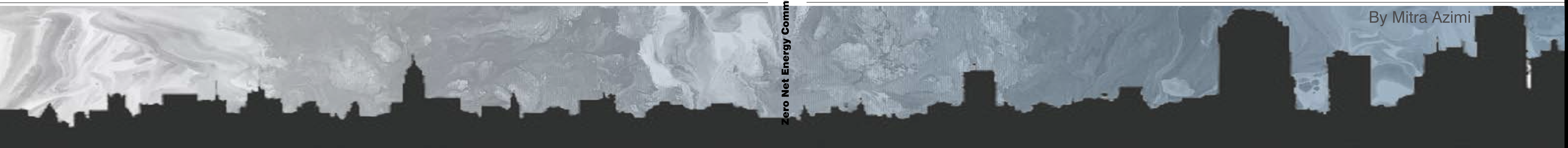
ZERO NET ENERGY

COMMUNITY EDUCATION & VISITOR'S CENTER IN SAN FRANCISCO

By Mitra Azimi

Zero Net Energy Community Education & Visitor's Center in San Francisco   Mitra Azimi   2018



Zero Net Energy Community Education & Visitor's Center in San Francisco

By: Mitra Azimi

Presented to the Faculty of the College of Architecture at Texas A&M University
for the Degree of M.Arch in Architecture

approved by:
Committee Chair: Negar Kalantar, PhD

Studio Professore: Ray Pentecost, DrPH

Committee Members: George Mann, PhD

Juan Carlos Baltazar, PhD

Robert D.Brown, PhD

2018

CONTENT

ABOUT THE AUTHOR:

Mitra in Farsi language means “Sun” and in acienPersia, Mitra is “Godess of Honesty, Friendship, Contracts and Meetings “. She comes from Iran and she can speak Farsi, English, Turkish and Azarbayjani. She has painted since her childhood and it leaded to choose architecture as her future careerr at age 18. She believes that when a person does research and work professionally on the cutting edge of her field of study, she looks like a growing plant: live, fresh, and useful; as soon as she sticks to cliché, she turns into withered plant. Her concerns about influences of urban development and technology advancement on climate change derived er to continue er academic education in landscape architecture to focus on sustainable urban restoration. Then, she moved to the USA to study M.Arch program in order to explore a new environmental knowledge of design as a response to the demands of energy consumption and climate change. This book is her M.Arch final studio project production. She persue to follow up her passion in architecture research in PhD in Architecture in Texas A&M University in Fall 2018.

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George Mann, Ph.D.

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PROGRAM

Abstract

This project is based on the “Zero’ competition challenge and the goal is to create a zero net energy bayside community education and visitor’s center to aid the mission of the Romberg Tiburon Center for Environmental Studies (RTC). I chose this project as my final studio challenge because the subject opens new perspectives about the integration of green building design, high performance building and design to improve occupant’s health. Moreover, these are my interest areas that I want to focus on my Ph.D. study as my next education step next year. Therefore, this project was an introduction for me about zero energy building, high-performance building , and biophilia.

San Francisco State University as client asks to design a Zero Net Energy Community Center where the general public, school groups and teachers can visit and learn about the ecology, biology, restoration and oceanography of the San Francisco Estuary and other nearby coastal ecosystems, as well as the environmental and naval history of the property itself. This new facility will be added to the whole 53 acres site plan and works as community education and visitor’s center.

Figure 1-Bird-eye perspective-Ref: author

Location

The Romberg Tiburon Center is an off-campus research and teaching center operated year round by San Francisco State University. It was established in 1978 by the late Paul F. Romberg, then President of the University, on a parcel of land rich with history. Tiburon RTC property sits on the bank of San Francisco Bay on steep hillsides with great views of the Richmond Bridge, Bay Bridge and the East Bay.

Design cluster is about 3 acres inside the 53 acres bigger RTC site and there are three types of public access on the Tiburon property, from the sea, road drive and pedestrian way.


Figure 2-California state map -Ref: googlemap

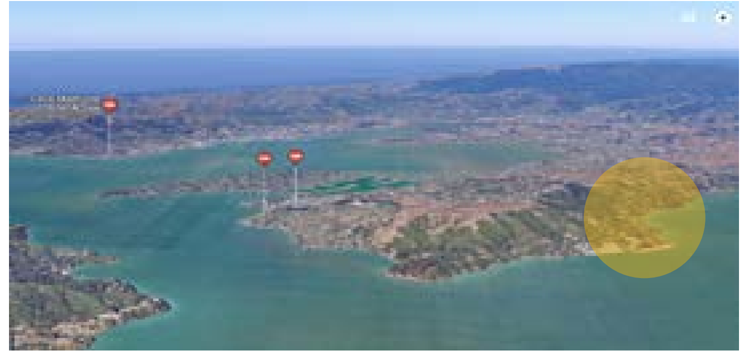


Figure 3-Tiburon map -Ref: googlemap


Figure 4-Bird-Tiburon -Ref: www.townoftiburon.org

History

Originally developed by the US Navy, the area for design is adjacent to a large concrete tarmac and seawall. Most of the existing buildings on the project site will be demolished due to their poor condition and in future, all buildings except one will replace with new constructions. A newly resurfaced and restored wharf and pier with a small harbor is planned in the location of the former one (pilings remain that can be resurfaced and incorporated).
In 1877, the waterfront site was used for process and ship codfish. Afterward, in 1905, navy owned the property to use for Navy ship coaling station and in 1930's the north warehouse was used warehouse to reel cables for the Golden Gate Bridge. The steel wire was wound and reeled, then barged to the Gate to be spun into cables. From 1931 to 1940, State of California established its first nautical training school (later to become the California Maritime Academy) in this site.

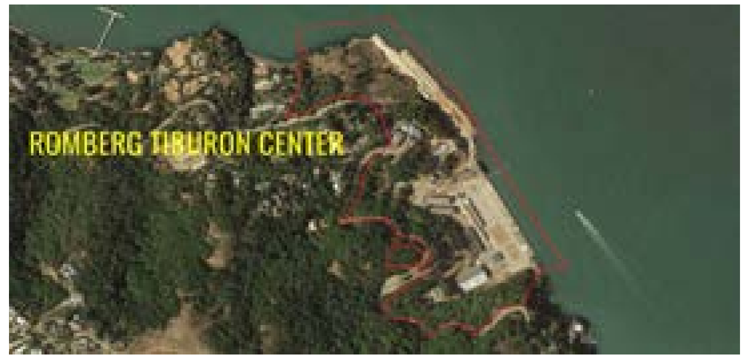


Figure 5- RTC- Reference: www.architectureatzero.com


Figure 6- design area- Reference: www.architectureatzero.com


Figure 8- Tiburon- Reference: www.townoftiburon.com


Figure 7- Deferrad maintenance value- Reference: www.architectureatzero.com

During World War II, Navy made use of the site for the construction of anti-submarine and anti-torpedo nets and the Maritime Academy relocated to its present site near Vallejo. The Navy Net Depot was active through the Korean War until 1958 when its operation was terminated and the property was transferred from the Navy to the Department of Commerce. In the 1960's, the site accommodated the National Marine Fisheries Service's Southwest Fisheries Center (NMFS), as well as the Minerals Management Technology Center. In 1977, San Francisco State decided to develop a field station and marine laboratory dedicated to the study of San Francisco Bay, and the Romberg Tiburon Center was established on the remaining acreage.

Site Analysis

Geology

It is well known that the region is traversed by six major slipstrike fault systems and as a result is exposed to hazards associated with large earthquakes.

Economic

Focus around technology, sustainable energy, agricul-

Climate

In addition, strong winds mostly form North-West penetrate the site at times . The site lies adjacent to the San Francisco Bay and thus will be impacted by Sea Level Rise. And we should consider the possibility of 100-150 cm of sea level rise above mean sea level.

The impacts of global climate change are already being felt in the form of drought and increasingly severe storm events. The Tiburon is a coastal area located in San Francisco Bay area which is in category of climate zome 3. Hence, the typical annual weather data of San Francisco Bay is chosen to be investigated for energy-saving strategies.

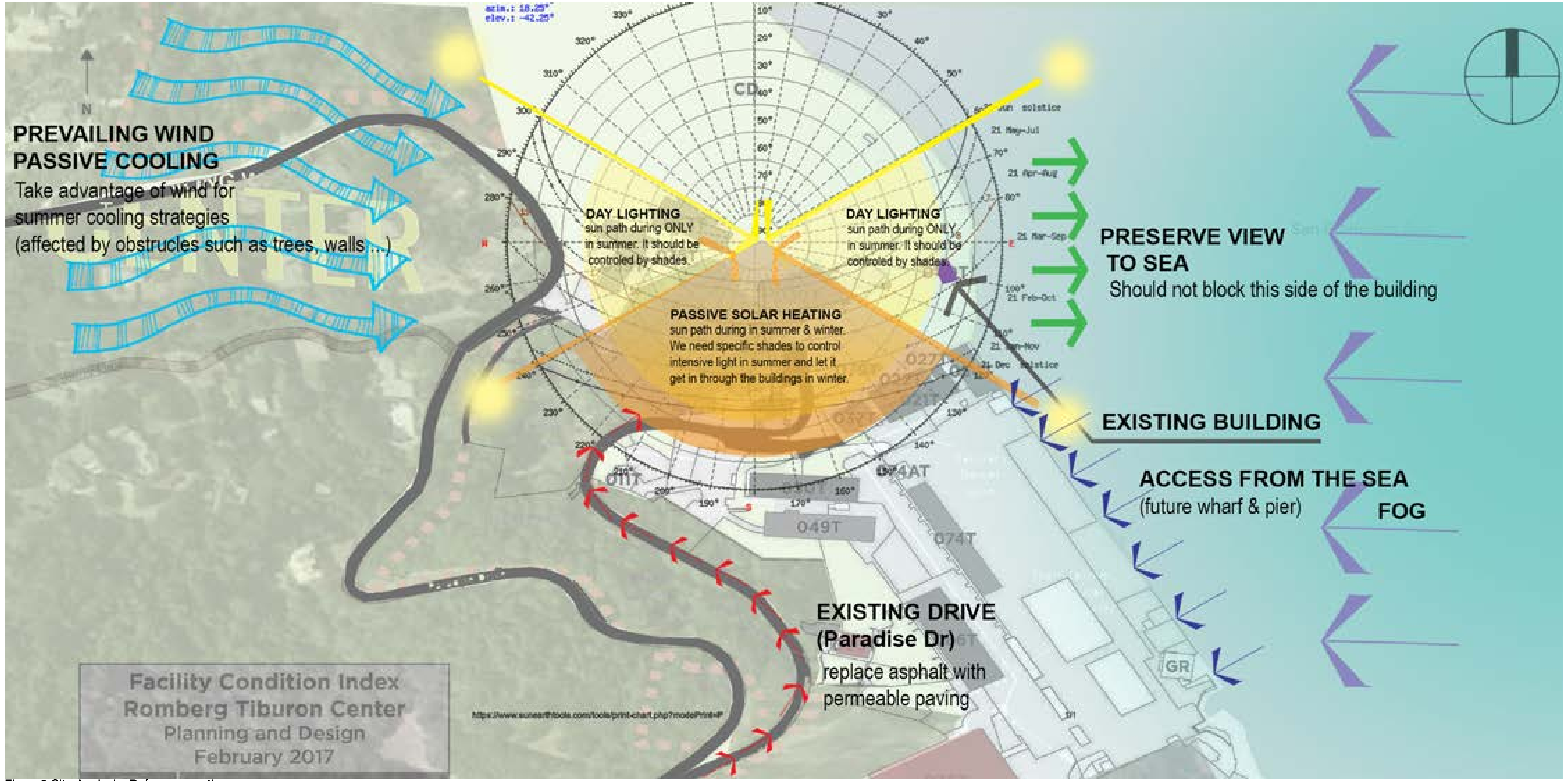


Figure9-Site Analysis- Reference: author

Using Climate Consultant software, the key local weather characteristics of San Francisco have been outlined:
- Mild winter and cool summer with temperature range matches the comfort and free cooling range in most times of the year. Summertime is characterized by cool marine air and persistent coastal stratus and fog and Winter temperatures are quite temperate.
- Based on Climate Consultant data characteristics, the natural ventilation and cooling and internal heat gains are potential energy saving measures which could ensure about 79% of the normal working time.

