

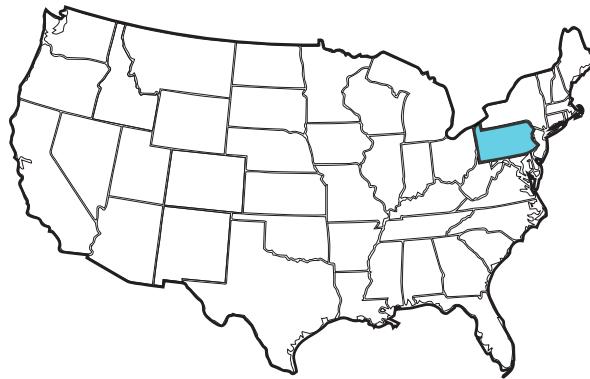
NEW CHAUTAUQUA INSTITUTE



Mansi Dhanuka & Samantha Aguilar
Master of Environmental Building Design
PennDesign | University of Pennsylvania
Spring 2017

Midterm Review
March 1, 2017
Professors:
Bill Braham
Mostapha Sadeghipour Roudsari

PHILADELPHIA, PENNSYLVANIA



LAT 39.87 LNG -75.23

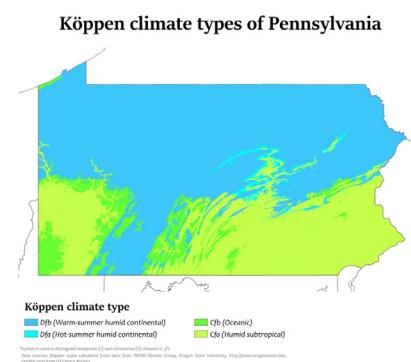
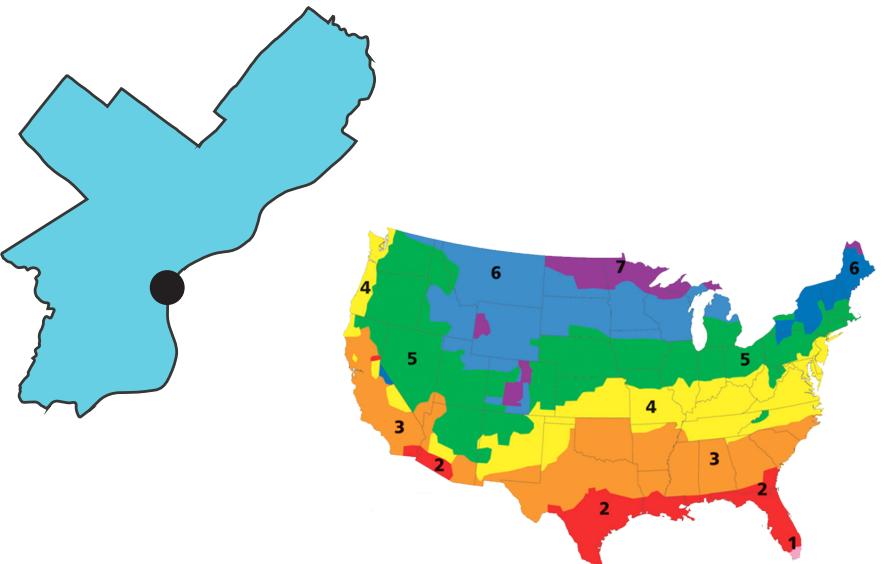
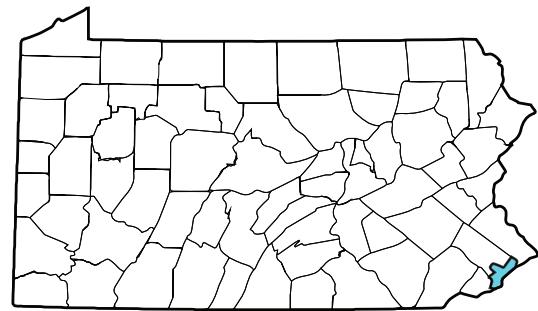
ASHRAE CLIMATE ZONE
4A (Mixed-Humid)

KOPPEN CLIMATE ZONE
Cfa (Humid Subtropical)

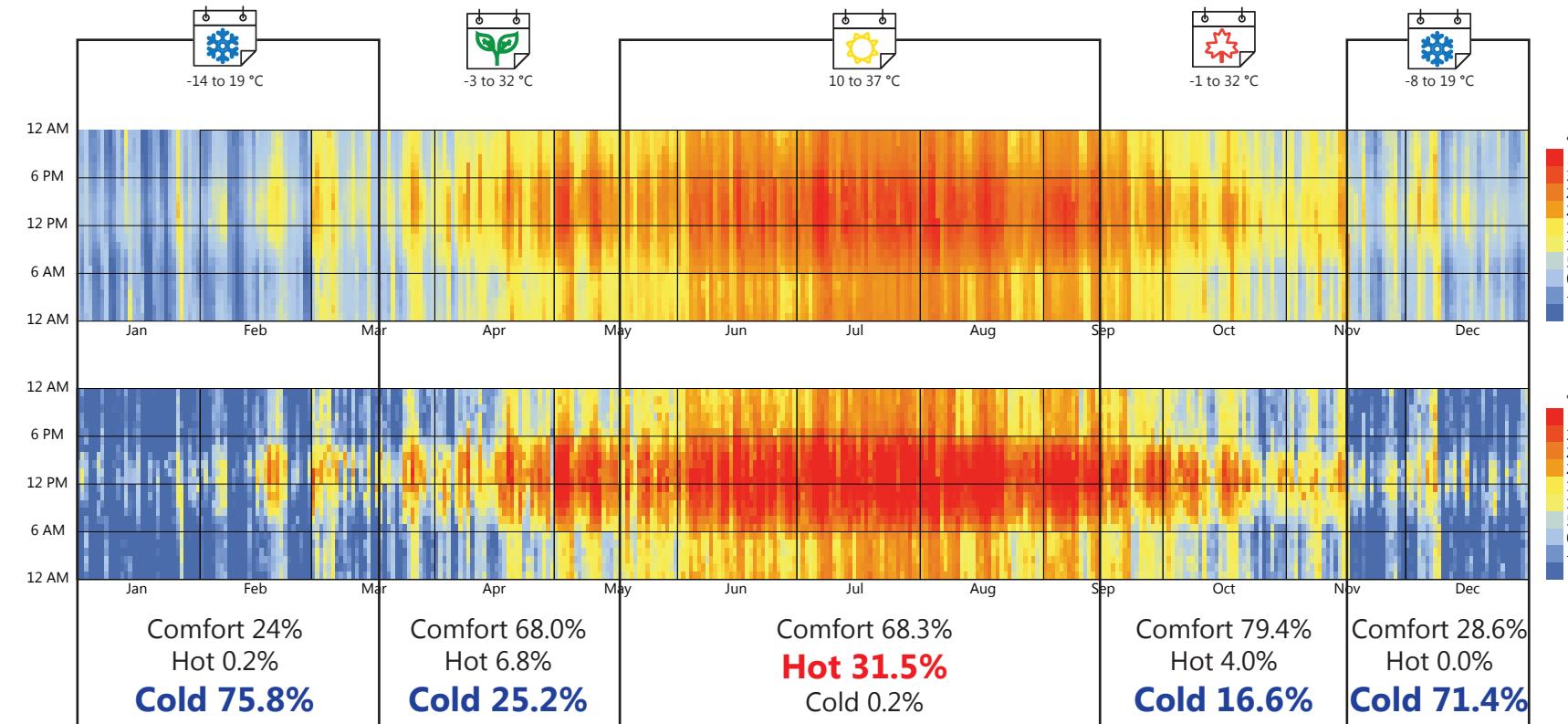
ADDRESS
720 - 724 North Front Street

LAND AREA
24,179 sf / 2,246 m²

LAND USE
Zoned for Community Commercial Mixed-Use

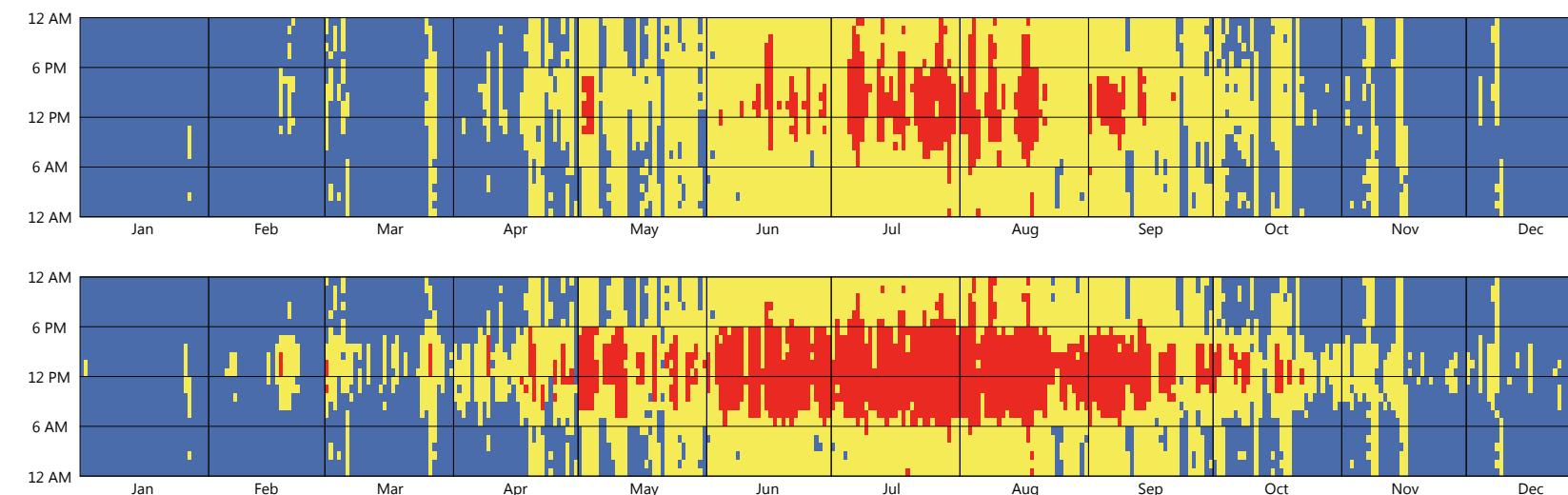


ANNUAL CLIMATE ANALYSIS



Dry Bulb Temperature

Universal Thermal Climate Index



Shaded

- Heat Stress
- Comfortable
- Cold Stress

3.1 %
41.3 %
34.3 %

Outdoor

- Heat Stress
- Comfortable
- Cold Stress

12.5 %
37.3 %
31.6 %

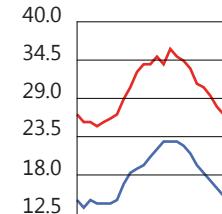
CLIMATE CHALLENGES & OPPORTUNITIES

TYPICAL HOT WEEK

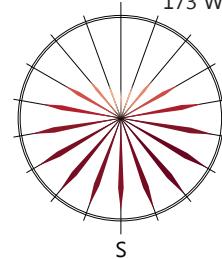
AUG 18 - AUG 24



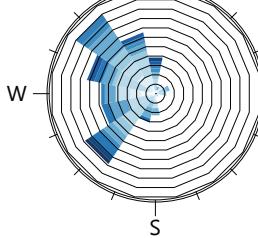
HOURLY MEAN MIN-MAX TEMPERATURE (°C)



