CASA DEL SOL

Team Orange County

U C IRVINE CHAPMAN IRVINE VALLEY COLLEGE SADDLEBACK

JURY NARRATIVES

ENERGY

IONAL RENEWABLE ENERGY LABORATORY

ORANGE COUNTY GREAT PARK

U.S. DEPARTMENT OF ENERGY SOLAR DECATHLON

CASA DEL SOL

Our Story;

CALIFORNIA POPPY
4 SCHOOLS | 4 PETALS
1. UC Irvine: Project Management and Engineering
2. Chapman University: Communications and Marketing
3. Irvine Valley College: Construction Technology
4. Saddleback College: Architecture and Interior Design

1. Passive Solar embraces the sun and prevailing winds
2. Disruptive Innovation pushes the limits of energy and design
3. SoCal Market Appeal inspires indoor/outdoor, multigenerational living
4.Drought Resilience landscape that beautifies as it sustains

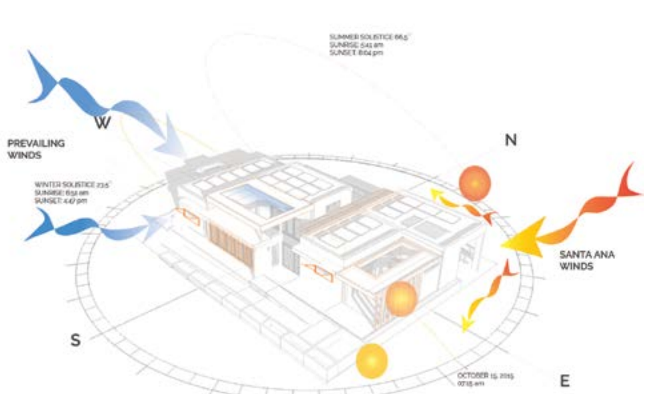
TABLE OF CONTENTS_

01_ ARCHITECTURE

PASSIVE SOLAR DESIGN

ARCHITECTURE_PASSIVE SOLAR DESIGN

Team Orange County's Casa del Sol is an innovative, net-zero energy home that draws inspiration from the California state flower: the Golden Poppy. Just like this flower, Casa del Sol is well-adapted to Southern California. Our contemporary approach combines aspects of both regional architectural traditions and modern innovations while capitalizing on our unique indoor-outdoor lifestyle and addressing the growing need for multigenerational accommodation.



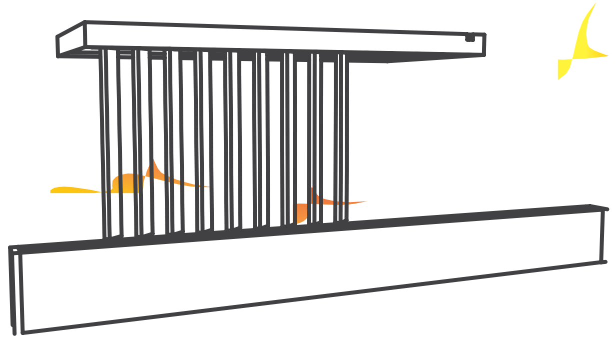
The California poppy, as a diurnal flower, blooms during the day and closes at night. We sought to incorporate this special behavior into our home and use passive solar design theory to accomplish this. Versatile shading, operable features and natural ventilation allow the home to open and close to the sun as needed for indoor climate regulation. We used Trimble's Sketchup, Autodesk's Revit and Integrated Environmental Solutions (IES) software to examine the sun's path and conduct building-wide energy analysis. This informs the design of the energy management control system which automates windows and tensile fabric to encourage natural ventilation and protect against heat gain.

ARCHITECTURE_PASSIVE SOLAR DESIGN

From the south elevation, viewers will notice six lightweight pivot panels made of redwood. Residents can adjust these panels to enclose the outdoor living area and provide shade from both the harsh summer sun and the direct light that hits the home at sunset. The panels can similarly be adjusted to take advantage of the mild winter sunlight, providing a source of natural heating and optimizing the space in any season. These panels also supply protection from wind and rain and create privacy for the residents of the home as they lounge outdoors.

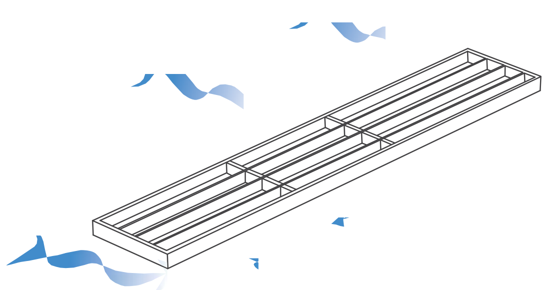
Regionally appropriate, Casa Del Sol uses architectural elements to effectively regulate the heating, cooling, and lighting demand in the most energy-efficient way possible.

ARCHITECTURE_PASSIVE SOLAR DESIGN



Unsheltered operable windows are strategically placed on the western side of the home to receive prevailing ocean winds. This serves to naturally ventilate and refresh indoor living spaces. Along the eastern side of the studio's outdoor patio space, vertical slats create a brise-soleil, which shields the home from Southern California's notorious hot, dry and unpredictable Santa Ana winds, which often strike the region in the fall. This brise-soleil also serves as a protective feature throughout the year by blocking morning sun glare from the studio bedroom and helping create a semi-private outdoor living area for the resident in the studio. This is not only architecturally functional, but also adds to a pleasing and marketable home for a renter or homeowner.

In addition to these shading elements, clearstory windows work to block direct sunlight and reduce solar heat gain inside the house while diffused natural daylight illuminates the home. Rigid foam insulation reduces thermal bridging, minimizing heat transfer and keeping the interior temperature stable.



The light-color high-albedo roof also reduces solar heat gain by reflecting sunlight, rather than absorbing it. Passive solar design assures that Casa del Sol is able to use architectural elements to gracefully increase energy efficiency and home comfort.

ARCHITECTURE_PASSIVE SOLAR DESIGN

Another versatile feature is the large shade structure suspended over the outdoor living area. Called the Halo, it is a structured overhang with a large opening that extends above the entirety of the outdoor living area. Residents can open a functional fabric shade to allow desirable light into the space, or close it to be shielded from strong sunlight or rain.

The Halo was carefully designed to block direct sunlight from entering the home itself during the summer season, preventing unwanted heating; however, during the winter months, sunlight will filter into the home and naturally heat it. In tandem, the pivot panels and the Halo actualize an adaptable outdoor and indoor living space, creating a comfortable environment for residents.

ARCHITECTURE_ LIFE STYLE

We designed Casa del Sol to be as flexible and spacious as possible to address changes in lifestyles and family culture. An operable interior wall partitioning the living area from a separate room can create an entertainment space or privatize the hallway leading to the bedroom. The room on the north side is a "flex room" that adapts to residents' needs - it can serve as child's bedroom, a workspace, or as storage space.

The studio space is also part of this "flex" philosophy; it allows for multi-generational housing, or as a suitable rent space.

One of the biggest draws to living in Southern California is the famous climate. Fair, sunlit days are expected most of the year. As a result, Californians have adopted a unique culture emphasizing the outdoors. Team OC has designed the home to reflect this regional way of life. By sheltering the large outdoor living room, we create an indoor-outdoor space.

ARCHITECTURE_ LANDSCAPING

Casa del Sol's landscape also reflects themes of sustainability and resource-efficiency seen throughout the design and powering of the house. We filled the planters with a mix of native and/or drought tolerant plants that can be irrigated with either grey water or rainwater. The edible vertical garden in the front of the house is able to produce a great deal of vegetables for the house's inhabitants, greatly reducing the demand they place on supermarkets, which usually supply produce grown and transported using energy and water intensive processes.