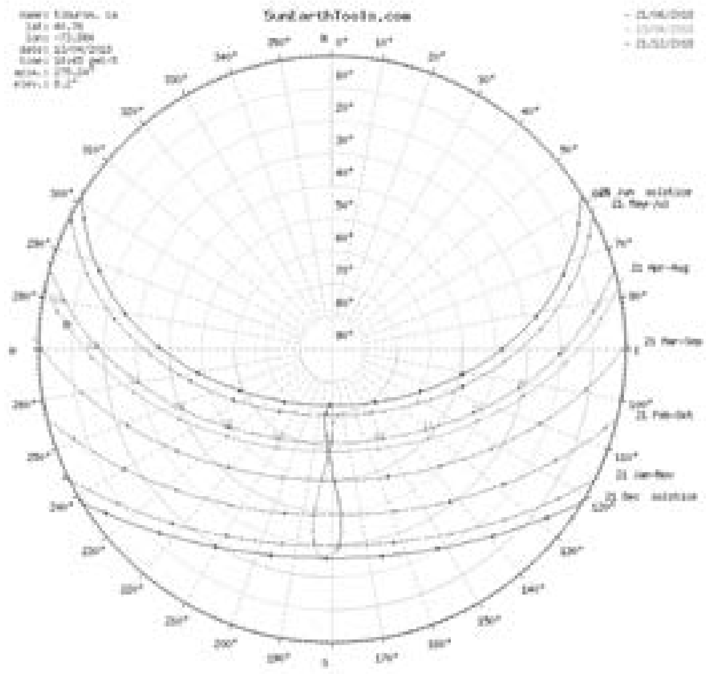


Figure 10 -Sun path- Reference: www.gaisma.com

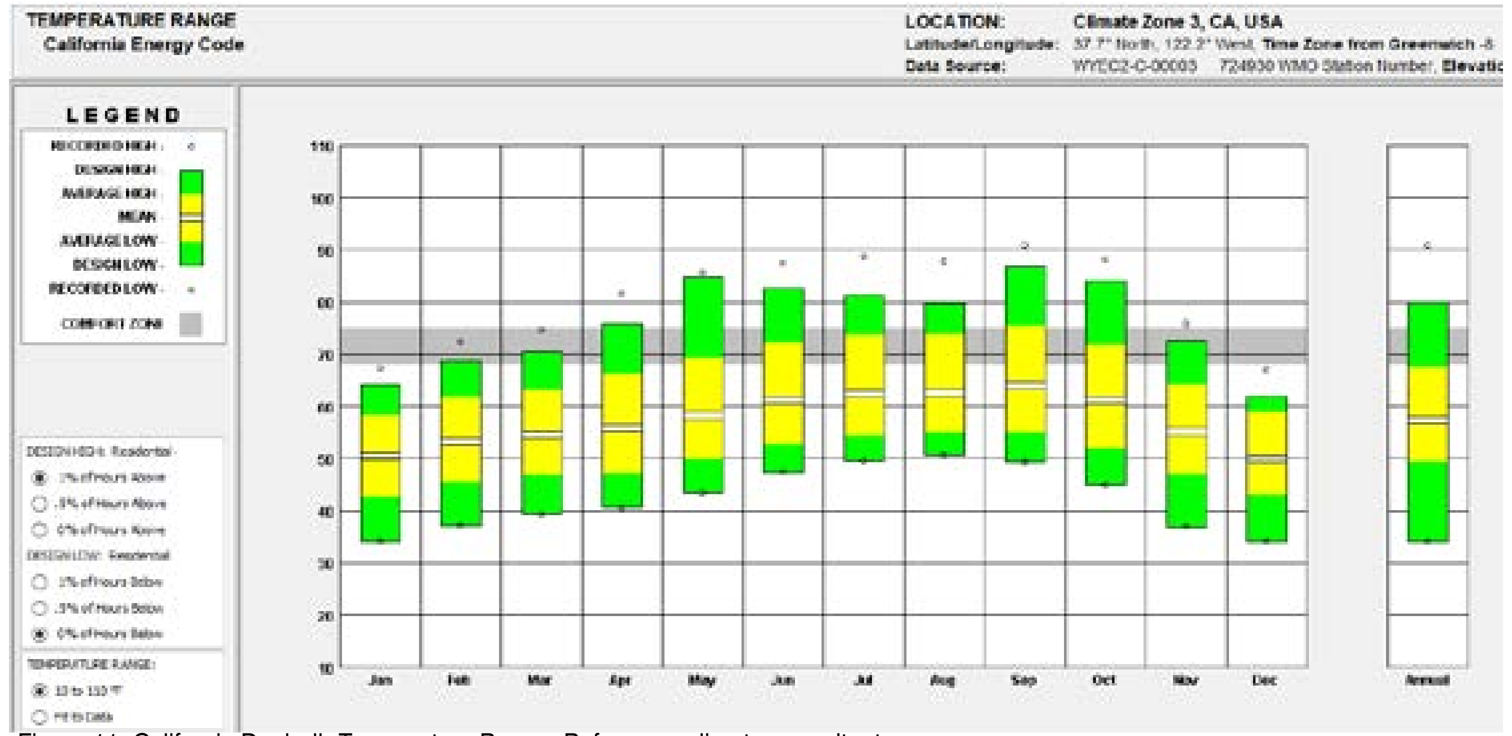


Figure 11 -California Dry bulb Temperature Range- Reference: climate consultant

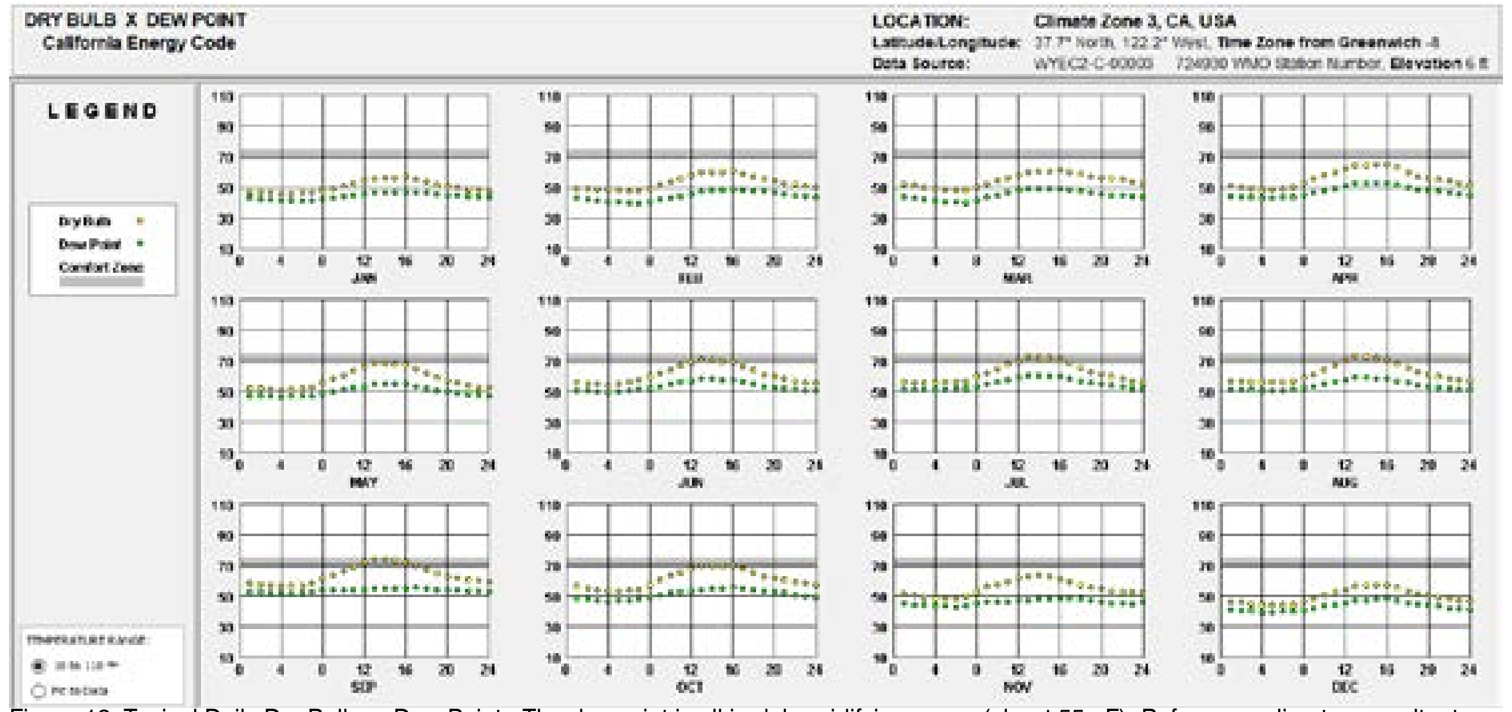


Figure 12 -Typical Daily Dry Bulb vs Dew Point - The dewpoint is all in dehumidifying range (about 55 oF)- Reference: climate consultant

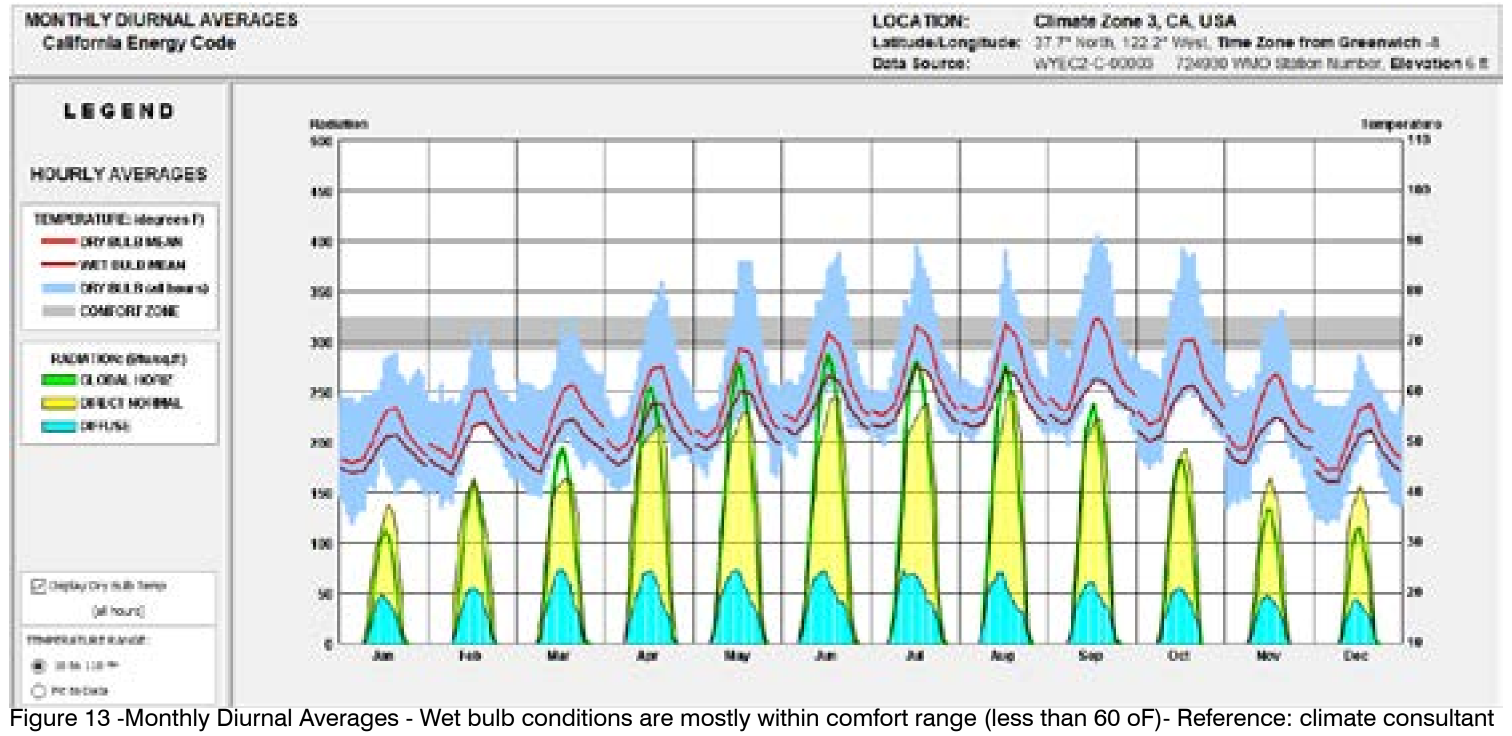


Figure 13 -Monthly Diurnal Averages - Wet bulb conditions are mostly within comfort range (less than 60 oF)- Reference: climate consultant

Client Needs

The first step in my design is to figure out client's needs and goals to define the program. In this project, client needs include below items:

1.Design a ZNE building
2.Educate environmental science to the general public & K-12 school students
3.Design a community and visitor's Center to Improve social activities
4.Get people on board with the mission of RTC
5.Increase Public and Environment health

The fact is that this building is a facility to accommodate 75 visitors (which includes 40 students in a group) and the number of staffs will be 5 persons.

According to client comments, Social meetings will be held inside and outside of the building and extraordinary views are available towards San Francisco Bay and bridges. There is no need to provide visitor's parking because there are plenty of visitor parking on the large tarmac adjacent to the project site.

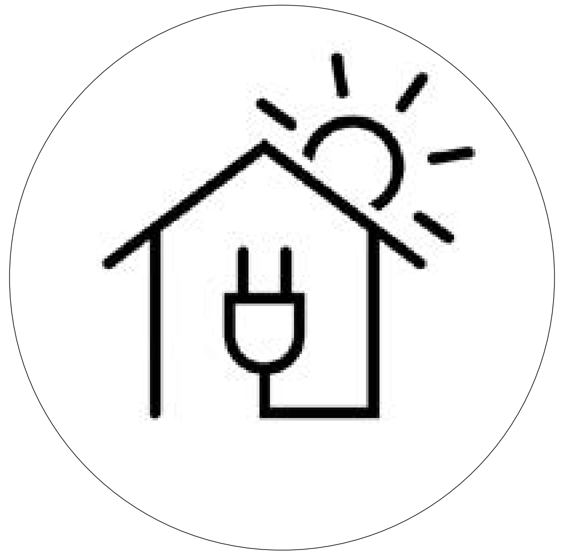
The Client, additionally, emphasized on goals that lead the architect to more accurate programming. These goals/concepts encompass 5 main areas :

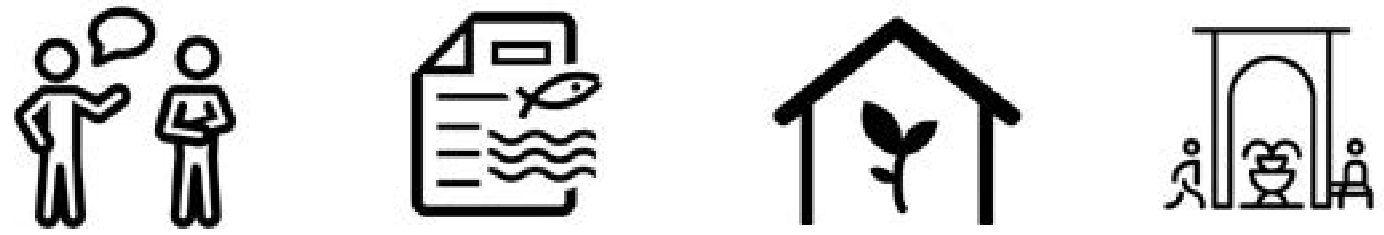
1.Save energy, water, and material resources
2.Design an interactive space for visitors with educational facilities
3.Consider facilities for on-the-bay education and recreation center for kayak and boat tours
4.Provide views of Richmond Bridge, Bay Bridge and the East Bay view for spaces
5.An outdoor picnic/ event space to serve visitor's

Architect Goals

Architect goals are extracted from the client goals and needs. Based on Zero Energy concept of the client for the building, one of the critical goals of the architect in this design is to decrease building energy loads and maximize use of natural energy resources. Social activity spaces are one of the main facilities in client needs where we can integrate with natural surroundings and bring outdoor inside the building and tell about company's story and remind general public about environmental concerns.

In addition, the core function of the facility is to provide a space to educate visitors about oceanography of San Francisco. Therefore, to prepare a space to exhibit and explore the life of under-sea became one of the goals in design the process.

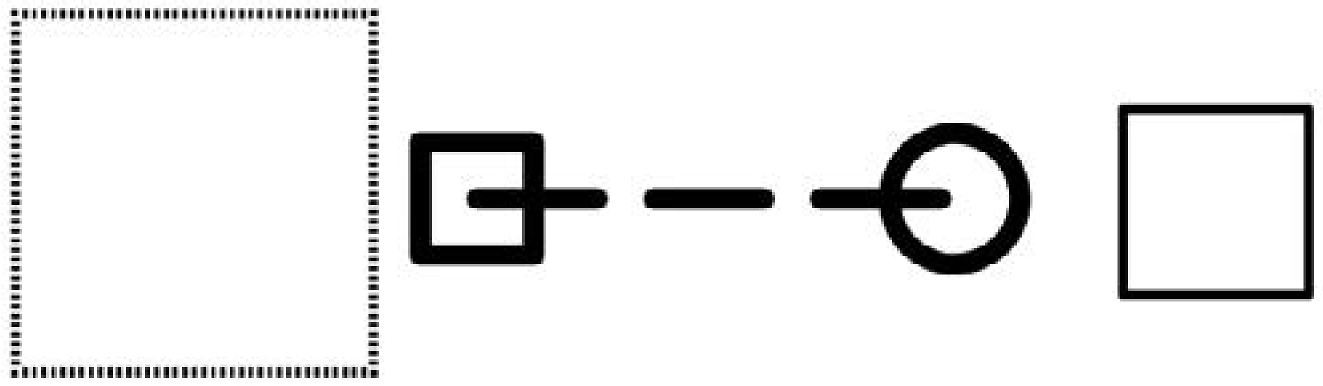




Spaces

Therefore, the design has two main component. First, designing a building as Bayside Visitor's Center for Environmental Science and History of San Francisco Bay that includes an interactive exhibition space with wet-lab classrooms for visiting school groups. This building ncludes aquariums and touch tanks, a multi-purpose room to present some events and is adjucent to an out-door picnic space to serve guests in event times. This building, in addition, is a place to integrate the environmental history of the RTC site and its research programs with Marin County and SF Bay. Activity time of this facility is from 10.00 am to 5:00 pm every day.

The second building is a space for support science-on-the-bay nature education kayak and small boat tours for visiting people. Adjacent this building should be a parking area as storage space for kayaks and other support services. Therefore, the second building is " Science-on-the-Bay and Aquatic Education and Recreation" building and there will be 2 staffs in the day time.



Below is the table of required spaces with needed squire feet area.

BUILDING A –BAYSIDE VISITOR'S CENTER					
SPACE	**BREAKDOWN SPACES**	**OCCUPANCY**	**OCCUPANT LOAD FACTOR**	**Area REQUESTED**	**Area needed**
INTRO / LOBBY	RECEPTION/ TICKET			100 sq.ft	
	ENTRANCE HALL	75			
	RETAIL SHOP	5-10	50 (net)	300 sq.ft	250-500 sq.ft
ADMINISTRATION	OPEN SPACE OFFICE	3	50-100	500	300
	KITCHENETTE/ BREAK ROOM/	3	%10 of total area (35 net)	800	50-105 sq.ft
	café	75	%10 of total building floor area OR 15(net)		800-1125 sq.ft
RESTROOMS	MEN	80	1 WC per 50, 1 Lav per 50, 1 DF per 100, 1 service sink	400	2 for men+ 2 for women
	WOMEN				
EXHIBITION	EXHIBITION HALL	80		2000 sq.ft	
	STORAGE FOR EXHIBIT		500 gross		800 sq.ft
	TECHNICAL ROOM		300 gross		300 sq.ft
	MECHANICAL ROOM	minimum of 4 percent of the typical floor's gross floor area	300 gross		330 sq.ft
	WET LAB CLASSROOM (to include "TOUCH TANK" exhibit of 200 gallon)	40	50 (net)	2200 sq.ft	2000 sq.ft
MULTIPURPOSE RM/ CONFERENCE RM	CONFERENCE HALL	75	Assembly without seats : 15(net)	1200 sq.ft	1125 sq.ft
	STORAGE				
PARKING	**PARKING FOR STAFF (CARPORT)**	3	200 (gross)		200 sq.ft in outdoor
	LOADING AREA FOR DELIVERY TRUCK/VAN/CAR	2 TRUCKS			
	PARKING FOR VISITORS	There is plenty of visitor parking on the large tarmac adjacent to the project site			
	ADA parking	2+1	2 standard handicap spaces and 1 handicap van space.		
BUILDING 2 –AQUATIC EDUCATION AND RECREATION					
RECEPTION FOR RECREATION CENTER		1		300 sq.ft	300 sq.ft
OFFICE		2	50 (NET)	200 sq.ft	100 sq.ft
STORAGE			500 gross		
LOCKERS, SHOWERS, EQUIPMENT CLEAN-UP		40	GROUP E 50(NET)	1000 sq.ft	2000 sq.ft
OUDOOR STORAGE FOR BOATS/KAYAKS				1000 sq.ft	

Precedents

I chose two case-studies which are Nexus and Fog-Catcher projects in San Francisco because the focus in their design was to create a zero building. Therefore, considered zero energy strategies in these projects can be very helpful for my approach since their location and goals are similar.

1- Nexus:

This project is Student housing which is located in Pacific west coast within the San Francisco Bay Area. The aim is to create a net-zero energy high-performance building with regard to Increase Social activities. Additionally, improve social connections among students, provide areas for gathering and socializing and provide areas focused on de-stressing are among health and wellness strategies in this design. Water collection, storage, and use are very important due to drought problem in California. Hence, drought tolerant plants are selected by installing low-flush fixtures to reduce irrigation.

One of the most important goals is to Capture as much rainwater as possible. To harvest solar energy, PV panels are installed on the entire area of the roof and some places of the site. To make natural ventilation, low level operable outdoor air intake vents with an external wall (eight per unit cluster) and high-level internal duct vents that allow warm air to pass into ventilation stacks are designed. The stacks rise 40ft above the building and exhaust into the lee-wind. Additional cooling and ventilation will be provided through operable windows.

