SunBlock Elementary

University of Arizona
Carina Eichorst, Alec Kelly-Jones, Wen Xie

College Garden

Wen Xie
4th Year - BA Architecture
Focus: Design

Carina Eichorst
4th Year - BA Architecture
Focus: Team Lead

Alec Kelly-Jones
1st Year - MA Architecture
Focus: Energy Modeling

Britt Wachter
5th Year - BA Architecture
Focus: Coordination

Jonathan Bean
Faculty Lead

Our Team

TEP
Tucson Electric Power

Watershed Management Group

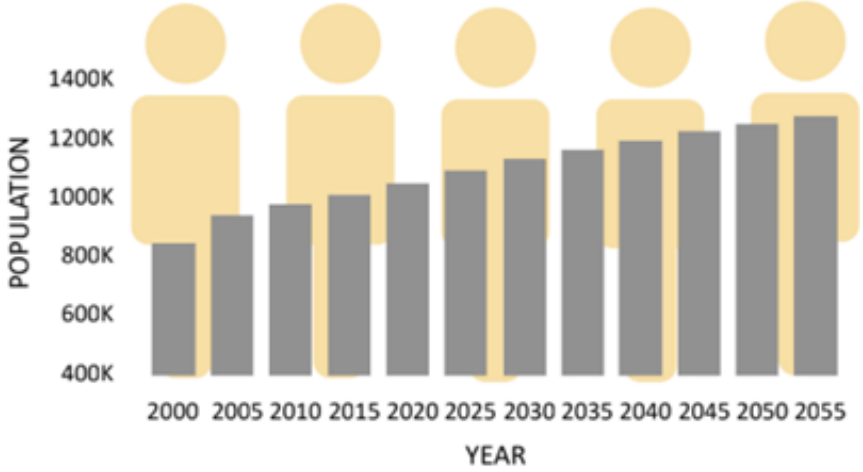
TUCSON UNIFIED
SCHOOL DISTRICT

Industry Partners

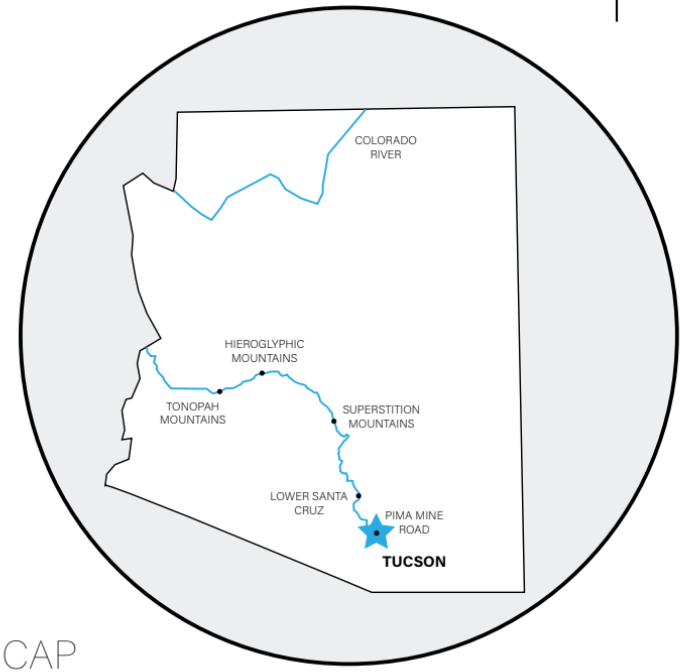

Utah
Nevada
Arizona
Califonia
New
Mexico
Colorado River
Central Arizona Project
Gila River
Tucson
Mexico
Water Source

Tucson

Introduction

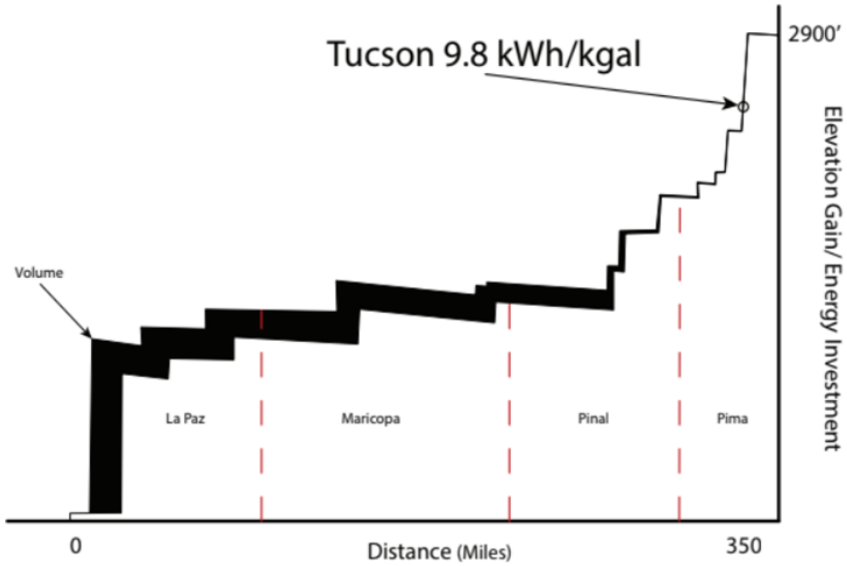


Tucson



CAP

CAP Water Energy Nexus



Tucson Water

TEMPERATURE (DEGREES)

highest in summer 110

difference between the high and low 20

YEARLY RAINFALL (INCH)

