The Fly Flat

Team Mod Squad
Prairie View A&M University

The Fly Flat

Team Mod Squad
Prairie View A&M University

Environmental Conditions

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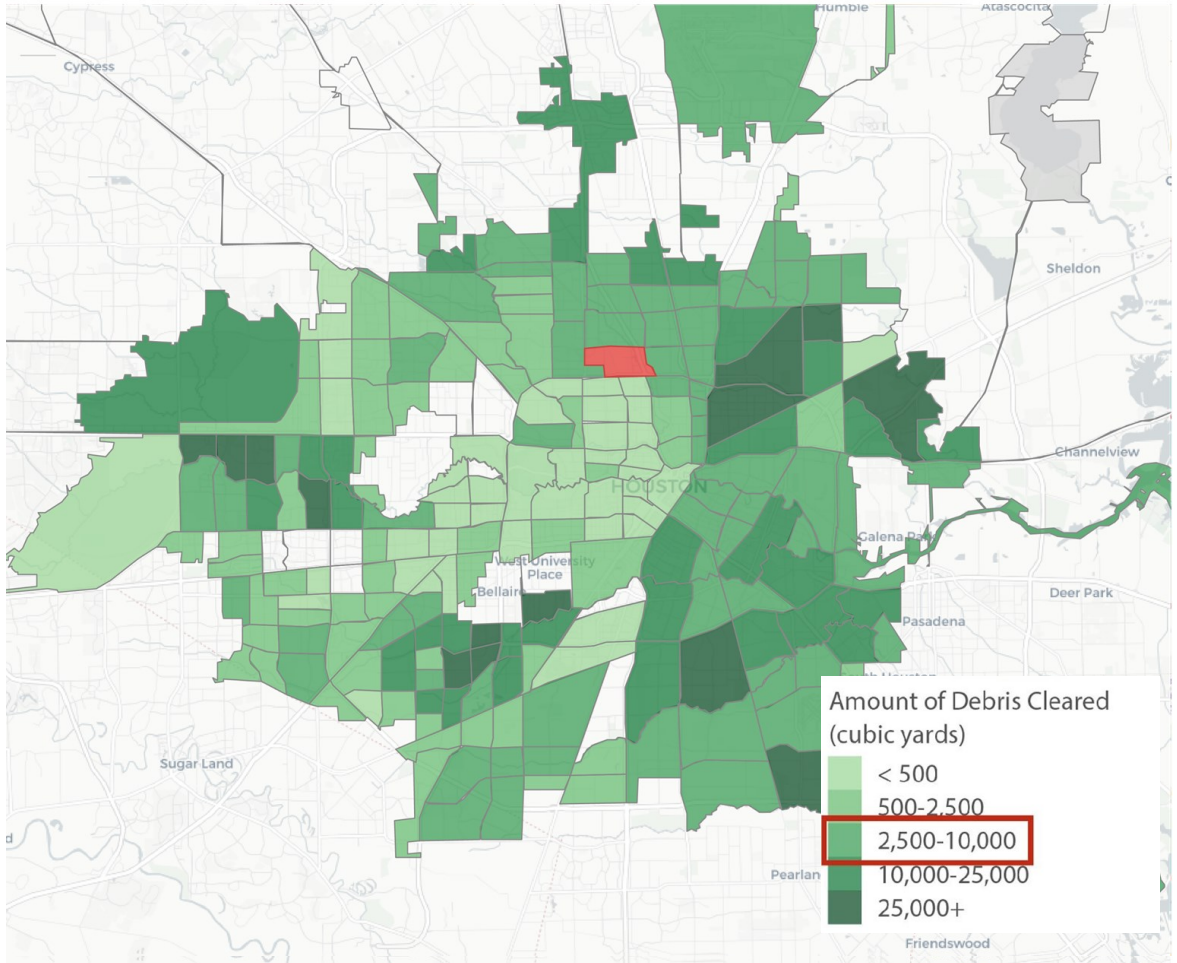
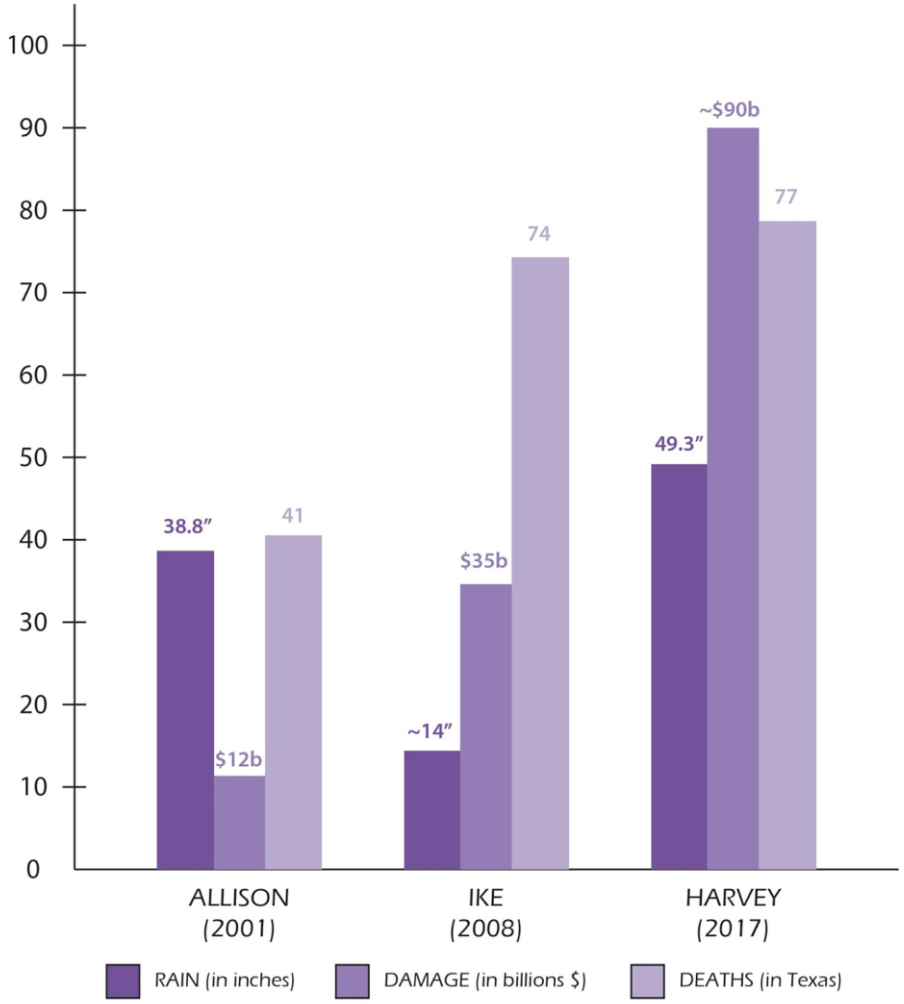
Debris Removal

Total debris collected by the City of Houston and contractors:





Environmental Conditions

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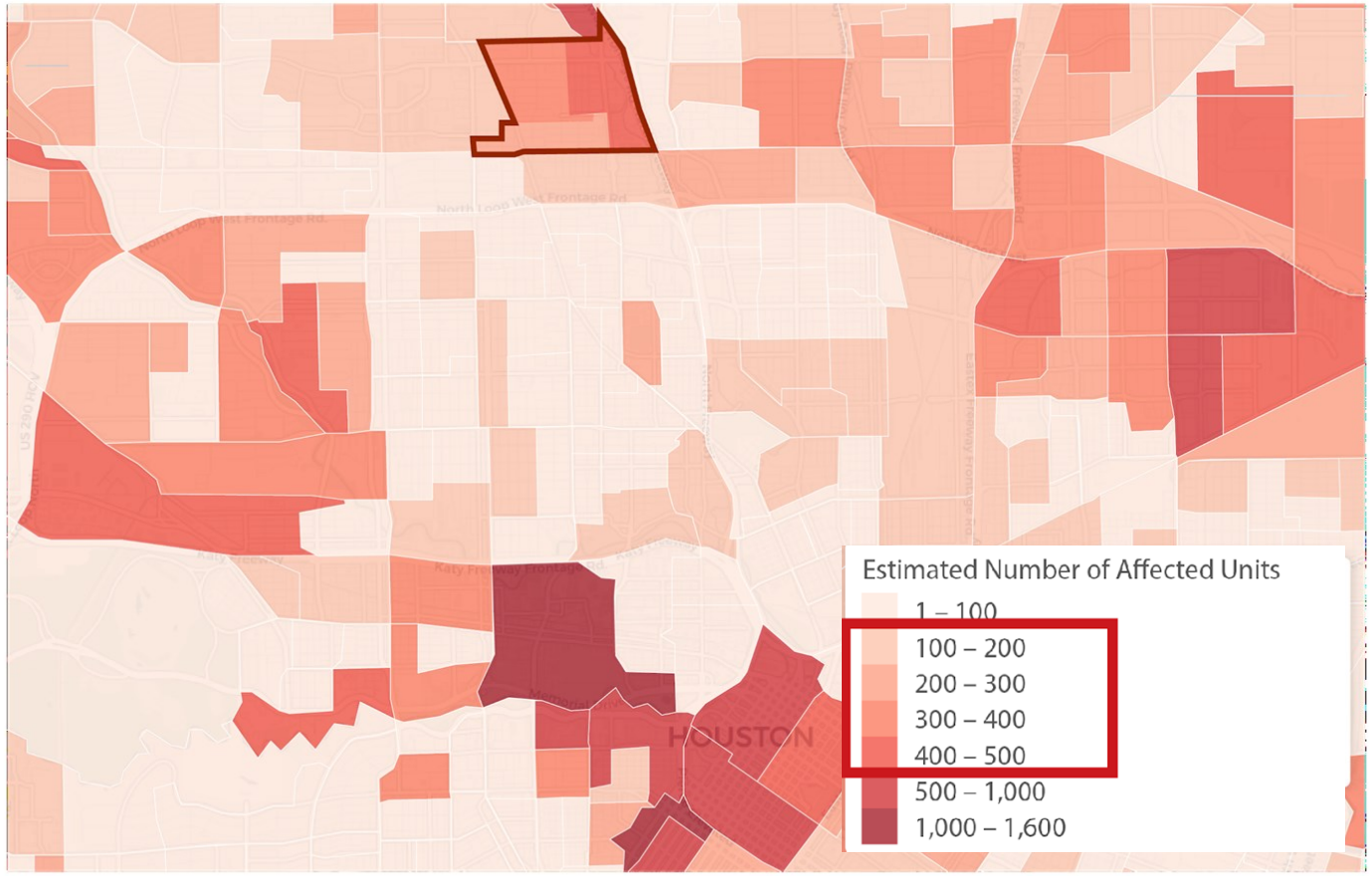
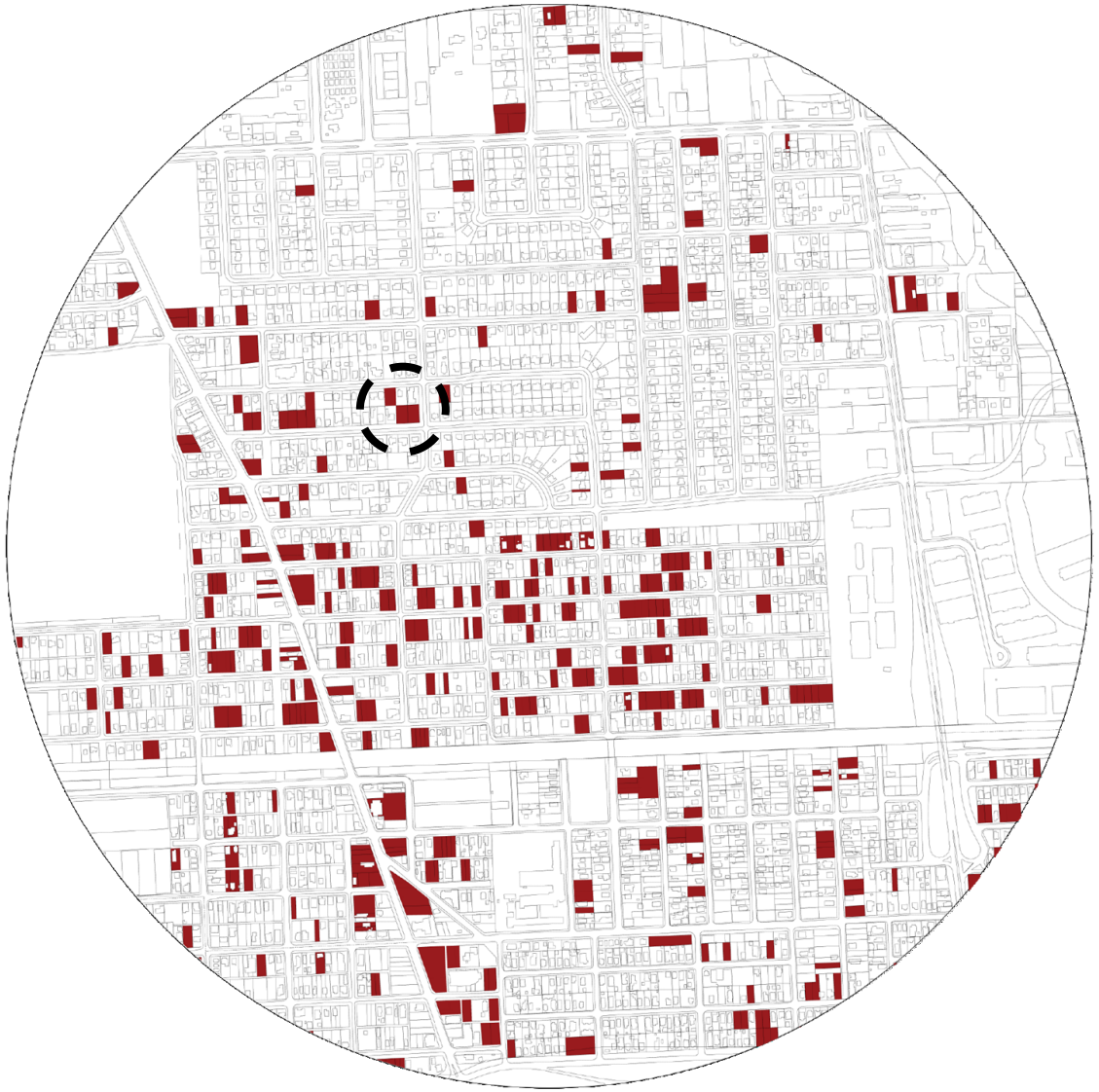
Damage

City of Houston assessments and FEMA damage estimates of structures with damage:



Photos courtesy of
Living Paradigm CDC

Economic Conditions



Social Conditions

Community Engagement

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%

Potential Residents

Resilience Goals

Economic Resilience

Social Resilience

Environmental Resilience

Economic

- Affordability
- Ownership
- Address vacancy
- Economically healthy neighborhood

Environmental

- Address flooding
- Surviving hurricanes and flooding events with minimal damage
- Man/Nature Connection
- Health
- Net zero residence

Social

Resilience Methods

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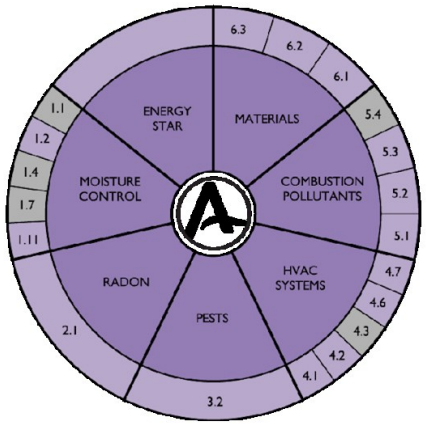
Economic Resilience

