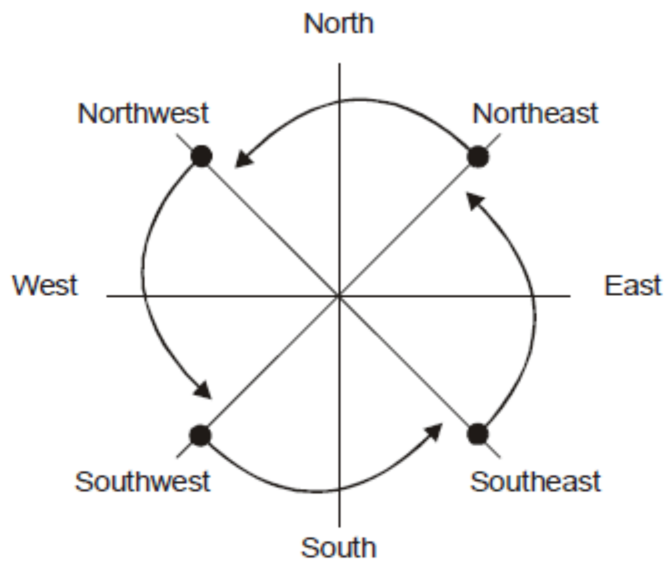
BREEZE BLOCK

2A. Window-to-Wall Ratio

Calculate the window-to-wall ratio for each elevation and the entire building. The window-to-wall ratio of a building is the percentage of its facade taken up by light-transmitting glazing surfaces, including windows and translucent surfaces such as glass bricks. It does not include glass surfaces used ornamentally or as opaque cladding, which do not provide transparency to the interior. Only facade surfaces are counted in the ratio, and not roof surfaces.

Here is the procedure for classifying facades that do not face a cardinal direction. In general, any orientation within 45^{o} of true north, east, south, or west should be assigned to that orientation. If the orientation is exactly at 45^{o} of a cardinal orientation, use the diagram at right to classify the direction of the façade. For example, an east-facing surface cannot face exactly northeast, but it can face exactly southeast. If the surface were facing exactly northeast, it would be considered north-facing.

As the window-to-wall calculation is a ratio, you may enter area in square feet or meters.



North

Step 1: Total area of light transmitting glazing surfaces on north facade: 10,627 sf

Step 2: Total area of north façade: 53,647 sf

Window-to-wall ratio of north façade = $\frac{\text{number from step 1}}{\text{number from step 2}}$ = 20%

East

Step 1: Total area of light transmitting glazing surfaces on east facade: 13,023 sf

Step 2: Total area of east façade: 56,369 sf

Window-to-wall ratio of east façade = $\frac{\text{number from step 1}}{\text{number from step 2}}$ = 23%

South

Step 1: Total area of light transmitting glazing surfaces on south facade: 16,112 sf

Step 2: Total area of south façade: 54,108 sf

Window-to-wall ratio of south façade = $\frac{\text{number from step 1}}{\text{number from step 2}}$ = 33%

West

Step 1: Total area of light transmitting glazing surfaces on west facade: 13,225 sf

Step 2: Total area of west façade: 48,675 sf

Window-to-wall ratio of west façade = $\frac{\text{number from step 1}}{\text{number from step 2}}$ = 27%

Total Building Window-to-Wall Ratio

Step 1: Façade area$_{total}$ = step one$_{north}$ + step one$_{east}$ + step one$_{south}$ + step one$_{west}$ = 212,799 sf

Step 2: Light transmitting glazing$_{total}$ = step two$_{north}$ + step two$_{east}$ + step two$_{south}$ + step two$_{west}$ = 52,987 sf

Total window-to-wall ratio = $\frac{\text{number from step 1}}{\text{number from step 2}}$ = 25%

2B. Window Openings and Window Shading

In the space below, describe the design approach at window openings to regulating incoming light and heat from the sun. Briefly describe the type of window and glass used on the east, south, west, and north elevations and the performance numbers targeted for U-factor, solar heat gain coefficient (SHGC), and visible transmittance.

Type of window and glass:

Punched opening and thermally broken curtain wall with triple IGU (Viracon VE 1-85) on South, East, West facades. Double IGU on North (allows higher SHGC, thus saving energy).

San Francisco is a temperate climate, so low U-value, high SHGC and high glazing percentage are desired to facilitate passive solar in cool months. High SHGC adversely affects cooling energy use in warm months, so vertical and horizontal fins enhance shading which effectively lower the SHGC to 0.15 when deployed are used. Shading is located on South and West facades.

East facing
U-factor: .20 assembly; SHGC: .47; Visible Transmittance: 65%

South facing
U-factor: .20 assembly; SHGC: .47; Visible Transmittance: 65%

West facing
U-factor: .20 assembly; SHGC: .47; Visible Transmittance: 65%

North facing
U-factor: .60 assembly; SHGC: .80; Visible Transmittance: 85%

If you included a projecting shading device(s) or a window reveal, include a diagram of a representative residential window on the south and the west elevations showing shadows cast at the dates and times shown below. These studies should be for ”solar time' rather than "clock time." (In solar time 12 noon represents the moment when the sun is due south and at the highest point in the sky it will reach that day.) Impose a 1'-0" grid on the window to make it possible for jurors to see the percent shading achieved at each time.

While there are a number of software tools that can be used to accurately cast shadows, it is straightforward to do this analysis in SketchUp, a free software tool.

