BEYOND ZERO

"Emissions now hurt more than emissions later"

-Erin McDade

The New Carbon Architecture

CONTENTS

INTRODUCTION

Even before the building is occupied, it has already contributed to climate change.
While the building sector, which contributes to 50% of the global emissions, focusses on reducing the operational cost of the building down through the ZNE strategies, hidden in plain sight is the embodied energy of the building. The most unnoticed effects are the result of the construction process itself and included emissions resulting from manufacturing building products, materials, transportation and construction.

BEYOND ZERO brings to attention the urgency of reducing emissions TODAY rather than planning for a building's average life of 80 years. Although over the building's life span, the cumulative operational energy eclipse the initial embodied ones but having committed to a carbon free environment by 2050 means we can no longer ignore embodied carbon.

Our building goes beyond zero and improves the health of the existing environment through its development, choice of materials and ecological restoration techniques. It intends to be an ultra–low carbon building for our best chance of staying below the two–degree Celsius threshold, honoring the Paris Climate Agreement


1 ENTRY
2
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4
5
6
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8
1 PEDESTRIAN ENTRY
2 VEHICULAR DROP-OFF
3 BIKE SHARING STAND
4 SOCIAL PATIO
5 RWH POND
6 EXISTING LANDSCAPE
7 BIKE PATH
8 SOLAR PANELS
BIKE PATH
FORMAL LANDSCAPE
DECIDUOUS PLANTATION
VISTA POINT
NATURE TRAIL
VERNAL POOLS
BIOPHILIA

SITE STRATEGY

The two buildings situate themselves on the site in a manner that enables the preservation and retention the existing wooded area on the Western boundary of the plot and strives to present an ecological hub for the surrounding flora and fauna to rely on and thrive off of. Taking careful consideration to the slope of the site, during construction we use a cut and fill technique to create rainwater harvesting vernal pools to the north of the site. The masses are oriented with their largest facades facing the south to harvest the power of the sun when it needs to and opens up to the North and the East, providing the smallest facade on the West where undesirable solar heat gains are avoided. The buildings are intended to readily service the campus' pedestrian mall, just to the North.

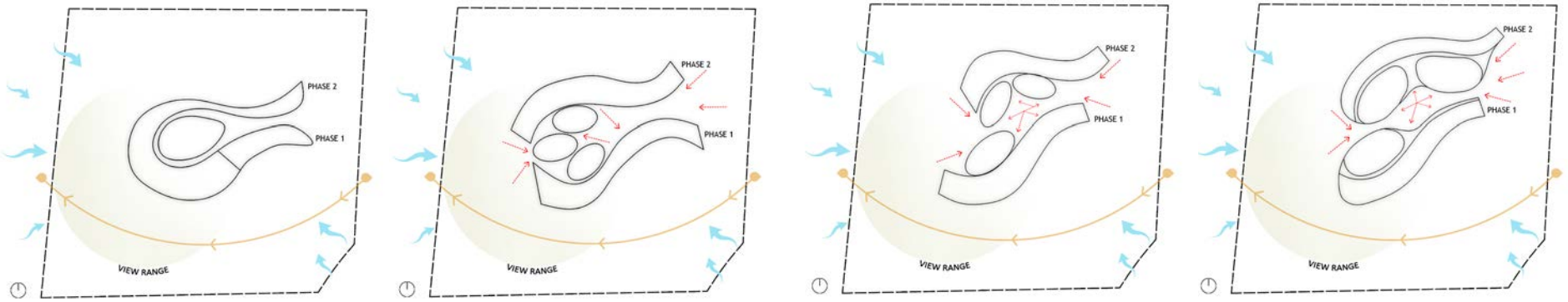
DESIGN CONCEPT

SITE STRATEGY

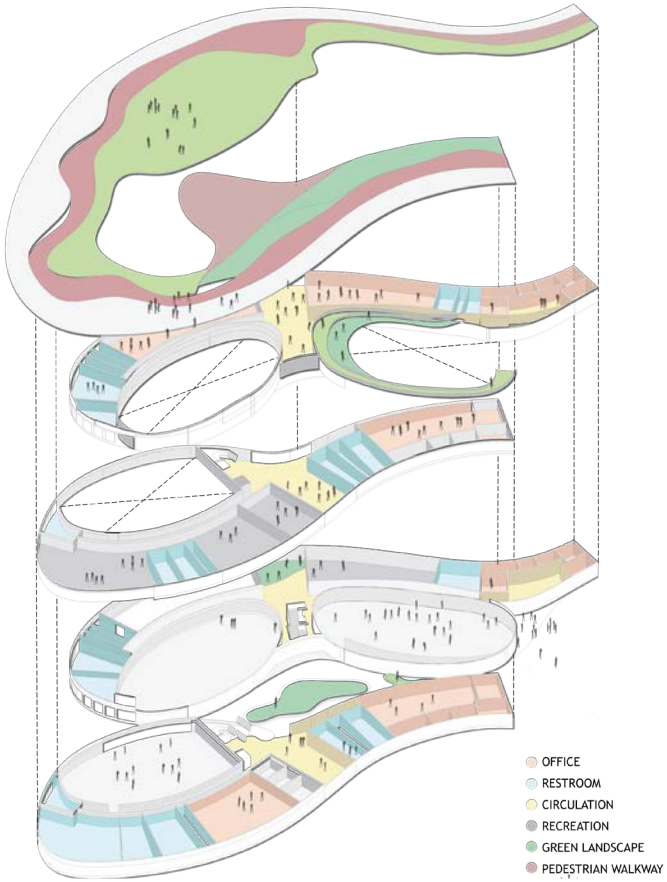
The two buildings are separated into two phases but continue to develop visually beyond the time of their completion. The ecologically rich landscape that the project provides begins as all life does in a fledgling state but will develop over the years as a true biological restoration of native habitat.

The industrialization and paving of great roadways in our nation have brought a great deal of commerce and business but in their wake they've left lots of surfaces that are fully impervious to water, preventing the natural rain water cycle. The site's earthworks have been planned to create rainwater harvesting vernal pools that help to collect and use rainwater rather than leaving the soil dry by sending it off into storm drains.

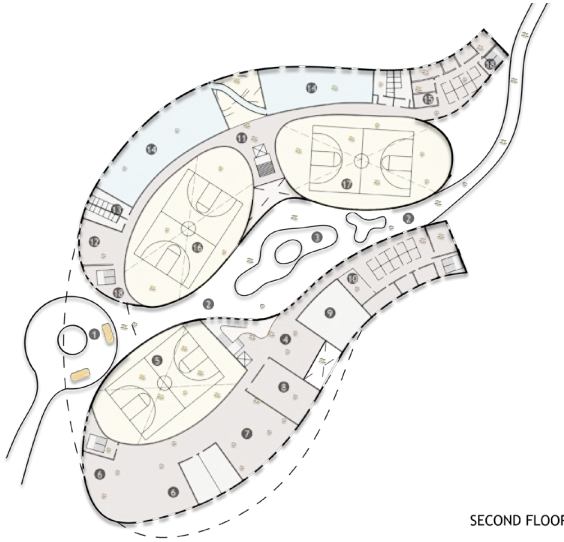
The diverse ecosystem our landscape plan provides acts as an educational lab for students and the local community. The different areas of the site are divided by the different plant groups that thrive in the individual micro-climates the buildings create. Visitors can relax and enjoy the numerous vistas of these natural landscapes as well as the Pacific Ocean from the occupiable rooftop garden where interpretive information is also provided.



