AESTUS

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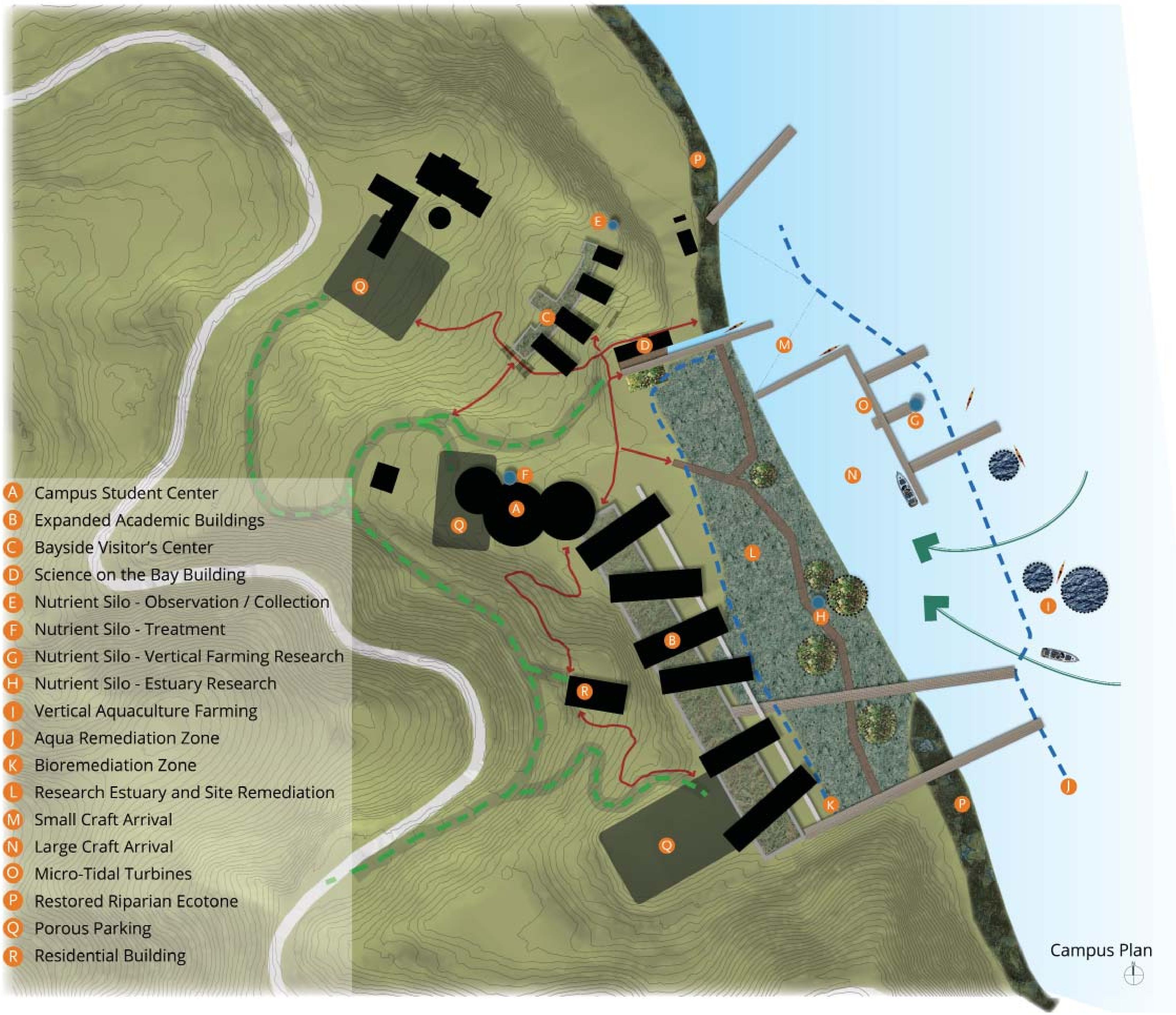
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H Nutrient Silo - Estuary Research
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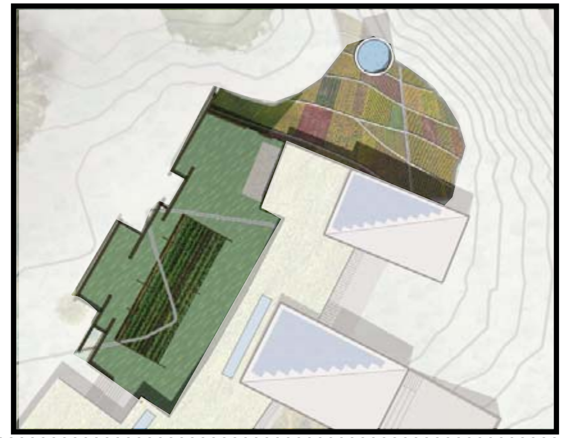
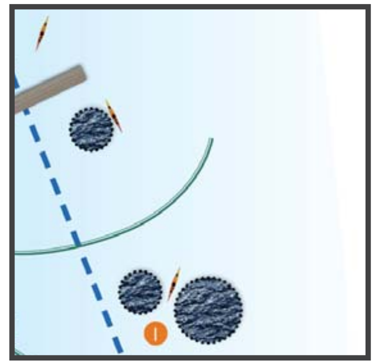
SITE



Edible landscape garden- evoking a renewal of an agricultural past, the naturally low sloped portion of the site is planted with native or locally adapted crops which support the on-site dining services. It is anticipated a program would also be developed around education to use the gardens as a teaching tool on proper growing practices and healthy eating and how this can support a holistic food-cycle which includes the water cycle. This landscape, along with the native plants in the restoration areas and on the roofs, also contributes to increase the site bio-diversity and natural habitats for local flora and fauna.

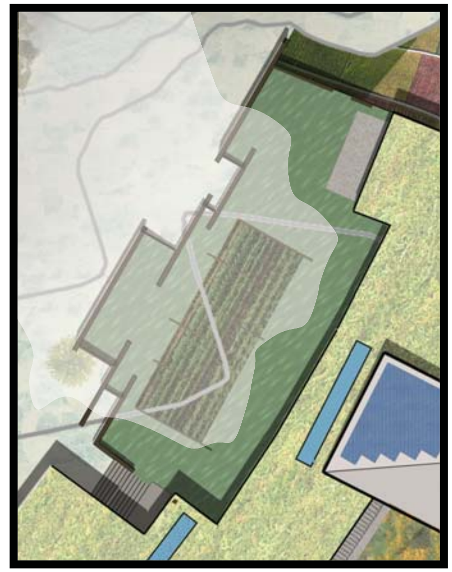


To further support the idea of the site as a factory for research, education and functional support, vertical farming aquaculture will be installed in the bay with the mission to create a new restorative and sustainable system of food production and distribution of sea greens, fish and shellfish. Using the principles of aquaculture, which is growing animals and plants in a water environment, the vertical farms operate “closed,” and “open” systems raising fish, multiple types of seaweed, mussels, oysters and scallops. These vertical farms not only provide food but they help clean the water by reducing the acidity levels while increasing biodiversity. From an education standpoint, aquaculture is a creative and productive way to understand biological cycles by observing how wastes become another’s resource for food or nutrients. The farms also provide significant non-edible benefits as well such as serving as a storm-surge protector and as a habitat for marine wildlife.

To assist in achieving regenerative campus design principles, parking for the Visitor Center and Science on the Bay Building, is relegated to the existing lot off of Paradise Drive next to the Bay Conference Center. The existing lot will be expanded to accommodate the anticipated visitors. The primary access to the Visitor Center will be through an immersive site path which weaves through the natural hillside with ample opportunities to experience the local ecosystem and expansive views of the bay. Alternatively, an all-electric shuttle bus will use the existing access road down into the campus to a drop off near the main entrance for those with accessibility needs or during inclement weather scenarios.

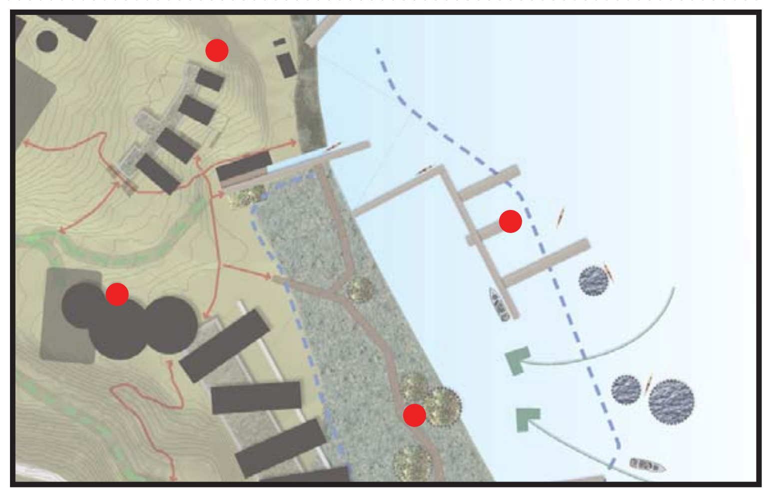
Additionally, with the goal for indigenous site reclamation, a campus estuary with tidal pools and phytoremediation plants will act as a campus bio-filter managing the hillside runoff as well as the incoming sea. The estuary becomes a vital research entity as a constructed wetlands for the larger RTC campus and becomes a vital habitat for reclaiming and nourishing sensitive plant and animal species.

WATER



Redwood forests in California receive approximately 30%-40% of their moisture from coastal fog by the way of fog drip. Knowing this and knowing that the project is in a region / state with significant water resource scarcities, strategically collecting and efficiently using as much available water is a priority. One strategy would be to take advantage of the naturally existing fog conditions of the bay and the natural phenomenon of cold, dense air flowing down the hillside. As designed, the building acts as a natural wind break of westerly winds traveling down the slope. A fog garden is designed on the upslope side of the building to capture the cool air and fog between the slope and the building. During fog conditions, expandable mesh fog scrims hung from cables would be opened to provide a condensing surface for the fog, with a collection basin at the bottom. This extra source of water would help supplement building and site water needs with a goal to move towards net positive water for the site.

To help support the capture, treatment and research of water throughout the site and campus, nutrient silo cisterns will be constructed as systems supportive, functional wayfinding nodes. Out in the ocean, within a naturally occurring upwelling, nutrient rich cold water rises to replace relatively warm surface water. The concept for the site is similar. Within the nutrient silos, nutrient rich and educational significant resources replace the depleted material input. Throughout the campus, four Nutrient Silos are designed and located to achieve the goals of collection and treatment of water, research observation and measurement, and vertical food supply gardens for research and use.



Additionally, rainwater collection is achieved on all roofs. The uplift design of the main roofs not only supports positive solar income collection but it also acts as a natural funnel, transporting the water falling on the roofs to secondary collection points which are then passively siphoned to a central storage and treatment nutrient silo cistern.

Working under the goal of reclamation, the building would also be piped to recover all greywater and blackwater from the plumbing and mechanical fixtures of the building. The effluent water would be treated properly and then re-used in the building to flush toilets and irrigate exterior green roofs and gardens.

MATERIALS

One of the goals of the project is to incorporate living building elements which contribute to a regenerative design solution while enhancing place and connection. A large part of this solution is to employ the right materials in the right way; essentially, having material solutions and applications grow from the place.

As an alternative to traditional concrete, the primary foundation and site wall construction will use Watershed Blocks – high-strength, low-carbon block material made with the on-site soil which will be dug out for the foundations. The block technology incorporates no colorants, dyes, or artificial pigments, just using the natural color and composition of the soil for aesthetic value. Further, the zero cement masonry which also uses lime, slag and natural aluminosilicates, will not require any harmful surface finishes or coatings.

To complement the site specific approach of the foundations, the primary structural material will be structural plastic lumber or SPL. Given the growing and detrimental problem of ocean plastic, we propose the SPL building components be comprised of 100% recovered ocean plastic, extracted from the bay and Pacific Ocean, helping to improve the very research area for the RTC. Versatile and durable, structural plastic lumber offers an alternative to treated wood and is ideal for heavy commercial coastal projects. This material performs especially well in extreme salt, sun, and corrosive type environments. It is waterproof, impervious to corrosion, non-leaching and toxin free and will be fully recycled at the end of its life. SPL is used as the primary and secondary elements for the roof, walls and cantilevered floors. To help structurally achieve the project's dramatic cantilevers, SPL components are designed as a composite vierendeel truss diaphragm to give spanning capacity as well as relevant seismic ductility.

The primary cladding material is acetylated western red cedar boards which will be installed as a rainscreen system. By detailing the façade with a rainscreen system, water is kept out of the building naturally. Additionally, with durability as a primary objective and given the wet and cool climate profile of the site, it is extremely important from a maintenance and long-term sustainability strategy to use materials that will last a long time with little maintenance. To accomplish this, the acetylated wood is used for all of the exterior wood applications. With a 50 year warranty and sustainable manufacturing method, acetylated wood will serve the needs of the project in the short and long-term. As a natural complement to the wood, all flat roof planes are covered in an intensive green roof system comprised of native living plant material which will naturally adapt to place throughout the life of the project.

Additionally, in an effort to minimize construction and resource waste and as a means to move the construction conversation towards a net positive waste stream, the buildings are designed on a two foot building module. With most standard and non-standard primary building components being fabricated in two foot increments, construction waste will be minimized. Further, all waste will be separated into technical nutrients, such as the SPL remnants which will be fully repurposed into future SPL, and the wood, which will be pulverized on site and used as nutrient fill for the garden soil.

FACADE

As an added benefit, the wood rainscreen design and installation exposes the grain edges of the wood cladding boards which facilitate carbon sequestration, thus helping, at least in a small way, to clean the air and lowering the carbon footprint for the project. Coupled with R-22 effective walls and phase change mats, the exterior wall system is designed to prevent water intrusion, eliminate thermal bridges and act as a highly insulated envelope.

As part of the building's passive ventilation system, the wood boards beneath the cantilevered floor are oriented perpendicular to help capture natural crosswinds, thus having the cladding act like breathable fins.

The concept of material biofabrication was also researched for the project and is partially implemented with the use of Mycelium Insulation for the exterior wall. As a mushroom based insulation, the material is grown rather than manufactured and has a competitive R value at R-3 per inch. This rigid insulation material is made from intertwining mycelium (root like filaments of a fungus) that are grown in agricultural waste materials (primarily seed hulls) under controlled conditions. The mycelium forms a foam-like material that insulates reasonably well and is installed like typical insulation.

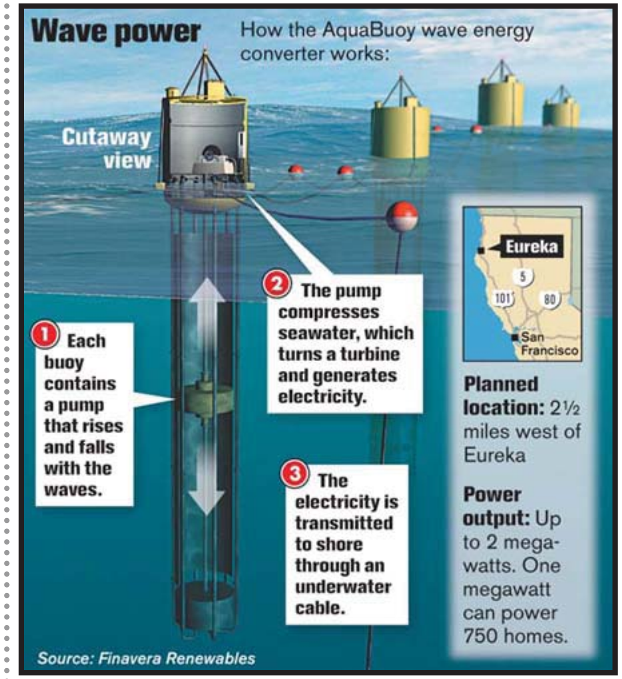
Pairing biophilic design with user-centric design, warm, natural materials are employed both inside and out to evoke positive visceral responses from the users. Locally sourced, clear sugar pine board will clad the interior walls and ceiling, providing for a warm, yet contemporary feel.

ENERGY NETWORK

The energy profile approach to the project is three-fold. First, and most important, is to inform, manage and inspire minimum energy use behaviors. Essentially, a holistic conservation approach while providing an elevated user experience. By minimizing energy consumption by the user (thus establishing the lowest baseline EUI profile possibly), this step is the most significant contributor to achieving net-zero goals.

Secondly, a high performance building with abundant passive energy features is critical. Within Aestus, the buildings are acutely oriented strategically to facilitate thermal gain (and control) when needed, as well as, enhancing the harvesting of wind coming from the west. As another passive design element, the program mass is broken into individual buildings that setup a shallow floor plate, thus assisting in daylighting and passive ventilation strategies. This orientation and massing also assists in setting up good views for all rooms.

Further, the buildings are designed under passive autonomy guidelines with no mechanical cooling or ventilation. Underfloor ventilation plenums and operable clerestories help to passive cool and heat the building. Also, the comfort profile threshold for the users is expanded with the concept of "Indoor Weather" which mimics and fluctuates with outdoor conditions and acts as a climate threshold in the main circulation corridor from the outside environment and the fully controlled building program spaces. Further, exterior "micro-climates" are to designed into the project along the south and east facing glazing elements. These micro-climates are setup with horizontal mass which tempers the air threshold by absorbing or releasing heat before the outdoor air conditions reach the glass. In essence, it sets up a tempered vertical air curtain.



As a compliment to the benefits of proper orientation, the building is designed under high performance guidelines. The walls are insulated to R-30 (R-22 effective) with an R-40 (R-32 effective) roof. The windows are triple glazed and implement electrochromic dynamic glass to regulate heat gain and glare.

Additionally, on-site renewable energy is necessary to create a balanced energy profile to get to net-zero. Building integrated rooftop PV is located on the south and west facing slopes of the main building roofs. The PV is calculated, along with passive autonomy systems strategy, to contribute more energy than is consumed. Thinking at a larger scale, to support a campus wide net-zero energy district, experimental and co-researched Micro-Tidal Turbines are anticipated to be installed within the structure of the existing dock piers and will contribute the entire energy consumption balance for the campus.

