

ANA SOFIA
CARDONA
JOANNE MUÑIZ

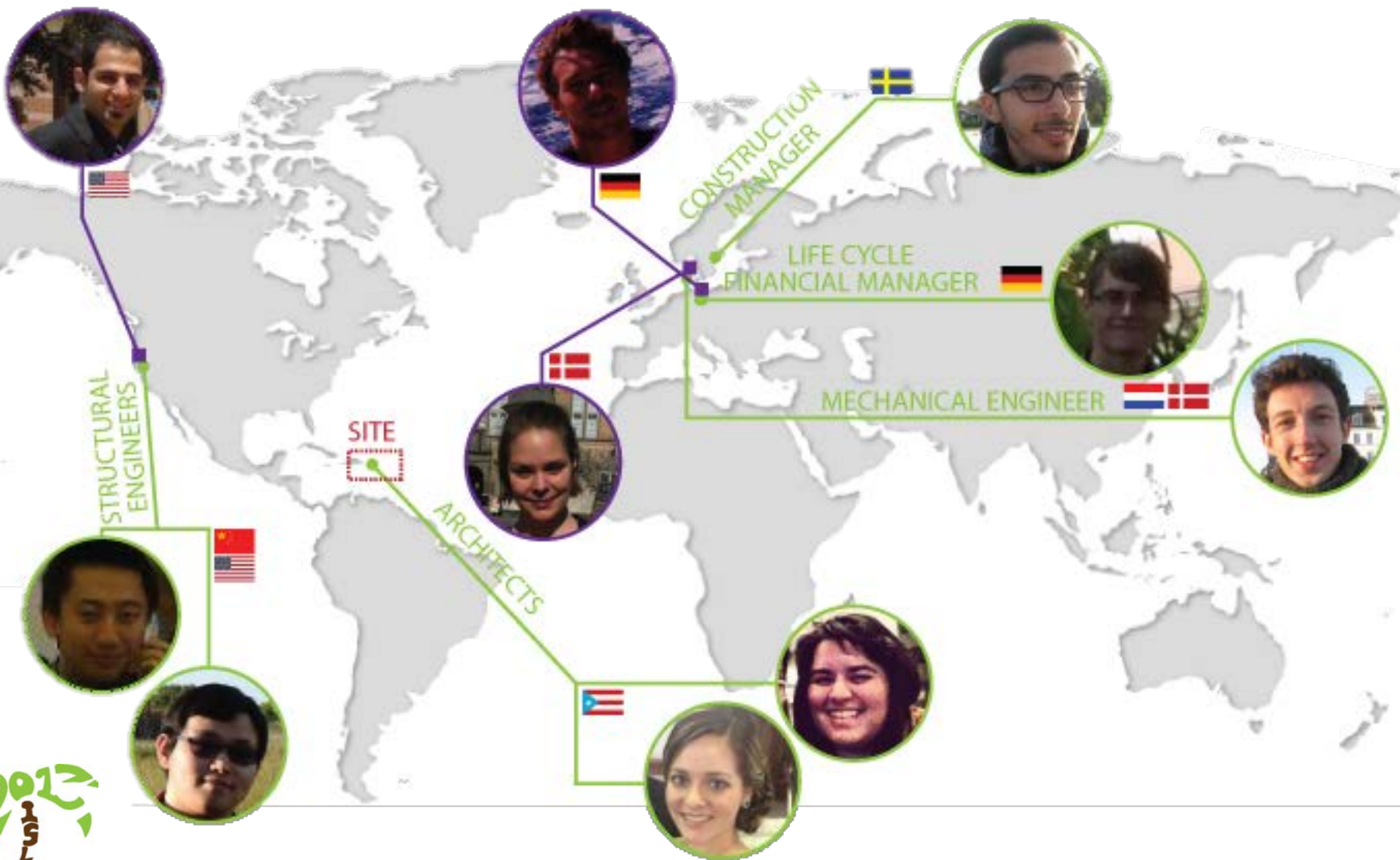
NANYU ZHAO
SHUHUI QU

REINIER KOK

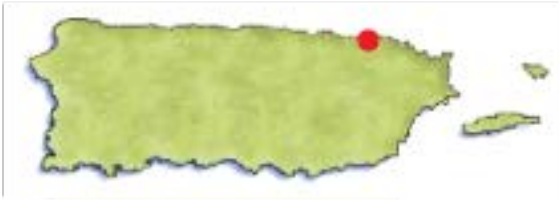
KOUROSH
SALEHZADEH

FELIX BOLLWAHN

WHO WE ARE



INTRODUCTION



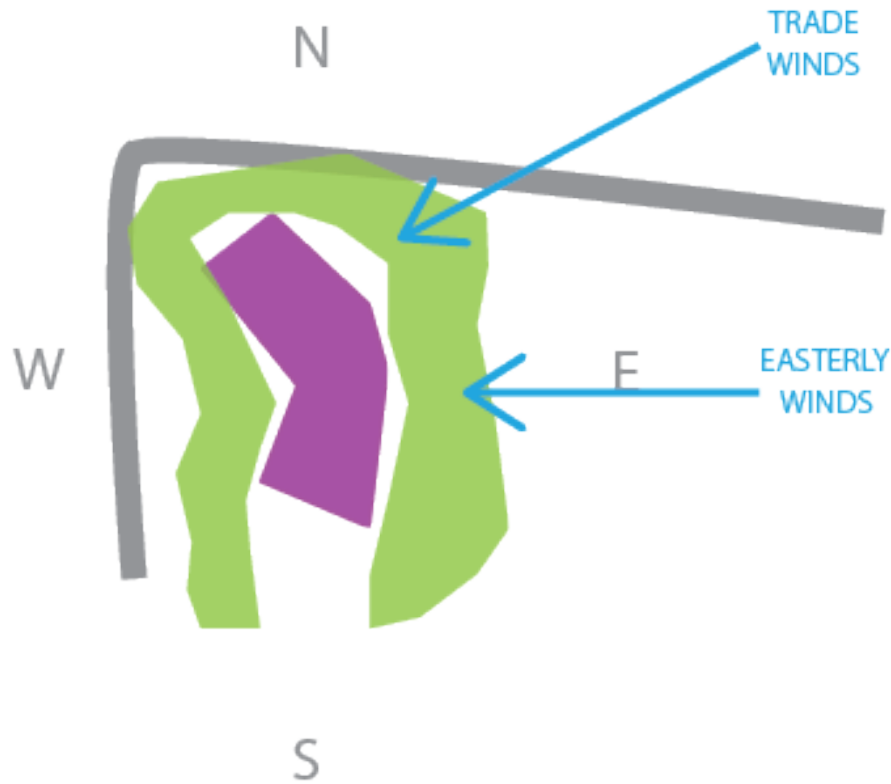
METROPOLITAN AREA



UNIVERSITY OF PUERTO RICO
RIO PIEDRAS CAMPUS



INTRODUCTION



GENERAL DESCRIPTION:

DAYLIGHT

12 HOURS [6AM - 6PM]

RAIN SEASON

APRIL - NOVEMBER

LOCAL HAZARDS:

HURRICANES

AUGUST - OCTOBER

EARTHQUAKES

LATEST (1918)- MAGNITUDE OF 7.5 IN RICHTER SCALE

TSUNAMIS

CLIMATE:

TYPE OF CLIMATE

HUMID - TROPICAL

TEMPERATURE

RANGES FROM 70 - 90 F [~ 20 - 30 C]

PRECIPITATION

RANGES FROM 2 -6 INCHES [~ 50 - 160 mm]

RELATIVE HUMIDITY

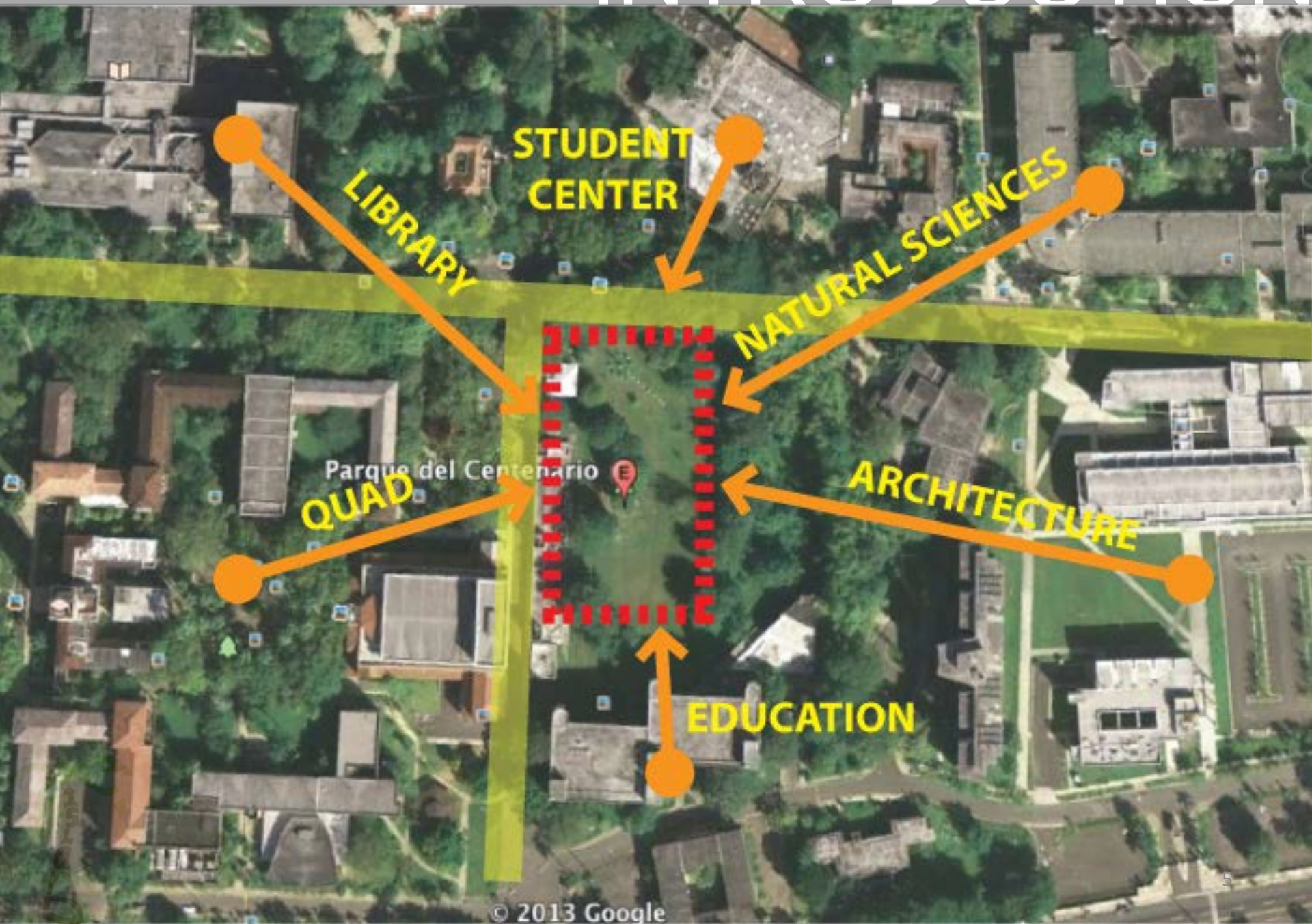
RANGES FROM 73% [MARCH] TO 78% [JUNE]

WIND SPEED

RANGES FROM 2 - 3 BEAUFORT [~ 2 - 5 m/s]

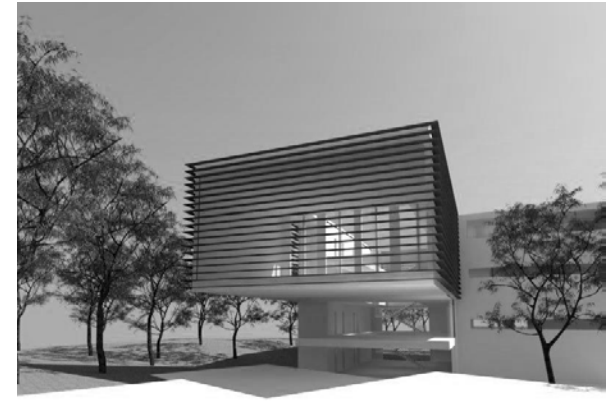


INTRODUCTION



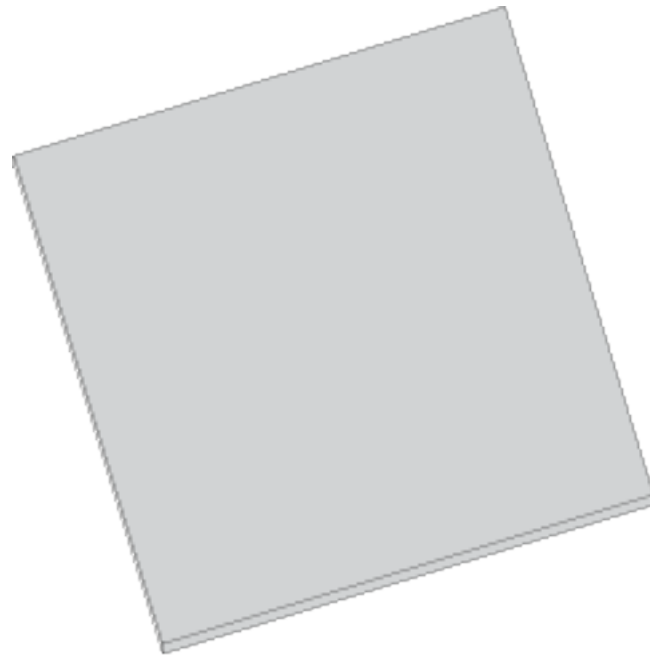
INTRODUCTION

Criteria	Emphasis	Palm Tree Concept Concrete		Palm Tree Concept Steel and Concrete		Hover Box Concept Steel and Concrete		Hover Box Concept Steel	
		Team	Owner	Team	Owner	Team	Owner	Team	Owner
Construction costs	5,00%	8,57	6,5	6,00	8,5	9,14	6,5	7,14	8
Value for money	12,33%	8,14	8	7,00	9	7,43	5,5	7,14	7,5
Architectural aesthetics	11,67%	9	7,5	9,00	8	6,43	8	6,57	8
Addressing the required room program	4,67%	8	9	8,00	9	8,14	9	8,14	9
Innovation in design - Leapfrogging	14,00%	6,57	6,5	7,14	7	5,71	5	5,71	5,5
Integration of nature	7,67%	8	8,5	8,00	8,5	6,00	7,5	6,00	7,5
Creation of an open and collaborative space	16,67%	8,29	8,75	8,43	8,75	7,00	9	7,00	9
Usage of natural ventilation	10,00%	8,71	7,5	8,72	7,5	5,29	9	5,29	9
Provided safety for the occupants	5,67%	7,86	7	8,00	7,5	6,86	8	7,00	9
Resistance to natural hazards, especially earthquakes & hurricanes	12,33%	8,29	6,75	8,57	8,75	5,57	6,5	5,86	8
Sum weighted:		8,11	7,61	7,99	8,23	6,53	7,29	6,46	7,92
Result:		7,86		8,11		6,91		7,19	



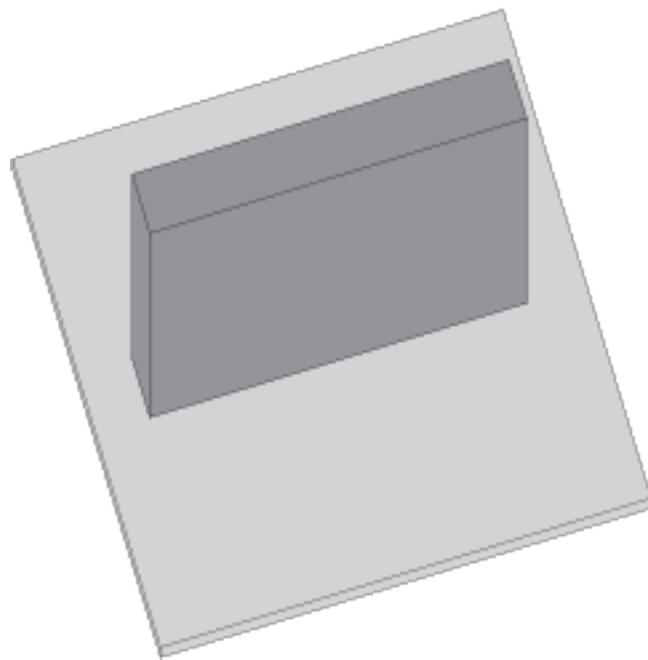
INTRODUCTION

CONCEPT DEVELOPMENT



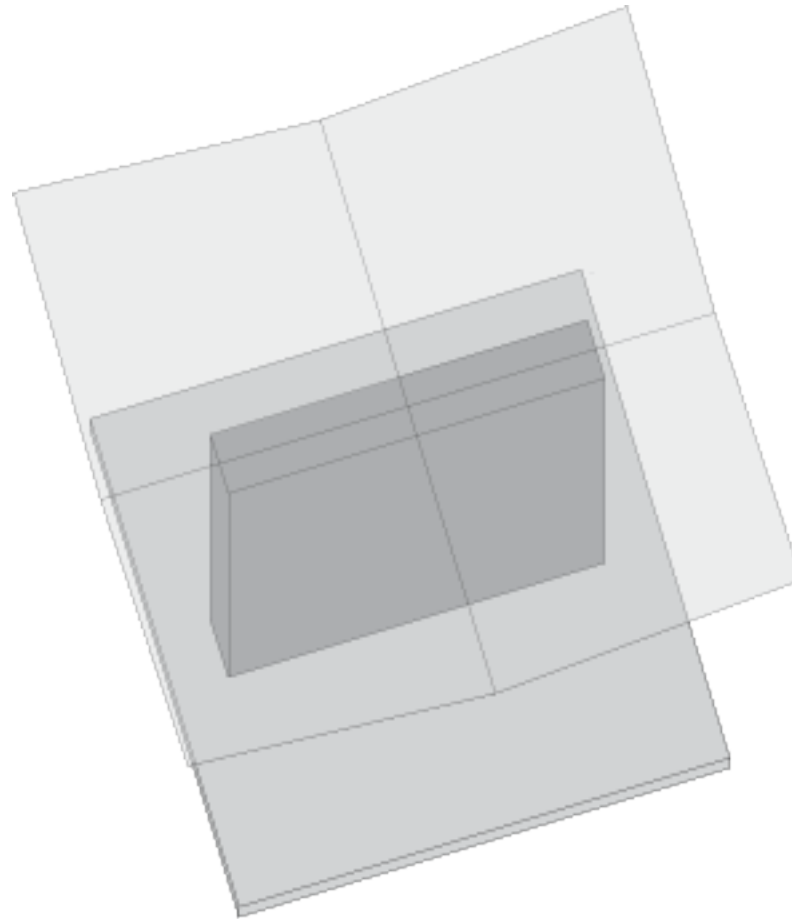
INTRODUCTION

CONCEPT DEVELOPMENT



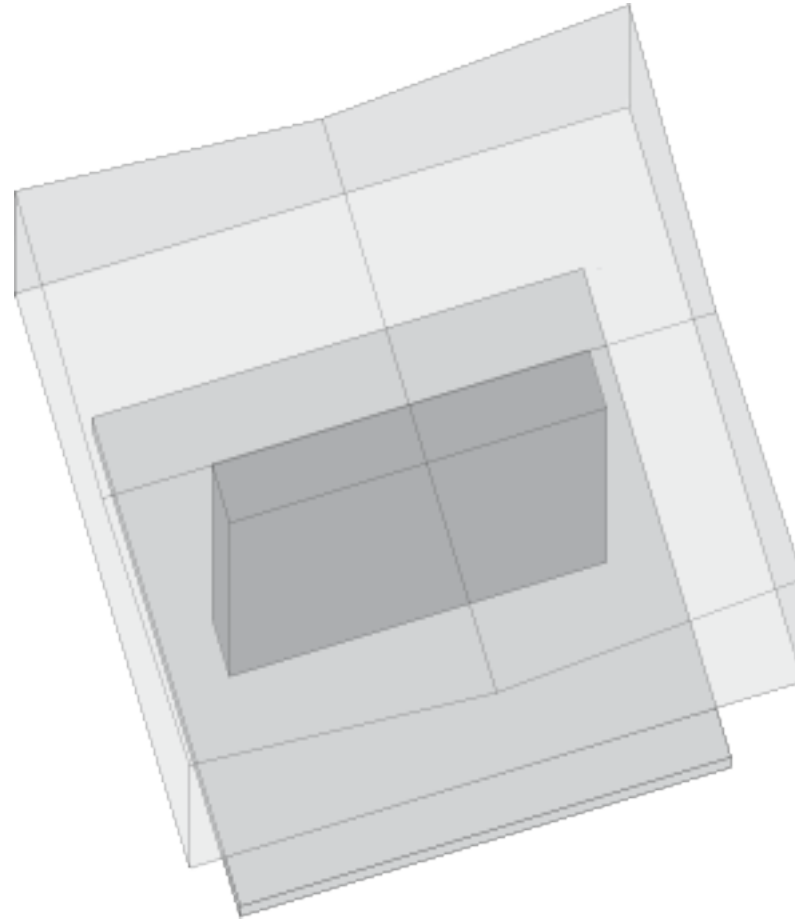
INTRODUCTION

CONCEPT DEVELOPMENT



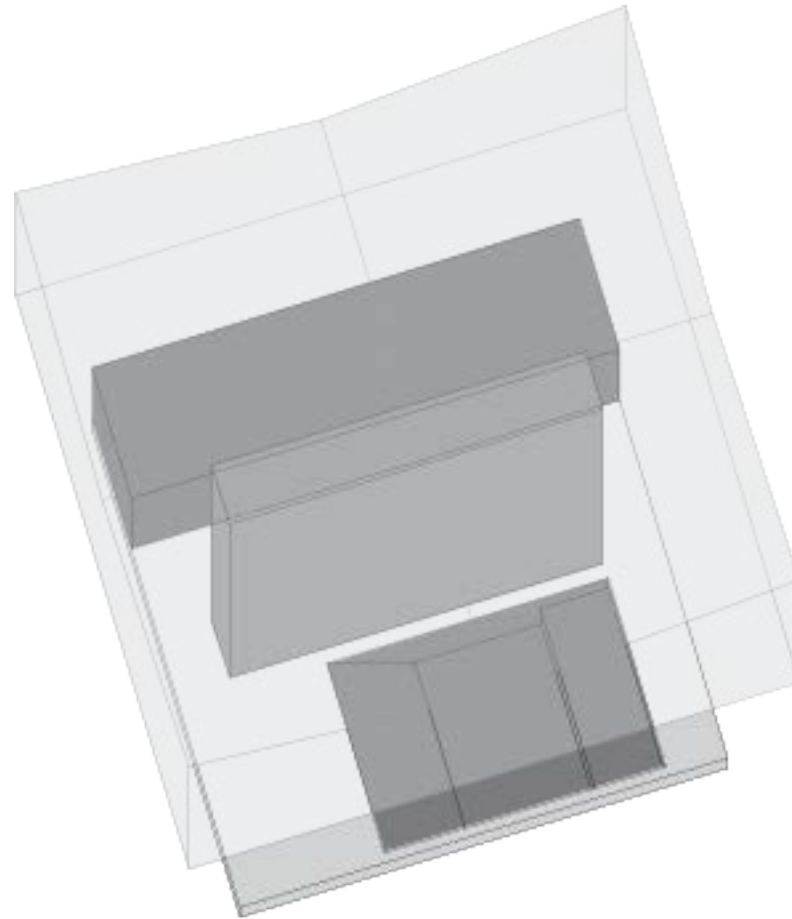
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CONCEPT DEVELOPMENT