INTERIOR STRATEGY



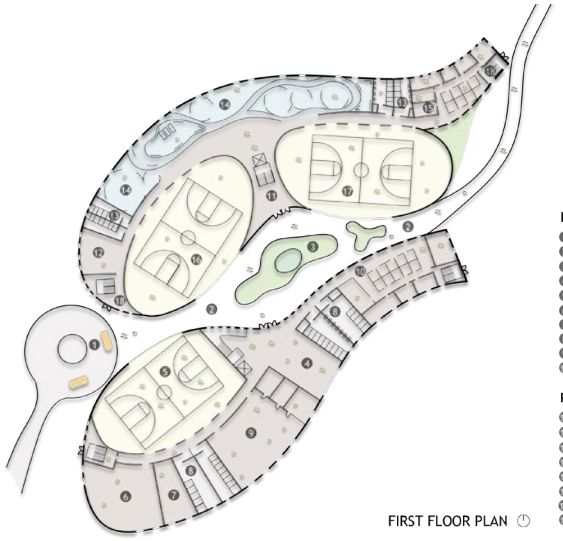
Beyond Zero's spacial arrangement provides maximized levels of natural light for the building's form. Each room has views of the surrounding landscape with many of them looking into the interior courtyard. Views into the athletic courts from inside and outside of the buildings help to provide a dynamic experience for passers by along with several double height spaces. The sloped and terraced rooftop garden and observation deck heighten this experience and allow students to experience the campus' landscape in a whole new way.



SECOND FLOOR PLAN

PHASE 1
1 DROPOFF
2 SOCIAL PATIO
3 BIOPHILIA
4 LOBBY
5 INDOOR COURT A
6 DANCE AND WEIGHTS
7 CARDIO
8 CONFERENCE ROOM
9 RESTROOM
10 OFFICE

PHASE 2
11 LOBBY
12 STORAGE
13 RESTROOM
14 CLASSROOMS
15 OFFICE
16 INDOOR COURT B
17 INDOOR COURT C
18 EMERGENCY EXIT

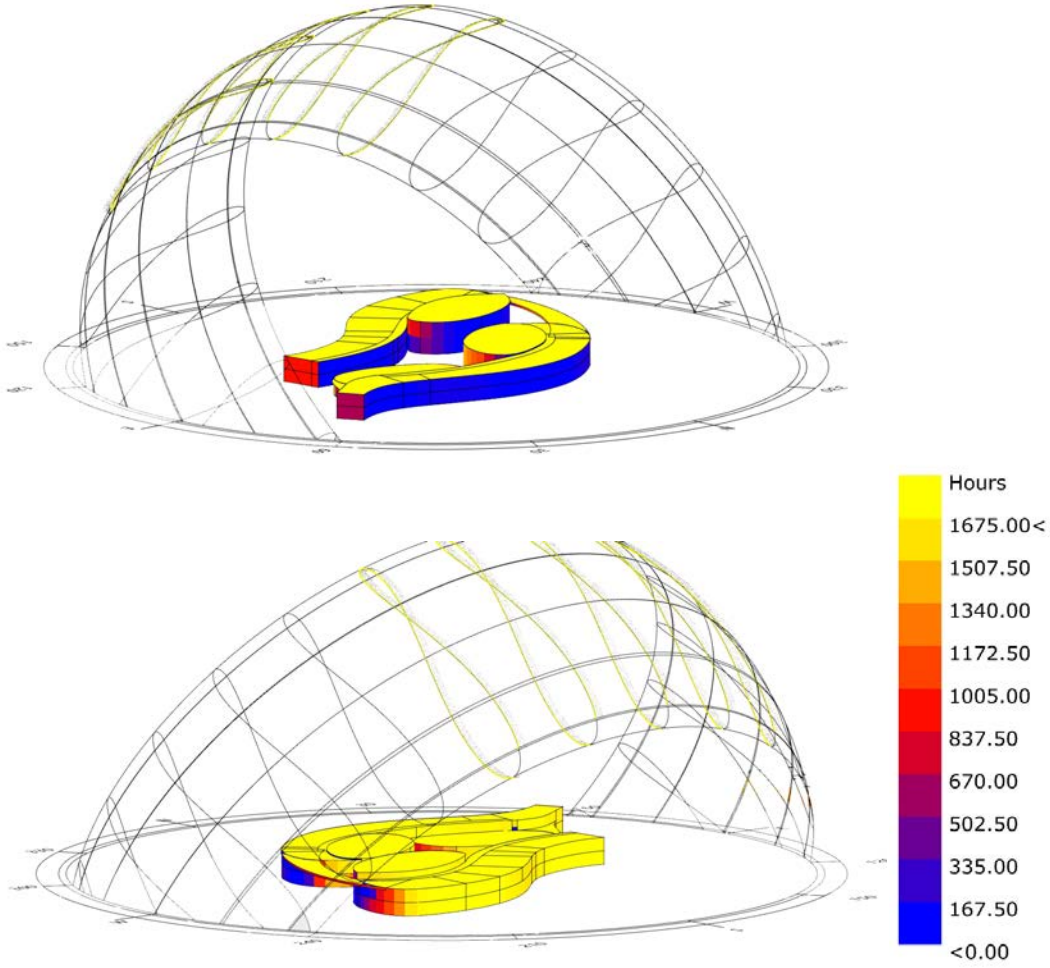


FIRST FLOOR PLAN

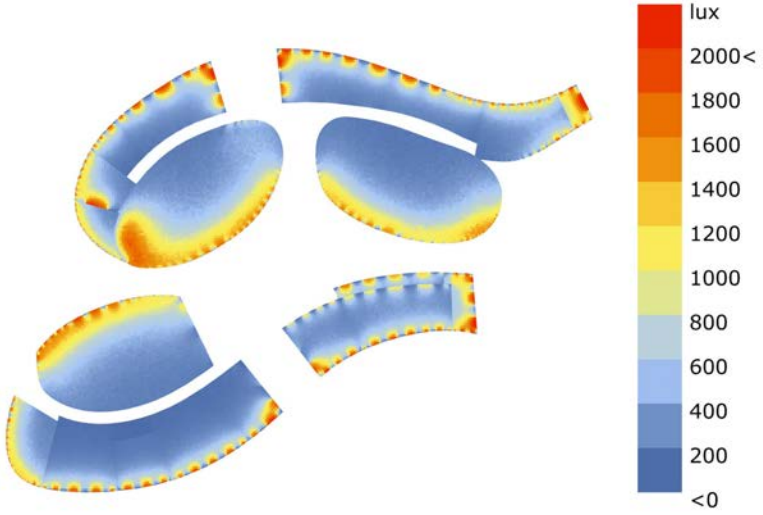
PHASE 1
1 DROPOFF
2 SOCIAL PATIO
3 BIOPHILIA
4 LOBBY
5 INDOOR COURT A
6 LOCKER ROOM
7 STORAGE
8 RESTROOM
9 DRY LAB
10 OFFICE

