The New

AffOrdable ZerO Homes

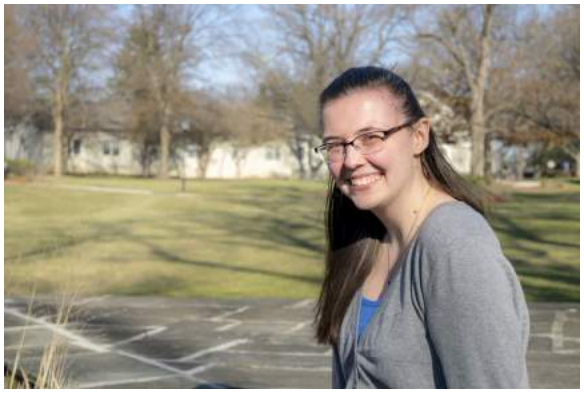
PhilaU Powered to Zero

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

Our Team:

Jessica Livezey

Tyler Scire



Megan Ullery

Certifications:

EPA Indoor airPLUS Qualified Home

ENERGY STAR

U.S. Green Building Council LEED USGBC

ZERO ENERGY READY HOME U.S. Department of Energy

WaterSense Meets EPA Criteria

Industry Partners:

Habitat for Humanity®

MaGrann Associates

JHa

Celentano Energy Services

WØCHTER ENGINEERING

Project Summary

Overview:

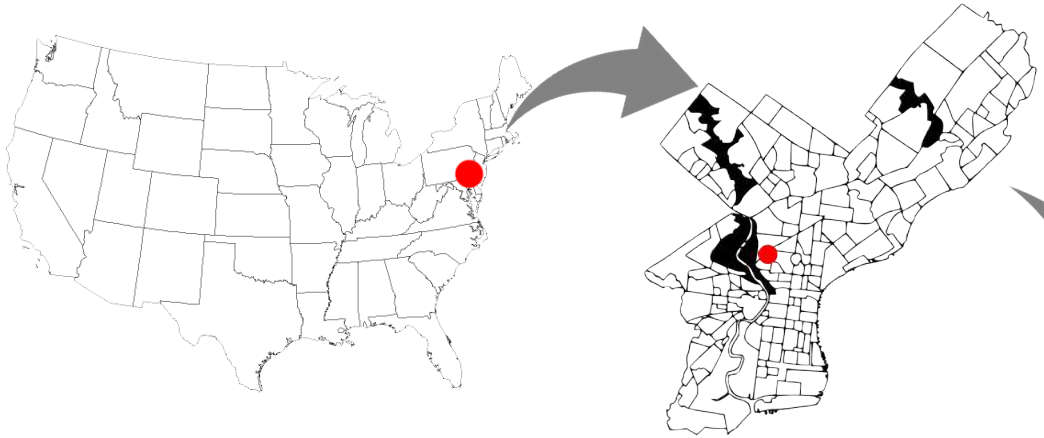
- Attached Duplex Housing
- Alternate option to non-profit home building organizations

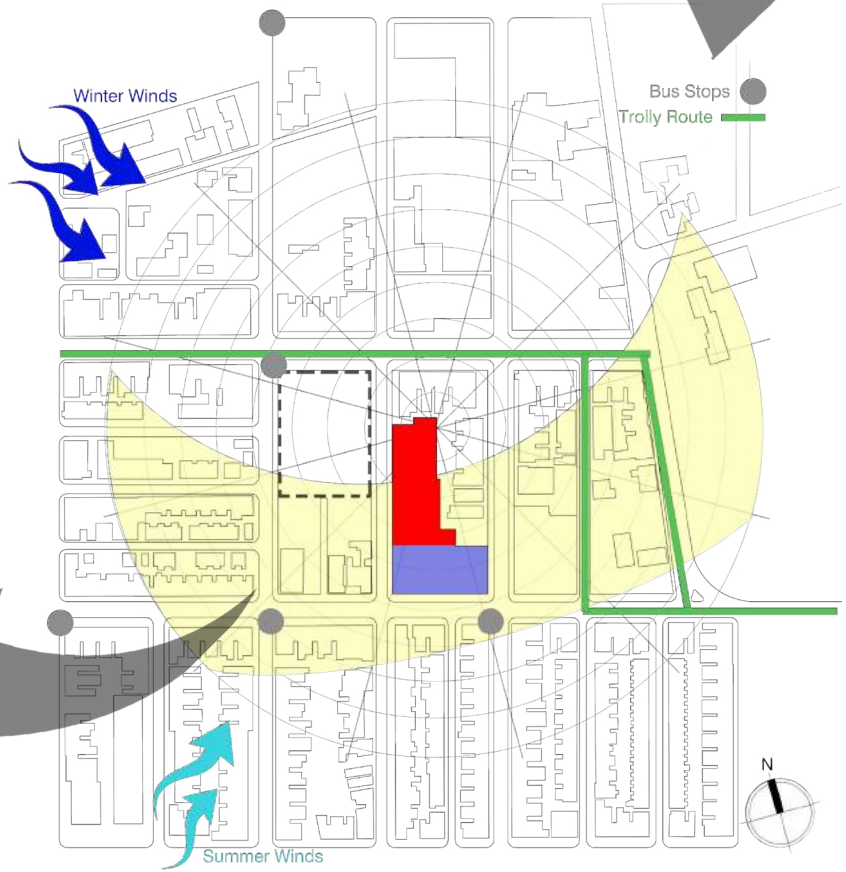
Key Facts:

	Unit 1	Unit 2
Square Footage:	1,414	1,060
Bedrooms:	3	3
Bathrooms:	2.5	2
HERS w/o PV:	36	39
HERS with PV:	-2	-2
Monthly Net Zero Ready Utility Costs:	$56	$46
Monthly Utility Costs with Renewables:	$5	$5

Site Location:

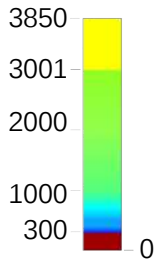
- Brewerytown, Philadelphia, Pennsylvania
- Climate Zone: 4a, mixed-humid





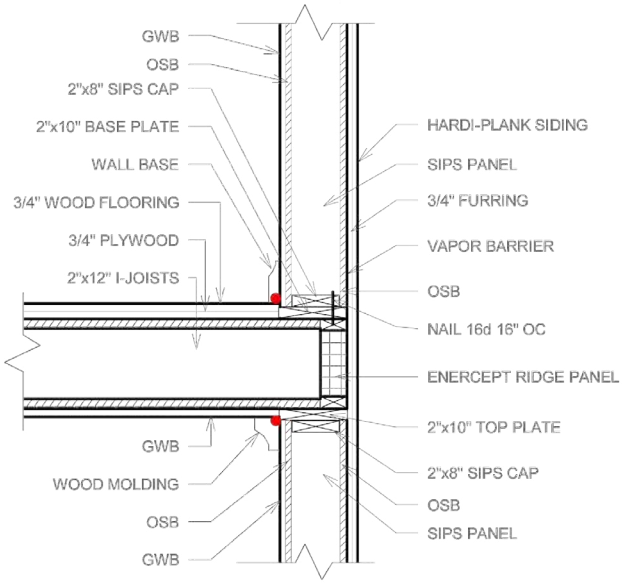
Design Goals:

- Exceed Baseline Standards
- High Performance
- Natural Daylight Analysis



Illuminance values of Lighting Analysis

	Brewerytown Rowhouse	Habitat for Humanity	New Affordable Zero Homes
Dwelling Sq. Ft.:	1,252	1,070	Unit 1: 1,414 Unit 2: 1,060
# Bed/Bath:	2/1.5	3/1.5	Unit 1: 3/2.5 Unit 2: 3/2
Cost:	$252,750	$160,000	Unit 1: $168,763 Unit 2: $175,321
Monthly Utilities:	$150-$200		Unit 1: $56 Unit 2: $46
R-Roof:	38	38	40
R-Wall:	13	30	30
Standards & Programs:	None	Minimum LEED Silver, Energy Star, Advanced Framing, IAQ	Energy Ready, LEED Platinum, Energy Star, EPA, Water Sense

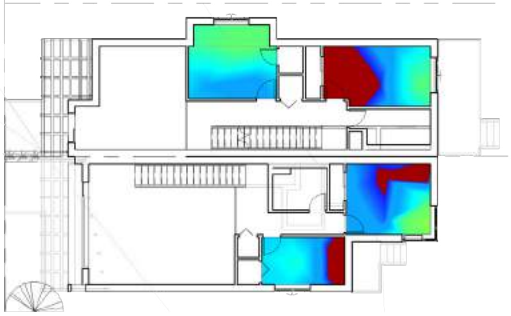


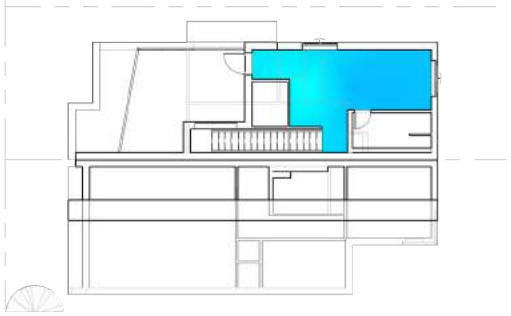
Level 1

Level 2

Level 3

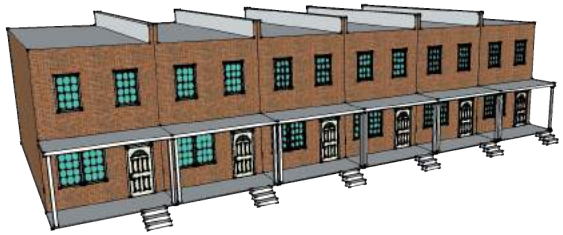
Daylight Levels: 9am



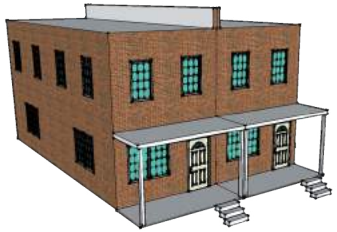


Daylight Levels: 3pm

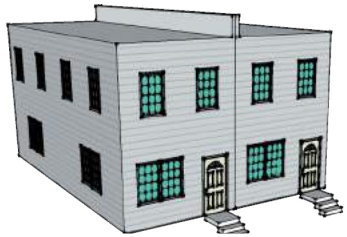
Comparison to Philadelphia Homes:



Typical Philadelphia Rowhome



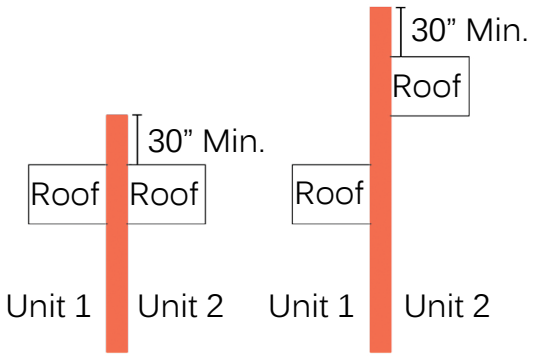
Typical Philadelphia Duplex

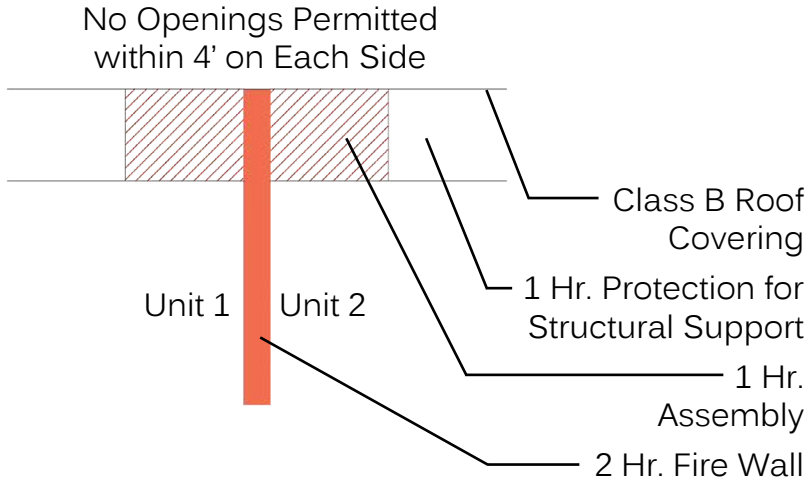


Typical Habitat Duplex

New Affordable Zero Duplex

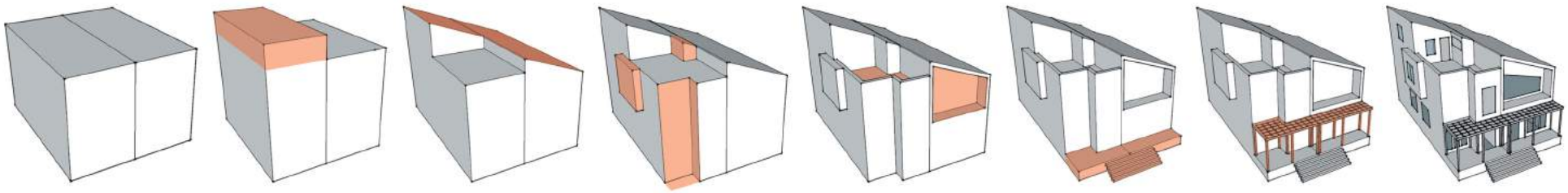
Fire Wall / Roof Conditions:





West Elevation:

Transformation from Typical Duplex to New Affordable Zero Homes:

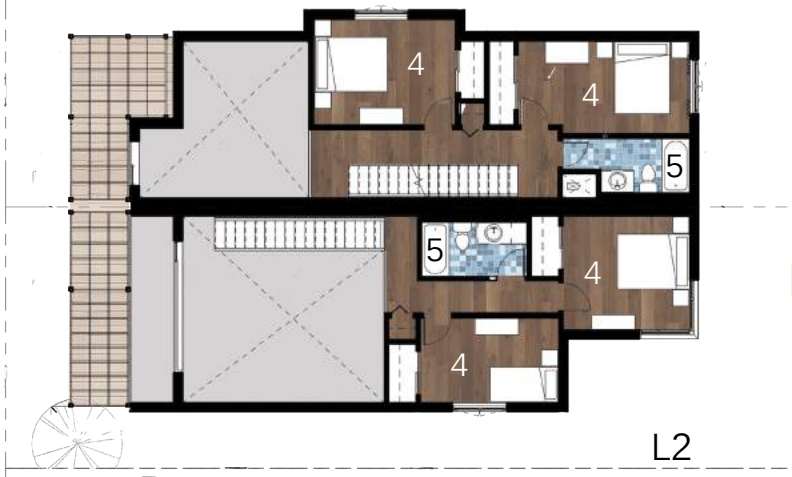


Typical Duplex Form → New Affordable Zero Duplex Form

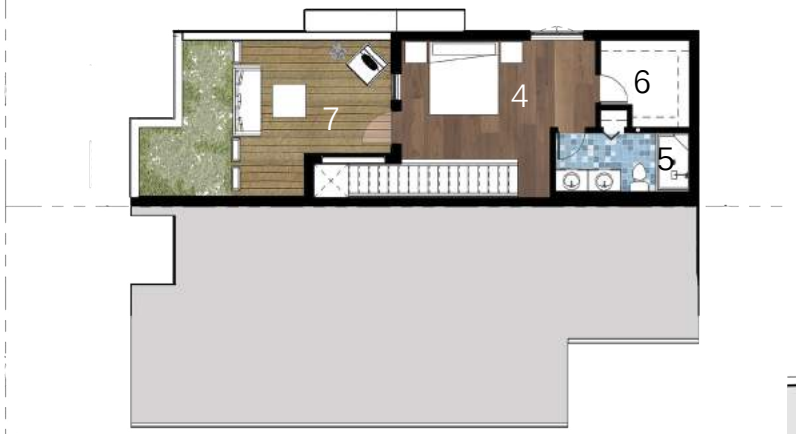
South Elevation:

View Towards W. Girard Avenue

L1



L2



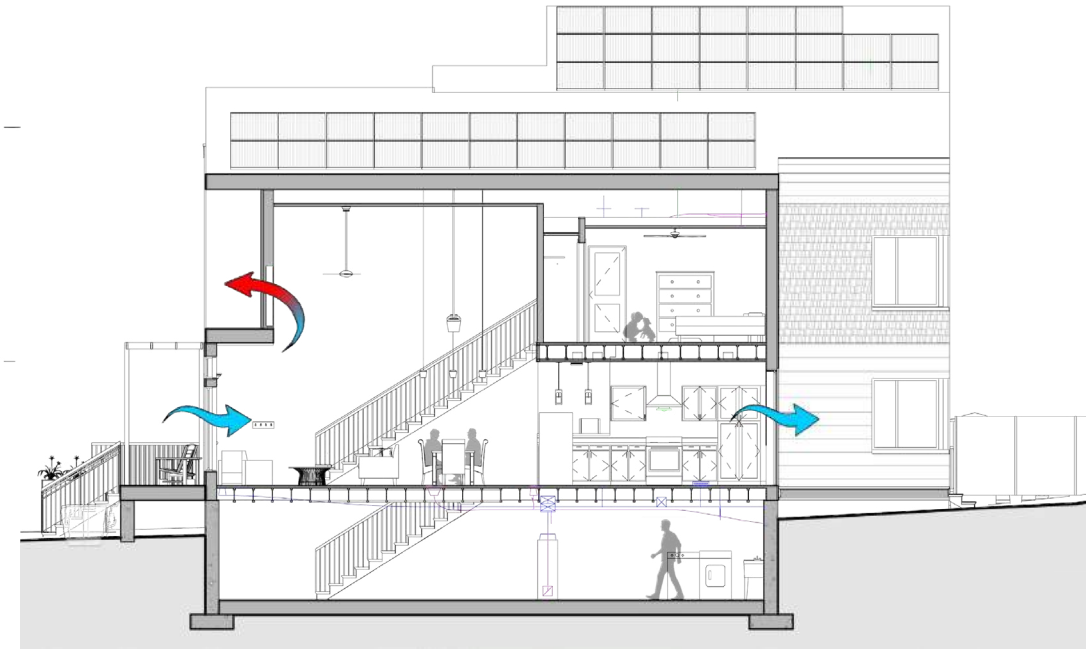
L3

Program Key:

1. Living Room
2. Dining Room
3. Kitchen
4. Bedroom
5. Bathroom
6. Walk-in Closet
7. Roof Deck

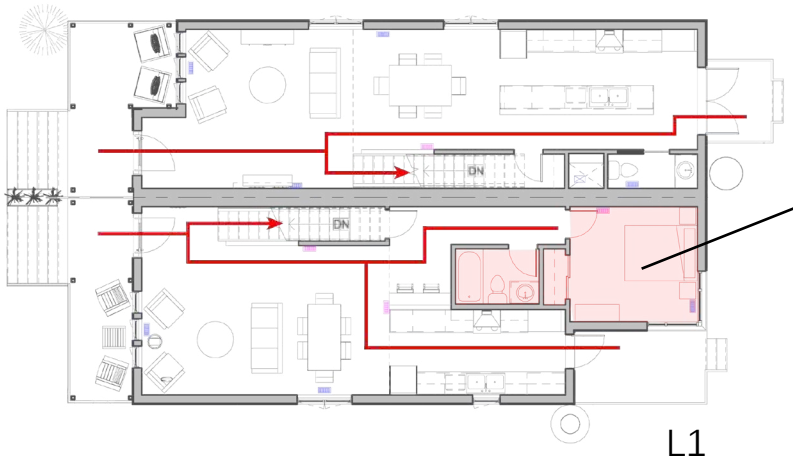
Unit 1 Dining Room

Natural Ventilation:

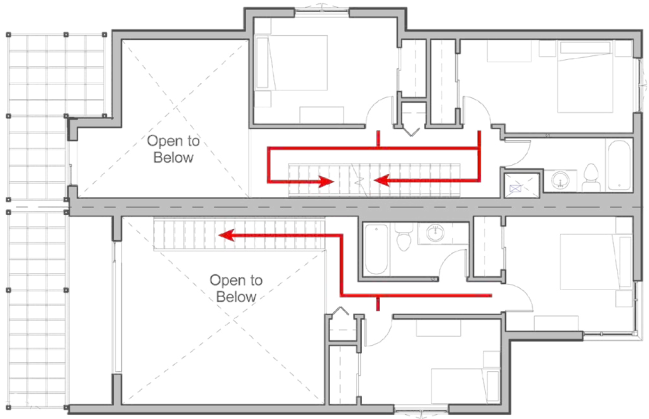


The New Affordable Zero Homes

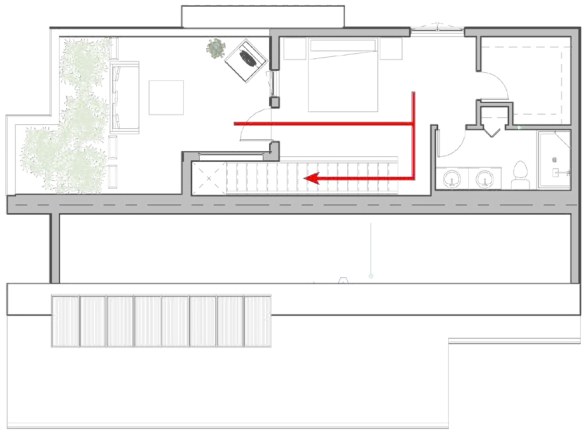
Circulation:



L1



L2



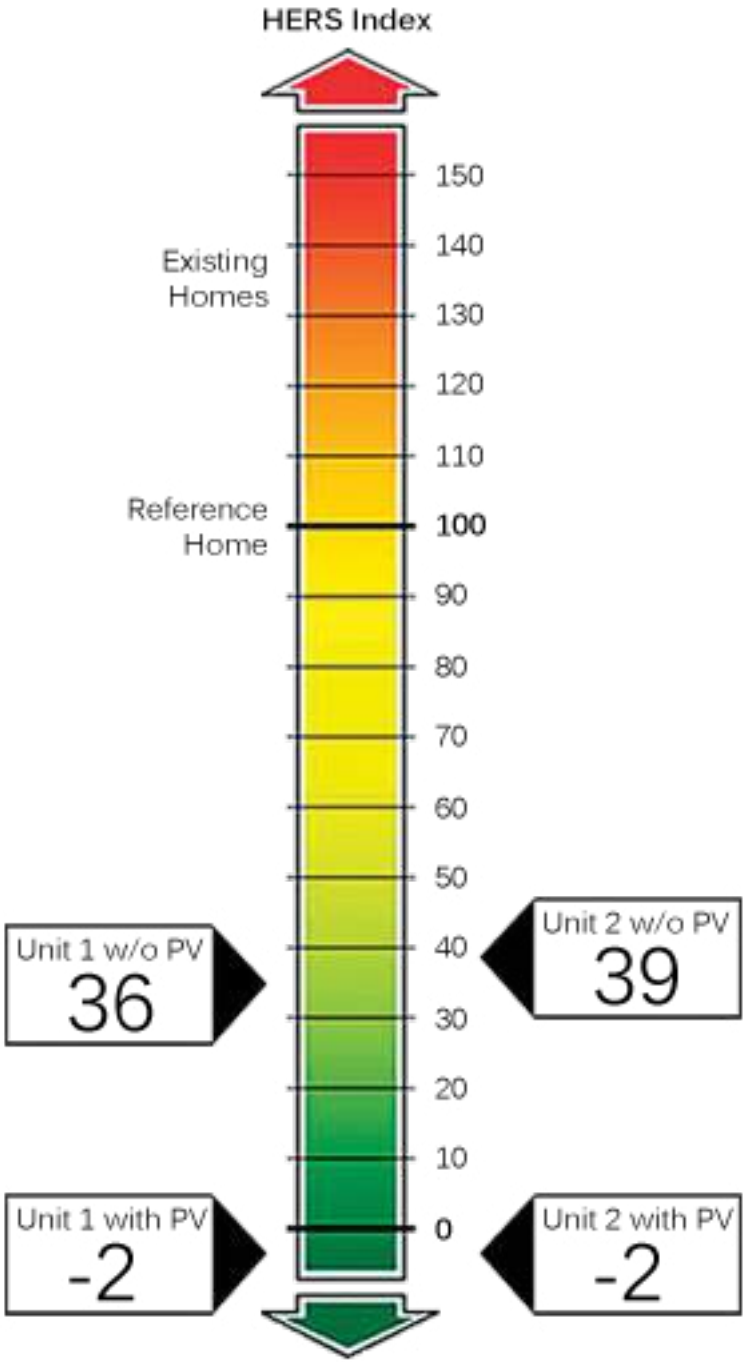
L3

- Aging in place
- ADA accessibility

Unit 2 Living Room

Unit 2 Kitchen

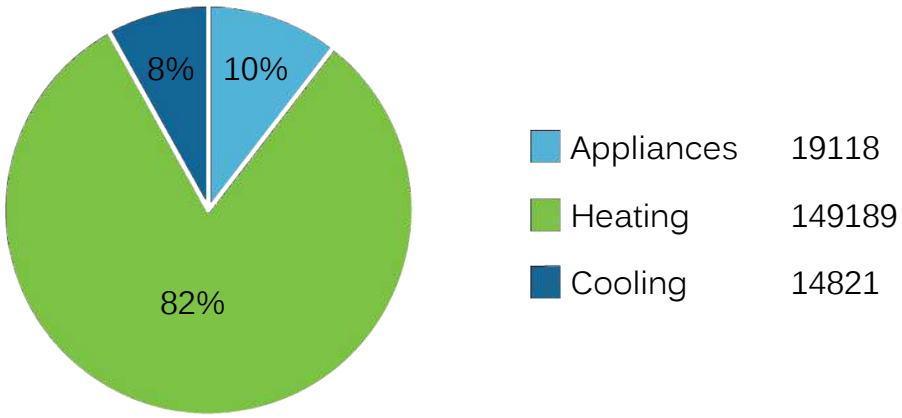
	IECC 2009	DOE NZRH R.5	New Affordable Zero Homes
Ceiling R-Value	38	49	50
Wall R-Value	13	20	35.7
Floor R-Value	19	19	21
Basement Wall R-Value	10 / 13	10 / 13	23.6
Window SHGC	NR	0.25	0.25
Window U-Value	0.35	0.3	0.2
AFUE		90%	90%
SEER		15	17
HSPF		9	9.8
ASHRAE 62.2 Ventilation System		1.4 cfm/W; no heat exchange	1.4 cfm/W
Infiltration (ACH50)		2.5	1
Water Heater Energy Factor		Electric: EF = 2.0	EF = 2.75