South Elevation:

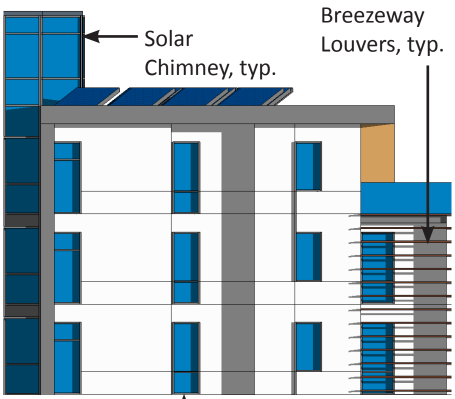
December 21:	9 am, 12 noon, 3 pm
March/September 21:	8 am, 10 am, 12 noon, 2 pm, 4 pm
June 21:	9 am, 12 noon, 3 pm

West Elevation:

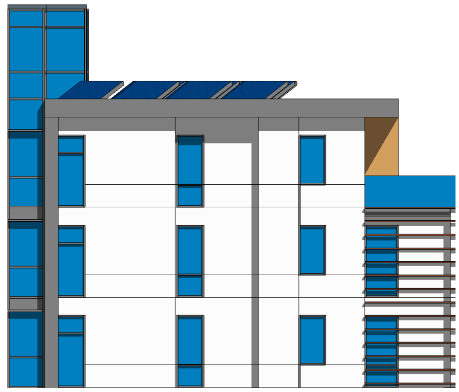
December 21:	3 pm
March/September 21:	2 pm, 4 pm
June 21:	3 pm, 5 pm

