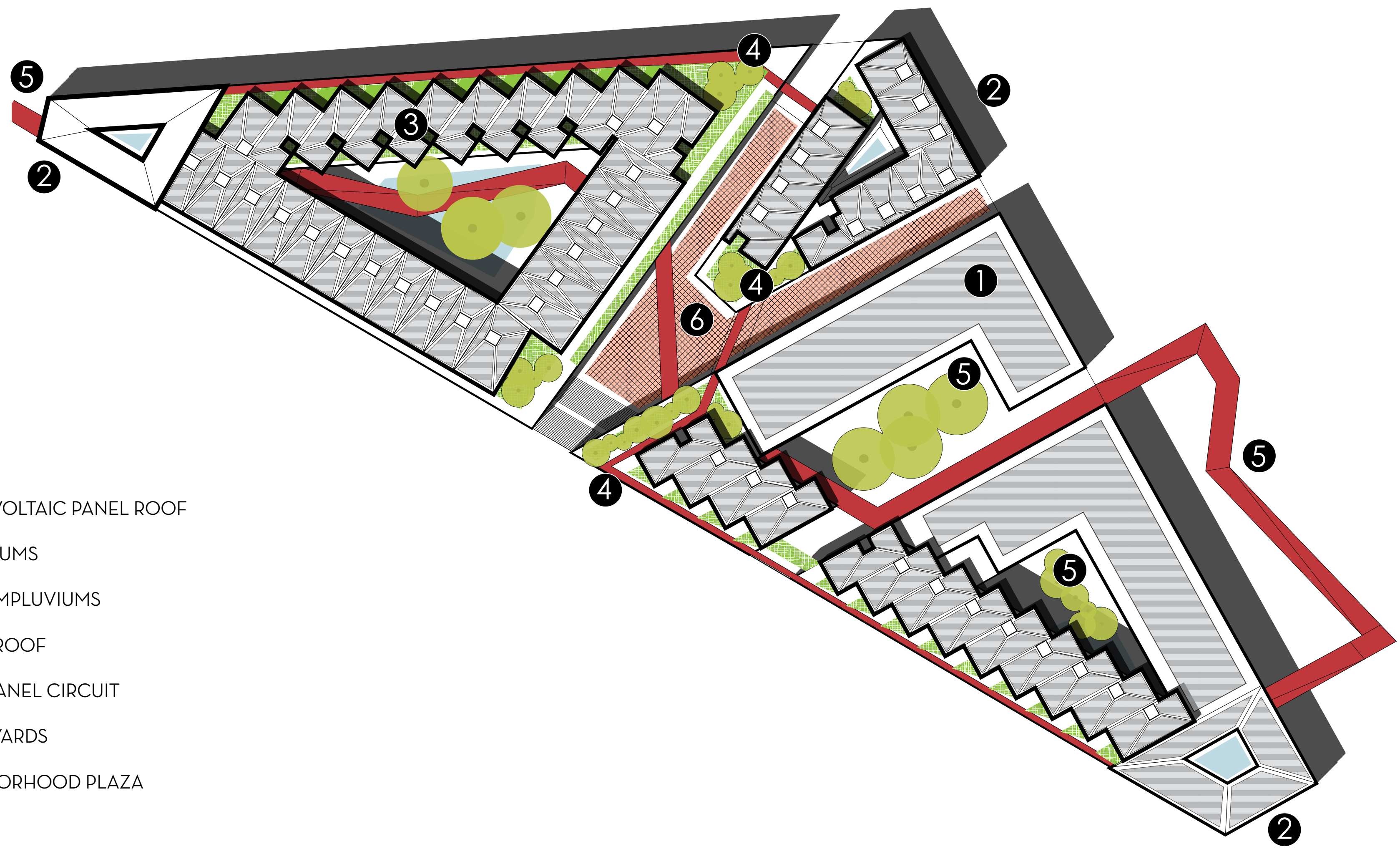
PIEZEIN CIRCUIT

ARCHITECTURE AT ZERO 2016

A NEW NEIGHBORHOOD CENTER

Piezein Circuit will become a fulcrum for the SFSU campus as well as the surrounding neighborhood. It sits as a hinge between a regional retail center, an underutilized lake and public park, the campus core, high density housing, and recreational facilities. We are proposing to use the pedestrian path as an architectural armature, a generator for neighborhood spaces, and a production platform for renewable energy -- all from the idea of a simple stroll.

