ENERGY PERFORMANCE DOCUMENTATION

Alveo:

AN URBAN PUEBLO FOR INNOVATIVE LIVING

TASK 2 - Preface
This project features highly integrated building systems as is required for high performance projects. It will be valuable for those evaluating this project to consider this brief project preface, as it sets the stage for a clear understanding of the project as a whole.

Structural System
The program design is satisfied by a single building with exposure specific zoning, and features a concrete podium for the first two building levels as well as the 100 cubic meter below grade/building water storage cistern. Above the podium, the hybrid structural system includes Cross Laminated Timber (CLT) floor/ceilings and exterior walls, paired with load bearing pre-cast reinforced concrete composite unit-demising shear walls (2 inch concrete, 4 inch air space, 2 inch concrete with steel web reinforcing similar to http://thin-wall.com/THiN-Wall/Engineers.html). This assembly makes it possible for the structure to serve many purposes at a similar first cost when compared to a traditional full concrete structure. The CLT floors provide thermal and acoustic isolation between units, have a lower embodied energy content and increased renewable material content, have a lower weight which drives decreased earthwork, foundation, and structure project costs and material impacts, and provide a beautiful warm finish appearance. There is not currently a code provision for the CLT structural system in this building height, but our structural engineer's extensive experience with this system brings confidence in the appropriateness of this solution as a topic for re-examining and updating building codes to be in alignment with the state of the art as well as the state of the environment. The 'above podium' unit-demising composite walls provide gravity and lateral resisting structure, a utility chase, acoustic separation performance, a clean durable modern finish, and an ideal thermal mass thickness and distribution that, due to its thin-ness, will remain closer to the thermal comfort range contributing to both conductive and radiative thermal comfort as well as modest passive thermal storage delay.

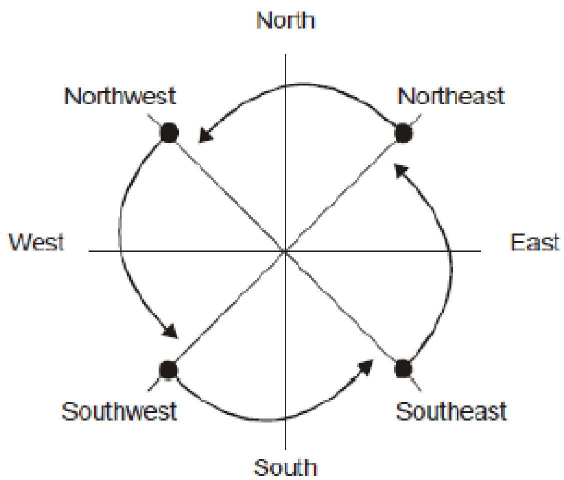
Thermal Mass
Thermal mass thickness and distribution has been optimized to moderate temperature fluctuations, level and delay passive heat distribution, as well as to provide radiative surface heat storage to work in concert with in-unit natural ventilation. Thermal mass is stored in 3 inch thick concrete slab floors, Cross Laminated Timber (CLT) exterior walls and pre-cast reinforced concrete composite unit-demising walls, 2 inch thick pre-cast concrete in-unit partitions, and exposed CLT floor/ceilings. Over the course of a year, this strategy improves thermal comfort by 22%, allowing natural ventilation to provide adequate space conditioning in the residential units even during the few hours of the year where outdoor air conditions are out of range for thermal comfort. These thermal mass strategies also help to reduce heating load demand in the residential common space areas as well as heating and cooling loads in the ground floor non-residential spaces.

2A. Window-to-Wall Ratio

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

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

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



North

Step 1: Total area of light transmitting glazing surfaces on north facade: 12,179 sf

Step 2: Total area of north façade: 35,963 sf

Window-to-wall ratio of north façade = $\frac{\text{number from step 1}}{\text{number from step 2}}$ = 33.9%

East

Step 1: Total area of light transmitting glazing surfaces on east facade: 10,419 sf

Step 2: Total area of east façade: 42,909 sf

Window-to-wall ratio of east façade = $\frac{\text{number from step 1}}{\text{number from step 2}}$ = 24.3 %

South

Step 1: Total area of light transmitting glazing surfaces on south facade: 12,947 sf

Step 2: Total area of south façade: 37,360 sf

Window-to-wall ratio of south façade = $\frac{\text{number from step 1}}{\text{number from step 2}}$ = 34.7 %

West

Step 1: Total area of light transmitting glazing surfaces on west facade: 9,880 sf

Step 2: Total area of west façade: 41,942 sf

Window-to-wall ratio of west façade = $\frac{\text{number from step 1}}{\text{number from step 2}}$ = 23.6 %

Total Building Window-to-Wall Ratio

Step 1: ~~Façade~~ area$_{total}$ = step one$_{north}$ + step one$_{east}$ + step one$_{south}$ + step one$_{west}$ = 45,426 sf glass

Step 2: ~~Light transmitting glazing~~$_{total}$ = step two$_{north}$ + step two$_{east}$ + step two$_{south}$ + step two$_{west}$ = 158,175 sf wall (gross)

Total window-to-wall ratio = $\frac{\text{number from step 1}}{\text{number from step 2}}$ = 28.7 %

