Solar™ Decathlon India

TEAM SUGRIHA

DELIVERABLE-4

FINAL DESIGN REPORT- APRIL 2023

SINGLE FAMILY HOUSING

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY, JAIPUR

MBS SCHOOL OF PLANNING AND ARCHITECTURE, DELHI

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EXECUTIVE SUMMARY

The SuGriha team, composed of multidisciplinary architects and engineers from MNIT Jaipur and MBS Delhi, collaborated with Mahima Group as project partner to construct a net-zero single-family housing project in Jaipur. Our goal was to create a sustainable living model that meets the needs of affluent individuals while reducing the impact on the environment.

Our project addressed environmental issues and resource utilization through the use of cutting-edge sustainable technology and strategies. We employed sustainable materials (like CSEB, rammed earth, recycled materials) , renewable energy sources, energy-efficient appliances, natural ventilation, Windows and shades optimized for sufficient daylighting throughout the year, and rainwater collection to achieve net-zero energy and water usage.

The value proposition of our design solution lies in providing a sustainable luxury lifestyle that satisfies high-end requirements without compromising environmental sustainability. We aim to create a positive impact on the global fight against climate change while meeting the demands of our clients.

Our project's context and the problems we addressed include the need for sustainable living and reducing carbon footprints in high-end living. Our design strategies involve incorporating architectural and engineering concepts to create a sustainable living model that serves as an example for future generations. Like stepped pool which performs multiple functions simultaneously.

Our achievements include successfully designing a net-zero energy water single-family housing project that meets the needs of our client while being ecologically responsible. Our next steps involve continuously improving and refining our design while incorporating the most cutting-edge sustainable building technologies and materials, to make it net zero carbon and mode efficient in other aspects

Overall, our net-zero sustainable house design offers a practical, premium, and value-for-money solution to lowering the carbon footprint of high-end living while providing our clients with a luxurious, eco-friendly lifestyle, for which they aspire.

TEAM SUGRIHA

MAHIMA GROUP
Committed to Excellence

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY, JAIPUR

MBS SCHOOL OF PLANNING AND ARCHITECTURE, DWARKA

RESPONSE OF REVIEWERS'S COMMENTS

Section	Reviewer's Comment	Our Response
REVIEWER-1		
Energy performance	IMAC has been used to analyse the climate and suggest recommendations for comfort. Calculations for the potential for Solar PV are also given. You can identify the solar modules that are to be used to generate the energy. The biogas plant is also described for cooking and generating electricity. The calculations for the energy consumption are also provided. The simulation results for daylighting are given for UDI and SDA. This is a very good analysis.	The solar modules have been suggested. Refer page no. 16.
Water performance	Water calculations are given for consumption, rainwater harveesting and grey water recycling. Low flow fixtures are also identified. The charts can be explained in terms of inference. The water cycle diagram can be added.	Water Cycle Diagram is added now. Charts has also been explained.
Embodied carbon	The embodied carbon calculations have been initiated. They need to be more elaborate and explained better.	Yes, it has been elaborated and well explained through tables and charts.
Resilient design	The problems and solutions for resilience have been identified. This needs to be elaborated in the next deliverable.	This has been addressed in page no. 29.
Engineering and operations	Drawings for structural and electrical have been provided.	No Response.
Architectural Design	The design has been completed including interior aspects. You need to have more iterations to improve the design further. For example, the staircase on the north side can be shifted to allow more light and ventilation.	We have considered and improved our design.

RESPONSE OF REVIEWERS'S COMMENTS

Section	Reviewer's Comment	Our Response
REVIEWER-1		
Affordability	Costing has been given. You can check that baseline and proposed design have been compared. It seems that the baseline is missing.	Please refer page no. 38.
Innovation	Building management system, green roof, insulation, optimum window sizes, and landscaping have been proposed. This needs to be checked or quantified using simulation results.	These have been checked and quantified
Health and wellbeing	The points for health and wellbeing are identified. Make it more elaborate. You have to add simulation results for thermal comfort and ventilation.	We have addressed this in page no. 16 and 19.
Value proposition	This section is connected to the affordability section. you can separate it and make it elaborate.	We have tackled this and have separated and addressed this issue.
Additional comment	You are on the right track. This report has the potential to do much better for the final submission.	No response

RESPONSE OF REVIEWERS'S COMMENTS

Section	Reviewer's Comment	Our Response
REVIEWER-2		
Energy performance	Good ambition to reach 5-star rating. There seems to be some missing data in Table 5. Also, would there be a peak of solar radiation in March? How do you plan to sustain net-zero given that the efficiency of the PV will fall over a period of time?	Table 5 has been updated. Solar radiation has been cross verified. Peak is in May. Efficiency issue has been addressed. Refer page 16.
Water performance	Well-planned and good to see that the water source is only rainwater harvested. Table showing greywater unused needs to be aligned. Rainfall data reference to be given.	This has been addressed in page no. 21.
Embodied Carbon	Excellent choice of materials. One important factor to be considered would be the end of life. There ought to be a balance between embodied carbon and recyclability.	No Response.
Resilient Design	While the threats are well-evaluated, the mitigations could be more well-defined. There will be an increase in the frequency of droughts, heatwaves accompanied by dust storms, loss of biodiversity over a relatively short period of time.	Please refer to page no. 25.
Engineering and Operations	Narrative has to be better. Systems for water and waste management are missing.	Narrative has been improved. Water and waste management has been added now.
Architectural Design	Sustainability aspects well-weaved into the design. Missing seems to be the emphasis on local flavour - context.	We have noted this and improved on the design.
Affordability	Good job in providing the excel with all the costs involved. However, the presentation in the main project proposal could be better. In the table, values are repeated.	Tables and charts has been improved. It is ensured that Nothing is repeated.
Innovation	Where you have a good repertoire of innovation interventions, please refer to the deliverable: It requires the team to identify one specific problem and present one innovation as a solution to that problem. Please rework.	The innovations section has been updated and restructured to the required guidelines of the competetion

RESPONSE OF REVIEWERS'S COMMENTS

Section	Reviewer's Comment	Our Response
REVIEWER-2		
Health and wellbeing	While the components of this contest are scattered under different other headings, the specific benefits of H & W need to be simulated and presented in a comprehensive manner in this section,	We have addressed this in page no. 34.
Value Proposition	The value proposition must have clear and simple statements that describe and quantify the tangible benefits and describe the intangible benefits.	We have tackled this and addressed this.
Additional comments	Proposal is too long. Spell check, esp have you understood what is Value Proposition?	We have worked upon it.

TEAM INTRODUCTION

TEAM

SuGriha

PRAKASH NARAYAN
B-Tech 3rd Year
Engg. & Opperations

ARSHDEEP SINGH
M-Tech 1st Year
Simulations and Energy head

ABHINAV JAIN
B-Arch 3rd Year
Design Team

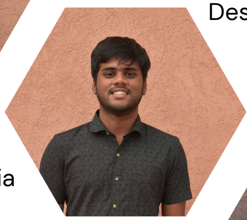
UTKARSH KHANDELWAL
B-Arch 4th Year
TEAM LEAD
Design & Simulations

RAJNEESH CHAURASIYA
B-Arch 3rd Year
Design and engineering Team

RISHI KUMAR
B-Tech 3rd Year
Engg. & Operations

SHREYA SINHA
B-Arch 3rd Year
Design and Documentation team

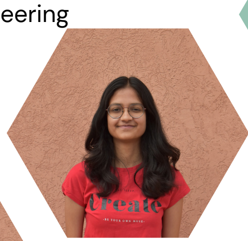
VAISHNAVI GUPTA
B-Arch 2nd Year
Documentation, Media and PR



SUBAKARAN
B-Tech 2nd Year
Research & Innovations

MEHAK GUPTA
B-Arch 4th Year

SWETHA KOZHIPURATH
B-Tech 2nd Year
Media, PR and communication Innovations



PRAKRATI TIWARI
B-Arch 2nd Year
Design and Documentation

FACULTY LEAD AND FACULTY ADVISORS

Ar. SANGEETH S PILLAI (Faculty Lead)
- Assistant Professor, Architecture
- Ph.D. (Architecture), M.Arch & B.Arch.

Dr. ANEESH PRABHAKAR (Faculty Advisor)
- Assistant Professor, Centre for Energy and Environment
- Ph.D.(Mechanical Engineering), M.Tech & B.Tech.

Dr.SANDEEP SHRIVASTAVA (Faculty Advisor)
- Assistant Professor, Civil Engineering
- Ph.D.(Sustainable Construction), M.Tech. & B.Tech.

Dr. GIREENDRA KUMAR (Faculty Advisor)
- Assistant Professor, Architecture
- Ph.D. (Architecture & Planning), B.Arch. (Architecture)

INDUSTRY PARTNER- PLAN M

Industry Partner will be helping us in value proposition through creative AR/VR visualizations.

BACKGROUND OF THE LEAD INSTITUTION

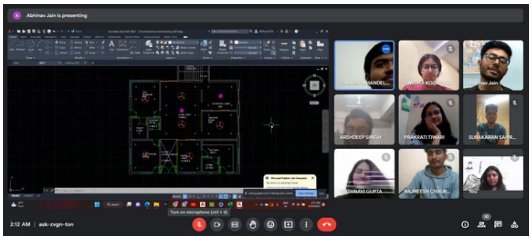
In 1963, Malviya National Institute of Technology Jaipur was founded as Malviya Regional Engineering College, Jaipur. Subsequently, in 2002, the institution was designated as a National Institute of Technology, and on August 15, 2007, it was designated as an Institute of National Importance by Act of Parliament. The Institute is entirely supported by the Indian Ministry of Education (Shiksha Mantralaya).

RELEVANT DEGREE PROGRAM

- B.ARCH
- B.TECH COMPUTER SCIENCE
- B.TECH-ELECTRONICS AND COMMUNICATION ENGINEERING
- B.TECH CIVIL ENGINEERING
- M.TECH RENEWABLE ENERGY

COURSEWORK

- BUILDING SERVICES
- SOLAR THERMAL TECHNOLOGY
- ENERGY EFFICIENCY
- ARCHITECTURE DESIGN
- BUILDING SCIENCE
- STRUCTURES
- SURVEYING
- CLIMATOLOGY



Design Charrette
↓
Online Meets
↓
Offline Meets
↓
TRG Meets
↓
Faculty Advisors Meets
↓
Project Partner Meets

TEAM AND DESIGN MANAGEMENT PROCESS

Our team conducted extensive research on the latest sustainable building practices, including passive design strategies, green building materials, and energy-efficient systems, to integrate them into the design. The final form is a harmonious blend of functionality, aesthetics, and sustainability, which offers a seamless transition between indoor and outdoor spaces and creates a strong visual connection with nature.

TOOLS USED

INTERACTION PLATFORMS

The idea of learning through experience guided us through each phase.

Analysis, comprehension, and working next to each point has led us to where we are now.

PROJECT INTRODUCTION

PROJECT NAME: SuGriha

PROJECT PARTNER: **Mahima Group**

Mahima, estate brand in Rajasthan, is known for creating innovative and secure residential and commercial properties. They are committed to excellence and strive to make a positive impact on as many lives as possible through their projects. Their mission is centered around ethics, social responsibility, and meeting the needs of their customers

KEY INDIVIDUALS INVOLVED-

MAHIMA GROUP
Committed to Excellence

Mr. Dhirendra Madan,
Chairman and MD, MAHIMA GROUP

Ar. Nishant Saxena,
Senior Architect, MAHIMA GROUP

PROJECT BRIEF

A luxurious net-zero energy single-family house provides high-profile residents with a sustainable and comfortable living environment. It uses energy-efficient materials and renewable energy sources. The house is equipped with upscale features and smart home technology for convenience and comfort. It is a responsible approach to high-end residential living and minimizing environmental impact.

Location - Opposite Adinath city village Jaisinghpura, Kankroda, Ajmer road, Jaipur Rajasthan
Climate zone - Composite
User profile - Nuclear family
Number of occupant- 4 to 6 members
Operating hours- 24x7
Type - High-end residential villa

Figure 1: Jaipur X Windchimes Mahima

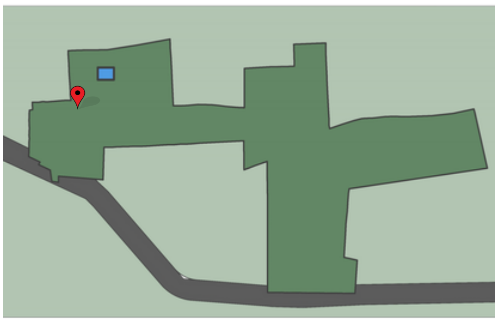


Figure 2: Windchimes Mahima X Site

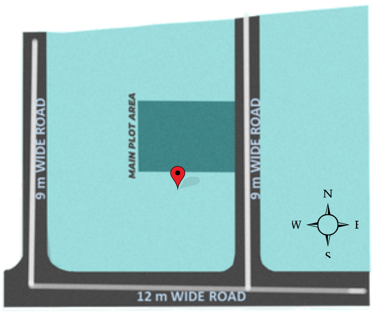
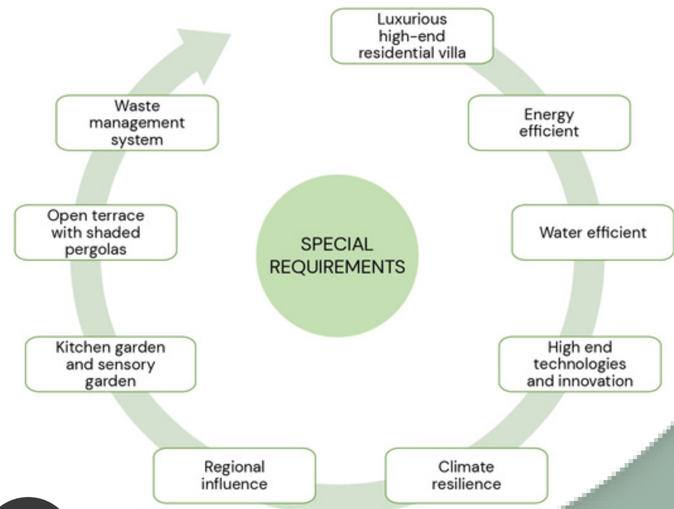


Figure 3: Location of proposed site zoned

SITE AREA	480 sq.m
GROUND COVERAGE	200 sq.m
PERMISSIBLE BUILT UP AREA	960 sq.m
ESTIMATED BUILT UP AREA	365 sq.m
FAR	0.8



PRELIMINARY ESTIMATE OF ON -SITE RENEWABLE ENERGY GENERATION POTENTIAL:

We will be utilizing solar energy by using grid integrated roof-top solar power plant for generation of electricity. Biomass may be used in case required.

