Final Design Report – April 2023

Team Synergy - Multifamily Housing

SIR J.J. COLLEGE OF ARCHITECTURE, MUMBAI

mahindra LIFESPACES

Solar Decathlon India™

SDI | SIRJJCOA | SYNERGY

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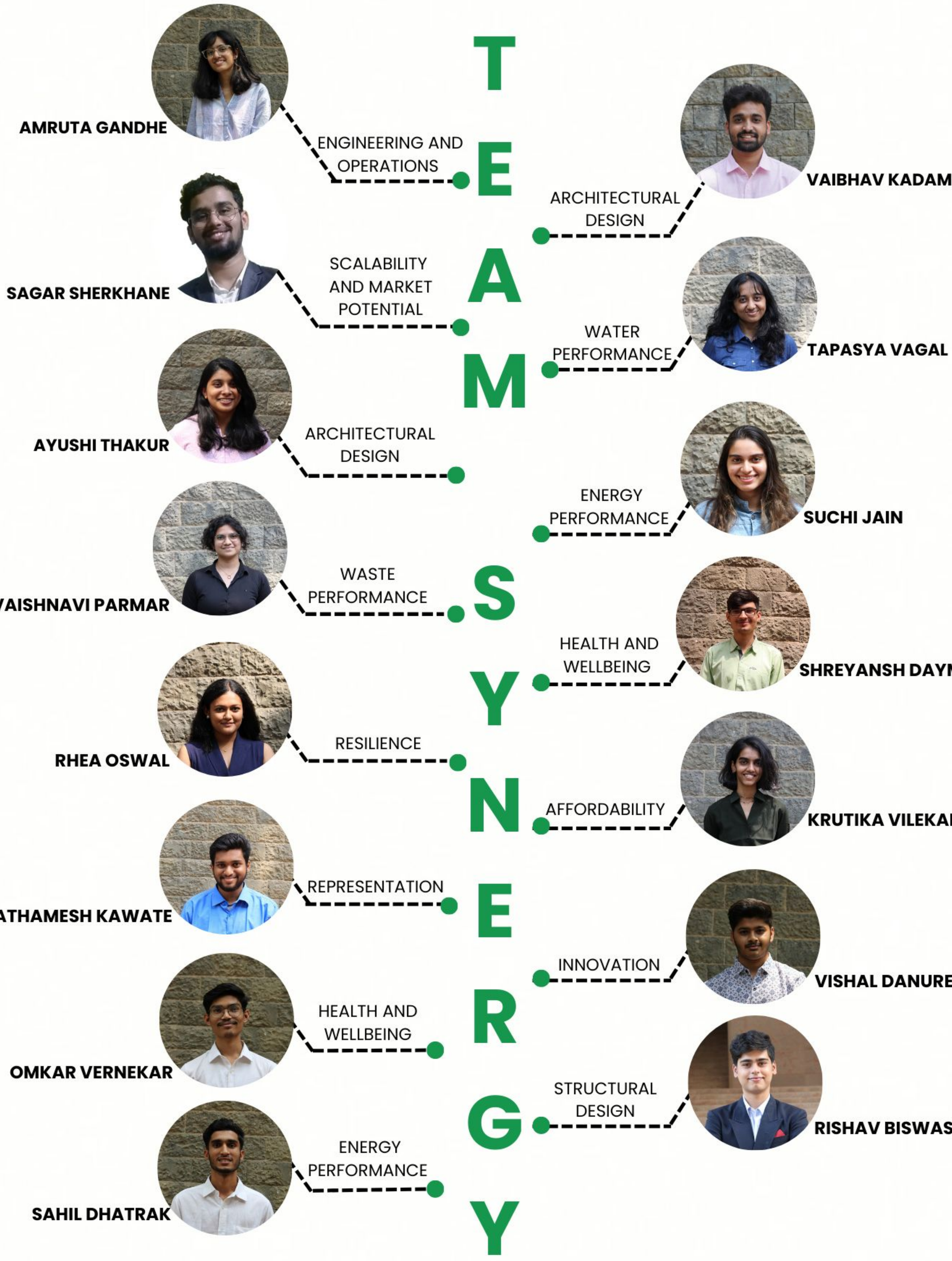
Response to reviewers comments

Section	Reviewer's Comment	Our Response
Energy Performance	• Reviewer 1 - Details about energy simulation for baseline EPI calculation, and also the schedules that your team has considered for the building, will help put across your thoughts more clearly. • Reviewer 2 - The data collected is good. the data needs narratives for better understanding	• We have included step-by-step procedure and calculations of the EPI numbers obtained in our design.
Water Performance	• Reviewer 1 - For the next stage, try to accommodate these services in your site, with realistic area depiction, along with rainwater storage tanks. • Reviewer 2 -Worked out well	• We have demarcated the location and specifications of the water tanks. • We have relooked at our goal for EPI by referring to ECBC norms. • We have mentioned ways for on-site renewable energy generation
Embodied Carbon	• Reviewer 1 - Elaborate on materials/ strategies to reduce embodied carbon in the rest of the building systems, as well. • Reviewer 2 - Worked out well	Addressed
Resilience	• Reviewer 1 - Your team has listed earthquakes and waterlogging as potential risks for your project, and tried to address them with design solutions. Also identifying solid waste management and mobility as PCMS's chronic stresses, and proposing design solutions in the form of waste management systems/ electric bikes, is commendable and shows the depth of your study. • Reviewer 2 - Worked out well	• We have added further by addressing security, micromobility and waste • We have also kept in mind the earthquake risks for our site
Engineering and Operations	• Reviewer 1 - Space provision and architectural integration of all the other systems, like HVAC, water, electrical and SWM is also expected at this stage. Going further, demonstrate the right-sizing of these systems with drawings and narrative. • Reviewer 2 - Worked out well	• We have included space allocation diagrams for all services along with the specifications of the products used in the design
Architectural Design	• Reviewer 1 - You have done good development of the architectural concept, and demonstrated how the decisions have been made. Concept development, initial form and massing analysis, floor plans, site plans and 3d drawings are comprehensive. • Reviewer 2 - Quite clear	• We have thought a step further about our approach to the design. Intergration of the needs of the future dwellers is focused. • We have included detailed plans and model of the structure.
Affordability	• Reviewer 1 - The strategies for cost reduction need to be elaborated. • Reviewer 2 - Give the understanding and workability of the materials and construction techniques used	Addressed

Response to reviewers comments

Section	Reviewer's Comment	Our Response
Innovation	• Reviewer 1 - You may want to put your efforts in identifying a problem from the design and infrastructure area, and then present an innovative solution for that. You could also explore the Piezoelectricity or biomass energy generation, for feasibility in your project. • Reviewer 2 -Good thinking of using a mobile app. Worked out well	• We have partnered with CoolAnt Studios to come up with a Terracota aerofoil panel for the facade system that will cool the air passing through it and reduce the indoor temperature.
Health & Well-being	• Reviewer 1 - Building-level strategies to provide thermal comfort and good indoor environmental quality are not elaborated. Annual simulations demonstrating thermal comfort are expected at this stage. • Reviewer 2 - Worked out well	• We have elborated on the health and well-being aspect of the design through our integrated solution for architectural design and innovation.
Value Proposition	• Reviewer 1 - Elaborate how the project partner will benefit from the net-zero energy-and-water project that you have proposed. A compelling narrative for the project partner is expected at this stage.	Addressed
Engineering and Operations	• Reviewer 1 - Space provision and architectural integration of all the other systems, like HVAC, water, electrical and SWM is also expected at this stage. Going further, demonstrate the right-sizing of these systems with drawings and narrative.	• We have included space allocation diagrams for all services along with the specifications of the products used in the design
Additional comments	• Reviewer 1 - Pay more attention to formatting and correct syntax. Ensure legibility of all drawings/charts and particularly text therein. • Reviewer 2 - Please make sure that the data that you use for study is not just copy-pasted	• We have tried formatted the document to make it more readable and understandable. • We have included list of tables and figures

Team Introduction



Team Introduction

ABOUT THE TEAM:

We intend to explore the concept of net zero energy with a futuristic outlook. Looking for practical solutions and bringing new ideas to the table to make a difference. The team has been brought together by the common desire to design energy-efficient structures based on the different skills of the students from not just Architecture backgrounds but as well as from different engineering backgrounds as mentioned in the team list adopting a multidisciplinary approach. Our team aims to win as it is not only driven by students who are passionate but also keen on creating a sustainable environment.

BACKGROUND OF LEAD INSTITUTION:

Sir J.J. College of Architecture is a 109-year-old institution and Asia's first school to teach architecture, with a heritage campus in the heart of Mumbai. The institution has imparted in us, the thirst to find solutions that will make an impact in the longer run on as to how we can contribute back to the earth by taking up a challenge that is as complicated as the design and construction industry

FACULTY LEAD AND ADVISORS:

Dr. Rekha Nair
Ph.D. (Arch.), Masters (Urban Planning)
Assistant Professor
15+yrs teaching in various disciplines.

- Expert in Climate change Vulnerability studies, Town Planning, and Architectural Design.
- Member of Board of Studies, University of Mumbai
- Reviewer of Elsevier and Springer Journals
- Researcher in sustainable architecture and urbanism, climate change impact, and adaptation studies in urban/ rural contexts with a focus on infrastructure, Exploring Culture and Architecture.

INDUSTRY PARTNERS :

Ant Studio

Green Jams

Eco STP

Pro Earth

Ambiator

G2V Solar

Executive Summary

REIMAGINING THE FUTURE OF LIVING

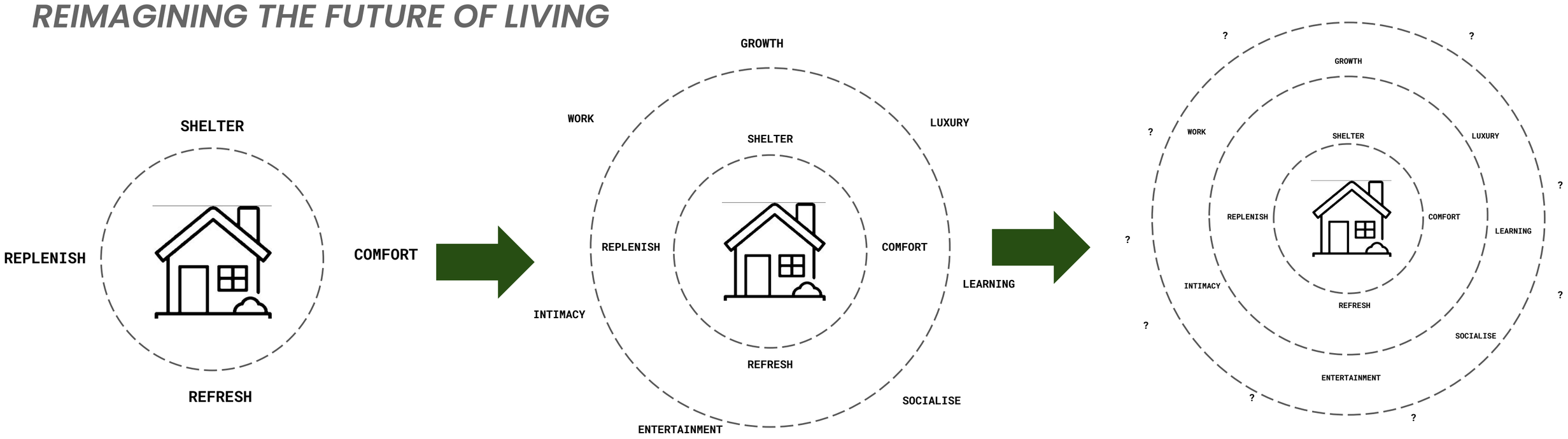


Figure 1: Evolutionary adaption of the roles of a house

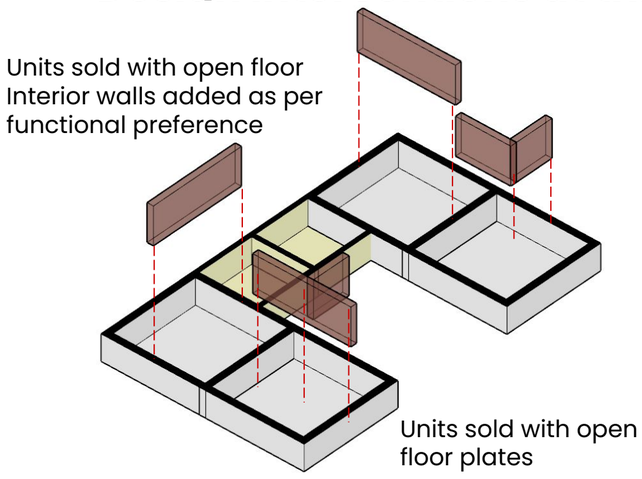
What we aim for -

A house serves many roles in our lives. Over the ages, through technological advancements, these roles have expanded further. While the current housing schemes cater to the primitive roles, how can we reimagine these roles in the future. However, we cannot predict what the future holds and that brings about uncertainty in the definition. And so the key factors we should keep in mind should be-

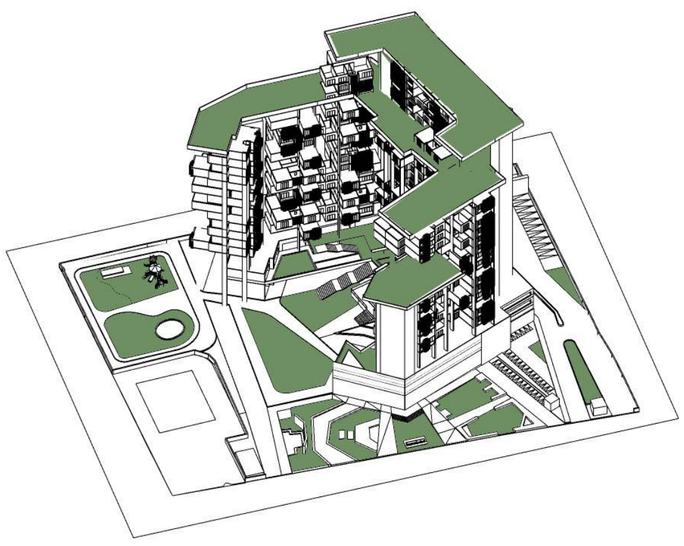
- **Flexibility and freedom of choice**
- **A connect back to our roots and to nature; that has been last with globalisation**
- **To have a symbiotic relationship with our environment**
- **To account for net-zero goals while keeping socio-cultural sustainability at a forefront**

How we achieve this -

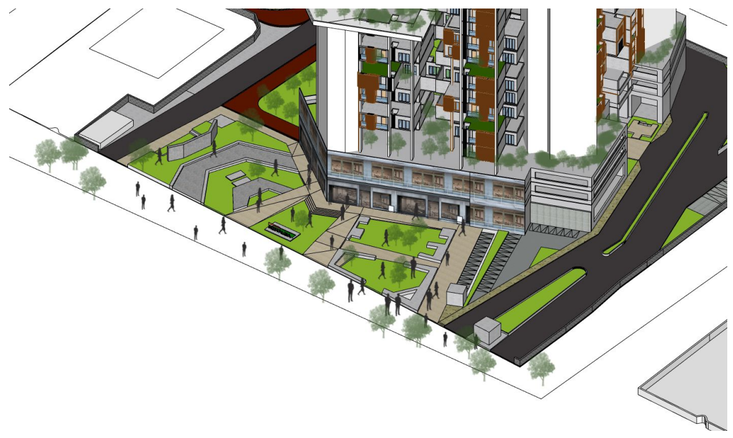
- **Desian interventions at three scales**



UNITS CREATED AS FLEXIBLE MODULES WITH OPEN FLOOR PLATES GIVING CHOICE TO USERS TO DESIGN INTERIOR WALLS



BUILDING FORM STAGGERED AND CURVED TO HARNESS WIND. GREEN SPACES INTERSPERSED THROUGHOUT.



CONCEPT OF 'URBAN LIVING ROOM' IMPLEMENTED IN THE COMMERCIAL PLAZA PLACED AT THE ROAD LEVEL

Figure 2: Three fold design interventions at Interior, Building and Urban scale

- **Innovating with nature-**

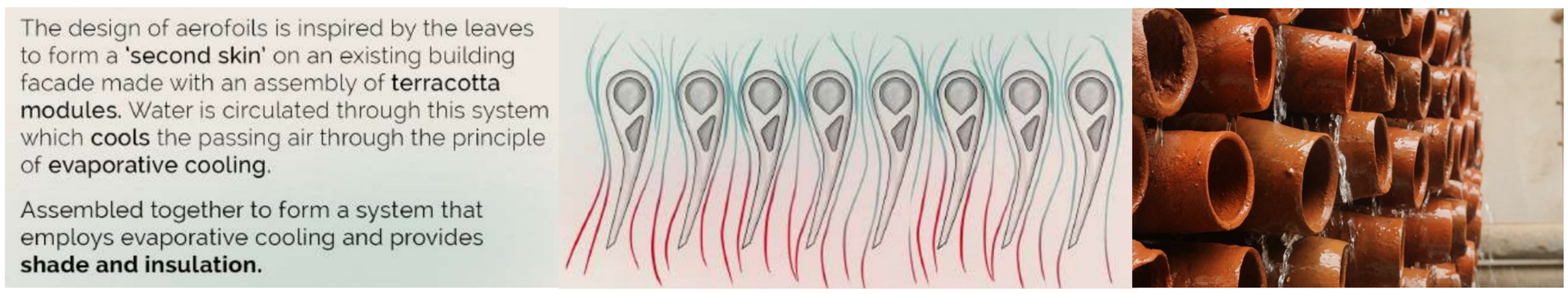
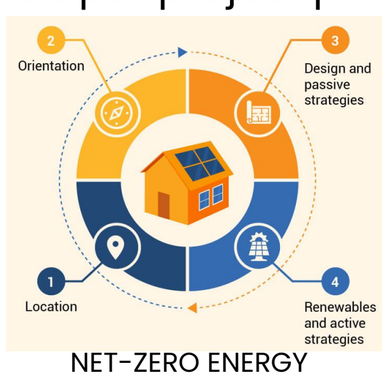


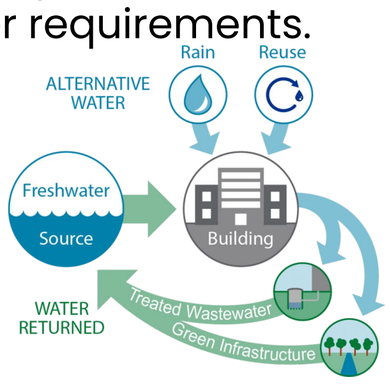
Figure 3: Coolant KINETIC, natural air conditioner in collaboration with AntStudio

- **Net-zero achievements-**

Net-zero goals are achieved in energy, water and carbon as well as a special emphasis of 100% waste diversion from landfills as per project partner requirements.

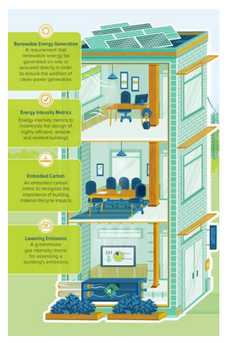


NET-ZERO ENERGY



NET-ZERO WATER

NET-ZERO WASTE



NET-ZERO CARBON

Figure 4: Net Zero Goals

Project Background

Project name:
Mahindra Homeground (Nestalgia)

Project partner:
Mahindra Lifespace Developers Ltd. is an Indian real estate and infrastructure development company headquartered in Mumbai, India. The company is engaged in residential developments under the Mahindra Lifespaces and Happiness brands and integrated cities and industrial clusters under the 'Mahindra World City' and 'ORIGINS' by Mahindra World City brands.

Key people:

- Dr. Sunita Purushottam (Head of Sustainability at Mahindra Lifespace Developers)
- Mahesh Kanak

The Board of Directors of the company is headed by Arun Nanda, chairman of Mahindra Lifespace Developers Ltd and Mahindra Holidays & Resorts (I) Ltd. Other members of the Board of Directors include Arvind Subramaniam, Anish Shah and Ameet Hariani, Bharat D. Shah and Amrita Verma Chowdhury hold the position of independent directors.

Brief description of the project:

- Project type: Mid-premium multifamily residential project.
- Location: Pimpri, Pune.
- Climate Zone: Warm and humid zone as per ECBC-2017.
- Status of the project: Foundation construction started.
- Type of building: Mixed use residential towers (2 and 3 BHK. The project consists of 4 residential towers with a G+4 Podium for parking + 23 habitable floors As well as commercial spaces on two floors of two towers
- Number of dwelling units: 498.
- Profile of occupants: The migrants working for various industries like IT, Electronics, Education, Pharma, etc. in Pimpri.
- Amenities: Elder's park, Burma Bridge, Playscape, Barefoot park, Swimming pool, Koi pond, Foot Chi, Brainbench, Kids play pool.
- Concept - Biophillia

Estimated total built-up area:
Total Site Area = 12613.49 sq.m.
Amenity space: 1256.24 sq.m.
Recreational space: 1130.62 sq.m.
Permissible built-up Area = 19999.14 sq.m.

Target Energy Performance Index (EPI):
35 kWh/sq.m. (According to the ECBC norms for 2 and 3 bhk residential projects)

Goals

ENERGY PERFORMANCE :
Goal:
To attain EPI < 35 kWh/yr/m2

Strategy:

- Massing optimization to attain most from renewable sources of energy. Orientation of built form, shading, massing and materiality.
- Envelope optimization to make the building thermally comfortable
- Usage Energy Efficient Appliances. Use efficient equipment for lighting, equipment and other services.
- Use of Aerofoil technology based terracota panels
- Sensory trackers within entrance spaces and jogging tracks. Use of piezotiles to generate energy by the footfall of people.

WASTE MANAGEMENT :
Goal:
To generate 40000 litre biogas from wet waste production kg/day and generate revenue from MRF for Dry waste.

Strategy:

- Using techniques like MRF, composting and biogas generation which helps with building autonomy and revenue generation.
- Efficient house keeping system infused with app to encourage people towards better waste management and minimize product of waste.
- To create a efficient and stable waste management and segregation system so the further process becomes simpler.
- Research and approach the various startups from Pune and Mumbai who cater to the waste to and recycle it.

WATER MANAGEMENT :
Goal:
Target per capita water consumption: 70 LPD.

Strategy:

- Using recharge borewells
- Using water-efficient fixtures and appliances, irrigation equipment, sustainable landscape design solutions, enhanced operation and maintenance of water systems.
- Reducing the storm water runoff by installing rain gardens, permeable pavements, green roofs, infiltration planters, rainwater harvesting systems, etc so that it. can help storm water to infiltrate the original water source.
- Water sub-metering and smart water metres for apartments.

Goals

AFFORDABILITY :
Goal:
Invest more in capital expenses to significantly bring down operational cost.

Strategy:
Using prefabricated construction technology to ease the time spent on the construction of the project and lower the financial cost.

RESILIENCE :
Goal:
Implement efficiency in material design to avoid the consistent and intense wind and rain.

Strategy:
- Inclusion of biowales
- Strategies to attain resilience to sesmic waves
- Rainwater harvesting and recharge systems that capture water on the roofs of buildings which can be stored during emergencies.
- Use of micromobility services
- Ensuring the waste is recycled in reused in a cyclic manner
- Ensuring social resilience by improving the safety and security of the residents

INNOVATION :
Goal:
To find a solution that is easy to implement and can be used in daily life without hindrance.

Strategy:
- Proposal of an post occupancy mobile app to minimise energy consumption, manage waste, conserve water at the residents level by creating a tracking software or app.
- Monitor in real-time building's operations and performance.

HEALTH AND WELLBEING :
Goal:
Ensure socio-cultural sustainability by incorporation of a system to get the community closer to each other.

Strategy:
- Maximizing the community spaces within the structure by linking towers to each other increasing the connectivity na ease of traverse.
- We believe, when designed carefully, communal spaces have the potential to influence each wellness dimension and improve life within the space.
- Use of Terracotta aerofoil panels to ensure good quility air inside the house.

Goals

ENGINEERING AND OPERATIONS :

Goal:

Integrate Engineering systems with Architectural Design for optimum long term building performance.

Strategy:

- Adapting for modular construction or machine learning and construction through artificial intelligence
- Use of Ambiator technology developed by our project partner which is an energy efficient VRF system
- Sensor based automation systems.
- Use of faster and advanced construction methods that will ensure financial gain for the partner

ARCHITECTURAL DESIGN :

Goal:

To reimagine the future of housing and taking biophilia (original concept of the building) a step further.

Strategy:

- Catering to the unique needs of the next gen buyers and giving them the freedom to personalize their home.
- Taking biophilia a step further and exploring it in terms of form and function
- Increasing the interaction spaces and ensuring socio cultural sustainability.
- The orientation of each block done in a way to increase the energy efficiency of the buildings.

Design Documentation

Energy Performance

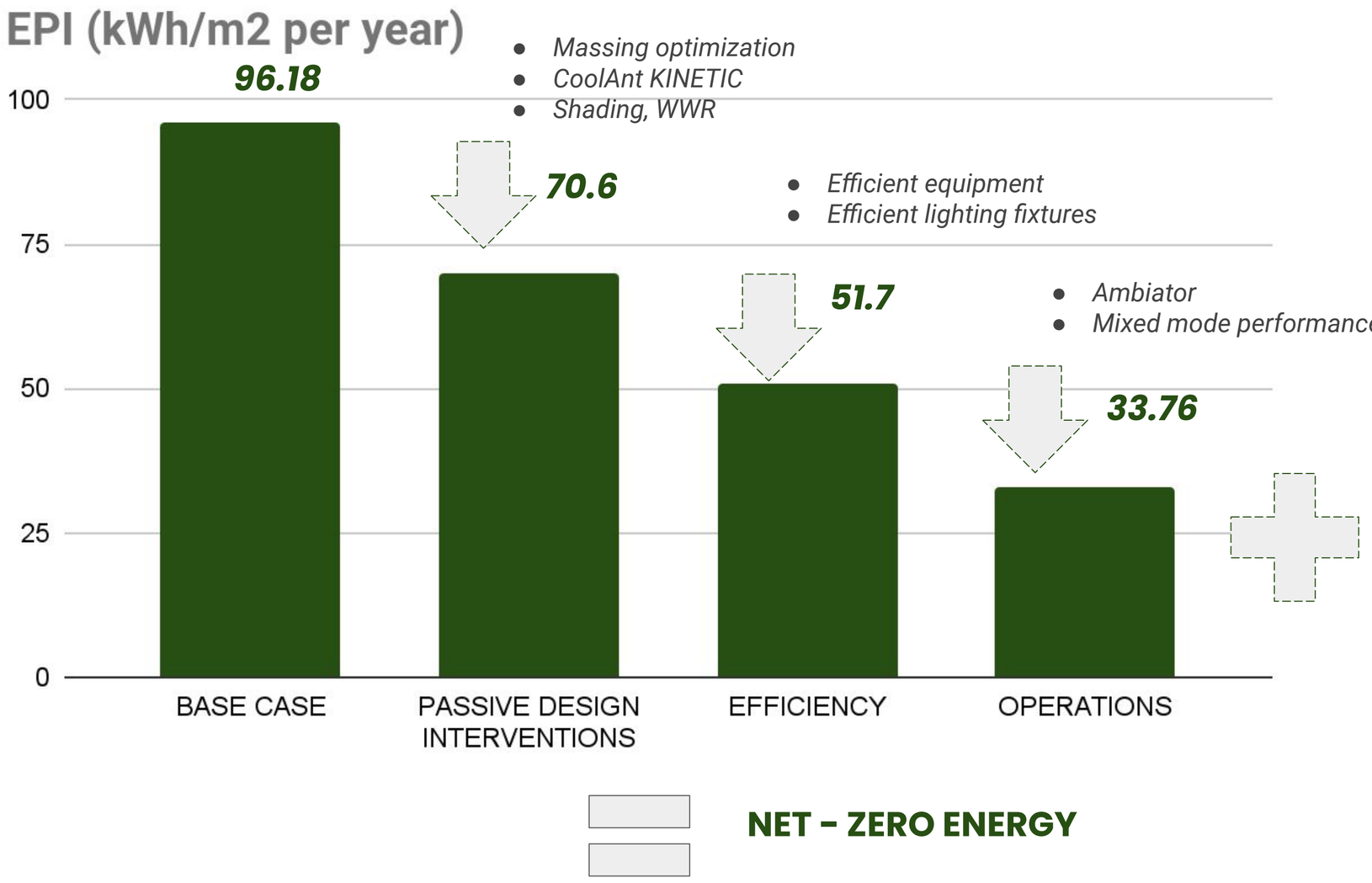


Figure 1.1 : Step-by-step EPI reduction

(Note: Base Case Calculations elaborated in appendix.)

MASSING OPTIMIZATION

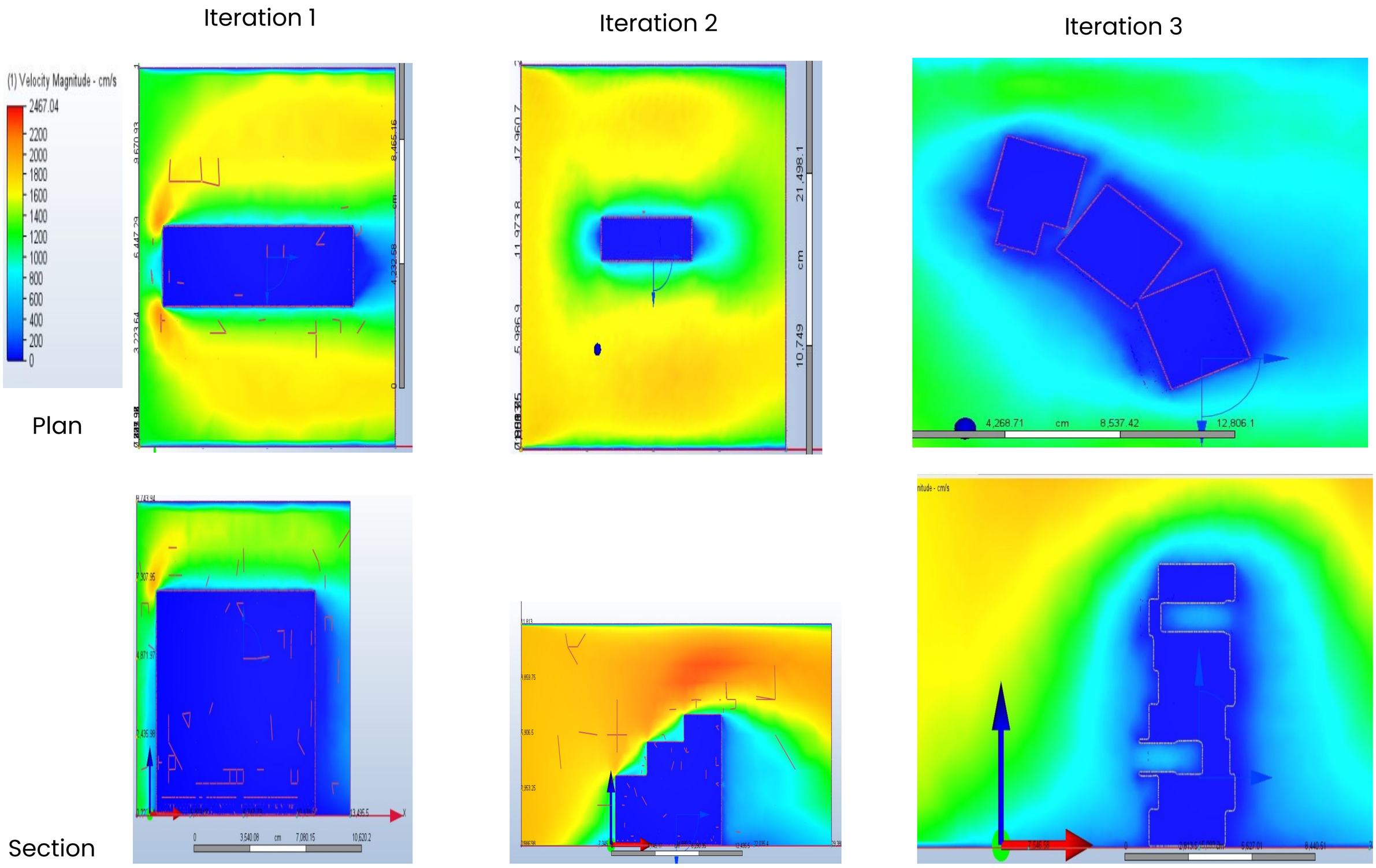


Figure 1.2 : Experimenting on massing options through CFD simulations run on Design Builder

ENVELOPE OPTIMIZATION

- **ROOF**

1. Concrete, Medium density (2000) (150 mm)
2. Concrete screed (50 mm)
3. Polyethylene/polythene, low density 0.15 mm (0.15 mm)
4. HARDROCK® Multi-Fix (DD) (150 mm)
5. Ethylene propylene diene monomer [EPDM] (1.8 mm)

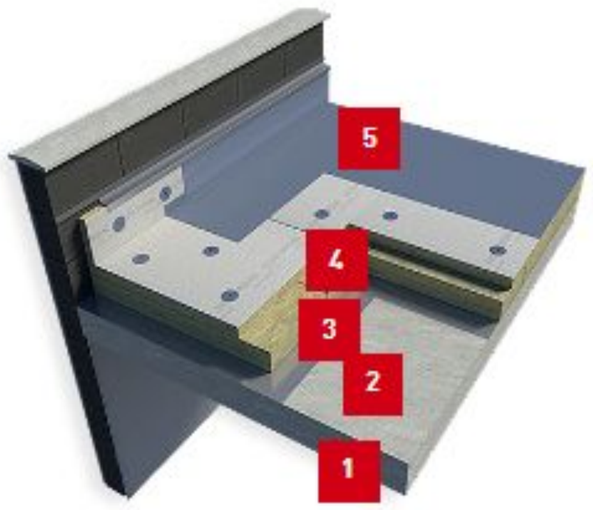


Figure 1.3 : Roofing assembly

U-value = 0.25 W/m2/K

- **FENESTRATION**

AIS Ecosense Essence – Performance Parameters

6 mm (Low-E Glass) – 12 mm (Air Gap) – 6 mm (Clear Glass)

Clear Essence Plus	Neutral	71	10	12	53	0.61	1.8

Figure 1.4 : Glass used for windows

U-value = 1.8 W/m2/K

- **WALLS**

Figure 1.5 : Agrocrete + Insulmix used for wall assembly

U-value = 0.3 W/m2/K

Hollow Blocks for Low-Rise to High-Rise

Dimensions (mm) : 400 x 150 x 225/ 150/ 100

Tested as per IS 2185: Part II

Strength
≥5 MPa
AAC: 3 - 4 MPa

Durability
75+ Years
AAC: <50 Years

Density
800 kg/m³
AAC: 650 kg/m³

Embodied Carbon
–0.14 kg CO_2/kg
AAC: 0.24 kgCO_2/kg

Water Absorption
13 - 15%
AAC: 15%

U - Value
1.3 - 1.6 W/m²K
AAC: 2 W/m²K

- **FACADE**

Coolant KINETIC designed to cool the air infiltrating the structure and serve as a shading device for the building. Further details are provided in Innovation.

