ARCHITECTURE AT ZERO

Competition Program and Zero Net Energy Considerations

COMPETITION PROGRAM

The Architecture at Zero competition challenge is to create a zero net energy bayside community education and visitor's center, in support of the mission of the Romberg Tiburon Center for Environmental Studies (RTC). This facility is San Francisco State University's center for estuary and ocean science located on 53 acres of bayside property in Tiburon, California. The competition has two components. First, entrants will create an overall site plan to accommodate the program outlined below. Entrants are encouraged to highlight any energy efficiency strategies or systems shown. Second, entrants will design two buildings in detail, to indicate zero net energy (ZNE) performance. In order to demonstrate the building design and its performance, entrants will provide required documentation and may also include supplementary documentation.

THE CHALLENGE

To complement a planned restoration of a pier and wharf with public access on the Tiburon property, RTC seeks to create an adjacent bayside community educational and visitor's center. This will be a place where the general public, school groups and teachers can visit and learn about the ecology, biology, restoration and oceanography of the San Francisco Estuary and other nearby coastal ecosystems, as well as the environmental and naval history of the property itself.

The bayside center will include two buildings:

1) An interactive exhibit space and visitors center with adjacent classrooms for visiting school groups or teachers (part of the exhibit area will include aquaria and touch tanks for marine organisms); and an adjacent outdoor picnic/event space to serve visitors, resident faculty, staff and students, conference center users and other special events;

2) A building to support science-on-the-bay nature education kayak and small boat based tours for school groups, university students and other visitors. These are envisioned as self-supporting non- profit units or public-private partnership ventures that would be integrated with the science education, research and public service missions of RTC and San Francisco State University.

The challenge will be to develop an energy plan for this two building cluster and associated uses in an approximately 3.5 acre area of the Tiburon property adjacent to a planned restoration of a large wharf and pier and adjacent shoreline to support a variety of aquatic educational programs and operations.

Important Information about the Site

The 53-acre property sits on the shore of San Francisco Bay on steep hillsides with extraordinary views of the Richmond Bridge, Bay Bridge and the East Bay. Originally developed by the US Navy, the area for the competition's building cluster is adjacent to a large concrete tarmac and seawall.

Most of the existing buildings on the project site are slated for demolition due to their poor condition. However, one building may be conserved for its historic value (see map for details). For the purposes of the competition, design teams should plan on new construction, rather than renovation, to meet the design program.

A newly resurfaced and restored wharf and pier with a small harbor is planned in the location of the former one (pilings remain that can be resurfaced and incorporated). In addition, strong winds penetrate the site at times.

Important note: The site lies adjacent to the San Francisco Bay and thus will be impacted by Sea Level Rise. While estimates for the amount of inundation vary, teams should consider the possibility of 100-150 cm of sea level rise above mean sea level.

Entrants are invited to use Marin County's BayWAVE program guidance on sea level rise for planning purposes. Scenarios can be found here: https://www.marincounty.org/main/baywave/sea-level-rise-scenarios. These scenarios will likely be updated in 2017 to higher levels.

Scientists at the Romberg Tiburon Center consider 100-150 cm rise in sea level to be a reasonable, conservative projection for 2100, but it doesn't capture "flooding potential" with king tides or storms. This interactive map provides visualizations of flooding potential that will be useful for designers: http://data.pointblue.org/apps/ocof/cms/index.php?page=flood-map

Two Building Program:

Bayside Visitor's Center: Environmental Science and History of San Francisco Bay

This program connects the environmental and maritime history of the site and RTC research & education programs with Marin County and San Francisco Bay. It will engage members of the general public, K-12 school groups, science teacher training programs, university students, staff and faculty, and community volunteers. It will connect with people arriving by water to a new pier and wharf (via water taxi service from downtown Tiburon, kayak and other watercraft following the Bay Water Trail and/or using Paradise Park facilities) and interpret the nature-based restoration planned for the adjacent shoreline to the north. The Bayside Visitor Center will also include a picnic space and lunch/break-room for RTC students, faculty, visiting scientists, staff, visiting K- 12 school groups, and public program visitors.

Building size: 8300 sq. ft.

- Lobby/reception (100 sq. ft.)
- Interactive Exhibit space (2000 sq. ft.)
- Support space for exhibits (800 sq. ft.)
- Restrooms (400 sq. ft.)
- Retail space (300 sq. ft.)
- Admin/offices (500 sq. ft.)
- Multipurpose room for up to 75 people (1200 sq. ft.)
- Lunchroom and break-room for up to 40 people (800 sq. ft.)
- Wet lab classroom for 40 people (2200 sq. ft.)
  to include: 1 shallow "touch tank" exhibit of
  200 gallons
    - large tanks (300 gallons each)
    - small tanks (75 gallons each)

Science-on-the-Bay: Aquatic Education and Recreation

This program will serve university students and recreational clubs, visiting school groups and public nature-education programing

Building size: 1500 sq. ft.

Reception/equipment check-in/check-out (300 sq. ft.)
Gear storage, lockers, equipment clean-up, showers (1000 sq. ft.) Small administrative office (200 sq. ft.)

This building should be a single story.
Adjacent to this building should be 1000 sq. ft. of outdoor storage space for kayaks and other support services.

RTC considers the following facilities to be inspiration for this project:

- Ocean Institute at Dana Point: http://www.ocean-institute.org/
- UCSC's Seymour Discovery Center, associated with their Long Marine Lab: https://seymourcenter.ucsc.edu/
- Oregon State University's Hatfield Marine Science Center and associated visitor's center: http://hmsc.oregonstate.edu/visitor-center

About the Site:

The Romberg Tiburon Center is an off-campus research and teaching center operated year round by San Francisco State University (SF State). It was established in 1978 by the late Paul F. Romberg, then President of the University, on a parcel of land rich with history.

The waterfront site was first used in 1877 when a packing plant to dry, process and ship codfish was constructed. In 1905, the Navy purchased the property for use as a Navy ship coaling station, and President Theodore Roosevelt visited with the Great White Fleet in 1908.

During construction of the Golden Gate Bridge in the 1930's, the Roebling and Sons Company used the north warehouse to reel cables for the bridge. The steel wire was wound and reeled, then barged to the Gate to be spun into cables.

From 1931 to 1940, the Navy loaned the base to the state of California, which established its first nautical training school (later to become the California Maritime Academy). With the outbreak of World War II, the U.S. Government re-appropriated the site for use by the Navy, and the Maritime Academy relocated to its present site near Vallejo.

During World War II, the Tiburon facility was used for the construction of anti-submarine and anti- torpedo nets. These nets were shipped to Navy bases all along the West Coast and across the Pacific. The biggest challenge faced by Navy Net Depot personnel during this time was the laying of an anti-submarine net seven miles long and 6,000 tons in weight across the entrance to San Francisco Bay. This net was in place by December 7, 1941.

The Navy Net Depot was active through the Korean War until 1958 when its operation was terminated and the property was transferred from the Navy to the Department of Commerce. In the 1960's, the property housed the National Marine Fisheries Service's Southwest Fisheries Center (NMFS), as well as the Minerals Management Technology Center, which investigated how to sustainably mine manganese nodules from the deep sea. In 1973, NMFS consolidated its operations to 10 acres of the parcel.

In 1977, SF State proposed submitted a proposal to development of a field station and marine laboratory dedicated to the study of San Francisco Bay, and the Romberg Tiburon Center was established on the remaining acreage.

DESIGNING TO ZERO NET ENERGY

There are several definitions of zero net energy. This competition uses the zero net energy site definition, that is: a building project that produces at least as much energy as it uses over a year when accounted for at the site level (as defined by the boundaries of the project, whether one or multiple buildings). This definition does not include the embodied energy in building materials or account for transportation of materials and people to and from the site, but it does include all forms of energy used on the site (most commonly electricity and natural gas).

Since zero net energy is a performance-based metric measured over time, entrants will need to demonstrate that their submitted design solutions have a reasonable expectation of approaching a zero net energy goal. At its most fundamental level, designing a zero net site energy building is a balancing act of reducing building loads and increasing efficiency enough to be able to produce sufficient on-site renewable energy to completely offset the remaining projected energy use over the course of a year.

All buildings designed as part of the competition must be grid-tied. “Grid-tied” buildings maintain a connection to the electrical grid, which allows for the natural fluctuations of renewable energy production without the need for on-site energy storage. When insufficient energy is generated by on-site renewables to meet the demand from building loads, electricity is drawn from the grid; when on-site renewables generate a surplus of electricity, the surplus electricity is exported to the grid.

INTEGRATION OF RENEWABLE ENERGY SOURCES

For this competition, “renewables” will be defined as solar power, wind power, and biomass/ biofuel. Renewable generation is distinct from load reduction, and both are components of a successful zero net energy design.

ENERGY DEMAND TARGETS

Energy Use Intensity (EUI) is a metric that is used to compare the energy consumption of different buildings by accounting for conditioned floor area. It is defined as annual energy consumption divided by conditioned floor area and is most commonly expressed in the units of kBtu/sf/yr. As a starting place for a ZNE design, some exemplary EUI targets for different building types in Marin County (CA Climate Zone 3) are listed below. They come from a 2012 study conducted by ARUP for California investor-owned utilities, The Technical Feasibility of Zero Net Energy Buildings in California.

Medium Office—17.2 kBtu/sf/year (p. 92) College—40
kBtu/sf/year (p. 159)

Sit Down Restaurant—178 kBtu/sf/year (p. 138)
Warehouse—8.7 kBtu/sf/year (p. 151)

The Technical Resources section of the website lists sources for further information about energy efficient and ZNE design.

DESIGN DOCUMENTATION

The design documentation allows entrants to present their work from both architectural and energy performance perspectives. Thoughts about responding to sea level rise are also encouraged.