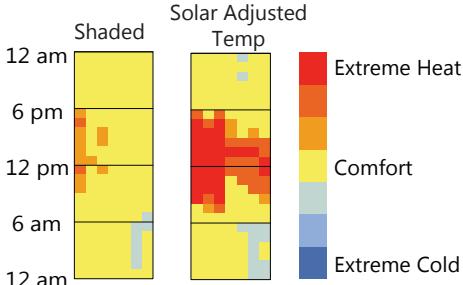
SOLAR RADIATION
N (6am-6pm)
173 Wh/m² - 860 Wh/m²



HOURLY WINDSPEED & DIRECTION
N
0 - 9 meters/second
NW - W - SW



OUTDOOR COMFORT

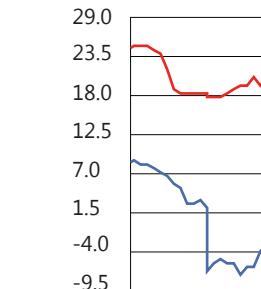


TYPICAL WEEK

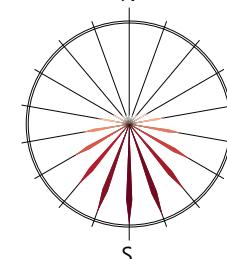
OCT 29 - NOV 4



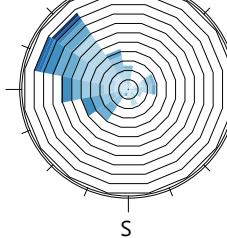
HOURLY MEAN MIN-MAX TEMPERATURE (°C)



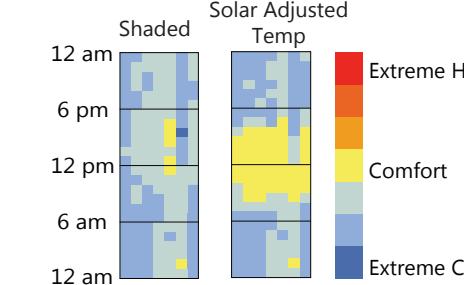
SOLAR RADIATION
N (7am-5pm)
90 Wh/m² - 913 Wh/m²



HOURLY WINDSPEED & DIRECTION
N
0 - 10 meters/second
NW - W



OUTDOOR COMFORT

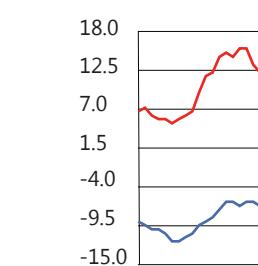


TYPICAL COLD WEEK

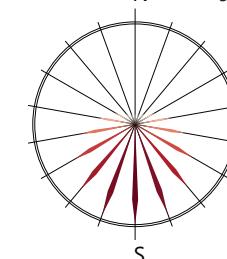
FEB 12 - FEB 18



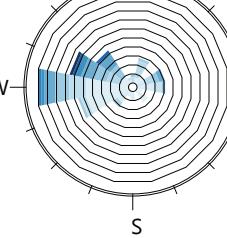
HOURLY MEAN MIN-MAX TEMPERATURE (°C)



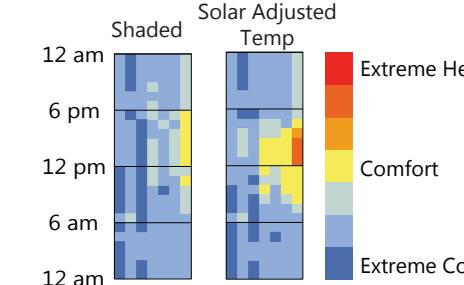
SOLAR RADIATION
N (7am-6pm)
90 Wh/m² - 930 Wh/m²



HOURLY WINDSPEED & DIRECTION
N
0 - 13 m/s
W



OUTDOOR COMFORT



CHALLENGES



Considerable heat stress in the summer and cold stress for a longer timeframe throughout the year
Considerable humidity during the summer



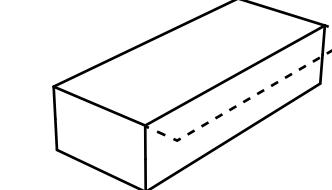
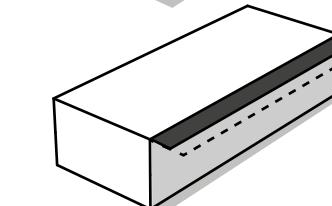
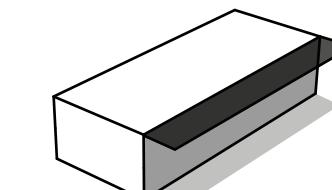
Long summer sun-up hours and short winter sun-up hours
Consistent southern sun



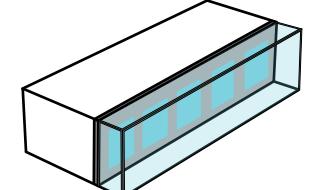
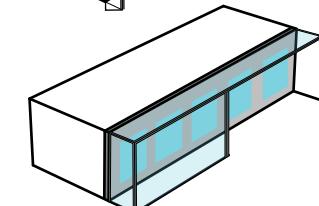
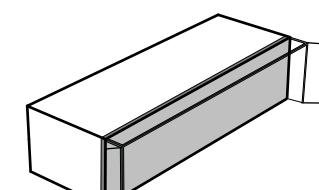
Mostly western wind with speed averaging between 0 and 13 m/s
Cold temperatures don't allow for natural ventilation year-round

OPPORTUNITIES

SHADING



SUNROOM



Horizontal shading can keep direct radiation away from southern-facing windows

Horizontal shading that can move, allowing for radiation when needed

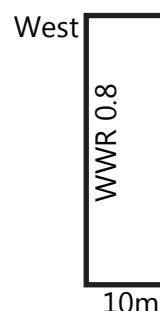
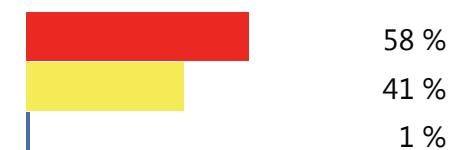
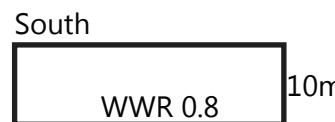
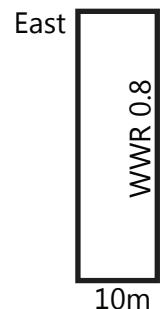
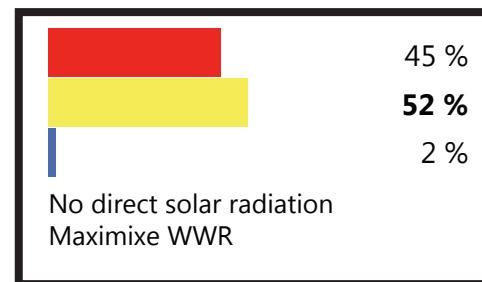
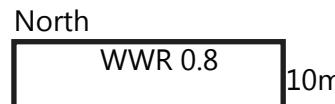
Operable windows for natural ventilation & night flushing

Sunroom that can capture radiation, coupled with thermal mass to store heat

ORIENTATION ANALYSIS

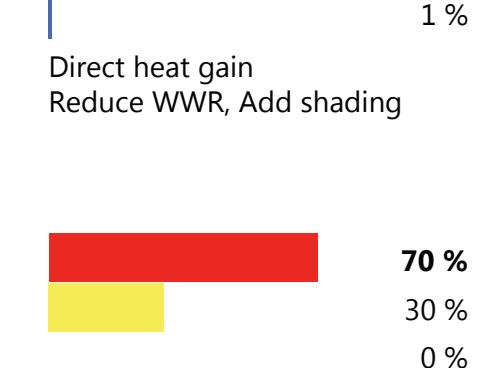
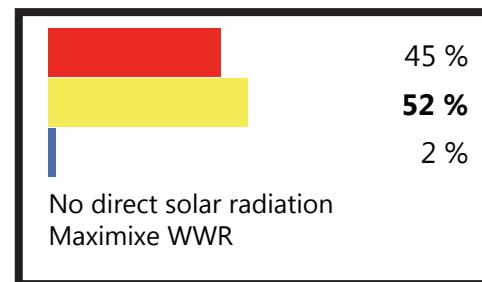
TYPICAL HOT WEEK

AUG 18 - AUG 24



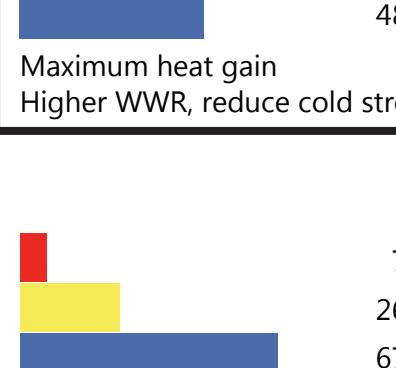
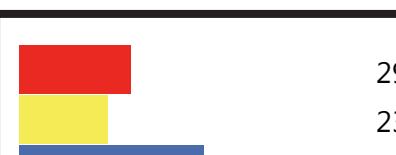
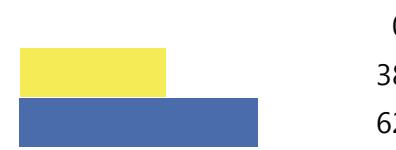
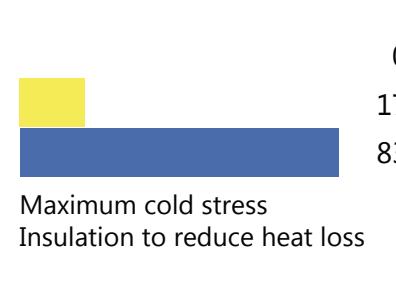
TYPICAL WEEK

OCT 29 - NOV 4

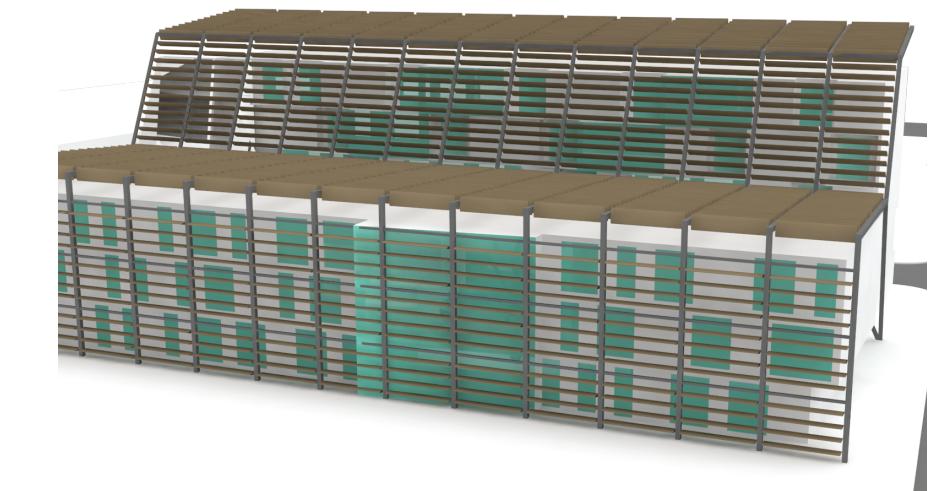
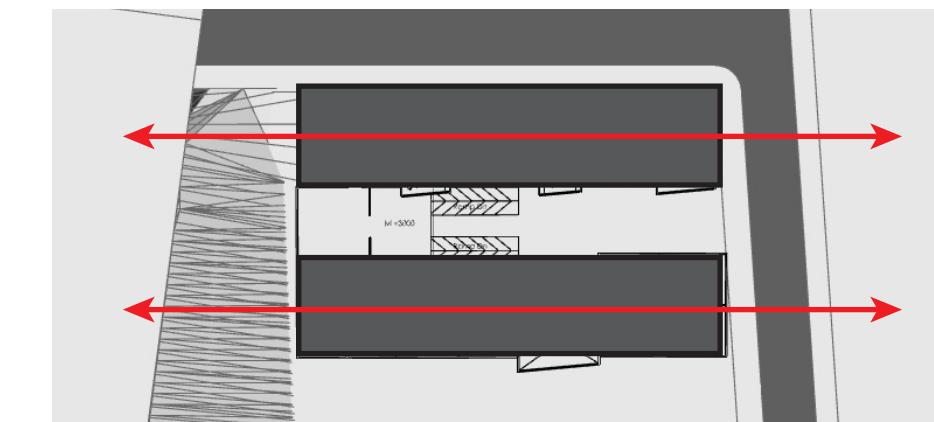


