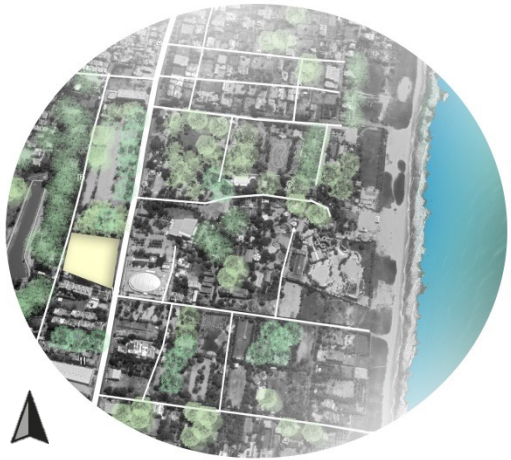
Commercial Complex At Chennai

SITE AND SURROUNDINGS

Site Details

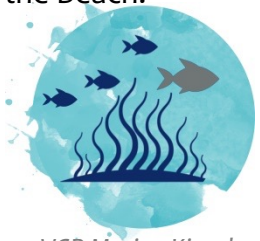
- **Location:** Injabakkam, Chennai.
- **Latitude:** 13.0827 N
  Longitutde: 80.2707 E
- **Climate:** Warm and Humid slowly moving towards Hot and Humid.



- **Site surroundings:**
- The site is abutting a 30 M wide East Coast Road and it is surrounded by low rise development.
- The surrounding area is well developed and it has Home stays and tourist Spots due to the proximity of the Beach.

VGP Golden Beach

Leisure Stays



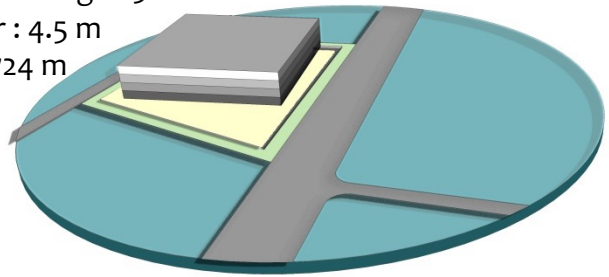
VGP Marine Kingdom

Site Calculations

- Site Area : 2.8 Acres (11350 sq.m)
- FSI : 2.5
- Total Built up : 28375 sq.m
- Recreational Space : 10 %

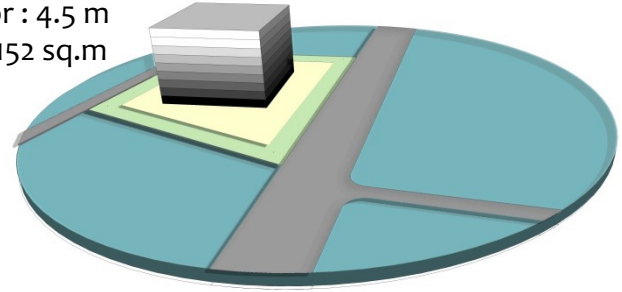
Maximum Ground Coverage and Minimum Height

- Maximum Ground Coverage : 50 %
- Height of Each Floor : 4.5 m
- Each Floor Plate : 6724 m
- No of Floors : 4
- Set Back : 7m



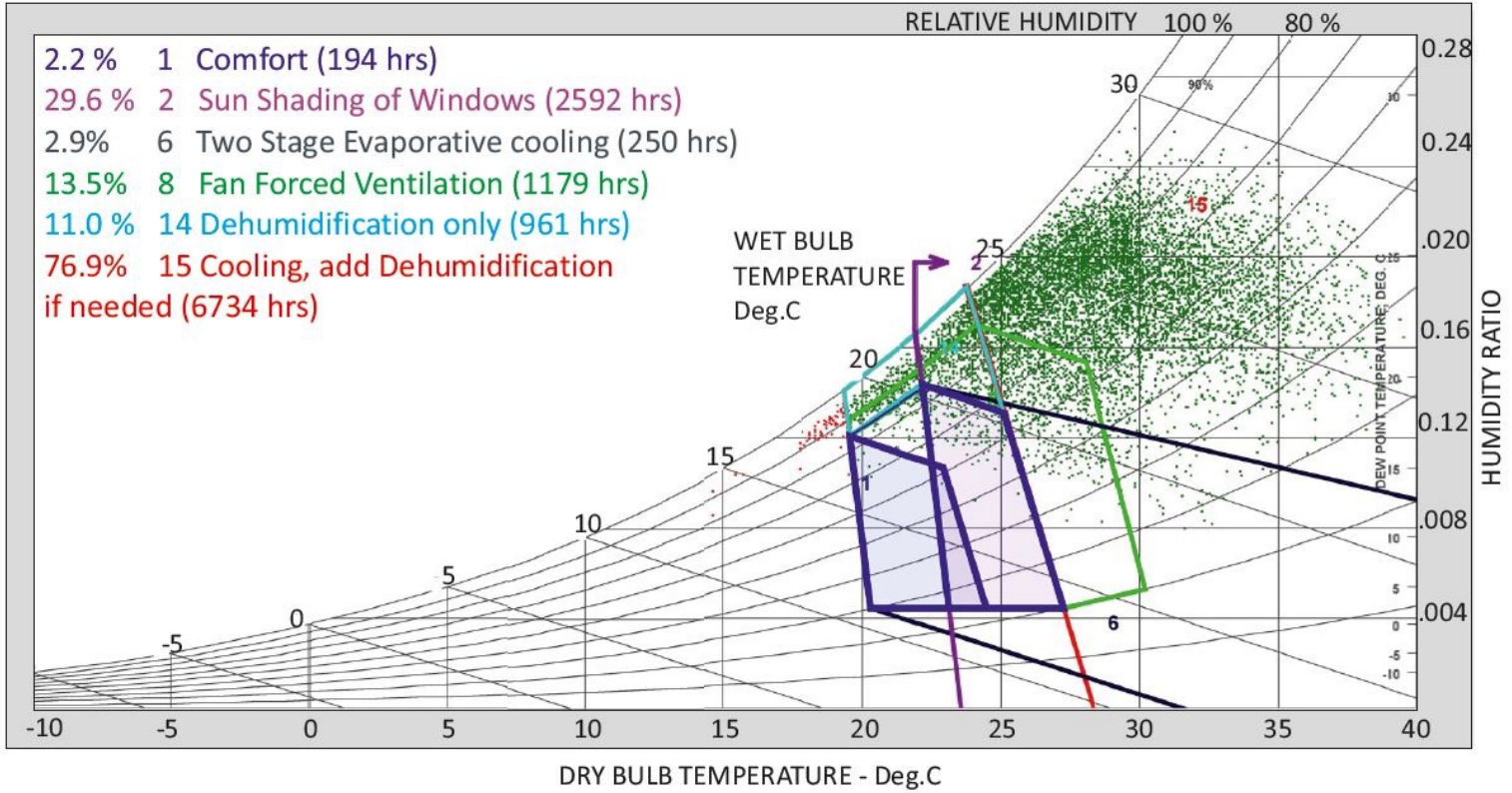
Minimum Ground Coverage and Maximum Height

- Height Restriction of the Building : 60 m
- Height of Each Floor : 4.5 m
- Each Floor Plate : 3152 sq.m
- No of Floors : 9
- Set Back : 12 m



PSYCHROMETRIC CHART

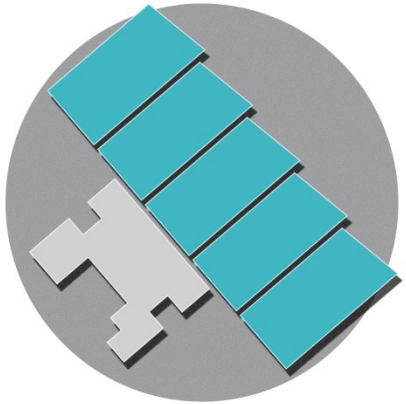
- The purpose of a psychrometric chart is to display the strategies used to achieve thermal comfort inside the building.
- Against each strategy the comfort hours have been mentioned as well.