Tucson 13

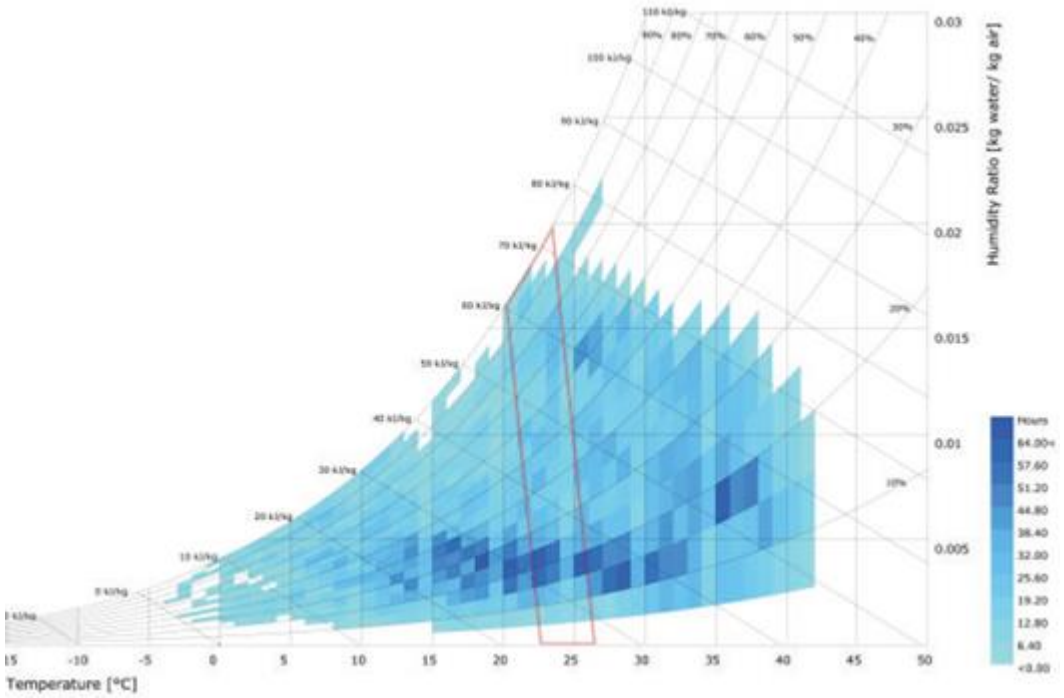
US average 40

Days of Sun

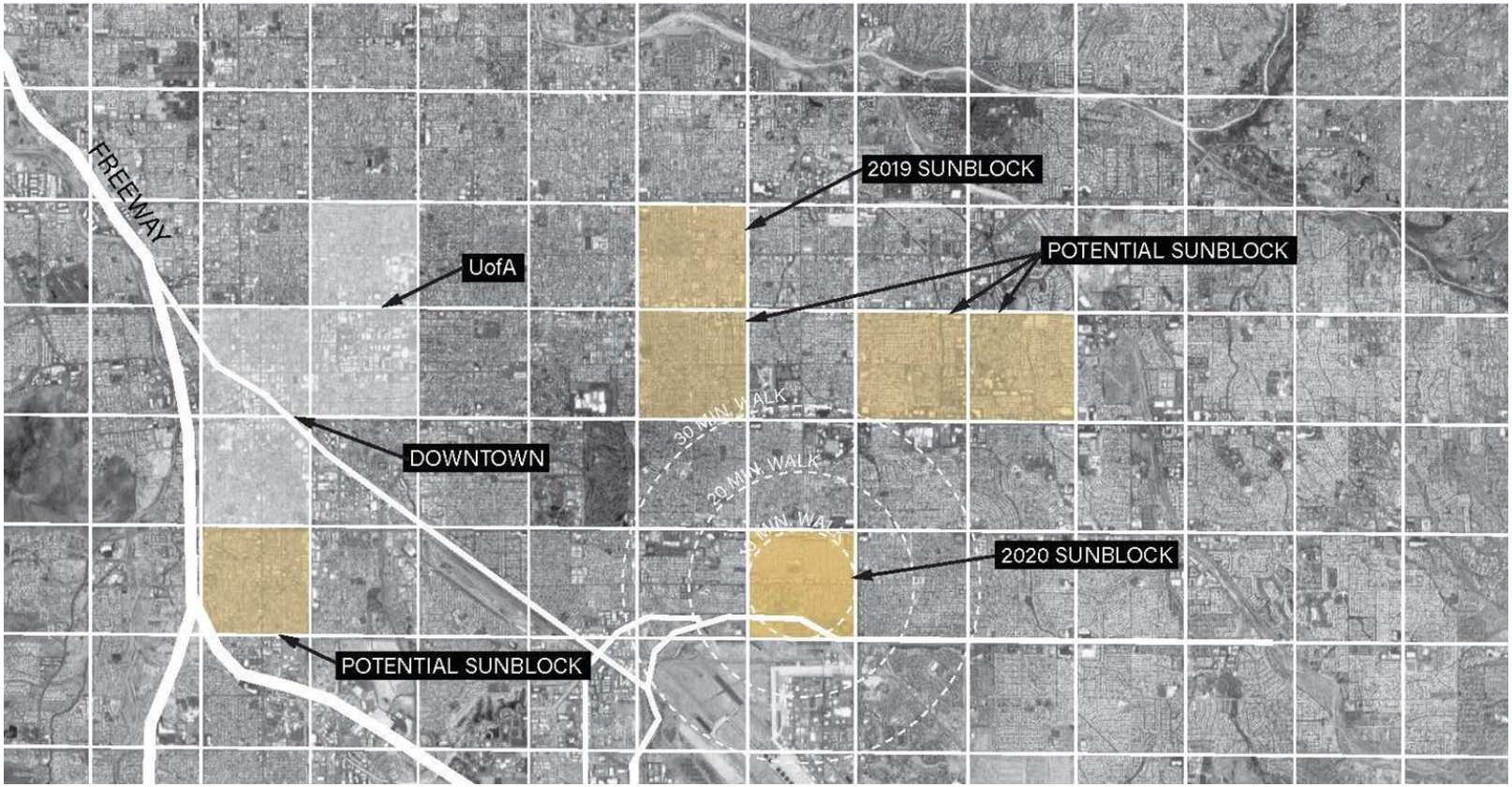
Not Sunny 81

Partly Sunny 91

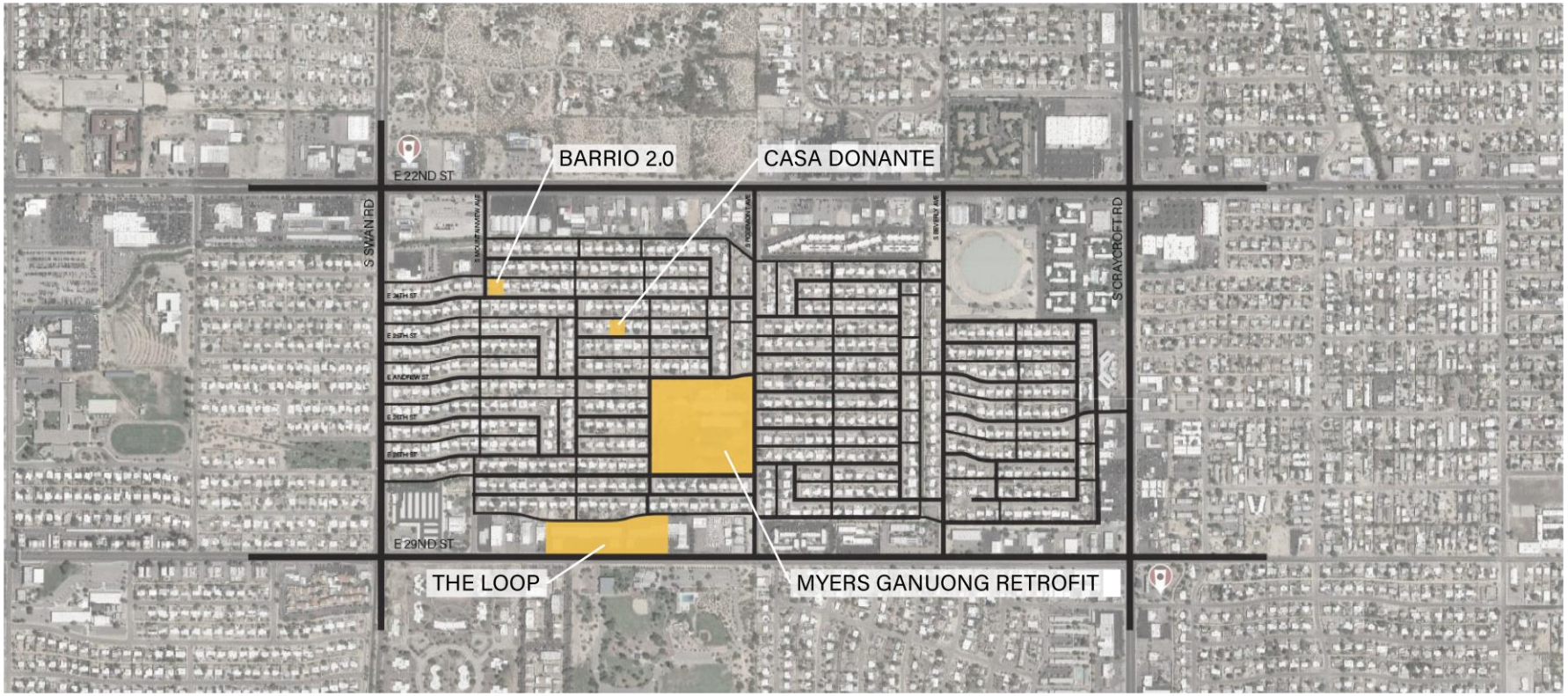
Sunny 193



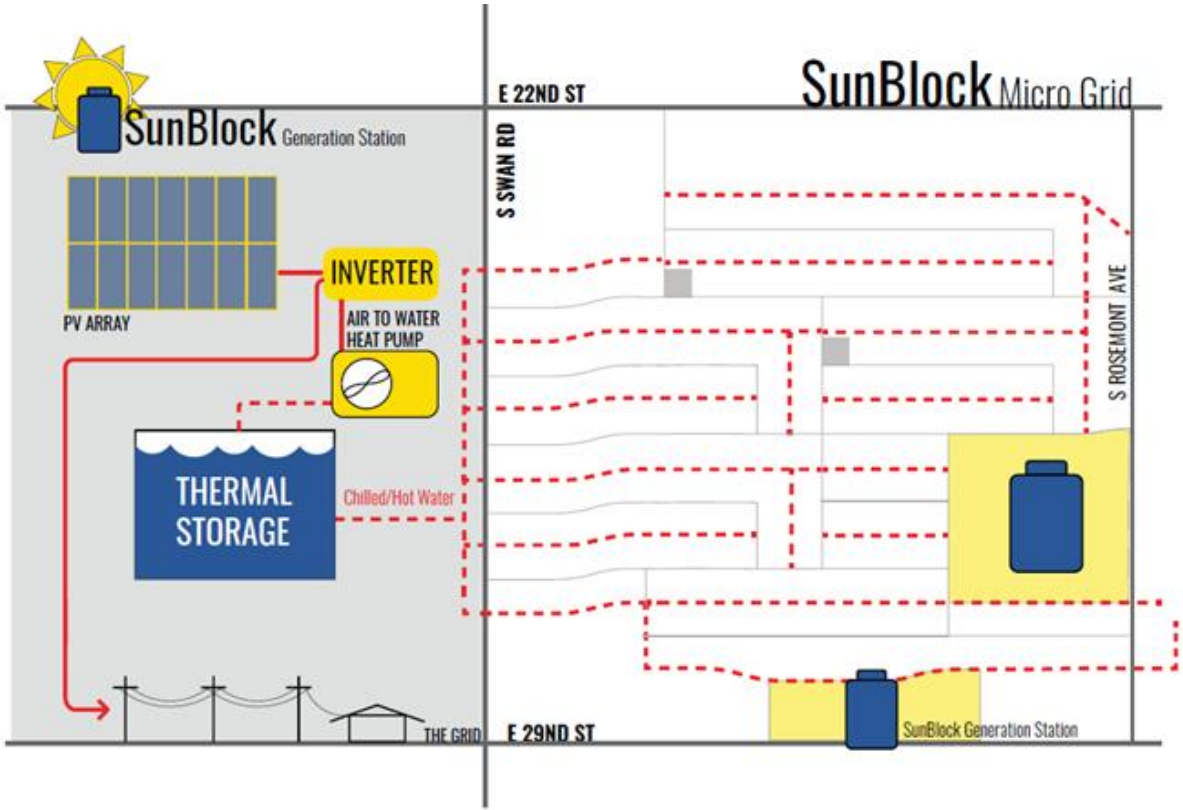
Climate


FREEWAY
2019 SUNBLOCK
POTENTIAL SUNBLOCK
UofA
DOWNTOWN
30 MIN WALK
20 MIN WALK
2020 SUNBLOCK
POTENTIAL SUNBLOCK

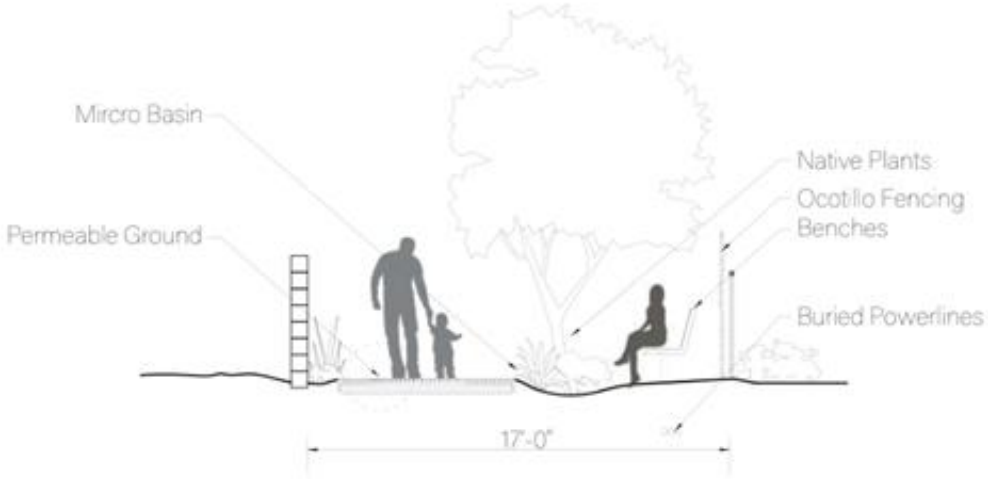
City Map



Sunblock District Energy Loop System



Sunblock District Energy Loop System



Utility Easements

LEARNING ENVIRONMENT

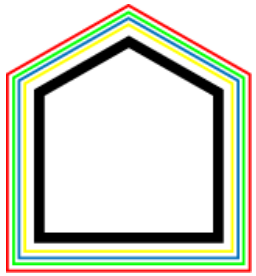
REPLICABILITY

SUSTAINABILITY

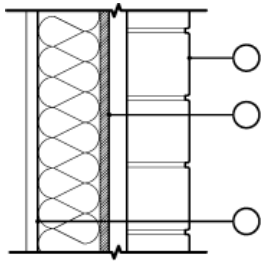
RENEWABLE ENERGY

GREEN BUILDING

Design goals



Airtightness

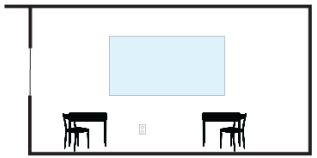


Envelope

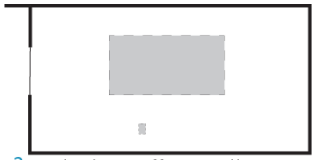
Ventilation system

Retrofit existing air handlers

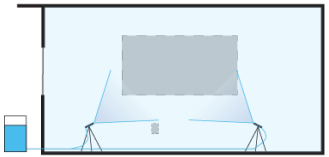
Thermal distribution



1. Before Application



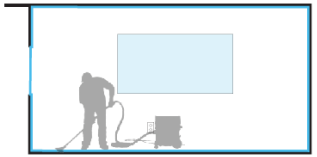
2. First clear the room of furniture and be sure to cover all apetures that are not being caulked such as windows and powerpoints.



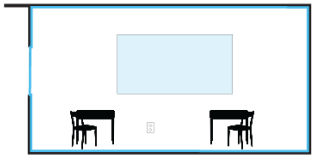
3. Pressurize and humidify the building with a blower door and then set up the nozzles and spray the AEROBARRIER caulking agent into th air for approximatley two hours.

4. The caulking agent will change phases from liquid to solid when it comes into contact with the exterior envionment at the point of leakage. The Product is capable of sealing holes up to 5/8" in diameter.

5. Depressurize the zone and allow 20 minutes for the remainder of the airborne AEROBARRI-ER to settle before entering.



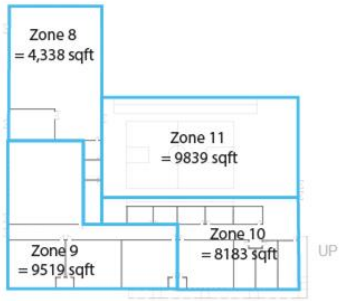
6. The Remove appeture coverings vacuum interior surfaces.