2B. Window Openings and Window Shading

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

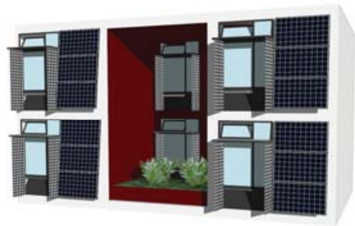
Type of window and glass:
North, South, West & East facing (all exposures feature the same glazing performance as described below)
U-factor: 0.3503 SHGC: 0.7127 Visable Transmittance: 0.76

Building Massing, Façade Design, and Window Shading
The building massing and unit plans are deeply informed by optimizing utilization of passive energy resources in the push toward Net Zero Energy. The East and West facades are dominated by deep relief (10 foot deep) window wall pockets. This undulating façade form provides building self-shading, increases access to daylight and natural ventilation, and works to provide a combination of views and comprehensive privacy for all in-unit spaces. In addition, each window group is fitted with a horizontal interior and exterior light shelf located between the eye level glazing and the upper daylighting ribbon glass. the large eye level glazed area is also fitted with accordion style manually operated perforated metal shutters that provide occupant controllability of solar penetration into the unit.

The North and South facing building areas have primarily flat facades supplemented by interior light wells to maximize passive resource access for these solar exposures. For the North and South, less low angle building self-shading is required and are best served with modest horizontal shading on the south, and slightly inset windows on the North. The light wells provide the additional daylight and natural ventilation for these conditions.

With the building façade design, moderate climate, and extensive natural ventilation access, computer simulations show that the window to wall ratio (WWR) and glazing performance are much less critical to energy consumption and thermal comfort control than is the case in less optimized conditions. Given the efficacy of natural ventilation in this design and the minimum Title 24 performance requirements for windows, daylighting was the primary energy consideration when designing the window wall ratio. A gross WWR of 28.7% was implemented to incrementally push the project toward its energy goals. The overall form of the building plan was developed to maximize access to the free energy resources of sun and air, in an effort to maximize quantity of these passive capture building surfaces and edges. This approach resulted in a building with two large courtyards which also provide extensive social gathering and recreation space. This urban forest with large trees and a mix of hardscape and landscape provide a beautiful views as well visual privacy separation between dwelling unit windows and courtyard occupants.

South Facade shading effect



December 21: 9am

December 21: 12noon

December 21: 3pm

March 21: 8am

March 21: 10am

March 21: 12noon

March 21: 2pm

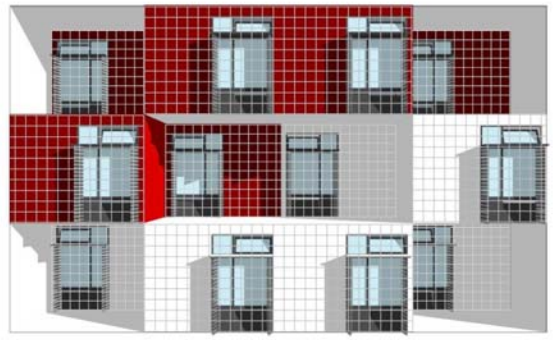
March 21: 4pm

June 21: 9am

June 21: 12noon

June 21: 3pm

West Facade shading effect

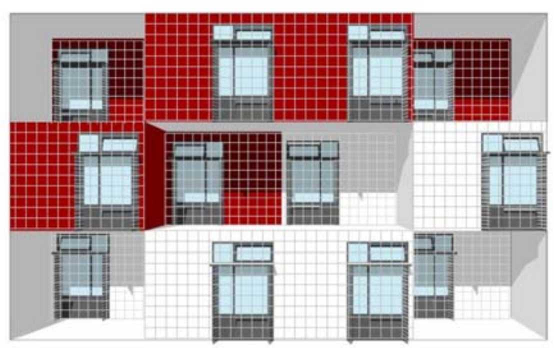


December 21: 3pm

March 21: 2pm

March 21: 4pm

June 21: 3pm



June 21: 5pm

2C BUILDING ENCLOSURE DETAILS
SOUTH AND WEST FACADE, RESIDENTIAL

1 - Exterior wall and ceiling interior finishes – exposed architectural cross laminated timber structure
· Provides insulated, thermal mass, low embodied energy, renewable material assembly

2 - Linear direct daylight dimmable LED fixture – oriented parallel to the window wall
· Provides high efficacy, low glare supplemental lighting

3 - Daylight vent window – fiberglass frame, manually operable, 6.5 sf open area
· Thermally broken, view, light, and ventilation vent

4 - Roof Insulation – R-30

5 - Light shelf – (30" exterior / 18" interior projections), High Pressure Laminate – exterior grade
· Moderate thermal conductivity for reduced thermal bridging, high recycled content and exceptional weathering durability

6 - Operable shutter – Twin 2 panel accordion folding perforated anodized aluminum screens (75% opacity), manually operable
· Provides adjustable summer heat rejection, glare control, and privacy

7 - Solar thermal collector – mounted 25 degrees off of the South wall
· Provides heat for building low temperature thermal loop and thermal battery storage system

