Road Map Towards Net Positive Buildings

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Net Zero / Positive Energy Buildings

- A Net Zero Energy Building / Positive Energy Building (NZEB/PEB) refers to a building with zero or net negative energy consumption.

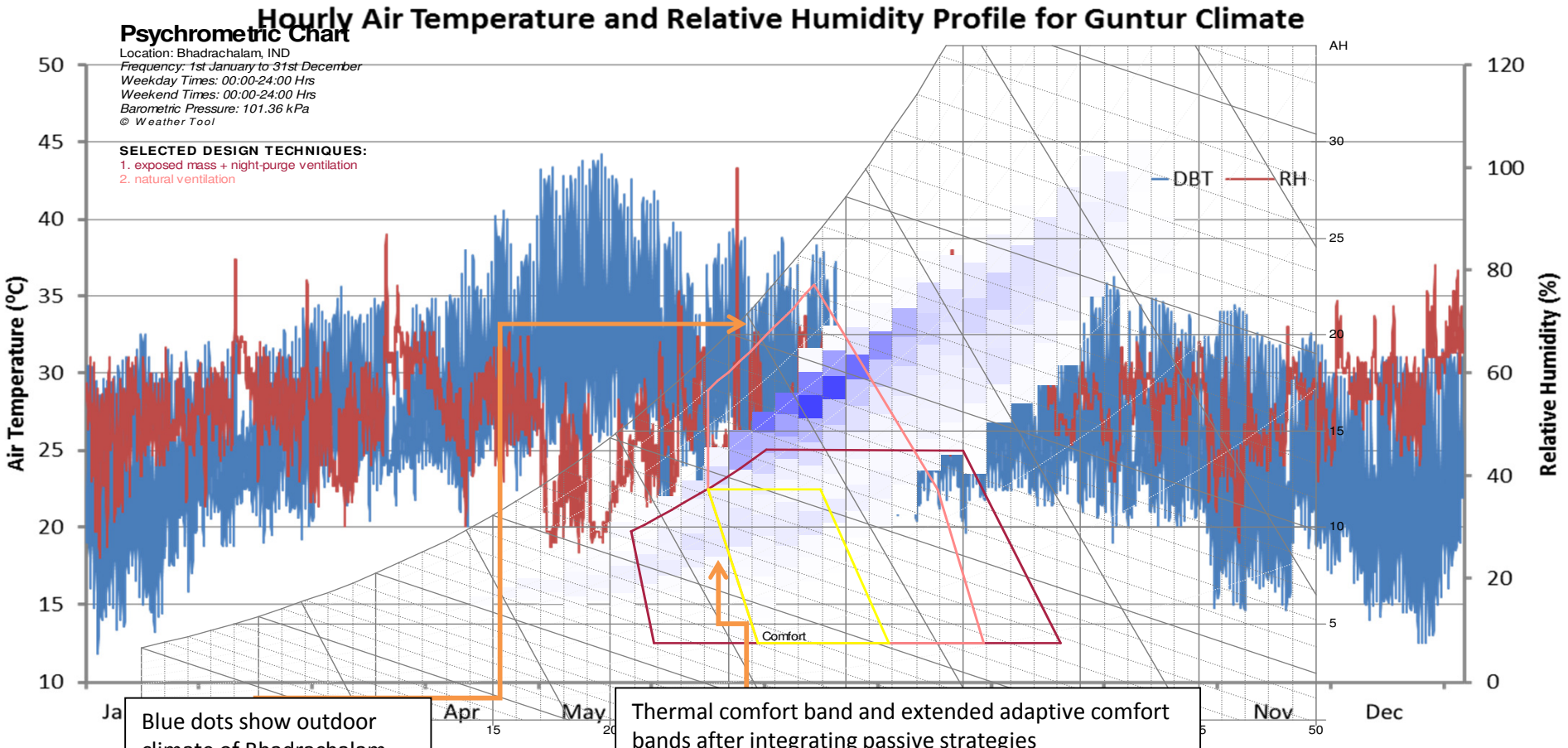
- As on 23rd April, 2009, EU Parliament has requested all new buildings by 2019 to conform to zero energy and emission standards. (European Paliament,2009)

Approach to Attain Net Positive Buildings

- Climate & Micro climate Analysis
- Bioclimatic architectural design and selection of materials
- Innovative system designs (Air conditioning & Lighting)
- Integration of Renewable Energy & Interaction with the grid
- Intelligent Controls & BMS

Climate Analysis

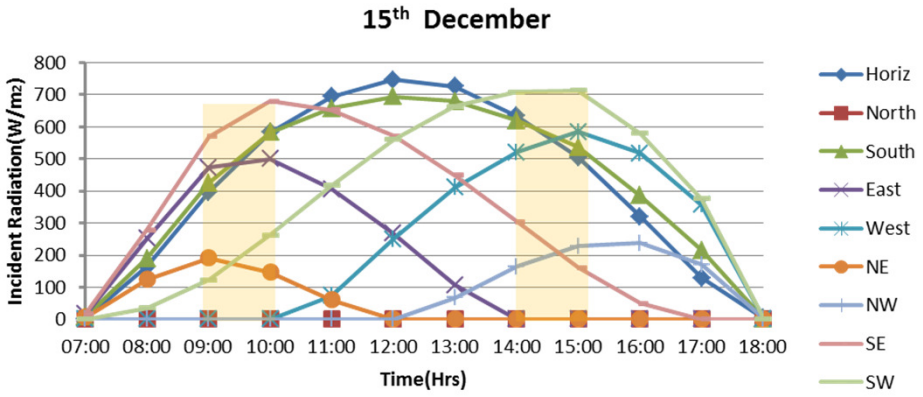
Hourly weather file processing from daily data acquired from meteorology department



Blue dots show outdoor climate of Bhadrachalam

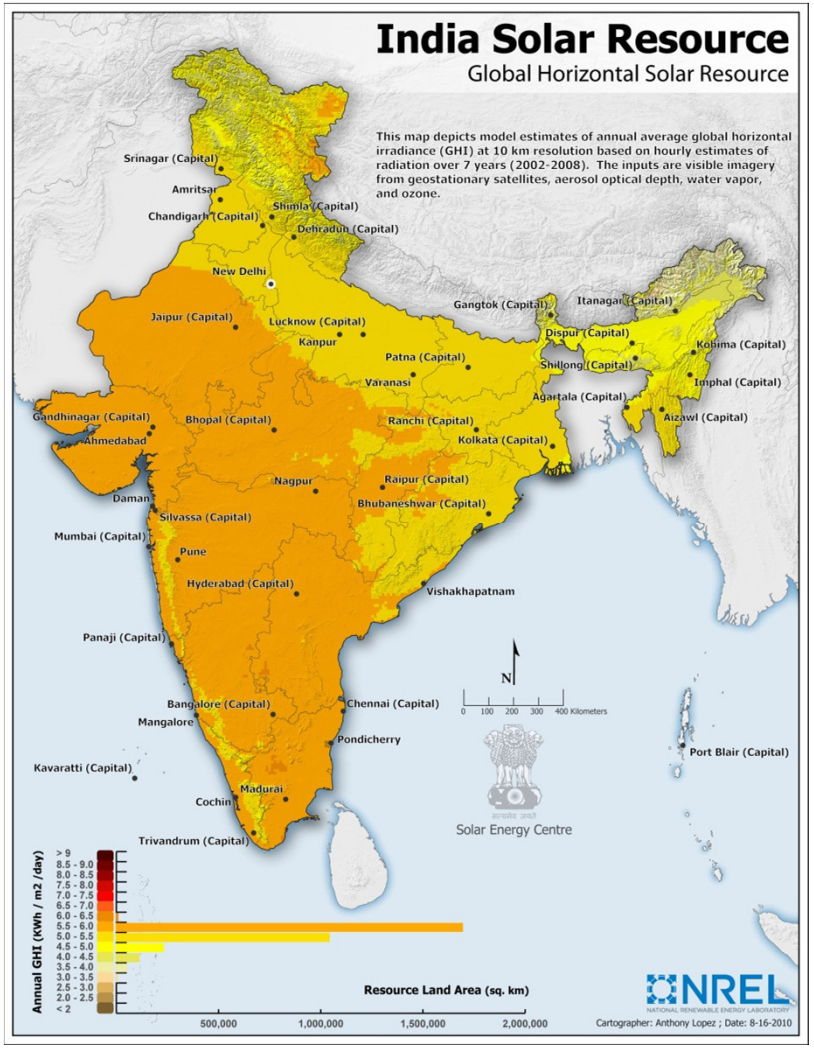
Thermal comfort band and extended adaptive comfort bands after integrating passive strategies

Solar Irradiation data



South

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
07:00	0	1.5	10	34	41.7	37	31	26	34	29	6.6	8.9
08:00	131	128	154	135	91.3	88	86	88	137	228	199	189
09:00	373	323	292	231	150	144	146	163	241	348	353	425
10:00	525	451	386	319	210	199	195	227	322	464	461	583
11:00	601	529	489	380	251	245	239	286	388	544	531	658
12:00	661	589	515	408	279	260	244	307	410	544	571	694
13:00	658	567	499	404	269	256	253	307	392	509	527	680
14:00	620	515	473	356	224	228	233	279	354	485	477	619
15:00	532	457	391	283	170	197	202	236	303	359	411	537
16:00	429	362	293	203	109	151	147	173	203	250	285	386
17:00	245	232	170	114	50.5	93	93	102	101	129	137	216
18:00	51	73	58	39	14.7	42	39	39	26	20	0	2.1



Earth Science and Climate Change
Decentralized Electricity Solutions
Environment Education & Youth Services
Energy Environment Technology Development
Environment & Industrial Bio-Technology

Sustainable Habitats
Water Resources
Bio-Technology & Bio-Resources
Resources Regulation & Global Security
Modeling & Economic Analysis

Sustainable Habitats

Industrial Energy Efficiency
Sustainable Development Outreach
Social Transformation

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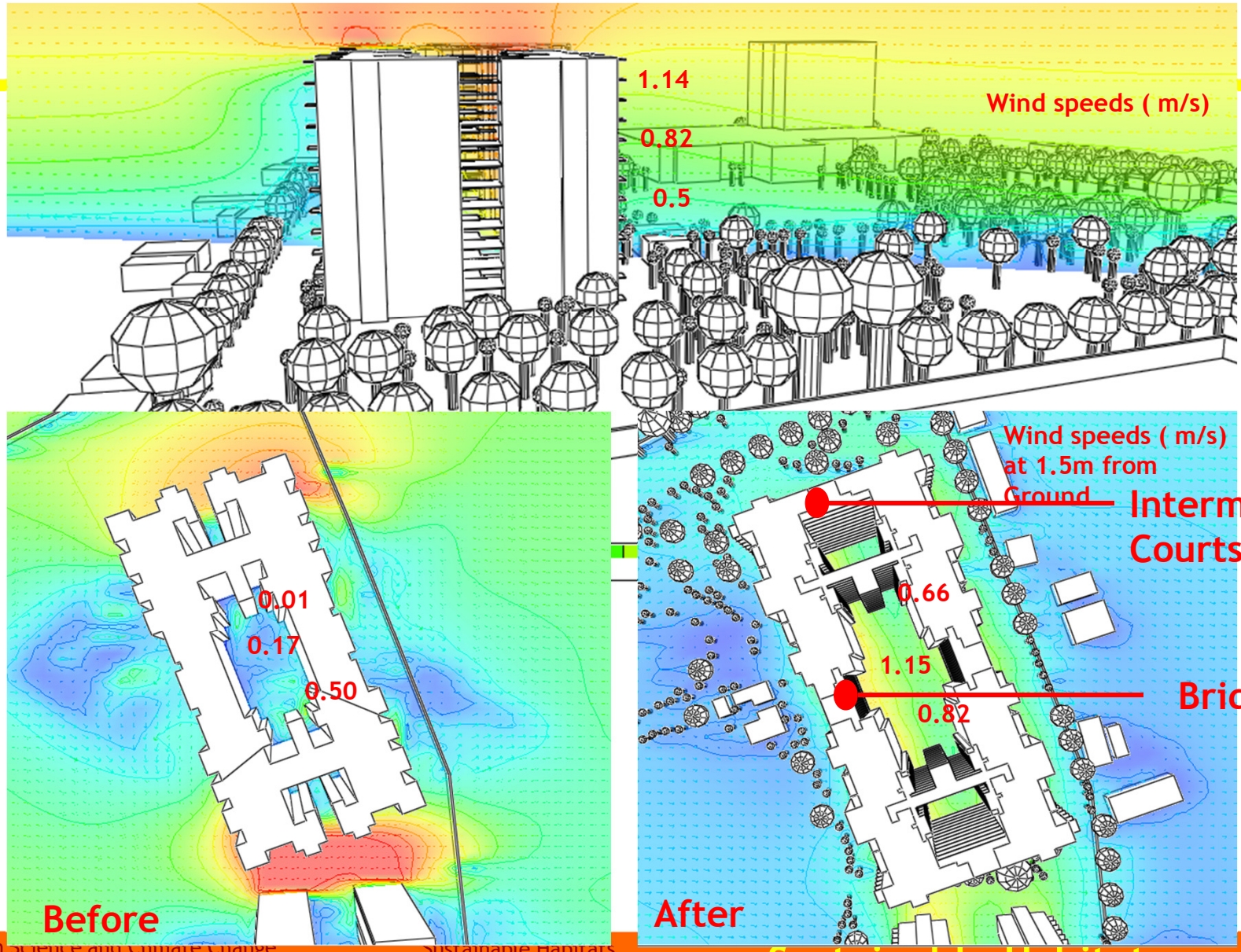
Sustainable Site Planning