REQUIRED DOCUMENTATION

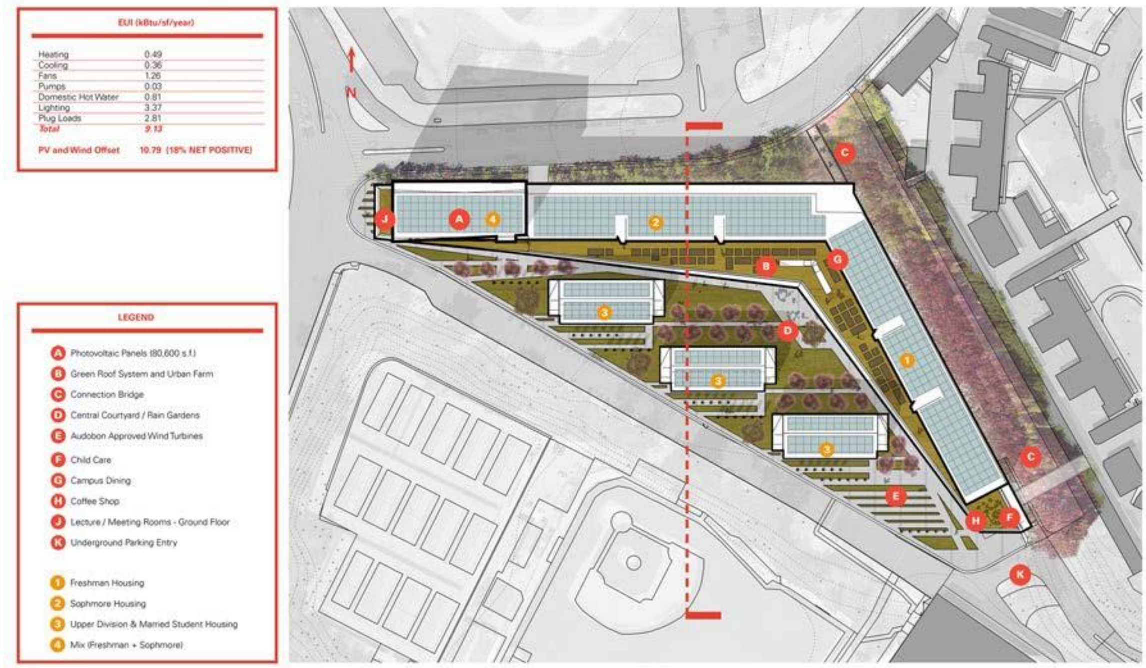
The drawings, table, and chart described below are required elements on the submitted board. Successful examples from past competitions and other sources are provided as illustration but are not meant to be prescriptive. The design board format is available on

1. Project Narrative Heading

The narrative should clearly outline and summarize the project's context and goals. This text should be a high level summary. If you would like to include an extended project brief or explanations of assumptions and methodology, please include them in the supplementary documentation. This summary should not exceed 250 words.

2. Site Plan

The site plan should indicate the parcel boundaries, location of the building, and size (kW) and placement of renewable energy sources. Highlight any energy efficiency strategies or systems shown. Include a north arrow, section marks (as needed) and scale.



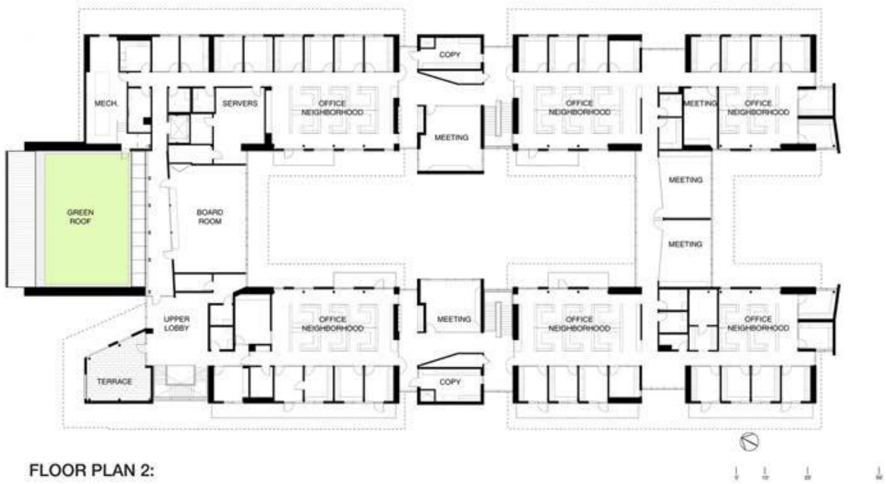
Source: “Fog Catcher” – Little; 2016 Competition

Source: “Nexus” – Dialog; 2016 Competition

3. Floor Plans

The floor plans should depict the interior conditions of both buildings. If desired, indicate how the space is heated, ventilated, and cooled; how water is heated and delivered; and the design of the natural and electric lighting in the unit. Indicate the total conditioned floor area.

Source: *Zero Net Energy Case Study Buildings,* Volume 2 (IBEW-NECA JATC Training Center) by Edward Dean



Source: *Zero Net Energy Case Study Buildings* (Packard Foundation Headquarters) by Edward Dean

4. Perspective Drawing

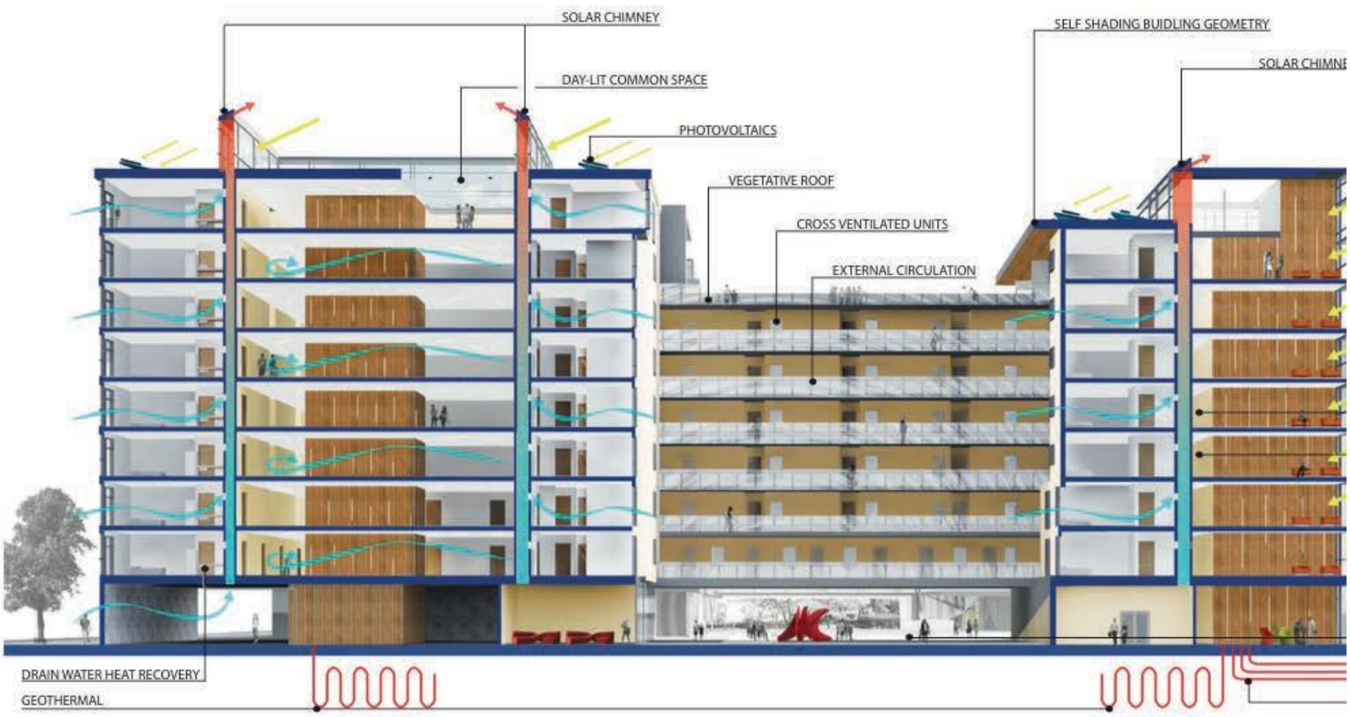
The perspective drawing should convey the "big idea" of your design.

Source: "Energized Canopy" - Ecole Nationale Supérieure d'Architecture; 2016 Competition

Source: "Piezein Circuit" – Modus Studio; 2016 Competition

5. Illustrated Sections

One section per building should illustrate principles of passive design and envelope construction that would contribute to the buildings' highly efficient performance. The sections should call out daylighting strategies, natural ventilation, air flows, specific materials choices, etc. In addition, highlight the energy efficient aspects of the mechanical and lighting systems.



Source: "Breeze Block" - Cornell University; 2015 Competition

Source: “Conspicuous Consumption” - Weber Thompson; 2015 Competition

6. Annual End Use Summary Table

Fill in the table below to provide annual energy use and production broken down by major end uses. See the Technical Resources page on the website for information about possible software tools.

