morphogenesis.

Sustainability : Affordability : Identiy : Liveability

The 3rd Skin : Shelter *– Air, Water, Light, Thermal Comfort, Access*









Challenges faced by Urban India

TIMES CITY

THE TIMES OF INDIA, NEW DELHI
THURSDAY, APRIL 22, 2010

Power cuts trigger water shortage in Gurgaon

TIMES NEWS NETWORK

Gurgaon: Even as the Millennium City continues to reel under long and unscheduled power cuts, an acute water shortage has made life even more difficult. The situation is bad not only in DLF City, Sushant Lok and Palam Vihar but also in HUDA sectors and old parts of the city.

"In DLF city, about 65% households get water supply through canal water which comes from Basai while the rest get water through their own boring. Now that the supply is erratic, we are facing lot of trouble in this peak summer season," said R S Rathi, president, Gurgaon citizens' council.

"For the last 10 days, we are forced to manage with whatever little water we have. Most of the times we are compelled to buy water from water tankers who have raised the prices in wake of high demand," fumed Mala Verma, a resident of C block, Sushant Lok. Meanwhile HUDA officials claimed that problem had arisen because of damaged Basai pipeline — which is main source of water supply to the city. Officials however claimed that the normal supply of 60 MGD water was badly hit. "We are currently supplying 45 MGD water against the demand of 50 MGD and we do understand that residents are suffering because of the water shortage. Also, due to power outages sometimes pumps do not work hampering the water supply. We hope to overcome the problem in a few days," said a senior HUDA official. He added that the problem was fixed on Tuesday but pipeline broke again on Monday and repair work is going on.

Residents, meanwhile, alleged that the maintenance of the pipeline was poor by the department because of which the people suffer every summer.

"Against the demand of over 80 MGD for the population of 18 lakh, they supply 50-60 MGD and even that is erratic because of lack of maintenance and power crisis. We are victims of government's apathy even after paying so much," Rathi rued.

toireporter@timesgroup.com

HIGH & DRY

HUDA officials claimed that damage to Basai pipeline — which is main source of water supply to the city — has caused short supply

NIFTY 6,126.25 -9.60 SENSEX 20,683.51 -23.94 DOW JONES 15,837.88 -41.23 NASDAQ 4,083.61 -44.56 ₹/$ 62.51 +0.59 ₹/EURO

hindustanti

New Delhi/METRO Vol. XC No. 25 Price ₹4.50/with Hindustan ₹8.50 (₹7.00 in Faridabad) /with Mint ₹8.00 42 pages (excl. Meerut). Area specific pgs extra.

KIWIS CRUSH INDIA IN 4TH ODI TO SEAL SERIES WIN, DHONI BLAMES PACERS ›ht sport p21

JAPAN UNVEILS ELECTRIC BIKE ›ht business p17

'ALAGIRI SAID STA KARUNANIDHI SAYS THREAT

Delhi world's most polluted city

TOXIC India slips to 155 among 178 countries on environment performance index, Capital pips Beijing to be city with dirtiest air

Chetan Chauhan

NEW DELHI: It's no surprise that pollution is a perpetual problem in India. But it's definitely disheartening to hear that India has slipped 32 ranks in the global Environment Performance Index (EPI) 2014 to rank a lowly 155 and its capital Delhi has earned the dubious tag of being the world's most polluted city.

A comparative study of 178 countries on nine environmental parameters released earlier this month by the US-based Yale University shows that one of the world's fastest growing economies is a disaster on the environmental front.

What's worse, India's pollution levels could be playing havoc with the health of its citizens. "A bottom performer on nearly every policy issue included in the 2014 EPI, with the exception of forests, fisheries and water resources, India's performance lags most notably in the protection of human health from environmental harm," said a statement issued by Yale.

The study described India's air pollution as the worst in the world, tying with China in terms of the proportion of population exposed to average air pollution levels exceeding World Health Organisation (WHO) thresholds.

A deeper look at the data gathered by a Nasa satellite showed that Delhi had the highest particulate matter 2.5 pollution levels followed by Beijing. Delhi, with 810 million registered vehicles, has repeatedly beaten the Chinese capital on particulate matter pollution.

The high PM2.5 pollution caused by high vehicle density and industrial emissions is the reason for the dense smog that has been engulfing Delhi during the winter months in the last few years, with adverse health implications. And while Beijing's infamous smog has hogged headlines and prompted government action, even led to the announcement of rewards for cutting back on pollution, the dangers in Delhi have been largely ignored.

According to a study by the Harvard International Review, every two in five persons in Delhi suffer from respiratory ailments. The Lancet's Global Health Burden 2013 report termed air pollution the sixth biggest human killer in India. The WHO last year termed air pollution carcinogenic.

Particles smaller than 2.5 microns in diameter (PM2.5 in shorthand) are fine enough to lodge deep in human lung and blood tissue and cause diseases ranging from stroke to lung cancer, the Yale study said.

CONTINUED ON PAGE 8
» BREATHING POISON IN DELHI, P6

CAPITAL BREATHES UNEASY

Tops global cities with worst air pollution

1 NEW DELHI, INDIA
2 BEIJING, CHINA
3 CAIRO, EGYPT
4 SANTIAGO, CHILE
5 MEXICO CITY, MEXICO

INDIA SLIPS IN RANK TOO

Is second most polluted among its neighbours

	2014	2010
Bangladesh	169	139
India	155	123
Pakistan	148	125
Nepal	139	38
China	118	121
Sri Lanka	69	58

- Ranking based on 9 parameters: Health impact, air pollution, water & sanitation, water resources, agriculture, fisheries, forests, biodiversity & habitat, climate change & energy
- On list of 178 countries, India ranks as low as 174 on air pollution, 127 on health impact

5 CLEANEST COUNTRIES: Switzerland, Luxembourg, Australia, Singapore and Czech Republic

THE ECONOMIC TIMES magazine

February 02-08, 2014

IS GURGAON DYING?

Why one of India's youngest cities is fast running out of water and could become uninhabitable by 2020

Energy

Pollution

Water

Buildings are responsible for one of the largest amounts of harmful output in a city

Emissions/Pollution: **40% CO_2**
30% solid waste

Use of Resources: **40% energy**
30% mineral resources
20% water

http://www.flickr.com/photos/85296574@N00/185514559/sizes/o/in/set-72157594199106864/

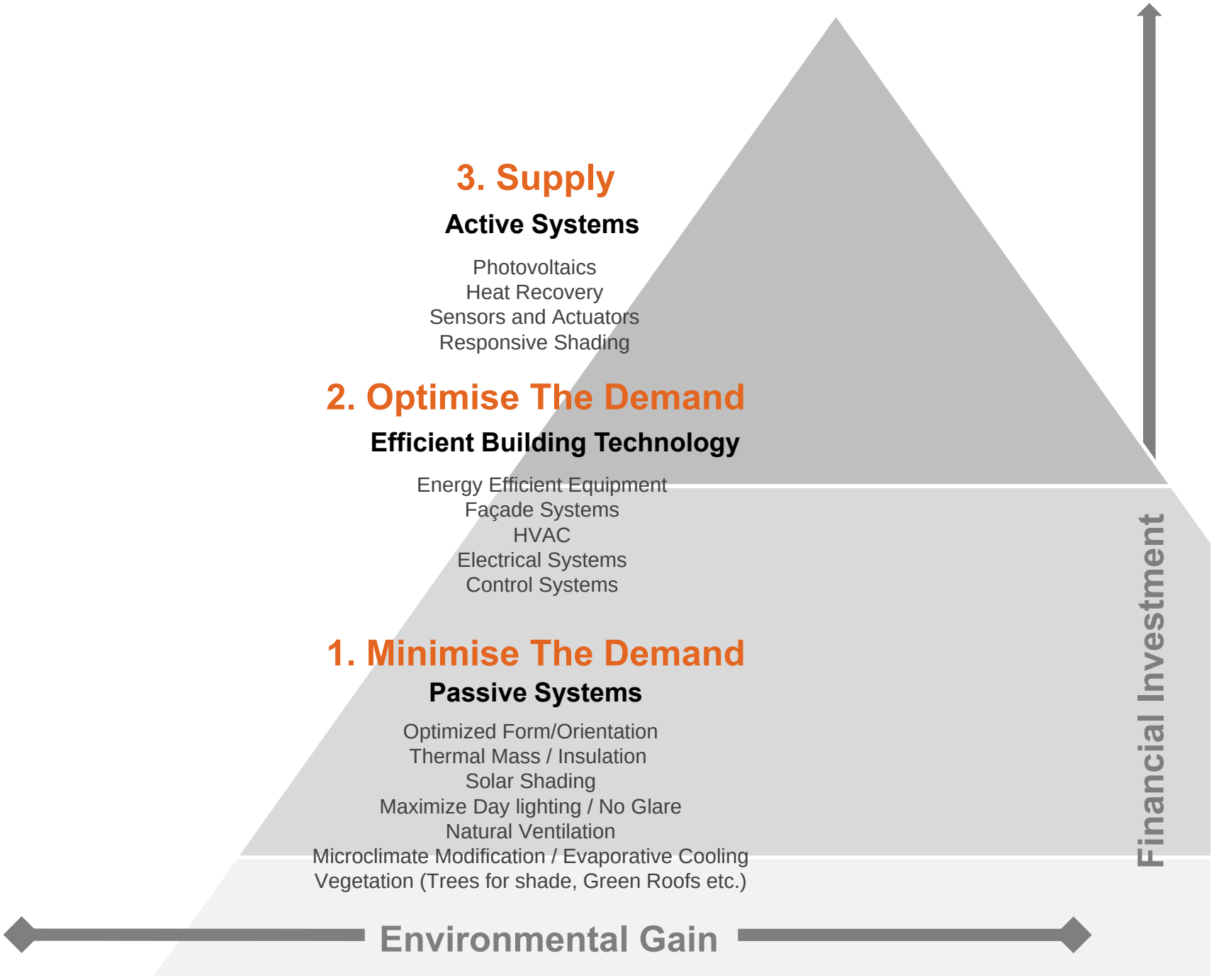
Resources: Build efficiently

Weight of a Building: 1500-2000 Kg/sq m

Office Buildings- 15000kg of material per person (average weight = 60kg)

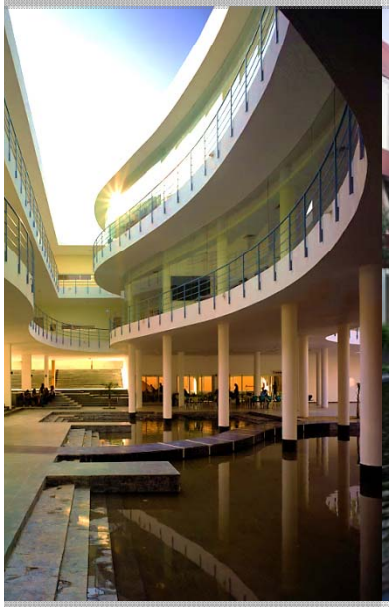
Residential Buildings- 50000kg of material per person

Source: Allianz/WWF


3. Supply
Active Systems
Photovoltaics
Heat Recovery
Sensors and Actuators
Responsive Shading
2. Optimise The Demand
Efficient Building Technology
Energy Efficient Equipment
Façade Systems
HVAC
Electrical Systems
Control Systems
1. Minimise The Demand
Passive Systems
Optimized Form/Orientation
Thermal Mass / Insulation
Solar Shading
Maximize Day lighting / No Glare
Natural Ventilation
Microclimate Modification / Evaporative Cooling
Vegetation (Trees for shade, Green Roofs etc.)
Financial Investment
Environmental Gain

Hybrid Building

Air-Conditioned Buildings



Pearl Academy, Jaipur
EPI : 25 kWh/sq.m/yr

India Glycols Ltd.
EPI : 90 kWh/sq.m/yr

GYS Vision
EPI : 64 kWh/sq.m/yr

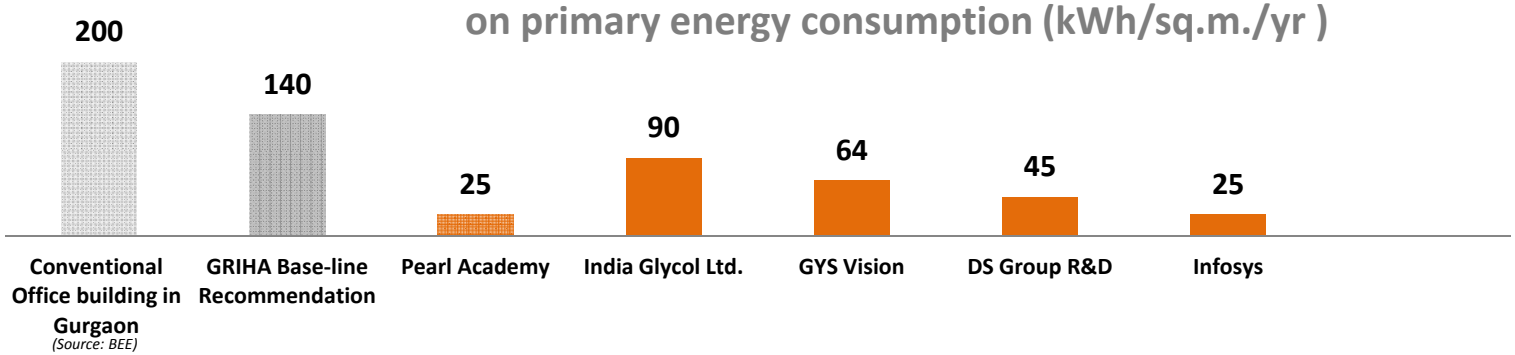
DS Group R&D Factory + Office
EPI : 45 kWh/sq.m/yr

Campus for Infosys, Nagpur
EPI : 25 kWh/sq.m/yr

2008 — 2009 — 2014 — 2016

Energy Performance Index (EPI)

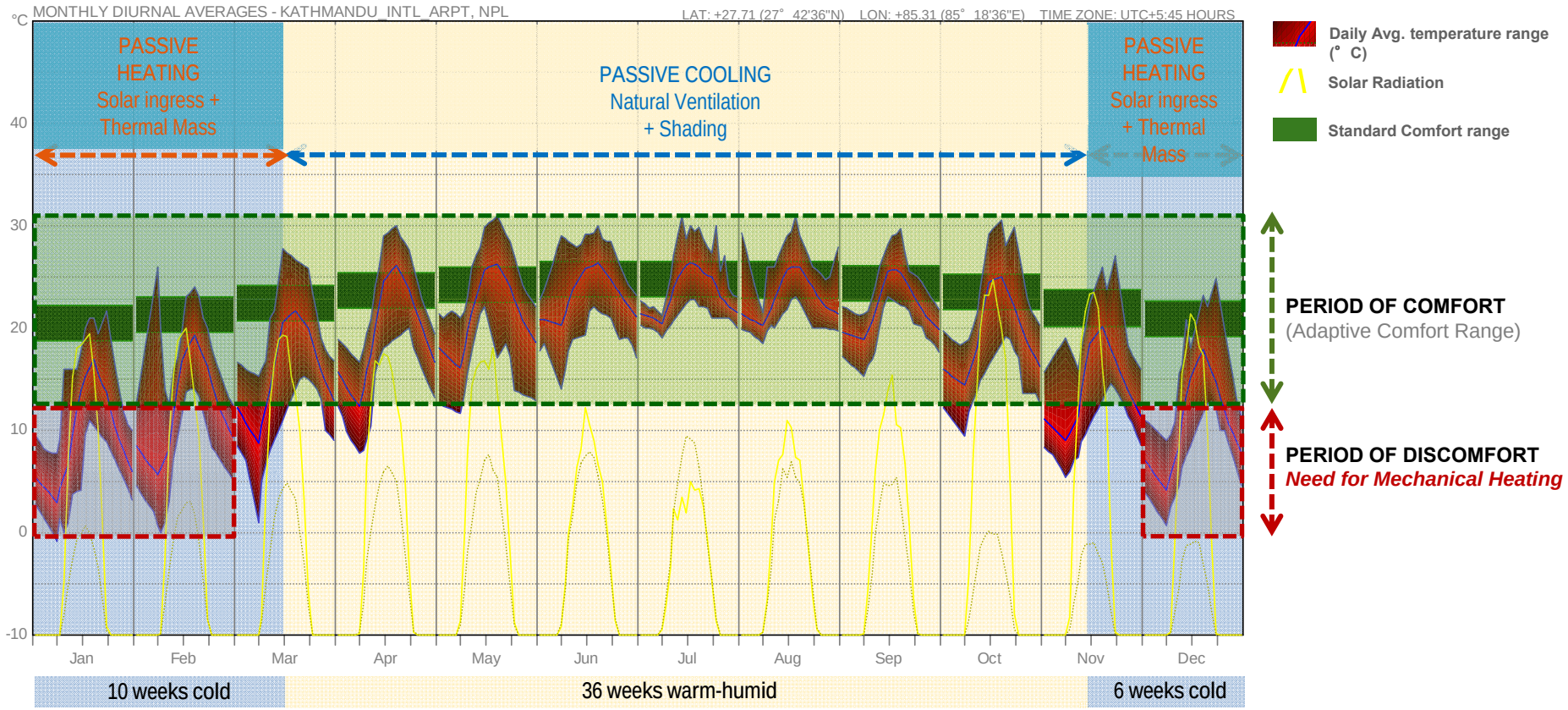
on primary energy consumption (kWh/sq.m./yr)



(Source: BEE)

Thermal Comfort: Passive Architecture – Decrease reliance on M&E

Comfortable thermal conditions for 80% of the year by passive strategies.

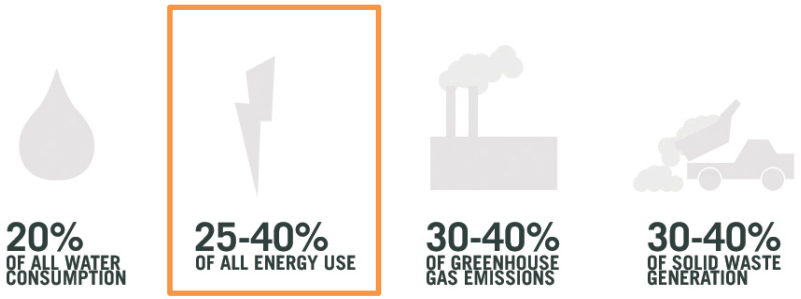


Inferences:

- **Warm-Humid period:** Solar Shading + Wind Movement
- **Cold-period:** Passive Solar Heating + Thermal Mass
- **8-9 weeks will need mechanical heating** during extreme conditions like cold nights

Light – Use daylight, its free and abundant!!!

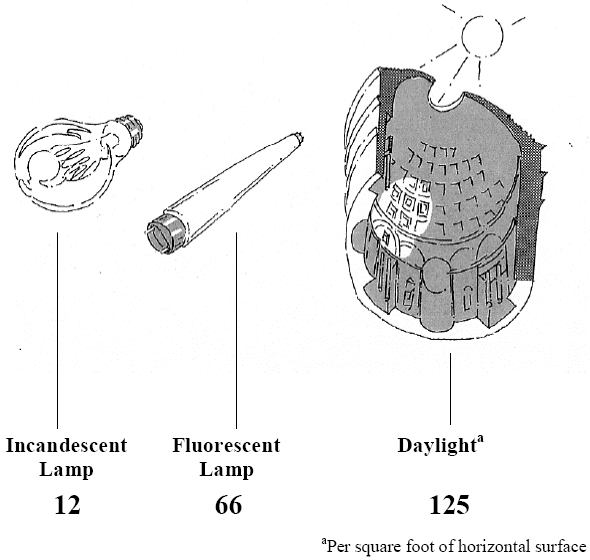
The Global Environmental Impact Of Buildings



Lighting accounts for 19% of the world's energy consumption

Source: Lighting The Clean Revolution Report, June 2012

Rationalize use of artificial lighting based on daylight availability

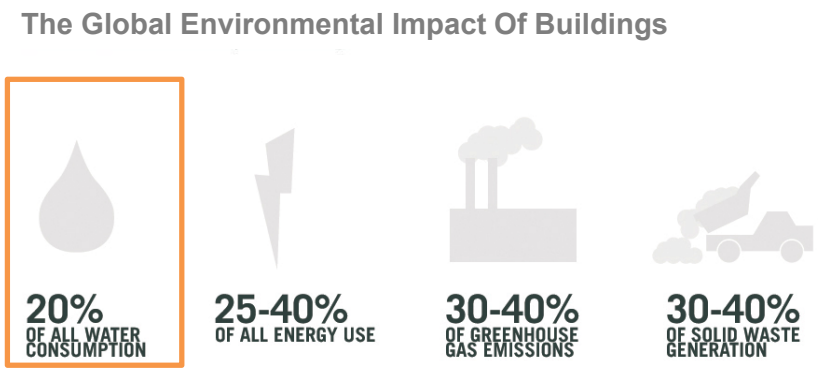


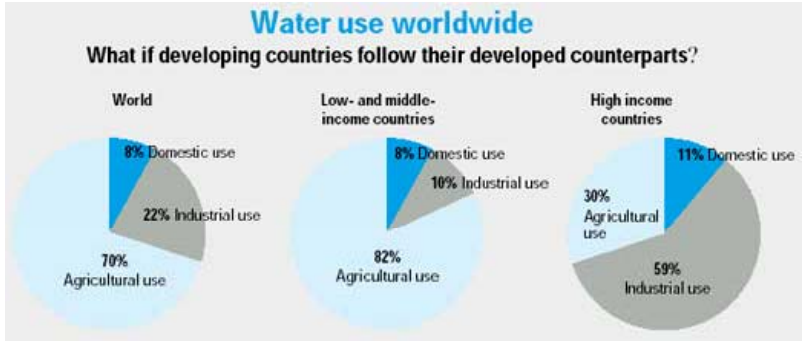
Relative efficacy of light sources (Ratio of number of lumens of light energy per watt of power

Daylight has better QUALITY

Daylight is FREE

Water and Waste : Harvest and reuse what we have…

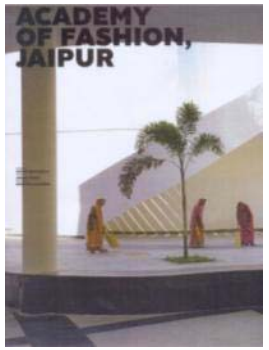




Source : CSE India

Average Annual Rainfall : **1.083M**
Landmass available : **29,73,190 sq. km.**
Population : **1.2 billion**
Harvesting Capacity : **30 - 50%**

13,01,851 lts of Rainwater Can Be Harvested Per Capita annually



publications ::

House Trends (Europe) 2012
Dwell Asia (Singapore) 2012
IFJ 2012
IA&B 2011
Icons & Reflections by Hettich 2010
Spaces Singapore 2010
Archiworld Design Detail (Korea) 2009
Domus (Italy) 2009

awards ::

