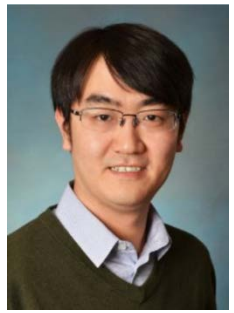
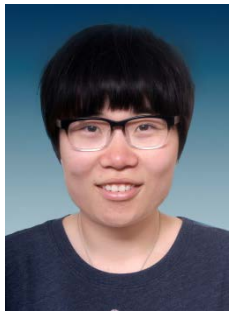
WESTART

Race to Zero Student Design Competition
Final Presentation
Team AtoZ
Georgia Institute of Technology

Team AtoZ from Georgia Institute of Technology

								
Lu, Di	**Zeng, Zhaoyun**	**Alhazmi, Mansour**	**Qiu, Chufei**	**Zhang, Zeyu**	**Cai, Ting**	**Gattani, Anirudh**	**Zhang, Xi**	**Chang, Tso-An**

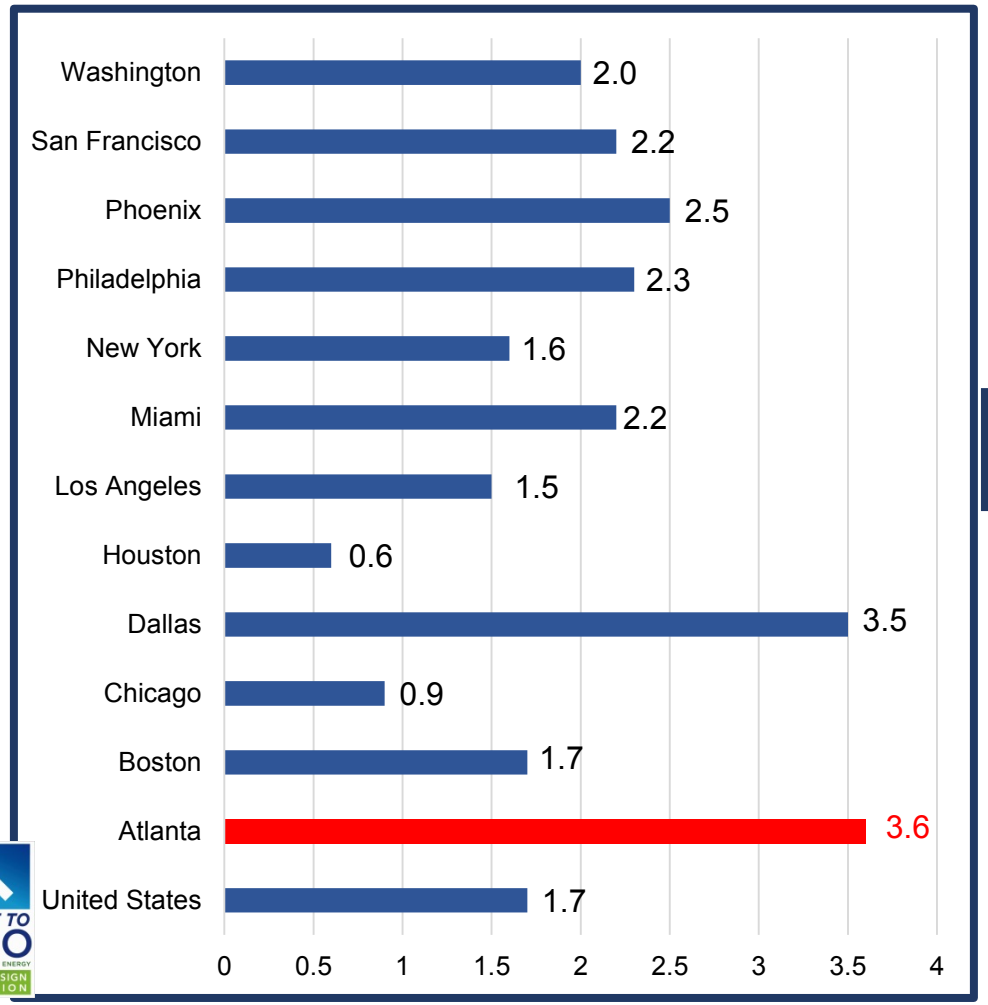
	**Faculty Advisor**
	Brown, Jason

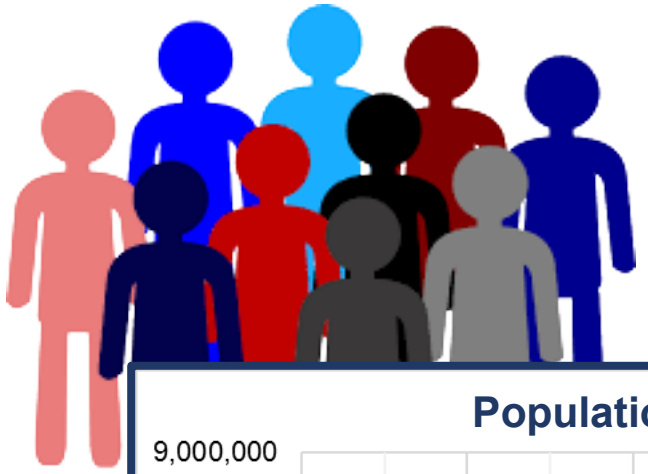
RACE TO ZERO U.S. DEPARTMENT OF ENERGY STUDENT DESIGN COMPETITION

Multi-family Building

ATLANTA

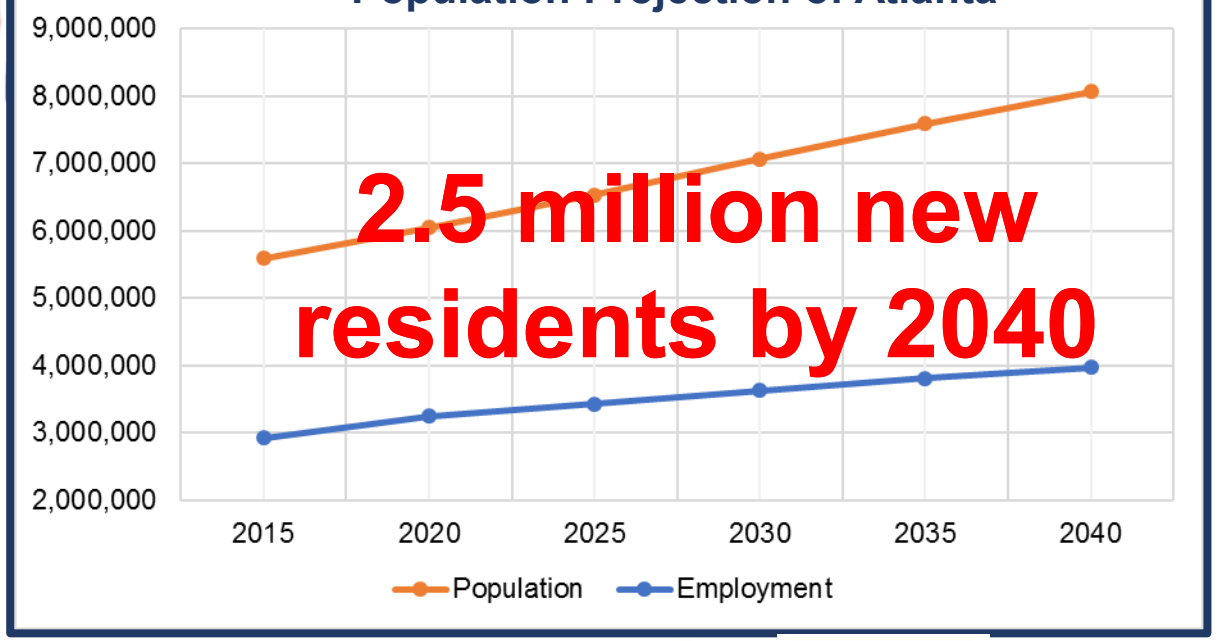
2016 Nonfarm Employment Growth Rate of the 12 Largest Metropolitan Areas in the US





90,000 new residents in 2016

Population Projection of Atlanta



2.5 million new residents by 2040

What happens to the life of local residents whose family has been living there for generations?

1952

Now

	West End	Atlanta
Average household income	$23,800	$79,304
Percentage of Atlanta average	30%	100%

Atlanta BeltLine

Eastside trail before and after renovation

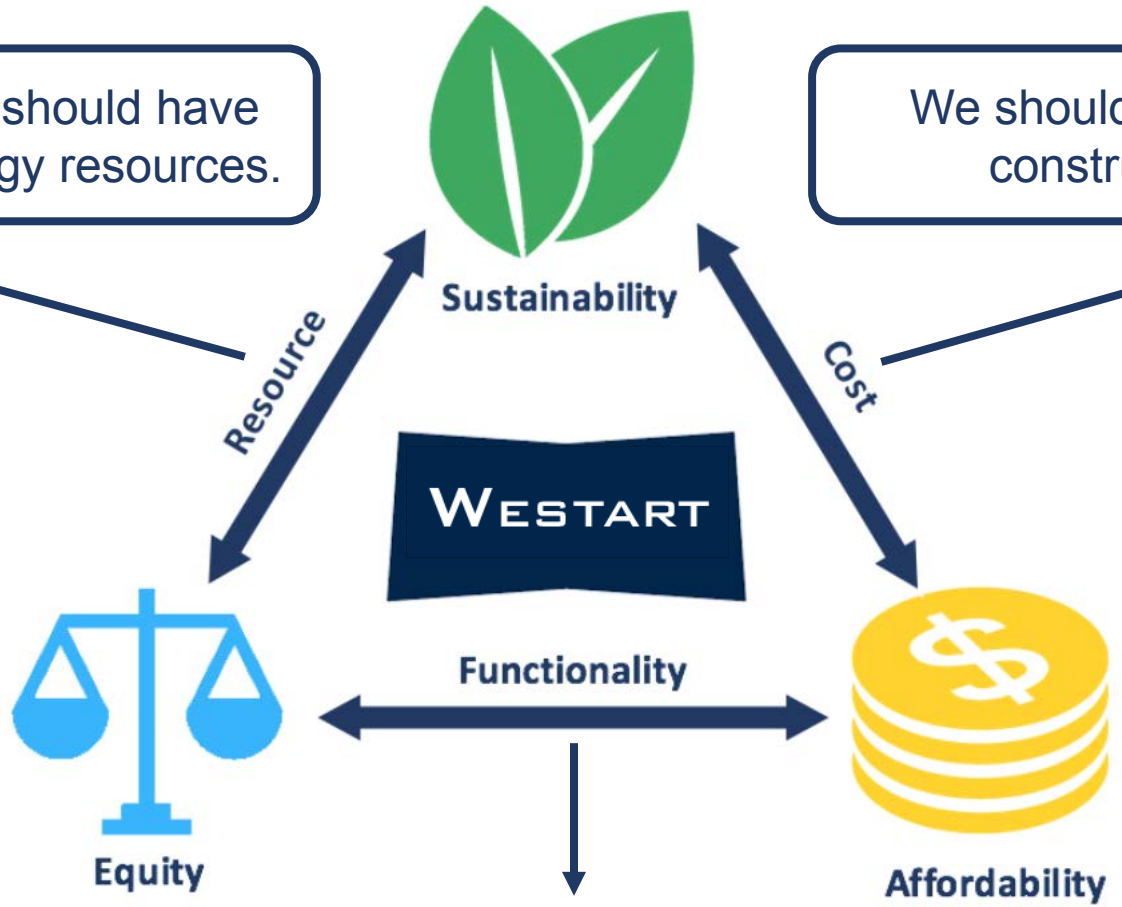
WESTART

this program.

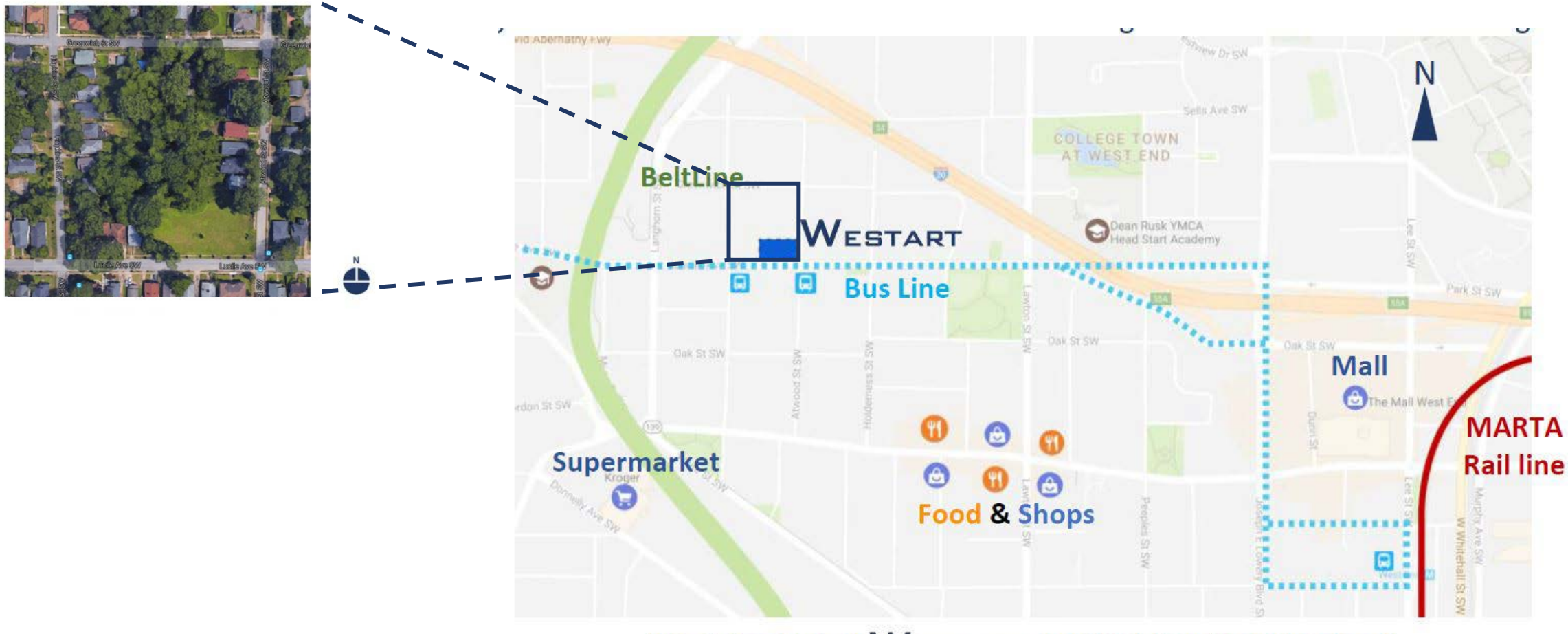
A piece of in End

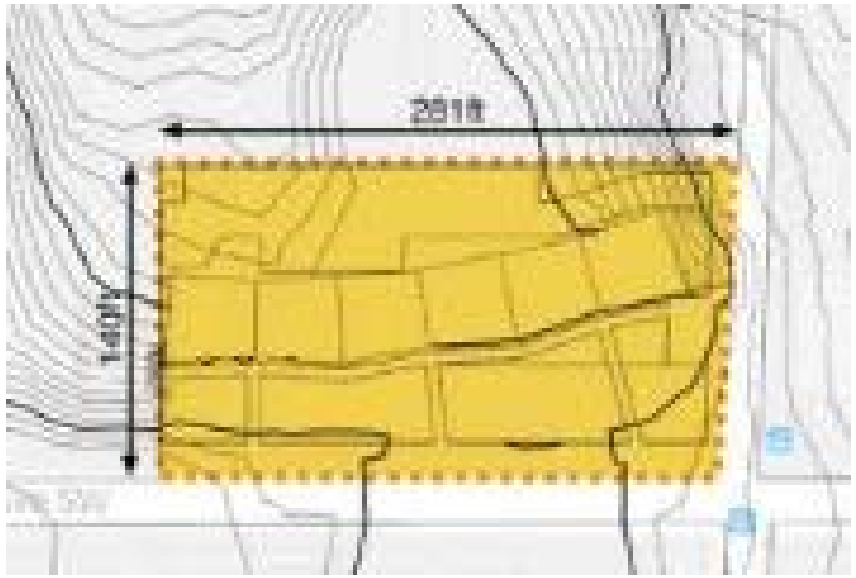
All the residents of Westart should have equal access to natural energy resources.