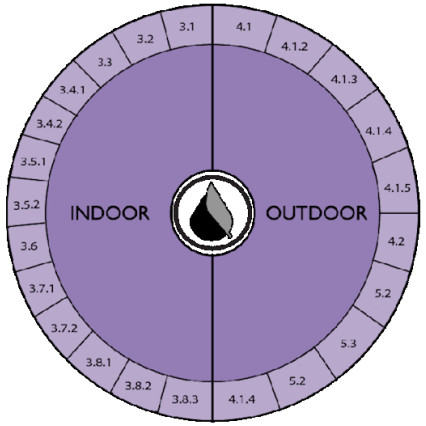
Social Resilience

Environmental Resilience

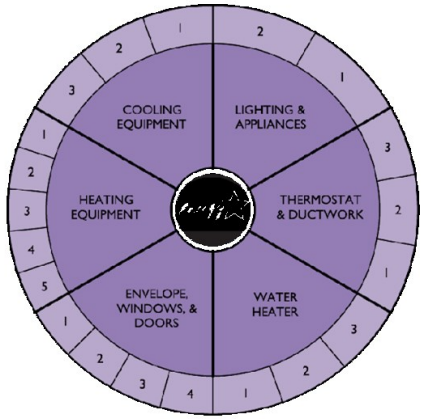
INDOOR airPLUS



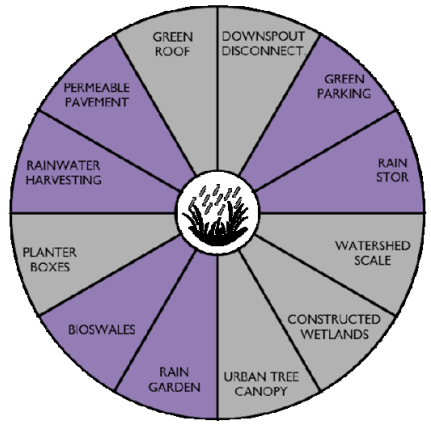
WATERSENSE



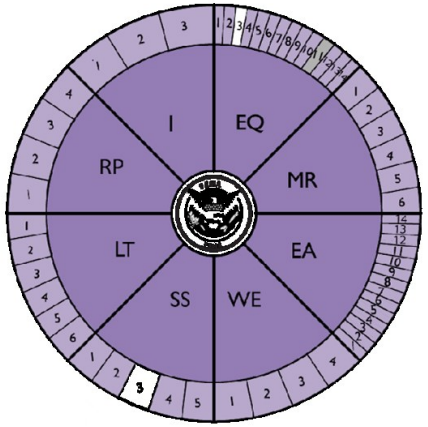
ENERGY STAR



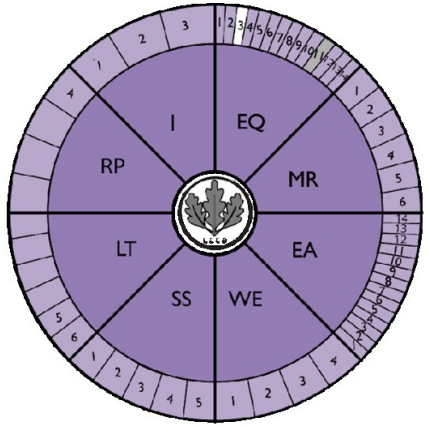
LOW IMPACT DEVELOPMENT



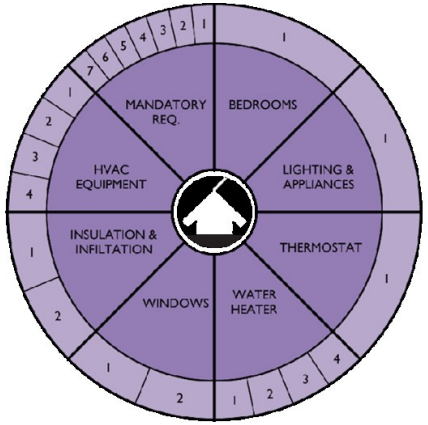
FEMA 499



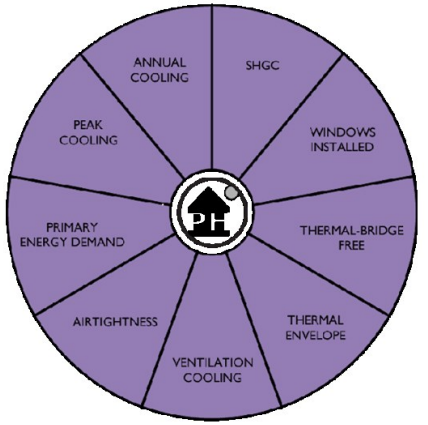
LEED FOR HOMES



ZERO ENERGY READY HOME



PASSIVE HOUSE



CATEGORIES NOT APPLIED

CATEGORIES MET

SUB-CATEGORIES: MET

SUB-CATEGORIES: NOT MET

Team & Industry Partners

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Prairie View A&M University

Economic Resilience

Social Resilience

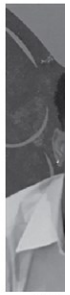
Environmental Resilience

Kristen Clark
B.S Mechanical Engineering

Aaron Farray
B.S Architecture

Kennia Yajaira Lopez
B.S Architecture

Shannen L. Martin
B.S Architecture



Nc
B.S

Cynthia Suarez-Harris
B.S Architecture
B.S Construction Sci.

Shelby Skinner
B.S Architecture

Ledell Thomas
B.S Architecture
B.S. Construction Sci.

Kaylah Wesley
B.S Architecture

architend

unity homes

positive energy

LIVING PARADIGM
Community Development Corporation

tend building

vermod

Integrated PSL Solutions

Architecture | Constructability | Financial | Energy & Envelope | MEP & IAQ | Innovation

Modules: Fab Lab Built

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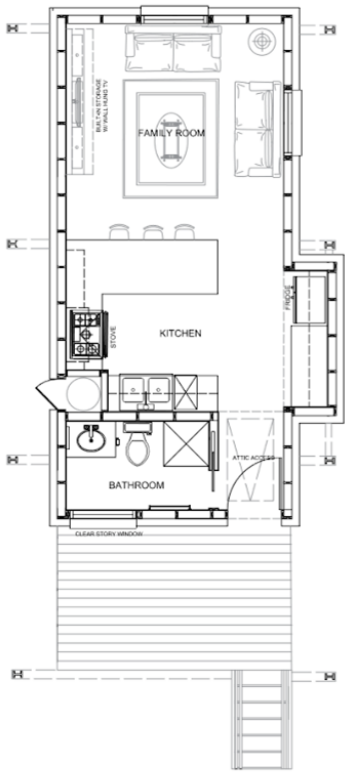
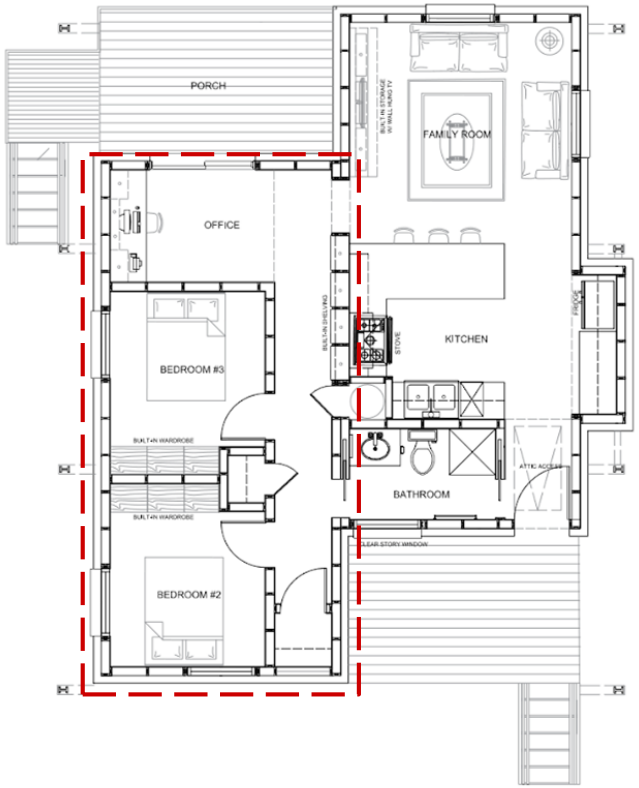
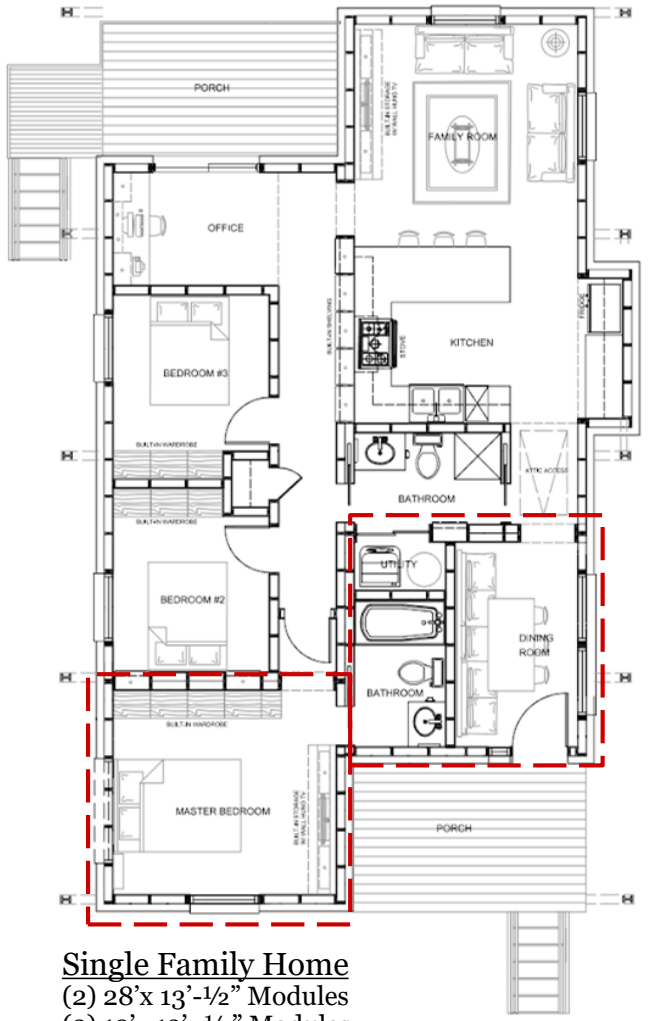


Single Person Home
(1) 28' x 13'- ½" Module
364 sqft.



Elderly Couple Home
(2) 28'x 13'-½" Modules
728 sqft.



Single Family Home
(2) 28'x 13'-½" Modules
(2) 12'x 13'- ½" Modules
1,040 sqft.

Fly Roof: Site Built

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Prairie View A&M University

Economic Resilience

Social Resilience

Environmental Resilience

2030 PALETTE

Architecture | Constructability | Financial | Energy & Envelope | MEP & IAQ | Innovation

Site Design

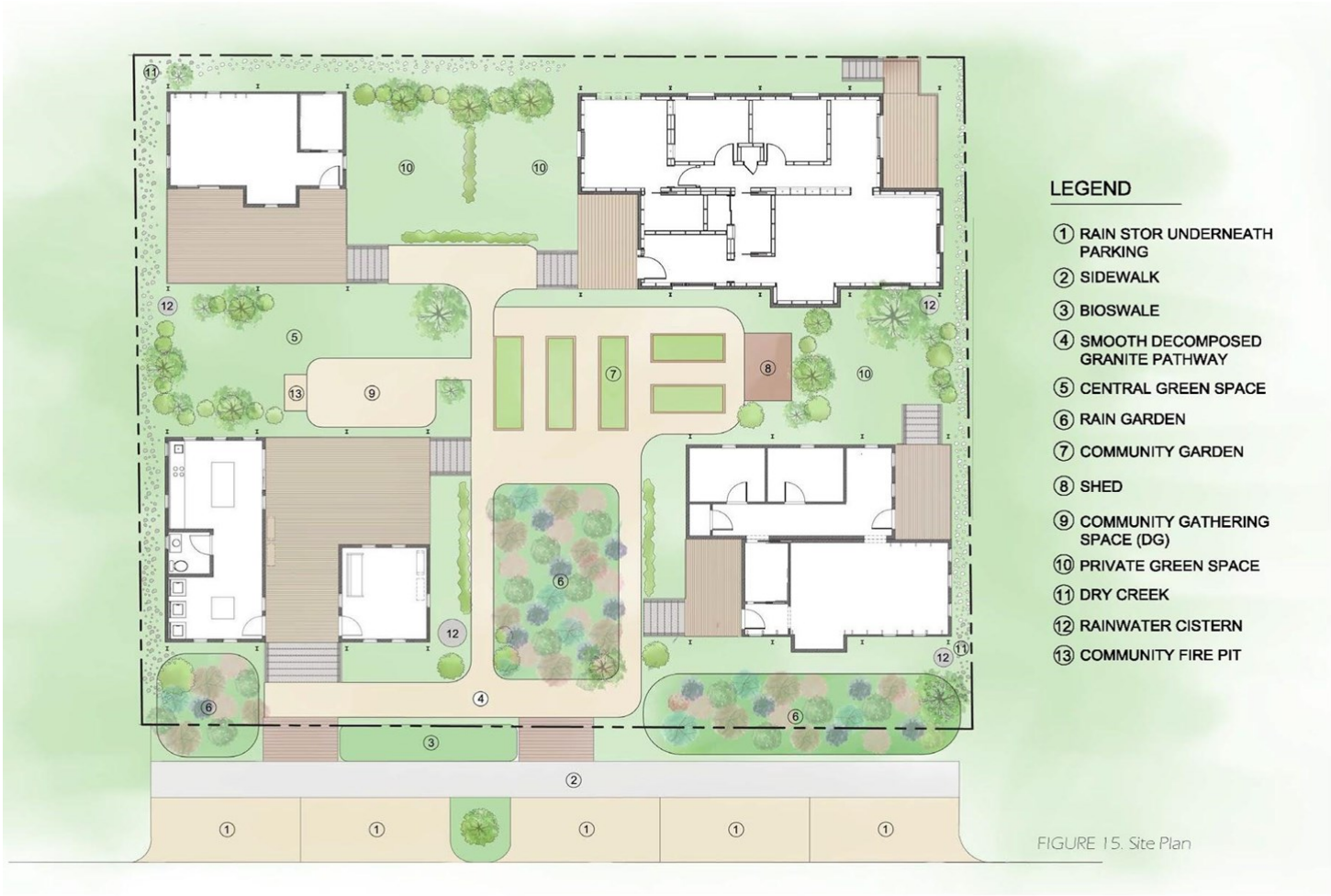

FIGURE 15. Site Plan

Exterior Design

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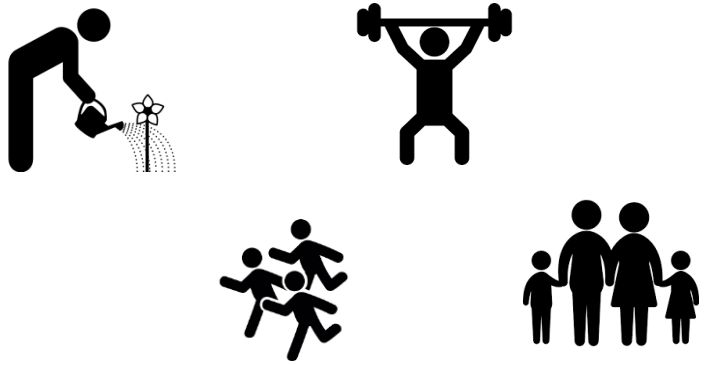
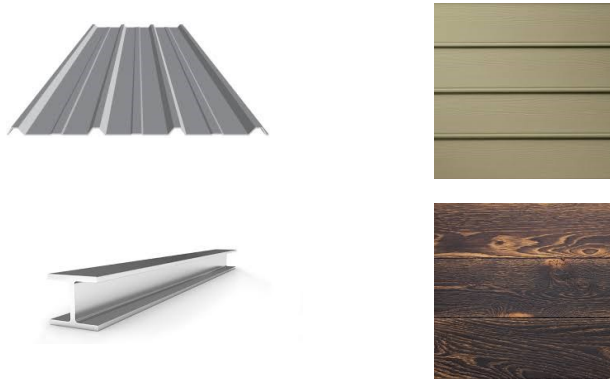
Safe, Interactive Community Spaces



