

INTERMEDIATE DESIGN DEVELOPMENT REPORT

APRIL 2021

ECOLUTION

COMPETITION DIVISION-EDUCATIONAL INSTITUTION

Balwant Sheth School of Architecture, Narsee Monjee Institute of
Management Studies, Mumbai



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01. EXECUTIVE SUMMARY

Team Ecolution represents NMIMS University, India. We propose a holistic approach to the education scenario in India. A multidisciplinary team and technical support of our Industry partners we direct our design towards fostering a lifetime of associations, between the school and its students. Nurturing the insert as a net-zero energy, low carbon and resource efficient solution, catering specifically to the hot-and-humid climate zone prevalent in Kalyan.

School is not just an academic setting, rather a foundation of healthy connections that build safe and positive learning environments. Outside of the home, school is the centre of most young people's worlds. Which involves fostering interaction & participation, leads to greater sharing and thus offers lots of opportunities for students and teachers to develop trust. We aim to ensure an environment of greater cooperation, resiliency, growth in self-directed behaviour, increased pursuit of social goals and an refined sense of relatedness and belonging.

Building on India's First Eco School rated project, through The Sacred Heart Association we selected the second phase of expansion of the school for the 11th and 12th standard. To augment on the existing practices of the 10.5 acre site based in Kalyan, Mumbai, India, we corroborate the applicability of our design. The existing school campus comprises of a an e-library, design labs, rainwater harvesting system, catchment pond, in-house fabrication & production unit, livestock management, waste recycling and a functional solar power generation set-up.

Considering the reuse systems in place we strongly pursued an enhanced passive-energy strategies, balanced and affordable proposal. With keen interest in all the building science principles and affordability, we carried out the pre design comfort & energy simulations. We develop an optimized building massing with a huge potential for achieving thermal comfort through natural ventilation and mixed mode operations. With special attention to shading devices, roof insulations and at the same time accommodating project partner demands.

Introduction of Grow your Greens business model on the roof to sustain the green school approach and involve the people within the resilient system. At the same time shading the roof in solar PV, while generating 60079 KWh annually against a calculated annual consumption of 59797 KWh. A biogas system reusing the produced green, brown and animal waste on site, to supply for fuel to the nearby RSSB & the school kitchen, successfully creating a Net-Positive energy building. Water efficiency measures coupled with wastewater recycling system reduces water demand by 47%, per person. We also use a water management system, which gives back to the cycle through percolation as well as in sold for revenue. Several climate models were employed to check the thermal, lighting, wind, comfort and acoustic performance of the building. A lot of attention was paid to the type and kind of landscaping in and around the building, to minimise the cooling and dehumidification by 20%.

02. TEAM INTRODUCTION

TEAM NAME: ECOLUTION.

INSTITUTE NAMES :

- Balwant Sheth School of Architecture, Narsee Monjee Institute of Management Sciences, Mumbai.
- Mukesh Patel School Of Technology Management & Engineering, Narsee Monjee Institute of Management Sciences, Mumbai.

DIVISION: EDUCATIONAL INSTITUTE

APPROACH:

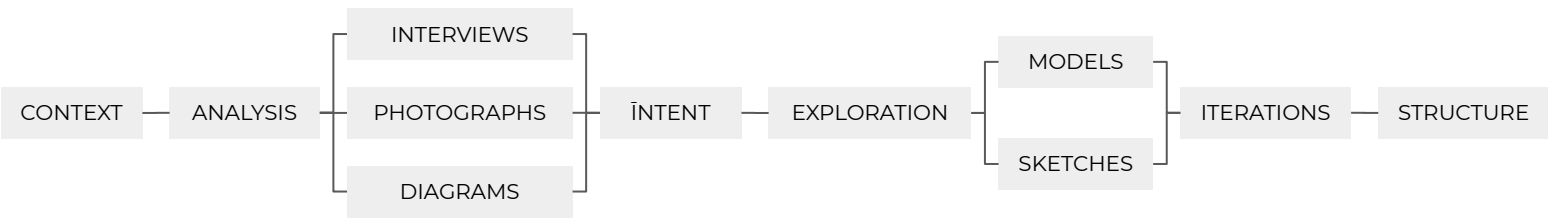


Diagram 1.1 - Approach Steps.

The NMIMS’ Balwant Sheth School of Architecture (BSSA) focuses on various modes of architectural education, research and practice. The students are offered holistic exposure and understanding through Art, History, Technology, Architectural Design and Construction process. BSSA awards a Bachelor of Architecture (B.Arch), Masters of Architecture (M.Arch) and Centre of Interior & Environment Design (CIED) of NMIMS which is recognized by the COA

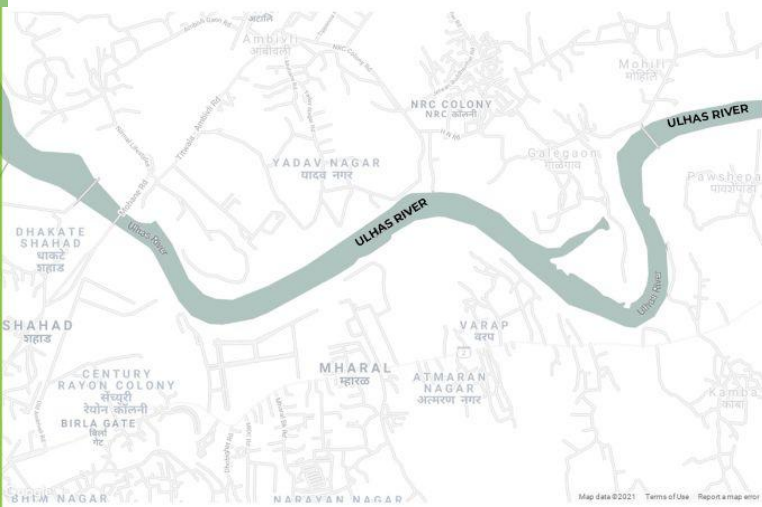
Mrs. Shriya Bhatia is an Associate Professor with 11 years of professional, academic and research experience in the field of urban environment management and sustainable habitat planning.

Detail	Description
SHS Design Team	Two young graduates from Balwant Sheth School of Architecture.
Durvesh Mhatre & Associates	Professional graduated from AA.London, and currently working as a freelancer.
Axis Facades	A global firm of Facade and Curtain Wall engineering experts focused on innovative solutions to architect's design concepts.
Pavithra Lakshmi	Senior architect from Morphogenesis, graduated from AA,London.
Gunveer Singh	Freelance architect & LEED expert, AA,London graduate.

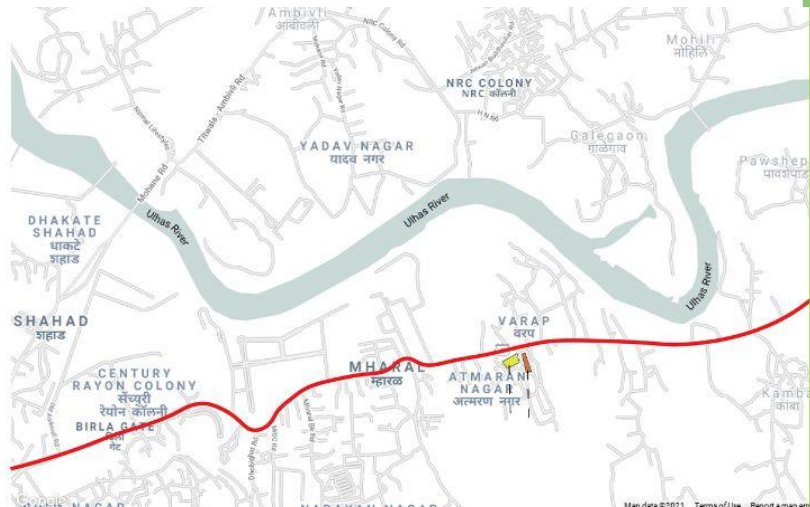
Table 1.1 - Brief details of the industry partner organisation.

Divy	Shreya	Richa	Harshiv	Rushil	Tirth	Nikhil	Khush	Manas	Atharva
Lead	Site & context	Graphics	Energy & simulations	Engineering & innovation	Cost & affordability	Estimations	Building systems	Structure	Structure

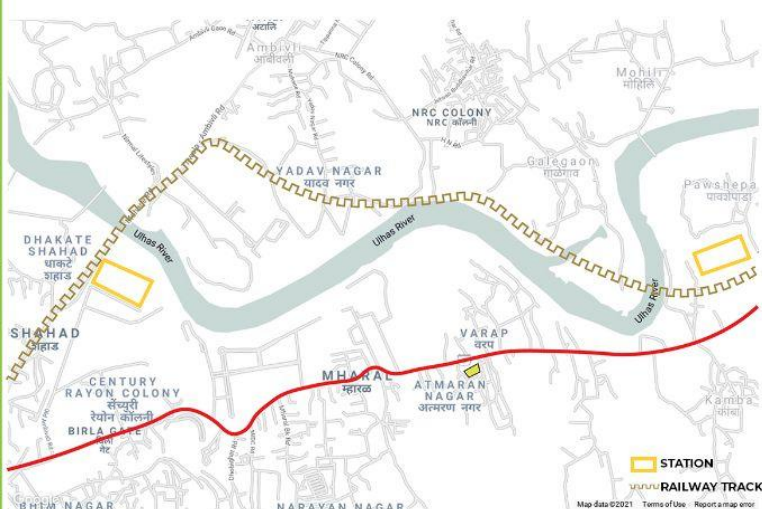
03. PROJECT BACKGROUND



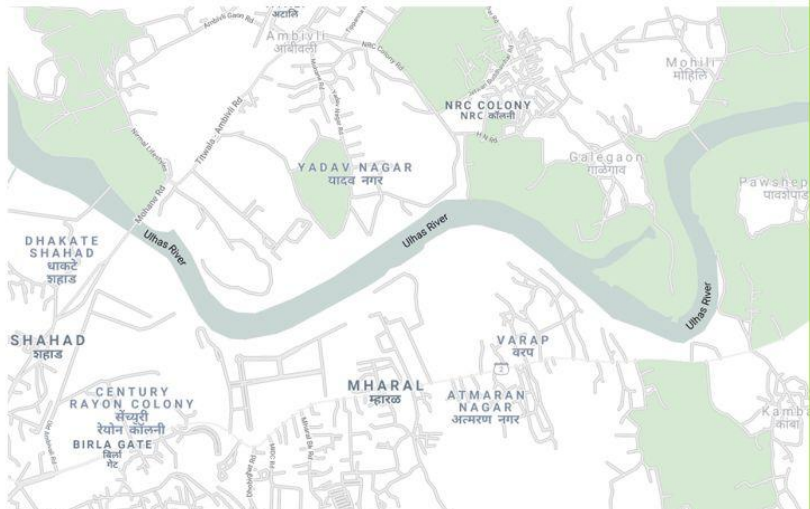
ULHAS RIVER NEAR THE SCHOOL



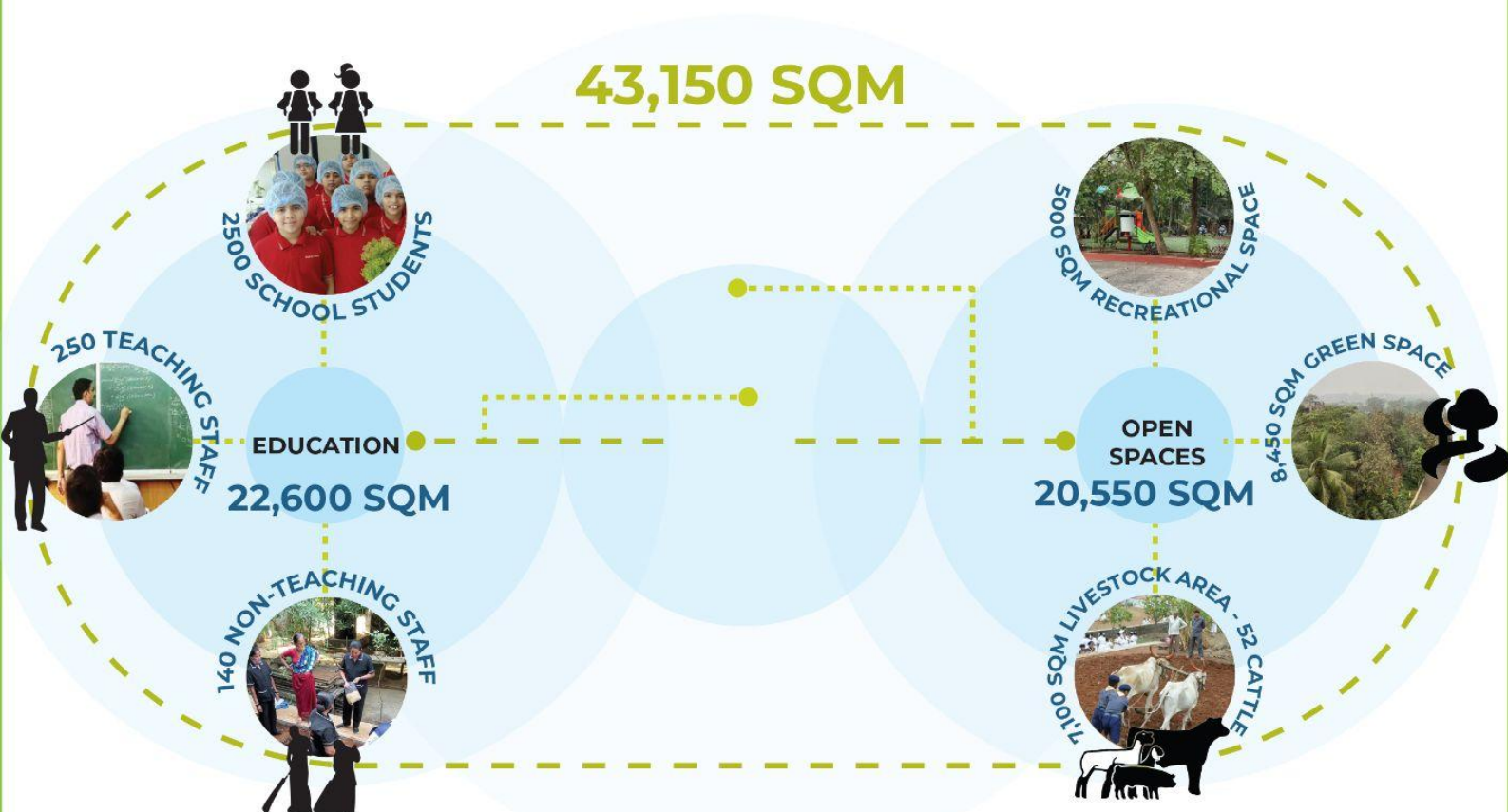
NATIONAL HIGHWAY 48



ACCESSIBILITY AND RAIL NETWORK



AGRICULTURAL FIELD



SCHOOL RESOURCES AND DATA INFORMATION

Project Name: Sacred Heart Secondary Education Building

Project Partner: Sacred Heart CBSE School, Kalyan

Fauwaz Khan & Moses Cheyaden are the co principal architects, for the SHS Design team. Both are graduates from Balwant Sheth School of Architecture, Mumbai.

Location: Kalyan-Murbad Road, Kalyan

Climate zone: Hot and Humid, Kalyan-Dombivali lies on 2m above sea level.

Significant rainfall between June to September months, with a short dry season.

Stage of the project: Design phase.

PROJECT BRIEF

Detail	Description
Project - Sacred Heart School, Kalyan	Sacred Heart School is a primary and secondary co-educational CBSE school based in Kalyan , Maharashtra.
Project Description	A Build - Own - Operate CBSE affiliated school looking to add an educational block for the 11th and 12th grade. This educational block is a stand alone building with dedicated amenities. The building will be self occupied by the project partner, and used for their educational commerce.
Special Requirements Of The Partner	We along with the school committee view this project as a unique opportunity to not only design a building that manifests and exemplifies the ideologies but also one that explores new pedagogical practices and experiences. The Grow - Your - Greens initiative, is one requirement of the project partner we intend to cater to.
Total Occupancy	300-350 students + faculty + staff.
% Of Teaching Activities	70%.
Plot Size	10.5 acre, The revenue model of the school, supports the proposed first cut design.

Table 1.2 - Brief details of the project partner organisation and the project.

SITE CONTEXT

Chief access to the Sacred Heart School is from the Sacred Heart School Road which connects to the Bhiwandi Murbad Road (NH2). The Primary and Secondary School are the existing structures next to the Proposed site. Around the school there is Radha Soami community gathering plot to the west and a village neighbourhood behind the campus. Presence of Ulhas river in 1km vicinity in the north-east and fast development of the kalyan neighbourhood.



Figure 1.1-Context Plan



Figure 1.2 Google Site Map
Source-Google earth



Figure 1.3-Site Pictures

TARGET ENERGY PERFORMANCE INDEX (EPI) (kWh/SQ.M.)- 59.4 kWh/sq.m/year*

TOTAL CONSUMPTION ESTIMATE - Summer (March to April)(excluding May)= 15900 kWh **Winter(Nov-Feb)** 20520 kWh

*As a correction, for the anomaly in the previous deliverables.

PERFORMANCE SPECIFICATIONS

Climate zone

Figure 2.1- Average Temperature and Precipitation

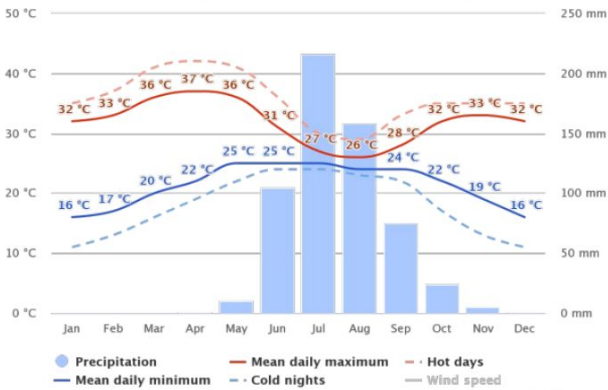
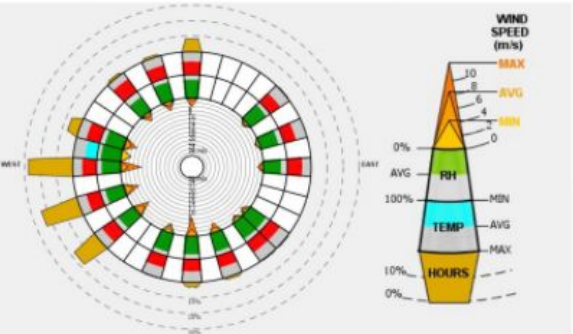
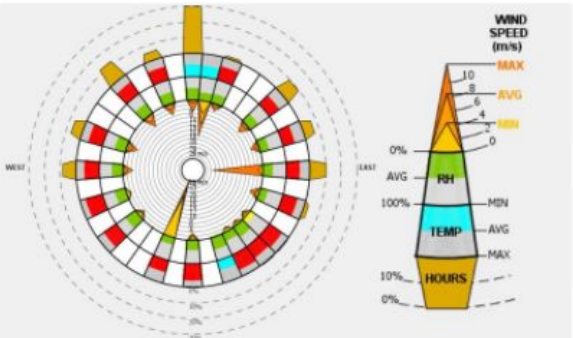


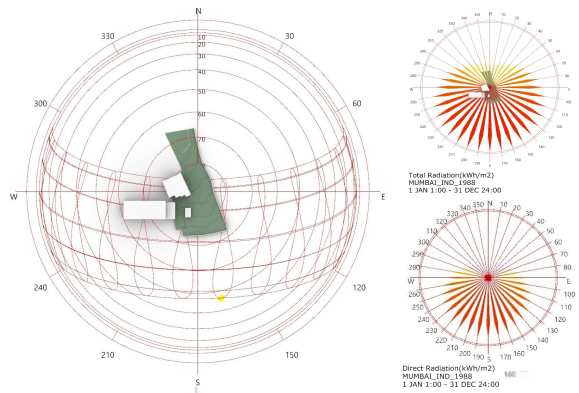
Figure 2.3- Wind Wheel



Monsoon Season



Monsoon Season



Penetration of sun rays and maximum radiation from the southern side on the proposed site area are obstructed by the existing trees on site.

Figure 2.2- Site Climate Analysis



The Radiation analysis shows southern & eastern side in lower radiation zones, central area in high radiation zone

ENVELOPE					
MATERIAL	DESCRIPTION	U VALUE W/M2	R VALUE W/	VLT	SHGC
AAC	200 MM THICK WALL	0.50	2.00	-	-
BRICK		0.77	0.15	-	-
RCC		1.95	0.51	-	-
PERFORMANCE GLASS	Viridian superBlue	2.60	0.38	47	0.39
PUF PANELS		0.53	11.00	-	-
BAMBOO		1.40	0.72	-	-
EIFS coating		0.25	4.00	-	-

Table 2.1 - Building envelope specifications

CATEGORY	DESCRIPTION
HVAC	A Variable Refrigerant Volume (VRV) system of Daikin adopted to cater to the cooling load of 5.19kBTU/hr. The system is divided into 3 zones with separate outdoor units, catering to multiple indoor units of varying capacities.
LIGHTING AND APPLIANCES	- Use of 5-star rated appliances - All lighting fixtures used are LEDs - Lighting power density = 5.6 - Automatic controller system added for optimised usage & user comfort
RENEWABLE	- Rooftop Solar PV system - Biogas Plant
	- MYSUN solar panels : Size 45kW, 20 degree tilt - Orientated south-east - Capacity of orgnic waste digester= 143 Kg/day - Total biogas generation per month is 1843 Kg

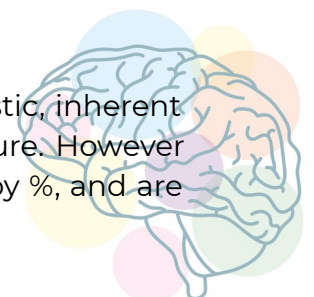
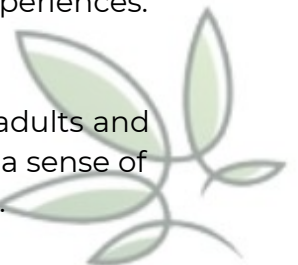
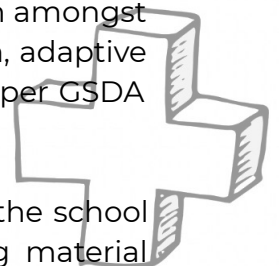
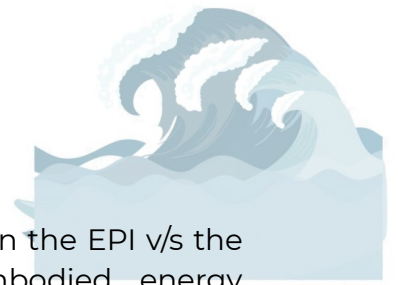
Table 2.2 - Building systems specifications

Systems	Description	Specifications
Gravity Sand Filter	They use relatively coarse sand and other granular media to remove particles and impurities that have been trapped in a floc through the use of flocculation chemicals. Water and flocs flows through the filter medium under gravity and the flocculated material is trapped in the sand matrix.	2 GPM/sq ft
Sequential Batch Reactor	Electro Mechanical plant for sewage & sullage treatment.	45.13 (million/MLD/year) O & M Cost
Swales	Landscaping element channeling storm water & surface runoff.	
Overhead Tank	Made of RCC, placed above the toilet	Flushing Tank = 22 KI Domestic Tank = 44KI
Underground Tank	Existing Underground Tank on site.	90 KLD
Water Storage Pond	Manmade pond on site.	1777.6 KLD
Percolation - Injection Shaft Method	Basalt rock 160m below ground level	194 KLD
MicroDrip Irrigation System	In drip irrigation, water is run through pipes (with holes in them) either buried or lying slightly above the ground next to the crops. Water slowly drips onto the crop roots and stems.	0.90 efficiency