SOUTH ELEVATION

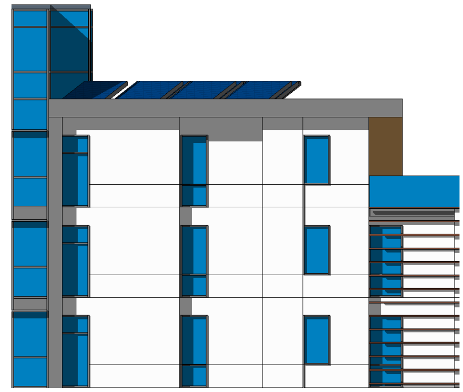
DECEMBER 21



9:00 AM

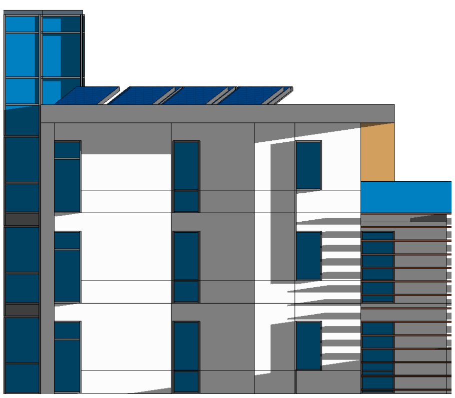


12:00 NOON

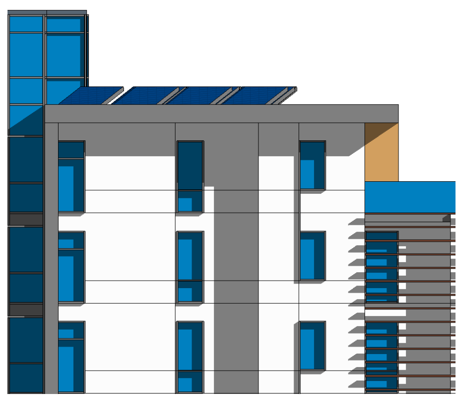


3:00 PM

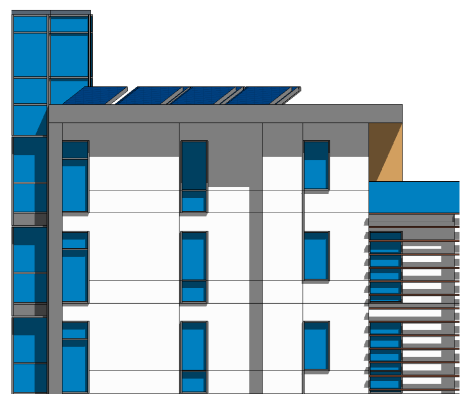
MARCH/SEPTEMBER 21



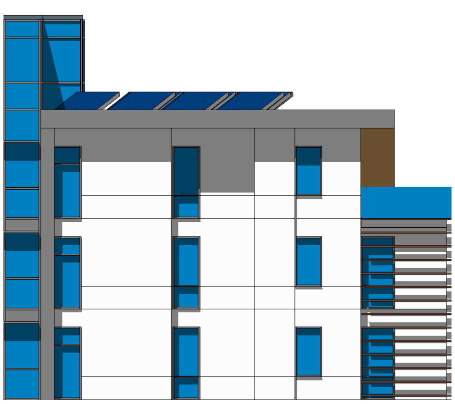
8:00 AM



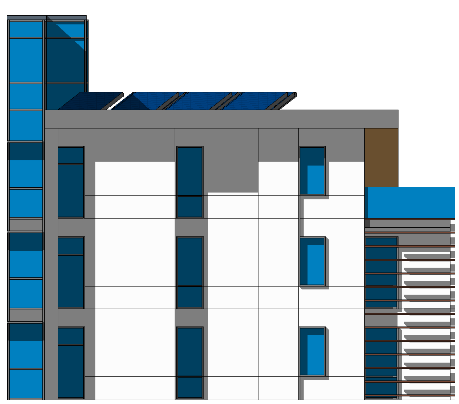
10:00 AM



12:00 NOON



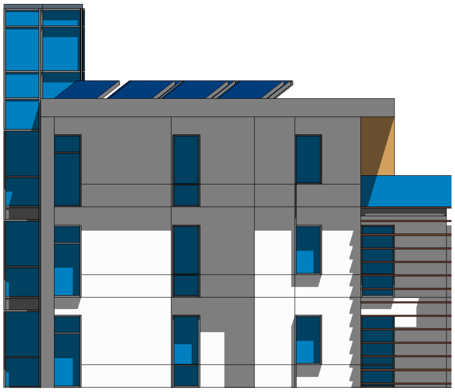
2:00 PM



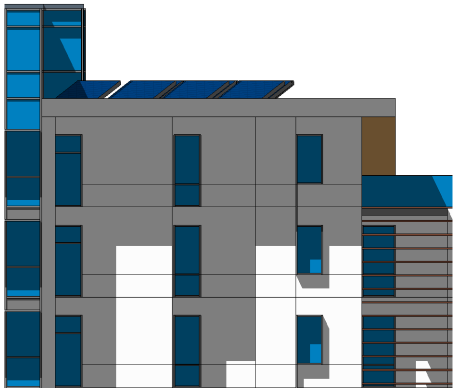
4:00 PM

JUNE 21

9:00 AM



12:00 NOON



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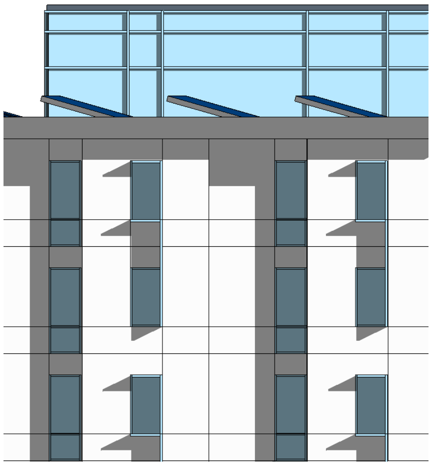
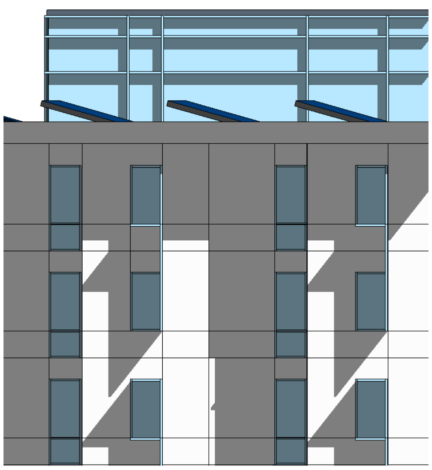
WEST ELEVATION

DECEMBER 21

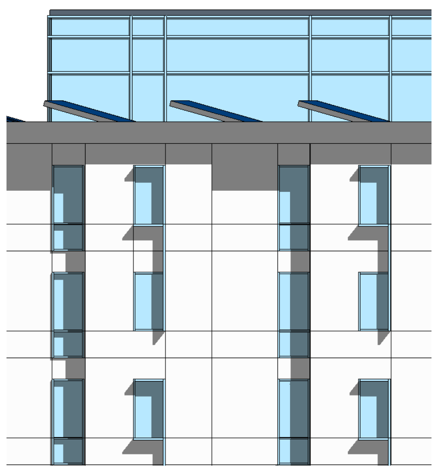


3:00 PM

MARCH/SEPTEMBER 21



2:00 PM



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JUNE 21

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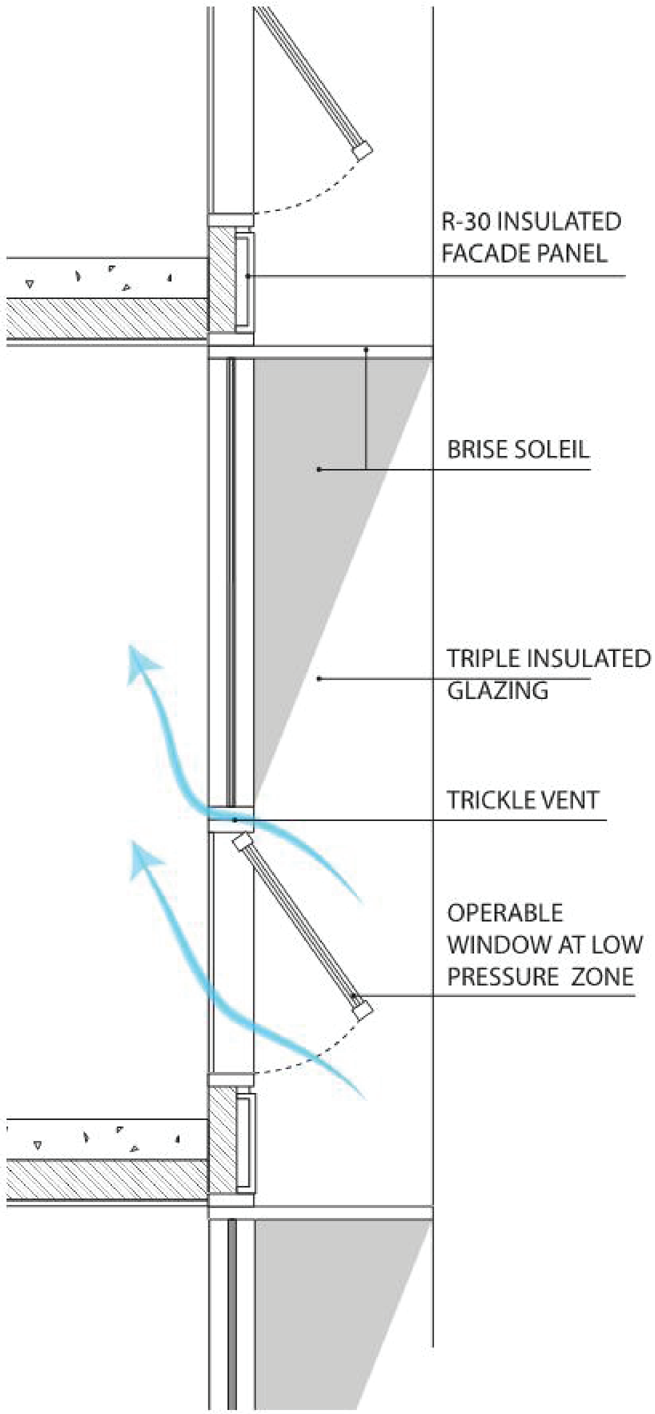
5:00 PM