Categories		Units	Without Double skin (base case)	With Double skin	With Double skin & ventilation	With Double skin & water flow	With Double skin, ventilation and water flow
Cooling Load	Total AC Tonnage	TR	34.5	30.8	28.1	28.8	26.8
	Capital cost saving		-	11%	18%	16%	22%
EPI	Cooling	kWh / m2-yr	88.28	74.74	70.29	63.79	60.04
	Fans		10.51	8.36	7.23	7.21	6.17
	Lighting		4.99	4.86	4.86	4.85	4.85
	Equipment		4.53	4.41	4.41	4.42	4.41
	Total		108.31	92.37	86.79	80.27	75.47
	Operational Savings		-	15%	20%	26%	30%

Table T.1 : Annual Energy Reduction Analysis with Coolant KINETIC

ON-SITE RENEWABLE ENERGY GENERATION

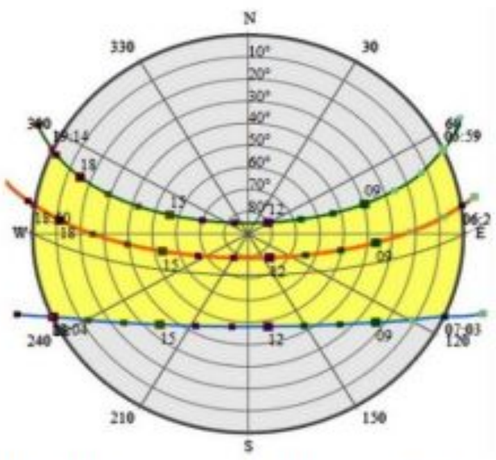


Figure 1.7 : Sun path diagram of Pimpri

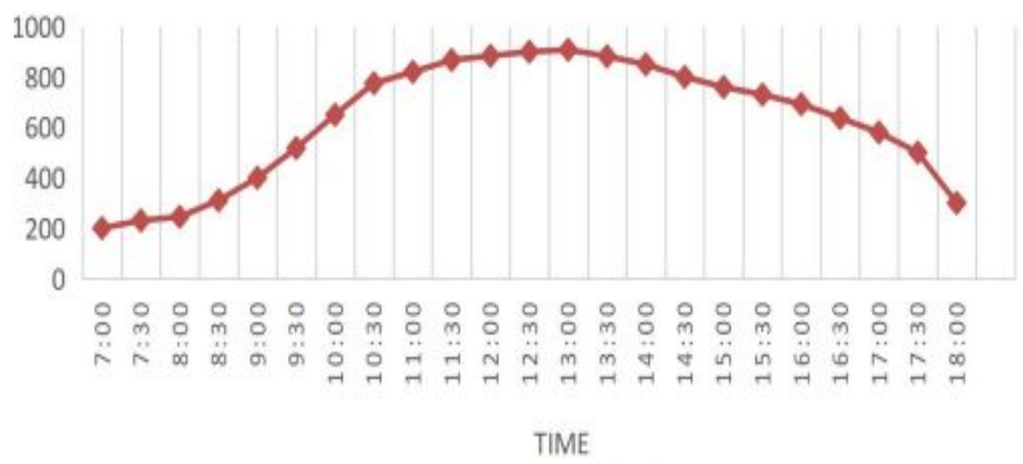


Figure 1.8:: Radiation Range in Pimpri

Solar Generation Potential:
The site promises a positive solar potential. Maximum heat is radiated into the building through the roof. It receives maximum solar irradiance compared to the building facade. The solar panels are placed on the terrace as well as mumty to meet the demands of energy requirements.

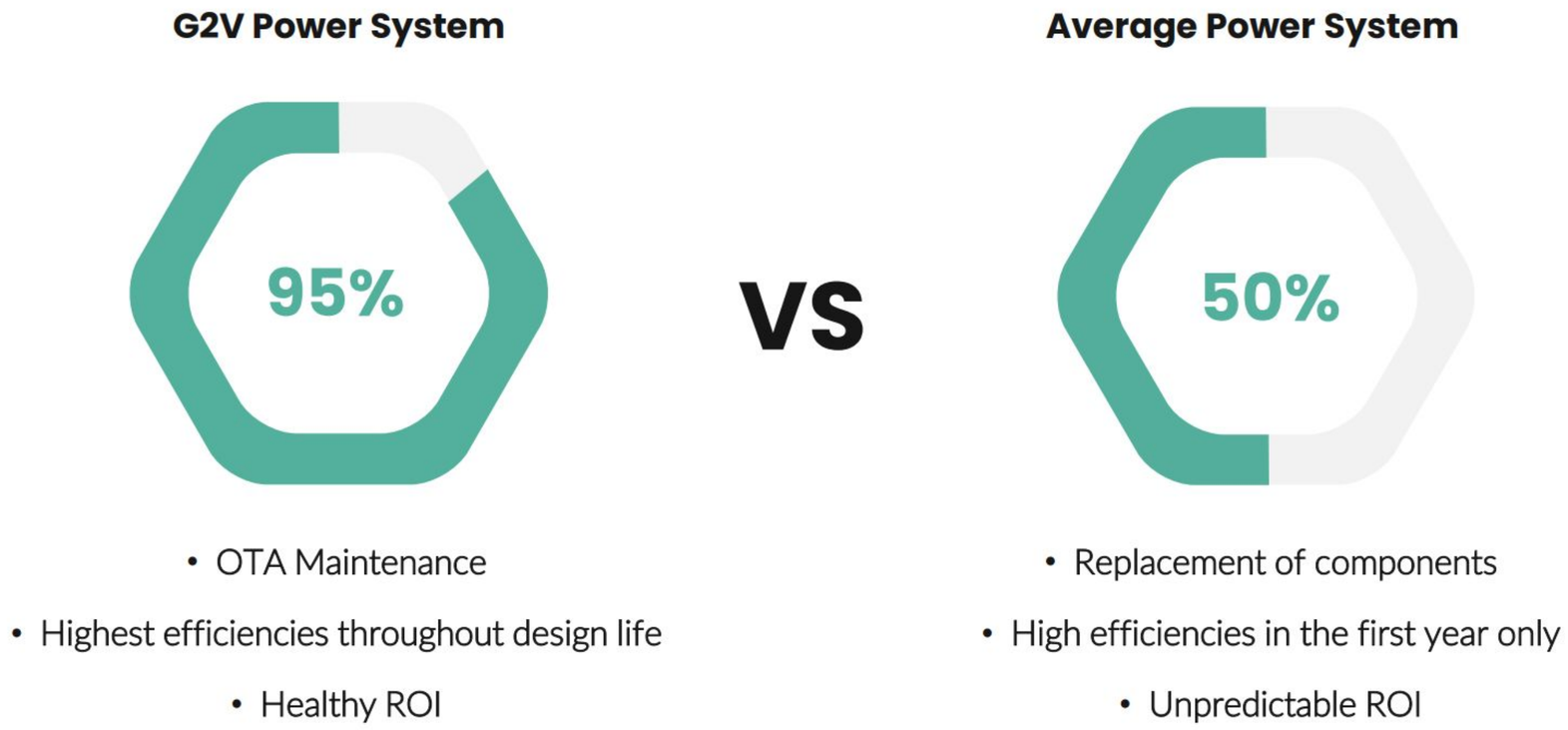


Figure 1.9 : Comparison of G2V solar solar system with other systems

ON-SITE ENERGY GENERATION POTENTIAL

Wind Generation Potential:
The site promises a positive solar potential. Maximum heat is radiated into the building through the roof. It receives maximum solar irradiance compared to the building facade. The solar panels are placed on the terrace as well as mumty to meet the demands of energy requirements.

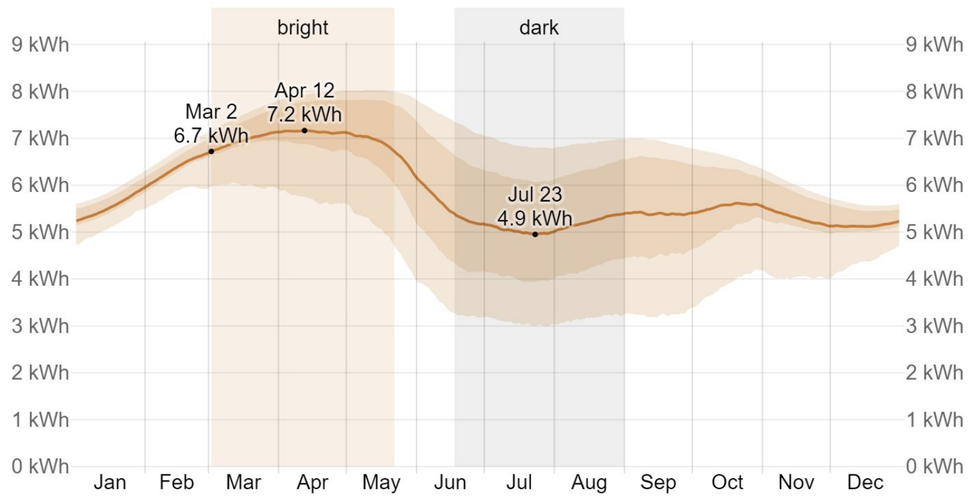


Figure 1.10 : Wind chart diagram of Pimpri

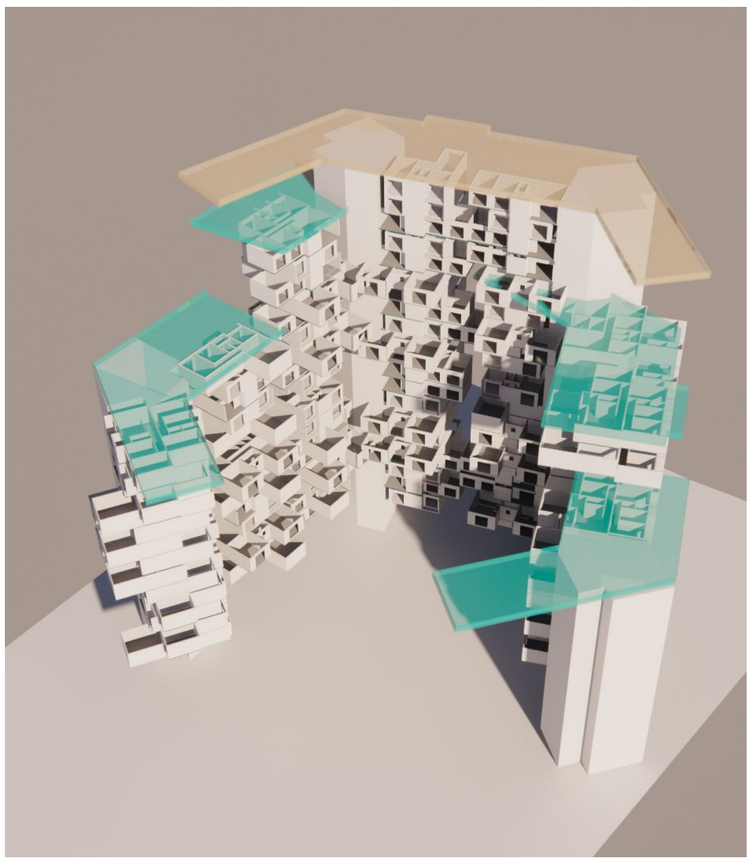


Figure 1.11 : Combined roofs to maximize area for renewable energy generation

Rooftop with wind towers and solar panels

Rooftop with solar panels only

EPI reduction achieved = 32%

Total rooftop area:
1120 + 590 + 525 + 330 + 550 = 3115 sq. m.

- **ENERGY GENERATION IN A DAY**

  Solar Panels:
  4.5kWh energy is produced for 10 sq.m. area
  No. of solar panels: 2500 sq.m.
  Energy produced: 4.5 x 250 = 1125kWh

  Wind Towers:
  7.5kWh energy is produced for 5 sq.m. area
  No. of wind towers: 4
  Rooftop area required: 80 sq. m.
  Energy produced: 120kWh

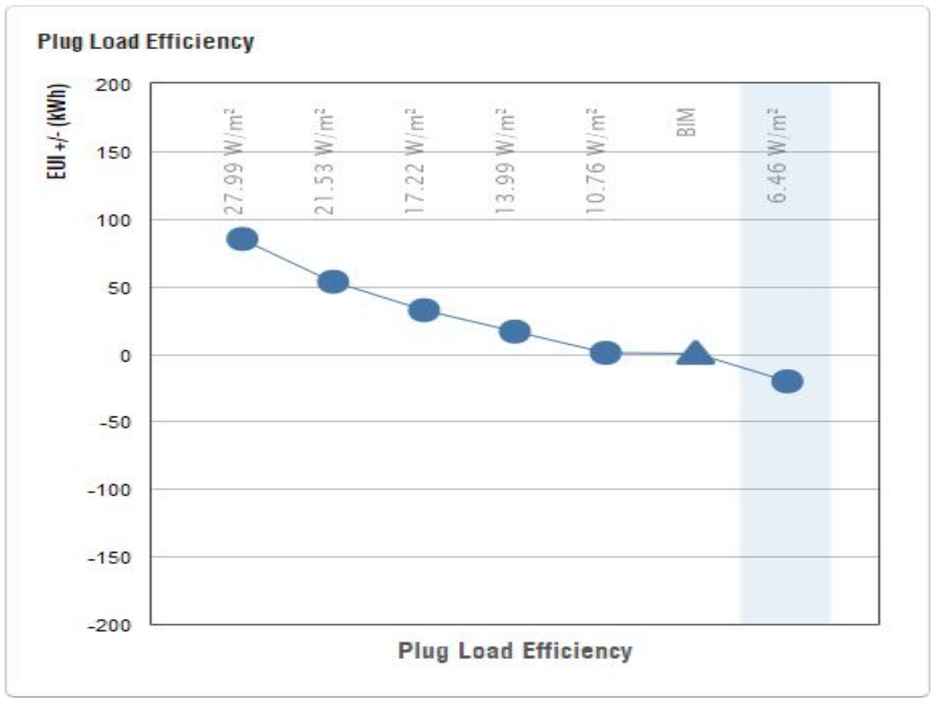
- **ENERGY GENERATION IN A YEAR**

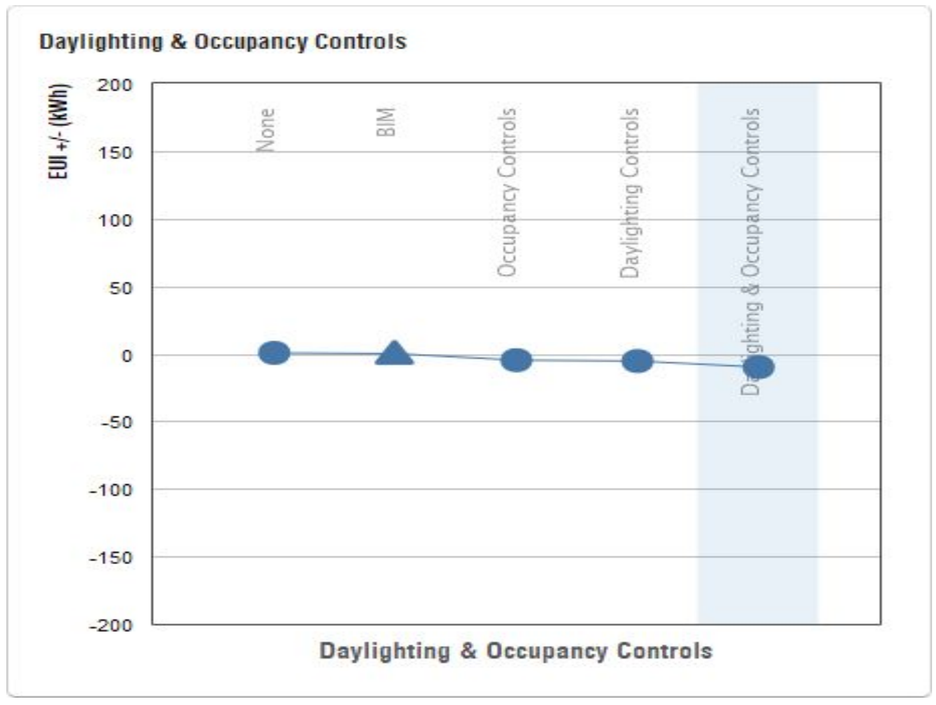
  (Energy by solar panels + Energy by wind towers) x 365
  =(1125 + 120) x 365 = 456,250 kWh/yr

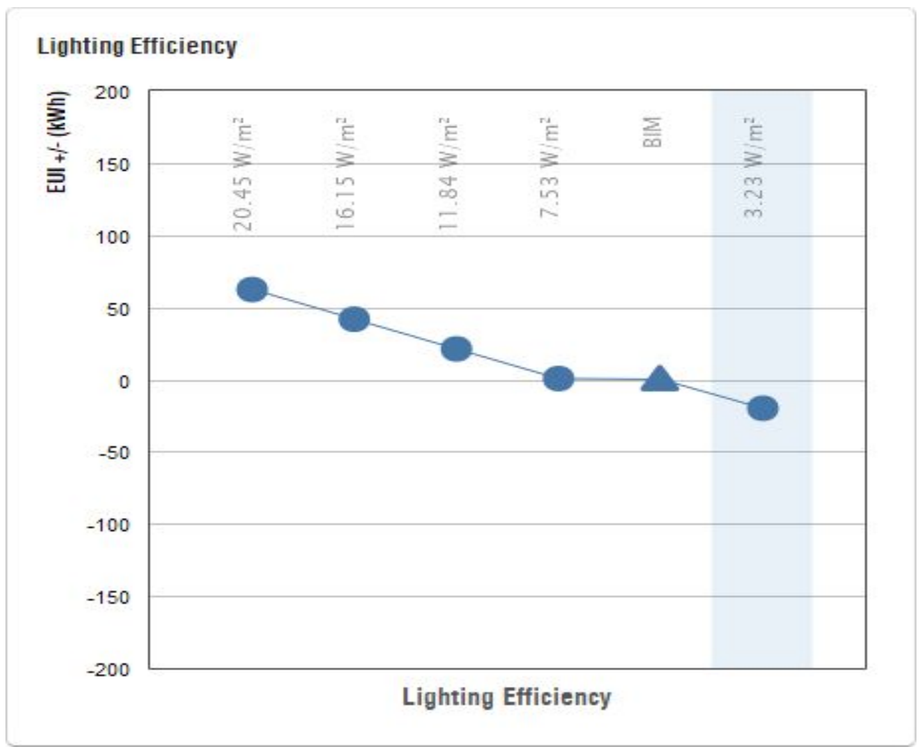
- **ENERGY GENERATION IN A YEAR**

  456,250 / 10,57,514.5 x 100 = 32%

Optimization of energy consumption by the use of energy efficient appliances and fixtures has been covered under **Engineering and Operations.**







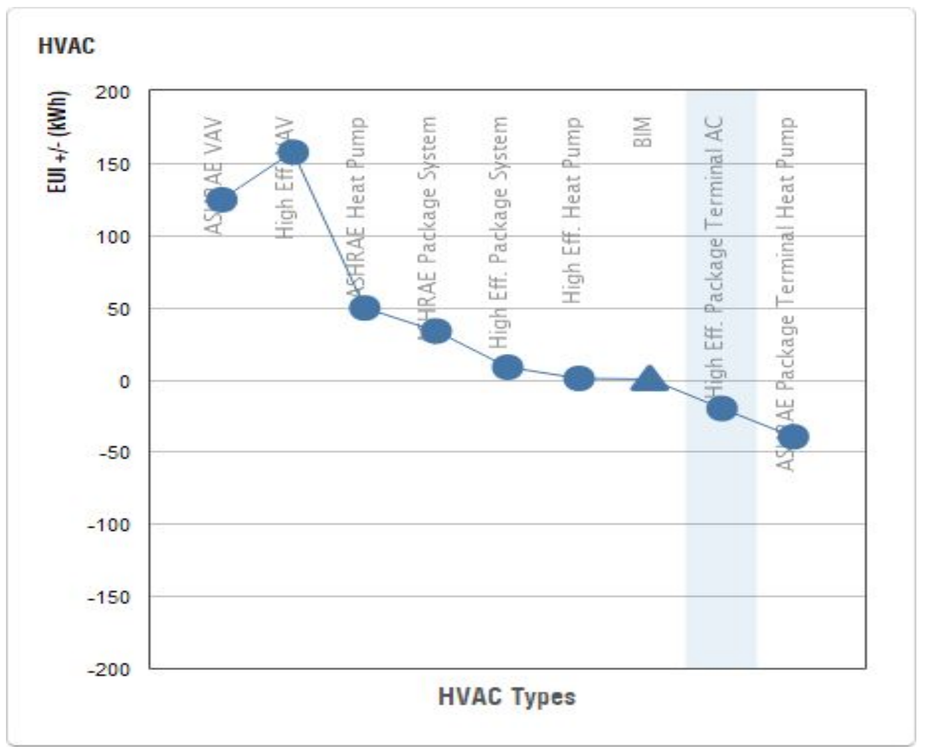
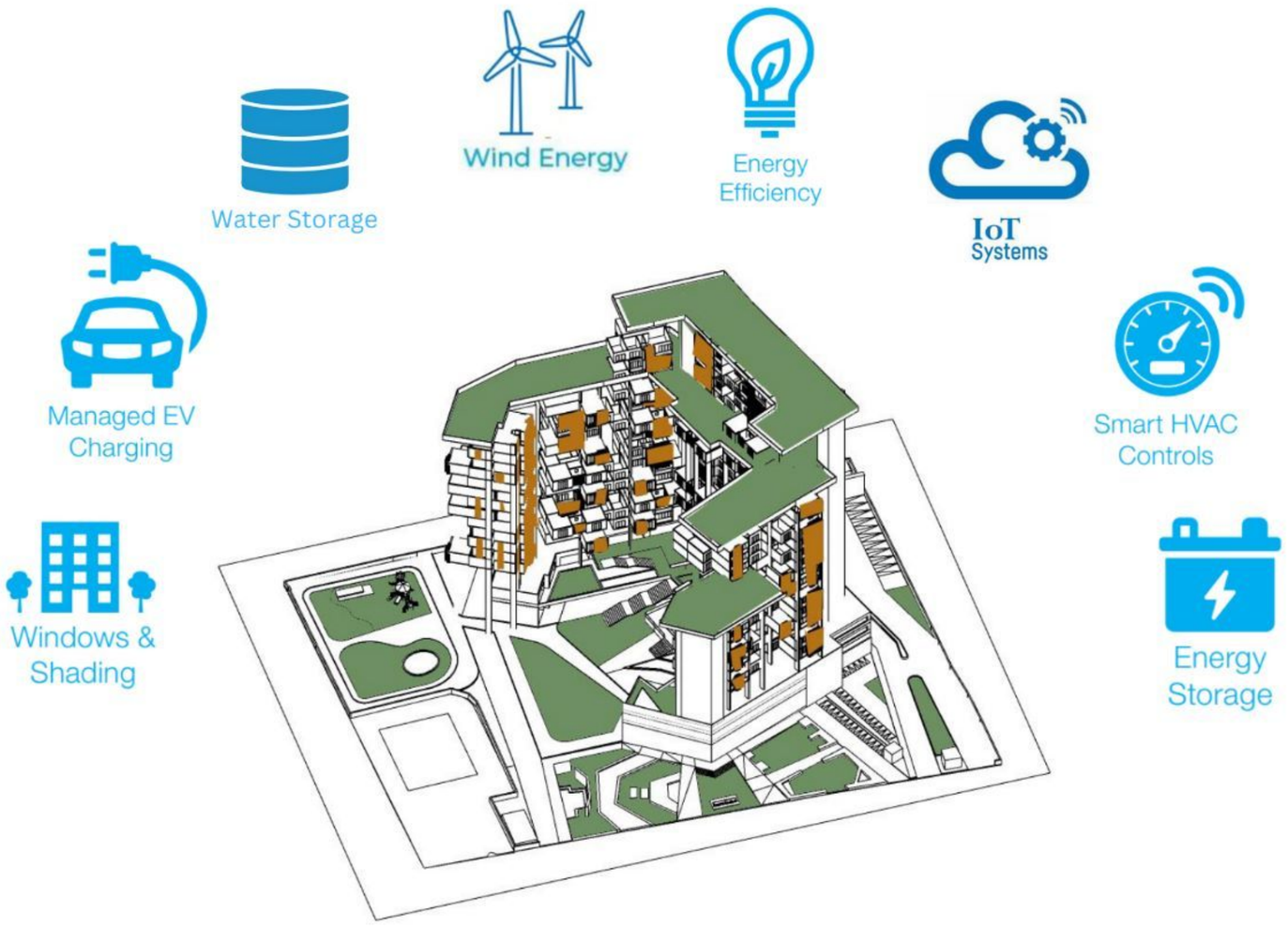


Figure 1.12 : Optimization for a) Plug Load Efficiency, b)Daylighting and Occupancy Controls, c) Lighting Efficiency, d) HVAC

- **OPTIMIZING ENERGY CONSUMPTION PER DAY**

  Base case requirement: 14,23,098.5 kWh/yr
  Optimized requirement: 11,30,234.64 kWh/yr (Same method followed as base case)
  Deficit energy required to be drawn from the system after on-site energy generation:
  11,30,234.64-4,56,250 = 6,73,984.64 kWh/yr
  Total EPI attained: 33.76 kWh/yr/m2

- **SMART GRID INTEGRATION CAPABILITIES-**



Windows and shading. These systems can automatically adjust the amount of sunlight and heat that enters a building, reducing the need for heating and cooling.

Managed EV charging:. This can help balance the load on the grid, reduce peak demand, and provide additional revenue streams for building owners.

Water storage: This can help to reduce the strain on the local water supply, and improve the sustainability of the project.

Wind energy: This can help to reduce the reliance on traditional energy sources, and improve the sustainability of the project.

Energy efficiency: it can reduce the overall energy consumption of the building. This can include things like LED lighting, efficient appliances, and insulation.

IoT systems: This can include things like smart thermostats, lighting controls, and occupancy sensors.

Smart HVAC controls: This can help to reduce energy consumption and improve occupant comfort.

Energy storage: This can help to improve the reliability and resilience of the building's energy system.

Water Performance

Domestic consumption under normal condition in an Indian city as per National. Building Code, has been taken as **135 litres per head per day**
Total no. of occupants : 1065
Water consumption per day : 135 ltrs
Water requirement: 31392130.1 L

Base Case	Per Capita daily consumption (L)	NO. of occupants	Total Consumption daily	Total water requirement in a year (L)
Base Case	135	1065	153581.85	56057375.3
Reduced Case	76	1065	86005.836	31392130.1

Table T.2 Water use case

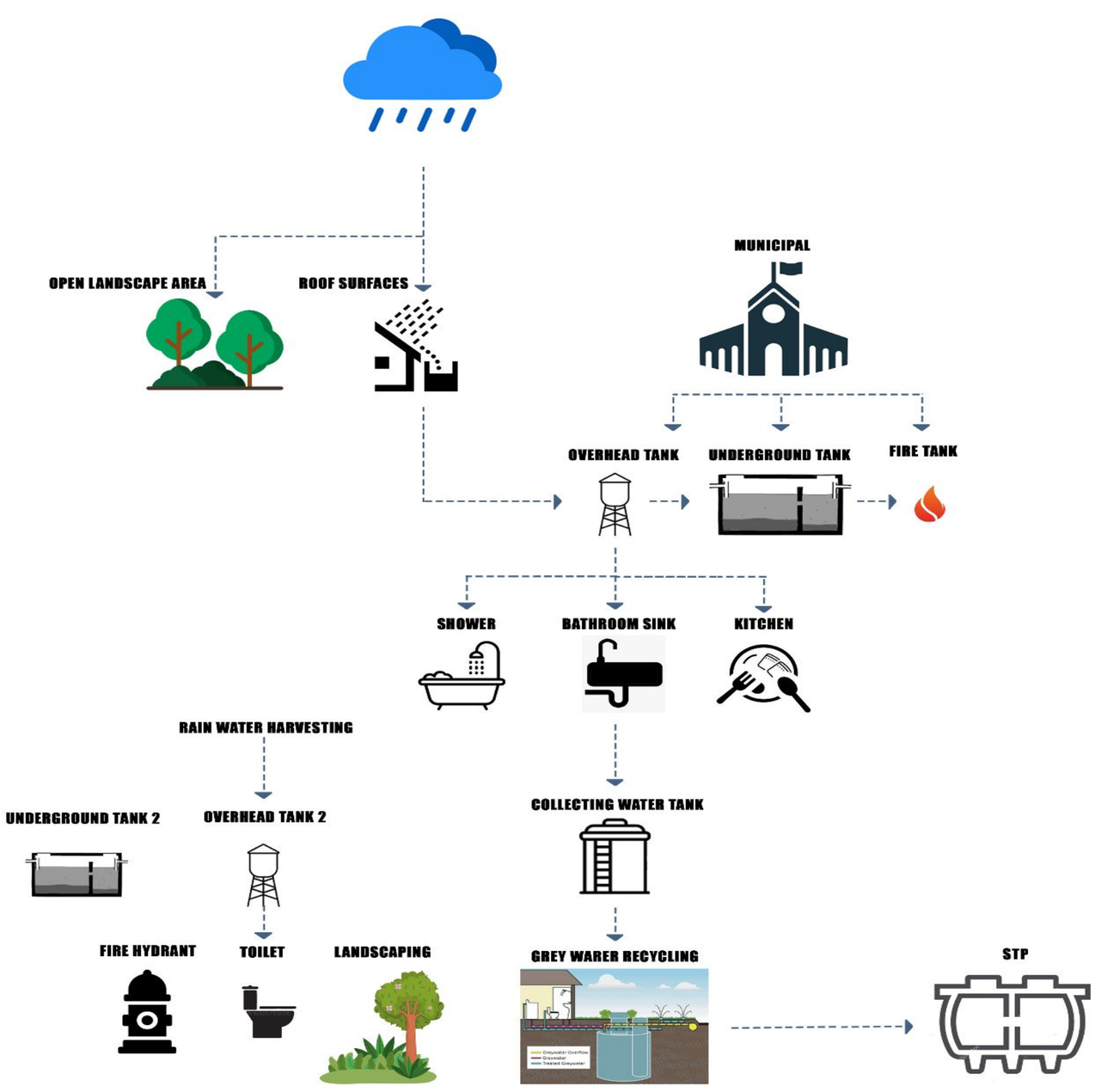


Figure 2.1 Net zero water cycle

Harvested Rainwater (Kl/year) = **8178 Kl**
Amount of water saved by using Low Flow fixtures = **8Kl**
Amount of water saved by recharging pits = **1825 Kl**
Amount of water saved by grey water recycling = **23544.097 Kl**

TOTAL AMOUNT OF WATER REGENERATED AND RECYCLED : 31730.097

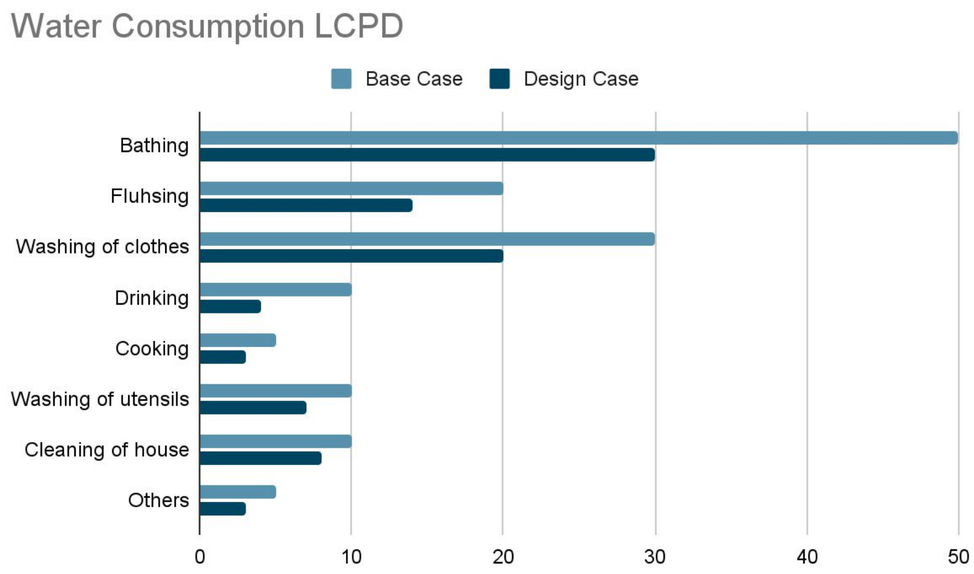


Figure 2.2 water use case graph

Strategies used:

- **Install Low-Flow Fixtures:**Low-flow showerheads, faucets, and toilets use less water while still providing adequate water pressure. The EPA estimates that the average household can save up to 700 gallons of water per year by installing water-efficient fixtures. Installing low-flow fixtures is relatively easy, and many models are available on the market.

NBC	
Washbasins:	6 LPM
Sinks:	6 LPM
Showerheads:	9 LPM
Urinals:	1 LPM
Water closets (toilets)	10 LPM

Table T.3 NBC fixtures flow rates

IGBC	
Washbasins	5 LPM
Sinks:	5 LPM
Showerheads:	9 LPM
Urinals:	1 LPM
Water closets (toilets):	6 LPM

Table T.4 IGBC fixtures flow rates

- **Fixing leakage** in residential buildings is an important step in conserving water and reducing water bills. Leakage can occur in various areas such as pipes, faucets, showerheads, and toilets. Identifying the location of leaks is the first step towards fixing them.