TYPICAL COLD WEEK

FEB 12 - FEB 18



DESIGN DECISIONS



SITE CHALLENGES & OPPORTUNITIES



STRENGTHS

- Northern Liberties:** Upcoming commercial neighborhood
- Popular Corridors:** 2nd Street and Spring Garden Street
- Public Transport:** Metro, Bus, Trolley, Bike friendly
- View:** Delaware River and Benjamin Franklin Bridge
- Walkability:** Essentials, groceries and amenities
- Demographic:** Culturally diverse with design professionals
- Historic District:** Italianate, Greek Revival and Federal Style

WEAKNESSES

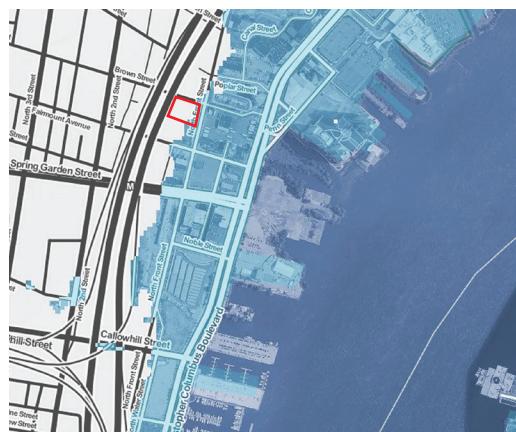
- Delaware Expressway:** pollution, noises, blocks view
- Immediate surrounding:** Bus maintenance depot
- Underpass Brown street:** deserted/ seems unsafe
- Underdeveloped:** minimal pedestrian traffic

OPPORTUNITIES

- Building Heights:** low rise development, no obstructions
- Corner Plot:** Open from north, east and south
- Future waterfront development:**
- Brown Street:** Green corridor to Delaware River
- Festival Pier:** Mixed-use residential community
- Residential development:** parks and recreation

THREATS

- Climate Change:** Flooding with rise in temperatures
- High-rise tower:** blocking river view
- Neighborhood Plan:** Potential Parking lot



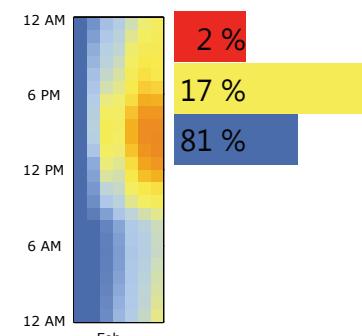
RESPONSIVE DESIGN - SUNROOMS

TYPICAL COLD WEEK

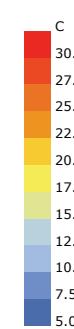
FEB 12 - FEB 18

Occupied Space

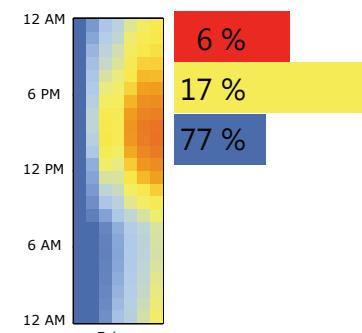
Baseline Case
(ASHRAE Zone 4A Construction)



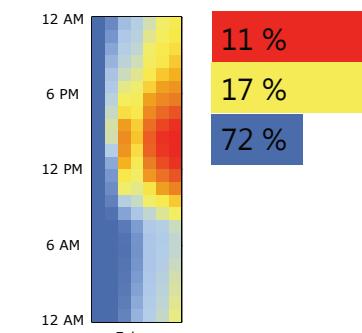
Sun Room



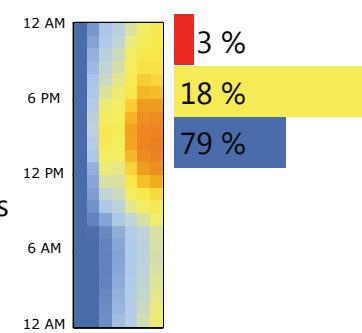
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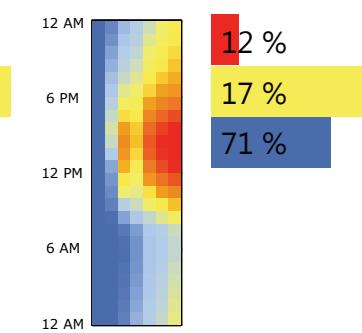
+
SunRoom
(ASHRAE Zone 4A Construction)



Baseline Case
(ASHRAE Zone 4A Construction)

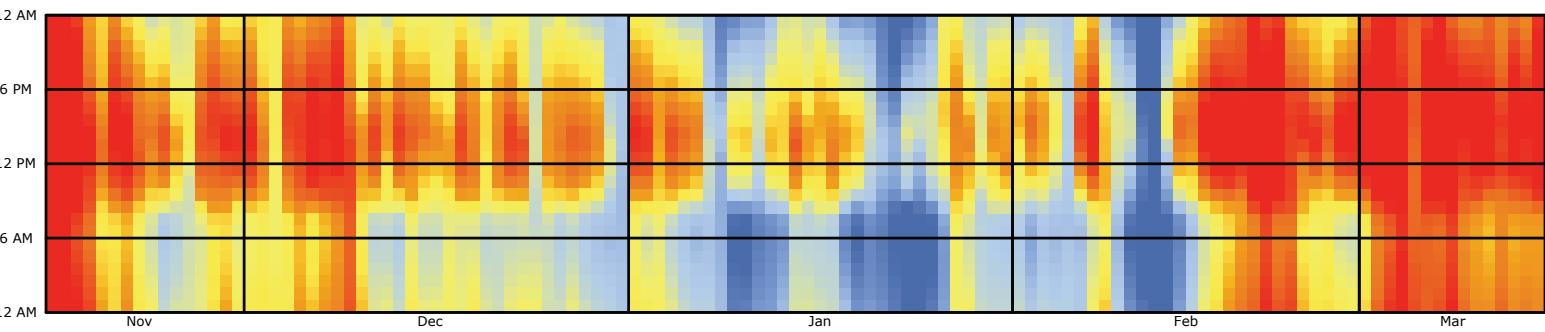


+
SunRoom
(ASHRAE Zone 4A Construction)



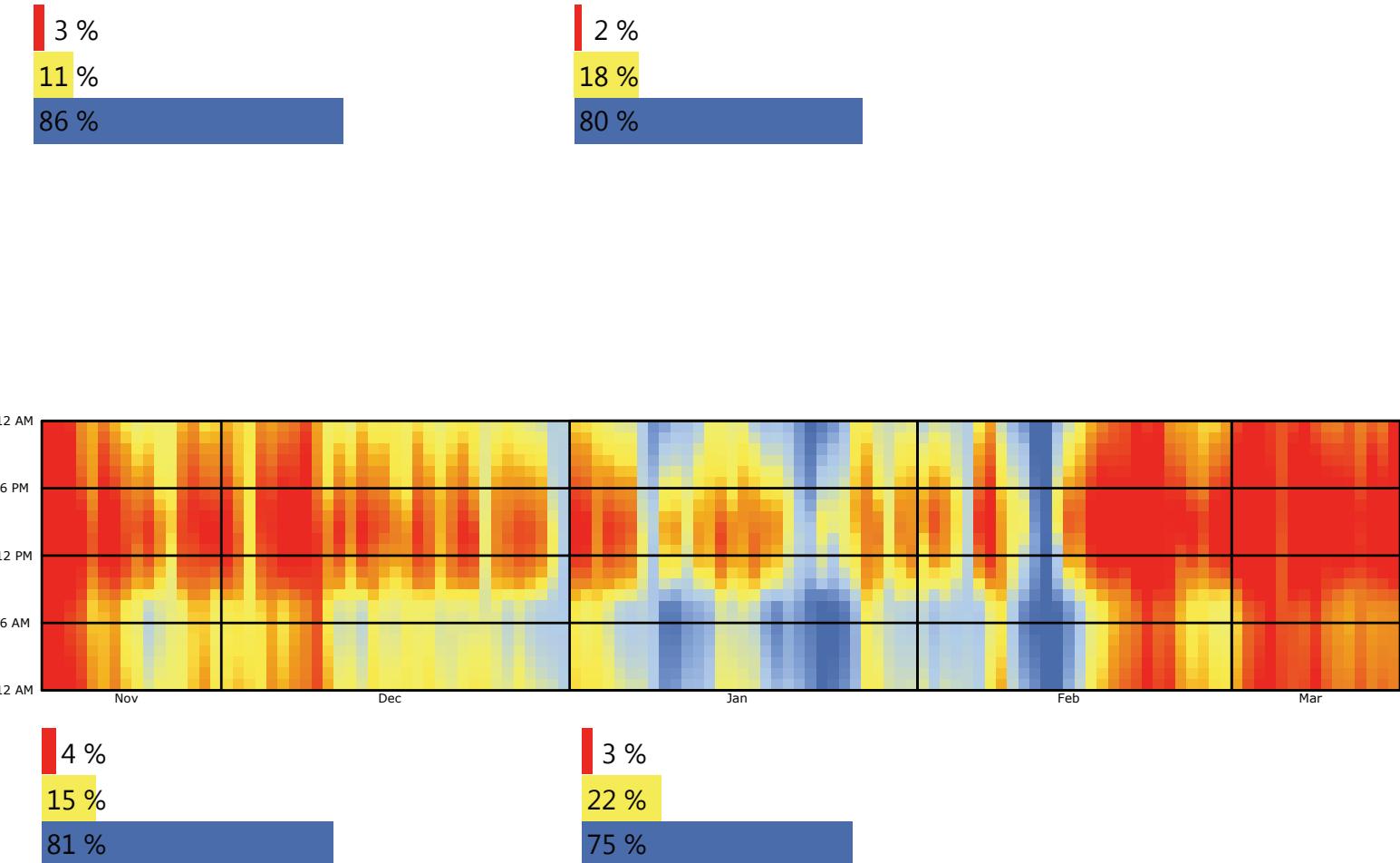
+
High Thermal Mass
(Interior Walls)

