ISHRAE

CAHO
Committed to Safer Patient Care

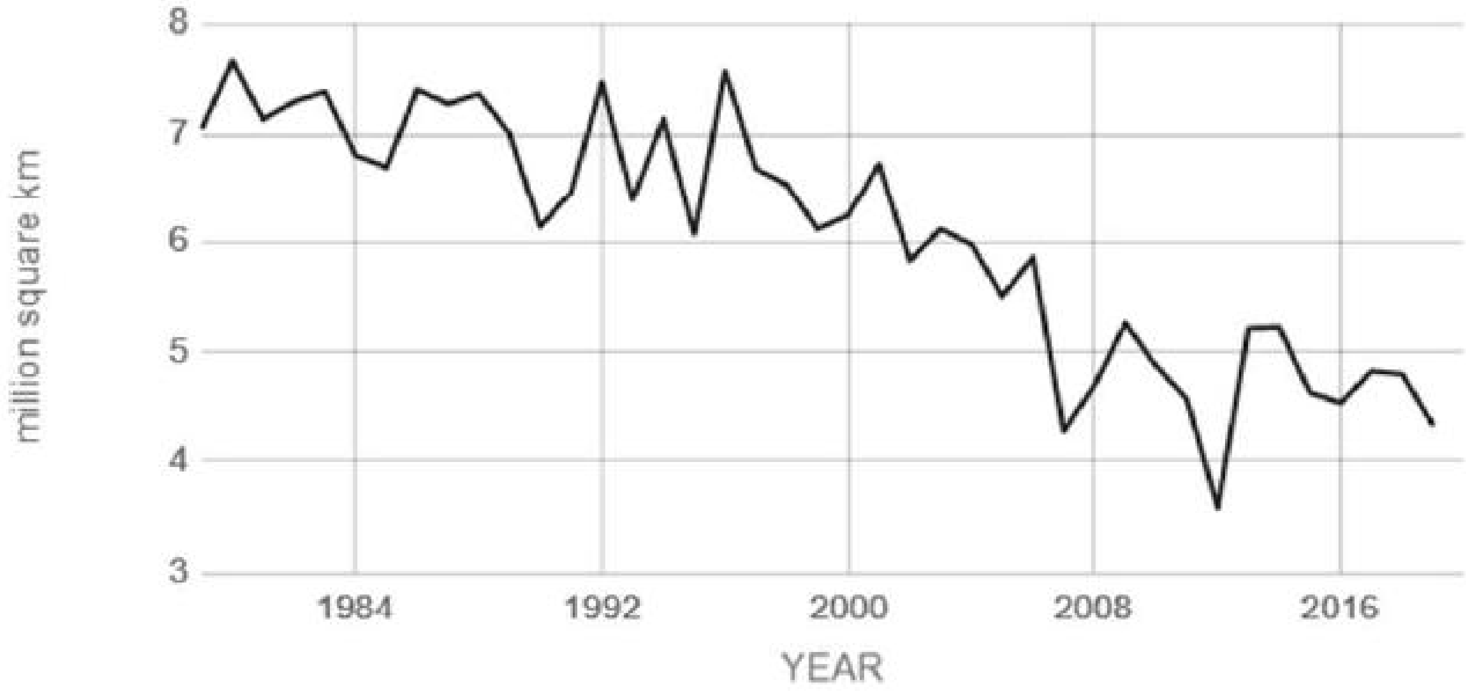
Building Construction, materials and design towards energy efficient HVAC systems