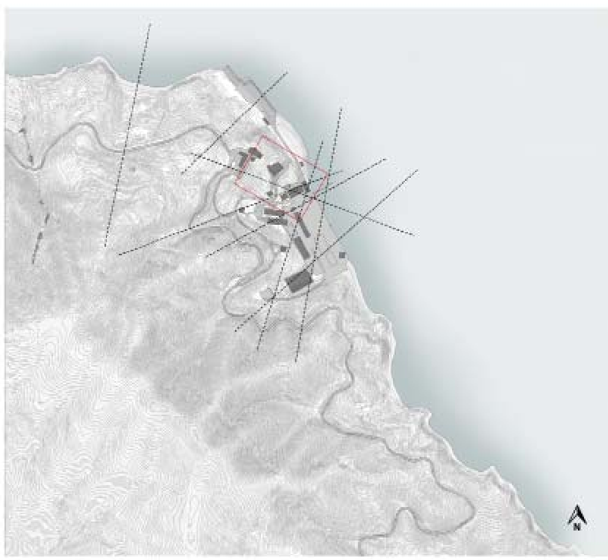
Lastly, phase change mats are installed on the warm side of the insulation of the exterior walls and roof. The phase change material, in combination with exposed mass floors, help achieve a more consistent temperature gradient across the interior spaces by capturing thermal energy during the day and to release that thermal heat at night when needed.

01 PLACE

SITE ANALYSIS_campus

solar path

water level rise - 50year

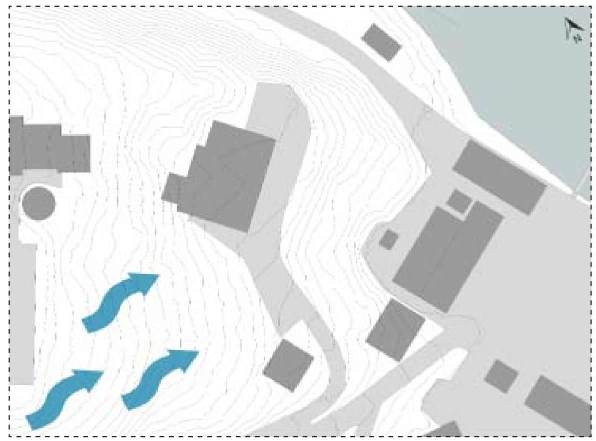


natural runnels

mountain runoff

SITE ANALYSIS_project site

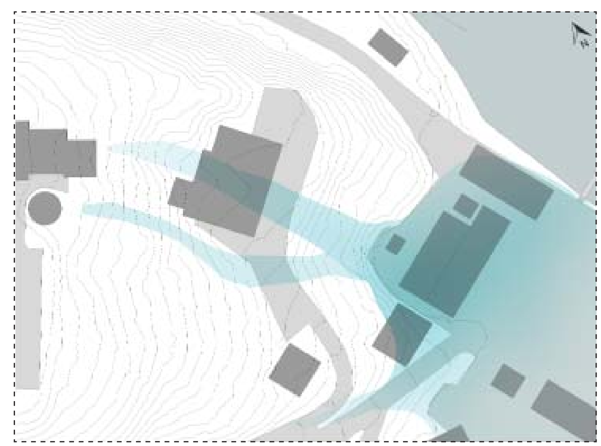
solar path


predominant wind flow

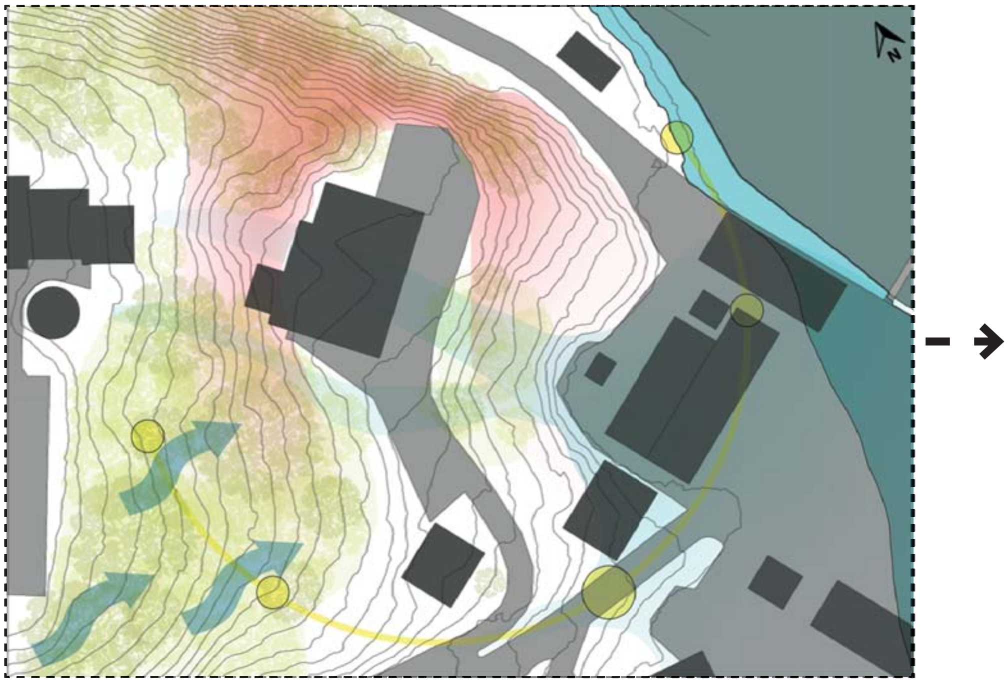

existing tree canopy to remain


slopes above 30 degrees

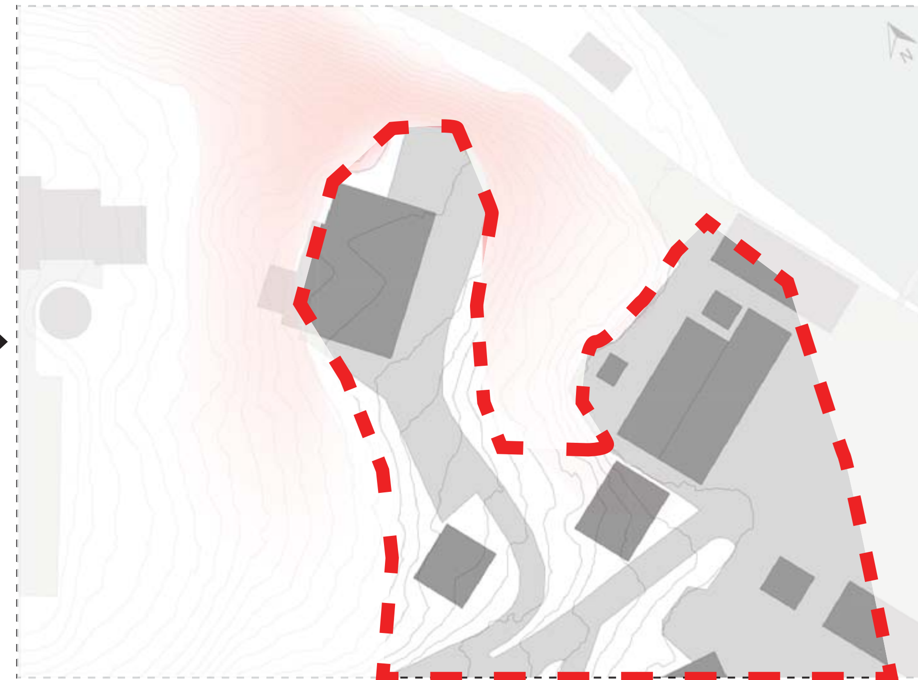

water level rise - 50year


natural runoff flows

SITE ANALYSIS OVERLAY_buildable area



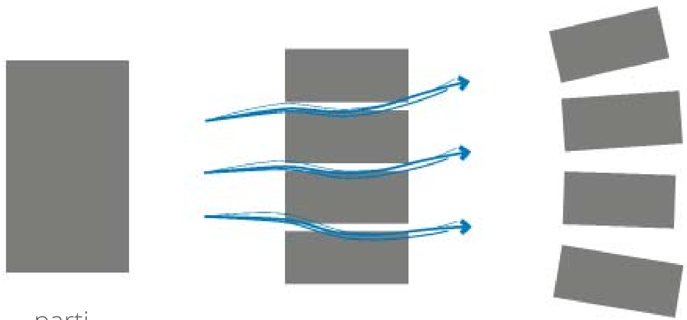
site influences overlay



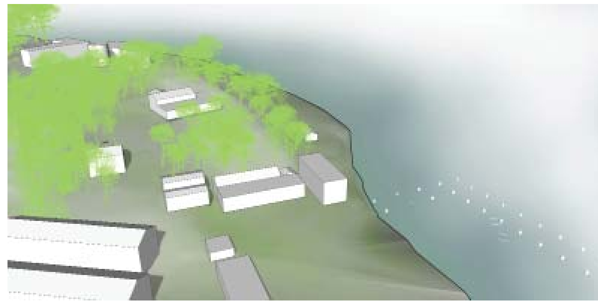
buildable area

02 DESIGN

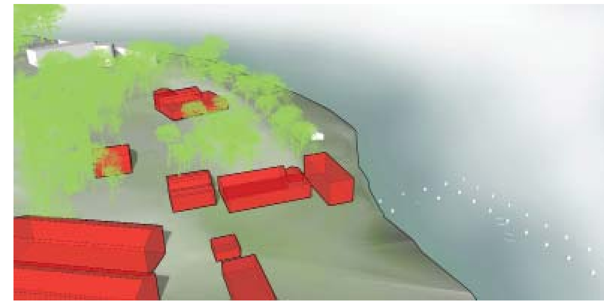
BUILDING FORM GENERATION



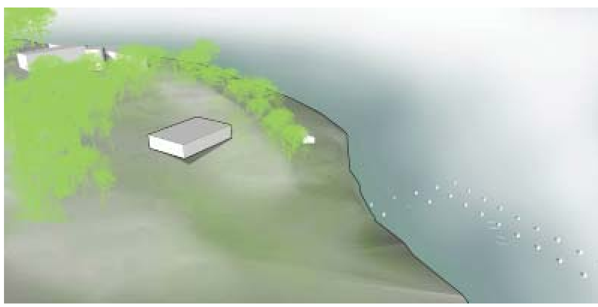
parti



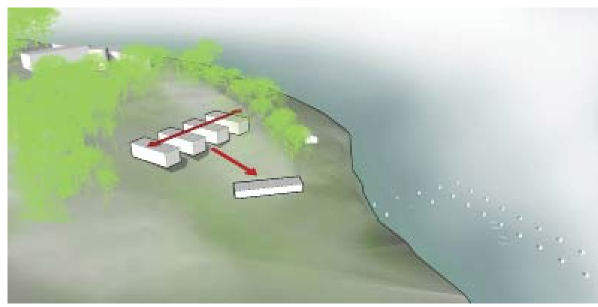
existing conditions



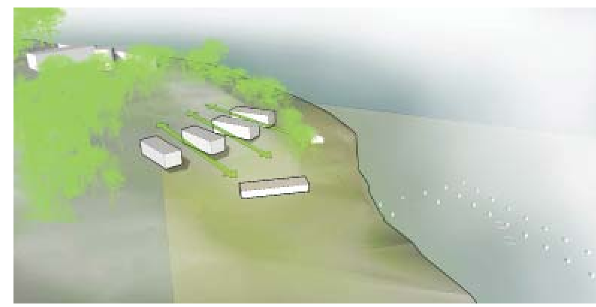
scheduled for demolition
existing buildings based on design competition brief



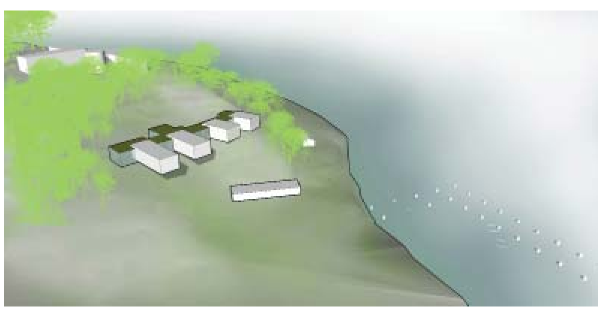
program box
general program siting



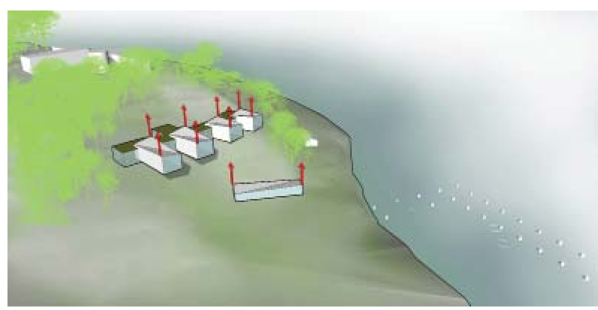
program allocation
group program into smaller components



flow articulated forms
program “fingers” oriented to views / natural site flows



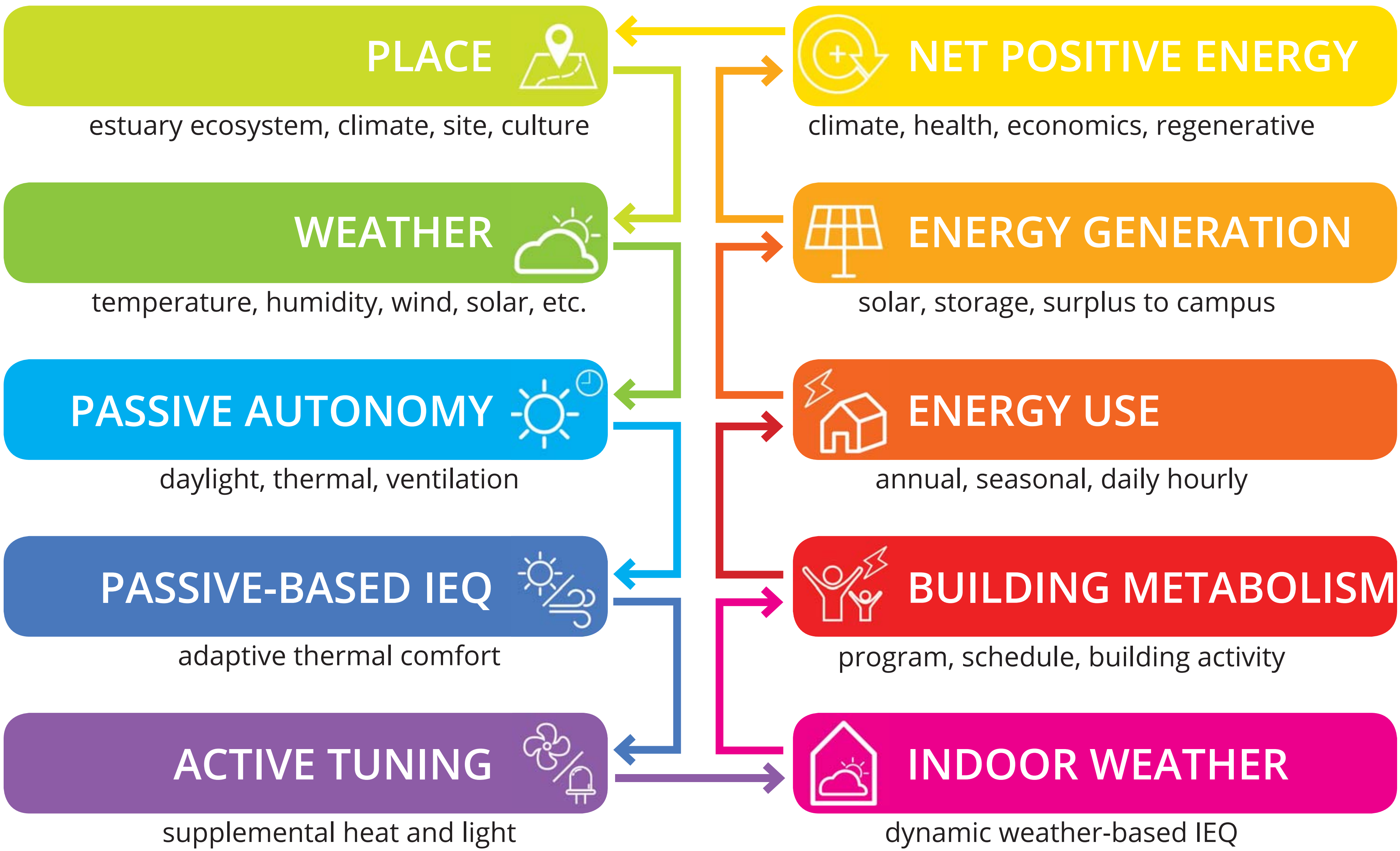
connective spine
1 story circulation integrated with contours



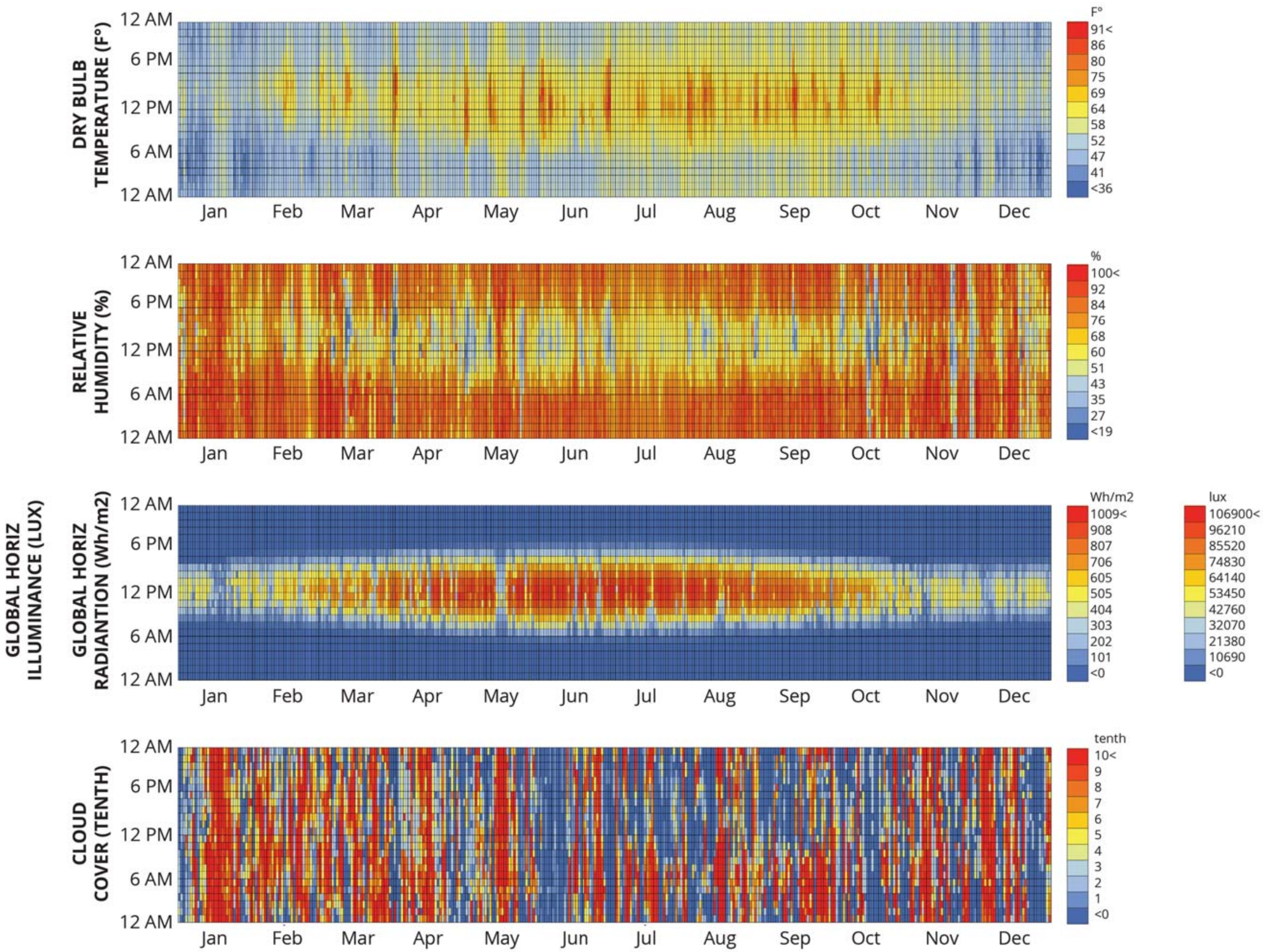
roof massing articulation
roof corners lifted to capture wind, water and solar income

site connections

03 SYSTEMS



NET POSITIVE ENERGY FRAMEWORK



ANNUAL HOURLY CLIMATE

PASSIVE AUTONOMY

Passive autonomy is the optimization of architecture to provide heating, cooling, ventilation and lighting for as many hours as possible through passive strategies and without the use of active systems. There are three main components of passive autonomy.