Figure 14 -Nexus site plan- Reference: www.architectureatzero.com

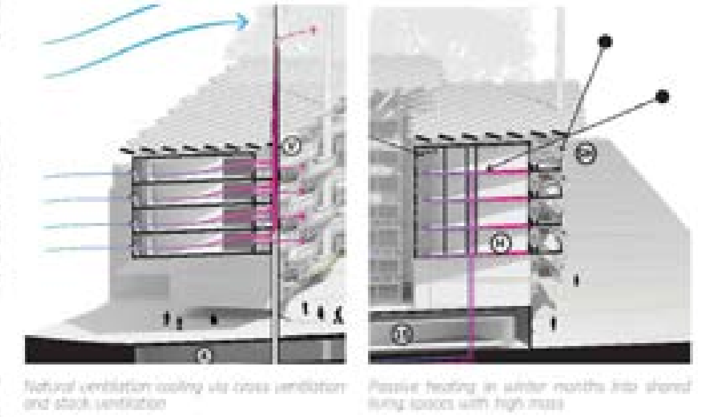


Figure 15 -Nexus section- Reference: www.architectureatzero.com

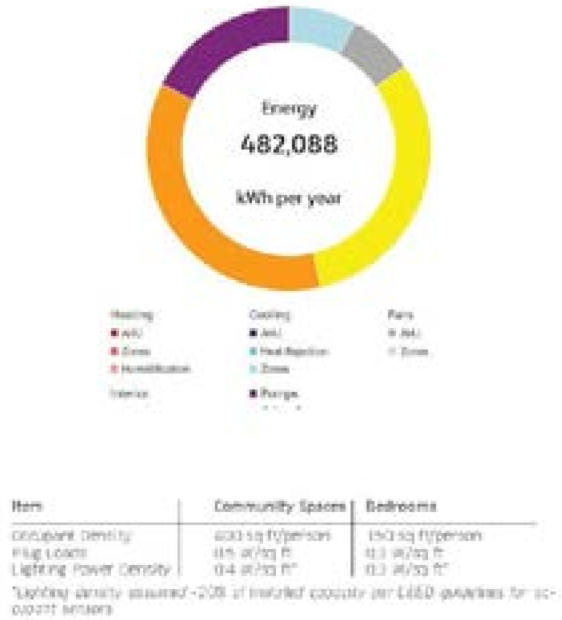


Figure 16 -Nexus energy consumption- Reference: www.architectureatzero.com

Figure 17 -Nexus- Reference: www.architectureatzero.com

2- Fog-Catcher

Second case-study is Fog-Catcher. The building is enveloped in a "cloud-like" metallic shroud expressive of the natural breezes that enfold the student housing buildings like a perforated, filmy blanket. Addressing California's continued struggles with droughts, the design follows biomimicry.

Figure 18-Fog-catcher Bldg- Reference: www.architectureatzero.com

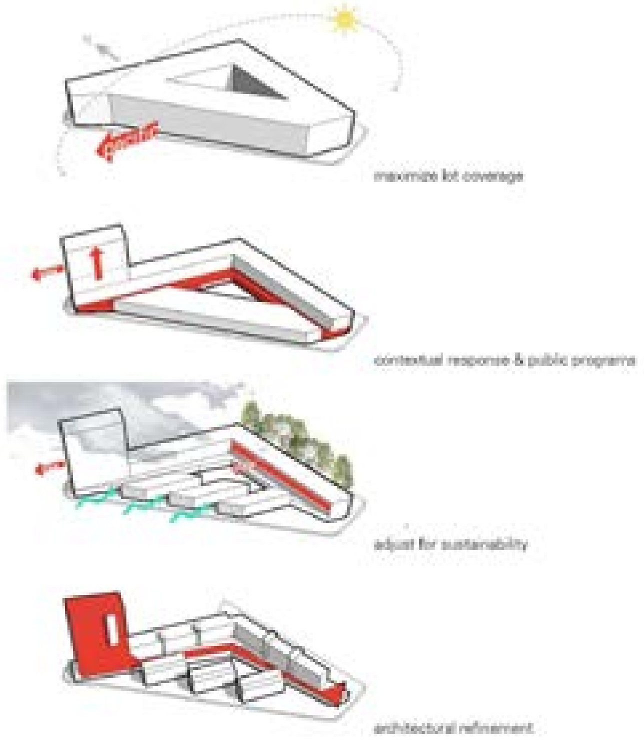


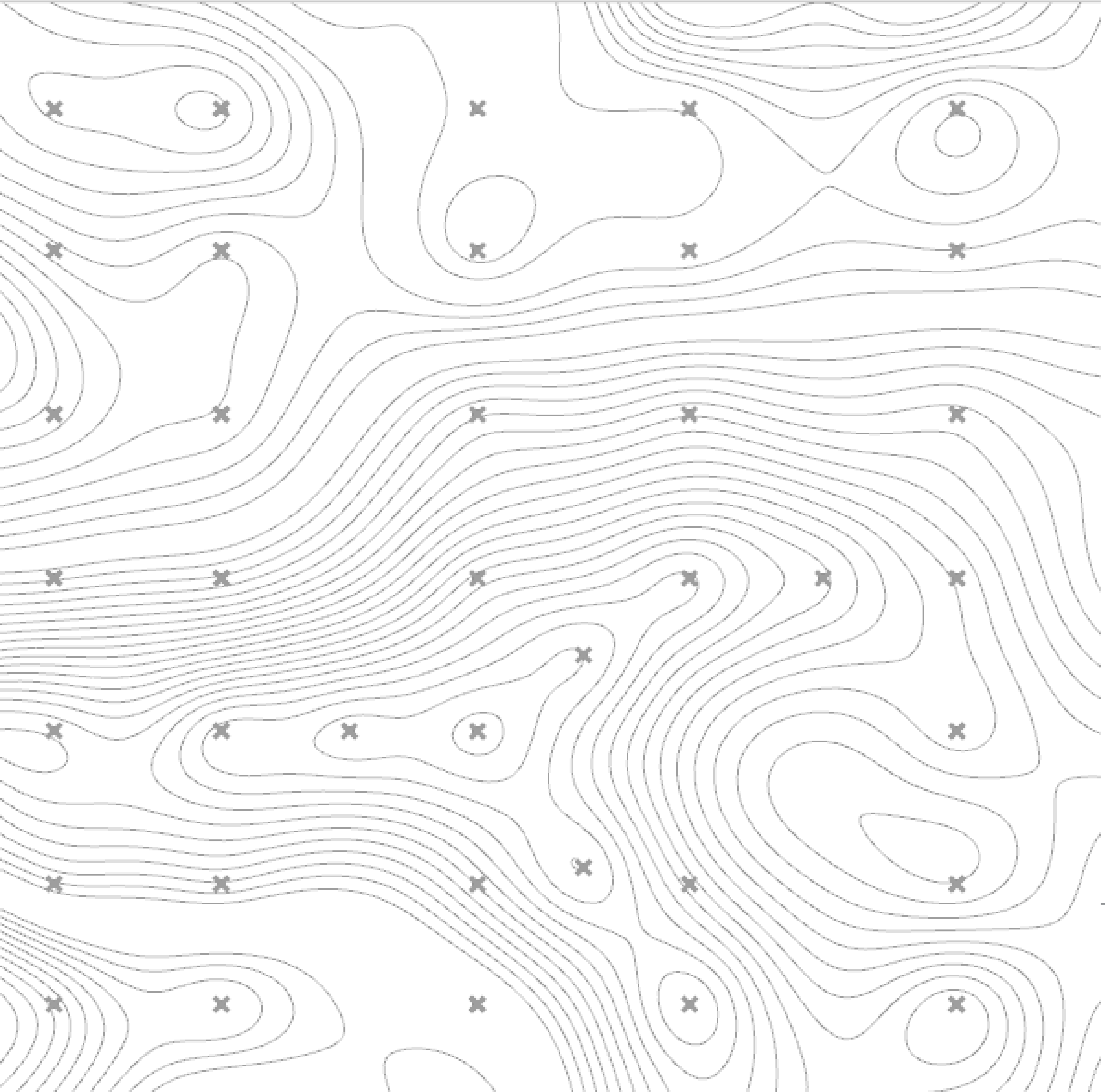
Figure 19-Fog-catcher concept diagram- Reference: www.architectureatzero.com

Figure 20-Fog-catcher- Reference: www.architectureatzero.com

Moreover, incorporating fog catchers into the building envelope to capture enough water is the approach to harvest water for landscape irrigation. The goals of the project consist of net-positive energy, utilizing no mechanical system for the student housing and relying instead on passive strategies for heating and cooling. Therefore, solar orientation, natural breezes, and fog greatly shaped the site design approach, as well as the overall building planning that we can count on them as passive strategies in design.

Figure 21- Fog-catcher site plan- Reference: www.architectureatzero.com

Figure 22-Fog-catcher materials- Reference: www.architectureatzero.com



DESIGN STRATEGY

ZNE Strategy

The psychometric chart is exported from Climate Consultant software. Moreover, based on its calculations, it suggests some preliminary design strategies to decrease energy loads of the building and increase harvest of natural energy resources in this location. These strategies as well as psychometric chart is shown below.

1.Reduce Energy Loads
2.Keep the building small
3.Organize floor plan to harvest solar energy
4.Use high mass (thermal mass) materials for interior and exterior faces
5.Use geothermal pumps
6.Provide double pane high-performance glazing (Low E) on the west, north, and east, but clear in the south to maximize solar gain
7.Windows overhangs or operable sunshades
8.Low-pitched roofs with wide overhangs
9.Extra insulation
10.Operable walls or sun shaded outdoor spaces
11.Use breezes in summer
12.Locate storage areas or garages on the side of the wind
13.Sunny wind protected outdoor spaces
14.Small well-insulated sky-lights
15.PV cells in the site plan
16.Wind garden
17.Collect rainwater in shallow pools in the site plan
18.Use natural materials and finishes biophilic)
19.Trees help create a sense of place, reduce noise and glare

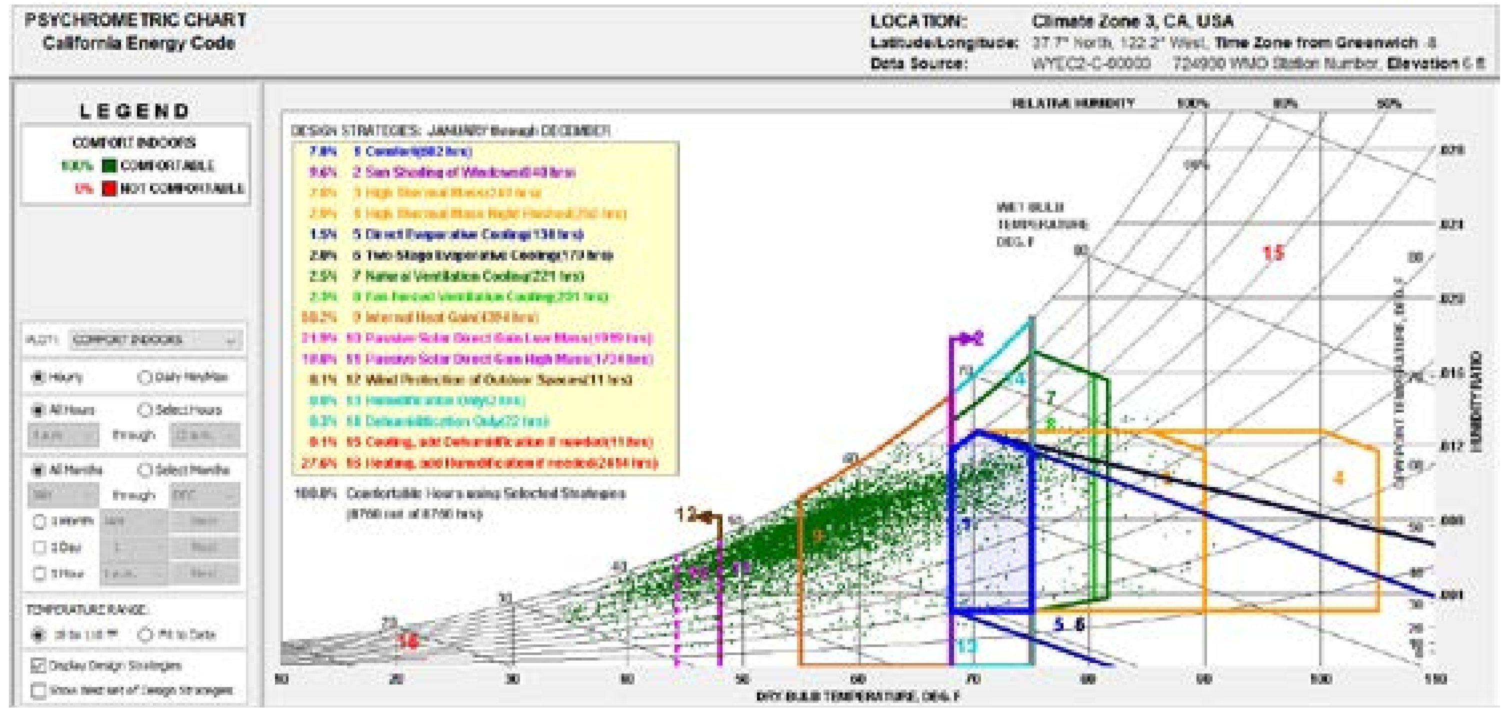
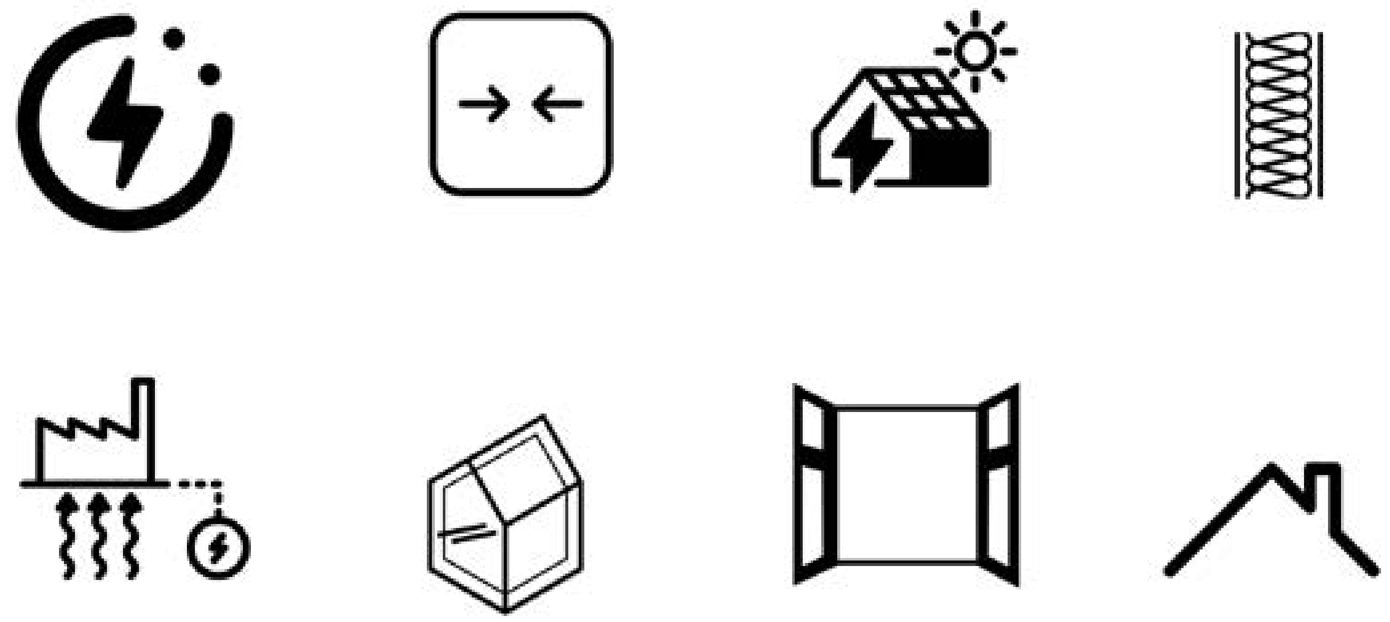
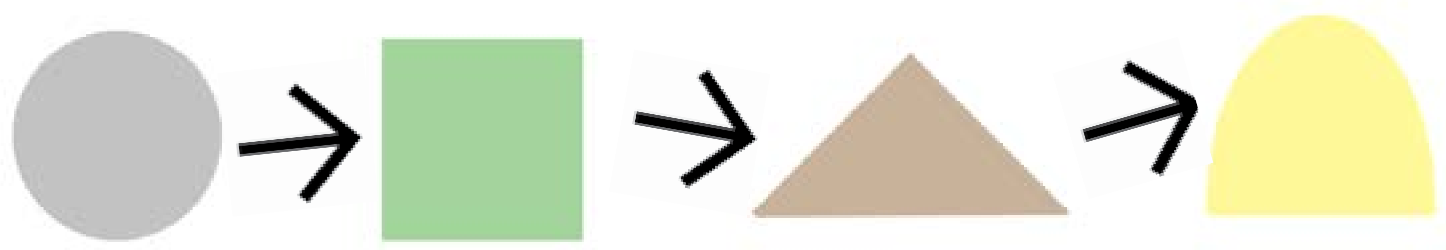


Figure 23- Psychometric chart- Reference: Climate consultant



Functional Strategy

Since the goal to visit this facility is to learn about an unknown world which is the under-sea world; Therefore, exploration of this world is the core functional concept and I decided to design different sequences to increase sense of exploration and attraction of the space for visitors.