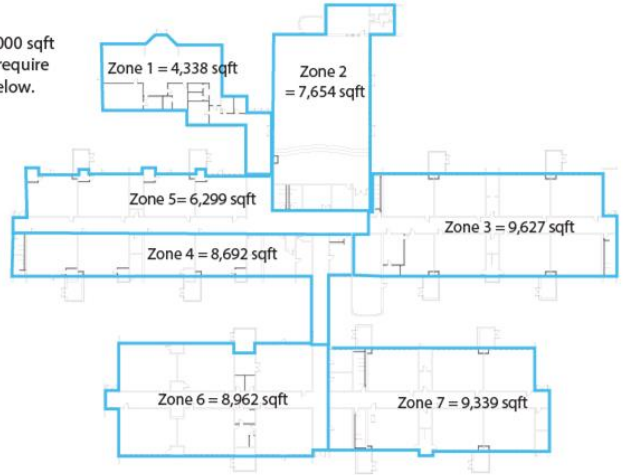


7. The area is now tighly airsealed and safe for occupation.

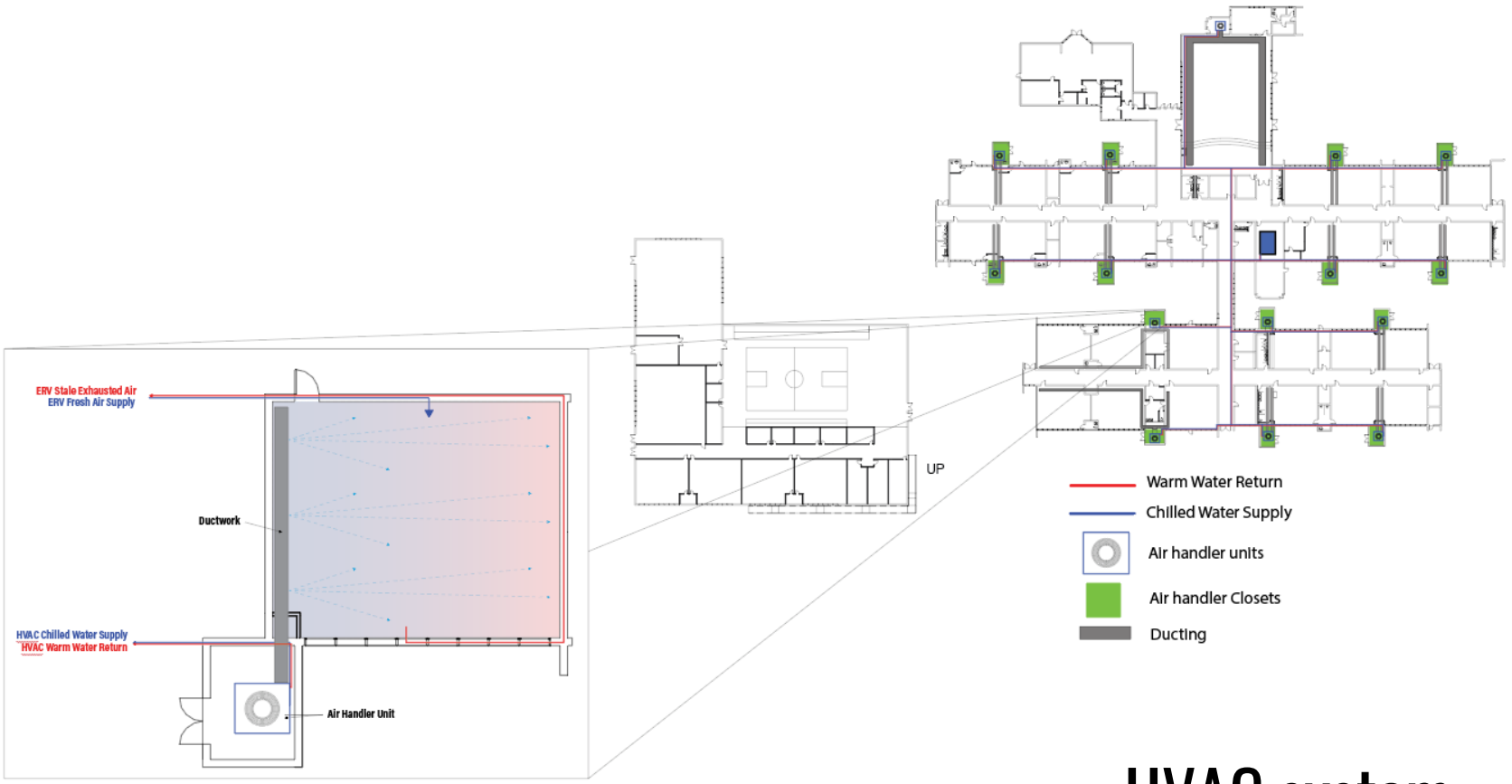
AEROBARRIER™
Breakthrough Envelope Sealing Technology

AeroBarrier works best if applied to areas of 10,000 sqft at a time. This means that Myers Ganoung will require 11 applications across the zones displayed below.



