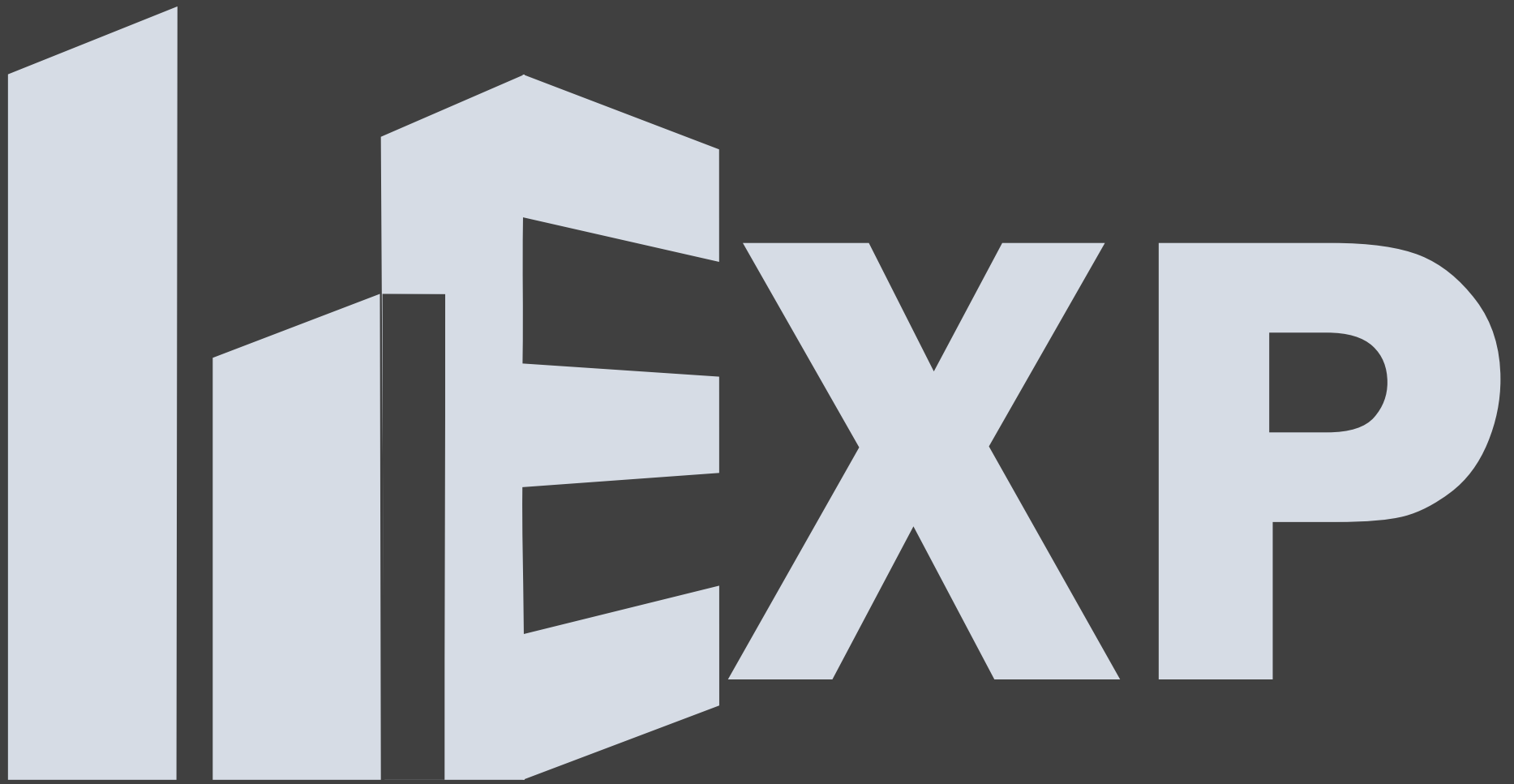
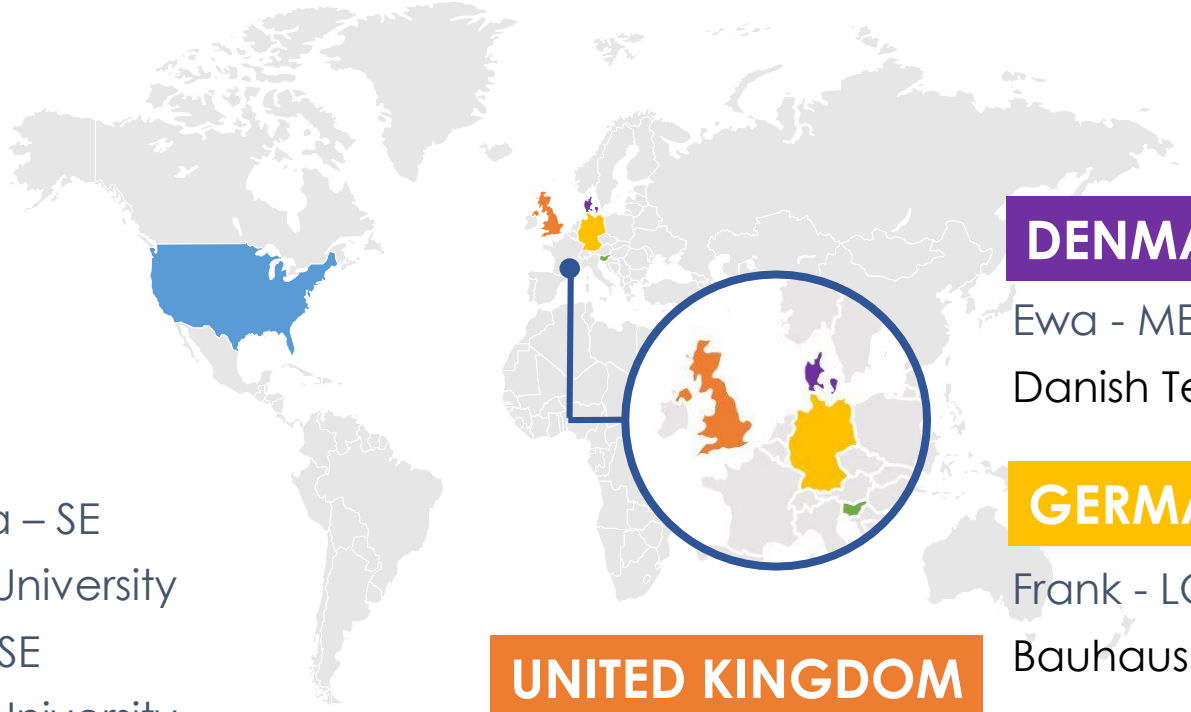

IEXP

RESS


EXPRESS

Team Map



USA

- Aleshia – SE

Stanford University

- Ying – SE

Stanford University

- Elisa – CM

University of Wisconsin-Madison

UNITED KINGDOM

Sam – CM

Loughborough University

DENMARK

Ewa - MEP

Danish Technical University

GERMANY

Frank - LCFM

Bauhaus University Weimar

SLOVENIA

Rok – Arch

University of Ljubljana

Team

A

Rok
University of Ljubljana
Slovenia

SE

Ying
Stanford University
USA

SE

Aleshia
Stanford University
USA

MEP

Ewa
Danish Technical Univesity
Denmark

CM

Samer
Loughborough University
UK

CM

Elisa
University of Wisconsin-Madison
USA

LCFM

Frank
Bauhaus University Weimar
Germany

Owners

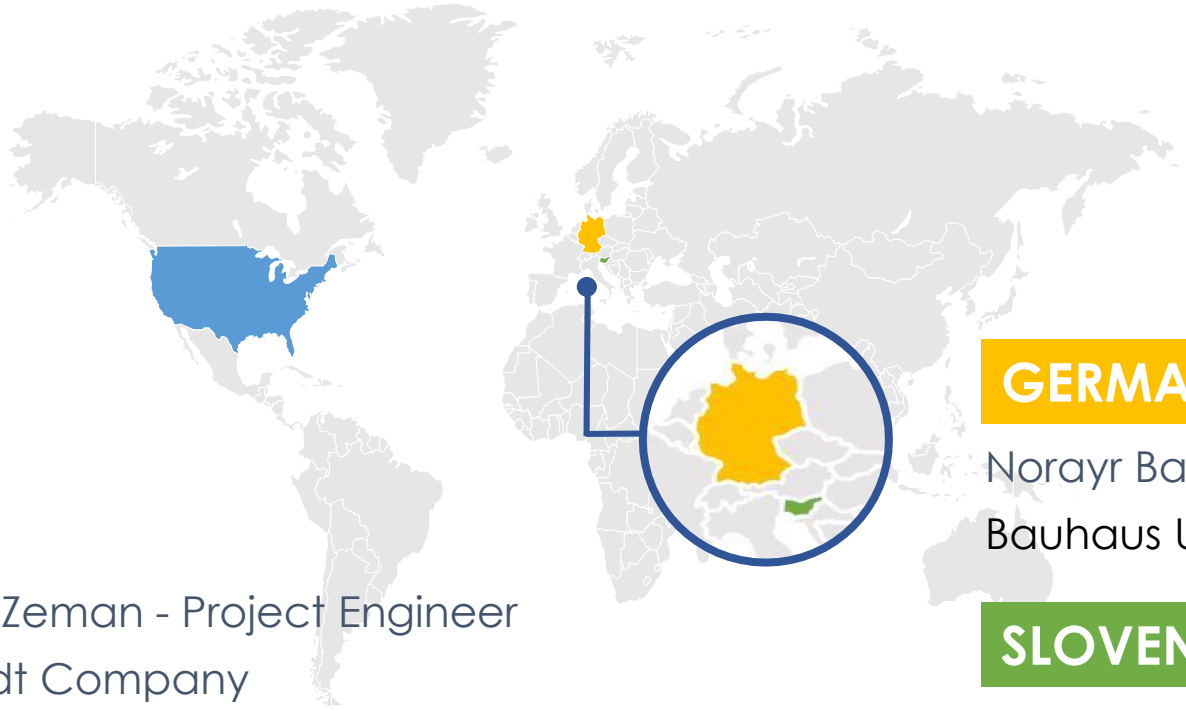
Anja Jutraž
Architect
University of Ljubljana
Slovenia

Norayr Badasyan
Research Asociate
Bauhaus University Weimar
Germany

Michael Seaman
Project Engineer
Walt Disney Imagineering
USA

Nick Zeman
Project Engineer
The Boldt Company
USA

Owner Map



USA

- Nick Zeman - Project Engineer

The Boldt Company

- Michael Seaman - Project Engineer

Walt Disney Imagineering

GERMANY

Norayr Badasyan - LCFM

Bauhaus University Weimar

SLOVENIA

Anja Jutraž – Architect
University of Ljubljana


EXPRESS

Ljubljana

Capital city of Slovenia

300,000 inhabitants

50,000 students

Green capital of Europe 2016

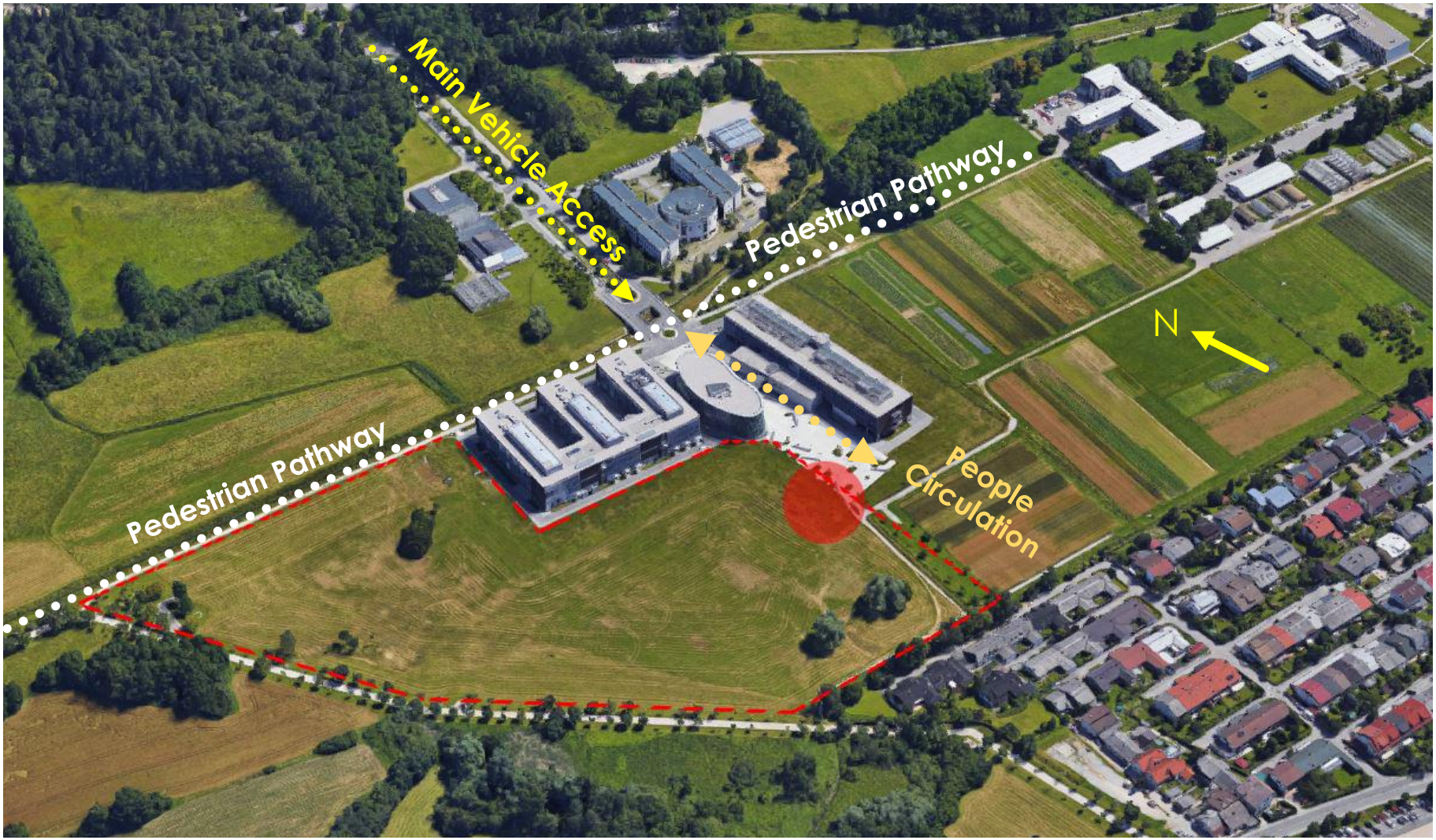
People-friendly city

Walking distances

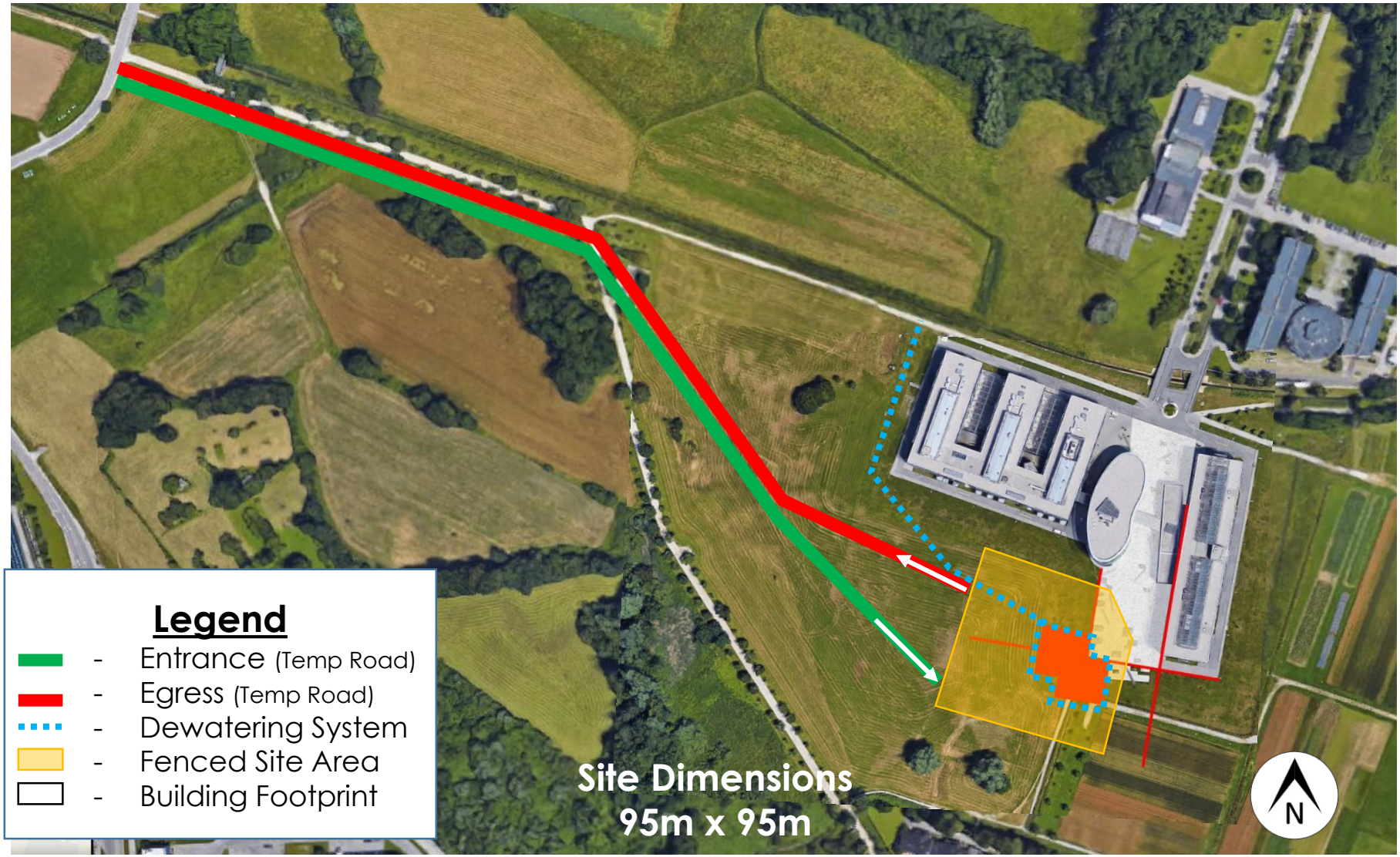
Location


Rožnik Hill
Express
3.0 km / 1.86 mi
City Center
Ljubljana Castle

Site Analysis

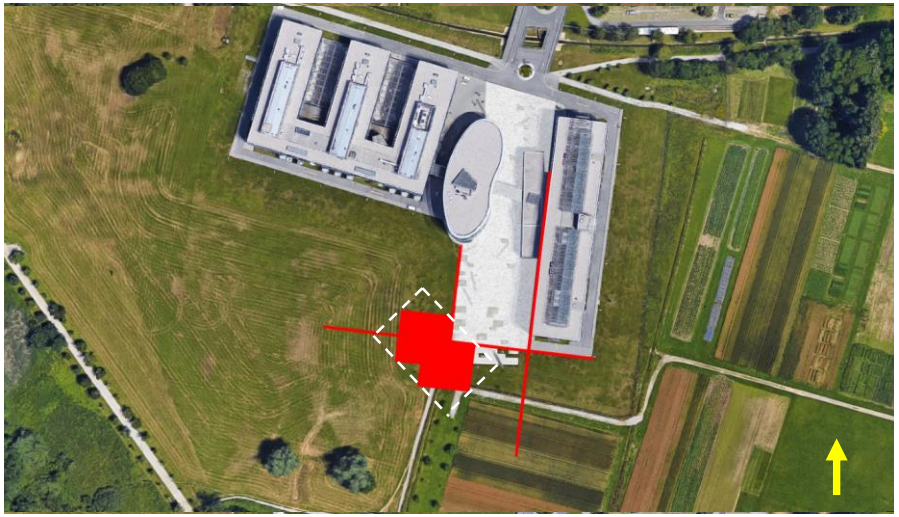


Site Plan Overview

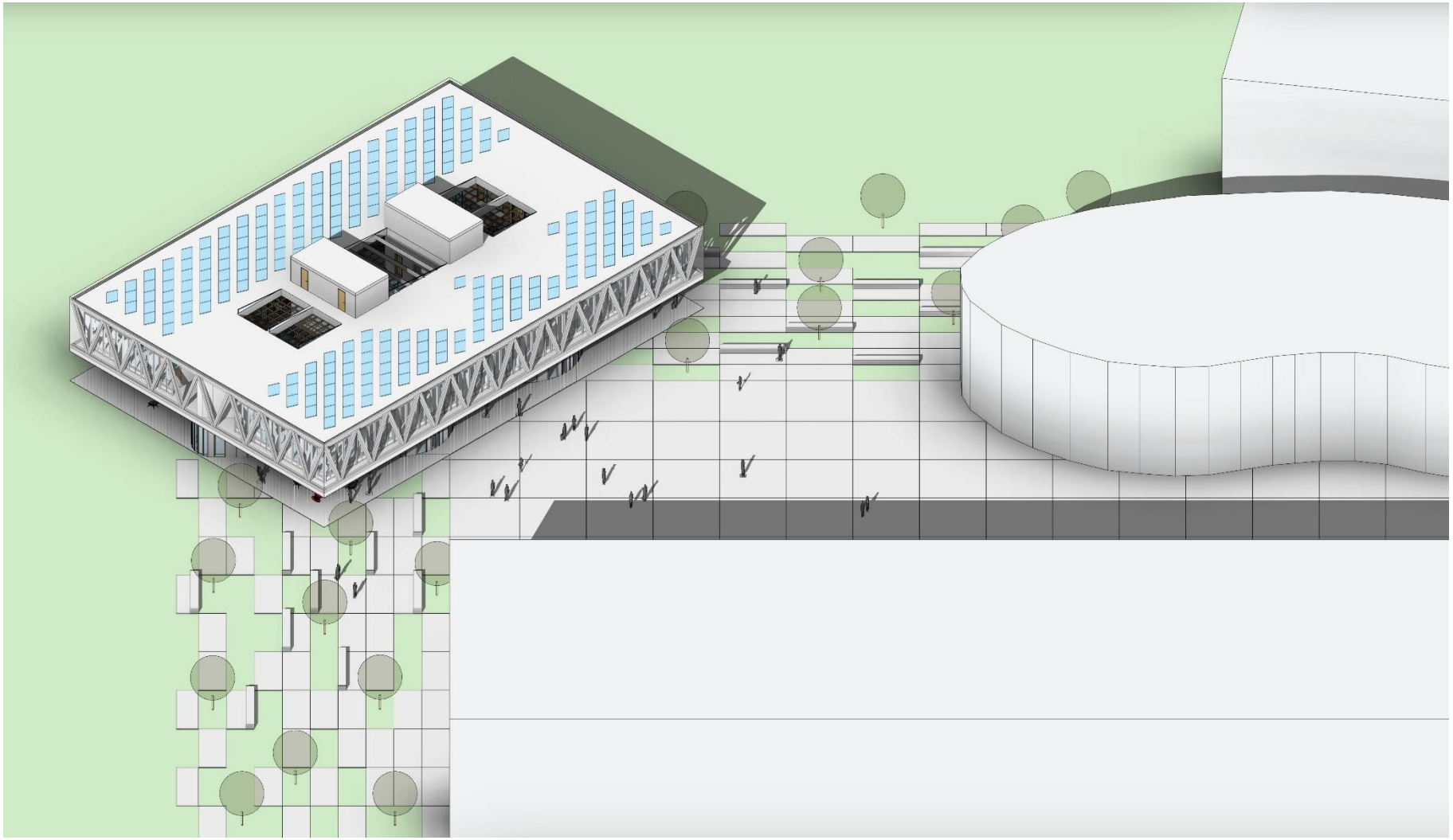


Building Placement

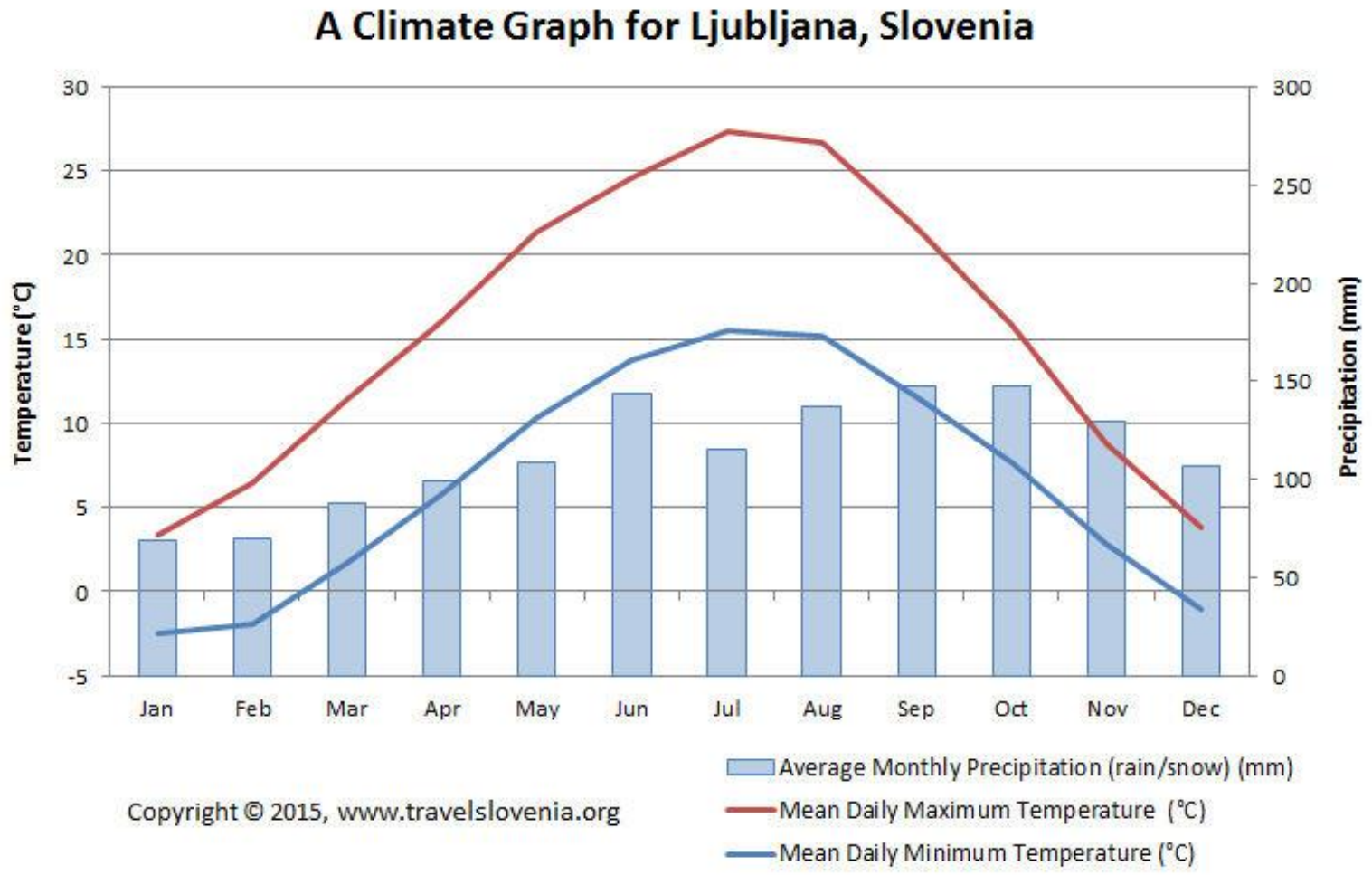
- Connection with the existing faculties
- Alignment with existing footprints
- Forming an entrance square
- Closing the SW corner



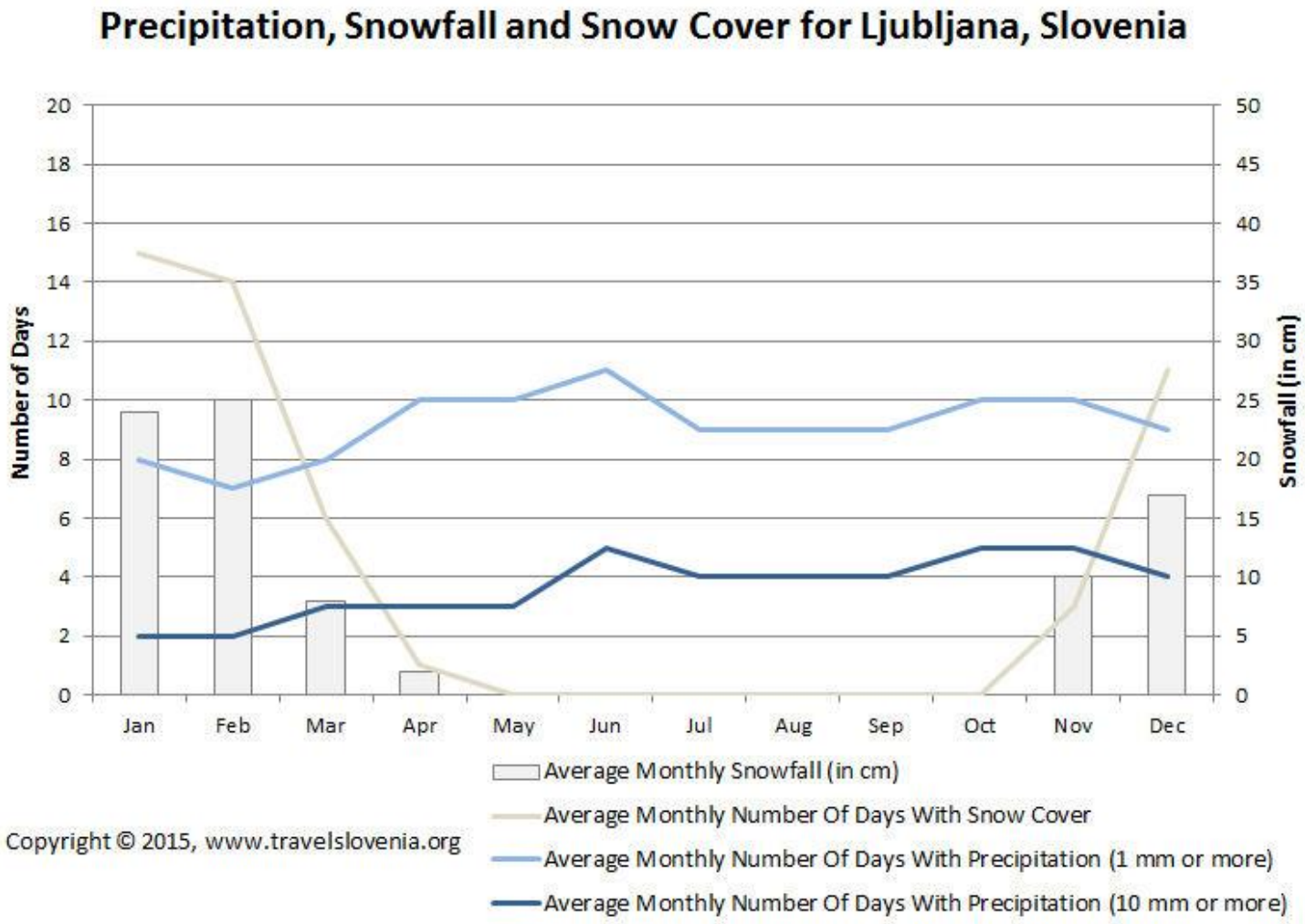
Aerial View



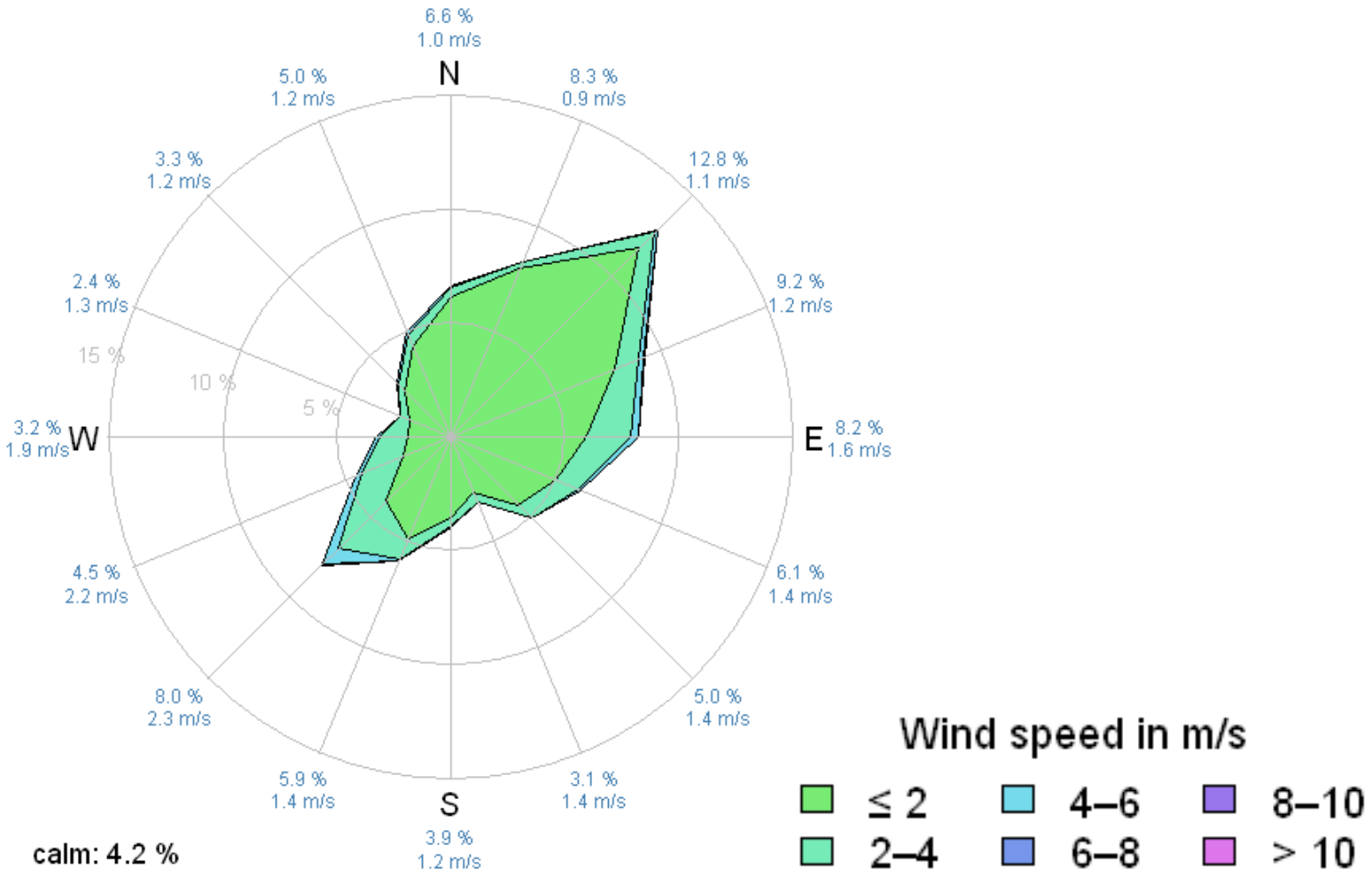
Temperature



Precipitation



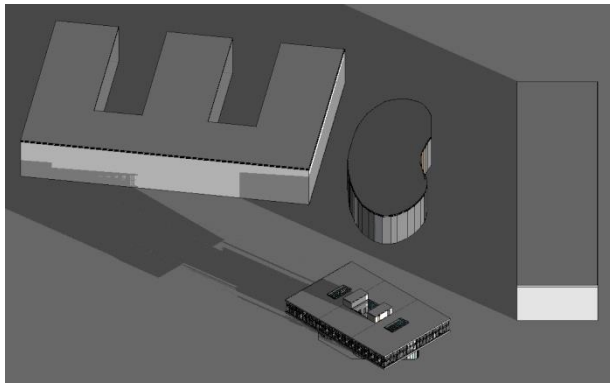
Wind


6.6 %
1.0 m/s
N
8.3 %
0.9 m/s
12.8 %
1.1 m/s
9.2 %
1.2 m/s
E
8.2 %
1.6 m/s
6.1 %
1.4 m/s
5.0 %
1.4 m/s
3.1 %
1.4 m/s
S
3.9 %
1.2 m/s
5.9 %
1.4 m/s
8.0 %
2.3 m/s
4.5 %
2.2 m/s
W
3.2 %
1.9 m/s
2.4 %
1.3 m/s
3.3 %
1.2 m/s
5.0 %
1.2 m/s
15 %
10 %
5 %
calm: 4.2 %
Wind speed in m/s
≤ 2
2–4
4–6
6–8
8–10
> 10

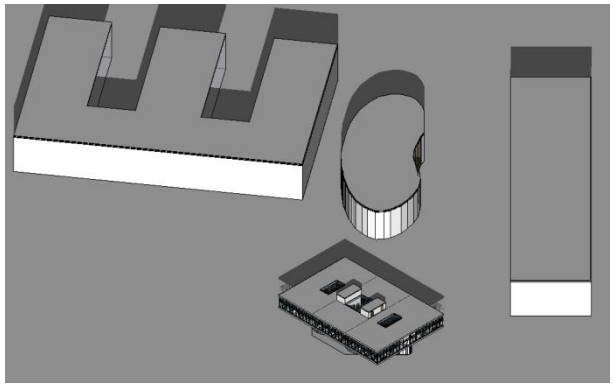
Sun Path and Shadows

1974 h of Sunshine → **No shadows** → **PV Potential**

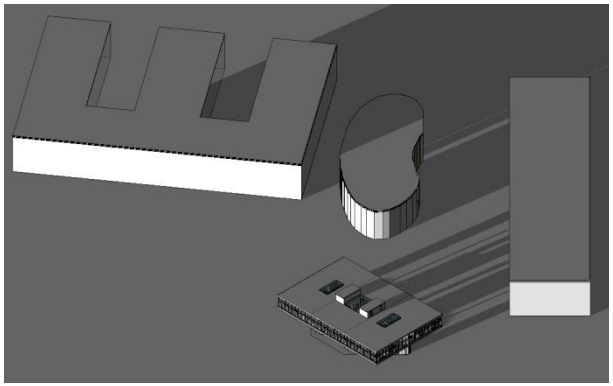
Sunrise



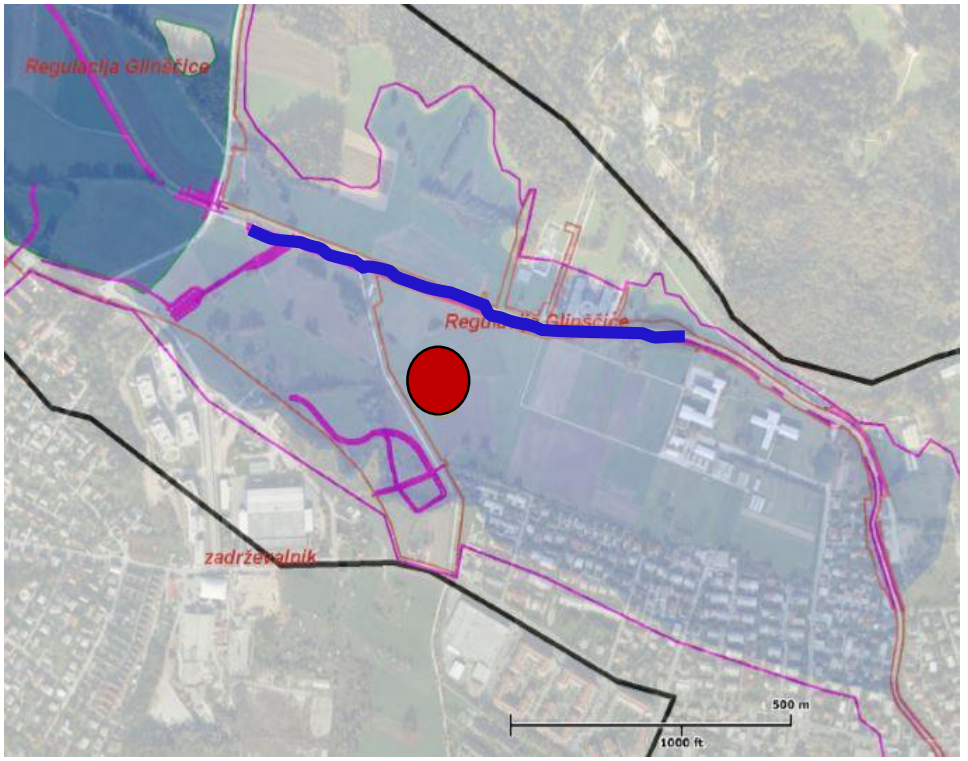
Noon



Sunset



High Water Table



Challenge

High water level: -1.5 m

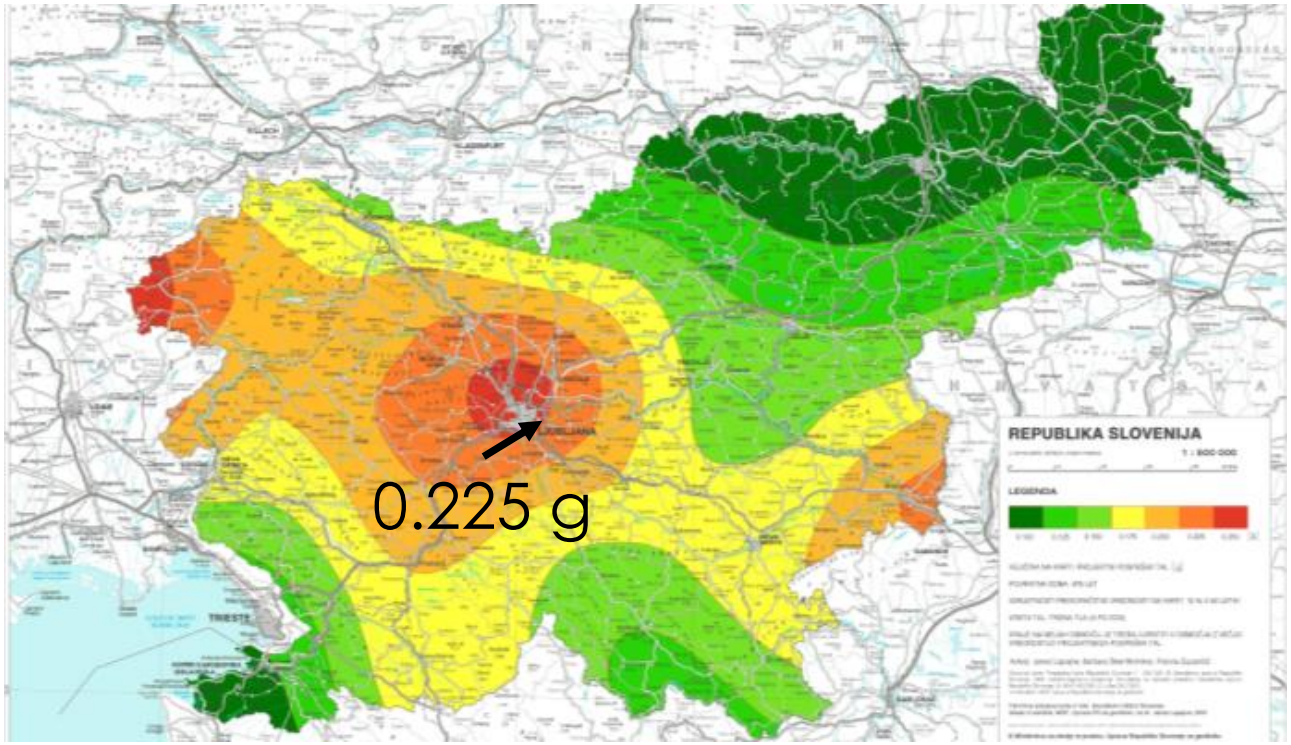
Flood Zone

Risk Mitigation

Raise critical program above ground

- Moderate Flood Risk
- Low Flood Risk
- Not in Flood Zone

Earthquakes



Challenge

Seismic zone

Risk Mitigation

Design strong, but ductile lateral system


E


C


ND


UST


RY

Ecosphere

ec · o · sphere

/'ēkō ˌsfēr/

noun

The biosphere of the earth, or another planet, especially when the interaction between the living and non-living components is emphasized.


ECO

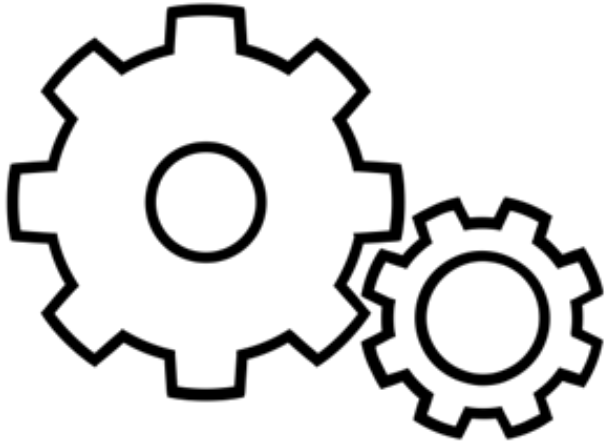

NDUSTRY

Industry

in · dus · try

/’indəstrē/

noun



Systematic labor, especially for some useful purpose or the creation of something of value

Space Efficiency

"Rethink space and let the transformation begin!"

Adhamina C. Rodriguez, Sustainability Challenge 2017

Common Definition:

The smallest possible amount of space needed for the building program to function.

Space efficiency = Program area / Gross floor area

Space Efficiency

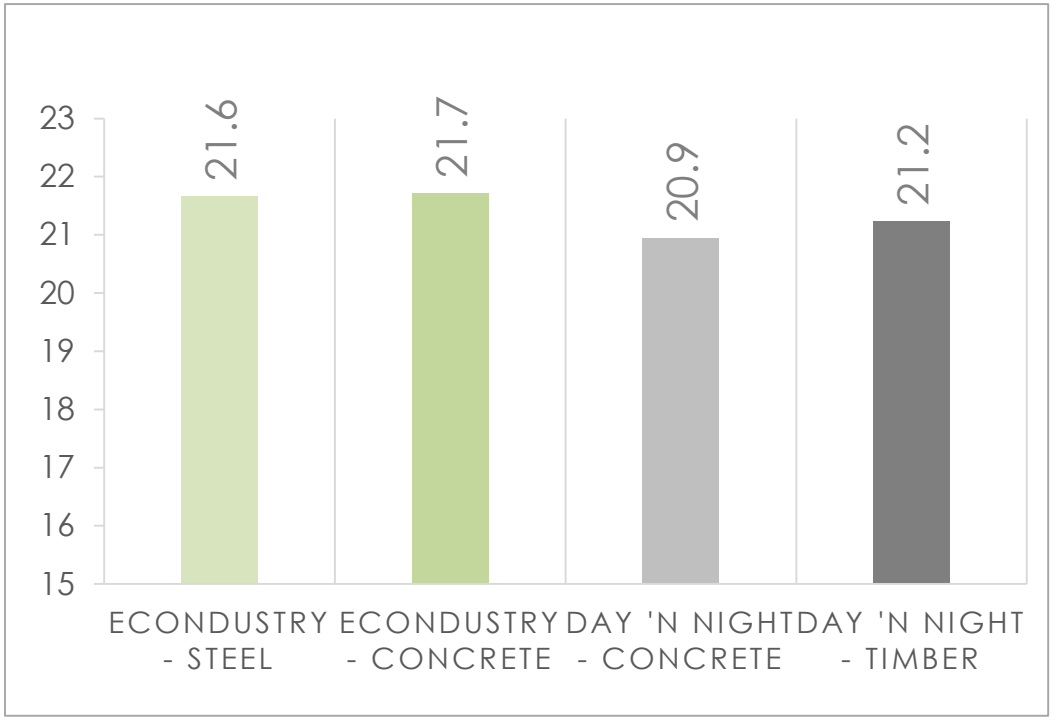
Team Definition:

Team Express defines a space efficient building as one which offers the flexibility to adapt to and interact with changing user requirements in a digital society on a day-to-day, as well as long-term, basis.

Econdustry

Decision Matrix

CATEGORY	CRITERIA
GENERAL	Robustness of BIG Idea
ECONOMIC	Life-Cycle-Cost
ECONOMIC	Construction Cost
ECONOMIC	Annual rent
ECONOMIC	Level of EQ Risk Impact
ECONOMIC	Level of Flood Risk Impact
ECONOMIC	Space efficiency
ECONOMIC	Prefabrication
ECOLOGIC	User comfort
ECOLOGIC	Water consumption
ECOLOGIC	Energy demand
ECOLOGIC	Energy production
ECOLOGIC	Carbon Footprint
ECOLOGIC	Source of material
ECOLOGIC	Design2disassembly
SOCIAL	Architectural Integration
SOCIAL	Daylight
SOCIAL	Appeal
SOCIAL	Space & Circulation
SOCIAL	Stress Reduction
INDIVIDUAL WEIGHTED SCORE	



Options Comparison

			Econdustry 1	**Econdustry 2**	Day n' Night 1	Day n' Night 2
Structure			Steel & concrete	Concrete	Concrete	Timber
MEP System			Air-Air Heat Pump	Water-Air Heat Pump	Mechanical Ventilation	Natural Ventilation
Energy Demand		[kWh/m^2]	39	39	40	41
Heating Load		[kWh/m^2]	4.66	4.80	4.95	4.87
Cooling Load		[kWh/m^2]	6.64	5.52	4.87	5.79
STV	CO_2	[%]	96	91	68	65
	Energy	[%]	63	60	48	47
Energy	PV Facade	[m^2]	1103		756	
	PV Roof	[m^2]	1498		1281	
Water	Collection	[m^3/y]	2087		1784	

The Fusion

"…the selection of one of these designs does not lock you in to use all aspects of that option, most of the time the best design is a compromise of all four."

Nick Zeman, Owner Team Express

"While you will be choosing one of these four options to proceed with the next quarter, you still have a whole quarter of development to go, which is a great opportunity to bring in your favorite and the most innovative aspects of each of these four options into your final design."