Several Material Options



Interior Design

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Economic Resilience

Social Resilience

Environmental Resilience

Interior Design

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Prairie View A&M University

Interior Design

Cross Ventilation

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Prairie View A&M University

Interior Design

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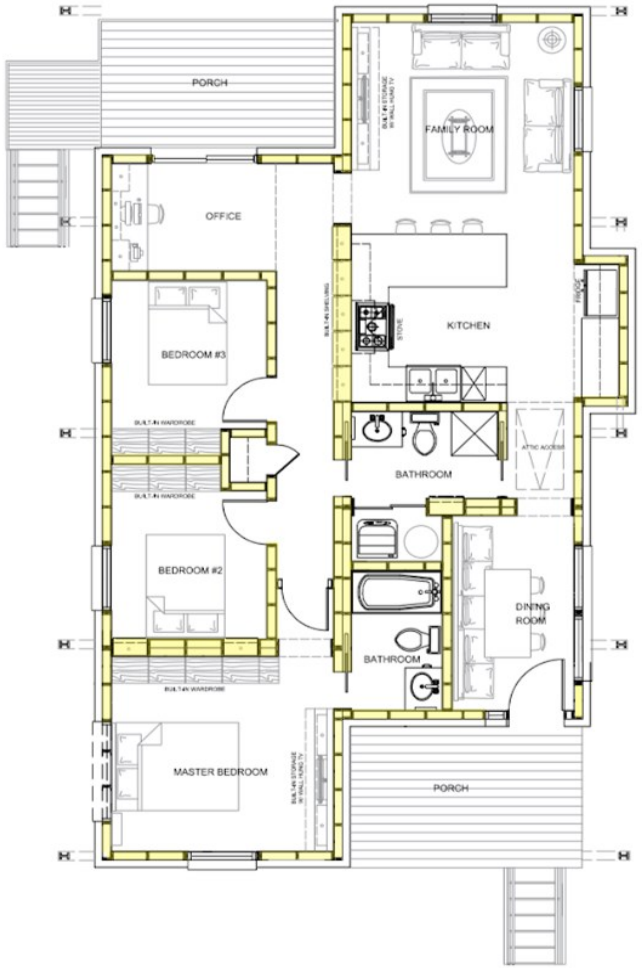
Prairie View A&M University



Open Wall Cavities Benefits

- Gain 128 square feet of storage space
- Built-in furniture optimizes storage space
- Elimination of cavity insulation and drywall offset cost of continuous insulation to improve thermal performance

White Wash Finish

Natural Wood Finish

Modular Research

Unity Homes

Panelized System

Vermod

Factory Built

Design Your Fly Flat

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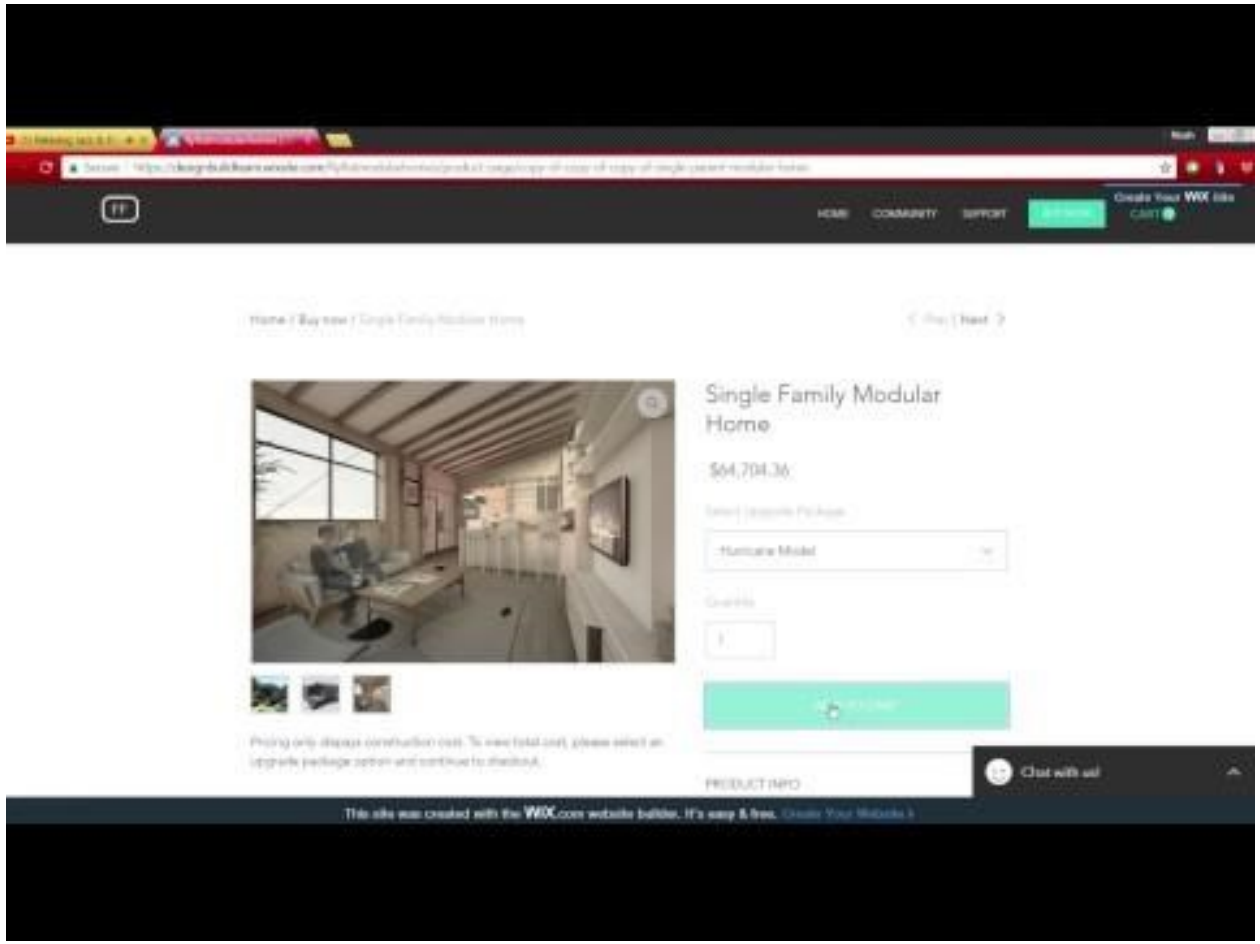
Economic Resilience

Social Resilience

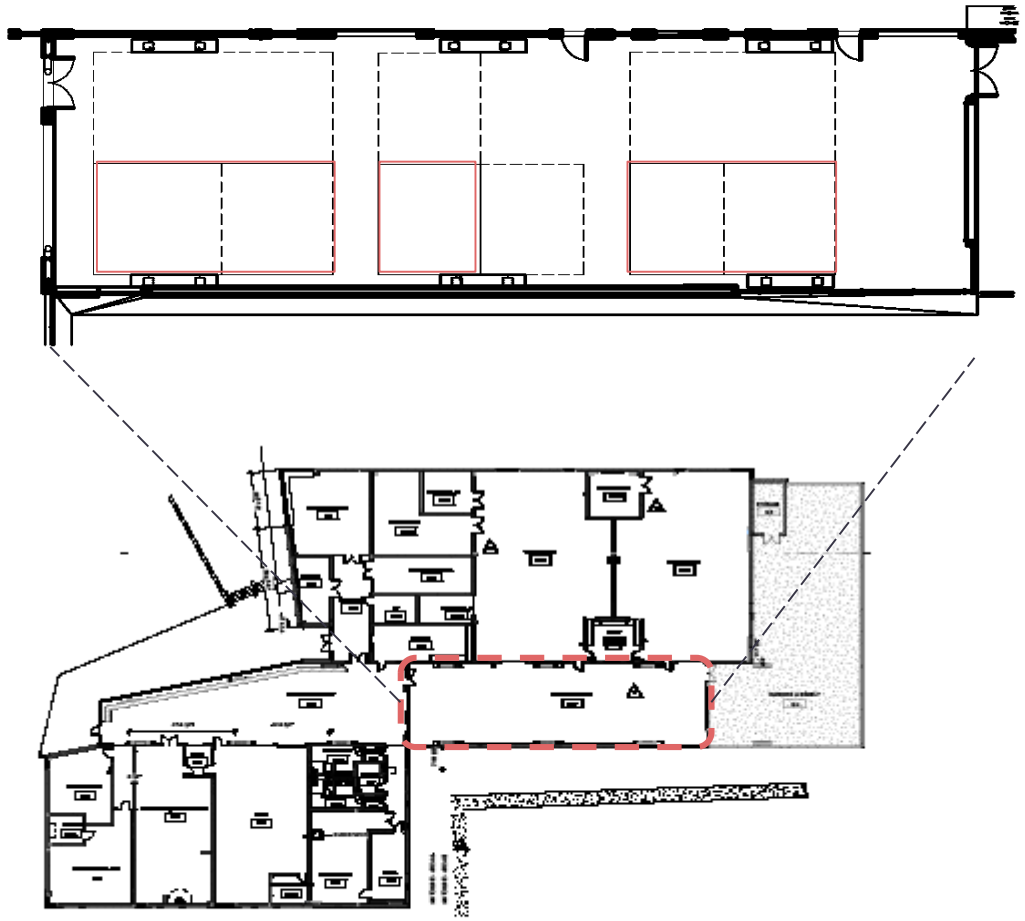
Environmental Resilience

Owner customizes modules & packages along with built-in furnishings.

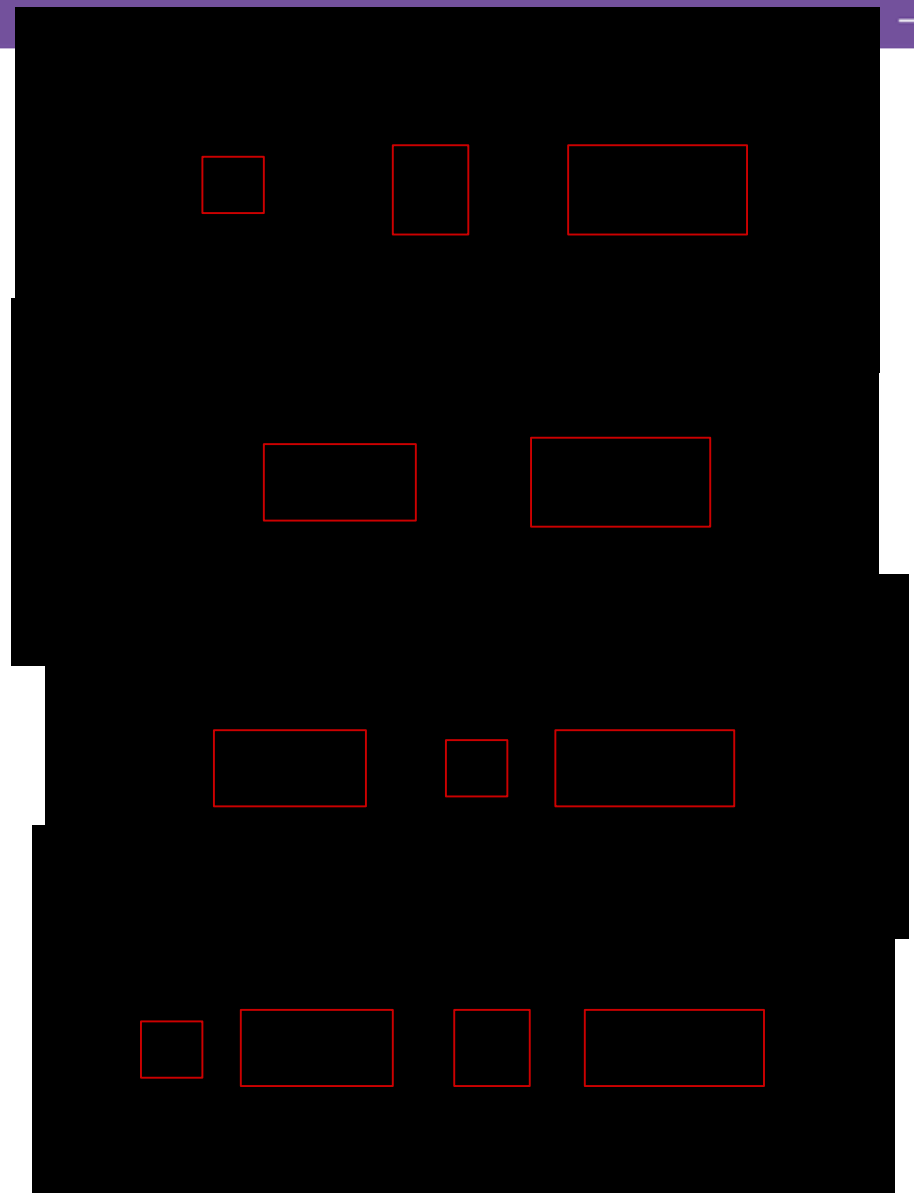


http://www.designbuildteam.wixwebsite/flyflatmodularhomes

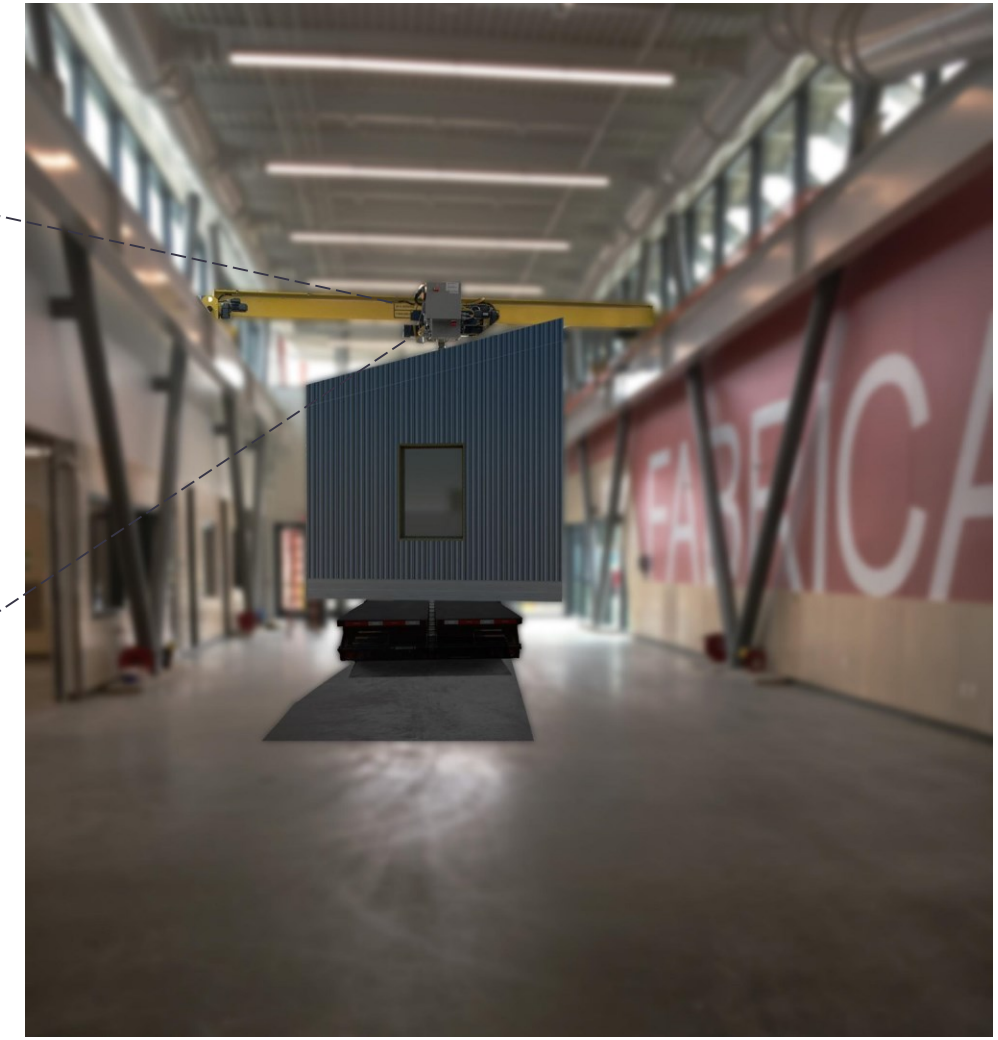
Fabrication



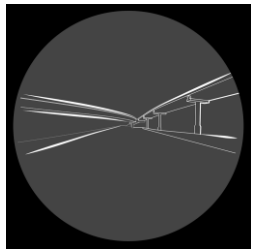
Prairie View A&M University Fabrication Center