PHASE 2
11 LOBBY
12 STORAGE
13 RESTROOM
14 WEIGHTS AND CARDIO
15 OFFICE
16 INDOOR COURT B
17 INDOOR COURT C
18 EMERGENCY EXIT

SUNLIGHT ANALYSIS



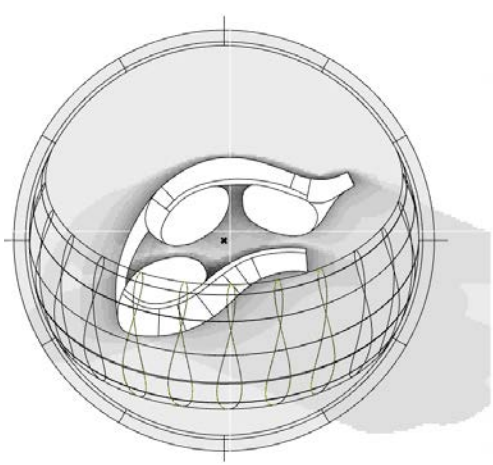
Sunlight Hours Analysis



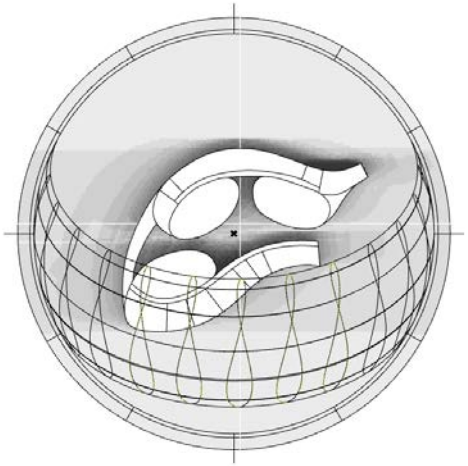
Illuminance

SUN-SHADING ANALYSIS

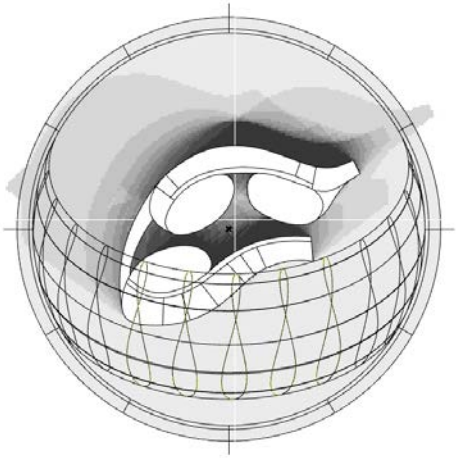
Illuminance



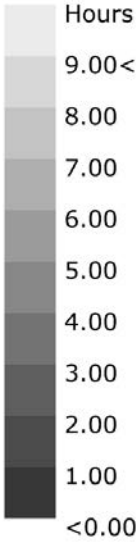
June 21



September 21

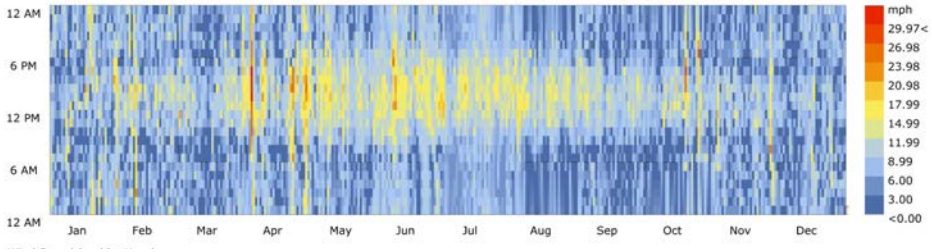


December 21

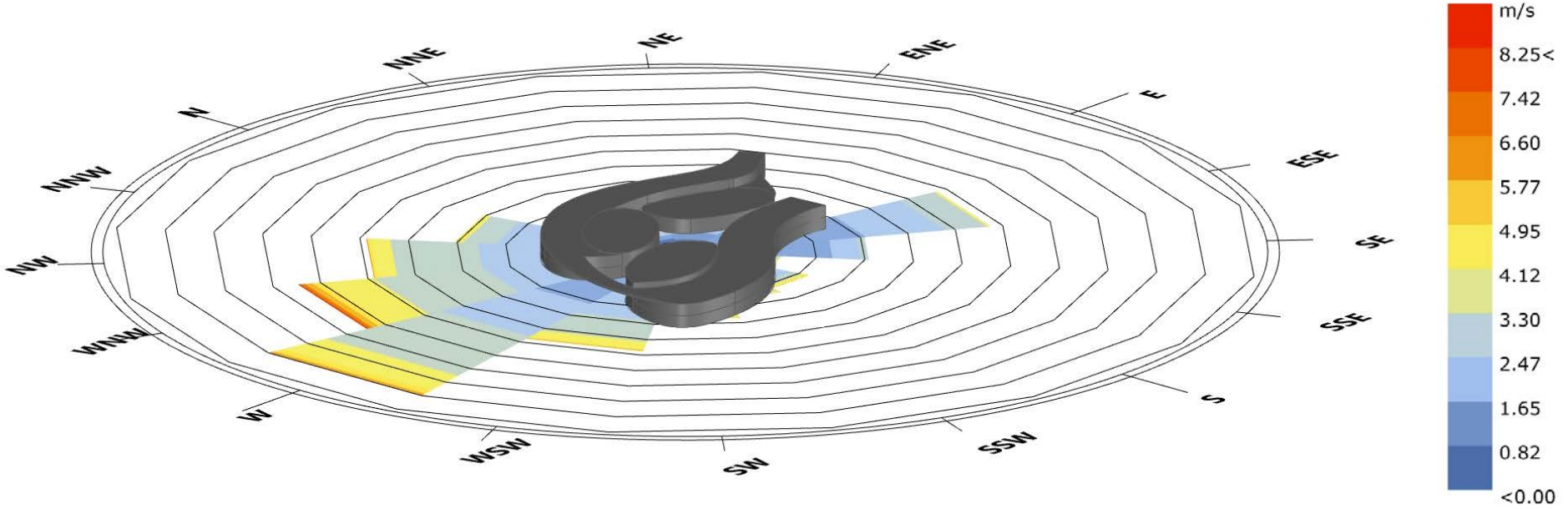


Sun-Shading Analysis

PREVAILING WINDS

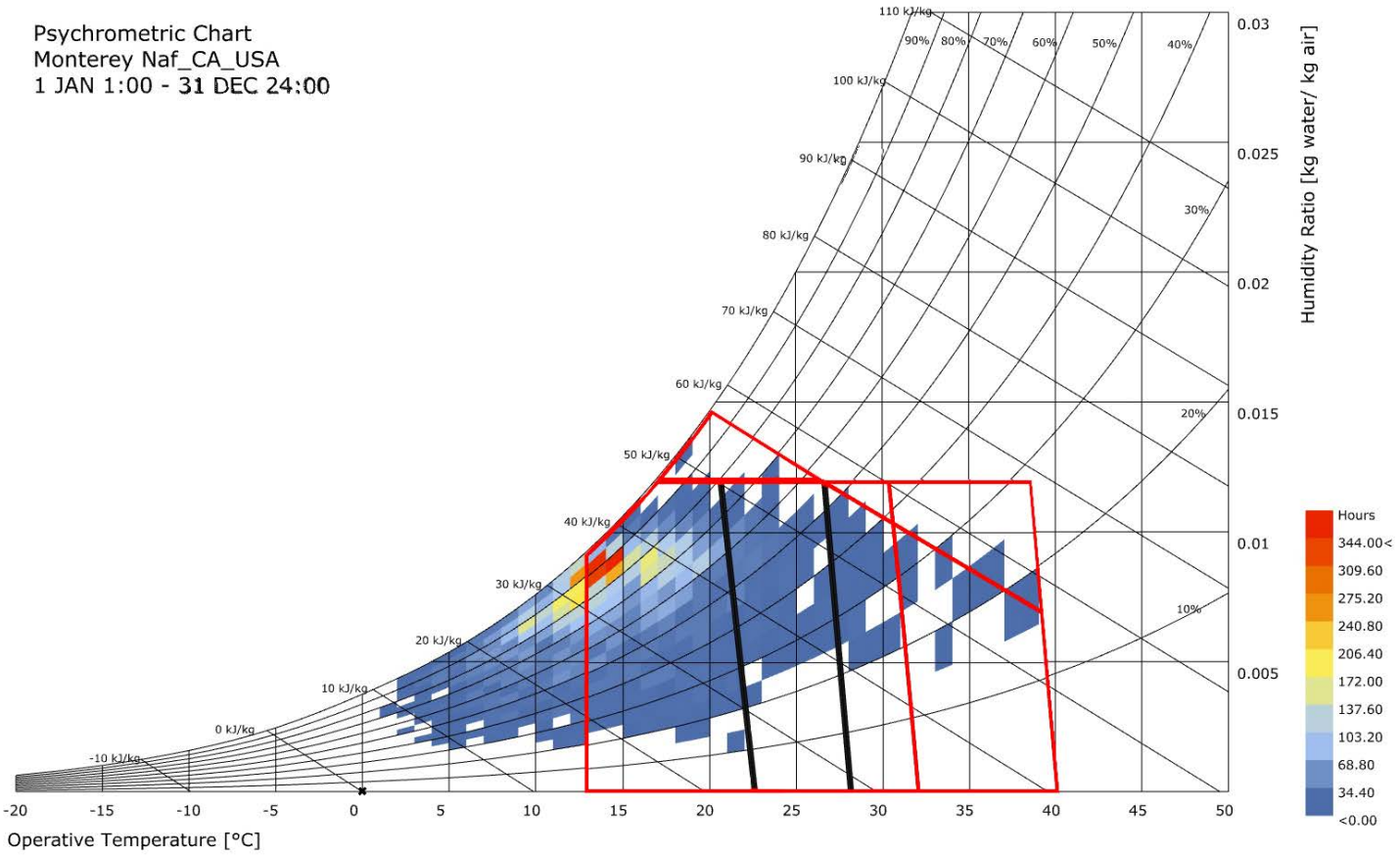


Beyond Zero orients its building masses according to the flow of the wind. With the majority of wind being westerly and