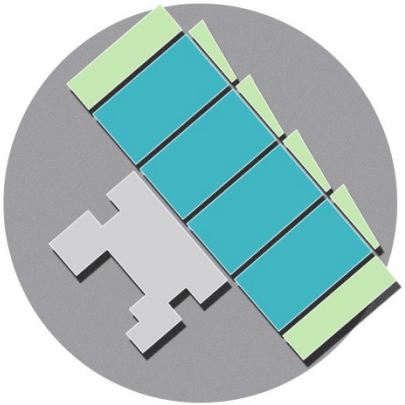
A STEP TOWARDS EFFICIENCY

❑ Design Stimulants

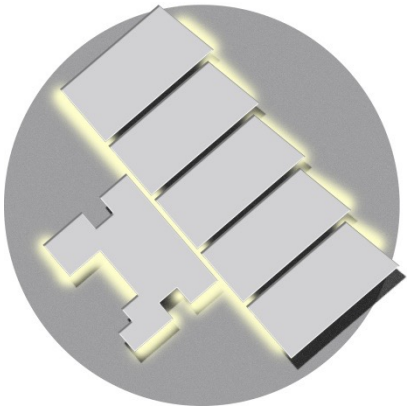
Since the site is surrounded by low rise development on all the sides, the commercial complex is a symbolic Building in the vicinity of Injabakkam. All the spaces would also have an axis that would connect one visually to the coast.



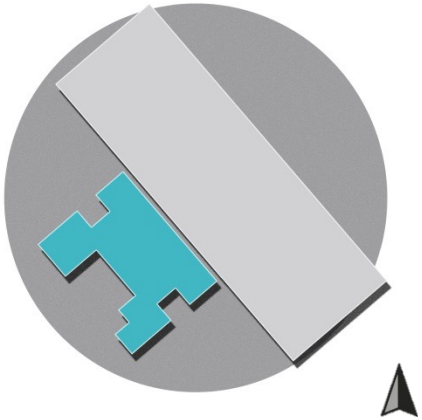
- The modular form helps in having flexible working spaces, thus benefiting the owner and tenants while leasing out the space.



- The building has been oriented in such a way, that the habitable spaces receive the north light and have an advantage of the view too.

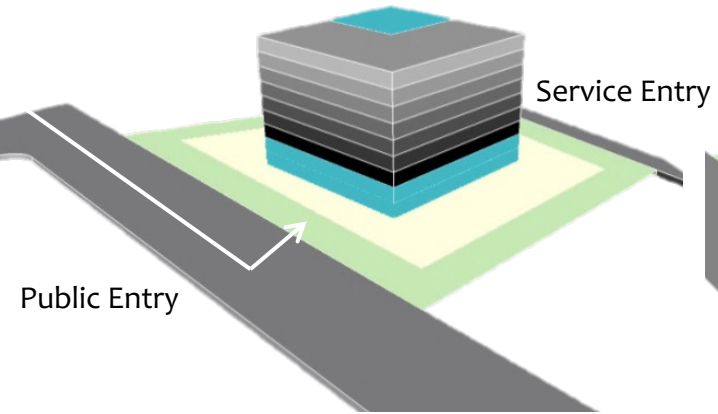


- Creating an island of daylight around the working spaces benefiting the occupants health and well being

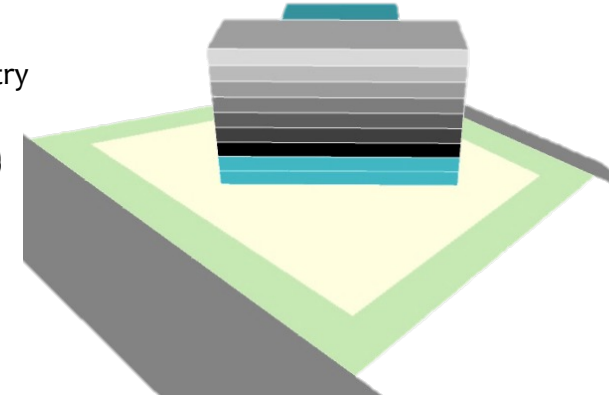


- The spaces are zoned in such a way that the service areas are to the south west gaining maximum heat and do not get advantage of the view.

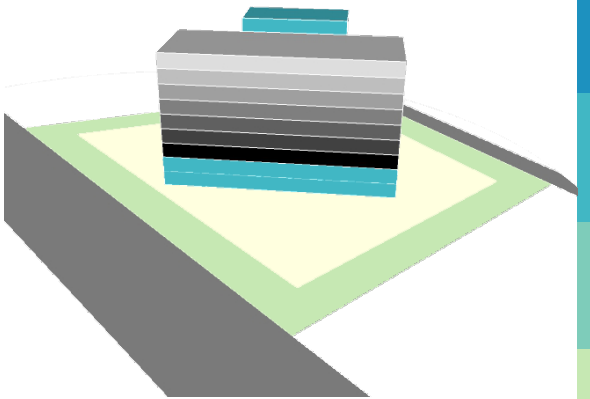
EVOLUTION OF FORM



Zoning
Segregation of Activities

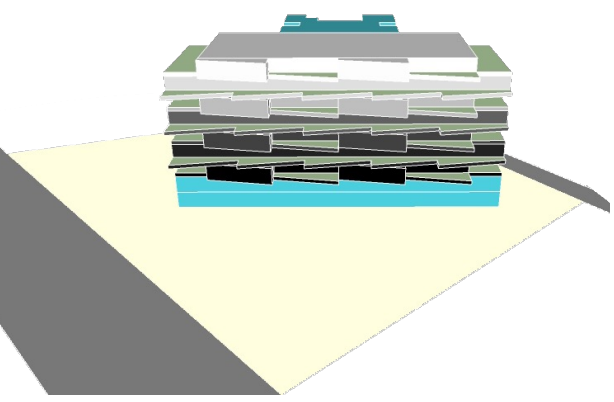


Orientation
Orientating the Public and Working space in such a way that they are visually connected to the Sea and receive North East Light.



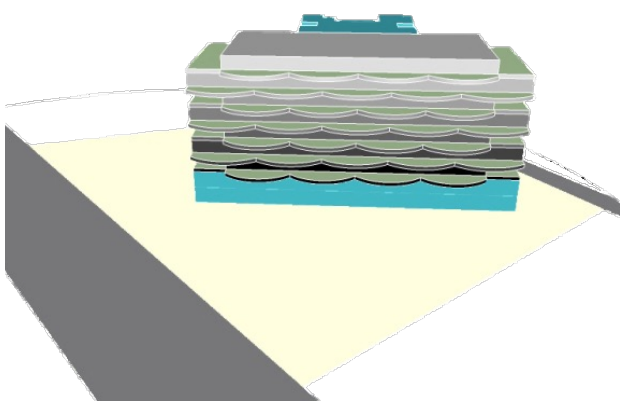
Strategy
By separating the core from the working spaces and bridging the same would create an island which would enable the spaces to receive daylight from all sides.

EVOLUTION OF FORM



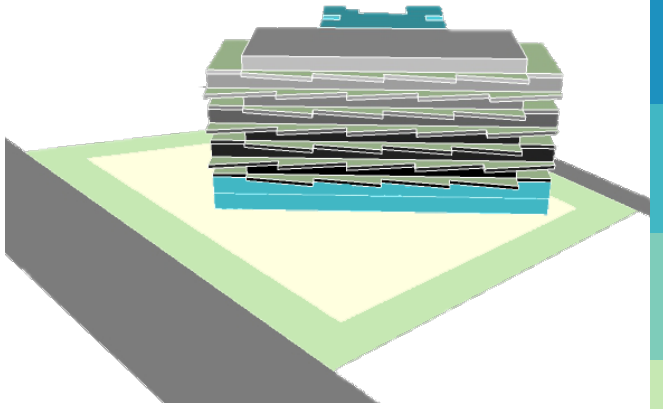
Transformation

Buffer spaces and terraces have been added to mutually shade the spaces. Also these spaces will benefit the occupant's health and comfort.