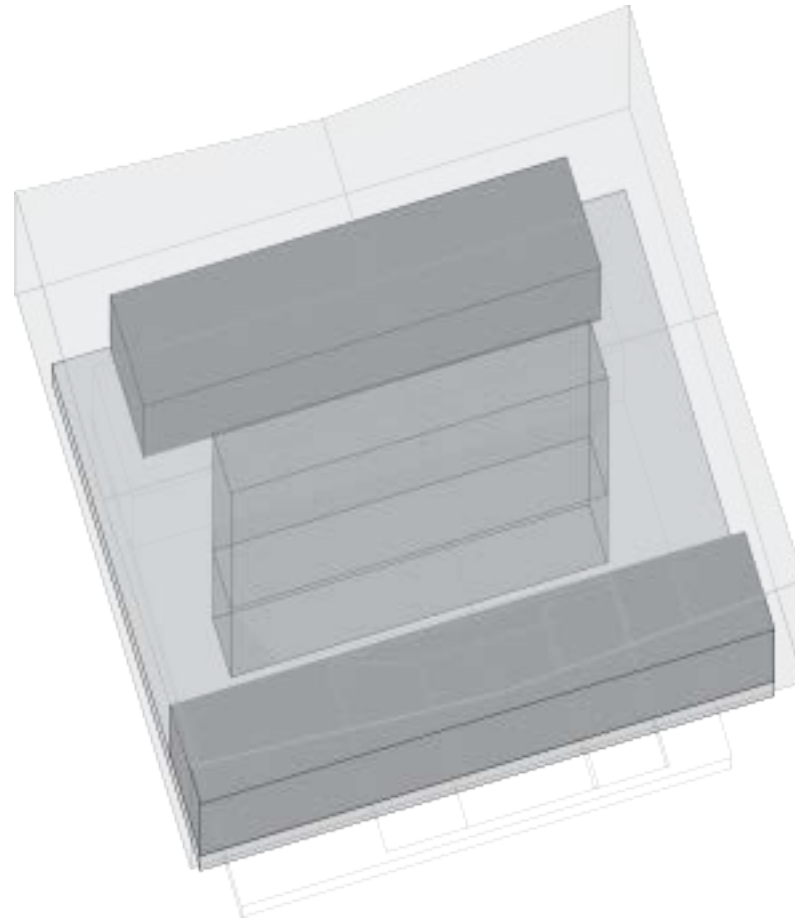
INTRODUCTION

CONCEPT DEVELOPMENT



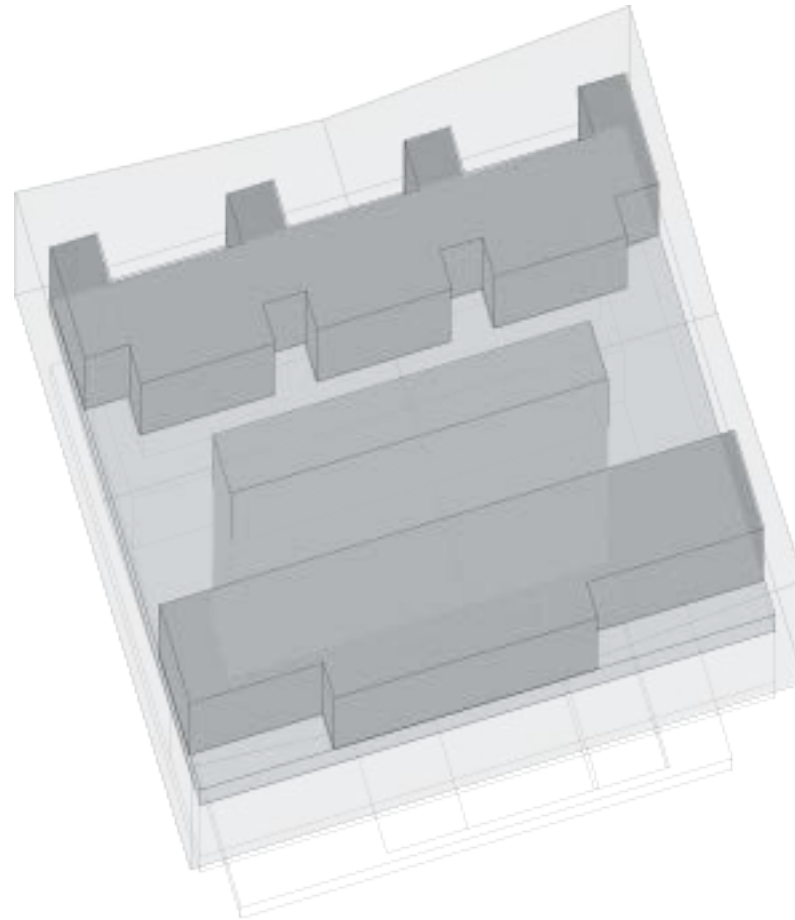
INTRODUCTION

CONCEPT DEVELOPMENT

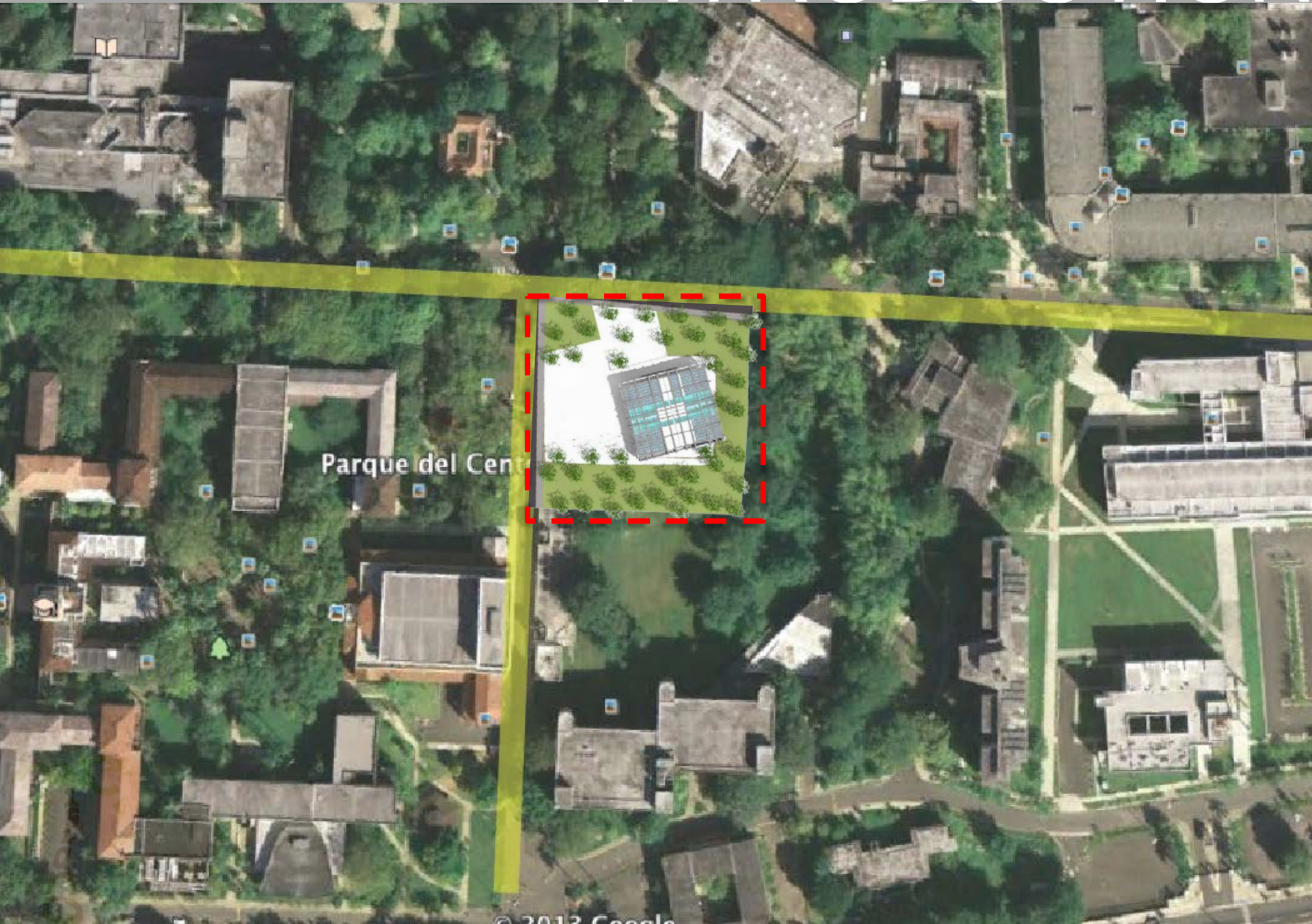


INTRODUCTION

CONCEPT DEVELOPMENT



INTRODUCTION



Parque del Cent





COMFORT & SPACE



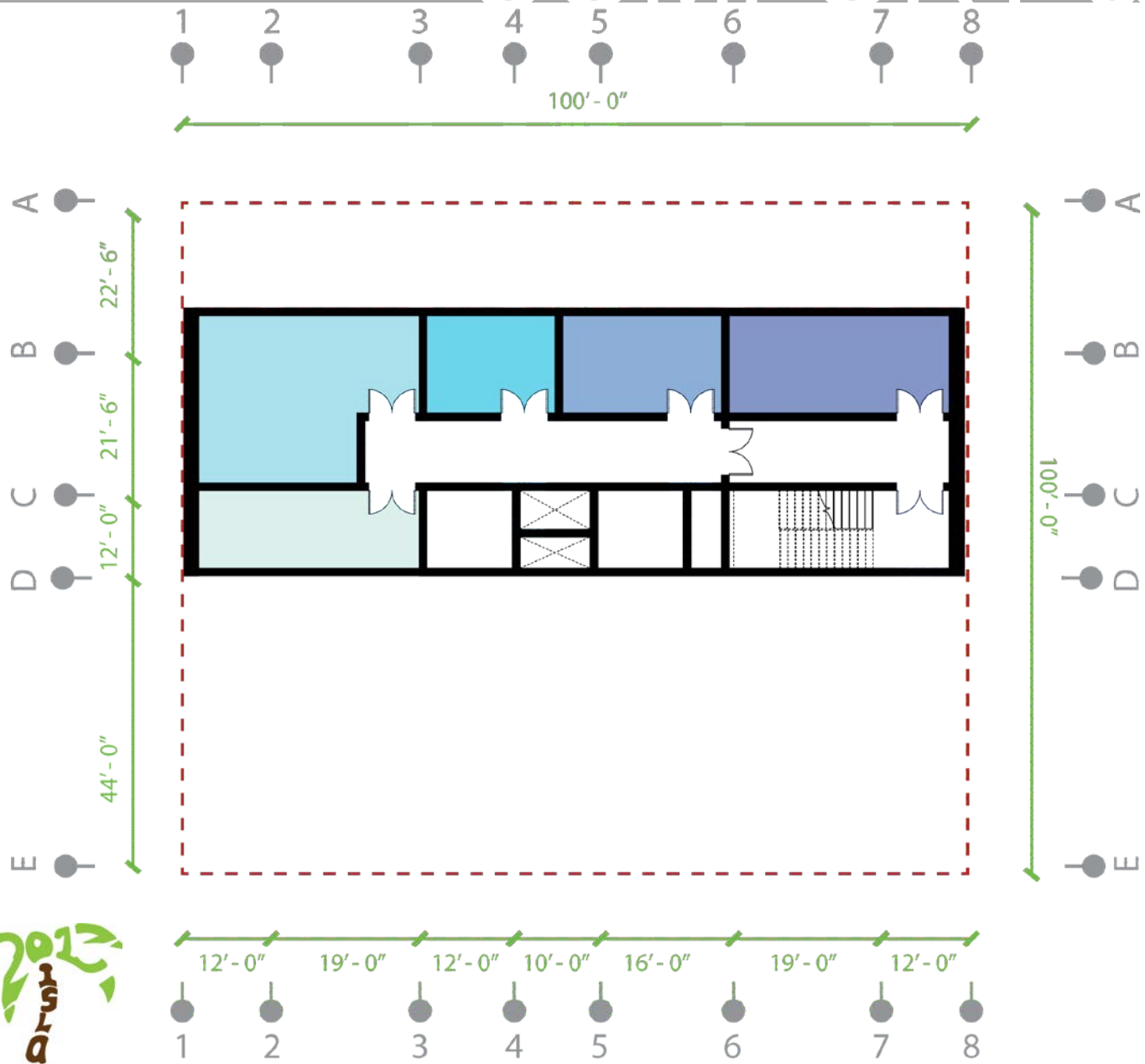
COMFORT & SPACE

SOCIAL GATHERING



COMFORT & SPACE

BASEMENT

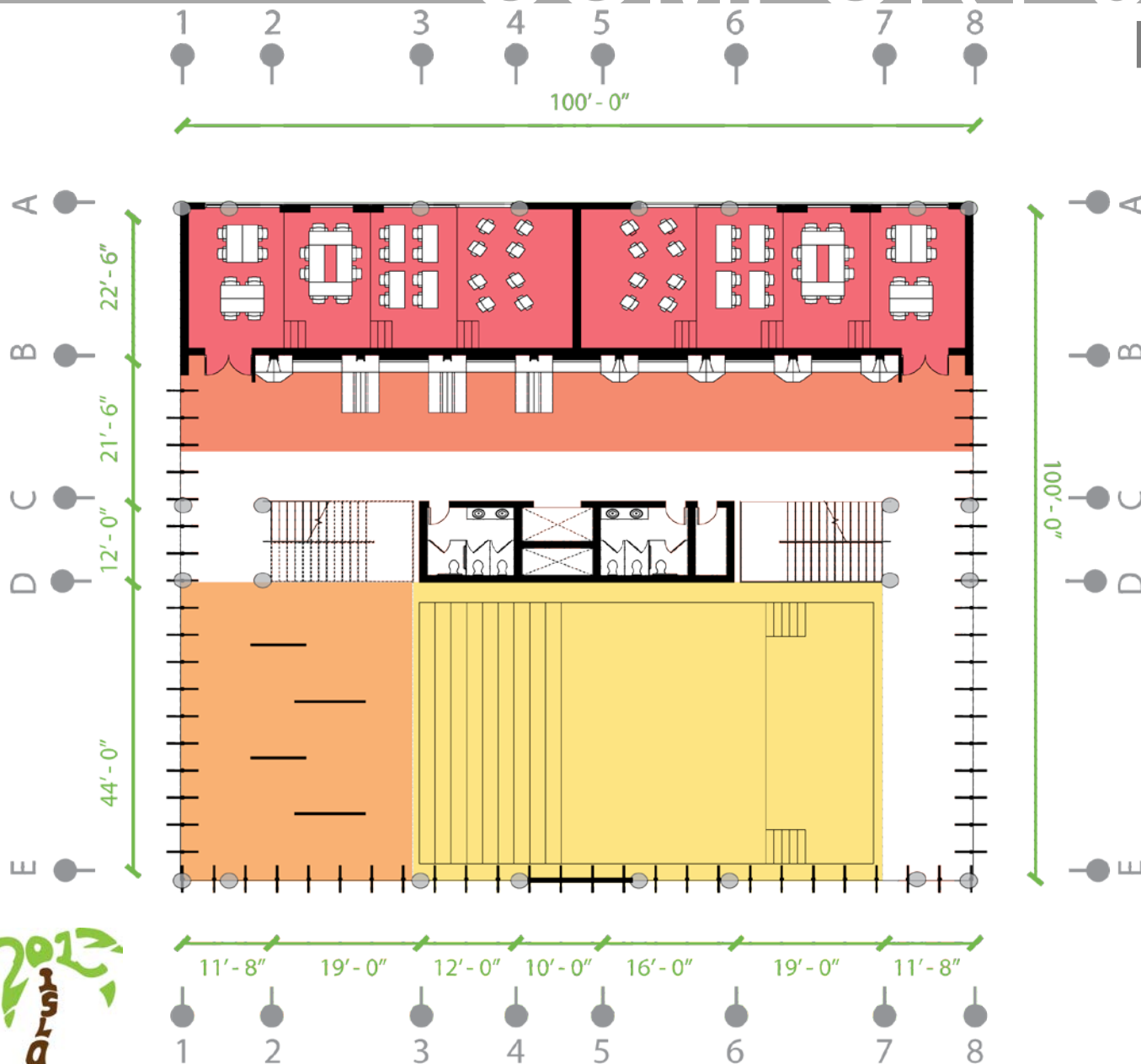


- RECYCLING ROOM
- TRANSFORMER VAULT ROOM
- SWITCH GEAR ROOM
- WATER SYSTEMS ROOM
- AIR HANDLING UNIT



COMFORT & SPACE

FIRST FLOOR



- INSTRUCTIONAL LABS
- SEMINAR SPACES
- GALLERY SPACE
- AUDITORIUM

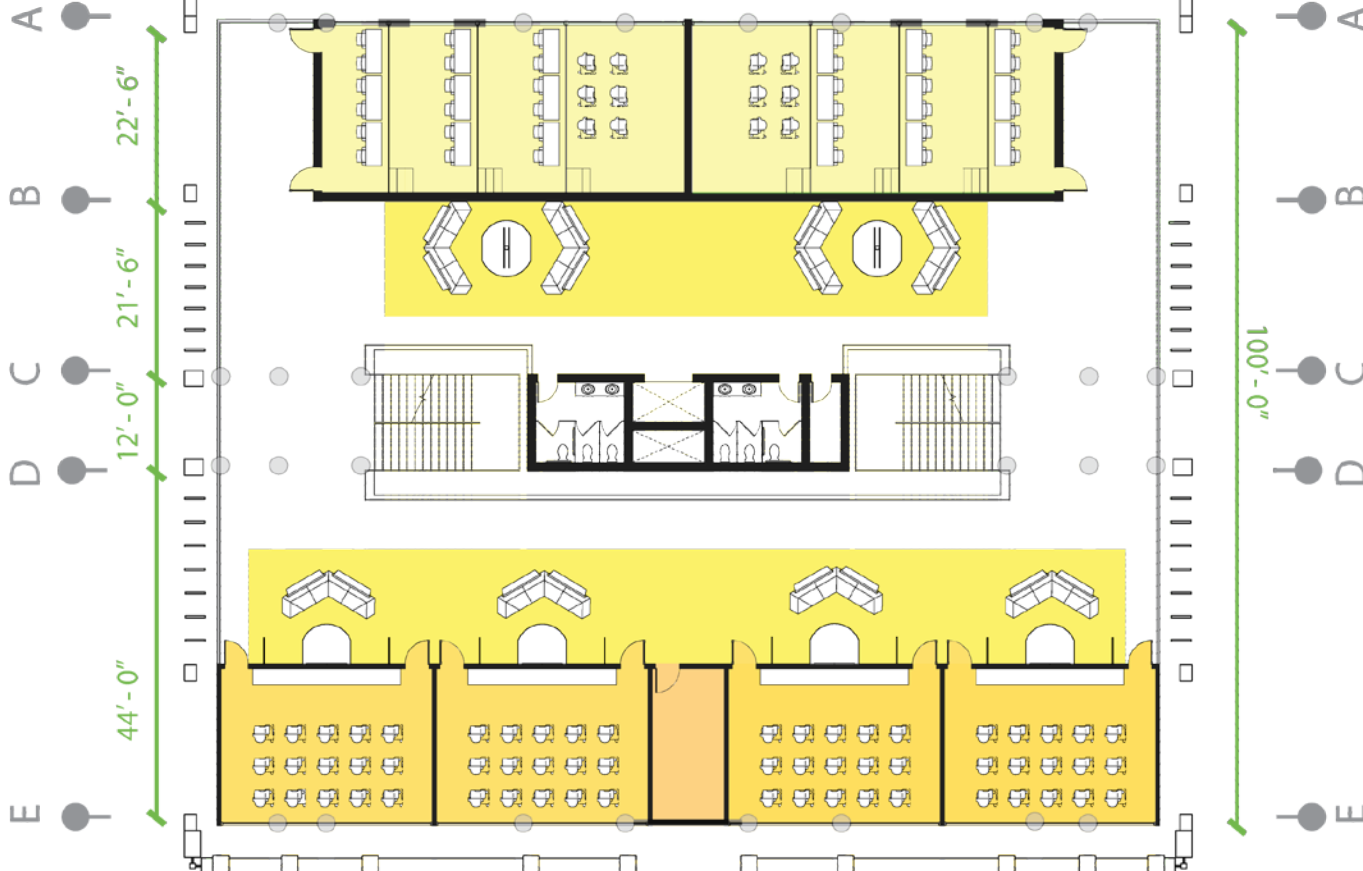


COMFORT & SPACE

SECOND FLOOR

1 2 3 4 5 6 7 8

117'-0"



22'-6"

21'-6"

12'-0"

44'-0"

100'-0"

8'-0" 12'-0" 19'-0" 12'-0" 10'-0" 16'-0" 19'-0" 12'-0" 8'-0"

1 2 3 4 5 6 7 8

- LARGE CLASSROOMS
- STUDENT SPACES
- SMALL CLASSROOM
- STORAGE CLOSET



COMFORT & SPACE

THIRD FLOOR

1 2 3 4 5 6 7 8

117'-0"

A

B

C

D

E

22'-6"

21'-6"

12'-0"

44'-0"

A

B

C

D

E

100'-0"

8'-0" 12'-0" 19'-0" 12'-0" 10'-0" 16'-0" 19'-0" 12'-0" 8'-0"

1 2 3 4 5 6 7 8

- FACULTY OFFICE
- FACULTY LOUNGE
- ASSISTANT OFFICE
- SENIOR ADMINISTRATIVE OFFICE
- DEPARTMENT CHAIR OFFICE
- CONFERENCE ROOM



SECOND FLOOR

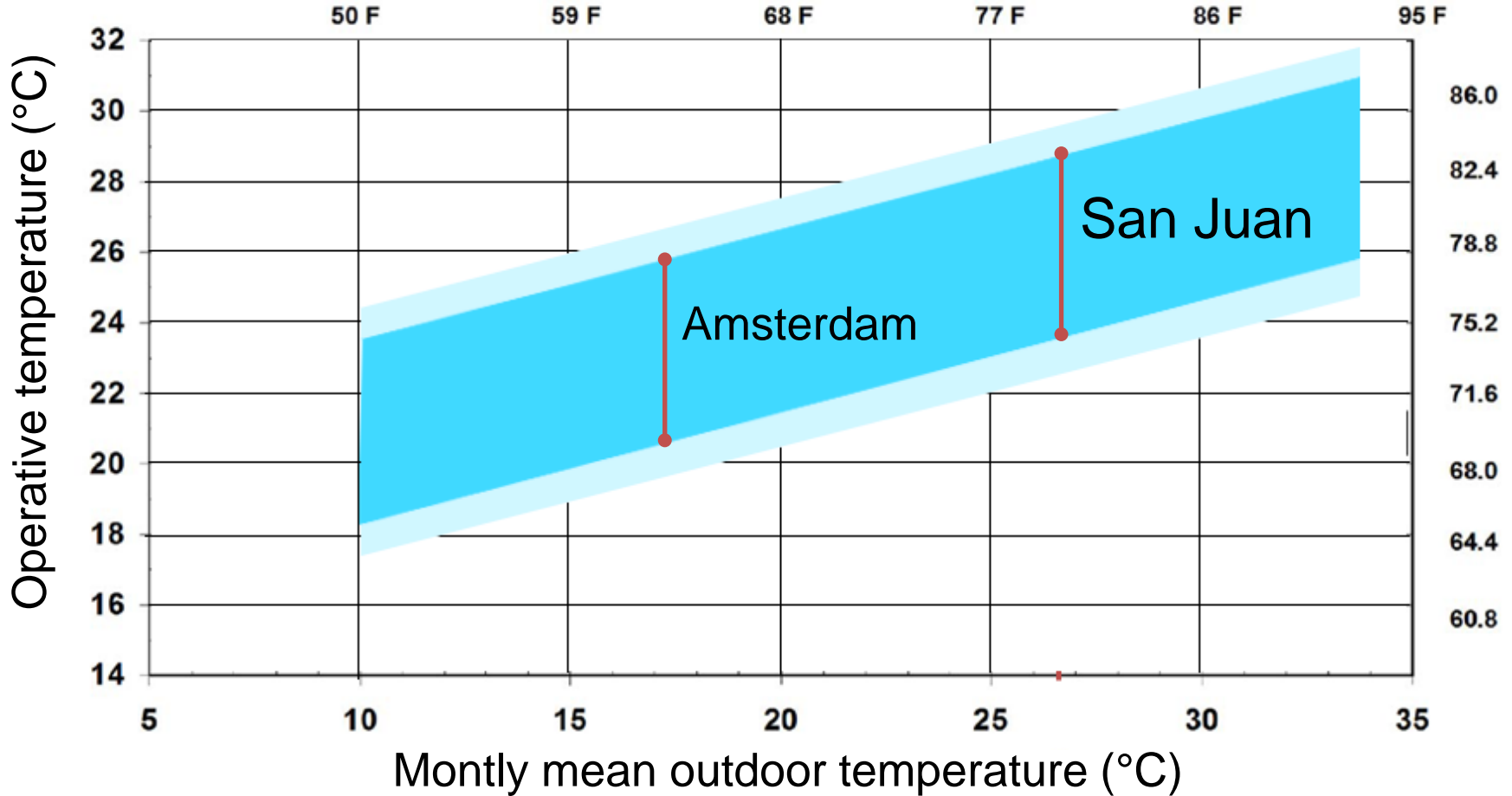


THIRD FLOOR



COMFORT & SPACE

ADAPTIVE THERMAL COMFORT



- 90% acceptability limit
- 80% acceptability limit



COMFORT & SPACE

COMFORT REQUIREMENTS

	Mechanically conditioned		Naturally conditioned	
	Class	Specifications	Class	Specifications
Thermal comfort	Class B	24.5 to 27.5 °C 76 to 81.5 °F	Class B	23 to 30 °C 73.5 to 86 °F
Indoor Air Quality	Excellent	40 < RH < 55%; CO ₂ ≤ 800 ppm	Outdoor	CO ₂ ≤ 800 ppm
Daylighting quality	Good	DF ≥ 2.5%	Good	DF ≥ 2.5%

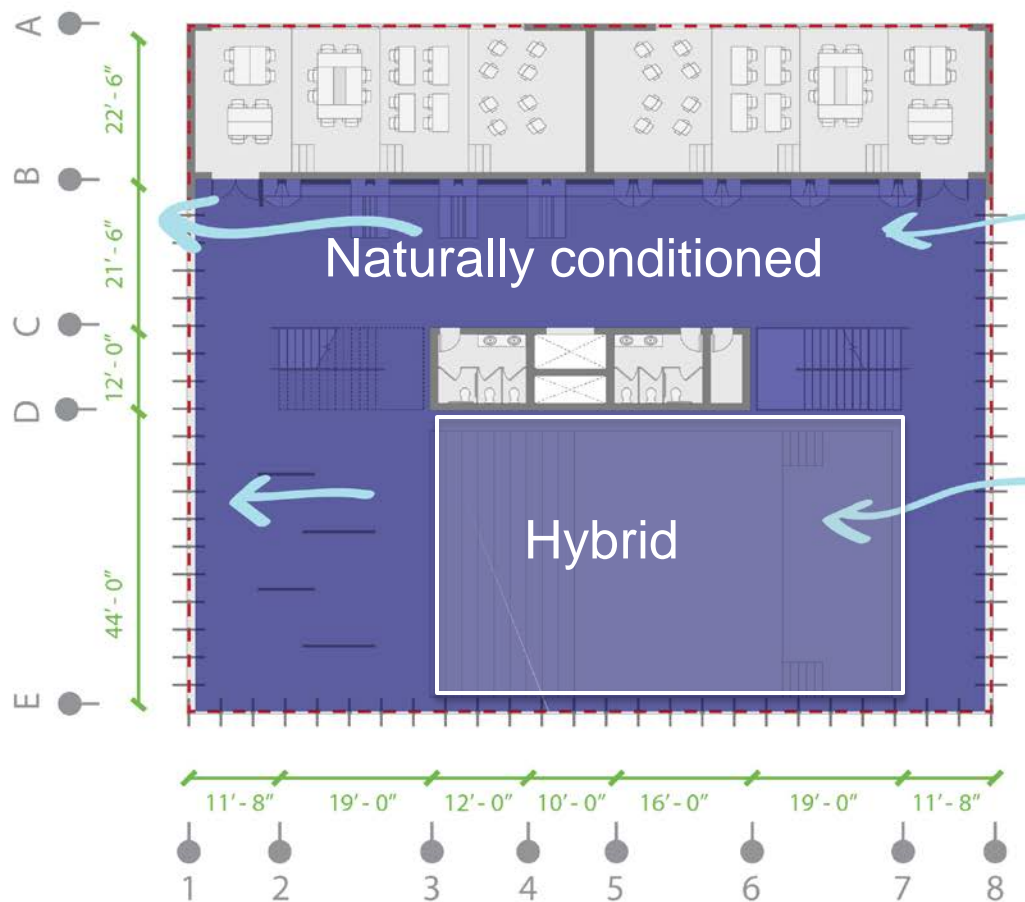




COMFORT & SPACE

HYBRID CLIMATE

- Minimum wind speed: 0,2 m/s

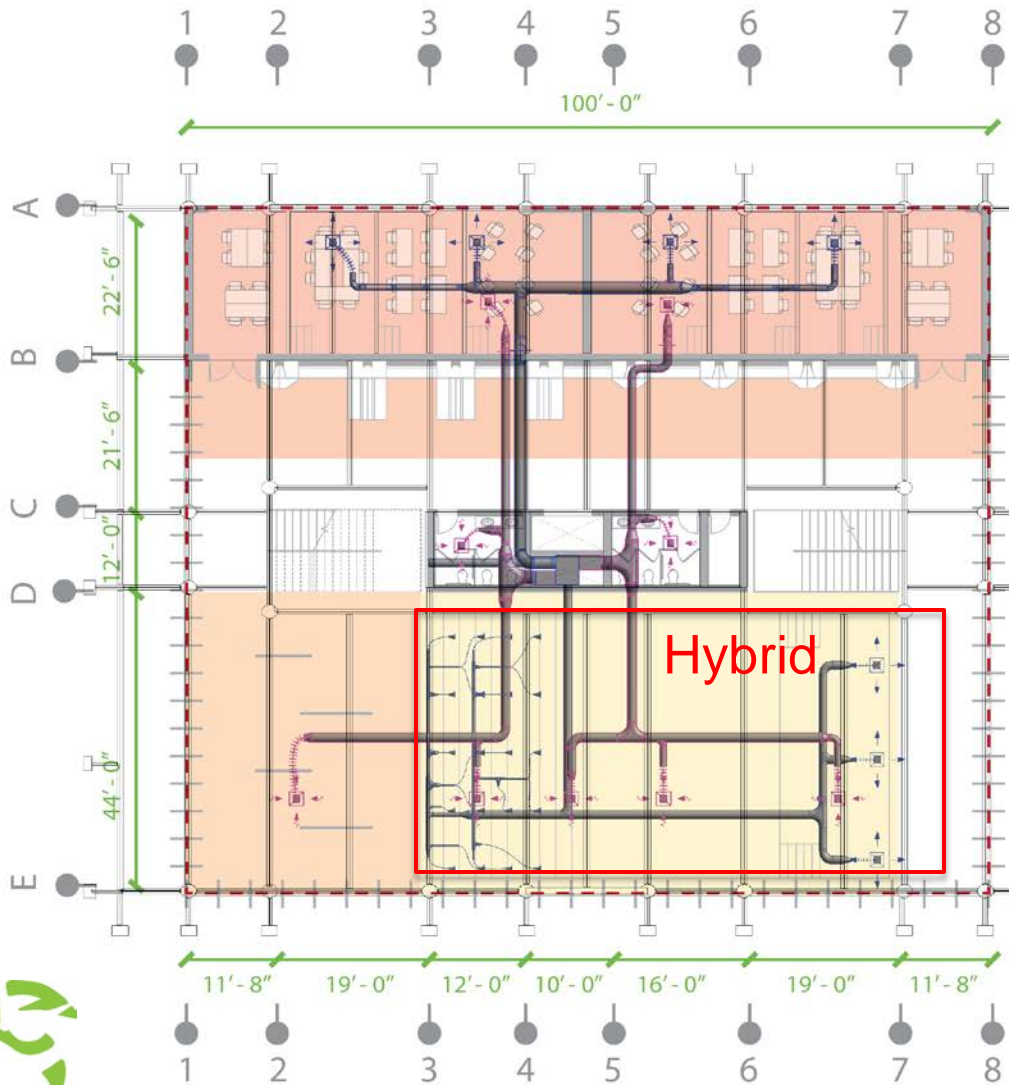


ASHRAE Handbook. Atlanta, GA: American Society of Heating, Refrigerating and Air Conditioning Engineers. 2009.



COMFORT & SPACE

FIRST FLOOR



- Conditioned classrooms
 - Humidity control
 - Control thermal loads
- Hybrid Auditorium

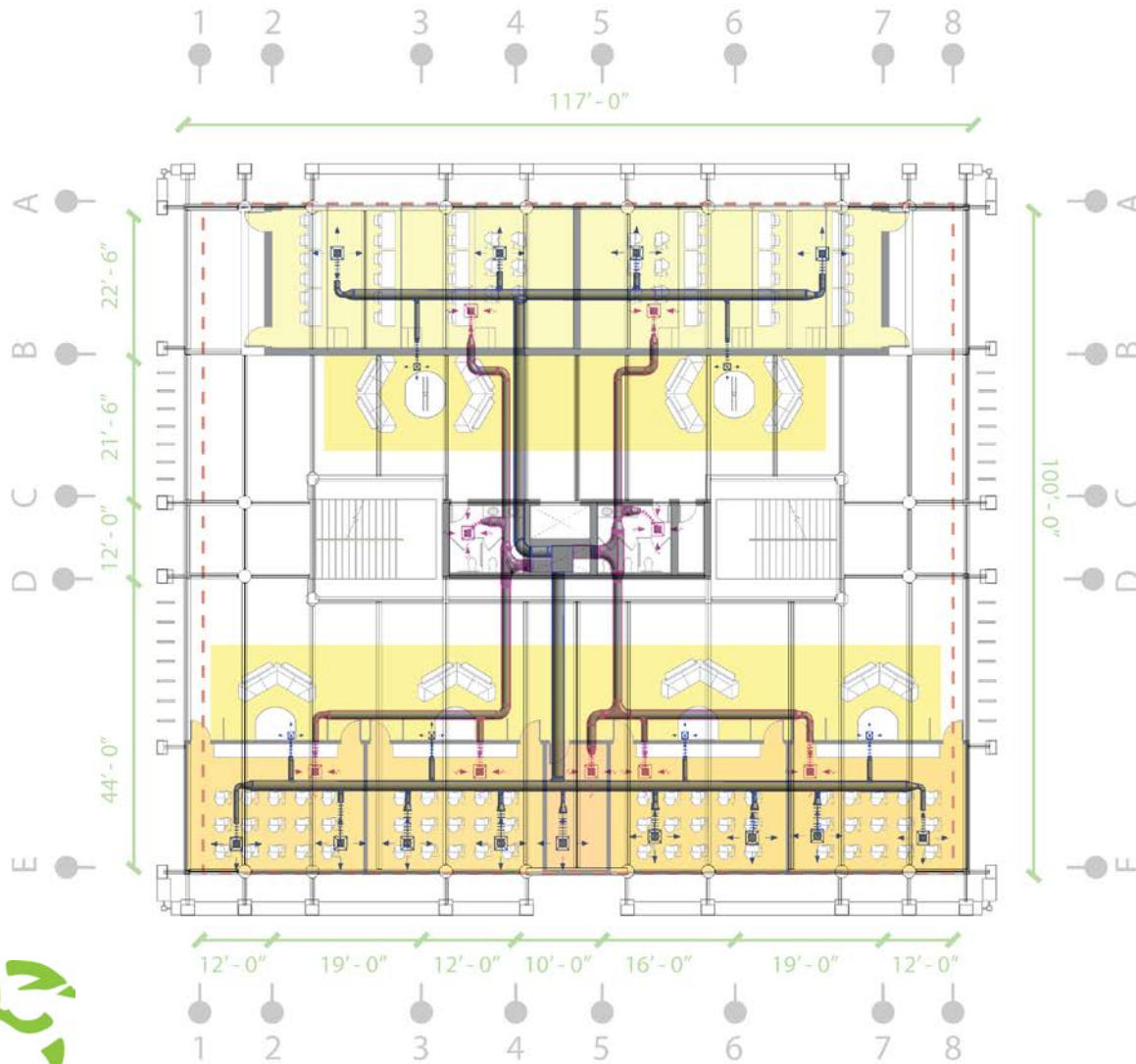




COMFORT & SPACE

SECOND FLOOR

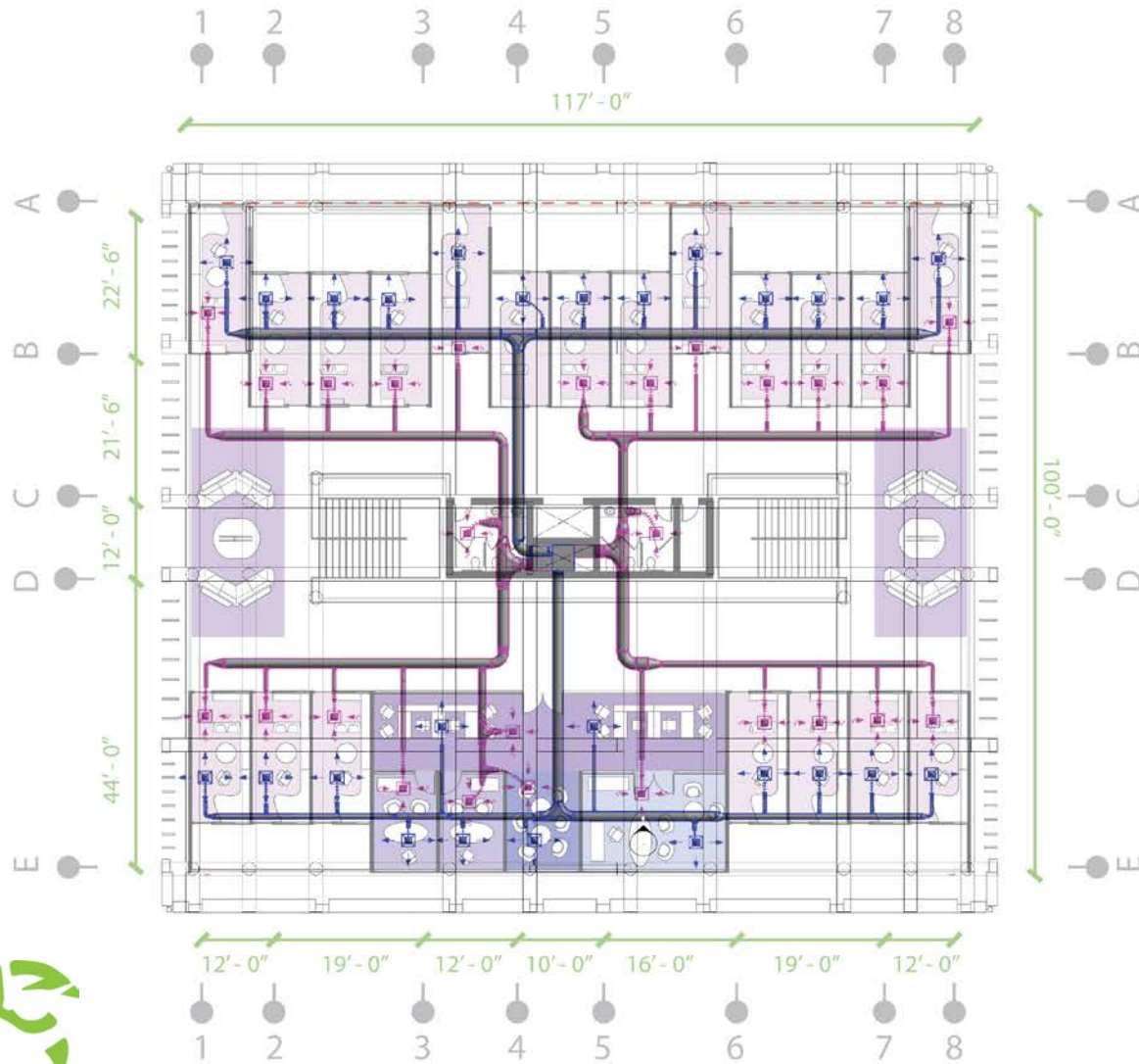
- Microclimate desks





COMFORT & SPACE

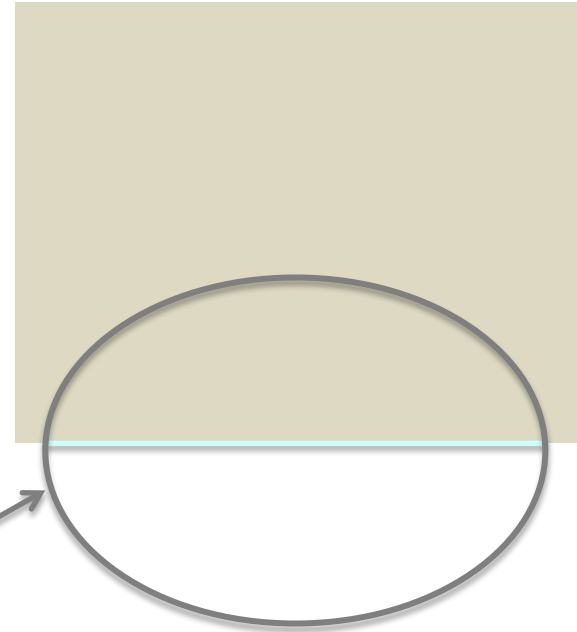
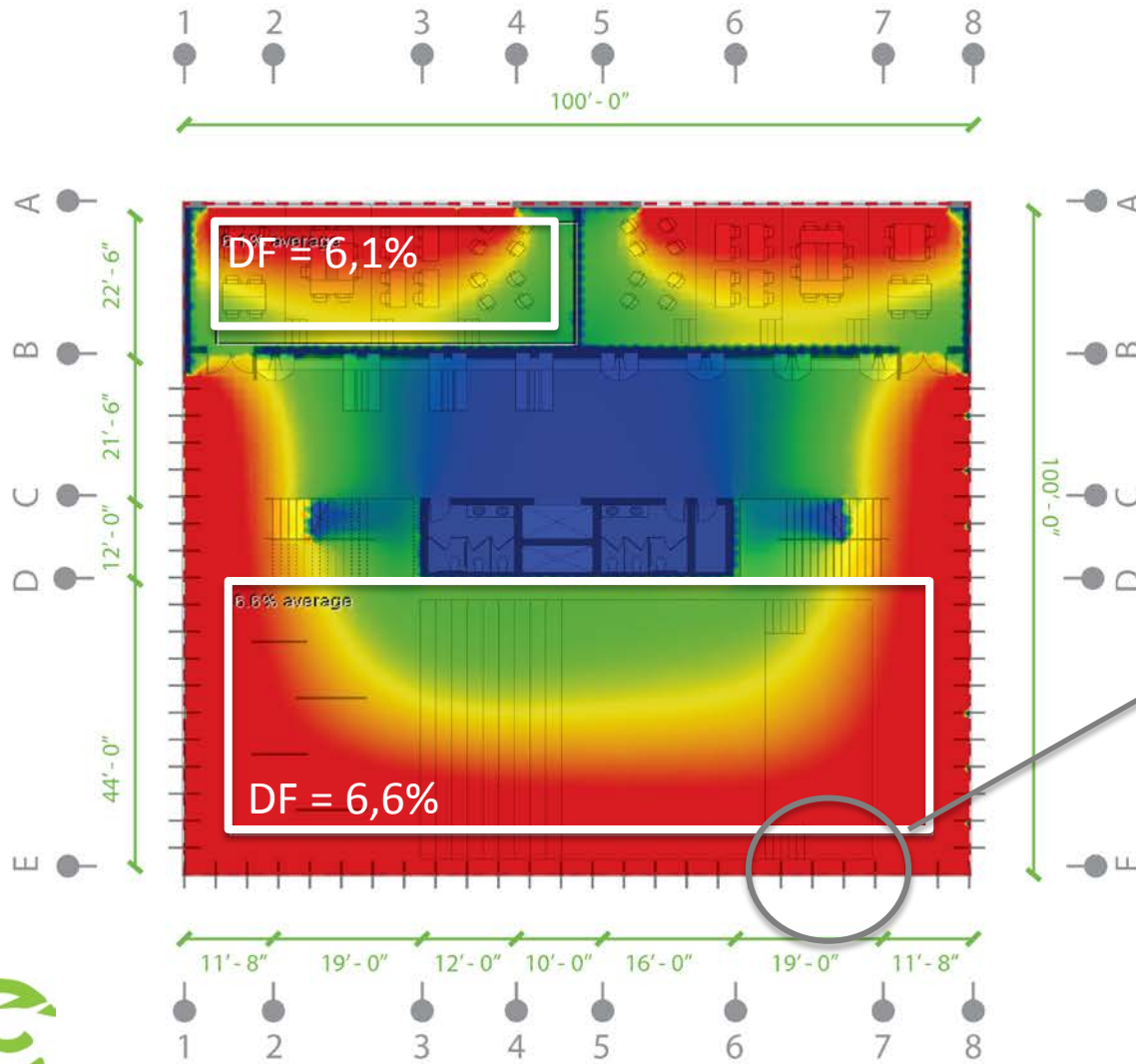
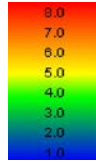
THIRD FLOOR