Amount of leakage water saved : 8 KL

Base Case and Reduced case Calculations

CONVENTIONAL							
Fixture type	Max. flow rate/ consumption		Duration		Estimated daily uses per FTE	No. of users	Total usage
Water closets (full flush)	6	LPF	1	flush	1	1114	6684
Urinals	4	LPF	1	flush	2	100	800
Water closets (half flush)	3	LPF	1	flush	2	1114	6684
Washbasin / sink	5	LPM	0.25	minute	4	2228	11140
Health faucet	6	LPM	0.25	minute	1	2228	3342
Shower head / Handheld spray	9	LPM	8	minutes	0.1	1114	8020.8
Total usage (LPD)							**36670.8**

Table T.5 Conventional water usage

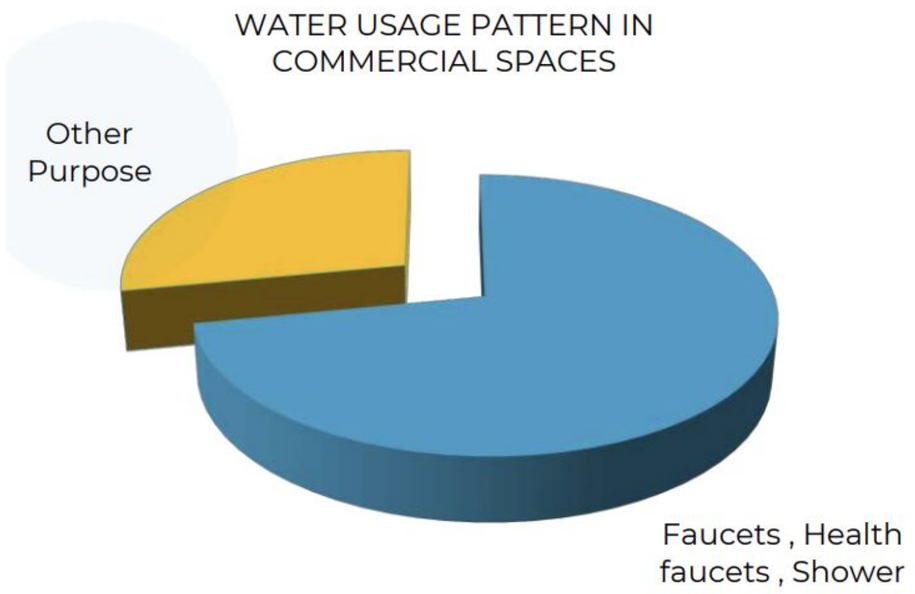
REDUCED - Earthfokus fixtures							
Fixture type	Max. flow rate/ consumption		Duration		Estimated daily uses per FTE	No. of users	Total usage
Water closets (full flush)	2	LPF	1	flush	1	1114	2228
Urinals	1	LPF	1	flush	2	100	200
Water closets (half flush)	1	LPF	1	flush	2	1114	2228
Wash basin / sink	1	LPM	0.25	minute	4	2228	2228
Health faucet	4.5	LPM	0.25	minute	1	2228	2506.5
Shower head / Handheld spray	6	LPM	8	minutes	0.1	1114	5347.2
Total usage (LPD)							**14737.7**

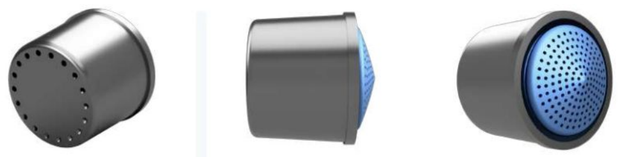
Table T.6 Reduced case by using Earthfokus fixtures

ECOSTREAM DIAMOND

NAME	ECOSHOWER DIAMOND
PRODUCT ID	EFESD01
MATERIAL	BRASS
FLOW TYPE	ANGLED STREAM FLOW
OUTPUT	1.5 LPM
PRODUCT SIZE	DIAMETER: 20.8MM HEIGHT: 15MM COMPATABILITY: M24-F22
MIN-MAX PRESSURE	0.5 BAR – 10 BAR
MANUFACTURER NAME	EARTHFOKUS EARTHWISE PVT.LTD
WARRANTY	3 YEARS

Figure 2.3 Earthfocus Ecostream diamond specifications





Earthfokus faucets are some of the best water saving fixtures

Figure 2.4 Water Usage Pattern

RAINWATER HARVESTING

Rain water harvesting technique is one of the other alternatives to manage and conserve water for a secure and sustainable future.X

Roof/Non Roof area dimensions of Mahindra Homeground Pimpri Chinchwad		
Sr.no.	Particulars	Area(sq.m.)
I	Total Site Area	1 1126.74
2	Rooftop Area (All Towers+Amenity Blocks)	2360.16
3	Hardscape Area	5266.29
4	Podium Area	2034.83
s	Softscape Area	1465.46

Table T.7 Area specifications of project

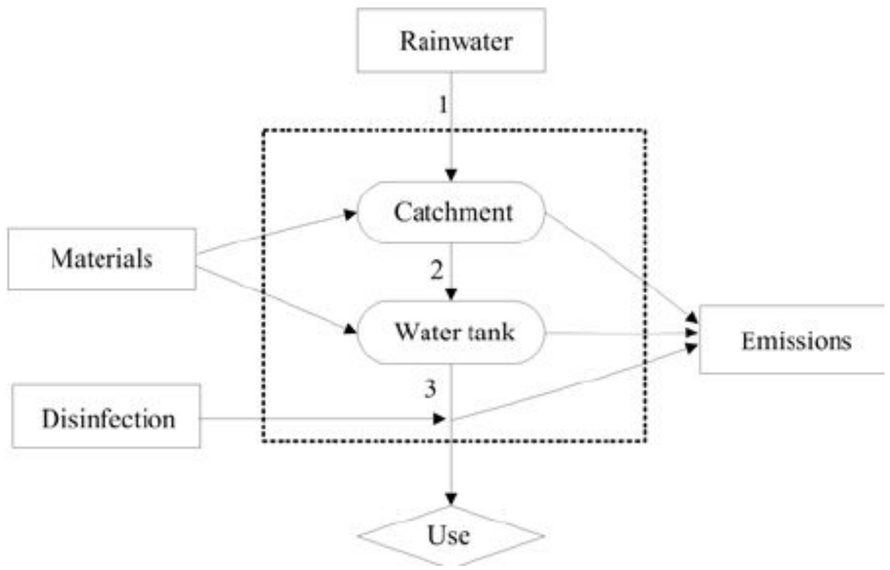


Figure 2.5 Rainwater Harvesting Process

Estimation of Rainwater Availability per year					
Sr. . o.	Particulars	Area(m2)	Average yearly rainfall	Runoff Coefficient	Rainwater Harvesting Potential (Rainwater endowment)(m^3)
2	Rooftop Area	2360.16	0.735	0.95	1647.98172
3	Podium Area	2034.83	0.735	0.95	1420.820048
4	Hardscape Area	5266.29	0.735	0.95	3677.186993
5	Softscape Area	1465.46	0.735	0.25	269.278275
	Total Plot Area	11,126.74	Total Quantity of available rainwater		7015.267035

Table T.8 Rainwater harvesting Potential

A) Total Availability of Rain water before construction (For Open Plot)
= Geographical area x Rainfall x Runoff Coefficient

= 11126.74 sq.m. x 0.735 mts. (Rainfall 705 mm) x 0.50 (Coeffi. of Runoff)
= 4089.07 M^3

B) Total Availability of Roof top water
= Geographical area x Rainfall x Runoff Coefficient
= 2360.16 sq.m. x 0.735 Mt. (735 mm) x 0.95
= 1647.9817 M^3

C) Total availability of Non-Rooftop water
=5367.2853 M^3

D) **Total availability of rooftop water in one day**
= Surface area x Runoff Coefficient x One-day Rainfall.

= 2360.16 sq.m. (total rooftop area) x 0.95 x 0.016
= 35.874432 m^3
X

Total effective catchment area: 9544.581 sq.m
Total Rainfall harvested in a year (KL) : 8178.1539

RECHARGE BOREWELL

Recharge borewell is a simple yet effective strategy to conserve water by recharging the groundwater level. It involves drilling a borewell and then using a filtration system to divert the rainwater collected from rooftops, roads, and other surfaces into the borewell. The water is then filtered and allowed to percolate into the ground, replenishing the groundwater table. This helps to reduce the dependency on freshwater sources and provides a sustainable solution for water conservation. By implementing recharge borewell, we can improve the availability and quality of groundwater, reduce water scarcity, and promote the sustainable use of water resources.

Bore Hole Diameter in m	Borewell Depth in m	Holding capacity of one borehole in Cum	Total number of recharge BW	Total holding capacity for 3 BW in Cum
0.1524	60.97	1.11218	3	3.33654

Table T.9 Holding capacity of Borewell

Water Holding Capacity of one recharge pit in Cum	Total Number of recharge pits considered at 3 recharge borewells	Total water holding capacity of 3 recharge pits in 3 recharge borewells in Cum
9.675	3	29.025

Table T.10 Holding capacity of recharge pits

Total Holding Capacity of 3 Recharge Pits in Cum	Total Holding Capacity for 3 BW in Cum	Total Holding Capacity for 3 BW in Cum
29.025	3.33654	32.36154

Table T.11 Holding Capacity for 3 BW in Cum

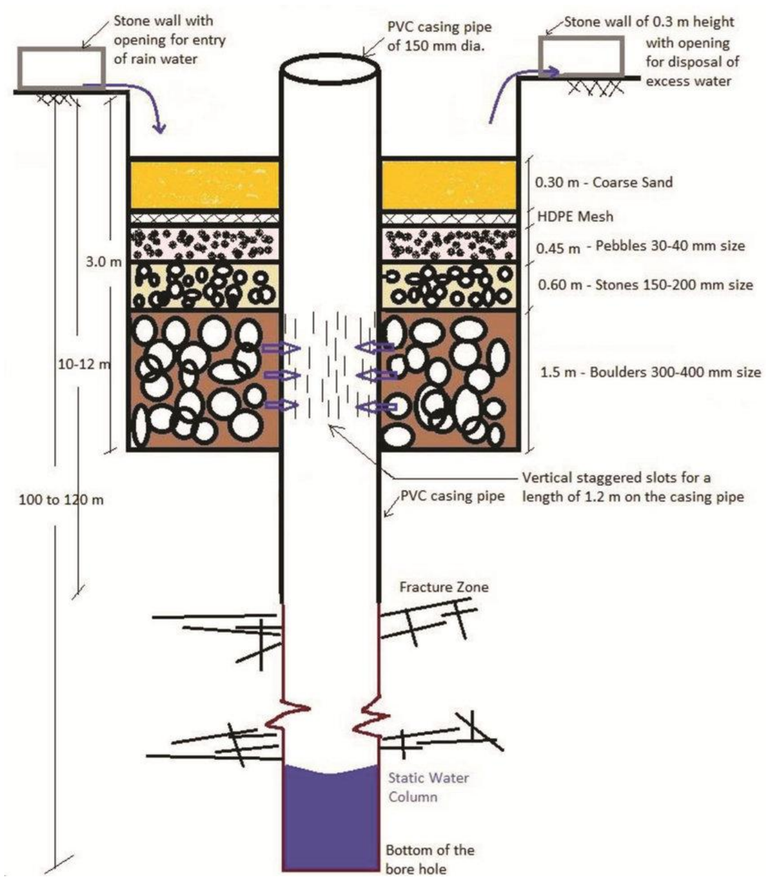


Figure 2.6: Recharge borewell

RWH pit one-day capacity

1. RWH pit capacity till 800mm free board space

-1.5x1.5x0.8

= 1.8 cum (no infiltration rate considered as no filtration medium provided)

2. RWH pit capacity for space occupied by filtration layer-(depth 2.15 m)

=|5x15×215×0,288 x 24

- 33.4368 cum (considering infiltration rate of 288 mm/hr for weathered compact basalt) Source- (As per actual field test at the site)

3. Total RWH holding capacity 1.8 cum+33.4368 cum

35.2368 Cum

RWH pit cum barewell one-day capacity

1. Shallow aquifer percolation per day -2.5-7.5 cum (based on slug lest-refer to section 4.10 Recharge estimation from slag test analysis)

2. Borewell Tube 1-day holding capacity-

Volume of Borehole-h

11 0.0762-60.97

-0.3540186468

-11121 Cam (No filtration rate considered as no filtration medium provided)

3. RWH pit capacity as above-35.2368 Cum

Total RWH holding capacity of 1 Pit cum Recharge BW 75 cum +1.1121 Cam+35.2368 Cum

433489 Cum

Total I day hobling canacity for 7 RWH pits & Pit cum Recharge Borewells

1. Total 1-day holding capacity of 7 RWII pits

-7x35.2368 cum

-245.6576 Cum

Total 1-day holding capacity of 3 pits cum recharge Borewells

-13 x 35.2368) (1.1121 x 3)

109.0467 Cam

3. Total 1 day holding capacity of 7 recharge pits and 3 pit cum Recharge Borewells in

Carn is

-246.6576-109.0467

354 7043 Cum

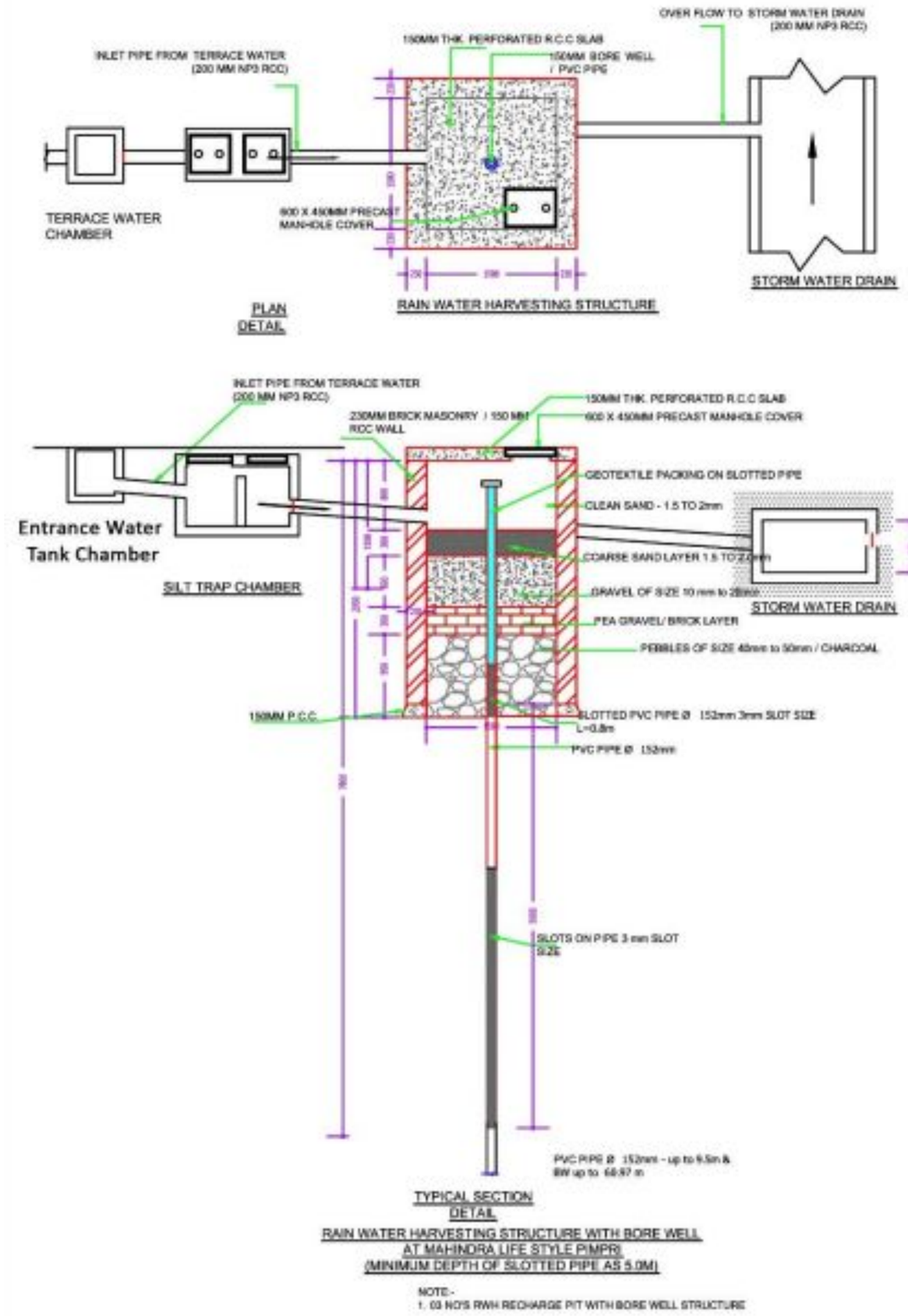
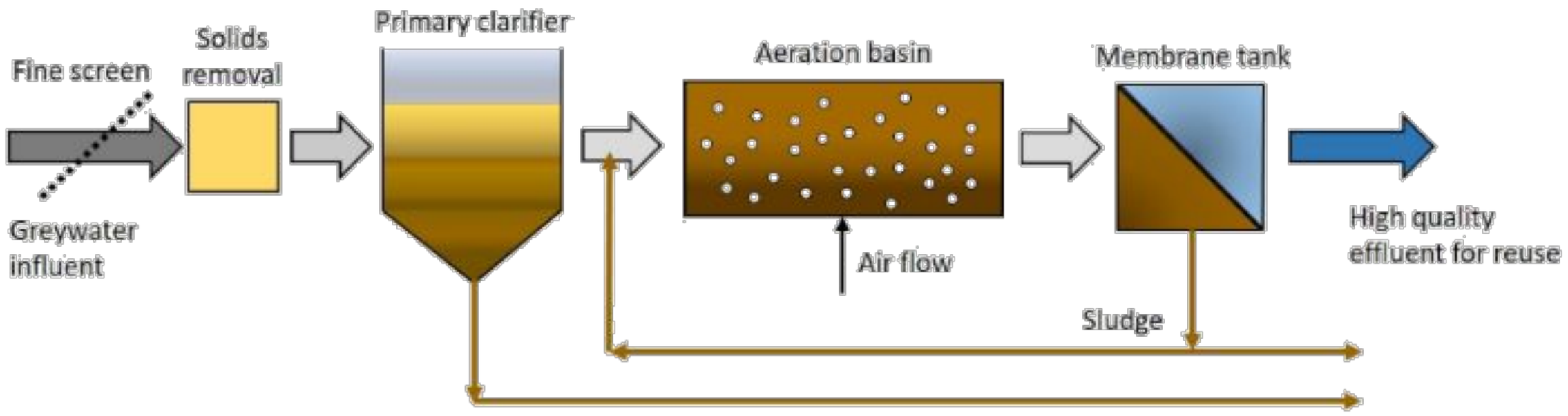


Figure 2.7: Recharge pits details

Grey water recycling

Amount of grey water recycled: 23544.097 KL

- **Greywater** generated can be collected and reused for non-potable purposes, such as irrigation, toilet flushing, and laundry. Reusing greywater can conserve freshwater resources, reduce wastewater treatment costs, and decrease the strain on wastewater treatment plants.



STP Calculations : ECOSTP

The technology works independent from power supply and daily surveillance, treating
the wastewater to pollution control board specifications. The ECOSTP product comprises of three separate units as shown in figure

CAPACITY (In KLD)	Space Required (in Sq.mtrs)	
	Primary & Secondary Treatment (Stage1,2&3)*	Tertiary Treatment (Stage -4 : PBF - Plant Bio Filter)**
85	190	102 (clear area)
* Primary & Secondary Treatment Plant Area goes underground and space can be reused completely.		
** PBF (plantation area) can be adopted as a part of the landscaping.		

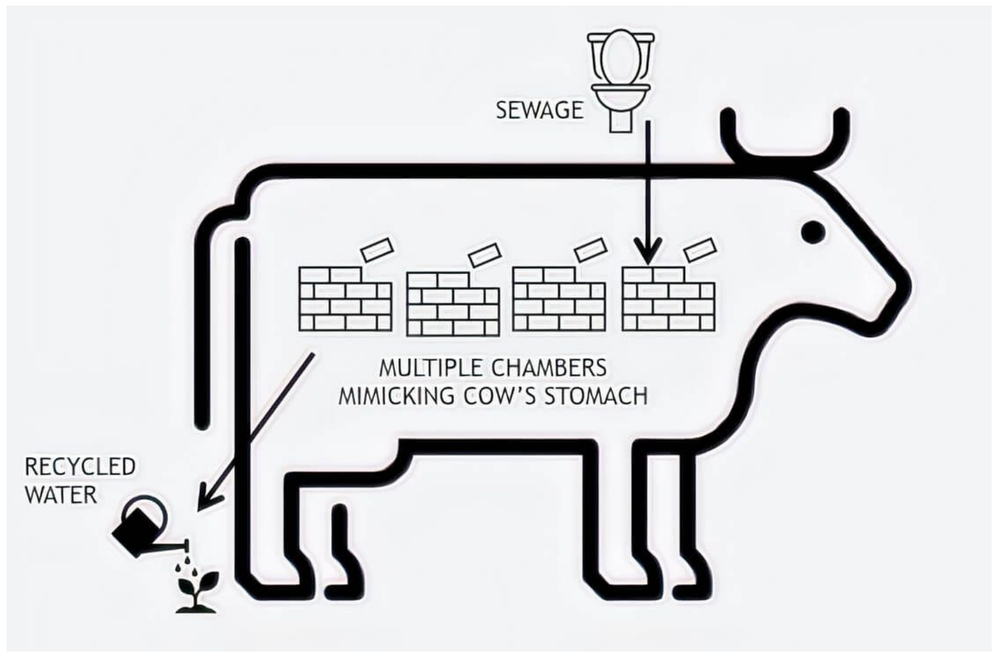


Figure2.8 : ECOSTP

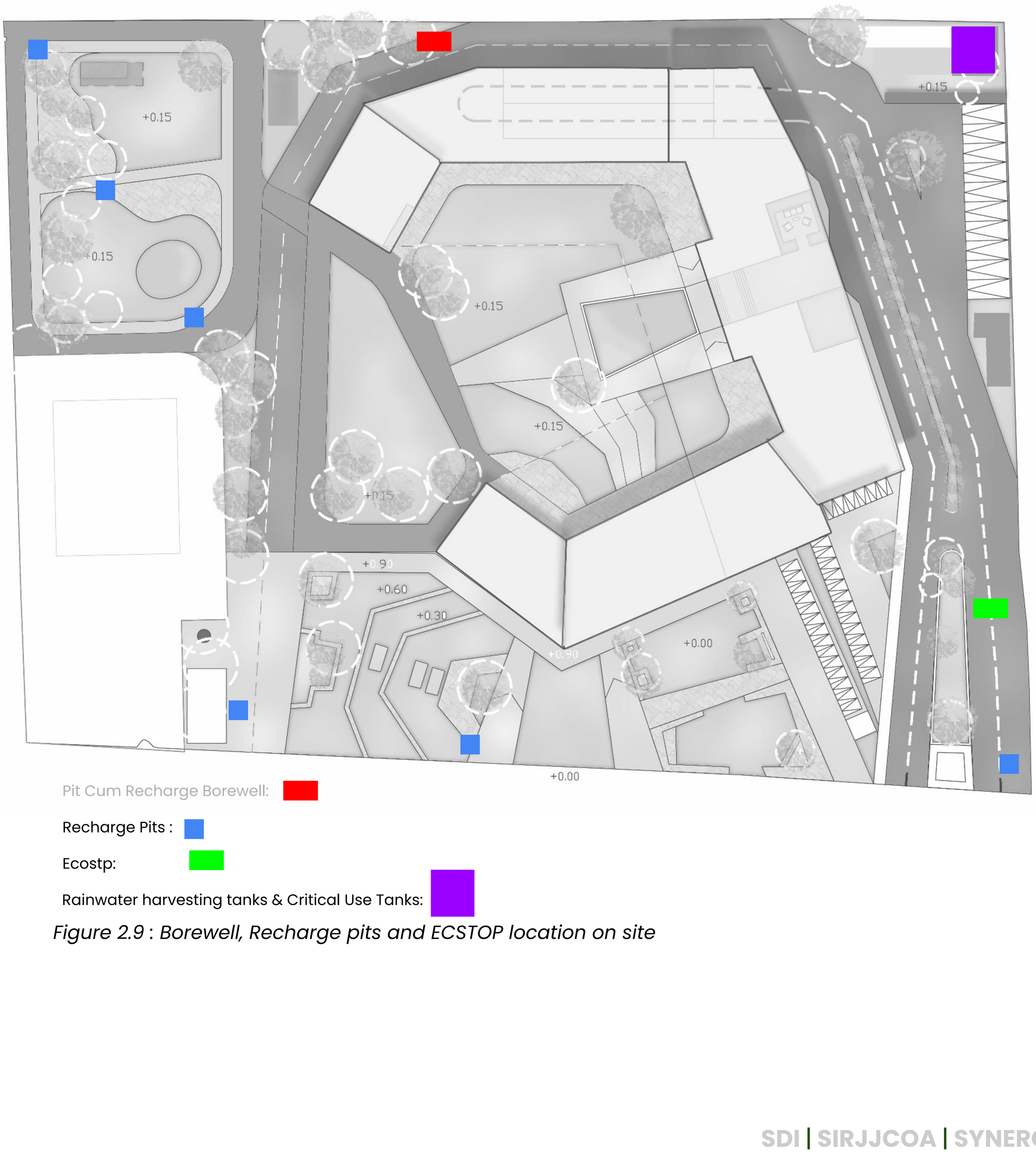


Figure 2.9 : Borewell, Recharge pits and ECSTOP location on site

EMBODIED CARBON

This section outlines 4 strategies based on research, market study and industry partnerships, that lower the embodied carbon of the project. Summary of Embodied Carbon emissions per functional unit of building systems is provided in the Appendix.

1. *CARBON-NEGATIVE BUILDING MATERIAL USE*

The primary building material used for walls is **Agrocrete**, which is made from agricultural waste.

2. *MODULAR PREFABRICATED CONSTRUCTION REDUCING EMBODIED EMISSIONS*

As per studies, going for prefabricated construction reduces embodied emissions at various levels.

Components	EE conventional building (MJ)	EE prefabricated building (MJ)
Total transportation	267,978.15	115,956.10
Total material	4,229,616.10	3,502,610.57
Plant process	32,524.07	13,046.20
Site process	78,858.17	6530.20
Human labor	40,303.52	93,964.90
Total EE	4,649,280.01	3,732,107.97
Total EE per unit Floor area (GJ/m^2)	5.01	4.02

Table T.12 : Embodied Energy of prefabricated and conventional building

3. *REDUCING MATERIAL WASTE AT CONSTRUCTION STAGE*

MIG and HIG, usually break walls and fixtures provided by developers to suit their functional and aesthetic requirements. Opting for an open floor plate design and not building interior walls at the construction stage, not only gives the flexibility to users to customize according to needs but also reduces the carbon wasted of breaking down the walls constructed by developers.

Certified by:

4. *USING NATURAL AND LOCAL BUILDING MATERIALS TO OFFSET COOLING DEMANDS*

Coolant KINETIC, the shading system designed is made of terracotta tubes manufactured by local artisans.

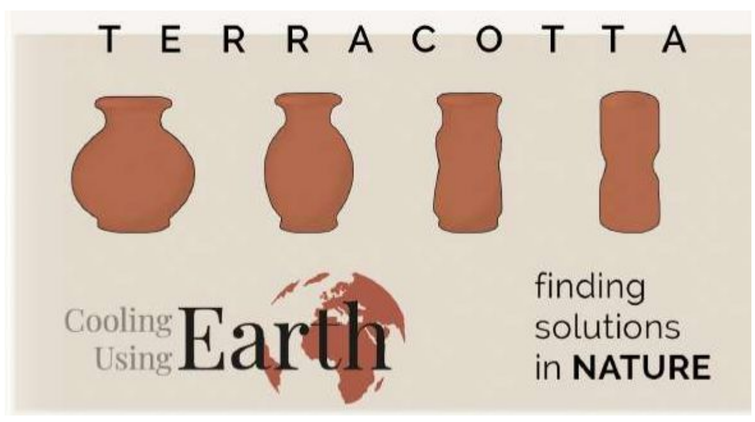


Figure 3.2: terracotta as a coolant

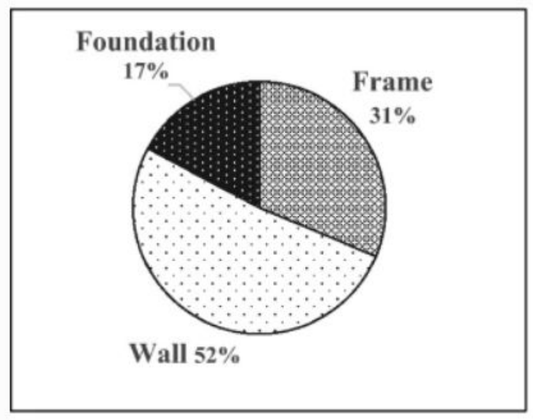
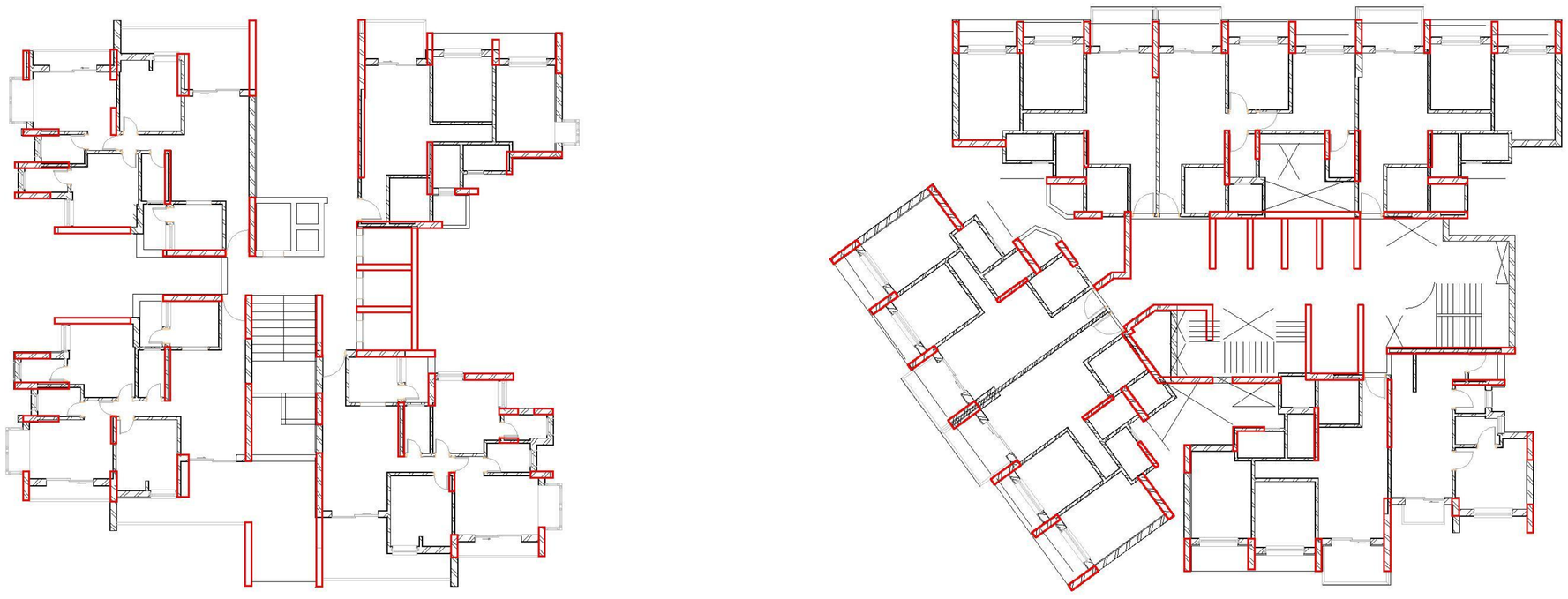


Figure 3.1 : Walls account for 52% of embodied emissions in construction

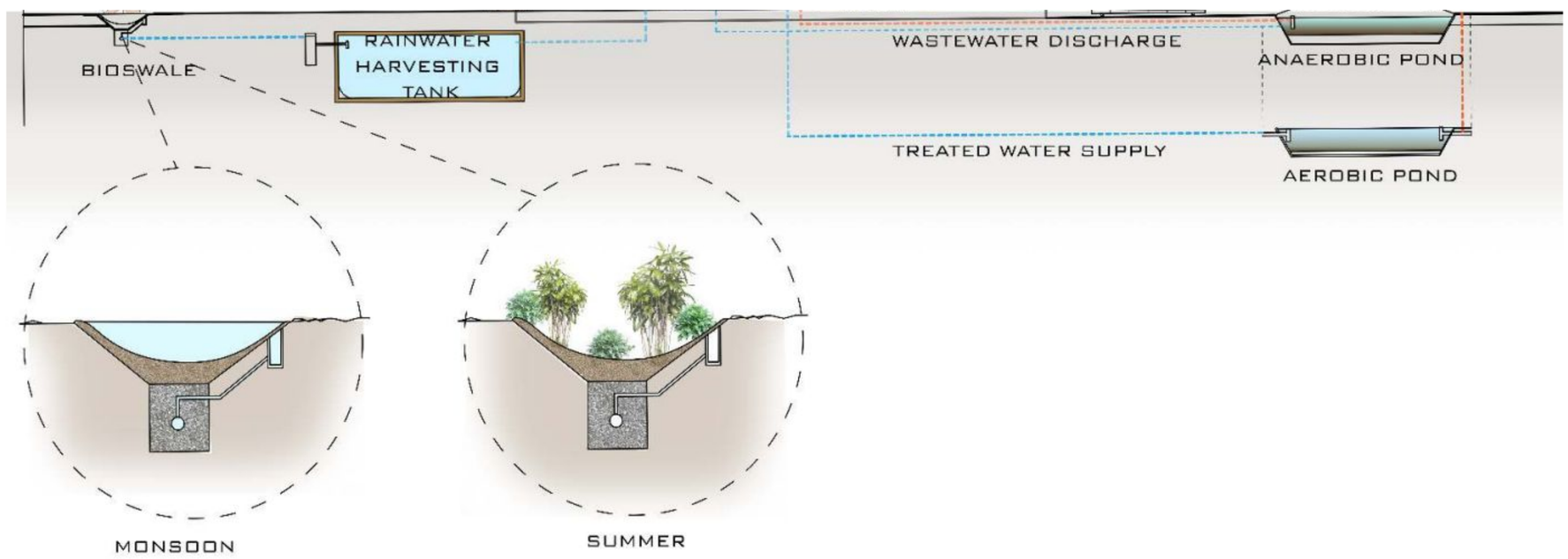
Resilience

- ***STRUCTURAL RESILIENCE AGAINST SEISMIC FORCES***

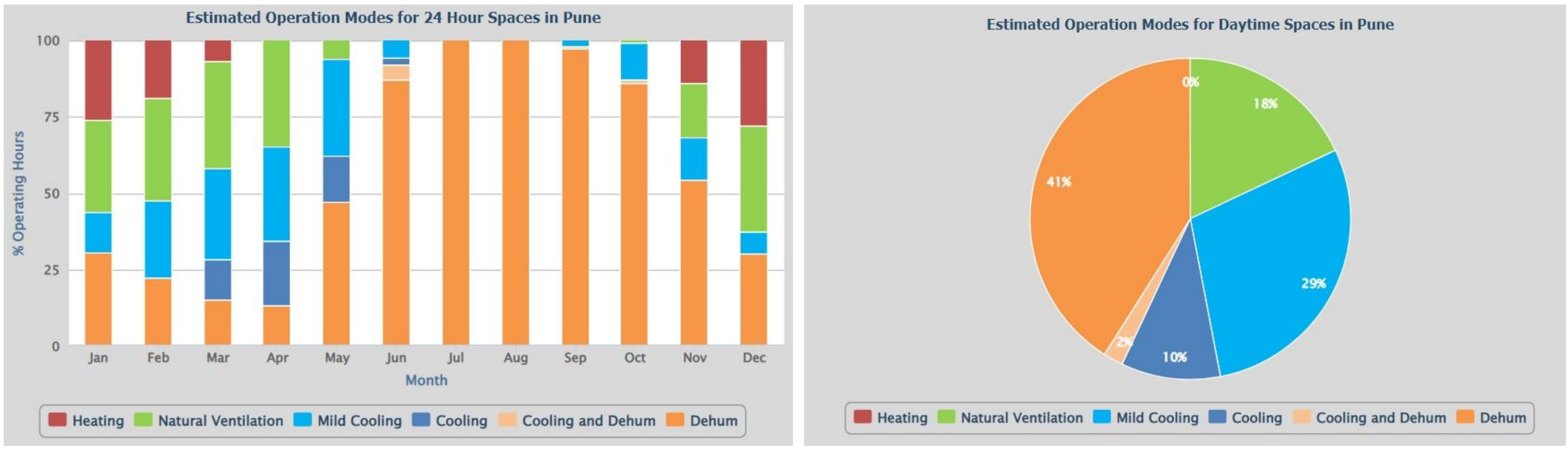


The columns have been arranged in an orthogonal grid with almost equal distribution of horizontally aligned columns and vertically aligned columns. For greater stability shear walls have been provided. The expansion joint is given at certain points to optimize the vibrations in the building.