Occupied Space



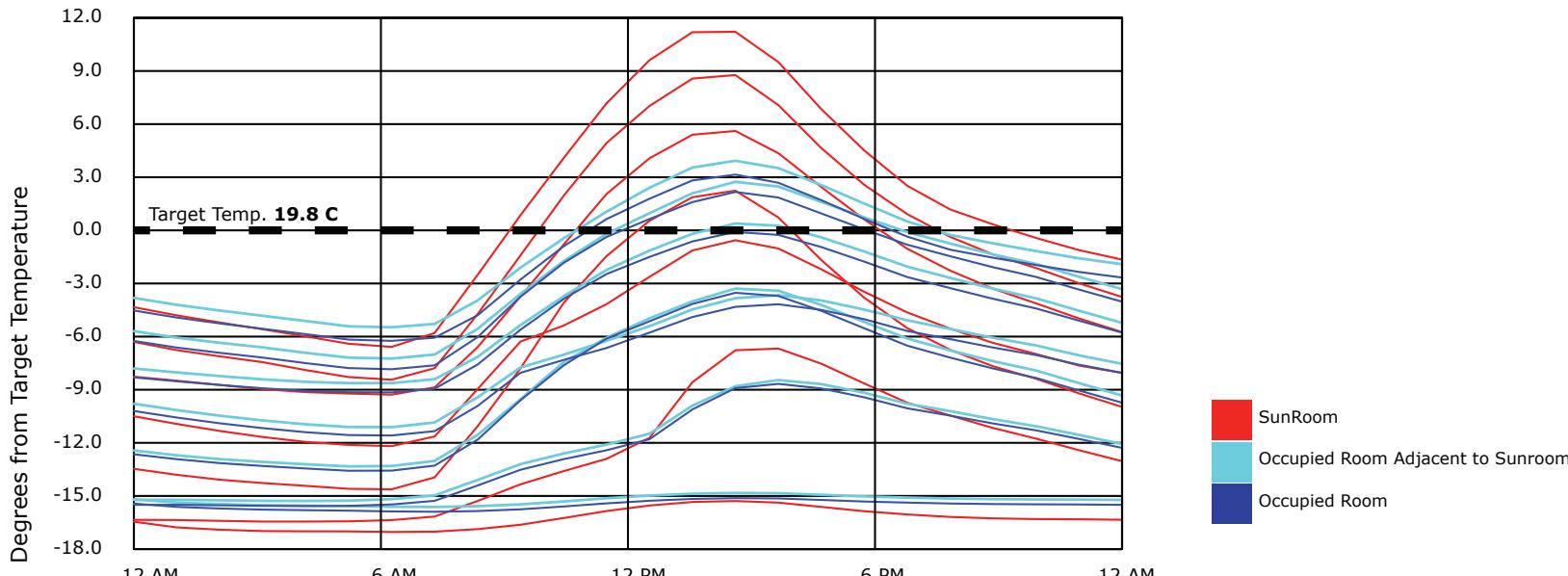
WINTER

NOV 15 - MAR 15

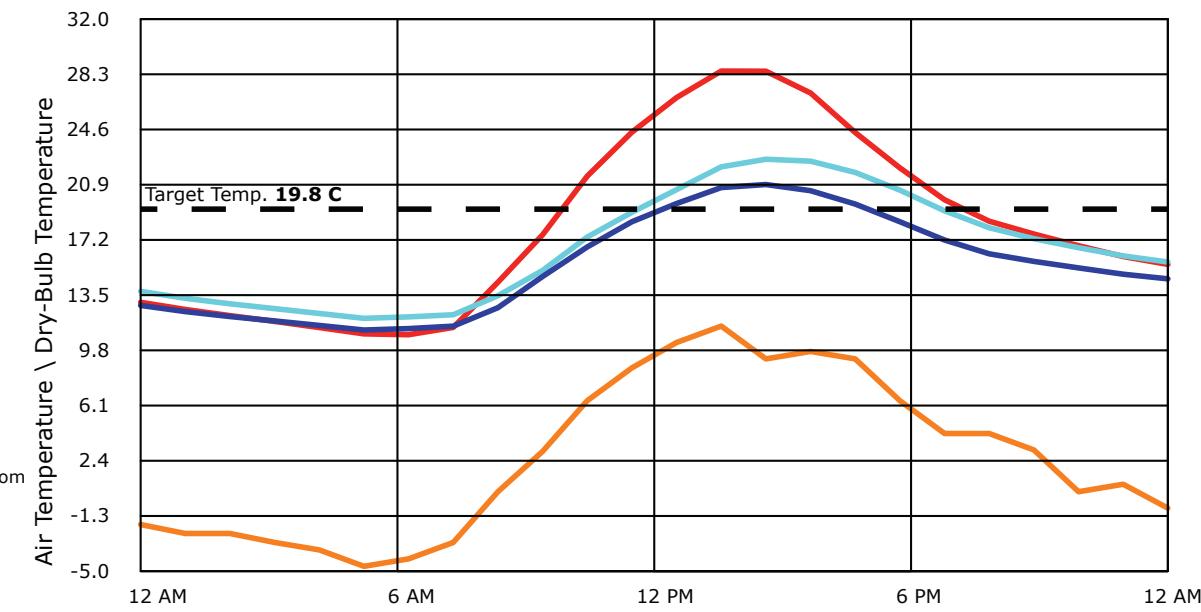
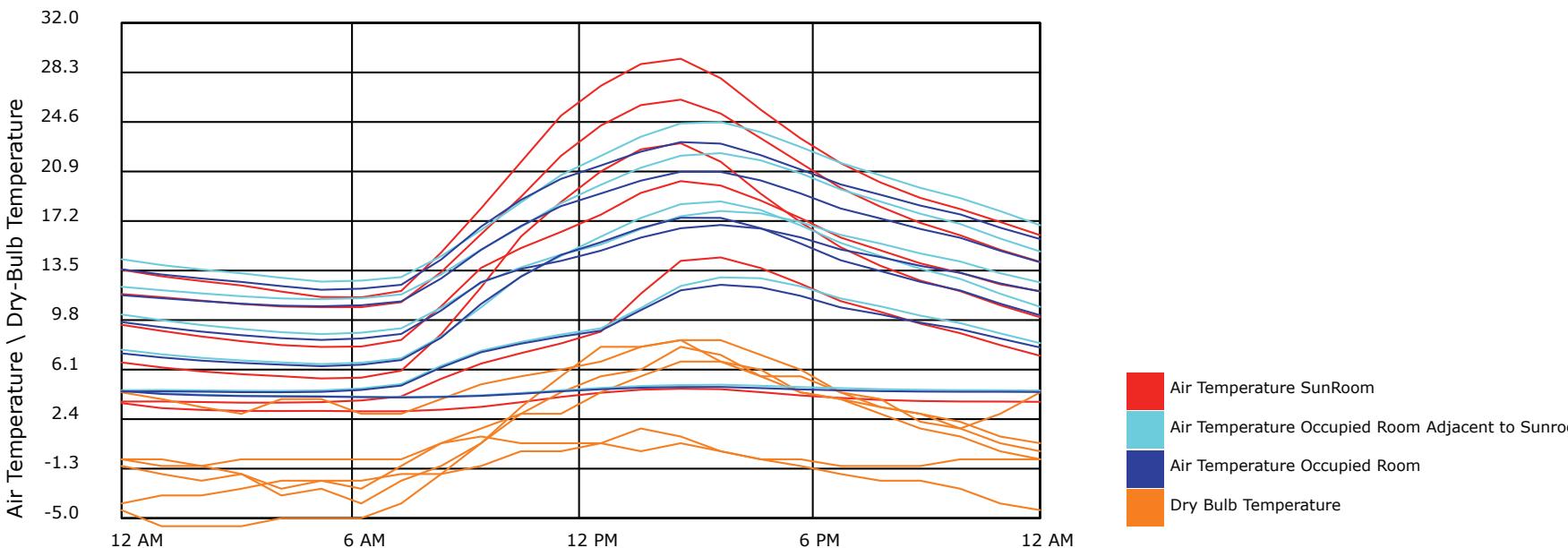
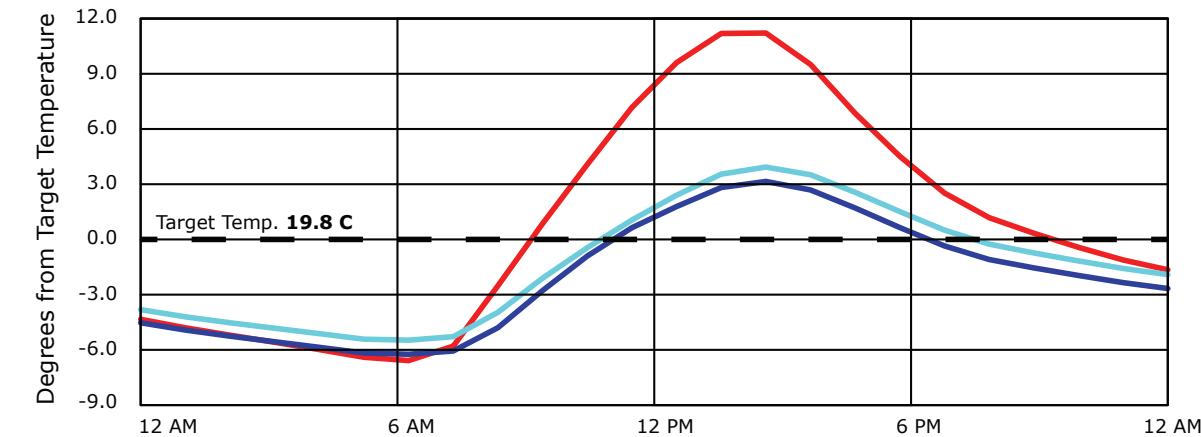


RESPONSIVE DESIGN - SUNROOMS

TYPICAL COLD WEEK
FEB 12 - FEB 18



TYPICAL COLD DAY
FEB 18



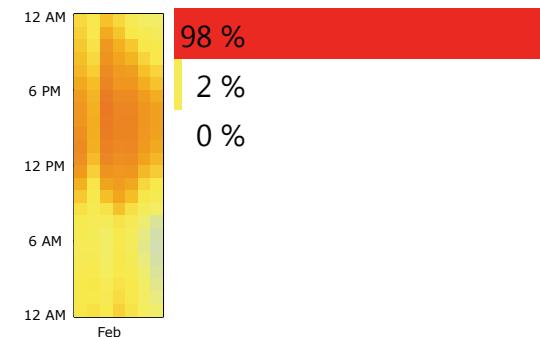
RESPONSIVE DESIGN - SUNROOMS

TYPICAL HOT WEEK

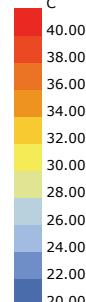
AUG 19 - AUG 25

Occupied Space

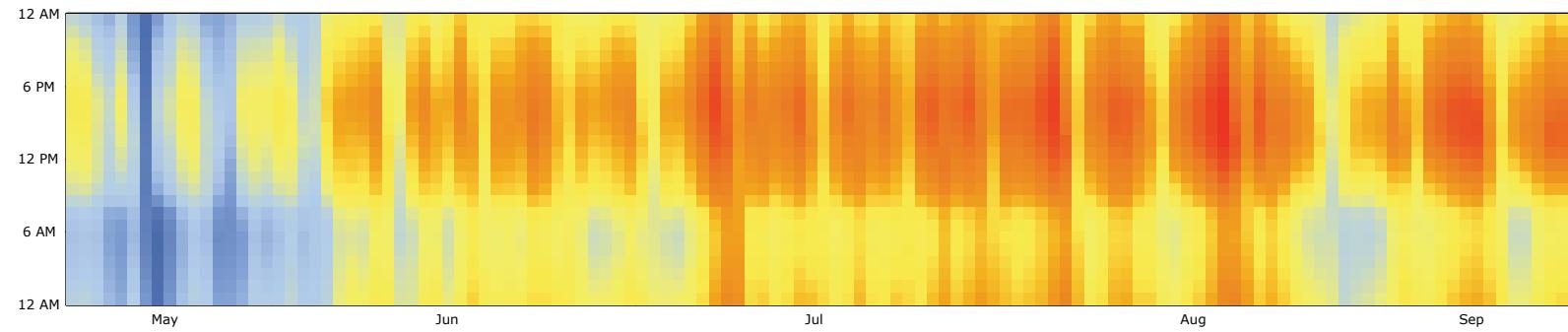
Baseline Case
(ASHRAE Zone 4A Construction)