THE SITE PLAN



1 PHOTOVOLTAIC PANEL ROOF
2 IMPLUVIUMS
3 MICROIMPLUVIUMS
4 GREEN ROOF
5 PIEZO PANEL CIRCUIT
6 COURTYARDS
7 NEIGHBORHOOD PLAZA

URBAN PERFORMANCE SYSTEMS

The sustainable components of the Piezein Circuit begin at the scale of the individual user and living unit. Both passive and active sustainable design features address all scales they are propogated along the piezoelectric path from doorstep to streetscape, the building and beyond.

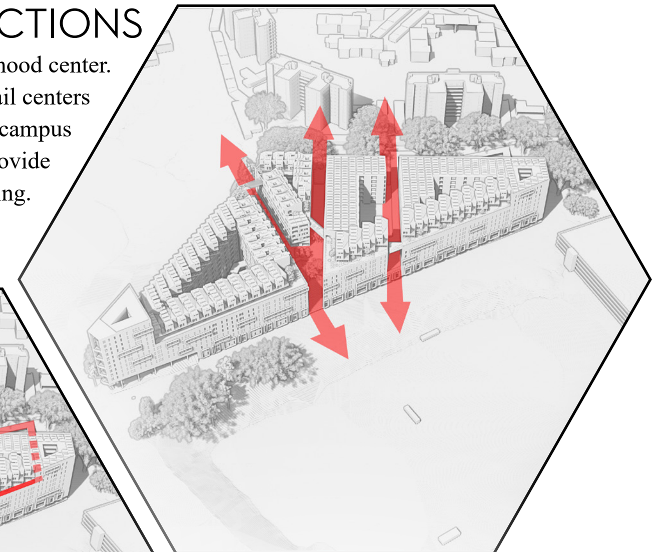
Micro-impluviums are used in key locations, such as the denser areas of the building, to collect rainwater in shallow pools. As the water evaporates and mixes with air in the atrium, it produces a natural cooling effect for the adjacent units. This coupled with stack ventilation for night flushing provides a thorough passive strategy for cooling the thermal masses of living areas. As for an overall heat island mitigation strategy, a layer of vegetation is applied to all roof areas where possible to provide shade and evaporative cooling, reducing not only the roof temperatures, but the temperature of the surrounding air.

To provide a large scale, practical form of renewable energy, grid-tied solar photovoltaic (PV) panels are applied to roofs and facades in areas with the most efficient orientation and full sun exposure. A photovoltaic thermal hybrid system (PVT) is used on roofs in conjunction with this to also provide for water heating, as this is much more efficient than a pure PV design, and the cooling effect of water assists in generating electricity at a much higher efficiency.

In a net zero building with such a high occupancy, it's difficult to dismiss the energy being continuously exerted by its residents. In multi-family complexes, there is a constant ebb and flow of human activity throughout the common circulation and gathering spaces. In order to harvest this energy produced, an organized series of circulation conduits are situated throughout the building, guiding foot traffic into calculated stretches. Clusters of piezoelectric floor tiles are placed in these paths to capture the wasted energy from the applied pressure of the occupants' footsteps, convert this kinetic energy into electricity, and then redistribute it as needed. One principal path is generated and given prominence by design. This celebrated passageway leads through the entire complex and acts as a significant generator of building form, winding its way through all major spaces, spilling out to major public and university thoroughfares, and providing some of the best vistas the site can offer. This encourages more use, further aiding in the piezoelectric energy harvesting efforts, while having the added benefit of contributing to the increased overall health of the occupants.

