ENERGY ANALYSIS



ENERGY ANALYSIS

ENERGY ANALYSIS

RESULTS

7,306 kWh per Year*

Month	Solar Radiation (kWh / m² / day)	AC Energy (kWh)	Energy Value ($)
January	2.69	400	44
February	3.28	441	48
March	4.21	614	67
April	4.87	675	74
May	5.55	778	85
June	6.04	804	88
July	5.88	802	88
August	5.51	755	83
September	4.85	653	72
October	4.20	590	65
November	3.15	438	48
December	2.40	356	39
Annual	**4.39**	**7,306**	**$ 801**

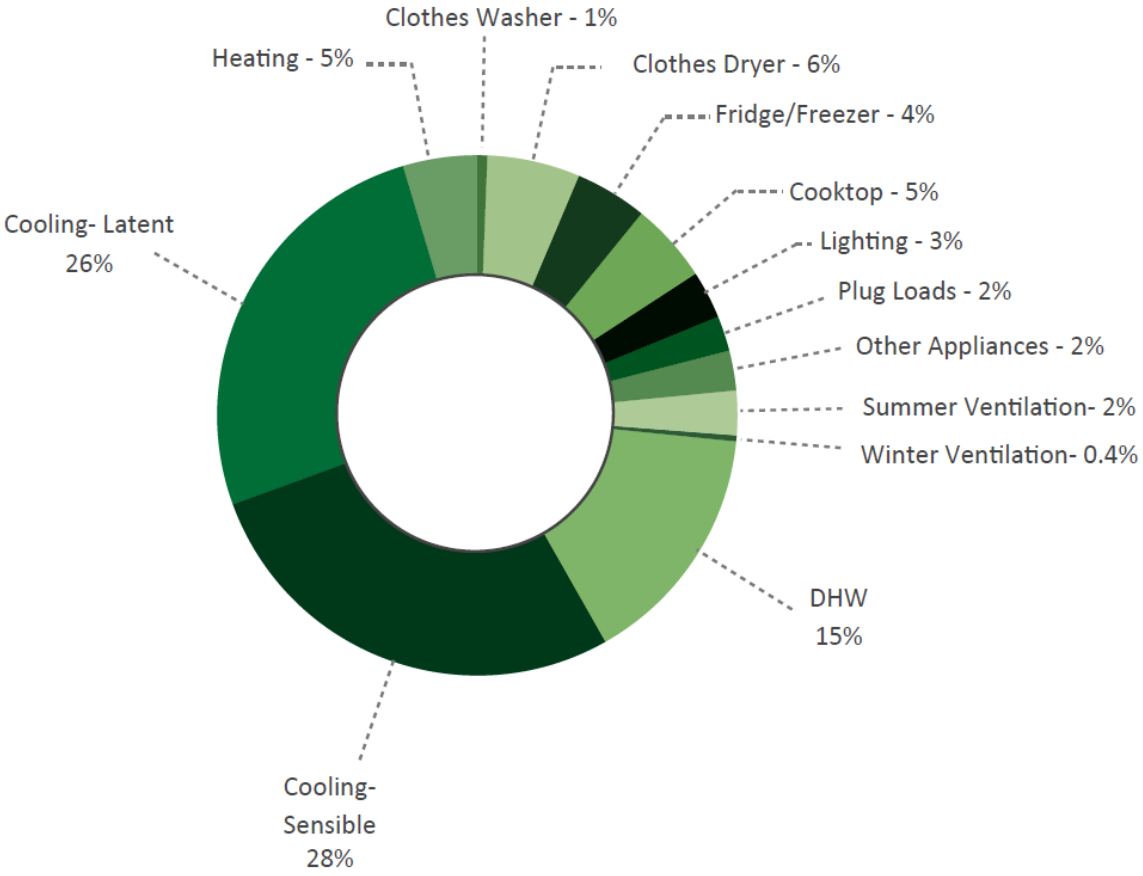
Location and Station Identification	
Requested Location	0 44th street, houston, texas
Weather Data Source	(TMY2) HOUSTON, TX 12 mi
Latitude	**29.98° N**
Longitude	**95.37° W**

