



Bureau of Energy Efficiency



सत्यमेव जयते  
Government of India  
Ministry of Power



**giz** Deutsche Gesellschaft  
für Internationale  
Zusammenarbeit (GIZ) GmbH

# ANGAN

## Augmenting Nature by Green Affordable New-habitat

A Courtyard for Revolutionary Change in Building Energy Efficiency

An International Conference on Building Energy Efficiency

9<sup>th</sup>-11<sup>th</sup> September, 2019 | Hotel The LaLIT, New Delhi





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german  
cooperation

DEUTSCHE ZUSAMMENARBEIT

**giz** Deutsche Gesellschaft  
für Internationale  
Zusammenarbeit (GIZ) GmbH

THIS PRESENTATION WAS SHARED BY

**Isha Anand**

Director Projects , Morphogenesis

FOR THE SESSION:

*“Steps towards Net Zero Energy Buildings”*

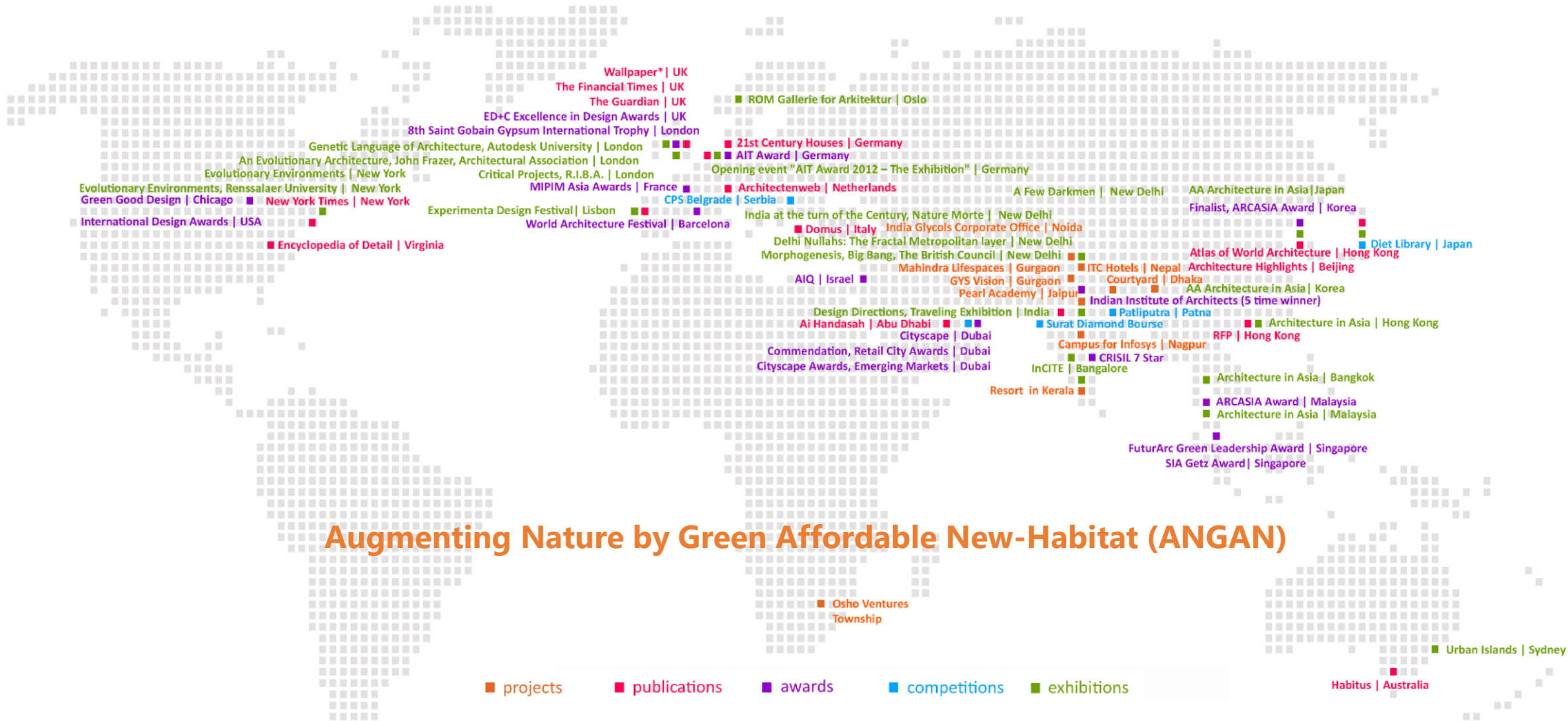
DURING ANGAN 2019

Knowledge Partner



**teri** | THE ENERGY AND  
RESOURCES INSTITUTE  
Creating Innovative Solutions for a Sustainable Future

Event Partner **TEC INDIA**™  
EVENT & BRAND MANAGEMENT CO.



## Augmenting Nature by Green Affordable New-Habitat (ANGAN)

The Indian Perspective | The Global Context

**morphogenesis.**

Delhi | Bengaluru | Mumbai

# **NET ZERO ENERGY BUILDINGS**

The issues, challenges and way forward

- Step one : **Don't build**
- Step two : **Build the minimum that is required**
- Step three : **Build with the assumption that the building is off grid : ENERGY & WATER**
- Step four : **Minimize the demand load of the building**

# DESIGN PHILOSOPHY

Our buildings consume **upto 50- 75% lesser energy** than certified green building benchmarks through Passive Design and Microclimate Creation proven through **Post Occupancy Evaluation**



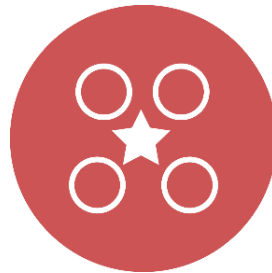
**S**USTAINABLE

**O**PTIMISED



Resource Optimization is achieved through **Integrated Project Delivery**. We break barriers of established **cost** benchmarks and **reduce consumption** through design innovation

All our projects are **unique**. Our design responds to **client, climate & context**, yet is mindful that the project is **globally pertinent**.



**U**NIQUE

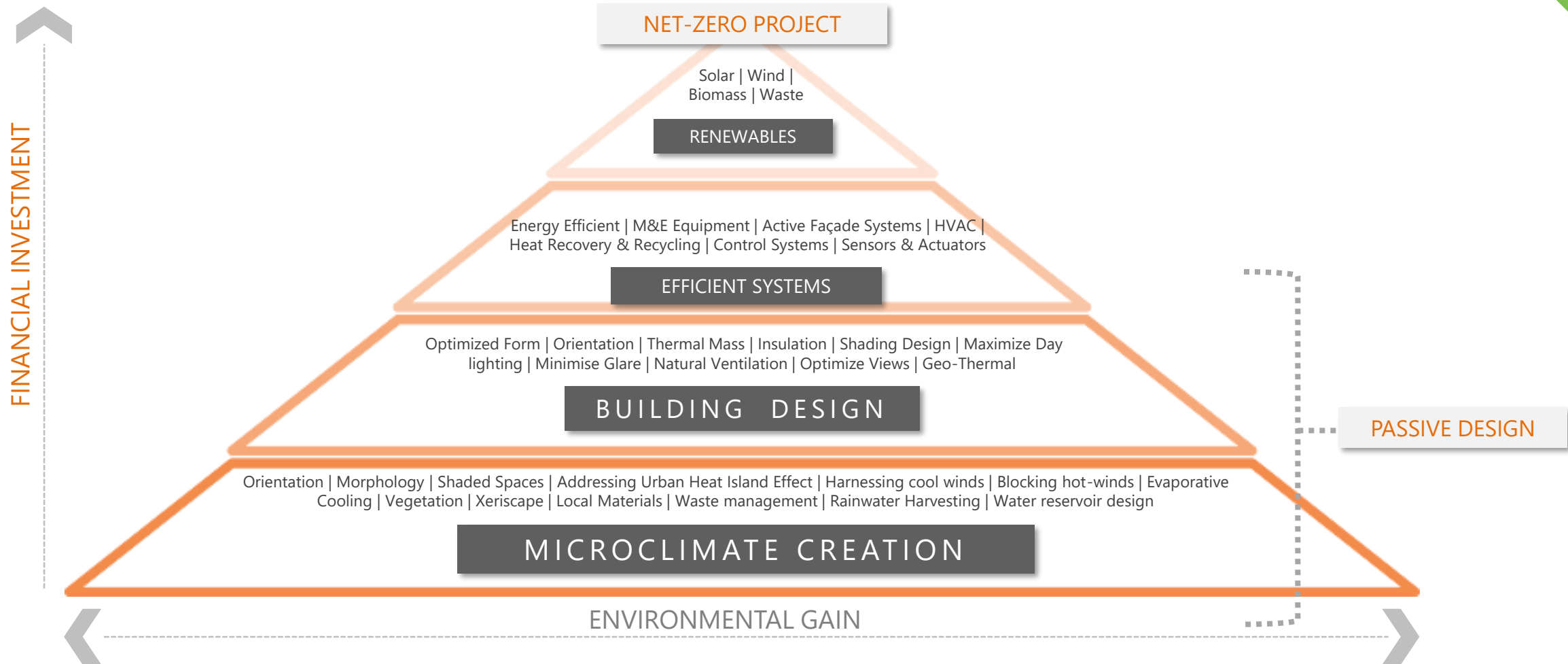
**L**IVABLE



Building **Smart** environments by placing the **user at the centre of the design process**

# SUSTAINABILITY

Combining the wisdom of the past and cutting edge technology to create exemplars of sustainable design



# SUSTAINABILITY

## Passive Design in Nature



Evaporative Cooling



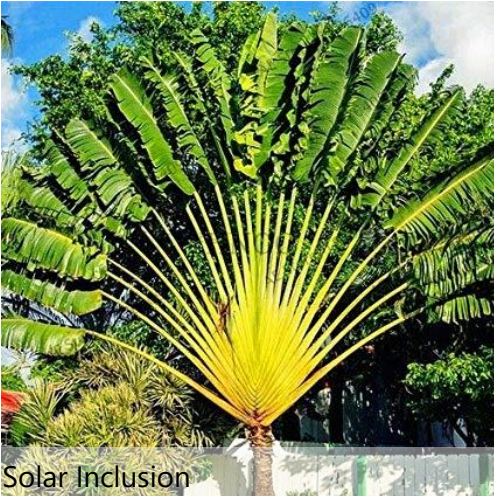
Minimal Solar Exposure



Thermal Mass | Earth sheltering



Insulation



Solar Inclusion



# SUSTAINABILITY

## Passive Design in History and the Vernacular



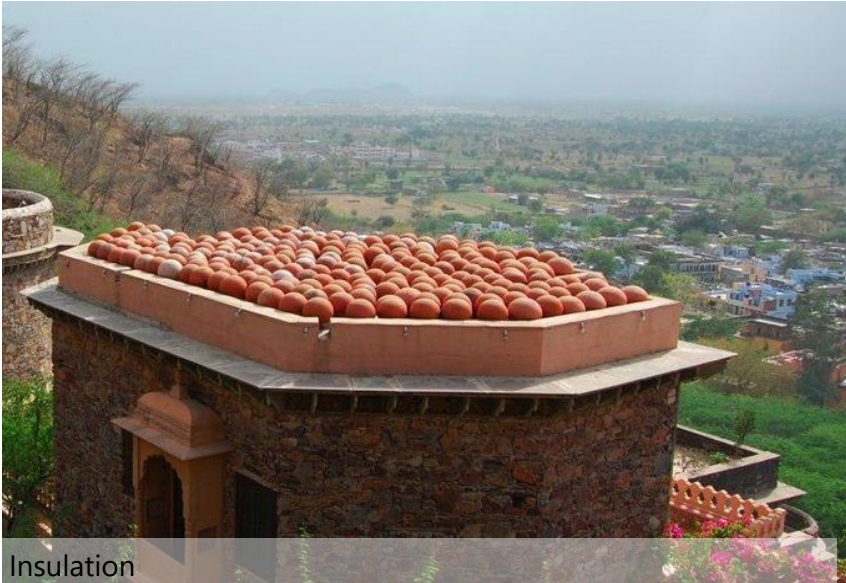
Thermal Mass | Earth sheltering



Minimal Solar Exposure



Inward planning



Insulation



Evaporative Cooling

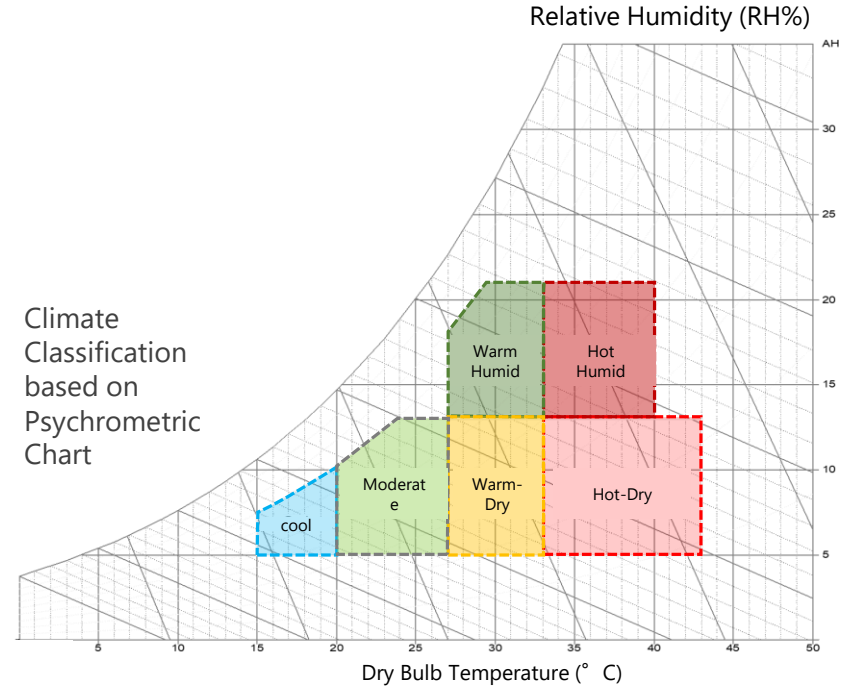
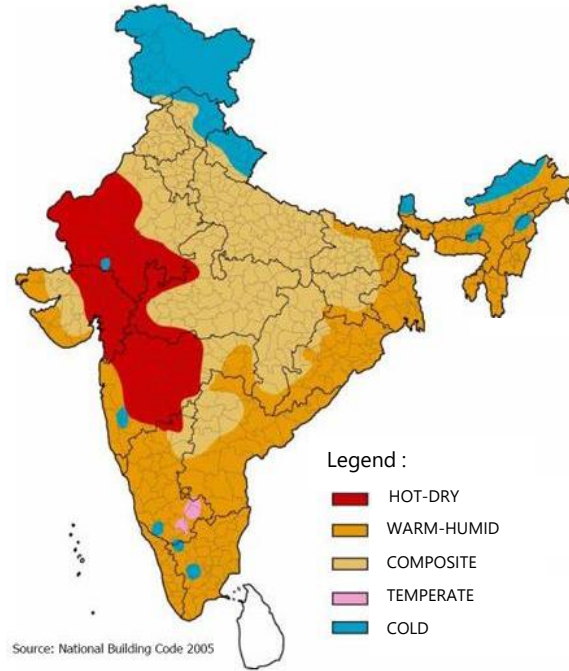


Screen Walls



# SUSTAINABILITY

Passive Strategies achieve Thermal Comfort > 75% Time



## APPLICABLE PASSIVE STRATEGIES

APPLICABLE STRATEGIES	HOT-DRY	WARM-HUMID	COMPOSITE	TEMPERATE	COLD
SOLAR CONTROL	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D
THERMAL MASS + NIGHT PURGING	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D
AIR MOVEMENT	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D
EVAPORATIVE COOLING	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D
PASSIVE HEATING	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D

# SUSTAINABILITY

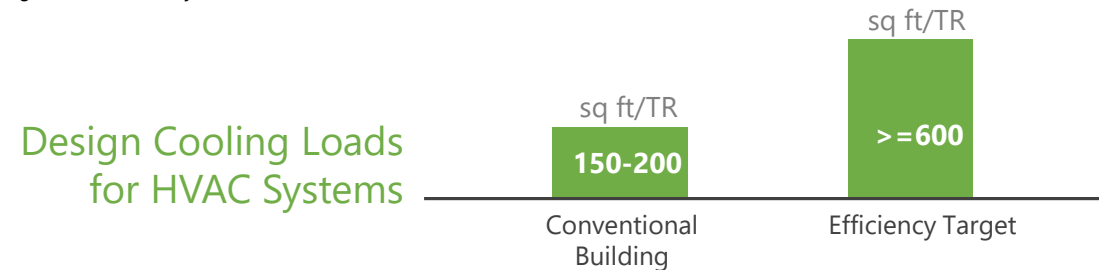
## Envelop design



Efficiency Parameters		Design Considerations
<b>Orientation :</b>		
Optimum Orientation for Minimal Solar Exposure		North-South
<b>Robust Envelope Design:</b> Optimal Thermal Properties and Element Proportions		
Efficiency Parameters	ECBC Baseline Metrics	Design Considerations
U-value of Walls (W/sq.m.K)	0.44	0.34
U-value of Roofs (W/sq.m.K)	0.26	0.26
U-value of Glass (W/sq.m.K)	3.30	1.5
Max. Window : Wall Ratio (WWR)	60%	≤ 30%
<b>Solar Control:</b> Effective Shading Design		
Effective SHGC for Glass (Shading)	0.25	0.05-0.15

<b>Resultant Envelope Load*</b>	≥ 4.5 W/sq.ft.	≤ 0.9 W/sq.ft.
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\*Envelope Load : Design cooling load for HVAC systems



# SUSTAINABILITY

Our buildings consume **upto 75% lesser energy** than certified green building benchmarks through passive design and microclimate creation proven through **post occupancy evaluation**



90

## BEE

Baseline EPI

**BUREAU OF ENERGY  
EFFICIENCY**

EPI: Energy Performance Index  
on primary energy  
consumption (unit: kWh/sq.m/yr)