8 - Rain screen over a 2 inches rigid foam insulation continuous therm break (R-14)

9 - Cross laminated timber exterior wall panels
· Non-structural panels (R-7.5)

10 - Natural ventilation vent - fiberglass frame, manually operable, 6.5 sf open area (R-14)

11 - Vision glazing
· Fiberglass frame, manually operable, provides access to the shutters

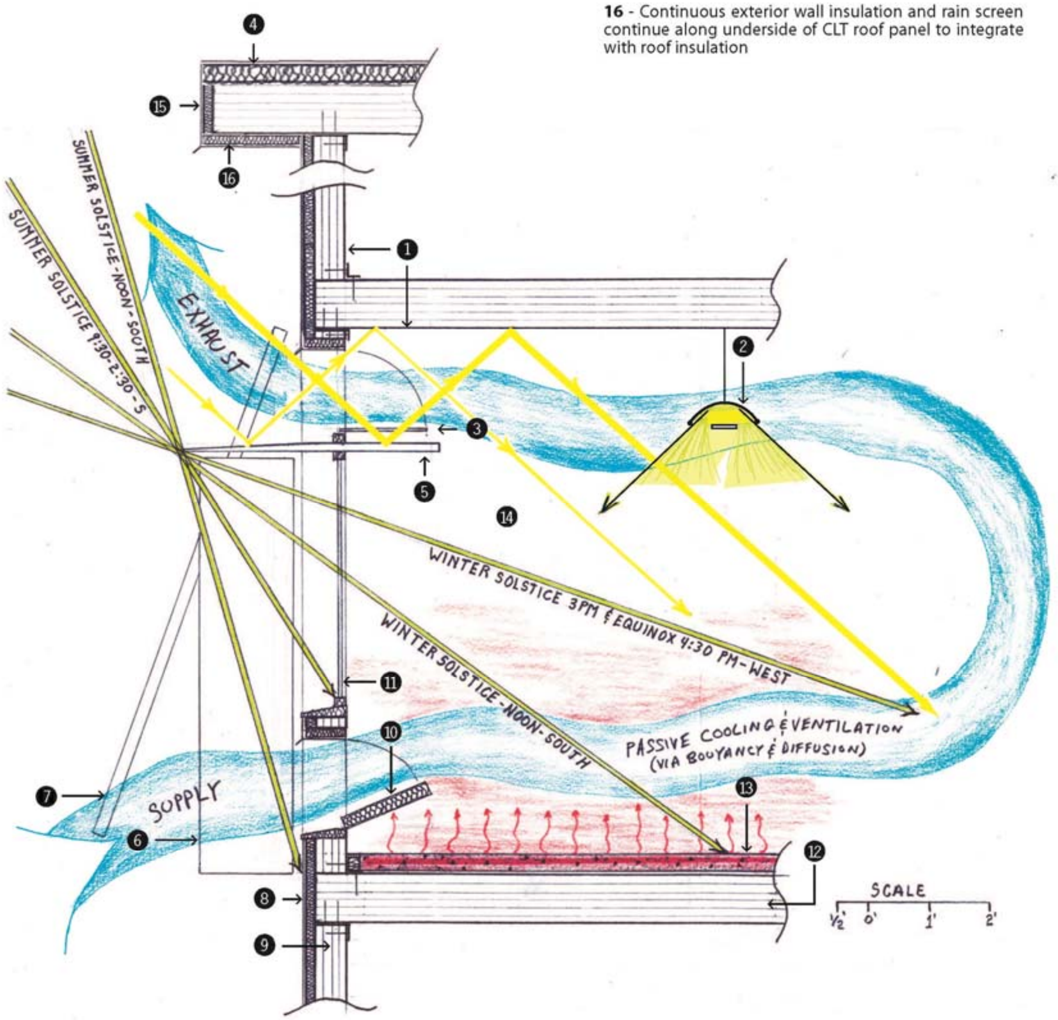
12 - Cross laminated timber floor structure (R-11)

13 - Exposed sealed pea gravel concrete topping slab with a pex tubing radiant hydronic heat source placed on a ½ inch rubber sound mat

14 - Composite precast thin wall concrete unit-demising wall – exposed finish

15 - Sheet metal fascia integrated via self-adhered membrane to high SRI 2-ply SBS roofing

16 - Continuous exterior wall insulation and rain screen continue along underside of CLT roof panel to integrate with roof insulation



2D END USE BREAKDOWN MODELLING INPUT AND RESULTS

All energy system performance calculations were performed using the IES's Virtual Environment and NREL's System Advisor Model (SAM). In order to determine the inputs for these tools a number of resources were consulted to develop baseline lighting and plug load energy use numbers. These baseline numbers were then adjusted based on the assumption that maximum energy efficient technologies were to be employed. The table below details the results of this effort.