Our vegetables are grown in a mixture of coco coir and organic compost that retains water more efficiently compared to traditional soil mixes. Drip irrigation controlled by a weather-sensitive irrigation controller also means the garden wastes little to no water when watering is required. Casa del Sol features an outdoor solar stove that helps reduce the house's energy use by baking, frying, roasting and boiling food at temperatures up to 550 degrees |Fahrenheit.

Grow Medium

The landscaping area also provides a designated bike storage area, encouraging inhabitants to forgo the use of a car for short trips.ring is required. Casa del Sol features an outdoor solar stove that helps reduce the house's energy use by baking, frying, roasting and boiling food at temperatures up to 550 degrees |Fahrenheit. The landscaping area also provides a designated bike storage area, encouraging inhabitants to forgo the use of a car for short trips.

02_ ENGINEERING

DISRUPTIVE INNOVATION

Much like our state flower, the California Poppy, we designed Casa del Sol to take advantage of its environment. The house works in harmony with Southern California's Mediterranean climate by utilizing a solar thermal system in collaboration with a radiant cooling system and natural ventilation. Casa del Sol maximizes energy production and lowers energy consumption with specifically engineered designs for drought resistance, decreased HVAC energy loads and a cutting-edge AC/DC microgrid to minimize power losses. Team Orange County has created a home that stays within the 175 kWh energy budget and also creates a net-positive energy output. The following sections provide details about our engineering design methods and how we were able to achieve our goal.

Energy Analysis

Byconducting energy simulations through two main software platforms (Integrated Environmental Solutions Virtual Environment, also known as IESVE[1] and Design Builder[2]), we can provide load calculations for our home. We used simulations to estimate heating and cooling loads throughout the competition week as well as annually. This data take into account the following: internal heat gains, building envelope (e.g., wall and insulation materials & thickness, windows, etc.), shading structures, natural ventilation and infiltration rates of undesired air. The design daily load calculations, as determined by the two energy simulation software packages, are presented in **Table 1**.

Software	Heating (kBTU/h)	Cooling (kBTU/h)	Heating (kW)	Cooling (kW)
IESVE	13.0	15.3	3.8	4.5
Design Builder	12.8	14.2	3.8	4.2

Table 1 Maximum Daily Load Calculations for Casa del Sol

Internal Load	Approx. Heat Gain (W)	Schedule
Refrigerator	10.0	24 hours
Lights	20.0	4 hours
Dish Washer	30.0	2 hours
Cooking	1500	2 hours
Miscellaneous	10.0	24 hours
Occupants	10.0	16 hours

Table 2 Internal Gains

Table 2 shows the approximate heat gain of Casa del Solol internal loads. For this information to be useful in an energy simulation, there must be a corresponding schedule. We created the schedule based on the most demanding day of the Solar Decathlon 2015 competition and used it for design-day load calculations. Additionally, heat can enter the home through ventilation, infiltration and solar gains. These sources of heat gains were factored into the simulations as well. Simulation results can be found in Appendix A.

Insulation

The simulations found in **Appendix A** were compared to a base of
R-Value of 28 in walls
R-Value of 46 in roofs
R-Value of 32 in raised floors

Insulation, which resists heat transfer from the outside to the inside environment, is one of the biggest contributing factors to lowering heating and cooling loads. Casa Del Sol uses the Midori Haus[3], a passive house in Santa Cruz, as a starting point for simulations. Later iterations optimized insulation and R-values in the walls, roof and raised floors. IESVE calculates the most optimal R-value of the insulation material based on construction of the home in the design model.

Natural Ventilation

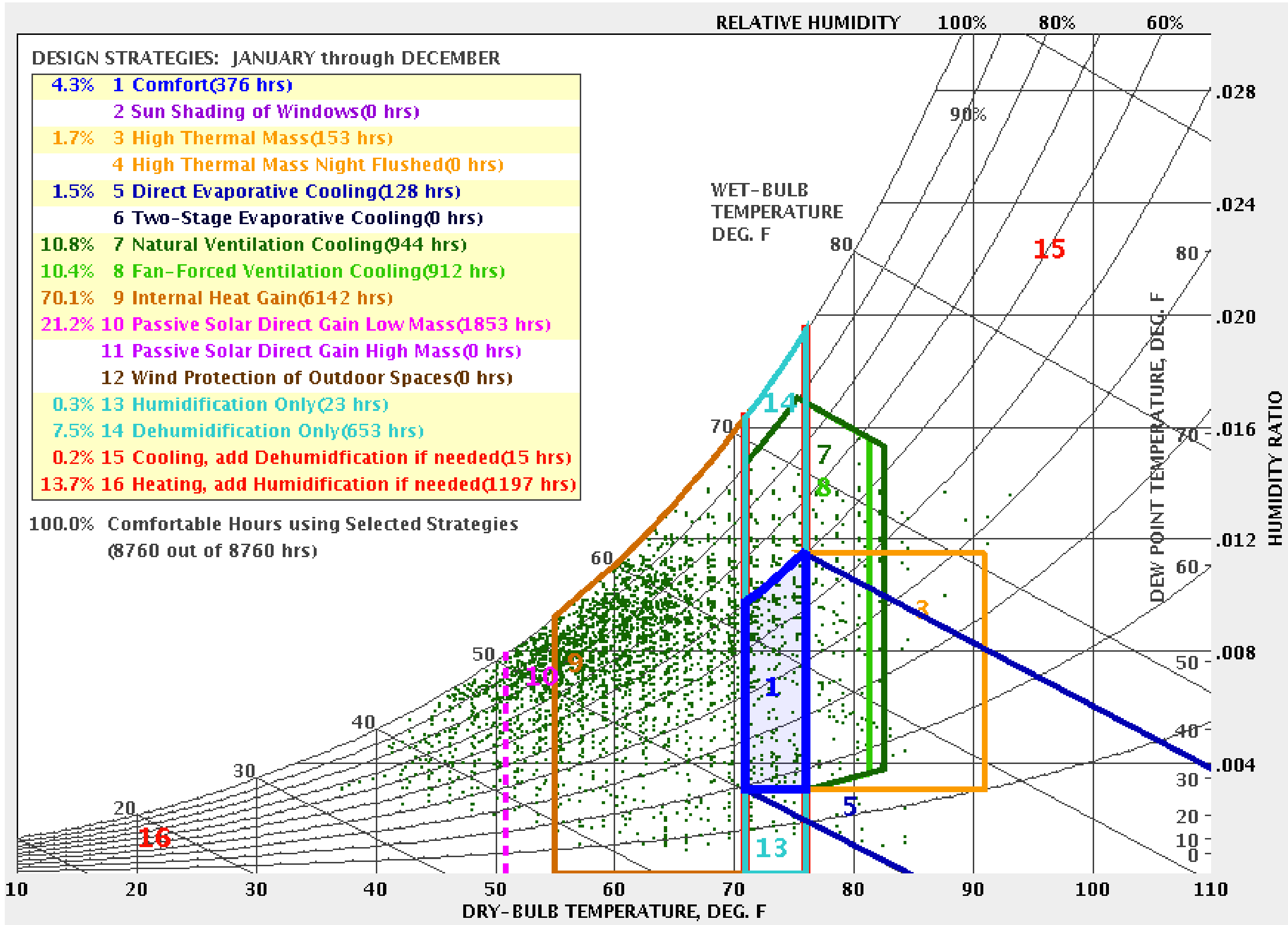
In Orange County, cool breezes that blow in from the coast allow cost-free cooling through natural ventilation. Casa del Sol features automated windows that open when temperature sensors indicate that outdoor temperatures are cooler than indoor temperatures. This eliminates the need to physically operate windows and ensures that we utilize free cooling whenever possible. To take full advantage of natural ventilation, Casa del Sol has a ducted ventilation system that performs as a whole house fan. With strategically placed return ducts, a simple duct fan draws warm indoor air from the home and exhausts it outdoors, creating a draft that pulls the cooler outdoor air in. The energy consumed by the duct fan is minimal compared to that used by an active HVAC system.

