IRIC Building

Team 2

PROPOSED NBBJ BUILDING

Location: Moscow, Idaho

Occupancy: 300

Square Footage: 70, 500 sqft

3 Floors

Actual Architects: NBBJ

Client: University of Idaho

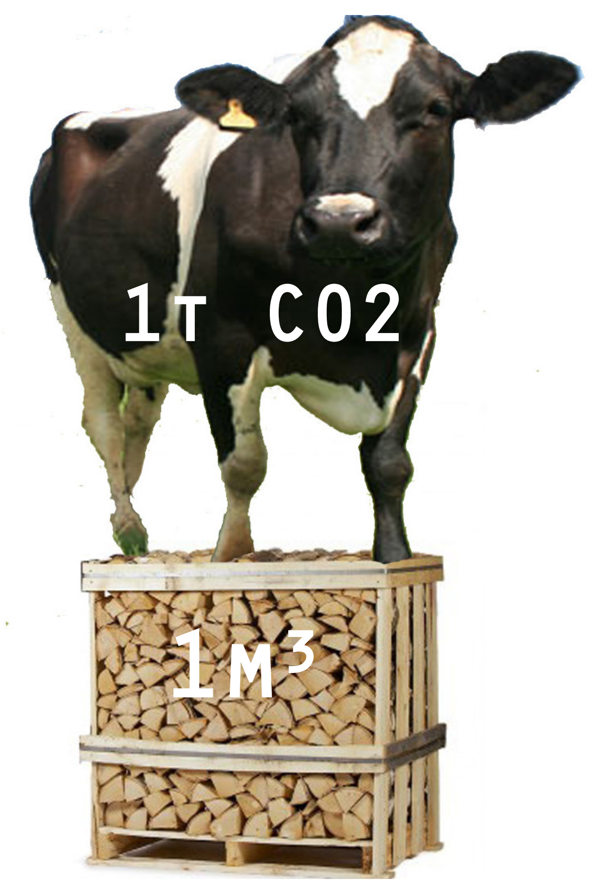
Type: Integrated Lab

Contents

Team 2

Goals

- Re-Design in Idaho Forest Species
  - Structure
  - Envelope
  - Express the wood in accordance to its properties and strengths
  - Protect the wood from the natural elements
  - Use the wood in its most natural state
    - Straight from the saw mill
- Responsible Design
  - Structure
  - Envelope
  - Daylighting
  - Water
  - Systems
  - On-site power
- Educational
  - Exposed structure
  - Exposed systems
  - Exposed water
  - Tree species



TREES

TEAM 2

Douglas Fir

Glue-Laminated Timber

Ponderosa Pine

2x6 Framing

Mountain Hemlock

Interior paneling

Trees

Western Hemlock

Flooring

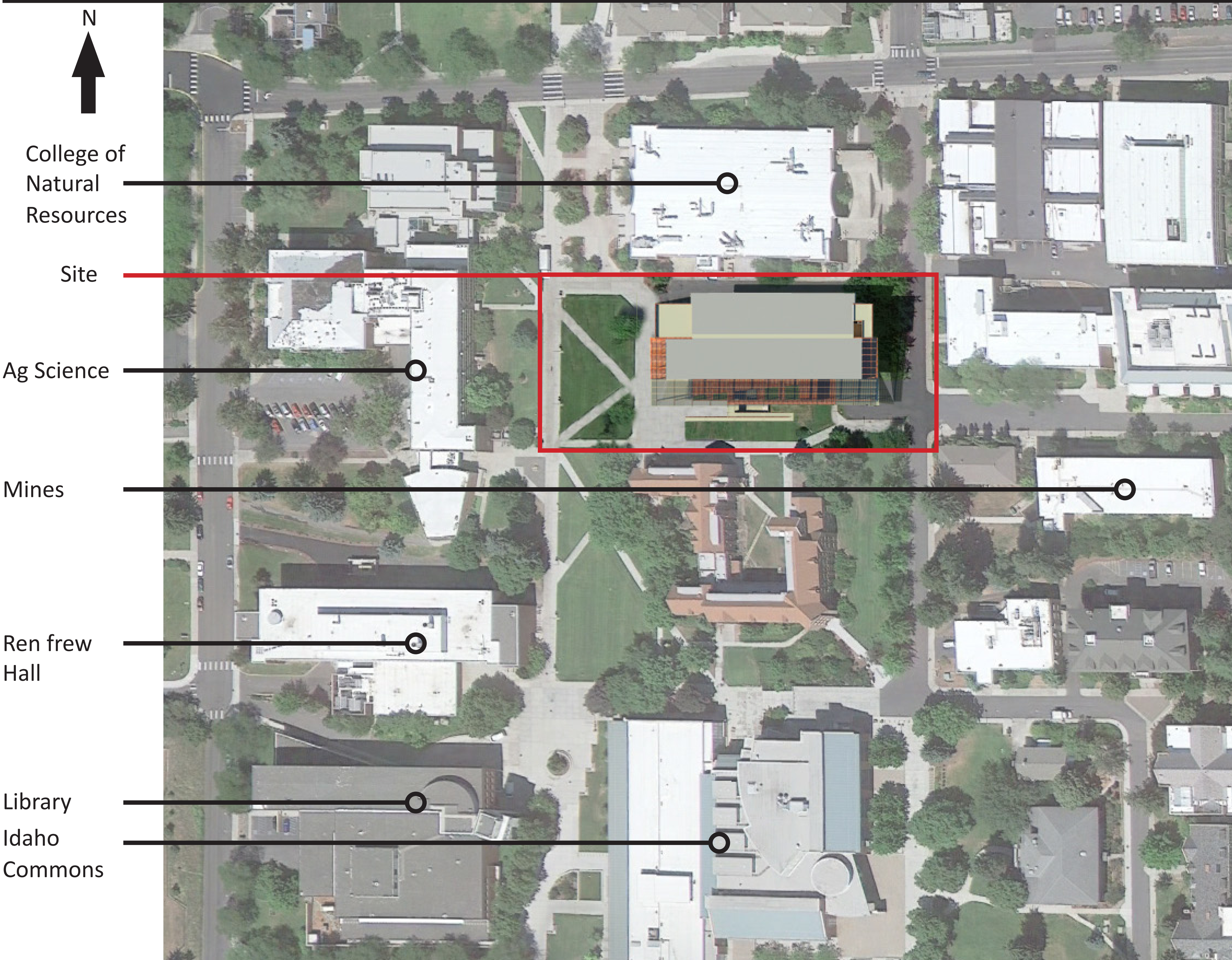
Western Red Cedar

Exterior & Interior Paneling

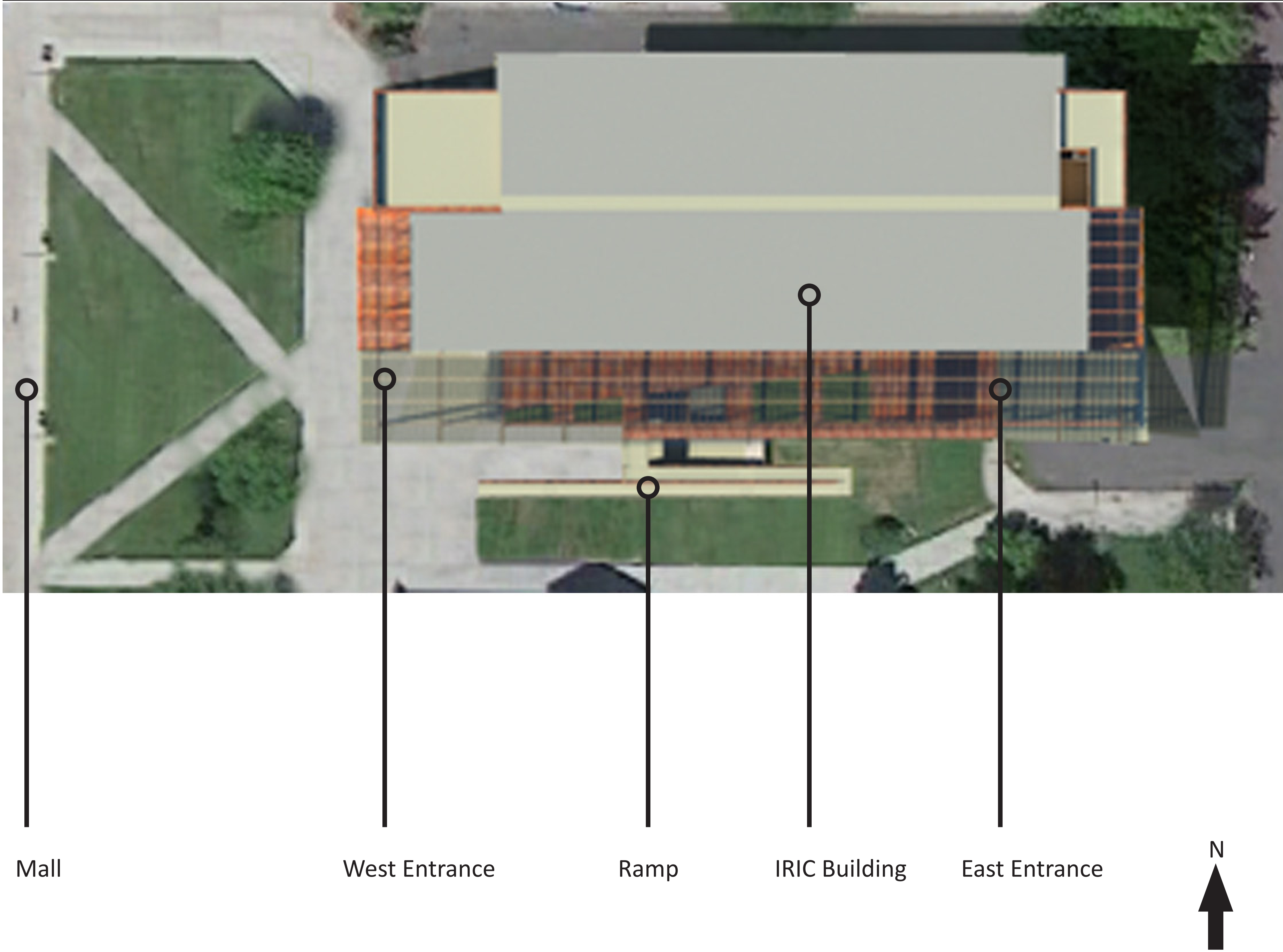
Western Larch

Window molding

CONTEXT


N
College of Natural Resources
Site
Ag Science
Mines
Ren frew Hall
Library
Idaho Commons