COMFORT & SPACE

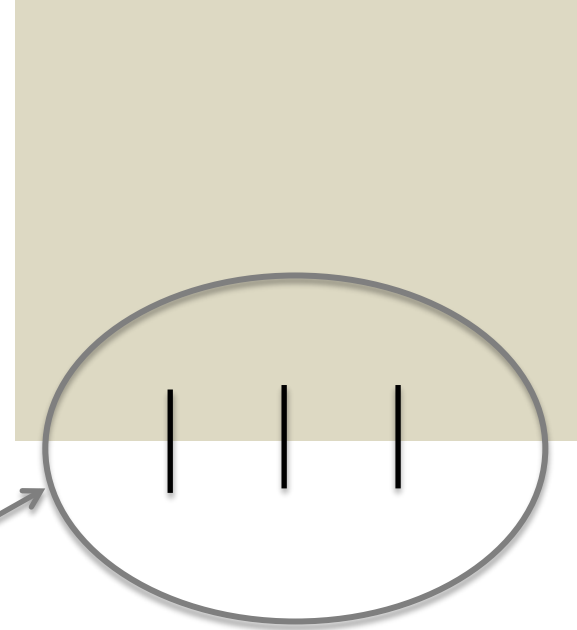
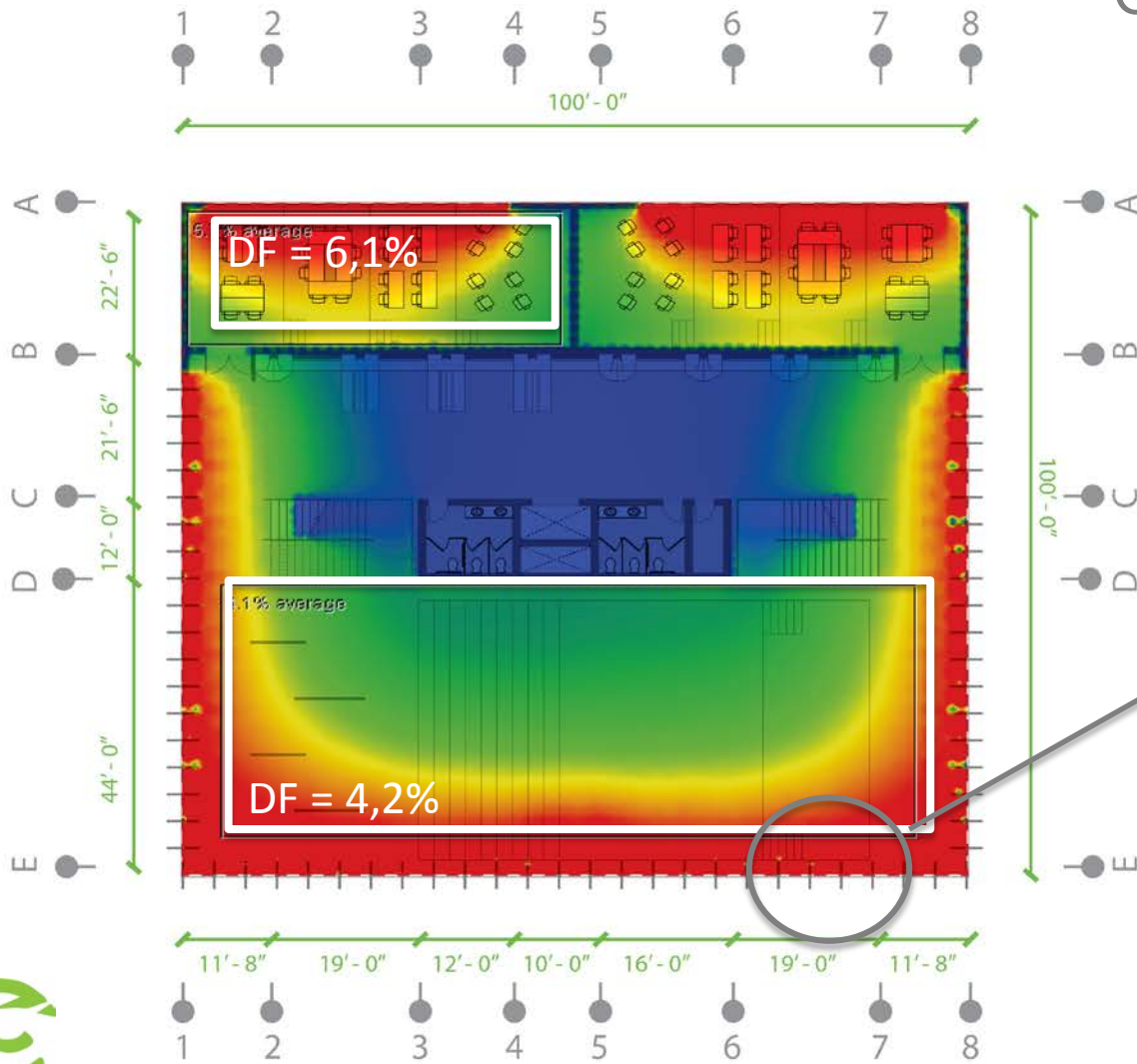
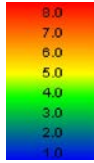
NO SHADING FINS





COMFORT & SPACE

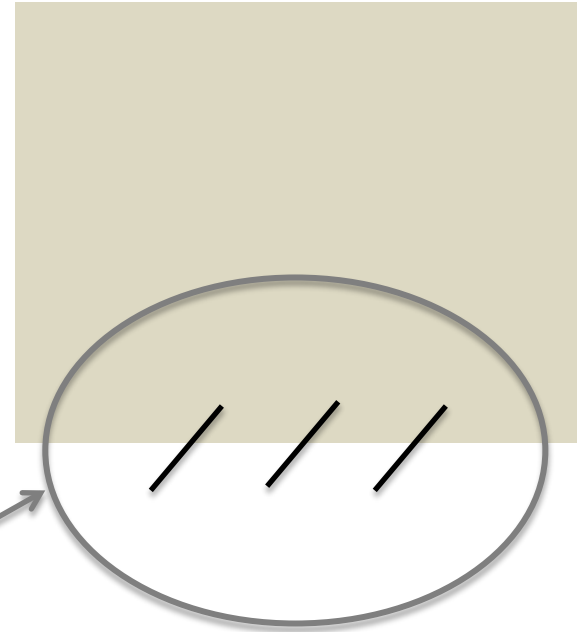
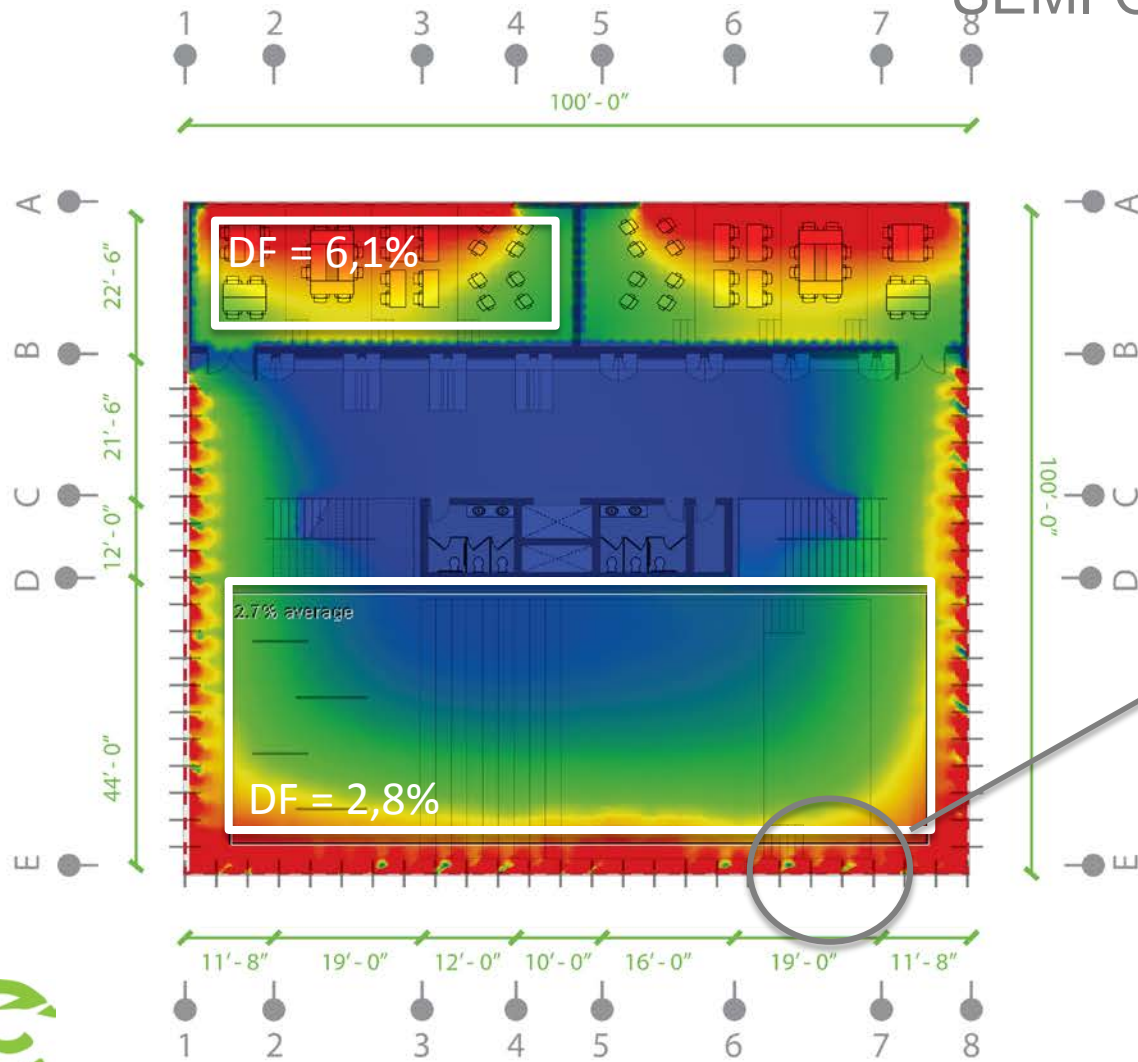
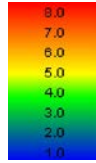
OPEN SHADING FINS





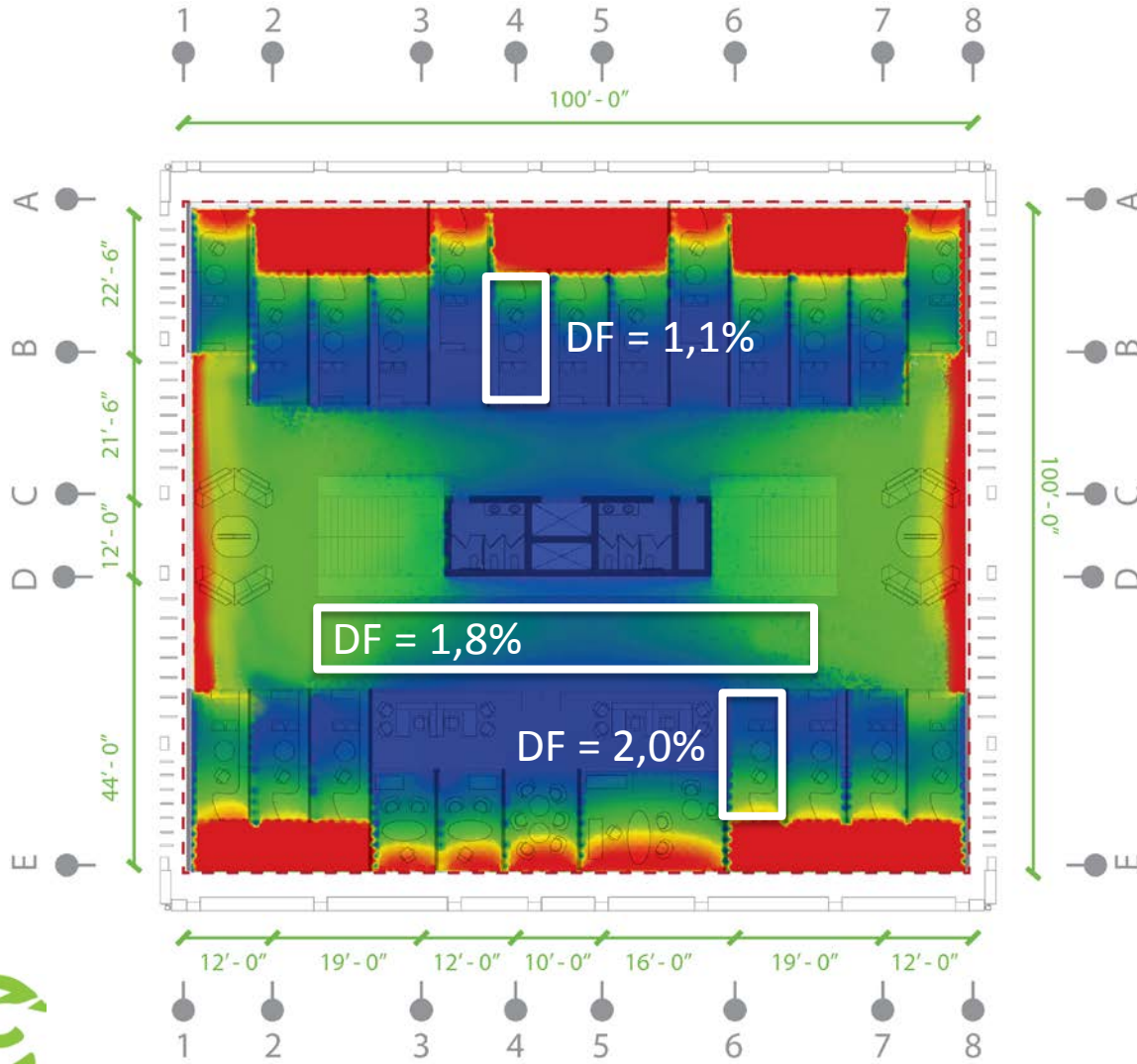
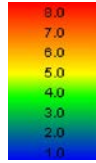
COMFORT & SPACE

SEMI-OPEN SHADING FINS





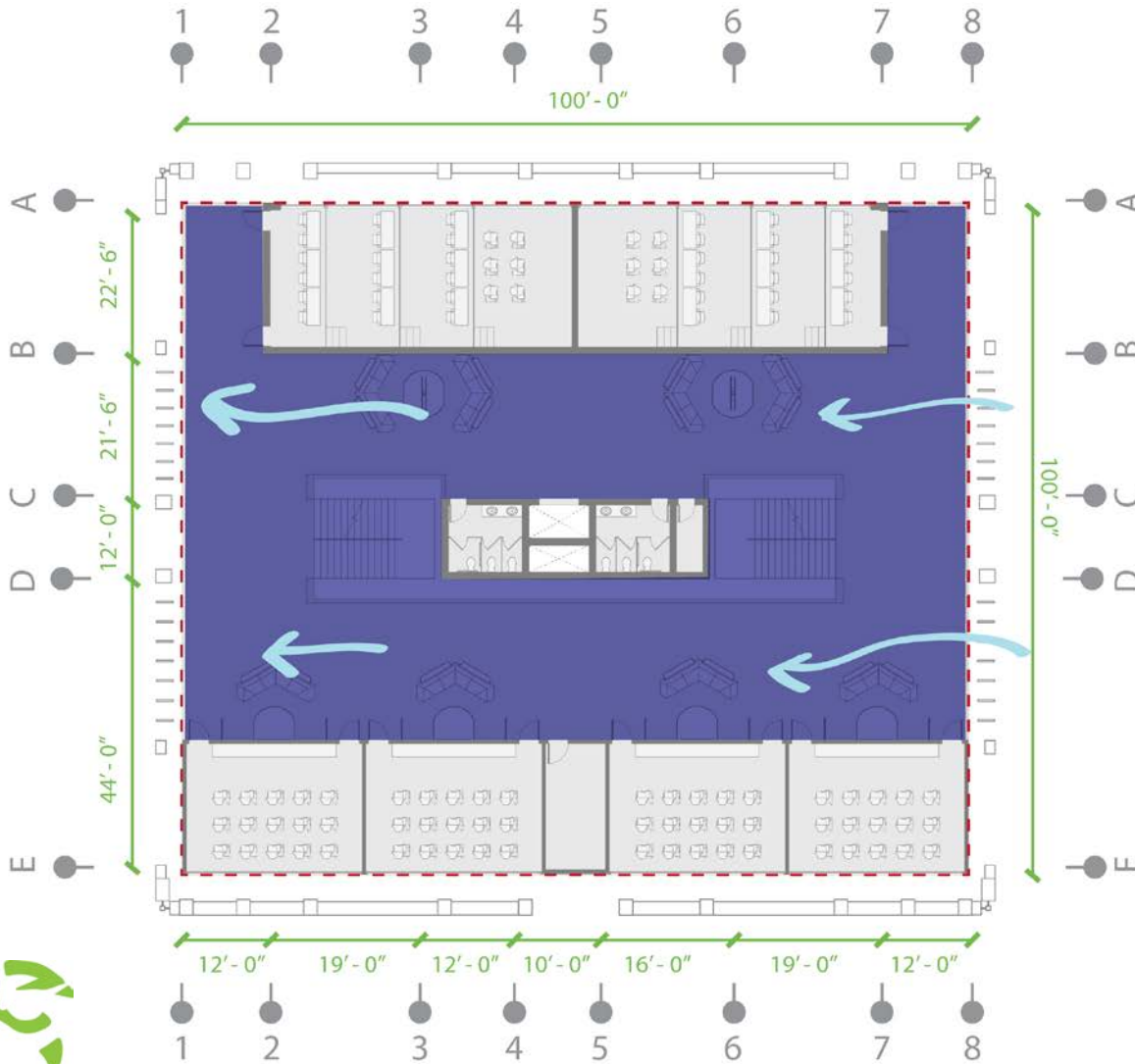
COMFORT & SPACE





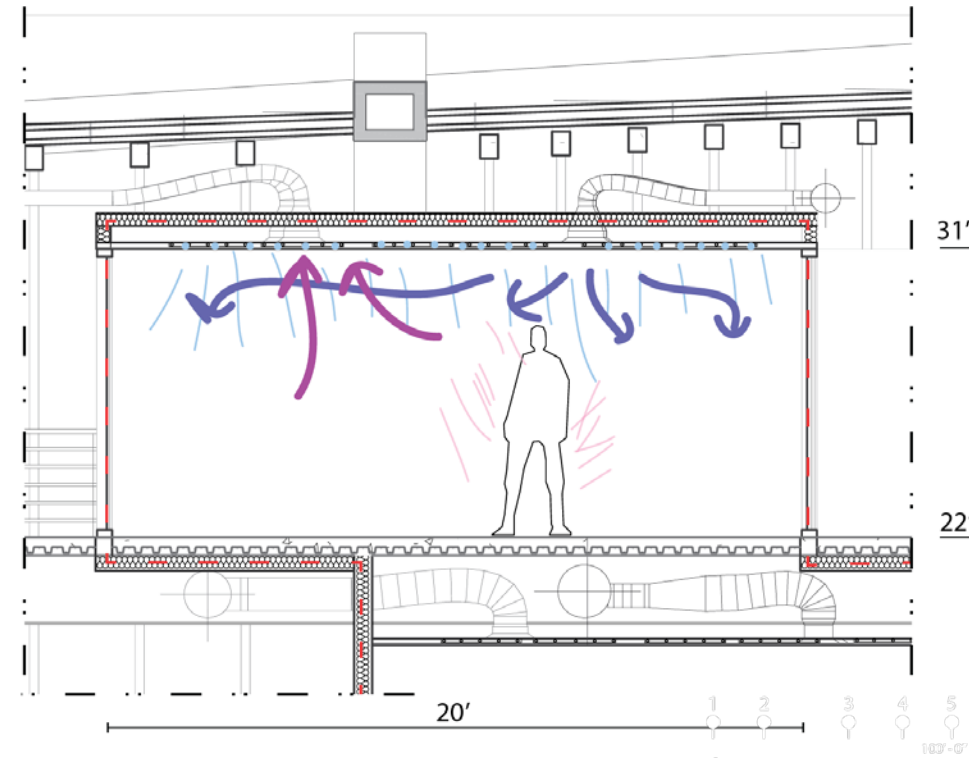
COMFORT & SPACE

LEVEL 2

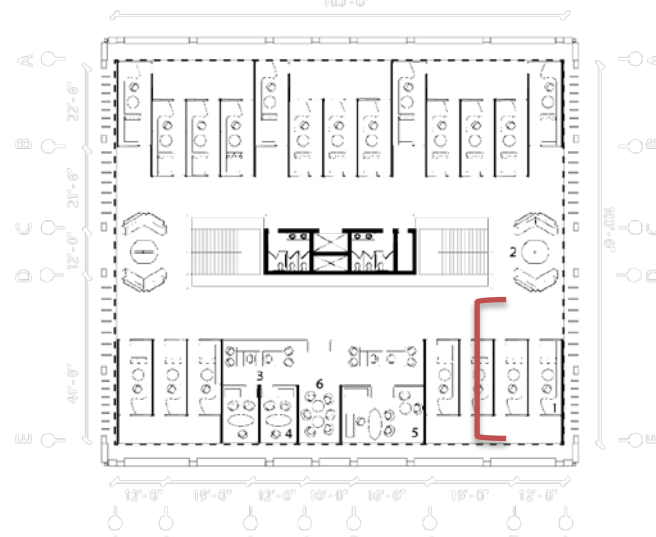


COMFORT & SPACE

OFFICE SECTION



- Thermal and moisture barrier
- Radiant cooling system
- Sprinkler system
- Concrete slabs
- Loads 25 W/m²
- Cooling power 40 W/m²

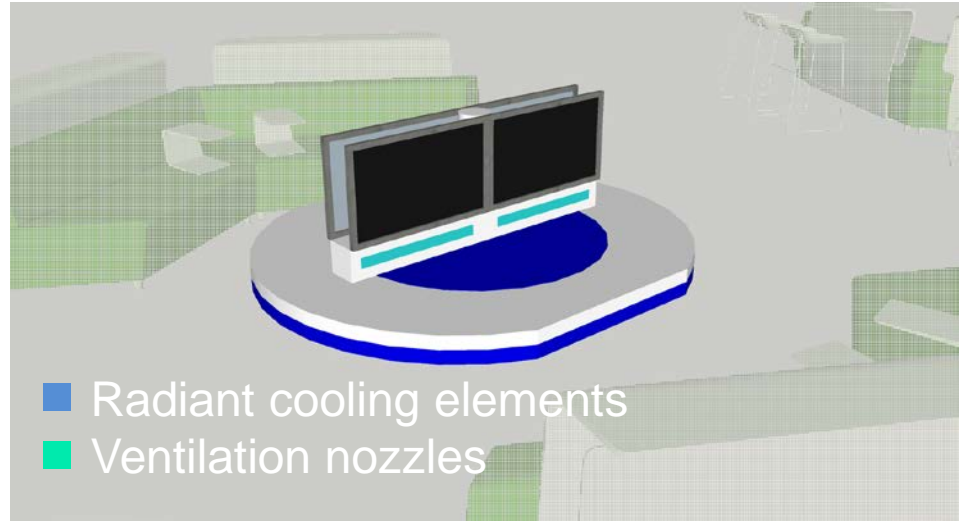


COMFORT & SPACE

MICRO CLIMATE FURNITURE

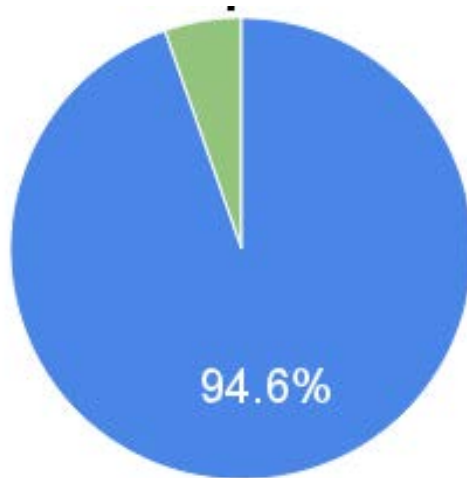


Kotatsu



Micro climate furniture

Annual energy consumption distribution of total 500 kWh



- Cooling machine consumption
- Ventilation energy consumption



COMFORT & SPACE

Design Loads

Floor	Dead Load (PSF)	Live Load (PSF)
Roof	40	60
3	72	75
2	72	75
1	72	110

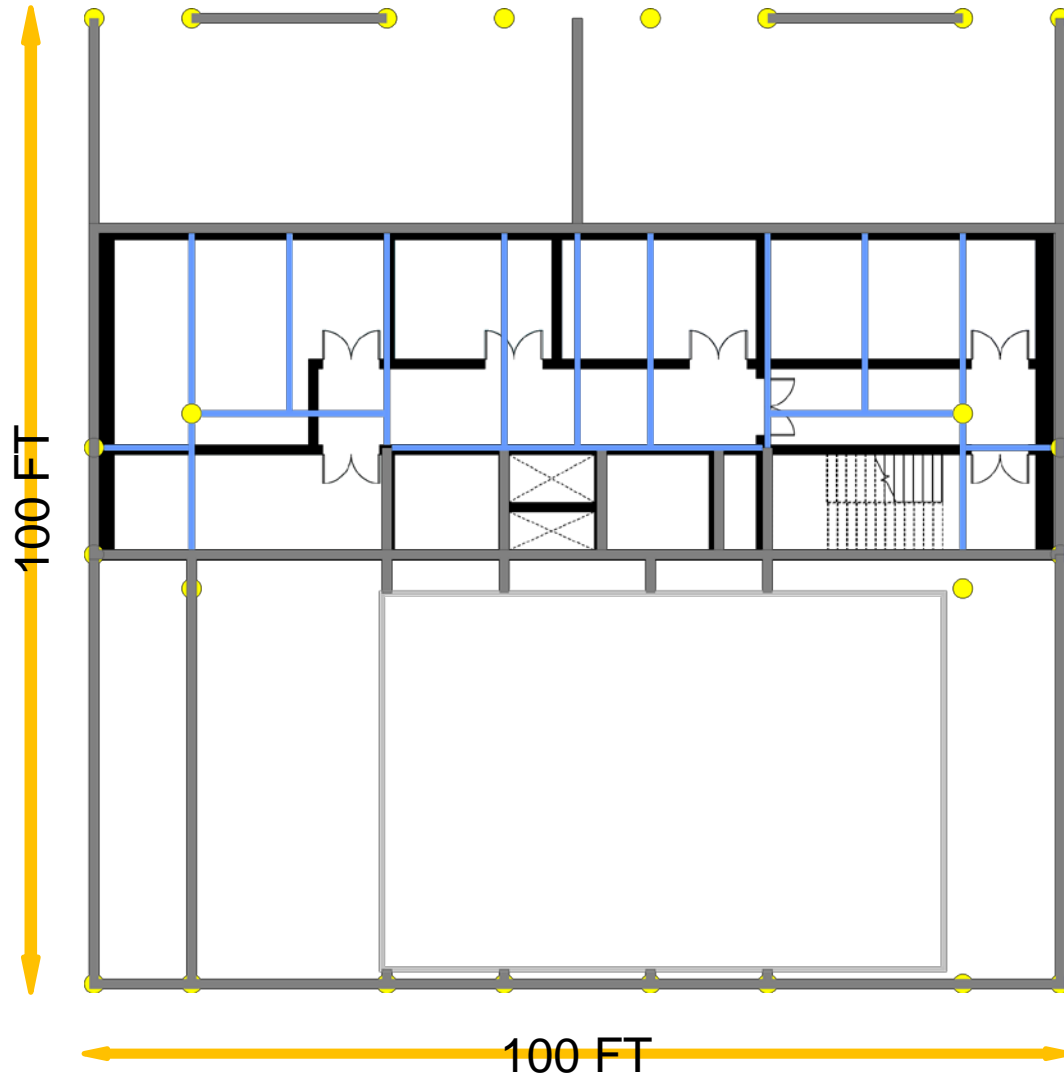
Wind	Seismic
Wind Speed 170 mph	Risk III
Base Shear 170 kips	12% Building Weight

Function Spaces	Live Load (PSF)
Office	50
Faculty Lounge	80
Auditorium (average)	100
Classroom & Seminar	40
Labs	100
Server Room	125
Technical Support	100
Storage	250
Mechanical Room	100
Stair	100
Corridor	80 or 100
Roof	60