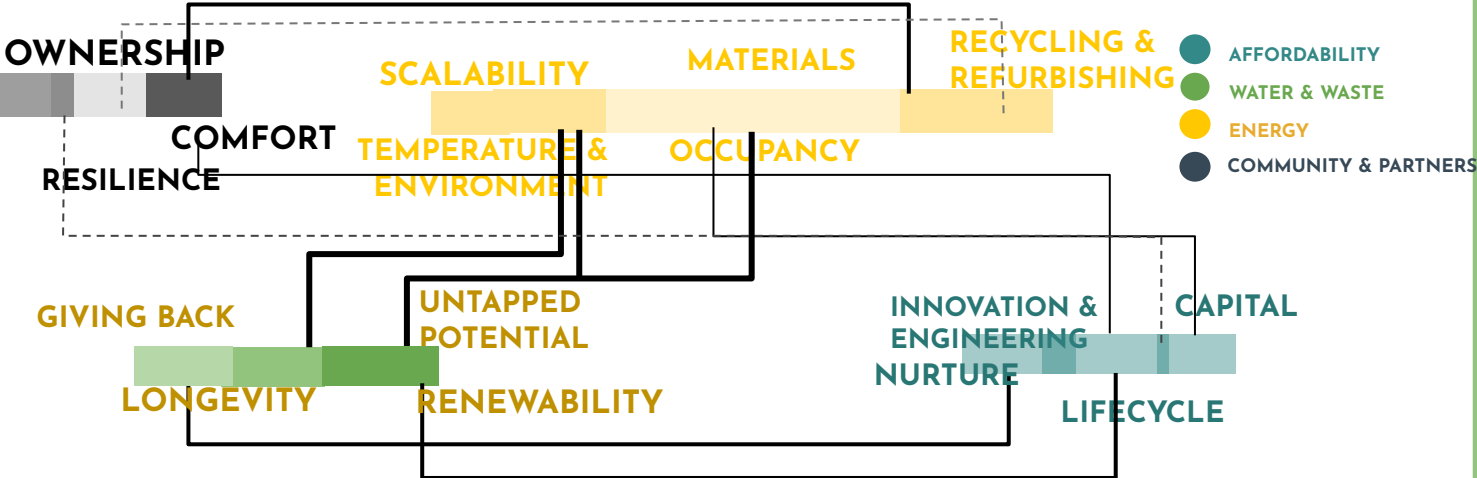
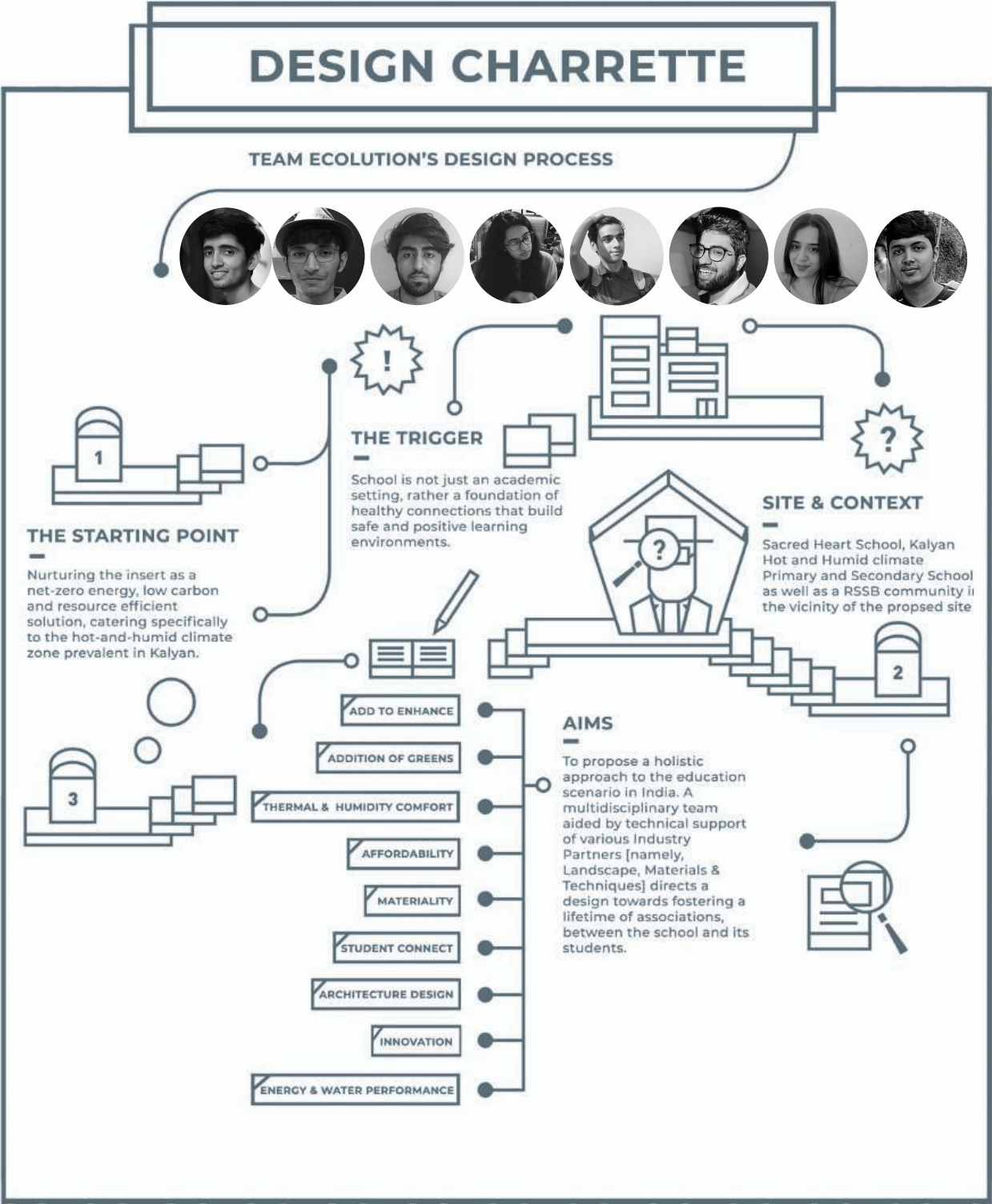
Table 2.3 - Water performance specifications

04. GOALS

- **Energy & Water Performance** - Achieving a 49% reduction in the EPI v/s the target EPI. (SuperECBC) Using materials with low embodied energy. Reduction of 51% water demands, towards a net positive water and energy design. (GRIHA Standards)
- **Thermal & Humidity Comfort** - Designing a building envelope to maintain the comfort indoors. Maintaining an adaptive comfort temperature and tackling solar radiation through passive strategies. Creating a microclimate in the structure, and reducing the mechanical dehumidification needs. Keeping the WWR to 40% coupled with clerestory windows, which allows for well ventilated spaces. (as per LEED & ASHRAE guidelines)
- **Add to Enhance** - Bringing the peripheral context into play, location amongst the greens and the market around to strategise revenue generation, adaptive resilience and explorative ideas for affordability, water & energy. (as per GSDA Maharashtra Gov.)
- **Materiality** - Building a soft, holistic and aesthetic environment of the school by using earthy, sustainable and low hazard materials. Balancing material properties with (U & R values) cost. Reducing energy loads by 40%, and cost by 38%.
- **Affordability**- Looking at affordability as a multifaceted parameter beyond operational & capital expenditure. In addition to saving on operational and construction cost, looking at investments in the future. Learning sustainability synergising affordability goals with communities around as ... Using materials from onsite debris, or recycling produced dry waste, as building material.
- **Architecture Design** - Embracing the culture of the school, with equal interior and exterior environments which should act as seamless connectors. Fostering learning moments through student - student, faculty - student & faculty - faculty interactions via various circulatory building spatial experiences. Bringing down the construction time by 20%.
- **Student Connect** - Recognizing the needs and demands of young adults and providing for sufficient collaborative and interactive spaces. To instill a sense of ownership in the students, and a "You dream, we execute", approach.
- **Addition of Greens** - Our project partners look at adding greens, not just as merely landscape and landscaping elements. Creating a biophilic microcosm which can be incentivised by the ancillary staff, students and school. Improving the indoor air quality levels by 10%+.
- **Innovation** - Integrating innovative ideas and techniques as holistic, inherent parts of the design and not as stand out elements of the structure. However adding functionality, character to the building. These save costs by %, and are additionally sustainable.



05. DOCUMENTATION OF DESIGN PROCESS



STATEMENT OF INTENT



CONSIDERATIONS

The existing school campus comprises of rainwater harvesting system, livestock management, waste recycling and a solar power generation set-up.

① PASSIVE ENERGY STRATEGIES

② BUILDING SCIENCE PRINCIPLES AND AFFORDABILITY

③ OPTIMIZED BUILDING MASSING

④ PROJECT PARTNER REQUIREMENTS

THE SOLUTION

GROW YOUR GREENS

Business model on the roof to sustain the green school approach and involve the people within the resilient system

SHADING THE ROOF

Generating 60079 KWh annually against a calculated annual consumption of 59797 KWh

BIOGAS SYSTEM

Reusing the produced green, brown and animal waste on site, to supply for fuel to the nearby RSSB & the school kitchen

WATER EFFICIENCY

Wastewater recycling system reduces water demand by 47%, per person. water & gives back to the cycle through percolation

CLIMATE MODELS

Check the thermal, lighting, wind, comfort and acoustic performance of the building

EFFICIENT LANDSCAPE

To minimise the cooling and dehumidification loads by 20%.

CONCEPT

CENTRE FOR RELATIONSHIP-BASED

EDUCATION. Outside of the home, school is the centre of most young people's worlds. School is not just an academic setting, it is where students learn to be a friend, resolve conflict, bounce back from difficulty, and begin to define who they are. Support for students should happen in the school and viceversa The common denominator underpinning both academic achievement and student well-being are these

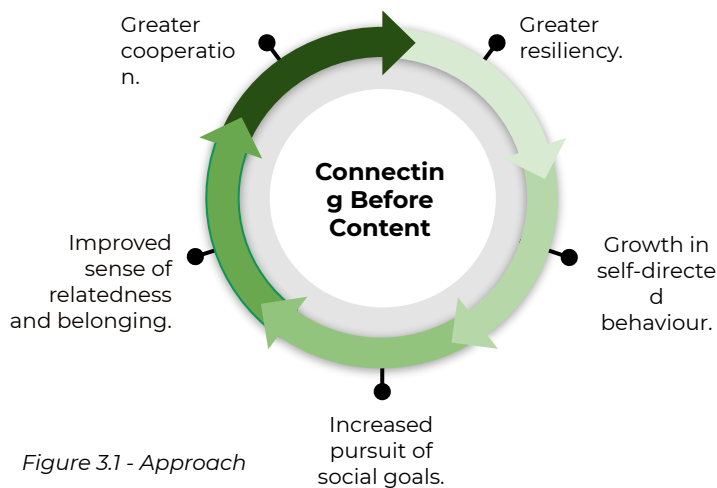
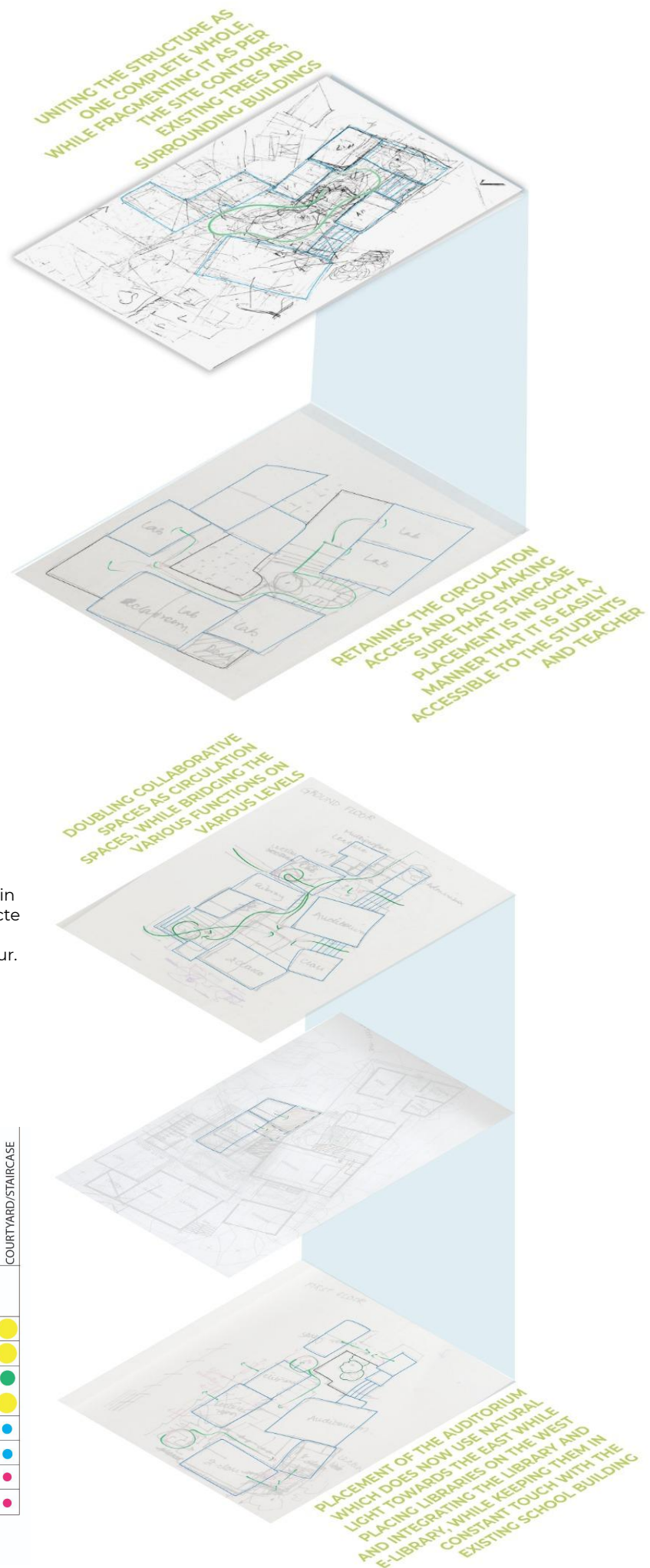


Figure 3.1 - Approach

Figure 3.2 - Requirement Matrix

	CLASSROOM	LABS	LIBRARY	LECTURE ROOM	AUDITORIUM	BATHROOM	OFFICES	COURTYARD/STAIRCASE
ENVIRONMENTAL								
DAYLIGHT	●	●	●	●	●	●	●	●
NATURAL VENTILATION	●	●	●	●	●	●	●	●
SOLAR ACCESS	●	●	●	●	●	●	●	●
VIEWS OUT	●	●	●	●	●	●	●	●
CLOSE CONTROL THERMAL COMFORT RANGE	●	●	●	●	●	●	●	●
INDIVIDUAL CONTROL	●	●	●	●	●	●	●	●
PRIVACY	●	●	●	●	●	●	●	●
GLARE CONTROL	●	●	●	●	●	●	●	●



06. DESIGN DOCUMENTATION

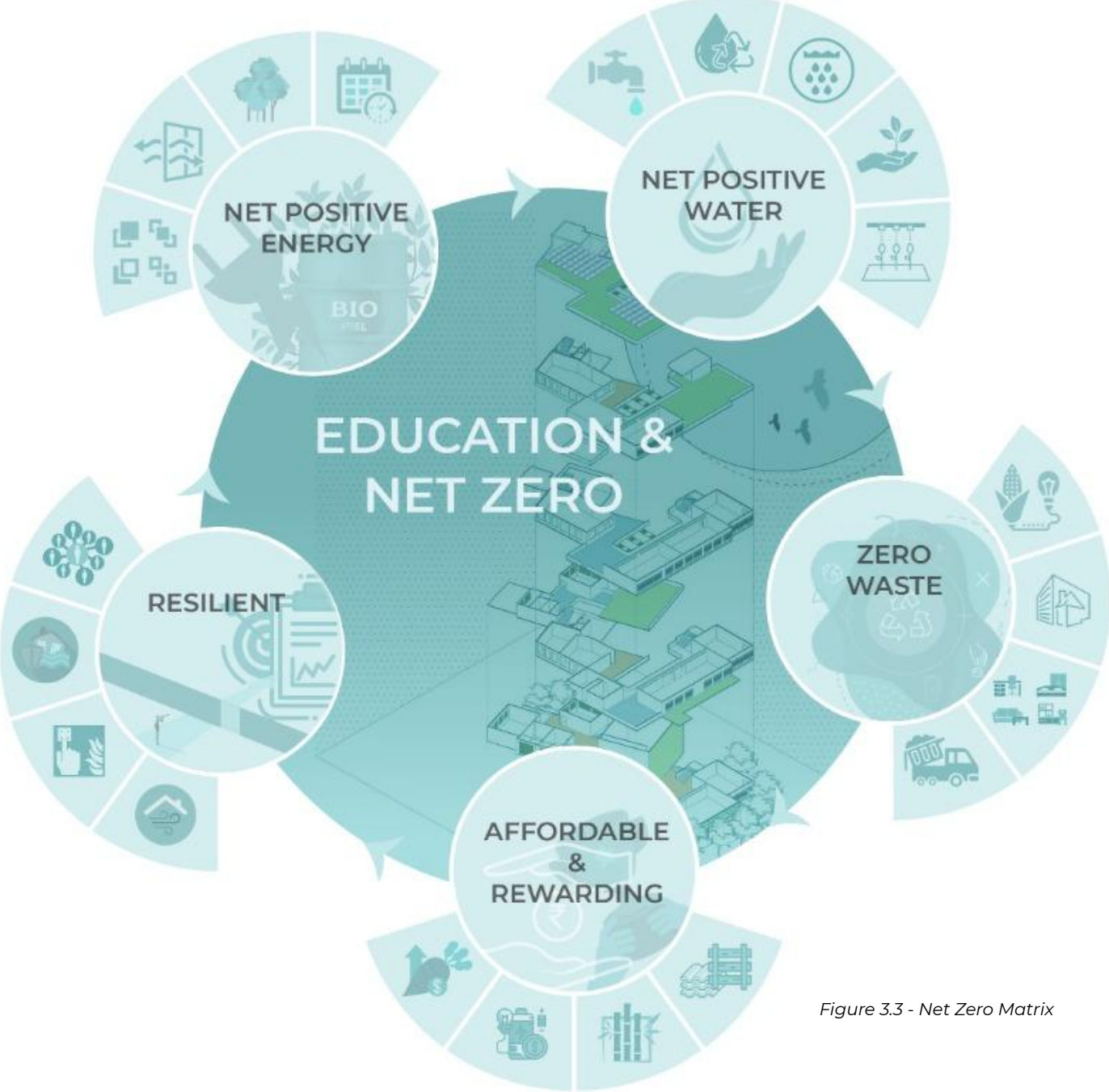


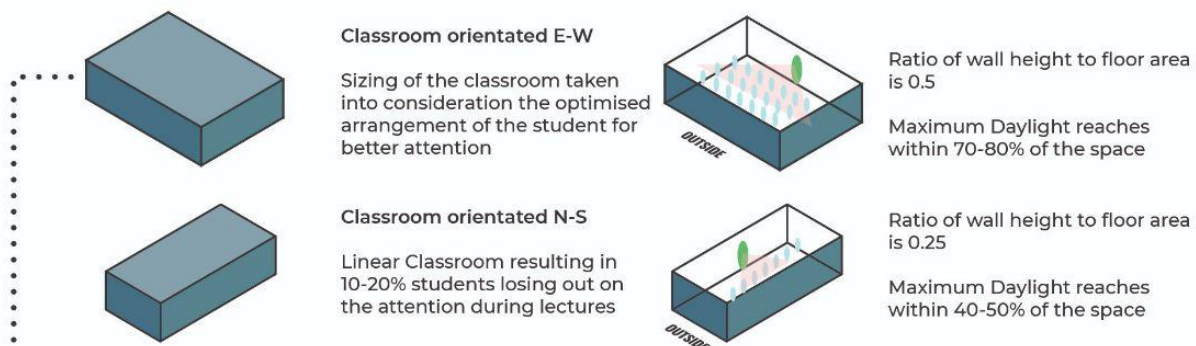
Figure 3.3 - Net Zero Matrix

NET POSITIVE ENERGY	NET POSITIVE WATER	ZERO WASTE	AFORDABLE & REWARDING	RESILIENT
<div> Detailed Occupational Schedules</div> <div> Extensive Green Cover</div> <div><div></div>Strategic Placement of Ventilation</div> <div><div></div>Placement of Functions</div>	<div><div></div>Low Flow or No Flow Fixtures</div> <div><div></div>Reusing Grey Water</div> <div><div></div>Percolation Shafts</div> <div><div></div><1 Plant Factor Species</div> <div><div></div>95% Efficient Irrigation System</div>	<div><div></div>Biomass Energy</div> <div><div></div>Trenches, Screens & other Building Elements</div> <div><div></div>Chipboard Furniture</div> <div><div></div>Reuse of Construction Debris</div>	<div><div></div>Business Models for Vegetable Energy & Water</div> <div><div></div>Low Cost Materials like Bamboo</div> <div><div></div>Reuse of Materials like Corrugated Sheets & Railroad Sleepers</div>	<div><div></div>Community Co-Management</div> <div><div></div>Rain & Flood Management-Elevated Floors & Recycled Water Usage</div> <div><div></div>Fire & Emergency Communication</div> <div><div></div>Comfort & Adaptive-Comfort in Outages & Seasonal Variations</div>

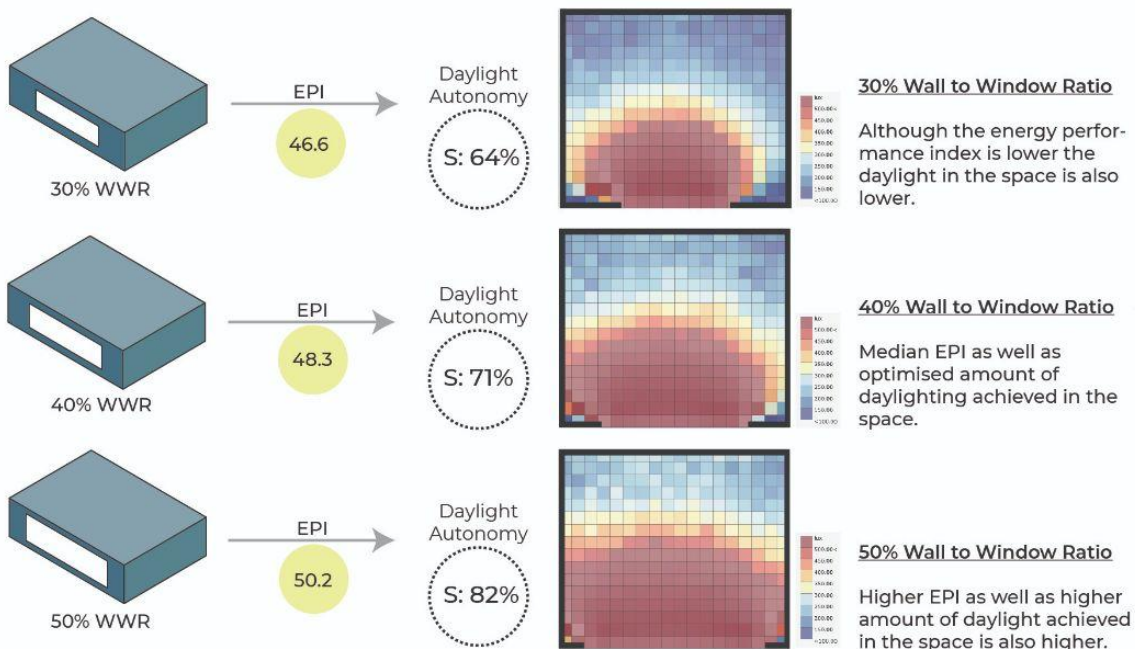
07. ENERGY PERFORMANCE

Building Optimisation Process of a Classroom:

Form and Orientation:



Wall to Window Ratio Optimisation:



Fenestration Optimisation:

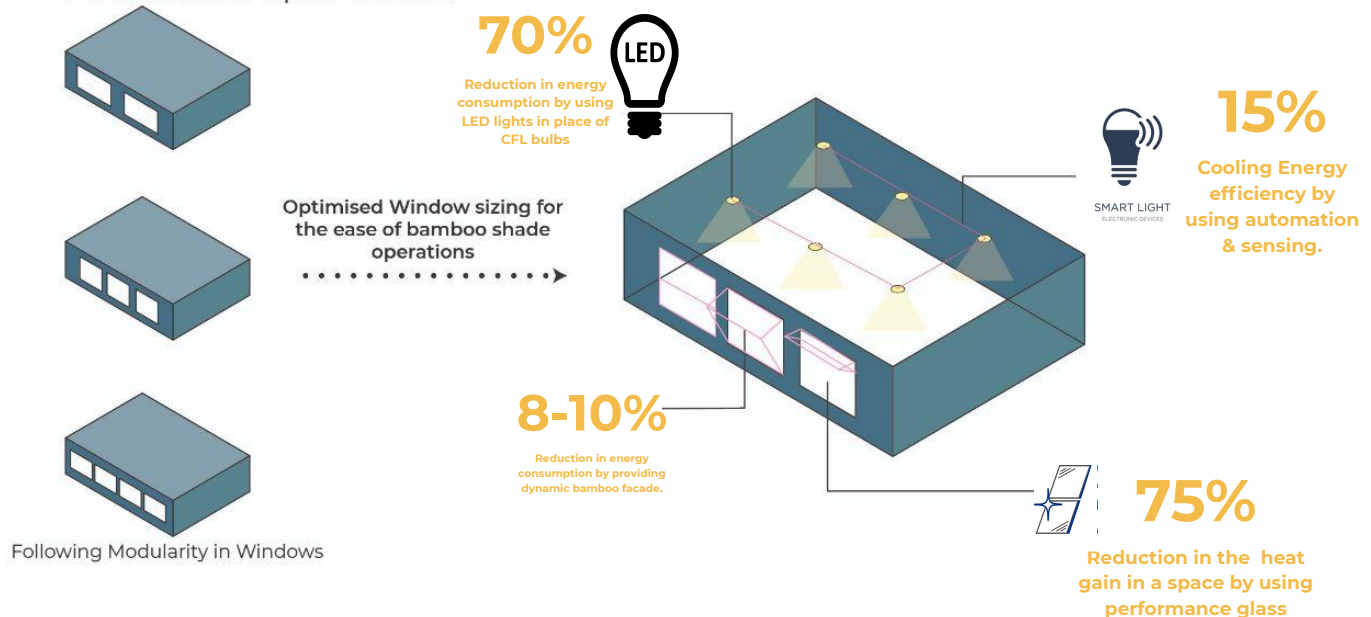


Figure 4.1 Form and Orientation

Simulation Parameters and Output:

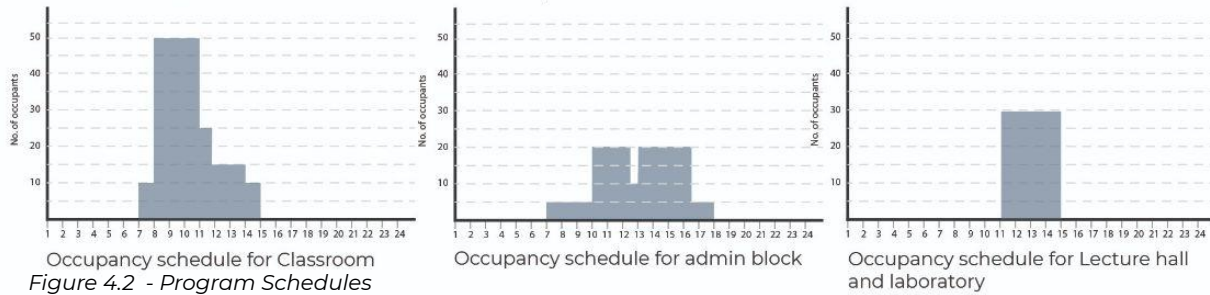


Figure 4.2 - Program Schedules

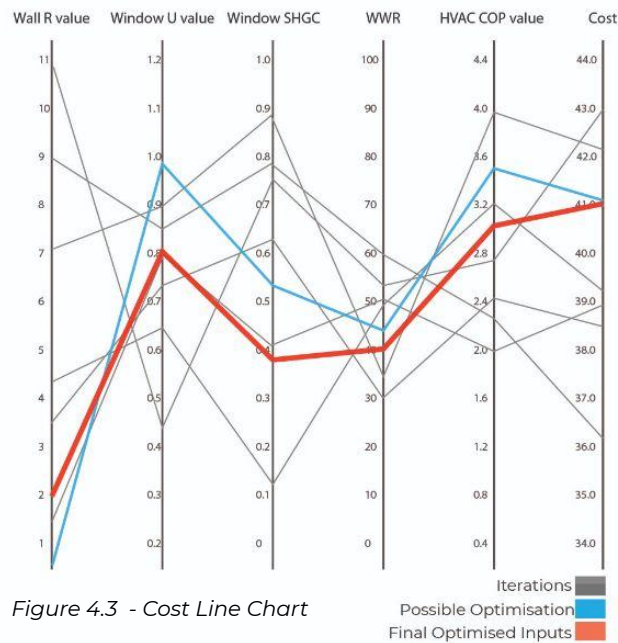
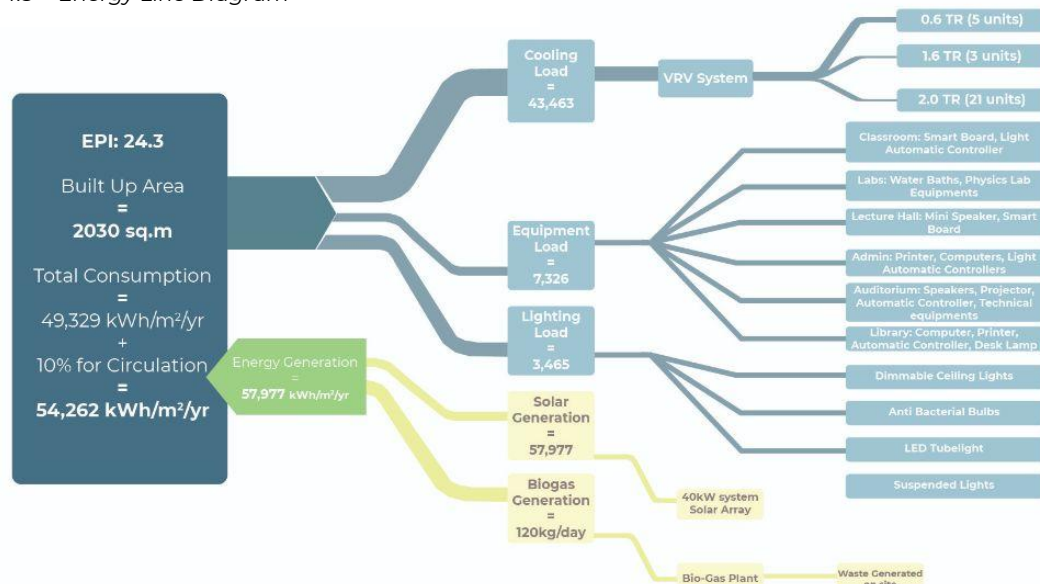


Figure 4.3 - Cost Line Chart



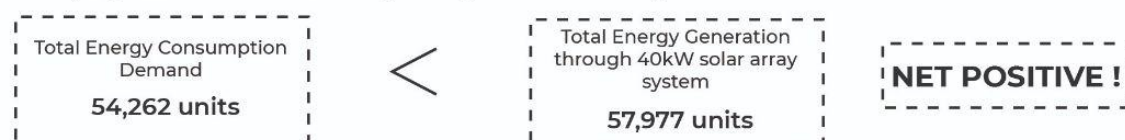
Figure 4.4 - Energy Consumption

Figure 4.5 - Energy Line Diagram



Energy Generation and Achieving Net Zero:

Major generations on site are through solar generation and bio-gas



Solar PV Panels Generation of Site:

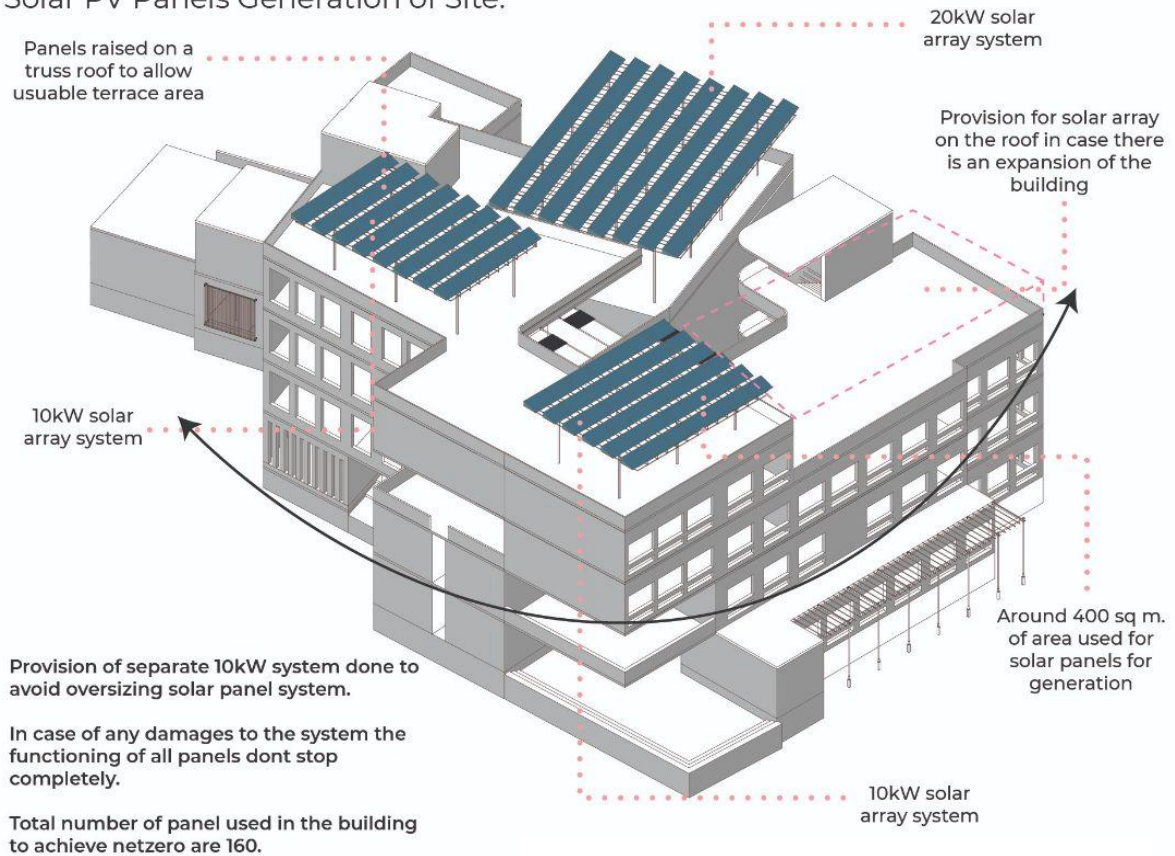
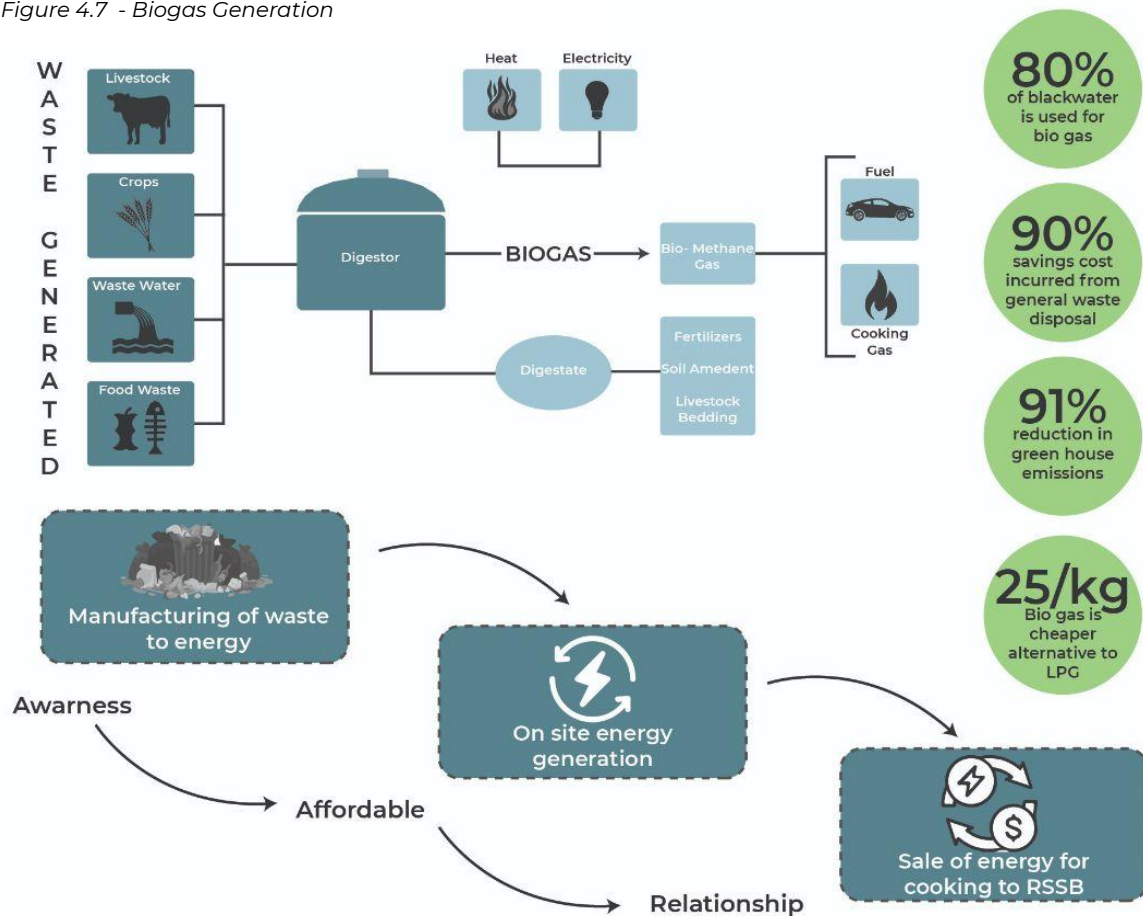


Figure 4.6 - Renewable Energy source

Figure 4.7 - Biogas Generation



08. WATER PERFORMANCE

B. WATER PERFORMANCE

Water usage and wastage is a growing concern, not only in Kalyan - Dombivali but nationwide. To address these issues & concerns, we look at:

- Resusing,
- Recycling and
- Minimizing the wastage and consumption of water in/ by the building.
- Utilizing sewage waste.

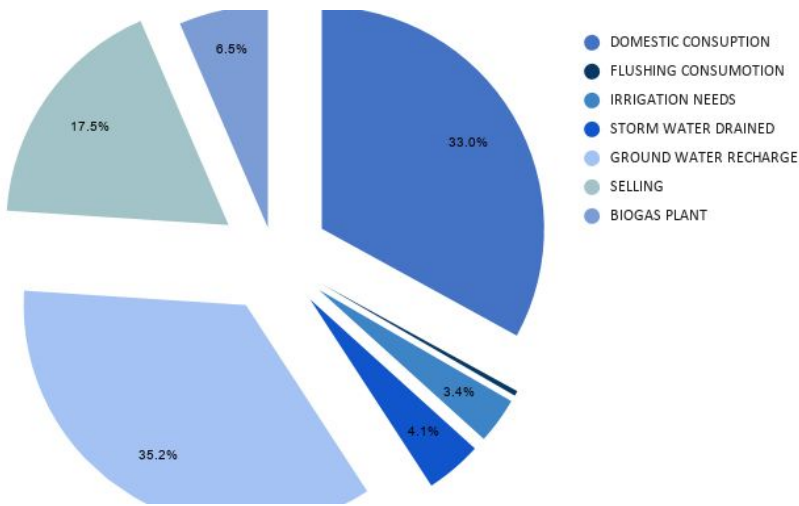


Figure 5.1 - Breakup of water intake & give back

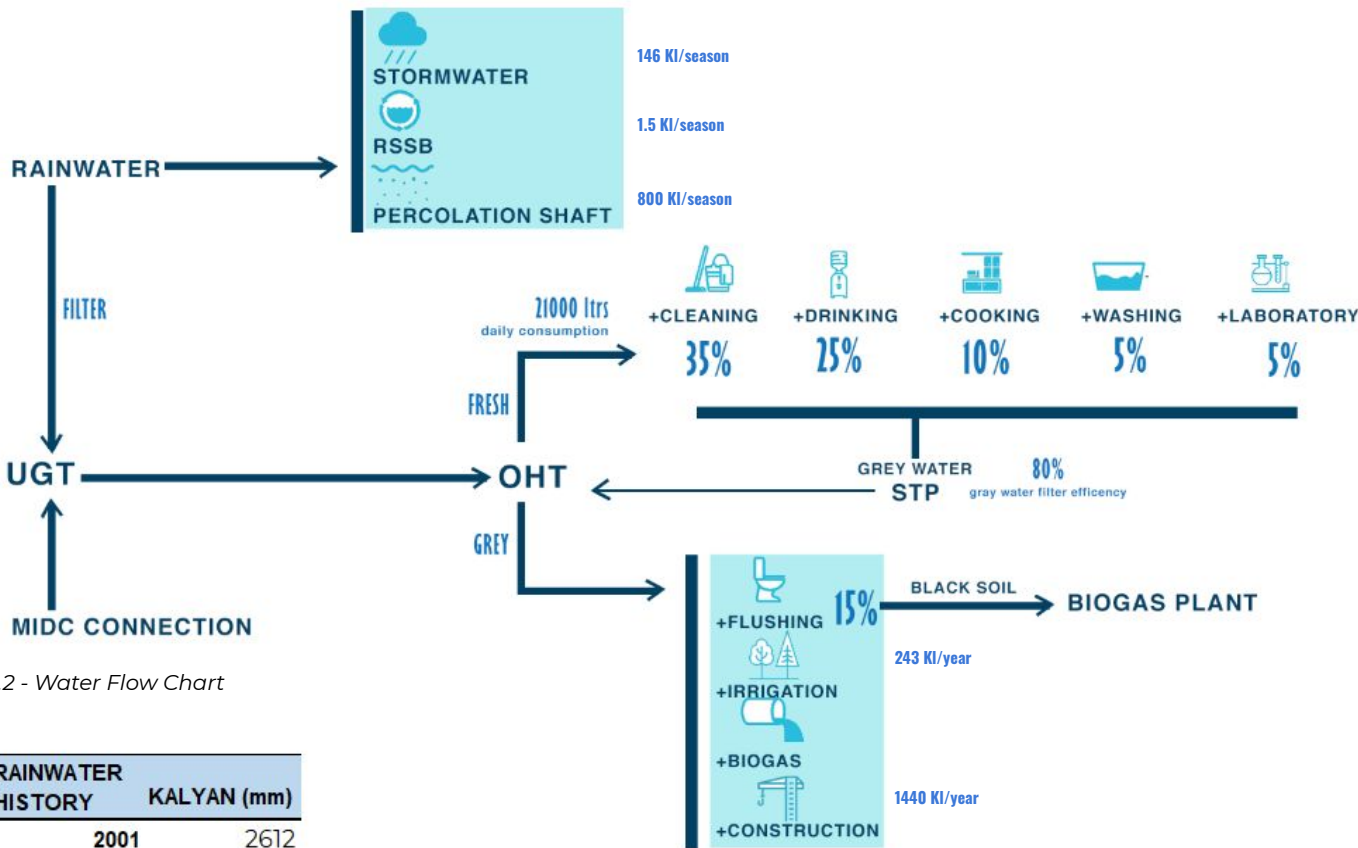


Figure 5.2 - Water Flow Chart

RAINWATER HISTORY	KALYAN (mm)
2001	2612
2002	2688
2003	2680
2004	2507
2005	4012
2006	3620
2007	2655
2008	2941
2009	1957
2002	3226
2002	2909
2020	2800

Table 3.1 - Rainfall in Kalyan
Sources-GSD Maharashtra Government

Utilizing the UGT on site, while it can accommodate for both the buildings and structures on site. The drains and swales along the site channel water into an existing man made pond on site. The OHT is divided in 1:2 ratio for flushing and domestic consumption. A 66 KI RCC overhead tank allows for storage of close to 2 day water supply for the building.

TYPOLOGY - SCHOOL	WPI	25%	ECOLUTION	50%	75%
	80	60	42.7	40	20

Figure 5.3 - Water Distribution Chart
SOURCE : GRIHA

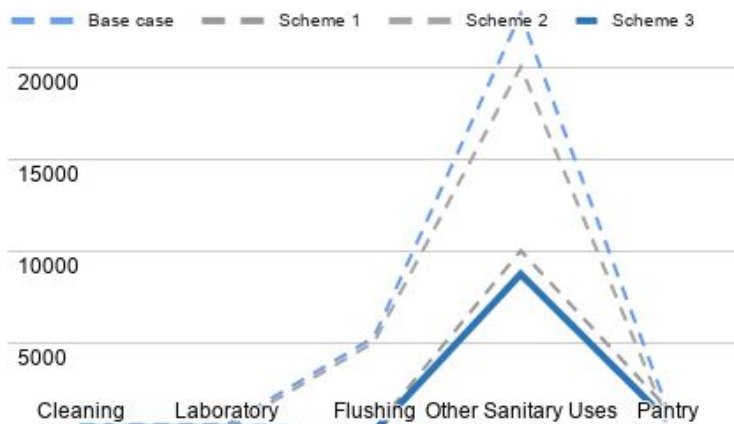


Figure 5.4 - Comparison of water use reduction. In Litres

243.3 KL/year black water reused to generate gas.

In order to reduce the total consumption, we introduce low flow & no flow fixtures.

51% Reduction in per person domestic water demand.

The treated grey water required for flushing is 0.1KL/day on a normal day and landscape irrigation is 1.9KL/day. The landscape requirement is catered by collecting and treating grey water generated by washing, cleaning, labs etc. Existing **gravity biofilters** on site treat this water. The excess grey water is percolate into the injection shafts on a monthly basis and sold to construction sites, as construction water.

A part of the grey water goes to the Biogas plant along with the entire blackwater generated.

Off the total rainwater collected, 3359 KL/year, 7% is drained off at storm water drains, all along site. Landscape species especially consider plant factor <1, and low evapotranspiration rates to minimise water consumed to 295 KL/year.

4.2% Reduction in landscape water demand.

We augment the existing **SBR type STP**, on site, to cater to treatment demands for both the buildings. A capital of 25000 INR, is invested to treat the daily generated grey water whereas the black water is channeled into the Biogas plant.

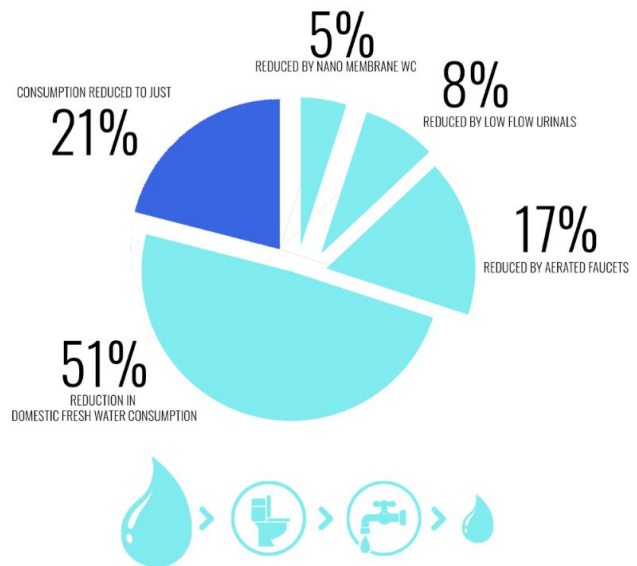
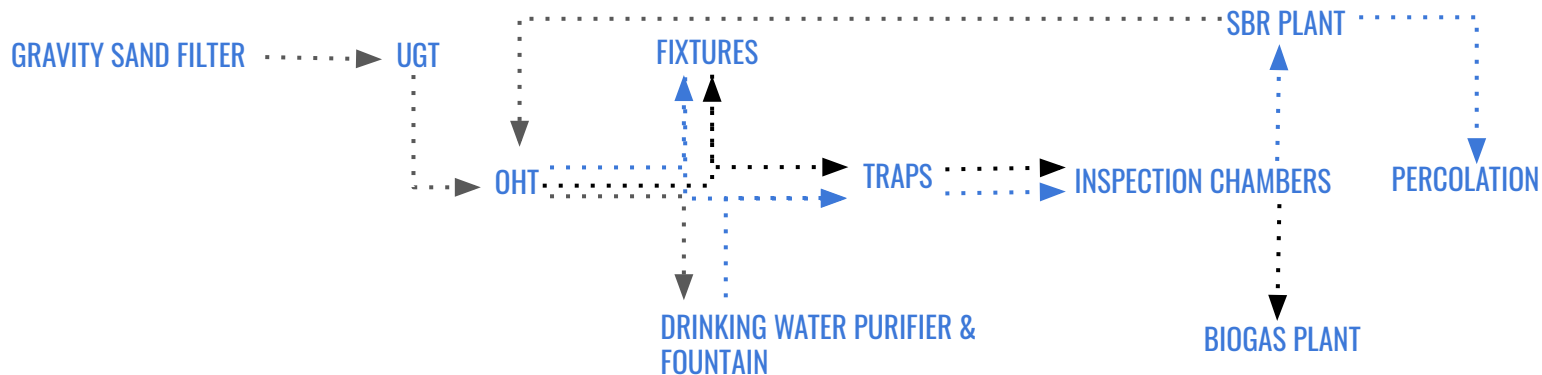


Figure 5.5 - Comparison of irrigation use reduction. In Litres



It is impractical in Mumbai and suburbans like Kalyan, to store entirety of rainwater. The cost of land and setup for such large scale interventions would be unrewarding, and cumbersome.