Using Solar Photovoltaic
Roof Area = 210 sq meter
Estimated units generation = 11620.8 units

Using Deenbandhu Biogas Plant
Estimated units generation = 730 units

Figure 4: PLOT AREA- 480 sq. m

Figure 5: Kitchen Garden
[Source : Pinterest]

Figure 6: Terrace garden
[Source : Pinterest]

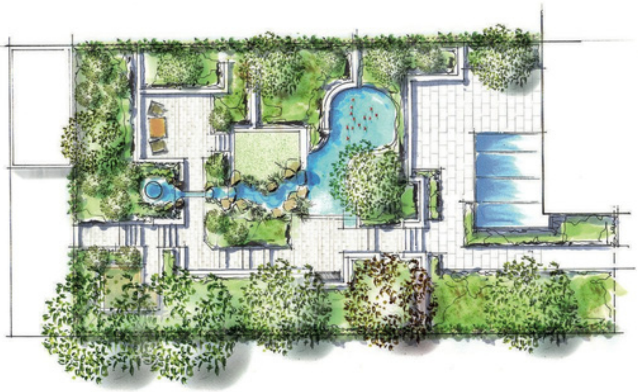


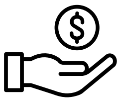
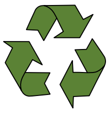
Figure 7: Sensory Garden
[Source : Pinterest]

Figure 8: Xeriscaping
[Source : Pinterest]

Img Credits: Google Images and inspirations of project partner

GOALS AND STRATEGIES

	GOAL	AIM	STRATEGIES	ACHIEVEMENT
	Renewable Energy generation potential	Building energy positive within a span of one year	Generating 11620.8 units of electricity by 7.2 kW solar plant on 72 sqm area. Using biogas, annual electricity generated= 2x365 = 730 kW	Total Generation = 12,350.8 units
	Energy Efficient design for net zero building	EPI target of 29 kWh/m^2 year as per BEE 5 Star	Natural ventilation and Evaporative cooling against HVAC . Minimized the non-comfort hours to 29hrs by resetting the schedule and set points.	EPI achieved is 31 kWh/m^2
	Water Performance	Achieve net zero water and reduce water Consumption up to 50%	Usage of Modern plumbing fixtures, using upto 50% of Recycled grey water L/year for flushing & irrigation. Drip Irrigation system for Gardening which reduced water demand upto 80%.	Net zero water has been achieved. Consumption reduced from 135 to 75 Lpcd
	Materials	Constructing with the least embodied carbon footprint & materials which are environmentally friendly and comply with ECBC	Use of materials with less carbon and U value. Locally available material with the context & culture of Rajasthan- stone, cseb blocks & recycled materials	This reduced embedded carbon by 83.6% from baseline
	Resilience	Designing building to mitigate the impact of extreme weather & other calamities.	Rainwater Harvesting to tackle drought. Upcycling and recycling water. Use of Underground water tank.	climate responsive design, tackling drought and heat waves with innovative technologies and systems
	Architectural Design	To achieve functionality, create a climate responsive design and to provide interactive space for family.	House has been designed using multiple passive strategies, cutouts are given to create interactive spaces at the same time enhancing ventilation.	We are able to considerably lower the temperature of the house by using passive techniques. The cutout in the roof of ground floor act as a interaction link between two floors.
	Health and well being	Ensuring a Comfortable and healthy lifestyle, and to encourage the residents in to being	Providing four types of comfort- Acoustic, illumination, Indoor air quality, thermal comfort Acoustic comfort- Acoustic materials, use plants as a noise barrier. illumination- Natural sunlight, giving light at every corner. Indoor air quality- Natural ventilation and fresh air from our aromatic garden. Thermal Comfort- using the passive technique.	246 days of thermal comfort passively. Cleaner air because of green roof and other vegetation. Annually sufficient daylight.
	Engineering & Operations	To reduce the use of RCC by using it with other alternative materials that provide more thermal lag with less carbon emission.	We have used less of RCC and have used it with 25% GGBFS which produces less carbon and increased the usage of other green materials.	This reduced embodied carbon by 83.6% from baseline. U values has also been reduced as to get thermal comfort with less energy consumptions.

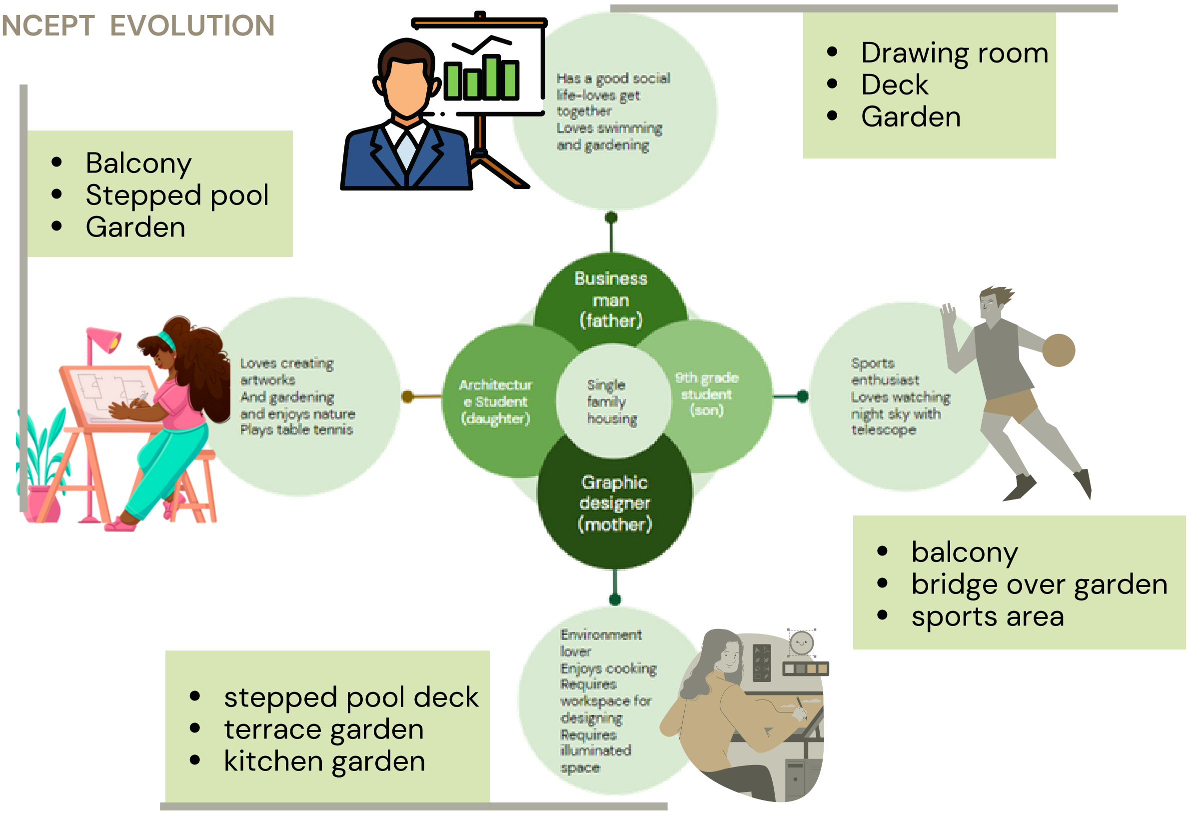
	CONTEST	AIM	STRATEGIES	ACHIEVEMENT
	**Affordability**	providing a better quality of things justifying value to the client.	Adopting sustainable market strategies to educate clients about focusing on life cycle cost. Self-reliable net zero house to achieve quick breakdown cost.	We have reduced our Life Cycle Cost by 12.74% which is 33.4 Lakhs
	**Security**	Well integration of all the services for the flawless functioning of the space providing all luxuries and comfort.	To segregate private, semi-private, open areas with different materials such as Jali, Partition walls, and Smart screens. Creating visual barriers through the plantation. Designing advanced monitoring systems.	We have CCTV systems in our House. Plan is also been made considering the security factor as well.
	**Waste Management**	To collect, segregate waste and reuse where ever possible.	use of wetland water treatment system, recycling of grey water	at the aeration system in the WWTS obstructs the produced inorganic obnoxious gas and even manages solid, liquid, and organic wastes by 80-90%
	**Carbon**	Reducing carbon emissions more than 80-90% on producing our constuction materials as well as on operation.	Use of materials with minimal emission in production as well as which produces less emissions on operation	We have reduced the total carbon emmisions per functional unit by 83.6 % from the baseline.

DESIGN PROCESS

APROACH TOWARDS THE DESIGN

Thoughts and feedbacks	Zoning	Layouting	Best possible result
Regular discussions and workflow distribution with all feedbacks from TRG mentor, faculty advisors and team members	with the flow of discussions and feedbacks, zoning in the spaces and possibilities were taken care of	after zoning many iterations were made for the best results in terms of the 10 contestants	the best of the result out of all the iterations of the layouting is presented

CONCEPT EVOLUTION



This sheet showcases the comprehensive design process and concept development undertaken by our team to arrive at the final design for the net-zero single family housing. We started by identifying the project requirements and client's aspirations to create a luxurious yet sustainable living experience. Through various design iterations, we explored different forms, materials, and technologies to optimize the building's energy performance and minimize its environmental impact.This concept and form development sheet represents the culmination of our team's collaborative efforts and innovative design approach towards achieving a truly net-zero, sustainable, and luxurious living space.

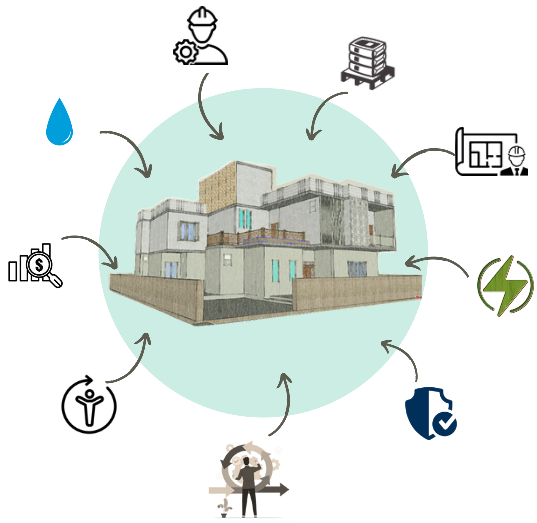


Figure 9: 10 contests

BUILDING AREA PROGRAM

SERIAL No.	SPACE NAME	DIMENSIONS(m)	AREA(sqm)	CONDITIONED	FLOOR NO.
1	Entrance Lobby	2.77X2.22	6.15	No	Ground
2	Stairs	6.50X1.70	11.05	No	Ground
3	Formal Living Space(drawing)	4.54X5.24	23.79	No	Ground
4	Powder room	1.30X1.77	2.3	No	Ground
5	Guest Room	4.42X3.54	15.65	Yes	Ground
6	Toilet	2.00X2.50	5	No	Ground
7	Dressing area	2.00X1.72	3.44	No	Ground
8	Living Space	8.24X5.50	45.32	No	Ground
9	Kitchen	3.65X3.05	11.13	No	Ground
10	Store	2.00X1.75	3.5	No	Ground
11	Master Bedroom	4.42X3.54	15.65	Yes	Ground
12	Dressing area	2.00X2.89	5.78	No	Ground
13	Toilet	2.00X2.50	5	No	Ground
14	Parking	6.79X6.34	43.04	NA	Ground
15	Son’s Bedroom	5.95X3.54	21.06	Yes	First
16	Toilet	2.00X2.50	5	No	First
17	Dressing area	2.00X1.72	3.44	No	First
18	Daughter’s Bedroom	4.54X5.35	24.29	Yes	First
19	Dressing Area + Toilet	4.16X2.33	9.69	No	First
20	Kitchen Garden	7.00X5.60	39.2	NA	First
21	Mumpty	7.00x3.40	23.8	NA	Second

Surface type	Area m2
Roof Surfaces	190
Hardscape areas	120
Softscape areas	170

Table-1: BUILDING AREA PROGRAM

DESIGN DOCUMENTATION

ENERGY PERFORMANCE

SOLAR ELECTRICITY GENERATION

Solar Generation		
Month	Monthly Average (kWh/m2/day)	Month Generation (kWh)
January	4.19	754.2
February	5	900
March	6.09	1096.2
April	7.08	1274.4
May	7.23	1301.4
June	6.64	1195.2
July	5.15	927
August	4.81	865.8
September	5.42	975.6
October	5	900
November	4.27	768.6
December	3.68	662.4
Annual Average - 5.38 kWh/m2/day		
Total Generation - 11620.8 kWh		

Table 2 : Monthly Generation by Solar

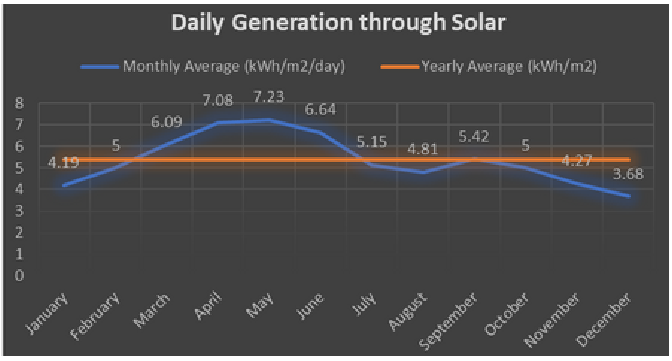


Figure 10: Daily generation through Solar

8 kW Roof-Top Plant

70 sqm Roof-Top Area

11620.8kWh Annual Generation

Source:-
1. https://solarrooftop.gov.in/rooftop_calculator
2. Design and assessment of solar PV plant for girls hostel (GARGI) of MNIT University, Jaipur city: A case study

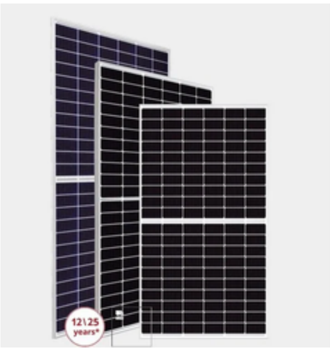


Figure 11: PV Panels

Suggested Solar Cell - N-type Mono TOPCon Bifacial Solar Panels

These PV cells come with a 30-year linear power output guarantee and a 15-year product guarantee. The degradation in the first year is purportedly 1.0%. The 30-year end power output is **guaranteed to be no less than 87.4%** of the nominal output power.

So, even **after 30 years**, the **power generation will be 10,156.6 kW** of annual generation. This still meets the requirements and our building.

Bio-Gas for 4 members

- Gas cooking requirement for 1 person = 0.2 -0.3 m3 => Average = (0.2+0.3)/2 = 0.25 m3
- For 4 persons, Gas required = 4 x 0.25 = 1 m3.
- 1 kg of cow dung produces 0.023 - 0.04 m3 of gas => Average = (0.023 + 0.04)/2 = 0.032 m3 /kg
- Amount of Dung required = 1/0.032 = 31.25 kg
- Gas obtained = 1 m3/day (@0.032 cubic meter gas/ kg dung)
- Electricity generated= 2 kWh (@2 kWh/cubic meter gas)
- **Therefore, Annual Electricity Generated = 2*365 = 730 kW**

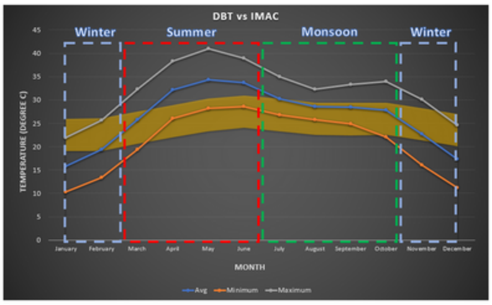
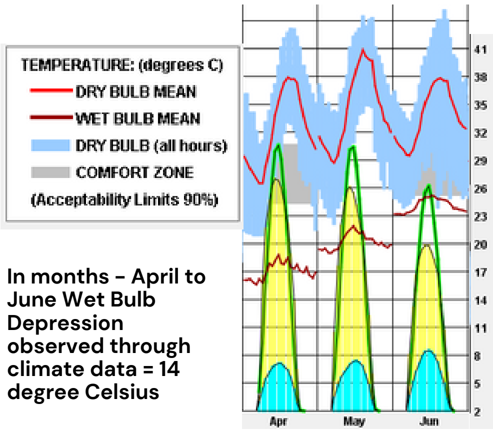


Figure 12: DBT VS IMAC Graph



In months - April to June Wet Bulb Depression observed through climate data = 14 degree Celsius

Figure 13: DBT and WBT data

Month	Outside Temperature			Diurnal Variation	IMAC Range	
	Avg	Minimum	Maximum		Minimum	Maximum
January	15.77	10.25	21.94	**11.69**	19.06	25.98
February	19.35	13.34	25.66	**12.32**	19.06	26.14
March	25.8	19.4	32.34	**12.94**	20.53	27.45
April	32.16	26.01	38.29	**12.28**	21.99	28.91
May	34.39	28.15	41.02	**12.87**	23.33	30.25
June	33.69	28.59	38.9	**10.31**	24.04	30.96
July	30.2	26.84	34.97	**8.13**	23.34	30.26
August	28.63	25.81	32.27	**6.46**	22.46	29.38
September	28.43	24.92	33.25	**8.33**	22.43	29.35
October	27.85	22	34.01	**12.01**	22.48	29.4
November	22.71	16.11	30.05	**13.94**	21.4	28.32
December	17.39	11.18	24.6	**13.42**	20.03	26.95

Table 3: DBT and IMAC data

CFD of Evaporative cooling in Living Room

On simulating the months - April to June, we see evaporative cooling is able to maintain the temperature well within thermal comfort - around 24 degree Celsius.