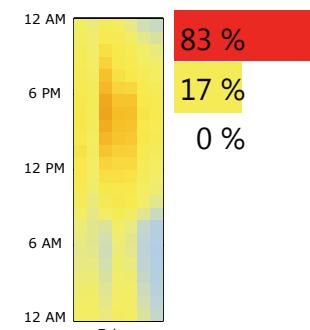
Sun Room



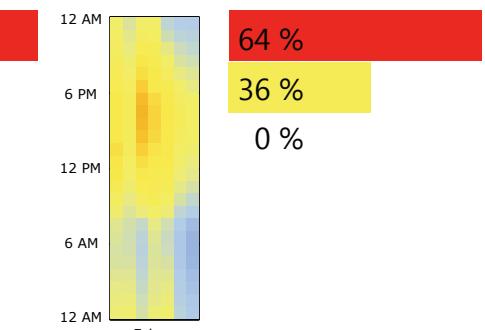
Occupied Space



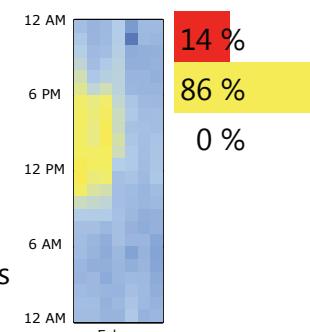
Baseline Case
(ASHRAE Zone 4A Construction)



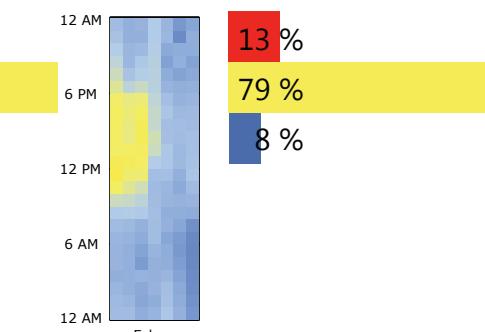
+
SunRoom
(ASHRAE Zone 4A Construction)
+
Shading Louvers



Baseline Case
(ASHRAE Zone 4A Construction)



+
SunRoom
(ASHRAE Zone 4A Construction)



+
Shading Louvers

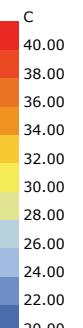
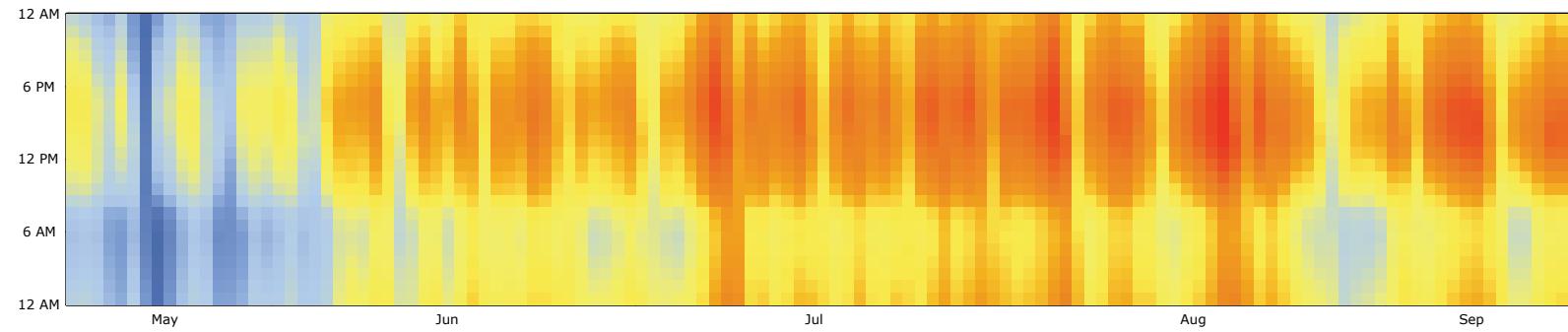
+
High Thermal Mass
(Interior Walls)

+
Night Purging

SUMMER

MAY 15 - SEP 15

Occupied Space



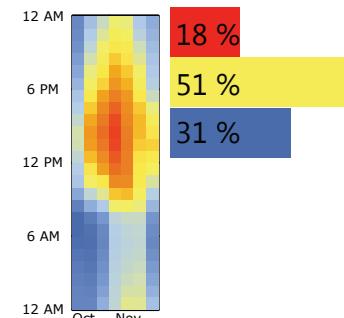
RESPONSIVE DESIGN - SUNROOMS

TYPICAL WEEK

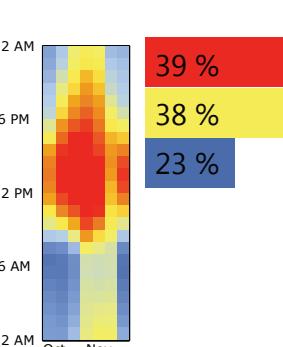
OCT 29 - NOV 4

Occupied Space

Baseline Case
(ASHRAE Zone 4A Construction)



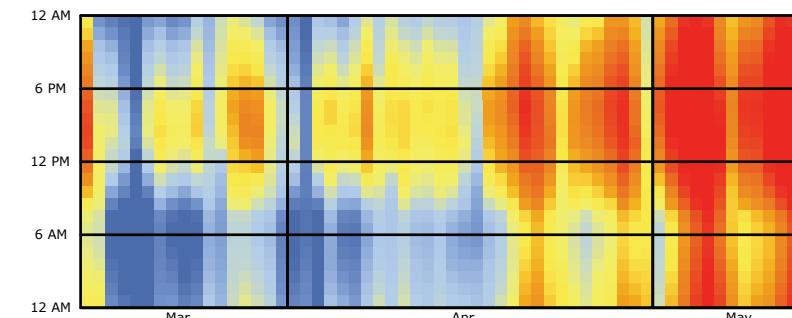
Sun Room



SPRING

MAR 15 - MAY 15

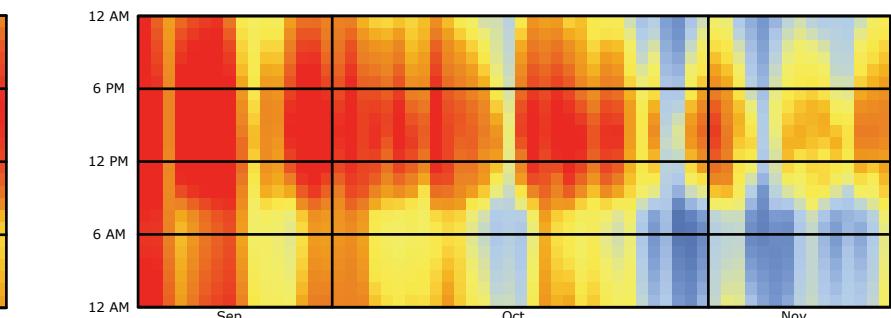
Occupied Space



FALL

SEP 15 - NOV 15

Occupied Space



Baseline Case
(ASHRAE Zone 4A Construction)

+
SunRoom
(ASHRAE Zone 4A Construction)

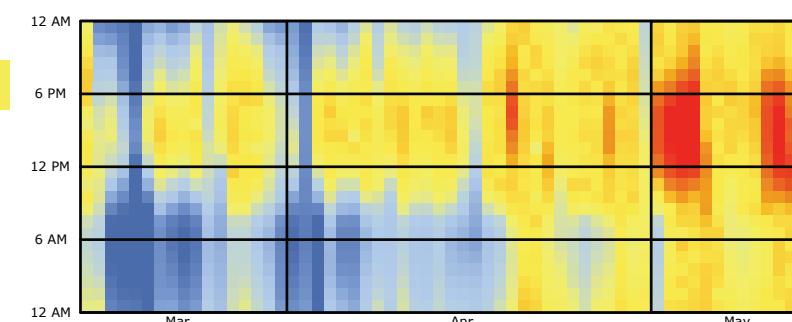
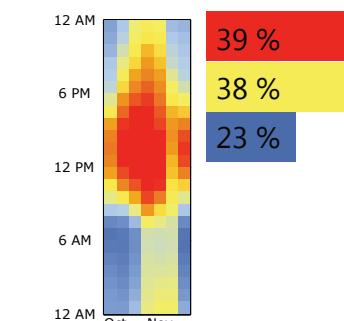
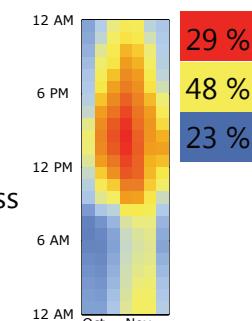
+
High Thermal Mass
(Interior Walls)

Baseline Case
(ASHRAE Zone 4A Construction)

+
SunRoom
(ASHRAE Zone 4A Construction)

+
High Thermal Mass
(Interior Walls)

+
Natural Ventilation
(@ minimum indoor temp. 24 C)

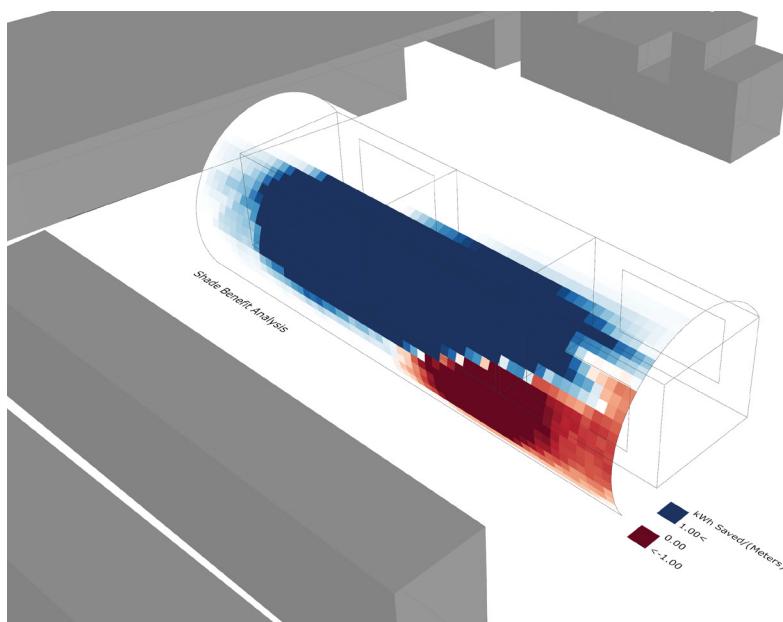


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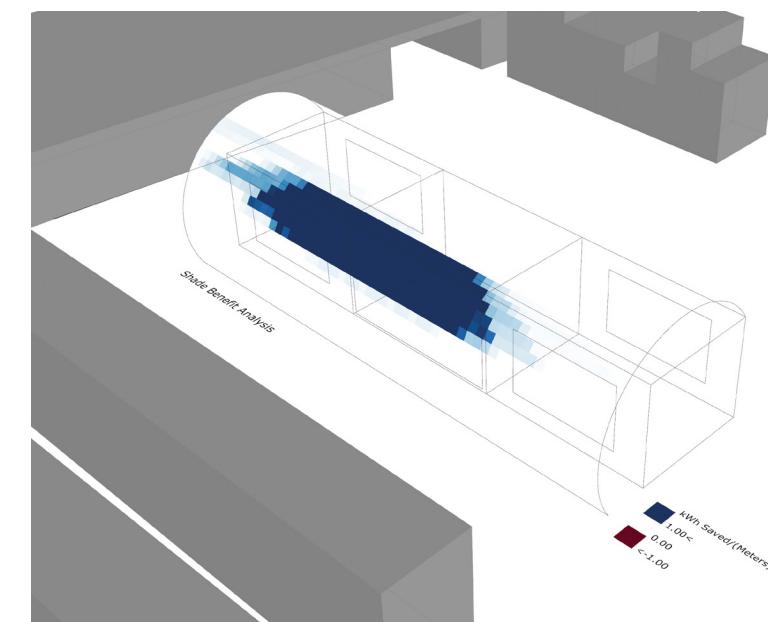
- 30.0
- 28.5
- 27.0
- 25.5
- 24.0
- 22.5
- 21.0
- 19.5
- 18.0
- 16.5
- 15.0