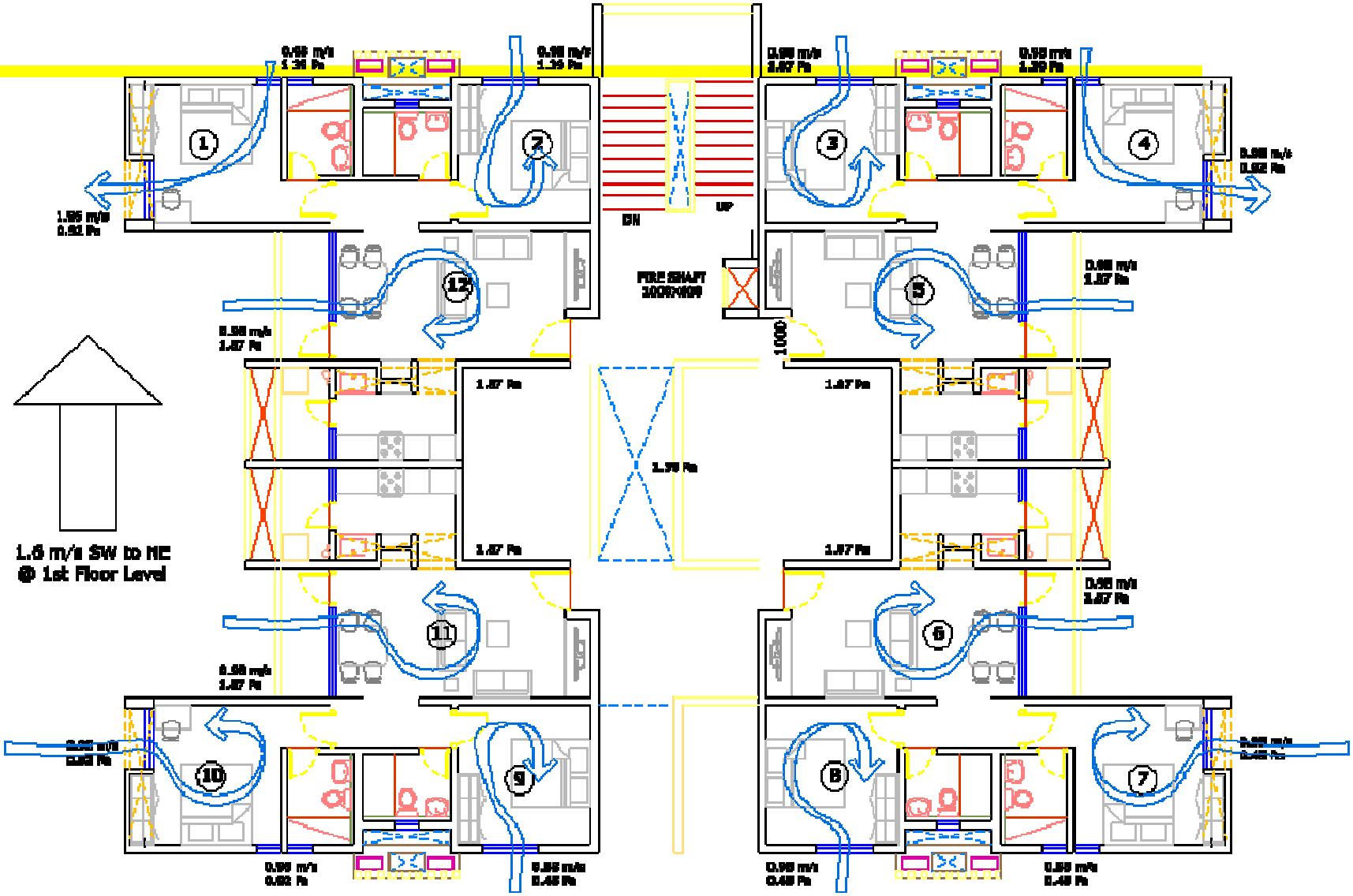
- Wind analysis – Potential to achieve thermal comfort through natural ventilation
- Solar Irradiation analysis – Resource for daylight
- Urban Heat Island Studies / Microclimate air temperature studies – Helps reduce dependence upon air conditioning.

Out door Wind Flow analysis for High-rise structures



Higher wind speeds for better comfort in outdoor ,semi outdoor and courtyard spaces and by adding a stilt, bridges and intermediate courts and landscape elements

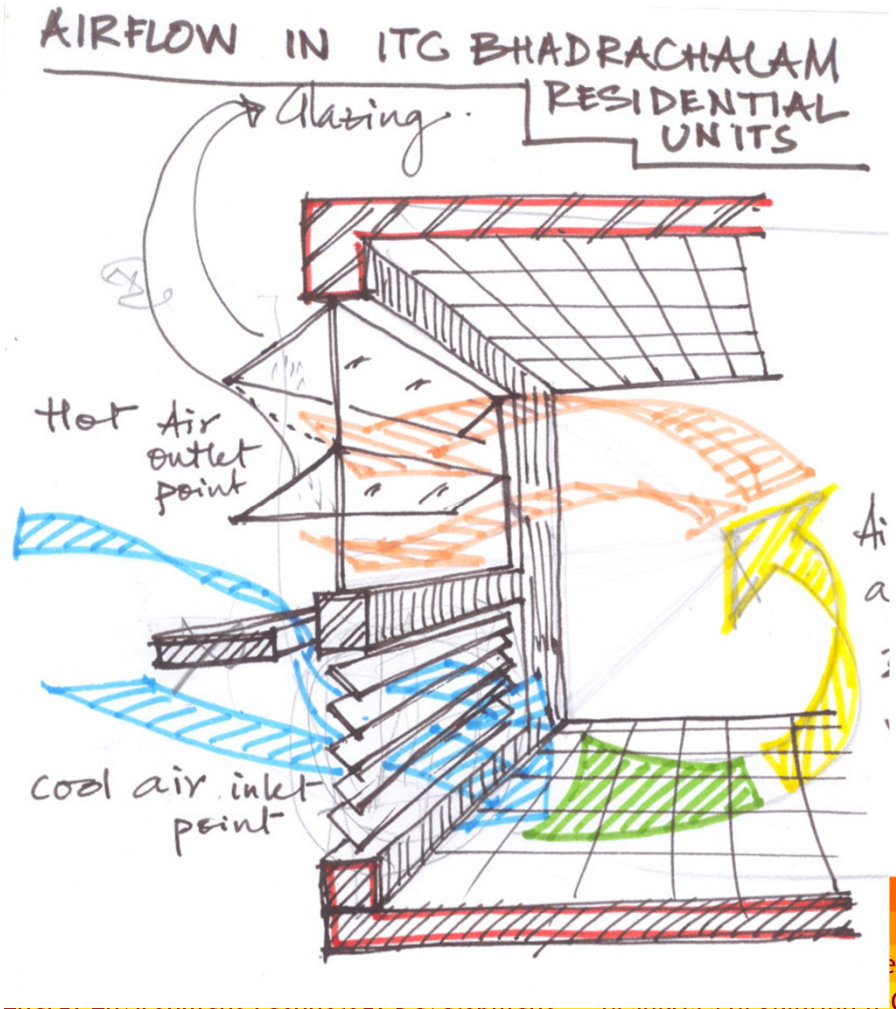
Indoor Air Movement in Employee Quarters



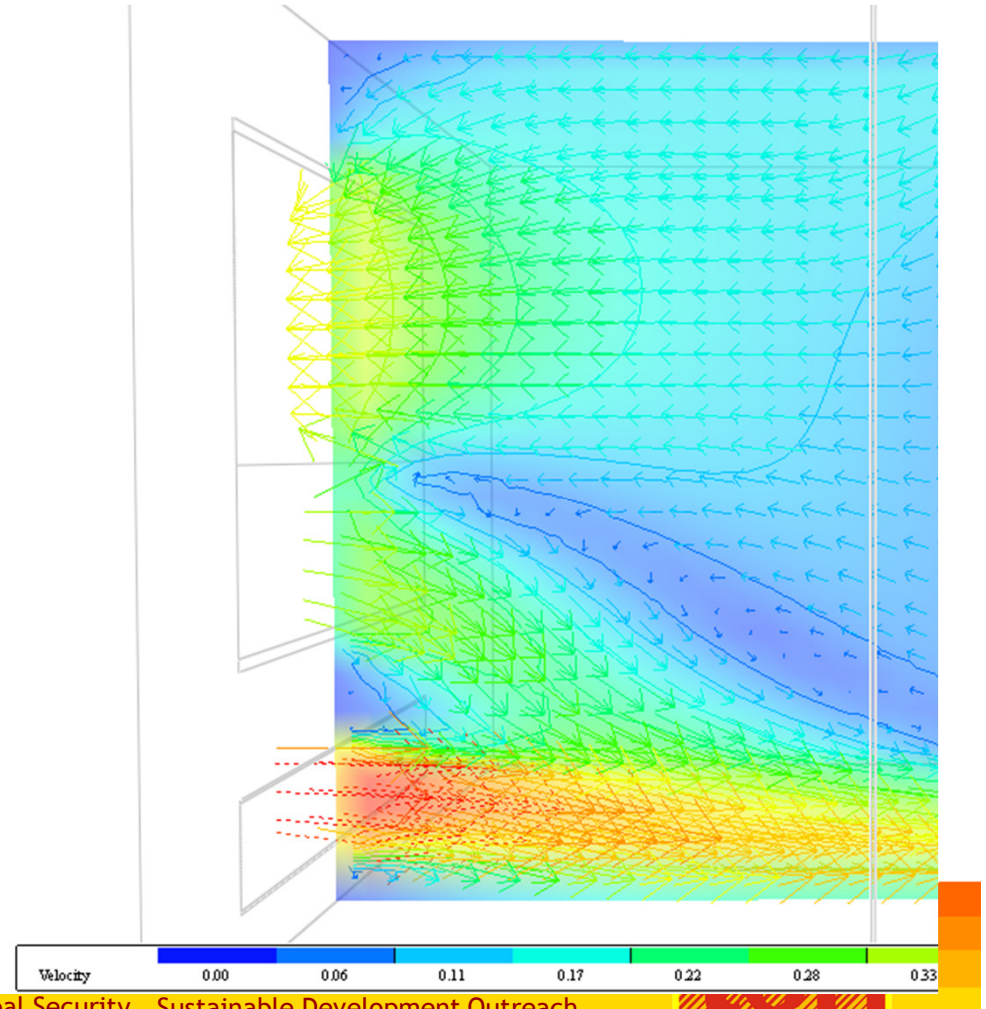
Earth Science and Climate Change	Sustainable Habitats	Sustainable Habitats
Decentralized Electricity Solutions	Water Resources	
Environment Education & Youth Services	Bio-Technology & Bio-Resources	Industrial Energy Efficiency
Energy Environment Technology Development	Resources Regulation & Global Security	Sustainable Development Outreach
Environment & Industrial Bio-Technology	Modeling & Economic Analysis	Social Transformation

Conceptual Sketch and actual CFD model of Window System Proposed For Non Ventilated Spaces