THERMAL AUTONOMY

DAYLIGHT AUTONOMY

VENTILATION AUTONOMY

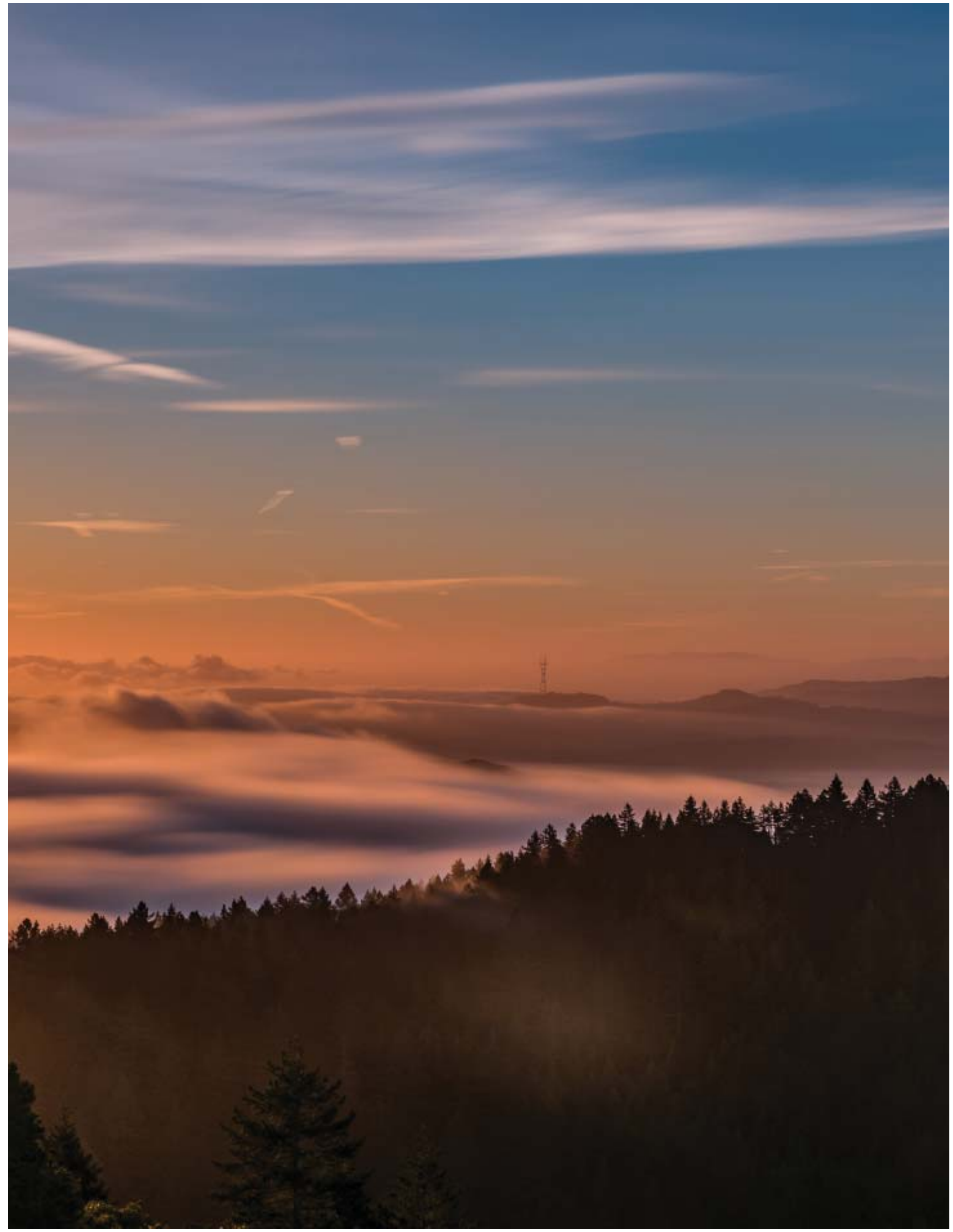
THERMAL AUTONOMY

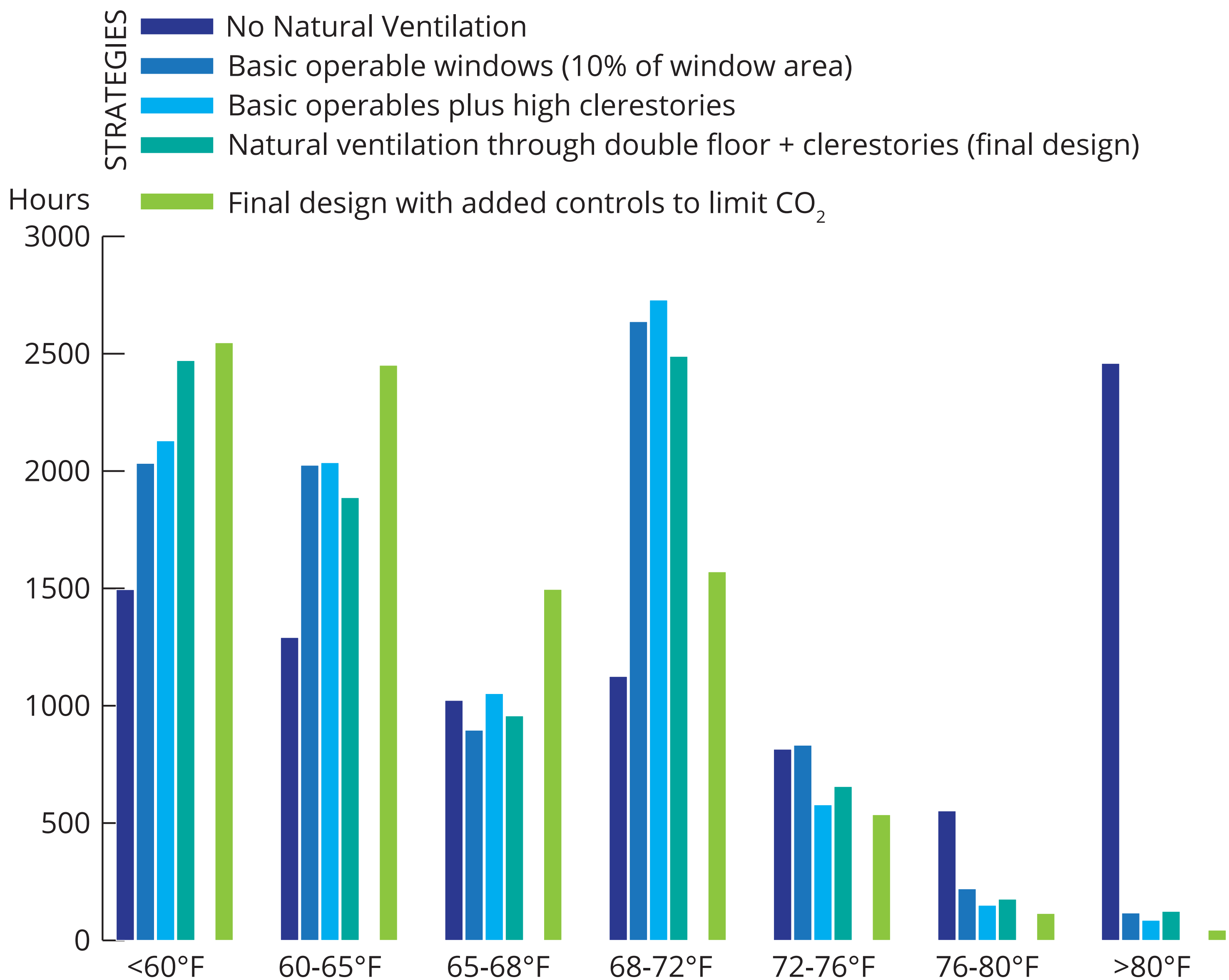
The project's passive design minimizes activing heating requirements and completely eliminates the cooling system. There are several key passive strategies used to maximize thermal autonomy.

- High-performance envelope (Wall U-0.046, Roof U-0.032, Fixed Glazing U-0.258)
- Dynamic glazing to reduce solar gain and to selectively allow passive solar
- Natural ventilation for passive cooling
- Thermal mass (concrete floors) and night flush (using predictive controls)
- Ceiling fans

We tested several different natural ventilation strategies to understand their impact on thermal autonomy and to dramatically reduce the number hours any zone in the building would be over 80°F. The addition of dynamic glazing virtually eliminated these over-heating hours. While we worked to reduce the hours any space would be under 60°F, it was not the top priority as we needed to provide an active heating system for comfort during periods of cold weather.

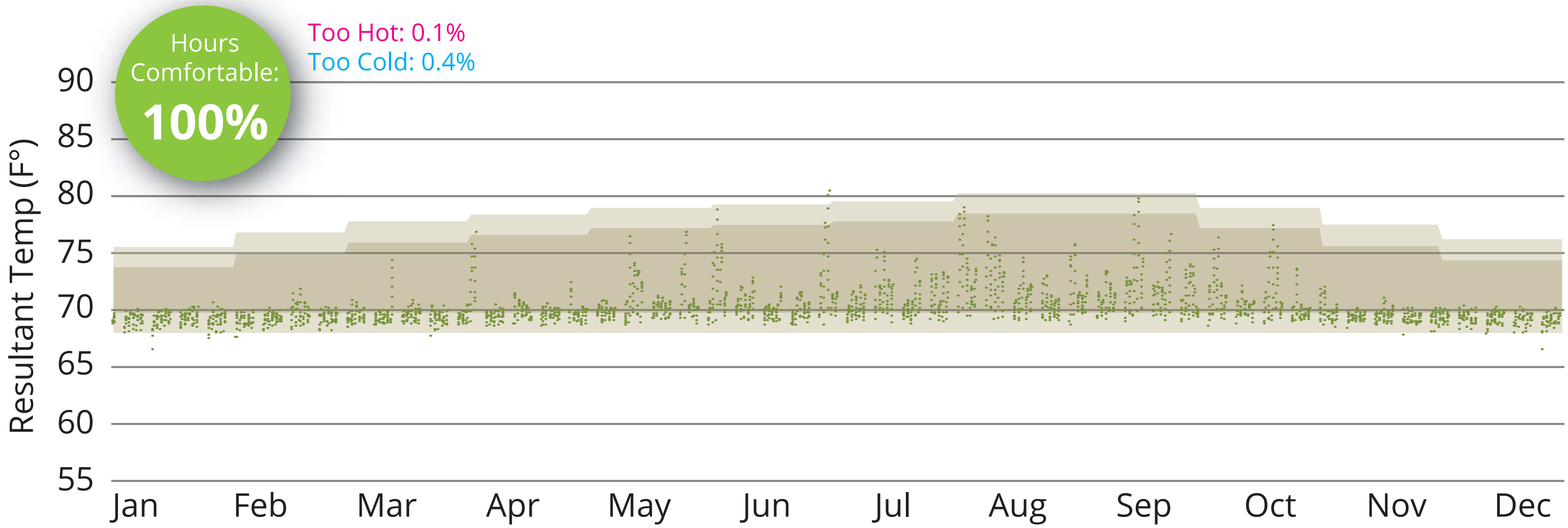
To maximize thermal autonomy and to eliminate the active cooling system an adaptive thermal comfort model is used. Internal comfort conditions reflect the seasonal (and in our case daily and hourly) weather conditions. Occupants are given many options to adapt the building to meet comfort such as ceiling fans, controlling the dynamic glazing, and opening a window. Also, there are options for the occupant to adapt their behavior to provide comfort such as clothing choice and migrating within the building to a more comfortable location. Our aim was more than just high comfort and low energy. It was to use indoor environmental quality as an occupant experience – or to provide thermal delight.



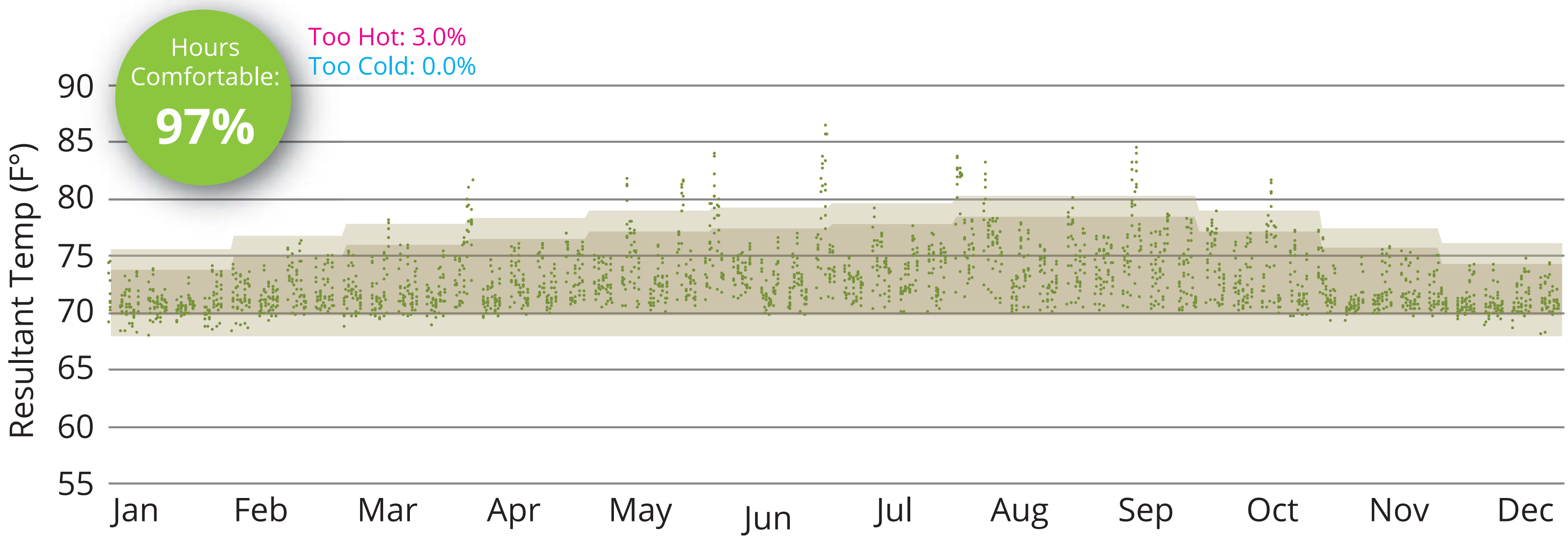


THERMAL AUTONOMY
NATURAL VENTILATION SCENARIOS

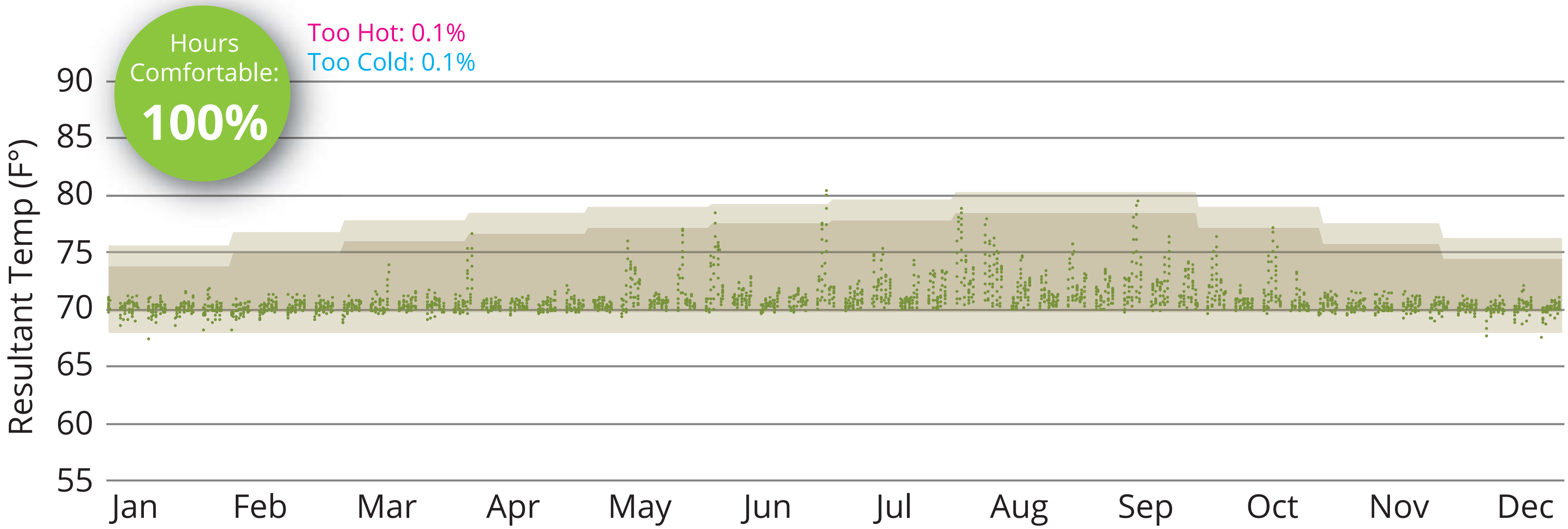
Model run without heating, cooling or mechanical ventilation