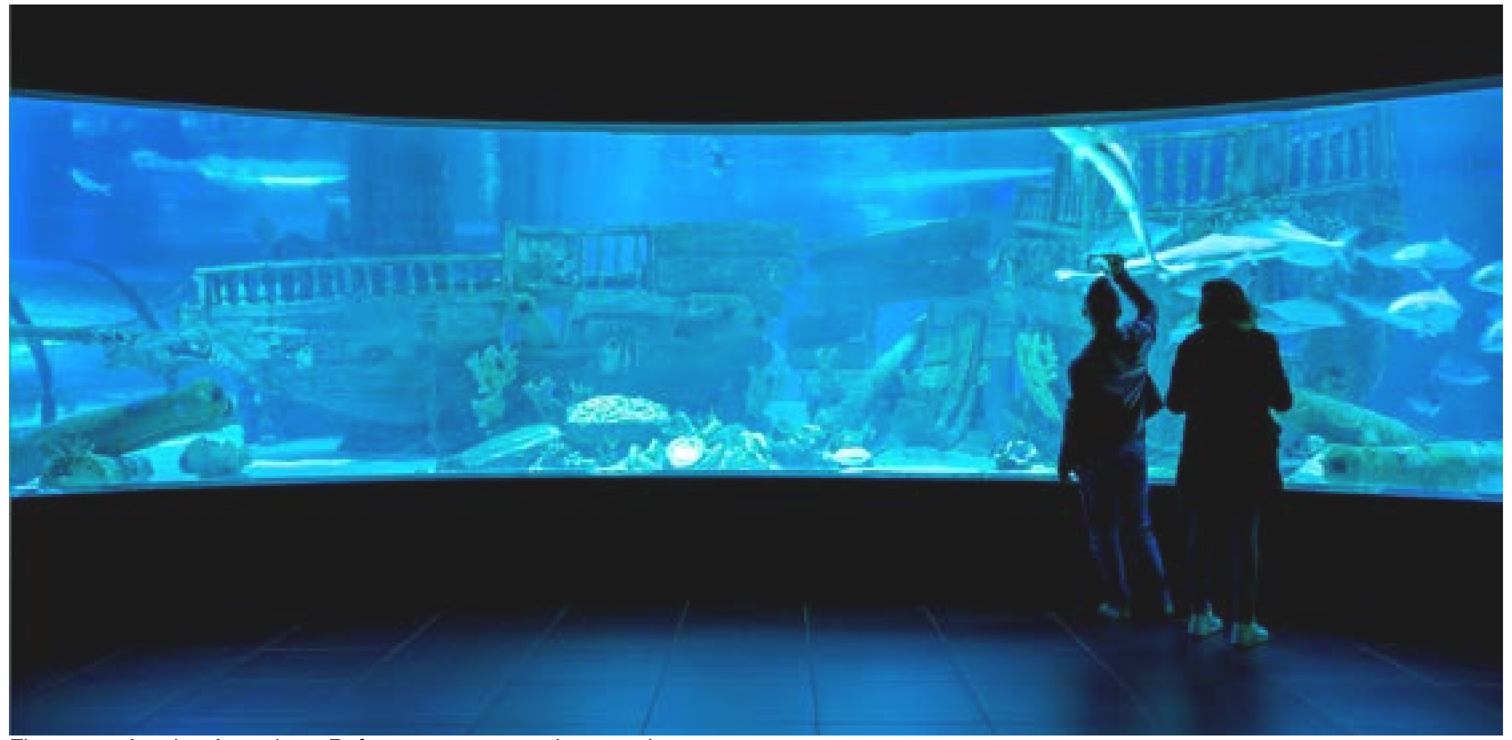


Figure 23- Antalya Aquarium- Reference: www.antalyaaquarium.com

function → learn about an unknown world (MARINE WORLD) → - exploration - visual connection - experience-touch → **mysterious exploration**

↓

design different **sequences**

Zone Division

In addition to those two strategies, I have split functions of this facility into three zones based on their need for-natural light: light zone, dark-zone, and outdoor zone.

Dark Zone

- interactive xhibit with aquaria & shallow touch tanks
- restrooms
- support for exhibition
- retail shop
- wet-laboratories
- storage
- lockers/ showers
- Mechanical/ Technical Spaces
- Conference Room
- Cloakroom

Light Zone

- Atriume/ Entrance
- Administration/ Office
- Wet-lab Classroom
- Launch room/Cafe
- Multi-purpose Room
- Lobby Reception

Outdoor Zone

- Cofe Terrace
- Staff & ADA Parking
- Loading Dock
- Outdoor Storage for Kayak
- Entrance Garden
- Platform/ Waterfall
- Waterfront

DESIGN

Figure 24- Bird-eye perspective- Reference: author

Parti Development

The design was formed based on design strategies that mentioned previously. This building has a unique story which extracts from its unique natural hillside site as well as its special function.

Contrast is the best word to explain the design. Contrast happens between building sculptural geometry and its surrounded organic site. Moreover, this contrast is accentuated in building architectural design. I split the building into two parts based on public functions and private functions. Public functions conclud wet-lab classrooms, multi-purpose rooms, administrative and retail and private function is the aquarium and each function has a special architectural character. To put it more simply, contrast happens between the spaces that belong to these separated functions. Organic geometry is selected for aquarium and more rigid structural geometry is chosen for the public function. These two enclosed geometries are combined with a fluid semi-open roof.

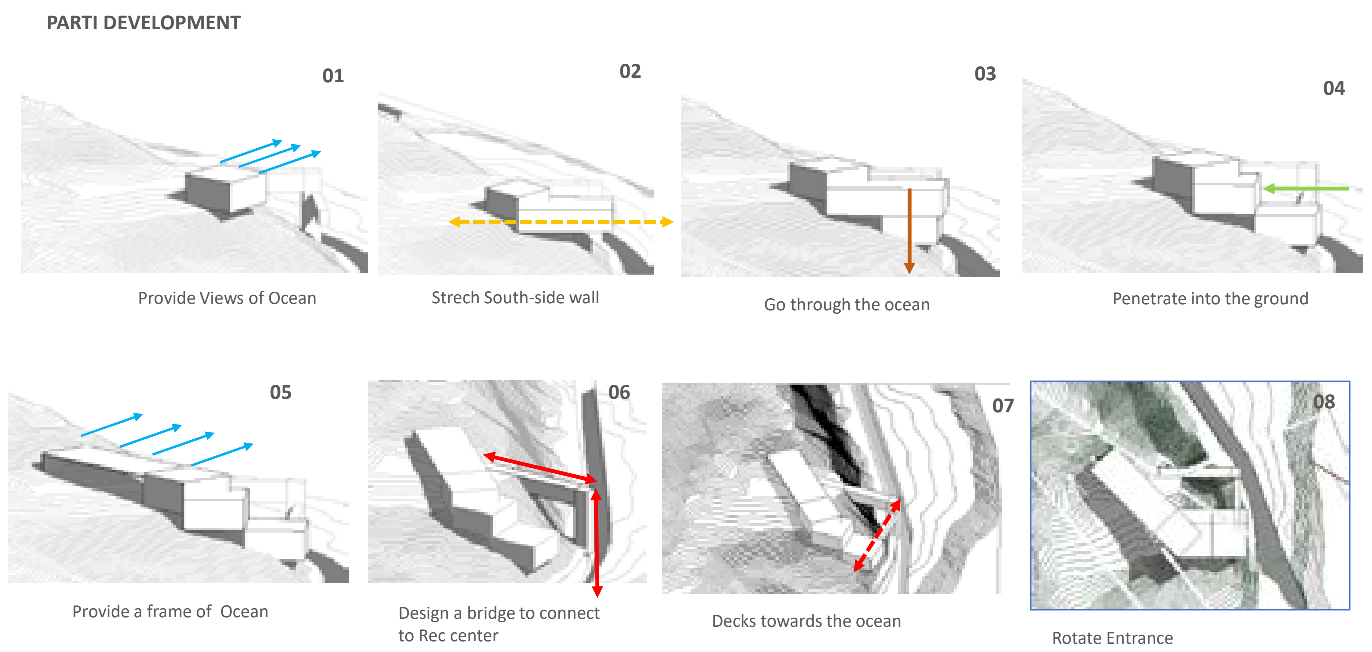


Figure 24- Parti-development- Reference: author

The whole idea is to integrate the surrounding nature and the enclosed spaces. Therefore, nature flows through the architecture, becomes one of the main elements of this design and forms the valley and then connected to outdoor again. Therefore, nature and architecture have finger crossing relation together.

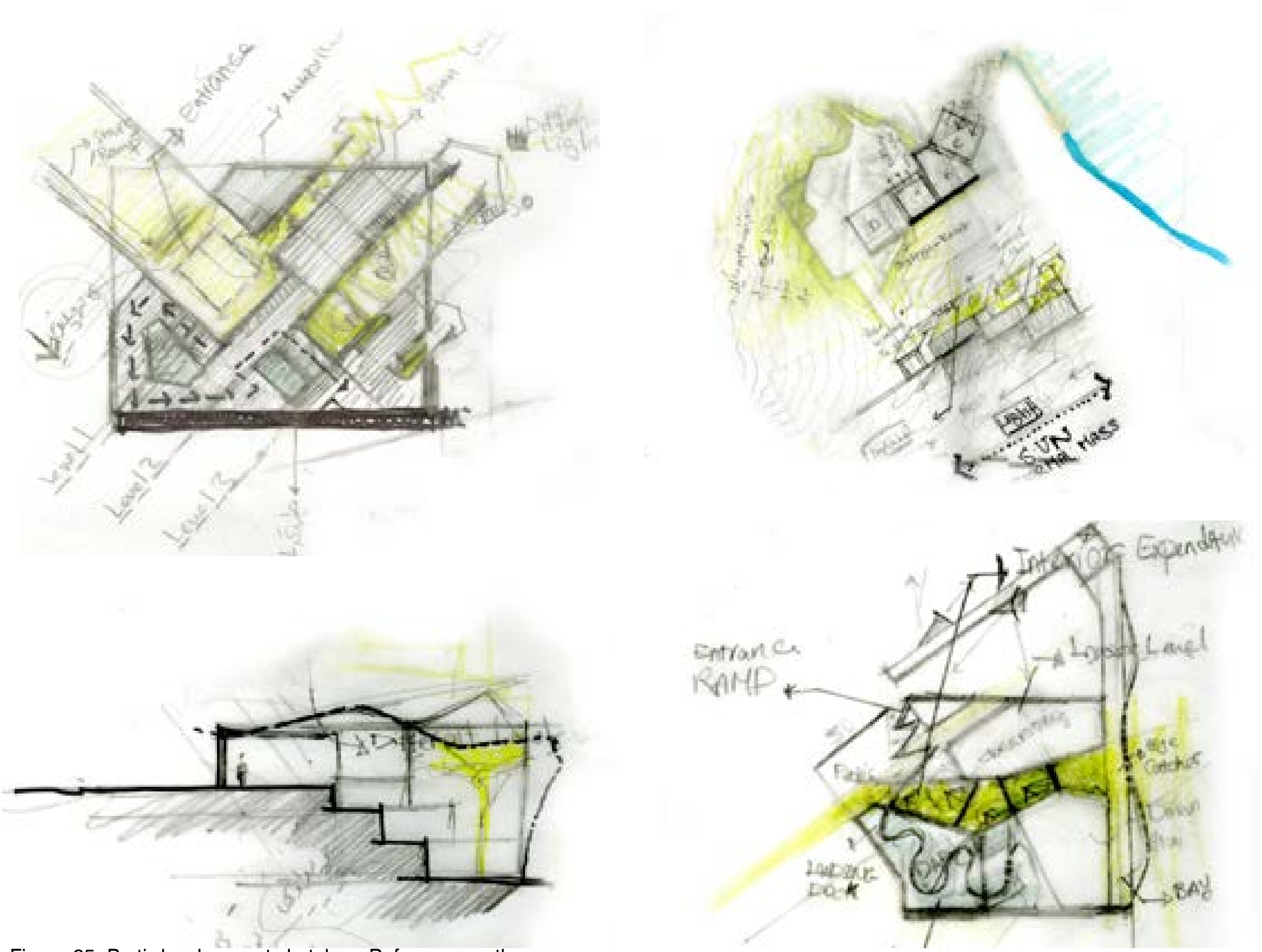


Figure 25- Parti-development sketches- Reference: author

Indoor green valley frames the ocean for the visitors who enter the facility. To increase the connectivity of nature and architecture, I broke the solid geometry and provided two decks as stop spots through the ramps. Moreover, this open space between two sides of the building provides natural light for all spaces.One of the most important features of the design is to play with natural hillside slope. Therefore, visitors go down by provided ramps and stairs. The public functions connected together with these outdoor ramps and decks. However, the aquarium is an individual enclosed space that starts from the entrance deck and goes down with a curved path and exhibited aquariums and shallow tanks happen around this ramp.

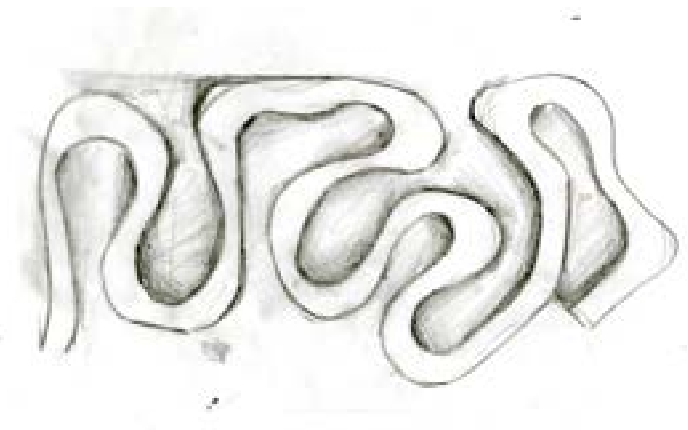


Figure 26- River shape sketch- Reference: author

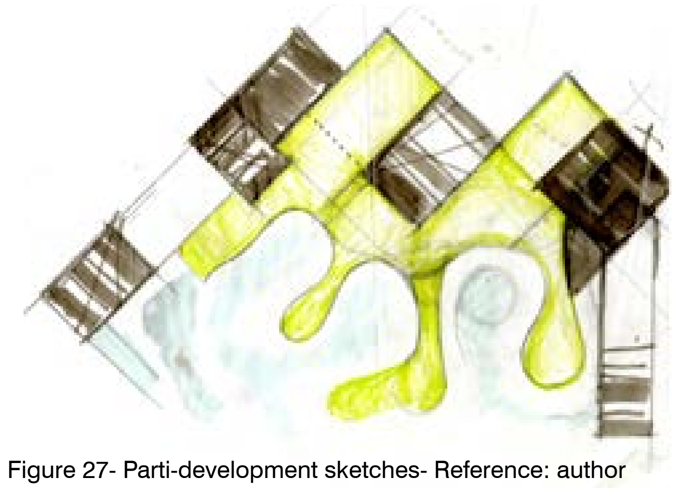


Figure 27- Parti-development sketches- Reference: author

Figure 28- River- Reference: http://peter-mulroy.squarespace.com

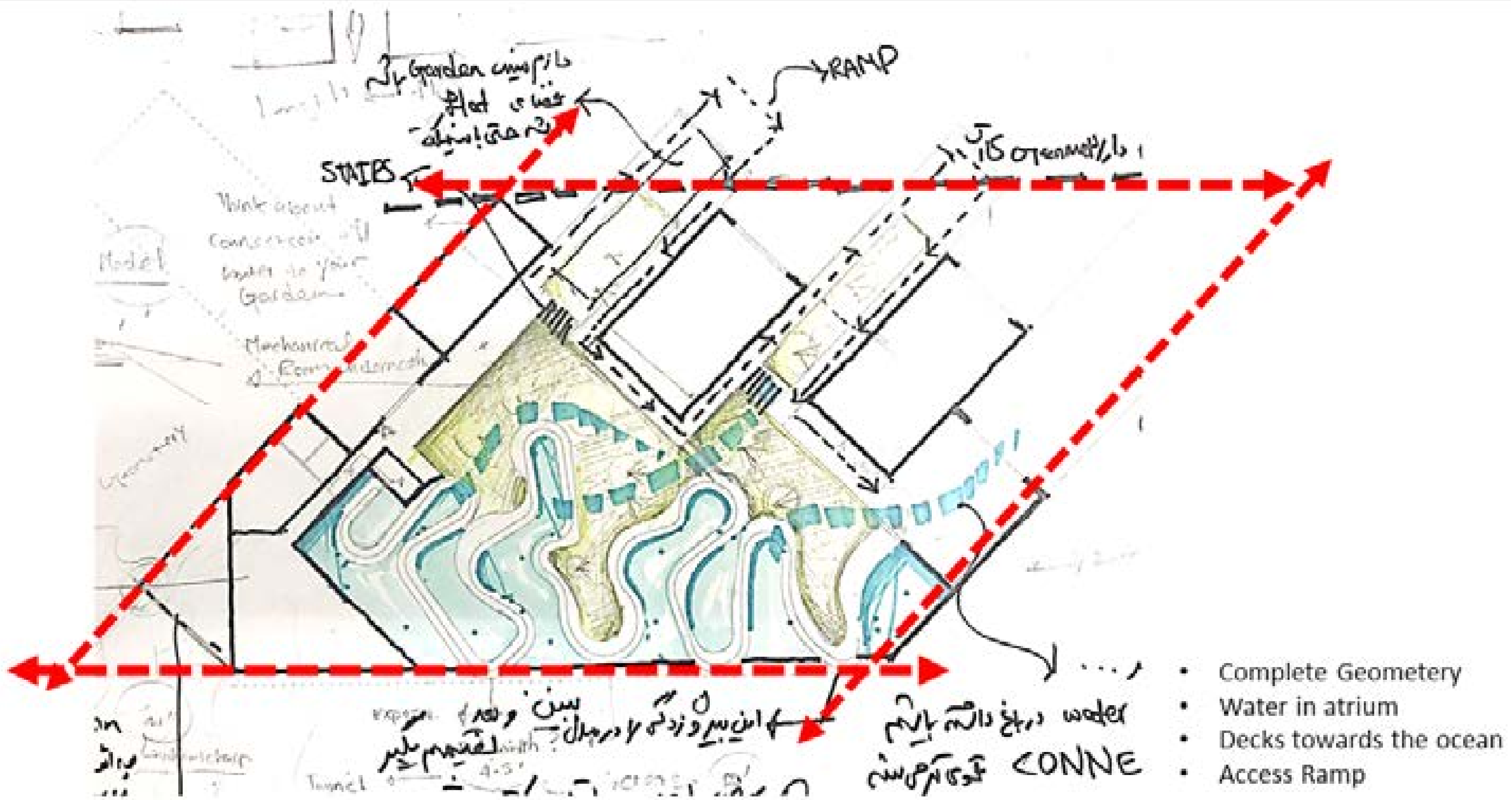


Figure 29- Parti-development sketches- Reference: author

The concept of the curvature comes back to the shape of a river because the aquarium is a place to exhibit aqua creatures and the site is adjacent to the sea as same as a river that connects to the sea in its last step.

