SUSTAINABILITY DESIGN ANALYSIS

SHIV NADAR UNIVERSITY
CHENNAI

@ KELAMBAKKAM
CHENGALPATTU, TAMILNADU

February 2023

TRILOGUE

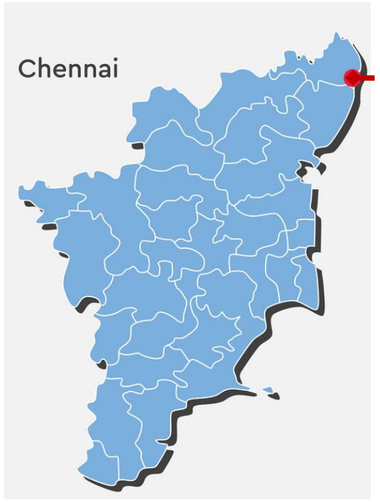
WHERE EARTH MEETS ECONOMICS

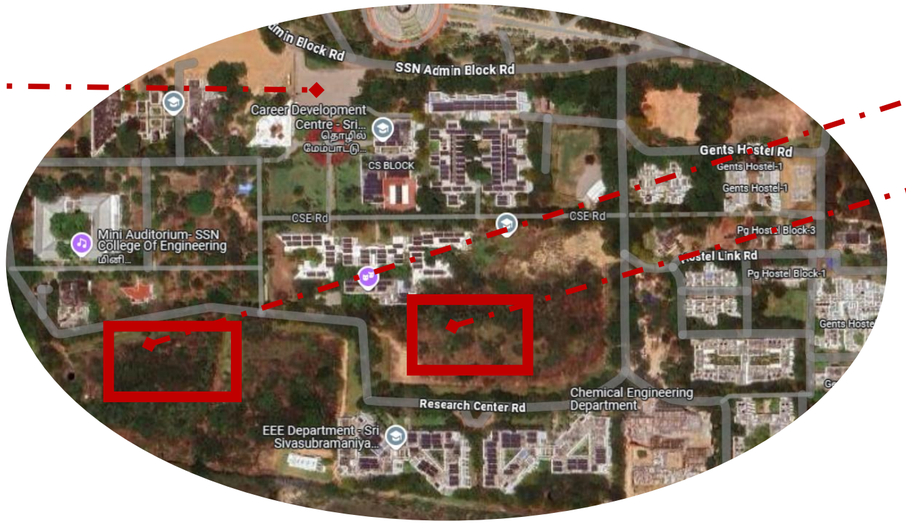
EARTHONOMIC ENGINEERS®

1.INTRODUCTION

Passive Design Analysis is performed for Shiv Nadar University,Kelambakkam which falls under warm and humid category under the ECBC 2017.

Simulation Analysis is performed for SNU academic Building with a Built-up Area of 8,753 Sq.m.

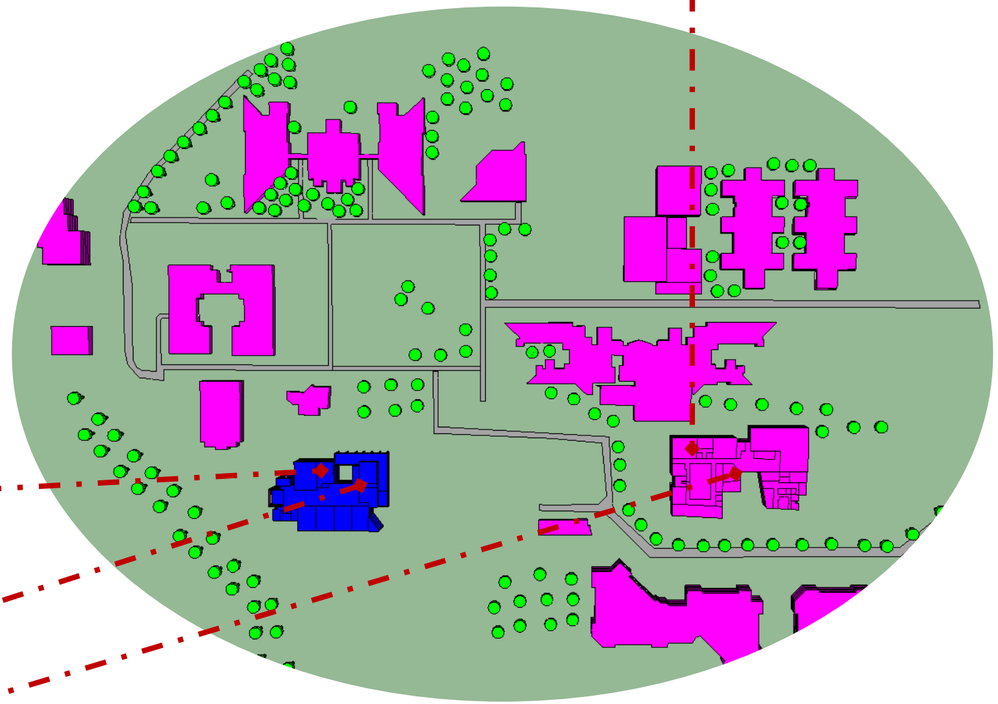




Site location

Research Building

Academic Building



Proposed Building

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SSN
ACADEMIC
BLOCK

SITE PLAN

LEGEND :

1. Vehicular drive way
2. Vehicular drop-off
3. Main entrance
4. Pedestrian footpath
5. Services drop-off
6. Internal courtyard seating
7. Existing Storm water drain

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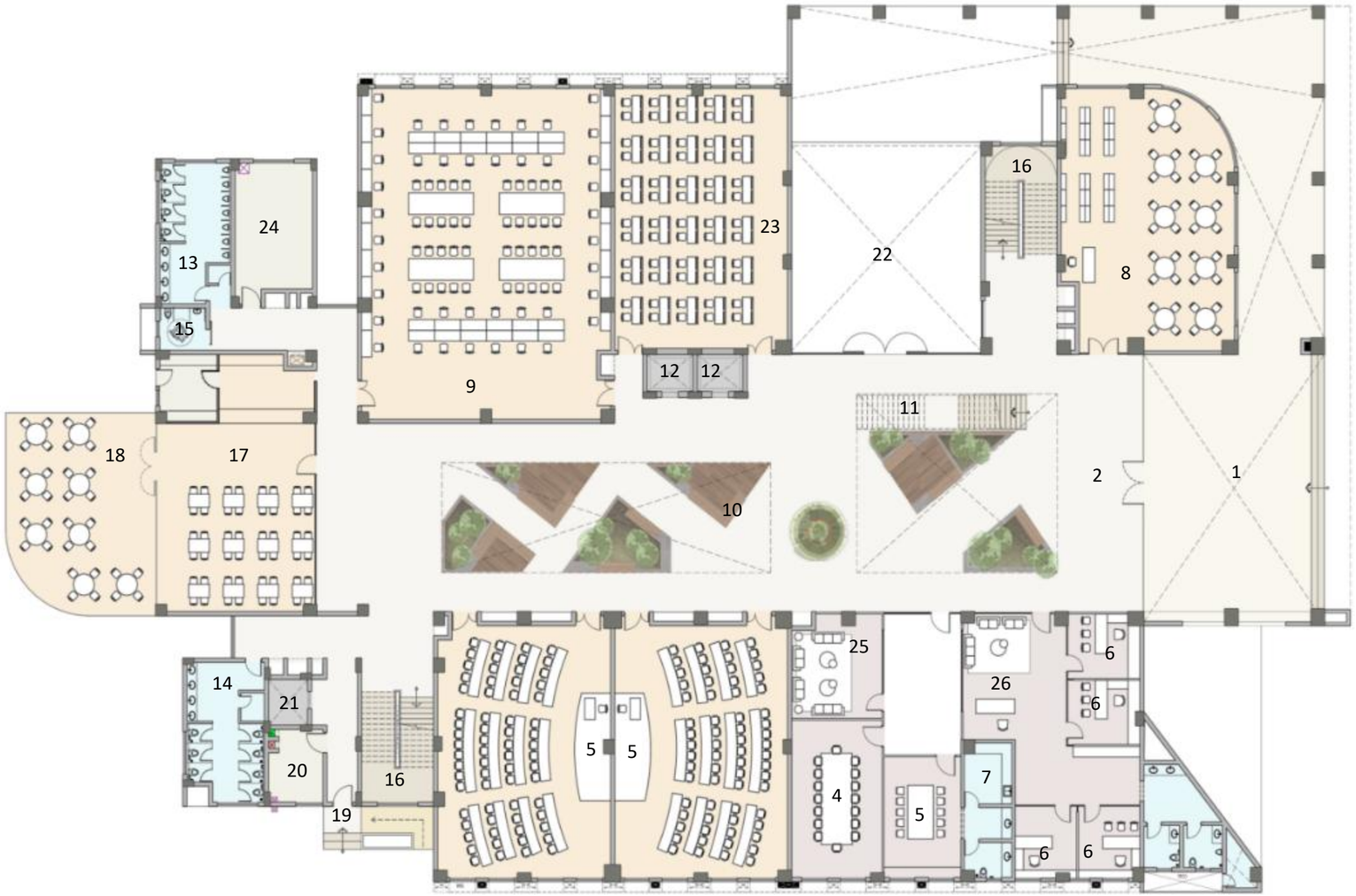
GROUND FLOOR PLAN



LEGEND :

1. Verandah
2. Entrance lobby
3. Admin offices
4. Conference room
5. Lunch room
6. HOD Cabins
7. Pantry & Toilets
8. Library
9. Physics laboratory
10. Central Atrium
11. Main Staircase
12. Passenger lift
13. Gents Toilet
14. Ladies Toilet
15. PWD Toilet
16. Staircase
17. Cafeteria
18. Outdoor Cafeteria
19. Serive entrance
20. Store room

LEGEND :

21. Service lift
22. Open to Sky Courtyard
23. Language laboratory
24. Electrical room
25. VIP waiting lounge
26. Common lounge room

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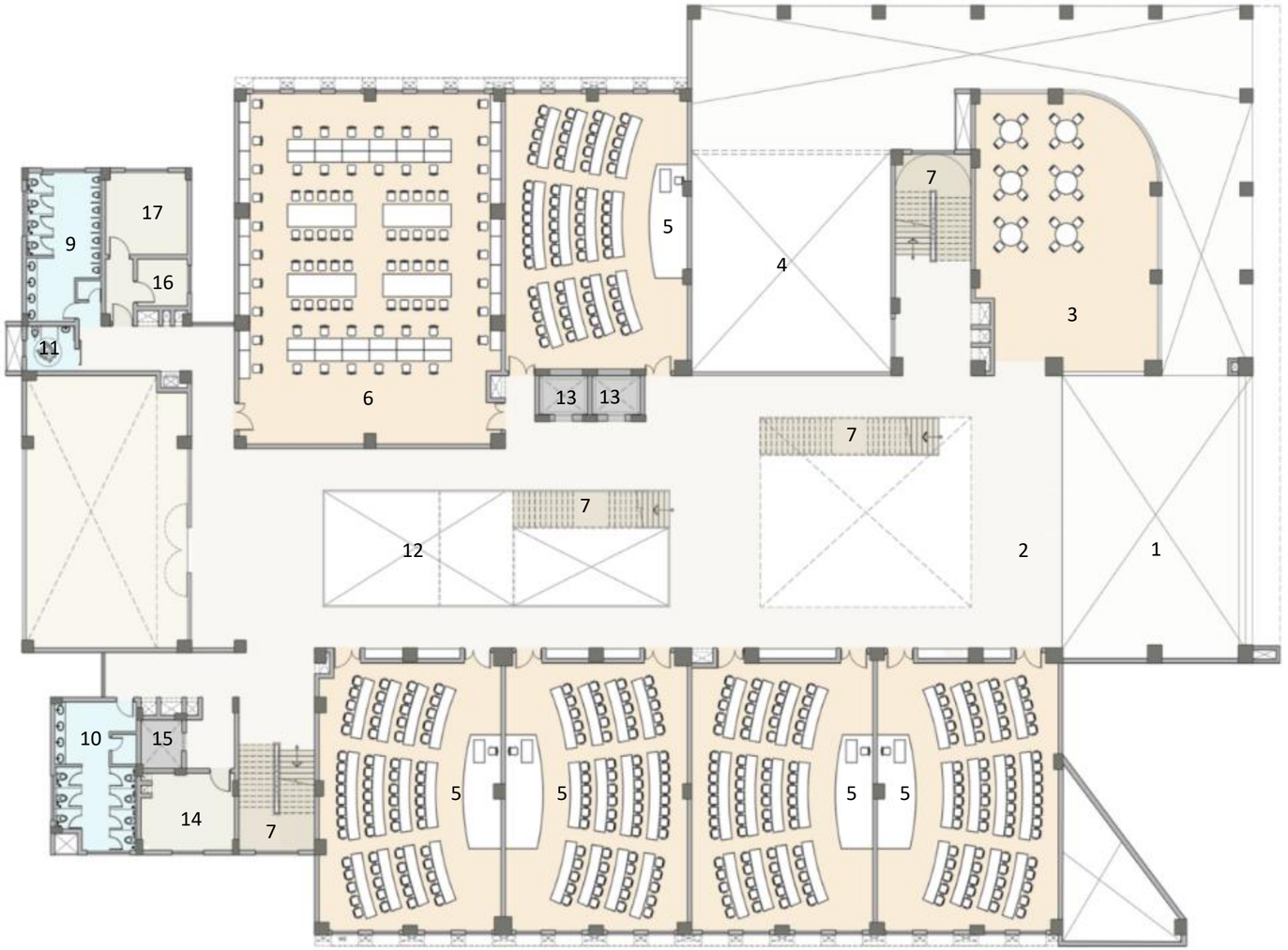
FIRST FLOOR PLAN



LEGEND :

1. Double height verandah
2. Student lounge area
3. Sitout terrace
4. Open to Sky courtyard
5. 67 seater Classroom
6. Chemistry Laboratory
7. Staircase
8. Double height lecture theater
9. Gents toilet
10. Ladies toilet
11. PWD Toilet
12. Cut - out to Atrium space
13. Passenger lift
14. Sick room
15. Service lift
16. Electrical room
17. Server room

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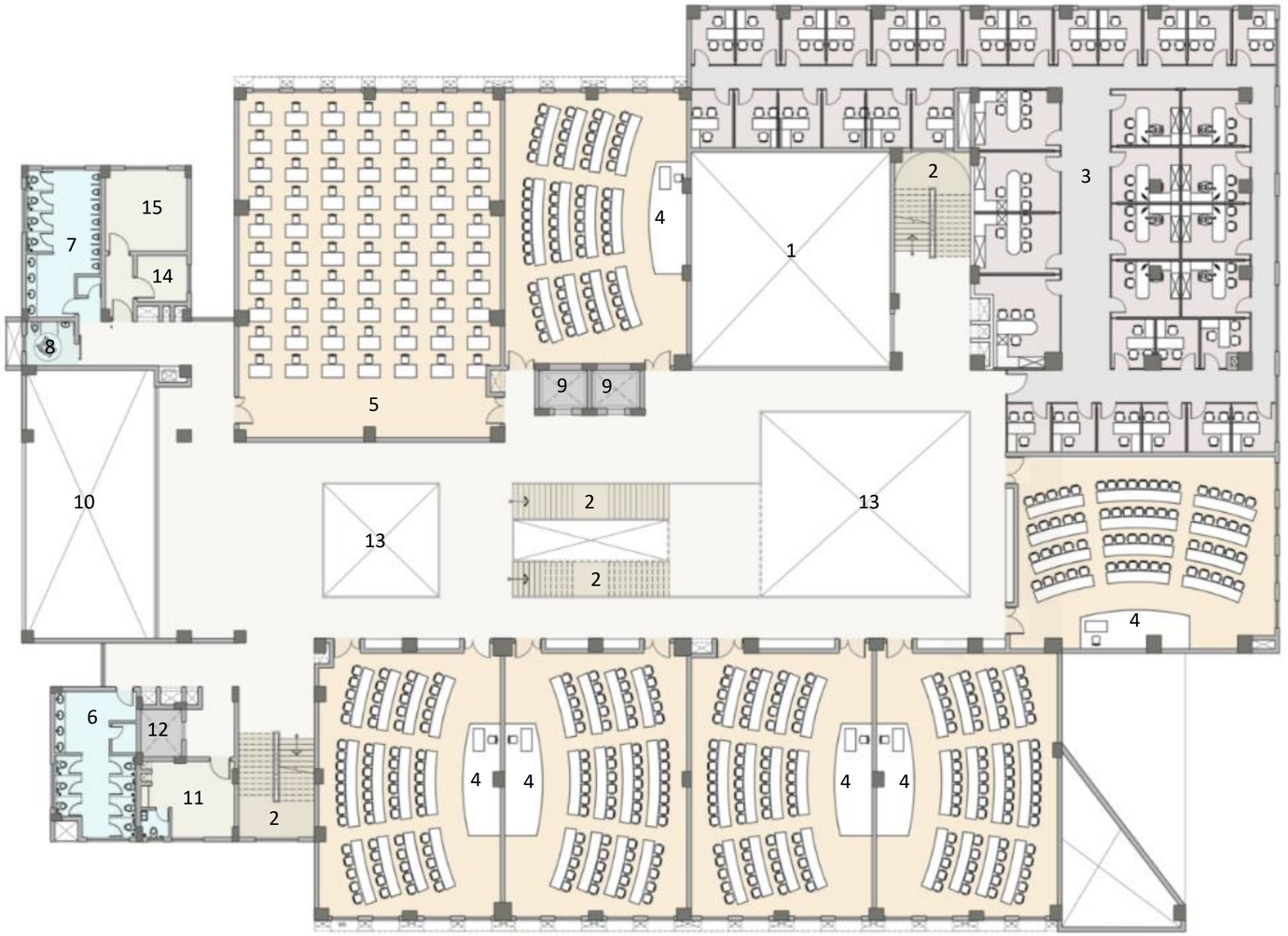
SECOND FLOOR PLAN



LEGEND :

1. Open to Sky courtyard
2. Staircase
3. Faculty cabins
4. 67 seater Classroom
5. Drawing hall
6. Ladies toilet
7. Gents toilet
8. PWD Toilet
9. Passenger lift
10. Open terrace
11. Non teaching Staff room
12. Service lift
13. Cut out to Atrium space
14. Electrical room
15. Server room

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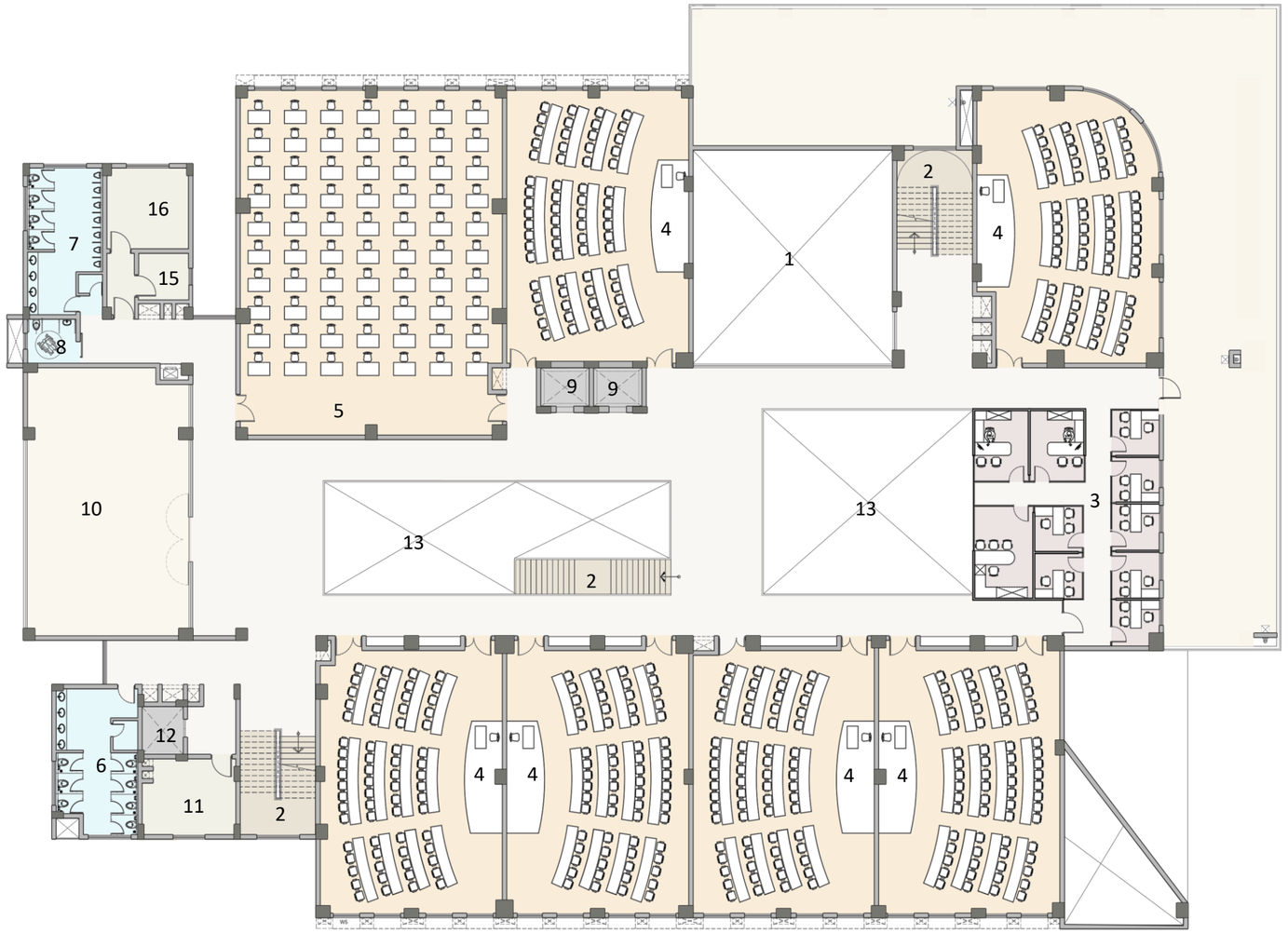
THIRD FLOOR PLAN



LEGEND :

1. Open to Sky courtyard
2. Staircase
3. Faculty cabins
4. 67seater Classroom
5. Drawing hall
6. Ladies toilet
7. Gents toilet
8. PWD Toilet
9. Passenger lift
10. Over looking terrace
11. CCTV and control room
12. Service lift
13. Cut out to Atrium space
14. Student lounge area
15. Electrical room
16. Server room

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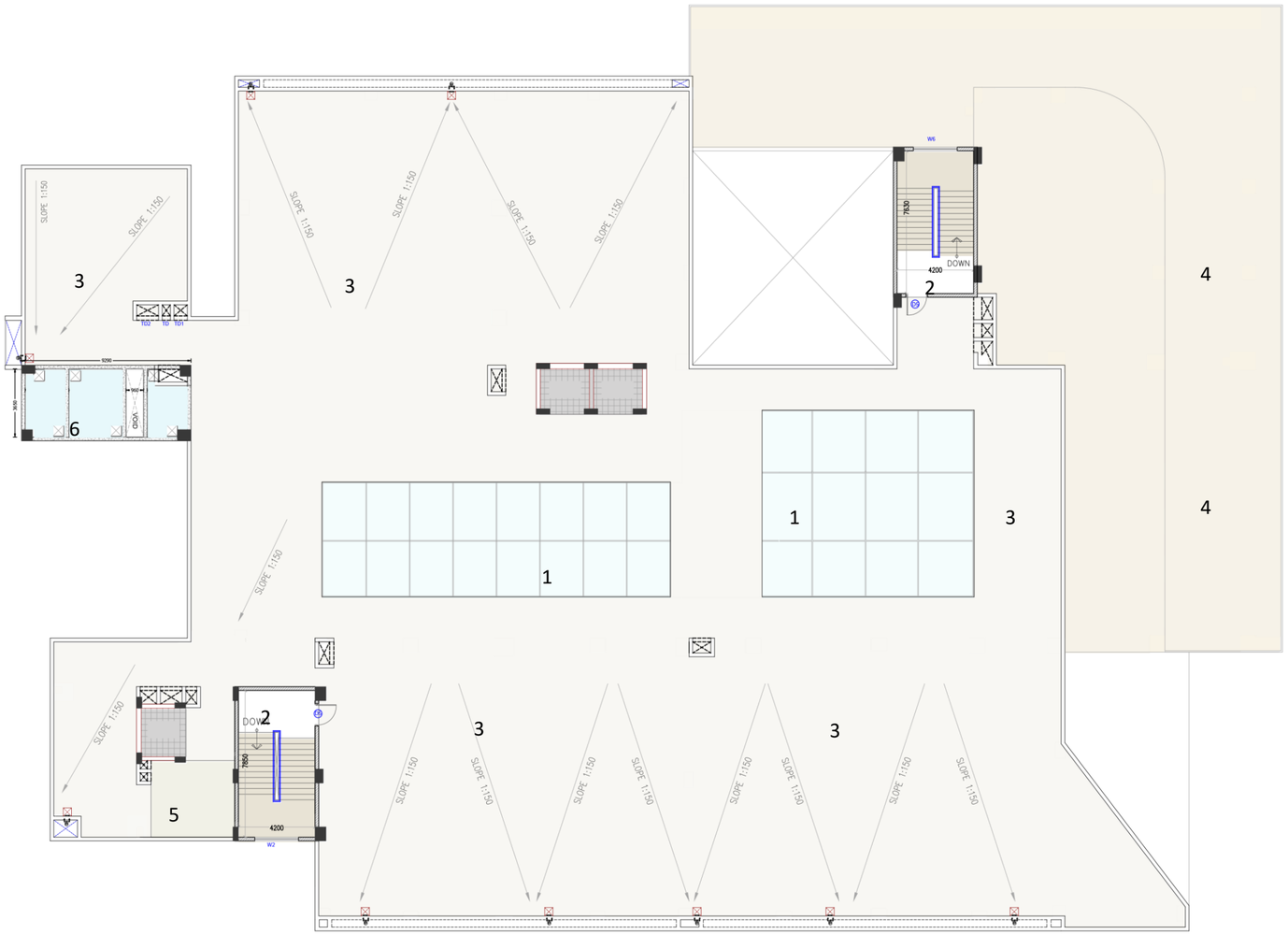
TERRACE FLOOR PLAN



LEGEND :

1. OTS Courtyard
2. Staircase
3. Open terrace
4. Lower terrace
5. RO Plant
6. OHT
7. Skylight courtyard

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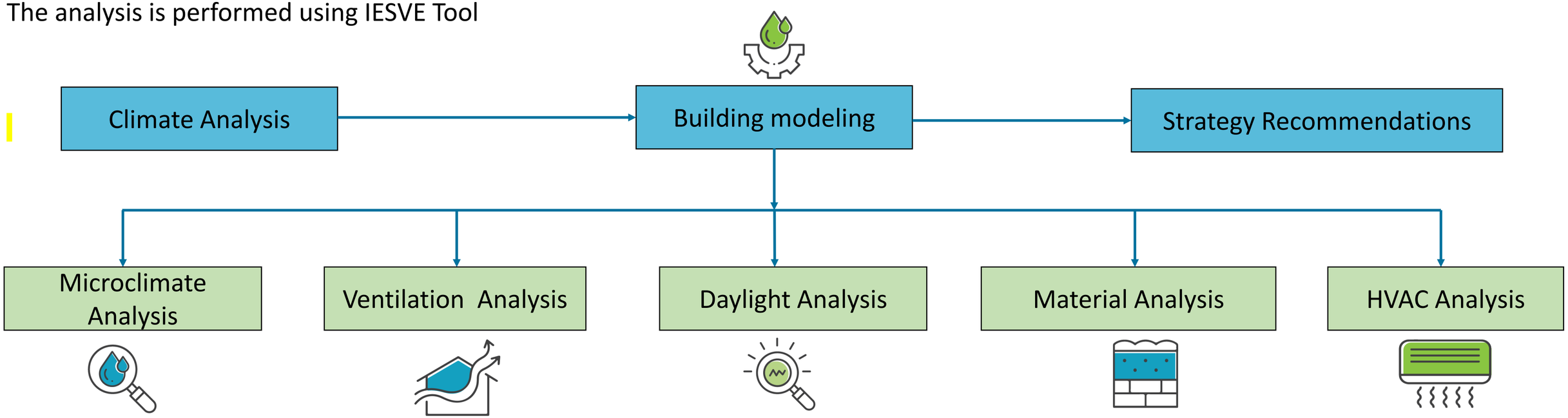
2.SCOPE OF WORK

The following analysis have been performed for SNU project for better building performance and facilitate climate adaptive strategies . The analysis is performed using IESVE Tool



To study the impact of Shading structures on the temperature and heat island effect within the school premises.