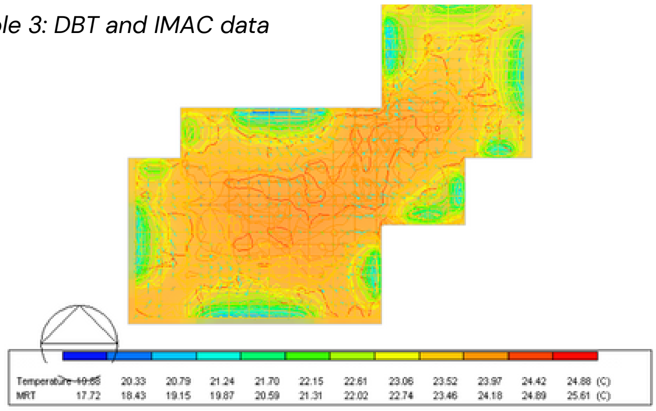


Figure 14: CFD of Living room

	Total Energy	Energy per total building area (kWh/m2)	Energy per conditioned building area (kWh/m2)
Total site energy	7764.14	31.62	110.32
Net site energy	7764.14	31.62	110.32
Total source energy	24589.03	100.13	349.38
Net source energy	24509.03	100.12	349.38

Table 4: Energy

Comfort and Setpoint Not Met Summary

	Facility [Hours]
Time Setpoint Not Met During Occupied Heating	8.17
Time Setpoint Not Met During Occupied Cooling	29.00
Time Not Comfortable Based on Simple ASHRAE 55-2004	7715.67

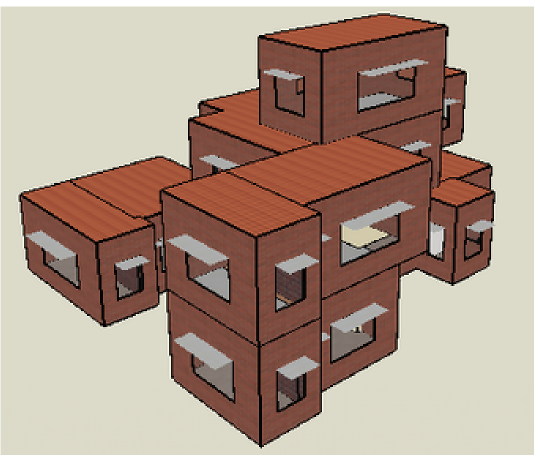


Figure 15: Design Builder Model with Shading

For WWR

Direction	Exposed wall area	Window Area	Ratio
East	106	16.11	15.19%
West	22.75	3.33	14.64%
North	122.5	31.8	25.96%
South	36.855	7.38	20.02%
Average			18.95%

Table 6 : WWR as per direction

ELECTRICAL APPLIANCES

S.No.	Type of Equipment	Brand	Power (Watt)	Quantity Ground Floor	Quantity First Floor	Total Quantity
1	Tubelight LED	Philips	40	6	4	10
2	LED Bulbs	Philips	7	5	2	7
3	LED Bulbs	Philips	10	10	6	16
4	Exhaust Fan	Havells	20	4	3	7
5	Fan	Havells	80	6	4	10
6	AC (5 Star Rating)	Voltas	1060	2	2	4
7	Refrigerator (700 litre)	Samsung	180	1	0	1
8	Cooler (100liter)	Crompton	230	1	1	2
9	Water Pump	Kirloskar	375	1	0	1
10	Microwave	LG	2200	1	0	1
11	Laptop	Dell	80	4	0	4
12	Geyser (5 Star Rating) (3l)	Bajaj	3000	1	0	1
13	Chimney	Glen	150	1	0	1
14	Geyser (5 Star Rating) (15l)	Bajaj	2000	2	2	4
15	Iron	Havells	1200	1	0	1
16	TV	LG	100	2	1	3
17	Juicer - Mixer	Sujata	900	1	0	1
18	Water Purifier	Kent	25	1	0	1
19	Washing Machine	LG	450	1	0	1

Table-7: Equipments

PERFORMANCE SPECIFICATION

Sl No.	Month	Unit	Generation	Consumption
1	January	kWh	815.03	425
2	February	kWh	960.83	450
3	March	kWh	1157.03	800
4	April	kWh	1335.23	880
5	May	kWh	1362.23	940
6	June	kWh	1256.03	960
7	July	kWh	987.83	1208
8	August	kWh	926.63	1312
9	September	kWh	1036.43	1154
10	October	kWh	960.83	810
11	November	kWh	829.43	480
12	December	kWh	723.23	423
	Total	**kWh**	**12350.76**	**9842**

Table-8: Monthly Energy Performance

Monthly

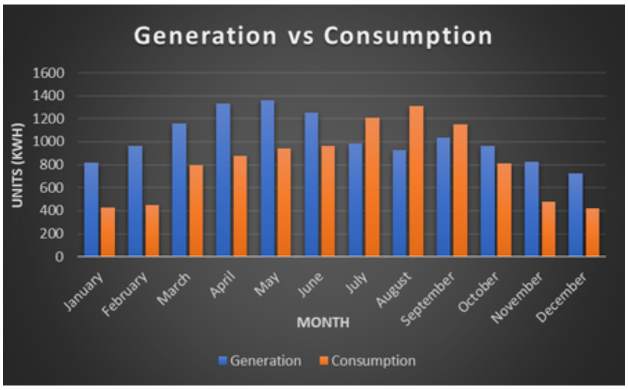


Figure 16: Monthly Generation vs Consumption

Annually

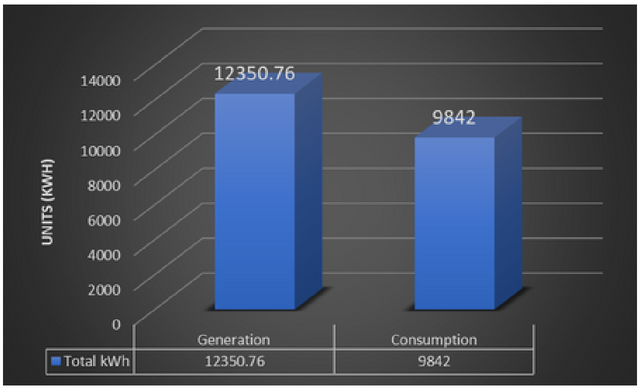
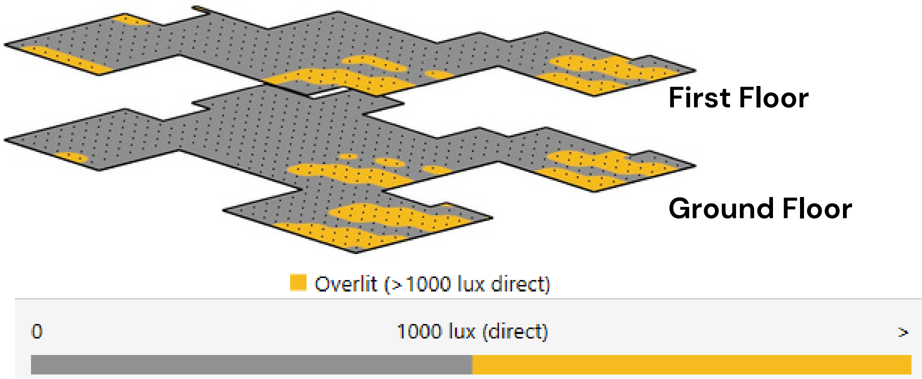


Figure 17: Annual generation vs consumption

DAYLIGHT SIMULATION RESULTS-

In our project we are getting luminance of 110-2200 lux

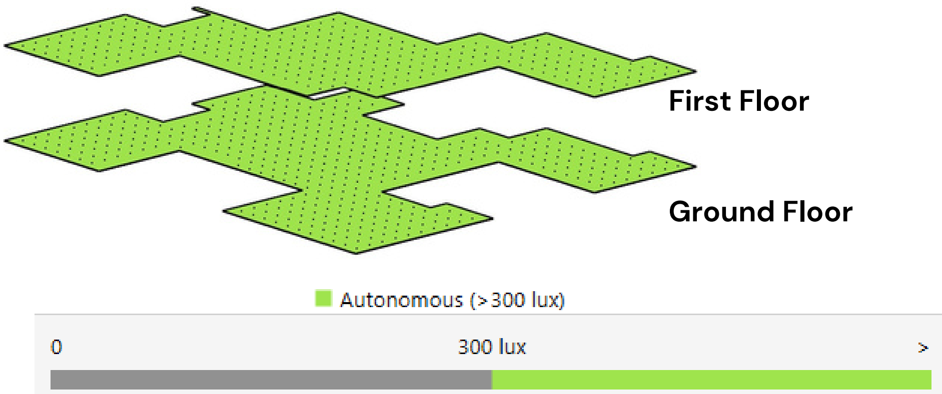
ASE (Annual Sun Exposure, 1000 lux - 250 hrs)



ASE (1000 lux - 250 hrs)

ASE is 10% less

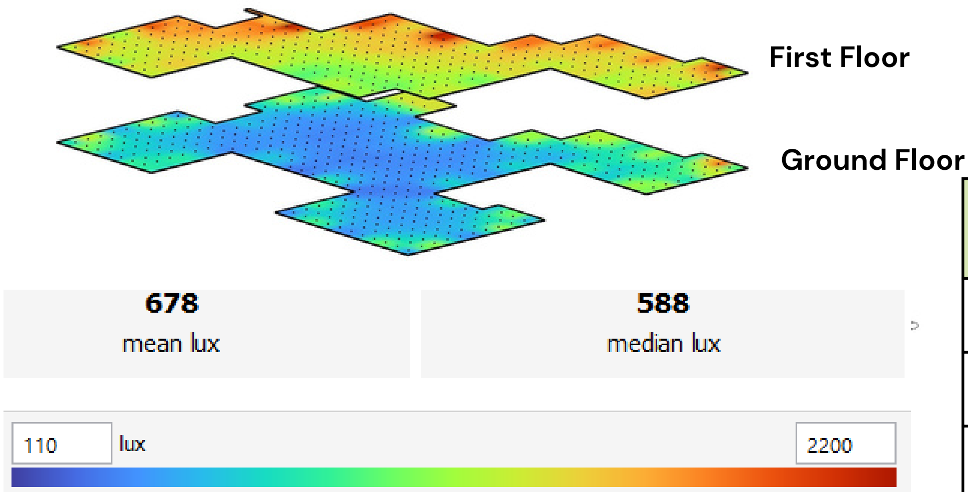
Sda (Spatial daylight autonomy)



SDA (300 LUX-50% HRS)

SDA is 100%

Illumination points in time – Ground Floor and first floor



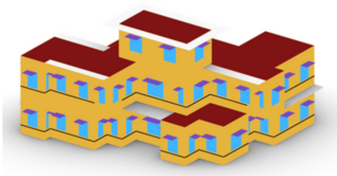


Figure 18: Simulations results

Type of surface	Reflectance
Wall	50%
Ceiling	80%
Floor	20%
Glazing	VT-50%

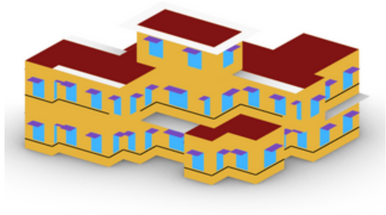
Table 12 : Surface reflectance properties

Optimizing WWR and adopting daylight measures, we see that our building has sufficient daylight annually.

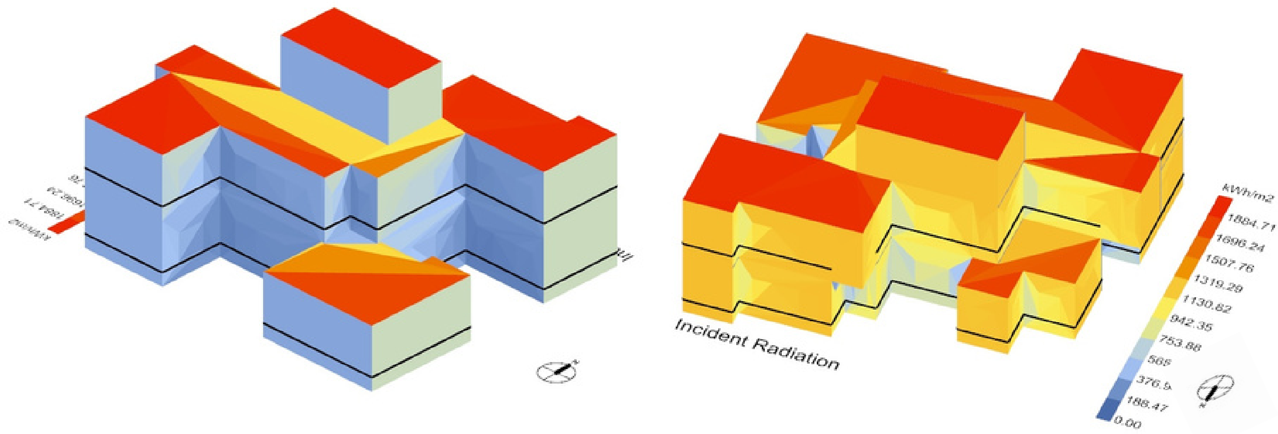
RADIATION SIMULATION RESULTS-

RADIATION ON Windows

Window radiation without shade	88 kw/sq.m
Window radiation with optimized horizontal shading	63kw/sq.m
Window radiation with horizontal and vertical shading	46 kw/sq.m



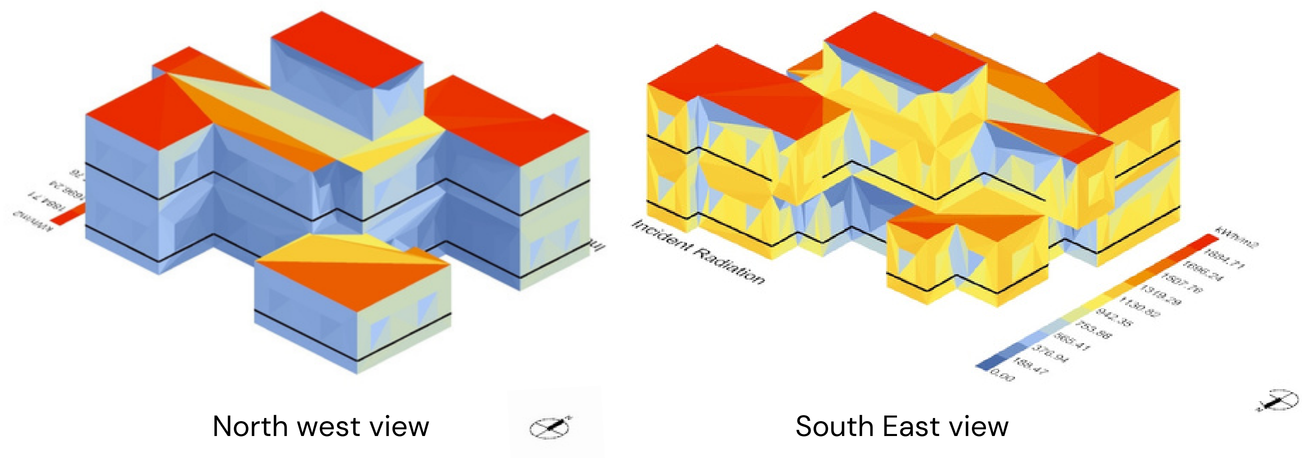
RADIATION ON ENVELOPE WITHOUT SHADING 741 kW/sq. m



North west view

South East view

RADIATION ON ENVELOPE WITH SHADING 643 kW/sq. m



North west view

South East view

Figure 19: Different view Simulation Results

It is evident through simulation that radiation on our building envelop decreased due to shading which in help prevent the solar heat gain.