KALYAN - MURBAD	TYPE OF WELL	DRILLED DEPTH	DISCHARGE	AQUIFER	DRAW DOWN
19.5 N 72.85 E	Drilled/Injected Shaft	160m	0.651 lps	Fractured & Vesicular Basalt	>50m

Figure 5.6 - Aquifer In Kalyan
Sources-GSD Maharashtra Government

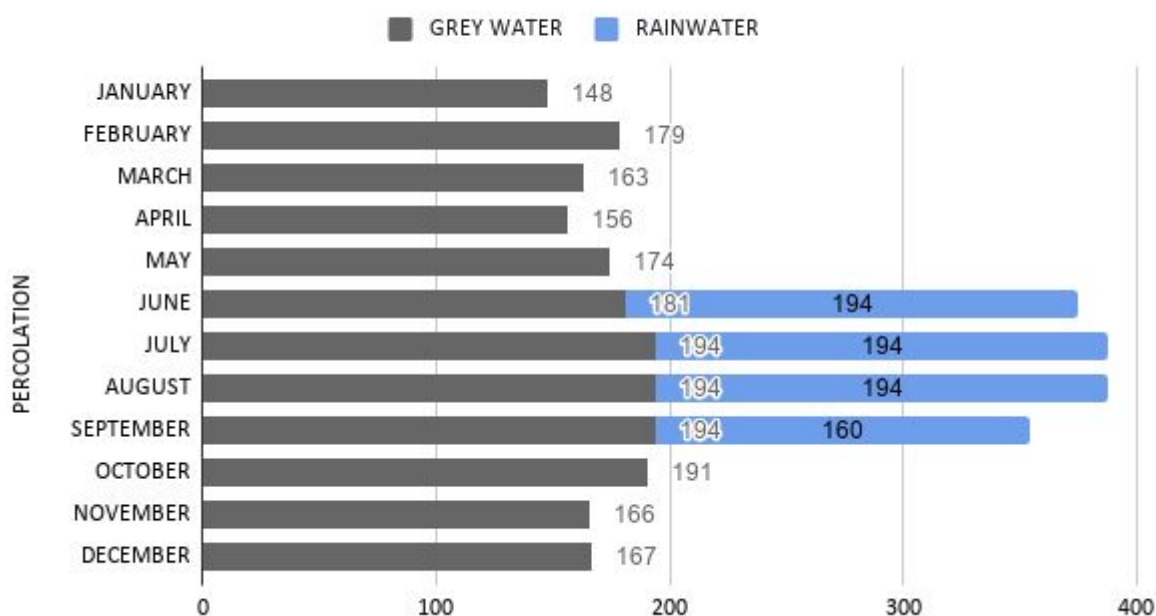


Figure 5.7 - Monthly breakup of percolation of water. In KiloLitres

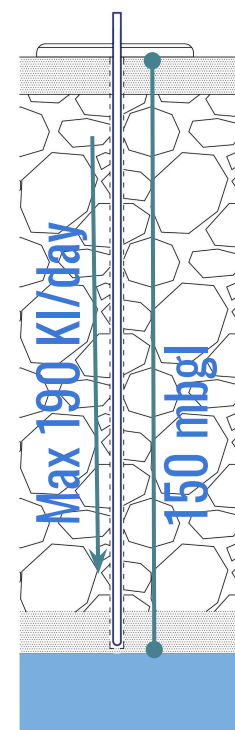


Figure 5.8-Percolation Shaft

Source : GSD Gov Data



Figure 5.9 - Percolation shaft on site

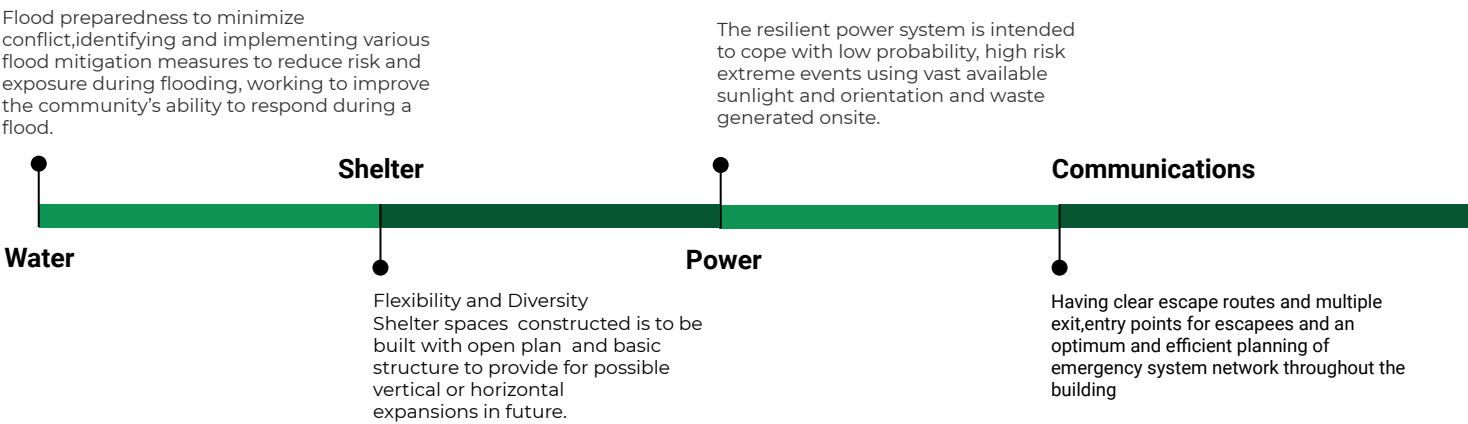
Bedrock is 1 mbgl therefore impossible to build large underground tank. In order to compensate, a percolation scheme is worked out on site, and we add more such systems on the new site.

Injection Shaft Ground water recharge system, which injects water in the 140-150 mbgl aquifers. A maximum of 194KLD can be percolated in these shafts, connected to ground water aquifers. Thus returning back to nature.

In the monsoon months we plan to percolate bi monthly, whereas once a month, in the rest of the year.

09. RESILIENCE

Challenges on site



Site Strategy

By reducing stormwater runoff and protecting floodplains, green infrastructure can help manage both localized and riverine floods. In areas impacted by localized flooding, green infrastructure practices absorb rainfall, preventing water from overwhelming pipe networks and pooling in streets or basements. Green infrastructure practices to enhance infiltration include Rain gardens, Bioswales, Permeable pavements and water channels

Shelter and Community safety

Providing for Immediate Use Students/Staff - 3 - 30 days Community Shelter, Distribution Center and Camp Area during calamities like floods, excessive rains within the school.

Design Strategies

Not all schools need to be designed to an 'operational' performance level to serve as emergency facilities. When the school system is viewed as a network as opposed to individual sites and a disaster response and recovery plan is put in place in advance of a disaster, it is followed by efficiency in the system.

1.

Openable classrooms

School to be designed with flexible spaces allowing adaptability of use for both everyday and disaster situations as well as maximizing long-term utility of the facility.

2.

Habitable circulation spaces- pergolas

New school construction and retrofits for the purposes of risk reduction leveraged to create additional benefits to schools through the introduction of passive design concepts

3.

Co-management

Developing a program of **co-management of facility** maintenance, cleaning and improvements (and associated fund management) by parents, students and communities to promote a culture of care and respect for the physical infrastructure

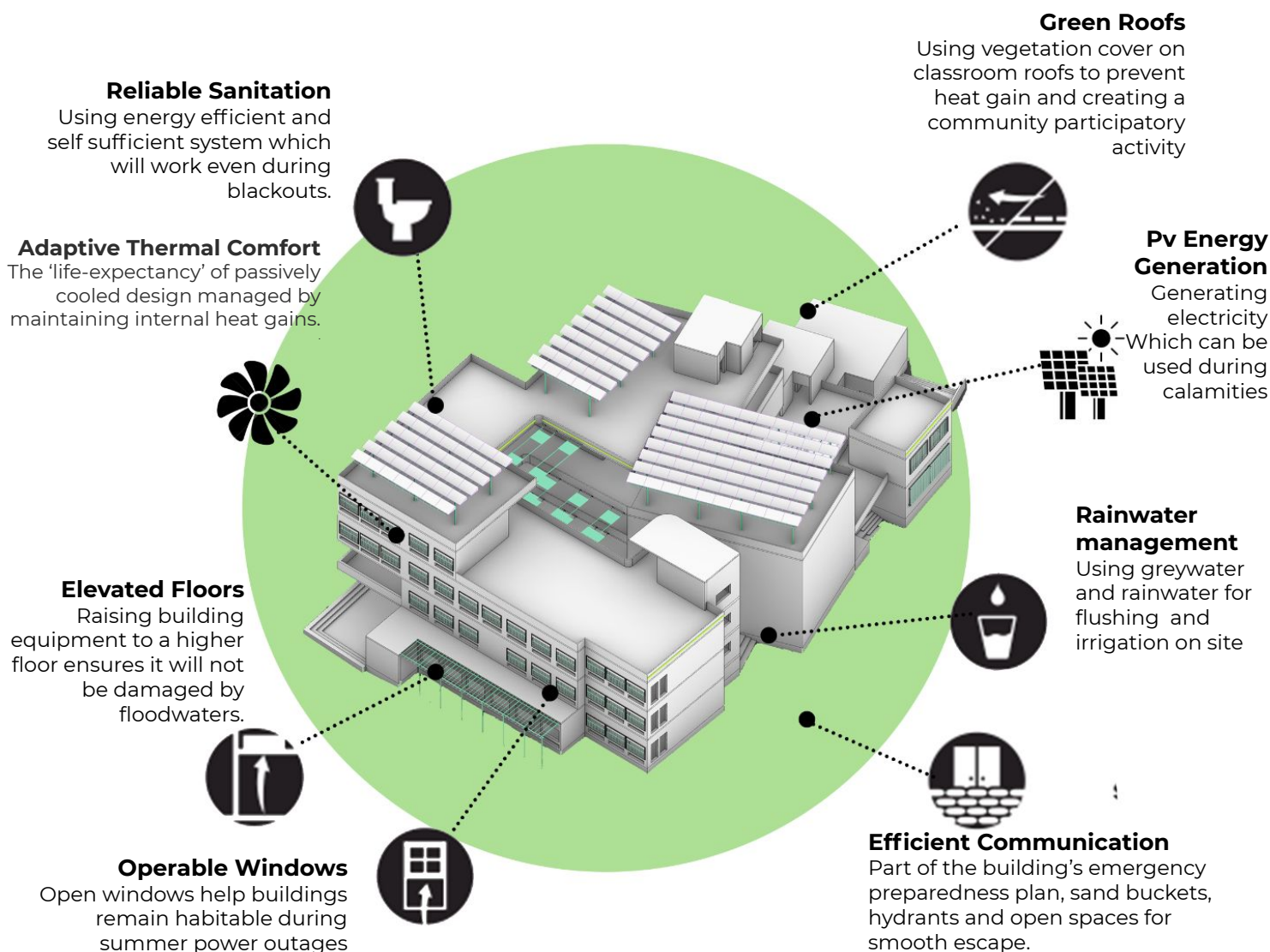


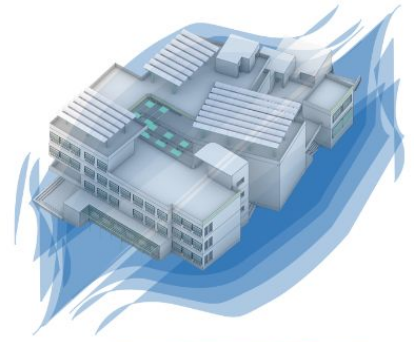
Figure 6.1 - Resilience Strategy

Climate-smart interventions to enhance water, energy and food security (eg. rainwater harvesting, solar panels, renewable energy, school gardens).

1. **Maintaining tree cover around the building**-Shaded rooftop areas, a more thermally resistant building envelope, and the standard provision of air-conditioned bedrooms for all units provide resiliency against heat waves.
2. **Efficient HVAC and Lighting Expands Coverage**
3. **PV Inverter Choices for Higher Efficiency**--Power back up during calamities. Rooftop Photovoltaic (PV) systems have the potential to supply electricity during grid disruptions resulting from extreme weather or other emergency situations. When in place, the Electricity System Resiliency will limit the consequences of a power disruption and specifically address protection of life and property.
4. **Grey water management and reuse**
Four key interventions have been implemented in the design; a. rainwater harvesting at school and campus level; b. recharging rainwater overflows into the ground to restore groundwater; c. treating and recycling, black and grey wastewater in stormwater systems by promoting an ecosystem of solutions - construction of low-flow toilets, building bio-remedial treatment systems to treat and repurpose blackwater and reuse the water for urban agriculture/horticulture and sell the remaining clean water at an effective rate.

Flooding /Storm Surges

raised flooring enables the building to be protected from the effects of flood. **The building is already raised upto 1.8 meters high.** With the improved structural frame integrated column pedestals, this will also support the ground underneath and resist soil erosion caused by flooding

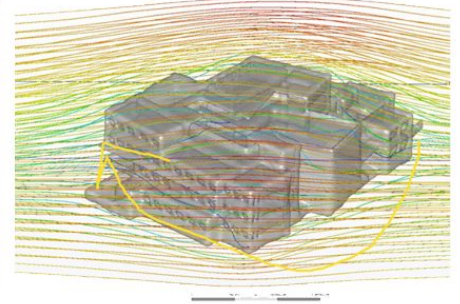


Hydrodynamics

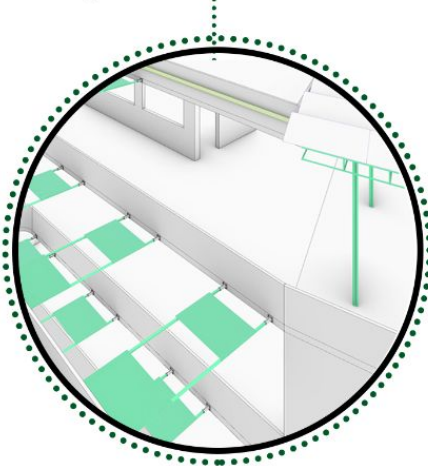
Since the building is raised on stilts, the water during flooding will just pass through the stilts without intervention. In addition to that, the structure will be arranged in a slanting and alternate fashion (not in grid) so as not to create strong water movements.

Aerodynamic design

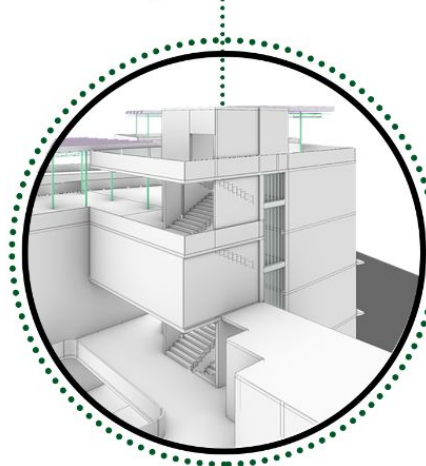
The structure is designed to let the wind pass through it rather than resisting it. The structure's open design is not just for natural ventilation but also an advantage during extreme winds. Filtered amount of air flows through the classrooms and the quality can be maintained according to comfort levels



Using green covers on courtyard for shade and cover. Using bamboo as material for frame and creepers for covering.



Emergency systems at accessible radius from all sides and floors and with ventilator windows to allow for natural light and ventilation



Sustainable Bamboo used as easily maintainable material for windows and is a durable system of filtered daylight in classroom



ROOF

Using a bamboo queen post truss which allow uplift of air on the side and allows for elevated exposure for solar panels

Bamboo hinged windows are aligned along the southern side not only for aesthetics but also to act as a ventilation and daylight measure during rainy days

Main structural frame is reinforced using running columns. the floors are provided with air ways for channeling wind inside the school and reduce wind pressure

Green wall as sound buffer/breaker- and provide fresh air to the users

RAISED PLINTH

A raised and levelled plinth to allow for protection during floods



Figure 6.2 - Resilience Strategy

10. AFFORDABILITY

Affordability, is the direct measure of sustainability measures, net zero costing. Not just in terms of capital but also through Time and Operational challenges.

The PV panels, incur a setup expense of Rs. 14.4 lakhs. It is paid back over in 6 years.

The energy load is also minimised through passive strategies, which then, allows for net positive energy building.

Figure 7.1 - Solar Panel 10 & 25 Year life cycle chart

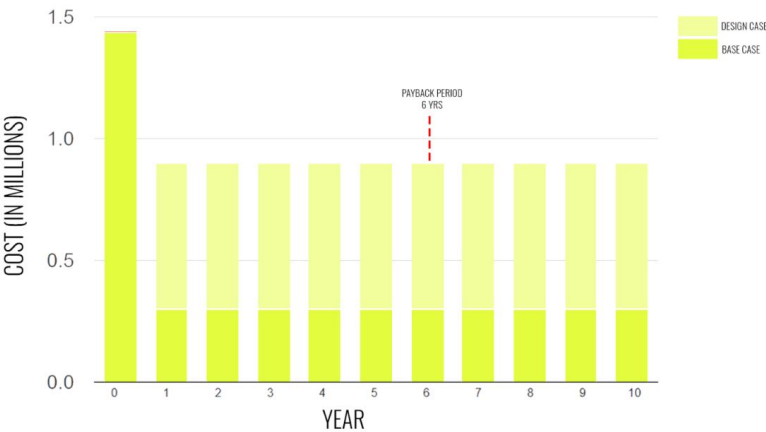
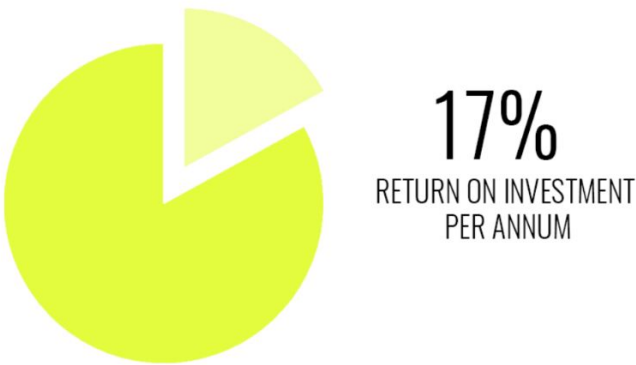
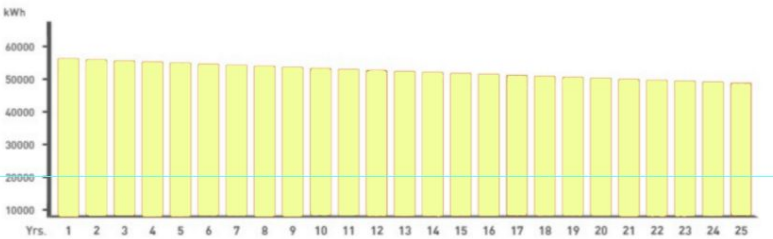


Figure 7.2 - Solar panel ROI chart



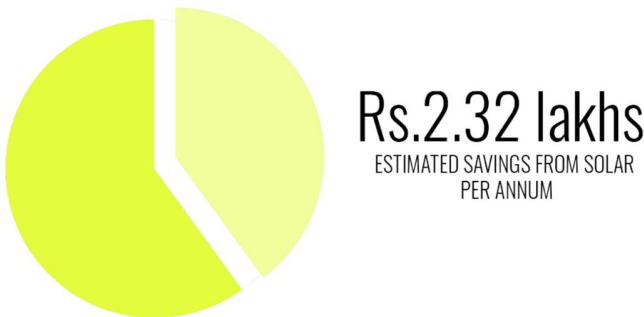
ESTIMATED GENERATION
OVER 25 YEARS (LIFETIME)

13,25,524kWh



ESTIMATED SAVINGS FROM SOLAR
OVER 25 YEARS (LIFETIME)

43,60,000 Rs.



Water & Biomass, are two other revenue arenas, which we harness. While we purchase water from the Municipal lines during the summer months, due to site restrictions, the cost is recovered by harnessing and utilising rainwater. The biomass plant energy is a revenue based system, for better waste management on site, and helps recover the capital for the school.

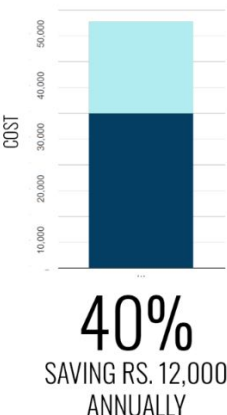
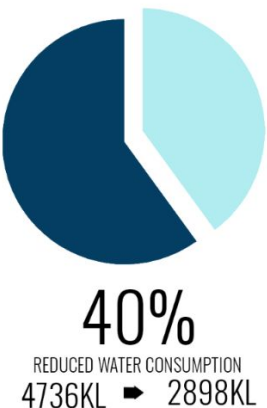


Figure 7.3 - Savings in water management

Figure 7.4 -Water Management 10 Year life cycle chart

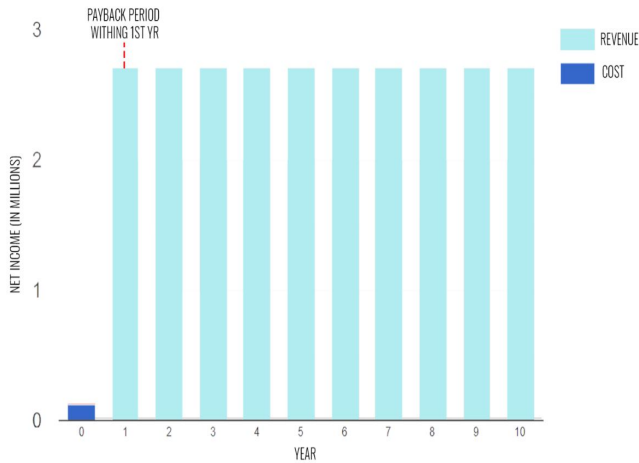


Figure 7.5 - Biogas plant 10 year life cycle chart

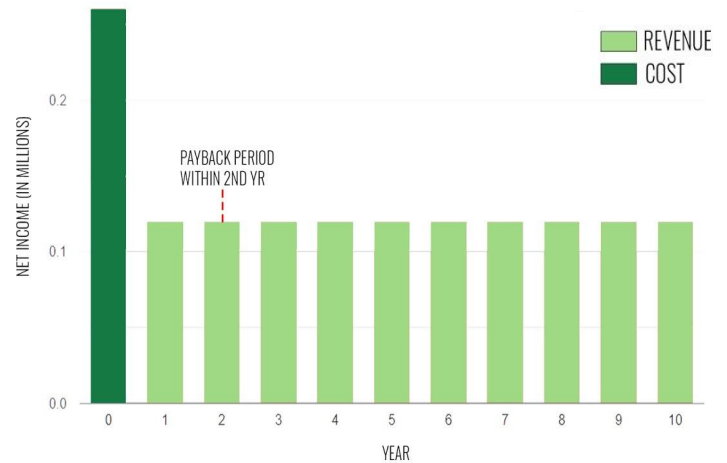


Figure 7.6 - Cost differences in Materials

Material	R Value	U Value	Costing Reflect
AAC Blocks (200mm)	0.95	1.05	200%
Performance Glass	0.38	2.6	50%
Bamboo Shading & Roofing	0.72	1.4	80% - & 50%
EIFS Coating	4	0.25	100%
Puff Panelling	11	0.53	83%

Figure 7.7 - Biogas plant Revenue generation

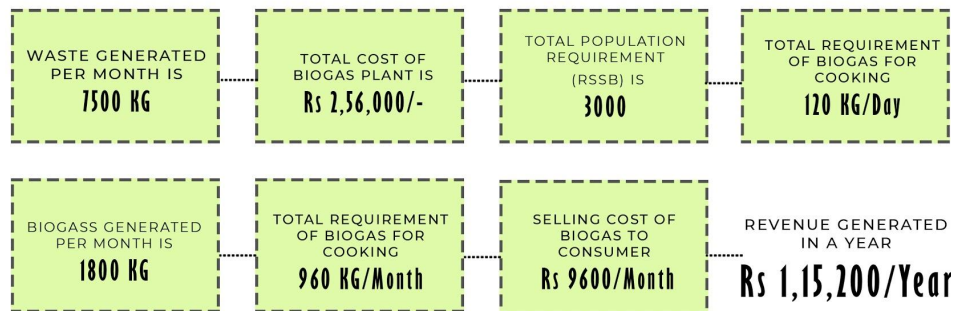


Figure 7.8 - Revenue generation

MONTH	COST PRICE/1KL	QUANTITY SOLD/ MONTH	AVERAGE INCOME GENERATED/ MONTH	AVERAGE YEARLY INCOME
JUNE	1800/-	192	345600	2690820
JULY		880	1584000	
AUGUST		422.9	761220	

The grey water produced on site is sold to nearby construction sites, which generates revenue.

The rainwater generated is sent to nearby consumer for a small profit.

By replacing CFL lights with LED lights an additional CAPEX cost is generated, however with 31% savings in electricity cost and a nearly 5 times longer durability of the LED system turns out profitable in a 10 year life cycle.