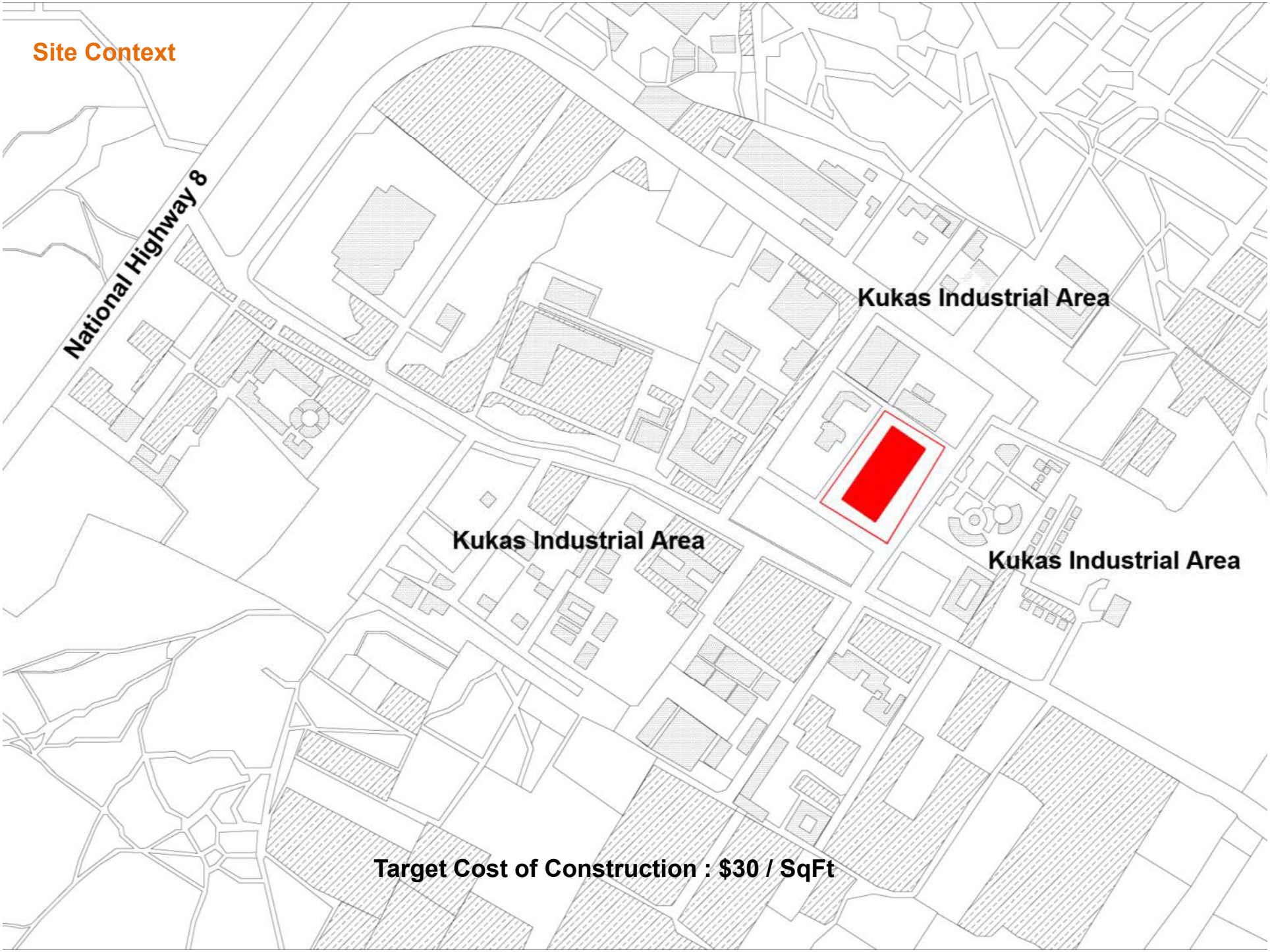
IIA for Excellence in Architecture, Public 2011
FutureArc Green Leadership Award Singapore 2011
Cityscape Architectural Awards, Highly Commended Seal of Distinction Dubai 2010
World Architecture Festival Award, Best Learning Building Barcelona 2009
International Design Awards, Winner USA 2009
20+10+X World Architecture Community Awards, Citation 2009
ArchiDesign Awards, Best Sustainable/Green Architecture 2009

fact file ::

Area :: 2,15,278 sq ft
Climate :: Hot and Dry
Client :: Pearl Academy of Fashion
Year of Completion :: 2008

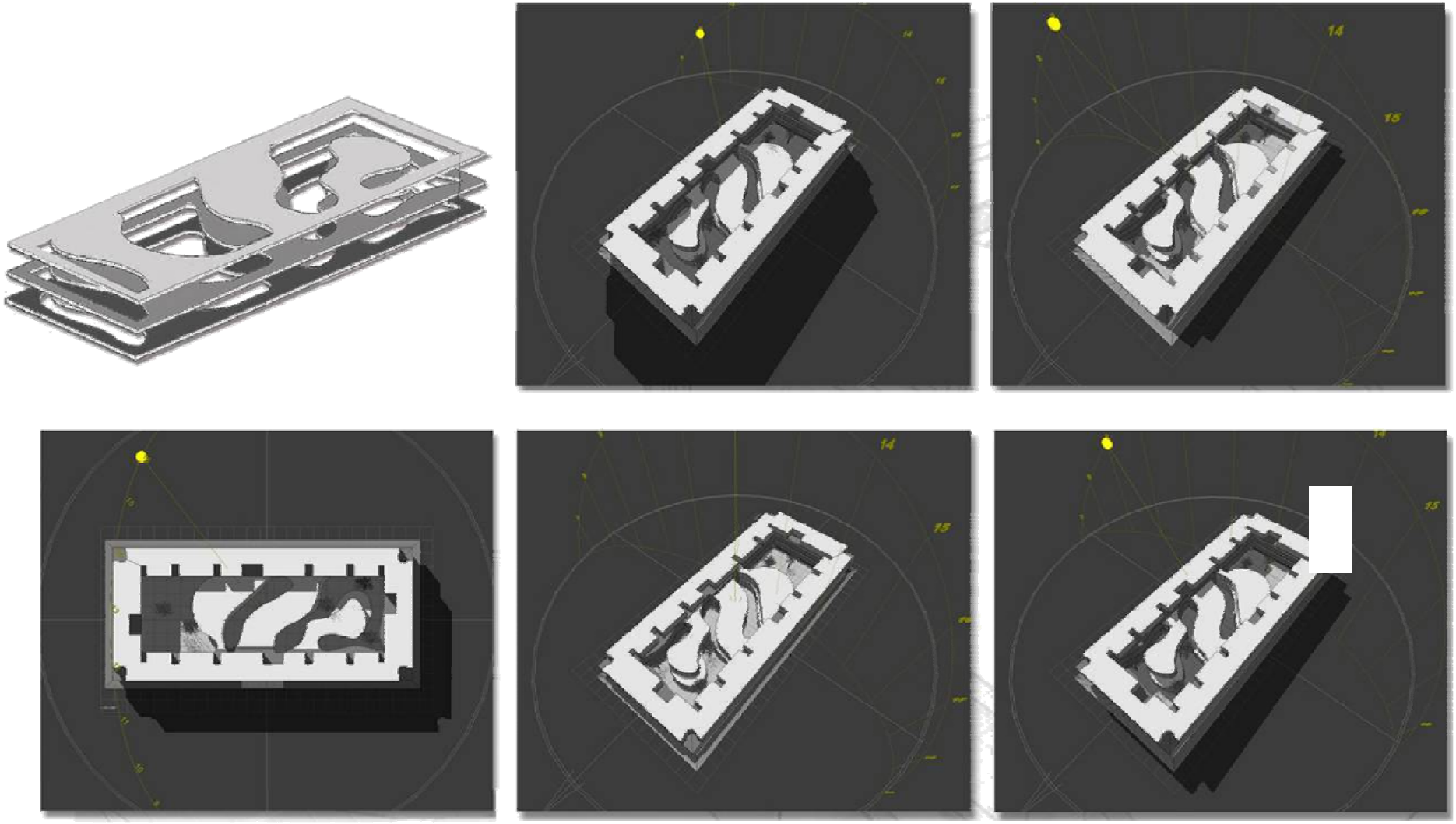
Pearl Academy of Fashion
Jaipur

Site Context

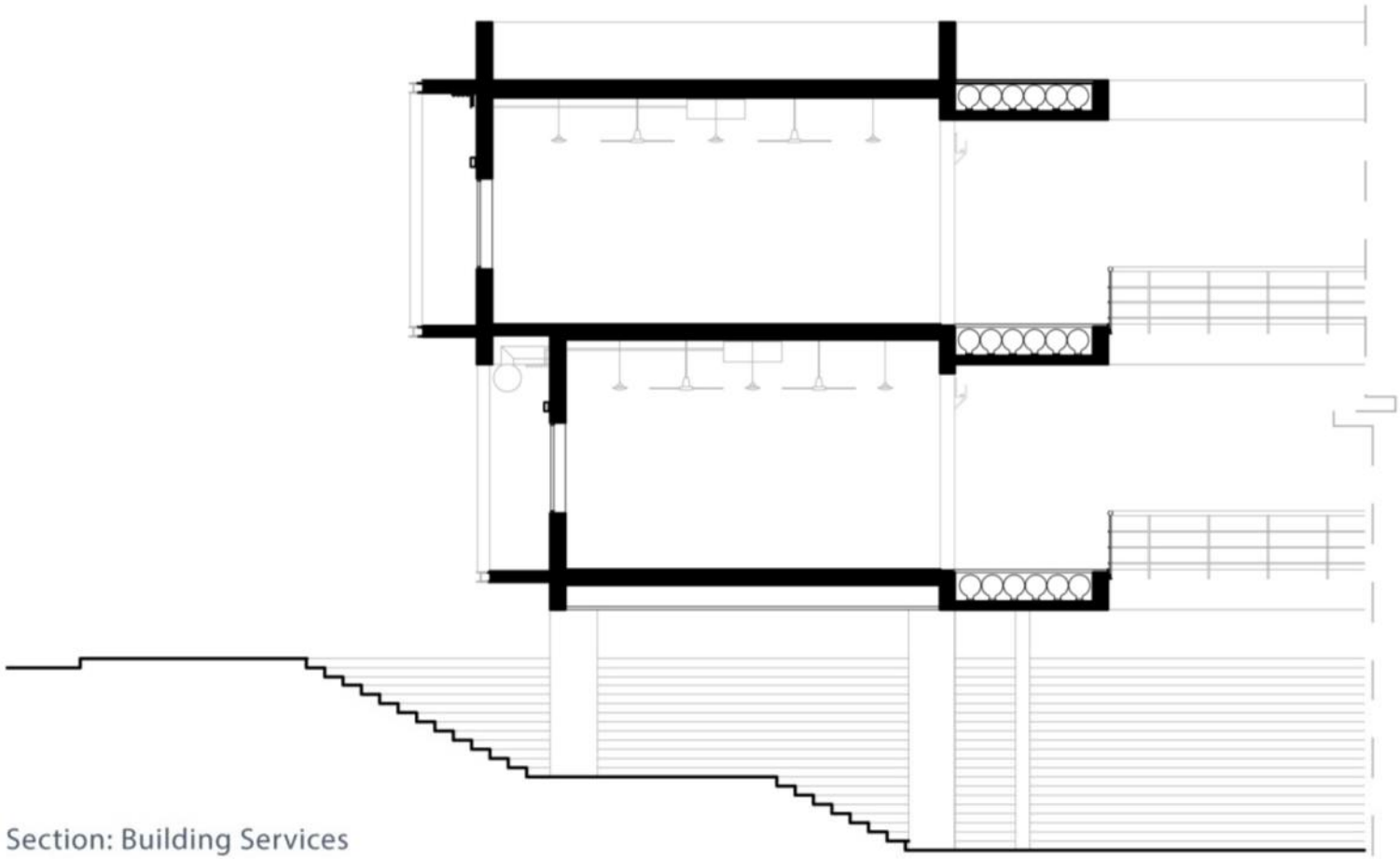


Target Cost of Construction : $30 / SqFt

Envelope Optimisation / Shadow Studies

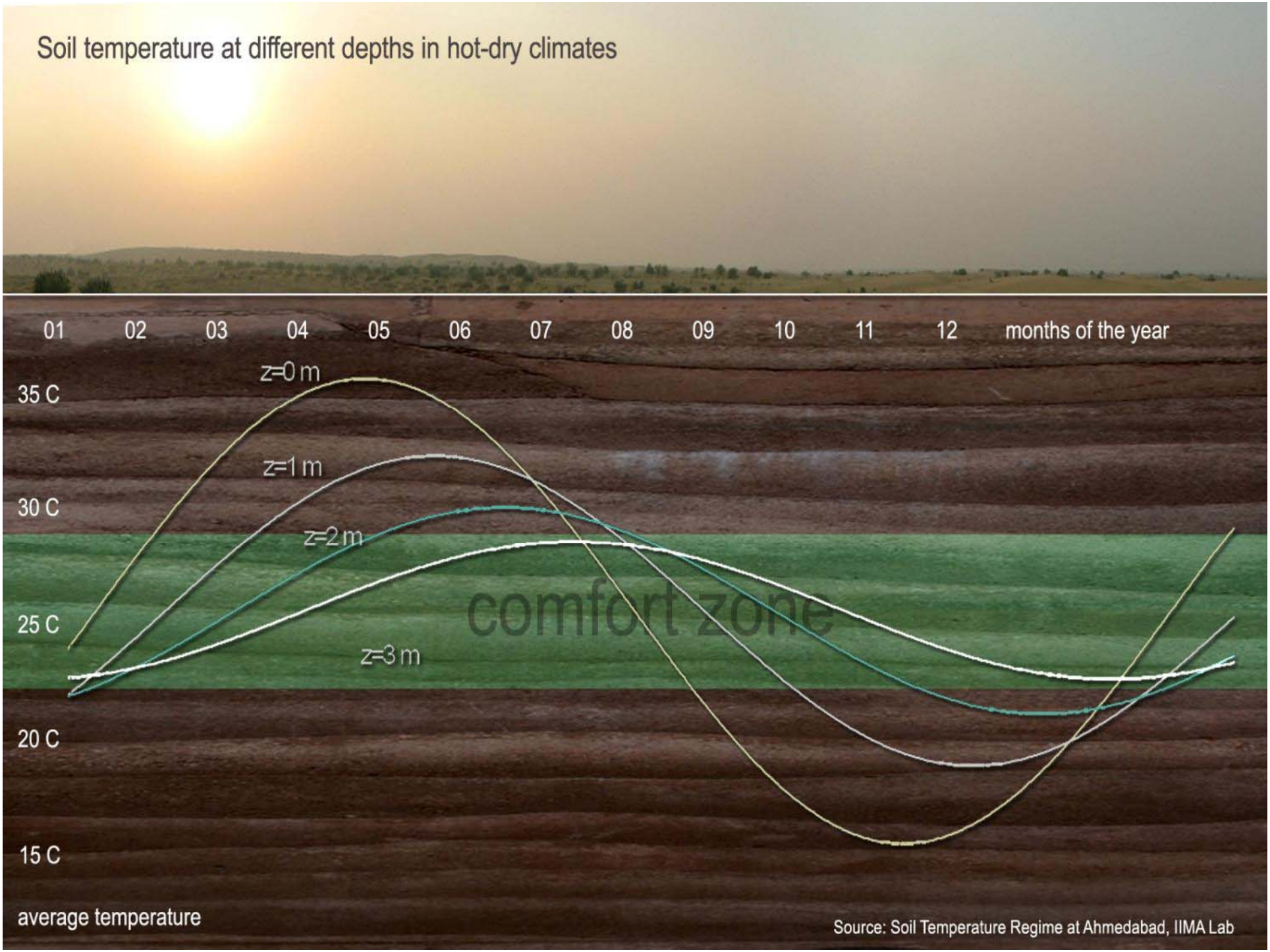


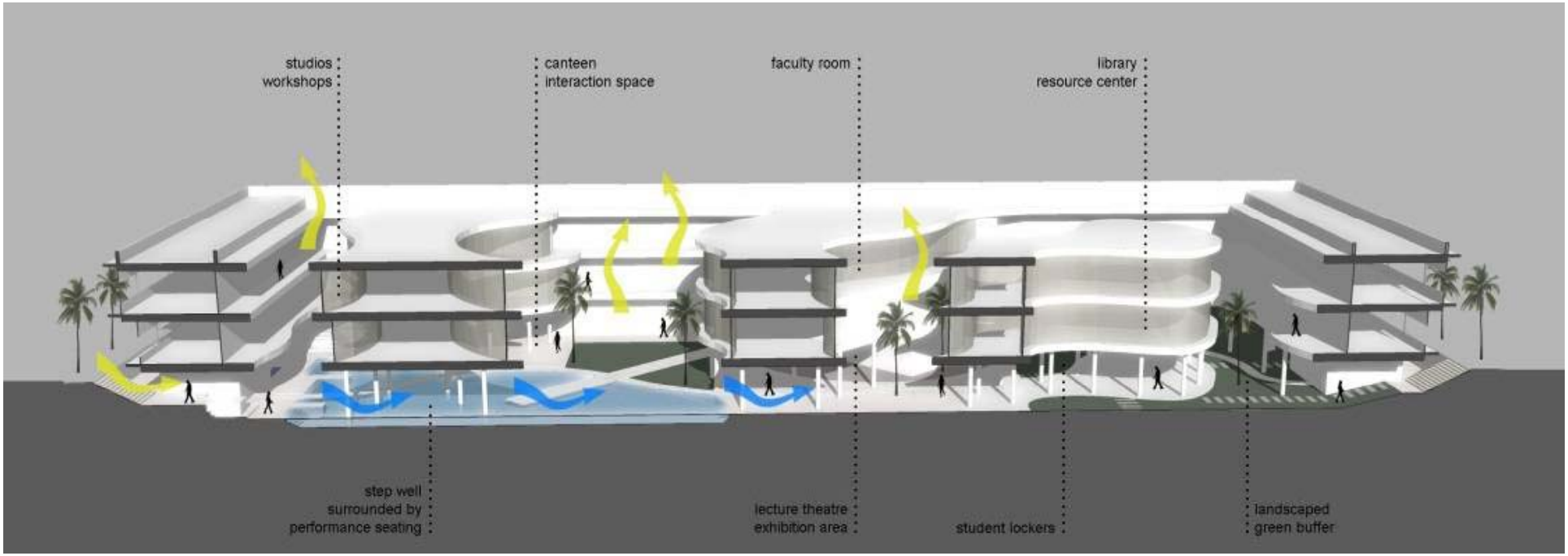
Flexibility of Services / Daylighting

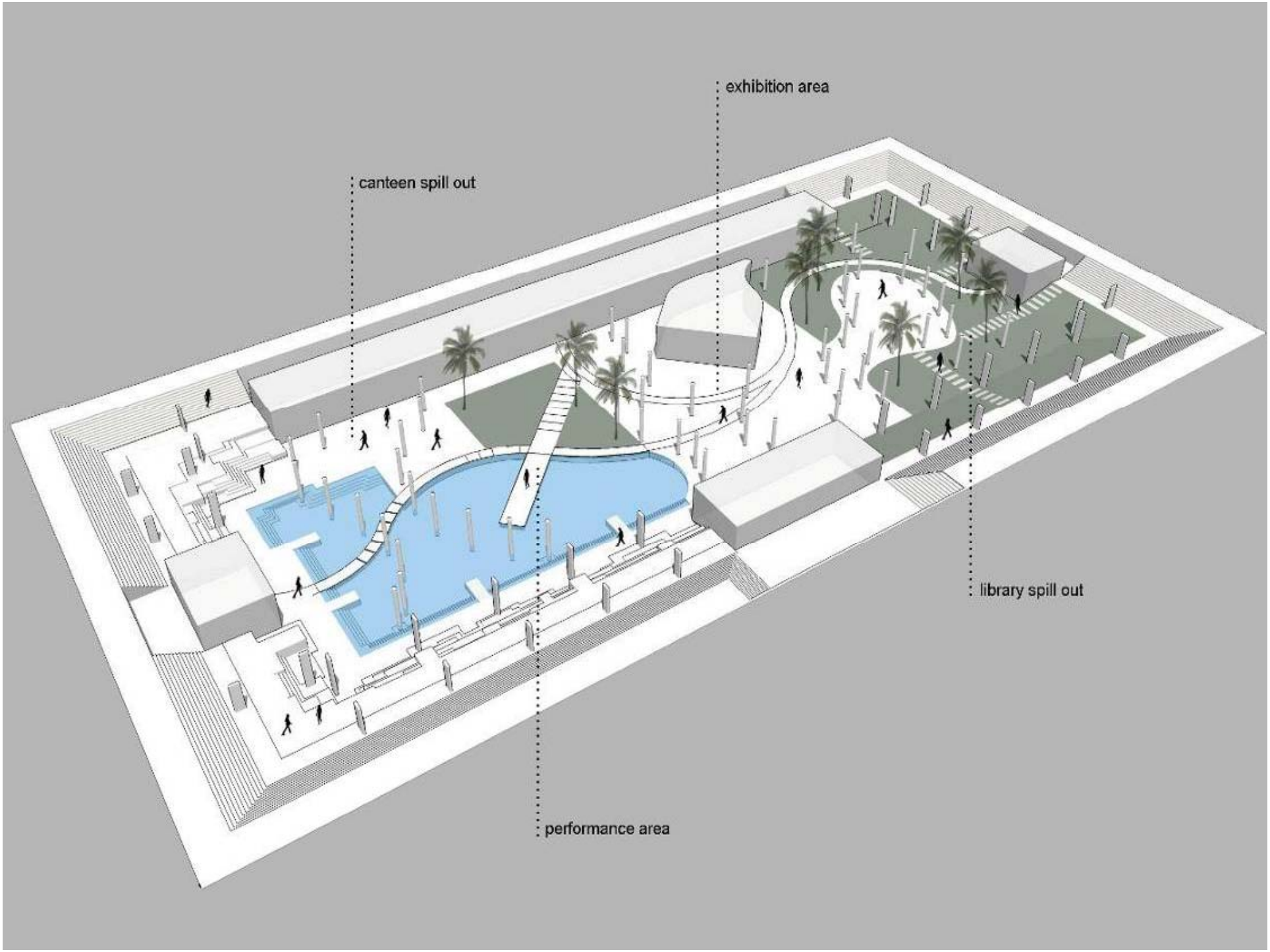


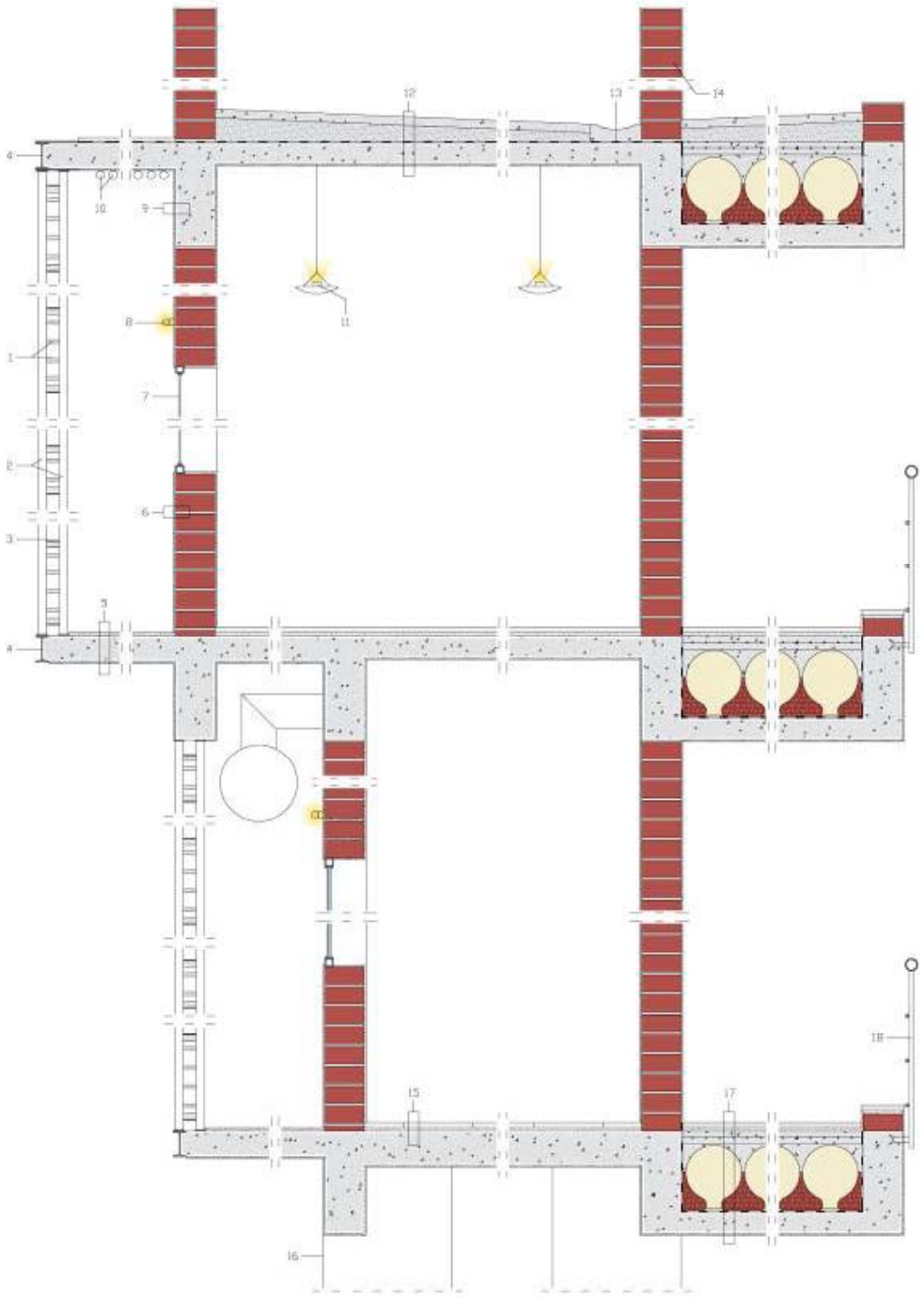
Section: Building Services

Classrooms
Daylight
Flexible Structural System
Non-Air conditioned corridors


Soil temperature at different depths in hot-dry climates
01
02
03
04
05
06
07
08
09
10
11
12
months of the year
z=0 m
z=1 m
z=2 m
z=3 m
35 C
30 C
25 C
20 C
15 C
comfort zone
average temperature
Source: Soil Temperature Regime at Ahmedabad, IIMA Lab