Site



Floor Plans

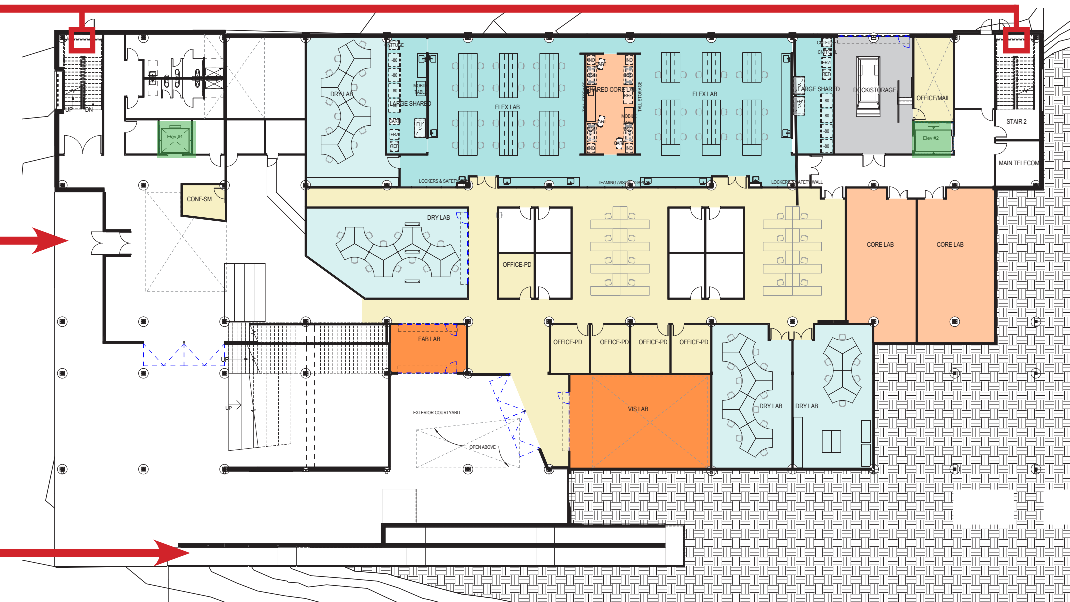
Team 2

First Floor

Fire Exits

West Entrance

ADA Ramp



Legend:

- Flex Lab
- Dry Lab
- Core Lab Spaces
- Fabrication and Testing
- Office and Admin Spaces
- Elevators