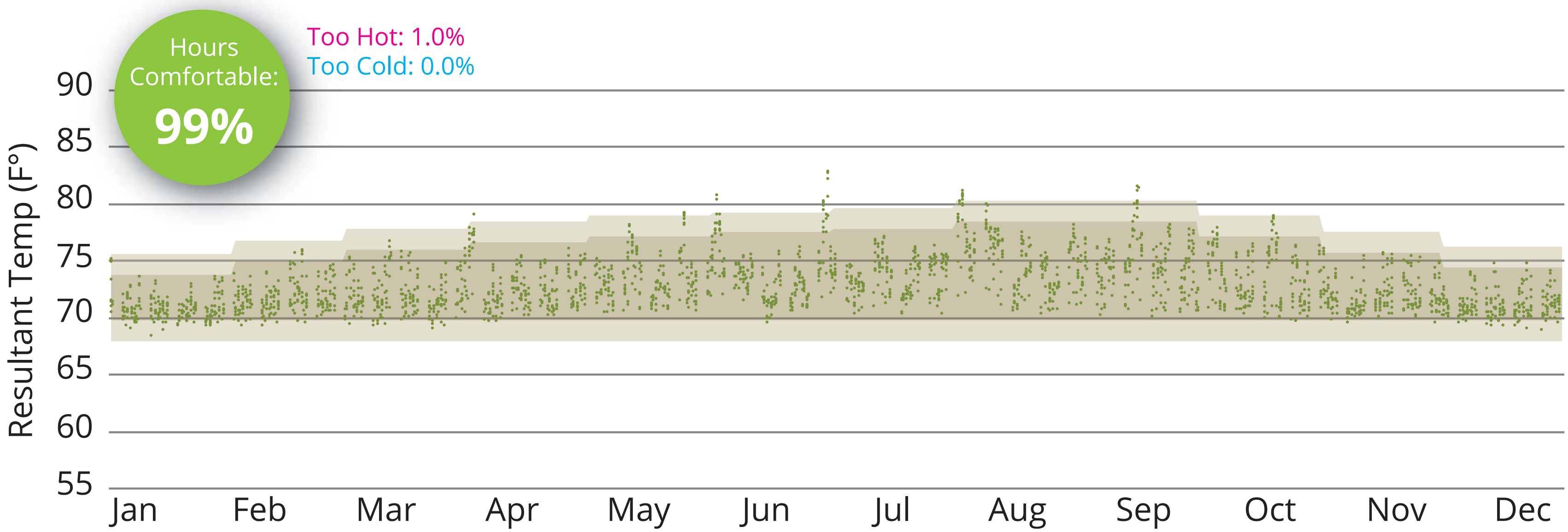
THERMAL AUTONOMY - CLASSROOM



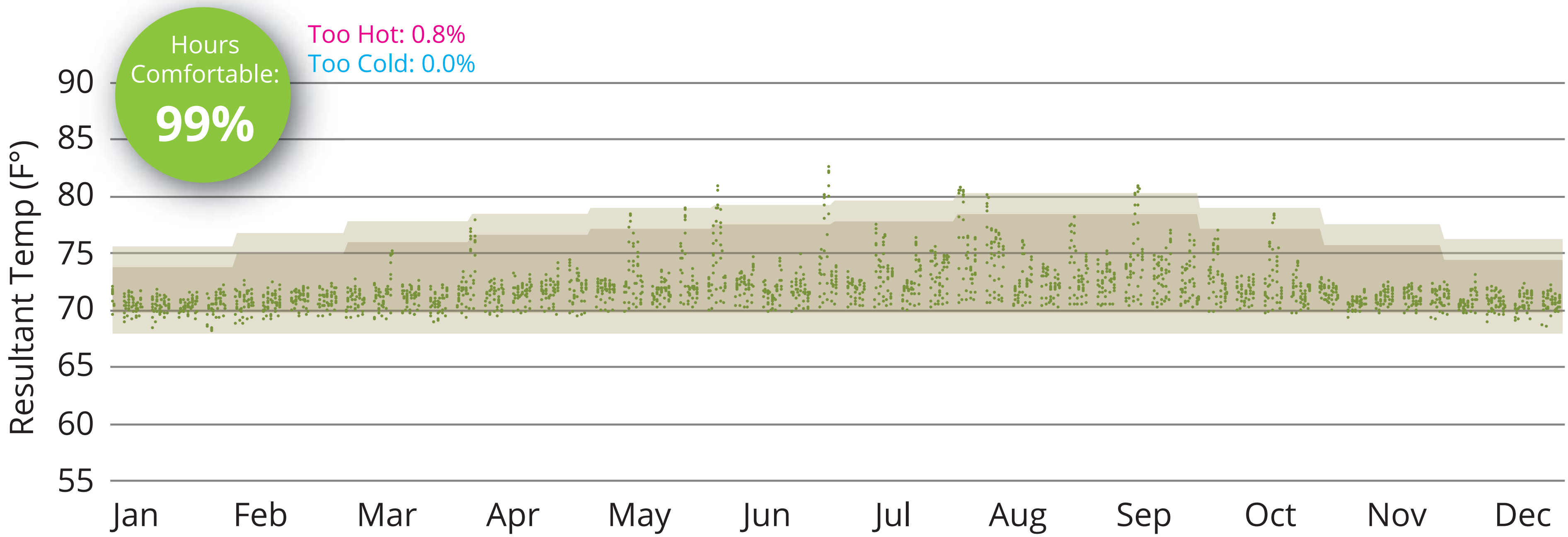
THERMAL AUTONOMY - CLASSROOM (PERIMETER)



THERMAL AUTONOMY - EXHIBIT



THERMAL AUTONOMY - EXHIBIT (PERIMETER)



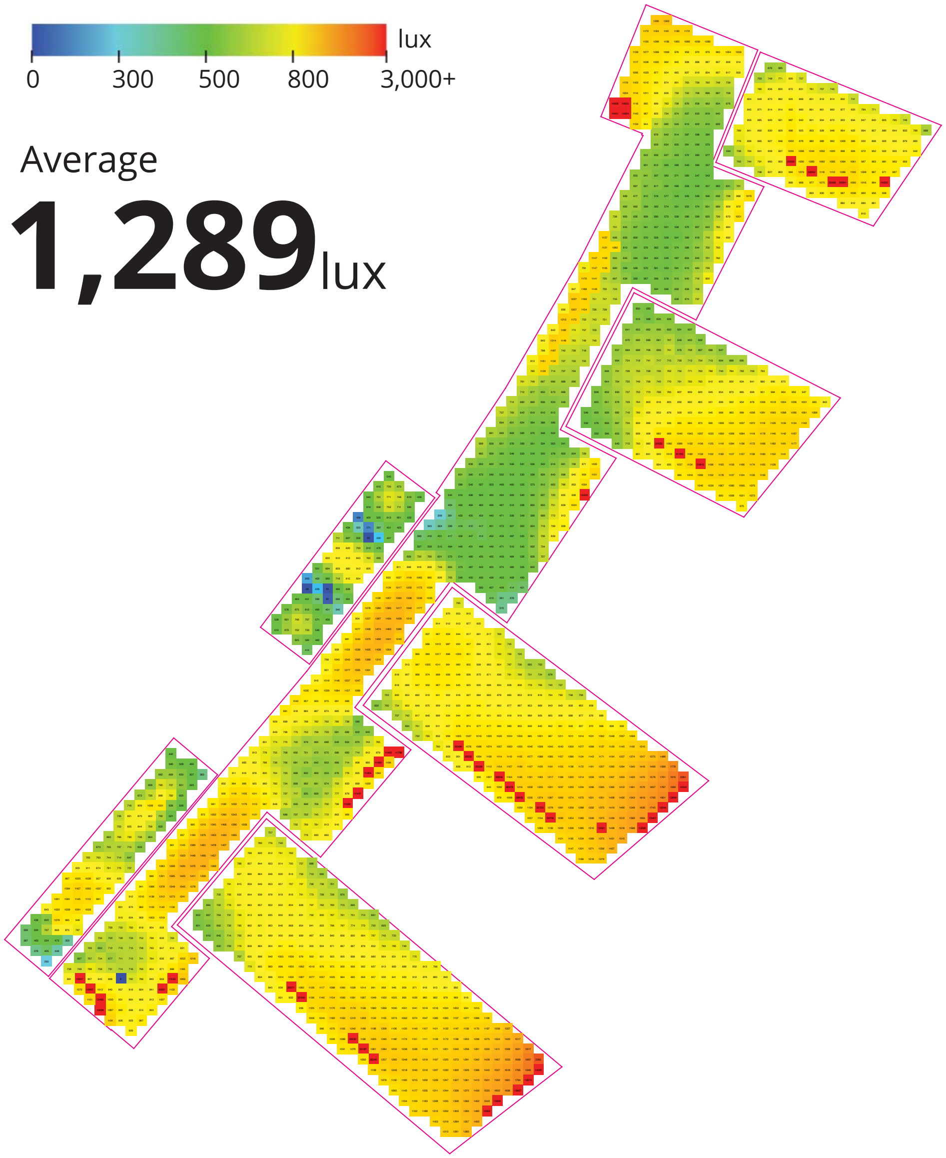
THERMAL AUTONOMY - LOBBY

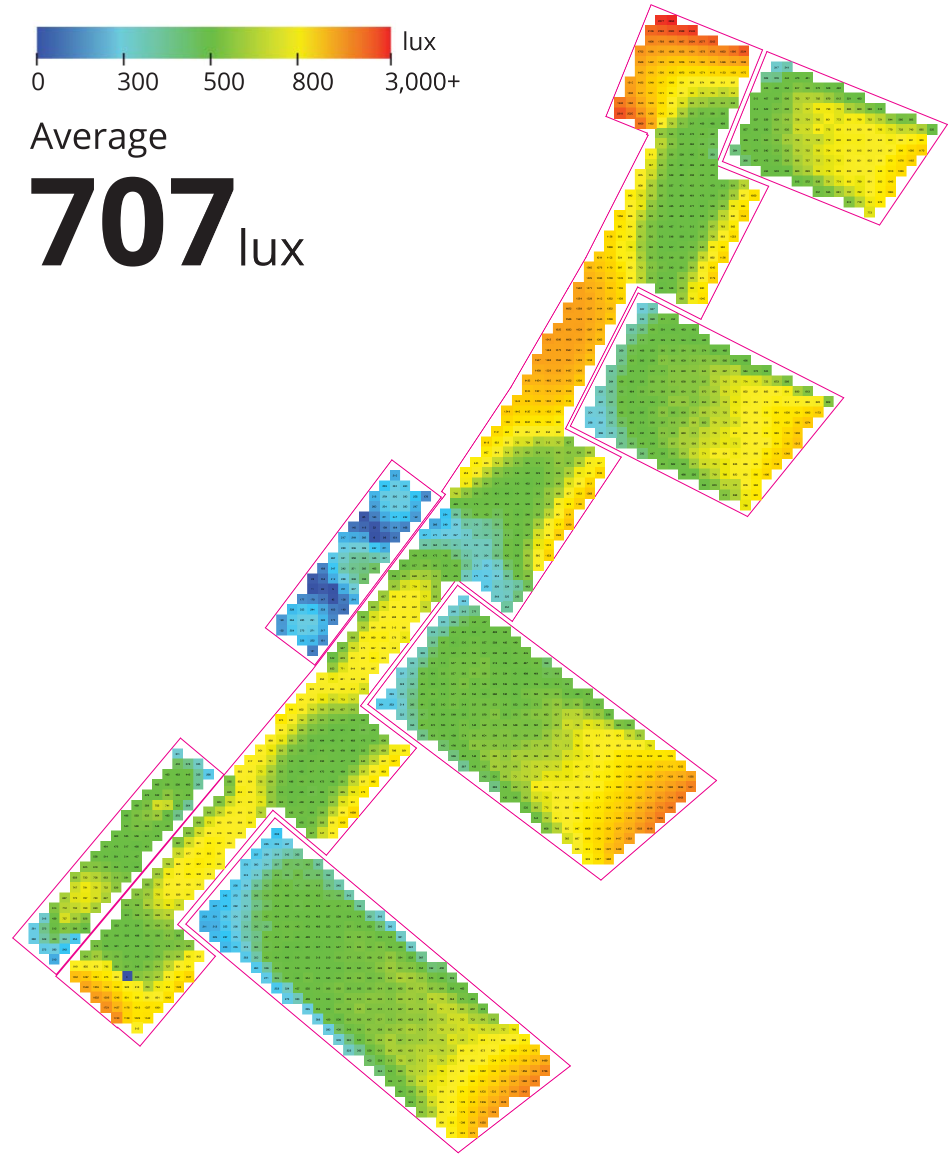
DAYLIGHT AUTONOMY

The project's massing and glazing design minimizes the electric lighting requirements with a very high degree of daylight autonomy. The seasonal change in sun angles and the steady mix of overcast and clear sky conditions created challenges in delivering year-round quality daylight. There are several key strategies used to maximize daylit hours.

- Narrow floor plates allow side-lighting
- Single story spaces allow top-lighting
- Dynamic glazing on key facades and skylights accommodates the wide range of external illuminance between overcast and clear sky conditions.
- No interior blinds are needed for the project.

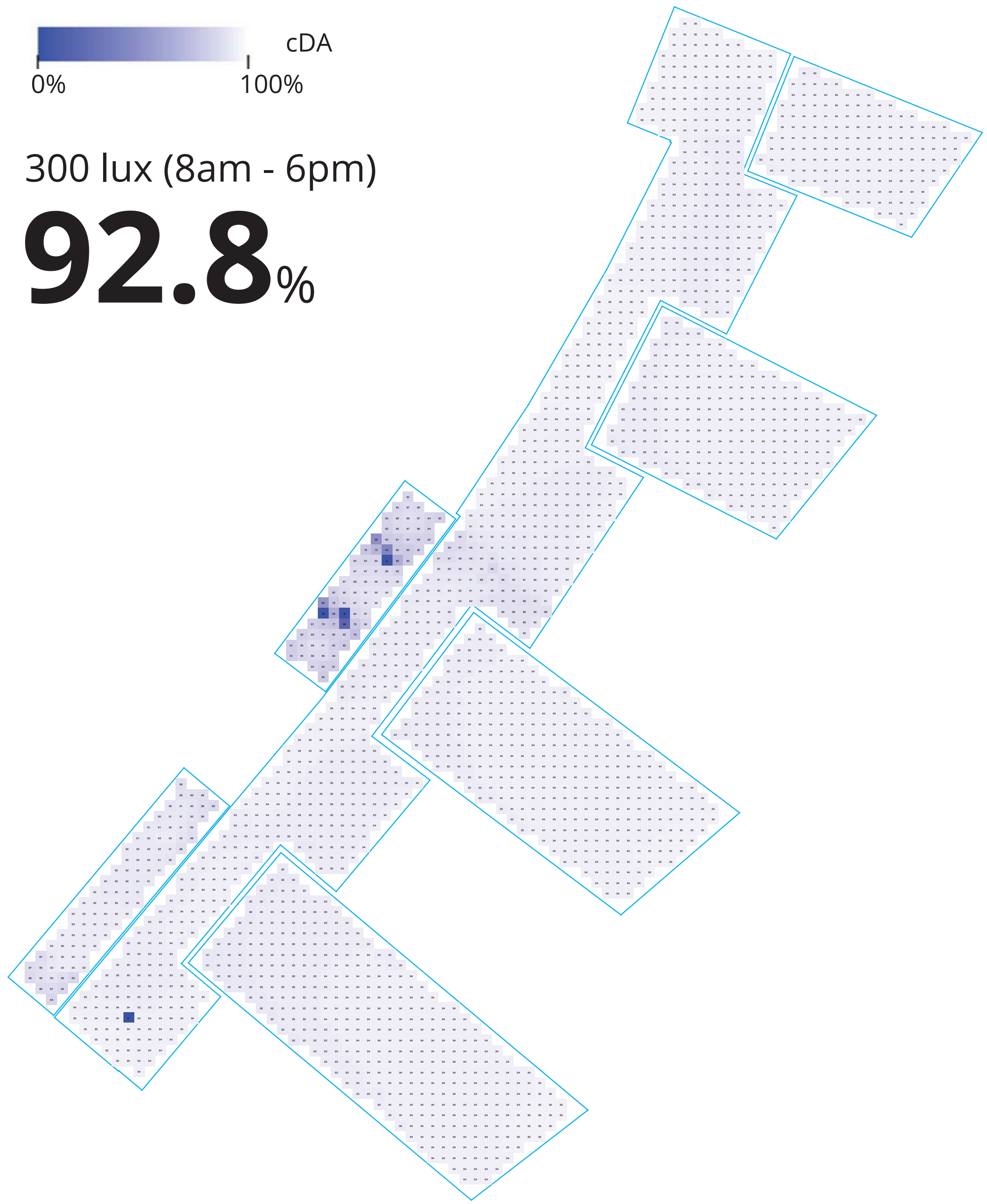
Because daylight is our primary source of space lighting the building's lighting levels will vary seasonally as well as daily in response to the available sunlight but are designed to stay uniform with good glare control.