coming from the ocean, the curved, aerodynamic forms accomodate these strong winds and reduce the wind load that the buildings' structures need to resist. These strong winds also aid in providing natural ventilation, helping to reduce energy use on warm days.



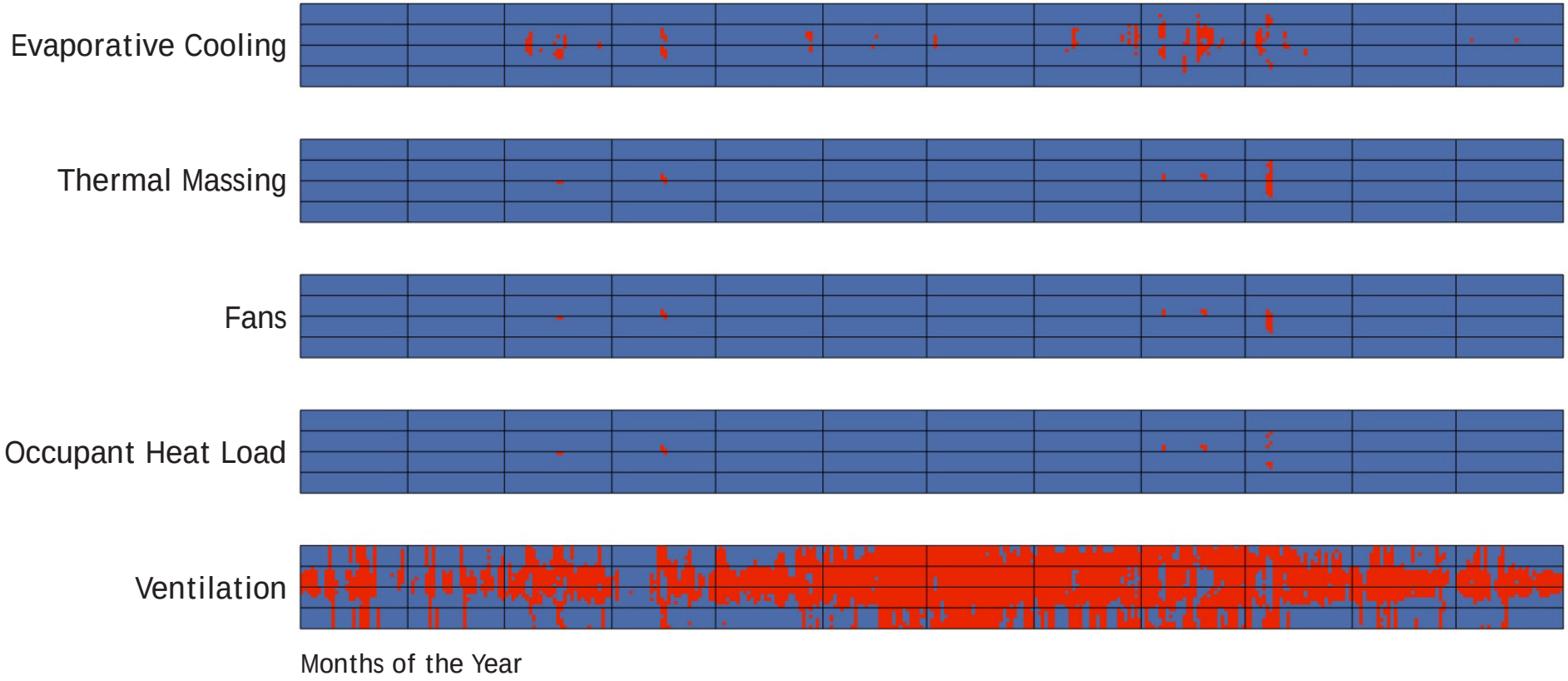
PSYCHROMETRIC ANALYSIS

The psychrometric chart maps outdoor air temperature and humidity levels as different colors depending on their frequency. The red and black enclosed areas indicate a comfortable combination of air temperature and humidity. The black area indicates the baseline comfort range in Monterey while the red area indicates the expanded comfort range that Beyond Zero's passive strategies provide.