Envelope parameters have been modelled as per drawings

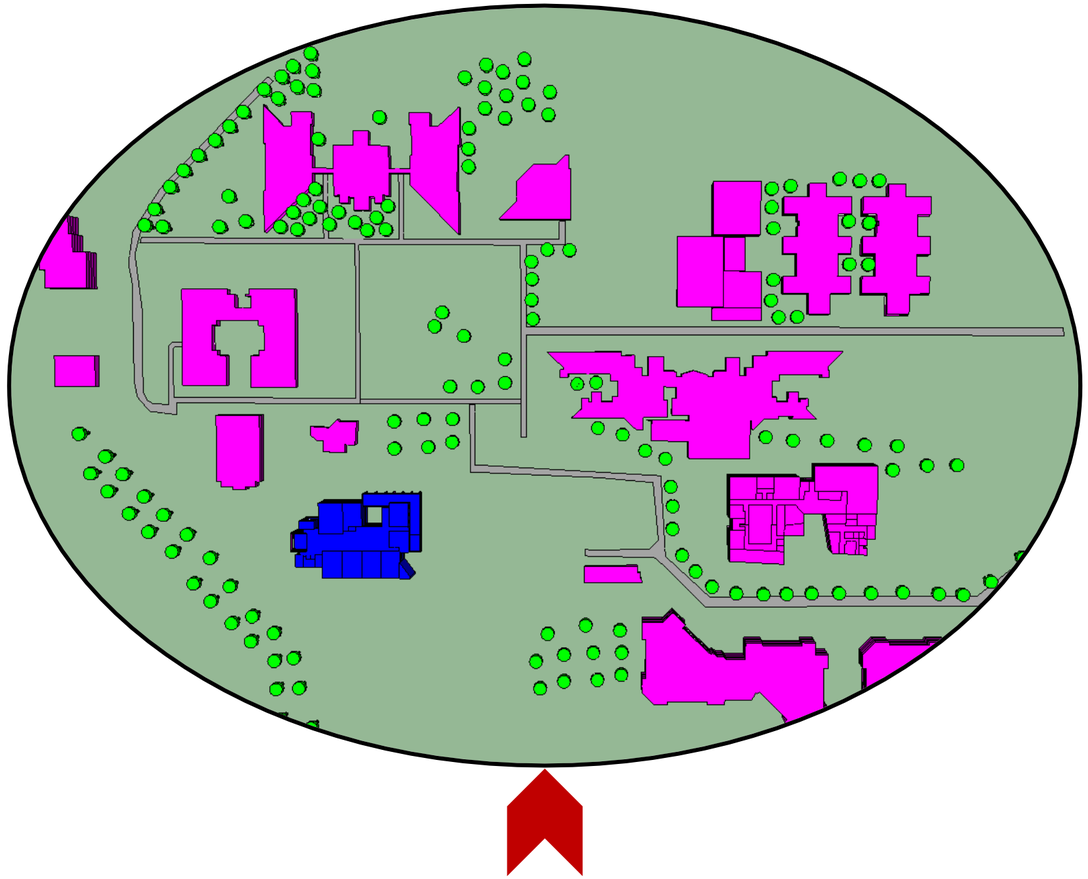
Ventilation Analysis provides temperature corresponding to the minimum and maximum external airflows

Daylight analysis focuses on optimizing the natural light within a building. Enhances occupant well-being, reduces the need for artificial lighting,.

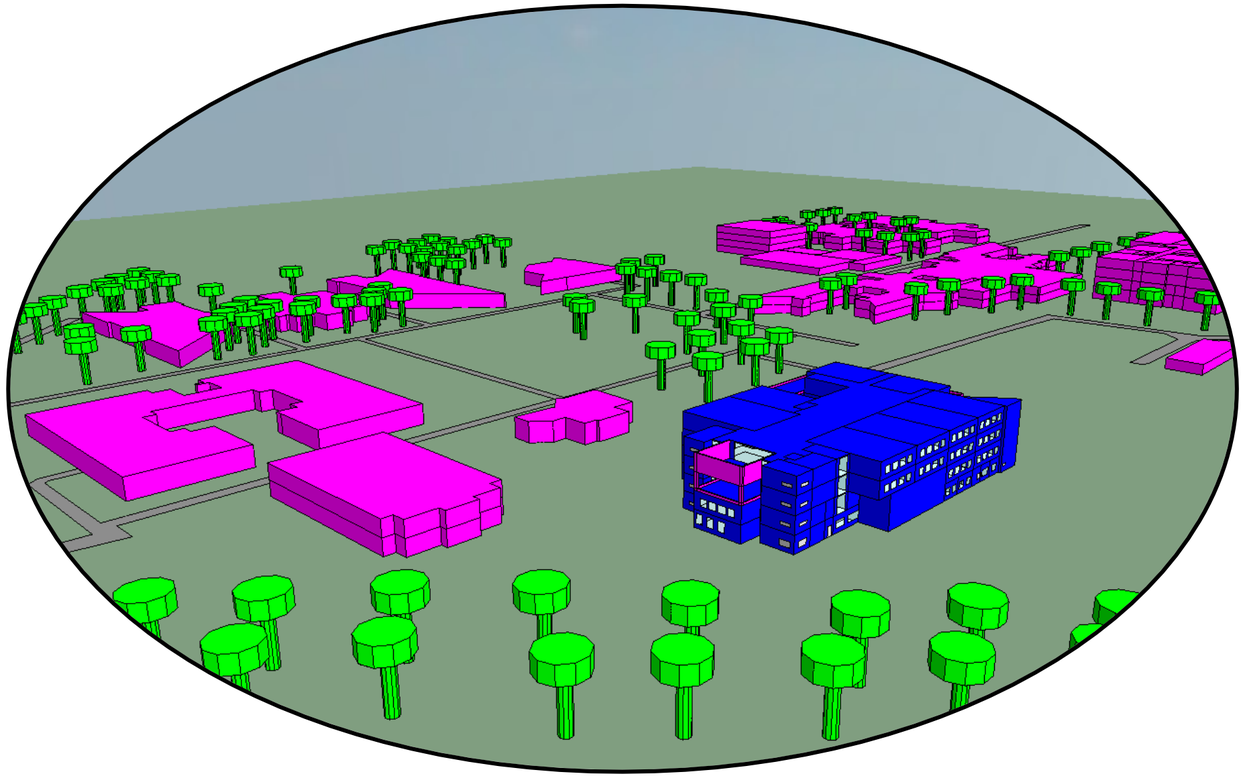
Material analysis involves choosing construction materials based on their properties and impact on the building's performance(energy efficiency, sustainability, and occupant well-being) .

HVAC analysis is performed to give accurate HVAC sizing (Tonnage) for the proposed Building.