Figure 30- Perspective- Reference: author

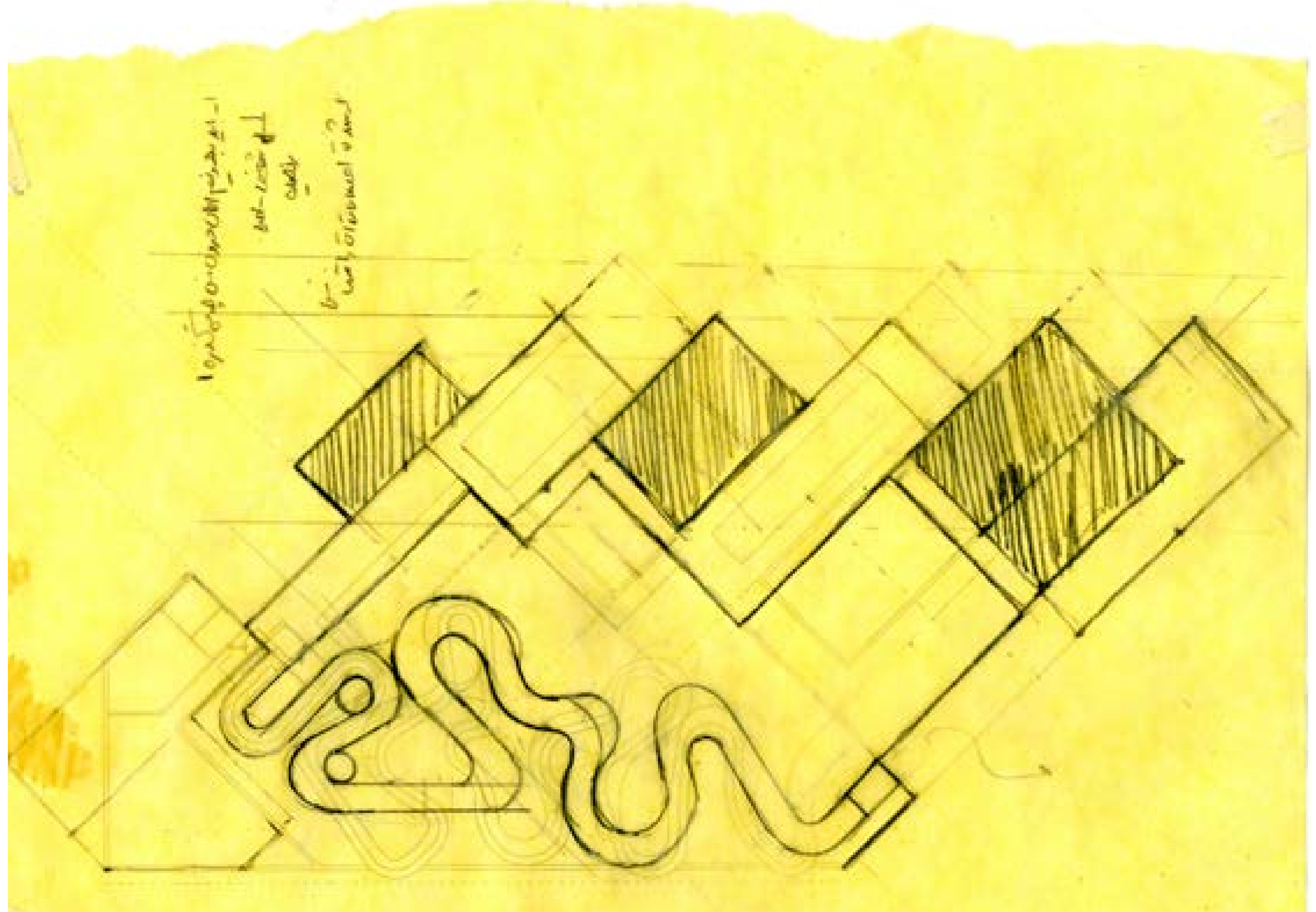


Figure 31- Parti-development sketches- Reference: author

Figure32-indoor garden perspective- Reference: author

Figure33- Cafe interior perspective- Reference: author

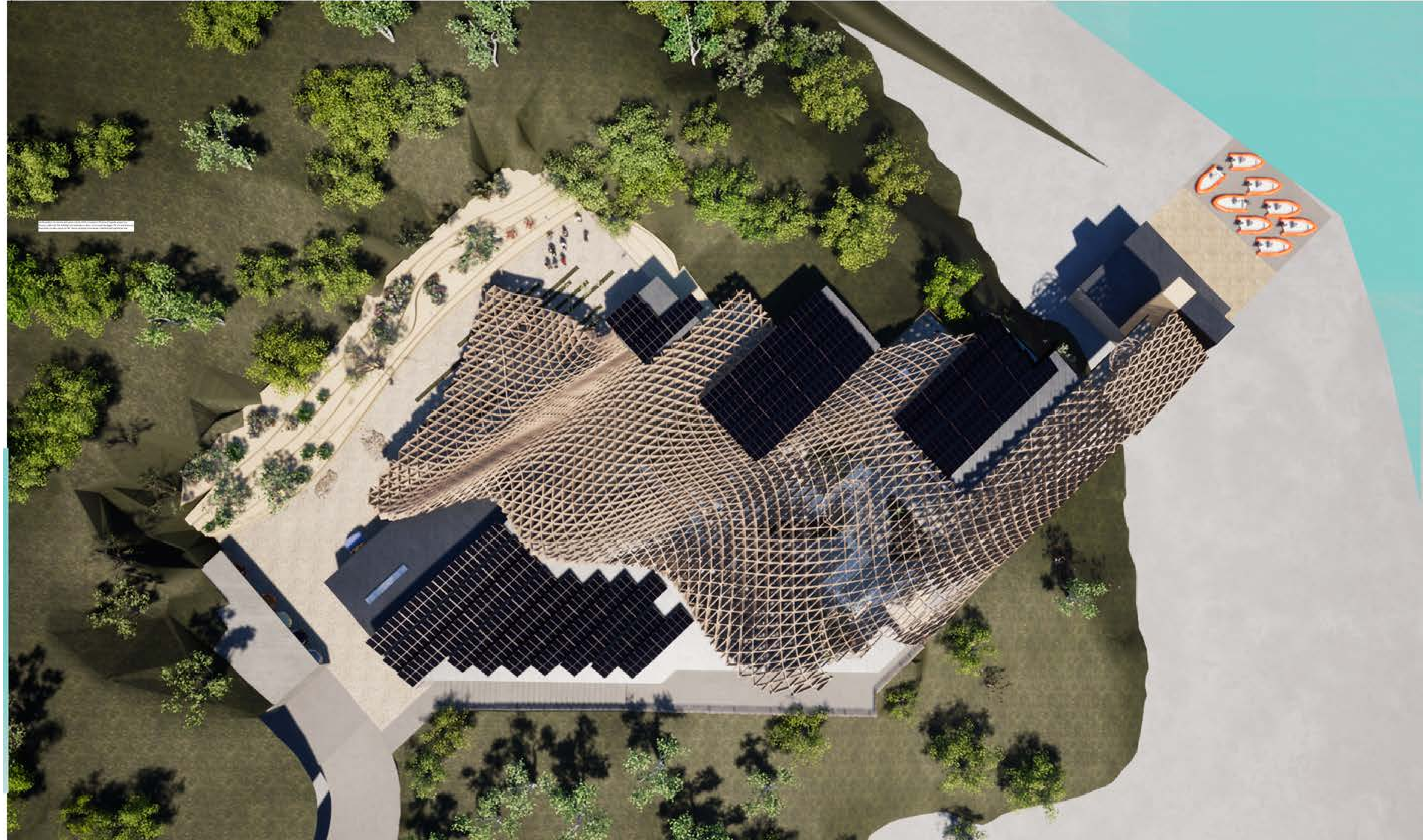


Figure34- Site plan- Reference: author

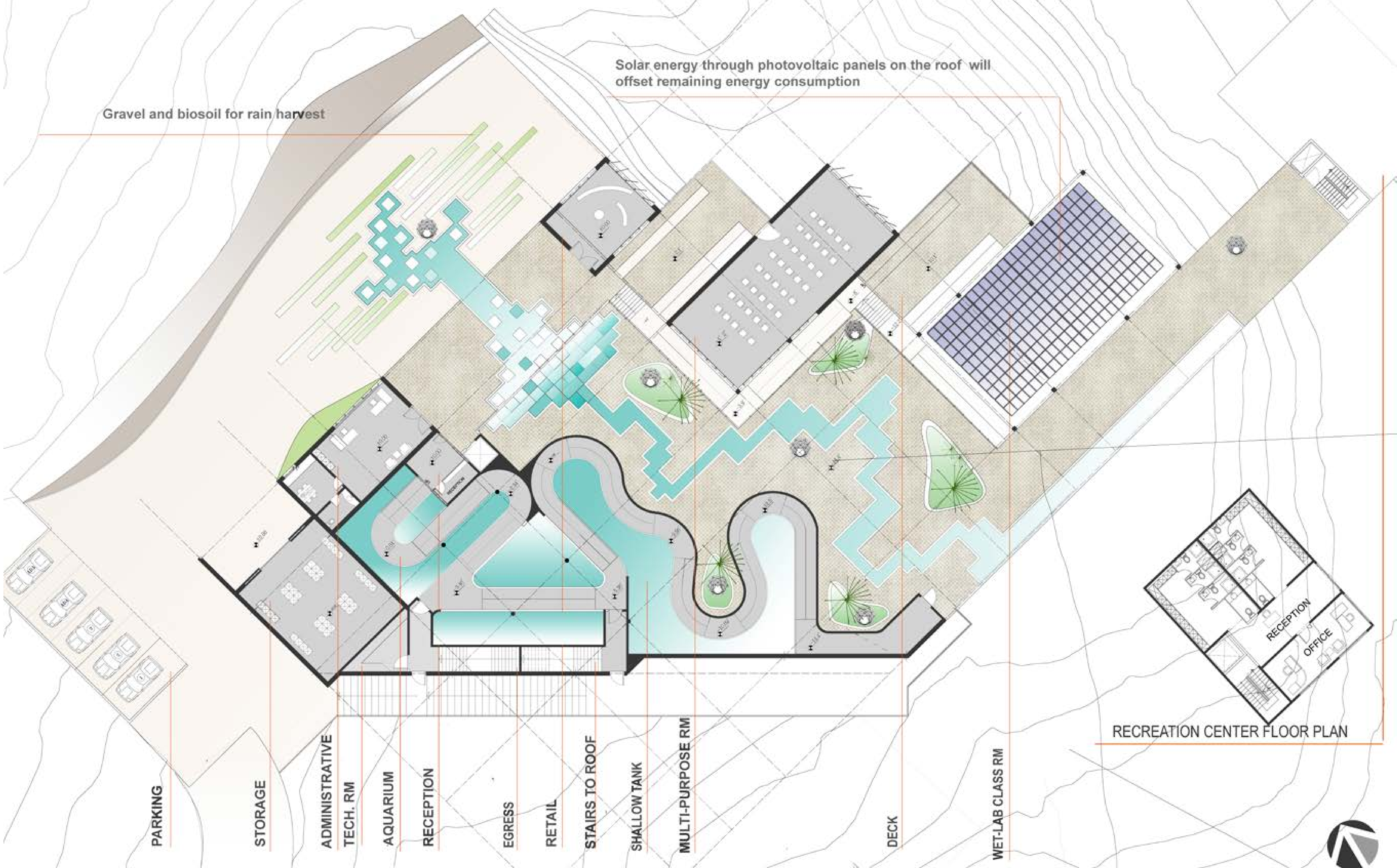


Figure34-First floor plan- Reference: author

Figure35-Basement floor plan- Reference: author

Figure36-Entrance perspective-Reference: author

Figure37- indoor garden perspective-Reference: author

Figure38- View from deck to ocean-Reference: author

Figure39- View from deck to ocean-Reference: author

Figure40- Entrance perspective-Reference: author

Figure42- View to indoor garden from entrance-Reference: author

Figure42- View to waterfall-Reference: author

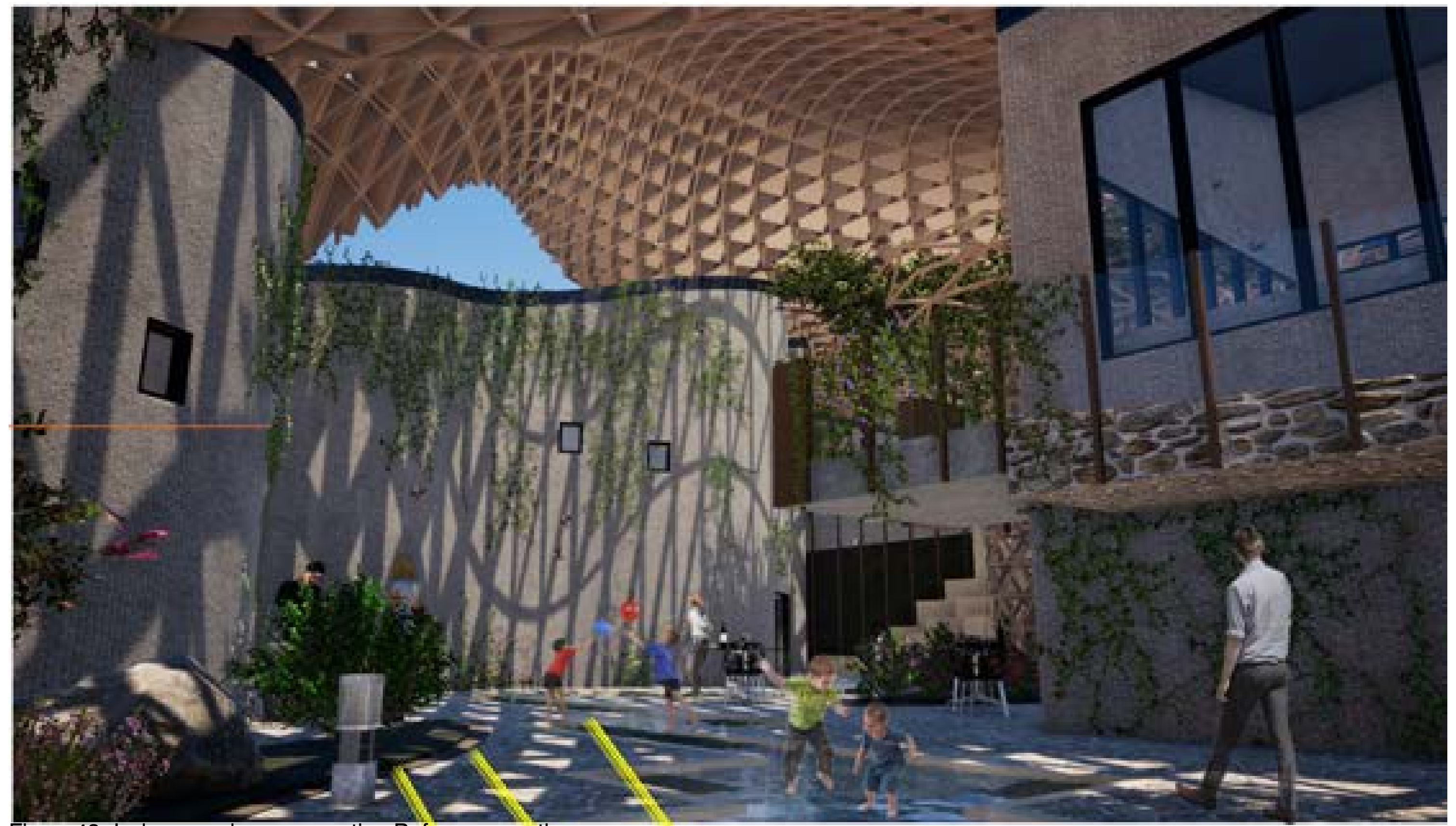


Figure43- Indoor garden perspective-Reference: author

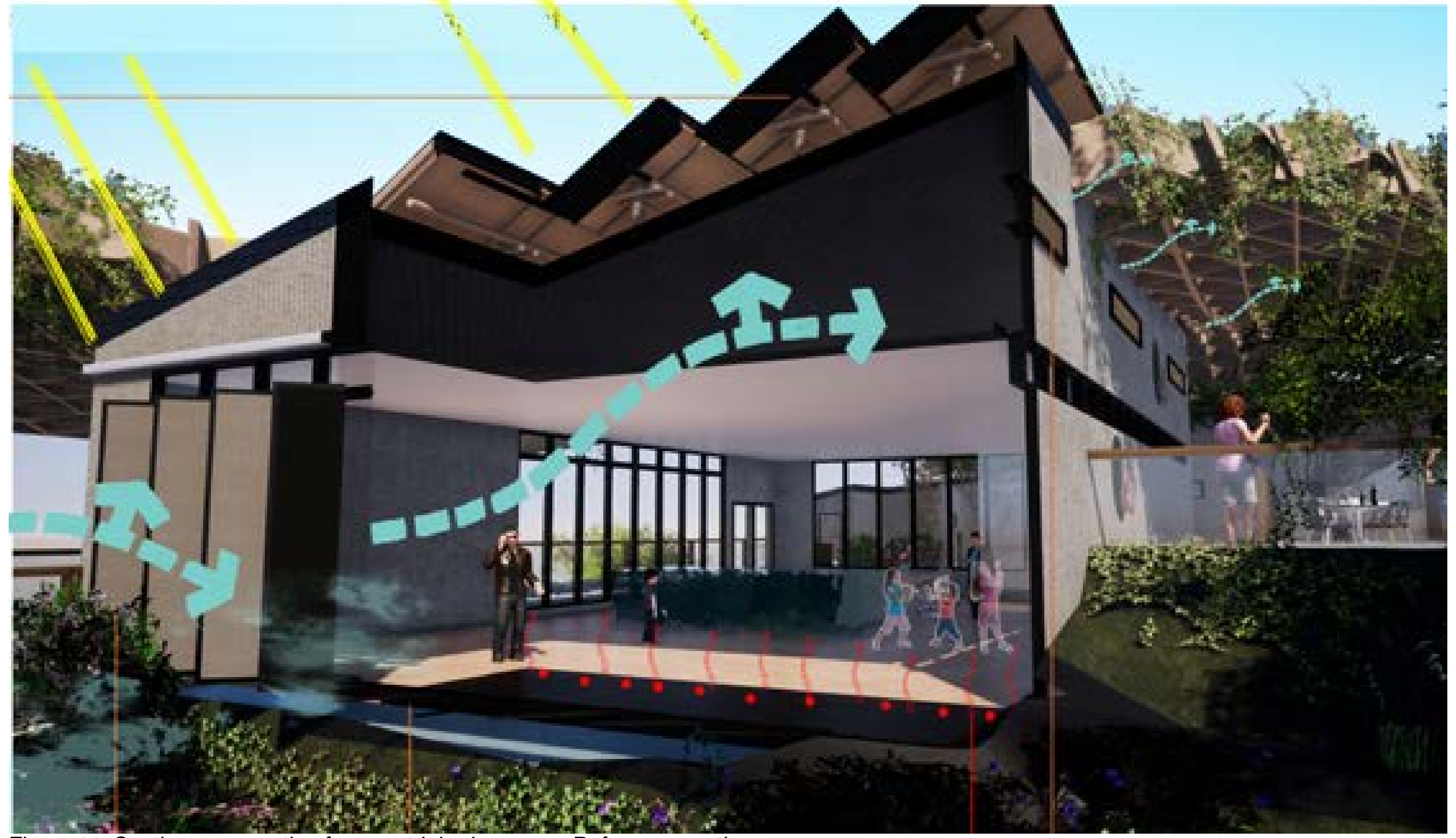


Figure44- Section-perspective from wet-lab classroom-Reference: author

Figure45- East Elevation-Reference: author

Figure46- Section-Perspective from Aquarium -Reference: author

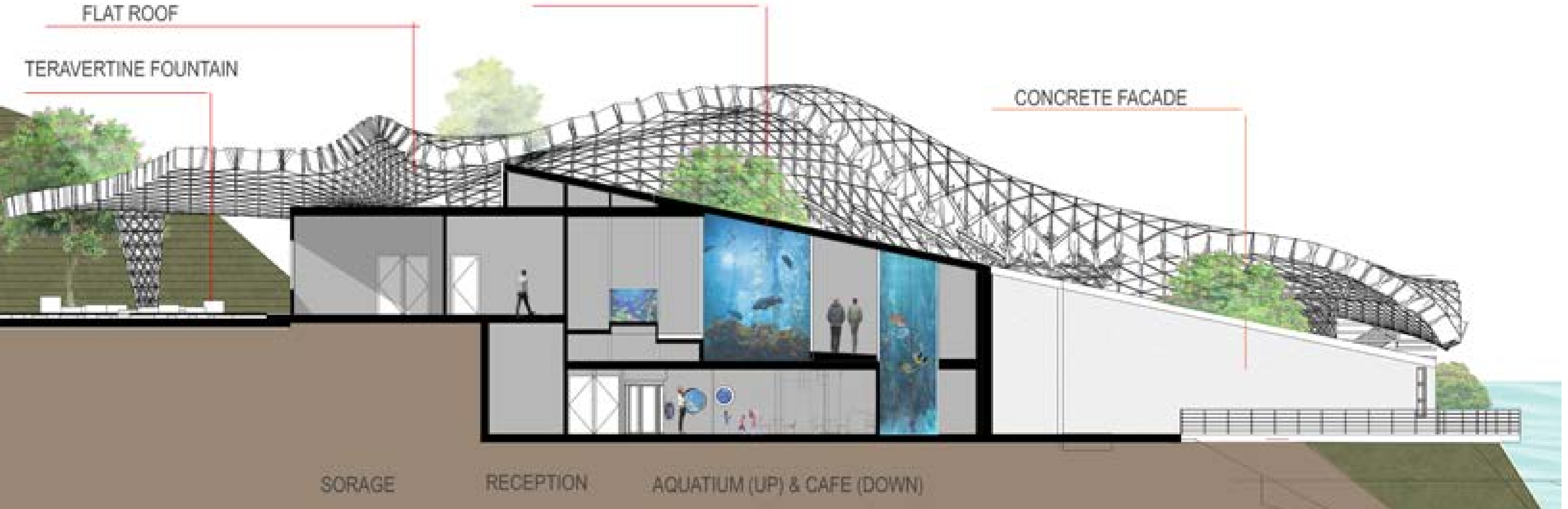


Figure47- Section from Cafe & Aquarium -Reference: author

Figure48- Indoor garden perspective -Reference: author

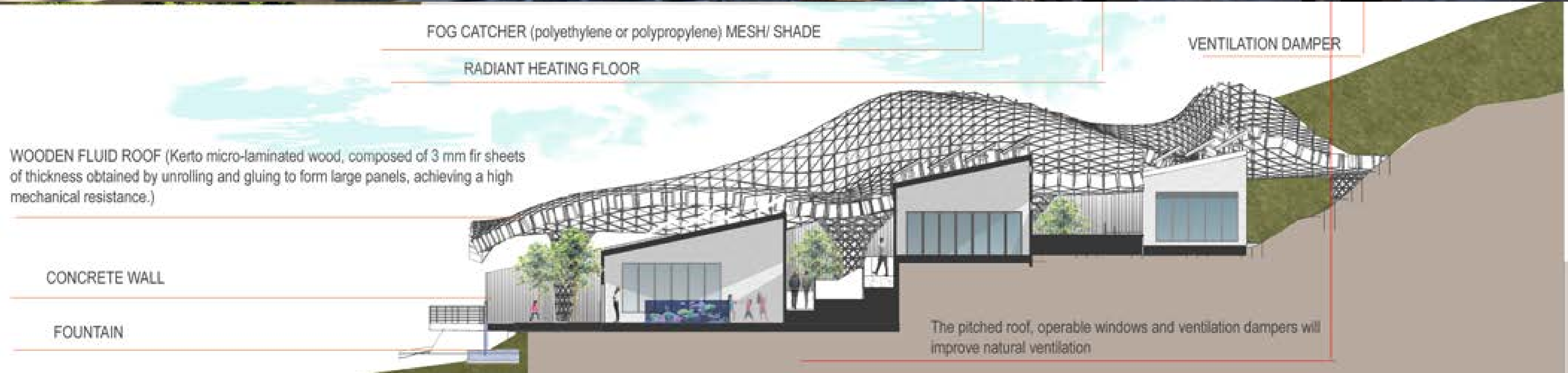
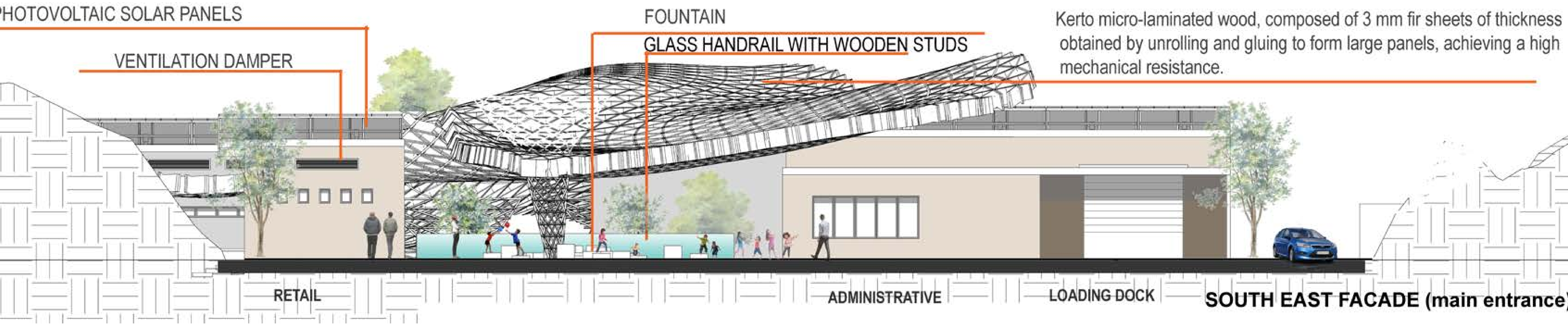


Figure49- Section from public spaces -Reference: author



