Climate Resilience & Green Building

21st April'15

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CONTENT of PRESENTATION

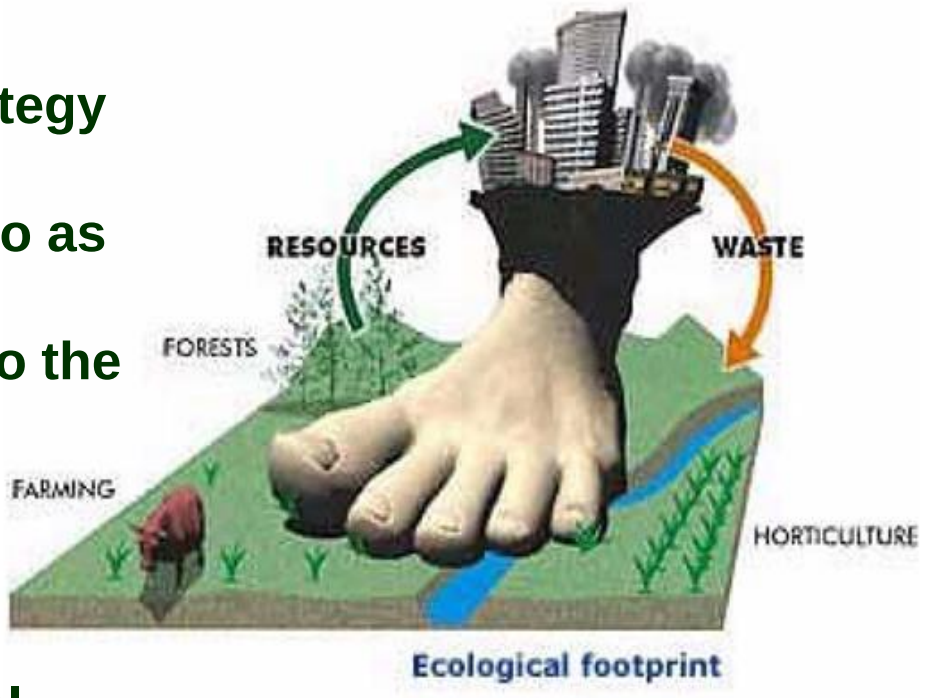
1. **WHY – Green Building ?**
2. **Green Building ~ Climate Resilient Building**
3. **Climate Responsive Building**
    1. Sustainable site planning
    2. Solar passive building design
    3. Energy Efficiency
    4. Water & Waste Management
    5. Low energy building material & Const. Tech.
    6. Renewable energy integration
    7. Health, well being & Environmental Quality
4. **Checklist of Climate Resilient Building.**
5. **Gap**
6. **Solution**

Why Green Building ?

- **“Unknowingly, the architecture and building community is responsible for almost half of all greenhouse gas emissions annually."**

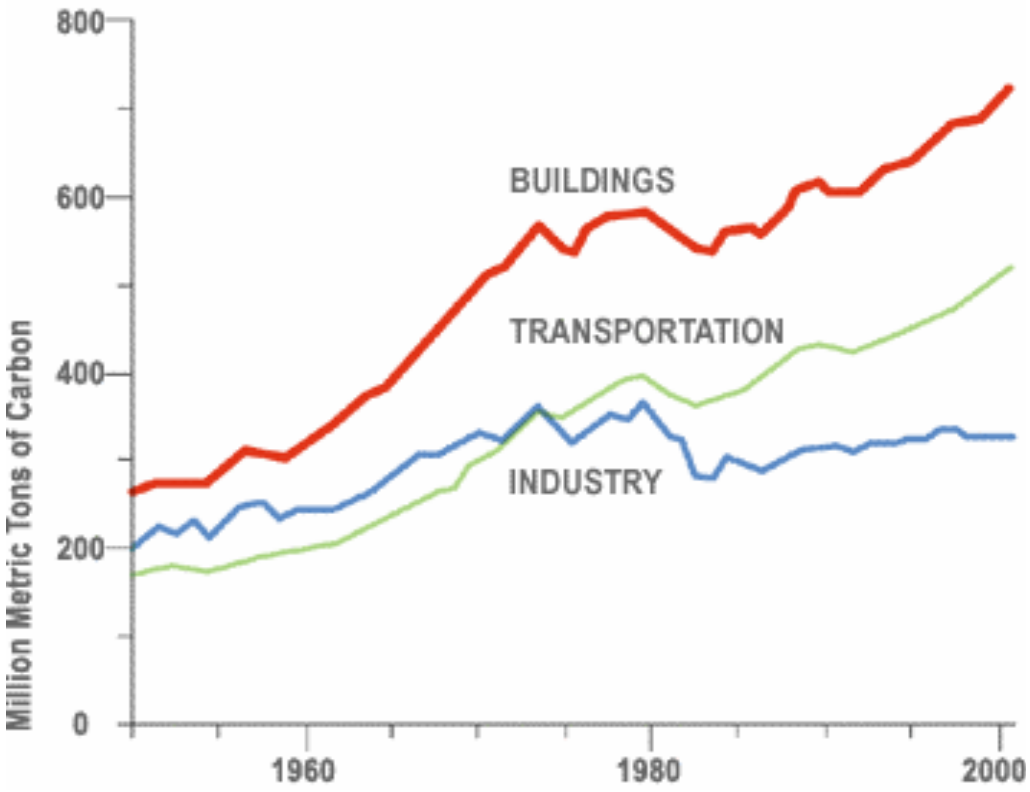
- **The objective is to evolve a strategy to reduce energy, water & other natural resources in buildings so as to reduce energy costs and the emission of greenhouse gas into the earth’s atmosphere.**

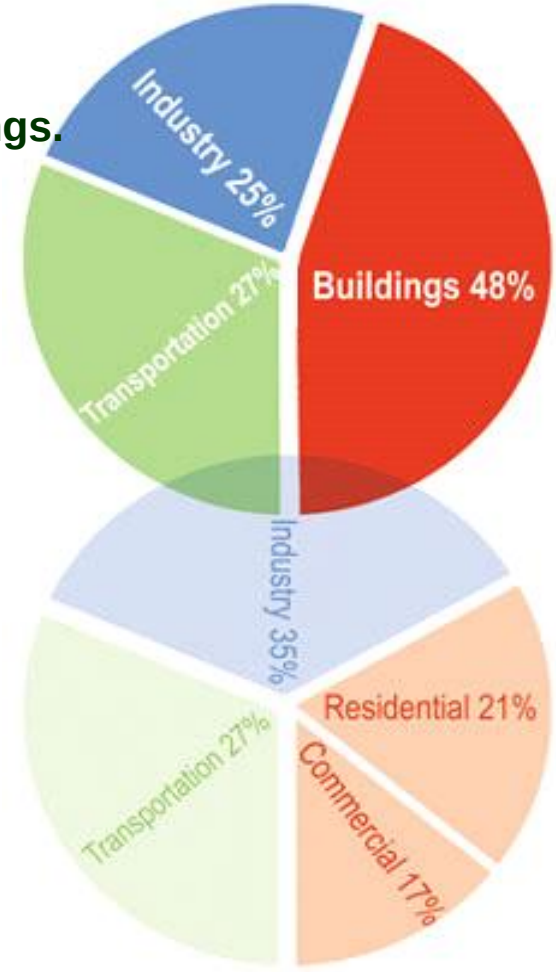
- **“A green building is designed, constructed and operated to minimize the total environmental impacts while enhancing user comfort and productivity.”**



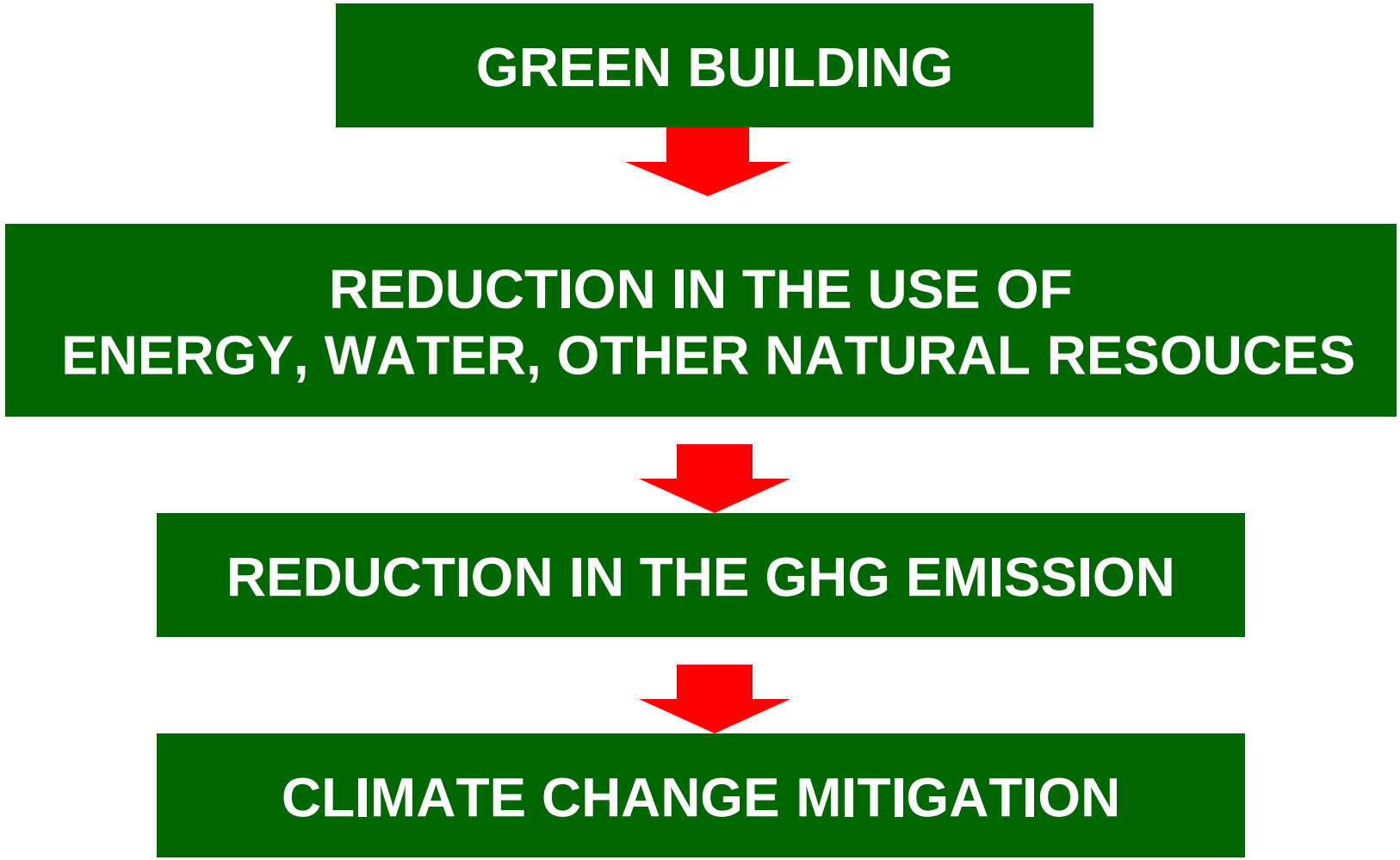
How “Sustainable” building sector is ?

- 40% of global energy consumption is building related.
- 50% of global greenhouse gas emissions are due to buildings.
- 80% of global GHG emissions are attributed to cities
- 50% of material resources taken from nature are building related.
- Over 50% of national waste production comes from the building sector.





***Source:** U.S. Energy Information Administration statistics (Graphic Published first in Metropolis Magazine, October 2003 Issue)*


GREEN BUILDING
REDUCTION IN THE USE OF
ENERGY, WATER, OTHER NATURAL RESOUCES
REDUCTION IN THE GHG EMISSION
CLIMATE CHANGE MITIGATION

Green Building ~ Climate Resilient Building

Climate Responsive Building

Appropriate Adaption Strategies for projected climate data

Climate Resilient Building

SUSTAINABLE BUILDING

GREEN BUILDING

MITIGATION MEASURES

CLIMATE RESILIENT

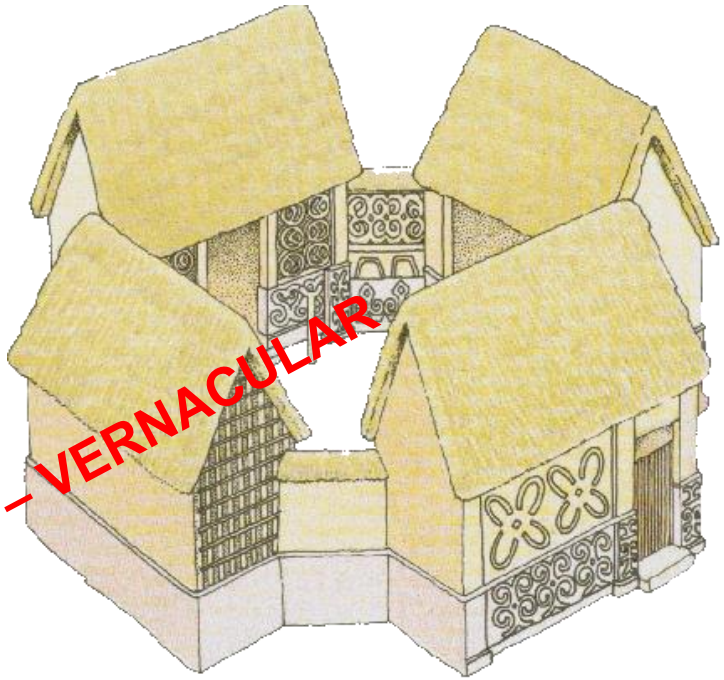
ENERGY EFFICIENT BUILDING

ADAPTIVE MEASURES

CLIMATE VULNERABILITY

IS IT REALLY REQUIRED ?