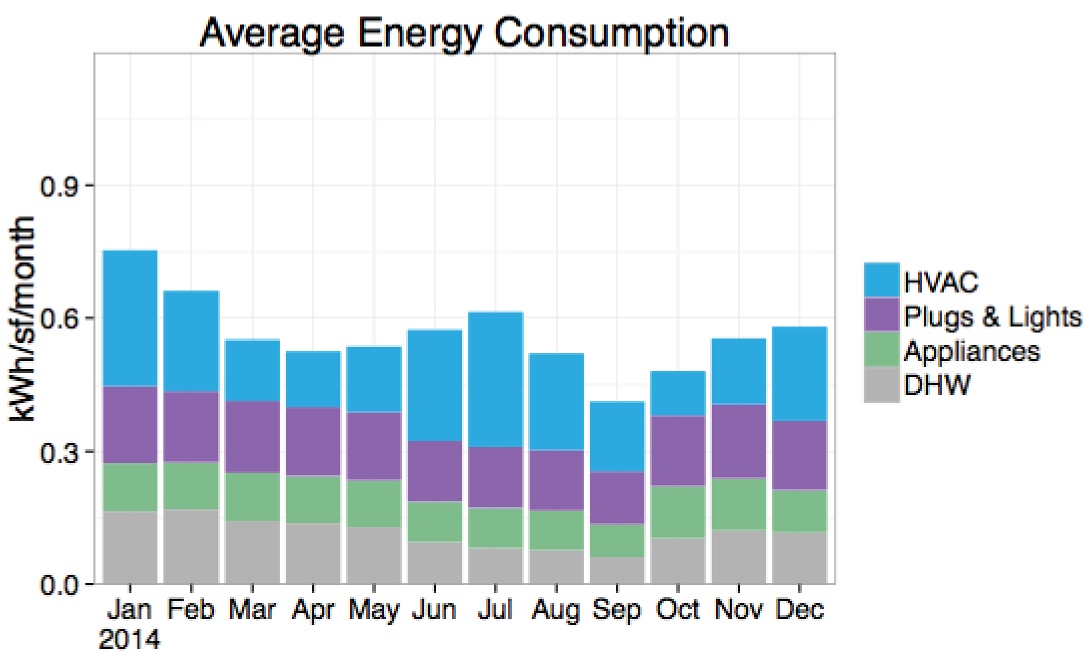
The aquaria and touch tanks in the exhibit space and visitor center consume a significant amount of electricity cooling and pumping water to keep the animals alive. A consumption estimate for these unusual loads is included as “Total Exhibit Consumption” in the table below. To evaluate the energy efficiency of the buildings themselves, this exhibit consumption is listed as a separate line item. However it must be included in the ZNE calculation.

Other information, such as the breakdown between gas and electricity consumption, one table per space type, or more detailed end use categories, may be provided.

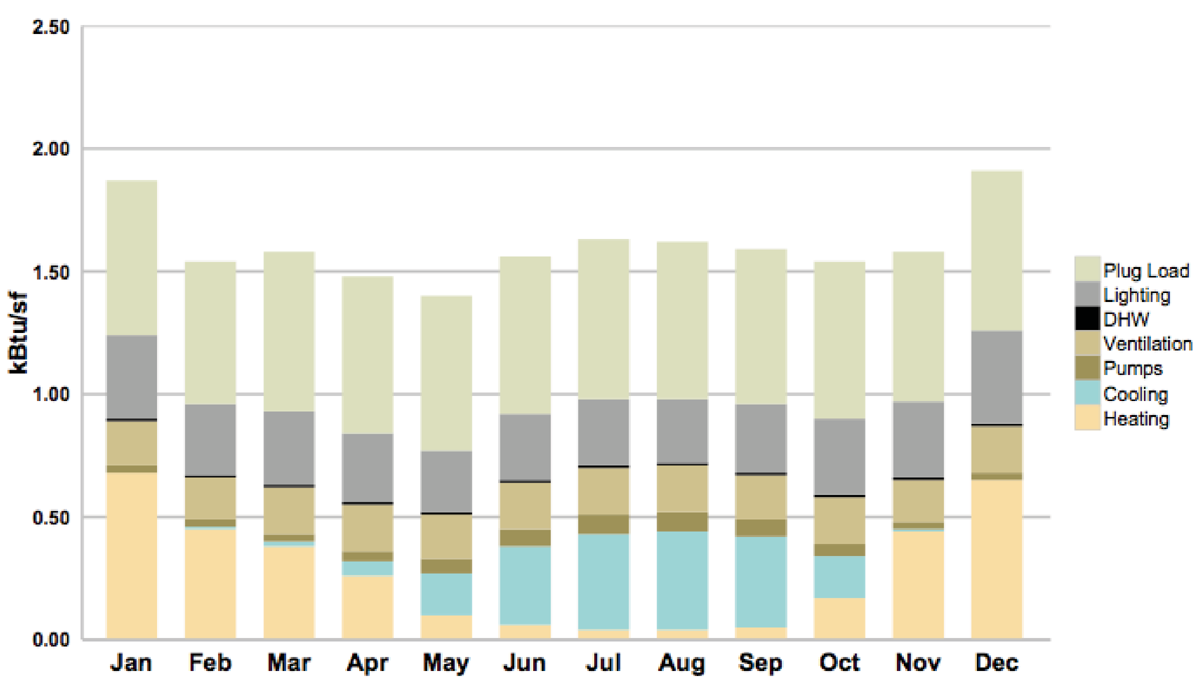
	Calculated Energy Use (kBtu/sf/year)
HVAC	
Lighting	
Appliances and Plug Loads	
Domestic Hot Water	
Total Building Consumption	
Total Exhibit Consumption	2 kBtu/sf/year
Gross EUI	
Renewable Production	
Net EUI	

7. Monthly End Use Energy Consumption Bar Chart

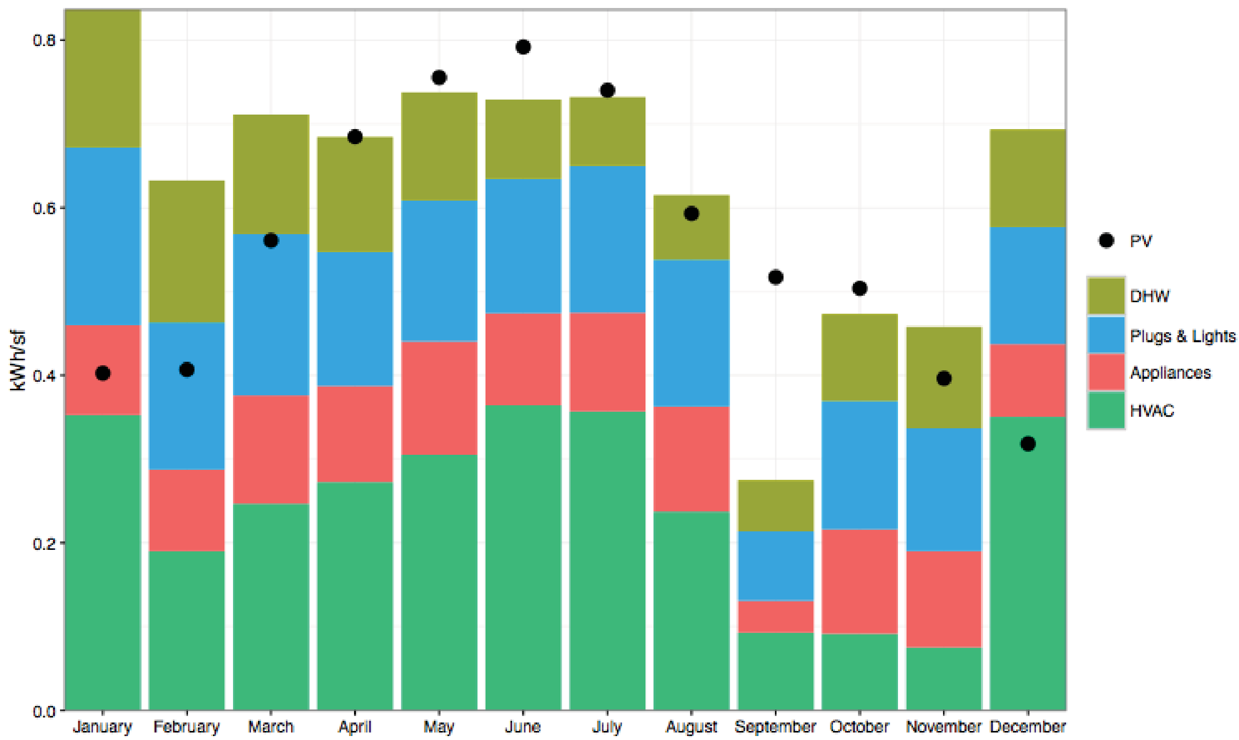
Show the energy consumption by end use and production of the buildings (or project) on a monthly basis.



Source: "ZNE Assessment & Verification for the West Village Development" - Greg Risko and Katie Gustafson



Source: *Zero Net Energy Case Study Buildings* (Packard Foundation Headquarters) by Edward Dean



Source: Margaret Pigman

8. Details of Renewable Energy Systems (if applicable)

For designs that include sources of renewable energy other than solar and wind, provide detailed specifications: where the system will be located and how much area it will take up; an example of an existing installation of the system showing the same performance. This information does not have to be on the presentation board but must be included in the submission.

