NZB.RGChan.
5.2 San Marino_JEA

Net Zero Building Design - Residential Study

20 November 2020

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ABOUT THE SERIES
This pdf file-binding is part of the NZB.RGChan.Series on foundational researches undertaken by R.G.CHAN & Associates for in-house office use, towards systematic steps for Net Zero Building Design of projects.

THE SITE

Figure 01 A photo taken from Google Maps showing the Project Site and the proposed NZB1 San Marino Project overlaid on its exact location.

Project Information

Project Title:	**NZB1 San Marino**
Location:	**San Marino Subdivision, Bonuan, Dagupan, Pangasinan**
Latitude:	**16°03'38.6"N**
Longitude:	**120°20'33.2"E**
Elevation:	**5.00 m above sea level**

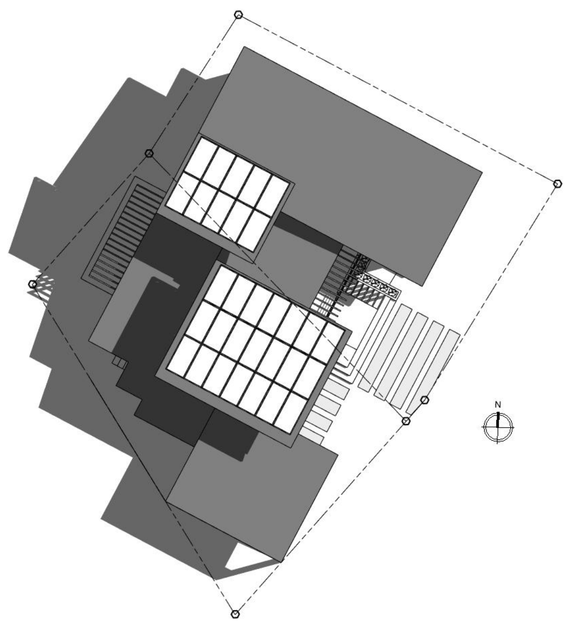
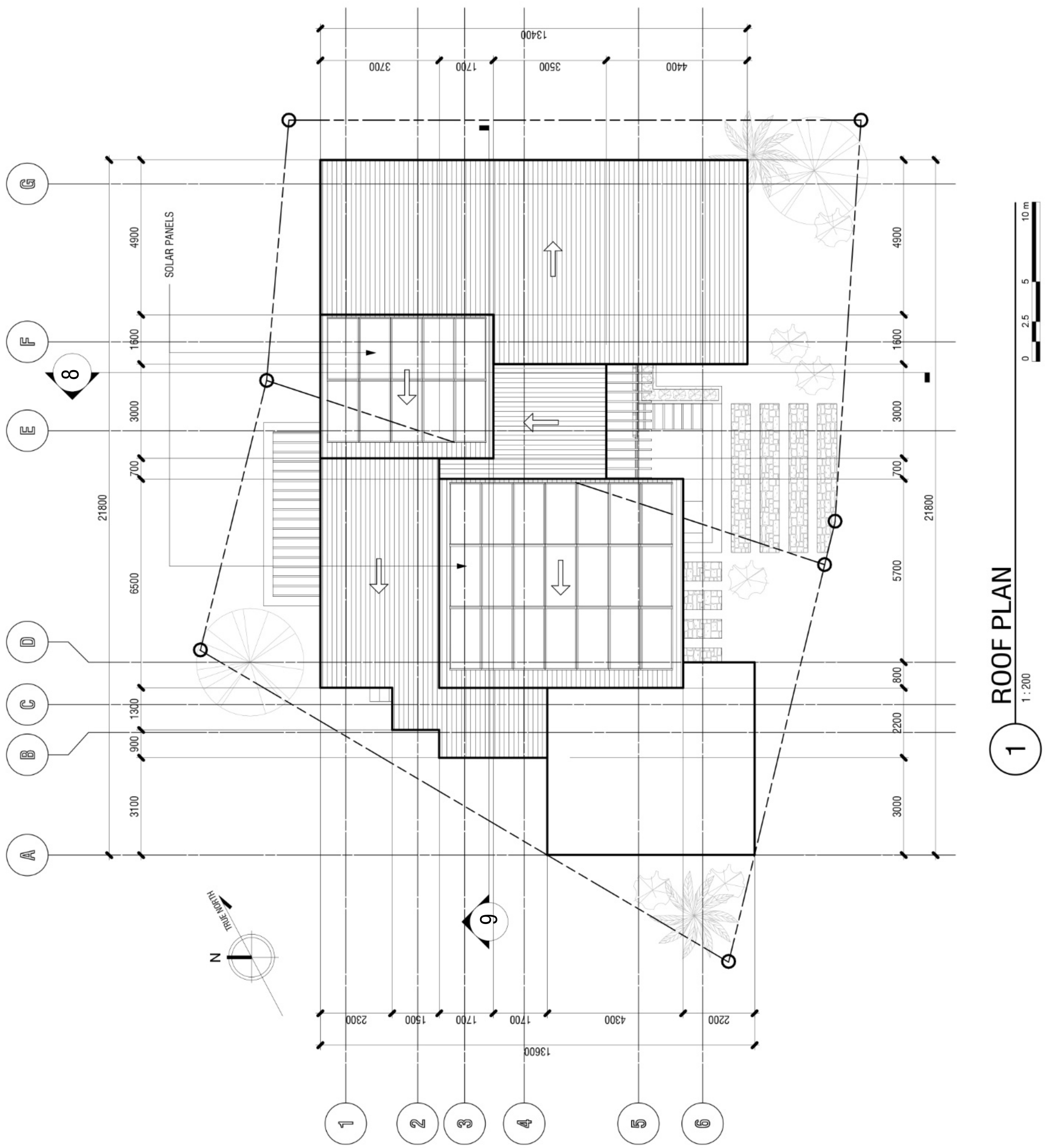
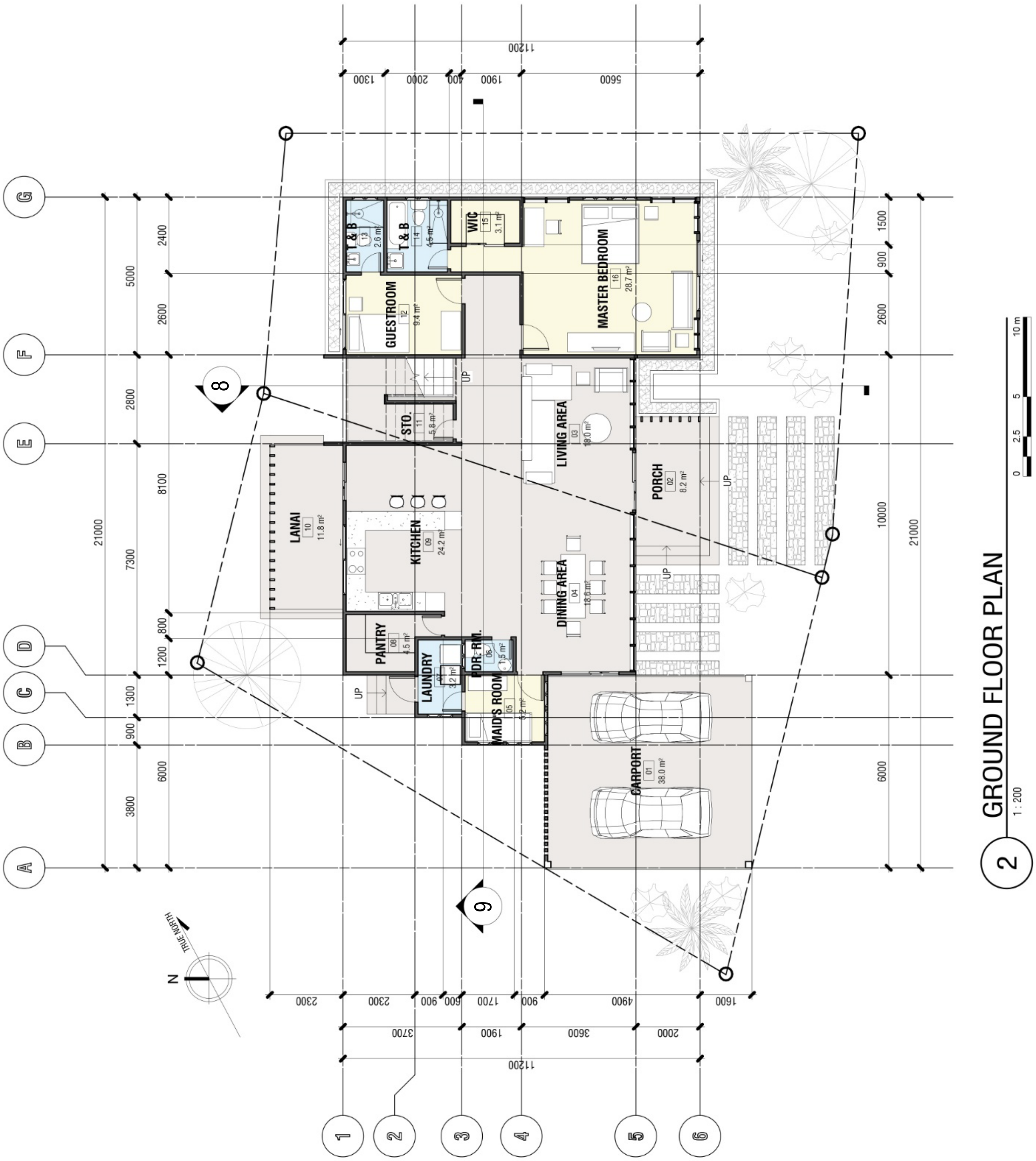
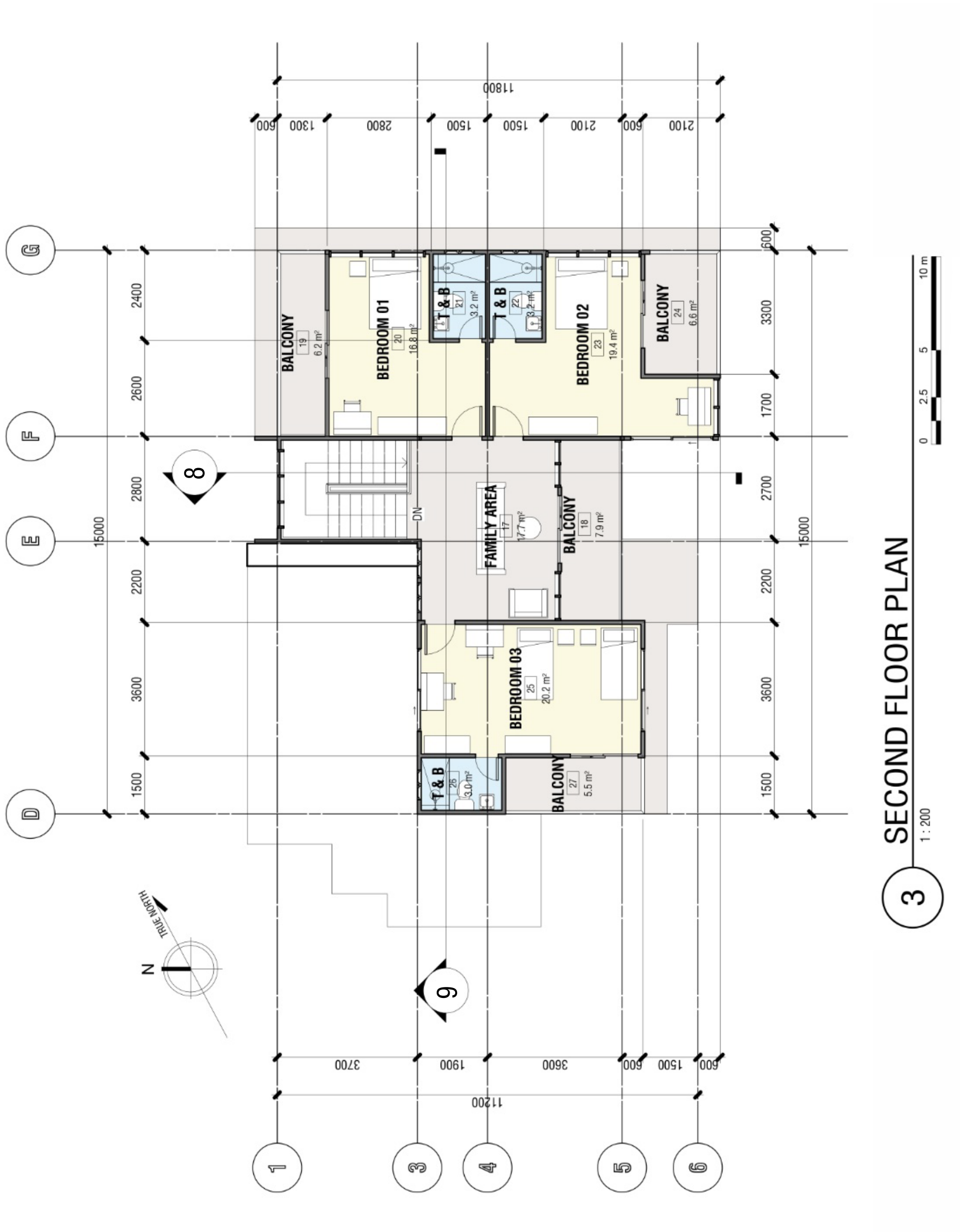