60



47



45



45



25



BASELINE  
EPI

INDIA GLYCOLS,  
GREATER NOIDA

ZYDUS OFFICE,  
AHMEDABAD

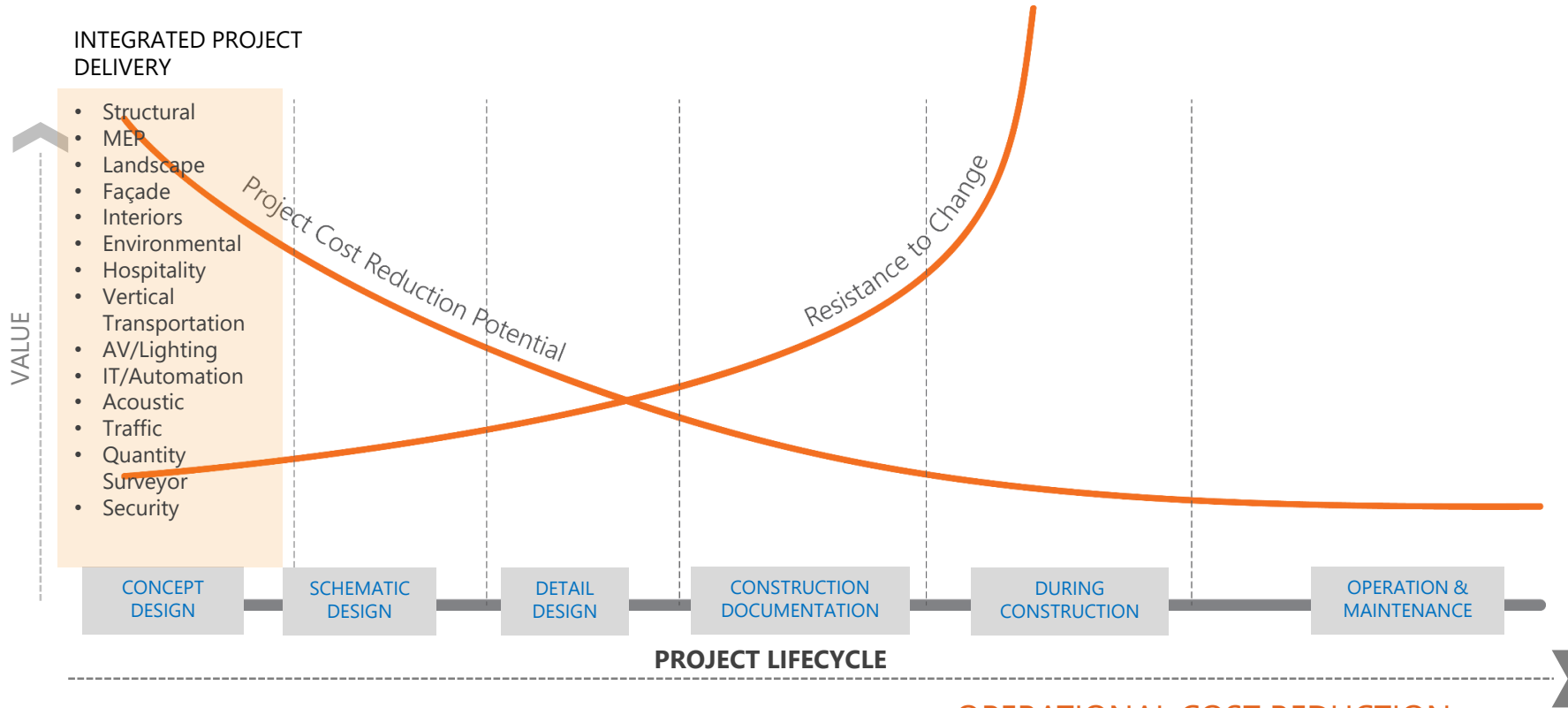
RPSG,  
KOLKATA

DS OFFICE,  
NOIDA

INFOSYS CAMPUS,  
NAGPUR

# OPTIMISATION

Integrated project delivery with spatial, structural, façade and M&E efficiency bring in reduction in capital and operational cost



## CAPITAL COST REDUCTION

SPACE PLANNING: Efficient Parking & Structure Optimisation

M&E OPTIMISATION : Passive design reducing lighting & HVAC loads

FAÇADE OPTIMISATION : Façade Optimised for Daylight, Glare and Shading

## OPERATIONAL COST REDUCTION

FACILITIES MAINTENANCE Reduction expected due to lesser installation of M&E equipment

M&E OPERATIONAL COST : 90% Daylit spaces & reduced envelope load reduce Lighting & HVAC Loads & hence operational costs

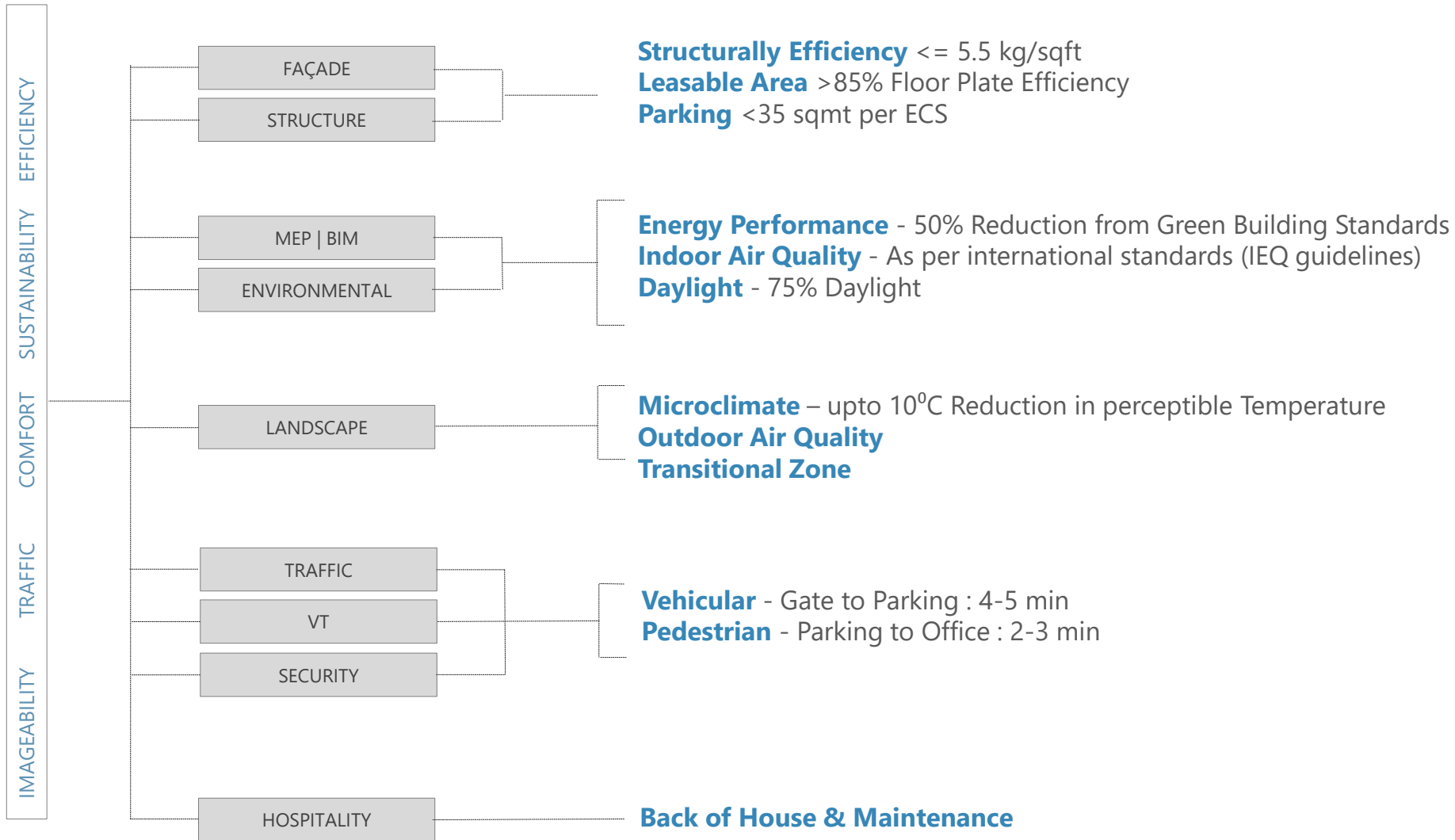
“ Morphogenesis lays out few simple strategies that make **perfect sense** in **Social ,Economic and Aesthetic terms**. Their buildings are **pragmatic**, often **frugal** **always imaginative...** ”

- Michael Webb \*

\*Michael Webb is a Los Angeles Based writer who has authored more than 20 books on Architecture & Design

# OPTIMISATION | INTEGRATED PROJECT DELIVERY

Early stage specialist expertise contributes to strong, cohesive, integrated design that is less prone to costly revisions in the future





**Weight of a Building**

**: 1,500 Kg/sqm**

Spatial Standard

: 10 sqm / person

Spatial Efficiency

: 8 sqm / person

Weight of Building

: 15,000 kg / person

Weight of Building

: 12,000 kg / person

**Efficient and Optimized Design can save up to 3,000 kg of material per person**



# UNIQUE

ALL OUR PROJECTS ARE **UNIQUE**. OUR DESIGN RESPONDS TO **CLIENT, CLIMATE & CONTEXT**, YET IS MINDFUL THAT THE PROJECT IS **GLOBALLY PERTINENT**.



ZYDUS HEADQUARTERS | AHMEDABAD



INFOSYS | NAGPUR



WIPRO | HYDERABAD



IGL | NOIDA

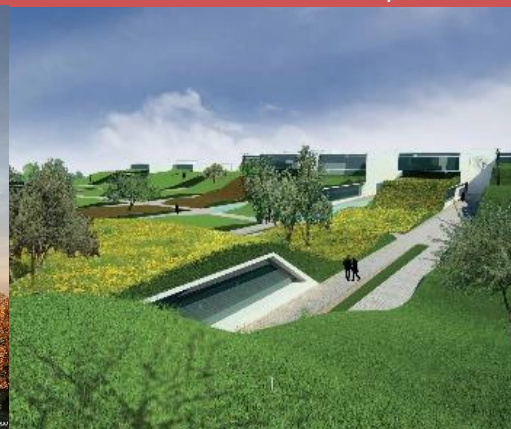
RPSG | KOLKATA



BAXI | NOIDA



DS FACTORY | NOIDA



77/32 | GURUGRAM



“Morphogenesis has consistently developed an architectural language which is **contextual, climatically sensitive** and high in **social content**. Their works are very much rooted into the **culture, climatic, social and economic conditions of India....**”

Jury Citation , 2014 Singapore Institute of Architects GETZ Award for Emergent Architecture In Asia

# LIVABILITY

BUILDING **SMART** ENVIRONMENTS BY PLACING THE **USER AT THE CENTRE OF THE DESIGN PROCESS**



Morphogenesis has mastered **the Architecture of Smart Environments** and created worthy buildings made to optimise resources

- Dr Simos Yannas

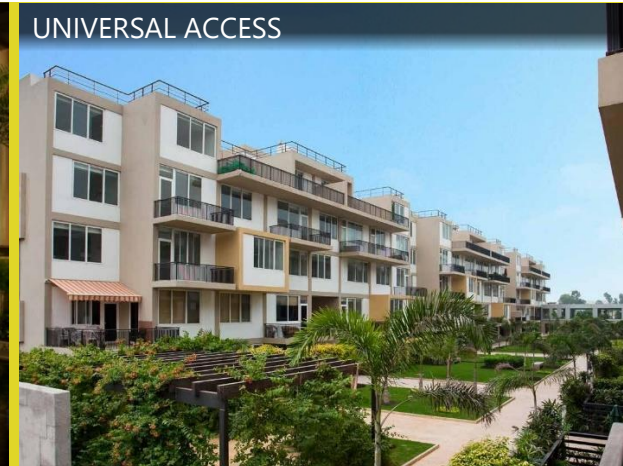
Dr Simos Yannas is the Director for the Sustainable Environmental Design Programme & PhD Programme at The Architectural Association, London



CELEBRATING ART AND CULTURE



MICROCLIMATE



UNIVERSAL ACCESS

MAKER MAXITY BKC | **MUMBAI**  
INDIA GLYCOLS HEADQUARTERS | **NOIDA**

INDIA GLYCOLS HEADQUARTERS | **NOIDA**  
GYS PRIUS | **GURGAON**

MARBLE ARCH | **CHANDIGARH**  
CITY CENTRE | **SILIGURI**



INTEGRATING 'OUTSIDE' AND 'INSIDE'



SAFETY



MAINTAINABILITY

?

**adaptive comfort ???**

# NET ZERO ENERGY BUILDINGS

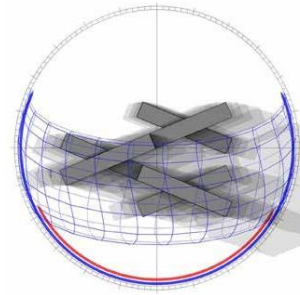
Campus for Infosys, Nagpur

<b>Built Up Area :</b>	8,25,000 sq ft
<b>Site Area :</b>	142 acres
<b>Climate :</b>	Warm & Humid
<b>Client :</b>	Infosys Ltd
<b>Status :</b>	In progress

# SOUL TARGETS



The building targets to consume **75%** lesser energy than certified benchmarks.



Self shading Morphology



Efficient MEP Systems



Integrating Renewable Energy systems:



Rain-water Collection  
+grey water recycling :+  
Heat sink for AC System



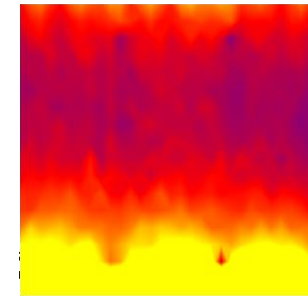
Reducing consumption of resources through design innovation and use of simplistic materials

**8.8 sq.m / person**

Efficient floor plate

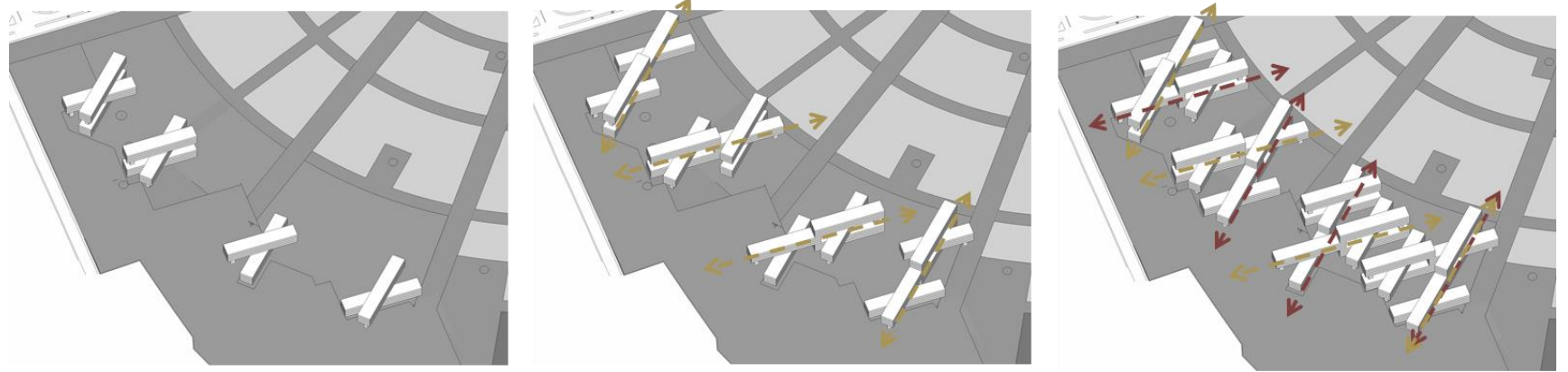
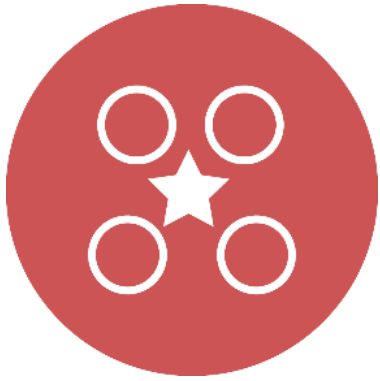


MEP Optimisation



Daylight Autonomy  
90% Daylit floor plate

# SOUL TARGETS



The building creates a unique morphology driven by environmental parametric design

Building orientation used to derive a **UNIQUE SELF SHADING MORPHOLOGY**



Building a **user centric** interactive indoor-outdoor environment

The morphology creates self shaded courts and terraces which not only act as **TRANSITION SPACES** but also as **EXTENDED INTERACTIVE ZONE FOR THE EMPLOYEES**

# CARRYING CAPACITY



Target : 50% reduction  
from NBC recommendation

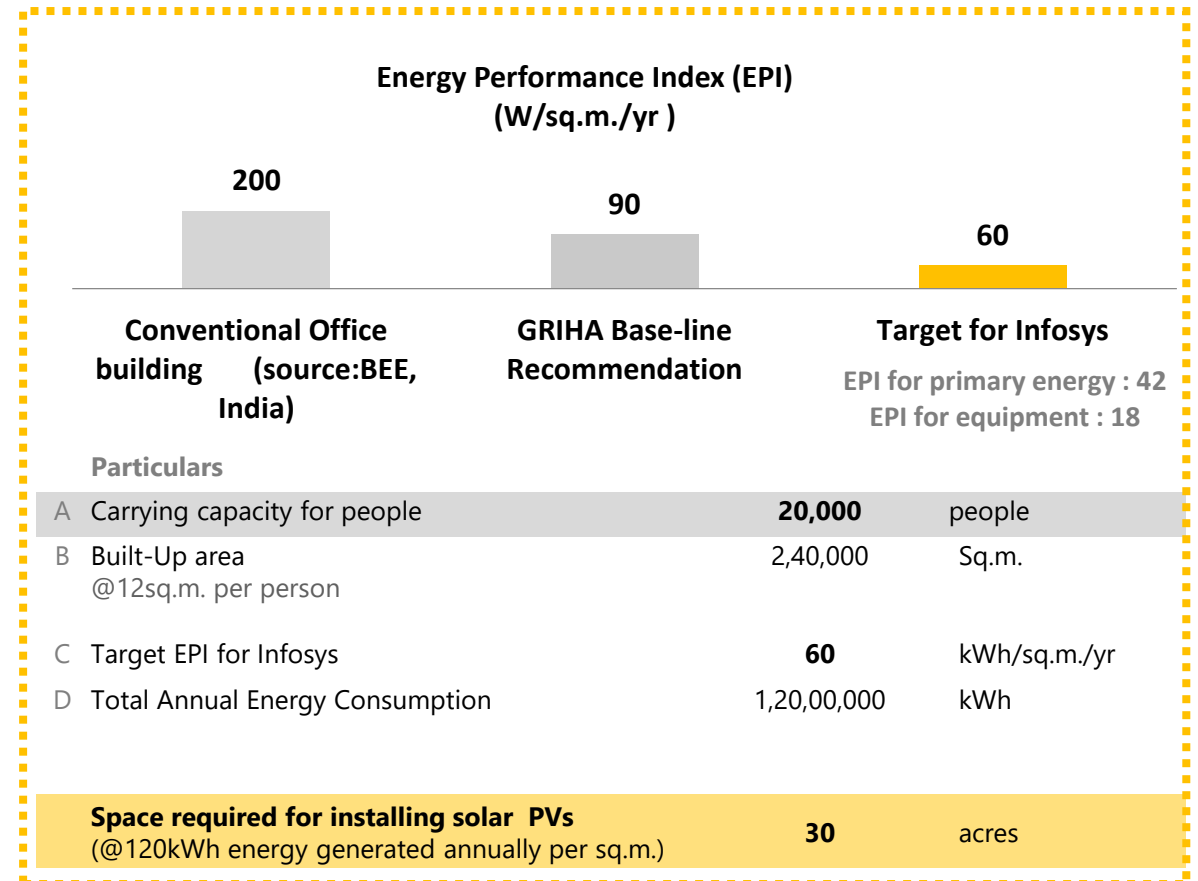
## ZERO WATER

Particulars	Water requirement
<b>A Rainwater Harvesting potential</b>	
1 Site Area	5,75,364 s.m
2 Annual rainfall	1.2 M
3 Run off factor	0.50
4 Total rainwater collected	3,45,281 cu.m. /yr
5 <b>Rainwater Harvesting potential (20% evaporative losses)</b>	2,76,172 cu.m. /yr
<b>B Rainwater Reservoir</b>	<b>3 M Depth</b>
1 Size of reservoir based on capacity	23 acre
<b>C Carrying Capacity</b>	
Carrying capacity for water demand	
1 @27.5lpcd with water balance for domestic use, flushing, HVAC and irrigation	20,000 people