2.WATER PERFORMANCE

The primary strategy for achieving net-zero water is to maintain the quantity and quality of natural water by using viable substitute water sources.

Water Efficient Showers

An efficient shower head can save up to 19 litres of water per day. Water saving shower head uses up to 50% less water than regular free flow shower head.

Water Saving Tap Aerators

Addition of aerator to an older tap can reduce 6lit per minute. Tap aerator can save as much as half of the daily water usage.
The aerators can be installed in bathrooms taps, kitchens sinks, etc.

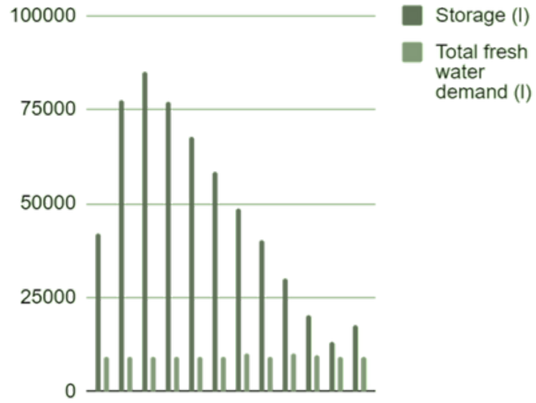


Figure 20: Storage and fresh water demand

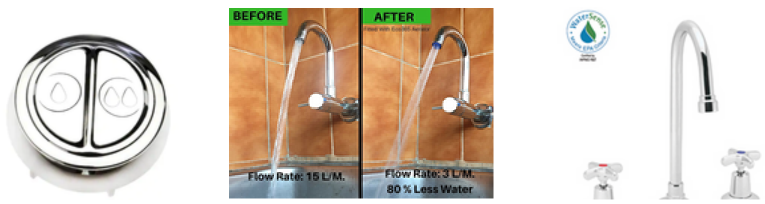


Figure 21 : Water Efficient Plumbing Fixtures

Dual Flush Toilets –
Two stage flush systems use 20 percent less water than conventional one flush toilets. One setting is a normal 1.6-gallon flush for solid waste, and the other is a lighter .8- to 1.1-gallon flush for liquid waste only

Low Flow Plumbing Fixtures and Technology Used in Low Flow Faucets

The reduction is ranges from 50% – 70% than typical flow rates.
Water sensed fixtures – bathroom sinks, faucets and other accessories use 30% less water than standard flow by reducing the flow of water.

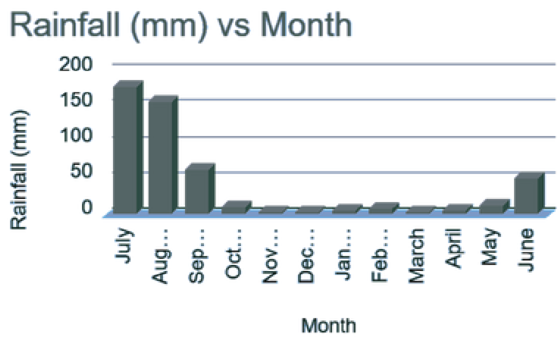


Figure 22: Rainfall graph

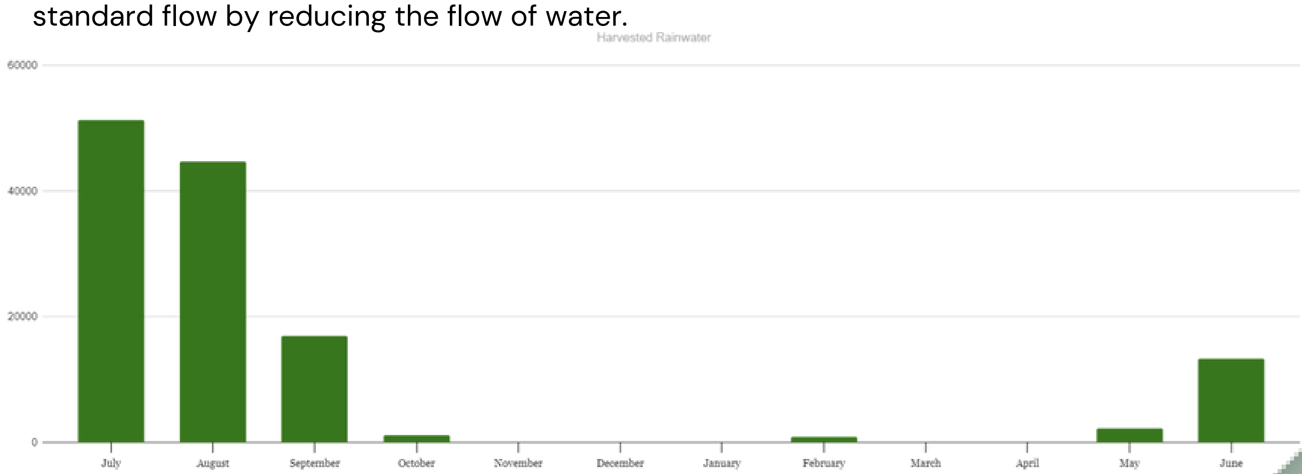


FIGURE 23: GRAPHS SHOWING RAINFALL OVER A YEAR AND RAINWATER HARVESTING OVER A YEAR

WATER HARVESTING TO AREA COVER

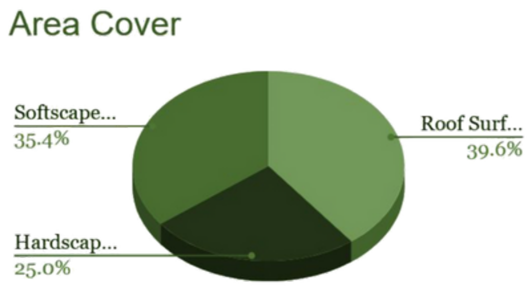


Figure 24: Area Cover

Rainwater harvesting surfaces	Area m2	Runoff coeffecient	Effective catchment area m2
Roof Surfaces	190	0.85	161.5
Hardscape areas	120	0.70	84
Softscape areas	170	0.30	51
Other			0
Total Effective catchment area			296.5

Table-9: SOURCES OF RAINWATER HARVESTING

WATER CONSUMPTION

Water consumption point	Quantity	Liters/day
Occupants	4	75
Irrigation	170	1.3
Cooling tower	0	

Table-9: Water Consumption point

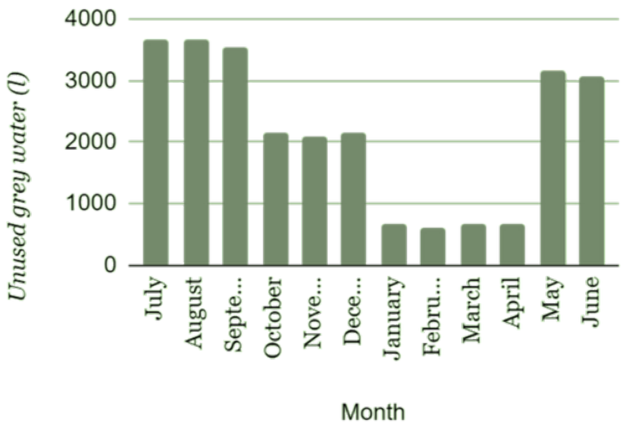


Table-9: Unused Grey Water

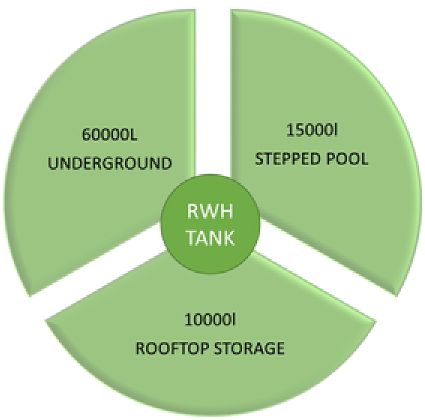


FIGURE 25: RWH Tank

End Use	Percent use	Use in LPD	Greywater in LPD	Blackwater in LPD
Bathing	30%	90	90	-
Washing	20%	60	60	-
Cleaning house	8%	24	24	-
Washing Utensils	16%	48	48	-
Others	2%	6	3	3
Drinking	4%	12	-	12
Cooking	3%	9	-	9
Toilet Flushing	17%	51	-	51
Total	-	300	225	75

Table-10: Grey water and black water usage

WATER USAGE OVER A YEAR

Month	Days in month	Rainfall (mm)	Effective rain (mm)	Harvested water (l)	Primary demand (l)	Grey water generated (l)	Irrigation seasonal factor (%)	Irrigation Water demand (l)	Irrigation fresh water demand (l)	Unused grey water (l)	Total fresh water demand (l)
July	31	178	173	51,294.50	9300	4650	20%	1370.2	0	3279.8	9300
August	31	156	151	44772	9300	4650	20%	1370.2	0	3279.8	9300
September	30	62	57	16901	9000	4500	20%	1326	0	3174	9000
October	31	9	4	1186	9300	4650	50%	3425.5	0	1224.5	9300
November	30	3	0	0	9000	4500	50%	3315	0	1185	9000
December	31	3	0	0	9300	4650	50%	3425.5	0	1224.5	9300
January	31	4	0	0	9300	4650	80%	5480.8	830.8	0	10131
February	28	8	3	890	8475	4237.5	80%	4994.6	757.1	0	9232
March	31	3	0	0	9300	4650	80%	5480.8	830.8	0	10131
April	30	4	0	0	9000	4500	80%	5304	804	0	9804
May	31	13	8	2372	9300	4650	30%	2055.3	0	2594.7	9300
June	30	50	45	13343	9000	4500	30%	1989	0	2511	9000

Table-11 Water Usage over a Year

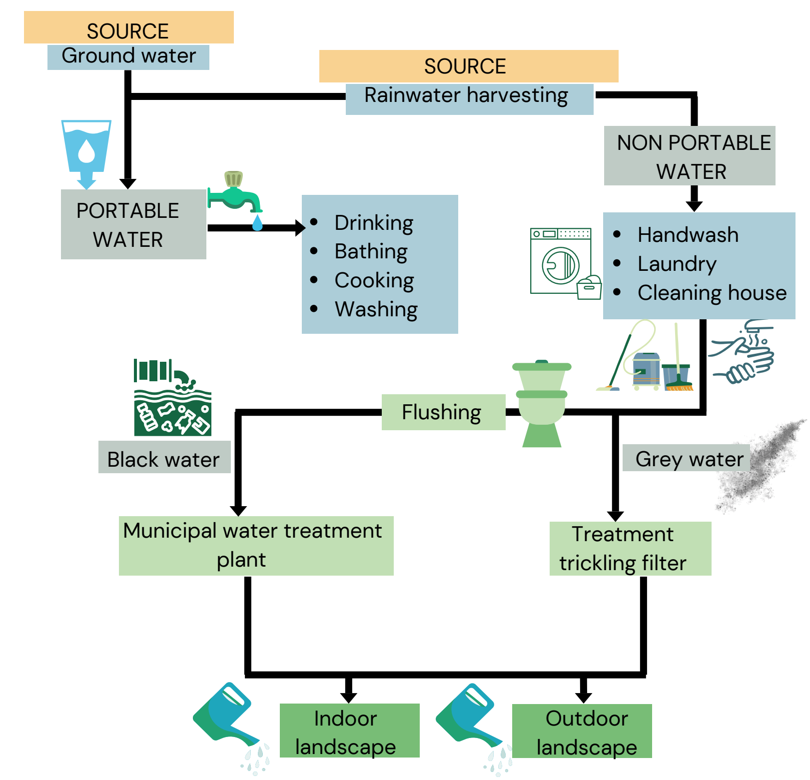


FIGURE 26: WATER CYCLE DIAGRAM

WATER CYCLE SUMMARY

Our Baseline Water Consumption is **75 l/day** with irrigation demand as 1.3 l/day.

We are only using Harvested Rainwater for our complete House water usage. We also have Ground water supply in case of any sudden requirements.

We are using **Drip Irrigation** system for irrigation which reduces **80%** of irrigation demand.

We have also used many water reduction fixtures to reach this demand.

We have used around **36300 l/year** recycled water for irrigation.

WETLAND WASTEWATER MANAGEMENT

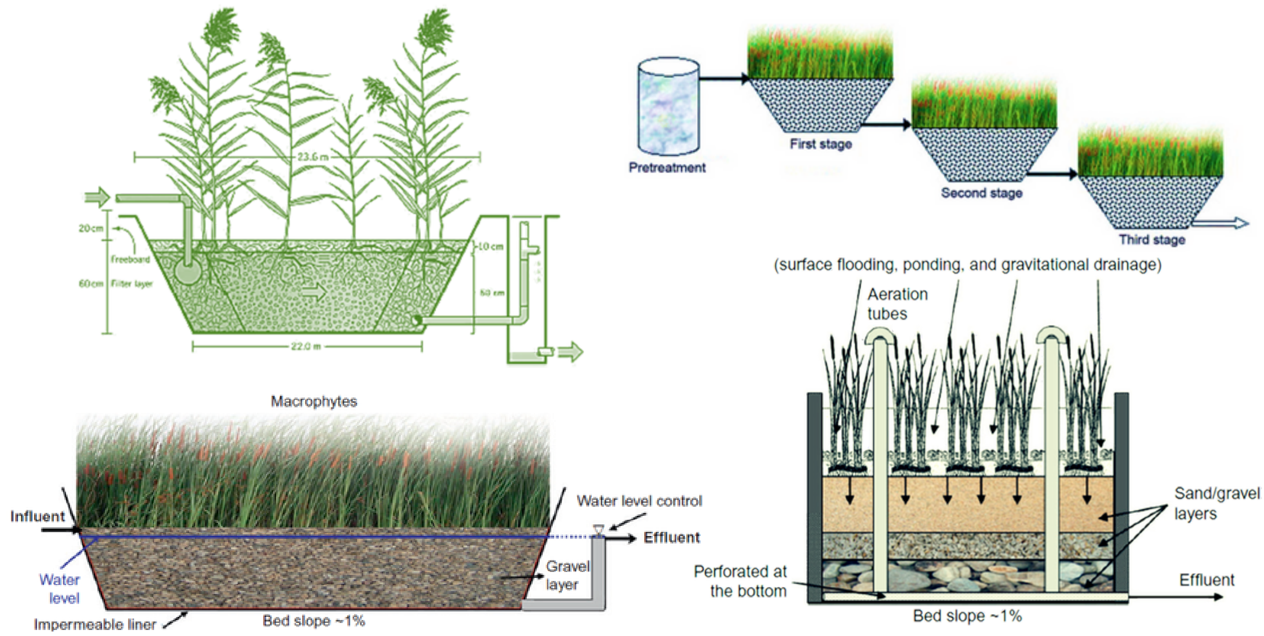


FIGURE 27: BED SLOPES

A constructed wetland is a type of organic wastewater treatment system that mimics and enhances the functions of naturally occurring wetlands in the purification of water. The basic idea is that the combination of substrates, microbes, and plants functions as a filter and purification system. Water can be safely discharged into surface waterways or used for a variety of purposes after being treated in a constructed wetland.