2C

BUILDING SECTION



TYPICAL FACADE SECTION

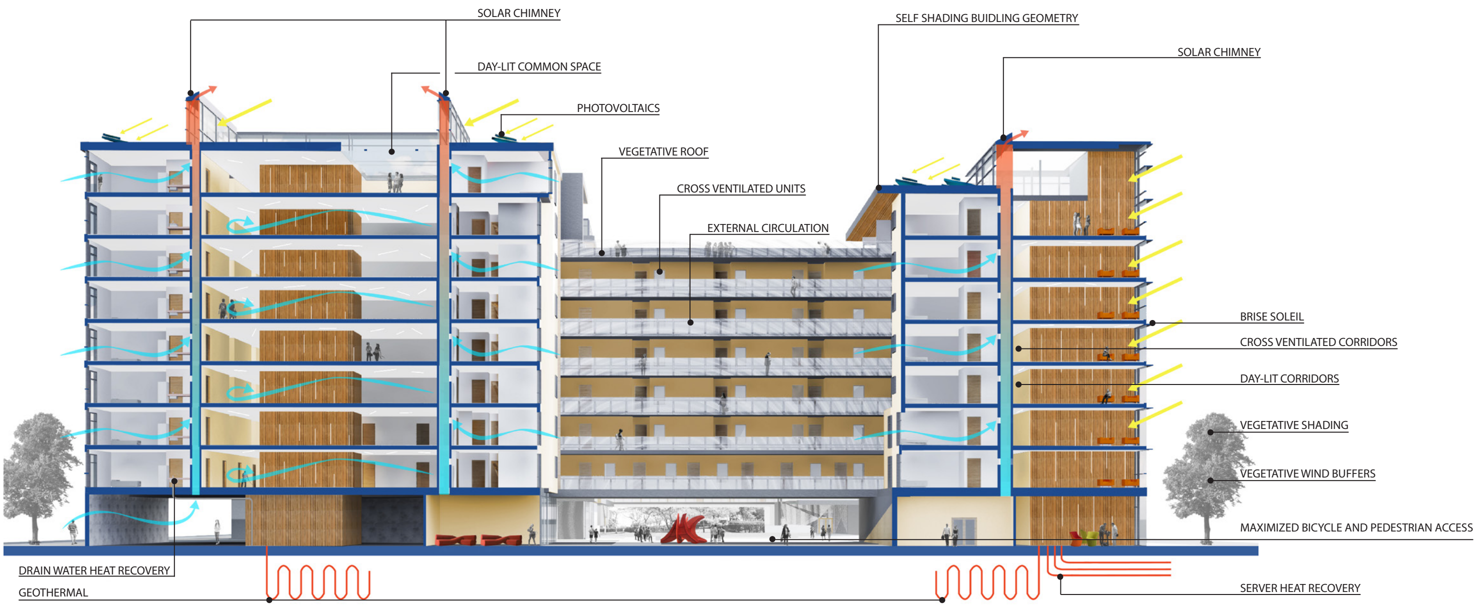
2D

	Design Load*		Calculated Energy Use (Btu/sf/year)
End Uses			
HVAC	---------------		1.9
Lighting	.2	*W/sf*	3.1
Appliances and Plug Loads	.2	*W/sf*	3.2
Domestic Hot Water	16,340	*gal/per/day*	5.1
TOTAL	---------------		
Renewable Production	---------------	---------------	.2
Net EUI	---------------	---------------	13.1

END USE BREAKDOWN

Lighting was minimized by day lighting not only residential units but corridors and common spaces as well. Combining this with LED lighting and occupancy sensors, lighting was dramatically reduced on the project, although it is attributed to a larger portion of the net EUI. Energy star appliances provided the basis of design throughout the project to help reducing appliance and plug load.

2E



WHOLE BUILDING HEATING AND COOLING SYSTEM

The approach to the overall heating and cooling system is comprised of a hybrid strategy that responds to the two building typologies. Stack ventilation is utilized at the residential towers while cross ventilation is used at the breezeway elements. These two strategies work to passively cool the building, while enhanced R values for the floors, walls and roof help to reduce heating loads as do well suited solar heat gain coefficients for the south, east and west facades. Trickle vents located within the residential units and located at corridor terminations help to facilitate air circulation and passive cooling. Gas fired boilers operating at the higher end of the efficiency spectrum, as utilized in the Sefaira analysis, supplement any additional heating demand working to greatly minimize the overall BTUs/sf on the project. Geothermal wells help to chill water used in vertical fan coils that provide cooling to the podium level of the towers. Well placed vegetation helps to reduce the heat gain on the ample glazing at the podium level. As hot air rises within the podium level , it moves up and into the solar chimneys of the towers to increase buoyancy and reduce infiltration to the floors above.

The most significant load on the building is the hot water demand. To help minimize this demand, drain water heat recovery systems which utilize the waste water from showers and taps help to 'pre-heat' water entering the gas fired boilers. This 'pre-heating' helps to reduce the overall demand and use of the gas-fired boilers. In addition to utilizing drain water heat recovery, this project takes advantage of adjacent resources such as campus server banks, simultaneously reducing the cooling load on server rooms while reducing demand from the gas fired boilers. Through this approach, the proposal not only seeks to reduce the cooling load on server rooms while reducing demand on its site, but on other campus buildings as well.