Delivery

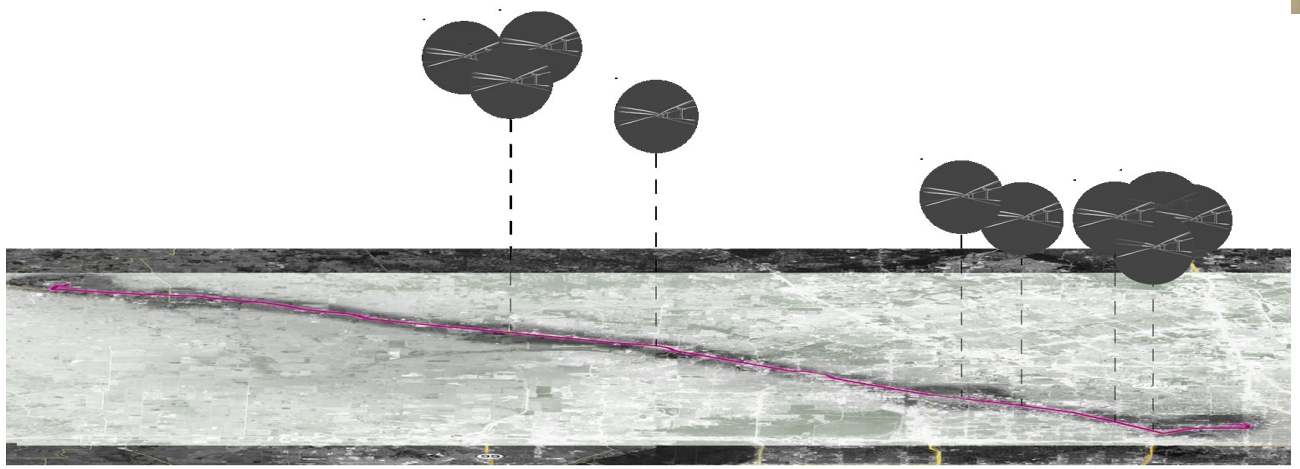


Delivery



Highway overpass min. 17’-00”

North Fwy & Crosstimbers St.
Overpass min. 16’-8”



Transport from Prairie View A&M University to Independence Heights neighborhood (fly flat modular home site)

Installation

Modularity

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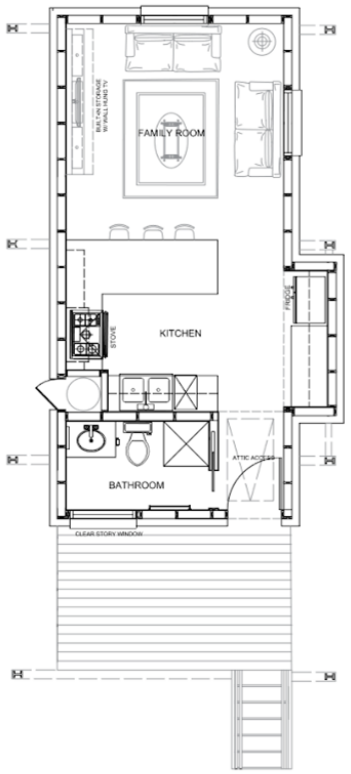
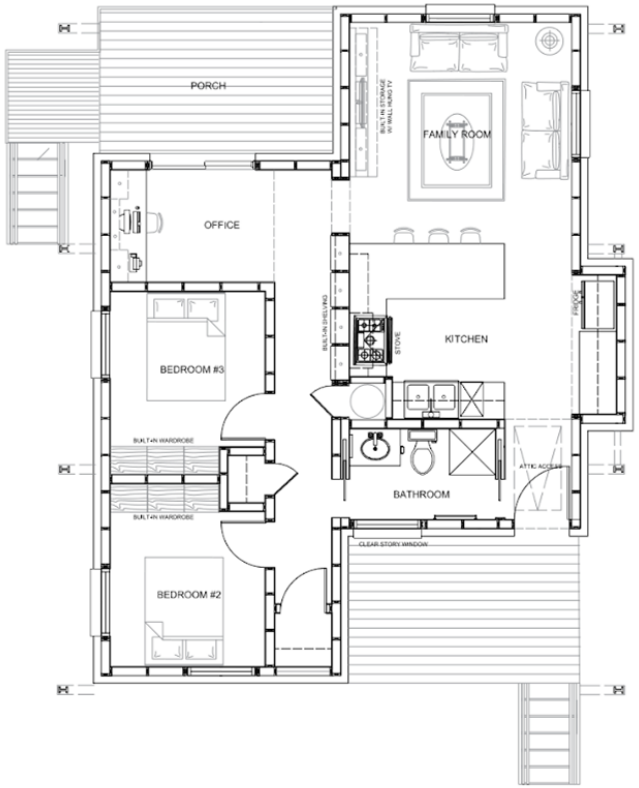
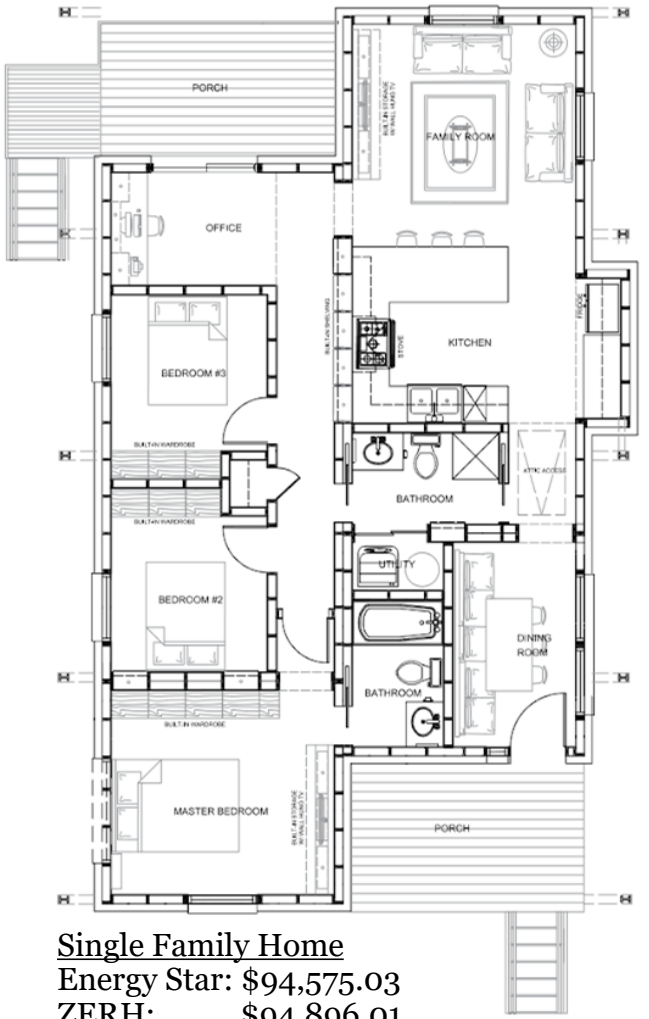


Single Person Home
Energy Star: $57,554.34
ZERH: $57,667.86
PH: $64,704.36



Elderly Couple Home
Energy Star: $74,741.81
ZERH: $74,959.06
PH: $88,306.24



Single Family Home
Energy Star: $94,575.03
ZERH: $94,896.01
PH: $115,837.21

Packages

ENERGY STAR

- Base package

$57,554.34
$74,741.81
$94,575.03

ZERO ENERGY READY HOME

- Upgraded Insulation

$57,667.86
$74,959.06
$94,896.01

PASSIVE HOUSE

- Upgraded Insulation
- Upgraded Windows
- Energy Recovery Ventilation

$64,704.36
$88,306.24
$115,837.21

HURRICANE

- Upgraded Sheathing
- Upgraded Floor Framing
- Impact Resistant Windows

$65,871.49
$89,944.81
$118,642.74

Land & Infrastructure

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Economic Resilience

Social Resilience

Environmental Resilience

Ownership

Land

- Land Trust

Or

- Privately Owned

This Scenario:
Land Trust

Fly Roof

- Land Trust

Or

- Privately Owned

This Scenario:
Optional

Solar

- Solar Co-op Utility

Or

- Privately Owned
  - PPA
  - Mortgage

This Scenario:
Optional

Affordability Scenarios

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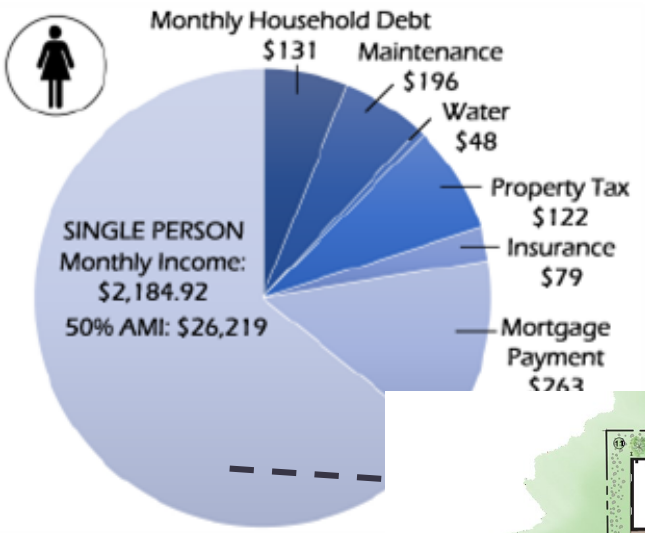

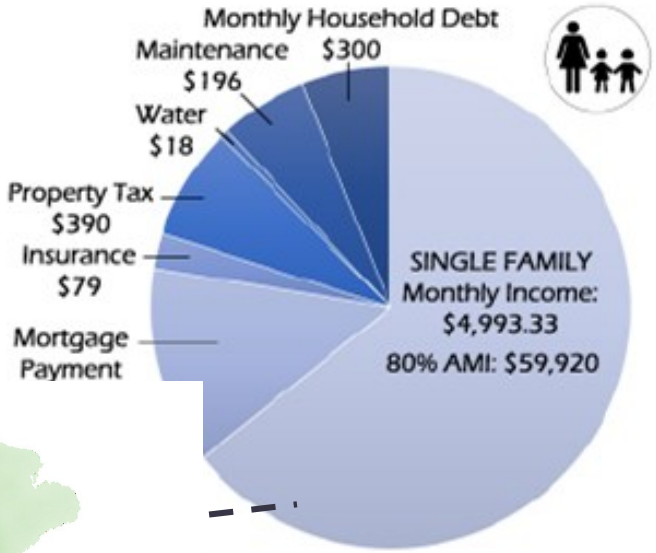

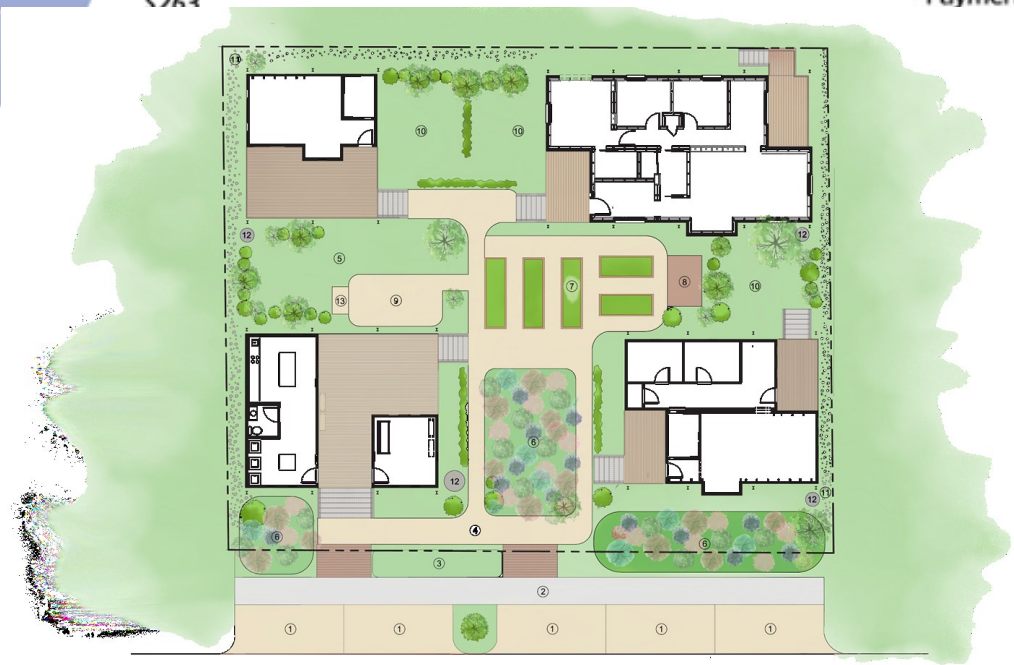

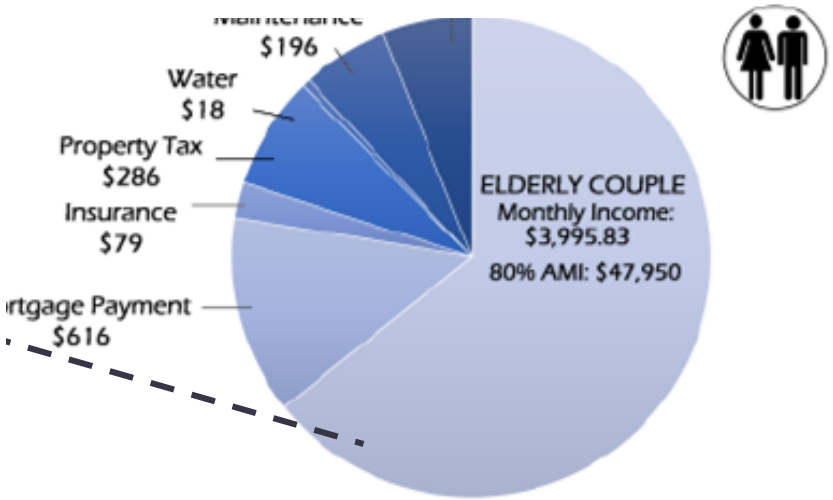

Economic Resilience

Social Resilience

Environmental Resilience

Community Impact

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Economic Resilience

Social Resilience

Environmental Resilience

Vacant lots in the studied area: 768 Lots

1,536 additional homes

Lara lots in the studied area: 11 Lots

22 additional homes

Approximately 5 homes can be powered per fly roof

7,680 Homes powered by fly roofs

Conceptual Design: Sefaira

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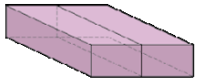
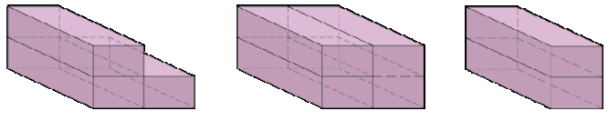
- Connecting modules (side by side) will decrease the EUI.