OPTIONAL SUPPLEMENTARY DOCUMENTATION

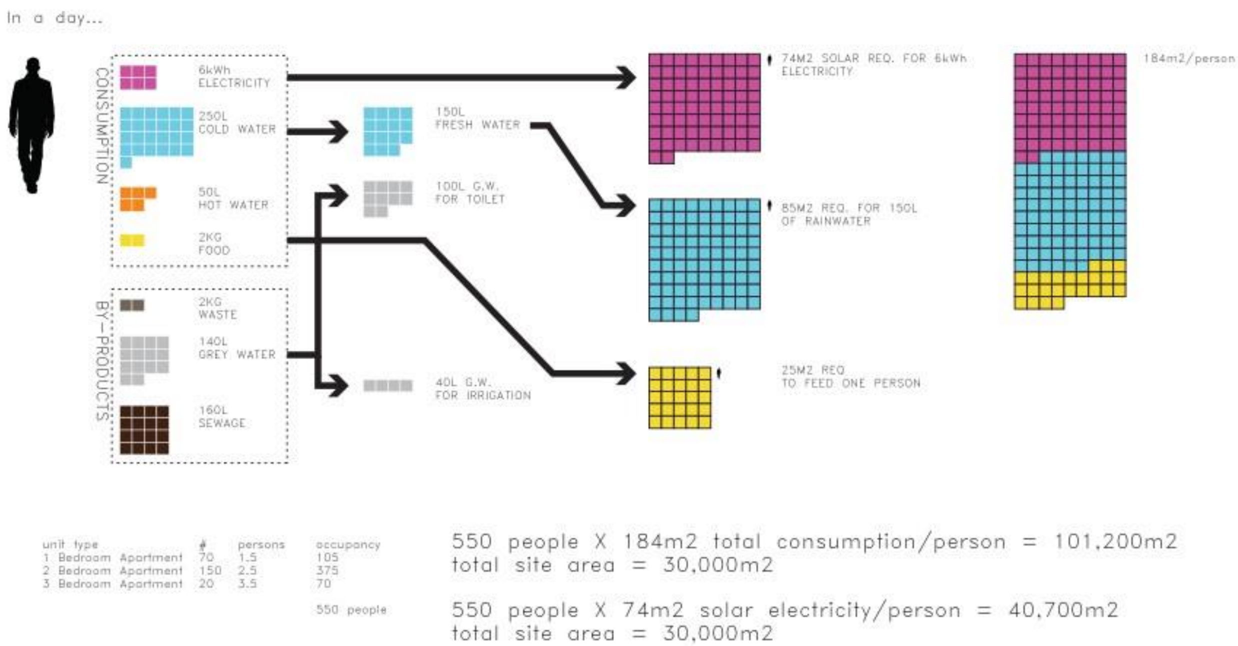
While it is not required, entrants are encouraged to submit supplemental documentation to elaborate on their ZNE design and the process around it. Examples of some of the possibilities are shown below as inspiration; other elements may be included.

ZNE Narrative

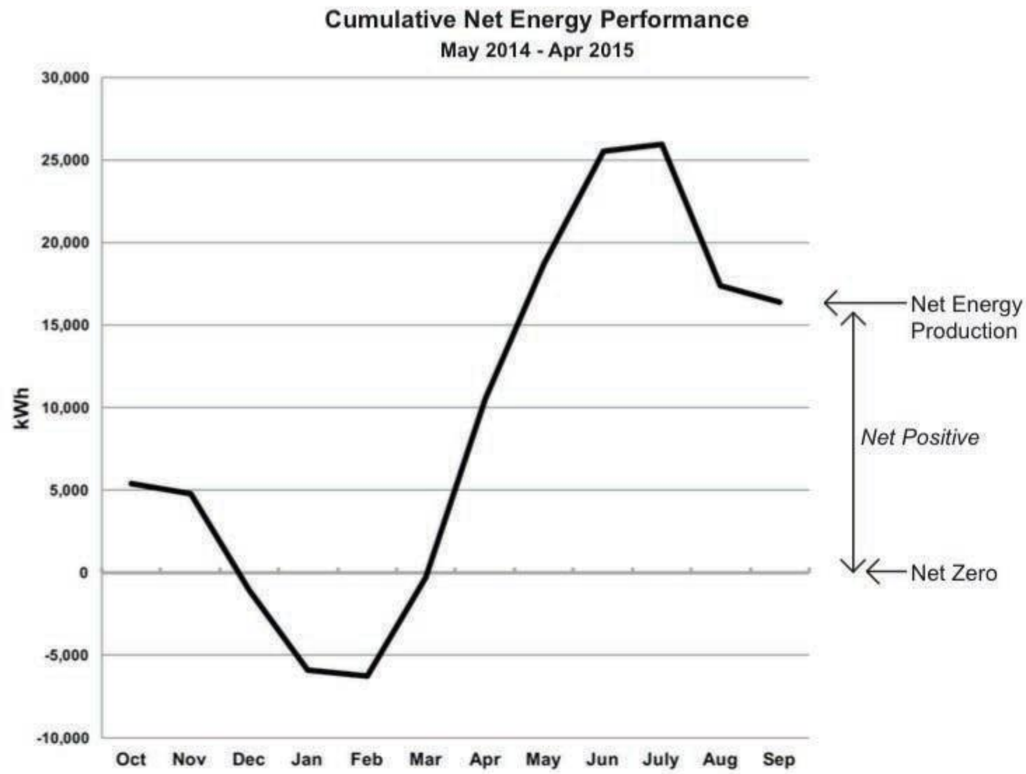
Does your design reach ZNE performance? What are the major reasons why it does or does not?

Here is a hypothetical narrative:

“While this building only offsets 70% of it energy consumption, the deep energy efficiency measures such as the high performance envelope, geothermal heating and cooling, and solar hot water reduce the EUI by 50% compared to a typical multifamily building. In order to maximize the outdoor space available to occupants, the building footprint was reduced, and the roof area cannot accommodate the PV required to offset 100% of the building consumption." Source: Margaret Pigman



Source: "Chimera" - Tom Tang; 2011 Competition



Source: *Zero Net Energy Case Study Buildings,* Volume 2 (Speculative Office Building at 435 Indio Way) by Edward Dean

Performance Characteristics Table

A table, like the example below, can quickly and clearly show the performance-related characteristics of a building and demonstrate how the ZNE goal is being met.

This is a hypothetical chart that can be modified by entrants.

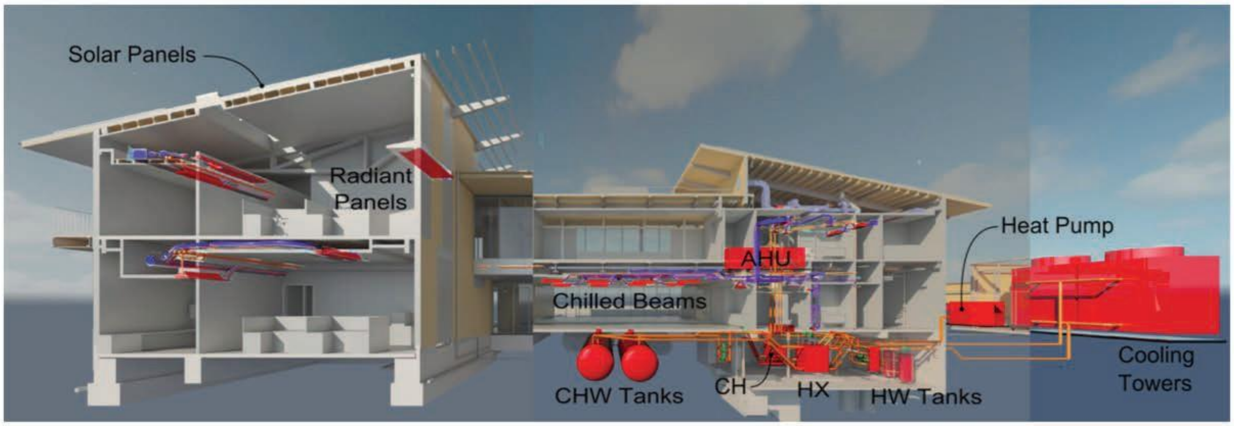
	Example 1	Example 2
Modeling Software	OpenStudio 1.10	eQuest 3.64, SketchUp
Building Envelope		
Wall R-value	R-21	R-30
Window to Wall Ratio	80%	40%
Window U-value, SHGC	0.22, 0.2	0.3, 0.25
Roof R-value	R-42	R-30
Space Conditioning		

Heating System Type	Condensing boiler	Ground source heat pump
Heating System Efficiency	0.96 EF	4.2 COP
Cooling System Type	Natural ventilation	Ground source heat pump
Cooling System Efficiency	N/A	4.2 COP
Ventilation Strategy	Natural ventilation	ERV
Water Heating		
Water Heating System Type	Solar thermal, condensing boiler	Heat pump water heater
Water Heating System Efficiency	boiler 0.96 EF	3.2 COP
Domestic Hot Water Demand (gal/person/day)	15	20
Lighting, Appliances, and Plug Loads		
Lighting Type	LEDs	LEDs
Lighting Power Density (W/sf)	0.7	1
Lighting Controls	occupancy sensors	daylight dimming
Appliance and Plug Load Power Density (W/sf)	0.7	0.8
Plug Load Controls	none	smart power strips
Renewables		
Renewable System Type	PV	PV, micro vertical axis wind turbines
Renewable Capacity (kW)	6,000 kW	4,000 kW PV; 1,000 kW wind

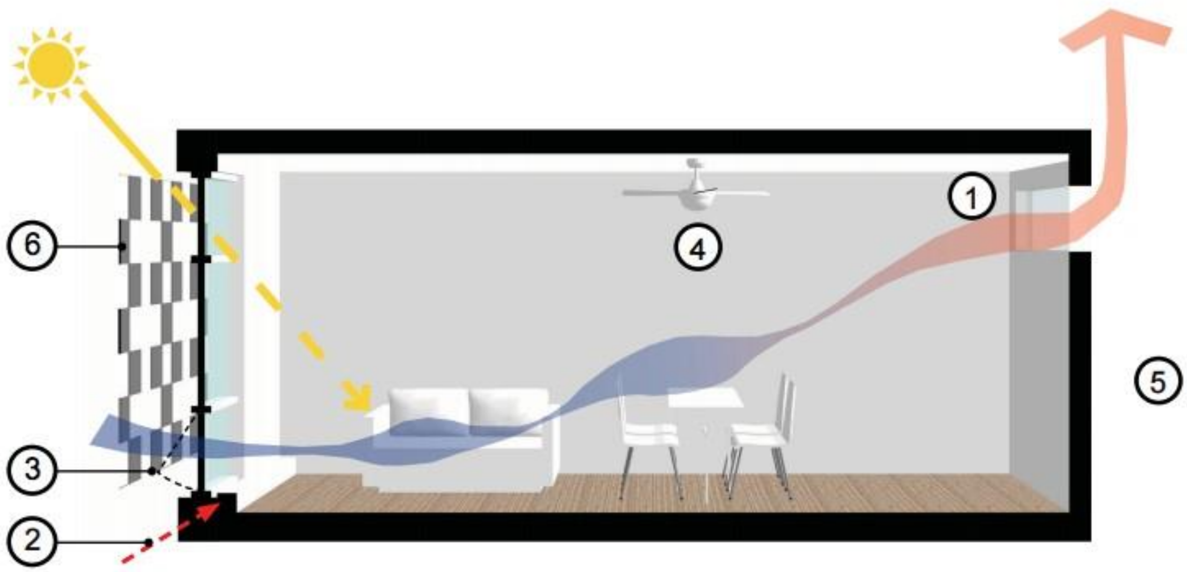
Annotated Diagram of HVAC System

A diagram depicting the major components of the HVAC system or systems serving spaces can be at the unit or building level.