3.MODEL SNAPSHOTS

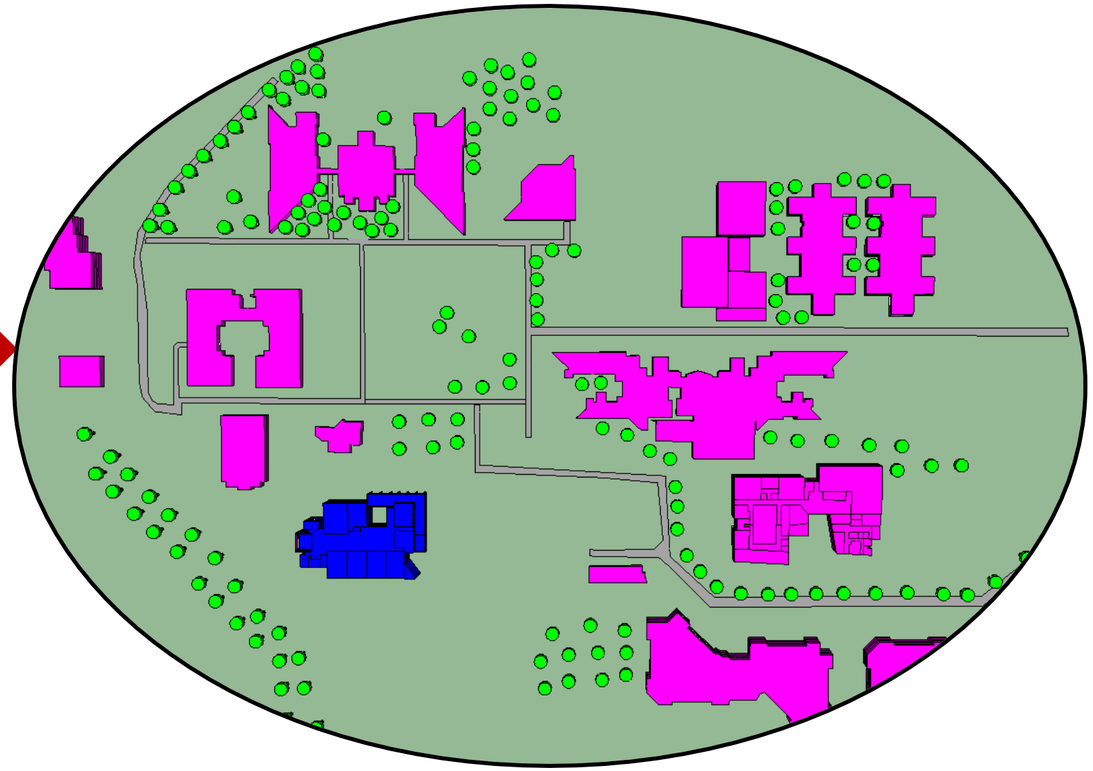


Site Model

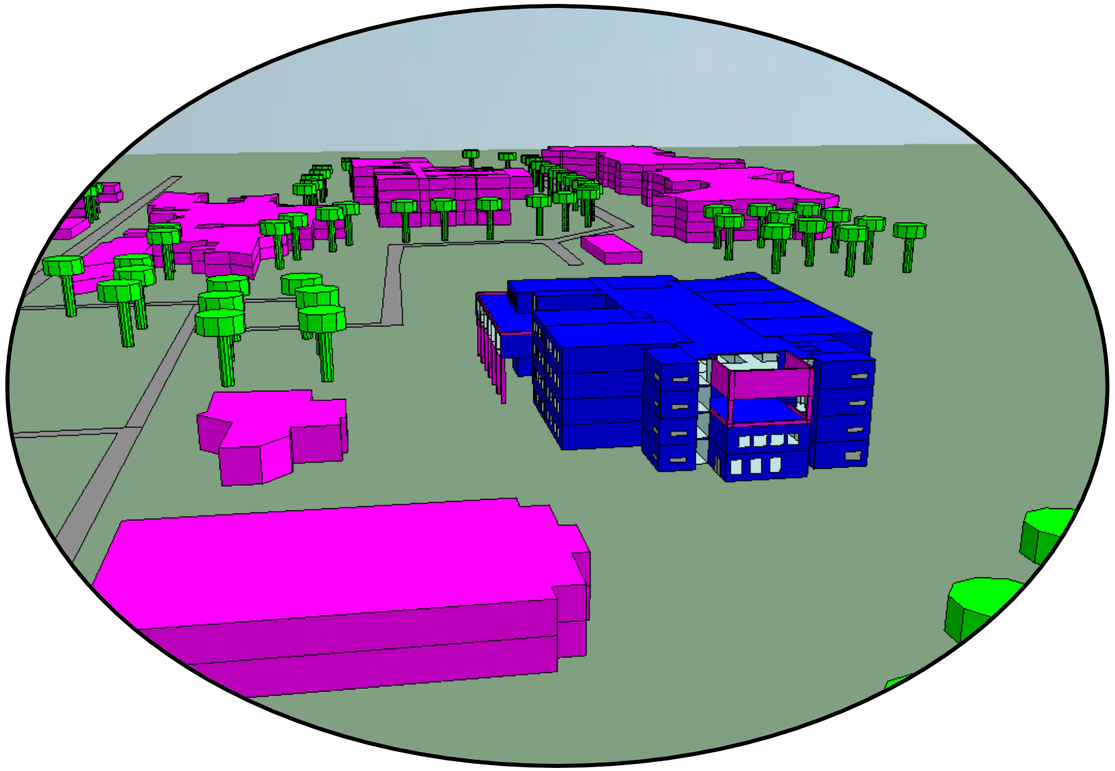


View from South direction

3.MODEL SNAPSHOTS

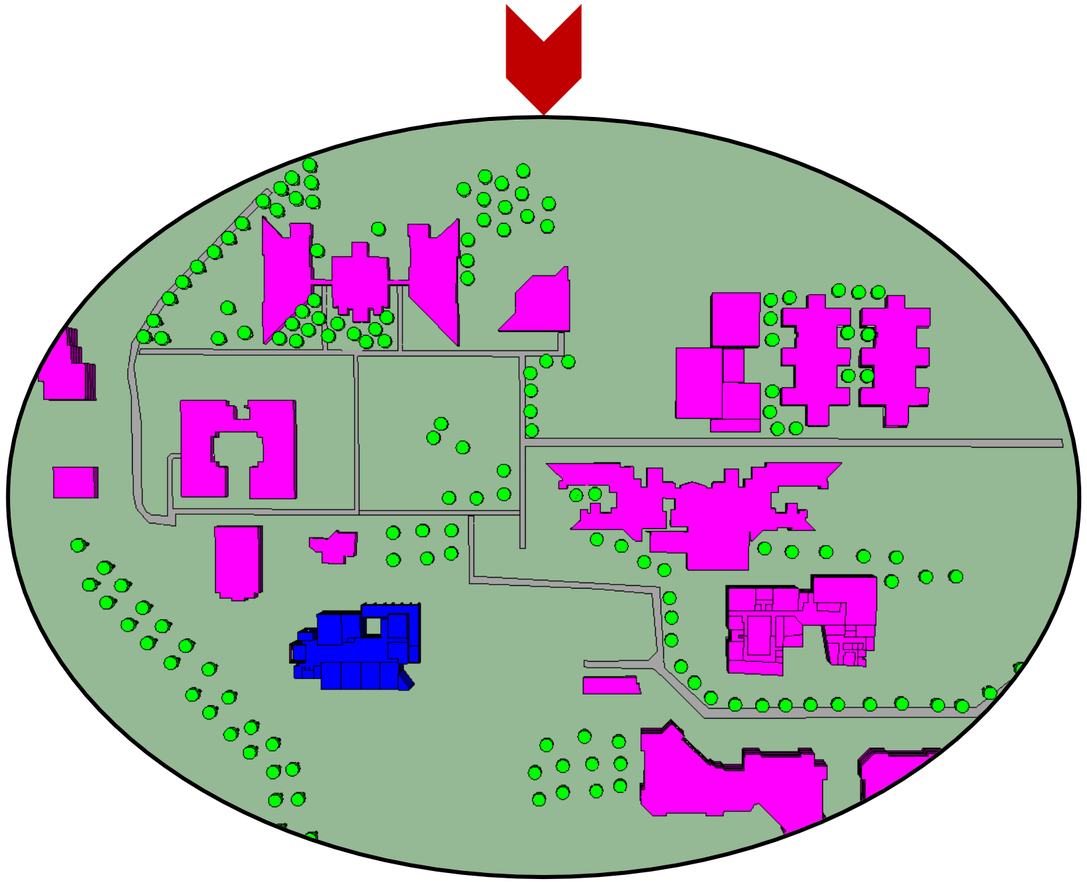


Site Model

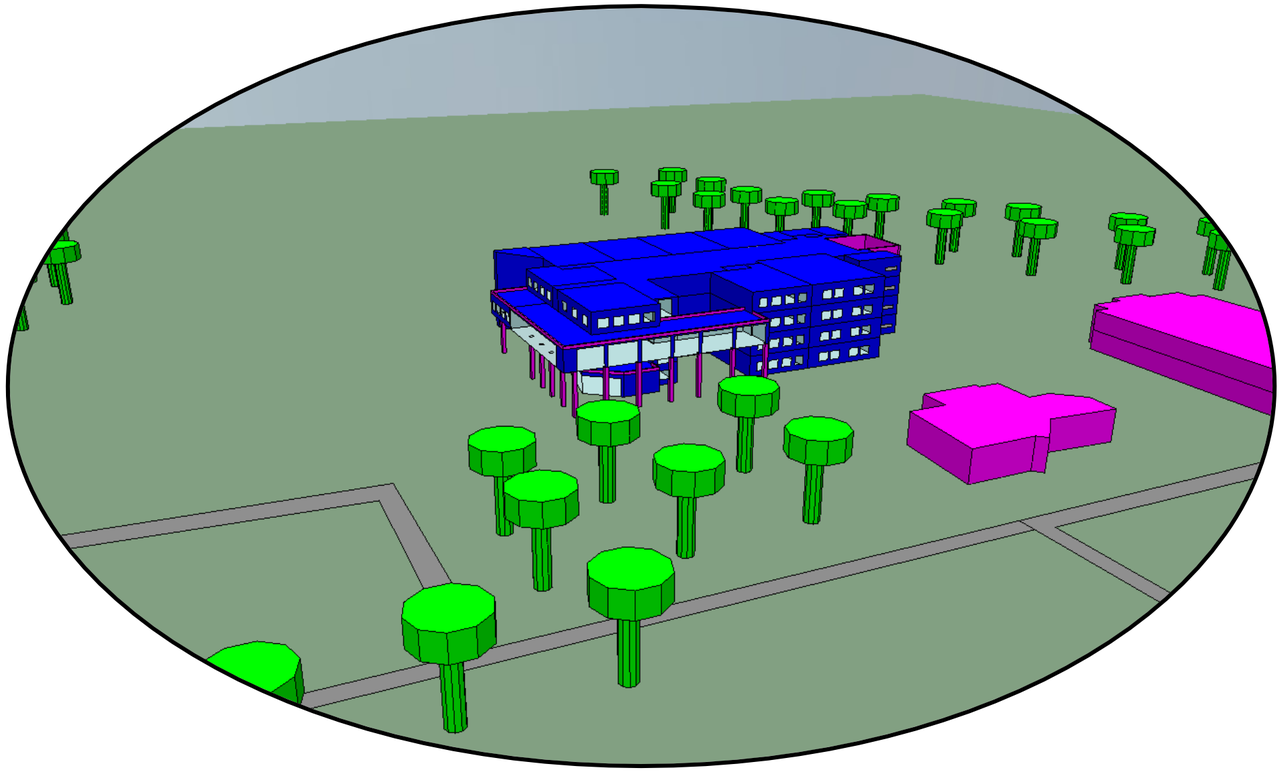


View from West direction

3.MODEL SNAPSHOTS

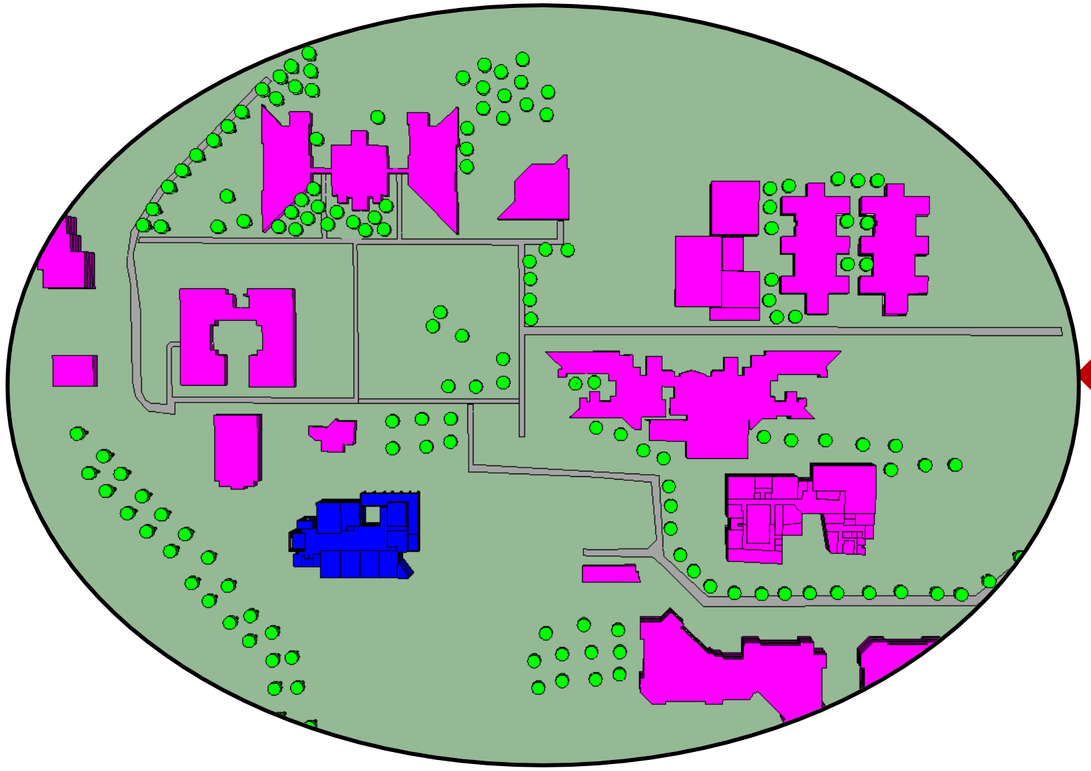


Site Model

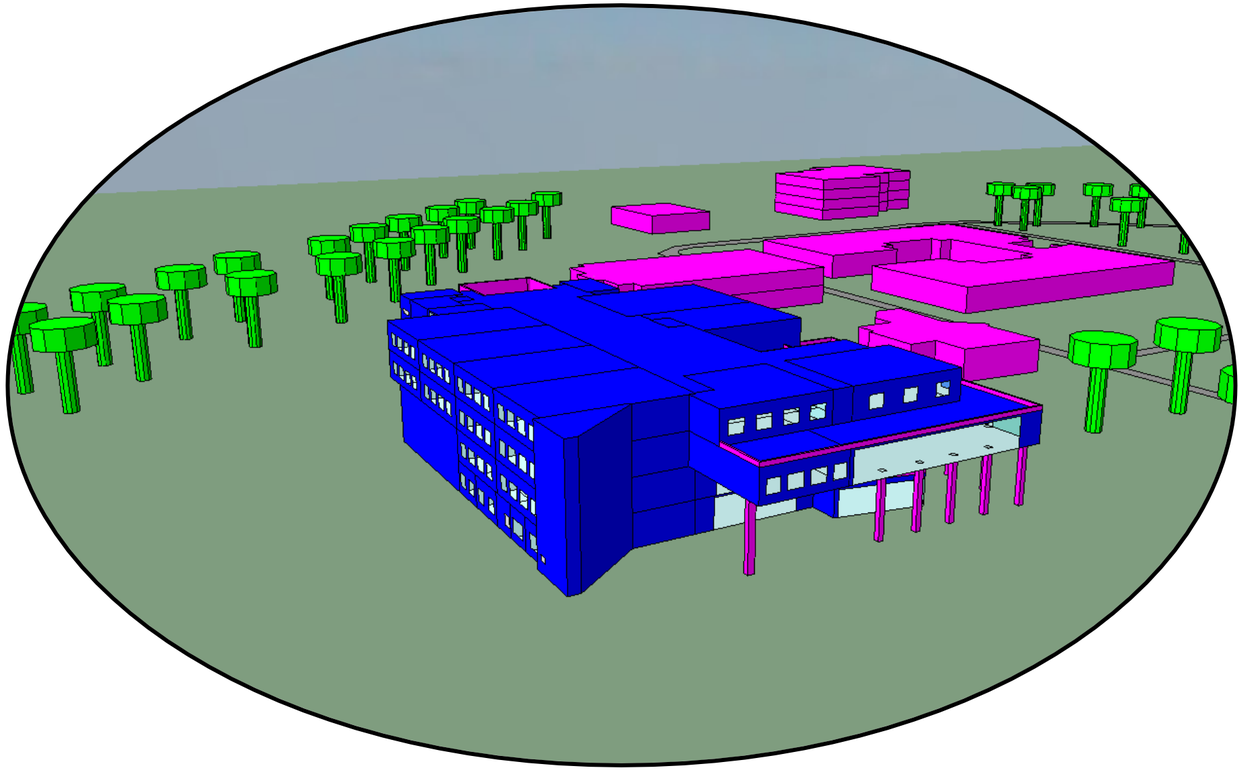


View from North direction

3.MODEL SNAPSHOTS

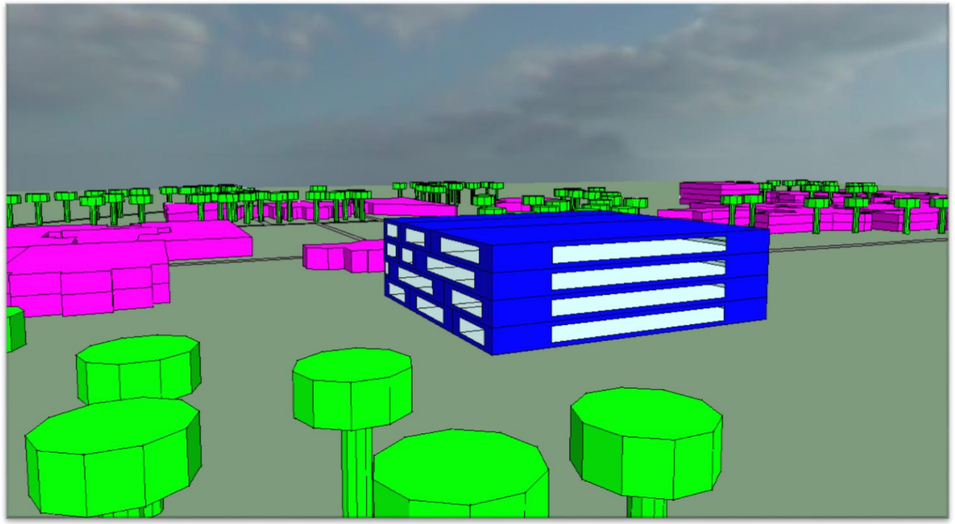


Site Model

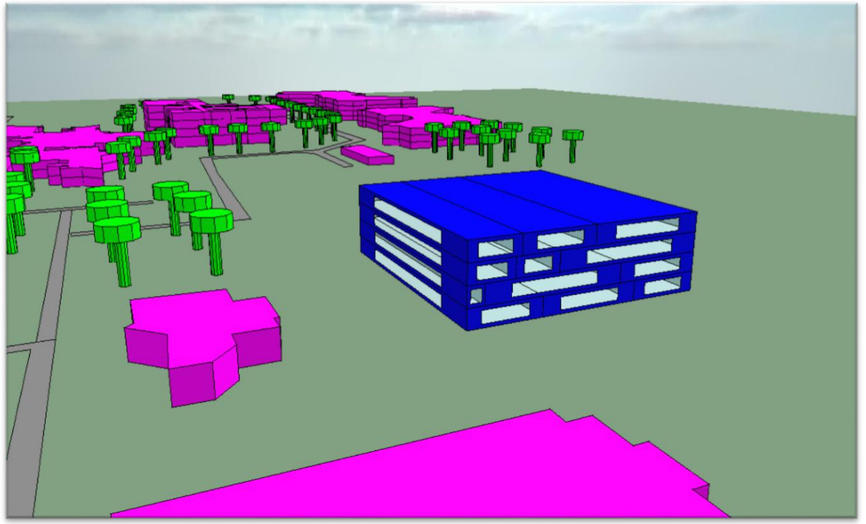


View from East direction

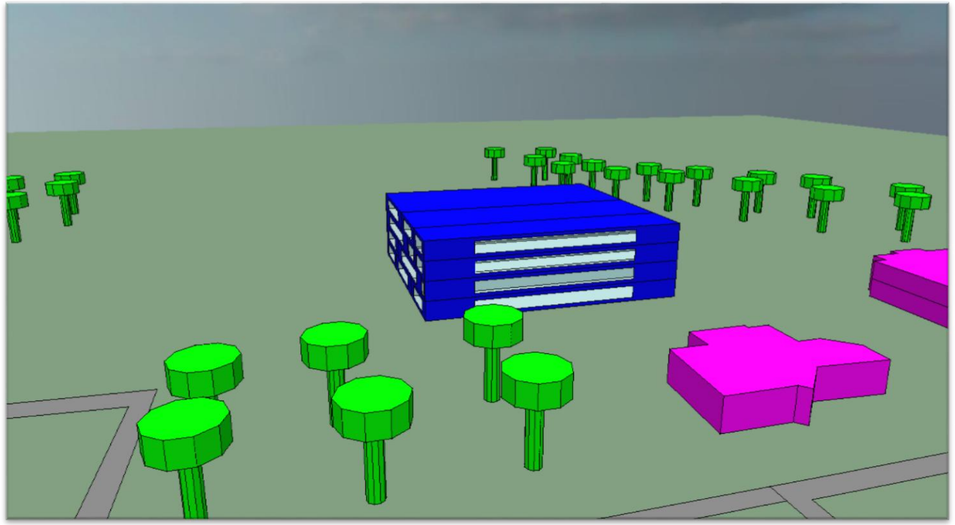
3.MODEL SNAPSHOTS



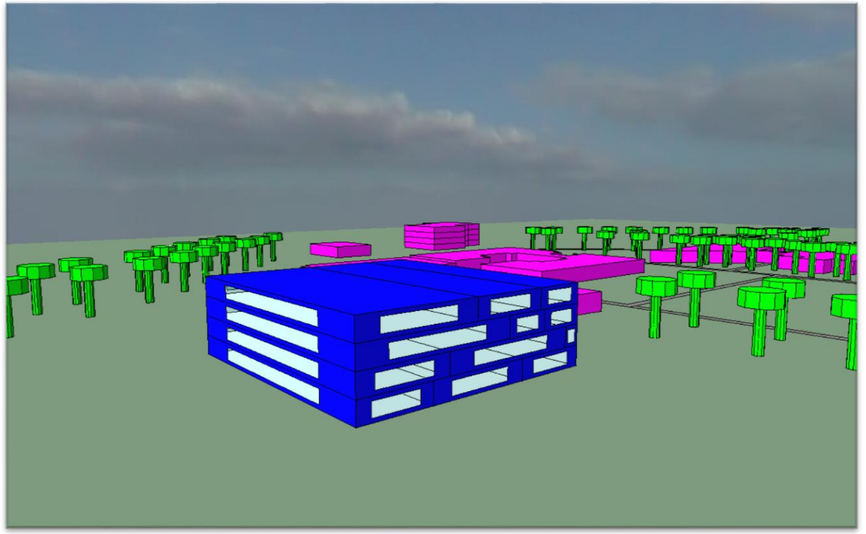
South Elevation



West Elevation



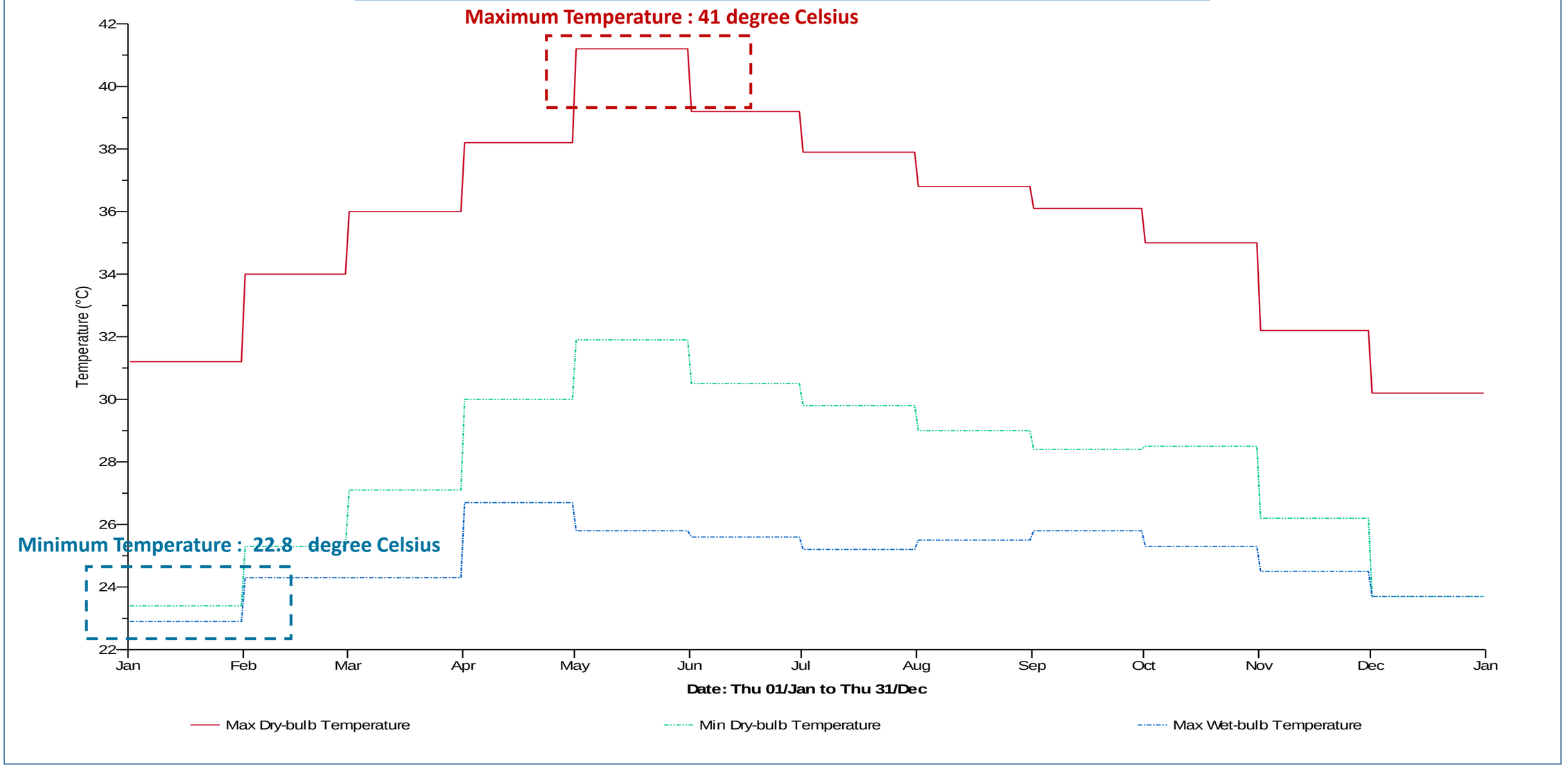
North Elevation



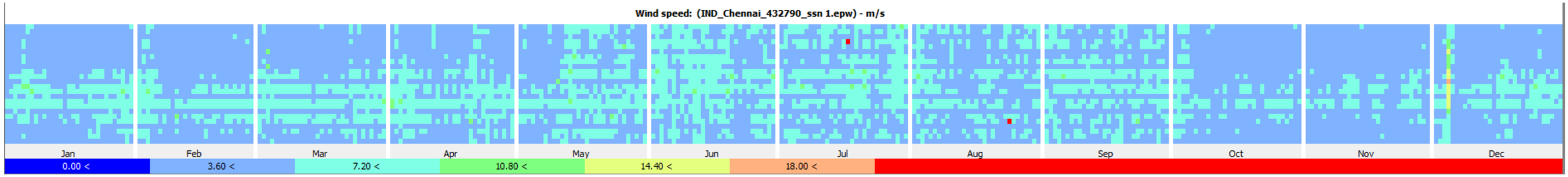
East Elevation

4.CLIMATE ANALYSIS

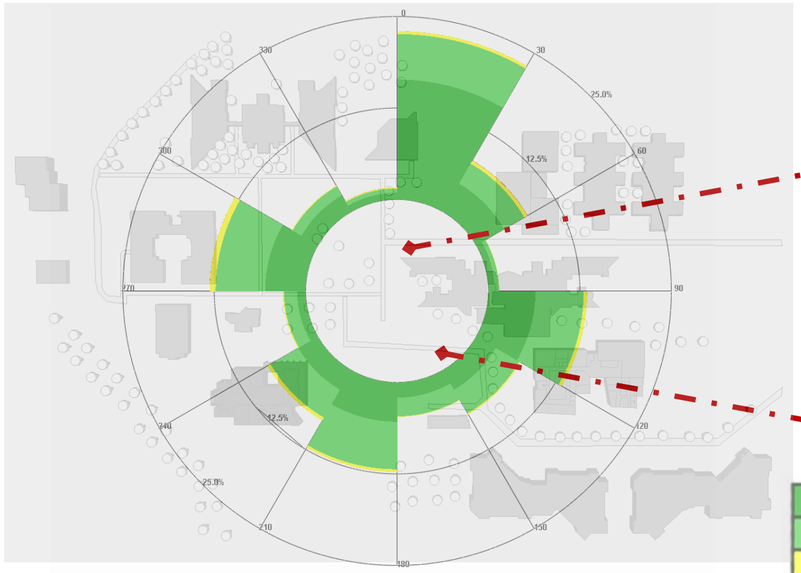
Max & Min Dry-bulb Temperature; Max wet-bulb Temperature

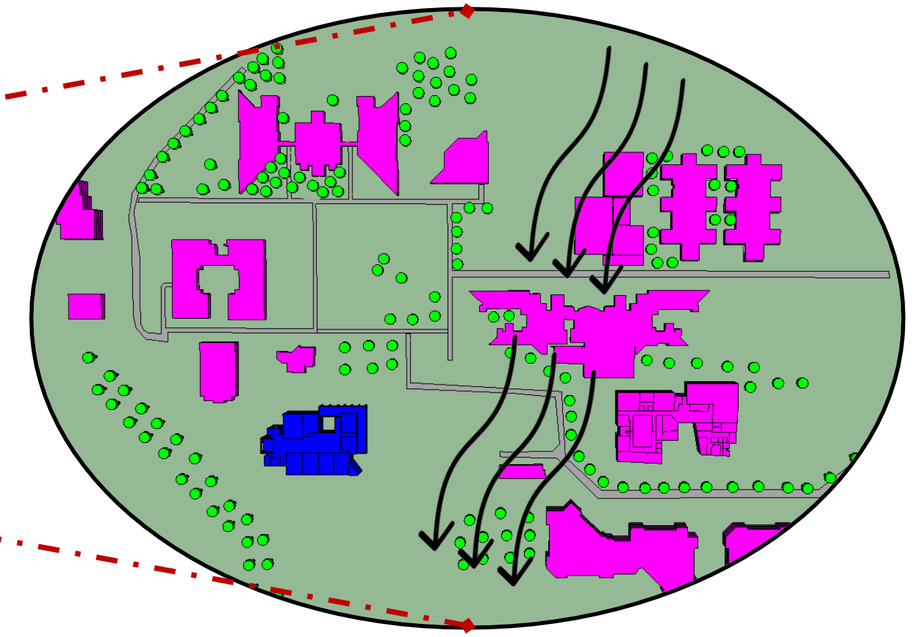


Wind Speed [Max- 25.4 m/s @ 17th July 4AM; Min- 0m/s @ 1st Jan 1AM]



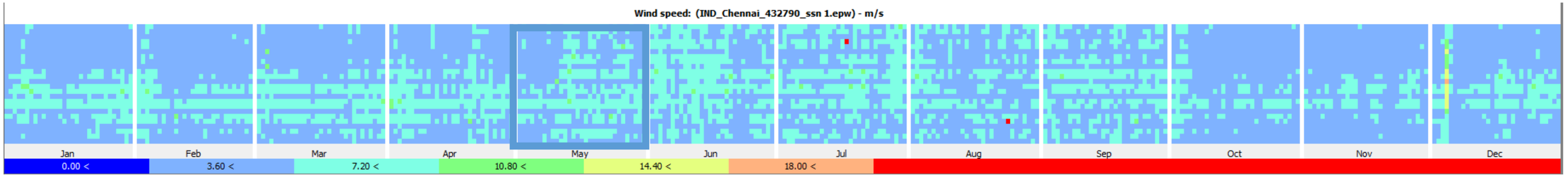
Windrose diagram – Annual



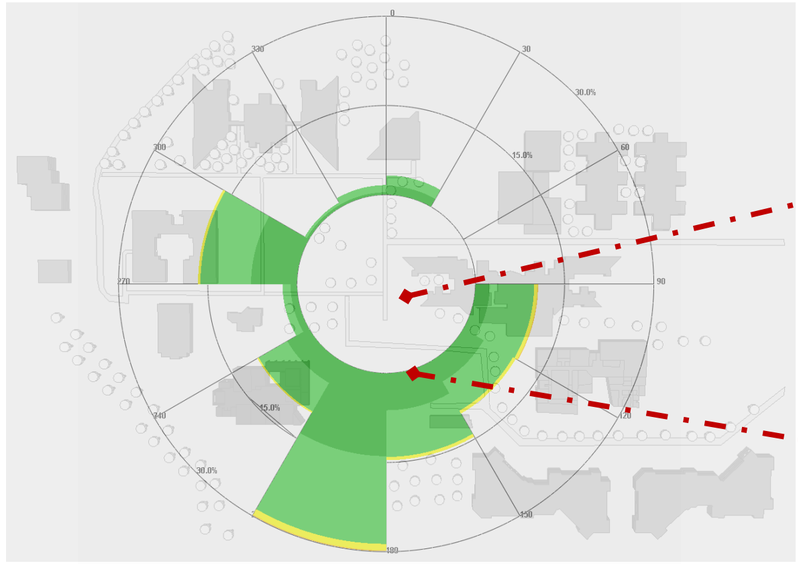


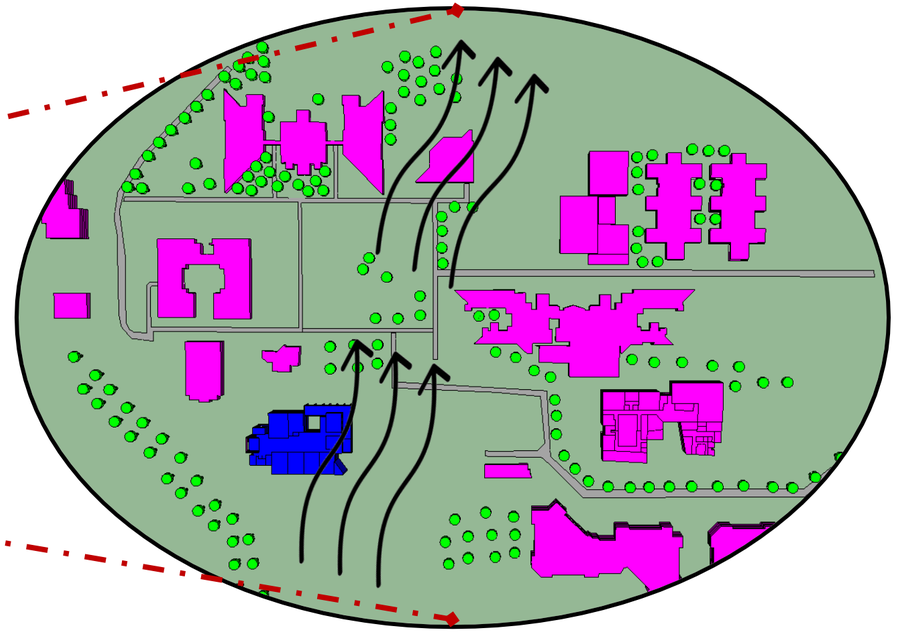
The predominant wind direction id from North-East to South -West

Wind Speed [Max- 25.4 m/s @ 17th July 4AM; Min- 0m/s @ 1st Jan 1AM]



Windrose diagram – MAY



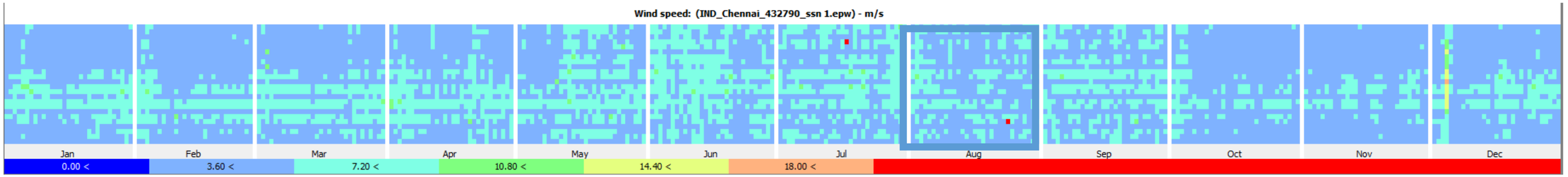


Hottest Month
-MAY
44.2°C
48.2% RH

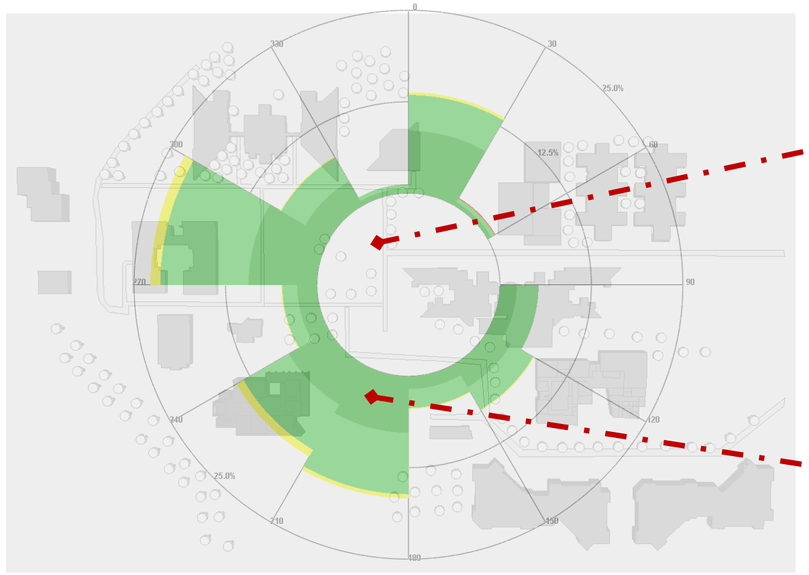
The wind direction is from South to North direction

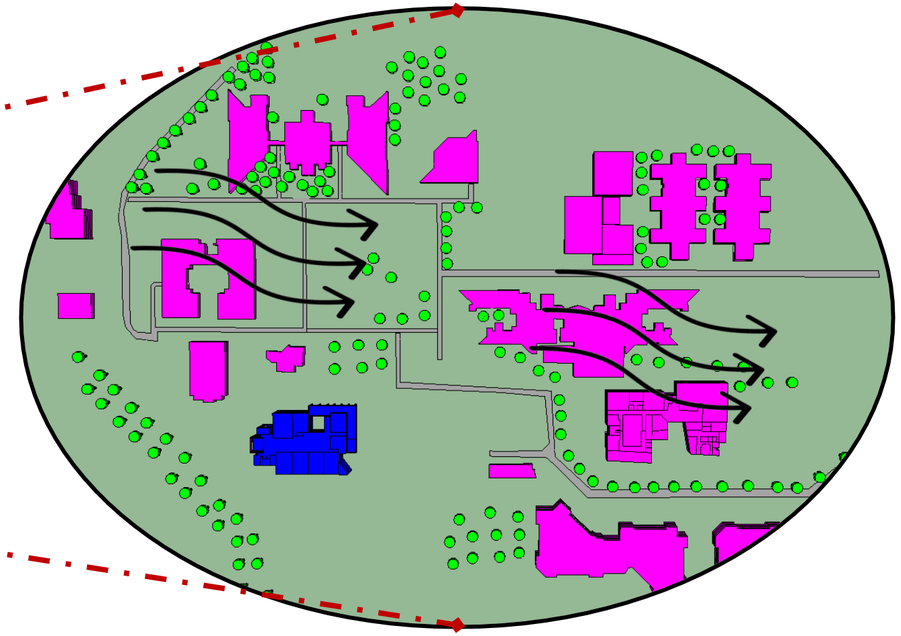
N

Wind Speed [Max- 25.4 m/s @ 17th July 4AM; Min- 0m/s @ 1st Jan 1AM]



Windrose diagram –AUGUST

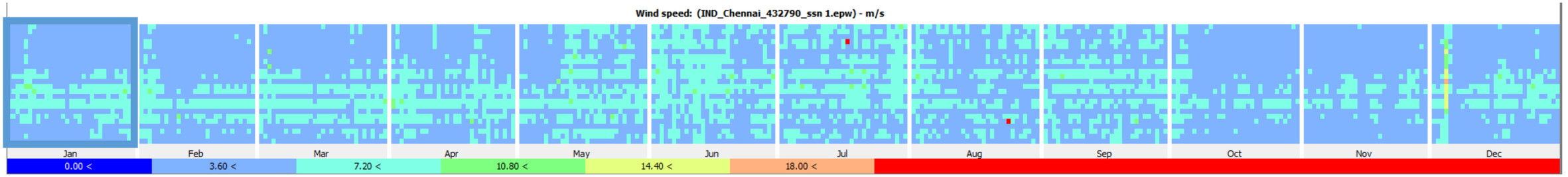




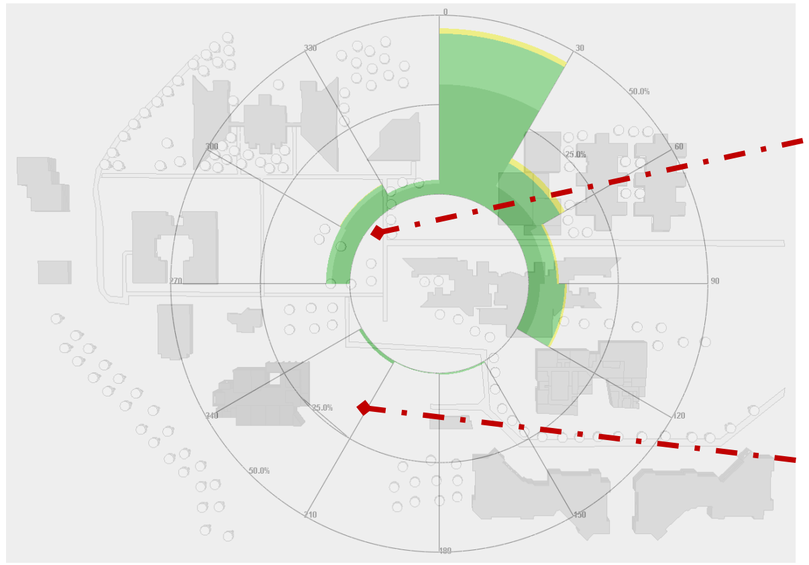
Most hot-humid month-AUGUST
33.5 °C
52.4% RH

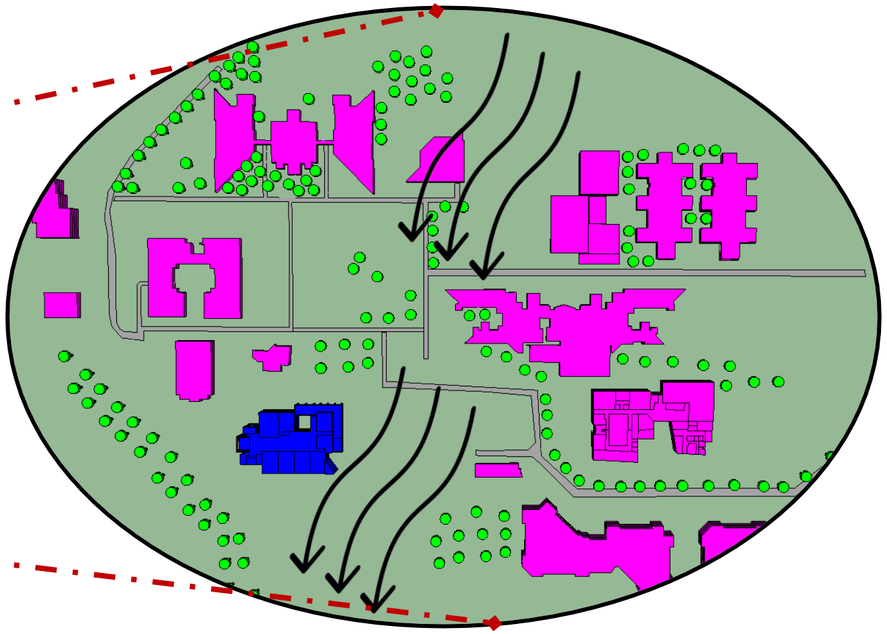
The wind direction is from North -West to South-East direction

Wind Speed [Max- 25.4 m/s @ 17th July 4AM; Min- 0m/s @ 1st Jan 1AM]



Windrose diagram – JANUARY





Coldest Month - JANUARY
31 °C
51.7% RH

The wind direction is from North to South

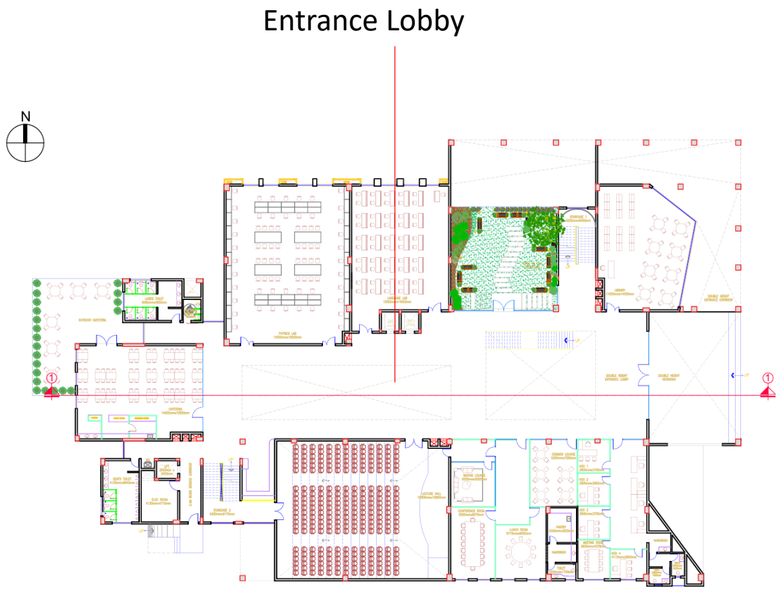
VENTILATION ANALYIS

- Ventilation Analysis is performed for Non Airconditioned spaces in Academic Buildings.
- The simulation is performed by considering 50 % Operable windows in all Non-Air-conditioned Areas.
- The Annual air flow rate and peak room temperature is determined from the ventilation Analysis.