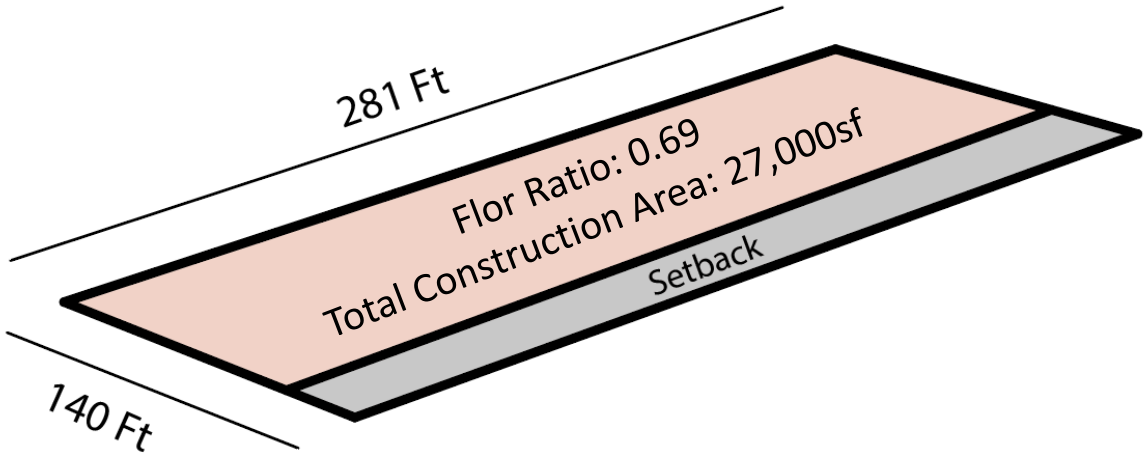
We should minimize the energy and construction cost of Westart.

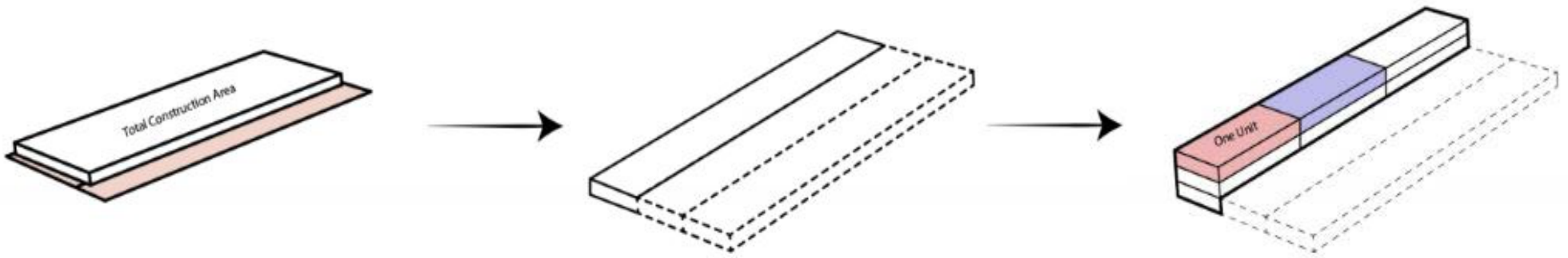


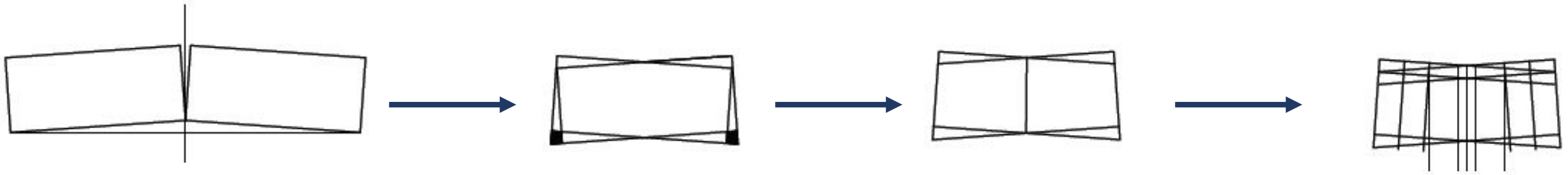
Westart have small units with no loss in functionality in order to provide a cost-effective living standard for the local residents.

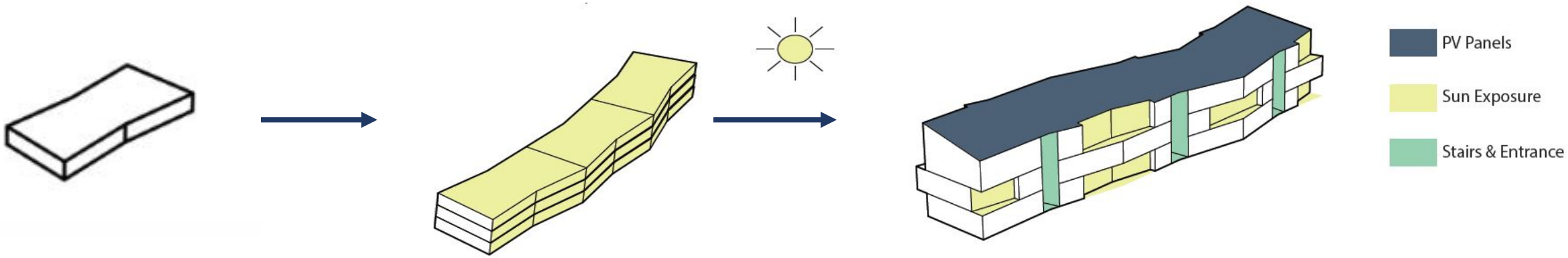

BeltLine
WESTART
Bus Line
N
COLLEGE TOWN AT WEST END
Dean Rusk YMCA Head Start Academy
Mall
MARTA Rail line
Supermarket
Kroger
Food & Shops
Oak St SW
Park St SW
Sells Ave SW


281ft
140ft


281 Ft
Flor Ratio: 0.69
Total Construction Area: 27,000sf
Setback
140 Ft


Total Construction Area
One Unit




PV Panels
Sun Exposure
Stairs & Entrance

Unit A
Studio for single or young couple.
463 sf

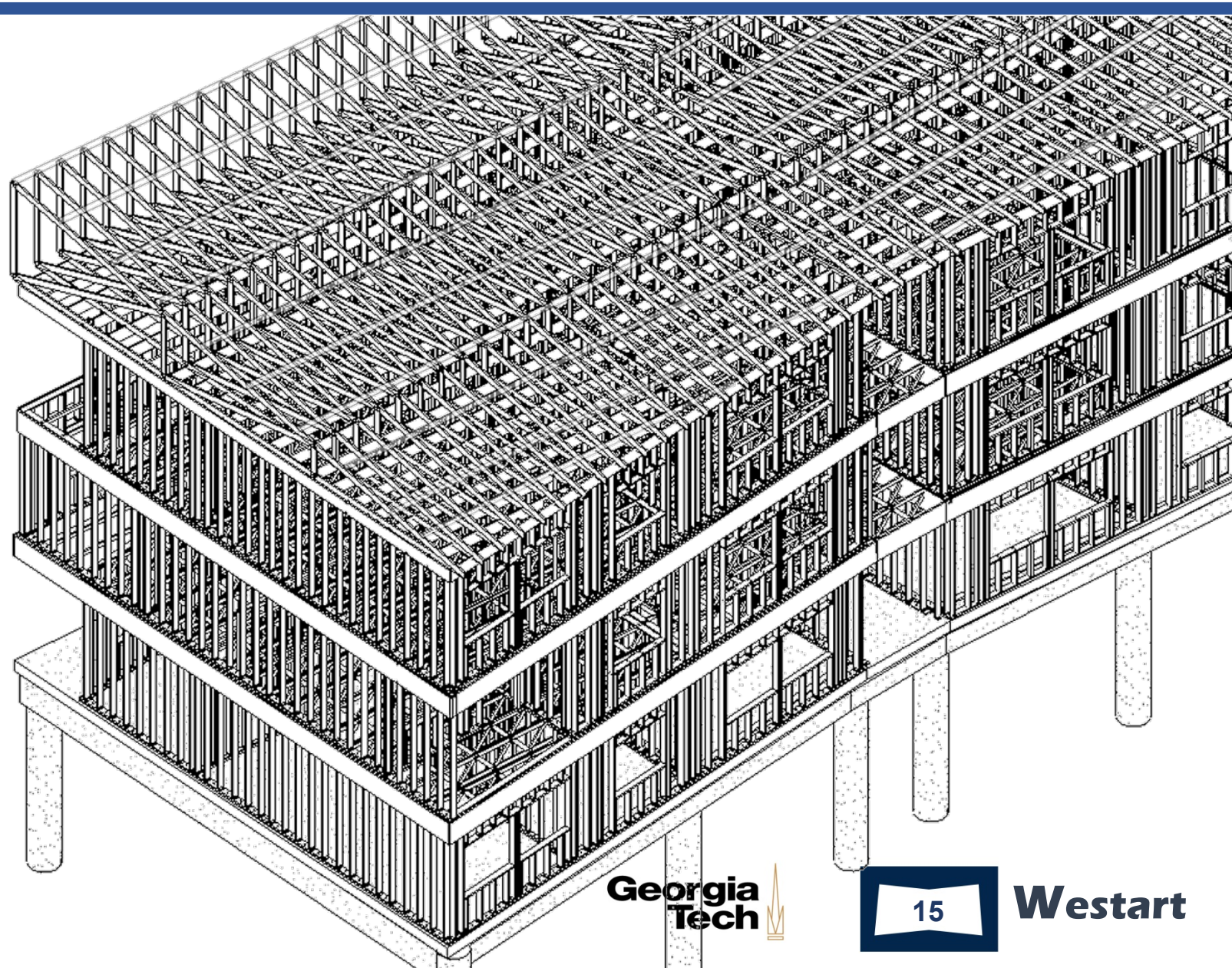
Unit B
Studio for single or young couple.
933 sf

Structure

- Concrete for foundation.
- Truss system for floors and Roof.
- Load-bearing Walls.

Floor Truss

- 2”x20” truss for the floor framing.
- 4 inches sprayed polyurethane foam for acoustic and thermal insulation.
- Cavity of the truss can also be used for the distribution of pipes and fresh air ducts

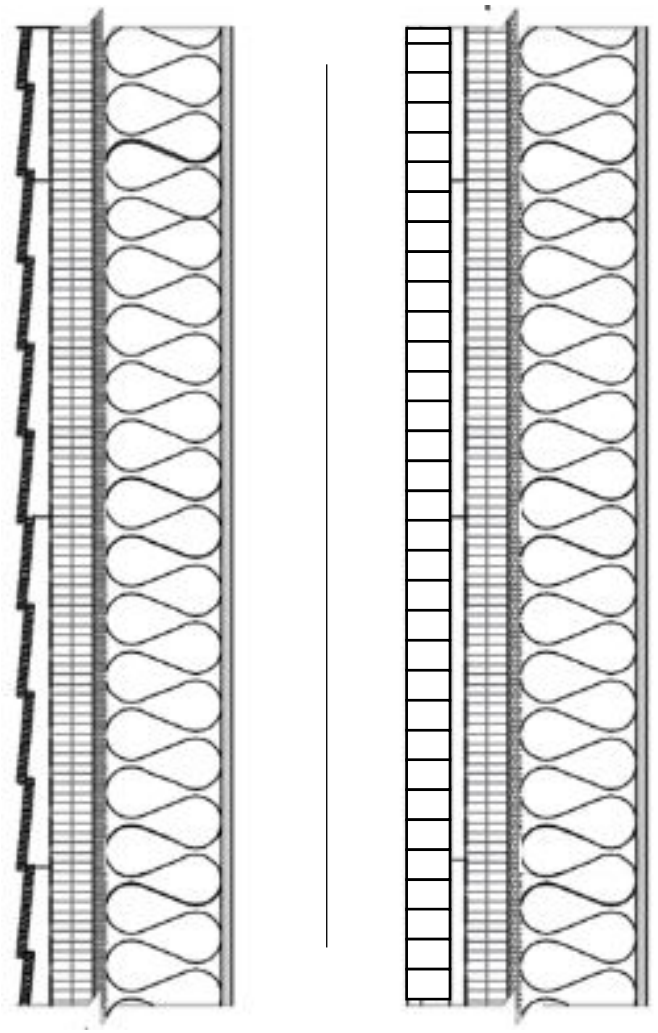


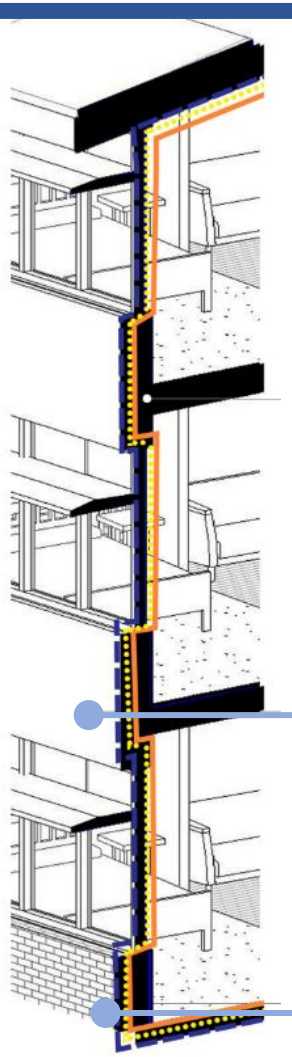
Exterior Wall

Left (Outside) – Right (Inside):

- Wood siding or Bricks.
- Air Gap
- Tyvek air & water barrier with sealing tapes.
- 2 inches XPS board, R of 10
- Plywood
- 5.5 inches Wood Stud, cavity filled with Fiberglass “R of 21”.
- Gypsum Board
- And Semi-permeable, 5 perm.