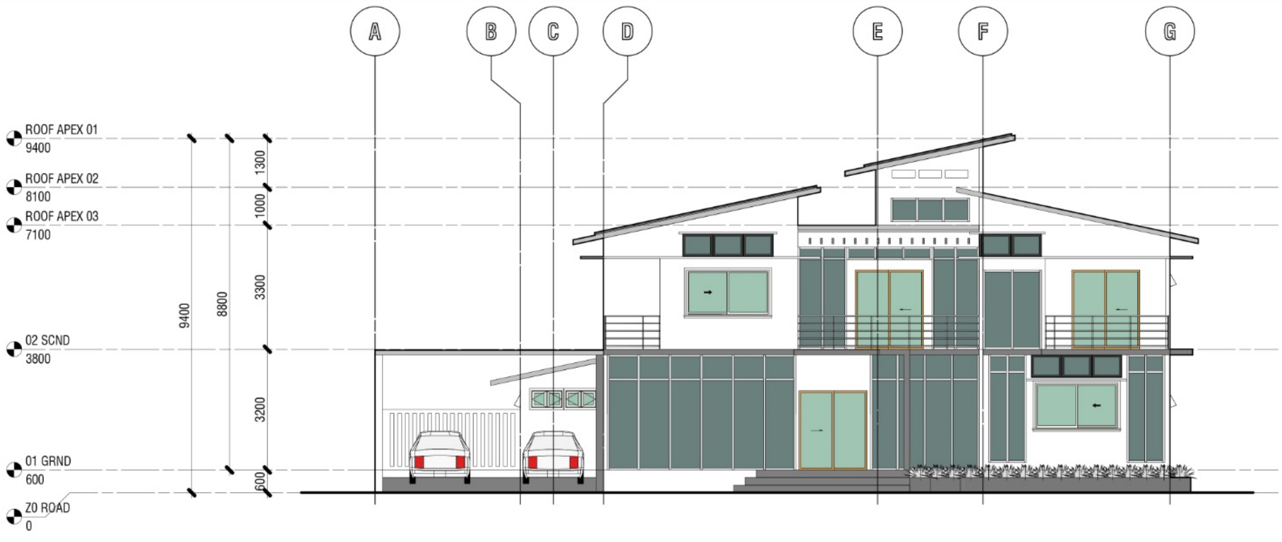
Figure 02 Orientation of the Proposed NZB1 San Marino Project showing the Photovoltaic Panels facing towards South-southwest direction (the sun's position is around 9:00 am of June 1).

ARCHITECTURAL DRAWINGS

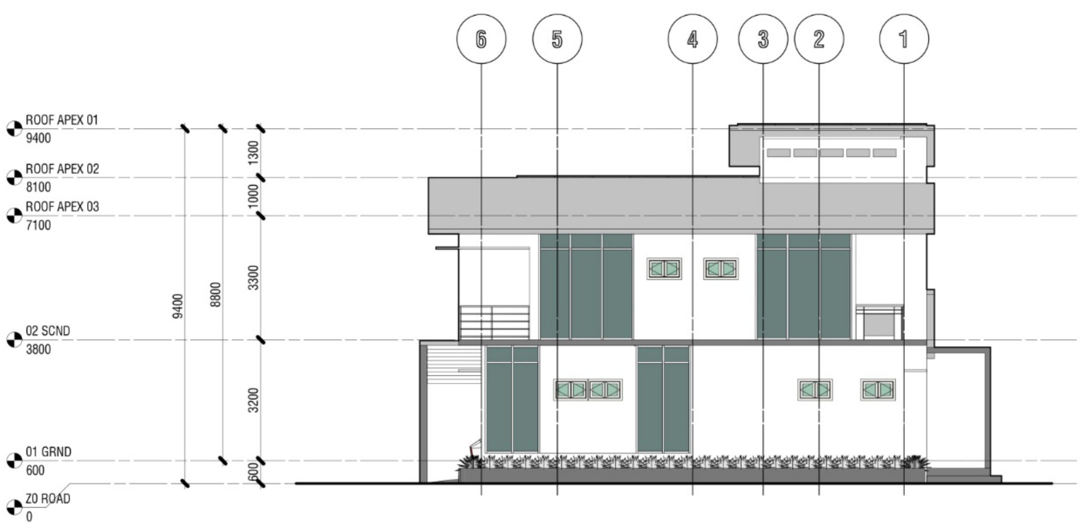



T & B
T & B
WIC
GUESTROOM
MASTER BEDROOM
STO.
LIVING AREA
LANAI
KITCHEN
PORCH
DINING AREA
PANTRY
LAUNDRY
PDR. RM.
MAID'S ROOM
CARPORT
2
GROUND FLOOR PLAN
1 : 200
TRUE NORTH
N

