Vertical River Office Building

Illinois Tech

U.S. Department of Energy
Solar Decathlon

Index

Team Members

Goals

Masterplan

Architecture

Engineering

Operations

Resilience

Finnancial Viability & Market Potential

Conclusion

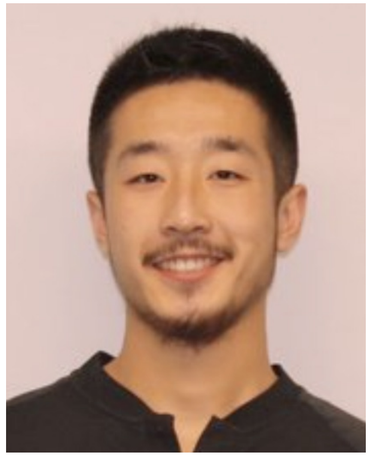
Team Members

Pablo Aranda Navarro
Expertise in Architecture Design

Rafael Ventura López
Expertise in Architecture Design

Nupoor Nileshkumar Kansara
Expertise in Energy Analysis

Sergio Vizcaino González
Expertise in Envelope Design



Fengyuan Jiang
Expertise in HVAC and Ventilation

David Polzin
Expertise in HVAC

Faculty Advisors

Edoarda Corradi, M.S.: Faculty Lead

Brent Stephens, Ph.D.: Department Chair

Mohammad Heidarinejad, Ph.D., P.E: Assistant Professor of Civil Eng.

Rohter Laurence, M.S.: Lecturer of Civil Engineering

Industry Partners

Solomon Cordon Buenz, Architectural Firm

Baumann Consulting

Passive House Institute US

dbHMS

HKS Architects

Cushing Terrell Architects

Goals

Design a 0 Energy Building.

Reduced carbon footprint on building materials

Workspace on a healthy envito-ment.

Goals

2 goals:

Development of an abandoned industrial area arround Chicago River.

Approach and recover the River natural enviroment to citizens.

MASTERPLAN

Masterplan under development that matches our objetives of actuation.

Image procuded by SCB

Masterplan

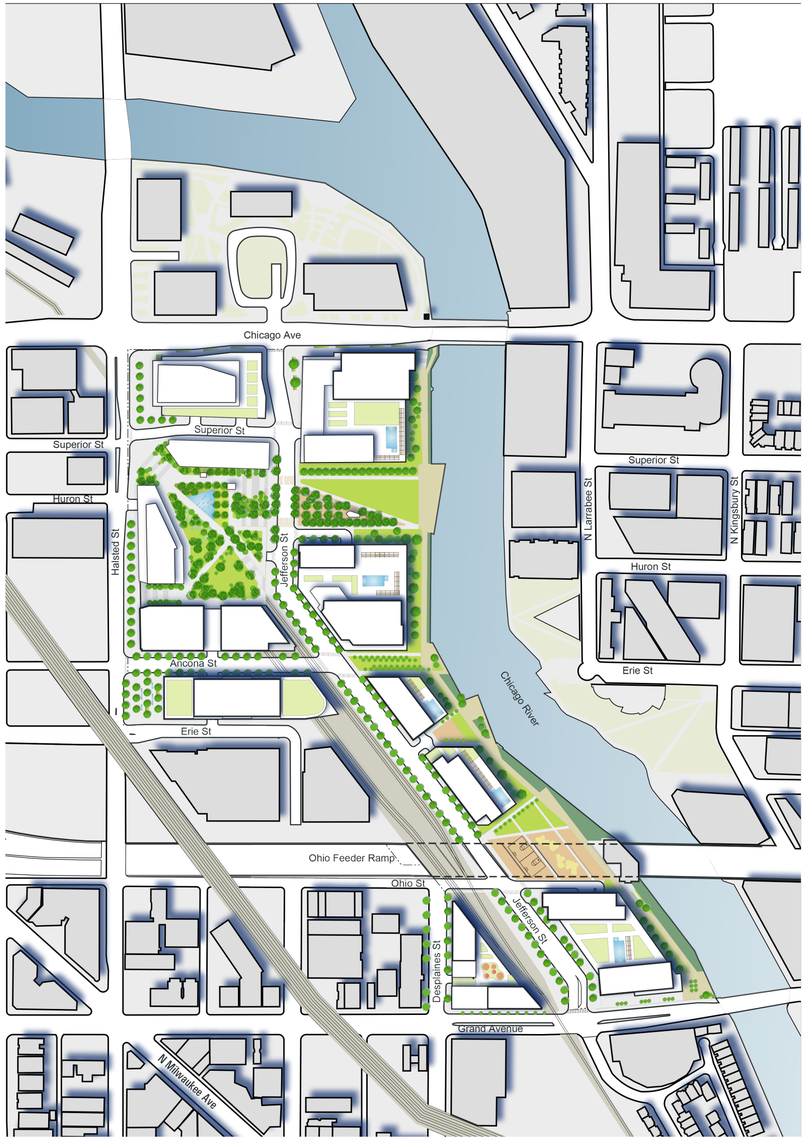
The Masterplan is neighbouring Chicago's finnancial district, the Loop.

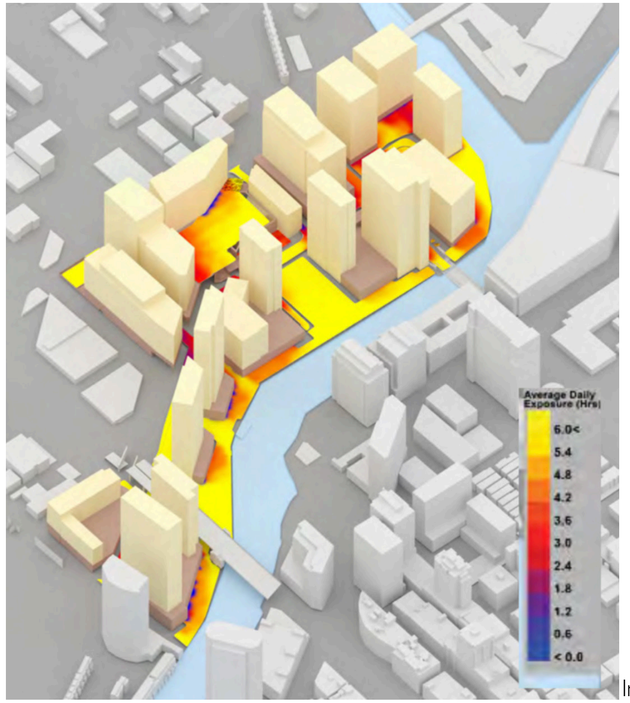
Located between River North and West Loop districts.

Served by major streets as Chicago, Grand, and Halstead streets.

Connected with CTA metro lines, bus routes, and bike lanes.

MASTERPLAN





Images procuded by SCB

Designed by SCB architects for the Chicago Tribune Group.

Located on the Chicago Tribune Printing Plant.

A 33 acre masteplan.

Residential & Oficce development on former industrial site.

Masterplan

After a solar shading calculation, the best plot for the building was selected.

Orange and green building have both the best solar exposition on the facade, but green one is located closed to the river.

Architecture

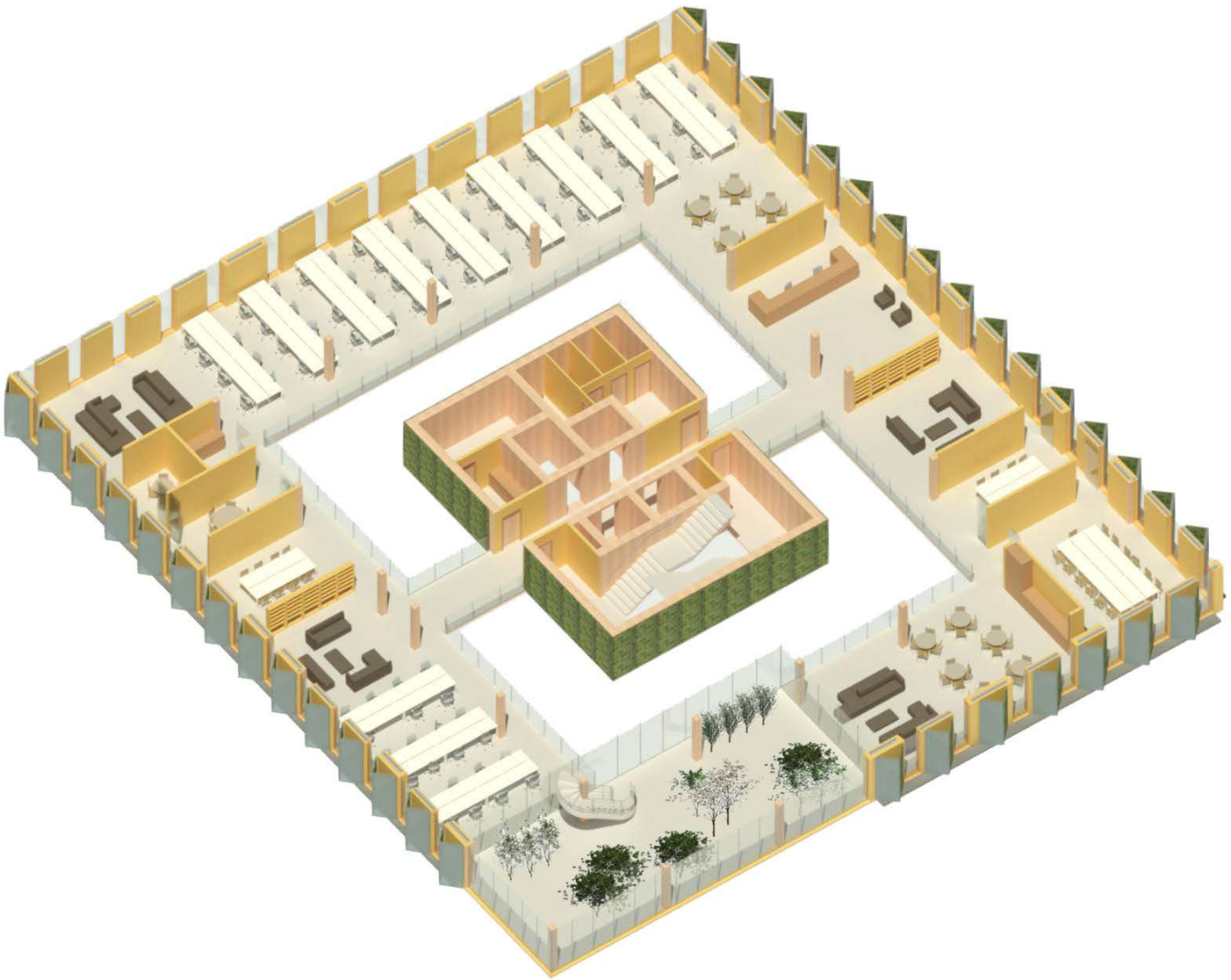
West elevation

PV panels are located on facade with a south orientation.

Section

Central core enclosed by an atrium and the workspace.