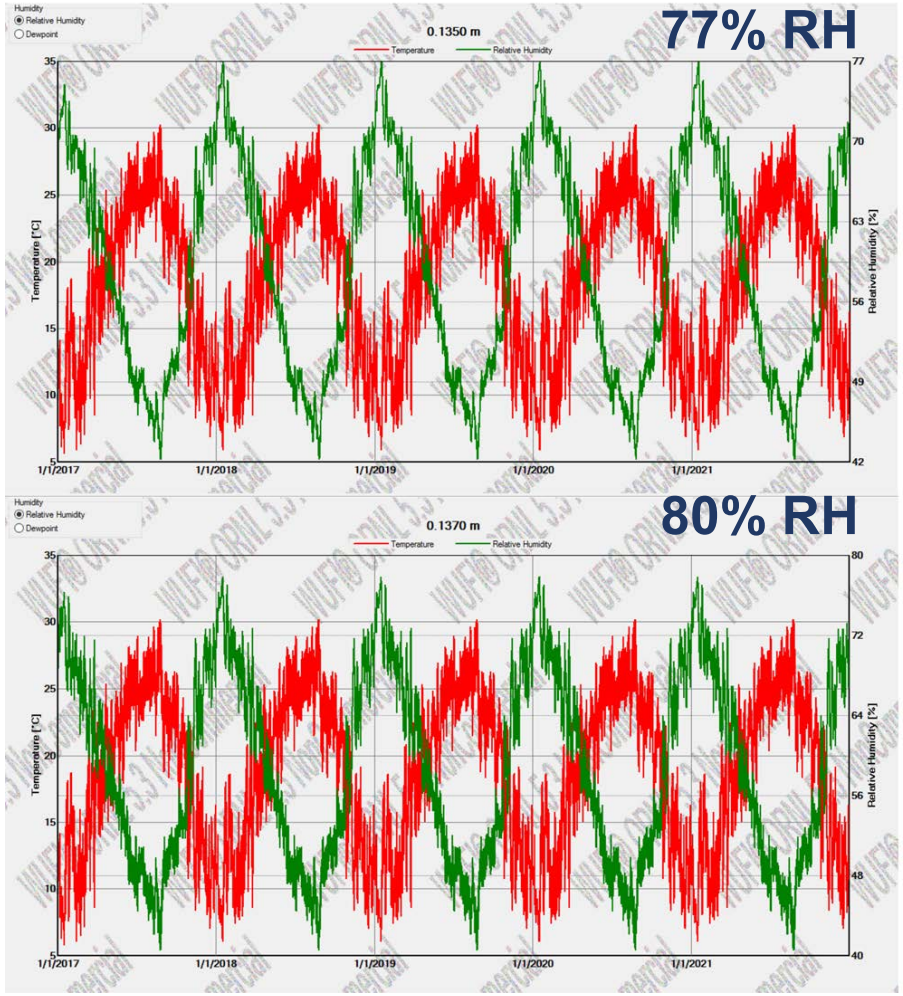
<u>Total R-Value are around 37 for both exterior wall types.</u>