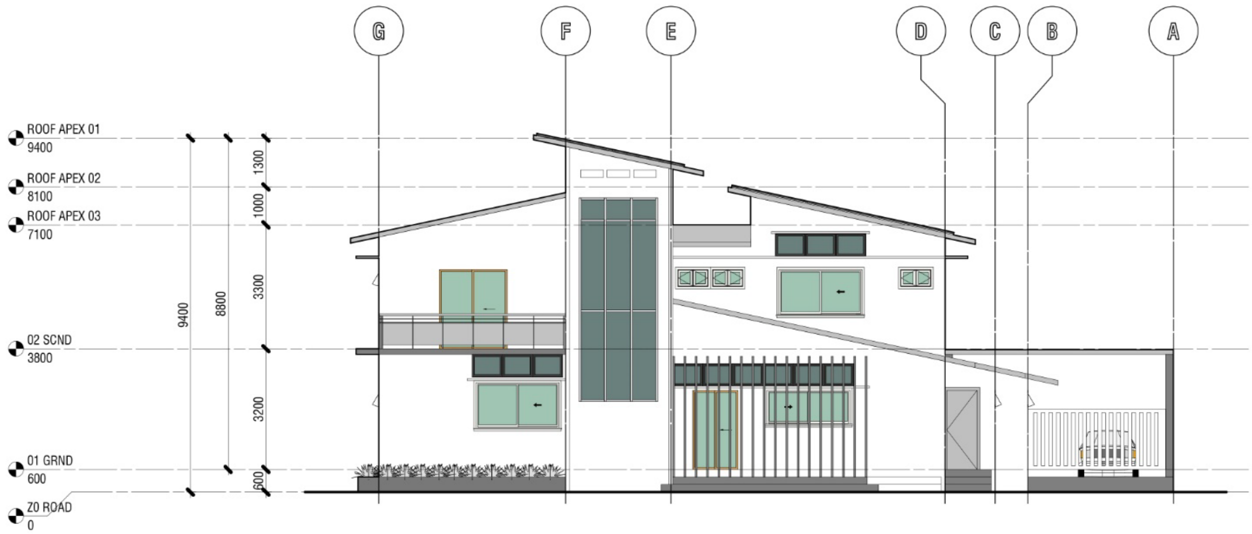

SECOND FLOOR PLAN
1 : 200
BEDROOM 01
BEDROOM 02
BEDROOM 03
FAMILY AREA
BALCONY
T & B
TRUE NORTH



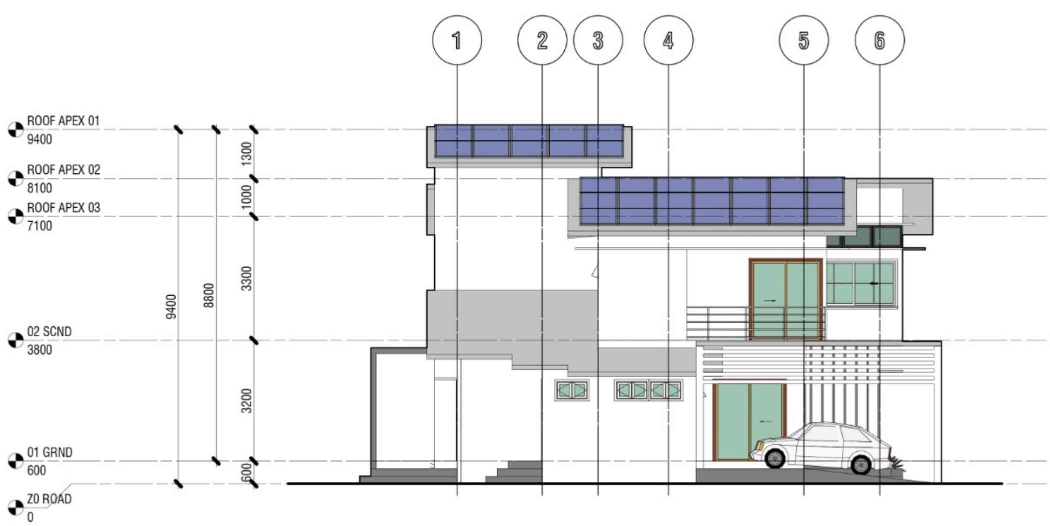
4 FRONT ELEVATION
1 : 200
0 2.5 5 10 m



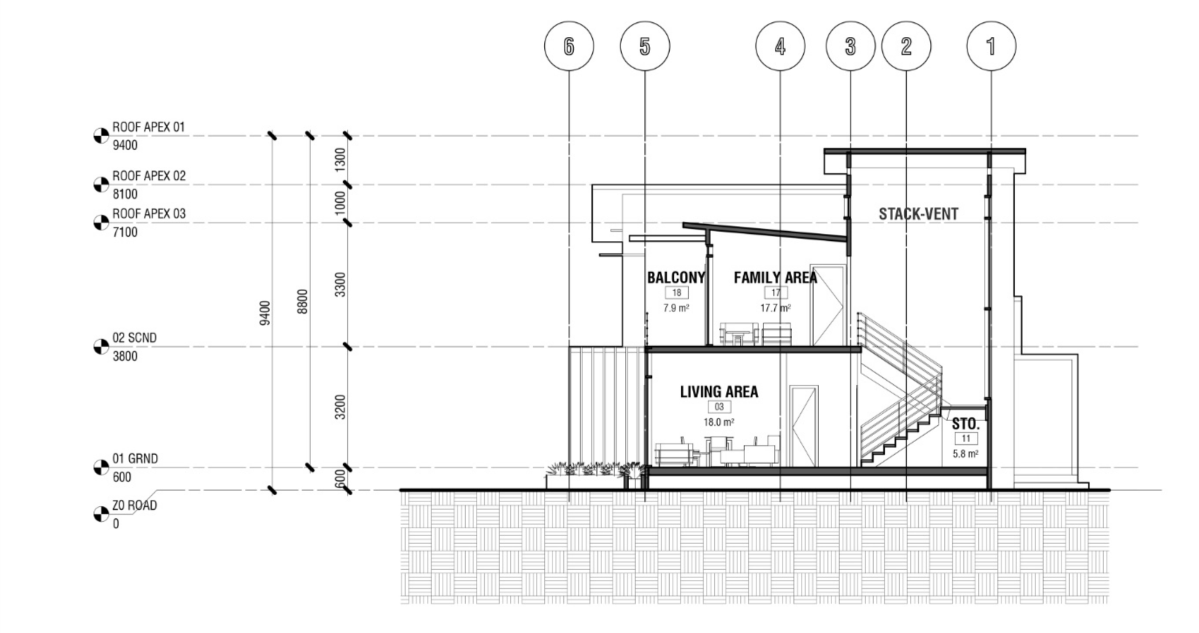
5 RIGHT SIDE ELEVATION
1 : 200
0 2.5 5 10 m



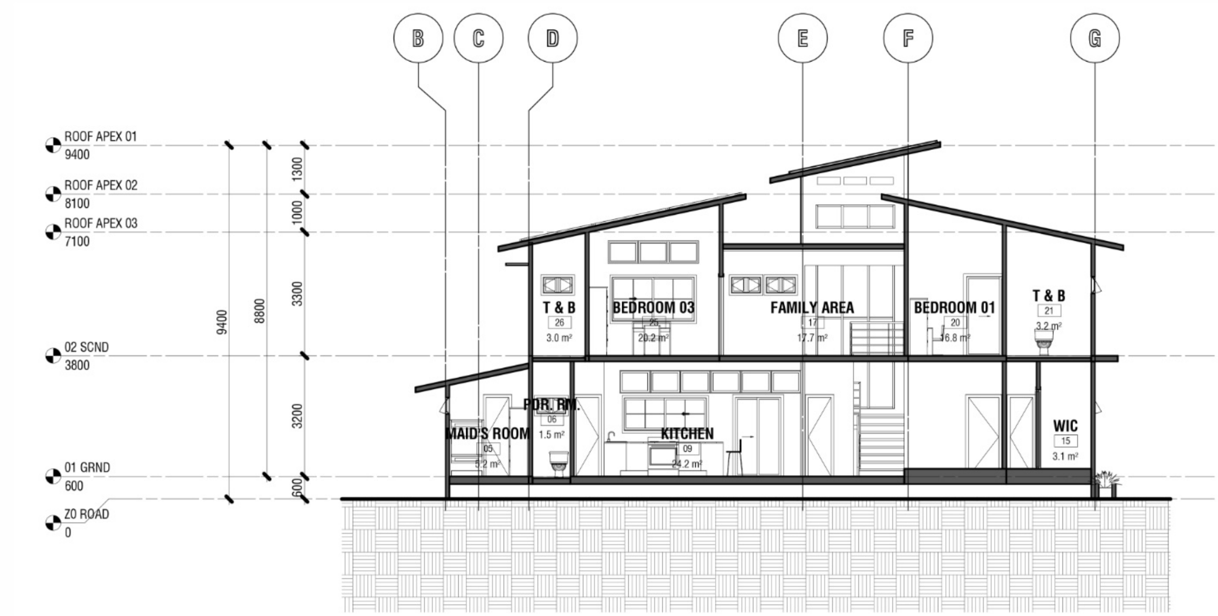
6 REAR ELEVATION
1 : 200
0 2.5 5 10 m



7 LEFT SIDE ELEVATION
1 : 200
0 2.5 5 10 m



8 CROSS SECTION
1 : 200



9 LONGITUDINAL SECTION
1 : 200

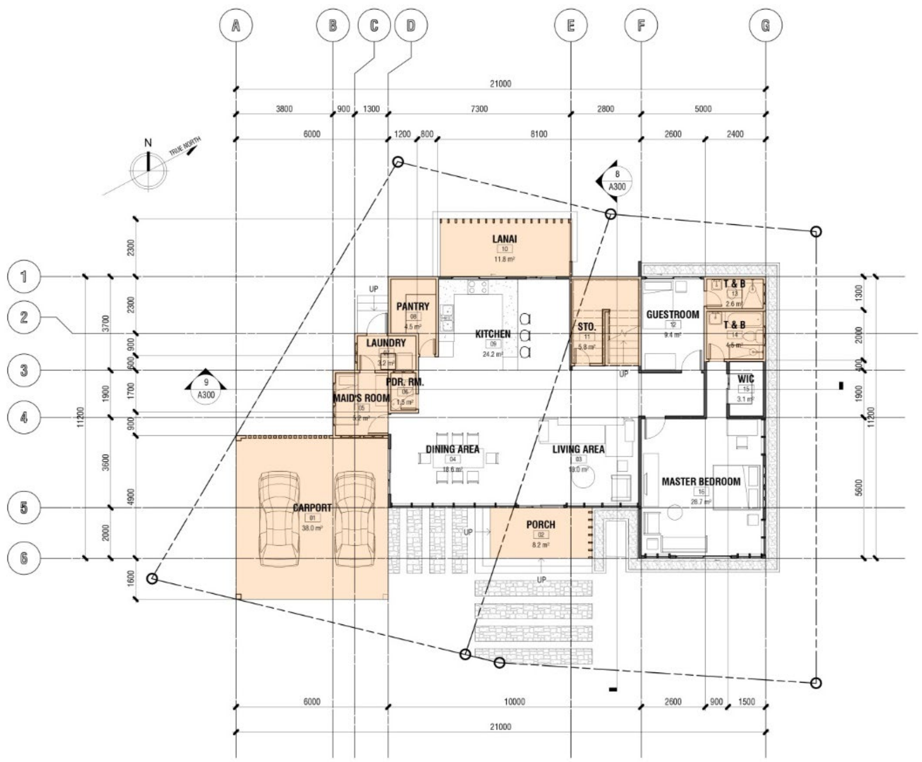
THE BUNDLE

The proposed NZB1 San Marino Project aims to be a passively cooled building. So, taking in consideration the bundle for passively cooled building under hot-humid climate, following are the core and situational strategies applied in the proposed residential building to take advantage and maximize the potential of the site's environmental factors to produce a Net-Zero Energy Building (NZEB).