- ***BIOSWALES PROVIDED TO MITIGATE STORMWATER RUNOFF AND PREVENT WATER LOGGING***



- ***THERMAL COMFORT PROVIDED WITHOUT DEPENDING ON MECHANICAL MEASURE DURING COMFORT HOURS***
  - ***As per IMAC Tool.***



Operation modes for critical hours for Pune as per IMAC tool

- **Critical Water Storage tank with 8000 KL provided along with rainwater storage tank. Refer Fig. 3.2 for location.**
- **Solar energy stored in battery banks. During Critical hours power from EV charging station also drawn to power common service areas like lifts, passages. (Refer Energy Performance section for energy generation capabilities.**

SECURITY

- Contact-less delivery system by robots.
- Reducing number of delivery persons entering the premises.
- Simplifying the delivery and collection system.

Figure: 4.1"Loomo Delivery Ambiator" by Segway Robotics

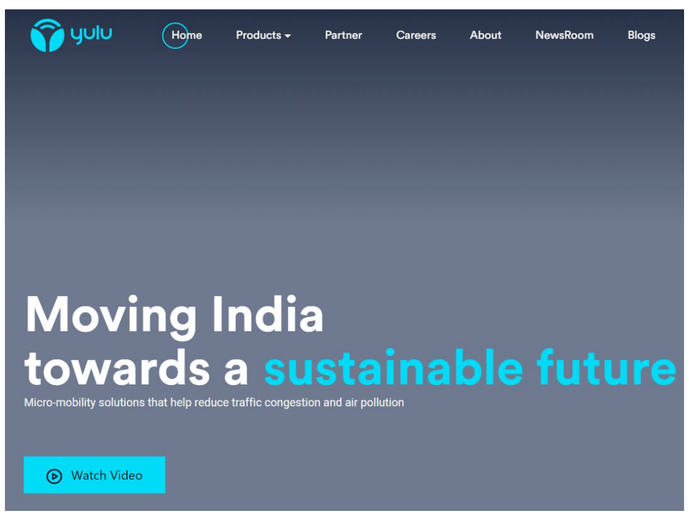
Loomo Delivery Ambiator : Is a mobile robot designed for indoor delivery services and is equipped with advanced autonomous navigation capabilities.

Here are some of the key features of the Loomo Delivery Ambiator:

- Delivery capability:The Ambiator is designed for delivering goods in a variety of indoor settings, such as hospitals, hotels, and office buildings. It can carry up to 50 kg (110 lbs) of goods in its cargo area.
- Autonomous navigation:The Ambiator uses advanced sensors to navigate autonomously in complex indoor environments. It can avoid obstacles and adjust its path in real-time to ensure safe and efficient delivery.
- Smart mapping: The Ambiator can create detailed maps of its surroundings and use them to plan the most efficient delivery routes
- Human-robot interaction:The Ambiator features a user-friendly touchscreen interface that allows users to interact with the robot and track their deliveries in real-time.
- Customization options: The Ambiator can be customized to meet the specific needs of different industries and businesses.

https://www.directindustry.com/prod/segway-robotics/product-233412-2330301.html

MICROMOBILITY



1. Last-mile connectivity: Yulu bikes can be used to bridge the gap between the residential campus and the nearest public transportation hub. This can help residents save time and effort while commuting.
2. Eco-friendly transportation: Yulu bikes are electric and emit zero emissions, making them an environmentally friendly mode of transportation. This can help reduce the carbon footprint of the residential campus and promote sustainability.
3. Cost-effective transportation: Yulu bikes are relatively inexpensive compared to other modes of transportation. This can help residents save money on transportation costs.
4. Convenience: Yulu bikes can be easily rented using a mobile app, and can be parked at designated locations within the residential campus. This can make it a convenient mode of transportation for residents.

Waste Management

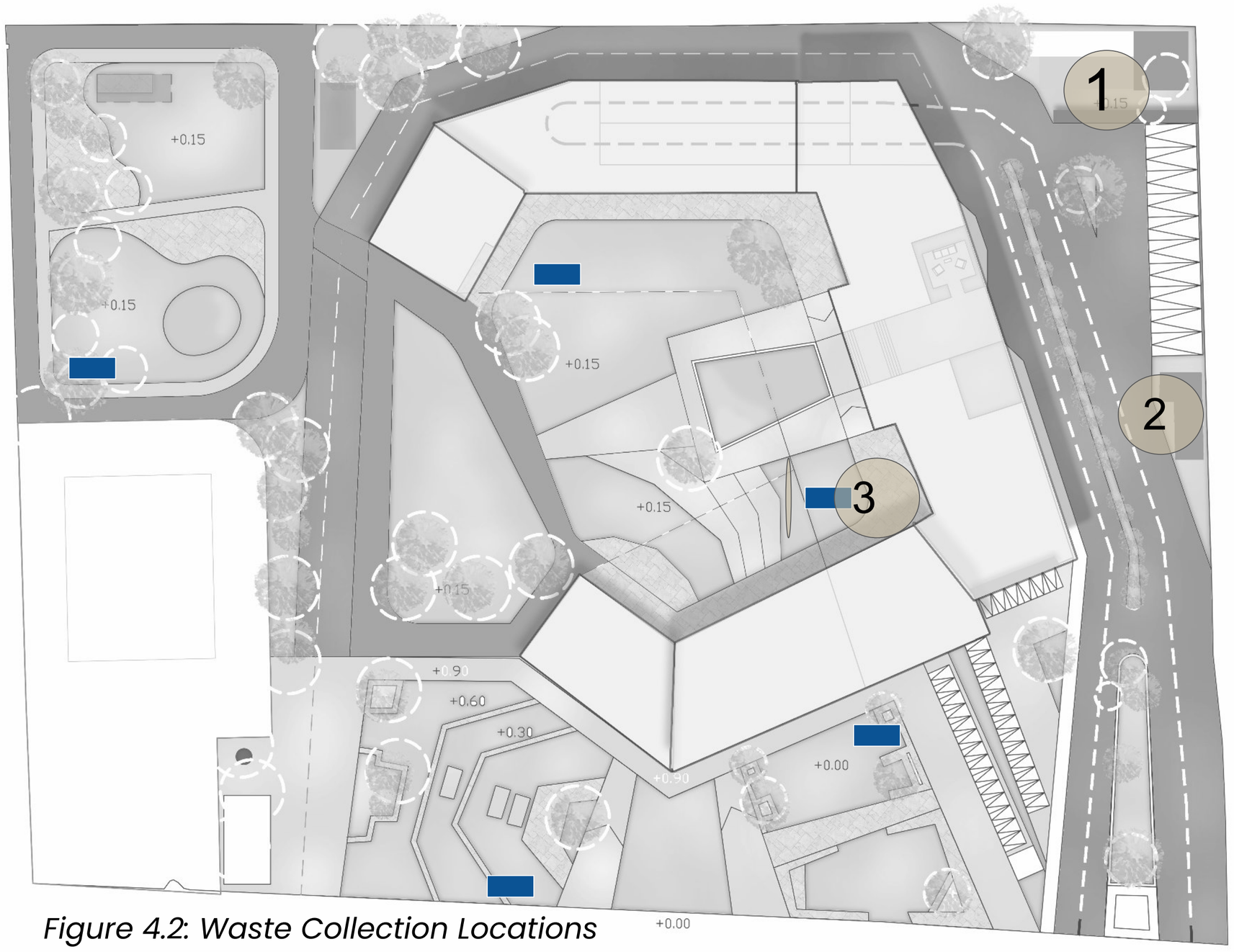


Figure 4.2: Waste Collection Locations

LEGENDS

1. Composting pit
2. Dry waste storage and MRF
3. Dustbin : dry /wet/plastic waste

No. of Occupants			
No.of units	**Units**	**Occupants as per IGBC**	**Total**
Studio	8	2	16
1 BHK	46	2	92
2 BHK	318	4	1272
3 BHK	126	5	630
Total	**498**	**13**	**2010**

Table T.13 : Calculation of total number of occupants

According to SWATCH BHARAT MISSION kg/per day waste generation factor for Pune is ‘ 0.46’

So accordingly as per occupancy and waste generation factor ‘924.6 kg/perday’ waste is generated

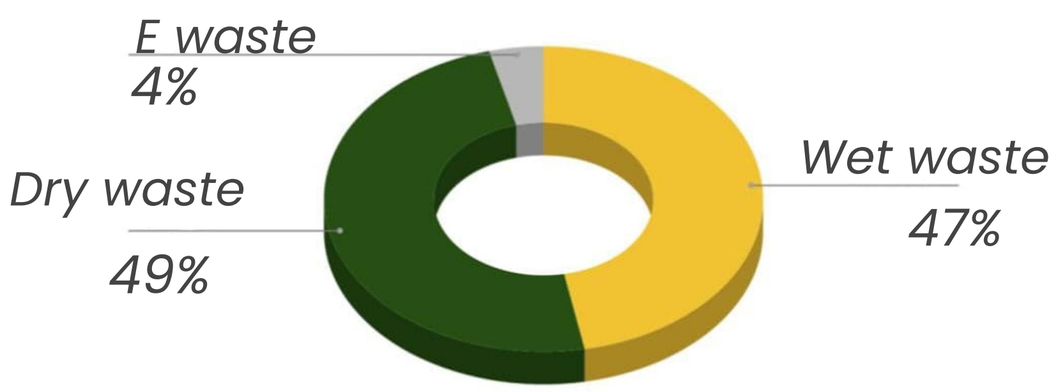


Figure 4.3: Pie chart indicating waste distribution

Sr.no.	Type of waste	Waste Generation Factor	Waste Generation *(kg/day)*	Waste Generation *(ton/year)*	Treatment of Disposal
1.	Garden waste		0.00	0	Composting
2.	Biodegradable/ Food waste	0.4743	2.77	1	Composting
3.	Paper	0.0813	0.48	0	Recycling
4.	Plastic	0.0922	0.54	0	Recycling
5.	Metal	0.0050	0.03	0	Recycling
6.	Glass	0.0101	0.06	0	Recycling
7.	Rags	0.0449	0.26	0	Reuse
8.	Inert	0.2516	1.47	1	
9.	Other	0.0402	0.23	0	

Table T.14 : Waste generation by type based on waste generation Factors and its treatment method

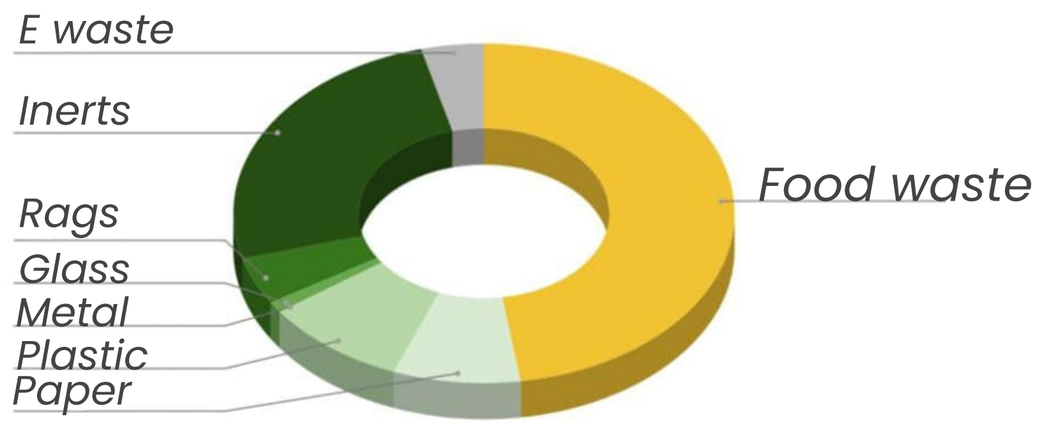


Figure 4.4: Pie chart indicating types of waste

Waste Management and Techniques

WET WASTE

BIOGAS + MANURE

Biogas plant by Vayu generates 10000 liter biogas for every 7-10 kgs of wet waste, which is equivalent to 335 grams of LPG along with slurry as bi product which proves to be a great natural fertilizer

5m by 5m

COMPOSTING

Composting helps to dispose off wet waste in a productive way, creating sustainable gardens, and also provides the opportunity for societies to generate extra income by the sale of compost fertilizer.

Height: 2.5 ft.
Internal width:3ft.
External width: 4ft.
Length: 30ft.

DRY WASTE

MRF REVENUE GENERATION

A materials recovery facility (MRF), sometimes called a materials reclamation facility or materials recycling facility, is a plant that separates and prepares single-stream recycling materials to be sold to end buyers.

Six storages of 27 cu.ft. each except one of 54 cu.ft. for paper and thermocol storage

E WASTE

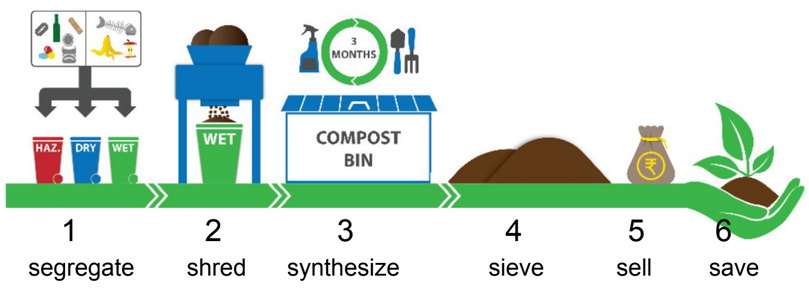


Figure 4.5: Composting process

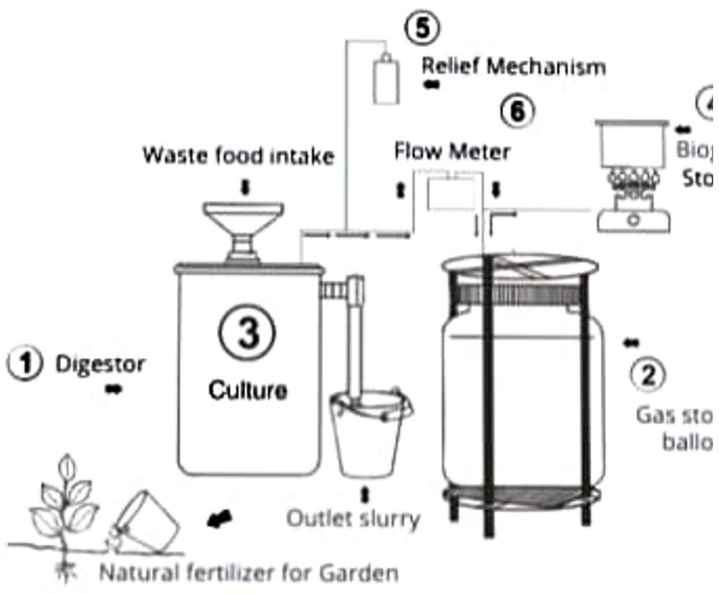


Figure 4.6: Biogas & Manure generation process

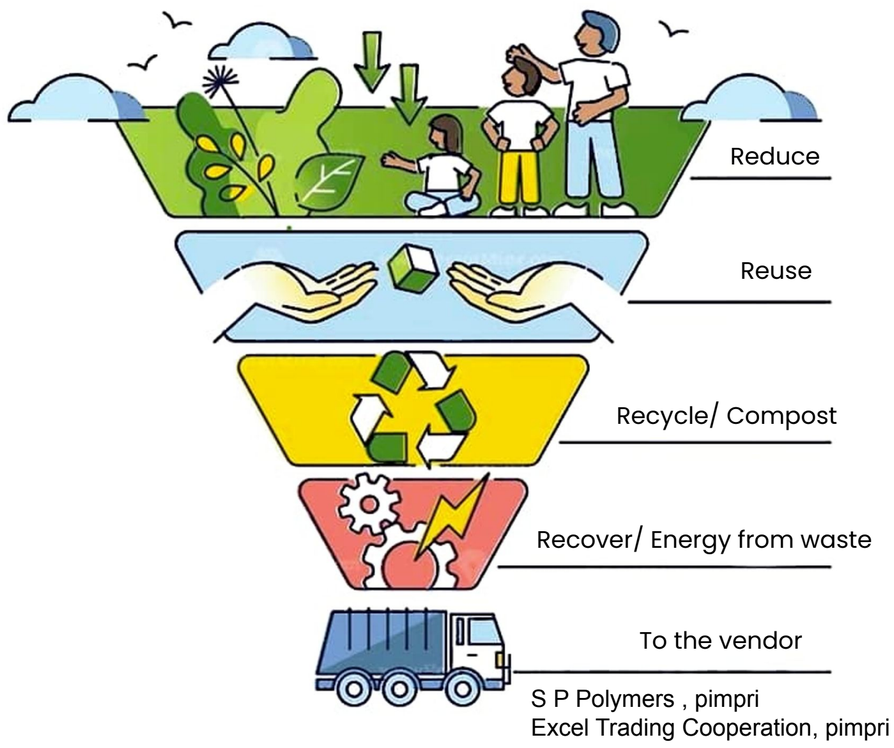


Figure 4.7: Waste Ecosystem

MRF

Social — Employment

MRF will create employment opportunities for the local people. These facilities require human labour to help in efficient segregation of the waste units. Labour is also required to manage the entire facility from the start (collection) till the end (selling).

Economic — Funds

Segregated waste units are compressed and moulded into cubicle units. These units are sold to industries/ end consumers that require these materials. Funds collected from this are used to maintain the MRF facility, and at the same time increase the institution's infrastructure.

Ecological — Net-zero waste

This method of solid waste management helps in achieving a net-zero waste status for the building wherein we are not contributing to dumping the building's waste in landfills. We are treating/processing our waste onsite and reducing its impact on environment as much as possible.

Engineering and operations

PREFABRICATED CONSTRUCTION DETAILS

It is a system of formwork for RCC that stays in place as a permanent interior and exterior for walls, floors, and roofs. These are interlocking modular units that are filled with concrete. ICFs are really a hybrid prefab material, since installing rebar and pouring concrete is done on-site, they offer many of the cost and environmental benefits of pure prefab. Compared with traditional concrete construction, it is faster to stack ICF foam blocks and since they are not removed, there is much less waste. ICFs provide much better thermal insulation than conventional framed construction. Since the wall is solid, there is no possibility of convection within the wall.

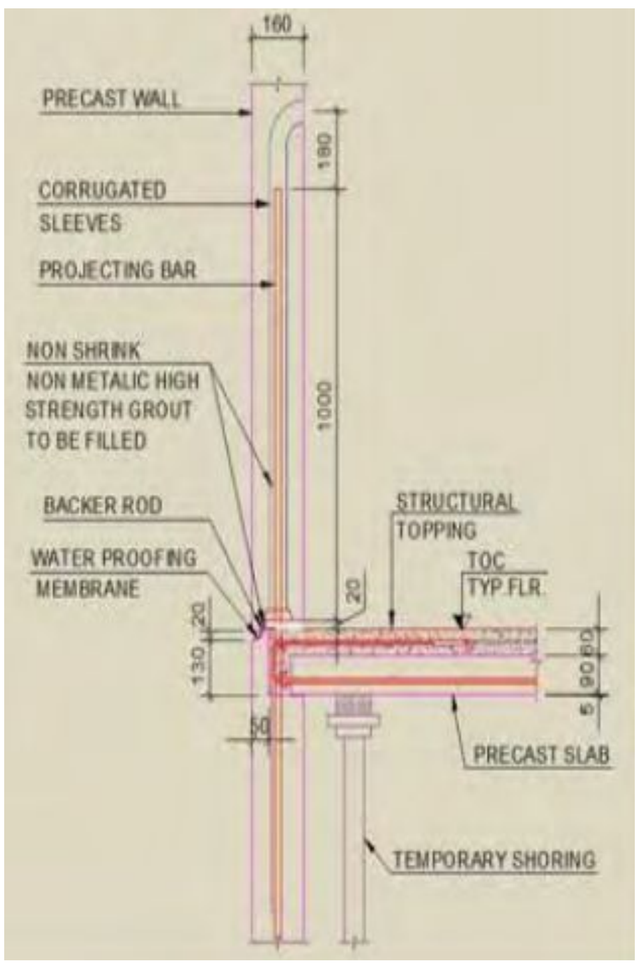


Figure 5.1: Wall to slab connection :Section

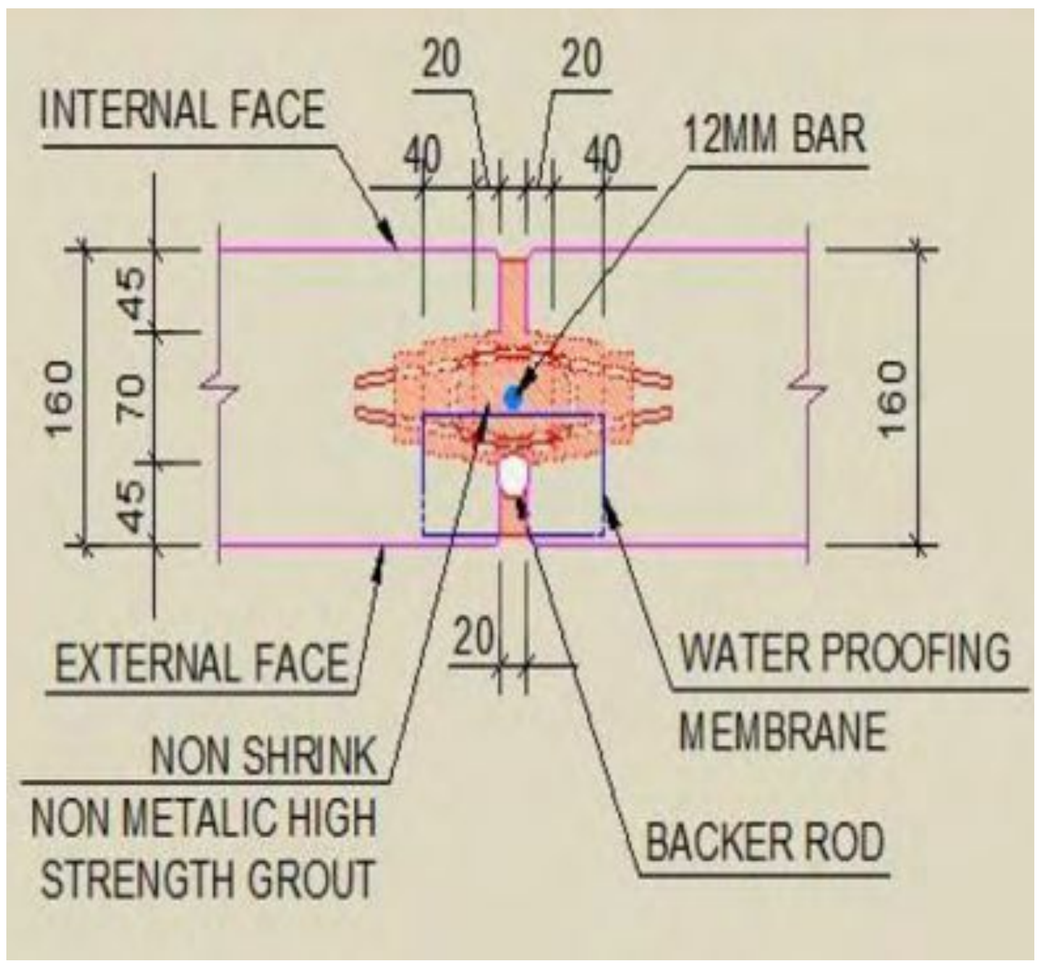


Figure 5.2: Wall to wall connection: Plan

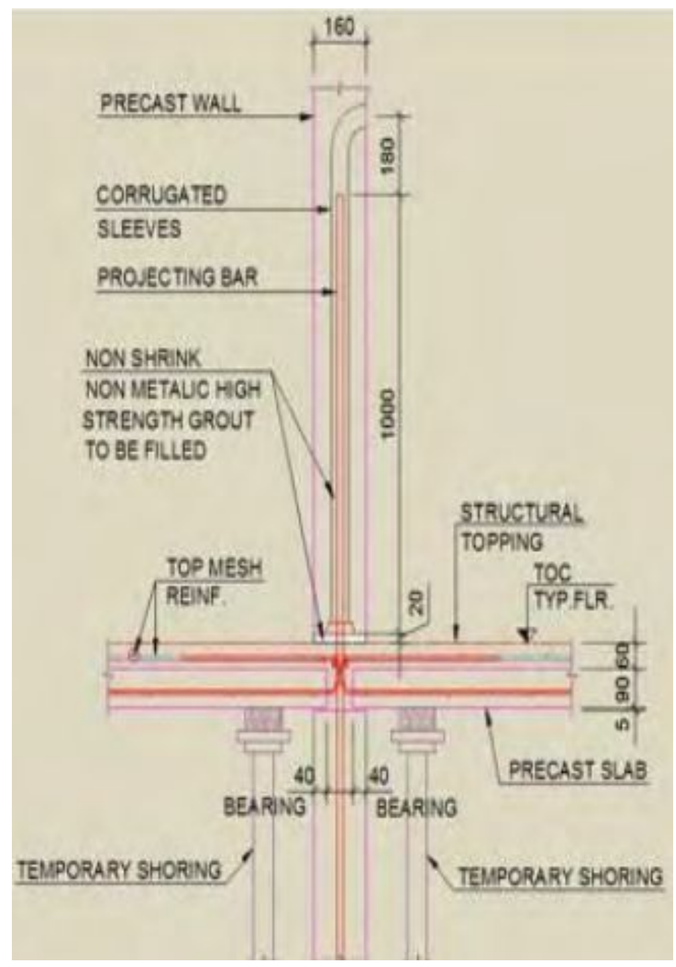


Figure 5.3:Ex. Wall to Int. wall connection: Section

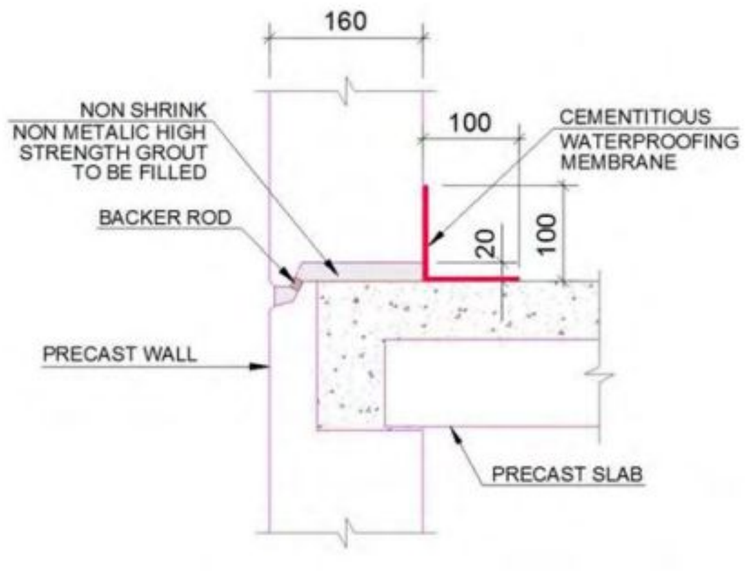


Figure 5.4: Cementitious waterproofing membrane

WATERPROOFING

External joints shall be sealed with baker rods and sealants after filling the joints with grout to avoid the leakage. Additional waterproofing treatment shall be provided at external joints and wet areas to ensure water tightness.

FIRE RATING

Fire rating period of fire resistance of RCC buildings is based on NBC requirements. To meet the fire rating requirement, provision specified in IS 456:2000 shall be followed.

DESIGN LOAD

- Dead loads – the dead load shall comprise of self-weight of all the frames and shell elements modelled in the structure as well as self-weight of slabs.
- Imposed loads – The imposed loads that are envisaged to act permanently (whichever applicable) are as follows: i. Waterproofing: Shall depend on the thickness, slope and kind of material to be used for waterproofing ii. False ceiling/Internal partitions: False ceiling load shall be calculated based on type of material and thickness using unit weights specified in **IS 875(Part 1):1987.**
- Partition loads shall be as per actuals. iii. All structural elements: Layout and size of elements shall be followed as per structural requirements.

Load combination	Limit state of collapse			Limit state of serviceability		
	DL	LL	WL/EL	DL	LL	WL/EL
DL+LL	1.5	1.5	--	1.0	1.0	--
DL+WL	1.5/0.9*	--	1.5	1.0	--	1.0
DL+LL+WL	1.2	1.2	1.2	1.0	0.8	0.8
DL+EL	1.5/0.9*	--	1.5	1.0	--	1.0
DL+LL+EL	1.2	1.2	1.2	1.0	0.8	0.8

*To be considered when stability against overturning and stress reversal is critical.
Where DL -- Dead load, LL – Live load, WL – Wind load & EL – Earthquake load

Table T.15 : Load calculations

EQUIPMENT EFFICIENCY

Appliances	Units/W		X	Count	=	Load
Bulb	5W	5	X	432	=	2160
Ceiling Fan	50W	50	X	32	=	1600
Table Fan	Other	32	X	10	=	320
TV	150W	150	X	7	=	1050
Air Conditioner	1.5TON	1500	X	15	=	22500
Washing Machine	700W	700	X	7	=	4900
Water Pump	-Select-	0	X		=	0
Geyser	800W	800	X	10	=	8000
Heater	550W	550	X	7	=	3850
Refrigerator	150litres	60	X	7	=	420
Electric Iron	550W	550	X	7	=	3850
Mixer / Grinder	150W	150	X	7	=	1050
PC / Laptop	100W	100	X	10	=	1000
Microwave Oven	1000W	1000	X	7	=	7000
Radio	50W	50	X	2	=	100
Stove	750W	750	X	7	=	5250
Cloth Drier	200W	200	X	7	=	1400
Electric Clock	5W	5	X	7	=	35
Cooking Range	5000W	5000	X	7	=	35000

Table T.16 : Load calculation per day per floor

Appliances	Cost in rupees	Power	Image of appliance
HP Pavillion 12 gen series laptop	64000	140	
Panasonic exhaust fan f-av 30as2	1190	32	
IFB 5 star washing machine	23500	360	
HVLS Ceiling fan	6550	350	
Samsung smart refrigerator 5star direct cool	17590	300	
Panasonic convention microwave	10790	750	
SAMSUNG 55 inch tv	35990	57	
5 star electric cooktop	7990	900	

Table T.17 : Suggestive appliances to reduce demand loads

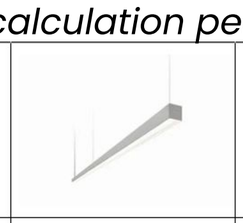
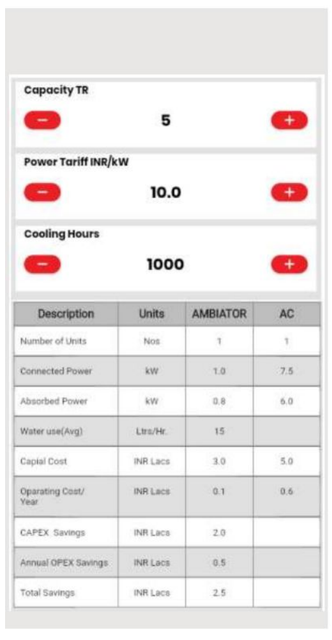
Images of Lighting Fixtures :							
Type of Light	Suspended LED light	Ceiling mounted LED light	Ceiling down light	Ceiling down light 2	Table Lamp	Candle bulb	False ceiling light
Company	Philips	Philips	Philips	Philips	philips	philips	philips
Wattage(w)	30	16	20	12	10	8	8
Average Lumen received (lm)	4000	2000	2000	1000	800	600	600

Table T.18 : Energy efficient lighting reducing demand loads

HVAC OPTIMIZATION



- Decentralized cooling using AMBIATOR technology is a cost-effective and environmentally friendly choice for high rise residential buildings.
- Its energy efficiency, lower cost of maintenance and servicing, and reduced GHG emissions make it a superior alternative to traditional district cooling or VRF/VRV systems.
- The AMBIATOR is 30% less expensive than an equivalent VRF/VRV system. The differential payback is typically 1 summer season.

AMBIATOR Specifications

Description	Units	Value
Cooling Capacity	TR Equivalent	5
Air Quantity	CFM/CMH	3000/5000
Height	mm	2000
Width	mm	750
Depth	mm	1000
Weight	Kg	180
Fan Motor	Watts	800
Fan	Type	Plug Flow (TORO)
Air Flow	Type	Blow Through
Drive	Type	Direct
Pump Motor	Watts	120
Pump Body	Type	Cast Iron
Electrical Input	Type	440 V – 3 Phase
Control Panel	Type	Integral with IoT
Temperature Control	Type	IoT
Humidity Control	Type	IoT
Fan Speed Control	Type	VFD + IoT
Remote Monitoring	Type	IoT via Web / App
Casing	Type	GI
Protection	Type	Powder Coating
Process IDEC	Type	Regenerative
Protection	Type	Granted Indian Patent
Air Filters	Type	20 Micron (Washable)
Ambient Temperature	^{0}C	Below 50
Ambient Humidity	%	Below 55
Supply Air (Summer)	^{0}C	18-24
Supply Air (Monsoon)	^{0}C	25-27
Sound (Indoors)	dba	Below 50
Water Use	Liters/Hour	10-25

Products	Power	Capex	Opex
AMBIATOR	1 kW	Low	Low
AC	7.5 kW	High	High

- Ambiator 1 TR can be accommodate for a unit on the service Slab provided for the toilets. From here supply and return air ducts are taken to the rooms where air conditioning is required As per user preference.
- Since interior walls would be designed as per users, ducting Systems can also be accommodated along with them.