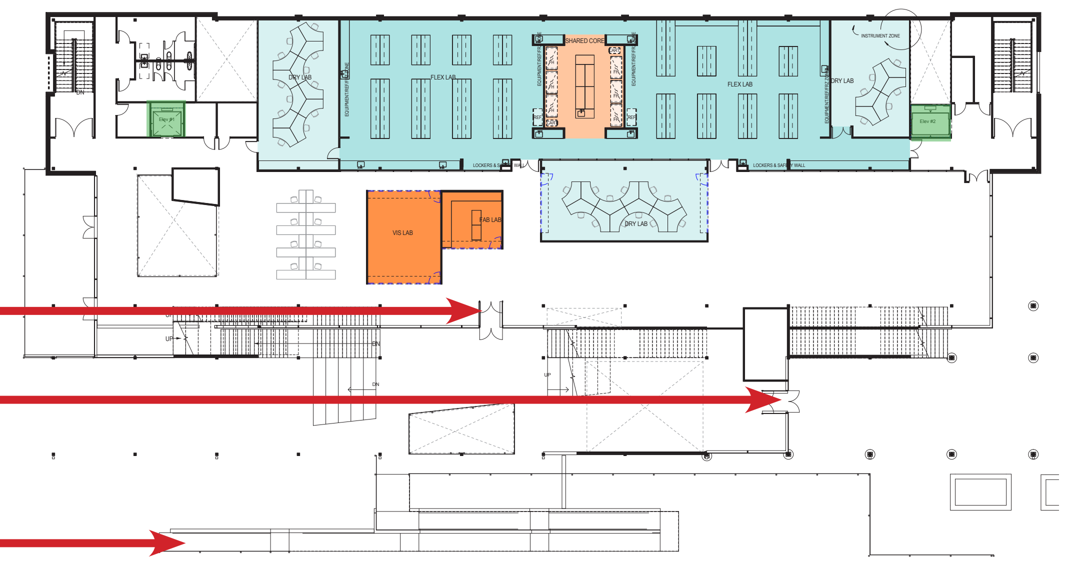
N

Second Floor

South Entrance

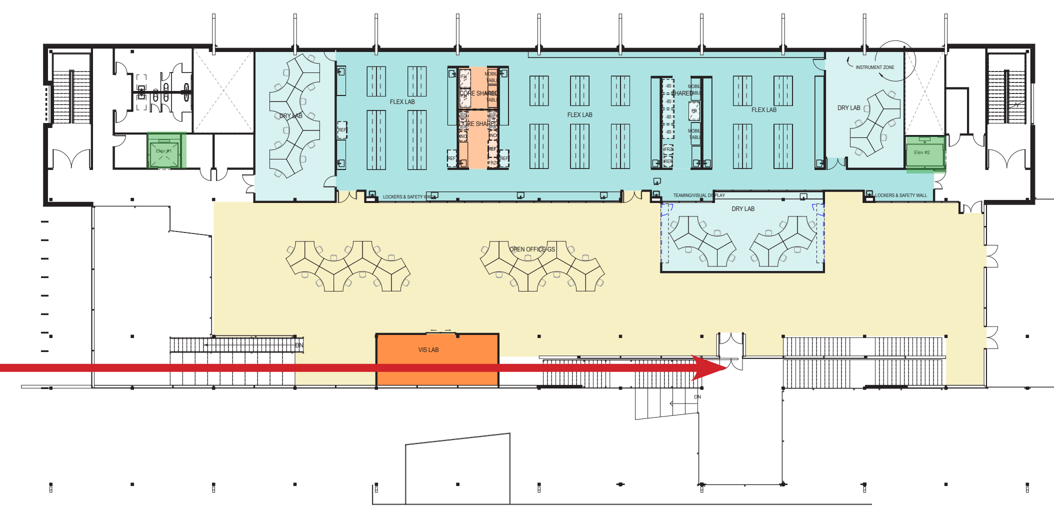
East Entrance

ADA Ramp



Third Floor

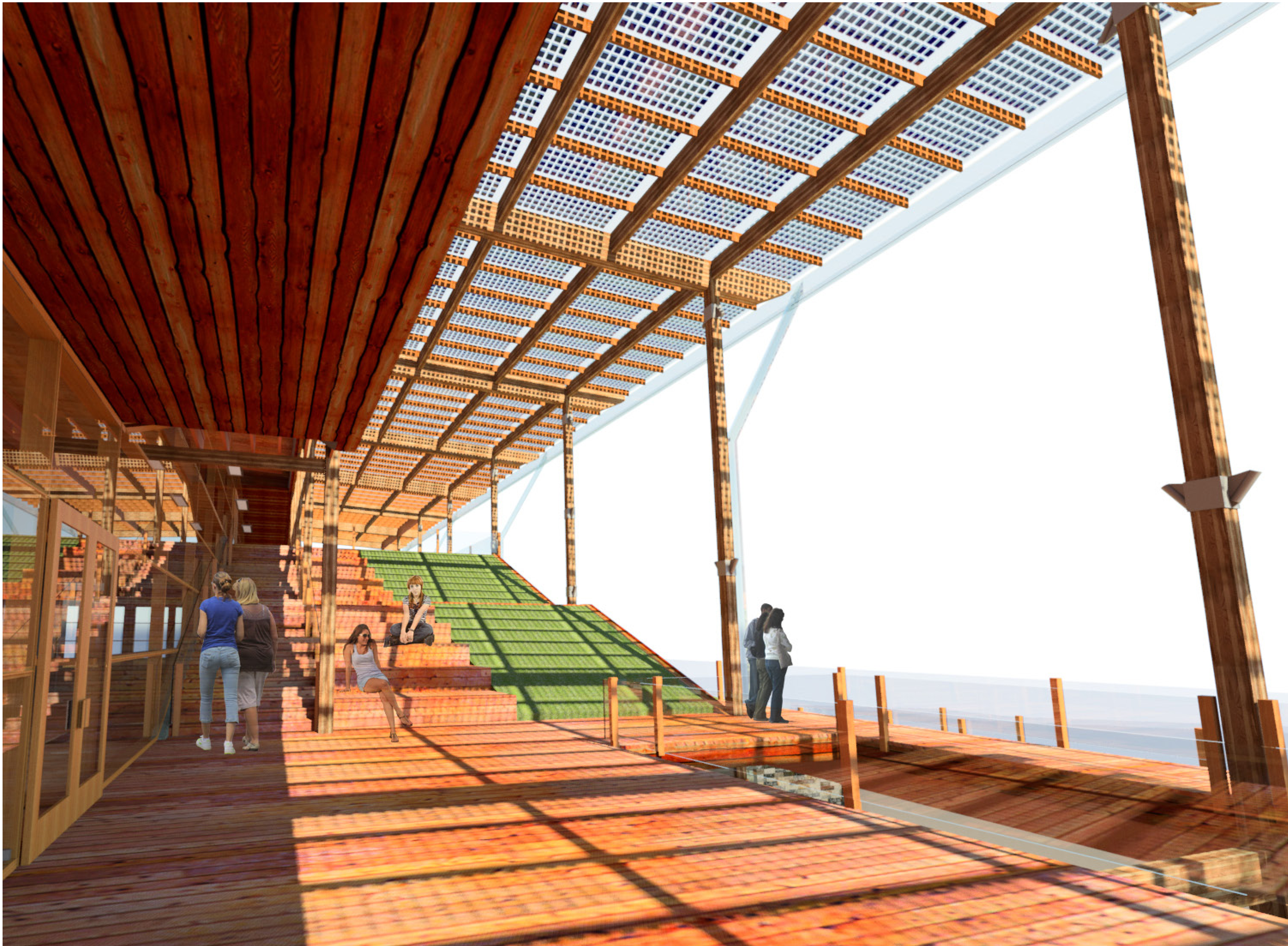
South Entrance



Southwest

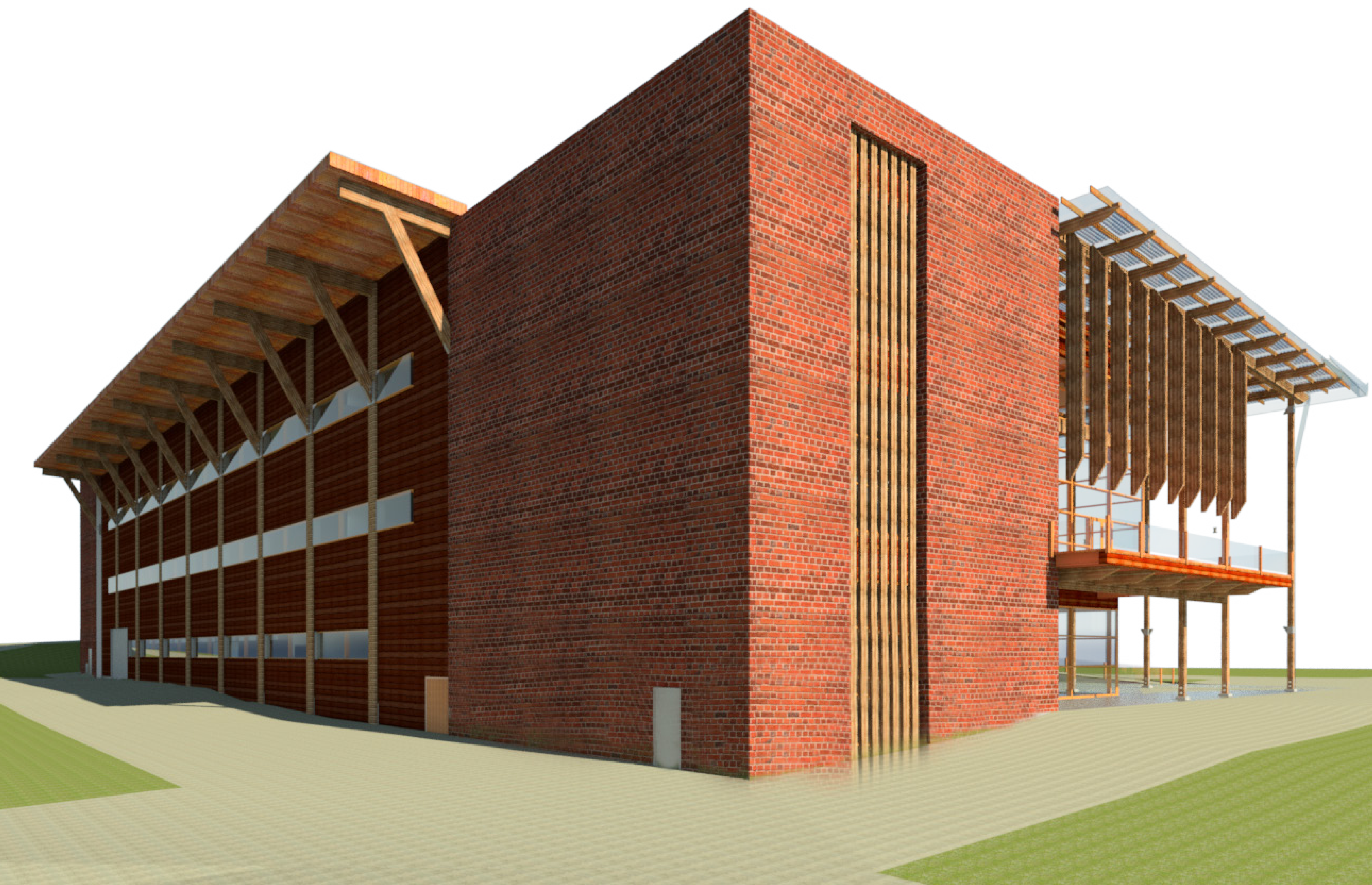
Atrium

Entrance



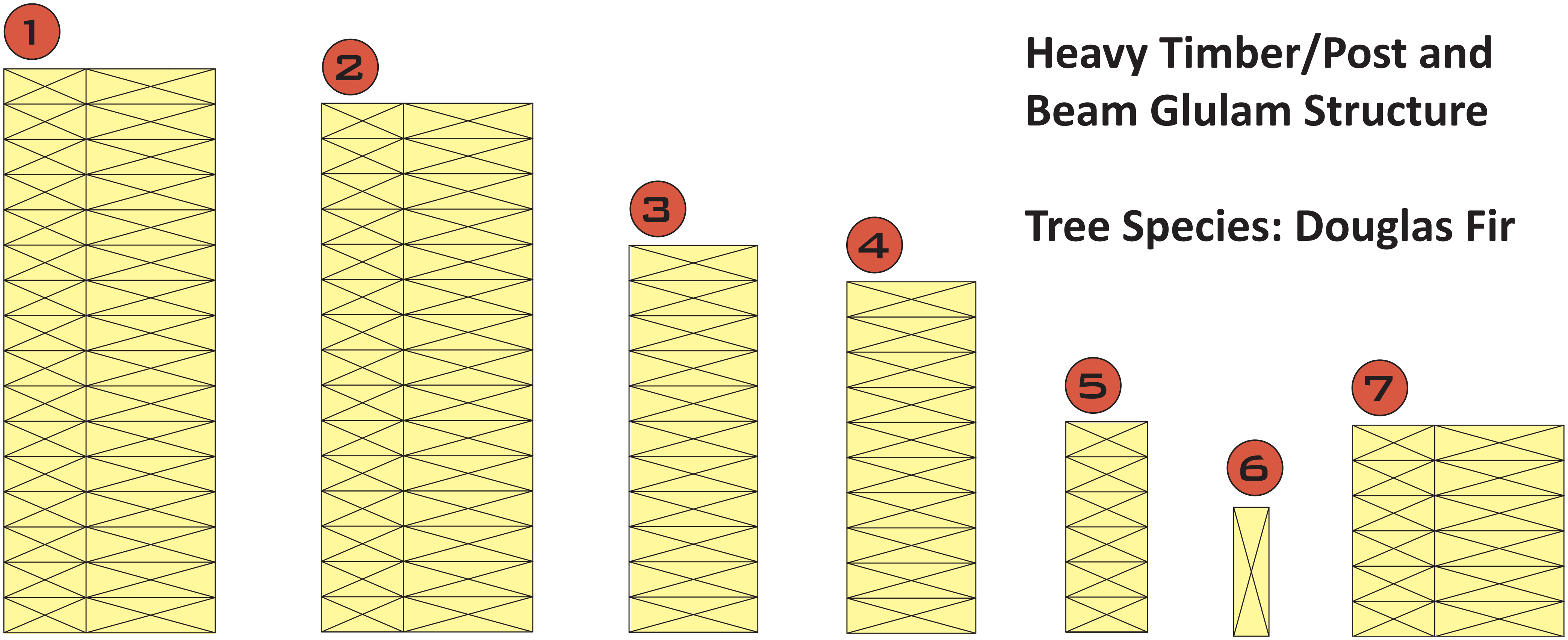
Perspective

Team 2

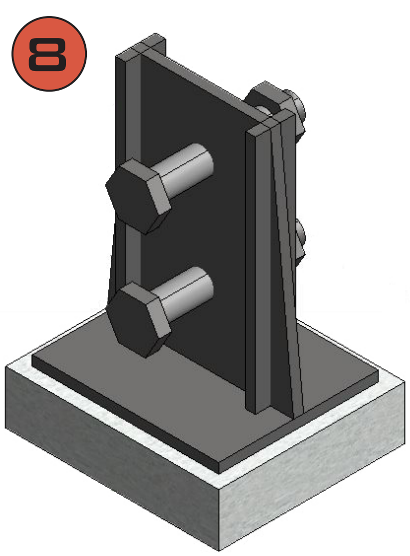


Heavy Timber/Post and Beam Glulam Structure

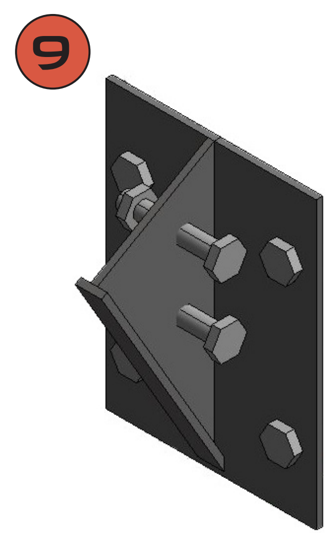
Tree Species: Douglas Fir



2’ x 9” Beam | 22.5” x 9” Beam | 16.5” x 5.5” Beam | 15” x 5.5” Beam | 9” x 3.5” Beam | 2” x 6” Joist | 9” x 9” Column



Footing to Column Connector



Angled Column Connector

STRUCTURE (CALCULATIONS) TEAM 2

1	Span : 40' 40'/20 = 2'	2'(24") x .33(depth) = 7.92" (1) 2x4 + (1) 2x 6 = 9"	1 row of 16 2x4's @1.5"x3.5"	1 row of 16 2x6's @1.5"x5.5"
2	Span : 37' 37'/20 = 1.85'	1.85'(22") x .33(depth) = 7.26" 1 - 2x4 + 1 - 2x 6 = 9"	1 row of 15 2x4's @1.5"x3.5"	1 row of 15 2x6's @1.5"x5.5"
3	Span : 14' 14'/20 = .7'	.7'(9") x .33(depth) = 2.97"	6 2x4's @1.5"x3.5"	
4	Span : 26' 26'/20 = 1.3'	1.3'(16") x .33(depth) = 5.28"	11 2x6's @1.5"x5.5"	
5	Span : 22' 22'/20 = 1.1'	1.1'(14") x .33(depth) = 4.62"	10 2x6's @1.5"x5.5"	
6	Span : 7'6"	Can span up to 8' for 2'x6'	Joists are spaced at 4'	
7	8" x 8" Wood Columns can support up to 1000 sq. ft. of floor area.	Area: 40' x 22'= 880sqft (1)2x4 + (1)2x 6 = 9"	1 row of 6 2x4's @1.5"x3.5"	1 row of 6 2x6's @1.5"x5.5"

12 2x6 Wood Framing

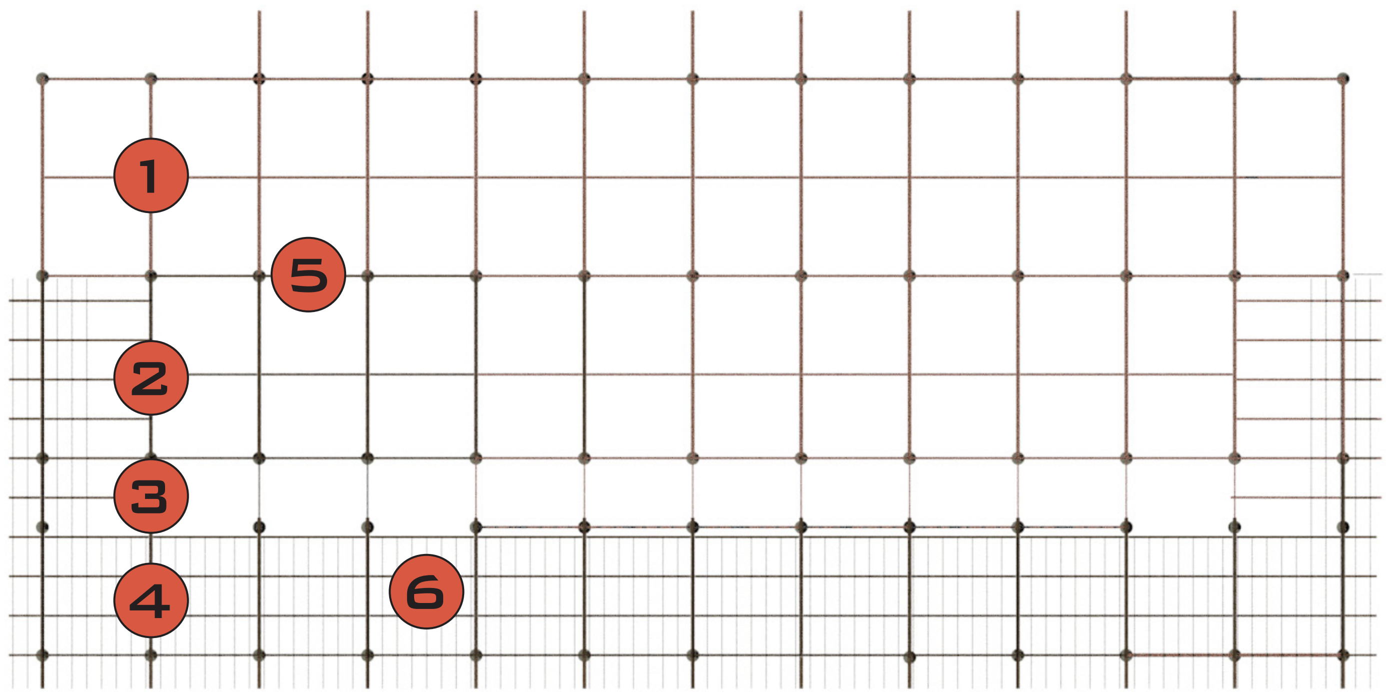
13 230 - 14" TGI's 16" o.c.