Project Name	: Shiv Nadar University
Site Location	: Kelambakkam ,Chennai
Built-up Area	: 8,752 Sq.m
Academic Building AC Area	: 5,546 Sq.m
Key Description	: Educational Facility
Geographical Location	: 12.75° N , 80.20° E
Climate Zone	: Warm & Humid

RESULTS

The Non-Air conditioned regularly occupied spaces are taken from the analysis

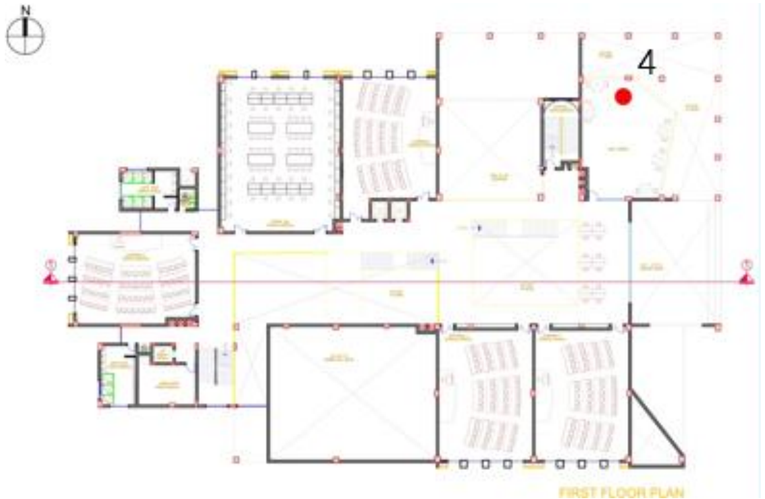


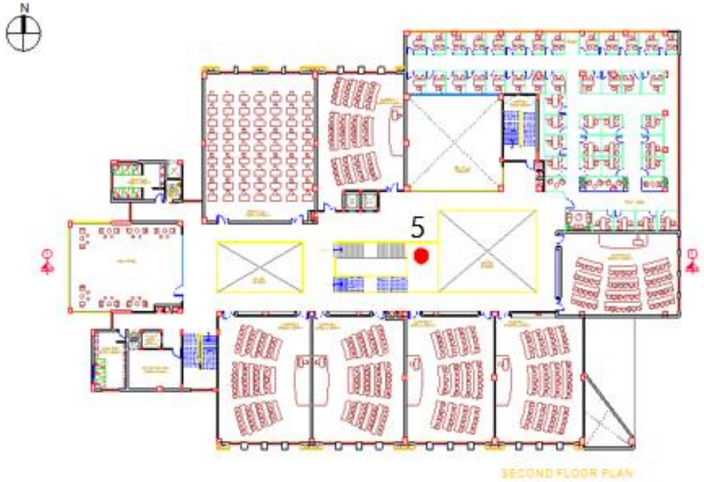
Ground Floor Plan(Academic Building)

Room Spaces	Air Temperature(Deg C) in degree Celsius for construction options External temperature condition: 41.40degC on May 28th 2024							
	Baseline(Box model)	Red Brick	Fly Ash Brick	AAC Brick	Cavity Wall	EIFS	EIFS With High SRI Paint	AAC Brick Brick With With High SRI Paint
ENTRANCE LOBBY	43.54	40.41	40.38	40.34	40.39	40.29	39.88	39.91

Room Spaces	Air change rate(ACH) in degree Celsius for construction options External temperature condition: 41.40degC on May 28th 2024							
	Baseline(Box model)	Red Brick	Fly Ash Brick	AAC Brick	Cavity Wall	EIFS	EIFS With High SRI Paint	AAC Brick With High SRI Paint
ENTRANCE LOBBY	5.36	7.69	7.58	7.38	7.62	7.19	8.96	8.75

AIR VELOCITY AND ACH AT MARKED POINTS

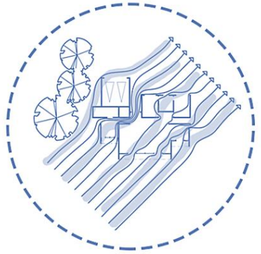




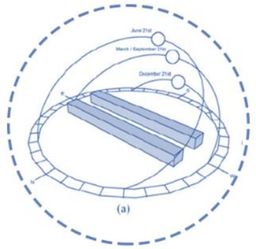
Space Name	Floor	ACH(Peak Humidity Day)	ACH(Peak Dry Bulb Temperature Day)	ACH(Peak Wind speed Day)	Annual ACH(Mean)
Lobby zone 1	Ground	16.25	17.99	14.04	16.17
Lobby zone 2		10.61	11.30	11.71	11.56
Lobby zone 3		14.51	16.91	15.02	15.72
Open Terrace 4	First	150.93	142.04	145.65	153.57
Lobby zone 5	Second	14.18	11.85	14.50	14.09

5. DESIGN RECOMMENDATIONS FOR WARM AND HUMID CLIMATE

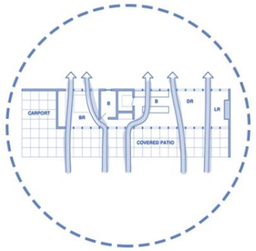
ORIENTATION



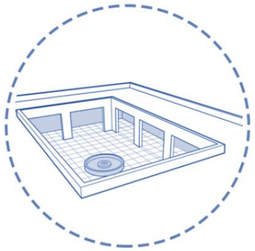
Orientation of buildings towards
prevailing wind direction for ventilation in summer
vegetation for deflecting wind



SPACING



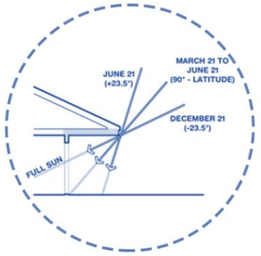
Well shaded courtyards and
open planning with buffer spaces
Open spacing for breeze penetration

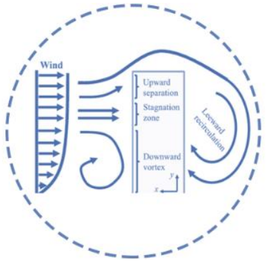


OPENING

In north at body height on windward side provide
Large openings, 40-80% Exclude direct sunlight

WALLS / ROOFS



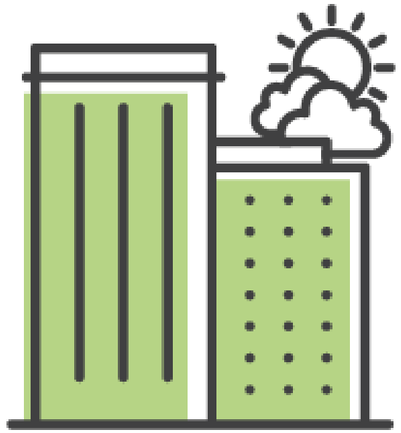


Wall: heavy shaded walls to reduce heat gain in
summer(west and south)
Roof: Material with high SRI for maximum
emissivity to minimize heat gain in in summer

AIR MOVEMENT

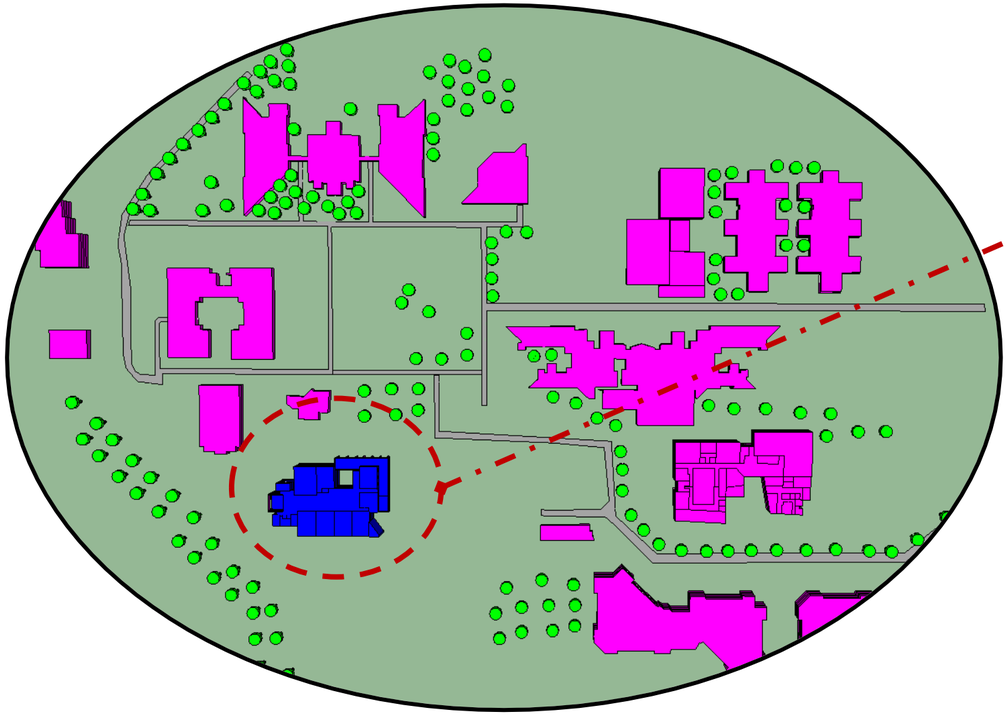
Cross ventilation through openings creating stack effect

SOLAR THERMAL ANALYSIS

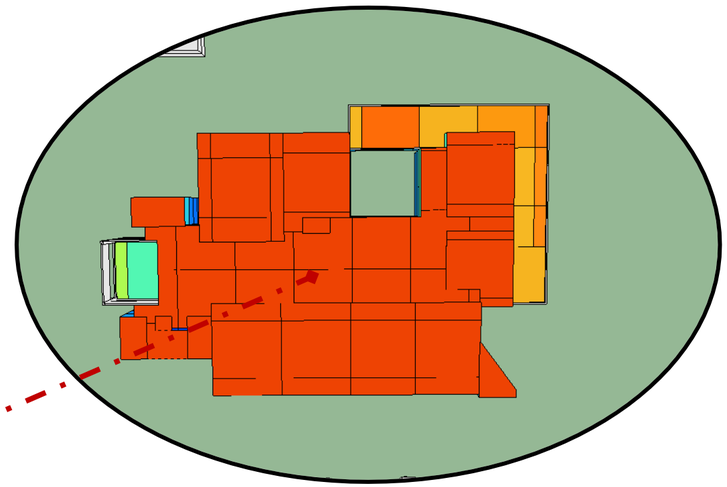


SOLAR ANALYSIS -Annual

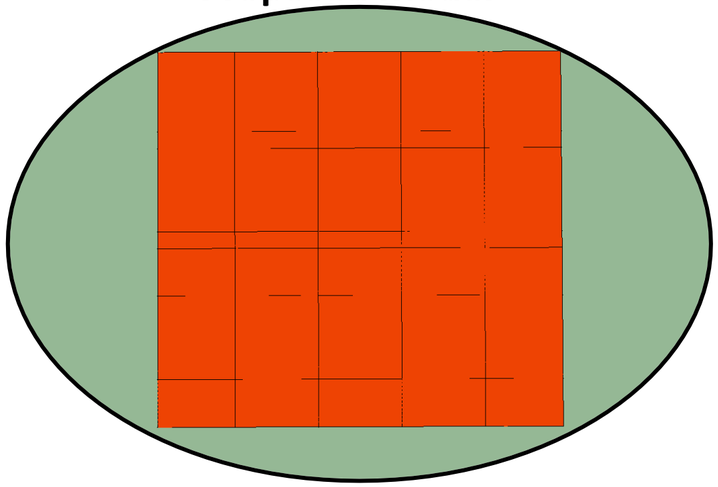
Roof Radiant Heat Academic Building



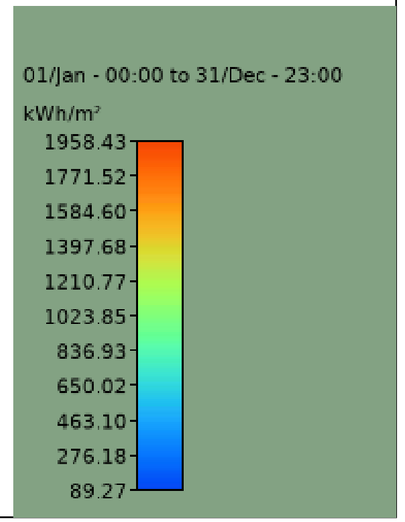
Key plan



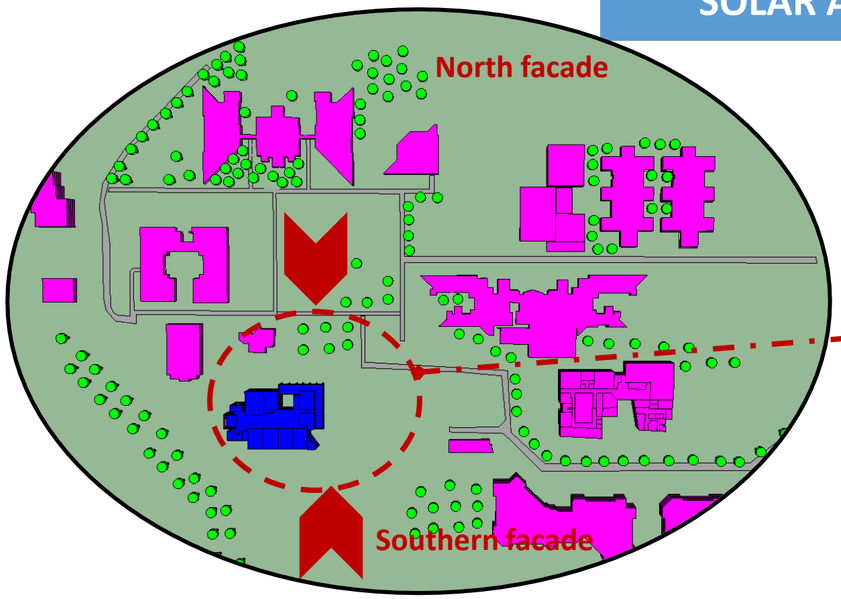
Proposed Model

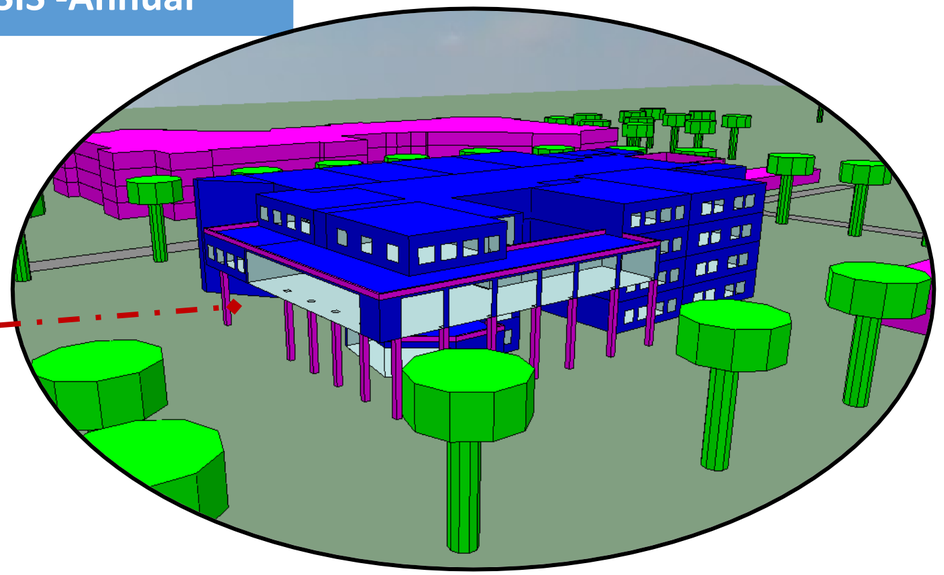


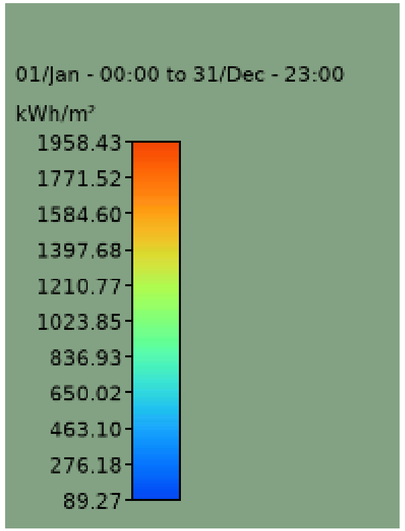
Box Model



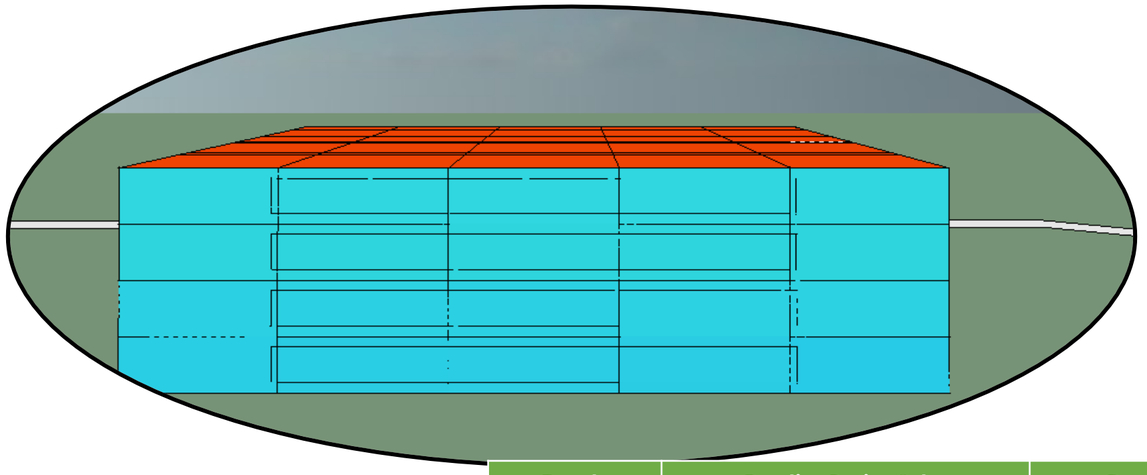
SOLAR ANALYSIS -Annual



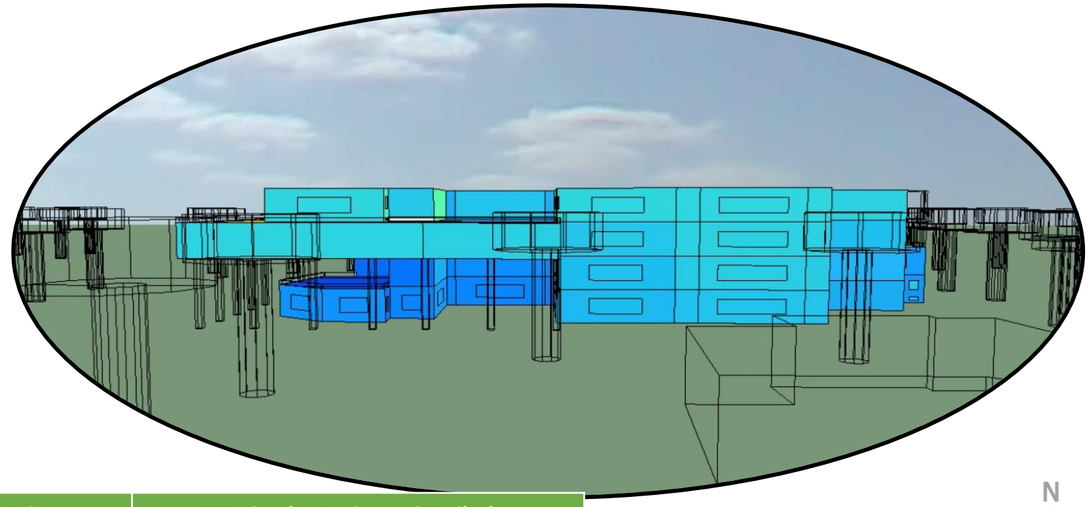




Northern Facade Radiant heat(Box Model)

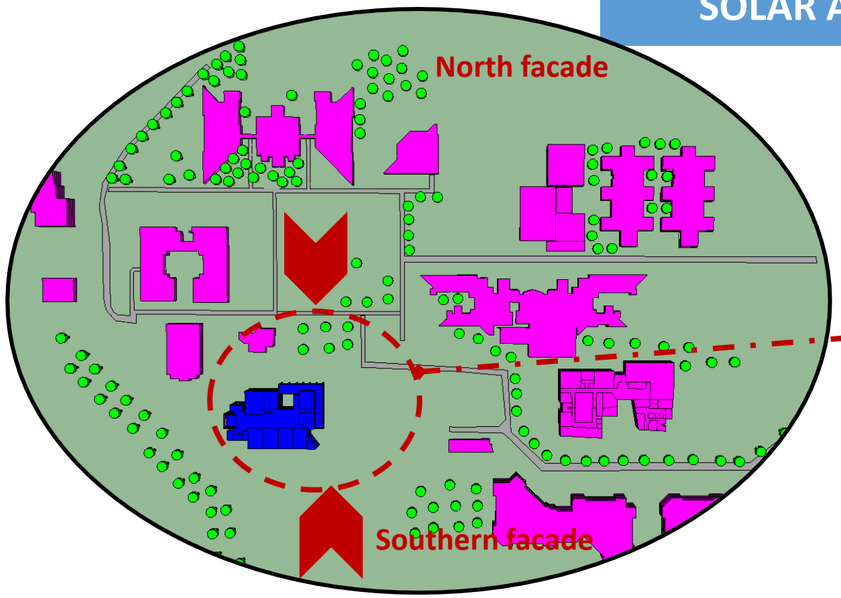


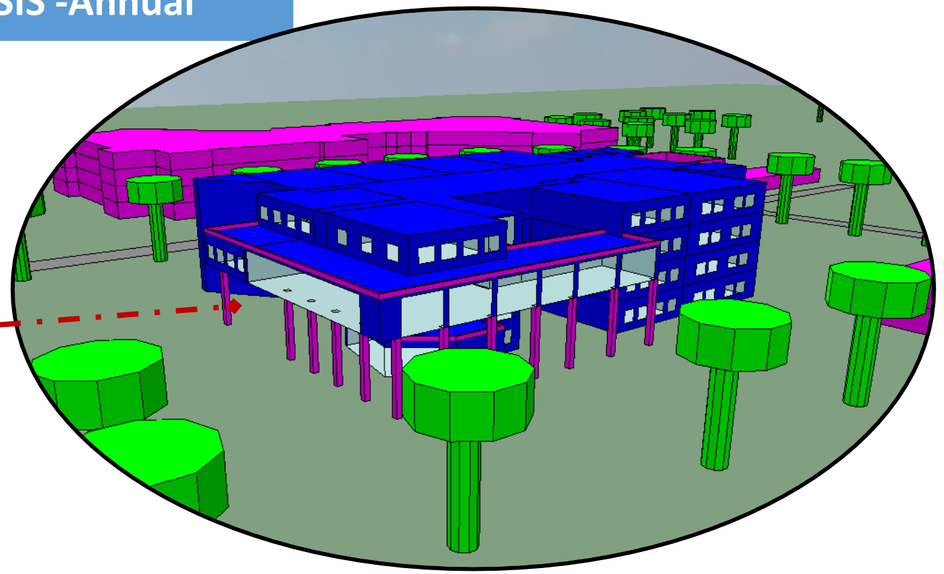
Northern Facade Radiant heat(Proposed Model)