SHADE BENEFIT ANALYSIS

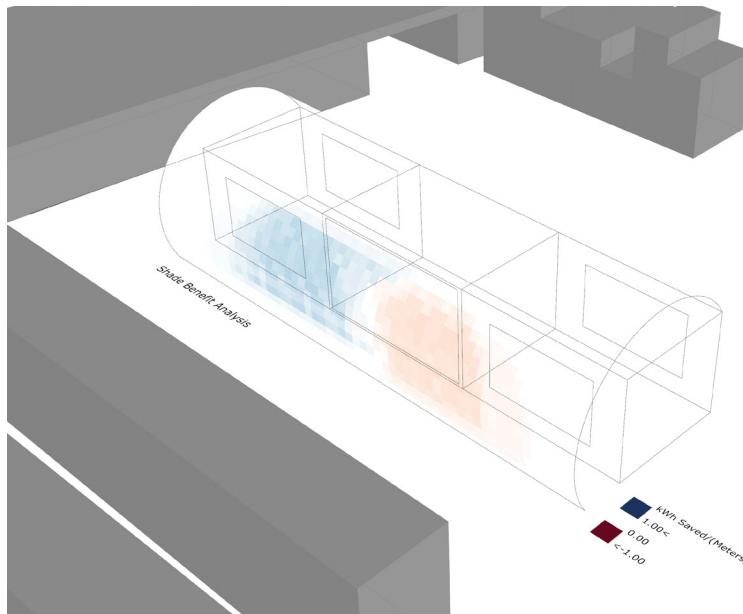
ANNUAL



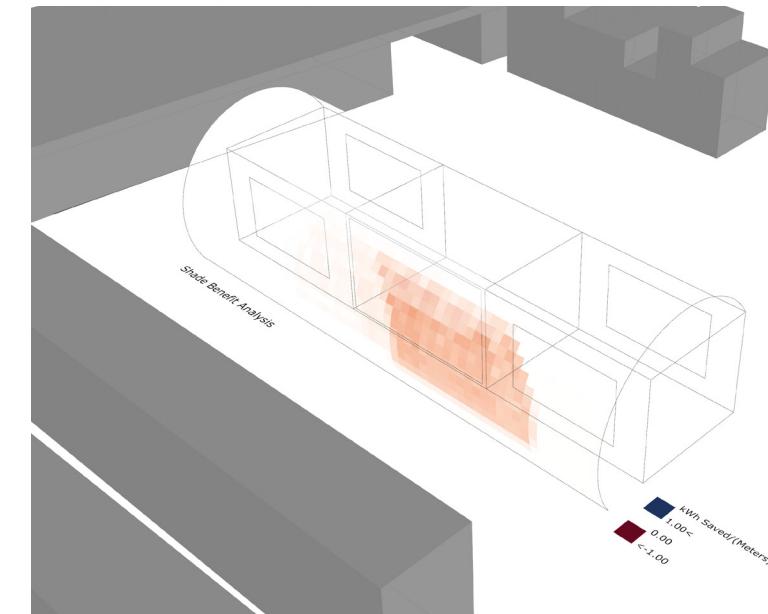
TYPICAL HOT WEEK



TYPICAL WEEK



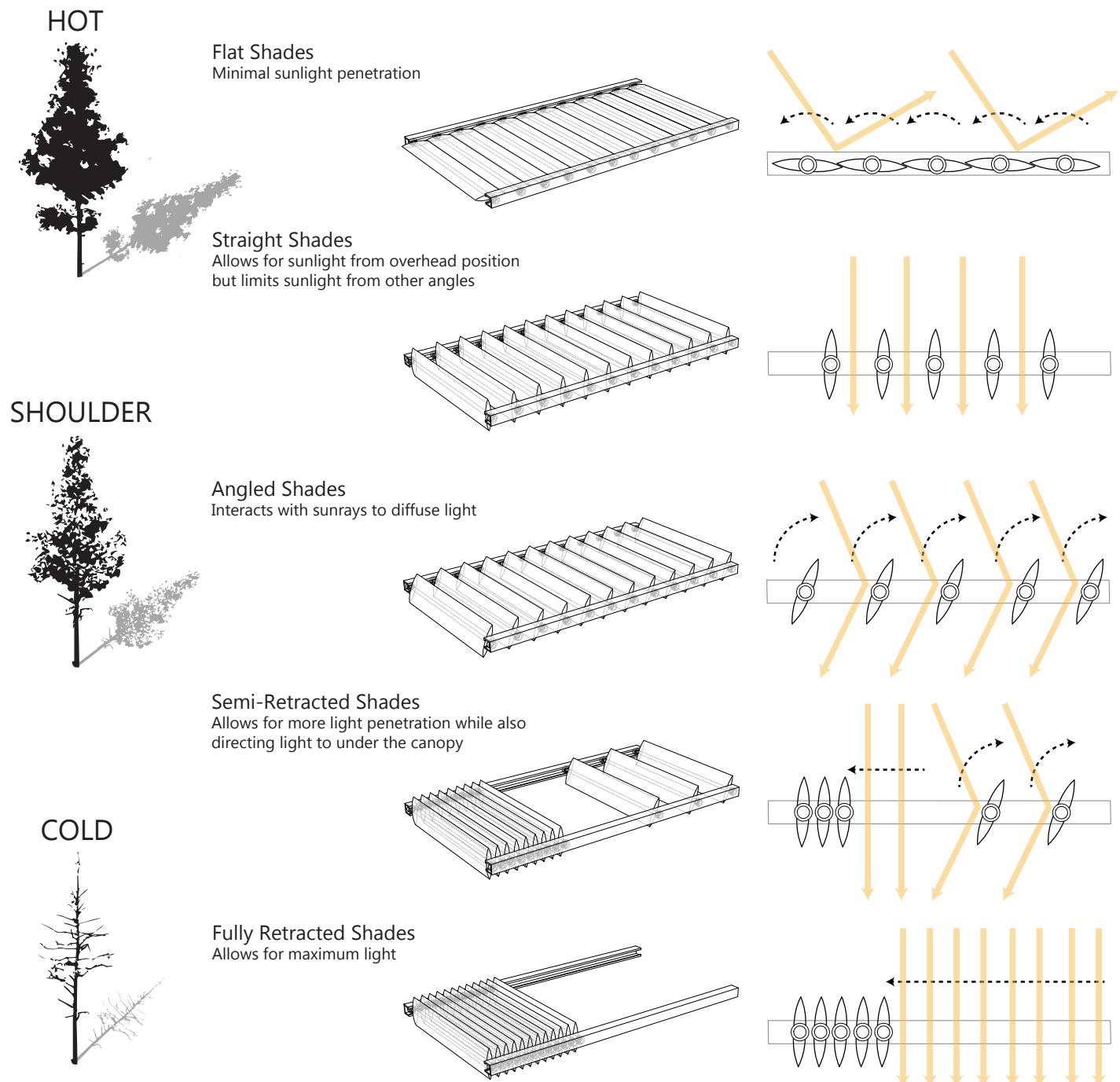
TYPICAL COLD WEEK



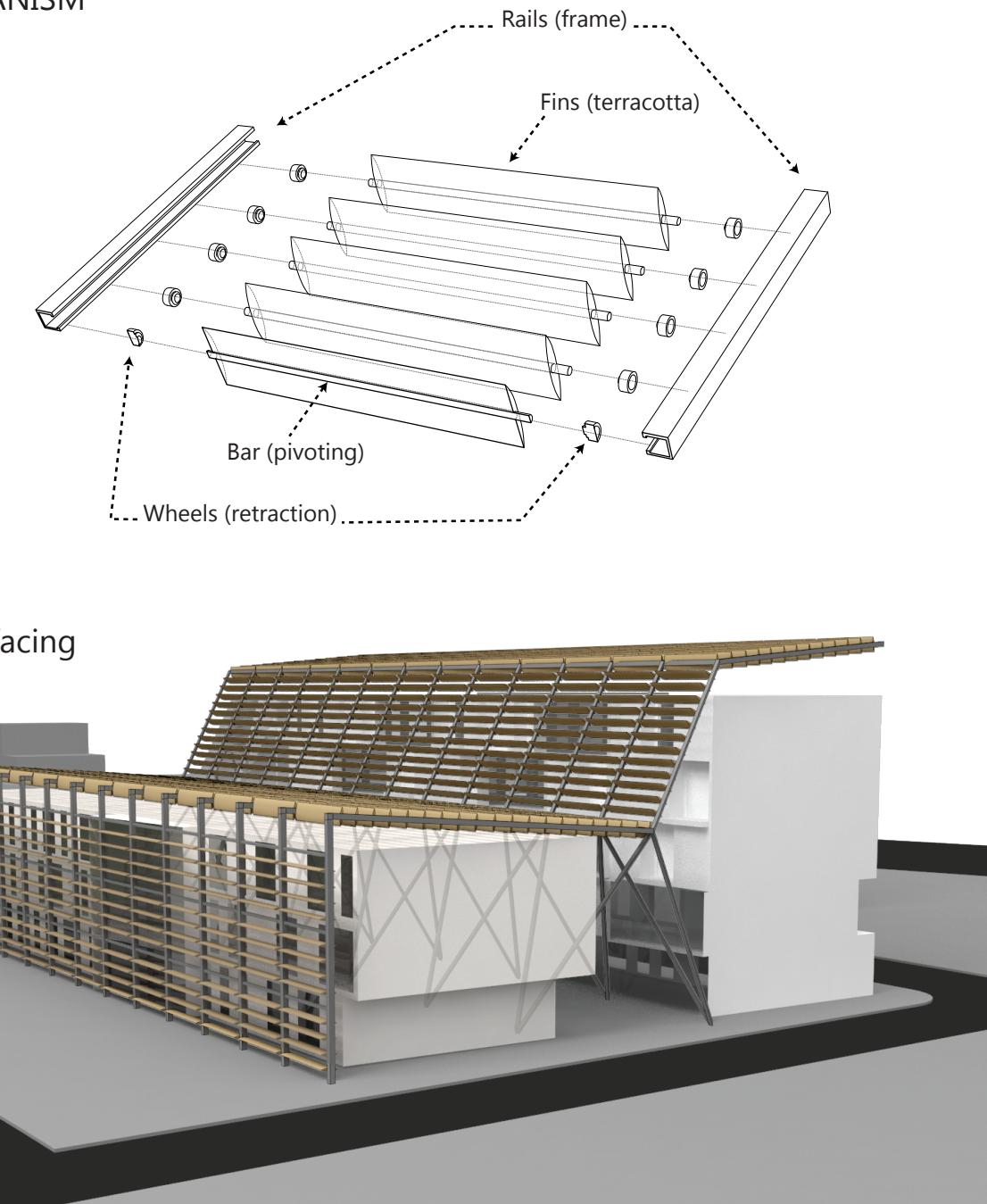
Legend

- █ Beneficial
- █ Neutral
- █ Harmful

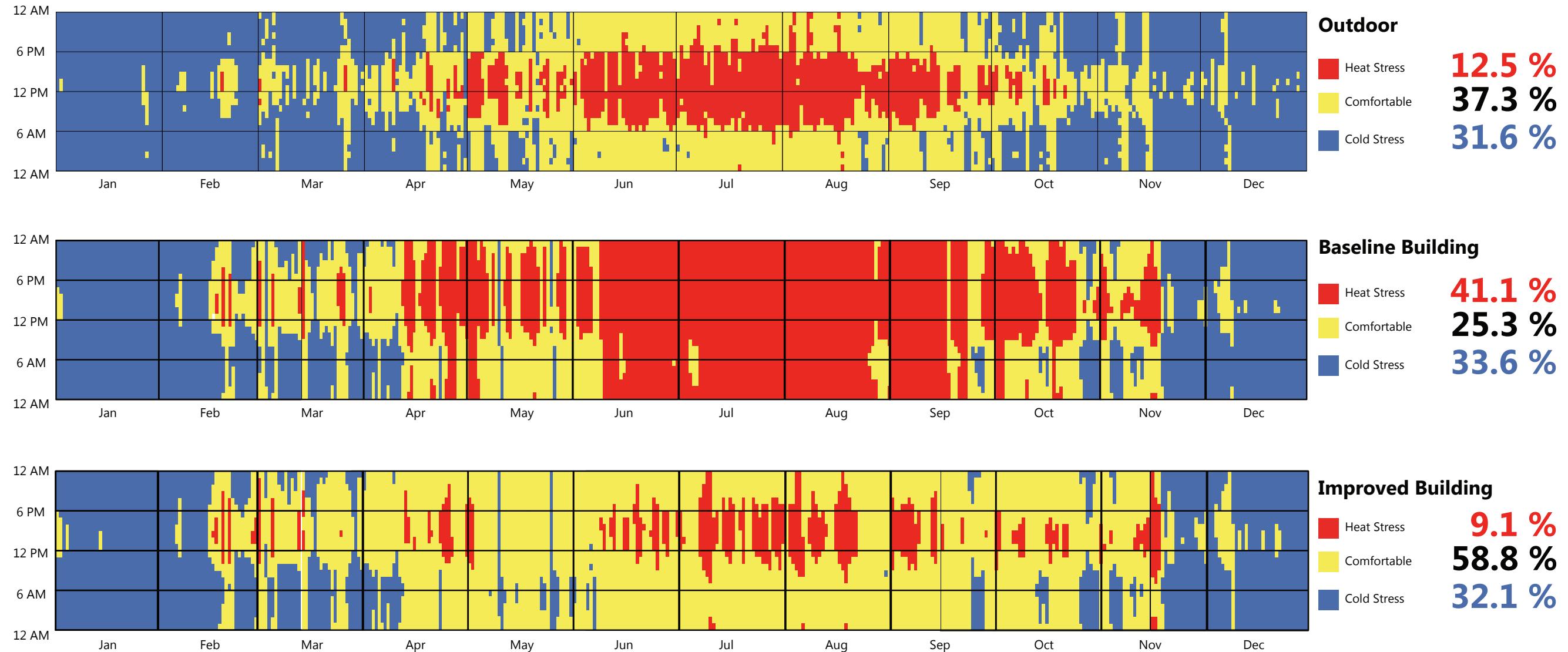
RESPONSIVE DESIGN - DYNAMIC SHADING



MECHANISM



ANNUAL ADAPTIVE COMFORT CHART



FLOOR PLANS & PROGRAM ORGANIZATION

Residential 1br & 2br apartments rise above on the north side to capture both views and light

Potential for long-term stays

Individual sun rooms provide comfortable and relaxing spaces

Dormitories allow for long-term educational opportunities

Views to Courtyard and Living Wall