QUANTITY OF FRESH WATER BOUGHT/YEAR	COST/1KLD	AVERAGE COST INCURRED/YEAR
1776.6 KL	10/-	17,766/-

MONTH	COST PRICE/1KLD	QUANTITY SOLD/ MONTH	AVERAGE INCOME GENERATED/ MONTH	AVERAGE YEARLY INCOME
JULY	575	23.70	13627.5	23230
SEPTEMBER		16.70	9602.5	
BER				

Figure 7.9 - Savings due to LEDs

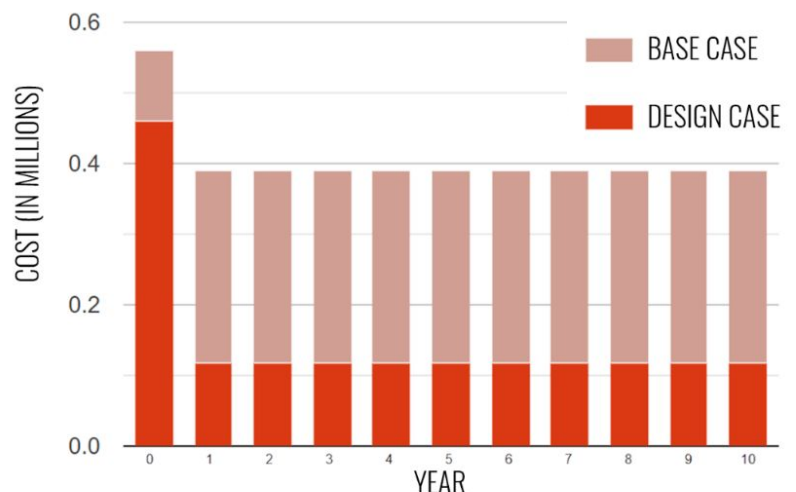
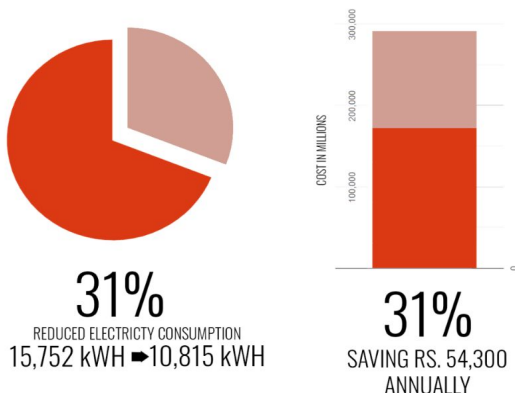


Figure 7.10 - Benefits of Aac Blocks



Optimising materials based on their their properties, is crucial for the affordability of the building and its sustenance.

AAC blocks for instance, raise the cost 2x when compared to brick, however the comfort, loading and sustainability that comes with it is worthy of the 16 year payback period. AAC block also makes the structure lighter reducing steel requirement and also allowing more flexibility for future expansion.

The Nanomembrane toilet, which saved 5%, water demand, can be fabricated using the 3D printers of the design lab on site, as a learning and prototyping activity. This can further bring down costs of the same by 50%

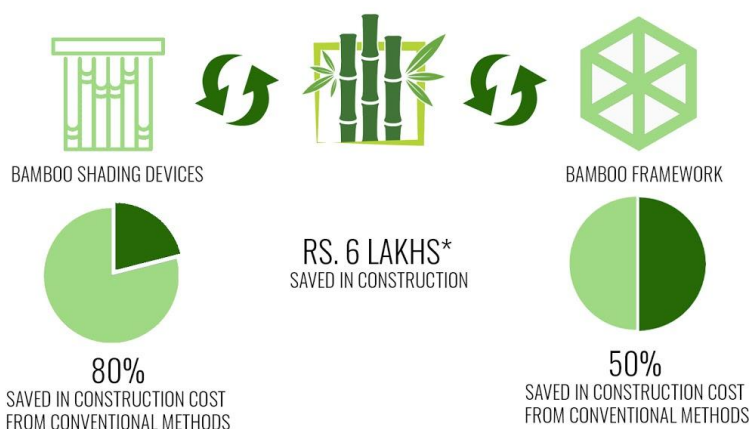
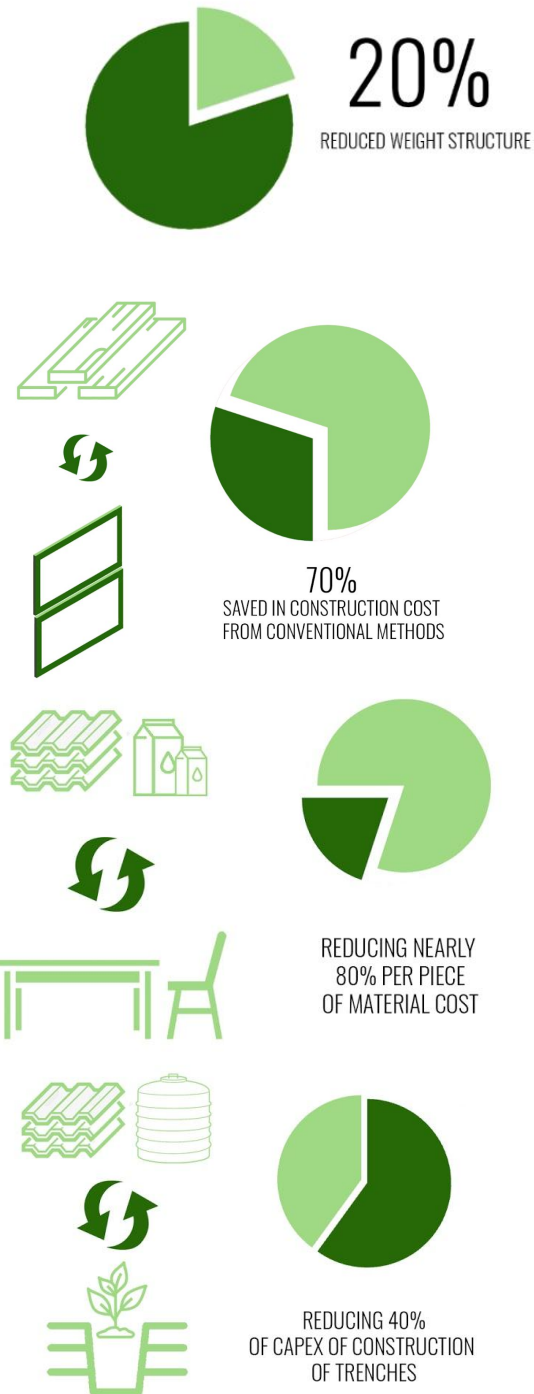
Following the 3 R's we utilise the material from the existing E library building for various aspects of roofing, shading, screening and planting. These not only have a cost benefit, but also are low maintenance. With close to **no OPEX and minimum CAPEX**, this can also be a handson fabrication experiment for the students.

After analysing a 10 year life cycle cost of all interventions, we save up nearly 18 million rupees.

	BASE	DESIGN
CAPEX	34.1	41.3
Life Cycle Cost (LCC)	50.6	22.31

Figure 7.12 - Cumulative Life cycle cost in Millions

Figure 7.11 - Utilising Low Cost Material



11. INNOVATION

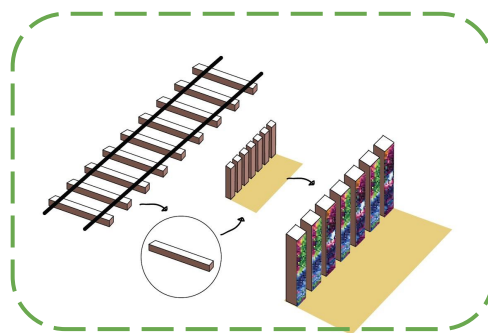


Figure 8.1 - Repurposing Railway sleepers

GENERATING RESOURCEFULNESS

The railroad sleepers, work as screens for the art lab and the Elibrary. These are tested for creosol, and are thus fit to be painted on.

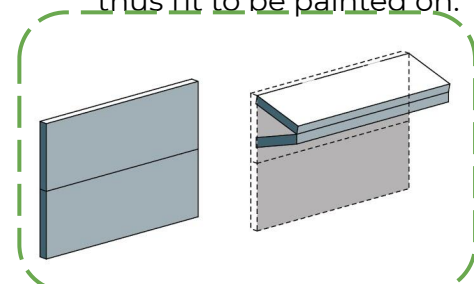


Figure 8.3-Deployable shading device

SUSTAINABLE SHADING OPERATION

The vertical angle and movement, is designed to cater to the setting oblique sun as well as the overhead daytime sun, through their various configurations.

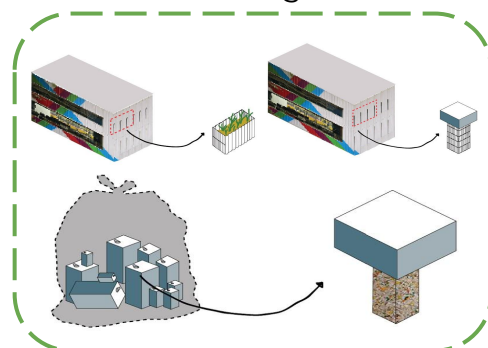


Figure 8.4 - Repurposing Corrugated sheet

ADDING VALUE TO THE WASTE

Corrugated sheets, and tetra pack waste from the canteen, is clean and reused for chipboard furniture as well as trenches for farming.

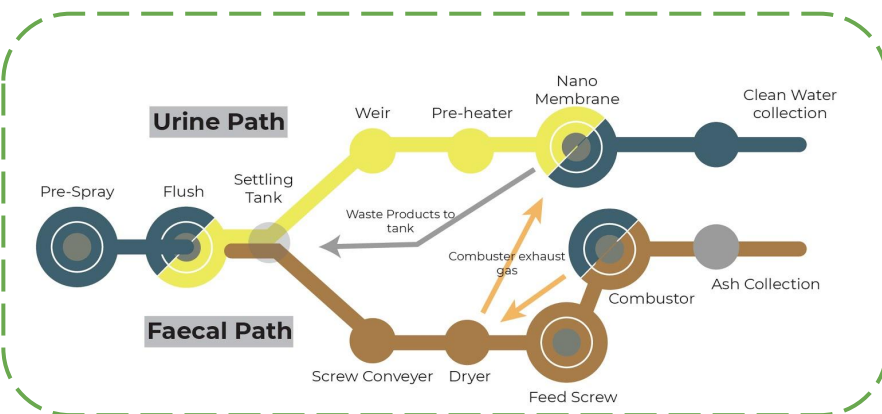


Figure 8.2 - Nanomembrane Cycle

Source : Cranfield University

ADOPTING THE NANOMEMBRANE TECHNOLOGY

The Nanomembrane toilet, is an efficient source to manage solid waste produced in the system, without using any water.

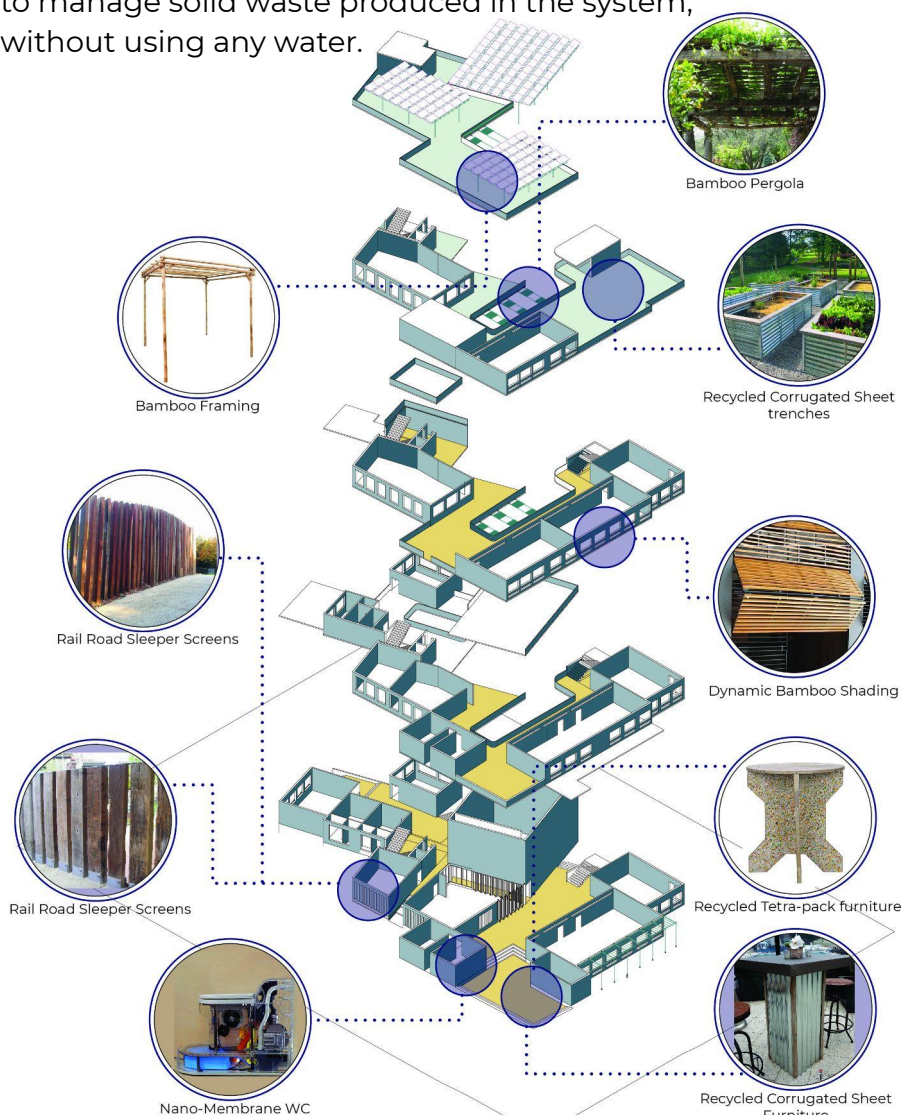


Figure 8.5 - Utilising Low Cost Material

Bamboo Roof Shade

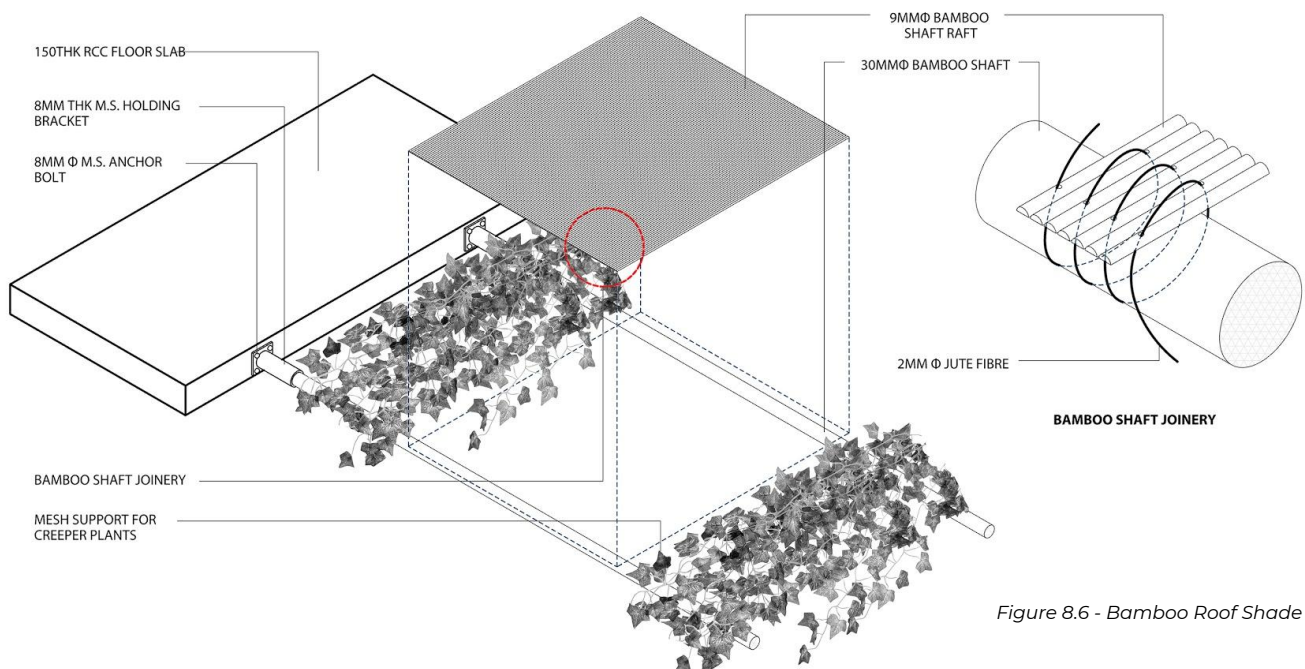


Figure 8.6 - Bamboo Roof Shade

As an attempt to shade open multipurpose spaces, while integrating the slab below, this bamboo roof works to reduce reflected sunlight.

Direct shading with bamboo in some parts. Secondary shading with creepers grown on mesh support in some parts. Bamboo poles are fastened using anchor bolts, and then further attached to the slab using MS plates. The entire detail and joinery takes the load of creepers on it and filters the southwest sun on the courtyard.

Reused Farming Trenches

Landscaping roofs can be tricky, specially considering the leakages and waterproofing demands. In an effort to enable low maintenance, low cost rooftop farming system recycled material trenches were detailed. Using corrugated sheets, old tanks, wooden crates, as planters for vegetative and herbaceous species. These give more depth than a intensive or extensive roof, while erasing any kind of elaborate waterproofing & root control layers. The materials for such trenches too are scrap and debri from the existing E- Library on site.

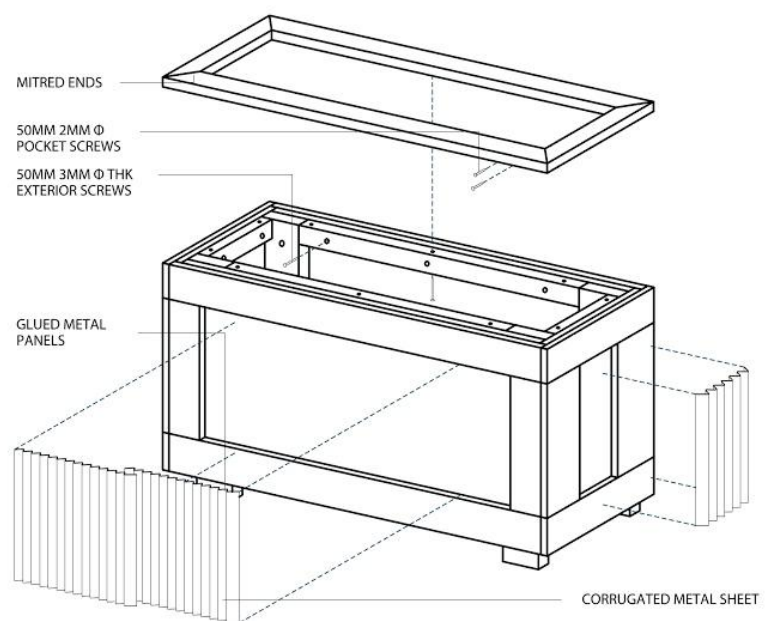


Figure 8.7 - Reused Farming Trench

The assembly is a framework of wood or steel, with bolted or glued corrugated metal panels. They can be customised to any size requirement, The added modularity allows for it to be relocated based on convenience, season and type of vegetation.

East Facing Window

These are non openable window covers, towards the admin block. Detailed according to the placement of the offices, towards the road. It allows for privacy with almost no added weight. The joinery is worked out for additional uses like pots/ bird house can be mounted when window is removed. The window is sustainable, aesthetic and cost effective.

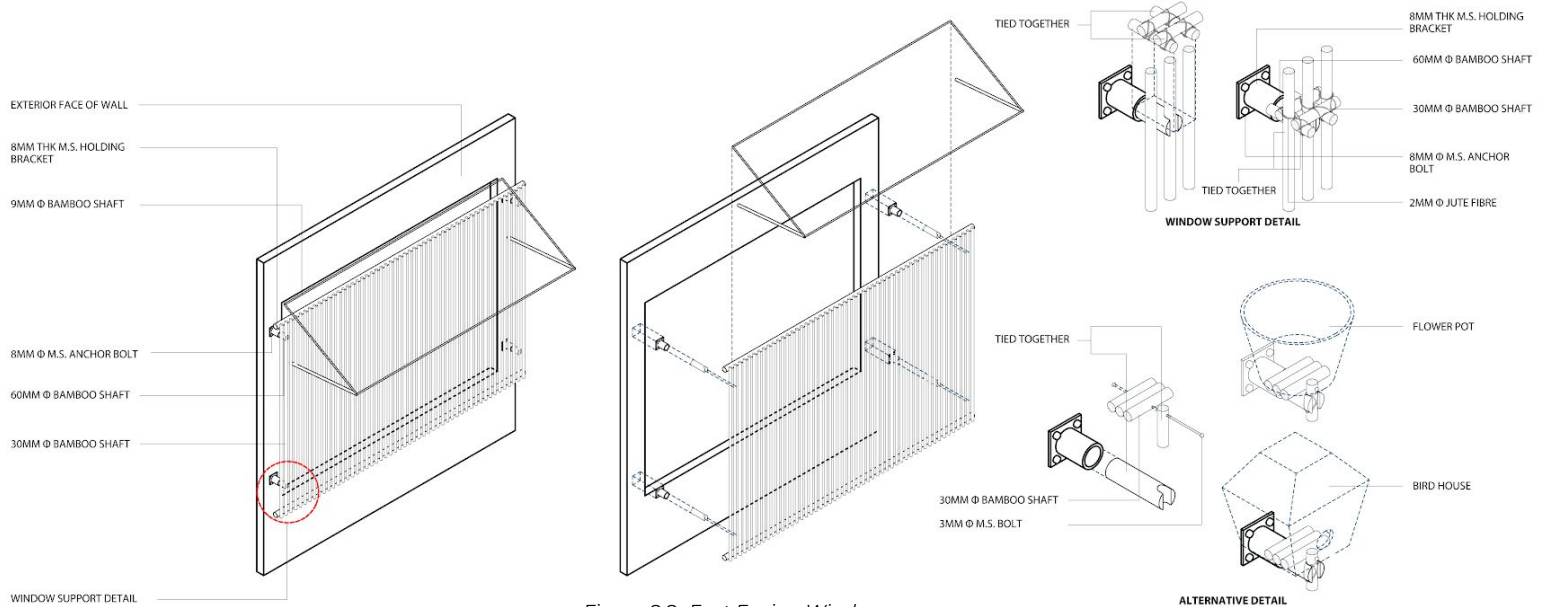


Figure 8.8- East Facing Window

South Facing Window

These bamboo modules exist as a shading frame along all the south facing fenestrations. It reduces the minimum overhang length requirement by 50%.

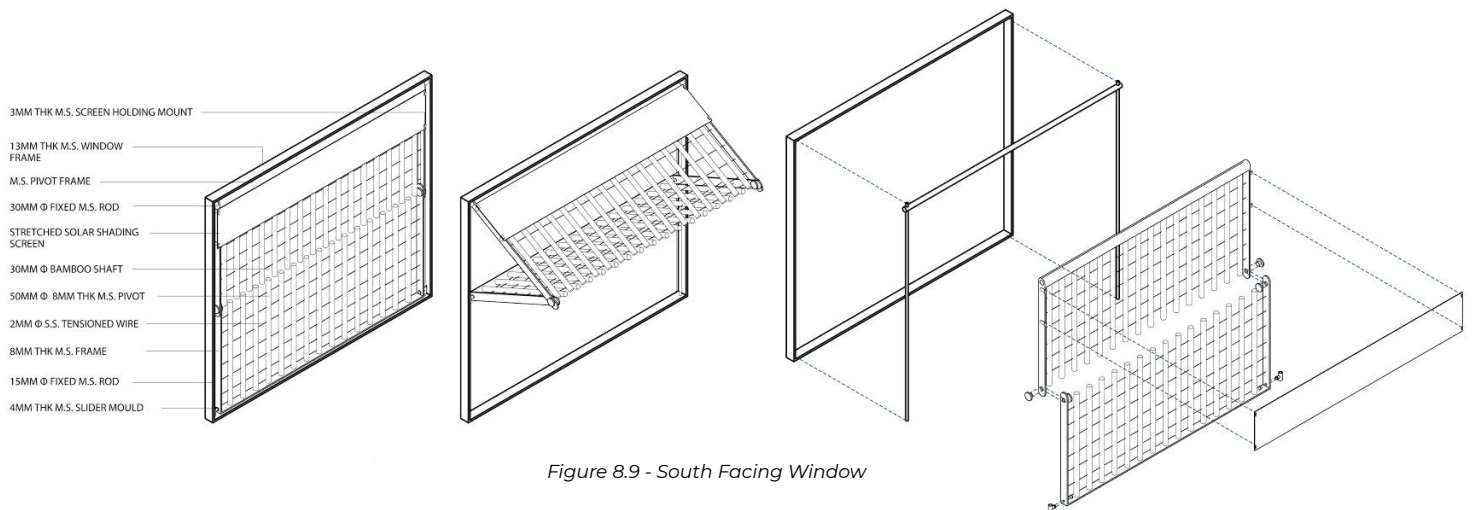


Figure 8.9 - South Facing Window

It provides complete shading from direct sunlight during the summer months (Light rays at an altitude of 60) while it allows partial sunlight during winter months (Light rays at an altitude of 28). The bamboo shafts are divided into two halves, top and bottom, and their respective bamboo shafts are arranged in an alternate fashion to create a two layered shading system when opened.