DAYLIGHT SEPT 21, NOON, CLEAR SKY

DAYLIGHT SEPT 21, NOON, OVERCAST SKY

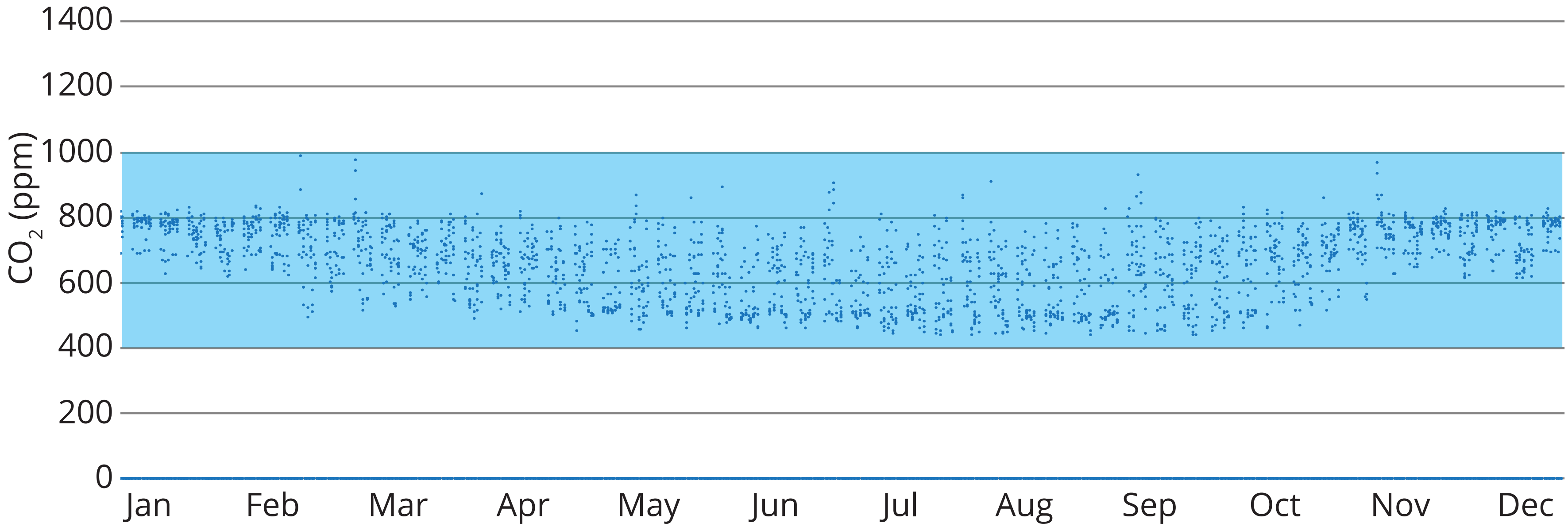


CONTINUOUS DAYLIGHT AUTONOMY

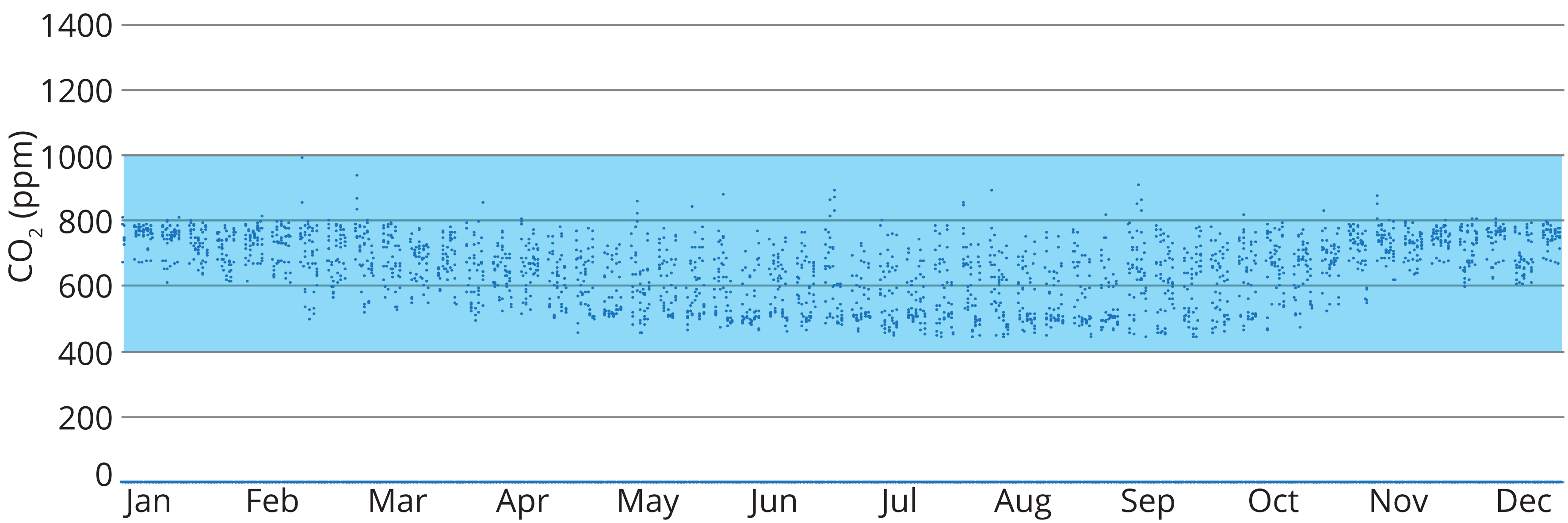
VENTILATION AUTONOMY

The building's massing, operable window design and integration of a floor plenum under the main program spaces minimizes the mechanical ventilation requirements and eliminates the need for traditional mechanical air system.

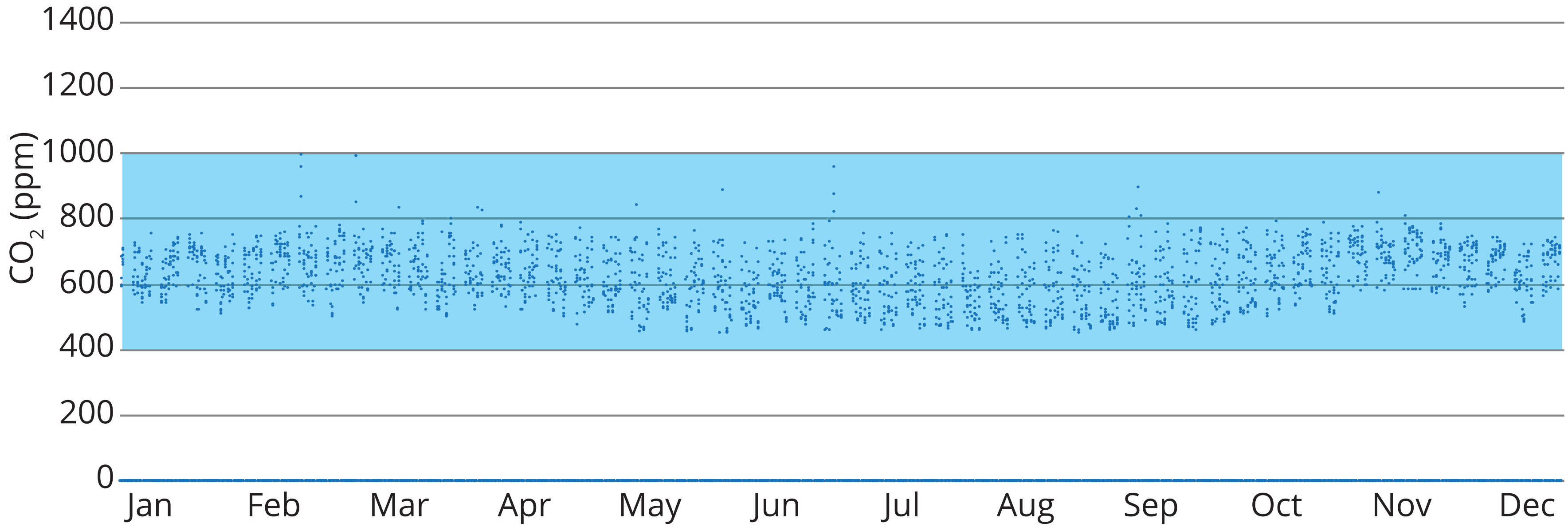
- The only fan-powered part of the ventilation system is the roof exhaust fans in the storage, restrooms and office, which pull natural ventilation from adjacent spaces with operable windows.
- The building's circulation spine is cross-ventilated with operable windows on each side.
- The main program spaces utilize a supply air louver (with damper) on the sea-facing edge of the building's cantilever that feeds fresh air into a plenum for supply into each space. A heating coil is also located in the ducted intake. Air is exhausted using operable clerestories for stack effect.
- The operable windows, the outside air louvers and the exhaust fans are all automated based on CO2 readings in each zone. The operable windows can also be manually operated.



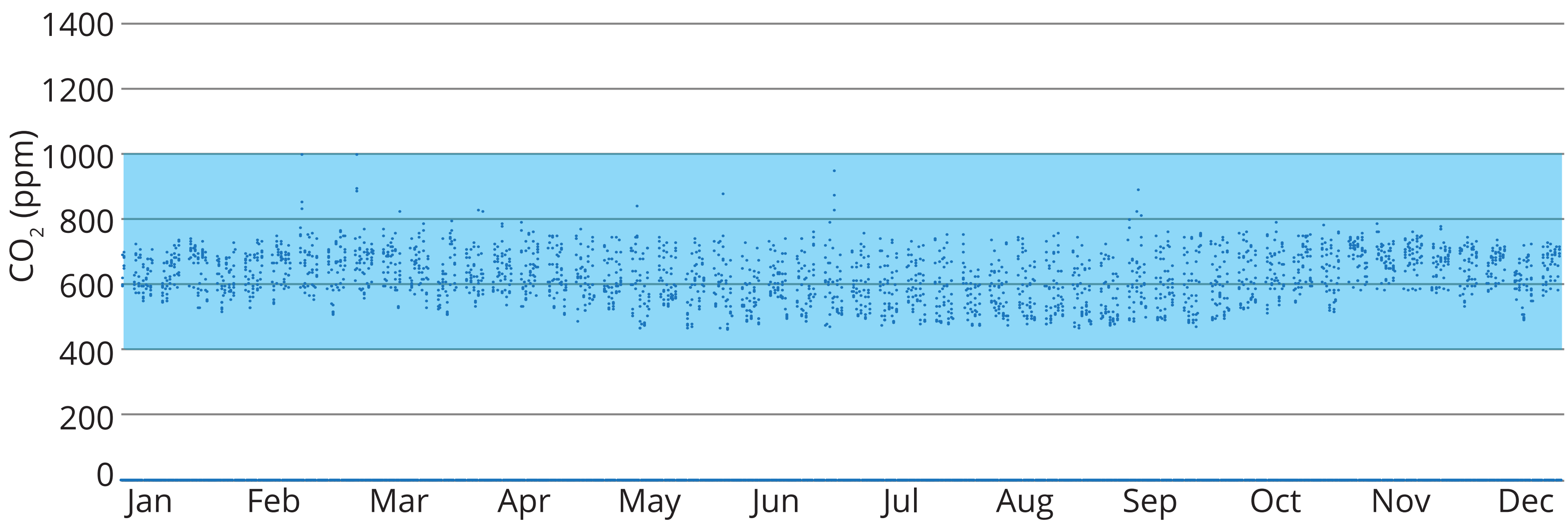
VENTILATION AUTONOMY - DINING



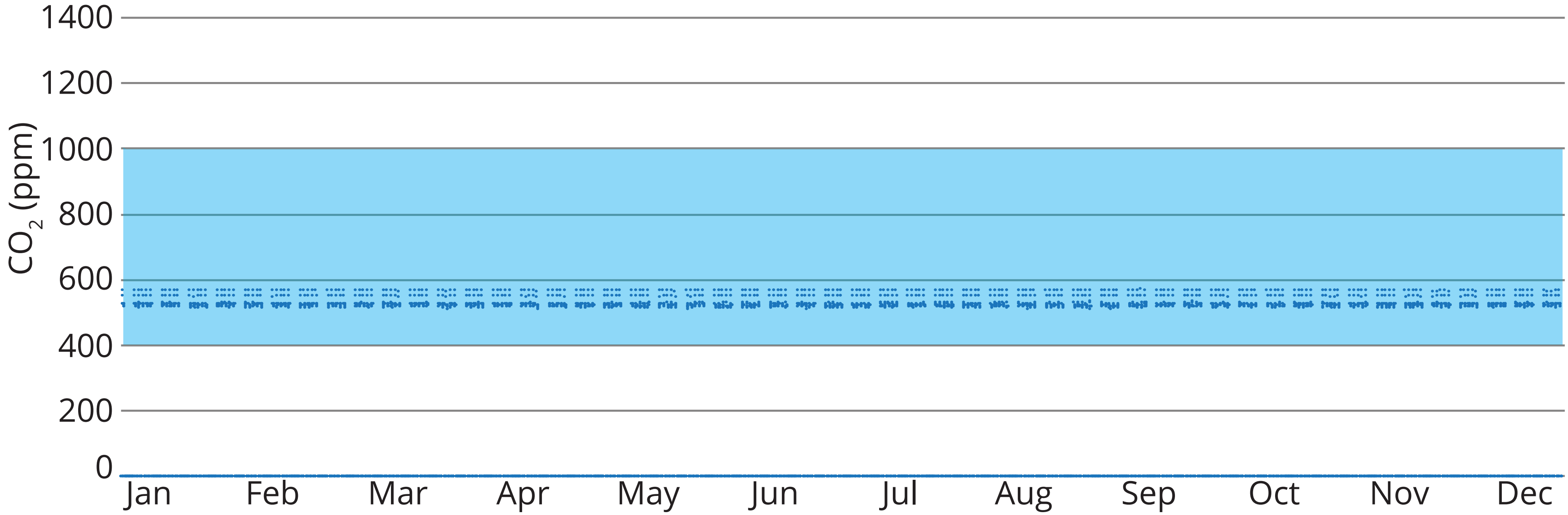
VENTILATION AUTONOMY - DINING PERIMETER



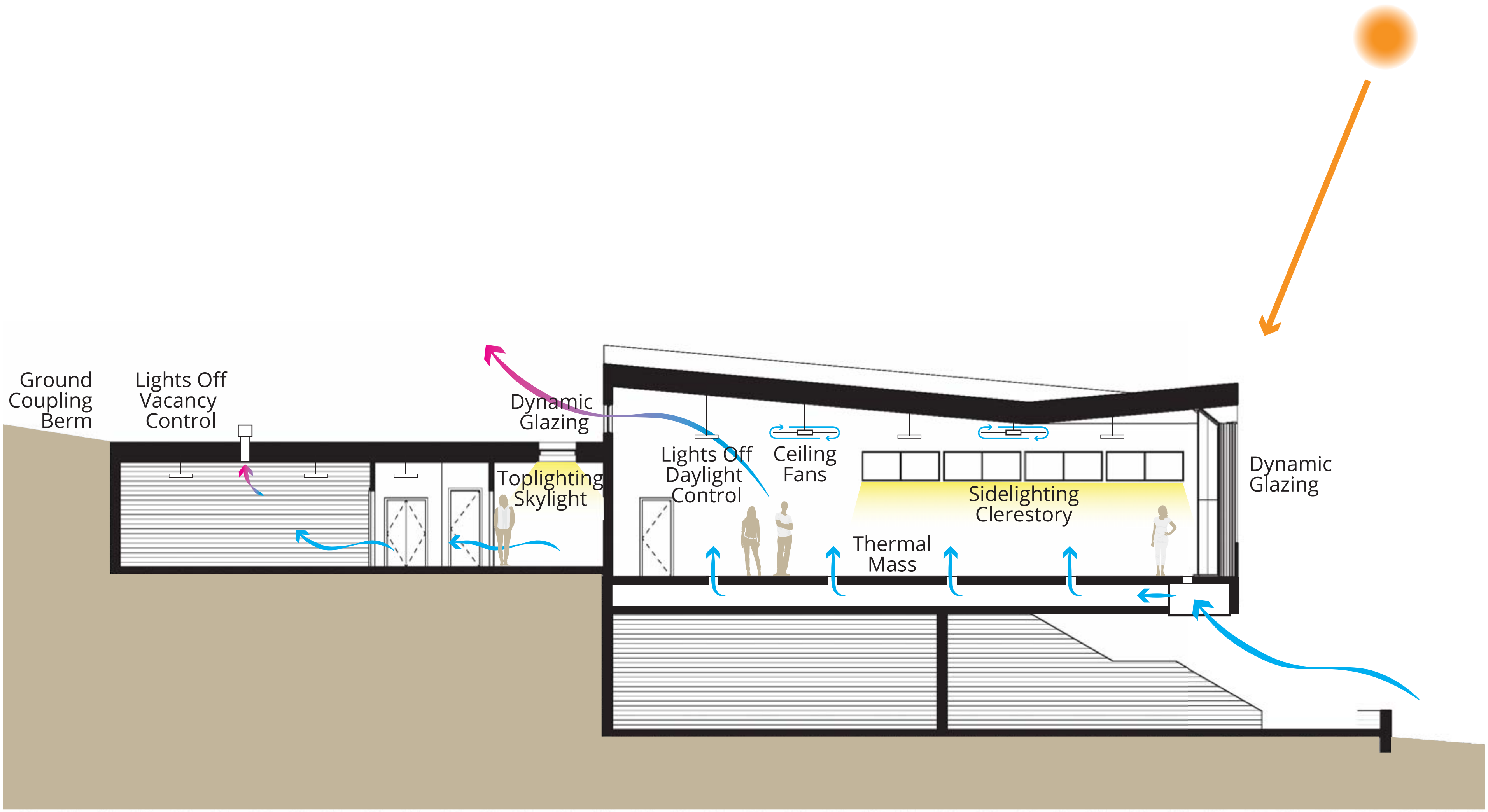
VENTILATION AUTONOMY - MULTIPURPOSE



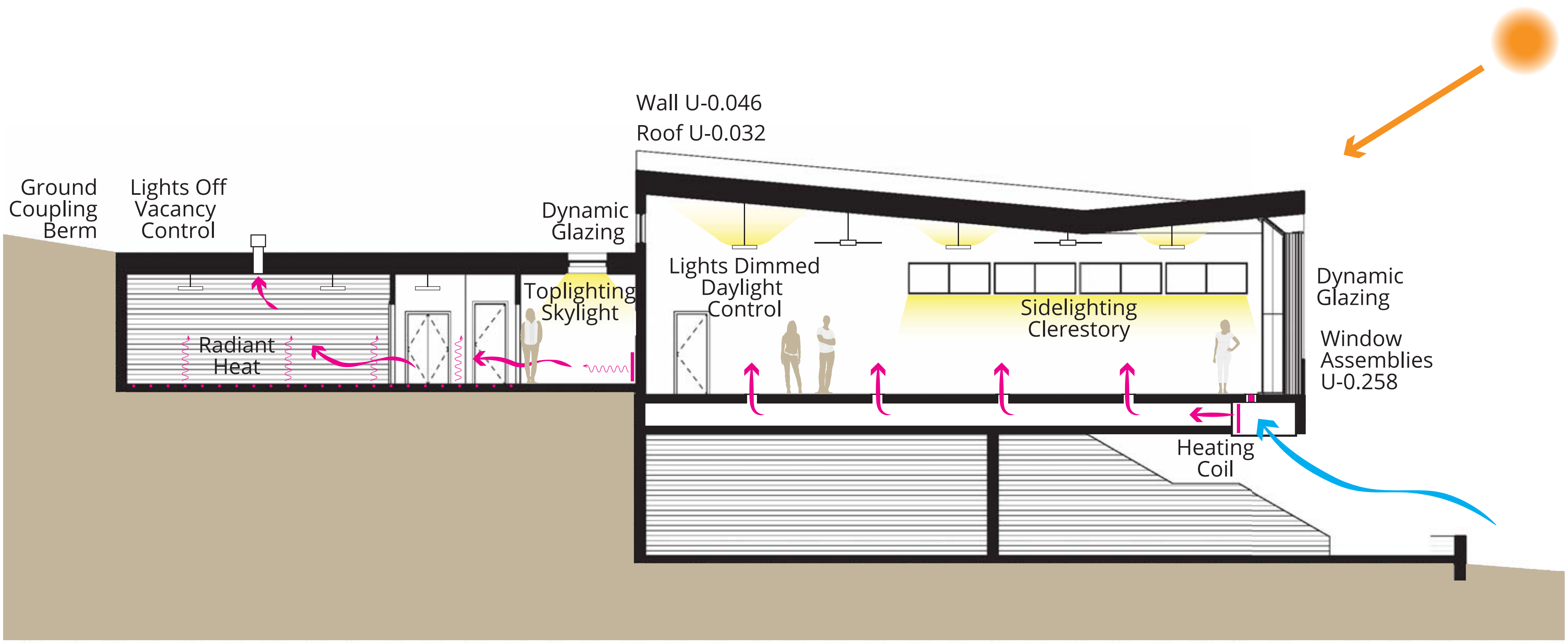
VENTILATION AUTONOMY - MULTIPURPOSE PERIMETER