studios
workshops
canteen
interaction space
faculty room
library
resource center
step well
surrounded by
performance seating
lecture theatre
exhibition area
student lockers
landscaped
green buffer


exhibition area
canteen spill out
library spill out
performance area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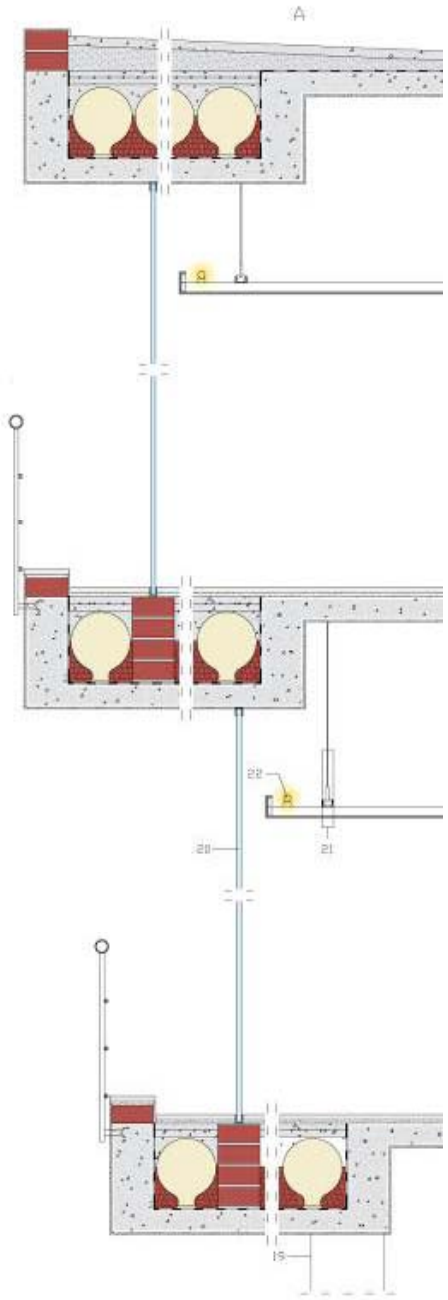
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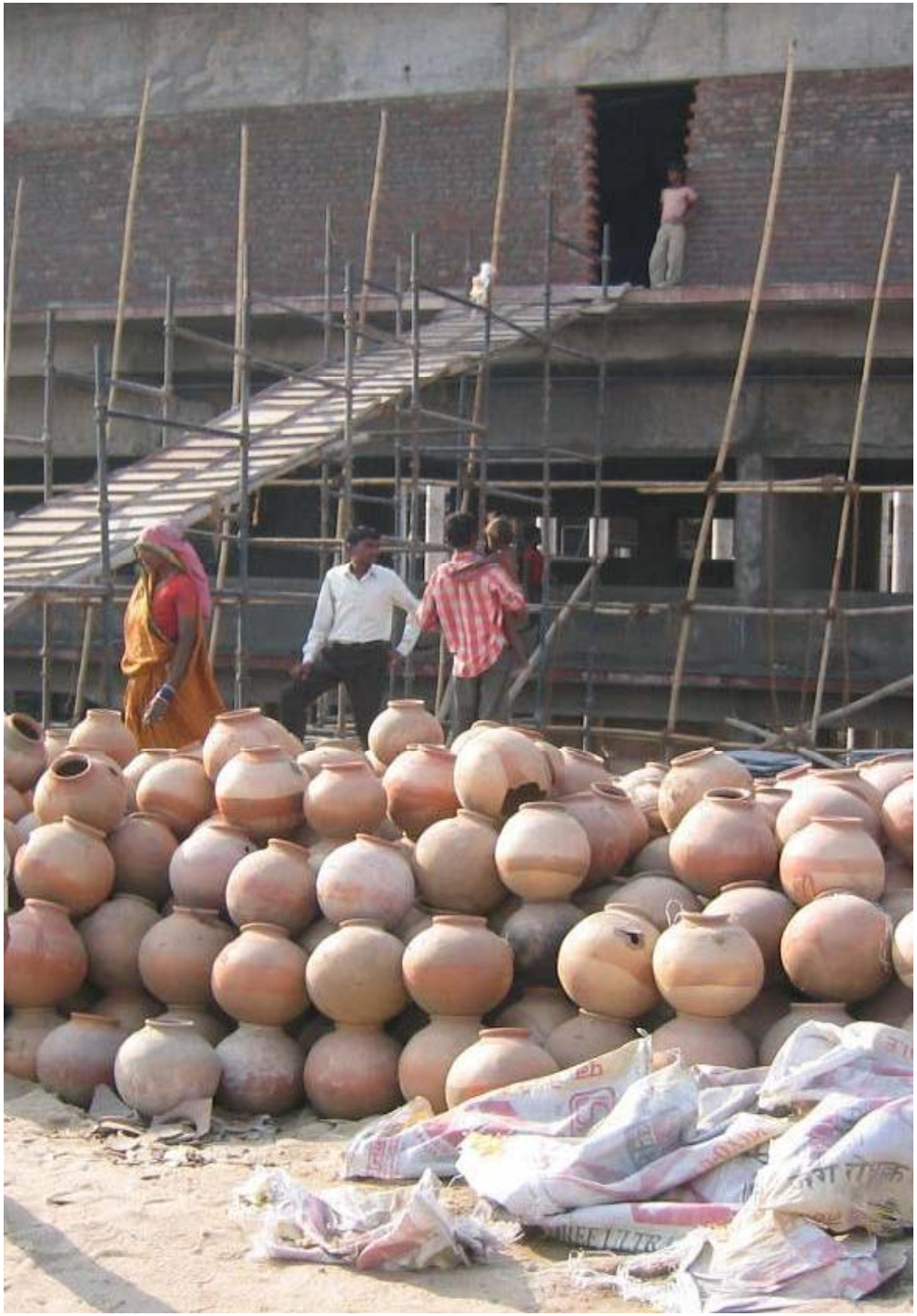
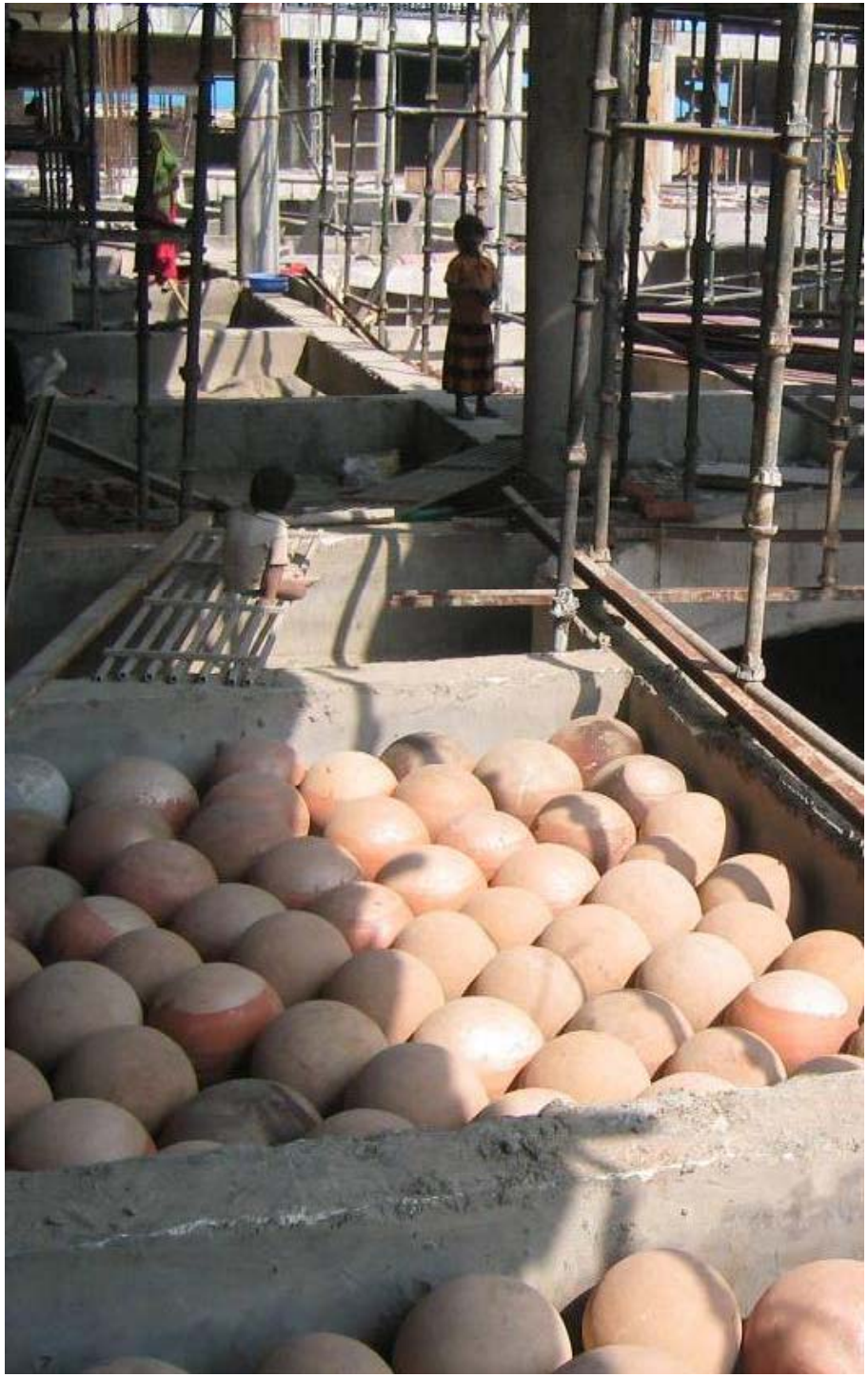
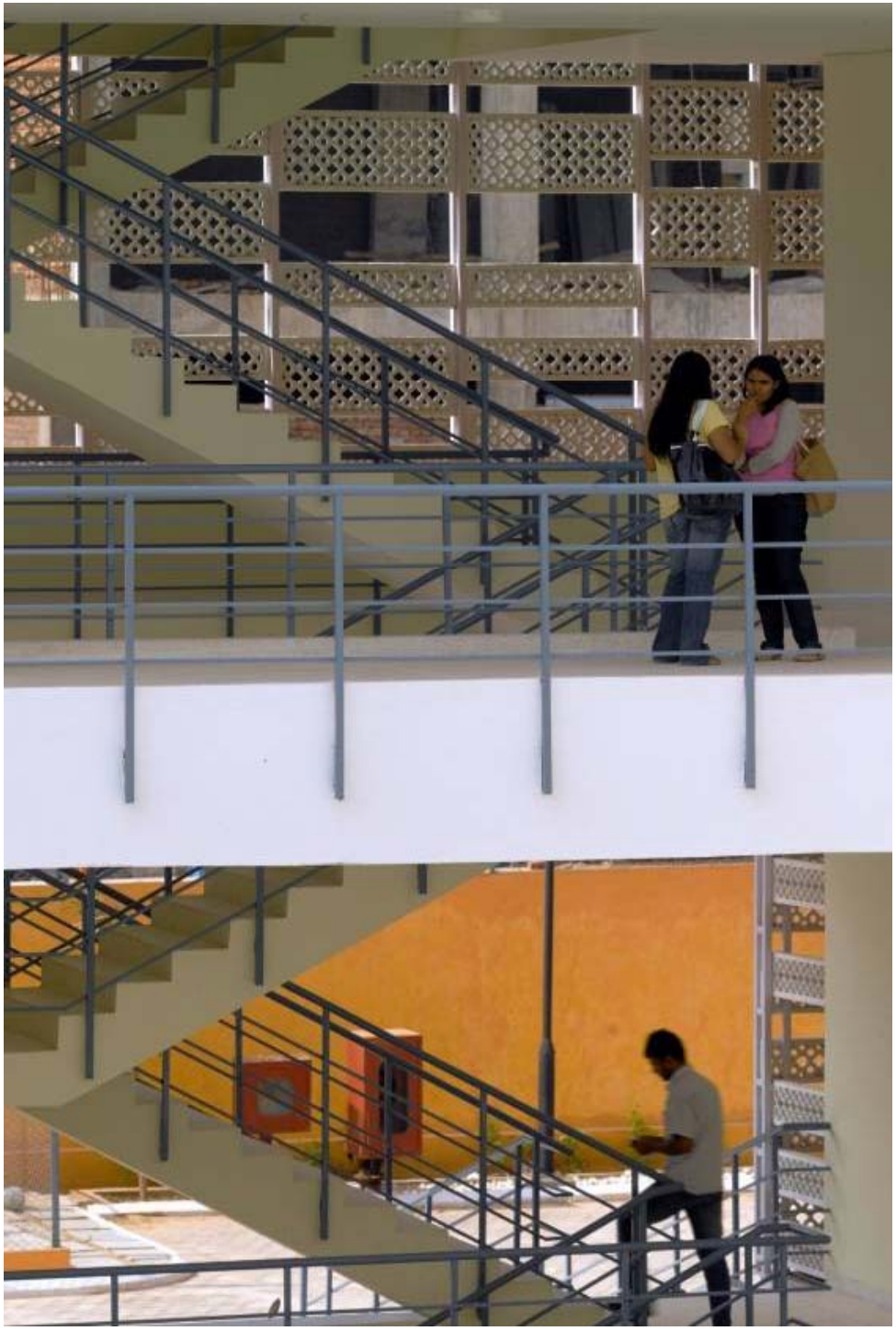
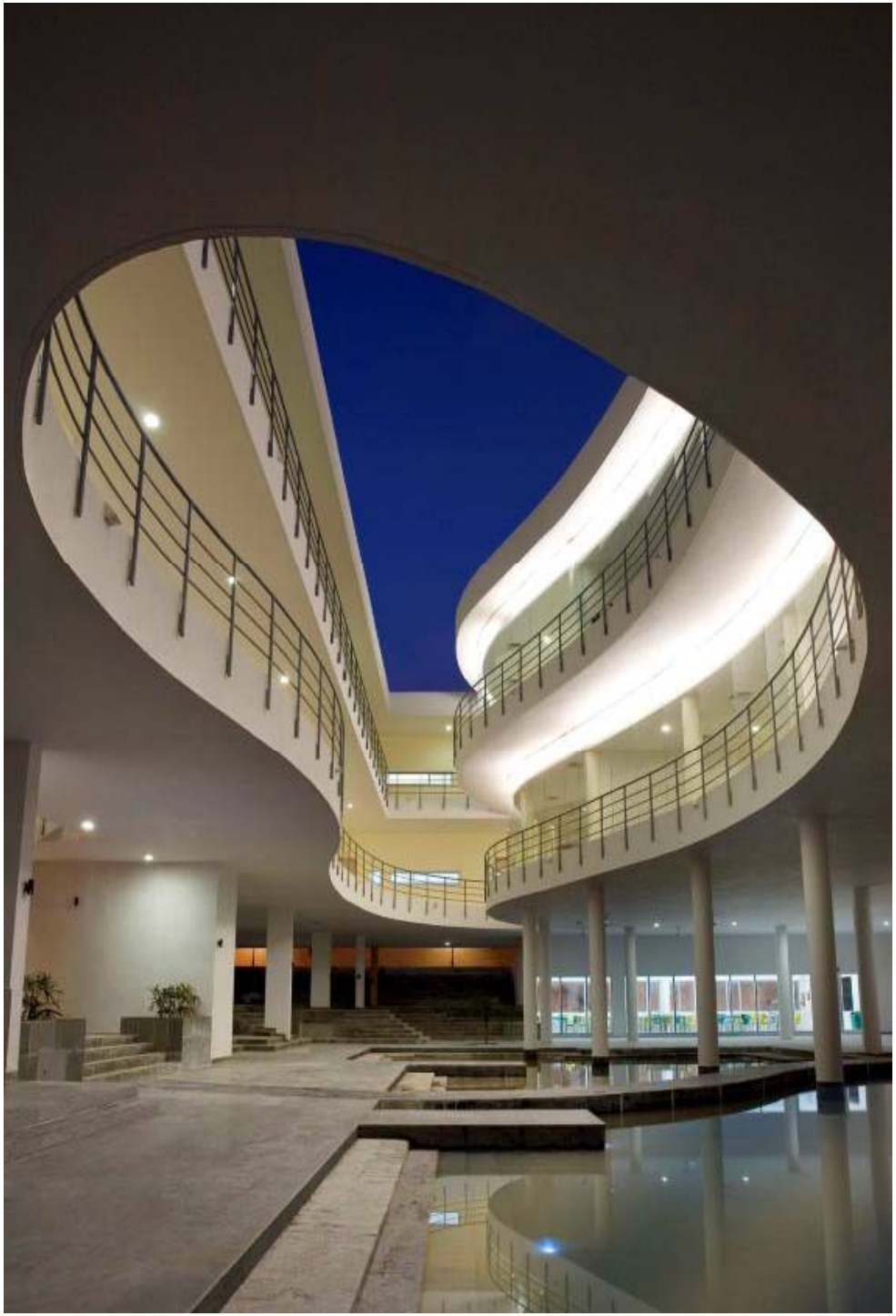
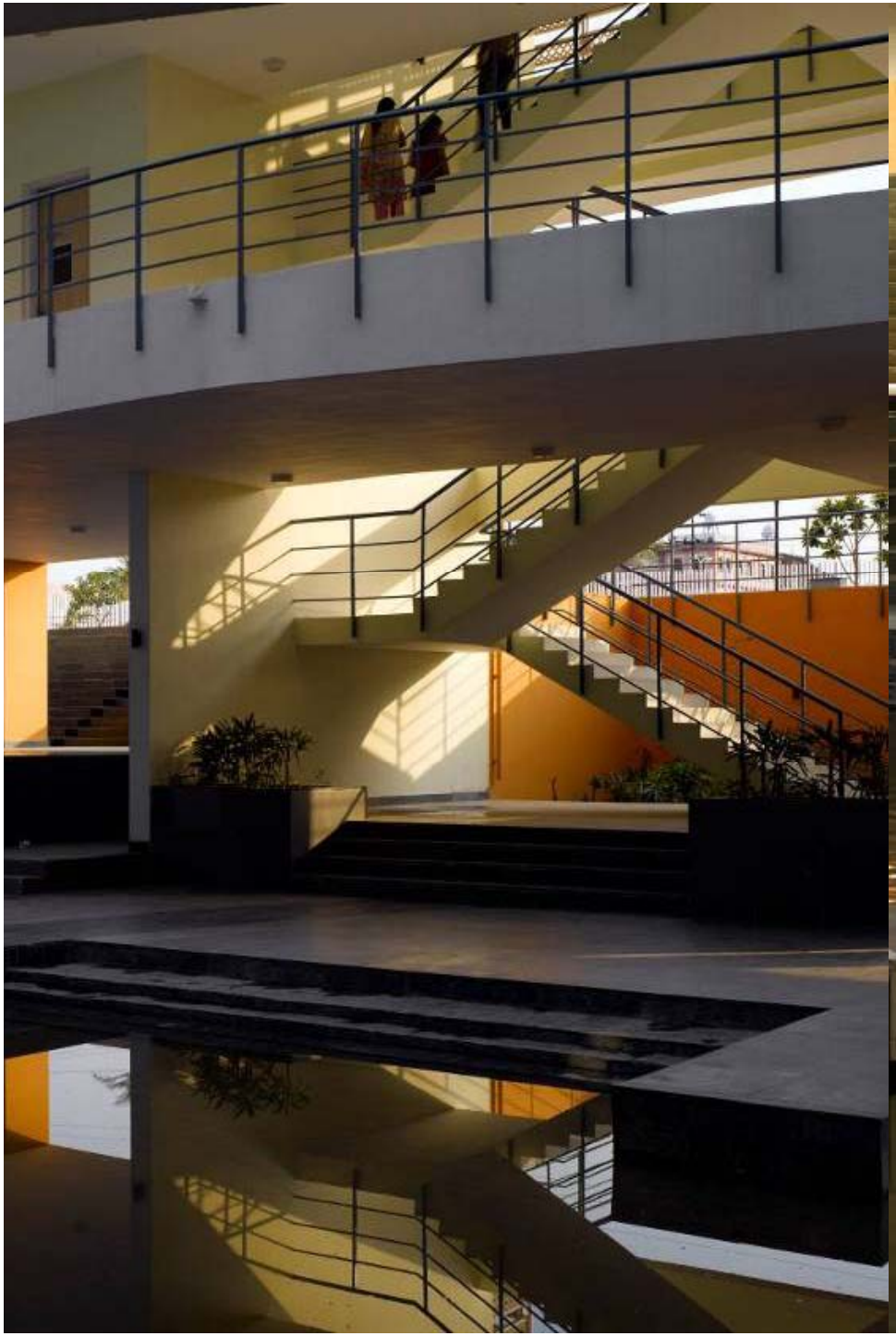
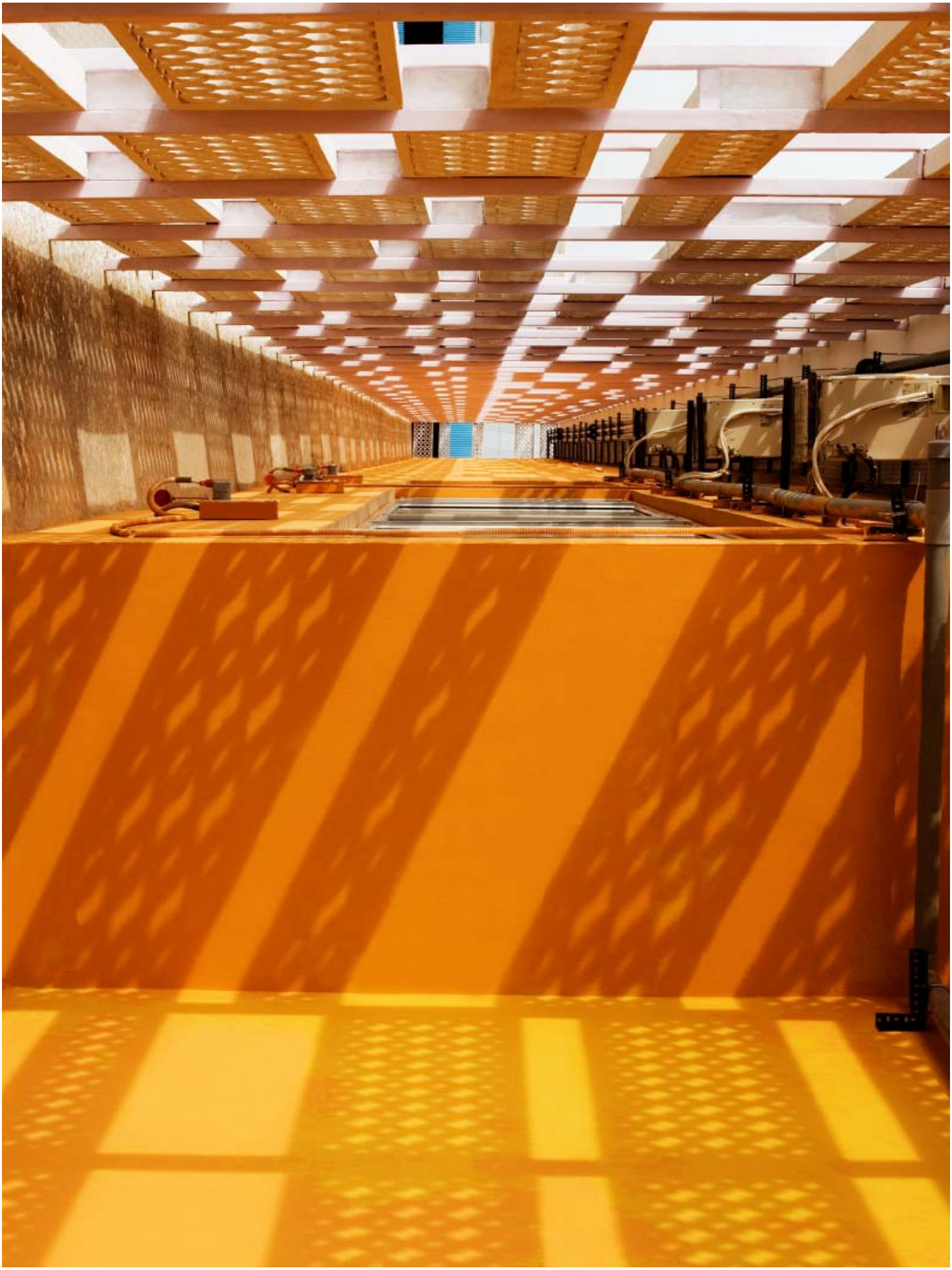