Michael Seaman, Owner Team Express

The Fusion

"ECONDUSTRY"

- Flexibility
- Program distribution
- MEP System

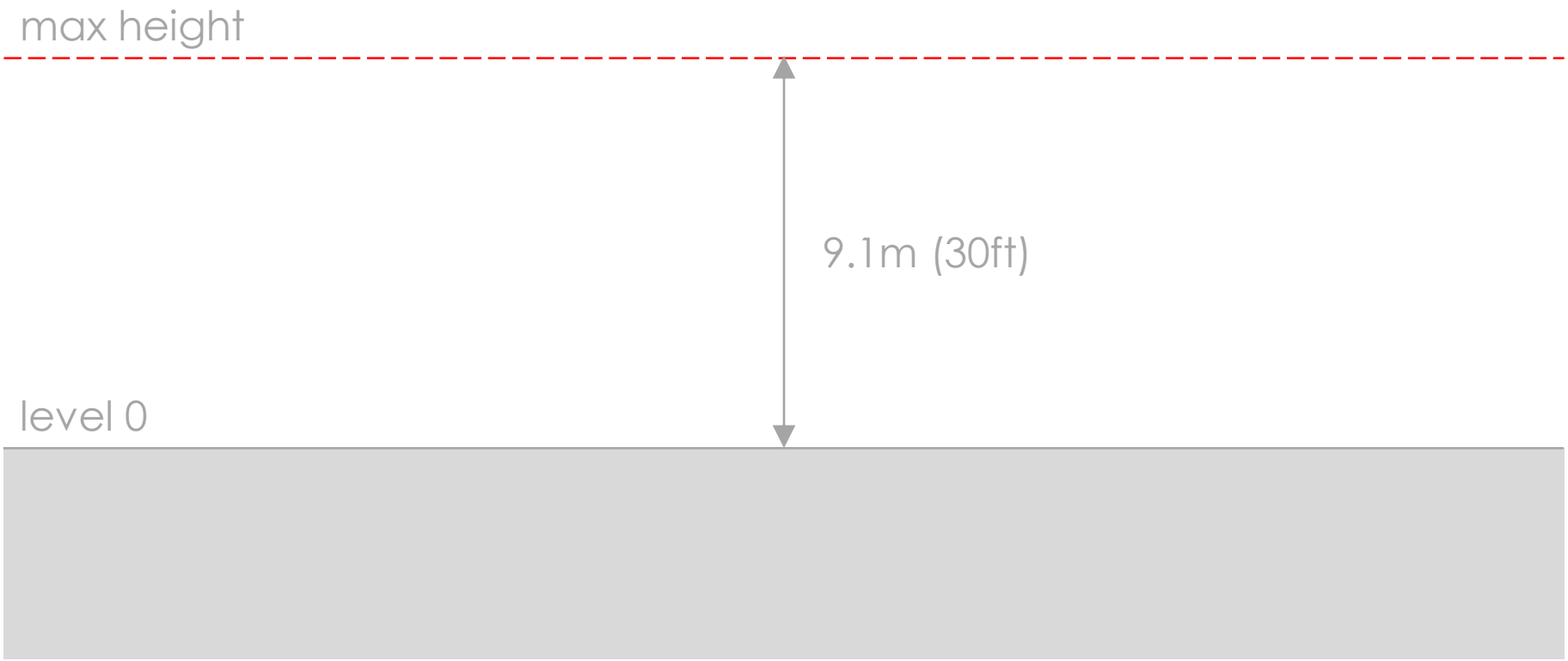
"DAY 'N NIGHT"

- Exterior shading
- Additional Skylights
- Natural Ventilation

THE FINAL PROJECT

Day N' Night

Max Height



Max Height

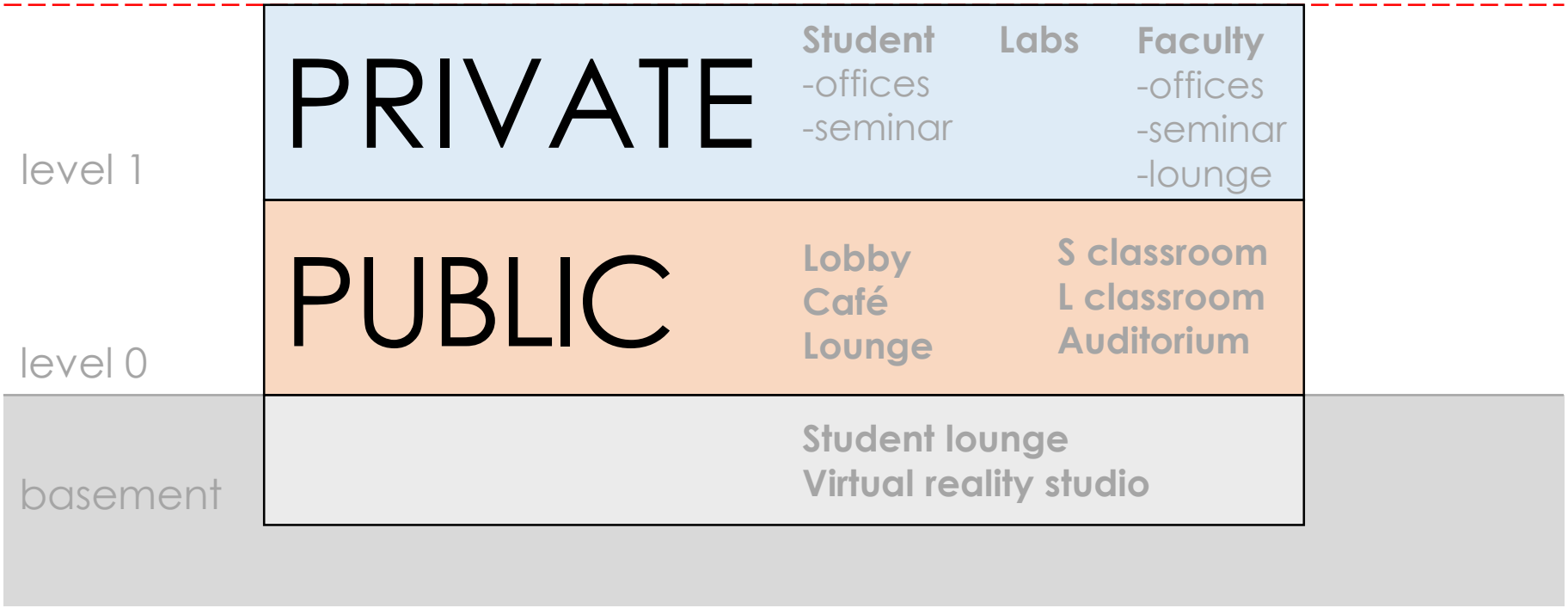
3 stories above level 0:
Floor height (together with floor slab): 3.0m

Max Height

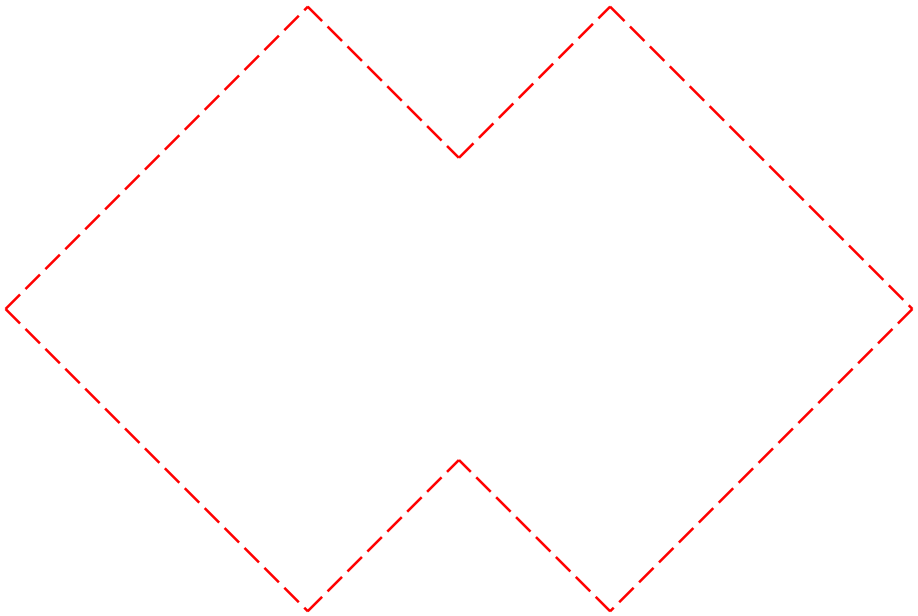
2 stories above level 0:
Floor height (together with floor slab): 4.5m

Max Height

Clear **PUBLIC/PRIVATE** division

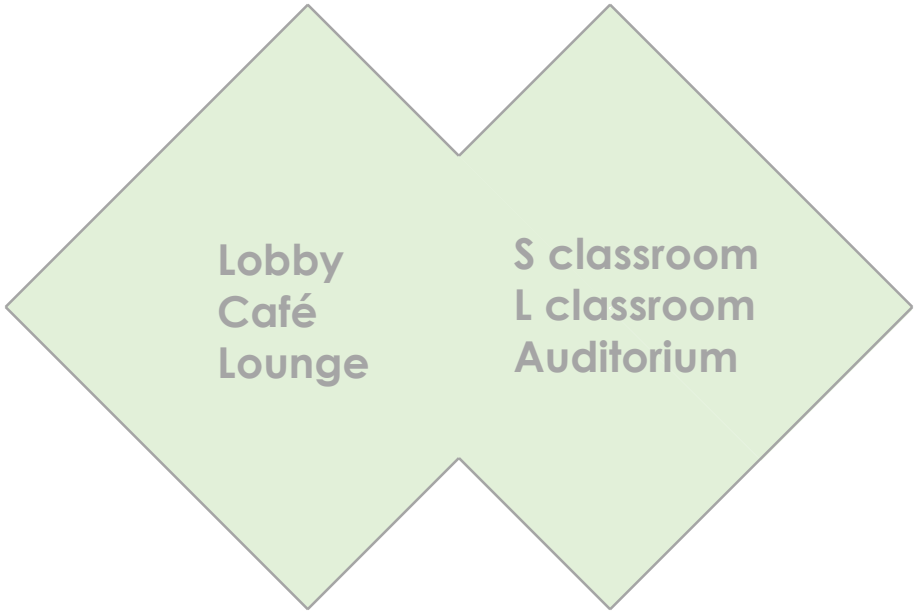


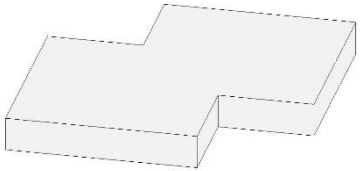
Footprint



level 0

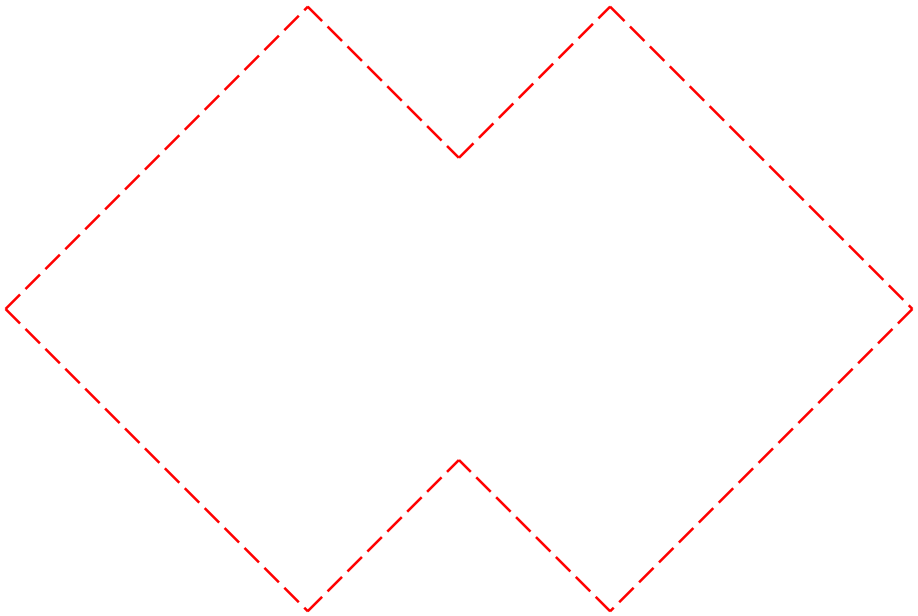
Footprint





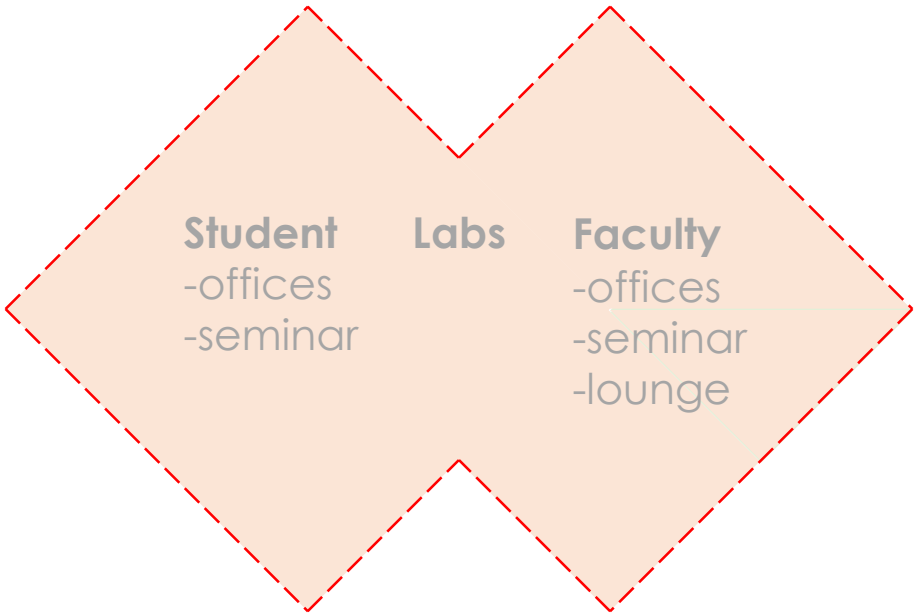
level 0

Footprint



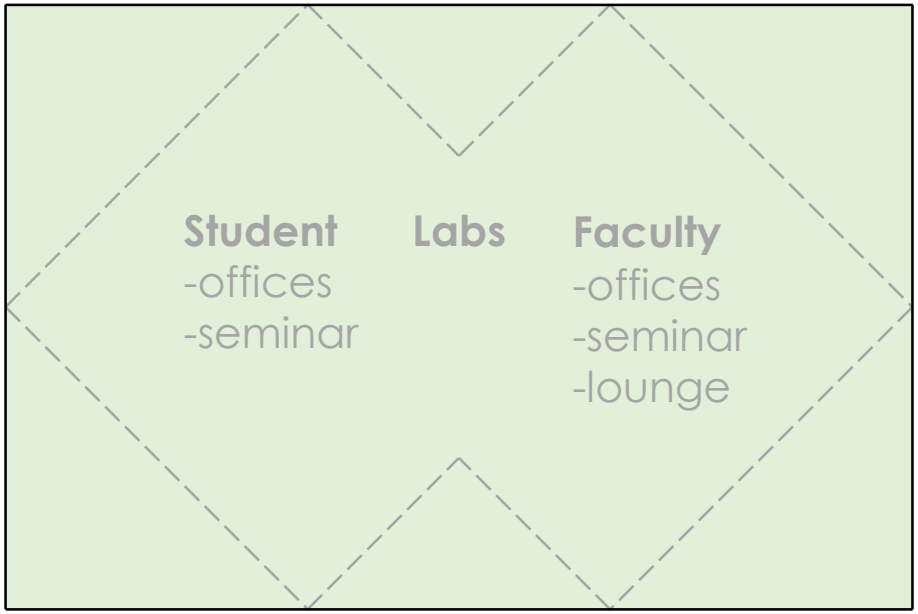
level 1

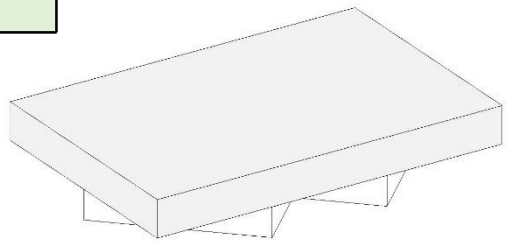
Footprint



level 1

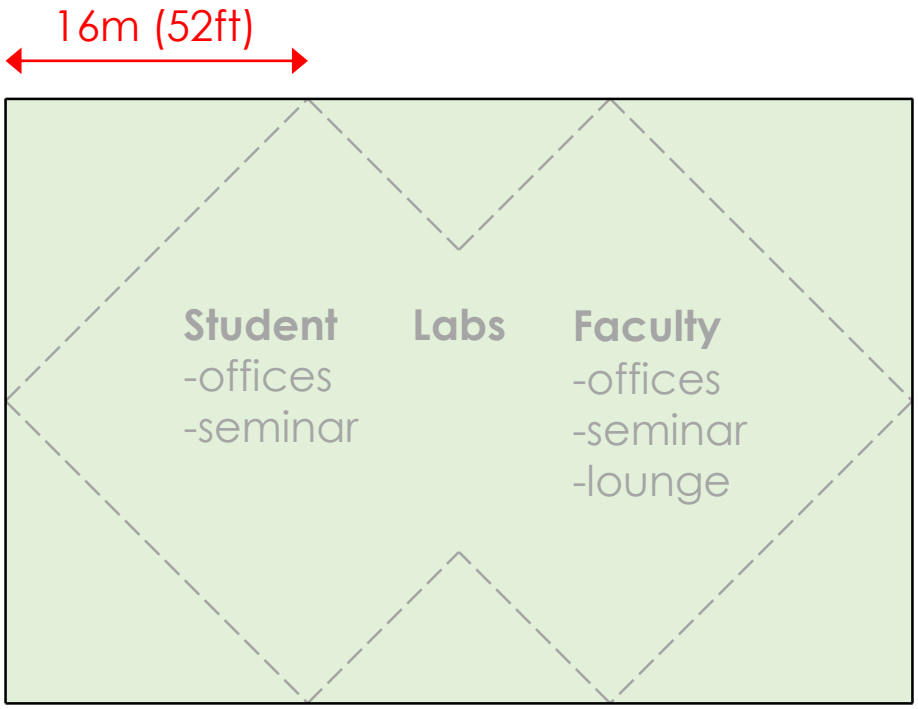
Footprint

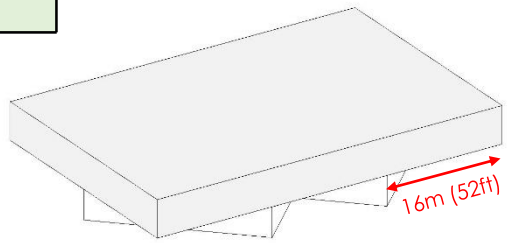




level 1

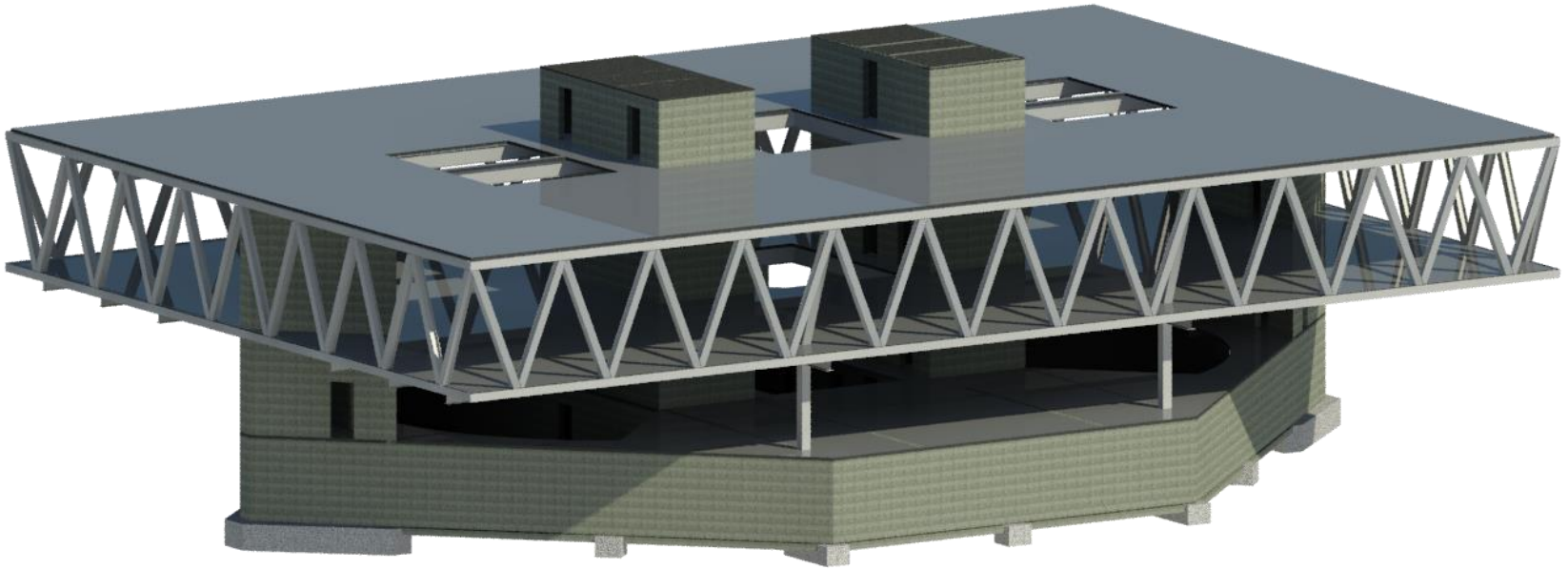
Footprint





level 1

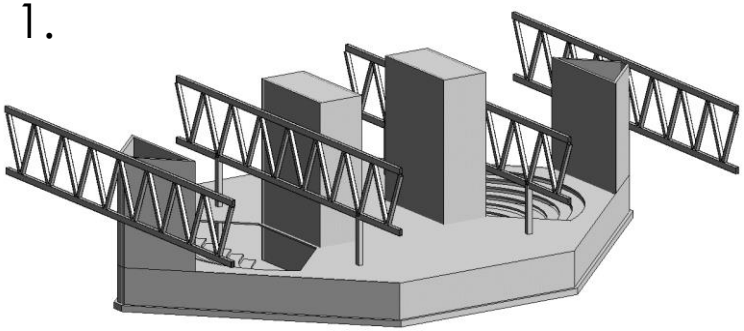
Structural



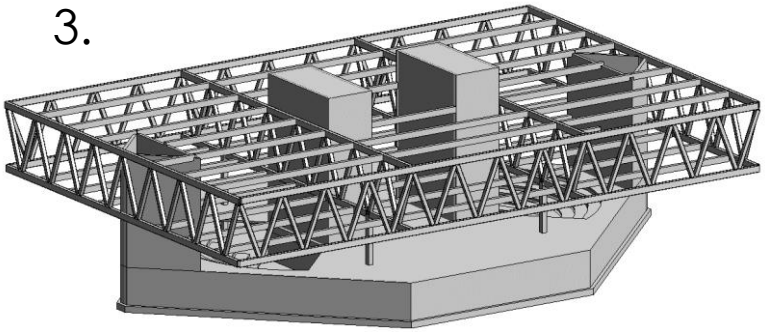
Cantilever Evolution

Winter Design

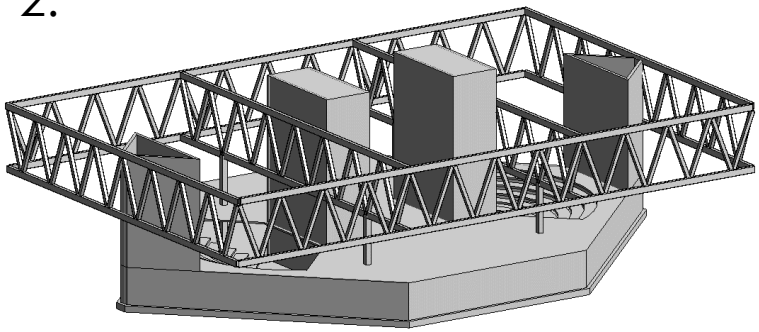
1.



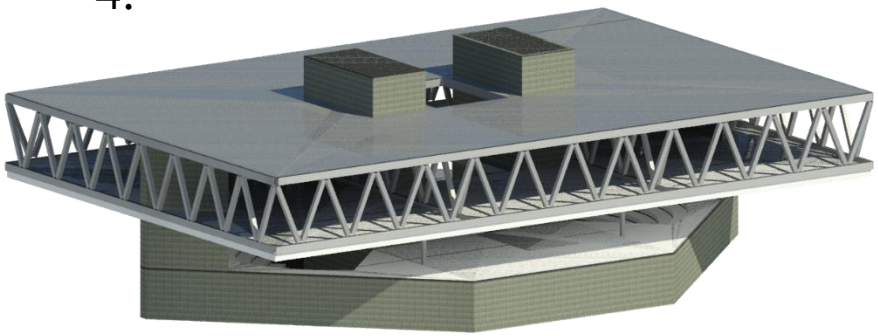
3.



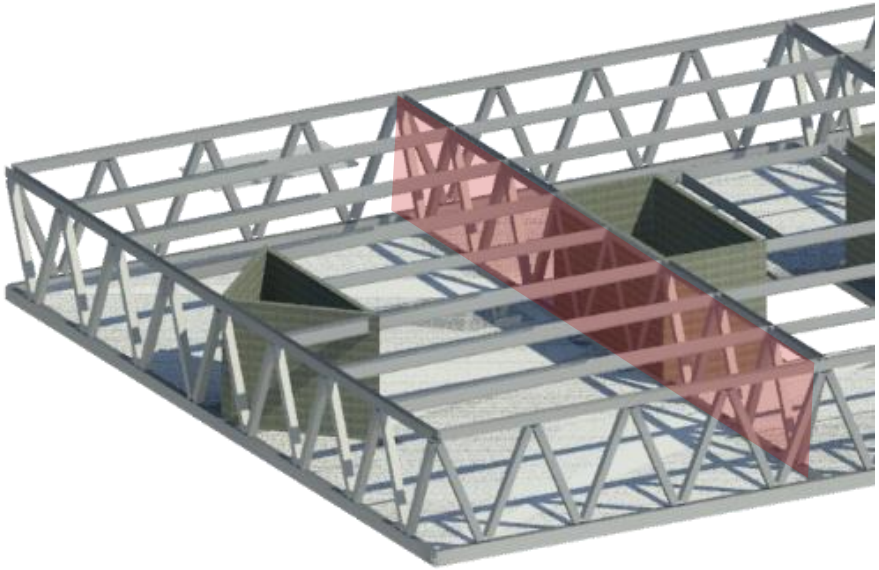
2.



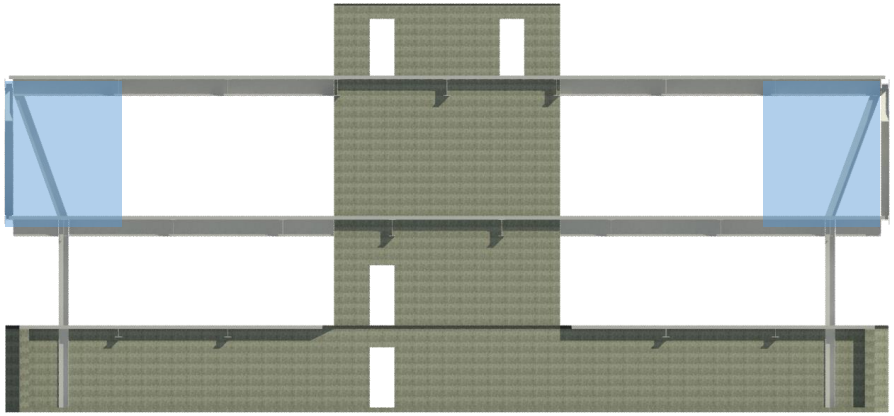
4.



Interior Coordination

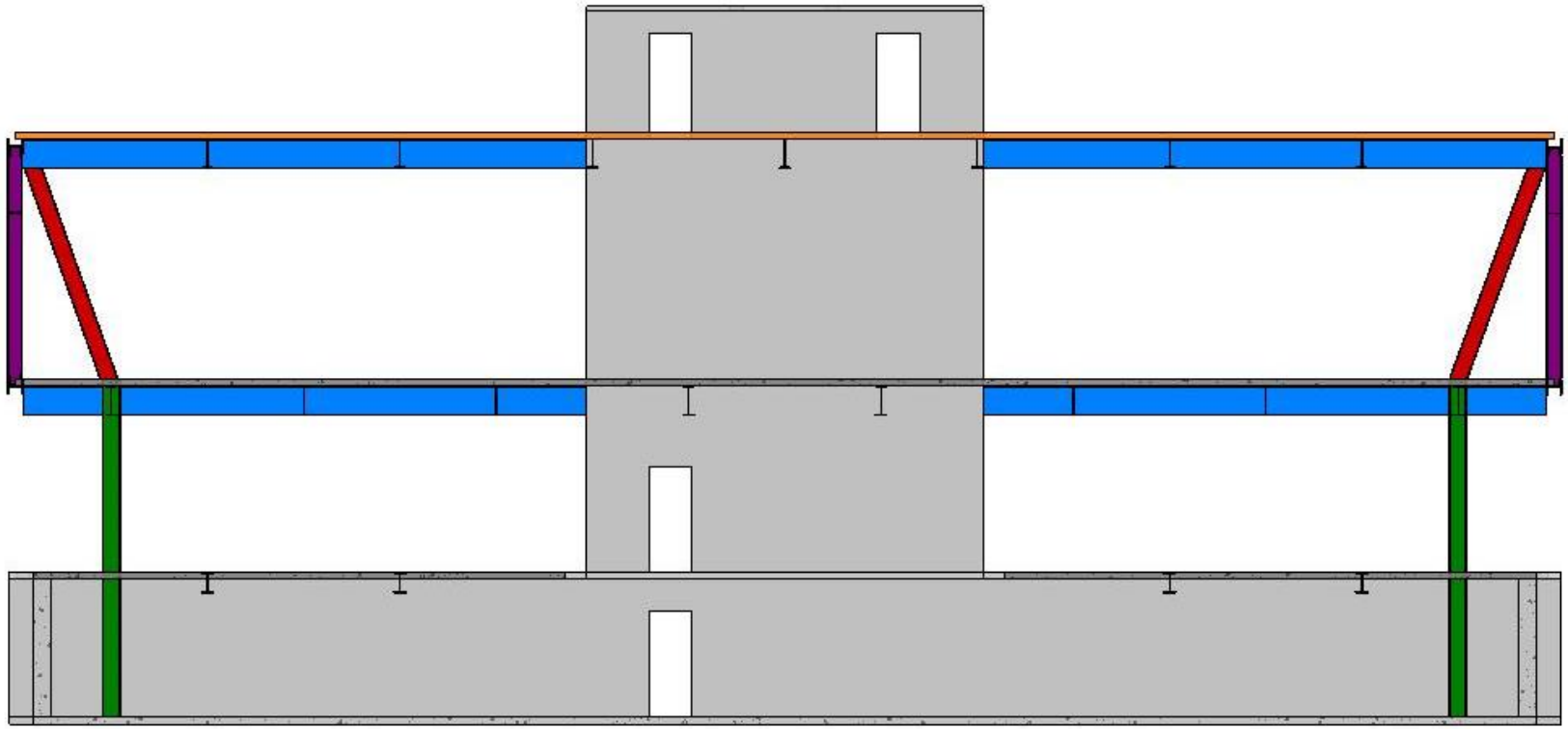


Winter Quarter Design:
Hindered circulation through open spaces



Final Design:
Free circulation paths, columns hidden in walls

Interior Section



Post-tensioned Slab

W14X90

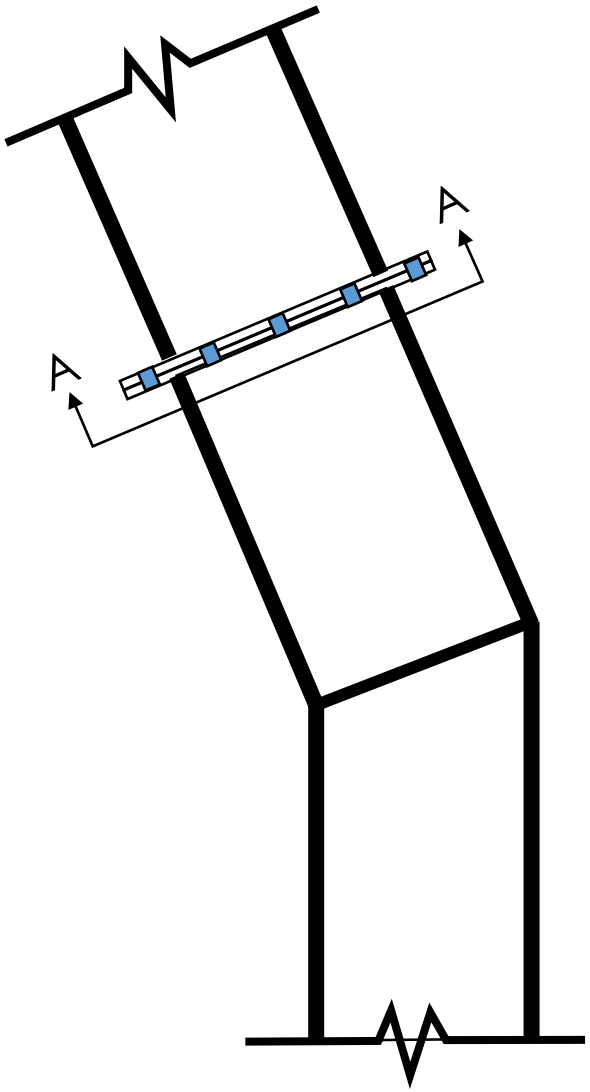
W14X90

W27X117

Side Truss

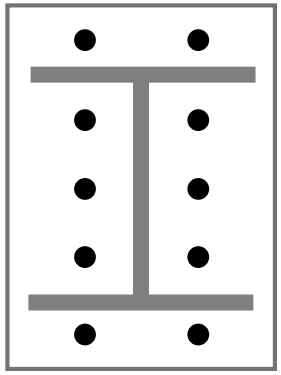
Shear Wall

Slanted Column Connection



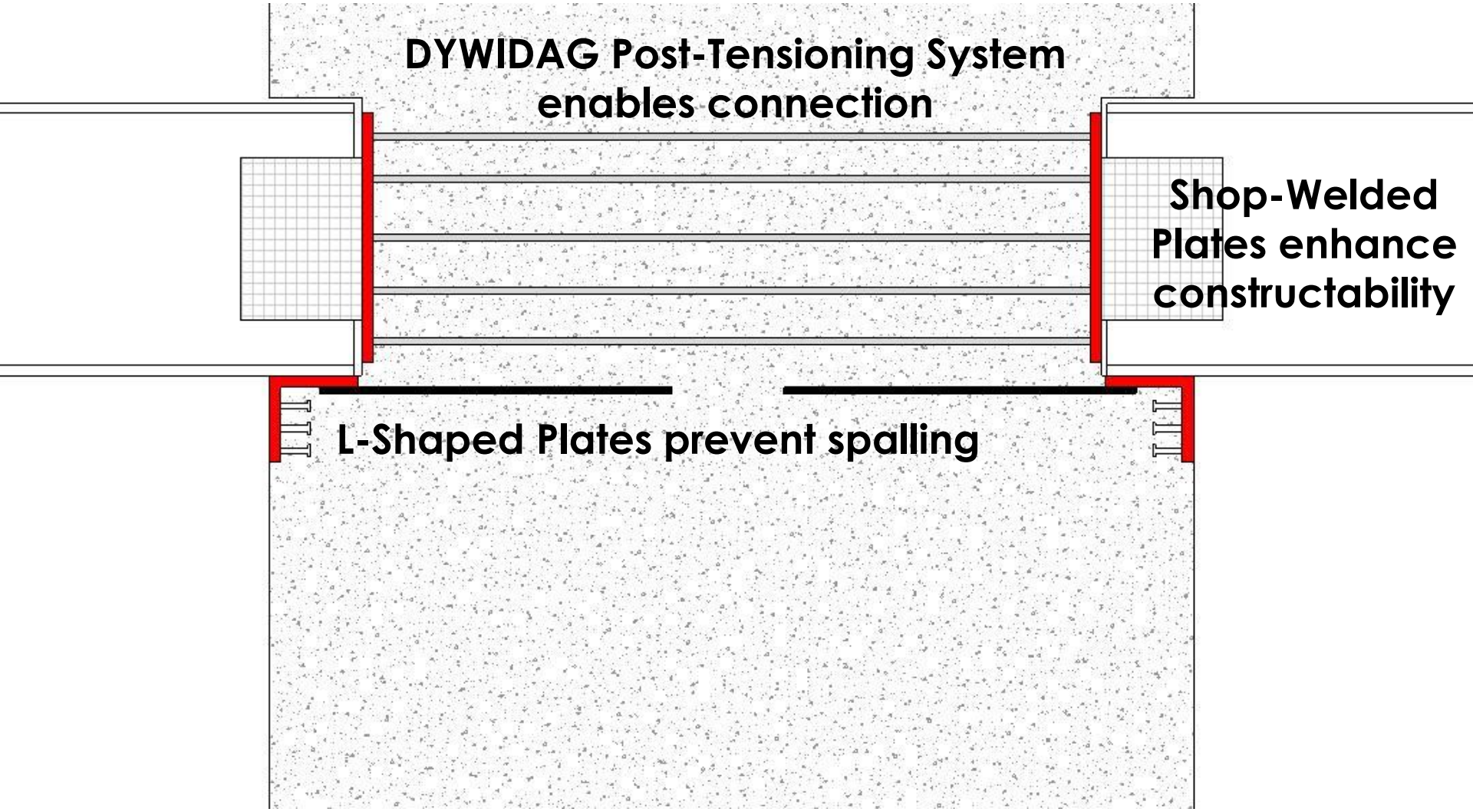
- Straight column shop-welded to section of slanted column with a stiffener in the bend
- Plates shop-welded to ends of two sections of the slanted column
- Plates bolted together on-site

Section A-A



10 ¾" A325 Bolts
3" spacing typ.
0.5" plates

Interior Shear Wall Connection

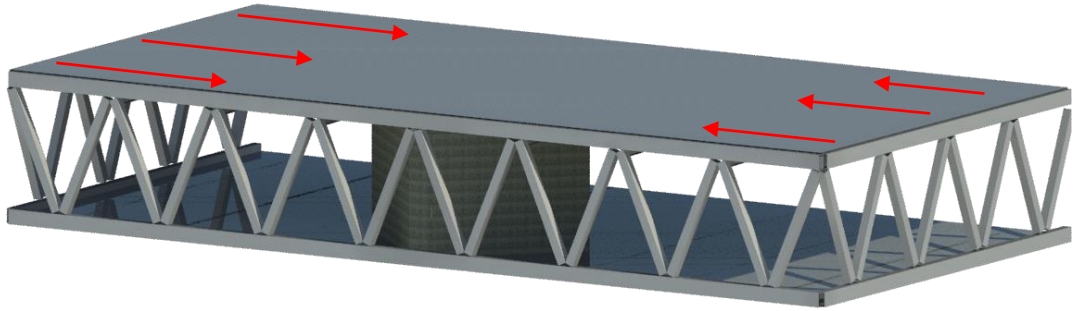


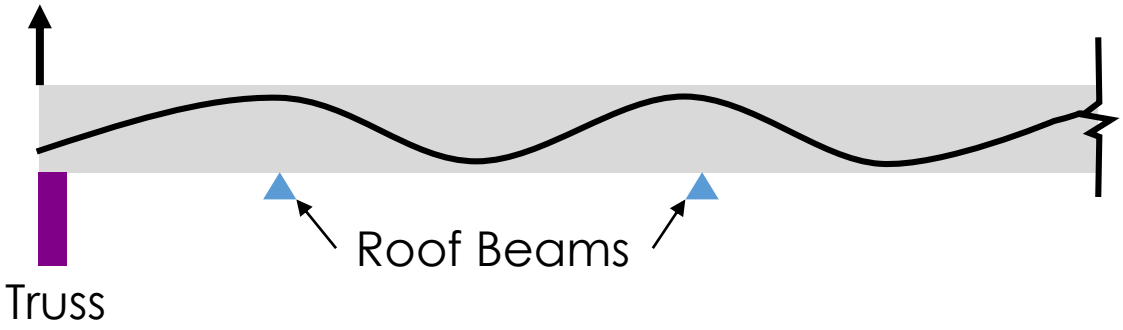
Post-Tensioned Roof Slab

Post-tensioned roof slab composite with top of trusses

Post-tensioning creates upward force on side trusses, reduces dead load deflections by 80%

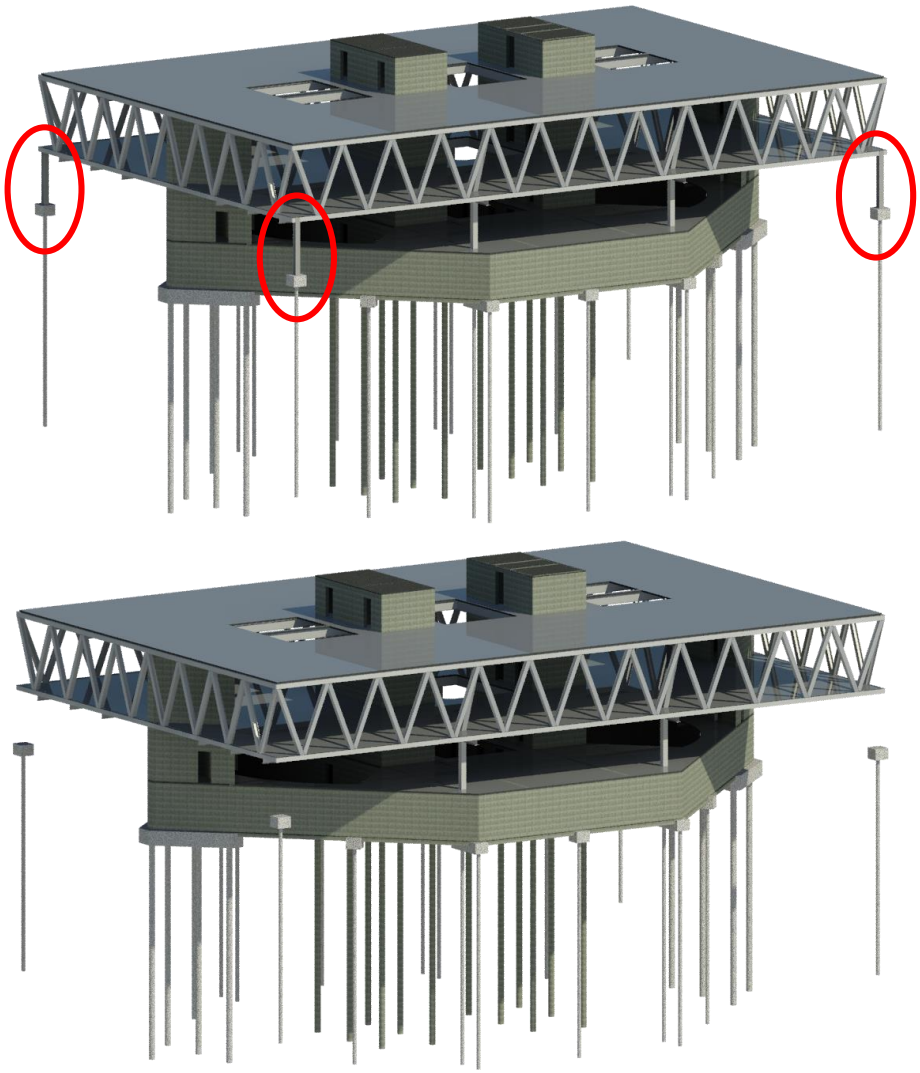
- 8” lightweight concrete slab on metal decking
- 0.6” unbonded low-relaxation strands at 6” spacing



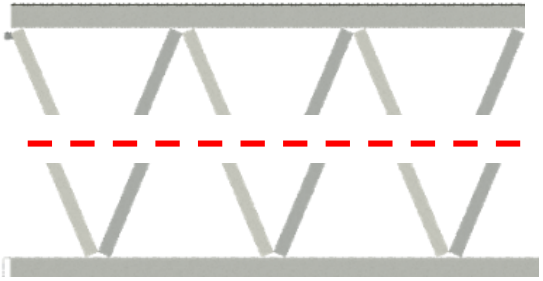


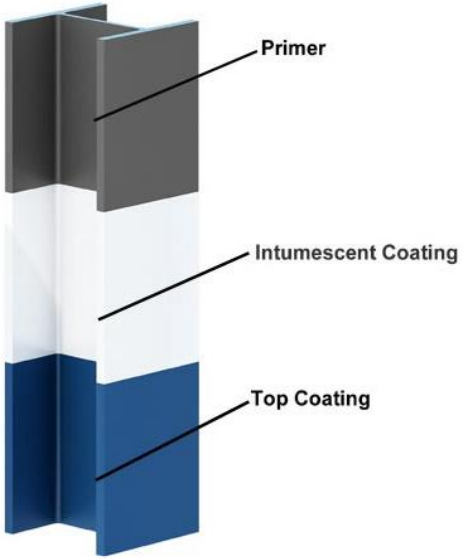
Temporary Columns

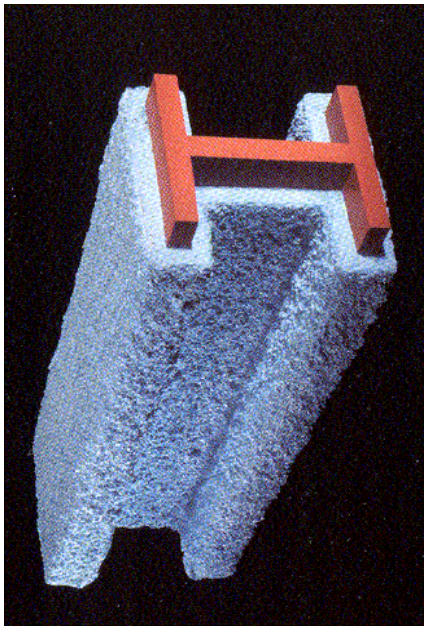
- Columns placed under corners of trusses during construction
- After roof slab cures and post-tensioning is released, the columns will be removed



Truss Fabrication



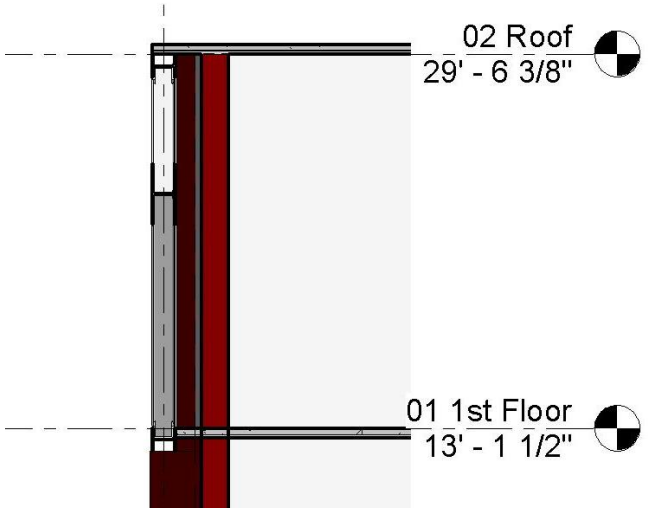




- Truss Prefabrication
- Weld and Grind
- Intumescent Paint

Truss Abutment

- End trusses will sit on abutment from shear wall.
- Shear studs on the top chord of the truss composite with the roof slab will support the top of the truss.



Conflict Resolution

Conflict:

- Architect wanted to remove the triangular shear walls.
- Structural engineers were supporting a lot of the building on them.

slack

The architect wrote a message in the structural channel.

Structural replied with their objections

GoToMeeting

The architect and structural engineers had a subgroup meeting.

Nureva Span™

Span was utilized to sketch possible options and load paths.

We discussed the options with owners and left the meeting with a final decision.

Student & Faculty Surveys

Napping spaces were designed in the basement.

"Our favorite study break activity is taking a nap."

A virtual reality room with innovative collaboration technology was assigned to the basement.

"Connections with other faculties and companies are missing from the current faculties."

Survey

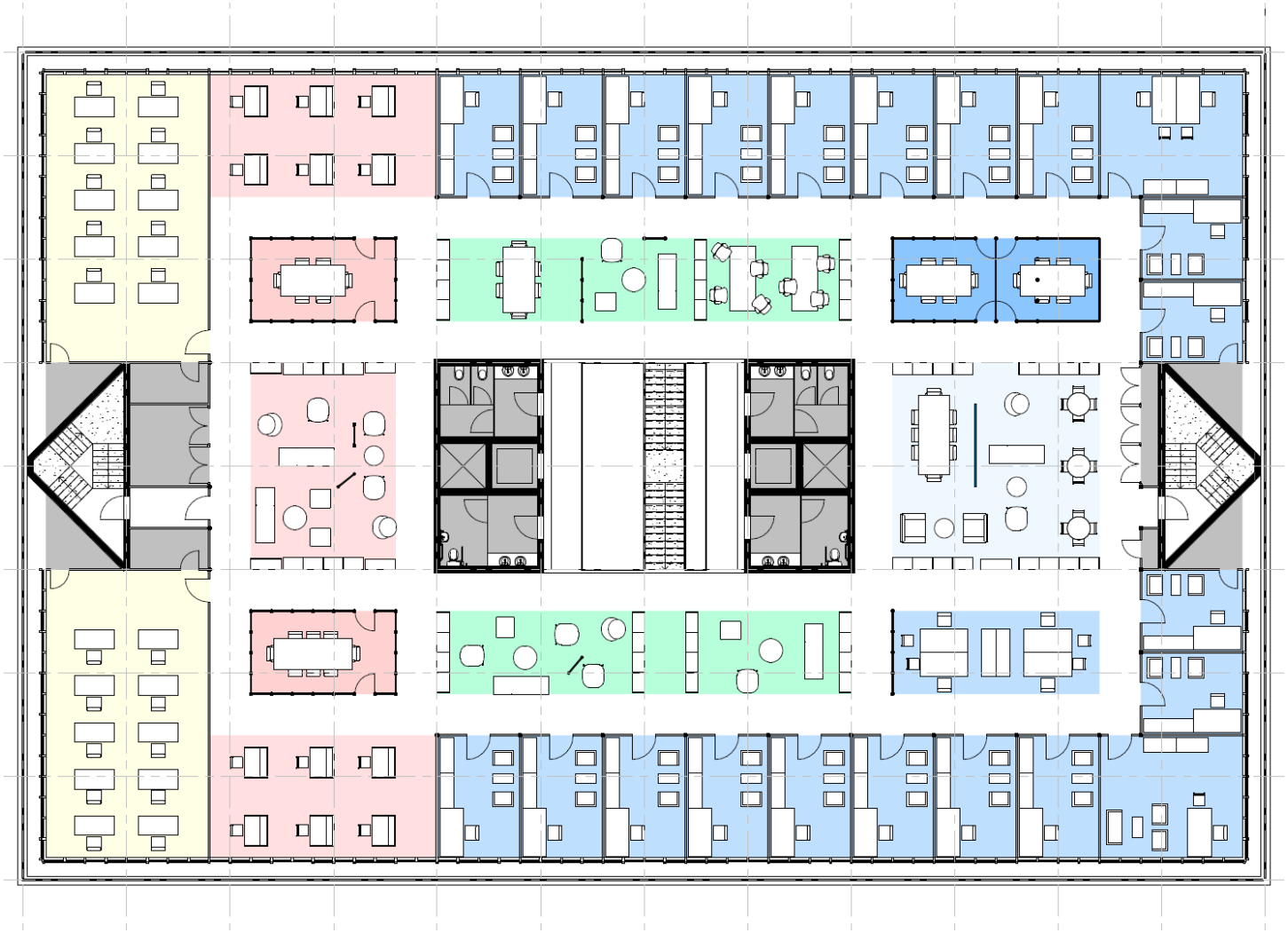
The layout of the first floor is extremely flexible and can be transformed for any use.

"We would like to have more spaces that could be transformed for professor and student uses."

A café was added to the ground floor.

"Between classes, we like to have a drink or grab a snack with friends."