COMFORT & SPACE

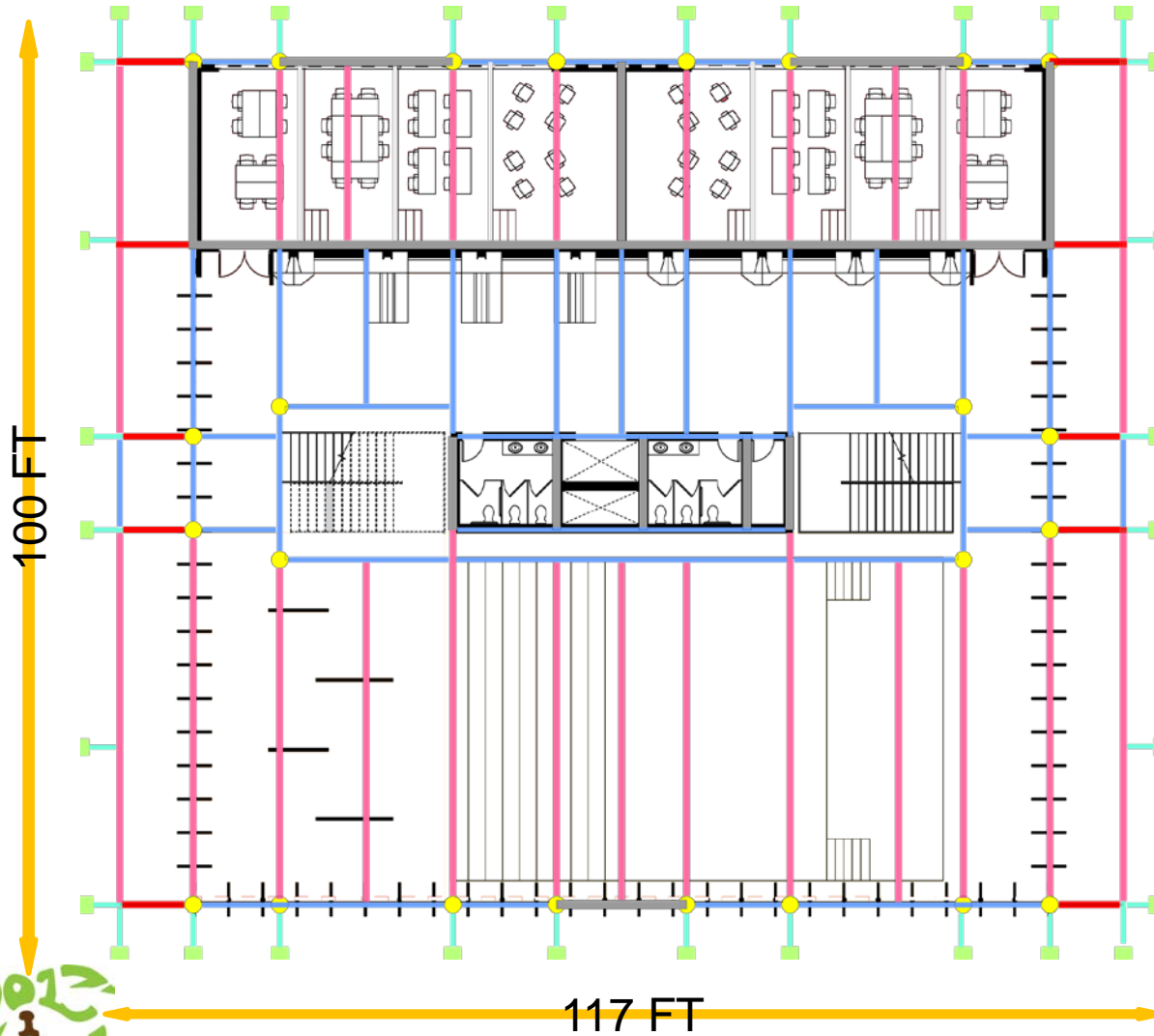
STRUCTURAL : Basement



- W24x55
- Wall 1FT
- Column D=2FT

COMFORT & SPACE

STRUCTURAL : First



— W24x55

— W24x68

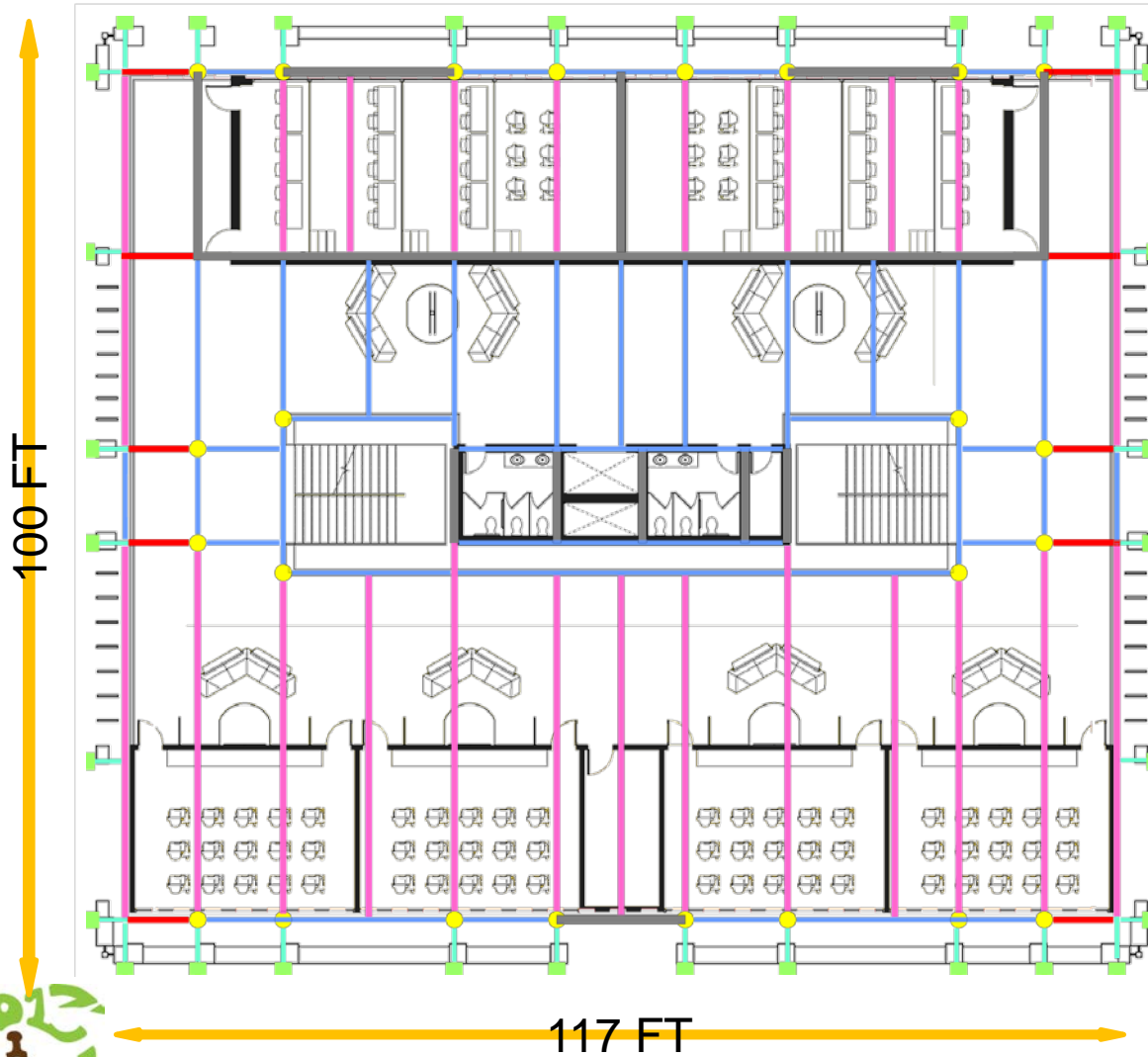
— W24x84

— Wall 1FT

● Column D=2FT

COMFORT & SPACE

STRUCTURAL : Second



— W24x55

— W24x68

— W24x84

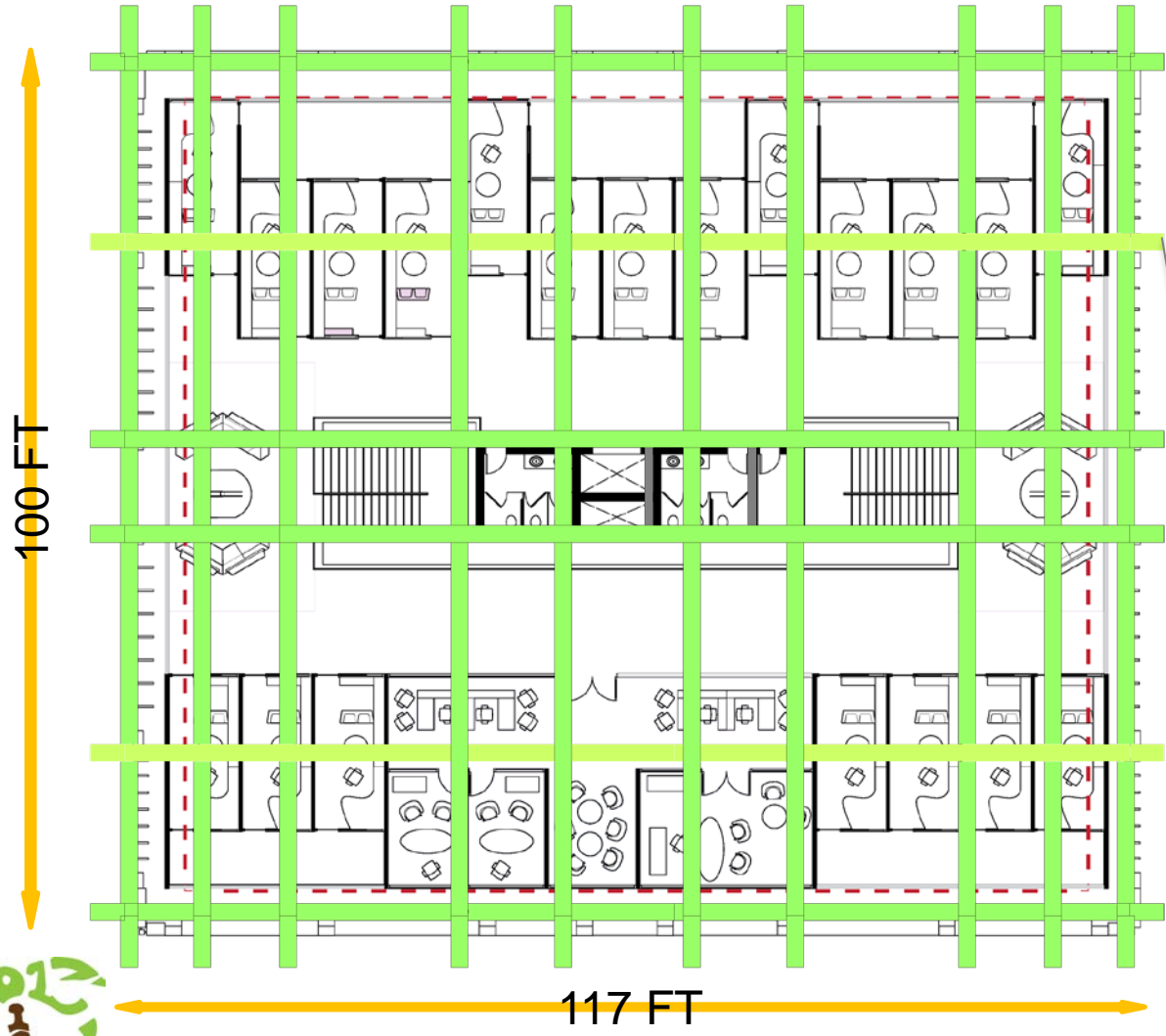
— Wall 1FT

● Column D=2FT



COMFORT & SPACE

STRUCTURAL : Third

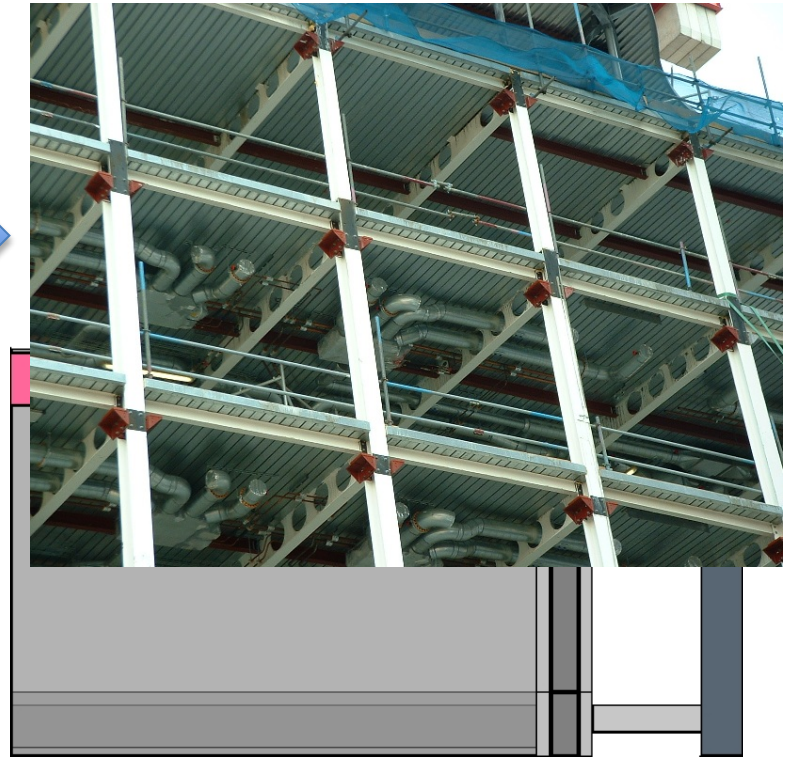
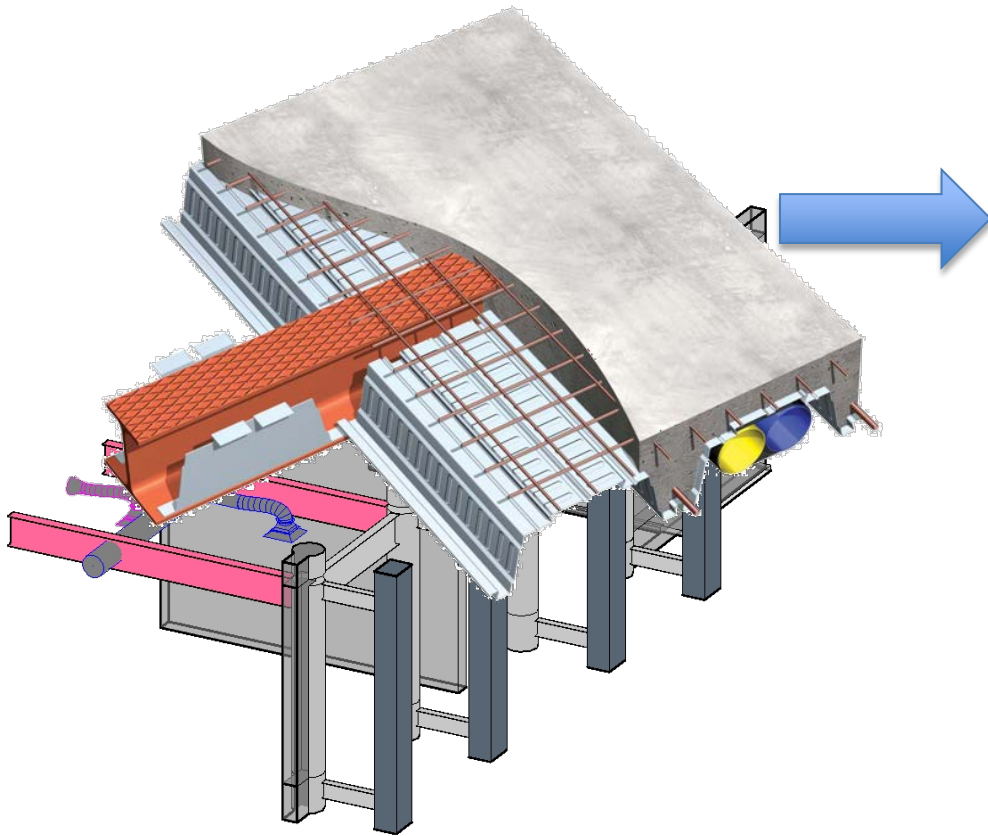


 HSS 18x18x1/2

Non Structural Roof Element



COMFORT & SPACE FLOOR SANDWICH INTEGRATION

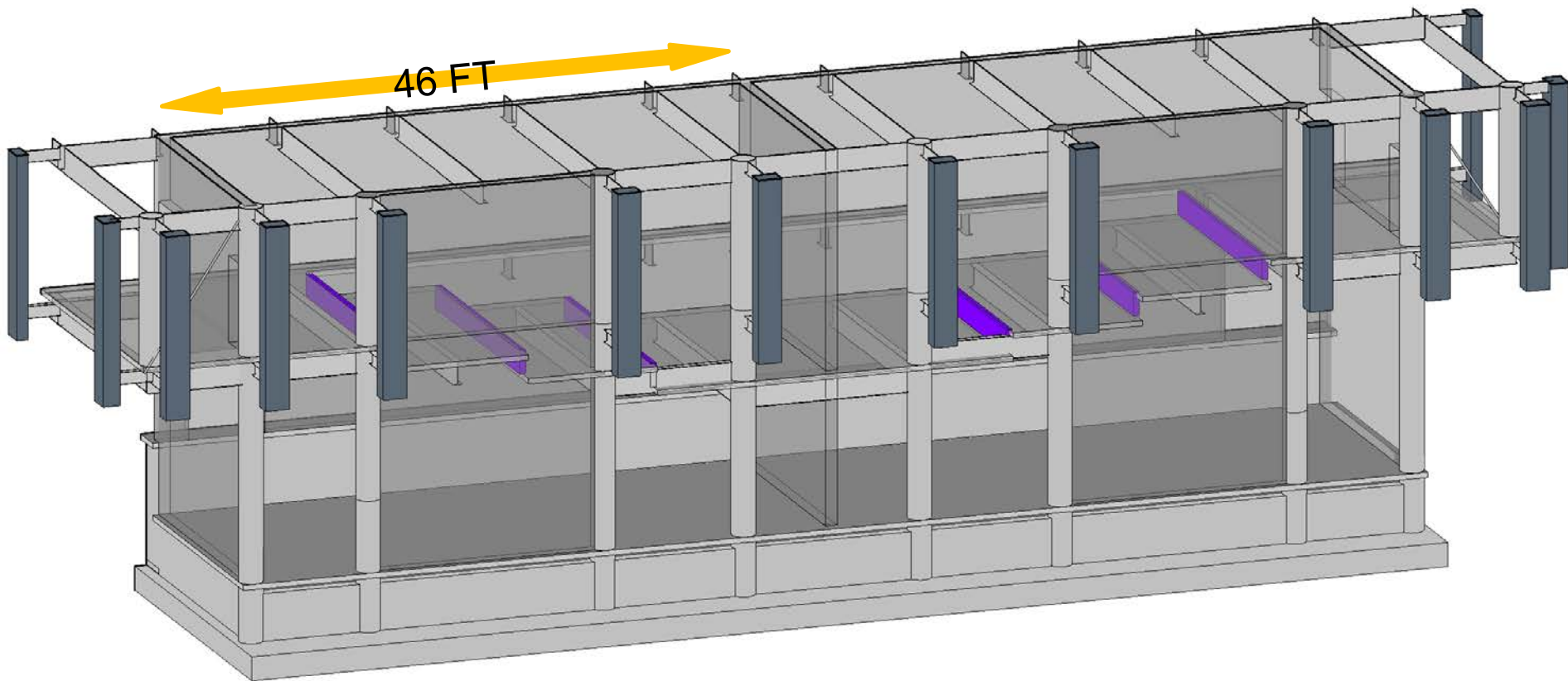


Major Beam Section: W24

Maximum Pipe Diameter: 21"

COMFORT & SPACE

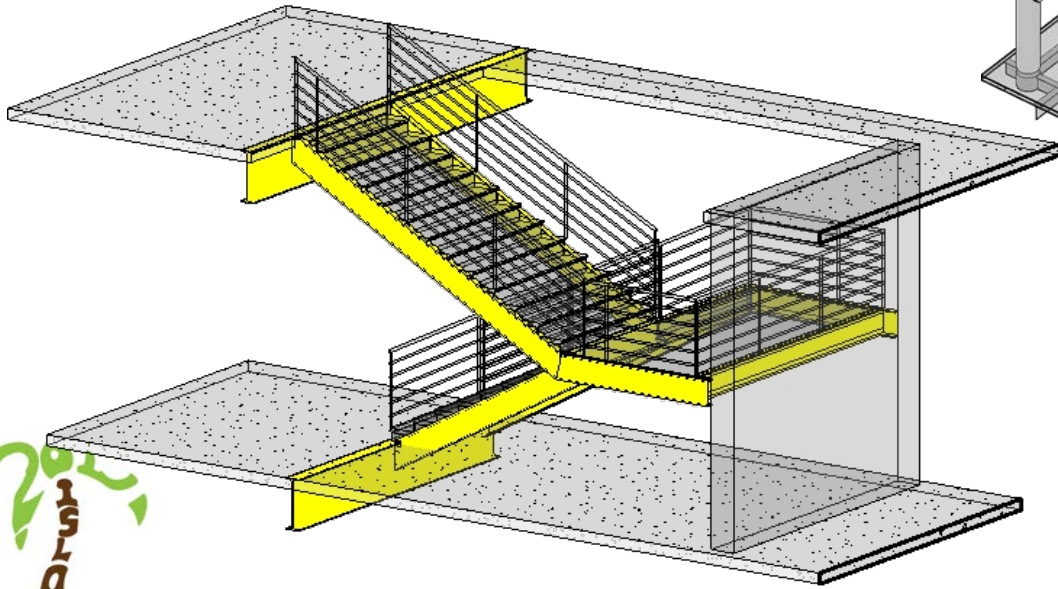
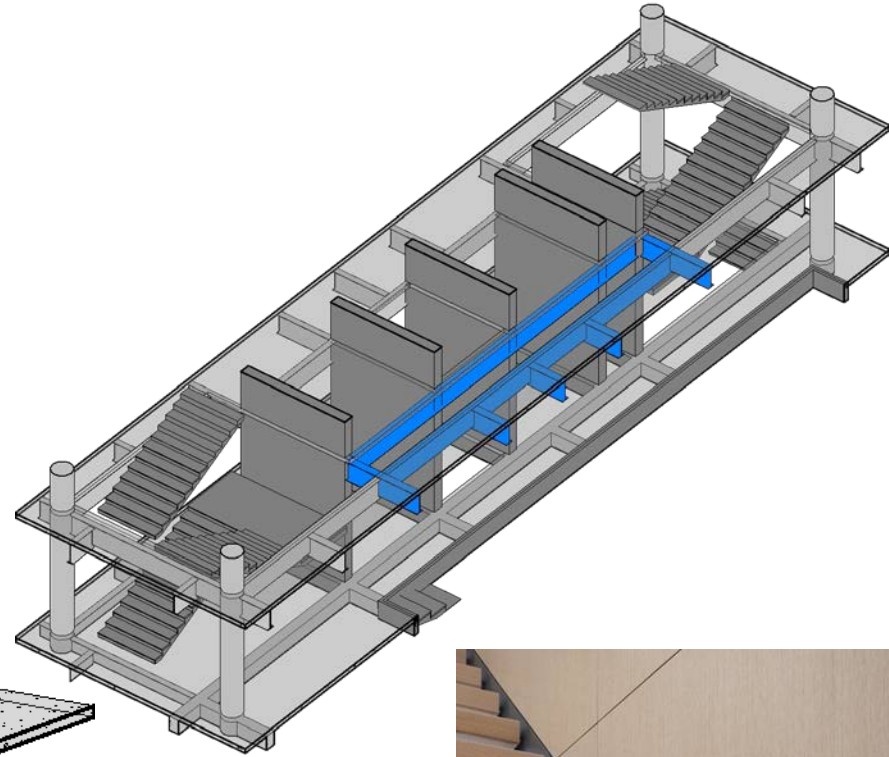
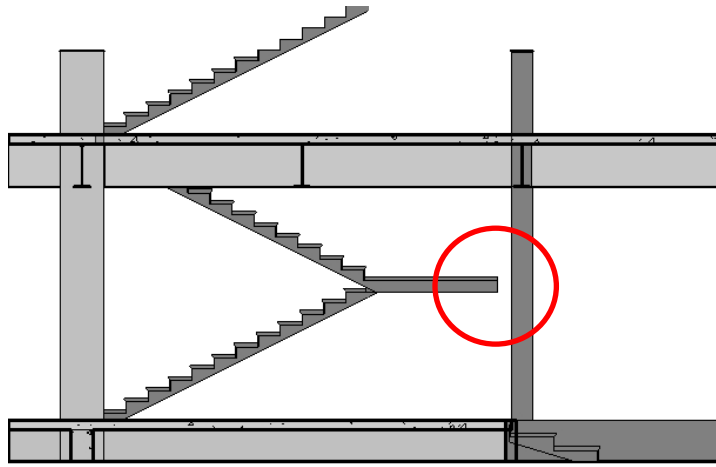
LARGE CLASSROOM



Maximum Height: 16 FT
Dropped Floor: 2 FT each

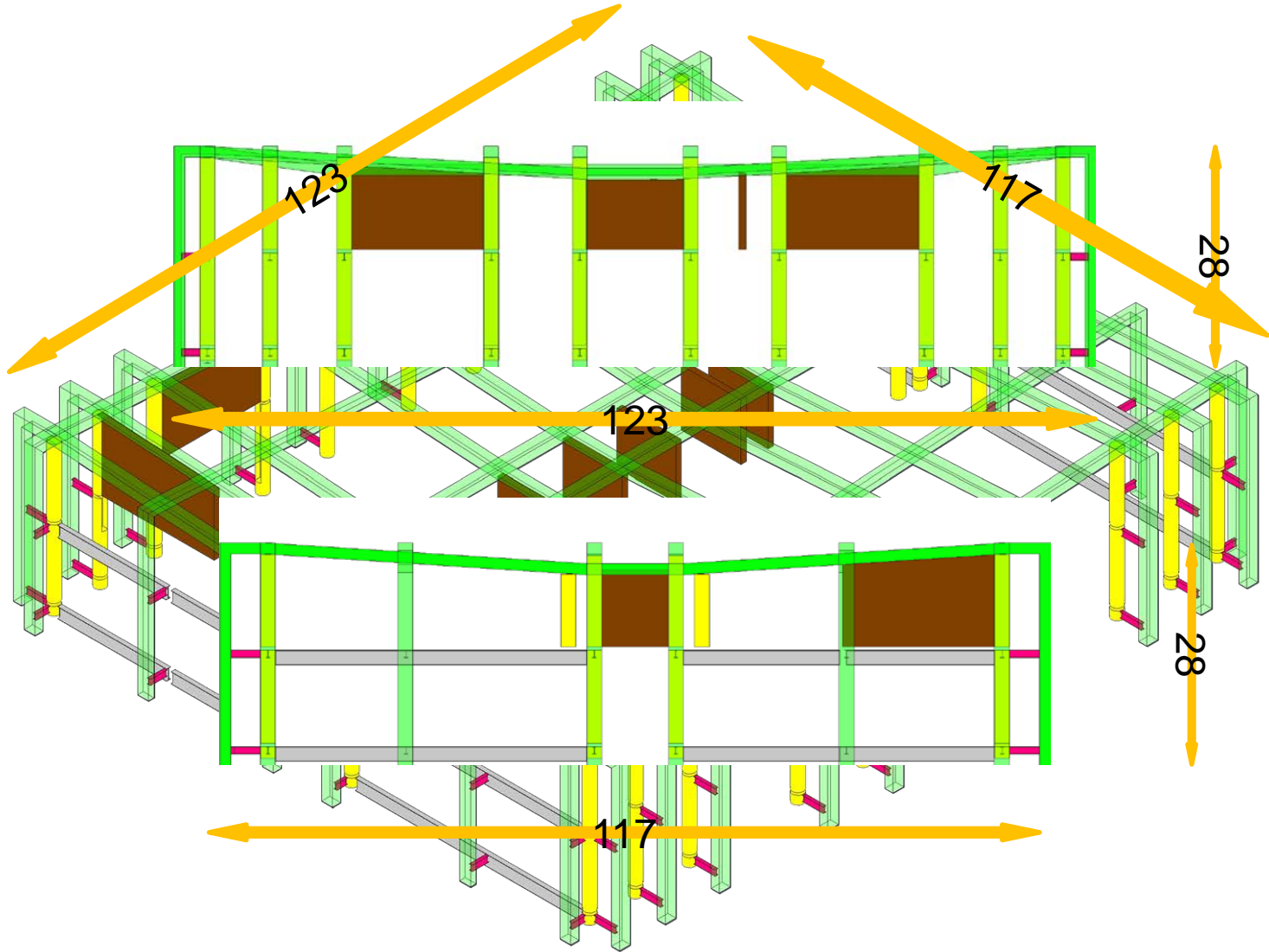
COMFORT & SPACE

CORE & STAIR



COMFORT & SPACE

ROOF INTEGRATED DESIGN



SECOND FLOOR



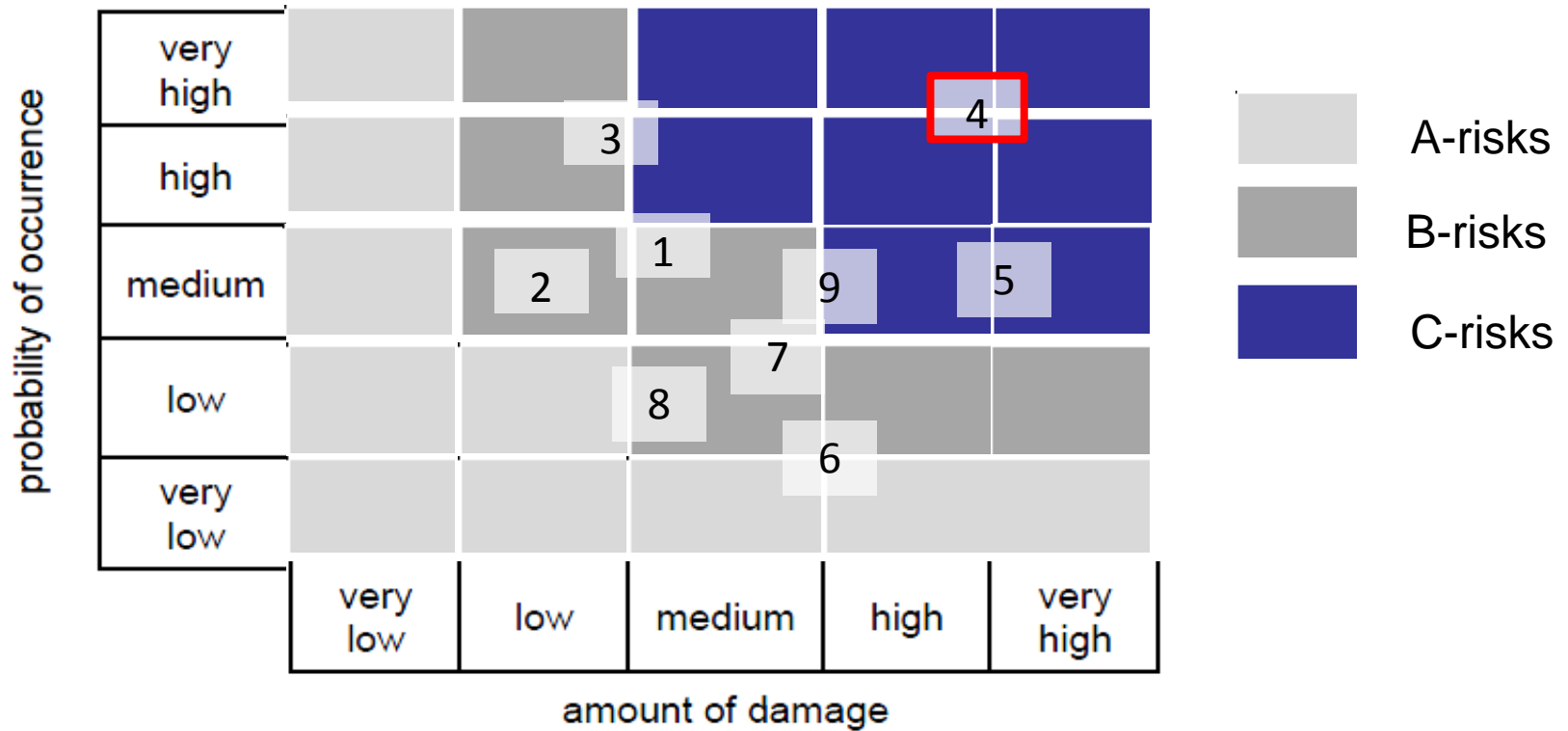
THIRD FLOOR



HURRICANE & EARTHQUAKE



HURRICANE & EARTHQUAKE



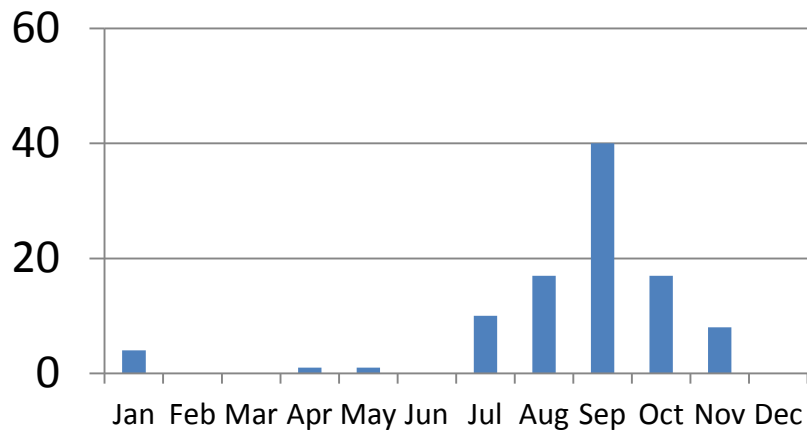
- | | |
|--|-------------------------------|
| 1. Inflation in construction costs | 6. Refused permission |
| 2. Water price change | 7. Electricity price change |
| 3. Vandalism in or outside the building | 8. Unexpected soil conditions |
| 4. Hurricane during O&M phase | 9. HVAC system performance |
| 5. Earthquake during O&M phase | |



HURRICANE & EARTHQUAKE

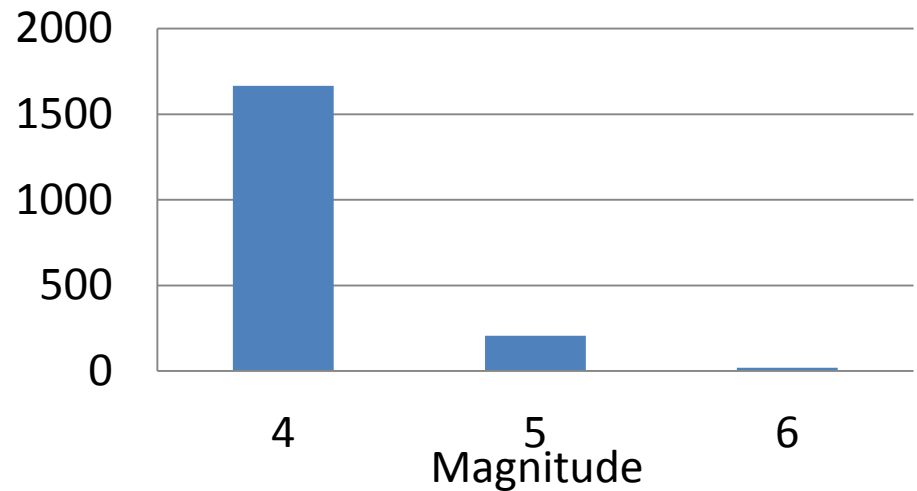
RISK OF HURRICANE & EARTHQUAKE

**Total Storms within
200miles (1900-2011)**



Hurricane Season

Earthquake (1973-2013)



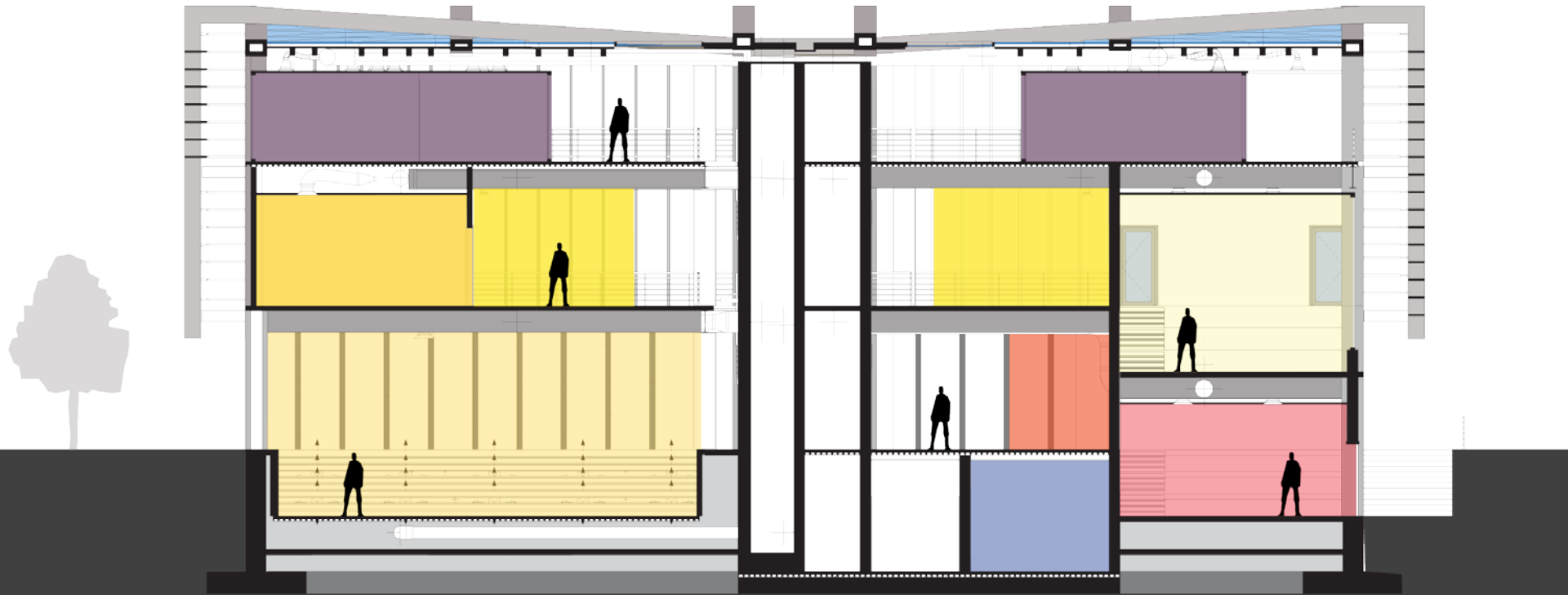
Earthquake Risk





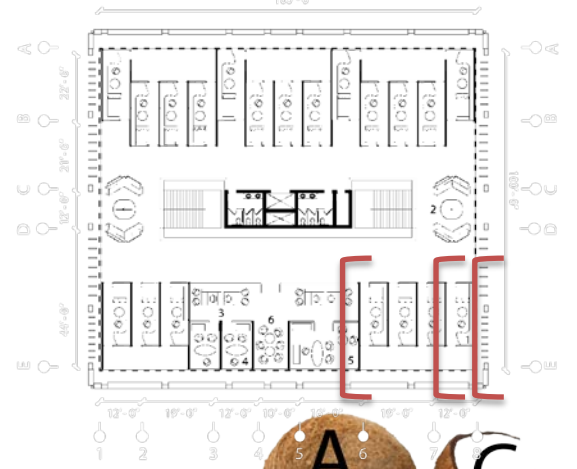
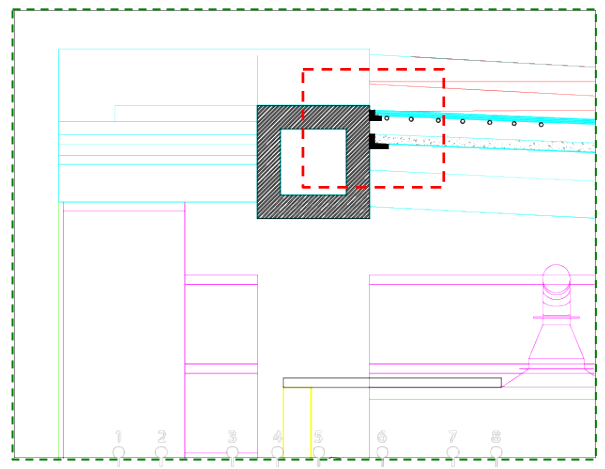
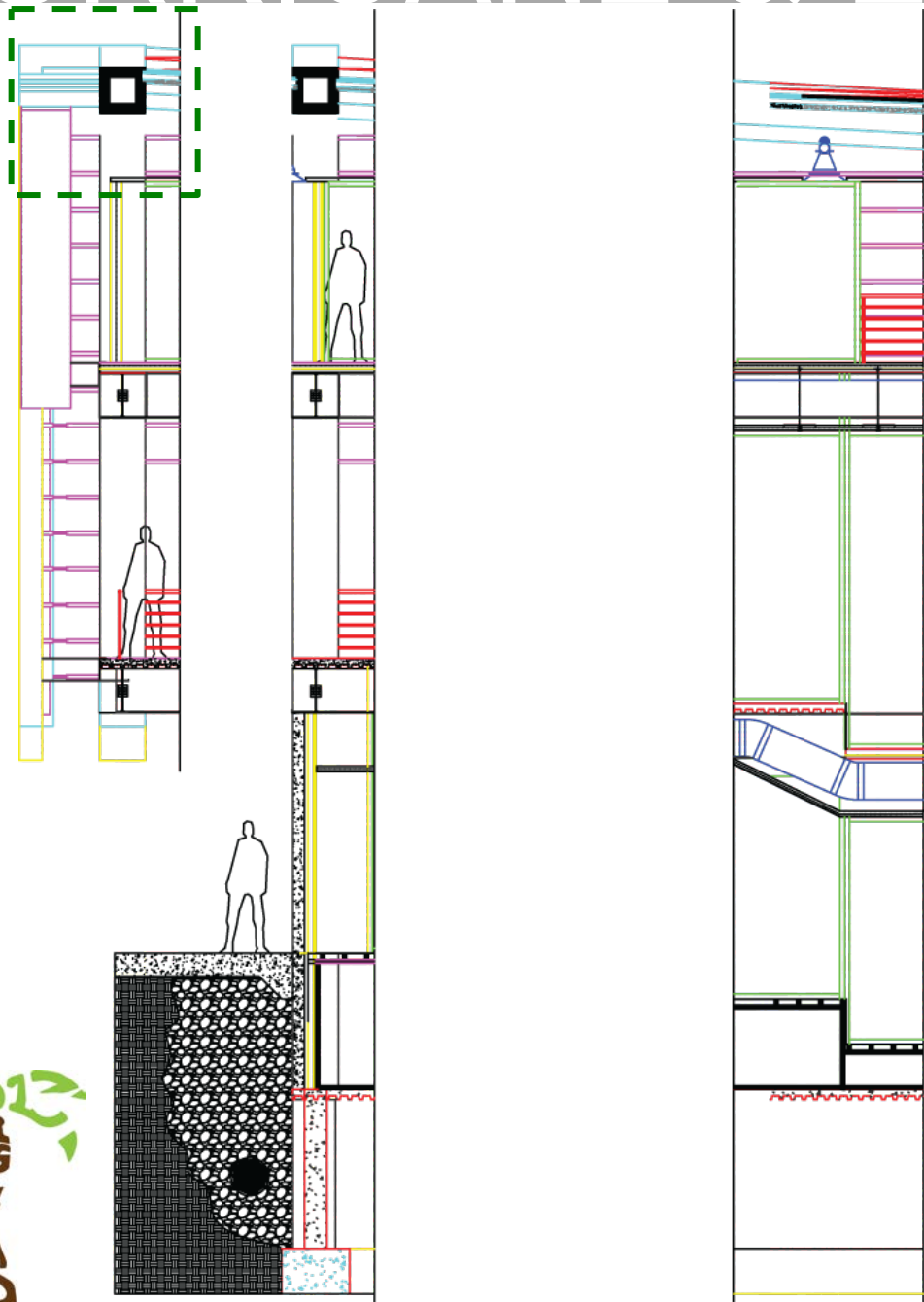
HURRICANE & EARTHQUAKE