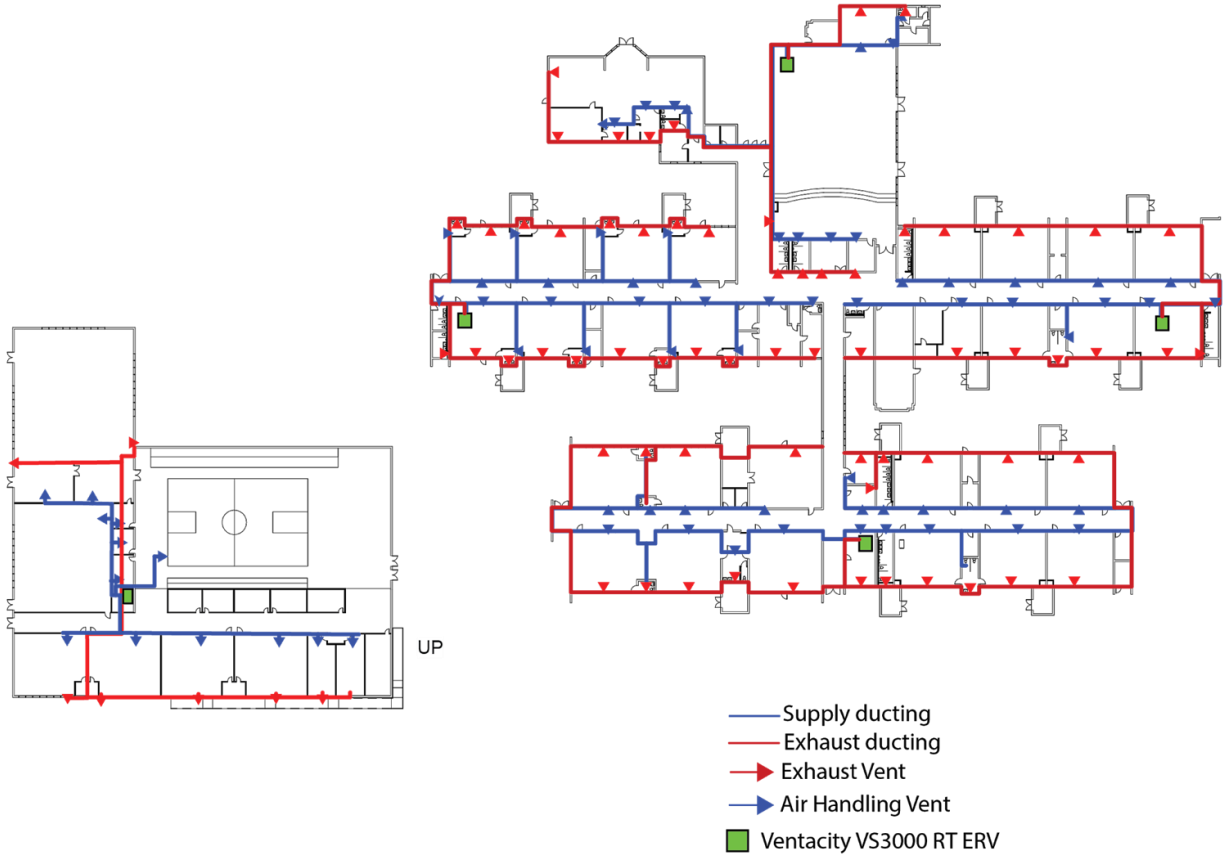


Airtightness



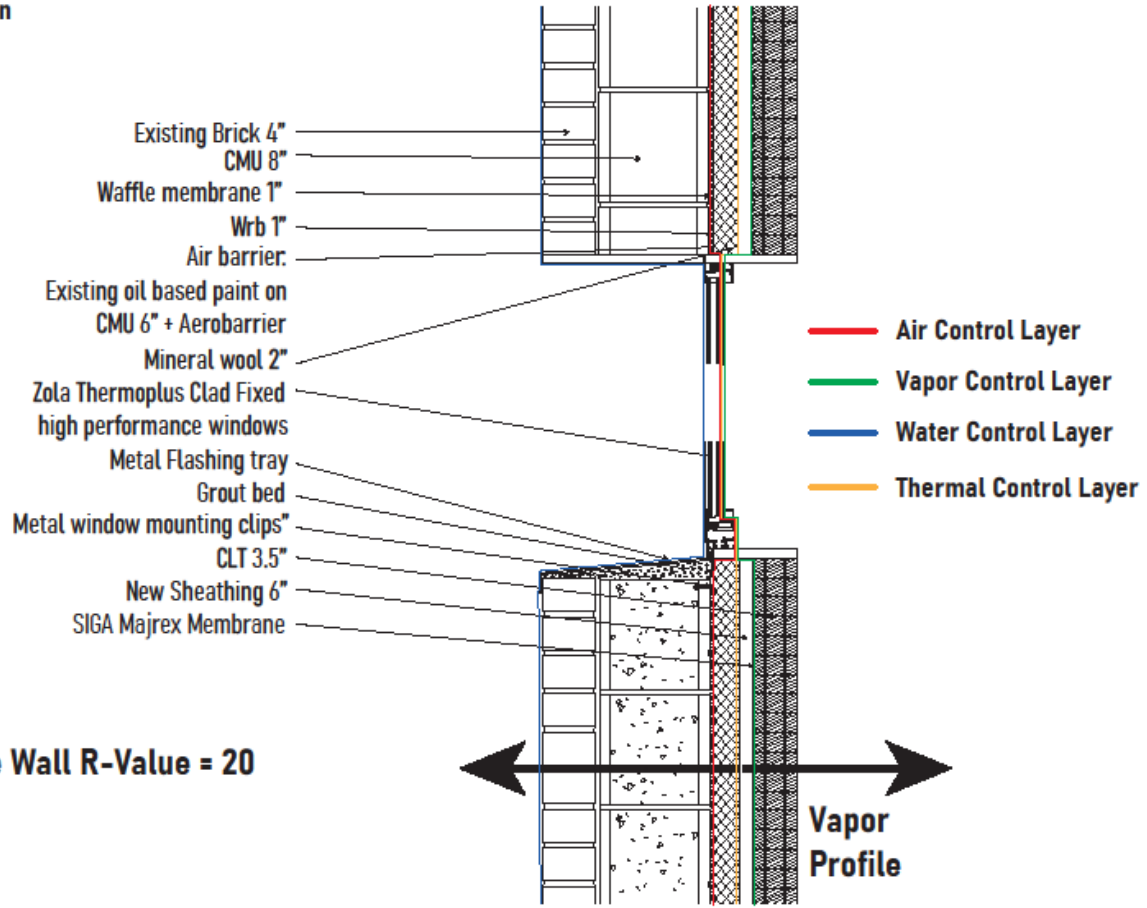
SINGLE CLASSROOM

HVAC system

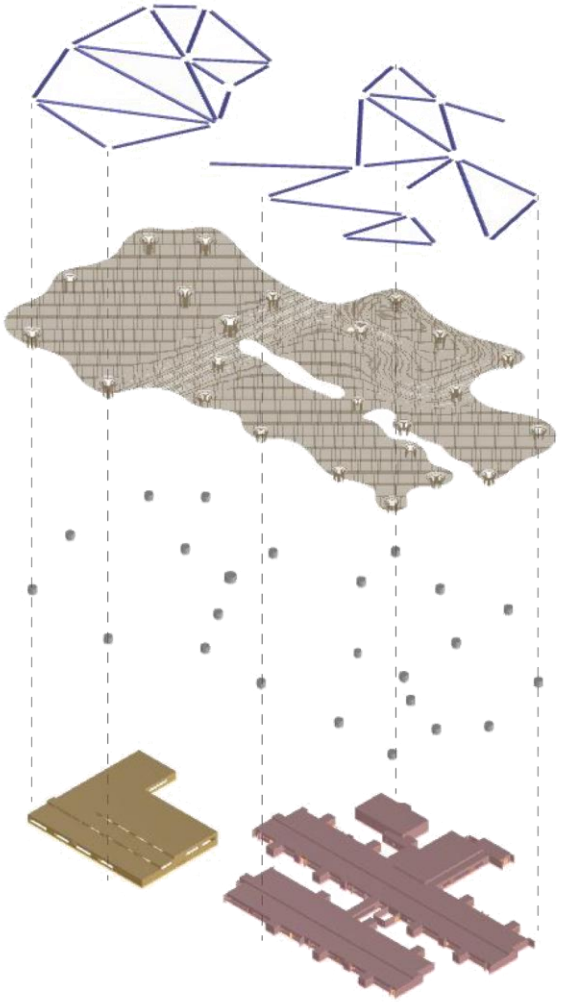


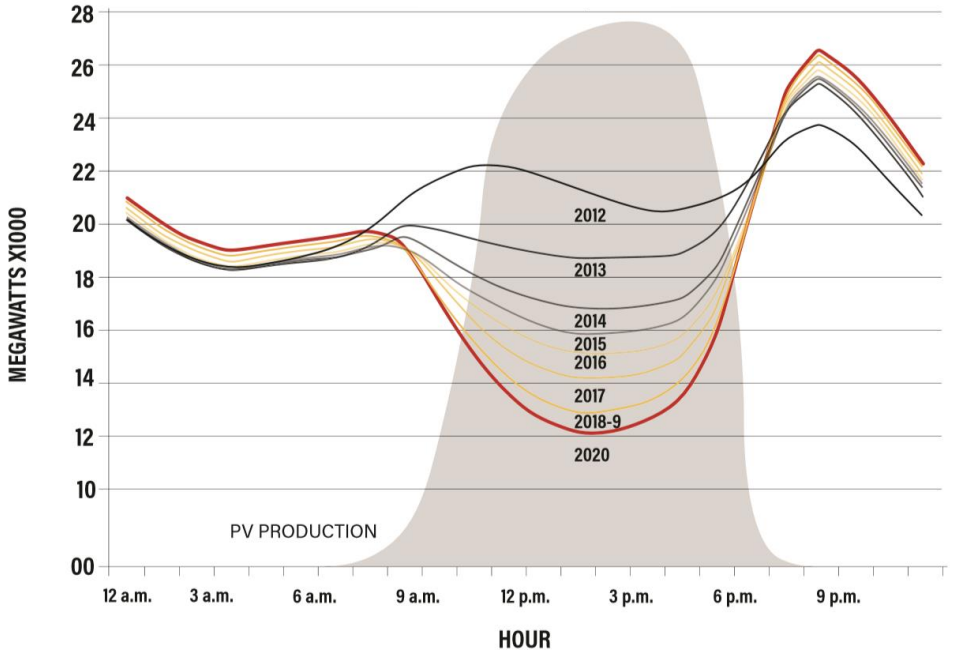
Ventilation system

Wall Section

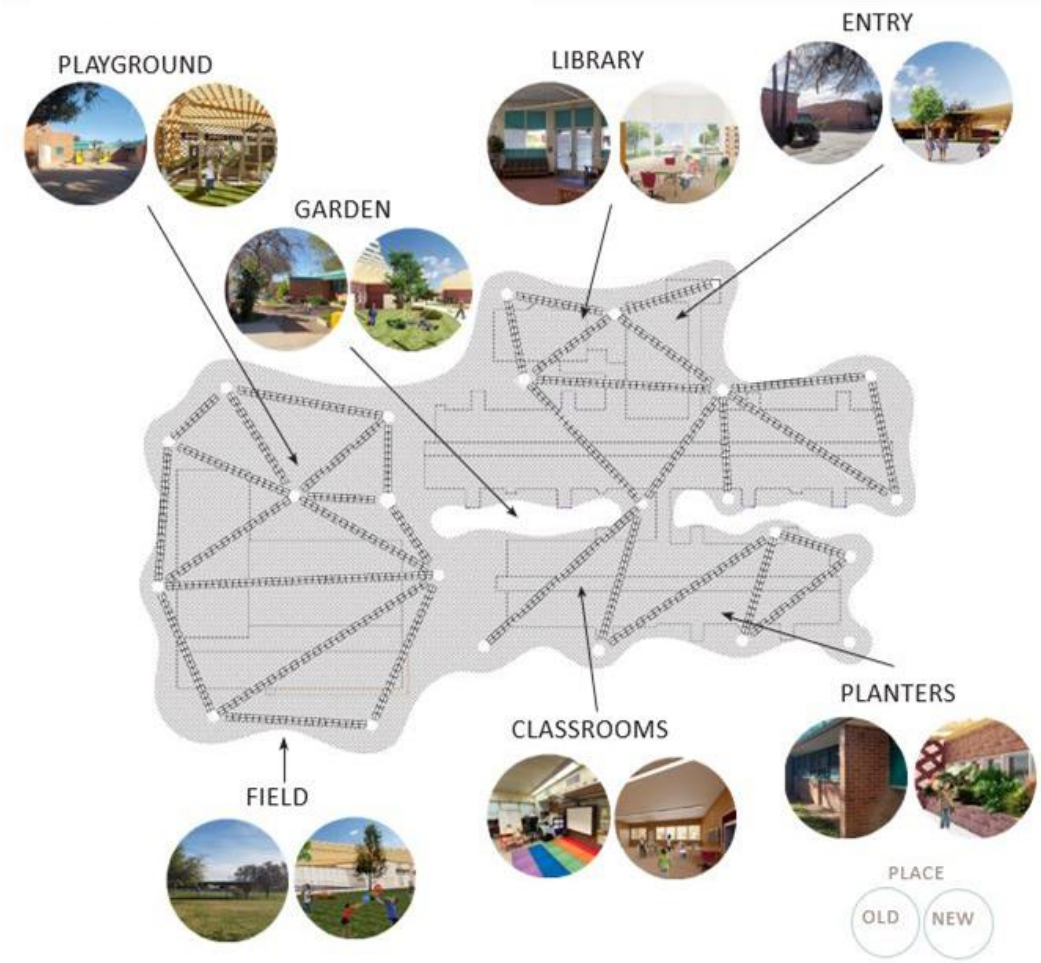


Envelope

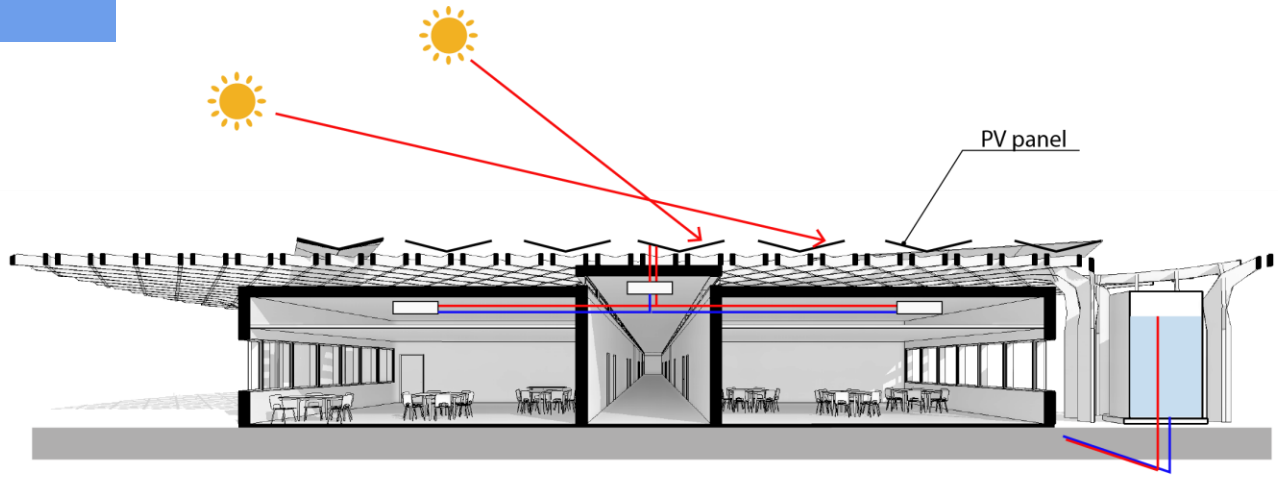



MEGAWATTS X1000
28
26
24
22
20
18
16
14
12
10
00
12 a.m.
3 a.m.
6 a.m.
9 a.m.
12 p.m.
3 p.m.
6 p.m.
9 p.m.
HOUR
2012
2013
2014
2015
2016
2017
2018-9
2020
PV PRODUCTION

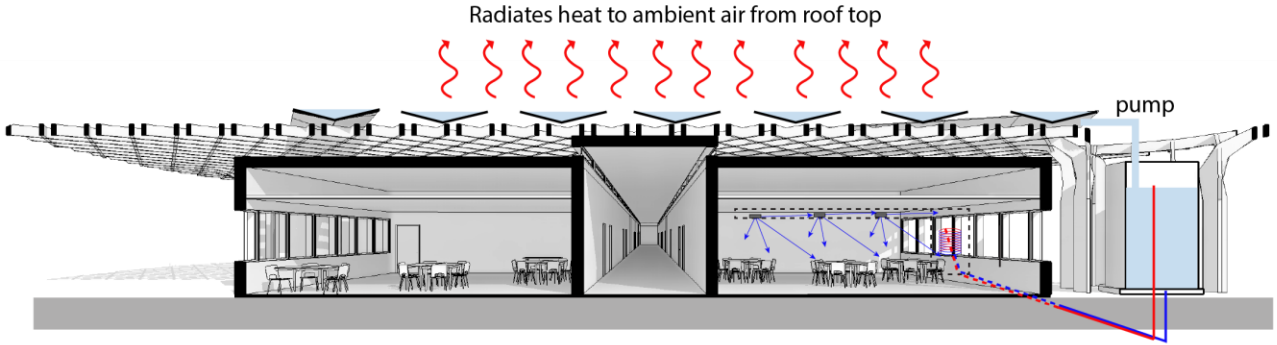
Grid Stress



Superstructure



Day time



Night time

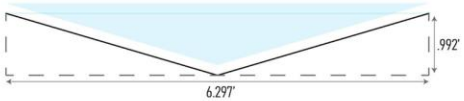
System Operation

Myers Ganoung Radiative Cooling System Capacity

1 Fundamental Thermodynamic Principle

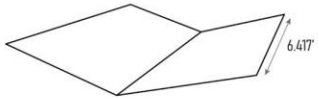
1lb of Water changing 1 degree Fahrenheit = 1 Btu of Energy

2 Cross-sectional area of PV array



(Base x Height) / 2 = Area
(6.297'x.992') / 2 = 2.895sqft

3 Length of Panels



1300 Panels (6.417' per panel) / 2 per unit = 4,171.05 linear feet

4 Total array volume

Cross-sectional area x length = volume
2.895sqft x 4,171.05ft = 12,075.19ft^3

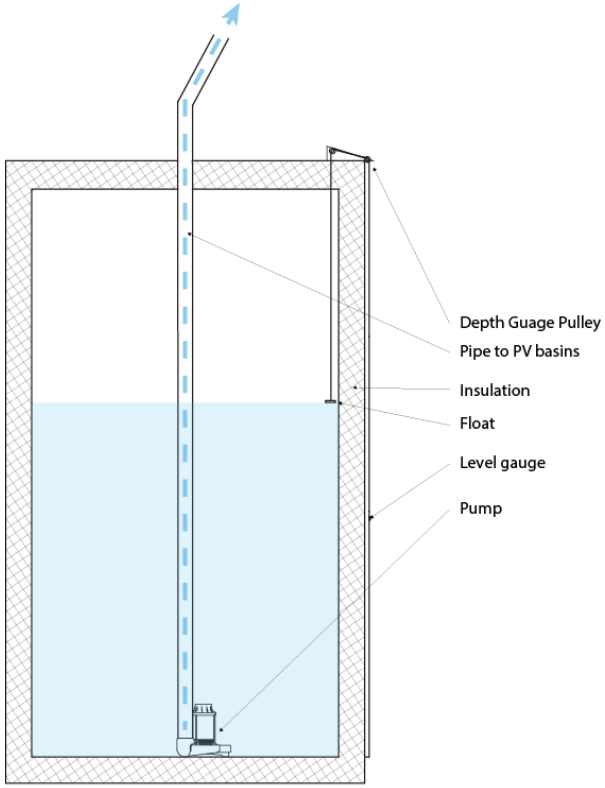
5 Mass(lbs) of Water

1 ft^3 of water = 62.43lbs
12075.19ft^3 x 62.43lbs = 753,854.05lbs

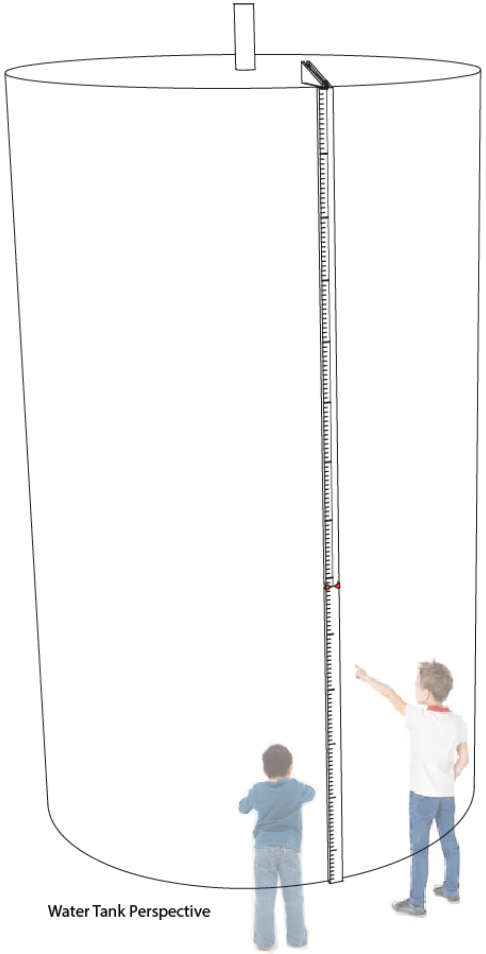
6 Thermal Capacity of system assuming 10 degree Fahrenheit temperature change.