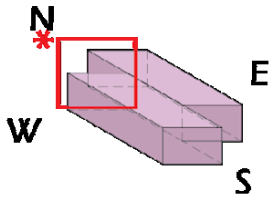


- Stacking modules will either decrease or have no effect on the EUI.



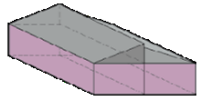
exception:
this raises EUI

- Shifting connected modules will increase the EUI.

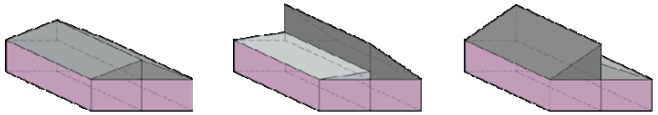


*Note:
amount of building exposed to the west may increase the EUI

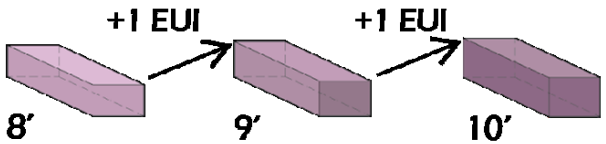
- Adding a pitched roof will increase the EUI by 1.



- The roof pitch (2:12 - 9:12) has no effect on the EUI



- Increasing the wall height will increase the EUI.



Conceptual Design: Sefaira

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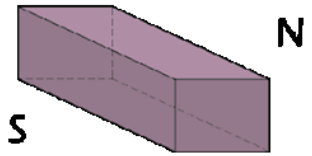
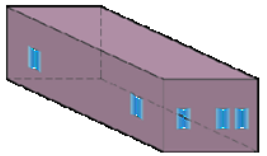
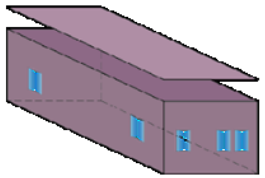
The following conclusions were drawn from energy modeling a double roof system:



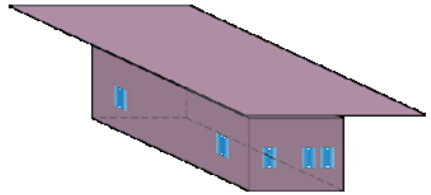
Module w/o windows
EUI: 23



Module w/ windows
EUI:25

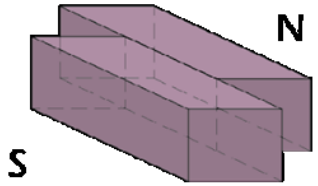


Simple double roof
EUI: 24

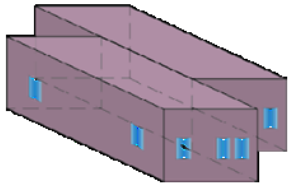


Double roof extended beyond the building line
EUI: 24

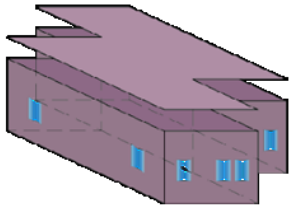
Simulation of floor plan option 1



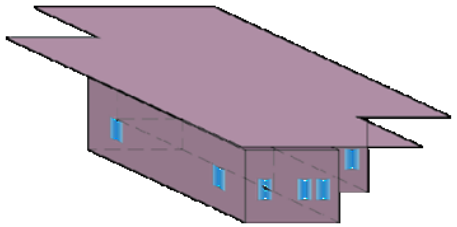
EUI: 21



EUI:22



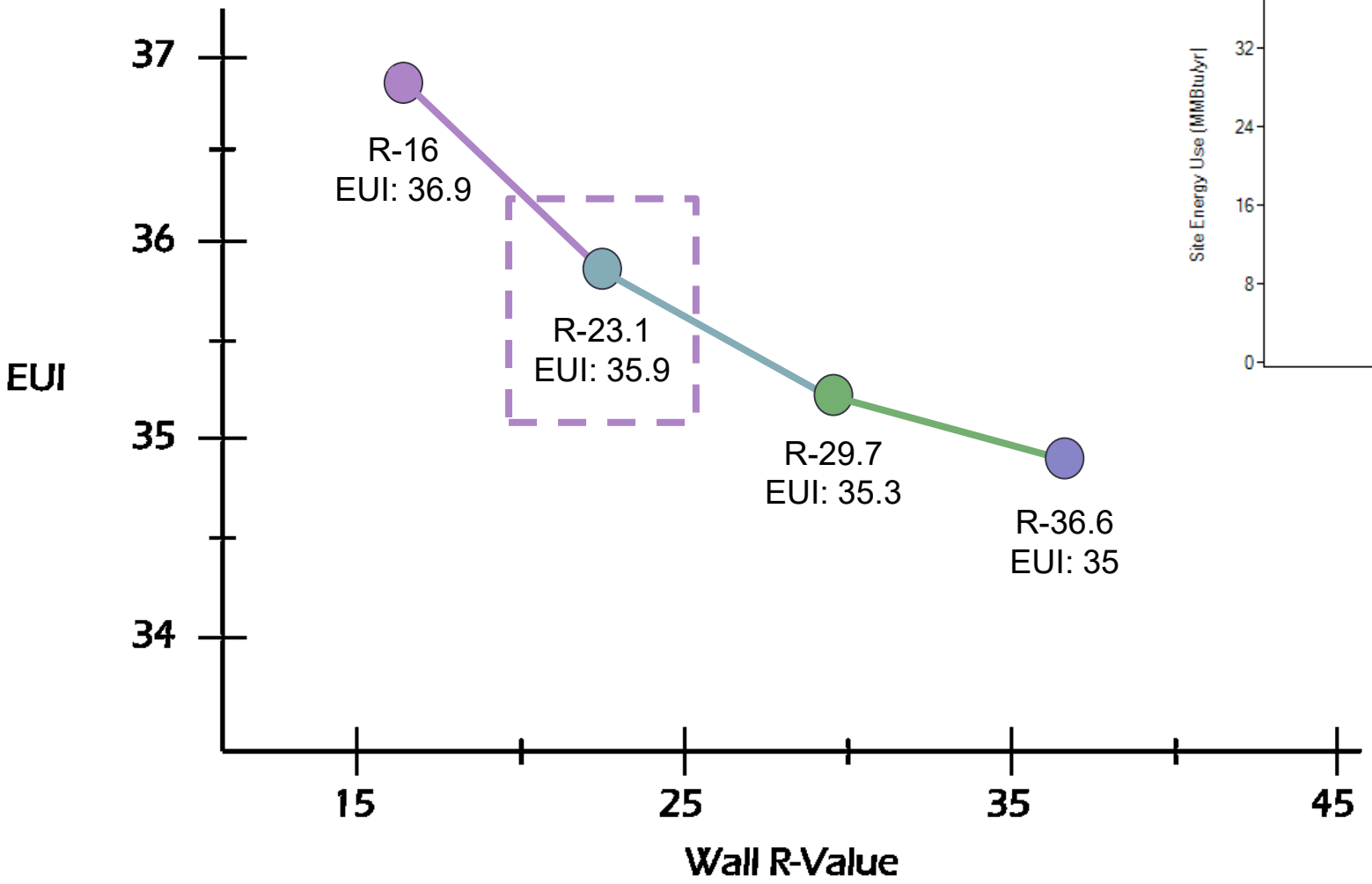
EUI: 22

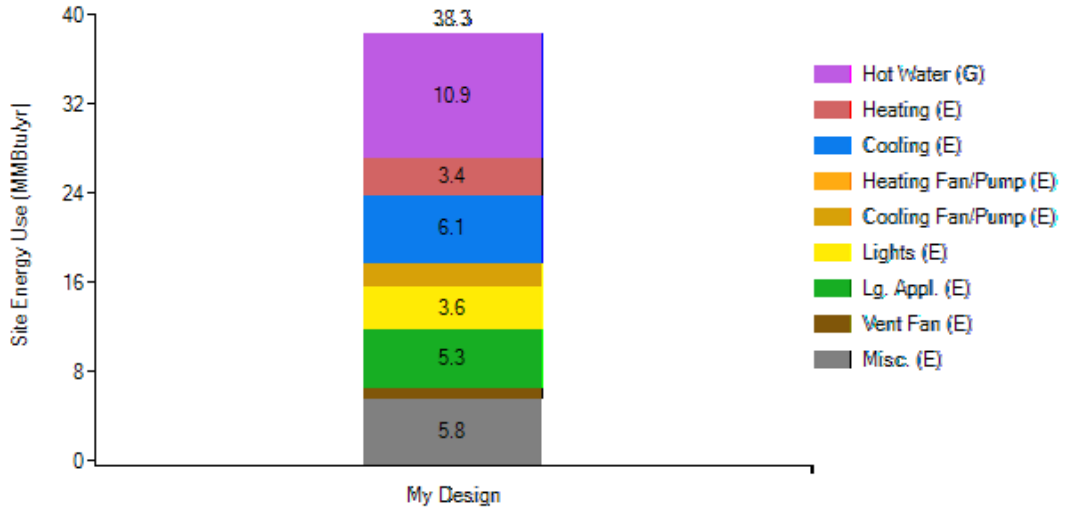


EUI: 22

We do not trust these results from Sefaira and will therefore test this hypothesis in other energy modeling software before making a final decision.

Schematic Design: BeOpt





Wall: R-23.1 – EUI: 35.9

Design Development: Fly Roof Verification

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PART 1

T_{RS} = Roof surface temperature

T_O = Avg. daily temperature (daylight hours)

GR= Global Radiation

SA= Solar absorbed opposite of solar reflectivity (from manufacturer)

RSE_i = Inverse of Surface Resistance Coefficient

$$T_{RS} = T_O + \frac{GR * SA}{RSE}$$

PART 2

G_T = hours of sunshine/1000 * ΔT

ΔT_1 = Outdoor temp. - Indoor temp. = 8

ΔT_2 = Surface temp. - Indoor temp. = 29

G_{T1}

G_{T2}

PART 3

$Q_{T1} = A * U * G_{T1}$

$Q_{T2} = A * U * G_{T2}$

Q_{T1}/ sq. ft. of home= wufi EUI

Q_{T2}/ sq. ft. of home= manual EUI

$EUI_{T1} - EUI_{T2}$ = EUI Error

Analysis of Heat Transmission Through Main Roof (without Fly Roof)			
Calculation	Energy Star	ZERH	PHIUS+2018
WUFI-Passive	2,074.8 kBTU/yr	498.4 kBTU/yr	409.1 kBTU/yr
Manual Calculation: Heat Transmission Relative to Roof Temperature	4,756 kBTU/cooling season	3,714 kBTU/cooling season	3,054 kBTU/cooling season
Calculation: Heat ssion Relative to Air Temperature	1,309 kBTU/cooling season	1,021 kBTU/cooling season	841 kBTU/cooling season
Calculation Difference	3,447 kBTU/cooling season	2,693 kBTU/cooling season	2,213 kBTU/cooling season
lly Unaccounted for ssion in WUFI-Passive	2,681.2 kBTU/yr	3,215.6 kBTU/yr	2,644.9 kBTU/yr

Construction Documents: Performance Packages

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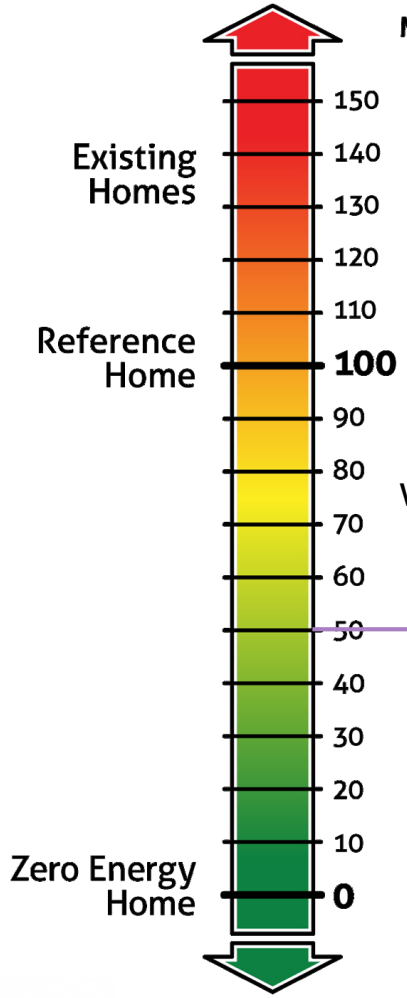
HERS® Index