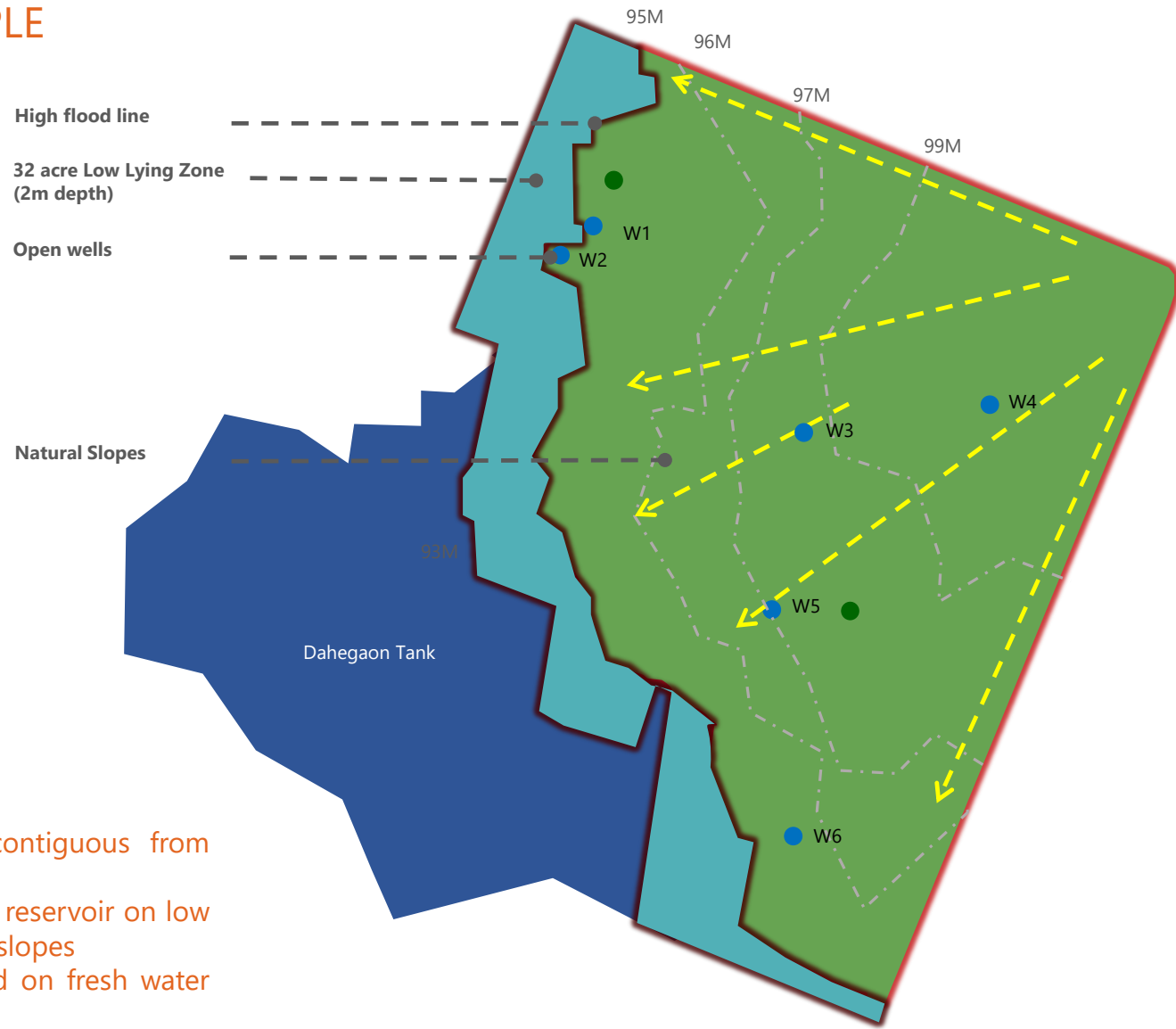
Target : 70% reduction  
from GRIHA baseline

## ZERO ENERGY



# MASTERPLAN

CARRYING CAPACITY  
WATER = 20,000 PEOPLE



High flood line  
32 acre Low Lying Zone (2m depth)  
Open wells  
Natural Slopes

Well	top water lvl.
W1:	92.4M
W2:	92.1M
W3:	89.6M
W4:	86.M
W5:	92.2M

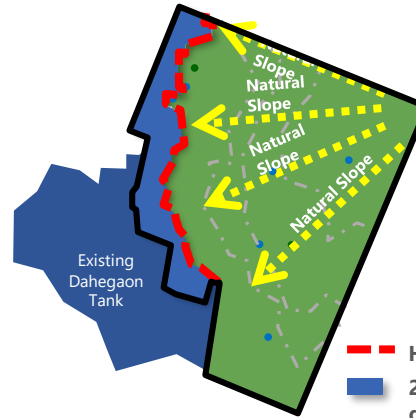
Av. Annual rainfall:1.2M  
142 acre site@0.5 runoff factor: 3,45,215 cubic mt.  
After 20% evaporative losses: 2,76,172 cubic mt.

Low lying area: 32 acre  
Average depth of low lying area: 3M  
Capacity of low lying area:3,88,500 cubic mt.

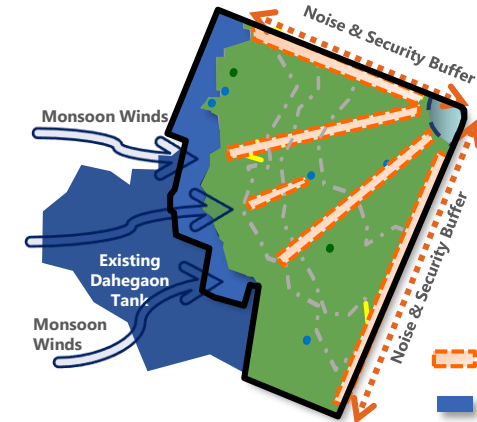
Annual fresh water requirement:12 cubic mt./per

- Inference:**
- Underground water level is contiguous from across the Dahegaon tank
  - Potential of 100% natural water reservoir on low lying area of the site with natural slopes
  - Carrying capacity of land based on fresh water requirement is 20000 people

# MASTERPLAN



- - - High flood line
- 23 acre Low Lying Zone (3m depth) planned as Lake



- - - Pedestrian Water Canyons
- 23 acre Low Lying Zone (3m depth) planned as Lake

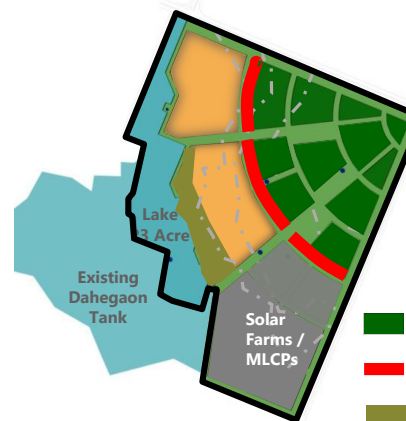
Site Location = Nagpur (21.14°N, 79.09°E).  
Area = 142 Acre

Natural Slopes maintained collecting surface run-offs at low lying areas of Site, creating a Lake

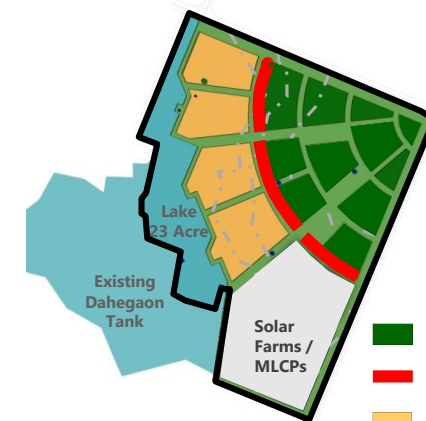
S-W, W & N-W Monsoon winds captured to induce wind movement within site by introducing radial pedestrian movement water canyons



- Proposed area for Solar PVs
- Proposed Built zone
- Native Tree Plantation / Future Development



- Native Tree Plantation/ Future Development
- Service and Utilities Blocks
- Leisure & Recreational Block



- Native Tree Plantation/ Future Development
- Service and Utilities Blocks
- 2-3 Acre Plot

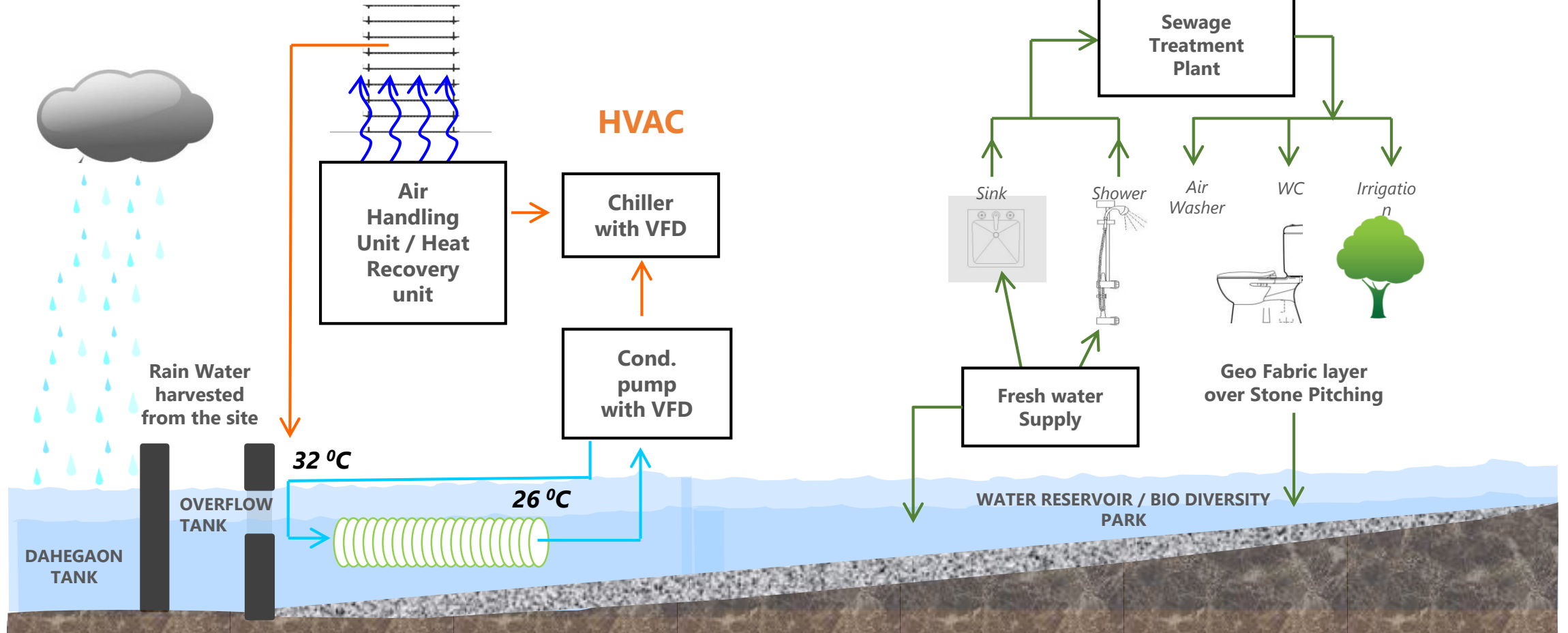
Southern Zone of the Site is allocated for Solar PVs. Proposed Built Zone is towards the proposed Lake, creating vistas towards the lake along.

The leisure/ recreational activities are lined along the lake, while the Utilities are tucked away, behind the built zone.

The Site is divided into 4 plots based on carrying capacity, following the radial lines of the pedestrian water canyons.

# LAKE AS A THERMAL SINK

## LAKE MEP STRATEGY



### Inferences:

- **6K temperature differential** by using reservoir water at 26°C instead of water from cooling tower at 32°C hence the **efficiency** of HVAC system **increases**.
- **No Cooling towers required** in HVAC system as it forms a closed loop with a perennial reservoir on site.
- The reservoir is **fed by rain** and **surface runoff** from rooftops and site enabling **zero water balance** on site for Phase 1 and 2

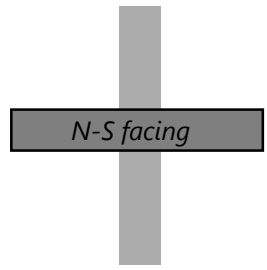
# SITE PLAN



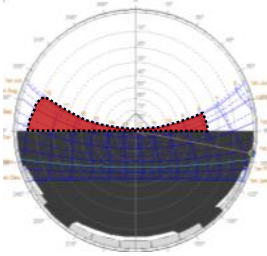
## Legend

- 1. Ceremonial Entry
- 2. Lake
- 3. Open Courts
- 4. Amphitheatre
- 5. Employee Care Centre Block
- 6. Native Tree Plantation
- 7. MLCP and Solar Farms
- 8. Employee Entry
- 9. Utilities
- 10. Turnstile Bay
- 11. Pedestrian Canyon
- 12. Software Development Blocks
- 13. Boardwalk

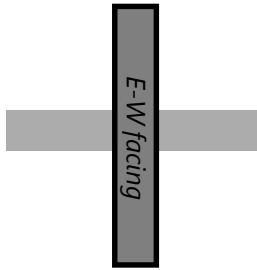
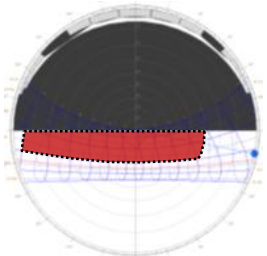
# SHADOW ANALYSIS



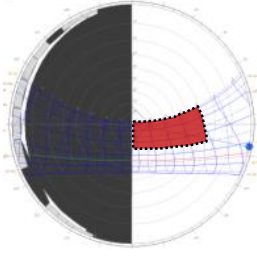
North



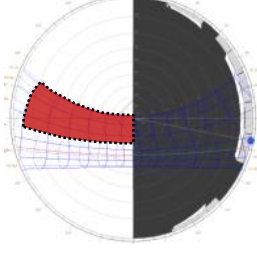
South



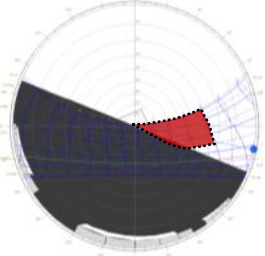
East



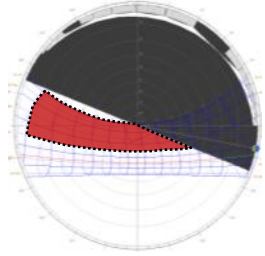
West



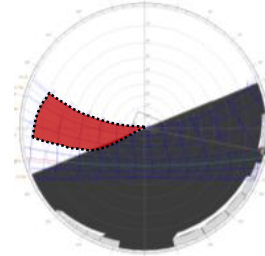
22.5° NNE



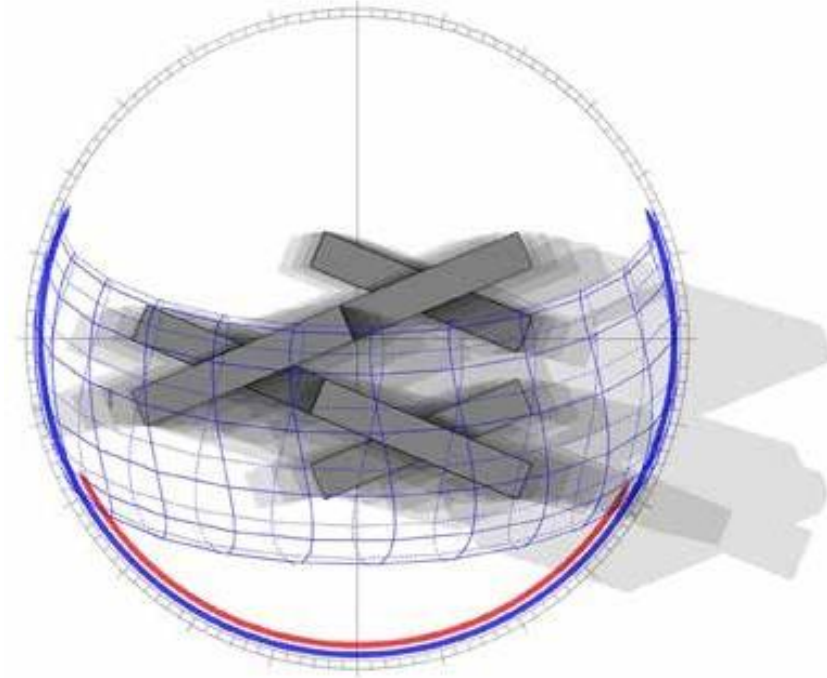
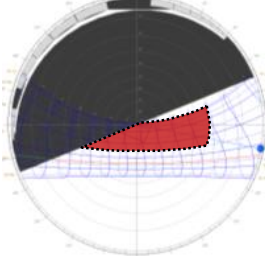
22.5° SSW



22.5° NNW



22.5° SSE



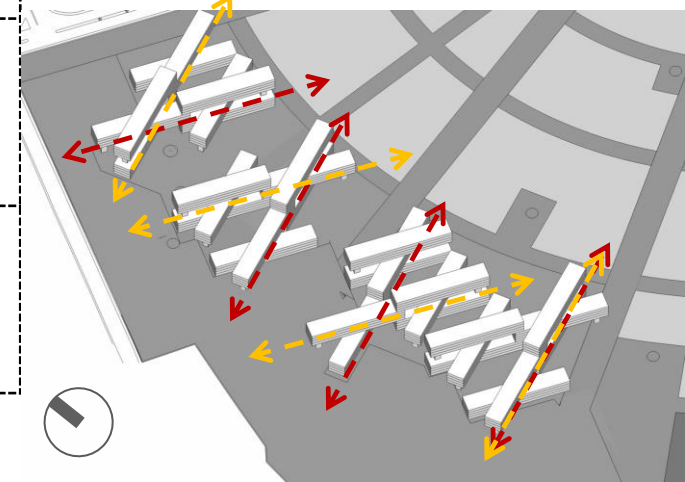
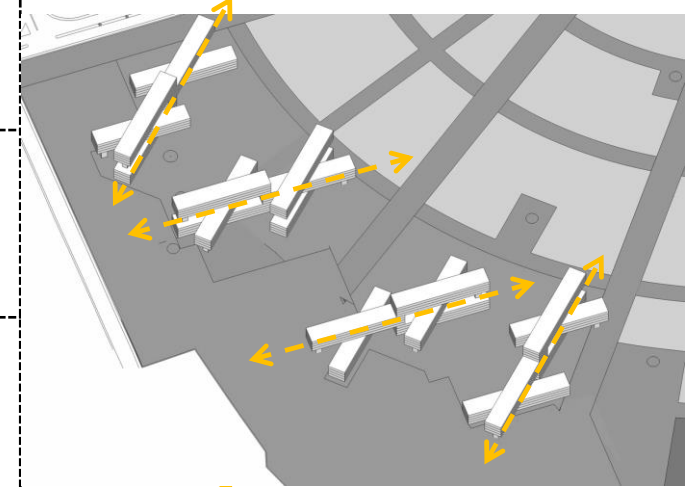
**Shadow Range:** June (9.00am – 7pm)  
Overall massing shows effective mutual shading and creation of shaded inter-building