XERISCAPING

FIGURE 28: Xeriscaping

STEPPED POOL

FIGURE 29: Stepped Pool

SOLID WASTE MANAGEMENT

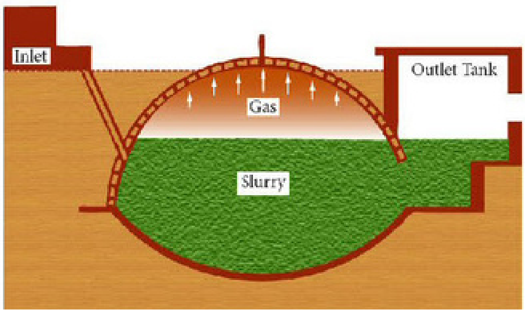


FIGURE 30: Biogas Plant

Solid waste management is crucial for maintaining environmental sustainability. A sustainable approach involves reducing waste generation and promoting recycling and reuse.

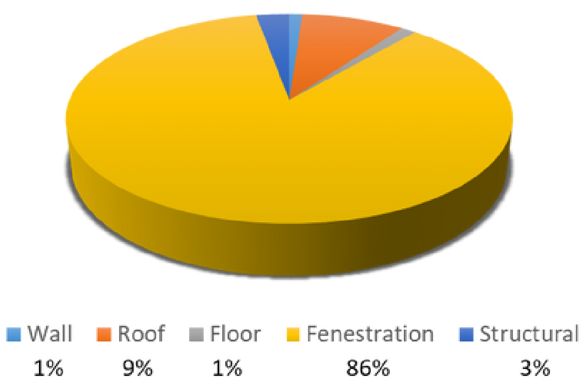
Deenbandhu Biogas plant can be deployed at our site to make best use of solid waste as biomass.

3.CARBON

System Type	Baseline				Proposed			
	Material emissions (kg- CO2 e)	Transport 1 (kg- CO2 e)	Transport 2 (kg- CO2 e)	Total	Material emissions (kg- CO2 e)	Transport 1 (kg- CO2 e)	Transport 2 (kg- CO2 e)	Total
Wall	106	1	3	110	3	1	3	7
Roof	93	1	0.5	60.5	84	1	0.5	54.5
Floor	60	0.5	0.5	23	10	0.5	0.5	8
Fenestration	3510	0.5	1	3511.5	527	0.5	1	528.5
Structural	29	1	1.5	21.5	23	1	1.5	17.5
			Total emmision per functional unit	3808.5			Total emmision per functional unit	657.5

Table-12: Carbon Content

PROPOSED MATERIAL CARBON



PROPOSED MATERIAL VS TRANSPORT MATERIAL

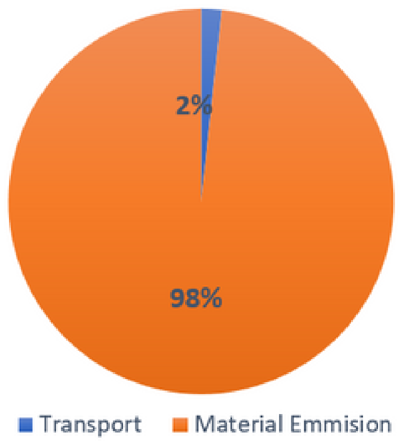
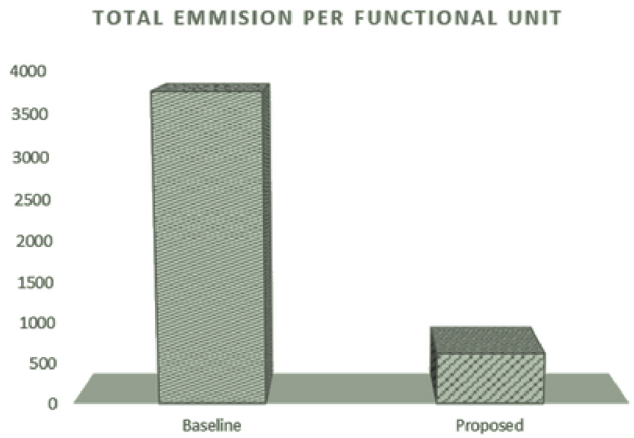


FIGURE 31: Pie Chart of material carbon



- We have used below proposed materials to reduce to reduce the total carbon emmisions per functional unit by 83.6 % from the baseline.

Total emission bar graph

MATERIALS

Proposed Wall Options

Wall construction Details									
Option1 (Proposed)					Option 3				
Material Layer	Thickness, t (mm)	Thermal Conductivity , k (W/mK)	Thermal Resistance, R=t/k (m^2K/W)	Carbon (kg CO2/ kg)	Material Layer	Thickness, t (mm)	Thermal Conductivity , k (W/mK)	Thermal Resistance, R=t/k (m^2K/W)	Carbon (kg CO2/ kg)
SRI Paint	0.6			0.65	SRI Paint	0.6			0.65
Lime Plaster	12			0.75	Lime Plaster	12			0.75
CSEB (PFA stabiliser)	100	0.72	0.14	0.01	AAC	100	0.24	0.42	0.5
Air	60	0.026	2.31	N/A	Air	50	0.026	1.92	N/A
CSEB (PFA stabiliser)	100	0.72	0.14	0.01	CSEB (PFA stabiliser)	100	0.72	0.14	0.01
Lime Plaster	12			0.75	Lime Plaster	12			0.75
SRI Paint	0.6			0.65	SRI Paint	0.6			0.65
Total	285.2		2.59	2.82	Total	275.2		2.48	3.31
Total Thermal Transmittance - U			0.387		Total Thermal Transmittance - U			0.403	
Option 2					Option 4				
Material Layer	Thickness, t (mm)	Thermal Conductivity , k (W/mK)	Thermal Resistance, R=t/k (m^2K/W)	Carbon (kg CO2/ kg)	Material Layer	Thickness, t (mm)	Thermal Conductivity , k (W/mK)	Thermal Resistance, R=t/k (m^2K/W)	Carbon (kg CO2/ kg)
SRI Paint	0.6			0.65	SRI Paint	0.6			0.65
Lime Plaster	12			0.75	Lime Plaster	12			0.75
CSEB (PFA stabiliser)	100	0.72	0.14	0.01	AAC	100	0.24	0.42	0.5
XPS	75	0.033	2.27	2.90	Air	50	0.026	1.92	N/A
CSEB (PFA stabiliser)	100	0.72	0.14	0.01	Porotherm	100	0.6	0.17	0.31
Lime Plaster	12			0.75	Lime Plaster	12			0.75
SRI Paint	0.6			0.65	SRI Paint	0.6			0.65
Total	300.2		2.55	5.72	Total	275.2		2.51	3.61
Total Thermal Transmittance - U			0.392		Total Thermal Transmittance - U			0.399	

Table-13: BUILDING ENVELOPE

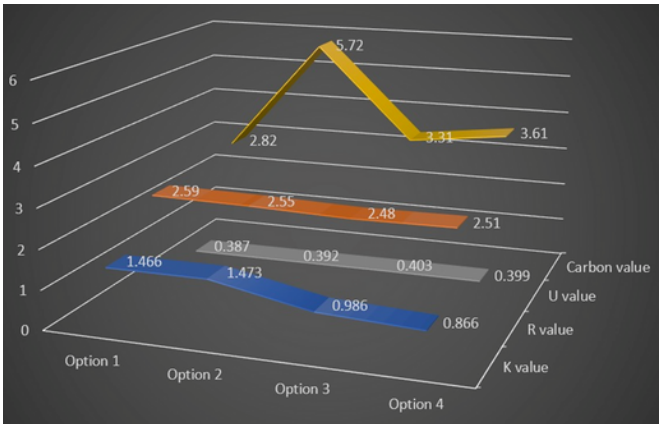


FIGURE 32: BUILDING ENVELOPE

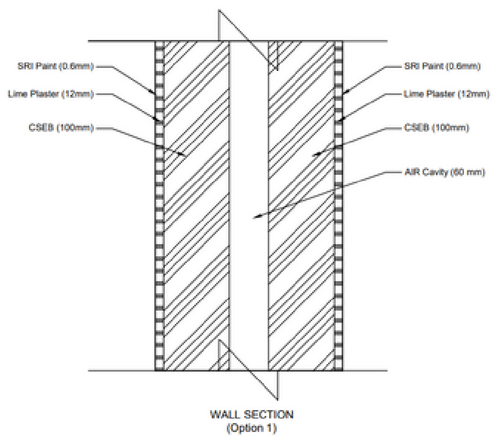


FIGURE 33: Wall Section

MATERIALS

BUILDING ENVELOPE-

WALL- Boundary-

Rammed Earth

We are using rammed earth in our boundary walls. Rammed earth walls are constructed by ramming a mixture of gravel, sand, silt, and a small amount of clay into place between flat panels called formwork. Rammed earth provides excellent thermal mass but limited insulation. Rammed earth is very strong in compression and can be used for multistorey load-bearing construction.

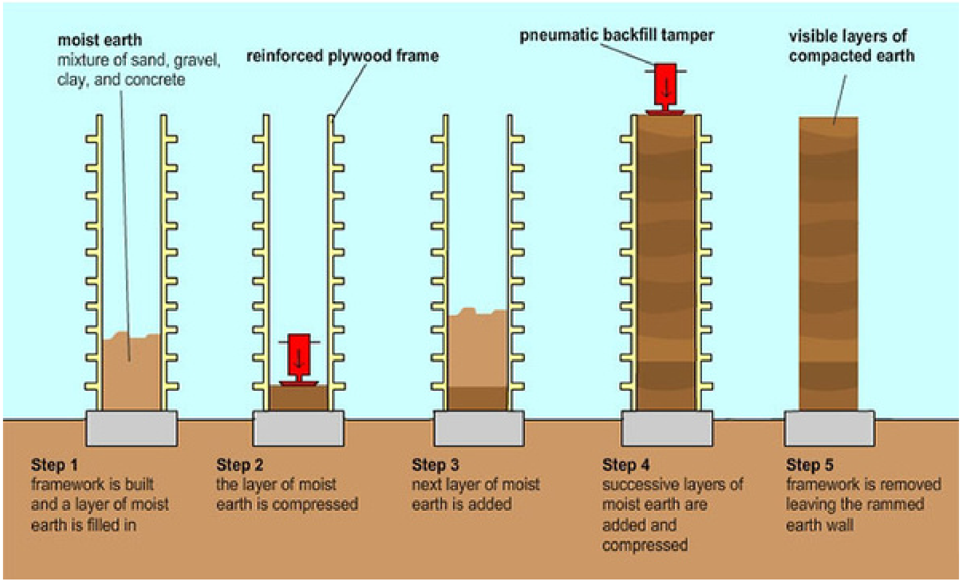


Figure 34: Process of Rammed Earth Wall Formation

Image credit- www.greenspec.co.uk/building-design/rammed-earth/

CSEBs - Compressed stabilized earth blocks (CSEB) are manufactured from local soil mixed/stabilized with a small amount of cement (up to 5%), sand, and water. It is produced from local soil and offers a sustainable alternative to burnt clay bricks/cement concrete blocks. The dry compressive strength of these blocks after 28 days of curing varies from 5 to 9 MPa whereas wet compressive strength varies from 3 to 4 MPa

FLOOR

Floor	Carbon Value (kg CO2/kg)
Natural Stone (Makrana Marble)	0.056
Ceramic Floor Tiles	0.67

Natural Stone - Mother Nature's original sustainable building material is natural stone. Natural stone flooring and countertops will last a long time, are 100 percent recyclable. They do not generate VOCs, and can be washed with a PH-neutral dish detergent.

MATERIALS

ROOF OPTIONS

Roof Details				
Option 1				
Material Layer	Thickness, t (mm)	Thermal Conductivity , k (W/mK)	Thermal Resistance, R=t/k (m^2K/W)	Carbon Energy,(kg)
RCC (100% cement)	125	1.1	0.11	0.11
Total	125		0.11	0.11
Total Thermal Transmittance - U			8.80	
Option 2				
Material Layer	Thickness, t (mm)	Thermal Conductivity , k (W/mK)	Thermal Resistance, R=t/k (m^2K/W)	Carbon Energy,(kg)
Vitrified Glazed Cool Roof Tiles	12	0.1	0.12	0.68
XPS	75	0.033	2.27	2.9
RCC (75% Cement+25% GGBFS)	125	1.10	0.11	0.08
Total	200		2.51	3.66
Total Thermal Transmittance - U			0.40	

Table-14: Roof options

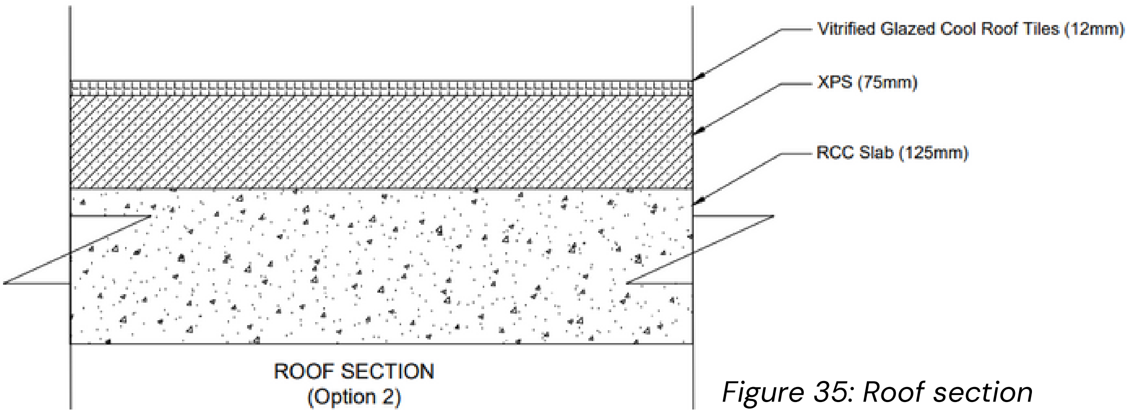


Figure 35: Roof section

FENESTRATION

Fenestration	U-value (W/m2K)	Carbon Value (kg CO2/kg)
U-PVC Double Glazed Windows	1.2	3.9
Aluminium Single Glazed Window	6	26

5.RESILIENCE

Potential and Prevailing Risks at our site-

- Observations show that changes being experienced in the climate of Rajasthan are over and above the natural climate variability prevailing in the region. Rajasthan falls within areas of greatest climate sensitivity, maximum vulnerability, and lowest adaptive capacity.