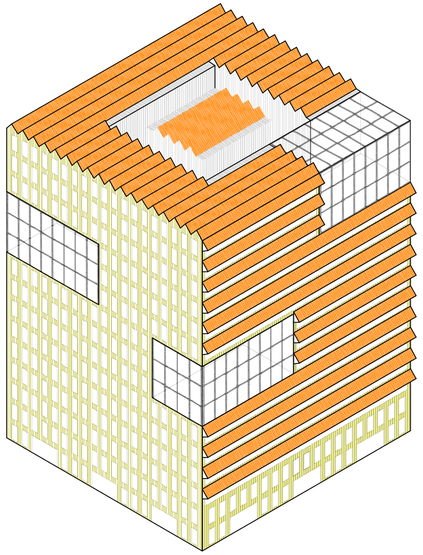
Architecture



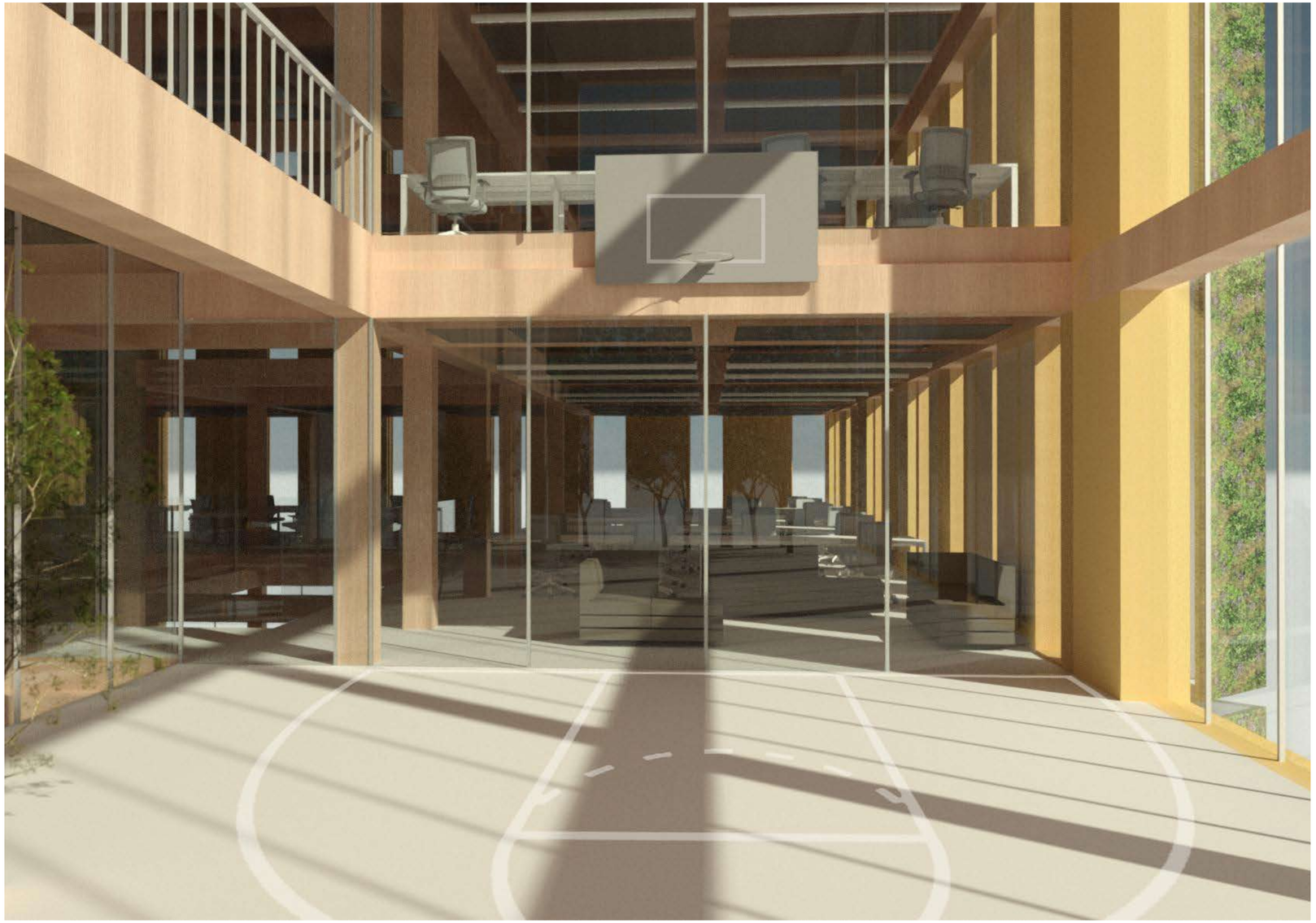
Rigid central core for structure purposes holding on its interior, restrooms and vertical communication.

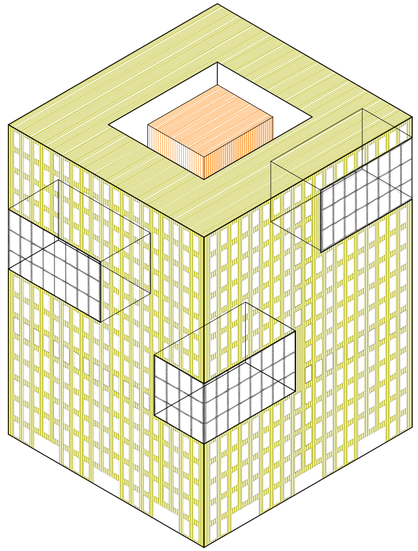
Architecture

The office space is distributed within the 20 by 20 feet grid on the exterior ring of the building.



Architecture

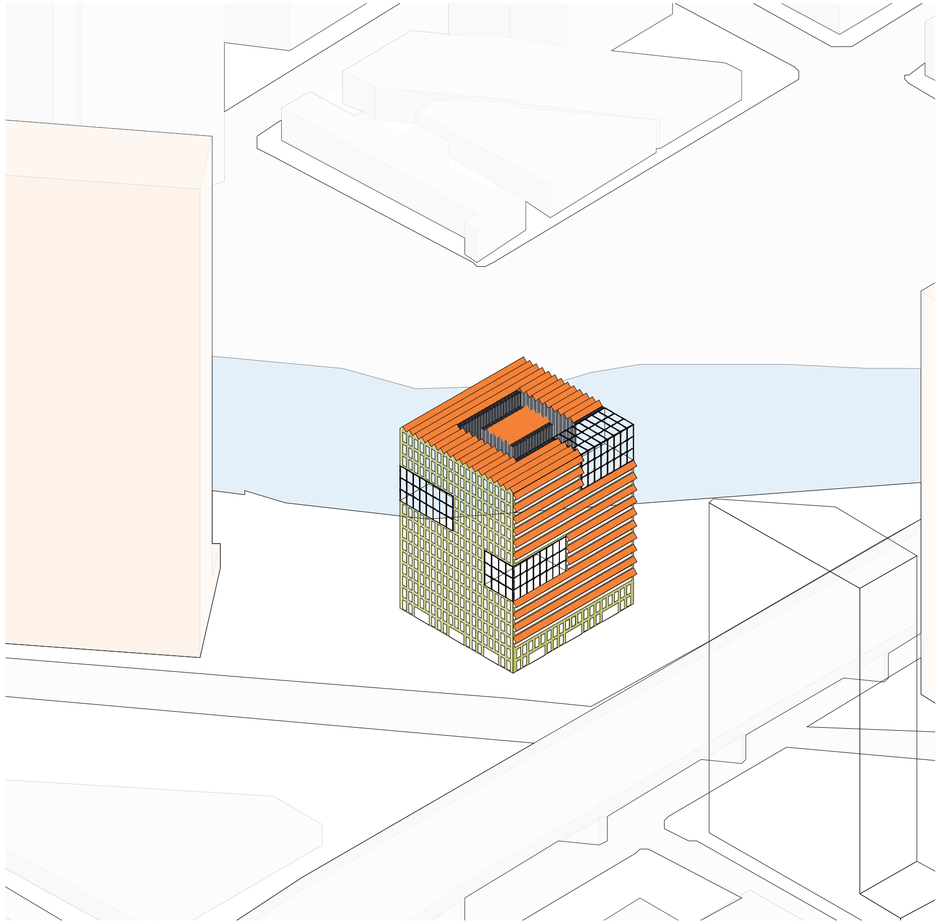


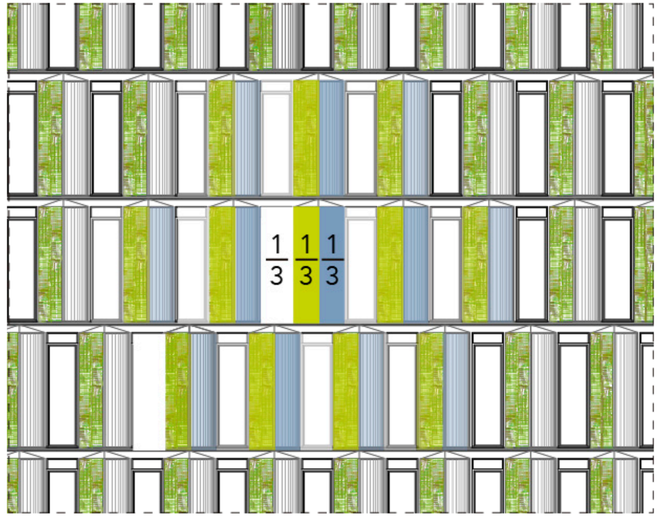


Four winter gardens are located along the building.

Each of them serving as a space of recreation but with a different theme.

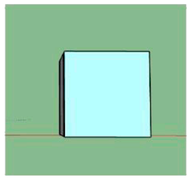
ENGINEERING ENERGY PERFORMANCE





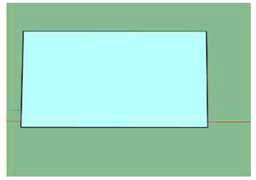
1/3 Window to wall ratio.

Form factor calculation giving a square as most optimal energy efficient shape.



FORM FACTOR CALCULATION

- Heat Loss Form Factor: 0.94
- Surface to Volume Factor: 0.07 1/ft
- Envelope Area: 85,946.64 ft²



FORM FACTOR CALCULATION

- Heat Loss Form Factor: 1.89
- Surface to Volume Factor: 0.12 1/ft
- Envelope Area: 14,229.7 ft²

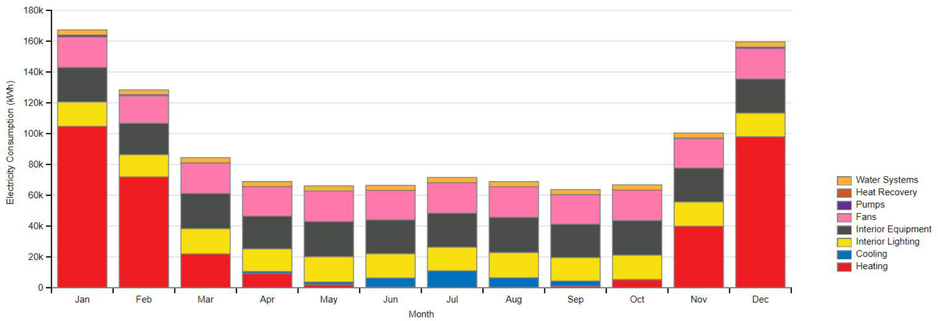
ENGINEERING ENERGY PERFORMANCE

Energy model results with Openstudio.