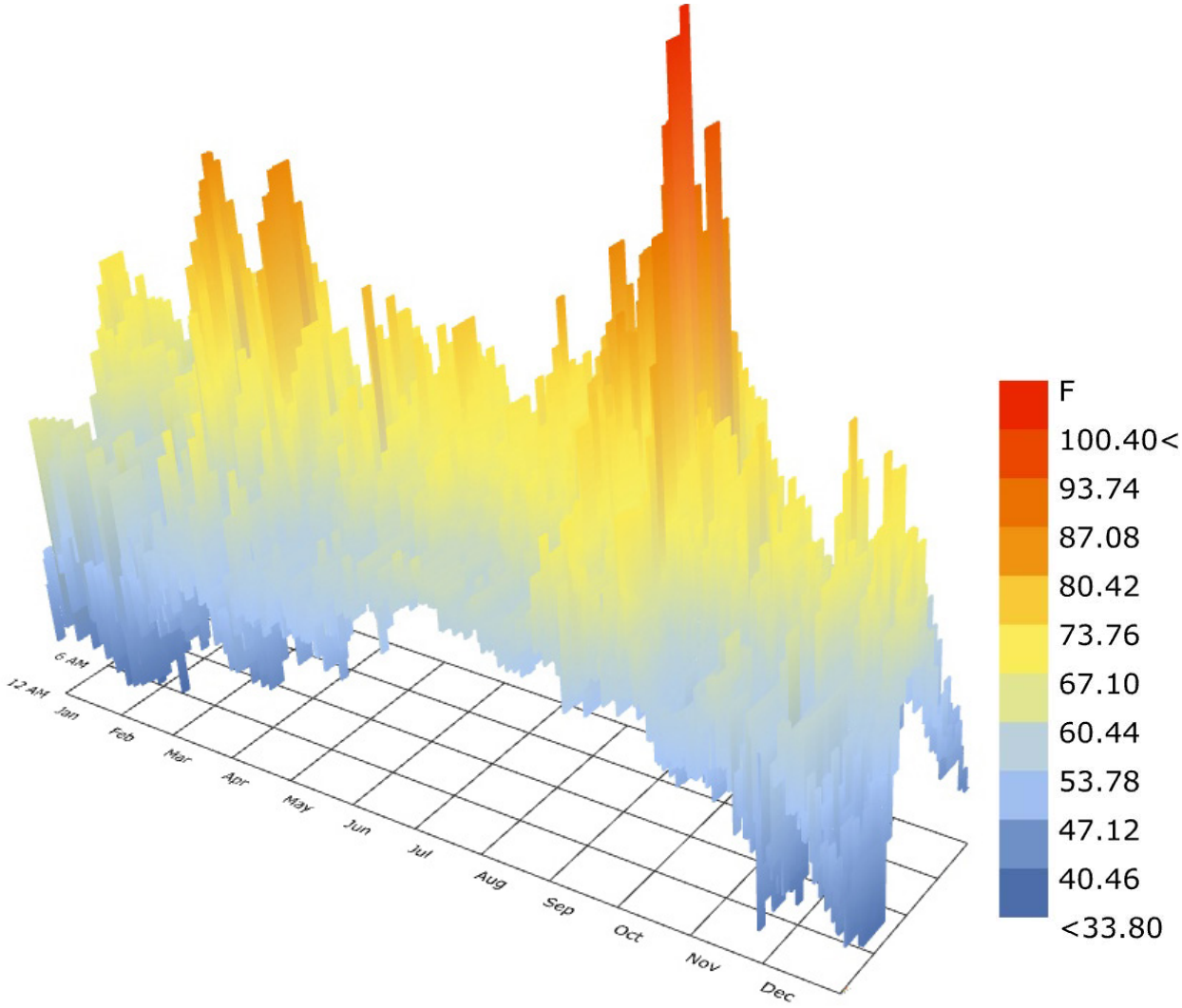
PASSIVE STRATEGIES

These charts examine several passive strategies that Beyond Zero employs. Each dot represents a day of the year – the blue dots are days that do not require the examined system. The red dots are days where the system is able to provide the most benefit to the occupants' comfort.



AVERAGE DRY BULB TEMPERATURE

The heating and cooling systems for Beyond Zero are designed to maximize the natural flow of thermal energy to the building and vent any extra unwanted heat.
Each regularly-occupied space has maximizd daylighting through light shelves and solar tubes which are able to increase daylight deep into spaces while having essentially no impact on energy use.
Classrooms were positioned on the Northern facade to maximize views and daylighting without glare while the Southern spaces are provided with ample overhangs to block intense summer sunlight. Eastern and Western spaces have vertical fins on their facade to counteract the sun's low angle in the morning and evening.
All circulation spaces are passively ventilated to create a more open social gathering space for the campus.