Mass of water(lbs) x change in temperature(Fahrenheit) = cooling energy created(btu)
753,854.05lbs x 10F = 7,538.54kbtu

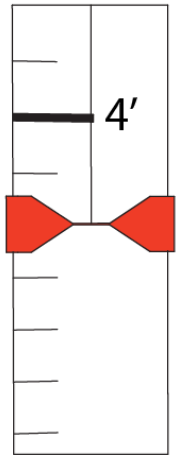
Radiative system



Water Tank Section

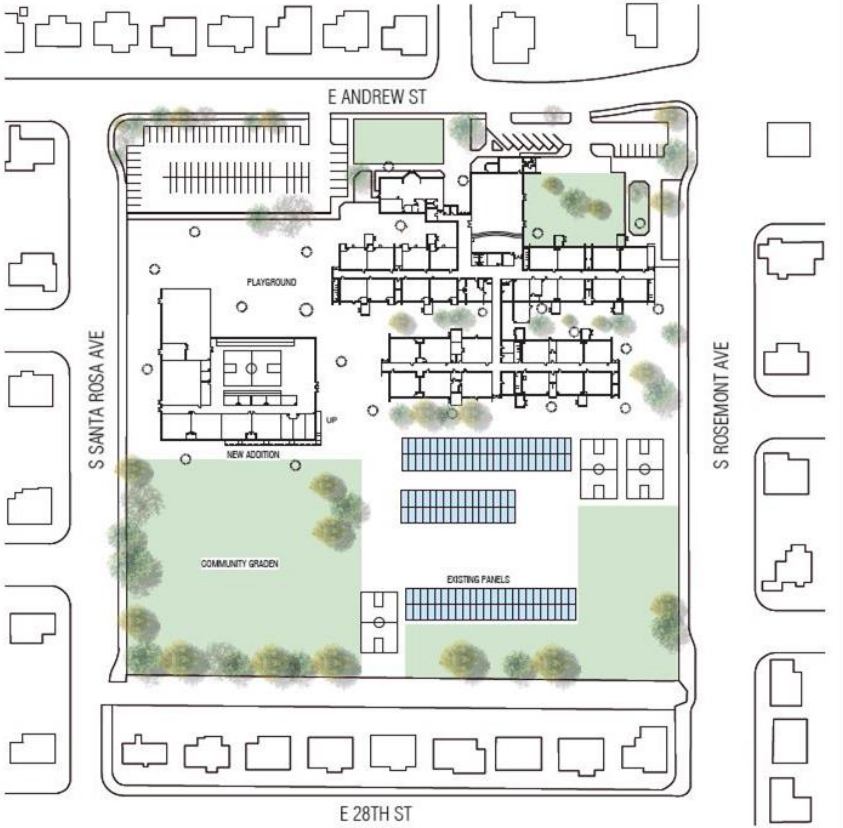


Water Tank Perspective



Water Tank Depth Gauge

Water Tanks

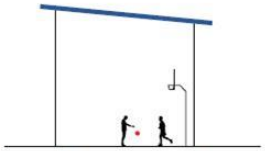


Site Plan

Design Introduction

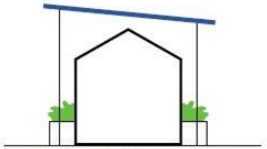
Exterior Condition

PROPOSED CHANGE:



This area will become a gym as well as permanent classrooms, family resources, child care, and a clothing bank.

Gym + Classrooms

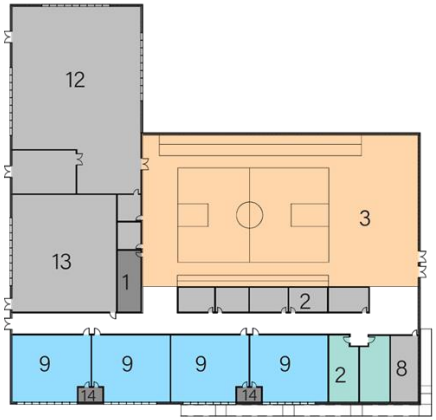


This area will receive higher performance windows and planters to cover the exposed slab edge and reduce thermal bridging.

Windows + Planters

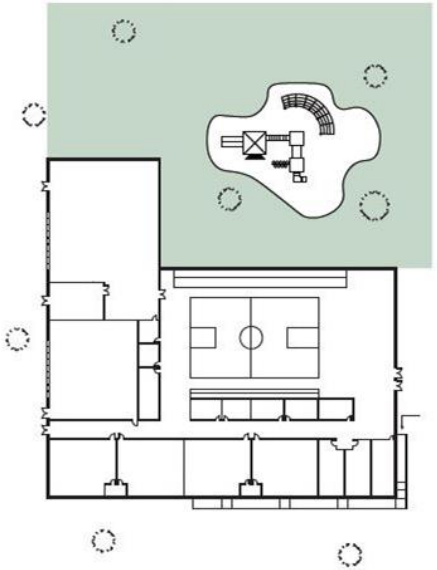
These areas will collect rainwater, some of which will be used to grow plants for shading.

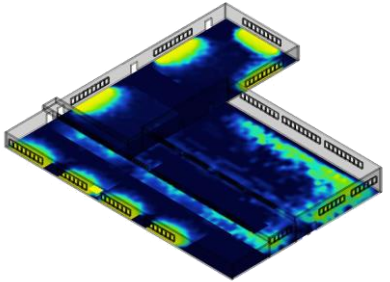
Program:
1. Mechanical room
2. Restroom
3. Gym/recreation area
4. Music room
5. Art room
6. Library
7. Home economics
8. Kitchen/service area
9. Classroom
10. Office/administration area
11. Cafeteria
12. Clothing Bank
13. Child care
14. Quiet Room