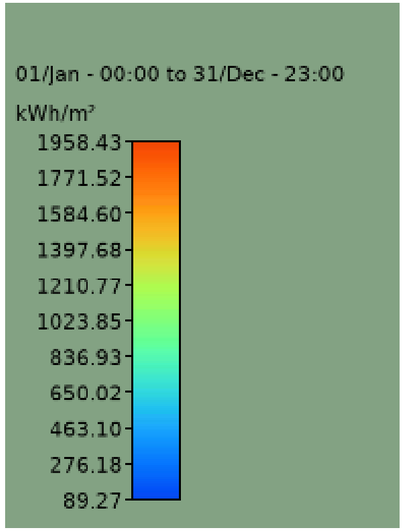


Facade	Baseline Design Solar Radiation(KWH/Sq.m)	Proposed Design Solar Radiation(KWH/Sq.m)	% Reduction In thermal Radiation
North	650	325	50%

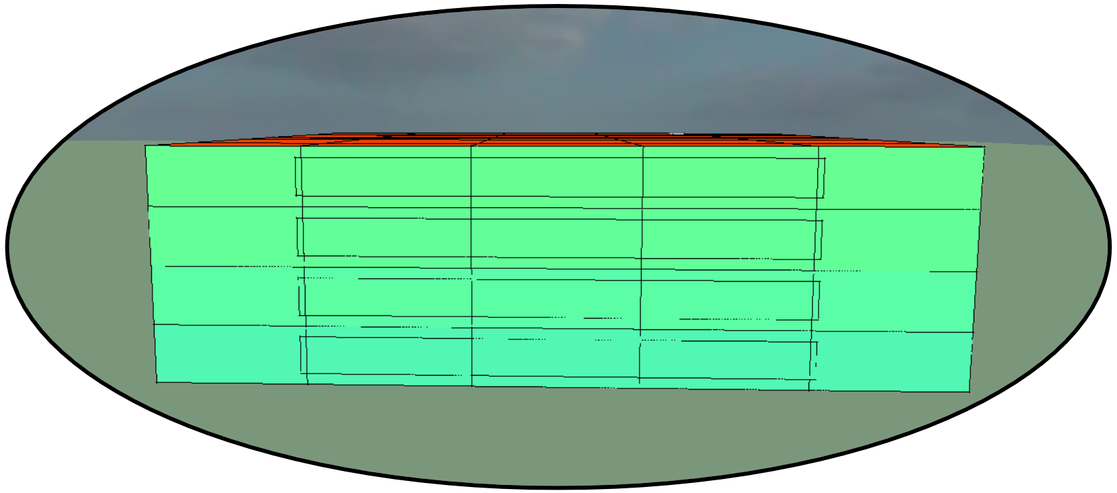
SOLAR ANALYSIS -Annual



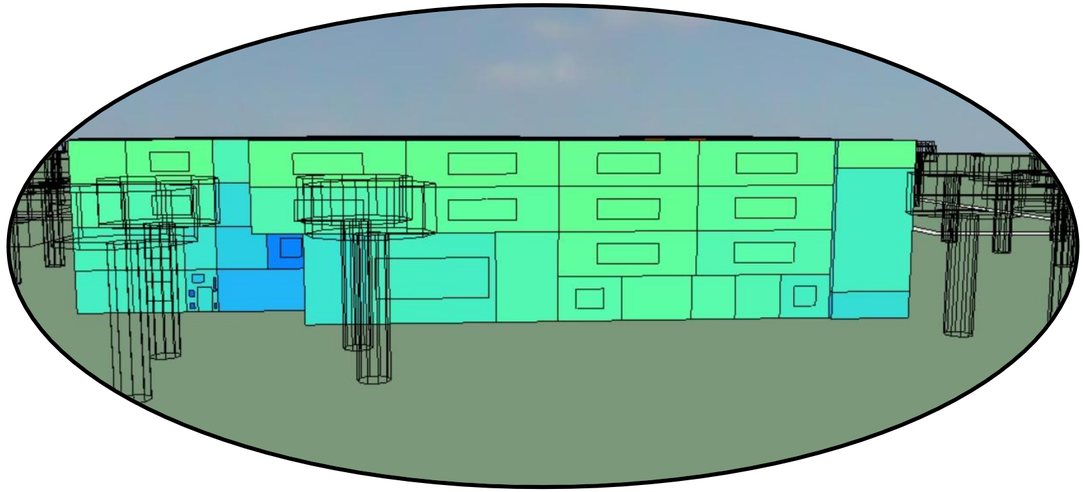




Southern Facade Radiant heat(Box Model)

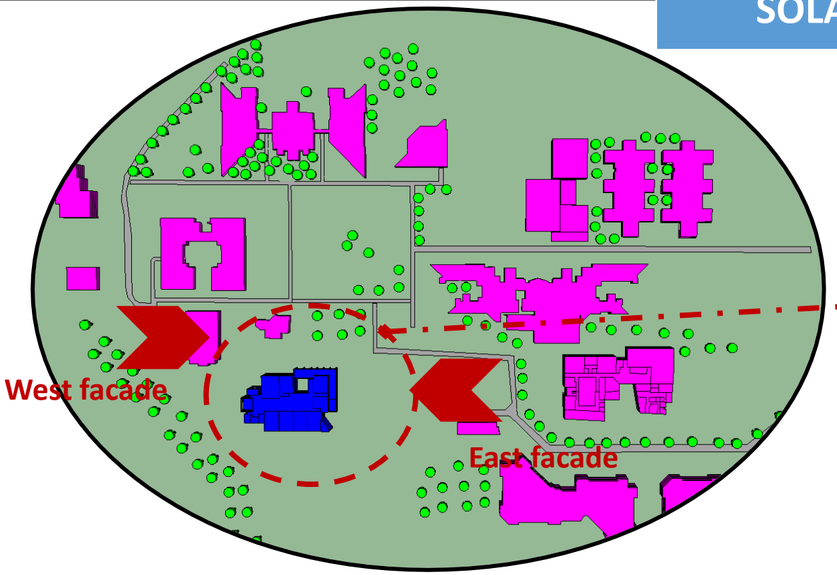


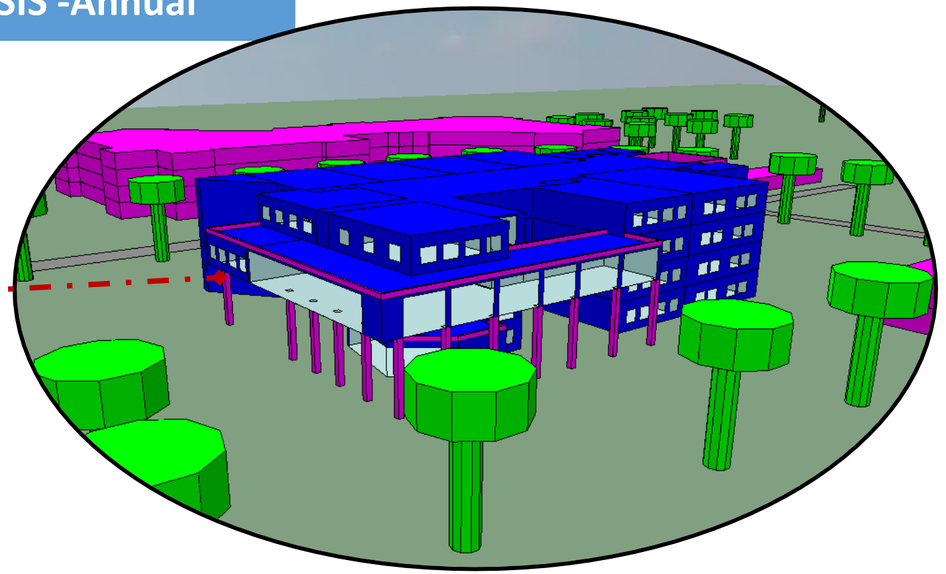
Southern Facade Radiant heat(Proposed Model)

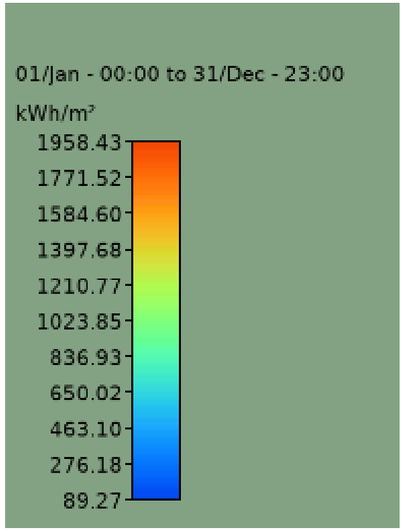


Facade	Baseline Design Solar Radiation(KWH/Sq.m)	Proposed Design Solar Radiation(KWH/Sq.m)	% Reduction In thermal Radiation
South	1000	550	55%

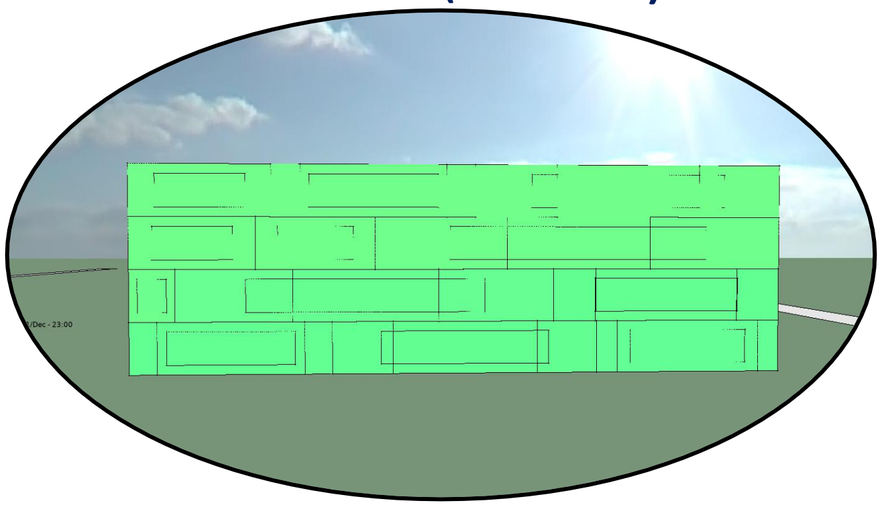
SOLAR ANALYSIS -Annual



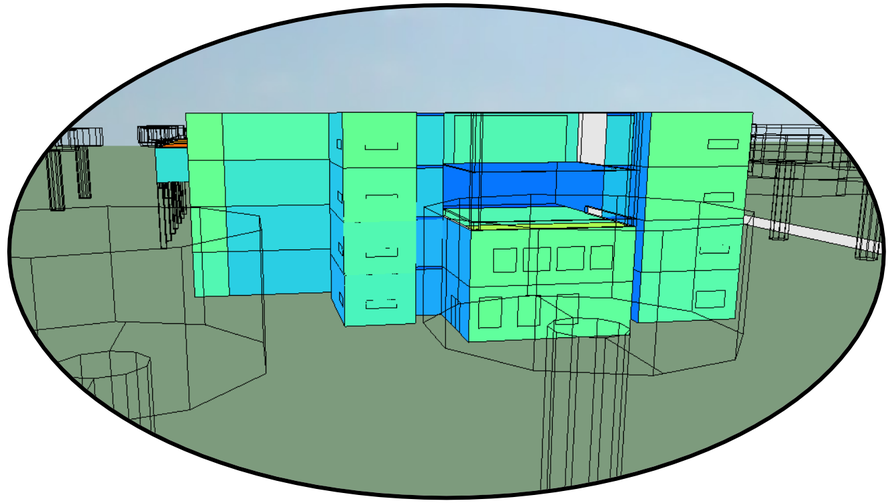




Western Facade Radiant heat(Box Model)

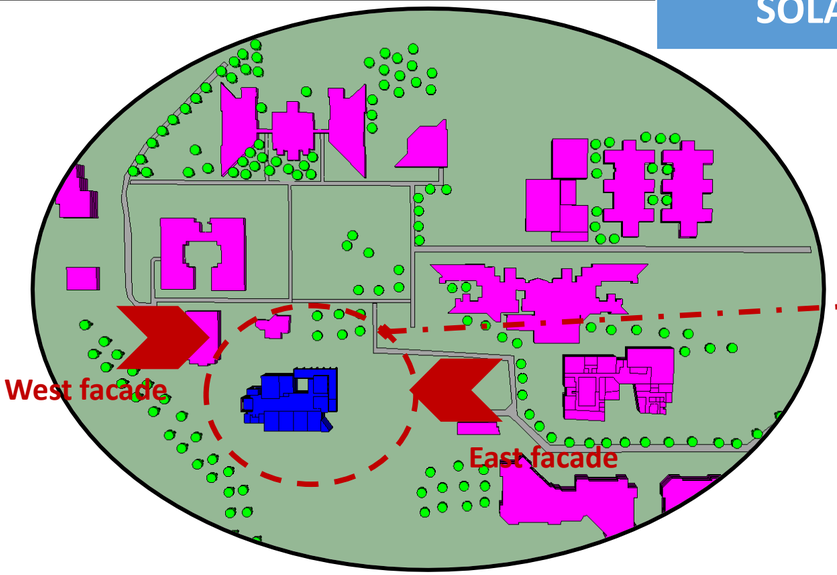


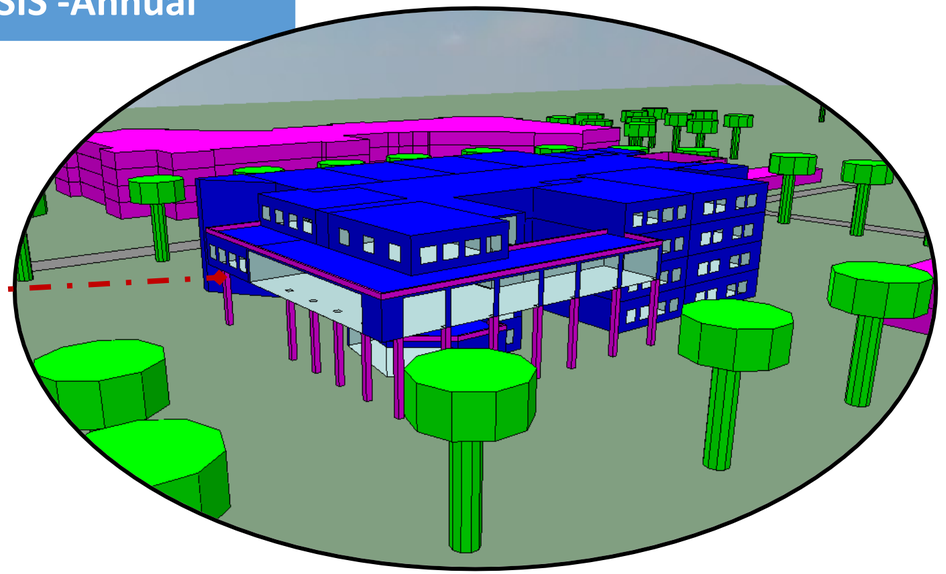
Western Facade Radiant heat(Proposed Model)

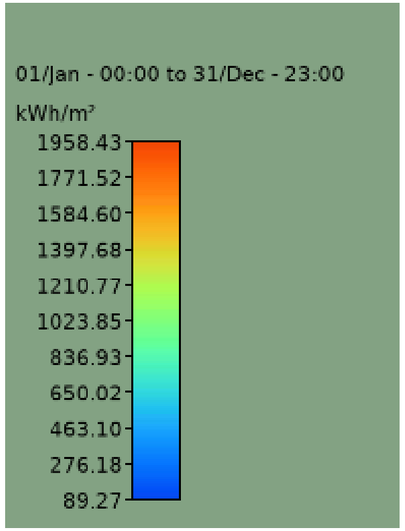


Facade	Baseline Design Solar Radiation(KWH/Sq.m)	Proposed Design Solar Radiation(KWH/Sq.m)	% Reduction In thermal Radiation
West	1023	666	65%

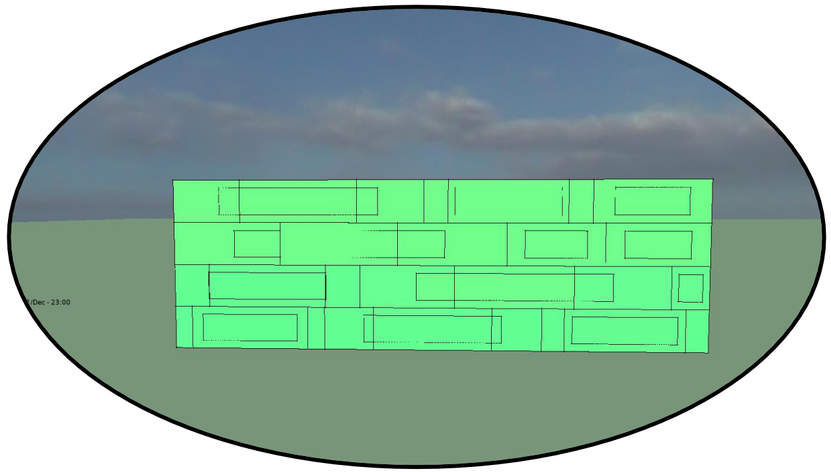
SOLAR ANALYSIS -Annual



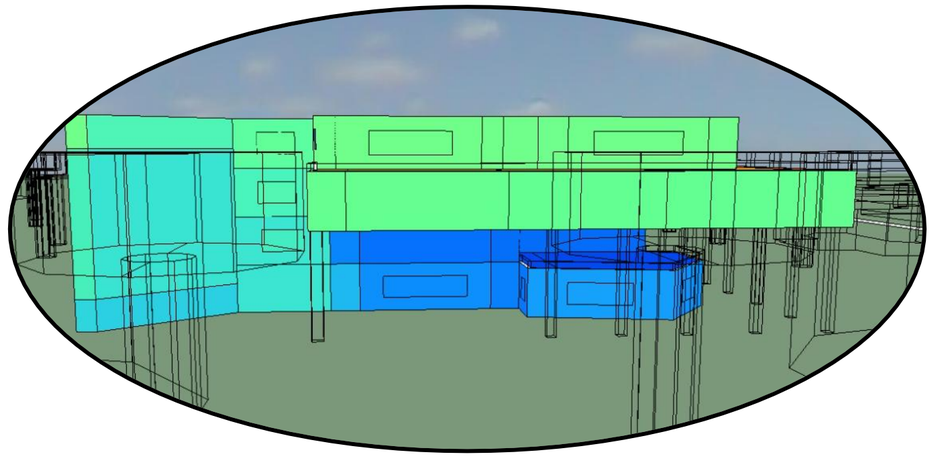




Eastern Facade Radiant heat(Box Model)

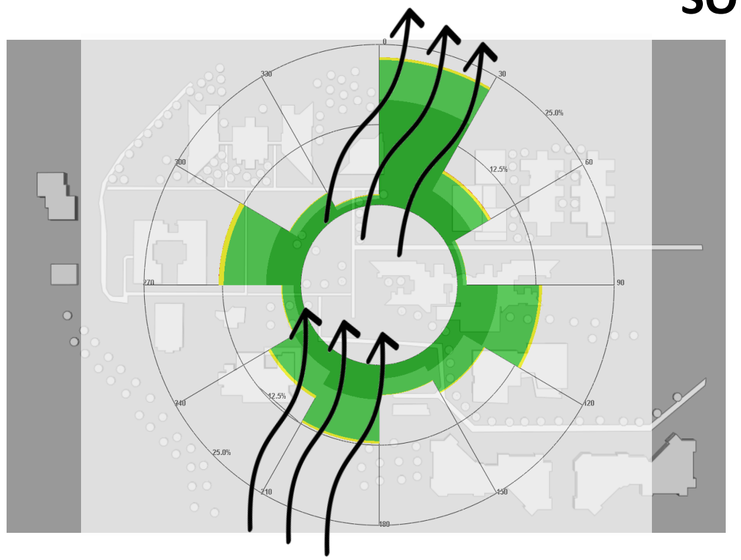


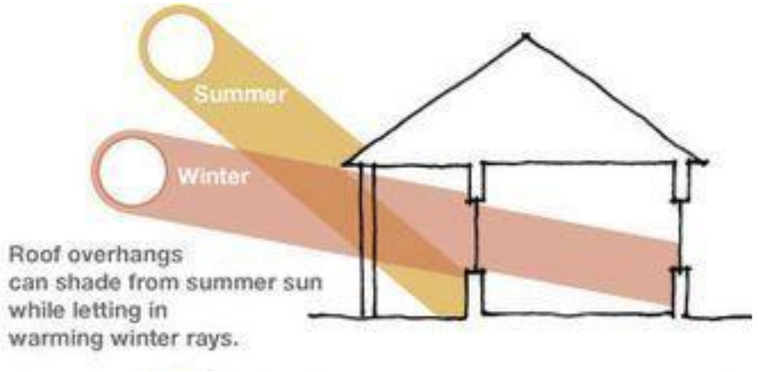
Eastern Facade Radiant heat(Proposed Model)

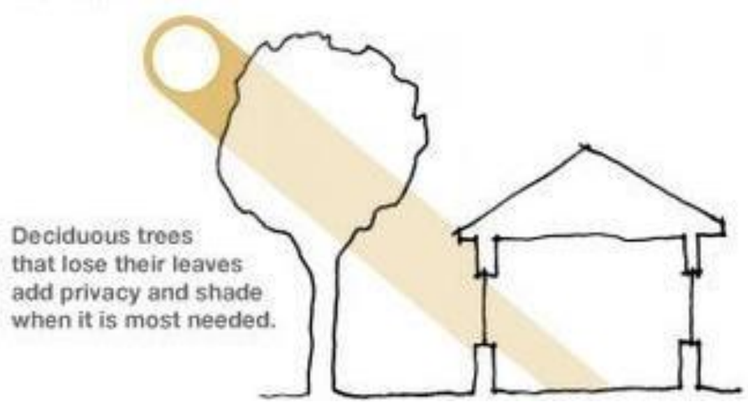


Facade	Baseline Design Solar Radiation(KWH/Sq.m)	Proposed Design Solar Radiation(KWH/Sq.m)	% Reduction In thermal Radiation
East	1010	808	80%

SOLAR THERMAL ANALYSIS INFERENCE



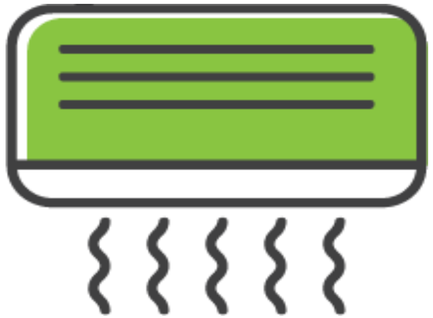




Facade	Baseline Design Solar Radiation(KWH/Sq.m)	Proposed Design Solar Radiation(KWH/Sq.m)	% Reduction In thermal Radiation
North	650	325	50%
South	1000	550	55%
West	1023	666	65%
East	1010	808	80%

- Hot and Dry winds(41 °C and 30% RH) is observed from South and west directions in May, By planting Large foliage trees in Western and southern façade site temperature is substantially reduced.
- Deploying Shading Elements/Large canopy trees shall reduce façade temperature. Thus, Heat ingress through Building Envelope is reduced.
- It is also observed that the Southern ,Eastern and Western façade is exposed to High Radiation .

HVAC ANALYSIS



HVAC ANALYSIS

- HVAC Analysis is performed for Academic Building.
- The Project has used efficient HVAC system which minimizes HVAC ODP and GWP.
- Implementing Efficient HVAC system shall achieve significant Energy savings.