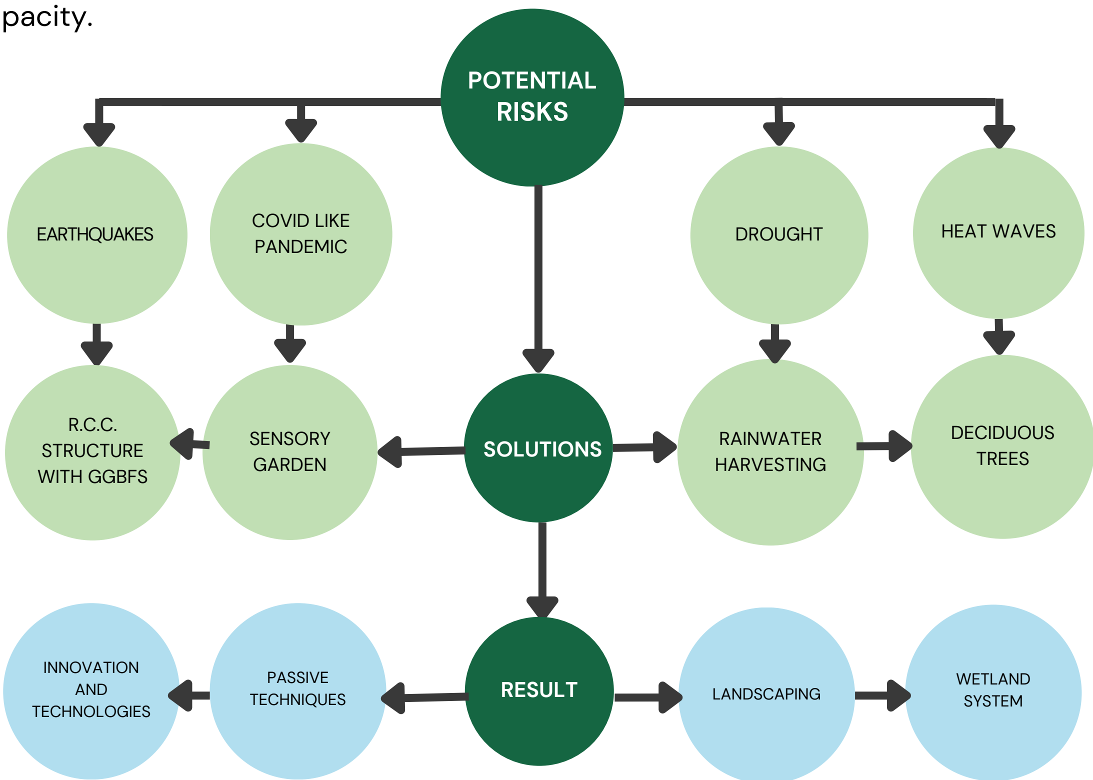
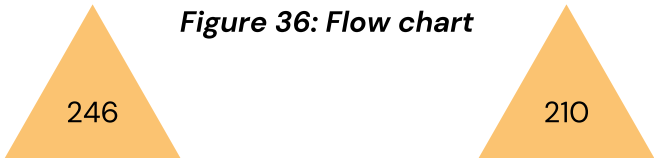


Figure 36: Flow chart



PASSIVE PERFORMANCE OF BUILDING

DAYS OF AUTONOMY FOR WATER

During the time of storms the power grid lines got broken, disrupting the power supply

BATTERY STORAGE

Heat waves prevail at our site during the summer season which induce drought, ultimately causing a very low precipitation and water scarcity for a particular period of time.

STEPPED POOL & ATMOSPHERIC WATER GENERATOR

Water security also threatens food security.
Food production and food supply are severely affected during the times of drought, but as our project is Self-Sustainable, food production at our site is the main goal.

KITCHEN GARDEN

Generation of large amounts of additional waste both hazardous and general.
For waste disposal, separate bins for recyclable and non-recyclable materials is set up.

COMPOSTER

6. ARCHITECTURAL DESIGN

CLIMATE ANALYSIS

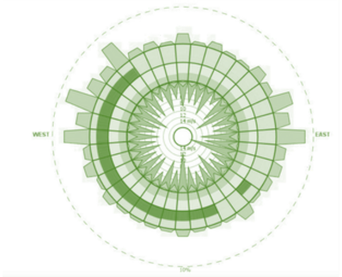


Figure 37: wind rose

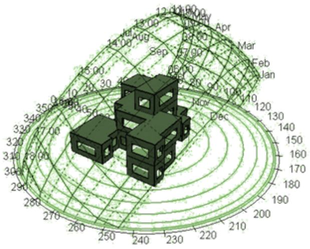


Figure 38: sunpath diagram

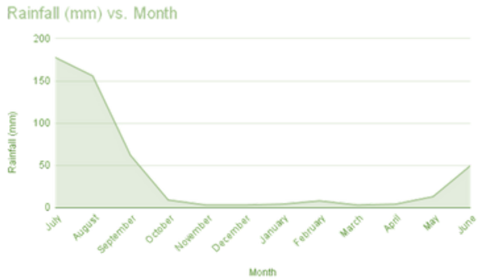


Figure 39: precipitation

Jaipur is situated in a region that is a combination of arid and semi-arid areas. This composite type of region includes the Thar Desert, which is known for its hot and dry climate, and the surrounding semi-arid regions, which experience low rainfall and high temperatures. The topography of the region is marked by sandy plains, sand dunes, and rocky hills.

DESIGNING FOR SUSTAINABILITY

Harnessing the Power of Nature with Strategic .Ventilation and Wind Flow in Building Architecture

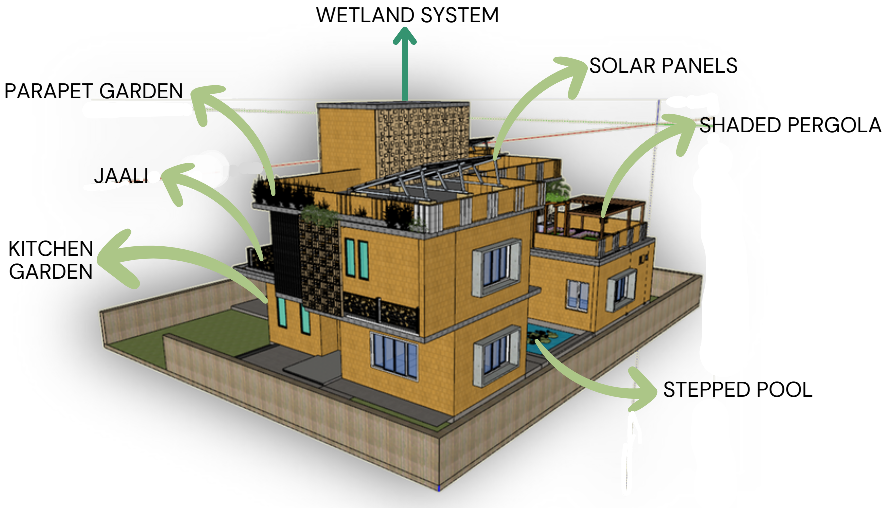
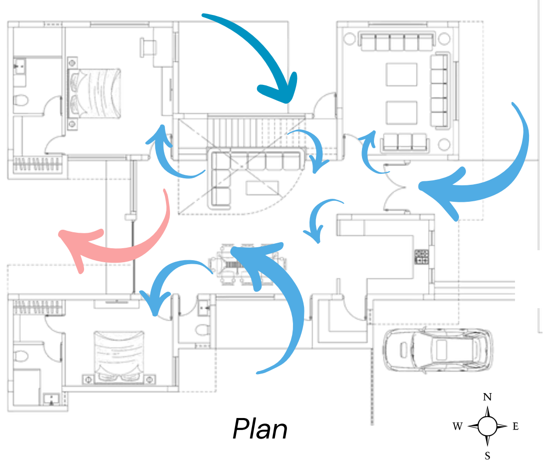


Figure 40: Sustainable House



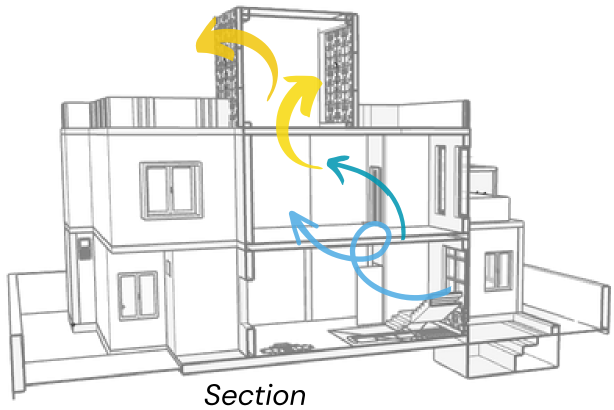
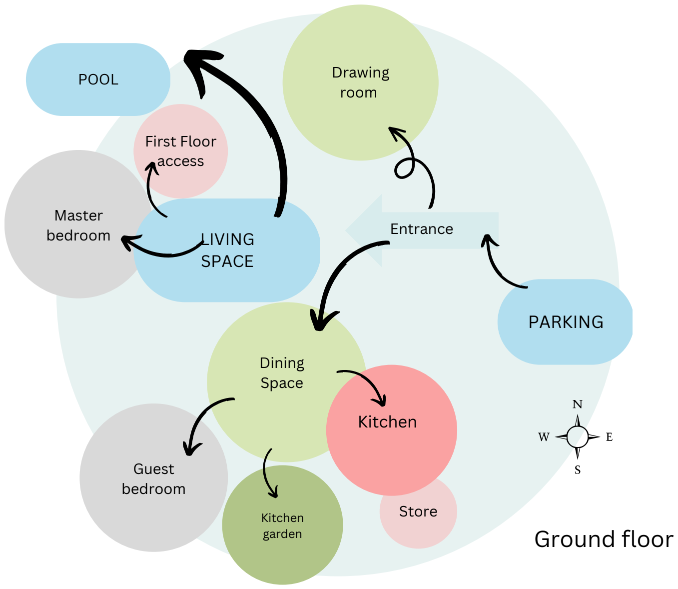
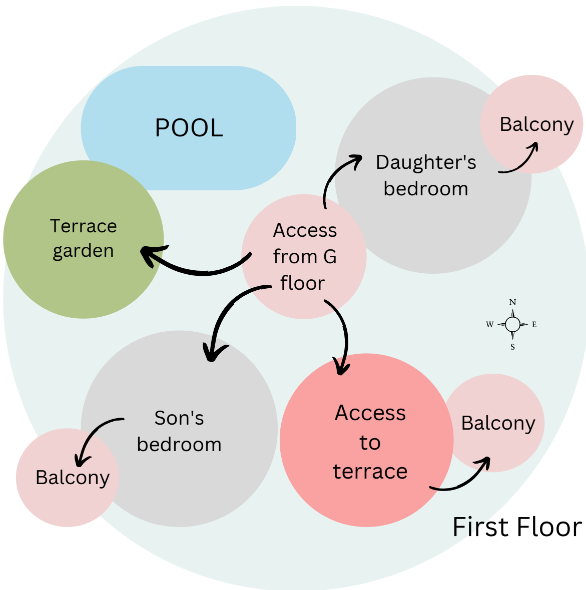


Figure 41: Ventilation

PROXIMITY FLOW CHART

Optimizing land use efficiency through zoning analysis: A proximity chart showcasing the spatial relationships between various functional areas of a home, promoting sustainable design and livability.





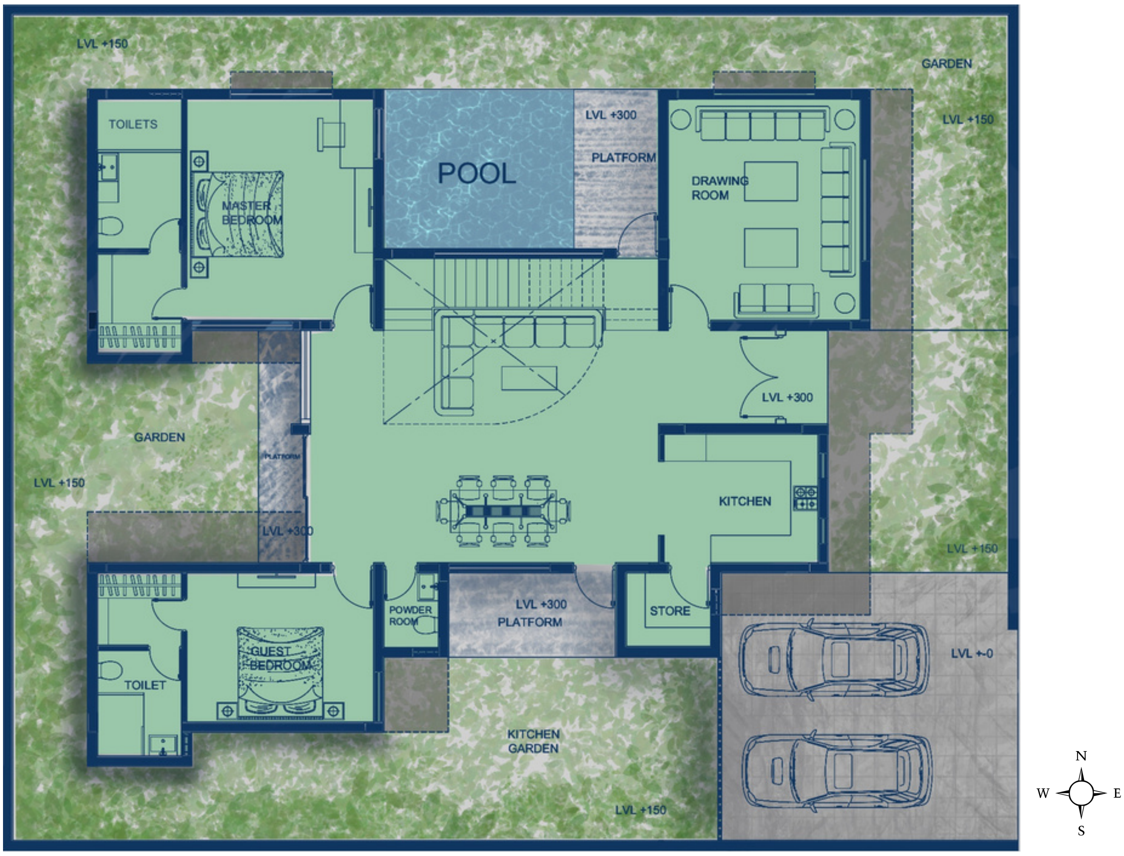
LEGEND-

1. Roof
2. Stepped Pool
3. Terrace garden
4. Solar Panel
5. Parking
6. Wooden Bridge
7. Green Space
8. Entrance Porch
9. Kitchen Garden