Depth	TJI®	40 PSF Live Load / 10 PSF Dead Load				40 PSF Live Load / 20 PSF Dead Load			
		12" o.c.	16" o.c.	19.2" o.c.	24" o.c.	12" o.c.	16" o.c.	19.2" o.c.	24" o.c.
9½"	110	16'-11"	15'-6"	14'-7"	13'-7"	16'-11"	15'-6"	14'-3"	12'-9"
	210	17'-9"	16'-3"	15'-4"	14'-3"	17'-9"	16'-3"	15'-4"	14'-0"
	230	18'-3"	16'-8"	15'-9"	14'-8"	18'-3"	16'-8"	15'-9"	14'-8"
11⅞"	110	20'-2"	18'-5"	17'-4"	15'-9"(1)	20'-2"	17'-8"	16'-1"(1)	14'-4"(1)
	210	21'-1"	19'-3"	18'-2"	16'-11"	21'-1"	19'-3"	17'-8"	15'-9"(1)
	230	21'-8"	19'-10"	18'-8"	17'-5"	21'-8"	19'-10"	18'-7"	16'-7"(1)
	360	22'-11"	20'-11"	19'-8"	18'-4"	22'-11"	20'-11"	19'-8"	17'-10"(1)
	560	26'-1"	23'-8"	22'-4"	20'-9"	26'-1"	23'-8"	22'-4"	20'-9"(1)
14"	110	22'-10"	20'-11"	19'-2"	17'-2"(1)	22'-2"	19'-2"	17'-6"(1)	15'-0"(1)
	210	23'-11"	21'-10"	20'-8"	18'-10"(1)	23'-11"	21'-1"	19'-2"(1)	16'-7"(1)
	230	24'-8"	22'-6"	21'-2"	19'-9"(1)	24'-8"	22'-2"	20'-3"(1)	17'-6"(1)
	360	26'-0"	23'-8"	22'-4"	20'-9"(1)	26'-0"	23'-8"	22'-4"(1)	17'-10"(1)
	560	29'-6"	26'-10"	25'-4"	23'-6"	*29'-6"*	*26'-10"*	25'-4"(1)	20'-11"(1)
16"	210	26'-6"	24'-3"	22'-6"(1)	19'-11"(1)	26'-0"	22'-6"(1)	20'-7"(1)	16'-7"(1)
	230	27'-3"	24'-10"	23'-6"	21'-1"(1)	*27'-3"*	23'-9"	21'-8"(1)	17'-6"(1)
	360	28'-9"	26'-3"	24'-8"(1)	21'-5"(1)	*28'-9"*	26'-3"(1)	22'-4"(1)	17'-10"(1)
	560	32'-8"	29'-8"	28'-0"	25'-2"(1)	*32'-8"*	*29'-8"*	26'-3"(1)	20'-11"(1)

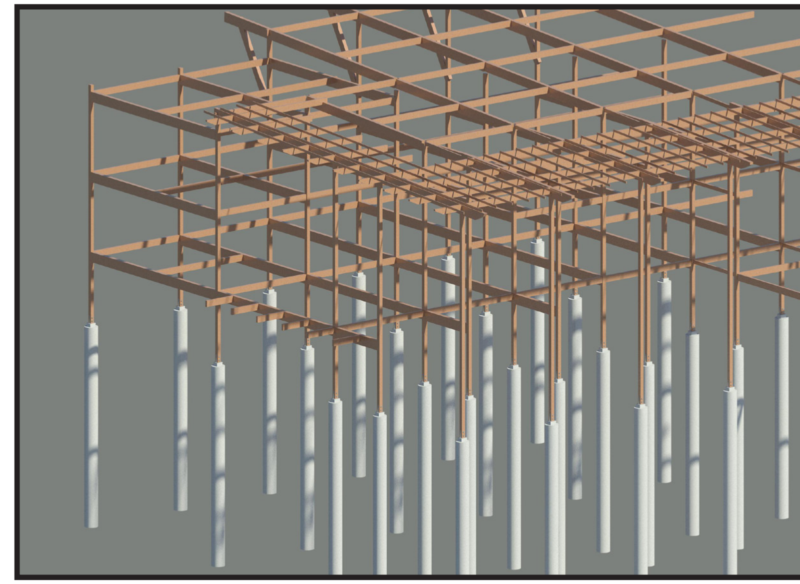
STRUCTURE (DIAGRAM)

TEAM 2

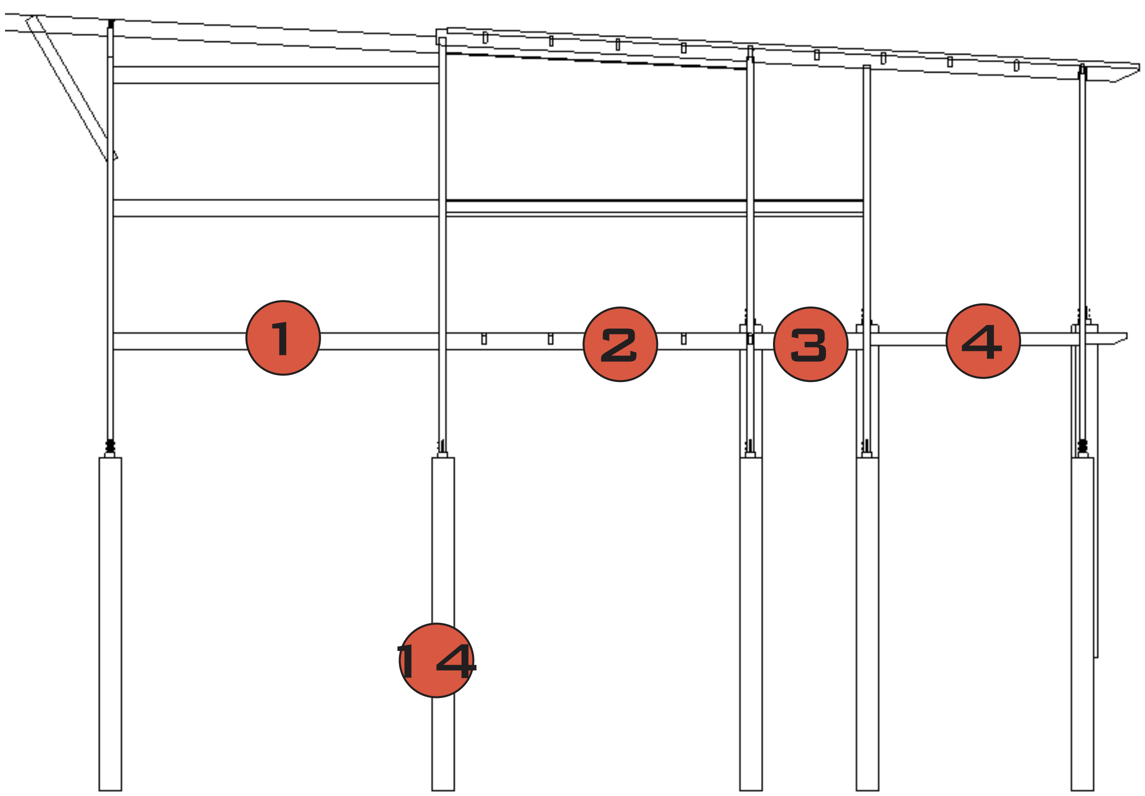
Plan



Isometric

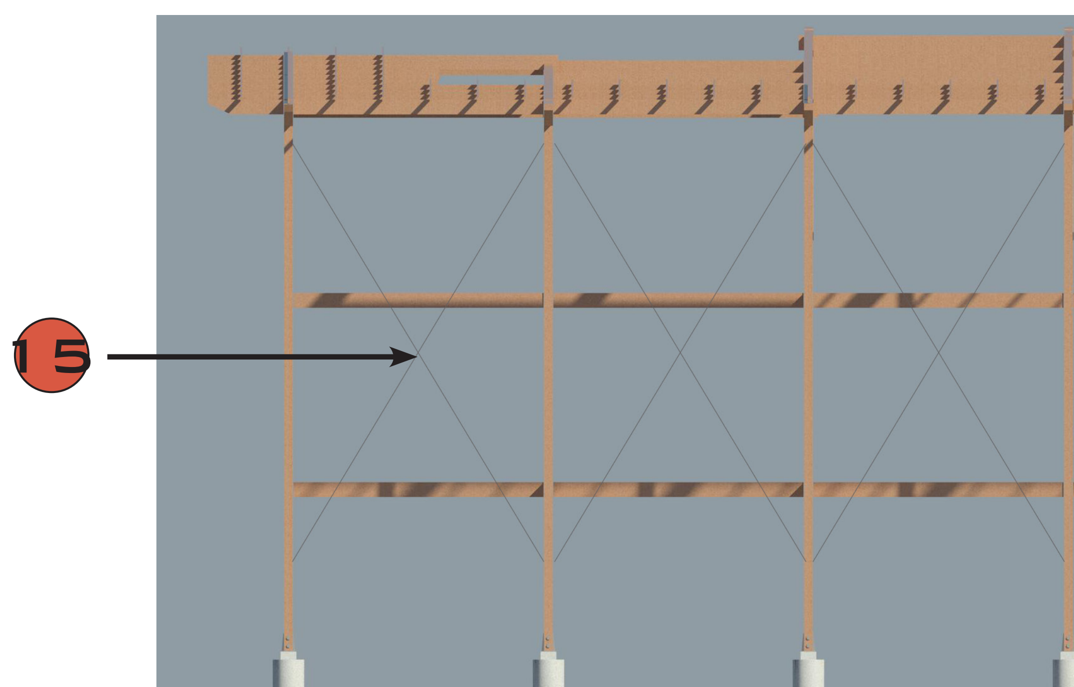


Section



14 40’ Concrete Pile

15 Tension Cables



Chiswick Park (Case Study)

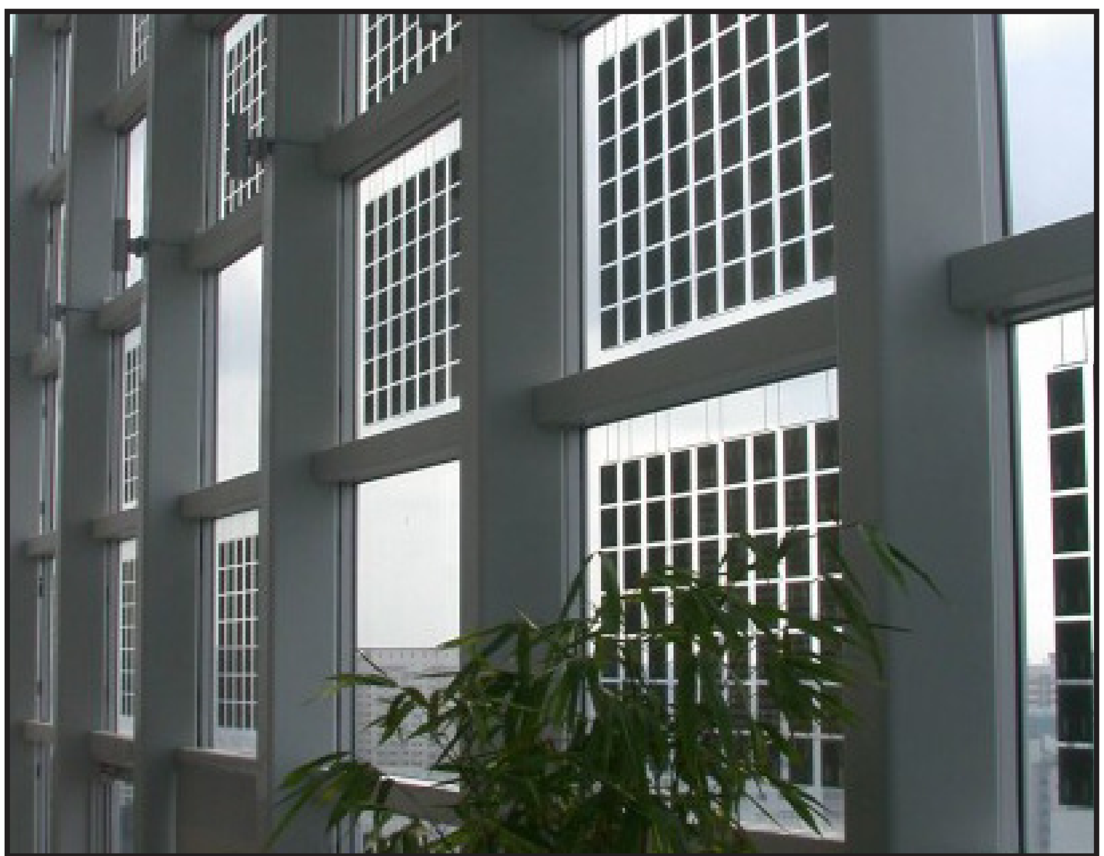
Team 2

Location: London, England
Type: Mixed Use - Offices
12 building in master plan
Richard Rogers Partnership
Client: Stanhope plc
Main Contractor: Bovis Lend Lease
Structural Engineer: Ove Arup & Partners

I studied this building because of the large shading structure the building provides, and the tension cable details.