The lecture hall on the ground floor near the admin area was designed to serve as a multipurpose space and hold auxiliary functions like PTA meetings, workshop programmes etc. Hence, the furniture layout is modular with half of it comprising retractable seating blocks.

Figure 8.10 - Collapsible Furniture

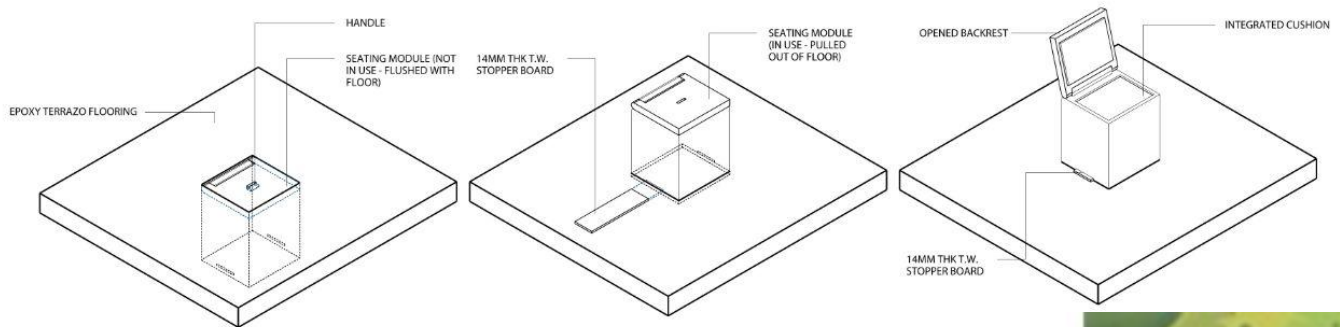
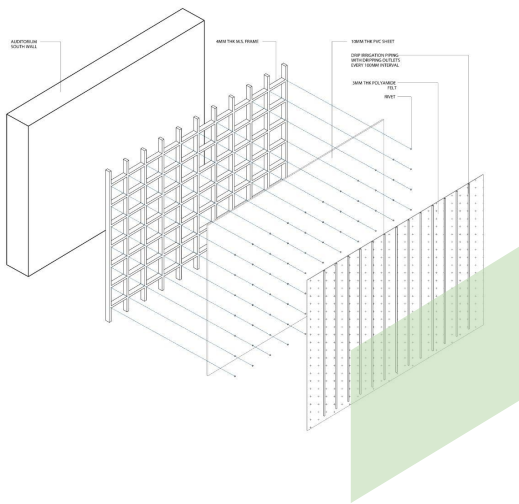


Figure 8.11 - Forest Wall exploded Isometric View

[illegible]

Boston Fern

We use most maintenance free species, while maintaining a balance between flowering and non flowering typologies



12. MARKET POTENTIAL AND SCALABILITY

- Harnessing the graphic and communication design potential of the students through PR designing. Promoting students at the market level as well as building a name for the school.
- The end-users also evaluate how their lifestyle meshes with that of the school design through direct participation.
- The design targets at creating flexible spaces which can accommodate the end-user needs and changing preferences for meaningful community spaces for increased livability.
- Coupling of GYG with innovative learning will create increased demand because of better work-life balance and advanced amenities.

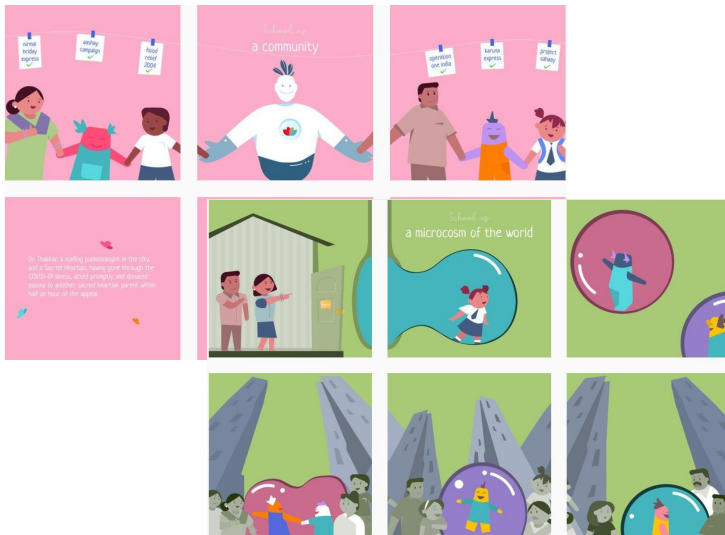


Figure 9.1 - PR Strategies

Source-Sacred Heart School Instagram Page

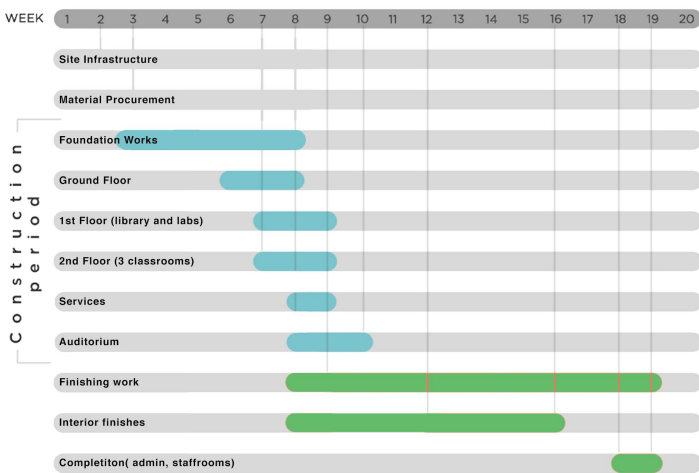


Figure 9.2 - Market Factors

Construction Technique

This rapid construction reduces other construction costs such as idle labor on site, and rental cost of equipment. It also brings the project to market sooner, which reduces the cost of capital to the developer/proprietor. The enrollment for the new session is planned to start from June and the building completion is to be done by May.

Hence, as the project requires a phased approach, we propose a similar manner of construction and occupation timeline as well.

1. For property owners and investors:

- Conduct regular building performance evaluation and service and maintenance activities on the technical installations. This will improve building performance, reduce energy consumption and prolong the lifespan of the components.
- PR and social coverage for awareness and community building

2. For building designers:

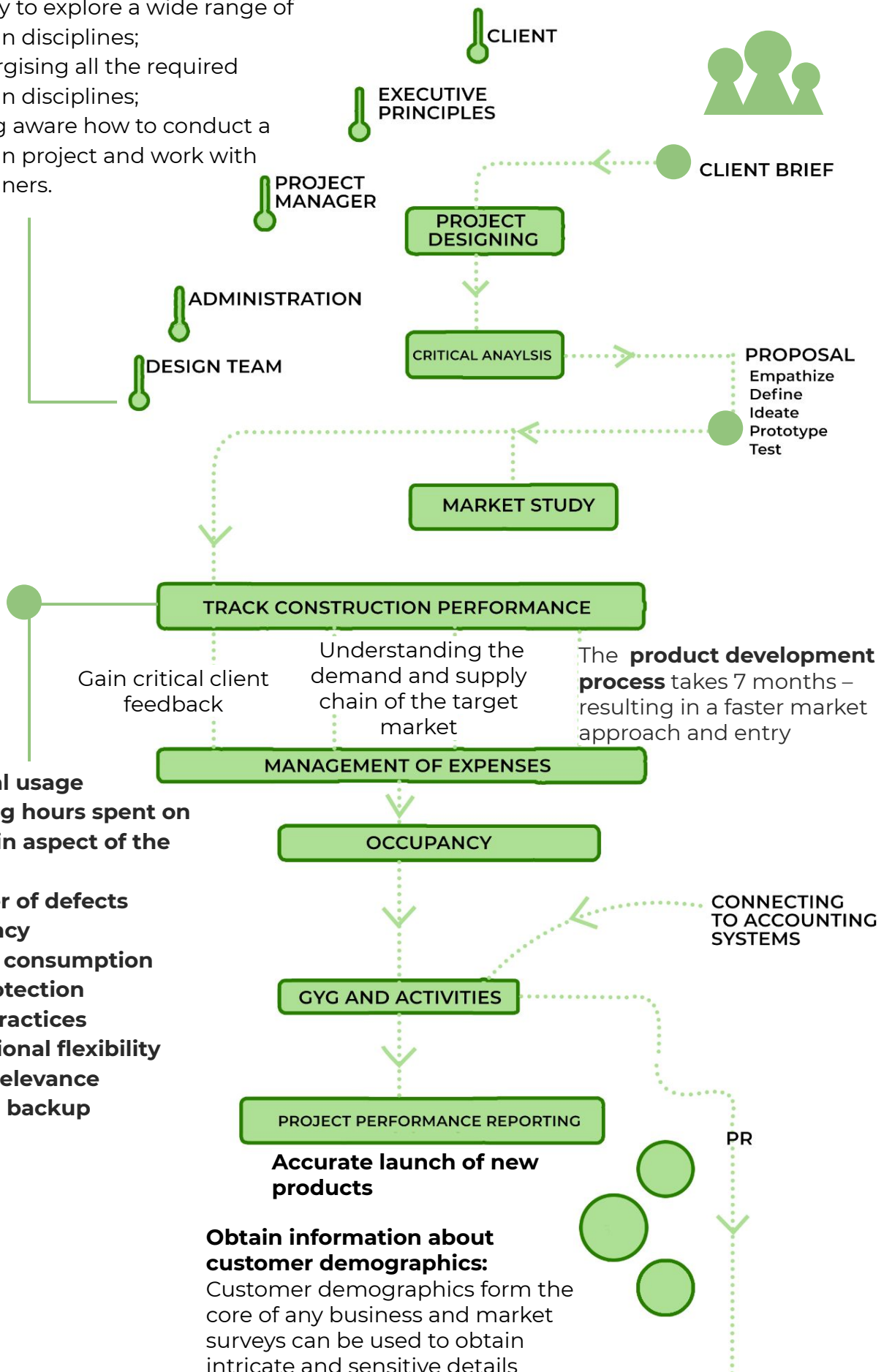
- Defining internal loads and indoor climate requirements in collaboration with property owner and end users.
- Ensure 10-20% extra capacity in technical installations to allow flexibility for future changes.
- Provides life-cycle environmental and economic performance

3. For end users:

- Avoid over-occupancy of rooms with people or technical equipment, such as flat screens which emit heat, CO2 and unacceptable noise
- User-defined inputs, provides comprehensive economic life-cycle

The design team has a diverse range of skills to manage the complexity of the design process. These include:

- Diversity of business, creative and design related experience, the will, and the people skills to make things happen;
- Ability to explore a wide range of design disciplines;
- Synergising all the required design disciplines;
- Being aware how to conduct a design project and work with designers.



GROW YOUR GREENS

School's administration
volunteers

Students

Parents Community



Incorporating the Stakeholders

FORMING A GARDEN COMMITTEE

Volunteering
Resourcing
Maintenance

FUND RAISING

Fundraiser Meets
Lending home resources
Canteen income funded

GOALS

- Outdoor hands on learning
- Take home fruits & vegetables
- Reduce food waste
- Imbibing & inculcating 3Rs
- Engage & benefit the marginal staff.
- 4 x 8 raised garden beds
- 4 x 4 raised garden beds
- raised bed climbing trellis
- mixed vegetable and flower seeds

LONG TERM RESULTS

Students get involved in cultivation
Beets, carrot, pumpkin, coriander, fenugreek, lettuce, nasturtiums
Villagers, parents, teachers, staff learn & practice
Expansion & scaling over time & place.

Tools	Used at what stage in the building's life cycle?	Applicable for multiple building types?	Scope of Tool	Market Share
Enrollment expansion	Design and construction	No	Incremental idea generating techniques are feasible as possibly only small changes can be made.	Students
Trigeneration technology	Enhancement of existing	Yes	Near term potential for growth in biomass derived energy	Students to learn and implement sustainable bio energy models and involve village community with the waste produced
Domestic animals management	Enhancement of existing	Yes	Expansion of poultry and herding to the village for involvement and local neighbourhood produce	Managing and aiding biodiversity within the premises with the help of local community
Grow your greens	Design optimization	Yes	Incentive participatory tool and enriching experience	Provides a base for work and reward for continuous involvement and relationship growth

Table 5.1 - Market Scope

13. COMFORT AND ENVIRONMENT QUALITY

The trees along the south eastern and southern edge of site, add to the thermal and visual comfort of the classrooms.

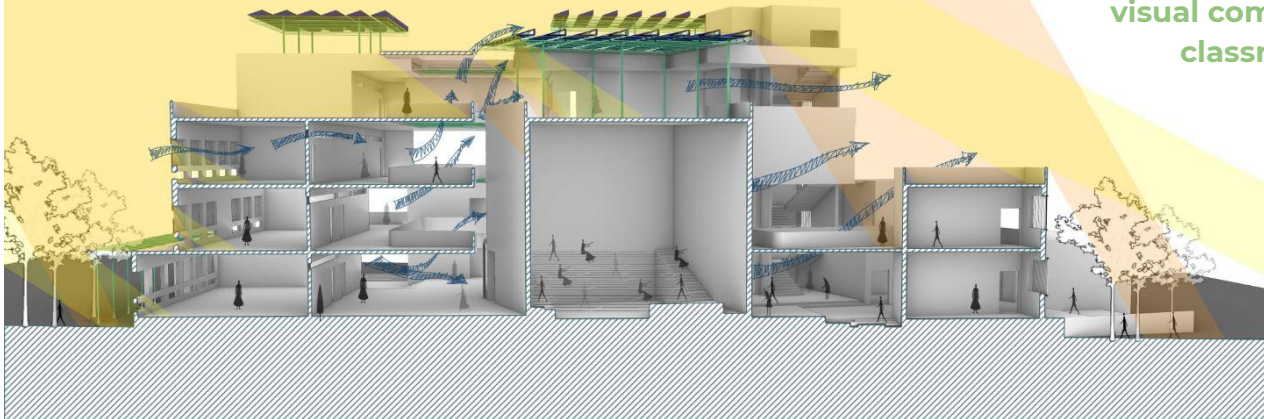


Figure 10.1 - Design incorporating comfort and environmental qualities

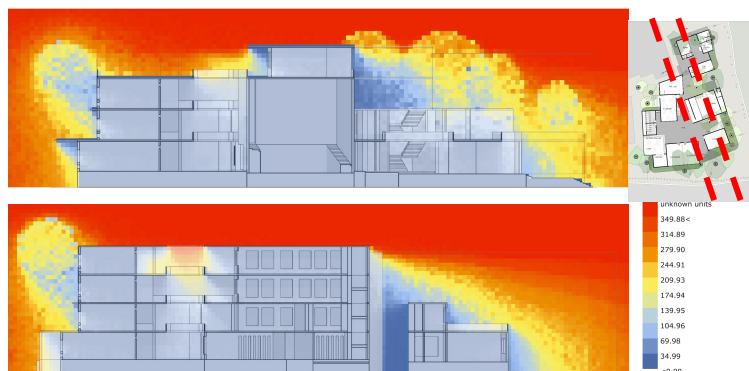
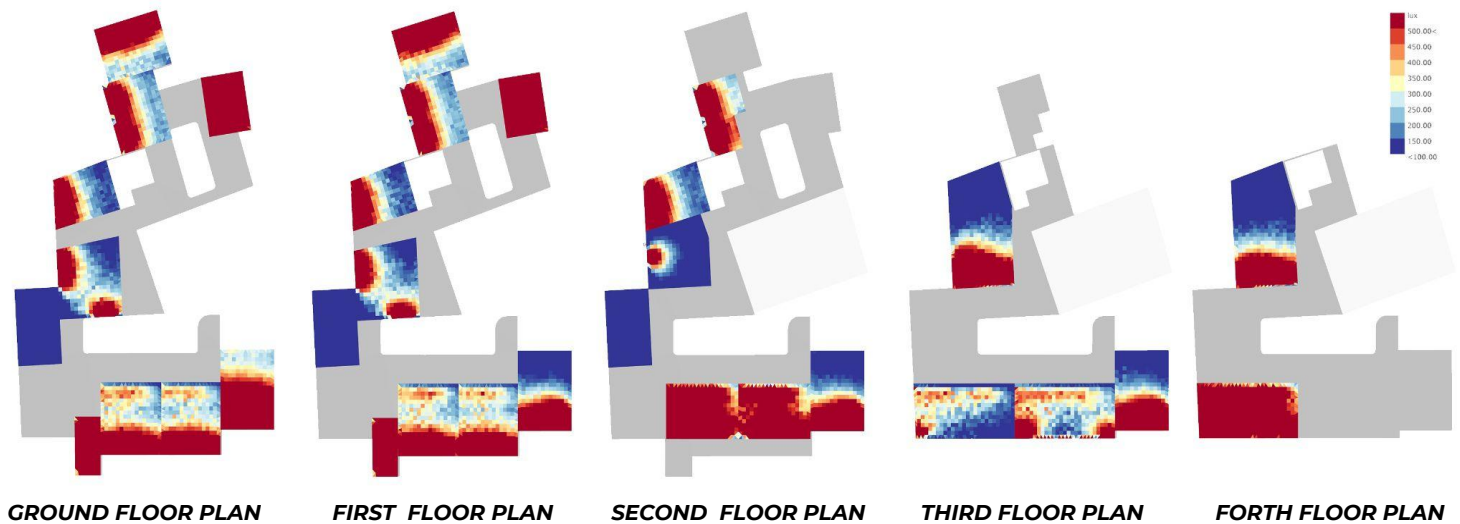


Figure 10.2 - Radiation Analysis

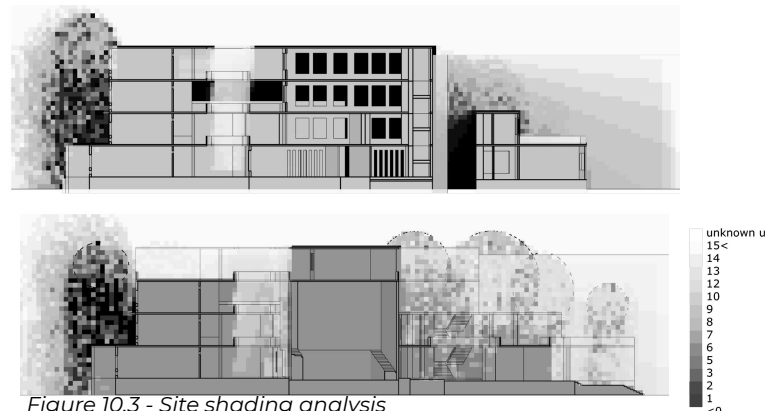


Figure 10.3 - Site shading analysis

The building massing is optimised for least radiation, even in the open to sky courtyard areas.
The shading of the nearby areas, enhances the comfort of the courtyard and open spaces

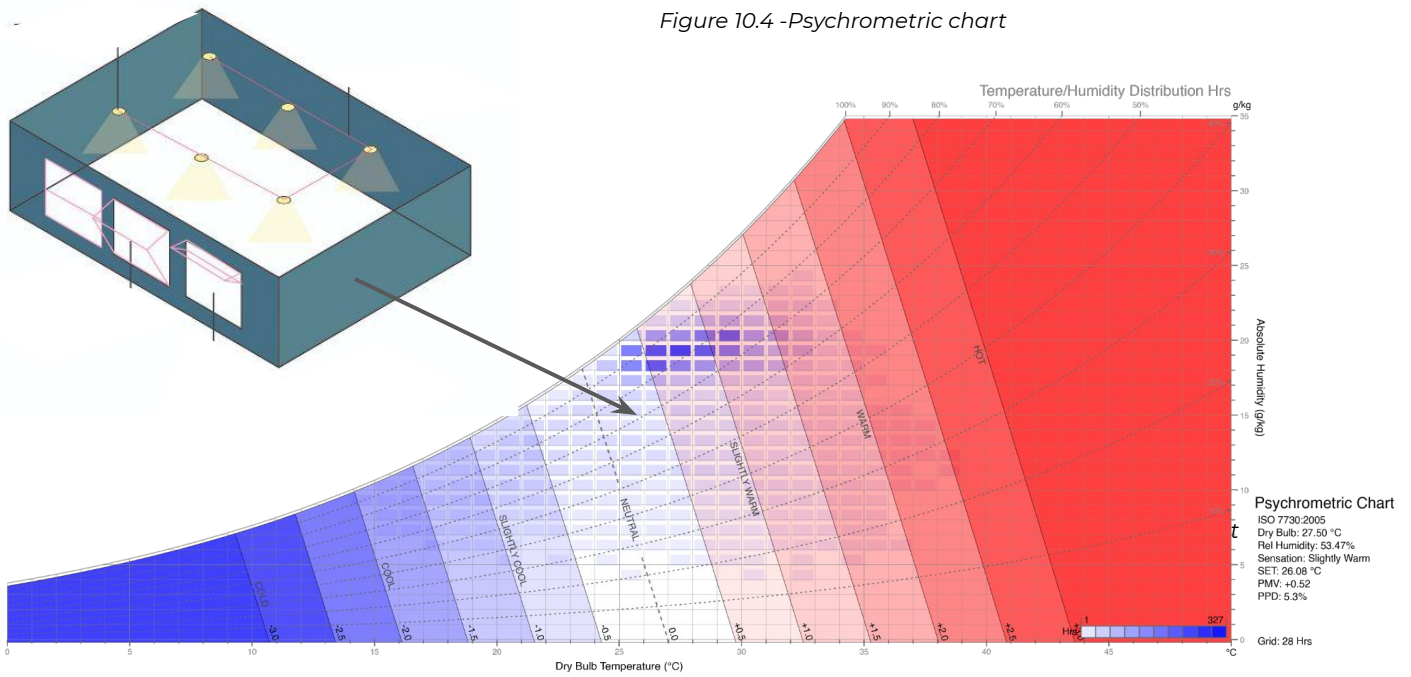


Daylight Analysis



Shadow Analysis

Figure 10.4 -Psychrometric chart



Looking at a PMV values and Psychrometric chart to plot out the neutral to warm thermal condition of the zone. Comfort range shows a minimal hours outside comfort range of the zone. Following standards of IMAC for adaptive comfort temperatures.

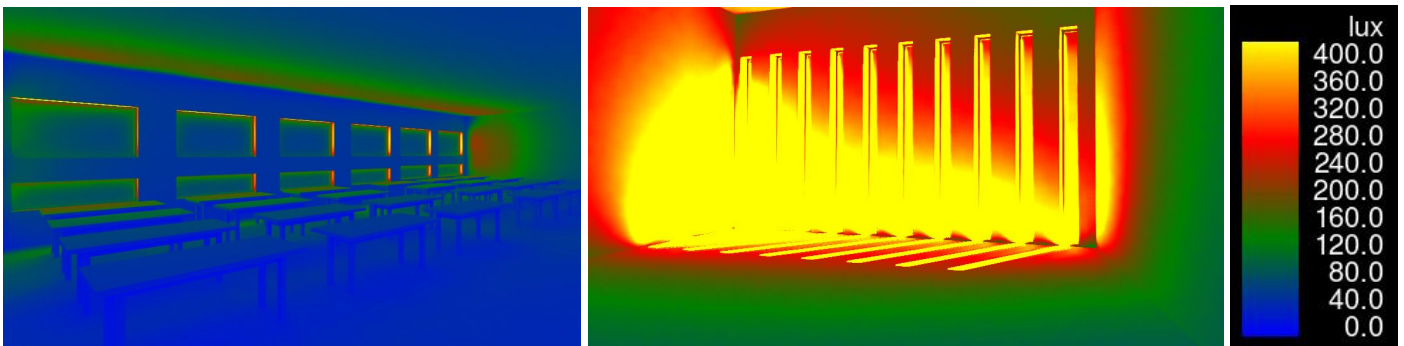


Figure 10.5- Glare Analysis

Glare Analysis shows lesser glare within the classroom because of the trees on the southern side of the classroom where maximum shading happens.