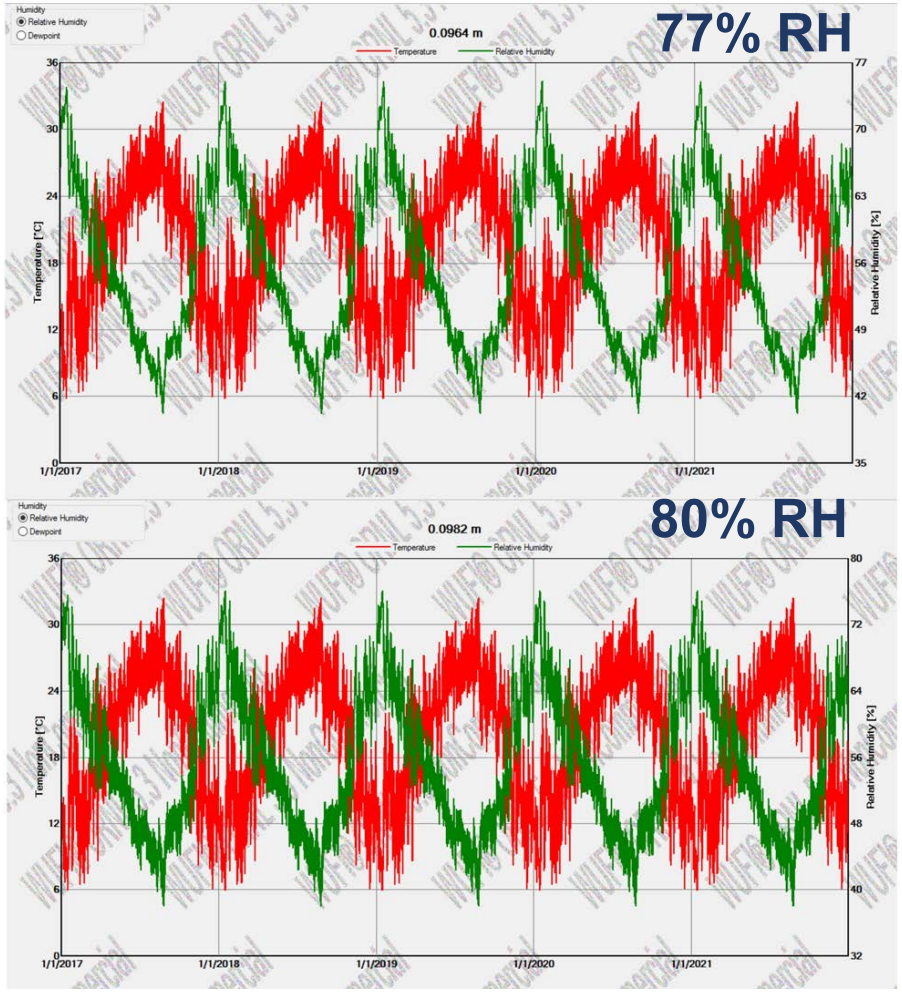


Exterior Wall with siding

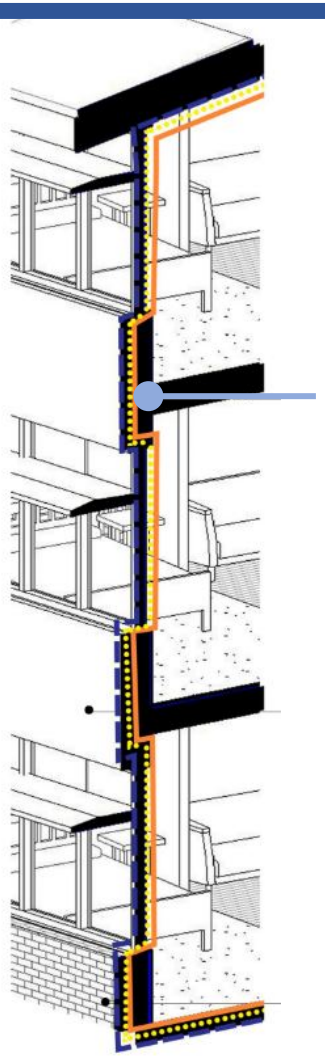
Exterior Wall with brick tile

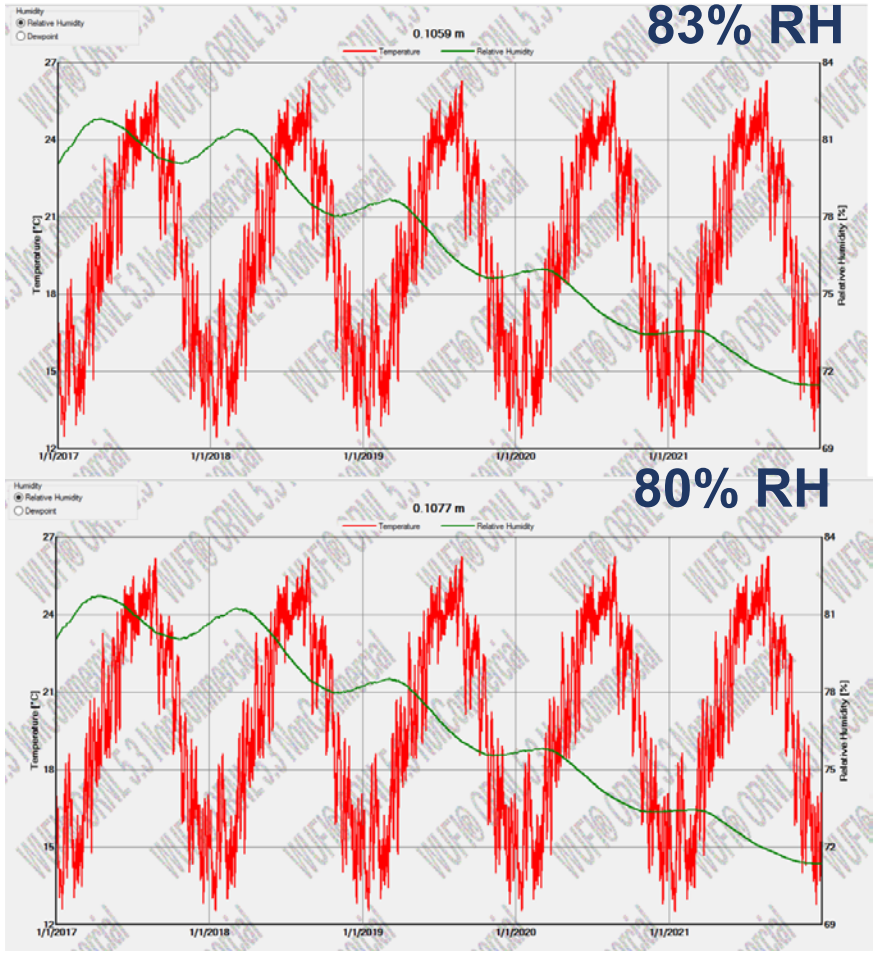


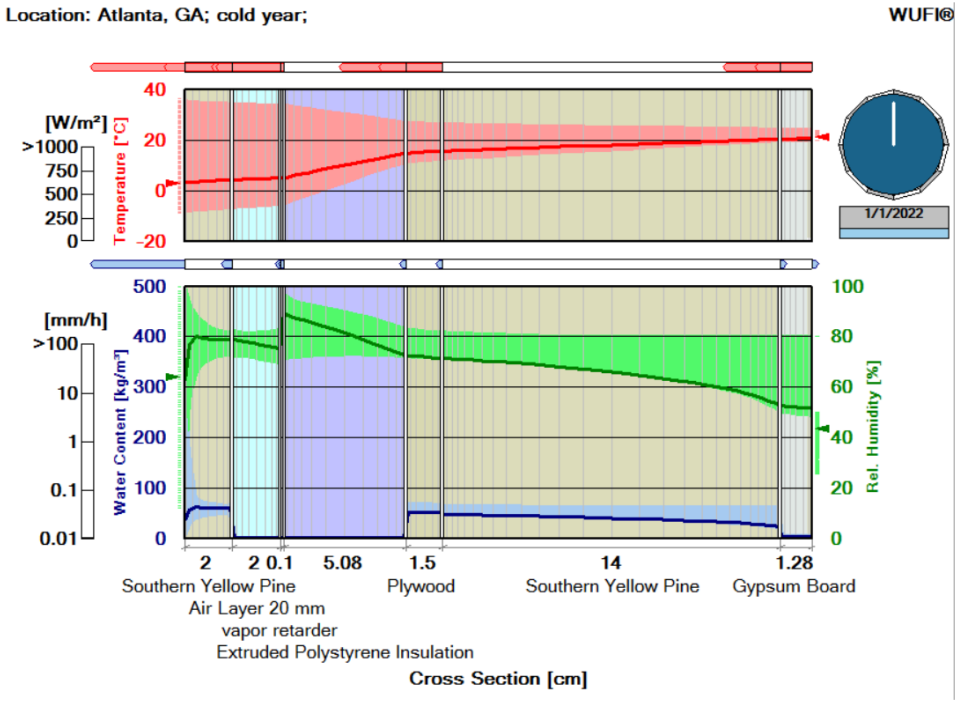
Exterior Wall with brick tile



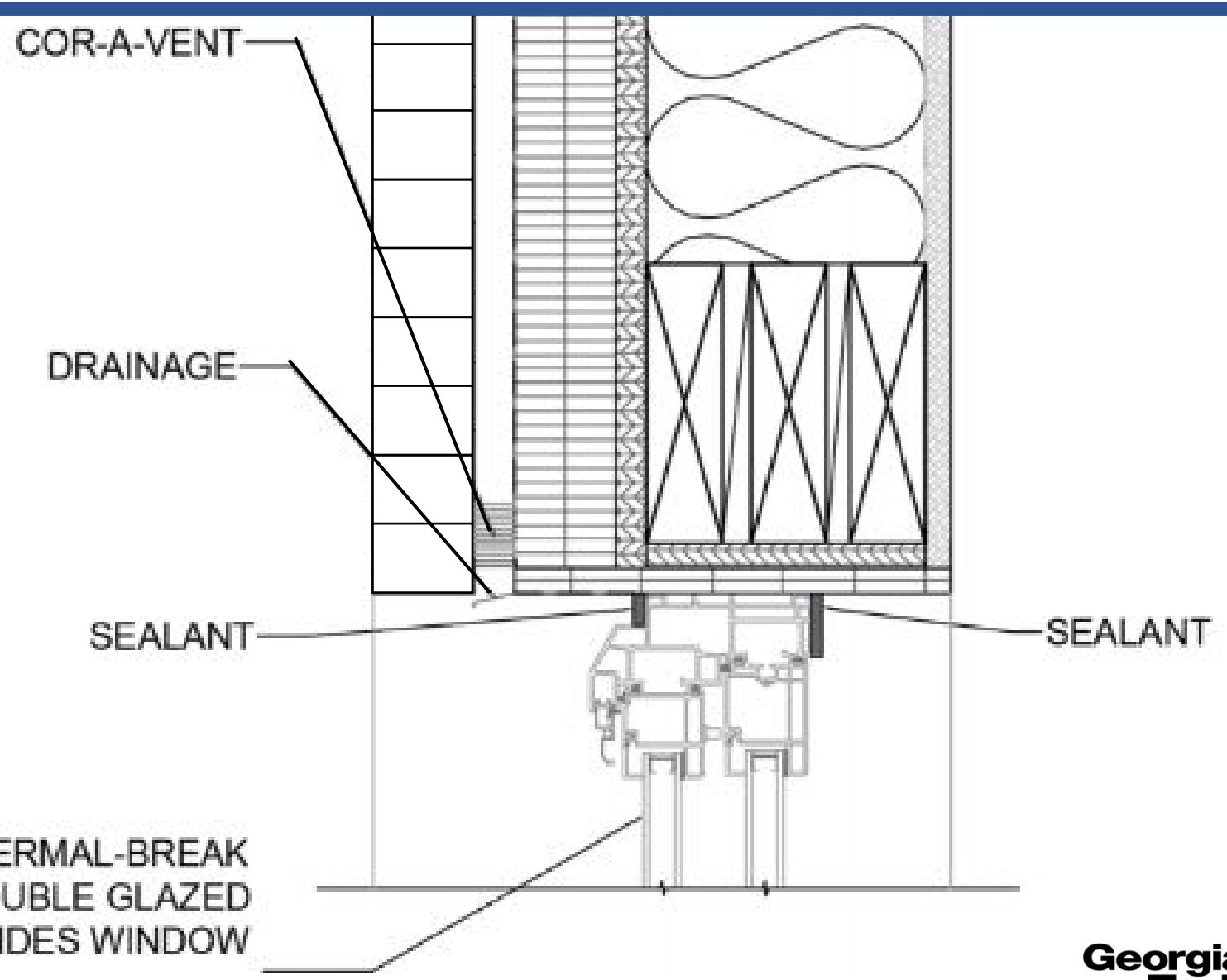
Exterior Wall with siding


Weak point

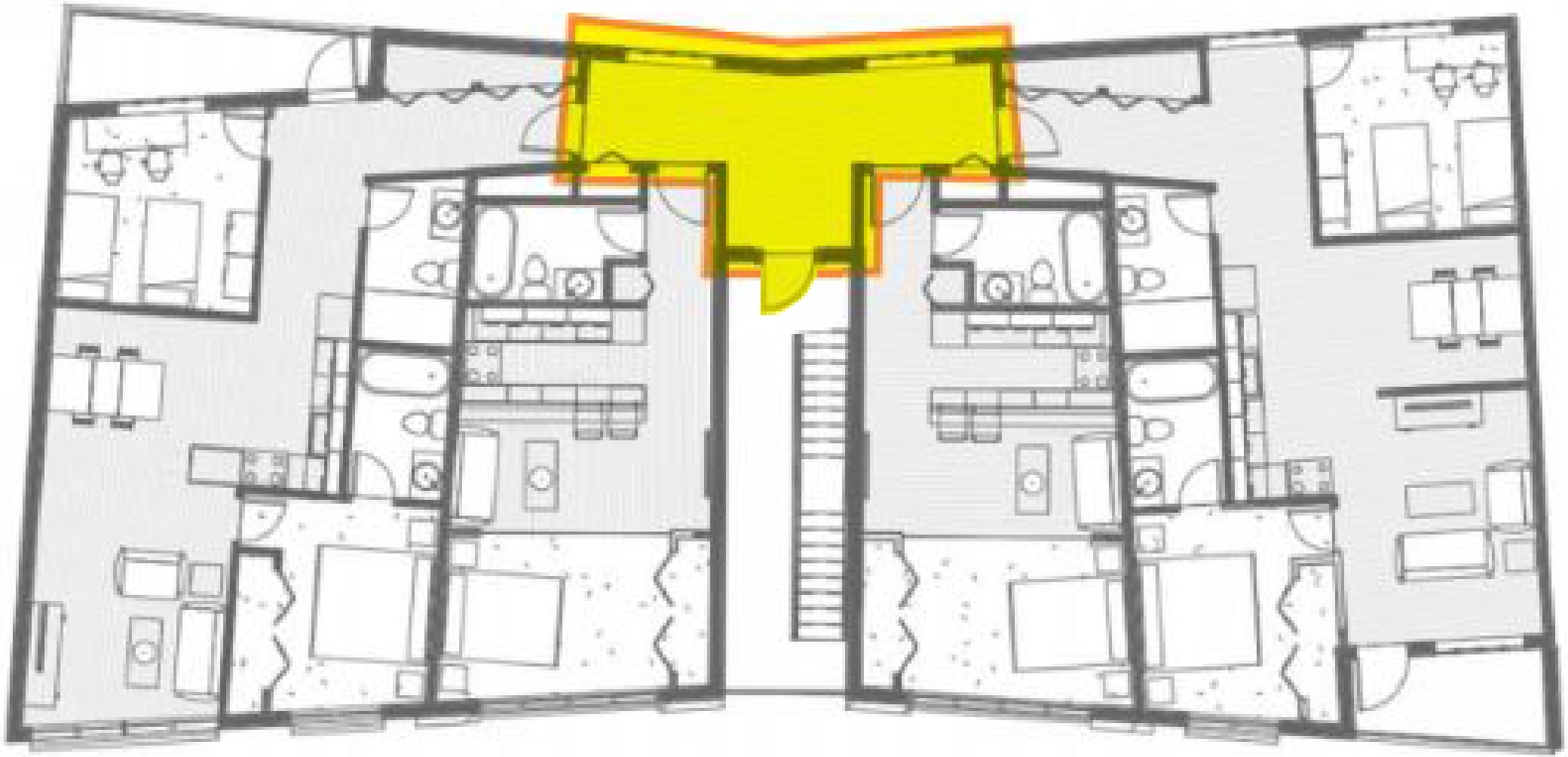

83% RH
80% RH
0.1059 m
0.1077 m
Temperature
Relative Humidity
1/1/2017
1/1/2018
1/1/2019
1/1/2020
1/1/2021


Location: Atlanta, GA; cold year;
WUFI®
[W/m²]
>1000
750
500
250
0
Temperature [°C]
40
20
0
-20
1/1/2022
[mm/h]
>100
10
1
0.1
0.01
Water Content [kg/m³]
500
400
300
200
100
0
Rel. Humidity [%]
100
80
60
40
20
0
2
2 0.1
5.08
1.5
14
1.28
Southern Yellow Pine
Air Layer 20 mm
vapor retarder
Extruded Polystyrene Insulation
Plywood
Southern Yellow Pine
Gypsum Board
Cross Section [cm]

Weak Point



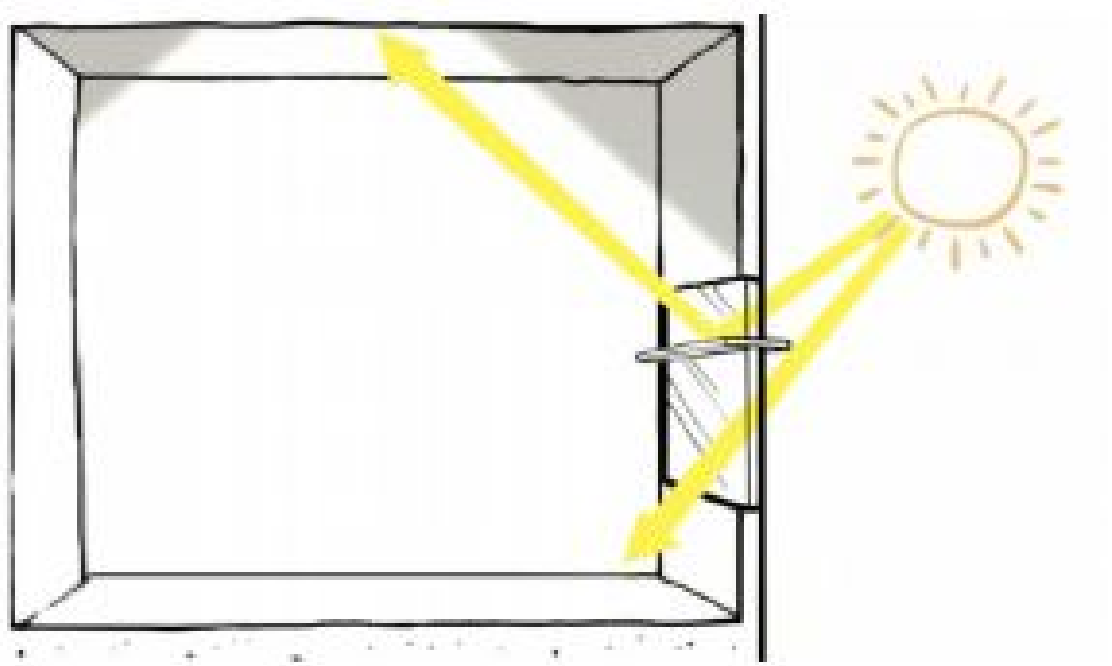
Thermal Properties:
U-Value 0.48
Emissivity 0.3
Solar Transmittance 0.3