Energy Analysis Strategies:

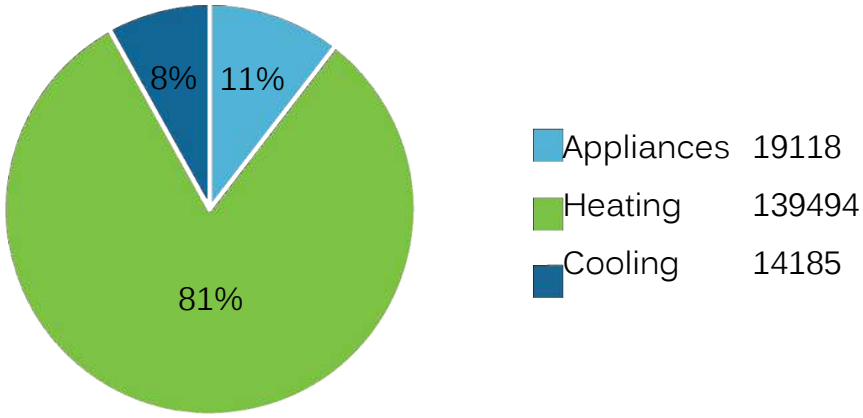
Sefaira Unit 1:

Unit 1 Annual Energy Use (kBTU)



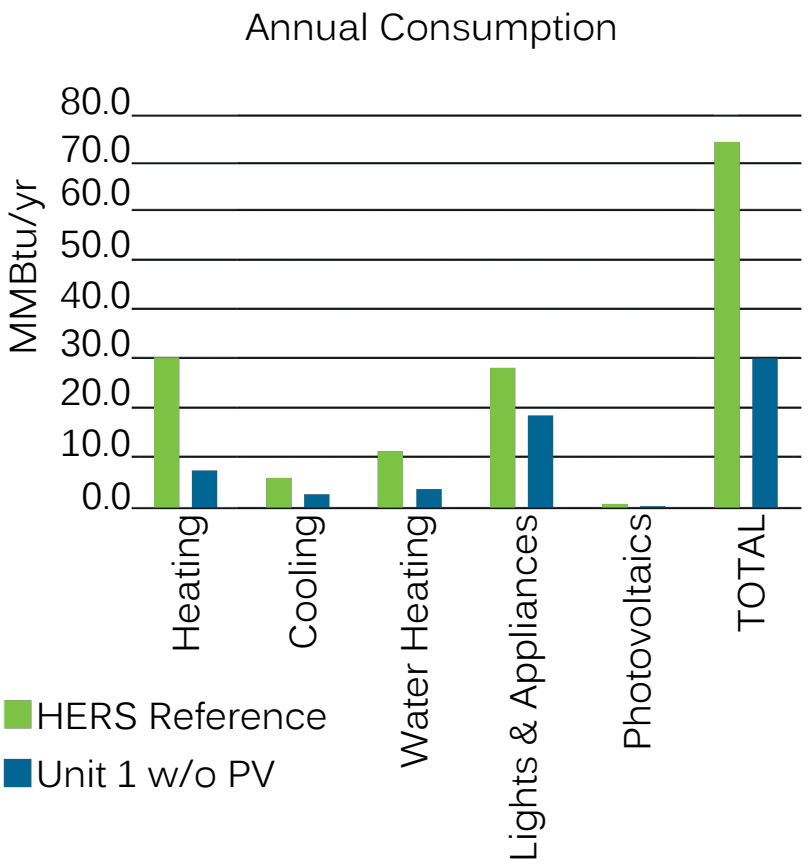
Sefaira Unit 2:

Unit 2 Annual Energy Use (kBTU)

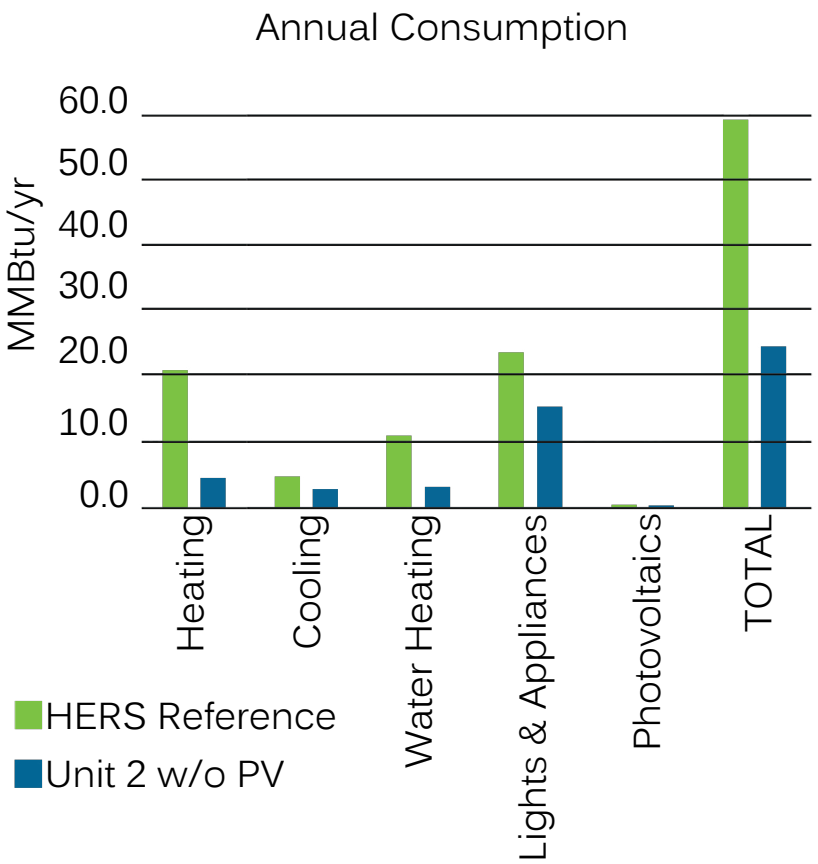


Energy Analysis Strategies:

REM/Rate Unit 1 w/o PV: 36



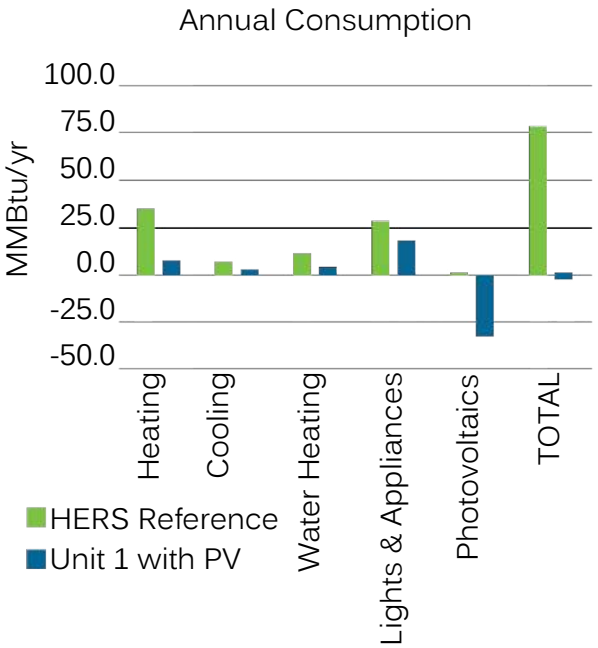
REM/Rate Unit 2 w/o PV: 39



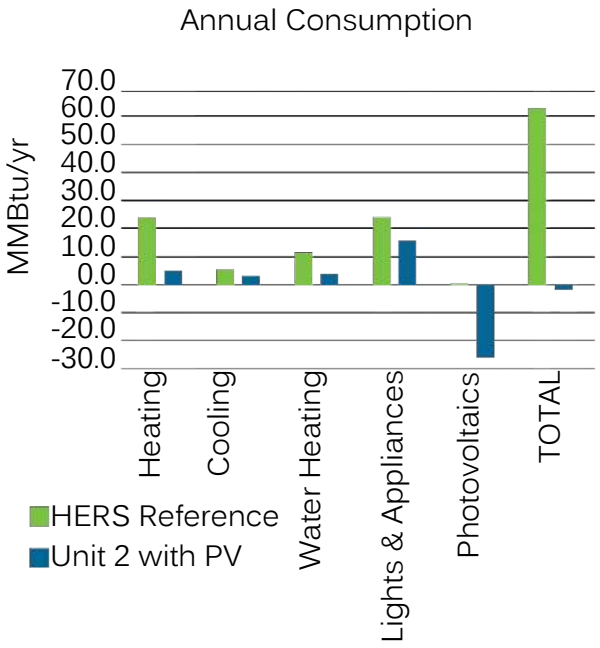
PV System:

	Unit 1	Unit 2
Roof Area	530 SF	1022 SF
Roof Slope	37.5 degrees	37.5 degrees
Annual Electrical Use	8662 kWh	7087 kWh
DC System Size	6.93 kW	5.67 kW
# 315W Panels	22	18
Panel Coverage Area	388.3 SF	317.7 SF
HERS Score with PV	-2	-2

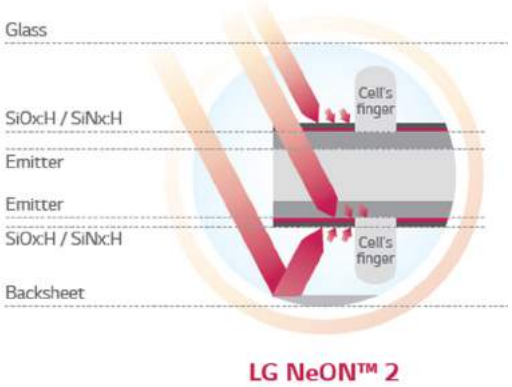
REM/Rate Unit 1 with PV:



REM/Rate Unit 2 with PV:

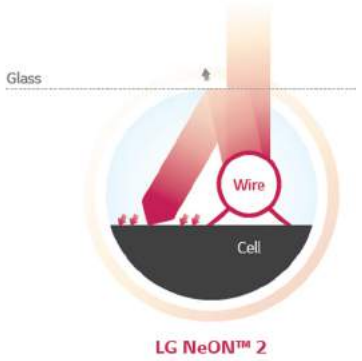


PV Double Sided Cell:

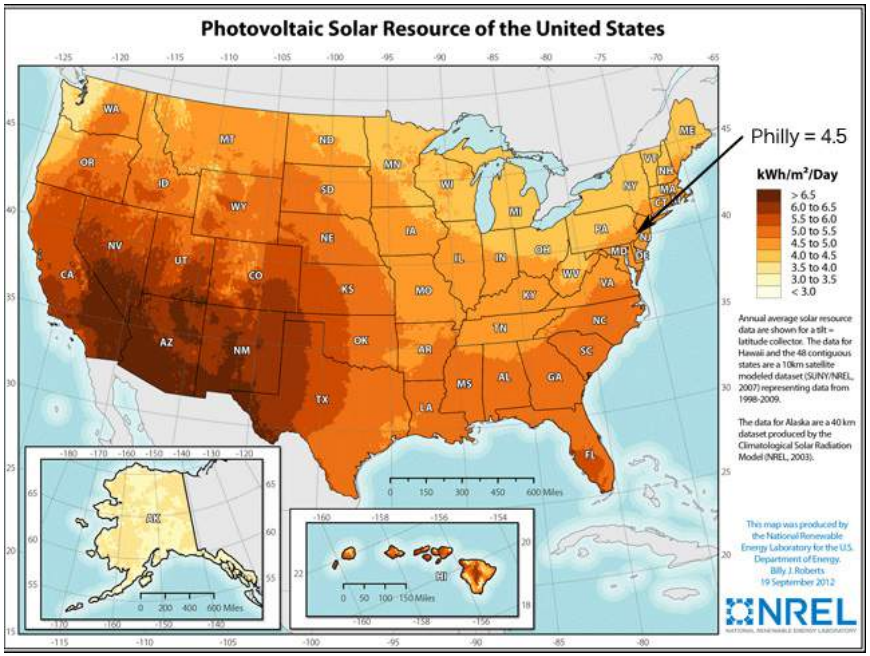


Double Sided Cell. Digital image. LG NeON 2 Module. LG, 2015. Web. <http://www.lg.com/us/commercial/solar-panels/lg-LG315N1C-G4>.