Core Strategies

Buffer Zones

Some rooms can tolerate temperature swings and can be located between the more protected rooms and undesired heat sources. In the organization of zones, south and west sides are more expose to sun and heat source that is why buffer zones is located in between to protect the other rooms from direct sunlight and heat. Such buffer zones are the service areas which is not often used like the T & B, storage, balcony, carport, and pantry.



10 GROUND FLOOR PLAN
1 : 300

Figure 03 The Ground Floor Plan highlighting Buffer Zones in orange color.

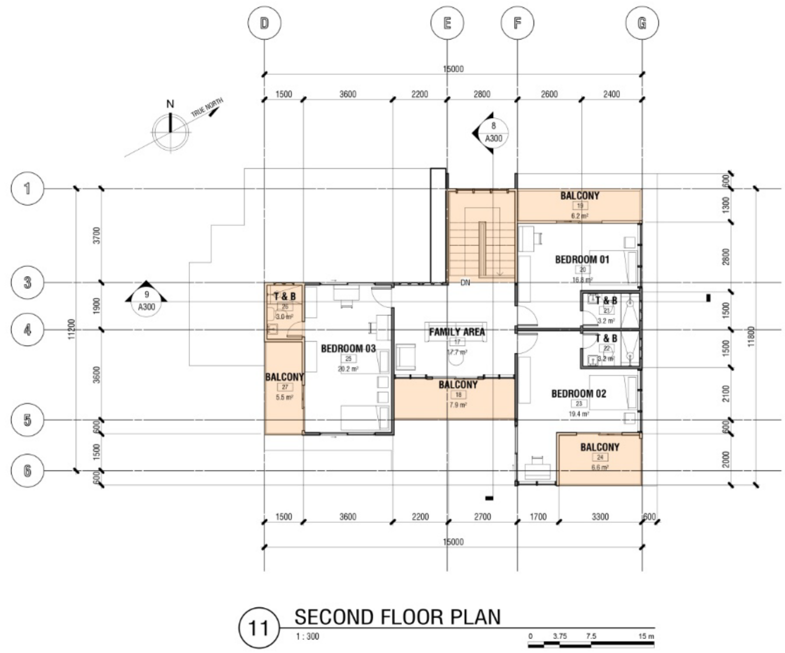


Figure 04 The Second Floor Plan highlighting Buffer Zones in orange color.

Cooling Zones

Living spaces such as living area, and dining area has the same cooling requirements that is why they are located in the same zone facing the most prevailing wind at Southeast in order to take advantage of the wind breeze.

Locating Outdoor Zones

Outdoor rooms expand the living spaces and allow places for migration. In the schematic plan, outdoor rooms such as the porch and balconies are located adjacent to living spaces facing the sun and wind. Thus, reducing the cooling load inside the building which could lessen energy consumption.

Stack Ventilation Rooms

Stairs at the Northwest portion serves as the main stack vent which allows the hot air to escape on top. In addition to that, each room on the second level will be incorporating clerestory windows that can also be utilized as an outlet for hot air.

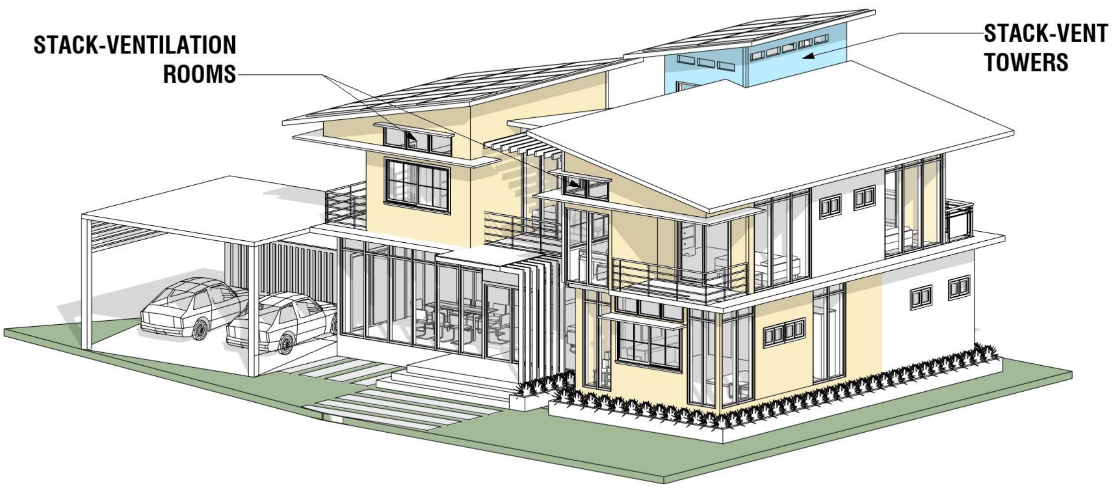


Figure 05 3D view of the proposed NZB1 San Marino Project showing the locations of Stack-vent Towers (shaded in blue), and Stack-Ventilation Rooms (shaded in yellow).

Layers of Shade

Outdoor spaces will be shaded by overhead elements. West and East portion is best to incorporate with vertical shading devices. Layers of shade are also applied by extending overhangs on top of every window openings.

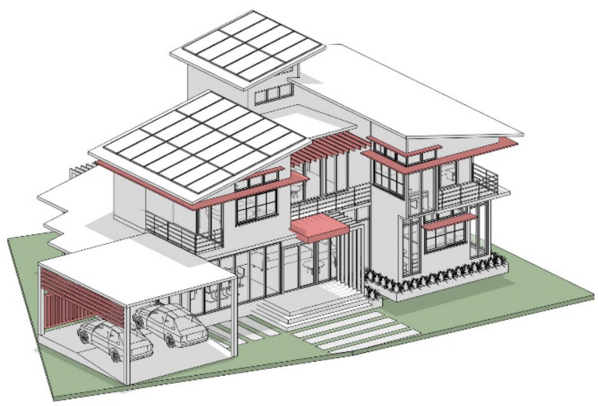


Figure 06 Highlighted layers of shades on the South and East Façade.

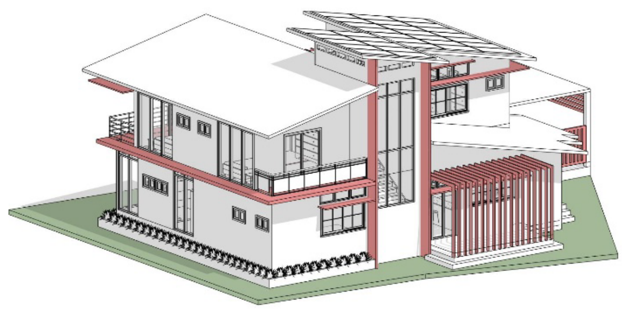


Figure 07 Highlighted layers of shades on the North and West Façade.

Pitched Roof

The roof has a 12° angle slope facing south-southwest which will also cater 58 m^2 photovoltaic panels that will supply additional energy to the proposed residential.

Situational Strategies

Permeable Buildings

The design of the building mainly focuses on cross- and stack-ventilation.

Rooms Facing Sun and Wind

Inlets are facing towards the prevailing breeze which is coming from the Southeast direction. Cross-ventilation outlets are located across the prevailing wind while the stack-ventilation outlet faces the Northeast and Northwest direction. There is also an outlet in the Southeast direction because there are also times that prevailing wind is not available.

Cross-Vent Rooms

Cross-vent rooms are effective when the wind is available. However, since the wind is not always available, stack ventilation rooms, by incorporating clerestory windows, will help eliminate hot air inside.

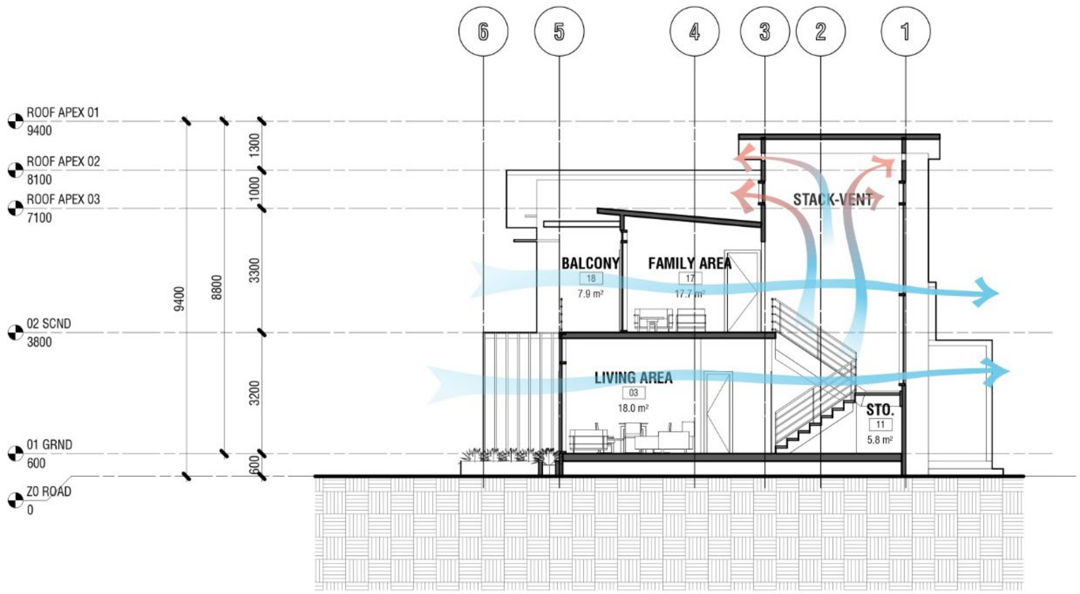


Figure 08 Section thru Stack-vent showing the flow wind in Cross ventilation and Stack ventilation.