The following diagrams are examples from entries from sources not connected to this competition and are meant to be for reference only.

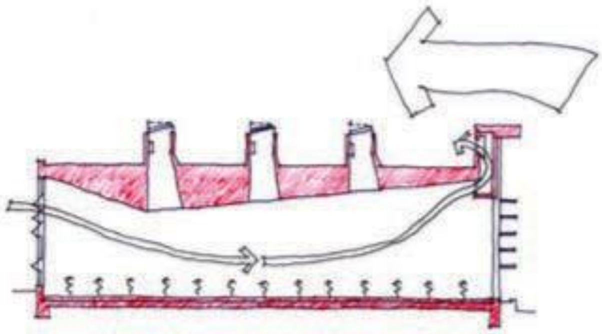


Source: Integral Group, taken from *Zero Net Energy Case Study Buildings* (Packard Foundation Headquarters) by Edward Dean

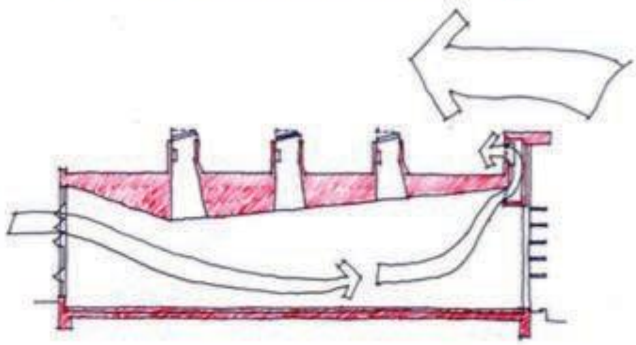


1. **PASSIVE STACK EXHAUST:** Single loaded corridor combined with operable windows allows for natural cross ventilation throughout the unit and on those occasions with warmer or hot weather in San Francisco, the window placement aids night flushing of the unit for greater occupant comfort.
2. **HYDRONIC BASEBOARD RADIATOR:** Part of a shared solar thermal domestic hot water loop which uses water as a highly efficient means to transfer heat from the centralized solar thermal panels. Placement beneath the window helps to temper any radiation of cold which may be felt by the occupant.
3. **OPERABLE WINDOWS:** Allows for natural ventilation. Using low/high placement of operable panes, in combination with operable panes at the opposite side of the unit, permits occupants a high degree of control, expanding the comfort range and improving Indoor Air Quality (IAQ) contributing to increased occupant comfort and wellness.
4. **CEILING FANS:** Very low energy devices providing increased air movement and greater occupant control for an expanded comfort range, improved Indoor Air Quality (IAQ) and contributing to increased occupant comfort and wellness.
5. **LIGHT WELLS:** Opening up the circulation side of the traditional double-loaded corridor allows for cross ventilation of units, provides more natural light over more of the interior (greater daylight autonomy) and helps balance the daylighting for a higher quality of light.
6. **SHADING SCRIM:** Translucent, lightweight and durable panels, suspended on cables in front of the south and west facades, the density of the scrim directly responds to the annual solar insolation falling on the façade, allowing all units to maintain a maximum amount of glass while still maintaining a comfortable interior environment. On the north and east facades, the solar insolation is lower so the scrim is not required and the interior comfort can be maintained with a high performance envelope and glazing.

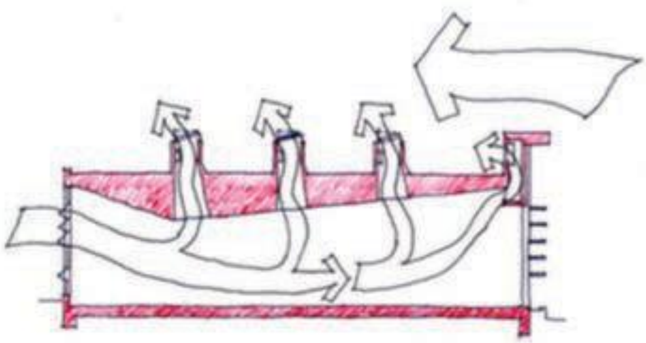
Source: "Zero Emission" - BAR Architects; 2015 Competition



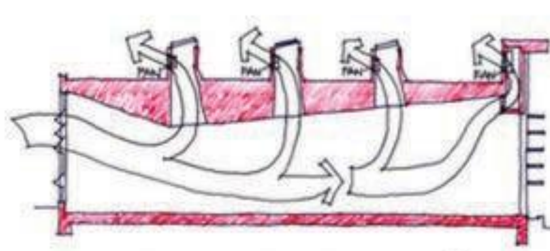
Mode 1: Heating Season



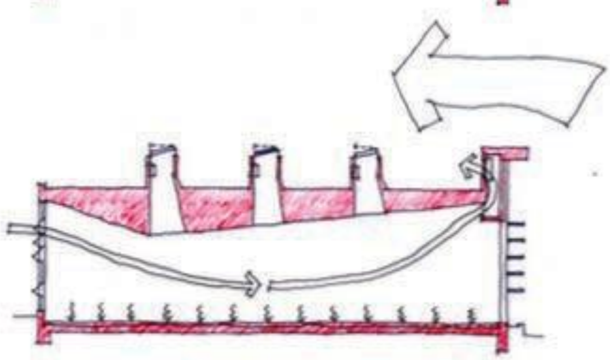
Mode 2: Swing Season



Mode 3: Cooling Season / Good Wind Conditions



Mode 4: Cooling Season / Poor Wind Conditions



Mode 5: Peak Cooling Events

Mode 1. Heating Season Operation. In this mode, the radiant heating system is on and the passive ventilation system admits the minimum amount of outdoor air as required by code.

Mode 2. Swing Season Operation. No heating required and the amount of outdoor air required for fresh air and (at times) cooling varies. The wind chimney drives the air flow through the building spaces.

Mode 3. Cooling Season Operation—Good Wind Conditions. Increased amounts of outside air are required for cooling purposes. Designated skylights open to allow movement of larger volumes of outdoor air.

Mode 4. Cooling Season Operation—Poor Wind Conditions. System design includes backup fans at skylight shafts to engage and ensure air flow under poor wind conditions and for *night purging*[9] using cool night air. (Skylights are closed.)

Mode 5. Operation in Peak Cooling Events. Outdoor air is too warm for cooling, so full cooling mode with radiant slab cooling via heat pumps engages. The passive ventilation system admits the minimum amount of outdoor air as required by code.

Source: *Zero Net Energy Case Study Buildings,* Volume 2 (West Berkeley Library) by Edward Dean

Occupant Behavior

Ultimately, it is the behavior of the occupants that determines a building's energy consumption. How does the design account for and influence occupant behavior?

These are two sample statements from the 2015 competition:

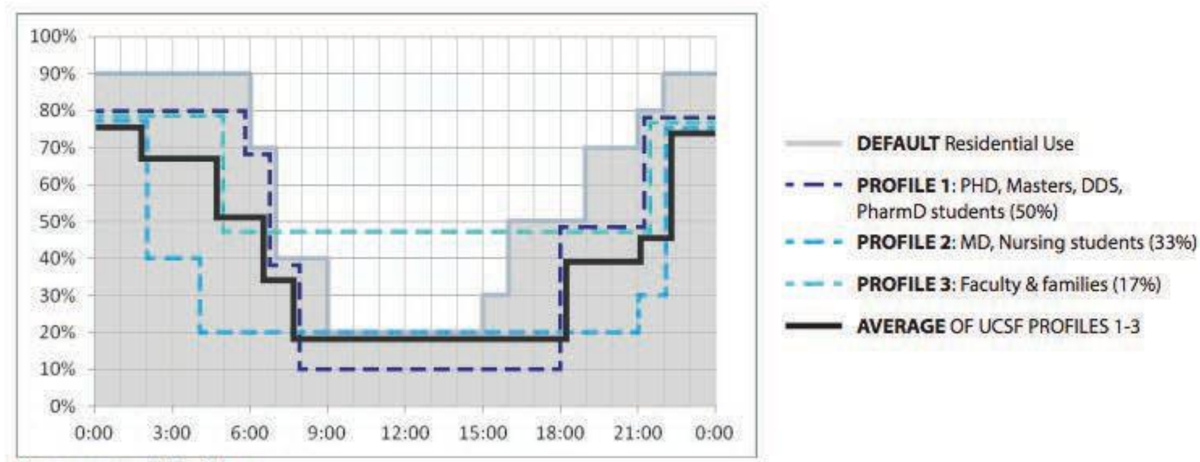
"Recognizing that Generation Z lives online and smart phones and other devices that enable it are ubiquitous, energy information feedback would include an app that provides:

1. How an individual resident's apartment and end uses use energy, including near-real time, historical usage, and usage relative to net zero "budget" that is weather-normalized. Residents would be able to view (anonymously) their own apartment's normalized energy usage within their "neighborhood" as a benchmark to privately see how they are performing compared to their neighbors.
2. How the individual's "neighborhood" within the building is using energy, again considering near-real time, historical usage, and relative to net zero "budget." Competition between floors is encouraged by clearly identifying the high-performing floors within the building.
3. How each building is using energy at any given time. Residents would again be able to view each building's normalized energy usage relative to the net zero budget. Competition between buildings can be encouraged by identifying the high-performing building(s) within the project.
4. Renewable energy production would be displayed in real time, as well as over the last week, month, and prior 12 month period.
5. Resident's may optionally configure the app to "push" energy alerts to them to them when they are wasting energy relative to their budget, or they achieve exemplary performance relative to the budget and benchmarks.