Appliance/Load Description	Watts	Min/day	hrs/week	kWh/week
Cell Phone and & Phone Charger	*2.24*	*191*	*22.3*	*0.05*
Clothes Dryer	*2800*	*8*	*0.9*	*2.52*
Clothes Washer	*512*	*12*	*1.3*	*0.69*
Coffeemaker	*1100*	*18*	*2.1*	*2.31*
Desktop Computer	*73.97*	*12*	*1.4*	*0.1*
DVD Player	*25*	*10*	*1.2*	*0.03*
Electric Kettle	*1500*	*1*	*0.1*	*0.14*
Hair Dryer	*1875*	*3*	*0.3*	*0.625*
Laptop Computer	*35*	*634*	*74.0*	*2.59*
LED Bulb (Floor & Desk Lamp)	*8.5*	*484*	*56.5*	*0.48*
Printer on Standby	*2*	*214*	*25.0*	*0.05*
Stereo	*400*	*7*	*0.8*	*0.33*
Total	*8334*	*10*	*1.19*	*9.915*

All of the values in the above table are assumed to scale linearly by occupancy. Additionally, some loads were considered to scale by number of dwelling units, the table below shows how these loads vary by unit type.

Unit	Average Occ.	Occ. Load	Fridge Description	Fridge kWh/week	Television Description	Television kWh/week
Studio	*1*	*9.91*	*4.5-cu ft., Energy Star*	*4.81*	*19"*	*0.17*
1 BR	*1.5*	*14.87*	*4.5-cu ft., Energy Star*	*4.81*	*32"*	*0.3*
2 BR	*2.5*	*24.7875*	*10-cu ft., Energy Star*	*6.81*	*42"*	*0.43*
3 BR	*3.5*	*34.7025*	*15-cu ft., Energy Star*	*8.27*	*50"*	*0.58*

To calculate installed lighting power density, IESNA standards for luminance level were used in conjunction with high performance lighting fixtures to determine the minimum power density required to meet the residential lighting needs.

For non-residential building areas, ASHRAE 90.1 2010 standard lighting levels were used in conjunction with appendix G modeling specifications for non-regulated loads (including plug loads), as well as typical schedules. The following table shows the final equipment and lighting power densities for all use area:

Use Area	**Lighting Power Density (W/sf)**	**Equipment Power Density (W/sf)**
Child Care	*0.87*	*1*
Residential	*0.6*	*0.75*
Offices/Common rooms	*0.9*	*0.75*
Security Office	*0.96*	*0.75*
Retail	*1.4*	*0.25*
Corridors	*0.66*	*0*
Total	*0.66*	*0.62*

In-unit lighting energy use is reduced through daylighting tailored to specific: unit density, solar exposure, building massing, and floor plate depth. The building includes light colored deep pockets primarily on the East and West exposures providing building self-shading for thermal and glare control during low sun angles. North and South exposures utilize both exterior wall and internal light well glazing to maximize daylight penetration and bi-lateral distribution, as well as the more uniform sun angles found on those walls. Exterior walls feature modest view glazing as well as high wall ribbon windows from 6'-6" AFF to 8'-0" AFF combined with inside/outside light shelves to achieve a 65% to 95% Continuous Daylight Autonomy (cDA) for the variety of unit type configurations based on 100 lux at the work surface. In-unit floor plate depths are limited to maximize daylight access, and closets are located in the deepest areas to reduce the effective floor plate depth. Ceiling heights are maintained at 9 feet above finish floor (AFF) in all residential spaces to maximize depth of light bounce, and all in-unit interior partitions feature full wall length borrowed light glazing from 7 feet AFF to the ceiling, allowing additional daylight penetration into all spaces. All daylighted spaces will be equipped with continuously dimming wired lighting fixtures and ceiling mounted light level sensors. Finally, the exterior facades are served by a metal mesh manually operated shutter system that allows residents a range of solar protection at the view glass ranging from 100% open to fully closed with a 80% opacity to control glare and un-needed heat gain. Based on this arrangement of light wells, deep building façade pockets, and modest shading exceptional thermal and visual comfort are available to the occupants.

Plug load reduction will be influenced primarily through unit level dashboards (Described in section 2H). Each room will also be equipped with a switched outlet connected to the daylight sensor intended for use with occupant provided lighting, as well as an occupancy sensor controlled outlet for non-critical plug loads.

The calculated energy use results for the whole building are detailed in the table below:

	Design Load		**Energy Use kBtu/sf/yr**
HVAC	*N/A*		*2.82*
Lighting[1,2]	*0.66*	*W/sf*	*3.52*
Appliances and Plug Loads[1]	*0.62*	*W/sf*	*6.82*
Domestic Hot Water	*20,300*	*Gal/day*	*10.12*
Total	*N/A*		*23.3*
Renewable Production	*N/A*		*24.46*
Net EUI	*N/A*		*-1.16*

[1]Loads shown are average values weighted by floor area.
[2]Light energy use modeled with a 30 fc minimum illuminance with daylighting controls