VENTILATION AUTONOMY - OFFICE



BIOCLIMATIC SECTION - COOLING MODE



BIOCLIMATIC SECTION - HEATING MODE

1. Outside air supply to underfloor distribution with heating coils and radiant heat at perimeter zone
2. Underfloor air distribution
3. Clerestory windows for stack ventilation
4. Operable windows for cross ventilation
5. Exhaust fan (in restrooms, storage and office)
6. Radiant floor heating (in restrooms, storage and office)
7. Concrete floor (thermal mass) and night flush cooling
8. Perimeter radiant heat at glazing

HVAC

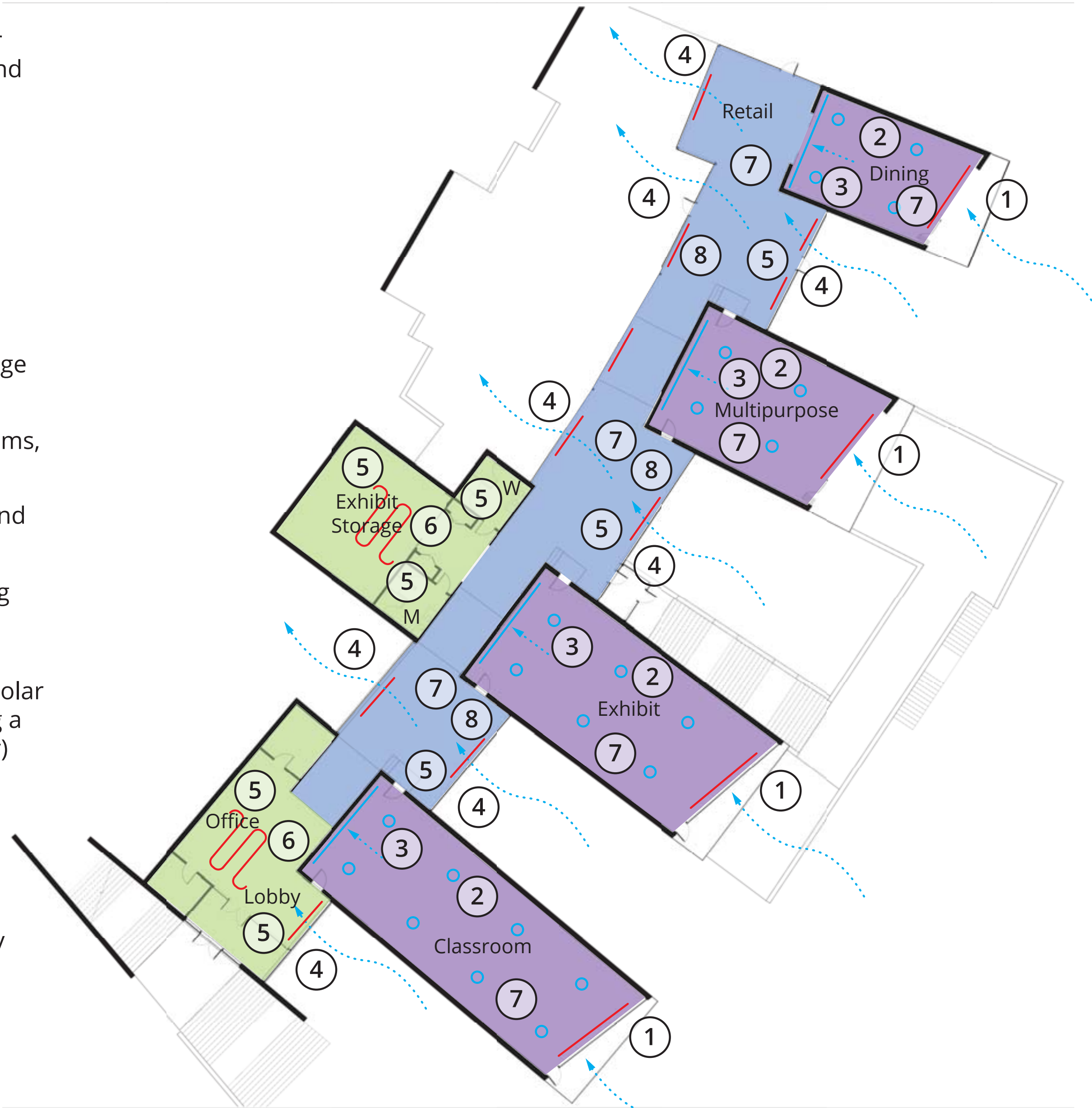
Heating with internal loads, passive solar and ground source heat pump (using a heat exchange closed loop in the bay)

Passive cooling (no active cooling)

Natural ventilation (no AHU)

Natural Ventilation Types

- Underfloor delivery + clerestory exhaust
- Operable windows
- Louvers to adjacent space and exhaust fans



HEATING COOLING + VENTILATION DIAGRAM
VISITOR'S CENTER

4 Operable windows for cross ventilation

5 Exhaust fan (in restrooms, storage and office)

6 Radiant floor heating (in restrooms, storage and office)

7 Concrete floor (thermal mass) and night flush cooling

8 Perimeter radiant heat at glazing

9 Central heat pump serving Aquatic Center and Visitor's Center with a heat exhange loop in bay

HVAC

Heating with internal loads, passive solar and ground source heat pump (using a heat exchange closed loop in the bay)

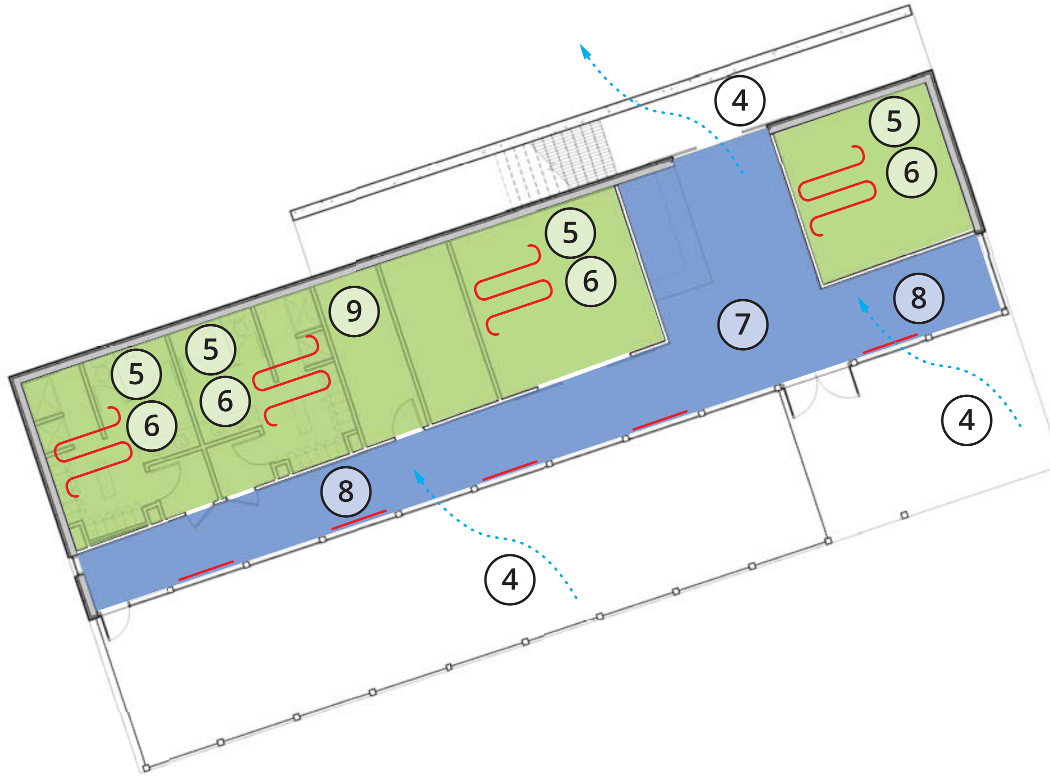
Passive cooling (no active cooling)

Natural ventilation (no AHU)

Natural Ventilation Types

Operable windows

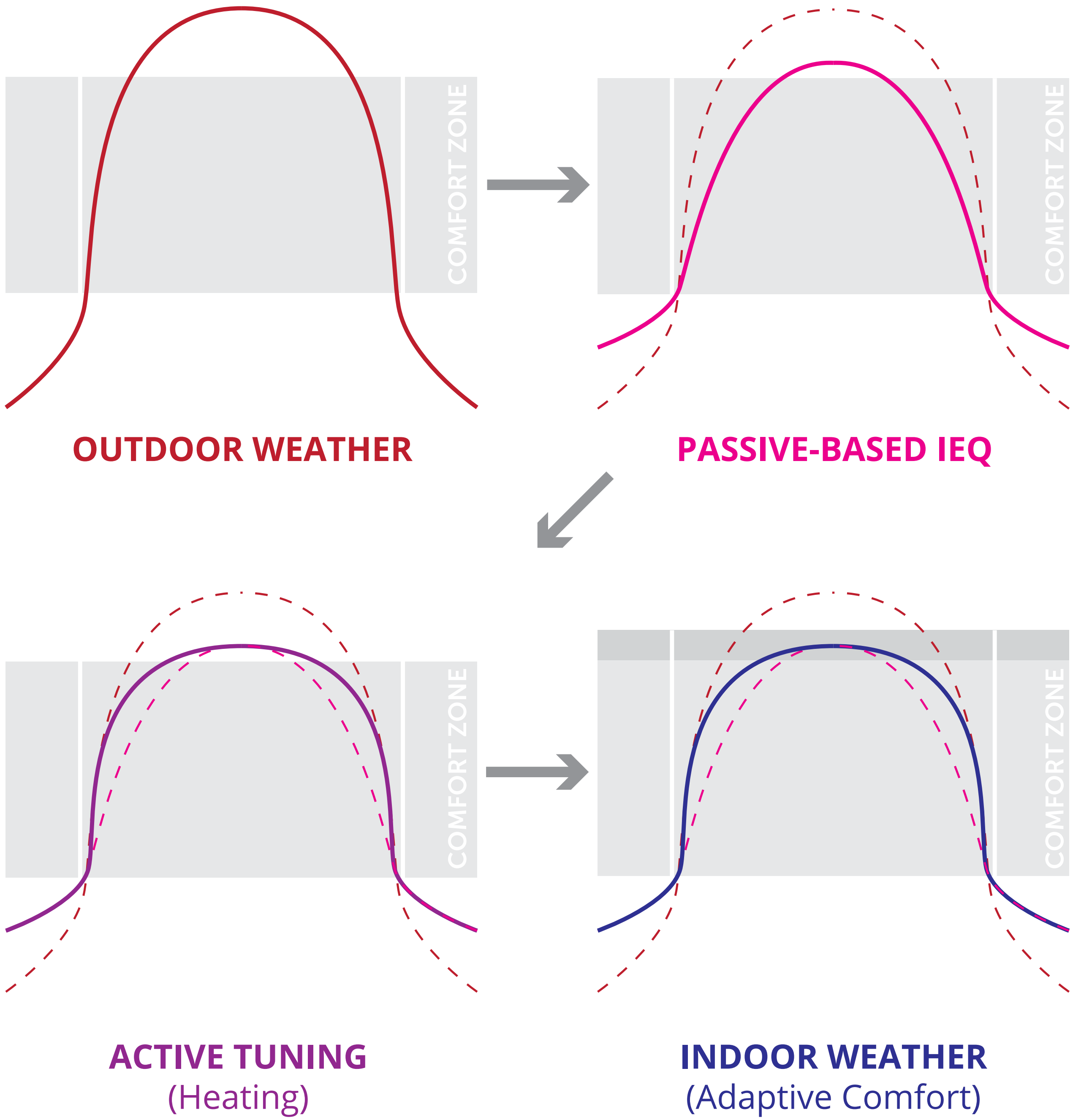
Louvers to adjacent space and exhaust fans