Building Envelope

The building envelope is a barrier between the indoor and outdoor environments that modifies and filters external weather conditions to create comfortable indoor environments. The thickness of insulation in the floors, ceilings and walls were simulated to determine the most efficient combinations for the conditions in Irvine, California. Simulations of the heating and cooling loads were also conducted based on ef-fects of windows and shading structures .

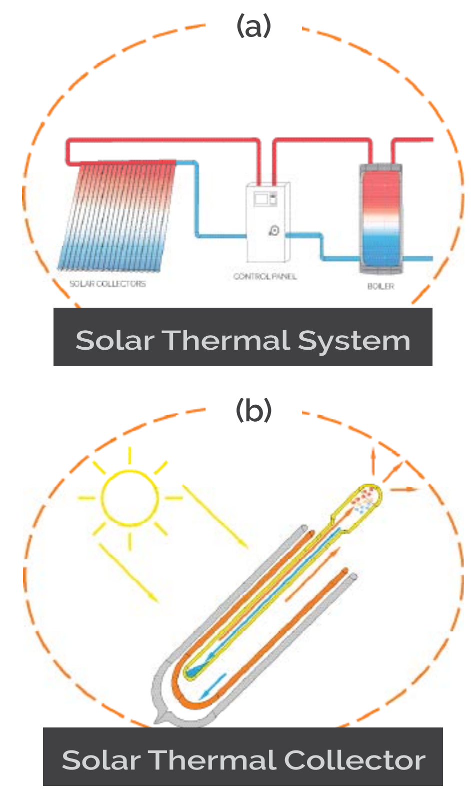
Climate Analysis

Team Orange County has the home team advantage with regard to climate analysis because we do not need to consider weather projections over multiple locations. We designed Casa del Sol for the Southern California area, which also is the competition site. Nonetheless, during the competition Casa del Sol will experience only a small portion of Southern California's annual climate. Therefore, we will experimentally evaluate our performance by calculating local conditions in October, and estimating performance over the entire year using Climate Consultant Software[4] – weather software that estimates Southern California conditions. Specific weather data used is from 2013 and was recorded from the Santa Ana weather station in Energy Plus Weather (EPW) format. In October the dry-bulb temperature (DBT) average is 65 degrees Fahrenheit (F), the dew-point temperature (DPT) average is 48 degrees F, and the relative humidity average is 63%. Though inland from the coast, our zone is still influenced by marine air. The ocean influence prevents extreme temperature swings so the range of temperatures we must design for is narrow compared to more extreme regions. In accordance with the Solar Decathlon Rules, our comfort zone for this program was set from 71-76F.



A psychrometric chart is a graphic representation of the relationship between air temperature and humidity that can show if humans will be comfortable in spaces with these characteristics. It can also help with designing heating, ventilation and air conditioning (HVAC) systems and building envelopes that can modify or filter these external weather conditions to create comfortable indoor environments. In Figure 1, the temperature (horizontal axis) and humidity ratio (vertical axis) for different design strategies are plotted for every hour of the year, with the color in-dicating whether it is in the comfort zone (blue trapezoid) or out of the comfort zone (everywhere else). Our home's HVAC incorporates a heat pump, a water-based solar heating system, Natural Ventilation and a Sub Wet-bulb Evaporative Chiller (SWEC) to condition the space, so we select the appropriate design strategies highlighted in the upper left corner of Figure 1, also known as the Design Strategies box. The Design Strategies box shows the percentage of hours that each strategy would be used to maintain comfortable conditions inside the home for the given climate. To select the strategies best suited to our building design, every yellow-highlighted section in the Design Strategies box was taken into account while every section left white was not. Based upon this analysis, our strategies will maintain the comfort zone for 100% of the year (8760 out of 8760 hours), which indicates that all weather contingencies comply with our complex and innovative design.

Solar Thermal System



(Figure 3a) thermal collectors connected to the manifold where heat transfer occurs.

(Figure 3b) Inside a solar thermal collector with the evacuated tube (outermost border), the absorbent plate (orange) and the thermal tube (yellow). The bulb at the top of the thermal tube is connected to the manifold for heat transfer.

The key component of the solar thermal system are the solar thermal collectors[7]. These consist of multiple evac-uated glass tubes, which collect heat from sunlight, then transfer that heat into water that circulates to the heat pipe. The heat pipe is a long, hollow copper pipe inside the tube collector, which contains the water. This heated water rises in the heat tube and travels to the solar tank, where the heat is stored. The heated water is then used for various functions in the house, such as space heating and domestic hot water use.

Of the two popular types of tube collectors available (flat plate vs. evacuated tube), we chose the evacuated tube collectors. Studies from our solar thermal collector company, Ritter, show that their evacuated tubes have a better energy yield and performance than flat plate collectors for any weather scenario, and their tubes provide hot water more quickly and efficiently than flat plate collectors.

As mentioned previously, the competition location (Irvine, CA) has a Mediterranean climate, with mild to cool winters and warm to hot summers. The vacuum-sealed tubes also act as a buffer between the outside environment and the working fluid, providing better thermal insulation. In a vacuum, no matter is present; therefore there is no heat loss by conduction or convection. In order to prevent heat loss by radiation and reduce reflection of light, an anti-reflective coating around the tubes works to keep the electromagnetic waves within the collectors. Figure 5 shows how the collector's tubulardesign allows the system to collect energy from the sun even at low angles in the sky (early mornings and late afternoons). We installed a compound parabolic concentrator (CPC) mirror assembly behind the solar thermal collectors. The CPC works to collect and concentrate a light source to a specific point, in our case the tube collectors. The CPC is made of two parabolic mirror segments. The parabolas have different focal points that allow the maximum possible amount of light to be directed to the tube collectors at all times of day.

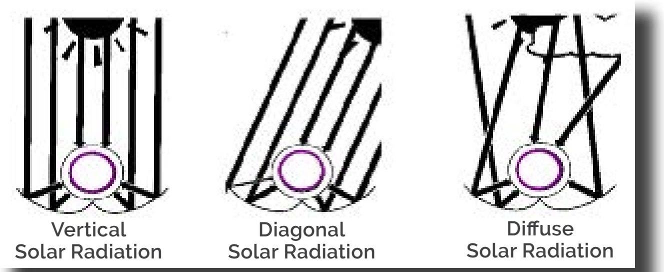
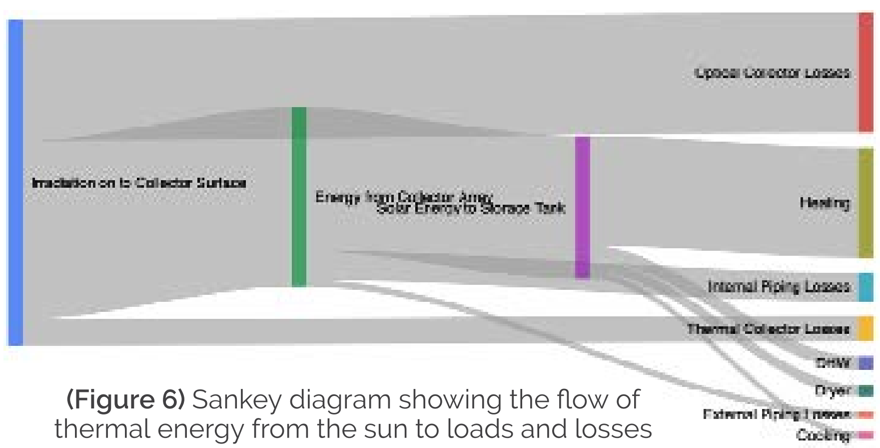


Figure 5 shows how the collector's tubulardesign allows the system to collect energy from the sun even at low angles in the sky (early mornings and late afternoons). We installed a compound parabolic concentrator (CPC) mirror assembly behind the solar thermal collectors. The CPC works to collect and concentrate a light source to a specific point, in our case the tube collectors. The CPC is made of two parabolic mirror segments. The parabolas have different focal points that allow the maximum possible amount of light to be directed to the tube collectors at all times of day.