***With a 5 kW Photovoltaic System, all packages achieve Net Positive Energy w/ a HERS Score between -8 to -12**

w/o PV: 50

Energy Star

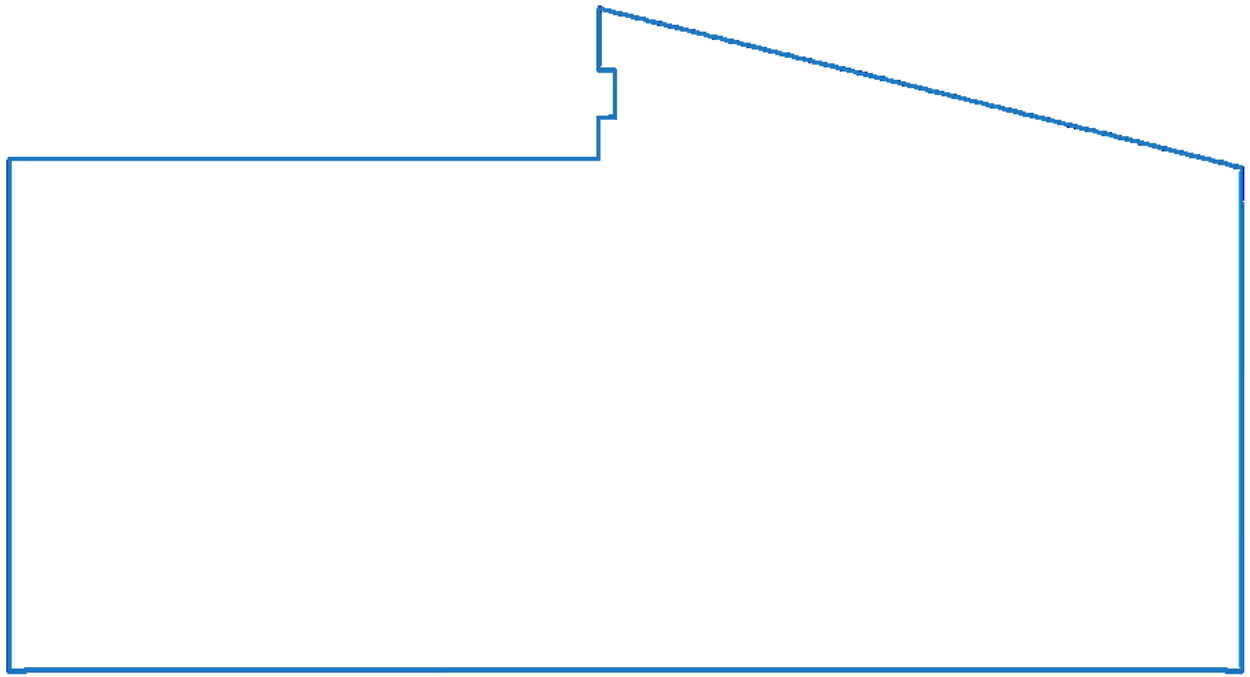
w/o PV: 44

Zero Energy Ready Home

w/o PV: 42

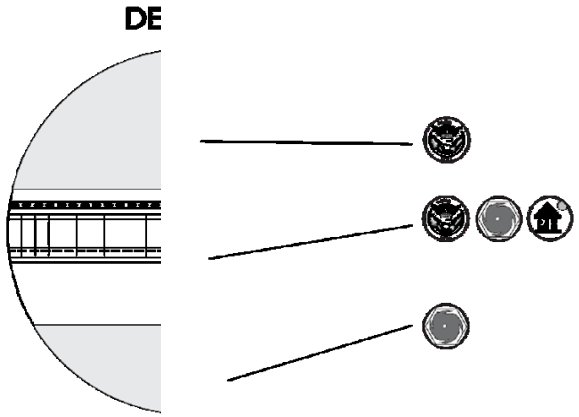
Passive House

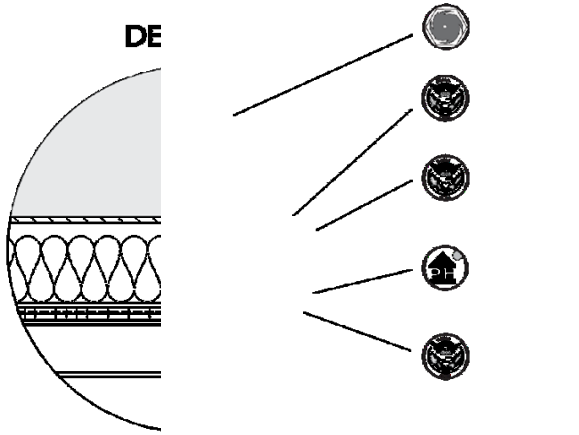
Energy Comparison of Energy Performance Packages			
Component	**Energy Star**	**ZERH**	**PHIUS+2018**
Floor Insulation	R-25 + R-6 c.i.	R-28 + R-6 c.i.	R-28 + R-9 c.i.
Wall Insulation	R-7 c.i.	R-18 c.i.	R-24 c.i.
Roof Insulation	R-18 c.i.	R-24 c.i.	R-30 c.i.
Air Tightness	3 ACH50	1.5 ACH50	.6 ACH50
Fresh Air Ventilation	Balanced (slightly +) Supply: Dehumidifier Exhaust: Bath Fans	Balanced (slightly +) Supply: Dehumidifier Exhaust: Bath Fans	Balanced (slightly +) Supply: ERV Exhaust: ERV
Hood Ventilation	Balanced (slightly +) Supply: Make-Up Air Exhaust: Hood	Balanced (slightly +) Supply: Make-Up Air Exhaust: Hood	Balanced (slightly +) Supply: Make-Up Air Exhaust: Hood
HERs Score w/out PV	50	44	42
REMRATE Annual Energy	32.6 MMBTU/yr	29.1 MMBTU/yr	29.1 MMBTU/yr
WUFI-Passive Annual Energy	25.5 MMBTU/yr	19.4 MMBTU/yr	15.6 MMBTU/yr
WUFI-Passive Cooling Demand	13.21 kBTU/yr ft²	10.64 kBTU/yr ft²	12.73 kBTU/yr ft²
WUFI-Passive Heating Demand	10.63 kBTU/yr ft²	7.51 kBTU/yr ft²	1.93 kBTU/yr ft²
WUFI-Passive Cooling Load	3.19 BTU/hr ft²	2.51 BTU/hr ft²	2.94 BTU/hr ft²
WUFI-Passive Heating Load	13.71 BTU/hr ft²	9.7 BTU/hr ft²	5.18 BTU/hr ft²
PHIUS+2018	No	No	Yes
Construction Cost 3BD/2B	$94,575	$94,896	$115,837

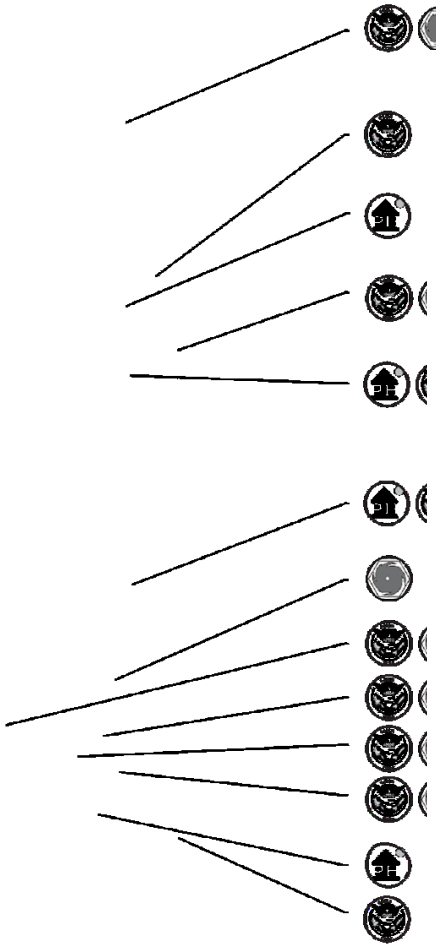


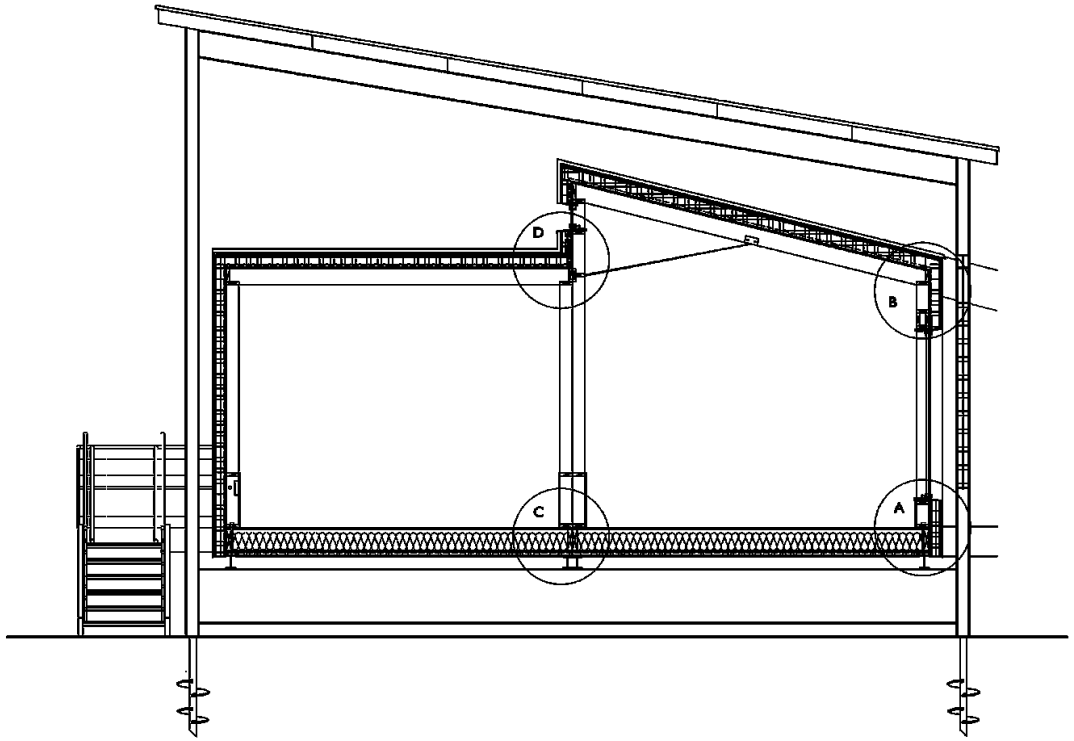
CONTINUOUS AIR BARRIER
CONTINUOUS THERMAL BOUNDARY

Envelope: Base Package

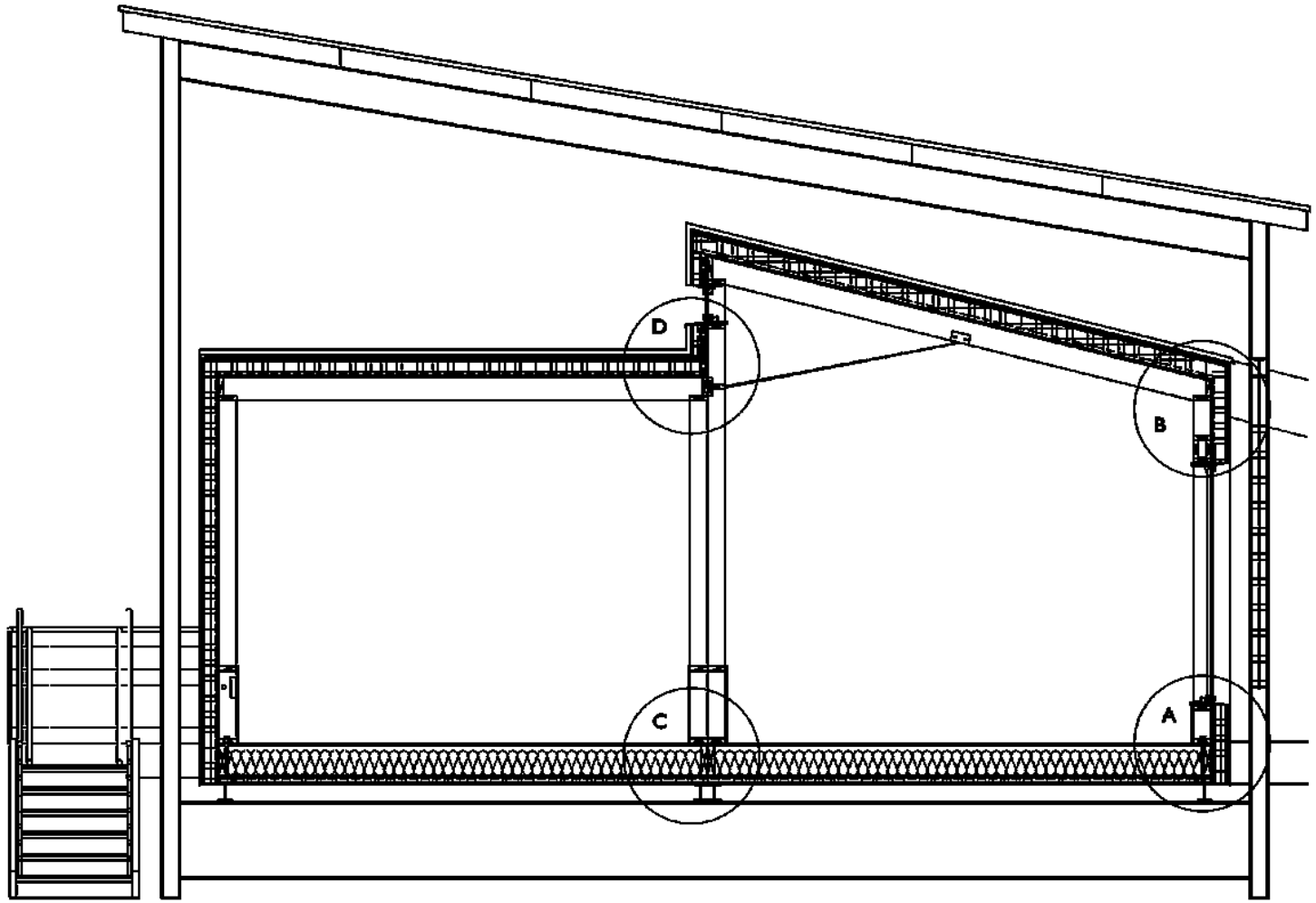








Performance Upgrades



ci | Wall: R-7ci | Floor: R-21, R-5ci

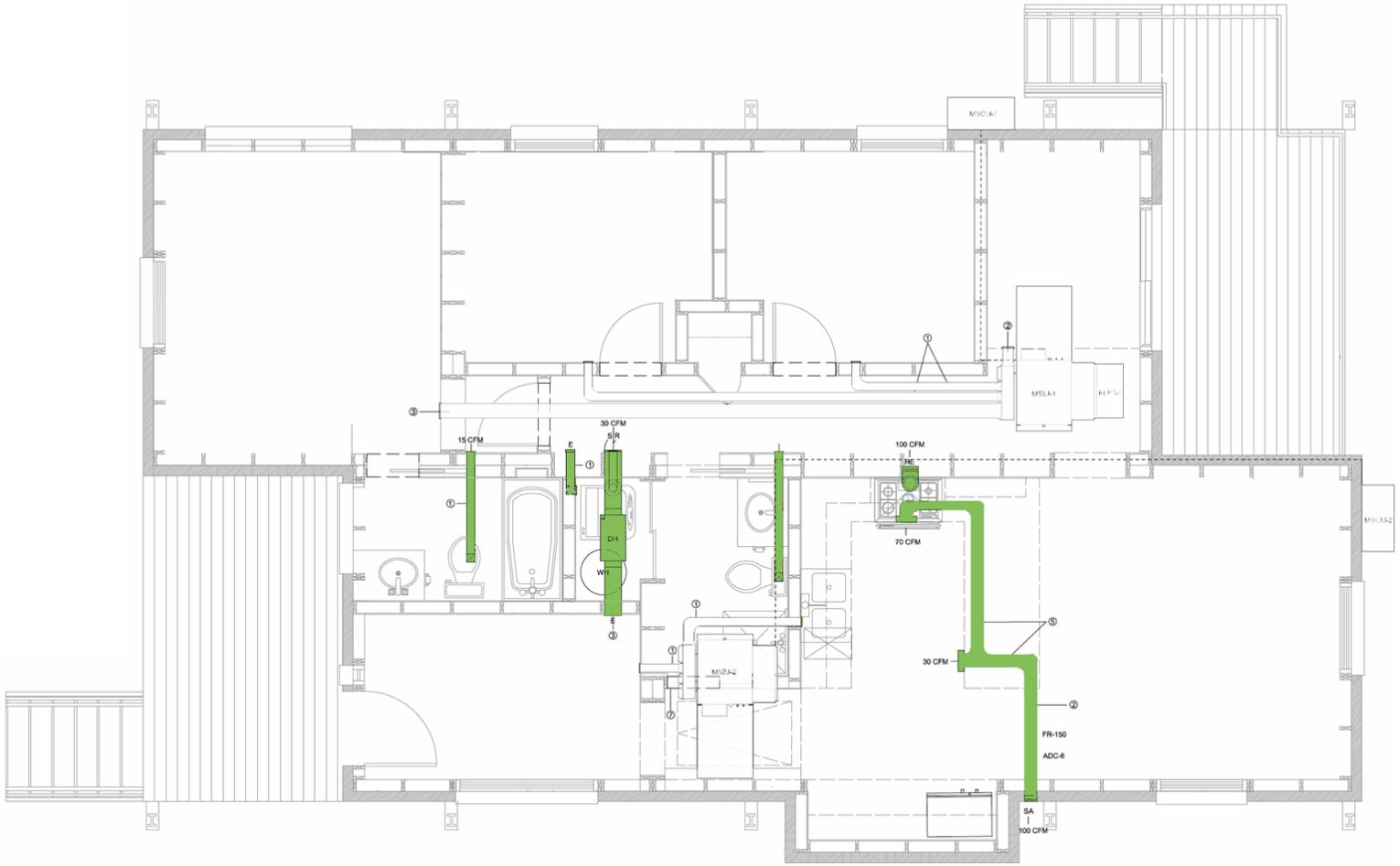
ci | Wall: R-18ci |Floor: R-25, R-6ci

ci | Wall: R-24ci |Floor: R-25, R-9ci

Ventilation: Base Package

- Balanced ventilation; BSC Standard 01
- 100 CFM Kitchen Hood w/ makeup air
- 12 MERV filtration