Building Summary

Data	Value
Building Name	Building 1
Total Site Energy	3,795,230 kBtu
Total Building Area	159,132 ft^2
Total Site EUI	23.85 kBtu/ft^2
OpenStudio Standards Building Type	n/a

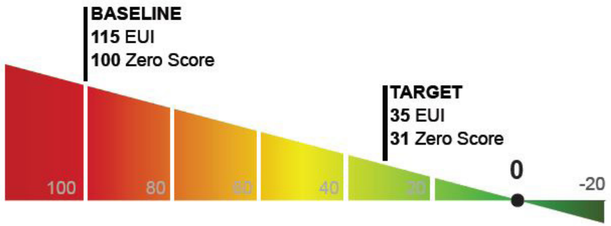
Electricity Consumption (kWh) - view table



2030 Baseline

RESULTS

Target EUI is 35 based on a 70% reduction



BUILDING SUMMARY

LOCATION	Chicago, IL	60654
USES	Office	159,132 sq.ft (100.0%)

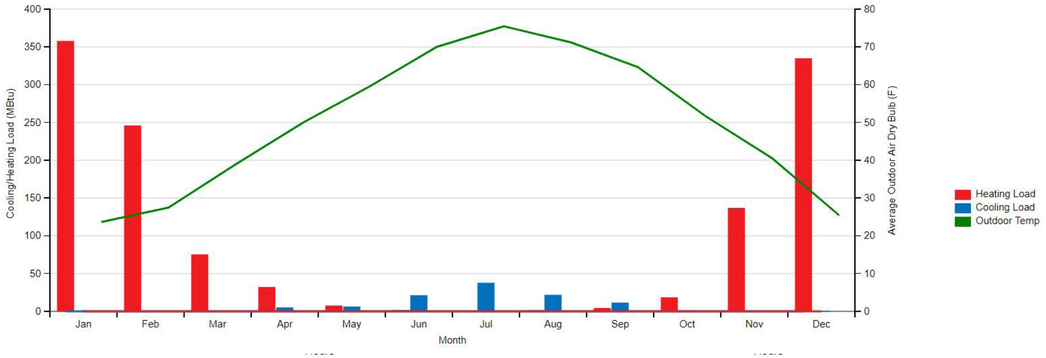
RESULTS	BASELINE	TARGET	YOUR BUILDING
EUI % Reduction from Baseline	0%	70%	N/A
Zero Score	100	31	N/A
Site EUI (kBtu/ft²/yr)	115	35	N/A
Source EUI (kBtu/ft²/yr)	254	77	N/A
Total GHG Emissions (metric tons CO_2e/yr)	2,472	742	N/A

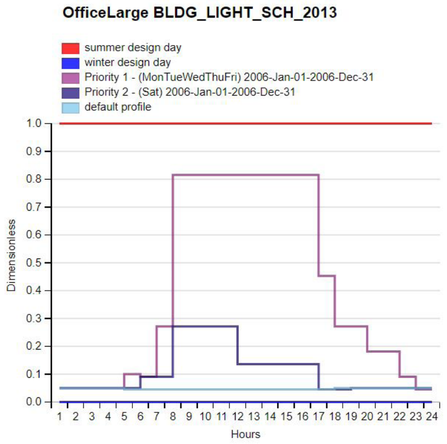
ENGINEERING ENERGY PERFORMANCE

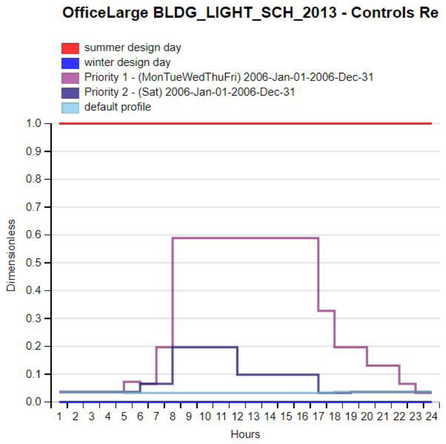
HVAC Load Profiles

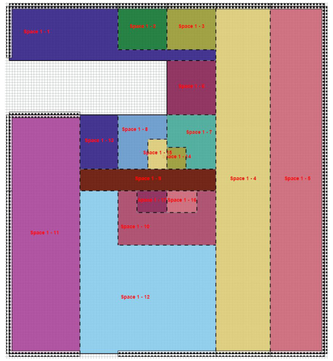
Monthly Load Profiles - view table

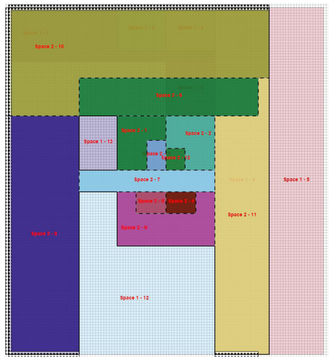
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Outdoor Air Dry Bulb (F)	23.6	27.5	38.9	49.9	59.5	70.0	75.4	71.2	64.6	51.8	40.5	25.4
Cooling Load (MBtu)	0.1	0.08	0.11	4.48	5.76	20.55	37.16	21.21	10.98	0.35	0.11	0.1
Heating Load (MBtu)	357.29	245.39	74.74	31.46	6.94	1.01	0.25	0.81	3.75	17.92	136.18	334.34

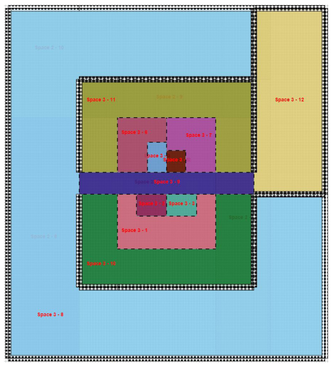






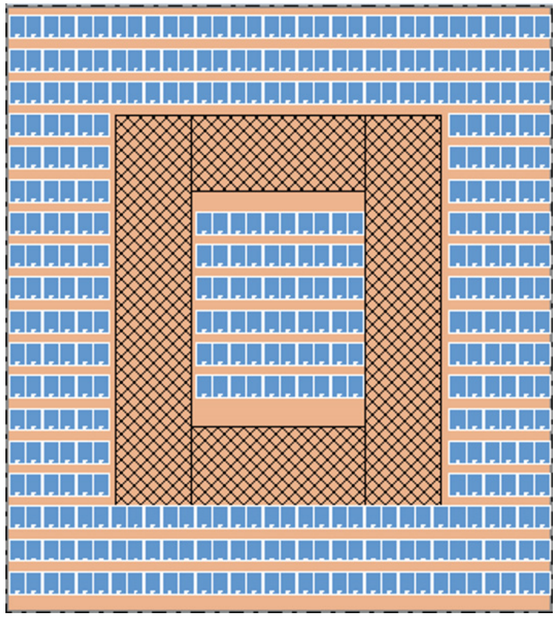




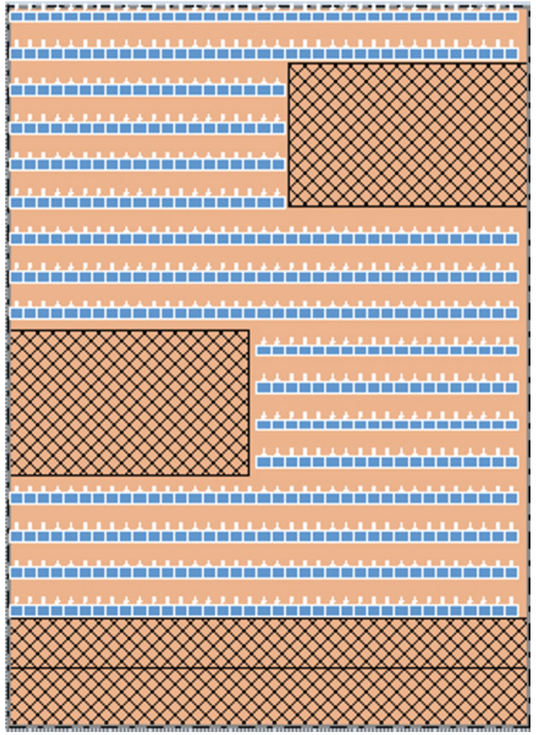


Constructive section of the buildings enclosure.

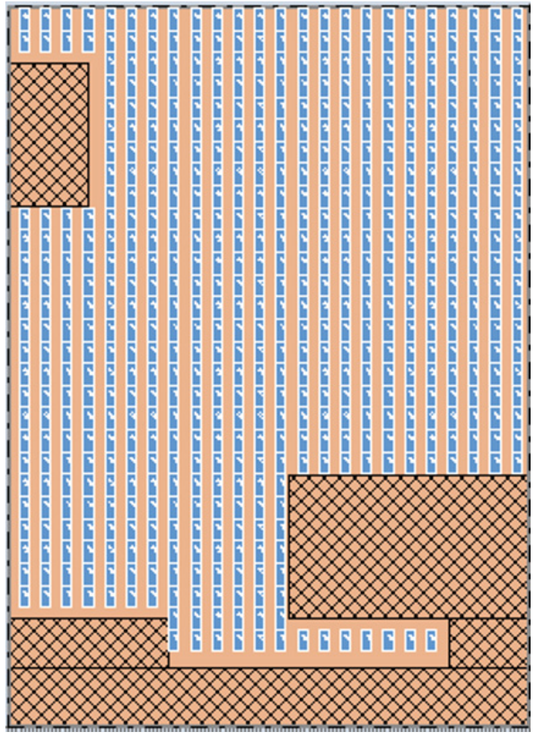
ENGINEERING ENERGY GENERATION



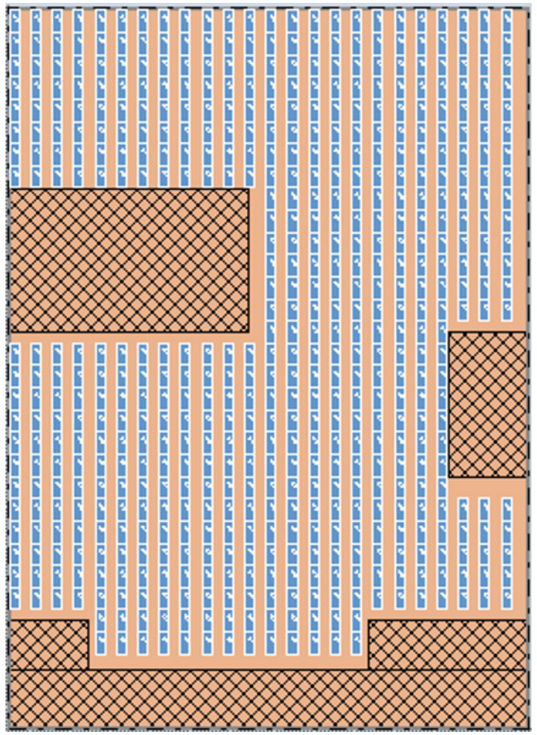
Rooftop



South facade



East facade



West facade

Surface	Annual production (kWh)	Annual production (kBtu/ft^2)
Roof	239,769	5.14
East façade	146,438	3.14
West façade	157,057	3.36
South façade	202,797	4.35

ENGINEERING ENERGY GENERATION

Biomass power station model.