Various working fluids can be used in a solar thermal system. The optimal working fluid is effective over a broad temperature range (-15 C to 125 C), has no corrosive or destructive effects on materials, has no harmful effects to health or the environment, has a low maintenance cost,



(Figure 6) Sankey diagram showing the flow of thermal energy from the sun to loads and losses

Various working fluids can be used in a solar thermal system. The optimal working fluid is effective over a broad temperature range (-15 C to 125 C), has no corrosive or destructive effects on materials, has no harmful effects to health or the environment, has a low maintenance cost, and is not prone to freezing. Considering these specifications and the climate where our home is located, we decided to use water as our working fluid. With its relatively high thermal conductivity (0.582 W/mK), volumetric heat capacity (4.18 kJ/LK), and low viscosity, which help keep running costs low by requiring less work from pumps to circulate the fluid, water is an ideal choice. It is important to note that water has a high freezing temperature in comparison to other working fluid choices, making it more likely to freeze. However, keeping in mind Southern California's climate and Ritter's anti-freeze collector design, we can assume water can be used for our solar thermal system without the risk of freezing.

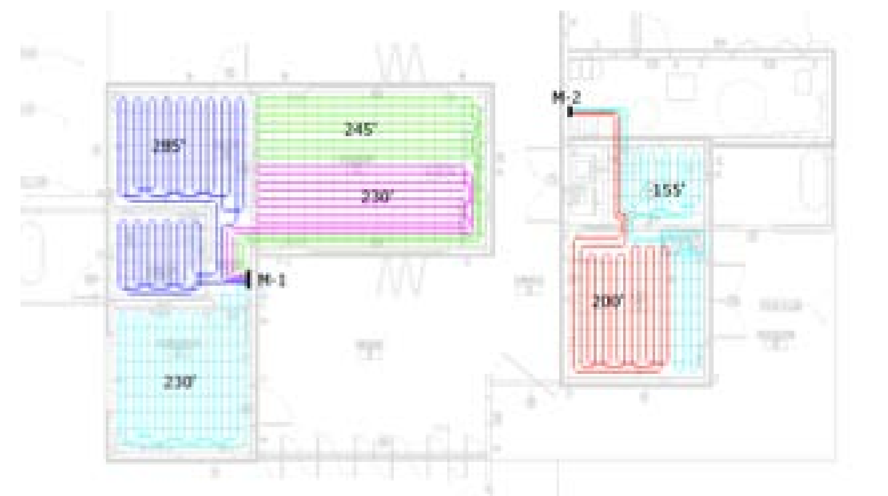
Solar Thermal Loads

Testing Condition	6 Towels	12 Towels
Energy used (kWh)	0.336	0.645
Time to dry (h)	1.5	2.5
Water temperature (F)	180 F	179 F
Remaining Moisture Content (%)	0	-0.36

Table 3

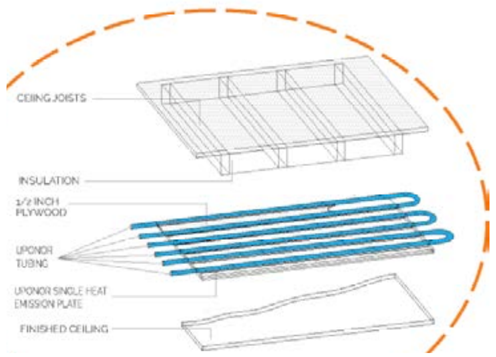
Dryer and Hot Water Tap

Most clothing dryers work by generating heat with a gas burner or electric heating element. Air comes in through a duct and passes through the heating element, which heats it to 125-165 F, depending on the setting. That hot air goes into the dryer drum, where it pulls the moisture and excess lint out of the clothing. Then, the moisture-filled air is carried outside through ducts.



In comparison, the SafeMate dryer uses a heat source to heat paraffin wax in the dryer. Paraffin wax has a heat capacity ranging from 2.14 to 2.9 J g-1 K-1, but it retains the heat from the 180F water well during latent heat trans-fer. This means the dryer uses less energy to heat the air blowing through the drum. The heat from the water transfers to the paraffin wax, which heats the air going into the drum to dry the clothes. We incorporate SafeMate's inno-vative technology into our HVAC design by sending a line from our 180 F solar hot water tank to a heat ex-changer inside of the paraffin container, thus heating the dryer with sunlight. In cooperation with SafeMate, we conducted tests of the system. We ran a line of 180 F water to the dryer to dry a load of wet towels. Time to dry, energy usage and remaining moisture content were recorded for these tests and are summarized in the table above. The results show that our dryer consistently dries the towels within the time frame required, using much less energy than a standard dryer. Furthermore, the thermal energy comes from our solar hot water collectors, reducing dependence on the power grid. Casa del Sol also employs an insulated line from the 180 F storage tank to a hot water tap in the kitchen. This tap, heated with solar thermal energy, provides 170-180 F water for cooking, saving time and energy in bringing water to a boil.

Radiant Ceiling



(Figure 8) Radiant ceiling panel made by Uponor

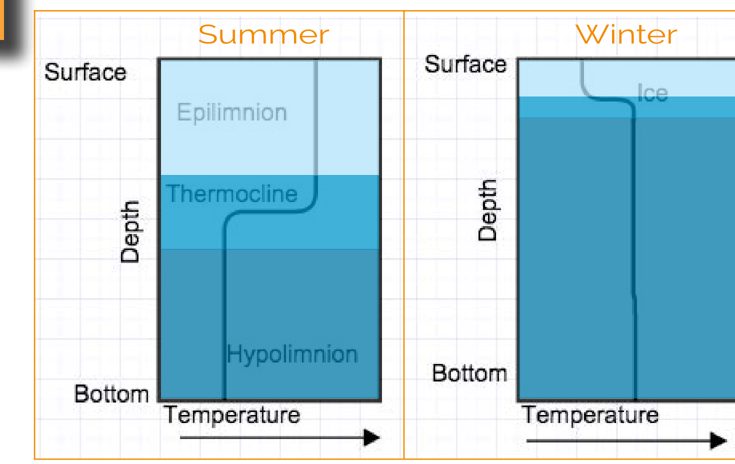
Guided by the results of our energy analysis, we chose a radiant system for our final HVAC design. Benefits include energy efficiency, superior comfort, reduced operating and maintenance costs, and more effective ventilation control. We decided to install a radiant ceiling (as opposed to a radiant floor) for two main reasons. First, in Southern California's climate, cooling loads outweigh heating loads. Because cold air falls and warm air rises, a radiative ceiling is more efficient. Thermal convection allows for transportation of heat energy from the rest of the room to the coils running through the emission plate of the ceiling, leaving the home cool. Also, most people perceive a cold floor as uncomfortable, even in warm weather. Having the radiative panels in the ceiling allows for more flexibility in interior design, compared to a radiative
floor, where a significantly active area might be covered by furniture.