SECTION A-A



HURRICANE & EARTHQUAKE

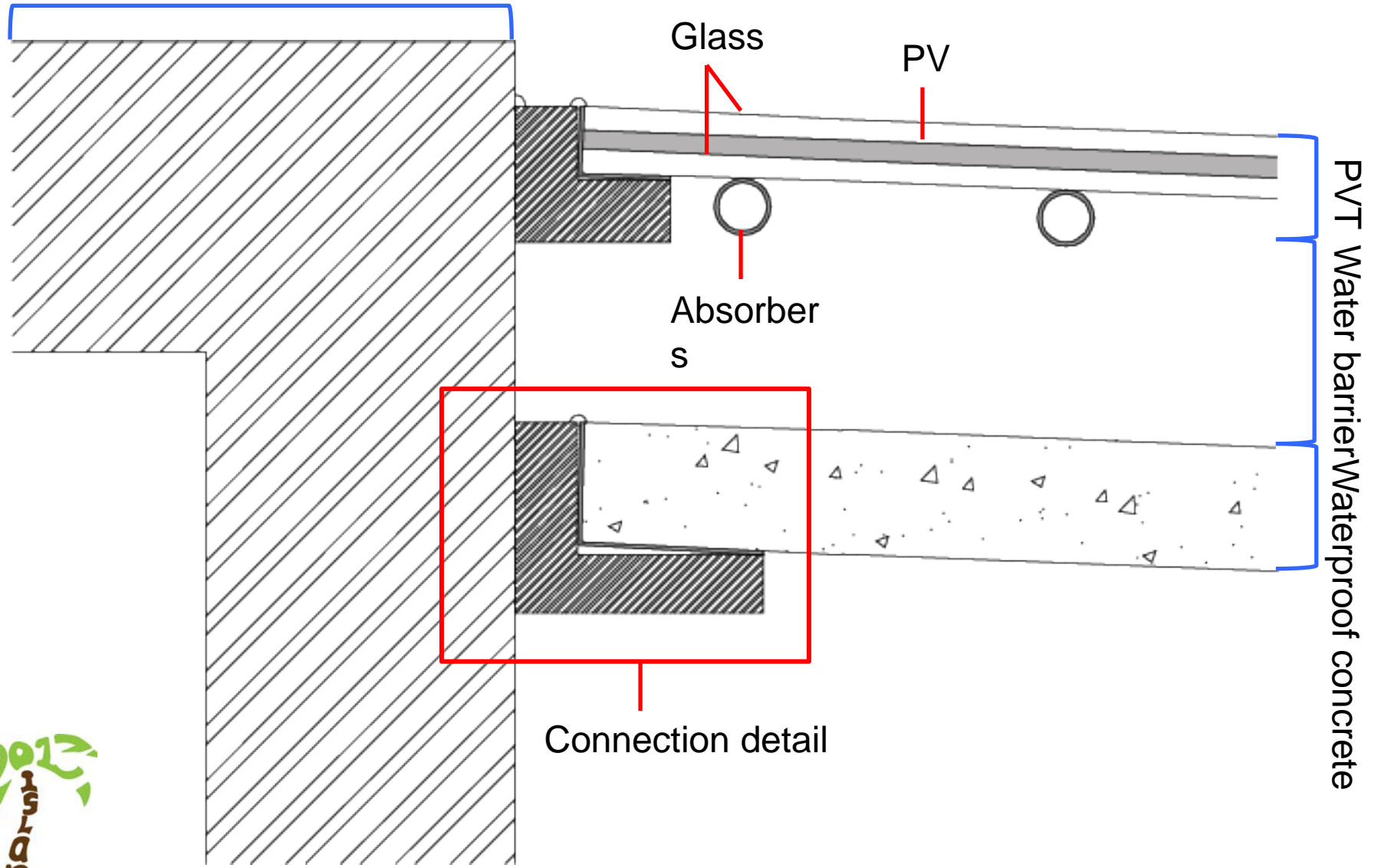
WALL SECTION



COMFORT & SPACE

ROOF DETAIL

Structure





NORTHEAST

CONCEPT

WEST FACADE



SOUTH FACADE

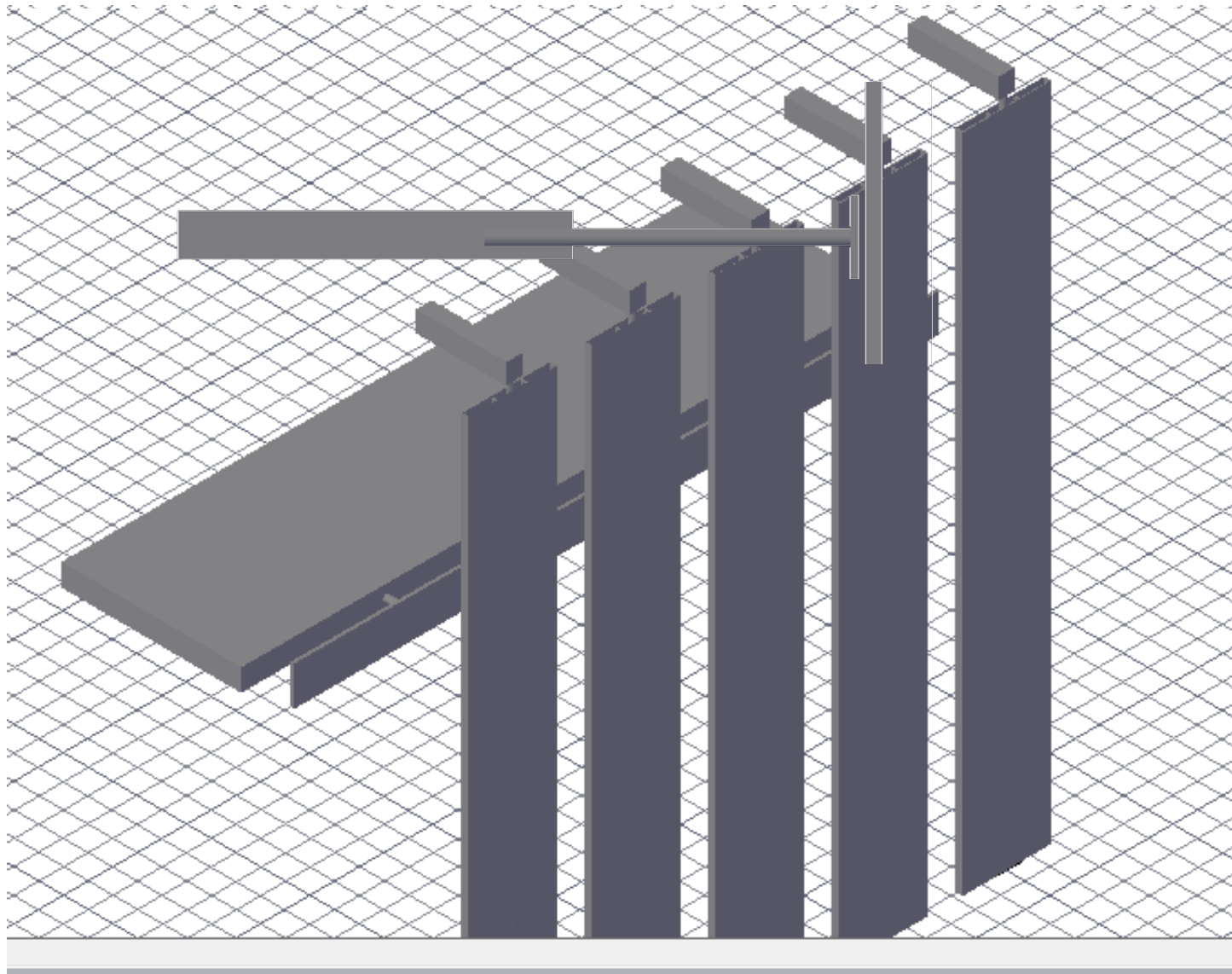
HURRICANE & EARTHQUAKE DESIGN CRITERIA

- Safety
 - CODE:IBC2006 ASCE
- Structure Component Meet TVD
 - 24% of total budget
- Integrate with A/C/M/L



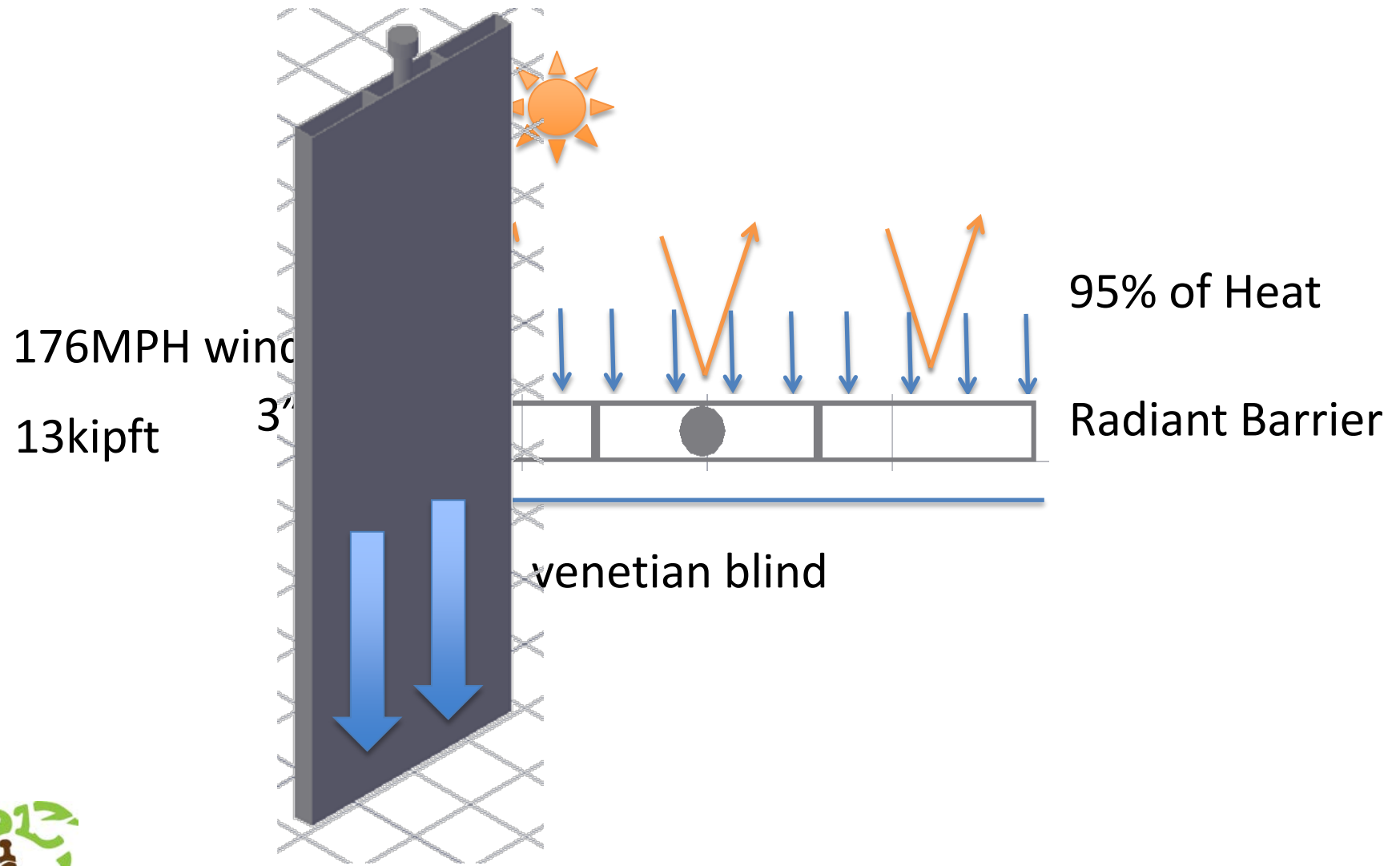
HURRICANE & EARTHQUAKE

CANOPY DETAIL

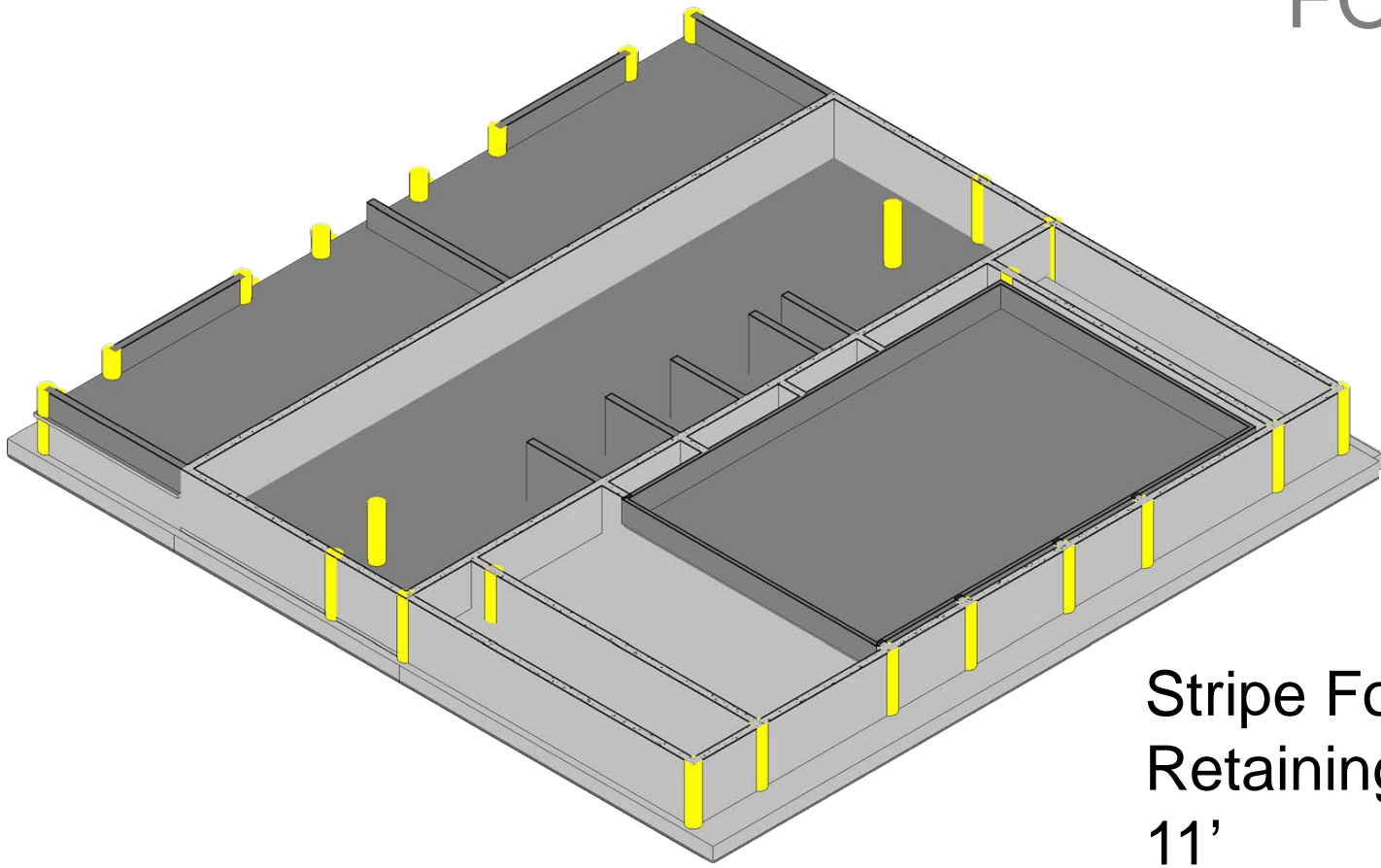


HURRICANE & EARTHQUAKE

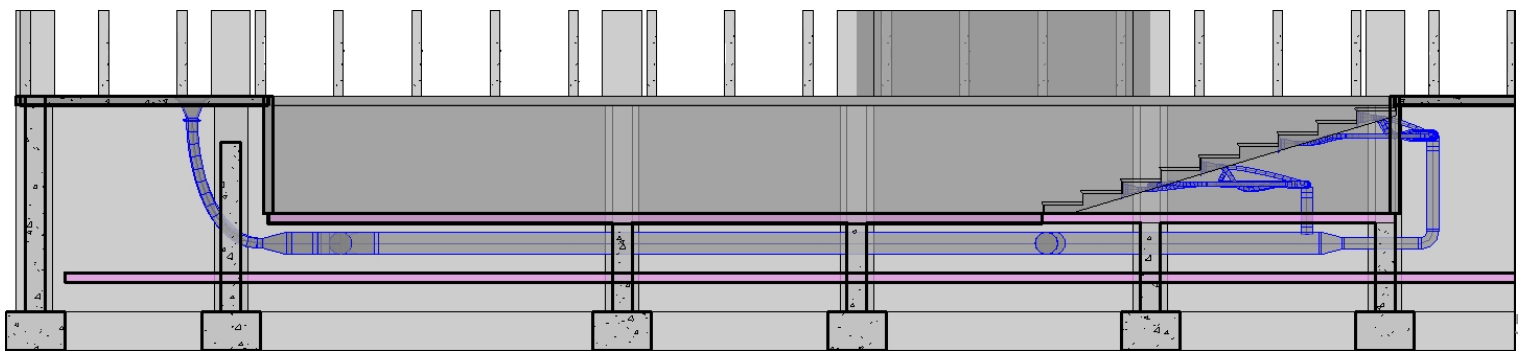
CANOPY DETAIL



HURRICANE & EARTHQUAKE FOUNDATION



Stripe Footing 2'
Retaining Wall (MAX)
11'

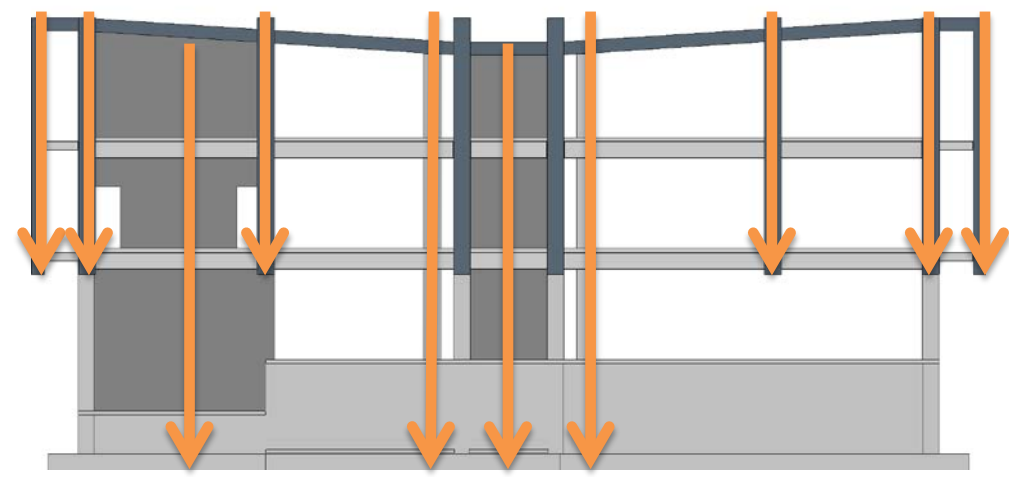
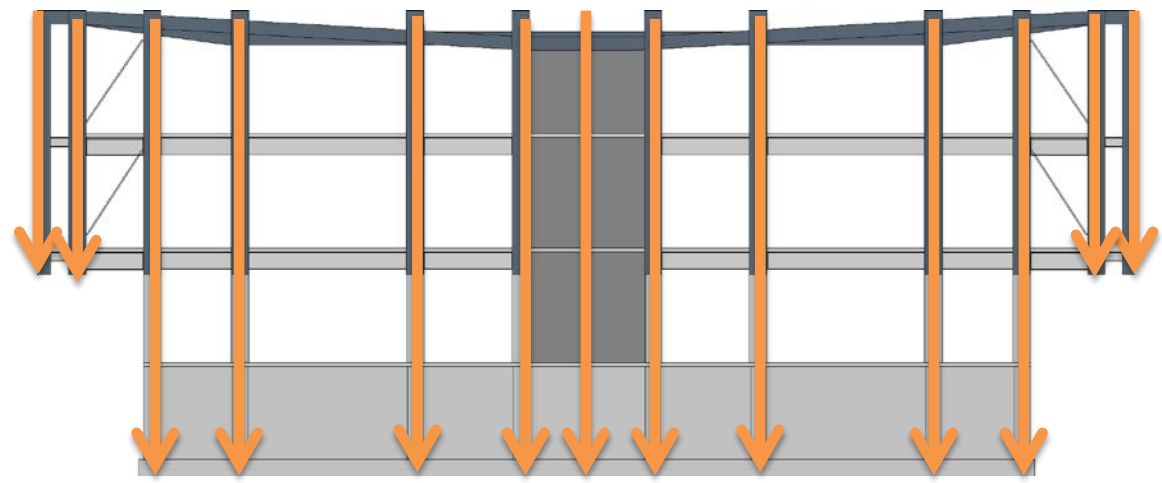


59 N



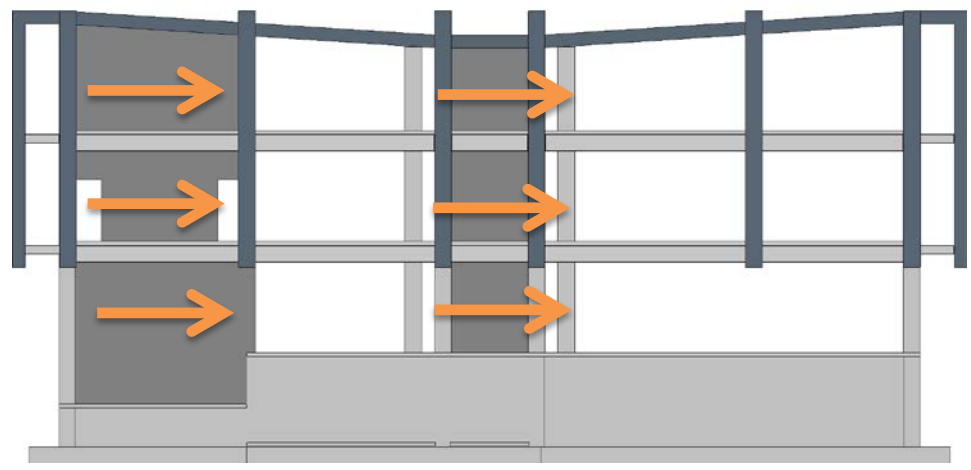
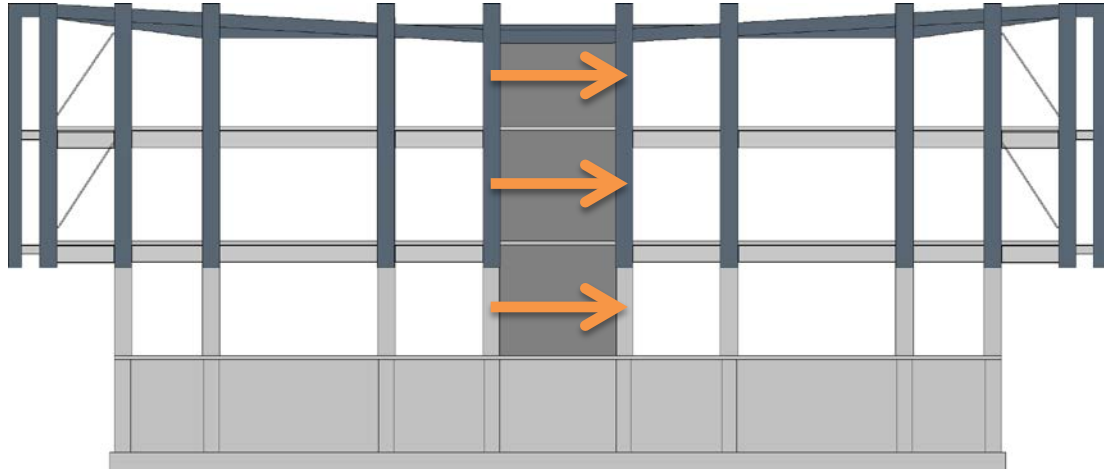
HURRICANE & EARTHQUAKE

LOAD PATH

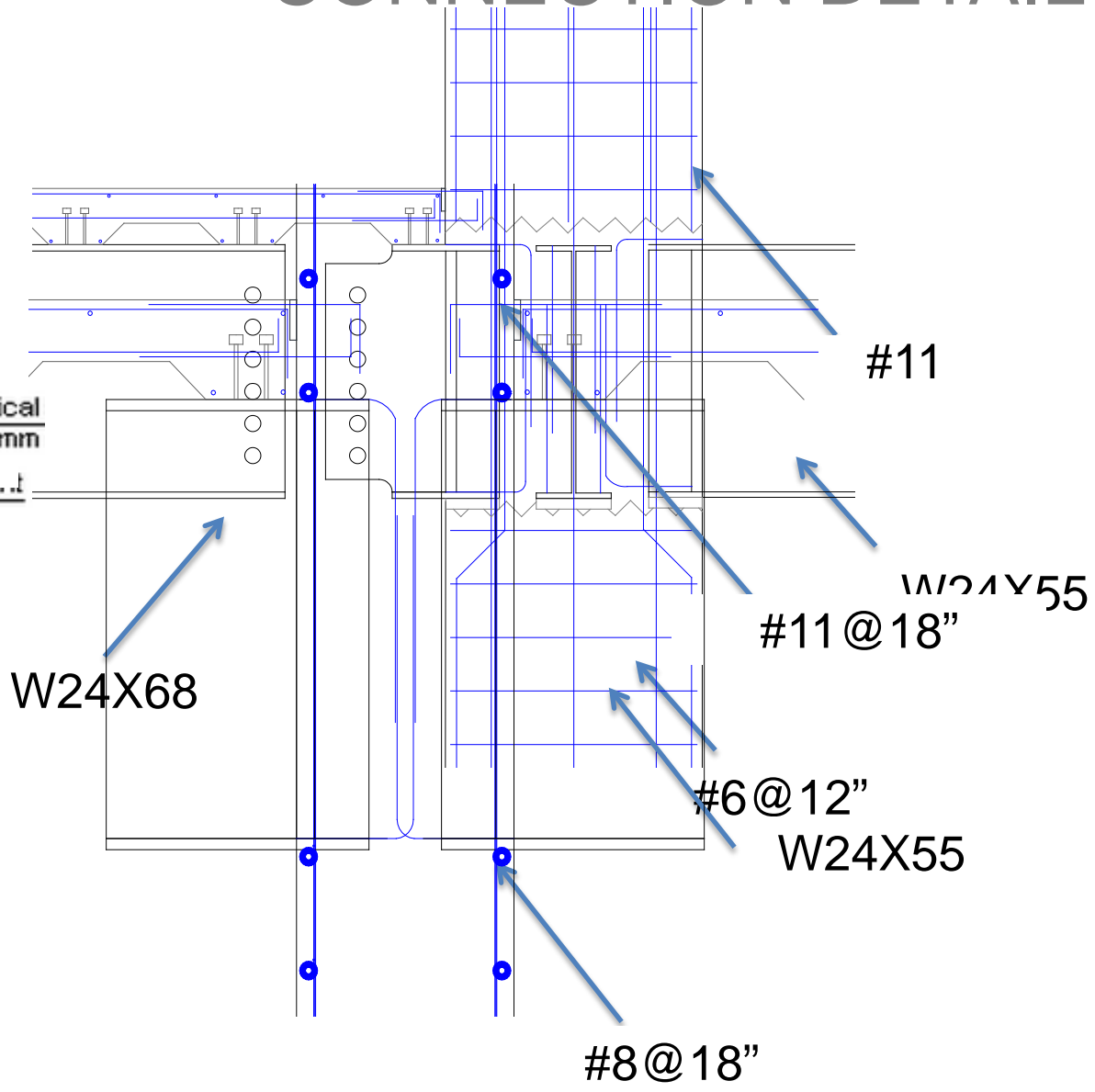
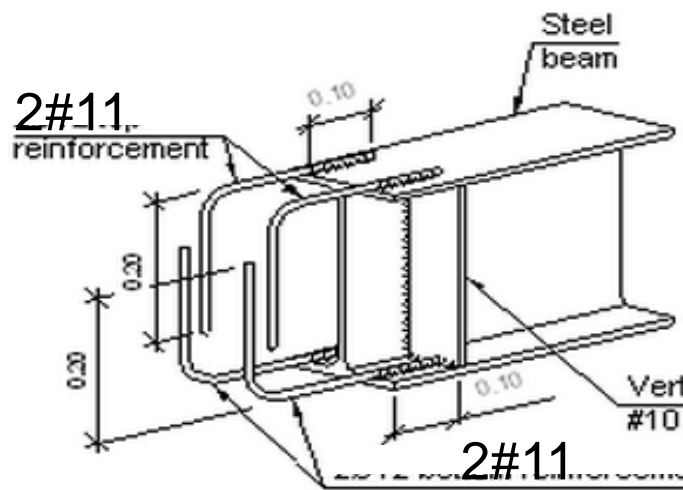


HURRICANE & EARTHQUAKE

Load Path



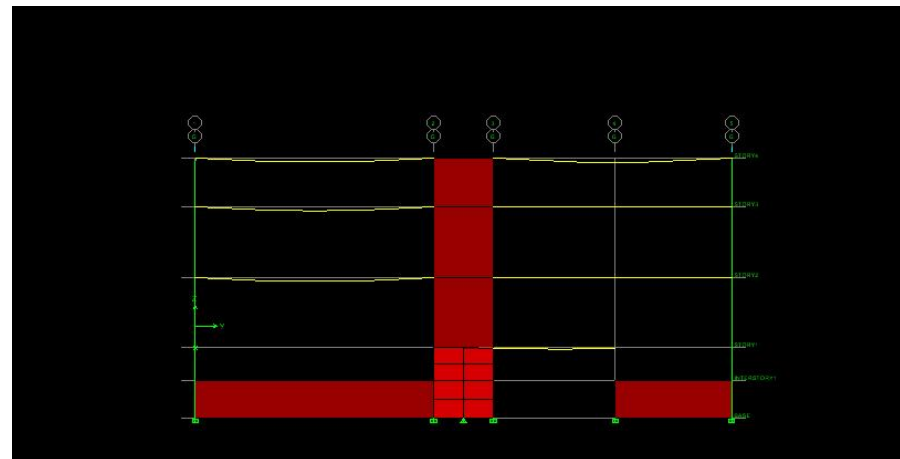
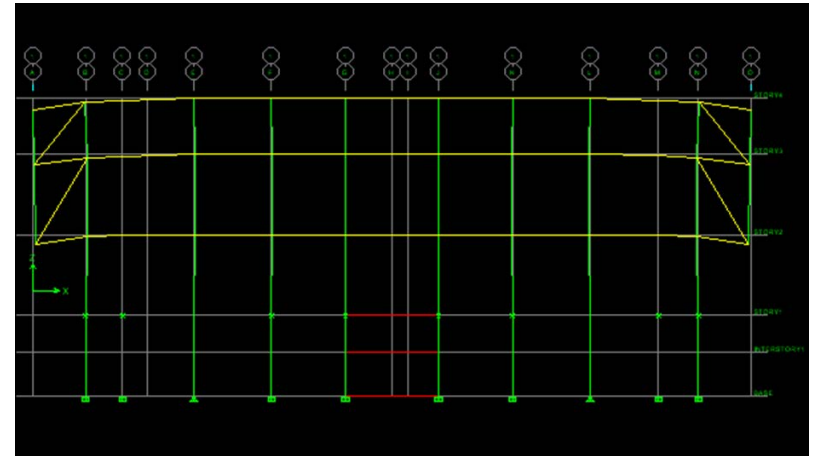
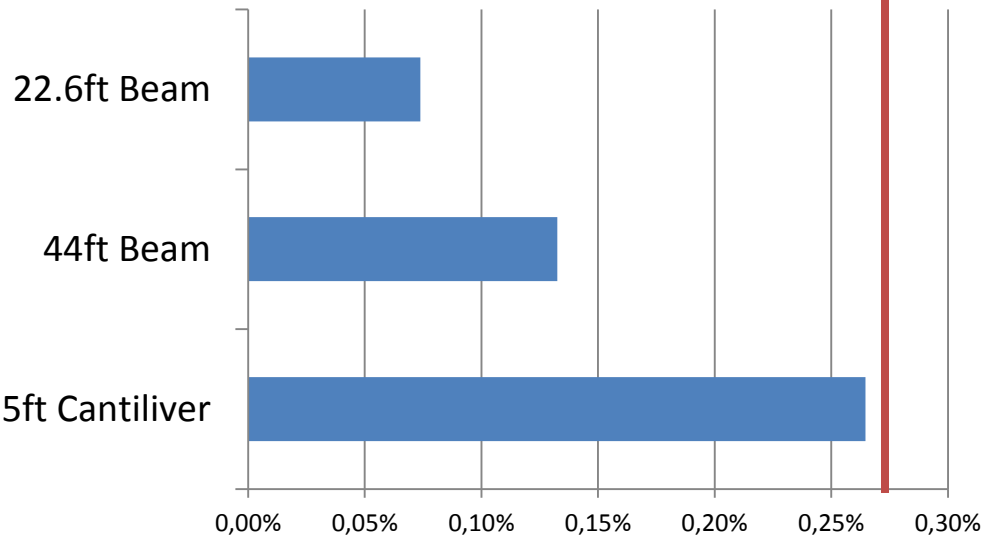
HURRICANE & EARTHQUAKE CONNECTION DETAIL