First Floor



Private

Labs

Faculty
-offices
-lounge
-seminar

Student
-offices
-seminar

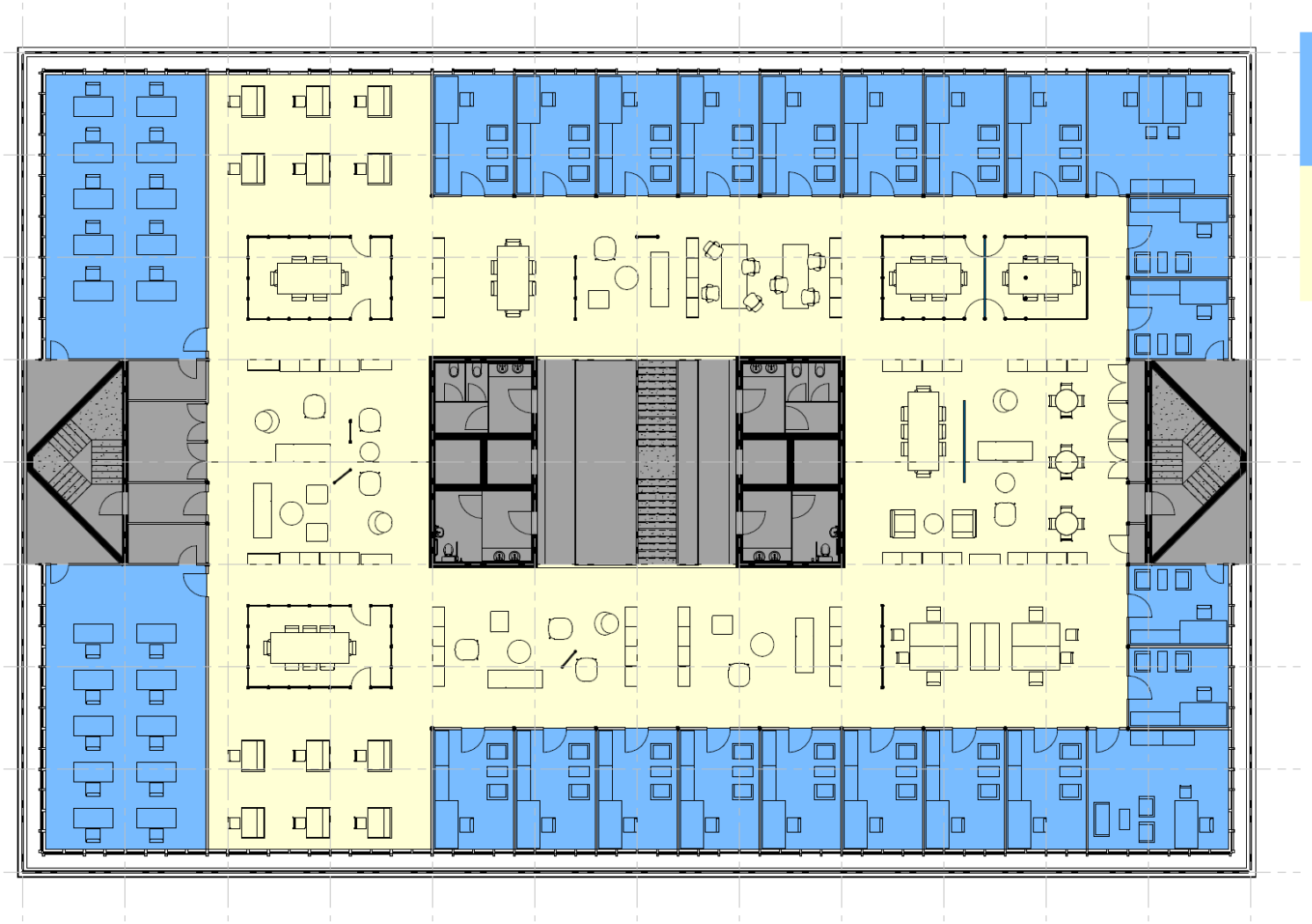
Collaboration

Services

Restroom
MEP Shaft
Elevator
Storage

Grid: 4.0 x 4.0 m

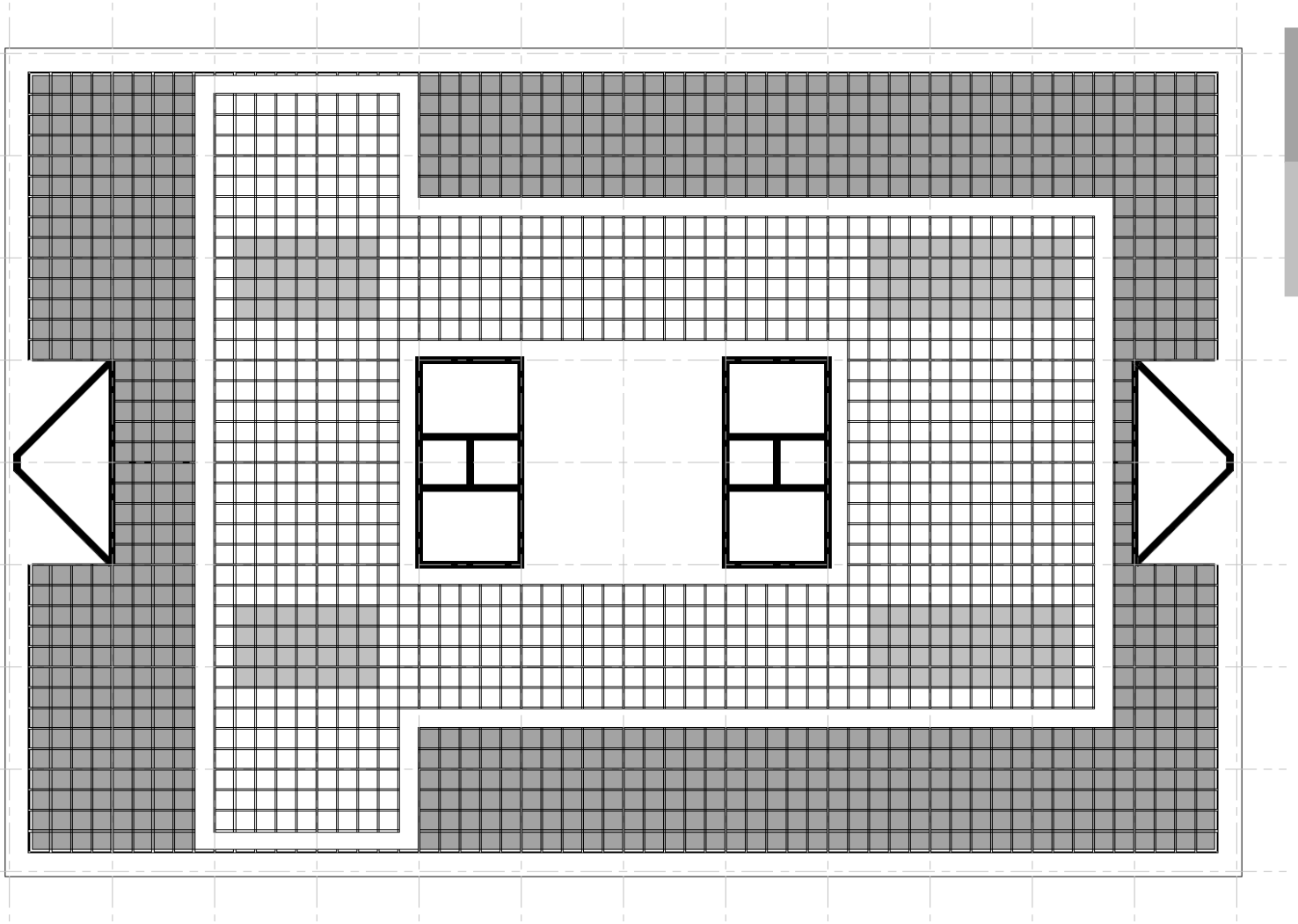
Flexibility



Semi-flexible rooms

Open-flexible space

Suspended Ceiling

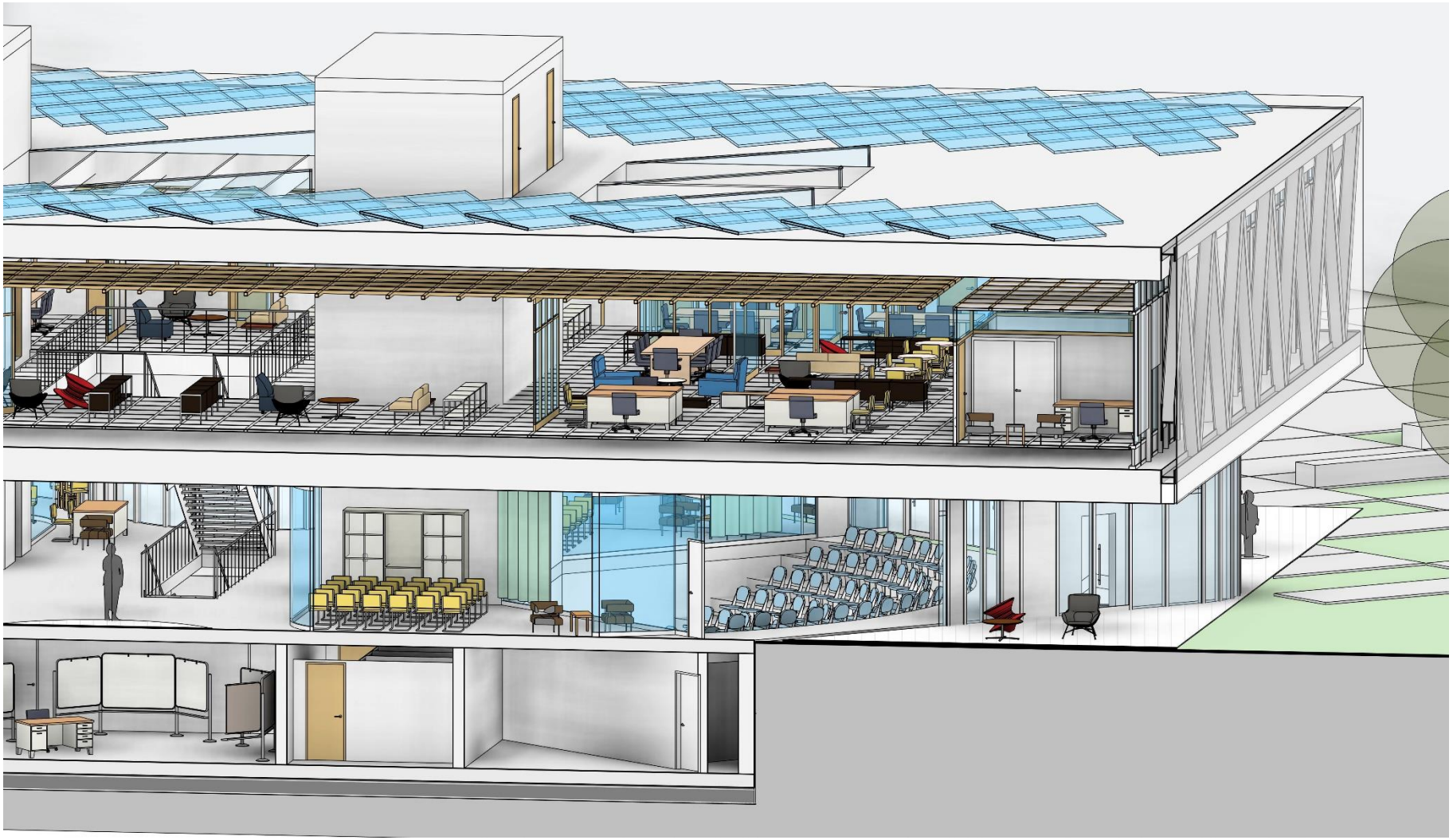


Closed ceiling above cellular offices

Closed ceiling above open space

Grid: 80 x 80 cm

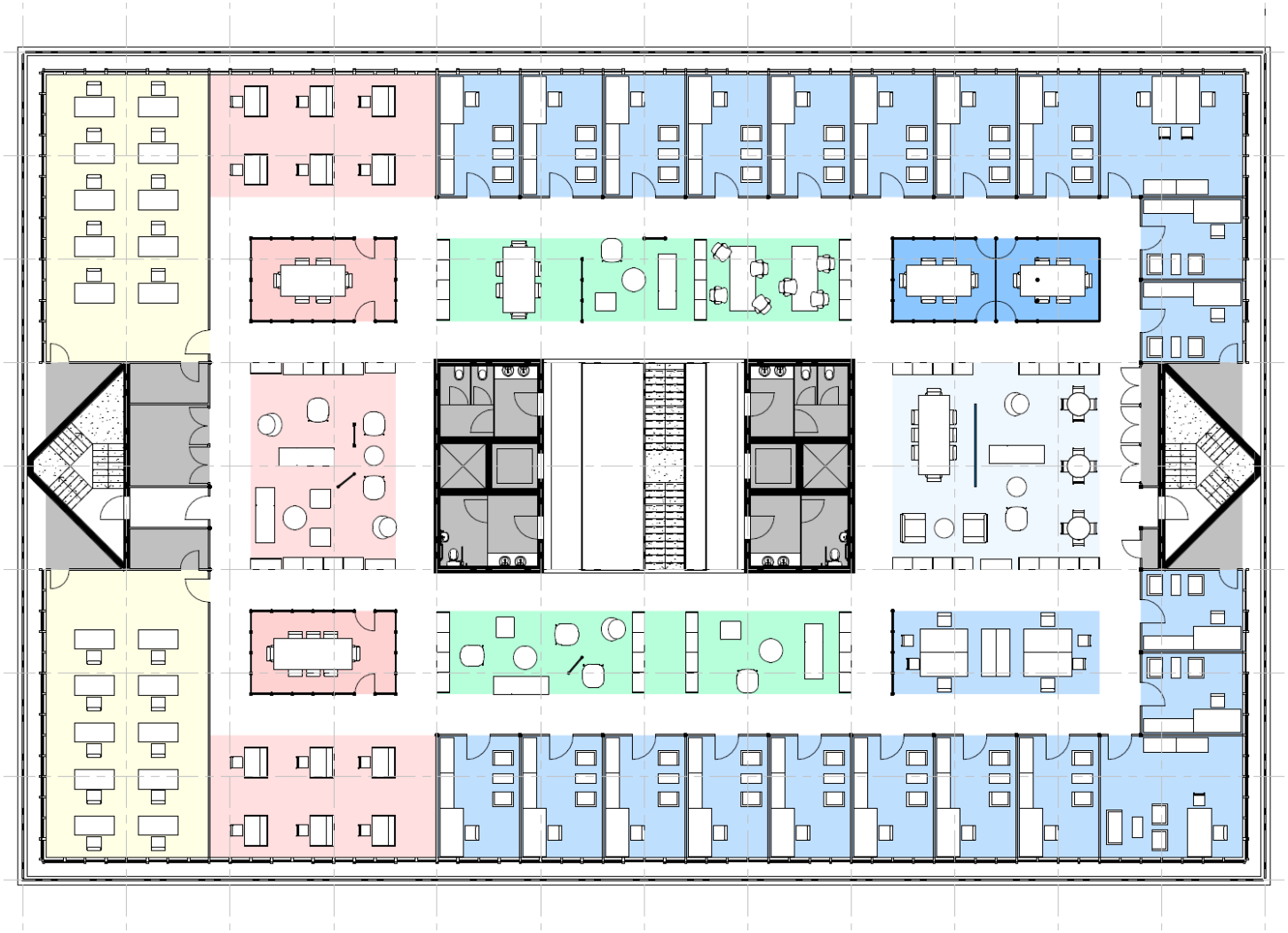
First Floor 3D Section



Moving Walls

Student Space

1st Floor



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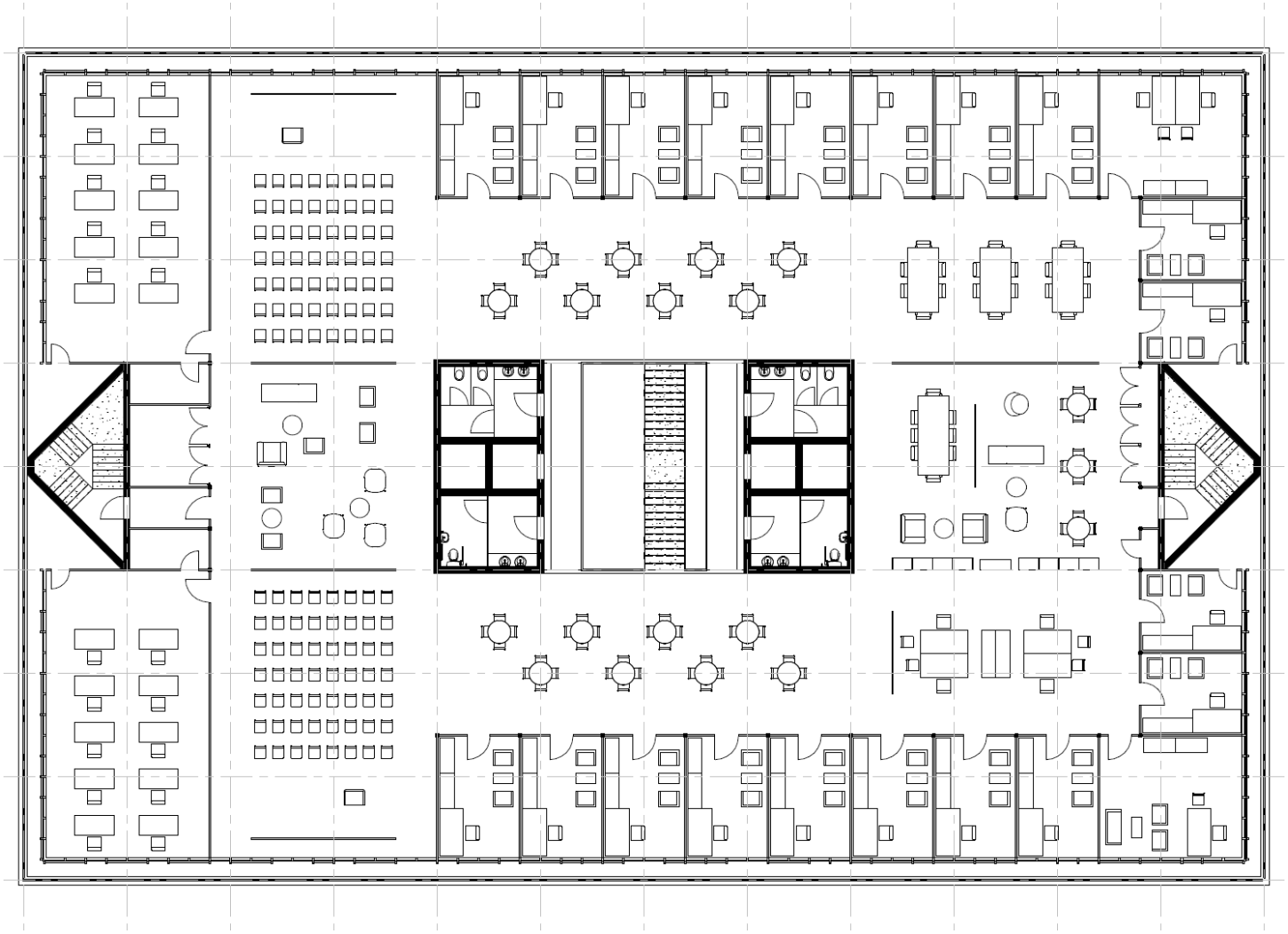
Collaboration

Services

Restroom
MEP Shaft
Elevator
Storage

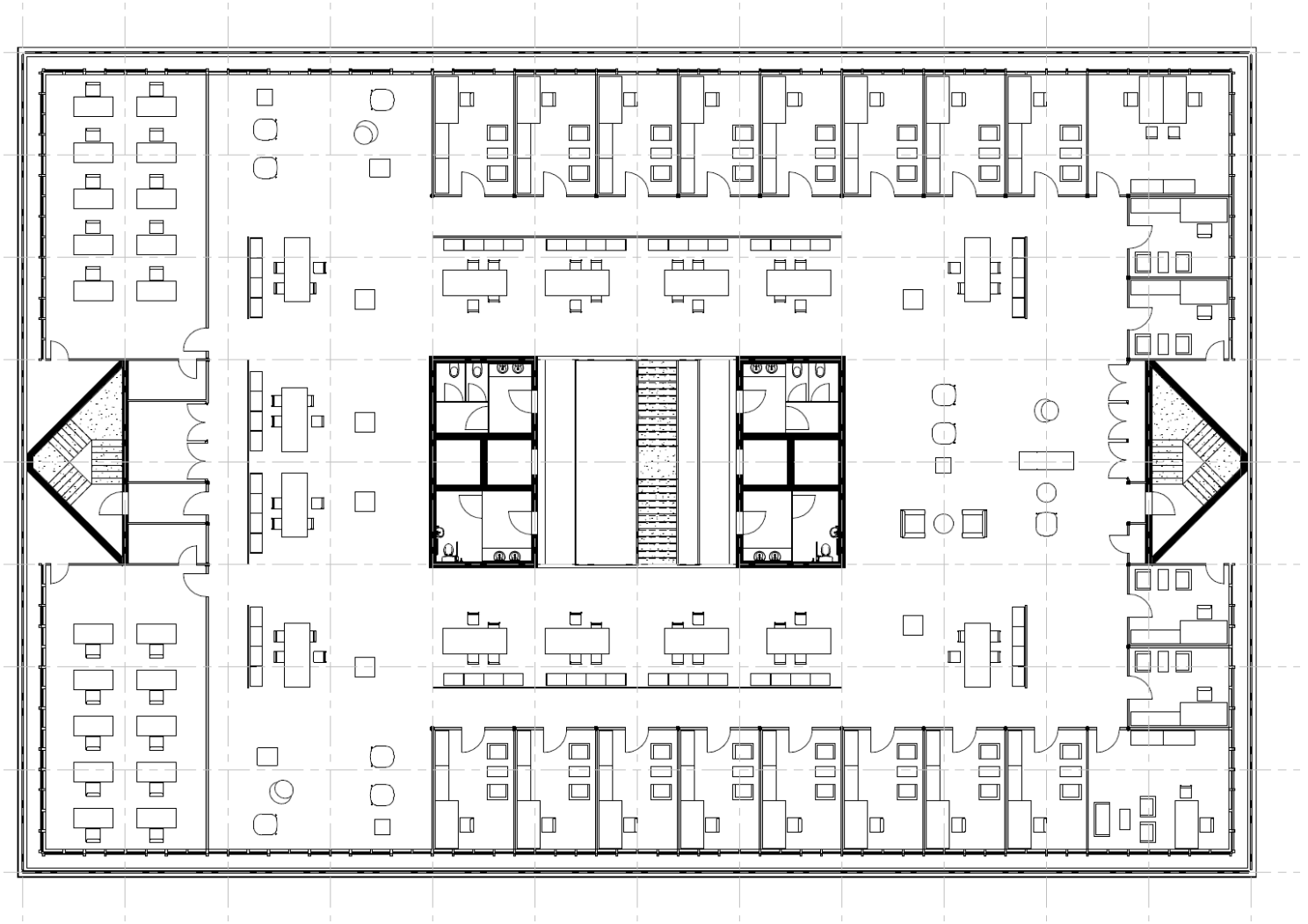
Grid: 4.0 x 4.0 m

Final Presentation



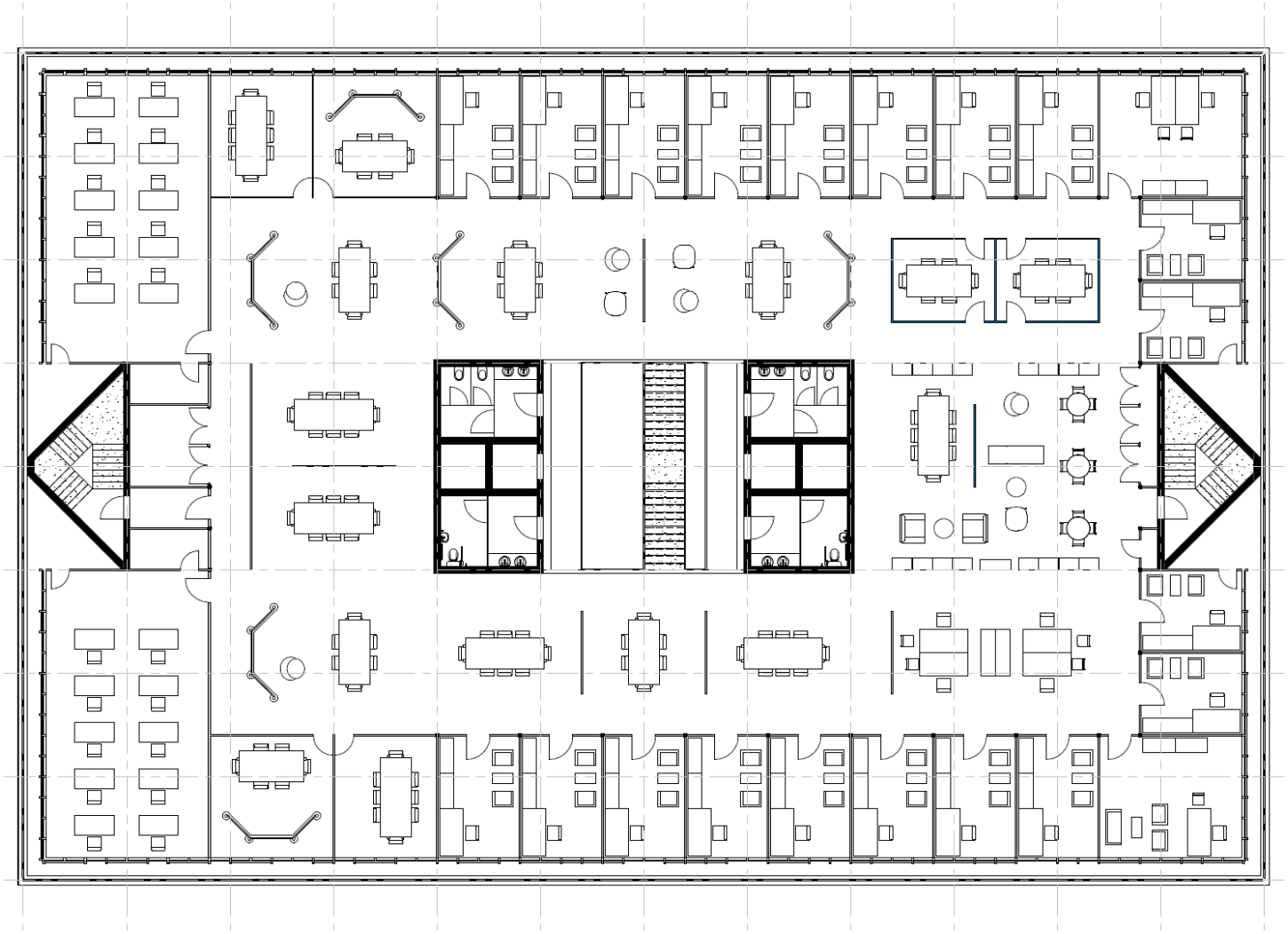
Two presentation areas with 49 seats, bar tables and lounge area in-between the presentation areas

Convention



14 tables dedicated for companies/ groups and 3 lounge areas

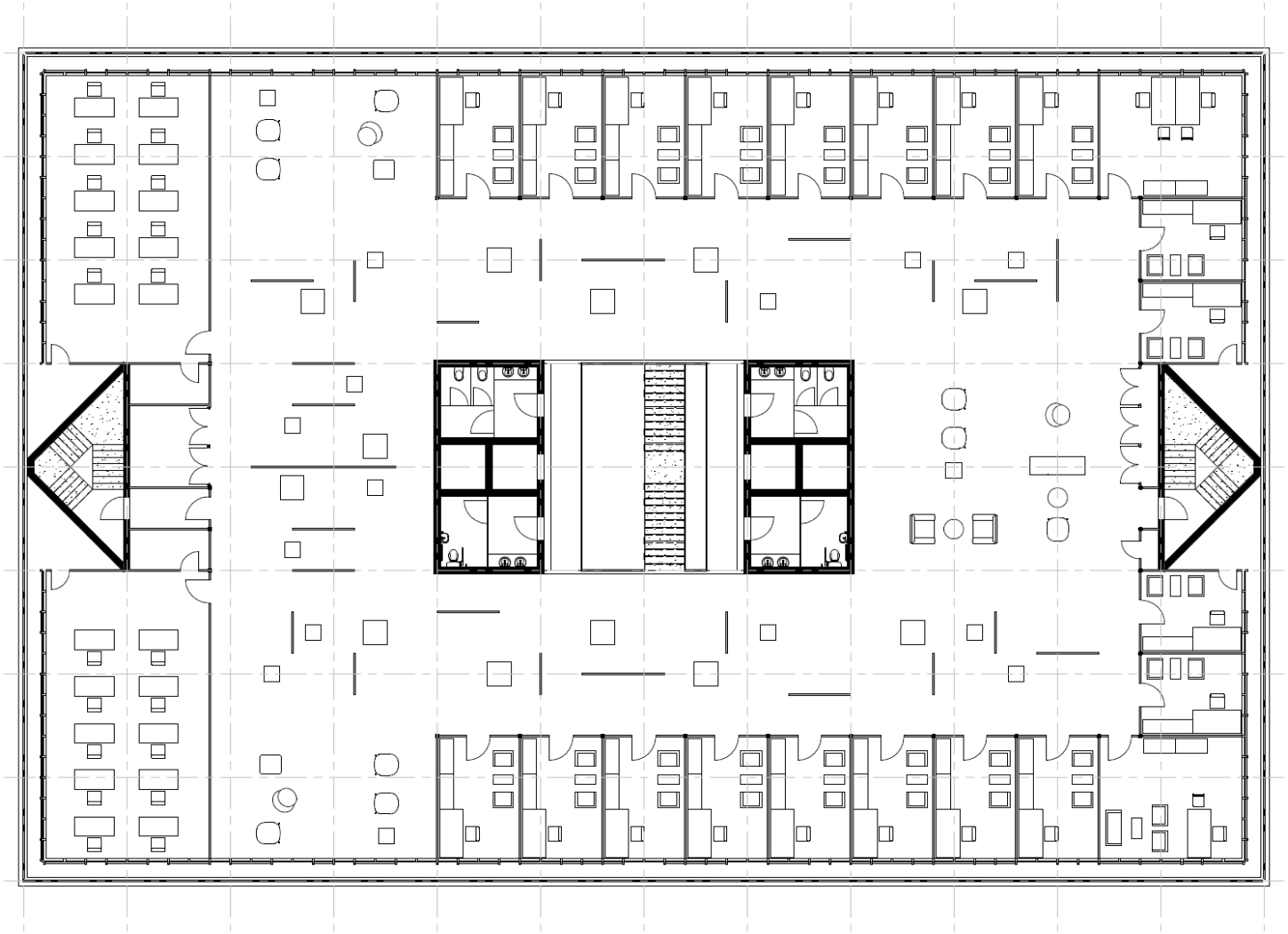
Working Space



13 tables dedicated for group work (4 of them enclosed) with moving smart boards

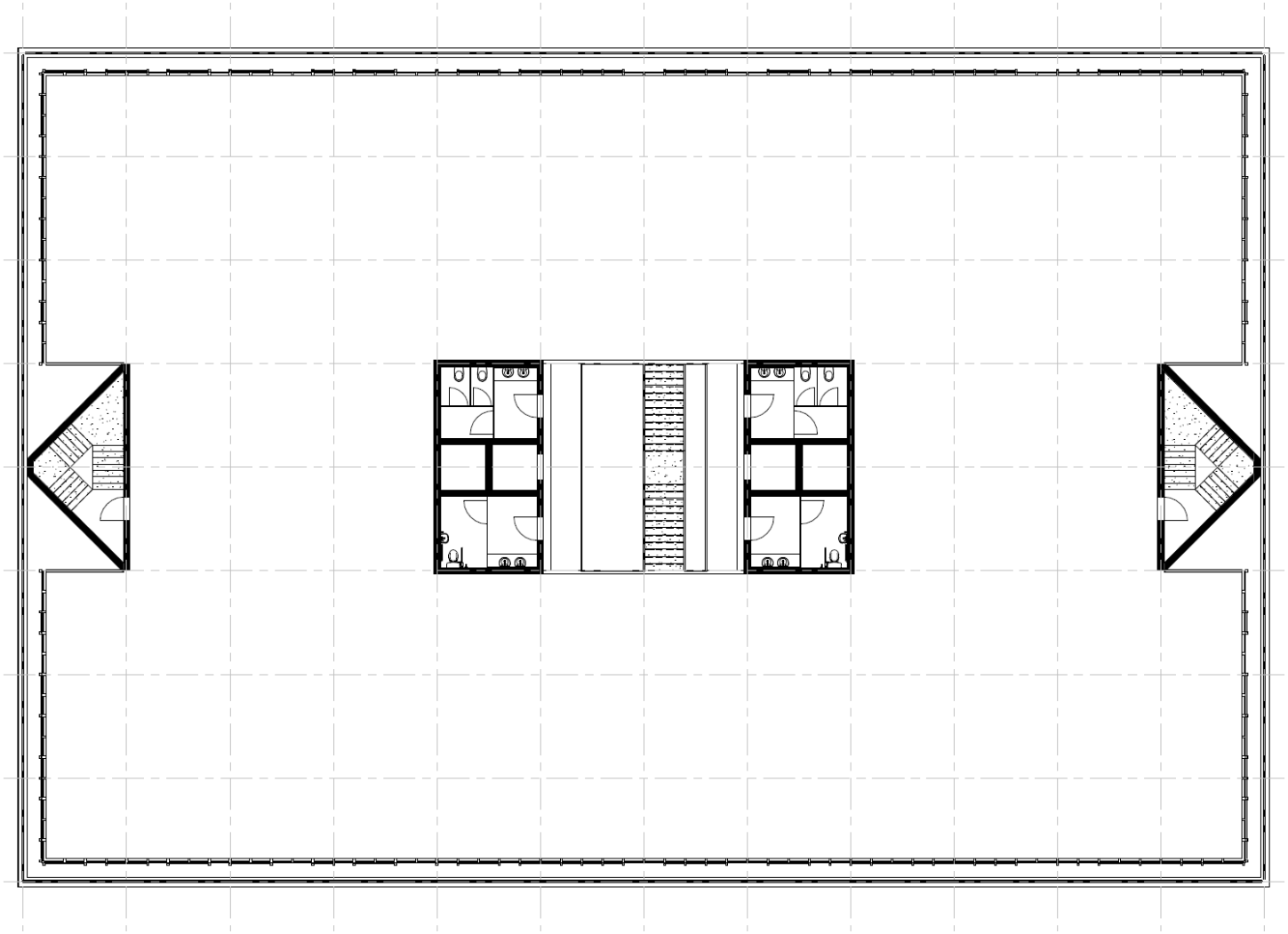
Faculty area stays unchanged

Exibition



Exibition area created with horizontal (tables) and vertical (moving walls) display surfaces

Retrofitting Space Allocation



Completely cleared space in case of a change of the program

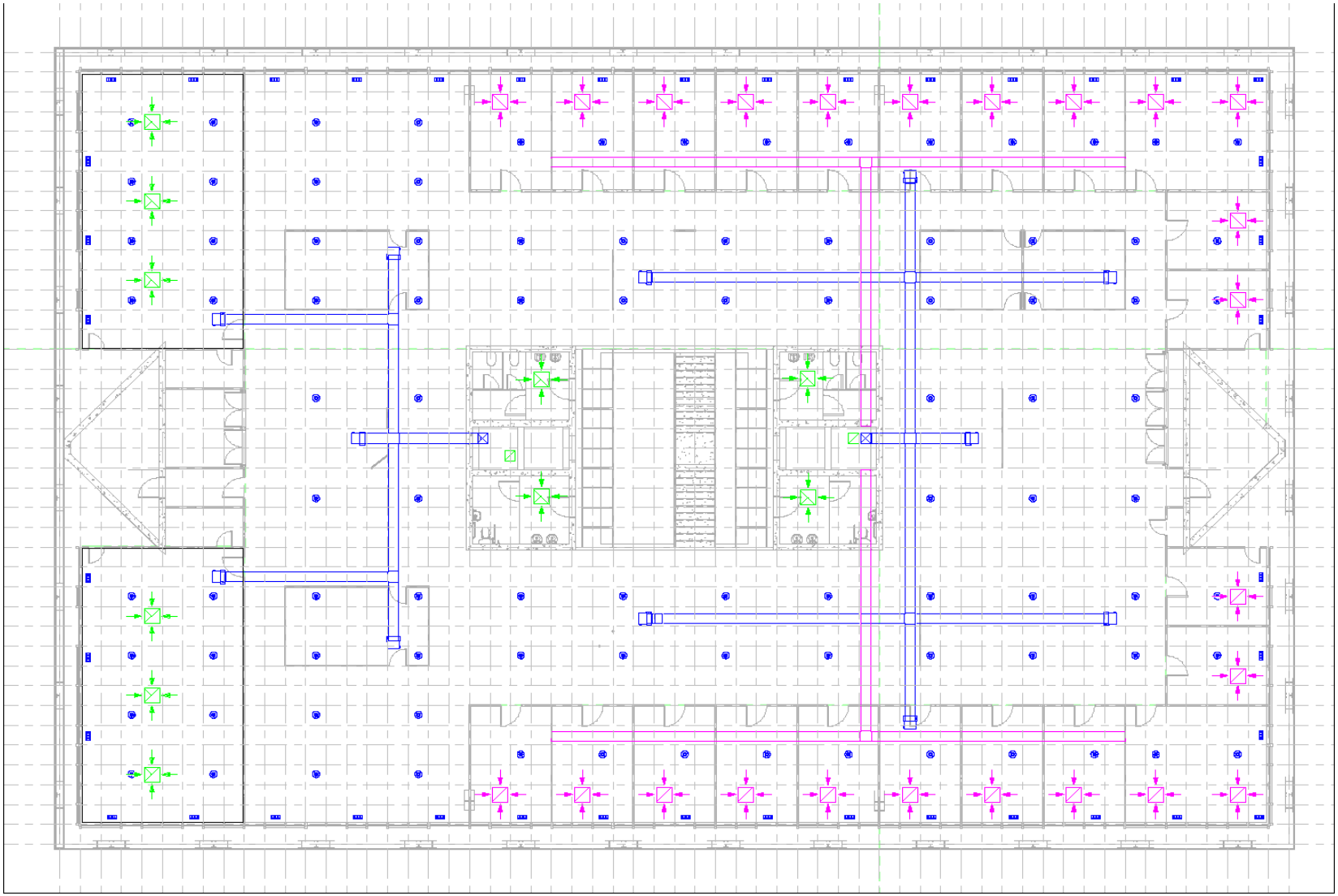
Example: school of engineering > school of arts

System Description

- Ground Source Heat Pump
  - Economizer
- Raised Floor
  - Under-floor Heating
  - Swirl Diffusers with Thermostats
- Plenum Supply
- Plenum Return
-