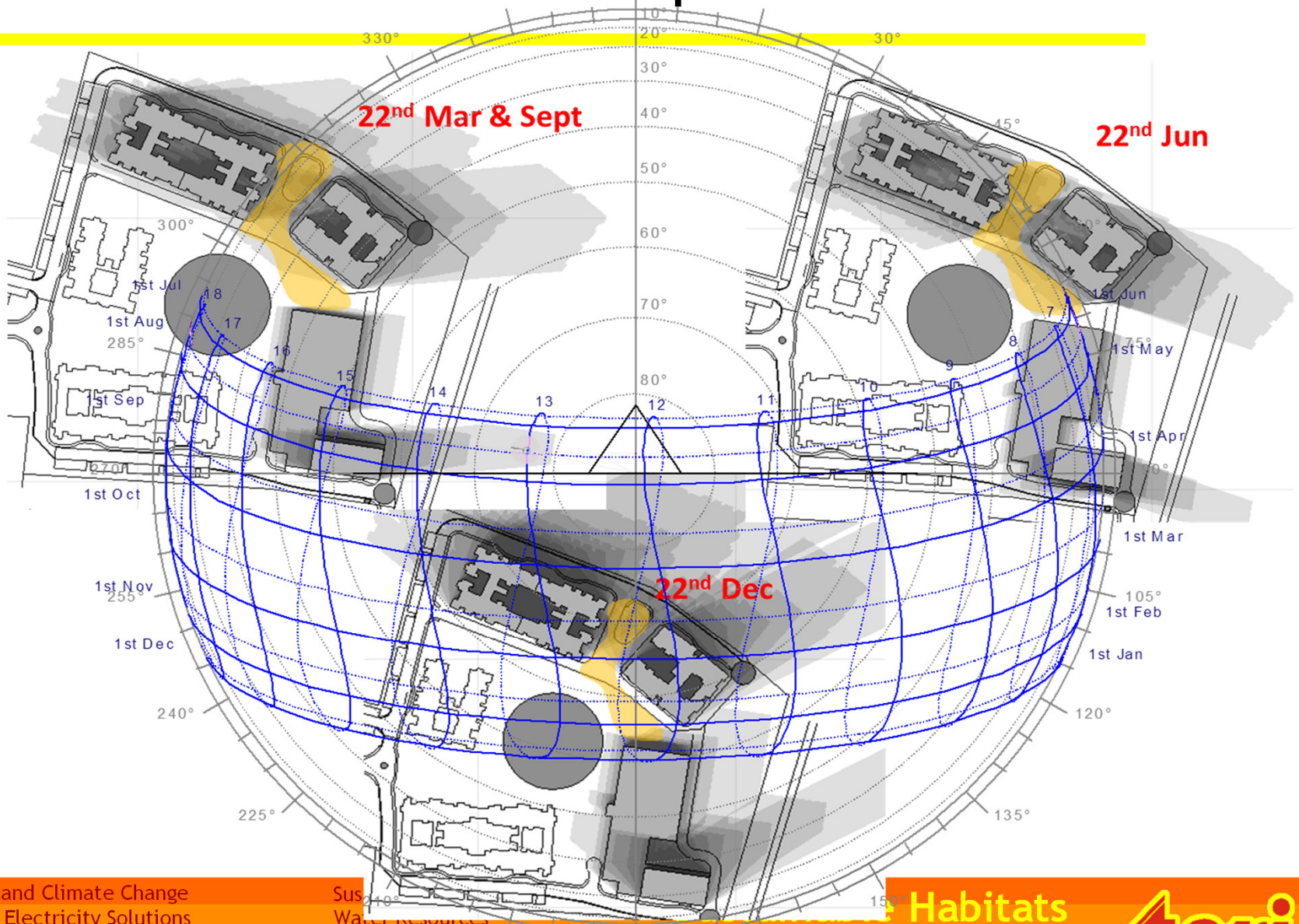
Conceptual sketch



CFD Model



ITC Guntur – Residential Township in Andhra Pradesh



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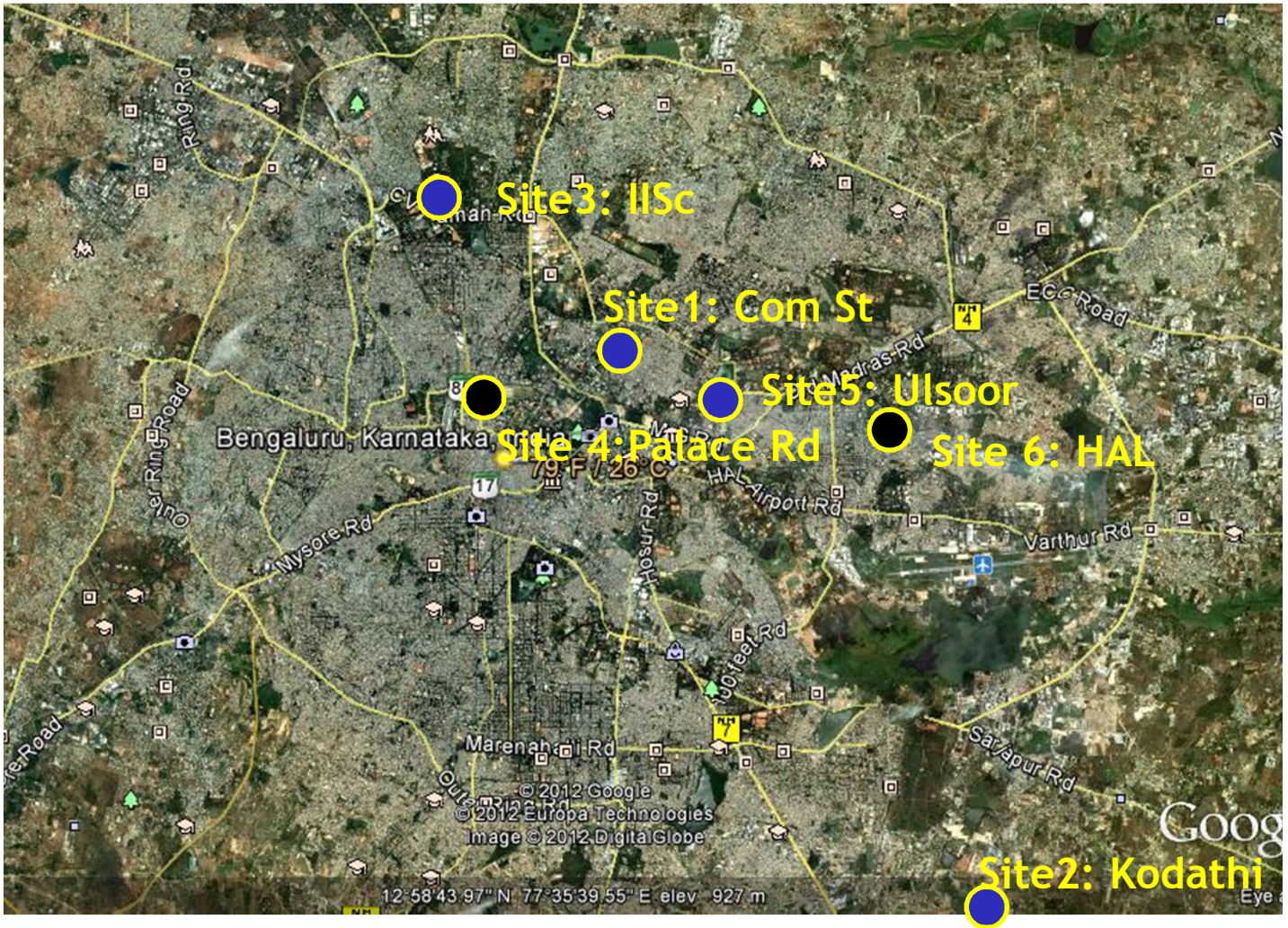
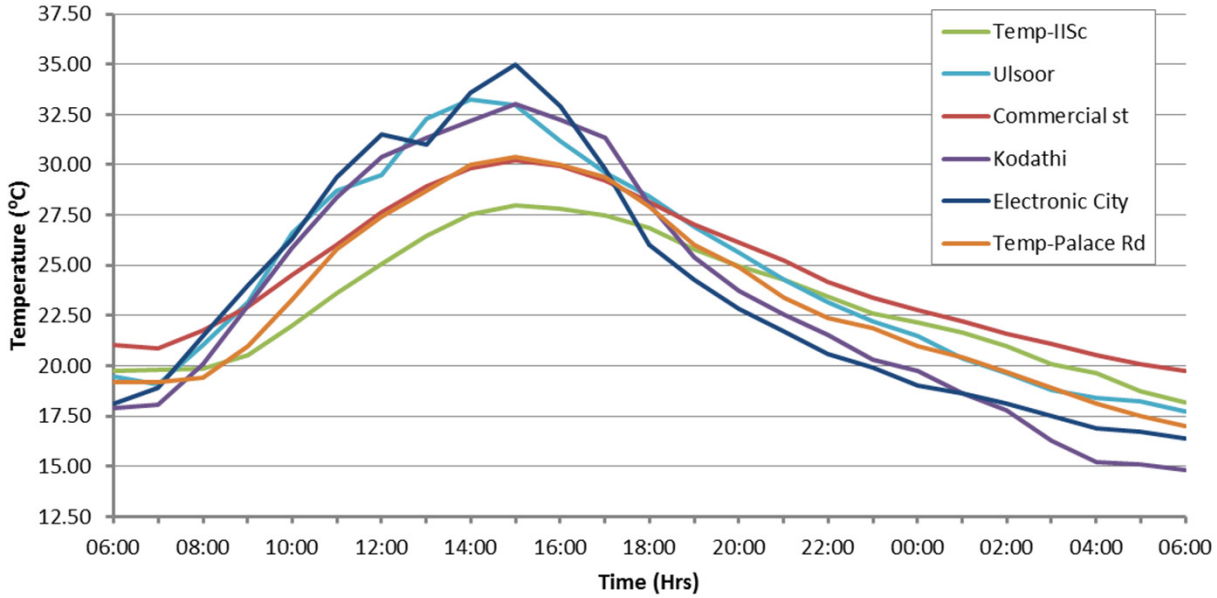
Sustainable Urban Development: Minimizing urban heat island effect and imperviousness factor

Hypothesis

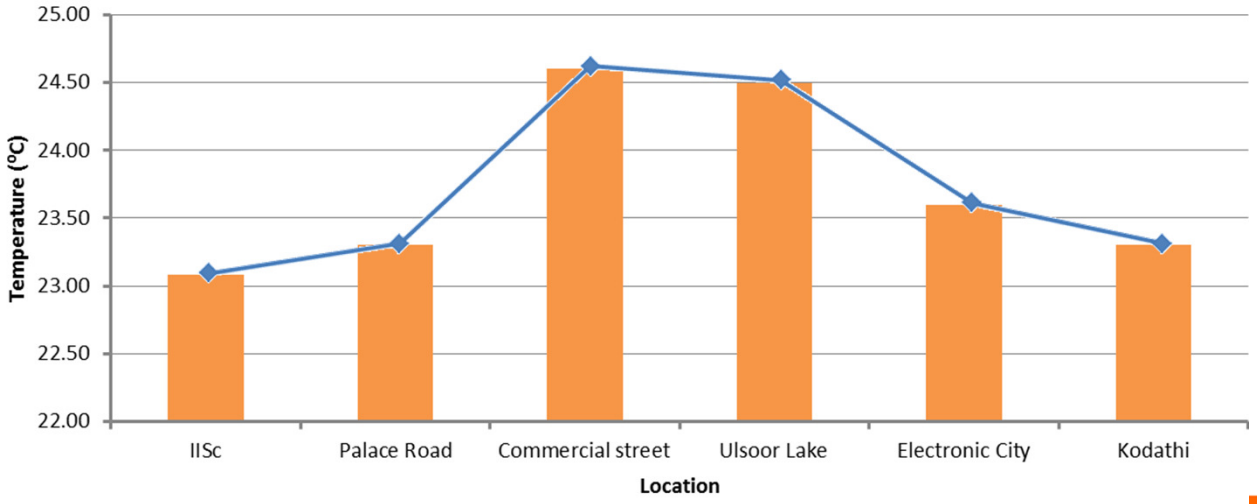
- **Implementation of Urban Heat Island (UHI) mitigation measures for various urban surfaces will reduce the ambient air temperatures.**
- **Energy savings in air conditioned buildings will possible due to improved micro climate around the buildings.**
- **Increased permeability of the urban surfaces will reduce the storm water runoff.**