Building Integrated Photovoltaics (BIPV)

Provides a designer with completely new possibilities. The wide variety of elegant forms, colors, and optical structures of cells, glass, and profiles. It enables many creative and modern approaches to design. They can be incorporated vertically, horizontally, and at an angle. The panels can be customized to desired dimensions. The amount of cells and the positioning can also be customized to the needs of the designer. Used for transparency, light control, and shading.



I studied and chose this material because it generates clean energy, it can be used for shading, and it can shelter people from the elements.

BIPV (Snow Load)

Building Integrated Photovoltaics (BIPV)
Snow Load: 30psf(1.4kN/m-squared) An example from a company that specializes in PV's. www.sunforson.com
Calculating snow load in psf Depth of snow in inches - convert inches into feet. Multiply the depth by the weight
Average snow weight in Idaho: 10-20 psf(pounds per square foot) According to the University of Idaho, Moscow receives an average of 49", of snow, each year. Moscow receives the most in January with 16" The average amount of snow to fall, in a single period, in January is 4"
Calculations Average snow weight in Idaho: 10-20 psf(pounds per square foot) If it snowed 1'6" or 18" = 1.5' 1.5' x 20 psf = 30 psf
The Building Integrated Photovoltaics could hold an estimated 1'6" (18") of Idaho's wettest average snows in a single period. Basically, the BIPV's can handle 37% of Idaho's wettest and Moscow's average snowfall in a single period.

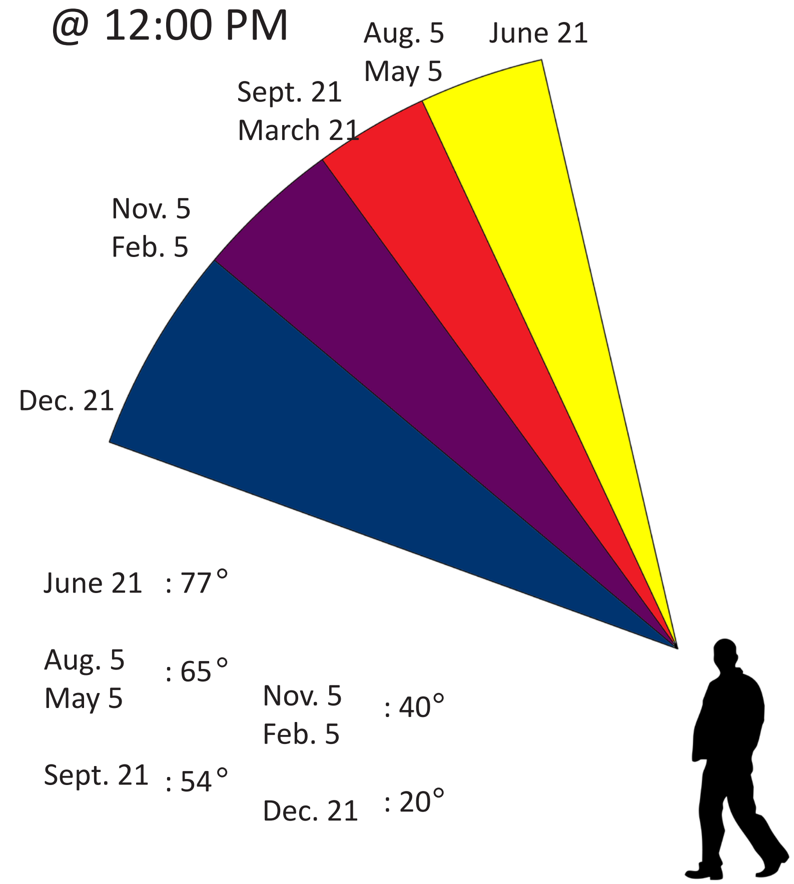
The roofing tiles are designed to blend seamlessly with a building's shingles or roofing tiles, and can be installed just in just the same way. They can support up to 200 pounds per square foot of snow and they resist wind up to 125 mph. And they come in a variety of colors to match any building's roof.

The Image below is an example of BIPV's in Aspen, Colorado (Ski Resort)

BIPV (ENERGY)

BIPV's typically produce 10-15 watts per square foot On Average, Moscow, Idaho has 4 hours of potential energy producing hours a day
BIPV Roof square footage of the building 33,760 sq ft 3,136 sq m
According to PVWatt According to PVWatt in Moscow, Idaho @ 5 degrees, the building can produce: Typical Performance BIPV: (15%) 484,726 kWh High Performance BIPV: (18%) 581,713 kWh Premium Performance BIPV: (20%) 646,336 kWh

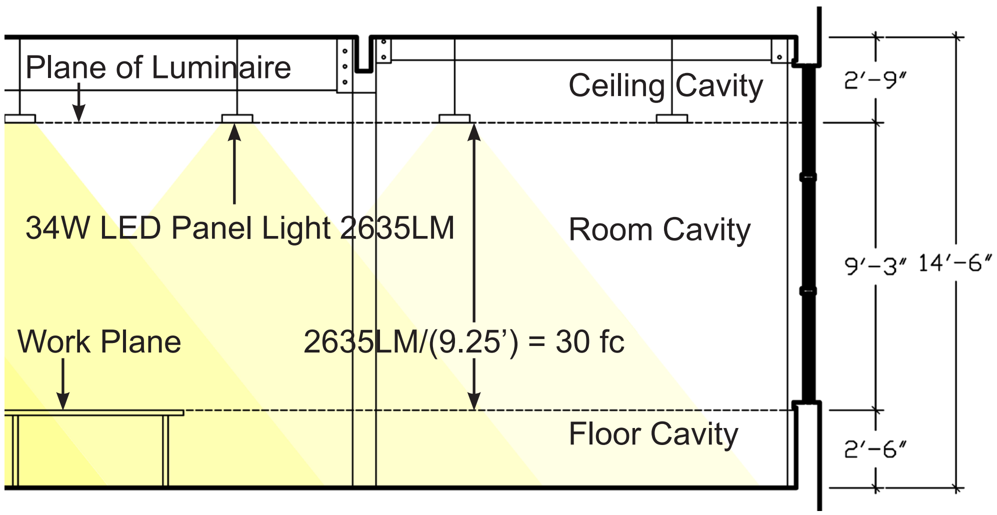
Sun Diagram
@ 12:00 PM



Manufacturer:

RAB

Example Diagram:



The calculations here provide the Peak kwh's during the year. This accounts for all the lights on for 12 hours a day in all rooms, including the mechanical room, the electrical room, the offices, and in the storage spaces. To reduce energy consumption, a lighting based control system will control lights, through sensors, to generate the amount of light needed.

Much of the building is well daylite on the south, west, and east side, so the building will save on energy.

Recommended Levels of lighting

Circulation areas: 30 Foot-Candles/300 Lux
Laboratories: 80 Foot-Candles/800 Lux
Study Halls: 30 Foot-Candles/300 Lux

1

2' x 2' 34W LED Panel Light

Offices, hallways, schools etc.
Power: 34W
Luminous Flux: 2635 LM
Dimensions: 2' x 2' x 3"

2

2' x 4' 44W LED Panel Light

Applied in homes, bars, hotels, restaurants, offices, banks etc.
Power: 44W
Luminous Flux: 4678 LM

Foot-Candles

$E = I/d^2$

I=LM d = distance from plane of luminare to work plane in ft
Circulation: $E = 2635/(9.25^2) = 30$ fc - work plane: floor
Laboratories: $E = 4678/(7.6^2) = 80$ fc - work plane: 2'6" above floor
Study Halls: $E = 2635/(9.25^2) = 30$ fc - work plane: 2'6" above floor

Number of Luminares for Rectangular Spaces

= (E x A)/(n x LM x CU x LLF)
LED Light Loss Factor(LLF) = 1 - according to RAB Lighting

Cavity Ratio (CR)

CR = [5 x MH(L+W)]/(LxW)

MH= Room Cavity
Example: CR = [5 x 9.25(40 +23)]/(40 x 23) = 3.16 so 3
From the IES File, the manufacturer provides, take the Cavity Ratio, the Ceiling Cavity reflectance(material) and Wall Surface Reflectance(material) to determine the Coefficient of Utilization (CU)
So, from the table, the CU of the example above would be .81

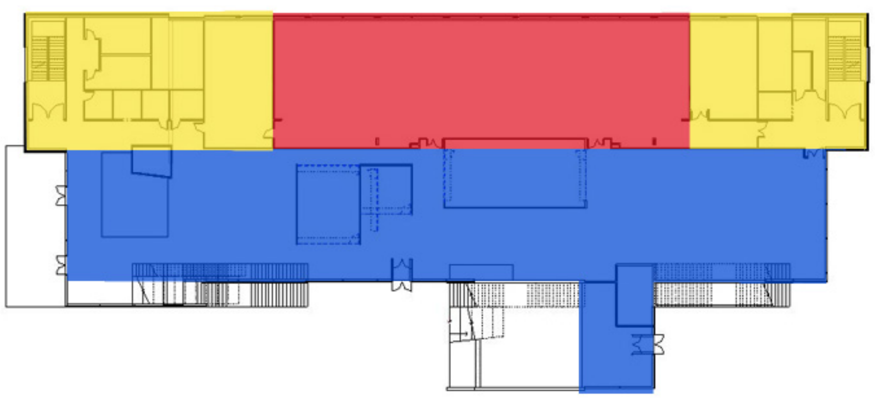
LIGHT

TEAM 2

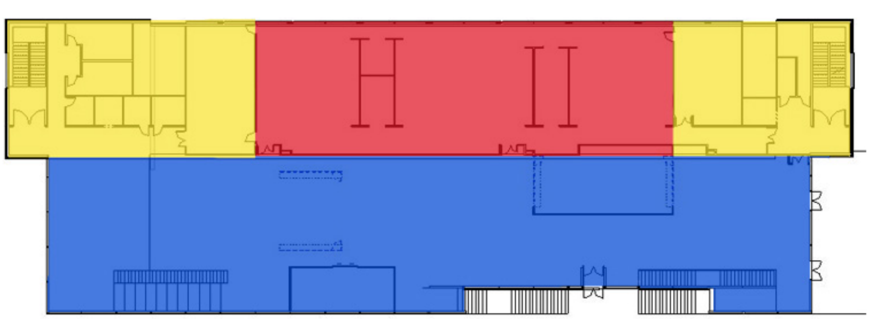
Basement

1st Floor

2nd Floor



3rd Floor



Zones

Zone 1:
Zone 2:
Zone 3:
Zone 4:
Zone 5:

Number of Luminares - Basement

1. Zone 3: # = (30 fc x 920 sqft)/(1 x 2635LM x .81 x 1) = 13 Luminares
Zone 5: # = (30 fc x 7440 sqft)/(1 x 2635LM x 1.05 x 1) = 80 Luminares