## Inference:

- Shading is required on all orientations both on window & wall

# MORPHOLOGY

	P	Q	R	S	T	U
<b>Generation</b>						
<b>Function</b>						
Mirror along X axis	<b>P1</b> 	<b>Q1</b> 	<b>R1</b> 	<b>S1</b> 	<b>T1</b> 	<b>U1</b> 
Mirror along Y axis	<b>P2</b> 	<b>Q2 = Q1</b> 	<b>R2</b> 	<b>S2</b> 	<b>T2</b> 	<b>U2 = U1</b> 
180° rotation	<b>P3</b> 	<b>Q3 = Q</b> 	<b>R3</b> 	<b>S3</b> 	<b>T3</b> 	<b>U3 = U</b> 
Mirror along X axis & 180° rotation	<b>P4 = P2</b> 	<b>Q4 = Q1 = Q2</b> 	<b>R4 = R2</b> 	<b>S4 = S2</b> 	<b>T4 = T2</b> 	<b>U4 = U1 = U2</b> 
Mirror along Y axis & 180° rotation	<b>P5 = P1</b> 	<b>Q5 = Q1 = Q2 = Q4</b> 	<b>R5 = R1</b> 	<b>S5 = S1</b> 	<b>T5 = T1</b> 	<b>U5 = U1 = U2 = U4</b> 



# ENERGY PERFORMANCE

Energy demand can be significantly reduced by designing an efficient building envelope and efficient active systems

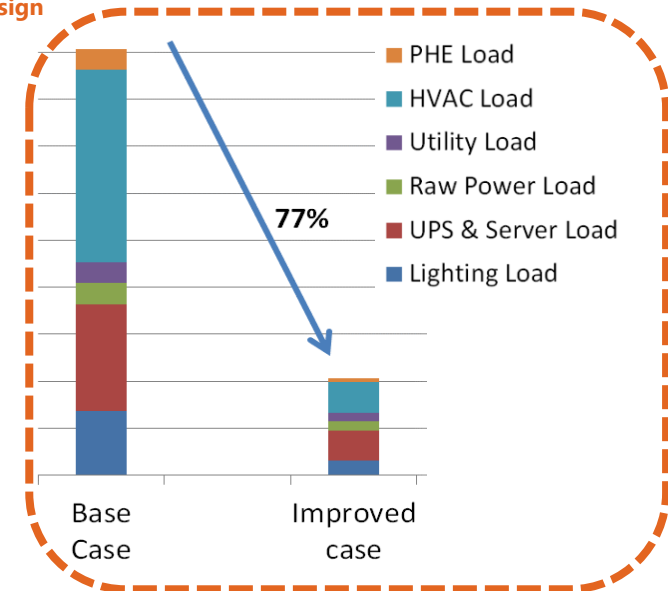
Description	Conventional Building		Improved Case	
	Load Density (W/sq.ft.)	EPI (kWh/sq.m)	Load Density (W/sq.ft.)	EPI (kWh/sq.m)
Lighting Load	1.5	37.8	0.3	7.6
HVAC Load	4.5	113.3	1.0	25.2
UPS & Server Load	2.5	63.0	0.7	17.6
Raw Power Load	0.5	12.6	0.2	5.0
Utility Load	0.5	12.6	0.2	5.0
PHE Load	0.5	12.6	0.1	2.5
<b>Total</b>	<b>10.0</b>	<b>251.9</b>	<b>2.5</b>	<b>63.0</b>

Note : EPI Calculations are carried out based on 260 annual working days (260 days x 9hours = 2340 hours) on peak loads. Average diversity of 80% will result in an EPI of 25Kwh/sq.m/yr

## PASSIVE BUILDING STRATEGY

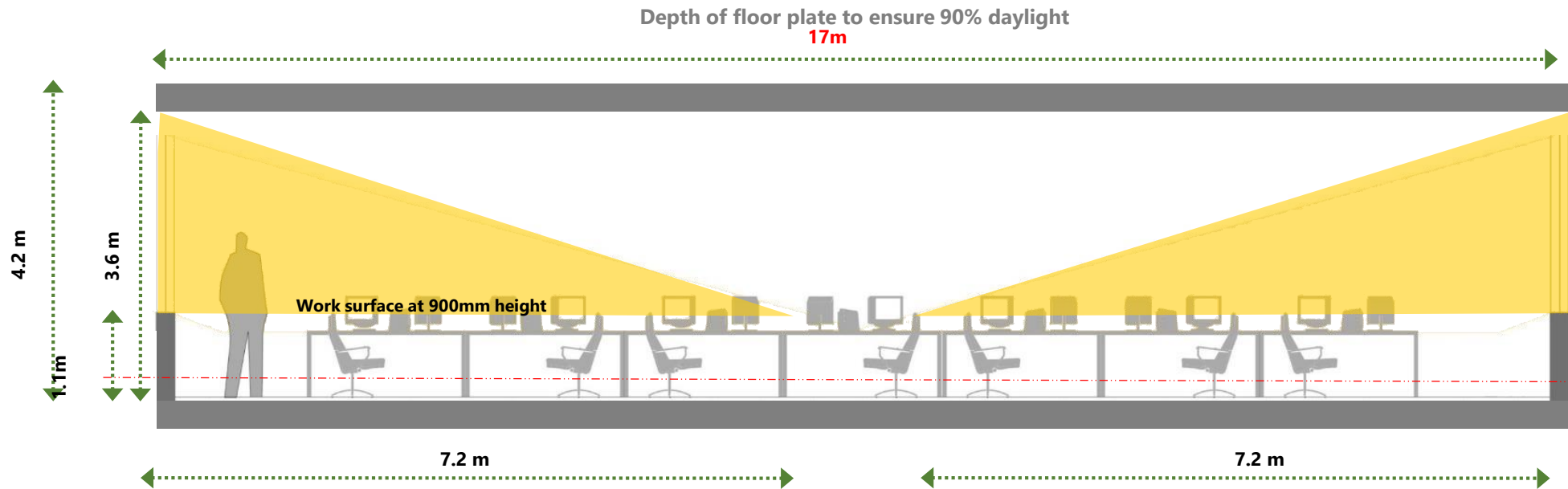
- 90% DAYLIGHT
- 90% SHADING
- NO GLARE
- NO BLINDS – CLEAR VIEWS
- EPI – 25 KWH/SQM/YR
- WWR < 30%
- ENVELOPE LOAD < 1 W/SFT

Governed by Building Design

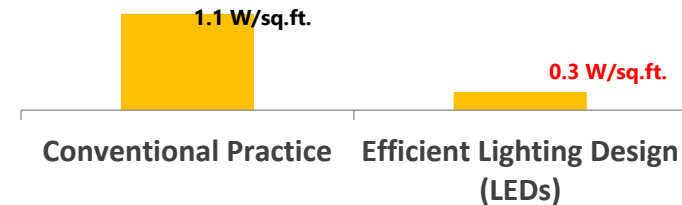


# DAYLIGHT

Efficiency Parameters	ECBC Baseline Metrics	Design Considerations
% Day-lit living spaces (from available daylight hours)	25%	90%
Efficient Lighting Design (W/sq.ft)	1.1	0.3



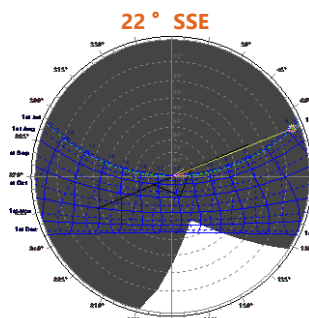
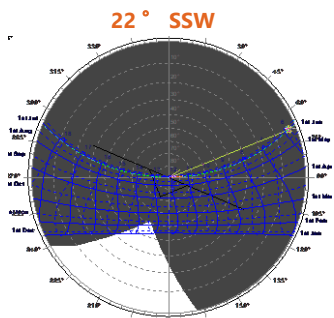
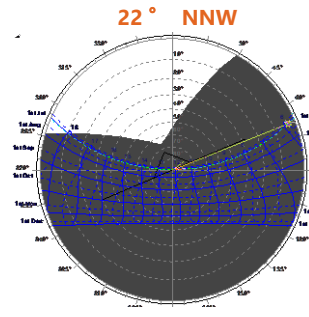
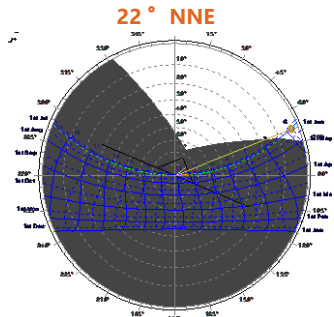
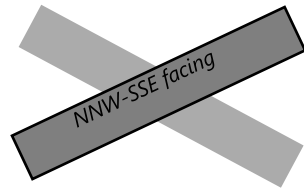
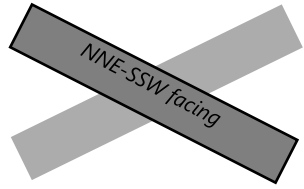
## Reduction in Lighting Power Density (W/sq.ft)



### Inference:

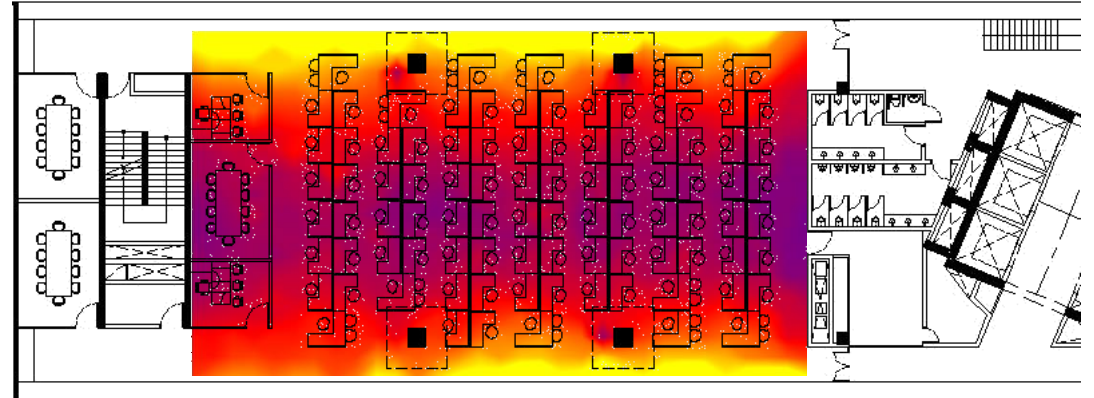
- Floor plate depth may not exceed 17m with a floor to floor height of 4.2 M
- Employing efficient lighting fixtures like LEDs can reduce the lighting load on the building by over 70%

# DAYLIGHT



Shadow analysis for Building with Shading Device  
(21.14°N, 79.09°E)

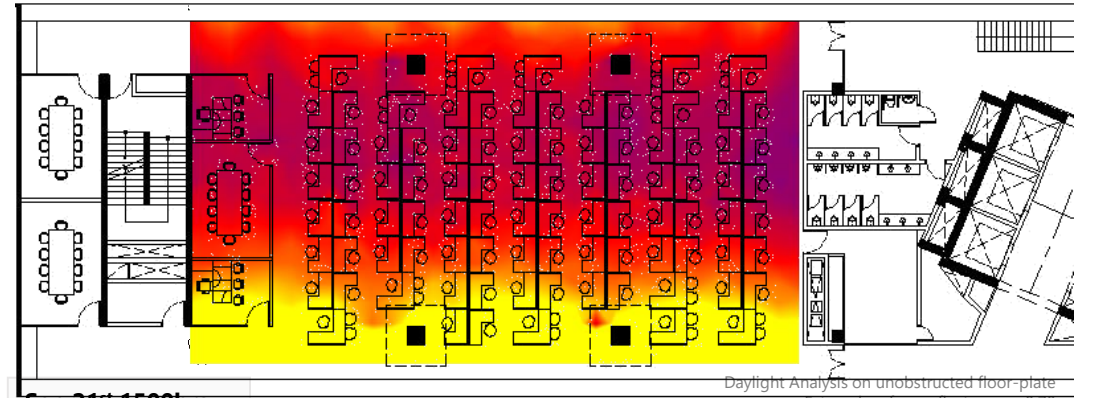
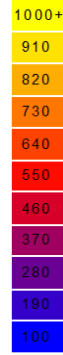
Lux



Sep 21<sup>st</sup> 0900hrs

Daylight Analysis on unobstructed floor-plate  
External surface reflectance : 0.70  
Terrace reflectance : 0.90  
Ground reflectance : 0.75

Lux



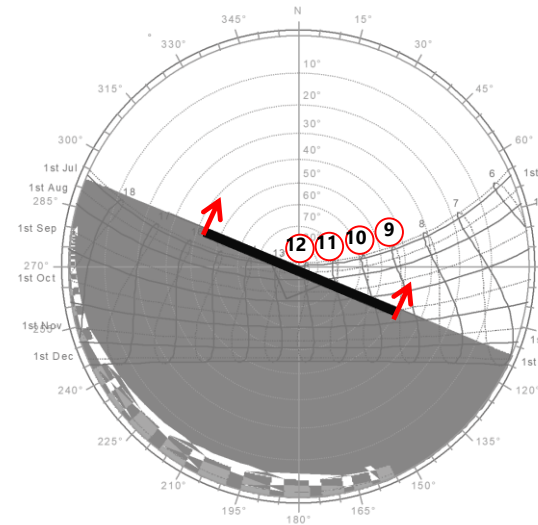
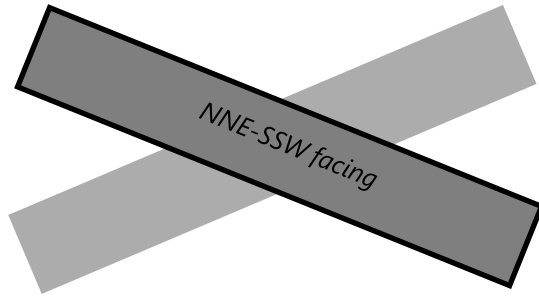
Sep 21<sup>st</sup> 1500hrs

Daylight Analysis on unobstructed floor-plate  
External surface reflectance : 0.70  
Terrace reflectance : 0.90  
Ground reflectance : 0.75

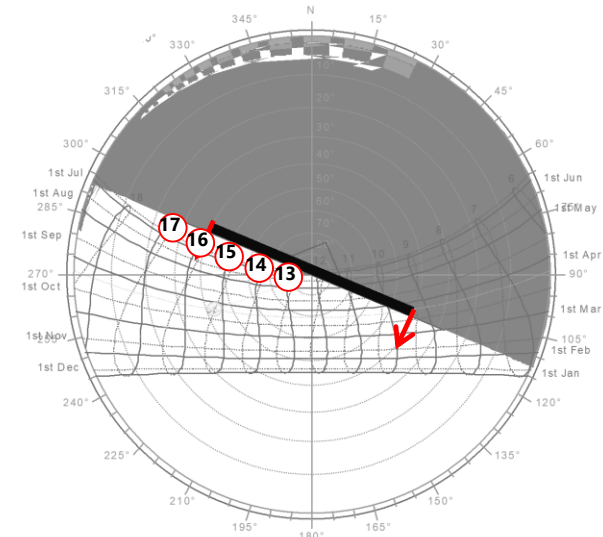
Day-light Analysis using Ecotect with Radiance  
no glare, 100% day lit workspace, uniform distribution of daylight

# SHADING ANALYSIS

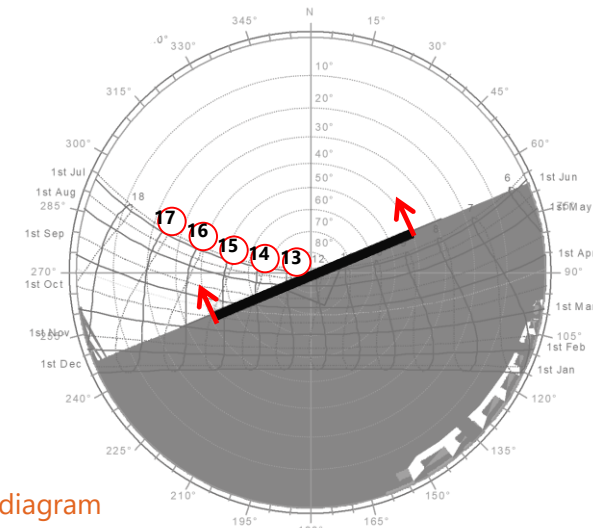
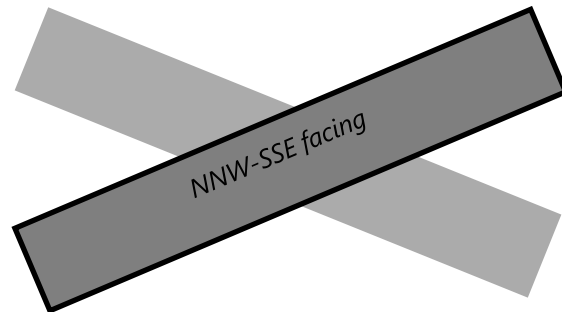
## IDENTIFYING CRITICAL TIMES FOR SHADING