ESTABLISH URBAN CONNECTIONS

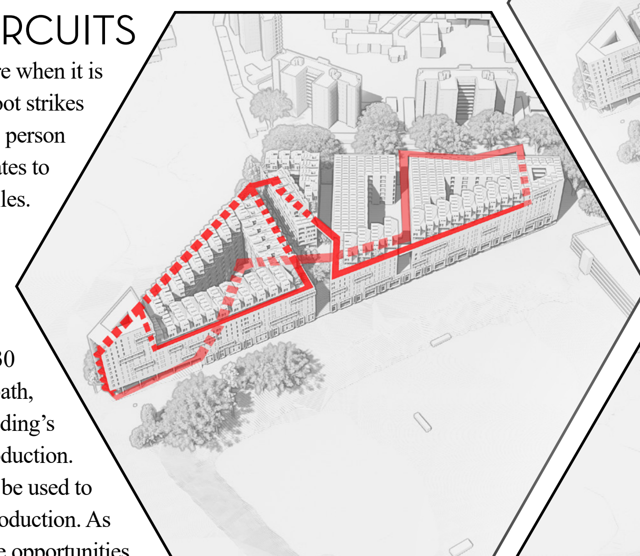
These new circulation spines create new opportunities for the creation of a neighborhood center. Walkability within the neighborhood is enhanced through connections between the large retail centers to the northeast, recreational fields to the south, Lake Merced to the east, and the SFSU campus core to the southeast. These passages also carve additional, linear “courtyards” that provide units with opportunity for natural ventilation and daylighting.



CREATE LOCAL PEDESTRIAN CIRCUITS

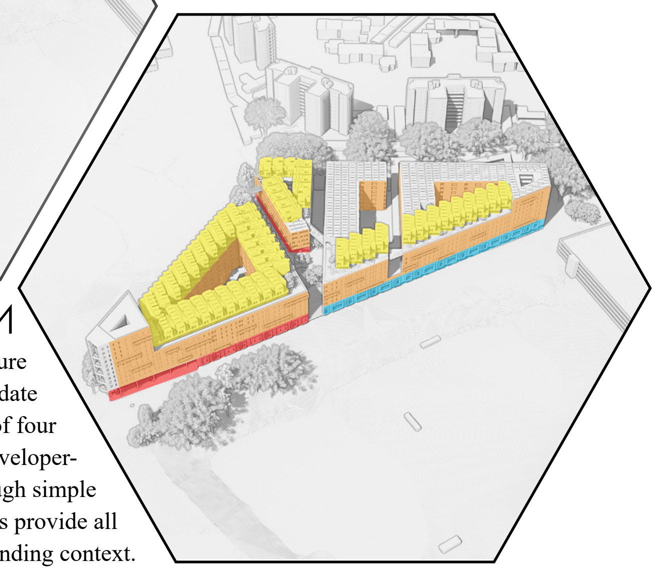
Piezoelectric materials generate electricity by creating a potential within the material structure when it is displaced. In this case, by using the piezoelectric materials allow for energy harvesting caused by foot strikes as a person walks over it. The energy output will depend on the frequency and force exerted by the person as they walk, which can be approximately 1 to 1.5 times the individual’s body weight. This translates to approximately 5 Watt-seconds per step for an average sized person that can be harvested by the tiles.

The Piezoelectric path as designed is approximately 0.5 miles long. Assuming the average person has a stride of ~1.3 feet, it would take 1,974 steps to walk the entire length of the pathway. This would generate approximately 2.75 W/h per person. The housing complex at full capacity will contain approximately 2,630 residents. Using a 1.2 multiplier to account for staff and visitors, 3,130 people would be available to traverse the Piezo path. If each person were to walk a full mile on the path, it would produce a total of 17.1 kWh of energy a day, and 6,265 kWh annually, or 0.2% of the building’s total annual energy usage. These are baseline models. Increasing walkability increases energy production. This technology is new and rapidly improving. At this time, the energy production would only be used to light the exterior lights. However, new versions of the paver show promise for additional energy production. As important as energy production, the Piezo circuit is designed to facilitate a human scale and provide opportunities for daily interaction between, residents, commuting students and visitors alike.