As seen in figure 8, the radiant ceiling will be installed between the drywall and insulation, and supported by aluminum heat-emission plates. These plates help carry heat away from the tubing and into the plates themselves while supporting the PEX-a tubing in the ceiling. These plates also reduce losses in the tubes, making for an effi-cient system. Radiant ceiling energy savings result primarily from lower transport energy usage.
This is because the heat-transfer capacity of water is much higher than that of air: a radiant system that uses a circulator to move water (in lieu of a fan to move air) can achieve the same heat transfer using significantly less energy. The smaller forced-air system — made possible by the radiant cooling system — translates to lower operating and capital costs (reduced fan horsepower, smaller filtration, smaller dehumidification equipment, etc.). Additionally, a radiant system allows the decoupling of cooling and ventilation requirements. In most HVAC systems, air-handling systems are based on the total cooling and ventilation requirements of the spaces and occupants they serve. However, these airflow rates are rarely constant, often resulting in ineffective delivery of airflow to satisfy both requirements simultaneously. Decoupling these functions as we have done in Casa del Sol gives us greater ventilation control, ensuring that the occupants always receive the right amount of outside air. With a properly designed system, occupants should not be aware that the environment is being heated or cooled. When the temperature of surfaces comprising the building (particularly outdoor exposed walls with extensive fenestration) deviates excessively from the ambient temperature, convective systems sometimes have difficulty counteracting the discomfort caused by cold or hot surfaces. Heating and cooling panels neutralize these deficiencies and minimize radiation losses or gains by the human body[8].

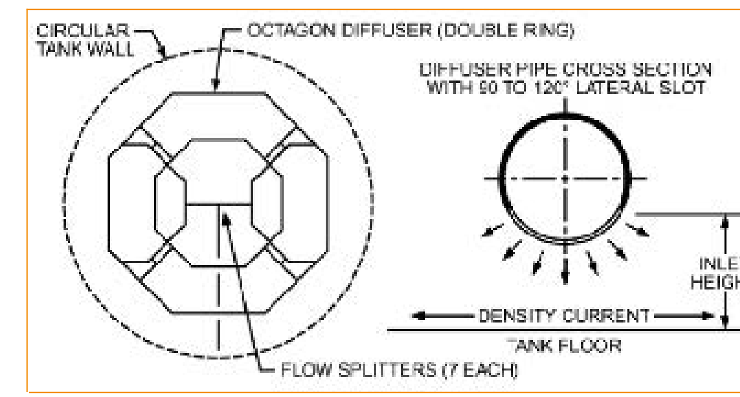
Cold Water Storage

One challenge of designing our HVAC system was constructing it to cool our home with low energy consumption. With an efficient radiant system and our SWEC system, which allows our home to cool without humidification, cold-water storage is crucial. Allowing the cooling load to incorporate water as a thermal mass throughout the radiant system and using a thermal water storage tank, we are able to efficiently produce and store cold water.

Our radiant ceiling runs 818 ft2 of ¾" and 1" diameter PEX tubing filled with water for cooling the home. In order to constantly run chilled water throughout the home as well as cooling additional water for recirculation, a chilled water tank is needed. Functioning as thermal energy storage, the 800-gallon tank also provides stratification for our cooling design. The tank imitates the functionality of a lake, with the depth creating a change in density and consequently a change in temperature. The thermocline is the area in a body of water that changes temperature more frequently with depth than other areas of water above or below it.



(Figure 9) Figure explaining the relationship between water temperature and depth

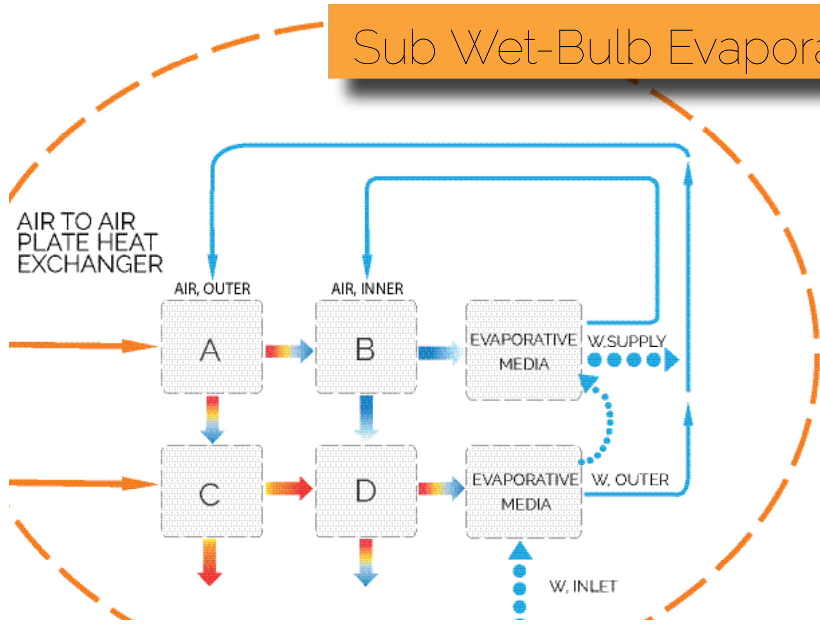


(Figure 10) Design of diffusers throughout the chilled water tank for stratification from HVAC & RASHRAE Research Project 1185

Engineering_DISRUPTIVE INNOVATION

The denser the water, the cooler it is. This means that heat will enter and leave the tank primarily from its highest point, allowing for the rest of the tank to remain chilled and insulated at a steady temperature. In extremely cool conditions, the thermocline creates stratification. Stratification allows for distinctive and even layers of temperature and density, each with equal pressure, to keep the tank functioning properly. In order to promote such a system, we installed specially engineered perforated single-pipe diffusers (see figure 10) throughout the chilled storage tank to allow for laminar flow and resistance to vertical mixing. The octagonal shape is important in allowing symmetry for equally spaced openings and allowing the top and bottom diffuser to direct flow upwards and downwards in the tank, generating a thermocline from a gravity current. The octagonal piping system also allows for half of the total flow to go to each of the diffusers, balancing the system. Tempera-ture sensors will regulate each layer of our tank to monitor the stratification. This design is the most efficient way to regulate and control radiant cooling loads.

Sub Wet-Bulb Evaporative Chiller (SWEC)



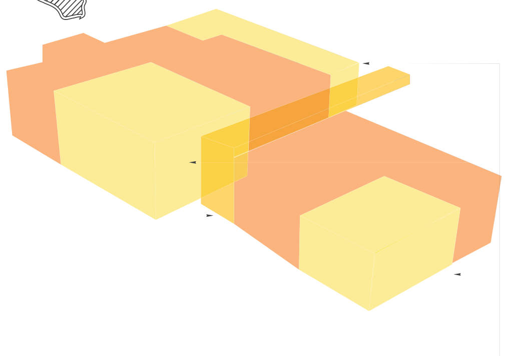
A Sub Wet-bulb Evaporative Chiller (SWEC) uses direct and indirect cooling to chill water below ambient wet bulb temperature. The use of pumps and fans instead of refrigerants or compressors greatly reduces the energy consumption compared to a conventional heat pump. The input water, which flows from the top to the bottom of the SWEC through gravity, initially precools with incoming ambient air through the conventional evaporative cooling (direct cooling) process. Meanwhile, the wet bulb temperature of the incoming air decreases and takes heat from the ambient air coming from another direction via the indirect cooling process. This procedure repeats twice in all four air channels so that gradient chilling can decrease the water temperature.