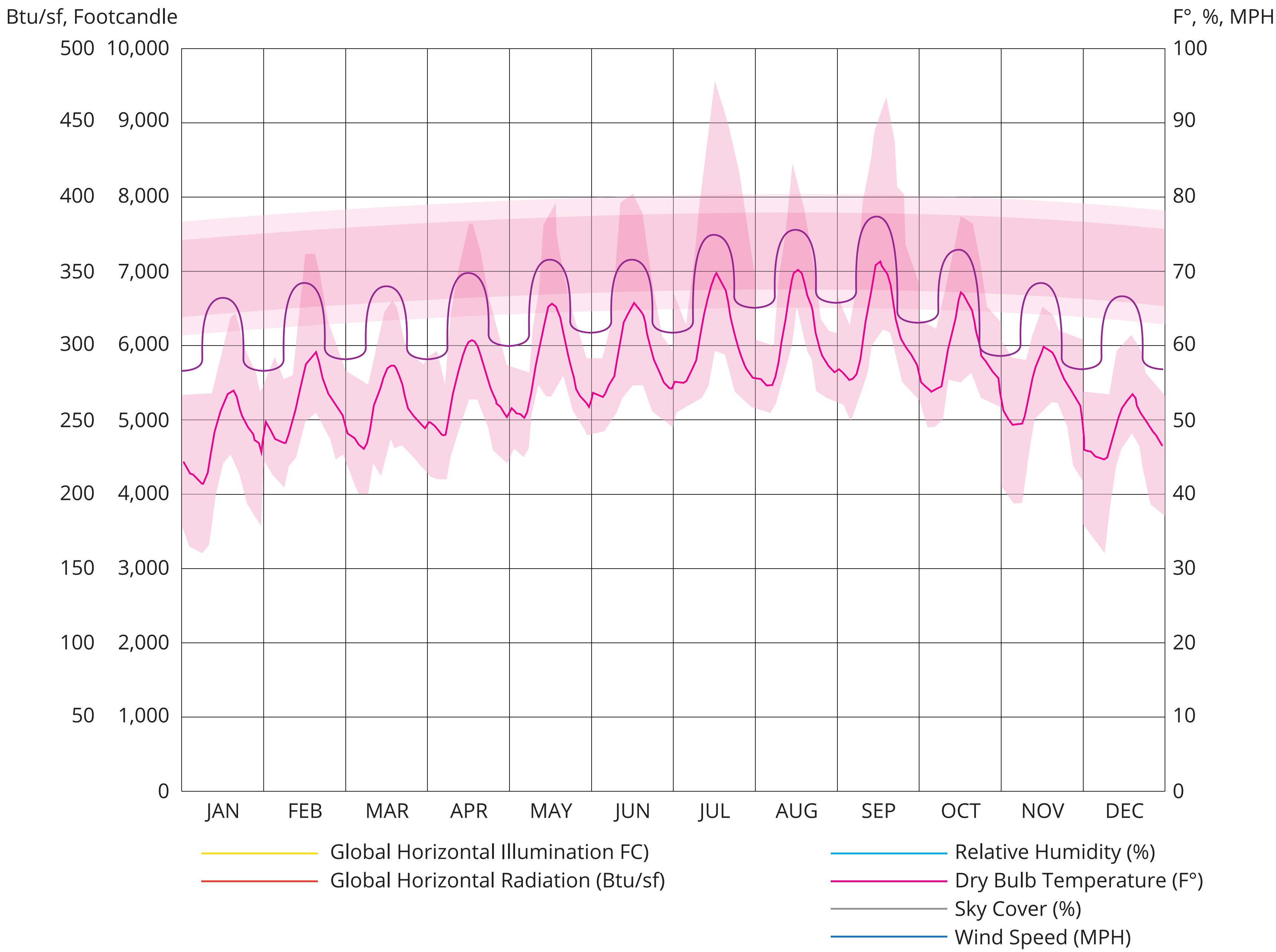


HEATING COOLING + VENTILATION DIAGRAM
SCIENCE ON THE BAY BUILDING

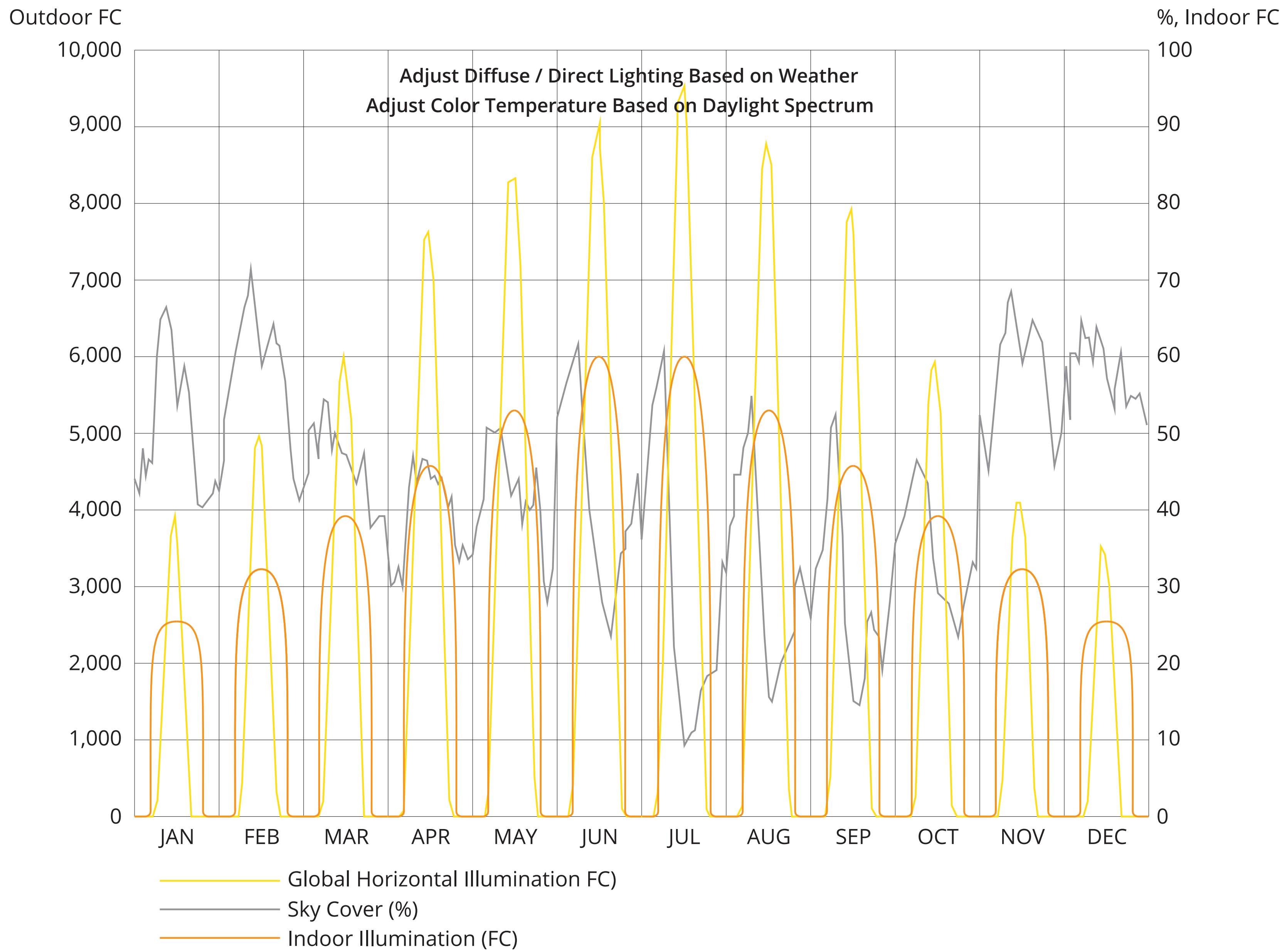
INDOOR WEATHER

This building is deeply connected to nature. The life of the building takes on the same patterns and metabolism as its estuary ecosystem. To further strengthen the building occupant's connect to the project's site and ecosystem we are using a biophilic based indoor environmental quality concept we call Indoor Weather. Indoor Weather fully leverages our passive autonomy and adaptive thermal comfort approaches to create indoor environmental conditions that "mirror" the current weather at the site. While indoor environmental conditions will vary seasonally, daily and hourly, the building is designed to not be over-lit, under-lit, over-heated, under-heated, over-ventilated or under-ventilated. But with those high-level comfort constraints we are letting the building conditions flow with the weather conditions. Indoor Weather is a key strategy in our net positive energy framework but it also valuable in the way it engages occupants and shapes their experience in the building.


COMFORT ZONE
OUTDOOR WEATHER
COMFORT ZONE
PASSIVE-BASED IEQ
COMFORT ZONE
ACTIVE TUNING
(Heating)
COMFORT ZONE
INDOOR WEATHER
(Adaptive Comfort)



INDOOR WEATHER TEMPERATURE CONCEPT

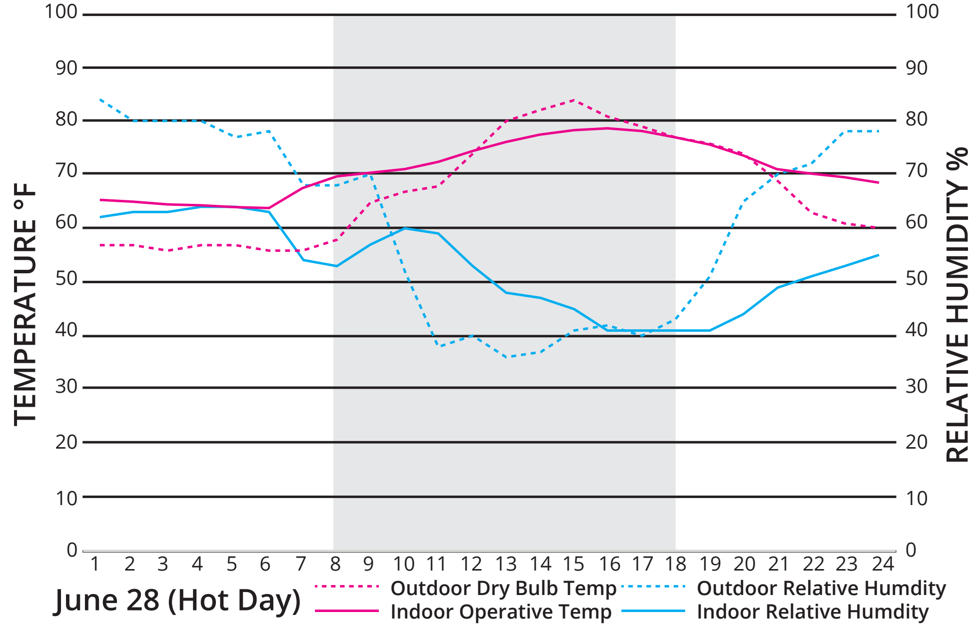


INDOOR WEATHER ILLUMINATION CONCEPT

INDOOR WEATHER

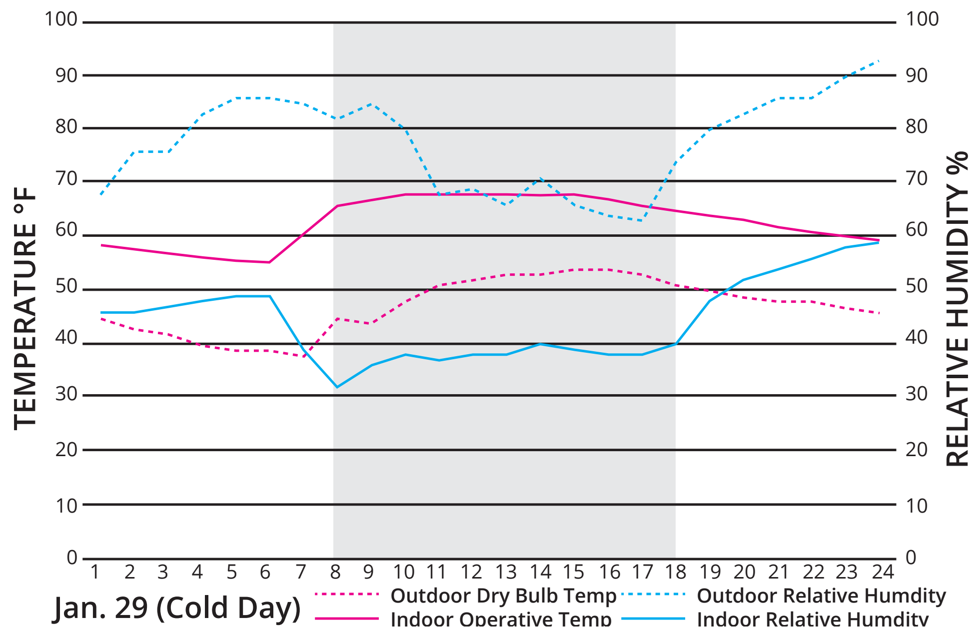
On a hot, sunny, summer day for the classroom:

- The building warms up from its night time temperature of 65°F to hit 70°F by 8am.
- Even though the weather heats up to a high of 84°F in the early afternoon the interior operative temperature stays in the 70's with a peak under 79°F (the highest indoor temperature the zone sees the entire year).
- The building cools back down in the high 60's as the exterior temperatures drop into the evening.



On a cold, partly cloudy winter day.

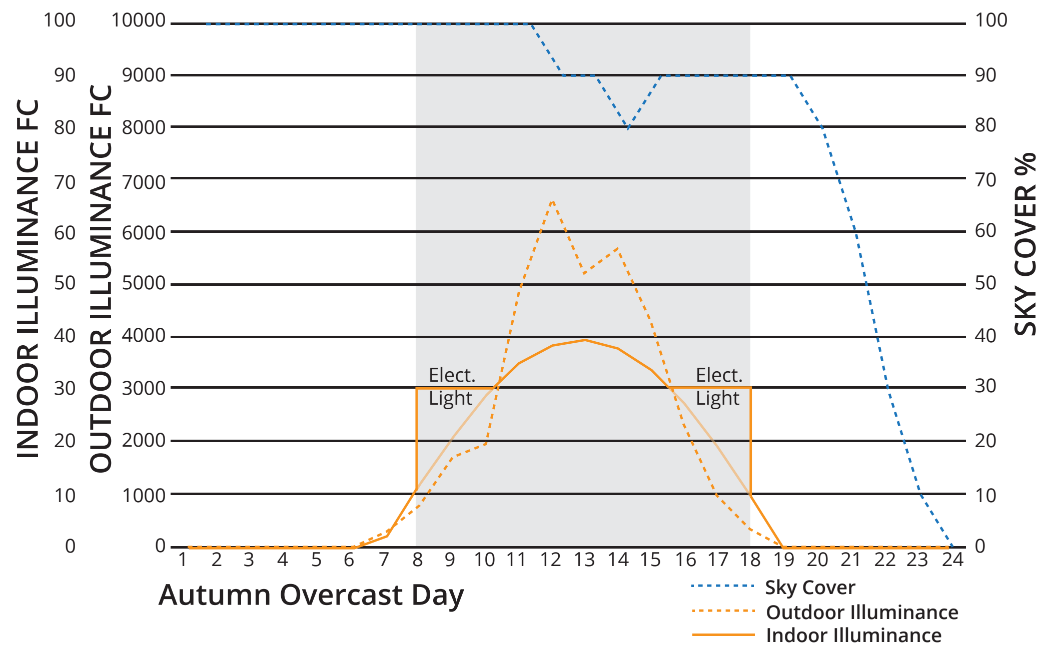
- Morning warm up starts at 6am and brings the interior temperature to 66°F by 8am.
- The set point adjusts up to 68°F by 10AM and slowly drops back down 66°F by 4pm matching the rising and falling curve of the outdoor temperature.
- The building interior drops just below 60°F overnight.



INDOOR WEATHER

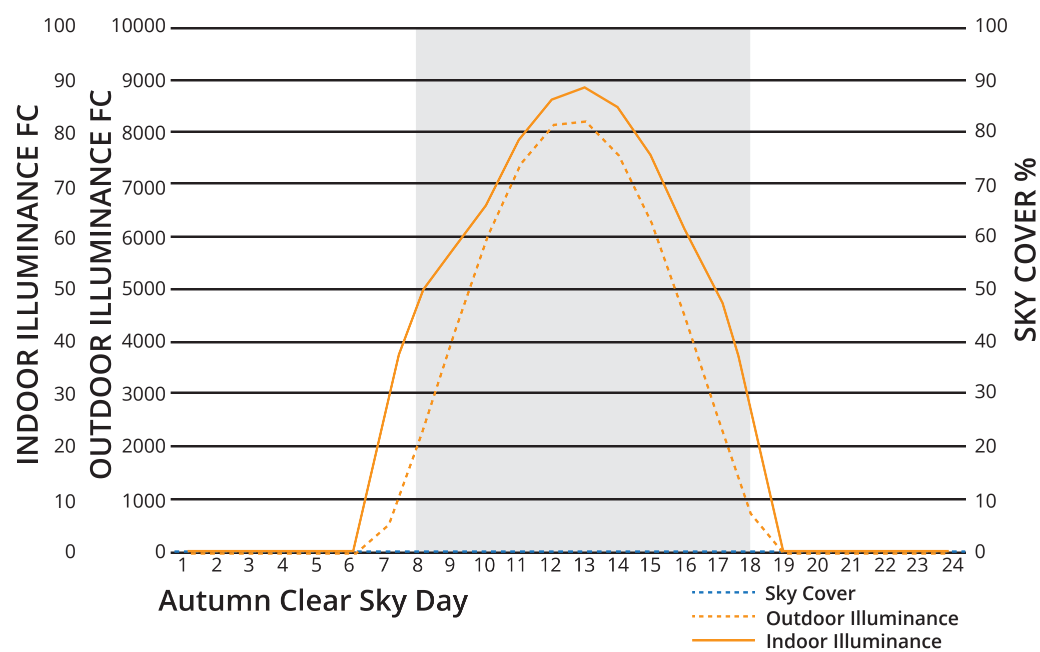
On an autumn overcast day for the classroom:

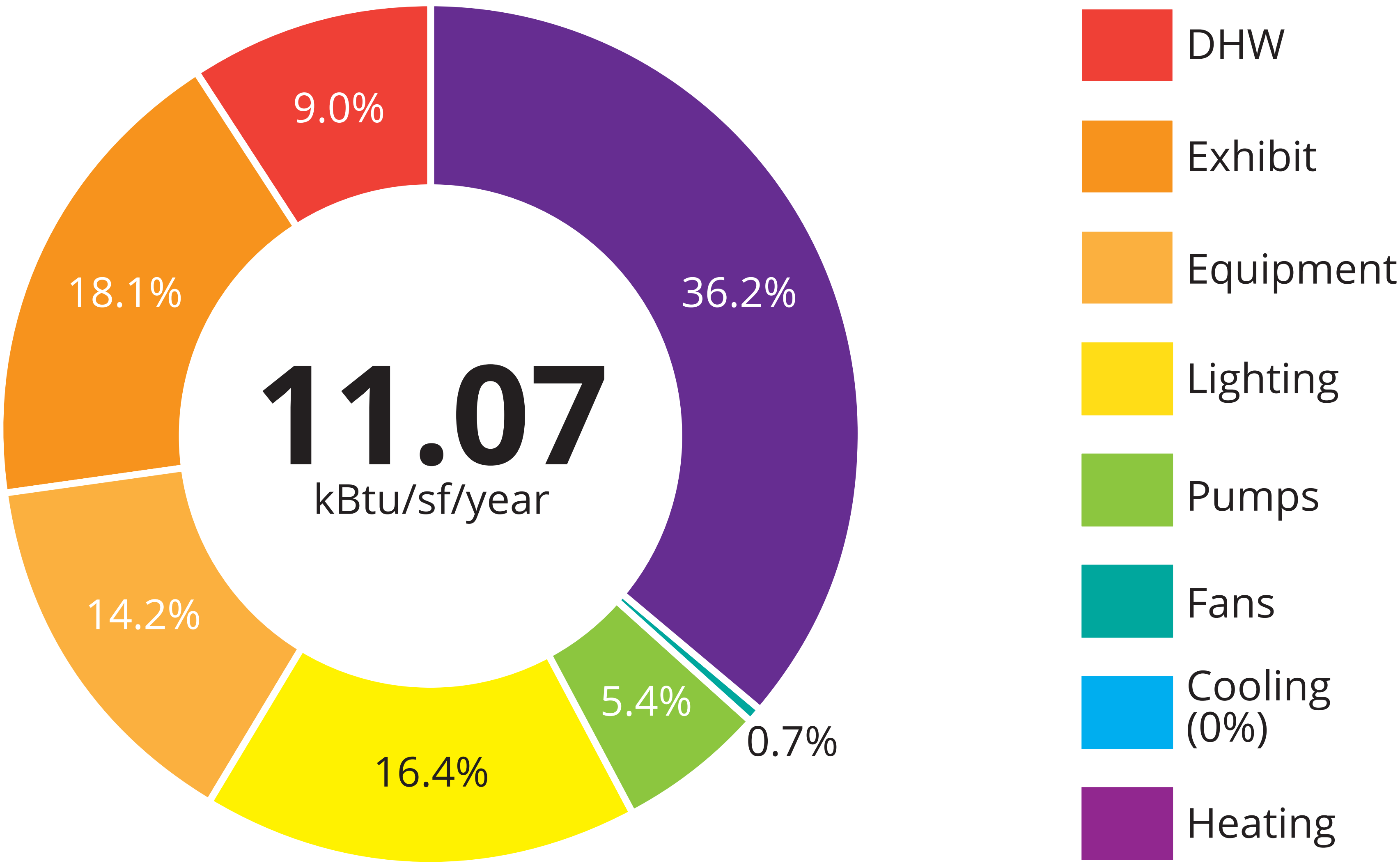
- Daylighting begins at sunrise bringing low levels of light into the space. Electric light dims up to bring the space to 30 fc until daylight can take over a little after 10am.
- Daylight levels pick at mid-day around 40 fc.
- Dynamic glazing is at its highest visible light transmission throughout the day.
- Dimmed electric light supplements daylight after 4pm.