HURRICANE & EARTHQUAKE STRUCTURAL ANALYSIS RESULTS

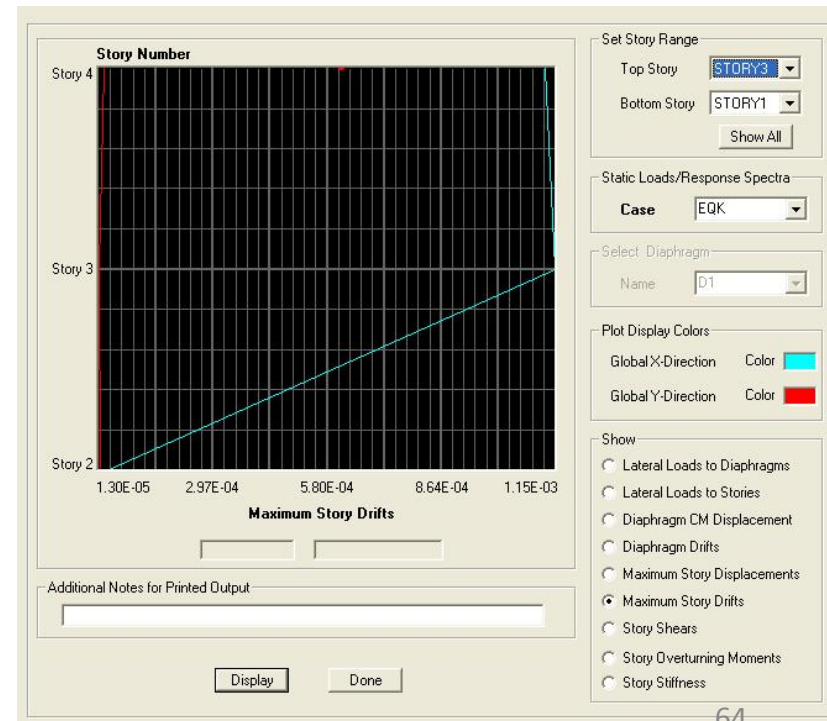
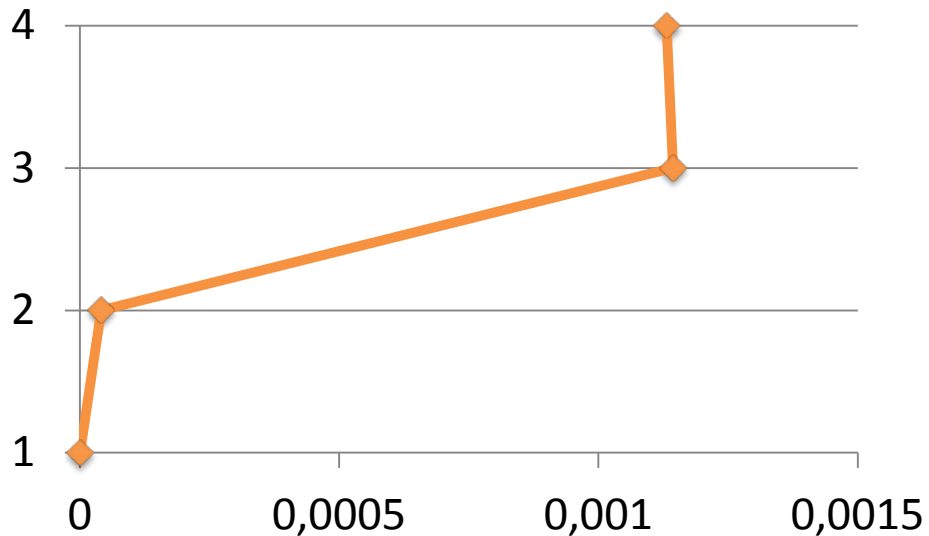
ETABS®
INTEGRATED ANALYSIS, DESIGN AND
DRAFTING OF BUILDING SYSTEMS

Displacement < Length/360

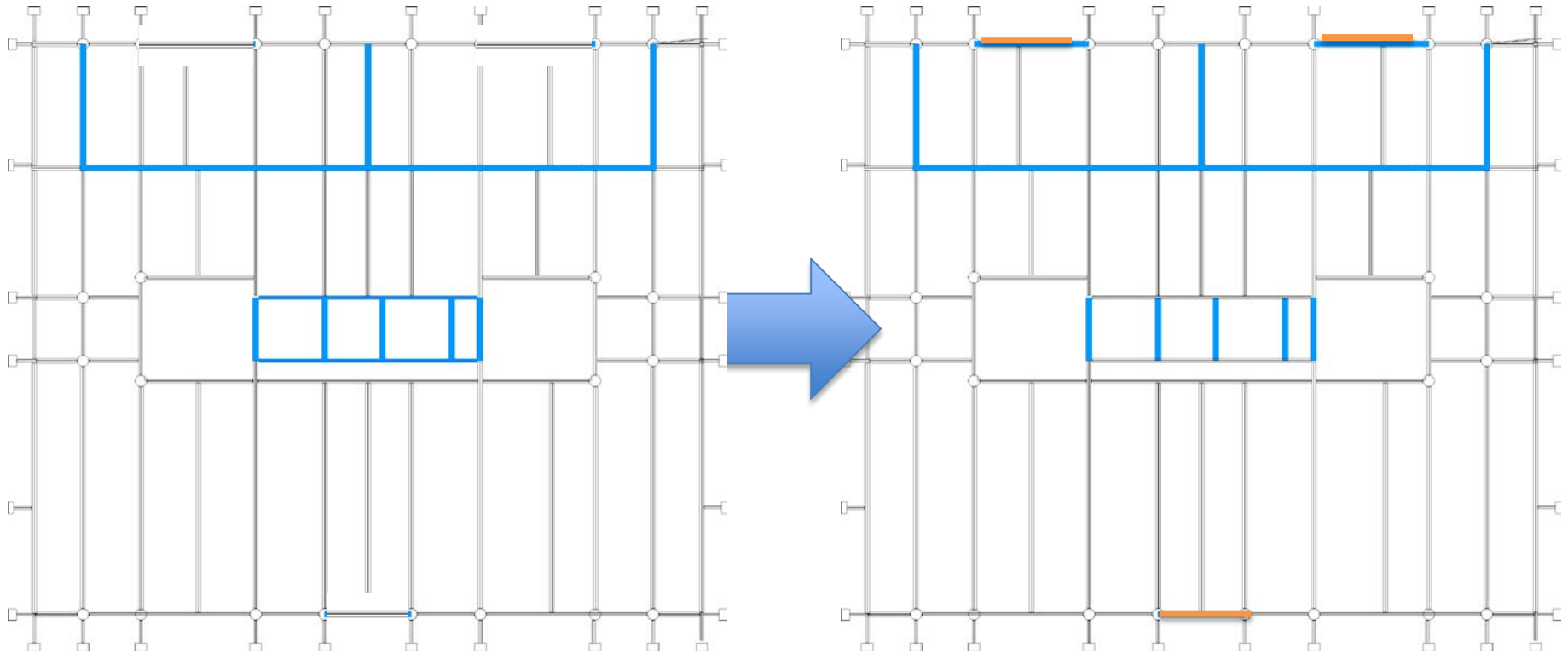


HURRICANE & EARTHQUAKE STRUCTURAL ANALYSIS RESULTS

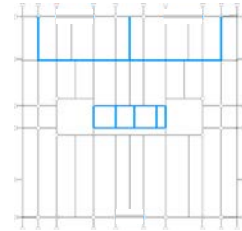
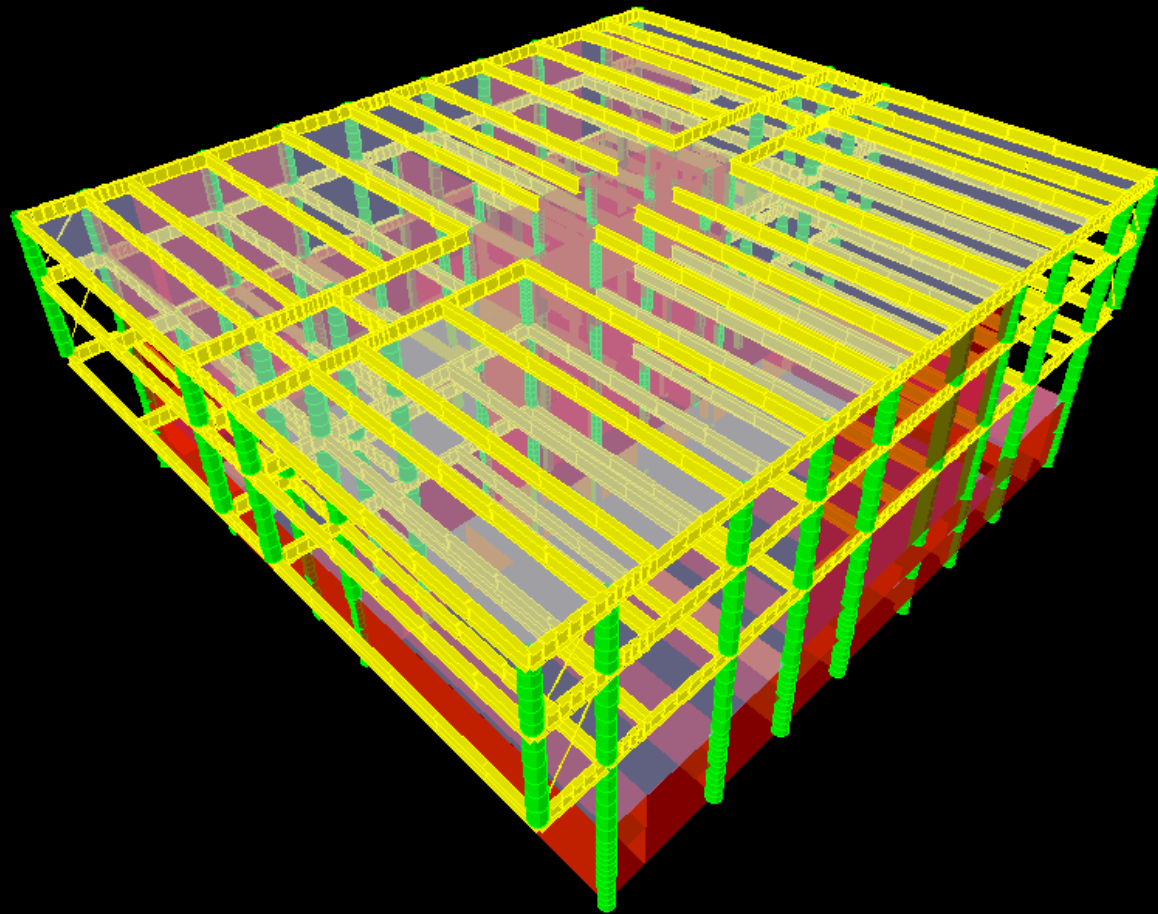
Maximum Interstory Drift Ratio < 0.02



HURRICANE & EARTHQUAKE SYSTEM TRADE OFF

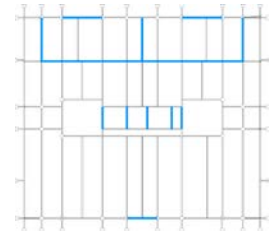
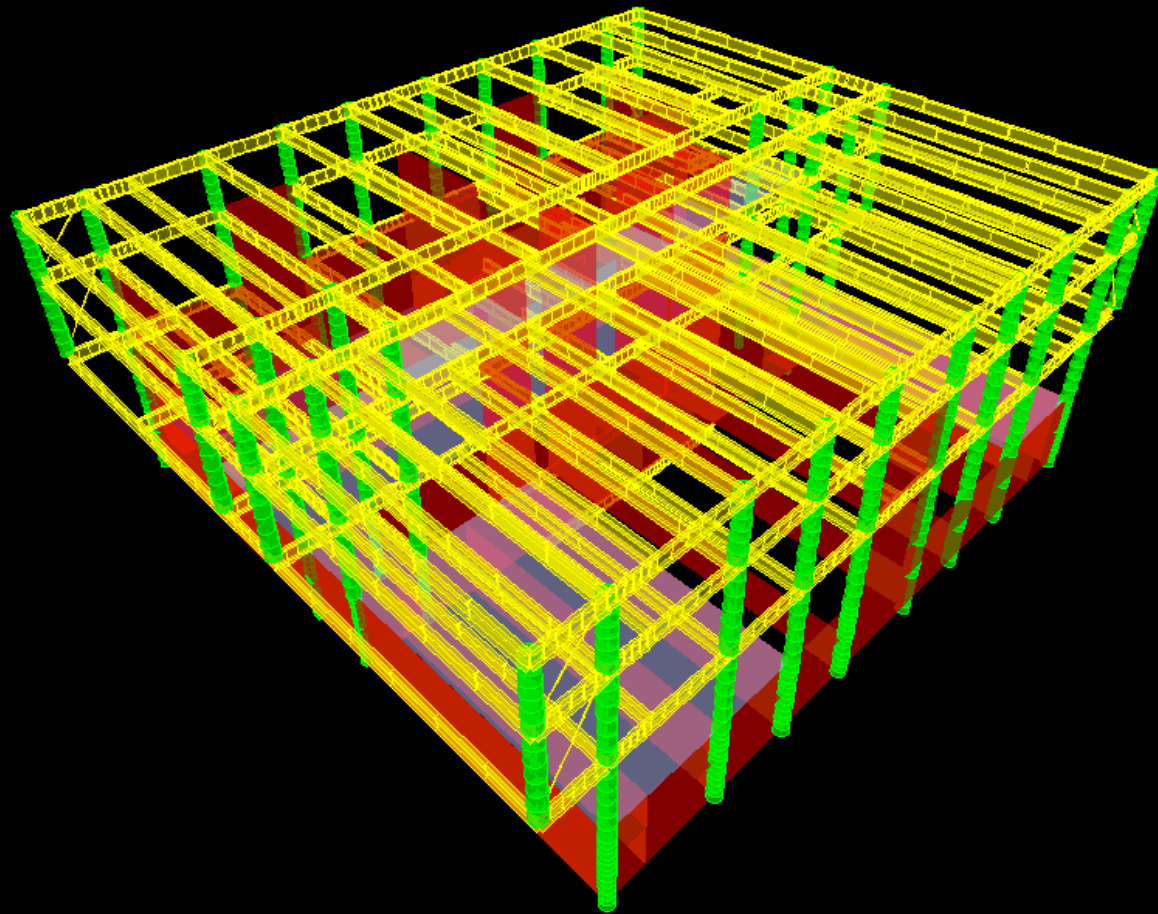


HURRICANE & EARTHQUAKE SYSTEM TRADE OFF

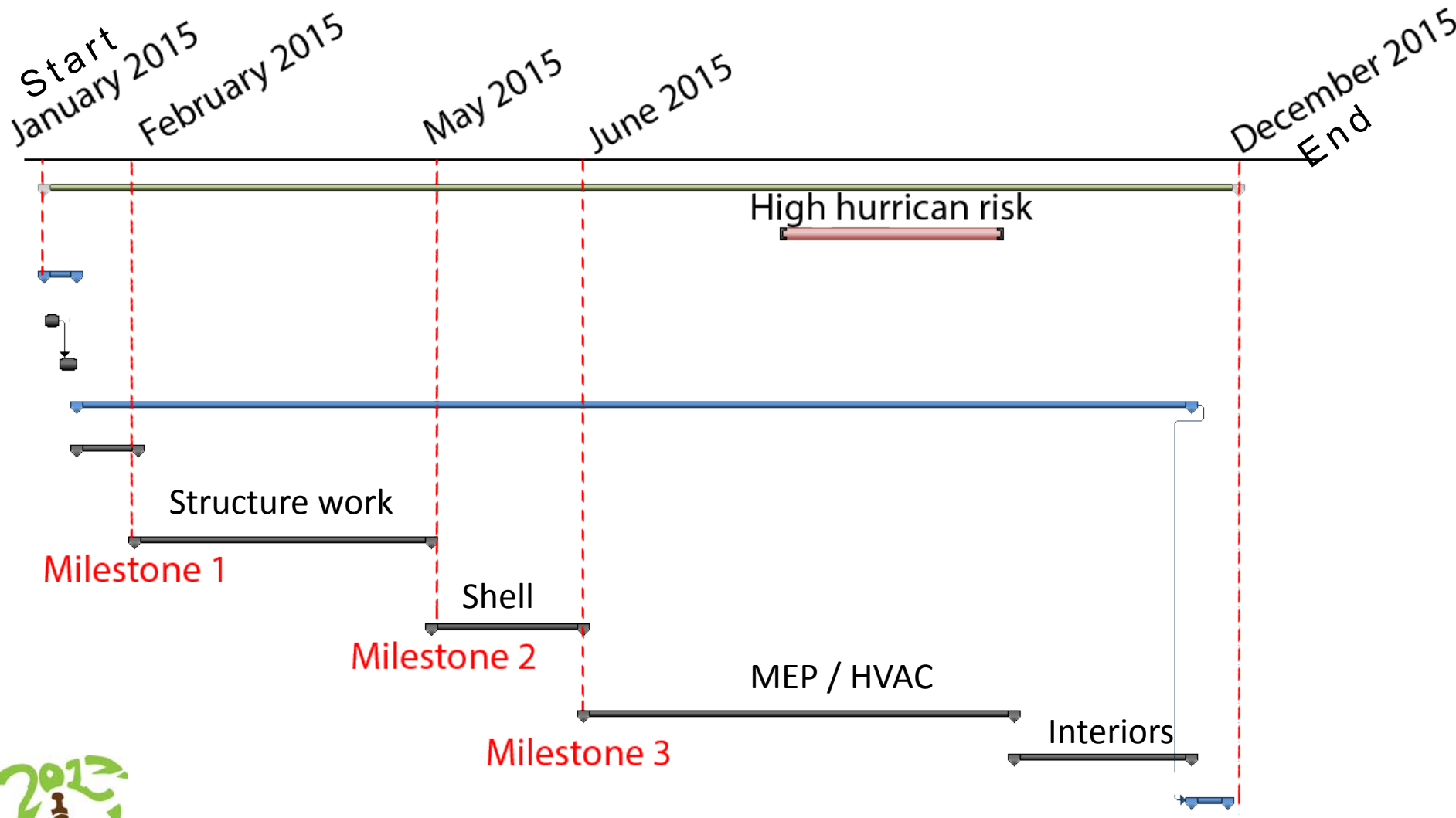


038

HURRICANE & EARTHQUAKE SYSTEM TRADE OFF



HURRICANE & EARTHQUAKE SCHEDULE

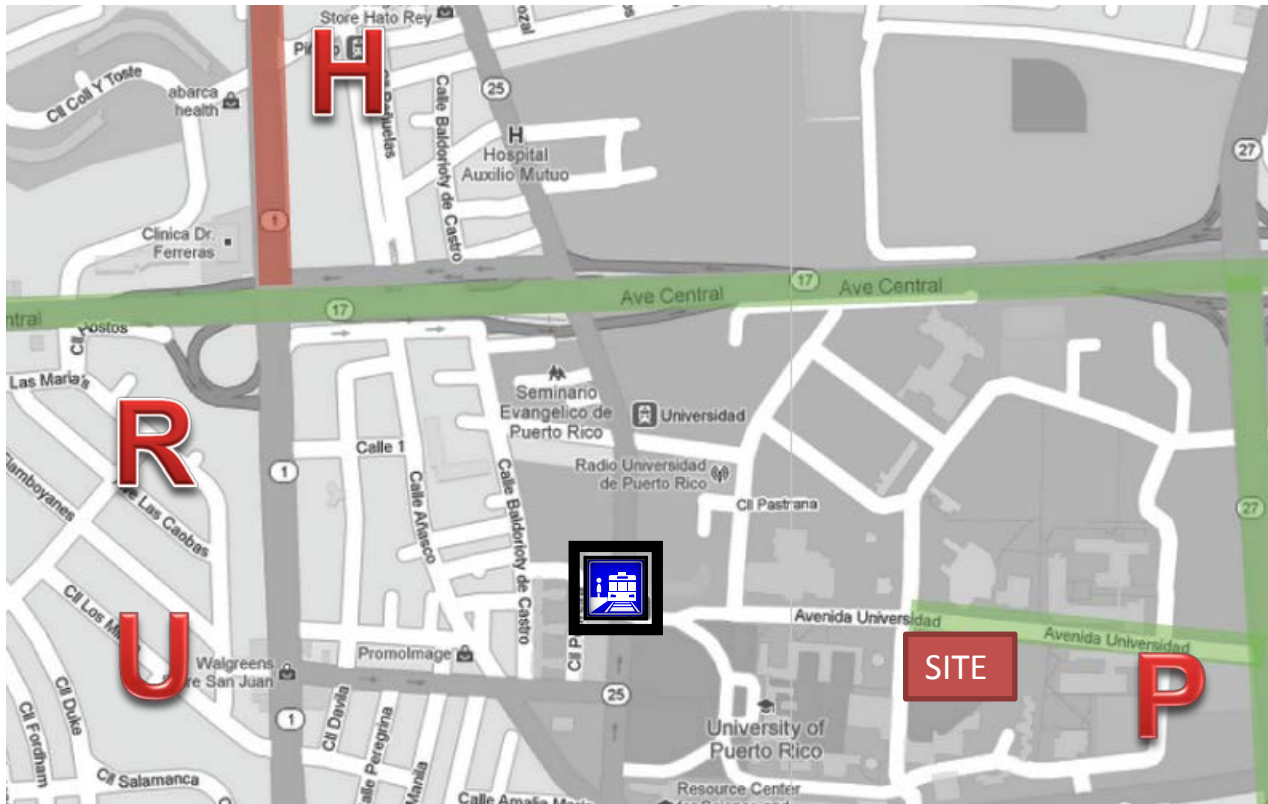


HURRICANE & EARTHQUAKE

SITE

 High traffic

 Normal traffic



- P – Parking
- H – Hospital
- R – Residence
- U – University

HURRICANE & EARTHQUAKE

LOGISTIC & SITE



- Orange square: Loading/Unloading area
- Red square: Building
- Blue square: Parking
- Yellow square: Establishment

HURRICANE & EARTHQUAKE EQUIPMENT

Liebherr LTM 1095-5.1

Total counterweight = 50,700 lbs
Telescopic boom = 41 ft - 190 ft
Operational weight = 132,000 lbs



Volvo EC140D

Operating weight = 28370 -33400 lb



HURRICANE & EARTHQUAKE

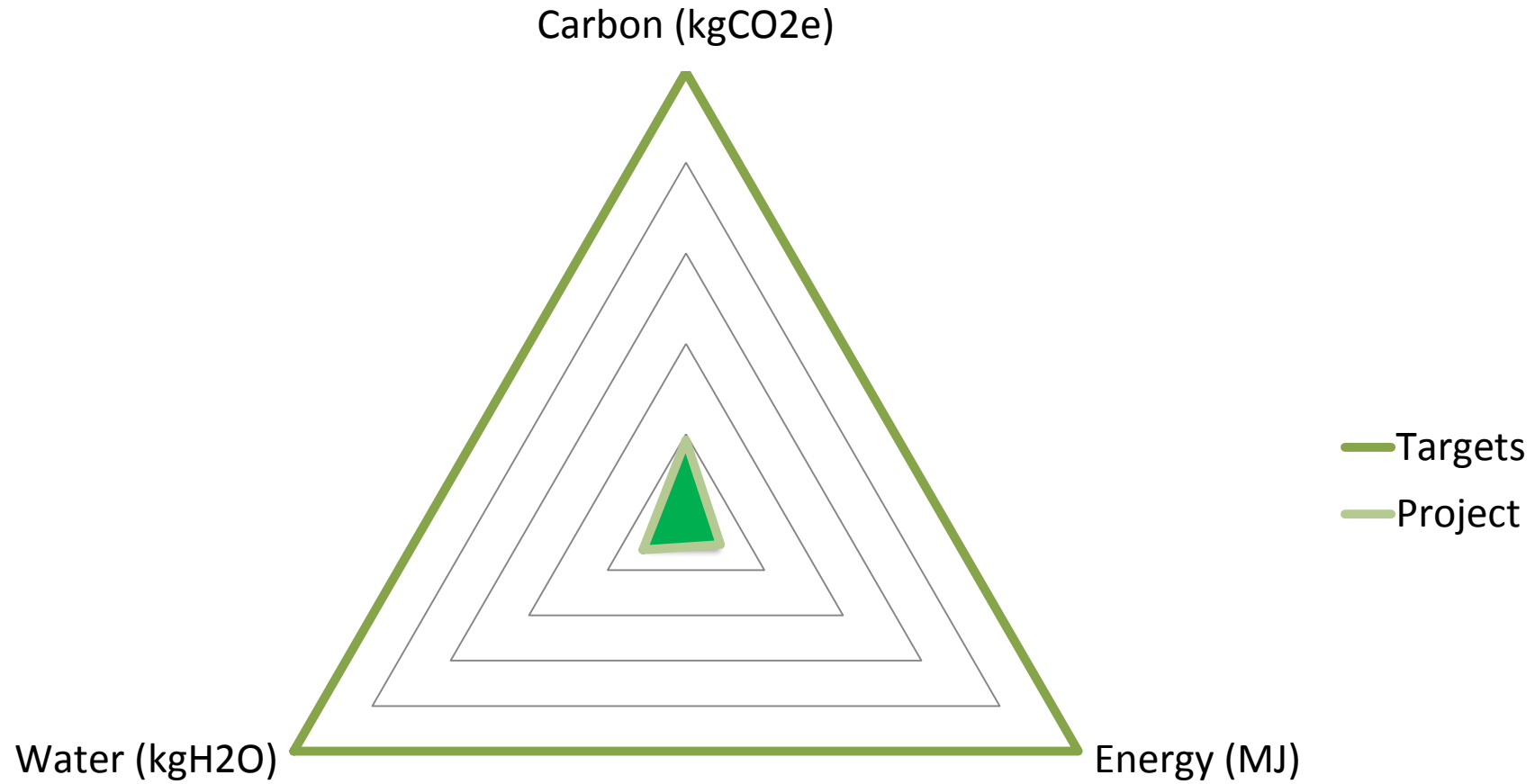
SITE





SUSTAINABILITY





Active energy savings

- Phase change materials
- Cooling ceiling with mixing ventilation
- Variable Air Volume ventilation
- Employ nearby workers
- Nearby construction materials

Passive energy savings

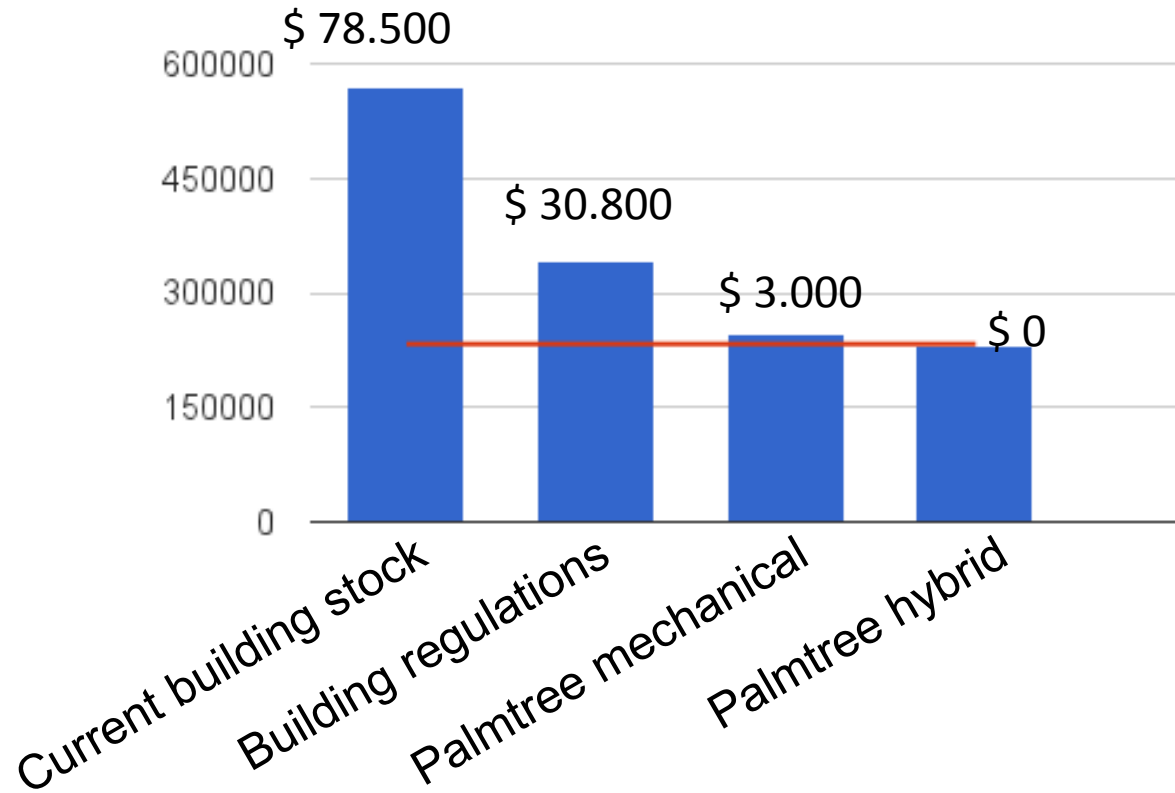
- Natural ventilation
- Insulation
- Exposed concrete slabs
- Overhang
- East-west orientation

Renewable energy

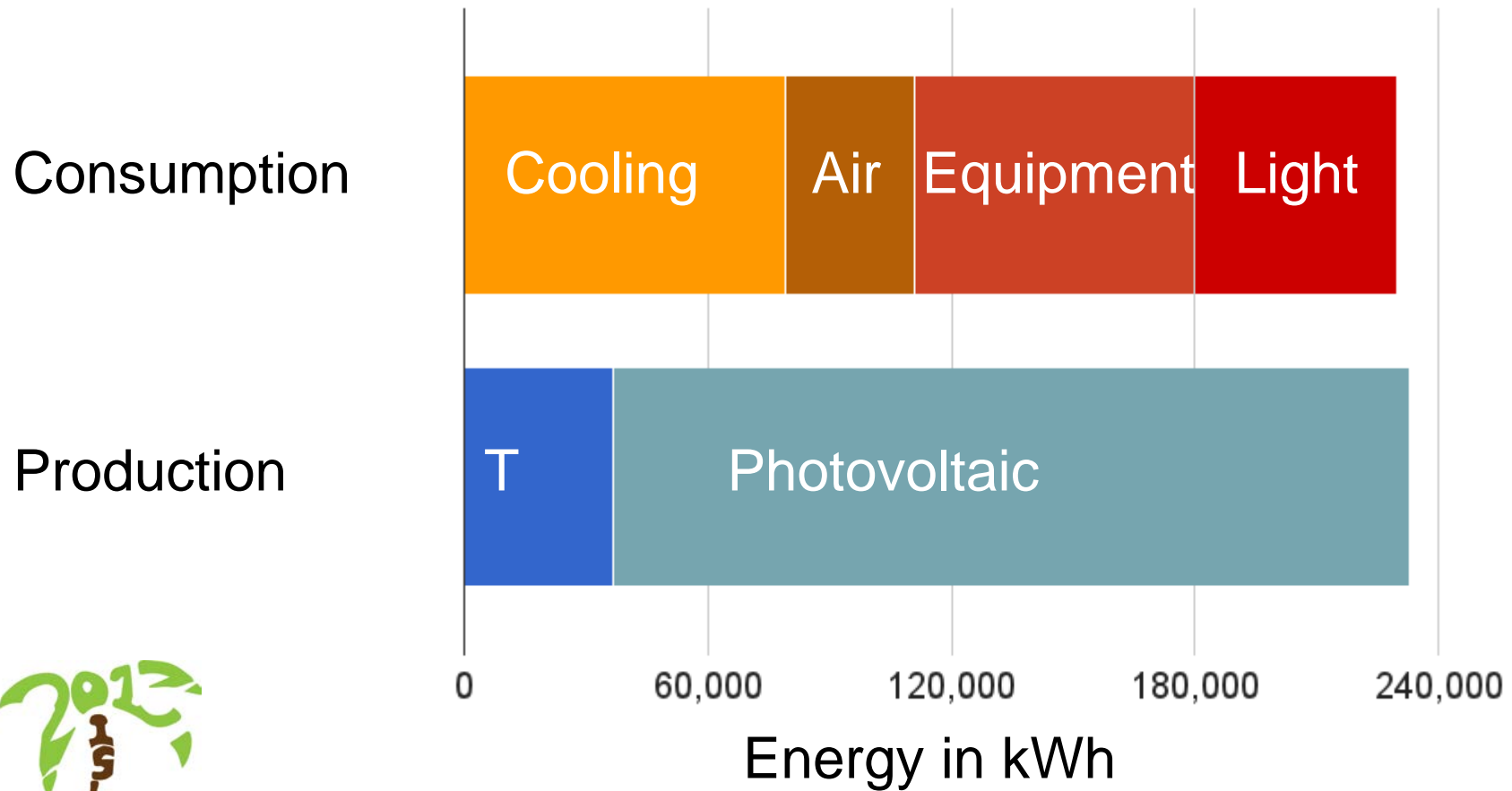
- Photovoltaic thermal - Night radiation cooling
- Photovoltaic