ENGINEERING ENERGY GENERATION

CONSUMTION EUI

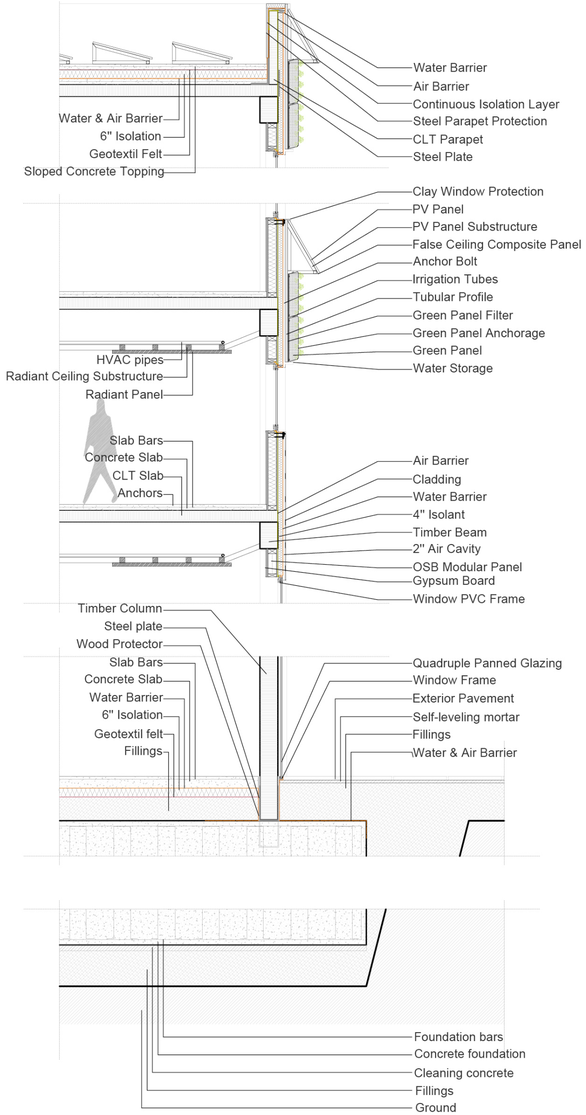
23,85

GENERATED EUI

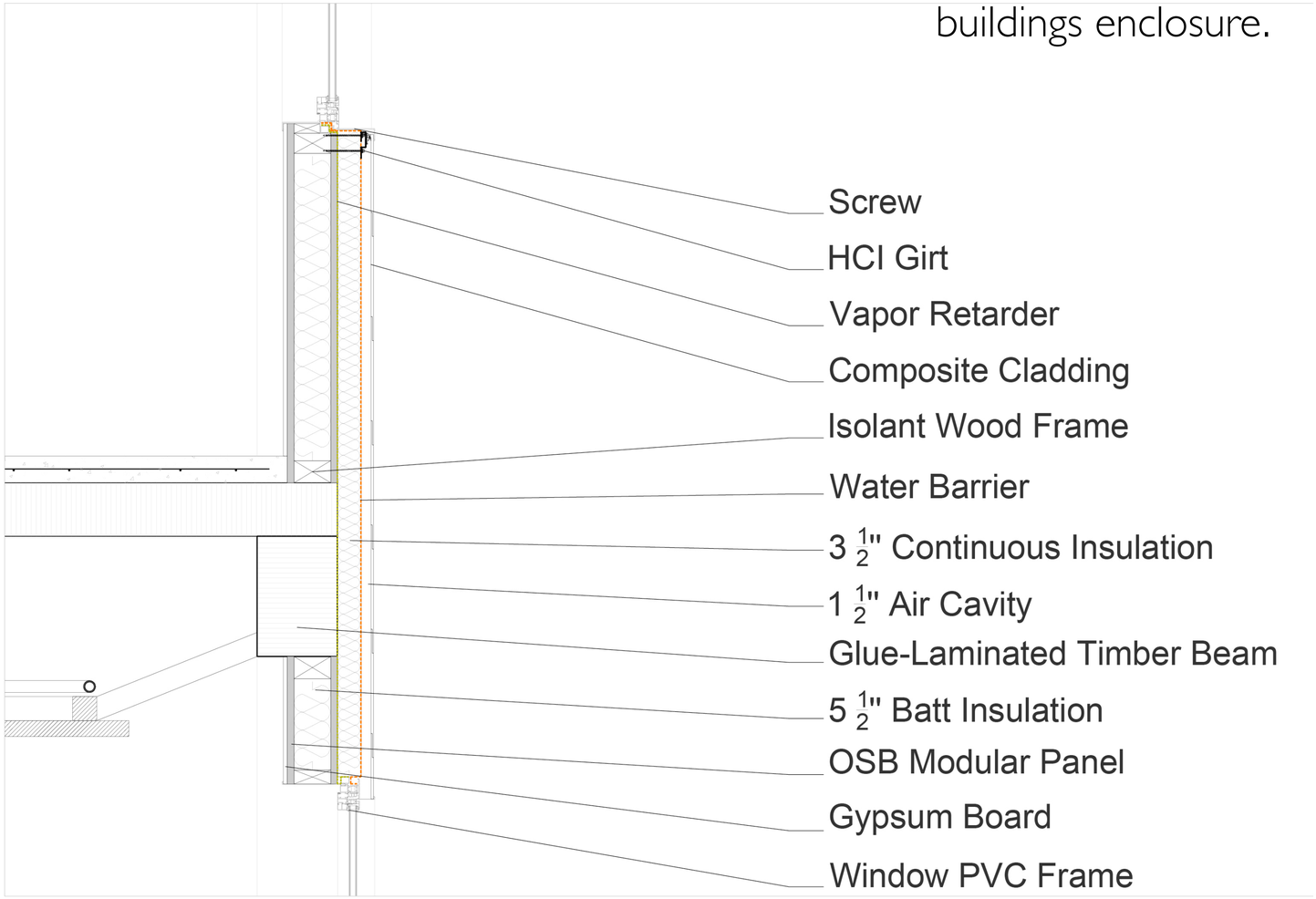
27,37

Renewable energy	Annual generation (kWh)	Target EUI (kBtu/ft^2)
Solar	746,061	16
Biomass	530,000	11.37
Total	1,276,061	27.37

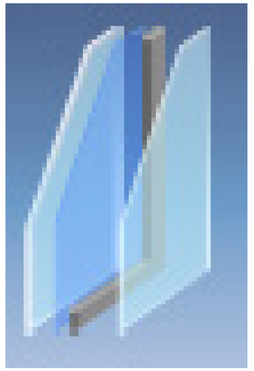
ENGINEERING ENVELOPE



Constructive section of the buildings enclosure.



ENGINEERING ENVELOPE



Pane 1	PLANICLEAR 6 mm
Coating 2	COOL-LITE XTREME 60-28
Cavity 1	16 ARGON 90%
Pane 2	PLANICLEAR 4 mm

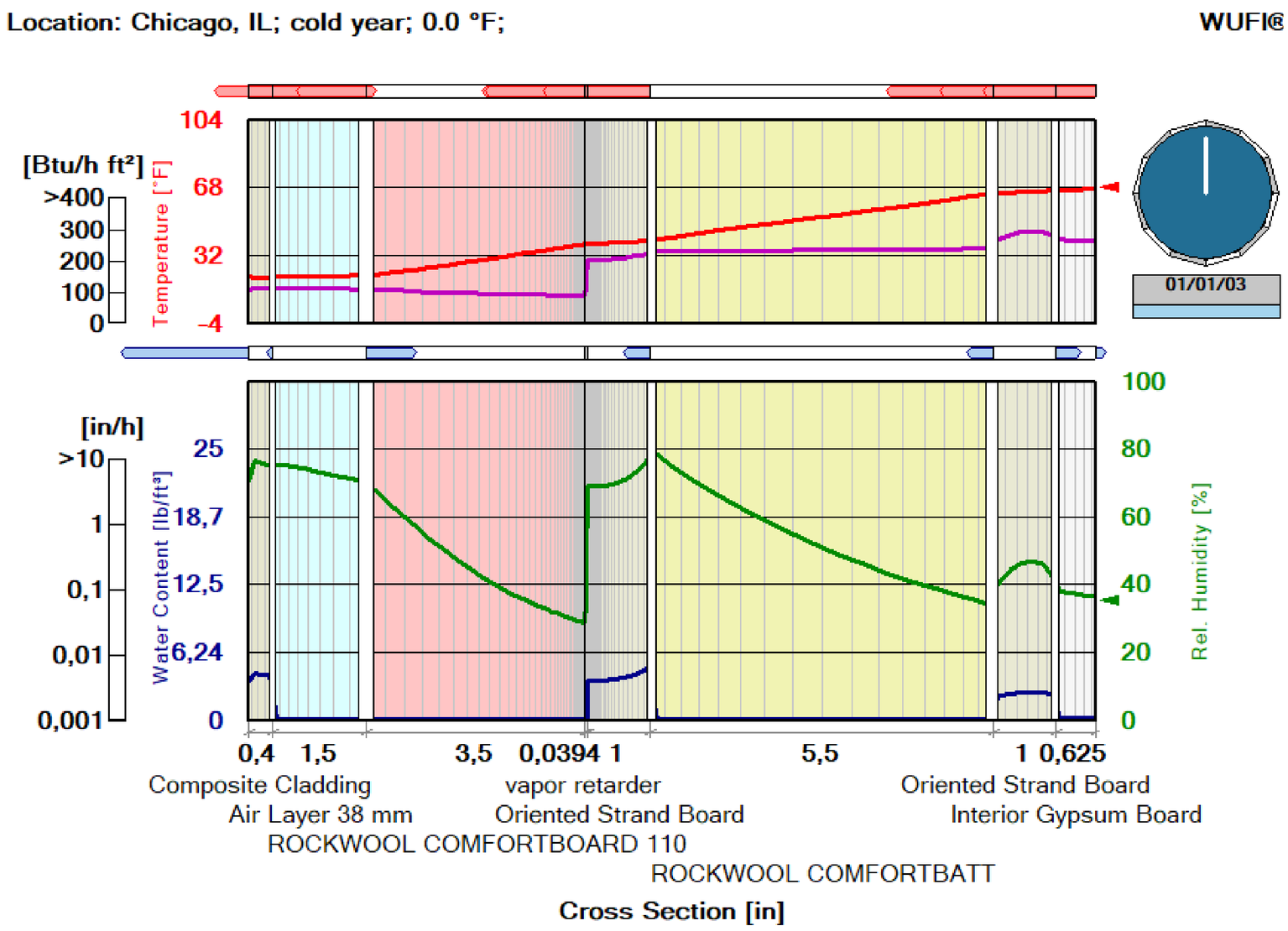
Glazing for exterior facade

Hoja 1	DIAMANT 8 mm

Glazing for exterior facade

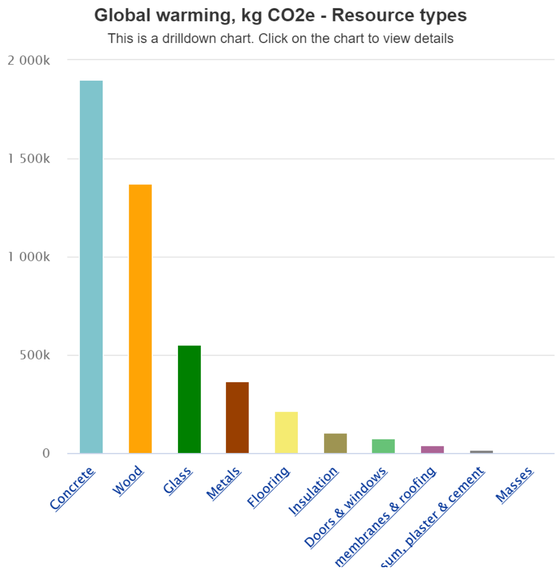
ENGINEERING ENVELOPE

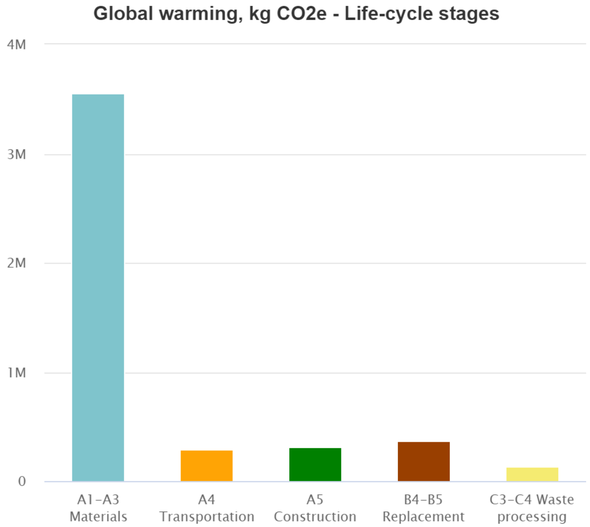
Wufi analysis.