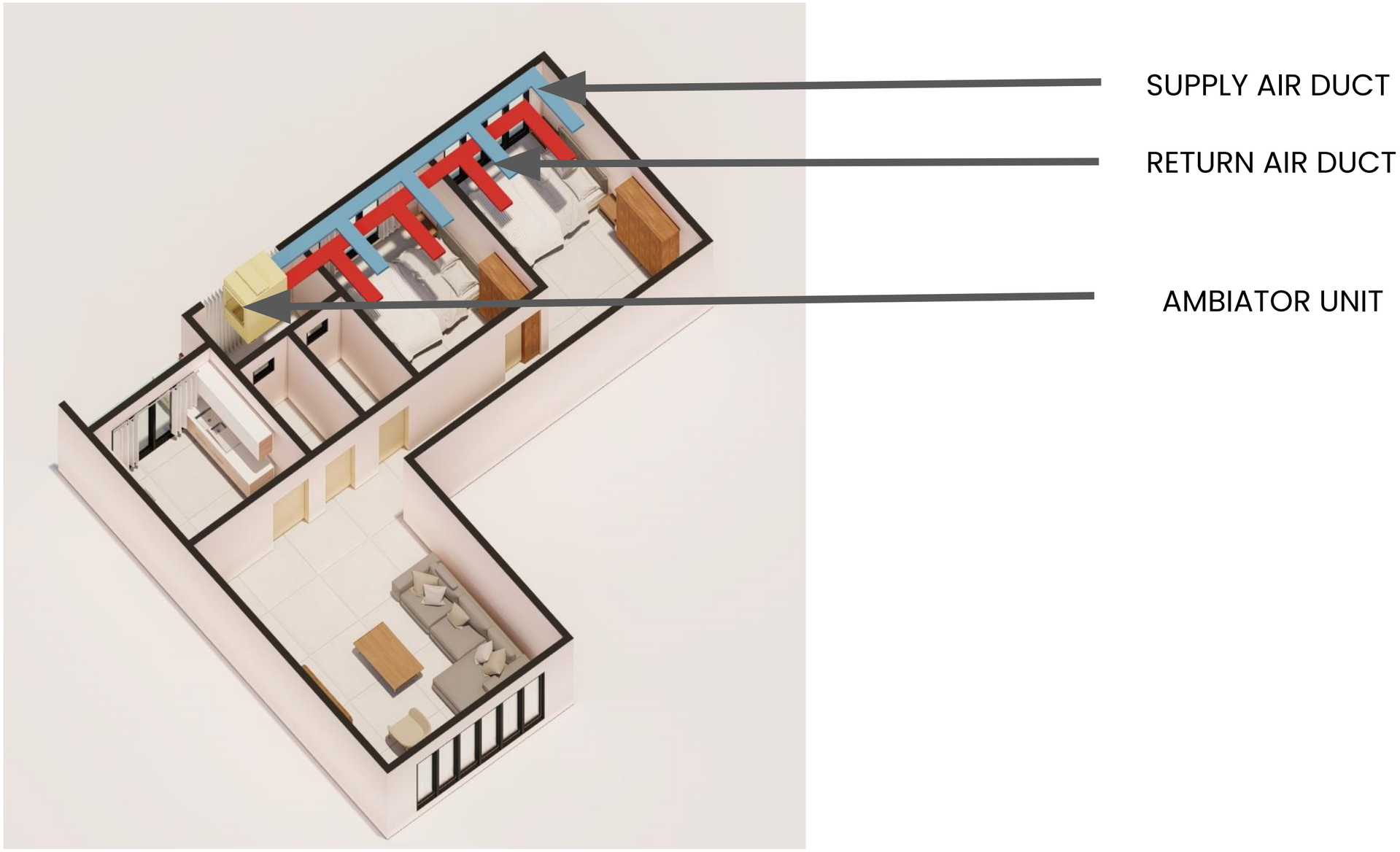


Figure 5.5 : Ambiator ducting for a 2bhk unit

- The following graphs show the operating schedule of Ambiator during peak cooling demand hours, i.e., peak summer days.

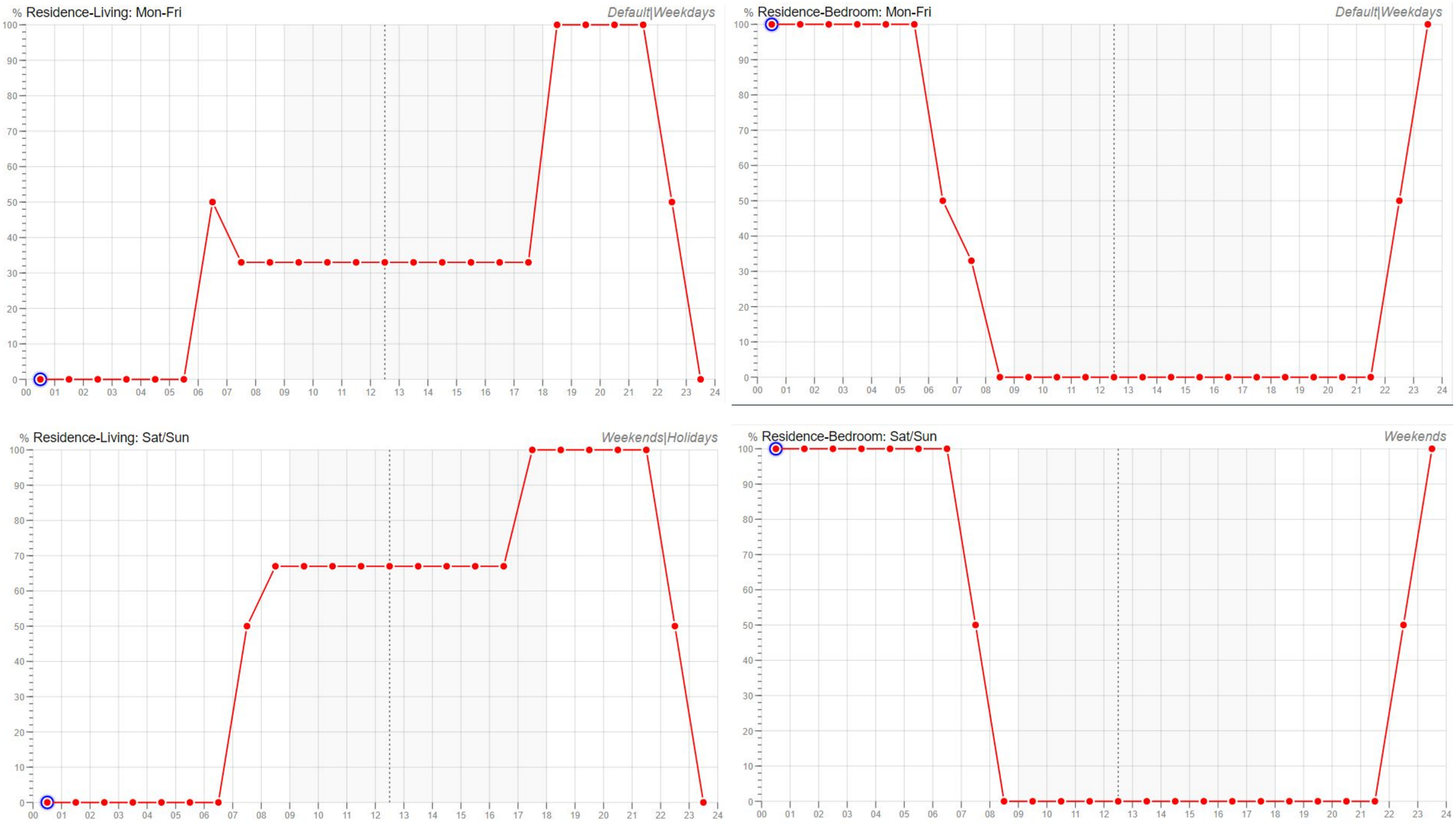


Figure 5.6 : Operating Schedule graphs for Ambiator air conditioning

Architectural design

BUILDING THROUGH NATURE

Vernacular habitats have evolved around a network of community spaces generally translated through a hierarchy of courtyards transitioning from the central square through to the public / private “otla” .
The sense of place, community and identity fostered by these archetypes has been subverted by the proliferation of stacked floor plates leaving little room for the informal

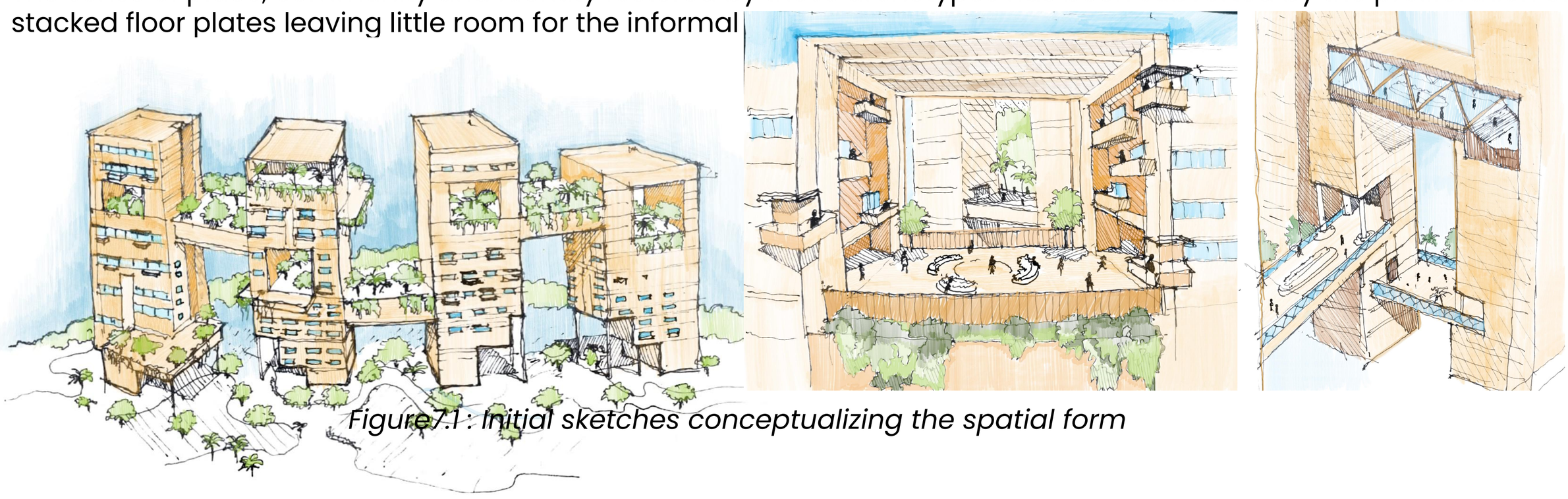


Figure7.1 : Initial sketches conceptualizing the spatial form

The extension of the street and garden into the high rise towers is the guiding principle behind the development of the building form.

- ***SITE PLANNING***

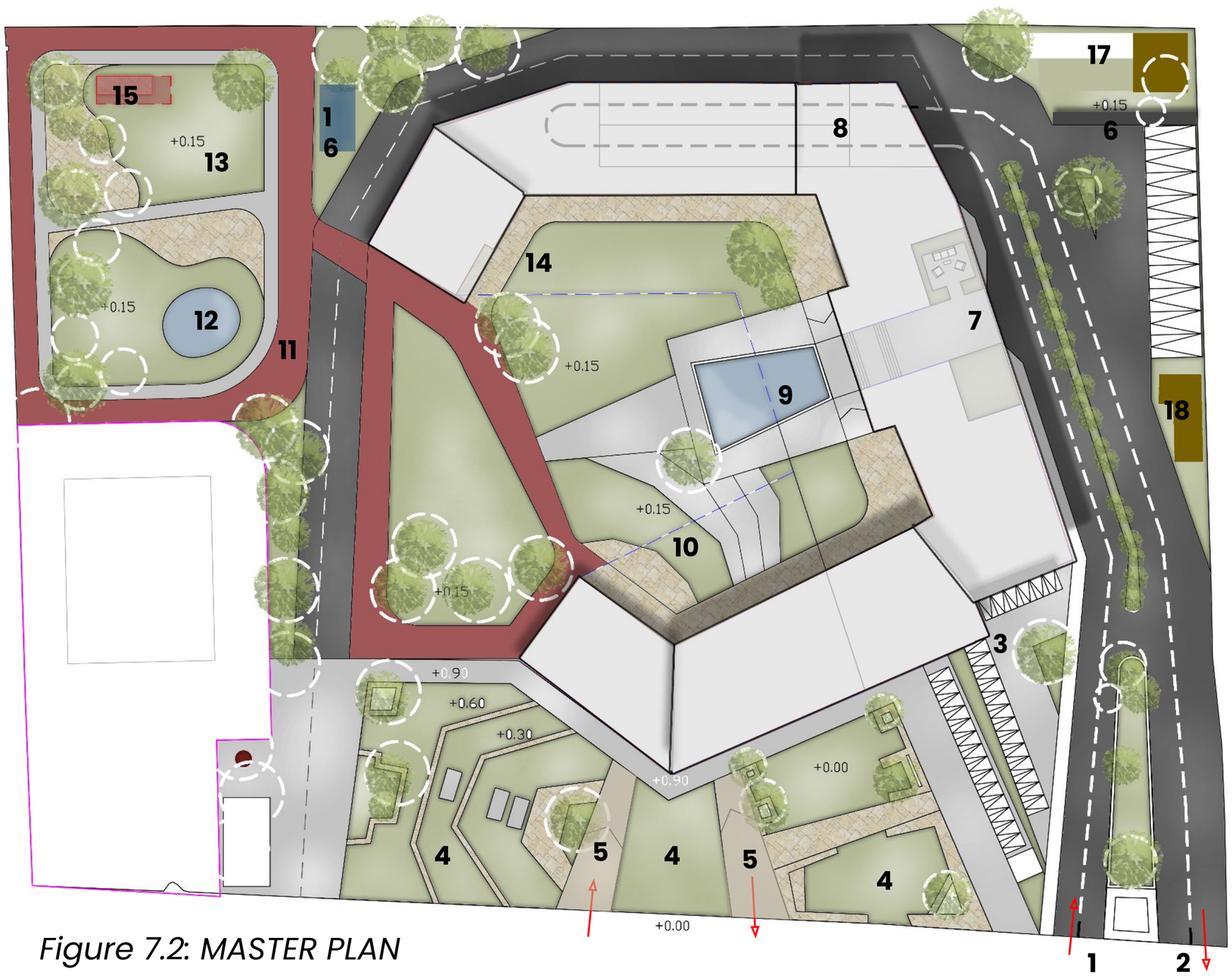


Figure 7.2: MASTER PLAN

1. SITE ENTRANCE
2. EXIT
3. VISITORS 2 WHEELER PARKING WITH ELECTRIC CHARGING POINT
4. ‘THE URBAN LVIING ROOM’
5. PIEZOELECTRIC TILES
6. VISITORS 4 WHEELER PARKING WITH ELECTRIC CHARGING POINT
7. RESIDENTIAL DROP OFF POINT
8. VEHICULAR RAMP TOWARDS PODIUM
9. SWIMMING POOL
10. OPEN AMPHITHEATER
11. CYCLING TRACK
12. POND
13. CHILDRENS PLAY AREA
14. KITCHEN GARDEN
15. ECO STP
16. RAINWATER HARVESTING TANK
17. COMPOST PIT FOR WET WASTE
18. MRF FOR DRY WASTE

THE 'URBAN LIVING ROOM'

- As part of the building program, commercial spaces for shops have been provided at the street front.
- A public plaza is proposed in front of this which can serve as a urban insert for the need of a public open recreational space at the neighbourhood level.
- It can host various activities such as **farmer's markets, seminars on awareness (especially climate awareness), exhibitions to promote small businesses, yoga classes, etc. or just as a place for assembly or leisure.**
- This asserts its space as a non-exclusive space with provisions made in terms of security to not infiltrate the private grounds of the project.
- The hardscape tiles selected are **piezoelectric tiles** thus helping generate power for the plaza lighting and commercial shops. *Details of piezoelectric tiles in appendix.*

VOIDS AS CONNECTORS

- With skywalks, balconies and deck, green spaces flow through the structure, creating a healthy biophilic environment.

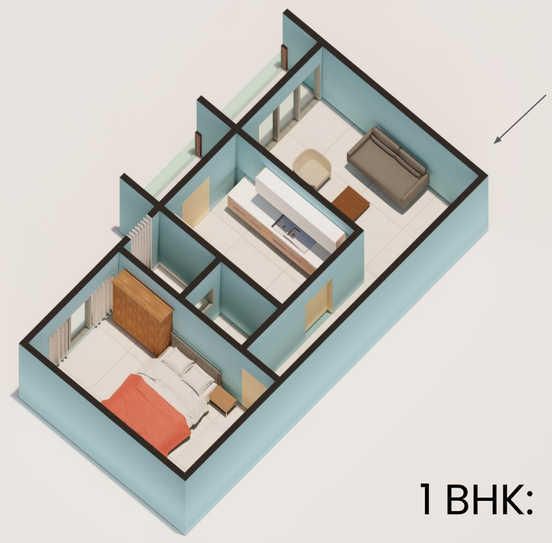
UNIT ALTERATIONS

The housing is designed in a grid of 5m x 4.4m.
These houses caters to different user groups such as bachlors and family . the housing is designed as high rise structures that are faster to build and flexible to modify. The housing unit can multiply into variety of configurations and develop into an into an intimately attach balcony and open spaces.

BACHELORS HOUSING

STUDIO APARTMENT:

CONVENTIONAL FAMILY HOUSING



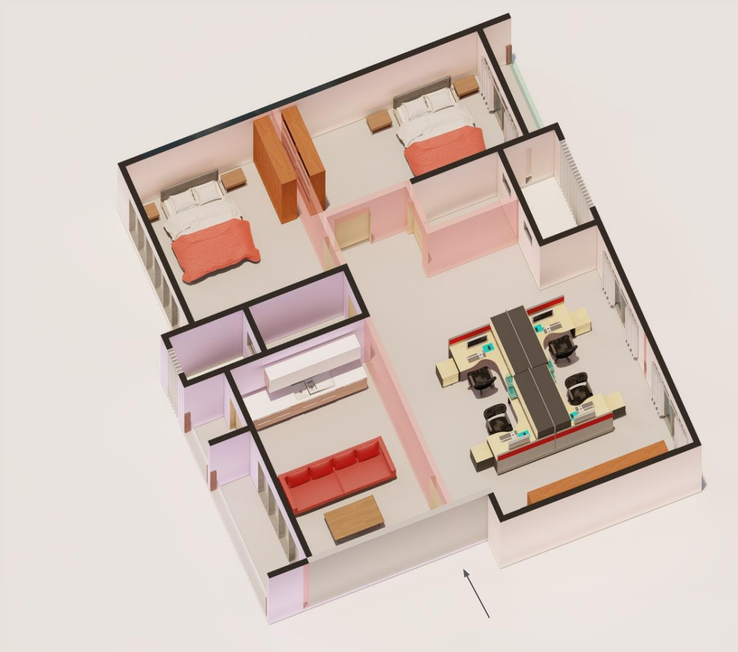
1 BHK:

2 BHK:

3 BHK:

COMBINATION OF UNITS

For Small business running of house-
clothing/food/product/service/ classes



STUDIO AND 2 BHK COMBINED:

2 BHK & 3BHK COMBINED:

2 BHK WITH OFFICE SPACE :

Affordability

Project Project Information					
Team:	Team Synergy				
Division:	Multifamily Housing		**Land Cost:**	112	Million INR
	Site Area (sqm)	11,306	**City:**	Pune	
	Built-up Area (BUA) (sqm)	12,437	**State:**	Maharashtra	
	Ground Coverage (Plinth Area) (sqm)	4,522			

S.No.	Particulars	Definition	Baseline Estimate (Project Partner / SOR basis)			Proposed Design Estimate		
			Amount (Million INR)	**%**	**Amount** (INR per sqm)	**Amount** (Million INR)	**%**	**Amount** (INR per sqm)
1	Land	Cost of land purchased or leased by the Project Partner	112.00	56.4%	9,006	112.00	74.2%	9,006
2	Civil Works	Refer Item A, Civil works in Cost of construction worksheet	2.20	1.1%	177	2.60	1.7%	209
3	Internal Works	Refer Item B, Civil works in Cost of construction worksheet	1.44	0.7%	116	1.43	0.9%	115
4	MEP Services	Refer Item C, Civil works in Cost of construction worksheet	40.17	20.2%	3,230		0.0%	-
5	Equipment & Furnishing	Refer Item D, Civil works in Cost of construction worksheet	0.01	0.0%	1	0.01	0.0%	1
6	Landscape & Site Development	Refer Item E, Civil works in Cost of construction worksheet	0.20	0.1%	16	0.00	0.0%	0
7	Contingency	Amount added to the total estimate for incidental and miscellaneous expenses.	2.20	1.1%	177	3.21	2.1%	258
	TOTAL HARD COST		**158.2**	**80%**	**12,722**	**119.3**	**79%**	**9,589**
8	Pre Operative Expenses	Cost of Permits, Licenses, Market research, Advertising etc	10.00	5.0%	804	10.00	5.0%	804
9	Consultants	Consultant fees on a typical Project	10.00	5.0%	804	10.00	5.0%	804
10	Interest During Construction	Interest paid on loans related to the project during construction	20.25	10.2%	1,629	11.72	5.9%	943
	TOTAL SOFT COST		**40.3**	**20%**	**3,237**	**31.7**	**16%**	**2,551**
	TOTAL PROJECT COST		**198.5**	**100%**	**15,959**	**151.0**	**100%**	**12,139**

- HVAC LIFE CYCLE COSTS VS CONVENTIONAL AIR CONDITIONER

Comparative Study - AMBIATOR vs Air Conditioner (VRV/VRF)									
Outdoor Temperature	°C	40° ± 2							
Outdoor Humidity	%	<30% ± 5							
Indoor Temperature	°C	26° ± 2							
Indoor humidity	%	<50% ± 5							
Capacity	**TR**	**5**		25		50		100	
Description	Units	**AMBIATOR**	AC (VRF/VRV)	AMBIATOR	AC (VRF/VRV)	AMBIATOR	AC (VRF/VRV)	AMBIATOR	AC (VRF/VRV)
Connected Power	kW	**1**	7.5	5	37.5	10	75	20	150
Absorbed Power	kW	**0.8**	6	4	30	8	60	16	120
Water use (Avg)	Ltrs/Hr.	**15**		75		150		300	
Capital Cost	INR Lacs	**3**	5	15	25	30	50	60	100
Power Tariff	INR/kWh	**10**	10	10	10	10	10	10	10
Cooling Season	Hours	**1800**	1800	1800	1800	1800	1800	1800	1800
Operating Cost/Year	INR Lacs	**0.144**	**1.08**	**0.72**	**5.4**	**1.44**	**10.8**	**2.88**	**21.6**
CAPEX Savings	INR Lacs	**2**		10		20		40	
Annual OPEX Savings	INR Lacs	**0.94**		**4.68**		**9.36**		**18.72**	
Total Savings	INR Lacs	**2.94**		**14.68**		**29.36**		**58.72**	
AMBIATOR Payback 1 Summer Season									

Cost benefits of Coolant KINETIC

Factors	Facade	Air cooler	Fan	Split AC
Spaces	Closed and open	Closed and open	Closed and open	Closed
Method	Natural + mechanical ventilation	Mechanical	Mechanical	Mechanical
Technique	Evaporative cooling	Evaporative cooling	Air movement	Refrigerant based cooling
Energy consumption	0-15%	15%	10%	10%
Humidity	Can control humidty by regulating water flow	No control on humidity	Same as RH	Can be controlled
Application	Can be applied on building facades	NA	NA	NA
Longevity	10-15 years	8-10 years	6-10 years	8-10 years
Cost	1200 - 1500 / sft	10000 per unit	1000 per unit	40000 per unit
Heat transfer	Cuts the heat entering the building	NA	NA	NA
Air quality	Open fresh air	From cooling pads	No change in surrounding air	Circulates same air inside in most cases
Aesthetic Value	Has a good aethetic value	None	None	None
Planters	Can integrate plants	NA	NA	NA
Custom based	Customisable	NA	NA	NA
Environment	Very good	To an extent	Good	Bad
Water	Smart Drip system	Continous flow	NA	NA
Refrigerant	Water	Water	NA	Chemical
Primary material	Earth and aluminum	Plastic	Metal / plastic	Plastic /copper / aluminum
Post life cycle	Back to earth	Plastic waste - landfill	Electronic waste	Plastic and HCFCs - harmful to environment

Innovation

COOLANT KINETIC

Revolutionizing the air conditioning industry, in collaboration with Ant Studio, **Coolant KINETIC** is proposed as **movable external shading and insulation device**. Made from local terracotta tubes, this solution is an affordable solution inspired by nature.

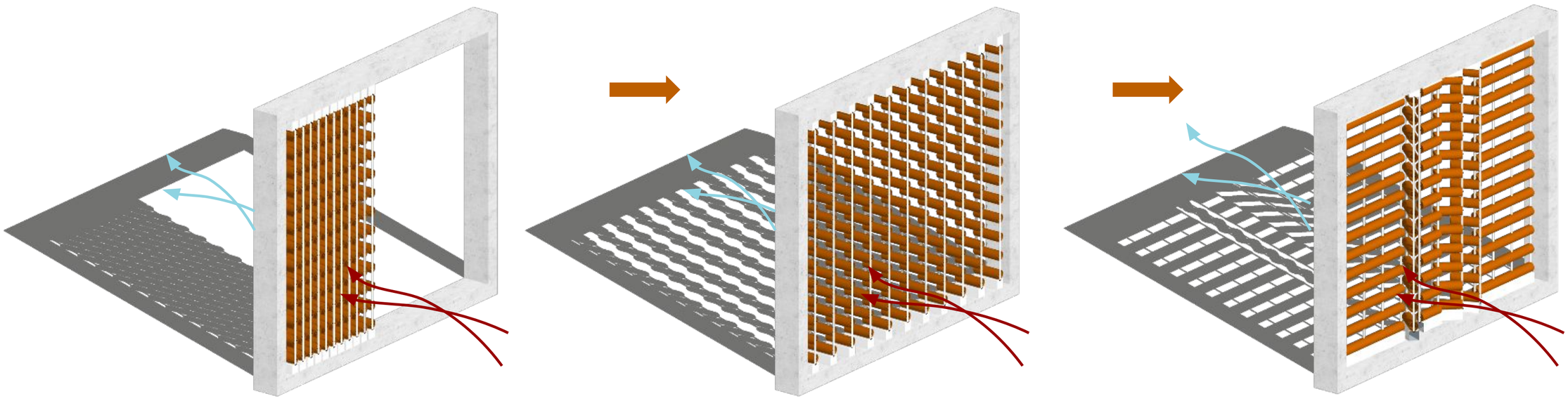
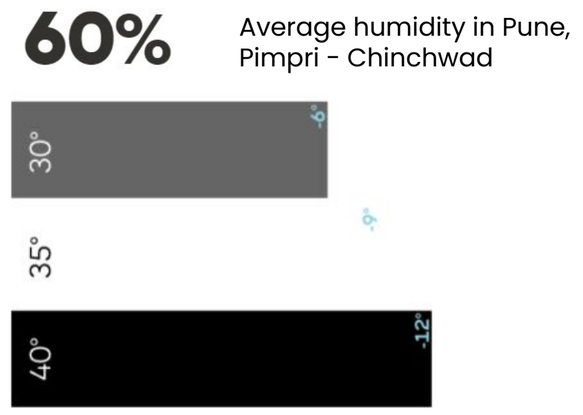


Figure 10.1: Terracotta Sliding folding panels

These facades can lead to drop in temperatures ranging from 3 to 12°C, depending on the humidity.



- A 'natural' temperature drop of **upto 15%**
- Capital Savings of **upto 22%**
- Reducing our **Carbon Footprint**
- Our air is **Net Fresh**

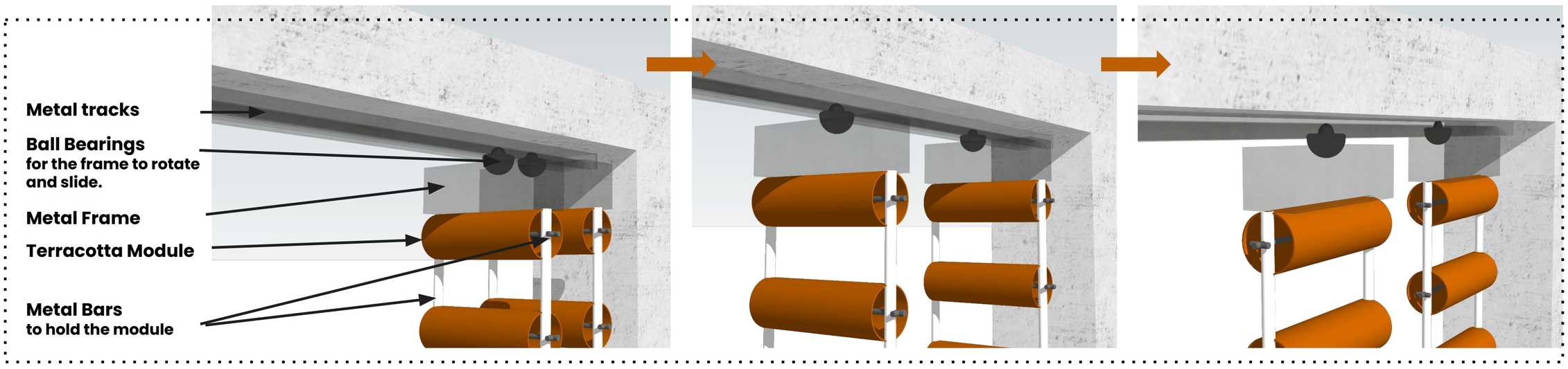


Figure 10.2: Module working

Beating the heat with Low-Tech Terracotta Cooling System.

The cooling system consists of inner and outer surfaces embedded on a metal framework. Water passes through the terracotta tubes, facilitating evaporative cooling.

- We can use drip system to keep the material moist for a longer period of time and the same water collected at the bottom tray can be pumped up to reuse.

Air is cooled when it passes through the terracotta tubes and comes out and stays cool like water in an earthen pot.
This installation also gives a beautiful cascade effect when drenched in water.
The humid clay traps some heat the air and the surrounding air gets cooled down to around 6-10° C due to the process of evaporative cooling.

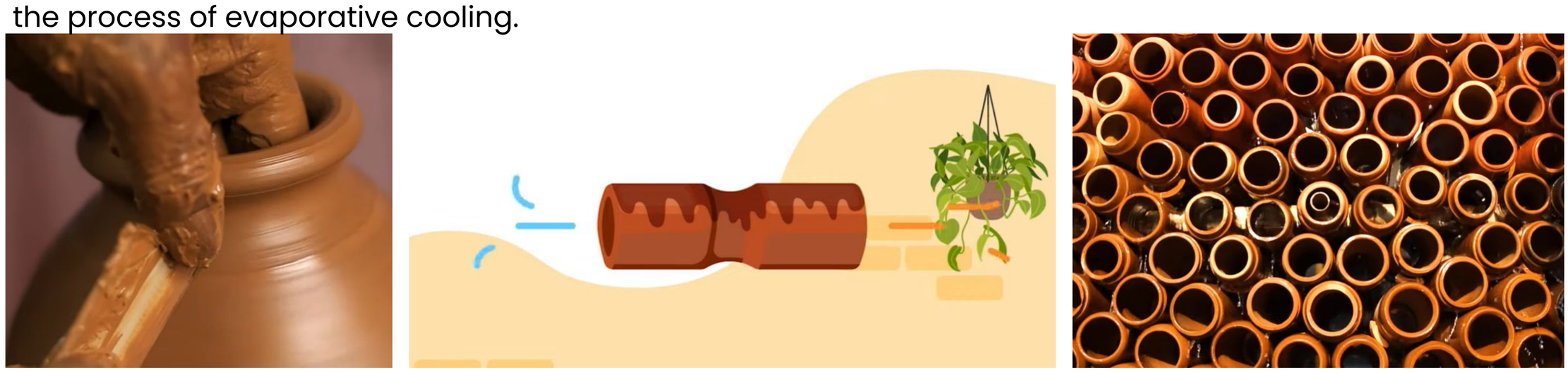


Figure 10.3: Terracotta System

Cost benefits and energy offset analysis is detailed under Energy Performance and Affordability contests.

Industry Partner: *Ant Studio*

AN INTERACTIVE AND MONITORING APP

MOTIVES:

- TO CREATE AWARENESS ABOUT ENERGY AND, WATER CONSERVATION AND WASTE MANAGEMENT AND THEIR IMPACT ON THE CLIMATE .
- TO EDUCATE THEM ABOUT THE DIFFERENT WAYS OF CONSERVATION ON THEIR SCALE
- TO CREATE A COMMUNITY WHERE PEOPLE INTERACT WITH WITH EACH OTHER REGARDING THEIR WORK ON CONSERVATION AND DIFFERENT ACTIVITIES.

Figure: App Mockup Screen

Data access in India is increasingly cheaper and afoordable. A guidance app proposed to guide the occupants towards a sustainable and healthy lifestyle. The app will guide the users within the five aspects of lifestyle for environment i.e. Energy, Water, Waste, Air and Greenery. The app educates why and how should they conserve the resources at a small scale and give them a daily record of how they are doing . It will be based on a point mark system throughout the community for social interaction among the respective category

An app which involves you In a community where people compete with each other to develop a sustainable environment . At the same time interacting , and educating each other.

The users are given points on the basis of their daily energy consumption, waste segregation, water conservation ,etc . and eventually they get rewards and rankings.