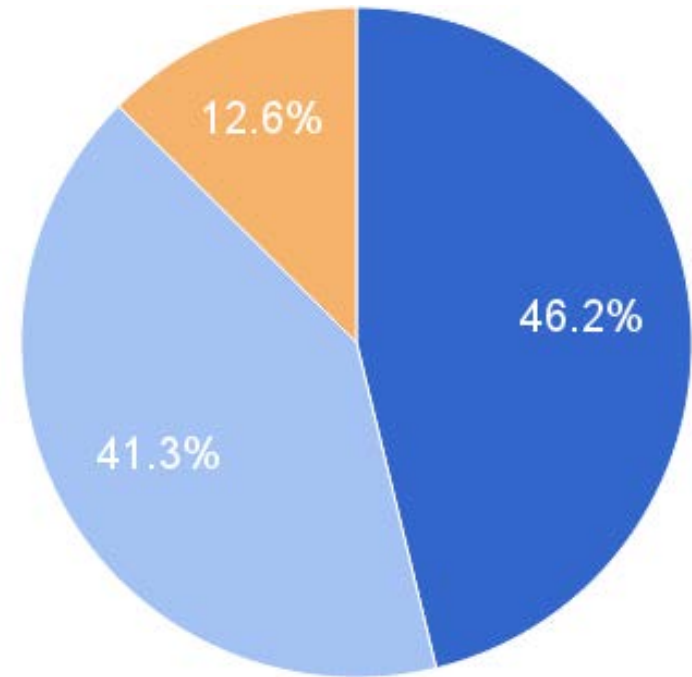
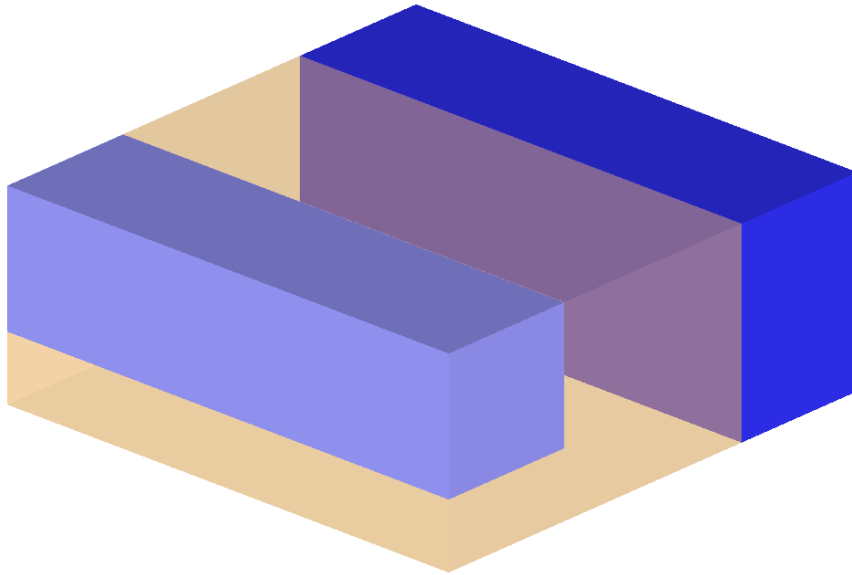
Energy balance (kWh/year)



- Energy consumption (kWh/year)
- Energy production from PVT (kWh/year)



- Electricity consumption 230.000 kWh

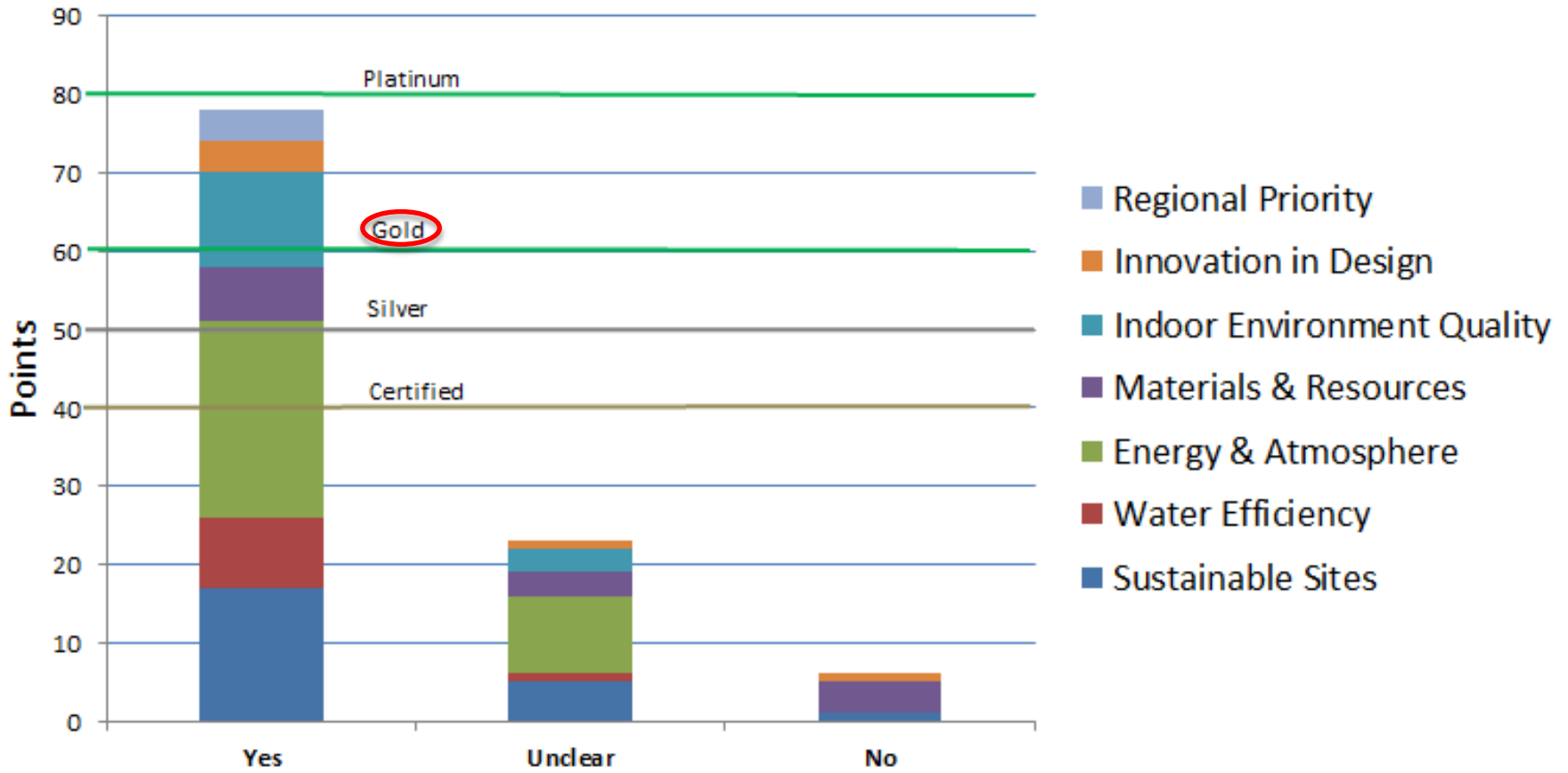


- North geometry
- South geometry
- Naturally conditioned geometry

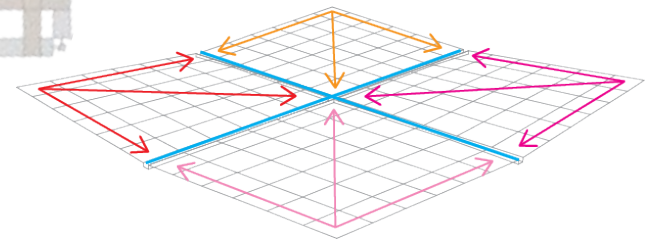
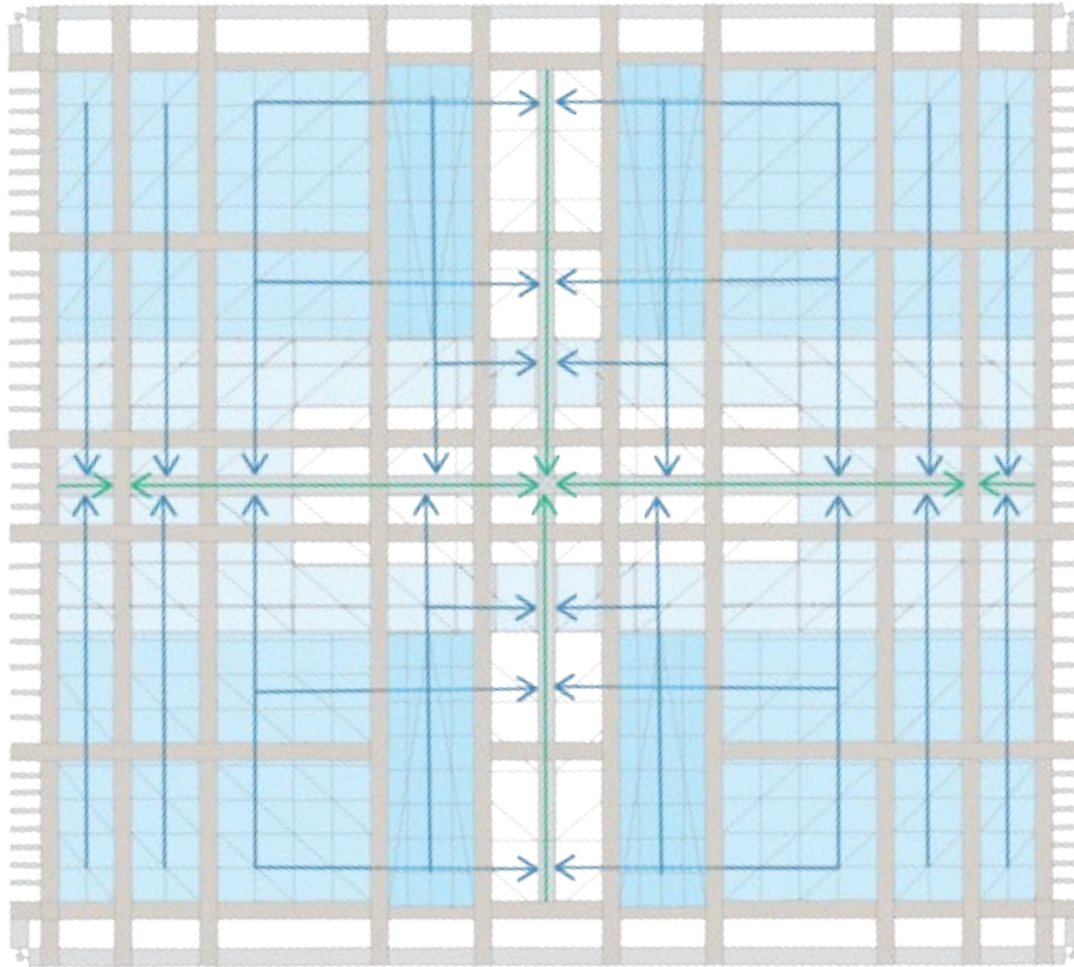


SUSTAINABILITY

ACHIEVABLE LEED POINTS PER CATEGORY



ROOF PLAN



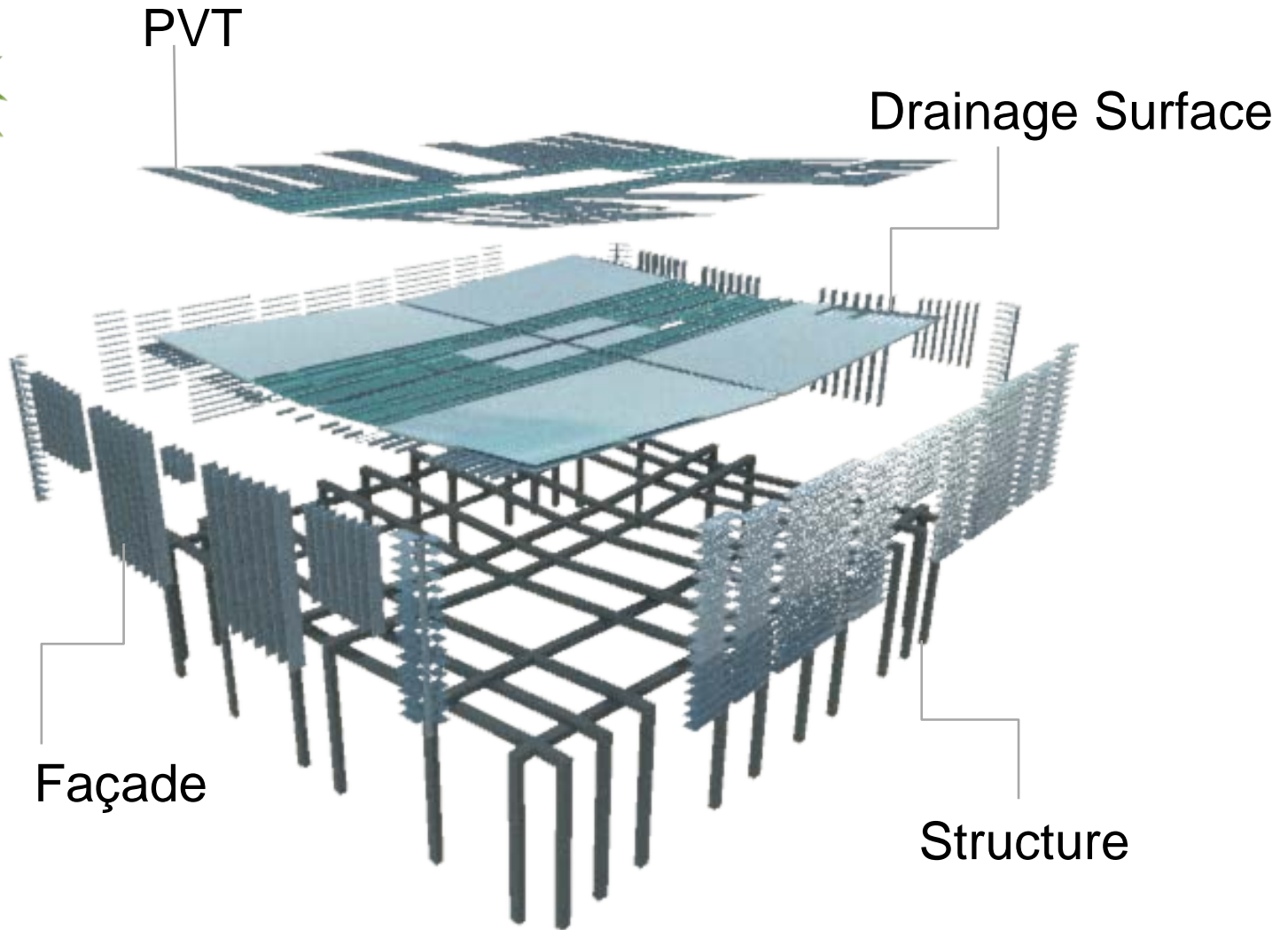
- Surface
- Gutter

HYPERBOLIC PARABOLOID₈₁



SUSTAINABILITY

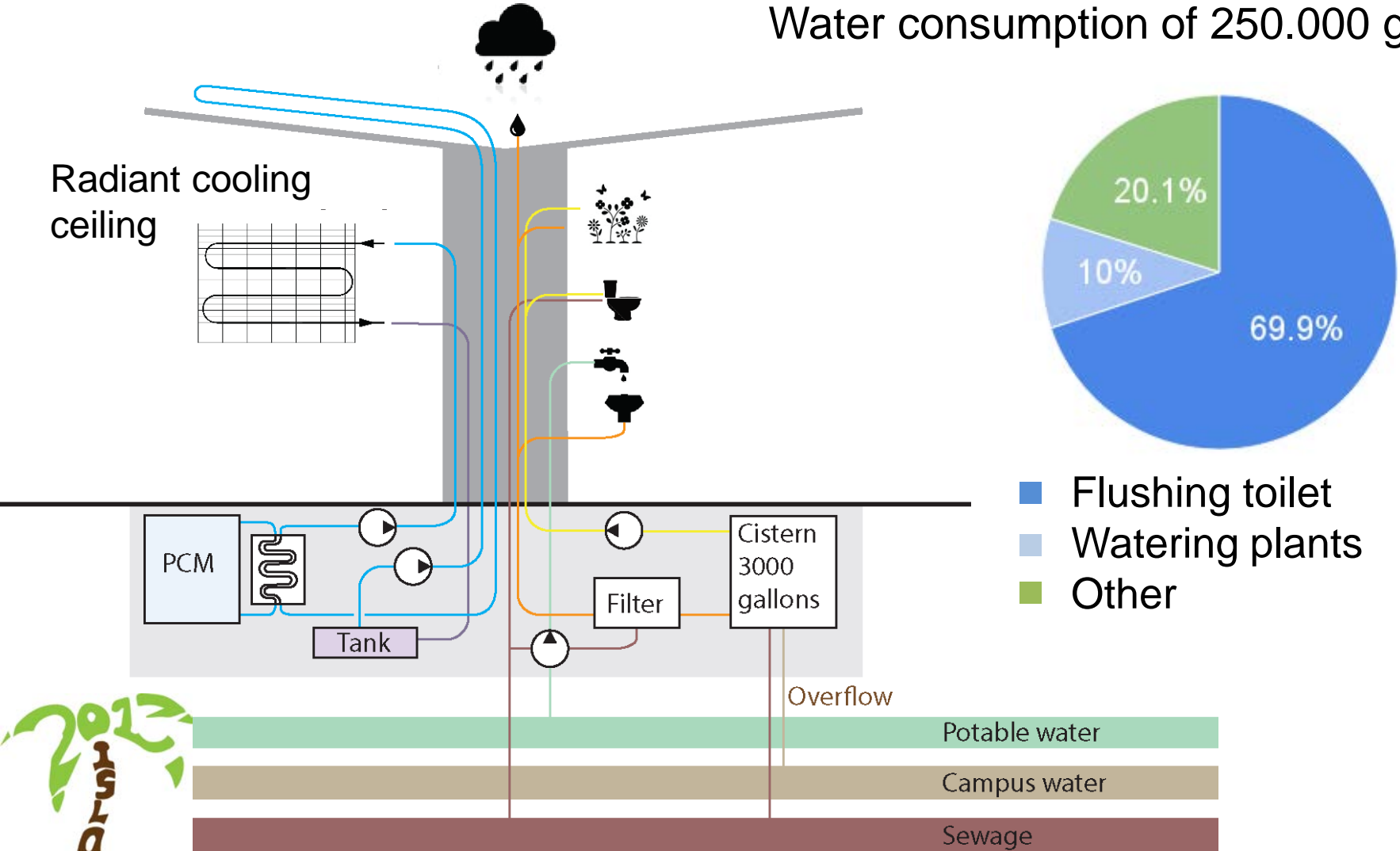
CANOPY ASSEMBLY



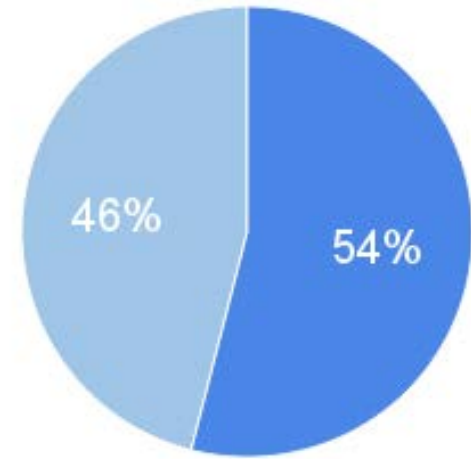
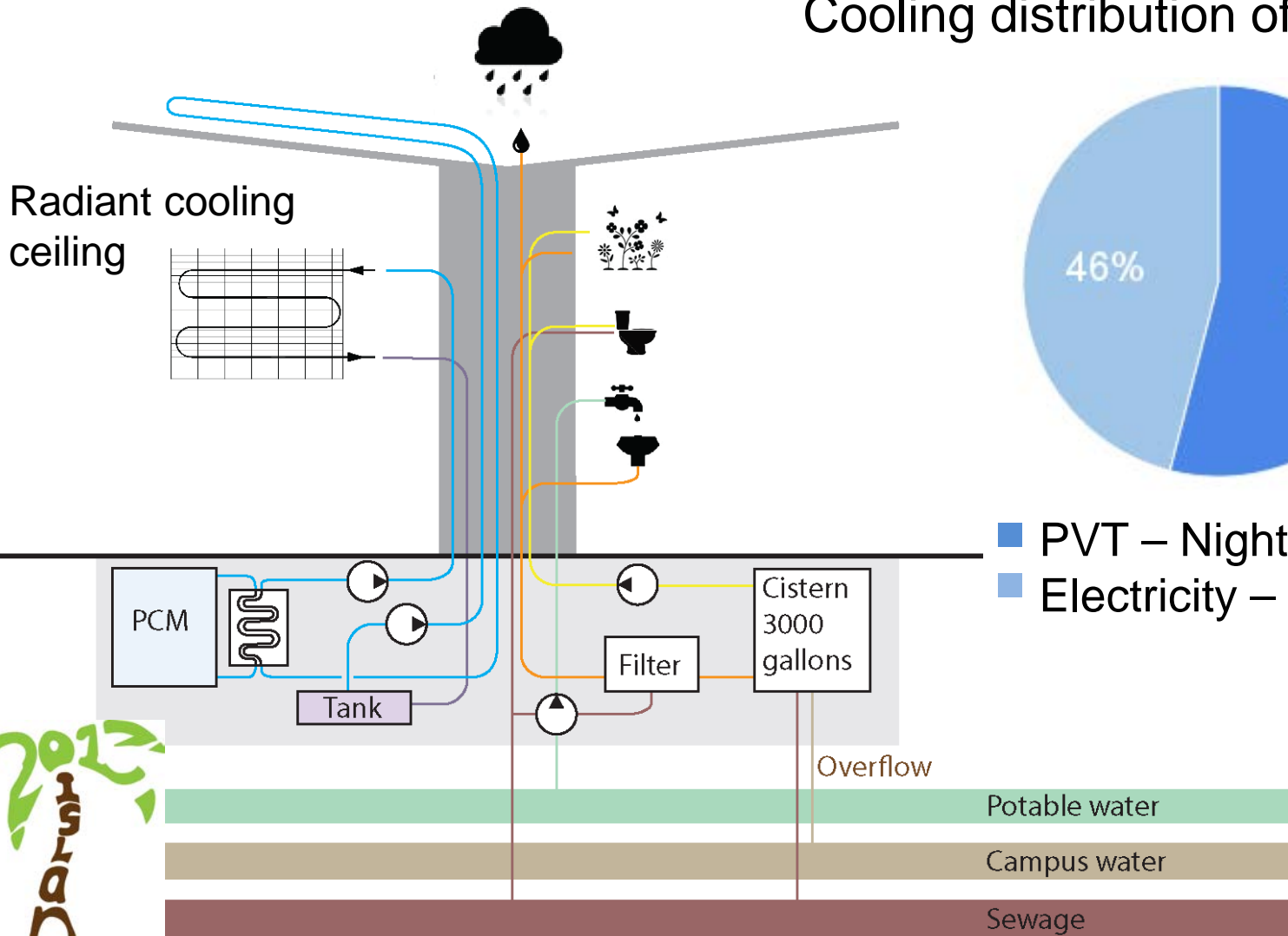
SUSTAINABILITY

WATER

Water consumption of 250.000 gallons



Cooling distribution of 68.000 kWh



- PVT – Night Radiation cooling
- Electricity – Cooling machine

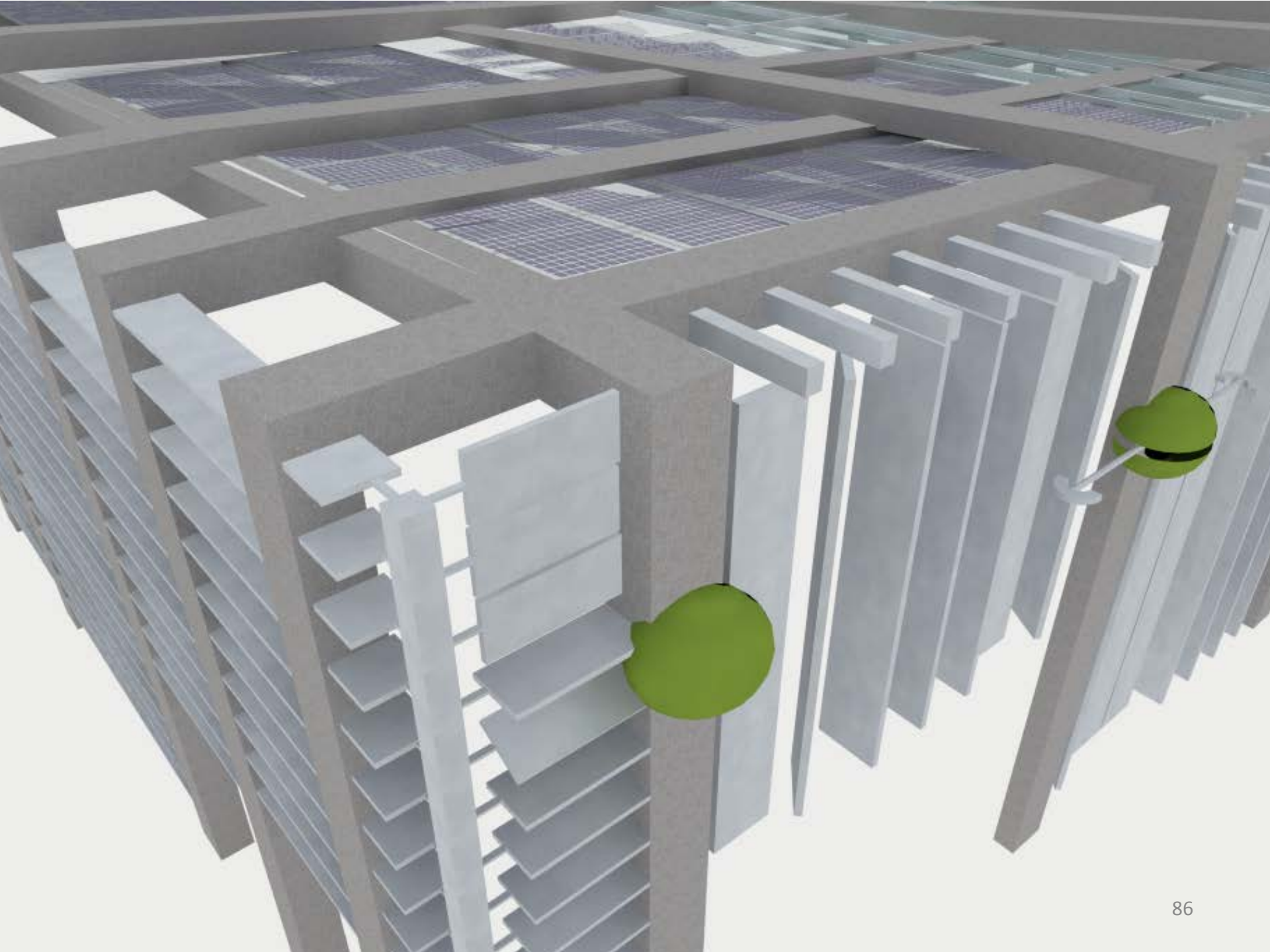
SUSTAINABILITY

SITE CONDITION - LOCAL COMPANIES

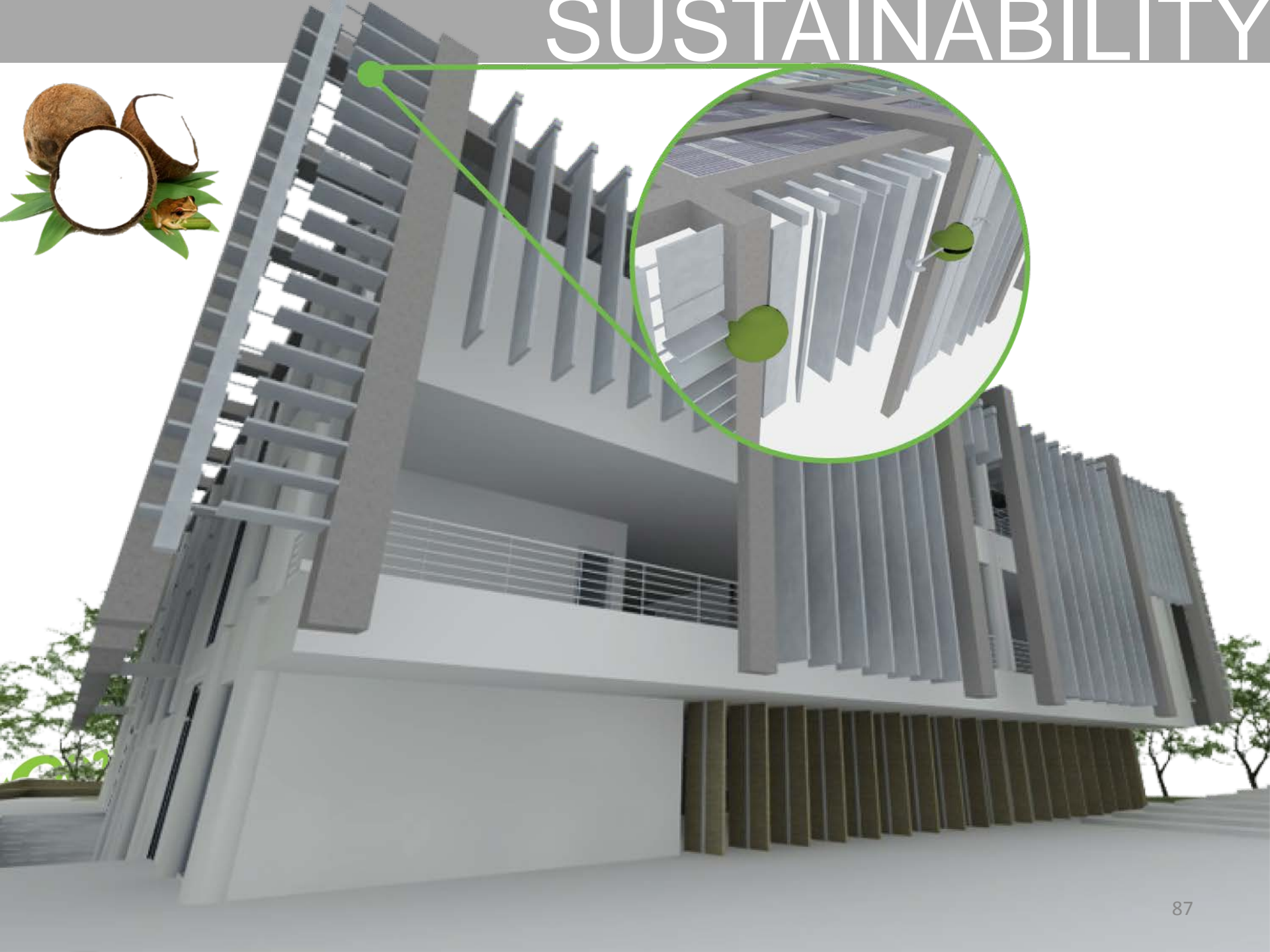
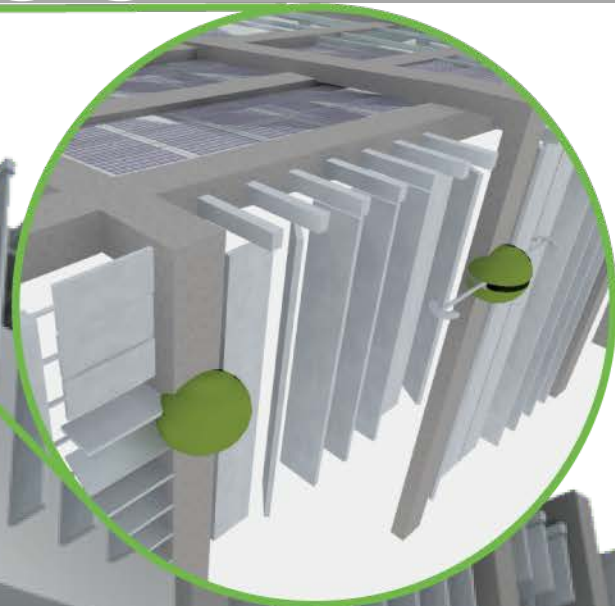


- | | |
|------------------------|-------|
| Steel | ➤ 5mi |
| Concrete | ➤ 6mi |
| Construction equipment | ➤ 3mi |
| Precasting concrete | ➤ 5mi |
| Glazing company | ➤ 1mi |
| Off-storage company | ➤ 9mi |
| MEP company | ➤ 2mi |