2E WHOLE BUILDING
HEATING AND COOLING SYSTEM

2E.1 Heating and cooling system Description

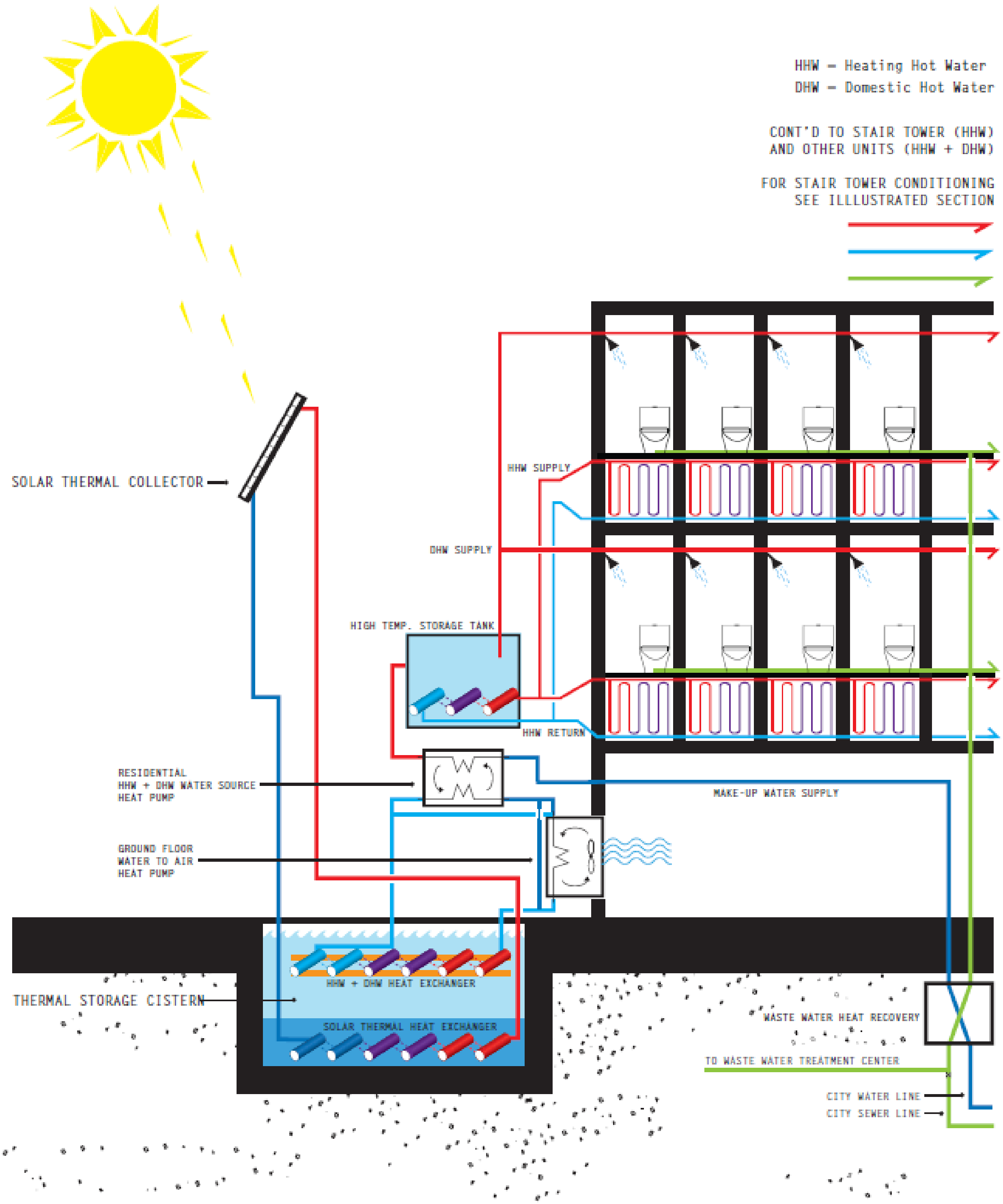
Solar radiation is collected and supplied to a moderate temperature thermal storage cistern. A moderate temperature water loop circulates between the warm upper layers of the cistern and water-to-water heat pumps (WWHP) arranged in parallel. The heat pumps collect energy from the moderate temperature water loop and store it in high temperature water tanks. The WWHPs and high temperature storage tanks are located adjacent to zones served. Residential units grouped by orientation and exterior exposure are served by a single linked heat pump and hot water storage system, providing both domestic hot water (DHW) and heating hot water (HHW). The hot water storage tanks include an integral heat exchanger to provide HHW to the radiant floors in the residential units. This HHW loop also serves to supplement the passive heating of the common areas and corridors.

Ventilation and air tempering of residential common spaces (corridors, stairs, stair lobbies, and open study spaces) is provided by a novel passive/active hybrid approach. Stair towers are located along the East, West, and South building exposures and function as ventilation air supplies providing either unconditioned ambient or tempered outside air. Each of these stair towers are sheathed with transpired air collector (TAC) panels, and are positioned to have multiple solar exposures. This allows each stair tower access to either ambient temperature or solar heated air during daytime hours, which is then delivered directly to the stair volume and connected common spaces on a floor by floor basis. A TAC air header located at each floor level includes a 0% to 100% modulating bypass damper controlled by indoor/outdoor differential temperature sensors to optimize supply air temperature. The TAC air supply system also benefits from passive stack effective pressurization within the collector, therefore helping to augment supply air pressure. The exhaust side of this system consists of a corridor high-ceiling located 90 degree turning vane duct and exhaust grill at the mid length of each corridor section spilling that air into the courtyards. The supply locations also include low static pressure hydronic radiators (served by the residential space heating hot water systems) which are available to increase common space supply air temperatures during the limited evening hour seasonal periods when additional heat is required. The supply and exhaust locations are also fitted with in-line auxiliary fans (having low static pressure when not powered up) which allow these spaces to respond to the occasional condition when CO2 levels are above threshold, or when temperatures are below threshold.