PV System Specifications *(Residential)*	
DC System Size	6 kW
Module Type	Standard
Array Type	Fixed (roof mount)
Array Tilt	**9.46°**
Array Azimuth	**90°**
System Losses	14%
Inverter Efficiency	96%
DC to AC Size Ratio	1.1

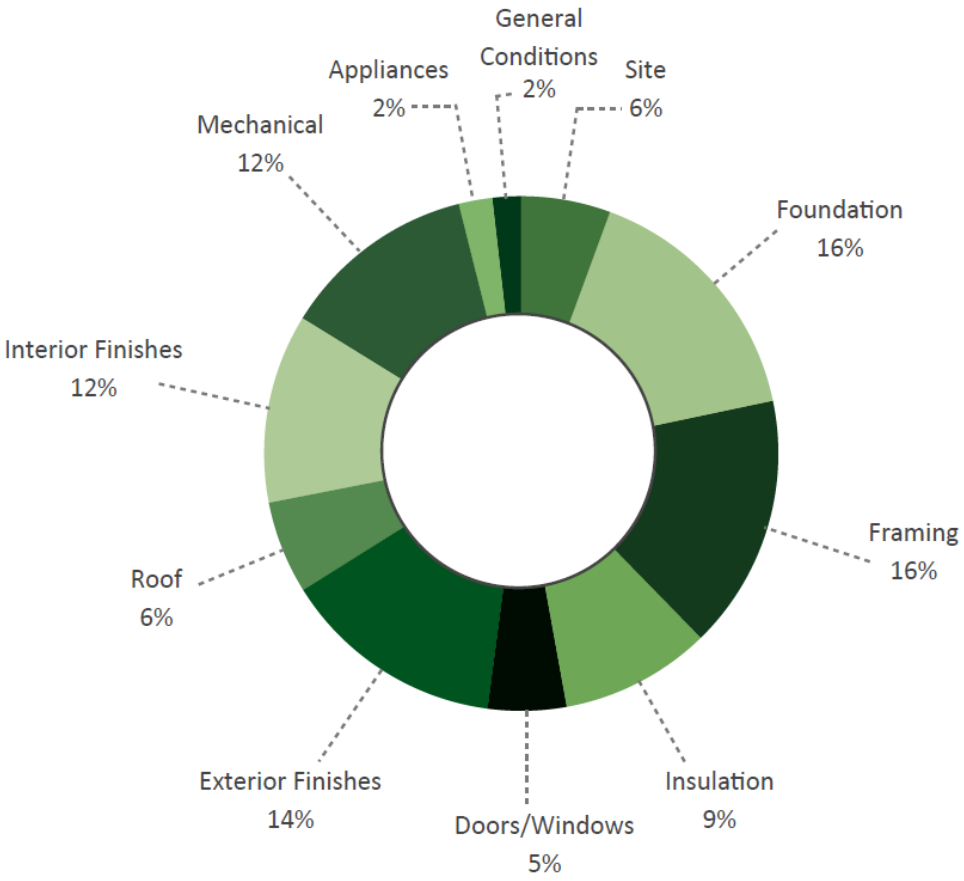
Initial Economic Comparison	
Average Cost of Electricity Purchased from Utility	0.11 $/kWh
Initial Cost	3.30 $/Wdc
Cost of Electricity Generated by System	0.22 $/kWh

These values can be compared to get an idea of the cost-effectiveness of this system. However, system costs, system financing options (including 3rd party ownership) and complex utility rates can significantly change the relative value of the PV system.