Project Name	: Shiv Nadar University
Site Location	: Kelambakkam ,Chennai
Built-up Area	: 8,753 Sq.m
Academic Building AC Area	: 5,546 Sq.m
Key Description	: Educational Facility
Geographical Location	: 12.75° N , 80.20° E
Climate Zone	: Warm & Humid

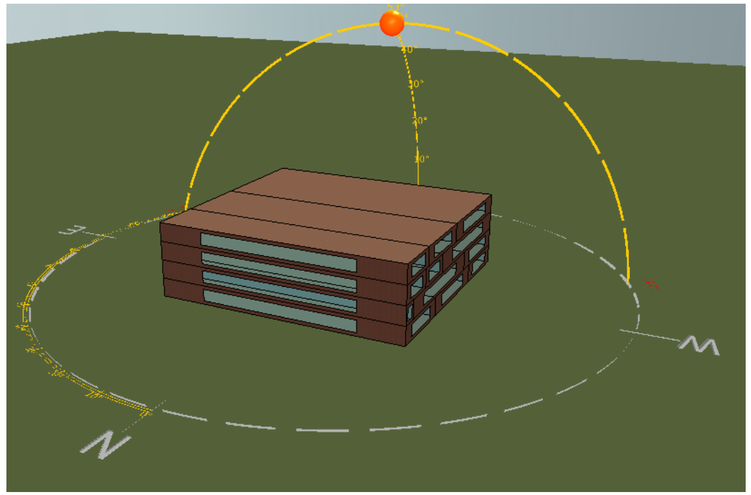
PARAMETERS CONSIDERED FOR SIMULATION

Parameters	Red Brick (Base Box Model)	Red Brick U Value(W/sq.mk)	Fly Ash Brick U Value(W/sq.mk)	AAC U Value \(W/sq.mk)	Cavity Wall U Value(W/sq.mk)	EIFS U Value(W/sq.mk)
External Wall(W/sq.m k)	3.28	3.28	2.31	0.98	1.35	0.25
Roof(W/sq.m k)	3.41(Roof - Concrete)	3.41(Roof - Concrete)	0.26(Roof with Rock Wool Insulation)			
SRI (Solar Reflective Index)	53	53	53	100	53	100
External Window(W/sq.m k)	5.5					
SHGC	0.37					
VLT	0.23					

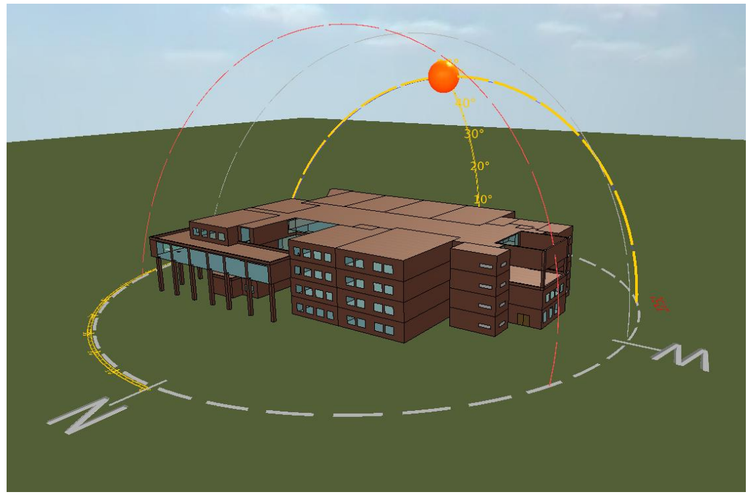
PARAMETERS DATA CONSIDERED FOR SIMULATION

Parameters	Base case (Actual) case
Internal Lighting(W/sq.m)	12.92
People load(Sq.m/Person)	15.51
Equipment Load (W/sq.m)	5.38
Primary HVAC System type	Split system system
HVAC Cooling Set point	24°C
Fresh air	As per ASHRAE 62.1 2016
Timing Profile	8AM to 6 PM

HVAC ANALYSIS SUMMARY-ACADEMIC BUILDING



Box Model



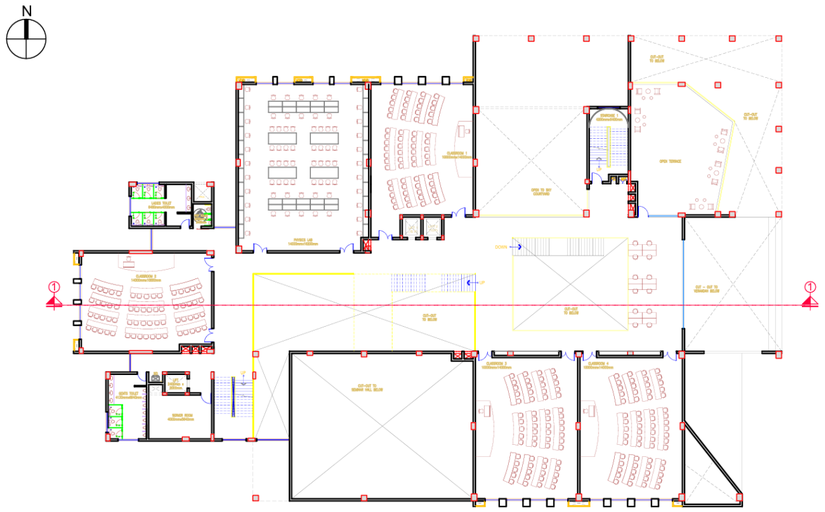
Proposed Model

PARAMETRS	Red Brick (Box Model)	Red Brick	Proposed case(AAC)	Fly ash Brick	Cavity Wall	EIFS	Proposed case(AAC with High SRI)	Proposed case(EIFS with High SRI)
Peak Load(TR)	179	157	145	152	149	140	142	136
HVAC Consumption(MWH)	946	834	781	813	792	770	765	754
Drop in Cooling Capacity (%)	24.02%							
Drop in Cooling Consumption (%)	20.29%							

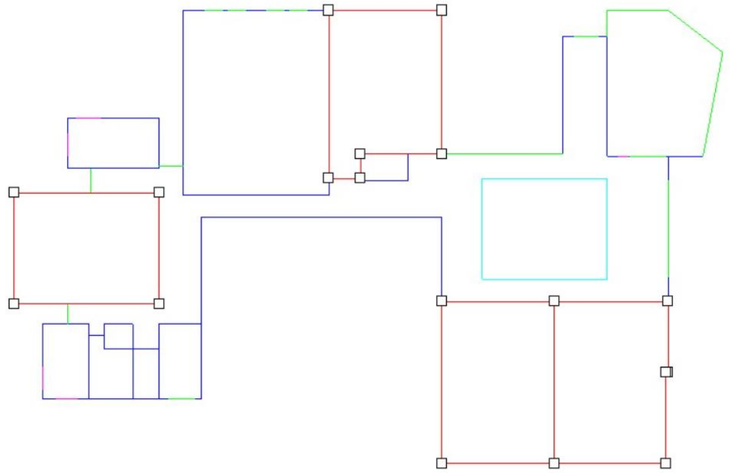
DAYLIGHTING ANALYSIS

DAYLIGHT ANALYSIS

Regularly occupied spaces considered for simulation - Academic Building



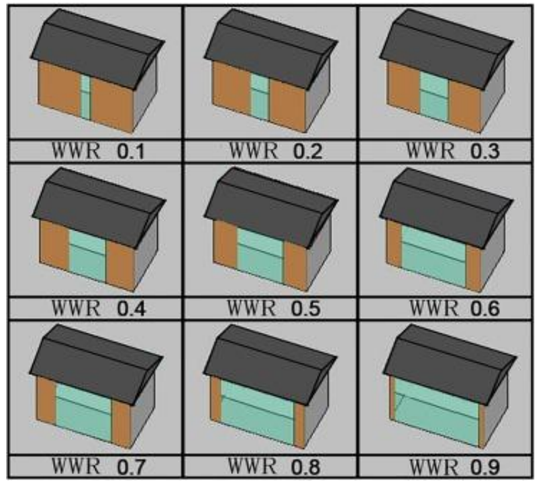
First Floor Plan

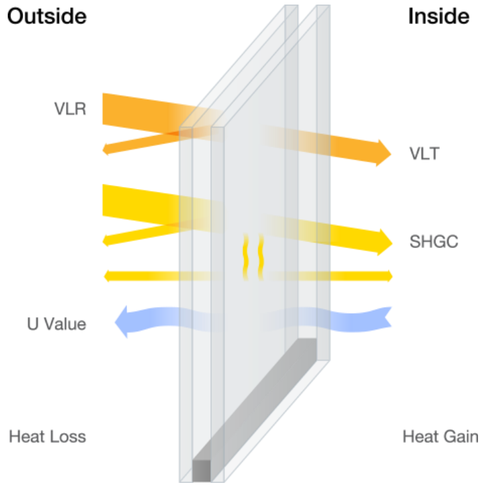


Regularly occupied spaces

Regularly occupied First floor Room Spaces
F-CLASSROOM 1
F-CLASSROOM 2
F-CLASSROOM 3
F-CLASSROOM 3

DAYLIGHT ANALYSIS INFERENCE

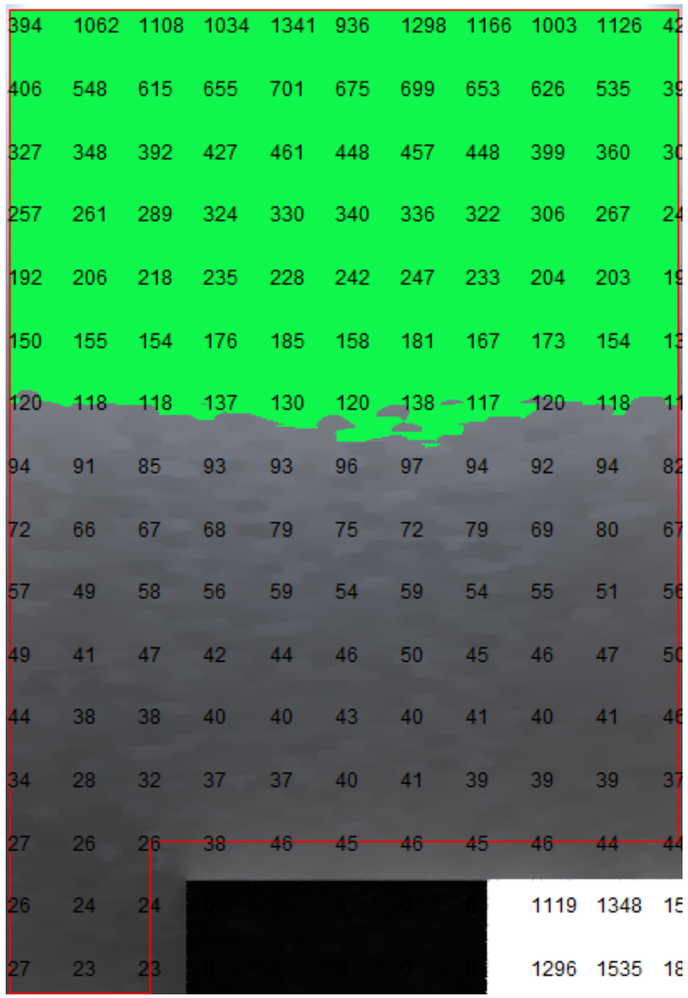


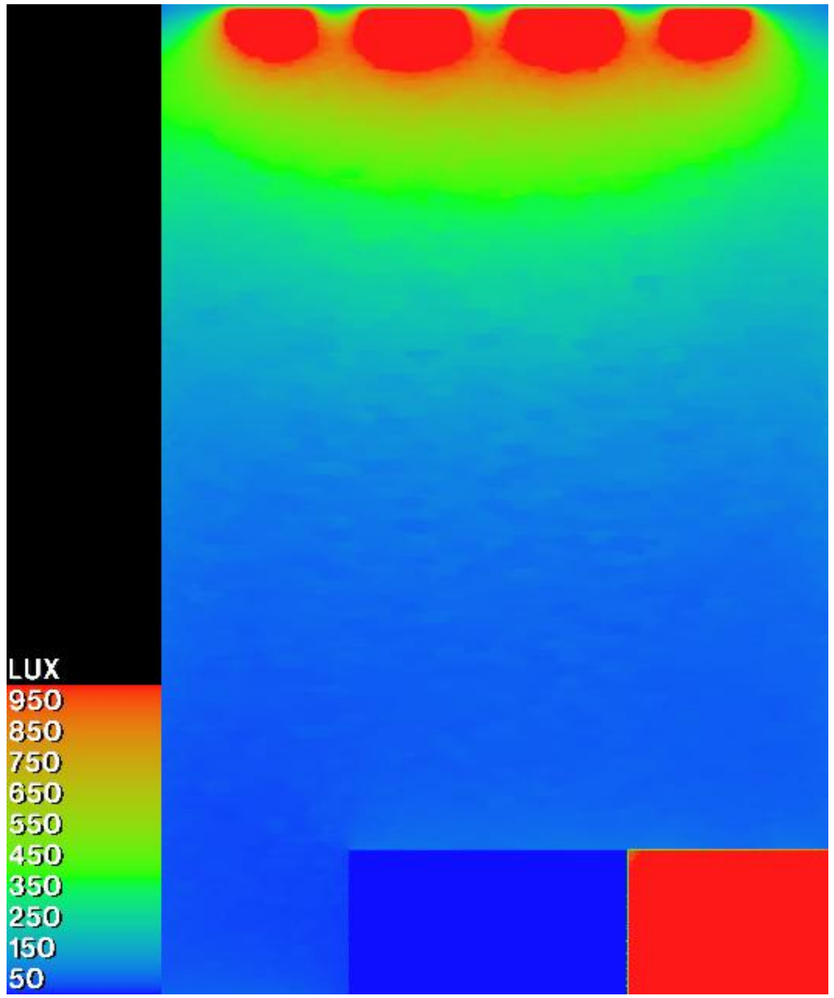


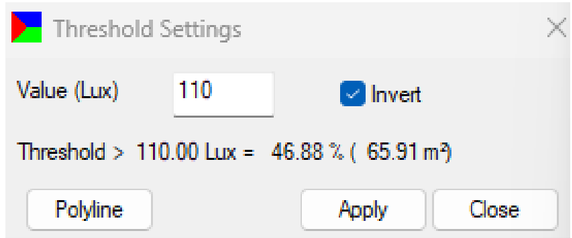
S.NO	SPACE NAME	BASELINE DAYLIGHT PERCENTAGE(%)	PROPOSED(WITH LIGHT SHELVES) DAYLIGHT PERCENTAGE(%)
1	Class Room 1(North)	46.88	63.21
2	Class Room 2(West)	51.01	69.37
3	Class Room 3(South)	45.91	62.52
4	Class Room 4(South west)	45.7	60.95

Base case(Without Light shelves) - Academic class room 1 First floor

Base case



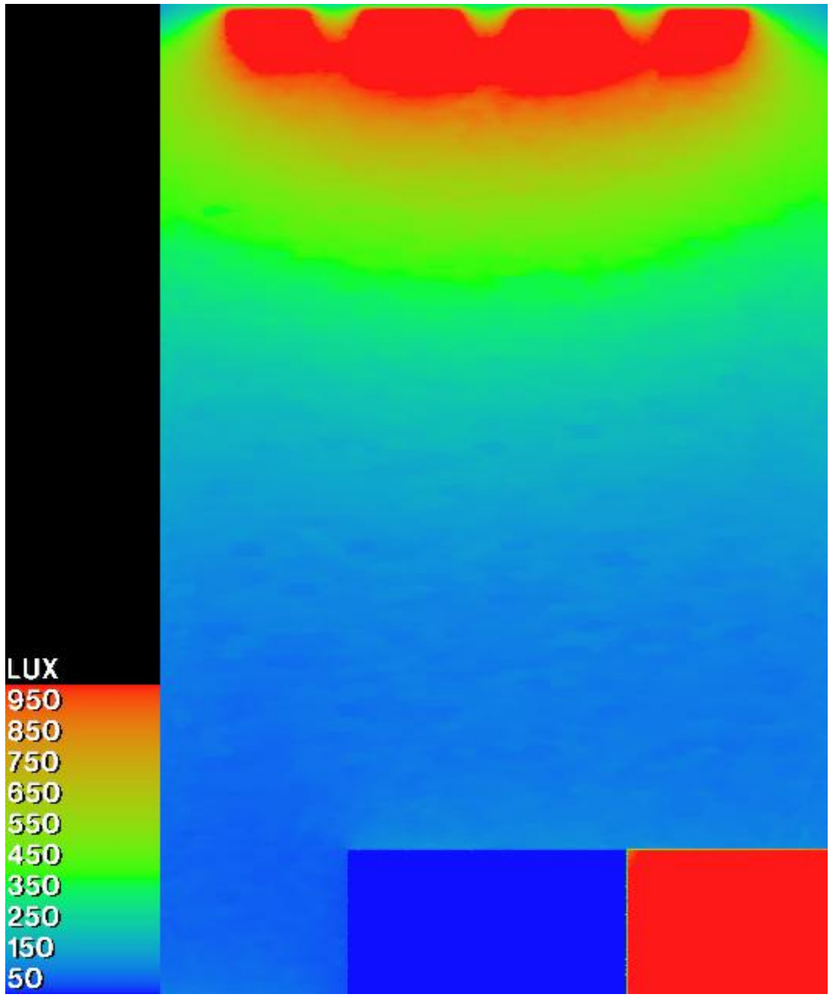


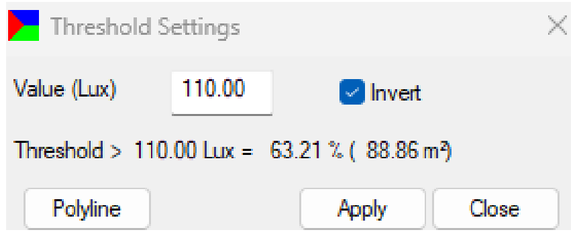


Proposed case(With Light shelves) - Academic class room 1 First floor

Proposed case

472	1091	1190	1138	1430	1032	1378	1255	1083	1182	52
545	713	816	891	945	894	941	880	838	743	53
458	533	601	654	683	663	678	637	601	510	44
369	402	451	466	487	507	487	476	442	402	36
297	317	340	360	366	379	353	358	325	314	29
241	248	257	267	276	280	277	266	251	251	22
191	194	207	206	224	220	213	214	196	190	18
153	159	156	163	157	168	168	165	161	156	14
127	121	127	128	131	135	133	129	129	114	12
102	96	98	98	109	104	110	109	107	97	10
88	69	88	91	91	87	87	84	84	88	85
73	61	71	75	75	79	71	70	76	74	66
61	55	60	64	75	70	65	74	75	65	65
55	47	48	69	83	80	80	82	81	82	72
48	43	42						1122	1349	15
49	44	43						1305	1523	18

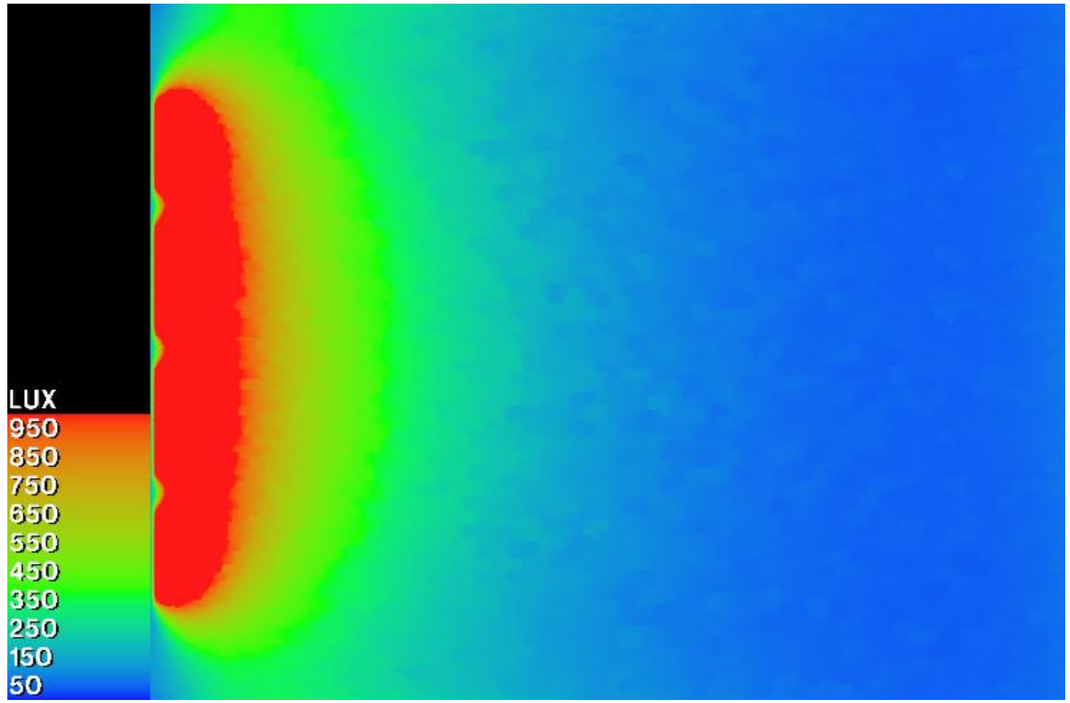


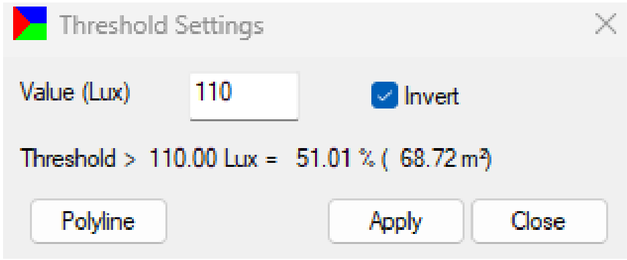


Base case(Without Light shelves) - Academic class room 2 First floor

Base case

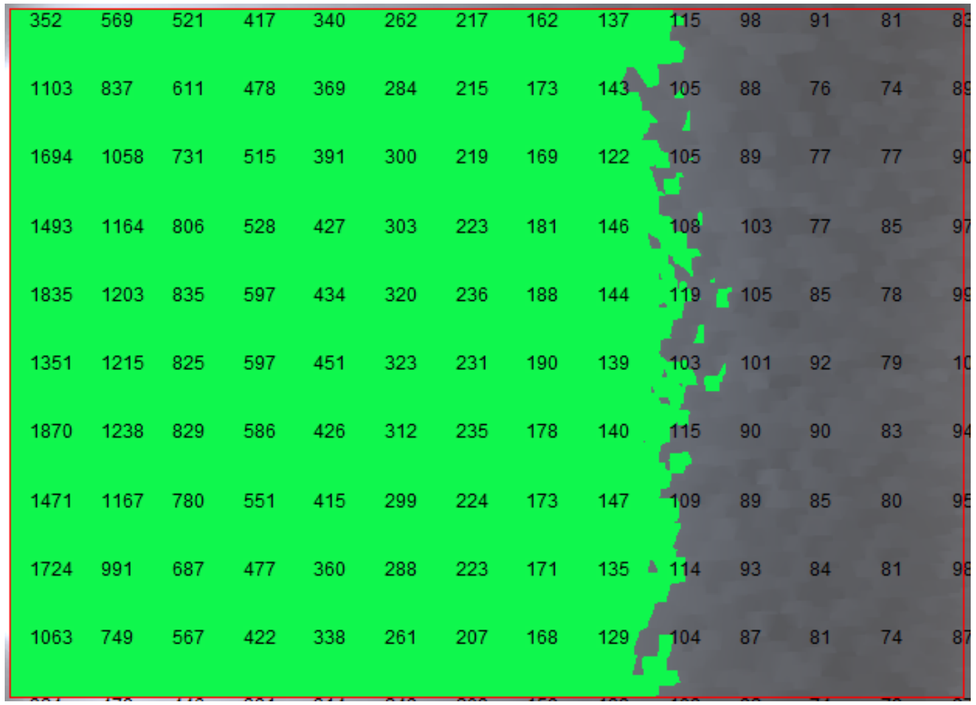
280	414	354	280	225	169	133	92	78	63	57	47	42	52
1177	631	409	289	223	153	129	89	68	57	47	46	42	51
1806	814	491	338	242	173	133	87	73	62	58	45	43	54
1542	881	543	356	258	196	140	104	75	64	47	46	43	51
2004	930	559	391	278	194	130	98	74	65	46	43	43	54
1414	913	576	380	278	217	141	95	79	67	56	46	44	56
1971	907	552	382	259	169	132	92	80	59	49	42	44	55
1477	858	528	348	258	177	131	103	83	60	47	49	47	48
1840	801	466	316	238	166	115	103	71	60	47	44	48	51
1012	560	384	282	207	154	122	98	75	63	45	42	42	51