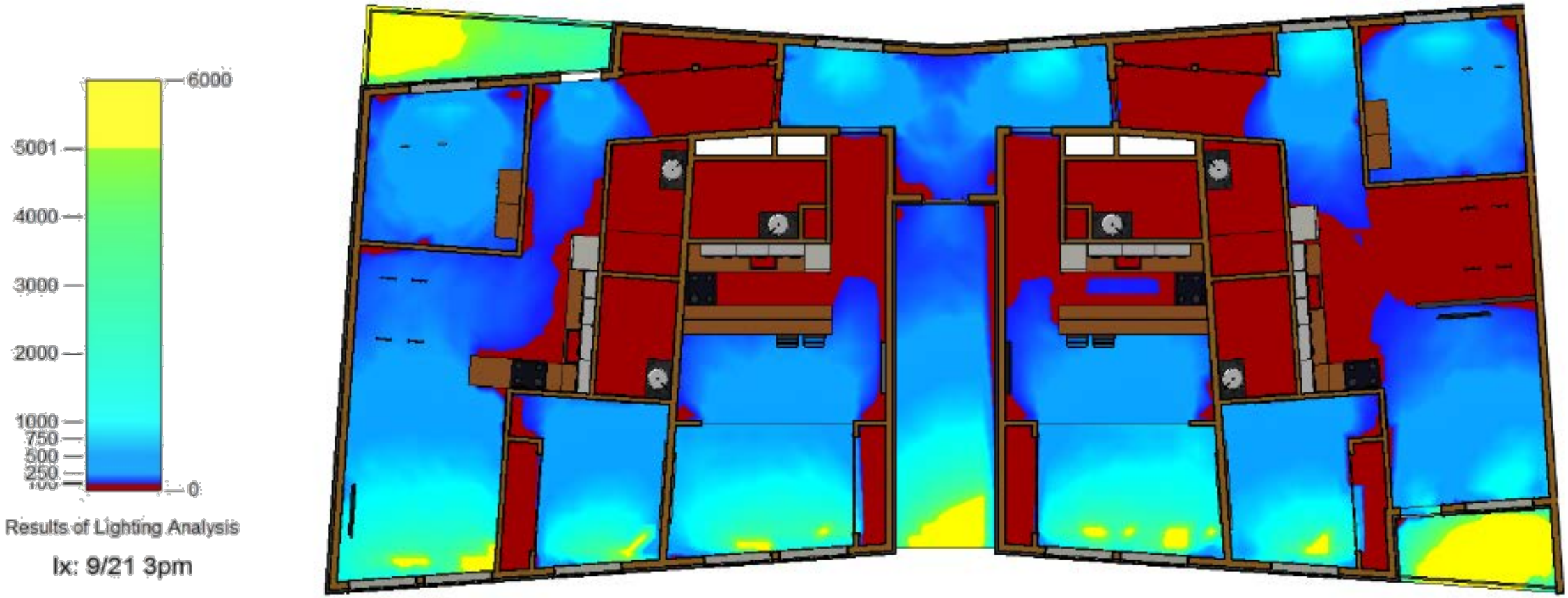

1
2
3
4


3
4
1
2

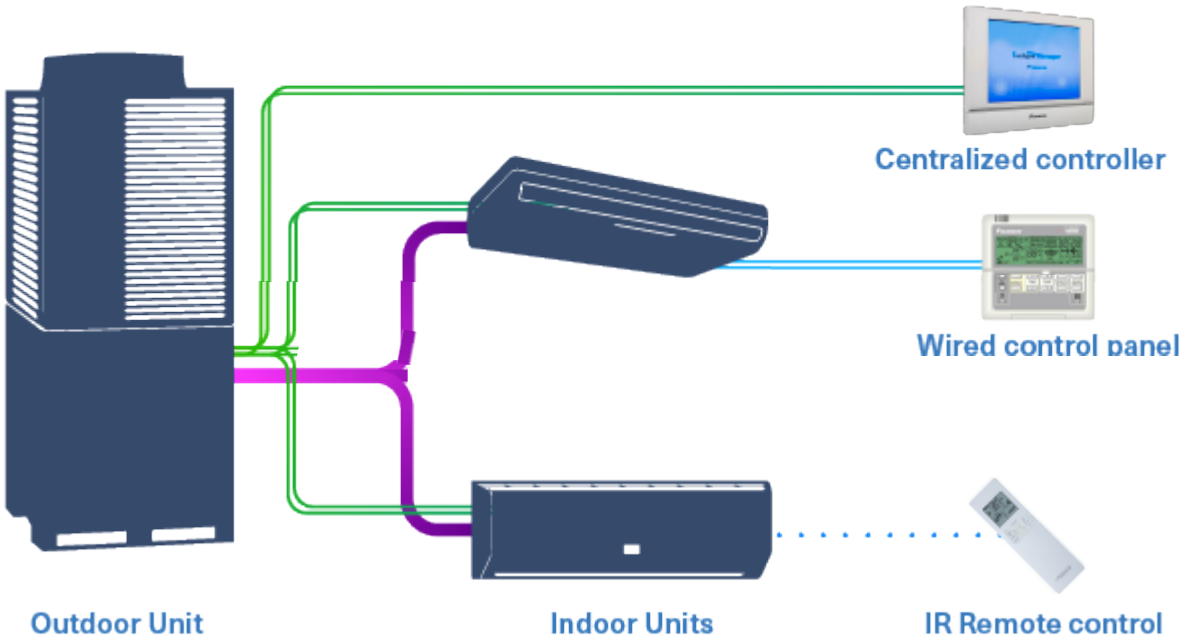
Light Shelf



Illuminance Map



Variable Refrigerant Flow (VRF) System

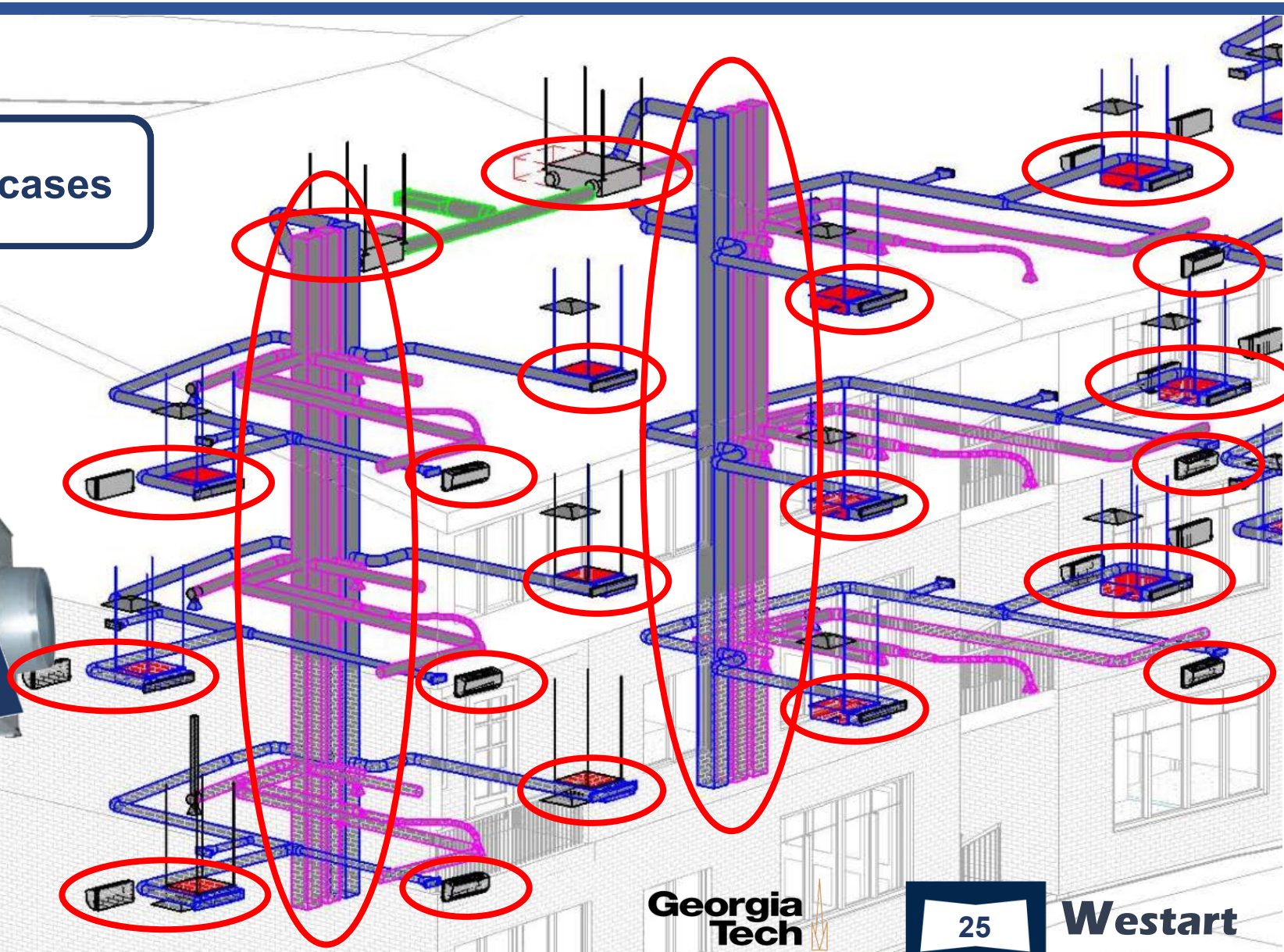


1. For a multi-family building, a centralized system has a higher efficiency and lower cost compared to split air conditioners.

2. Since Atlanta has a moderate summer and winter, air source heat pump is the best option for both cooling and heating.

3. Different families in a multi-family building have different schedules, and VRF systems have the best partial load performance.

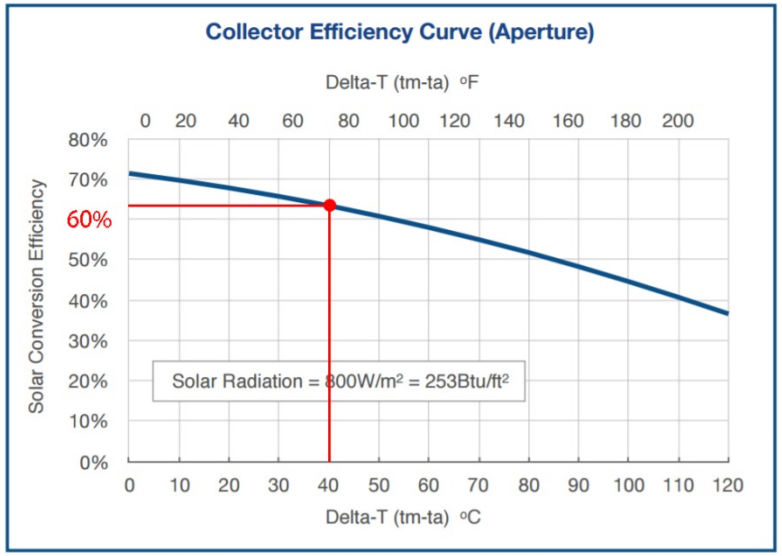
Vertical Shafts Near the Staircases



Option 1:
PV + Heat pump water heater (HPWH)

Efficiency of PV modules	Annual average COP of HPWH	Total system efficiency of HPWH
20% ×	2 =	40%

Option 2:
Solar wat[illegible] heat[illegible]

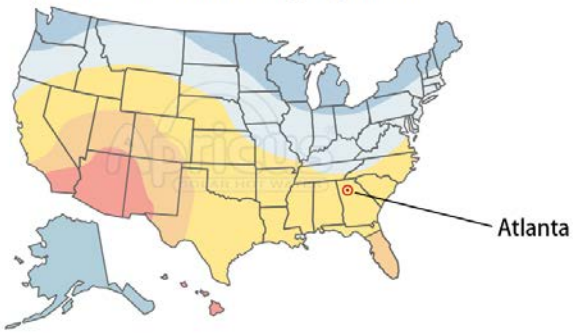


Efficiency of solar water heater for Atlanta
60%

50% higher

Step 1: Sizing map

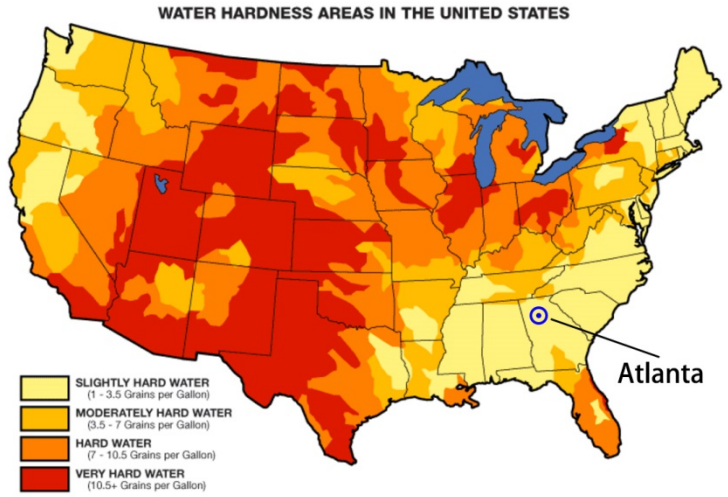
Apricus AP Solar Collector Sizing Map for USA

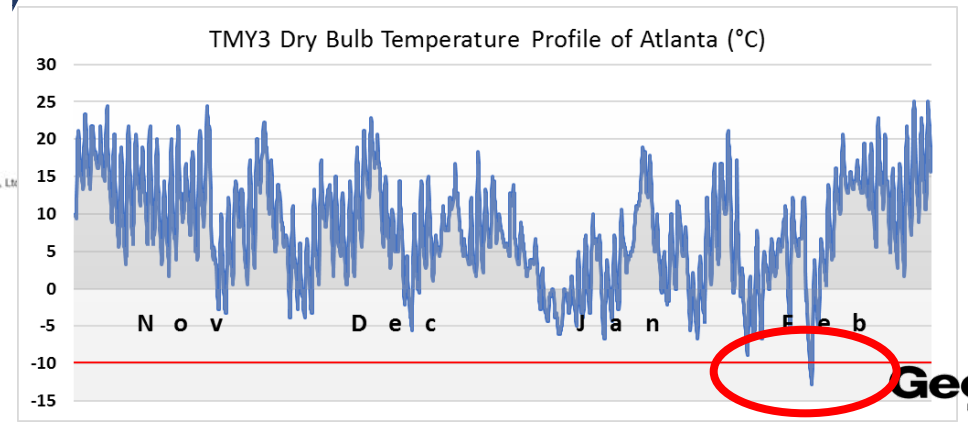


		Number of People in the Household							
		3 people		4 people		5 people		6 people	
		Tank Size*	Collectors**	Tank Size*	Collectors**	Tank Size*	Collectors**	Tank Size*	Collectors**
CLIMATE	HOT	60gal / 250L	1 x AP-20	80gal / 300L	1 x AP-20	80gal / 300L	1 x AP-30	80gal / 300L	1 x AP-30
		60gal / 250L	1 x AP-20	80gal / 300L	1 x AP-30	80gal / 300L	1 x AP-30	120gal / 450L	2 x AP-20
		80gal / 300L	1 x AP-20	80gal / 300L	1 x AP-30	80gal / 300L	1 x AP-30	120gal / 450L	2 x AP-30
		80gal / 300L	1 x AP-30	80gal / 300L	1 x AP-30	120gal / 450L	2 x AP-20	120gal / 450L	2 x AP-30
	COLD	80gal / 300L	1 x AP-30	80gal / 300L	2 x AP-20	120gal / 450L	2 x AP-30	120gal / 450L	2 x AP-30

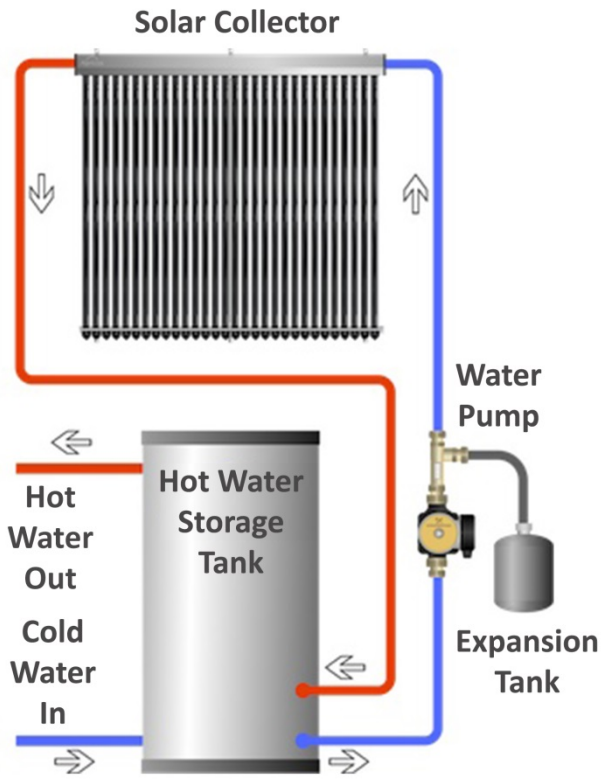
* Suggested minimum solar storage tank capacity in US gallons or Litres.
** Apricus AP 20 and 30 tube evacuated tube solar collectors

Step 2: Direct flow system





Step 3: Done!

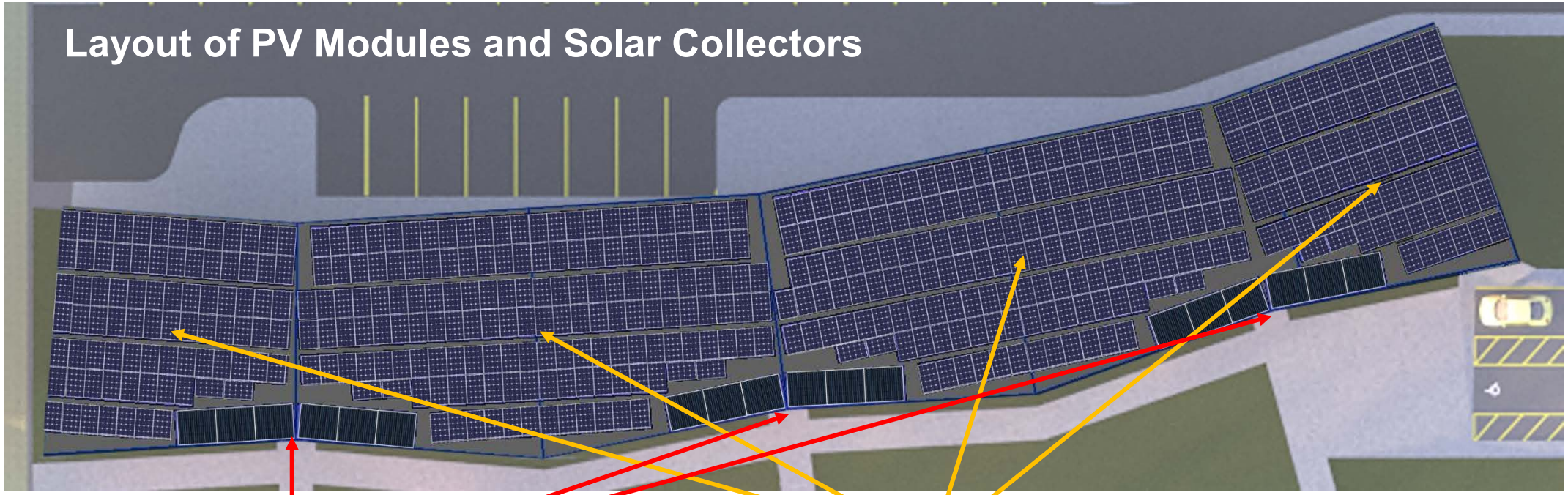


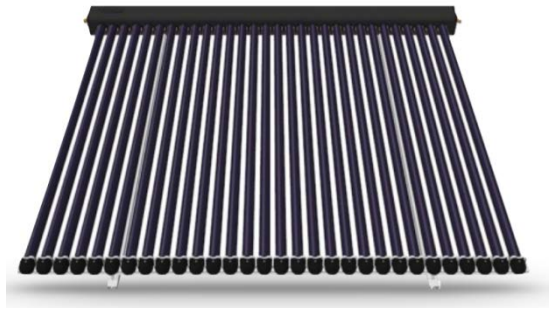
Annual electricity consumption: 212,000 kWh (ac)

System size: 149 kW

Option number	Module size	Number of PV Modules	Actual System Size (Wattage)	PV module efficiency	Module Area (m^2)	Total PV Module Surface Area (m^2)
1	280W (60-cell) (e.g. SolarWorld or Suniva)	533	149,240	16.7%	1.675	892.78
2	320W (60-cell) (e.g. LG Neon2)	466	149,120	19.5%	1.64	764.24
3	350W (72-cell) (e.g SolarWorld XL)	426	149,100	17.6%	1.993	849.02
4	245W (60-cell) (e.g. SolarWorld or Suniva)	609	149,205	15.1%	1.623	988.56

Layout of PV Modules and Solar Collectors





Unit Price	Total Price	Total Price with Tax Credits (30%)
$2.60 per DC Watt	$387,000	$271,000

2017 Federal Tax Credits

Tax Credit: 30% of cost with no upper limit

Expires: December 31, 2021

Tax credits for Solar Energy Systems are available at 30% through December 31, 2019.