SOUTH EAST FACADE (main entrance)

STRUCTURE

Figure51 - case study -Reference: http://dlingoo.com

The whole structure is divided into three parts. Two enclosed parts of the building are stained by a concrete structure and middle opening is covered by a fluid wooden roof. Metal-deck pitched roof cover concrete structure that details of the roof is shown below.

Figure52 - Struture zone divisions-Reference: author

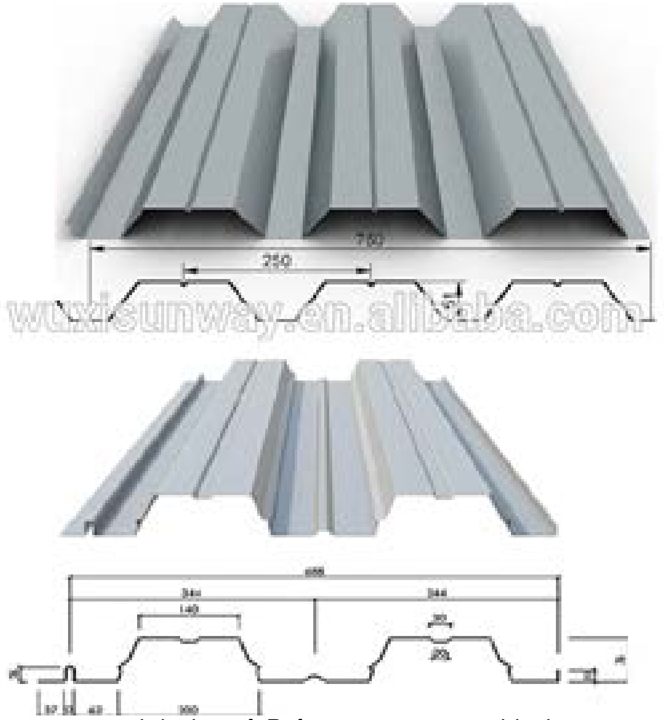


Figure53 - metal deck roof -Reference: www.metaldeck.com

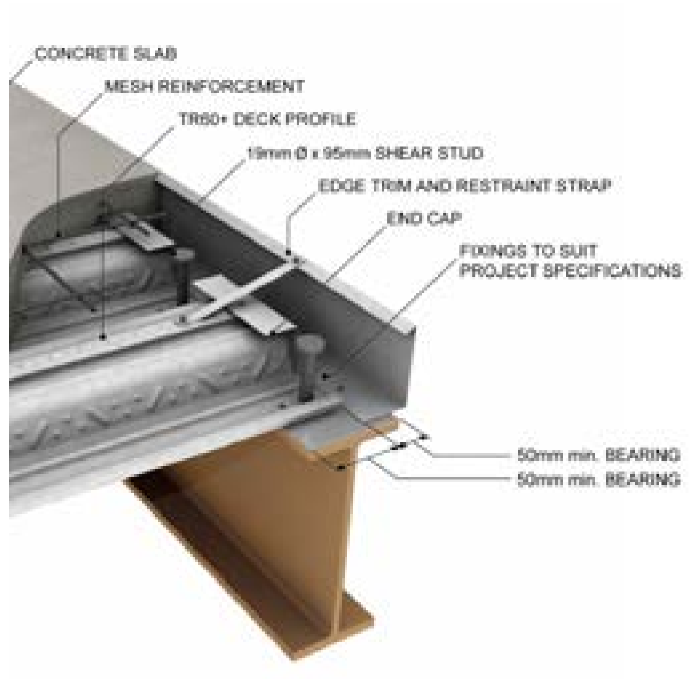


Figure54 - metal deck roof -Reference: mpiloverseas.ae/steel-decks

Figure 54 - Metropol Parasol -Reference: www.archdaily.com

Figure 55 - Metropol Parasol -Reference: www.archdaily.com

Figure 56 -New International Airport Mexico City -Reference: www.fosterandpartners.com

Figure 57 -New Milan Trade Fair -Reference: http://www.fuksas.it

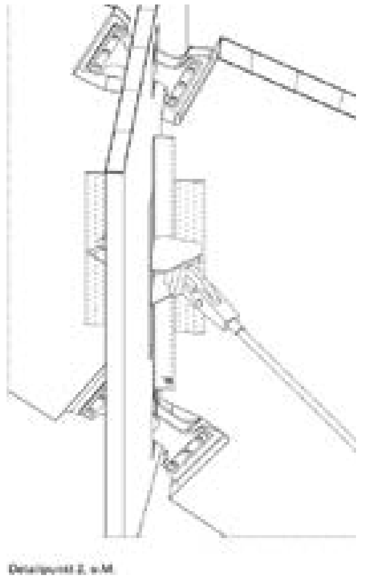


Figure 58 - Metropol Parasol -Reference: www.archdaily.com

Tiburon has strong wind from the west. Therefore, I chose a triangular base geometry which is the most strong geometry and decrease movements

Material: Kerto micro-laminated wood, composed of 3 mm firm sheets of thickness obtained by unrolling and gluing to form large panels, achieving a high mechanical resistance.
The roof is integrated with its columns and they work as a triangular 3D structural system.

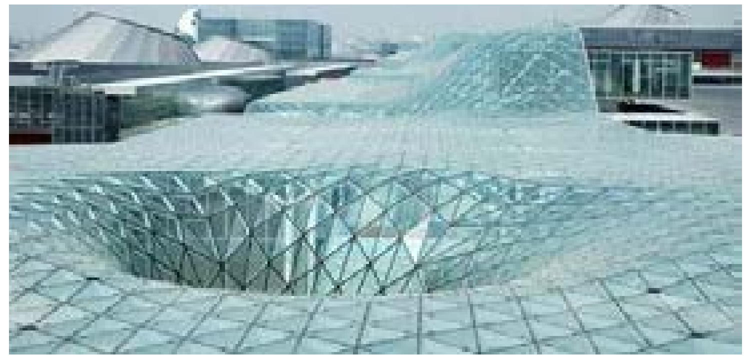
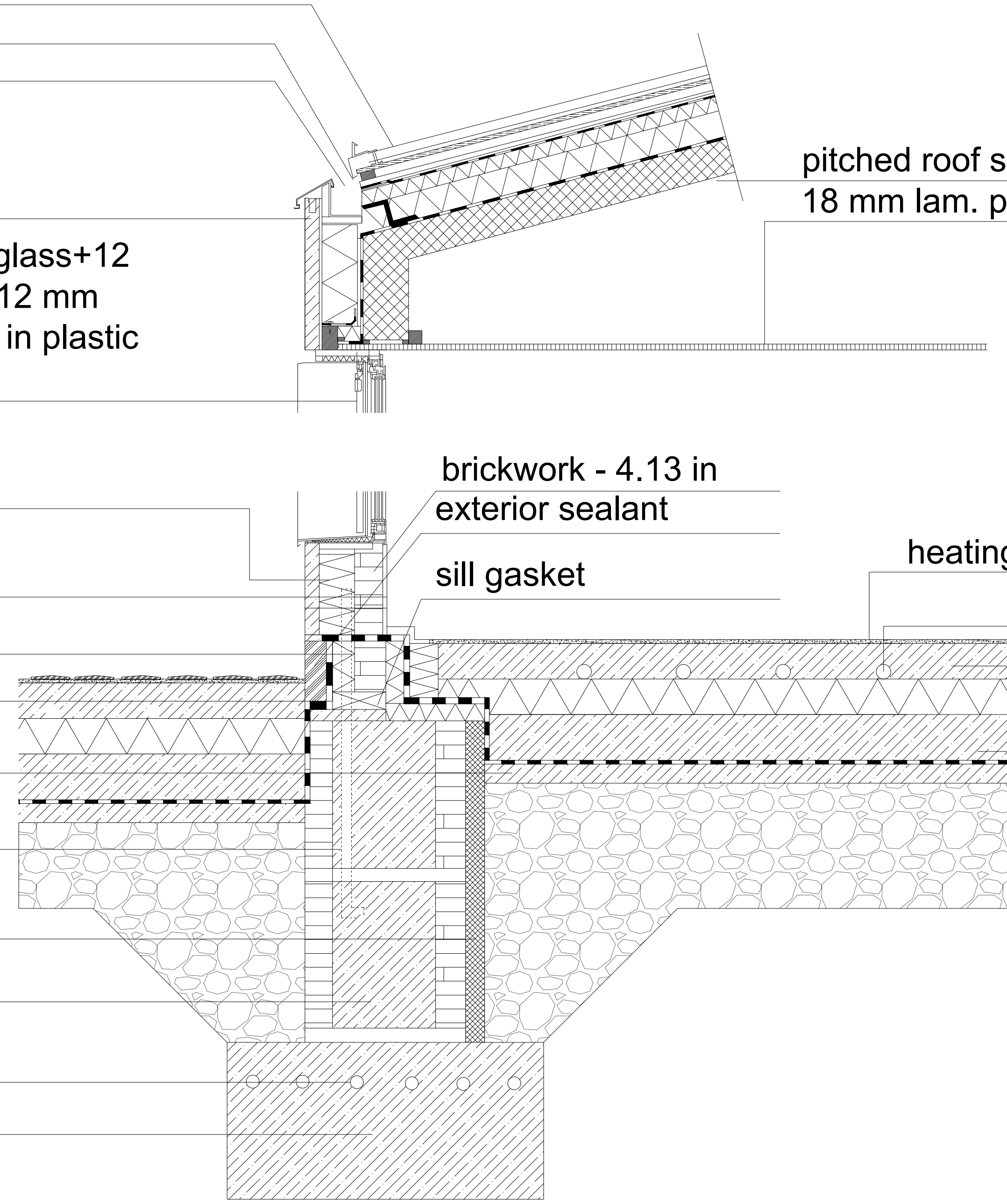