ODISHAN TRADITIONAL ARCHITECTURE…

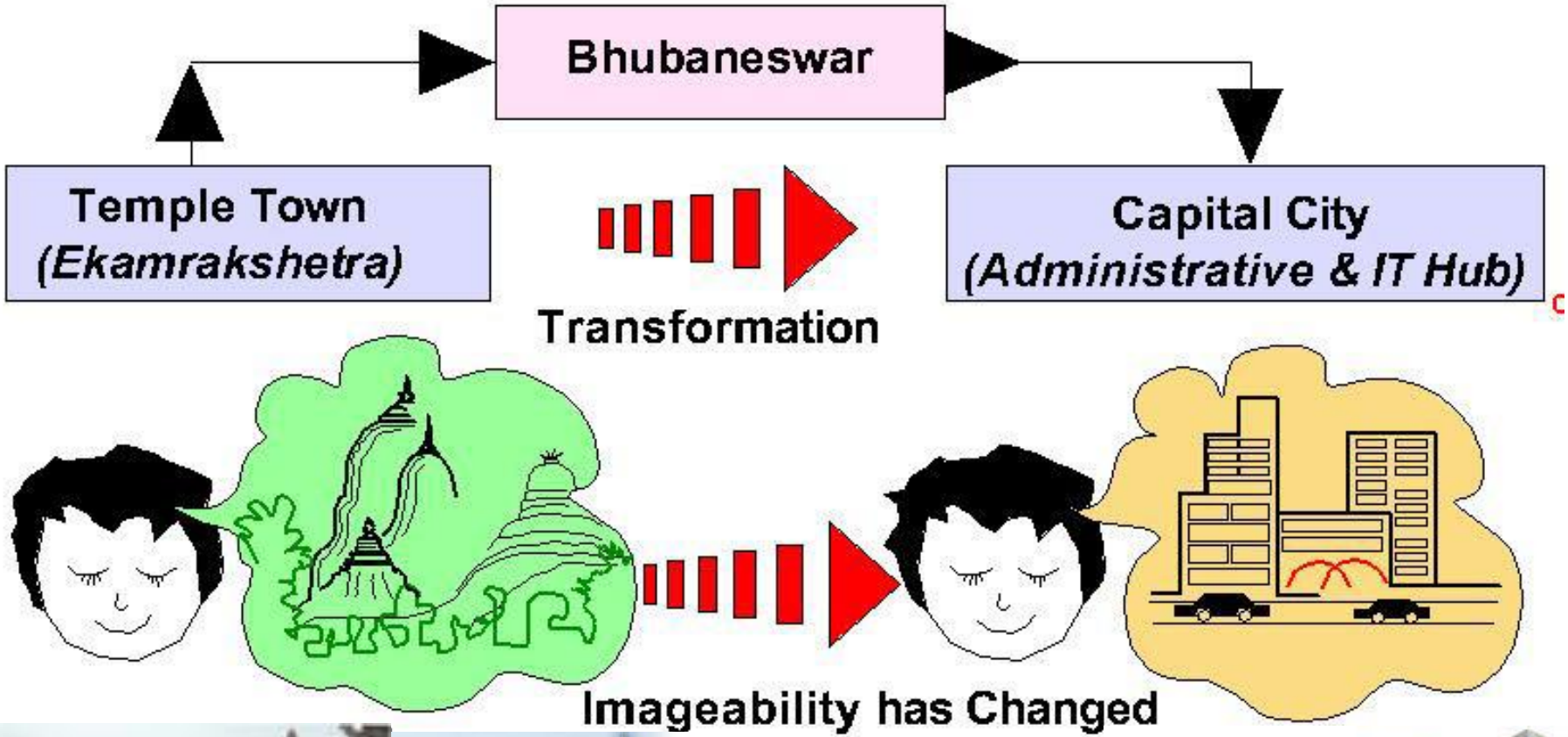


LOW COST- LOW ENERGY – VERNACULAR

MORDERN FACE OF ARCHITECTURE IN ODISHA

MORDERN, SOFISTICATED MORE COMFORT

COMPLETE TRANSFORMATION OF URBAN FORM



IS IT SUSTAINABLE ???

Power, water trouble for capital as mercury soars

TNN Apr 7, 2013, 06.54AM IST

Tags: Summer | CESU

BHUBANESWAR: Power cuts and water crisis have dealt a double blow to the capital already searing under the rising temperature.

Different parts of the city are experiencing power cuts up to six or seven hours a day because of some maintenance work. The demand for water tankers is shooting up at many localities.

Source: http://articles.timesofindia.indiatimes.com/2013-04-07/bhubaneswar/38345492_1_power-cuts-water-shortage-power-failure

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Odisha

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Bhubaneswar to face power cut this summer

Last Updated: Friday, April 12, 2013, 22:01 A- A A+

0 Share 3 Tweet 4 +1 0 Like 0

Tags: Odisha , Bhubaneswar

Bhubaneswar: Central Electricity Supply Utility of Odisha (CESU) providing electricity services to about 16 lakh consumers in coastal districts including in the state capital, today announced to go for power cut in this summer.

"CESU has decided to restrict power supply to people in loss making feeders. Hence, there will be

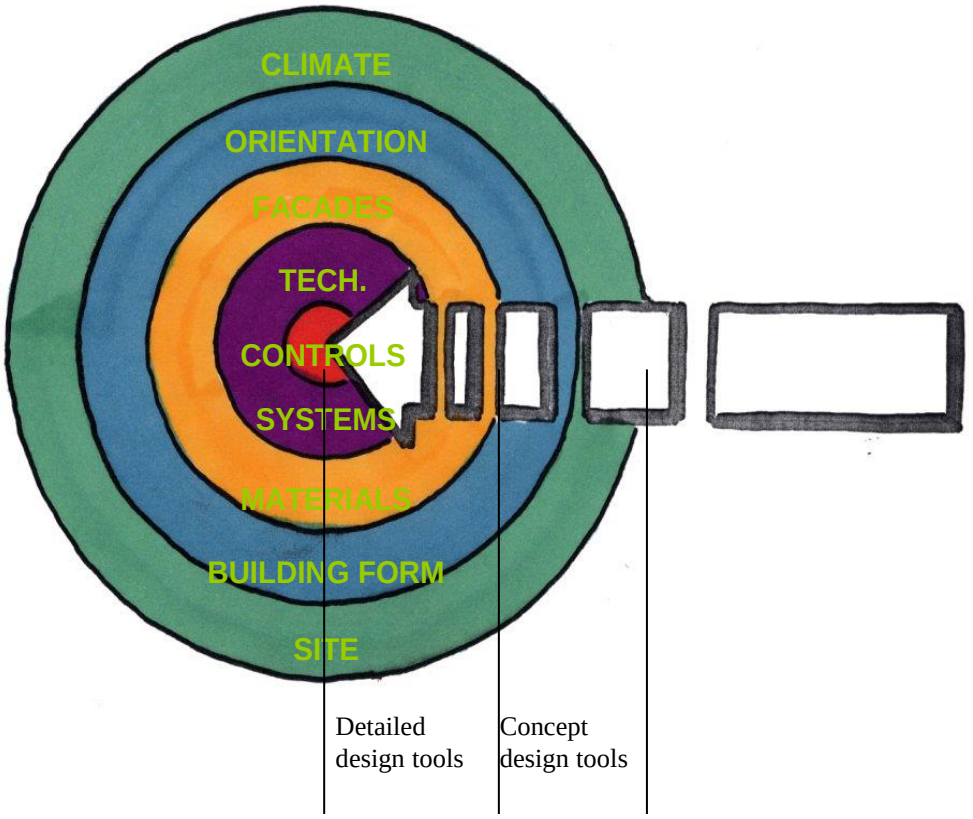
Source: http://zeenews.india.com/news/odisha/bhubaneswar-to-face-power-cut-this-summer_841706.html

SOLUTION ?

CLIMATE RESPONSIVE BUILDING

Major components of climate responsive building…

1. Sustainable Site planning
2. Building design Optimization
3. Energy Performance Optimization
4. Renewable energy utilization
5. Water and waste management
6. Sustainable Building Material & Construction Tech.
7. Health, Wellbeing & Environmental quality



Sustainable Site Planning…

“Maximize the conservation and utilization of resources (land, water, natural habitat, avifauna, and energy) and enhance efficiency of the systems and operations.”

Conventional Site Planning

http://www.lpisd.org/Campuses/bse/new/BayshoreElementarySchool20090520.jpg

1. Sustainable Site Planning

a. **Site Selection**

b. **Preserve and protect the landscape during construction/ compensatory depository forestation**

c. **Soil conservation (till post-construction)**

d. **Design to include existing site features**

e. **Reduce hard paving on-site and/or provide shaded hard-paved surfaces**

f. **Plan utilities efficiently and optimize on-site circulation efficiency**

Sustainable Site Planning

Building Design Optimization…

“To apply climate responsive building design measures, including daylighting and efficient artificial lighting design, in order to educe conventional energy demand.”

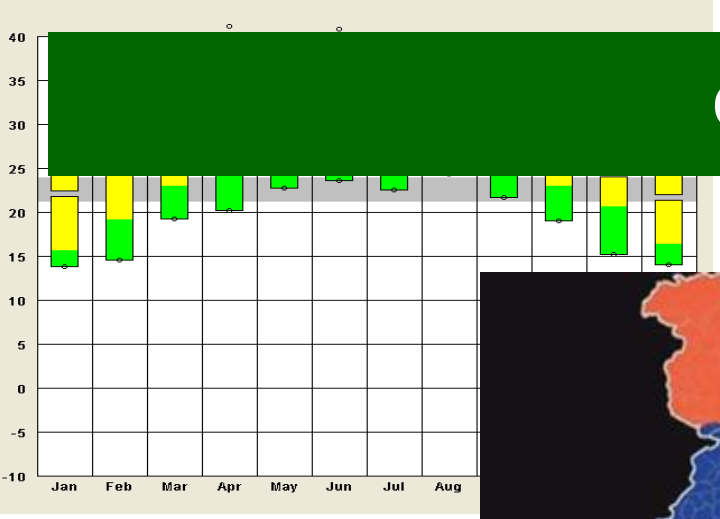
Conventional Building Design

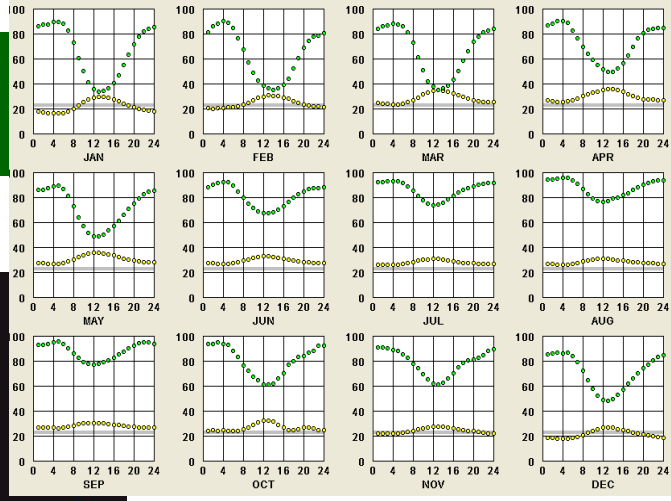
2. Sustainable Building design

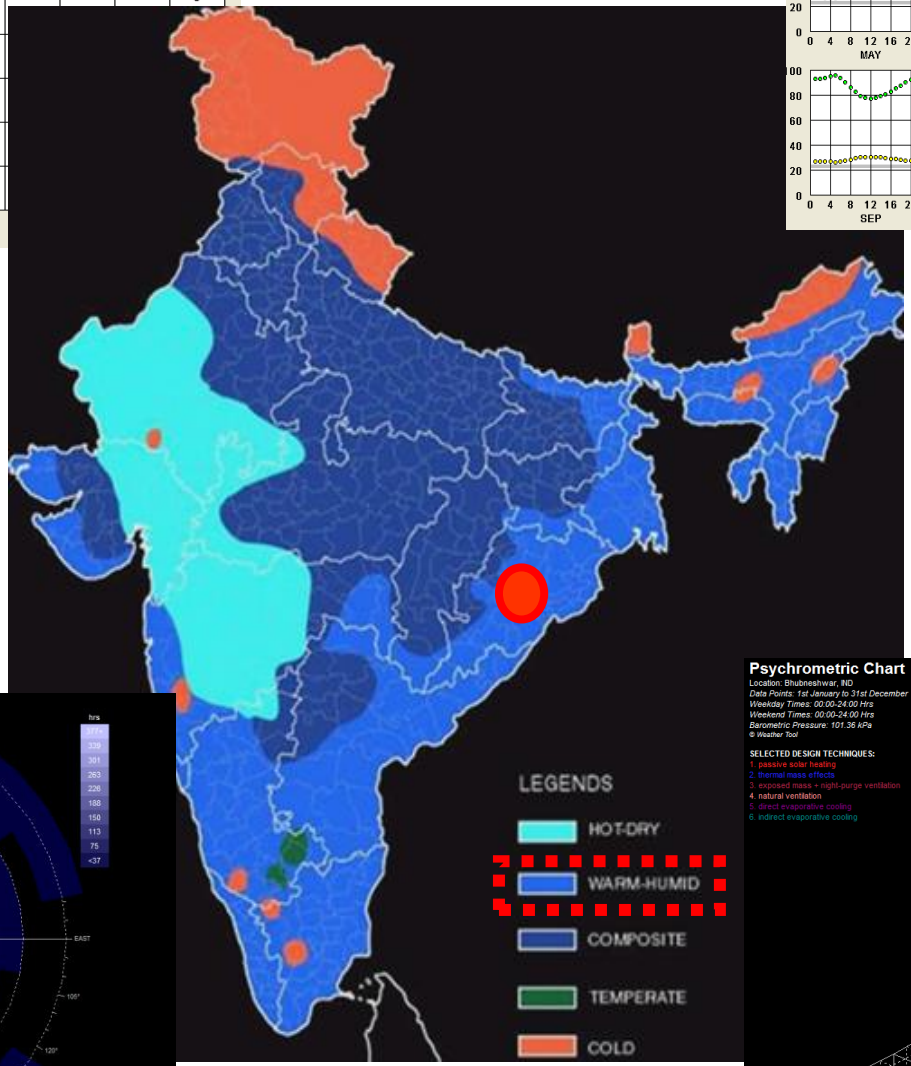
Steps followed for sustainable building design are –

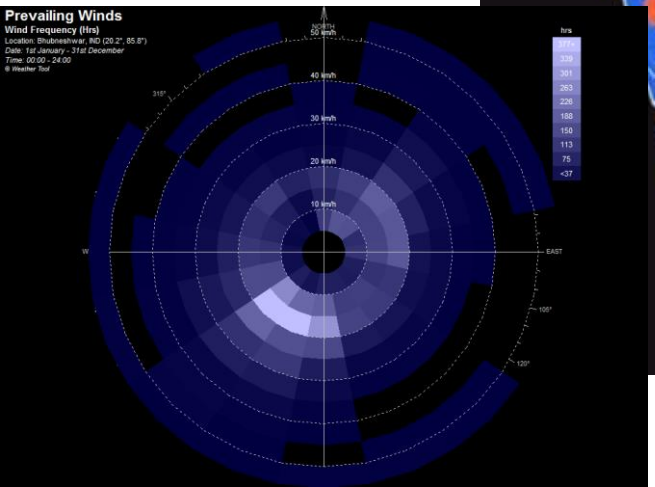
1. **Climatic Analysis**
2. **Solar Exposure Analysis**
3. **Shading Design**
4. **Day light Analysis**
5. **Window Optimization**
6. **Artificial Light Analysis**
7. **Daylight Integration**