Alternatives

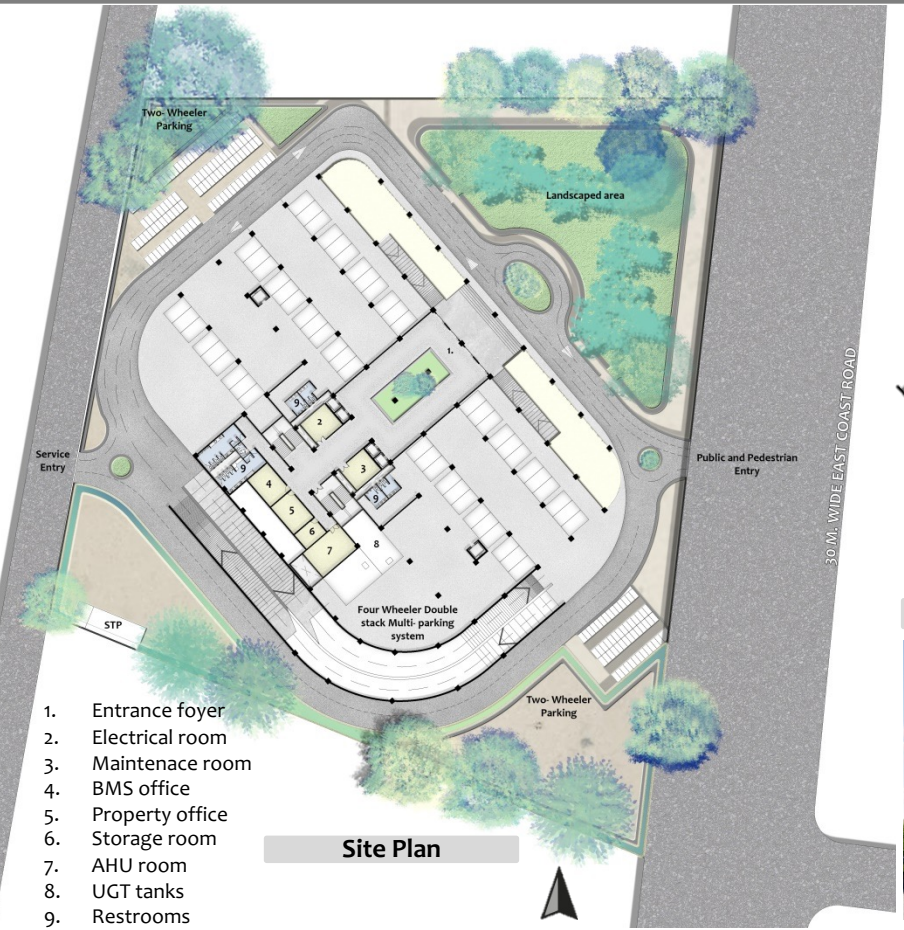
Various permutations and Combinations were used to derive the best form which would benefit the occupants as well as prove to be efficient in terms of energy and sustainability.



Evolution

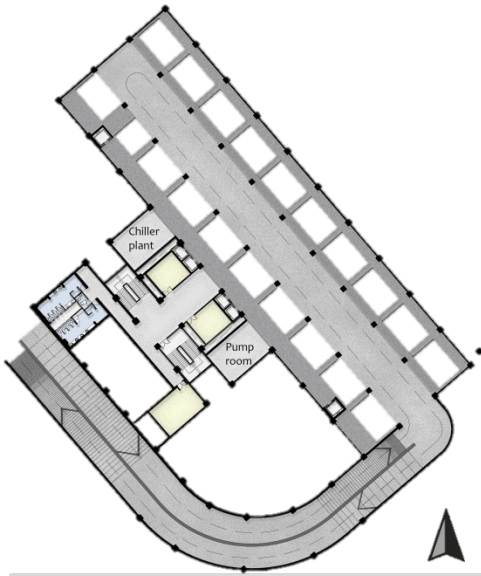
The final form consists of mutually shaded buffer spaces at every level to cater to the occupants health and comfort. The working spaces oriented North East help in receiving diffused light throughout the day.

COMMERCIAL COMPLEX- BUILDING PLANS



Site Plan

1. Entrance foyer
2. Electrical room
3. Maintenace room
4. BMS office
5. Property office
6. Storage room
7. AHU room
8. UGT tanks
9. Restrooms



Podium Plan

First Floor Plan

COMMERCIAL COMPLEX- BUILDING PLANS

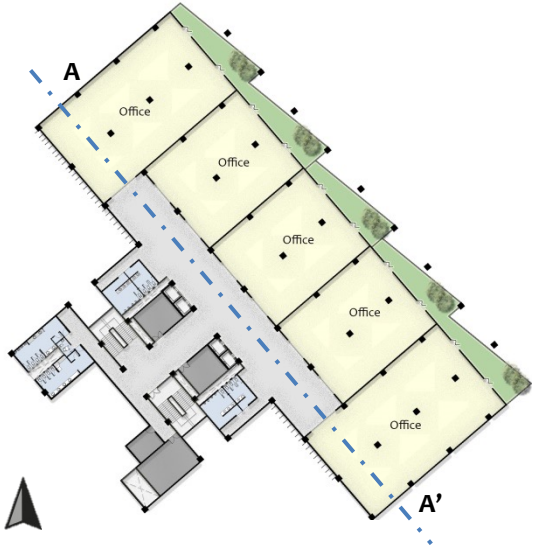
Second Floor Plan

Third Floor Plan

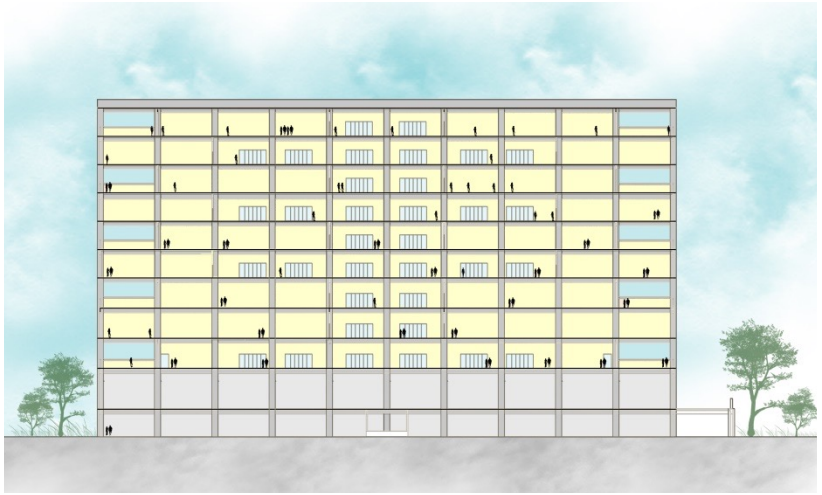
Fourth and Eighth Floor Plan

COMMERCIAL COMPLEX- BUILDING PLANS

Fifth, Seventh, Ninth Floor Plan



Sixth Floor Plan



Section A-A'

CALCULATION AND SIMULATION RESULTS

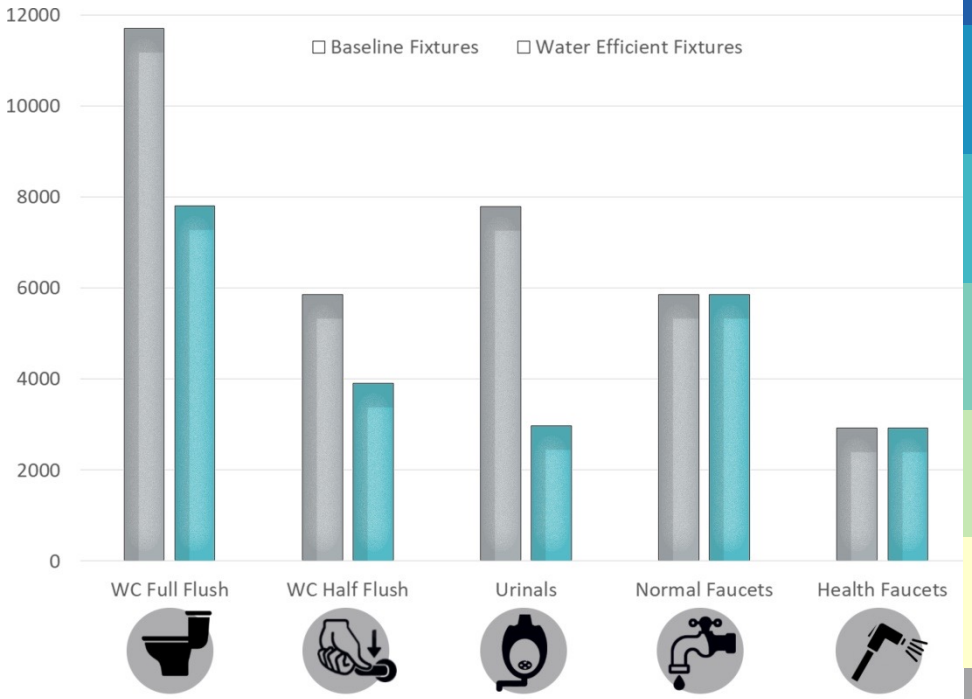
WATER CALCULATIONS

❑ Baseline Fixtures vs Water Efficient Fixtures

Water efficient plumbing fixtures with low flow rates as compared to the baseline criteria in aggregate are selected.