PANASONIC WHISPER GREEN BATH FAN



Ventilation: Passive House Package

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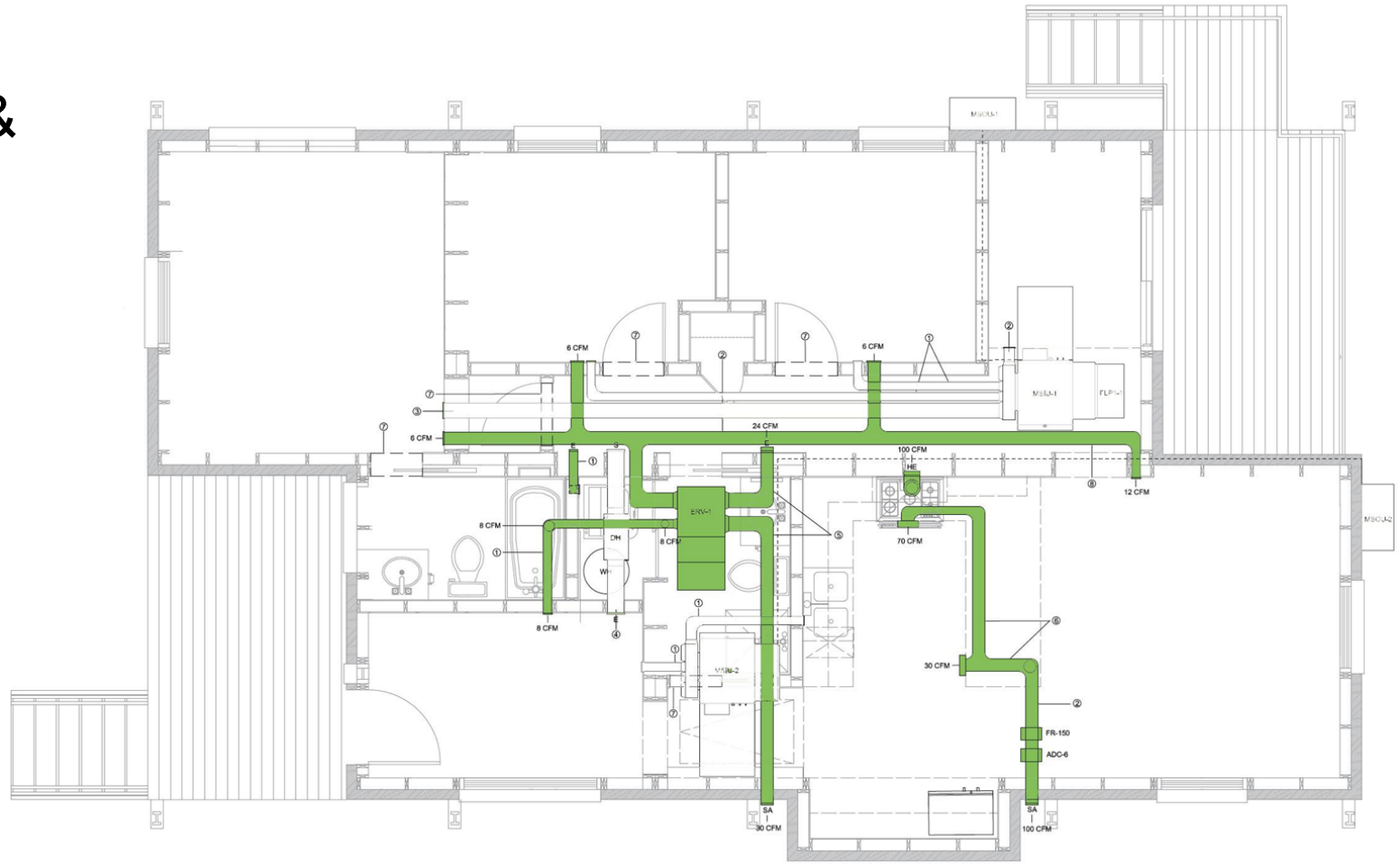
- Eliminate bath fans & supply air through dehumidifier
- Add ERV
- Keep hood with makeup air

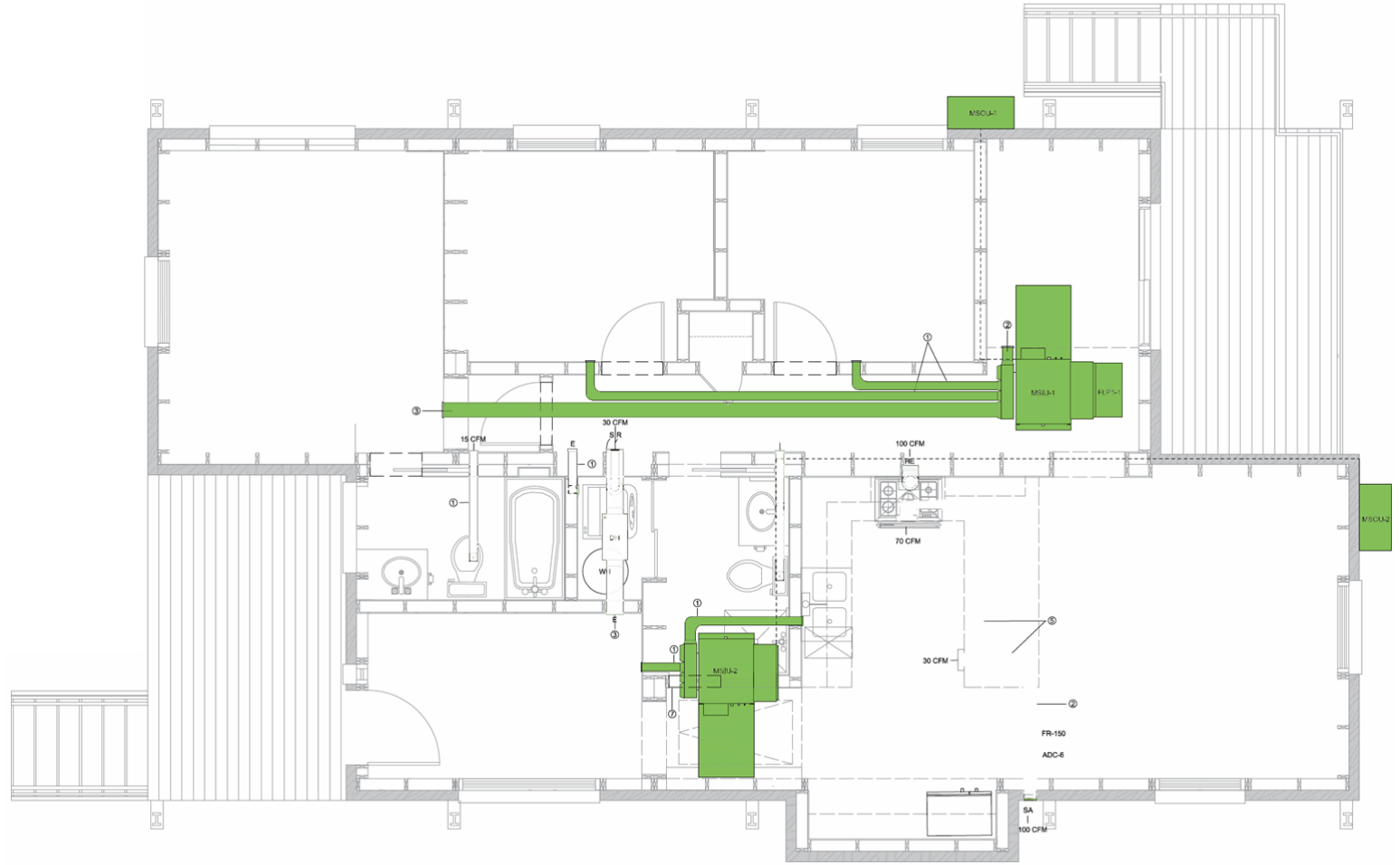
PANASONIC
INTELLI-BALLANCE ERV



Heating & Cooling

- Right sized ducted mini-split
- 1.34 ton system based on Manual J

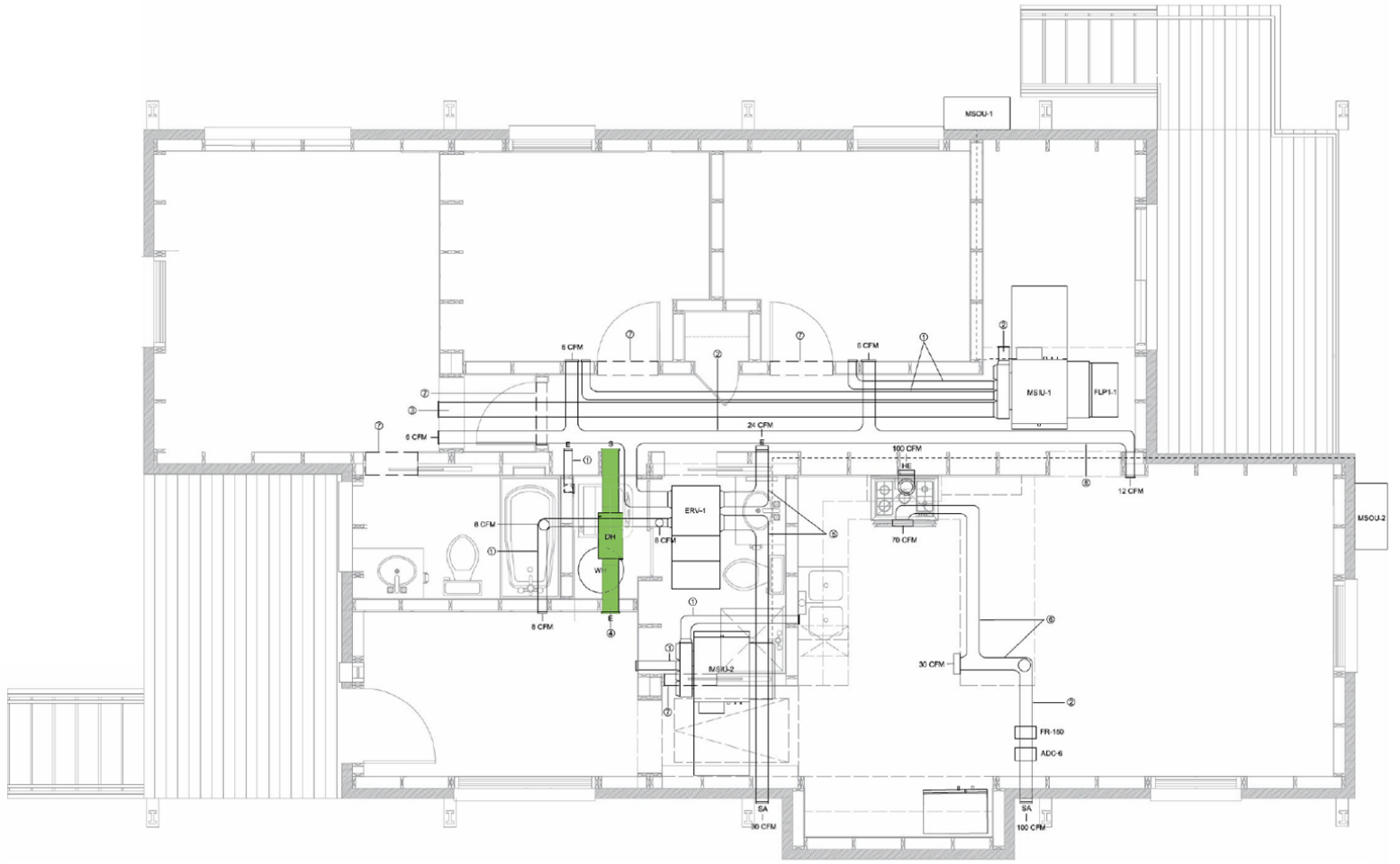
MITSUBISHI MINI-SPLIT



Dehumidification

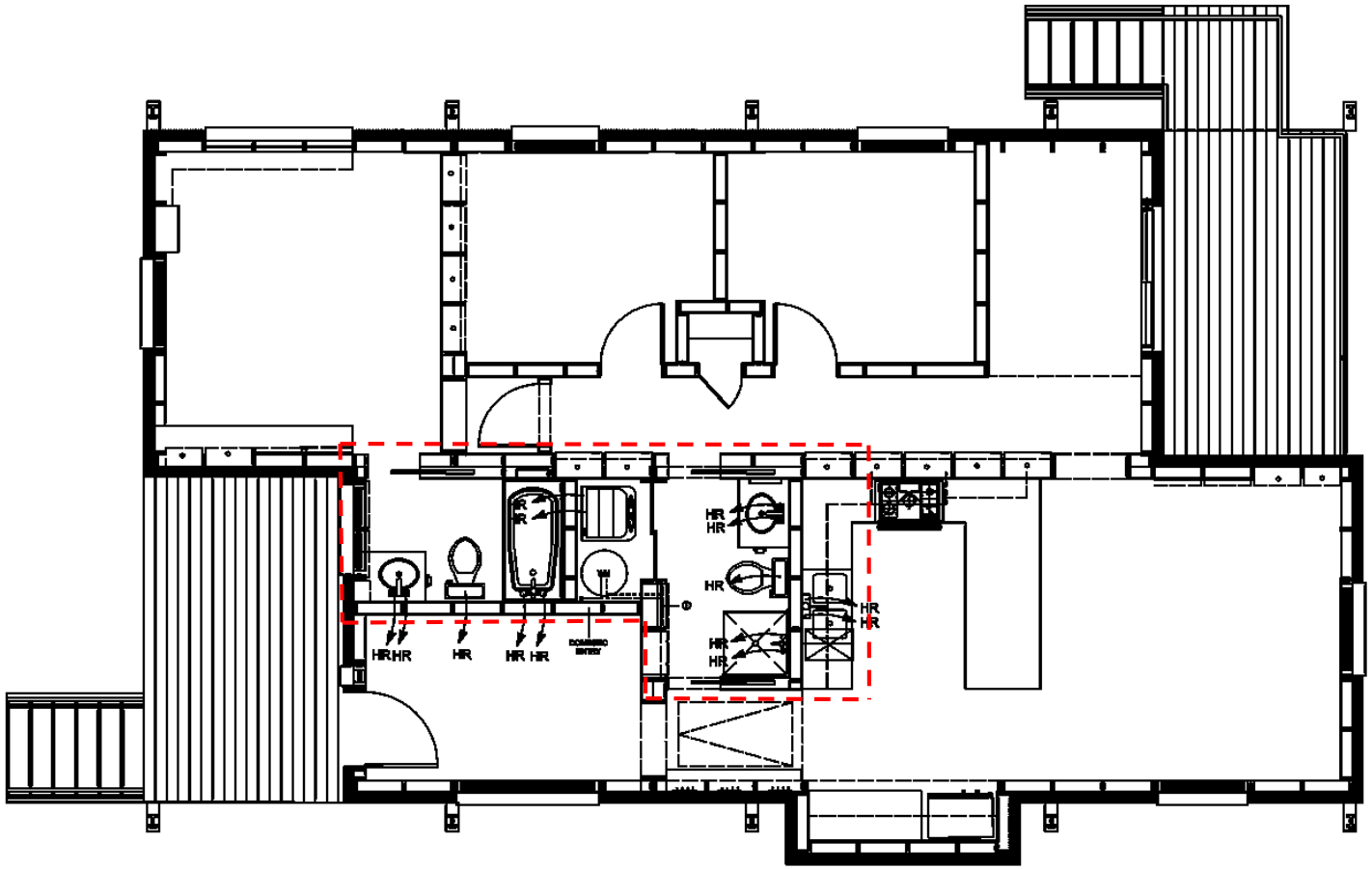
- Dedicated dehumidification
- Solves IAQ & durability issues