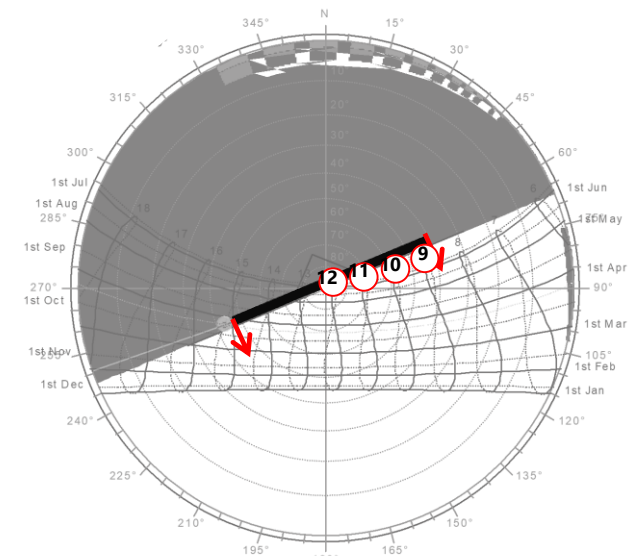
NNE Facade



NNW Facade



SSE Facade

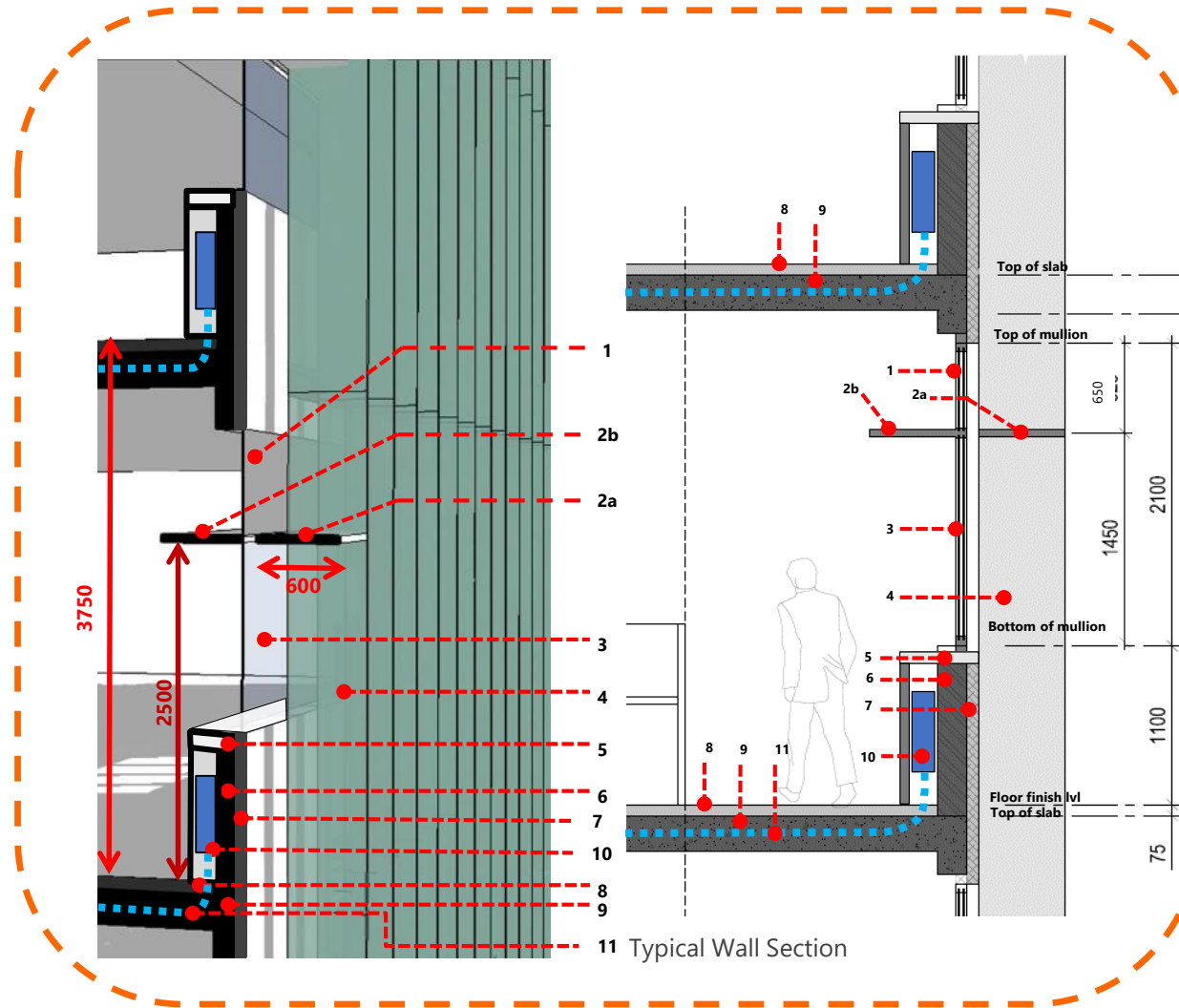
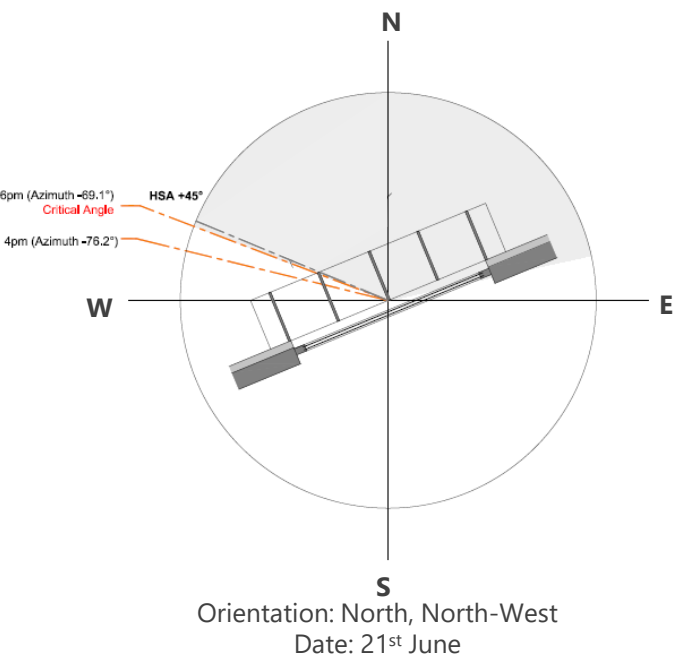
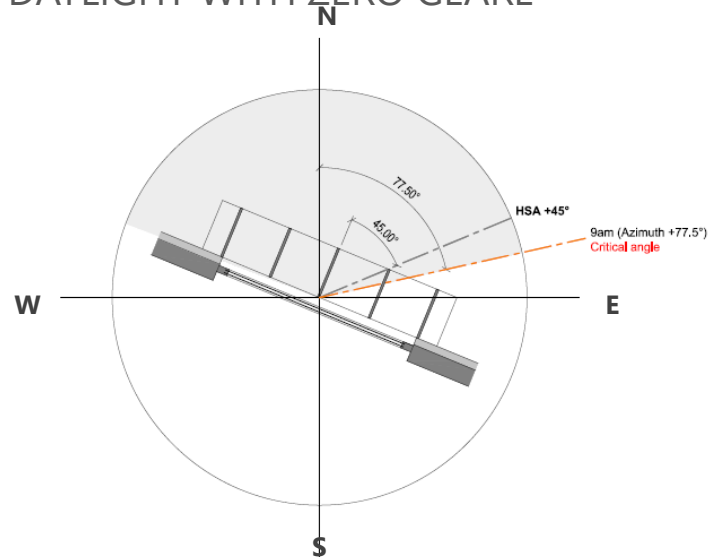


SSW Facade

Shading Analysis for peak conditions identified through sun-path diagram

# SHADING ANALYSIS

## DAYLIGHT WITH ZERO GLARE

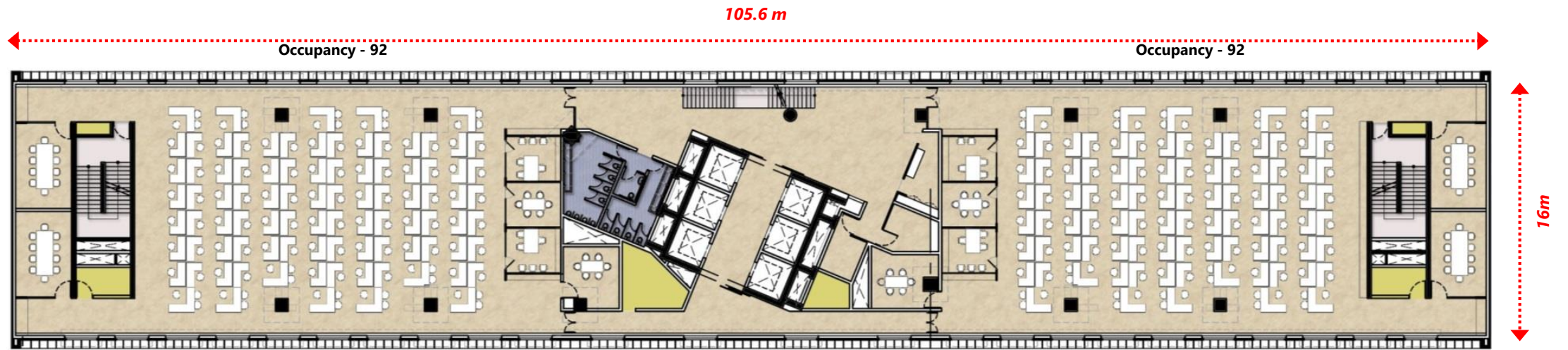


### LEGEND

1. Daylight Window (SKN: 154, frosted, LT: 40% (unobstructed floor plates), 50% (obstructed floor plates))
- 2a. 600mm deep solar shade@2100
- 2b. 600mm deep internal light shelf @2500
- 2c. 400mm Opaque panel (75mm thick insulated)
3. Vision Window (SKN: 154)
4. Vertical shading device 600mm deep @ 600mm c/c
5. RCC sill
6. Concrete block single wall (200mm thick)
7. 100mm thick exterior insulation + plaster + paint
8. 75mm floor finish (including 12mm vitrified tile, screed and raceways)
9. RCC slab (250 mm thick)
10. Manifold for Radiant Cooling
11. Radiant Cooling Piping

100 % Shading and ZERO glare

# FLOOR PLATE



Floor plate 92 + 99 (191) people; Efficiency 95 sq. ft. per person





# NET ZERO ENERGY BUILDINGS

A Modern Ayurvedic Production facility in Rishikesh

**Built Up Area :** 15,000 sq ft

**Site Area :** 5 acres

**Climate :** Cool & Humid

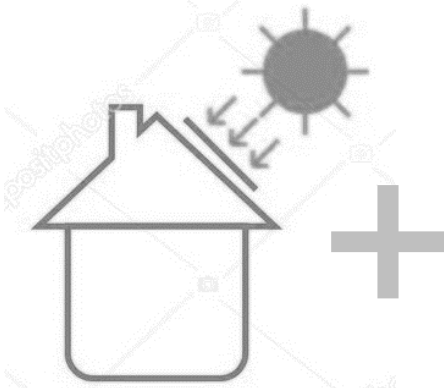
**Client :** Van Amrit

**Status :** In progress

# SOUL TARGETS



The building targets to consume 50% lesser energy than certified benchmarks.



Implementation of passive strategies in design at Site and Building level



Mixed Mode



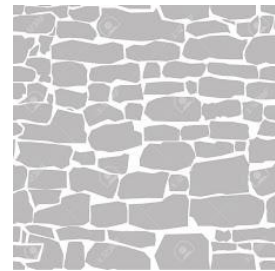
Integrating Renewable Energy systems:



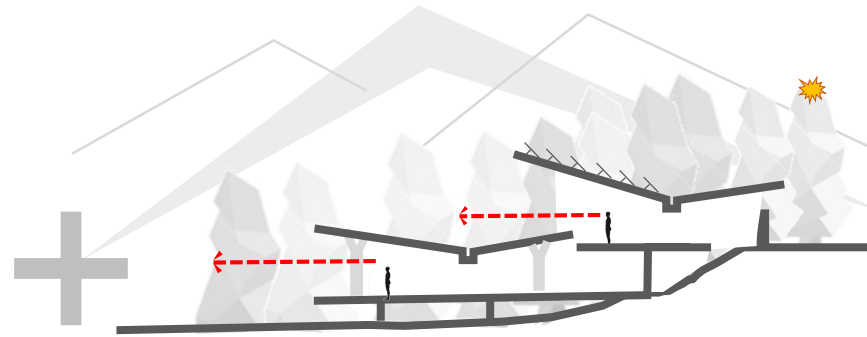
Rain water Collection + grey water recycling :



Reducing consumption of resources through design innovation and use of simplistic materials



Local Stone Masonry

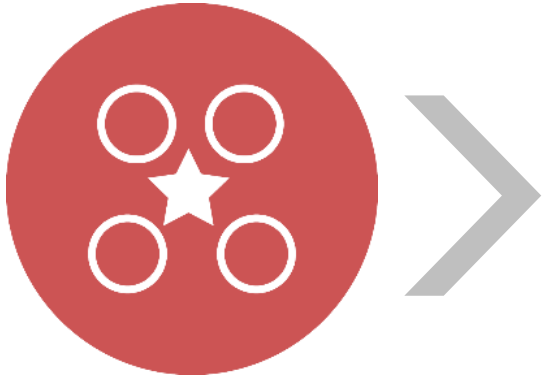


Site optimisation by working with the existing site levels into the built-form led to material reduction



Reducing on site waste

# SOUL TARGETS



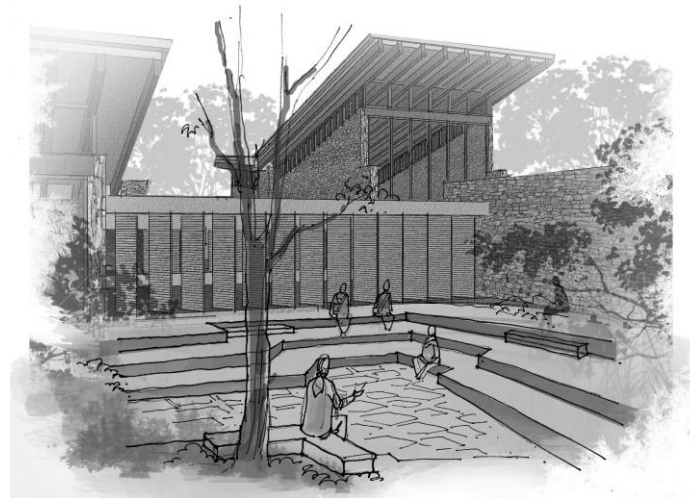
The building encapsulates the Philosophy of the company , while being homogenous to the local and global context.



The Built form inspired by the traditional Kholi form of Vernacular houses  
Creating a **MODERN VERNACULAR** where the built form *touches the Earth lightly* ( Glenn Murcutt)



Building a **user centric** interactive indoor outdoor environment



The Architecture inspires a **Community** living by creating spaces conducive of social interaction  
Supporting the local Village **community** lies at the heart and core of the project

# CARRYING CAPACITY



**ZERO WATER**

Rainwater Harvesting potential	
Site Area	8832sq.m
Annual Rainfall	1.3m
Run off Factor (including 10% evaporative losses)	50%
<b>a). Rainwater Potential of site</b>	<b>5740.8Cu.m</b>
Terrace Potential	684sqm
Annual Rainfall	1.3m
Run off Factor (including 10% evaporative losses)	90%
<b>b). Rainwater Potential of Terrace</b>	<b>800.28Cu.m</b>
<b>Annual Water requirement for factory</b>	<b>1053Cu.m (45lpcd as/NBC)</b>
<b>Water requirement for irrigation of entire site</b>	<b>9671.04Cu.m (3l/sqm for lawn )</b>
<b>Total Water Demand</b>	<b>10724.04Cu.m</b>
<b>Inflow to STP</b>	<b>842.4 Cu.m</b>
<b>Outflow to STP(85%)</b>	<b>716.04Cu.m</b>



**ZERO ENERGY**

Parameters	Notes	
Site Area	8832	sq.m
Total Built-up area	1400	sq.m
Target EPI for Factory	45	kWh/sq.m./yr
Total Annual energy consumption	63000	kWh
Required installed capacity of solar PVs	42	kWp (@ 1500kWh energy generated annually per 1kWp of installed capacity)
Area required for installing solar PVs	335	Sq.m (@ 1kWp for every 8sq.m.)

**Harvesting Solar Energy by installing PV panels roof**

**Terrace Rainwater Collection + Grey water recycling = Water demand of factory**  
**Rainwater collection from site used to suffice demand for part irrigation and RO**  
**Plant water supply**



# CONCEPT

The site is punctuated with various trees. However a lone tree stands proud in the flat part of the site which is also the most workable zone. **This tree seems like an apt starting point for the development**



The Lonely tree



Caspar David Friedrich, *The lonely tree*, 1822, Alte Nationalgalerie, Berlin



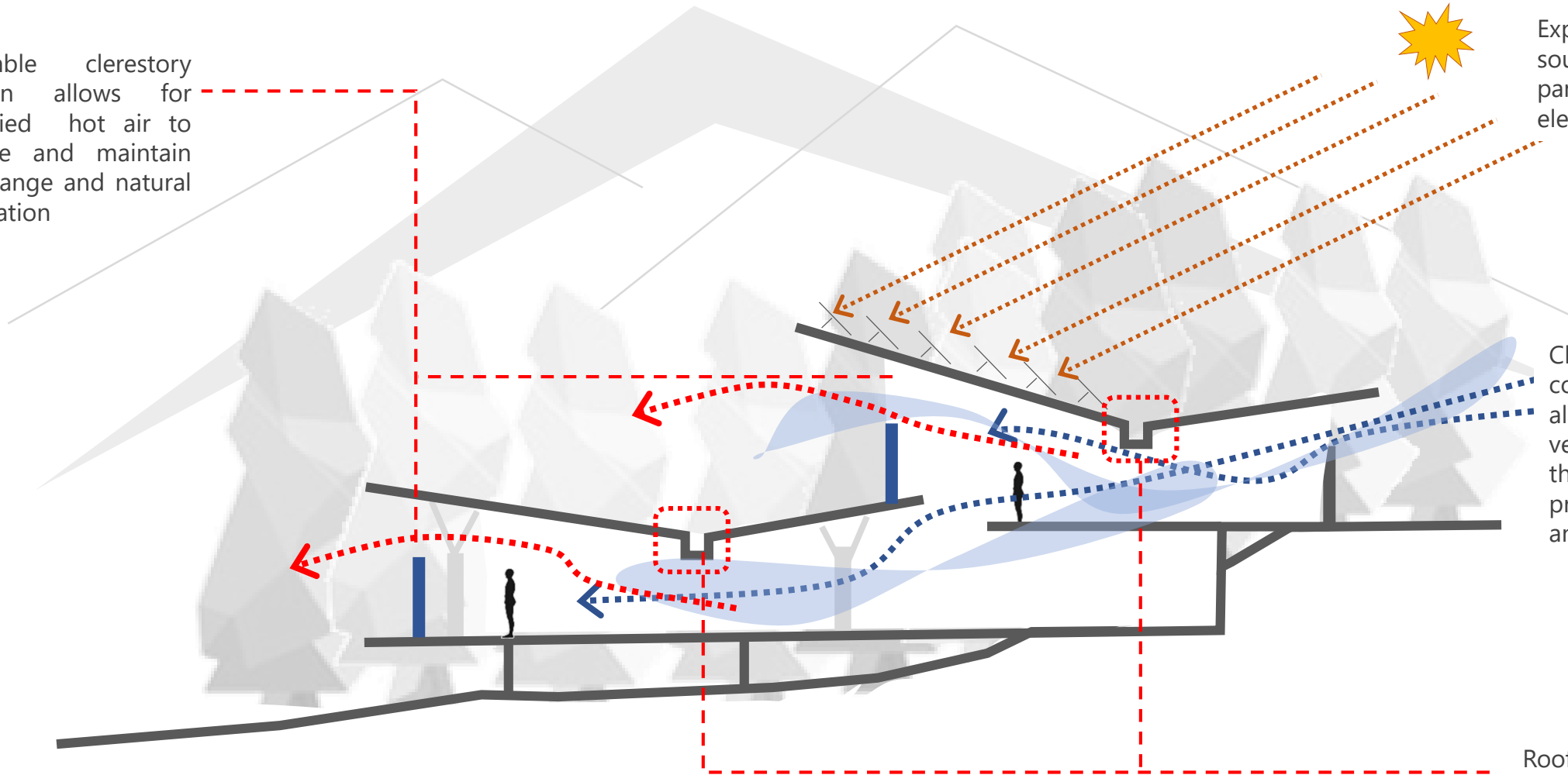
# ENVIRONMENTAL SECTION

Operable clerestory section allows for stratified hot air to escape and maintain air change and natural ventilation