Site Selection in Bangalore under UHI Research

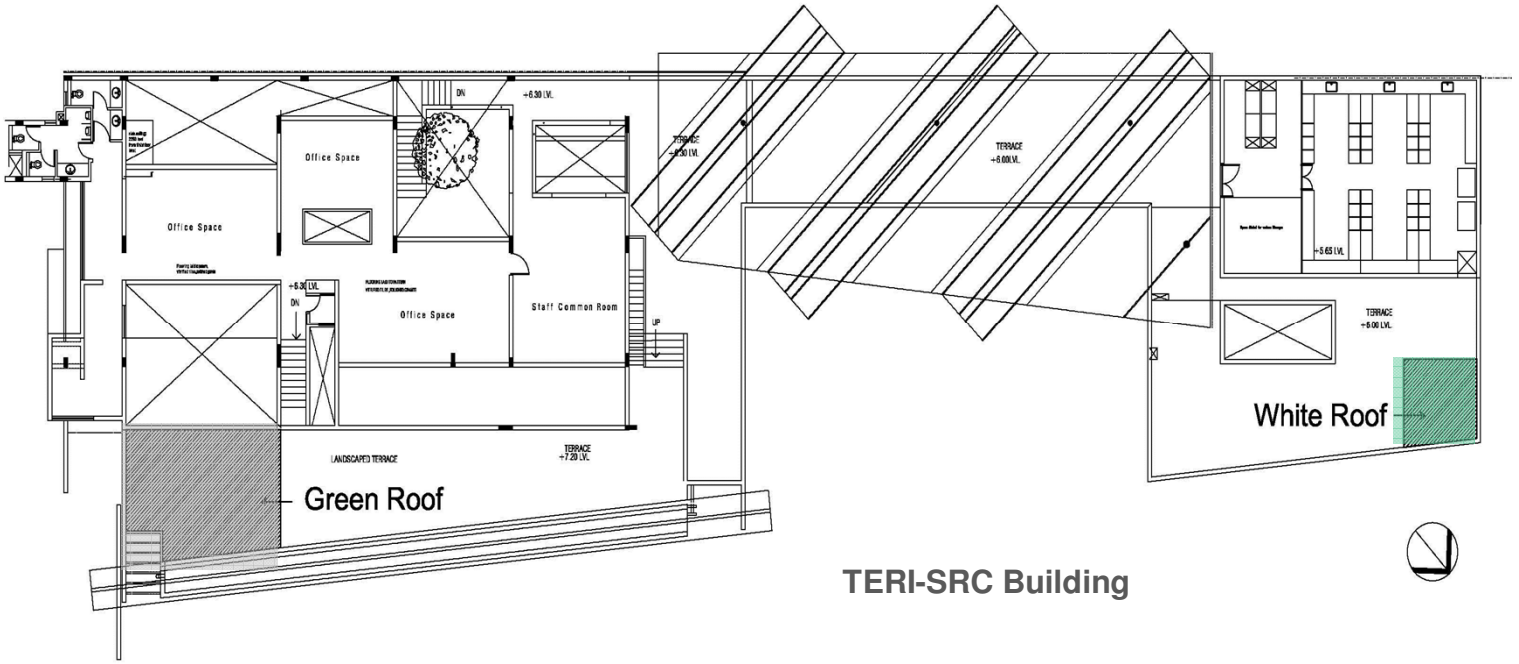




Hourly Mean Temperatures measured at different locations



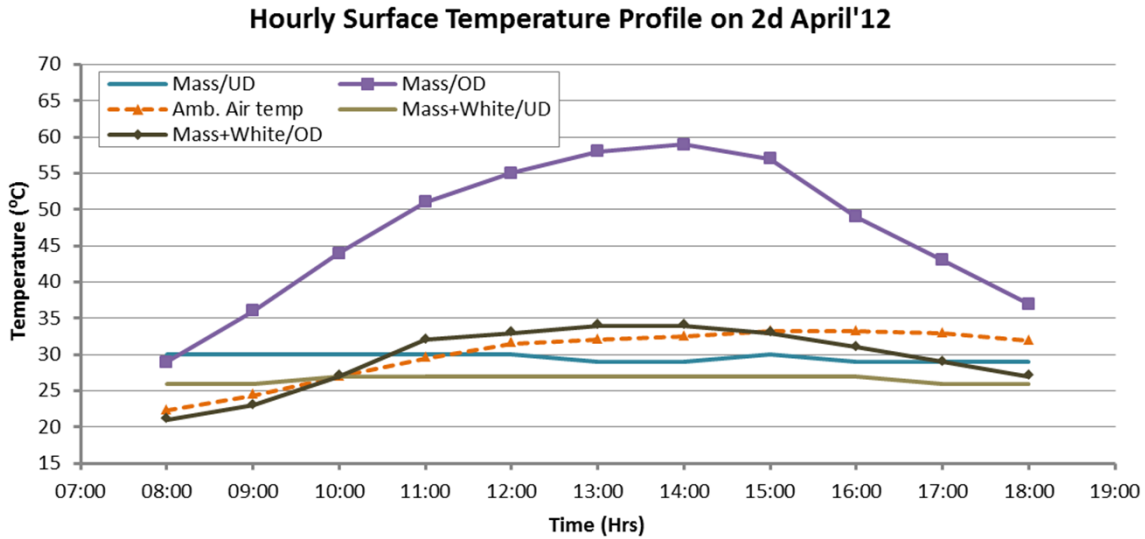
Studies on Mitigation Options of UHI



TERI-SRC Building

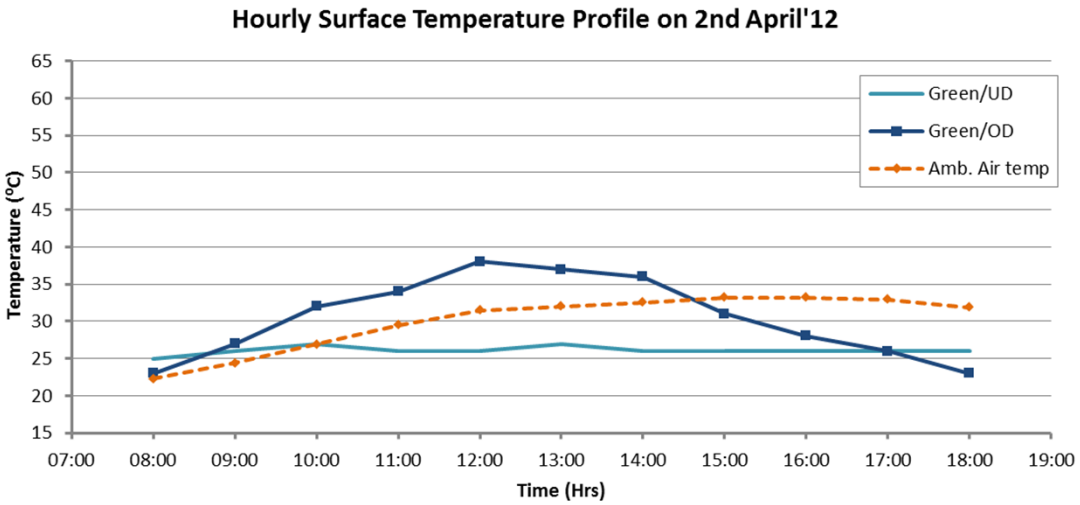
- Hourly Air and surface temperatures monitoring
  - Over and under deck
  - Ambient & Indoor Temperatures

Mass RCC roof with white coat



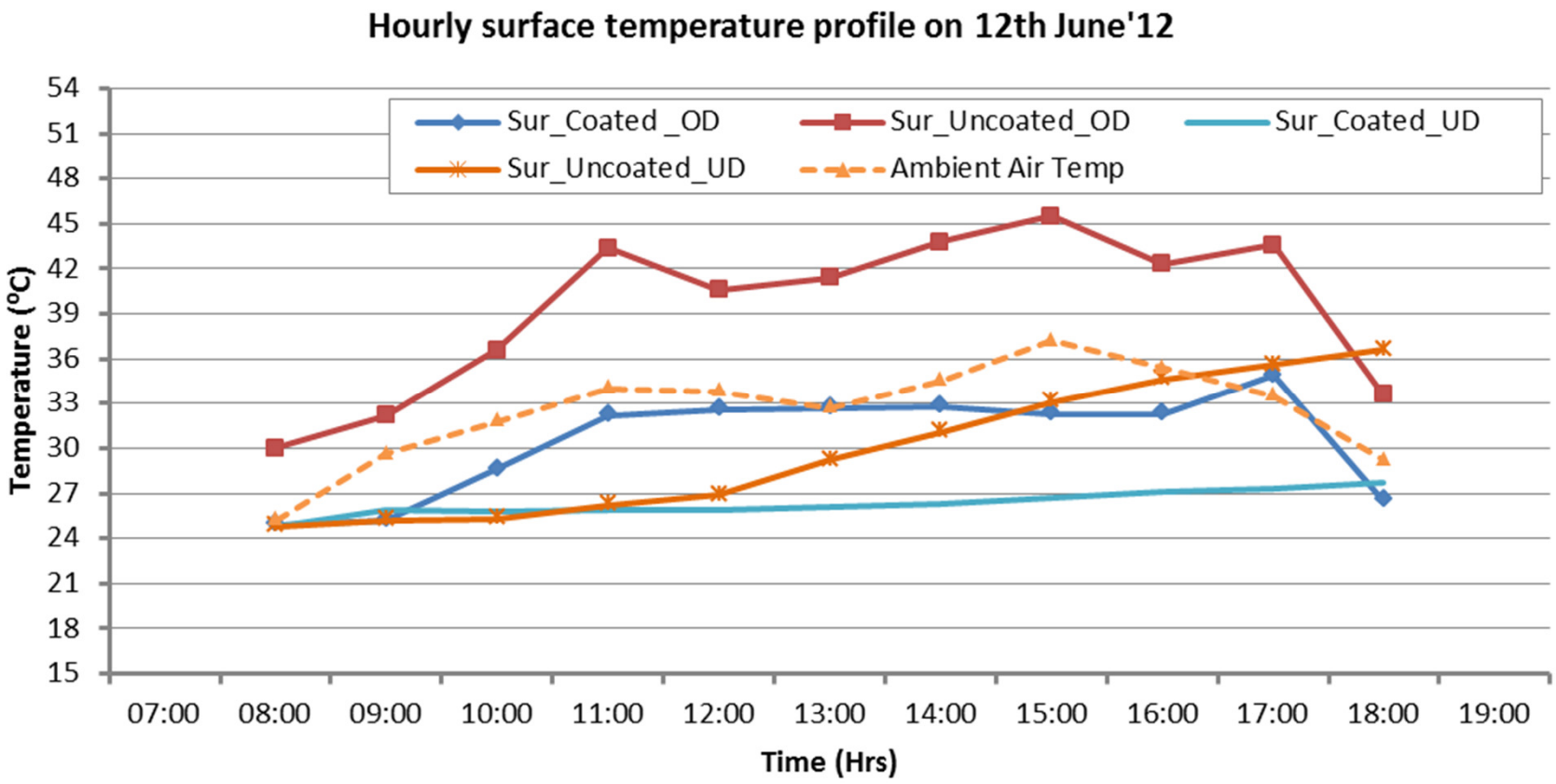
- **3 degC difference in underdeck surface temperature throughout the day**
- **Constant under deck surface temperatures throughout the day**

Green Roof

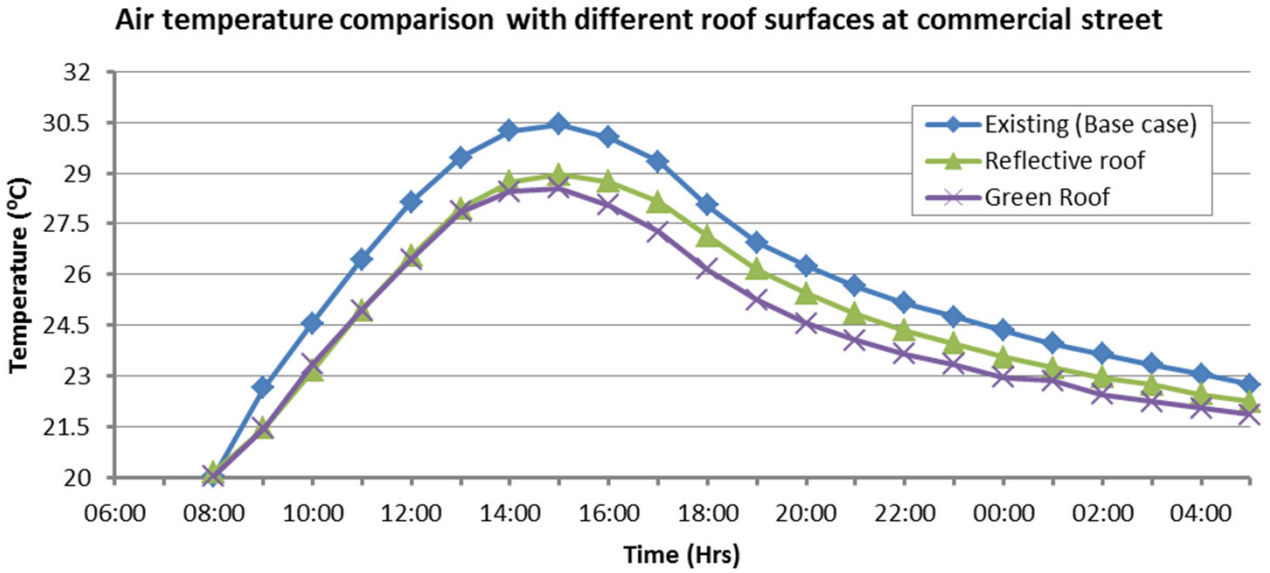


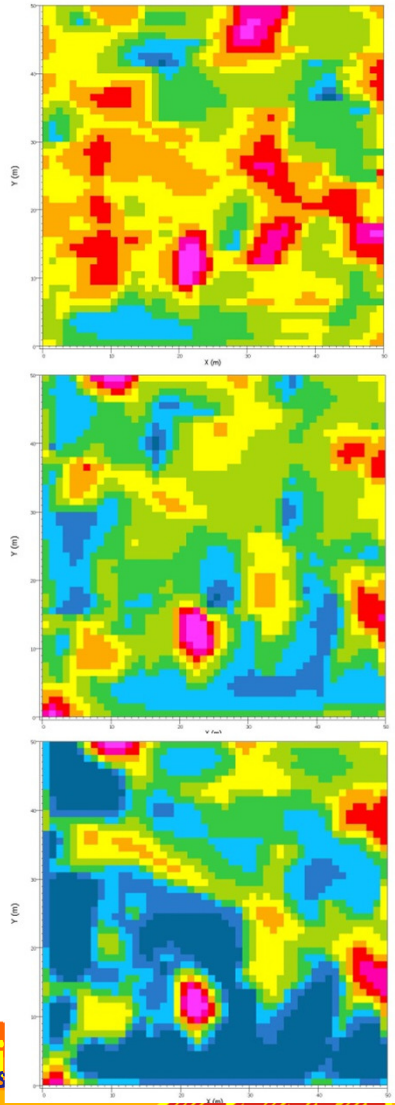
- **Overdeck surface temperature goes down below air temperature after watering grass in the evening**
- **Under deck surface temperature is constant at 26^{0}C throughout the day**