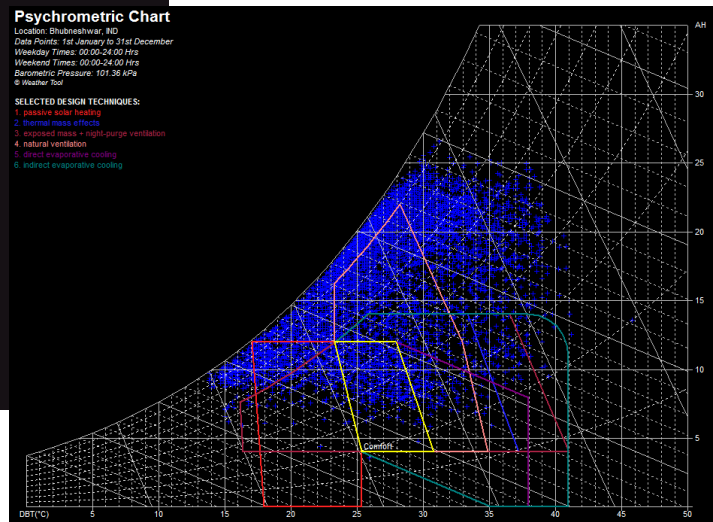
Climate Analysis











Appropriate Passive Strategies

Psychrometric Chart

Location: Bhubneshwar, IND

Data Points: 1st January to 31st December

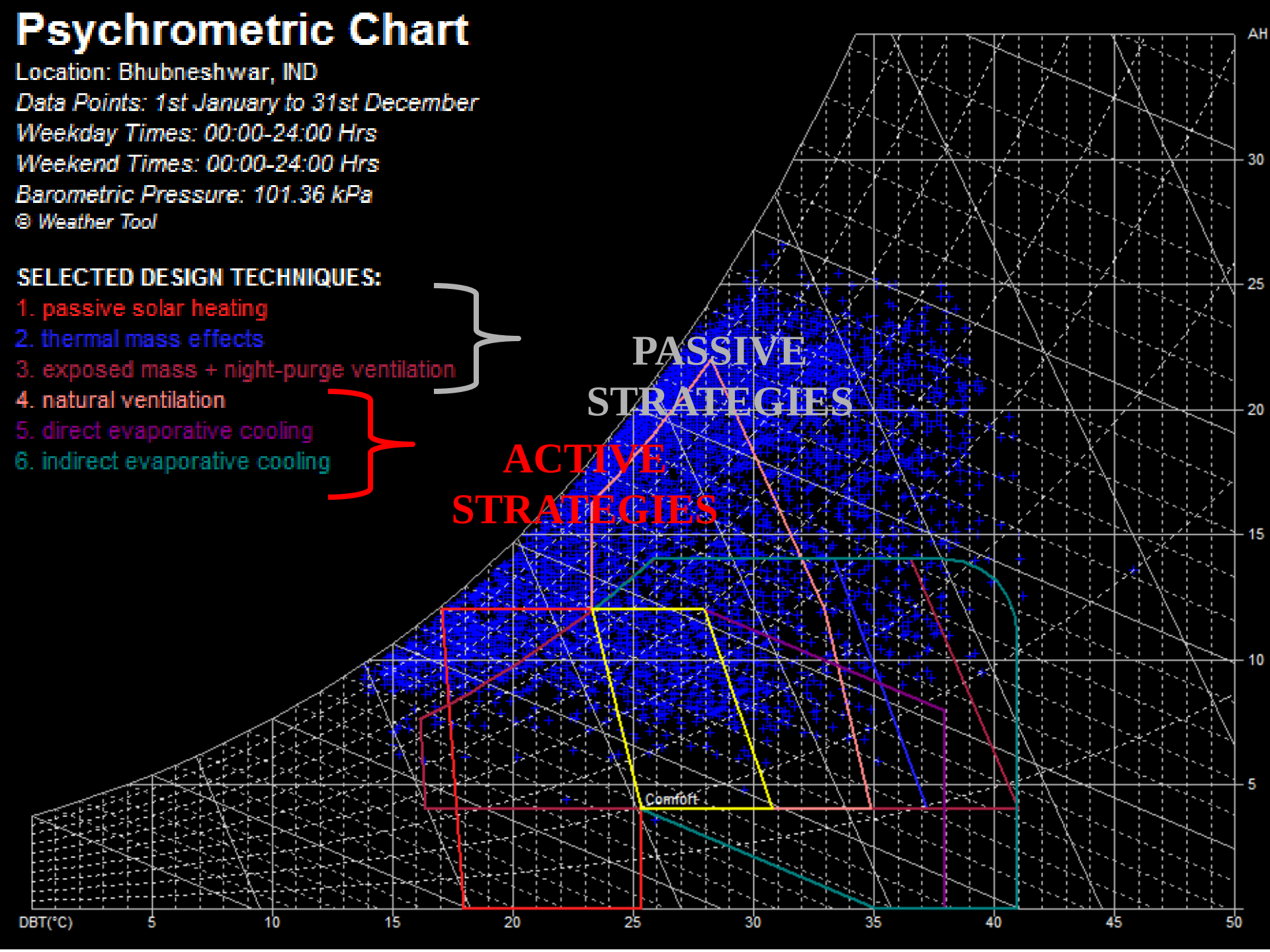
Weekday Times: 00:00-24:00 Hrs

Weekend Times: 00:00-24:00 Hrs

Barometric Pressure: 101.36 kPa

SELECTED DESIGN TECHNIQUES:

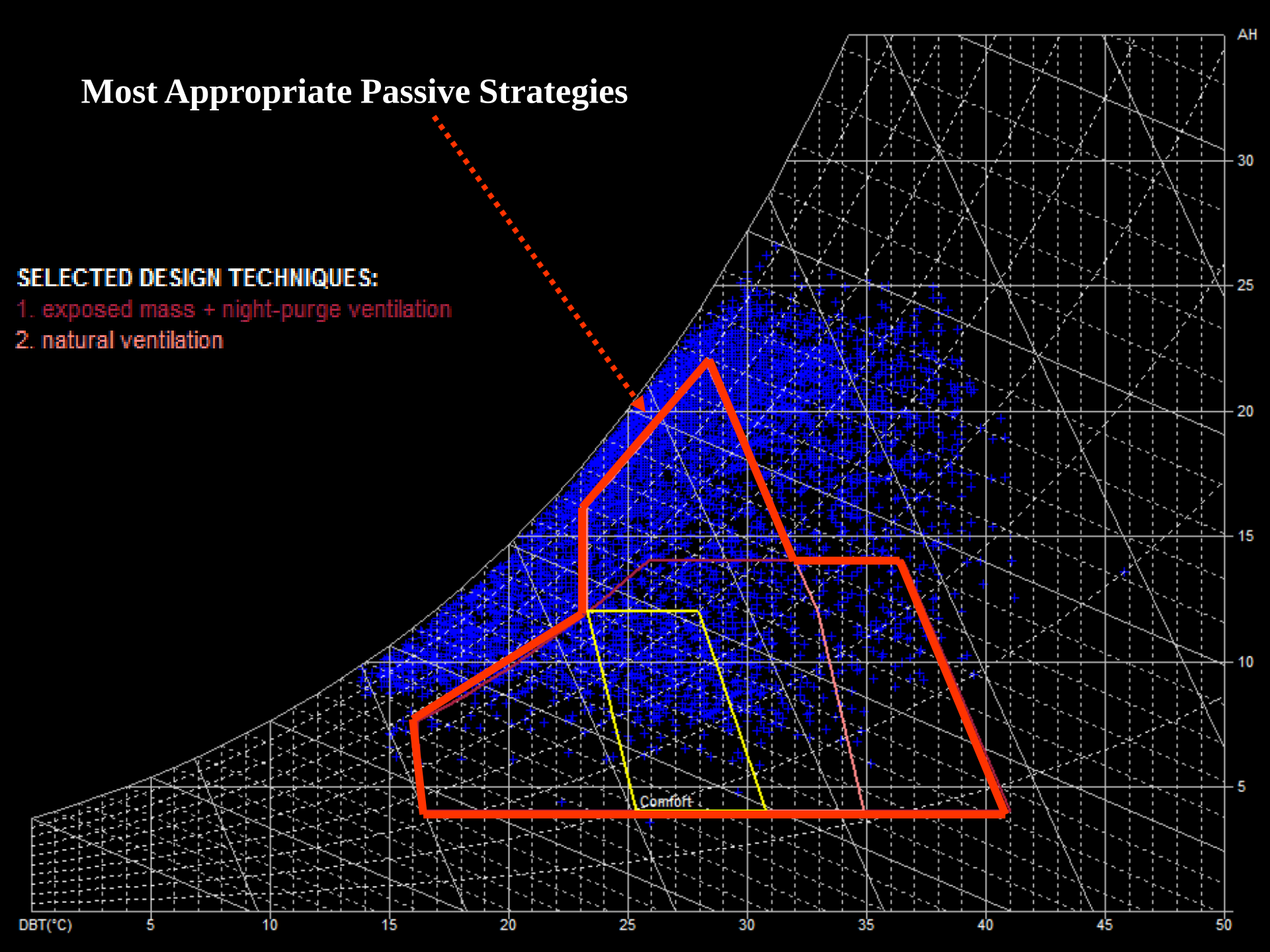
1. passive solar heating
2. thermal mass effects
3. exposed mass + night-purge ventilation
4. natural ventilation
5. direct evaporative cooling
6. indirect evaporative cooling



Most Appropriate Passive Strategies

SELECTED DESIGN TECHNIQUES:

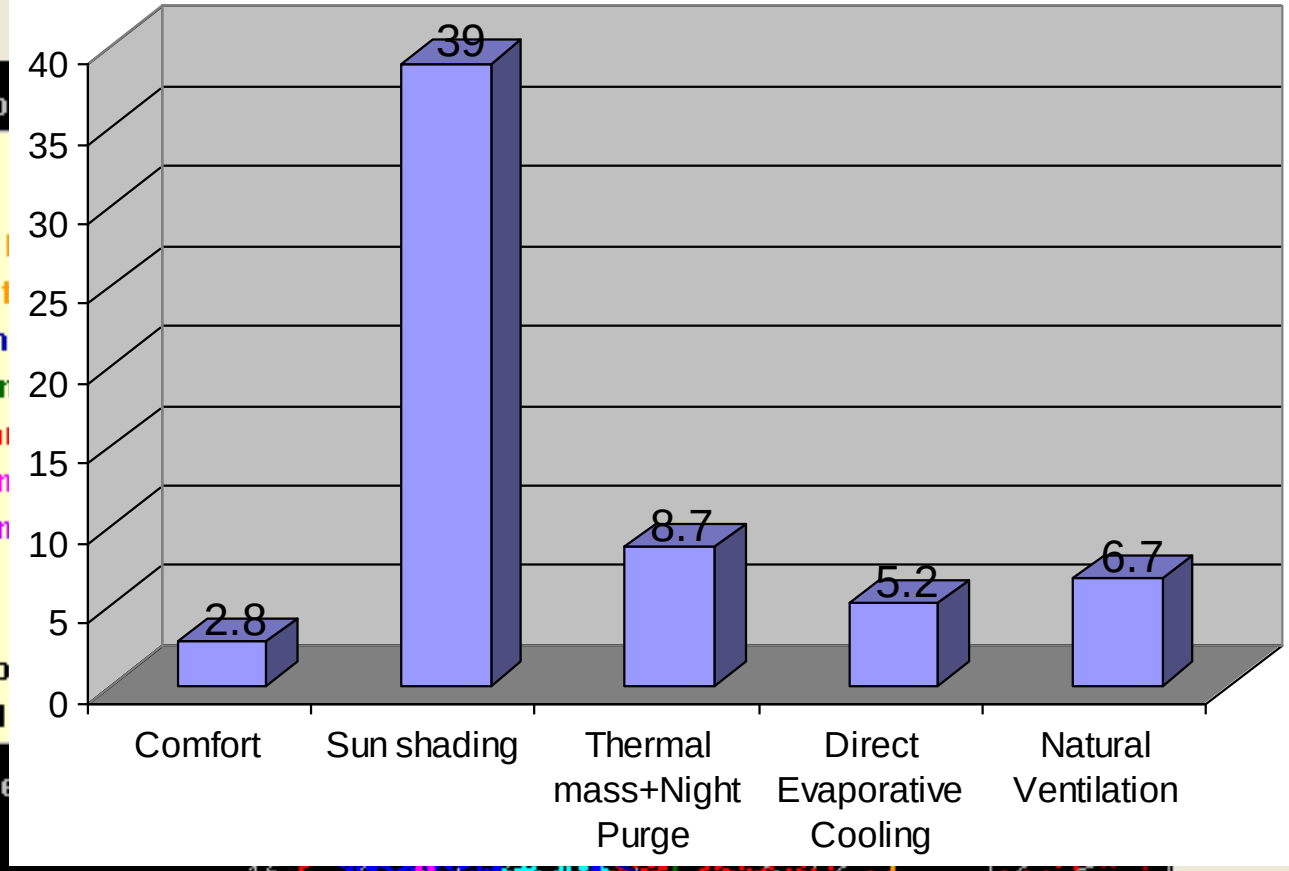
1. exposed mass + night-purge ventilation
2. natural ventilation

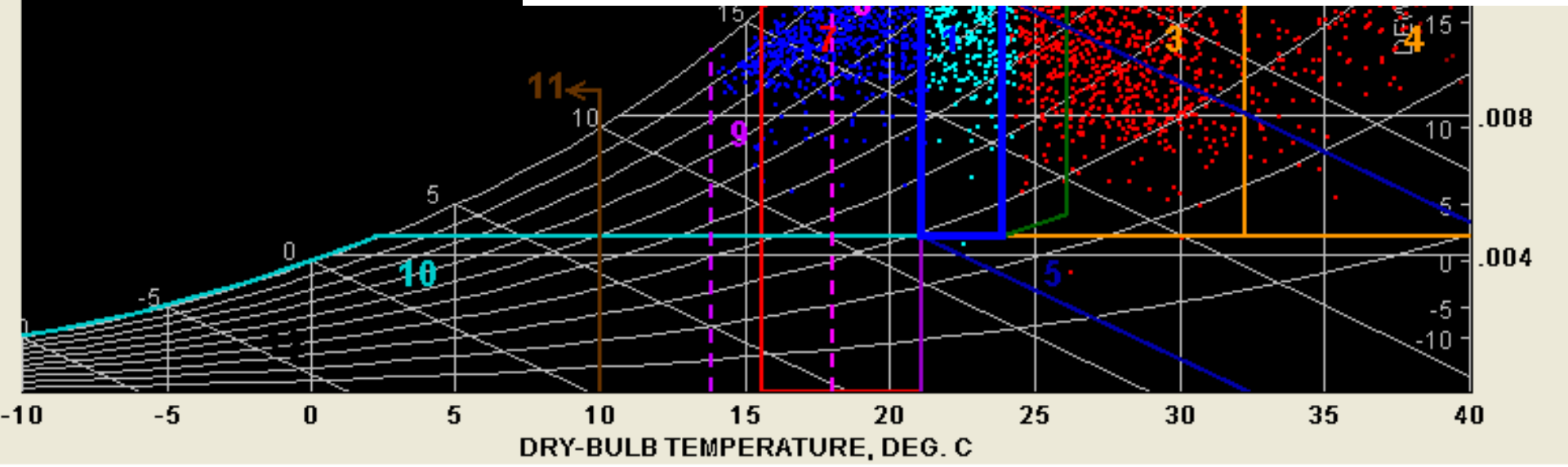


DESIGN STRATEGIES: JANUARY thro

2.8%	1	Comfort (246 hrs)
39.0%	2	Sun Shading (3415 hrs)
8.4%	3	High Thermal Mass (737
0.3%	4	High Thermal Mass/Night
5.2%	5	Direct Evaporative Coolin
6.7%	6	Natural Ventilation Coolir
8.4%	7	Internal Heat Gain (738 h
0.8%	8	Passive Solar Direct Gain
7.5%	9	Passive Solar Direct Gain
0.0%	10	Humidification (0 hrs)
0.0%	11	Wind Protection (0 hrs)
73.0%	12	Conventional Air Conditio
0.7%	13	Conventional Heating (61

100.0% Composite of Selected Strate

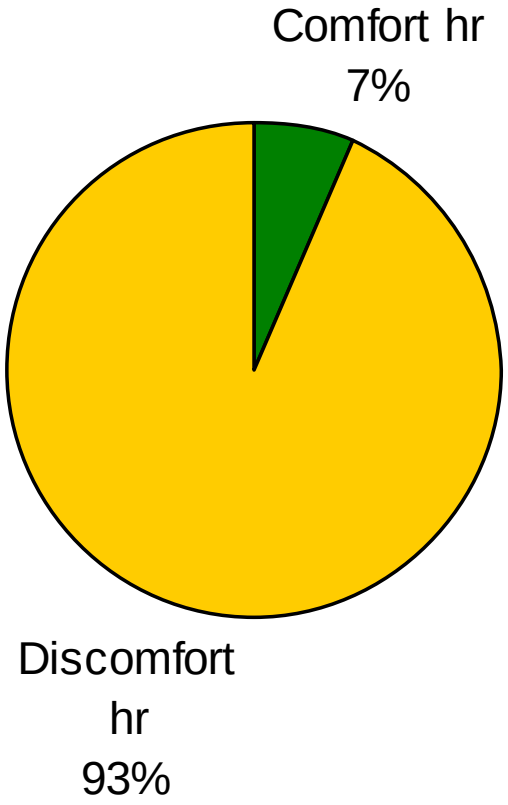




The most effective Passive Strategies for Bhubaneswar

The objectives to attain thermal comfort;