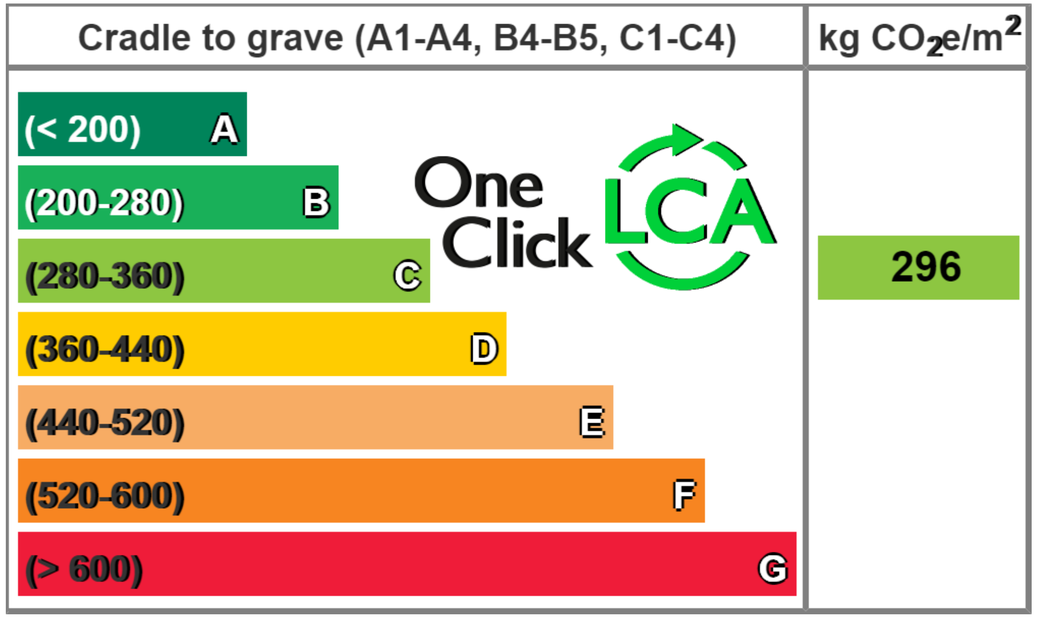


ENGINEERING

Life Cycle Analysis for timber structure building.

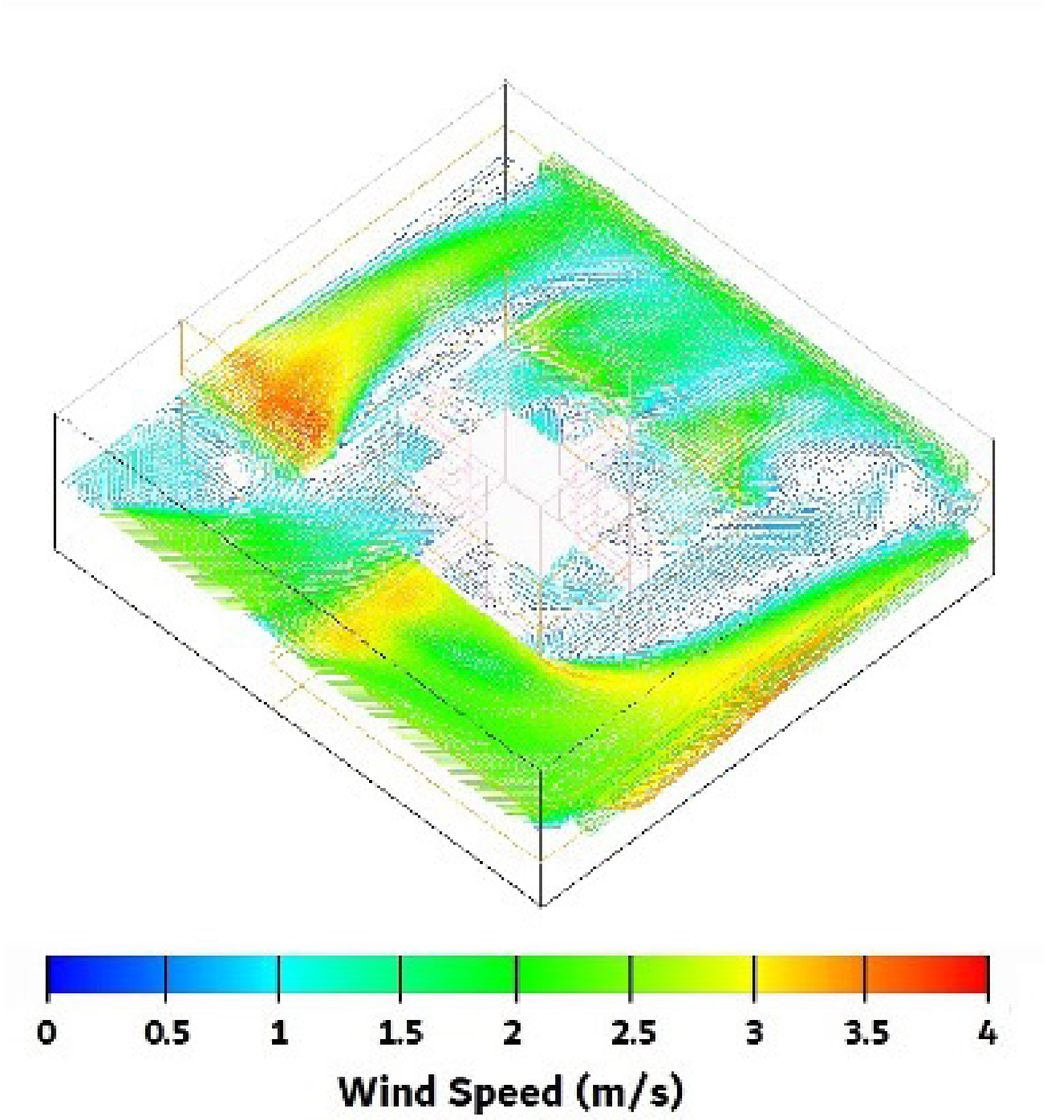


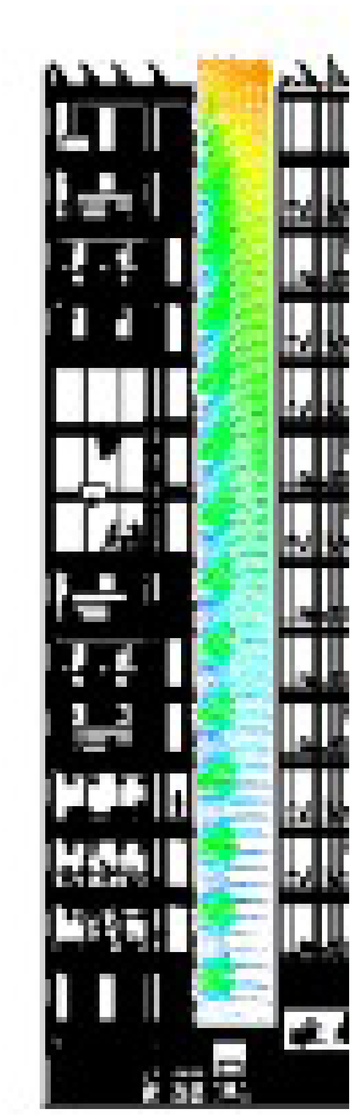




Enviromental ranking

OPERATIONS NATURAL VENTILATION

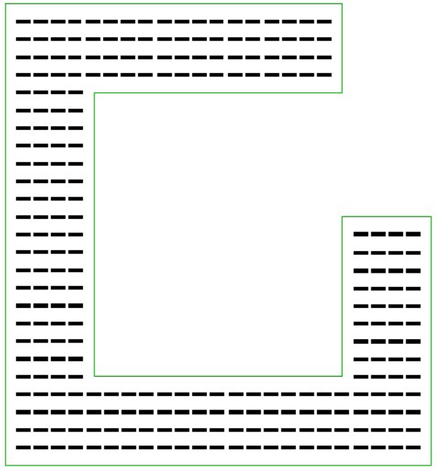




Simulations done with Fluent Airpaks and ANSYS R3.