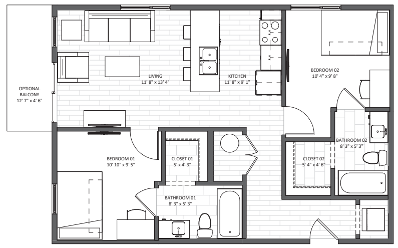


STACK PROGRAM

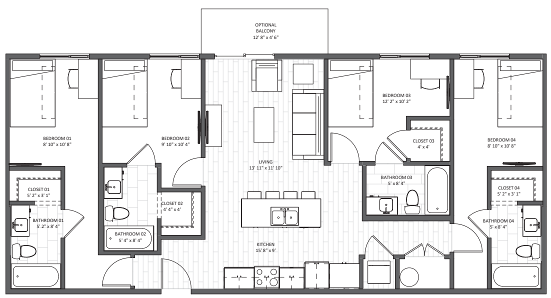
There are four basic components of program. The base is made up of public and semipublic program including parking, lecture halls, public art gardens,and a plaza with adjacent coffee shop and daycare. The parking is tucked away to accommodate vehicular entry but ultimately encourage a park-once environment. The public “plinth” sits below several stories of four bedroom suites. These suites are accessed off of double loaded corridors and provide an economically-efficient, i.e. developer-friendly “meat” to the project. In otherwords, additional cost of other architectural components can be offset through simple unit types. The townhouses are actually triplexes derived from the iconic San Fransisco townhouse, These units provide all the walkability of a typical San Fransisco street with unparalleled views of the surrounding context.