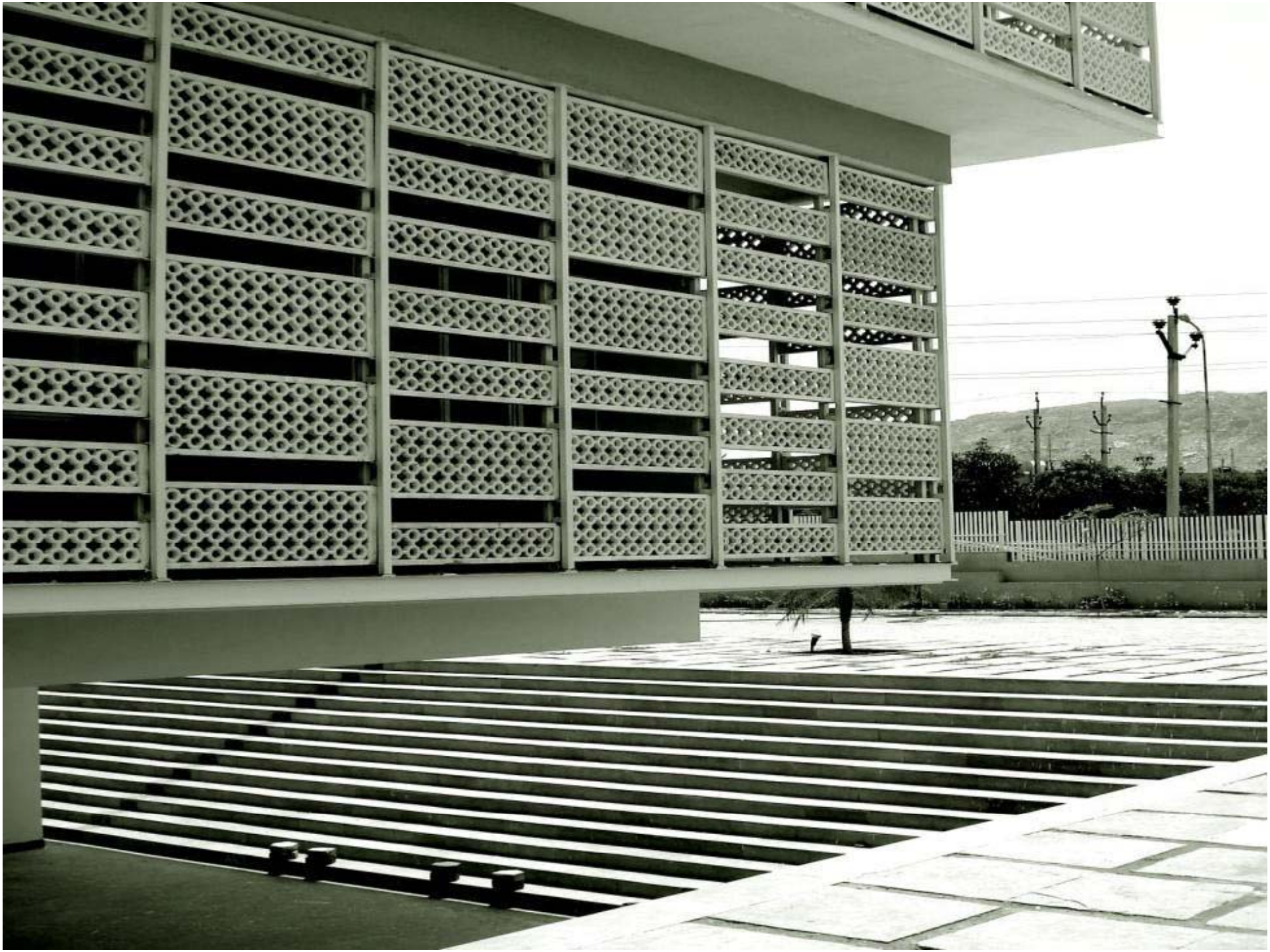






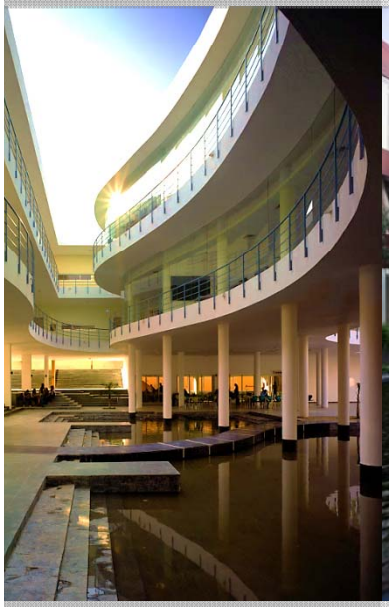






Hybrid Building

Air-Conditioned Buildings



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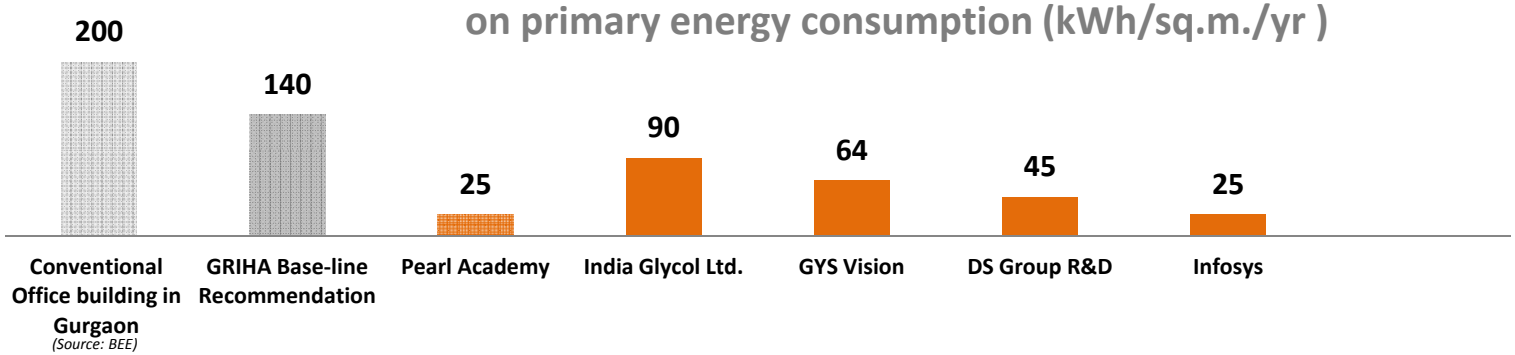
Campus for Infosys, Nagpur
EPI : 25 kWh/sq.m/yr

2008 — 2009 — 2014 — 2016

Energy Performance Index (EPI)

on primary energy consumption (kWh/sq.m./yr)



(Source: BEE)

Net Zero Energy for **20,000** people

Zero Water Balance for **20,000** people

Zero Waste Discharge for **20,000** people

Naturally day-lit, Glare-free Workplace

15 acre **Lake** for **Rainwater Harvesting**

Productive Landscape and **Bio-diversity** Park

Infosys
Mihan, Nagpur

publications ::

NDTV Profit, Infosys Campus to be set up on 142 acre land, February 2014
Deccan Chronicle, Chavan lays foundation stone for Infosys' campus at MIHAN, February 2014
Business Standard, Infy's Nagpur campus to be up in 2 years, February 2014
Post.Jagran.com, Maharashtra CM Chavan lays foundation stone for Infosys' campus, February 2014
The Hindu, Infosys Campus, February 2014
DNA , Infosys Campus, February 2014

fact file ::

Built Up Area :: 78,500 sq m (Phase 1)
Site Area :: 574,650 sq m
Client :: Infosys Ltd
Project Duration :: July 2013 - 2016
Cost :: 28.1 million Euros (Phase 1)

Site: Context

Latitude and longitude:	**21° 01' N & 79° 01' E**
Site Area:	**575358 sq. m (142.176 acres)**
Ground Coverage	**30148 sq. m (40%)**
Permissible FAR:	**1438395 sq. m (1.5 + 1)**
Civil Aviation Height Cap:	**45 M**

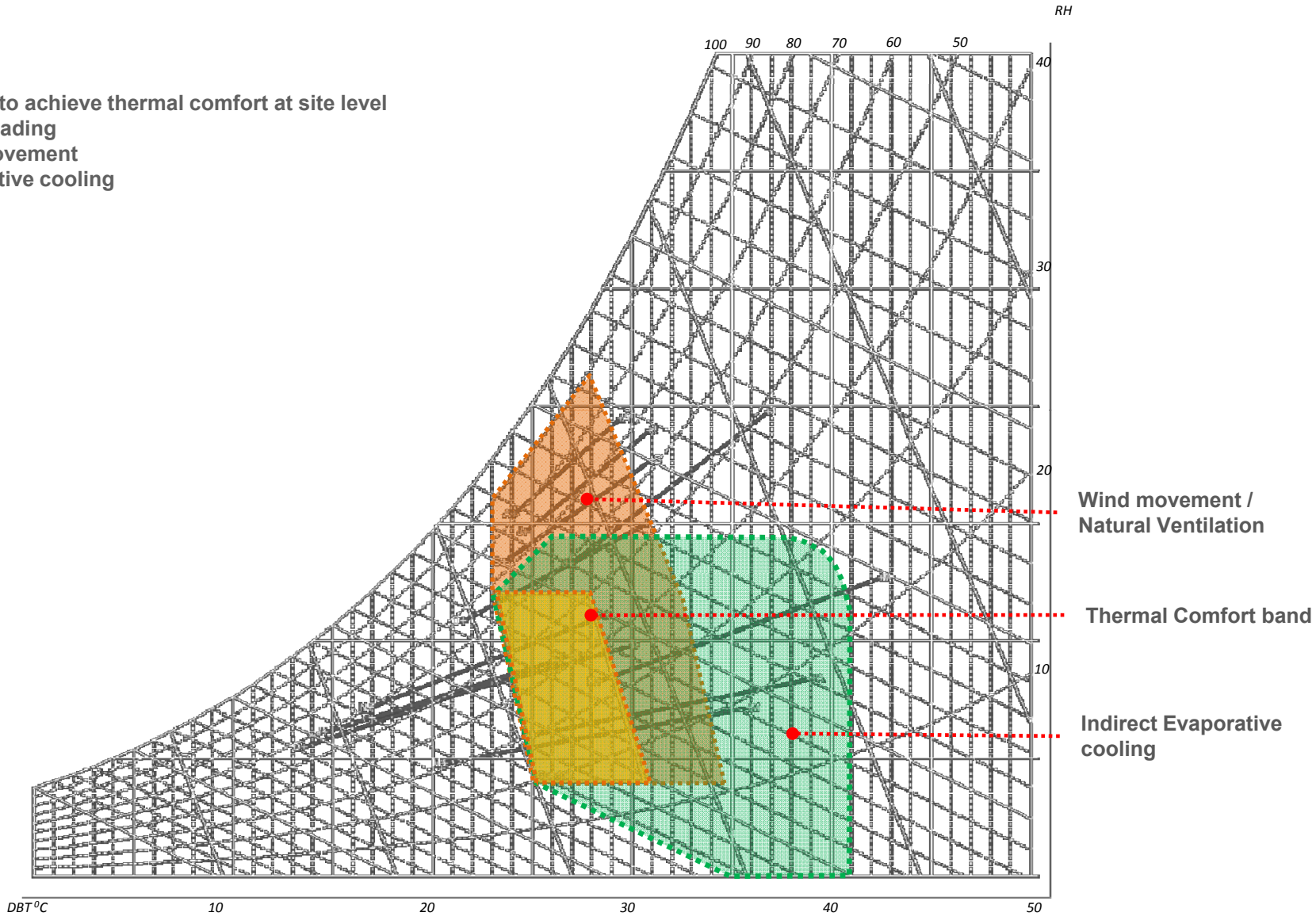
Based on Information provided by MIHAN during the 28 March, 2013 Site Visit:
The maximum permissible height of the building - 45m is measured from the Airport Reference Point (ARP) which has an AMSL of 307.0m. In the event that the site AMSL is lower, the height of the building will be 45m + the difference between the ARP and Site AMSL.

For Infosys, Nagpur:
AMSL of road intersection at N-E corner – 303.0m AMSL
AMSL of road adjacent to proposed Phase-1 Building at N-W corner – 300.0m AMSL (± 0)
Top of Phase-1 Building – 307.0m + 45m = 352.0m AMSL (+52m)

Building Strategies: Morphological Development

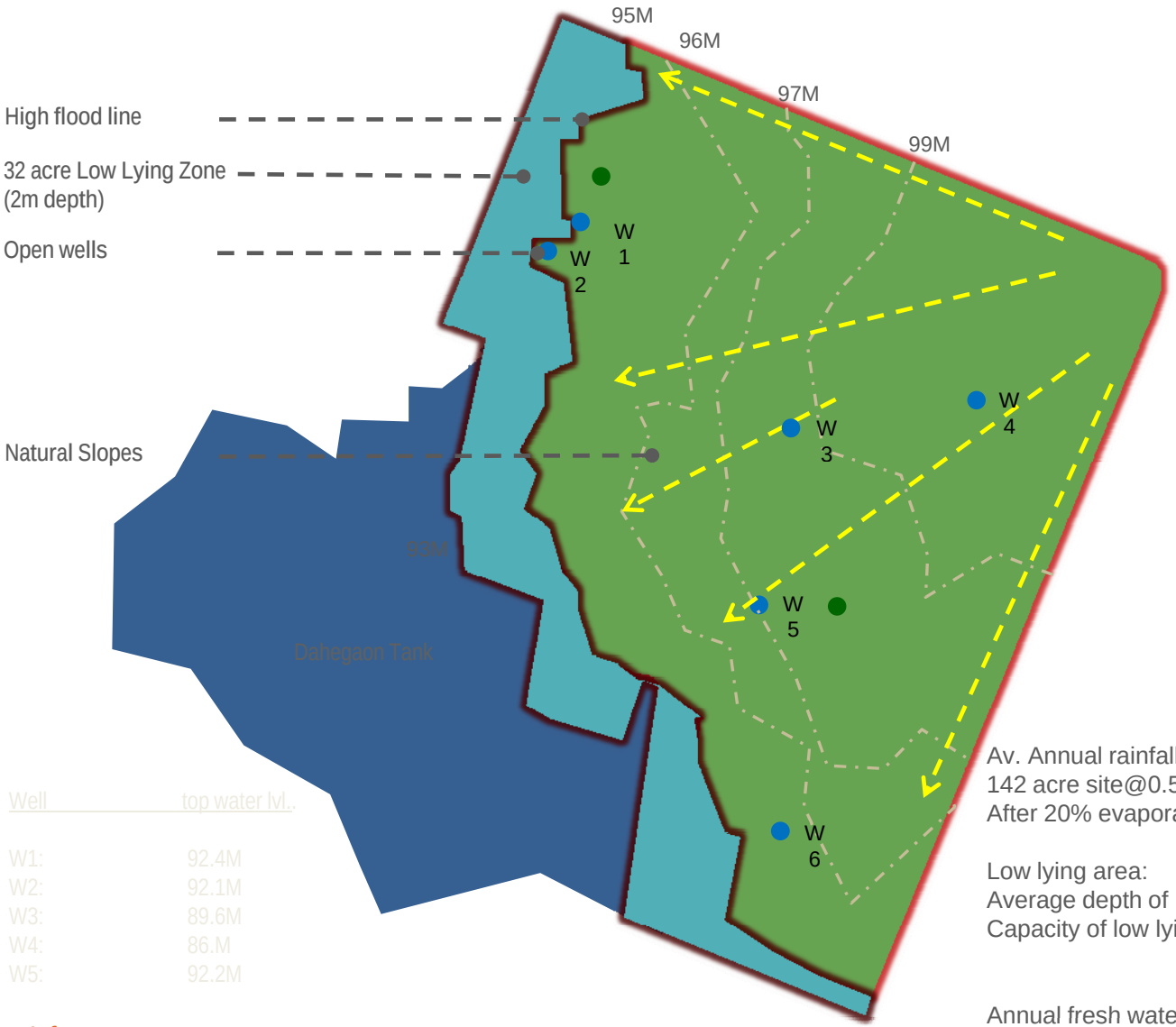
Analysis:

Strategies to achieve thermal comfort at site level
1. Solar Shading
2. Wind movement
3. Evaporative cooling



Inference:
80% of the time in thermal comfort zone by adoption the above passive strategies at site level.

Carrying Capacity: Water = 20,000 people



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:	2M
Capacity of low lying area:	2,59,072 cubic mt.
Annual fresh water requirement:	12 cubic mt./per
Carrying capacity:	21500 people

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 21500 people

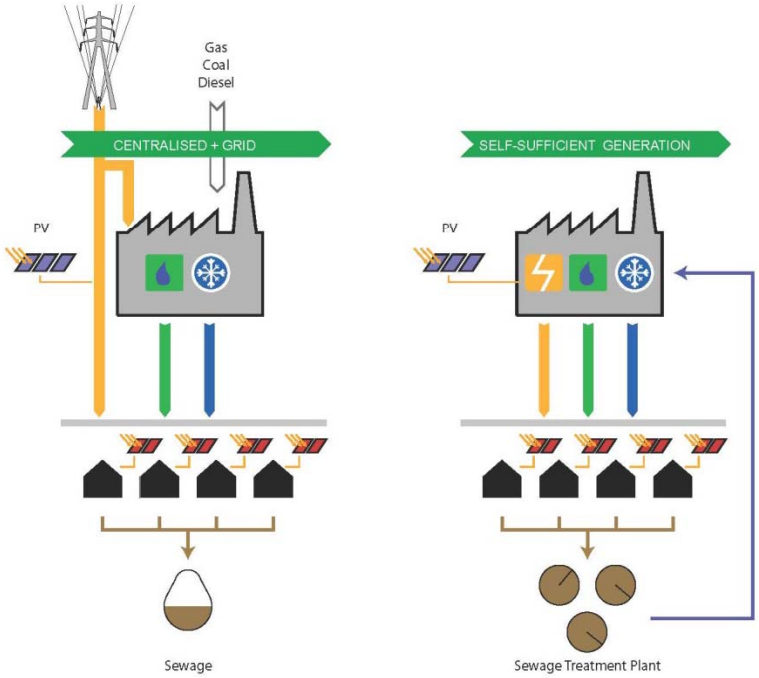
Carrying Capacity: Energy = 20,000 People

Annual estimated energy demand = 19,968,000 Kwh
(@40w/Sqm for 2080 hrs : 8hrs for 260days)

Proposed energy generation through 11MW Solar PV Cells = 20,680,000 Kwh
@6 hrs. for 300 sunshine days {11 Mw x 1880 hrs]
(Day System Grid Interactive)

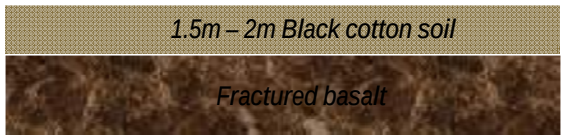
Space required for solar power generation = 1,21,000 Sq.m
@10,000 Sqm/MW

Reduction in Carbon Footprint vs Thermal = 13977.6 Tons
(Thermal Plant : 1Kw/hr of energy = 1Kg Carbon
Solar Plant : 1Kw/hr of energy = 0.3 Carbon)



Inference:
• To be self sufficient in energy demand for phase 1&2, 30 acre of solar farm can be created on site over the parking lot and/or the reservoir/Bio diversity park which may also help reduce evaporative losses

Carrying Capacity: Site Geology



Existing Geological condition on site

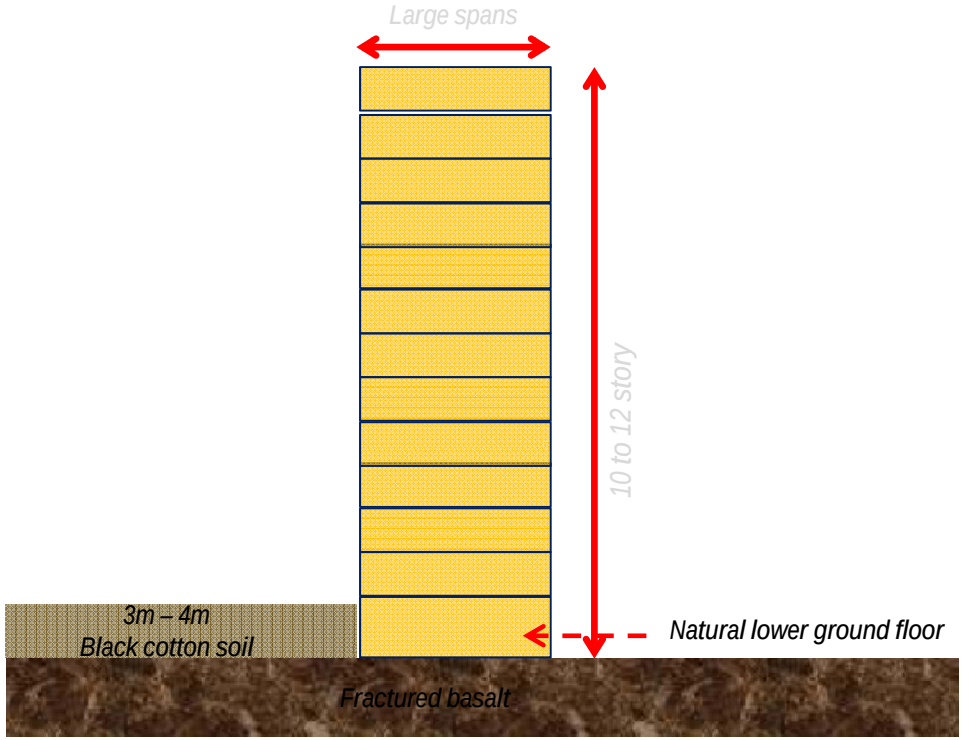
Removing black cotton soil to get soil bearing capacity

Inferences

1.The top Black Cotton Soil needs to be removed under the structure. Structures can be founded at approx. 1.5 m to 2.0 M Depth. There is good possibility of using an inexpensive lower ground floor only if architecturally required.

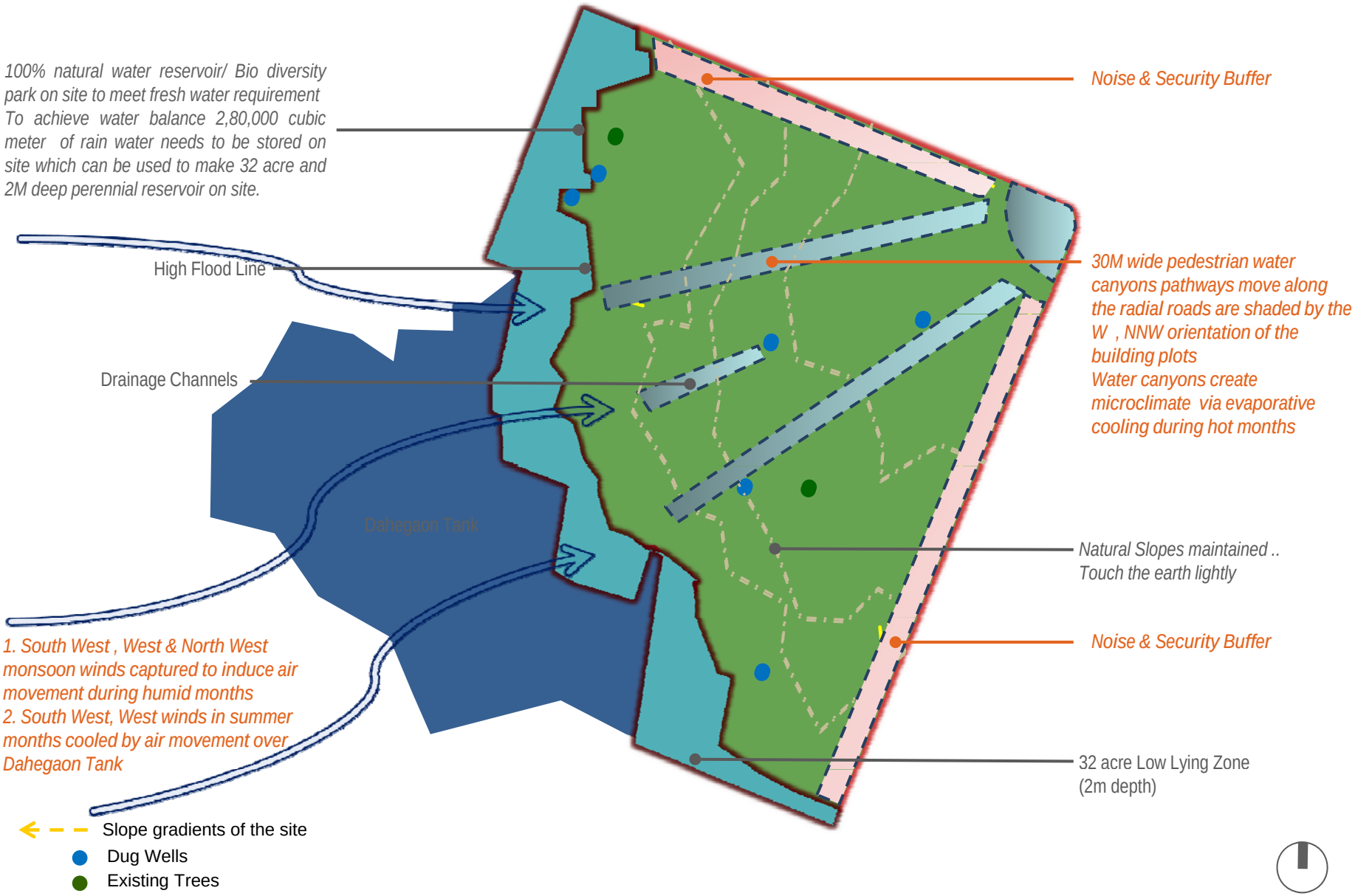
2.Founding strata is basically a Basalt Stone. Although, weathered Basalt Stone is encountered, the founding strata will not permit high structural settlements. The Allowable Bearing Pressures will be high. A maximum of 10 to 12 story structures are possible in accordance to the maximum permissible height.