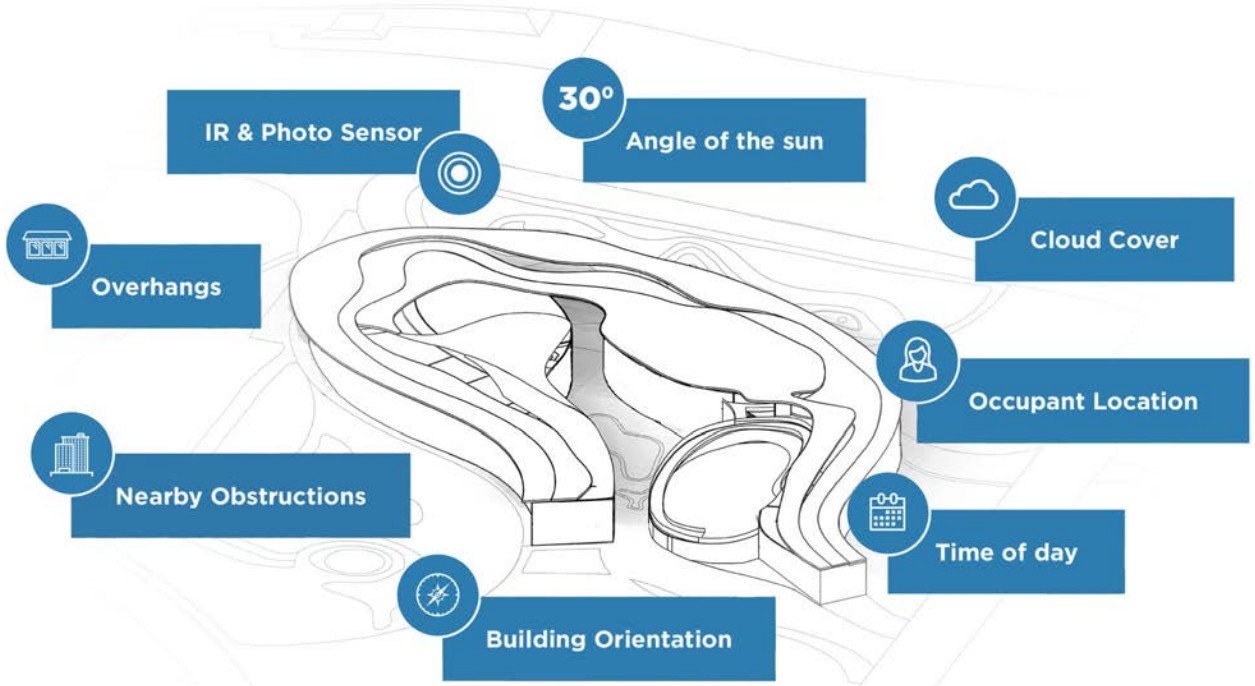
Illustrated Cross Section

GLAZING SYSTEM

view

How it Works

Intelligence gathers inputs to predictively control the space for increased occupant delight



View Intelligence® Uses:

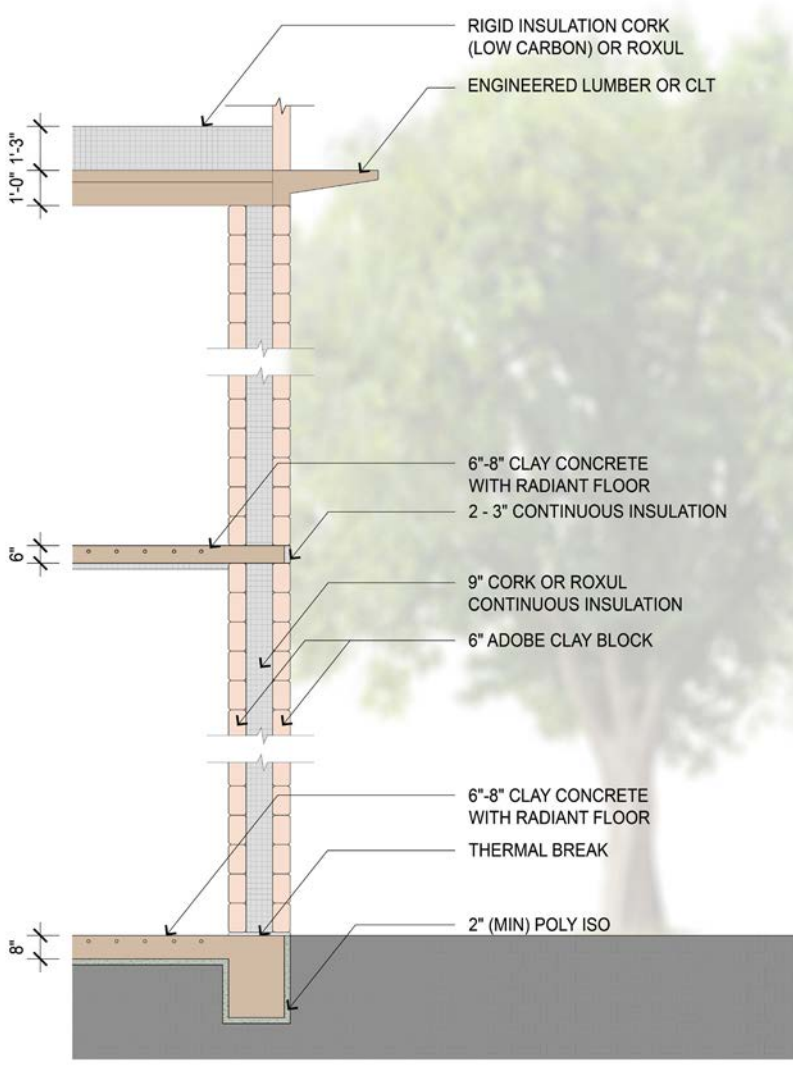
- Sun Angle
- Cloud Cover
- IR and photo sensor readings from the View Sky Sensor
- Weather Measurements
- Building Orientation
- Time of Day
- Overhangs and obstructions
- Nearby buildings and other external obstructions
- Occupant Location

View Intelligence® Uses:

The View Intelligence dynamic glazing system is aware of its surroundings and adaptively controls glazing tint to maximize daylight, minimize glare, optimize thermal comfort, and maintain beautiful views to the outdoors.

WALL SECTION

Monterey has a rich history of highly-performative adobe architecture. Distinctive structures such as the Larkin House epitomize this local style of Monterey Colonial architecture and have a wonderfully low carbon-footprint. Beyond Zero aims to take this technique and bring it into the 21st century, combining adobe block walls with engineered lumber systems that arrive pre-fitted and greatly reduce construction waste, requiring considerably less carbon to produce compared to steel or traditional reinforced concrete systems. The local clay-heavy soil helps to contribute to the low-carbon goal in the floor slabs where a carbon-sequestering clay concrete is used which additionally avoids the high-carbon-impact portland cement which takes a great deal of energy to produce. The thick adobe walls are able to store huge amounts of thermal energy. Throughout the day they work to absorb heat from the sun and then slowly release it throughout the night rather than relying heavily on HVAC systems.