Research labs, offices and support

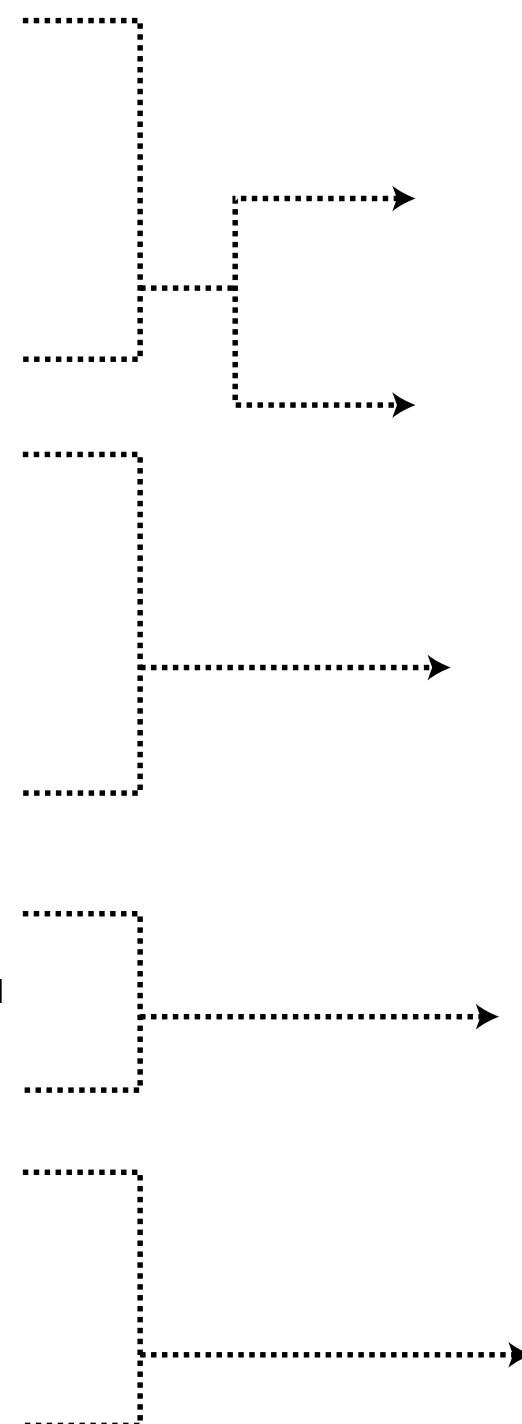
Large sunroom atrium in the South wing allows for heat and cross-floor interaction

Chautauqua offices expand across both North and South wings with access to Living Wall and Courtyard

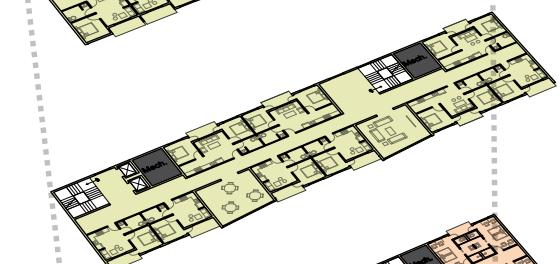
Residential and Office/Research Lobbies

Access to Auditorium from Courtyard

Cafe/Retail on Brown and North Front Streets that can potentially flow into Courtyard



FOURTH FLOOR



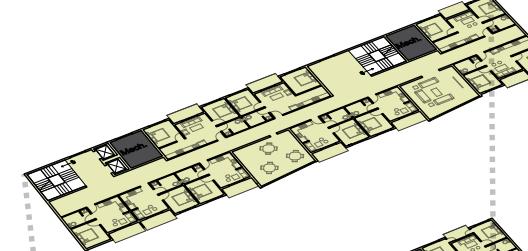
THIRD FLOOR



SECOND FLOOR



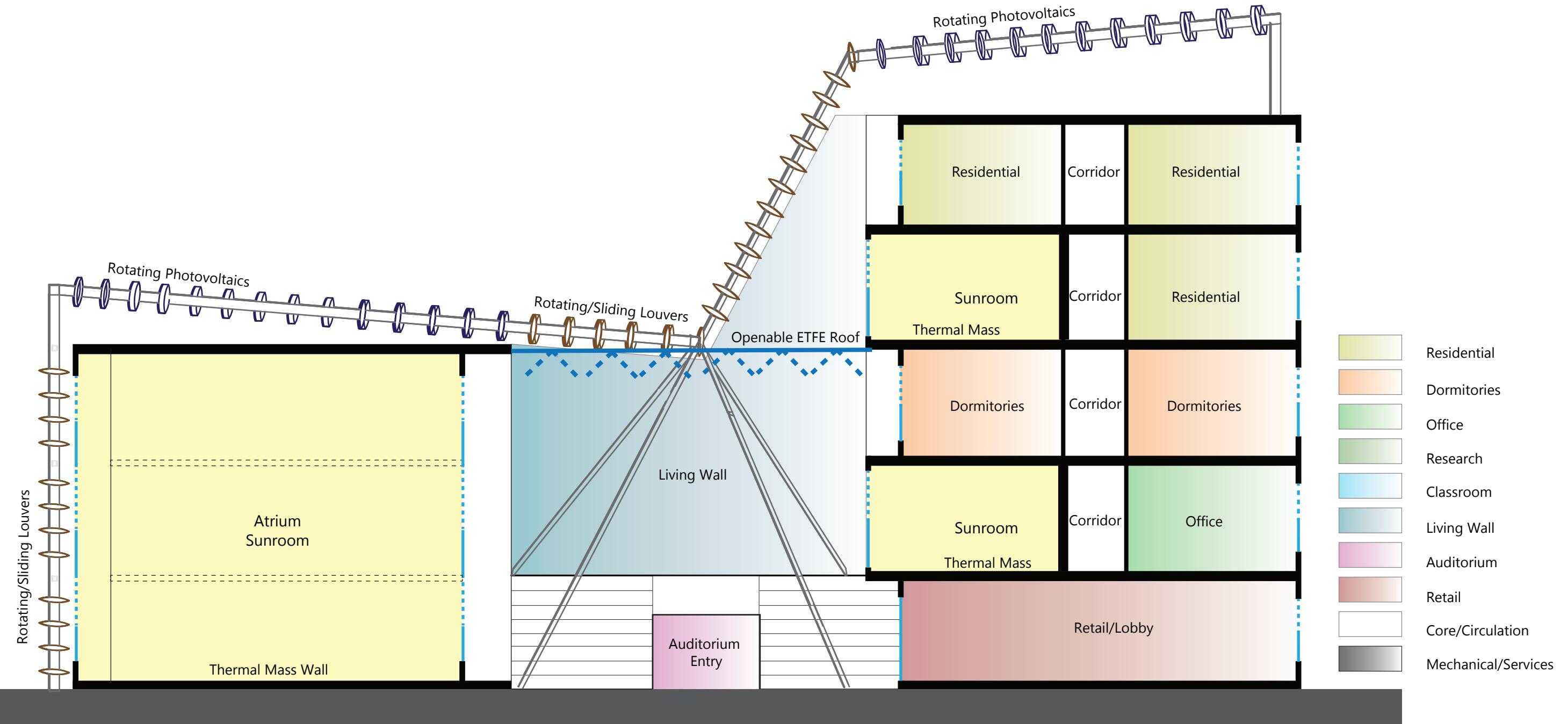
FIRST FLOOR



FOURTH FLOOR

	Residential
	Dormitories
	Office
	Research
	Classroom
	Living Wall
	Auditorium
	Retail
	Core/Circulation
	Mechanical/Services