	Baseline Criteria as per IGBC	Water Efficient fixtures
Water closet (full flush)	6 Litres / Flush	4 Litres / Flush
Water closet (Half flush)	3 Litres / Flush	2 Litres / Flush
Urinals	4 Litres / Flush	1.6 Litres / Flush
Normal and health faucets	0.1 Litres / Second	0.1 Litres / Sec

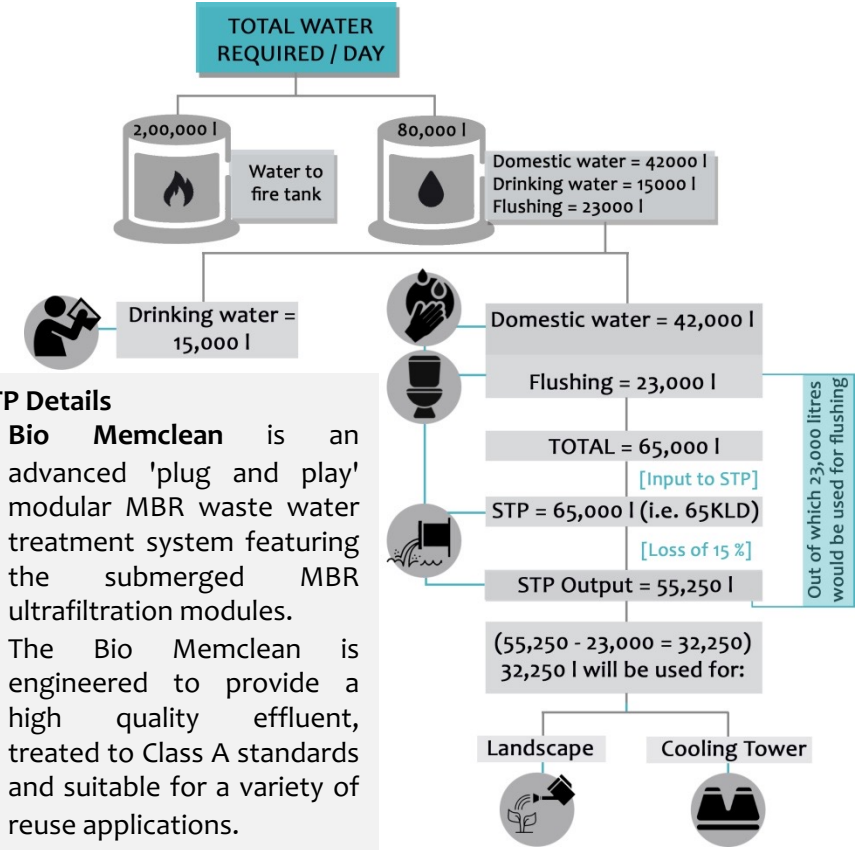
Summary of the Flow Rates of the Fixtures



Graph Showing the comparison between the Baseline Fixtures and Water Efficient Fixtures

WATER CALCULATIONS

❑ Total Water Required per day



STP Details

- **Bio Memclean** is an advanced 'plug and play' modular MBR waste water treatment system featuring the submerged MBR ultrafiltration modules.
- The Bio Memclean is engineered to provide a high quality effluent, treated to Class A standards and suitable for a variety of reuse applications.

❑ Rainwater Harvesting System

Type of Area	Area (Sq. m)	Average Daily Rainfall in M.	Run Off Coefficient	Total
Roof Area	2700	0.037	0.95	94.905
Road area concrete Pavers	2000	0.037	0.95	70.3
Landscaped Area (Turf)	1135	0.037	0.35	14.69825
Open grid grass pavement	4180	0.037	0.5	77.33
Area around Building (Ground surface)	1335	0.037	0.75	37.04625
TOTAL	11350			294.2795
				Cu.m.
Roof Area				94.905
Non Roof Area				199.3745
				294279.5

Litres
94905
199374.5
294279.5

To harvest the rainfall from Roof & non roof area to be percolated through pits we need atleast 12 recharge pits of 25 cu.m each per day

Rainwater harvesting calculations - Chennai

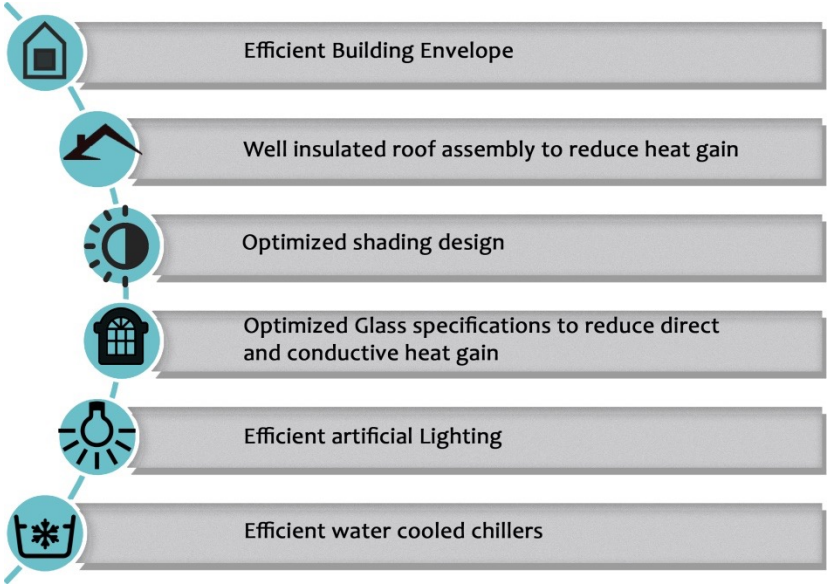
PROJECT SCOPE: ECBC + COMPLIANCE

❑ Energy Consumption Benchmarks

- **Computer simulation** has been used to analyse energy performance.
- A baseline building as per the requirements of **ECBC 2017** whole building performance method was modelled.
- The building was simulated with its actual orientation and again after rotating the entire building **90, 180, 270 degrees**, then averaging the results to get the Baseline building Energy consumption in Kilowatt Hours.

Identification	Energy Use (kWh / Annum)
Average Baseline Building as per ECBC 2017 whole building performance based method.	6257437
Proposed Building :	5299222
% Savings over baseline:	16%

❑ Energy Efficient Measures



- The baseline building was modified to model a number of individual energy conservation measures (ECMs). A final list of ECMs was prepared based on the feasibility of the option.
- The ECMs on the final list were then combined into a single case to model the Proposed Building. As stipulated by the Performance Rating Method, the Proposed and baseline building are identical in terms of:

1. **Geometry** 2. **Simulation software** **3. Weather data** **4.Occupancies**

- Whole building performance approach is an alternative to the prescriptive approach of Code Compliance and it applies to all building types covered by the ECBC Code.

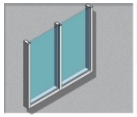
PROJECT SCOPE: ECBC + COMPLIANCE

❑ Envelope Design

- The envelope design plays a vital role in creating energy efficient buildings with high comfort for its occupants.
- It is one of the easiest ways to significantly increase the performance of a commercial building.

1. Glazing

- A glass with **high VLT and low SHGC glass was selected, which would cut down the heat load to a great extent.**
- Double Glazed Unit – (Outer = 6mm with coating Face 2 – 12 mm Air Gap – Inner 6mm Clear).