Number of Luminaires - 1st Floor

1. Zone 1: # = (30 fc x 3480 sqft)/(1 x 2635LM x .79 x 1) = 50 Luminaires
Zone 2: # = (30 fc x 9012 sqft)/(1 x 2635LM x .92 x 1) = 112 Luminaires
Zone 3: # = (30 fc x 5200 sqft)/(1 x 2635LM x .81 x 1) = 73 Luminaires

2. Zone 4: # = (80 fc x 4400 sqft)/(1 x 4678LM x 1.02 x 1) = 74 Luminaires

Number of Luminaires - 2nd Floor

1. Zone 2: # = (30 fc x 7756 sqft)/(1 x 2635LM x .92 x 1) = 96 Luminaires
Zone 3: # = (30 fc x 5320 sqft)/(1 x 2635LM x .83 x 1) = 73 Luminaires

2. Zone 4: # = (80 fc x 5240 sqft)/(1 x 4678LM x 1.02 x 1) = 88 Luminaires

Number of Luminaires - 3rd Floor

1. Zone 2: # = (30 fc x 11175 sqft)/(1 x 2635LM x .92 x 1) = 138 Luminaires
Zone 3: # = (30 fc x 5320 sqft)/(1 x 2635LM x .83 x 1) = 73 Luminaires

2. Zone 4: # = (80 fc x 5240 sqft)/(1 x 4678LM x 1.02 x 1) = 88 Luminaires

Total Luminaires:

1. 708 Luminaires
2. 250 Luminaires

kWh

1. (708 Luminaires x 34W)/1000 = 24.07 kW
Peak Hours: (24.07 kW x 12 hr)(365 days) = 105,435 kWh/year

2. (250 Luminaires x 44W)/1000 = 11 kW
Peak Hours: (11 kW x 12 hr)(365 days) = 48,180 kWh/year

Total: 153,615 kWh/year

These calculation are based on the amount of equipment NBBJ put into the revit model. The computers were based on the amount of offices and desk spaces.

16 Freezers @ 650W: (650W x 16) = 10,400W
(10.4 kW x 24 hr) x 365 days = 91,105 kWh/yr

12 Frigerators @ 300W: (300W x 12) = 3,600W
(3.6kW x 24 hr) x 365 days = 31,536 kWh/yr

6 Incubators @ 400W: (400W x 6) = 2,400W
(2.4kW x 24 hr) x 365 days = 21,024 kWh/yr

16 Hoods @ 100W: (100W x 16) = 1,600W
(1.6kW x 12 hr) x 365 days = 7,008 kWh/yr

36 Computers w/ power saver @ 85W: (85W x 36) = 3,060W
(3kW x 12 hr) x 365 days = 13,402 kWh/yr

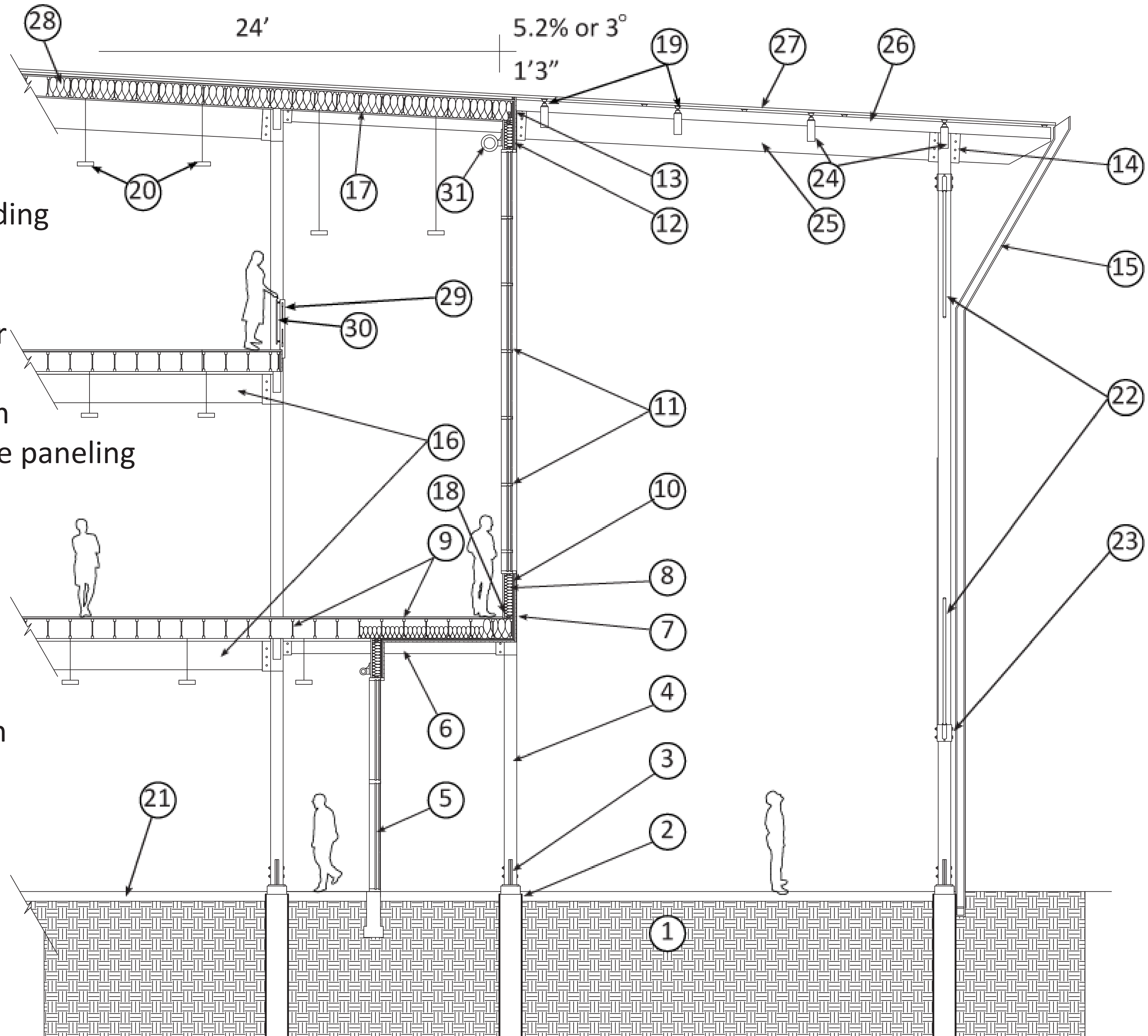
2 Coffee Makers @ 800W: (800W x 2) = 1,600W
(1.6kW x 1 hr) x365 days = 584 kWh/yr

4 Copiers/Printers @ 350W: (350W x 4) = 1,400W
(1.4kW x 2 hr) x 365 days = 1,022kWh/yr

Applience Total: 165,681 kWh/yr

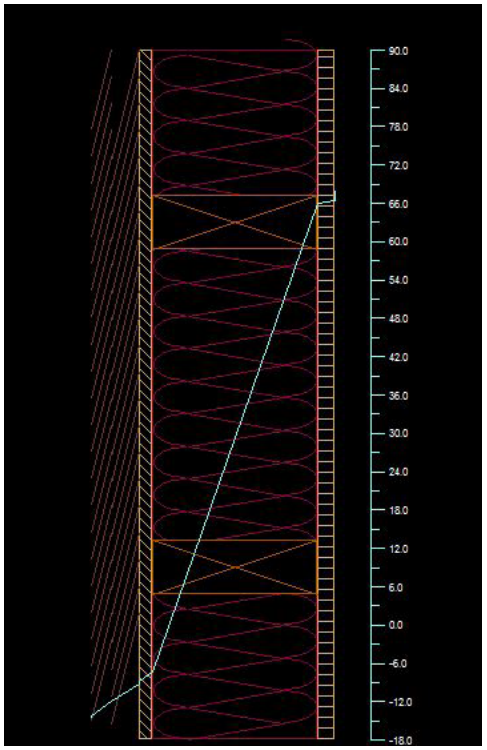
Detailed Section Team 2

1: Earth
2: 16” dia. - 40’ Concrete Pile
3: Steel Footing to Concrete Connector
4: 9” x 9” Glue-Laminated Column
5: Clear Laminated Double Paned Glazing
6: 9” x 3.5” Glue-Laminated Beam
7: Western Red Cedar Lap Siding
8: 6” deep Insulation
9: 230 TGI: 14” Depth - 16” O.C.
10: Vapor Barrier
11: Western Hemlock Window Molding
12: 5/8” Plywood sheathing
13: 2” Wood furring
14: Steel Glue-Laminated Connector
15: 7” x 7” Acrylic Gutter System
16: 22.5” x 9” Glue-Laminated Beam
17: 1” Ponderosa tongue and groove paneling
18: Base Plate for 2” x 6” Framing
19: BIPV supports
20: 34W LED Luminaire @ 11’ 9”
21: 7” Concrete Slab
22: Tension Cable
23: Tension Cable Base
24: 15” x 5.5” Glue Laminated Beam
25: 2’ x 9” Glue-Laminated Beam
26: 2” x 8”
27: BIPV’s
28: 10” deep Insulation
29: Cedar 3.5” x 3.5” Post(Railing)
30: Glass Railing
31: Automated Interior Shading



WALL VALUES

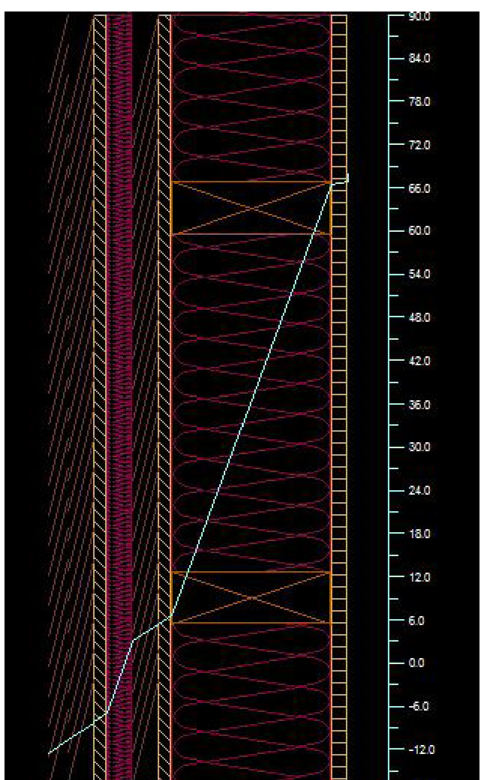
TEAM 2



South/West/East Wall:
R-Value: 30.3
U-Value: .03

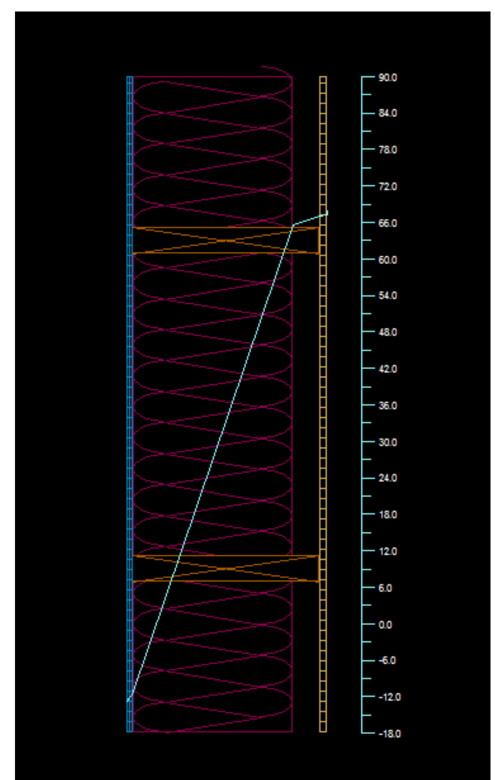
East/West/South Windows:
Clear Laminated Double Paned Glazing

Roof:
R-Value: 57.9
U -Value: .02



North Wall:
R-Value: 37
U-Value: .03

North Windows:
Low Solar-gain Low-E Triple Paned Glazing



HEAT LOAD (CALCULATIONS) TEAM 2

For heating and cooling, this building will be using a chilled beam system. The University of Idaho provides this opportunity through a heat exchanger.