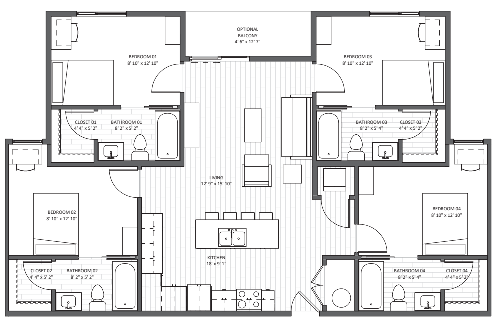
UNIT PLANS - STUDENT SUITES



SUITE TYPE 03

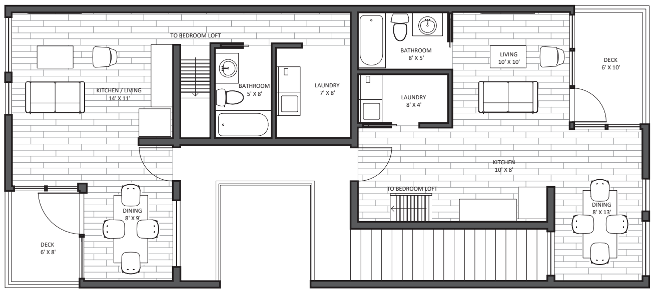


SUITE TYPE 02

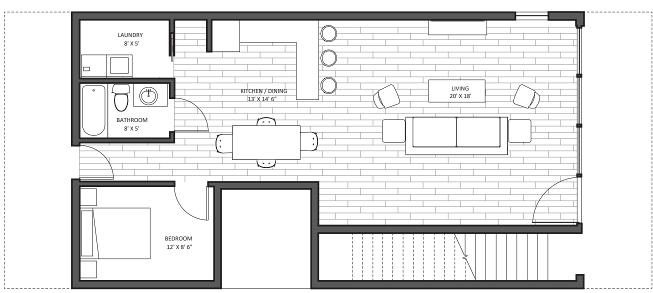


SUITE TYPE 01

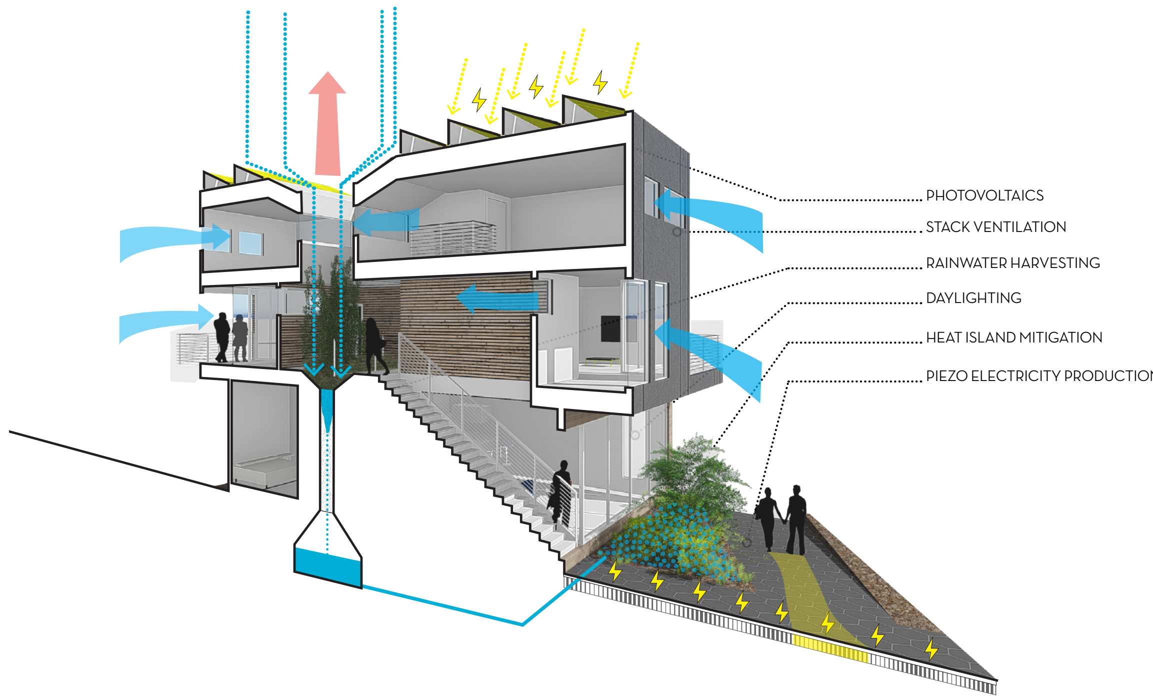
UNIT PLANS - EVOLVING THE TOWNHOUSE

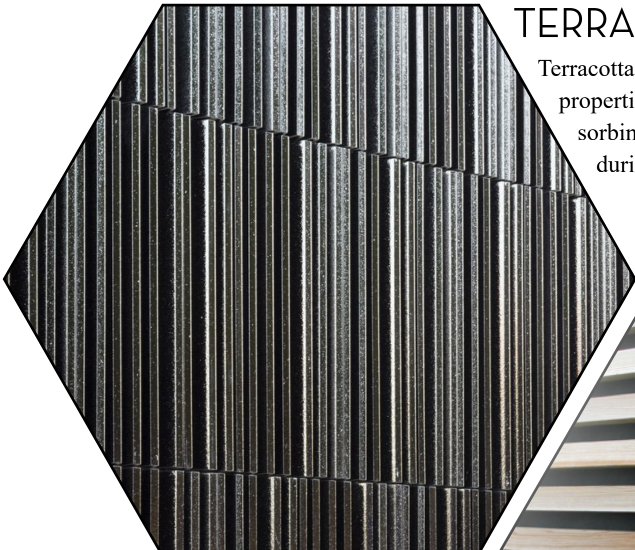


TOWNHOUSE UNIT - LEVEL 2



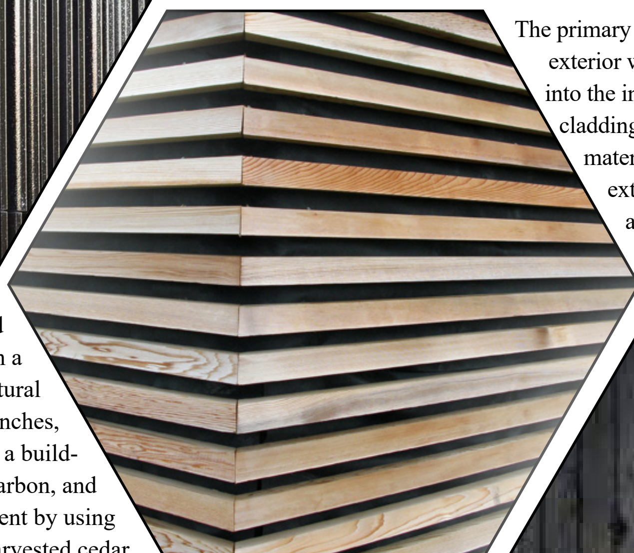
TOWNHOUSE UNIT - LEVEL 1



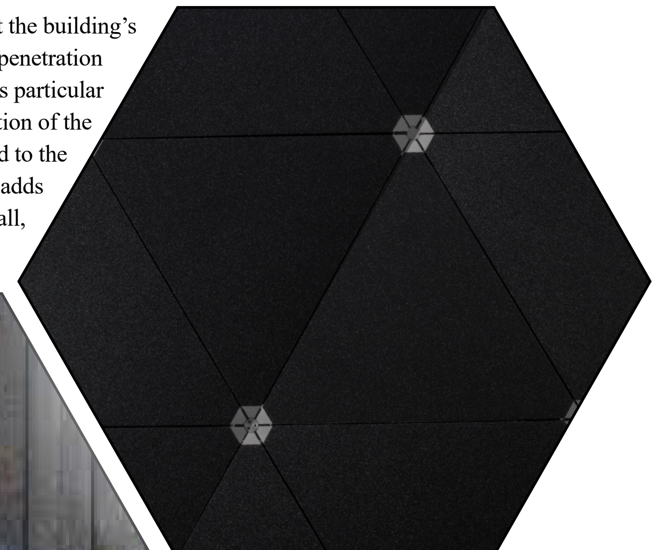


TERRACOTTA RAINSCREEN

Terracotta is a clay-based natural material used in building construction. The thermal properties of this earthen material allows for the façade to act as a thermal mass, absorbing and storing heat energy to keep buildings cool during the day, and warmer during the night when the heat dissipates.



The primary purpose of a rain screen is to protect the building's exterior walls from water in order to prevent penetration into the interior of the building. By adding this particular cladding system, you can slow the deterioration of the materials that would otherwise be exposed to the exterior elements. The rain screen also adds a layer of thermal insulation to the wall, which can minimize energy costs.



Carbon sequestration is a process by which CO2 is removed from the atmosphere and held in a liquid or solid form. Trees are a natural storage place for C02; their leaves, branches, and roots absorb it. By using cedar as a building material, we are continuing to store carbon, and actually reducing the carbon in the environment by using sustainably harvested cedar.