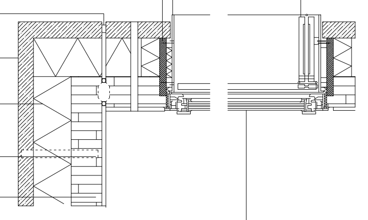
Figure 59 -New Milan Trade Fair -Reference: http://www.fuksas.it

Figure 60- Metropol Parasol -Reference: www.archdaily.com

Vertical Wall-Section



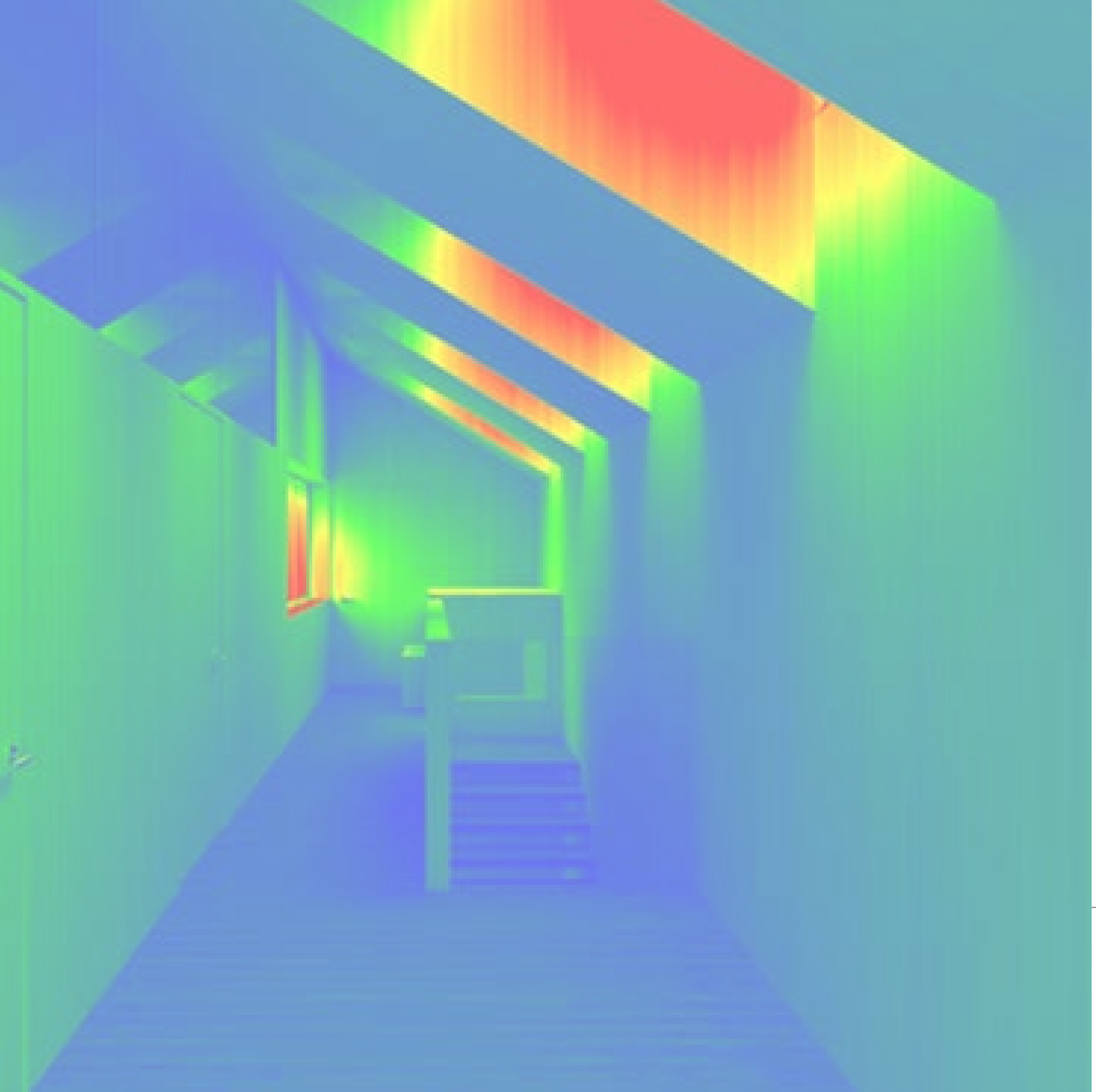
Horizontal Wall-Section



WALL-SECTION
SC:$\frac{1}{4}$"=1'

1' 5' 10'

Figure 61 -Wall-section from wet-lab classroom -Reference:author



MECHANICAL SYSTEM

Energy Efficiency Evaluation

EUI is a good metric to measure if the building works as a zero building or not. The EUI is expressed as energy per square foot per year. It's calculated by dividing the total energy consumed by the building in one year (measured in kBtu or GJ) by the total gross floor area of the building. 1st energy simulation of the concept shows that EUI = 78.6
Kbtu/ft2/y. Therefore, to decrease this number to achieve an EUI=16 Kbtu/ft2/y, zero energy strategies are reviewed again .

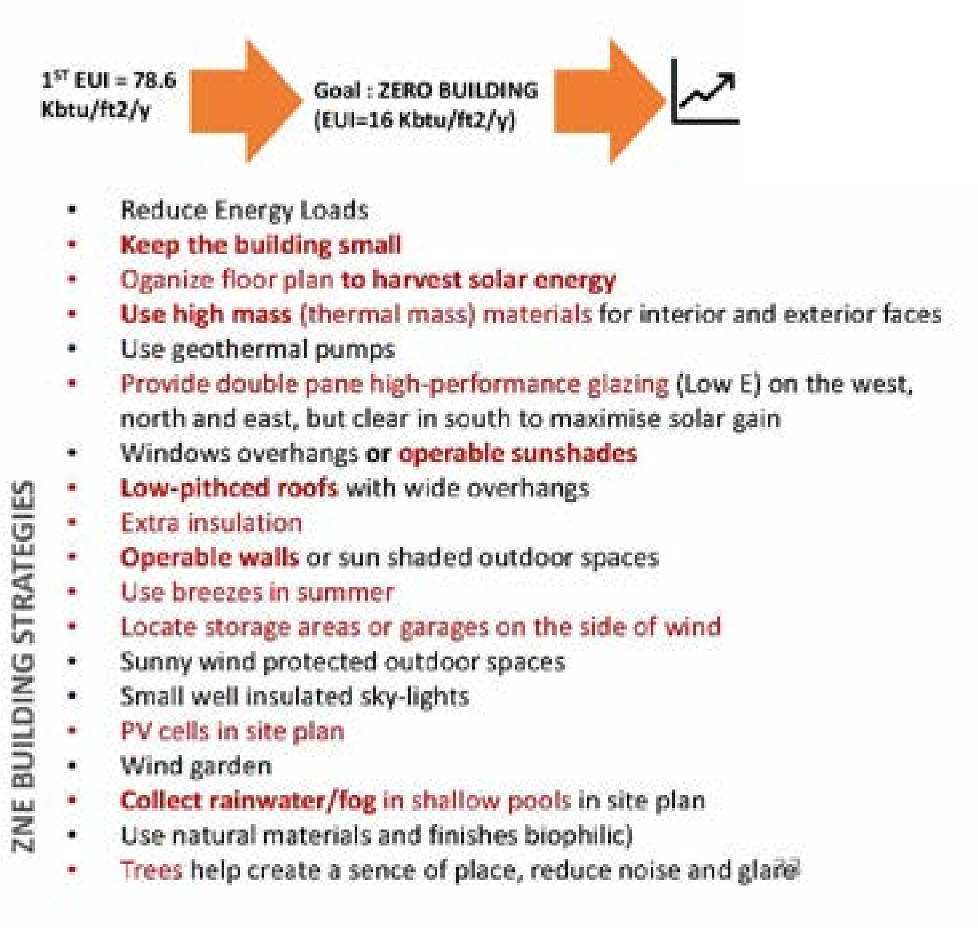


Figure 62 -1st energy consumption analysis in Sefaira

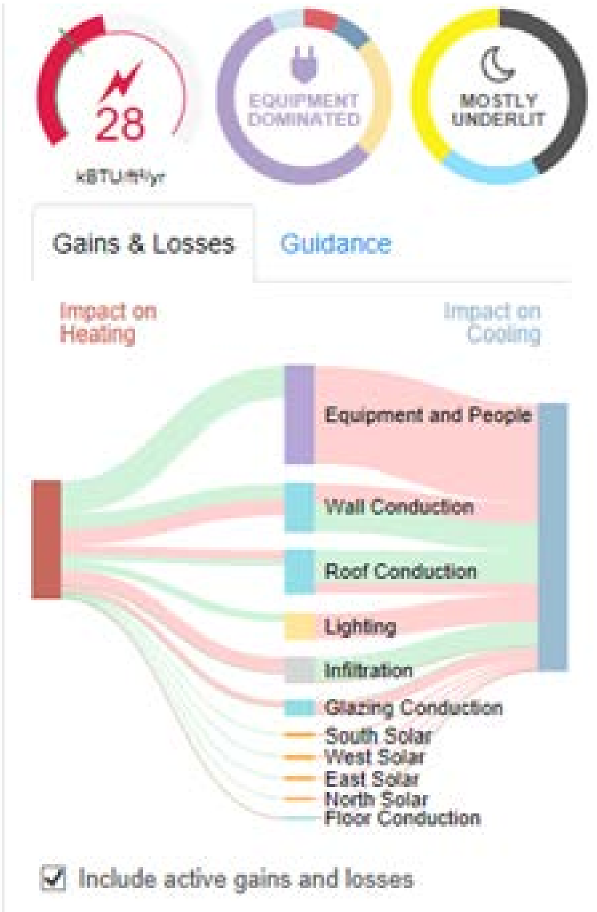


Figure 63 - 1st energy consumption analysis in sefaira

Oganize floor plan to arvest solar energy

The orientation of the building was modified to increase more solar harvest and therefore, the building is rotated 30 degrees Clockwise. EUI changed from 78 TO 51 kBTtu/ft2/y.

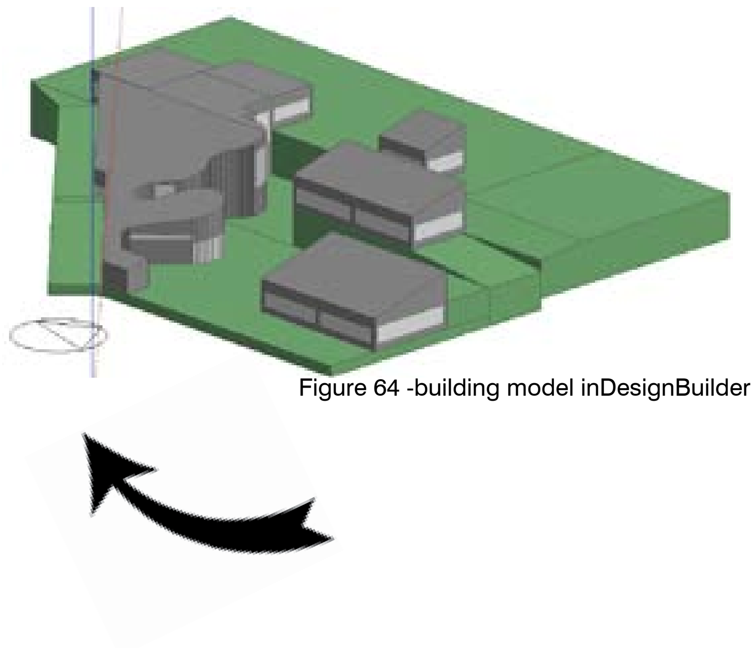
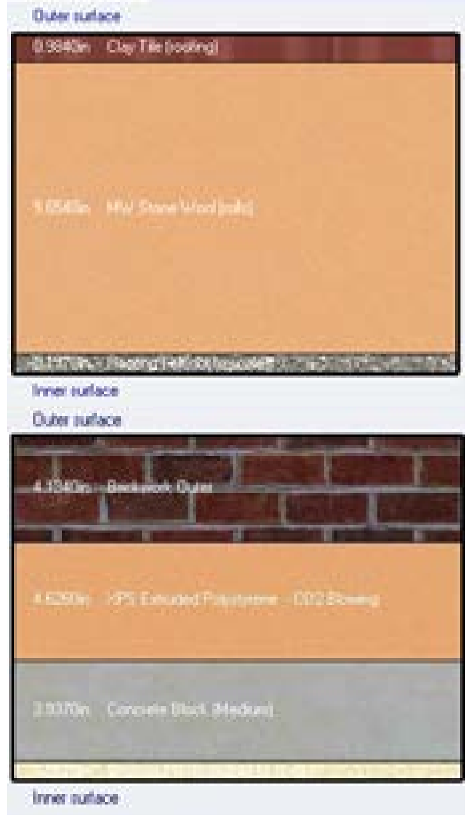


Figure 64 -building model inDesignBuilder

Use high mass (thermal mass) materials

After modifying wall and roof construction and increase in U-value , EUI changed from 51 TO 21 kBTtu/ft2/y.