3.The structure falls in a very low Seismic Zone. No additional precautions are required for lateral loads so large spans are viable.



Masterplan: Wind Movement Strategy

30M wide tree lined pathways form primary movement axis on the site along the natural slope lines and wind movement



MASTER PLAN TARGETS ACHIEVED

Target Population = 60000 minimum

Ground coverage < 40%

Site area under native trees on site: >33%;

Total tree cover on site (including roads): >60%

Energy Performance Index (EPI) ≤ 45 KWh / sq. m / Year

Maximum Solar heat gain: < 1 W / sq. ft of BUA

90 % building floor plate is day -lit, uniformity ratio ≥ .6, glare free office space

Office Floor efficiency ≤ 100 sq.ft per person of built up area

Tree plantation along the plot boundaries

Shaded 8M fire – driveway abuts all sides of buildings on site

Buildings placed strategically to create wind - tunnel effects and street shading

External services integrated with roads and open spaces

No workstations abut the external wall; Workstations oriented perpendicular to the external wall with monitors facing away from the windows.
Envelope optimization

LAND ALLOCATION SUMMARY		
Water reservoir:		32 acre
12 SDB plots:		36 acre
Surface parking:		16 acre
Multilevel parking:	16 acre	
Road & Forest		42 acre
TOTAL:		142 acre

PASSIVE BUILDING STRATEGY

a. 100% Daylight
b. 100% Shading
c. No Glare
d. No Blinds – Clear Views

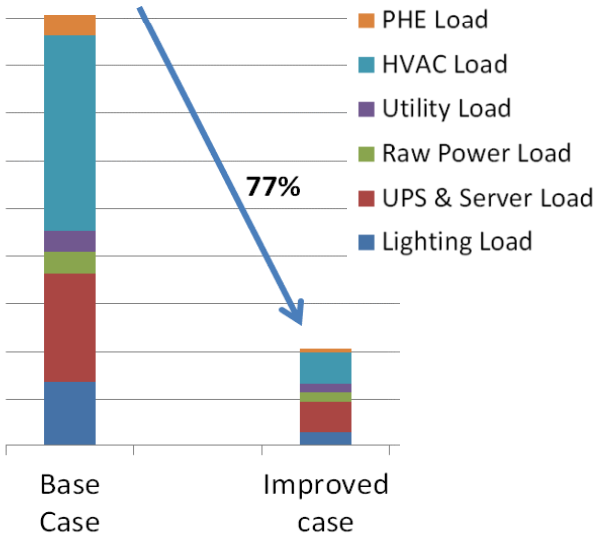
Building Morphology : Energy Performance Index

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

	Conventional Building		Improved Case	
Description	**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
Total	**10.0**	**251.9**	**2.5**	**63.0**

→ **Governed by Building Design**

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



Building Morphology

Efficiency Parameters		Design Considerations
Orientation : North-South Orientation		
Optimum Orientation for Minimal Solar Exposure		22.5º NNE-SSW

Robust Envelope Design: 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	1.04
Max. Window : Wall Ratio (WWR)	60%	≤ 25%

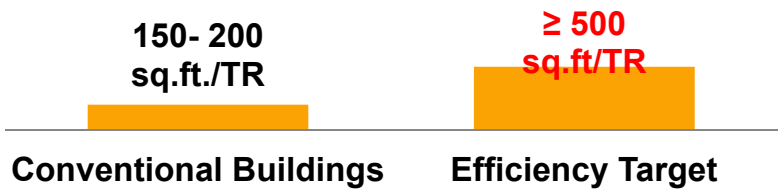
Solar Control: Effective Shading Design

Effective SHGC for Glass (Shading)	0.25	0.03 - 0.15

Resultant Envelope Load*	**≥ 4.5W/sq.ft.**	**≤ 1.0W/sq.ft.**

**Envelope Load : Design cooling load for HVAC systems*

Design Cooling Loads for HVAC Systems



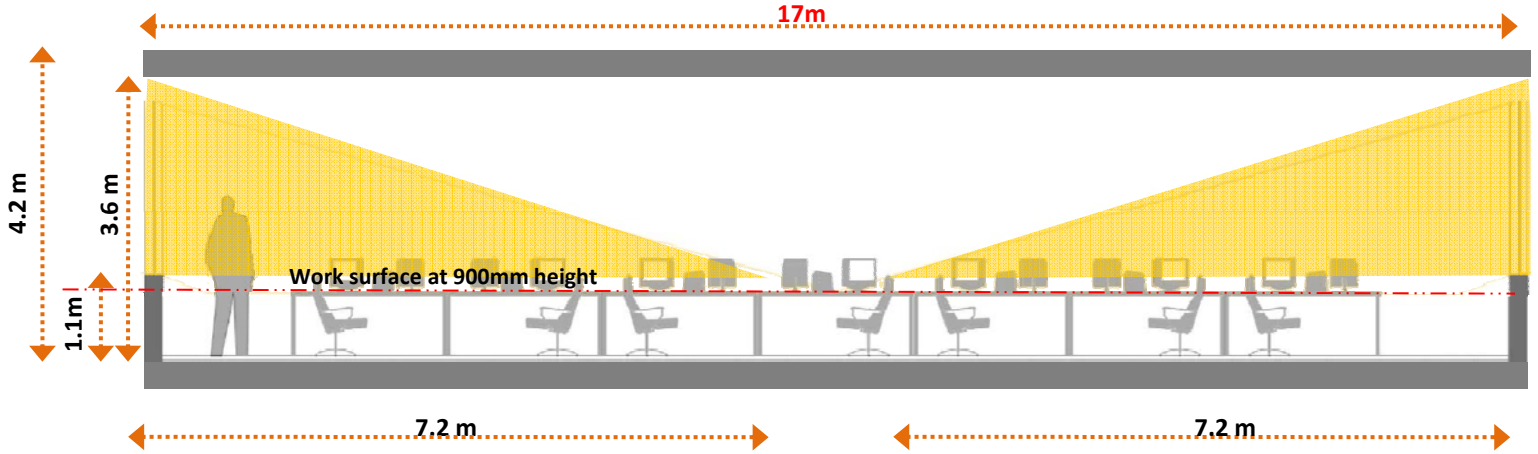
Inference:

Cooling Loads on HVAC systems can be reduced by ~80% through efficient design of the building envelope

Building Morphology : 90% Daylighting / No Glare

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

Depth of floor plate to ensure 90% daylight



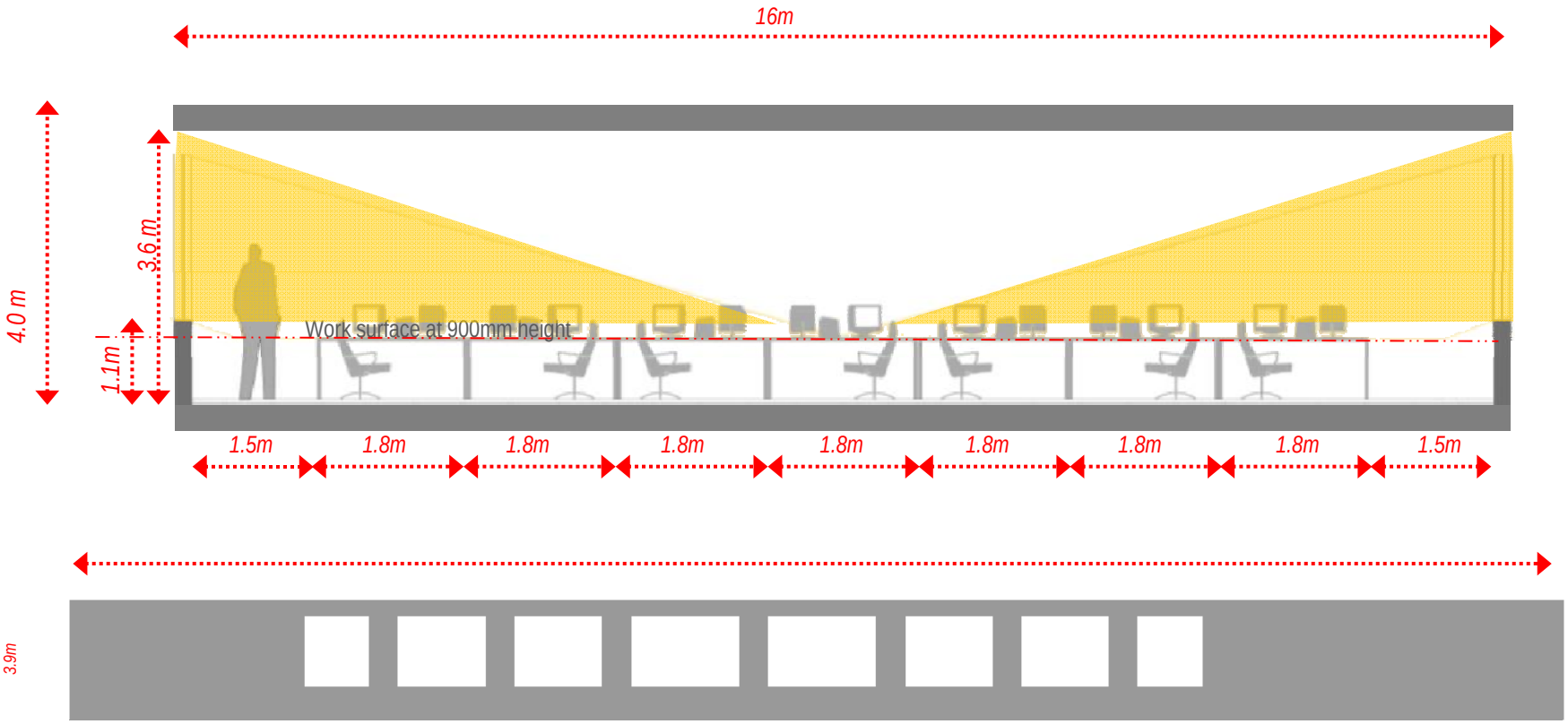
Reduction in Lighting Power Density (W/sq.ft)

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%

Building Strategies: 90% Day lighting <30%WWR

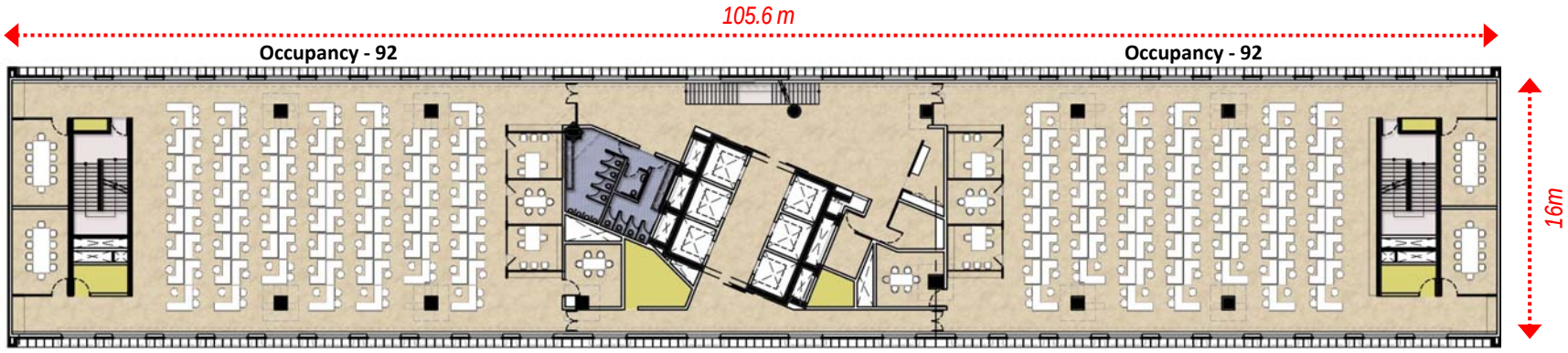


North & South Elevation: 28.5% WWR

Inference:

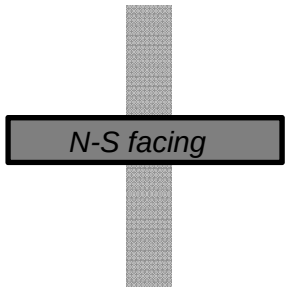
- *The extent of daylight penetration in a building floor plate is 2 times the height from the floor to top of the window.*
- *Therefore, floor plate depth limited to 16m with a floor to floor height of 4 M*

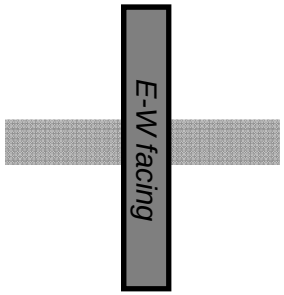
Building Strategies: Morphology: Floor plate design

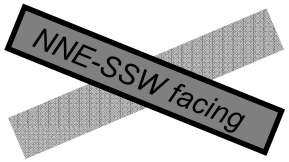


Floor plate 92 + 99 (191) people; Efficiency 95 sq. ft. per person

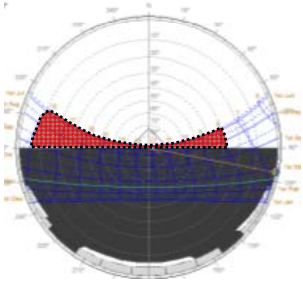
Building Strategies: Shadow Analysis



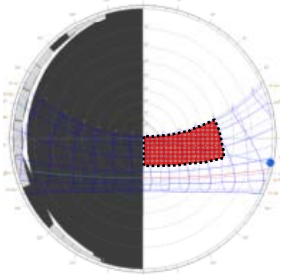




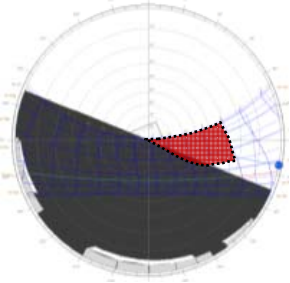
North



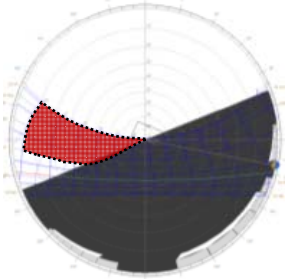
East



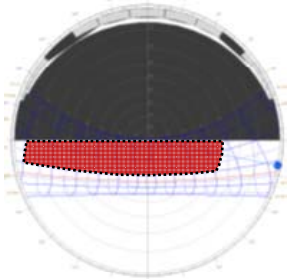
22.5 ° NNE



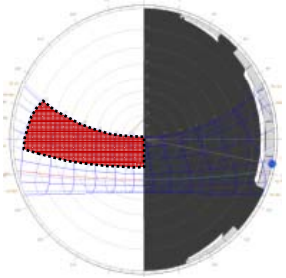
22.5 ° NNW



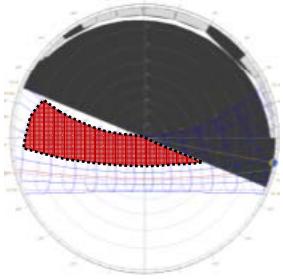
South



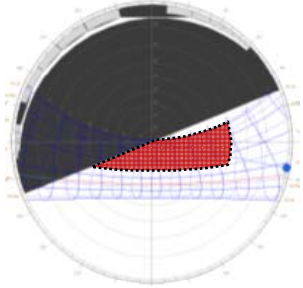
West



22.5 ° SSW



22.5 ° SSE

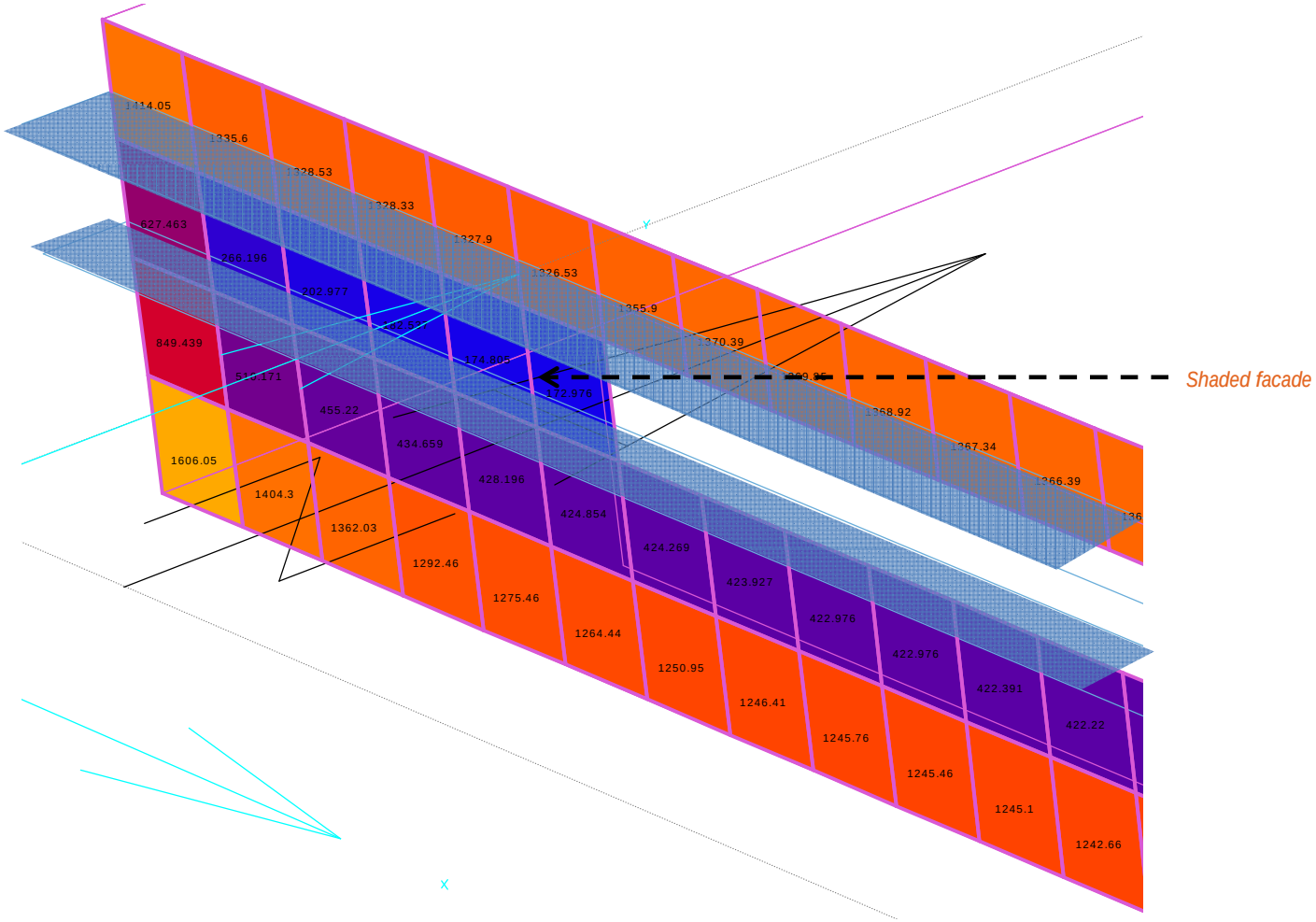


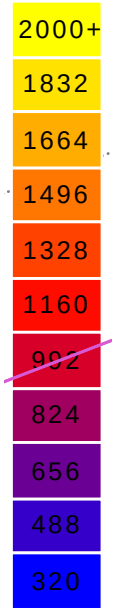
Inference:

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

Shading Analysis : Wall

Shaded Wall has 1/5th the amount of solar radiation than on a non shaded area of Wall

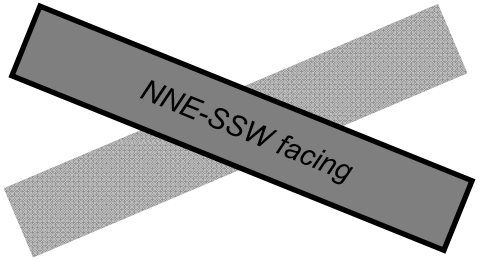


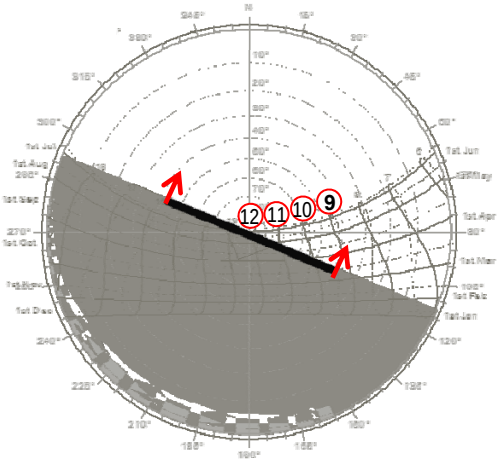


Inference:

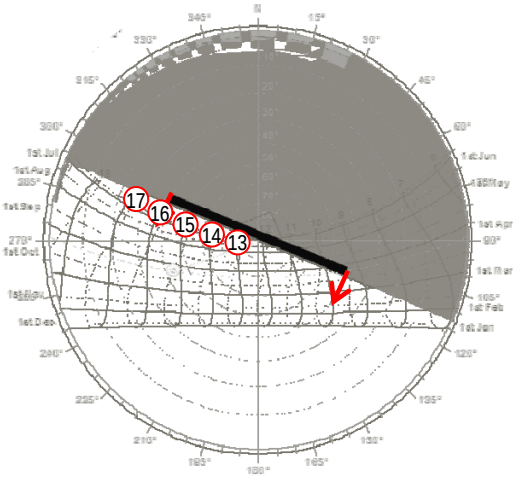
•Shading of wall surface is highly beneficial to reduce solar heat gains