ULTRAAIRE DEHUMIDIFIER

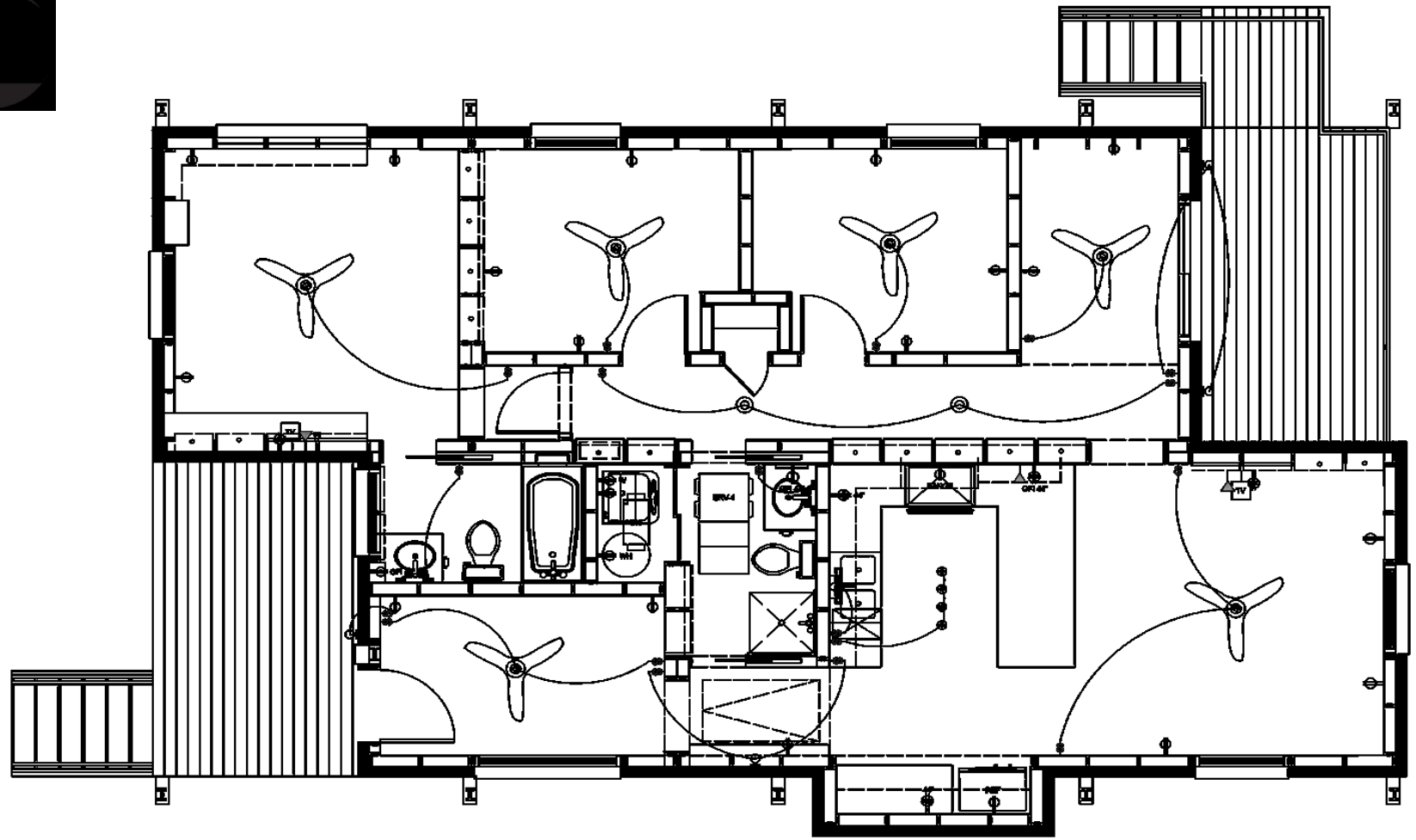


Plumbing

- Tight wet core
- Includes heat pump hot water heater
- Meets WaterSense requirement for residual hot water in pipes

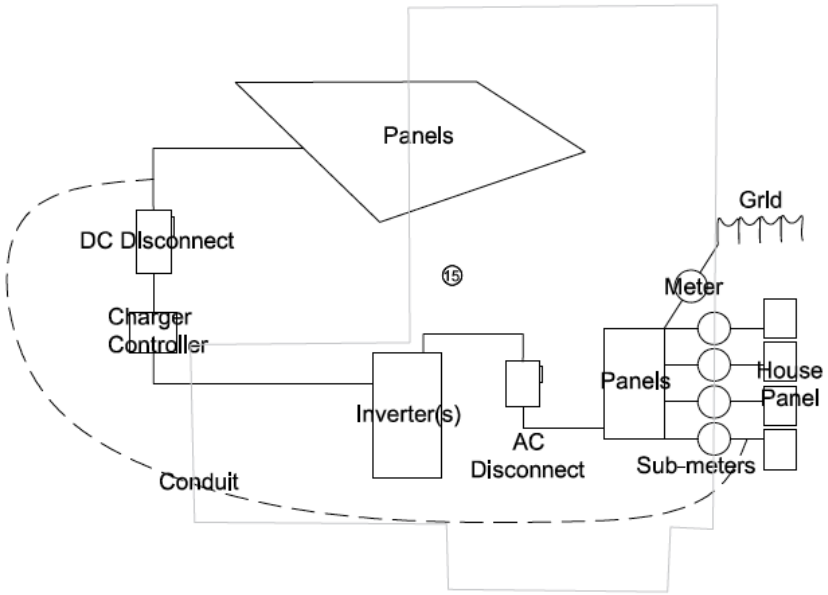


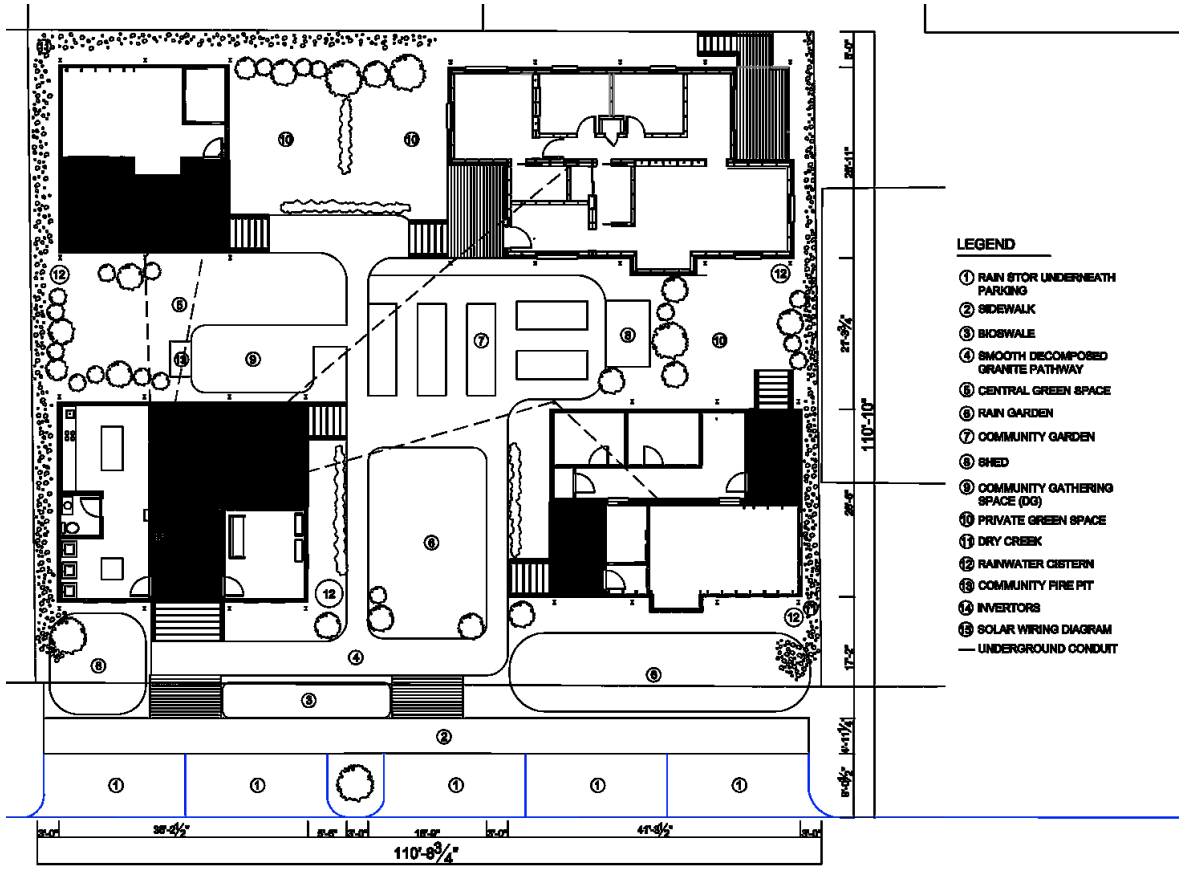
Electrical



Photovoltaic System

- 27.3 kW PV system per fly roof
- 5.2 kW PV system required for 3 bedroom home





Sustainability Overview

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Economic Resilience

Social Resilience

Environmental Resilience

- Solar Fly Roof
- Resilient Materials
- Shading Device
- Airtight Exterior

- Wind Resistant Windows
- Elevated Home
- Community Garden/ Greenspace
- Site Water Management

Resiliency Overview

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Economic Resilience

Social Resilience

Environmental Resilience

Economic

- Affordability
- Ownership
- Address vacancy
- Economically healthy neighborhood

Environmental

- Address flooding
- Surviving hurricanes and flooding events with minimal damage
- Man/Nature Connection
- Health
- Net zero residence

Social

- Social Agency
- Community connectivity/relationship development
- Health

- Modular construction
- Package options
- Community solar
- Durability
- Energy Independence

- Fly Roof
- Net Zero Energy
- Durability
- Low Impact Development
- Preservation of green space

- Pocket Neighborhood
- Indoor air quality
- Passive Survivability
- Collective Ownership

The Fly Flat

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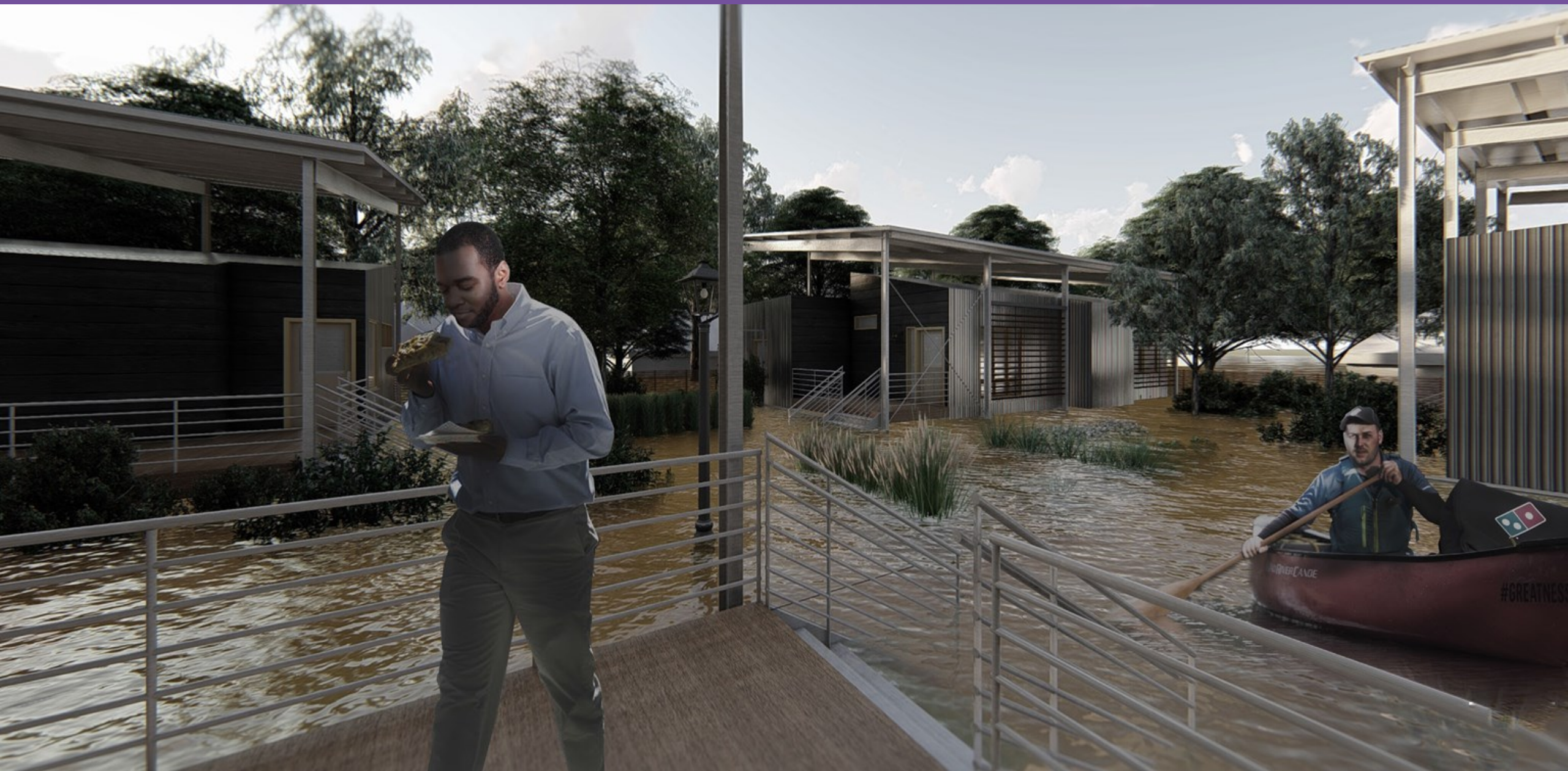

The Fly Flat

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