Enables Flexibility

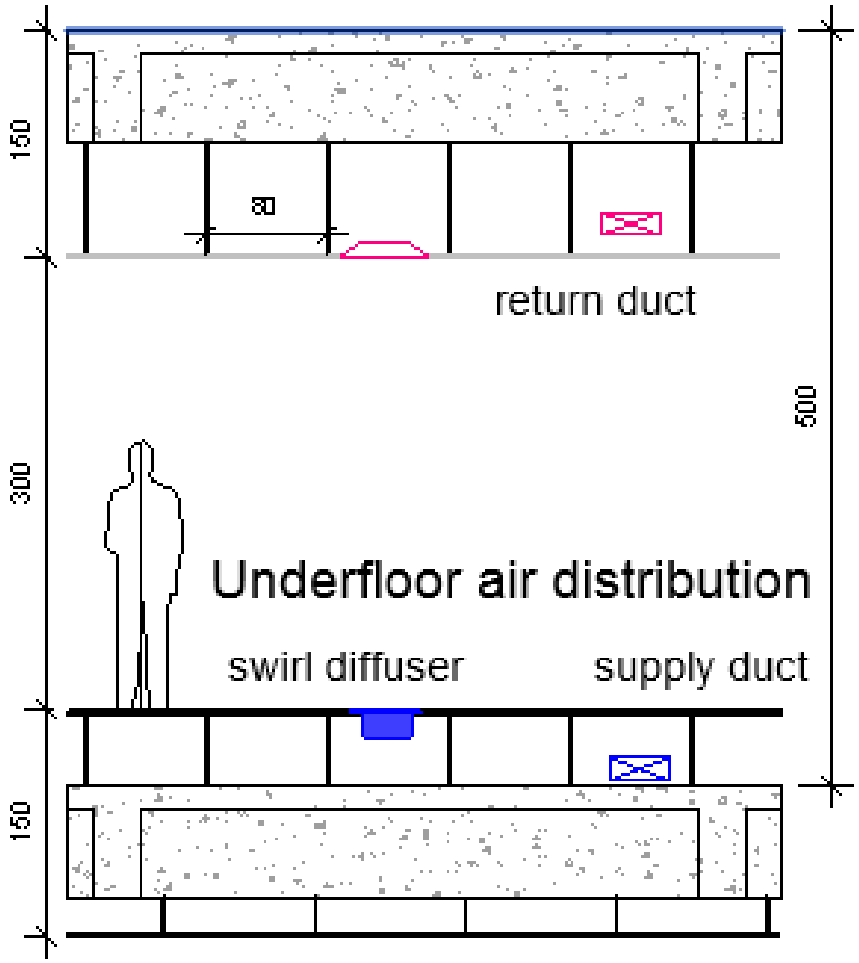
Econdustry Distribution



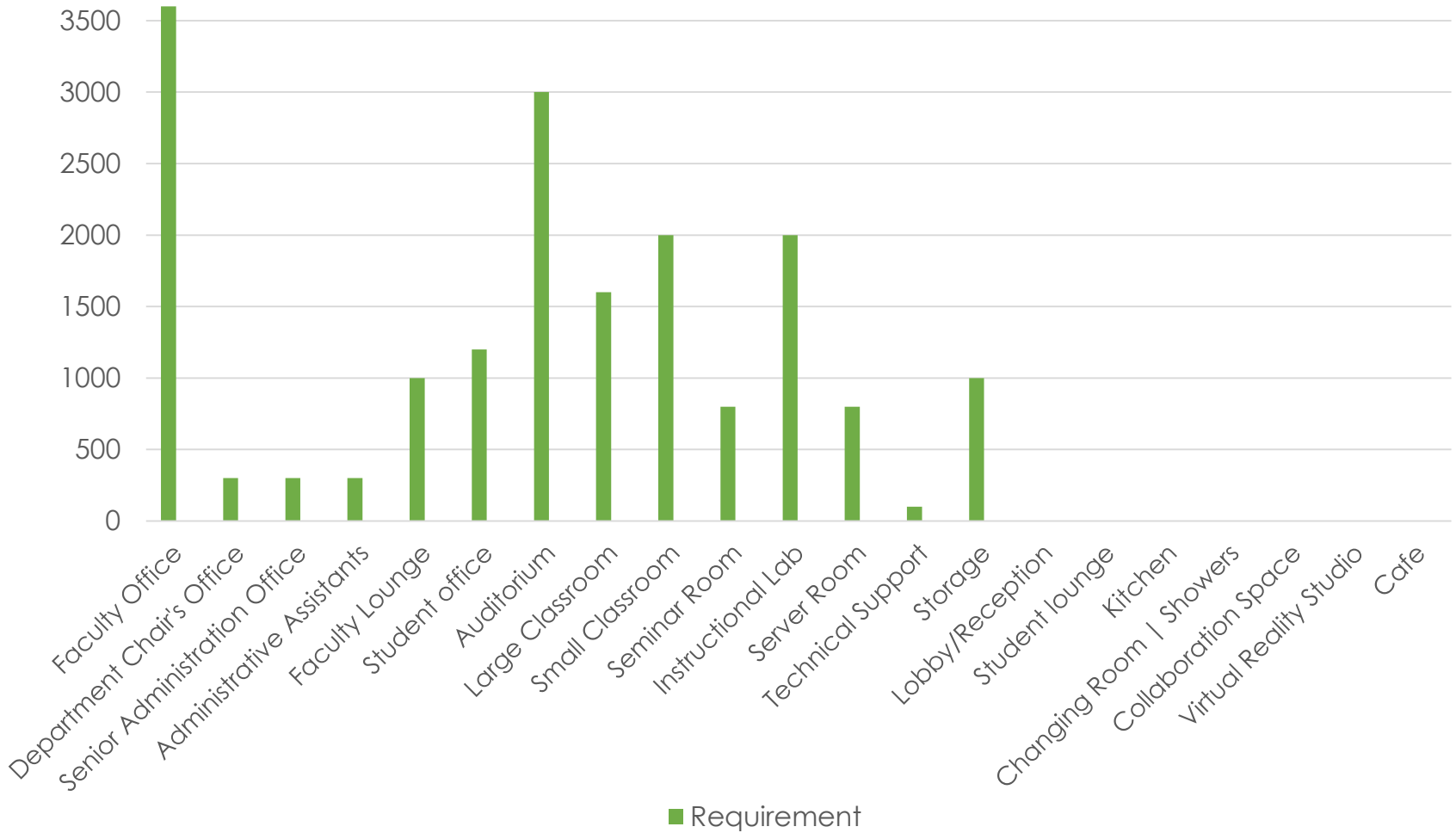
Supply diffusers

Return Terminal

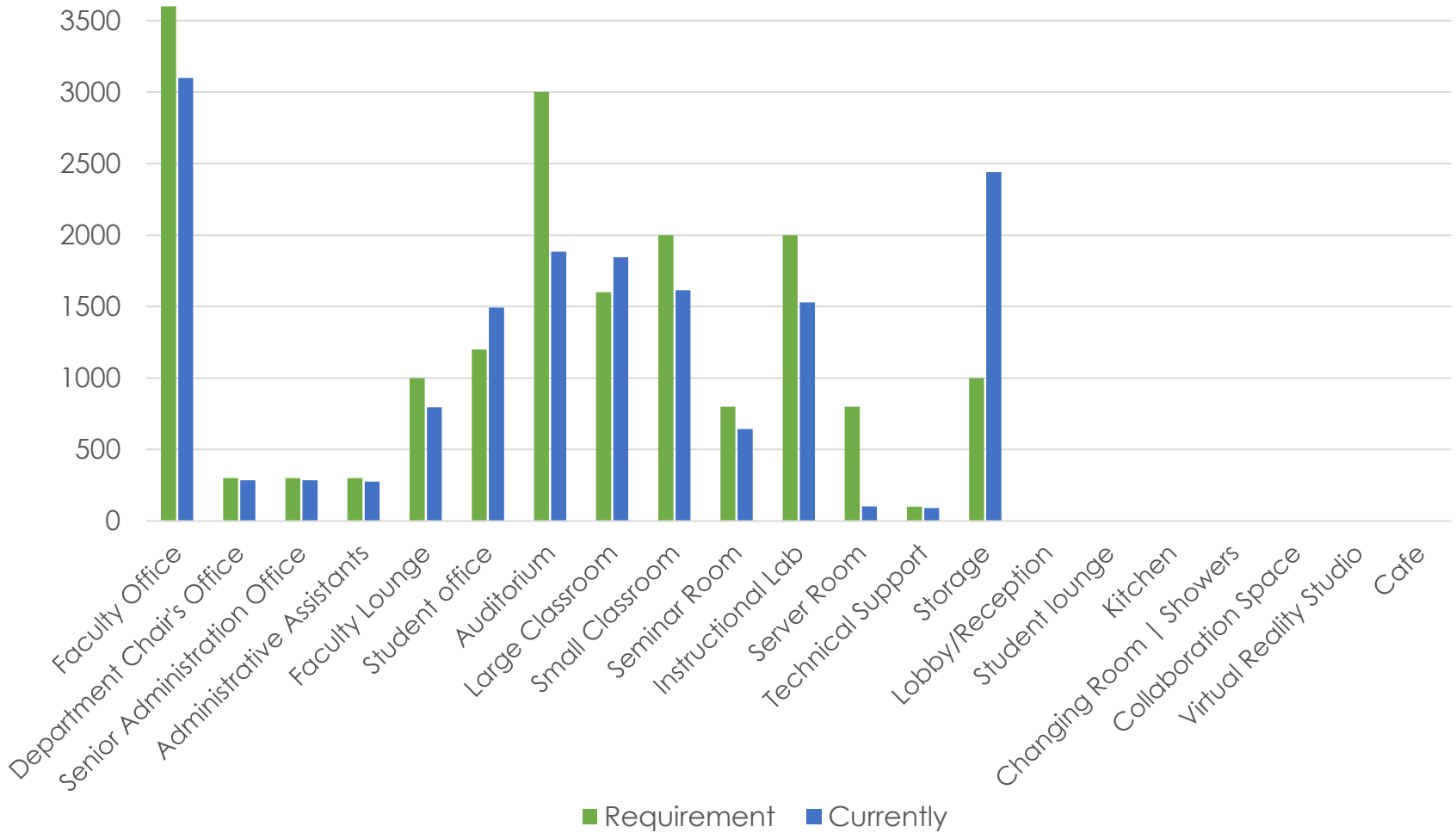
Floor Sandwich



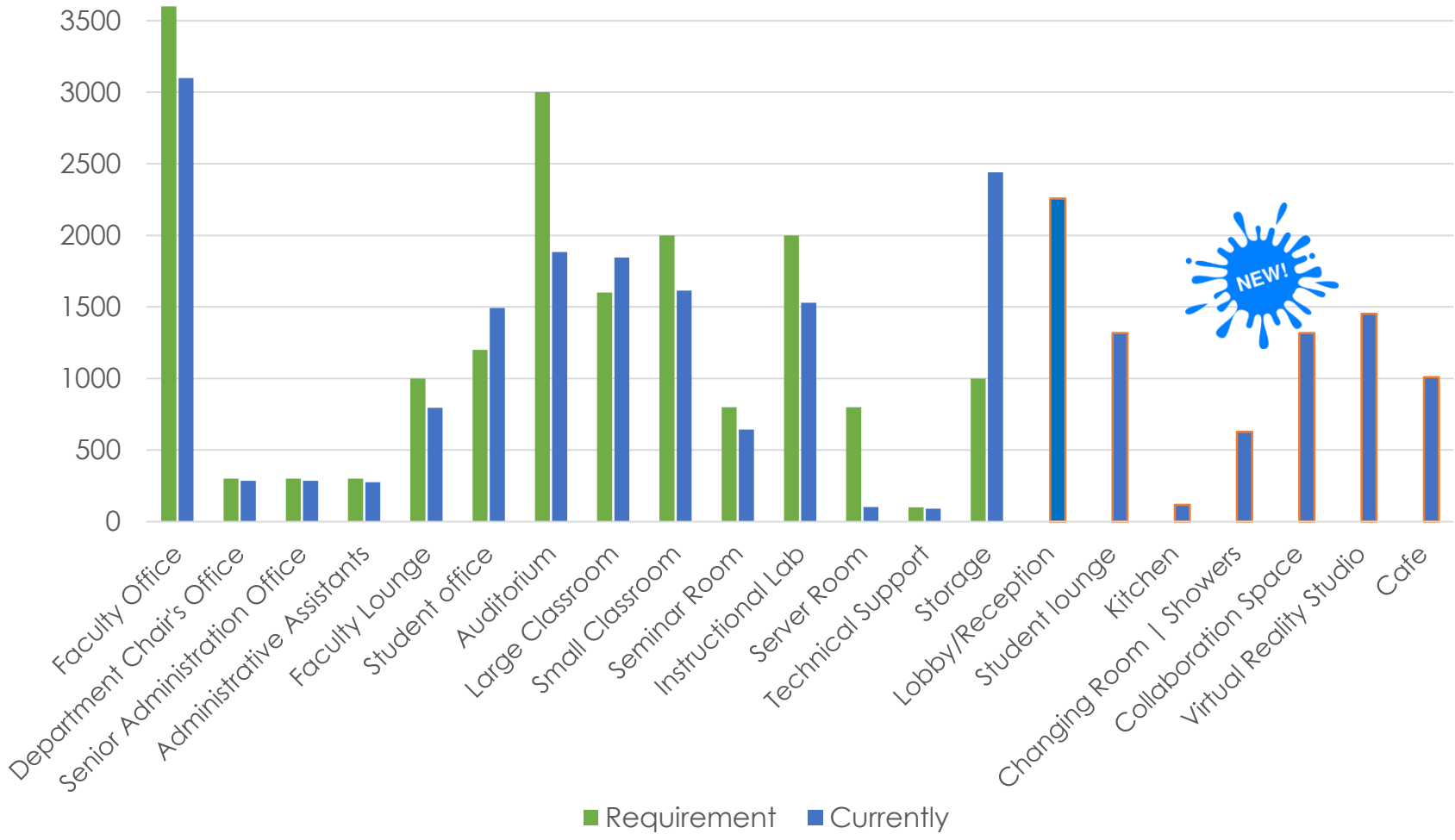
Area Distribution



Area Distribution

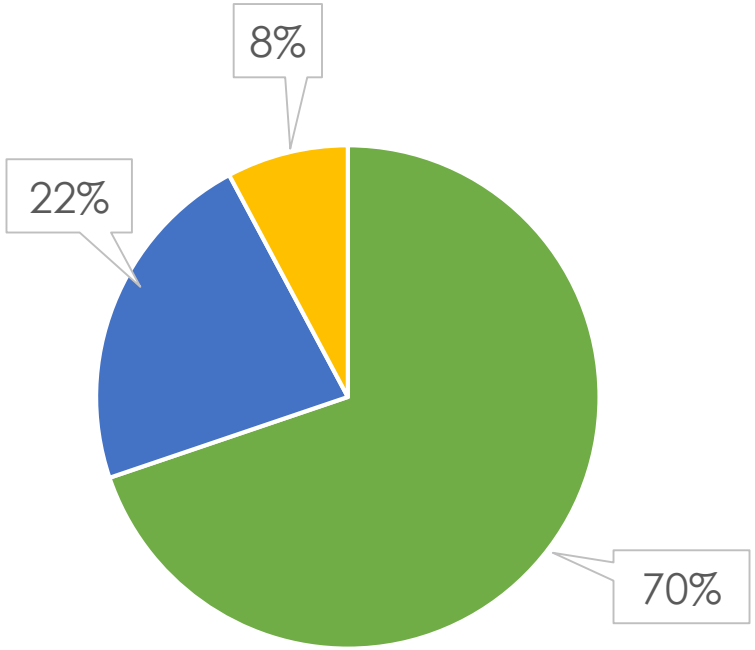


Area Distribution

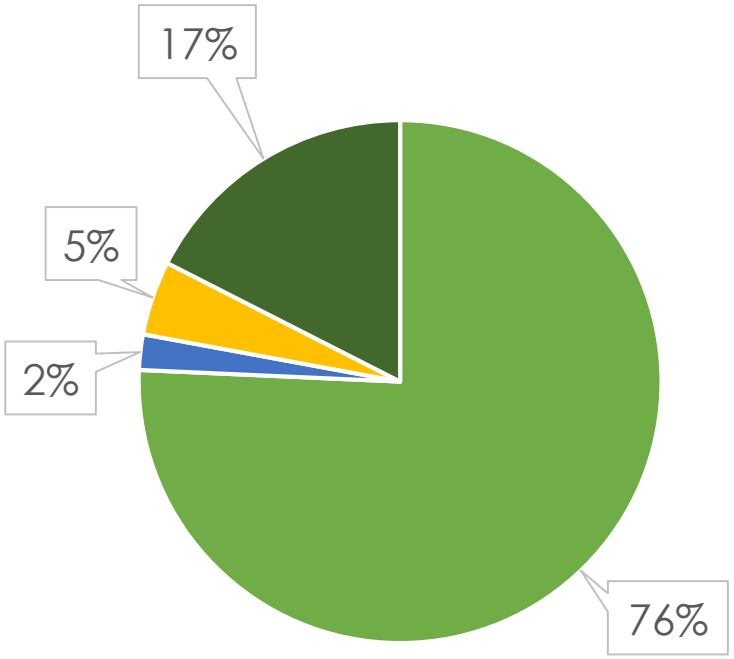


Ratio

GROSS FLOOR AREA



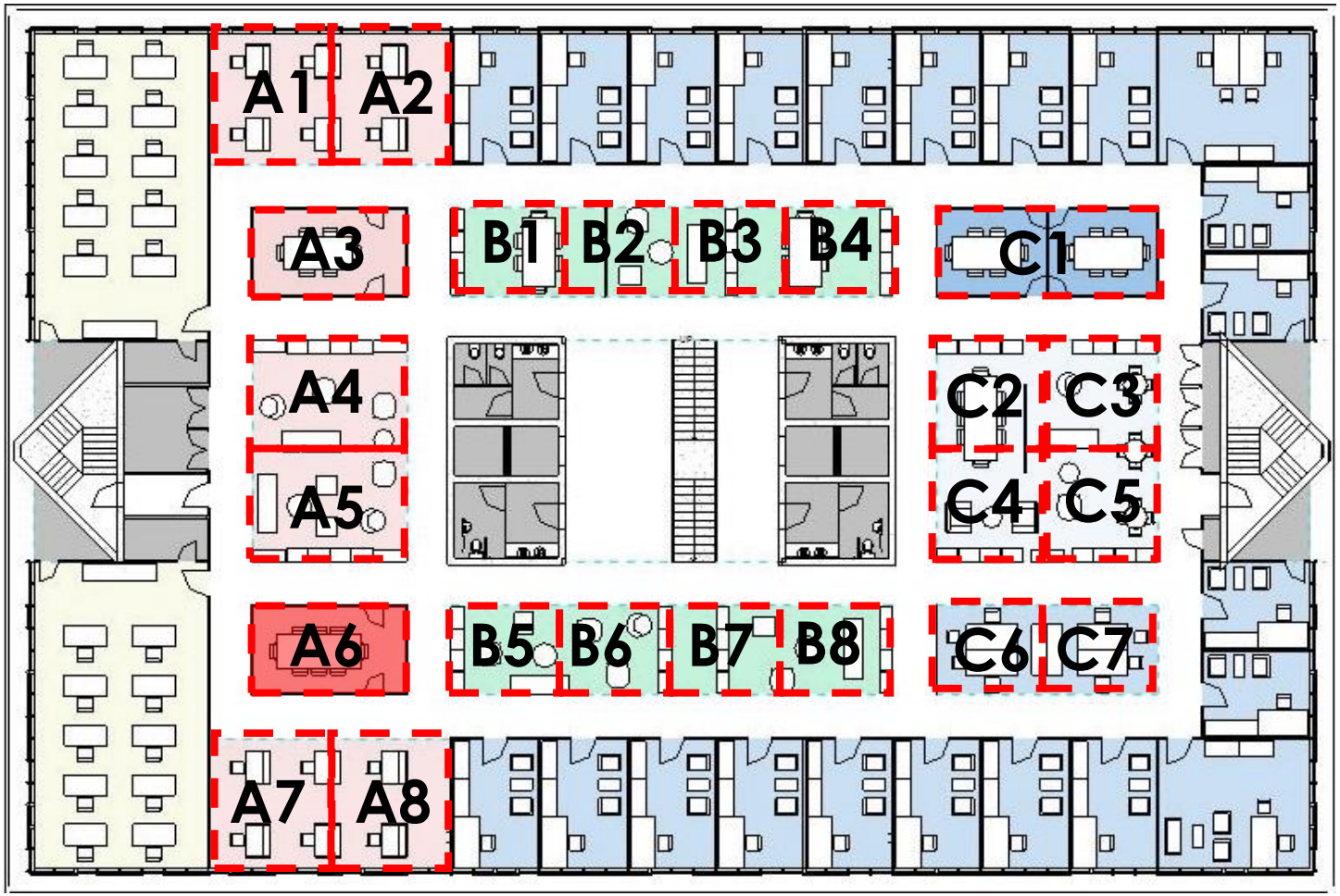
USABLE AREA DISTRIBUTION



- ASSIGNABLE
- NON ASSIGNABLE
- STRUCTURAL

- ASSIGNABLE AREA
- MECHANICAL
- RESTROOMS
- CIRCULATION

First Floor Zoning

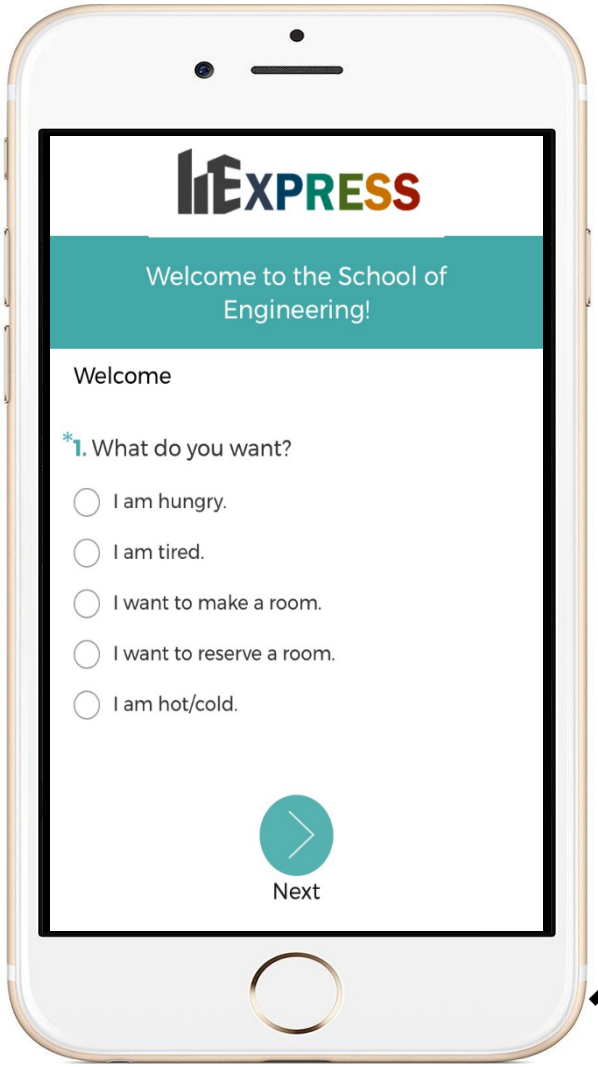


Interactive Wall

Interactive Wall

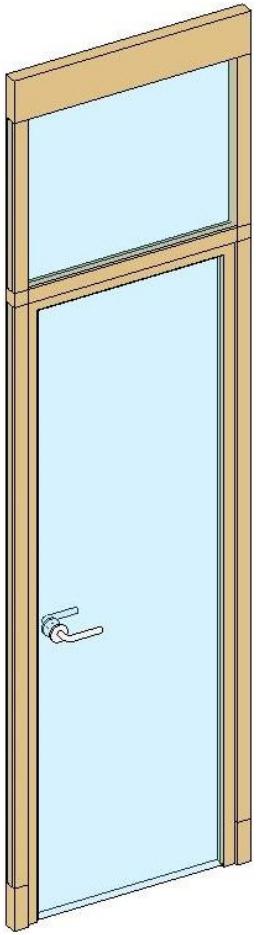
Integrated App

Use this QR Code to test out a prototype of our integrated building app!

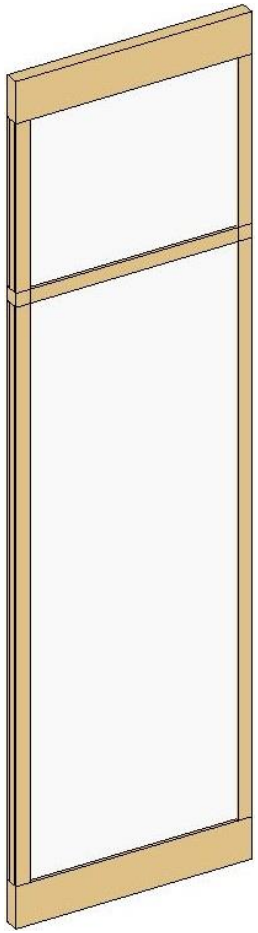


Items You Will Need:

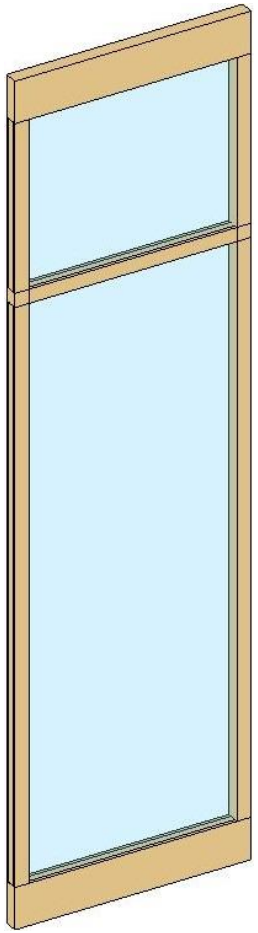
Door panel
2x



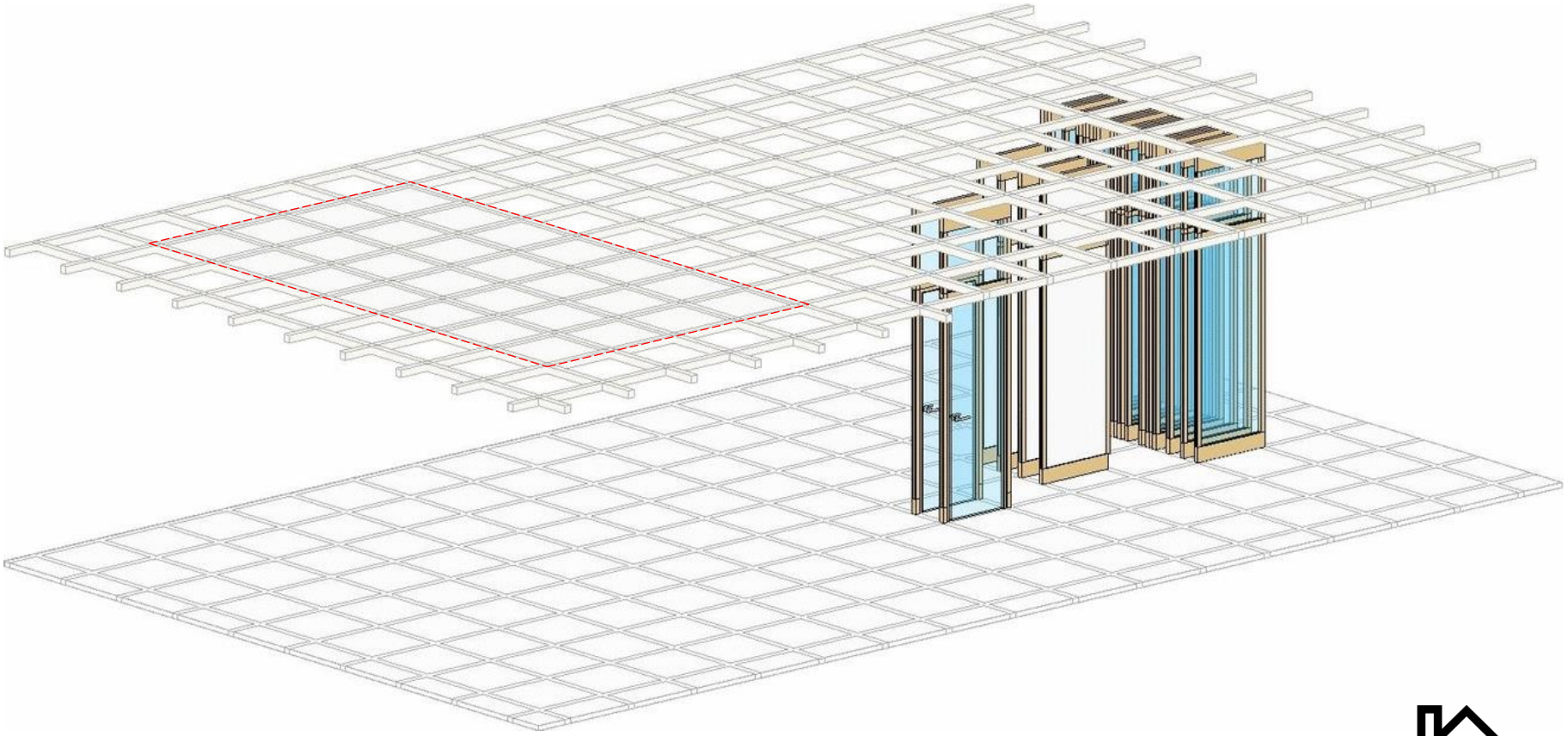
Opaque panel
4x



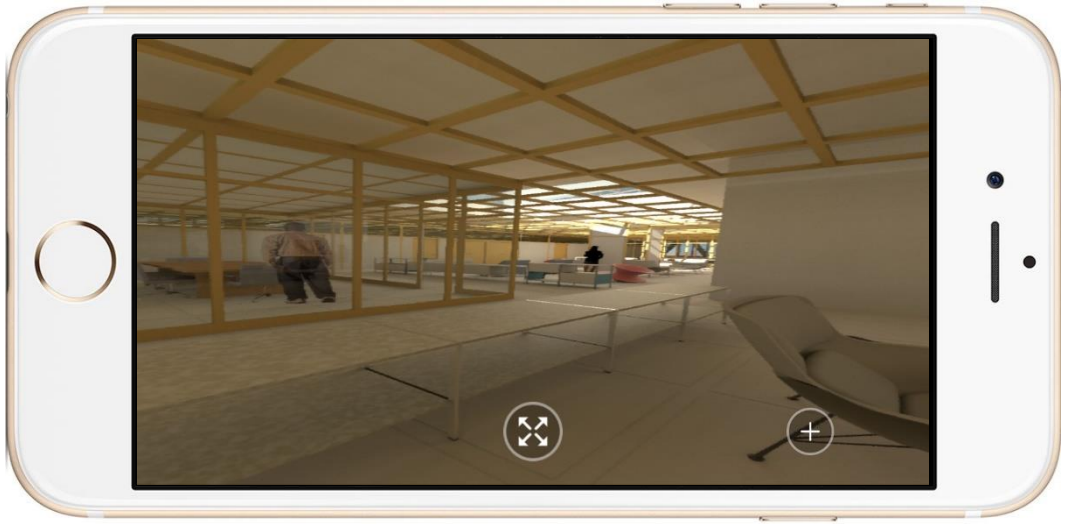
Transparent panel
16x



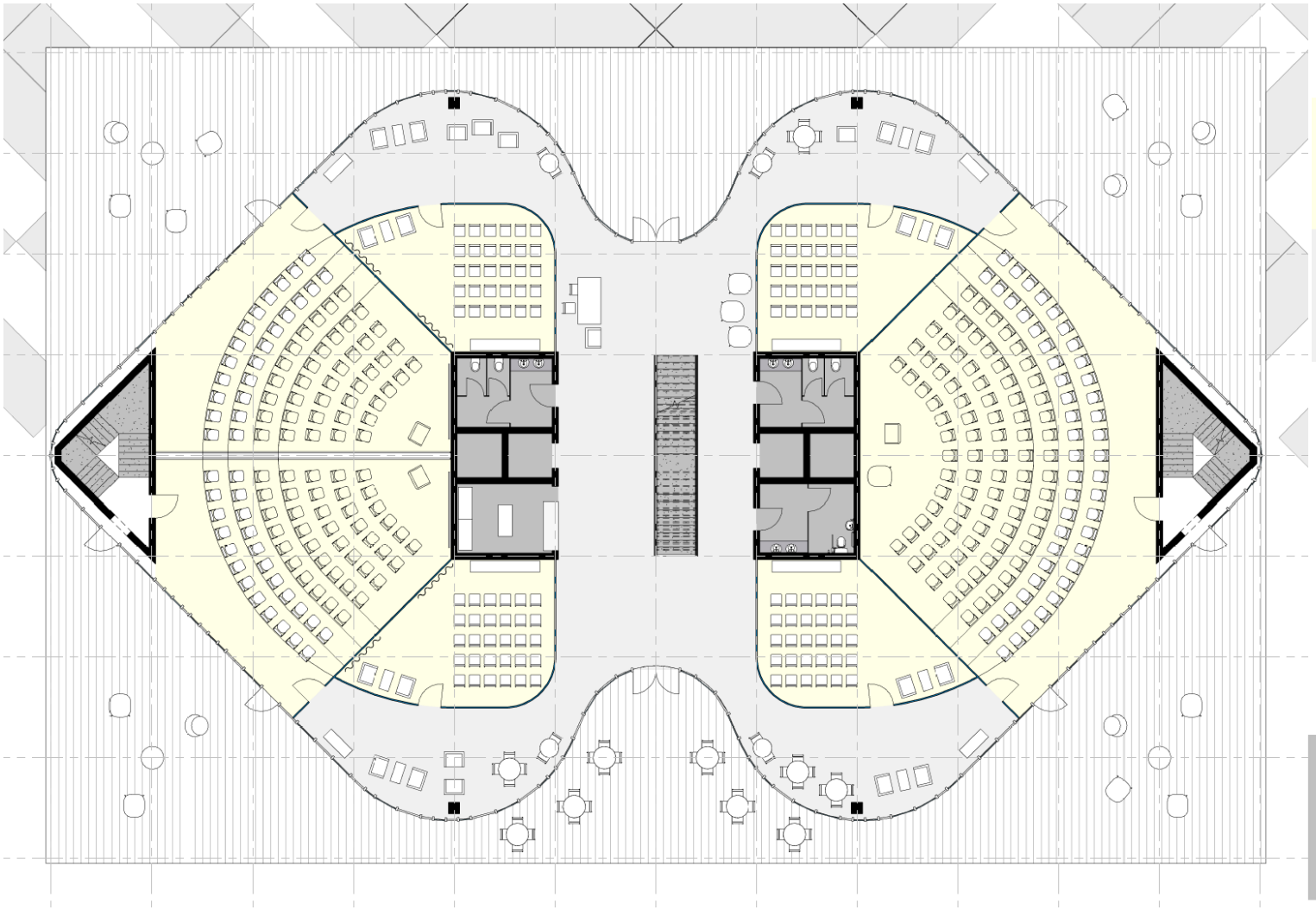
Assembly Instructions:



First Floor 360°



Ground Floor



Public

Auditorium
L Classrooms
S Classrooms

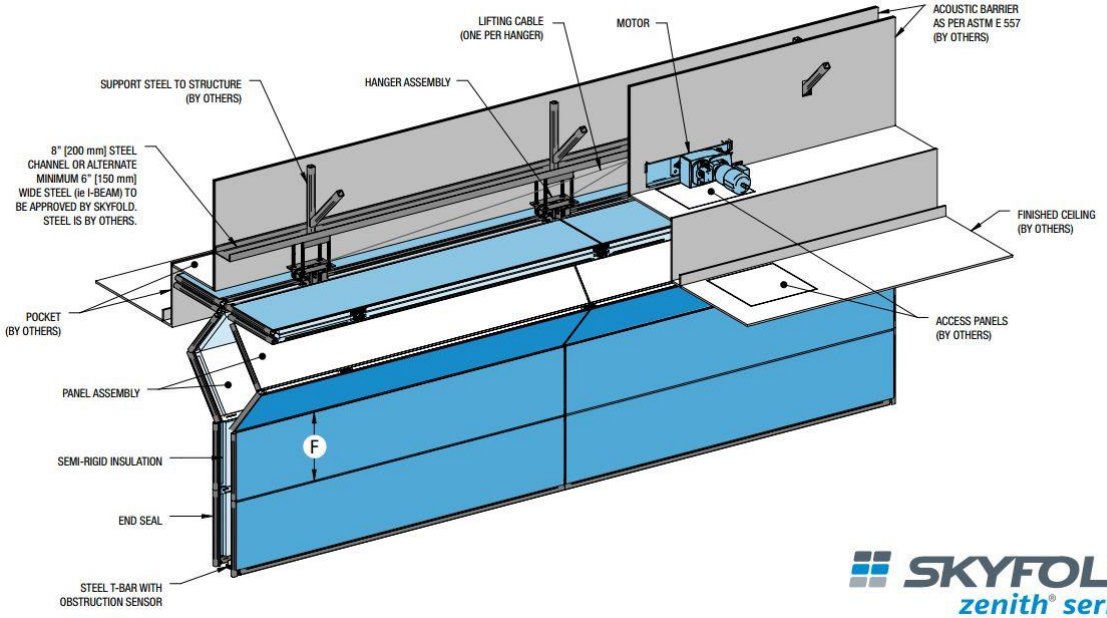
Lobby
Cafe
Reception

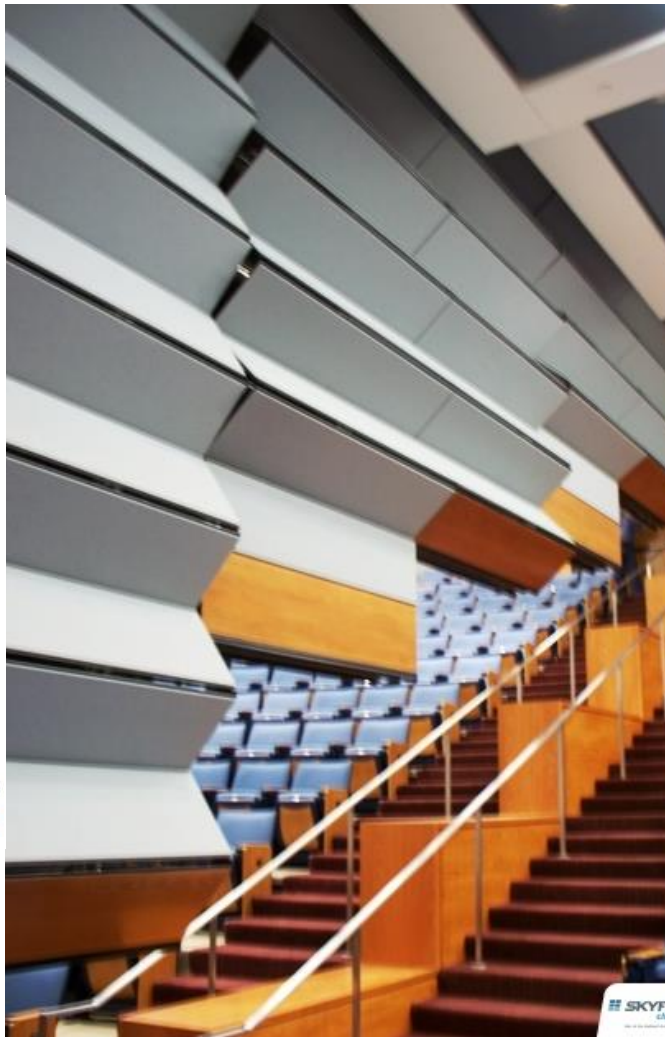
Services

Restroom
MEP Shaft
Elevator
Storage

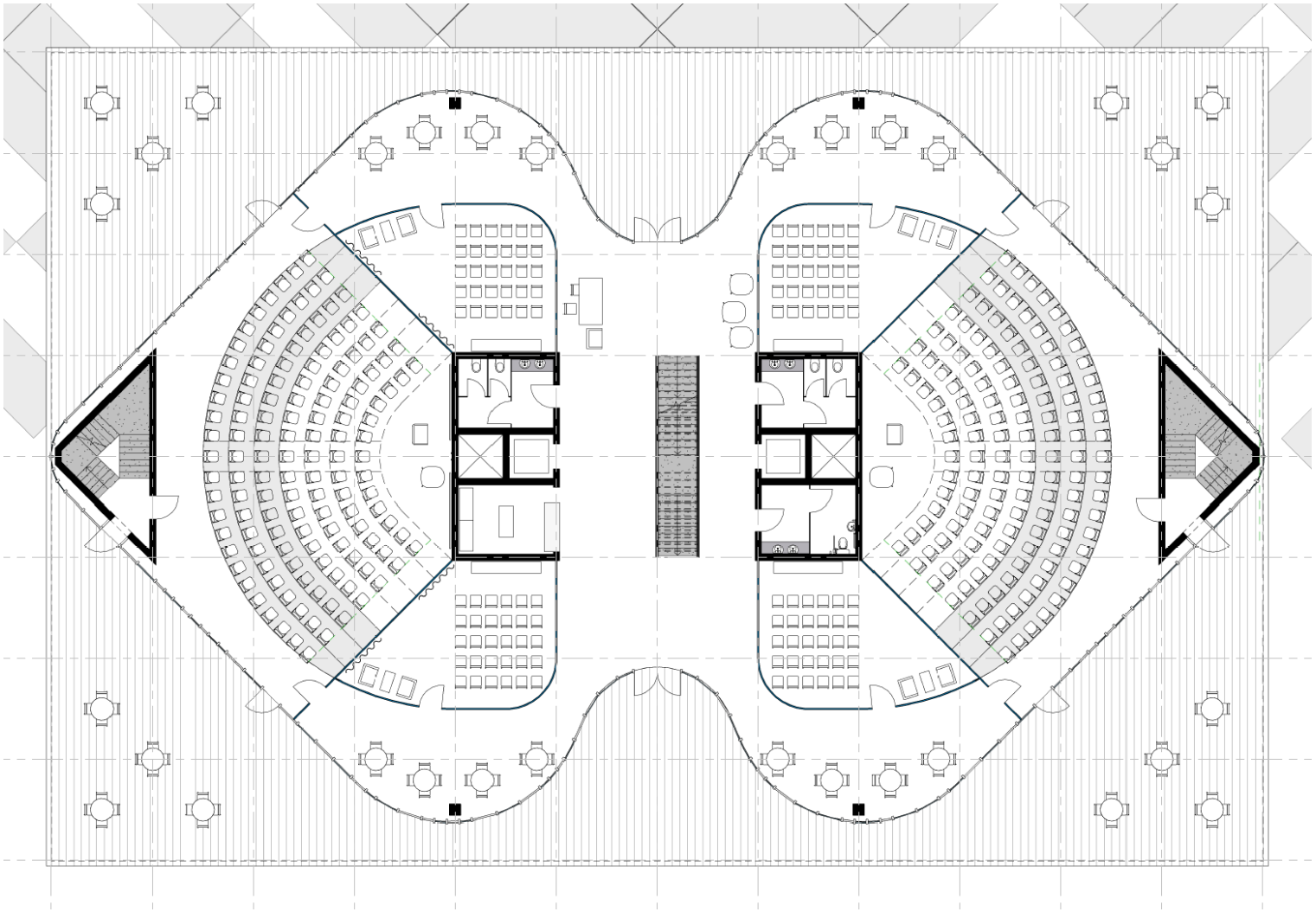
Grid: 4.0 x 4.0 m

Retractable Wall



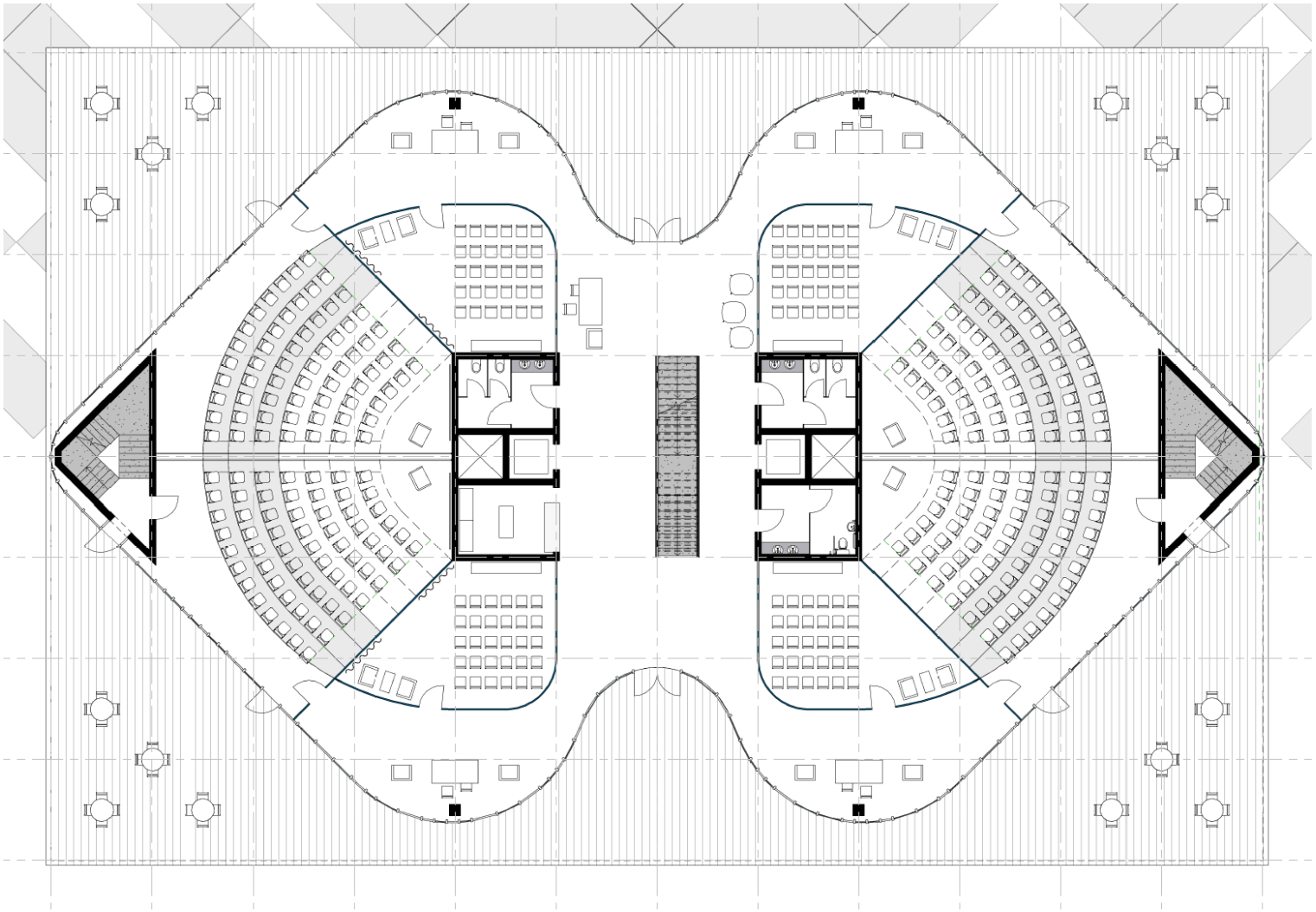


Final Presentation



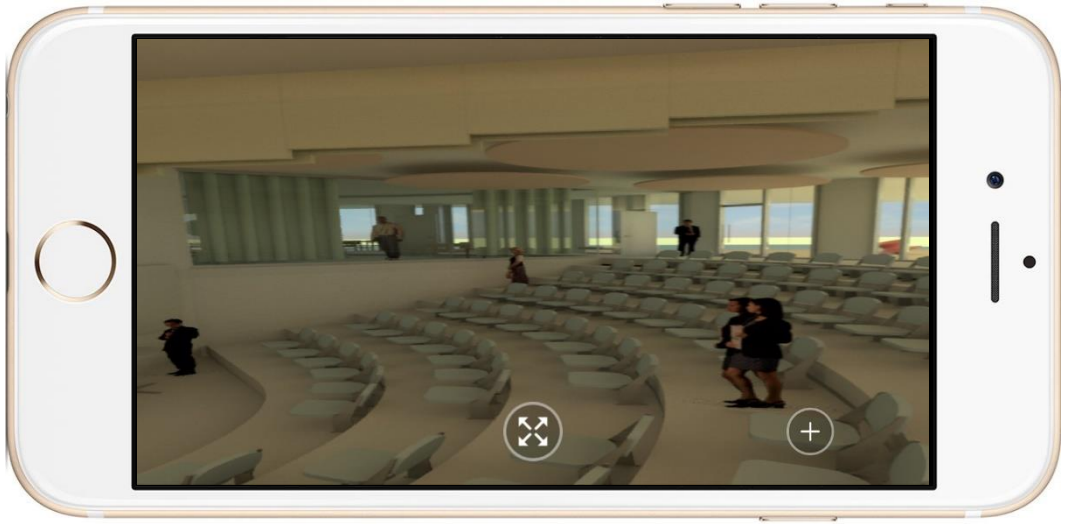
Two big auditoriums with bar tables in front and under the cantilevers

Convention

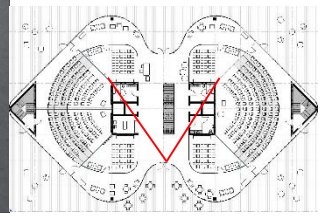


Four large classrooms with reception desks in front and bar tables under the cantilevers

Auditorium 360°



Ground Floor



Winter Quarter

Collaboration

LCFM thinking

- Integration of walkway to achieve access and maintenance opportunities

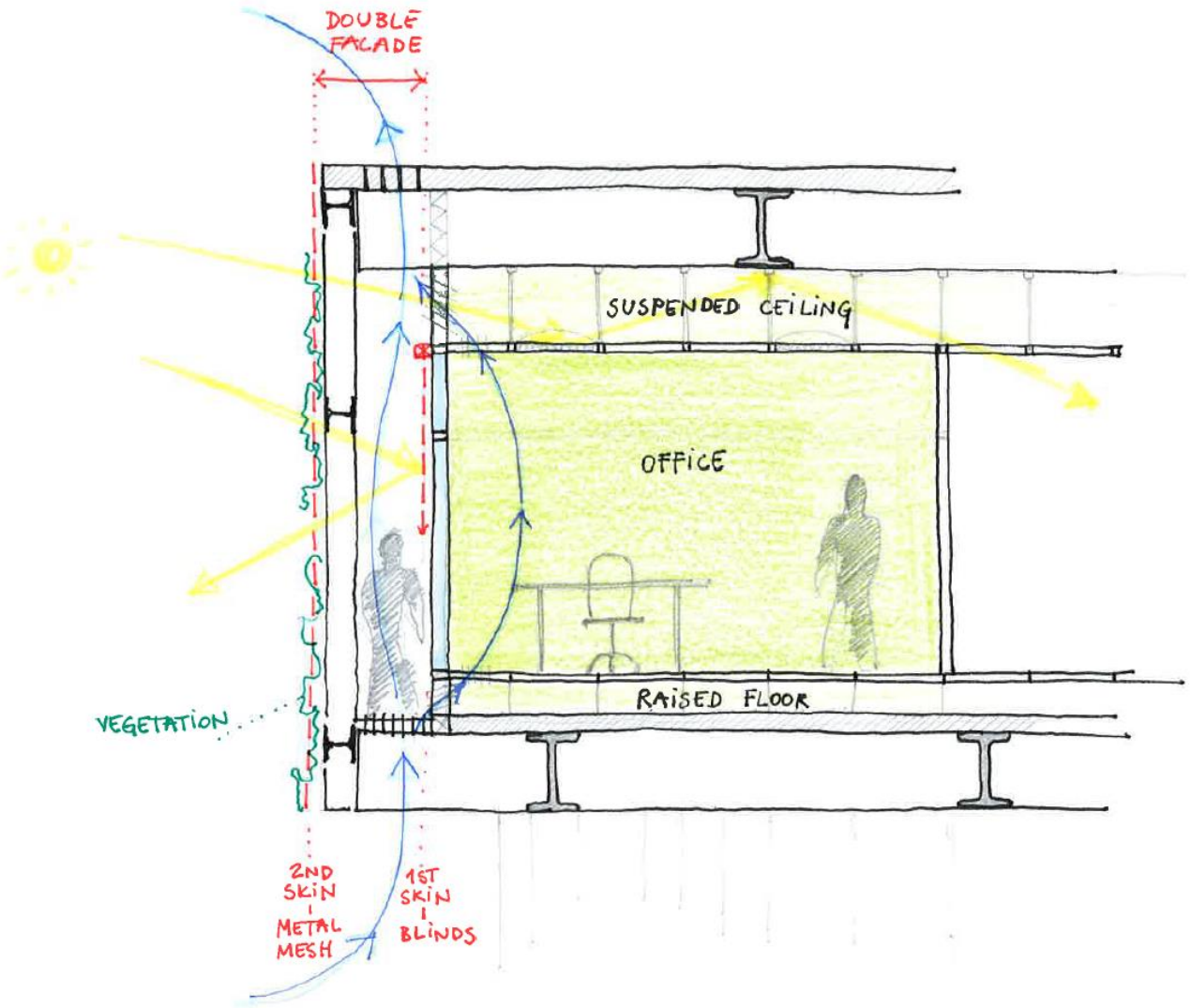
Winter design feedback

- Risk of Overheating of 1st floor
- Maintenance is critical

MEP thinking

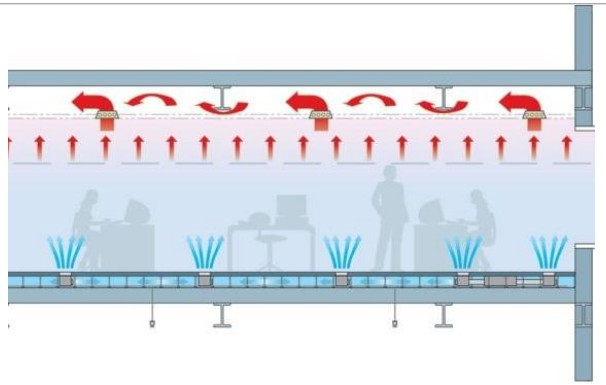
- Overhang above the façade
- External shading

Facade Section

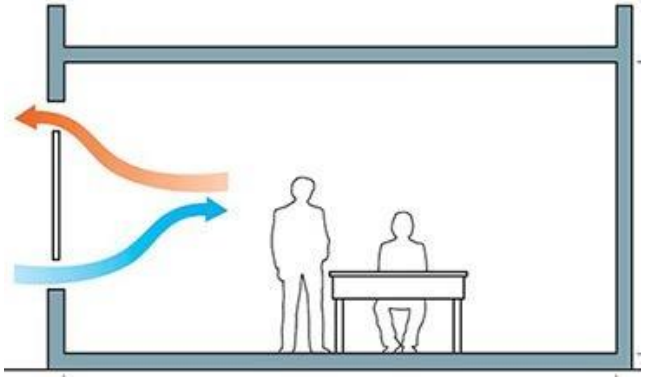


Ventilation

- Hybrid System



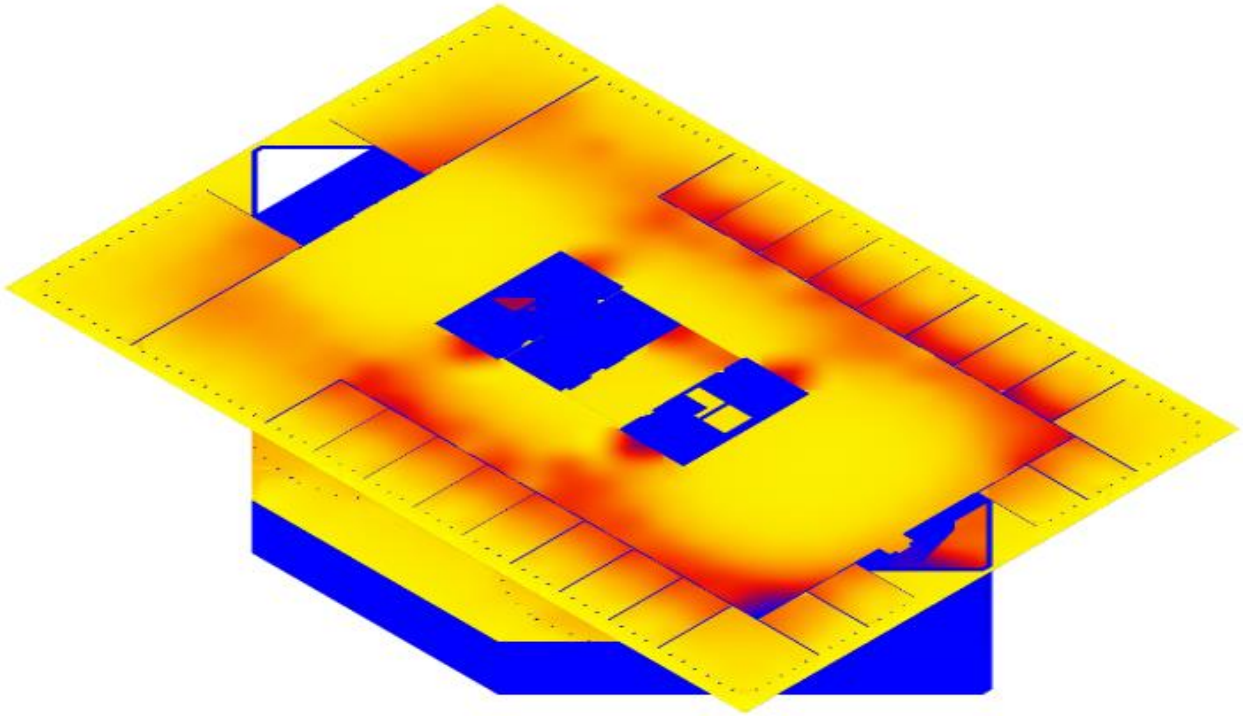
- Mechanical – when natural is not sufficient
- Natural - when external conditions are fine



- Controls by windows
- Red light:
- - bad outside conditions

- Green light:
- - good outside conditions

Daylighting



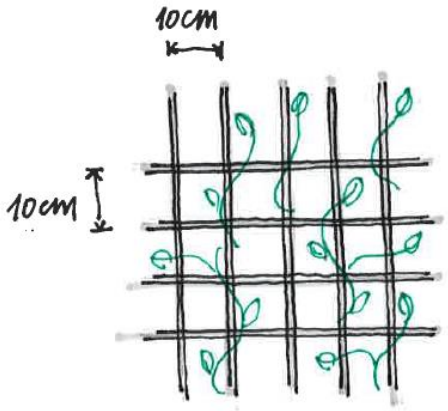
Percentage of occupied hours where illuminance is at least 300 lux, measured at 0.85 meters above the floor plate.