Shading Analysis : Identifying critical times for shading

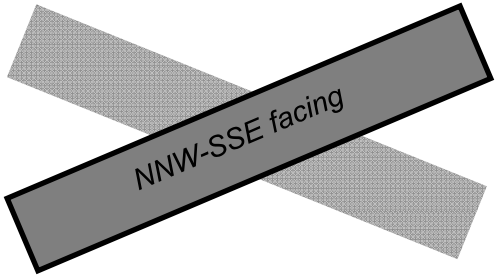


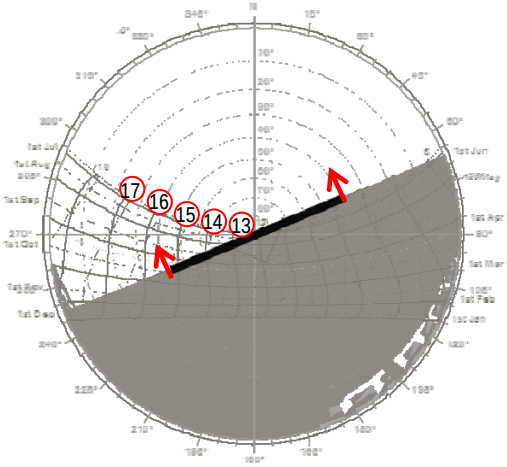


NNE Facade

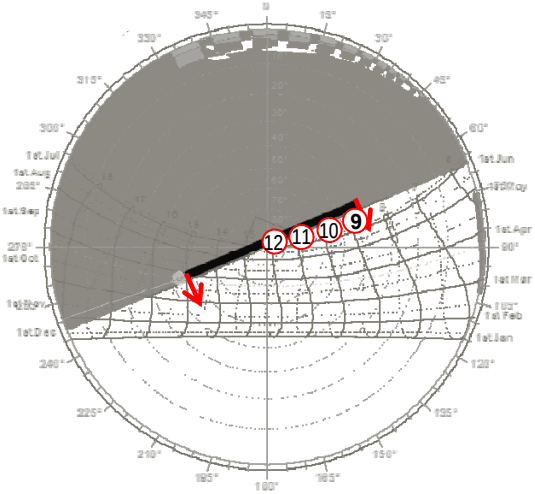


NNW Facade





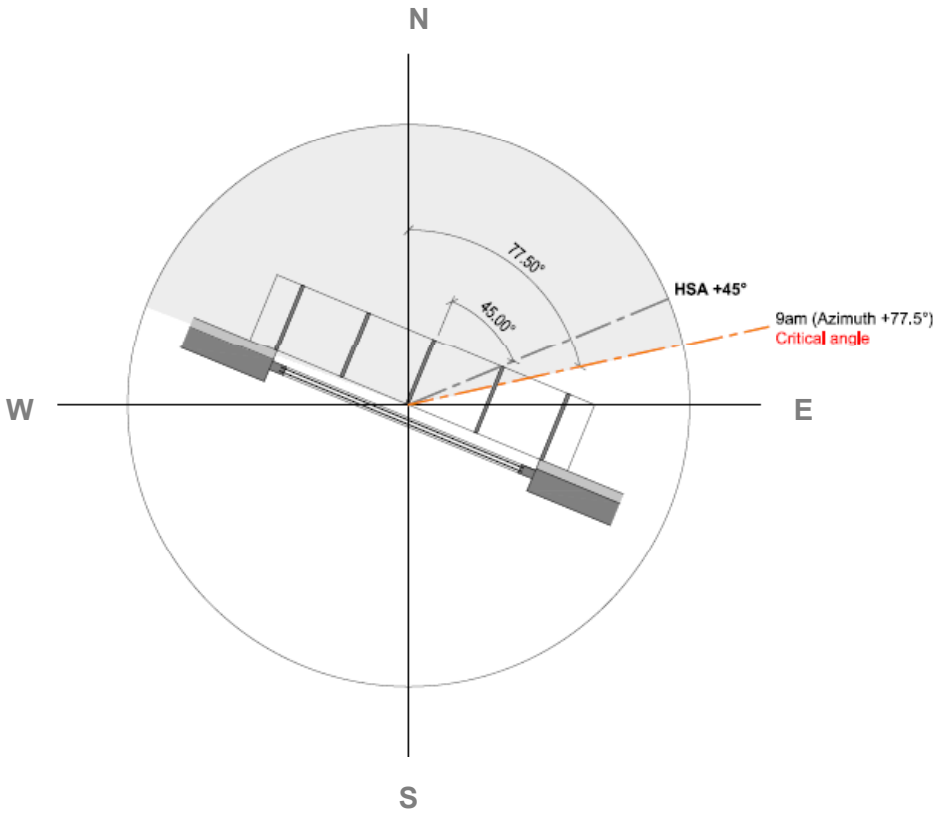
SSE Facade



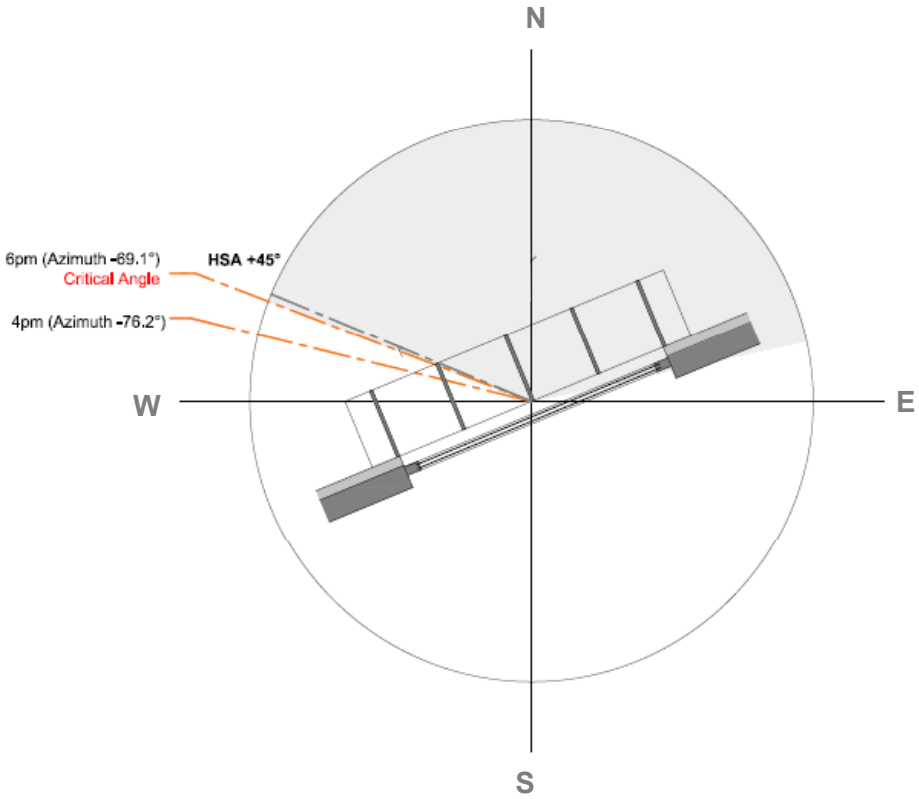
SSW Facade

Shading Analysis for peak conditions Identified through sun-path diagram

Shading Analysis : Shading critical angles for northern façades



Orientation: North, North-East
Date: 21st June

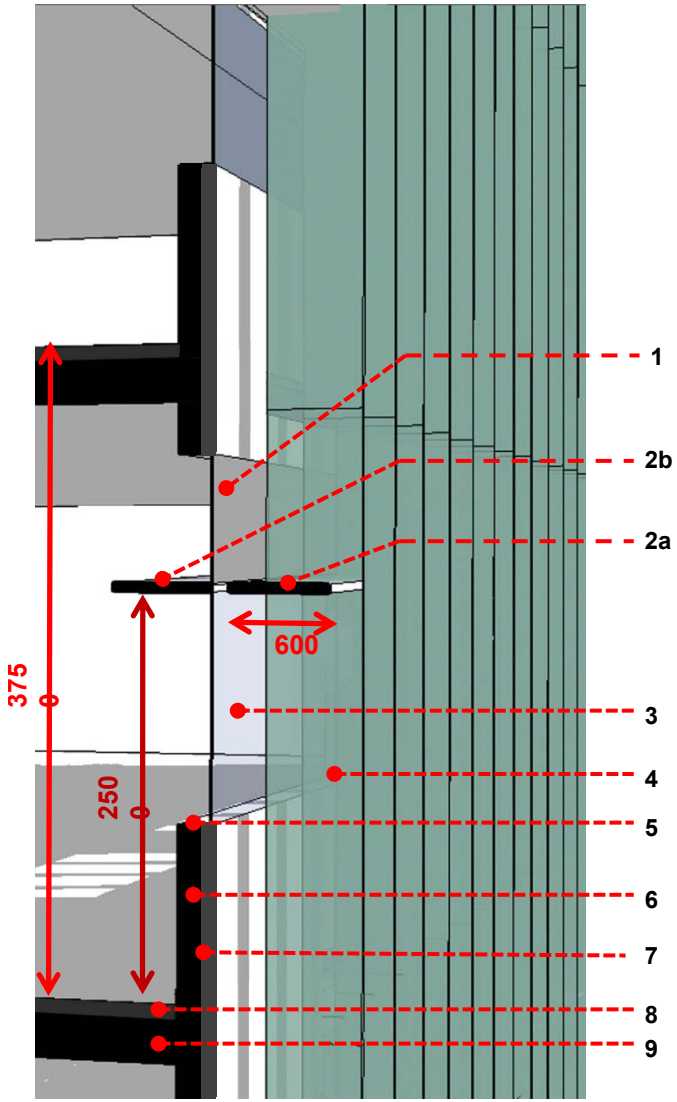


Orientation: North, North-West
Date: 21st June

Shading System: North façade (NNW,NNE)

Façade system with vertical fins for shading

600 deep vertical fins @ 600 c/c and 600 deep horizontal fin @ 2500



Legend

1. Daylight Window
(SKN: 154, frosted, LT: 40% (unobstructed floorplates), 50% (obstructed floorplates)

2a. 600mm deep solar shade@2500

2b. 600mm deep internal light shelf @2500

3. Vision Window (SKN: 154)

4. Vertical shading device 600mm deep @ 600mm c/c

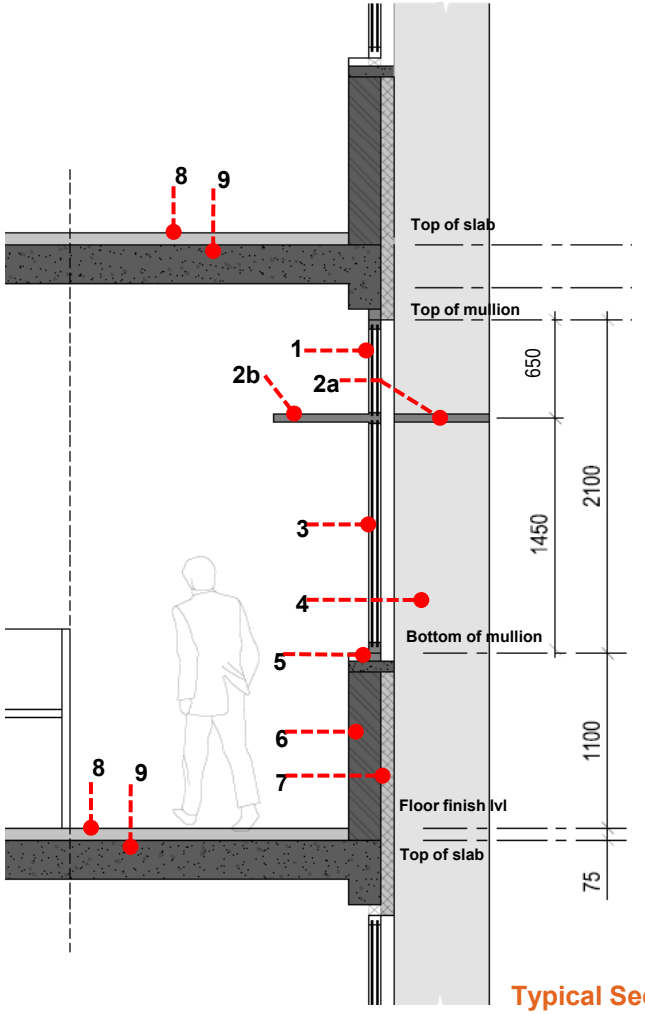
5. RCC sill (To be detailed)

6. Concrete block single wall (200mm THK)

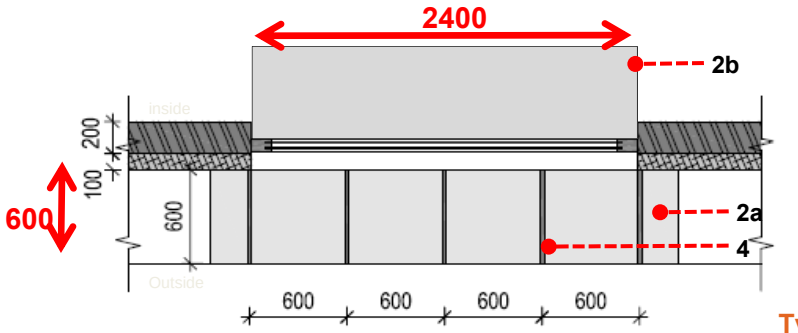
7. 100mm THK exterior insulation + plaster + paint

8. 75mm floor finish (including 12mm vitrified tile, screed and raceways

9. RCC slab– 250 mm thickness assumed (to be confirmed by LERA)

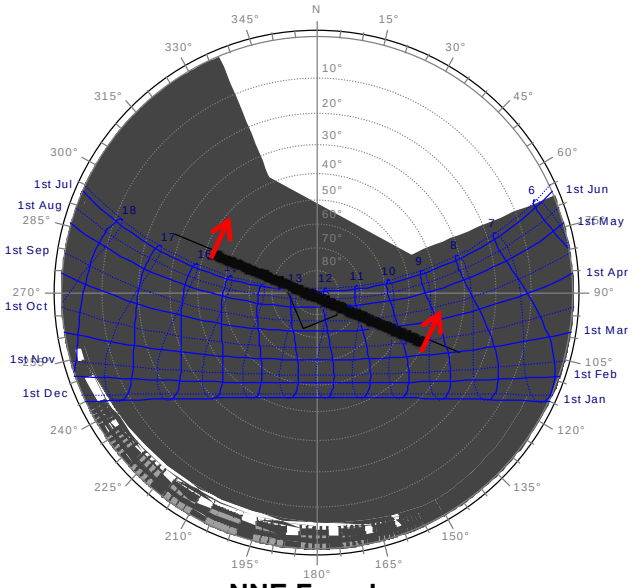


Typical Section

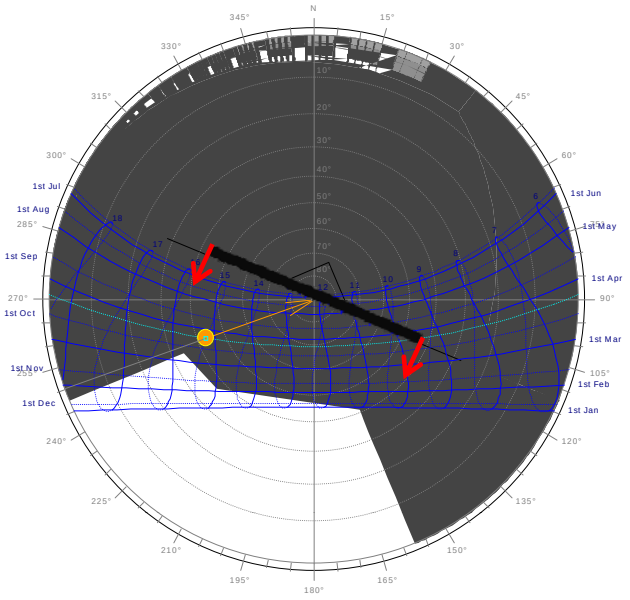


Typical Plan

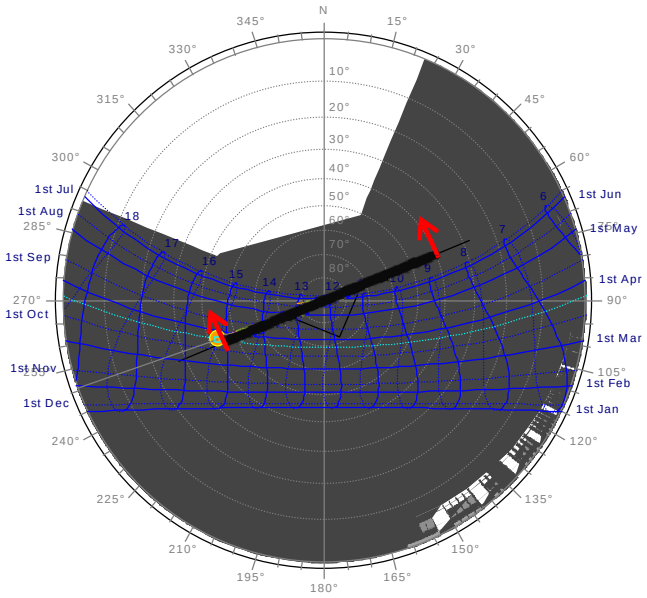
Shading Analysis : Effect of shading device design by manual calculations



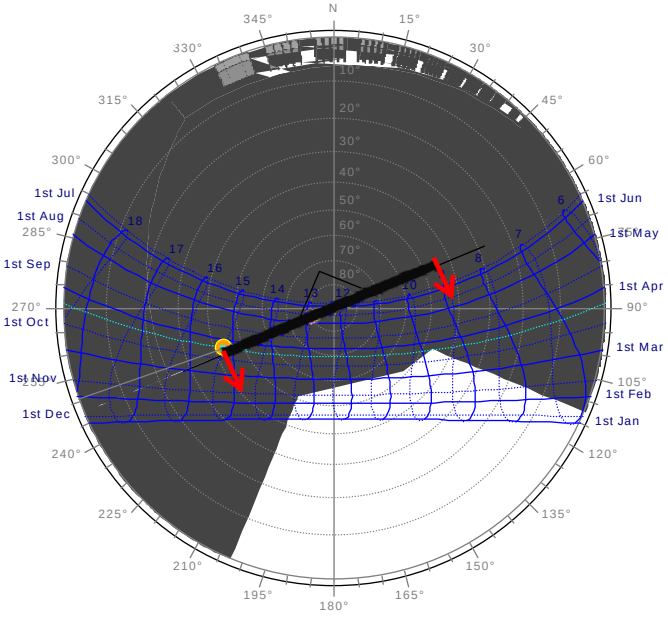
NNE Facade



NNW Facade



SSE Facade



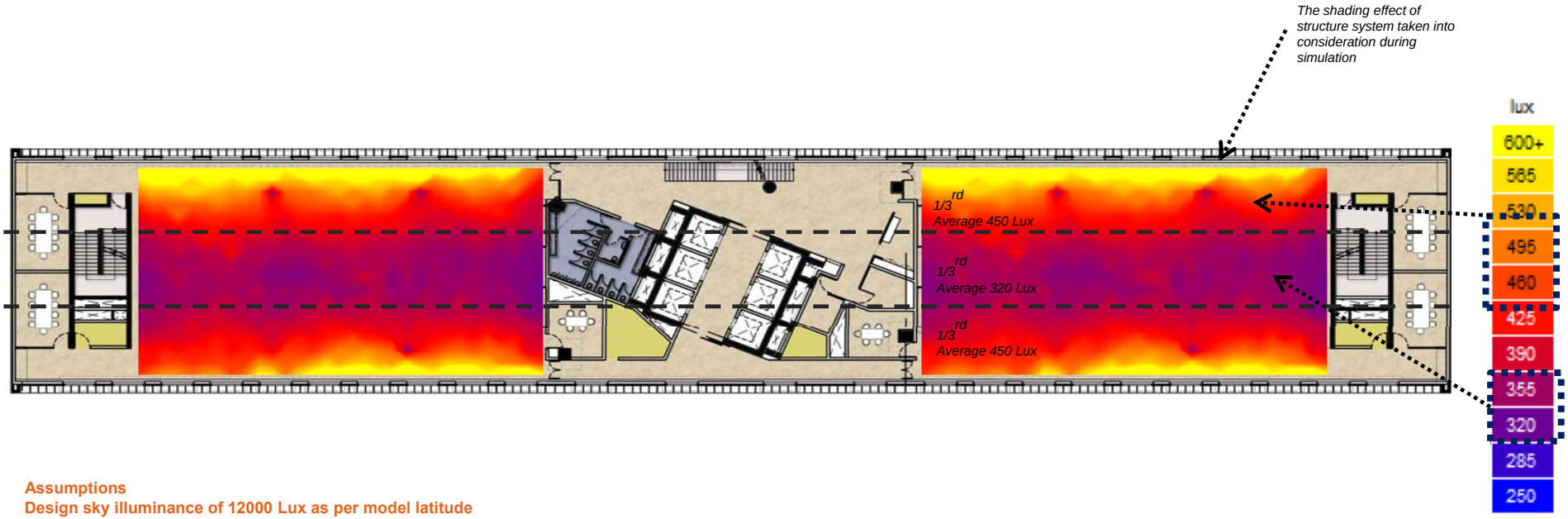
SSW Facade

Building Strategies: Daylight Analysis

A daylight analysis was undertaken for a typical floor in Ecotect.

The result shows that a good daylight distribution is achieved throughout the floor plan, i.e. 90% of the floor plate day-lit (29% WWR)

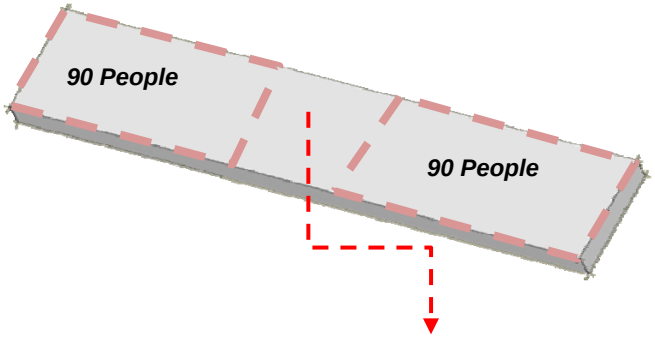
An average of 320-450 Lux of illuminance will be achieved with no glare and a uniformity ratio ≥ 0.6



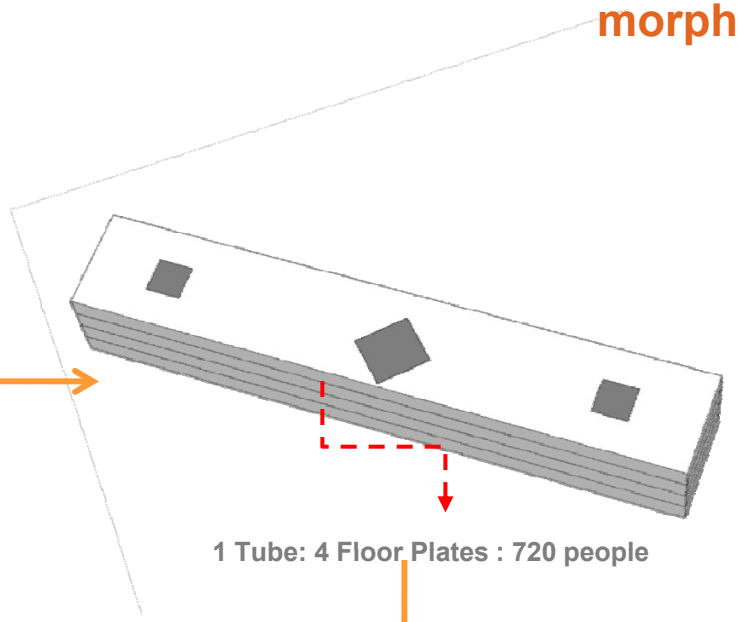
Assumptions
Design sky illuminance of 12000 Lux as per model latitude
Visual Light transmittance: 0.7

Surface Reflectance:

Walls:	**50%**
Floor	**30%**
Ceiling:	**50%**



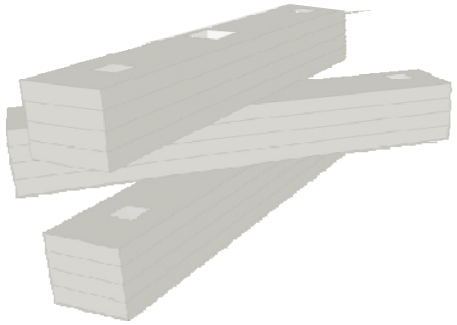
One Floor Plate : 180 people



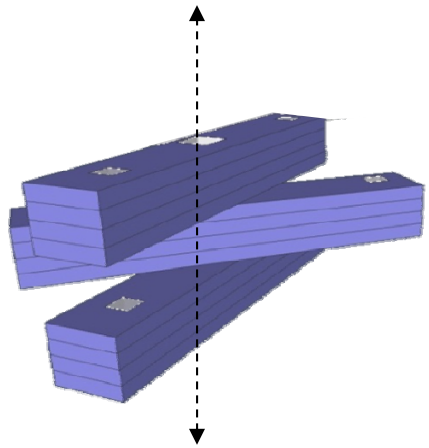
1 Tube: 4 Floor Plates : 720 people

Total occupancy of 1 SDB	*: 5000 people*
1 Tube	*: 720 people*
Number of tubes required	*: 7*
	(5000/720)
CCC Block	*: 1 tube*

Total number of tubes required for one block : 8



Base Module 'X' with 3 tubes

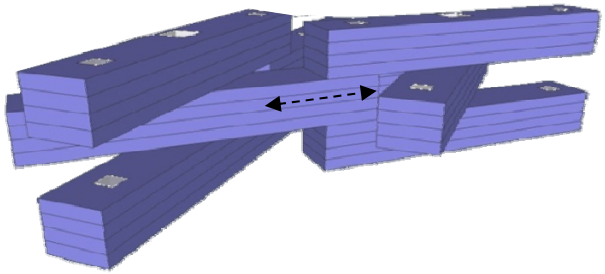


Module 'X':

3 Tubes Rotated along the core

(45 degrees)