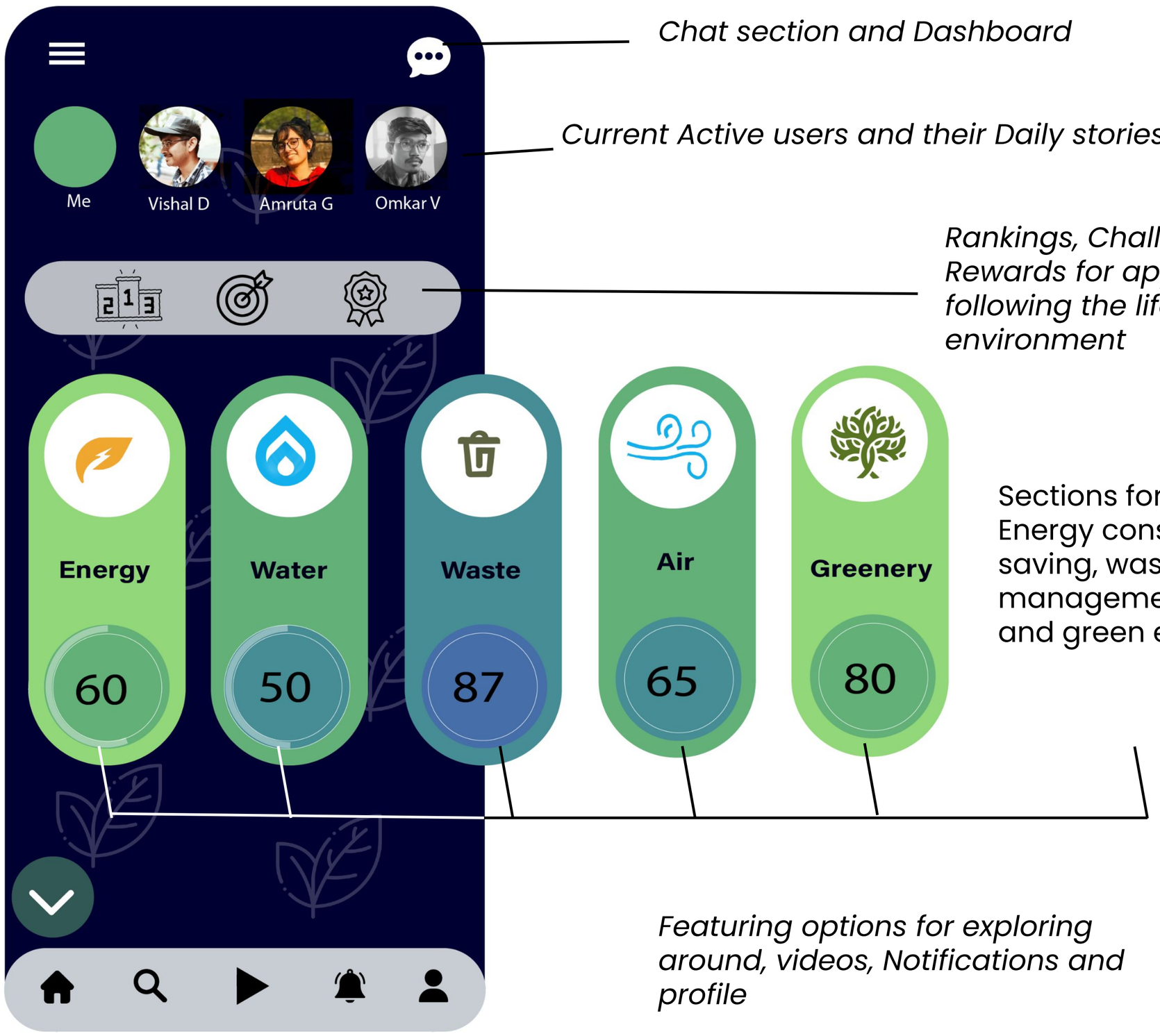
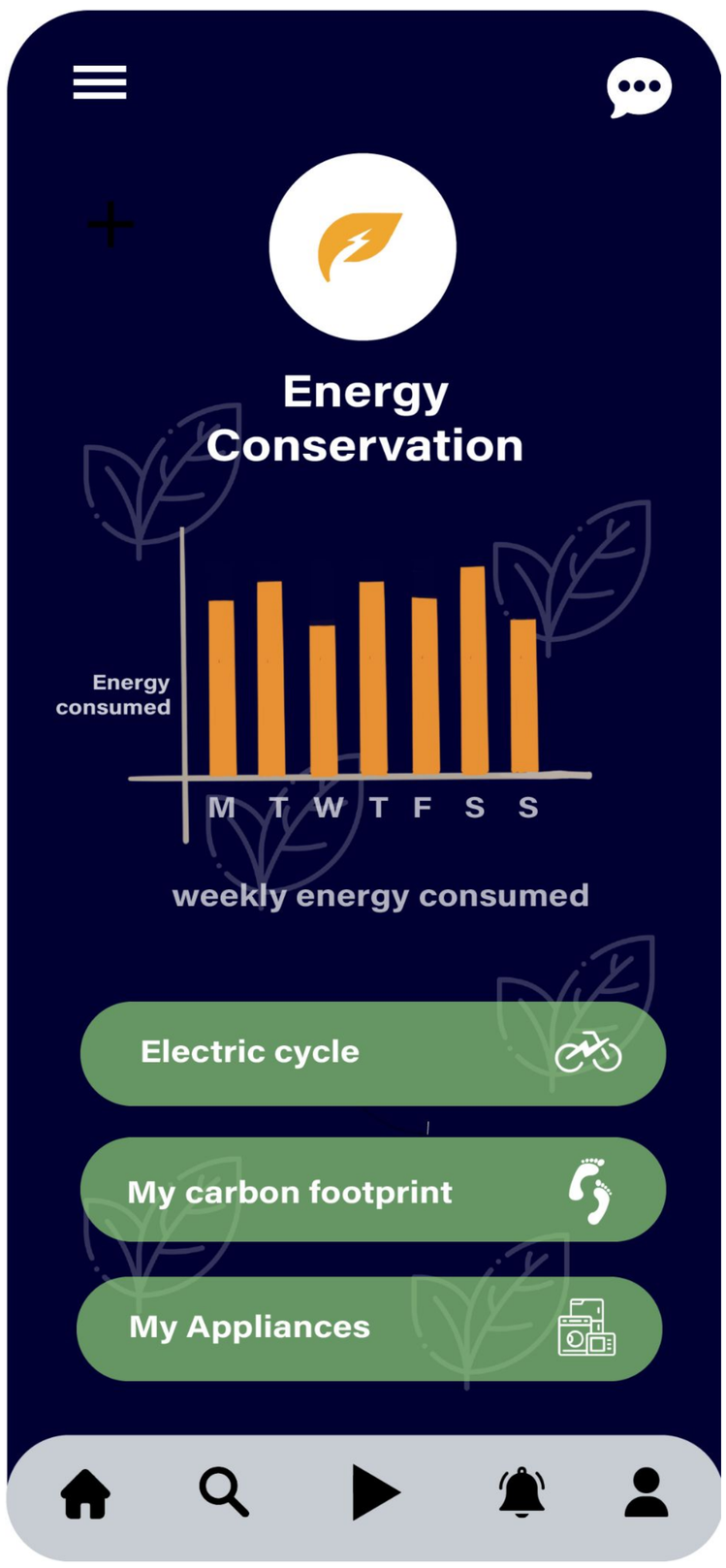


Figure: App UI and Specifications

SPECIFICATIONS

- Energy conservation- monitoring energy consumption on daily basis
- Waste Management - monitoring amount generated and how it is segregated and treated on user basis.
- Water conservation- monitoring water consumption and saved on daily basis .
- Carbon footprint monitoring

Calculating data from different appliances and presenting it in the form of point based data of the user



ENERGY CONSERVATION TRACKING

Daily Community *Challenges* under saving energy, waste segregation, water saving ,etc. Also includes challenges uploaded on the Government Website Links.

WASTE CONSERVATION TRACKING

Health and well-being

With the poor air quality prevalent in Pune, it was essential to look at natural ventilation methodologies to accommodate fresh air as well as healthy comfortable environment. This was done by using the IMAC tool to first assess the annual comfort hours for Pune and indicating suggestive modes of operation at a passive level.

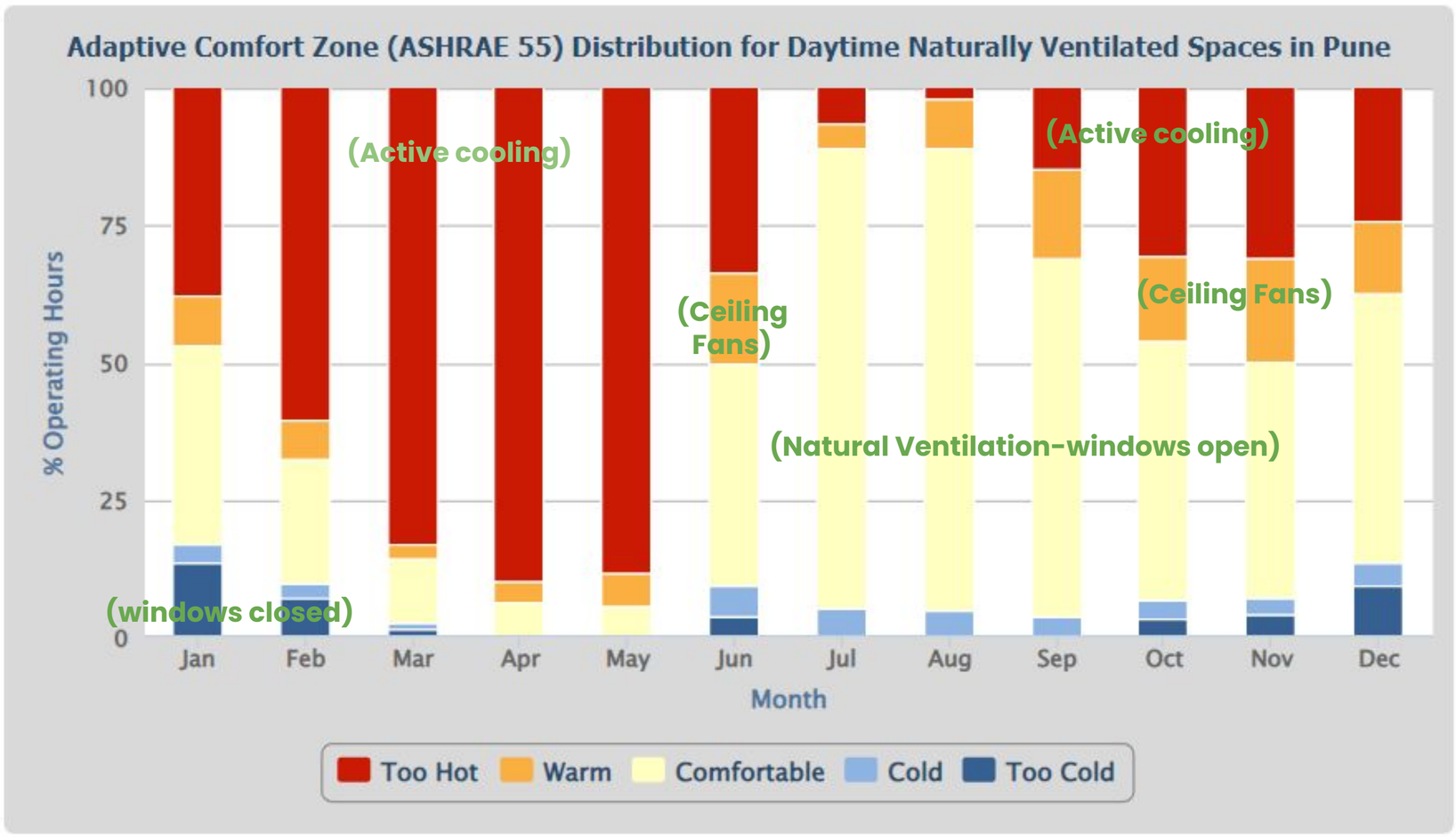


Figure 11.1: ASHRAE 55 Comfort Distribution for Annual Daytime Hours in Pune - With suggestive operations annotated

COMFORT ACHIEVED WITH UNDER DIFFERENT OPERATIONAL MODES -

- **NATURAL VENTILATION - WINDOWS OPEN WITH COOLANT KINETIC**

Coolant KINETIC is designed in such a way to act as a natural air conditioner. As shown, it helps achieve the comfort temperatures within the IMAC suggested band.
The warm air is taken through the terracotta tubes cooling it and also filtering it in the process. The tubes can also accommodate plantations inside them, helping in filtering the air further.

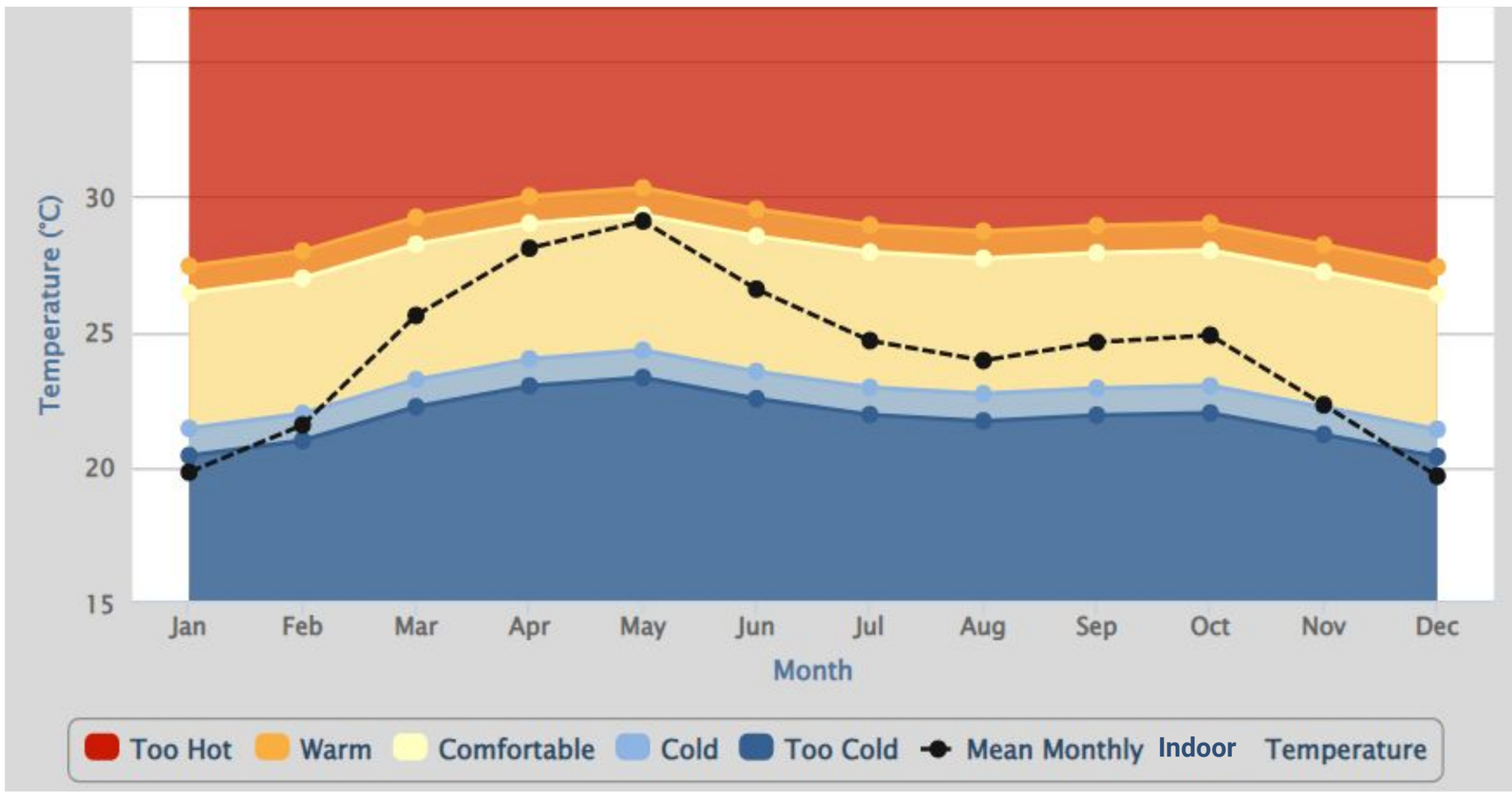
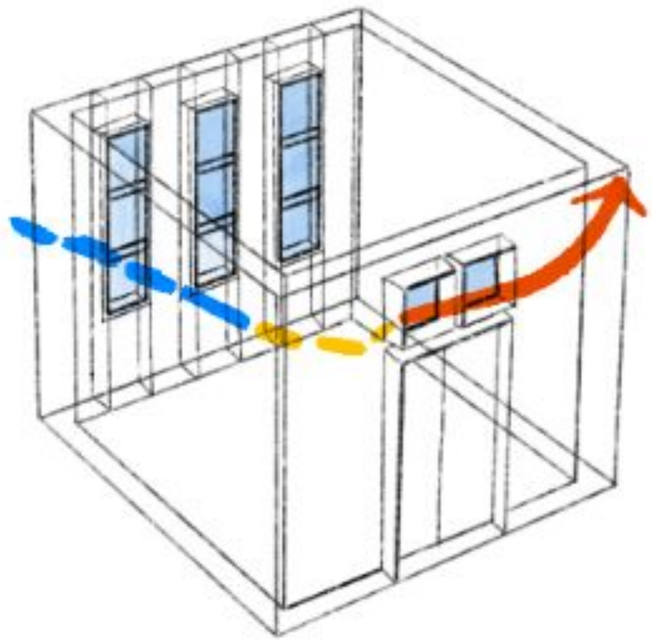
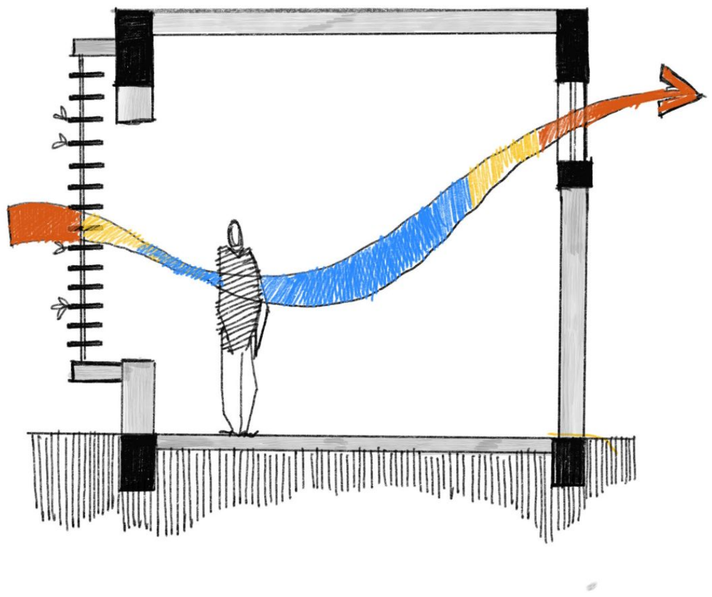


Figure 11.2: Graph showing comfort temperatures achieved using Coolant KINETIC

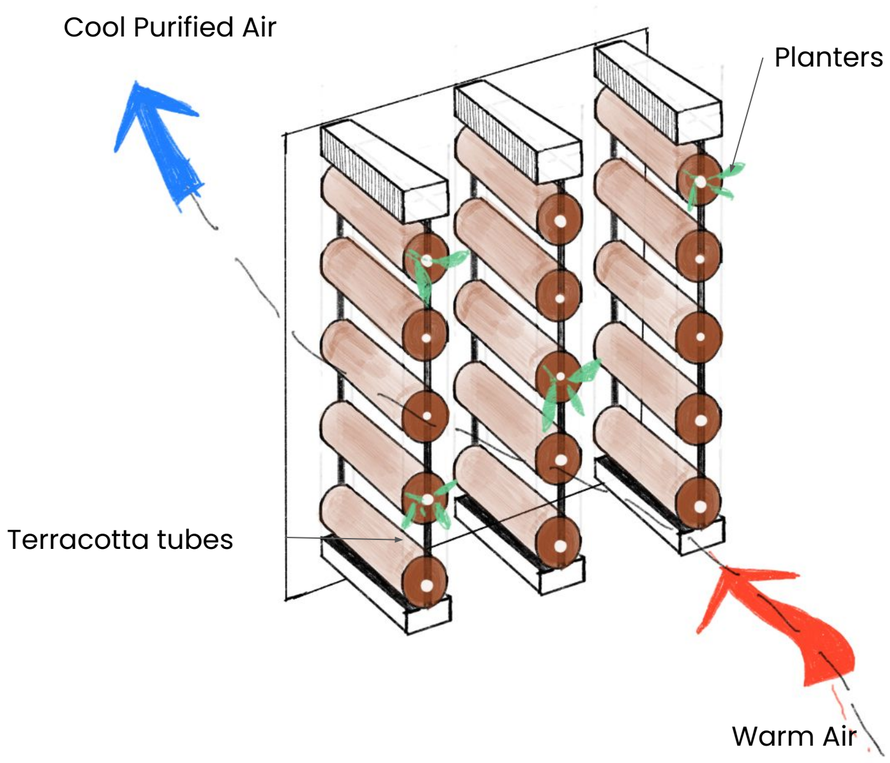
- **PASSIVE COOLING THROUGH CROSS VENTILATION**

  Windows provided above doors to accommodate proper cross ventilation.





- **GETTING INSPIRATION FROM NATURE TO PURIFY AIR AND PROMOTE WELL-BEING**



Coolant KINETIC blocks the direct suns rays, reducing thermal gain and planters of air purifying species accommodated inside tubes purify air.
Details of system provided under *Innovation*.

Further, green spaces have been interspersed throughout the building to promote well-being..

Figure 11.3: Warm air cooled and purified as it passes through the Coolant KINETIC panels

- **MECHANICAL VENTILATION WITH AMBIATOR**

- With the rising temperatures due to climate change, passive cooling might not suffice cooling needs in the future. Hence, bioclimatic air conditioning in the form of Ambiator can be employed by individual tenants.
- Decentralized – central cooling for apartments in hot and dry climates using AMBIATOR technology offers numerous benefits for high rise residential buildings, particularly in terms of energy efficiency, ventilation, and indoor air quality (IAQ).

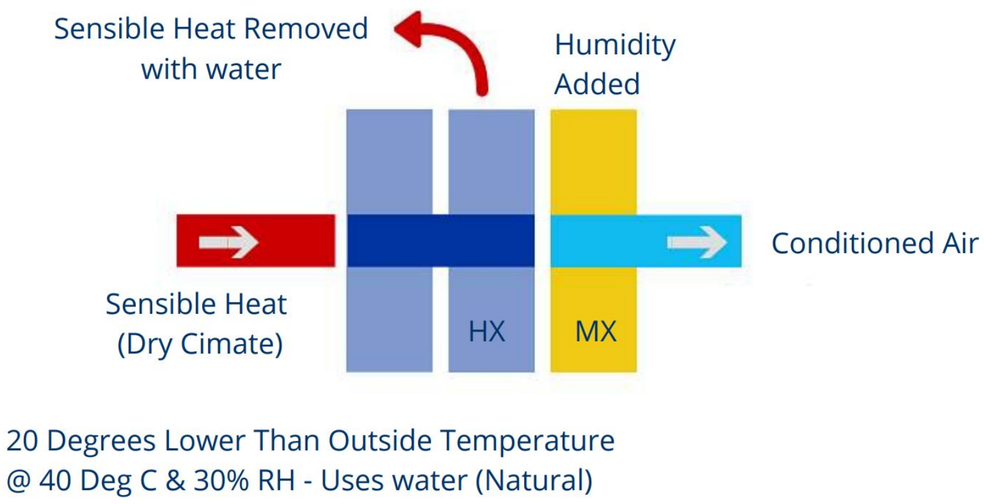


Figure 11.4 : Schematic representation of air flow through Ambiator

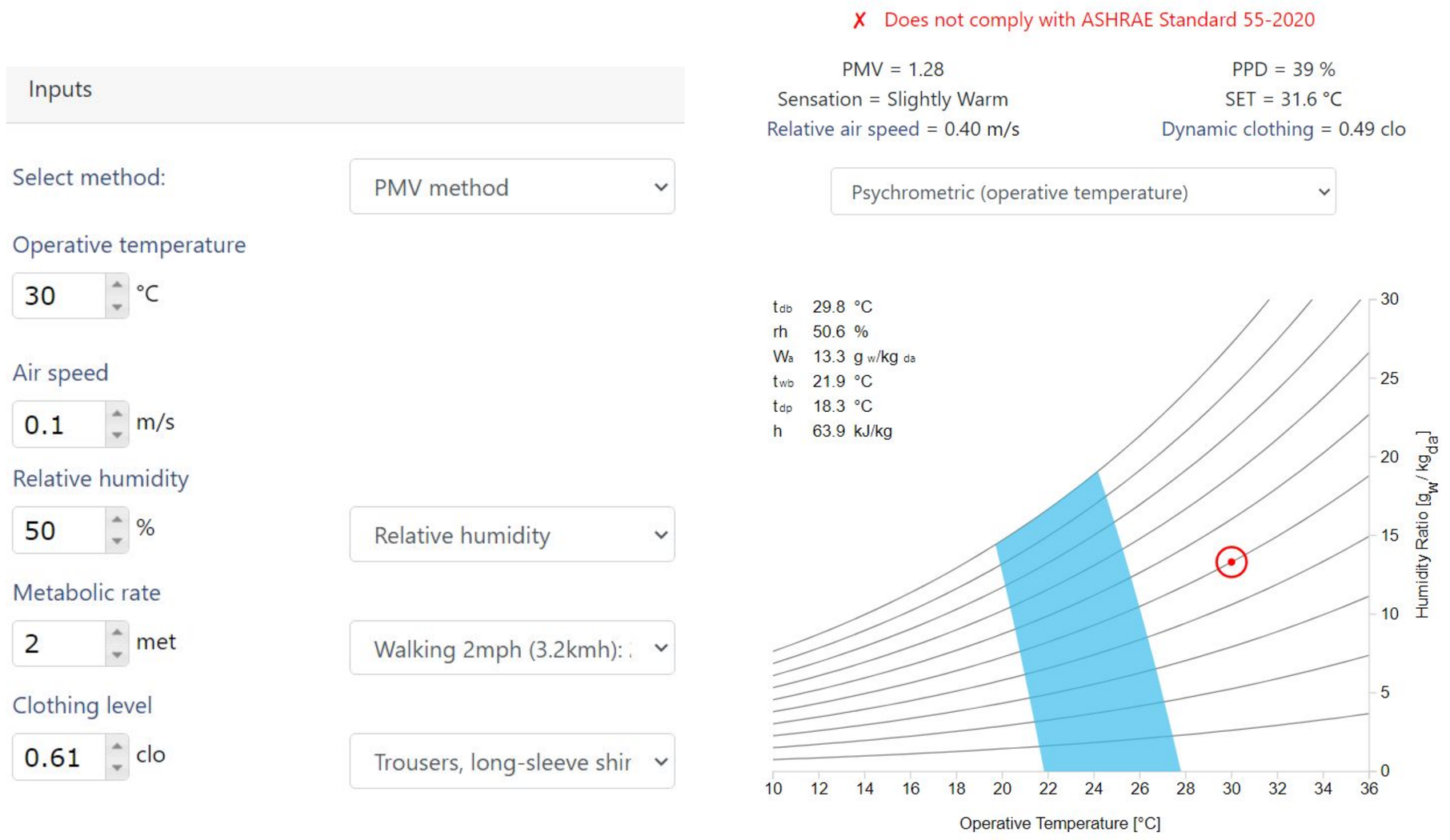


Figure 11.5 : Psychometric chart showing operative temperature ***without Ambiator air conditioning***

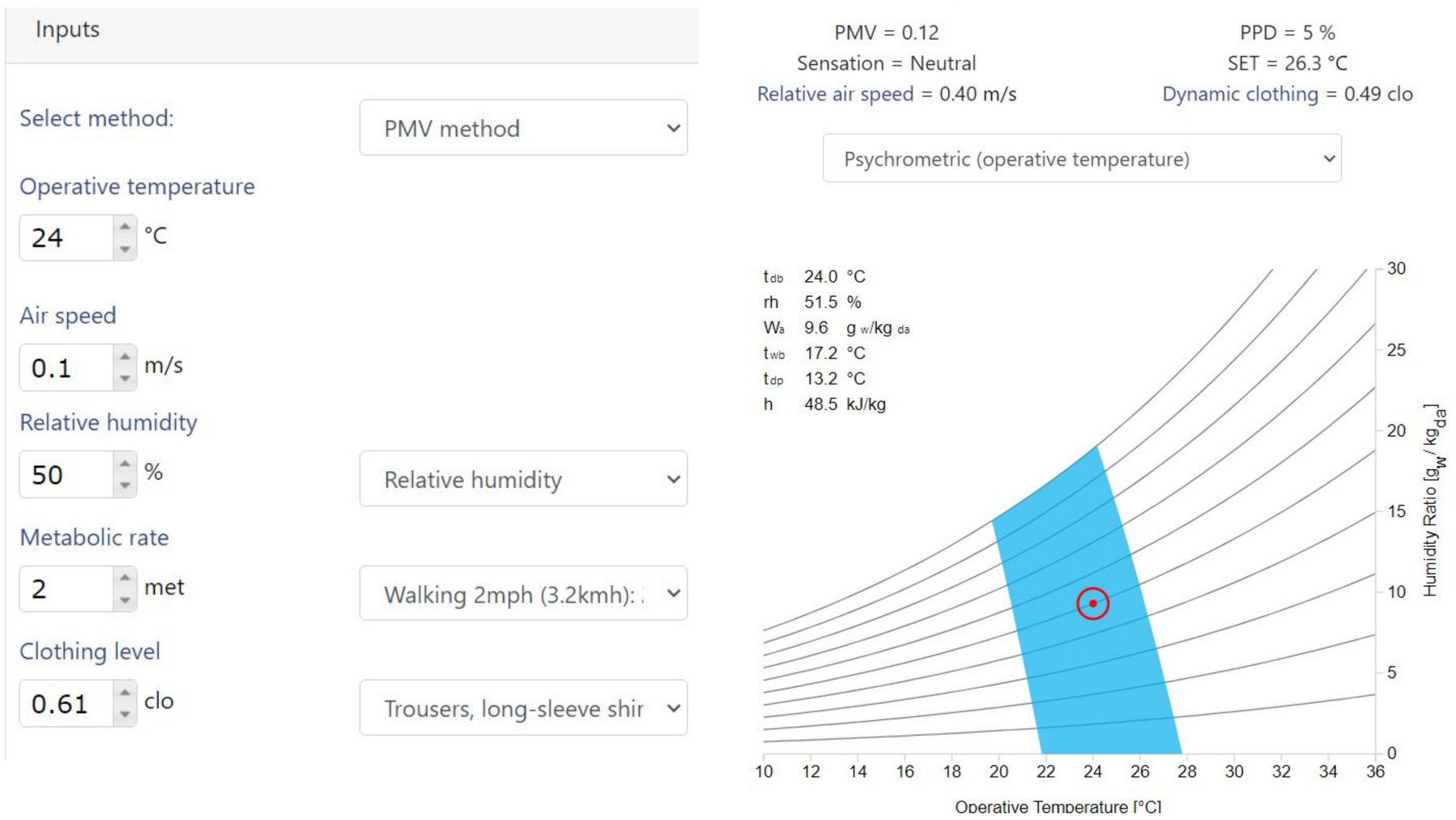
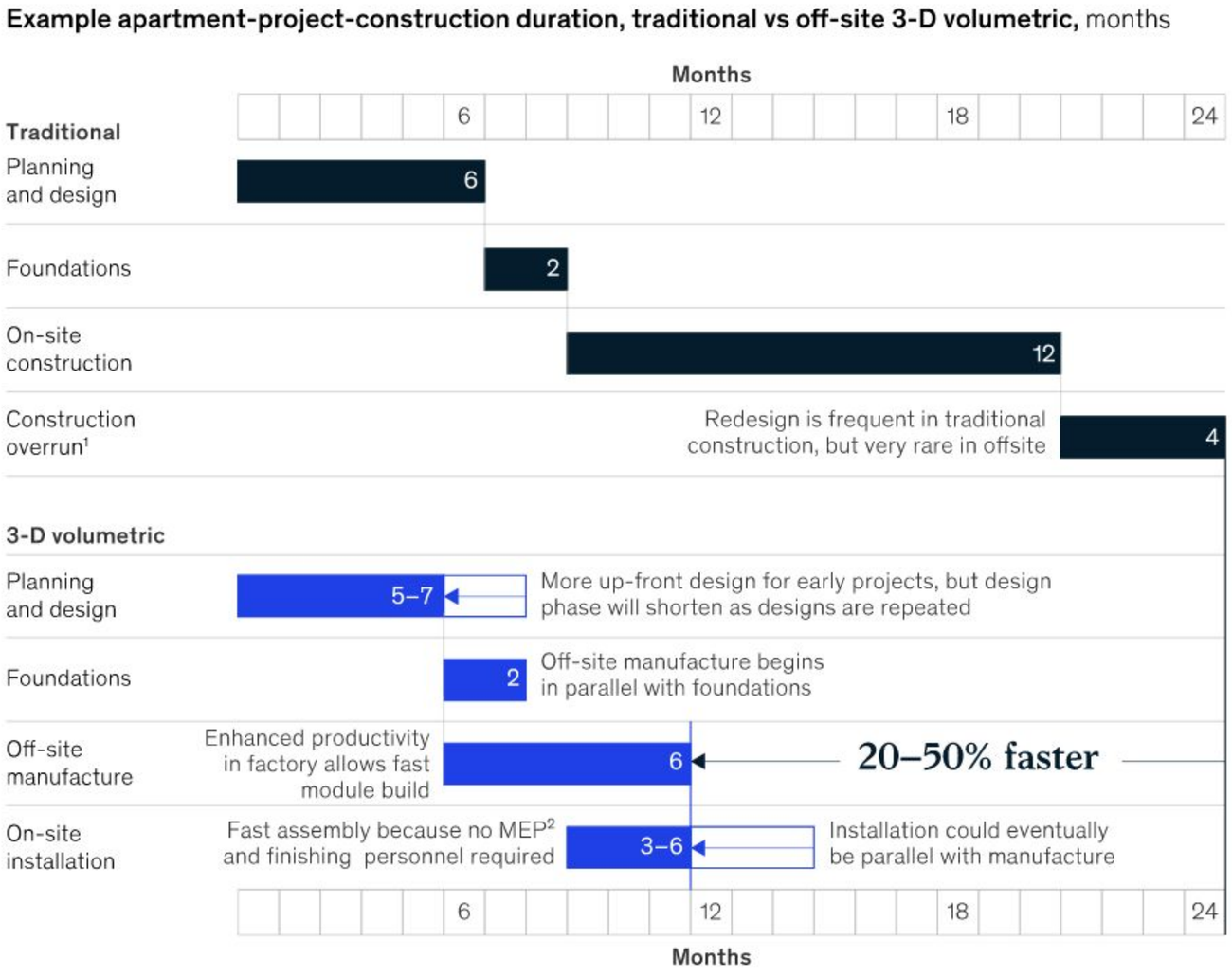
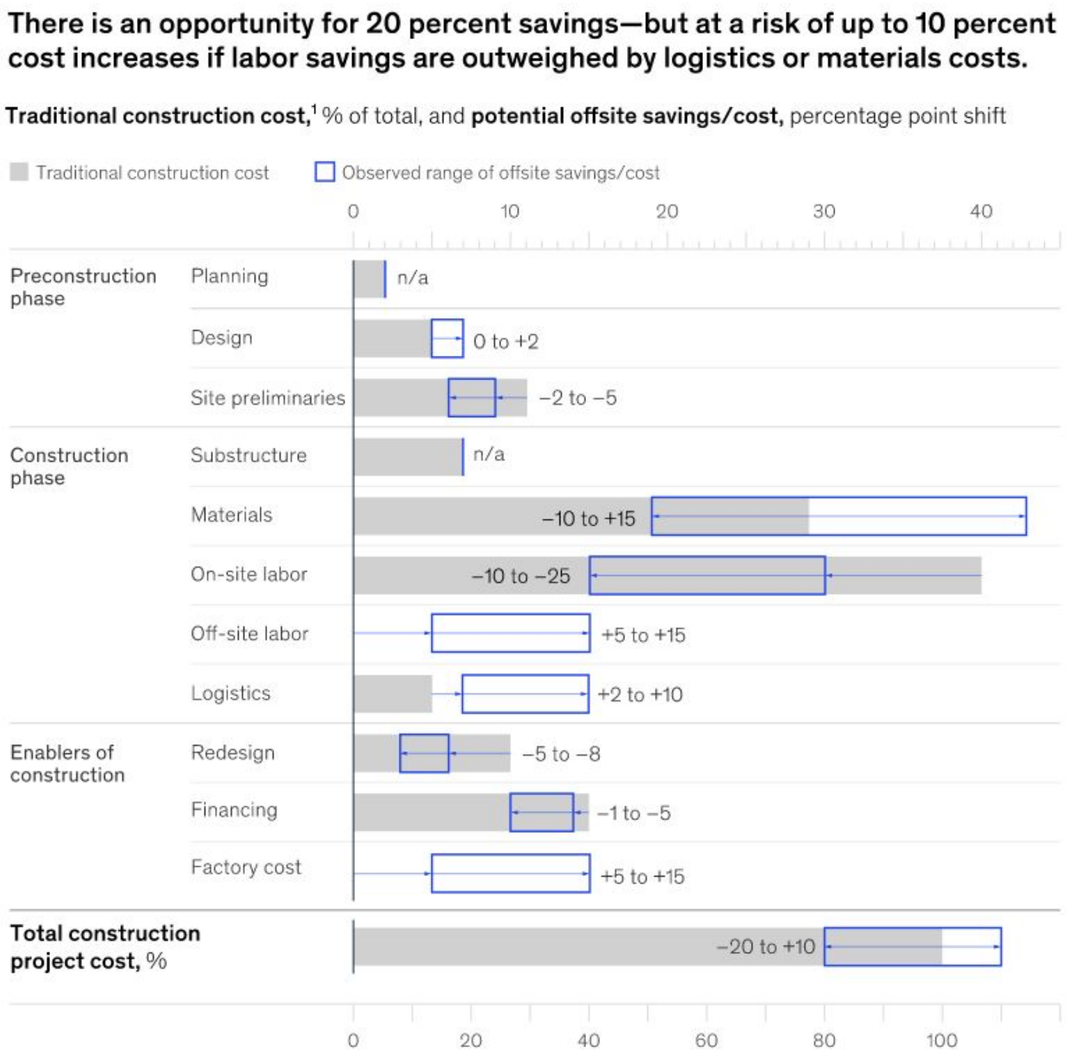


Figure 11.6 : Psychometric chart showing operative temperature ***with Ambiator air conditioning***

Value Proposition

- This project while being Net-Zero energy, Net-Zero water and Net-Zero waste, helps to reduce operational costs.
- The concept of biophilia promotes longevity of community
- Socio-Cultural sustainability makes it a attractive buy for customers, especially with the flexibility options provided.
- Waste diversion from landfill has been focused on and as elaborated under *Resilience* addresses key issue of solid waste management persisting in Pune.
- Prefabricated construction technique implemented which as researched has the following benefits.