PV Light Absorption:



Light Absorption Cell. Digital image. LG NeON 2 Module. LG, 2015. Web. <http://www.lg.com/us/commercial/solar-panels/lg-LG315N1C-G4>.



Structural Insulated Panel System:

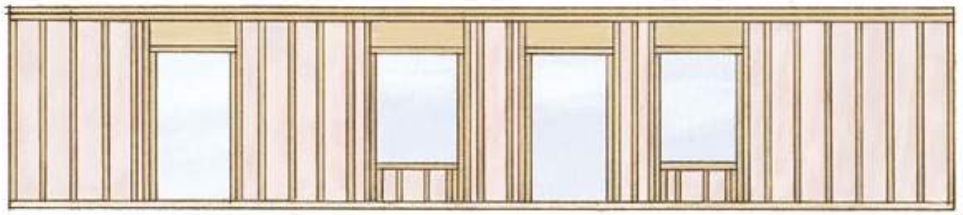
- Self contained system
- Insulation and structure are pre-assembled
- Panels are stacked and joined to form a complete sealed envelope with minimal labor and can be assembled quickly

Insulated Concrete Forms System:

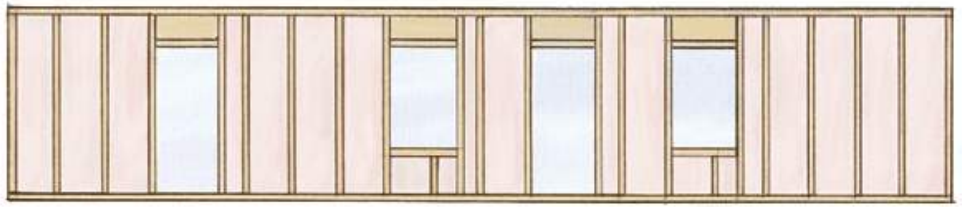
- Pre-insulated formwork for foundations
- More efficient and quicker to assemble than traditional wood formwork.

"Its like building with legos and any unskilled volunteer can put together the formwork"

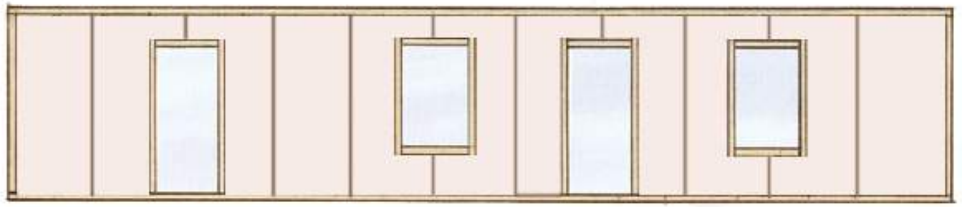
~Habitat Philadelphia on ICF construction



Typical Stud Framing

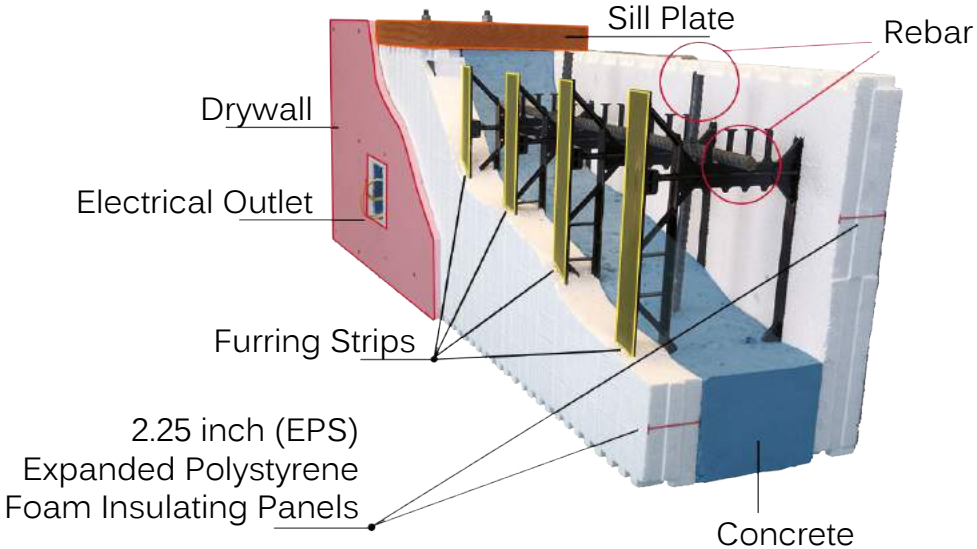


Advanced Stud Framing



SIPs Construction

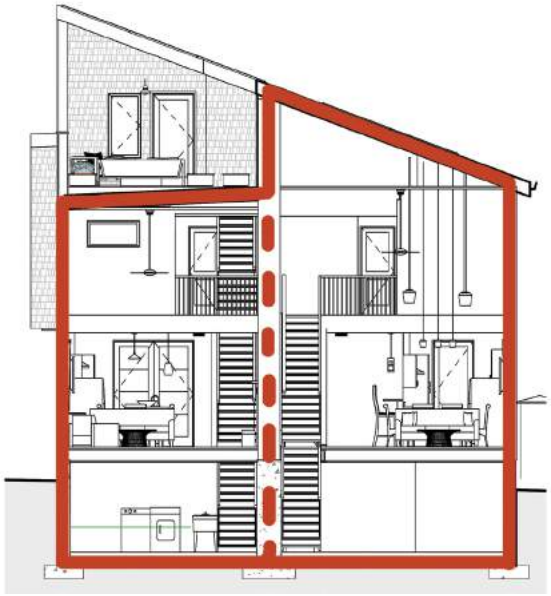
"Energy-Efficient Framing, A.k.a. Advanced Framing." Green Building Advisor. N.p., n.d. Web. 8 Apr. 2016; Gibson, Scott. "High-Performance Walls." Home Power. N.p., n.d. Web. 8 Apr. 2016.



Concrete Forms. Digital image. Insulated Concrete Forms. Advanced NRG, 2012. Web. <http://www.advancenrg.com/concreteforms.html>.

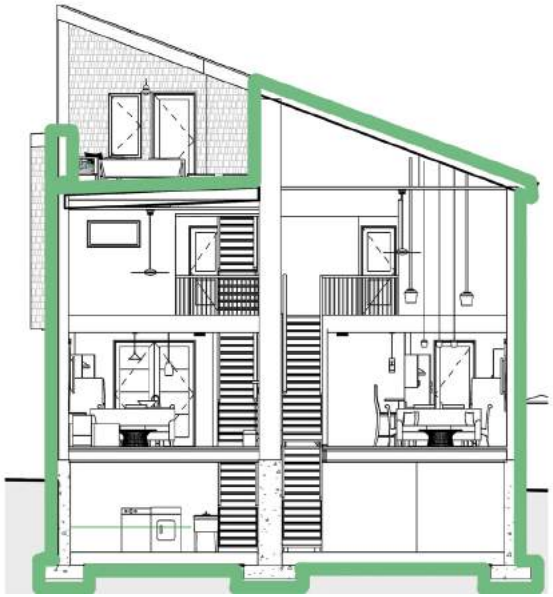
Sealing the Envelope:

Thermal Barrier:



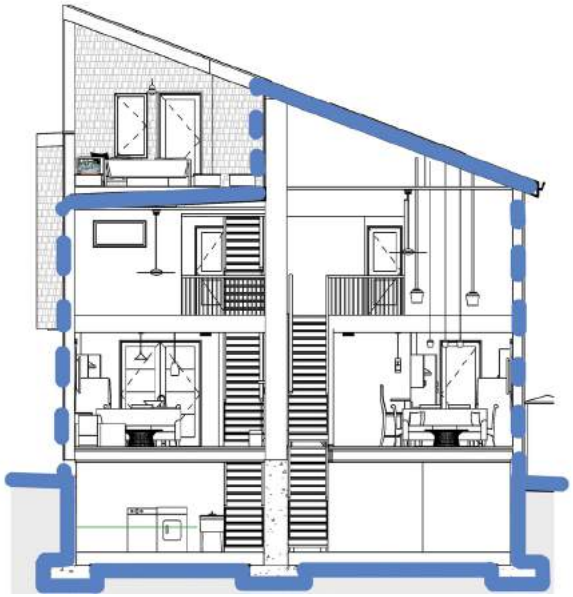
The thermal barrier exists within both the SIP and ICF system due to the fact that insulation is within these pre assembled systems.

Vapor Barrier:



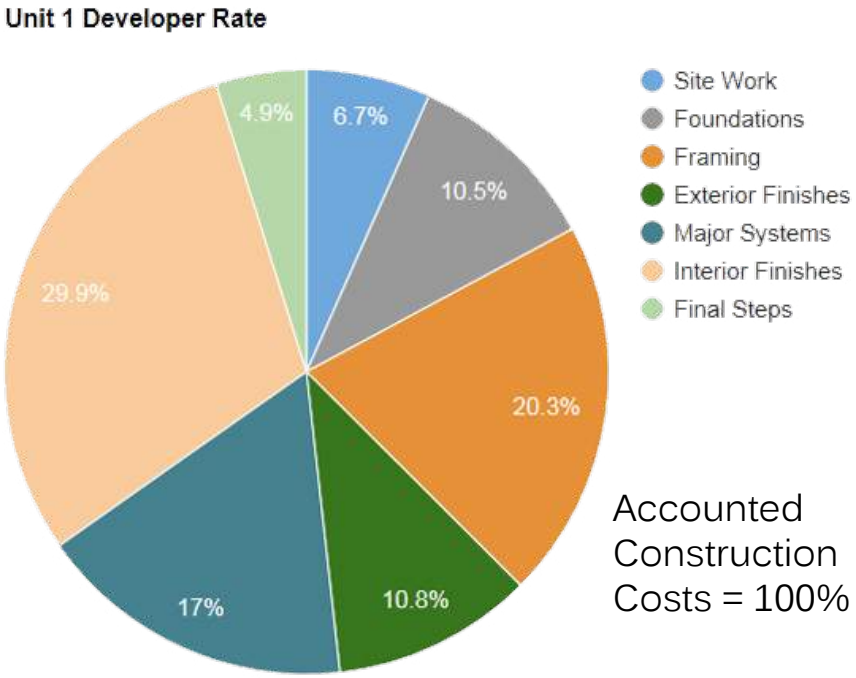
Sheeting is applied directly to the exterior face of these systems underneath the exterior finishes.

Moisture Barrier:

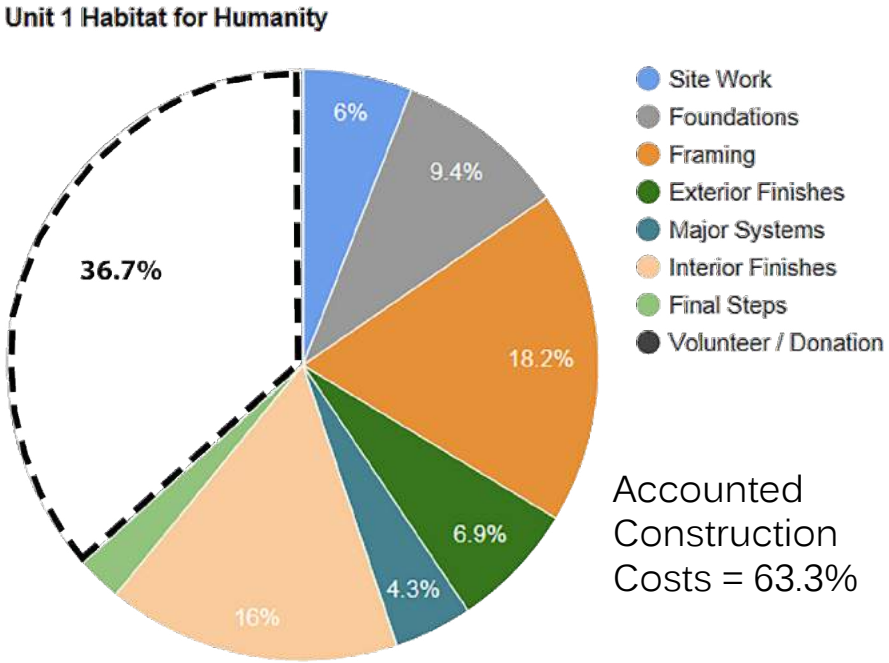


The moisture barrier exists at the ground, roof and foundation while the exterior walls just repel the water to the ground.