SECTION



LIVING WALL VENTILATION OPPORTUNITY

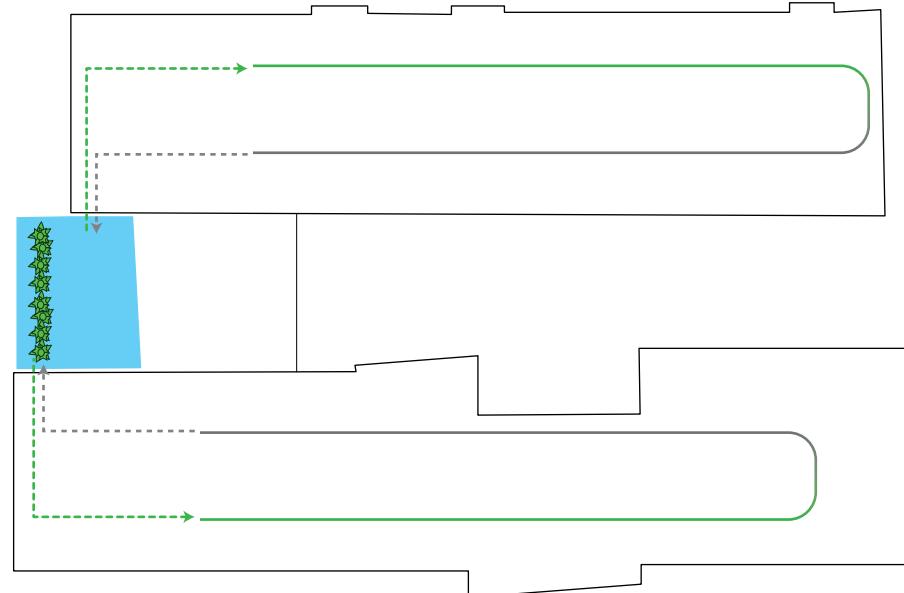
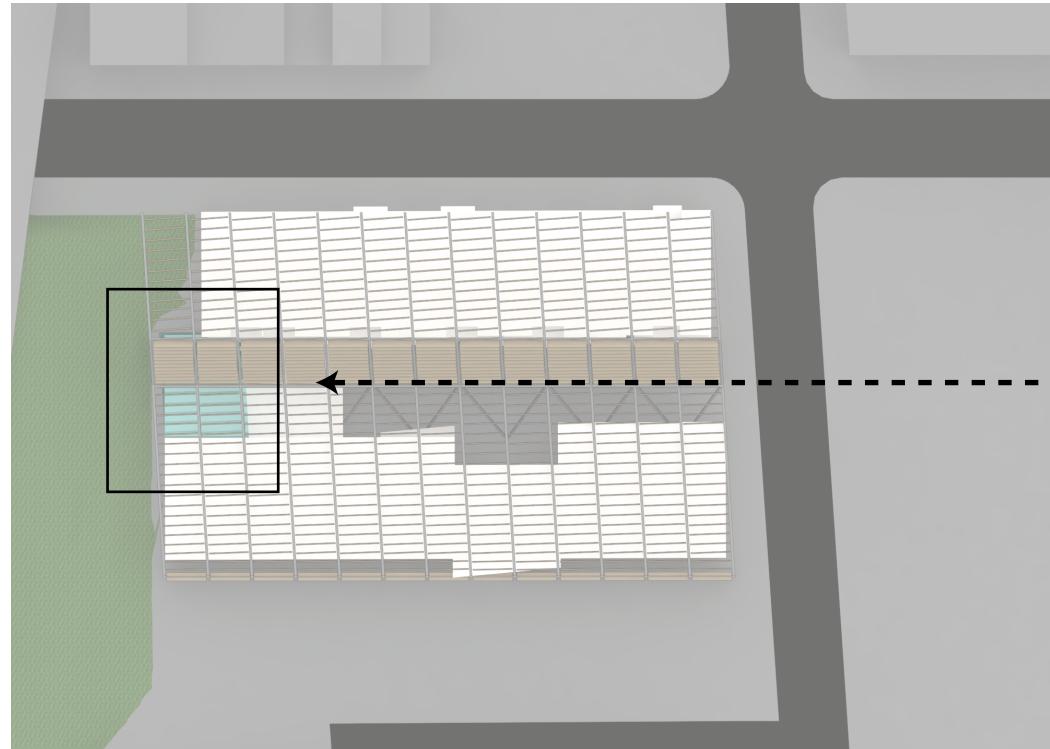
CHALLENGE

Highway just west of the site produces pollutants and noise

OPPORTUNITY

Create a living wall ventilation system

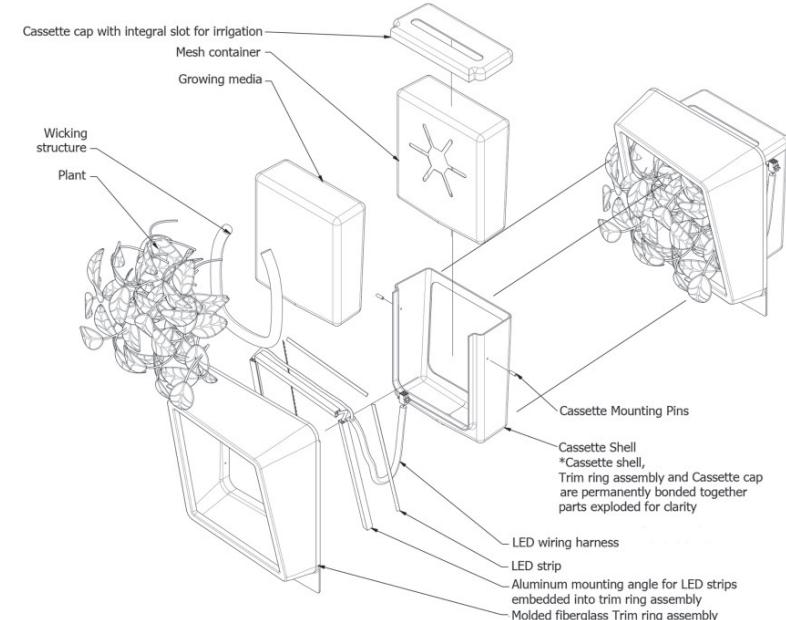
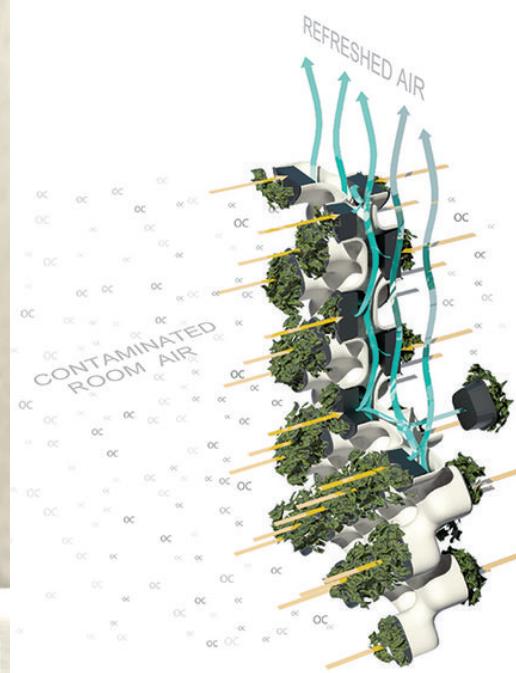
Living wall can also be seen from the highway



CASE STUDY

Center for Architecture Science and Ecology (NCASE) & Skidmore, Owings & Merrill

Active Modular Phytoremediation System (AMPS)



NET-ZERO ENERGY POTENTIAL

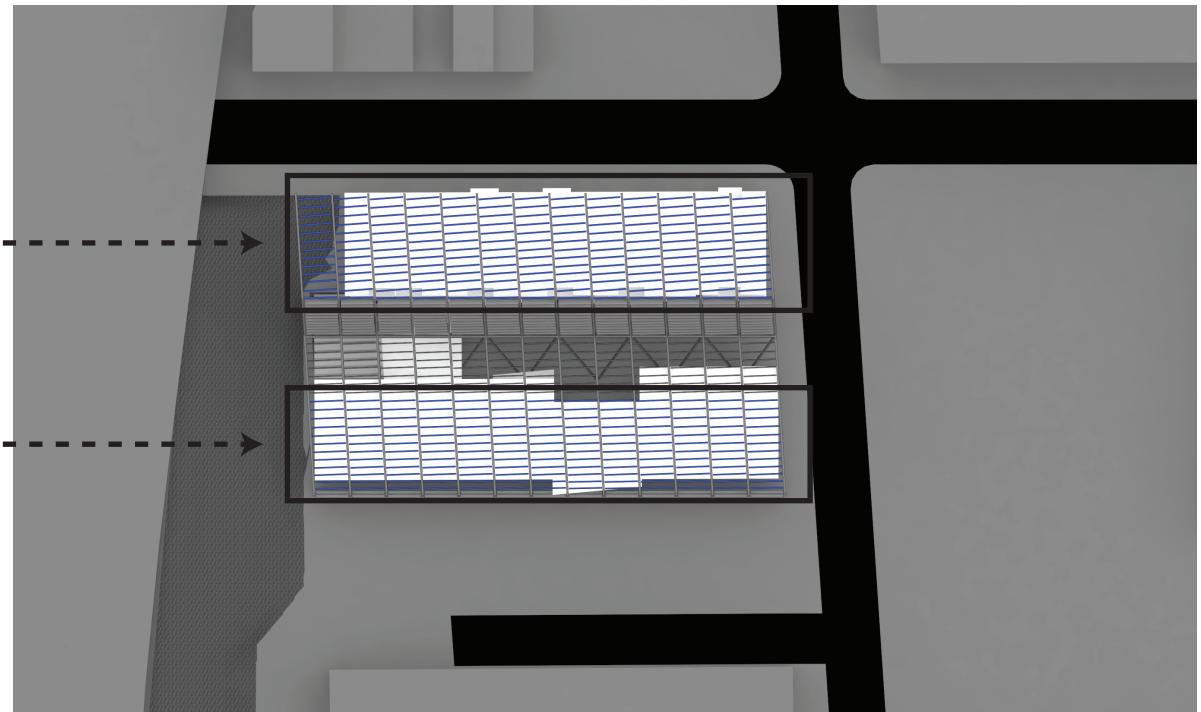
PV PANEL SIZING pvwatts.nrel.gov

DC System Size:	208 kW
Module Type:	Standard
Array Type:	1-Axis Tracking
Array Tilt:	40°
Array Azimuth:	180°
System Losses:	13.18%
Inverter Efficiency:	96%
DC to AC Size Ratio:	1.1
Ground Coverage Ratio:	0.4

Avg. Philly Electricity: 0.07 \$/kWh

*Size (kW) = Array Area (m^2) x 1 kW/ m^2 x Module Efficiency
208 kW = 1,300 m^2 x 1 kW/ m^2 x 0.16

PV Panels with
1-Axis Tracking
over rooftops
(no retraction)



System Output 337,109 kWh per Year
Annual Savings \$20 - \$25,000

Average BTU p/sf: 80 kBtu * 50k sf = 4,000,000 kBtu ~ 1,172,000 kWh
Architecture 2030 Goals: 27 kBtu * 50k sf = 1,350,000 kBtu ~ 395,600 kWh
PHIUS+ 2015 Passive Building Standard: 10 kBtu * 50k sf = 500,000 kBtu ~ 146,500 kWh