The project redefines and revolutionises the mass housing scenarios in the Pimpri-Chinchwad area and is a pride for its residents.

Appendix

Area Programme

A) AREA STATEMENT		SQ.M.
1. Area of plot (Minimum area of a,b,c, to be considered)		12613.49
(a) As per ownership documents (PRC extract)		13191.62
(b) as per measurement *heet		12613.49
(c) as per site		12613.49
2. Deduction for		
(a) Proposed D.P./ D.P. Road widening Area/Service Road/ Highway Widening		51.05
(b) Any D.P. Reservation area		
(c) Other area		
TOTAL (a+b+c)		
3. Balance area of plot (1-2		12562.44
4. Amenity Space (if applicable)		
(a) Required		1256.24
(b) Adjustment of 2(b), if ny		
(c) Balance Proposed		1256.24
5. Net plot area (3-4 (c))		11306.2
6. Recreational open space (if applicable)		
(a) Required		1130.62
(b) Proposed		1130.62
7. Internal Road area		
8, Plotable area (if applicable)		
9. Built up area with reference to Basic F .S.I. as per front road width		12436.82
(Sr. No. 5xbasic FSI 1.10)	(11306.20 x 1.10)	
10. Addition of FSI on of premium	(12613.49 x 0.50)	0
(a)Maximum permissible premium FSI - based on road width / TOD Zone.		0
(b) Proposed FSI on payment of premium		0
11. In-situ FSI / TDR loading		
(a)in-situ area against D.P. road [2.0 x sr. no. 2 (a)I,if any	(51.05 x 2.05)	0
(b)in-situ area against amenity space if handed over [2.00 orI.85 x sr. no. 4 (b)and /or(c)I		0
(c)TDR area (As per page no 112) Max permissible TDR 0.90		0
(d) Total in-situ / TDR loading proposed (11 (a)+(b)+(c)		0
12. Additional FSI area under Chapter No. 7 (5% OF basic FSI green building FSI)		0
13. Total entitlement of FSI in the proposal		12436.82
(a) [9 + IO(b)+11 (d)] or whichever is applicable.		
(al) Deduction Built-up area / FSI/ Utilizes area FSI to be retained as per old DC Rules		
(a2) Balance entitlementfor Ancillary Area (a - al)		
(b) Ancillary Area FSI upto 60% or 80%with payment cf charges.		7562.32
(c) Total entitlement (a+b)		19999.14
14. Maximum utilization limit of F.S.I. (building potential) Permissible as per Road width (as per Regulation No. 6.1 or 6.2 or 6.3 or 6.4 as applicable) x 1.6 or 1.8) (9+10(a) - 11 - 13(a))		
15. Total Built-up Area in proposal.(excluding area at Sr.No.17 b)		
(a) Existing Built-up Area		0
(b) Old sanction Built-up Area		0
(c) Proposed Built-up Area (as per 'P-line')		19964.78
(d) Total (a+b+c)		19964.78
16. F vs.). Consumed (15/13) (should not be more than serial No.14 above.)		1
17. Area for Inclusive Housing, if any		
(a) Required (20% of Sr.No.9)		NA
(b) Proposed		0

Climate Analysis

:

- The PCMC area has an invigorating climate throughout the year, with high altitude, moderate rainfall and a green cover.
- In this period, PCMC witnessed an average annual rainfall of 700-800 mm.
- The maximum relative humidity during the rainy season is 70-80% and falls as low as 30% on summer afternoons.
- This is as close to a perfect climactic setup as one can achieve anywhere in Maharashtra, and is one of the main reasons why so many people from various regions choose to settle down here.

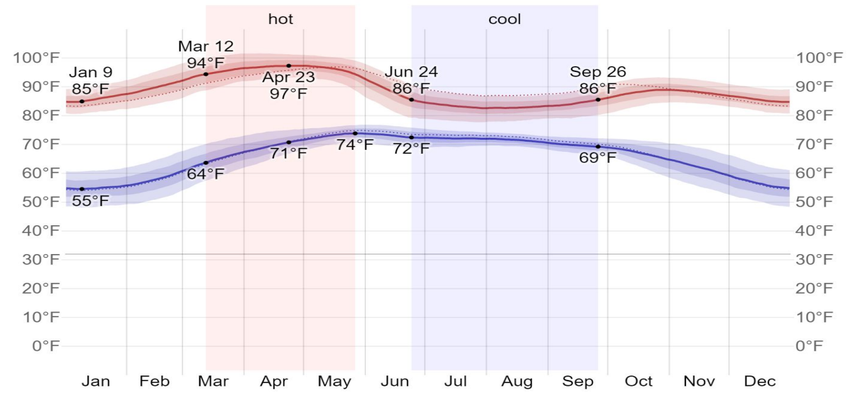


Figure:Average high and low temperature (mm)

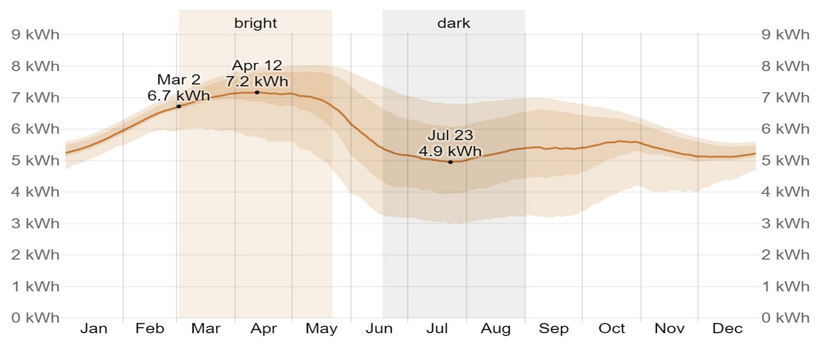


Figure :Average Daily Solar Radiation

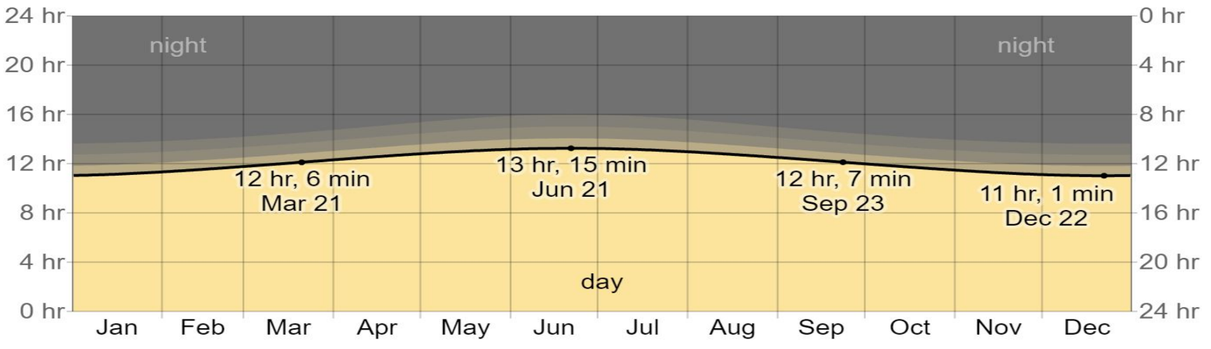


Figure :Average rainfall (mm)

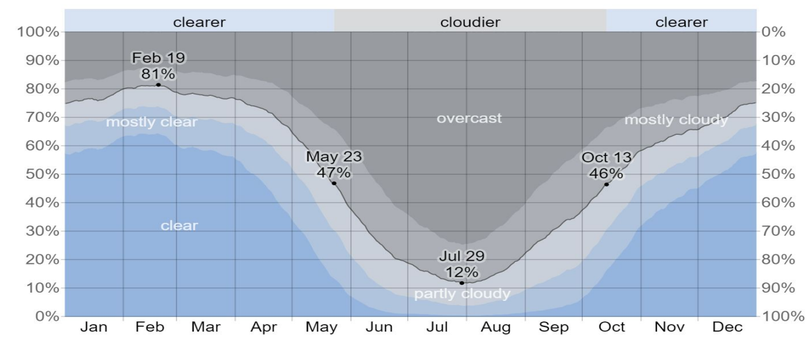


Figure Cloud cover

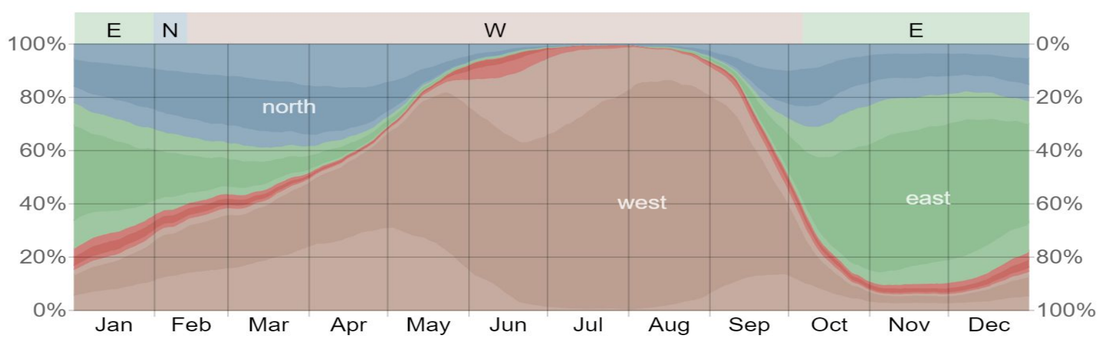


Figure:Wind Direction analysis

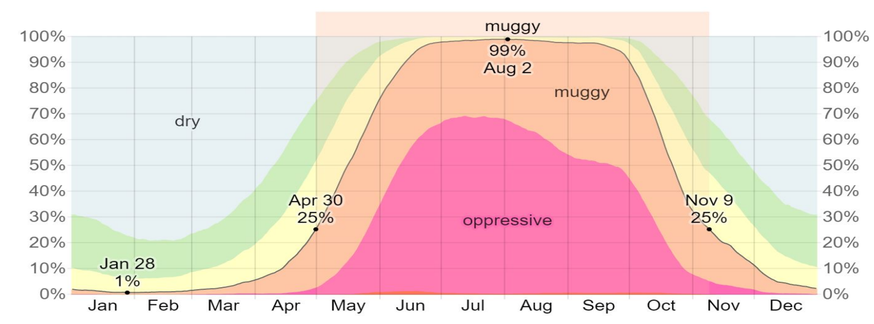


Figure :Humidity and Comfort Levels (%)

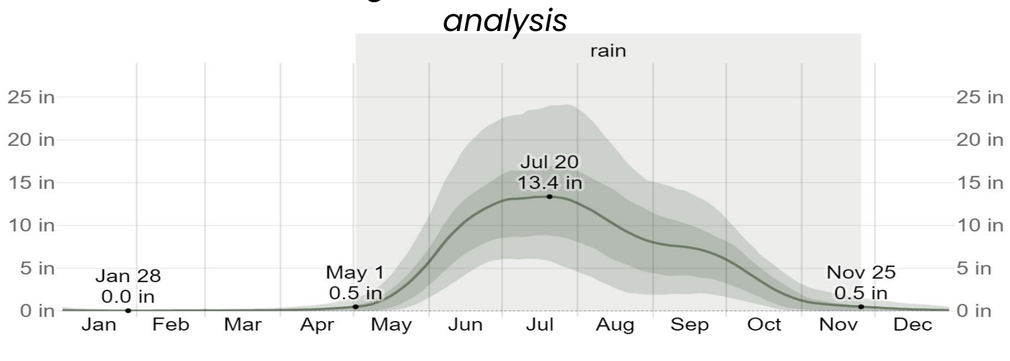


Figure :Average rainfall (mm)

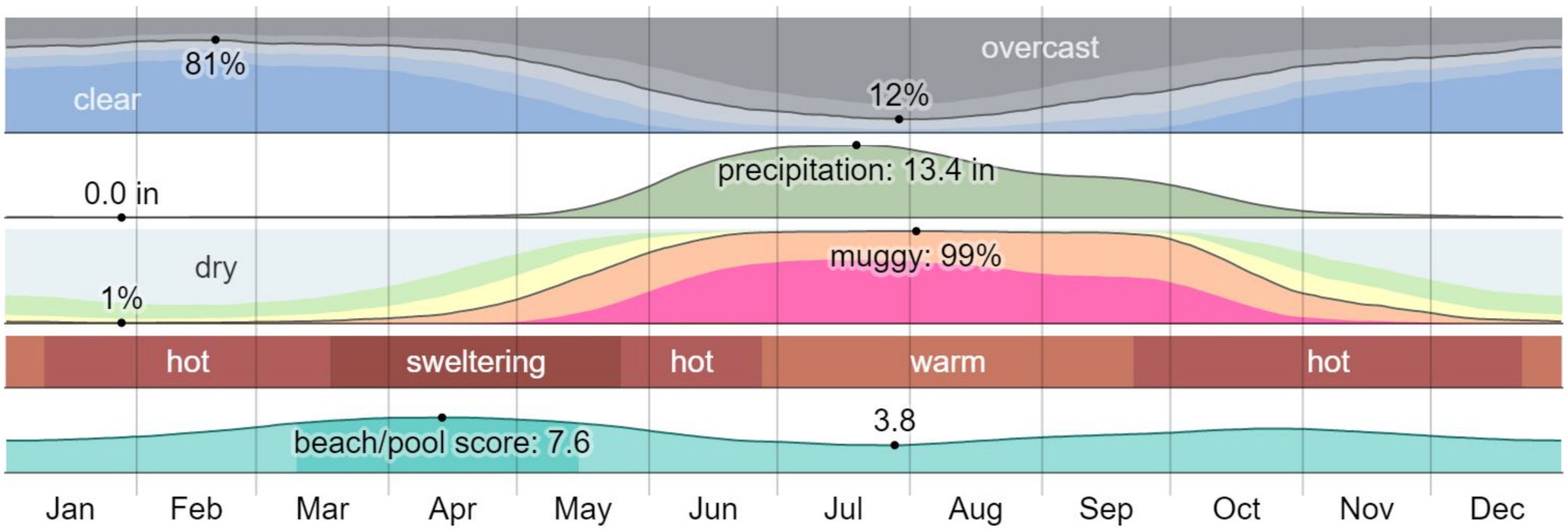


Figure :Month wise climate analysis of Pimpri

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
TEMPERATURE	21.7	23.7	26.5	28.6	27.9	24.9	23.1	22.8	23.2	24.2	23.3	21.8
HUMIDITY	1%	3%	6%	25%	74%	93%	96%	99%	95%	55%	25%	6%
RAINFALL	1mm	2mm	3mm	10mm	26mm	247mm	340mm	270mm	189mm	81mm	26mm	5mm
CLOUD COVER												
WIND SPEED	1.7km\hr	2.2	2.9	3.5	3.5	2.9	2.5	3	3	2	2.5	2.5
SUN HOUR	10	10	11	11	10	6	4	4	5	9	10	10

Base case energy calculations

- **ENERGY CALCULATION FOR INDIVIDUAL FLOOR**

In this segment, we have calculated the net energy that will be required for the building in a year and the base case EPI.

Appliances	Units/W		X	Count	=	Load
Bulb	25W	25	X	432	=	10800
Ceiling Fan	70W	70	X	32	=	2240
Table Fan	40W	40	X	10	=	400
TV	250W	250	X	7	=	1750
Air Conditioner	2TON	2000	X	15	=	30000
Washing Machine	700W	700	X	7	=	4900
Water Pump	-Select-	0	X		=	0
Geyser	3000W	3000	X	10	=	30000
Heater	1500W	1500	X	7	=	10500
Refrigerator	350litres	200	X	7	=	1400
Electric Iron	1000W	1000	X	7	=	7000
Mixer / Grinder	500W	500	X	7	=	3500
PC / Laptop	250W	250	X	10	=	2500
Microwave Oven	5000W	5000	X	7	=	35000
Radio	50W	50	X	2	=	100
Stove	1000W	1000	X	7	=	7000
Cloth Drier	200W	200	X	7	=	1400
Electric Clock	5W	5	X	7	=	35
Cooking Range	5000W	5000	X	7	=	35000

Table T.19 : Electrical load calculation per day per floor

For first 14 floors:
Energy consumed in a day
= 165.7 x 14
= 2319.8 kWh

For next 5 floors:
Energy consumed in a day
= 115.5 x 5
= 577.5 kWh

Total energy consumption per year:
= (2319.8 + 577.5) 365
= 10,57,514.5 kWh

- **ENERGY CALCULATION FOR COMMON AREAS**

Common amenities = 60.8 kWh/day
Common equipment: Elevators = 240 kWh/day
Pumps = 0.8 kWh/day
Total annual consumption of energy in common areas = 365 (60.8 + 240 + 0.8)
= 8,62,623 kWh/yr

- **TOTAL EPI CALCULATION:**

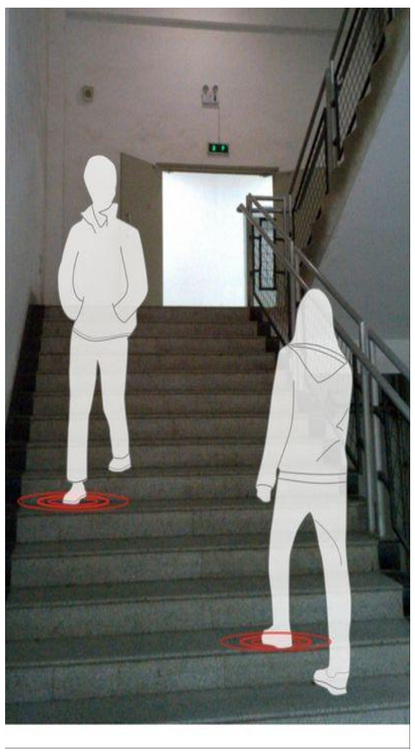
Total energy consumed in a year = 10,57,514.5 + 8,62,623
= 14,23,098.5 kWh/yr
EPI = Total energy consumed per year / floor area
= 19,20,137.52 / 19964
= 96.18 kWh/yr/m2

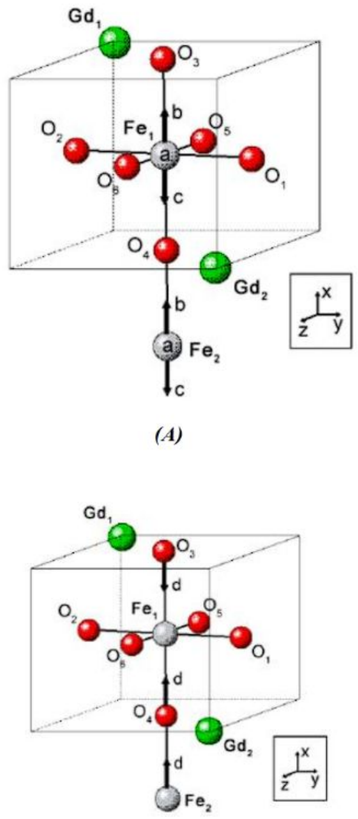
BASE CASE EPI = 96.18 kWh/yr/m2

Sustainable Energy Sources

PIEZOELECTRICITY
INSTALLATION

1. The simplest way is to install them in the floor or steps of the building, where there is a lot of foot traffic. When people walk, the mechanical stress created by their weight is converted into electrical energy.





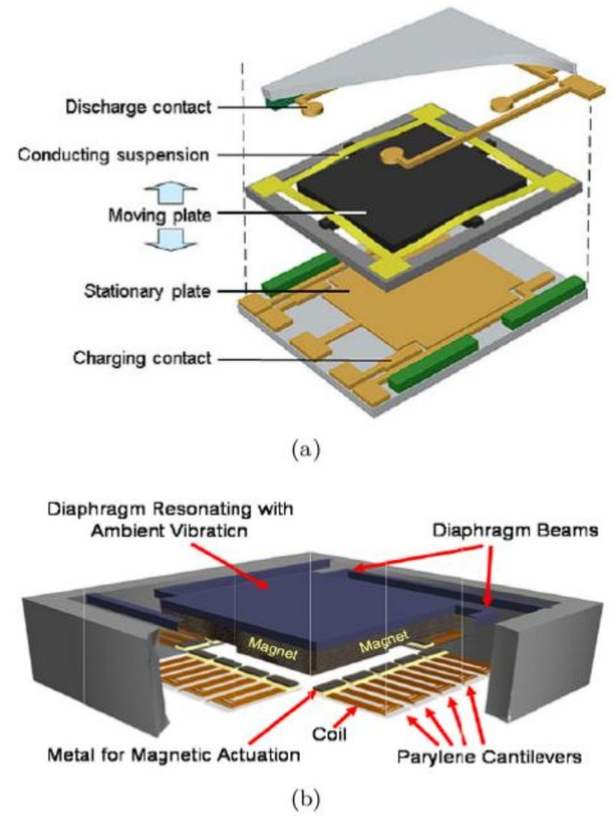


Figure :Month wise climate analysis of Pimpri

2.

Effective Use

Attaching them to the building's structural elements, such as columns or beams. The mechanical stress created by the building's vibrations or wind can be converted into electrical energy.

It has recently gained attention as a potential source of sustainable energy, particularly in high-rise buildings, there is a large amount of mechanical stress caused by vibrations and foot traffic. we can explore the feasibility of installing a piezoelectric generator in a high-rise building for renewable energy resource and identify areas where it can be used effectively to achieve sustainable energy goals.

- Lighting: The energy generated by the piezoelectric generator can be used to power the building's lighting systems. LED lights, which consume less energy than traditional lighting systems.
- Elevators: Piezoelectric generators can be installed in elevators to generate energy from the mechanical stress created by their movement.
- HVAC Systems: Piezoelectric generators can also be installed in HVAC systems to generate energy from the mechanical stress created by the air moving through the system. This energy can be used to power the HVAC system's electrical systems,
- Security Systems: Piezoelectric generators can be used to power security systems, such as cameras and sensors, in the building.

NO OF FOOT STEPS	DURATION FOR LIGHTING A 100-WATT 230 VOLT BULB (S)	TOTAL ENERGY (J)	ENERGY /STEP (J)
250	6	600	2.4
500	12	1200	2.4
750	18	1800	2.4
1000	25	2500	2.5

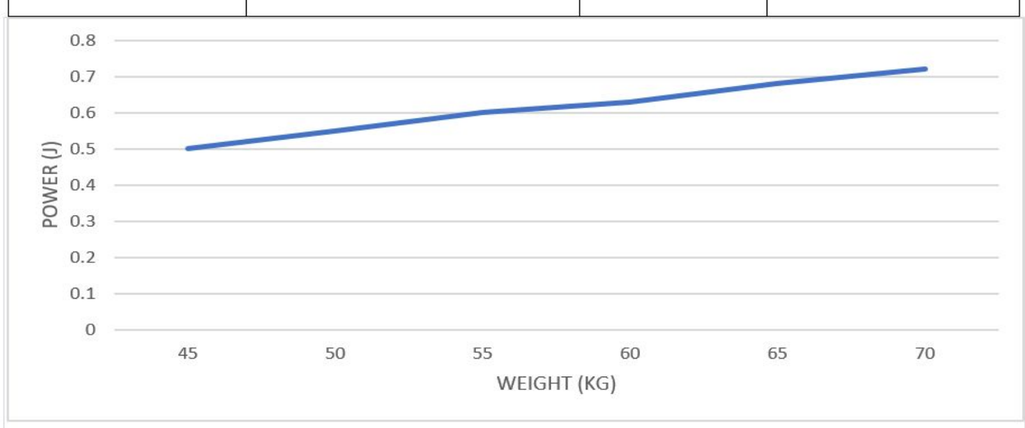
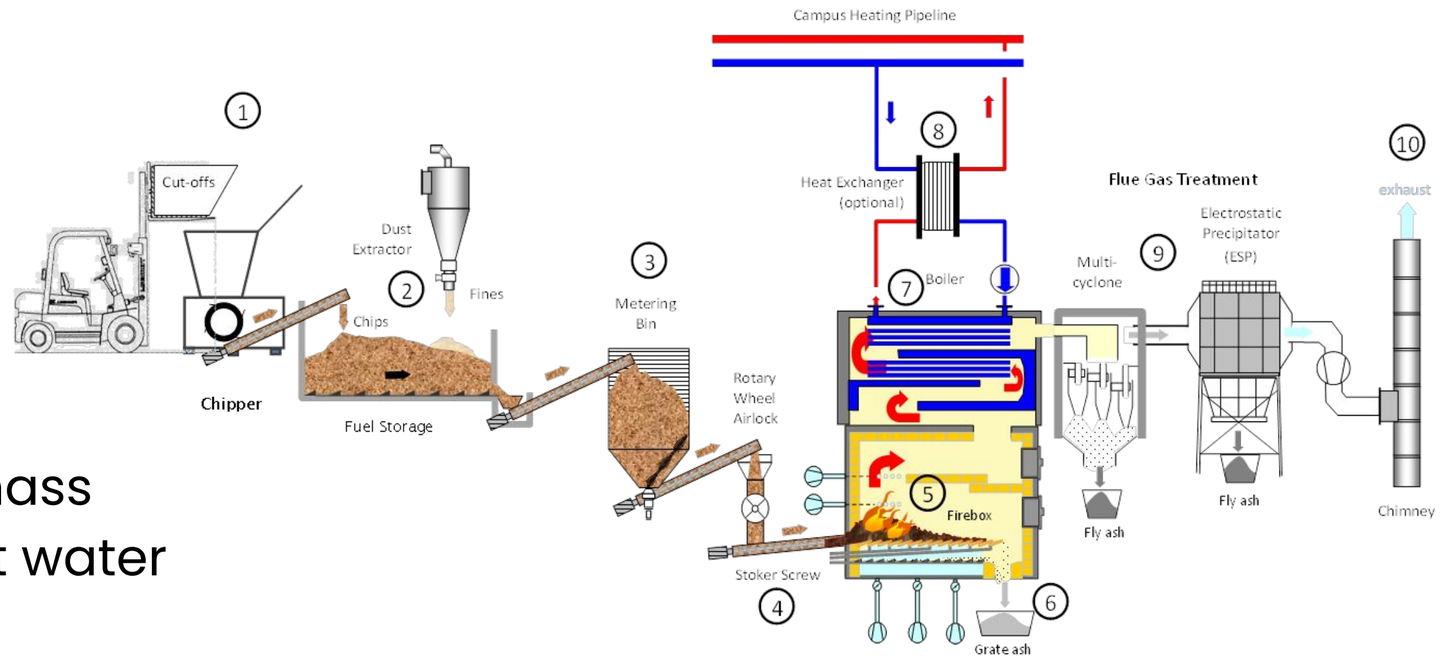


Figure :Month wise climate analysis of Pimpri

Alternate examples on Sustainable Energy Resourses

BIOMASS ENERGY

Biomass energy can be utilized in various areas within a high-rise building complex, such as:



1. Heating and Cooling Systems: Biomass boilers can be used to generate hot water and steam for heating and cooling systems in high-rise buildings. These boilers can be fuel with wood chips, pellets, or other organic matter to generate heat, which can be distributed throughout the building using pipes or ducts

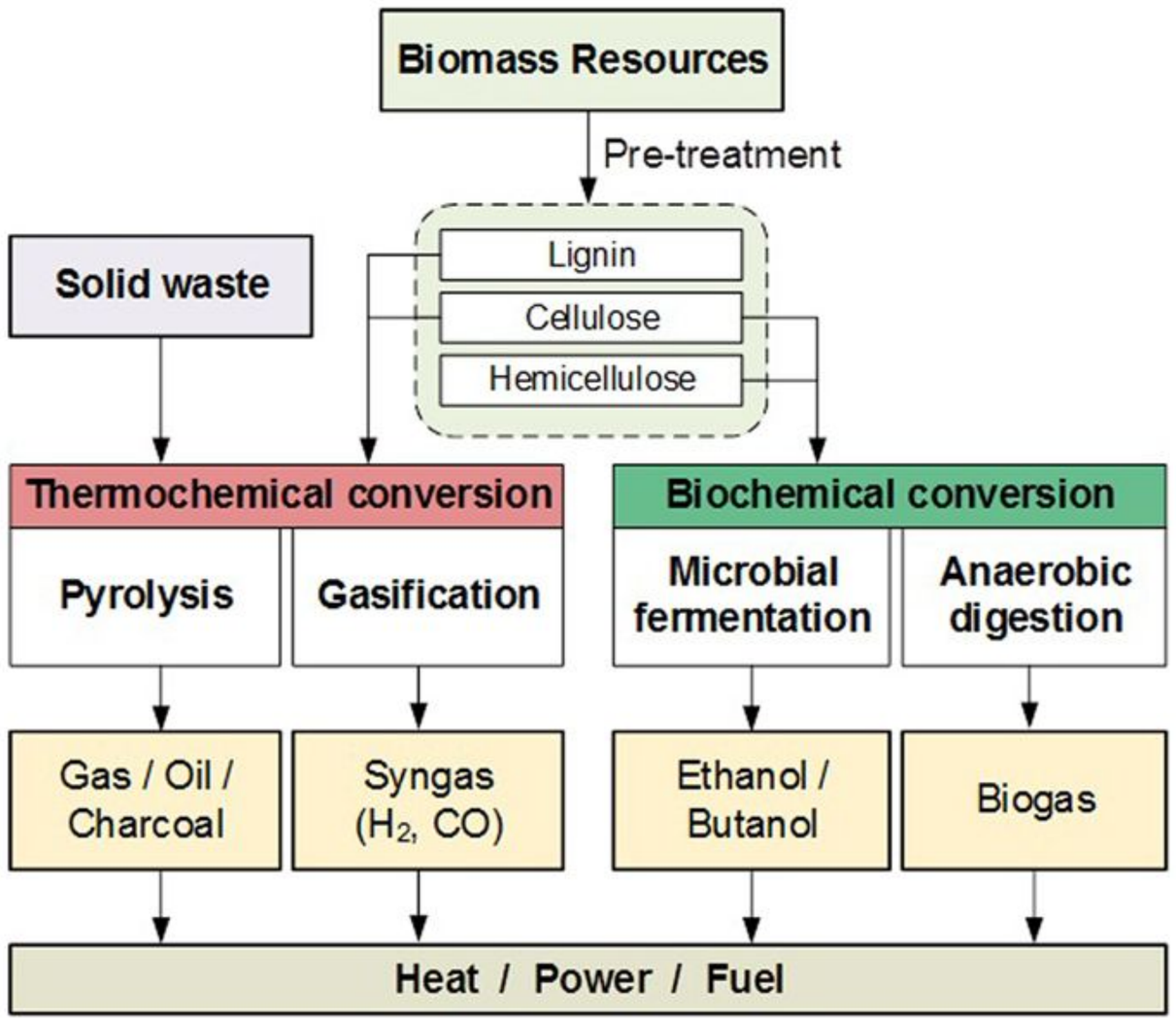


Figure :Month wise climate analysis of Pimpri

2. Electricity Generation:Biomass can also be used to generate electricity using technologies such as gasification, combustion, and anaerobic digestion. The electricity generated can be used to power various systems within the building, including lighting, elevators, and other electrical appliances.

3. Waste Management:Food waste and other organic waste generated within the high-rise building complex can be used as a feedstock for biomass energy production. This can help reduce the amount of waste sent to landfills and also provide a sustainable source of energy.

4. Landscaping Biomass energy can be derived from the trimming and pruning of trees and other vegetation within the building complex. This can help reduce the amount of waste generated and provide a sustainable source of energy for the building.

- Government incentives and Subsidies for Biomass Energy Production

The Ministry of New and Renewable Energy (MNRE) provides Central Financial Assistance (CFA) in the form of capital subsidy and financial incentives to the biomass energy projects in India. CFA is allotted to the projects on the basis of installed capacity, energy generation mode and its application etc. Financial support will be made available selectively through a transparent and competitive procedure.

Technical Specifications of Solar Panels

Descriptions

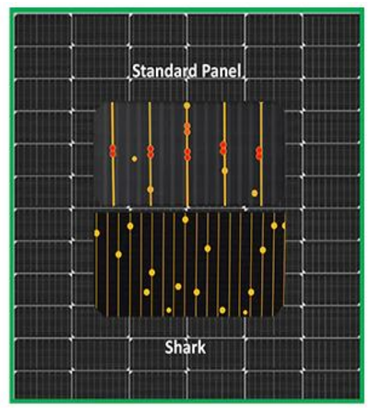
Brand	LOOM SOLAR
Output Power	445 Watts
Space Requirement	24 sq. feet
Operating Voltage	24 Volt
Panel Technology	Mono PERC
Manufacturer warranty	10 year on manufacturing defects
Performance Warranty	25 Years
	6th Generation Monocrystalline Solar Cell (PID FREE) from Germany

Technical

wattage (Wp)	445 watts
voltage at max power	42 volts
current at max power	10. 5 amps
open-circuit voltage	49 volts
short circuit current	11 amps
Number of Cells	144

SHIPPING DETAILS

Weight	24 Kg
Dimensions L x W x H	2063 x 1026 x 35 mm



Advanced Cell Connection Technology

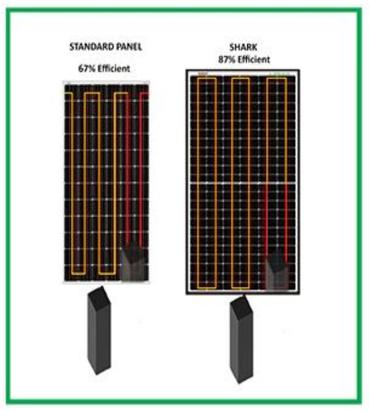
Full-black variant is a design master-piece and the most elgant feature for your home.