UNIT 1:

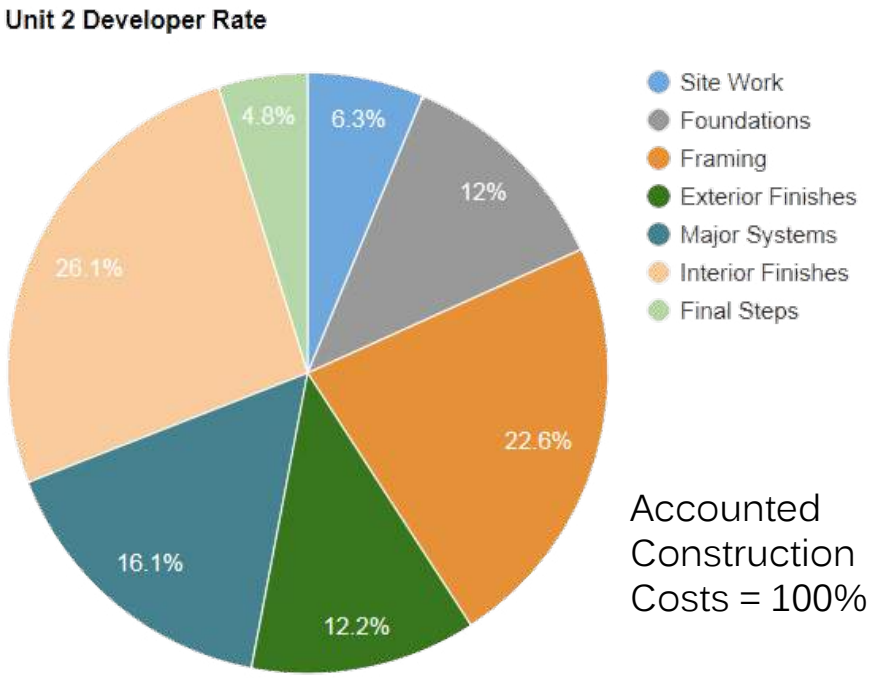


Accounted Construction Costs = 100%

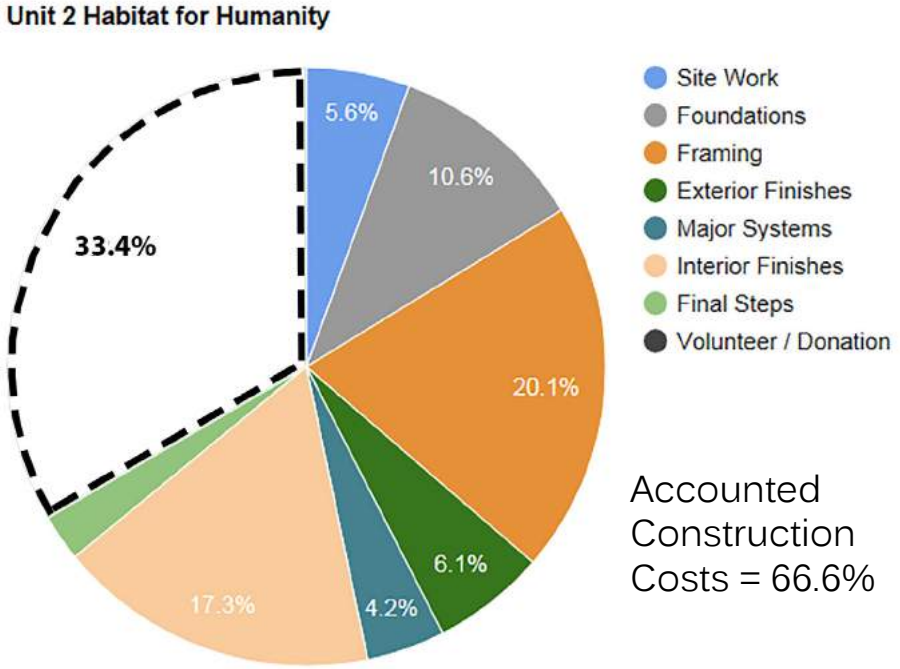


Accounted Construction Costs = 63.3%

UNIT 2:



Accounted Construction Costs = 100%



Accounted Construction Costs = 66.6%

Habitat for Humanity is able to reduce our costs due to the fact that they receive selection of building materials and appliances by donation as well as a portion of labor is done by volunteers.

Habitat for Humanity Volunteer Work:

- Site Work Labor
- Framing Labor
- Envelope Sealant

Habitat for Humanity Reductions:

- HVAC
- Plumbing
- Electrical

Habitat for Humanity Typical Donations:

- Windows
- Doors
- Paint
- Washer
- Dryer
- Refrigerator
- Range/Oven
- Lighting
- Casework

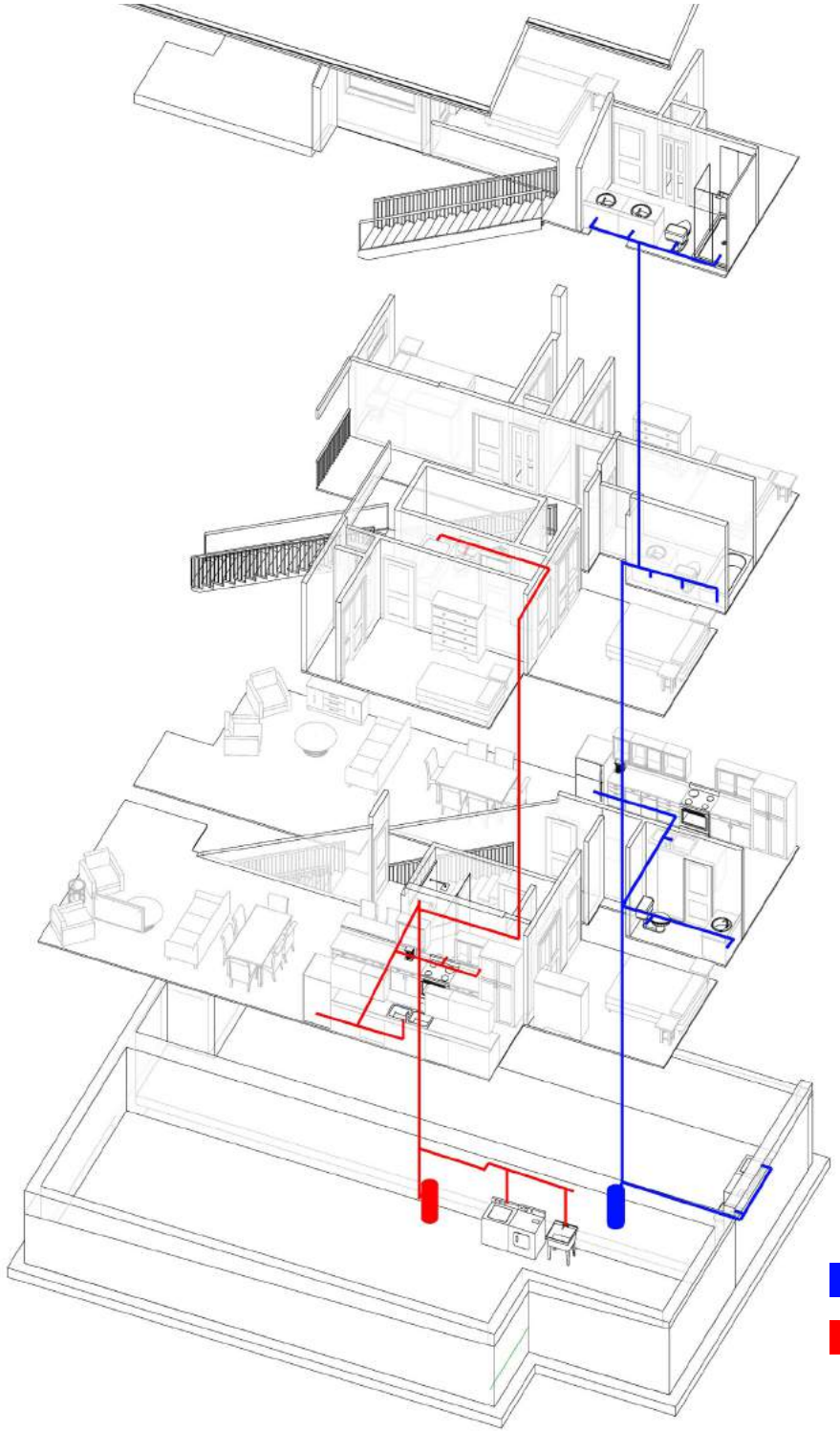
Financial Chart	Unit 1
Site Work	$13,303
Foundations	$20,983
Framing	$40,596
Exterior Finishes	$21,499
Major Systems	$34,000
Interior Finishes	$59,755
Final Steps	$9,708
Total	$199,844

Financial Chart	Unit 2
Site Work	$11,876
Foundations	$22,612
Framing	$42,709
Exterior Finishes	$22,966
Major Systems	$30,358
Interior Finishes	$49,358
Final Steps	$9,104
Total	$188,983

Financial Chart	Unit 1 HfH
Site Work	$13,303
Foundations	$20,983
Framing	$40,596
Exterior Finishes	$15,399
Major Systems	$9,500
Interior Finishes	$35,650
Final Steps	$5,460
Volunteer / Donation	$81,578
Total	$140,891

Financial Chart	Unit 2 HfH
Site Work	$11,876
Foundations	$22,612
Framing	$42,709
Exterior Finishes	$13,043
Major Systems	$9,000
Interior Finishes	$36,822
Final Steps	$5,368
Volunteer / Donation	$71,013
Total	$141,430

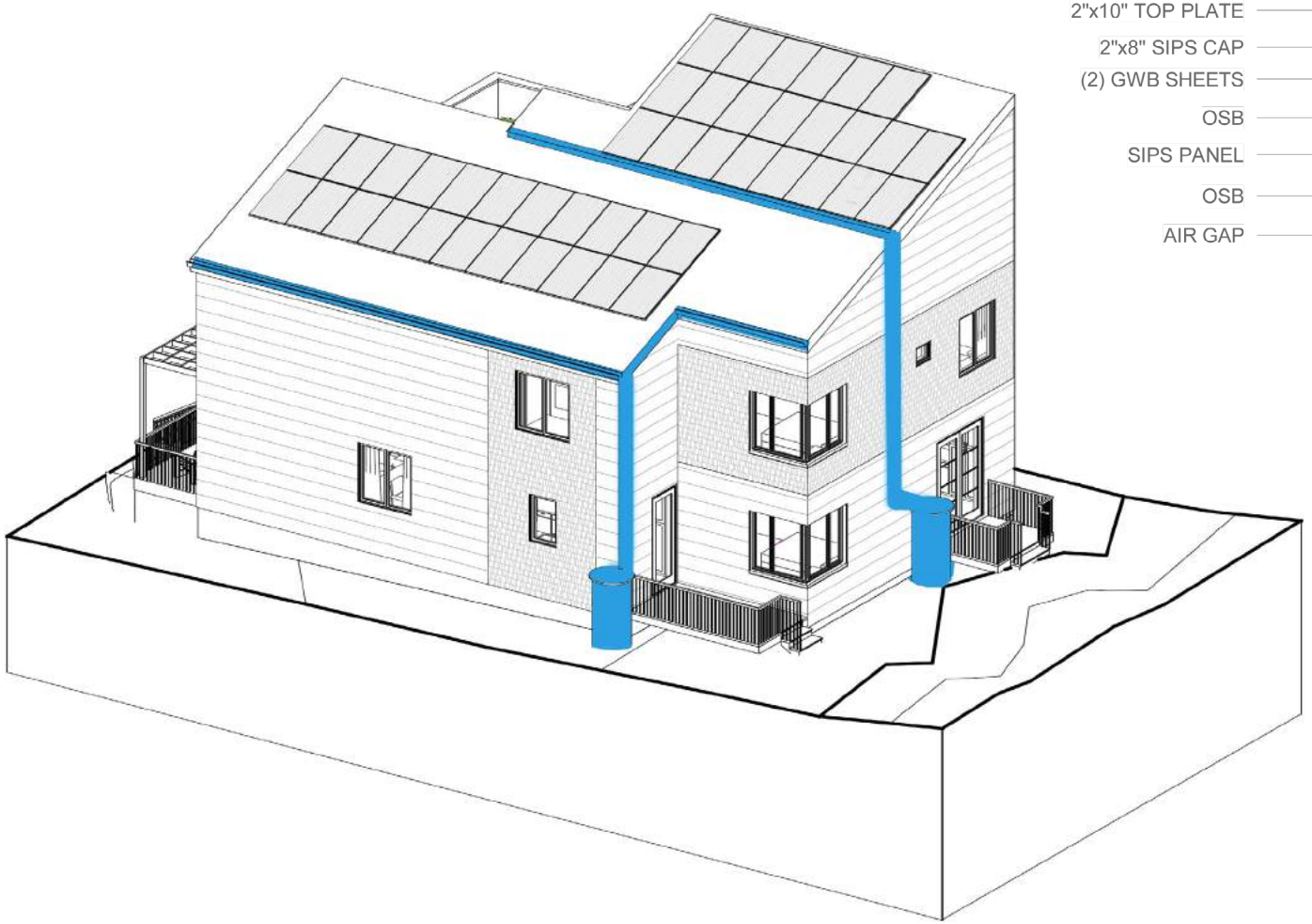
Plumbing System:

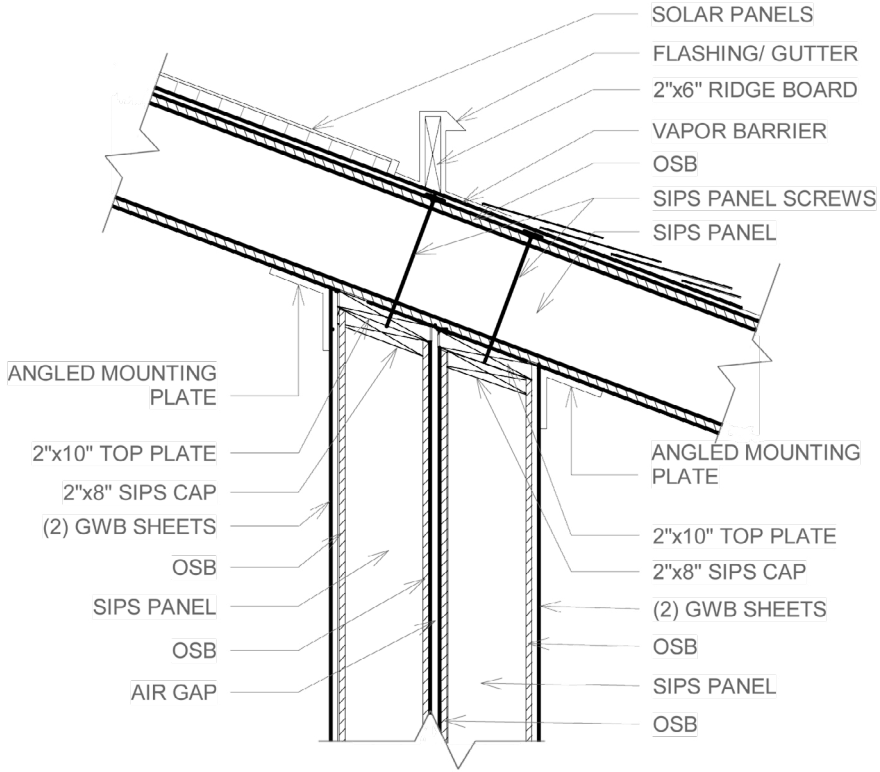


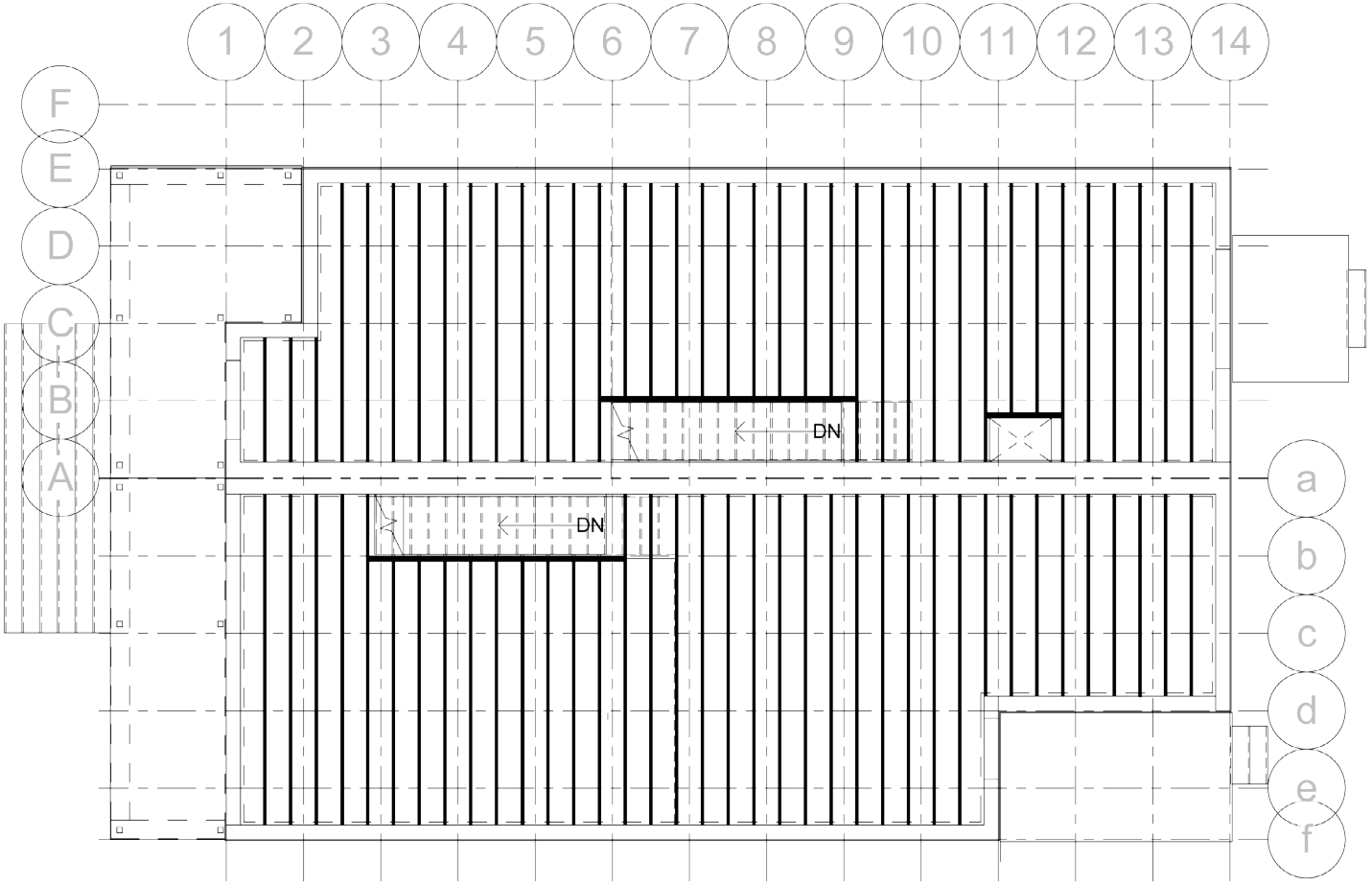
Unit 1 Plumbing

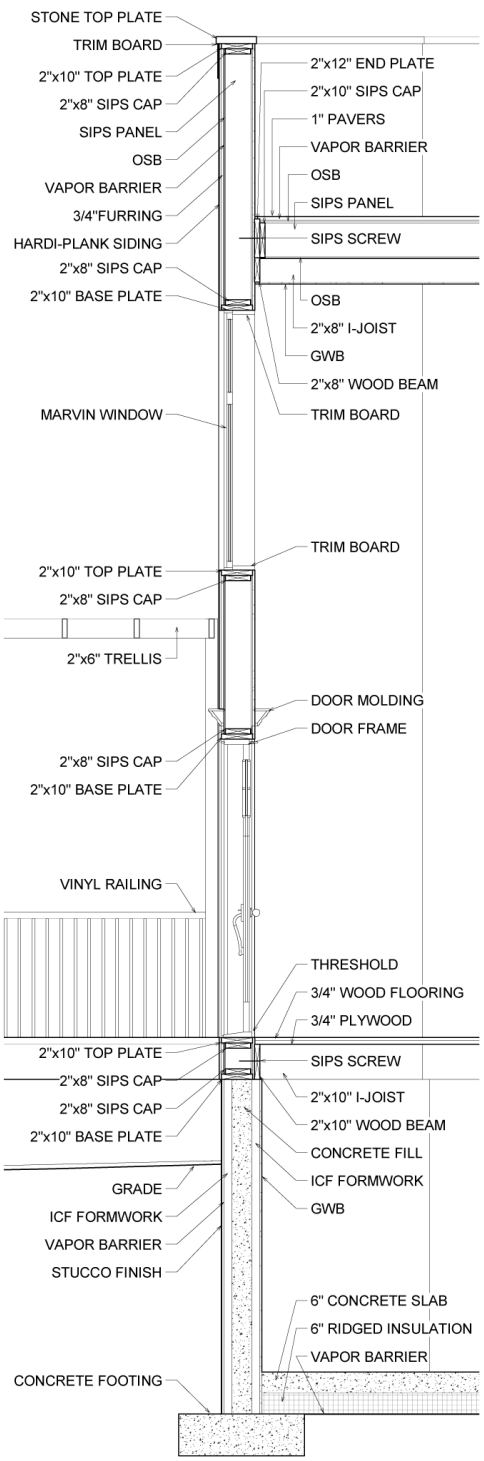
Unit 2 Plumbing

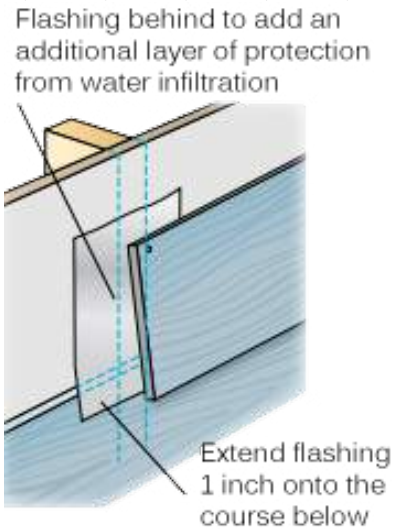
Rainwater Harvesting + Greywater System:





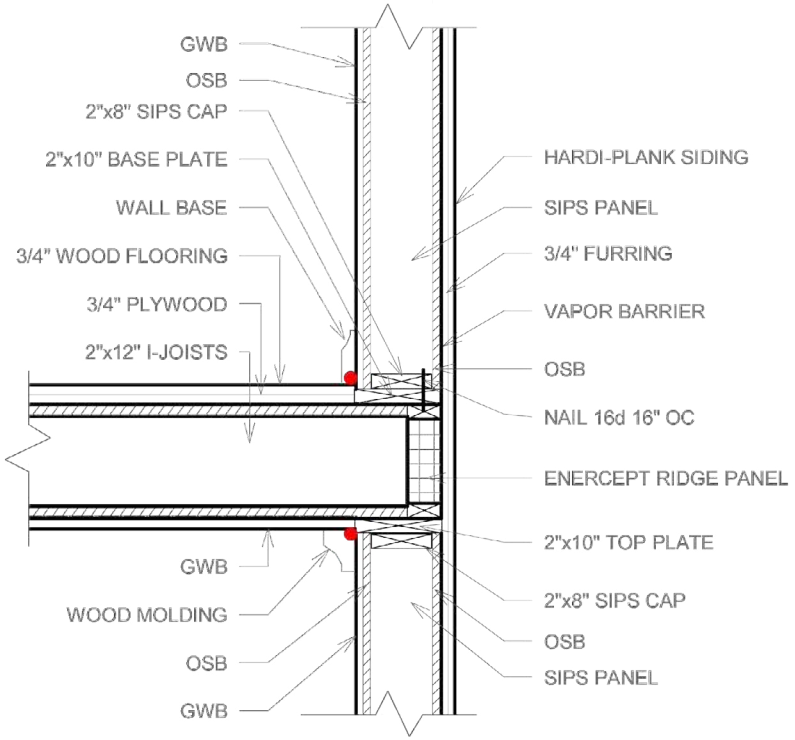




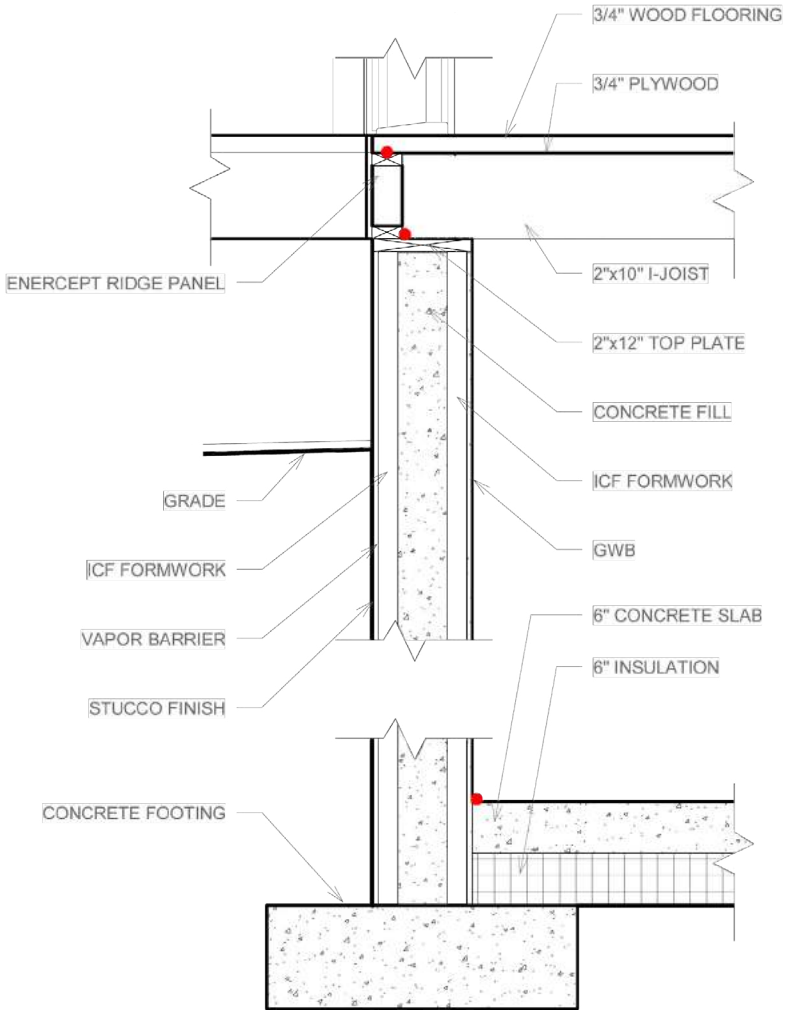


Installation of HardiPlank Siding. HardiPlank, 2013. Print.

Wall / Floor Detail:



Foundation Wall / Floor Detail:

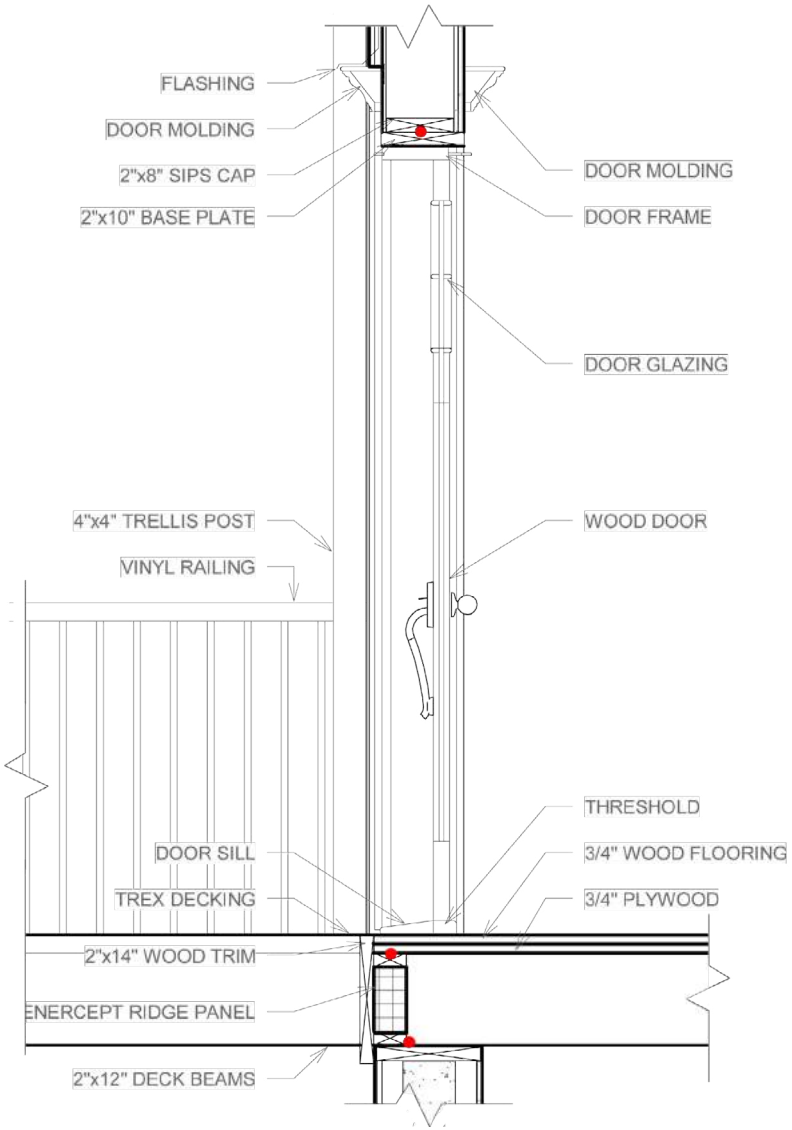


PV Racking Assembly:

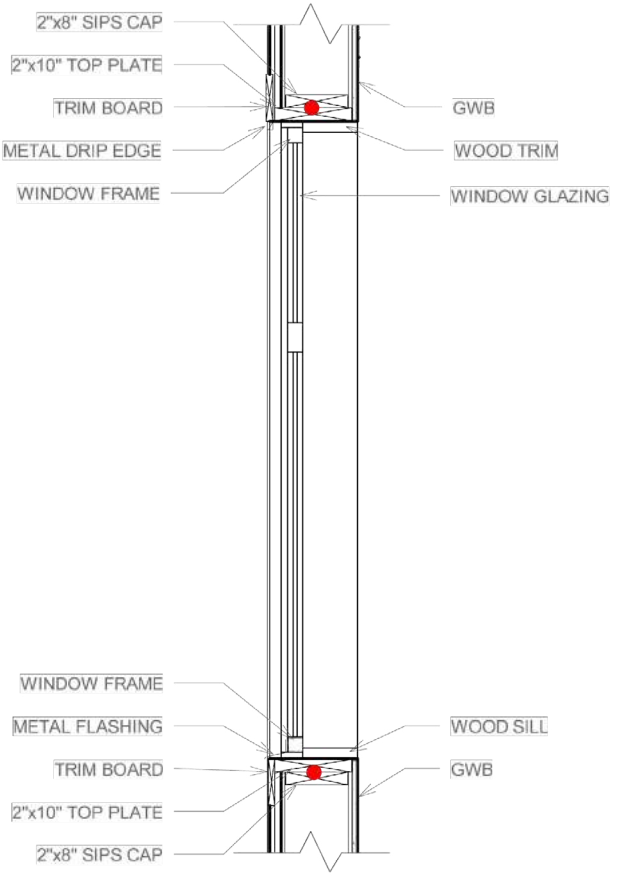
1. EF-44R-SS-NDD
2. XHD: #15 Self Drilling Fastener
3. EFL-44RNDD-1214-BLK Flashing
4. EPDM Sealing Washer
5. L-102-3 Compression Bracket
6. 3/8” Bonded Washer
7. 3/8” Flange Nut

ECO-44R-NDD Product Guide.
EcoFasten Solar, 2014. Print.

Door Detail:

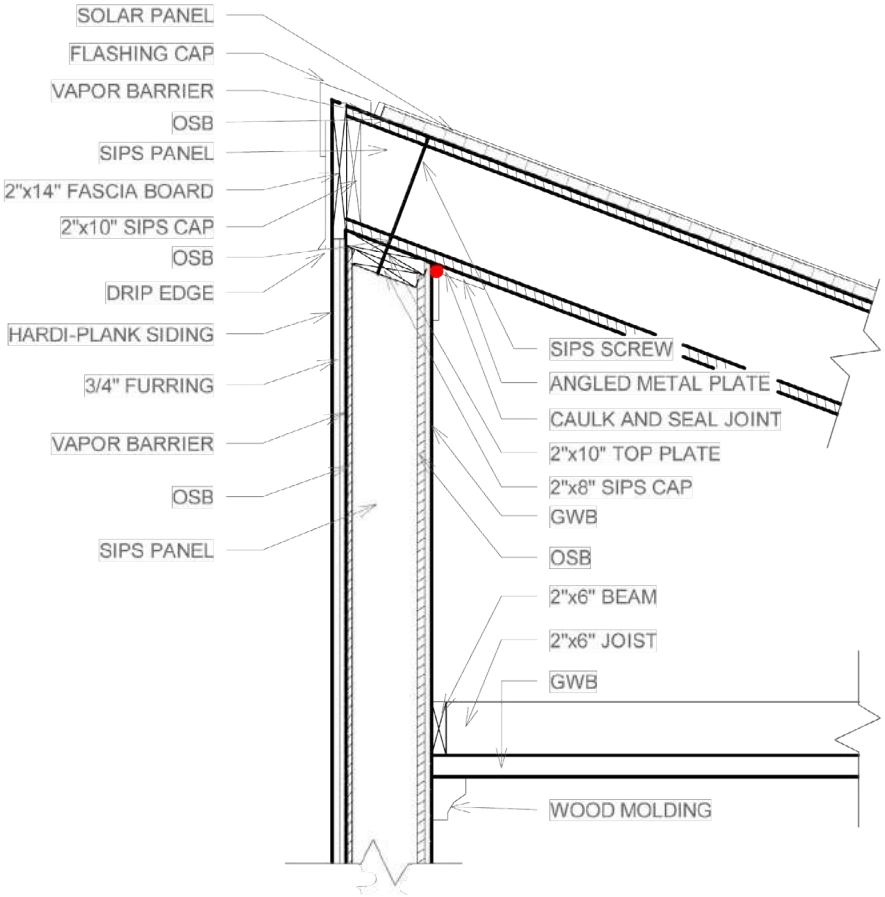


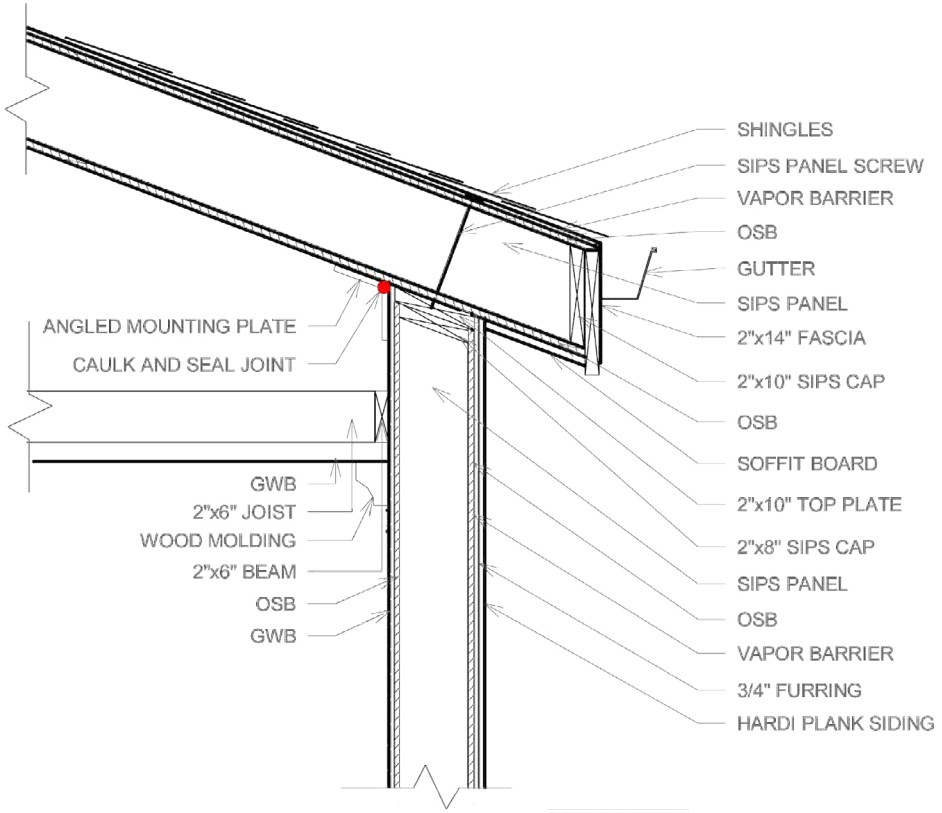
Window Detail:

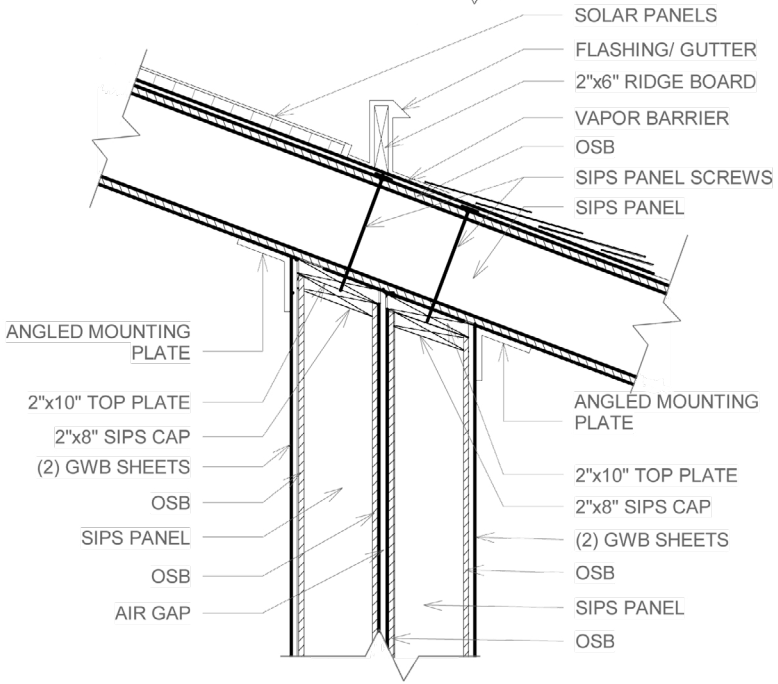


Roof Details:

- The party wall is an integral structural, thermal and fire resistant element
- The air gap within the party wall aids in the reduction of noise and the spread of fire between the units

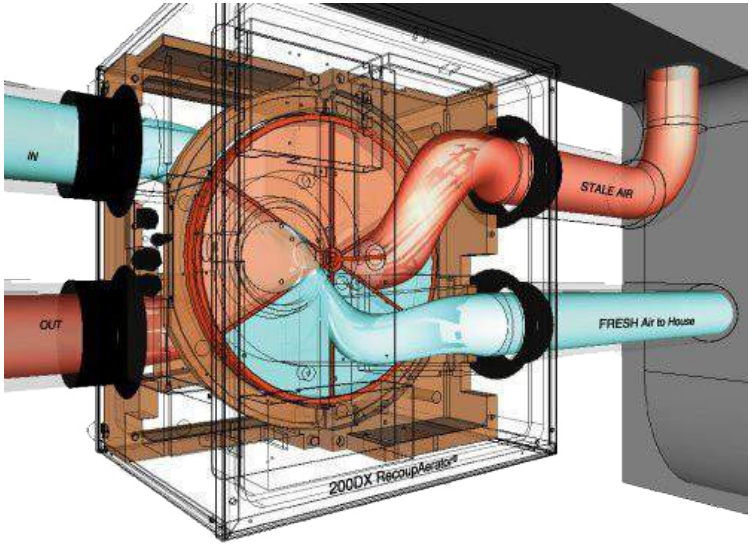




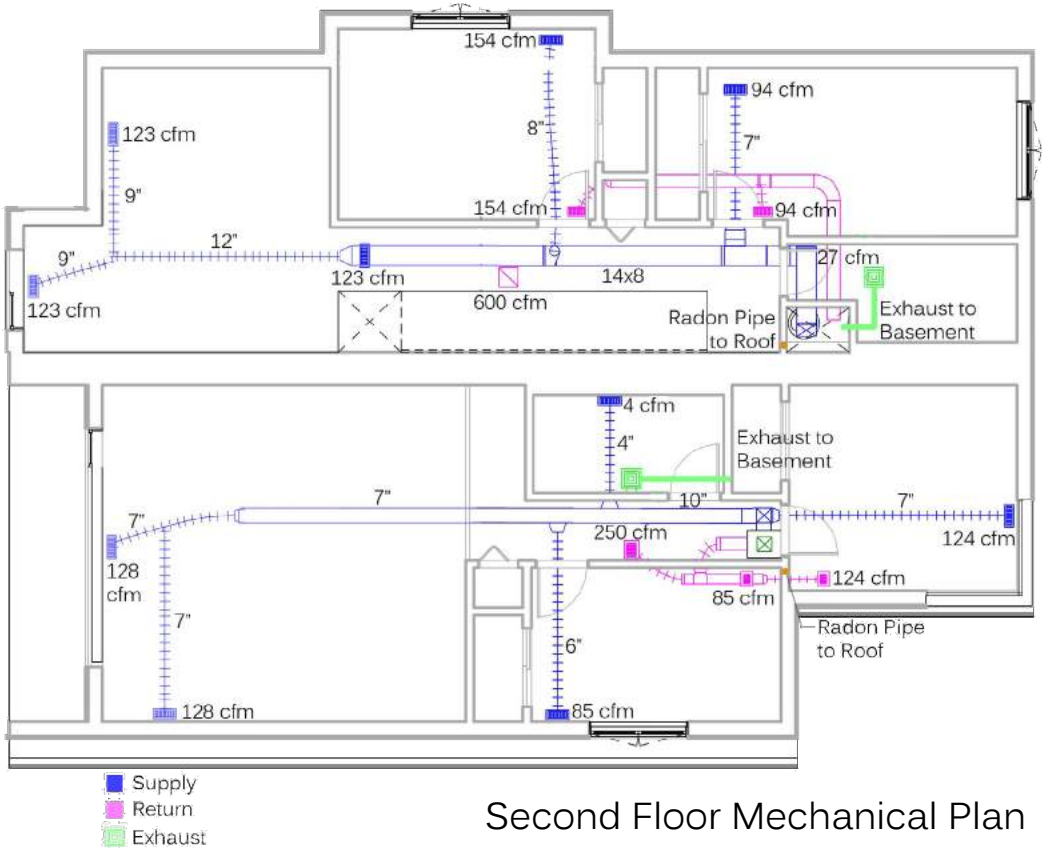


Systems:

- ReCoupAerator 200DX ERV System
- Mitsubishi Ductless System



ERV. Digital image. Ultimate Air: Energy Efficient Ventilation. Web. <www.ultimateair.com>.



Second Floor Mechanical Plan

Appliances:

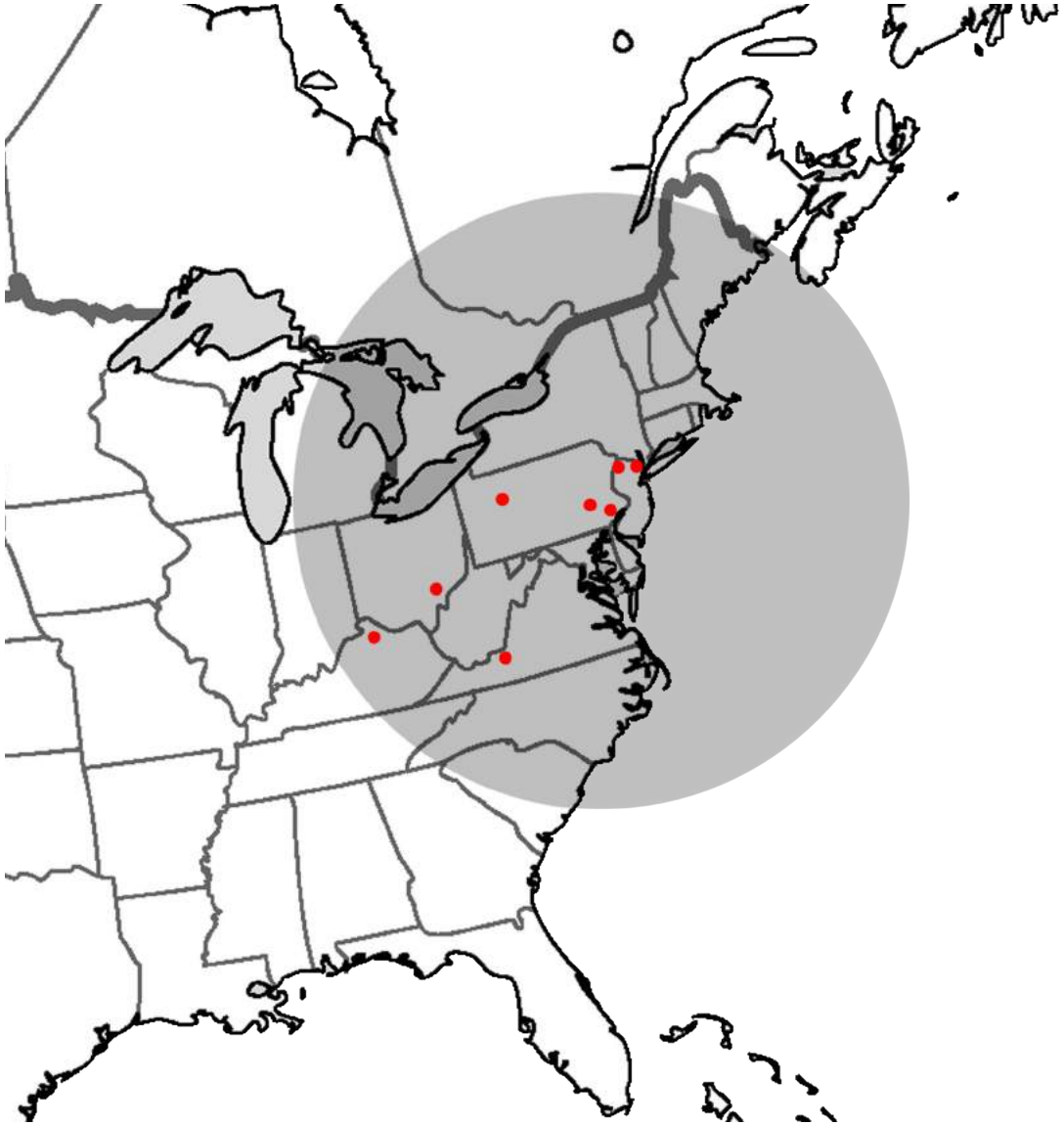
- Frigidaire Top Mounted Refrigerator

- LG Studio Series Dishwasher

- Frigidaire Induction Electric Range with Self-Cleaning Convection Oven

- Glacier Bay 2-piece Single Flush Round Toilet

Materials Source Mapping:



Comparison of Design Parameters:

	Brewerytown Rowhouse	Make it Right Foundation	Phila. Habitat for Humanity	Unit 1 Developer Rate	Unit 2 Developer Rate	Unit 1 Habitat Rate	Unit 2 Habitat Rate
Dwelling Sq. Ft.:	1252	1400	1070	1414	1060	1414	1060
Bed/Bath:	2 Bed/1.5 Bath	3 Bed/2 Bath	3 Bed/ 1.5 Bath	3 Bed/2.5 Bath	3 Bed/2 Bath	3 Bed/2.5 Bath	3 Bed/2 Bath
Construction Price:	$209,055	$140,000	$112,000	$199,844	$189,039	$140,891	$141,430
Sale Price:	$298,650	$200,000	$160,000	$281,947	$277,251	$187,027	$195,617
Price after Incentives:	$298,650	$200,000	$160,000	$250,341	$246,334	$168,763	$175,321
Monthly Morgage Price w/ Utilities & PV:	$1,154	$773	$618	$970	$952	$654	$678
Standards + Programs:	None	LEED, Earthcraft, Energy Star, Advanced Framing	Minimum LEED Silver, Energy Star, Advanced Framing, IAQ	Energy Ready, LEED Platinum, Energy Star, EPA, Water Sense	Energy Ready, LEED Platinum, Energy Star, EPA, Water Sense	Energy Ready, LEED Platinum, Energy Star, EPA, Water Sense	Energy Ready, LEED Platinum, Energy Star, EPA, Water Sense

- Meet or Exceed Baseline Standards of DOE NZRH, IECC 2009, and Philadelphia Habitat for Humanity Criteria
- High Performance Exterior Envelope
- Achieved Direct Natural Daylight Values of 70% at 9am and 60% at 3pm Versus a Typical Philadelphia Rowhome with an Average of 30%
- HERS Score w/o PV: Unit 1 = 36 and Unit 2 = 39, HERS Score w/ PV: Unit 1 = -2 and Unit 2 = -2
- Total Cost Built at a Habitat for Humanity Rate is 36% Less Than Our Home Built at a Developer Rate