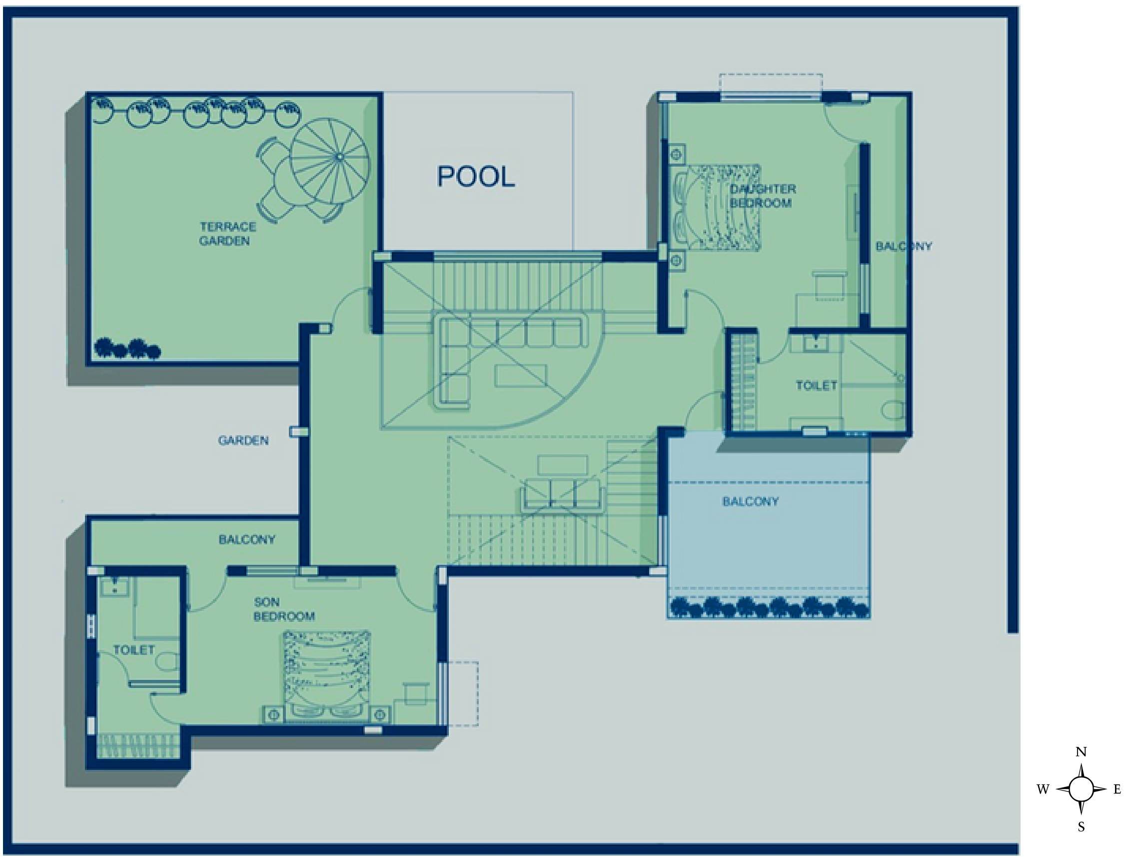
N
W E
S

FIGURE 42: SITE PLAN

PLANS



Ground Floor



First Floor

FIGURE 43: LAYOUT PLANS

ELEVATIONS

EAST ELEVATION

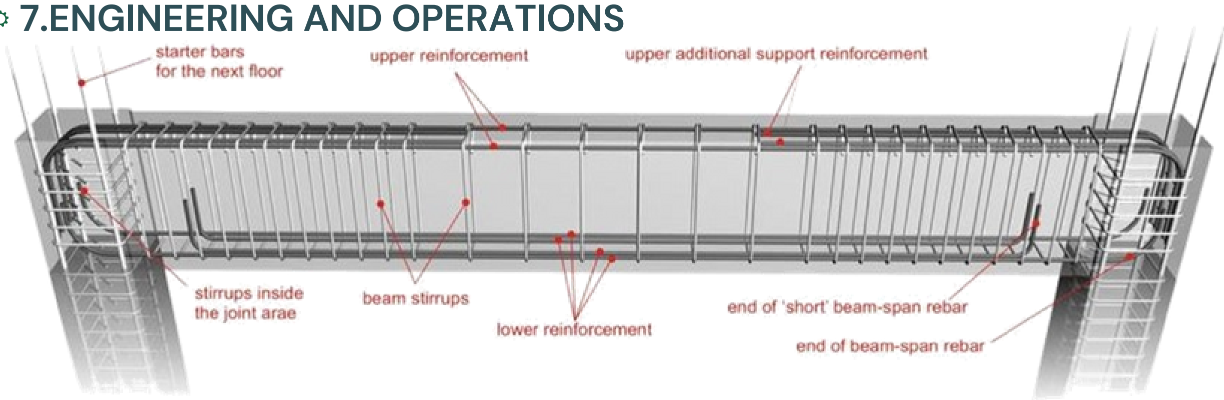
NORTH ELEVATION

3D VIEWS

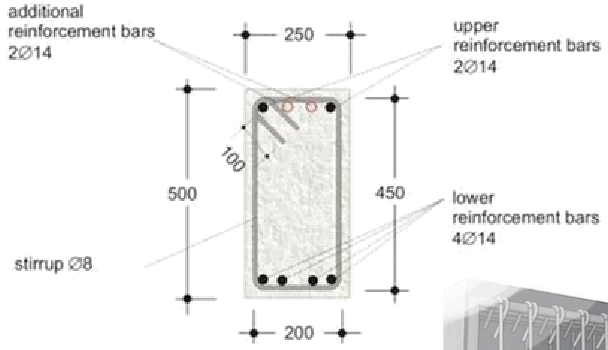
SHADED PERGOLAS ON TERRACE GARDEN

FIG 43: 3D VIEWS

7.ENGINEERING AND OPERATIONS



COLUMN TO COLUMN



COLUMN TO BEAM

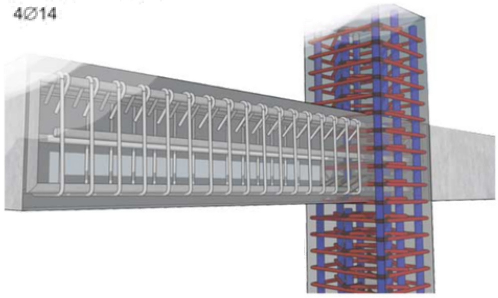
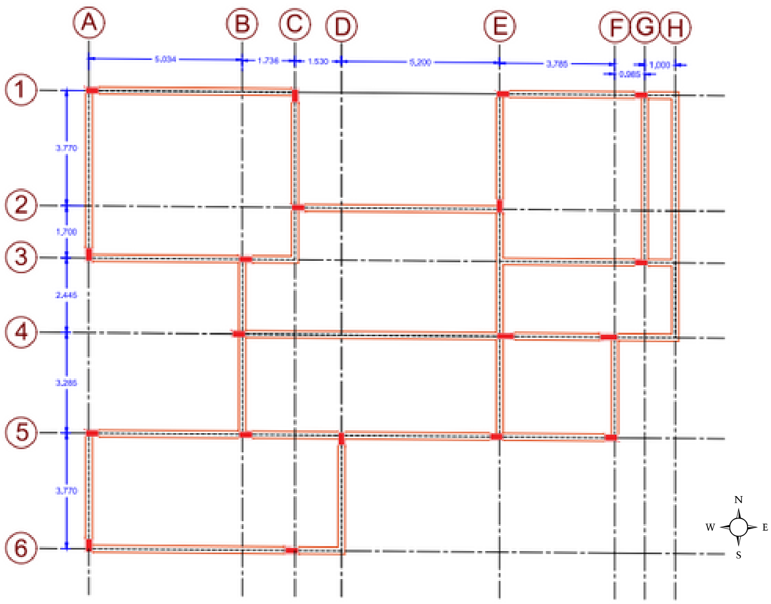


FIGURE 44: RCC DETAILS

PLACEMENT OF COLUMNS



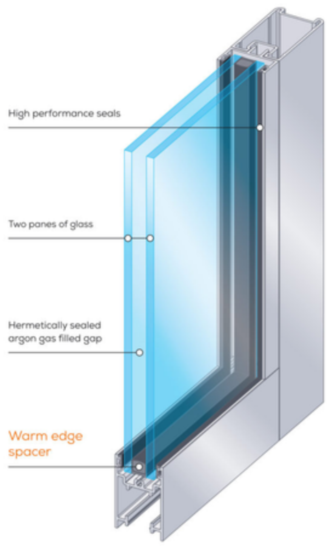
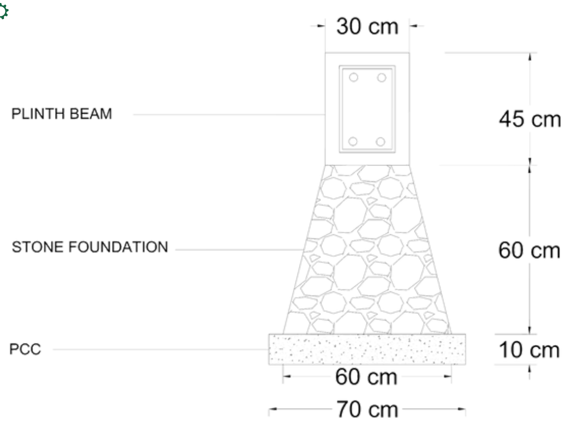


FIGURE 45: GLASS DETAIL



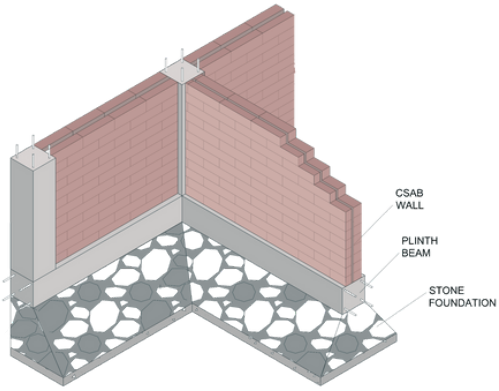
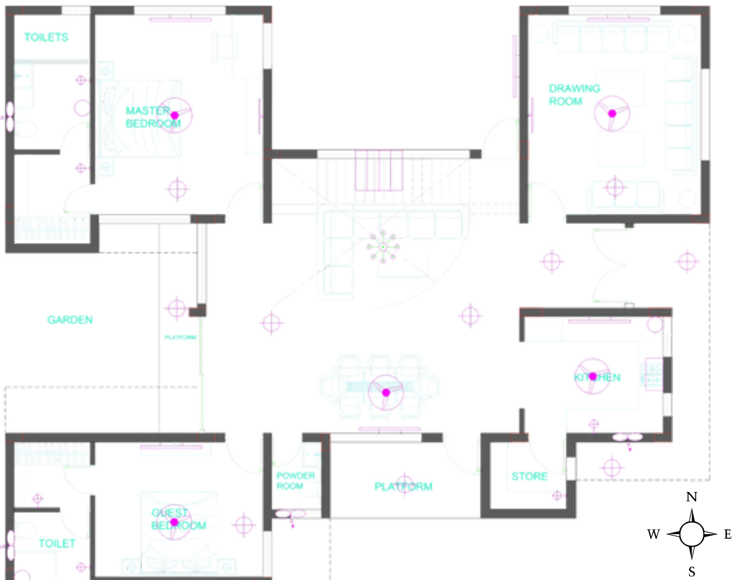
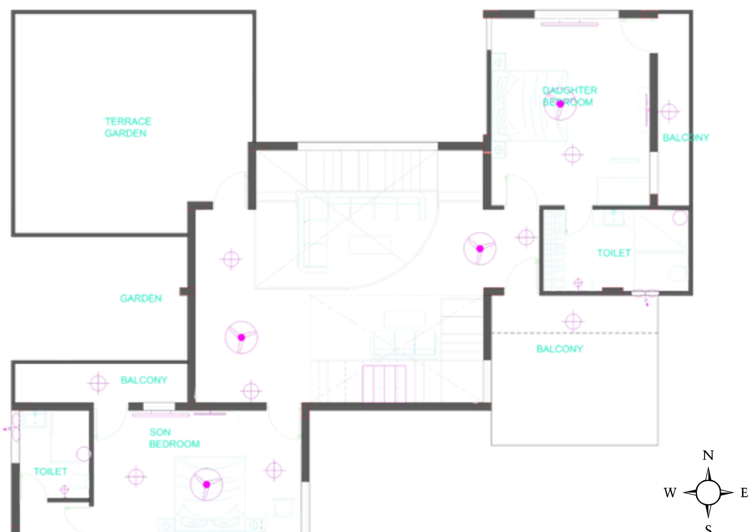


FIGURE 46 : FOUNDATION DETAILS

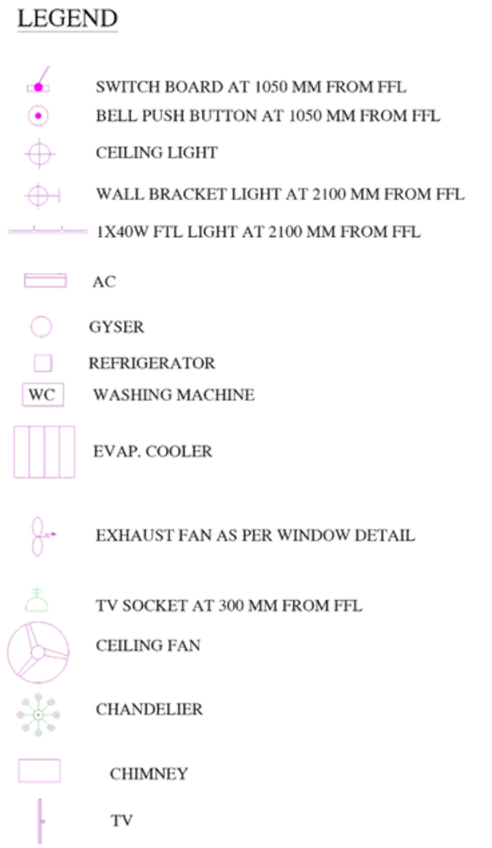
ELECTRICAL LAYOUT



Ground Floor



First Floor



8.VALUE PROPOSITION AND AFFORDABILITY

<table>
<tr><td>Project Information</td><td colspan="4"></td></tr>
<tr><td>Team:</td><td>Sugriha</td><td colspan="3"></td></tr>
<tr><td>Division:</td><td>Single family house</td><td></td><td>Land Cost:</td><td>1cr</td></tr>
<tr><td rowspan="3"></td><td>Site Area (sqm)</td><td>480</td><td>City:</td><td>Jaipur</td></tr>
<tr><td>Built-up Area (BUA) (sqm)</td><td>322</td><td>State:</td><td>Rajasthan</td></tr>
<tr><td>Ground Coverage (Plinth Area) (sqm)</td><td>192</td><td></td><td></td></tr>
<tr><td colspan="4"></td><td></td></tr>
<tr><td rowspan="2">Particulars</td><td colspan="2">Proposed Design Estimate</td><td></td><td></td></tr>
<tr><td>Amount in Lacs INR</td><td colspan="2">%</td><td></td></tr>
<tr><td>Land</td><td>100</td><td colspan="2">46.4</td><td></td></tr>
<tr><td>Civil Works</td><td>52.5</td><td colspan="2">24.4</td><td></td></tr>
<tr><td>Internal Works</td><td>14</td><td colspan="2">6.5</td><td></td></tr>
<tr><td>MEP Services</td><td>20.2</td><td colspan="2">9.4</td><td></td></tr>
<tr><td>EQuipment and Furnishing</td><td>13.4</td><td colspan="2">6.2</td><td></td></tr>
<tr><td>Landscape and Site Development</td><td>5.4</td><td colspan="2">2.5</td><td></td></tr>
<tr><td>Contingency</td><td>5.3</td><td colspan="2">5</td><td></td></tr>
<tr><td>Total Hard Cost</td><td>210.8</td><td colspan="2">100.4</td><td></td></tr>
<tr><td>Pre-Operative Expenses</td><td>10</td><td colspan="2">4.6</td><td></td></tr>
<tr><td>Consultant</td><td>10</td><td colspan="2">4.6</td><td></td></tr>
<tr><td>Interest during construction</td><td>0</td><td colspan="2">0</td><td></td></tr>
<tr><td>Total Soft Cost</td><td>20</td><td colspan="2">9.3</td><td></td></tr>
<tr><td>Total Project Cost</td><td>230.8</td><td colspan="2">107.1</td><td></td></tr>
</table>