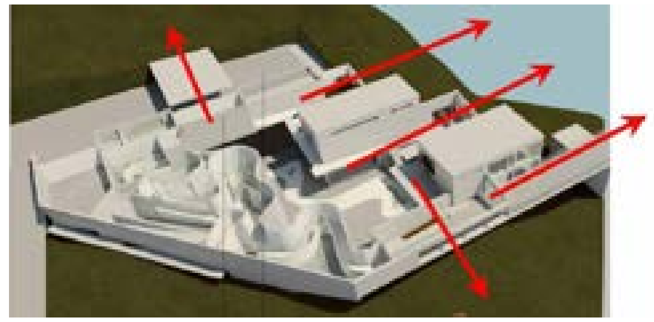
Roof detail

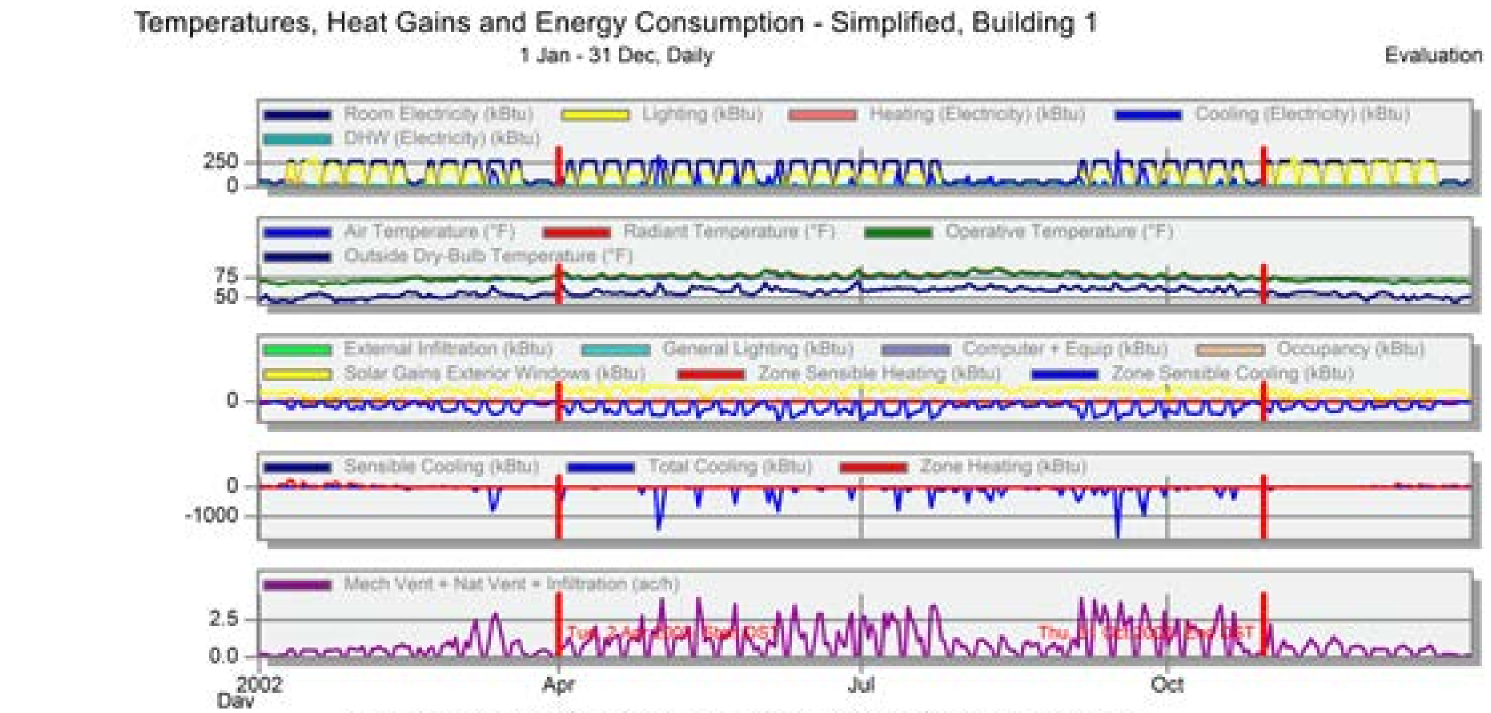
Wall detail

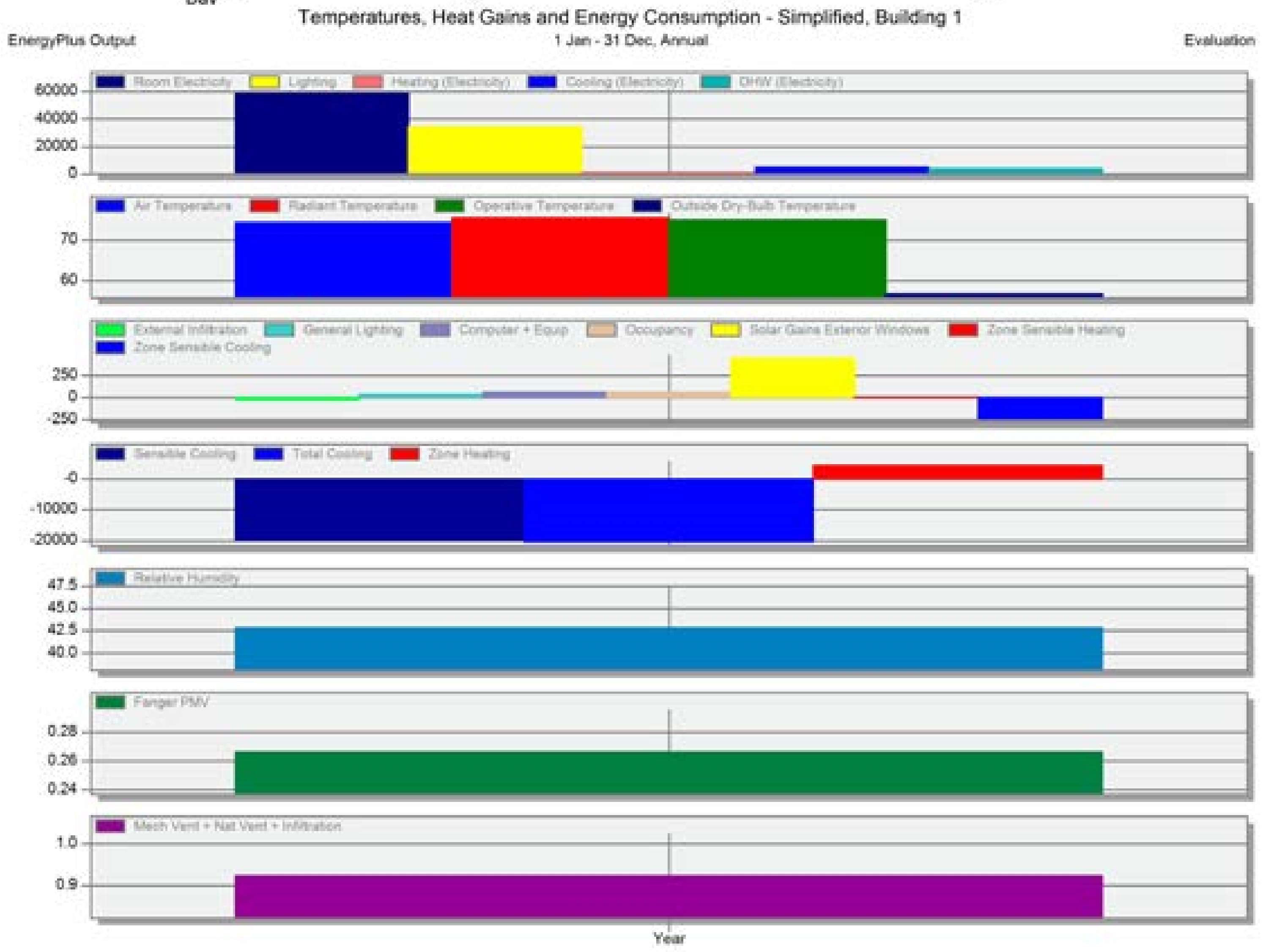
Keep the building small (decrese areas to optimal area)

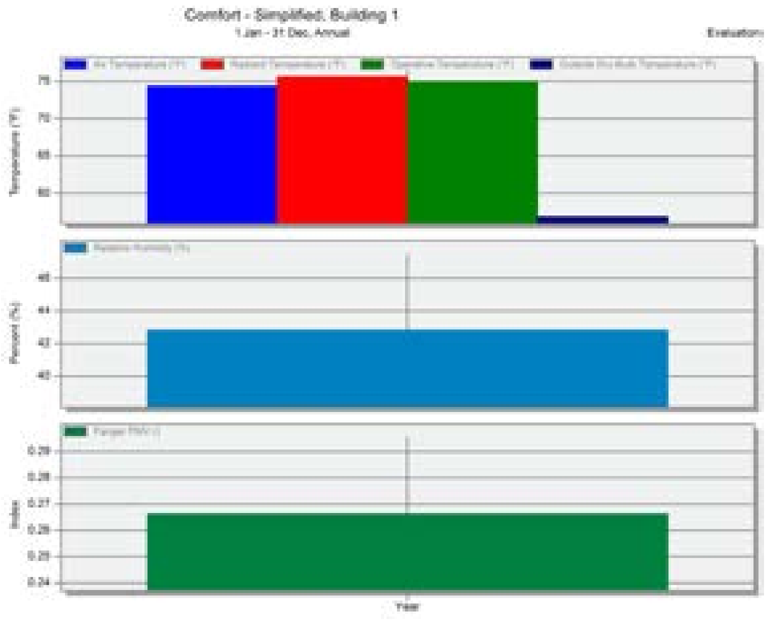
Low-pithced roofs

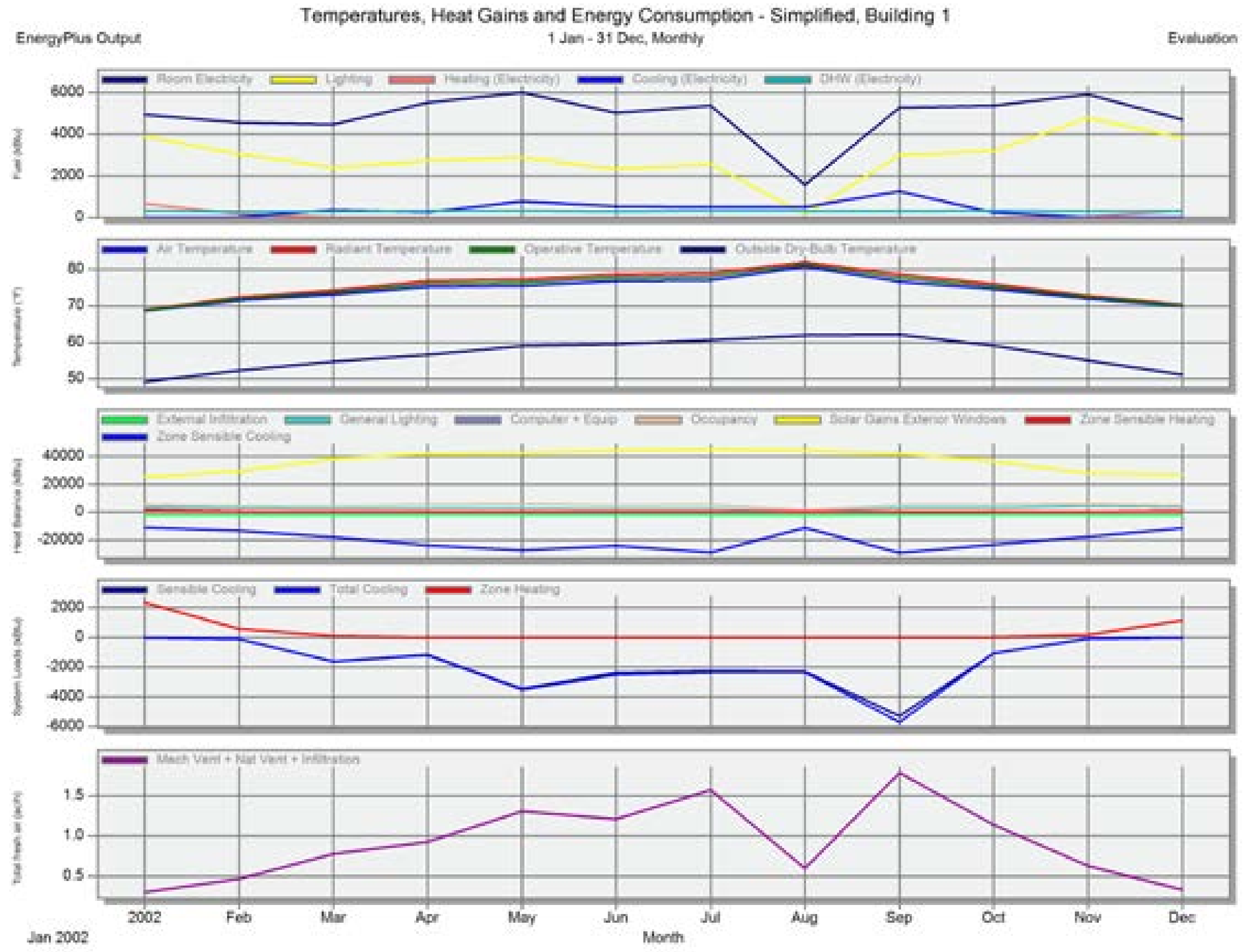
Operable walls




Temperatures, Heat Gains and Energy Consumption - Simplified, Building 1
1 Jan - 31 Dec, Daily
Evaluation
Room Electricity (kBtu)
Lighting (kBtu)
Heating (Electricity) (kBtu)
Cooling (Electricity) (kBtu)
DHW (Electricity) (kBtu)
Air Temperature (°F)
Radiant Temperature (°F)
Operative Temperature (°F)
Outside Dry-Bulb Temperature (°F)
External Infiltration (kBtu)
General Lighting (kBtu)
Computer + Equip (kBtu)
Occupancy (kBtu)
Solar Gains Exterior Windows (kBtu)
Zone Sensible Heating (kBtu)
Zone Sensible Cooling (kBtu)
Sensible Cooling (kBtu)
Total Cooling (kBtu)
Zone Heating (kBtu)
Mech Vent + Nat Vent + Infiltration (ac/h)
2002
Apr
Jul
Oct
Day


Temperatures, Heat Gains and Energy Consumption - Simplified, Building 1
1 Jan - 31 Dec, Annual
EnergyPlus Output
Evaluation
Room Electricity
Lighting
Heating (Electricity)
Cooling (Electricity)
DHW (Electricity)
Air Temperature
Radiant Temperature
Operative Temperature
Outside Dry-Bulb Temperature
External Infiltration
General Lighting
Computer + Equip
Occupancy
Solar Gains Exterior Windows
Zone Sensible Heating
Zone Sensible Cooling
Sensible Cooling
Total Cooling
Zone Heating
Relative Humidity
Fanger PMV
Mech Vent + Nat Vent + Infiltration
Year


Comfort - Simplified, Building 1
1 Jan - 31 Dec, Annual
Evaluation
Year


Temperatures, Heat Gains and Energy Consumption - Simplified, Building 1
1 Jan - 31 Dec, Monthly
EnergyPlus Output
Evaluation
Room Electricity
Lighting
Heating (Electricity)
Cooling (Electricity)
DHW (Electricity)
Air Temperature
Radiant Temperature
Operative Temperature
Outside Dry-Bulb Temperature
External Infiltration
General Lighting
Computer + Equip
Occupancy
Solar Gains Exterior Windows
Zone Sensible Heating
Zone Sensible Cooling
Sensible Cooling
Total Cooling
Zone Heating
Mech Vent + Nat Vent + Infiltration
2002
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan 2002
Month

Mechanical System

Hybrid (Mixed type) Ventilation is favorable as the natural ventilation seems "no-brainer" at the site. A comprehensive motorized façade system has been selected not only for natural ventilation but also daylight control.

The building is located at waterfront site and surrounded by large landscape area so geothermal and surface water heat rejection is highly available. Moreover, a surface heat rejection site could be a part of integration objectives for ocean science's education as the performance of heat rejection site is depended on surface water condition. It also is being an indicator of water flooding level on site.

While ambient outside air conditions are mostly dry and cool enough, the radiant heating and cooling approaches are well complemented with ground source plant production and could not only use less energy than traditional mixed air distribution system but also increases the thermal comfort of the user. The education function of the building is also fitted with characteristics of cooling/heating supply rate and system layout requirements of radiant cooling and heating systems.

At the end, follow HVAC sub-systems are chosen for Romberg Tiburon Center for Environmental Studies.

- Ground-source/Surface hydronic heat pump (GSHP) for cooling and heating production:
The main building uses ground-source heat pump while the small one near waterside utilizes surface water source

- Dedicated Outside Air System (DOAS) for mechanical ventilation with Demand Control

- Active Chilled Beam(ACB) and Radiant Heating Floor (RHF) for room cooling and heating respectively. The seaside building use radiant floor and natural ventilation for cooling

Site and Source Energy

	Total Energy [kBtu]	Energy Per Total Building Area [kBtu/ft2]	Energy Per Conditioned Building Area [kBtu/ft2]
Total Site Energy	128166.95	13.79	13.79
Net Site Energy	128166.95	13.79	13.79
Total Source Energy	361716.19	38.91	38.91
Net Source Energy	361716.19	38.91	38.91

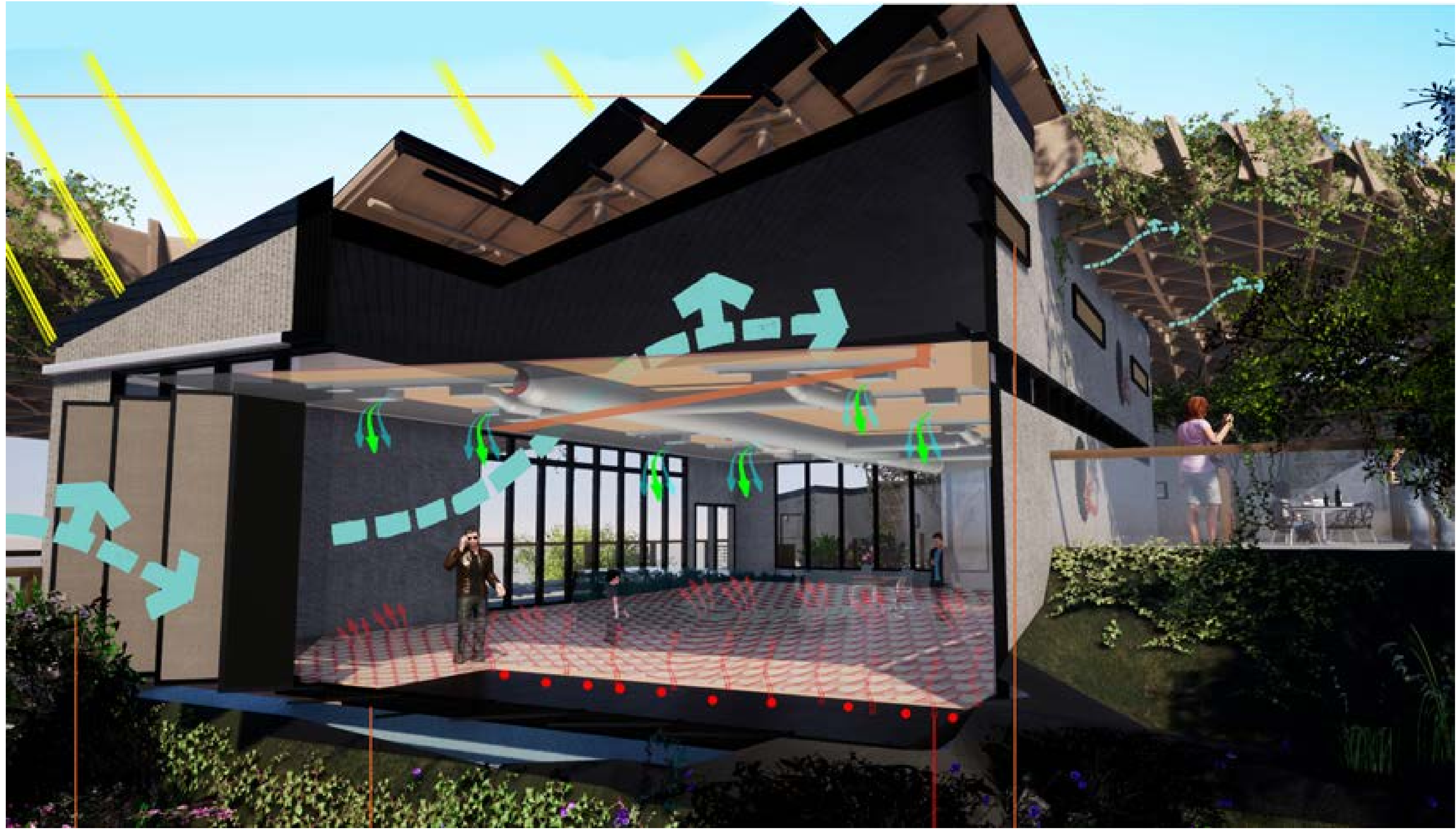


Figure 64 - Mechanical system illustration-Reference: author

LESSONS

Interested in conducting research to amalgamate the frontiers of knowledge and architecture by generating and exploring new environmental friendly ideas for the world's most pressing urban ecology challenges, I decided to participate in architecture at zero project that is a zero net energy design competition in the pursuit of energy efficient design. Therefore, I wanted to delve deeper into the subject to integrate research and practical design that can cross the boundaries of conventional aesthetic disciplines in architecture towards creating a new environmental knowledge of design as a response to the demands of sustainability in developing countries like Iran. This project formed a rational mind for me in design thinking process. I learned to consider different aspects of a design in primary phases, then evaluate the design in several steps and modify it to achieve design goals. As an exemplification, design programming is one of my achievement during this year. I learned to focus on client needs and concepts to extract architect goals and determine next phase of design.

Moreover, I learned to evaluate the design in the most beginning phase based on goals. In this project, after illustrating goals and program, I simulated energy consumption of the basic design to check whether if the building orientation is right or I need to rotate it in regard to solar energy. Moreover, I learned to search for different design solutions and strategies for achieving green zero energy building, high-performance building, and biophilic architecture accurately in all phases of design and perform the experiences in my design.

If I had extra time, I would work on materials and details more accurately and explore new technology and materials that impact on energy saving and increase the efficiency of energy in a building. Moreover, I liked to focus on landscape architecture design to create a micro-climate to improve human comfort in outdoor spaces because this design is totally integrated with nature. Struc-

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