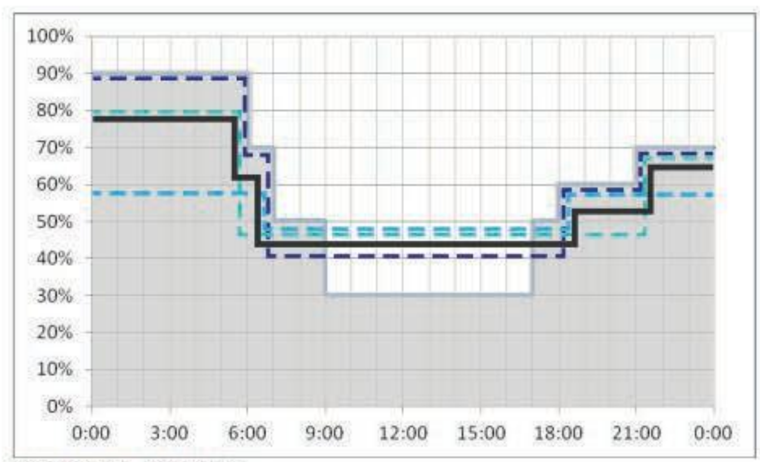
A key aspect to encourage competition and drive occupancy behavior to better efficiency, is to publicly display performance levels in addition to the smart phone app for the individual. Between "neighborhoods" (floors within the building), a visual display on centrally located walkways in the open courts will indicate the top three efficiency leaders. Similarly, between the three apartment buildings within the project, a portion of the exterior of the building will identify

the highest performing building (relative to the zero-energy budget) to the broader campus through colored LED lighting."
Source: "Conspicuous Consumption" - Weber Thompson; 2015 Competition

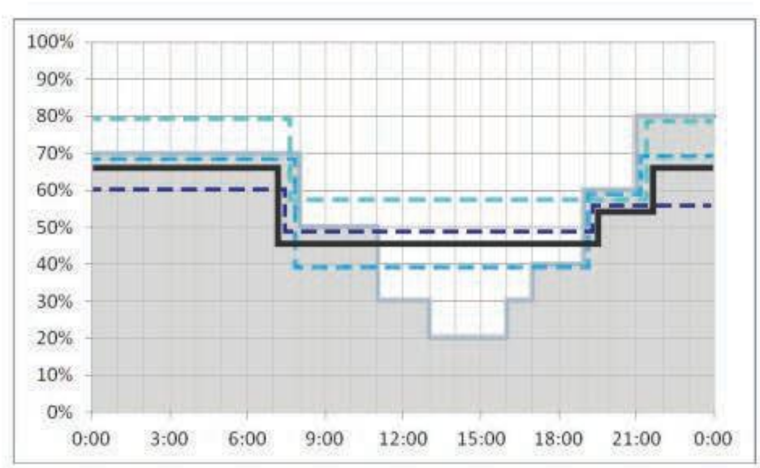
"As building's set lower resource use goals and employ active strategies to achieve those goals the role of occupants is critical. There is an opportunity to address how high performance buildings affect occupants (comfort) and how occupants can in-turn affect building performance (engagement). Occupant 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."
Source: "Breeze Block" - Cornell University; 2015 Competition



Occupancy – Weekday



Occupancy – Saturday



Occupancy – Sunday

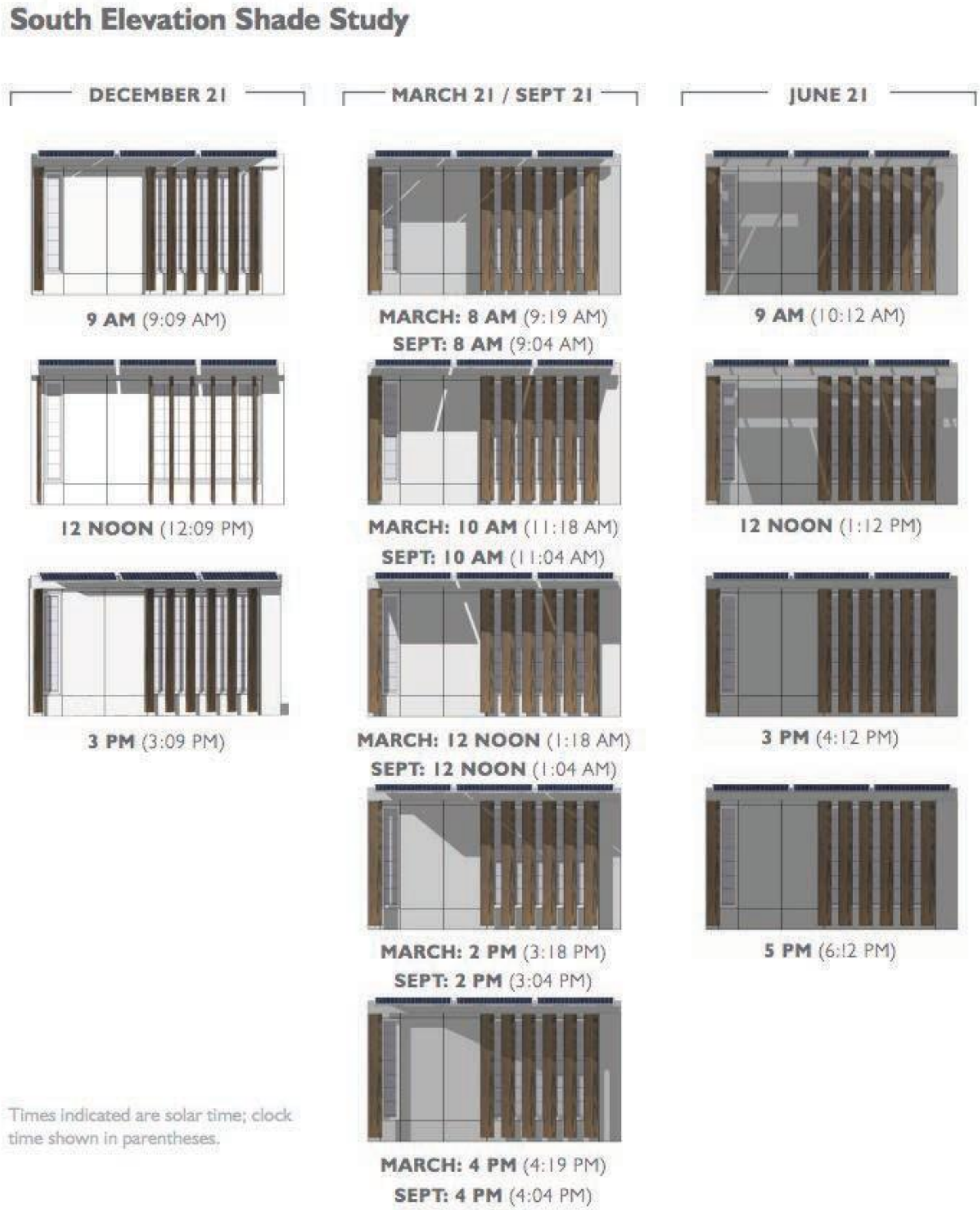
Source: "Conspicuous Consumption" - Weber Thompson; 2015 Competition

Shading Studies

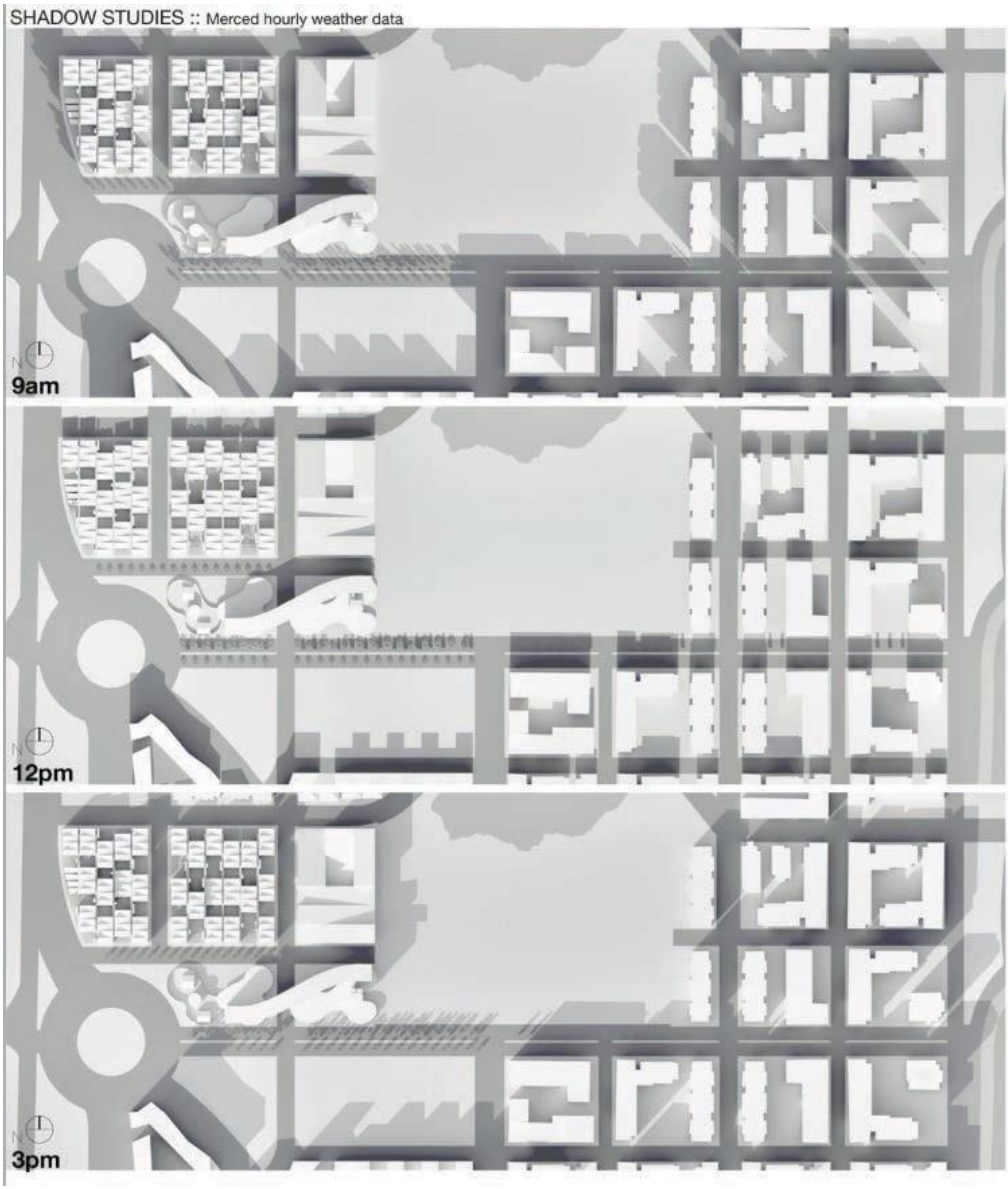
Shading studies at both the site and facade levels can help maintain access to and freedom from direct sun under different conditions.