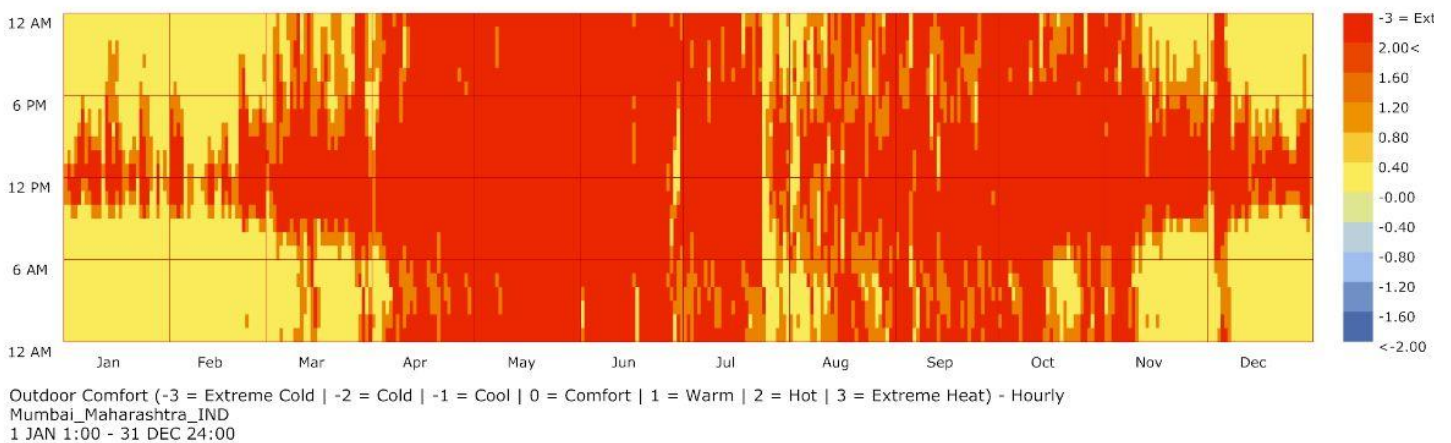
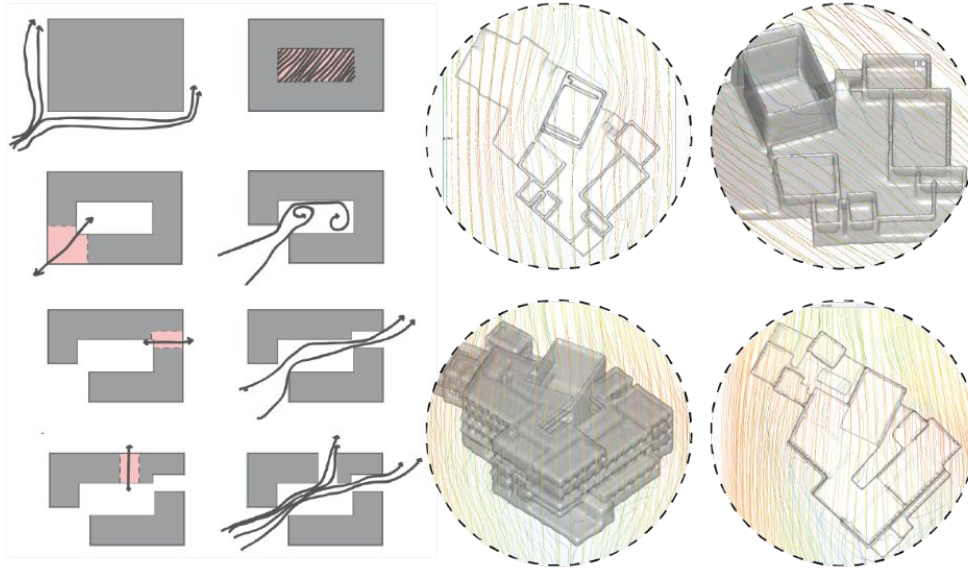
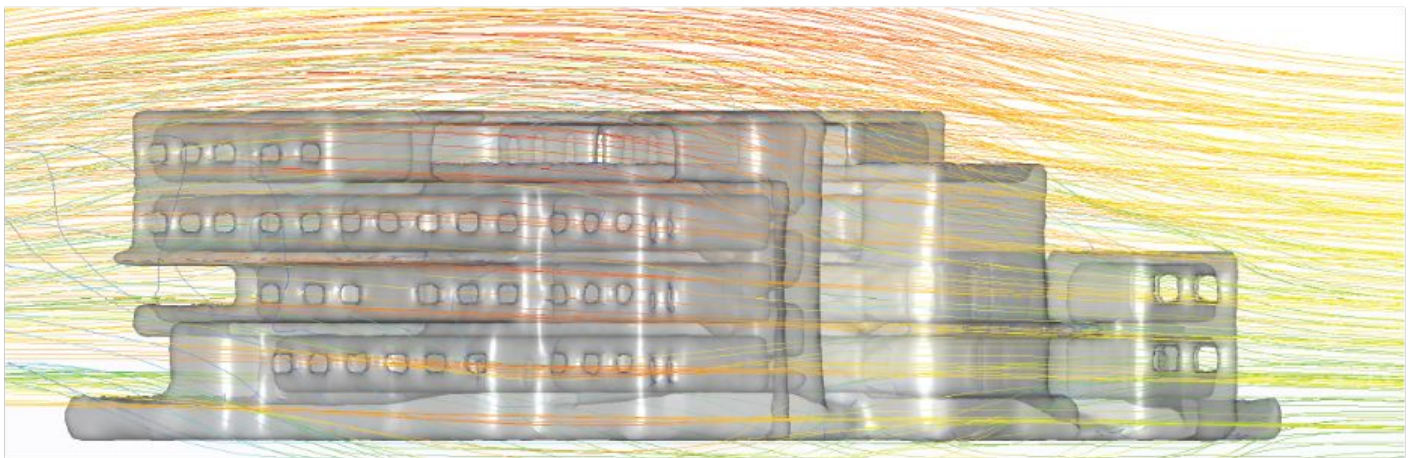


Figure 10.6 - Outdoor Comfort Chart

Figure 10.7 - Wind simulations



The building is designed in consideration with the wind patterns which are prevalent from the south west and west. Thus giving an opening through the south west side of the building so as to allow maximum amount of wind to enter the structure and cool the internal courtyard. Also the tree cover on the periphery lowers the temperature of the wind coming in thereby facilitating the thermal comfort for the users. The ventilation design also caters to the dehumidification needs of the humid climate of kalyan.



The green roof is one major addition, in regards to thermal comfort. They greatly reduce, the proportion of solar radiation that reaches the roof slab and provides additional insulation. Majorly on the southern & south western facades, the vegetation also helps with evaporative cooling.

Reduction of cooling load by 26%.

It allows the proposal to maintain its temperature while reflecting and absorbing solar radiation during the hot summer months. The period of reception of direct solar radiation on walls is shorter than on roofs, 1/3rds of that received by the roofs. Undoubtedly the most critical part of the whole building surface is the roof, which carries a lot of heat load. The simulations below close to a 4 degree roof temperature drop owing to the green roof v/s a standard RCC slab roof.

4 degree drop in temperature.

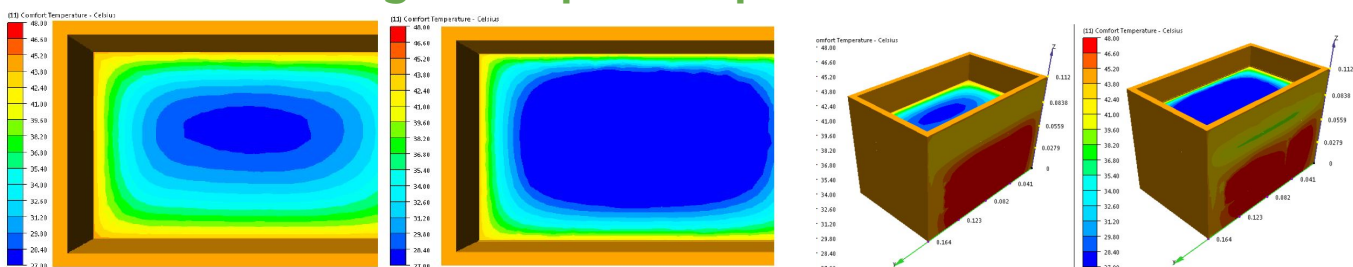


Figure 10.8 - Impact of green roof

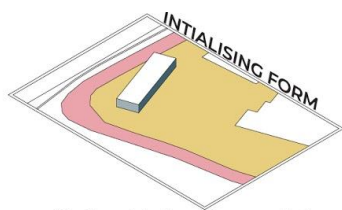
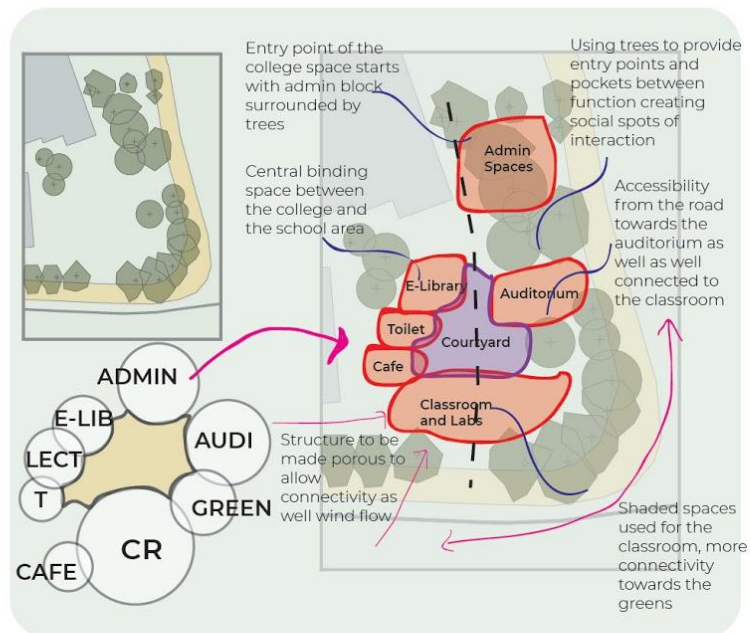
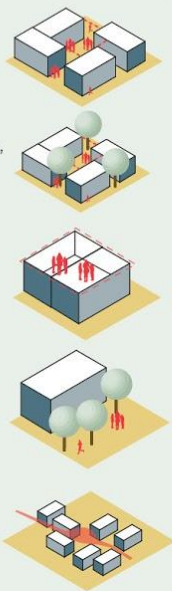
14. ARCHITECTURAL DESIGN

The main intention behind this design was to have fragmented functions that were bound together through a central space and smaller green pockets. Orientation and placement of classroom resulted in the use of the site trees to its full potential. Keeping in mind the ecology aspect and importance of green, the functions were placed in such a way that there was minimum need of destroying the tree belt on site.

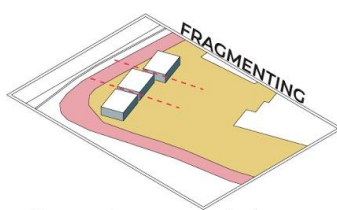
Flexibility in spaces was one major factor considered in the design intent. Opening of classrooms for furthermore helped in creating spaces of large social interactions.

The use of green pockets between functions were incorporated within the design to create small social pockets within the site to maximise group interactions.

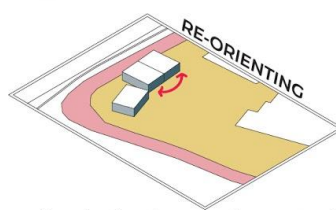
The main circulation axis cuts through the site and the courtyard becomes an assembly point for the flow of students to accumulate and then radiate towards their specific functions.



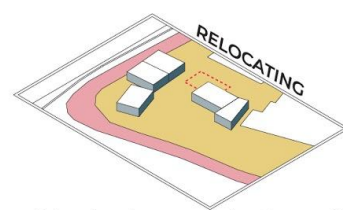
Placing a block on site towards the southern portion for the classrooms.



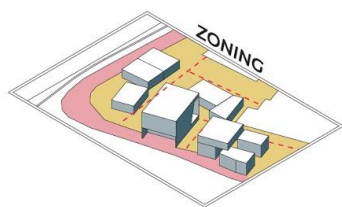
Fragmenting spaces on site for to create pockets in between the spaces.



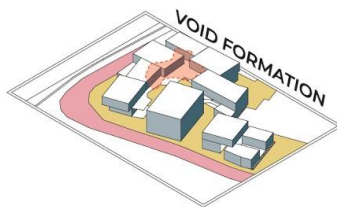
Re-orienting the spaces in a way to allow maximum flexibility without defining boundaries.



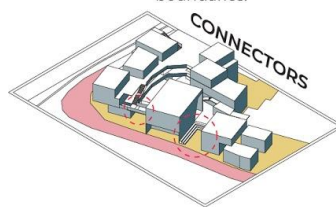
Relocating the common function to still have a connect between the new and the existing.



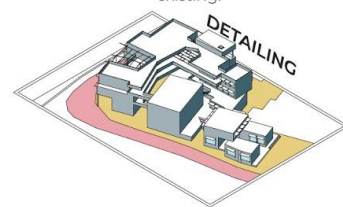
Assigning functions to zones from admin towards the north side to classrooms on the southern area.



Formation of spaces done in a way that a central void is formed which becomes an assembly point for the structure.

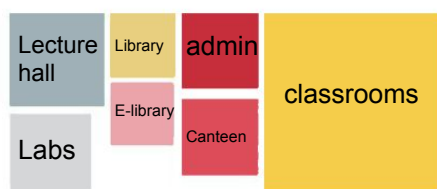


Looking at connectors in-between spaces to bind the spaces together.



Detailing out the facades with bamboo elements and also looking at circulation spaces and terrace areas.

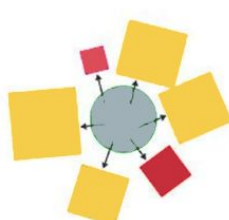
Figure 11.1 - Form Development



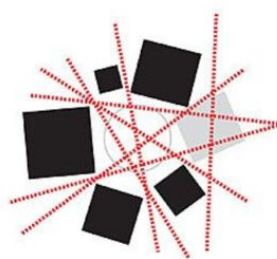
PROGRAM



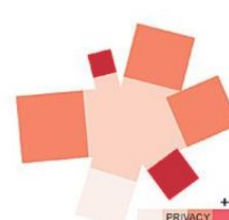
PROGRAM DEFINES PUBLIC FORUM



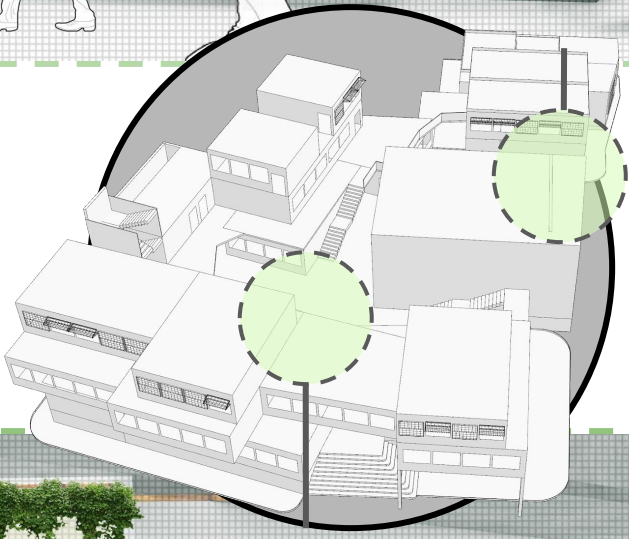
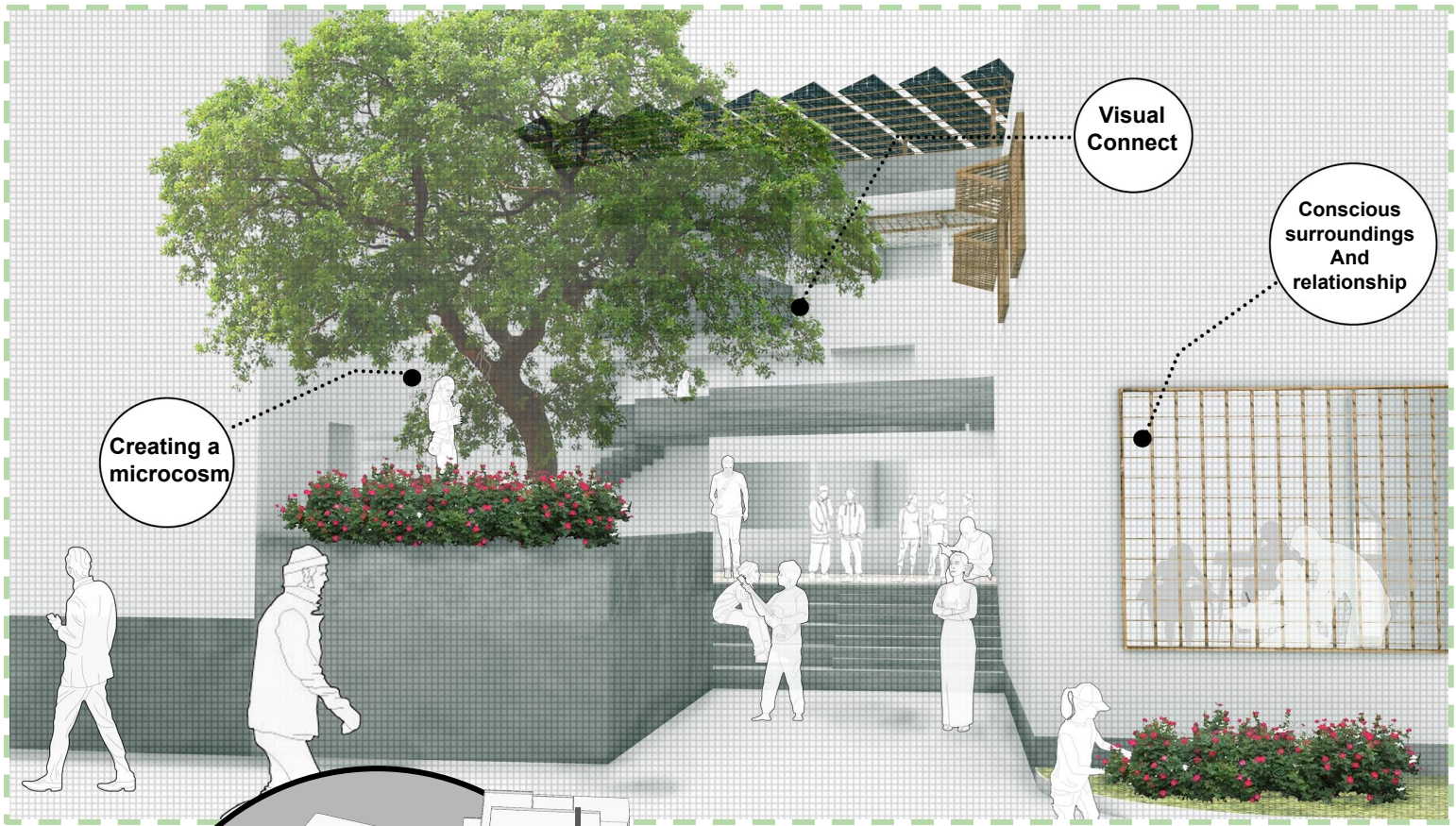
ARTICULATED PROGRAMMATIC RELATIONSHIPS



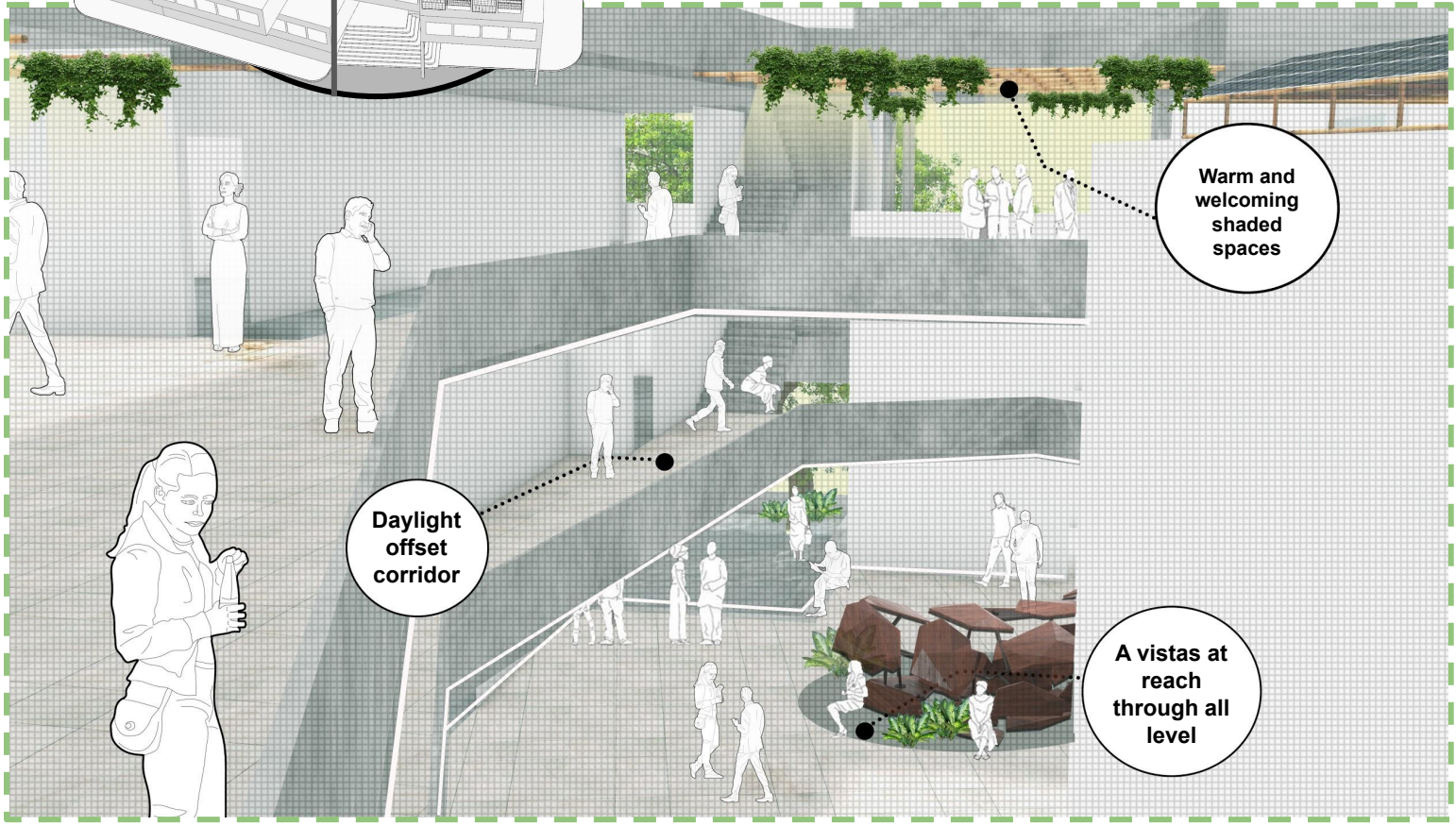
BUILDING REMAINS OPEN TO THE LANDSCAPE

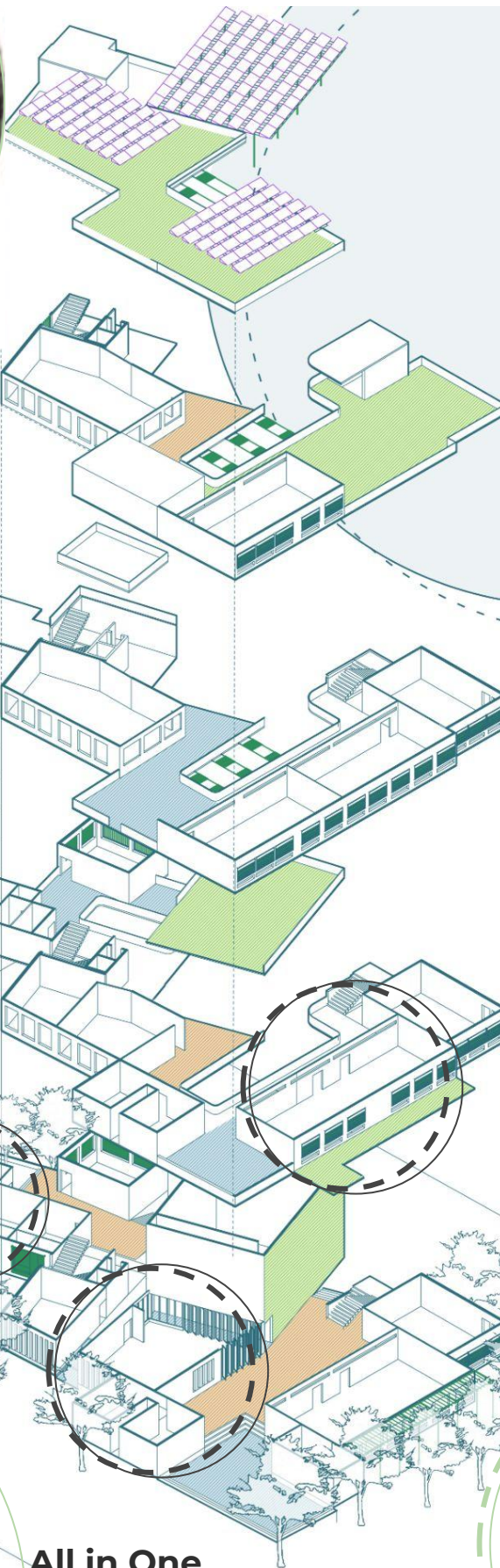


PUBLIC/PRIVATE



The “school community” concept is closely related to the concepts of **voice** and **shared leadership**, which generally seek to broaden the involvement of more individuals, and more diverse viewpoints, in the governance and programming in a school





The Library

"Down to Earth"

Informal seating paired with a friendly atmosphere.