CEDAR RAINSCREEN (NATURAL OR CHAR FINISH)

Cedar is yet another natural material used in the project. Cedar has a dense quality and is lightweight. It is also resistant to decay, making it ideal for a construction application.

Charred cedar has a multitude of design benefits. The ancient Japanese technique of charring, known as *shou sugi ban*, extends the life of cedar siding by decades – up to 75 years with no additional maintenance. The darkened finish of this charred application allows the cedar to also act as a thermal mass for the complex.

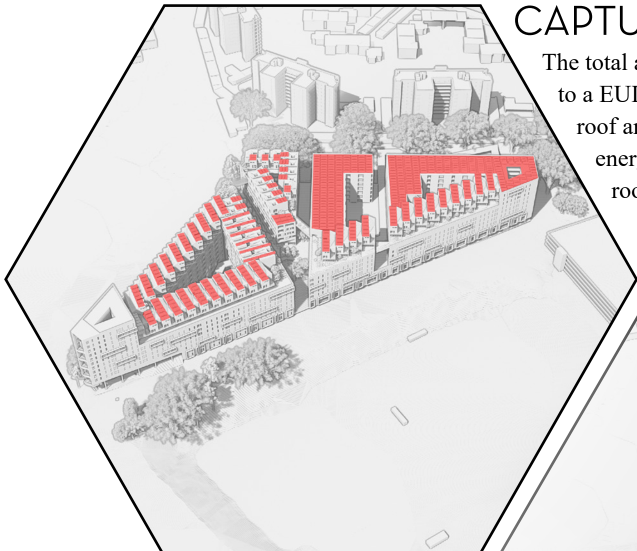
PIEZOELECTRIC TILES

Piezoelectric floor tiles are made from eco-friendly recycled plastic material. Coupled with its ability to harvest energy from foot traffic, it becomes a viable resource in green energy production.

ENERGY PERFORMANCE SYSTEMS

Based on the schematic design, an energy model was created to predict the building energy consumption. This analysis represented all space types defined within the competition outline. The model was initially based on ASHRAE 90.1-2007 values for envelope, lighting, HVAC, and plugloads before being improved to what might be found in a Net Zero building. This Net Zero building increased wall and roof insulation to R-20 and R-30, respectively. Center-of-glass glazing performance was set to U-0.35 and SHGC of 0.25, with a window to wall ratio of 20% applied to the entire building. Interior lighting was reduced to 0.3 W/ft2 in the dorm spaces and 0.25 W/ft2 for the corridors. Each dorm room was assumed to house 4 students.