0% 25% 50% 75% 100%

Double Green Facade

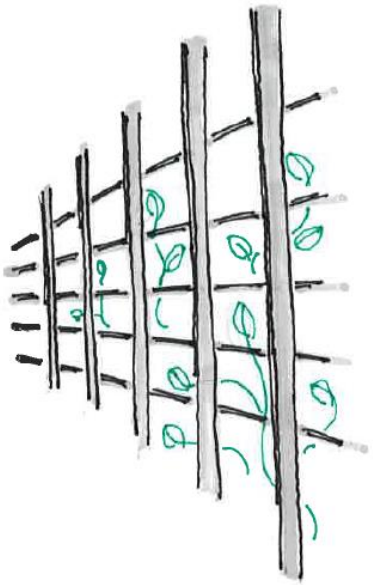
External Shading

Metal Mesh



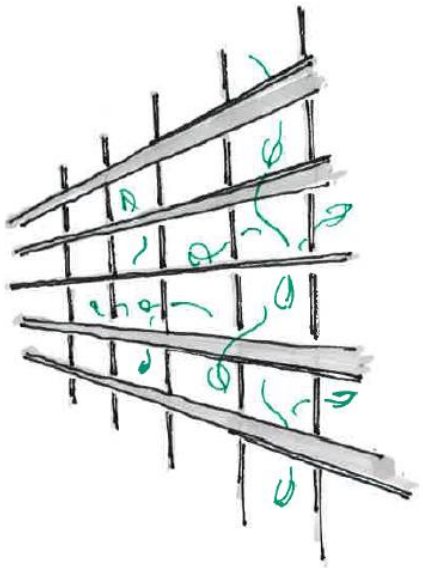
METAL MESH

75% TRANSPARENCY



EAST/WEST FACADE

- THICKER VERTICAL MEMBERS



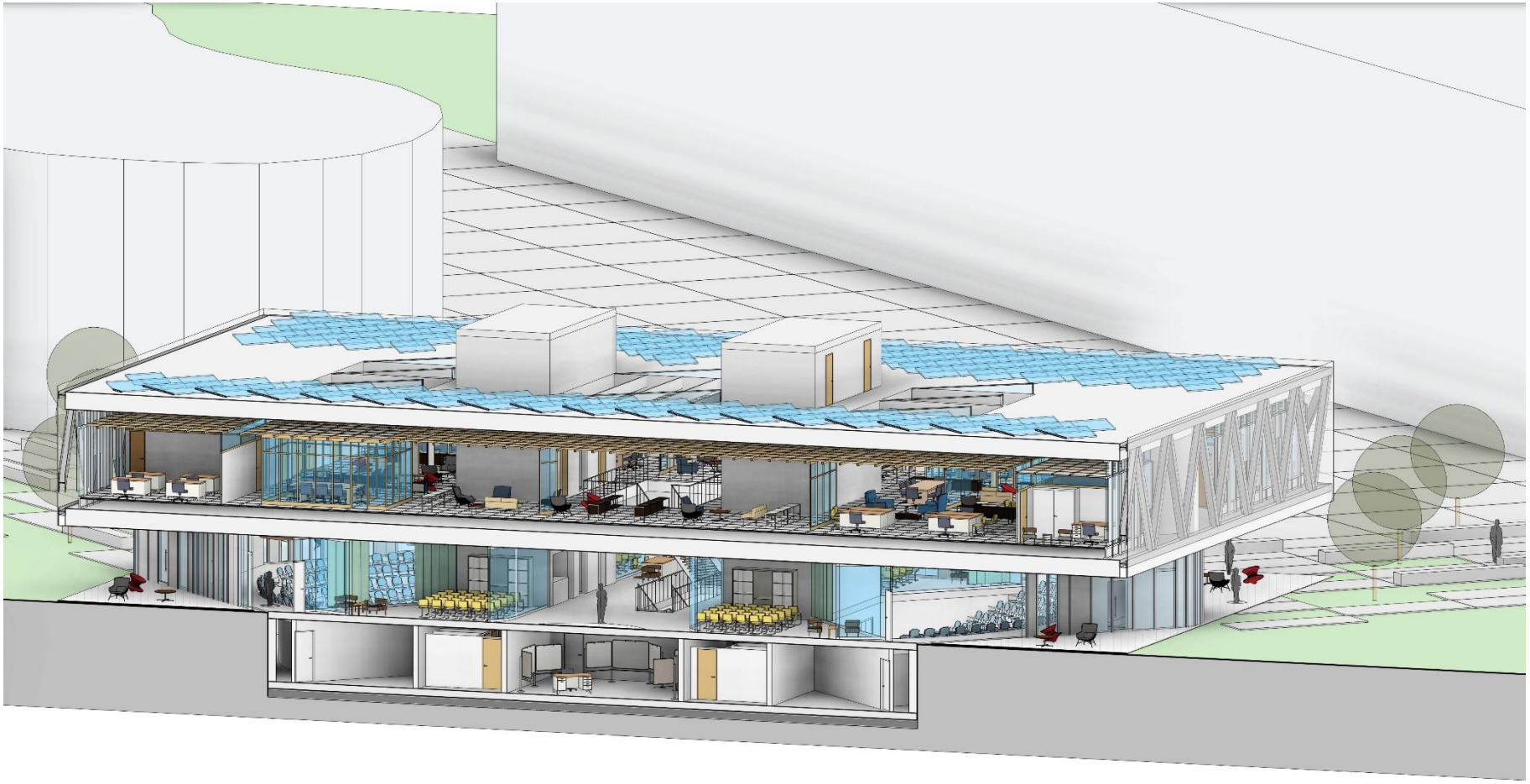
SOUTH FACADE

- THICKER HORIZONTAL MEMBERS

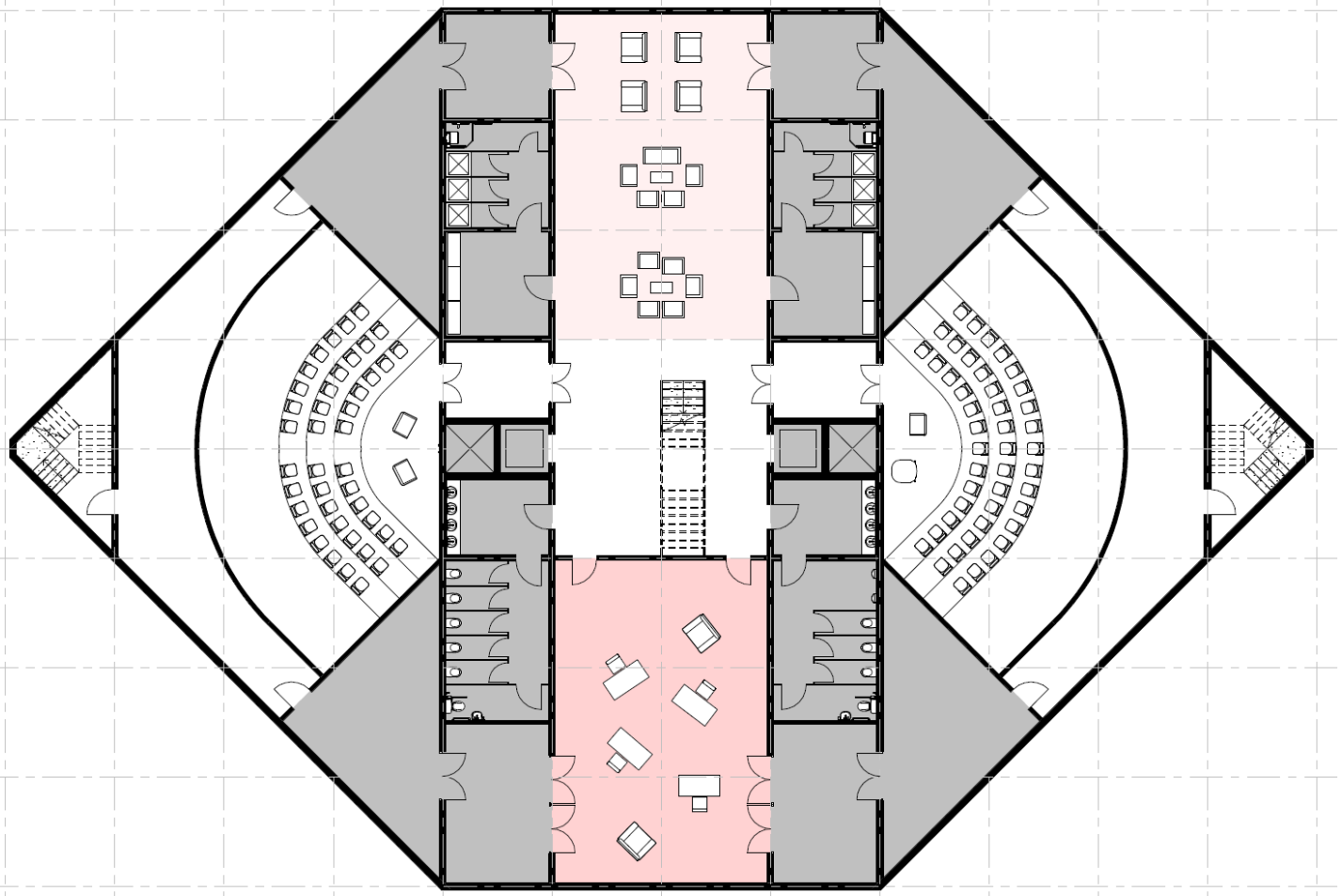
Winter Quarter

Entrance Square

Section View



Basement



Private

Student lounge
Relaxation area

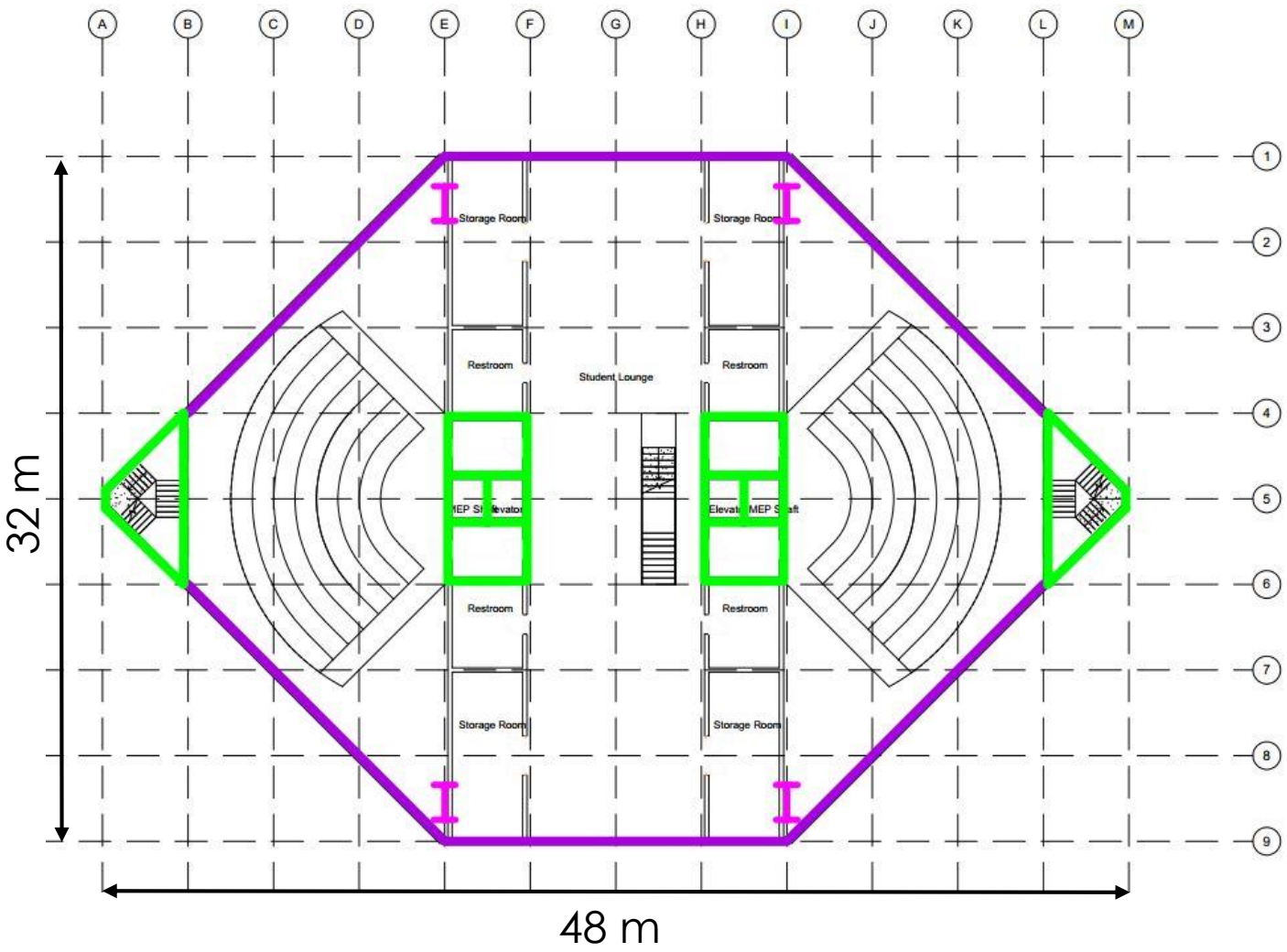
Virtual reality studio

Services

Restroom
MEP Shaft
Elevator
Storage
Showers

Grid: 4.0 x 4.0 m

Basement



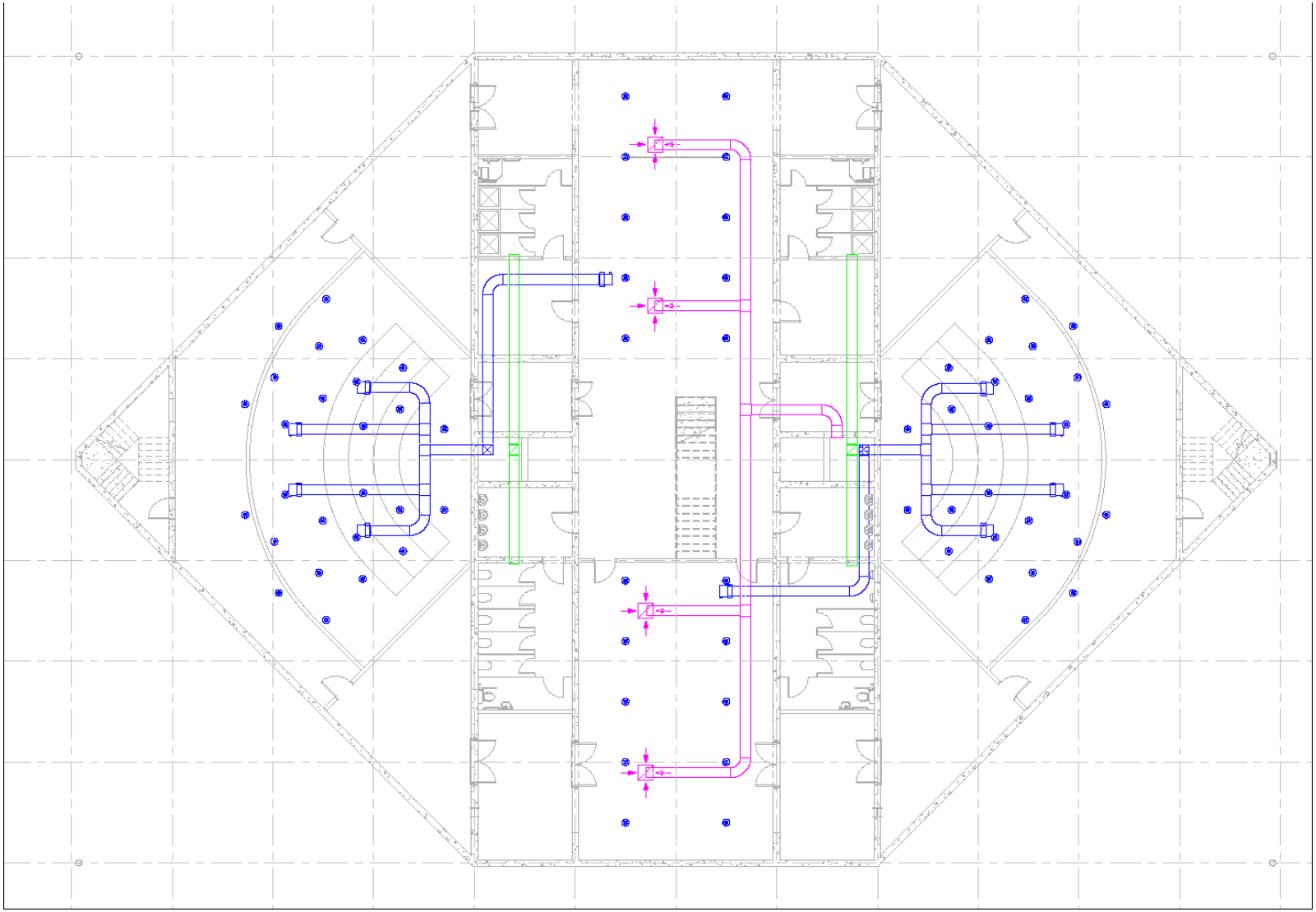
Retaining Wall (10")

Shear Wall (10")

Column W14X99

Grid Span
4m

Econdustry Distribution



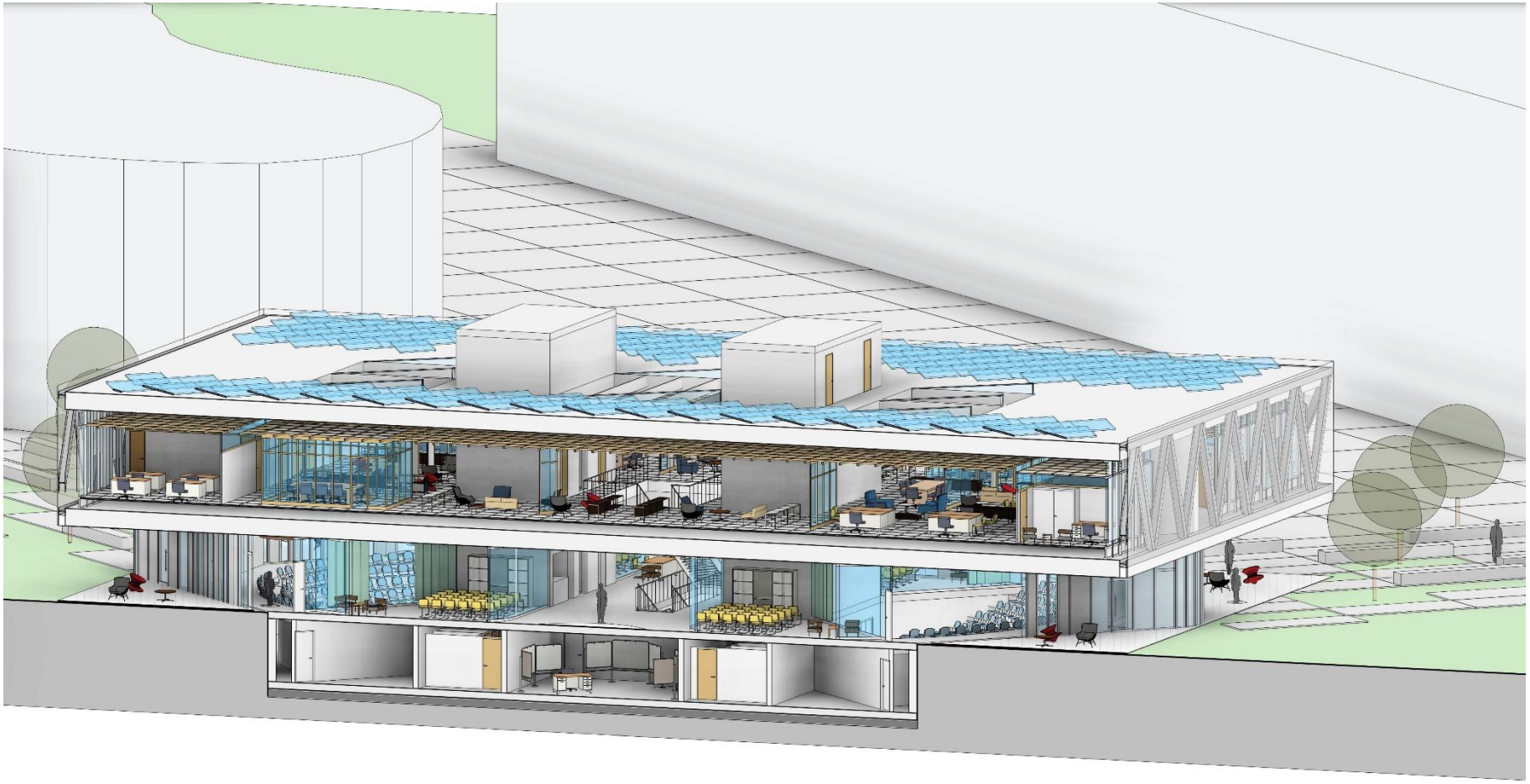
Supply diffusers

Return Terminal

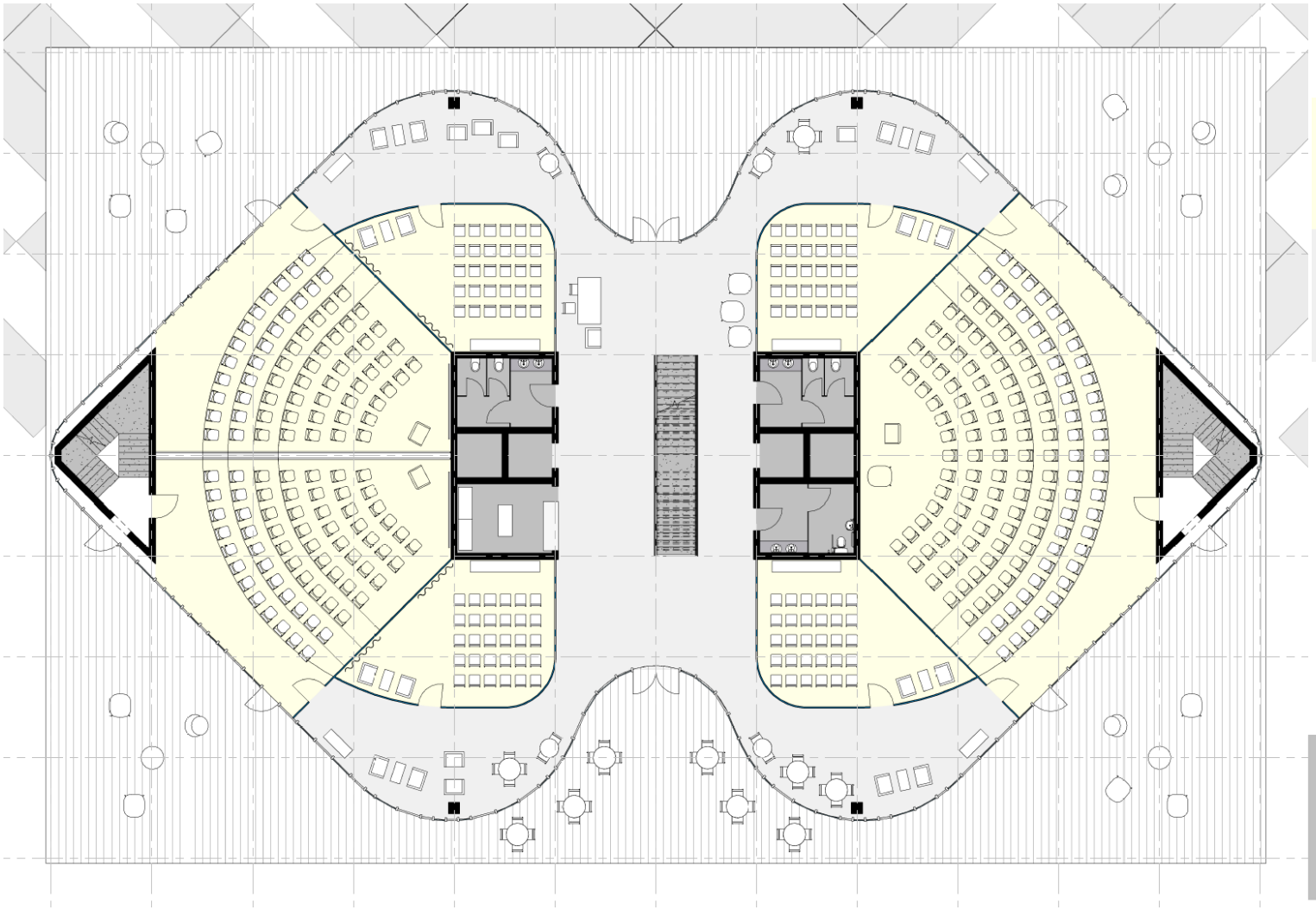
Exhaust

Basement

Section View



Ground Floor



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MEP Shaft
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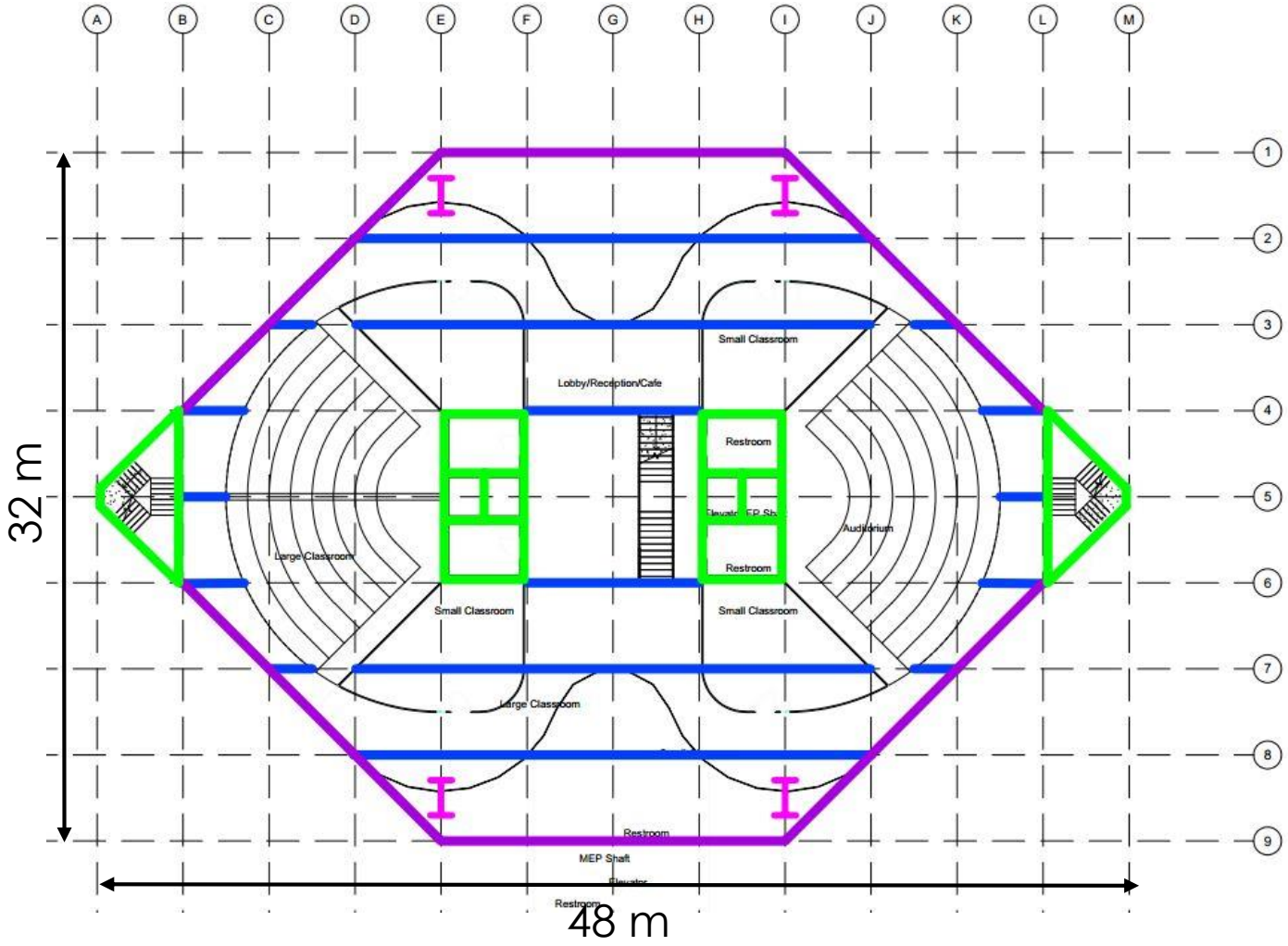


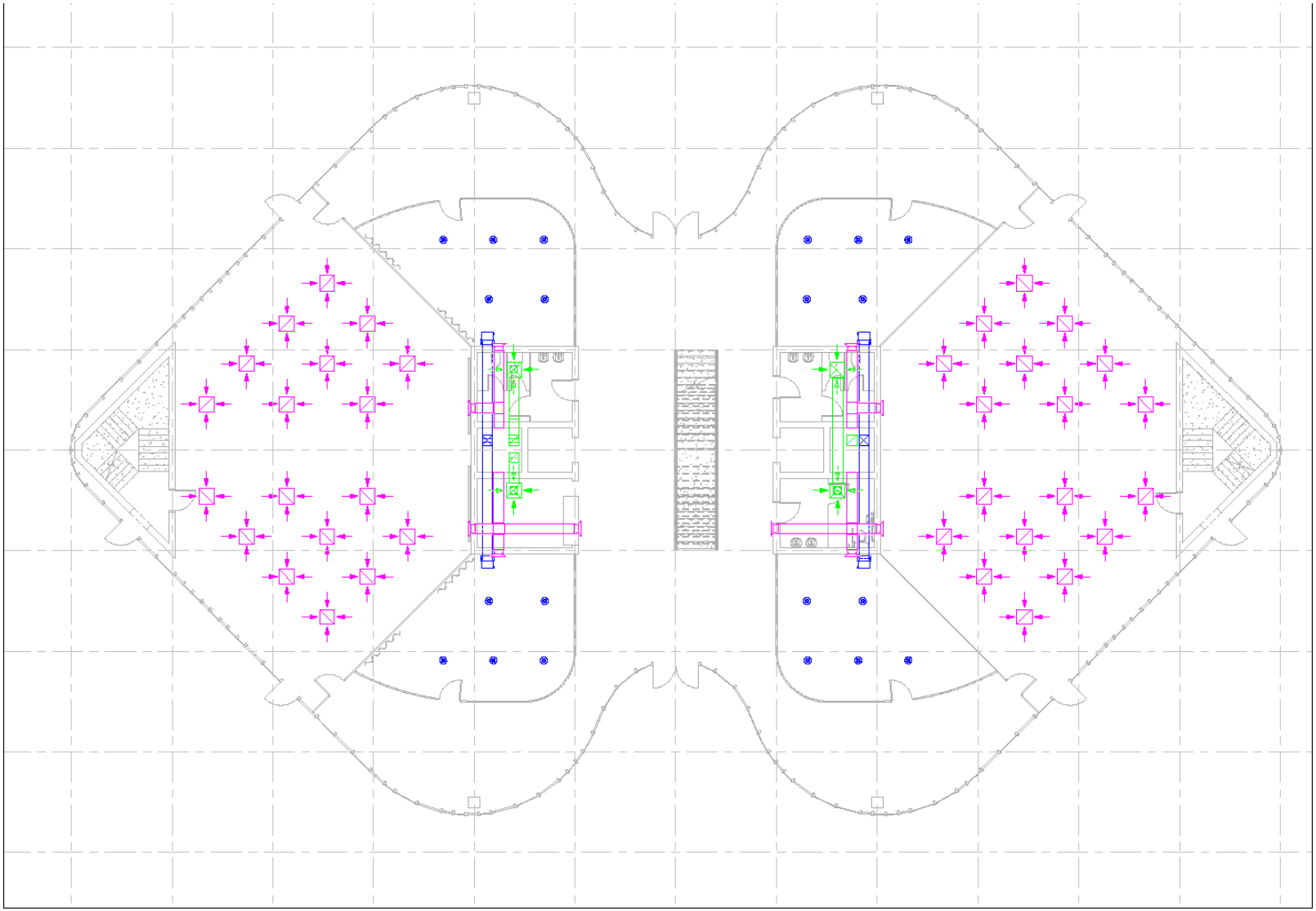
Shear Wall (10")

Beam W16X89

Column W14X99

Grid Span
4m

Econdustry Distribution

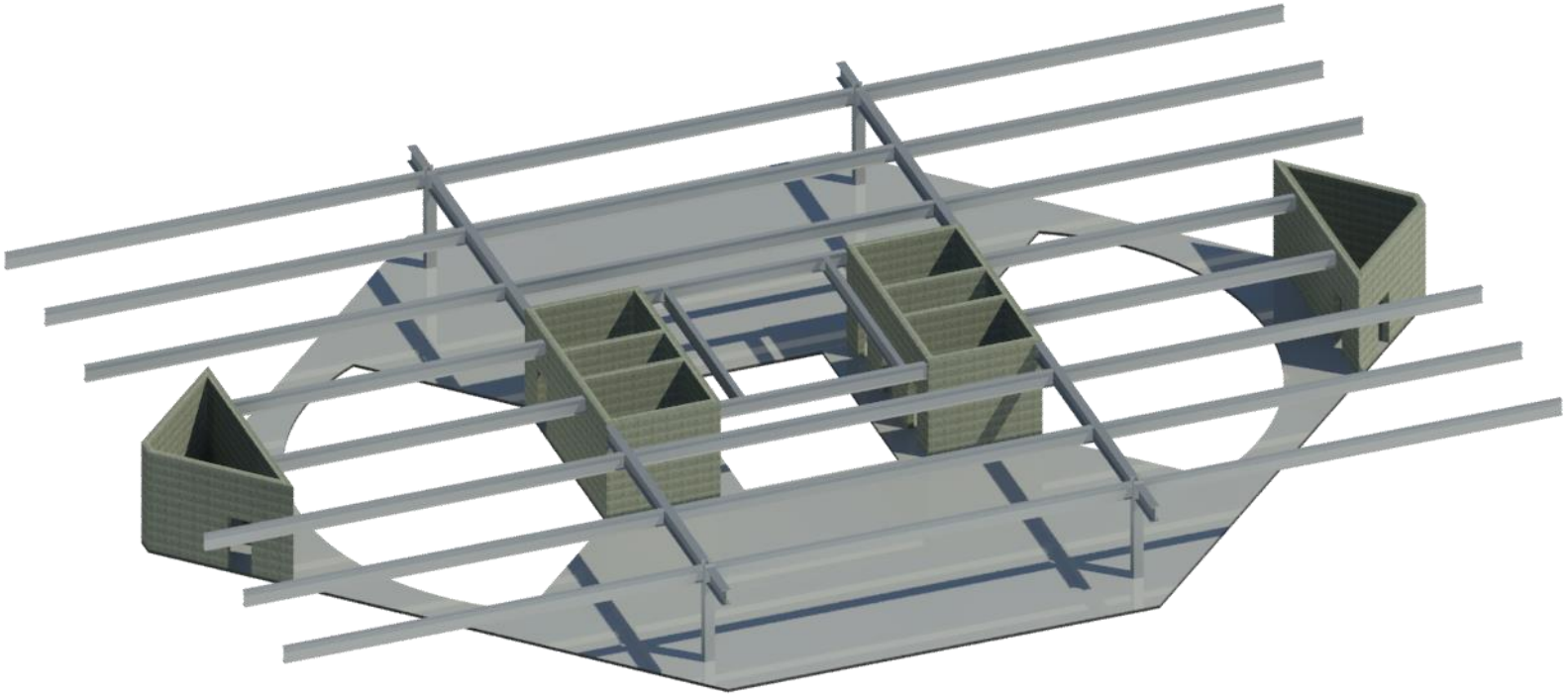


Supply diffusers

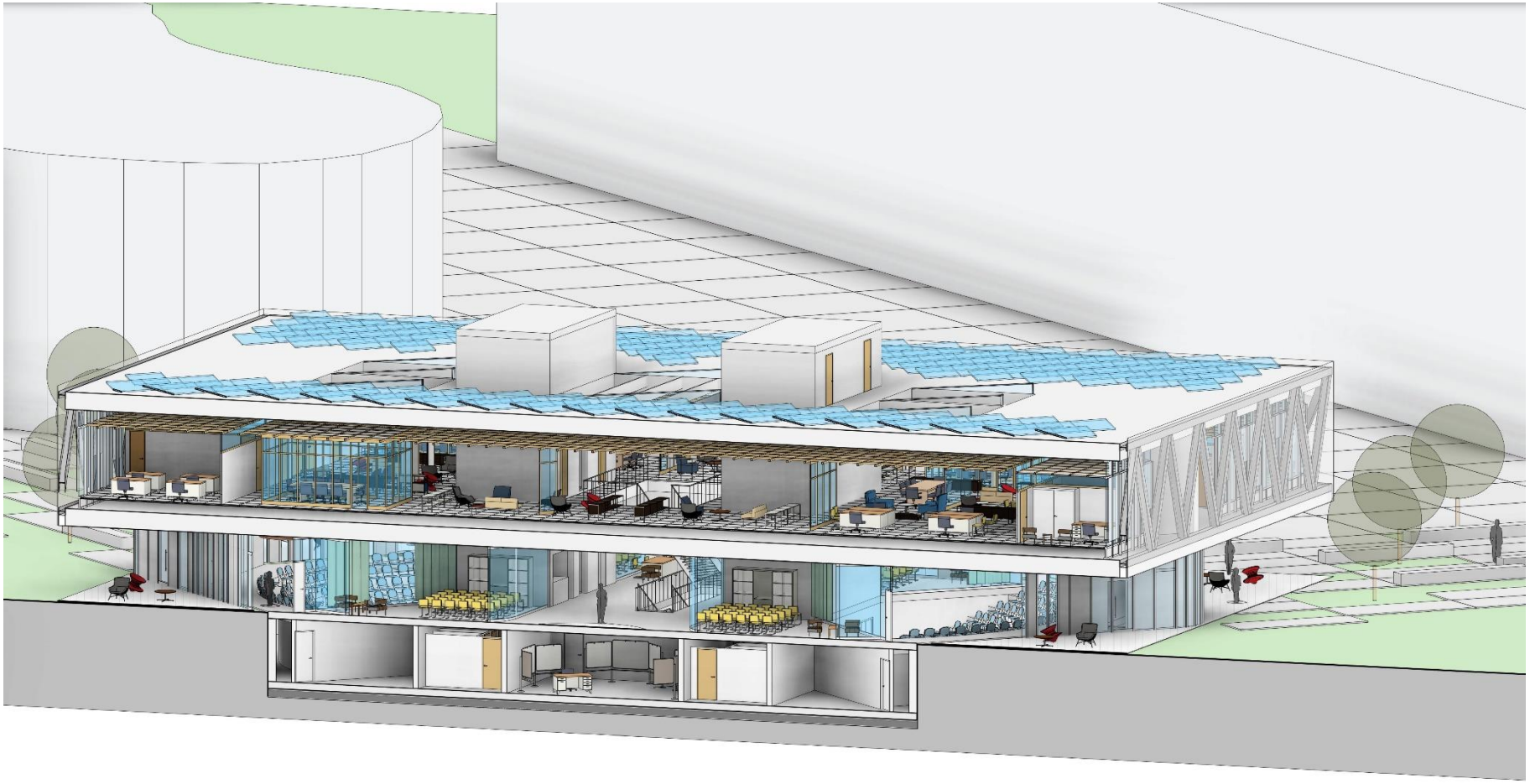
Return Terminal

Exhaust

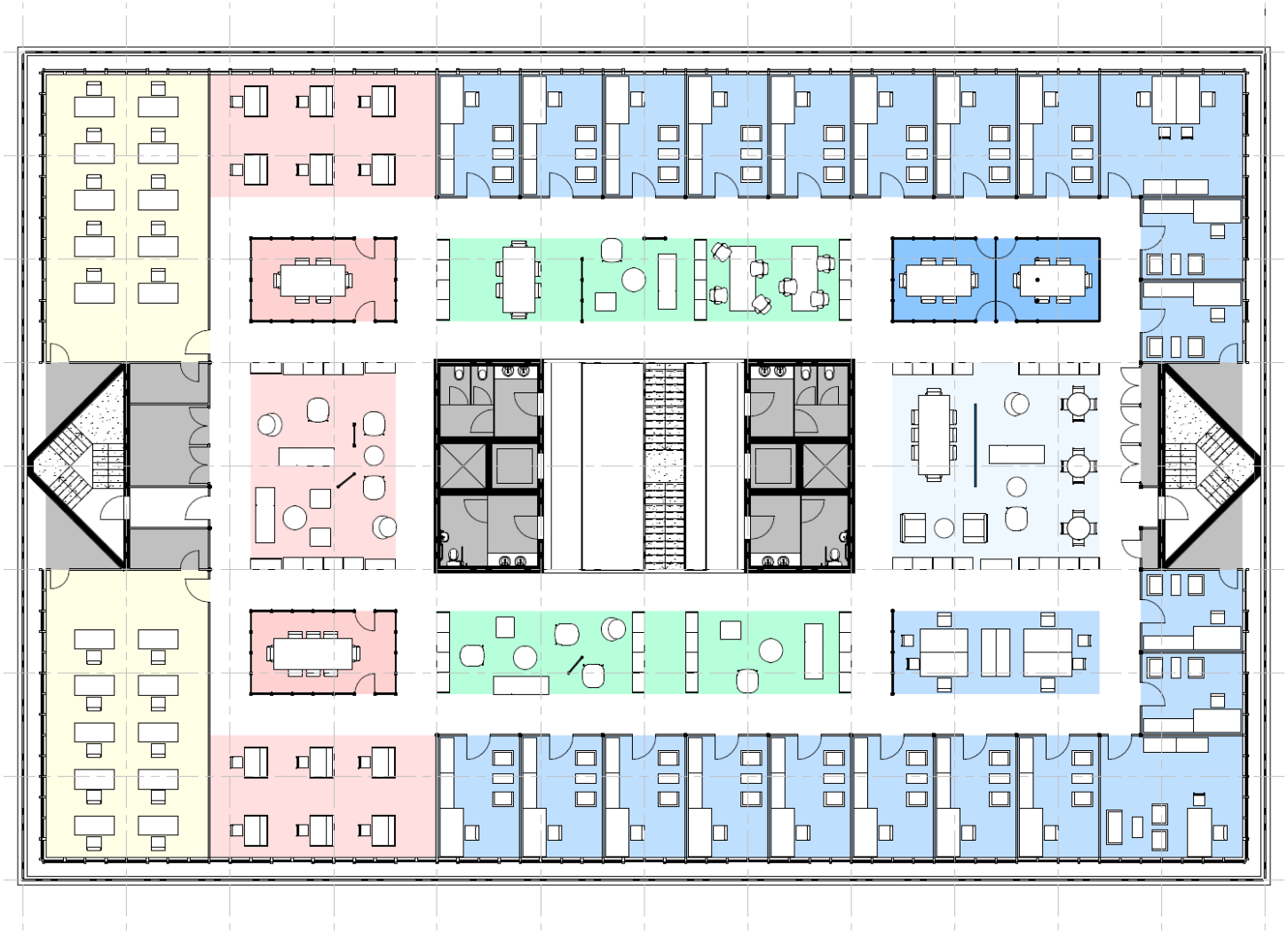
Ground Floor



Section View



1st Floor



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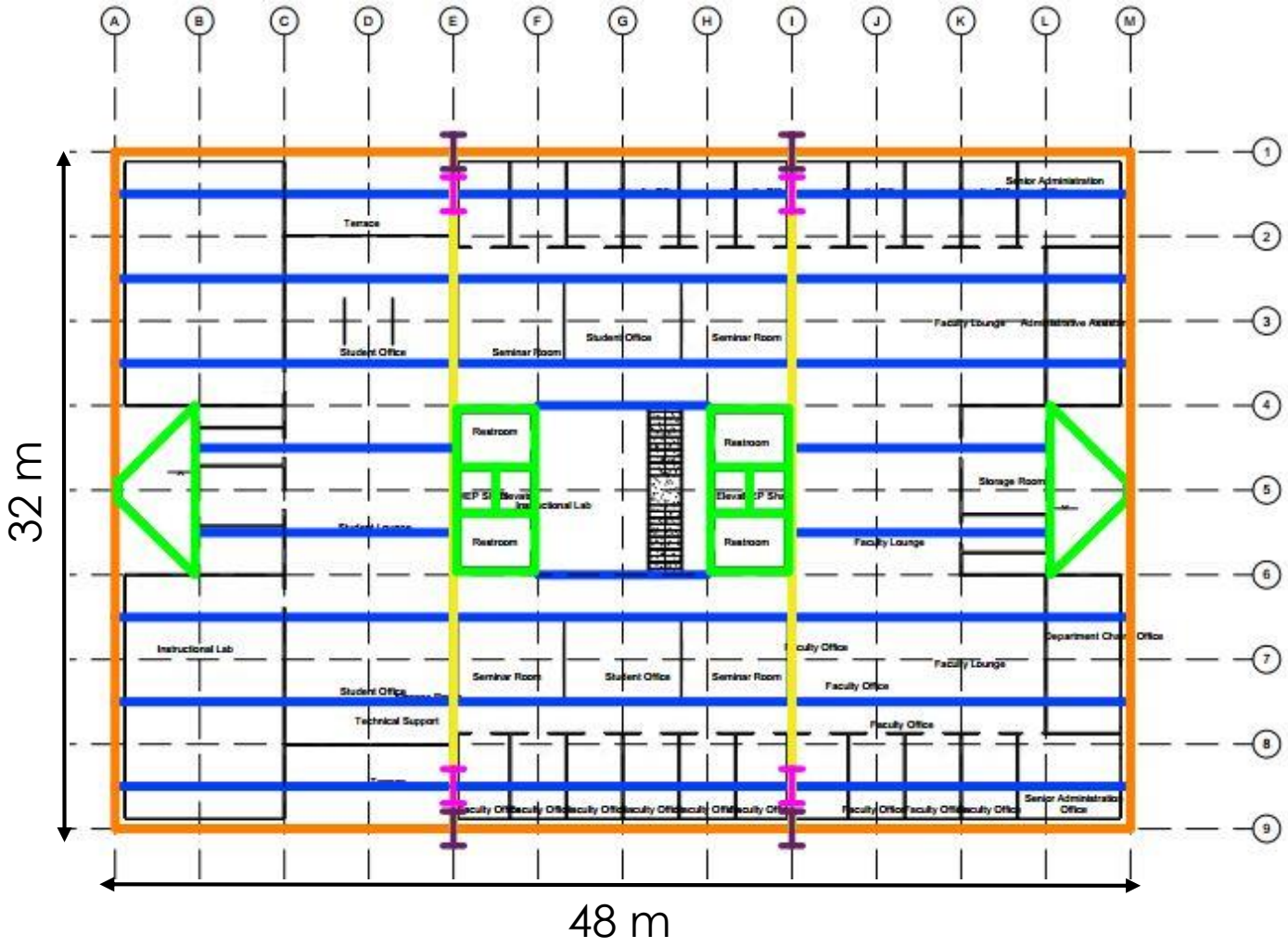
Services

Restroom
MEP Shaft
Elevator
Storage

Grid: 4.0 x 4.0 m

First Floor



Truss
Chord W12x96
Web W12x65

Shear Wall (10")

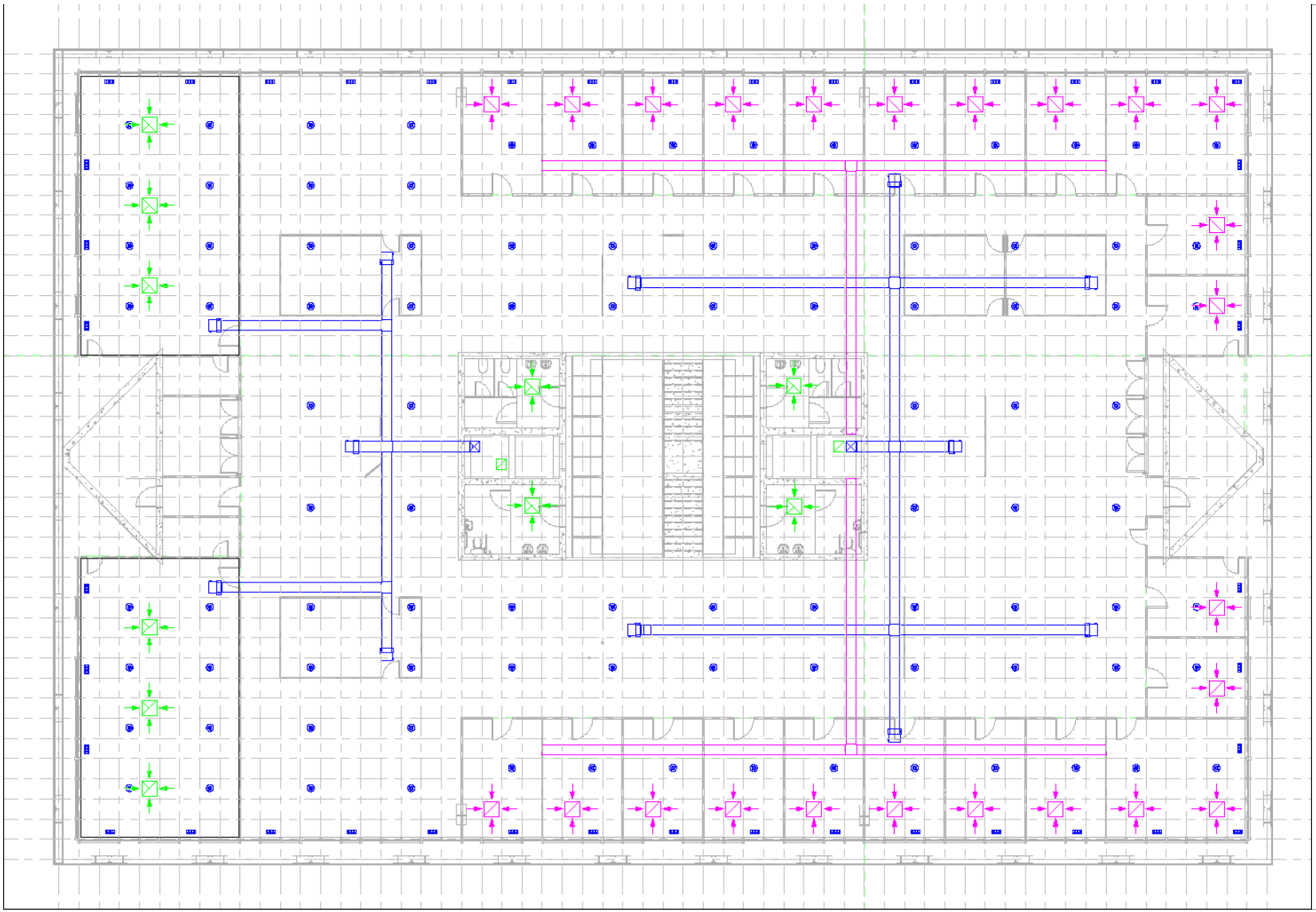
Girder W24X117

Beam W24X76

Slanted Column
W14X90

Grid Span
4m

Econdustry Distribution

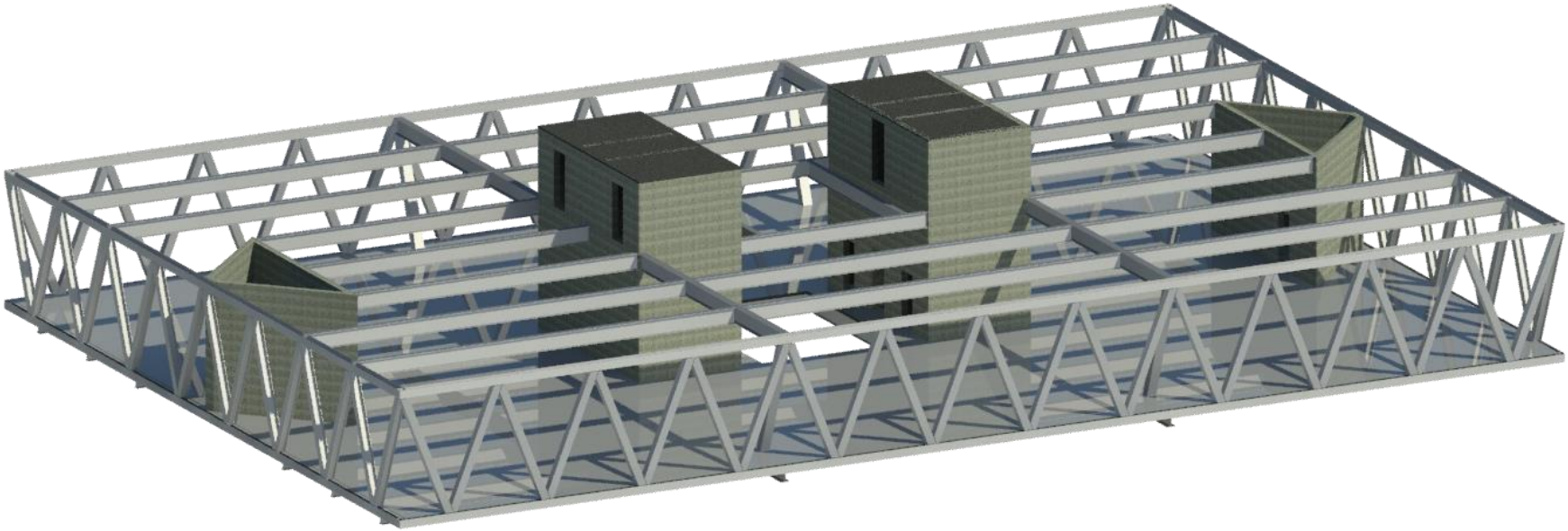


Supply diffusers

Return Terminal

Exhaust

First Floor



Load Overview

Live Load:

- 40 psf – Seminar Rooms, Small Classrooms
- 50 psf – Offices, Lounges, Labs
- 60 psf – Auditorium, Large Classrooms
- 100 psf – Lobby, Corridors, MEP & Storage Rooms
- 20 psf – Roof

Snow Load:

- 30 psf

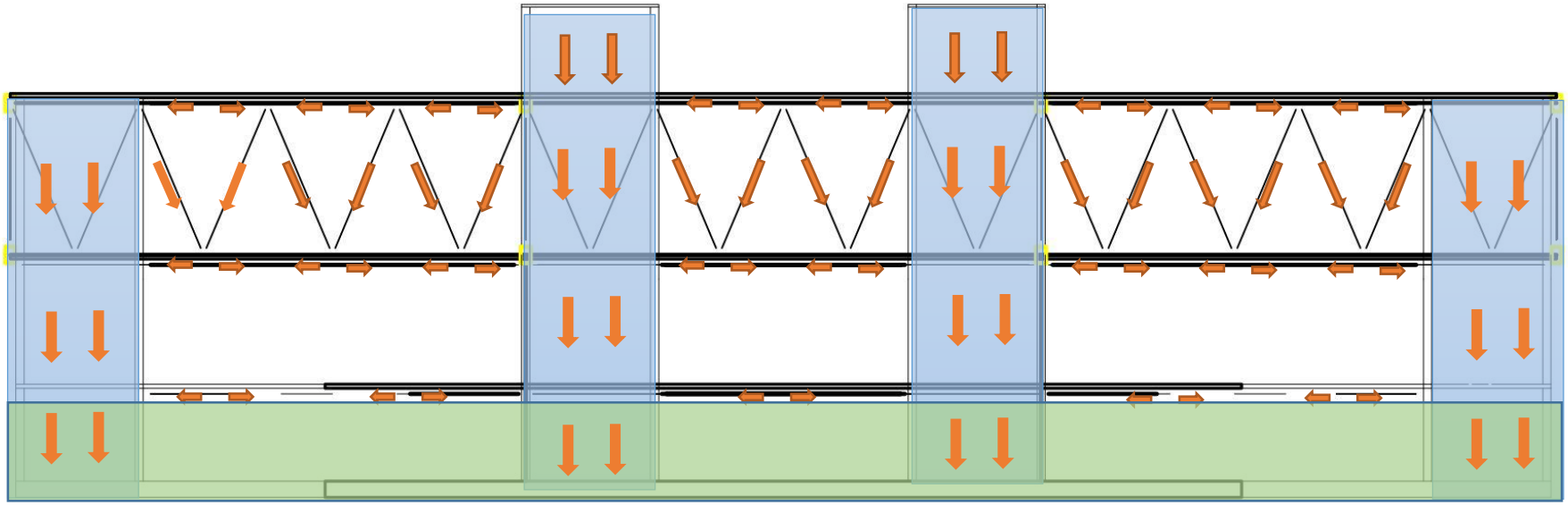
Seismic:

- Base Shear = 0.106W

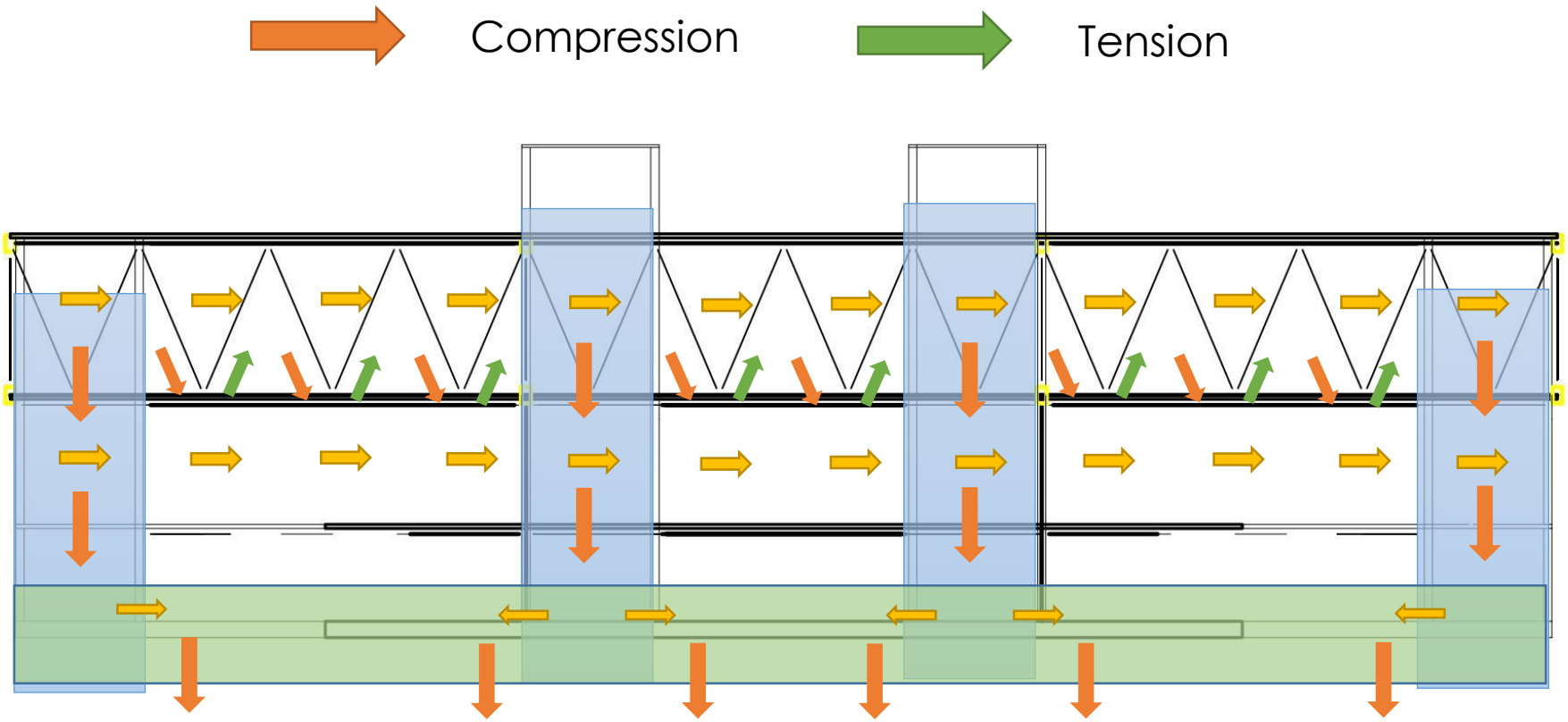
Water Table:

- 5 feet of hydrostatic head

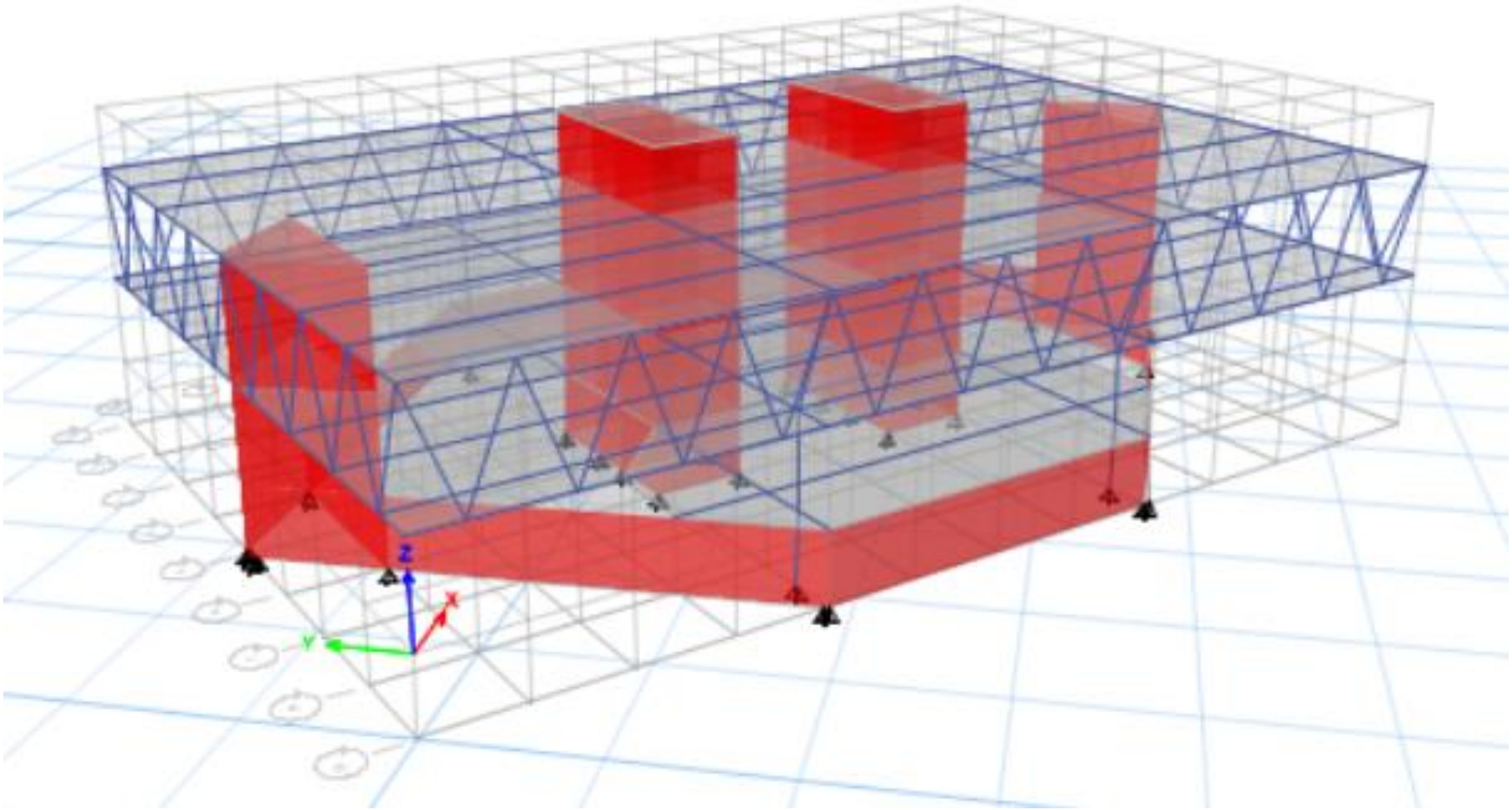
Gravity Load Path



Lateral Load Path



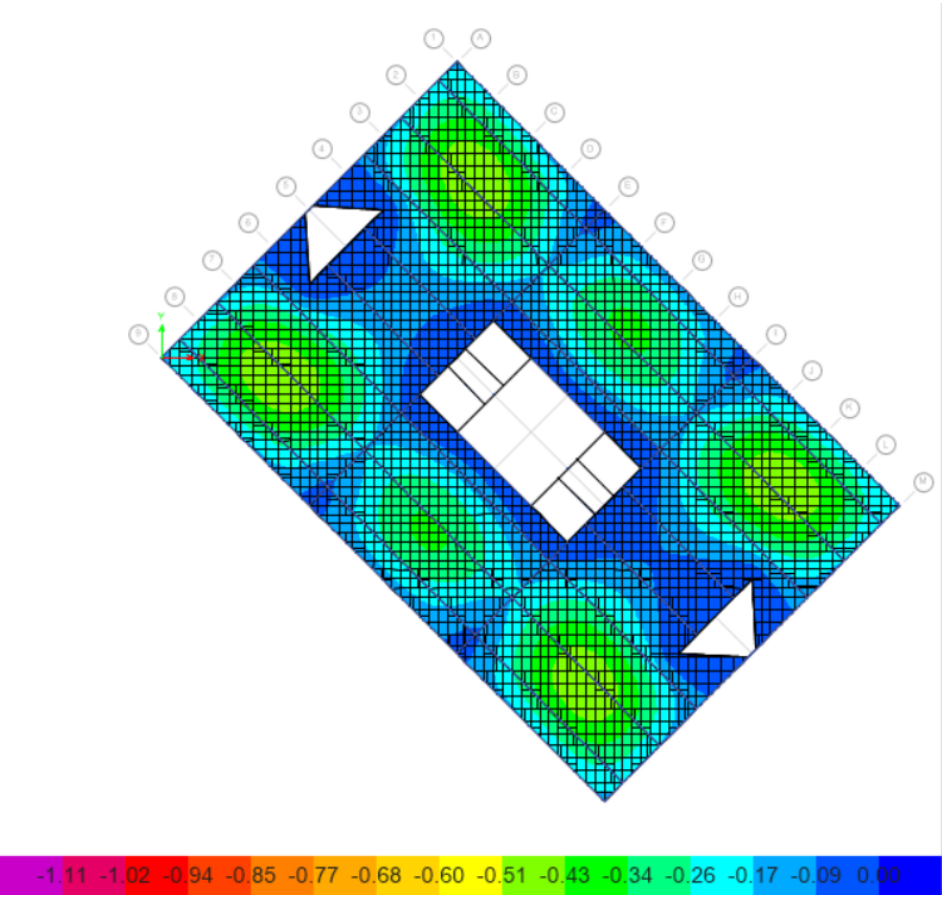
ETABS Model



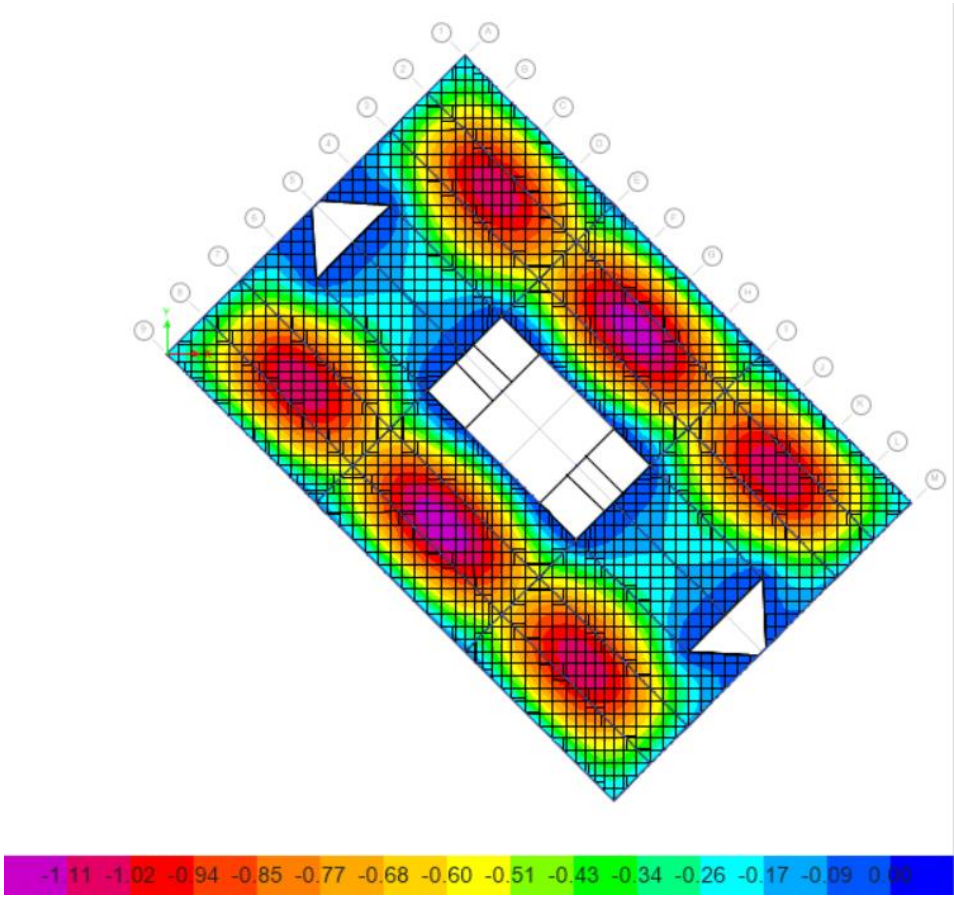
Slab Deflections

Check 1: Live Load Only (Limit: L/360)

First Floor = 0.49 < 1.75 in



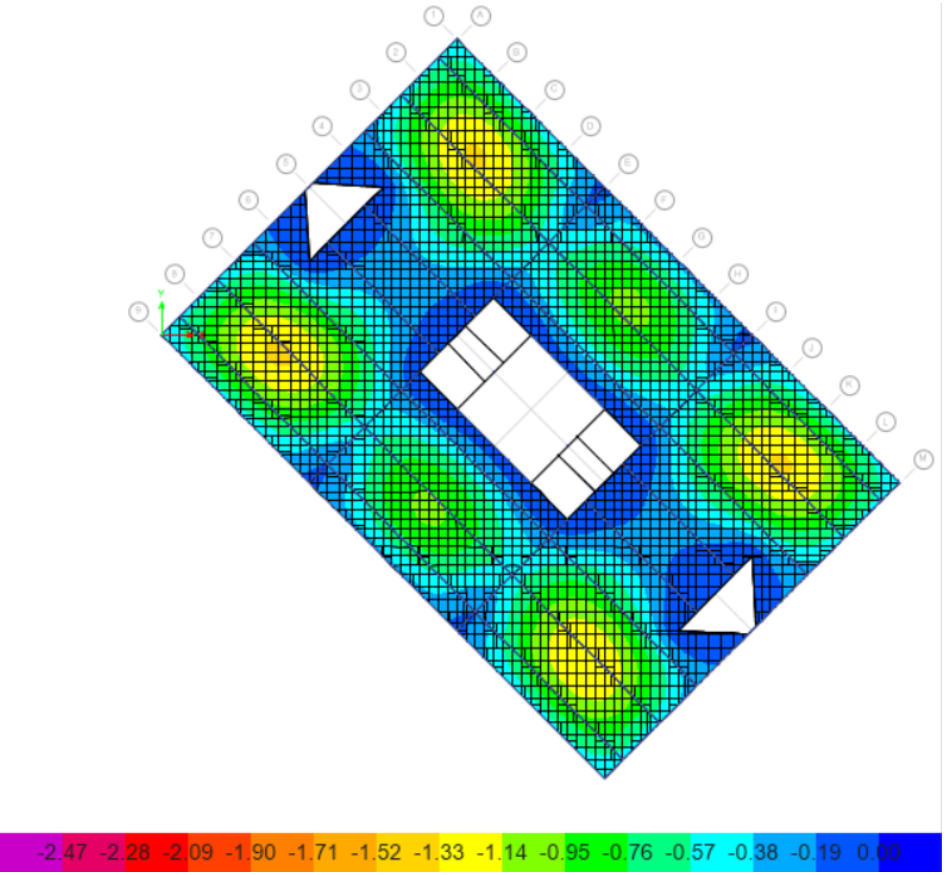
Roof = 1.18 in < 1.75 in



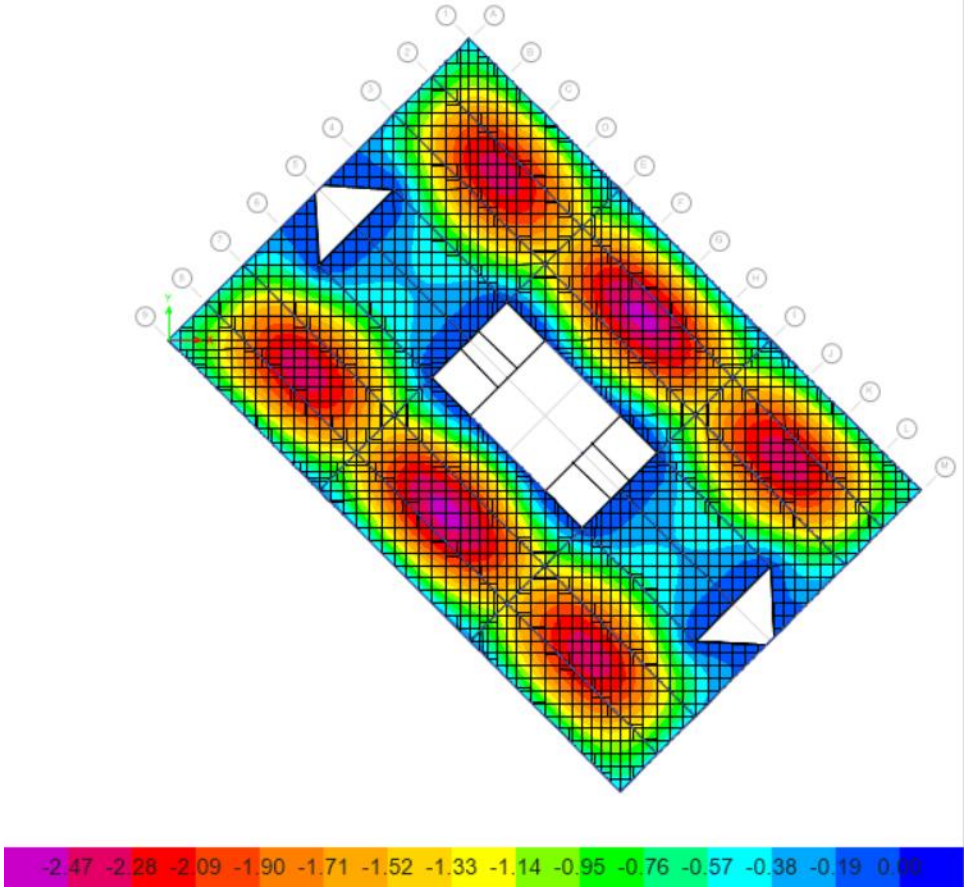
Slab Deflections

Check 2: Dead Load + Live Load (Limit: L/240)

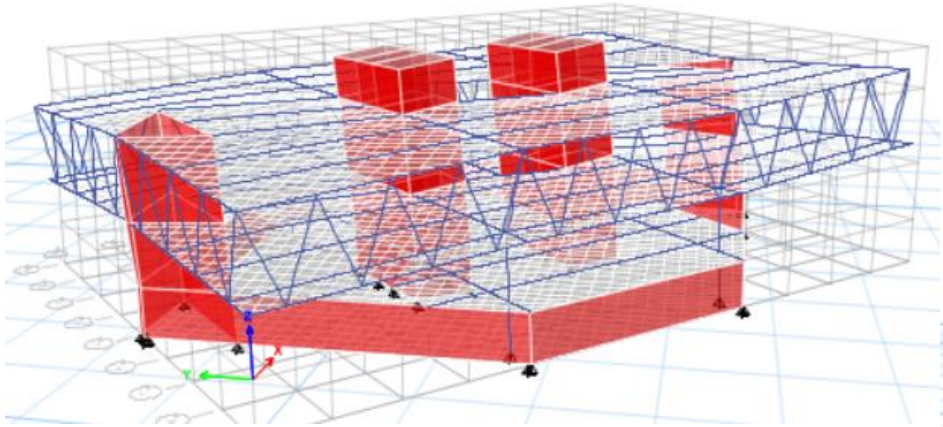
First Floor = 1.35 < 2.625 in



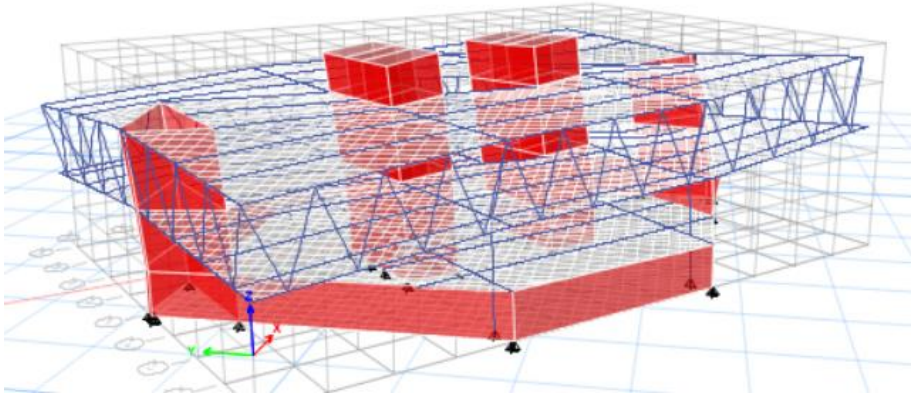
Roof = 2.55 in < 2.625 in



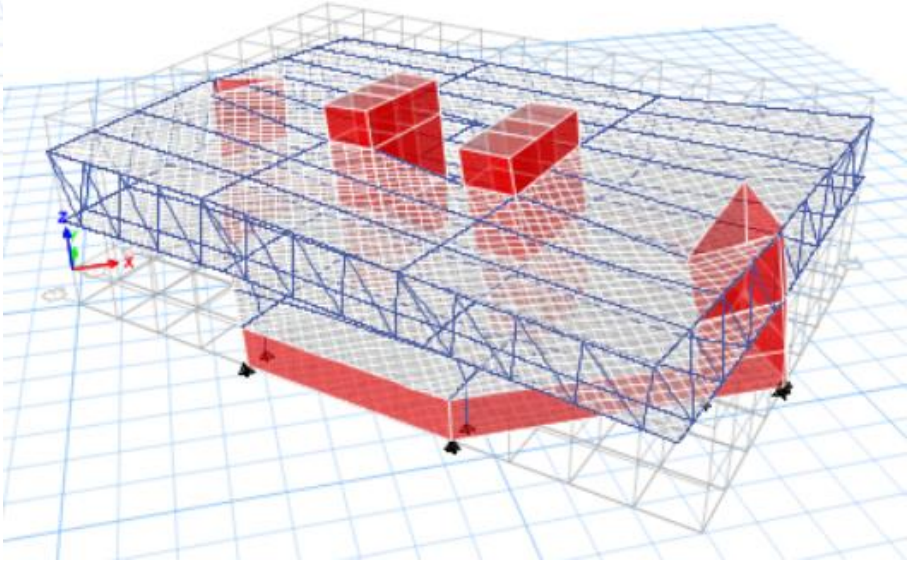
Mode Shapes



First Mode



Second Mode



Third Mode

Story Displacement

Earthquake parameters:

S_{DS} = 0.86g

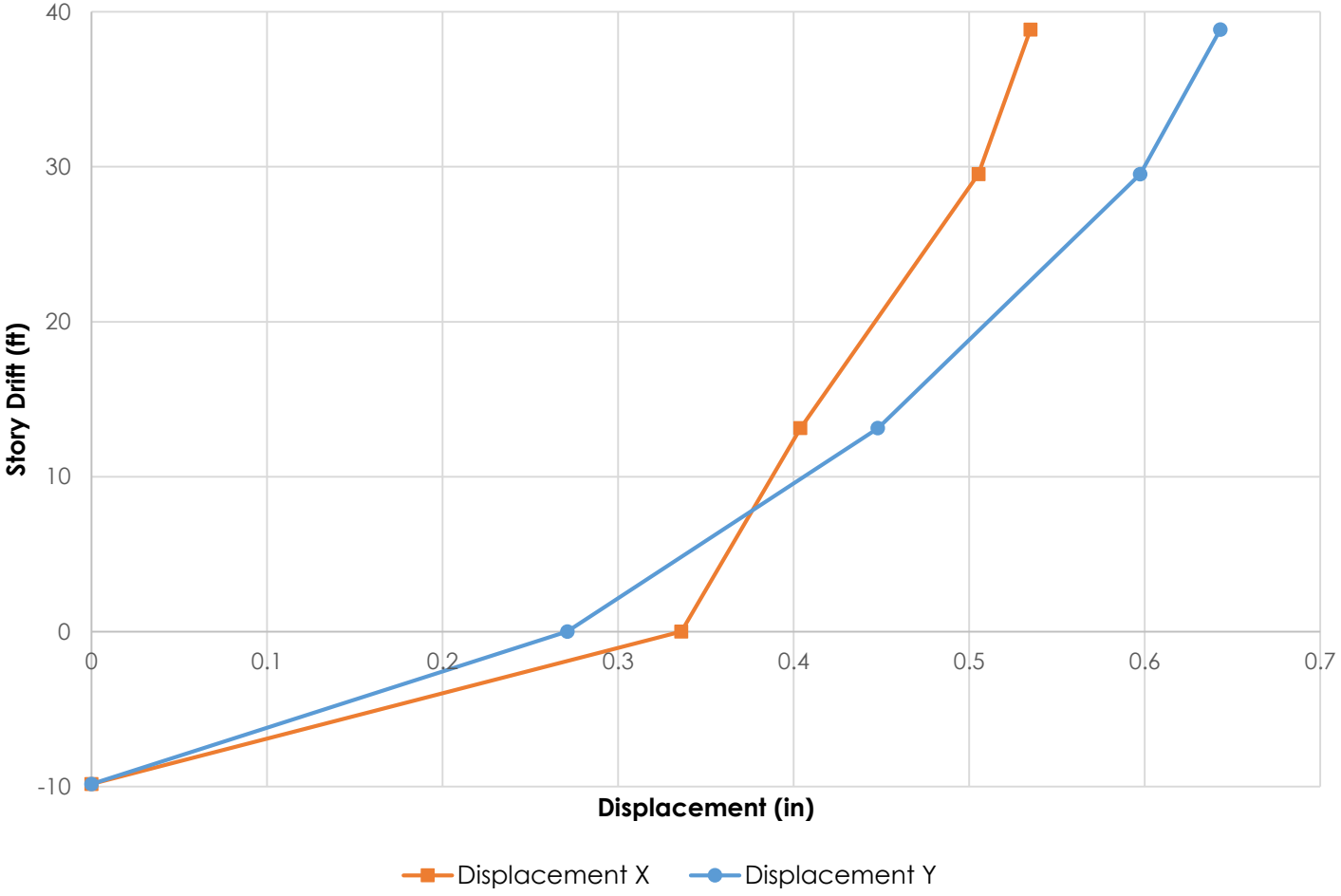
S_{D1} = 0.35g

Site Class D

C_d = 5

I_e = 1

T_n = 0.113 s



Zero Building Strategies

- Renewable energy sources
- Well insulated and tight
- Highest efficiency of appliances

Other Requirements

Daylight factor	[%]	2
Infiltration	[m^3/m^2h]	1.8
Ventilation rate	[L/sm^2]	0.3

Building Envelope

HEAT TRANSFER COEFFICIENT		
External Wall	[W/m^2K]	0.1
Slab on Grade	[W/m^2K]	0.4
Roof	[W/m^2K]	0.1
Glazing	[W/m^2K]	0.8

Solar heat gain coefficient	
Glazing	0.5

CONCERTED ACTION EPBD

2020

9 kW/m^2/y

Water Efficiency

Rain Water

Water Collection 2000 m^3/y

450,000 gallon

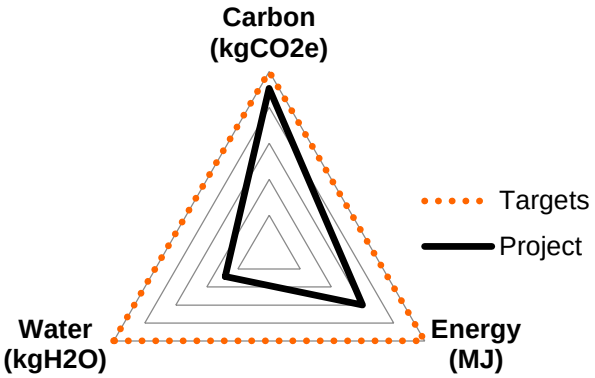
Tanks are capable of storing monthly rainfall

Grey water

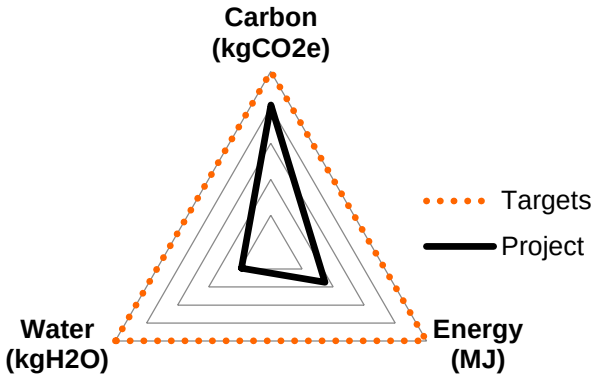
Small Tank

Landscape Watering

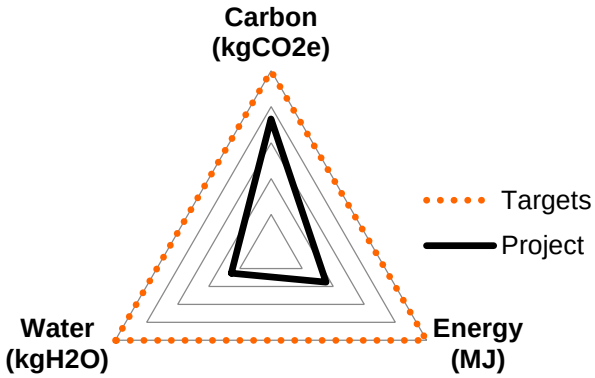
STV Evolution



WINTER

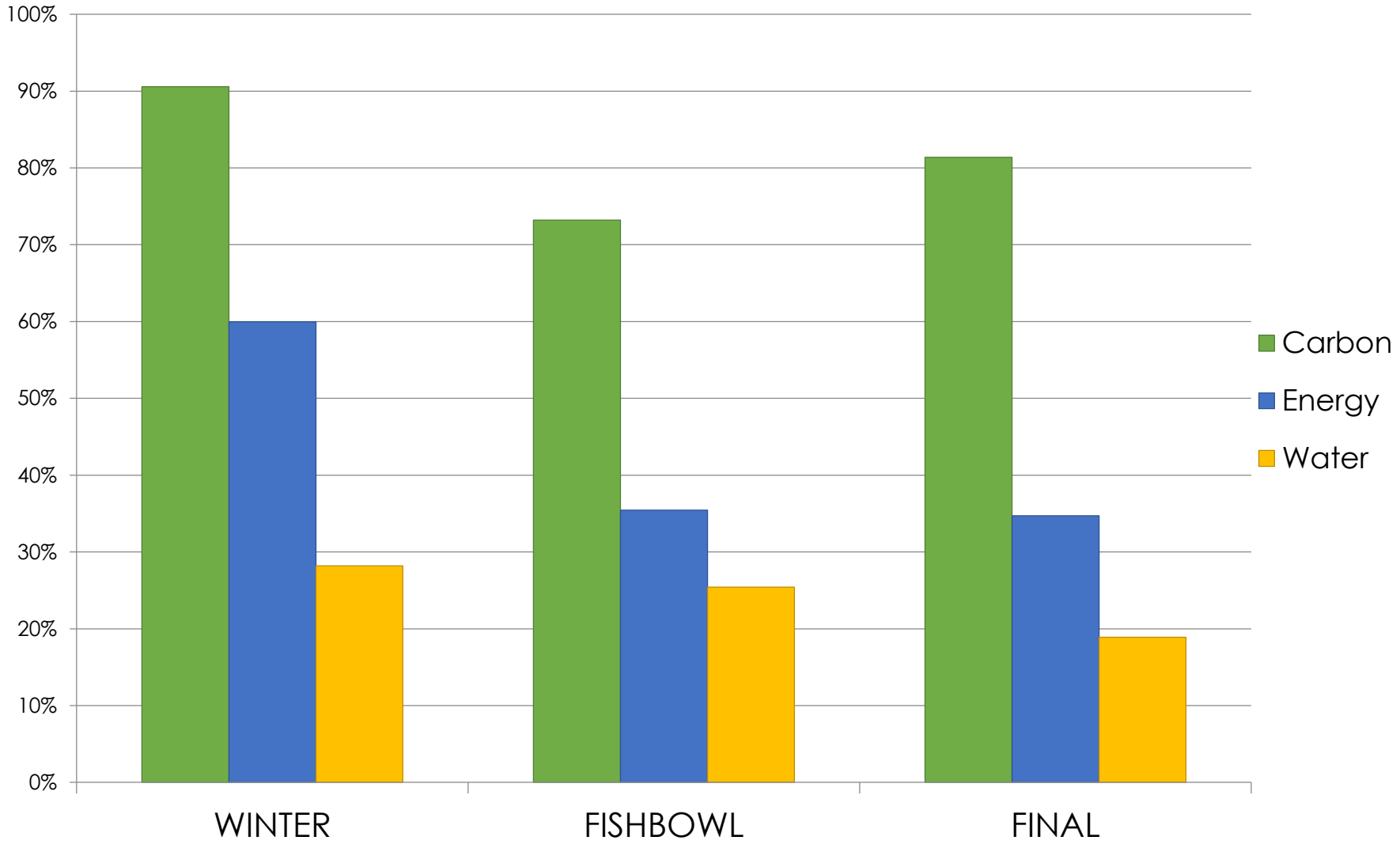


- FISHBOWL

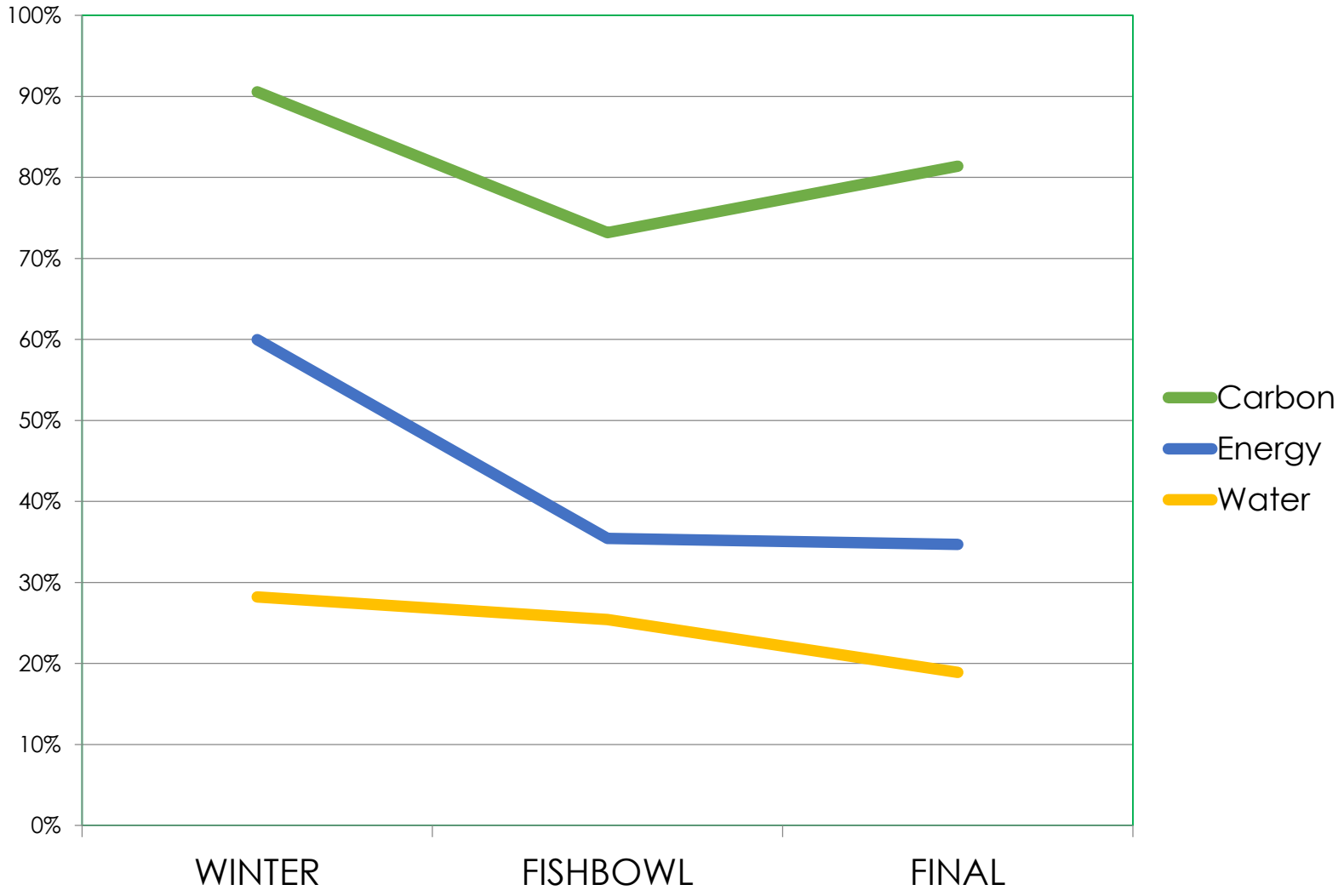


FINAL

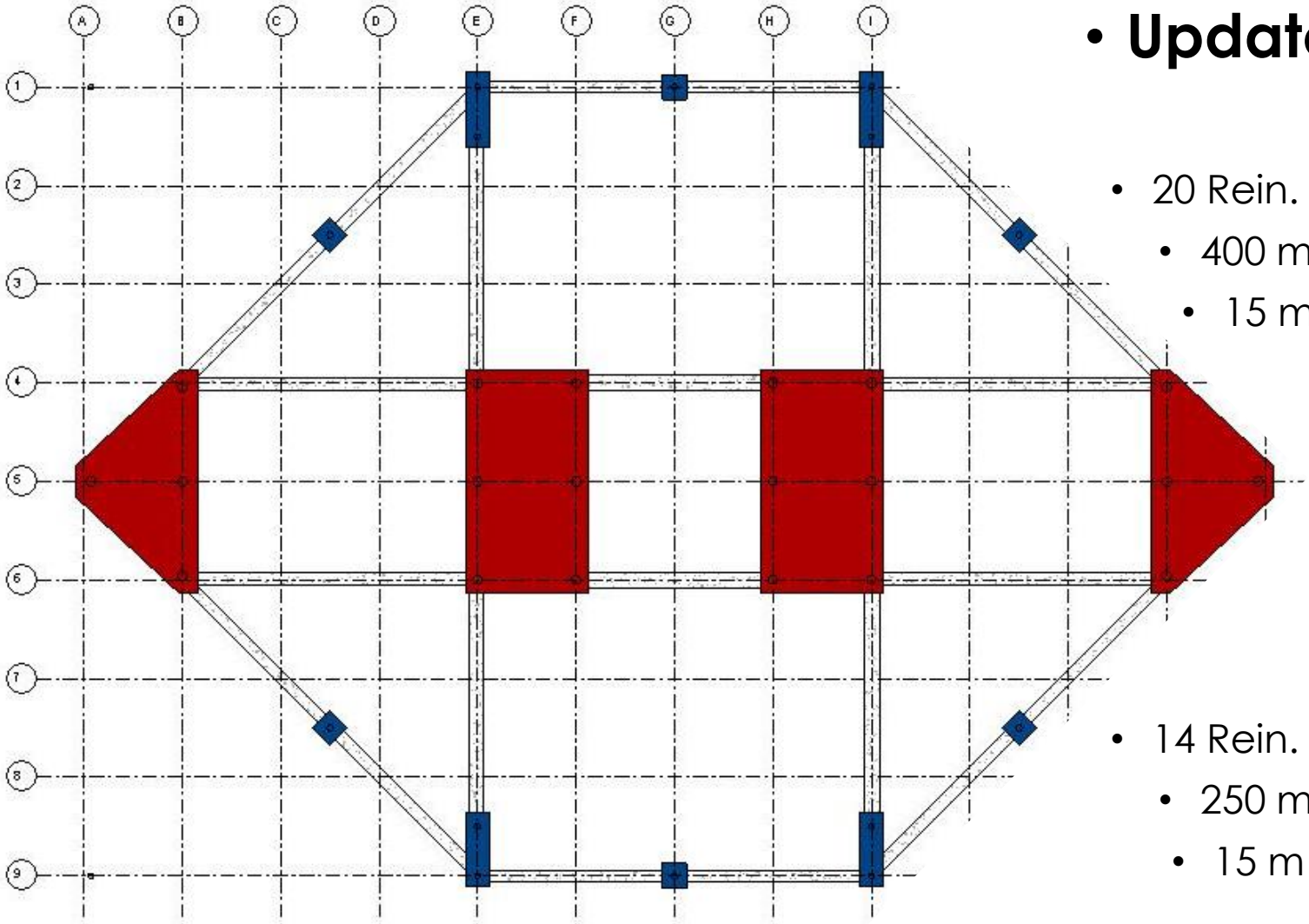
STV Evolution



STV Evolution

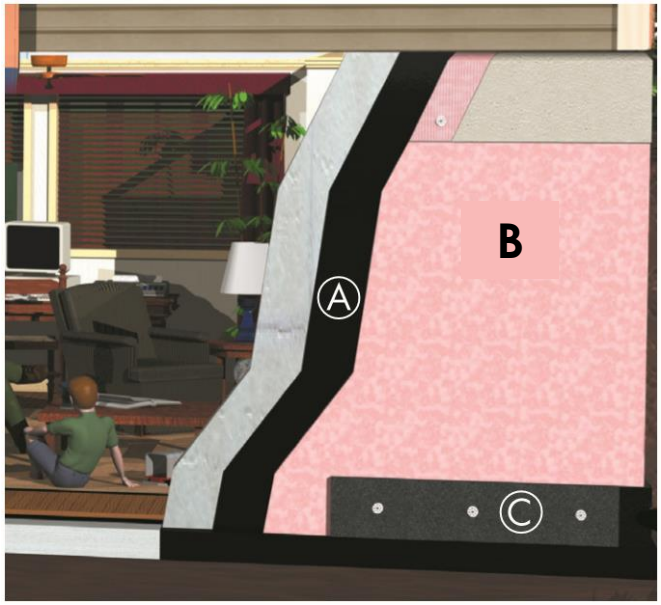


Pile Design



- **Updated Design:**
  - 20 Rein. Concrete Piles
    - 400 mm diameter
    - 15 m long (red)
  - 14 Rein. Concrete Piles
    - 250 mm diameter
    - 15 m long (blue)

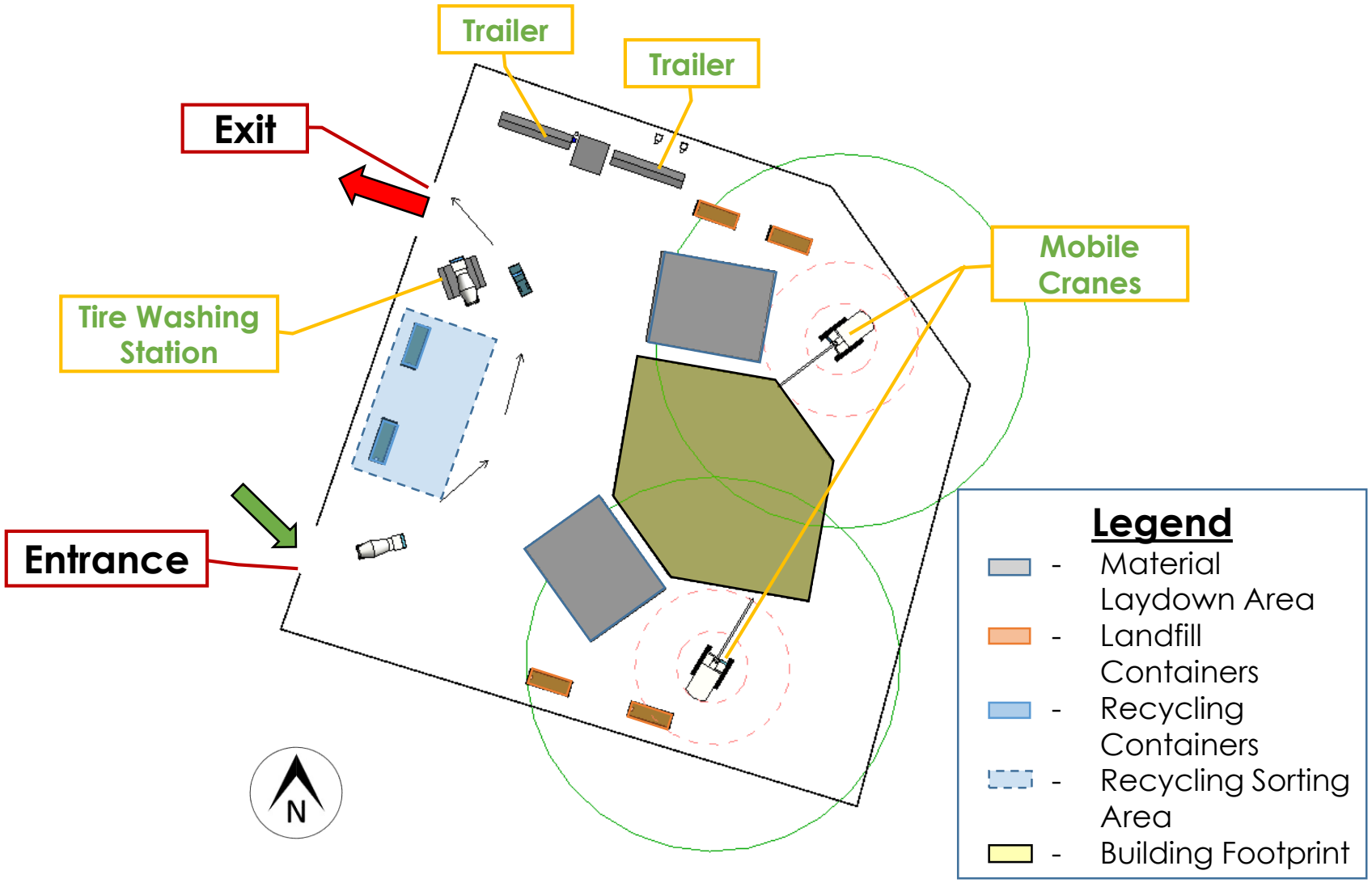
Waterproofing



- TUFF-N-DRI XTS (A)
- WARM-N-DRI Foundation Board (B)
- Stripdrain (C)

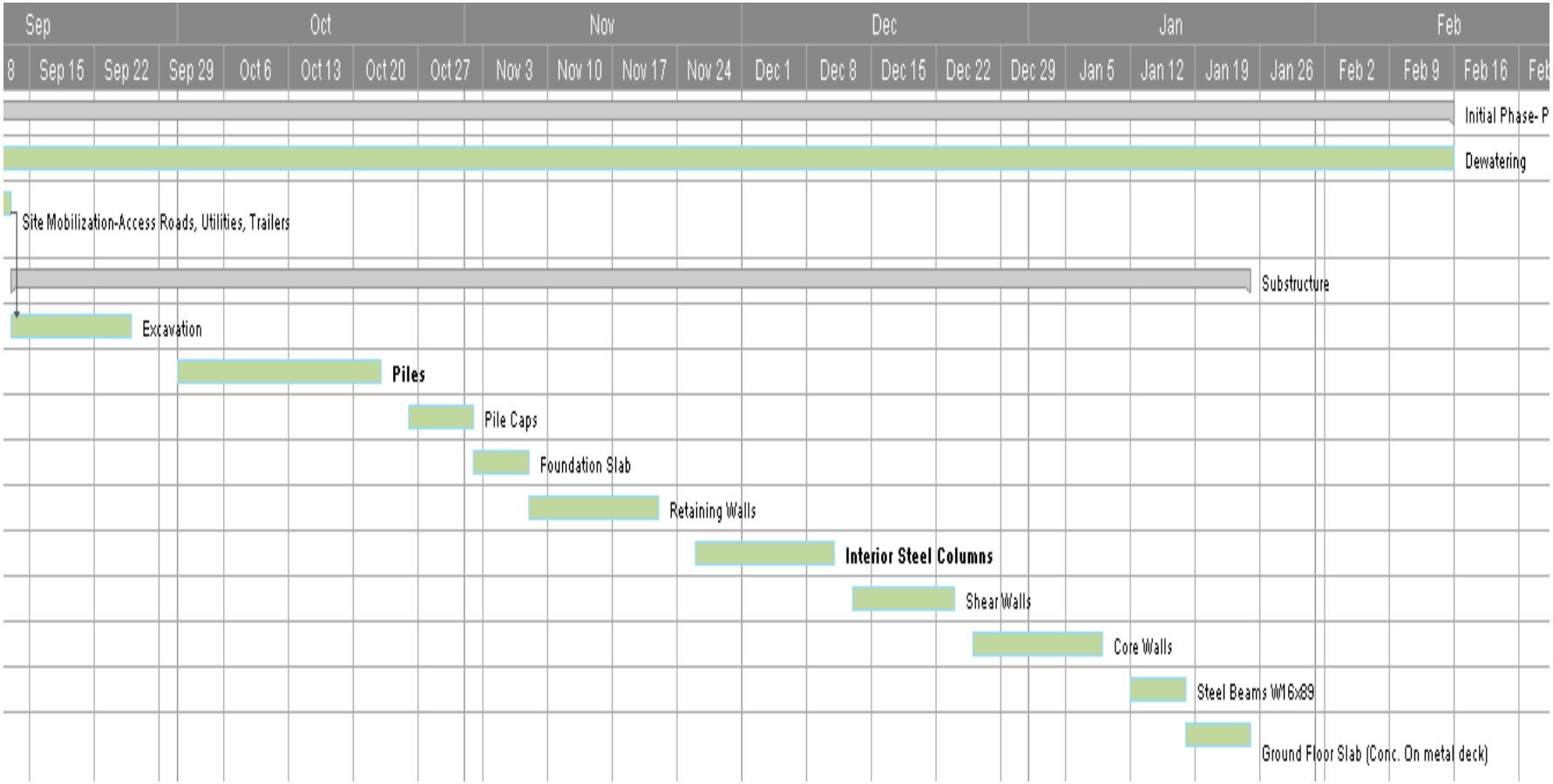
- Sump pumps in elevator pits and under-seating storage