Breezy/Calm Courtyard

Outdoor rooms, such as the porch, carport, lanai, and balconies will not be fully enclosed, rather they will be designed with shades and partial enclosure which promotes good ventilation.

Vent Opening Arrangements

Vent openings are well arranged because the inlet faces the prevailing wind and the outlet faces the opposite side.

ECOTECT ANALYSIS

Sun Path Diagram and Shadow Range

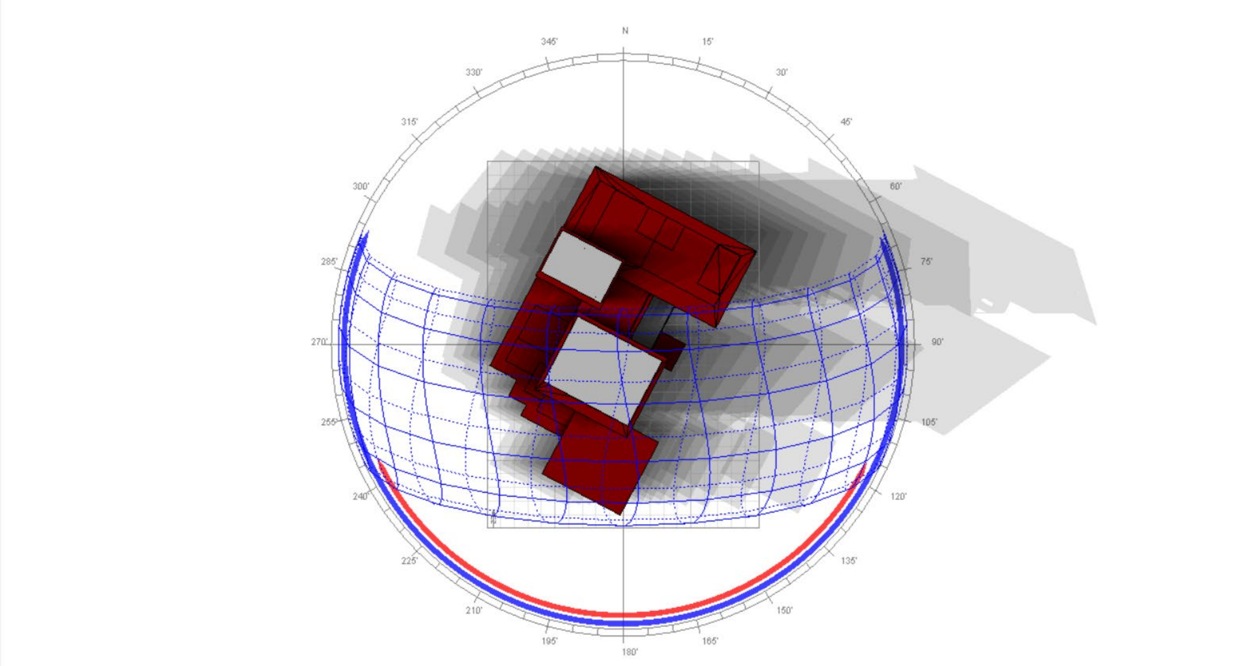


Figure 09 Top view of the Annual Sun Path Diagram and Shadow Range.

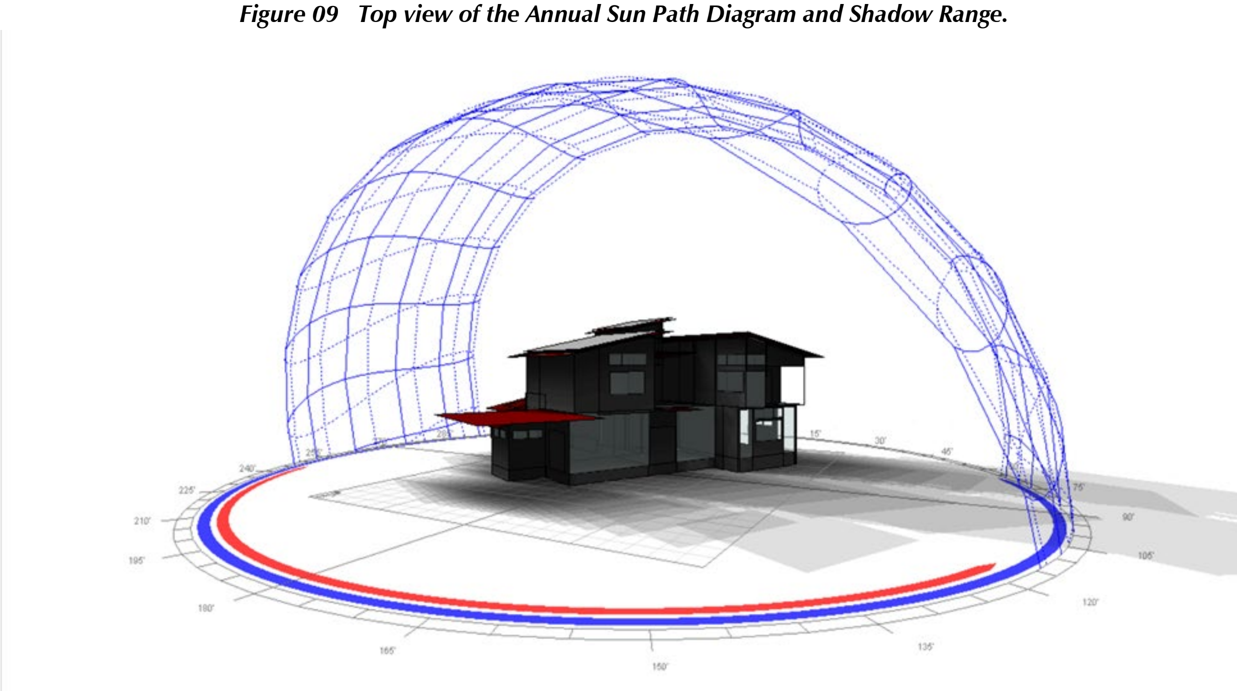
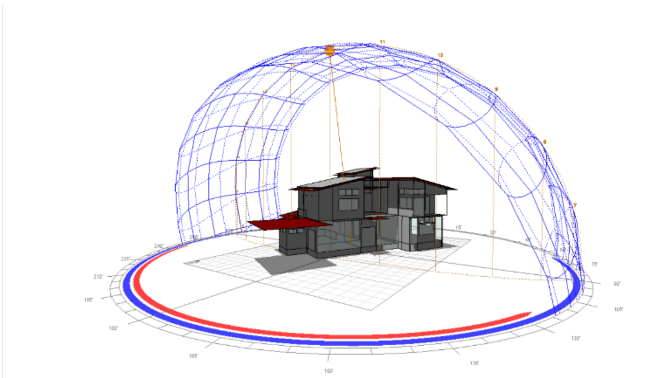
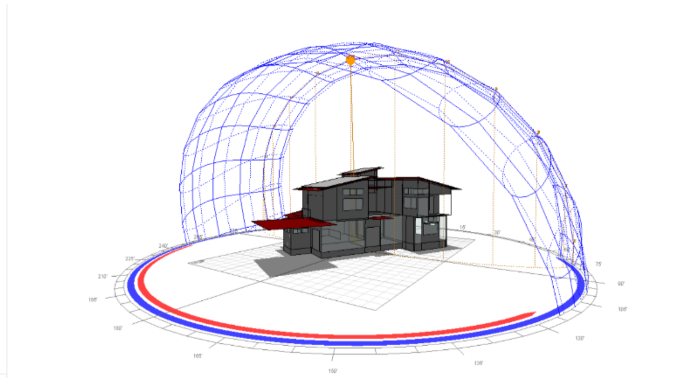


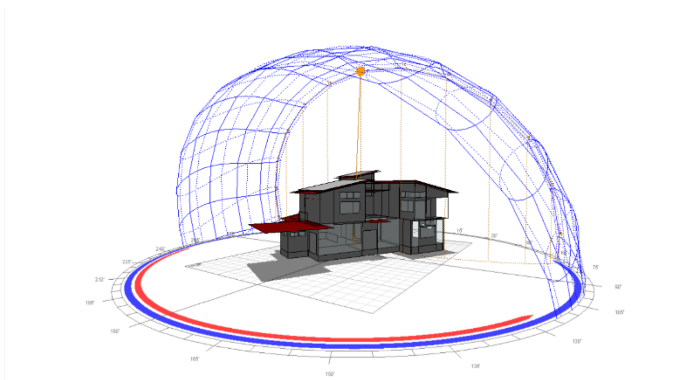
Figure 10 Perspective View of the Proposed Residential showing the Annual Sun Path Diagram with its corresponding Shadow Range.



April 1st



May 1st



June 1st

Figure 11 Perspective View of the proposed Residential showing daily Sun Path Diagram with the corresponding shadows during 12:00 noon of April, May, and June.