Benefits:

- Uses far less fan energy than a traditional air-based system
- Temperature required for water in chilled beams is far less extreme than the temperature required for conventional air systems.

-Chilled beam systems allow for cool air to be distributed more evenly

-Much more efficient heating and cooling energy transportation costs

-Maintenance costs are much lower for chilled beam systems

-Traditional all-air systems use 2 to 2.5 times more space than chilled beam systems

In addition, chilled beams increase thermal comfort, air quality, and have lower than conventional installation costs.

The calculations provided are the Peak heating and cooling loads to help determine types of equipment.

Values

Roof: R-Value: 57.9 U-Value: .02
North Wall: North Wall: R-Value: 37 U-Value: .03
East/West/South Wall: R-Value: 30.3 U-Value: .03
North Windows: U: .24
East/West/South: U: .32

Average Indoor temp. to be maintained for Labs : 65-70 degrees & 70 for offices

Heating dry bulb temp. in Spokane, WA is 1 (Closest city to Moscow, ID in table) $\triangle$T:(70)-(1)=69 degrees

Wall Area

Area of North Exterior Wall: 12,719 sqft
Area of North Windows: 1,792 sqft
Area of East/West/South Exterior Walls: 6,864 sqft
Area of East/West/South Windows: 5,915 sqft
Area of Ceiling: 22,527 sqft
Volume of Building: 1,020,240 cubic feet

Calculating Wall/Window transmission Btu/hr: Q = U x A x $\triangle$T

Qceiling = (.02Btu/hr x F x sqft)(22,527 sqft)(69F) = 31,087 Btu/hr
QNwindows = (.24)(1792)(69) = 29,675 Btu/hr
QNwall = (.03)(12719)(69) = 26,328 Btu/hr
QE/W/Swindows = (.32)(5915)(69) = 120,603 Btu/hr
QE/W/Swall = (.03)(6864)(69) = 14,208 Btu/hr
Total: 221,901 Btu/hr

Next page

C = Heat capacity of air
ACH = Air change per hour
C = Usually ranging from .014-.018. Depends on elevation, so .018 for lower elevation
ACH = .41-.59 for energy efficient construction = Avg. = .5

Qinfill = C x ACH x V x ΔT

Qinfill: (.018Btu/cubicft)(.5)(950,040 cubicft)(69) = 589,974 Btu/hr
Heating Load

Q_{LT} = 223,125 Btu/hr + 589,974Btu/hr = 813,099 Btu/hr

Equipmet Load

Appliences: $N \times HG_{sensible} \times F_{usage} \times CLF$

QFreezer: 16(3.41 x 650W) x1 x 1 = 35,464 Btu/hr
QFrigerator: 12(3.41 x 300W) x 1 x 1 = 12,276 Btu/hr
QIncubator: 6(3.41 x 400W) x 1 x 1 = 8,184 Btu/hr
QHoods: 16(3.41 x 100W) x 1 x 1 = 5,456 Btu/hr
QComputer w/ power saver: 32(3.41 x 85W) x 1 x 1 = 9,275 Btu/hr
Total: 70,655 Btu/hr

Occupant Load : 150 People my use the space at one time

For heating load, Qoccupant: n x ($HG_{sensible}$) x CLF

$HG_{sensible}$ for occupants generally slow walking = 300 Btu/hr
Qoccupant = 150 x (300 btu/hr) x 1 = 45,000 Btu/hr

Next page →

Window Load

QSolar transmission: A x SHGS x SHGF x CLF

Typical SHGS fot commercial buildings is = .70

At 12 AM, in December, at 48 degrees latitude the SHGF is the following

N = 13 Btu/hr x sqft   S = 233 Btu/hr x sqft

E = 14 Btu/hr x sqft   W = 14 Btu/hr x sqft

CLF for glass with interior shading for north latitude

N = .06 S = .03

E = .03   W = .04

Calculations

Qsn = (1,792 sqft)(.70)(13Btu/hr x sqft)(.06) = 978.4 Btu/hr

Qss = (2,375)(.70)(233)(.03) = 11,620 Btu/hr

Qes = (1854)(.70)(14)(.03) = 545 Btu/hr

Qws = (1916)(.70)(14)(.04) = 563 Btu/hr

Total: 13,707 Btu/hr

Lighting Load

Qlighting: = 3.41 x W x F_{usage} x CLF

QL1 = 3.41(34W x 708 Luminares) x .5 x 1 = 41,042 Btu/hr

QL2 = 3.41(44W x 250 Luminares) x .5 x 1 = 18,755 Btu/hr

Total: 59,797 Btu/hr

Total Peak Heating Load

(QWall/Window Transmission Total + Qinfill) - Equpment Load - Occupant Load - Qsolar Transmission - Lighting

Total: 813,099 Btu/hr - 70,655 Btu/hr - 45,000 Btu/hr - 13,707 Btu/hr - 59,797 Btu/hr = 623,940 Btu/hr

Values

Roof: R-Value: 57.9 U-Value: .02
North Wall: North Wall: R-Value: 37 U-Value: .03
East/West/South Wall: R-Value: 30.3 U-Value: .03
North Windows: U: .24
East/West/South: U: .32

Average Indoor temp. to be maintained for Labs : 65-70 degrees & 70 for offices

The cooling load design conditions in Spokane, WA is 89 (Closest city to Moscow, ID in table) ΔT:(89)-(70)=19 degrees

Wall Area

Area of North Exterior Wall: 12,719 sqft
Area of North Windows: 1,792 sqft
Area of East/West/South Exterior Walls: 6,864 sqft
Area of East/West/South Windows: 5,915 sqft
Area of Ceiling: 22,527 sqft
Volume of Building: 1,020,240 cubic feet

Calculating Wall/Window transmission Btu/hr: Q = U x A x ΔT

Qceiling = (.02Btu/hr x F x sqft)(22,527 sqft)(19F) = 8,560 Btu/hr
QNwindows = (.24)(1792)(19) = 8,171 Btu/hr
QNwall = (.03)(12719)(19) = 7,249 Btu/hr
QE/W/Swindows = (.32)(5915)(19) = 35,963 Btu/hr
QE/W/Swall = (.03)(6864)(19) = 3,912 Btu/hr
Total: 63,855 Btu/hr

Next page →

C = Heat capacity of air
ACH = Air change per hour
C = 1.1 = the constant 1.1 is based on the heat capacity of air under standard conditions multiplied by 60 minutes. .018 x 60 = 1.1
ACH = .3 - .38 for energy efficient construction = Avg. = .35

Qinfill = C x ACH x V/60 x △T

Qinfill: 1.1 x .35 x 950,040 cubicft/60 x 19 = 115,825 Btu/hr
Cooling Load

Q_{LT} = 63,855 Btu/hr + 115,825 Btu/hr = 179,680 Btu/hr

Equipmet Load

Appliences: N x $HG_{sensible}$ x F_{usage} x CLF

QFreezer: 16(3.41 x 650W) x 1 x 1 = 35,464 Btu/hr
QFrigerator: 12(3.41 x 300W) x 1 x 1 = 12,276 Btu/hr
QIncubator: 6(3.41 x 400W) x 1 x 1 = 8,184 Btu/hr
QHoods: 16(3.41 x 100W) x 1 x 1 = 5,456 Btu/hr
QComputer w/ power saver: 32(3.41 x 85W) x 1 x 1 = 9,275 Btu/hr
Total: 70,655 Btu/hr

Occupant Load : 150 People my use the space at one time

For cooling load, Qoccupant = n x ($HG_{sensible}$ + HG_{latent}) x CLF

$HG_{sensible}$ for occupants generally slow walking = 300 Btu/hr
HG_{latent} for occupants generally slow walking = 330 Btu/hr
Qoccupant = 150 x (300 Btu/hr + 330 Btu/hr) x 1 = 94,500 Btu/hr