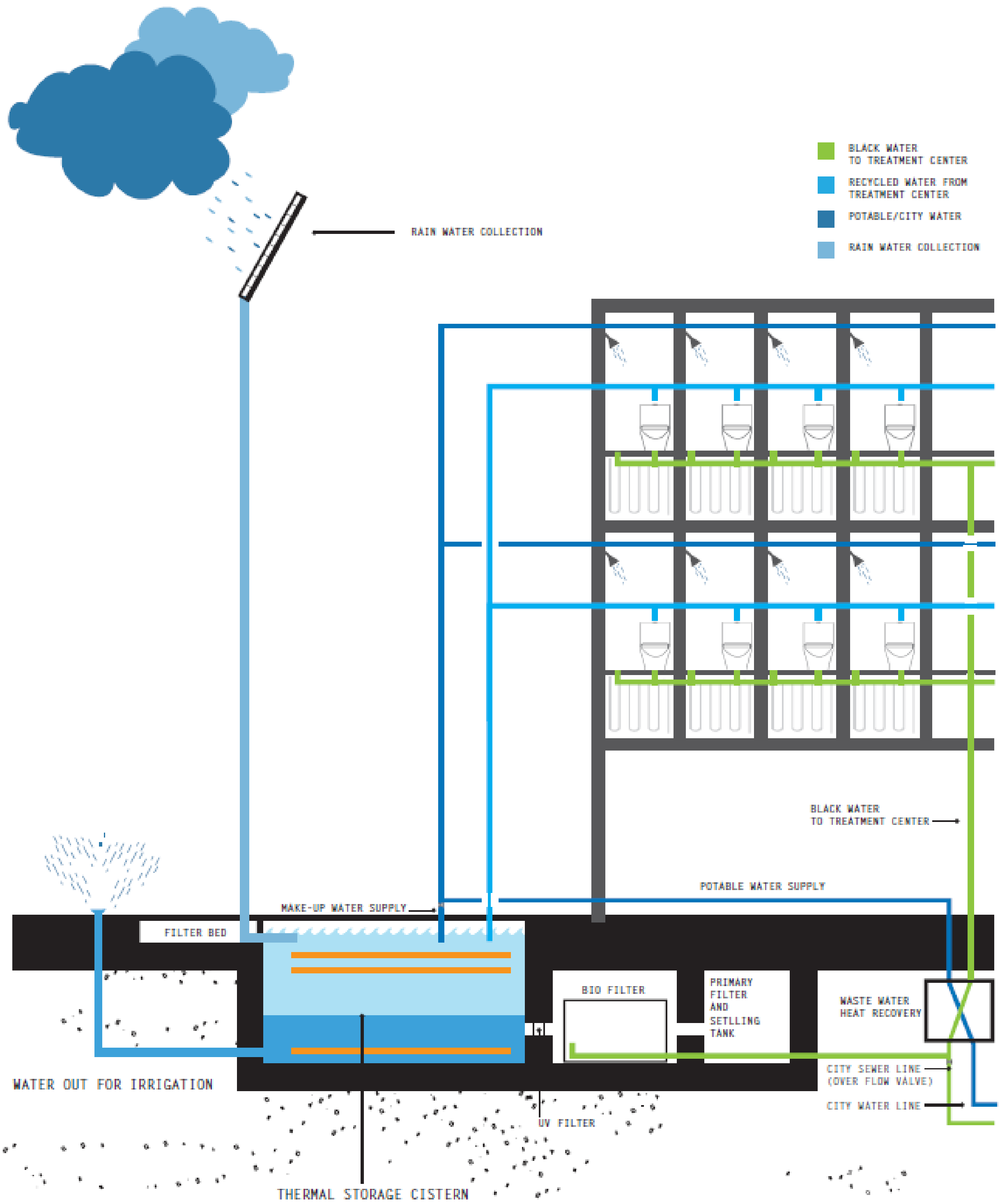
All non-residential use areas in the building are served by water to air heat pumps (WAHP). Each thermal zone is equipped with a WAHP which serves a traditional air side distribution system. The WAHPs are served either by the same water loop that serves the residential WWHPs or by the water loop leaving the evaporators of the WWHPs depending on if the zone calls for heating (the former) or cooling (the latter). This way any heat that is removed from the ground floor is recovered and contributes to the heating of domestic hot water.

Though not contributing directly to the building's achievement of net zero energy, the design includes a water capture, treatment and reuse system. The inclusion of this system is an acknowledgment of the water energy nexus, and serves to minimize the global impact of the building rather than simply confining our sustainability goals with a property line. The water reuse system captures rooftop rain water as well as redirecting and treating all sewer water produced in the building. This water is reused as thermal storage, irrigation supply and meets 100% of interior non-potable demand. The water balance shows the supply of recycled/captured water outstripping demand, allowing for the maintenance of water levels in the thermal storage cistern, with only nominal day to day variation.