The HVAC system selected was the ASHRAE 90.1-2007 Appendix G Baseline System 2, packaged terminal heat pumps. These had an improved heating efficiency of 3.5 COP and baseline cooling efficiency of 8.46 EER. Cooling efficiency was not improved over the baseline due to the local climate zone requiring small amounts of cooling. The building rarely requires cooling, but will require heating throughout the entire year.



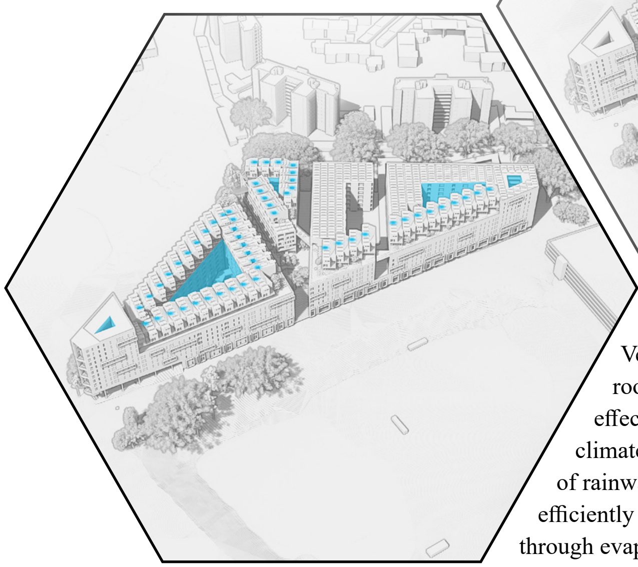
CAPTURE SUSTAINABLE ENERGY

The total annual energy use for the building from the energy model is 2,736,647 kWh, which works out to a EUI of 7.5, well within the estimated requirement for a Net Zero building. The building has a total roof area of 150,500 ft2, which could potentially hold a 2,090 kW photovoltaic system. However, the energy from the model would only require a 1,800 kW system, which would use 129,650 ft2 of the rooftop.

HEAT ISLAND MITIGATION & GROUNDWATER RECHARGE

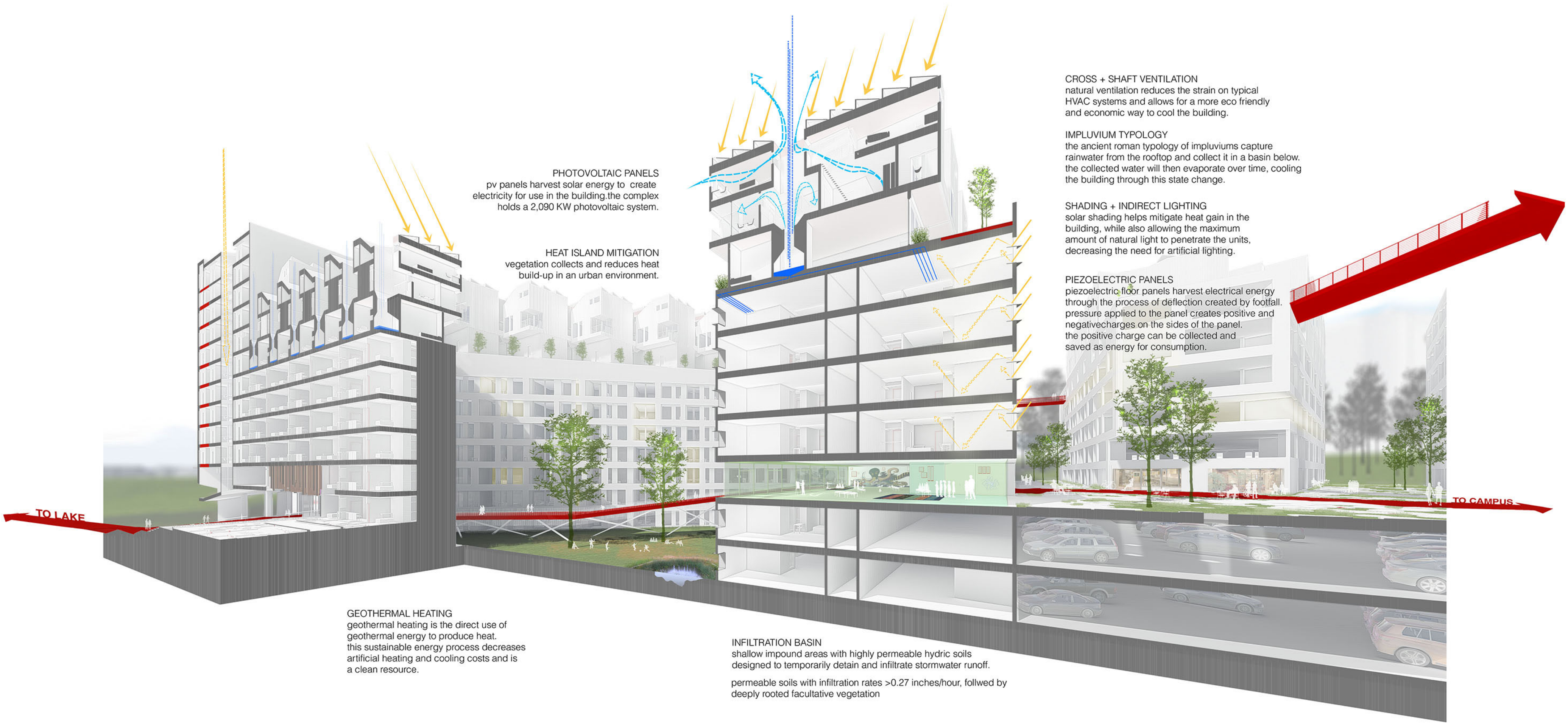
Healthy trees are essential components of green infrastructure and urban forestry. Shade trees planted along hard surfaces reduce the heat island effect and improve air quality. Besides functioning as carbon sinks, trees also reduce stormwater runoff through interception, evapotranspiration, throughfall, and flow attenuation. Trees help create a sense of place, reduce noise and glare, and provide a safety barrier for pedestrians from traffic, which is why neighborhood value is increased by their presence.