DESIGN PERFORMANCE

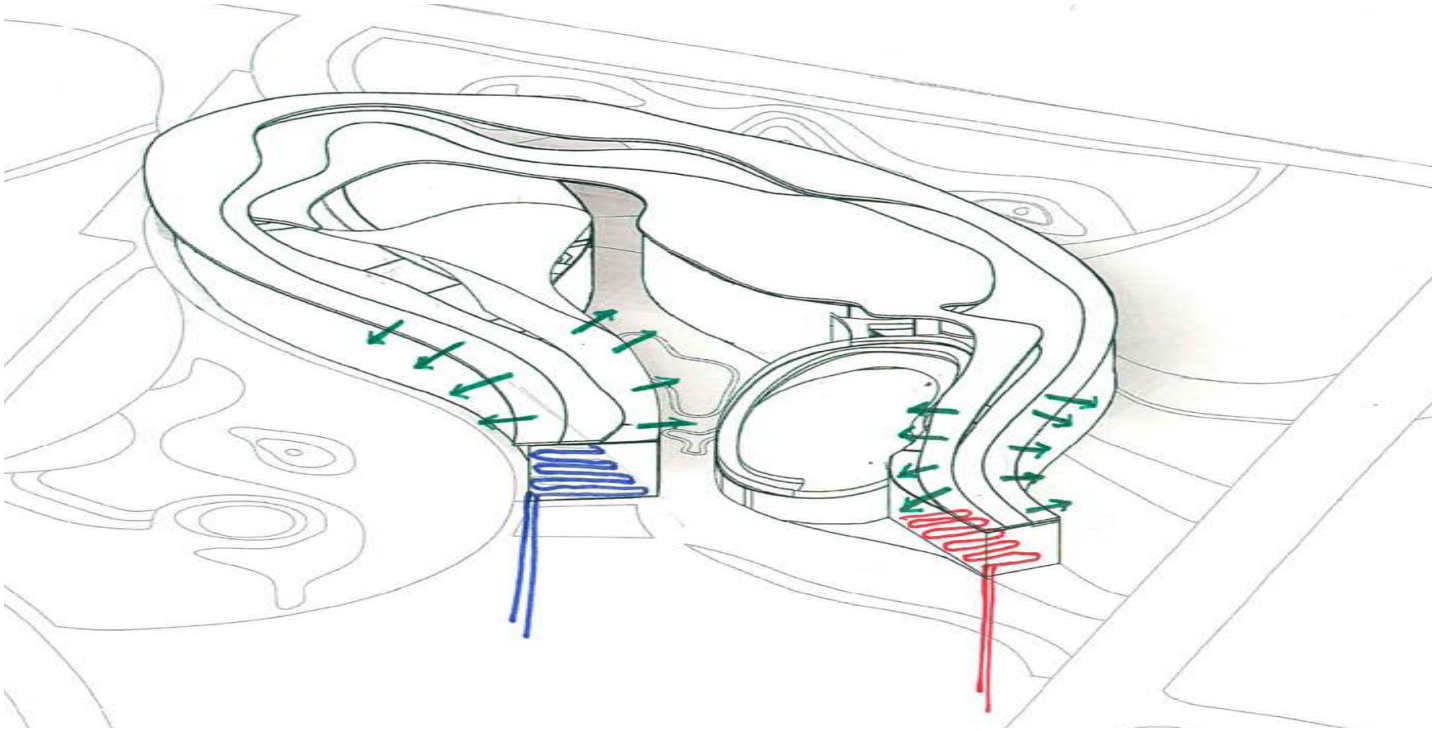
SOLAR PANELS

DC System Size	360 kW
Module Type	Standard
Array Type	Fixed (open rack)
Array Tilt	20°
Array Azimuth	180°
System Losses	14.08%
Inverter Efficiency	96%
DC to AC Size Ratio	1.2

To achieve net–positive the building is heavily relied upon photovoltaic panels for renewable energy generation. 15% Surplus was assumed as per Living Building Challenge requirement over the estimated energy use. The PV is proposed over parking spaces. It serves as a dual purpose. It does not take up useful roof area and provides shades to parking thus reducing heat island effect. The site does not have any parking; hence PV panels are proposed on neighboring parking lot and "lot 59" oriented towards the south at a 180° azimuth angle and a 20° solar angle from horizontal for optimal production. Overall Energy Generation Intensity was estimated to be 100 KWh/ft2 and 1,531 kWh/Year per kW for Monterey climate. LG LG395N2W–A5 solar modules formed the basis of design, with calculated installed power density of 16W/ft2. An installed panel area of 36,000 ft2 covers the parking lot with. The total installed array capacity is roughly 360 kW. The calculated annual generation is 551,068 kWh. PVWatts was used to analysis the production capacity of the panels. Monthly and annual solar production at was generated from the online PVWatts tool (http://pvwatts.nrel.gov/).

ACTIVE SYSTEMS

Active systems are designed to support comfort in the hours which passive strategies cannot be incorporated. Low temperature radiant systems with dedicated outdoor air system for ventilation focuses on balanced, simple and low-grade thermal energy which provides maximum comfort.
Radiant systems provide the balance of the heating and cooling load. Social spaces use in-Floor radiant within the concrete slab to benefit from the high mass. Radiant systems are easily zoned by room, with programmable predictive thermostats for each space to respond to occupant requests. Night setbacks will be defaulted into the thermostat. Gymnasium and central court will have a wide comfort band (68°F-78°F). Temperatures are further set back by 2°F for weekends.



DESIGN PERFORMANCE

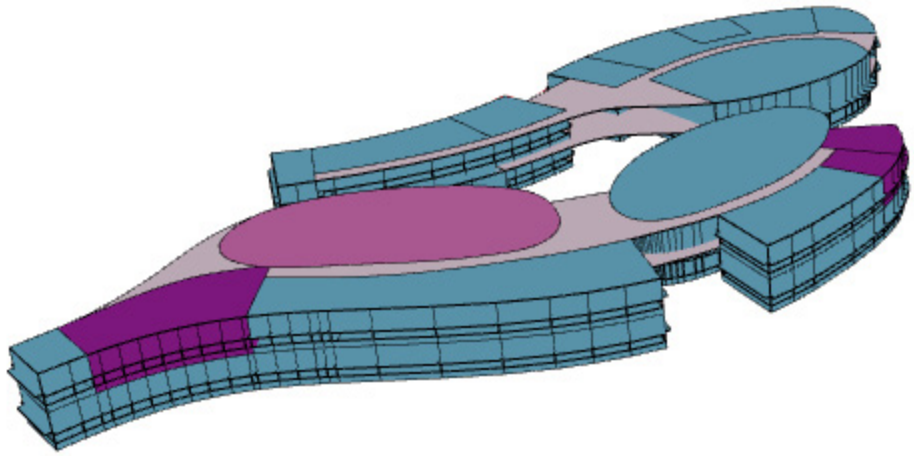
ENERGY MODELING

The building was analyzed using EnergyPlus with OpenStudio imported from Sketchup. All envelope performance was set to assumed values representing high quality construction that falls within standard high-performance buildings:

- Glazing: U-0.33, SHGC-0.25 (Dynamic glazing or Triple pane Fiberglass glazing units)
- Walls: R-30 effective
- Exposed Floors: R-30 effective
- Roof: R-40 effective
- Overhangs: thermally broken at tie-back
- Ground floor: R15 Insulation on perimeter and underfloor

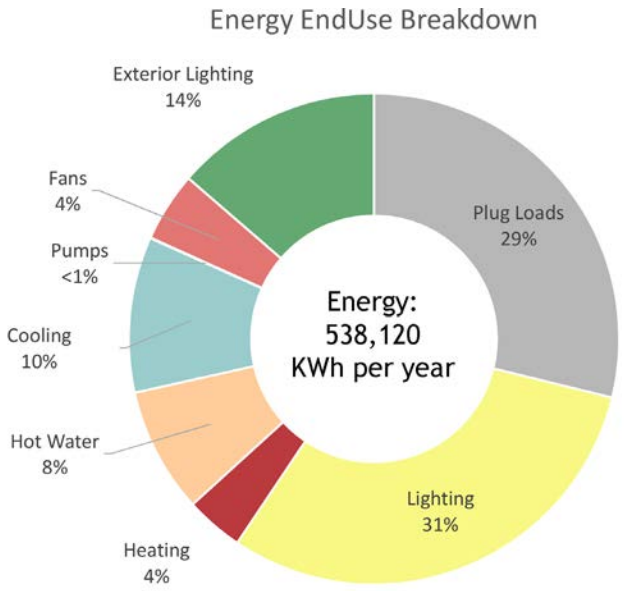
All conditioned spaces modeled as separate thermal zones with loads defined with appropriate diversity factors according to programming. The HVAC systems were modeled as District heating and cooling with multiplier of 1.2 and 0.98 respectively. There are no forced air fans other than the dedicated outdoor air power densities were set to 0.6 W/cfm, which was calculated using Greencheck energy recovery ventilators as a basis of design. The ventilation energy recovery ratio was set to 75%, which is consistent with premium ERV products. The Simulated EUI after multiple optimizations came out to be 22 kBtu/ft2 which is the median for recreational center. Overall Energy Generation Intensity (EGI) was calculated to be 26 kBtu/ft2, yielding a slightly positive annual generation.