	Transmission	(%) Solar Factor (SHGC)	U Value (W/ sq. m K)
Pristine White | Planitherm	75	0.57	1.8

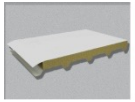
2. Wall

- The Wall assembly consists of AAC (Autoclaved Aerated Concrete) Blocks sandwiched between 19 mm of External Plaster containing sand aggregate and 12mm of Internal Gypsum Plastering.

AAC Block		Wall Assembly	
U Value (W / sq.m K)	0.6	U Value (W / sq.m K)	0.965

3. Roof

- Roof as a building surface that has the most exposed area to the sun, contributes to most of heat gain in the building.
- Therefore, high SRI Tiles were laid on the roof and a layer of 60 mm XPS Insulation Boards was provided above the RCC Slab.



	U Value (W /sq.m K)
Roof Assembly	0.512

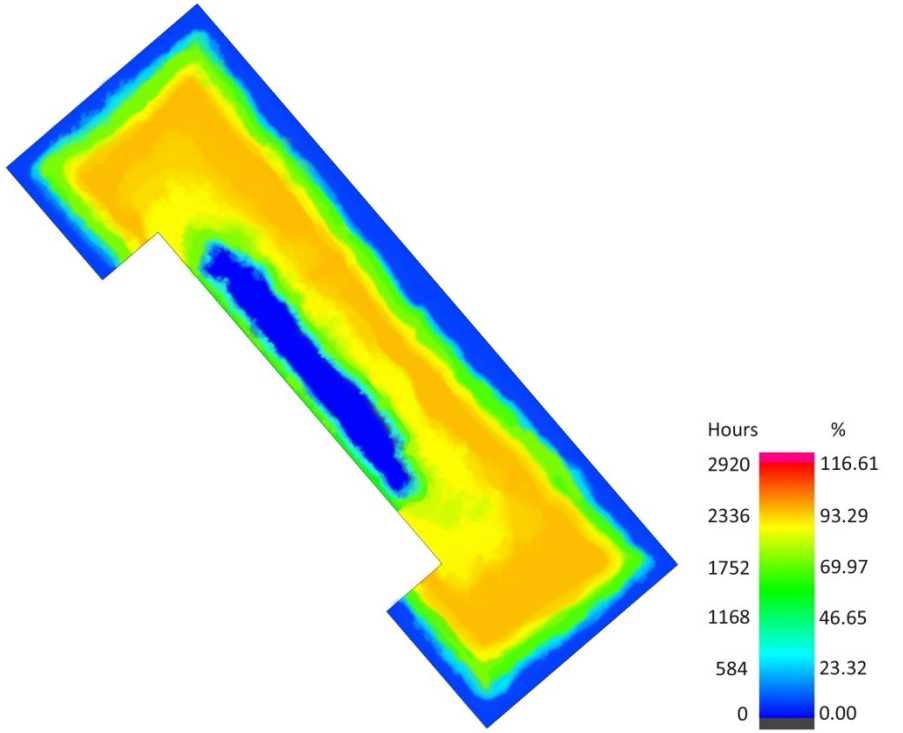
Element	Material/ Type	Reasons behind the choice
Roof	High SRI Tiles on the roof and RCC with underdeck XPS insulation sandwiched between layers of Plaster.	To reduce the heat gain from the roof top.
Wall	AAC Blocks sandwiched between layers of Plaster.	To maintain the high thermal mass and also they are lightweight, load-bearing, high-insulating.
Window	Double Glazed, low heat gain, high visible transmittance.	To reduce heat gain through conduction, direct heat gain through solar radiation.
Shading devices	Vertical fins, designed for architectural integration and shading.	To impose an architectural character and work on increasing their effectiveness as they provide the much needed shade.

LIGHTING DESIGN

- Lighting includes the use of both artificial light sources like lamps and light fixtures, as well as natural illumination by capturing daylight.
- Daylighting is sometimes used as the main source of light during daytime in buildings.
- This can save energy in place of using artificial lighting, which represents a major component of energy consumption in buildings.
- Proper lighting can enhance task performance, improve the appearance of an area and have positive psychological effects on occupants.

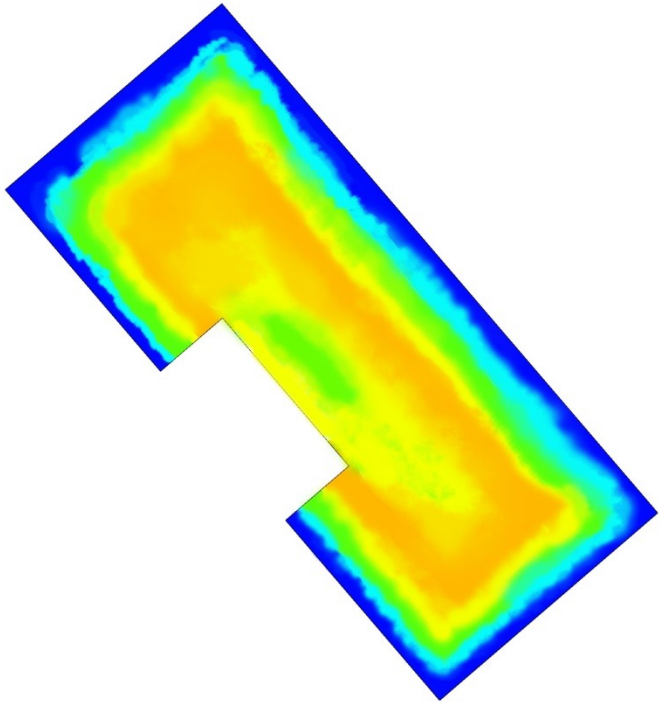
❑ Daylighting

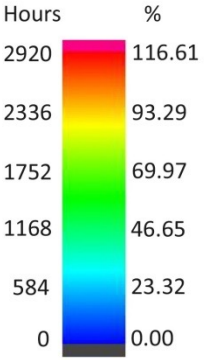
- Design Builder software is used to demonstrate compliance through the daylighting simulation method.
- The illuminance level was set between 100 Lux and 2,000 Lux for a minimum percentage of 50 % of the floor area for at least 90% of the potential daylight time.
- The measurements were taken at a work plane height of 0.8 m above the finished floor.
- The period of analysis was fixed for 8 hours per day, resulting in 2,920 hours in total.



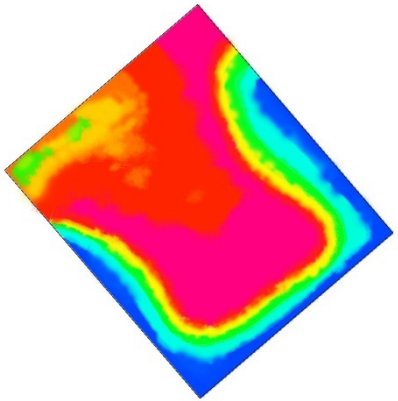
Block	Zone	Floor Area (m2)	UDI Area in Range (m2)	UDI Area in range %
5,7,9th floor	Offices	1872	1210	65

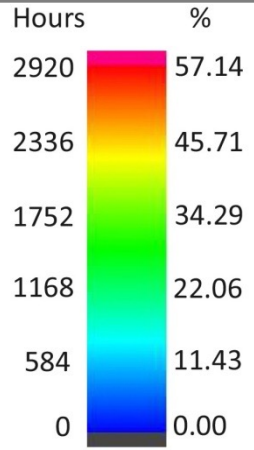
LIGHTING DESIGN





Block	Zone	Floor Area (m2)	UDI Area in Range (m2)	UDI Area in range %
4,6,8th floor	Offices	2232	1570	70.3





Block	Zone	Floor Area (m2)	UDI Area in Range (m2)	UDI Area in range %
2nd floor	Shops	1000	635	63.5