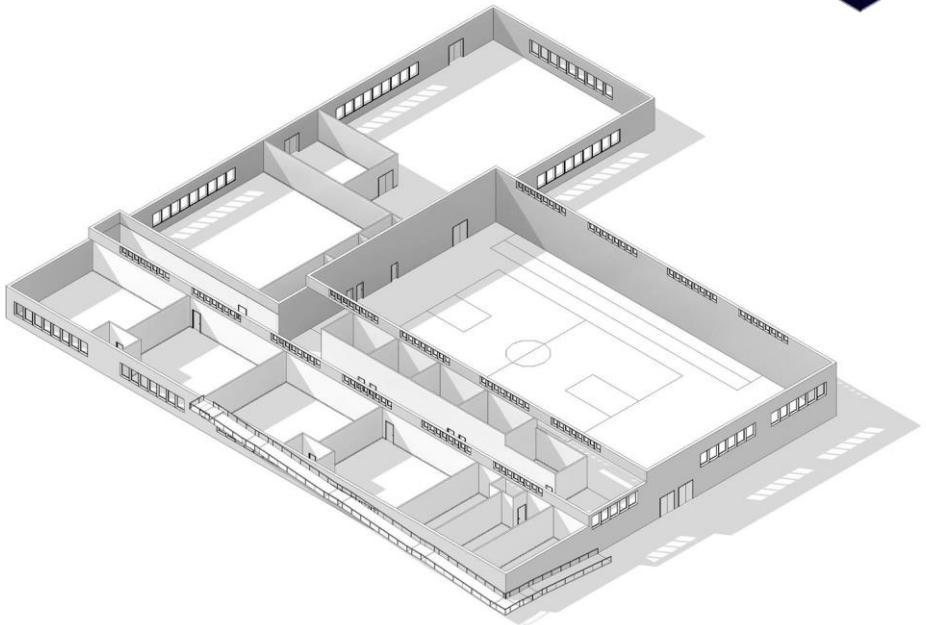


NEW ADDITION

Program

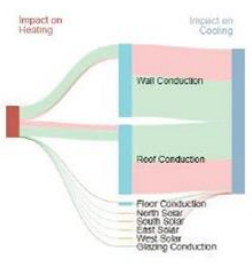




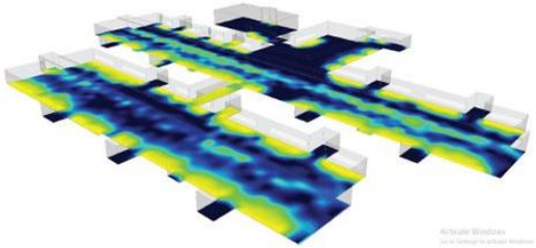


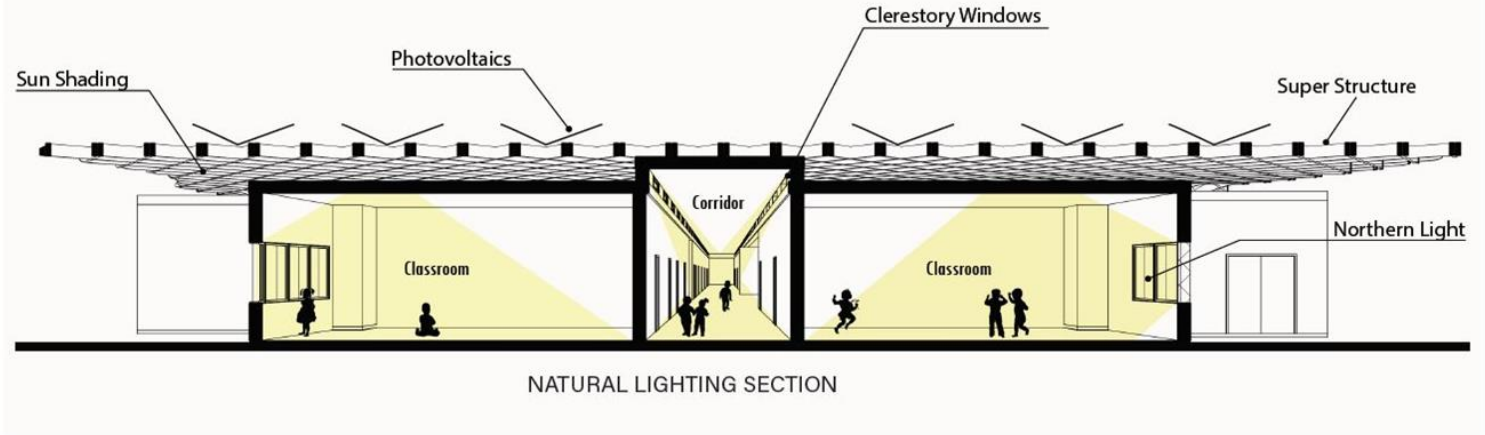
New build

Sefaira Energy Profile

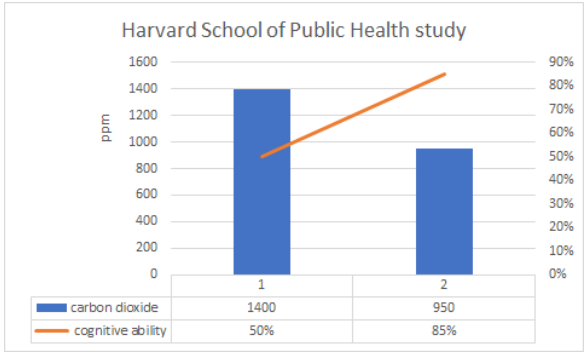


Sefaira Natural Light Analysis

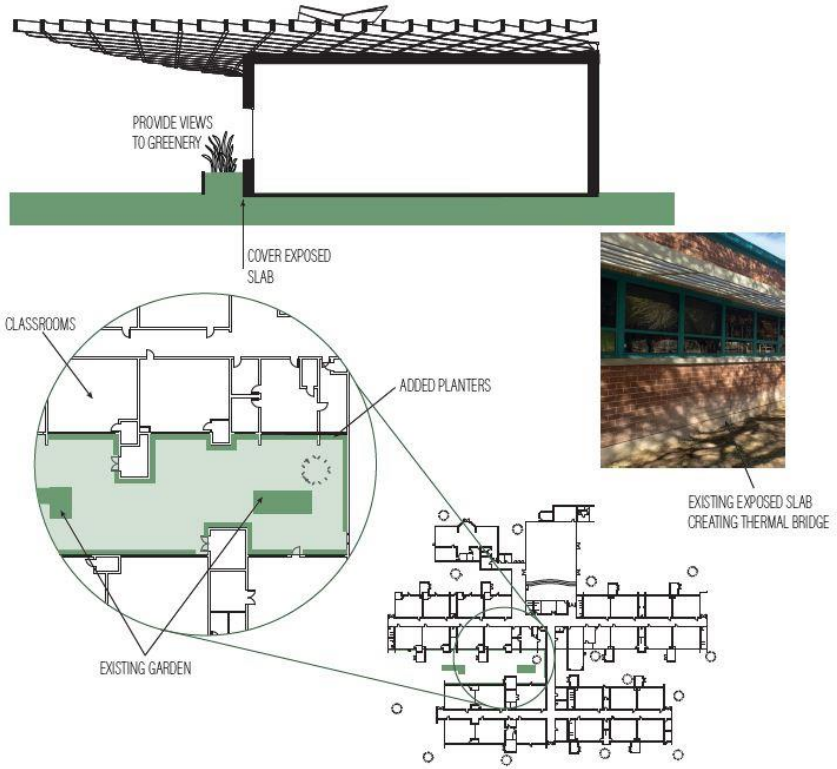




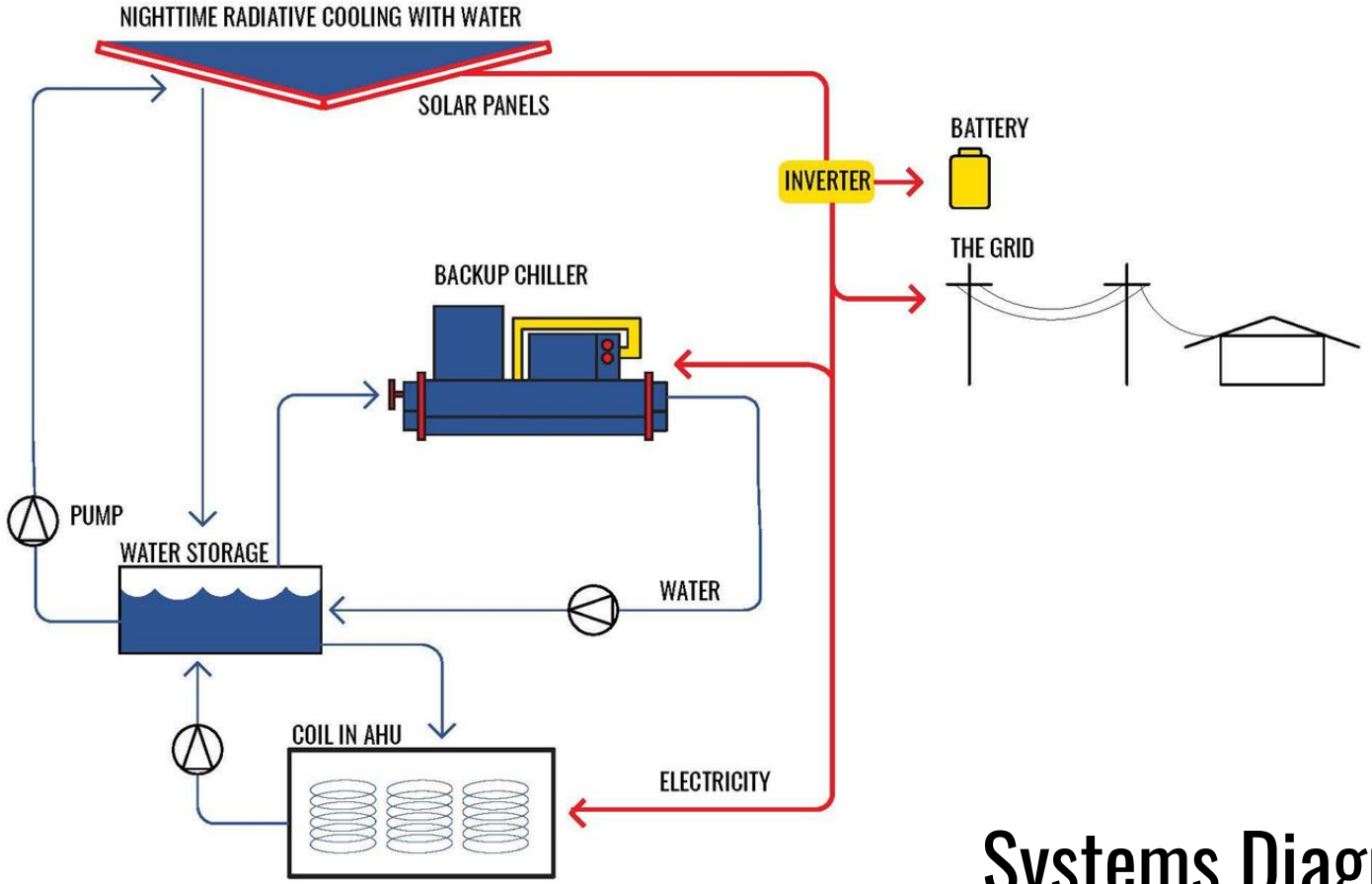
Lighting



Interior Render


PROVIDE VIEWS
TO GREENERY
COVER EXPOSED
SLAB
CLASSROOMS
ADDED PLANTERS
EXISTING EXPOSED SLAB
CREATING THERMAL BRIDGE
EXISTING GARDEN

Planters



Systems Diagram

Total Capacity

500,000 kWh existing + 471,269 kWh added = 971,269 kWh/yr

PHIUS+ 2018
Space Conditioning Criteria Calculator v2

METHOD:	CALCULATOR
UNITS:	IMPERIAL (IP)
STATE / PROVINCE	ARIZONA
CITY	TUCSON INTERNATIONAL AF

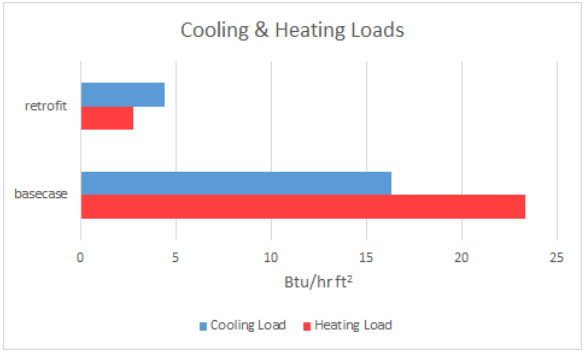
Envelope Area (ft²) / iCFA (ft²) 3.61 or enter here: 3.61

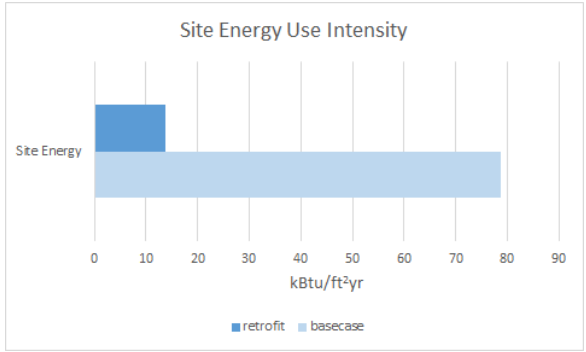
iCFA (ft²) / person 95 or enter here: 95

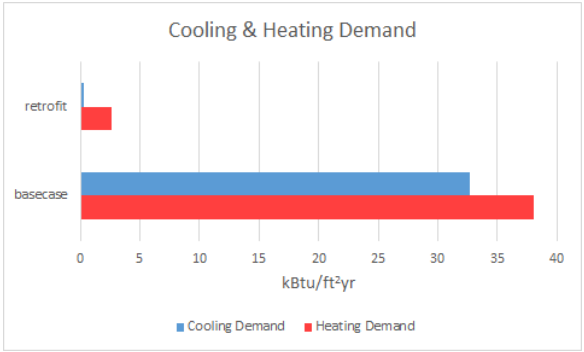
**Calculator method is used for official certification targets.*

Space Conditioning Criteria

Annual Heating Demand	2.7	kBTU/ft²yr
Annual Cooling Demand	25.6	kBTU/ft²yr
Peak Heating Load	4.4	BTU/ft²hr
Peak Cooling Load	7.3	BTU/ft²hr

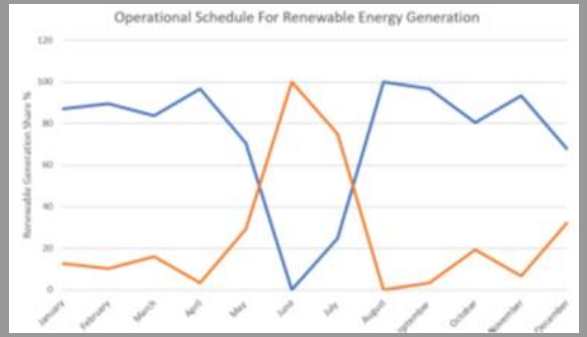






Energy Performance

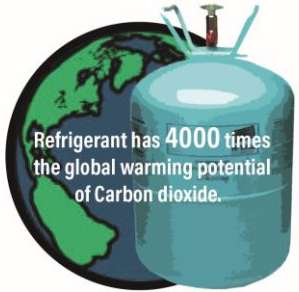

School Use
New addition building:
Basketball
Children Care
Clothing bank
Donation Center
Classroom
Outdoor space:
Playground
Garden
Sports
Community Use
Access to the Street
Community use area
New addition building:
Weekend events
Workshop
Job fair
Ourdoor space:
Playground
Dog Park
Weekend Festival
Farmer's Market
Sports


Operational Schedule For Renewable Energy Generation
Renewable Generation Share %
120
100
80
60
40
20
0
January
February
March
April
May
June
July
August
September
October
November
December


TUCSON UNIFIED
SCHOOL DISTRICT
SCHOOL CALENDAR 2019-2020

School Use

Resilience



Wooden Superstructure's Carbon Sequestration

- 39,737.87 cubic feet of Douglas Fir.
- Carbon Content Per 1000kg = 519kg
- Carbon Volume = 3.8%
- 308 Ton of Carbon Sequestered.

Equivalent to Carbon dioxide emissions from:

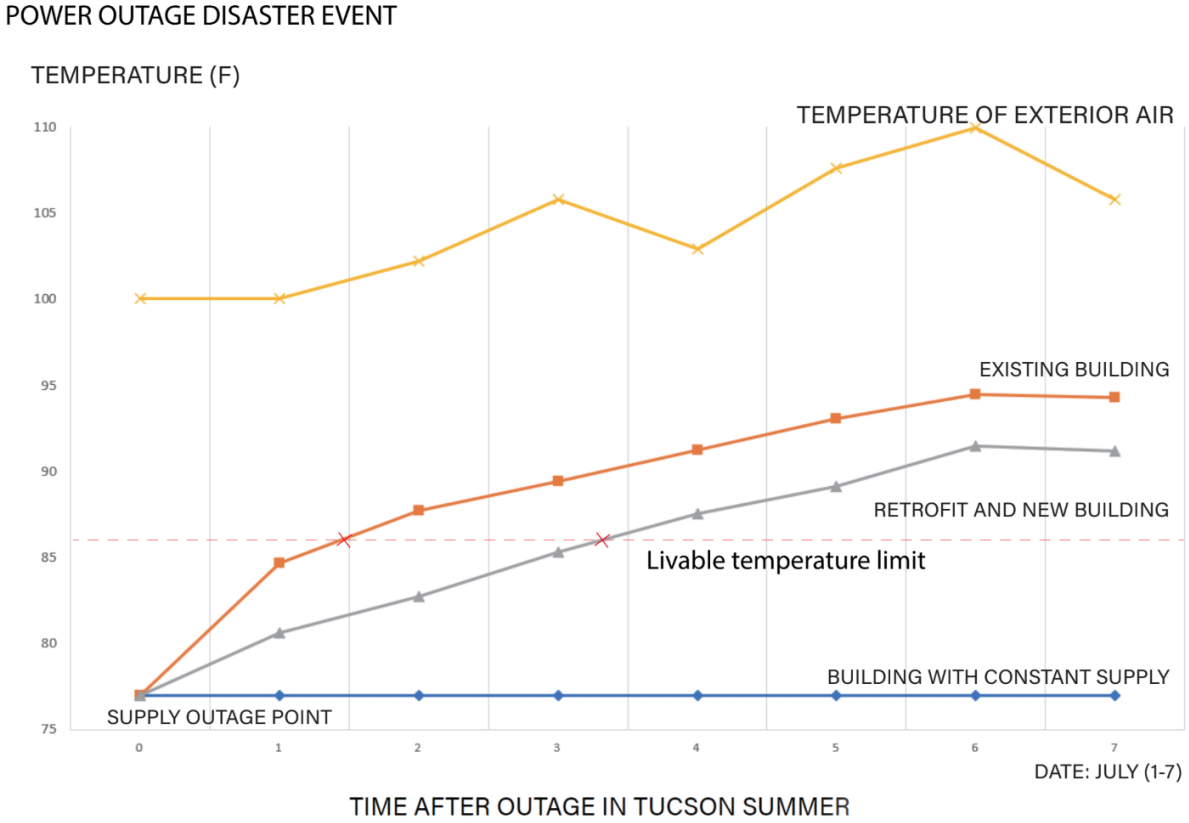
52 homes' electricity use for 1 year.

35 homes' energy use for 1 year.