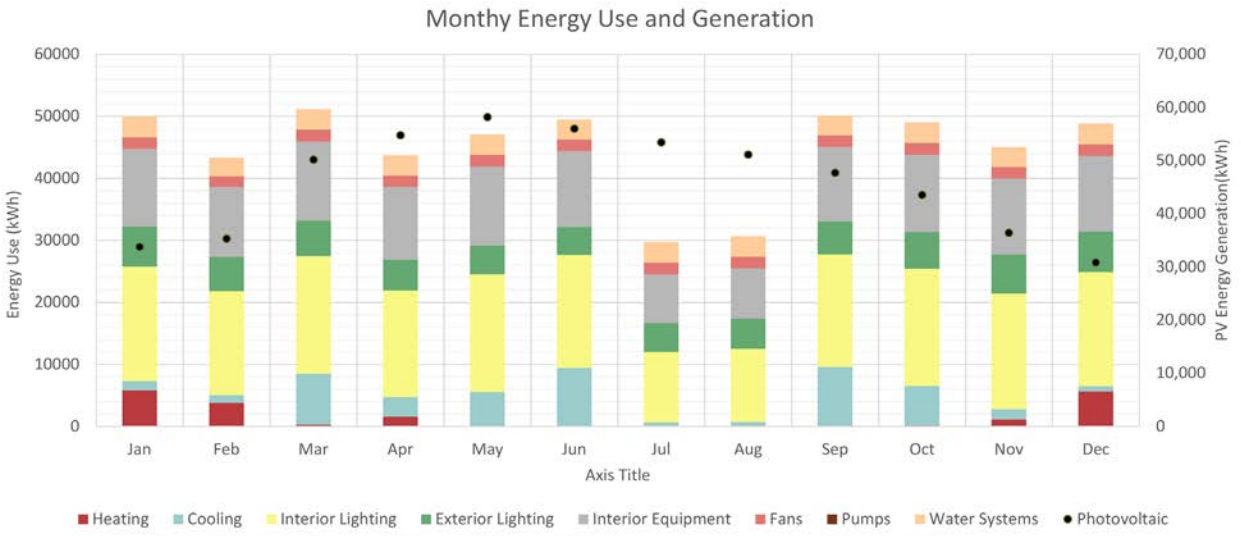
- Occupant Density: 400 sq ft/person 150 sq ft/person
- Plug Loads: 0.8 W/sq ft for classrooms, offices and labs, 1.2 W/sq ft for gym, cardio spaces.
- Lighting Power Density: 0.5 W/sq ft average.



MONTHLY ENERGY USE

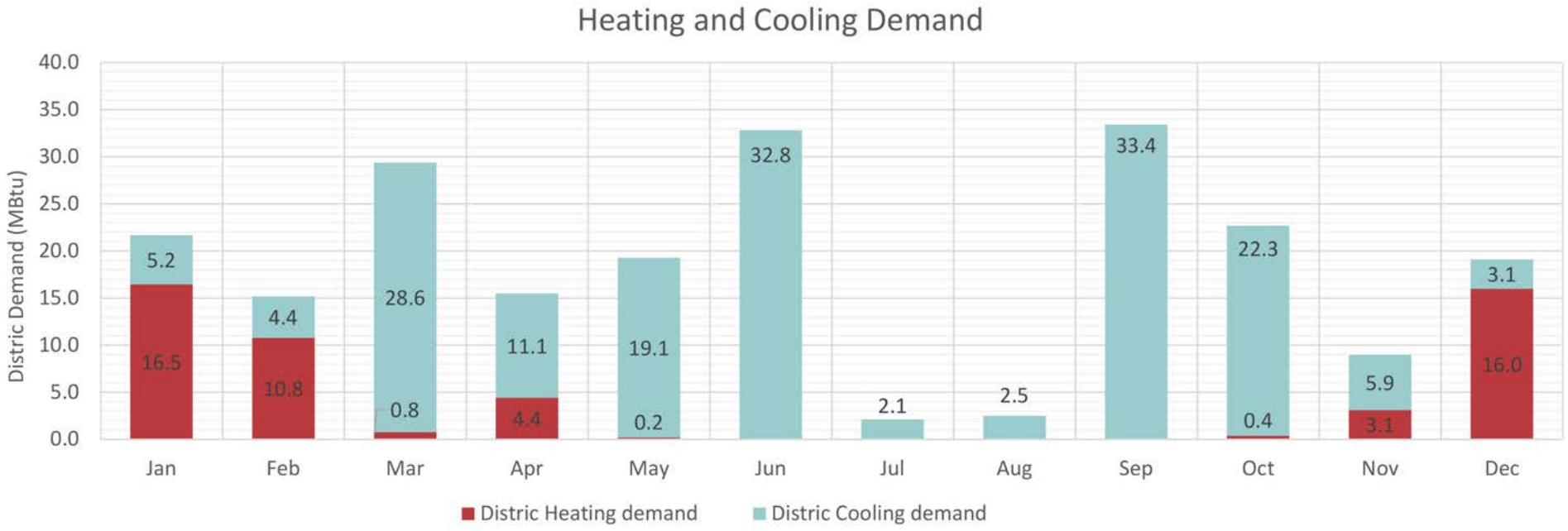
Lighting is optimized by daylighting and dimmable LED lighting to efficiently reduce lighting load. This also helps in reducing the peak connected load. Occupancy sensors are installed in common areas to disable lighting at night time. Electrical outlets will have occupancy sensors. Switches will turn off all non-dedicated loads, eliminating phantom loads.





HEATING AND COOLING

Ventilation is provided by dedicated outside air system with enthalpy recovery wheels. In floor radiant systems are provided for regularly occupied systems. Common areas like restrooms and lockers are conditioned via DOAS with Heat Recovery system (HRV).
The hydronic heating and cooling system are centralized and can integrate with the campus system or run on its own ground source heat pump. Domestic hot water heat is independently controlled via heat–pump water heat with demand control recirculation.



ANNUAL ENERGY CONSUMPTION