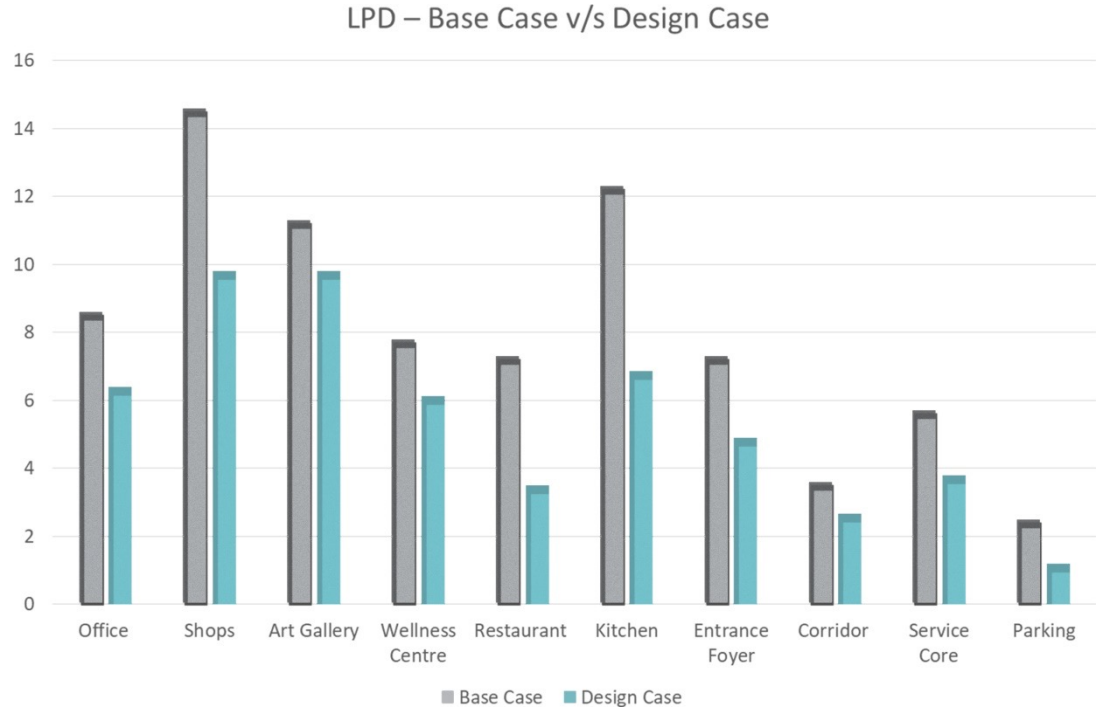
❑ Daylighting: Observation/ Conclusion

- The **Office spaces** met the requirement illuminance level that was set between 100 Lux and 2,000 Lux for a minimum **percentage of 50 % and Shops having a percentage of 15%** of the floor area for at least 90% of the potential daylight time and therefore complying to the ECBC + requirement.

LIGHTING DESIGN

❑ Artificial Lighting Design

- Use of energy efficient lighting fixtures and good placement of fixtures are two keep elements for reducing lighting load significantly.
- In order to make best use of high performance glazing with high VLT, lighting fixtures with stepped control were selected for the spaces.



HVAC SYSTEM DESIGN

- Air conditioning is responsible for a major part of a building's energy consumption.
- The Commercial complex consists of shopping plazas as well office spaces which require high end electronic equipment's and high lux level lightings for their day to day operations.
- Hence the HVAC system load would be more.
- Along with the internal heat gain that takes an account of the occupant and equipments, the heat gain due to the climatic conditions also contributes significantly to the extra load on HVAC system.

❑ Tonnage Calculations

Space name	Area Sq. Mt	Area Sq. Ft.	Height in m	Height in ft.	cu. m	cu.ft	No. of air changes	cfh	cfm	Total tonnage (TR)
Restaurant	1000	10764	3.75	12.30	12304	132438	8	1059501	17658	39
Office	12000	129168	3.45	11.32	135833	1462111	6	8772664	146211	325
Gym	200	2153	3.75	12.30	2461	26488	6	158925	2649	6
Non - Gym	300	3229	3.75	12.30	3691	39731	6	238388	3973	9
Shops	3250	34983	3.75	12.30	39987	430422	8	3443377	57390	128
Art Gallery	500	5382	3.75	12.30	6152	66219	5	331094	5518	12
Entrance Lobby	250	2691	3.75	12.30	3076	33109	3	99328	1655	4
Passages	4000	43056	3.45	11.32	45278	487370	3	1462111	24369	54
	21500	231426								576

Tonnage due to the Volume of Spaces

	Equipment Load	Occupant Load	Lighting Load	Increament due Air changes	
	BTU / Hr	Total Heat gain	40% Reduction due to LED	Volume in cu. ft.	
		BTU /Hr			x 1.25
Restaurant	0.00	2,00,000.00	24,398.40	58,272.53	72,840.66
Office	9,04,176.00	5,40,000.00	2,92,780.80	12,23,723.10	15,29,653.88
Gym	6,458.40	90,000.00	4,879.68	23,309.01	29,136.26
Non- Gym	0.00	35,000.00	7,319.52	34,963.52	43,704.40
Auditorium	0.00	66,000.00	79,294.80	17,481.76	21,852.20
Shops	16,146.00	2,25,000.00	12,199.20	3,49,635.17	4,37,043.96
Art Gallery	5382.00	45,000.00	6,099.60	58,272.53	72,840.66
Entrance lobby	0.00	0.00	97,593.60	29,136.26	36,420.33
Passages	0.00	0.00	0.00	4,66,180.23	5,82,725.29
	9,32,162.40	12,01,000.00	5,24,565.60		28,26,217.64

Tonnage due to internal heat gain

Extra Load due to occupancy, Lighting, Equipement and Infiltration of Air : 5483945.6371

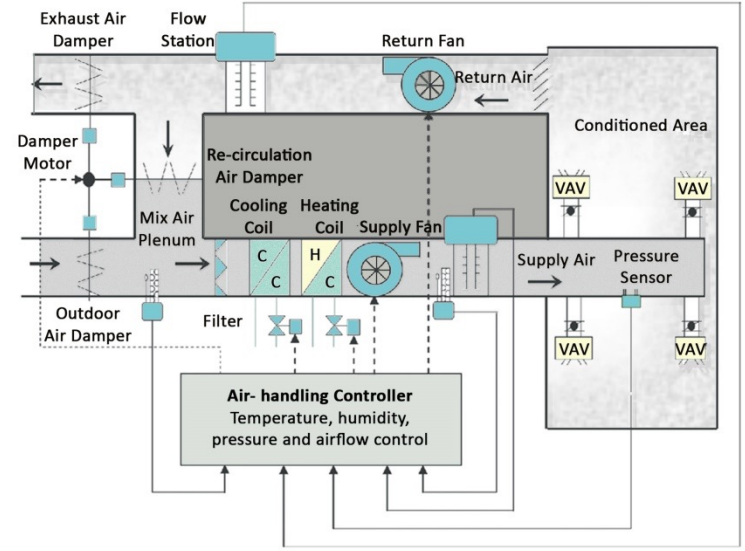
1 TR = 12000 BTU / Hr | Tonnage : 457 Tons

TOTAL TONNAGE : 1033 Tons = 1100 tons of Air Conditioning

HVAC SYSTEM DESIGN

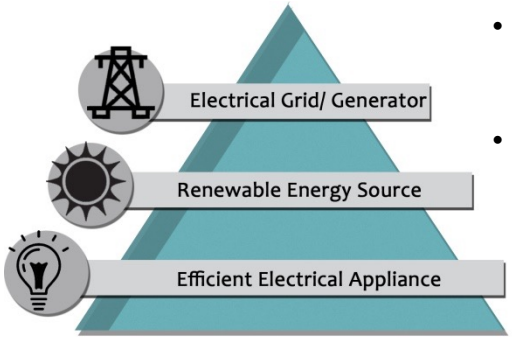
❑ VAV System

- Variable Air Volume with water chiller with dehumidifier is chosen for the project as it can satisfy the variable requirement of the end users and the space.
- The central chiller plant is located on the Podium and AHUs have been located on all floors to control the flow, moreover the system can be controlled centrally so that all the demands specific to that particular zone can be satisfied.



Schematic diagram explaining the VAV system

❑ Renewable Energy Integration: SPV Plant



- The top tier of the energy efficiency pyramid is renewable energy.
- Solar Energy is plentiful, reliable and renewable energy source and is also the cleanest type of energy known to man since it does not harm the environment.