Lighting Analysis

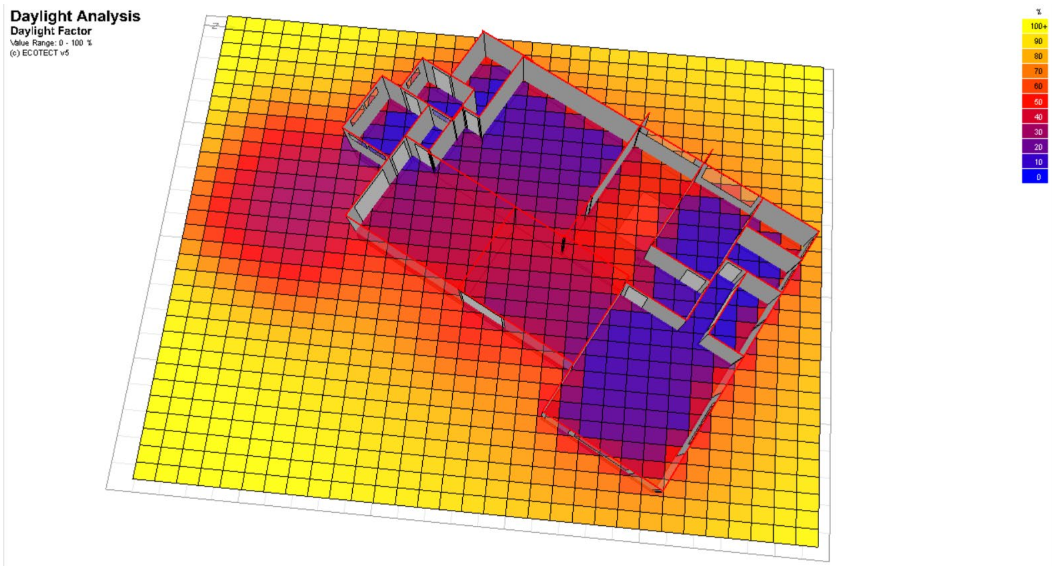


Figure 12 A view of the Ground Floor showing the Natural Daylight Factor inside

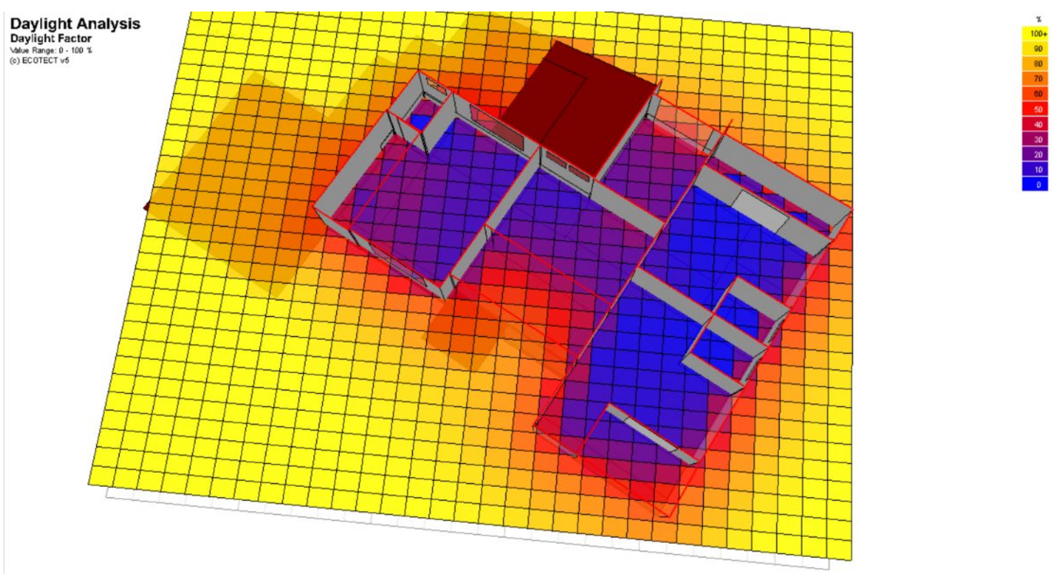


Figure 13 A view of the Second Floor showing the Natural Daylight Factor inside.

The diagrams above show that the public and service spaces can utilize and maximize the use of natural daylight as the primary source of lighting. Other areas such as the bedroom and toilet & bath can also receive daylight but with lower factor. Hence, these areas can utilize artificial lighting as additional lighting source.

Solar Access Analysis

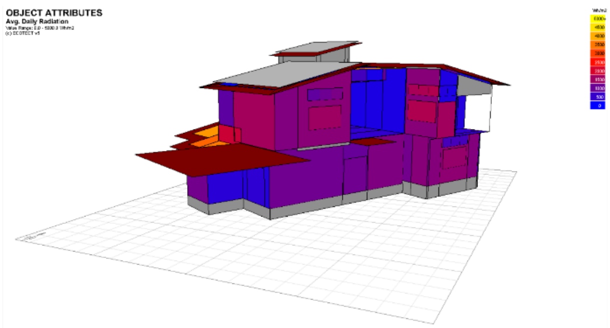


Figure 14 A view from Southeast portion showing the Average Daily Radiation.

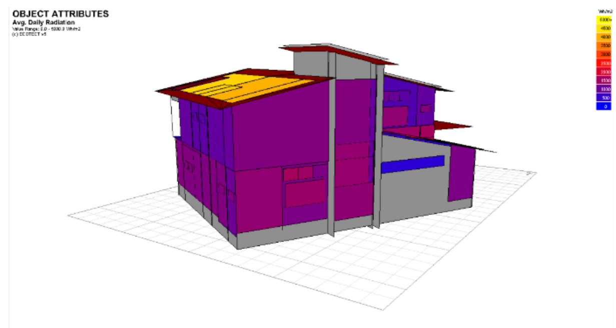


Figure 15 A view from Northwest portion showing the Average Daily Radiation.

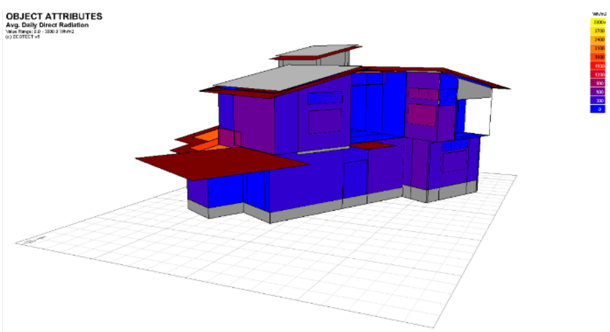


Figure 16 A view from Southeast portion showing the Average Daily Direct Radiation.

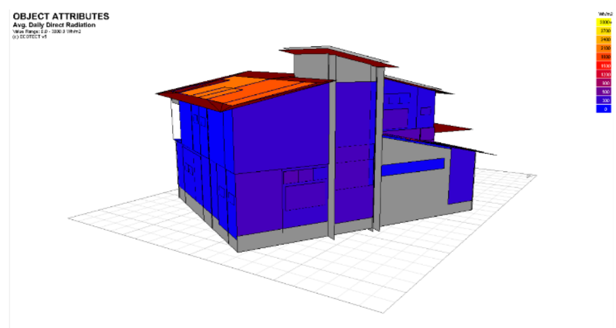


Figure 17 A view from Northwest portion showing the Average Daily Direct Radiation.

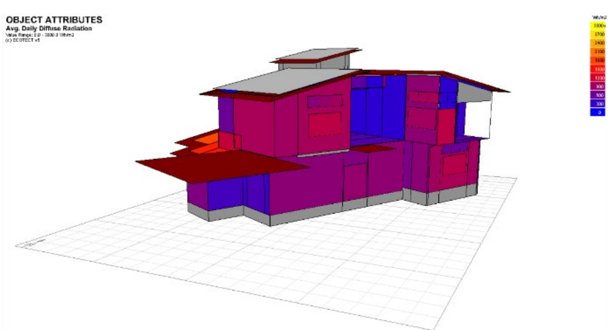


Figure 18 A view from Southeast portion showing the Average Daily Diffuse Radiation.

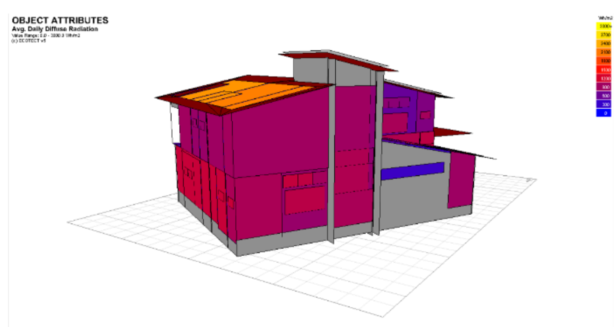


Figure 19 A view from Northwest portion showing the Average Daily Diffuse Radiation.

In summary to the solar access analysis from the previous diagrams, the building envelope of the proposed NZB1 Residential Project can receive 0 – 2000 Wh/m^2 Daily Radiation in exception of the roof structure which can receive up to 5000 Wh/m2 Daily Radiation.