Next page

Window Load

QSolar transmission: A x SHGS x SHGF x CLF

Typical SHGS fot commercial buildings is = .70

At 12 AM, in Augest, at 48 degrees latitude the SHGF is the following

N = 33 Btu/hr x sqft S = 189 Btu/hr x sqft

E = 36 Btu/hr x sqft W = 36 Btu/hr x sqft

CLF for glass with interior shading for north latitude

N = .06 S = .03

E = .03 W = .04

Calculations

Qsn = (1,792 sqft)(.70)(33Btu/hr x sqft)(.06) = 2,483 Btu/hr

Qss = (2,375)(.70)(189)(.03) = 9,426 Btu/hr

Qes = (1854)(.70)(36)(.03) = 1,402 Btu/hr

Qws = (1916)(.70)(36)(.04) = 1,931 Btu/hr

Total: 15,242 Btu/hr

Lighting Load

Qlighting: = 3.41 x W x F_{usage} x CLF

QL1 = 3.41(34W x 708 Luminares) x .5 x 1 = 41,042 Btu/hr

QL2 = 3.41(44W x 250 Luminares) x .5 x 1 = 18,755 Btu/hr

Total: 59,797 Btu/hr

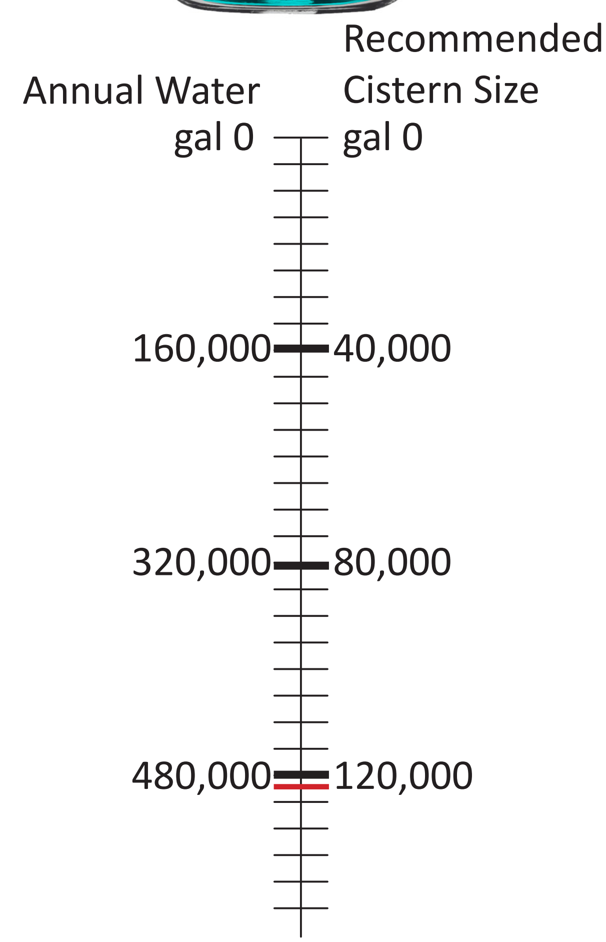
Total Peak Cooling Load

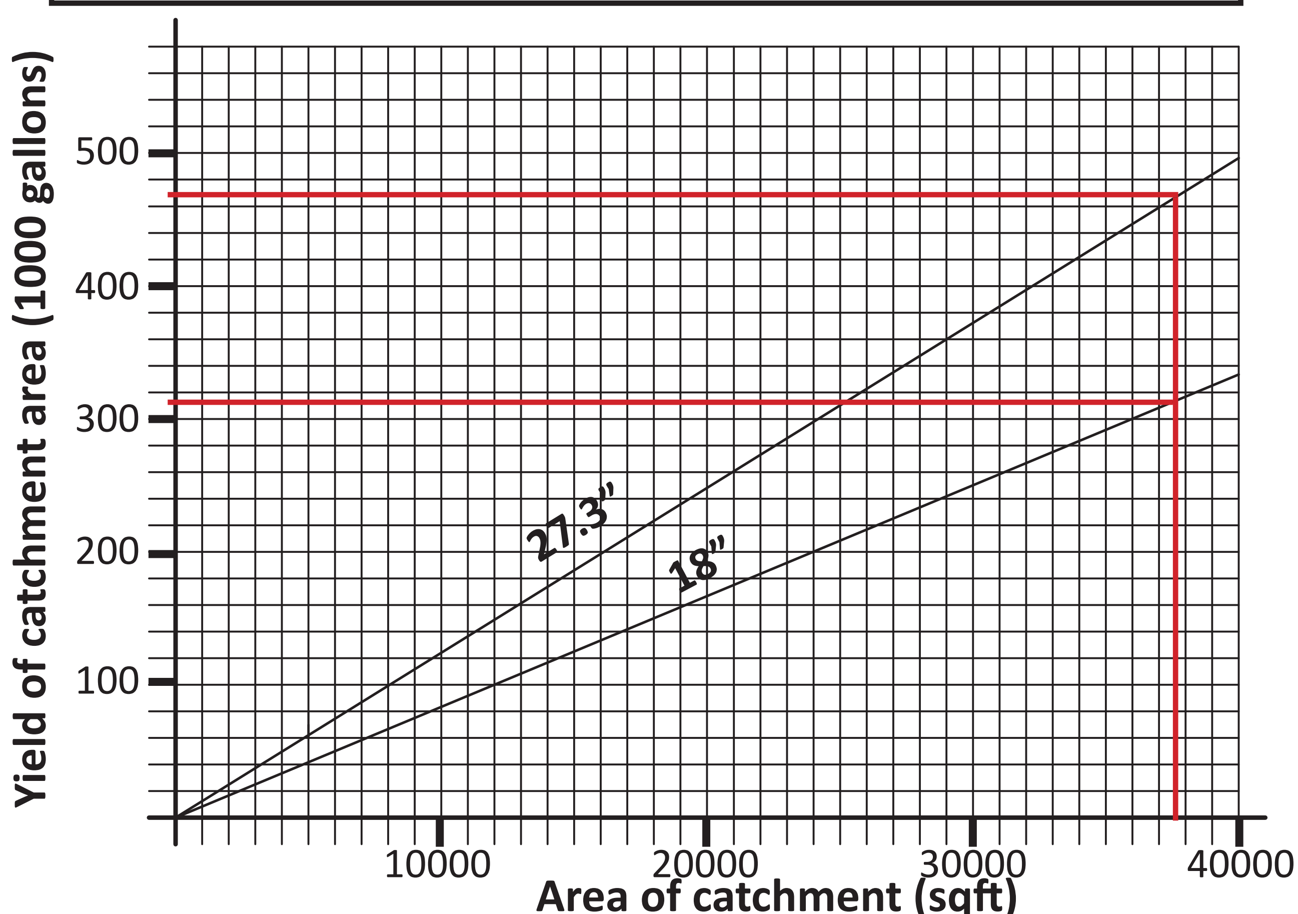
(QWall/Window Transmission Total + Qinfill) + Equpment Load + Occupant Load + Qsolar Transmission + Lighting

Total: :179,680 Btu/hr - 70,655 Btu/hr - 94,500 Btu/hr - 15,242 Btu/hr - 59,797 Btu/hr = 419,884 Btu/hr

WATER MANAGEMENT TEAM 2

Rain Moscow receives 27.3” of rain each year. Drought year(2/3) : 18” of rain a year
Area The roof is 35,717sq ft (horizontal area)
According to the graph: **Average: 488,000 gallons** **Drought: 310,000 gallons**
It is recommended that I have a **122,000 gallon cistern**
1 gallon of water = .1337 cubic feet, so my cistern needs to be at least 16, 311 cubic feet.





WATER (TOILETS/SITE) TEAM 2

My site has roughly 51,701 sq ft of plant/grass space

According to LAND ARCH program, the University uses a Fescue Kentucky blue grass blend. Fescue/Kentucky blue grass uses .7”-1.2” of water per week

624 gallons (83.3 cubic feet) of water are required to apply 1 inch of water on 1,000 square feet of lawn

I have 1,780 sq ft of covered green spaces

1780 sq ft of green space / 1000 sq ft of 1” water = 1.780
1.780 x 624 gallons
1,110.72 gallons = 1” of water on 1,780 sq ft

52 weeks in a year
-20 weeks of .7” per week = 14 “ per year
-32 weeks of 1.2” per week = 38.4” per year
-52.4” of rain a year to grow Kentucky bluegrass over a year

52.4” a year x 1,110.72 gallons per 1”
Total: 58,201 gallons a year

Assuming that 150 persons are flushing 3 times a day

Toilets: 1.6 gallons
Urinals: .5 gallons

450 flushes per day.
T: 300 toilets
U: 150 urinals

T: 300 x 1.6 gallons= 480 gallons per day
U: 150 x .5 gallons = 75 gallons per day
T + U = 550 gallons per day

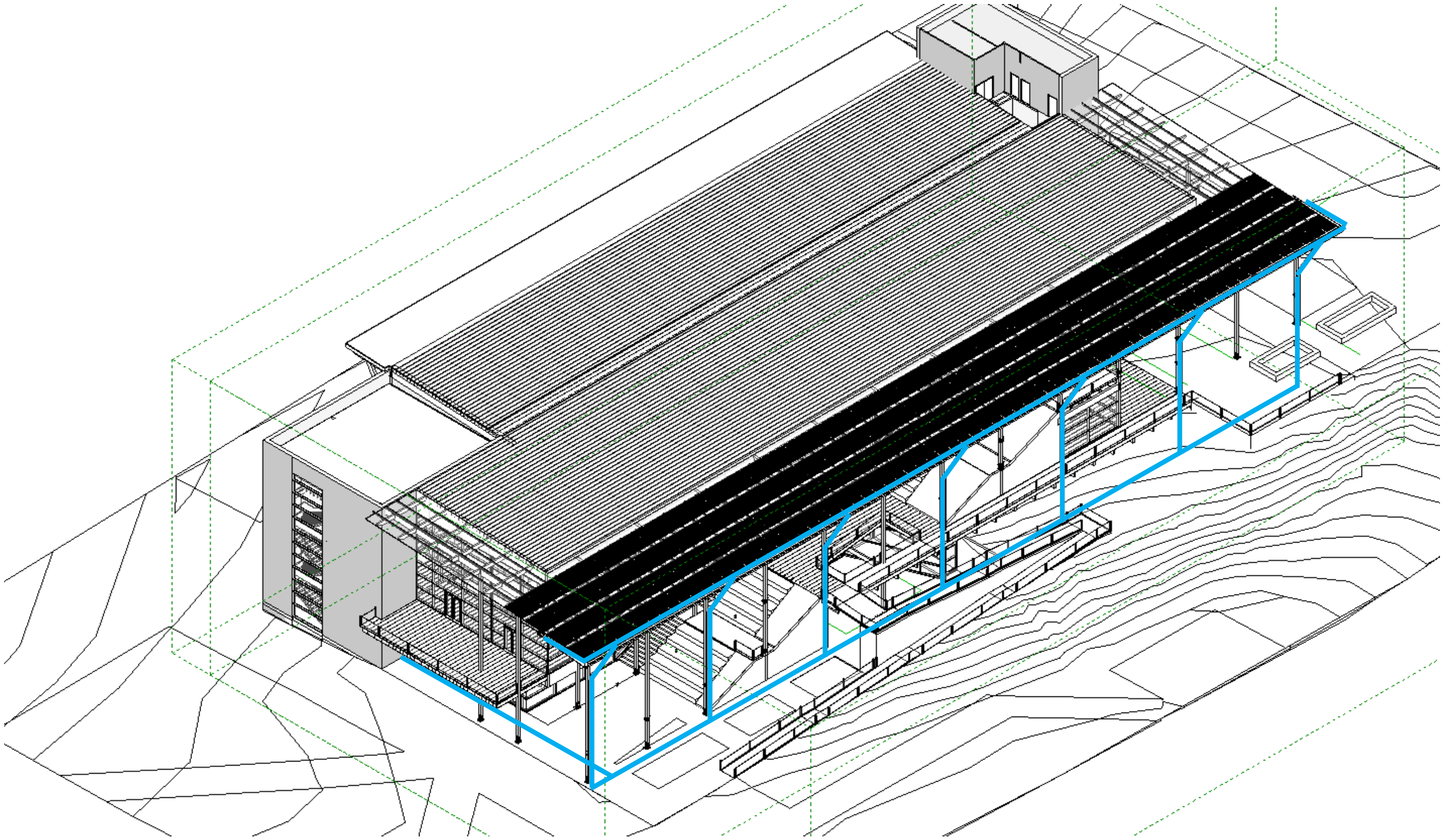
550 x 365 days/yr = 200,750 gallons per year

Total Gallons Needed
58,201 + 200,750 = 258,951 gallons

During a drought, I have 58,113 gallons left over
During the average year I have approximately 236,113 gallons left over

Water Management

Team 2



Conclusion

Peak Heating Load:
(623,940 Btu/hr)/1000 = 623.94 kBtu/hr
623.94 kBtu/hr x 24 hr x 365 days = 5,465,714 kBtu/yr
(5,465,714 kBtu/yr)/70,503 sqft = 78 kBtu/sf/yr

Peak Cooling Load:
(419,884 Btu/hr)/1000 = 419.88kBtu/hr
419.88 kBtu/hr x 24 hr x 365 days = 3,678,183 kBtu/hr
(3,678,183 kBtu/hr)/70,503 sqft = 52 kBtu/sf/yr

Peak Electricity Load:
165,681 + 153,615 = 319,296
Total: (319,296 kWh/yr)/70,503 = 4.5 kWh/sf/yr
15.35 kBtu/sf/yr

Heating + Cooling Load = 130 kBtu/sf/yr
Typical BIPV Electricity - Peak Electricity Load =
8.12 kBtu/sf/yr

- On an average year, this building can collect 488,000 gallons.
- During a drought year, this building can collect 310,000 gallons.
- 258,951 gallons a year are needed to supply the toilets and the covered vegetation

- Wood/Structure is harvested from sustainable Idaho forest practices

Heating + Cooling Load = 130 kBtu/sf/yr
Typical BIPV Electricity - Peak Electricity Load = 8.12 kBtu/sf/yr
- Because of the on-campus steam plant, my total EUI is -8.12 kBtu/sf/yr with typical performing BIPV's

EUI: -8.12 kBtu/sf/yr

Typical Performance BIPV: 484,726kwh/year = (484,726kWh/yr)/70,503 sqft = 6.88 kWh/sf/yr - 23.47 kBtu/sf/yr

High Performance BIPV: 581,713 kWh/yr = (581,713kWh/yr)/70,503 sqft = 8.25 kWh/sf/yr - 28.15 kBtu/sf/yr

Premium Performance BIPV: 646,336 kWh/yr = (646,336 kWh/yr)/70,503 sqft = 9.16 kWh/sf/yr - 31.25 kBtu/sf/yr

The carbon foot-print of this building is low. Condidering energy savings(Electricty and the use of the local steam plant), local materials, on-site power, and water management