Equivalent to Carbon Sequestered by:

402 Acres of U.S. forest land over a year

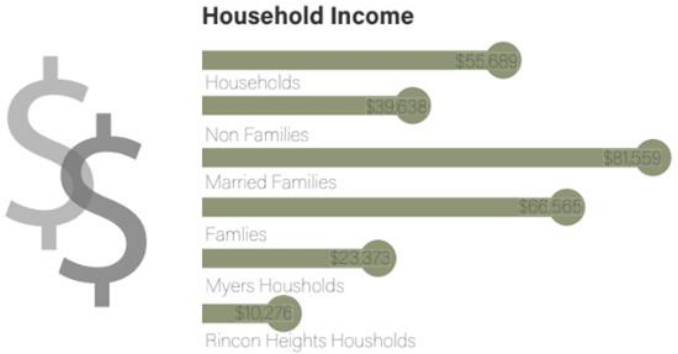
5,093 tree seedlings grown for 10 years

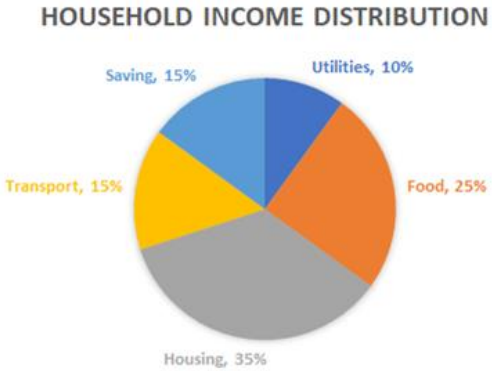


Disaster Resilience

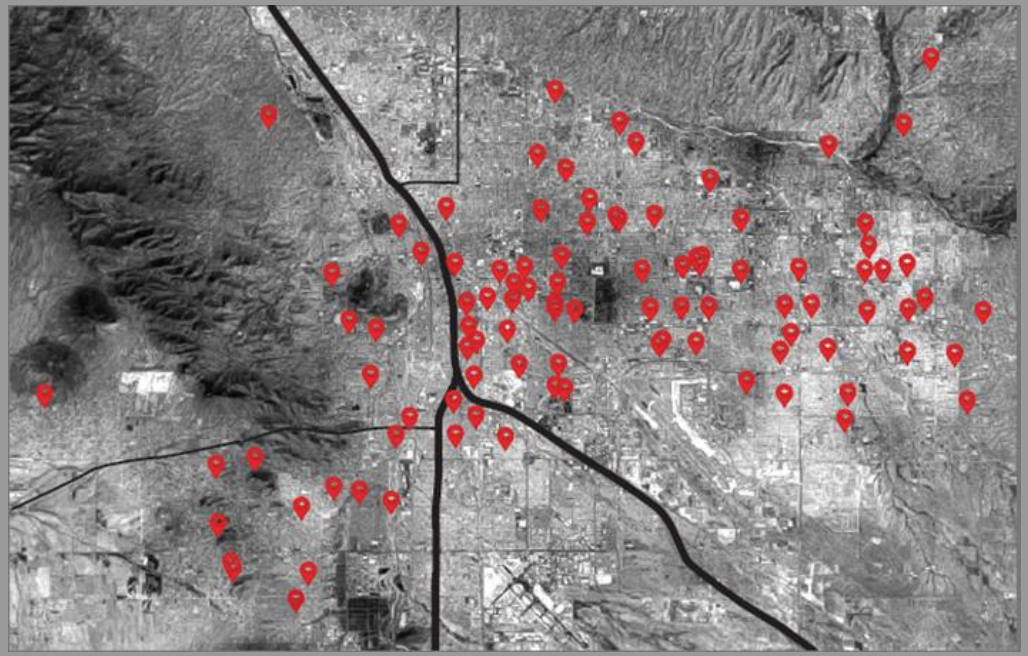
Cost Breakdown

Category	# of Items	Material Cost/unit	Material Cost Total	Labor cost/unit	Labor cost total	Total Cost	Project Sf	Cost/sf
Design								
Process	1		20,000		40,000	60,000	52205	1.15
Site Work								
Site work	1		30,000	80,000	80,000	110,000	52205	2.11
Permitting								
Permits	1	15,000	15,000	0	0	15,000	52205	0.29
impact fees	1	15,000	15,000	0	0	15,000	52205	0.29
contractor fees	1	50,000	50,000	180,000	180,000	230,000	52205	4.41
Energy + Water Collection								
Solar Panels	1300	3.2	4,160	$200	260,000	264,160	52205	5.06
Water Storage Tank	12	2,298	27576	$15.00	$5,280	32,856	52205	0.63
Structure + Envelope								
Aerobarrier Insulation	10,000	$9.00	90,000		$13	90,013	52205	1.72
Rockwool Insulation	37,198	$1.02	37,942	6	37198	75,140	52205	1.44
Sprayfoam Insulation	600	$2.00	1200	$3	19068	20,268	52205	0.39
Foam Board Insulation on roof	104,411	$2.30	240,145.30	$2	150040	390,185	52205	7.47
Super Structure						0	52205	0.00
Clerestory install						0	52205	0.00
Finishes								
Interior CLT finish	37198	6	223,188	$100	26,500	249,688	52205	4.78
High Performance windows	140	$450	63,000	$500	70,000	133,000	52205	2.55
Doors for addition	30	$700	21,000	$80	$2,400	23,400	52205	0.45
Mech + HVAC								
ERV	4	$3,200	$12,800	$1,000	$4,000	16,800	52205	0.32
Air Handling Units for addition	15	1,700	25,500	$500	$7,500	33,000	52205	0.63
DuctWork	6921.6	$1.90	13,151	$15	6300	19,451	52205	0.37
Metering System	4	$4,000	$16,000	$800	$3,200	19,200	52205	0.37
Plumbing and Electrical								
Plumbing for addition	730	$4.00	$2,800	$15	$8,300	11,100	52205	0.21
Lights	490	$6.00	$2,940			2,940	52205	0.06
Electrical wiring for addition	120	$90	10,800	25	2700	13,500	52205	0.26
Fixtures								
sinks	51	$56.42	$2,877	$50	$2,550	5,427	52205	0.10
faucet aerators	51	$2.74	$139.40	$6	$306	445	52205	0.01
Drinking fountains	10	$451	$4,510	$50	$500	5,010	52205	0.10
Toilet bowls for addition	10	$124	$1,240	$50	$500	1,740	52205	0.03
Toilet flush valves	48	$74	$3,552	$50	$1,350	4,902	52205	0.09
Pre-rinse spray valve	1	107.3	$107	$3	$3	110	52205	0.00
Appliances								
Dishwasher	1	$5,399	5,399	0	0	5,399	52205	0.10
Stoves	$3	$5,089	$15,267	0	0	15,267	52205	0.29
Hot Cabinet	1	$3,712	$3,712	0	0	3,712	52205	0.07
Oven	1	$3,390	$3,390	$250	$250	3,640	52205	0.07
Microwave	1	$250	$250	0	0	250	52205	0.00
Refrigerator	1	$3,288.60	$3,288.60	0	0	3,289	52205	0.06
Commercial Range Hood	1	$275.00	$275.00	$1,200	$1,200	1,475	52205	0.03
Furniture								
Chairs for addition	125	$40.00	$5,000	0	0	5,000	52205	0.10
Tables for addition	43	$140	$6,020	0	0	6,020	52205	0.12
gymnasium equipment	1	$10,000	$10,000	0	0	10,000	52205	0.19
Total			$987,230			$1,896,388		