Connected Load of the Building: **5299222.17**	2 % of the load: **105984.44 kWh**	30 % of Roof: **810 Sq. mt**

- The commercial complex at Chennai has an advantage to harness major of the solar energy since there are no high rise buildings surrounding the site.
- On the basis of MNRE Roof Top Solar PV calculator results, the **81 kW SPV power plant is estimated to generate 121500 kWh**. Considering 300 days of solar radiation i.e. 10 months approximately solar plant will generate **121.5 MWh** electricity annually. *[1kWp solar rooftop plant will generate on an average over the year 5.0 kWh of electricity per day].*

COMPARISON OF PROPOSED DESIGN VS BASELINE DESIGN

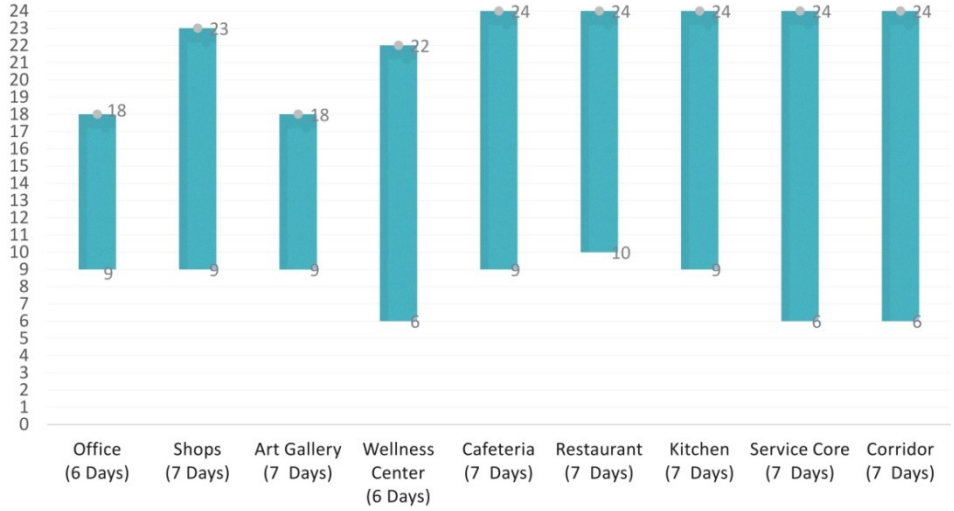
Parameters	ECBC + Base Case	Design Case
Exterior wall Construction Wall	U – Value: 0.34 W/m2.K	Plastered AAC Blocks U – Value 0.965 W/m2.K
Roof Construction	U – Value : 0.26 W/m2.K	U value of the entire assembly: High SRI Orientbell Cool Tiles + 60mm XPS + 150 mm RCC roof + plaster U Value: 0.512 W/m2.K
Glazing	Base case glass	Saint Gobain – Infinity Double Glazed Unit Pristine White | Planitherm
	U value: 2.20 W/m2.K	U value: 1.8 W/m2K
	SHGC: 0.25	Typical Floors with Shading Devices/ Balcony Projection SHGC: 0.57
	VLT : 27%	VLT : 75 %
Overall Wall window ratio (%)	40 %	North East : 60 % South West : 20 % The Overall WWR : 40 %
Shading device	None	Vertical fins, designed for architectural integration and shading

COMPARISON OF PROPOSED DESIGN VS BASELINE DESIGN

Parameters		ECBC + Base Case	Design Case
LPD (W/Sq mt)			
LPD (W/Sq mt)	Office	8.6	6.4
	Shops	14.6	9.8
	Art Gallery	11.3	9.8
	Wellness Centre	7.8	6.13
	Restaurant	7.3	3.49
	Kitchen	12.3	6.86
	Entrance Foyer	7.3	4.9
	Corridor	3.6	2.67
	Service Core	5.7	3.8
	Parking	2.5	1.2
Controls			
Occupancy sensors		None	**Yes**
Daylight sensors		None	**Yes**
HVAC		Water Cooled Centrifugal Chiller COP: 6.2	Water Cooled Screw Chiller COP: 5.5

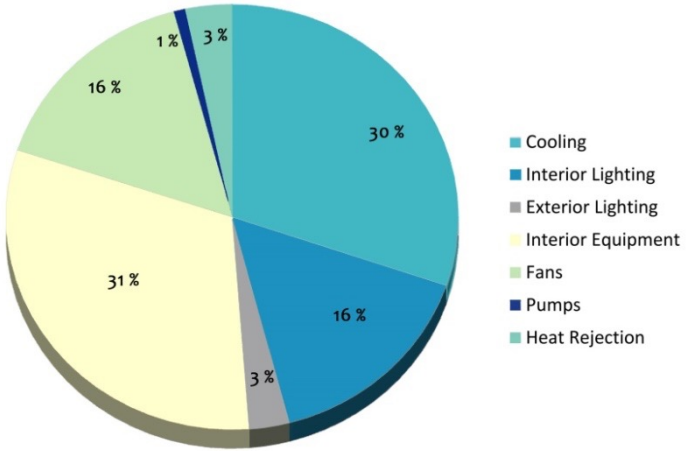
COMPARISON OF PROPOSED DESIGN VS BASELINE DESIGN

Occupancy Schedule



Simulation Results- Base case Energy Consumption [kwh]

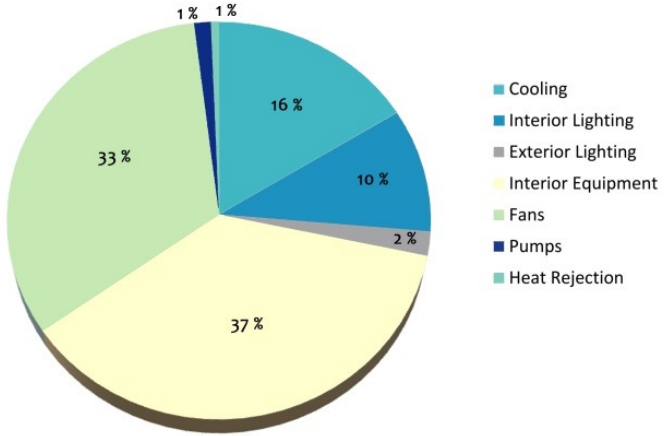
Parameters	Base case 00	Base case 90	Base case 180	Base case 270	Average Base case
Cooling	1891537	1889915	1896468	1887083	1891251
Interior Lighting	981360	981360	981360	981360	981360
Exterior Lighting	181907	181907	181907	181907	181907
Interior Equipment	1957385	1957385	1957385	1957385	1957385
Fans	984186	982574	995365	977010	984784
Pumps	51563	51484	52036	51313	51599
Heat Rejection	209144	209149	209170	209145	209152
Total End Uses	6257081	6253774	6273691	6245203	6257437



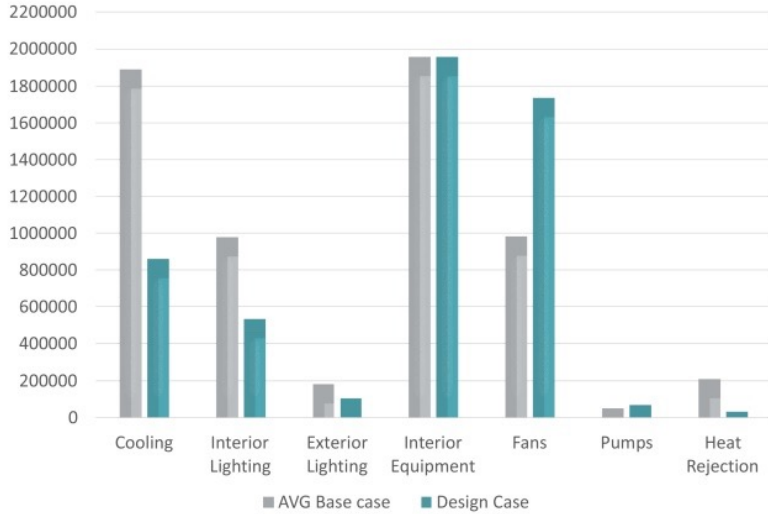
COMPARISON OF PROPOSED DESIGN VS BASELINE DESIGN

❑ Simulation Results- Design case Energy Consumption [kwh]