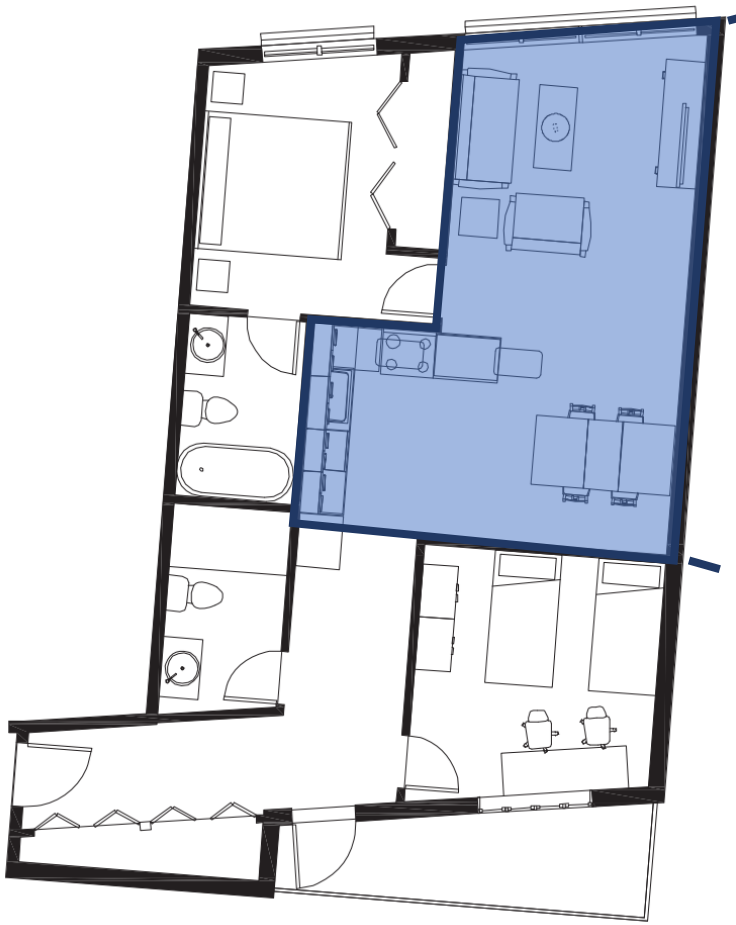
The credit decreases to 26% for tax year 2020; drops to 22% for tax year 2021 then expires December 31, 2021)

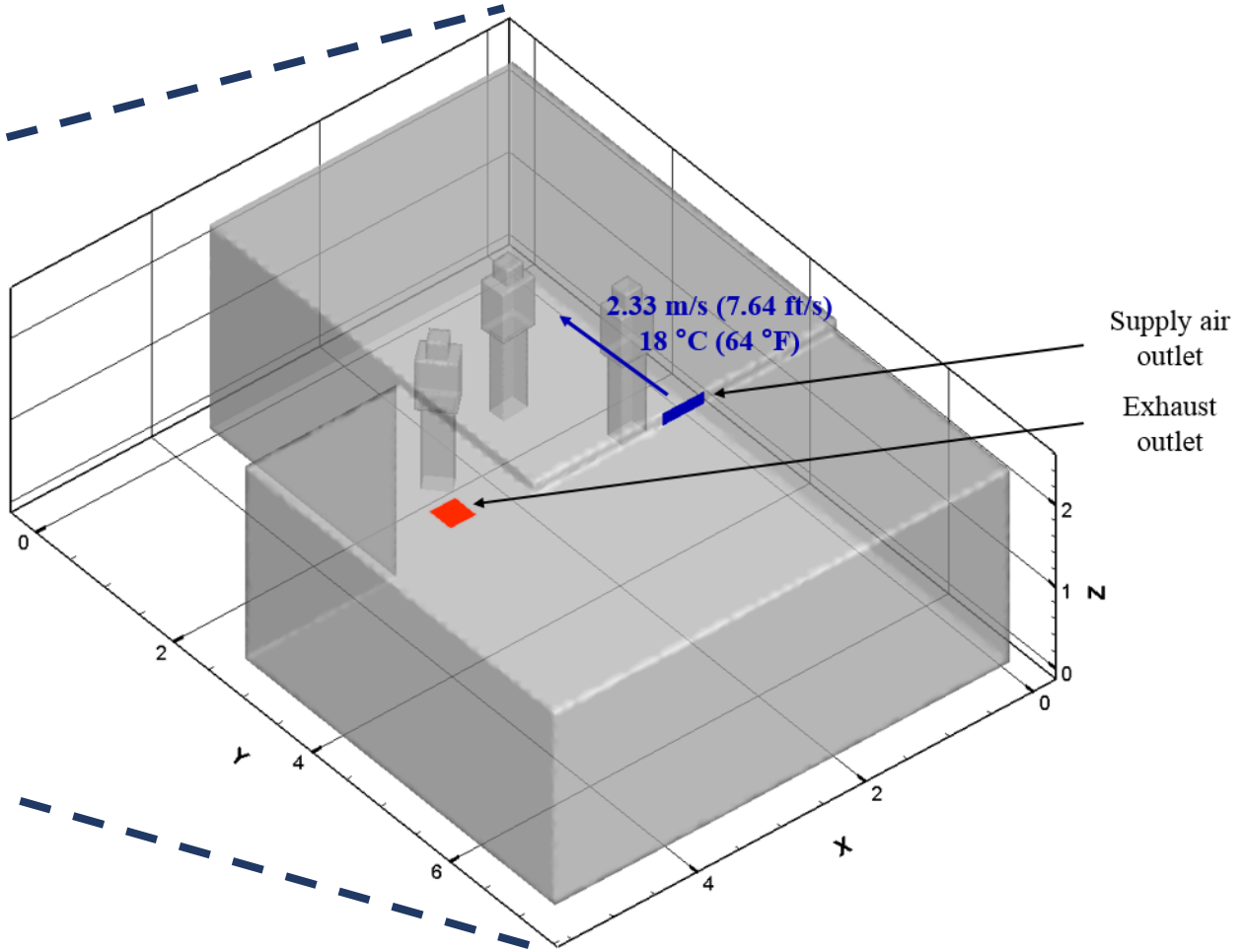
Details: Existing homes and new construction qualify. Both principal residences and second homes qualify.

Rentals **do not** qualify.