DESCRIPTION OF RESIDENTIAL UNIT SYSTEMS

Description of Building Conditioning and Comfort Strategies

Residential Heating
The first strategies are at the facade by including a 25% window to wall ratio, a R-20 solid wall, high SHGC (.44) and low U-value (.21) glazing which facilitate passive heating and prevent heat loss through enclosure. A geothermal system transfers ground source heat to residential unit heat pumps as the primary mechanical heating system. Supplemental heat is provided by high efficiency gas boilers.

Residential Ventilation
The solar chimneys drive the ventilation strategy in tandem with cross ventilation. They pull in outdoor air at each floor and exhaust it two stories above the roof (the sun heats the high thermal mass walls increasing the buoyancy of the air which promotes passive ventilation). Residential units bring in fresh air via exterior wall trickle vents and operable windows. After air circulates, it is passively exhausted directly into the solar chimney.

Residential Cooling
Mechanical systems are not required to maintain comfort if appropriate solar control measures are taken at the facade. Operable exterior roller shades at every windows provide good solar control and effectively lower the SHGC to 0.15 when employed. Mechanical cooling is available via the ground source heat pumps as a back-up.

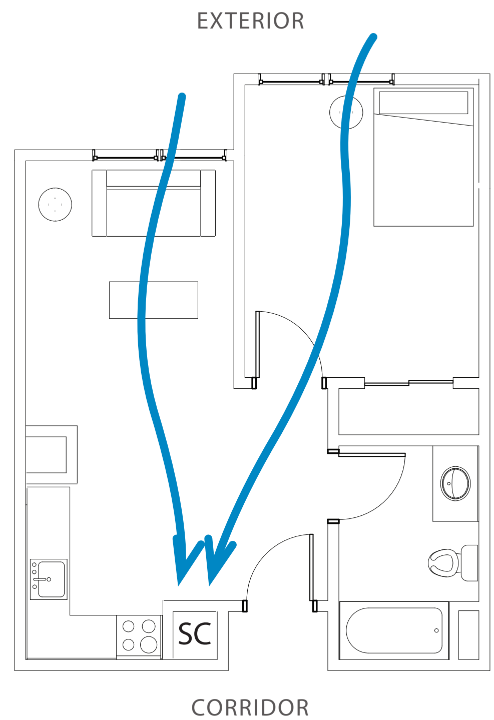
Residential Hot Water
Domestic hot water is provided by high efficiency gas boilers and draw water heat recovery and server heat recovery. Its usage is reduced through low-floor plumbing fixtures.

Residential Lighting
An LPD of 0.2 W/sf is achieved by using dimmable LED lighting throughout the unit.

Common Areas
Common areas are passively lit and ventilated by operable glazing at the end of opposing corridors. Roughly half of the corridors are external as are half of the stairways in the project. This ultimately reduces heating and cooling load.

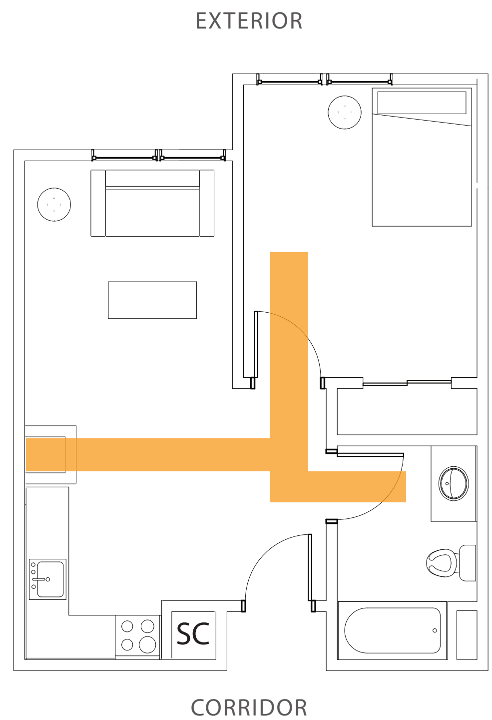
DIAGRAMMATIC SKETCHES OF RESIDENTIAL UNIT SYSTEMS

VENTILATION/COOLING



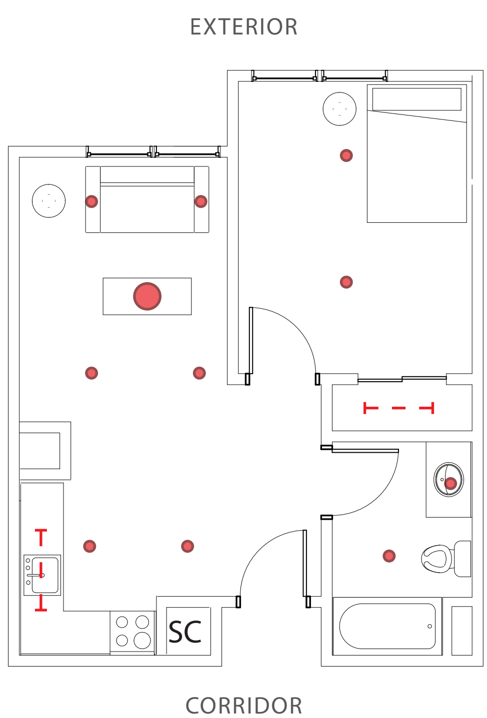
- Fresh air provided through exterior wall by
  - Wall trickle vents
  - Operable windows