Table-15: COSTING

Here 107.1% represents that it is 7% higher than the base project cost

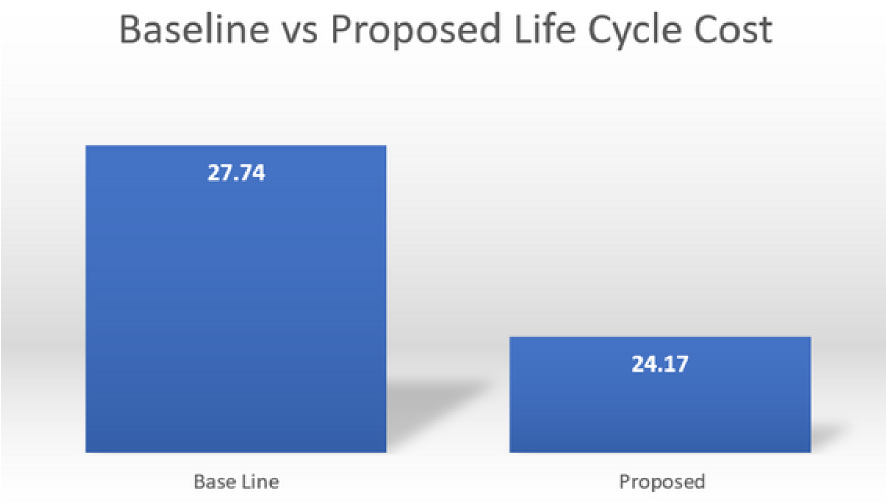


*FIGURE 47:
Baseline Vs Proposed
Life Cycle Cost*

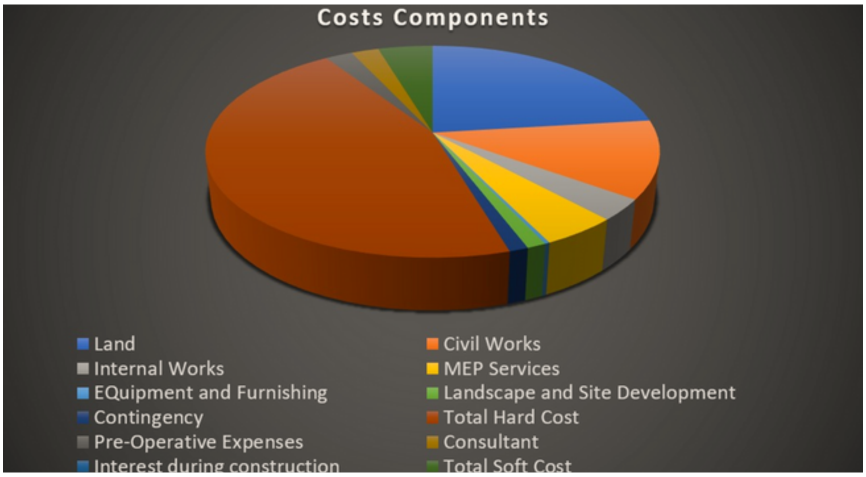


*FIGURE 48 :
Cost Components*

We have used efficient and green materials and equipments so as reduce our Life Cycle Cost by 12.74% which is 33.4 Lakhs

Time (Year)	**Cost Components**	**Baseline**	**Proposed**
0	Cluster Construction	21.54	23.08
5	OPEX + Repair & Maintenance	1.5	0.55
10	OPEX + Repair & Maintenance	4.5	0.55
15	OPEX + Repair & Maintenance	4.5	0.55
20	OPEX + Repair & Maintenance	5.5	0.55
25	OPEX + Repair & Maintenance	3.5	1.55
	Total with 10% Discount	**27.74**	**24.17**

Cost Components

9.INNOVATION

A lot of data is now available to facility managers that were previously inaccessible. These tiny connected sensors can be used in conjunction with automated building systems to make operations more sustainable. For example, IoT sensors can dynamically change appropriate ventilation and lighting levels in buildings based on temperature, weather, and CO2 data. Facility managers do not need to manually track these changes or enter data from another machine. System specifications will be addressed in future design iterations.

Need: Needed a way to cool down the house during extreme summers via increasing insulation

Solution: We used terrace garden to bring closeness to nature, at the same time create cooling effect through insulation. This not only reduced heat but also added aesthetic value to the building.
We also used air cavity walls on exterior for better insulation.

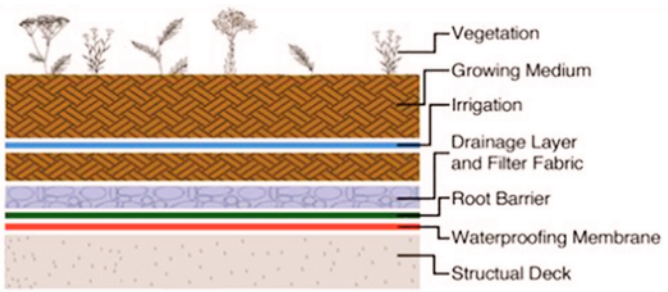


FIGURE 49: GREEN ROOF DETAIL

Need: To prevent the house from excess heat gain during summers through entering light via windows.

Solution: Size of the windows has been optimized in accordance with window to optimum wall area ratio in accordance with site location. Shading is also optimized and external window shades are being provided.

Need: Project partner wanted to built a high tech home.

Solution: We are using smart home systems in our home integrating automated lighting and automated temperature control. These not only looks attractive, but it also increases energy efficiency.

Need: Needed to prevent sunlight from heating walls

Solution: We planted lot of trees along west and south side to prevent heating of structure. This way we not only prevented excess heatiog but also improves aesthetic value of house.

Need: Project partner wants a pool for luxury which will affect water efficiency

Solution: We have incorporated a step type design for the pool which has many benefits:

- a step type design can make the pool look filled with lesser use of water.
- a step type design can also provide a family seating area if the pool isn't full during harsh climate.
- it can also provide easier access for those who cannot use deep pools.

The pool acts as a nearby water source which helps with the micro cooling of the house

The pool can also act as a rain water harvesting tank.

The pool is provided with a retractable shade which automatically retracts and deploys to reduce evaporation due to solar radiation.

With the use of atmospheric water generators we can reduce the amount of evaporated water wasted due to the heat of the weather in Jaipur and also accommodate a full size swimming pool without sacrificing too much on water.

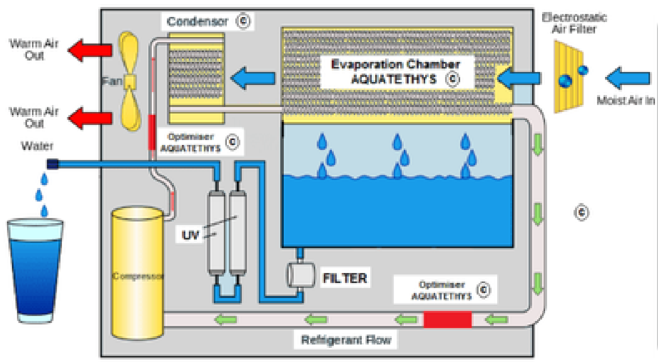


figure 50: atmospheric water generator

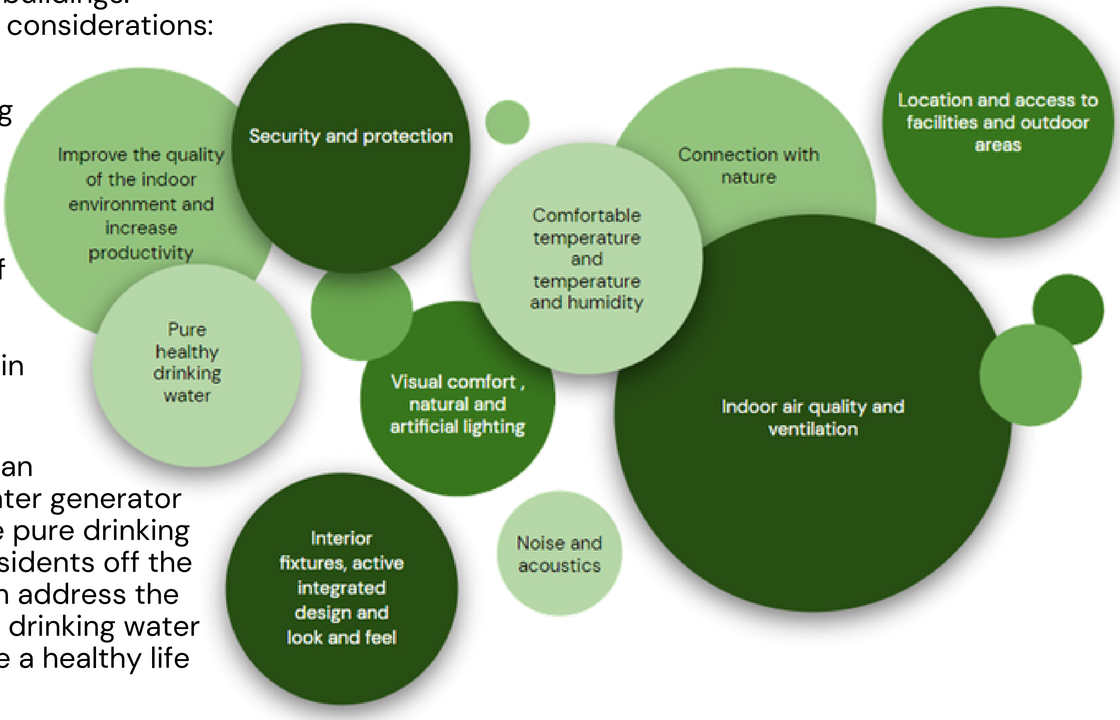
Need: The solar panels may overheat due to harsh climate of locality and have reduced efficiency

Solution: We are adding sprinklers which work when a sensor detects high tempratures on the solar panels. These sprinklers will sprinkle water on the solar panels which in turn cools them down.

10. HEALTH AND WELLBEING

Building design goes beyond individual optimization to truly enhance customer well-being. From parameters like temperature and humidity to a more holistic approach considering those cues
Healthy human behavior.
The following aspects were considered in the design, all of which have been shown to have an impact.
The health and well-being of building residents is important, and so is the design and construction of buildings.
and operational considerations:

As we are having green roof the plants provide cleaner air and also is good for mental health of a person as the colour green induces peace in a persons mind.



With the use of an atmospheric water generator we can produce pure drinking water for the residents off the project. This can address the scarcity of pure drinking water and also provide a healthy life style.

When it comes to **lighting**, lighting is a key factor in health and wellbeing, to address this we have used low VLT glass panels and optimized the window and shading for optimal sunlight. We have also installed light intensity sensors which will increase or decrease the intensity of indoor lighting depending on the sun light and the set required lighting intensity required. **Refer ASE, PIT and SDA daylight simulation on page 19 as its evidence.**

Thermal comfort is another important factor in health and wellbeing. We have used an efficient HVAC system, evaporative cooling, good cross ventilation and a green roof to help maintain comfortable temperature ranges. **Refer CFD simulation of Evaporative cooling system and Unmet hours result (29 hours) through Design Builder on page 16 as its evidence.**

Acoustics is another department we have concentrated on as it is a very important factor in a person's wellbeing. we have used CSEB for construction which blocks out noise for a good acoustic profile. The location also goes hand in hand with sound as the locality is in the outskirts of the city which renders a peaceful environment. As the project partners project is called windchimes, as the name suggests the area is nature focused and will give the residents a peaceful connection to nature through the sounds of birds chirping and wind rustling

Finally **air quality** is essential to a persons wellbeing. The locality again plays a hand in this as it has a pure atmosphere far away from the city. We have incorporated a green roof which also provides fresh air to the residents for better quality. We have also given proper cross ventilation for better air circulation and better air quality.

11. SECURITY

Figure 51: Security devices

With the use of motion senors on the exterior walls coupled with high quality motion activated cctv cameras we can keep the compound as safe as possible.
This sytem will be integrated into the smart home system

This system includes the following features:

- Motion sensors all around the compound.
- Sensor activated cctv cameras
- Door bell with camera and ability to leave messages
- The whole system will be connected to the smart home system to help contact the owner and notify about any suspicious activity, can also connect and send a call to emergency services
- The security system can also alert emergency services if there is any outbreak of fire.
- The system will include a door bell with biometric recognition to avoid any sort of burglary or suspicios activity

Figure 52: Security

Image Credit: https://www.shutterstock.com/search/home-security

APPENDIX

PERFORMANCE SPECIFICATION

Input Parameters	Units	Proposed Design Values
GENERAL		
Building area	m²	322
Conditioned area	m²	77
Electricity rate	INR/kWh	8
Building occupancy hours	-	24*7
Average occupant density	m² / person	81
INTERNAL LOADS		
Interior Average Lighting Power Density	W/m²	1.9
Average Equipment Power Density	W/m²	57.28
ENVELOPE		
Roof Assembly U value	W/m². K	0.39
Roof Assembly SRI	-	0.85
Average Wall Assembly U value	W/m². K	0.387
Window to wall area ratio (WWR)	%	20
Windows U value	W/m².K	2.68
Windows SHGC	-	0.52
Windows VLT	-	0.70
HVAC SYSTEM		
HVAC system type and description	-	Split Air Conditioner
Describe mixed mode strategy in operation / controls of AC and windows	-	Evaporative Cooling in months - April to June. Also, using cool wind at night during April for night purging. Because of latent loads during July to October, AC will be used as evaporative cooling is not effective during these months.
Cooling source		Electric
Cooling capacity	kW	1.6
Cooling COP		3.3
Operation hours		5 Hours
Cooling set point	°C	26
Relative humidity setpoint		55
OUTPUT PARAMETERS		
Proposed EUI		Proposed design values
EUI Breakdown by end use	kWh/m²/ yr	
Cooling	kWh/m²/ yr	10
Lighting	kWh/m²/ yr	8
Equipment	kWh/m²/ yr	11

APPENDIX

Total envelope heat gain (peak)	W/m²	
Cooling Load of Conditioned Area	SF/Tr	12.83
Building Electric (Peak)	W/m²	
Annual Operating Energy Cost	INR/m²	232
Cooling Capacity	Tr	1.5 x 4 units
Annual Hours of Comfort without Air Conditioning		5921 hrs (67.6%)

Table 16: Performance Specification

Plan Matrix
219, Gowra Tulips, Hi-Tech city,
Madhapur, Hyderabad-500081.
planmatrixindia@gmail.com
Hyderabad | Jaipur

Discover the world of designs beyond basics

Date: 23-11-2022

To,

The **Director**,
Solar Decathlon India

Dear Sir,

This is to inform you that our organization, Plan Matrix, is collaborating with the participating team SuGriha led by MNIT (Malviya National Institute of Technology, Jaipur) on Residential Building project for their Solar Decathlon India 2022-23 competition entry.

The nature of our collaboration will be the technical visualization of the project on our domain at AEC industry.
As a technical project partner to this team for Solar Decathlon India 2022-2023 competition, we will be providing our expertise in virtual reality by incorporating our product data into the final product. With our technology we will be bringing concept to life by immersing data to VR.

We intend to have a representative from our organization attend the Design Challenge Finals event in April/May, if this team is selected for the Finals.

We would like our organization's logo to be displayed on the Solar Decathlon India website, recognizing us as one of the Industry Partners for the 2022-23 competition.

With warm regards,

V. Sai Sudheer
Co-Founder
Plan Matrix
Email: planmatrixindia@gmail.com
Phone: +91 7891666600

GST No. : 08AACCM4491N1ZY
CIN : U70101RJ1996PTC011675
PAN : AACCM4491N

MAHIMA REAL ESTATE PVT. LTD.

Regd. Office : 4th Floor, Crystal Palm, 22 Godam Circle, Sardar Patel Marg, Jaipur - 302001,
Tel. : 0141-4050607
E-mail : info@mahimagroup.org | Website : www.mahimagroup.com

Date:
07-10-2022

To,
The Director,
Solar Decathlon India.

Dear Sir,

This is to inform you that our organization MAHIMA REAL ESTATE PVT. LTD. has provided information about our MAHIMA'S WINDCHIMES project to the participating team led by MNIT Jaipur, so that their team SuGriha may use this information for their Solar Decathlon India 2022-23 Challenge entry.

As a Project Partner to this team for the Solar Decathlon India 2022-23 competition, we are interested in seeing the Net-Zero-Energy, Net-Zero-Water, resilient and affordable solution this student team proposes and the innovation that results from this. We intend to have a representative from our organization attend the Design Challenge Finals event in April, if this team is selected for the finals.

We would like our organization's logo to be displayed on the Solar Decathlon India website, recognizing us as one of the Project Partners for the 2022-23 Challenge.

With warm regards,

Mr. Dhirendra Madan
Chairman and Managing Director,
MAHIMA GROUP
Email: md@mahimagroup.org
Phone: 9829019191