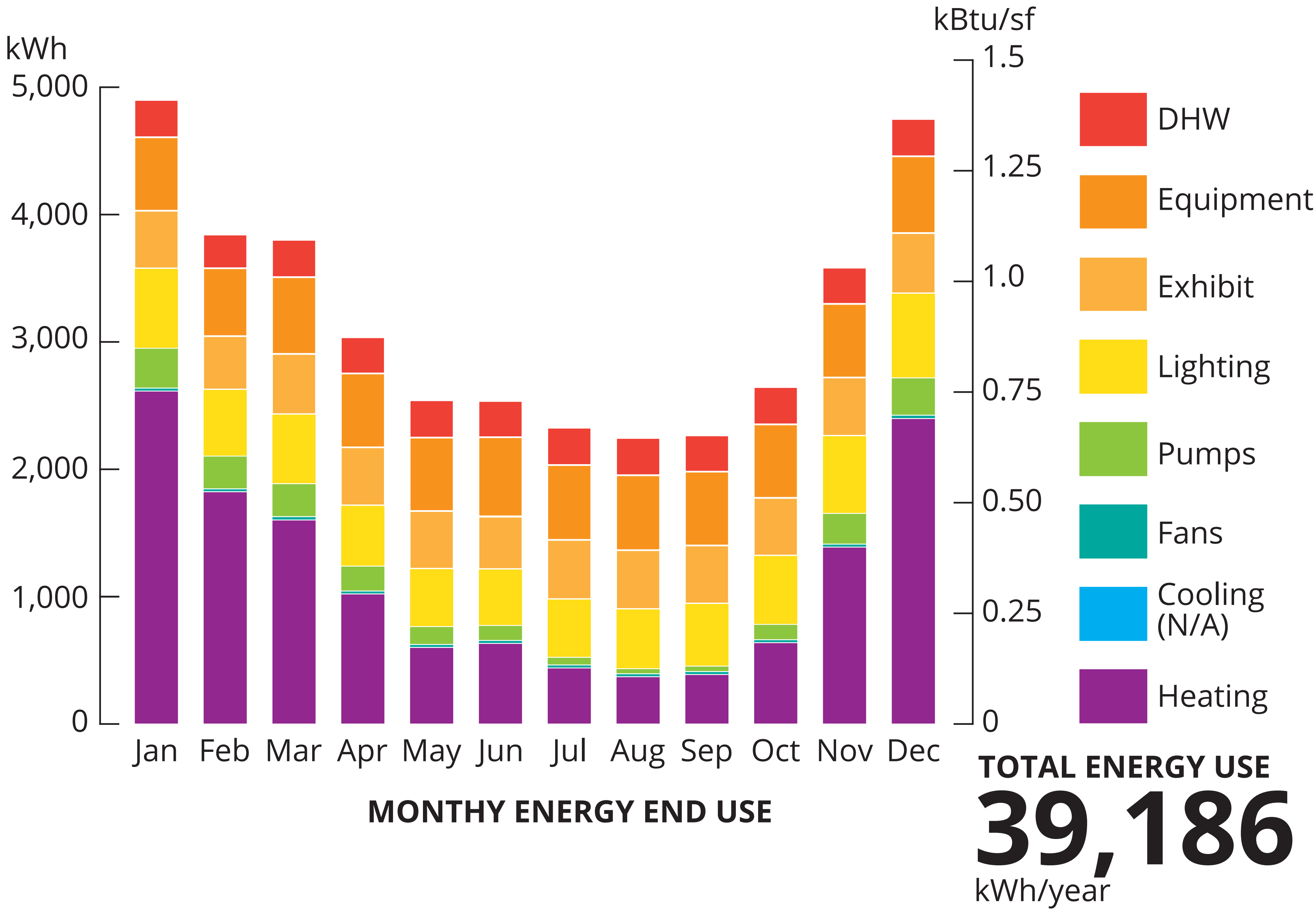
On an autumn clear sky day.

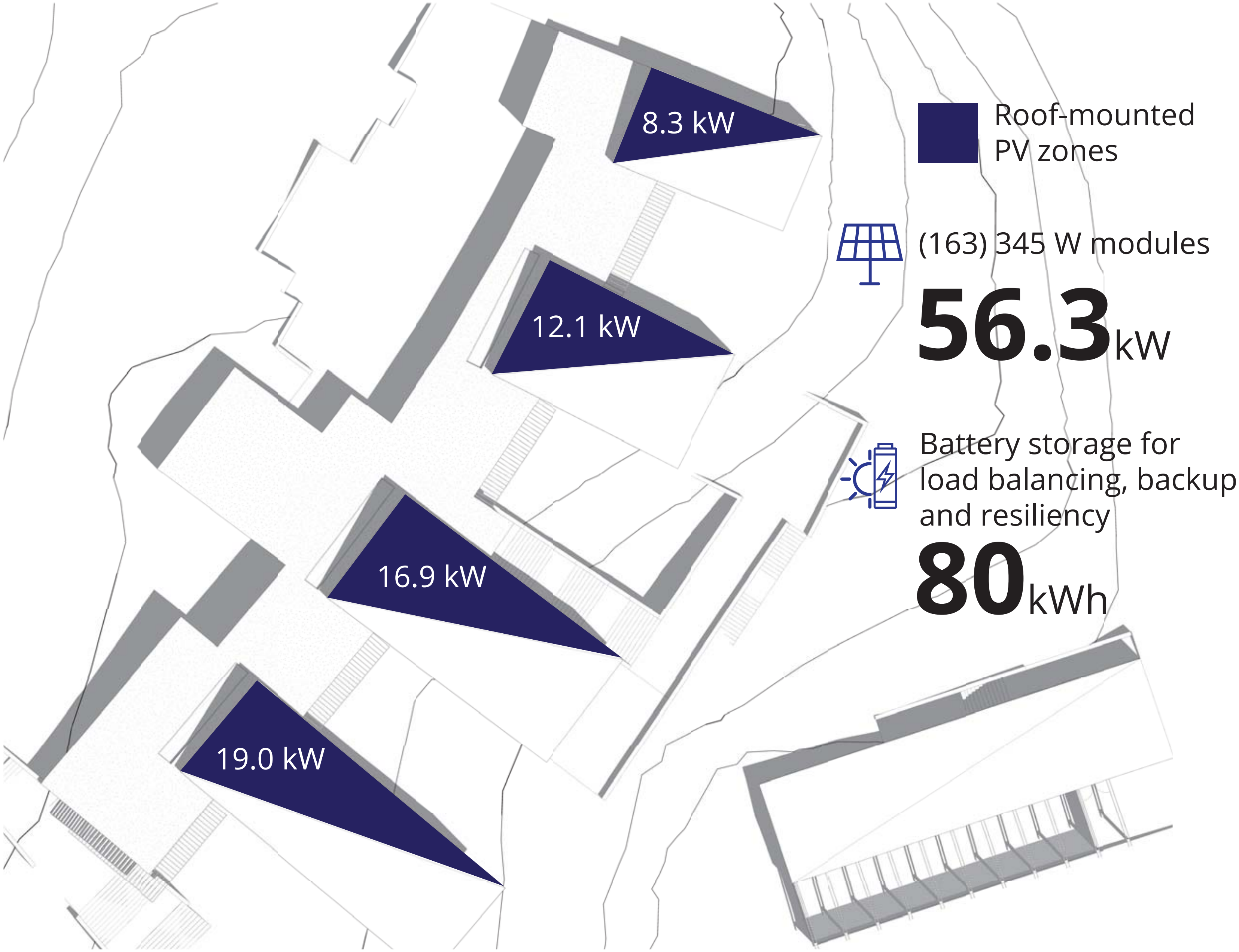
- By 8am daylighting is providing 50 fc average light in the space.
- Daylight levels peak at about 80 fc mid-day with the peaking of outdoor peak illuminance.
- At 6pm daylight levels are still at 30 fc.
- Dynamic glazing reduces visible light transmission during periods of direct sun exposure.
- No electric lighting is used in the space.



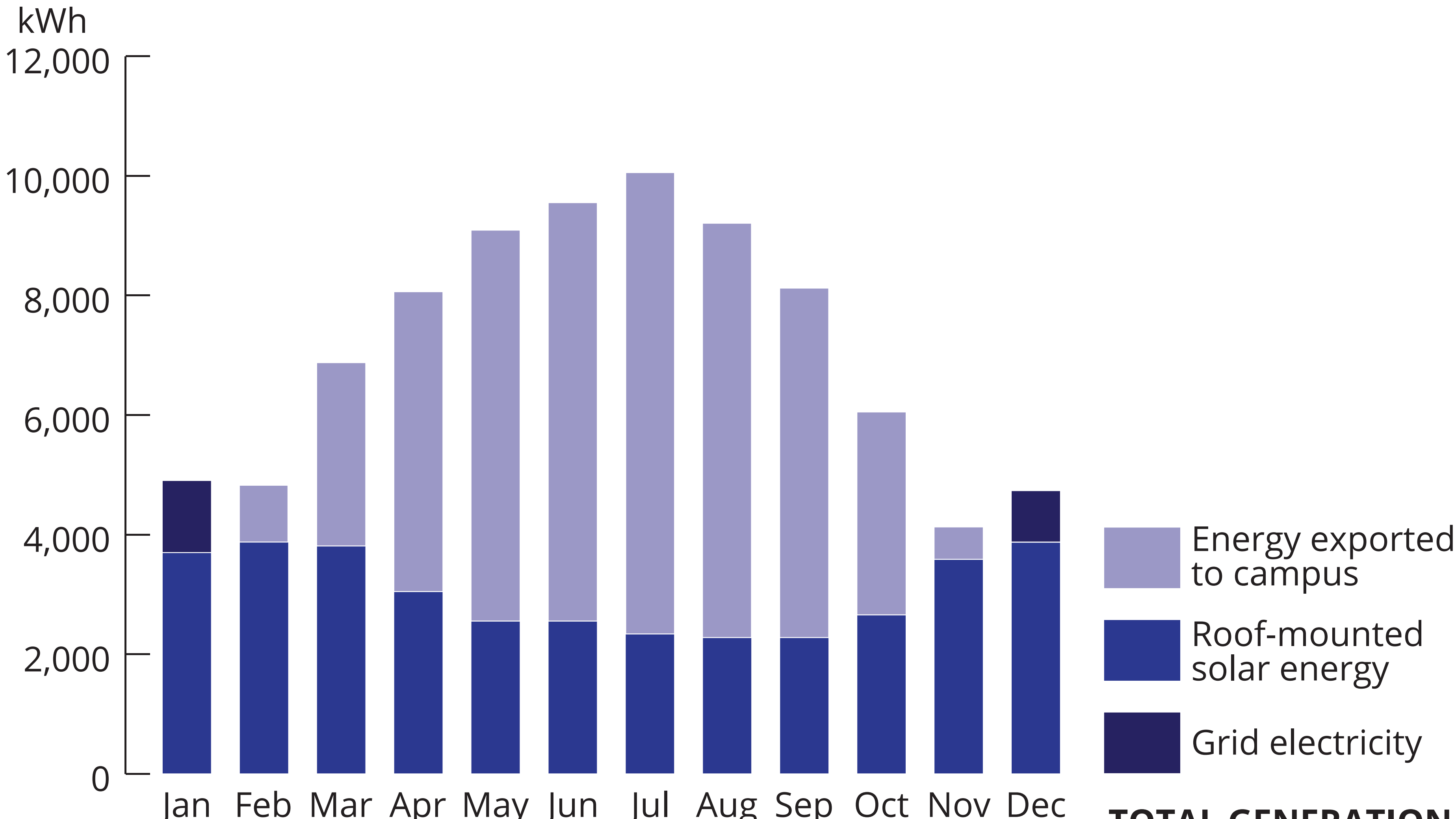


ANNUAL ENERGY BY END USE


kWh
5,000
4,000
3,000
2,000
1,000
0
kBtu/sf
1.5
1.25
1.0
0.75
0.50
0.25
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
DHW
Equipment
Exhibit
Lighting
Pumps
Fans
Cooling (N/A)
Heating
MONTHY ENERGY END USE
TOTAL ENERGY USE
39,186
kWh/year



RENEWABLE ENERGY DIAGRAM



MONTHY ENERGY GENERATION

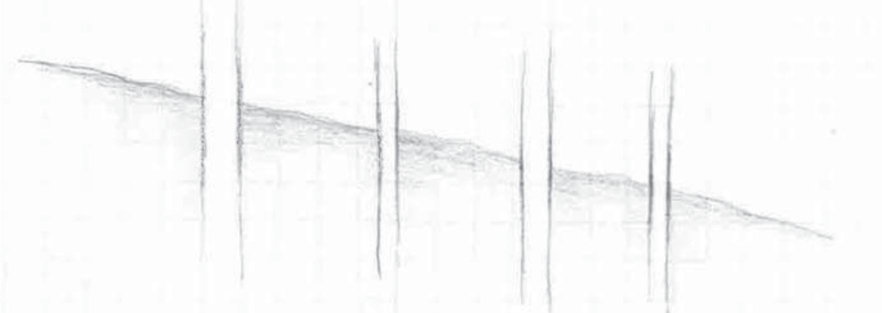
TOTAL GENERATION

83,595

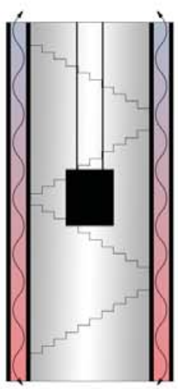
kWh/year

04 APPENDIX

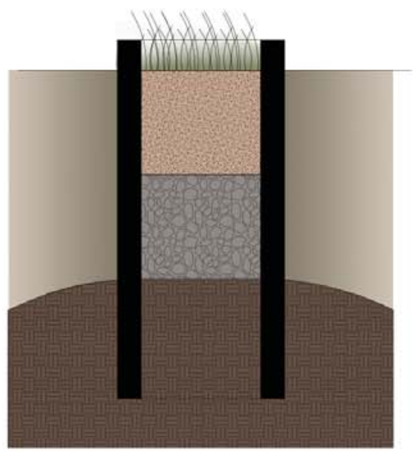
NUTRIENT SILOS



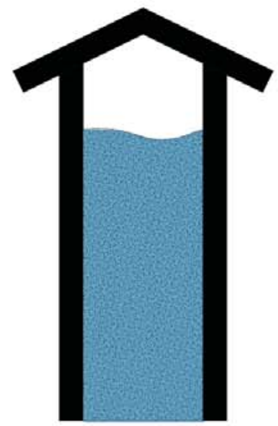
transportation



treatment



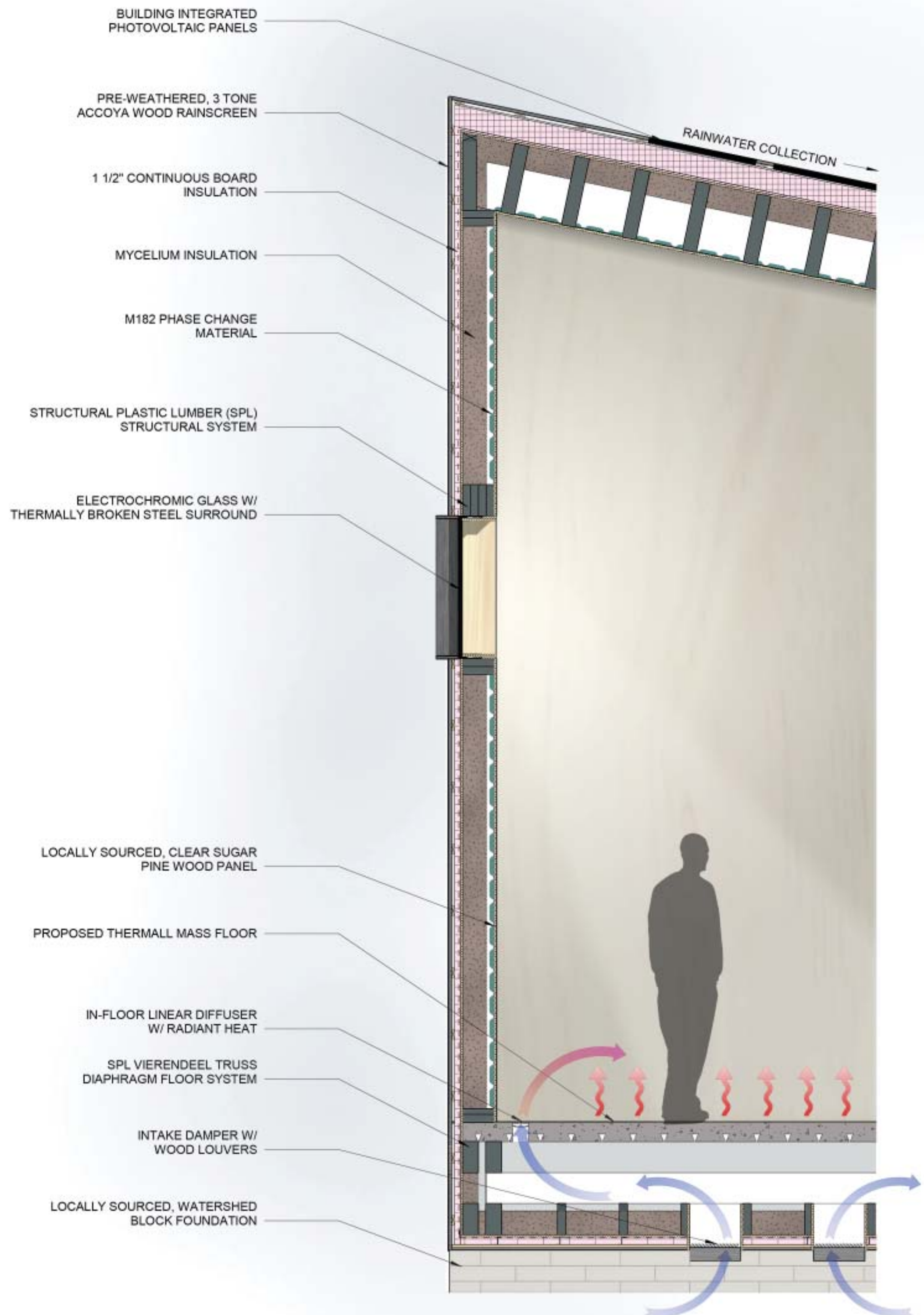
storage



research

Out in the ocean, within a naturally occurring upwelling, nutrient rich cold water rises to replace relatively warm surface water. The concept for the site is similar. Within the nutrient silos, nutrient rich and educational significant resources replace the depleted material input. Throughout the campus, four Nutrient Silos are designed and located to achieve the goals of collection and treatment of water, research observation and measurement, and vertical food supply gardens for research and use.

TYPICAL ENVELOPE SECTION



MAIN ENTRY PERSPECTIVE