HEATING/HOT WATER



- Supply ducts to exhaust air to solar chimney located along corridor

LIGHTING



- All LED lighting
- Overall LPD of 0.2 W/sf

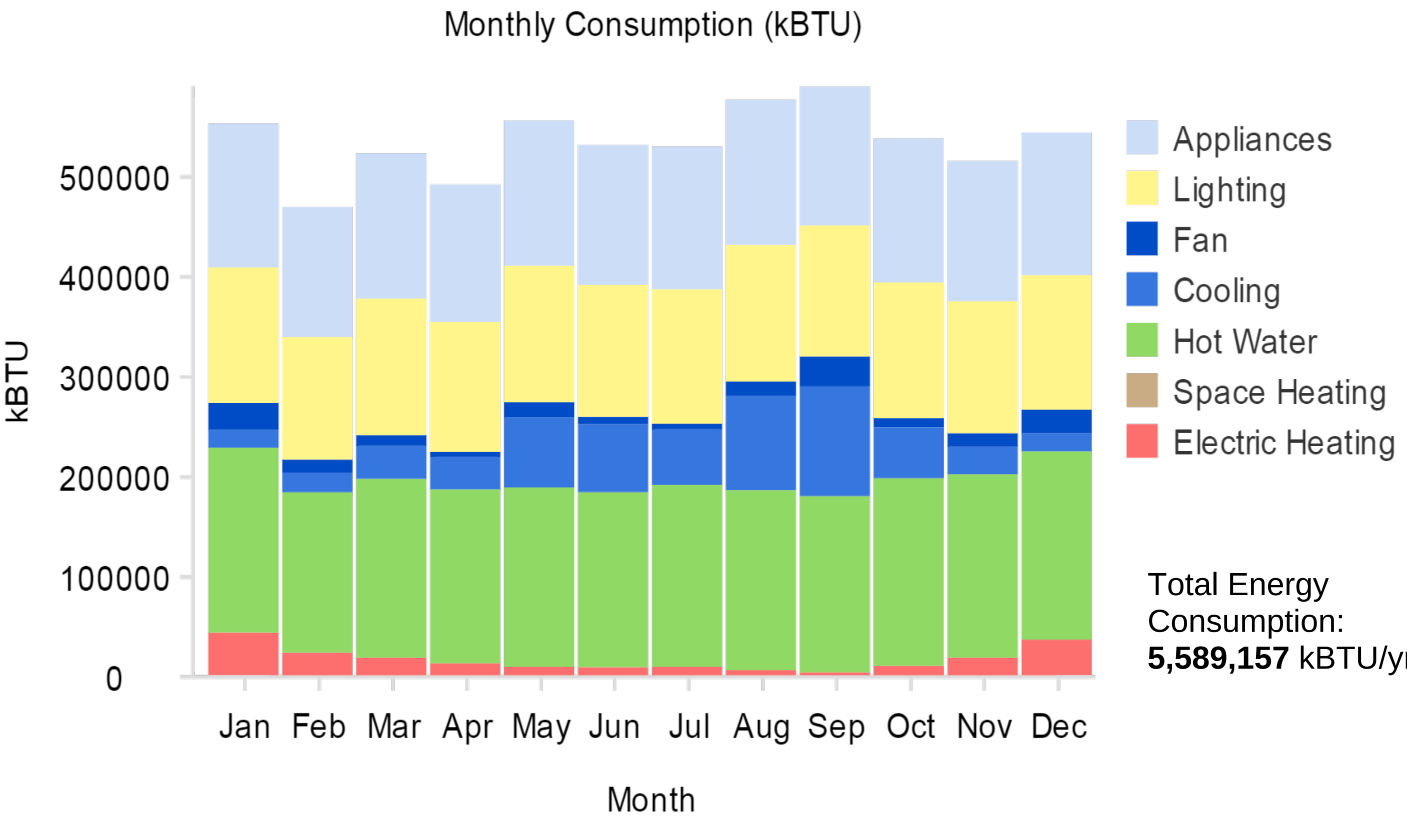
RENEWABLE ENERGY

For the purposes of this competition and as a result of the conceptual underpinning of the proposal as a unified architectural element, the massings were analyzed as a single, integrated building within the energy modeling software Sefaira. The primary strategy for renewable energy is attributed to roof integrated photovoltaics. This was selected because, as research indicates, in a net gain comparison of square footage between photovoltaics and solar hot water, the energy generated by photovoltaics is greater than the offset created by solar hot water. For that reason solar hot water was emitted from this proposal. Photovoltaics accounted for 40% of the roof area in the energy modeling calculations and were functioning at 8% efficiency.