Parameters	Design Case
Cooling	861991.52
Interior Lighting	534750.45
Exterior Lighting	103356
Interior Equipment	1957385.22
Fans	1737482.47
Pumps	70306.89
Heat Rejection	33949.6
Total End Uses	5299222.17



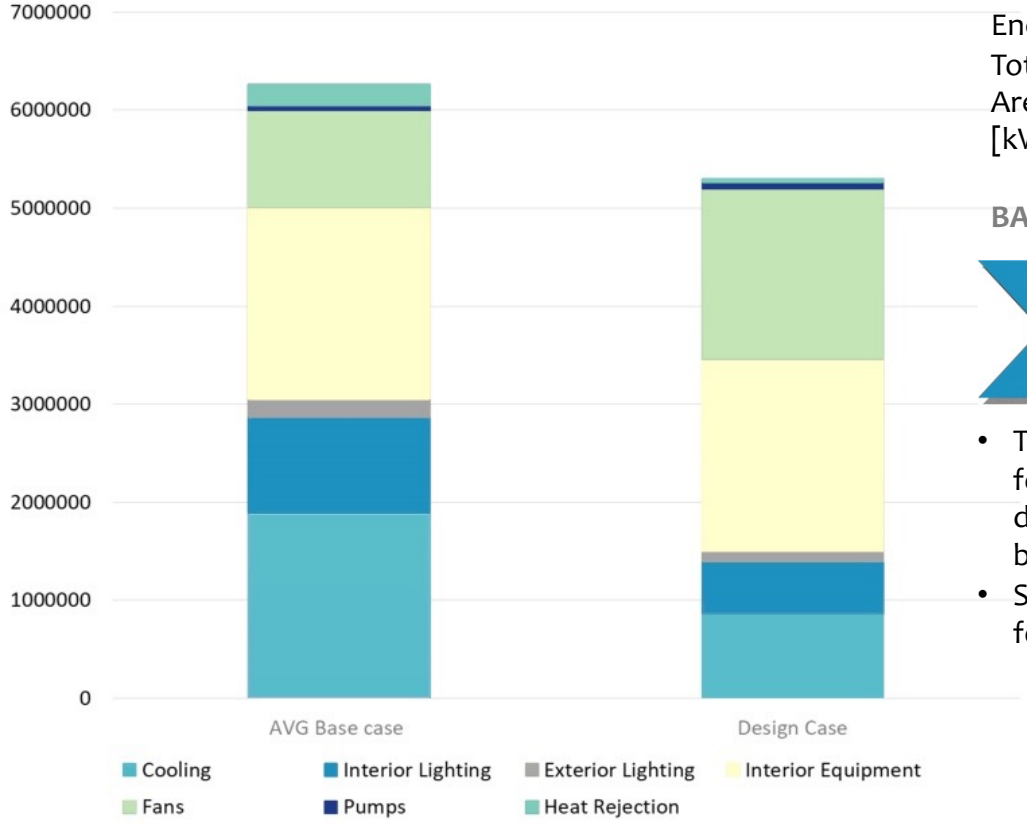
❑ Comparison of Base case & Design case Energy results [kwh]



	AVG Base case	Design Case
Cooling	1891251	861992
Interior Lighting	981360	534750
Exterior Lighting	181907	103356
Interior Equipment	1957385	1957385
Fans	984784	1737482
Pumps	51599	70307
Heat Rejection	209152	33950
Total End Uses	6257437	5299222

COMPARISON OF PROPOSED DESIGN VS BASELINE DESIGN

❑ Comparison of Base case & Design case Energy results [kwh]



❑ Energy Performance Index

	Energy Per Total Building Area [kWh/m2]	Energy Per Total Building Area [kWh/m2]
	BASE CASE	DESIGN CASE
	208.29	176.40

EPI Ratio : 0.84

- This demonstrates that the proposed design case is compliant for ECBC + as per whole building performance method and design case will consume less energy than average base case by 16 %.
- Since the EPI Ratio is less than 0.86, this project has paved way for ECBC + Compliance.

IGBC CHECKLIST

Yes	Maybe	No	IGBC Credit		Points
5	0	0	Sustainable Architecture and Design		5
1			SA CR 1	Integreted design approach	1
2			SA CR 2	Site Preservation	2
2			SA CR 3	Passive architecture	2
14	0	0	Site Selection and Planning		14
Mandatory			SSP MR 1	Local Building Regulations	Mandatory
Mandatory			SSP MR 2	Soil Erosion Control	Mandatory
1			SSP CR 1	Basic Amenities	1
1			SSP CR 2	Proximity to public transport	1
1			SSP CR 3	Low emitting vehicles	1
2			SSP CR 4	Natural topography or vegetation	2
1			SSP CR 5	Preservation or Transplantation of trees	1
2			SSP CR 6	Heat Island Effect, Non Roof : 50%, 75%	2
2			SSP CR 7	Heat Island Effect, Roof : 50%, 75%	2
1			SSP CR 8	Outdoor Light Pollution Reduction	1
1			SSP CR 9	Universal Design	1
1			SSP CR 10	Basic Facilities for Construction Workforce	1
1			SSP CR 11	Green Building Guidelines	1

IGBC CHECKLIST

Yes	Maybe	No	IGBC Credit		Points
19	0	0	Water Conservation		19
Mandatory			WC MR 1	Rainwater Harvesting	Mandatory
Mandatory			WC MR 2	Water Efficient Plumbing Fixtures	Mandatory
2			WC CR 1	Landscape Design	2
1			WC CR 2	Management of Irrigation Systems	1
4			WC CR 3	Rainwater Harvesting, Roof & Non-roof	4
5			WC CR 4	Water Efficient Plumbing Fixtures	5
5			WC CR 5	Waste Water Treatment and Reuse	5
2			WC CR 6	Water Metering	2
14	0	14	Energy Efficiency		28
Mandatory			EE MR 1	Ozone Depleting Substances	Mandatory
Mandatory			EE MR 2	Minimum Energy Efficiency	Mandatory
Mandatory			EE MR 3	Commissioning Plan for Building Equipment & Systems	Mandatory
1			EE CR1	Eco-friendly Refrigerants	1
7		8	EE CR 2	Enhanced Energy Efficiency	15
2		4	EE CR 3	On-site Renewable Energy	6
		2	EE CR 4	Off-site Renewable Energy	2
2			EE CR 5	Commissioning, Post-installation of Equipment & Systems	2
2			EE CR 6	Energy Metering and Management	2

IGBC CHECKLIST

Yes	Maybe	No	IGBC Credit		Points
16	0	0	Building Materials and Resources		16
Mandatory			BMR MR 1	Segregation of Waste, Post-occupancy	Mandatory
8			BMR CR 1	Sustainable Building Materials	8
2			BMR CR 2	Organic Waste Management, Post-occupancy	2
1			BMR CR 3	Handling of Waste Materials, During Construction	1
5			BMR CR 4	Use of Certified Green Building Materials, Products & Equipment	5
10	0	1	Indoor Environmental Quality		11
Mandatory			IEQ MR 1	Minimum Fresh Air Ventilation	Mandatory
Mandatory			IEQ MR 2	Tobacco Smoke Control	Mandatory
1			IEQ CR 1	CO_2 Monitoring	1
1		1	IEQ CR 2	Daylighting	2
1			IEQ CR 3	Outdoor Views	1
1			IEQ CR 4	Minimise Indoor and Outdoor Pollutants	1
3			IEQ CR 5	Low-emitting Materials	3
2			IEQ CR 7	Indoor Air Quality Testing, After Construction and Before Occupancy	2
1			IEQ CR 8	Indoor Air Quality Management, During Construction	1
7	0	0	Innovation and Design		7
4			ID CR 1	Innovation in Design Process	4
1			ID CR 2	Optimisation in Structural Design	1
1			ID CR 3	Waste Water Reuse, During Construction	1
1			ID CR 4	IGBC Accredited Professional	1
85	0	15			100

IGBC CHECKLIST

	Rating	
IGBC Green New Building Rating System	Certified	40-49
	Silver	50-59
	Gold	60-75
	Platinum	75-100

THANK YOU!