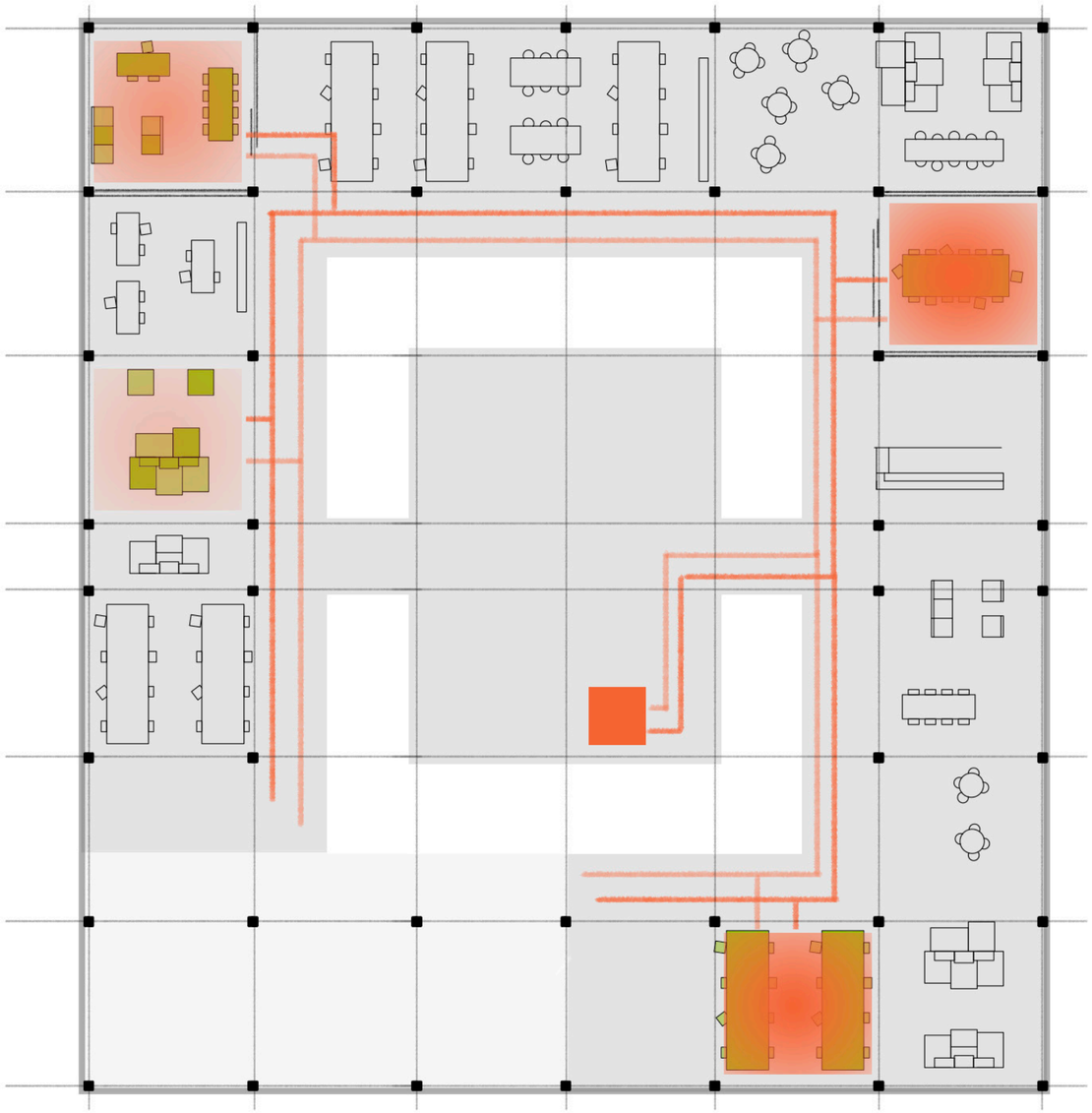
Operations Lighting Analysis

Lighting Plan from AGI32-19.14



COOPER
Lighting Solutions

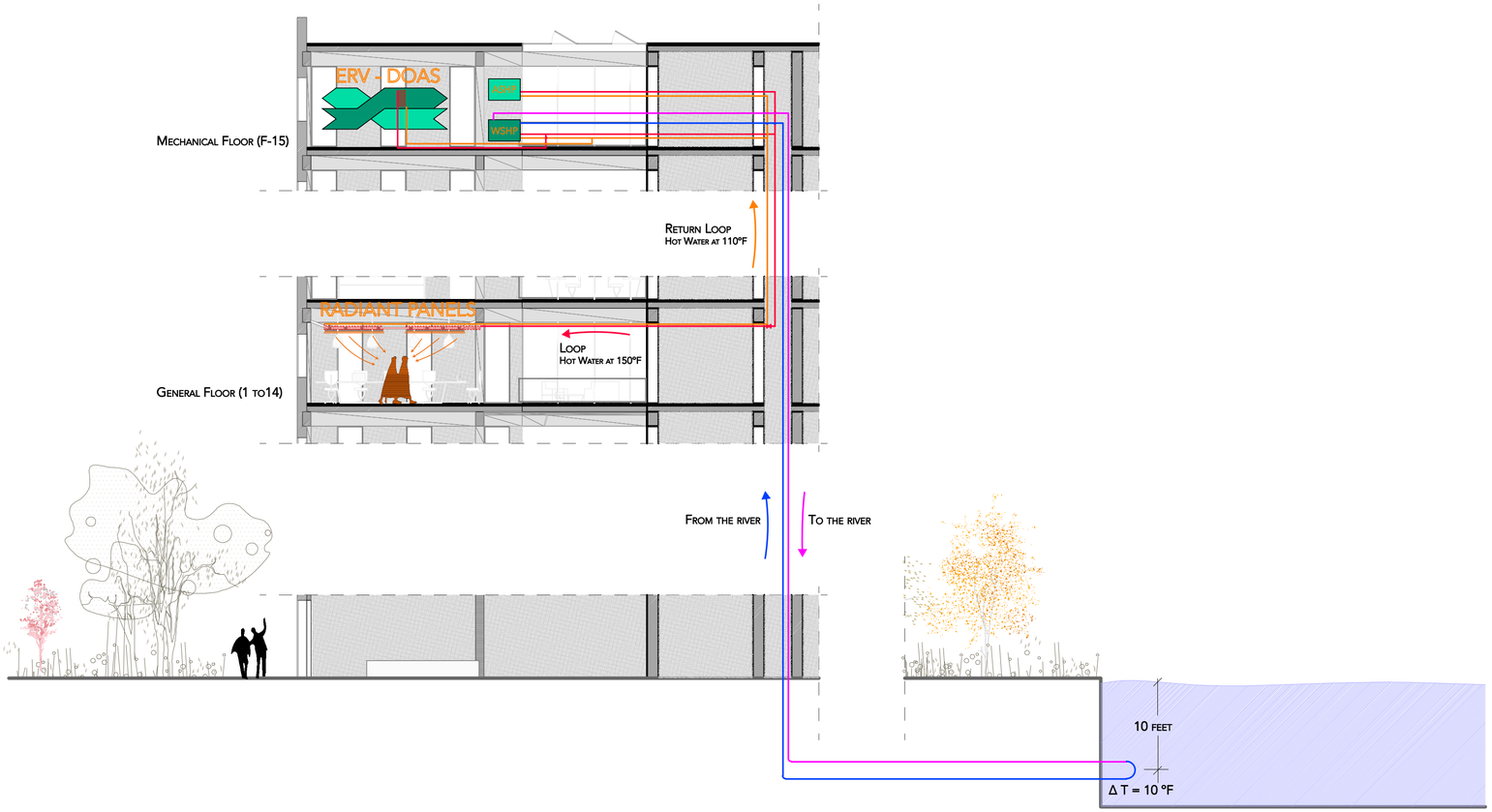
OPERATIONS HVAC



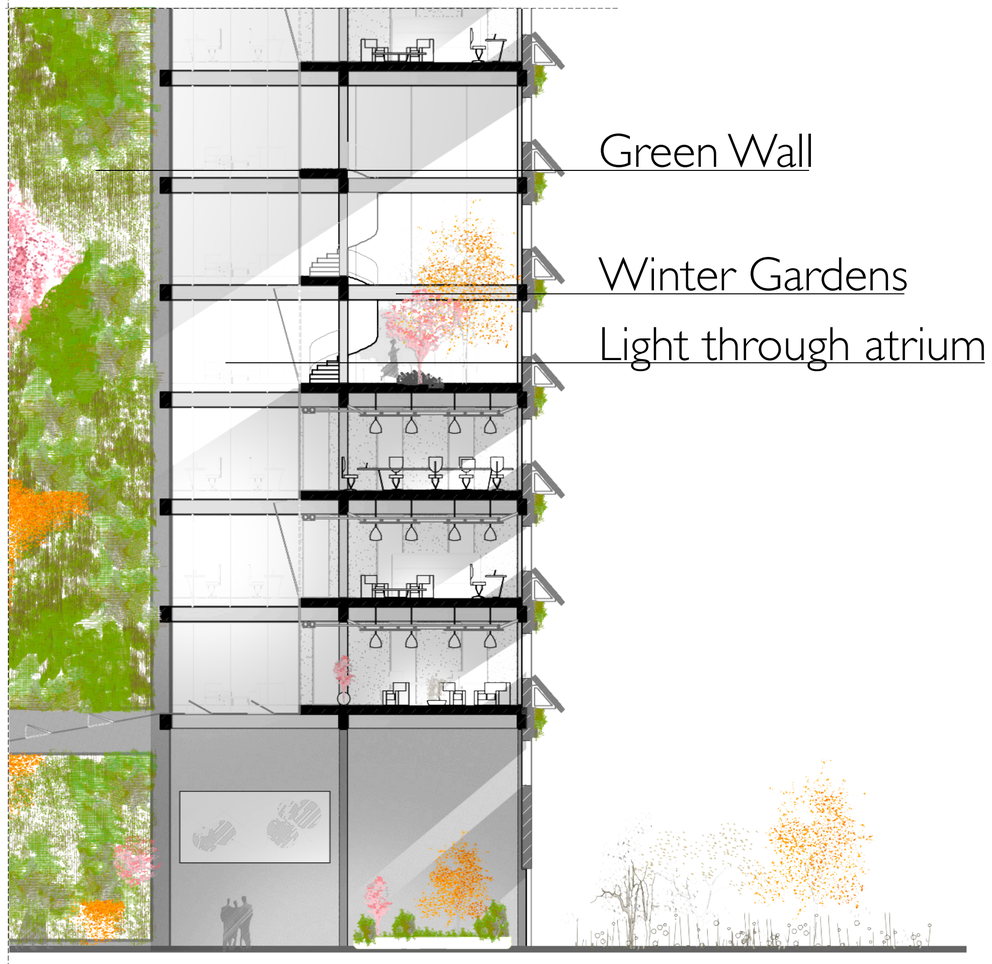
Radiant ceiling distribution on grid.

OPERATIONS HVAC

Water source heat pump.