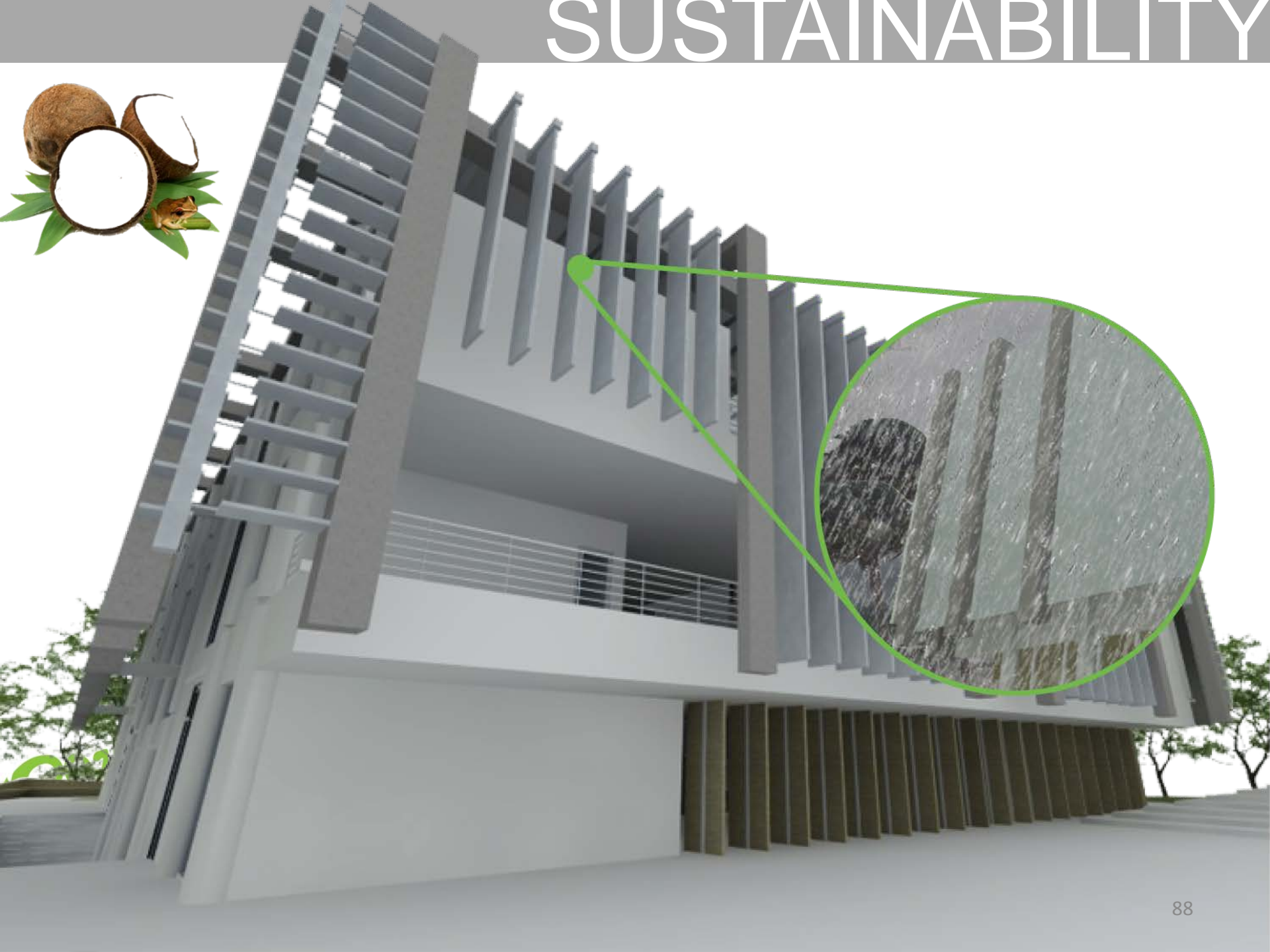




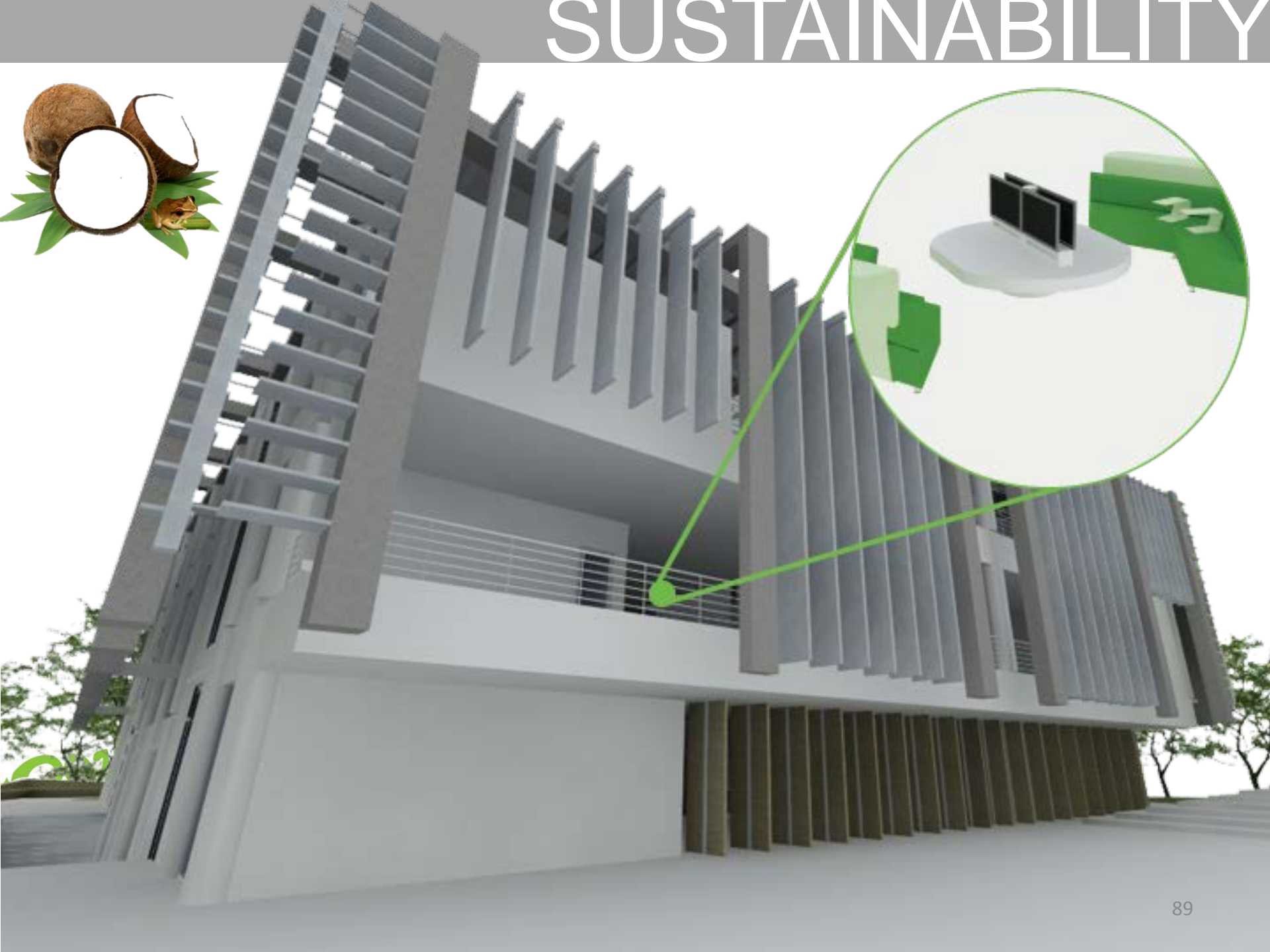
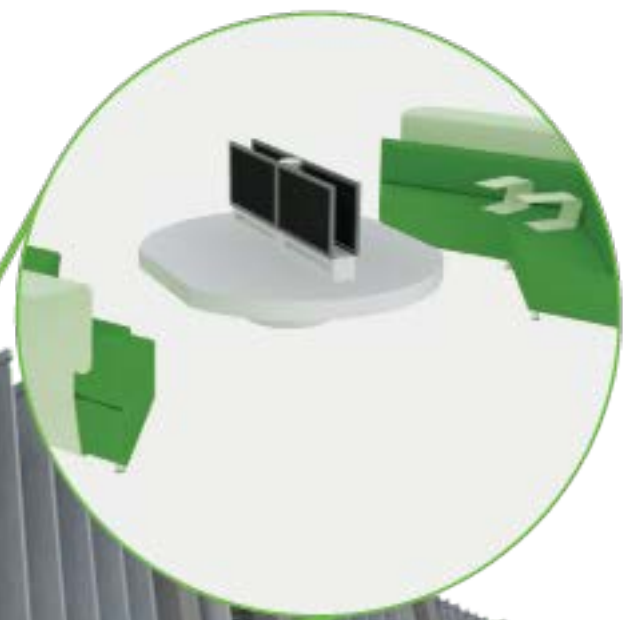
SUSTAINABILITY



SUSTAINABILITY

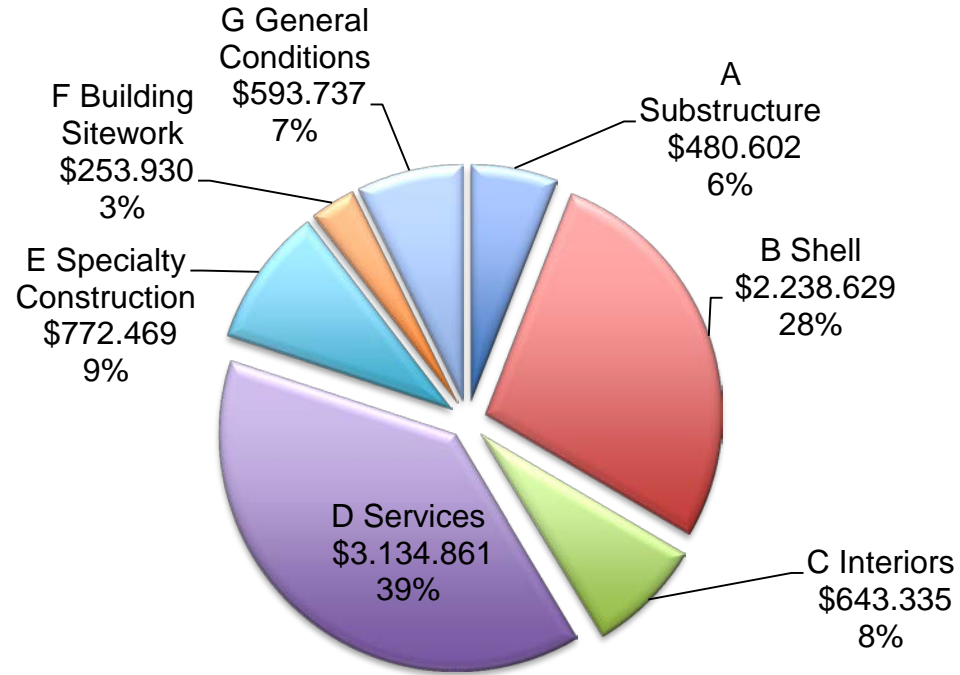


SUSTAINABILITY



SUSTAINABILITY

TVD



ESTIMATED VALUE	\$	8 117 000
TARGET VALUE	\$	8 400 000
VALUE DELTA	\$	283 000

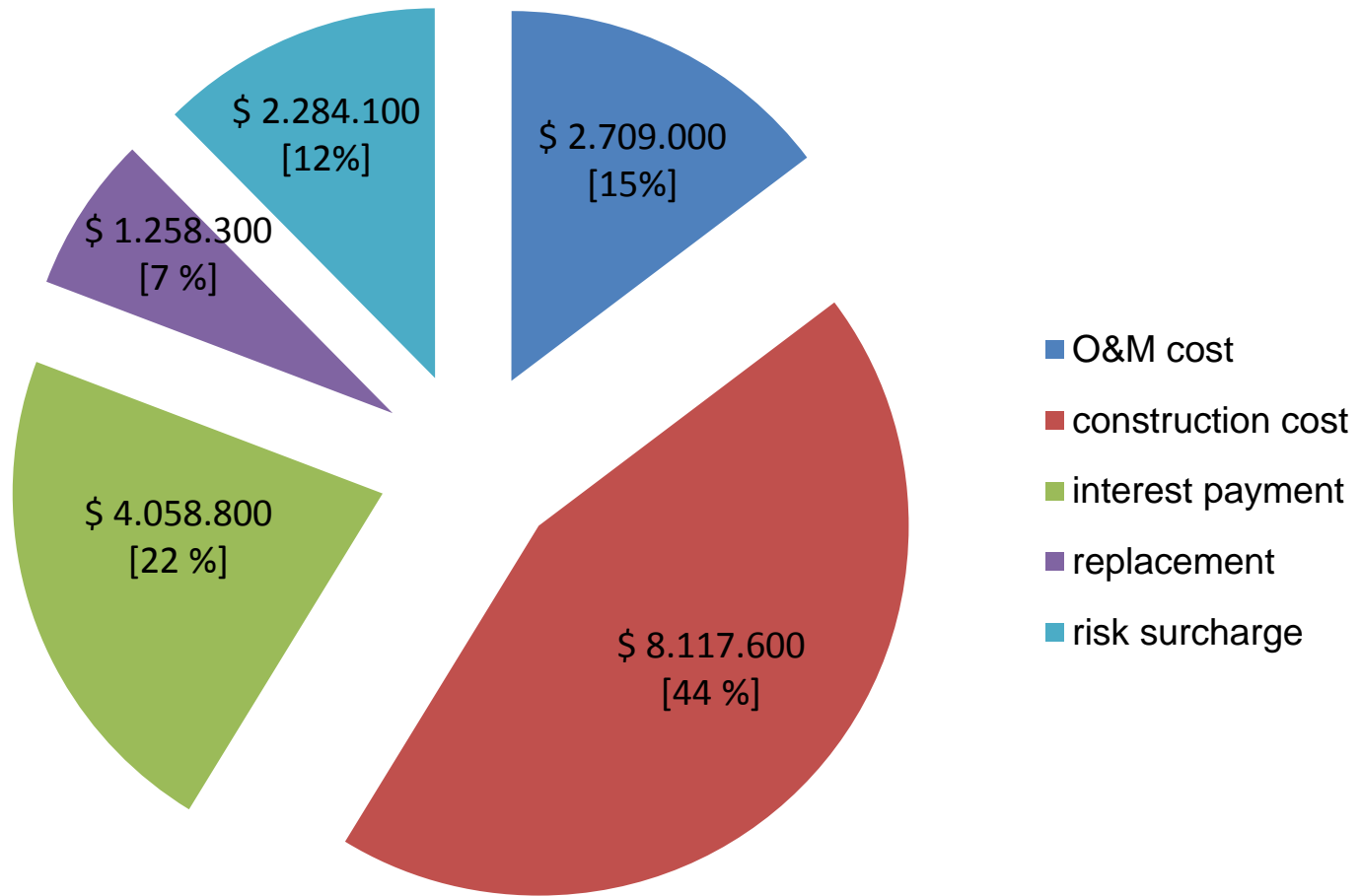
ESTIMATE AND TARGET VALUE - SUMMARY

	ESTIMATED VALUE	TARGET VALUE	VALUE DELTA
TOTAL	\$ 8 117 564	\$ 8 400 000	\$ 282 436
A Substructure	\$ 480 602	\$ 865 291	\$ 384 689
B Shell	\$ 2 238 629	\$ 2 005 911	\$ (232 718)
C Interiors	\$ 643 335	\$ 785 491	\$ 142 157
D Services	\$ 3 134 861	\$ 2 362 728	\$ (772 133)
E Specialty Construction	\$ 772 469	\$ 853 376	\$ 80 907
F Building Sitework	\$ 253 930	\$ 326 641	\$ 72 711
G General Conditions	\$ 593 737	\$ 1 200 561	\$ 606 824



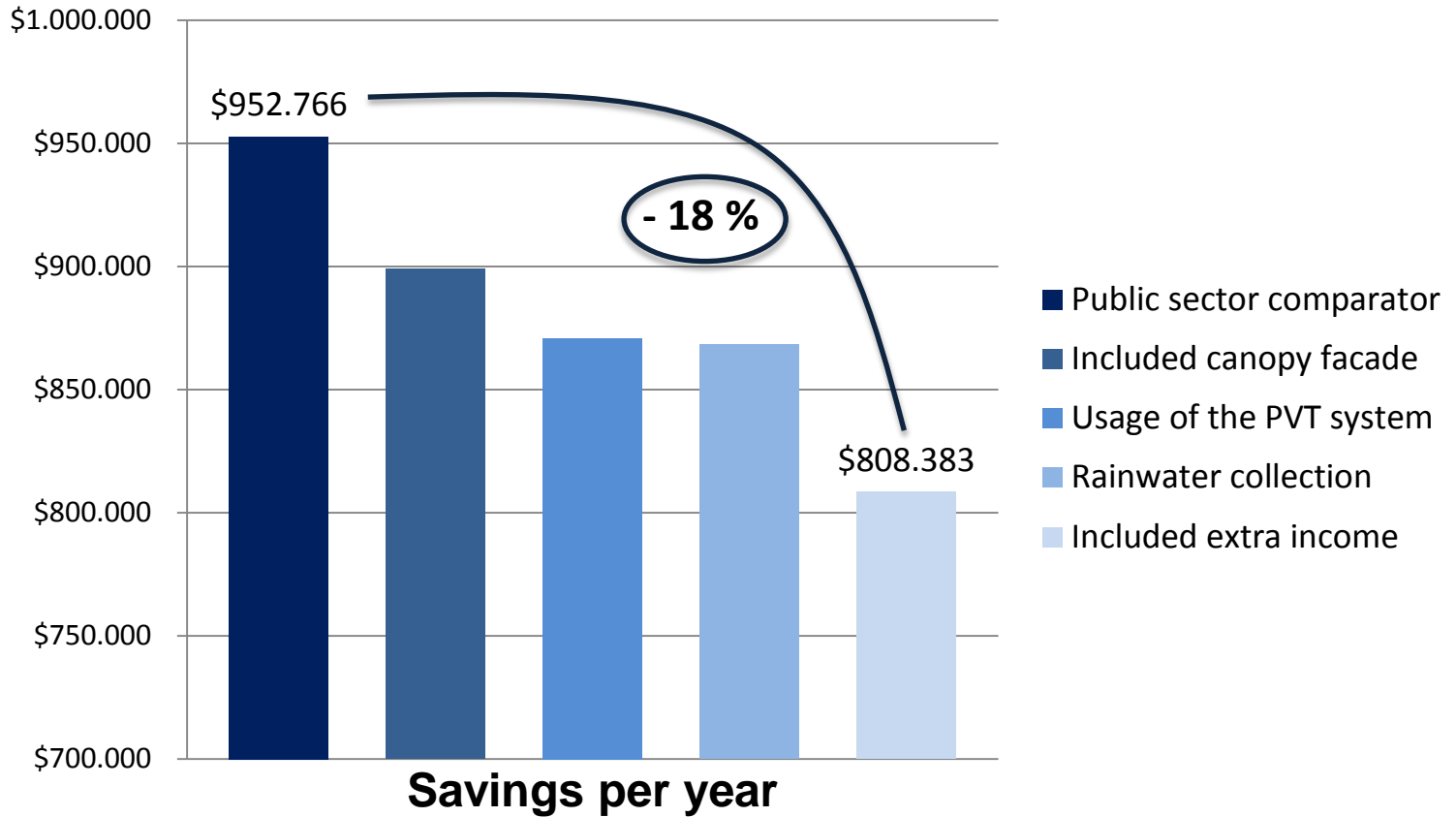
SUSTAINABILITY

ACCUMULATED LIFE CYCLE COSTS



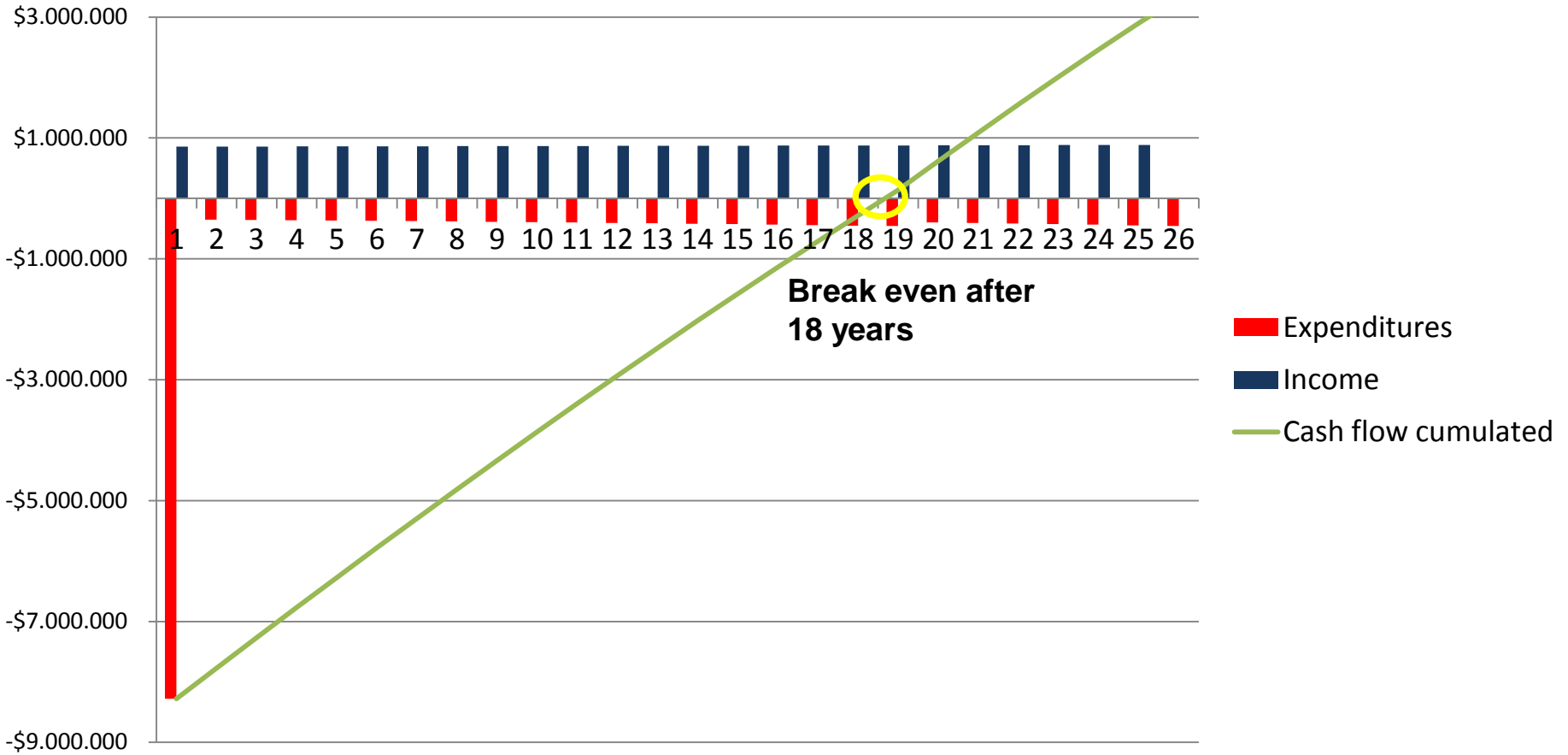
SUSTAINABILITY

RENT DEVELOPMENT



SUSTAINABILITY

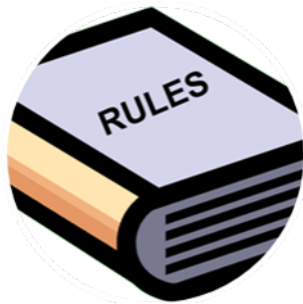
ACCUMULATED CASH FLOW



SUSTAINABILITY

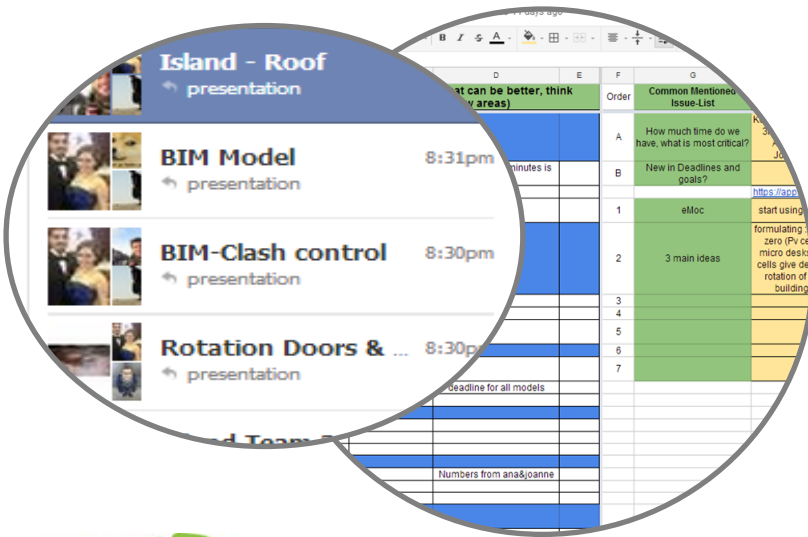


TEAM PROCESS



Establishing team rules

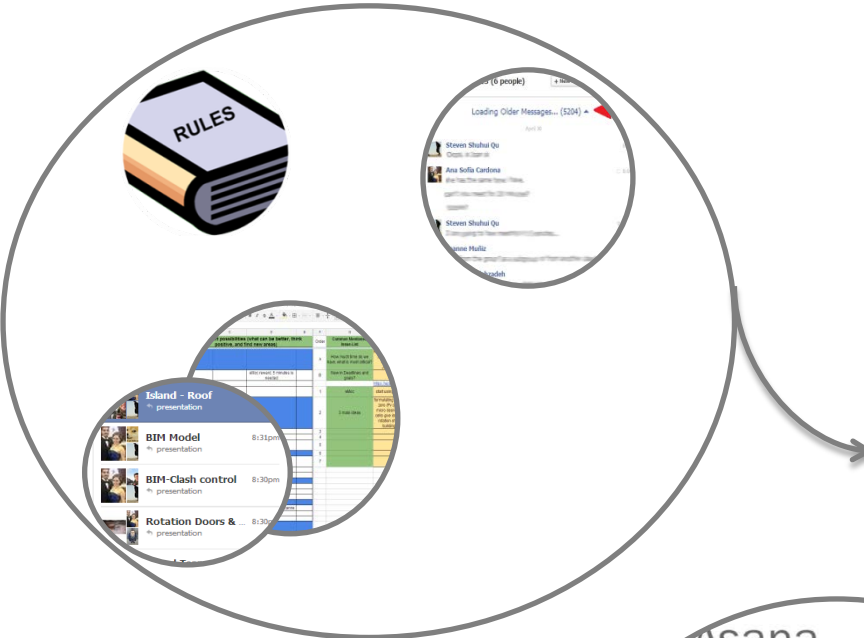
Communication Challenge



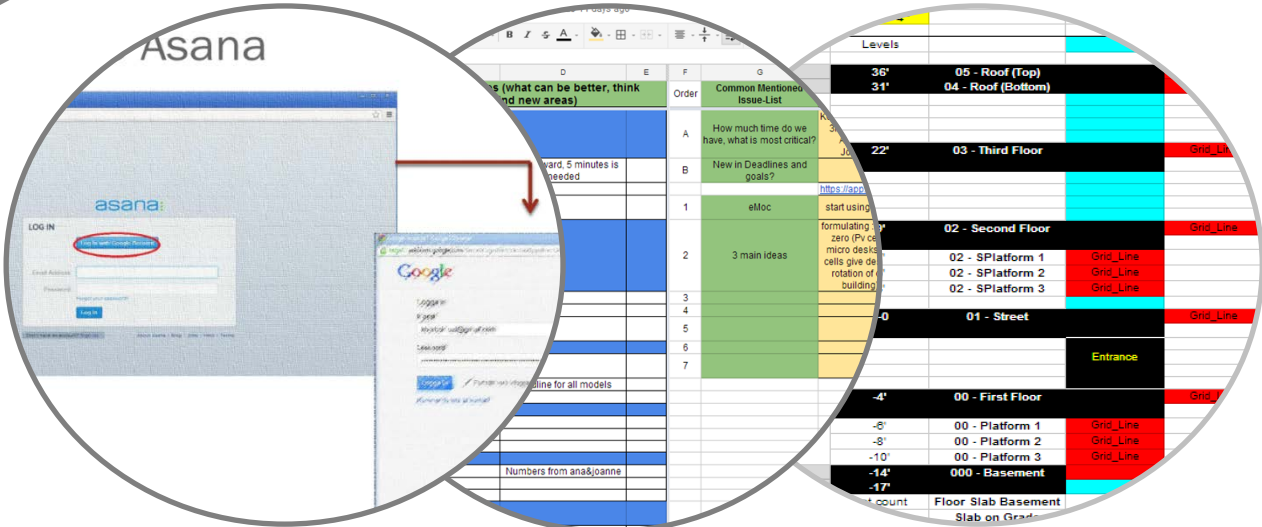
Decision-making Challenge



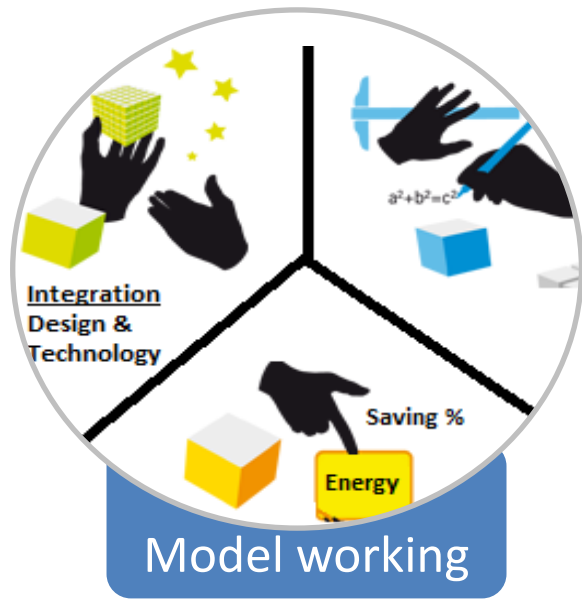
TEAM PROCESS



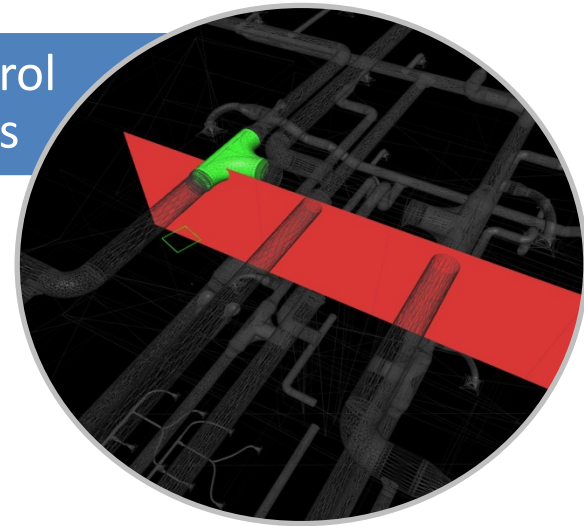
Visual decision making



BIM COORDINATION



Clash control
Navisworks



Step 2

Step 1

Levels			
top	36'	05 - Roof (Top)	
bottom	31'	04 - Roof (Bottom)	
Level 3			
top	22'	03 - Third Floor	Grid Line
bottom			
Level 2			
top	9'	02 - Second Floor	Grid Line
bottom			
top	7'	02 - SPlatform 1	Grid Line
Street Level	5'	02 - SPlatform 2	Grid Line
bottom	3'	02 - SPlatform 3	Grid Line
top	0-0	01 - Street	Grid Line
bottom			
Level 1			
top	-4'	00 - First Floor	Grid Line
bottom			
top	-6'	00 - Platform 1	Grid Line
bottom	-8'	00 - Platform 2	Grid Line
top	-10'	00 - Platform 3	Grid Line
bottom	-14'	000 - Basement	
top	-17'		
bottom			
Account		Floor Slab Basement	
		Slab on Grad	

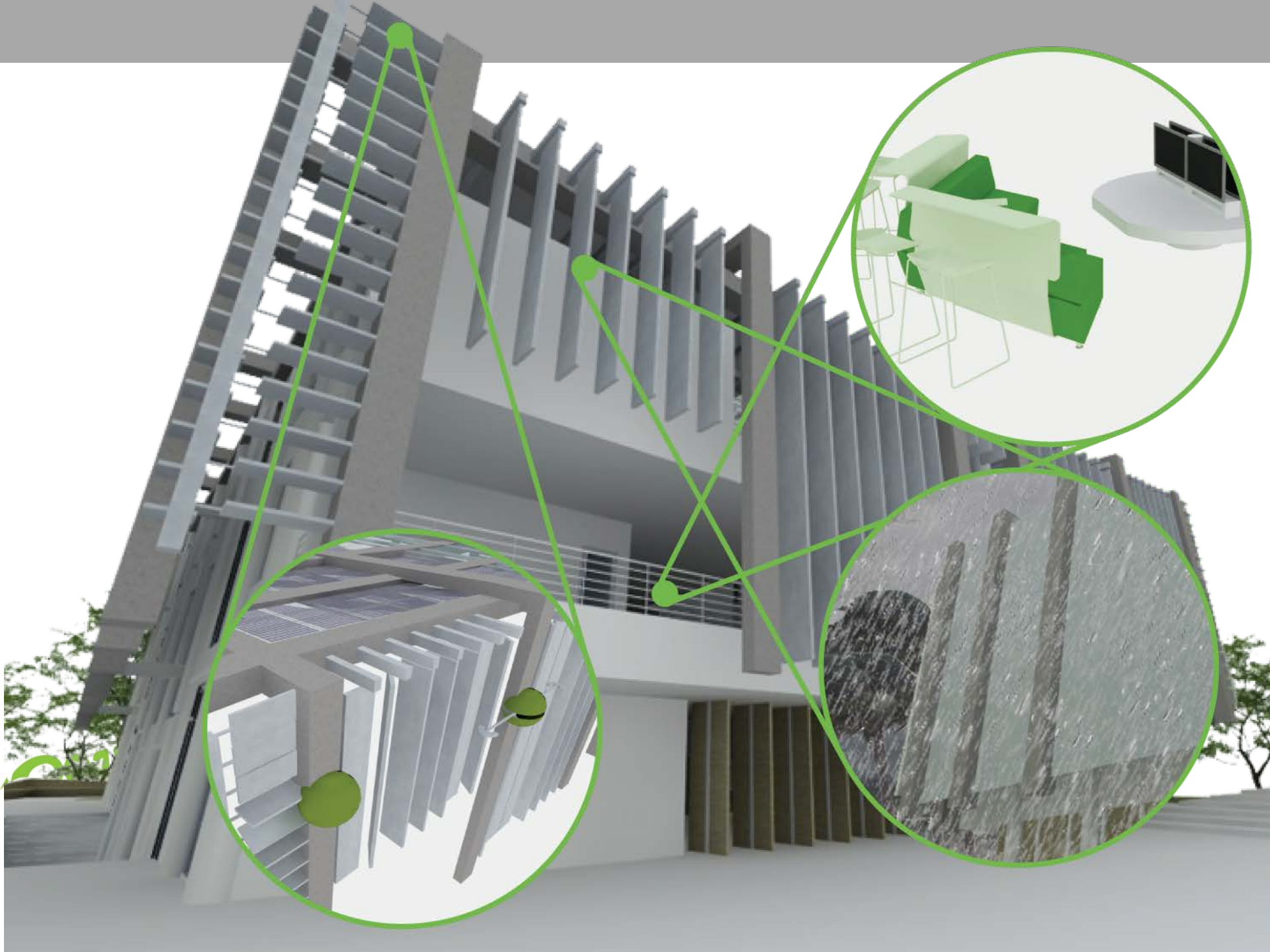
Establishing
Visual BIM-rules
[Grid & software]



VALUE FOR MONEY

Environmental	Economical	Social
<ul style="list-style-type: none">• LEED Gold certification• Low environmental impact• Passive and active energy saving strategies	<ul style="list-style-type: none">• Energy savings of 60 %• External rent of auditoriums and classrooms• Robots clean windows and PVT panels	<ul style="list-style-type: none">• Creation of open and collaborative space• Creation of the first educational net zero building in Puerto Rico as an icon





"2+2+1+1+1 > 7"
Steven, Stanford

"Ett nej är aldrig ett nej,
med tiden förändras allt!"
Kourosh, KTH

"Inhala paz, exhala
ansiedad"
Joanne, UPR

"ALLES diskutieren"
Felix, Bauhaus

"Cultura es mas que
nacionalidad"
Ana Sofía, UPR

"Pak jullie hamers
eigen sloep si silo"
Reinier, DTU

"我們會走得更遠"
Alan, Stanford



"2+2+1+1+1 > 7"
Steven, Stanford

"With time NO becomes YES"
Kourosh, KTH

"Breathe in breathe out"
Joanne, UPR

"Discuss EVERYTHING"
Felix, Bauhaus

"Culture is more than
nationality"
Ana Sofia, UPR

"Grab your hammers and
break down that silo"
Reinier, DTU

"This team goes further"
Alan, Stanford





GITTE SORENSEN

ANJA JUTRAZ

LUIS RIVERA

HUMBERTO CAVALLIN

BJÖRN WÜNDSCHE

HOSS NASSERI

EDUARDO MIRANDA

DAVID BENDET

RENATA ABMA

FREDRIK WINCENT

NIMA ASSADI

HENRY TOORYAN

AGNES BOREN

KYLE ADAMS

RENATE FRUCHTER

ALIAA EDDNAN HUSEIN

GREG LUTH

JOHN NELSON

WILLEM KYMELL

FERNANDO CASTILLO COHEN

MILOS TODOROVIC