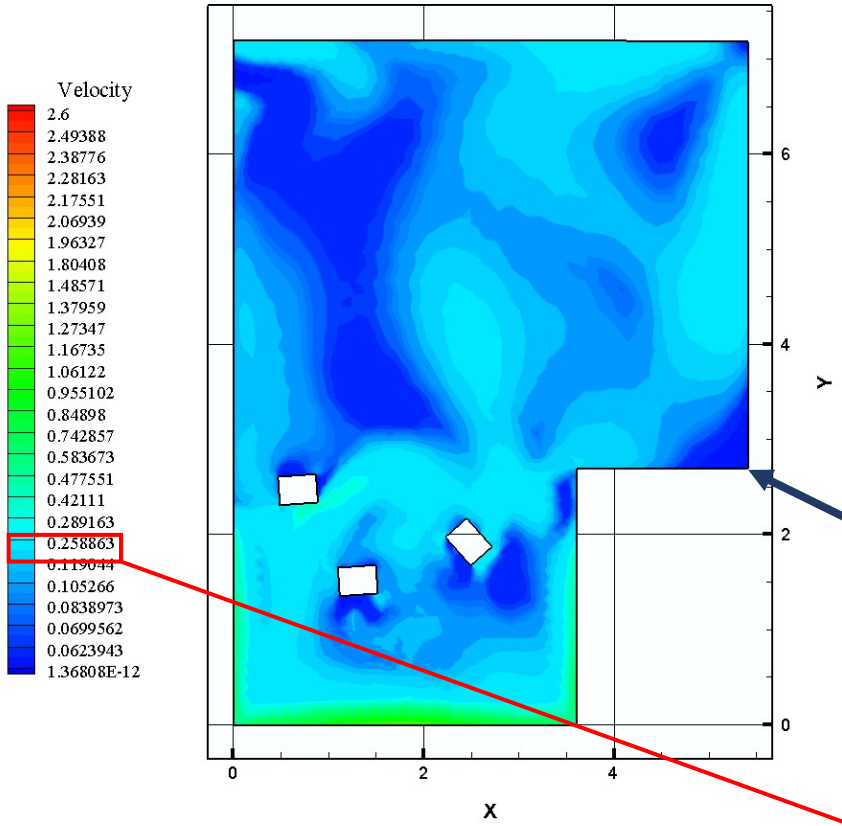
Solar Energy Systems

Living room of Unit B

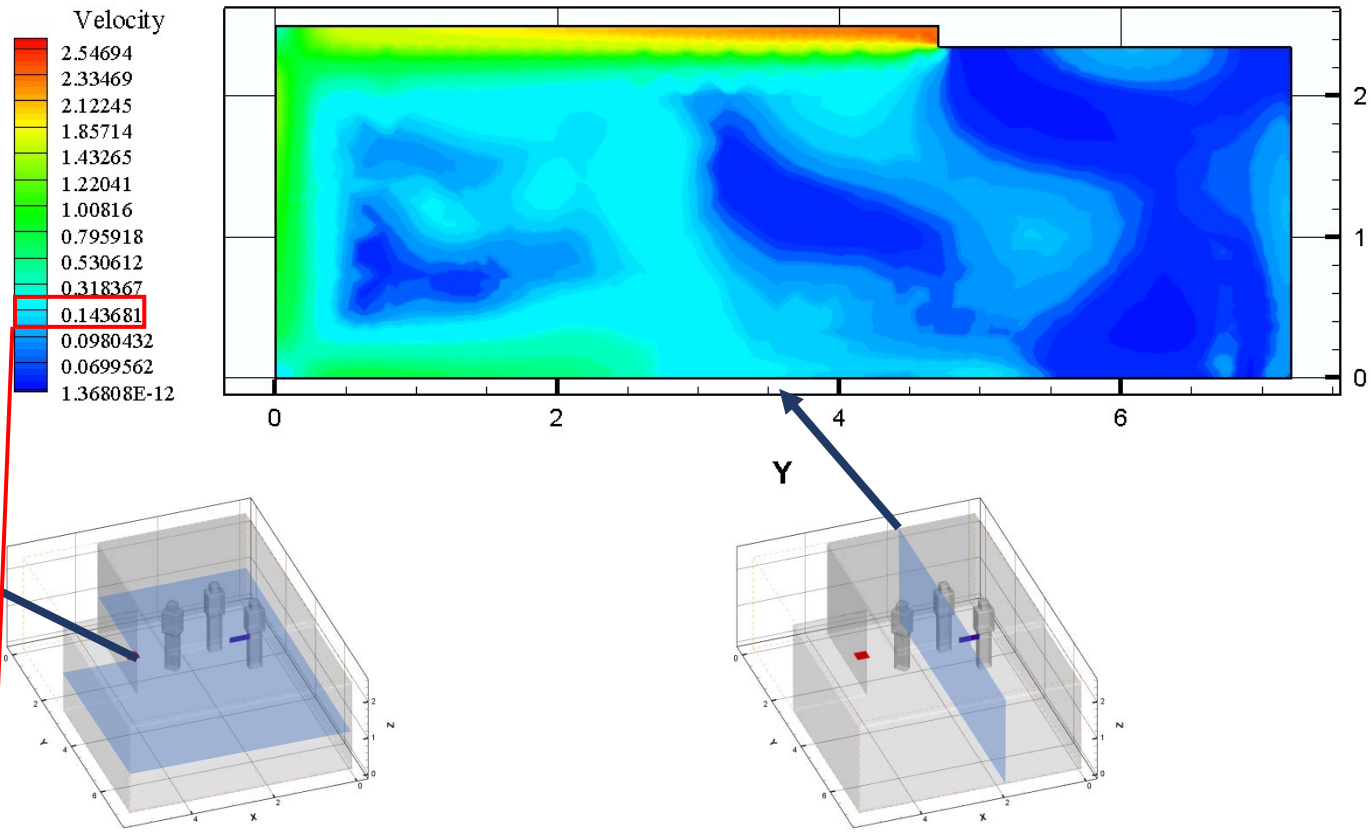




Air velocity distribution on z=1.4 section plane

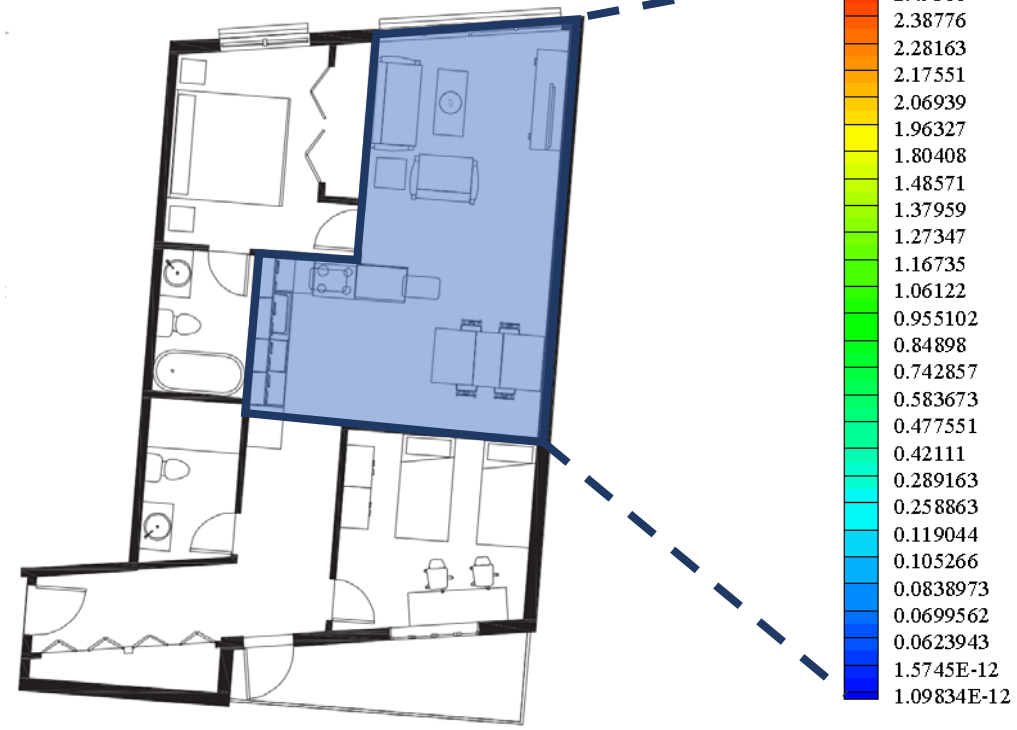


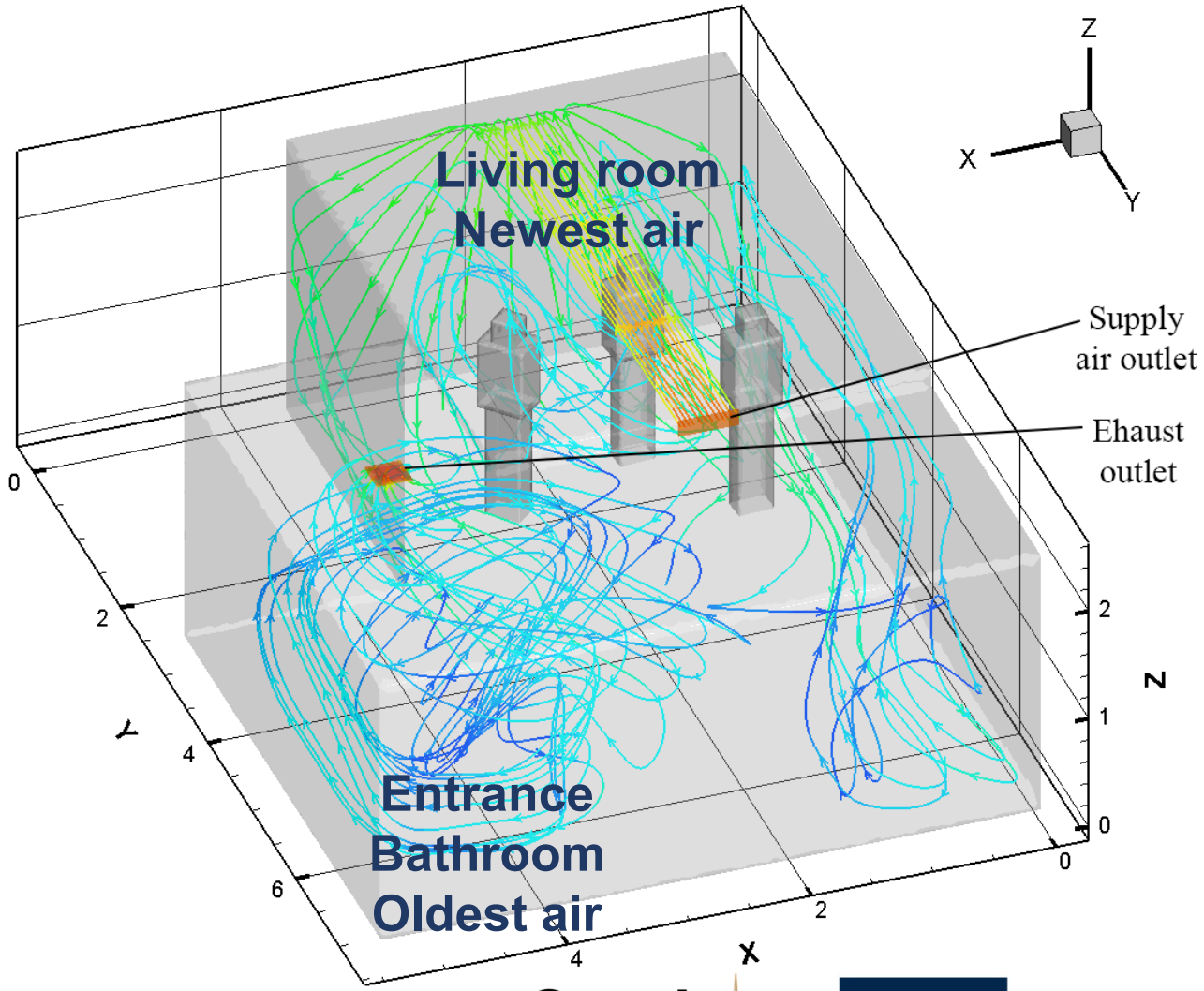
Air velocity distribution on x=1.8 section plane