Detailed Site Plan

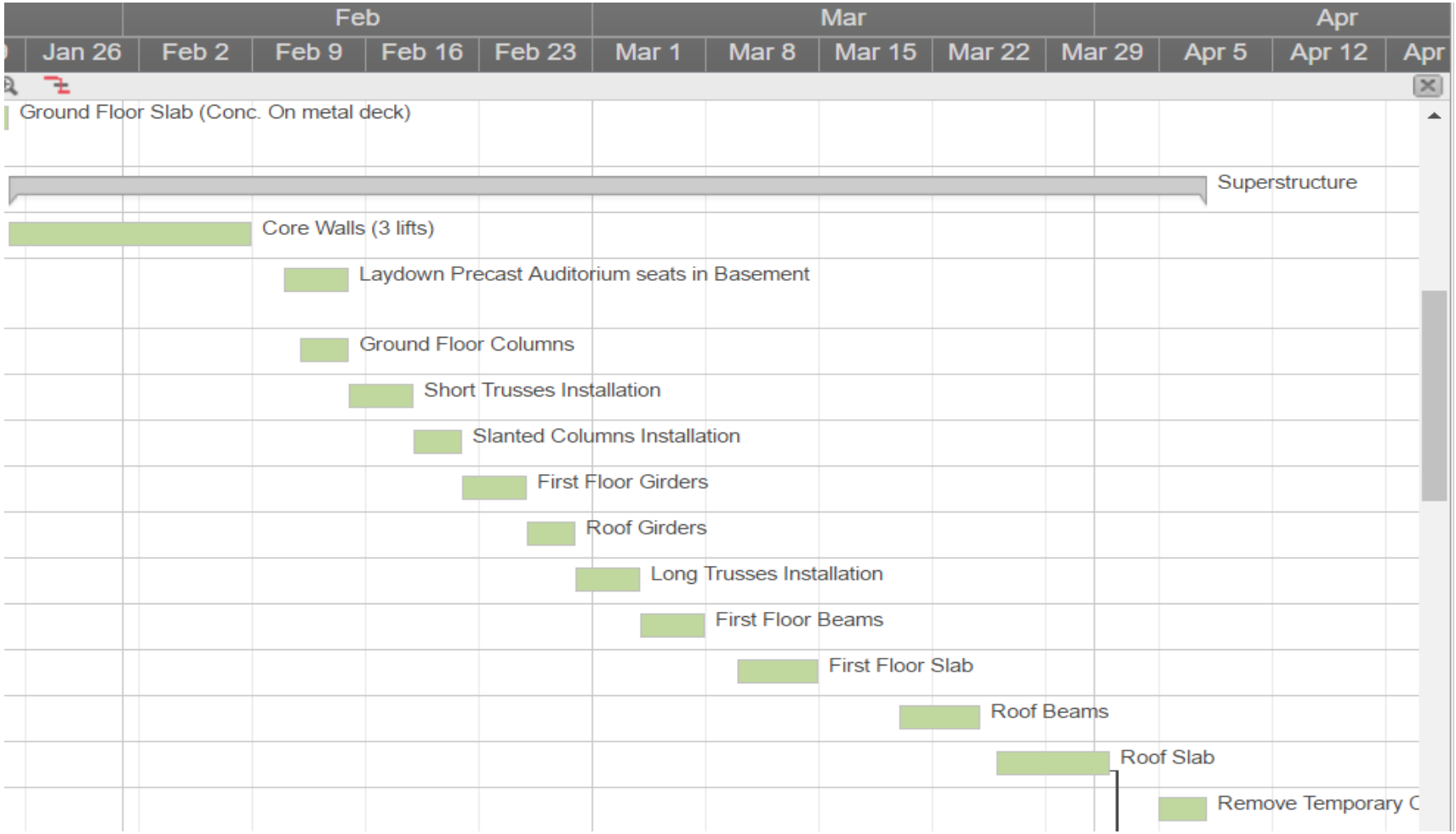


Sequencing Video

Substructure Schedule

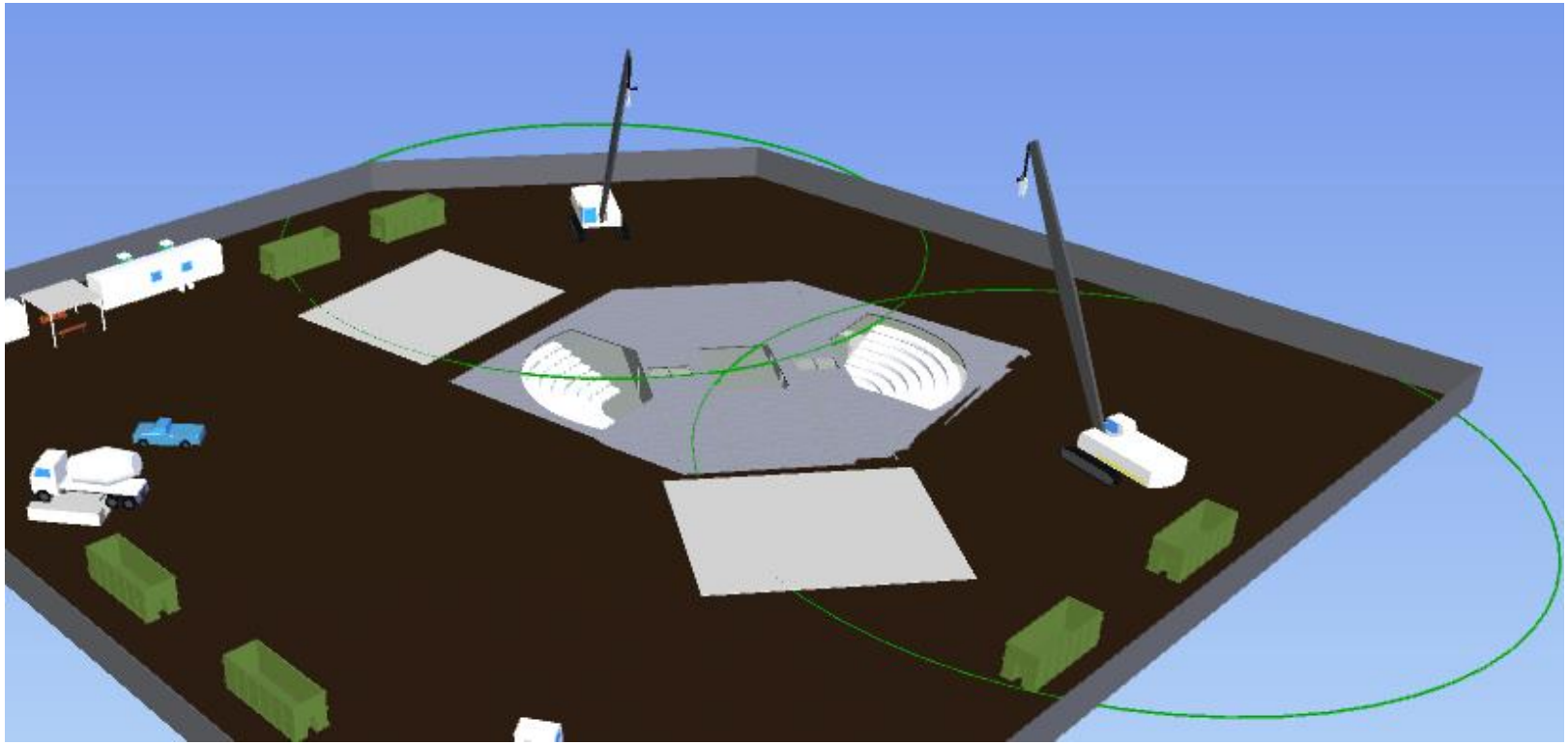


Superstructure Schedule



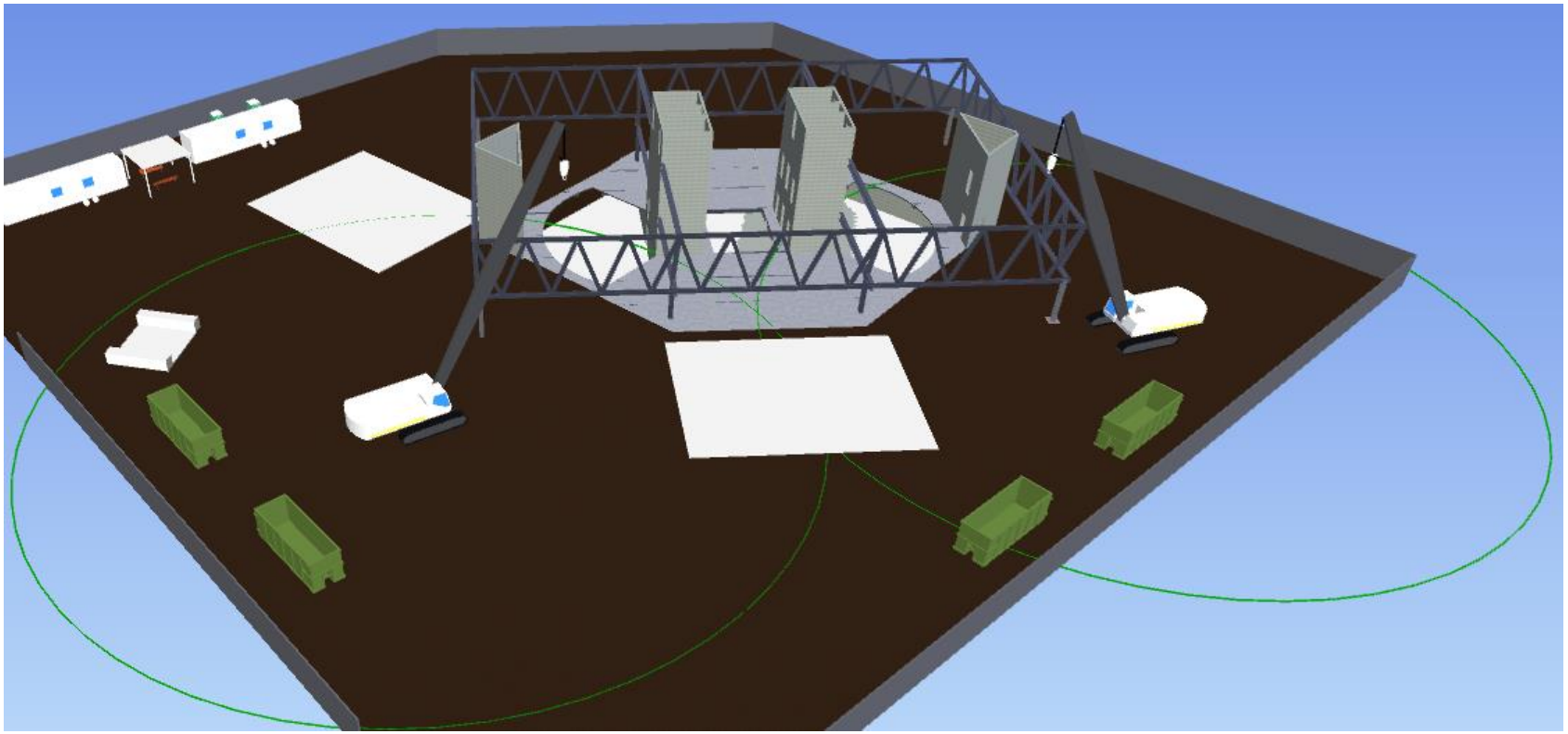
Crane Location 1

Lift precast tiered flooring into place
-Auditorium
-Large Classroom

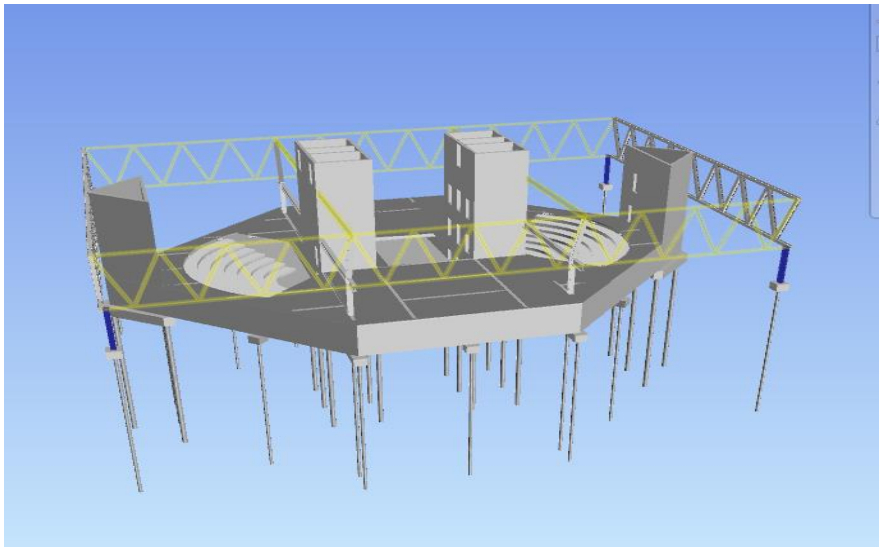


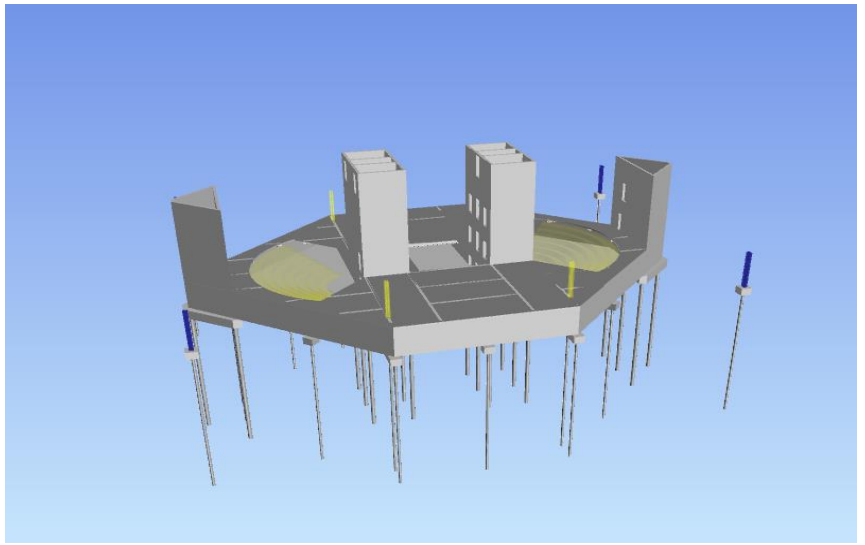
Crane Location 2

Weld truss systems on ground
Use cranes to lift into place



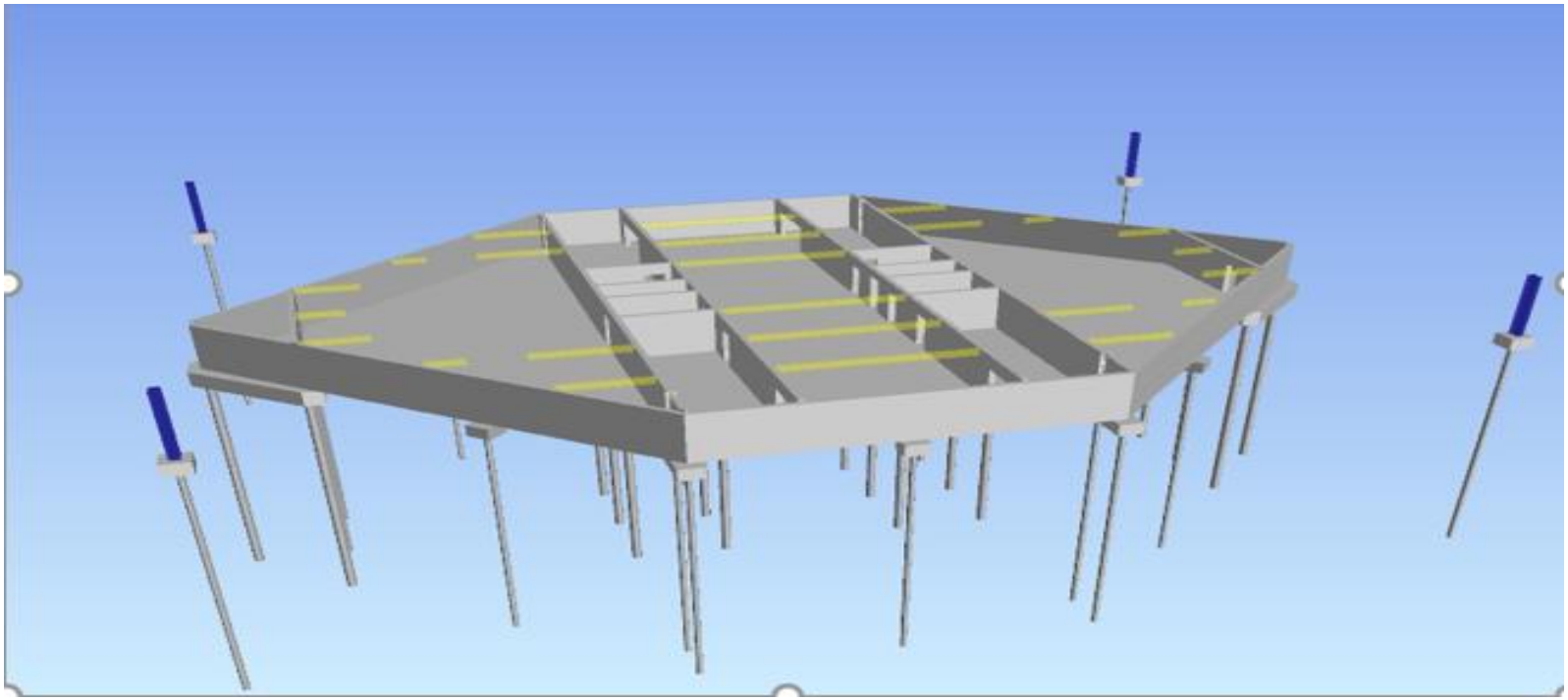
4D CAD Troubleshooting





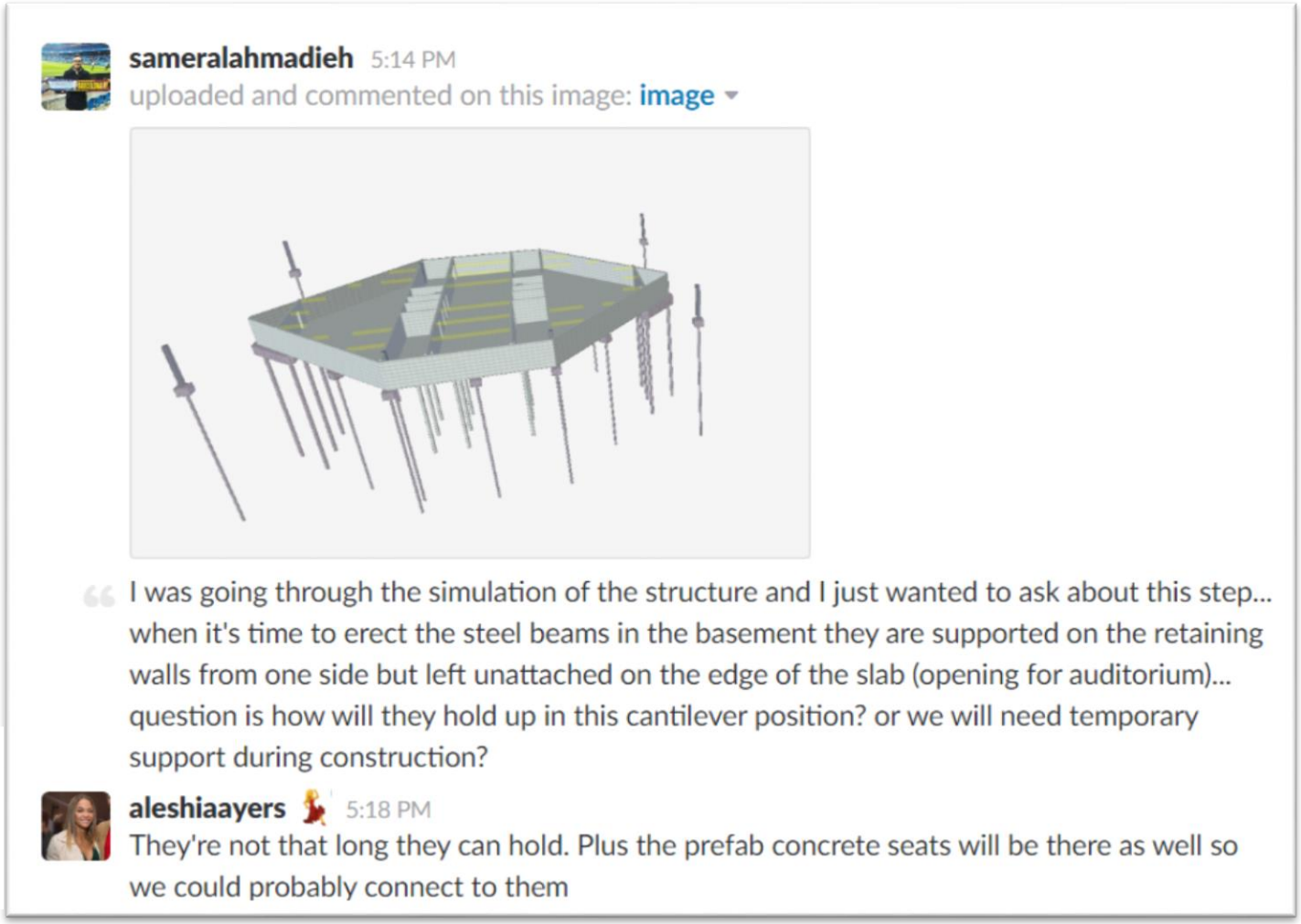
- Precast Auditorium Seating – Possible clash with Large Trusses
- Just in time Delivery to Site

4D CAD Troubleshooting



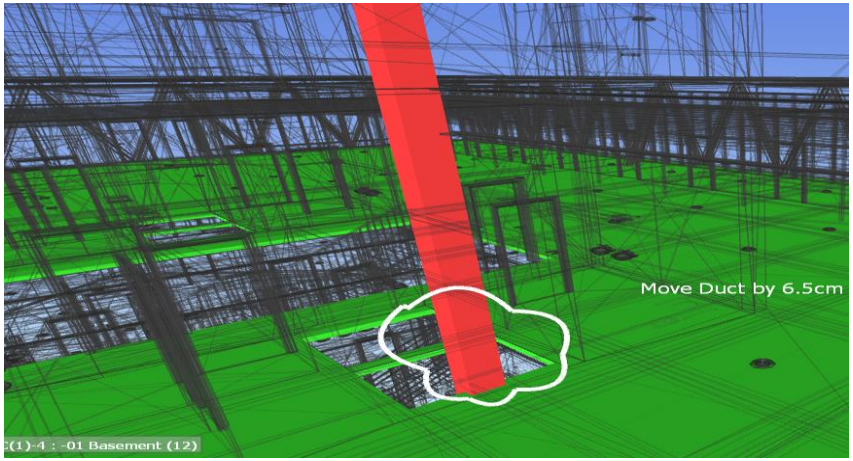
Steel Beams – Necessary Propping before casting Ground Floor Slab

Team Process



Clash Detection

- Identify Clashes – Navisworks
- Use Redline Tools – Clarity
- Communicate clashes to design disciplines using clash reports

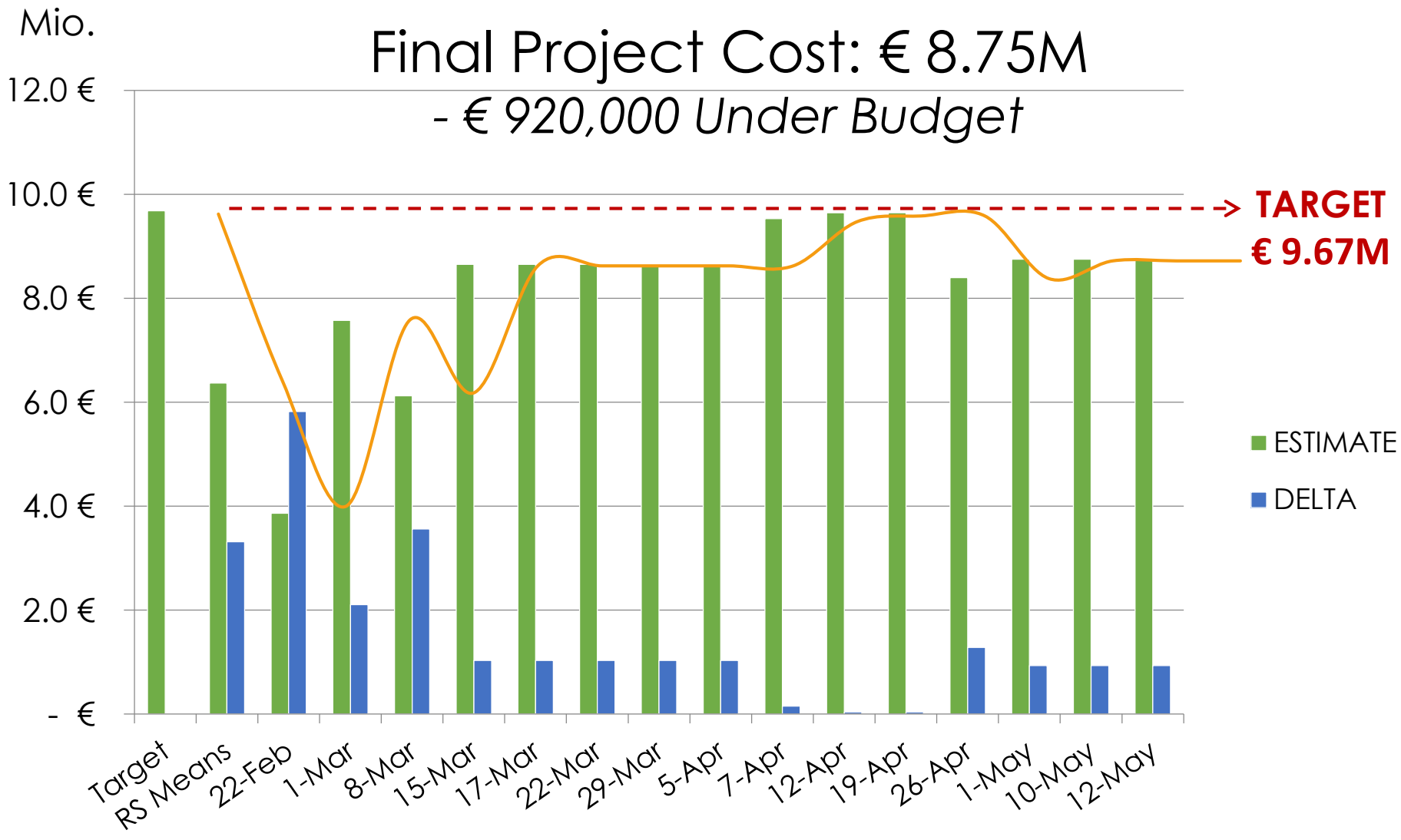


						Item 1				Item 2			
Image	Clash Name	Distance	Grid Location	Description	Clash Point	Item ID	Layer	Item Name	Item Type	Item ID	Layer	Item Name	Item Type
	Clash1	-0.407	E-5 : 01 1st Floor	Hard	x:22.151, y:-0.396, z:4.000	Element ID: 1315420	00 Ground Floor	Rectangular Duct	Solid	Element ID: 559378	01 1st Floor	Concrete, Lightweight - 4 ksi	Solid
	Clash2	-0.407	E-5 : 02 Roof	Hard	x:22.179, y:-0.368, z:9.127	Element ID: 1315420	00 Ground Floor	Rectangular Duct	Solid	Element ID: 562735	02 Roof	Concrete, Lightweight - 4 ksi	Solid
	Clash3	-0.223	H-3 : -01 Basement	Hard	x:35.729, y:-1.779, z:-0.268	Element ID: 1339426	-01 Basement	Rectangular Duct	Solid	Element ID: 573250	00 Ground Floor	Steel ASTM A500, Grade B, Rectangular and Square	Solid
	Clash4	-0.212	H-7 : -01 Basement	Hard	x:24.628, y:-13.304, z:-0.257	Element ID: 1339418	-01 Basement	Rectangular Duct	Solid	Element ID: 573399	00 Ground Floor	Steel ASTM A500, Grade B, Rectangular and Square	Solid
	Clash5	-0.181	E-5 : 01 1st Floor	Hard	x:21.967, y:-0.580, z:4.000	Element ID: 1315420	00 Ground Floor	Rectangular Duct	Solid	Element ID: 567983	01 1st Floor	Concrete, Cast-in-Place gray	Solid
	Clash6	-0.166	E-5 : 02 Roof	Hard	x:22.179, y:-0.368, z:9.000	Element ID: 1315420	00 Ground Floor	Rectangular Duct	Solid	Element ID: 568109	02 Roof	Concrete, Cast-in-Place gray	Solid

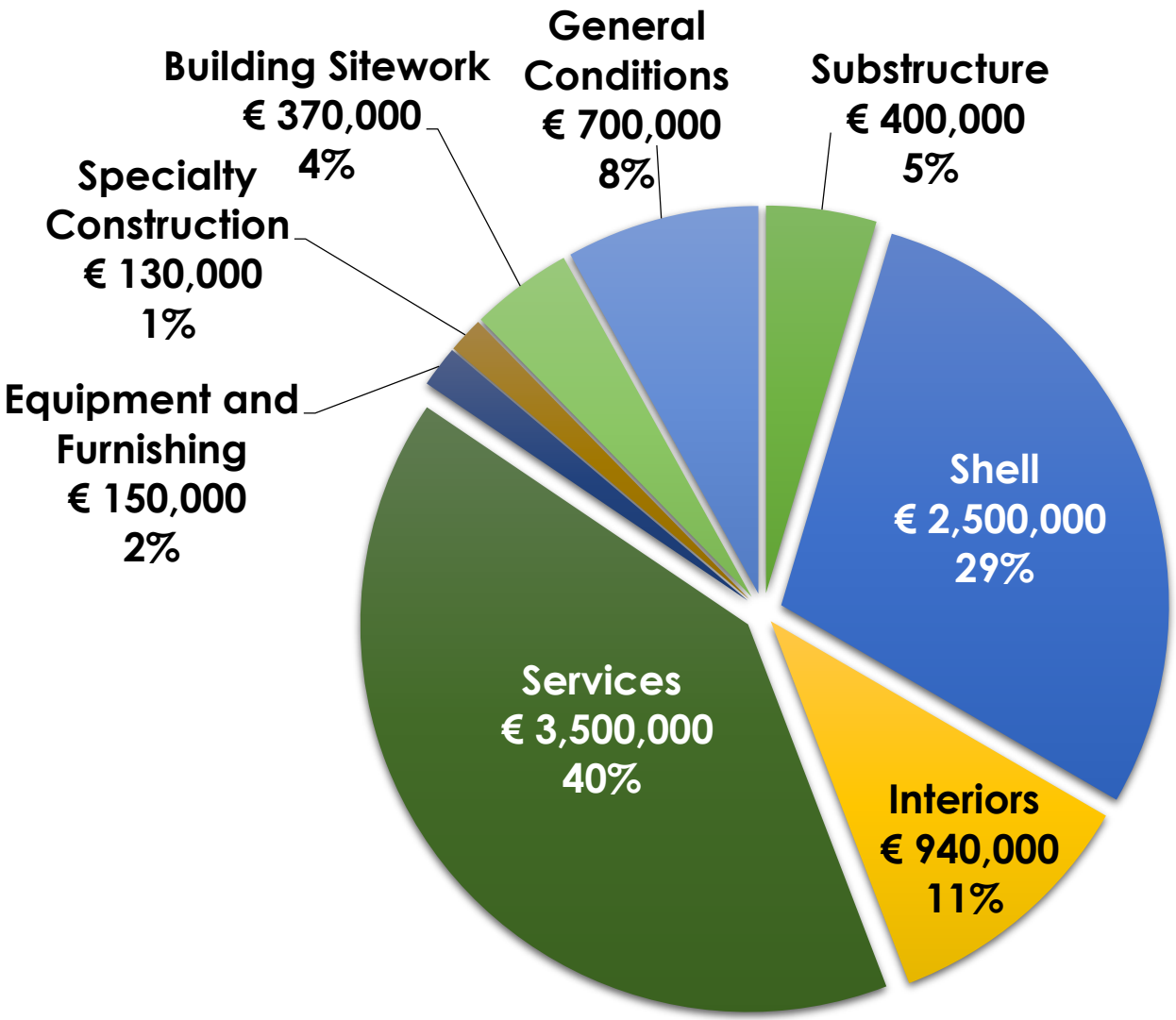
✓ Major Clashes Resolved

✓ Majority of remaining clashes deemed acceptable

TVD Evolution



Cost Breakdown



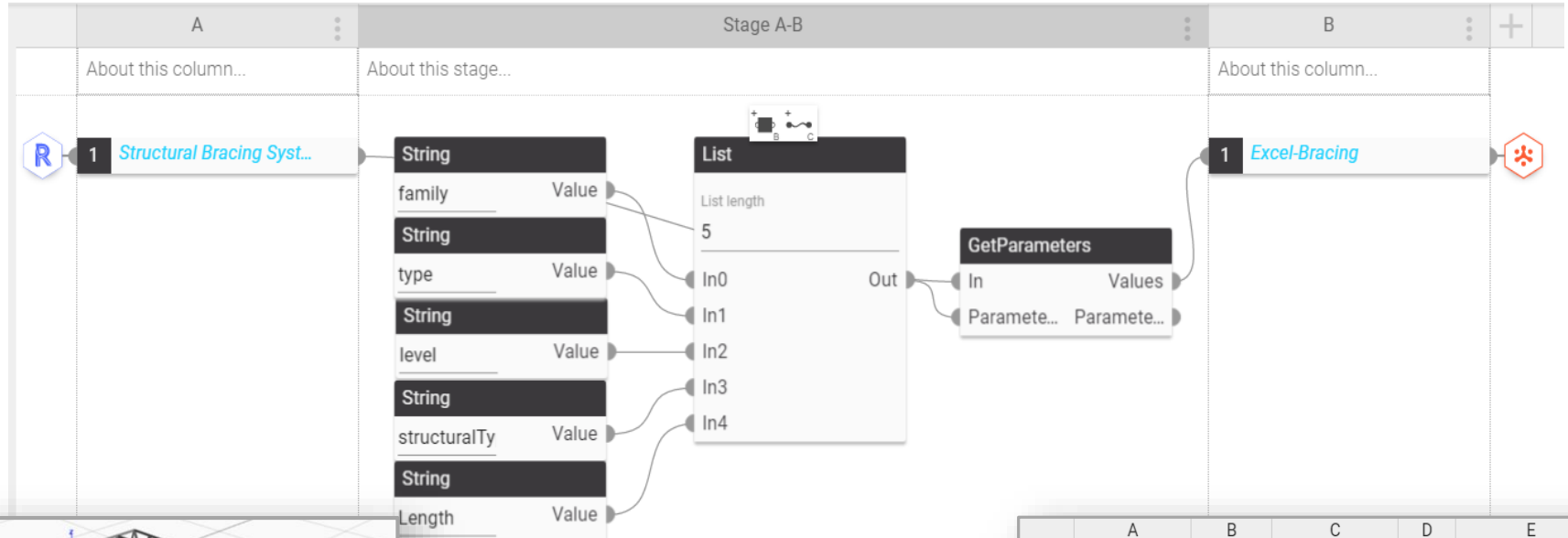
Slovenian CM Collaboration

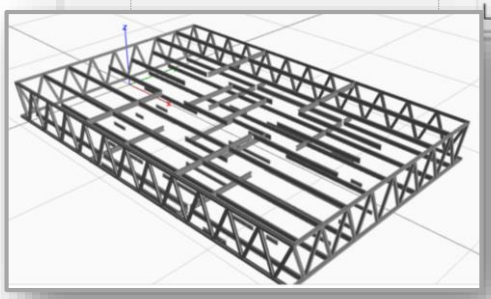
Create Takeoff

Obtain Slovenian Pricing

Enter into Values & Quantities into TVD

Auto-Updating Takeoff





	A	B	C	D	E
1	W-Wide Flange	W24X76	02 Roof	Beam	52.4934383202096
2	W-Wide Flange	W24X76	02 Roof	Beam	52.4934383202096
3	W-Wide Flange	W24X76	02 Roof	Beam	39.3700787401576
4	W-Wide Flange	W24X76	02 Roof	Beam	39.3700787401576
5	W-Wide Flange	W24X76	02 Roof	Beam	52.4934383202098
6	W-Wide Flange	W24X76	02 Roof	Beam	52.4934383202098
7	W-Wide Flange	W24X76	02 Roof	Beam	52.49343832021
8	W-Wide Flange	W24X76	02 Roof	Beam	52.49343832021

Revit – 3D Model

Excel – Quantity Takeoff

Flux.io

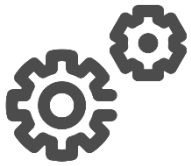
Life-Cycle Concept

- EFFICIENT DESIGN
- Create an efficient building related to space, cost, risk and future operations.

ADDITIONAL PROGRAM

Integrate Opportunities for additional income.

- OPTIMIZING O&M
- Reduce O&M Cost by integration of innovative Technologies and sustainable MEP-Systems.



- FINANCIAL STRUCTURE
- Optimizing the financial structure to reduce interest payments.

PV Panels

"ECO | NDUSTRY"

"Forgotten area Roof – Let's make it an efficient space."

- Energy production PV-Panels: 189.000 kw/h p.a.
- Energy Consumption by facility: 86.000 kw/h p.a.
- Overproduction/Feed in to grid: 103.000 kw/h p.a.

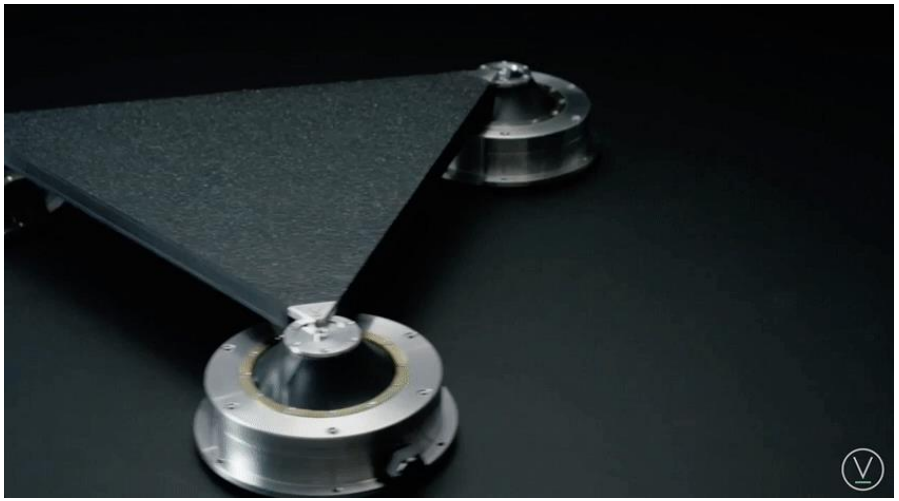
- Net Operating Income: 697.000€
- Return on Investment: after 8 years
- Reduces Energy consumption from grid by around 50 %
- 20 years of performance guarantee

- reduced Rent: - 25.000 € p.a.

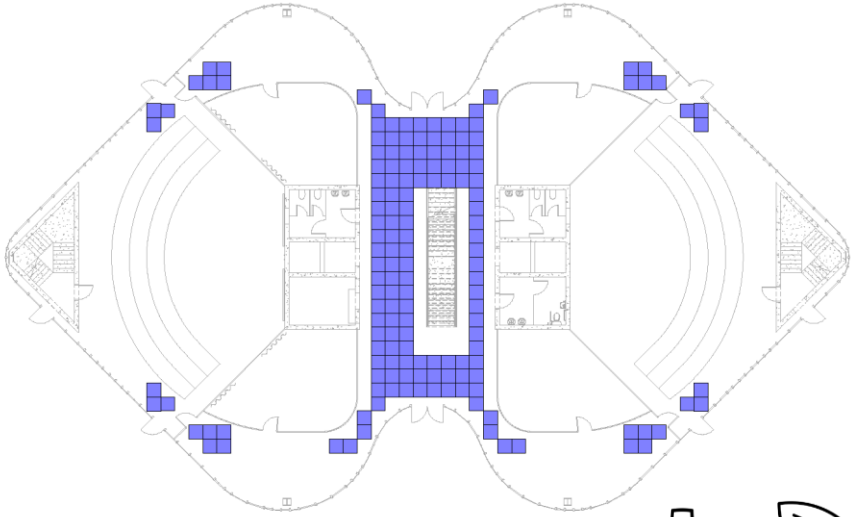
Pavegen Floor Tiles

"ECO | NDUSTRY"

„Usage of natural movement to create energy.“



- Massive price drop
- Efficiency increase in the last 5 years
- Energy production 18.000 kW/h/y
- Reduced grid energy by 15%
- Return on investment after 5 years
- Replacement after 10 years



Robotic Cleaning

"ECO | NDUSTRY"

"Being more ecologic by using innovative technologies from the industry."

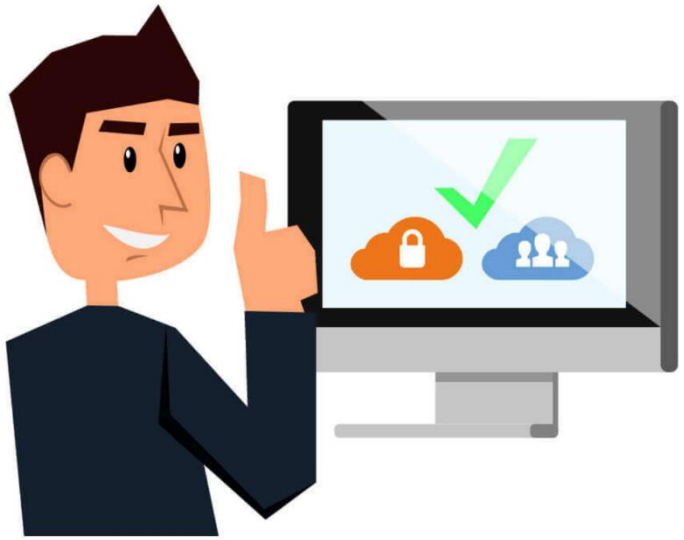
- Robots can be programmed to clean the assigned areas like the open spaces and circulation areas.
- fully automatic battery charging, fresh water supply, and drainage of the dirty water through a service station.
- Robot uses 85% less water than traditional cleaning practices, because of higher efficiency and a water recycling system
- LCC impacts:
  - Operation: -15.000 € p.a.
  - Maintenance: + 2.000 € p.a.
  - Replacement: +75.000 € in 25 years
  - Rent: - 8.000 € p.a.

- References:
  - https://www.intellibotrobotics.com
  - http://www.adlatus.eu

Outsourcing

- **Go Hybrid!**

- Local & Cloud Computing
- To get the most out of both IT-systems!



Benefits:

- Flexibility to changing requirements
- Availability from all around the Globe
- Security/ownership for sensible Data
- Reduces IT-Operation-Cost through Lifecycle by around 50%
- Increases Space efficiency by 2 %

LEED

CATEGORY	POINTS
Location and Transportation	5/16
Sustainable Sites	5/10
Water Efficiency	6/11
Energy and Atmosphere	23/33
Materials and Resources	8/13
Indoor Environmental Quality	12/16
Innovation	3/6
TOTAL	**63**

Risk Identification

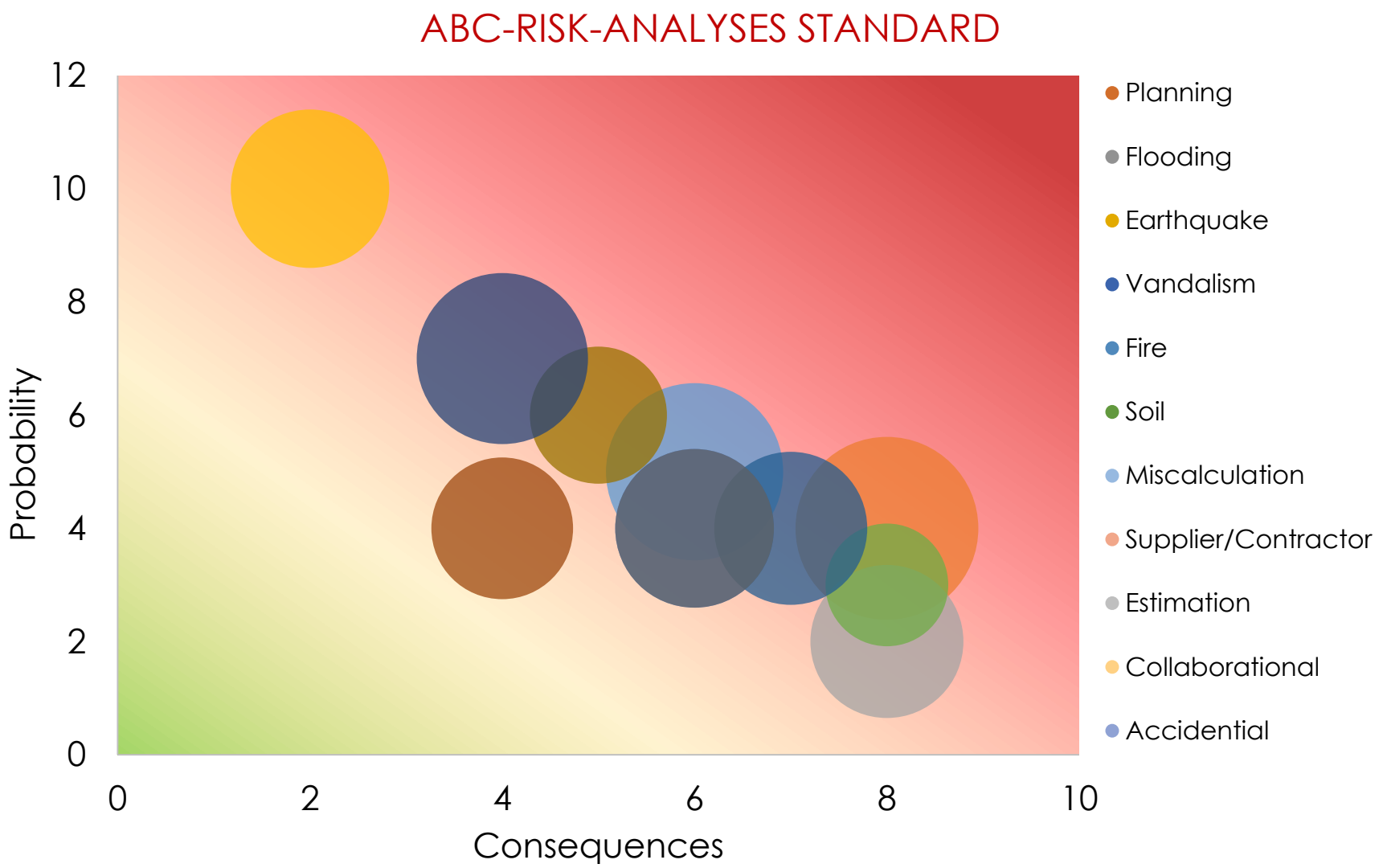
Planning | Construction

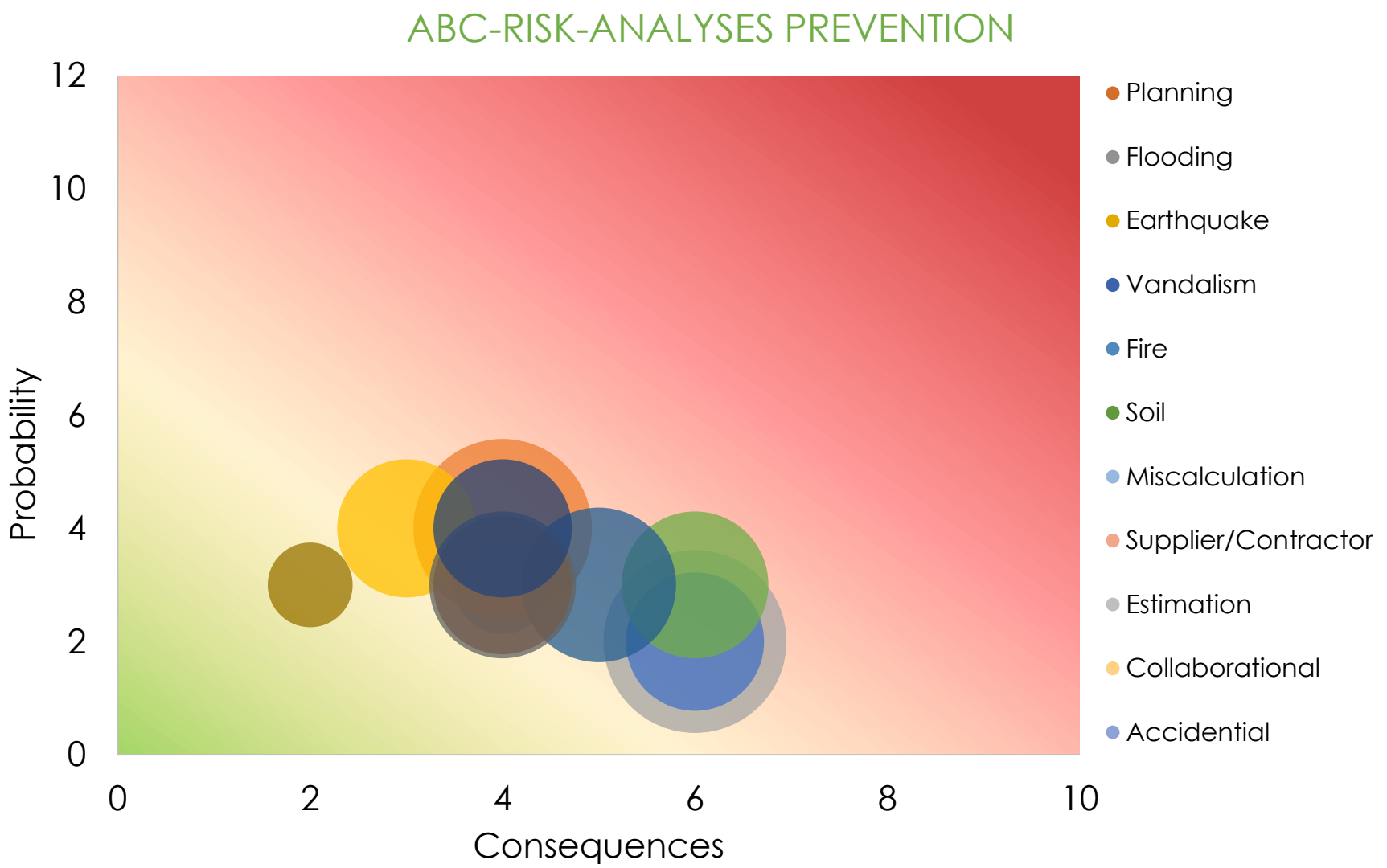
- Flooding
- Earthquake
- Vandalism
- Fire
- Soil
- Miscalculation
- Supplier/Contractor
- Estimation
- Collaborational
- Accidential

• Operation

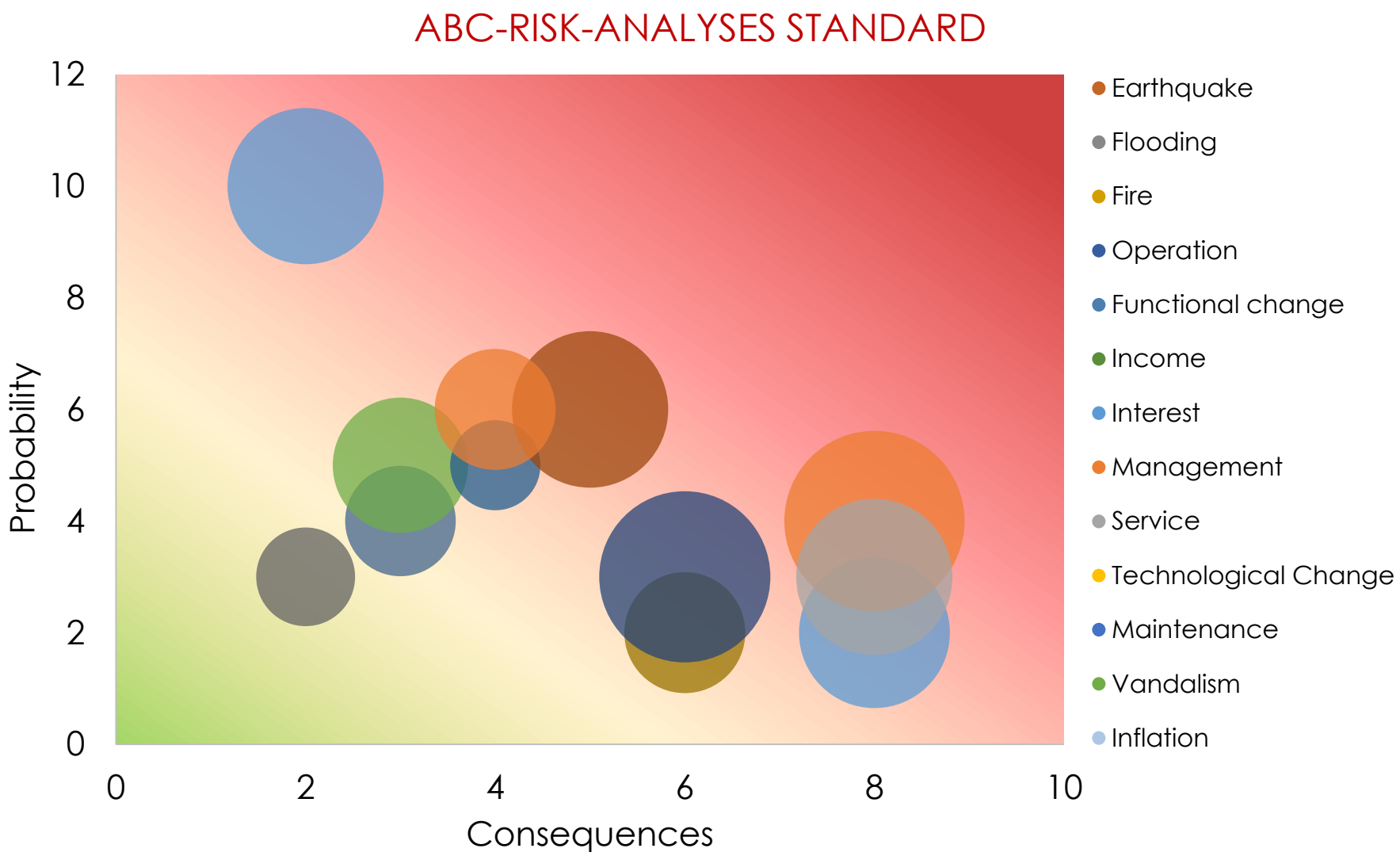
- Earthquake
- Flooding
- Fire
- Operation
- Functional change
- Income
- Interest
- Management
- Service
- Technological Change
- Maintenance
- Vandalism
- Inflation