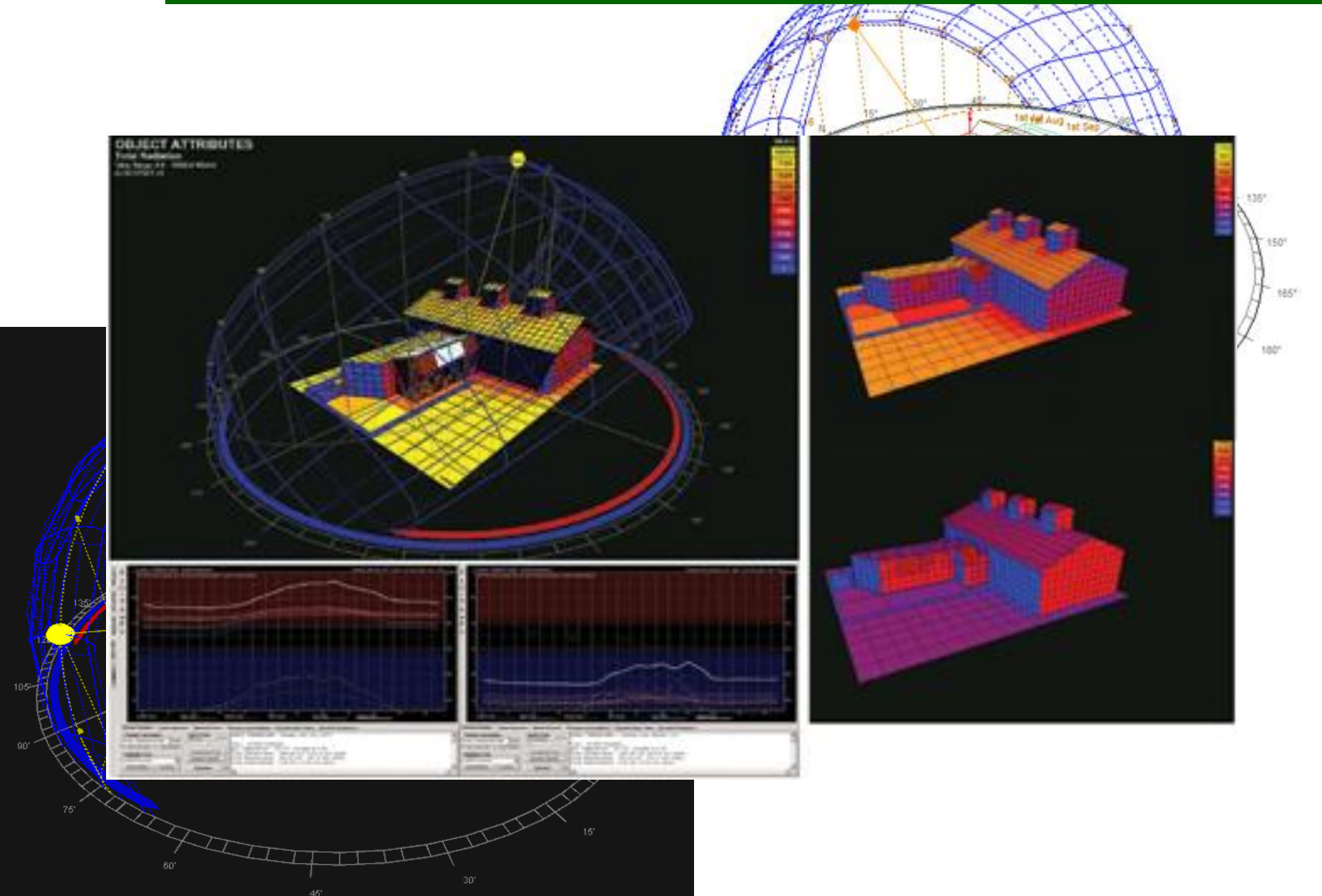
1. **To prevent heat gain**
2. **To maximize heat loss**
3. **To remove any excess heat by cooling**



Cooling Strategies

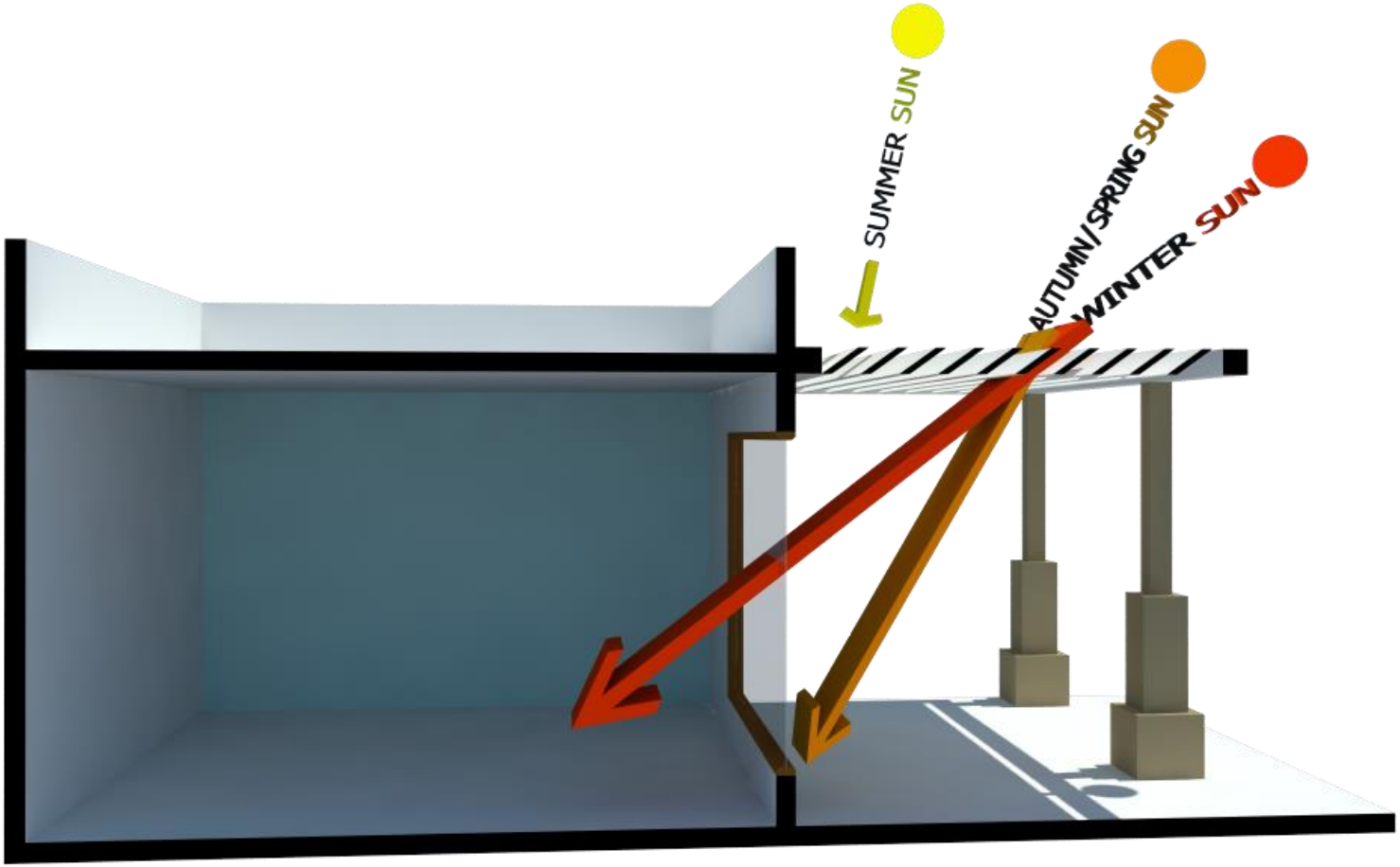
Maximum Thermal Comfort = **Sun shading** + **Exposed mass + Night purge ventilation** + **Natural Ventilation**

Solar Exposure Analysis

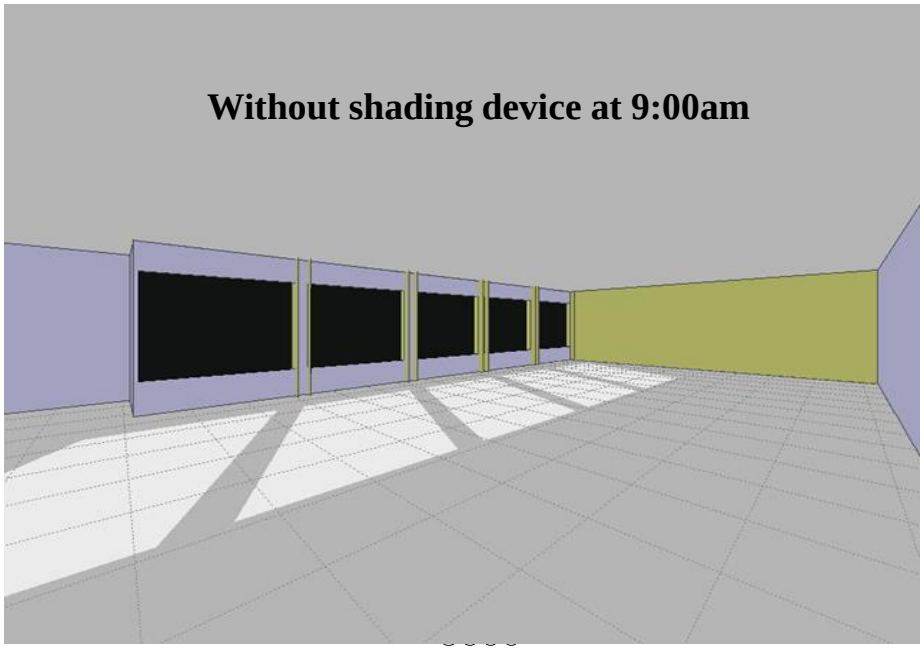


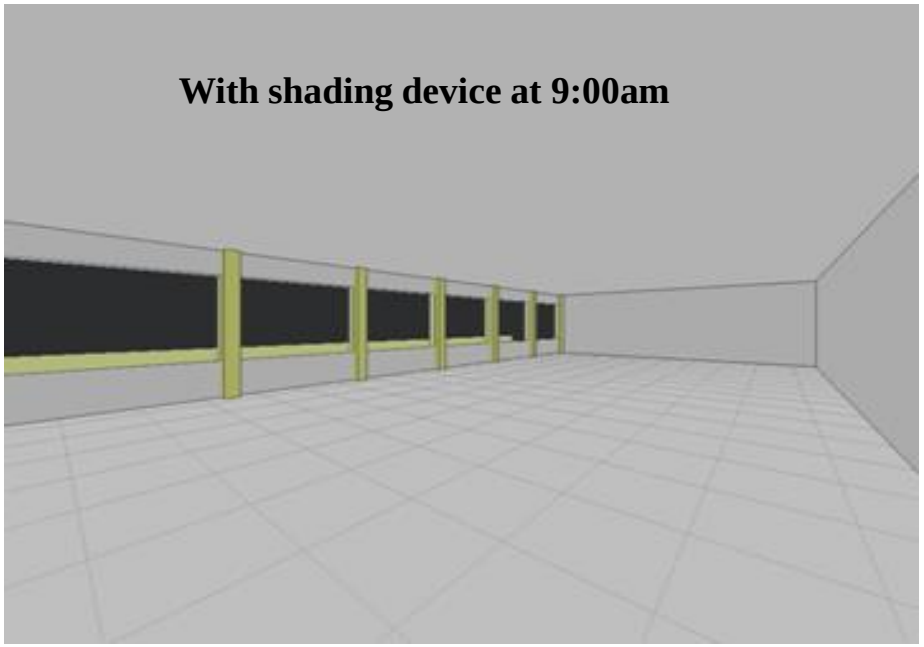
Shade building surface

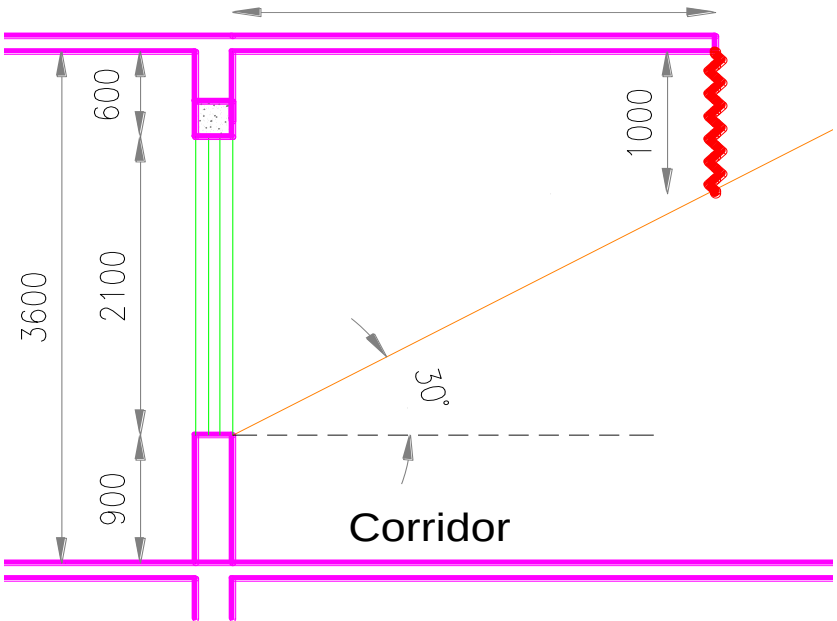
- **Shade the vertical as well as horizontal building surfaces, getting maximum solar exposure, such as – wall, roof, courtyard etc., with the use of external shading devices;**