These are examples from past competitions:

Source: “Catalyst SF” - Booth Hansen; 2013 Competition

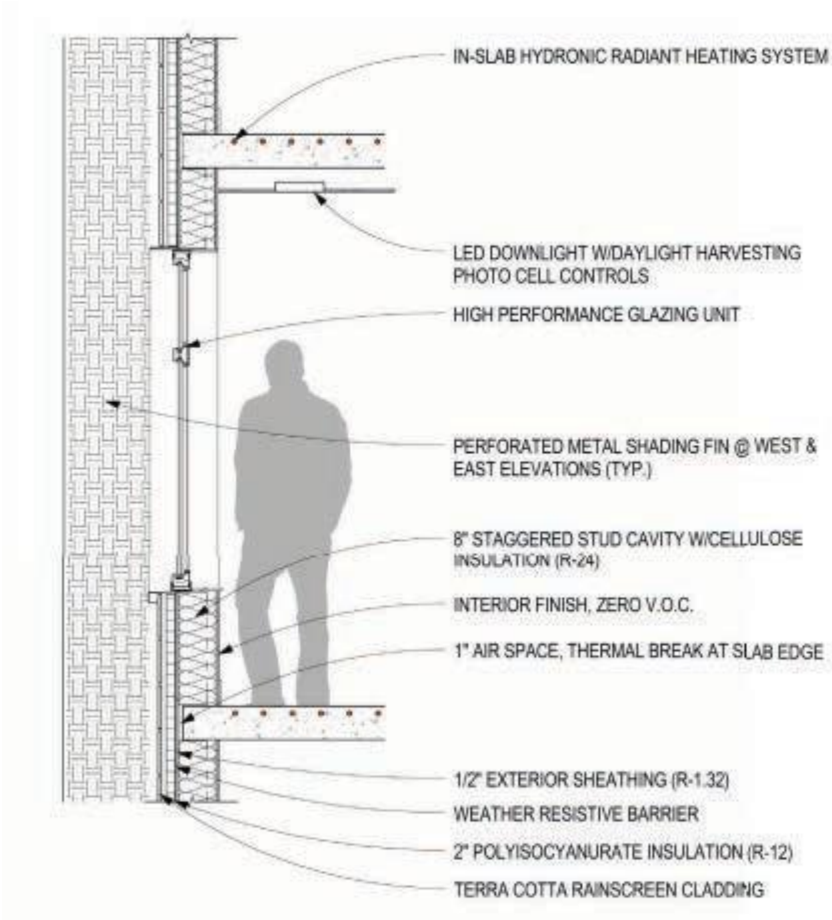


Source: “Conspicuous Consumption” - Weber Thompson; 2015 Competition

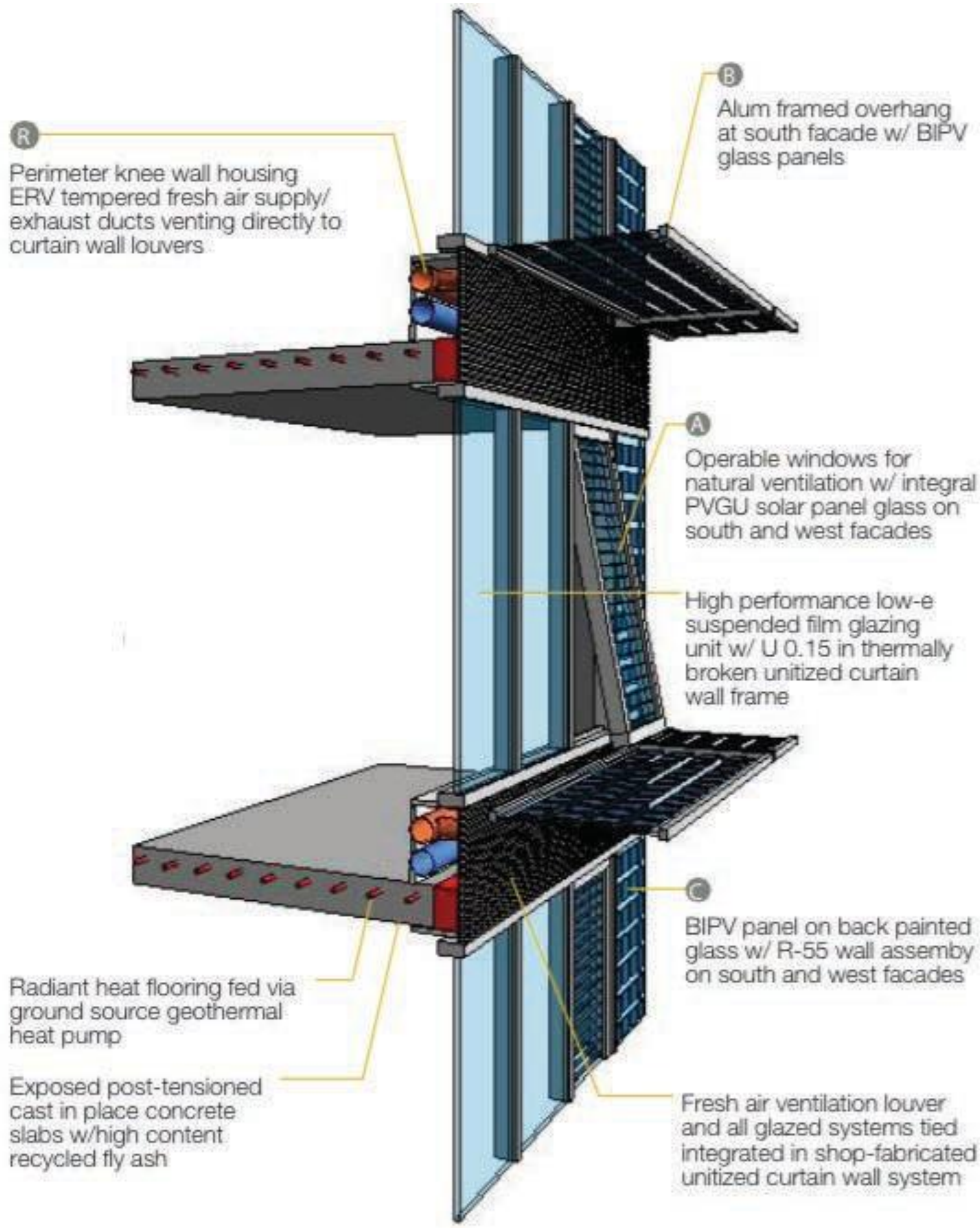


Source: “Silver Streak” - Loisos + Ubbelohde; 2012 Competition

Wall Section



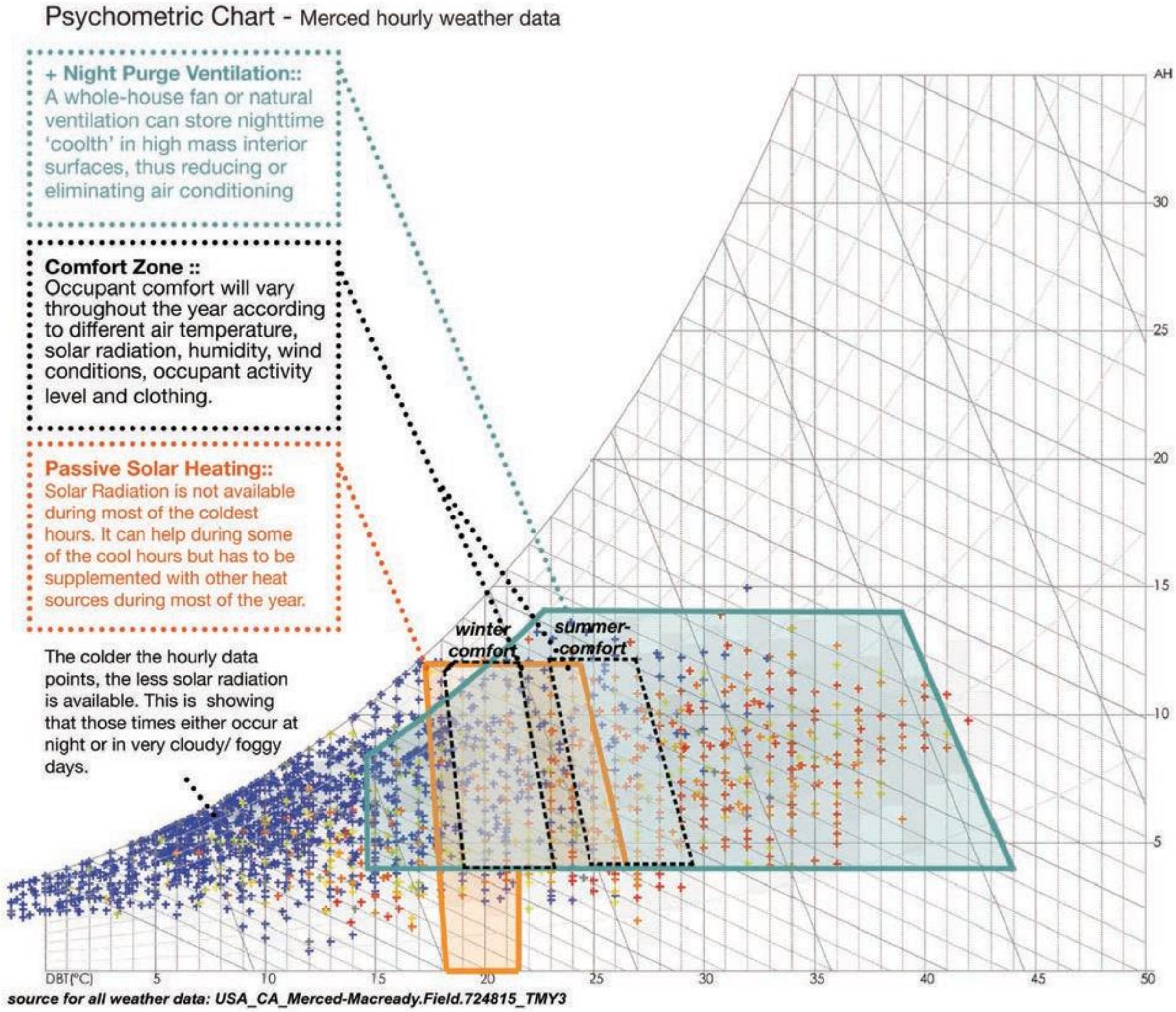
Source: “Estuary” - Mithun; 2015 Competition



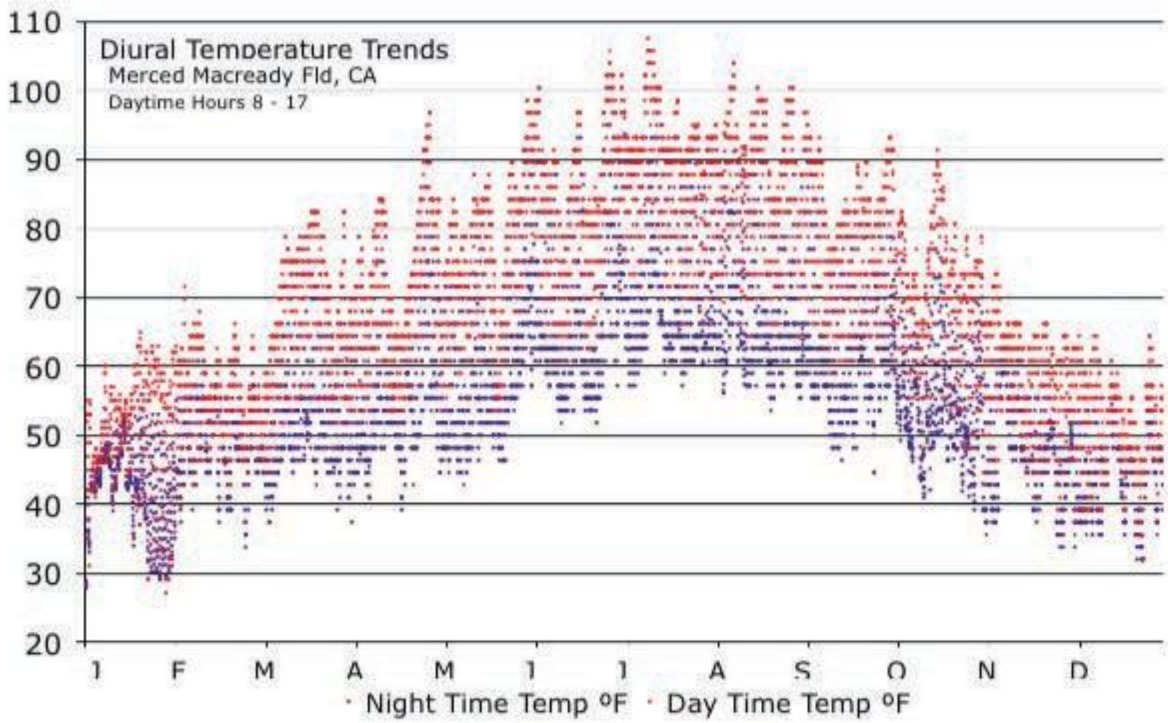
Source: "Catalyst SF" - Booth Hansen; 2013 Competition

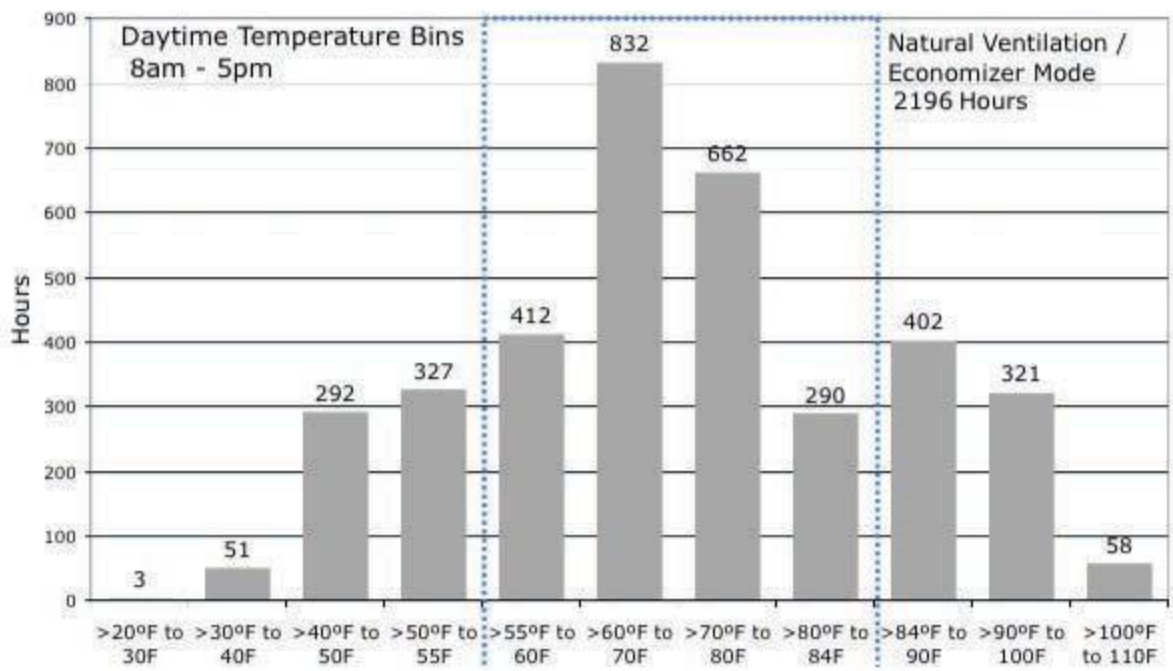
Climate Analysis

How does the particular climate of the site inform the building design? These are examples from past competitions:



Source: "Silver Streak" - Loisos + Ubbelohde; 2012 Competition





Source: "Homeostasis" - Wei Yan, Edward Clark; 2012 Competition

SUBMISSION REQUIREMENTS

Submission Materials

1. Design Board File
2. Board Imagery/Text Files
3. Design Team Spreadsheet
4. Supplementary Documentation (optional)
5. Copy of Student ID (if applicable)

1. Design Board File (PDF document)
Entries will be judged based on one presentation board containing the elements listed under "Required Documentation", above. Download Design Board Guideline File.
The Design Presentation Board must be exactly ARCH E1 Size (30"h x 42"w) in landscape format wide and saved as a PDF document. The drawing dimensions may vary slightly; the design board file is a guideline.

Do not include information about the design team on the Design Presentation Board. Indication of the design team will result in disqualification.

2. All components of your board must be submitted as JPEG files if they are images, or Microsoft Word files if they are text.

3. Design Team Spreadsheet (Microsoft Excel document): Fill in the names and contact information for **everyone** on your project design team. Download Design Team Form.

4. Supplementary Documentation - Optional (PDF document): While it is not required, entrants are encouraged to submit supplemental documentation to elaborate on their ZNE design and the process around it. Some possible elements are listed above for inspiration. The PDF document should measure 8.5" x 11".

Do not include information about the design team on the Supplementary Documentation. Indication of the design team will result in disqualification. Please number the pages.

5. Student ID (if applicable): Full-time student entrants must provide a copy of their student ID. Recent graduates must have been enrolled full-time during the 2016 or 2017 calendar years and must provide official documentation of their full-time student status during those years (diploma, student ID showing date, etc.).

Submission Packet: Ensure that your submission packet contains items 1-3 (#4 optional, #5 if applicable) and upload through submit section by **Tuesday, January 30, 2018 at 1:00 pm PST**.