Sunlight Analysis

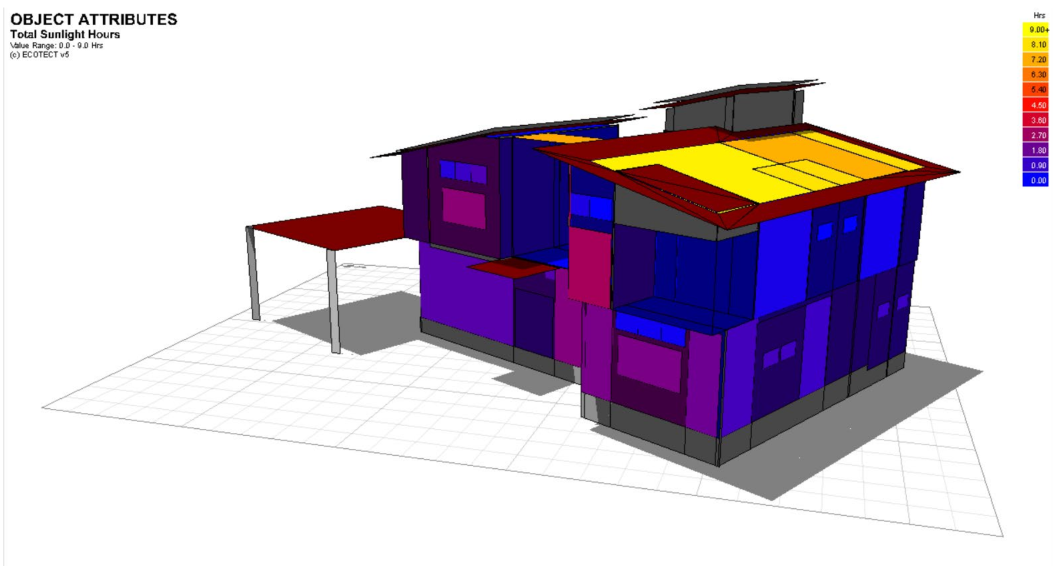


Figure 20 A view from East (left) and North (rigth) façade of the proposed NZB1 San Marino Project.

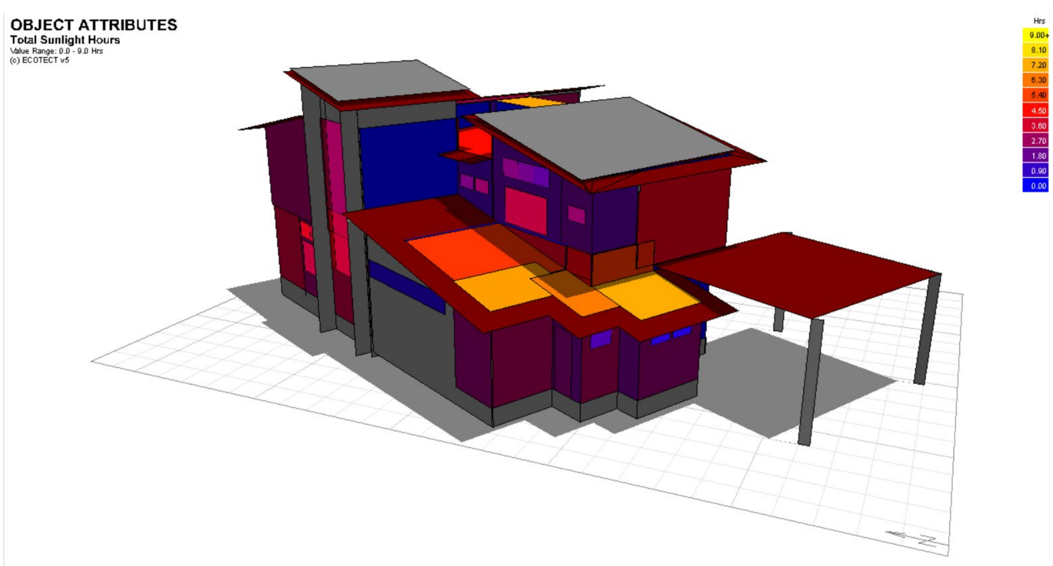


Figure 21 A view from West (left) and South (rigth) façade of the proposed NZB1 San Marino Project.

Sunlight Analysis generated from ecotect shows that the north façade of the proposed NZB1 San Marino Project receives the least amount of sunlight which has the greater opportunity for larger openings. On the other hand, the south façade receives the greatest amount of sunlight that's why service areas like the carport, T & B, maid's room, laundry, and pantry are strategically located at the south portion of the residential in order to serve as buffer zones that can protect the other rooms from direct sunlight and heat. East and west façades also receives certain amount of sunlight at certain periods of the day that is why shading devices are incorporated in order to lessen the amount of sunlight and heat.

Resource Usage (Photovoltaic Panels)

Photovoltaic panels use sunlight or solar energy as a source of energy and generate direct current electricity. Electricity generated by PV panels can be used for powering household appliances and equipment. In relation with the aim of producing a **Net-Zero Energy Building** (NZEB) design, the use of solar energy considers as environmentally friendly because it contributes to cutting carbon footprint which is at the same time, can reduce electricity consumption cost.

Photovoltaic panels are oriented facing south-southwest portion to collect sunlight at most and large enough to meet the building's electric load. Photovoltaic panels are tilted 12° having total area of about 58 m^2 which is within the recommended standard of 53 m^2 for the sizing of residential photovoltaic panels stated in SWL.

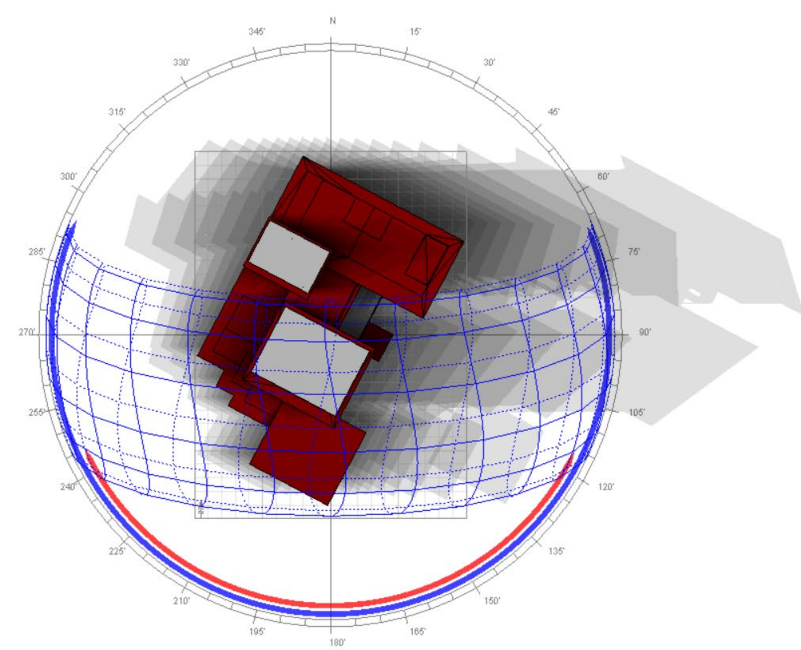


Figure 22 Top view of the proposed orientation and location of Photovoltaic Panels (shaded in grey color).

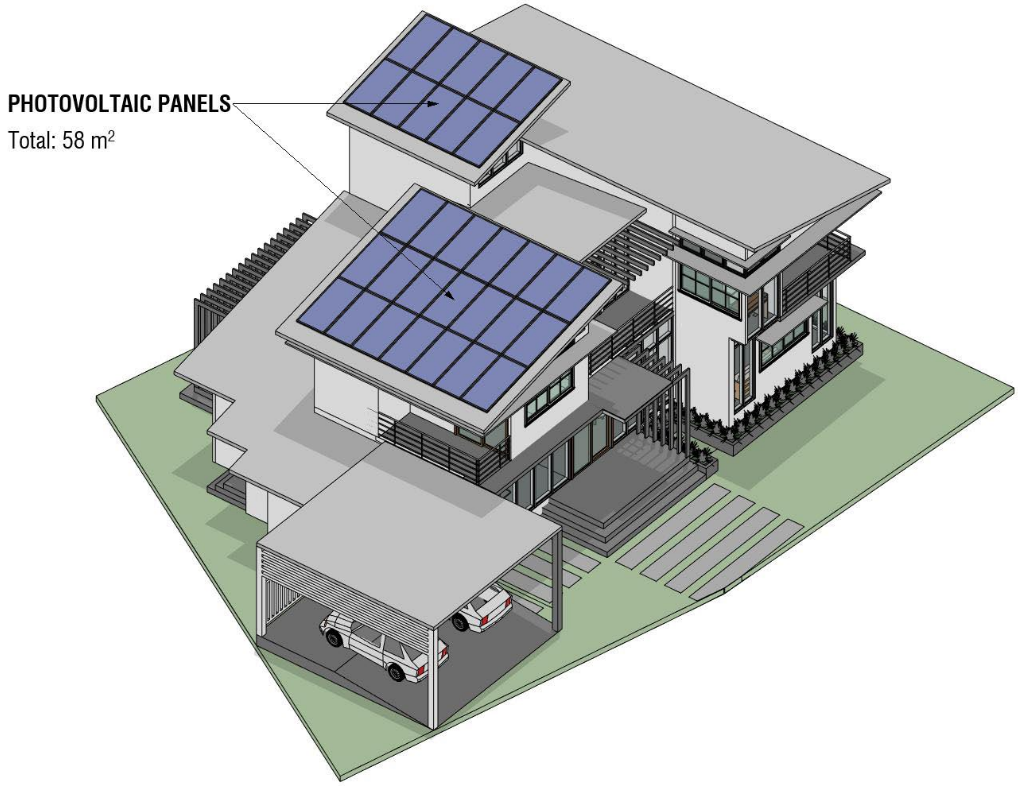


Figure 23 3D view of the proposed orientation and location of Photovoltaic Panels.