Glossy finish white roof for easy maintenance



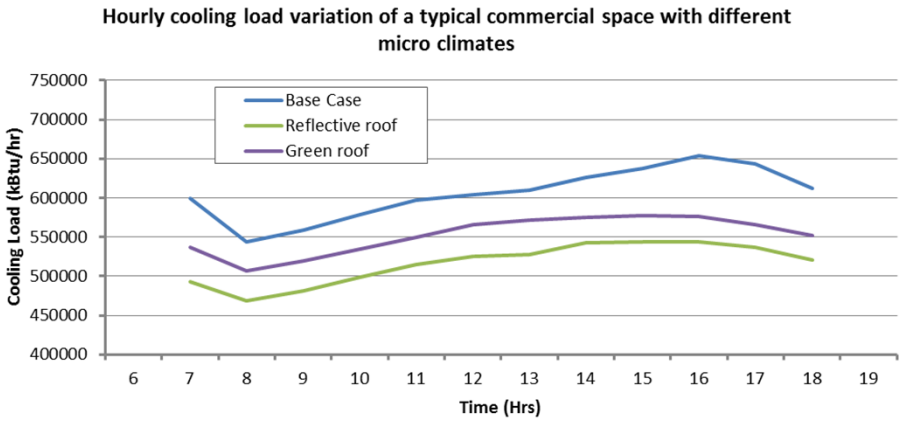
Parametric runs for UHI Mitigation measures

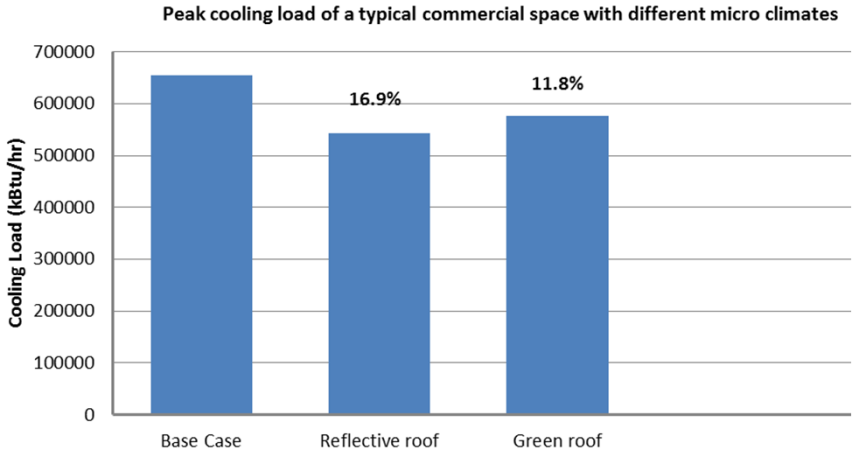




- **Reduction in peak air temperature**
  - **1.5^{0}C incase of Reflective roof**
  - **1.9^{0}C incase of Green roofs**

Cooling load reduction due to improved micro climate

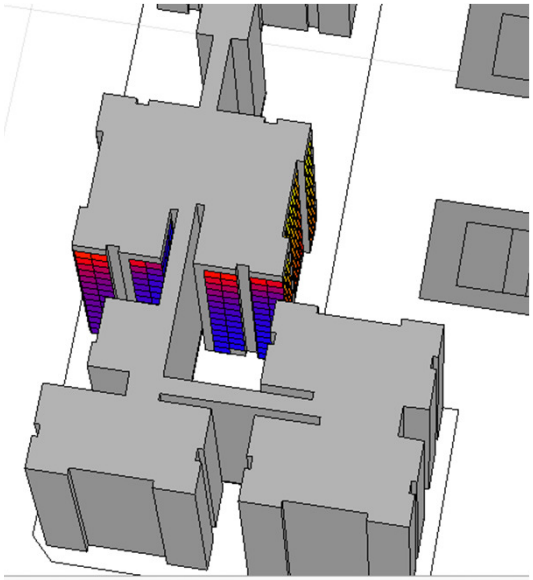


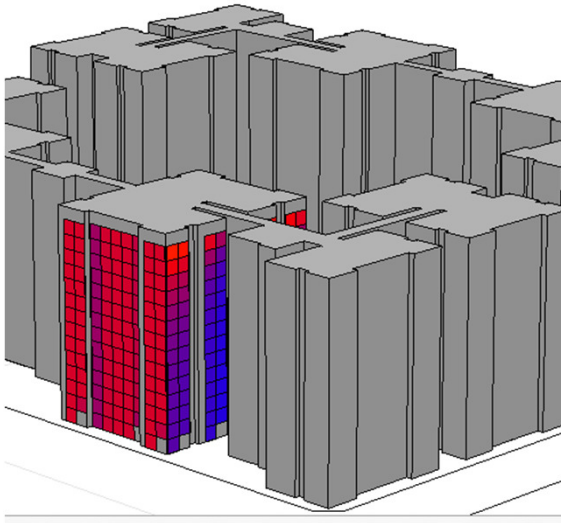


	Base Case	Reflective Roof	Green roof
Building Type	Commercial Office	Commercial Office	Commercial Office
Zone Area	40000Sft	40000Sft	40000Sft
Height	3 m	3 m	3 m
Lighting power density	1.4 W /ft^2	1.4 W /ft^2	1.4 W /ft^2
Equipment power density	0.75 W /ft^2	0.75 W /ft^2	0.75 W /ft^2
Occupants	275 ft^2 / person	275 ft^2 / person	275 ft^2 / person
Occupancy Schedule	8 hours, 5 days a week	8 hours, 5 days a week	8 hours, 5 days a week
External wall	Uninsulated 230mm Brick Wall	Uninsulated 230mm Brick Wall	Uninsulated 230mm Brick Wall
External Roof	Uninsulated 150mm RCC Roof	Uninsulated 150mm RCC Roof with reflective coat (albedo 0.9)	Green Roof with U- value 0.23W/m2
Glazing Specification	6mm clear glass	6mm clear glass	6mm clear glass

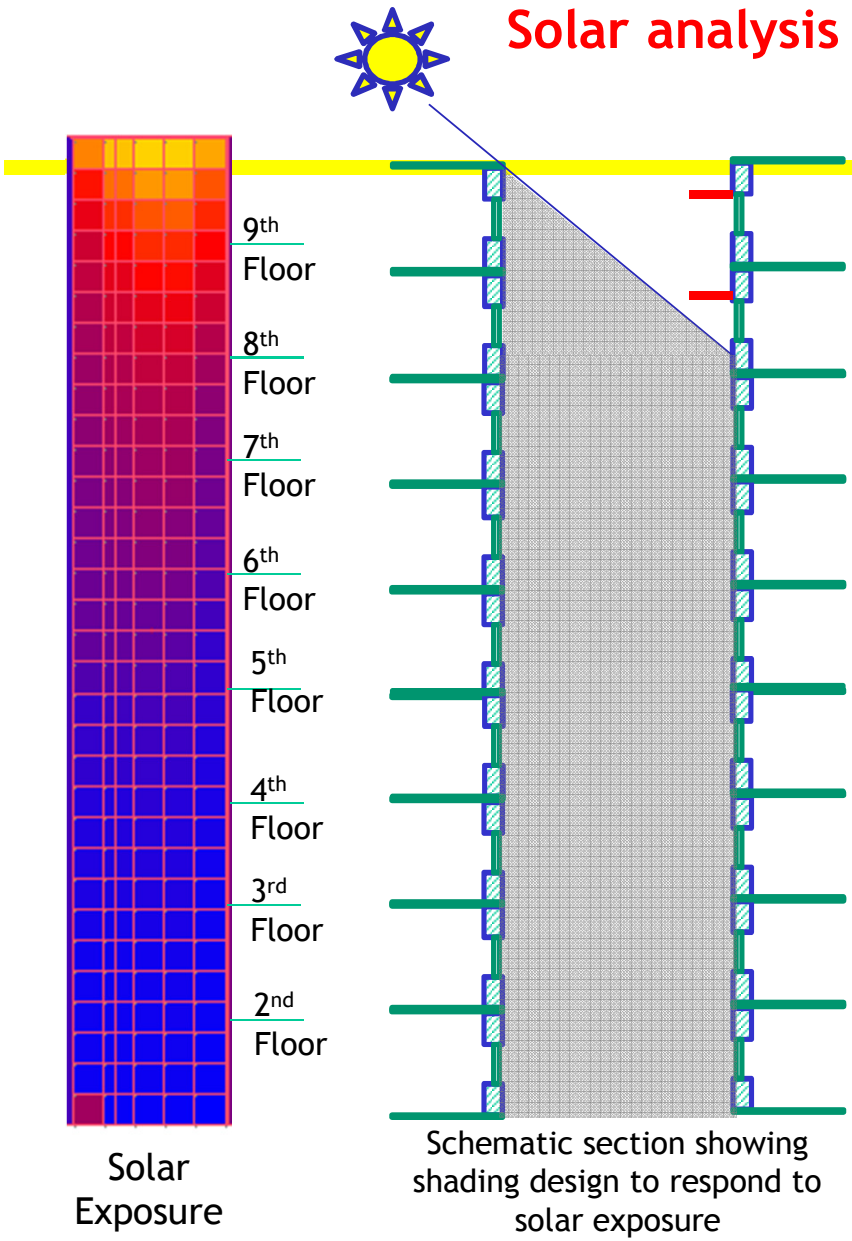
ITC Bhadrachalam – Residential Township

- Solar irradiation analysis – high rise dense development





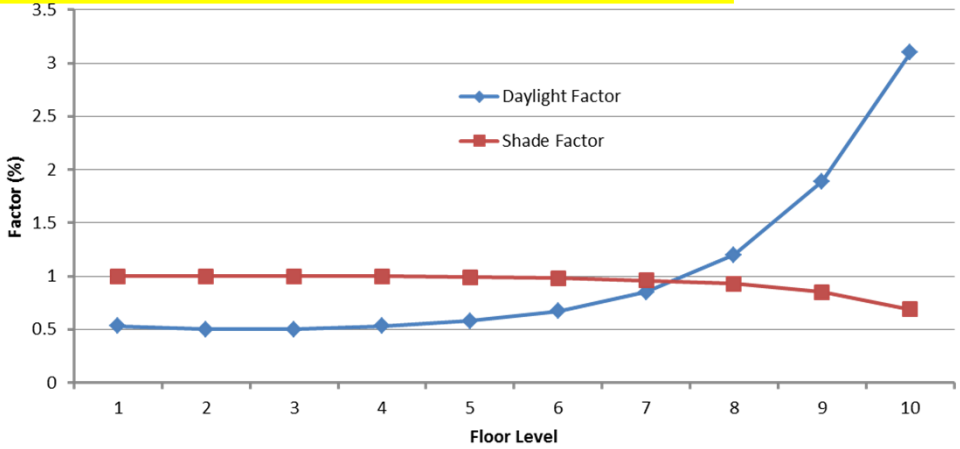
Solar analysis for High-rise structures

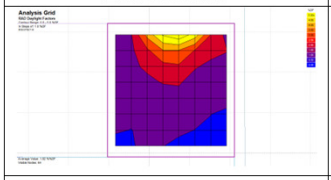
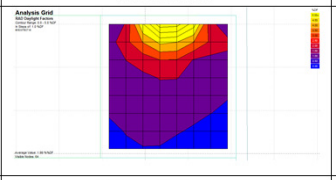
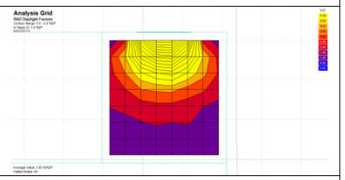


Solar Exposure

Schematic section showing shading design to respond to solar exposure

Daylight availability across the floors



Ground Floor	Fifth Floor	Ninth Floor
		
Average DF : 1.8	Average DF : 2.0	Average DF :3.8
Shading Factor: 1	Shading Factor: 0.83	Shading Factor :0.56

- Increase in daylight and decrease in shading factor especially in rooms facing inner courtyards - as we go up in dense developments
- No additional shading for lower floors and an optimized shading for upper floors is recommended to maintain uniform thermal and visual comfort conditions across the floors

/wwshop/images/ManMarinCap.jpg

http://u1.ipernity.com/u/2/3F/3A/604735.fef07a581.l.jpg

http://farm4.static.flickr.com/3102/2649874827_6fc6f36fe4.jpg?v=0

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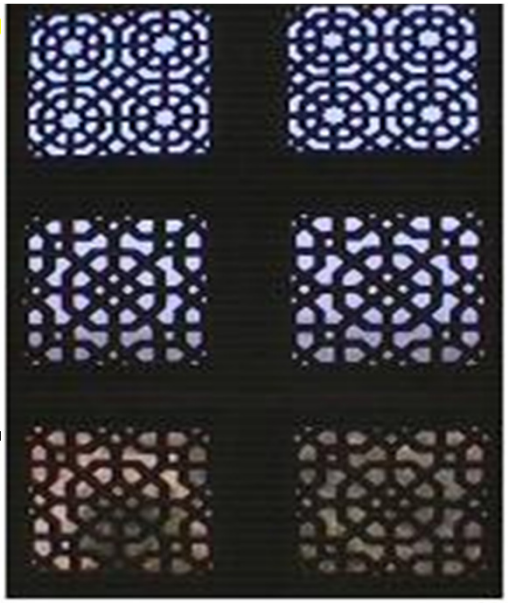

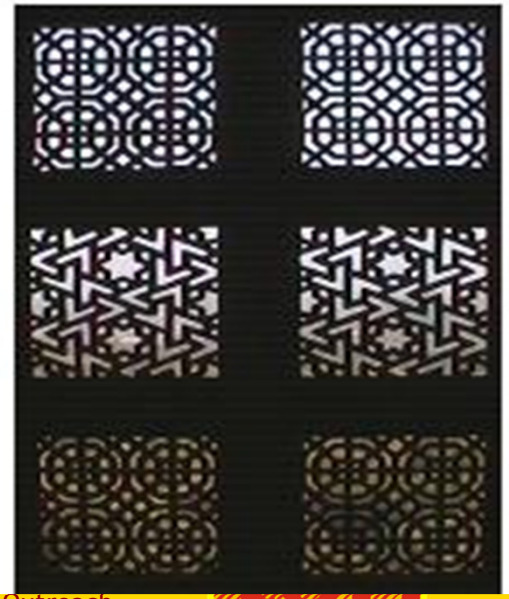

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Daylight Autonomy

It is essential to provide daylight in Kitchen, especially between 08:00hrs and 10:00hrs to reduce energy demand on artificial lighting.