2E WHOLE BUILDING HEATING AND COOLING SYSTEM



2E WATER SYSTEM RECYCLING AND REUSE



2F RESIDENTIAL UNIT SYSTEMS DESCRIPTION AND DIAGRAMMATIC SKETCH

In the residential common spaces, fan power and heating demand is reduced using passive and hybrid natural ventilation strategies (see the Task 2C sketch on page 7, as well as the Task 1C illustrated building section which show the requested 2F sketch content). In-unit spaces have minimal distances from operable windows, ranging from 12 to 24 feet. This allows all spaces to be effectively ventilated using high and low operable vents at the exterior walls for passive convective air movement. Additionally, all kitchens and bathrooms are located with large operable windows so that air moisture loads, as well as odors, are directly and passively exhausted, and not circulated in adjacent units, effectively eliminating the need for fan driven ventilation for all in-unit spaces.

Residential heating zones are multi-unit, multi-floor ganged zones which have been laid out based on shared attributes such as solar exposure, shared adjacent thermal mass and efficiency of system sizing distribution layouts. Instead of providing thermostats in individual dwelling units (allowing occupants to adjust energy consumption), occupants are provided manual window shutters as well as manual operable windows and vents, therefore providing full comfort control.

All active residential unit heating is provided by a central integrated space heating and domestic hot water (DHW) system (see system diagram 2E). The primary heat source for this system is solar thermal collectors arrayed across the south façade. This novel hybrid system employs a large (100 m^3) moderate temperature thermal storage cistern coupled with high efficiency water source heat pumps (WSHP) to overcome the challenges that arise in a more typical solar thermal system.

> *Typical solar thermal system inefficiencies are due to a dis-connect between the timing of DHW demand and solar radiation availability, which then drives excessive auxiliary heating demand. Under such a condition, collection efficiency drops due to elevated loop temperatures. Panel overheating can also occur which can lead to performance degradation and decreased system life. Large amounts of storage can in some ways mitigate these issues but large, high temperature storage and distribution systems suffer from elevated conduction loses and higher first costs.*

To overcome these deficiencies, this system utilizes a moderate temperature supply side loop coupled to significant moderate temperature storage and distribution. The low quality energy is captured from this supply loop using water to water heat pumps coupled with high temperature water storage located adjacent to each dwelling unit zone. Each solar exposure/zone will be served with both DHW and HHW by a single WSHP and high temperature storage system. The modular layout of the building allows these systems will be placed amongst the units they are serving, and so minimize distribution losses and pumping power.

The HHW will serve in-unit radiant slabs though a heat exchanger integrated into the high temperature storage tanks. Radiant heating is ideal in conjunction with natural ventilation as the mean radiant temperature can be kept in the comfortable range even when cooler outdoor air is entering the space via natural ventilation.

When used conscientiously by occupants these systems provide thermal comfort (a prediction that less than 10% of occupants will be uncomfortable as defined by ASHRAE standard 55) for 97% of annual occupied hours. This strategy sets up building residents for success, in minimizing negative environmental energy impacts, while maximizing positive impacts on indoor environmental comfort.

2G RENEWABLE ENERGY SYSTEM DESCRIPTION

There are 3 separate renewable energy collection technologies employed in this design. The primary source of energy is photovoltaic (PV) collector arrays installed on the roof. The building's roof design leads to 7 unique shading scenarios. Each was analyzed separately using NREL's System Advisor Model (SAM) 3D shade calculator to precisely account for shading from adjacent building elements. The panel tilt angle (10 degrees) was selected to maximize panel area while at the same time minimizing self-shading. The team's analysis, in consultation with the PV module manufacturer, of the tradeoff between optimal tilt, self-shading, panel density, and soiling impacts lead to the selection of a 10 degree tilt. Though less than the optimal latitude tilt for total annual generation, the lessened tilt allows for the maximizing the number of panels without excessive self-shading, and will reduce soiling by allowing morning condensation to run off the panels.

The table below outlines the specifics of each PV array with unique shading exposures.

Region	Panels	Panel Area (ft^2)	Power (kW)	Annual Energy (kWh)
South (West) Tower Array	*229*	*4,016*	*79*	*107,029*
Middle Tower Array	*396*	*6,945*	*137*	*192,564*
South (East) Tower Array	*540*	*9,471*	*186*	*262,725*
West Tower Array	*616*	*10,804*	*213*	*297,507*
East (South) Tower Array	*222*	*3,894*	*77*	*108,009*
East (North) Tower Array	*127*	*2,227*	*44*	*57,017*
North Tower Array	*550*	*9,646*	*190*	*245,816*
Total	**2,680**	**47,003**	**925**	**1,270,667**

The PV panel selected was the Sunpower X21 345 Commercial panel. An industry leader in panel efficiency, the Sunpower module was selected to maximize production on limited roof area. Additionally, Sunpower offers a high performance microinverter that was selected for the north tower array where shading impacts were elevated due to the setback restrictions imposed on the programming.