The unique combination of direct and indirect cooling processes enables the SWEC unit to cool water below the ambient air wet bulb temperature. The direct cooling involves the evapora-tion of water as well as the heat exchange between water and air. The SWEC unit adheres to our drought-tolerant design by using water captured by rainwater and grey water tanks to filter, cool, and refill water used for cooling. Meanwhile, indirect cooling pre-cools the incoming air for the direct cooling process, achieving more efficient overall cooling efficiency. Our radiant ceiling system then distributes the cold water throughout the house, avoid-ing an increase in indoor air humidity resulting from El Niño weather conditions.

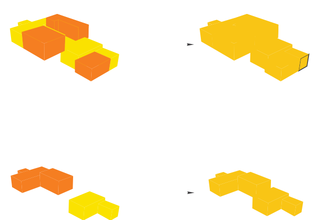
03_ MARKET APPEAL

SO CAL MARKET

MARKET APPEAL_ SO CAL

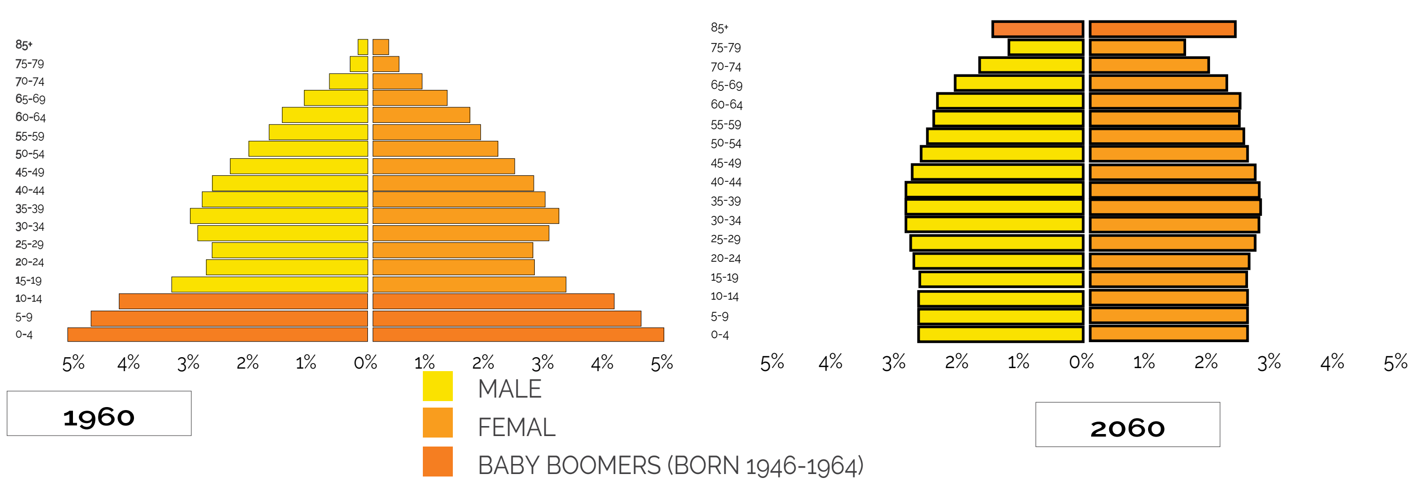


Casa del Sol exemplifies contemporary urban planning principles that reflect the native environment and optimize residential options. It is an innovative, net-zero energy home inspired by the drought-resilient California poppy. Casa del Sol emulates the diurnal flower with its passive solar design. Just as the poppy unfurls and retracts according to the light of the sun, Casa del Sol uses appropriate shading and natural ventilation to open and close itself. The open floor plan also reflects the indoor-outdoor California lifestyle.



Urbanization continues and creative approaches to housing are needed to meet the demands of a growing population. Casa del Sol offers a set of solutions to address family, resource and affordability needs of current and future residents of Southern California and beyond. In other words, Case del Sol is an innovative living environment that embodies the concept of sustainability.

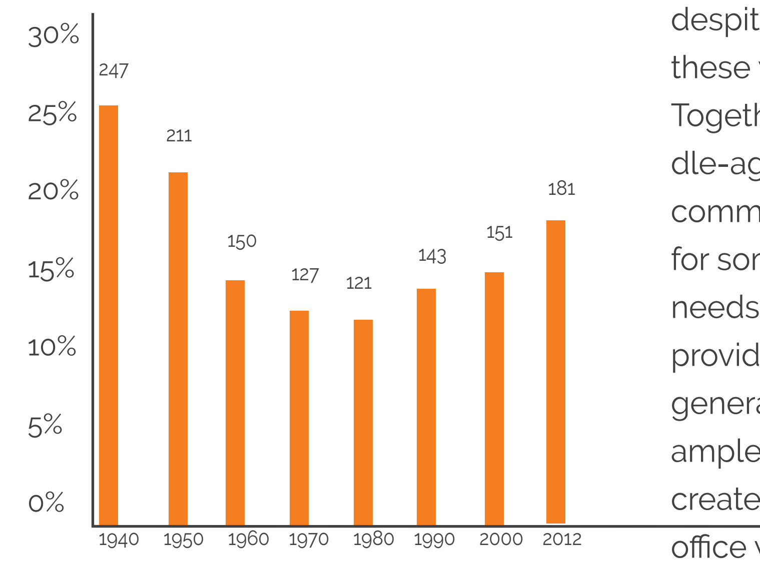
Percentage of U.S. Population by Age Group



Casa del Sol is designed to meet the demands of the changing demographic structure of our communities. According to Pew Research Center (2015), the classic pyramid of age distribution with a larger base of younger persons and a smaller top accounting for older persons is changing shape. In fact, by 2060, we will be closer to a 1-to-1 ratio of age groups, with just as many toddlers as senior citizens, than ever before in the U.S. In other words, the pyramid will look more like a block.

MARKET APPEAL_ SO CAL

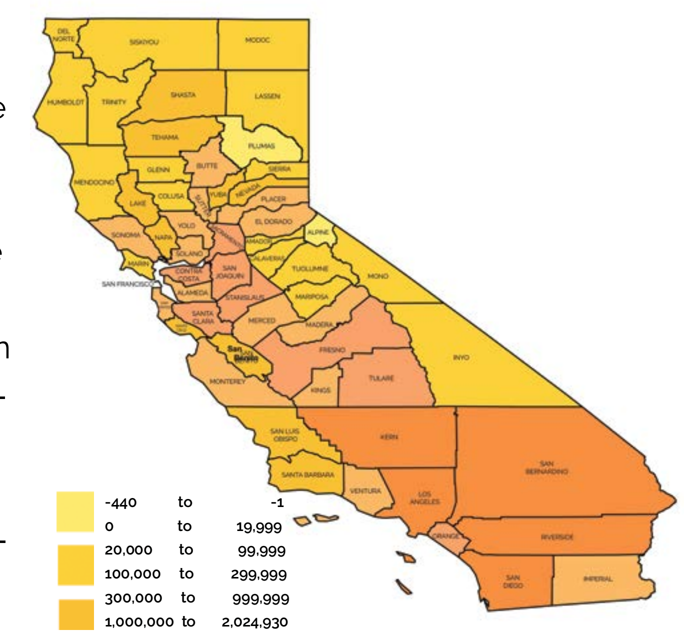
Boomerang Generation



The Pew Research Center also reports that the percentage of young adults (Millennials) living with their parents has increased over the last five years despite the recovery of the economy (some call these young people the Boomerang Generation). Together, these demographic trends suggest middle-age homeowners need housing that can accommodate an elderly parent and/or a young adult for some period of time and be adaptable to other needs when family members move out. Casa del Sol provides the needed flexibility in the age of multi-generational living. The optional flex room, for example, features movable walls allowing residents to create a separate bedroom for family members or an office workspace when there is no need for an extra bedroom. In addition, the separate studio offers a more private space for aging grandparents or returning college students.