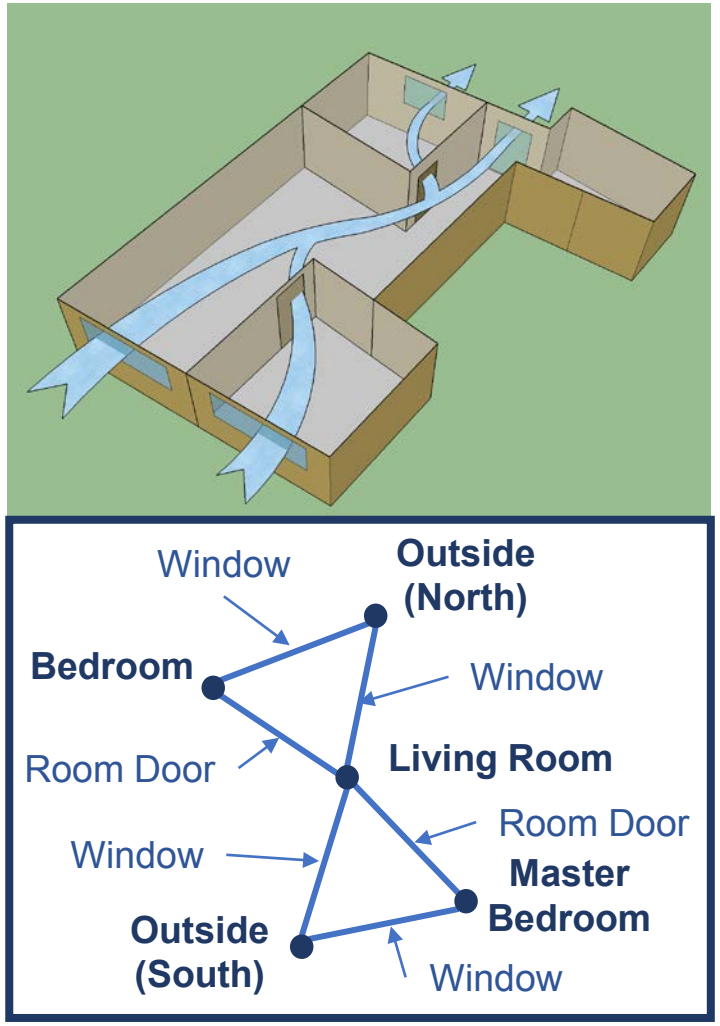
0.5 ft/s

Living room of Unit B

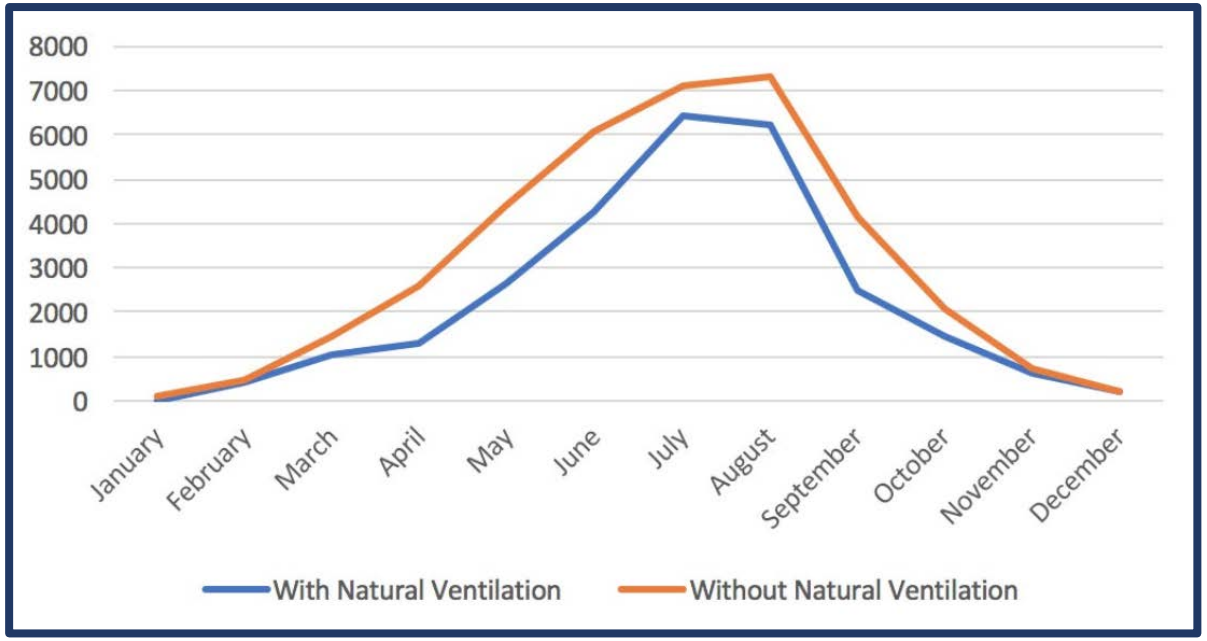




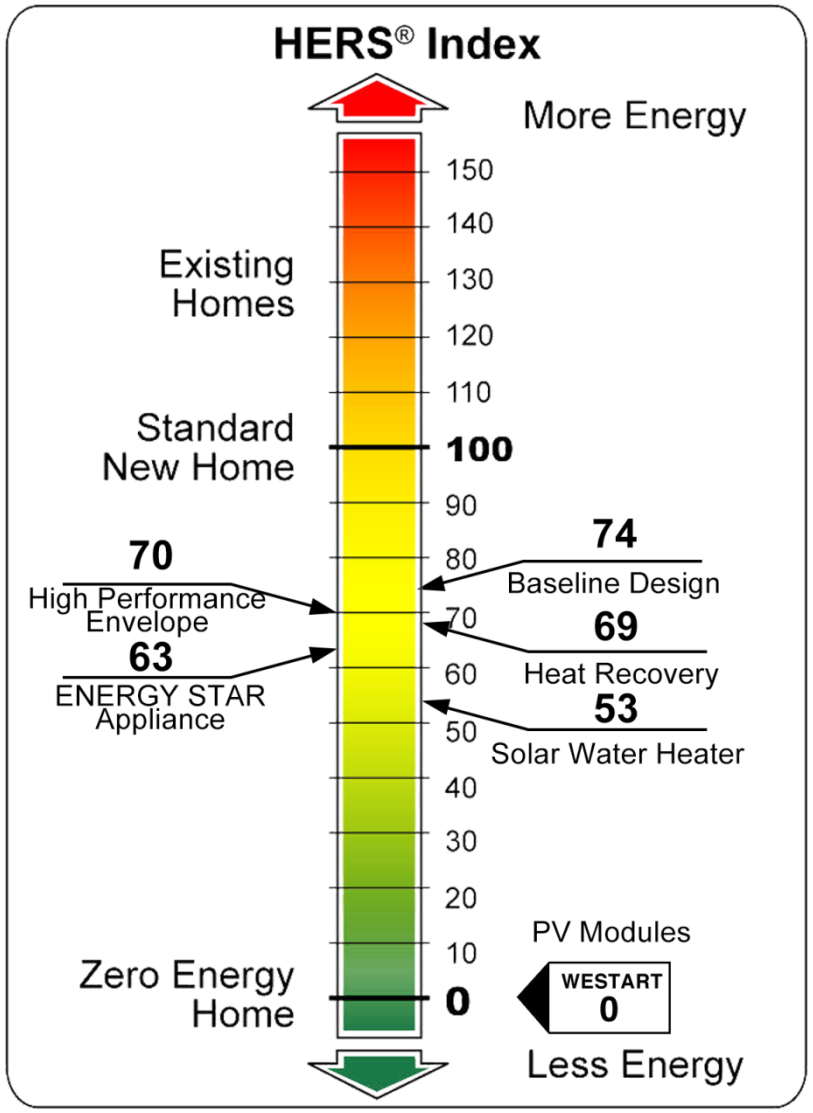
EnergyPlus Air Flow Network Model



Cooling Need with and without Natural Ventilation



Condensation and Mold Issue



74 • **Baseline Design**

69 • **High Performance Envelope & Heat Recovery**

63 • **ENERGY STAR Appliances**

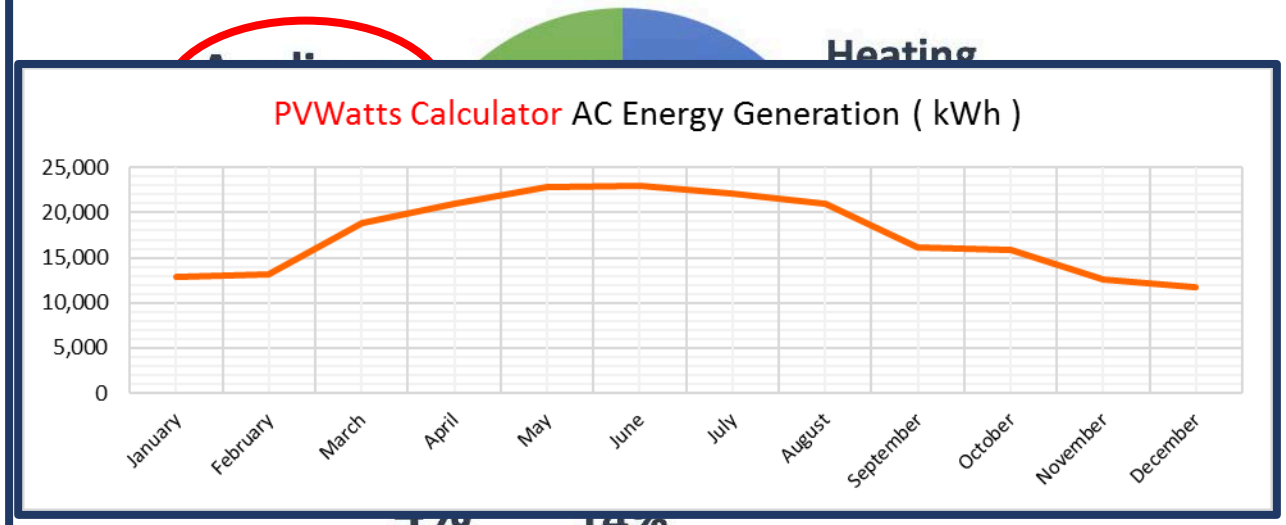
53 • **Solar Water Heater**

0 • **PV Modules**

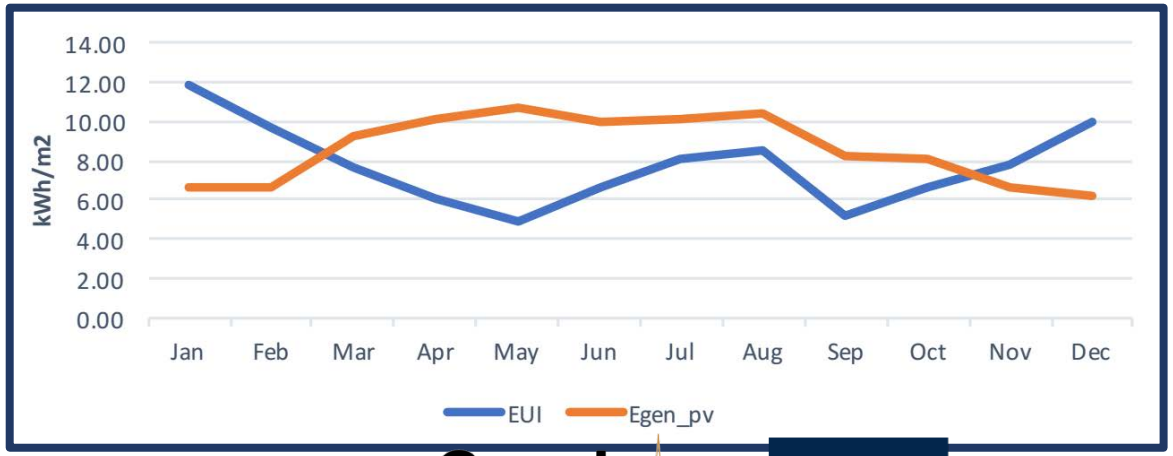
PVWatts Calculator 211,020 kWh per Year

Month	Solar Radiation ($kWh/m^2/day$)	AC Energy (kWh)	Energy Value ($)
January	3.33	12,819	1,282
February	3.86	13,202	1,320
March	5.09	18,880	1,888
April	5.99	21,001	2,100
May	6.39	22,829	2,283
June	6.71	22,966	2,297
July	6.31	22,099	2,210
August	5.98	20,991	2,099
September	4.66	16,114	1,611
October	4.34	15,863	1,586
November	3.49	12,585	1,258
December	3.07	11,673	1,167
Annual	4.94	211,022	$ 21,101

EUI Distribution



EPC Monthly Energy Consumption and Generation

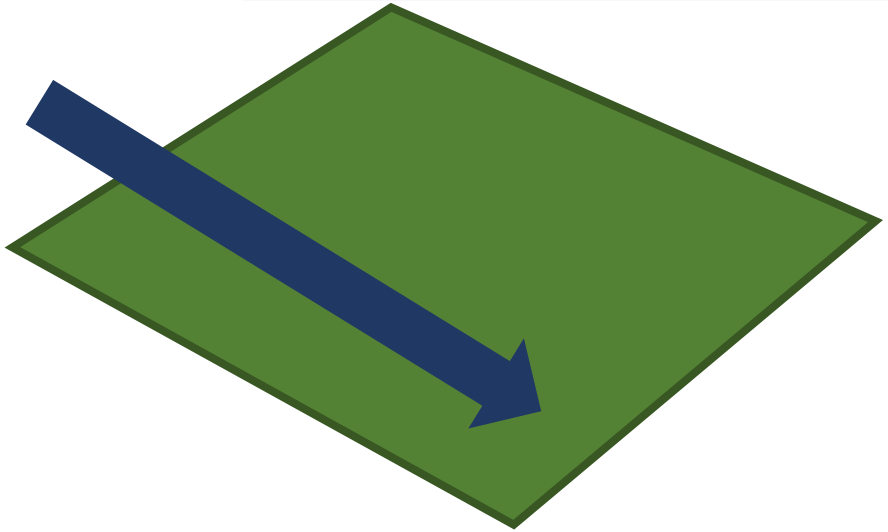


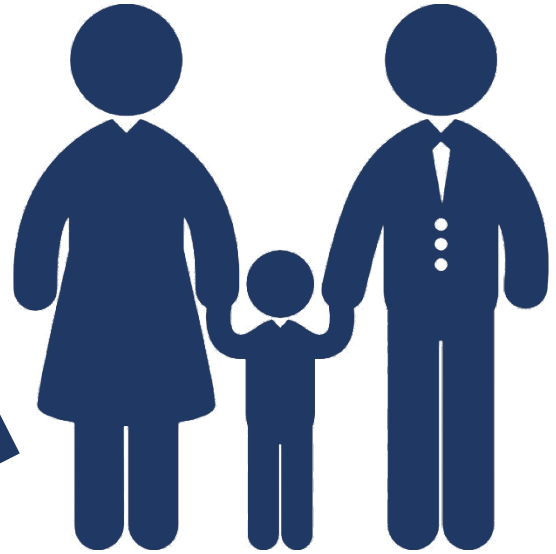
Westside Atlanta Land Trust (WALT)

Our Discussion with WALT Staffs

Westside Atlanta Land Trust (WALT)

Leases the land to the residents at a price of $1 for 99 years





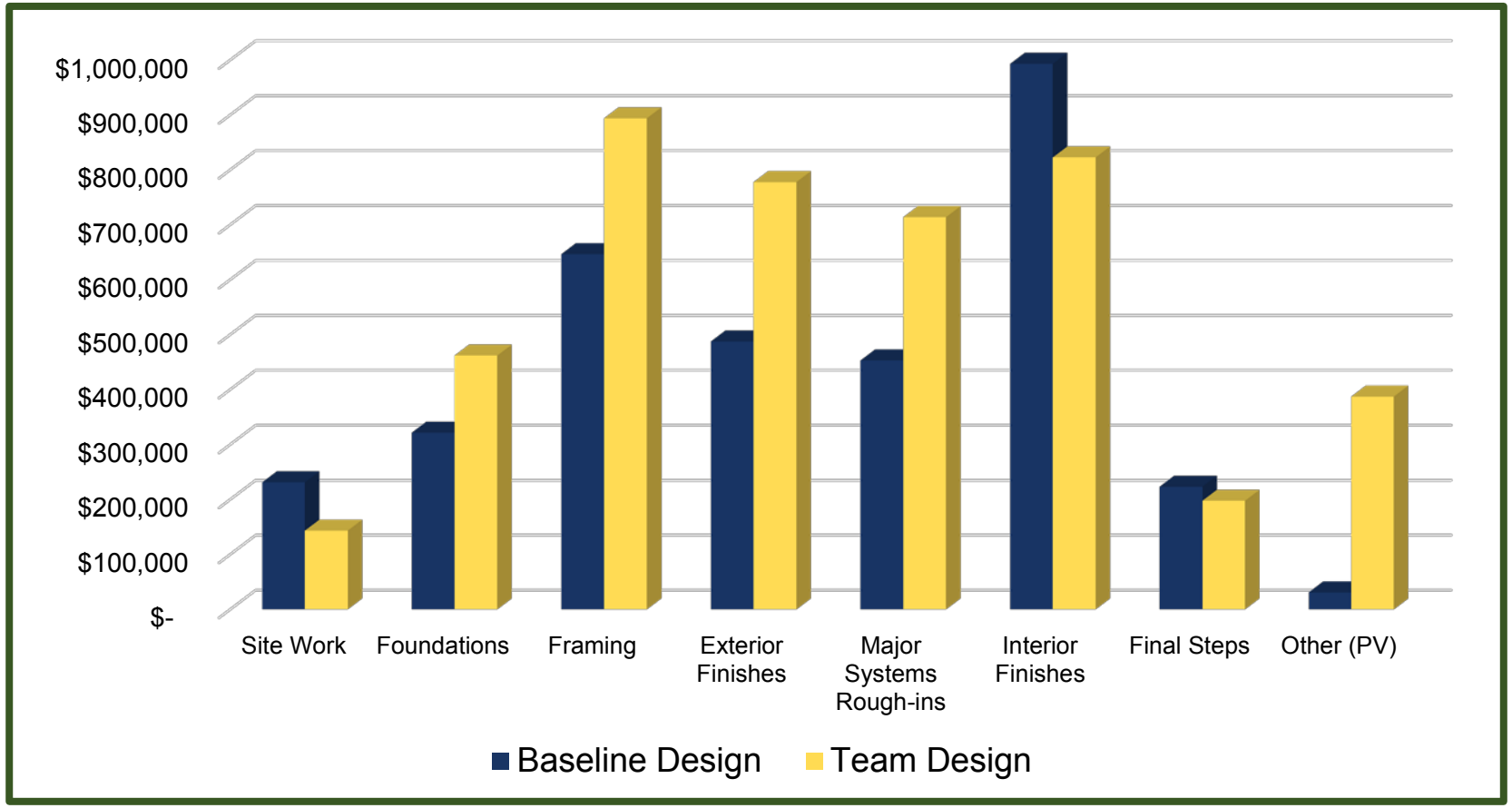
Residents

Only need to pay for the building itself

Total Construction Cost	
Westart	$3,388,152
Baseline	$4,282,901

26% higher than baseline

Construction Cost Breakdown



Case 1: Westart is part of the WALT program

No lot cost
No profit

Assuming families buy the units with a 30-year mortgage

Household income	$24,000	$48,000
Debt to income ratio	37%	33%

Case 2: Westart is not part of the WALT program

Taking all cost into account

Assuming families buy the units with a 30-year mortgage

Household income	**$30,000**	**$55,000**
Debt to income ratio	**38%**	**37%**

1. We integrate multiple simulations into the design process.

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WIFI

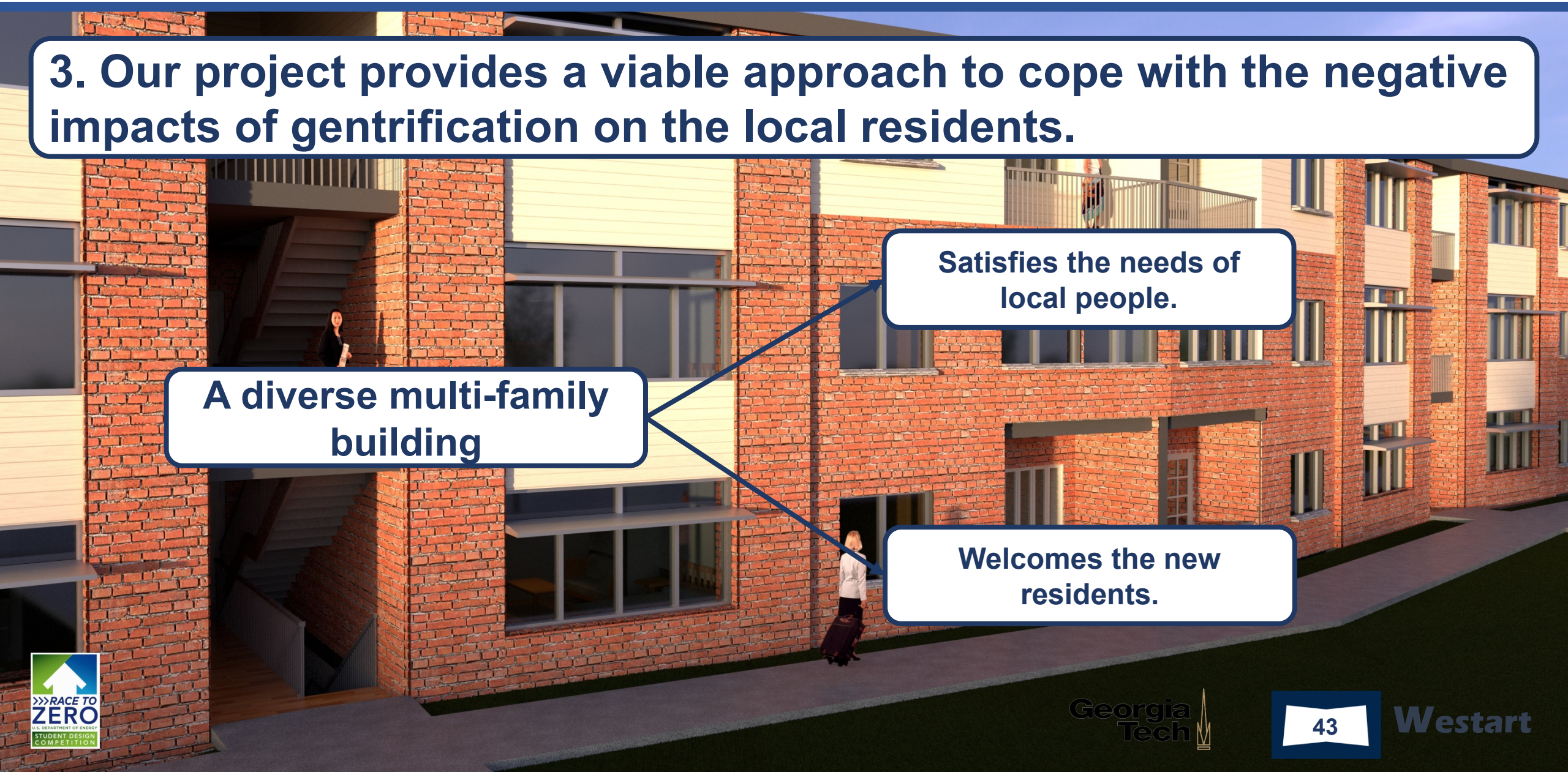
EPC

2. We interact actively with community the to learn what our target population really need.

We went to the neighborhood to communicate with the local residents.

We attended the Neighborhood Planning Units meeting of West End.

3. Our project provides a viable approach to cope with the negative impacts of gentrification on the local residents.



4. Our project shows a feasible path to improve the living quality of low-income families.

Unit A
463 sf
$90,000

Unit B
933 sf
$180,000


RACE TO ZERO
U.S. DEPARTMENT OF ENERGY
STUDENT DESIGN COMPETITION
Georgia Tech
Project Data
o 1261 Lucile Avenue Southwest, Atlanta, Georgia
o Historical area
o DOE Climate Zone 3A
o 933 square feet for 2B2B unit accommodating for 4-people family
o 463 square feet for 1B1B unit accommodating for 2-people family
Technical Specifications (Preliminary Value)
o Wall Insulation: R-36.8
o Window Performance: Double pane, Low E
o Roof Insulation: R-40.6
o HVAC specifications: Ductless VRF System
o Domestic Hot Water: Solar Water Heater with Back-up Electric Heating

Thank you!