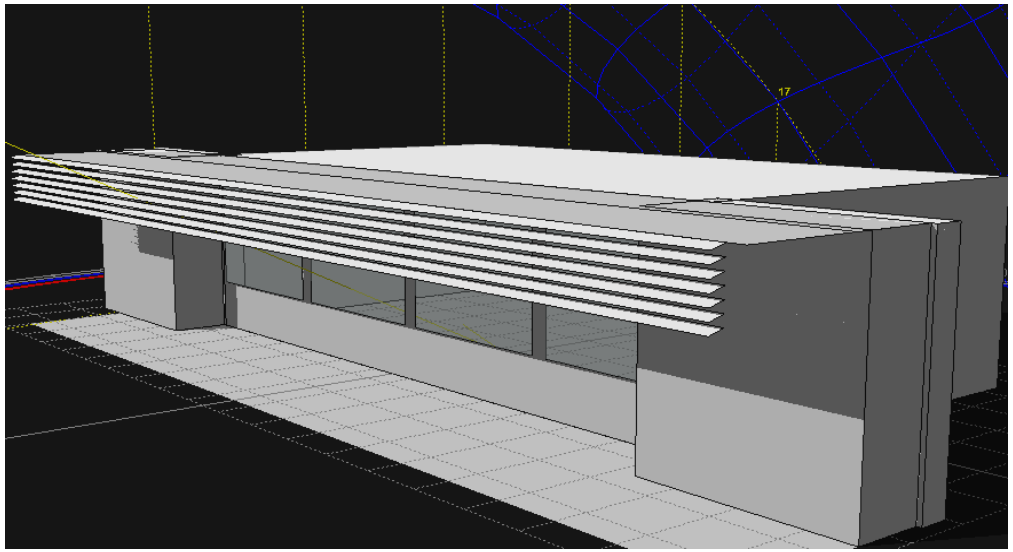


Shading Analysis

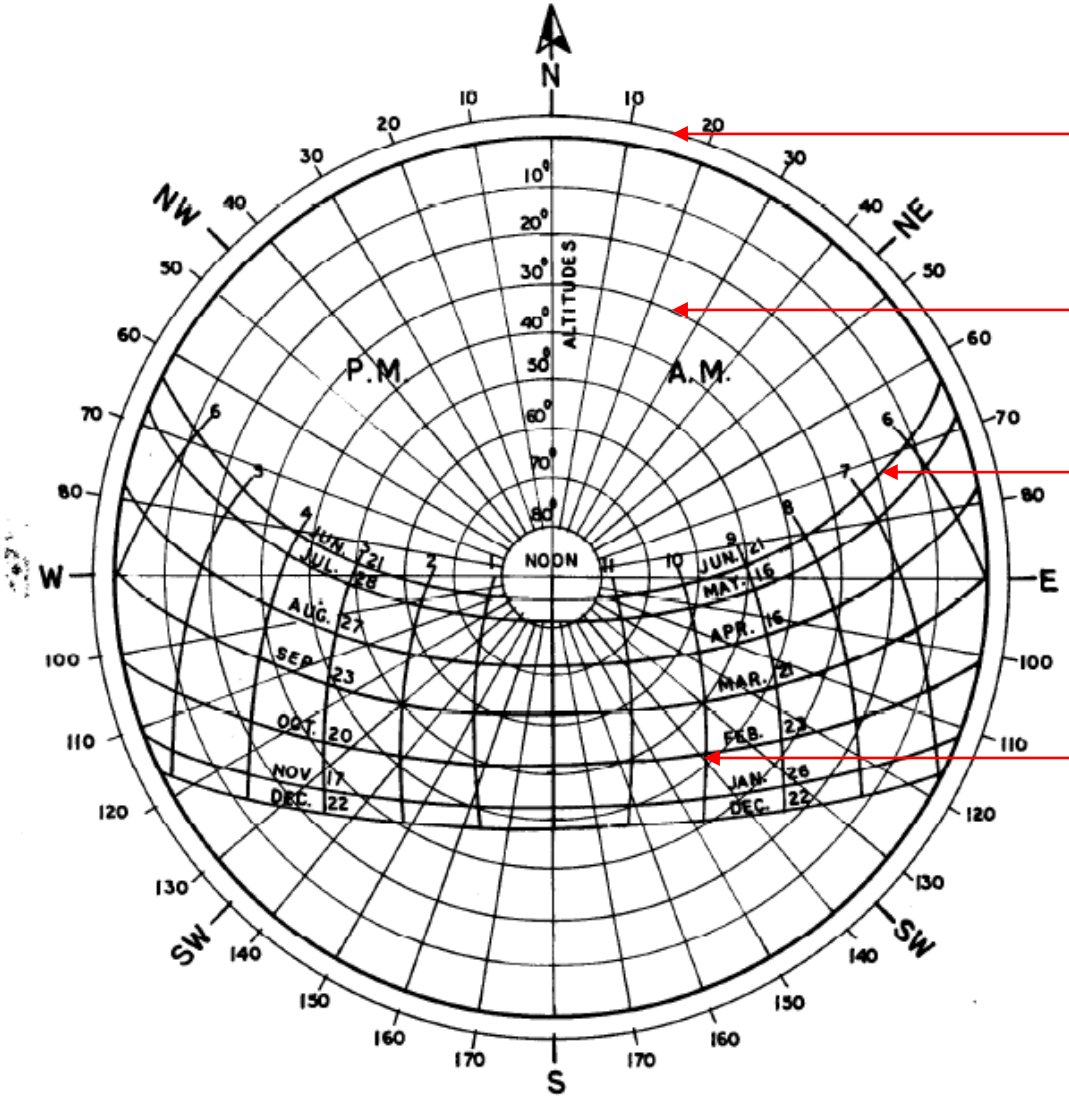








Sun-Path Diagram



Azimuth Line

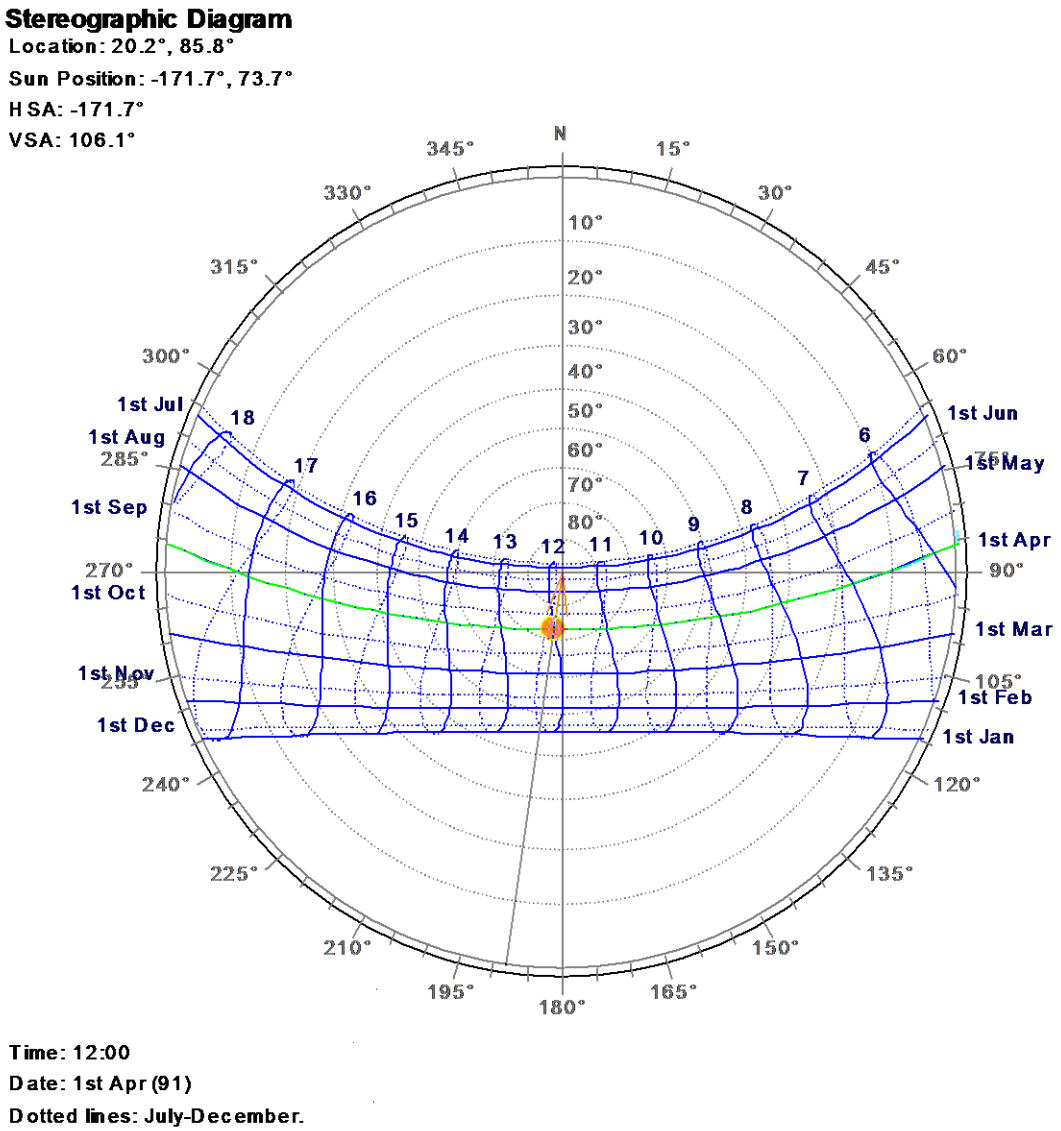
Altitude Lines

Month Lines

Hour Lines

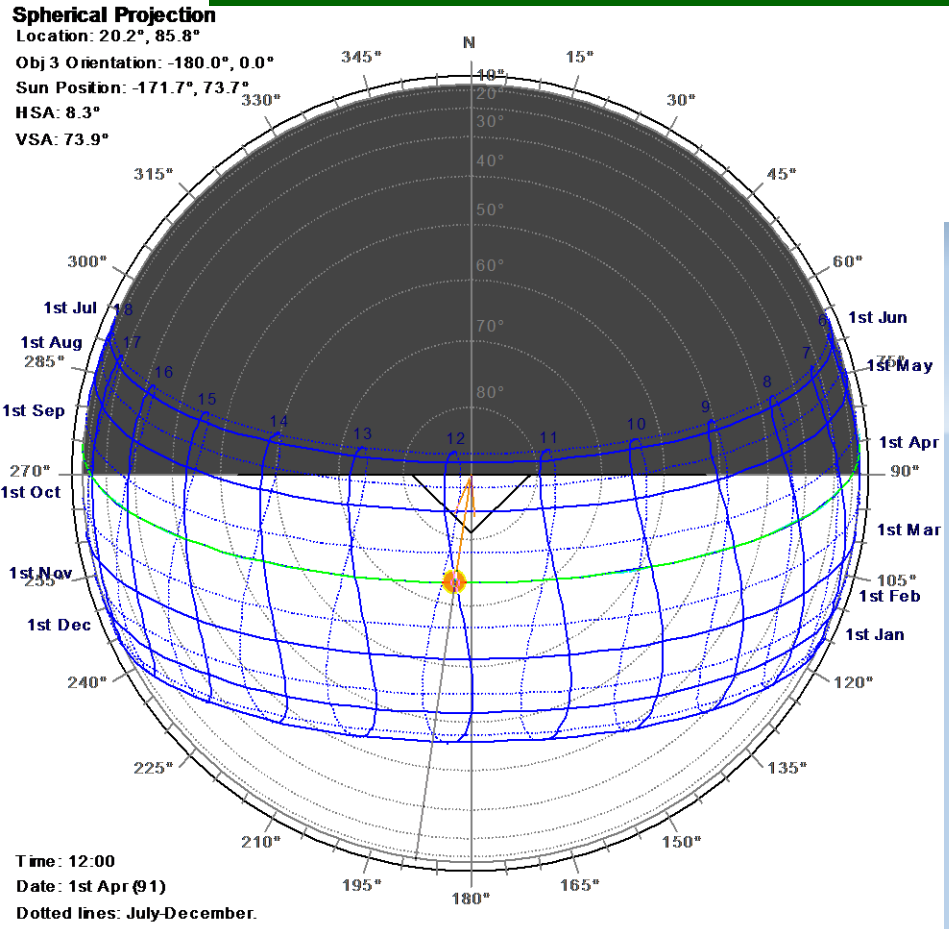
FIG. 4 LATITUDE 29° NORTH

Sun path analysis by using ECOTECT software



Sun-Path Diagram _ Bhubaneswar

Sun Path Analysis _ Southern Facade



Autodesk Ecotect - Sun-Path Diagram

File Graph Shading Display Table Help

Tabulated Daily Solar Data

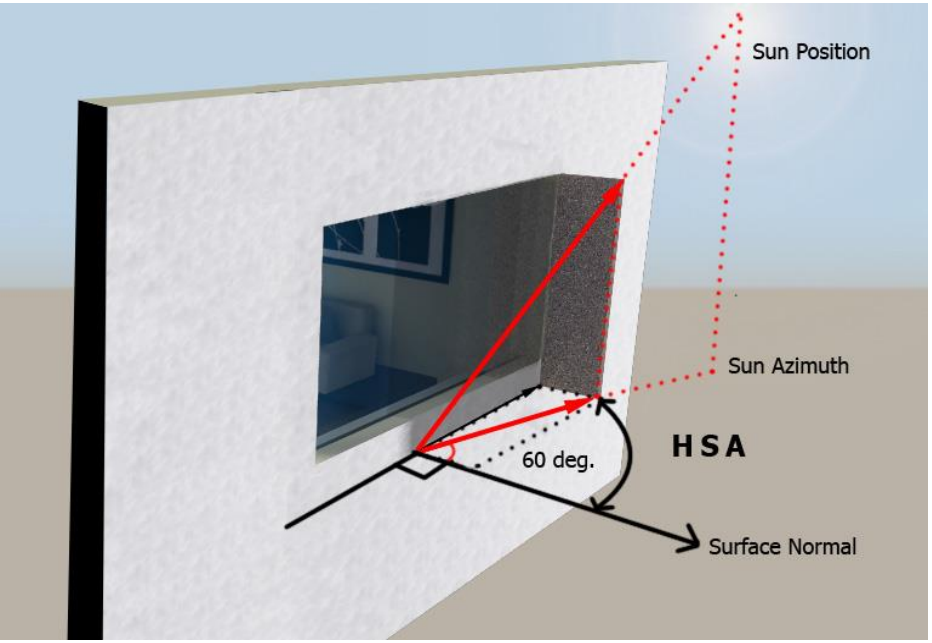
Latitude: 20.2° Date: 1st April Local Correction: 9.3 mins
Longitude: 85.8° Julian Date: 91 Equation of Time: -3.9 mins
TimeZone: +5.5hrs Sunrise: 05:44 Declination: 4.1°
OBJECT No.: 3 Sunset: 17:56 Orientation: -180.0°

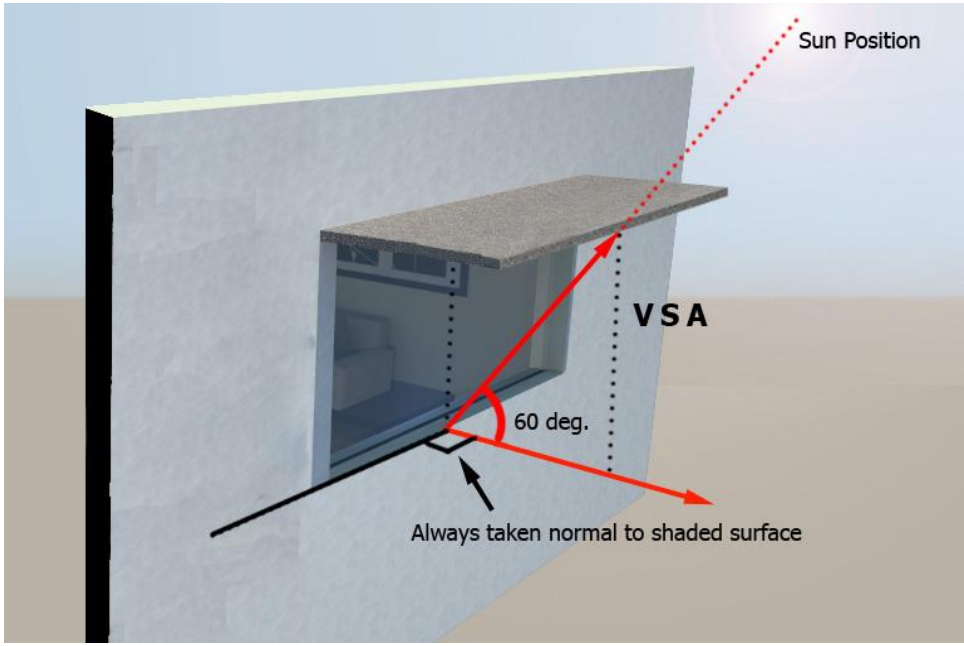
Local	(Solar)	Azimuth	Altitude	HSA	VSA	Shading
06:00	(06:09)	87.0°	3.6°	-93.0°	130.1°	--
06:30	(06:39)	89.5°	10.6°	-90.5°	92.5°	--
07:00	(07:09)	92.2°	17.7°	-87.8°	83.3°	--
07:30	(07:39)	94.9°	24.7°	-85.1°	79.4°	--
08:00	(08:09)	97.9°	31.7°	-82.1°	77.4°	--
08:30	(08:39)	101.4°	38.6°	-78.6°	76.2°	--
09:00	(09:09)	105.4°	45.5°	-74.6°	75.3°	--
09:30	(09:39)	110.5°	52.2°	-69.5°	74.8°	--
10:00	(10:09)	117.2°	58.6°	-62.8°	74.4°	--
10:30	(10:39)	126.7°	64.6°	-53.3°	74.1°	--
11:00	(11:09)	140.9°	69.7°	-39.1°	74.0°	--
11:30	(11:39)	162.0°	73.1°	-18.0°	73.9°	--
12:00	(12:09)	-171.7°	73.7°	8.3°	73.9°	--
12:30	(12:39)	-148.0°	71.3°	32.0°	73.9°	--
13:00	(13:09)	-131.4°	66.7°	48.6°	74.1°	--
13:30	(13:39)	-120.4°	60.9°	59.6°	74.3°	--
14:00	(14:09)	-112.8°	54.6°	67.2°	74.6°	--
14:30	(14:39)	-107.2°	48.0°	72.8°	75.1°	--
15:00	(15:09)	-102.8°	41.2°	77.2°	75.8°	--
15:30	(15:39)	-99.2°	34.3°	80.8°	76.9°	--
16:00	(16:09)	-96.0°	27.3°	84.0°	78.5°	--
16:30	(16:39)	-93.2°	20.3°	86.8°	81.5°	--
17:00	(17:09)	-90.5°	13.3°	89.5°	87.8°	--
17:30	(17:39)	-87.9°	6.3°	92.1°	108.2°	--