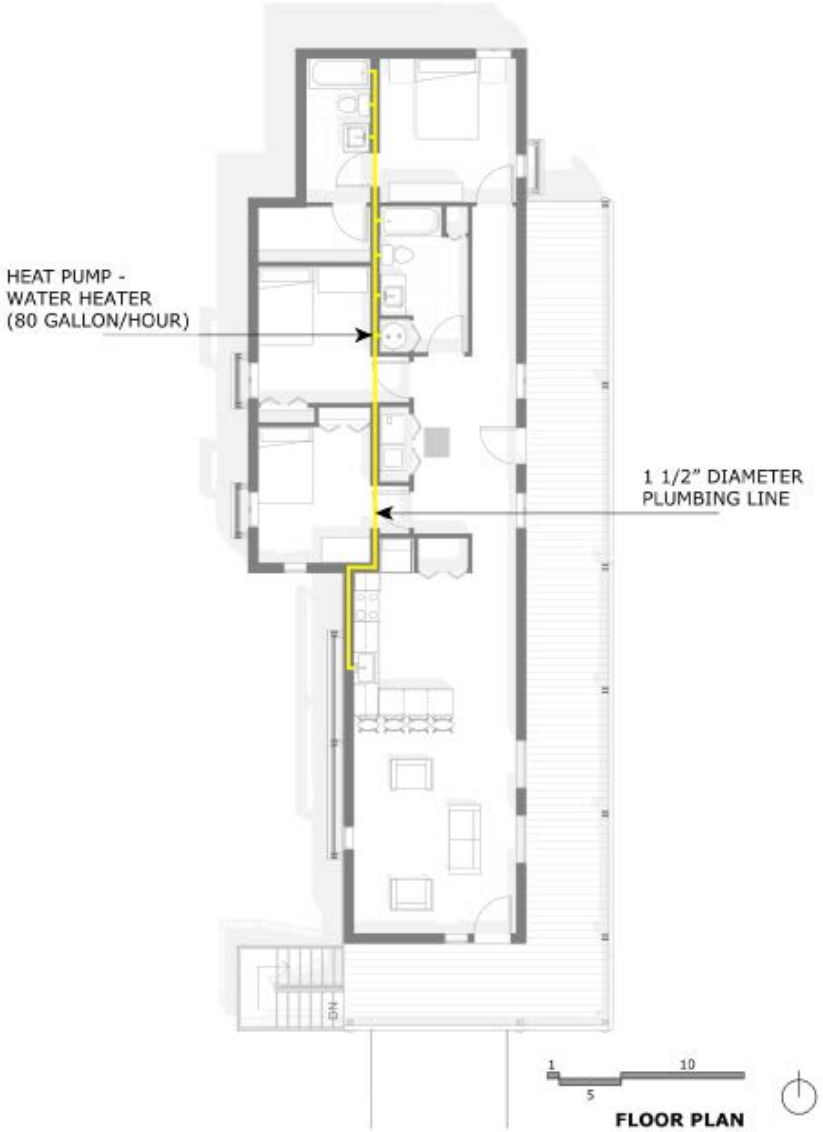
ENERGY ANALYSIS



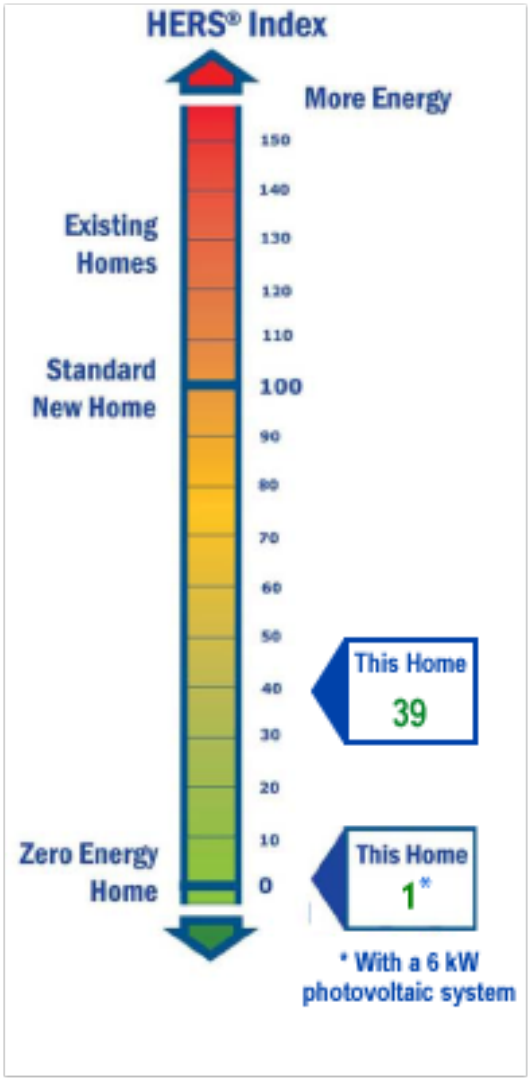
ENERGY ANALYSIS



FINANCIAL ANALYSIS

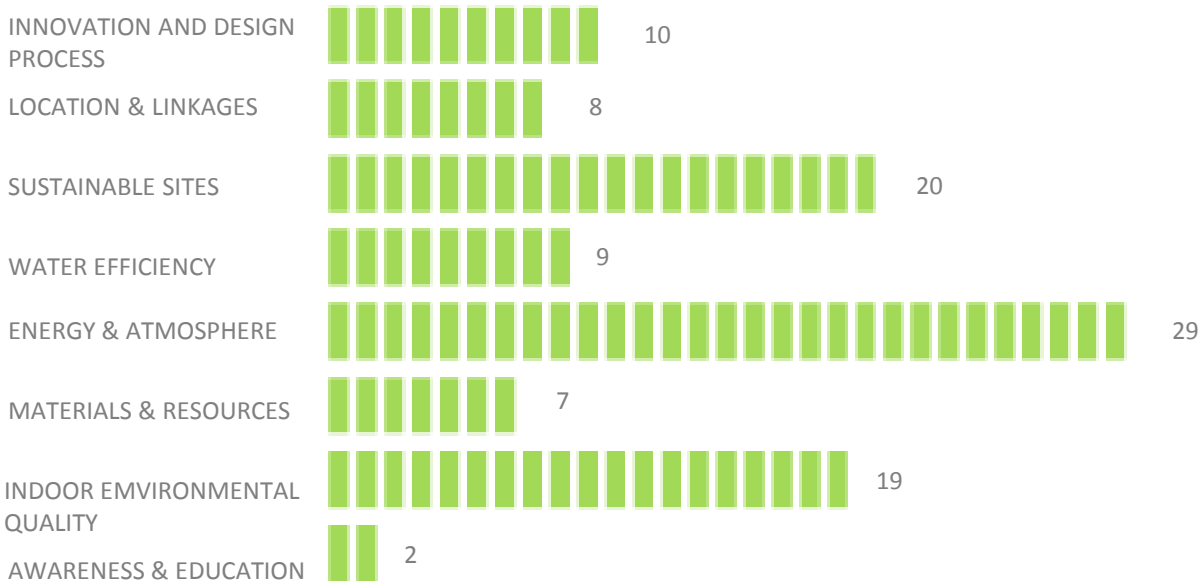


DOMESTIC HOT WATER


HERS® Index
More Energy
150
140
130
120
110
Existing Homes
Standard New Home
100
90
80
70
60
50
40
This Home 39
30
20
10
Zero Energy Home
0
This Home 1*
* With a 6 kW photovoltaic system

SUMMARY

LEED FOR HOMES



TOTAL LEED POINTS: 104

SUMMARY

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SUMMARY


LEED™
FOR HOMES


PH®


energy
ENERGY STAR


EPA Indoor
airPLUS
QUALIFIED HOMES


EPA
WaterSense

SUMMARY

The Independence Heights House

Prairie View A&M University