Library & Courtyard

"Light in the Darkness"

Bamboo louvres allow visual connection to the courtyard and walkway.

Class VS Class

"Two are better than one"

Modular floor layout allow spatial expansion and enhanced collaboration.

All in One

"Whatever you want it to be..."

A dynamic lecture hall space which can also be optimised to hold parent teacher meetings, exhibitions and student displays, etc due to its modular furniture.

Figure 11.2 - Exploded Isometric View

15. ENGINEERING DESIGN AND OPERATIONS

FOUNDATION DETAIL

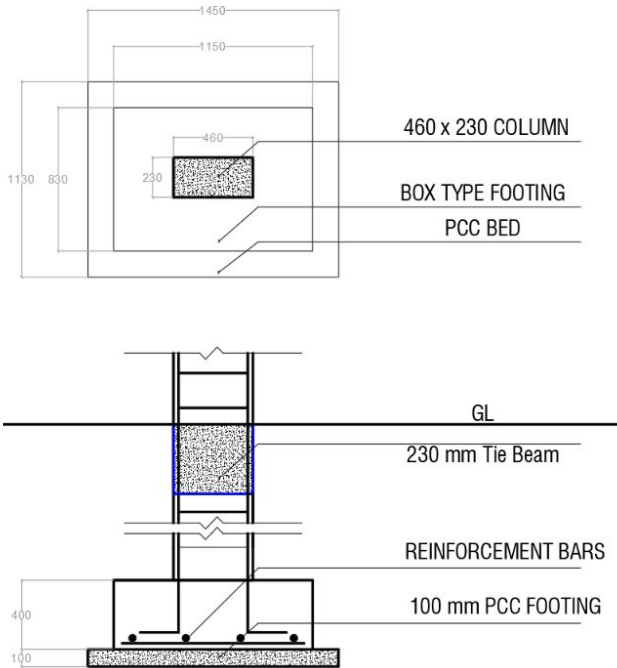


Figure 12.1 - Foundation Detail

COLUMN BEAM JUNCTION SECTION

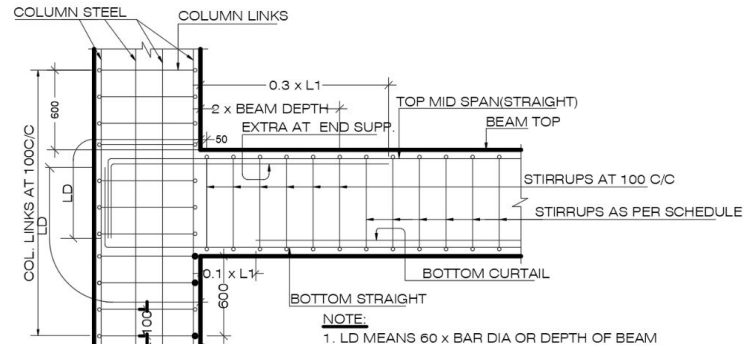


Figure 12.2 - Column Beam Junction Section

Structural Detail

The structure uses typical rcc framework requiring M20 grade cement-concrete-aggregate mixture for compressive strength and steel reinforcement bars for tension.

TYPICAL SLAB DETAIL SECTION

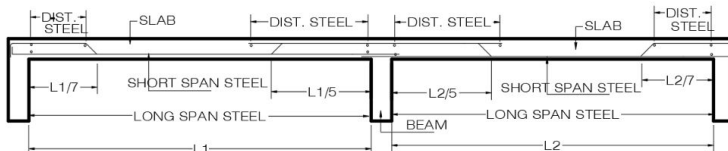


Figure 12.3 - Typical Slab Detail section

TYPICAL BEAM DETAIL SECTION

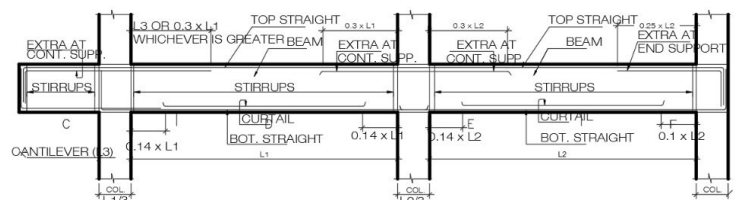


Figure 12.4 - Typical Beam Detail Section

Sanitary Detail

The toilet separates solids (faeces) principally through sedimentation. Loosely bound water (mostly from urine) is separated using low glass transition temperature hollow-fibre membranes. The unique nanostructured membrane wall facilitates water transport in the vapour state rather than as a liquid state which yields high rejection of pathogens and some odorous volatile compounds. The water is then collected for reuse at the school level for irrigation applications.

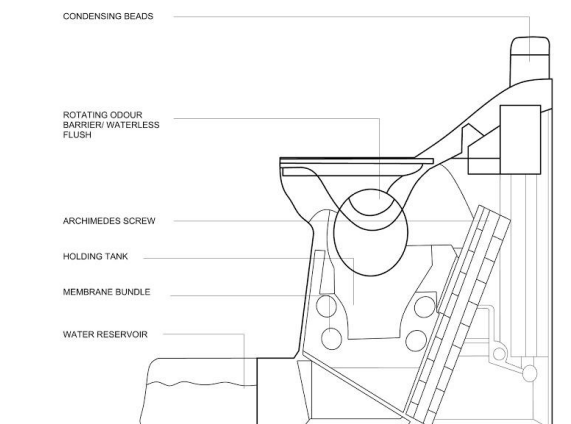


Figure 12.5 - Nanomembrane Toilet section

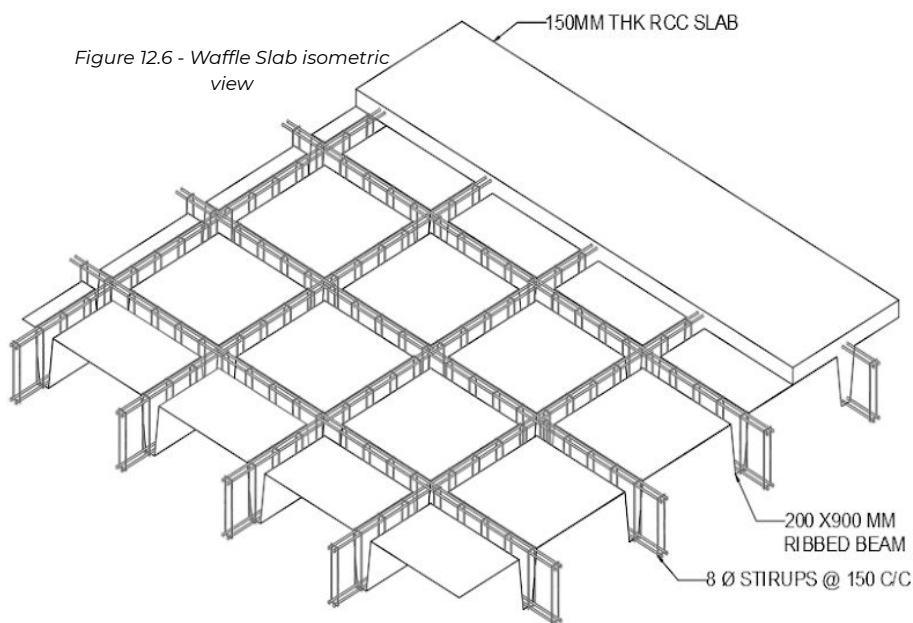


Figure 12.6 - Waffle Slab isometric view

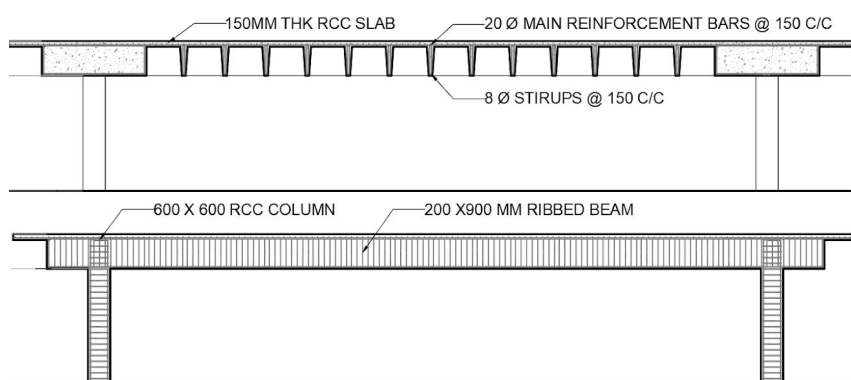


Figure 12.7 - Waffle Slab sections

WAFFLE SLAB

Waffle slab is used to cover the large columnless span of the auditorium. It used additional secondary beams integrated within the slabs by adding extra reinforcement steel bars and also increased depth at regular intervals.

Automation

Electric Distribution Boards connected to a wireless controller allows regular electric equipments to be controlled wirelessly over a private connection.

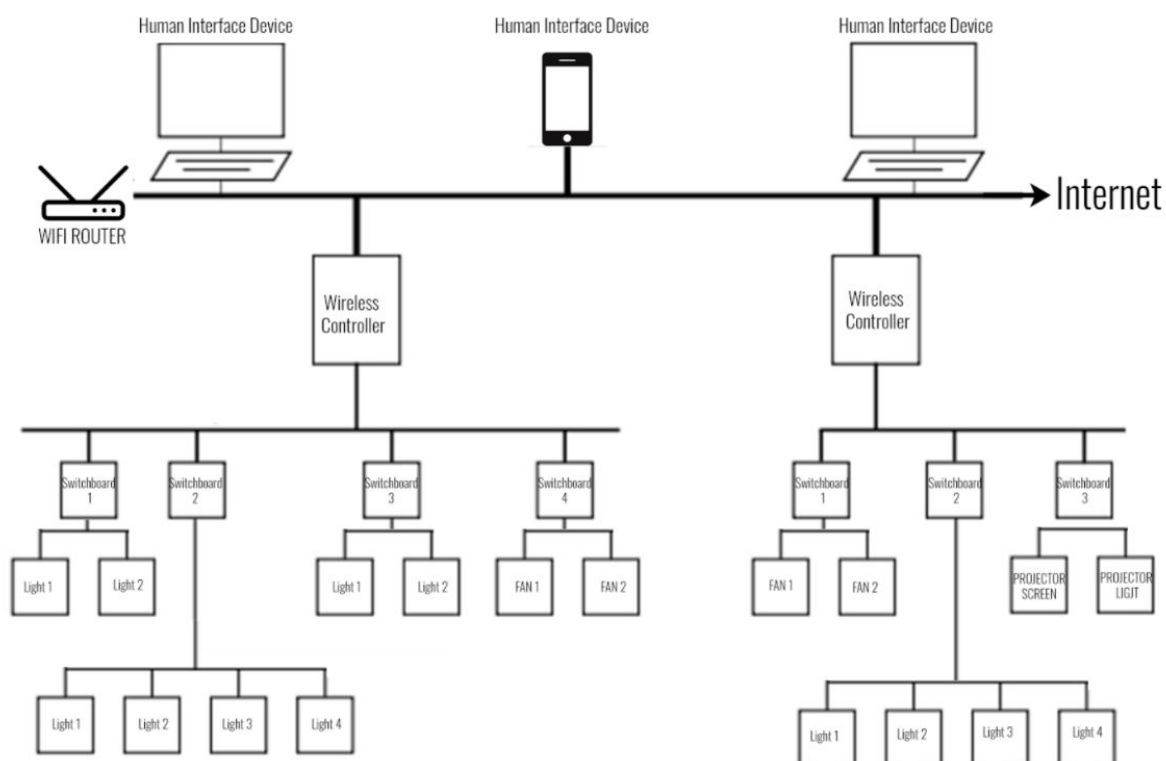
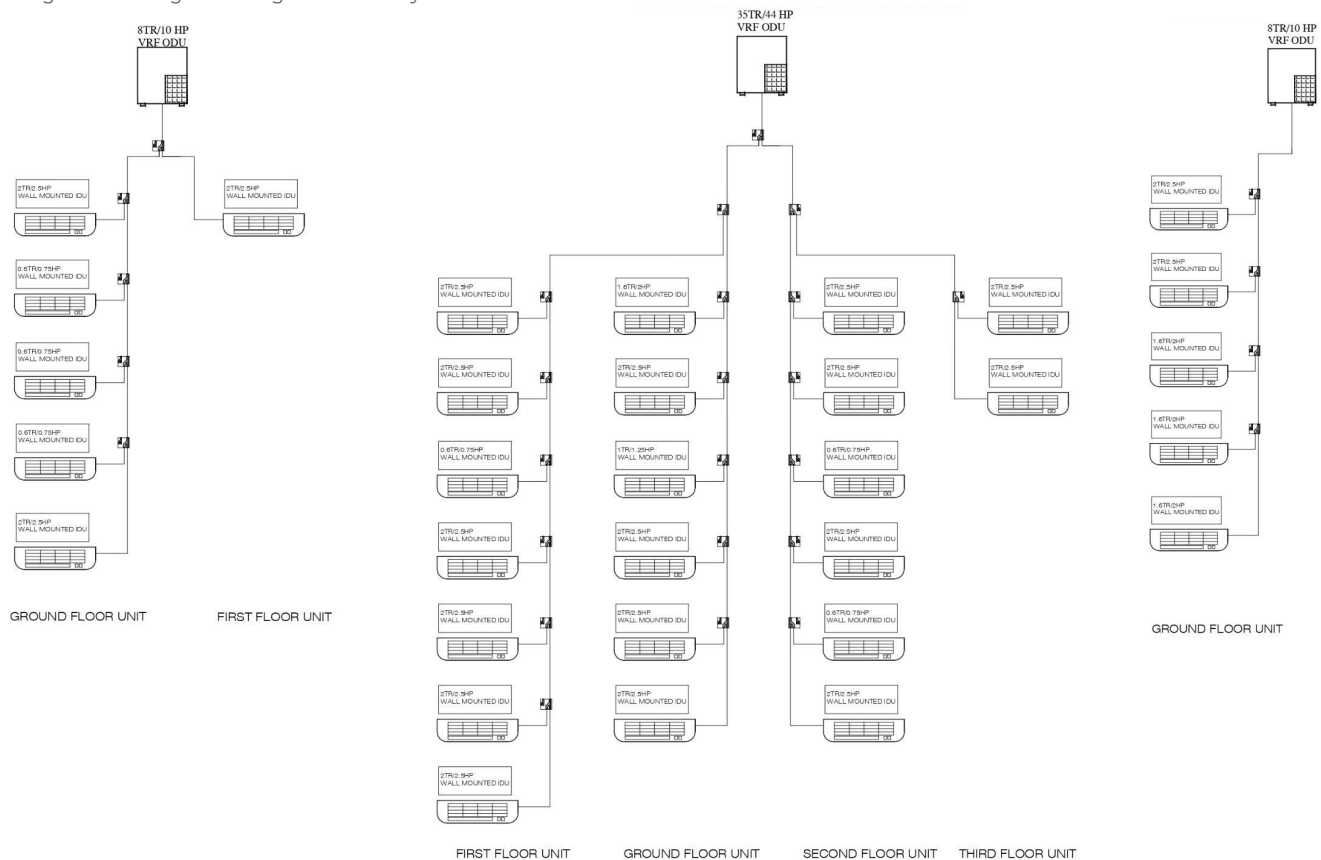


Figure 12.8 - Automation layout

Cooling load calculation and distribution

The cooling load for the building was calculated using the Cooling Load Estimation tool, which follows the ISHRAE data. The base and design case results for each space were calculated. The peak cooling load for the whole building came up to 51 TR. A VRV system of Daikin is adopted- divided into 3 zones with separate outdoor units. Wall mount indoor units are used for maximising effective headroom.

Figure 12.9 - Single line diagram for VRV system



PV PANELS

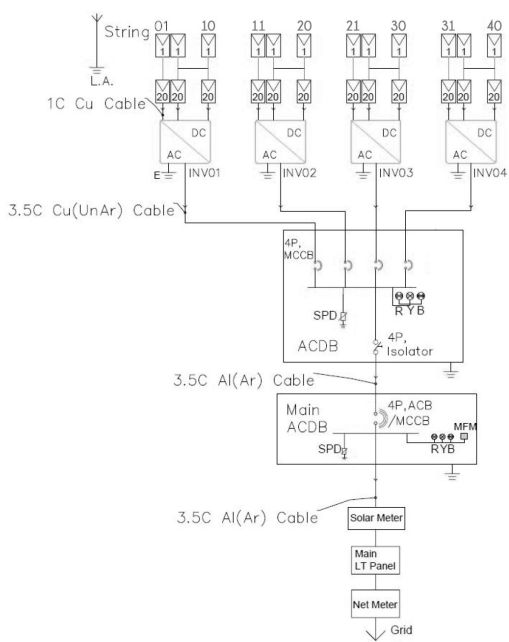


Figure 12.10 - Photovoltaic system single line diagram

ELECTRICAL LAYOUT

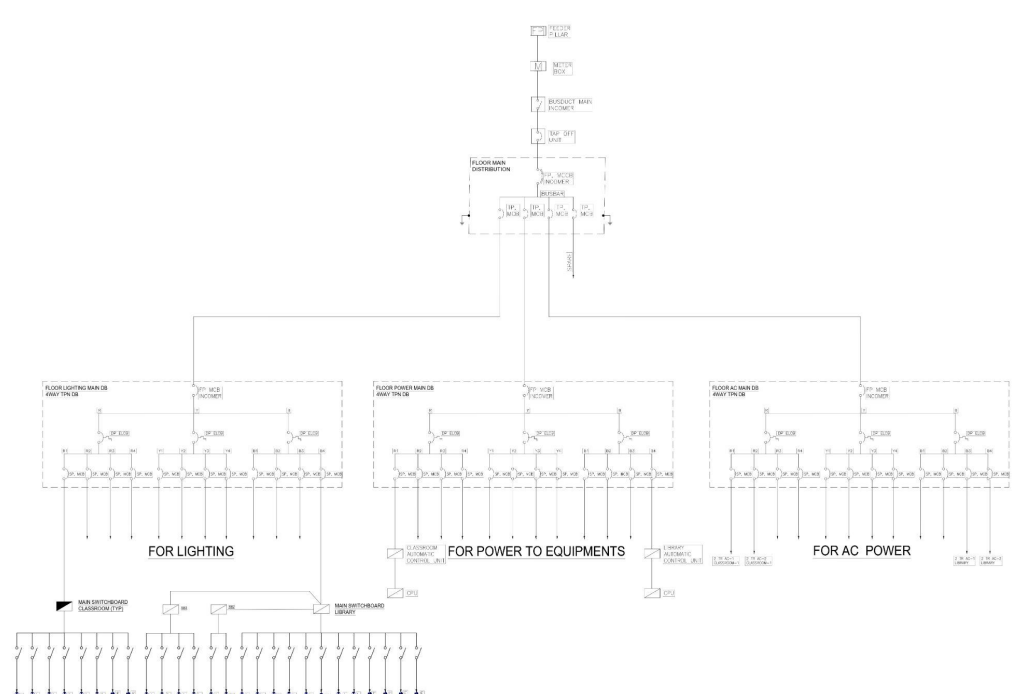


Figure 12.11 - SLD for electrical power distribution

16. PITCH TO YOUR PROJECT PARTNER

PROJECT PITCH

BUILDING THE PERSONAL CONNECT

Dealing with the first-hand emergency issues faced by the community



Allowing and prospering a thoughtful and dedicated environment



Providing a close relationship between the client and the students for a stronger foundation



MARKET REACH

Using **client's needs** and character to provide a strong solution



Establishing and carrying forward the principle of it's identity in the market as the **First Eco School of India**.



We aim to utilize the **on-site potential** to generate energy to its maximum capabilities and a relationship with the surrounding facilities.



Providing a new setup for the 11th 12th batch with a close integration of the existing school for a **seamless working model**



Incorporating the neighbourhood in the management of the new system and also promoting a local- community factor through the participation. This provides a **holistic image to the school**.

DESIGN OPTIMIZATION AND PROFIT

We aim to design a net-zero system with a careful consideration of **long term effects and maintainance**.



Materials used are economic and locally available and have a 10-12 yr life span.



We provide a system of maintainance and check through our stakeholders.



The school can withstand the climatic pressures through its pressure sensitive design.

RELEVANCE FOR IMMEDIATE STAKEHOLDERS



The students are provided with an collaborative and easy to approach setup for learning

The teachers are able to interact with the students at different platforms and encourage skill building

The school community has a stronger network through open and open and icollabo-building

QUALITIES OFFERED

COST FRIENDLY

Long term savings offer benefit

FLEXIBILITY

Easy for expansion or repurpose

ECO FRIENDLY

Utilising nature friendly materials for construction

RESILIENT

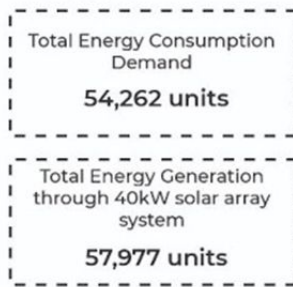
Self sustained system during emergencies

As we move into the next phase of design, and align the project with the partners' directives, we look at modelling and prototyping our louvres. In addition to keeping the construction period to that of 4 months

NET ENERGY SYSTEM



Major generations on site are through solar generation and bio-gas



17.5% OF GREY WATER
SOLD PER YEAR

3000 KWH OF SOLAR
POWER SOLD TO THE GRID PER YEAR

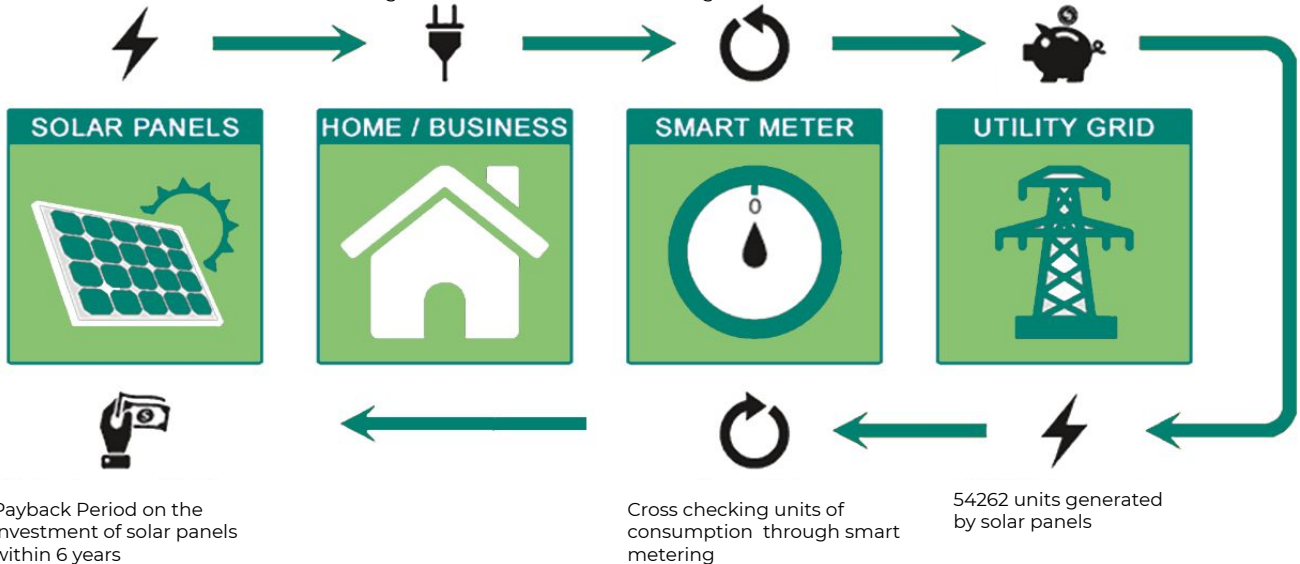
960kg OF BIOGAS SOLD
PER YEAR

57977 units generated by solar panels

Energy produced by the solar panels are net metered and sent to grid

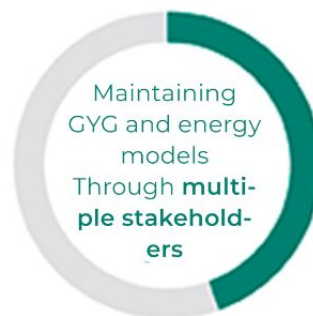
Cross checking units of production through smart metering

Savings in bill due to energy generation



AFTER THE PITCH

FOLLOWUP WITH THE PROPOSAL



Through designing the Net 0 institutional building, we are confident that the 10 contests are intrinsically linked to one another. At the same time, even capitalising on one or two of these entirely, assures, long term returns not just monetary but also with respect to well being and holistic boosts.

The dependency of one factor with the other, might look daunting, but through small yet meaningful measures, can be tackled with great ease.

As an added plan, we intend to communicate and convince our project partner of the same, and employ, a few if not all meaningful measures for sustenance of the land, building, quality education and the community.

17. REFERENCES

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