Spherical Equidistant Stereographic BRE Sun-Path Orthographic Waldram Tabular

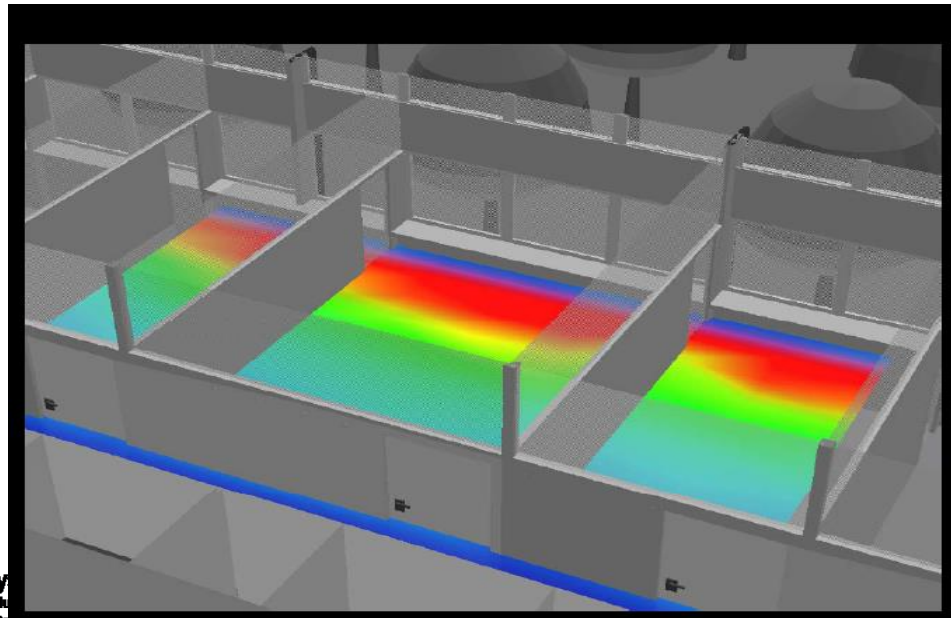
Window / Shadow Angle (HSA & VSA)

- **Vertical & Horizontal shadow angles are the vertical and horizontal angles between the sun and the normal to the wall surface.**

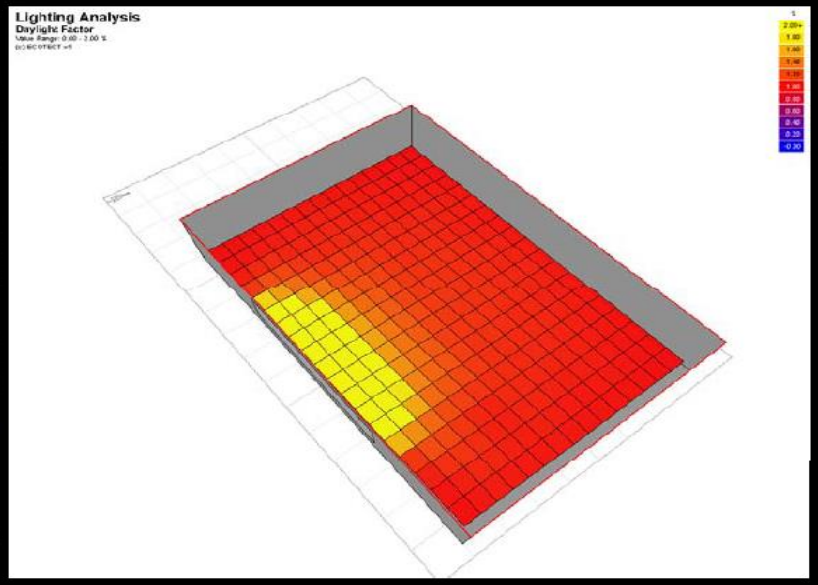




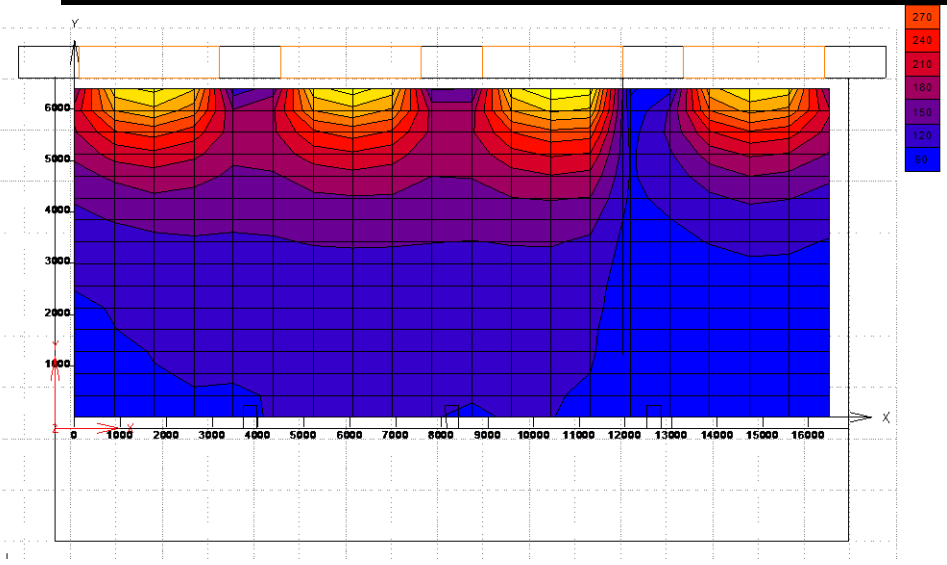
Daylight Analysis

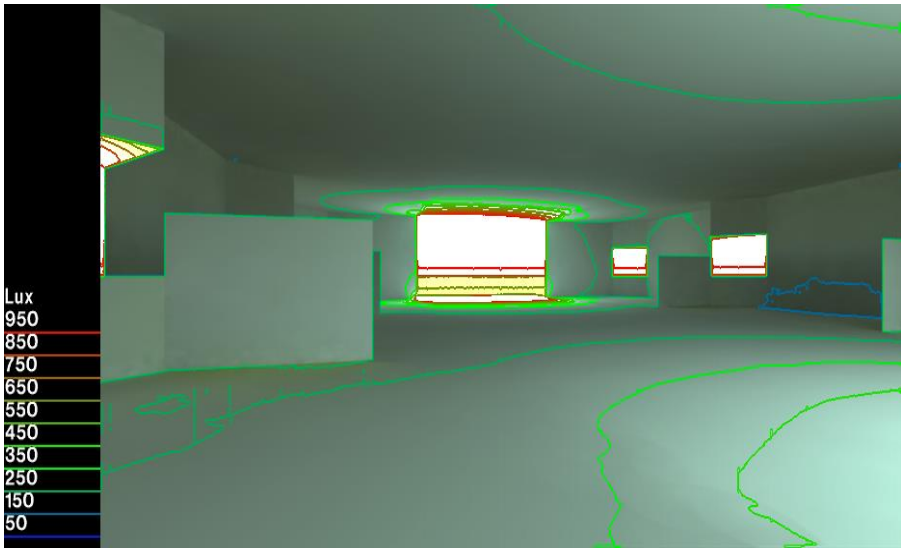


Daylight Factor- Radiance



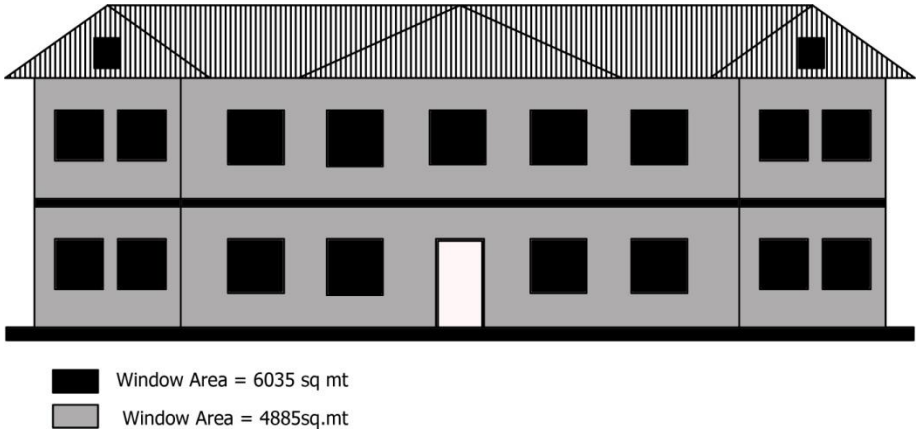
Daylight Factor ECOTECT

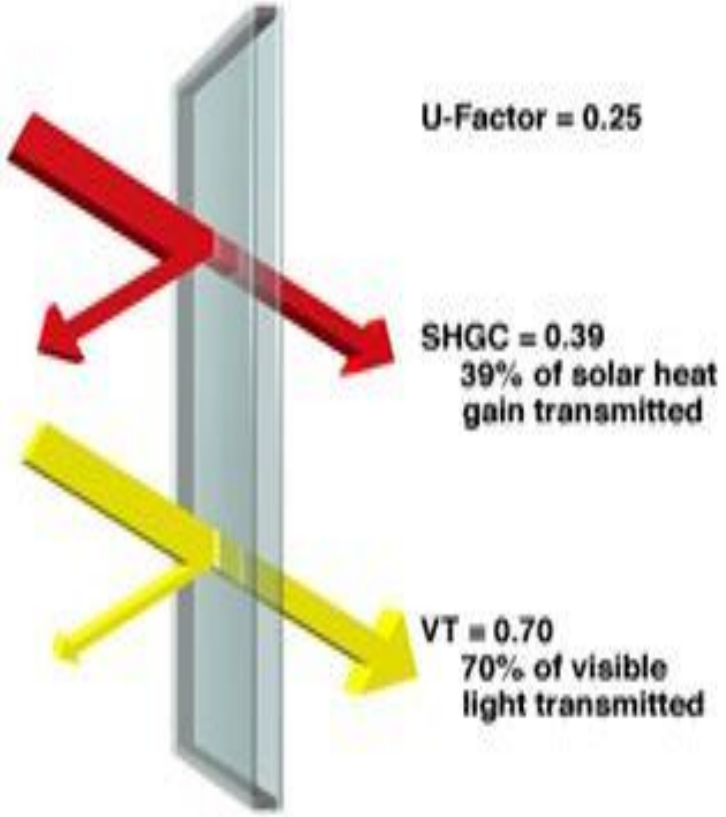




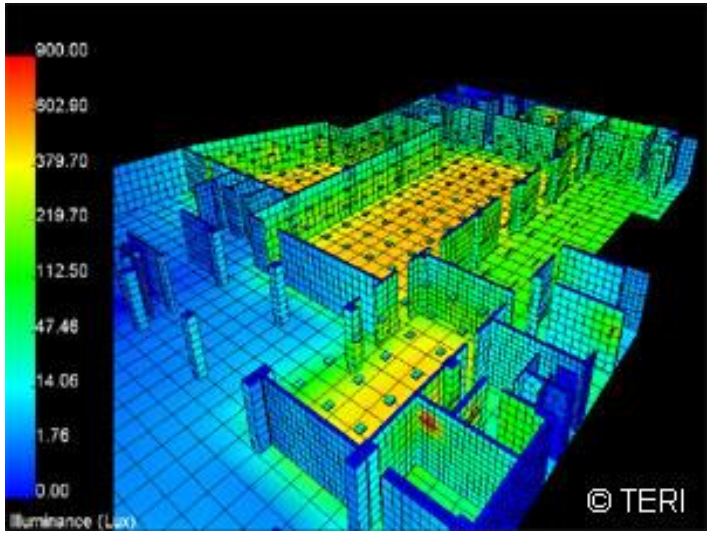
Window Optimization

- **WWR (optimization of window area)**
- **Energy efficient glazing property (SHGC, VLT, U-value)**