Daylight Autonomy (DA) is calculated and found that 26.6% of the day time in a year, lighting level of 225 lux (with 60% VLT) is present in the space on the first floor.

Study of Daylight Glare Indices

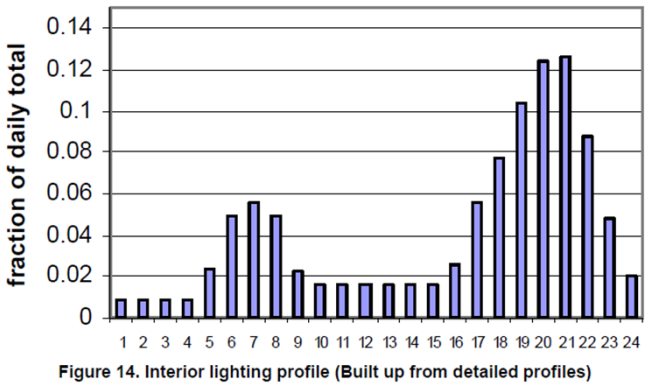
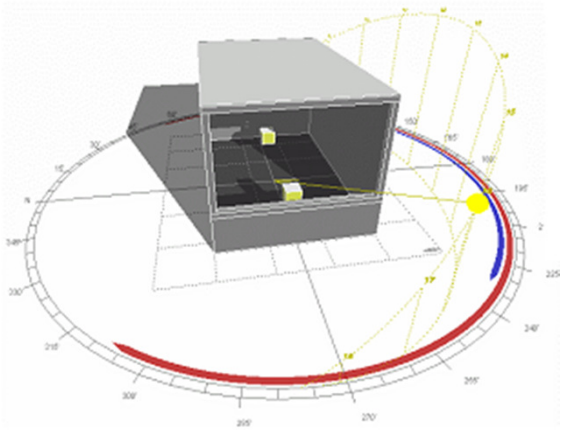
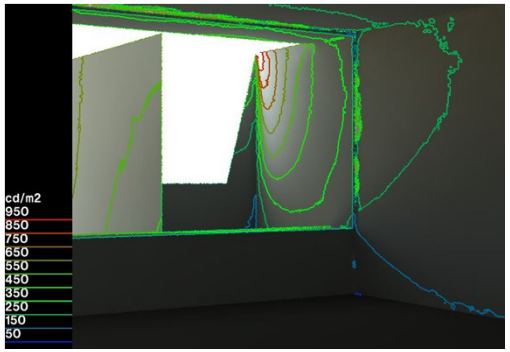


Figure 14. Interior lighting profile (Built up from detailed profiles)





High Performance Commercial Buildings
Research Study under APP

Only ECBC Envelope Gives a Pay Back Period of 7 - 8 years

High Performance Commercial Buildings Research Study under APP

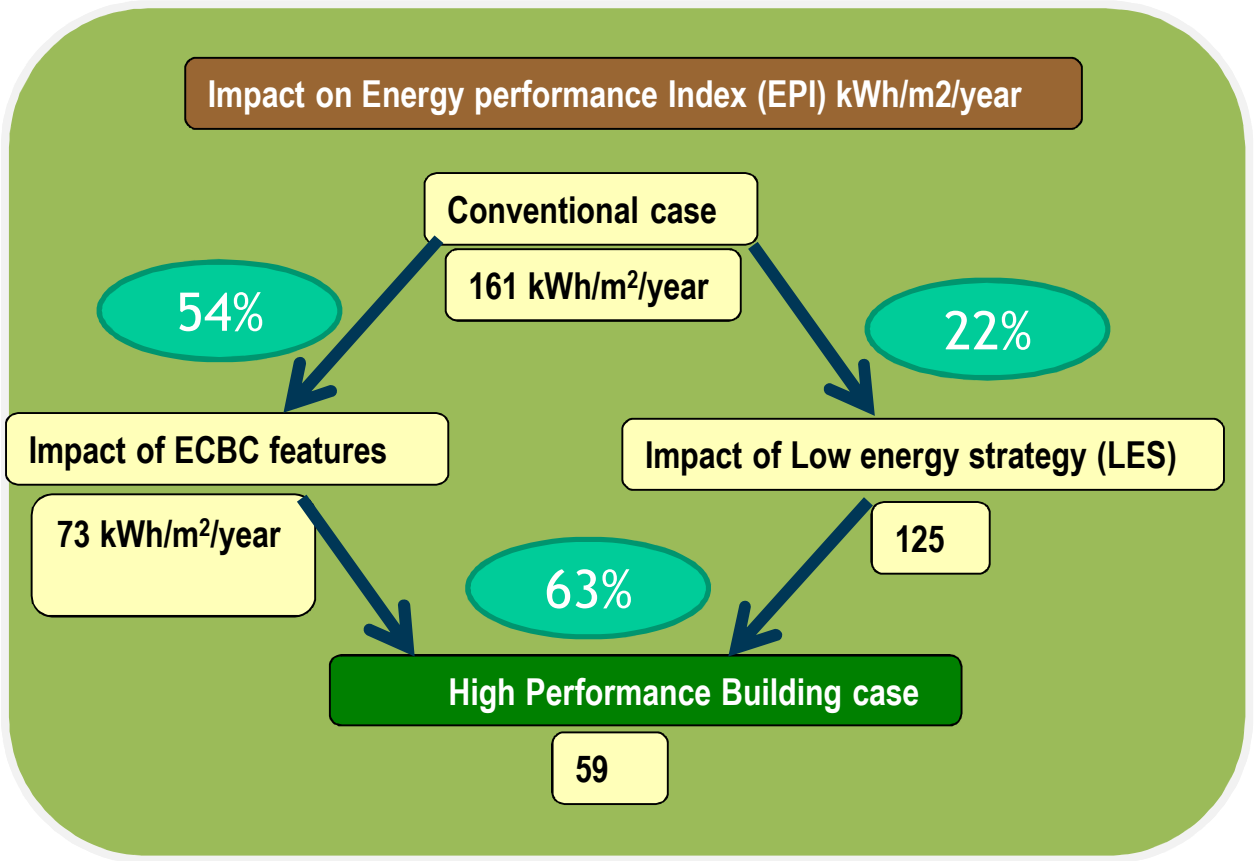
ECBC Envelope

+

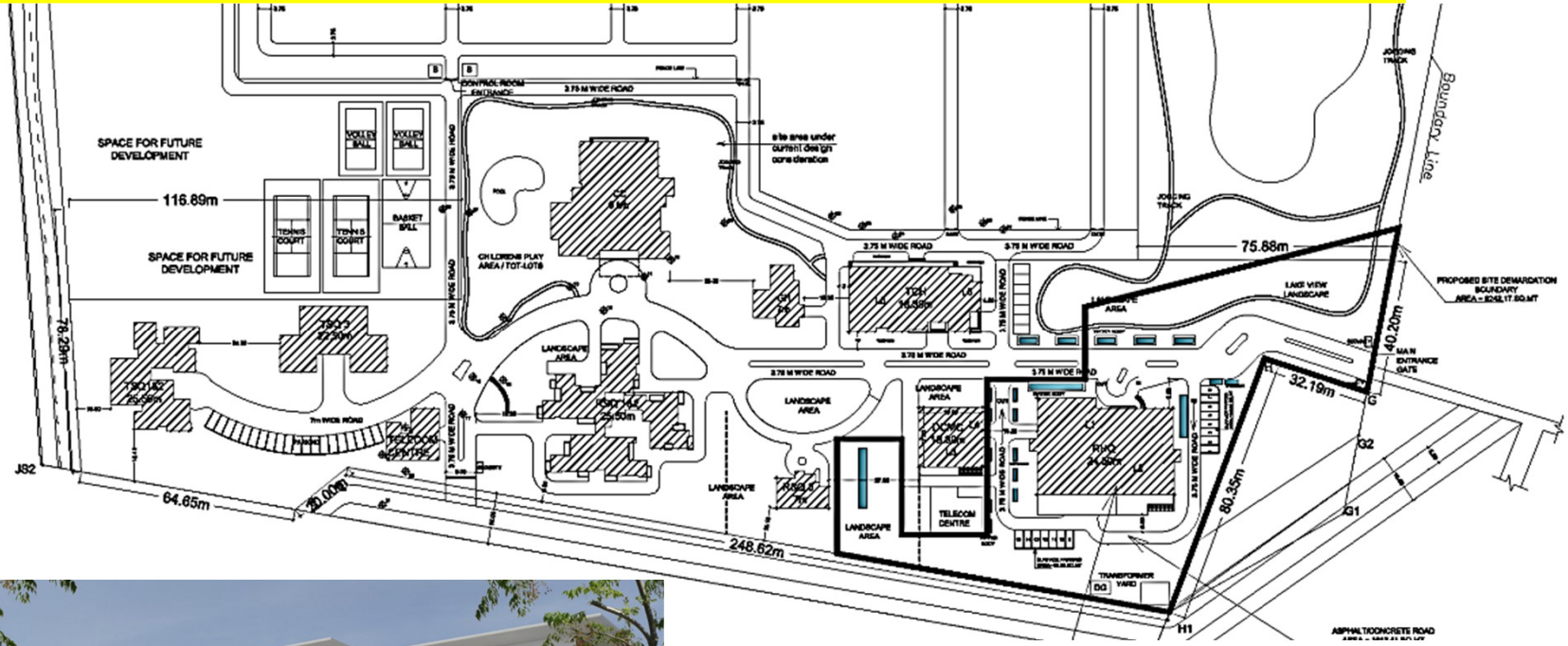
Daylight Integration

REDUCES THE PAY BACK PERIOD TO 4 YEARS

Energy Performance Index (EPI)_Saving Potential



Power Grid Corporation of India Limited Campus at Bangalore



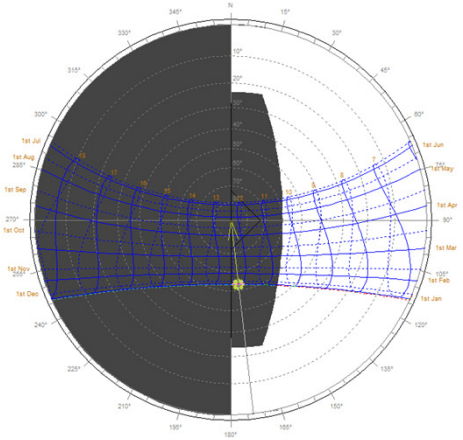
Courtesy: Klimart

Project Details

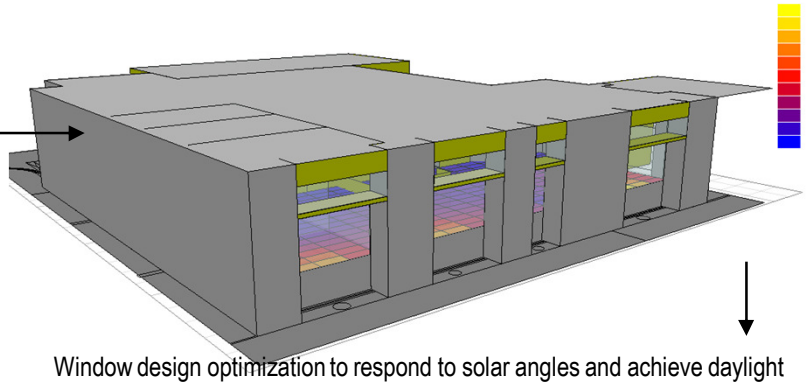
Site Area : 12 acres

Built-Up Area : 17,305 Sq.m

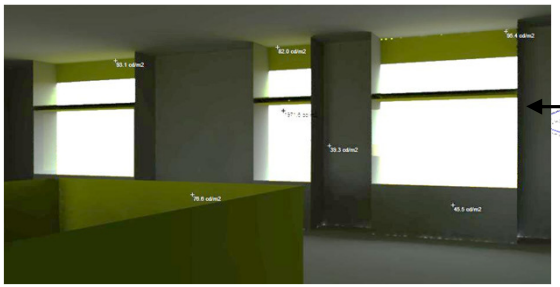
Solar analysis of PGCIL building for window optimization