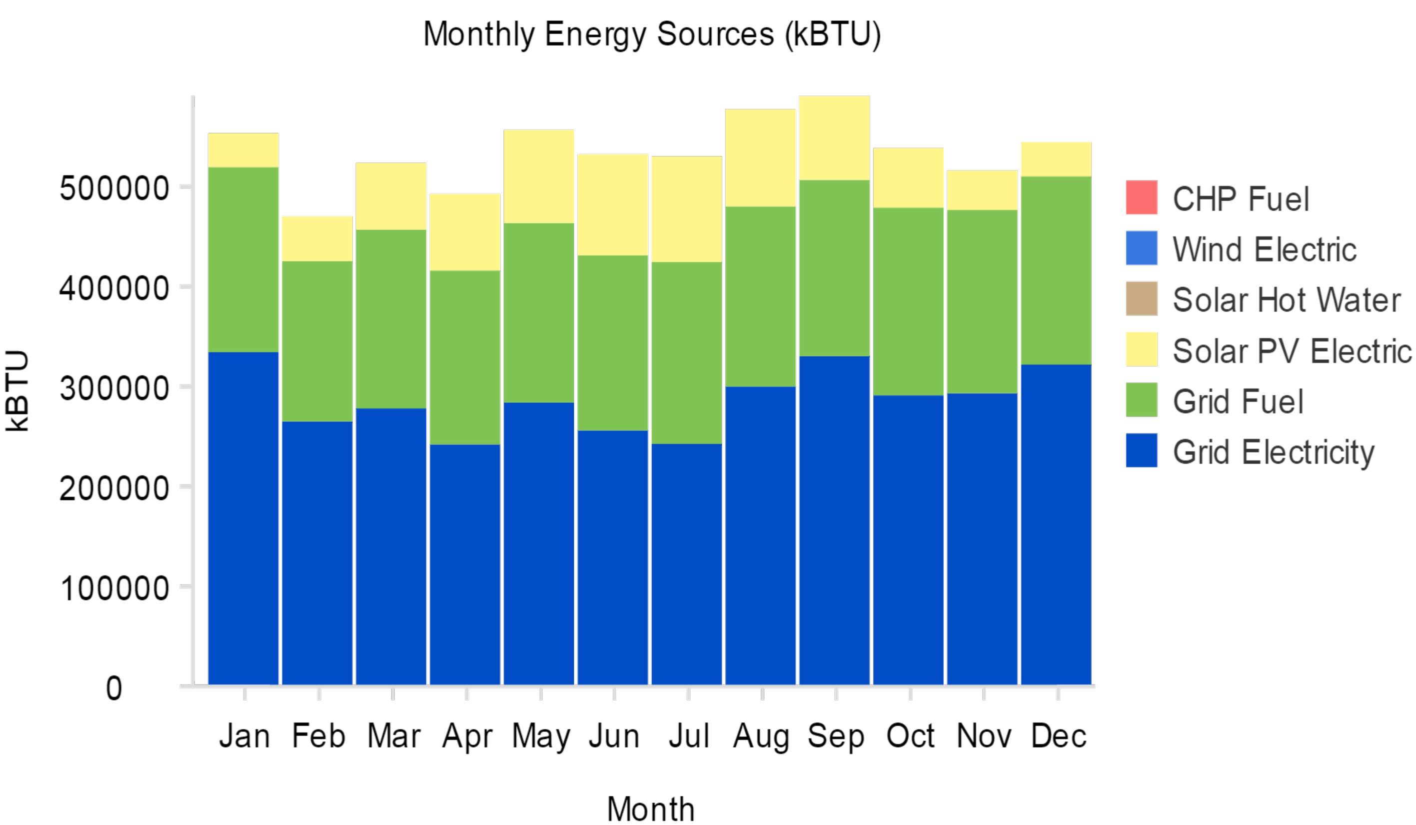
In lieu of solar hot water, systems such as drain water heat recovery and server heat recovery were implemented. As the modeling software Sefaira does not provide metrics for these two systems, standard input values were altered to create the estimated offset that server heat recovery and drain water heat recovery would provide. The goal of these systems is to decrease the demand of the hot water generated from gas fired boilers by raising the average temperature of the water to be heated for domestic hot water demands. Our numbers were calculated by reducing the average output of hot water in domestic conditions by 10 degrees, thus reducing a shower or tap average hot water temperature from 95 degrees Fahrenheit to 85 degrees Fahrenheit. This modeling methodology was developed because there is no metric for average temperature of water entering the boiler.

Ultimately, this project reaches the Net Zero goals for a building of its typology, coming in at a 13.1 EUI. Although successful, the opportunity for an even greater reduction in energy use and consumption remains. The success of the project lies in the stack effect and cross ventilation, rendering the overall HVAC demand quite low. The integration of the solar chimneys as an architectural element to increase day lighting on common spaces also helps to reduce overall energy demand, as does the premise of the pinwheel organization of the towers, wherein cross ventilation and day lighting may be achieved independently of the stack ventilation in the same building mass. The massing of the site also takes advantage of the wind conditions as well as creates generous self shading conditions against afternoon sun helping to reduce cooling load.