Planning | Construction

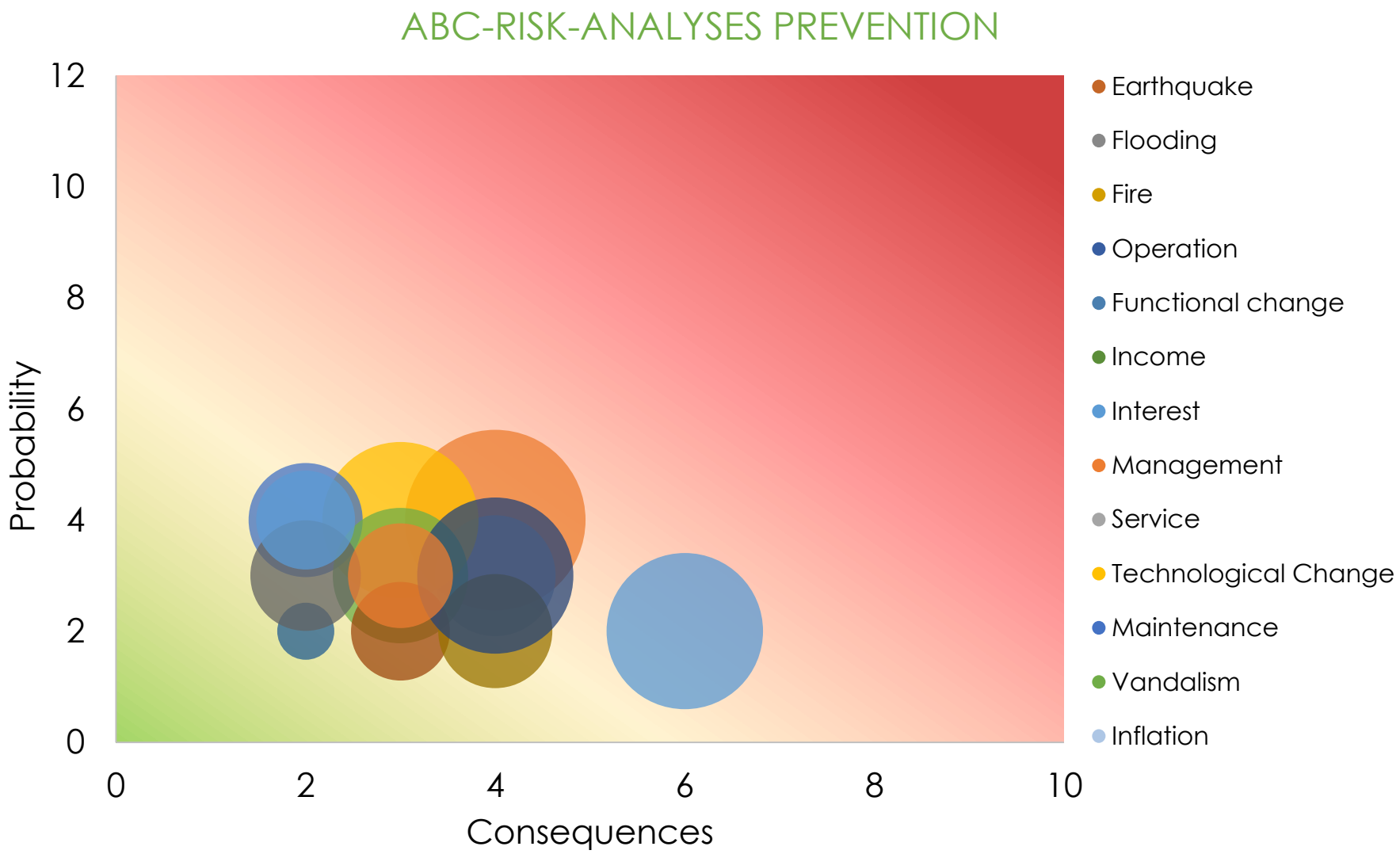



ABC-RISK-ANALYSES PREVENTION
Probability
12
10
8
6
4
2
0
0
2
4
6
8
10
Consequences
Planning
Flooding
Earthquake
Vandalism
Fire
Soil
Miscalculation
Supplier/Contractor
Estimation
Collaborational
Accidential

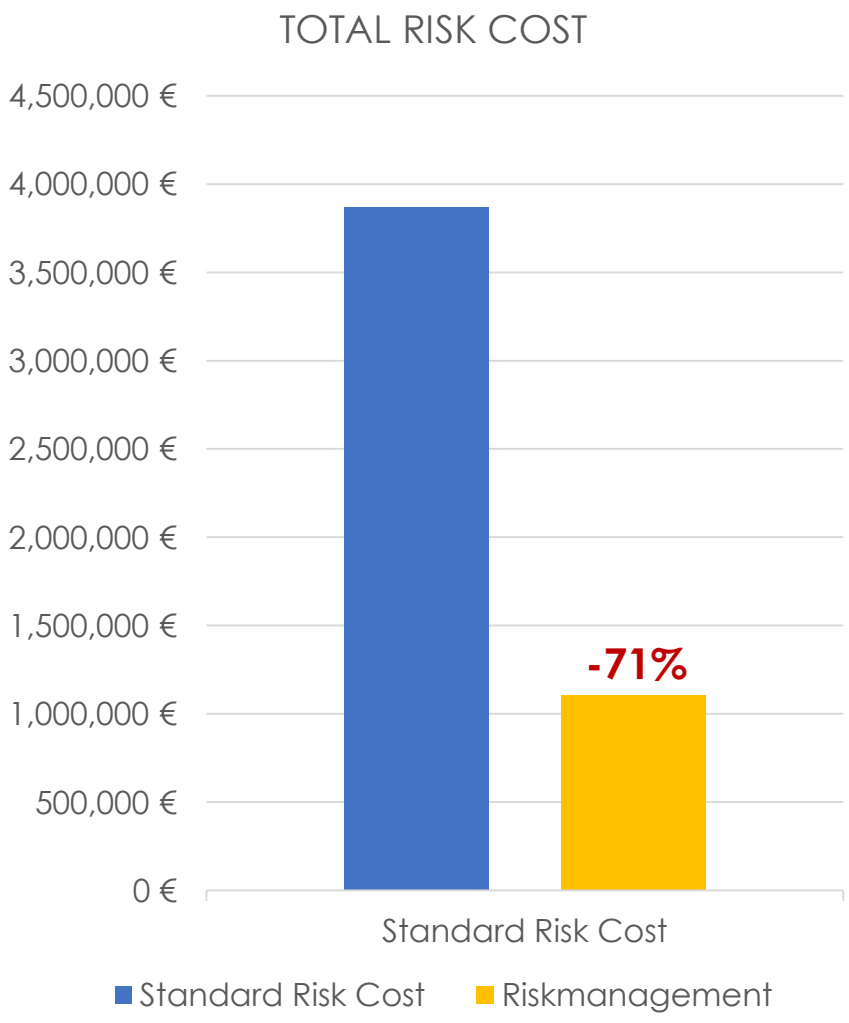
Operation

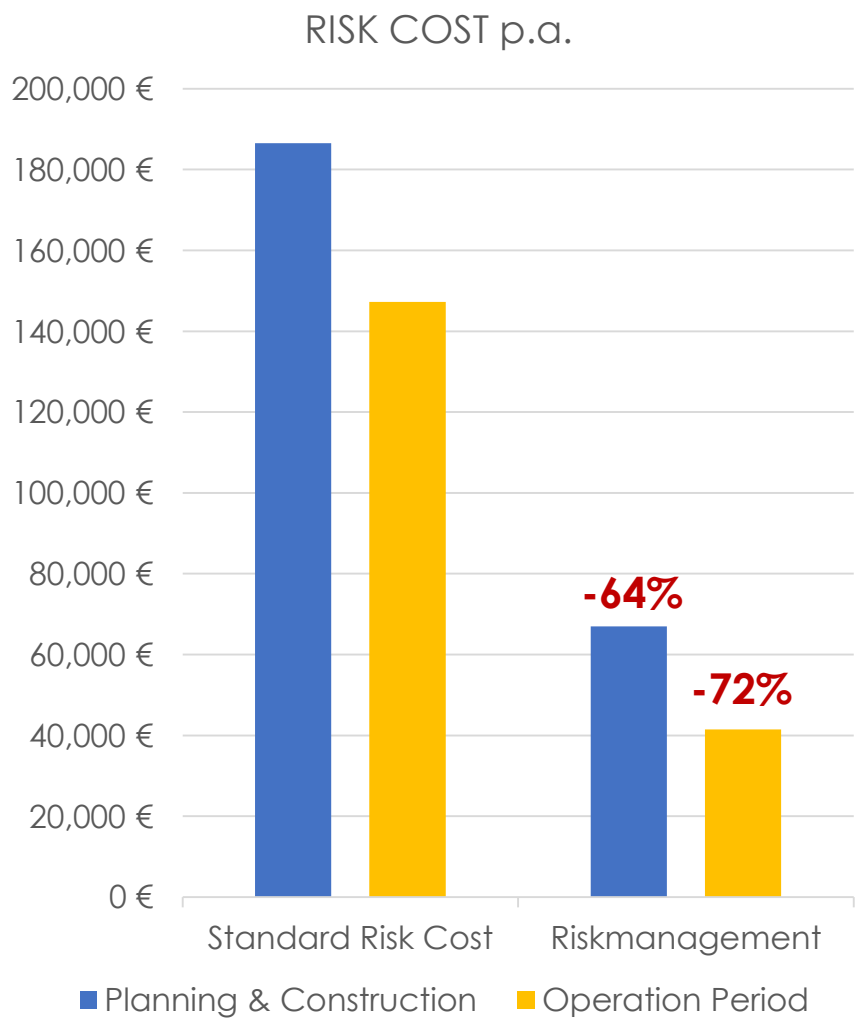

ABC-RISK-ANALYSES STANDARD
Probability
Consequences
0
2
4
6
8
10
12
Earthquake
Flooding
Fire
Operation
Functional change
Income
Interest
Management
Service
Technological Change
Maintenance
Vandalism
Inflation

Operation

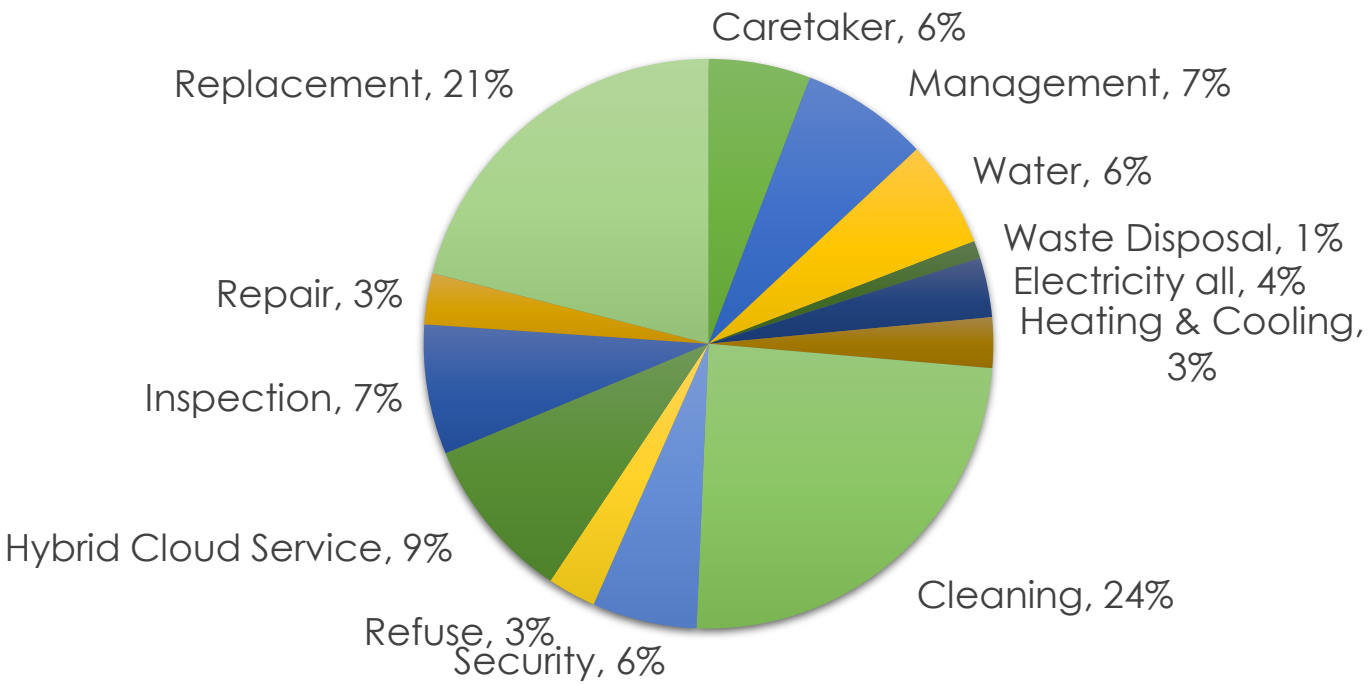

ABC-RISK-ANALYSES PREVENTION
Probability
Consequences
0
2
4
6
8
10
12
Earthquake
Flooding
Fire
Operation
Functional change
Income
Interest
Management
Service
Technological Change
Maintenance
Vandalism
Inflation

Risk Cost Evolution





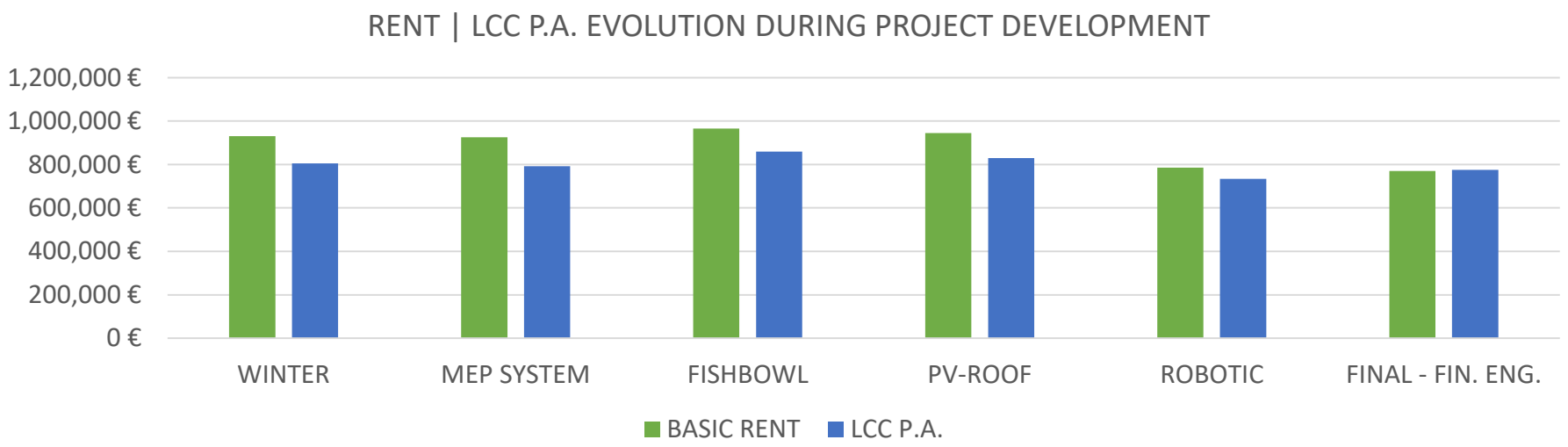
O&M&R

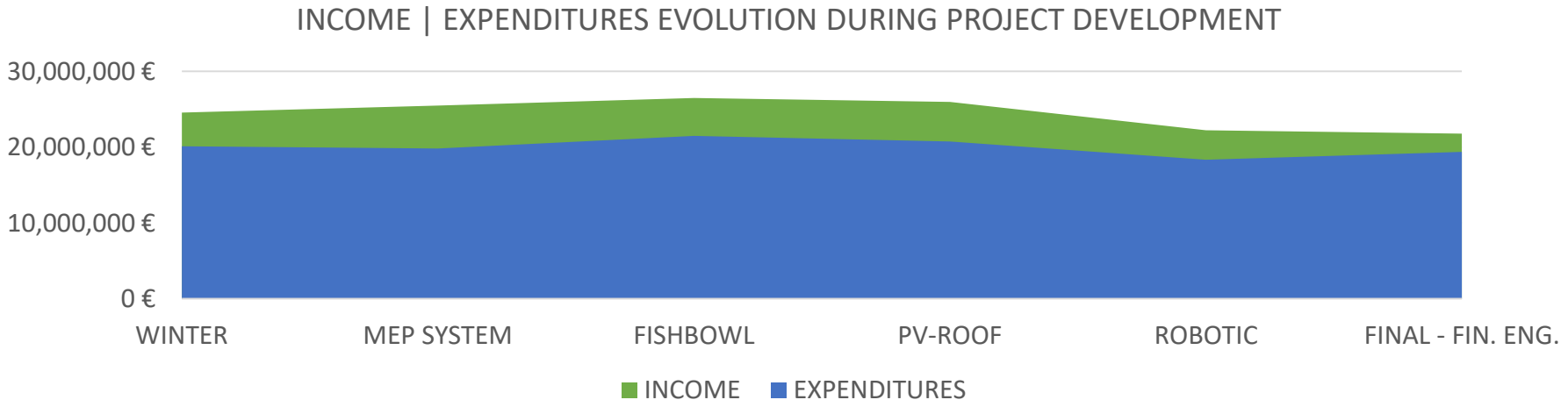


Operation & Maintenance 4.9 Mio €	Replacement 1.1 Mio €

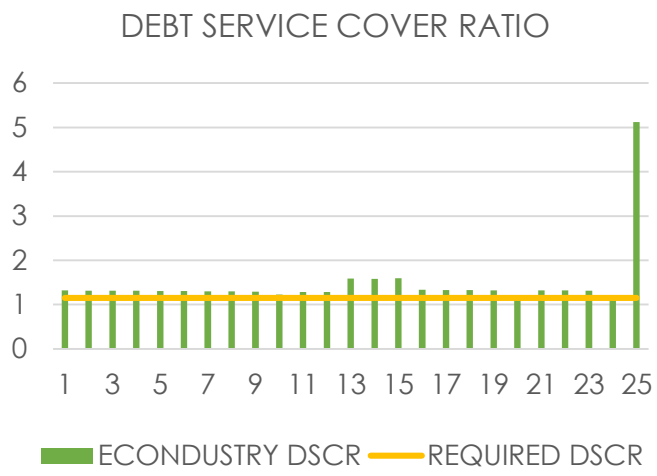
Total
6.0 Million €

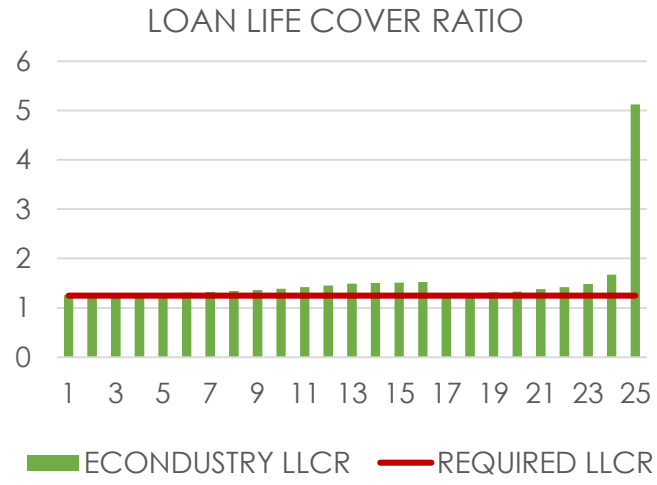
Income | Expenditures

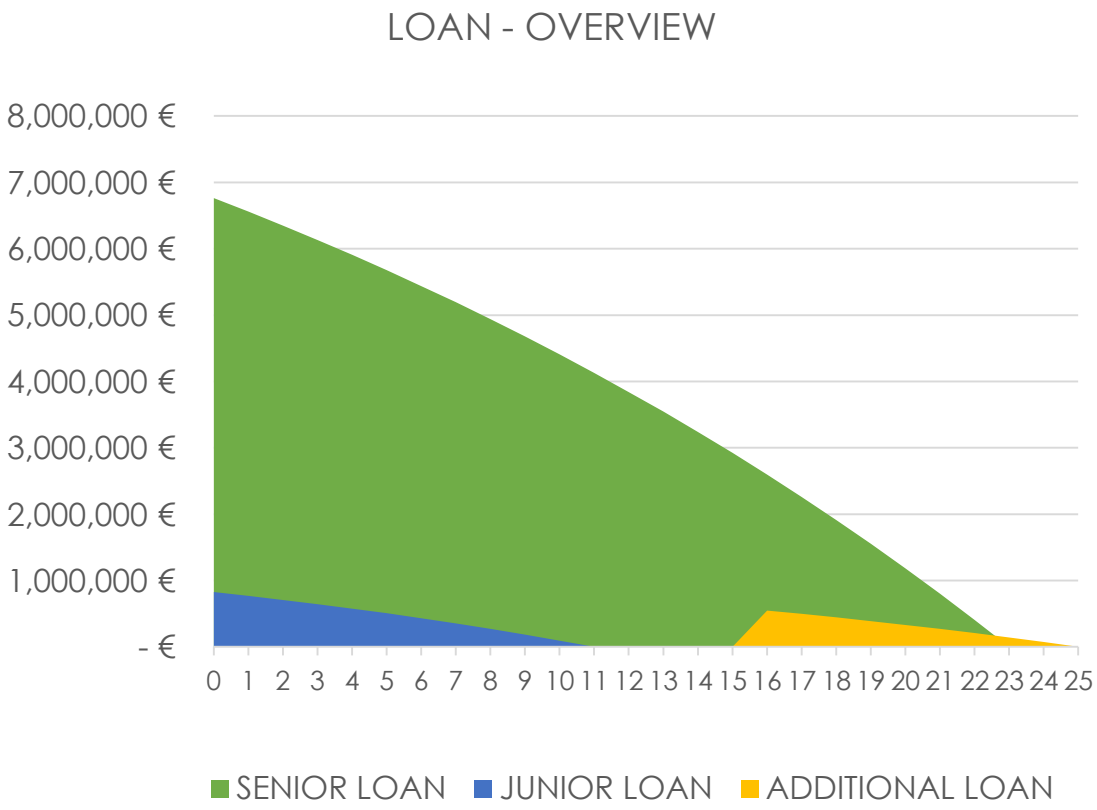




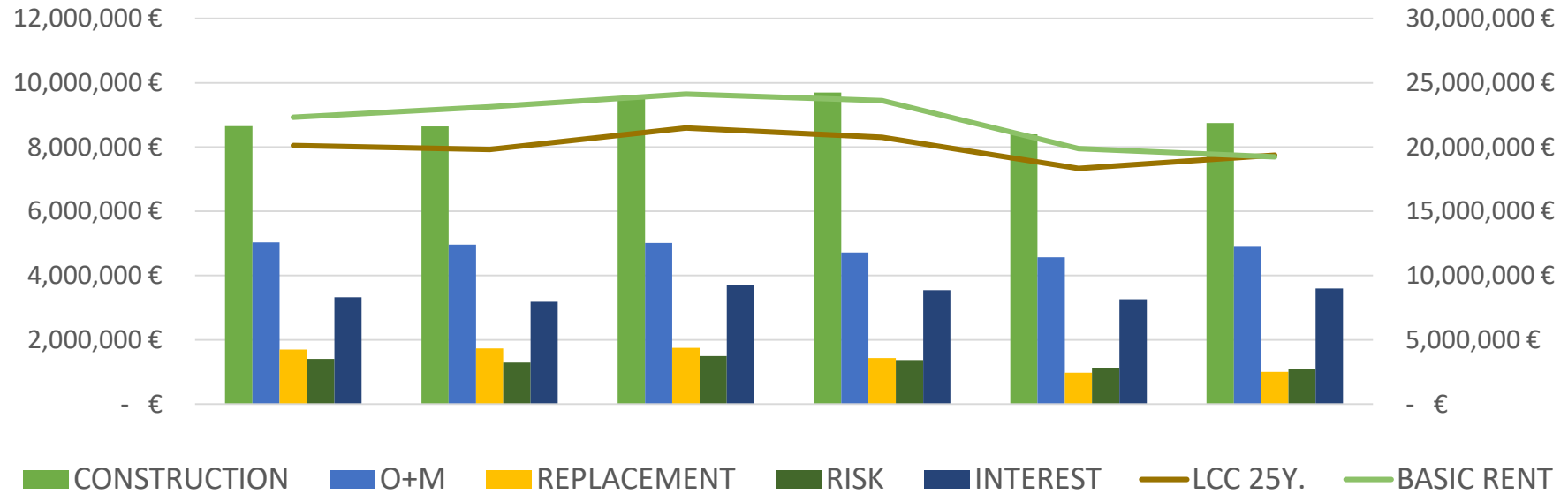
Financial Structure

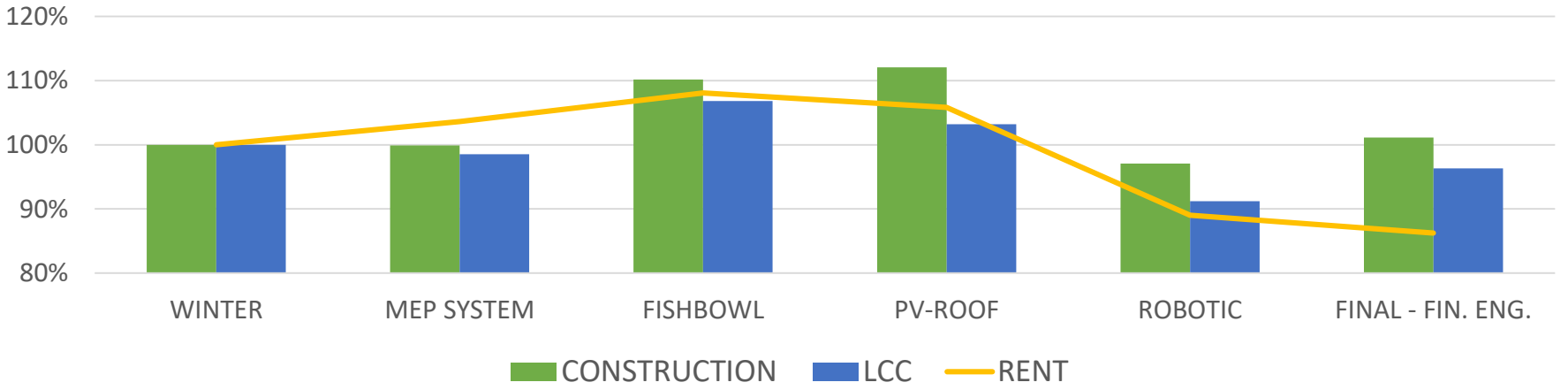




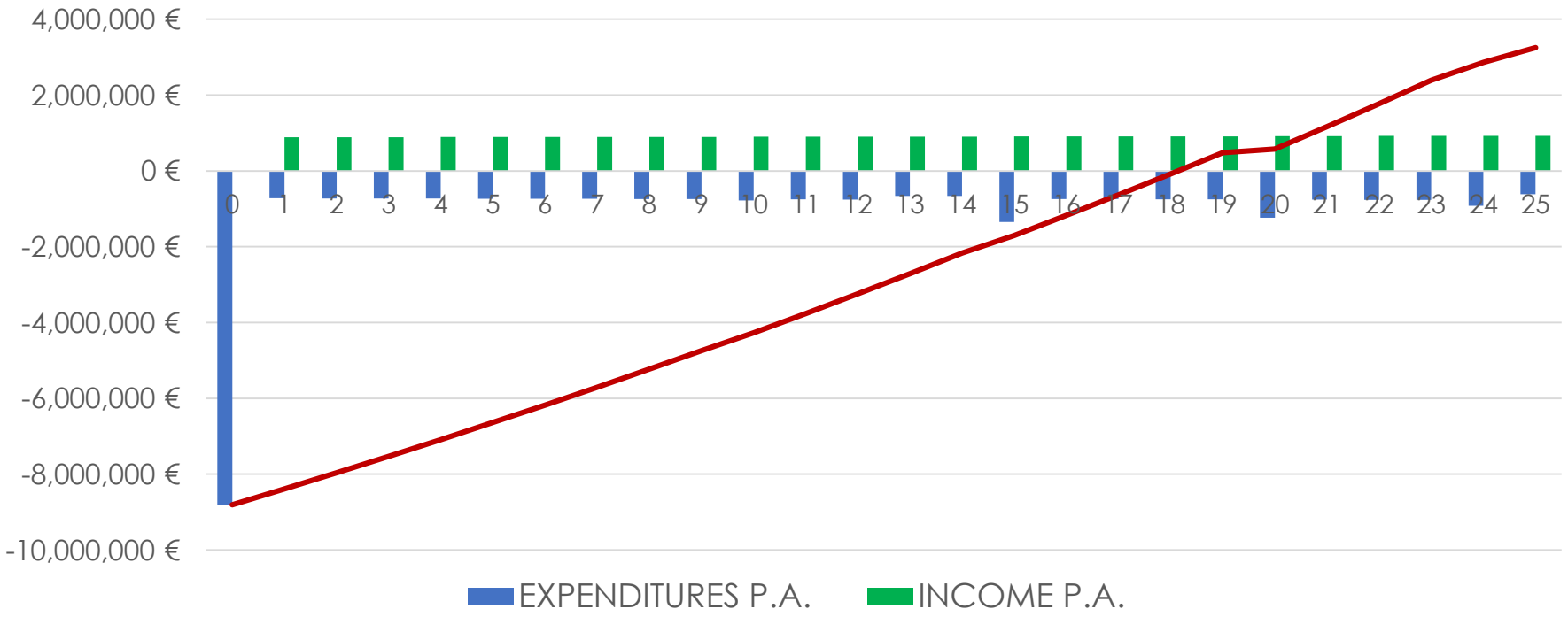


Cost Evolution





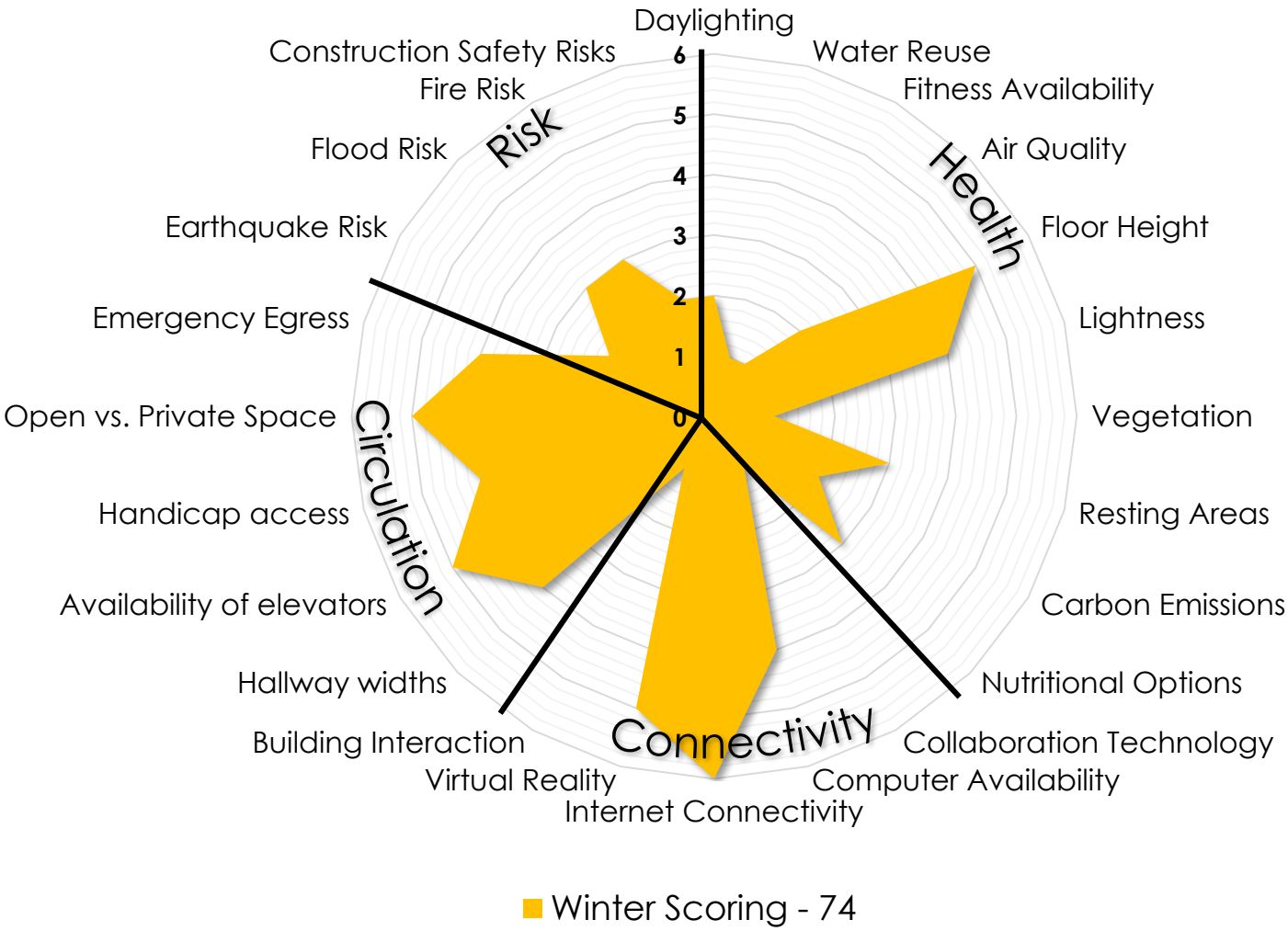
Cash Flow



- **Expenditure Positions**
  - Construction
  - Operation & Maintenance
  - Replacement
  - Risk
  - Interest Cost
- **Income Positions**
  - Rent
  - Café
  - VR-Studio
  - PV-Roof
- **Break even after Year 18**

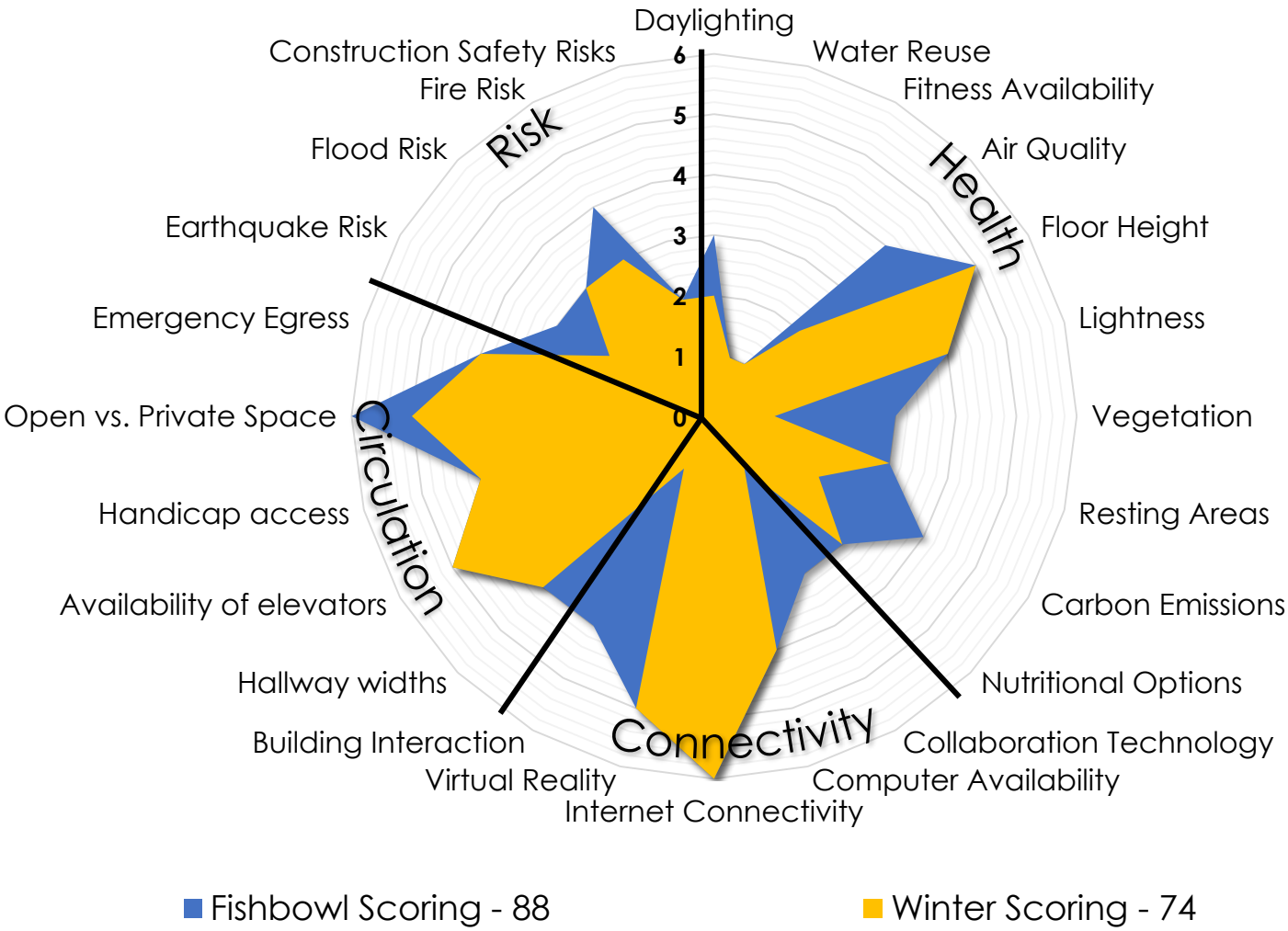
Value for Money

User Perspective - Occupant Well-Being



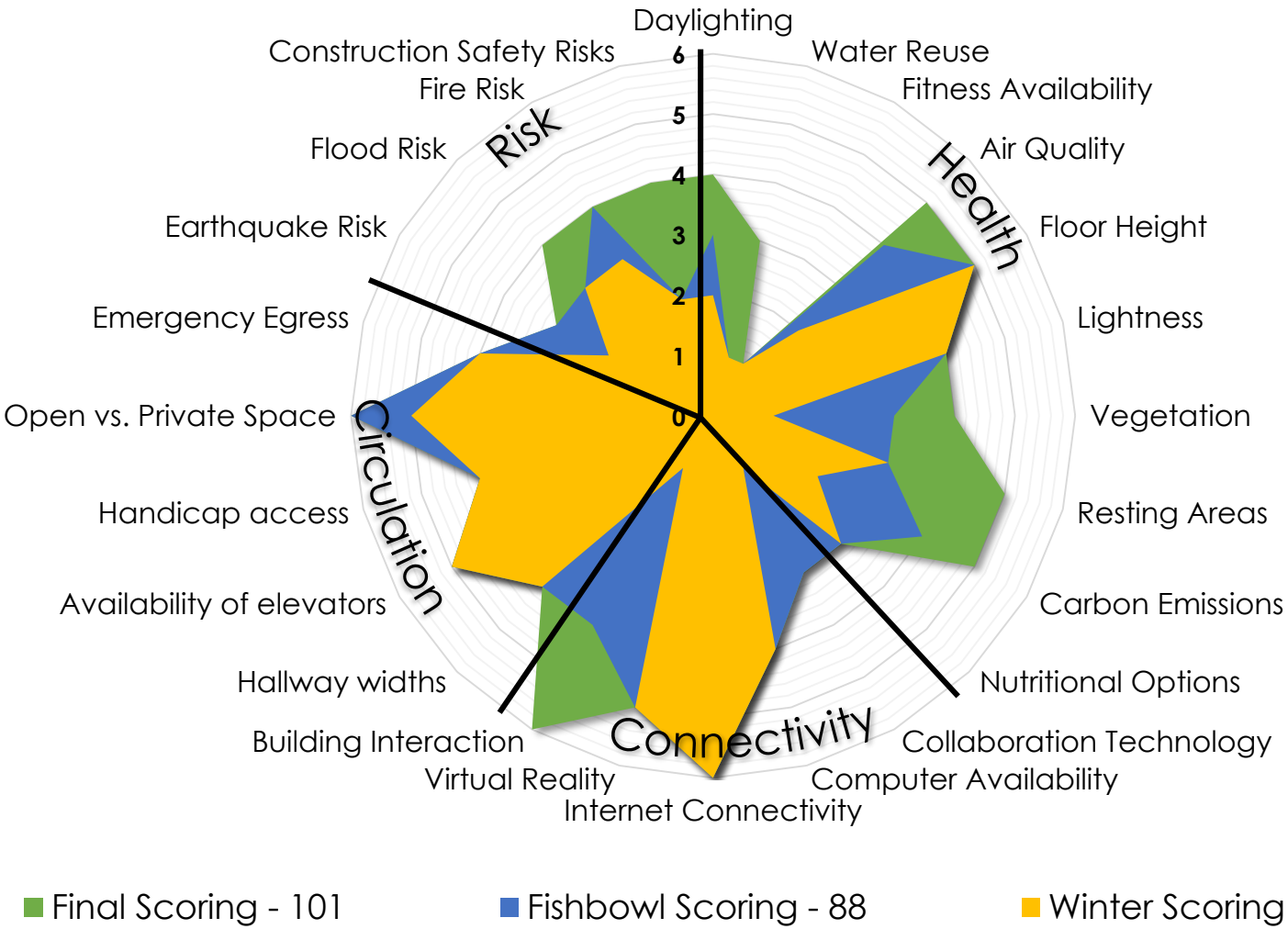
Value for Money

User Perspective - Occupant Well-Being



Value for Money

User Perspective - Occupant Well-Being

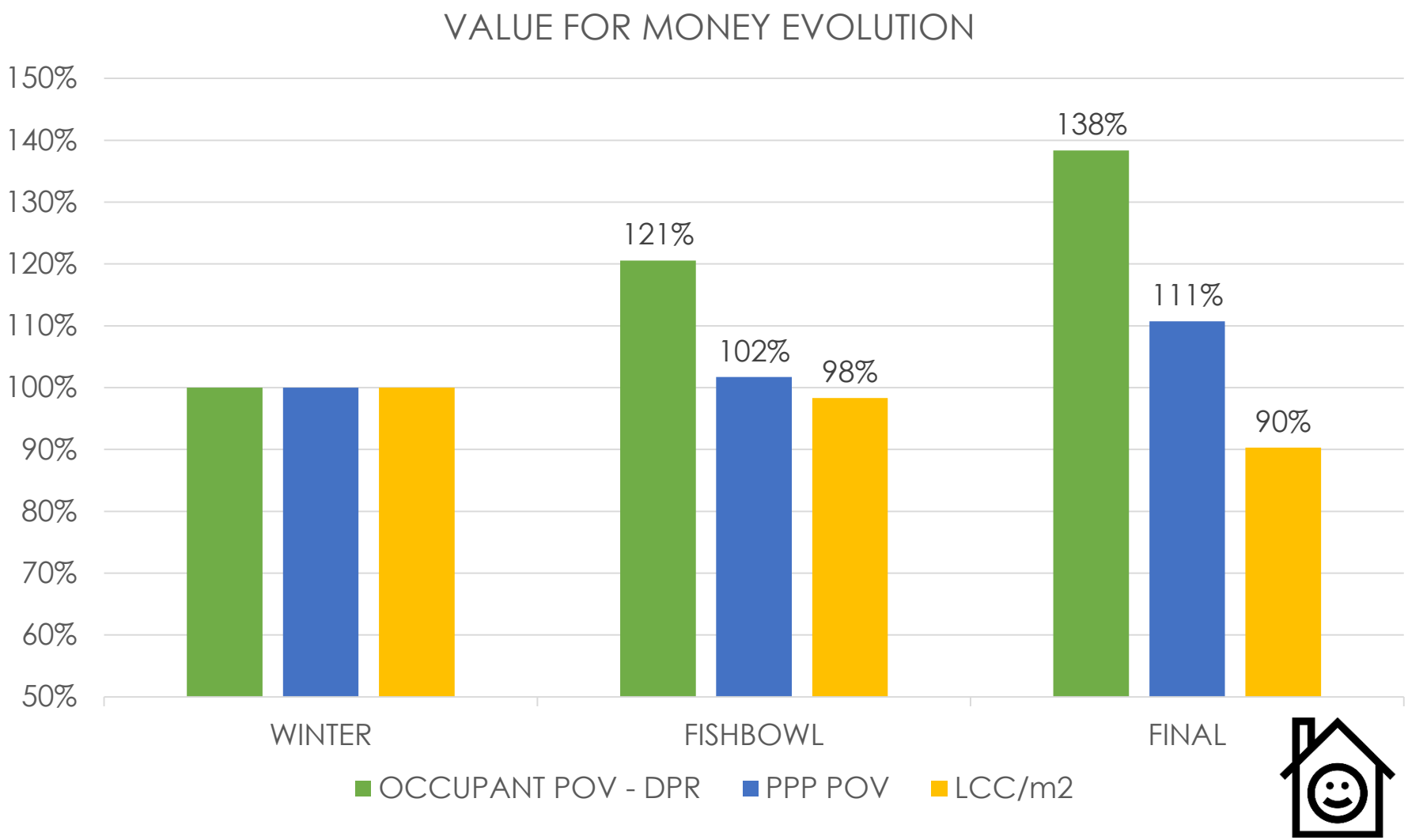


Value for Money

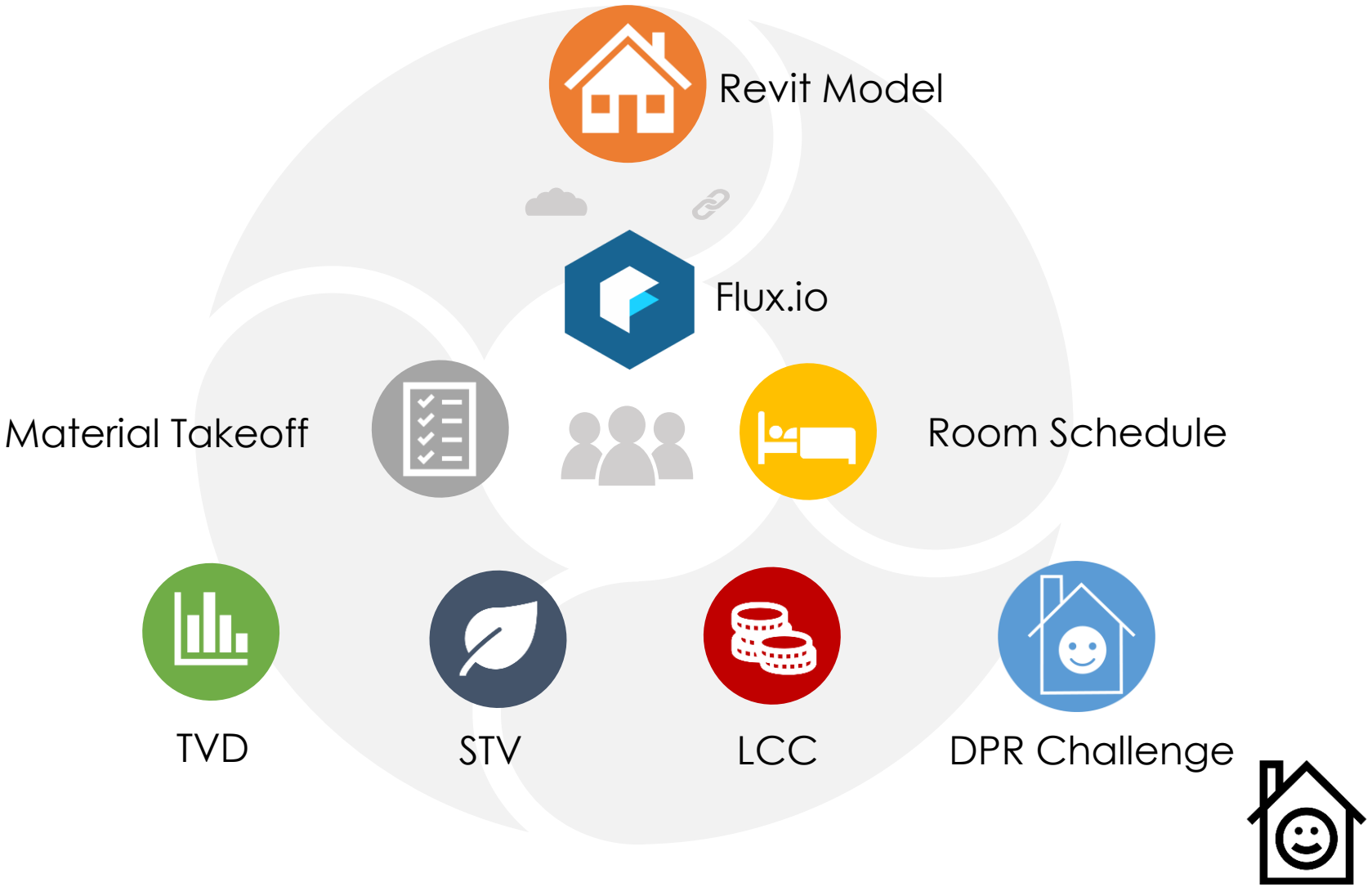
Private-Public-Partnership

- Winter:
  - 268 € LCC p.a./ m2 GFA
- Fishbowl:
  - 264 € LCC p.a./ m2 GFA
- Final:
  - 242 € LCC p.a./ m2 GFA

Value for Money



Value for Money



Lessons

Rok - Arch

"Less is more."

Ying - SE

"Collaborate with other disciplines and other cultures."

"It's easier to discuss in person than in cyber."

Ewa - MEP

"Always have a back-up plan for when someone has a bad connection."

Aleshia - SE

Learned

Samer - CM

"Pay attention during the meetings."

"Don't get caught up in the little details."

Elisa - CM

"Stop thinking in silos, interdisciplinary collaboration creates powerful solutions to reach the shared target!."

Frank - LCFM

Thank You

PBL Team

Renate Fruchter

Flavia Grey

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Nick Zeman

Norayr Badasyan

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- Jeff Tilden
- Nejc Filipic
- Christian Rønne
- Matthew Williamson
- Paul Switenki
- Bjorn Wuendsch
- Steve Resset
- Sinan Milhelcic
- Henry Tooryani

Entrance Square