Constant parameter 'X' connected using A



A : Sliding along the edge

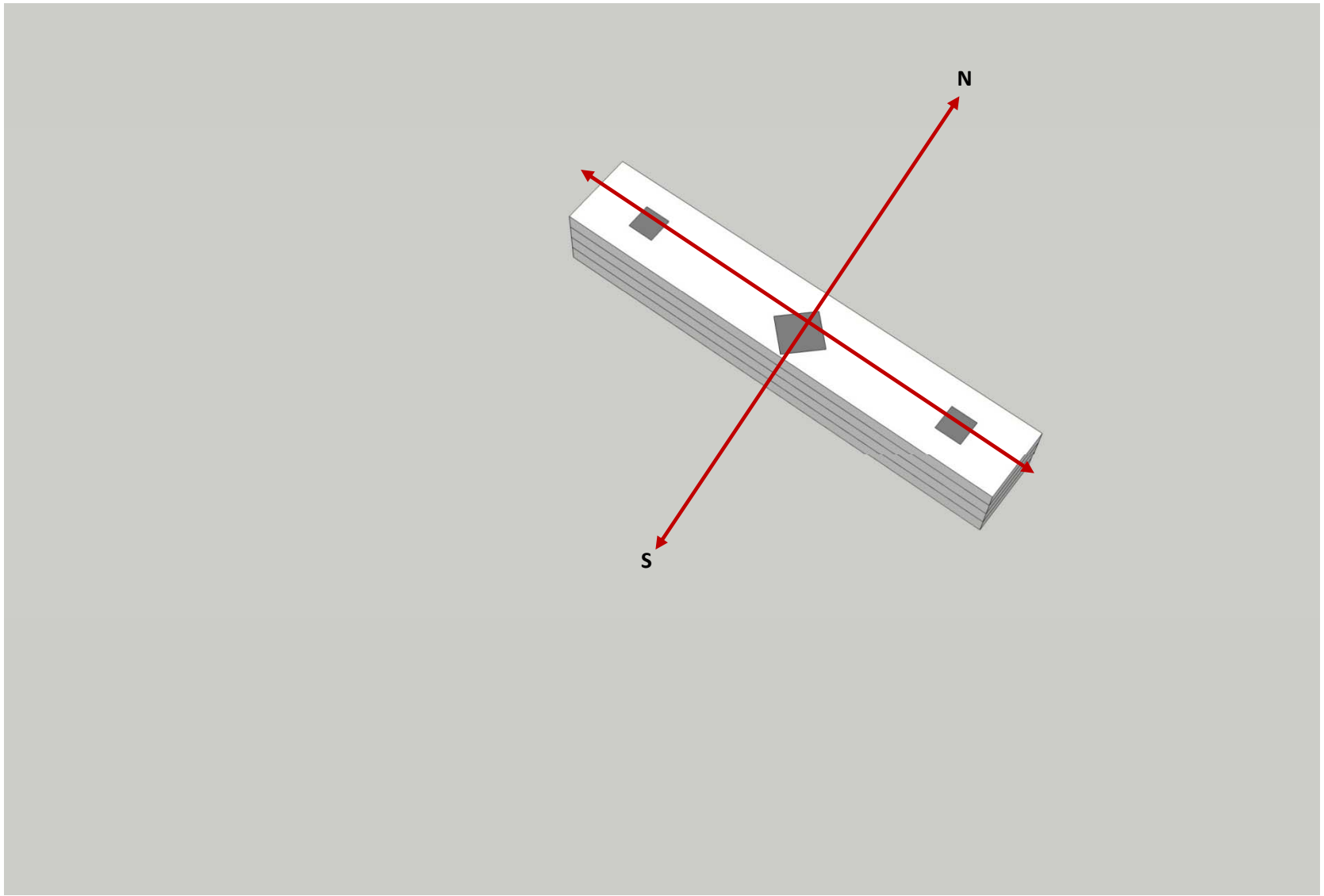
Combination of the same Module X using technique A (Sliding along edge) by placing 3 modules at the base generates 6 unique generations (P-U).

These unique generations under 6 similar functions gives 20 further new generations which can be used for SDB morphology according to specific plot size.

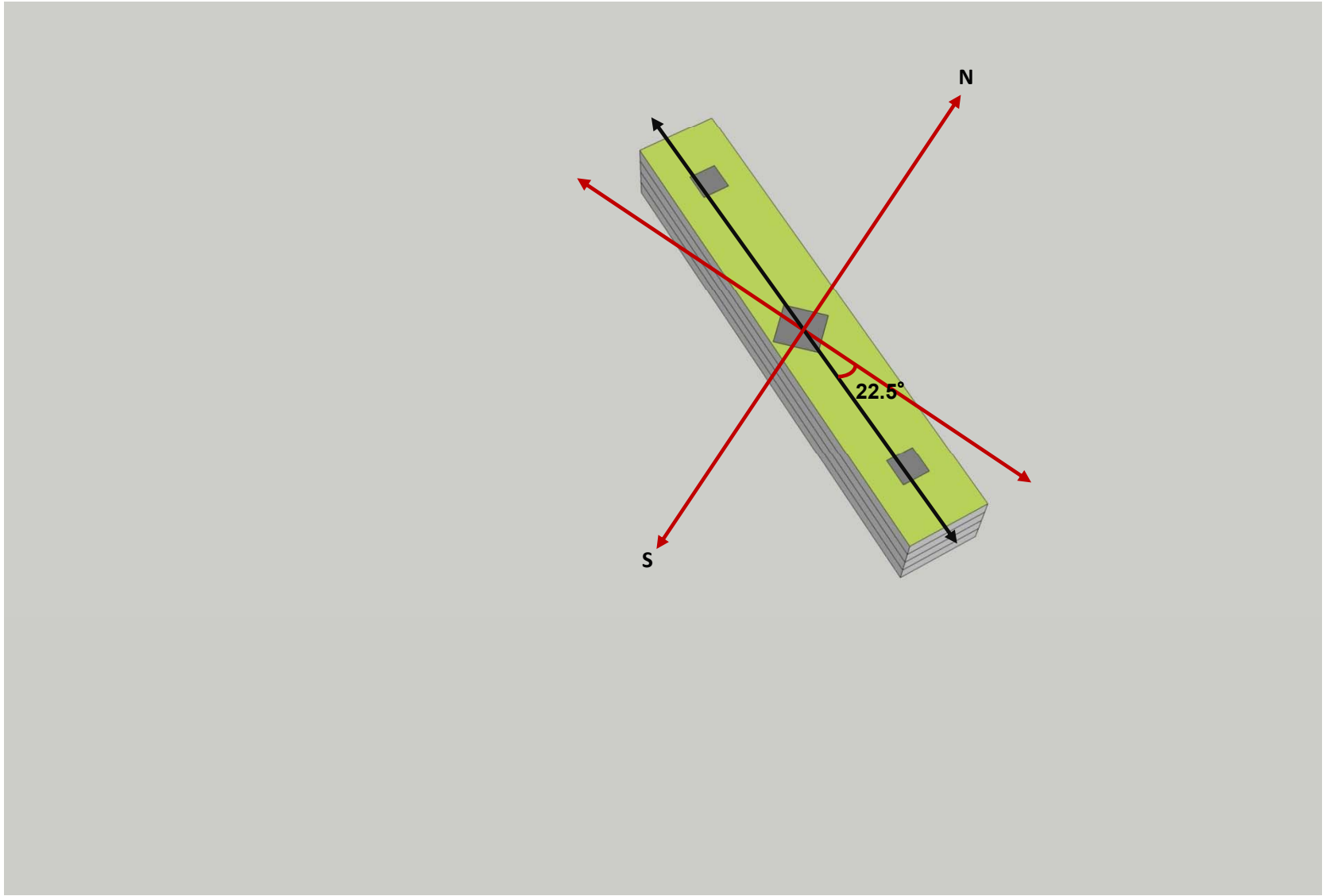
When 4 modules are placed at the base it generates 9 unique generations (A- J) Further these unique generations under similar functions gives 35 new generations which can be used in later phases where the site level increases.

Rule set : 3 tubes at the base at all times

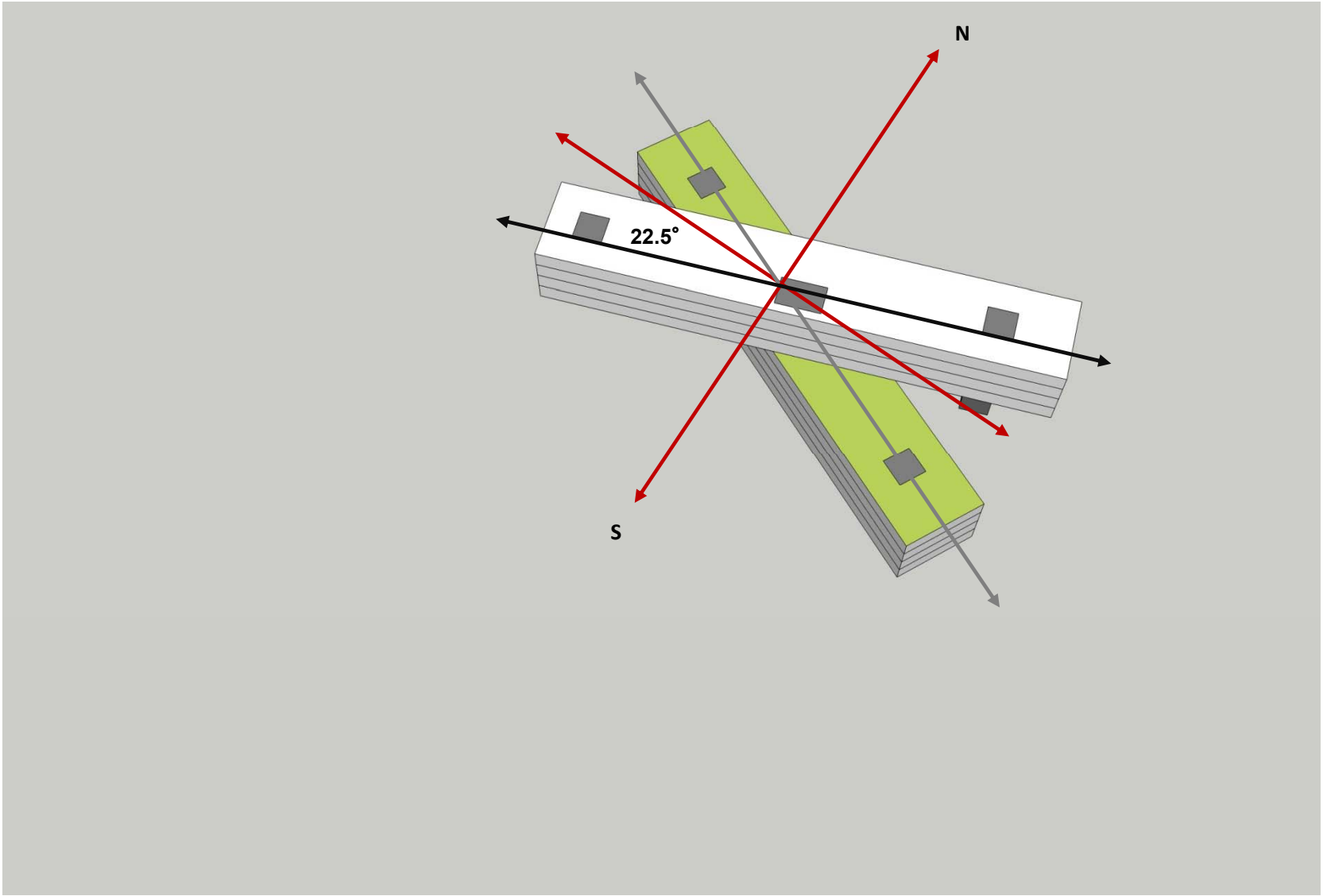
Building Strategies: Morphological Development



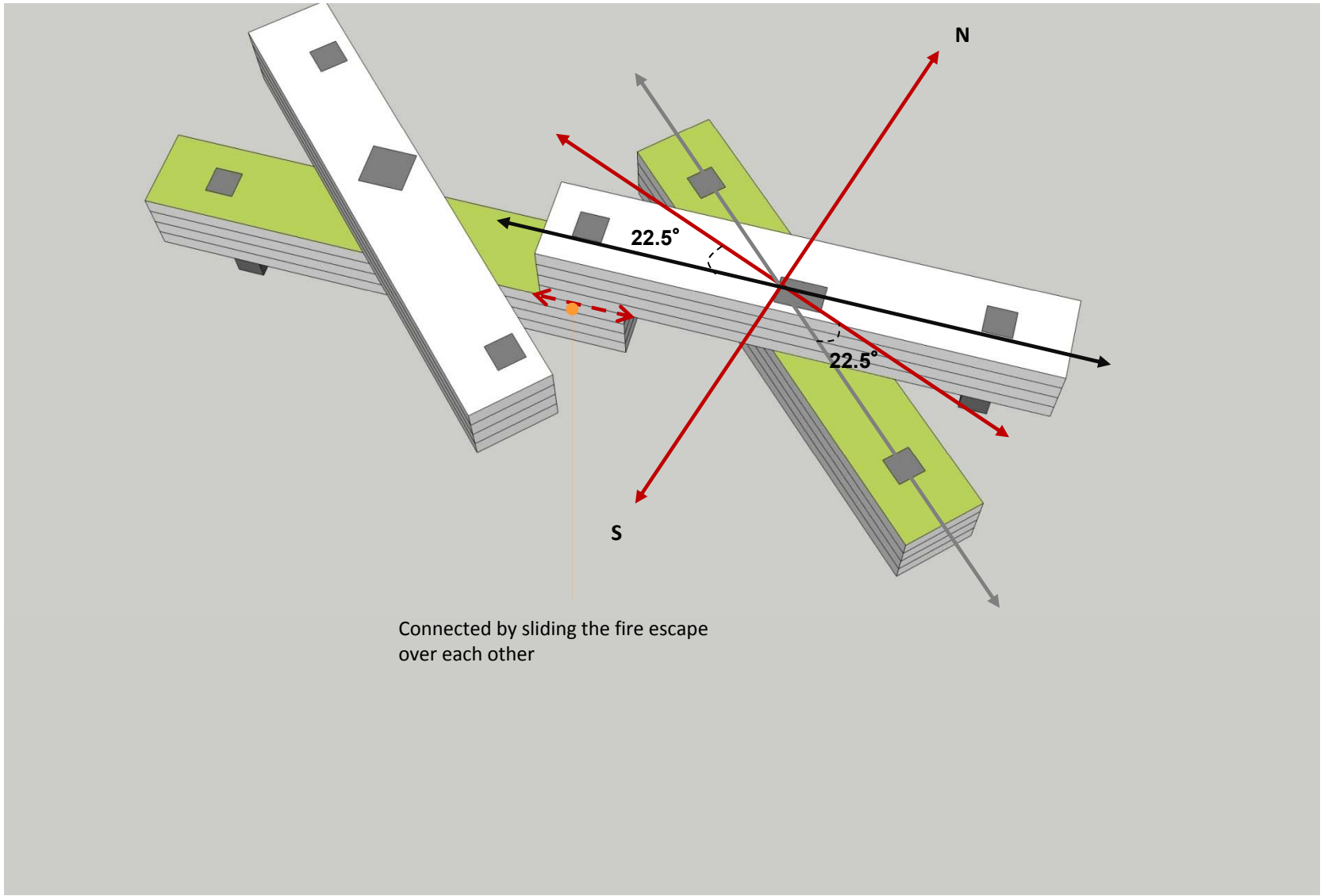
Building Strategies: Morphological Development



Building Strategies: Morphological Development

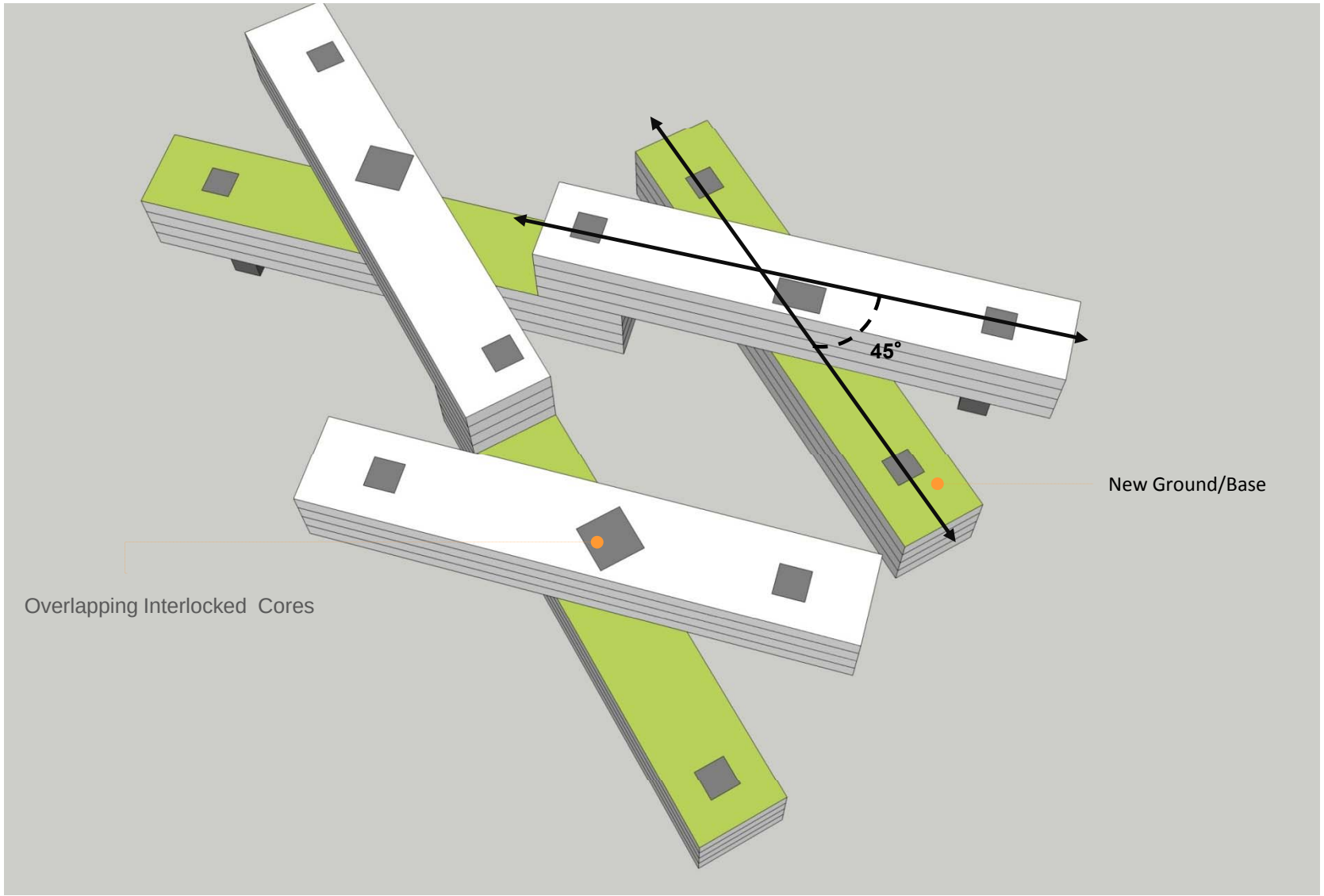


Building Strategies: Morphological Development



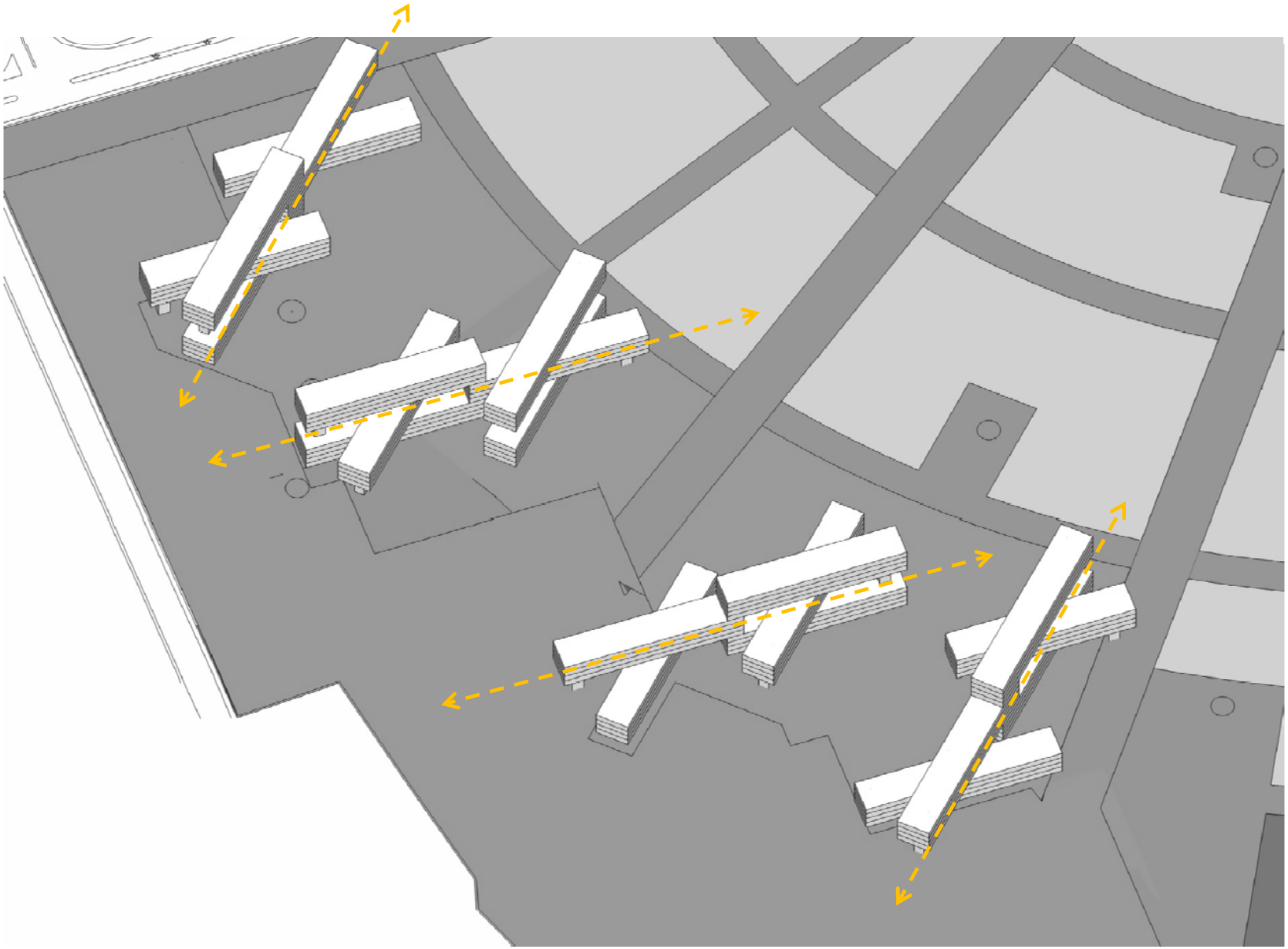
Connected by sliding the fire escape
over each other