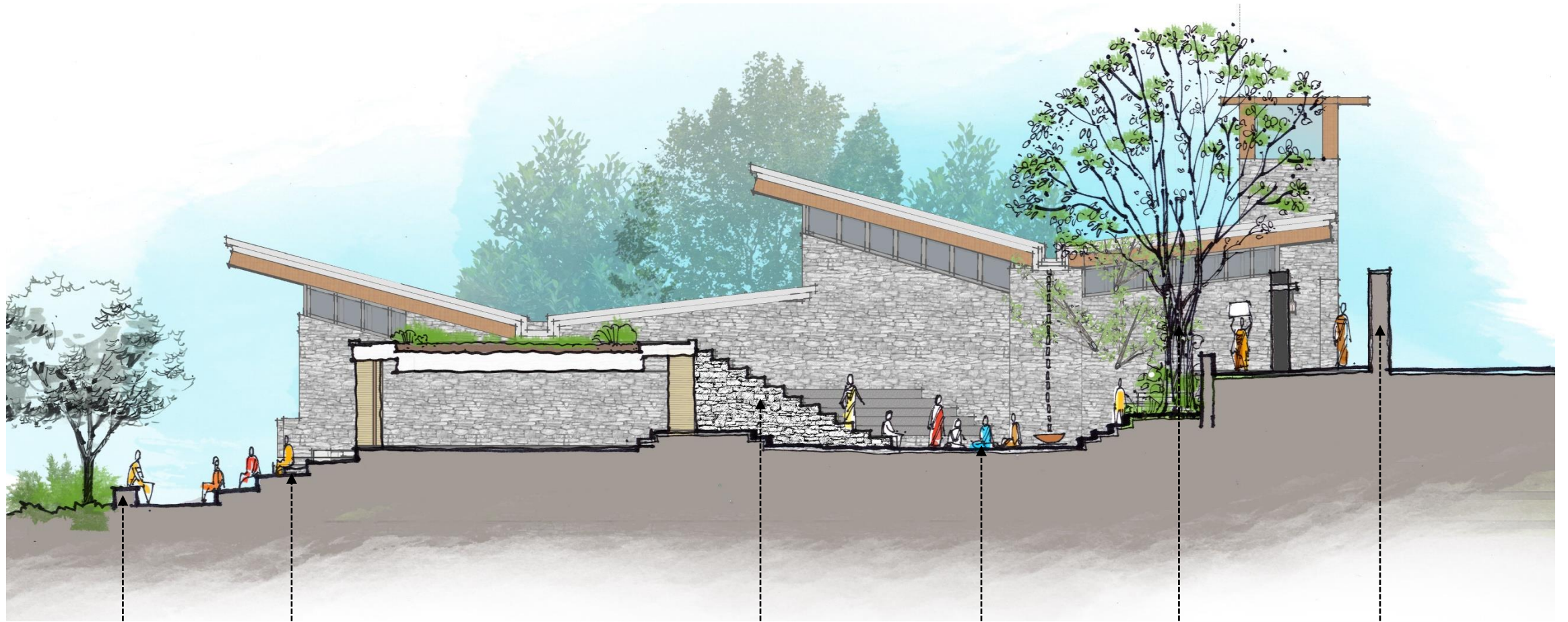
Exposed roof to the south to install Solar panels for on site electricity generation

Clerestories with controlled opening allow for cross ventilation and are in the direction of prevailing summer and monsoon winds

Roof acts as water collection vessels which channel water



# SECTION



Seating  
under a tree

Seating steps made of  
Rough cut stones in traditional  
manner

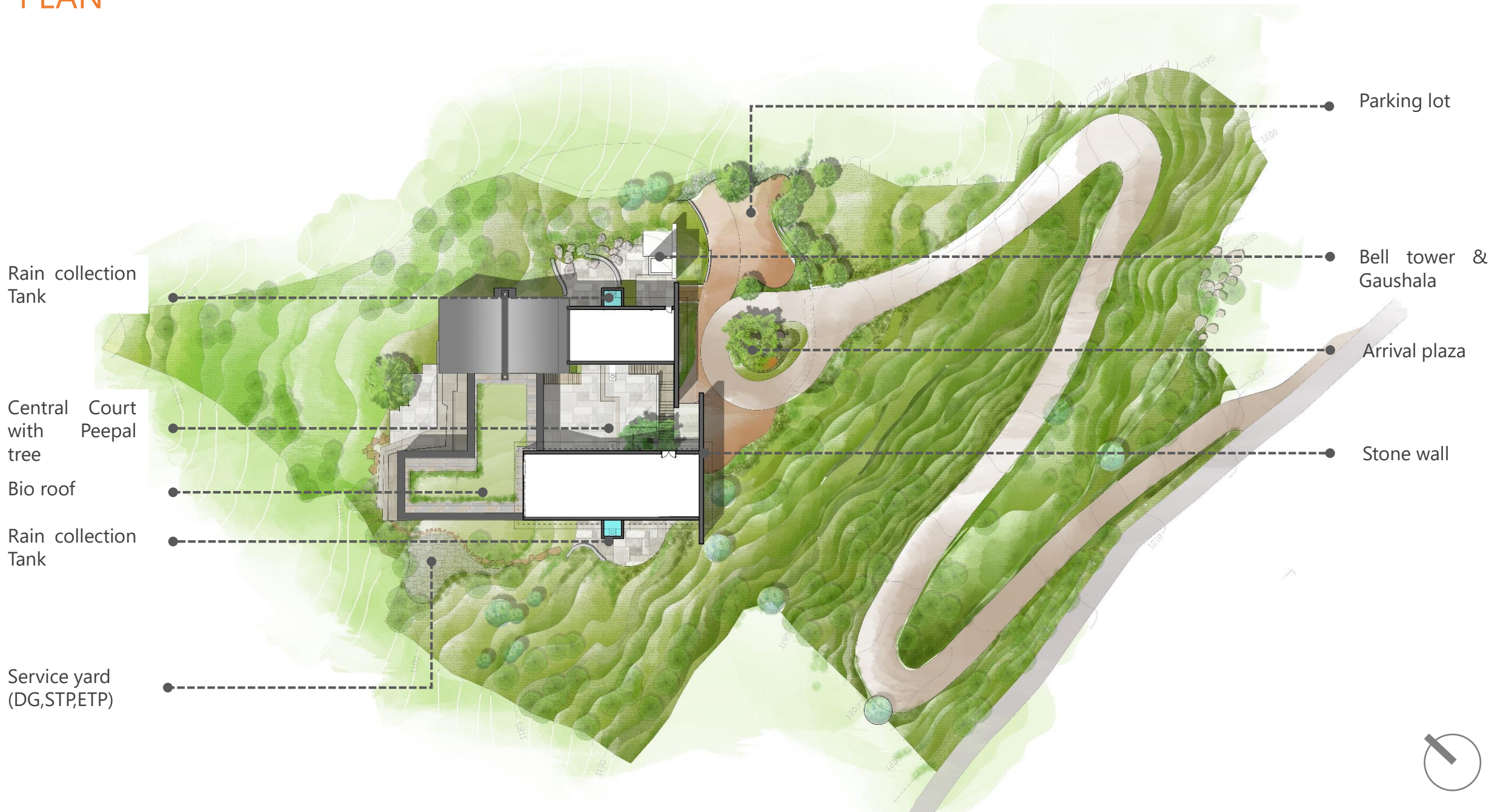
Steps to access  
roof garden

Community  
courtyard

Existing tree

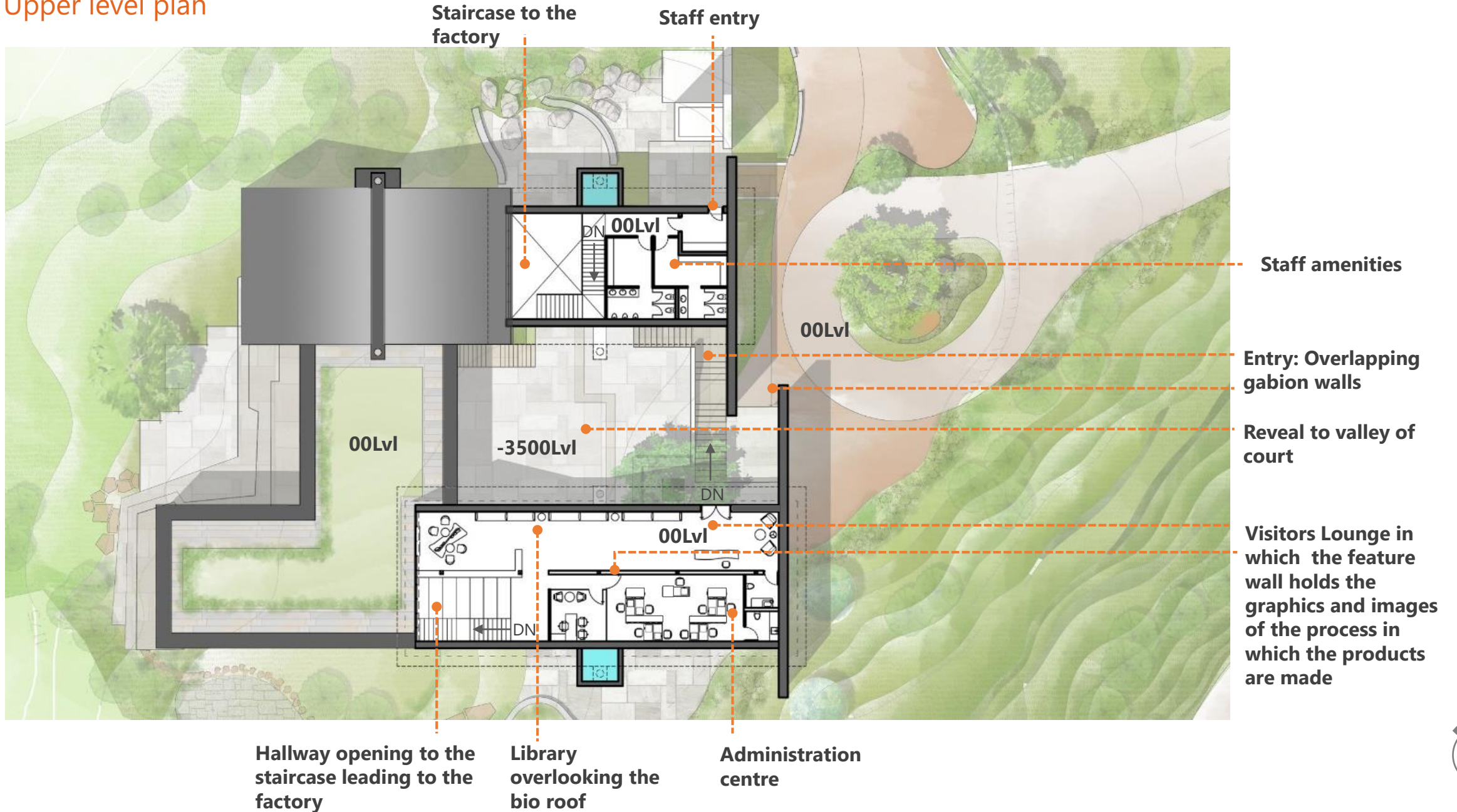
Entry through  
gabion walls

# PLAN



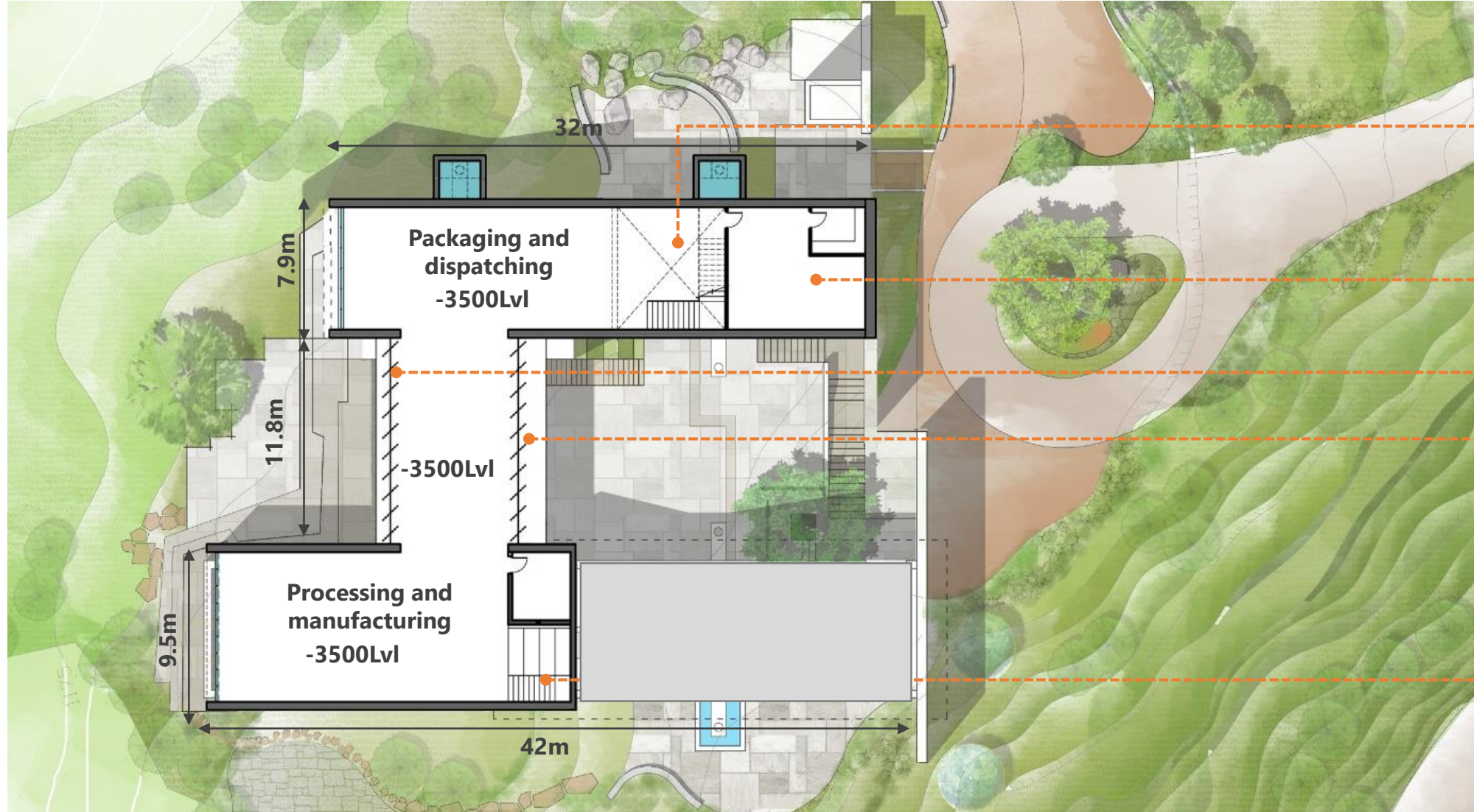
# PLAN

## Upper level plan



# PLAN

## Lower level plan



Double height staircase area for factory workers

Lunch Room and Pantry for factory staff

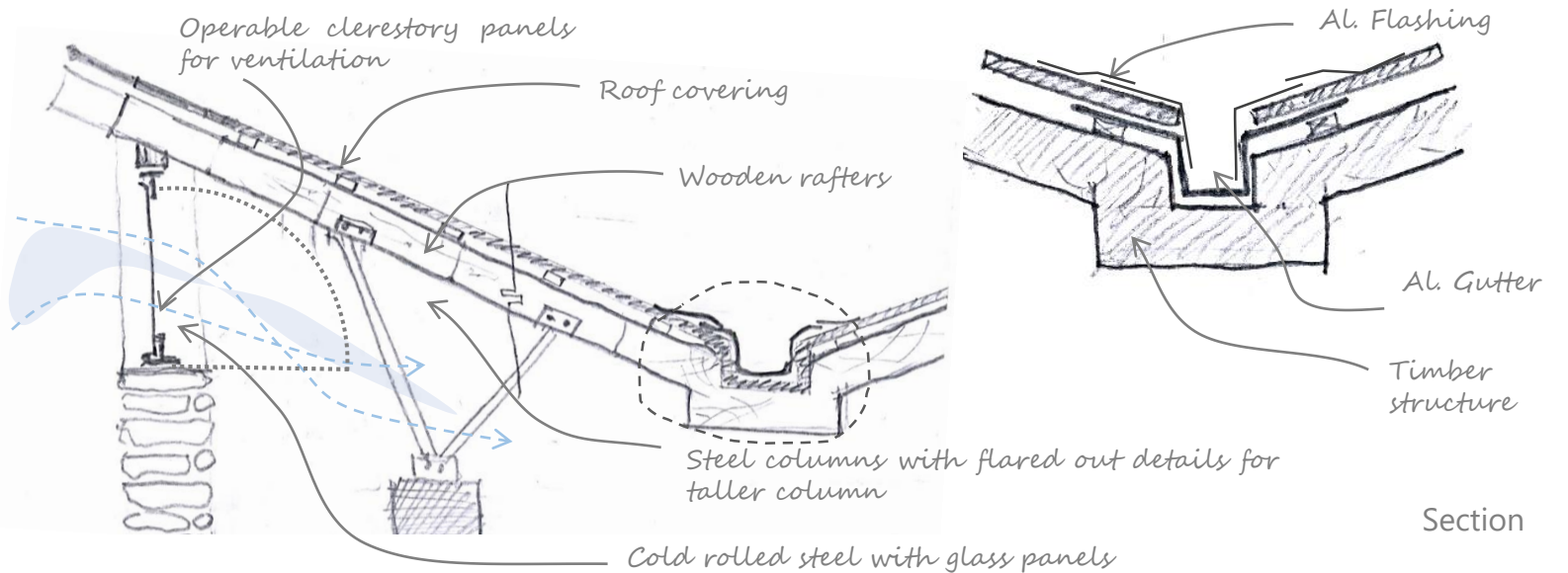
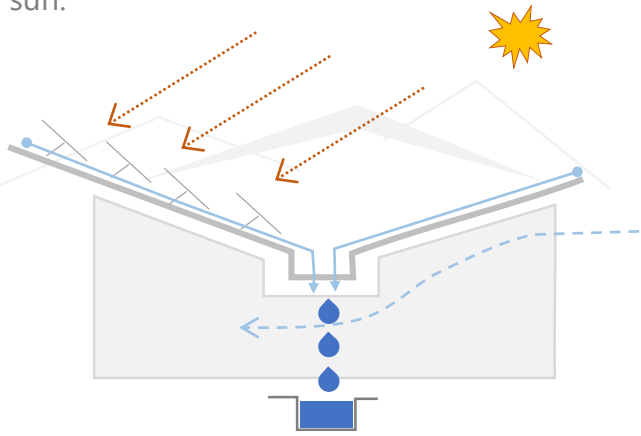
Wicker pivot panels which connect the landscape with the interior space and also allow for ventilation

Staircase leading to the factory for the visitors and administrative staff.