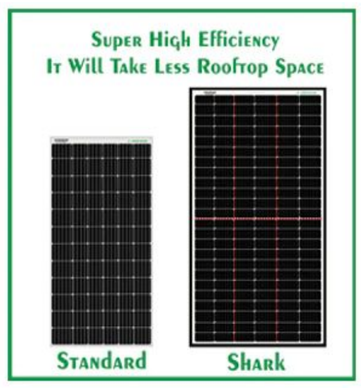
Stylish looks thanks to thin, barely-visible wires and uniformly black-colored cells.

Improved Performance When Shaded

Reduces internal resistance for more power and reliability

Continued energy production in shaded conditions means you see higher energy yields





Super High Efficiency Module

It's high power density (217 watts/m^2) helps to get more from limited spaces.

Leading temprature coefficient means more energy as temprature rises.

20% more power on your roof compared to conventional panels.

Super Strong Frame

Support bars protect cells and glass from bending under load

Panels maintain high performance levels over the installation lifetime

40/35 mm frame height makes panel easier to handle

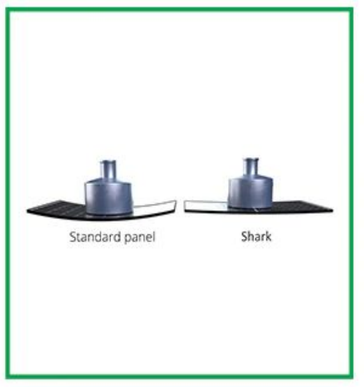


Figure: Technical specifications of solar panel

Project Project Information

Team:	Team Synergy				
Division:	Multifamily Housing		**Land Cost:**	112	Million INR
	Site Area (sqm)	11,306	**City:**	Pune	
	Built-up Area (BUA) (sqm)	12,437	**State:**	Maharashtra	
	Ground Coverage (Plinth Area) (sqm)	4,522			

S.No.	Particulars	Definition	Baseline Estimate (Project Partner / SOR basis)			Proposed Design Estimate		
			Amount (Million INR)	%	Amount (INR per sqm)	Amount (Million INR)	%	Amount (INR per sqm)
1	Land	Cost of land purchased or leased by the Project Partner	112.00	56.4%	9,006	112.00	74.2%	9,006
2	Civil Works	Refer Item A, Civil works in Cost of construction worksheet	2.20	1.1%	177	2.60	1.7%	209
3	Internal Works	Refer Item B, Civil works in Cost of construction worksheet	1.44	0.7%	116	1.43	0.9%	115
4	MEP Services	Refer Item C, Civil works in Cost of construction worksheet	40.17	20.2%	3,230		0.0%	-
5	Equipment & Furnishing	Refer Item D, Civil works in Cost of construction worksheet	0.01	0.0%	1	0.01	0.0%	1
6	Landscape & Site Development	Refer Item E, Civil works in Cost of construction worksheet	0.20	0.1%	16	0.00	0.0%	0
7	Contingency	Amount added to the total estimate for incidental and miscellaneous expenses.	2.20	1.1%	177	3.21	2.1%	258
	TOTAL HARD COST		**158.2**	**80%**	**12,722**	**119.3**	**79%**	**9,589**
8	Pre Operative Expenses	Cost of Permits, Licenses, Market research, Advertising etc	10.00	5.0%	804	10.00	5.0%	804
9	Consultants	Consultant fees on a typical Project	10.00	5.0%	804	10.00	5.0%	804
10	Interest During Construction	Interest paid on loans related to the project during construction	20.25	10.2%	1,629	11.72	5.9%	943
	TOTAL SOFT COST		**40.3**	**20%**	**3,237**	**31.7**	**16%**	**2,551**
	TOTAL PROJECT COST		**198.5**	**100%**	**15,959**	**151.0**	**100%**	**12,139**

Table T. : Summary of Cost Estimation

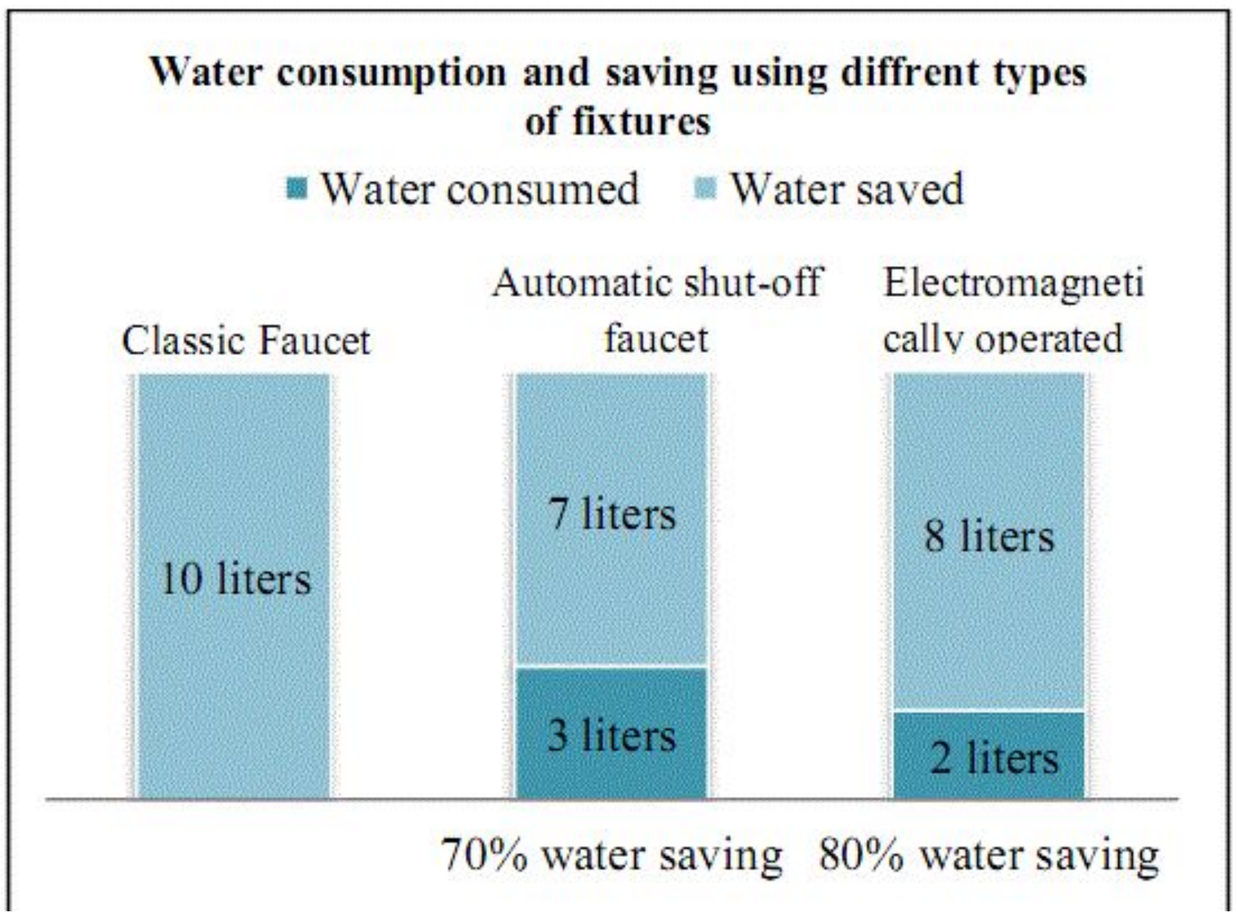
Summary of Embodied Carbon Emissions

System Type	Baseline				Proposed			
	Material emissions ($kg\text{-}CO_2\ e$)	Transport 1 ($kg\text{-}CO_2\ e$)	Transport 2 ($kg\text{-}CO_2\ e$)	Total ($kg\text{-}CO_2\ e$)	Material emissions ($kg\text{-}CO_2\ e$)	Transport 1 ($kg\text{-}CO_2\ e$)	Transport 2 ($kg\text{-}CO_2\ e$)	Total ($kg\text{-}CO_2\ e$)
Wall	215	1	1	217	195	1	0	196
Roof	200	1	1	202	150	1	0	151
Floor	155	1	1	157	120	1	0	121
Fenestration	120	1	1	122	105	1	0	106
Structural	325	2	1	328	300	1	0	301
Grand Total emissions per functional unit ($kg\text{-}CO_2\ e$)				1026	Grand Total emissions per functional unit ($kg\text{-}CO_2\ e$)			875

Table T.20 : Summary of Embodied Carbon emissions per functional units for building systems

Water fixtures consumption calculations

Fixture type	Max. flow rate/ consumption		Duration		Estimated daily uses per FTE	No. of users	Total usage
Water closets (full flush)	2	LPF	1	flush	1	1114	2228
Urinals	1	LPF	1	flush	2	100	200
Water closets (half flush)	1	LPF	1	flush	2	1114	2228
Wash basin / sink	1	LPM	0.25	minute	4	2228	2228
Health faucet	4.5	LPM	0.25	minute	1	2228	2506.5
Shower head / Handheld spray	6	LPM	8	minutes	0.1	1114	5347.2
Total usage (LPD)							**14737.7**



Amount of leakage water saved : 28715 KL

Rainwater harvesting surfaces	Area m2	Runoff coeffecient	Effective catchment area m2
Roof Surfaces	200	0.85	170
Hardscape areas	400	0.70	280
Softscape areas	200	0.30	60
Other			0
			0
Total Effective catchment area			**510**

Table T.21 Effective catchment area

Water use	Quantity	Liters/day
Occupants : {People x l/person}	8	135
Irrigation (max) : {m2 x l/m2}	400	1.7
Cooling tower (max) : {Ton x l/Ton}	8.57	64
Other		

Table T.22 Water Usage

Per Capita daily consumption	Number of occupants	Total daily consumption	Grey water filter efficiency
135	8	1080	75%

Table T.23 Grey water Filter efficiency

Occupant's Activity	Percent usage	Quantity	Grey water	black water
Bathing	29.0%	313.2	100%	0%
Washing	19.6%	211.68	100%	0%
Drinking	4%	42.12	0%	100%
Cooking	3%	31.32	0%	100%
Toilet	17.0%	183.6	0%	100%
Cleaning house	8.0%	86.4	100%	0%
Washing Utensils	16.4%	177.12	100%	0%
Others	3.20%	34.56	50%	50%

Table T.24 Percentage of greywater and black water

Months	Rainfall (mm)	Effective rain (mm)	Harvested rainwater (l)
July	200	195	99654
August	200	195	99603
September	123	118	59925
October	19	14	6885
November	3	0	0
December	10	5	2550
January	23	18	9027
February	20	15	7701
March	15	10	4845
April	10	5	2601
May	15	10	5100
June	68	63	32079

Table T.25 Harvested Rainwater Calculations

Month	Days in month	Generated black water	Generated Grey water	Filtered grey water	Month	Days in month	Occupant demand	Irrigation seasonal factor (%)	Irrigation demand	Cooling tower Usage factor (%)	Cooling tower water demand (l)	Total water demand (l)
Jul	31	8504	24976	18732.06	July	31	33480	20%	4216	0%	0	37696
Aug	31	8504	24976	18732.06	August	31	33480	20%	4216	0%	0	37696
Sep	30	8230	24170	18127.8	September	30	32400	20%	4080	0%	0	36480
Oct	31	8504	24976	18732.06	October	31	33480	50%	10540	0%	0	44020
Nov	30	8230	24170	18127.8	November	30	32400	50%	10200	0%	0	42600
Dec	31	8504	24976	18732.06	December	31	33480	50%	10540	0%	0	44020
Jan	31	8504	24976	18732.06	January	31	33480	100%	21080	0%	0	54560
Feb	28	7750	22760	17070.345	February	28	30510	100%	19210	0%	0	49720
Mar	31	8504	24976	18732.06	March	31	33480	100%	21080	50%	8501	63061
Apr	30	8230	24170	18127.8	April	30	32400	100%	20400	100%	16454	69254
May	31	8504	24976	18732.06	May	31	33480	50%	10540	100%	17003	61023
Jun	30	8230	24170	18127.8	June	30	32400	50%	10200	50%	8227	50827

Table T.26 Annual water Requirement

BOQ (Bill of quantities)

Mahindra Homeground - RWH System BOQ Pimpri Chinchwad					
Sr. No.	**Description**	**Unit**	**No.**	**Rate**	**Amount**
-	**RWH structure**				
1	**Rainwater Harvesting Structure :** Providing Rainwater Harvesting (1.5m x1.5 m x 2.95 m ht) in Second class Burnt Brick masonry with conventional brick in cement mortar 1:6, with HD concrete chamber cover including excavation, filter media, debris removal as directed in drawing, etc complete	No	10	119302	1193016
2	**Silt Chamber :** Providing Recharge Pit (1.5 x1 x1.5m ht) in Second class Burnt Brick masonry with conventional brick in cement mortar 1:6, with MD concrete chamber cover including excavation, plaster, debris removal as directed in drawing, etc complete	No	3	30004	90013
3	**Grease trap Chamber :** Providing Recharge Pit (1.5 x1 x1.5m ht) in Second class Burnt Brick masonry with conventional brick in cement mortar 1:6, with MD concrete chamber cover including excavation, plaster, debris removal as directed in drawing, etc complete	No	8	30004	240036
4	**Rain water drain Chamber :** Providing Brick SWD chamber (0.6 m x0.6 x 0.75m ht), with MD chamber cover as directed etc complete	No	3	12000	36000
5	**R.C.C. pipe of NP2:** Providing & laying 200 mm dia RCC NP 2 spun pipe as per drawing & design with sealing joints with cement with line, level finishing (Connection with SWD & Recharge pit etc complete.	Rm	10	1100	11000
8	**Design** :Providing detailed layout, design, drawing & estimation	LS	1	46022	46022
9	**Maintenance :** Removing & cleaning of recharge pit after three Year	LS	1	50000	50000
Total in words- Sixteen Lakh Sixty six Thousand eighty eight rupees only					**Rs. 16,66,088**

Table T.27 :BOQ

Considerations for Sumps and Recharge Pits

Rain water harvesting technique is one of the other alternatives to manage and conserve water for a secure and sustainable future.X

Sr. No	Water Storage Structures	Dimensions/Quantity of Structures	Storage Capacity in Cum
Considerations- Rainwater Sumps-2, Pit cum Recharge Borewells-3, Recharge Pits-7			
Total Rainwater Generated from Podium and Rooftop terrace area			3068.8017
1	Total intake capacity of the aquifer		417.25
2	Rainwater Sumps	2	200
3	Pit cum Recharge Borewells	3	131.5467
4	Recharge Pits	7	246.6567
5	Total quantum of storage with various sources		995.4543
	Total Excess Rainwater remains harvestable after		2073.3474
	utilizing all proposed storage options		

Table T.28 Storage capacity of various units

CONSIDERATIONS FOR SUMPS AND RECHARGE PITS

To harness the full capacity of subsurface aquifer it's recommended to have 3 Pit Cum Recharge Borewells. The Dimensions is recommended for recharge BW is 6-inch diameter and 60 meters depth, with a recharge pit of dimensions 1.5m*1.5m*2.95m.

Additionally to enhance recharge it's recommended to have 07 nos. Recharge Pits, with dimensions as 1.5m*1.5m*2.95m

It recommended that the subsurface aquifer be recharged only through Roof Top

generated rainwater only

2 rainwater storage sumps of capacity 100 Cum are proposed, which will accommodate 200 Cum rooftop water

As per EC, it's recommended that the construction of Recharge pits should not be in the Storm Water drain line

Eco STP Details

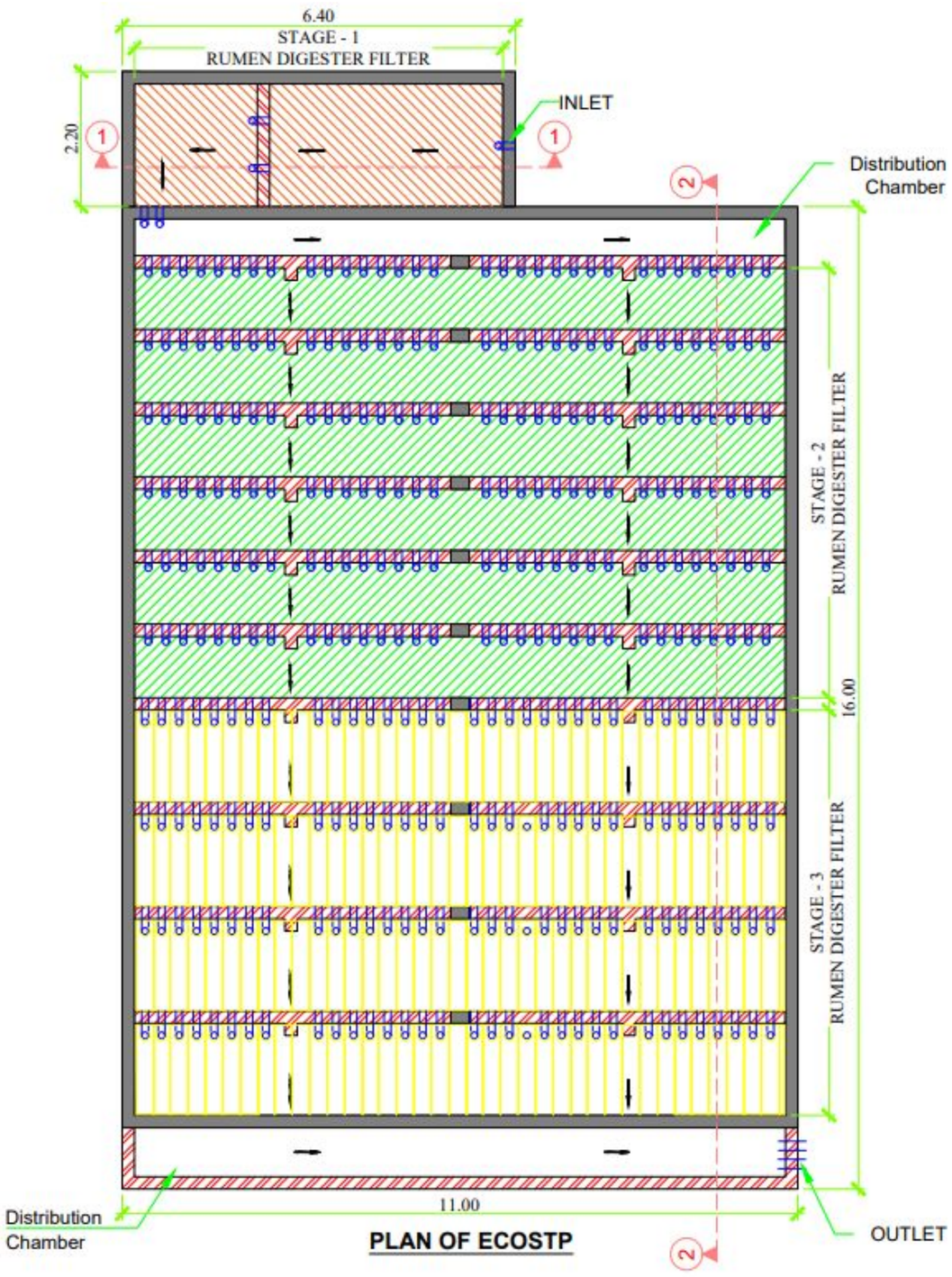


Figure3.6: Plan of ECOSTP

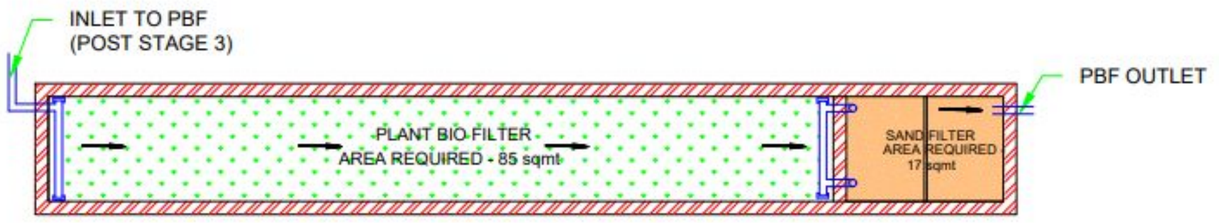


Figure3.4: Plan- Tertiary treatment

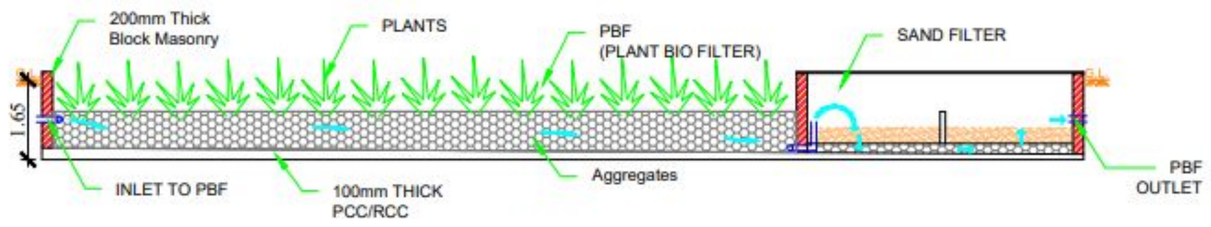


Figure3.5: Sectional detail

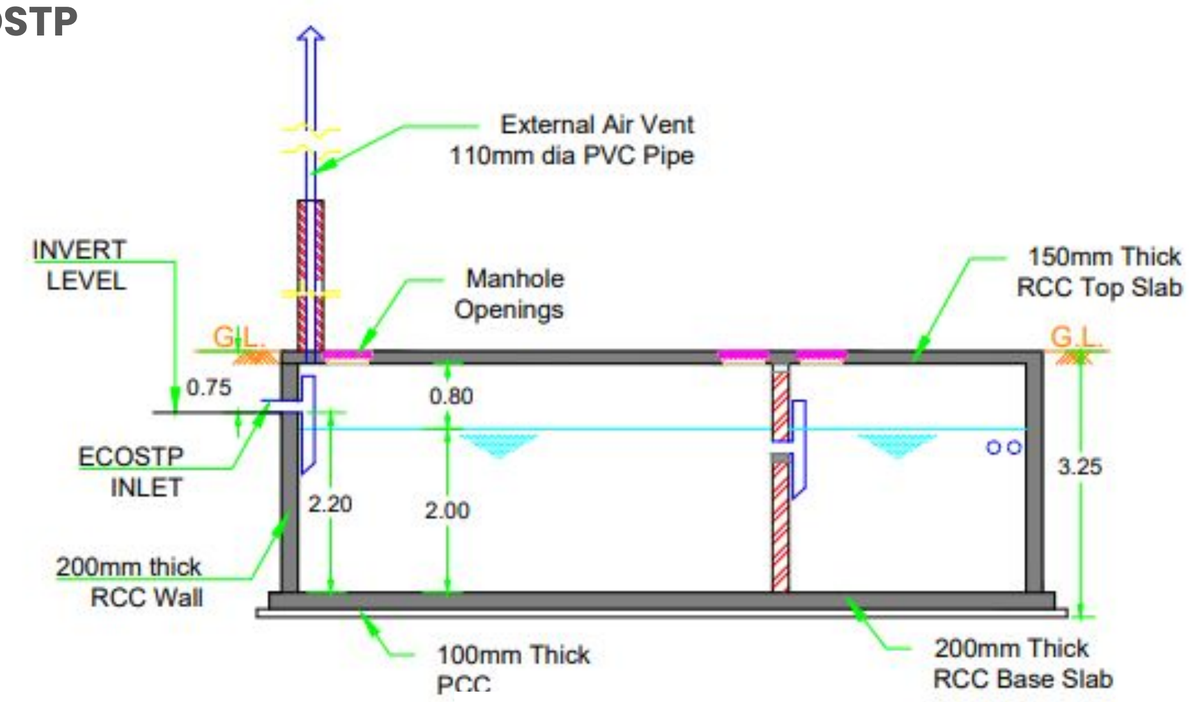


Figure 3.7: Cross section 1-1

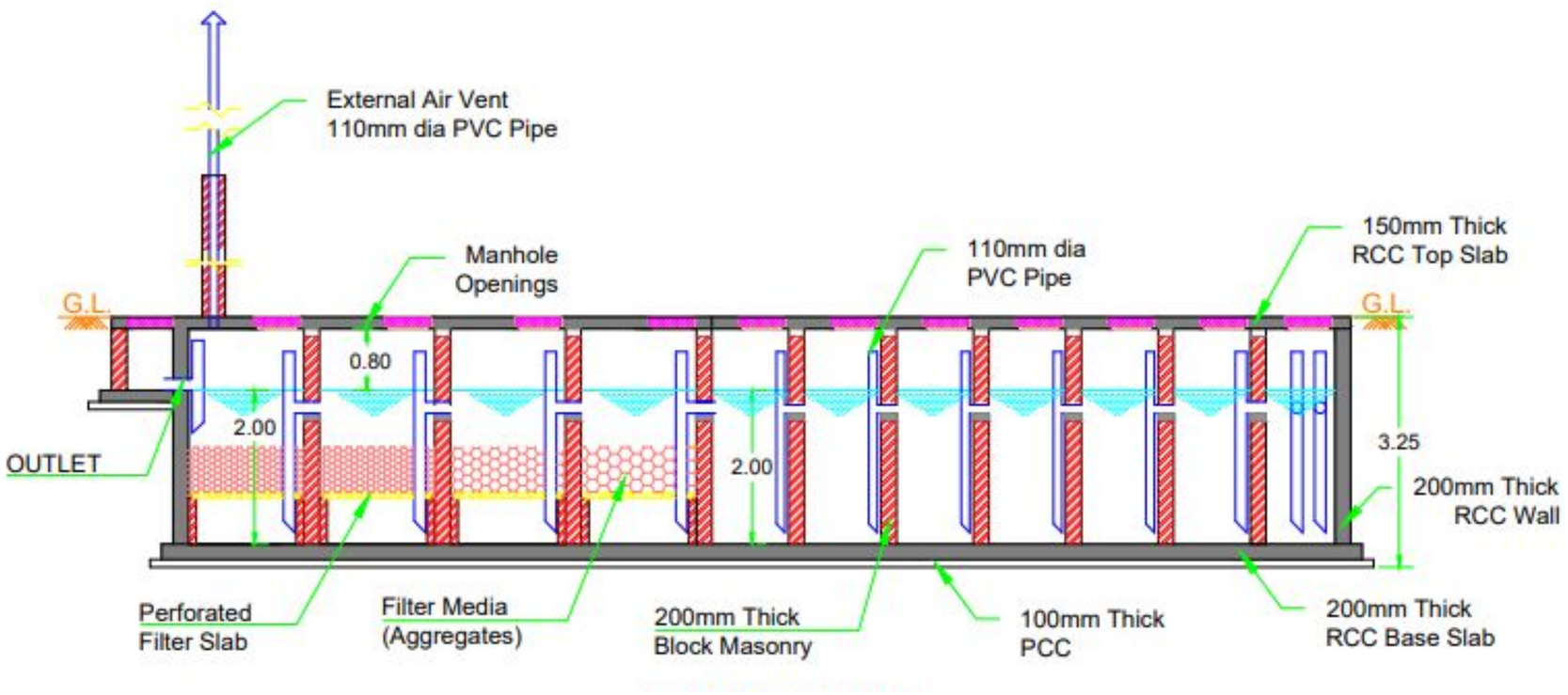


Figure 3.8: Cross section 2-2

Survey

SURVEY CONDUCTED FOR CUSTOMERS

Link to survey - https://docs.google.com/forms/d/e/1FAIpQLSfB0Jc5HpOGoCAV2WeEpXIo4v6VZQ2xhHaqIDgWfHslbSUtrQ/viewform
Results- https://docs.google.com/spreadsheets/d/1uxnIA5ycxvrDNvMiu1kHZblnspUOcbIcsA7UhMNiMfA/edit?usp=drivesdk

Project Partner

PROJECT PARTNERS GIVEN TO US BY SOLAR DECATHLON INDIA

GreenJams

Address

GreenJams BuildTech Pvt. Ltd.,

401, 10-5-14/c, Mantis,
Facor Layout, Ramnagar,
Visakhapatnam – 530 002

22.02.2023

To,
The Director,
Solar Decathlon India

Dear Sir,

This is to inform you that our organisation GreenJams is collaborating with participating team Synergy led by Sir J.J. College of Architecture on a Multi-family housing project for their Solar Decathlon India 2022-23 competition entry.

The nature of our collaboration will be to mentor the team on carbon mitigation strategies and provide information about the product offerings at GreenJams.

We would like 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 organisation'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,

Tarun Jami,
Founder & CEO
GreenJams
tarun@greenjams.org
+919591170791

Telephone
M: +91 9591170791

M: +91 9727139348

Web
E: hello@greenjams.org **W:** www.greenjams.org

ant studio

Communication office:
Khasra no. 207, Village Raipur Khader,
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Registered office:
D64, Fourth Floor, Amar Colony,
Lajpat Nagar 4, New Delhi 110024

Mobile: +91 99 53 33 02 70
website: www.ant.studio

21-02-2023

To,

The Director,
Solar Decathlon India

Dear Sir,

This is to inform you that our organisation, **Ant Studio**, is collaborating with the participating team led by Sir J.J. College of Architecture in a Multi-Family Housing Building project for their Solar Decathlon India 2022-23 competition entry.

The nature of our collaboration will be as **consultants for Climate Responsive Building Envelopes**.

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

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

With warm regards,

Pranjal Maheshwari
Architect
Ant Studio
pranjal.m@ant.studio
9213062741

ECOSTP®

ECOSTP Technologies Private Limited

Brigade Real Estate Accelerator Program
Brigade Gateway Campus,
26/1, Dr. Rajkumar Road, Malleswaram - Rajajinagar,
Bangalore 560 055, India : team@ecostp.com

22-02-2023

To,

The Director,
Solar Decathlon India

Dear Sir,

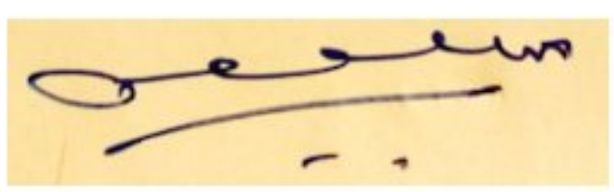
This is to inform you that our organisation ECOSTP is collaborating with the participating team led by Sir J.J. College of Architecture in a Multi-Family Housing Building project for their Solar Decathlon India 2022-23 competition entry.

The nature of our collaboration will be to explore natural biophillic sewage treatment based on biomimicry principles. ECOSTP is a zero power zero chemical sewage treatment technology based on digestive system of a cow.

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

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

With warm regards,



Tharun Kumar

Founder & CEO

+91 7259002986 / tharun@ecostp.com

AMBIATOR®
Sensible Cooling

22-02-2023

To,

The Director,

Solar Decathlon India

Dear Sir,

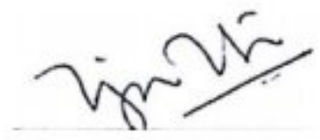
This is to inform you that our organisation, **AMBIATOR Pvt. Ltd.**, is collaborating with the participating team led by Sir J.J. College of Architecture on a Multi-Family Housing project for their Solar Decathlon India 2022-23 competition entry.

The nature of our collaboration will be to guide and assist the **Synergy** Team to enable Net Zero - Adaptive Thermal Comfort with the AMBIATOR in the Multi-Family Housing Project.

We would like to be able to have a representative from our organisation attend the Design Challenge Finals event in April/May, if this team is selected for the Finals.

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

With warm regards,



Tiger Aster
Founder & CEO

AMBIATOR Pvt. Ltd.
hi@ambiator.com
+91 9588663075

ProEarth

Being Earth Conscious

Date: 22nd Feb, 2023

To,
The Director,
Solar Decathlon India

Dear Sir,

This is to inform you that our organisation, **ProEarth Ecosystems Private Limited**, is collaborating with the participating team led by Sir J.J. College of Architecture in a Multi-Family Housing Building project for their Solar Decathlon India 2022-23 competition entry.

The nature of our collaboration will be to support the students of Sir J. J. College of Architecture to work on a practical and implementable zero waste model at the chosen residential project.

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

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

With warm regards,

Anil Gokarn
Director
ProEarth Ecosystems Private Limited
Email: anil.gokarn@proearth.in
Phone: +91 98812 54920

G2V Solar Solutions Private Limited
CIN: U29307AP2019PTC112951
Email: admin@g2vsolar.com
Web: www.g2vsolar.com

23rd of February 2023

To,

The Director,

Solar Decathlon India

Dear Sir,

This is to inform you that our organization, G2V® Solar Solutions Pvt. Ltd., is collaborating with the participating team led by Sir J.J. College of Architecture in a Multi-Family Housing Building project for their Solar Decathlon India 2022-23 competition entry.

The nature of our collaboration will be non-commercial and purely educative. We shall provide mentorship to the team and information relevant to the sector.

We would like 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,

Vivek Vardhan
Director & CTO
G2V® Solar Solutions Pvt. Ltd.
Email: inc@g2vsolar.com
Phone: +91 8121066567

University of Mumbai

SIR J. J. COLLEGE OF ARCHITECTURE

78/3, DR. D. N. ROAD, MUMBAI - 400 001. (INDIA) TEL.(O) : 2262 1649
Email -asirjjcoa@gmail.com Fax - 2262 1118

No.SJJCA/student/Bon./794/2023
23/02/2023

To
The Director,
Solar Decathlon India
Date: 23 February, 2023

Subject: Bonafide of students participating in Solar Decathlon India 2022-23

Vaibhav Kadam (5th year)
Sagar Sherkhane (5th year)
Ayushi Thakur (4th year)
Vaishnavi Parmar (4th year)
Tapasya Vagal (4th year)
Shreyansh Dayma (3rd year)
Prathamesh Kawate (3rd year)
Rhea Oswal (3rd year)
Suchi Jain (3rd year)
Amruta Gandhe (2nd year)
Vishal Danure (2nd year)
Omkar Vernekar (2nd year)
Sahil Dhatrak (2nd year)
Krutika Vilekar (2nd year)

I, hereby, assure that the students mentioned are bonafide students Sir J.J. College of Architecture for the academic year 2022-23.

23/02/2023

Prof.Rekha Nair,
Faculty Guide

Prof. Rajiv Mishra
The Principal,
Sir J.J. College of Architecture

Sir J. J. College Of Architecture • UNIVERSITY OF MUMBAI •