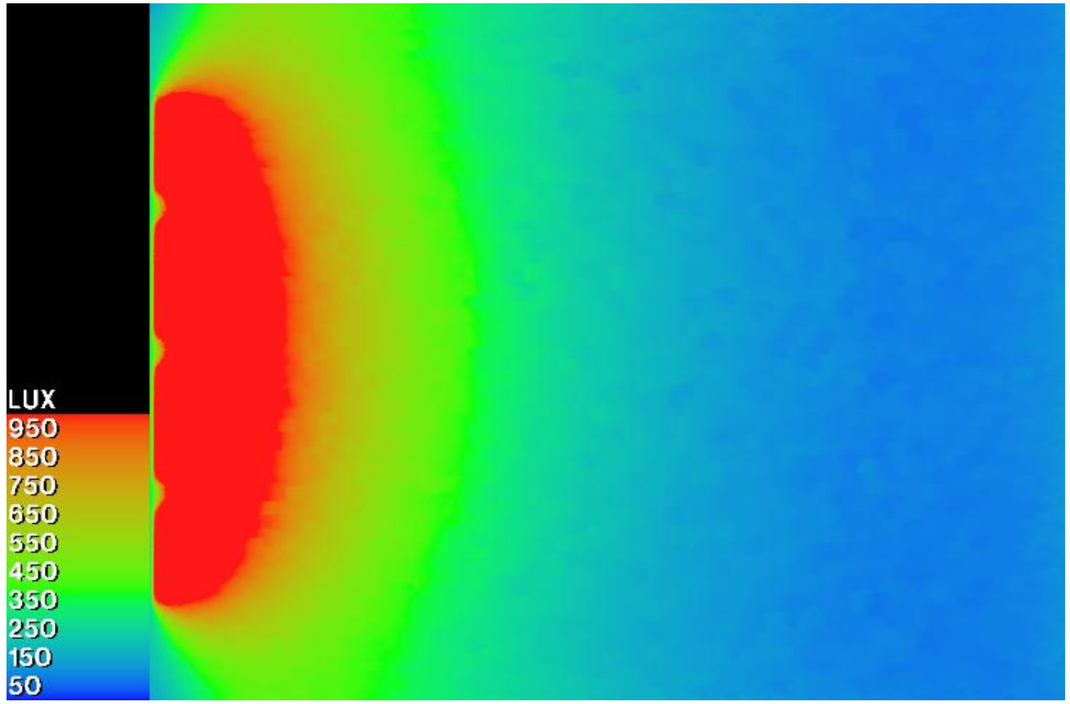


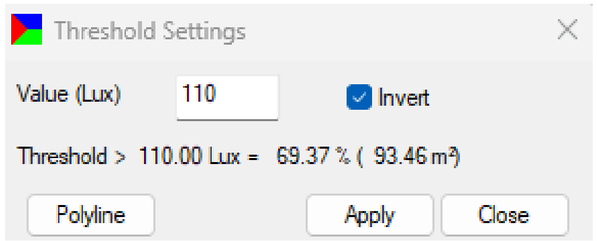


Proposed case(With Light shelves) - Academic class room 2 First floor

Proposed case

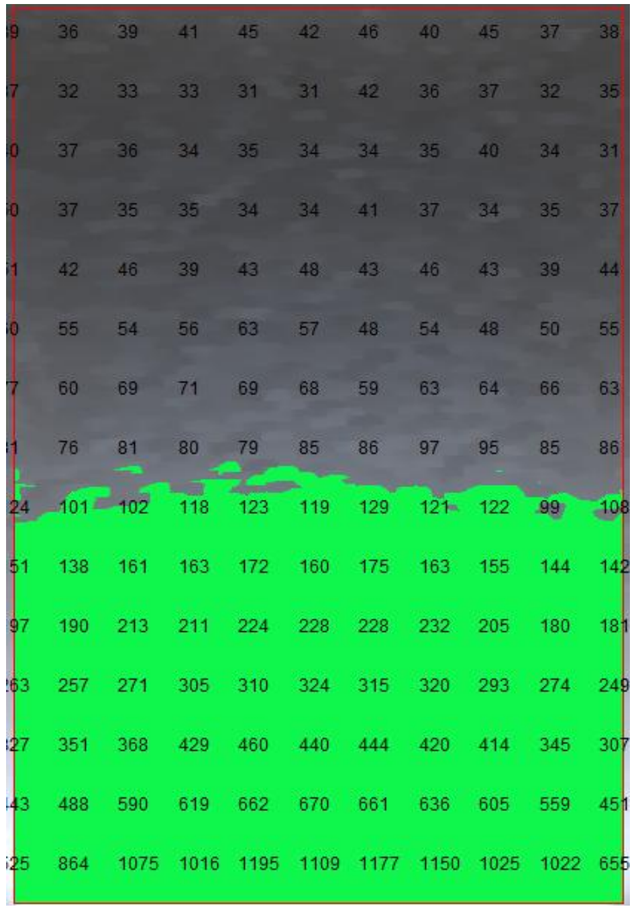


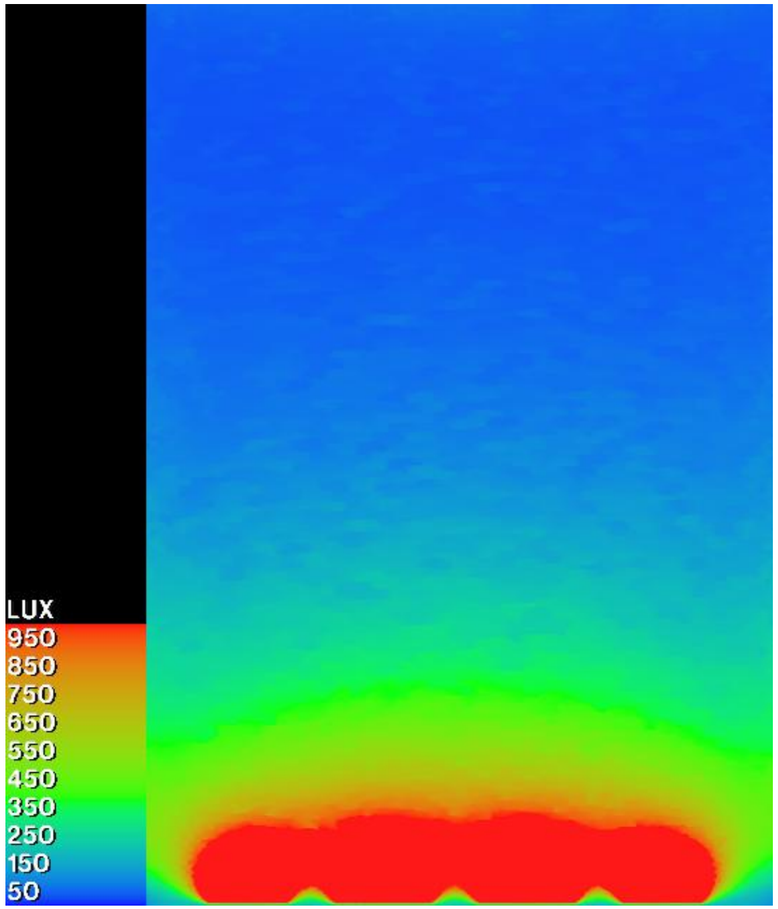


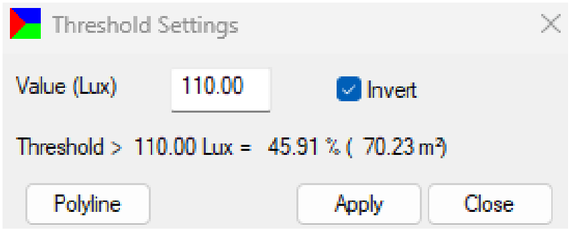


Base case(Without Light shelves) - Academic class room 3 First floor

Base case

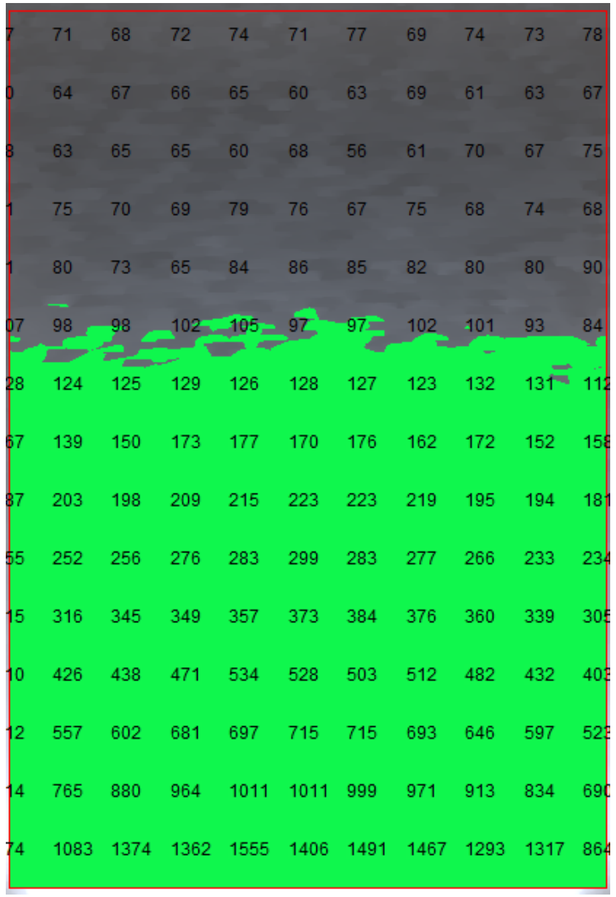


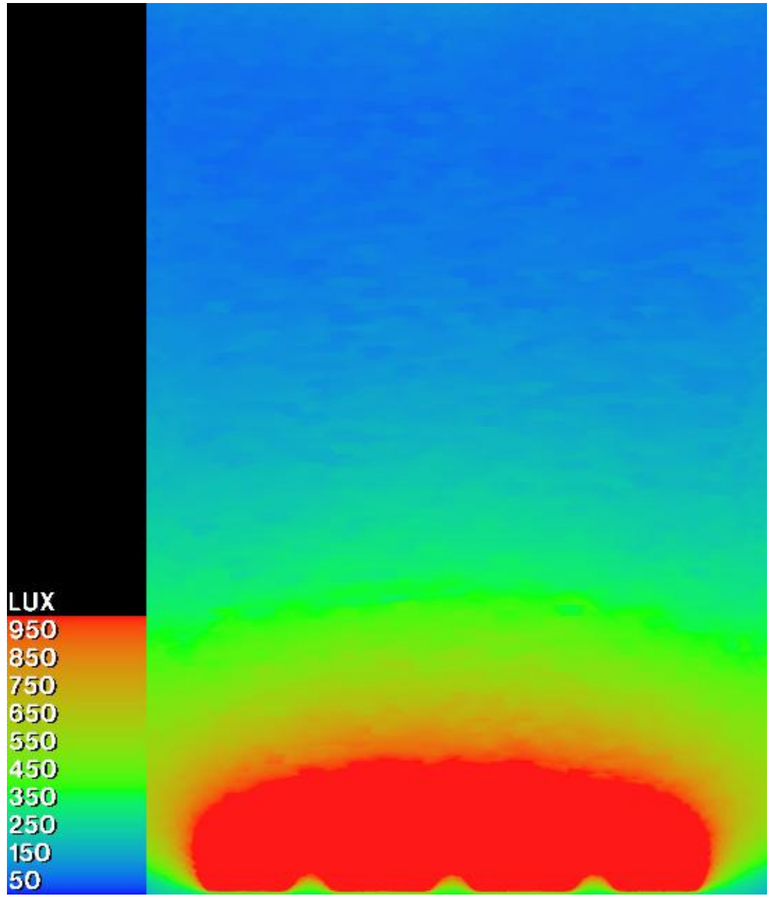


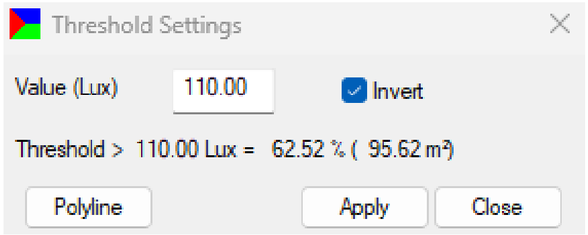


Proposed case(With Light shelves) - Academic class room 3 First floor

Proposed case

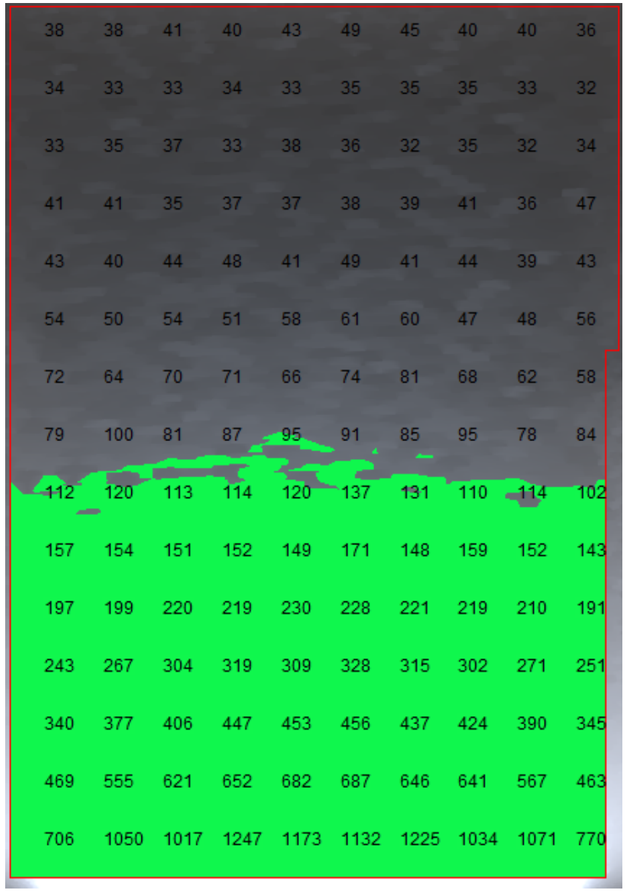


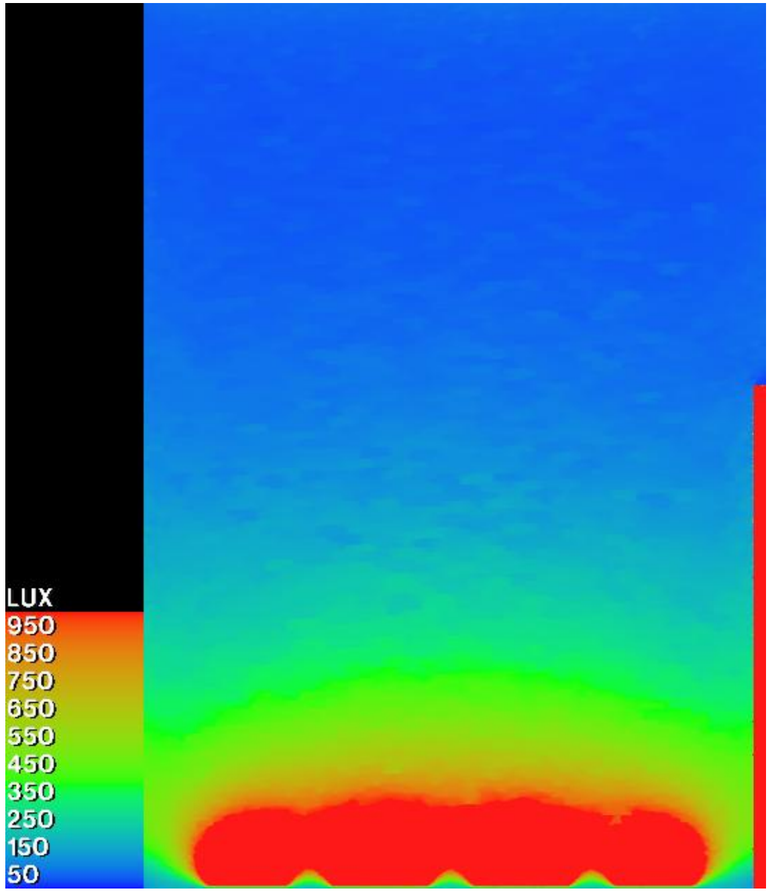


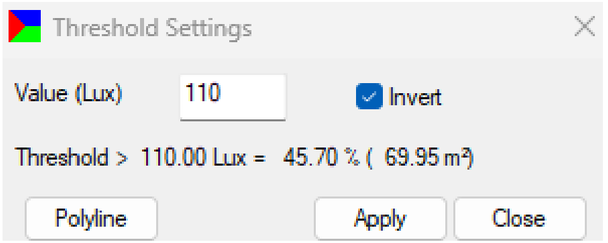


Base case(Without Light shelves) - Academic class room 4 First floor

Base case

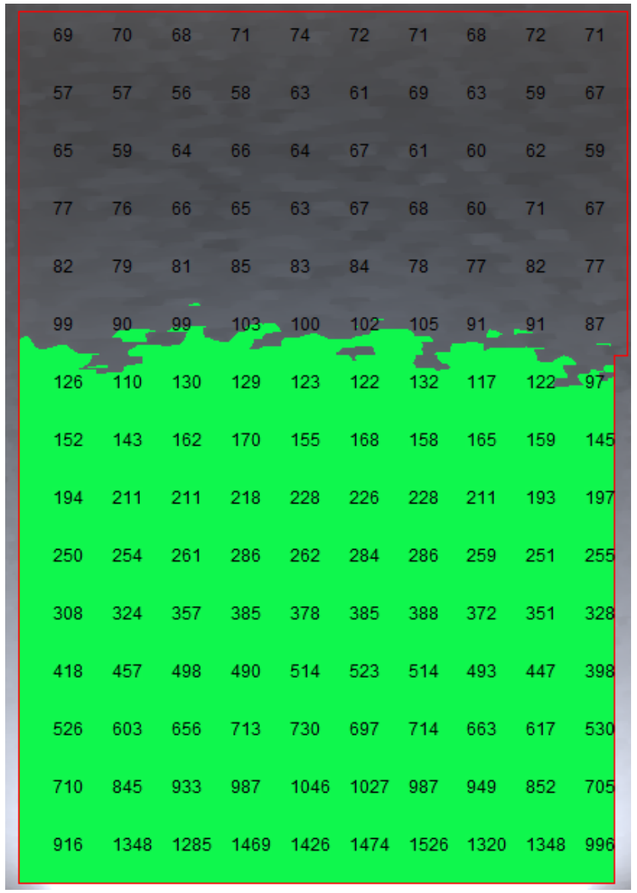


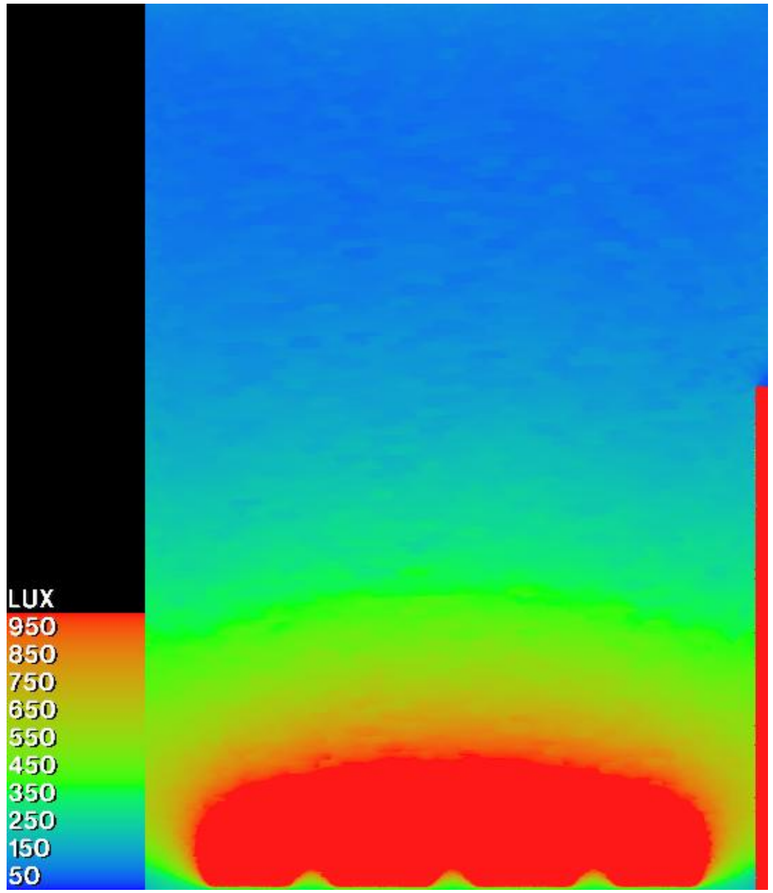


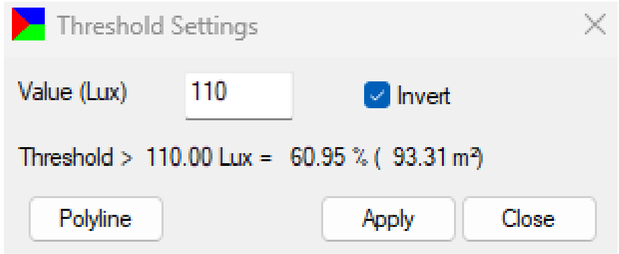


Proposed case(With Light shelves) - Academic class room 4 First floor

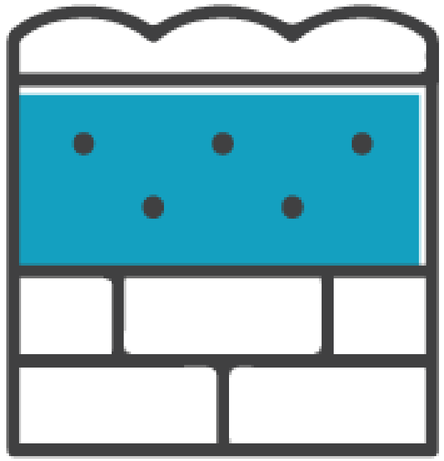
Proposed case

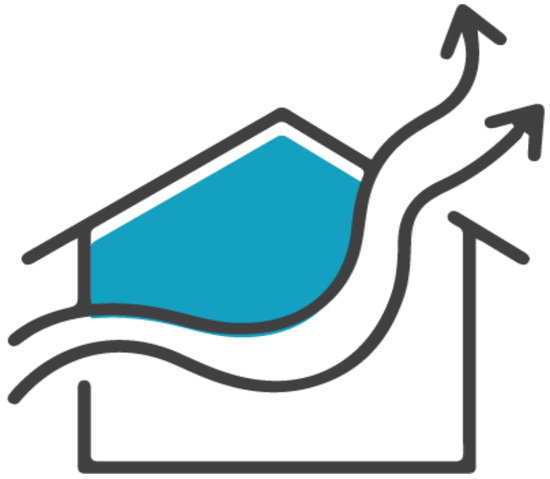






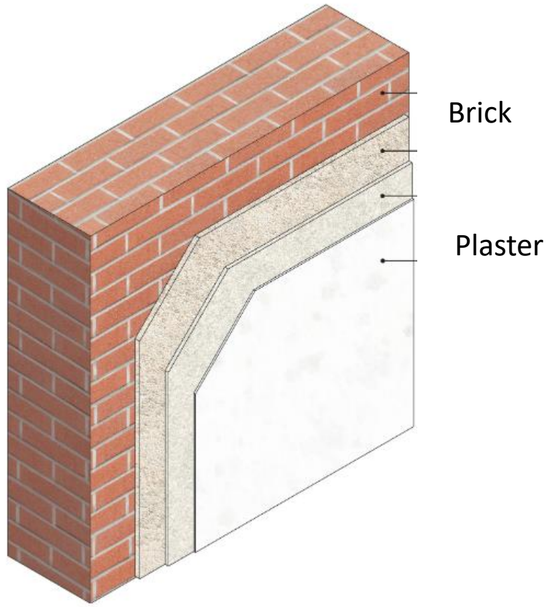
MATERIAL AND LIFE-CYCLE ANALYSIS





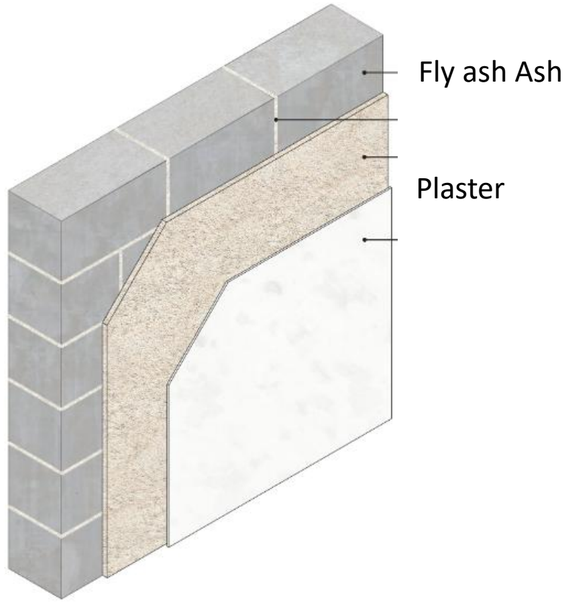
MATERIAL ANALYSIS

- Material Analysis is done using IESVE Simulation Tool
- Three wall assembly has been taken for the comparative analysis
- The result is compared using U-values from the result generated.



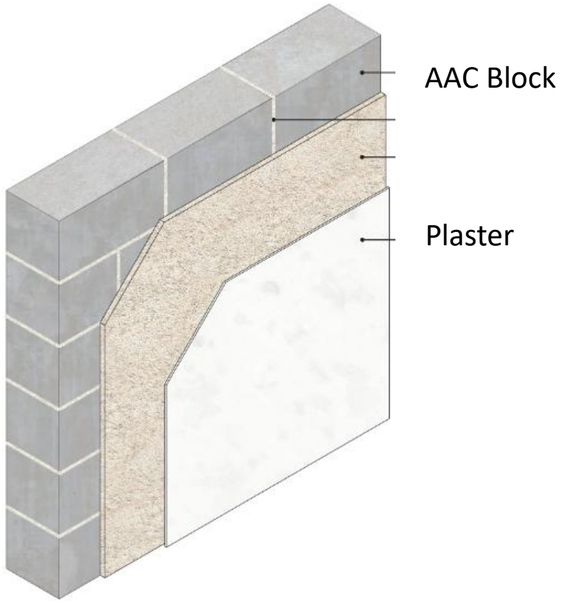
Project Base case : Brick

Wall U value – 3.28 W/m2k



Proposed case 1 :Fly ash

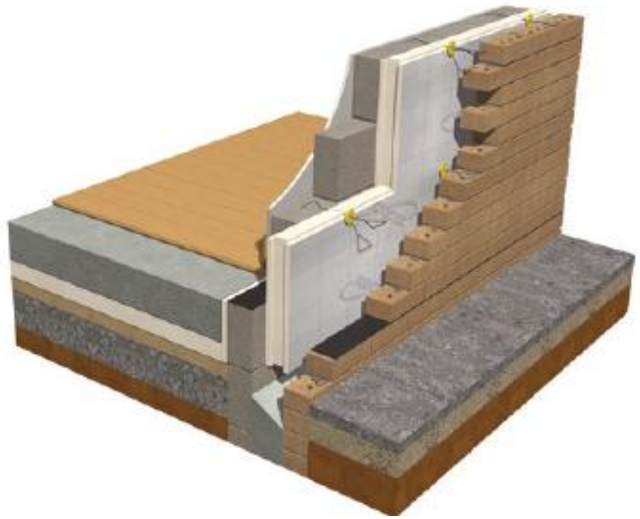
Wall U value – 2.32 W/m2k



Proposed case 2: AAC Block

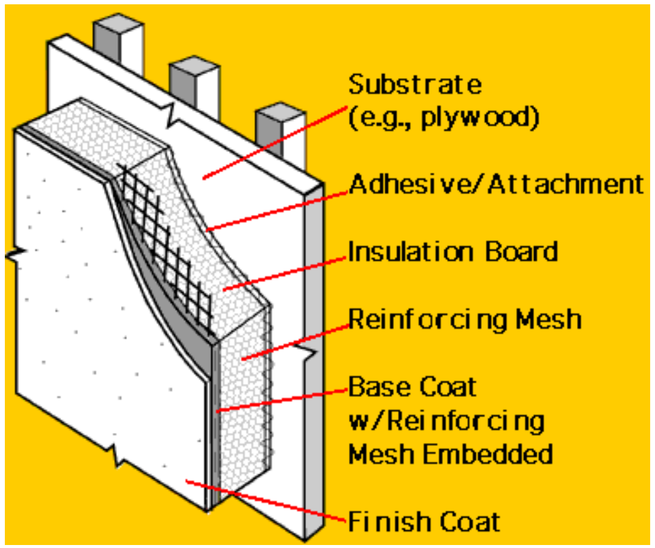
Wall U value – 0.98 W/m2k

MATERIAL ANALYSIS



Proposed case 3 : Cavity wall

Wall U value – 1.35 W/m2k



Proposed case 4 :EIFS

Wall U value – 0.25 W/m2k

LIFE-CYCLE ANALYSIS

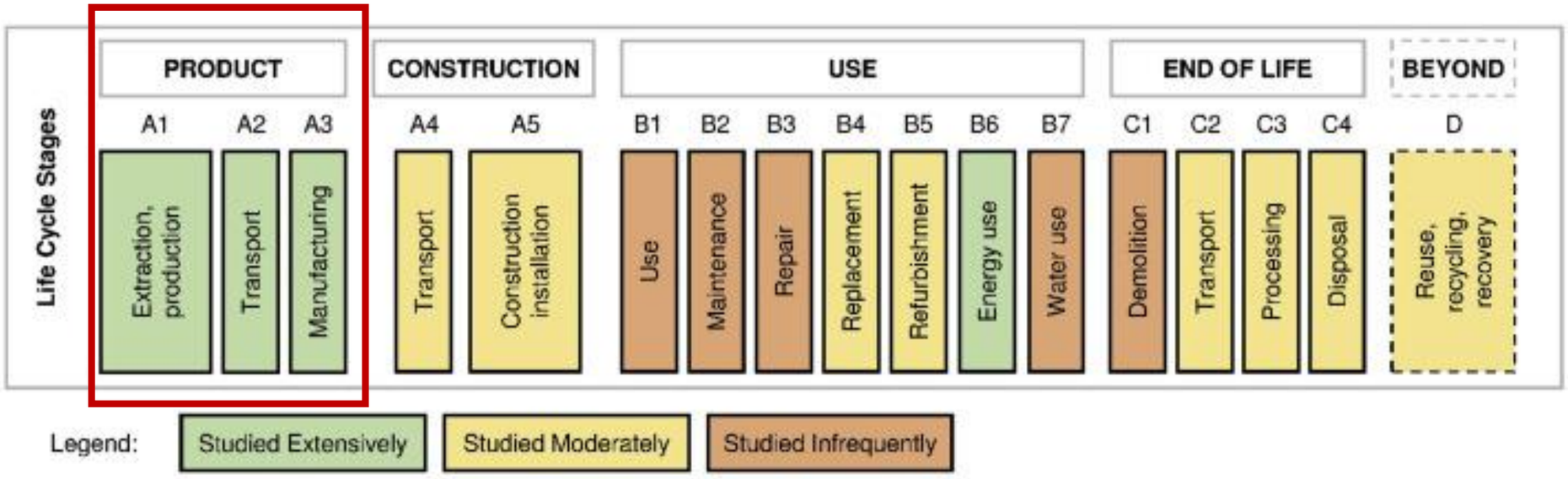
Address: Shiv Nadar University, Chennai

Author: Earthonomic Engineers Pvt Ltd, Chennai

The life cycle assessment scope and service life

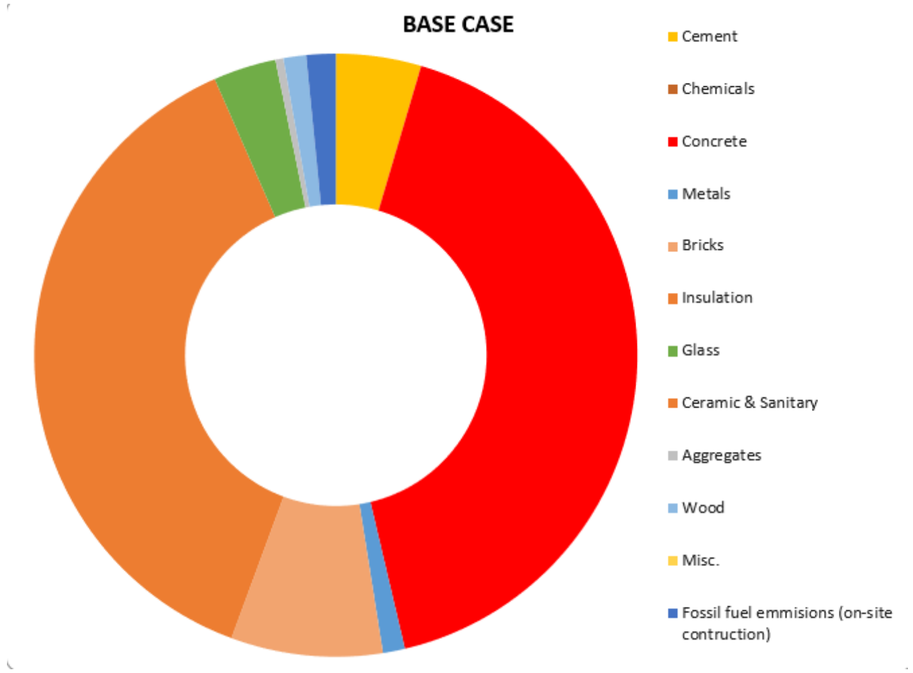
The material scope in was the same in both baseline and proposed design. The LCA analysis included following building elements