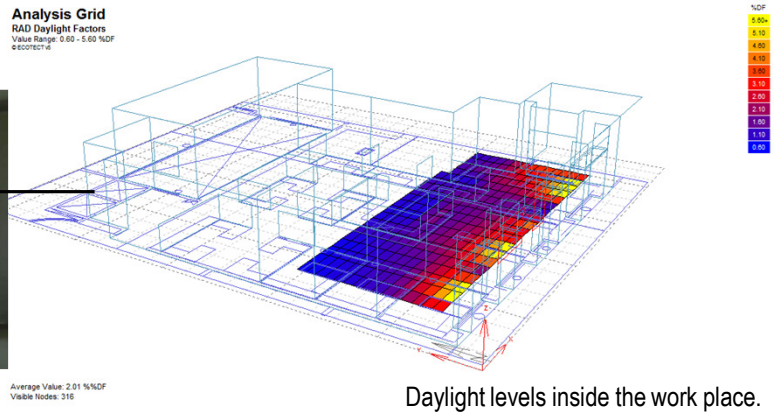
Solar Analysis and Daylight availability Studies



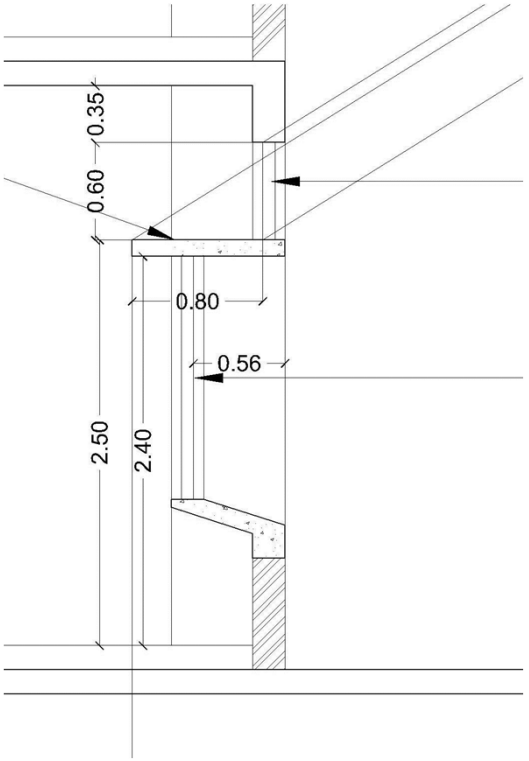
Window design optimization to respond to solar angles and achieve daylight



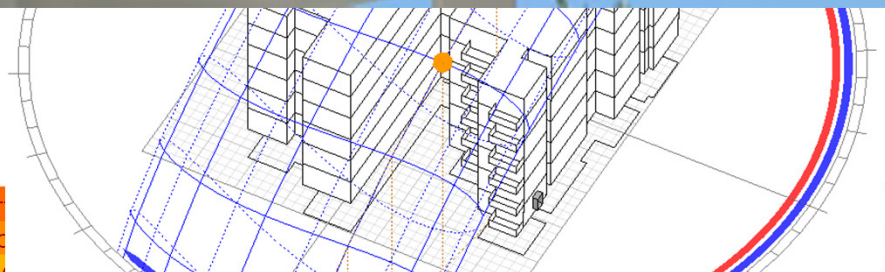
Optimize design to achieve glare free daylight with minimum external heat gains



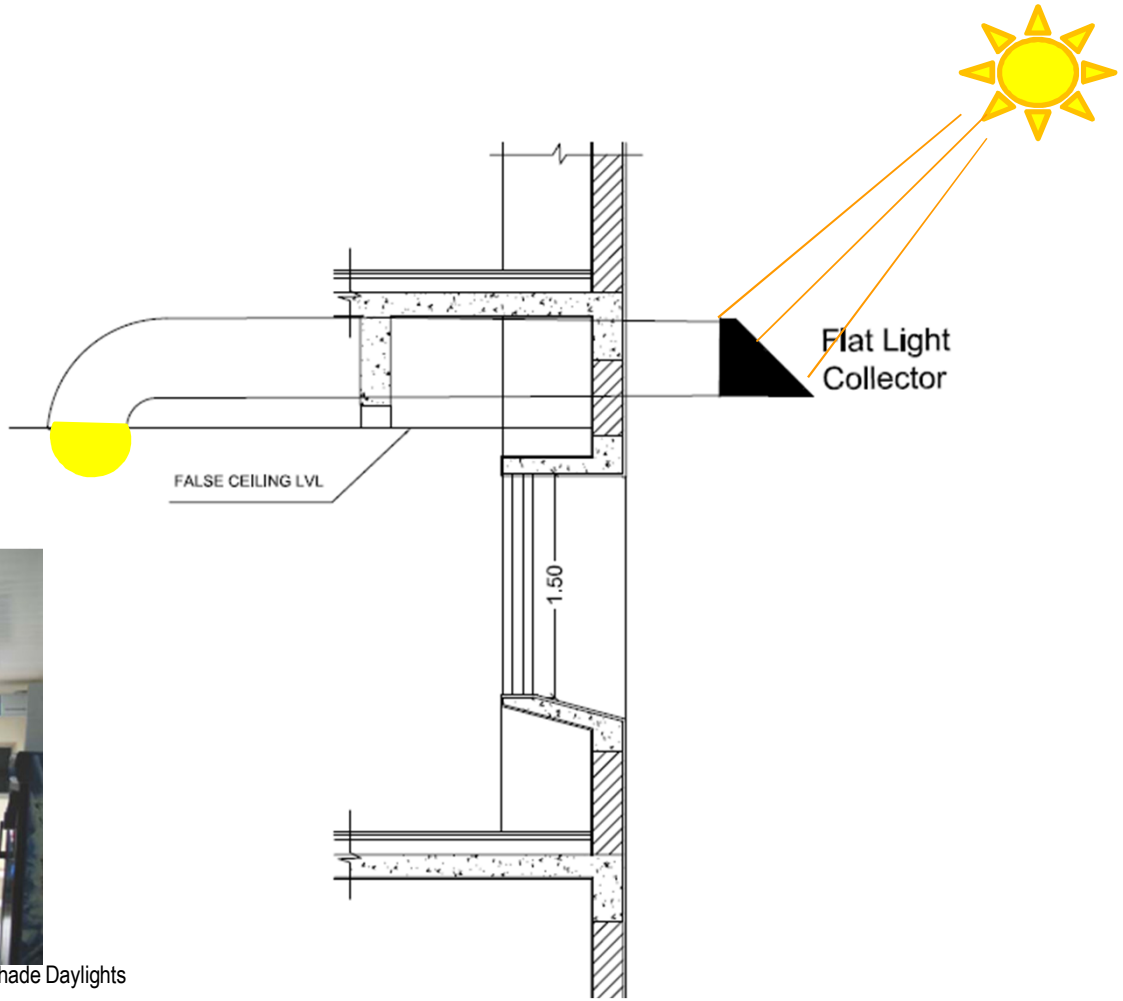
Daylight levels inside the work place.

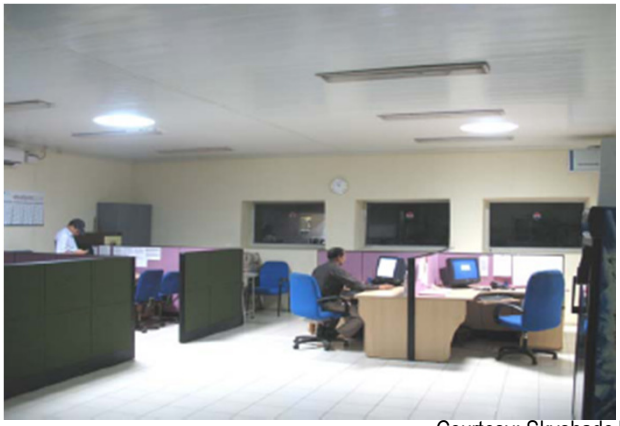


Window design optimization for PGCIL Buildings, Bangalore



Integration of light pipes in PGCIL headquarters





Courtesy: Skyshade Daylights

Building envelope optimization for Air conditioned and Non Air conditioned spaces

		Roof	Wall	Glazing_View Window			AC Spaces
	Alternative	U-Value	U-Value	U-Value	SHGC	VLT	Reduction in TR Load
		W/m2K	W/m2K	W/m2K			(%)
1	Base Case	2.49	3.17	6.17	0.815	0.88	
2	ECBC Roof Case_Over deck	0.36	3.17	6.17	0.815	0.88	1.76
3	ECBC Roof Case_Under deck	0.37	3.17	6.17	0.815	0.88	-0.18
4	Glazing optimised Case	2.49	3.17	1.59	0.28	0.4	4.20
5	Cumilative 1(Over Deck)	0.36	3.17	1.59	0.28	0.4	9.67
6	Cumilative2 (Under Deck)	0.37	3.17	1.59	0.28	0.4	7.93

Innovative & Efficient Lighting Design

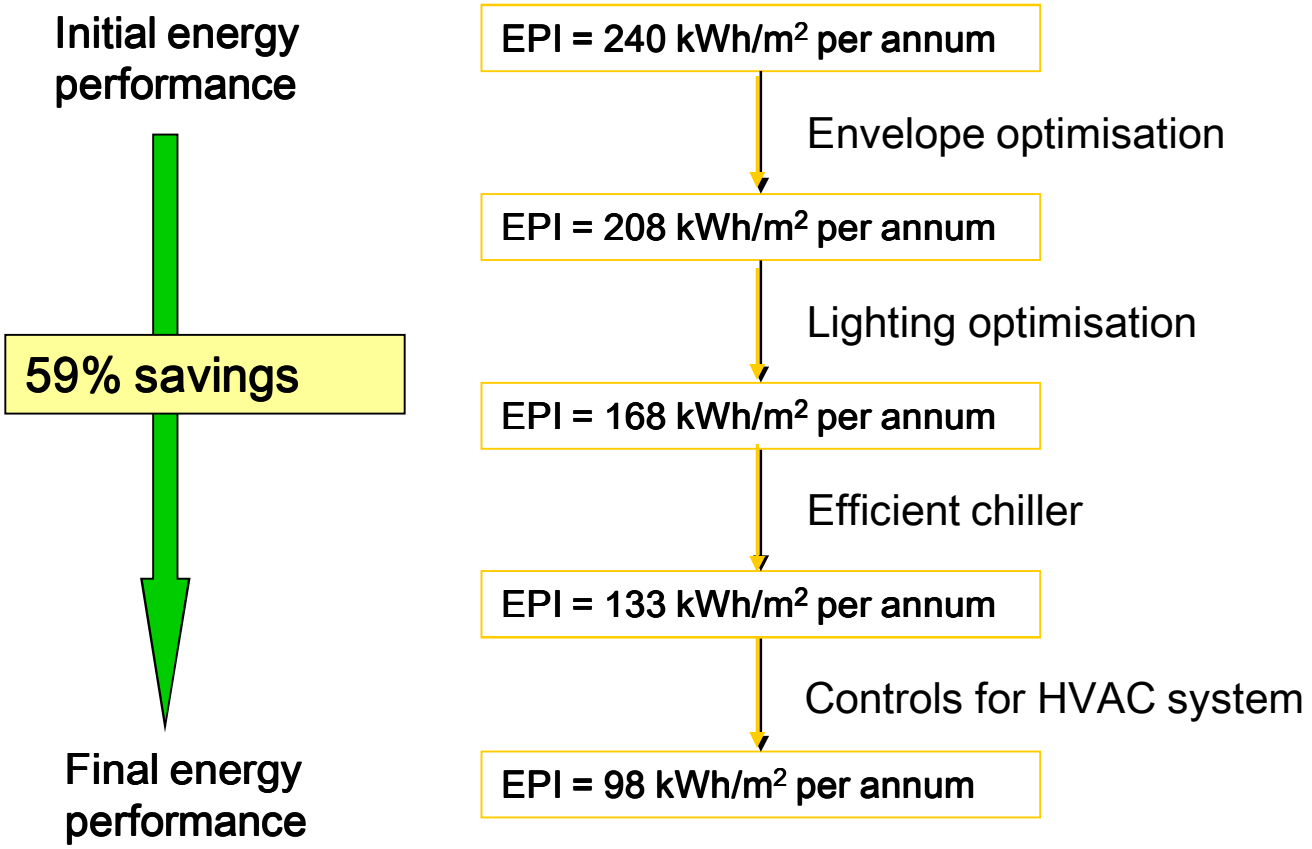
Inefficient lighting system-LPD **1.5** W/FT2	Efficient lighting System-LPD **0.7** W/FT2	Optimized lighting system- LPD **0.3** W/FT2
-Luminaire design not good - Lamp luminous efficacy low - Magnetic Ballast -Lighting design not good -Switches & Wire losses	-Luminaire design good - Higher lamp luminous efficacy - Electronic Ballast -Good Lighting design - Bi-Level Switches & No wire losses	-Efficient Luminaire - LED with higher luminous efficacy -Daylight & Occupancy sensor with daylight integration -Digital Electronic ballast

Optimized System -Save Energy & Cost; Enhance Comfort & Convenience; Increase Productivity; More Lamp Life; Lumen Output controllable-automatic;