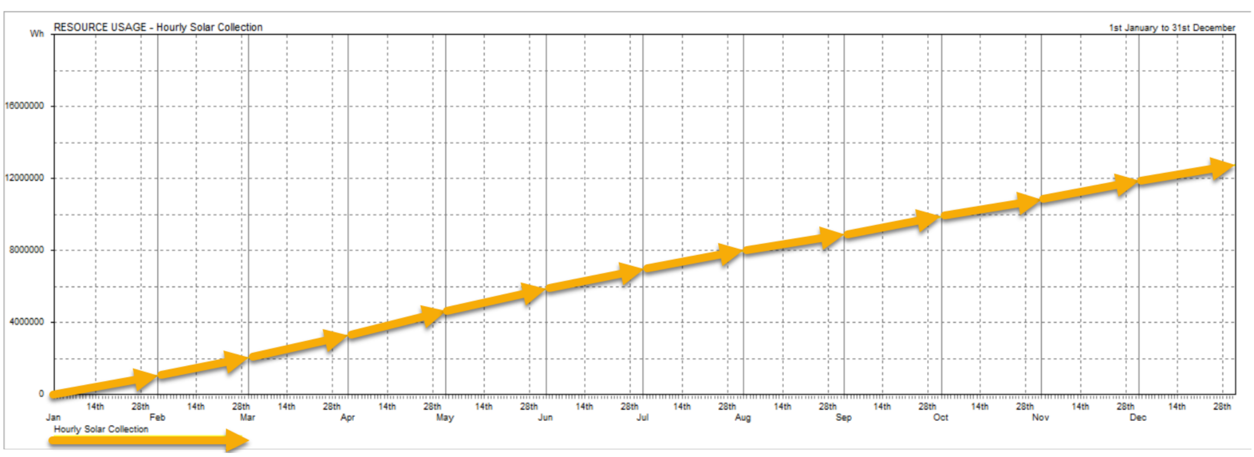
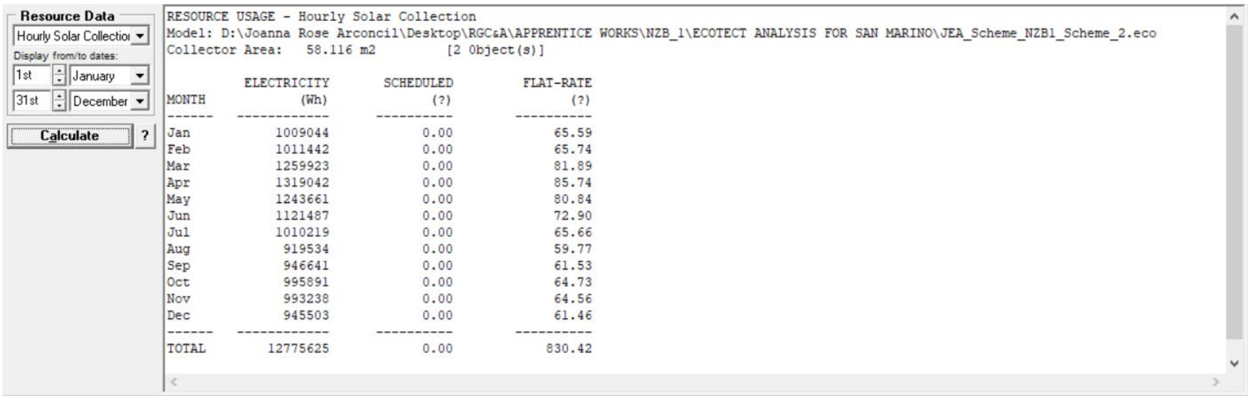


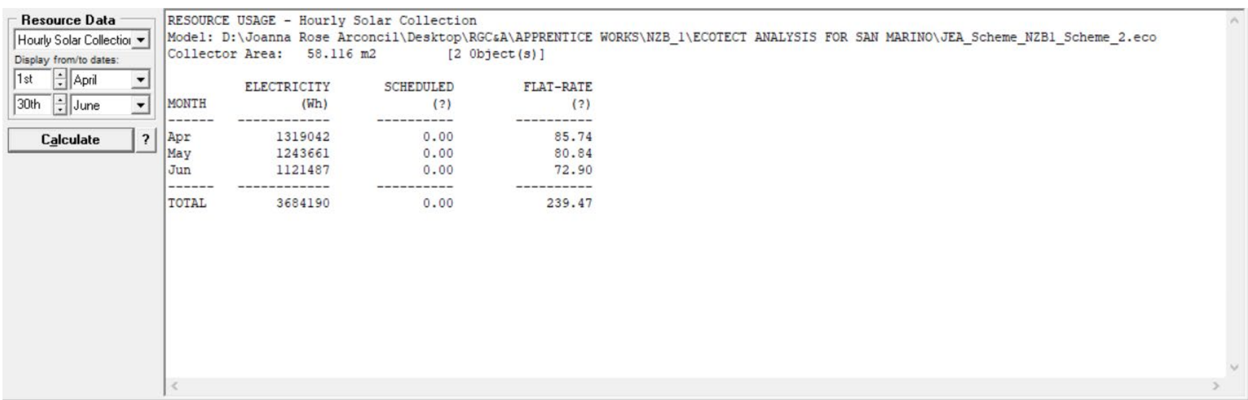
Figure 24 Data Chart for Resource Usage - Hourly Solar Collection from 1st January to 31st December.



RESOURCE USAGE - Hourly Solar Collection
Model: D:\Joanna Rose Arconcil\Desktop\RGC&A\APPRENTICE WORKS\NZB_1\ECOTECT ANALYSIS FOR SAN MARINO\JEA_Scheme_NZB1_Scheme_2.eco
Collector Area: 58.116 m2 [2 Object(s)]

MONTH	ELECTRICITY (Wh)	SCHEDULED (?)	FLAT-RATE (?)
Jan	1009044	0.00	65.59
Feb	1011442	0.00	65.74
Mar	1259923	0.00	81.89
Apr	1319042	0.00	85.74
May	1243661	0.00	80.84
Jun	1121487	0.00	72.90
Jul	1010219	0.00	65.66
Aug	919534	0.00	59.77
Sep	946641	0.00	61.53
Oct	995891	0.00	64.73
Nov	993238	0.00	64.56
Dec	945503	0.00	61.46
TOTAL	12775625	0.00	830.42

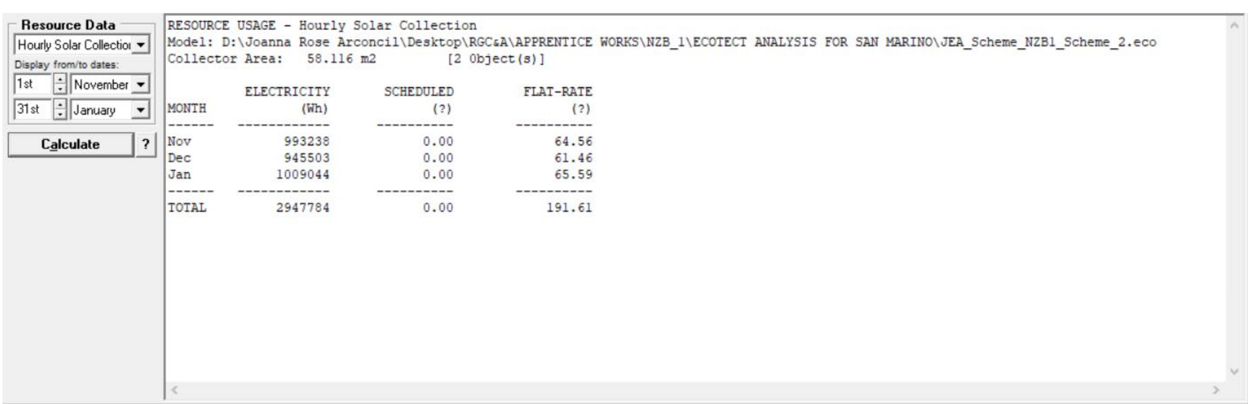
Figure 14 Hourly Solar Collection from January to December.



RESOURCE USAGE - Hourly Solar Collection
Model: D:\Joanna Rose Arconcil\Desktop\RGC&A\APPRENTICE WORKS\NZB_1\ECOTECT ANALYSIS FOR SAN MARINO\JEA_Scheme_NZB1_Scheme_2.eco
Collector Area: 58.116 m2 [2 Object(s)]

MONTH	ELECTRICITY (Wh)	SCHEDULED (?)	FLAT-RATE (?)
Apr	1319042	0.00	85.74
May	1243661	0.00	80.84
Jun	1121487	0.00	72.90
TOTAL	3684190	0.00	239.47

Figure 15 Hourly Solar Collection during overheated periods of the year (April to June).



RESOURCE USAGE - Hourly Solar Collection
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Collector Area: 58.116 m2 [2 Object(s)]

MONTH	ELECTRICITY (Wh)	SCHEDULED (?)	FLAT-RATE (?)
Nov	993238	0.00	64.56
Dec	945503	0.00	61.46
Jan	1009044	0.00	65.59
TOTAL	2947784	0.00	191.61

Figure 16 Hourly Solar Collection during underheated periods of the year (November to December).

Based from the calculated resource usage of the proposed Photovoltaic panels in NZB1 San Marino Project, the generated hourly solar collection for the whole year is 12,775.625 Kwh. The projected solar collection during the underheated periods from the months of November to January will be 2,943.60 Kwh and for the overheated periods from the months of April to June, the projected solar collection will be 3,685.587 Kwh.

CONCLUSION

Conception, design approach and solutions, and expected energy performance of a new Net-Zero Energy Building (NZEB), designed for a hot-humid climate, have been proposed. The building is the final outcome of the NZB1 San Marino Project, aimed to meet the needs of the building and its occupants through the application of the strategies proposed by the bundle for passively cooled building in order to improve the building's energy efficiency in hot-humid climate of Dagupan City. It is clear that the maximization of passive techniques is greatly important. Moreover, it is a great opportunity to consider mostly the sunlight and wind direction towards the proposed residential because these can mainly affect the organization of spaces and the location of openings. Many different architectural configurations have been analyse including lighting, solar, and thermal analysis, as well as the estimated resource usage from the collected solar energy of the proposed photovoltaic panel. All investigations, according to the simulation produced by Ecotect Analysis, revealed the target of Net-Zero Energy Building (NZEB).