California is experiencing very rapid population growth. According to the California Department of Finance and Population Projections, Southern California's population alone will increase by approximately two million people by 2060. Based on these projections, our cities will not be able to sustain the residential quarter-acre plot of land. This outdated infrastructure, originally designed to serve urban areas, cannot meet the demands of contemporary lifestyles without substantial fiscal investment. Water conservation and diminishing non-renewable energy resources will also escalate with a growing population. Casa del Sol addresses over crowding concerns with an adjustable floor plan and a separate studio. These features allow residents to alter and customize Casa del Sol to meet their evolving household or family needs.

Epicenter for Over Crowding

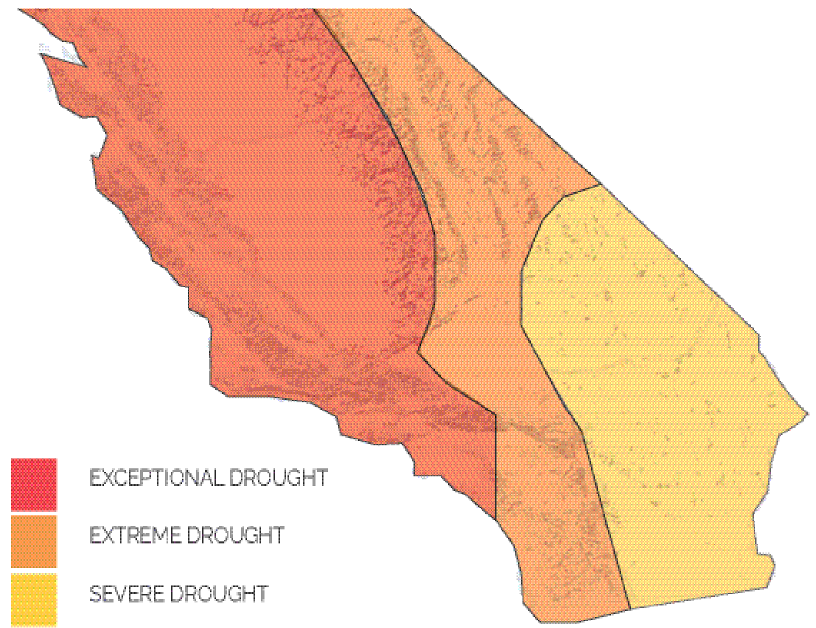


Percentage of U.S. Millenials Returning Home Post Graduation

04_ MARKET APPEAL
DROUGHT RESILIENCE

Environmentally Sustainable

Casa del Sol employs alternative power sources, state of the art technology and water conservation measures to reduce the strain on Casa del Sol's infrastructure and to prevent overuse of finite or non-renewable resources.



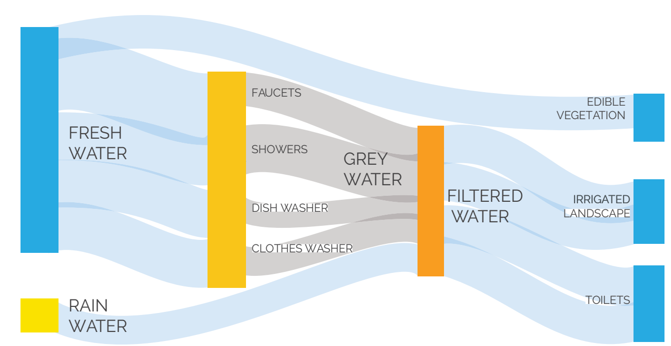
California Drought Map

MARKET APPEAL_ SO CAL

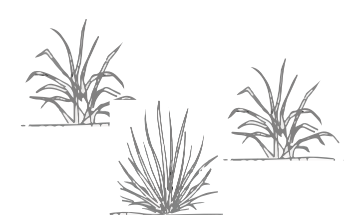
Solar Energy

Solar energy is a clean, efficient and environmentally desirable source of power. In a recent multi-state survey, households overwhelmingly (>90%) expressed support for the adoption of public policies to encourage the development of solar energy (Steel, Pierce, Warner, and Lovrich, 2014). California offers many of these types of programs, which have helped place it first in the nation in number of solar projects (GoSolarCalifornia, n.d.).