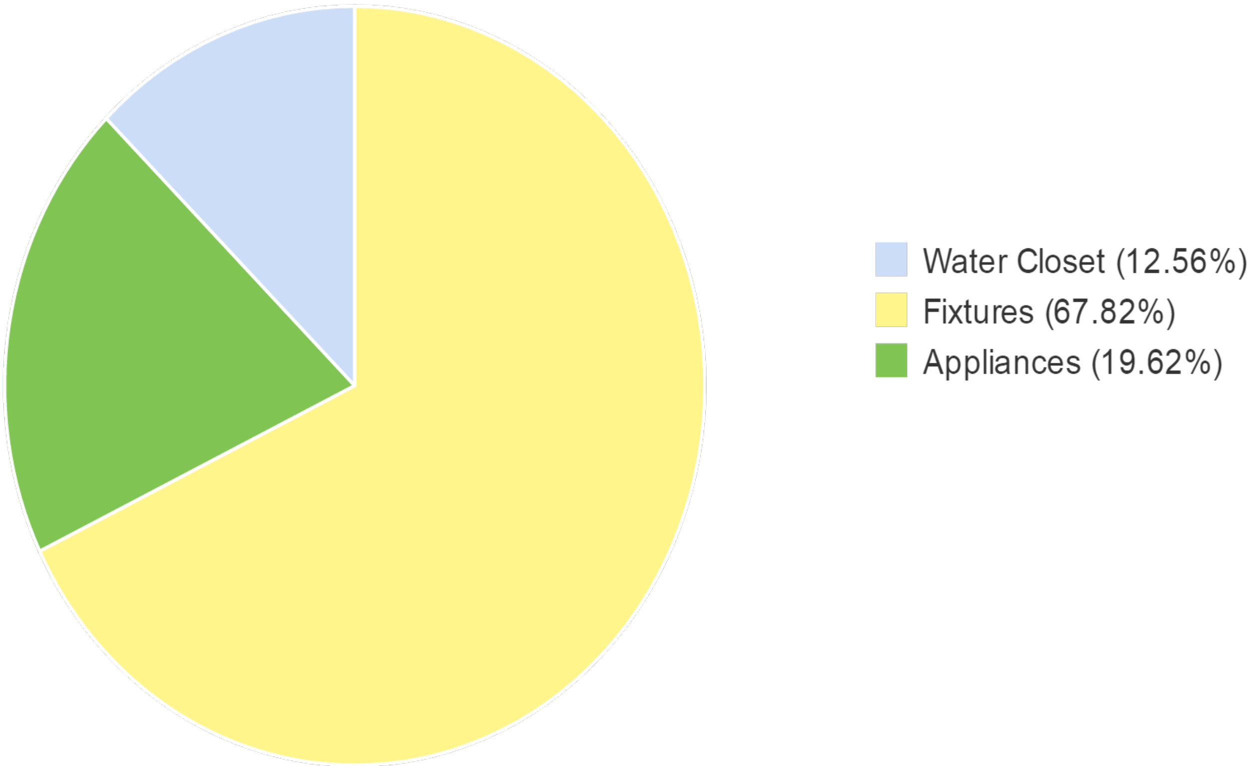
The proposal is least successful in its hot water demand, which is the strongest inhibitor for the project. The attached charts, generated from Sefaira, provide further detail as to the monthly demands breakdown.



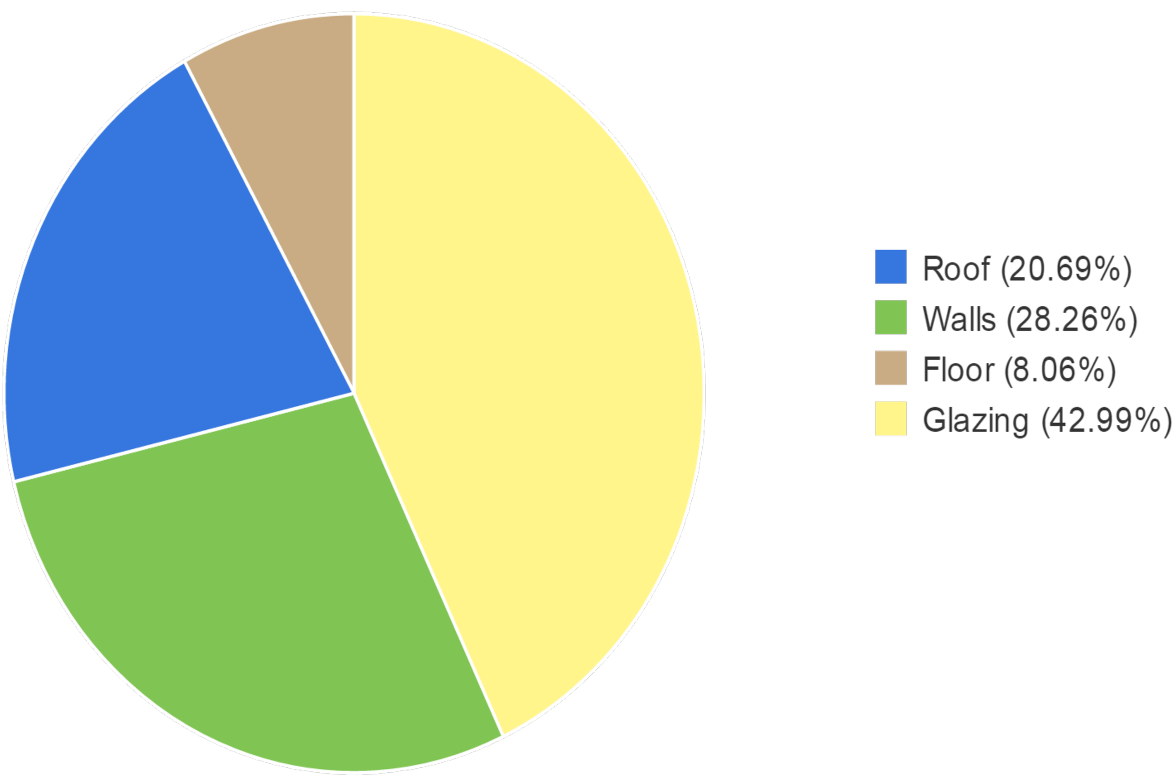
Total Energy Consumption: **5,589,157** kBTU/yr



Annual Water Use (gal)



Fabric Conduction Loss (kBTU)



OCCUPANT BEHAVIOR

As building's set lower resource use goals and employ active strategies to achieve those goals the role of occupants is critical. There is an opportunity to address how high performance buildings affect occupants (comfort) and how occupants can in-turn affect building performance (engagement). Occupant is defined as anyone inhabiting a building full or part time, visitors and maintenance staff. People are now a vital building "system". The following strategies are market ready solutions to affect occupant controlled energy use and and behavior

Sustainable Practices Guidebook: Each unit has a manual with best practices graphically illustrated
Operable Windows: occupants instructed with red light / green light signal next to panel
Smart Thermostat / Monitoring: Programmable thermostats with continuous energy use dashboard
Instructional Signage: Common spaces have educational signage installed throughout
Site Planning: Bike parking is located adjacent to and within proximity of external stairs. The intent is to encourage use of stairs over elevators as their is a load demand from multiple elevator cores within the project.