In the assessment following life cycle stages according to EN 15804 (2012) were included:



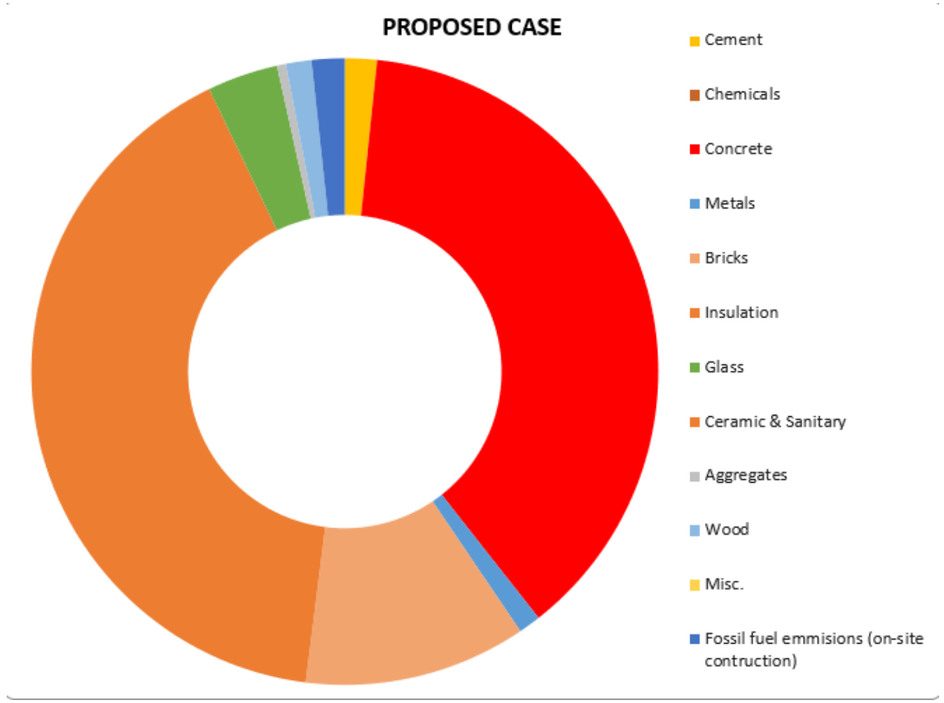
LIFE-CYCLE ANALYSIS- Academic Building(Base case)

Materials	Carbon Emission Value	Units
Cement	13.68	tCO2
Chemicals	0.00	tCO2
Concrete	125.05	tCO2
Metals	3.54	tCO2
Bricks	24.35	tCO2
Insulation	113.17	tCO2
Glass	10.09	tCO2
Ceramic & Sanitary	0.00	tCO2
Aggregates	1.28	tCO2
Wood	3.65	tCO2
Misc.	0.00	tCO2
Fossil fuel emmisions (on-site contruction)	4.70	tCO2
TOTAL EMBODIED CARBON in tons of CO2	299.51	
TOTAL EMBODIED CARBON in kgs of CO2	299507.98	
kgCO2 / sqm.	20.69	
TCO2 / sqm.	0.02	



LIFE-CYCLE ANALYSIS- Academic Building (Designed case)

Materials	Carbon Emission Value	Units
Cement	4.56	tCO2
Chemicals	0.00	tCO2
Concrete	104.50	tCO2
Metals	3.17	tCO2
Bricks	31.71	tCO2
Insulation	113.17	tCO2
Glass	10.09	tCO2
Ceramic & Sanitary	0.00	tCO2
Aggregates	1.28	tCO2
Wood	3.65	tCO2
Misc.	0.00	tCO2
Fossil fuel emmisions (on-site contruction)	4.70	tCO2
TOTAL EMBODIED CARBON in tons of CO2	276.83	
TOTAL EMBODIED CARBON in kgs of CO2	276827.66	
kgCO2 / sqm.	19.12	
TCO2 / sqm.	0.02	



LIFE-CYCLE ANALYSIS- Academic Building (Basecase vs Proposed)

BASELINE CARBON EMISSION (embodied + operational)		
End use	**Energy consumption**	**Units**
Embodied Carbon for 0 year	299,507.98	$KgCO_2$
Over all Baseline Consumption	834,000	kWh
Emission factor	0.82	$KgCO_2$/kWh
Embodied & Operational Carbon emissions accumulated after 1 year	983,387	$KgCO_2$
Embodied & Operational Carbon emissions accumulated after 5 year	3,718,907	$KgCO_2$
Embodied & Operational Carbon emissions accumulated after 10 year	7,138,307	$KgCO_2$

PROPOSED CASE CARBON EMISSION (embodied + operational)		
End use	**Energy consumption**	**Units**
Embodied Carbon for 0 year	276827.66	$KgCO_2$
Over all Baseline Consumption	754,000	kWh
Emission factor	0.82	$KgCO_2$/kWh
Embodied & Operational Carbon emissions accumulated after 1 year	895,107	$KgCO_2$
Embodied & Operational Carbon emissions accumulated after 5 year	3,370,027	$KgCO_2$
Embodied & Operational Carbon emissions accumulated after 10 year	6,461,427	$KgCO_2$

The Proposed case's accumulated carbon emission is predicted to be 9.48% lesser than Baseline emission due to selection of efficient Building Envelope and associated ,HVAC savings.

SUMMARY

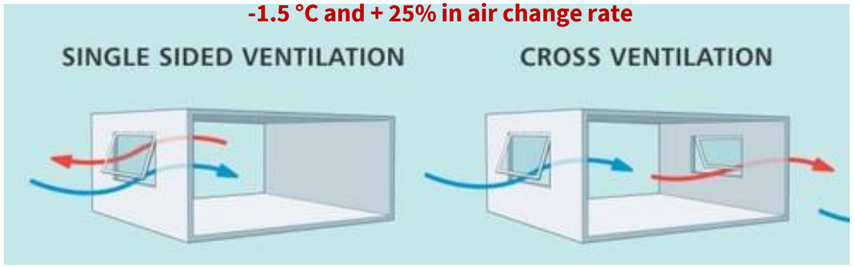
Ventilation Analysis

STUDY:

Simulation performed for Non-Airconditioned spaces considering 50% operable area to determine annual air flow and peak room temperature

INFERENCE:

-1.5 °C and + 25% in air change rate



There is reduction in indoor temperature by 3.63 °C due to EIFS Material, wind flow and cross ventilation combined with SRI paint on facades and trees for shading the façade and cooling the wind.

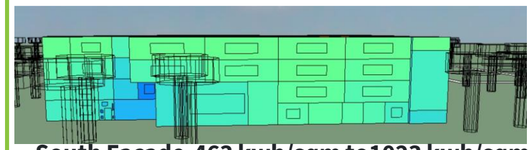
Solar Analysis

STUDY:

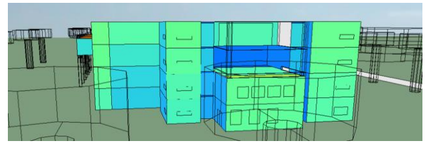
The impact of solar radiation on different facades through simulation and design recommendations

INFERENCE:

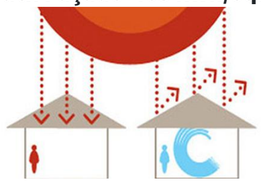
Academic Building



South Façade-463 kwh/sqm to1023 kwh/sqm



West Façade-463 kwh/sqm to1023 kwh/sqm



Without SRI paint **With SRI paint**

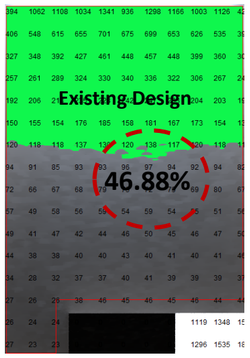
Implementing High SRI paint on Roof, Southern and Western façade shall reduce ingress into the Building.

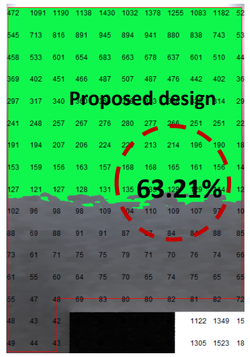
Daylight Analysis

STUDY:

The impact of Light Shelves, Window wall ratio(WWR) and glass Visual light transmittance (VLT) on daylight for Academic building through daylight simulation.

INFERENCE:





- **Daylighting is enhanced by use of light shelves.**
- **Lower VLT of 23 % is recommended in Air-conditioned spaces.**
- **Non-Air-conditioned spaces should use clear glass of VLT 80%.**

SUMMARY

LCA

STUDY:

Comparative study of Embodied & operational carbon emission for Base case and proposed building through life cycle stages according to EN 15804 (2012)

INFERENCE:

Baseline Embodied & Operational Carbon emissions accumulated after 10 year	7,138,307	KgCO2
Proposed Embodied & Operational Carbon emissions accumulated after 10 year	6,461,427	KgCO2

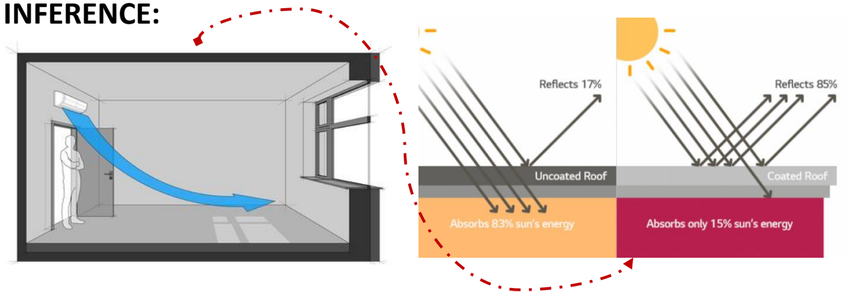
The Proposed case's accumulated carbon emission is predicted to be 9.48% lesser than Baseline emission due to selection of efficient Building Envelope and associated ,HVAC savings.

HVAC Analysis

STUDY:

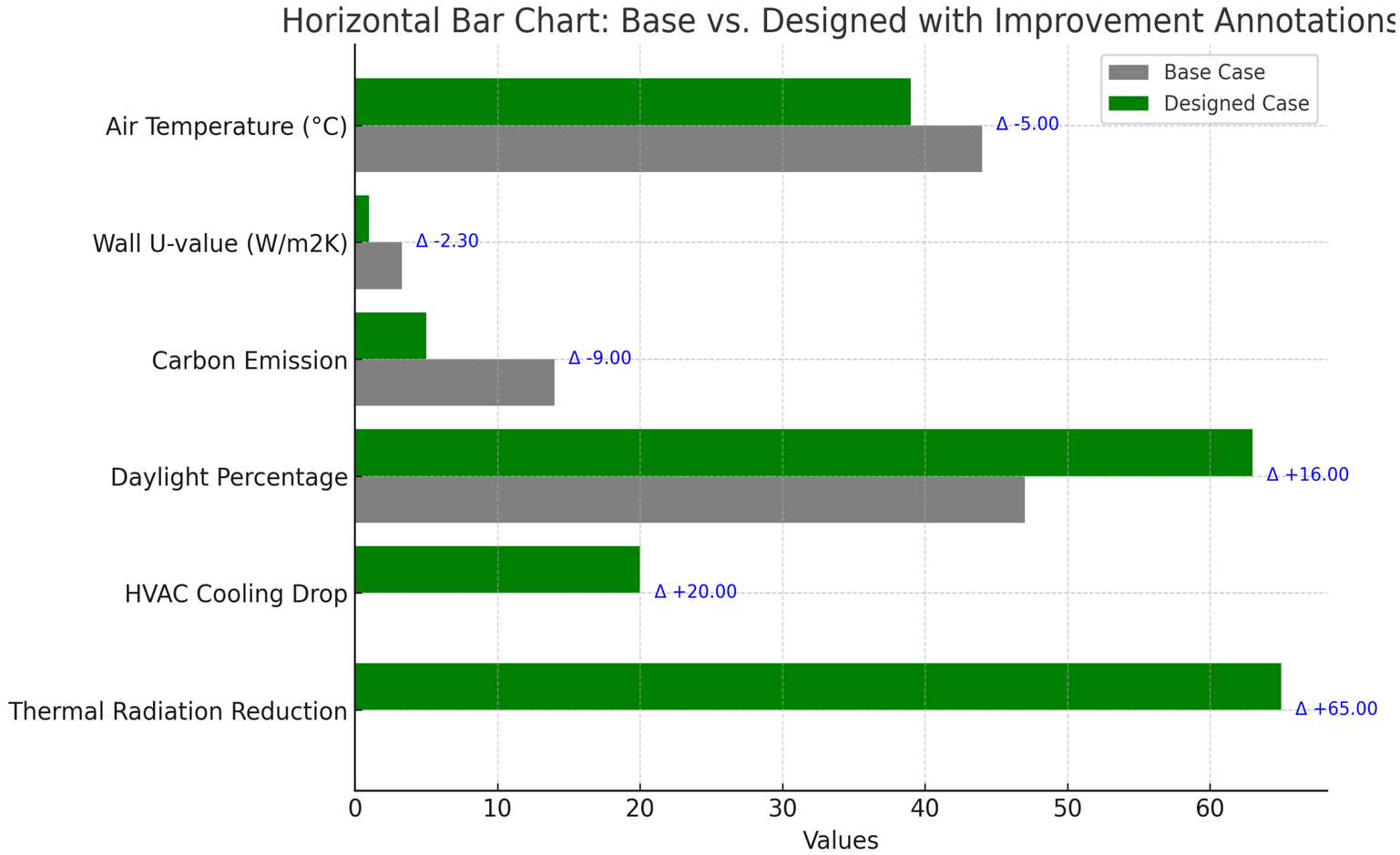
HVAC analysis is performed to give accurate HVAC sizing (Tonnage) for the proposed Building.

INFERENCE:

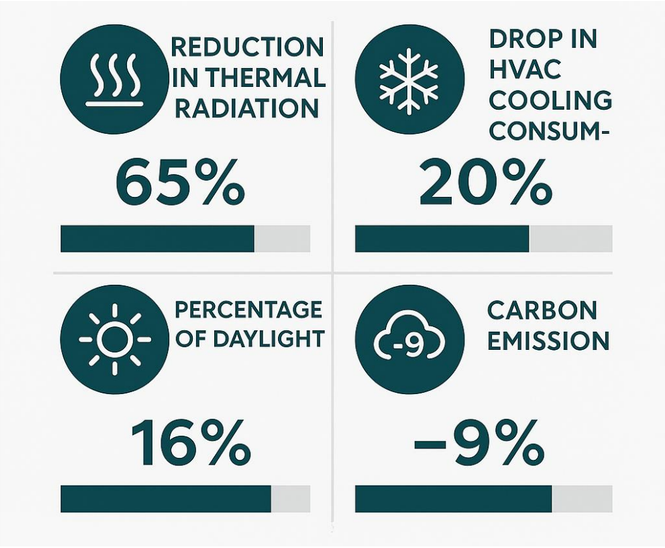


Proposed EIFS system achieves 24.02% drop in cooling load and 20.29% drop in Energy consumption for Academic Building compared to Box model.

Advantages of the proposed design case



- The proposed design case achieved a 65% reduction in thermal radiation, significantly reducing solar heat gain and thereby improving indoor thermal comfort.
- The indoor air temperature was lowered by 5°C, contributing to improved occupant comfort and reduced cooling loads.
- There is a 20% decrease in HVAC energy consumption in the designed case, reflecting enhanced thermal performance and reduced cooling demand due to passive strategies.
- The designed building allows 16% more daylight, improving indoor lighting quality and reducing dependency on artificial lighting.
- A 9% reduction in carbon emissions was achieved, demonstrating the design's contribution to sustainability and lower environmental impact.
- The wall U-value was significantly reduced by 2.3 W/m²K, indicating better insulation and thermal resistance in the proposed design case.



MEP SYSTEM – OPERATING COST COMPARISON

Savings in HVAC Power Consumption :

S. No	Description	Base Case	Proposed Case
1	Total Cooling Capacity (TR)	333.60	277.87
2	Cooling Capacity after applying 75 % diversity	250.20	208.40
3	Average Power Consumption (ikw / TR)	0.80	0.53
4	Operating Hours per Day	8	8
5	No of Days per year	250	250
6	Annual Power Consumption (kWh)	3,97,955	2,20,581
7	**Annual Energy Cost (Energy Cost Assumed as ₹ 8 / kWh)**	**₹ 31,83,636 /-**	**₹ 17,64,644 /-**
	Saving in Annual Power Consumption Cost	**₹ 14,18,992 /-**	

Savings in Fresh Air Power Consumption :

S. No	Description	Base Case	Proposed Case
1	Fresh Air Cooling Capacity (TR)	125.91	116.90
2	Cooling Capacity after applying 75 % diversity	94.43	87.68
3	Average Power Consumption (ikw / TR)	0.80	0.53
4	Operating Hours per Day	8	8
5	No of Days per year	250	250
6	Annual Power Consumption (kWh)	1,50,198	92,799
7	Annual Power Consumption due to the fresh air regulation through the CO2 Sensors for all air conditioning rooms. (Applied 30% savings)	-	64,959
8	**Annual Energy Cost (Energy Cost Assumed as ₹ 8 / kWh)**	**₹ 12,01,583 /-**	**₹ 5,19,674 /-**
	Saving in Annual Power Consumption Cost	**₹ 6,81,909 /-**	

Savings in Lighting Power Consumption :

S. No	Description	Base Case	Proposed Case
1	Built-up Area (Sq.m)	9,492	9,492
2	Lighting Power Distribution (Watts / Sqm)	10.7	5
3	Total Power Consumption (kW)	101.56	47.46
4	Operating Hours per Day	8	8
5	No of Days per year	250	250
6	Annual Power Consumption (kWh)	2,03,129	94,920
7	**Annual Energy Cost (Energy Cost Assumed as ₹ 8 / kWh)**	**₹ 16,25,030 /-**	**₹ 7,59,360 /-**
	Saving in Annual Power Consumption Cost	**₹ 8,65,670 /-**	
	Saving in Annual Power Consumption Cost (%)	**53 %**	

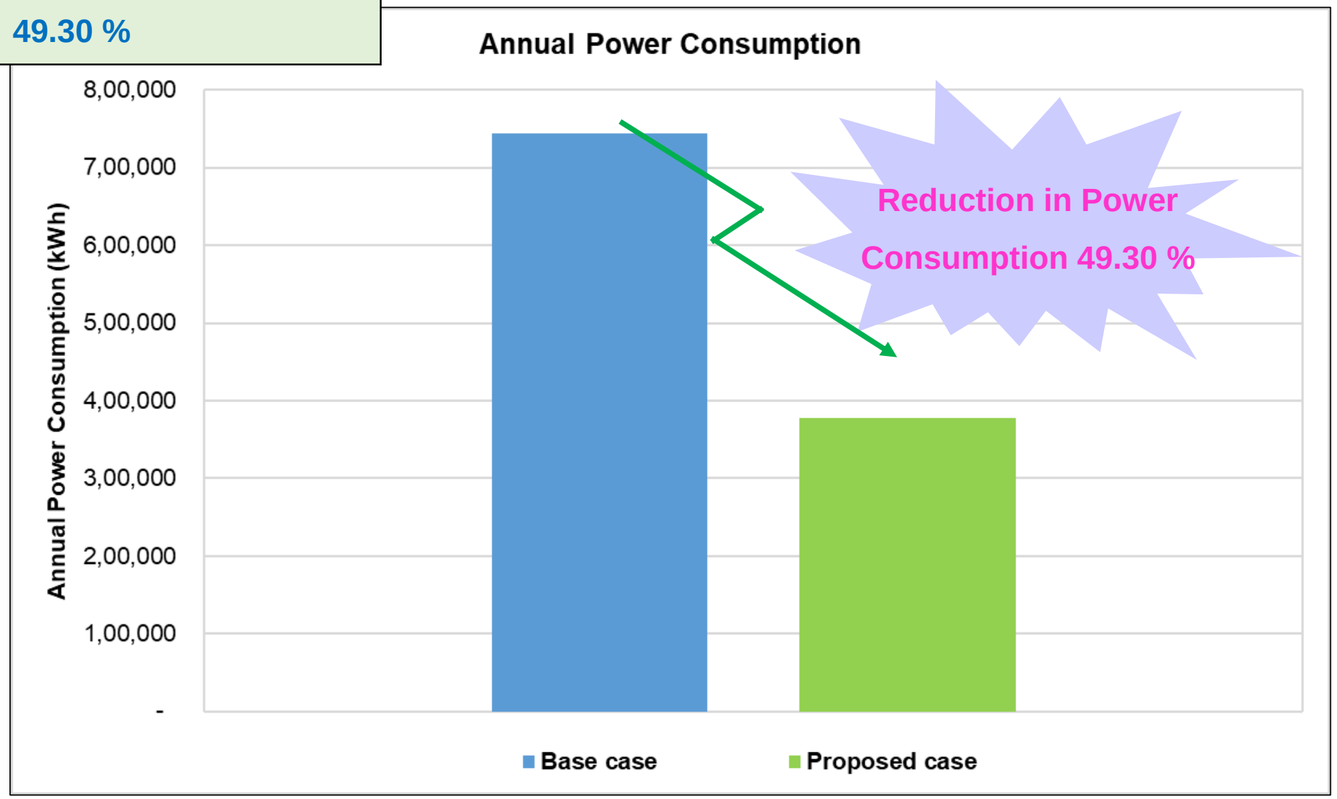
Savings in Water Supply :

S. No	Description	Base Case	Proposed Case (20% Efficient Fixtures)
A	**Savings on Water Demand**		
1	Domestic Water Demand per Day (KLD)	28.6	22.8
2	Flush Water Demand per Day (KLD)	20.7	16.56
3	Total Water Demand per Day (KLD)	49.3	39.44
4	Savings in Water Demand per Day (KLD)	9.86	
	Annual Savings in Water Demand (KL)	**2470**	
	Annual Cost Savings on Water (Assuming ₹ 1,000 /- per 12,000 Litres Tanker)	**₹ 2,05,417 /-**	
B	**Savings on Sewage treatment**		
1	Sewage Generation per day in KLD at 85%	41.91	33.52
2	Savings in Water Demand per Day (KLD)	8.38	
	Annual Savings in Treatment (KL)	**2095**	
	Annual Treatment Cost savings INR	**₹ 6,28,575 /-**	
C	**Domestic, Flush and Water Treatment plant pump power Saving**		
1	Pump Power Consumption (kW)	1.85	1.29
2	Annual Power Consumption kWh (Domestic Water Pump & Flush Water = 4 hours x 250 days) (Filter feeder Pump = 8 hours x 250 days)	2,400	1,660
	Annual Energy Cost (Energy Cost Assumed as ₹ 8 / kWh	**₹ 19,200 /-**	**₹ 13,280 /-**
	Saving in Annual Power Consumption Cost	**₹ 5,920 /-**	

MEP SYSTEM – ANNUAL POWER CONSUMPTION

MEP System – Annual Power Consumption

S. No	Description	Base Case	Proposed Case
1	HVAC Annual Power Consumption (kWh)	3,97,955	2,20,581
2	Fresh Air Annual Power Consumption (kWh)	1,50,198	64,959
3	Electrical Annual Power Consumption (kWh)	2,03,129	94,920
4	PHE Annual Power Consumption Pump(kWh)	2,400	1,660
	Total Annual Power Consumption (kWh)	**7,53,681**	**3,82,120**
	Reduction in power consumption	**49.30 %**	



MEP SYSTEM – RETURN OF INVESTMENT (ROI) ANALYSIS

Return of Investment (ROI) Analysis

S. No	Description	Amount
1	**Increase in Capital Investment (Civil and MEP System)**	**₹ 2,07,29,258 /-**
2	**Savings in Operating Cost**	
A	Savings in HVAC System	₹ 14,18,992 /-
B	Savings in Fresh Air Load (With CO_2 Sensors Control)	₹ 6,81,909 /-
C	Savings in Lighting Power Consumption	₹ 8,65,670 /-
D	Savings in Water Consumption	₹ 8,33,992 /-
E	Savings in Water Power Consumption	₹ 5,920 /-
	Total Savings in Operating Cost	**₹ 38,06,483 /-**
	Return of Investment (in Years)	**5.45 Years**

Note : There are onsite and offsite renewable energy are available in our project. Hence, the operation cost savings will be more and ROI will further reduce and more attractive.

THANK YOU