Energy efficient artificial lighting

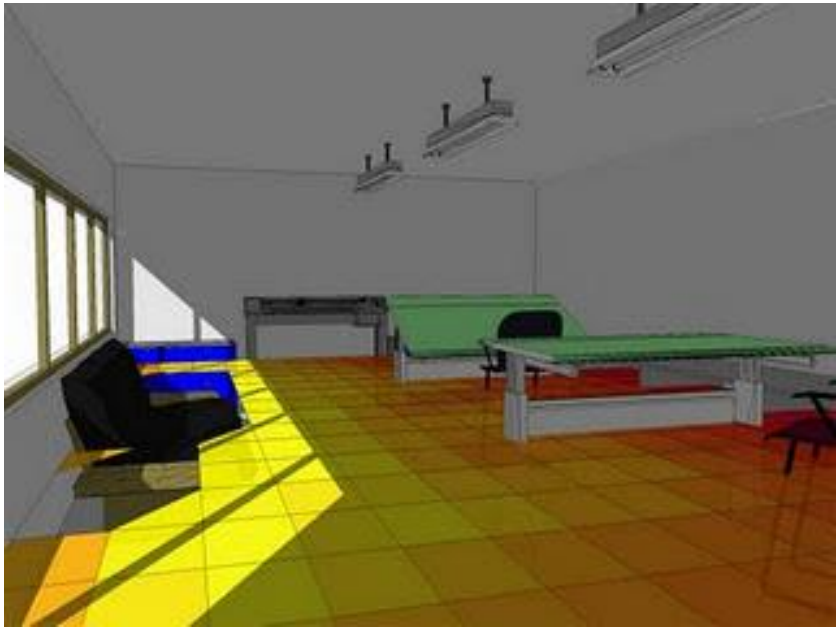


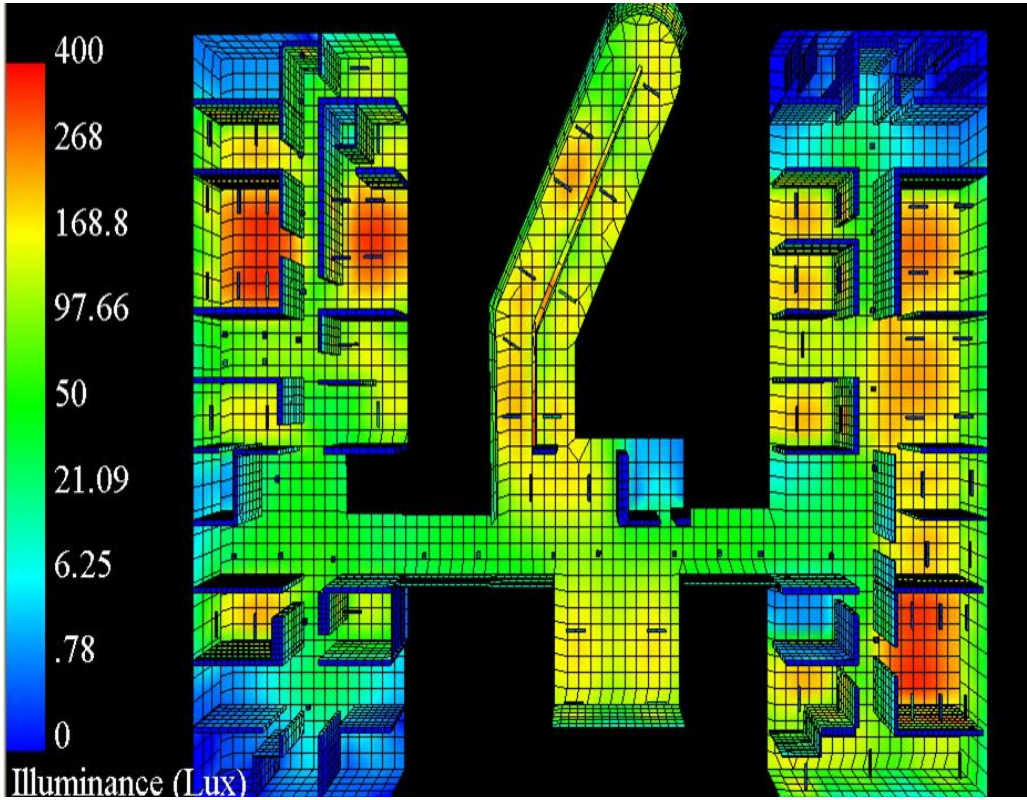
Genie 8W/11W E14

TCS 398/228 TL5

FCS 3l/ 2l l

Daylight Integration





3. Energy Performance Optimization

- **Optimize the energy performance of the building within specified comfort limits.**

Ensure that energy consumption in building under a specified category is 10%–40% less than that benchmarked through a simulation exercise.

- **Steps followed for this Study are –**

1. Thermal Analysis

Thermal comfort study is done and recommendations are given on design interventions to enhance thermal performance efficiency. Building simulation and modelling using software tools would be made to calculate reduced building loads by use of efficient construction material. Several options of efficient walling, roofing, and glazing systems would be studied with help of simulation to determine its effectiveness to reduce energy consumption vis-à-vis increased cost. These parametric analyses would enable client to arrive at optimum design for wall, roof and window specifications.

2. HVAC System Analysis

The HVAC system design, if any, would be reviewed and the thermal modelling done previously would enable review of space conditioning loads and recommendations on improved system design would be provided.

4. Renewable Energy Utilization

1. **Enhance outdoor lighting system efficiency**

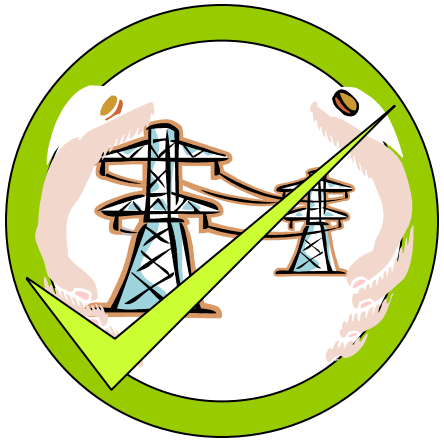
   Meet minimum allowable luminous efficacy (as per lamp type) and make progressive use of a renewable-energy based lighting system.

2. **Renewable energy utilization**

   Meet energy requirements for a minimum of 10% of the internal lighting load (for general lighting) or its equivalent from renewable energy sources (solar, wind, biomass, fuel cells, and others). Energy requirements will be calculated based on realistic assumptions which will be subject to verification during appraisal.

3. **Renewable-energy-based hot-water system**

   Meet 70% or more of the annual energy required for heating water through renewable energy based water-heating systems.



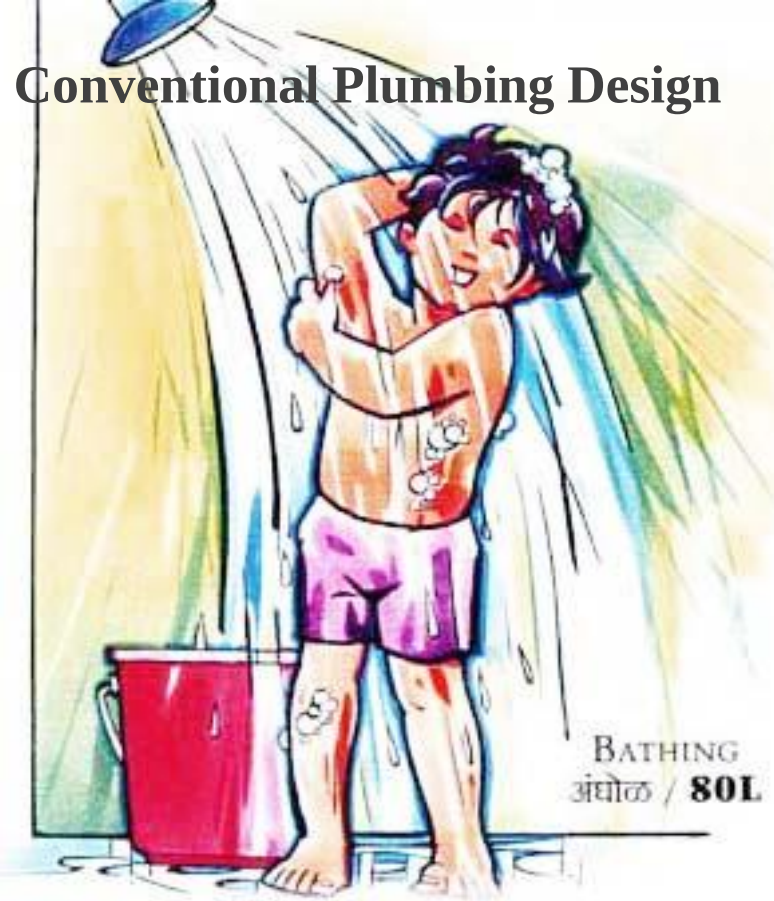
Application of Renewable Energy (Green Energy)

Water Management…

“Appropriate interventions at the planning and design stage can save valuable resources like WATER throughout the life cycle of the a building.”

Conventional Landscape Design

Conventional Plumbing Design



High-flow/ water inefficient fixtures

Conventional construction water usage

3. Efficient water management system

1. Reduce landscape water requirement
2. Reduce building water use
3. Efficient water use during construction

Water efficient plumbing fixture, irrigation system & construction technology…

Waste water & Solid waste management…

Conventional Solid & Liquid Waste

3. Waste water & Solid waste management

- *Recycle, Recharge, and Reuse of Waste-water*

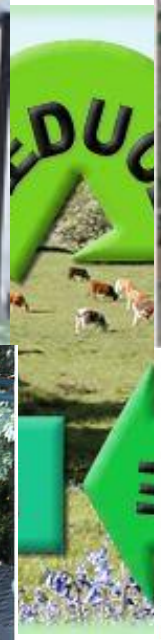
1. Waste-water treatment
2. Water recycle and reuse (including rainwater)

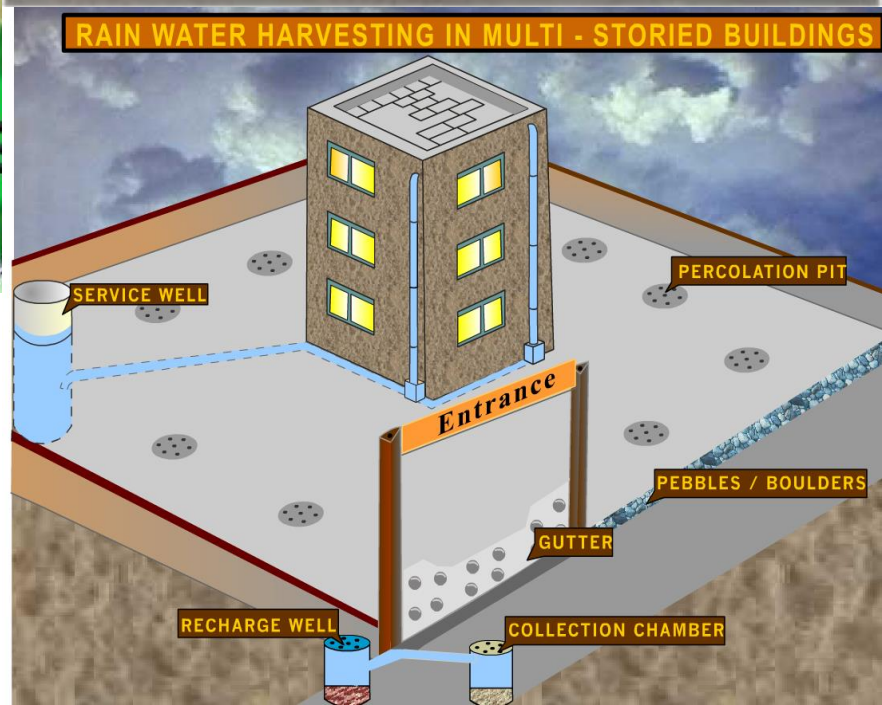
- *Waste management (To minimize waste generation; streamline waste segregation, storage, and disposal; and resource recovery from waste)*

1. Reduction in waste during construction
2. Efficient waste segregation
3. Storage and disposal of waste
4. Resource recovery from waste

Sustainable waste management (Solid & Liquid)

Enzotech system





7. Sustainable Building material & Construction Tech.

1. **Utilization of fly ash in the building structure**

2. **Reduce volume, weight, and time of construction by adopting an efficient technology (such as pre-cast systems, ready-mix concrete, and others)**

3. **Use low-energy material in the interiors**

8. Health, Well being & Environmental Quality

I. Protection of the health of construction workers and prevent pollution

1. **Provide at least the minimum level of sanitation/safety facilities for construction workers.**

2. **Reduce air pollution during construction**

II. For healthy indoor air quality, water quality, and noise levels, and to reduce the global warming potential

1. **Use of low VOC (volatile organic compounds) paints/ adhesives/ sealants.**
2. **Minimize ozone-depleting substances**
3. **Ensure water quality**
4. **Acceptable outdoor and indoor noise levels**
5. **Tobacco and smoke control**
6. **Provide the minimum level of accessibility for persons with disabilities.**

Examples of contemporary green buildings…

KEY INDICATORS OF CLIMATE RESILIENT BUILDING

1. Glare control/ shading
2. Reduction of CO_2 emissions
3. Building Material
4. Low/ Zero Carbon Technology
5. Natural Ventilation
6. Free Cooling
7. Water Consumption
8. Irrigation
9. Flood Risk
10. Surface Water Run off/ Hard Paving
11. Ecology Issues
12. Design for Robustness

GAP

1. **Research & Development**

   - **Climatic Projection Data**

2. **Policy Decisions**

   - **Revision of the Building Codes & Standards based on the climatic projection data**
   - **Adoption & Enforcement of existing green building codes/ rating systems**

SOLUITION

INDIAN STANDARDS & NORMS

- Energy Conservation Building Code (ECBC) 2007
- National Building Code – 2005
- SP-41
- Other BIS (Bureau of Indian Standards) bench marks
- Green Building rating systems
  - GRIHA
  - LEED

“Green-ness” is an accountability project …

- The qualitative and/or quantitative measures of sustainability and the actual benefits of green design need to be measured.

- These efforts are important because they will enable us to determine:
  1. The net GHG emission (Building Carbon footprint)
  2. Achievement in cost saving
  3. The impact on human health and the environment etc.

- In India there are some body & policy guidelines are responsible for assessing the sustainability in building sector. Such as –
  - Odisha Energy Conservation Building Code (ECBC) 2007
  - National Building Code – 2005
  - SP-41
  - Building & Planning Regulation (Bye Law)
  - Other BIS (Bureau of Indian Standards) bench marks
  - Prevalent Building rating systems in India:
    1. GRIHA: Green Rating for Integrated Habitat Assessment (National rating system)
    2. LEED: Leadership in energy and environmental design (India GBC) etc.

OECBC - 2011

1. **EIC (E) is the state designated agency (SDA) by BEE, Ministry of Power, GoI for the implementation of OECBC & other energy conservation projects in Odisha.**

2. **ECBC has been modified to OECBC and notified and mandated in the Gazzate of GoO in 2011.**

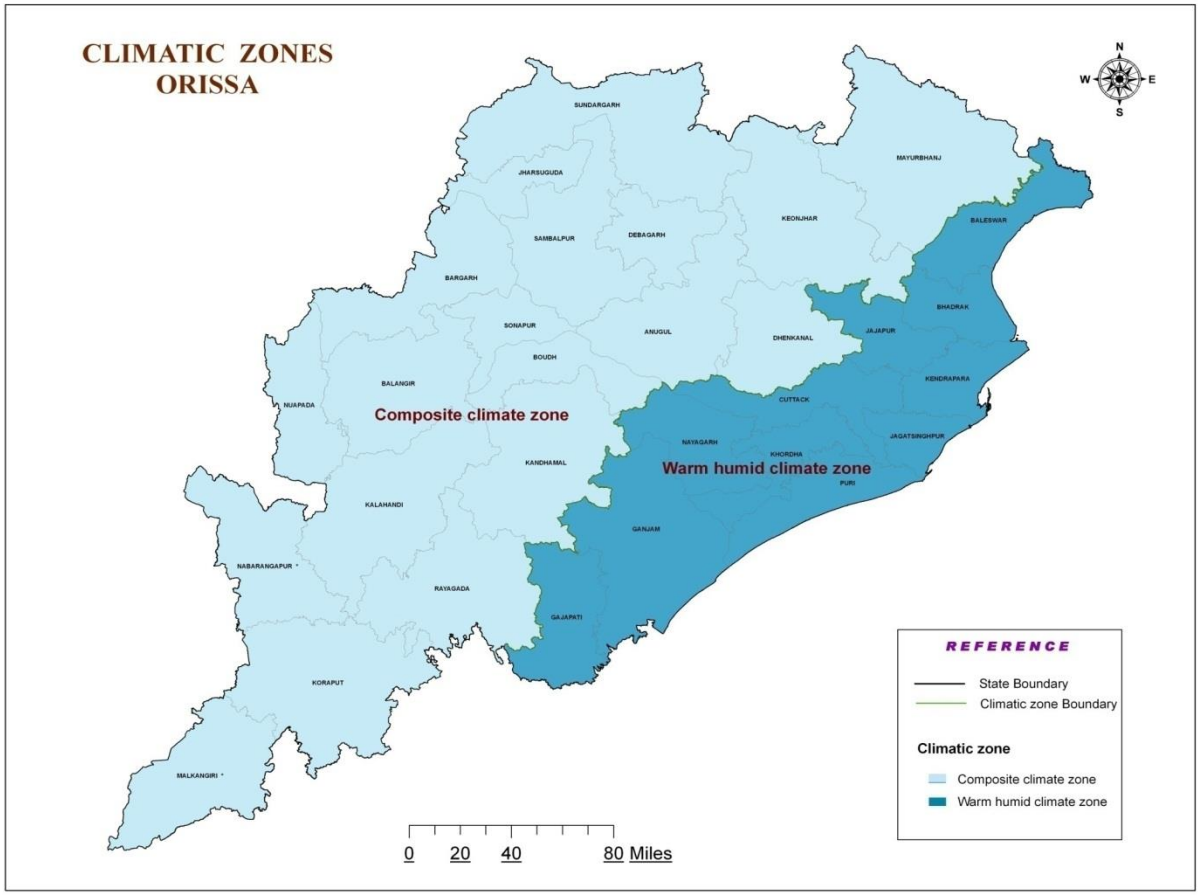
3. **SDA appointed TERI as their PMU (project monitoring unit) to implement the assigned task by GoI & GoO.**