Building Strategies: Morphological Development

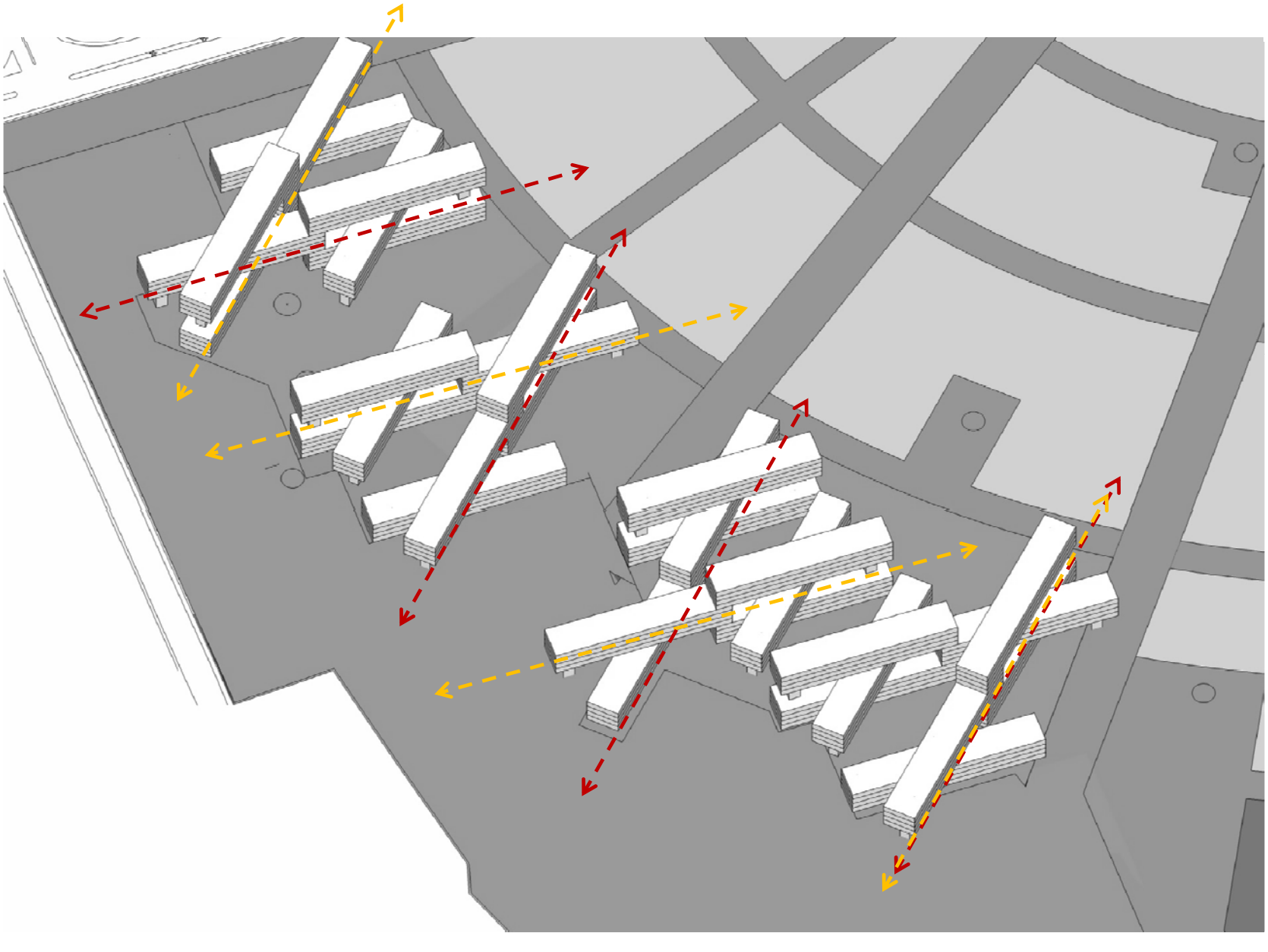


Building Strategies: Morphology: Phase-1 & 2 Configuration

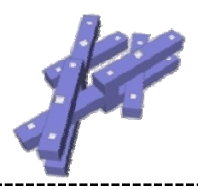
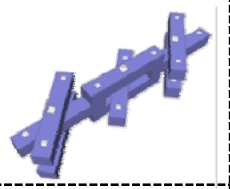
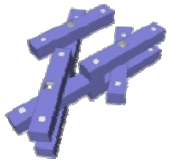
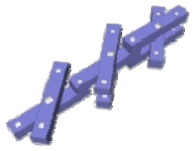
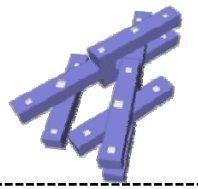
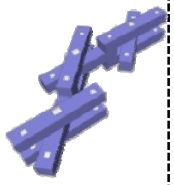
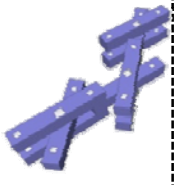
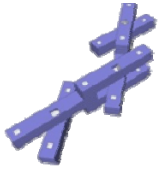
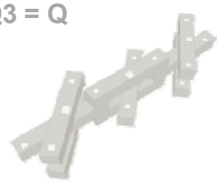
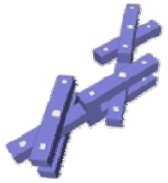
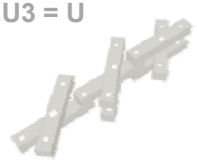
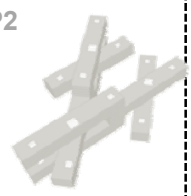
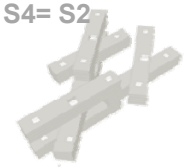
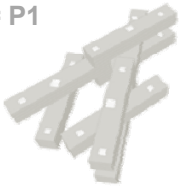
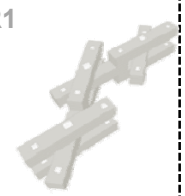
Building Strategies: Morphology: Phase-1 & 2 Configuration



Building Strategies: Masterplan Morphological Development



Building Strategies: Morphology : Potential Configurations for 8 Block SDB

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


In search of the world's most
sustainable office building:
Naturally day-lit,
Glare-free workplace
Infosys
morphogenesis.

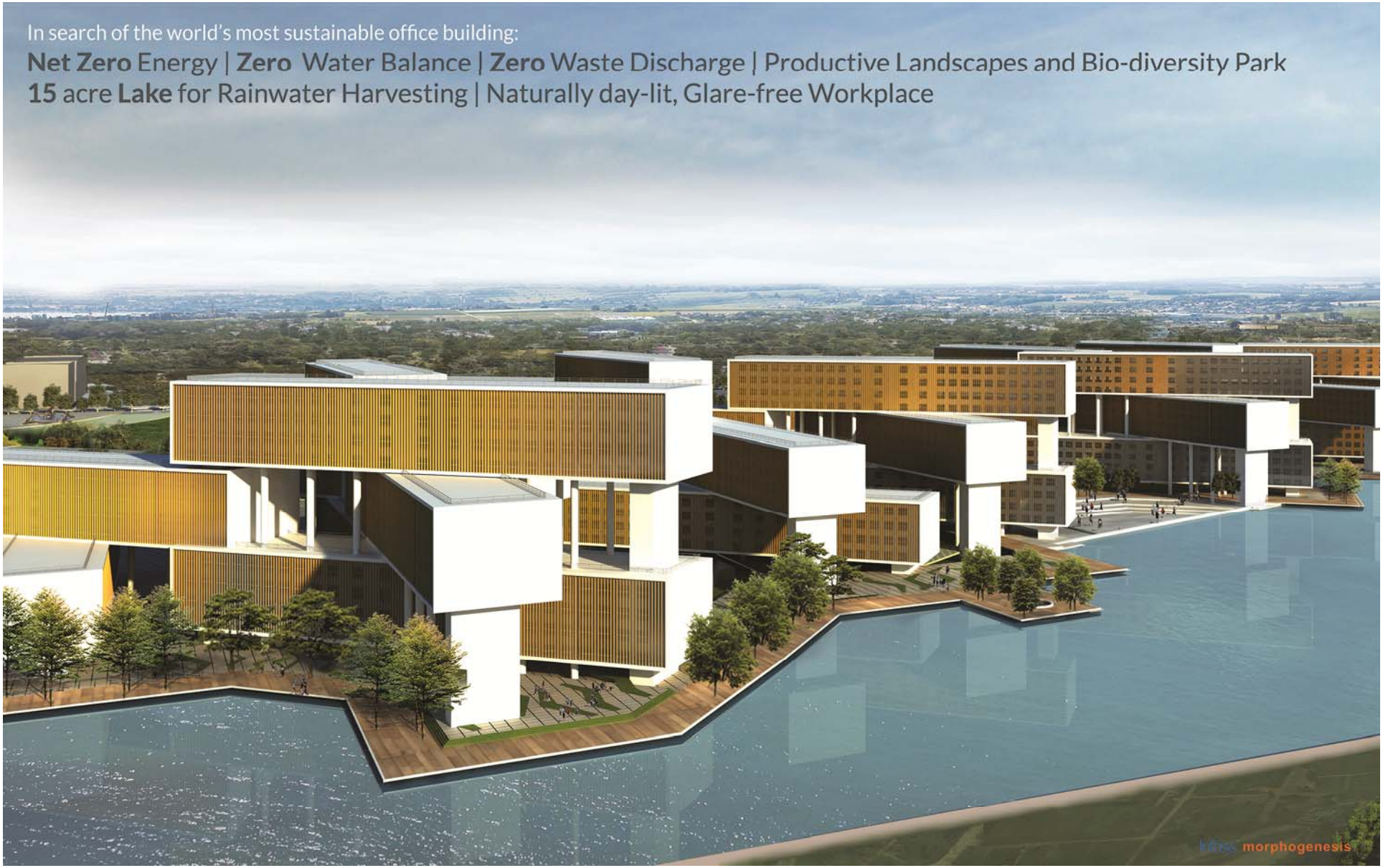

In search of the world's most
sustainable office building:
Productive Landscape
and Bio-diversity Park
Infosys
morphogenesis

In search of the world's most
sustainable office building:
NET ZERO ENERGY


In search of the world's most
sustainable office building:
Zero Water Balance
Infosys
morphogenesis


In search of the world's most
sustainable office building:
Zero Waste Discharge
Infosys
morphogenesis


In search of the world's most
sustainable office building:
15 acre Lake for
Rainwater Harvesting
Infosys
morphogenesis

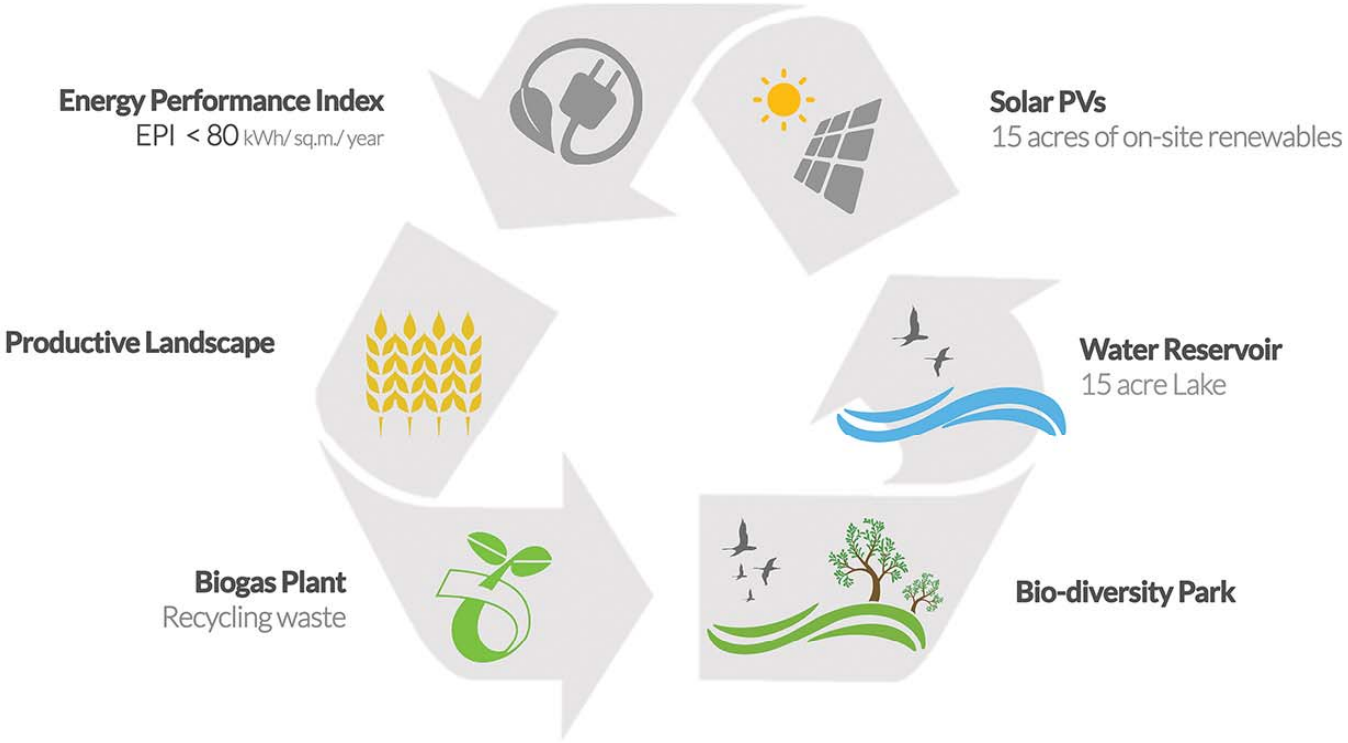

In search of the world's most sustainable office building:
Net Zero Energy | **Zero** Water Balance | **Zero** Waste Discharge | Productive Landscapes and Bio-diversity Park
15 acre **Lake** for Rainwater Harvesting | Naturally day-lit, Glare-free Workplace
morphogenesis

In search of the world's **most sustainable office building...**

ZERO energy

ZERO water

ZERO waste



Energy Performance Index
EPI < 80 kWh/ sq.m./ year

Solar PVs
15 acres of on-site renewables

Productive Landscape

Water Reservoir
15 acre Lake

Biogas Plant
Recycling waste

Bio-diversity Park

Rating pledge :

LEED® v4 Platinum | GRIHA® 5-star | LIVING BUILDING CHALLENGE™

Infosys®
morphogenesis.

Is Population the issue?

India's population: 1.22 Billion People

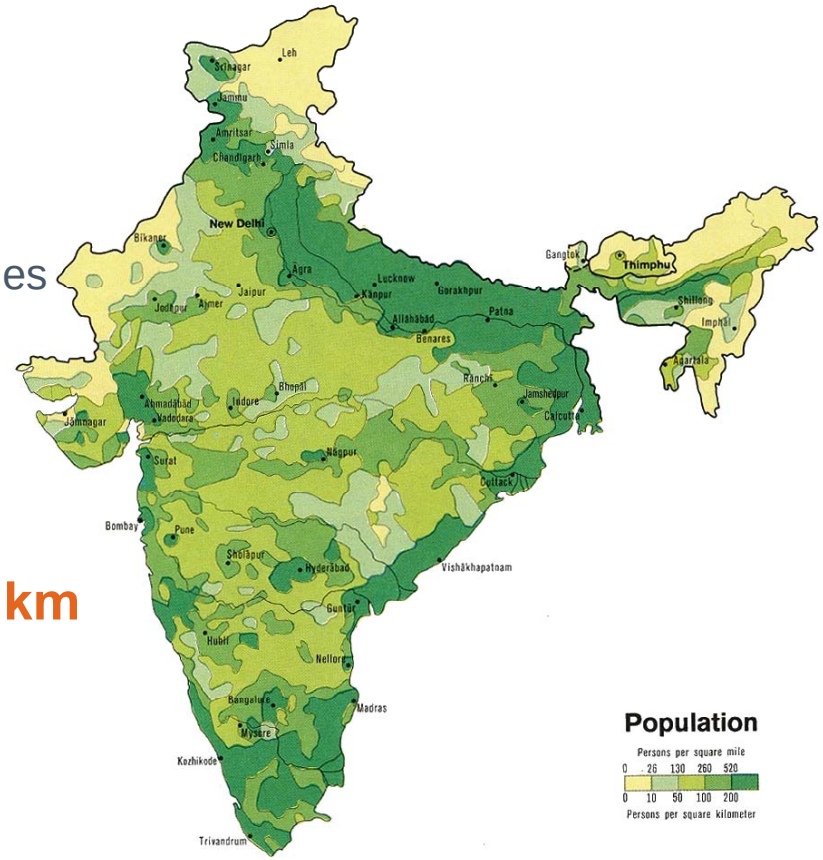
No: of people per Family: 5 – Total 244 Million Families

Each Family of 5: 200 sq m of Land
(400 sq m of Land including roads and Social Infrastructure)

Therefore, total land required: 97,600 sq km

Total Land Area of India: 3,060,500 sq km
(3.06 Million sq km)

Population Density in India

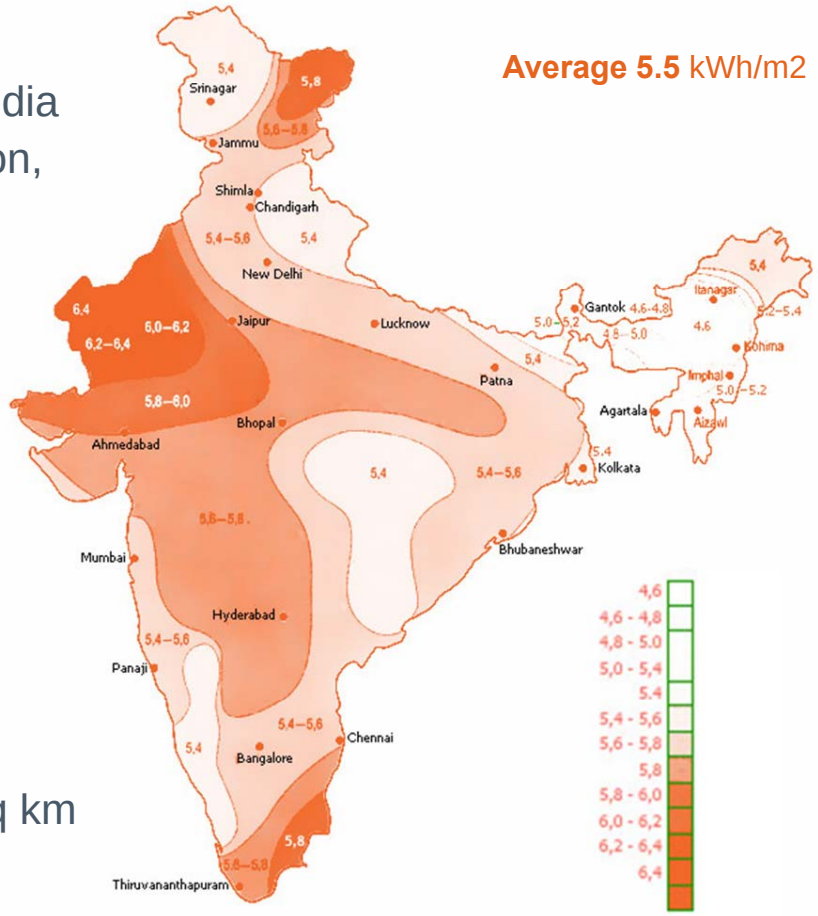


Which means Only 3% of India's Land Mass is required to house India's population – Each family with a 200sqm plot of land

Is Clean Energy the issue?

Daily Solar Radiation in India (KWh/m2)

Average 5.5 kWh/m2



The current yearly per capita energy consumption in India is **680 kWh,** after considering transmission, distribution, transformation losses of 20%, etc (source: World Bank)

India's population: 1.22 billion

Total Consumption: 829,600,000,000 kWh

Average annual solar radiation: 365 * 5.5 = 2000 kWh/m2

Average efficiency of solar unit (inc. transmission losses)**:** 15%

Average output per year: 2000 x 0.15 = 300 kWhr/m2

Area of solar panels required to produce required output: 2765 sq km

Land area required to house the panels 10,000 sq km or

2.2% of India's wasteland.

This is less than 1/3 of the desert district of Barmer in Rajasthan

Is Water the issue?

Shortfall: Currently only 25% of India's population has drinking water on their premises. According to World Bank estimates, India will exhaust its fresh water by 2050 at the current rate.
(source: Hindustan Times, Aug 26, 2012)

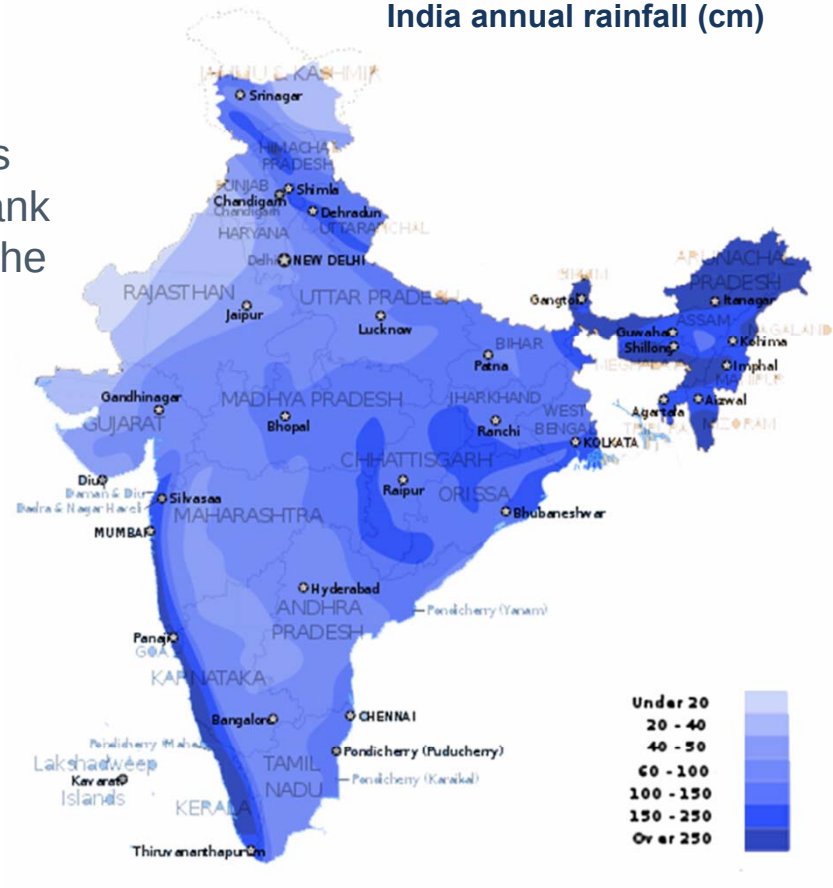
India's average yearly precipitation: 1083mm (source: World Bank)

Total Land Area of India: 3,060,500 sq km
(3.06 Million sq km)

Total Precipitation, therefore: 3,314,500 billion litres

Assuming 30% can be harvested: 994,350 billion litres for our population of 1.22 billion.

India annual rainfall (cm)



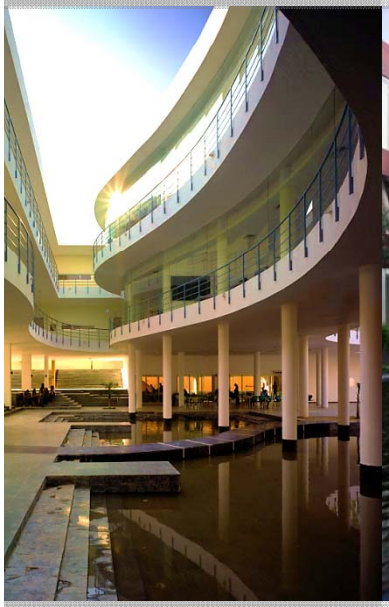
Therefore **each person, per day would have**

2230 litres of water

The International standard is 150 litres per person per day

Hybrid Building

Air-Conditioned Buildings



Pearl Academy, Jaipur
EPI : 25 kWh/sq.m/yr

India Glycols Ltd.
EPI : 90 kWh/sq.m/yr

GYS Vision
EPI : 64 kWh/sq.m/yr

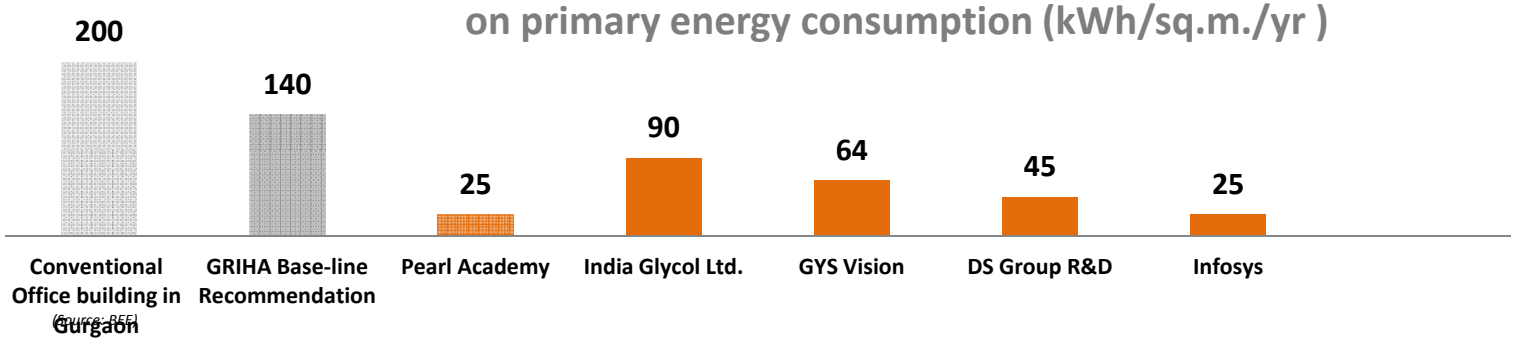
DS Group R&D Factory + Office
EPI : 45 kWh/sq.m/yr

Campus for Infosys, Nagpur
EPI : 25 kWh/sq.m/yr

2008 — 2009 — 2014 — 2016

Energy Performance Index (EPI)

on primary energy consumption (kWh/sq.m./yr)



(Source: BEE)