The design also incorporates two different solar thermal collection technologies, solar thermal water heating for domestic hot water (DHW) and heating hot water (HHW) in the residential units, and transpired air collectors (TAC) for air heating in the residential common areas. The solar thermal water heating panels are applied to roughly 50% of the south façade. The orientation and tilt of the panels was selected to maximize energy collection in the heating season and to provide consistent daily production year round to meet the level DHW demand.

The Radco 308C solar thermal collector was selected based both on it superior SRCC performance rating as well as having a form factor that integrated well with the window sizes dictated by daylight and natural ventilation requirements. Although not indicated on the rendering (that image was prepared prior to final energy modeling results), all wall mounted solar thermal collectors are mounted at a 25 degree angle off the wall to increase performance with a calculated balance of self-shading and panel spacing.

SolarWall's TAC system was selected to provide passive air heating for the corridors and residential common spaces (including open area study rooms). With TACs applied vertically to the south, east, and west facades, significant energy collection is realized through the course of the day, and optimized for winter collection.

The table below summarizes the different technologies employed and their impacts.

Technology	Description	Annul Energy Impact (kBtu)
Sunpower X21 345 Com	*Mono-crystalline silicon PV panel, 345 W/pp, 17.5 ft^2/pp*	*4,335,516*
Radco 308 C*	*Glazed Flat Plate solar collector, 4.01 kWh/m^2.day.pp, 23.7 ft^2/pp*	*3,215,482*
SolarWall	*125 kBtu/yr/ft^2, 7900 ft^2 installed***	*772,015*

**performance values in SAM database are out of date, analysis completed with updated performance characteristics taken form SRCC database (SRCC#: 10001856)*
***TAC performance based conservatively on adjustment from winter solstice optimal performance expectations*

<u>*ZNE Performance*</u>

Resulting from the process and systems described here, Alveo exceeds nZE by 1.16 kBtu/sf-yr.
It is felt that the load side of the equation is aggressive but accountable, and therein has been optimized very close to the limits of this program typology. Additional opportunities to reduce load are available primarily by imposing or inspiring additional occupant plug load reductions. On site generation can also be increased by increasing roof overhangs in areas that will impinge on zoning setbacks.

<u>*Scale Jumping*</u>

Furthermore, this system will have the byproduct of producing a consistent supply of chilled water. In the current design this chilled water is used to condition the ground floor, non-residential areas. This will allow for any unwanted gains on the ground floor to be returned to the system and recovered for use in the production of DHW or the heating of other building areas exposed to opposing thermal conditions, e.g. in the shoulder season when a residential unit might require heating while the ground floor still needs cooling. Though beyond the scope of this competition, the large amount of chilled water produced by the hybrid system outline above presents an opportunity for campus wide energy efficiency and integration. The building site is adjacent to a chiller plant that serves a number of campus buildings with year round chilled water. By integrating the WSHP DHW heating system with the adjacent-site chilled water plant return loop the chiller plant load could be reduced while at the same time increasing the capacity of the building level HHW and DHW systems.

2H OCCUPANT BEHAVIOR DESCRIPTION

Our current focus on net zero energy and sustainable building development comes, at least in part, from a desire to reverse the momentum of traditional 20th century human behavior patterns. Our success in this significant endeavor requires awareness, education, and action; and Alveo champions this effort for its occupants. To affect this change, the built environment needs to inform its users of trends and changes in performance as well as strategies for optimizing human influence on operations. Alveo achieves this through a variety of feedback mechanisms and building controls.

All residential units are equipped with a simple dynamic user interface that provides occupants with information and guidance on building use. The interface uses trending logic, building geometry, building system sensors, indoor / outdoor air temperature, date, time, and 24 hours weather forecasts to inform occupant comfort control and resource utilization strategies. Occupants will then receive recommendations on optimizing building use such as; optimal positon and time for adjusting natural ventilation openings, ideal adjustment of perforated-metal window-shutters, when to water your kitchen garden, what time to get out doors for some exercise, or even the best time of day to take a shower from a building energy perspective. These dashboards also provide lifestyle and building specific sustainability related educational content, as well as opportunities to participate in energy conservation drives and competitions, to further inform the industry on the potential of occupant behavior contributions toward building performance. A few of the educational content topics include: Growing veggies in the courtyard kitchen garden, How to get your clothes super clean using a cold water wash cycle in combination with zero harm detergents, selection and use of safe household cleaning products, easy cooking strategies, menu planning, money management, and others.

Alveo provides a setting for healthy lifestyles and harmonious relationships with resources and community. In contrast to traditional multi-family developments, Alveo replaces the floor to ceiling window-wall living-room 'view' with a floor layout that encourages students to spend time socializing around the cutting board & sauté pan, and even handwashing some dishes. The kitchen, emphasized as a place to hang out, study, and meet nutritional needs, has the potential to foster enjoyment of simple sustainable nutritional habits which are a central building block of human sustainability and happiness.

The multi-functional, energy integrated, ergonomic, and well lit stair towers function as 'activated' human powered vertical transportation spaces that help foster fitness and delight, why building community relationships.

These 'occupant behavior modification' features close the circle, as Alveo works to nurture a truly sustainability living environment for the growing generation of UCSF Mission Bay students.