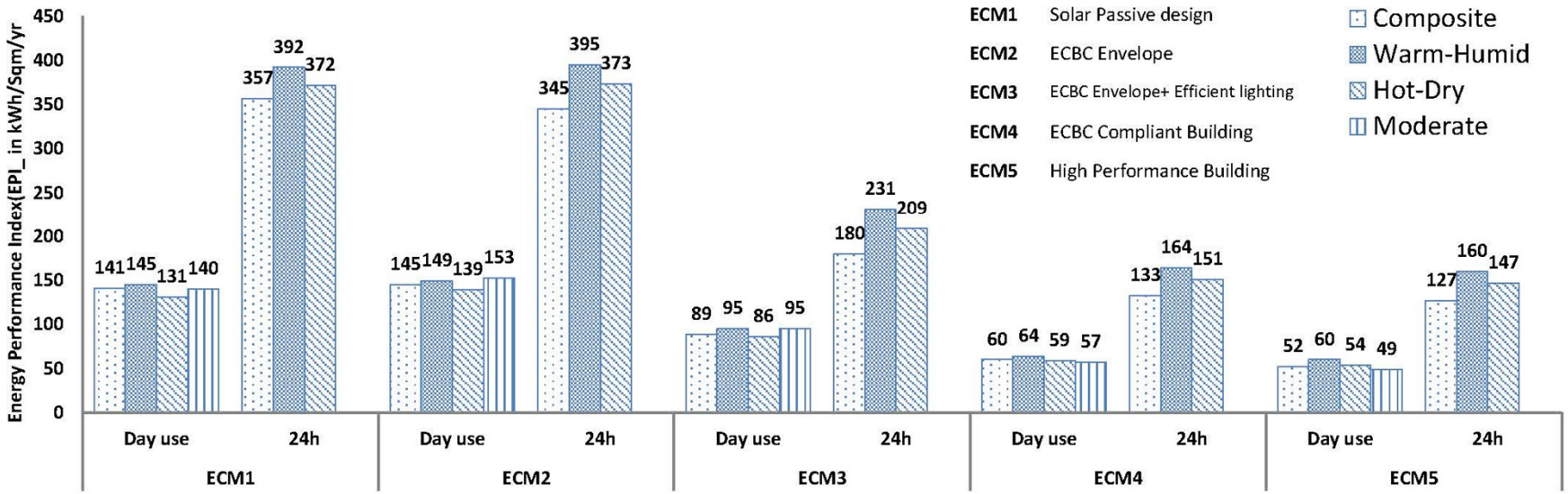
Innovative& Efficient Air conditioning systems

- Achieve thermal comfort with minimal refrigeration
- Set high temperature et points – 27deg C-28degC with high air volume (ach) to achieve the same thermal comfort as 24deg C.
- Low Energy cooling strategies –
  - EAT +2stage Evaporative cooling + Refrigeration
  - Thermal Mass Storage+2 stage evaporative cooling + Refrigeration
  - Radiant cooling
  - Night purge to avoid heat build.

Annual Energy Savings



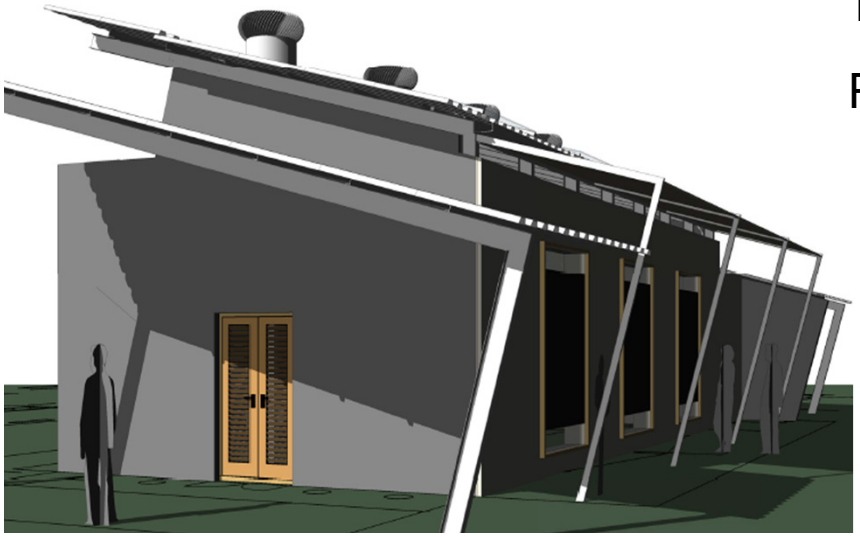
Indicative Energy Performace Indices of typical commercial offices in different climates



Integration of Renewable Energy - RETREAT

Green interventions not limited to high end buildings…..

Solar passive silkworm rearing house for enhanced productivity



Thermal comfort requirement:

Rearing room: 23 to 25 deg C with 70-80% RH

Non uniform heating/cooling leads to loss in 50-70% of yield

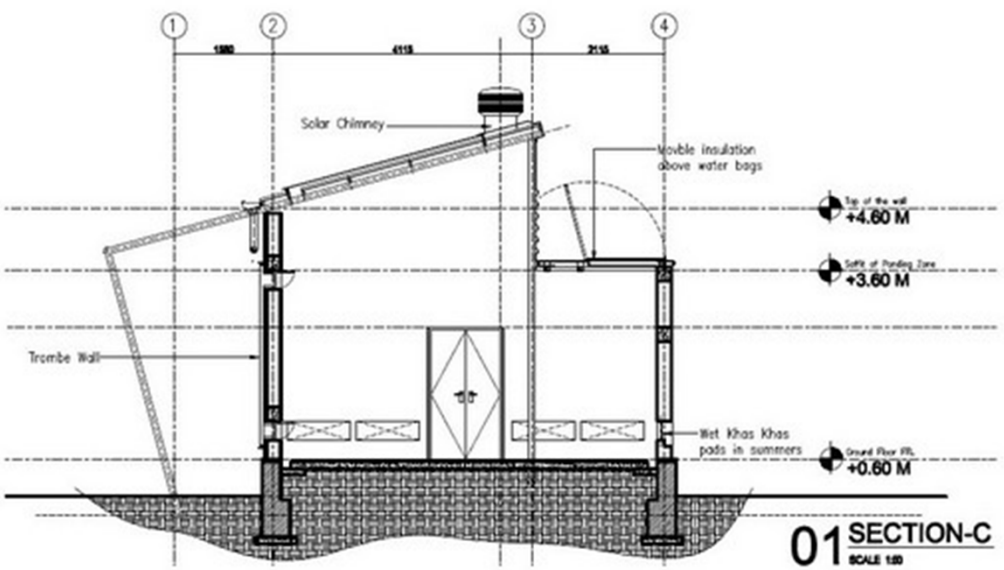
Strategies for summer:

Roof pond with insulation ;Insulated wall and roof; Wall shading

Solar chimney on south wall with adjustable vents (to improve ACH in the rearing room)

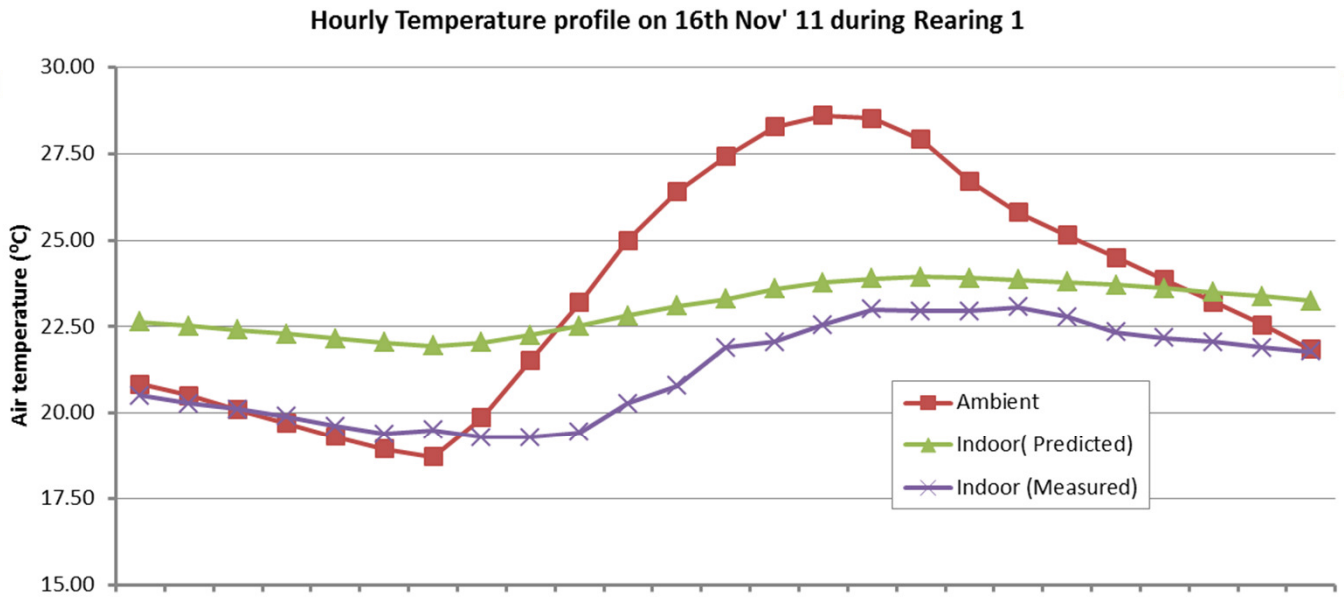
Air Inlet from north wall covered with wet gunny bags for added humidity

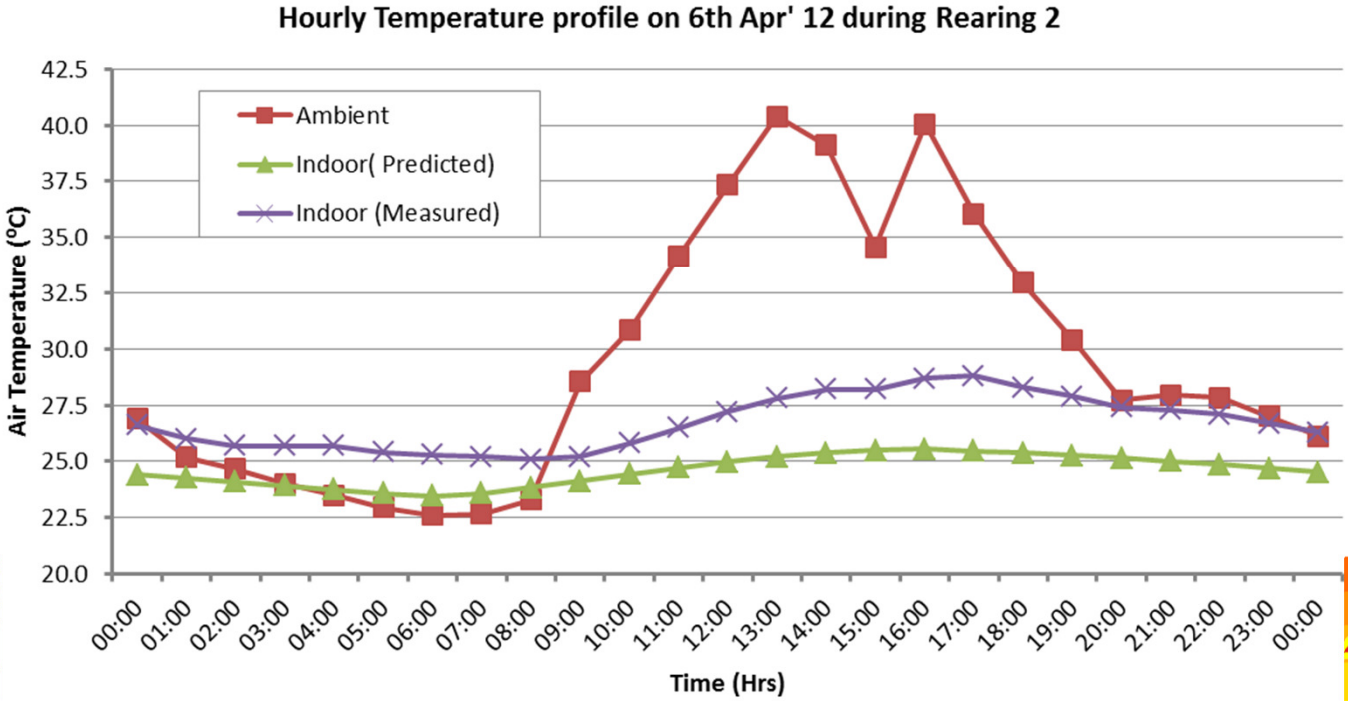
Constructed solar passive silk worm rearing house



Building section for silkworm rearing house

Silkworm rearing being carried out in the constructed solar passive house


Hourly Temperature profile on 16th Nov' 11 during Rearing 1
30.00
27.50
25.00
22.50
20.00
17.50
15.00
Air temperature (ºC)
Ambient
Indoor(Predicted)
Indoor (Measured)


Hourly Temperature profile on 6th Apr' 12 during Rearing 2
42.5
40.0
37.5
35.0
32.5
30.0
27.5
25.0
22.5
20.0
Air Temperature (ºC)
Ambient
Indoor(Predicted)
Indoor (Measured)
00:00
01:00
02:00
03:00
04:00
05:00
06:00
07:00
08:00
09:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
00:00
Time (Hrs)

Thank you

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