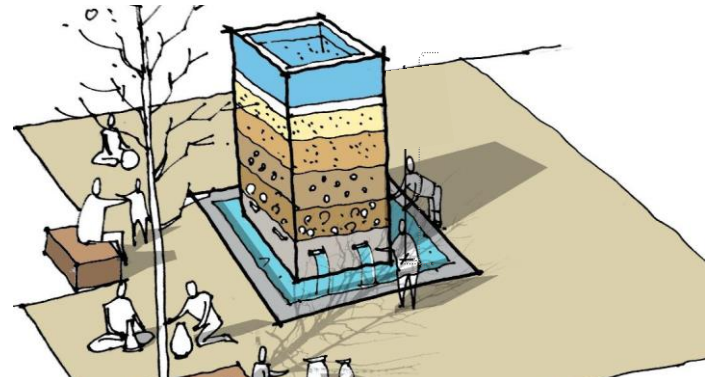
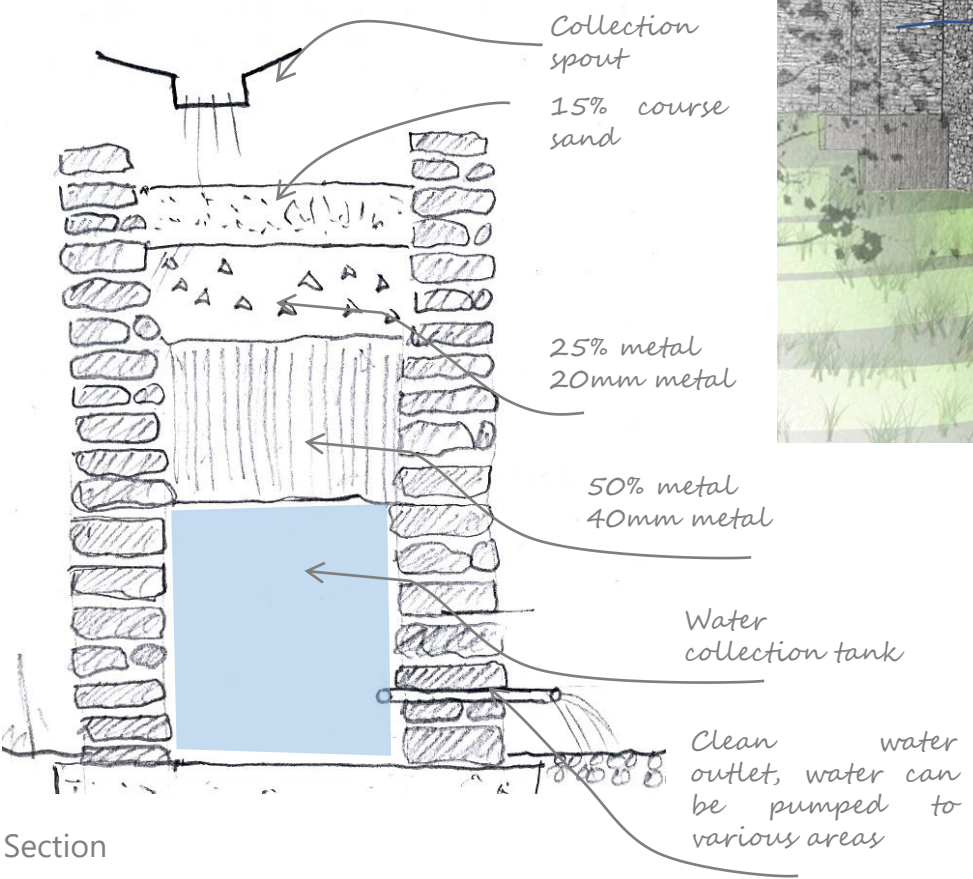
# ROOF AS A SOLAR AND WATER COLLECTOR

The roof form is developed in a flight format which is not only intended to lend the building a dynamic form visible from afar but also has environmental motives of collecting rain water and generating energy from the sun.

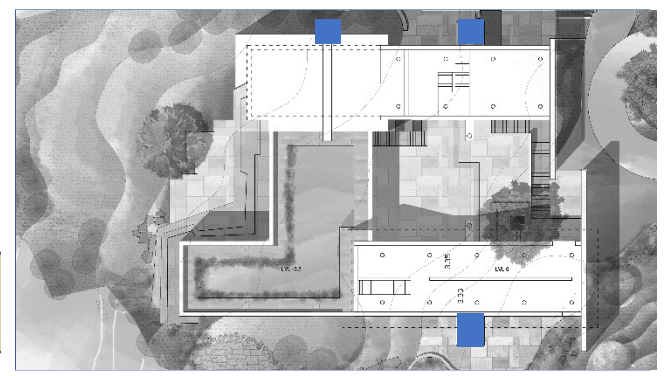


# WATER COLLECTION

A water filtration chamber has been created within the wall forming a natural filtration tank., which not only collects the rainwater but passes it through the varies filter layer ( sand and gravel). The filtered water is collected in the tank built and reused



Rain Water filtration chamber as landscape feature



Key plan with locations

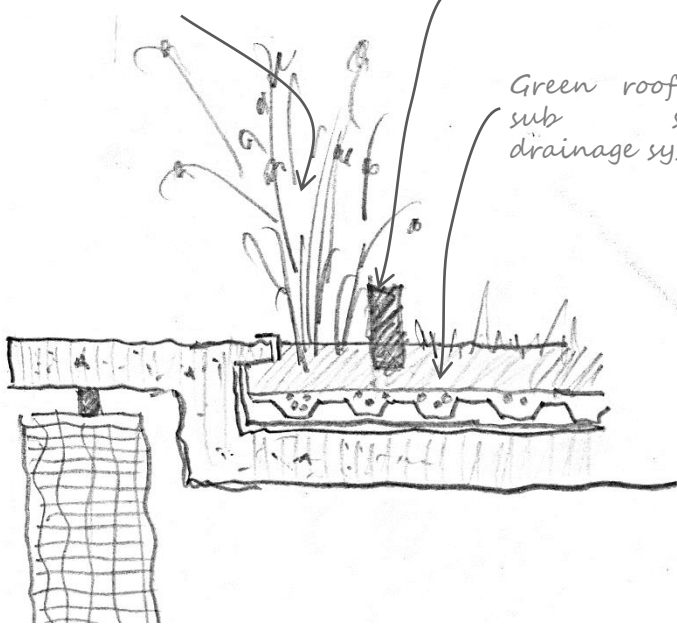
# GREEN / BIO ROOF

Designing with natural topography gives us accessible roof which merge with landscape with a bio diverse roof. Planter boxes with feral plantation edge the roof to form a natural parapet

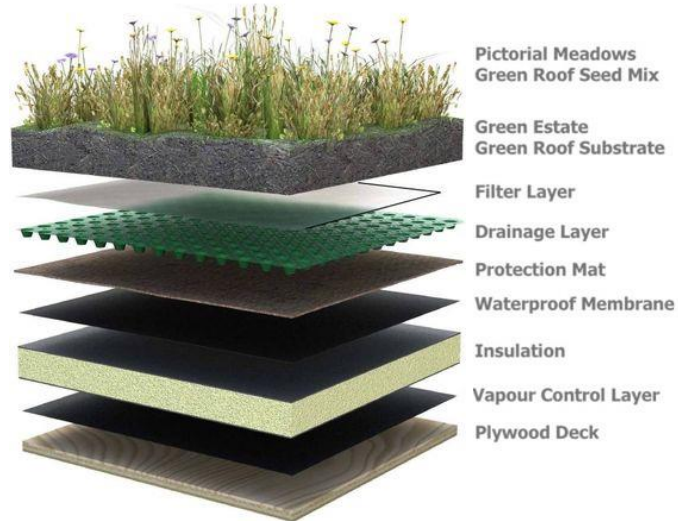
*Planted Edge with wild grass to form a parapet like edge*

Kerb edge

*Green roof with sub surface drainage system*



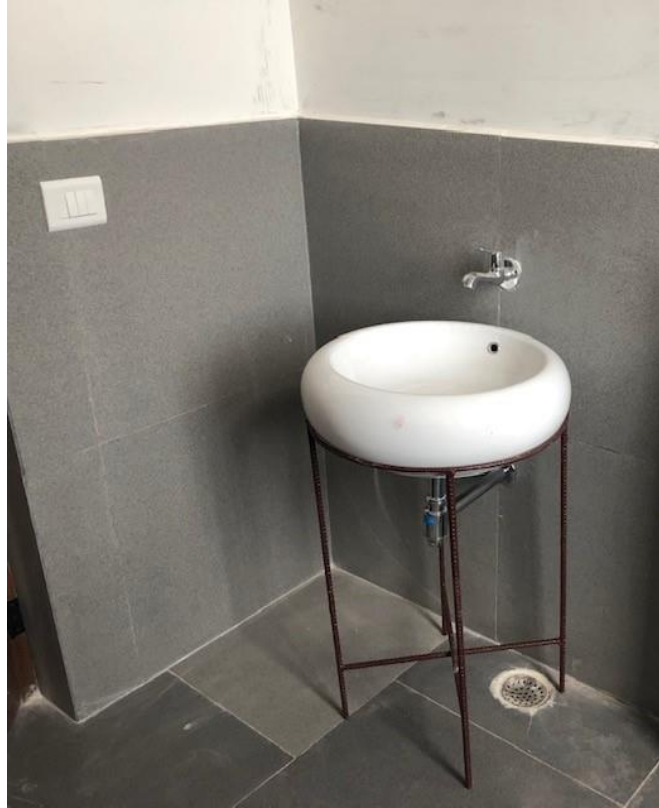
Section



# SITE IMAGES



# NO WASTE



INSTALLED CAPACITY

OUTPUT OF 1 KwP

TOTAL GENERATION PER YR

COST PER kWp

TOTAL INVESTMENT

65 kWp

1,410 kWh

91,650 kWh

Rs. 45,000

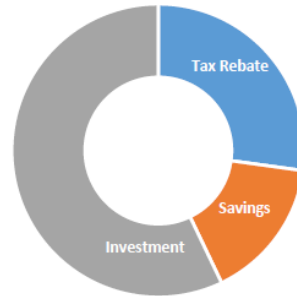
Rs. 29,25,000

Electricity from Diesel costs  
**2.5 times**  
that of solar electricity

₹14 to ₹18 per unit. In comparison, solar tariffs cost around ₹5- ₹7 per unit generated – resulting in substantial savings on your diesel bills.

**23%**

of your investment in the first year



**SAVING IN 25 YEARS**  
**Rs. 9.14 Cr**



**SAVING IN 25 YEARS : 9.14 Cr**

*( Assuming a rate increase in grid )*

Opex model : Investment Saving 55%

**ROI : 3.75 YEARS**

# NET ZERO ENERGY BUILDINGS

Institute for Integrated Learning in Management

**Built Up Area :** 1,75,000 sq ft

**Site Area :** 8 acres

**Climate :** Composite

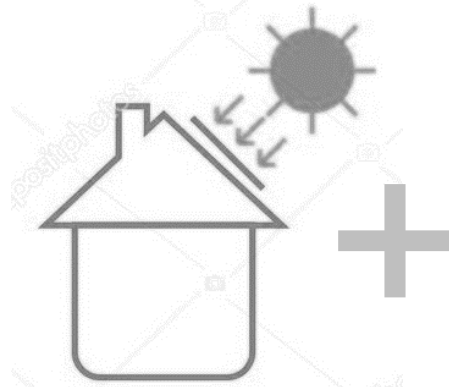
**Client :** IILM

**Status :** Built

# SOUL TARGETS



The building targets to consume 50% lesser energy than certified benchmarks.



Implementation of passive strategies in design at Site and Building level



Mixed Mode



Integrating Renewable Energy systems:



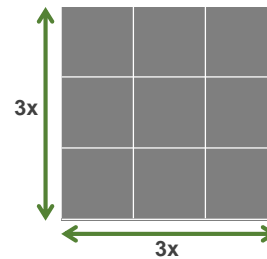
Rain water Collection +grey water recycling :



Reducing consumption of resources through design innovation and use of simplistic materials



Use of simplistic and readily available materials

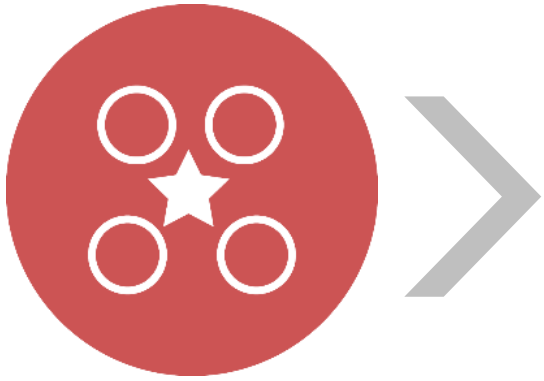


Typical modularity



Reducing on site waste

# SOUL TARGETS



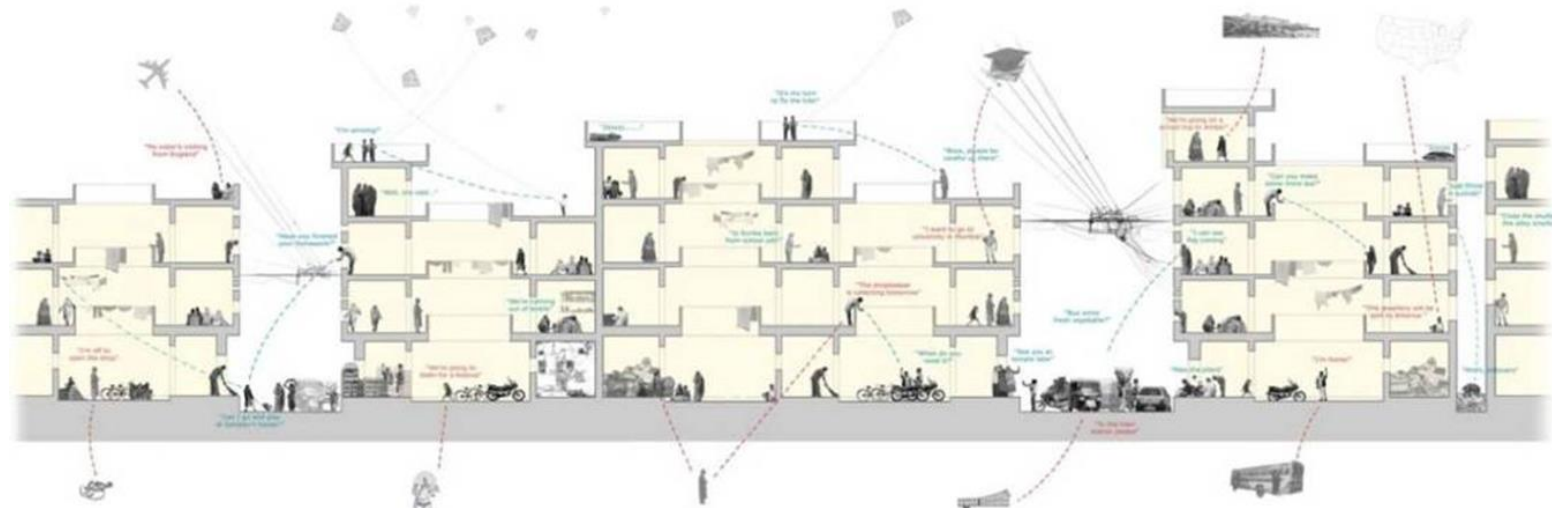
The building encapsulates the Philosophy of the school, while being homogenous to the local and global context.



Drawing inspiration from **THE WALL CITY** to create a **student's community**. A street pattern on a grid is used to generate the built volumes. Carving out voids at different levels creates a multitude of open spaces.



Building a user centric interactive indoor outdoor environment



The Solid Fort like perimeter with an introverted morphology creates a **SAFE** environment for students with **"Eyes" on all spaces No Dead-ends**.

# CARRYING CAPACITY

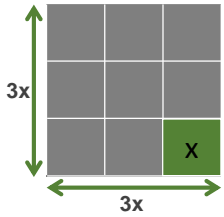


Particulars	Water requirement	
<b>A Rainwater Harvesting potential</b>		
1 Site Area	32,000 sq.m	
2 Annual rainfall	0.617 M	
3 Evaporation Losses	10%	
<b>Rainwater Harvesting potential</b>	<b>17,800</b>	<b>cu.m. /yr</b>
<b>B</b> Daily water requirement per person (35% Improvement over NBC i.e, 135 lpcd)	90	lpcd
<b>Total Annual requirement per person (@300 days occupancy)</b>	<b>27</b>	<b>cu.m. /yr</b>
<b>C</b> Carrying Capacity		
<b>Carrying capacity of site for water demand</b>	<b>660</b>	<b>people</b>



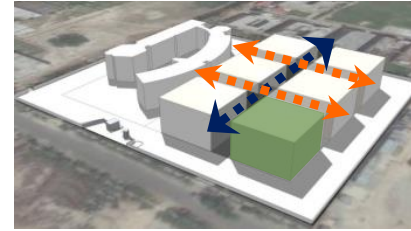
Particulars		
<b>A Carrying capacity for people</b>	<b>660 people</b>	
1 Site Area	32,000 Sq.m	
2 Ground Coverage (GC) @35%	11,200 Sq.m	
3 Roof Area available for Solar panels = GC	11,200 Sq.m	
4 Solar PV installation potential of roof (@1kWp per 15sq.m.)	750 KWp	
5 Total annual energy generation potential of solar PV (1kWp expected to generate 1500kWh annually)	11,20,000 KWh	
<b>B Built-Up area @ 30sq.m. per person</b>	<b>19,800 Sq.m.</b>	
<b>C Target EPI for IILM</b>	<b>56 Wh/sq.m./yr</b>	

# MORPHOLOGY



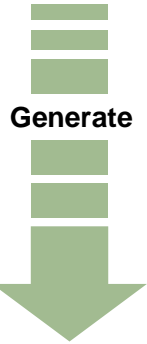
## Typical Module

Buildable boundaries generated from site and climatic parameters. Distributing the built-up equally, the result was a module 32M x 32M x 19M



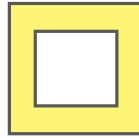
## Creating visual and physical planning axes

The building zone divided into 6 equal modules with an integrated pedestrian network