4. **OECBC focuses on –**

- **Building Envelope**
- **HVAC**
- **Lighting**
- **Electrical**

Features

- **Section 2: Scope**
  - ***Connected load of 100 KW or greater or a contract demand of 110 KVA or greater***
  - ***Conditioned area of 500 m^2 or more***



GRIHA…The national rating system

- **GRIHA (Green Rating for Integrated Habitat Assessment) is the National Rating System will evaluate the environmental performance of a building holistically over its entire life cycle, thereby providing a definitive standard for what constitutes a green building.**

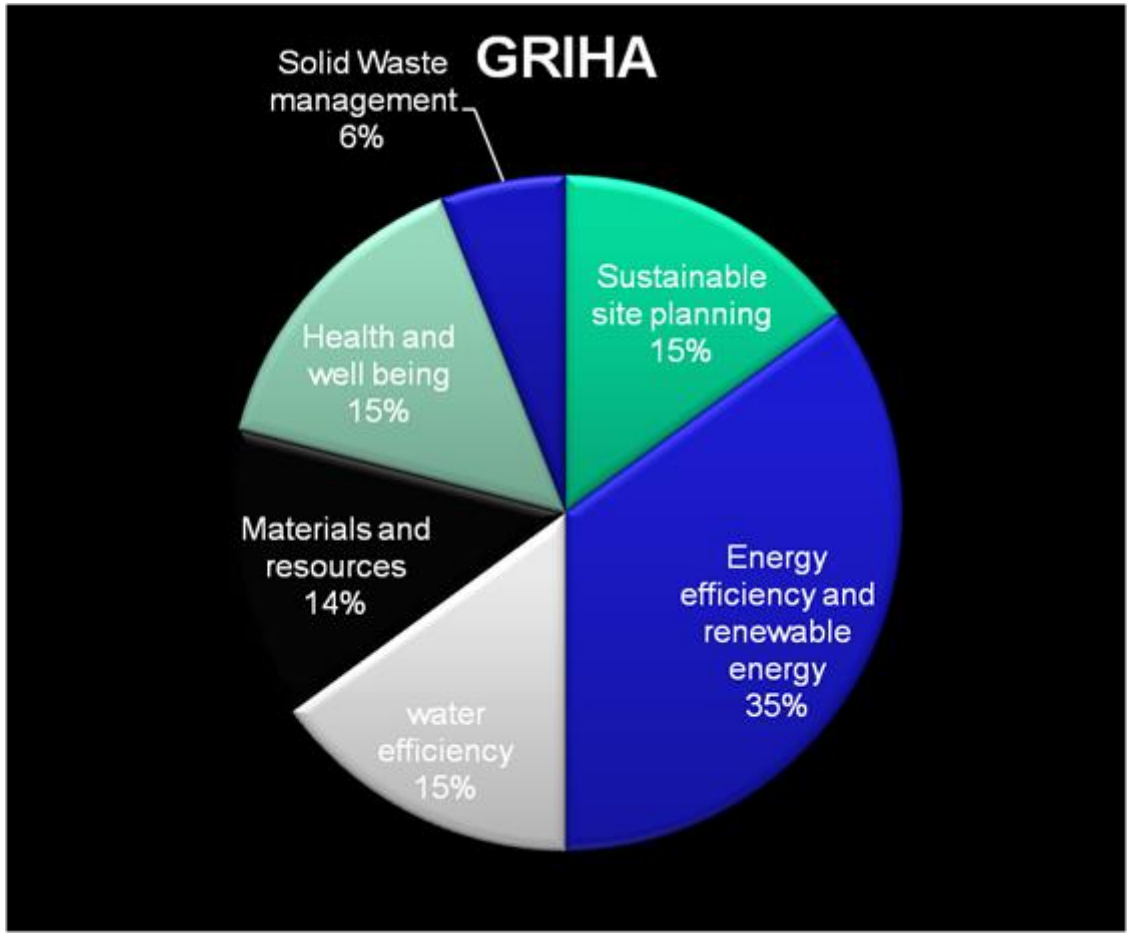
- **This rating system initially conceived and developed by TERI and now it has modified and accepted as a national rating system by GoI. Its takes in to account the National Building Code 2005, the Energy Conservation Building Code2007 and other IS codes, local bye laws etc.**

Set of 34 criteria100 (+4 innovation points) point system with differential weightage on various criteria

- **51 - 60** ★
- **61 - 70** ★★
- **71 - 80** ★★★
- **81- 90** ★★★★
- **91- 100** ★★★★★

GRIHA

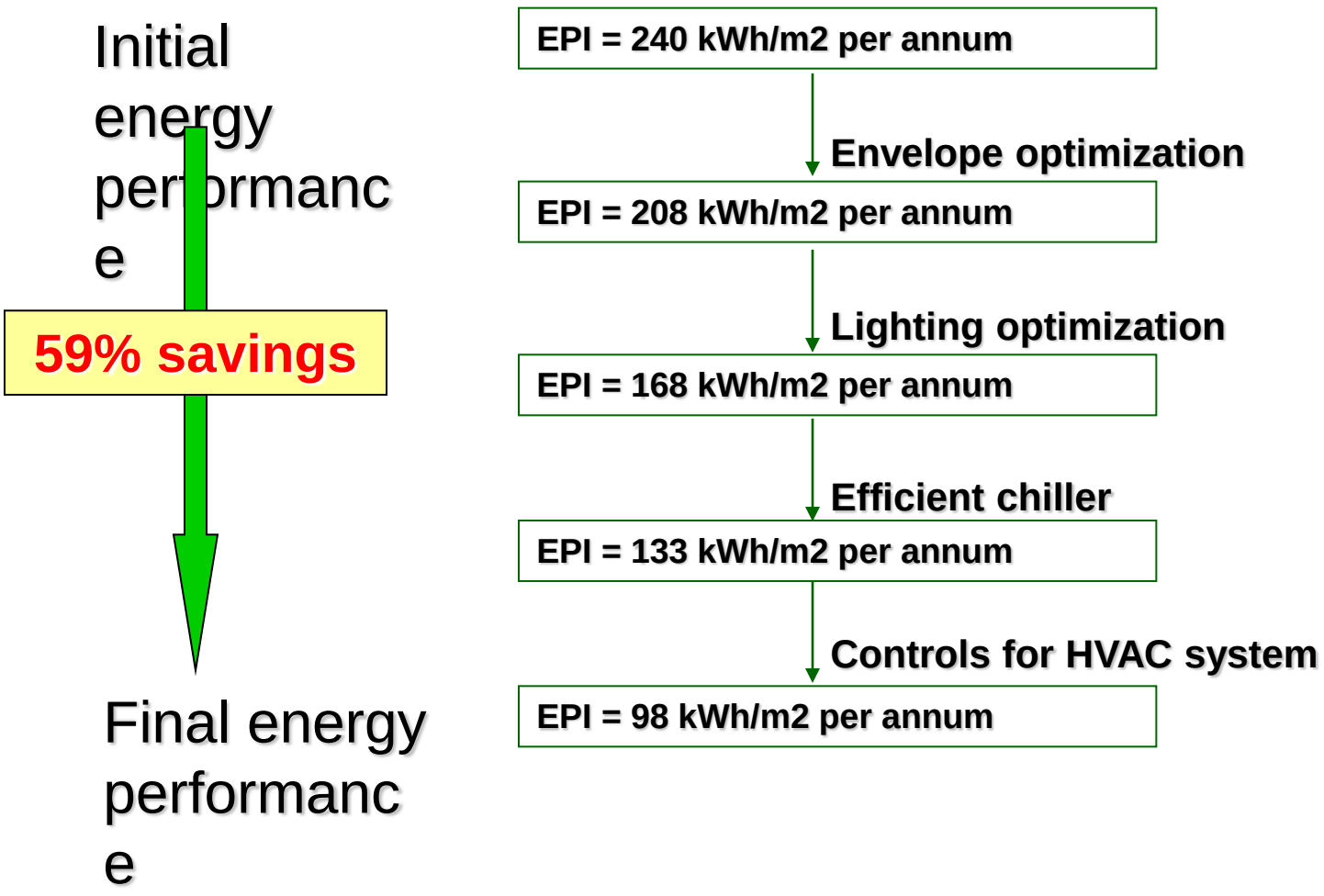
Weightage



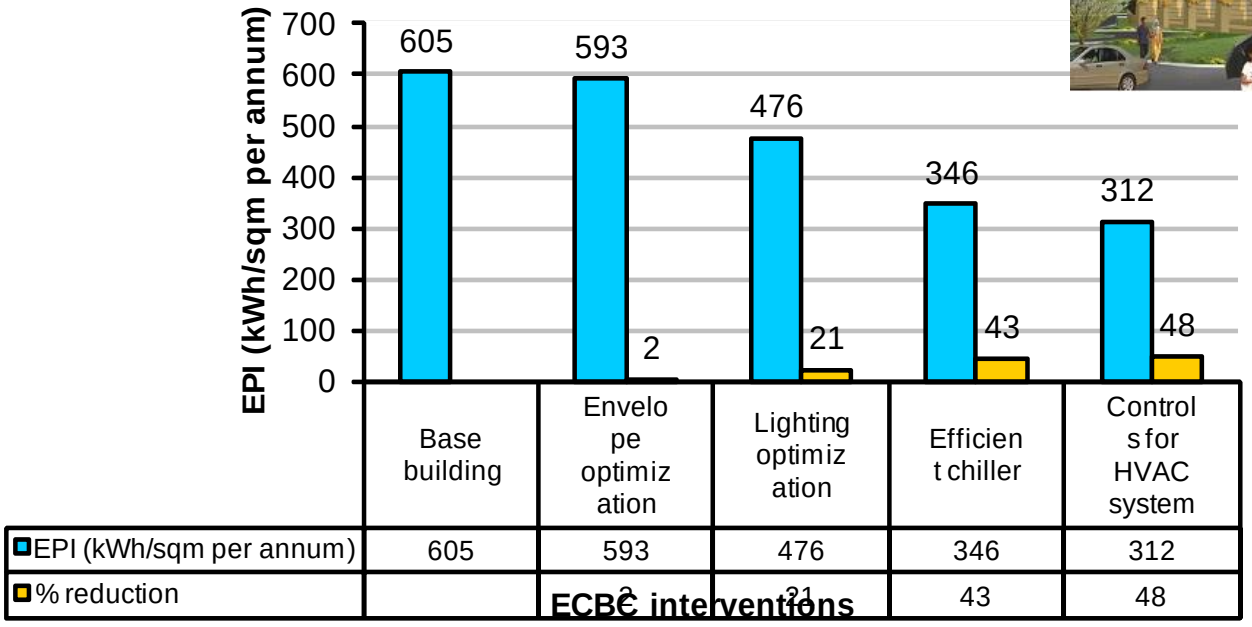
GRIHA innovation points over and above 100 points

Centre for Environmental Science, IIT Kanpur, 5 STAR GRIHA

Annual Energy Savings



Case Study: Fortis Hospital, Shalimarbagh, New Delhi

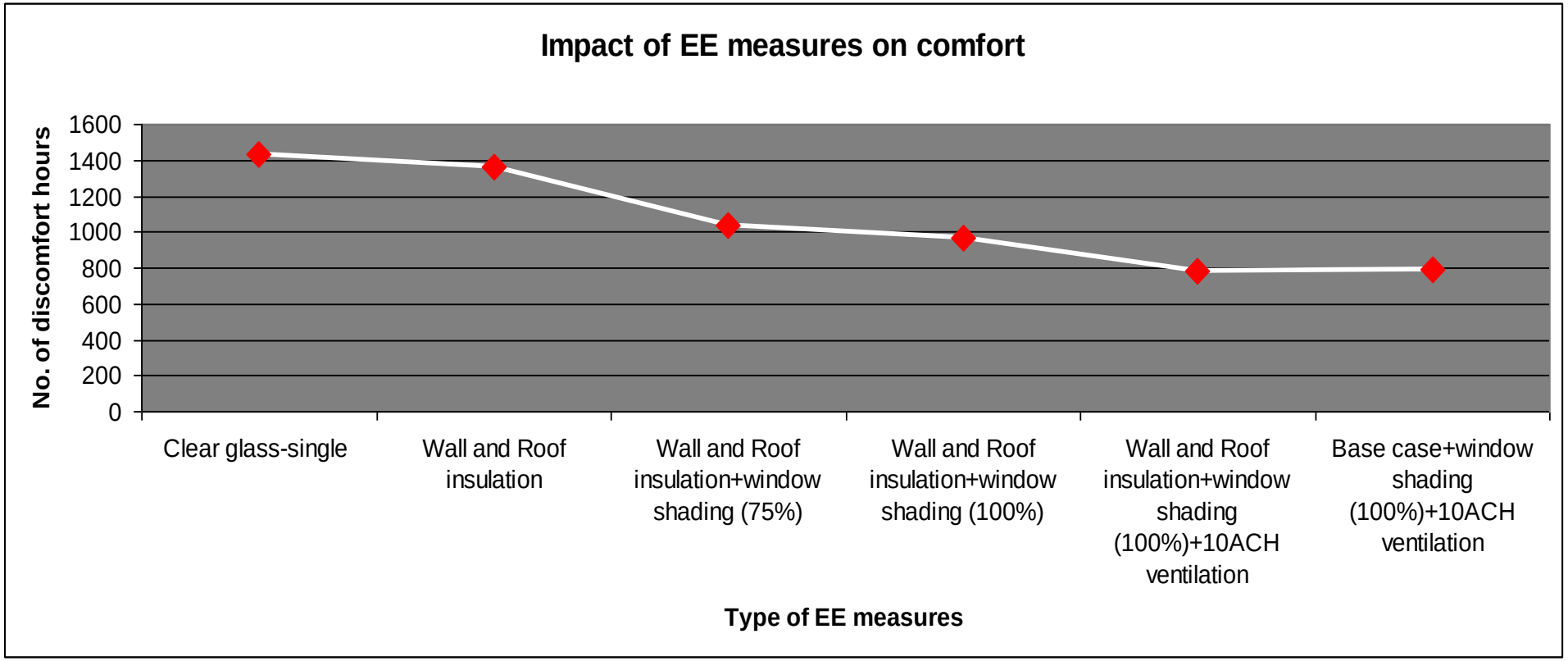


EPI (kWh/ m2 per annum)	Base Case	Final case	Total % Reduction
	605	312	48

Impact of energy efficiency measures on thermal comfort

- **Case study: Hospital building at Bhopal (AIIMs Bhopal)**

Reduction in total discomfort Hours	
Proposed building	6600
After incorporation of EE measures	791
% reduction	88%



“Dhanyabad”

Sudipta Singh
TERI