RESILIENCE COMFORT & ENVIROMENTAL QUALITY



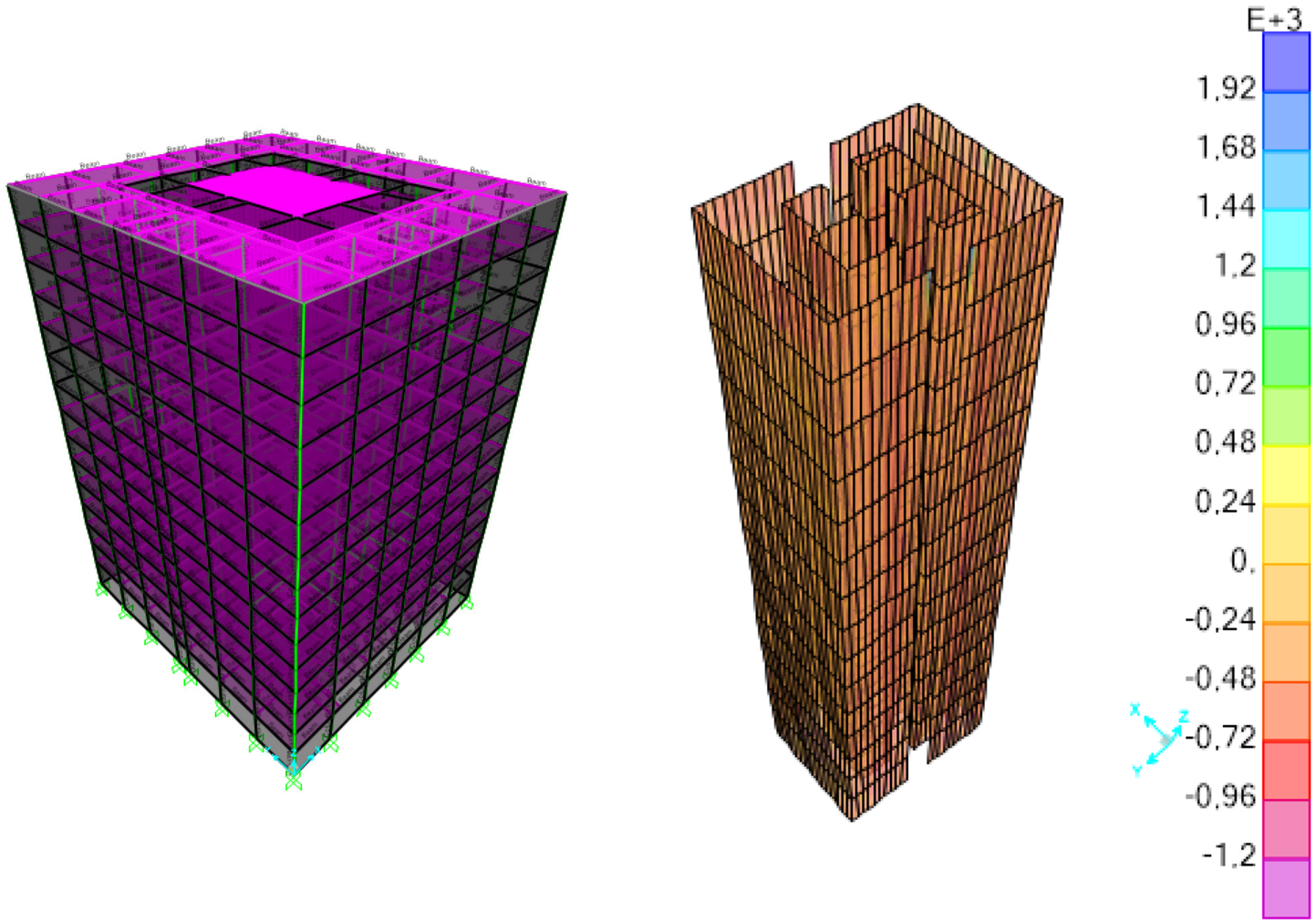
VIRGINIA CREEPER

HONEYSUCKLE

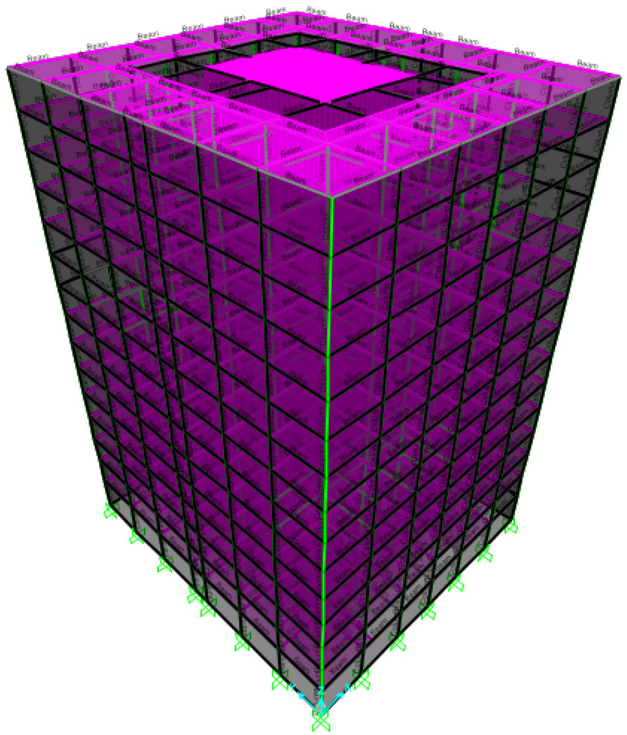
BOSTON IVY

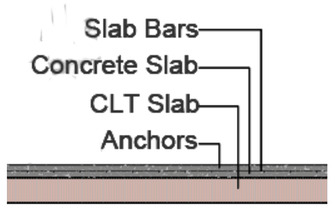
RESILIENCE STRUCTURAL RESILIENCE

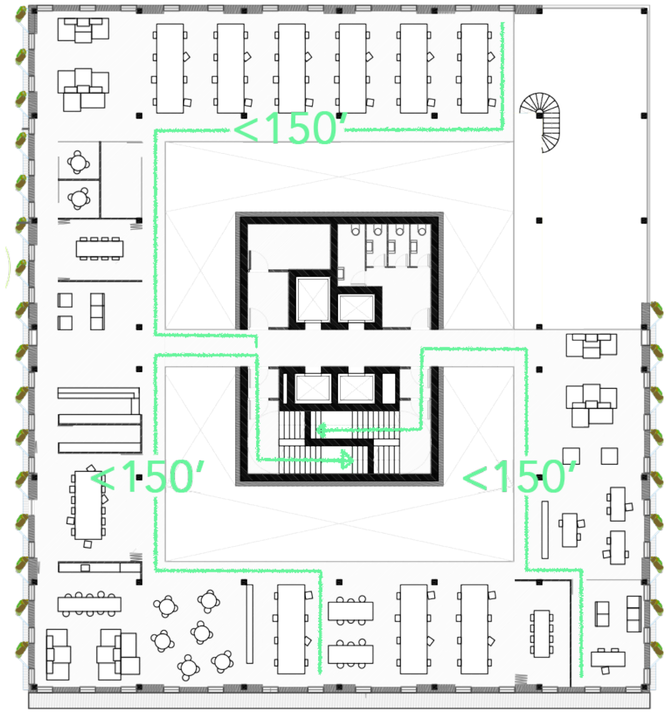
SAP structural analysis.



Resilience Structural Resilience

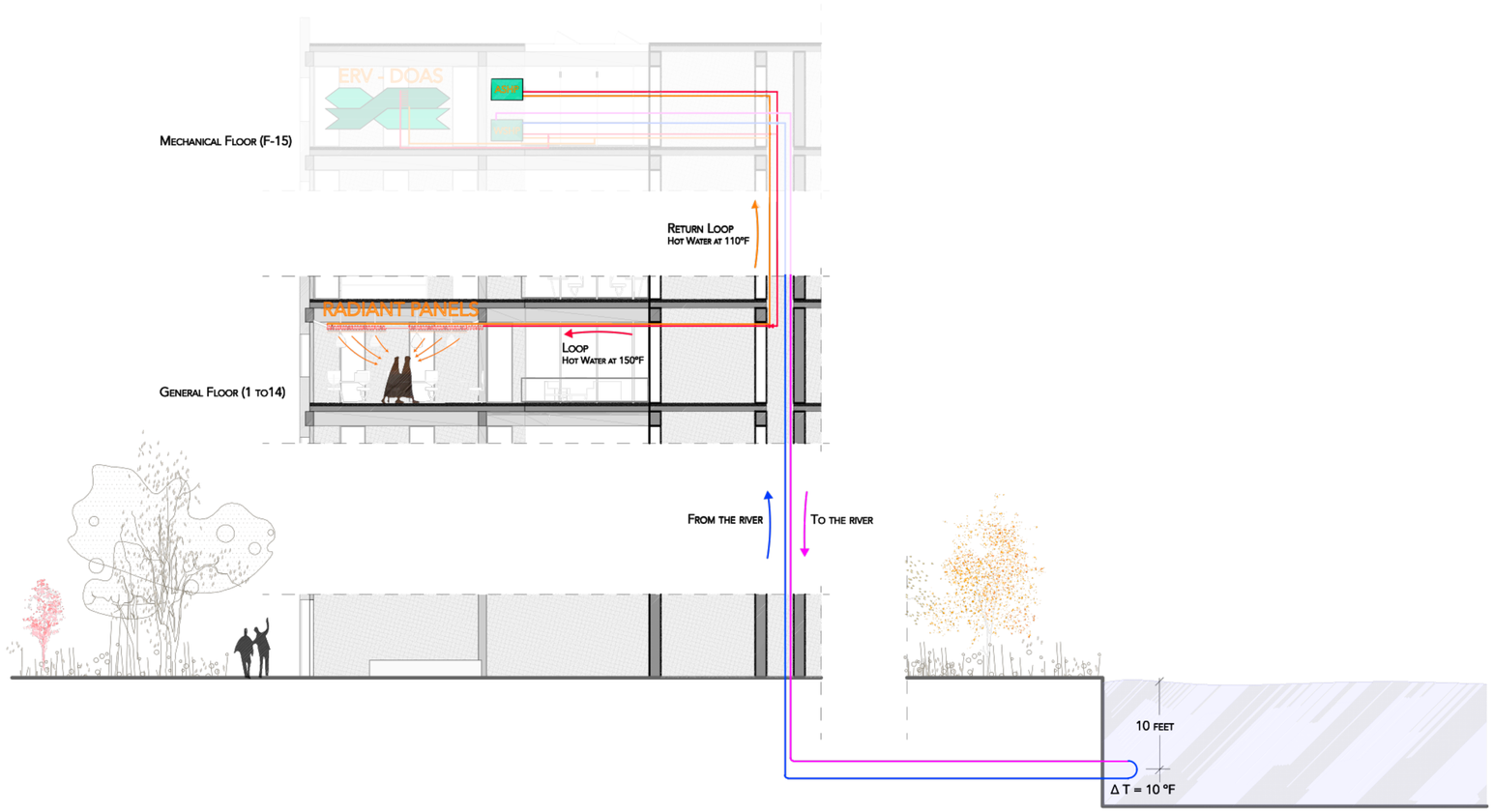






Resilience HVAC Resilience

Air source heat pump replaces the wáter source heat pump when river freezes.



Resilience Long Term Resilience

Cross ventilation through the atrium will improve the energy performance if mean temperatura increases.

FINNANCIAL ANALYSIS

Vertical River Office Building cost estimation.

CHAPTER		COST
01	SITE WORKS	46,646.78 US$
02	FOUNDATIONS	961,831.39 US$
03	STRUCTURE	14,183,237.03 US$
04	ENVELOPE	1,794,107.07 US$
05	ROOFTOP	200,852.77 US$
06	INTERIOR FINISHING	4,221,637.89 US$
07	VERTICAL GARDEN	247,434.88 US$
08	GLAZING	3,416,619.78 US$
09	ELECTRICAL SYSTEMS	2,203,900.00 US$
10	HVAC SYSTEMS	3,712,050.45 US$
11	PLUMBING SYSTEMS	834,558.81 US$
12	FIRE SUPRESSION	805,288.90 US$
13	COMMUNICATIONS	780,000.00 US$
14	ELECTRONIC SECURITY	446,641.20 US$
15	RENEWABLE ENERGY	2,284,679.35 US$
TOTAL CONSTRUCTION COST		**36,139,486.29 US$**

FINANCING COST	2.00%	722,789.73 US$
OVERHEAD AND GENERAL EXPENSES	15.00%	5,420,922.94 US$
CONTINGENCY	10.00%	3,613,948.63 US$
MARKETING COST	10.00%	3,613,948.63 US$
SALES COMMISSION	5.00%	1,806,974.31 US$
PROFIT	10.00%	3,613,948.63 US$
ARCHITECTURE, ENGINEERING	6.00%	2,168,369.18 US$

TOTAL COST	**57,100,388.35 US$**

FINNANCIAL ANALYSIS

Average building cost

Estimate Name: Vertical River Steel

Data Release: Year

Model: Office, 11-20 Story with Double Glazed Heat Absorbing Tinted Plate Glass Panels / Steel Frame

$23,289,675.83	**CHICAGO, IL**	**15**	**No**
Building Cost	Location	Stories (Ea.)	Basement
$155.26	**150,000**	**12.00**	**$82,924.13**
Cost per S.F.	Floor Area	Story Height	Additive Cost

TOTAL CONSTRUCTION COST 2011		**23,289,675.88 US$**
INFLATION EFFECT	33.00%	7,685,593.04 US$
TOTAL COST 2020		**30,975,268.92 US$**
FINANCING COST	2.00%	619,505.38 US$
OVERHEAD AND GENERAL EXPENSES	15.00%	4,646,290.34 US$
CONTINGENCY	10.00%	3,097,526.89 US$
MARKETING COST	10.00%	3,097,526.89 US$
SALES COMMISSION	5.00%	1,548,763.45 US$
PROFIT	10.00%	3,097,526.89 US$
ARCHITECTURE, ENGINEERING	6.00%	1,858,516.14 US$
TOTAL COST		**48,940,924.89 US$**

Finnancial Analysis

Energy savings and investor returns.