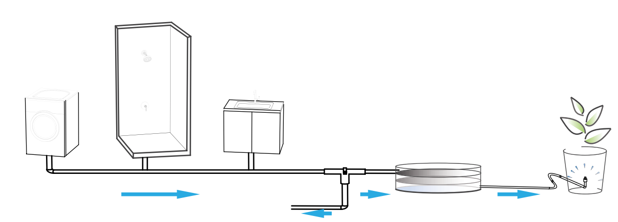
Water Conservation



WATER FLOW DIAGRAM



Xeriscape

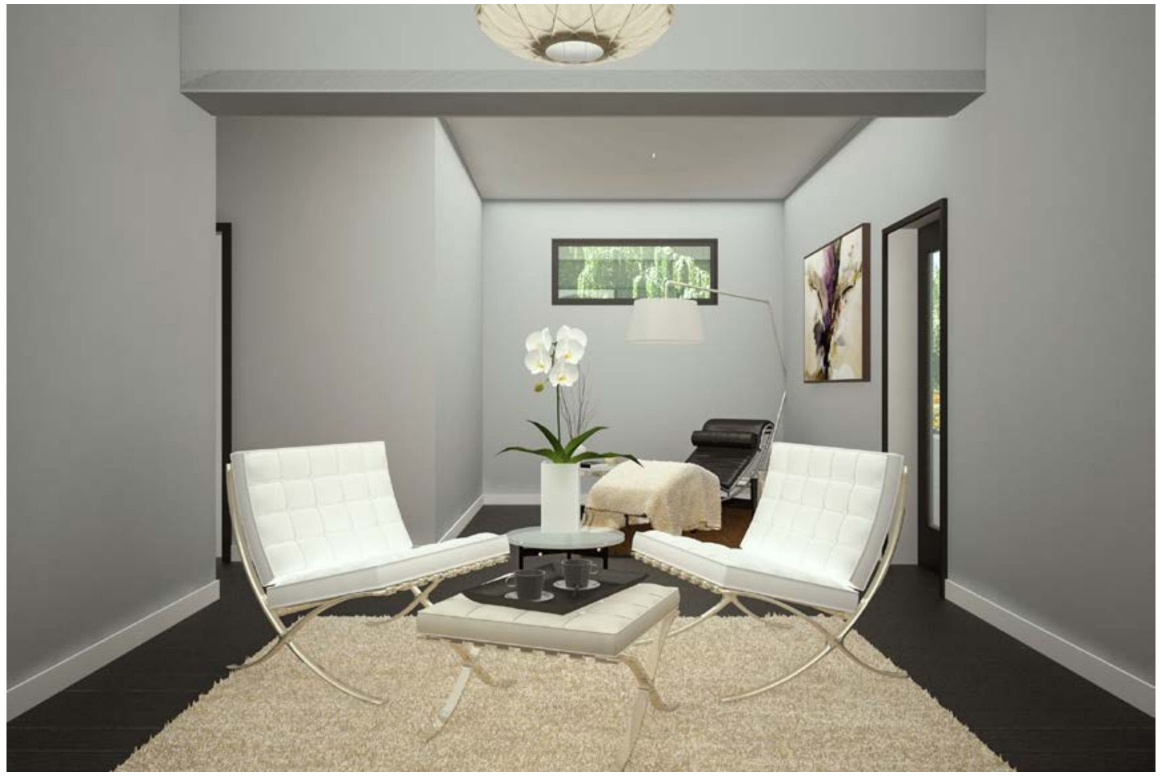


Grey Water Recycling

Casa del Sol conserves water with rainwater collection, grey water recycling for gardening and drought tolerant landscaping. These features all reduce dependence on the grid for water needs and are essential in drought conditions. For California, where 99% of the state is experiencing drought and about half of this area is in extreme drought (United States Drought Monitor, 2015), drought sensitive development is critical to sustaining communities. Regulations such as the California Green Building Standards Code for new homes are reducing internal water use, and rebate programs are helping homeowners lessen their water consumption for yards. For example, one Southern California rebate program aimed at turf removal received over 45,000 applications from property owners and as of July 2015 had fully committed the $340 million available to the program (Stevens, 2015). Casa del sol also addresses the California drought with its xeriscaping, demonstrating that a drought tolerant landscape can be beautiful and functional.

Affordability

MARKET APPEAL_ SO CAL



California is a very high housing cost area with some of the most unaffordable housing in the country. As an example, according to the real estate service, Trulia, the median sales price of housing from April to July 2015 in Orange County was $605,000, significantly higher than the United States or California as a whole. Casa del Sol is a more affordable option than the typical, standard lot, conventional stick built home. Also, savings in energy and water costs make this home even more affordable.

Finally, multigenerational living provides an opportunity for housing cost sharing, which allows household members to pay less for their living space than if they lived alone and could not share costs.

Casa del Sol provides solutions to some of the most pressing issues facing urban development. While it responds to the needs of the growing number of multigenerational households and to the need to reduce our dependence on non-renewable resources, the house must be affordable to the target population to achieve these benefits.

Data reveals existing real estate prices in Southern California continue to climb making ownership more difficult for families. The National Association of Home Builders/Wells Fargo Housing Opportunity Index considers median sales price and median family income to assess area affordability across the United States. According to this index (2015),

05_ COMMUNICATION

Brand Identity

Our brand stems from the California Poppy. The state flower's four petals symbolize our team's four academic institutions, and its resilient features inspire our home's fundamental design. Team OC is the home team of the U.S. Department of Energy's Solar Decathlon 2015. Our team consists of 100 students across four schools: UCI, Chapman, Irvine Valley College and Saddleback College. Reflecting the cultural diversity of Southern California, this cross-pollination of institutions equips Team OC with a broad range of talents, perspectives and contemporary ideas. This foundation of academic variety also makes us one of the largest and most diverse teams in the competition's history.

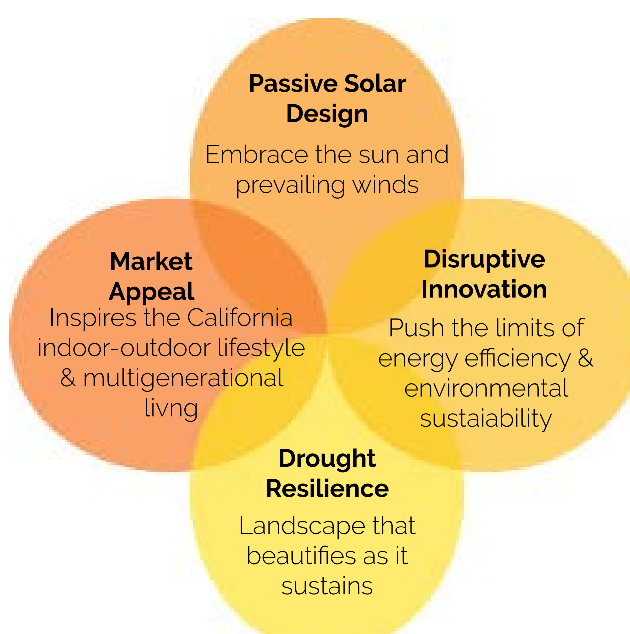
Feel Like Home

Through Casa del Sol, we aim to educate the public at large and demonstrate that it is possible to adopt sustainable living practices without sacrificing the comforts of home.

Together Forward

"Together forward" is inspired by the diversity of each competing team and the one reason we have all come together: to create a more sustainable future. We must first come together in order to build a better tomorrow.

We determined the most sustainable solutions for the decathlon's contest by emulating nature's time-tested patterns and strategies. Casa del Sol's architectural design, technological components and market appeal are rooted in a biomimetic approach to innovation and embraces four design principles.Our logo captures our "California poppy" brand with four circles, or "petals," that represent Casa del Sol's four design principles and four schools. Symbolic of our team's regional location and the poppy's orange pigment, a gradient of orange and gold distinguish each petal. The warm, sunny colors of the logo also reflect the name of our home, Casa del Sol, meaning "Home of the Sun."



05_ COMMUNICATION

The Team OC media relations student work group receives direction from a committee of faculty and staff members from across the four schools, and from professional mentors from the team's sponsors. Our advisors helped us construct a communications plan that includes both traditional and new media communication platforms. We coordinated our traditional media strategies around sharing a public audience with the competition venue. We want to capitalize on the competition's geographic significance to our community and generate buzz by making sure our audiences know there is a home team to root for. Traditional media exposure indicates community influence; we plan to acquire and utilize any exposure to provoke conversation and generate a following of local support in the months leading up to the October competition.

Target Audiences

1. **Businesses & Organizations**
   - **Primary:** Local sponsors from 2013's competition
   - **Secondary:** Relevant industry companies
   - **Tertiary:** Organizations we share audiences with
2. **Educational Institutions & Programs**
   - **Primary:** College students, young adults
   - **Secondary:** STEM classes, small learning acaemies
   - **Tertiary:** Public & Private K-12 schools in the region
3. **Orange County Residents**
   - **Primary:** Middle-aged homeowners, families
   - **Secondary:** Working adults, active adults
   - **Tertiary:** small-business owners in the local area (newspaper section readers)

General Audiences

Human Interest

Tech & Power

Goals

1. **Capitalize on "home town team" for traditional media & online exposure**
2. **Garner enough local engagement to draw large crowds to the Great Park**
3. **Produce materials that effectively engage & educate visitors and media**

Tactics

- engage with the 4 schools' online audiences
- invite local media to construction site
- pitch stories to relevant local media outlets
- organize school field trips to the competition
- invite local K-12 schools to visit the Great Park
- seek professional guidance for "creating buzz"
- work with professional mentors to develop brand consistency & produce strong marketing collateral
- utilize resources to enhance graphic design skills

Success Markers

Environment & Sustainability

Orange County (home pride)

- 600+ Facebook page likes
- 200+ Instagram followers
- 150+ Twitter followers
- More competition visitors than 2013's Solar Decathlon
- 200+ Field trip attendees at opening weekend
- 75+ Kaleri downloads
- A competitive communications contest score

Social Media & Online Presence

Our communications efforts have been geared toward engaging our various audiences in the local Orange County community. We engage our audiences through a blend of traditional and new media practices. Traditional media generates buzz, but it is our new media platforms that allowed us to retain and educate our audiences. Our website, blog and all of our social media platforms serve as individual touch points that our audiences have with our team, and it is the consistency of these touch points that will translate brand strength. By featuring social media content on our website and blog and also providing links back to the website and blog on our social media platforms, we made it easy for our cyber audiences to continuously navigate through our content and follow every step of our journey to the 2015 Solar Decathlon.