Infiltration basins (at the ground in courtyards) in the courtyards improve water quality by filtering stormwater runoff through hydric soils and recharging groundwater supply. In addition to water filtration, infiltration basins use facultative plants for phytoremediation to mitigate pollutants from stormwater runoff.



PROVIDE PASSIVE COOLING & STORMWATER HARVESTING

Vegetated roofs collect rainwater at its source, slow its release, and reduce its volume through evapotranspiration from plants. Vegetated roofs also regulate building temperature through additional thermal insulation, reducing heating and cooling loads. They are especially effective in controlling intense, short-duration storms, and have been shown to reduce cumulative annual runoff by 50 percent in temperate climates. In San Fransisco,where rainfall is more than 23 inches annually, a 1,000 square foot roof will produce a minimum of 13,800 gallons of rainwater per year for irrigation. Three impluviums at the scale of the project and a microimpluvium at each townhouse provide areas to efficiently collect stormwater for reuse in irrigation at localized conditions. These impluviums have an added benefit of cooling air temperature through evaporation and providing an additional face for units to allow for cross ventilation.


PHOTOVOLTAIC PANELS
pv panels harvest solar energy to create electricity for use in the building.the complex holds a 2,090 KW photovoltaic system.
HEAT ISLAND MITIGATION
vegetation collects and reduces heat build-up in an urban environment.
CROSS + SHAFT VENTILATION
natural ventilation reduces the strain on typical HVAC systems and allows for a more eco friendly and economic way to cool the building.
IMPLUVIUM TYPOLOGY
the ancient roman typology of impluviums capture rainwater from the rooftop and collect it in a basin below. the collected water will then evaporate over time, cooling the building through this state change.
SHADING + INDIRECT LIGHTING
solar shading helps mitigate heat gain in the building, while also allowing the maximum amount of natural light to penetrate the units, decreasing the need for artificial lighting.
PIEZOELECTRIC PANELS
piezoelectric floor panels harvest electrical energy through the process of deflection created by footfall. pressure applied to the panel creates positive and negativecharges on the sides of the panel. the positive charge can be collected and saved as energy for consumption.
TO LAKE
TO CAMPUS
GEOTHERMAL HEATING
geothermal heating is the direct use of geothermal energy to produce heat. this sustainable energy process decreases artificial heating and cooling costs and is a clean resource.
INFILTRATION BASIN
shallow impound areas with highly permeable hydric soils designed to temporarily detain and infiltrate stormwater runoff.
permeable soils with infiltration rates >0.27 inches/hour, follwed by deeply rooted facultative vegetation