Energy Savings & Inversion Returns

Vertical River Office Building

Energy Usage			Cost	
Yearly Consumption	**4252969**	**kBTU / year**		**51,643.27 US$**
PV Panel Generation	2827800	kBTU / year		
Biomass Generation	425169	kBTU / year	0.02 US$	6,643.27 US$
From Grid	1000000	kBTU / year	0.05 US$	45,000.00 US$

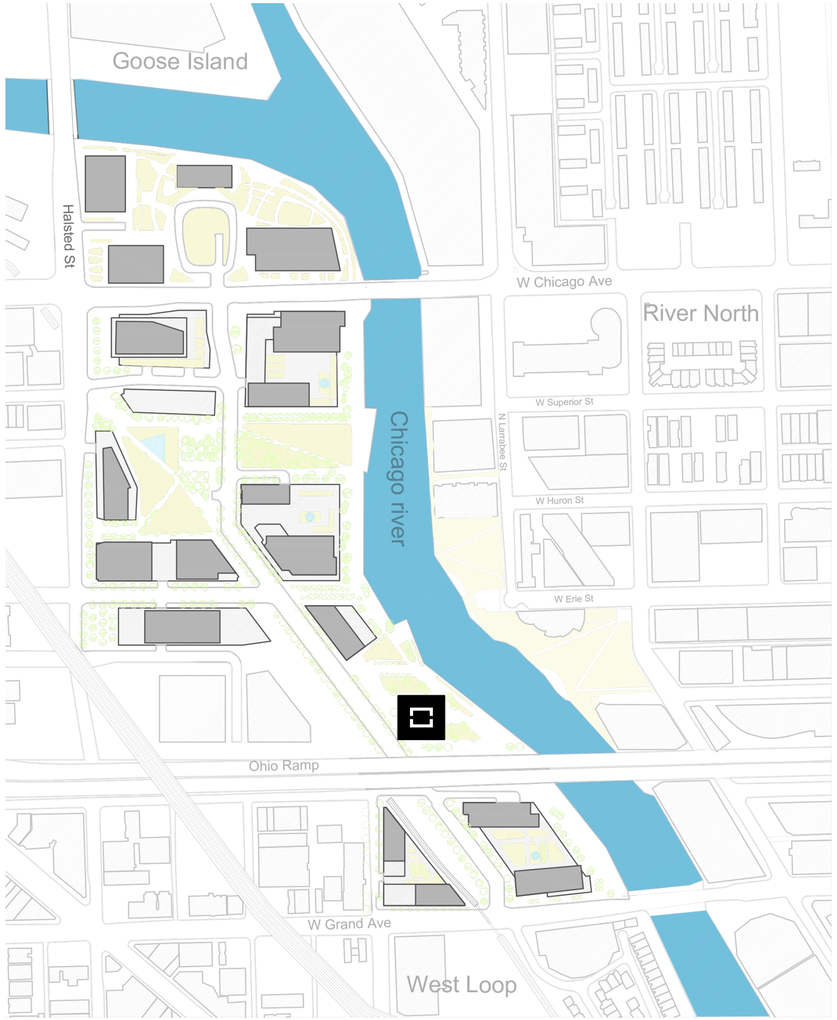
General Building

Source EUI	60	kBTU / sqft.y
Area	150000	sqft

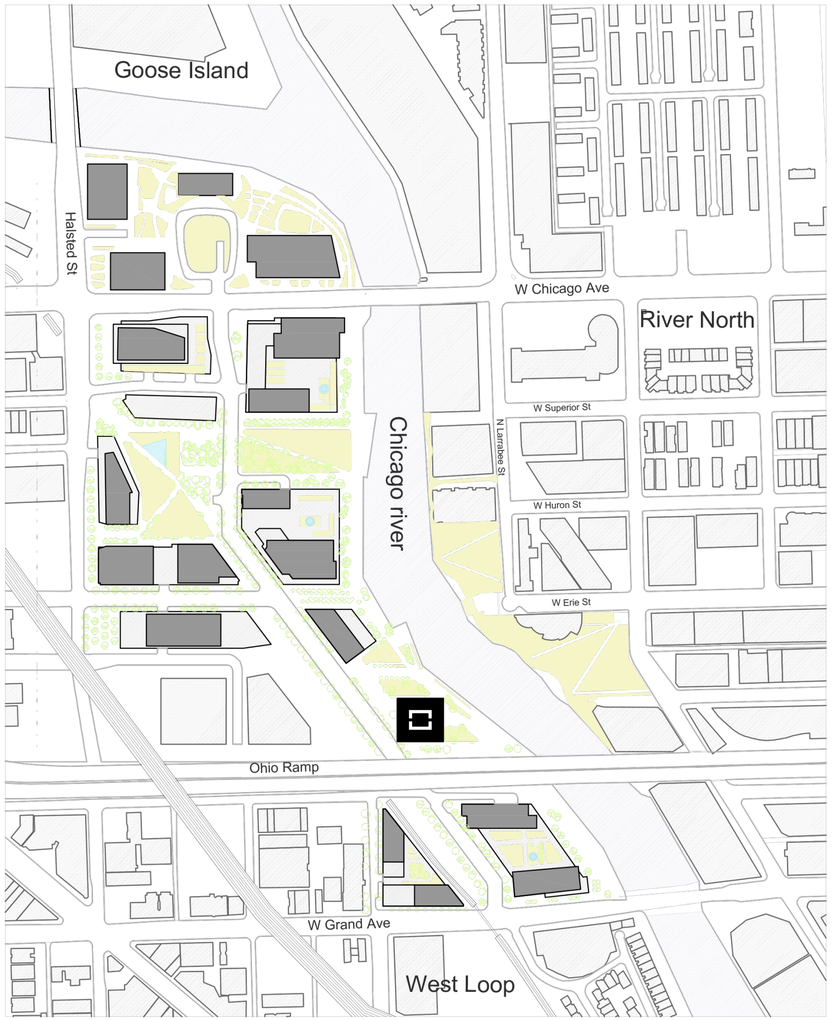
Energy Usage			Cost	
Yearly Consumption	**9000000**	**kBTU / year**	0.05 US$	**405,000.00 US$**

Vertical River Office Building Yearly Energy Expenses	51,643.27 US$
General Building Yearly Energy Expenses	405,000.00 US$
Total Savings	**353,356.73 US$**
Yearly Energy Cost Inflation	3.74%
10-Years Savings	**4,191,639.78 US$**
Vertical River Office Building Cost	57,100,388.35 US$
General Building Cost	48,940,924.89 US$
VROB Overcost	**8,159,463.45 US$**
REAL OVERCOST after 10 years	**3,967,823.68 US$**

Conclusion

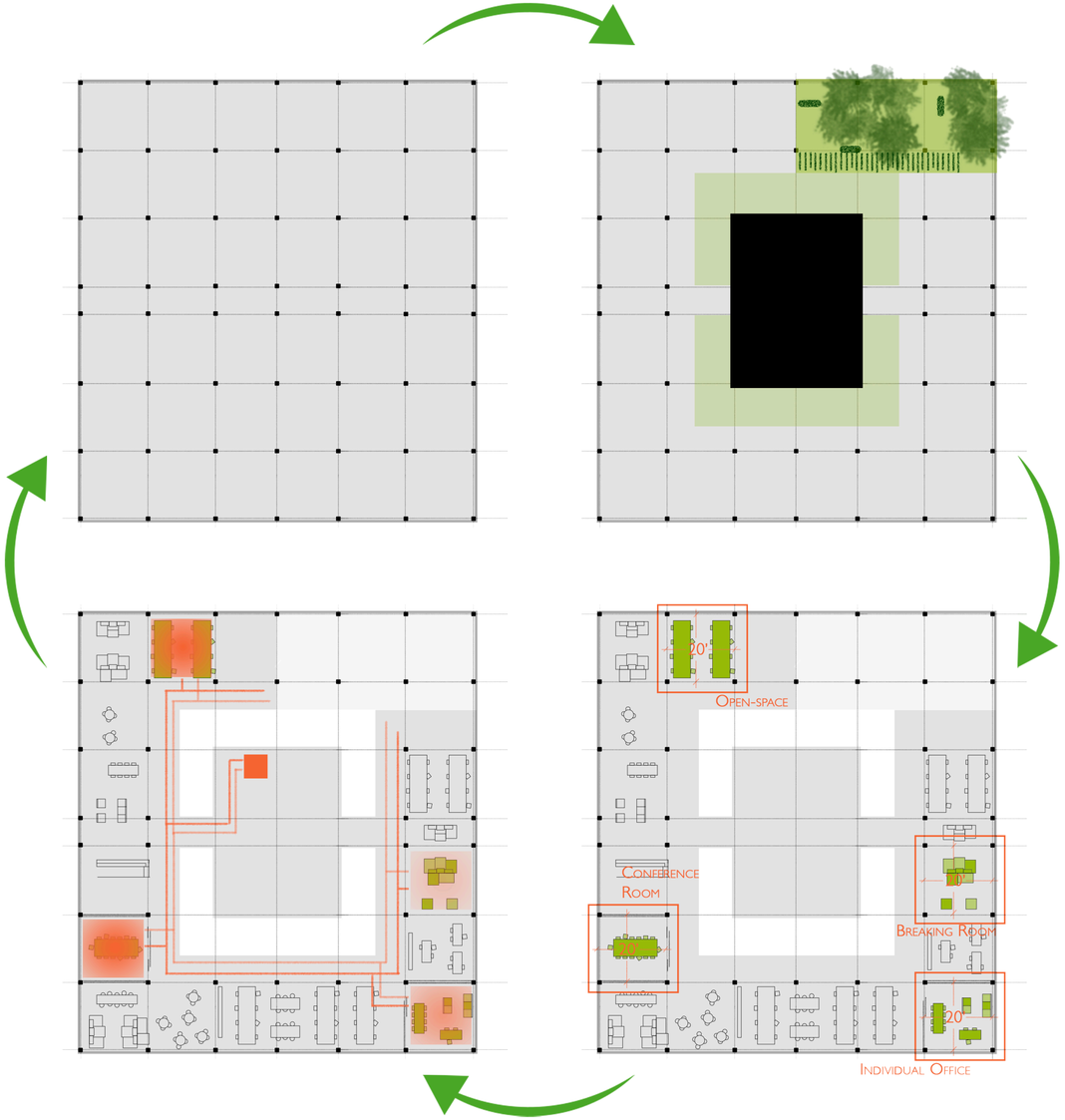


Succesful consideration of the river



Insertion within a masterplan

Conclusion



Relation between architecture, structure, passive strategies & systems.

Cohesive design process.

Vertical River Office Building

Illinois Tech

U.S. Department of Energy
Solar Decathlon