## Objectives :

- Daylight
- Solar control



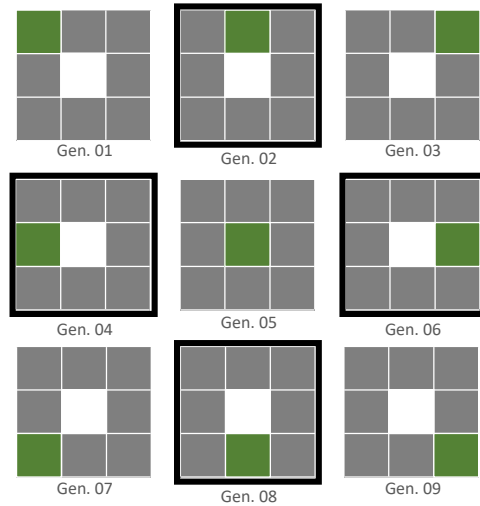
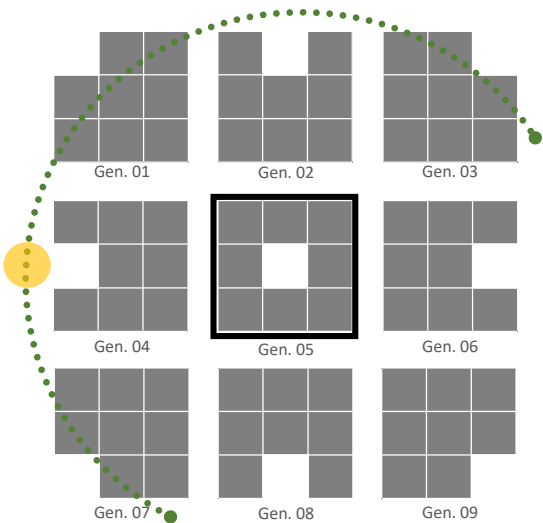
**Narrow Floorplate**  
Daylight + Cross Ventilation



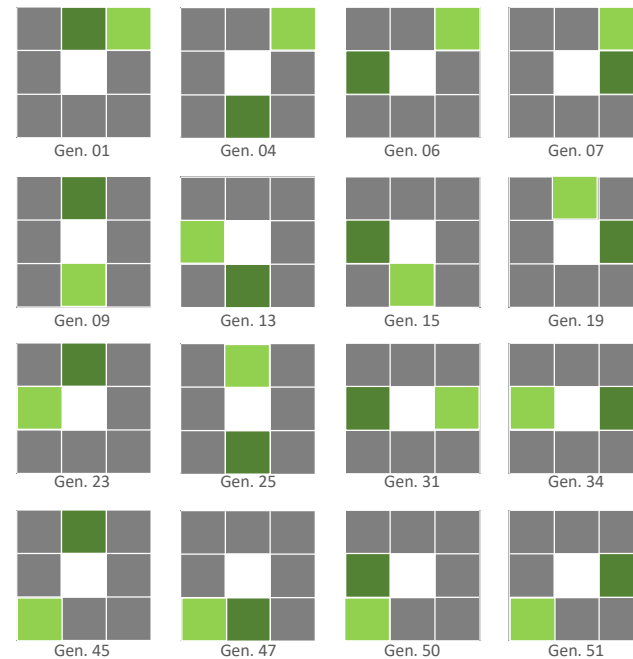
**Courtyard**  
Controlled Microclimate



**Staggered openings** Enhanced air-movement



Identifying the most suitable location for vertical connection



Introducing voids in the built-form to enhance air-movement within the courtyard and hostel units

## Objectives :

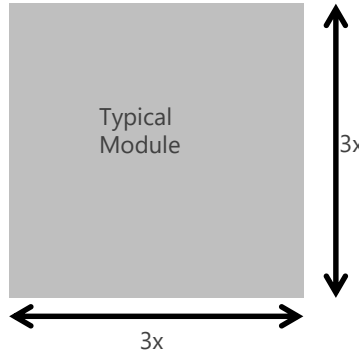
- Security
- Energy (56kWh/sqm/yr)
- Daylight
- Solar control
- Natural Ventilation
- Microclimate

Creating a courtyard surrounded by a narrow floorplate for daylit indoors and comfortable outdoor spaces

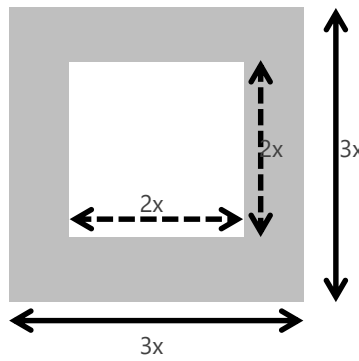
**Targeting 10°C reduction in perceptible temperature**

# MICROCLIMATE

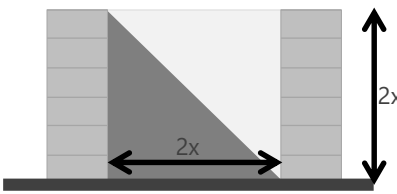
## SHADED COURTS | "EYES" ON ALL CIRCULATION AREAS



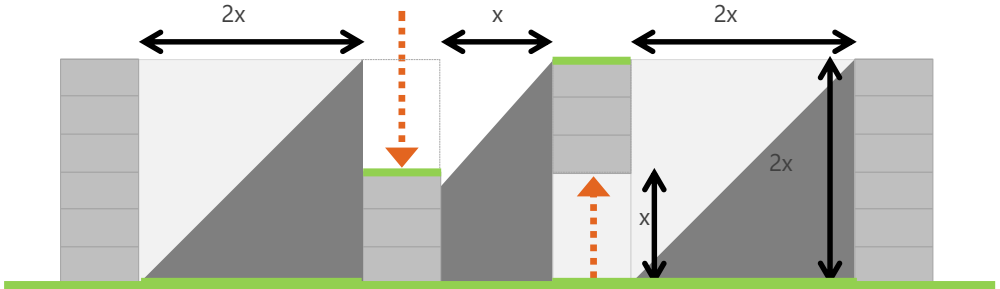
1. Typical Module  
Buildable boundaries generated from site and climatic parameters. Distributing the built-up equally, the result was a module measuring 32M x 32M x 19M



2. Introducing Central courtyard  
Opening up the block internally to create protected interactive spaces while allowing dual aspect floorplates



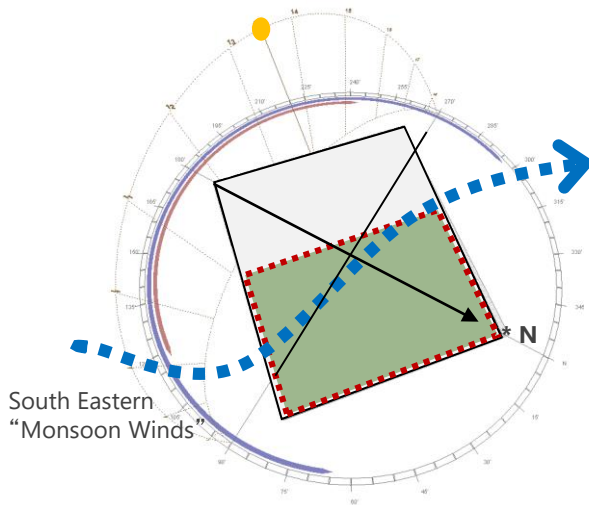
3. Stack Effect  
A 1:1 proportion of central open space is optimal in improving air movement as well as creating a well shaded courtyard



Creating a Network of Interactive Spaces  
Maintaining a visual connection between interactive spaces while allowing for semi-private terraces



Generating typical modules by balancing Built vs Open proportions







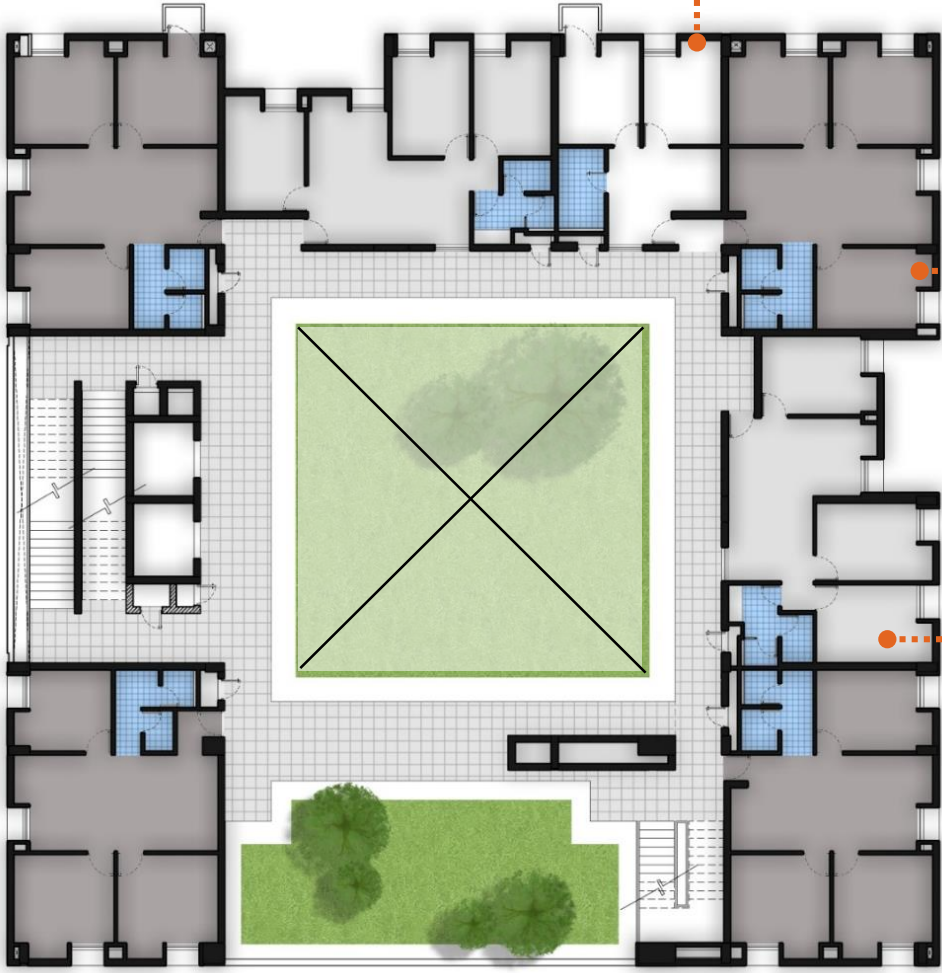
South Eastern "Monsoon Winds"

# FLOORPLATE ANALYSIS

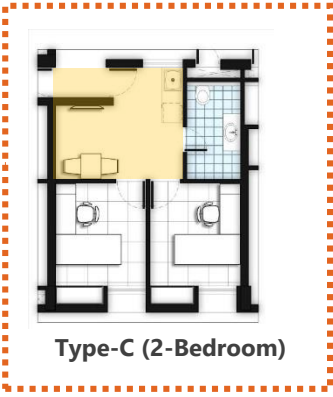
## SHARED LIVING

### LEGEND

	UNIT- TYPE - A
	UNIT- TYPE- B
	UNIT- TYPE- C
	TOILETS



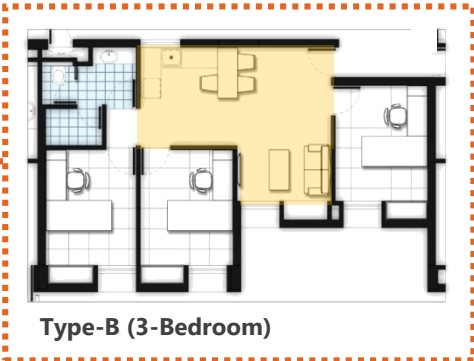
First Floor-Plan for Block-A



Type-C (2-Bedroom)



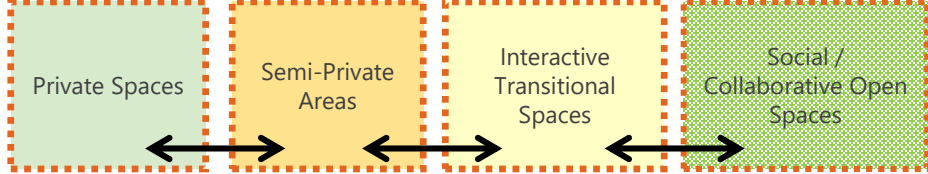
Type-A (3-Bedroom)



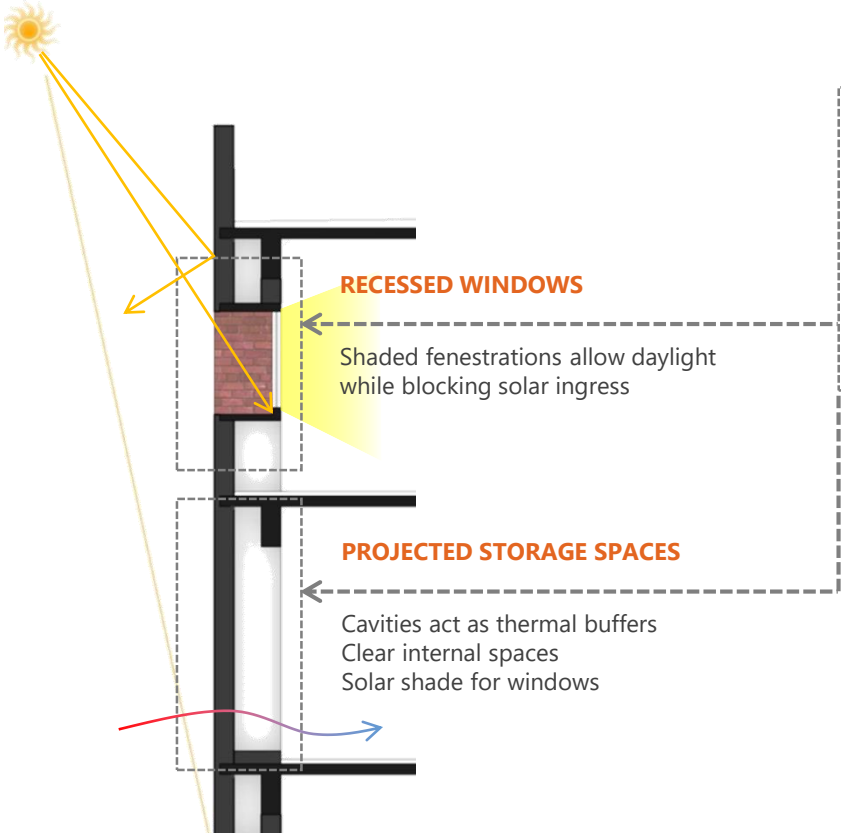
Type-B (3-Bedroom)

# FLOORPLATE ANALYSIS

## PASSIVE DESIGN



1. Linear Transition of Spaces

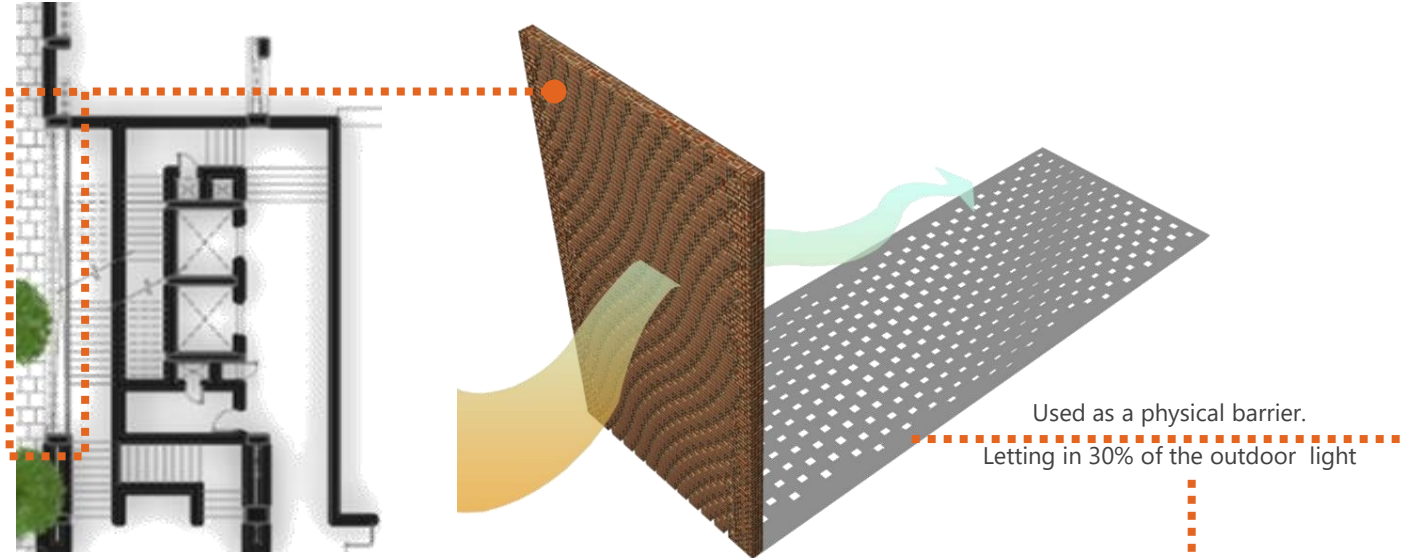


2. Façade Designed as a Thermal Buffer

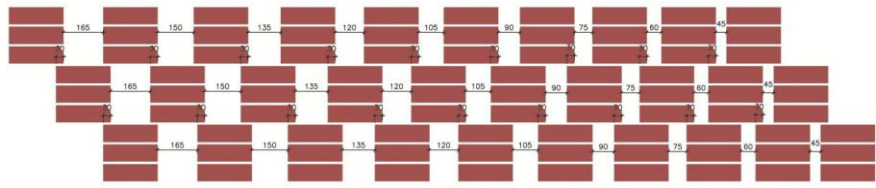
TYPICAL TYPE-B UNIT  
(3-BEDROOM)



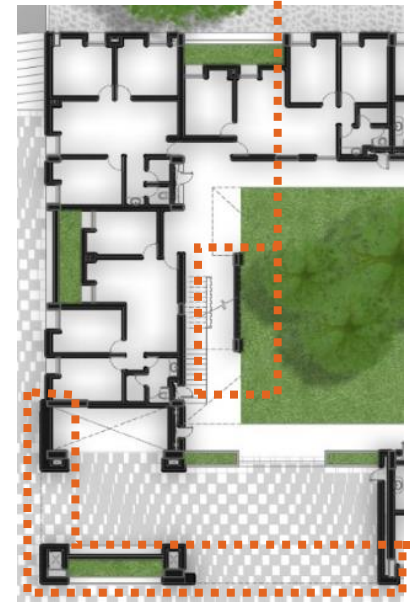
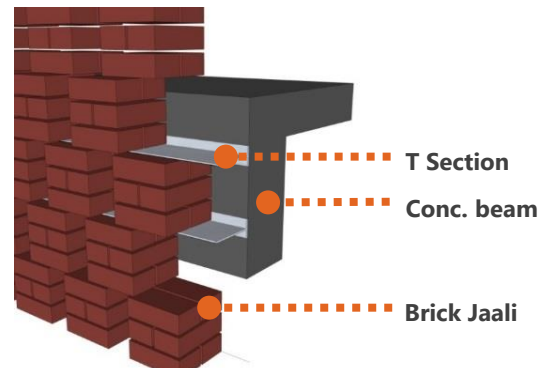
# FAÇADE DESIGN



**Brick Jaali** highlights the entrance, adding thermal mass making the inner environment relatively cooler than the outside.



Typical Jaali Module



# POST OCCUPANCY EVALUATION

13 Degree Celsius Reduction in Surface Temperature