Cost Breakdown

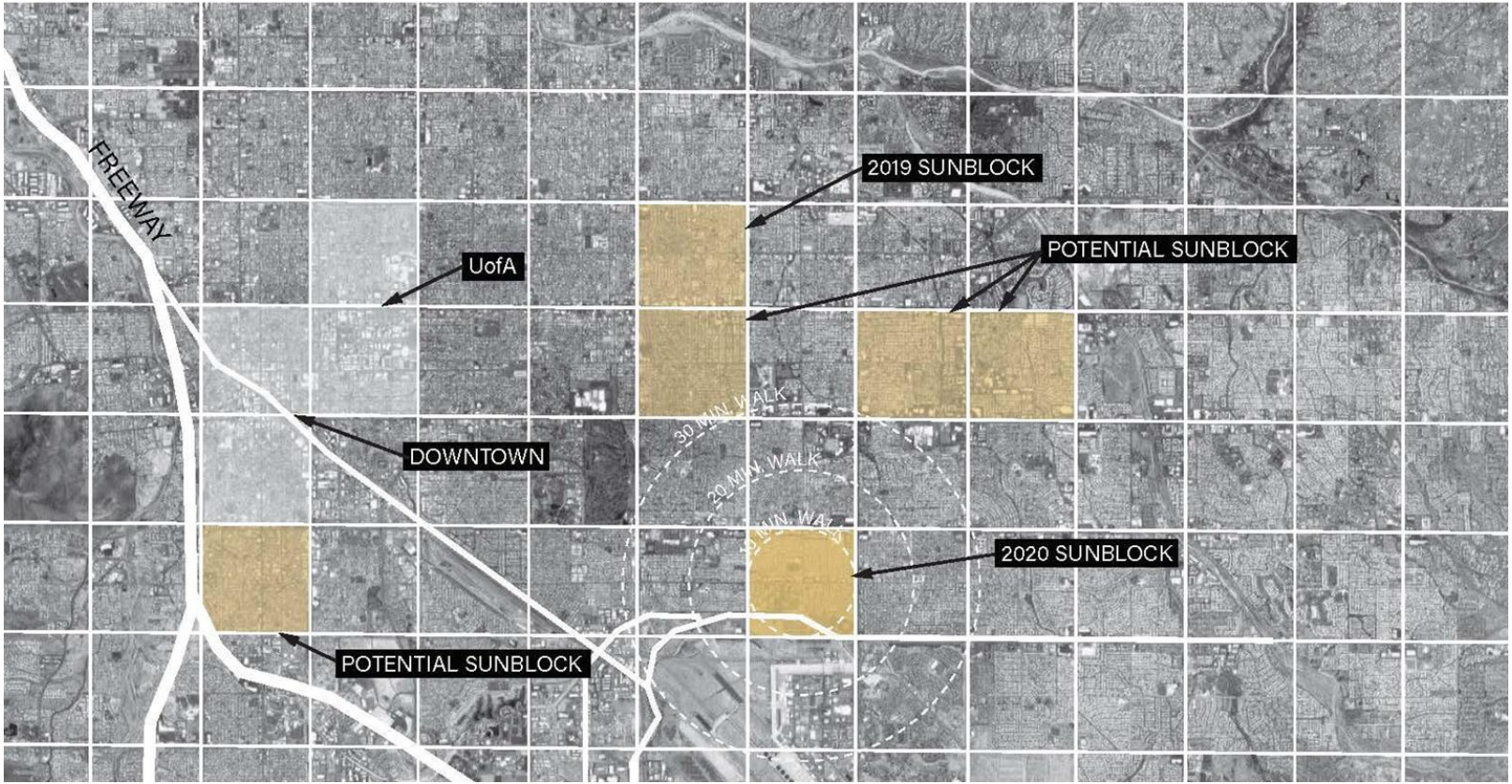


Tucson Unified School District Map

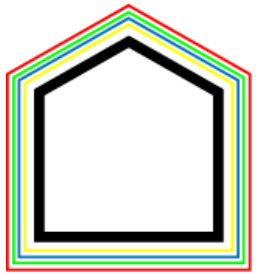
TUCSON UNIFIED
SCHOOL DISTRICT

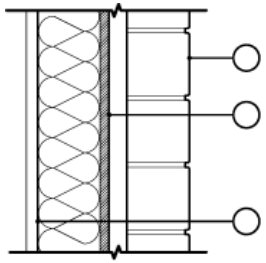
Market Potential

Conclusion: SunBlock

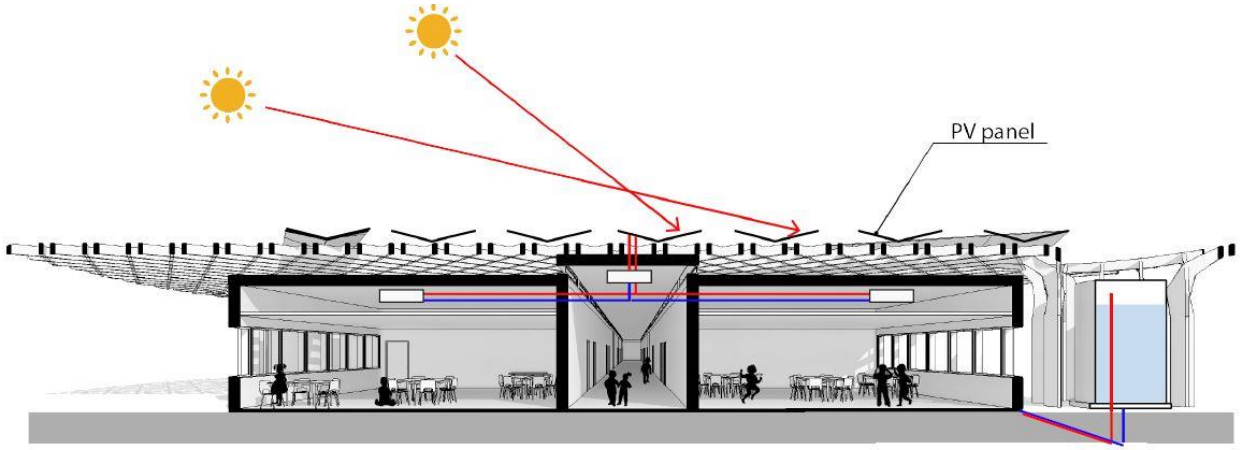


Conclusion: Engineering

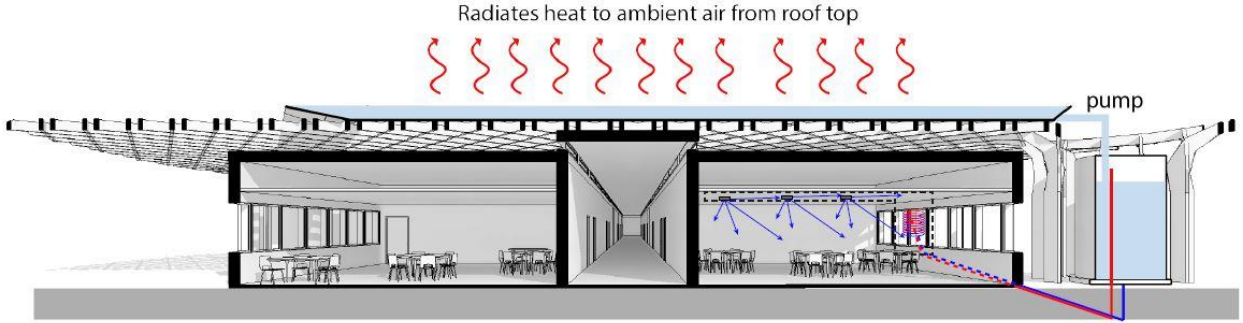




Conclusion: Innovation

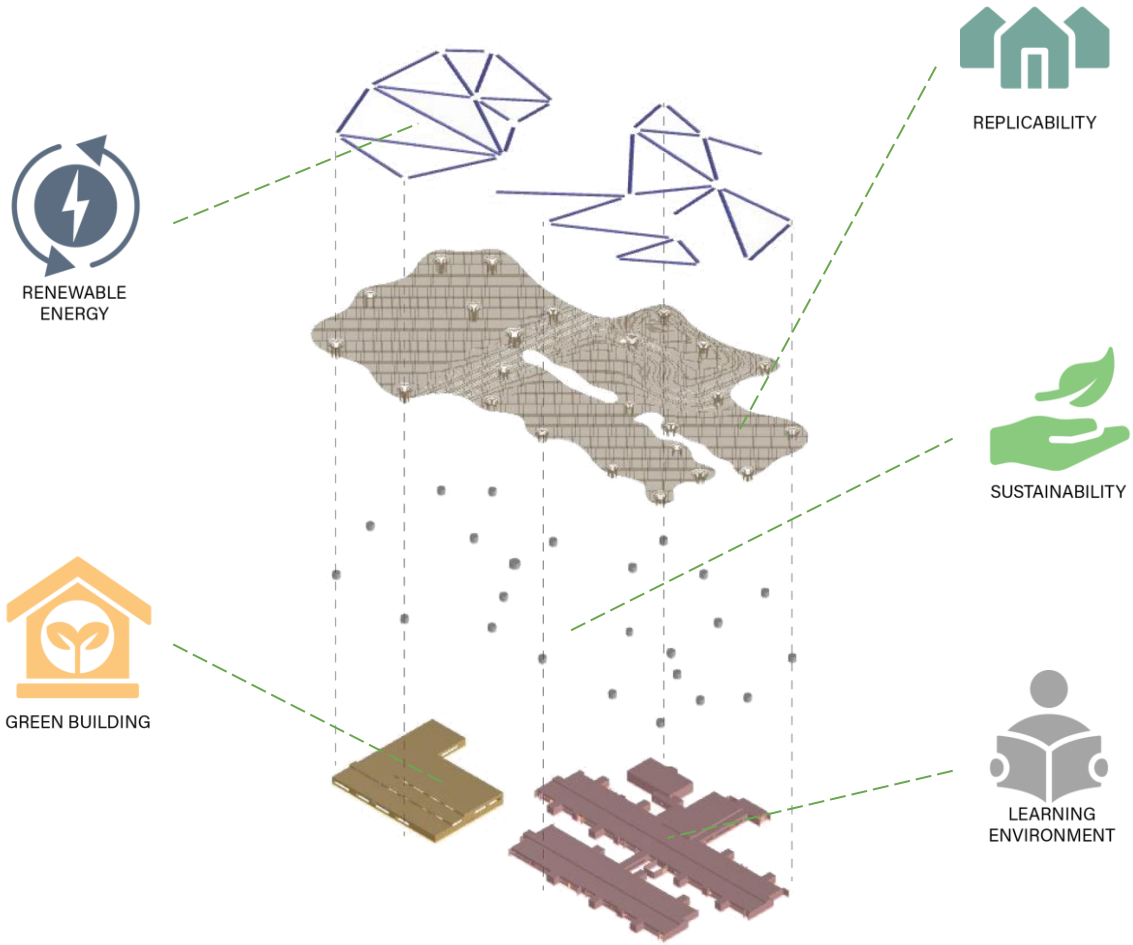


Day time



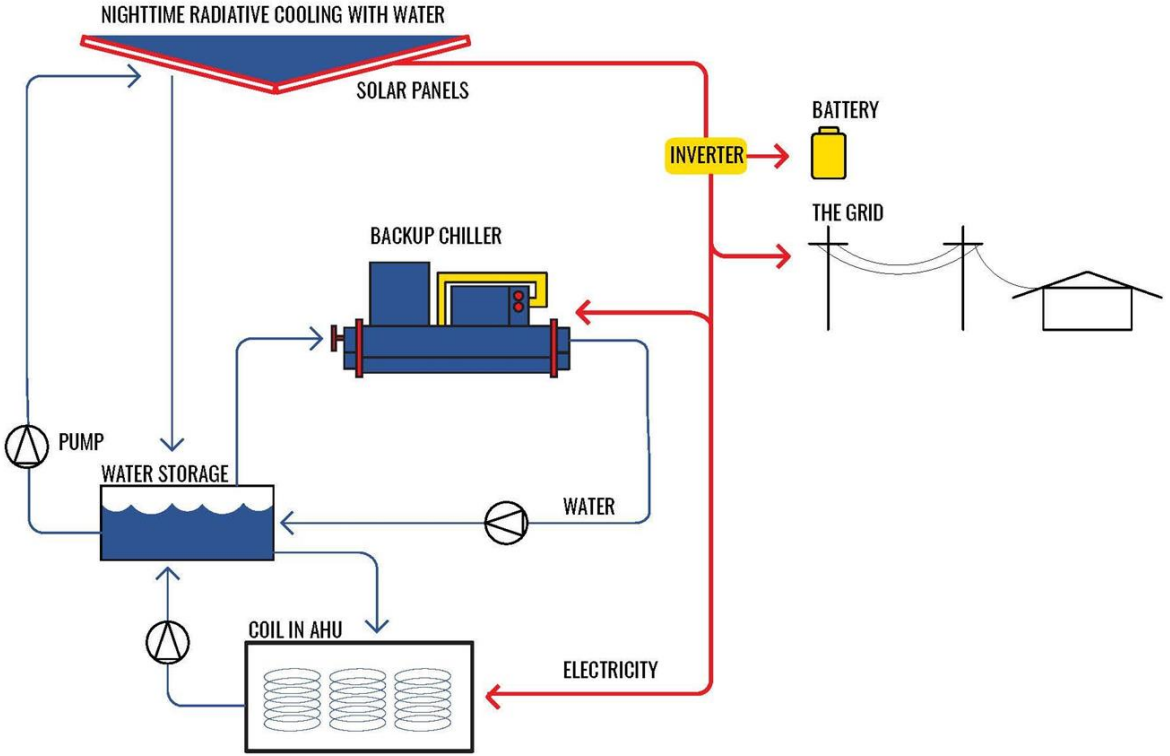
Night time

Conclusion: Architecture



Conclusion: Comfort & Environmental Quality

SYSTEMS DIAGRAM



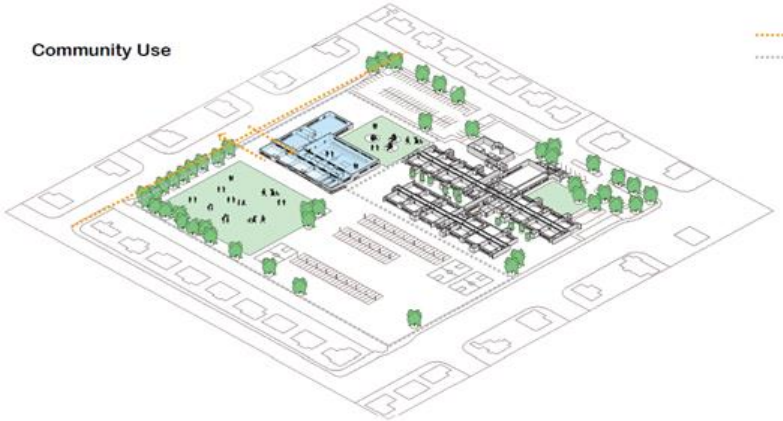
Conclusion: Operations

School Use

New addition building:
Basketball
Children Care
Clothing bank
Donation Center
Classroom

Outdoor space:
Playground
Garden
Sports

Community Use

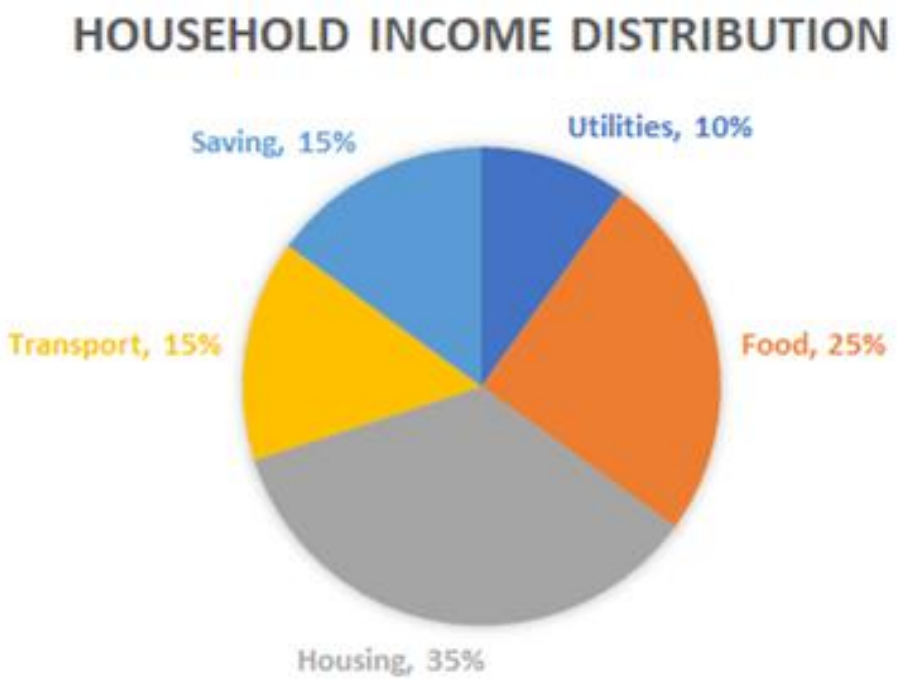


Access to the Street
Community use area

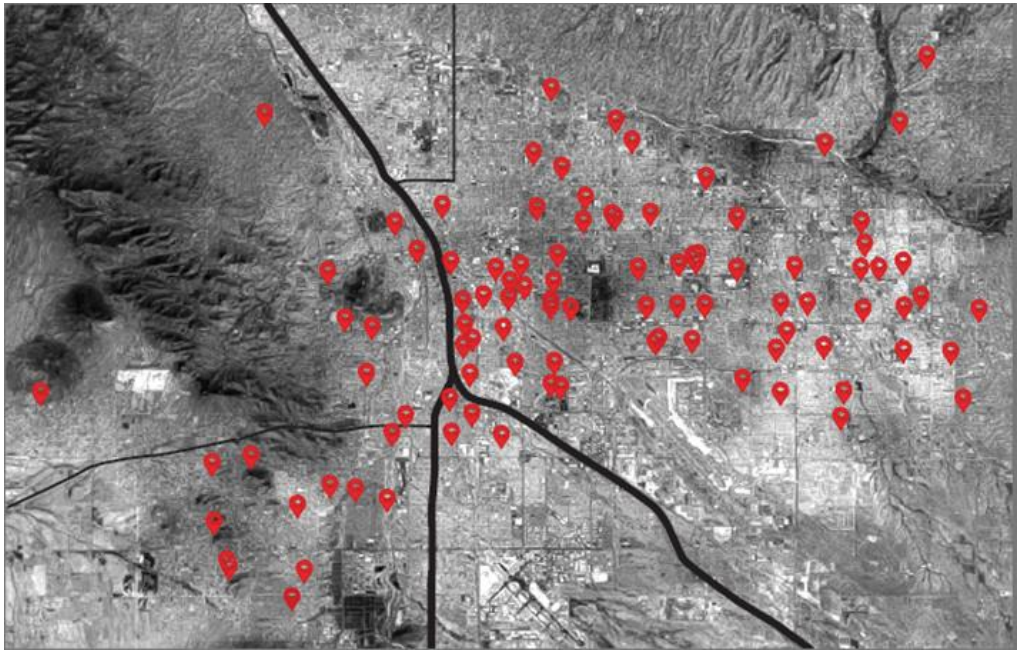
New addition building:
Weekend events
Workshop
Job fair

Ourdoor space:
Playground
Dog Park
Weekend Festival
Farmer's Market
Sports

Conclusion: Financial Feasibility



Market Potential



Conclusion