- Mukesh Suthar


Effects of climate change

Evidences & Impacts of Climate Change

Arctic Sea Ice Minimum



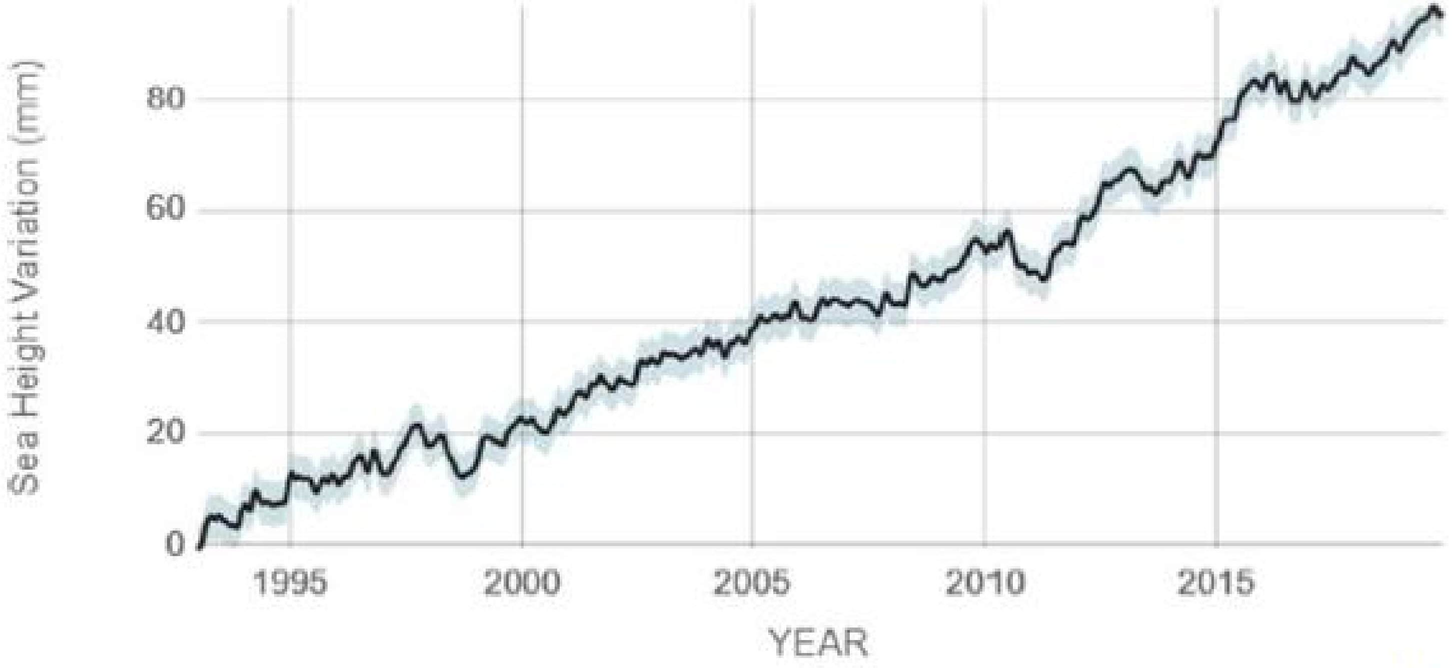
Source: climate.nasa.gov

Rate of Change
↓ 12.85% per decade

Evidences & Impacts of Climate Change

Sea Level

Satellite data: 1993 - Present

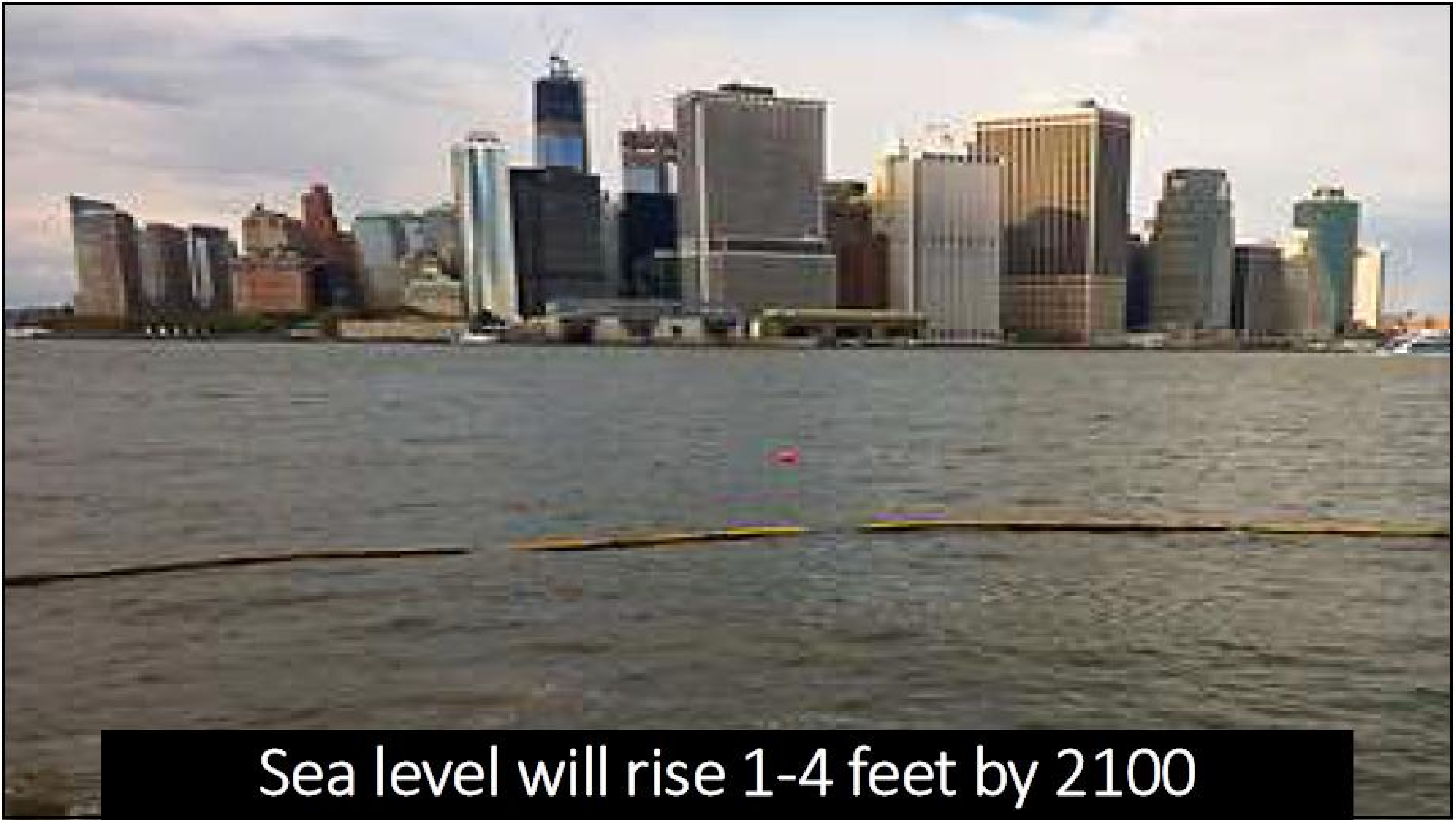


Source: climate.nasa.gov

LATEST MEASUREMENT:
November 2019
96 (± 4) mm

Rate of Change
↑3.3 millimeters per year

Data source: Satellite sea level observations.
Credit: NASA Goddard Space Flight Center


Sea level will rise 1-4 feet by 2100

GLOBAL TIMES

环球时报

DISCOVER CHINA, DISCOVER THE WORLD

US scholar's prediction about China in 2030

In 2030, China will become a country where everybody is richer than today, where the digital economy is pervasive, and a country with the biggest economy 7

Addis Ababa–Djibouti Railway: road to prosperity

Looking for an "express ride" in Africa? Buy a ticket on the Addis Ababa–Djibouti Railway, a display of how BRI shows "speedy" transformation in Africa in past decade 10

Sporadic COVID resurgences 'won't stop economic recovery'

Some Chinese cities see sporadic COVID resurgence, but analysts are optimistic that the country's overall economic recovery will not be affected 4

www.globaltimes.cn VOLUME 14 • NO. 3797 • FRIDAY JULY 15, 2022 PRICE 2 YUAN

Shops in Shanghai's Yuyuan Garden put to use misty spray heat prevention devices since July 14, 2022. Shanghai has issued its highest alert for extreme heat for the third time this summer as sweltering temperatures repeatedly tested records this week. Photo: Xinhua

▶ Scorching weather to continue in August, 900 million affected so far

China braces for prolonged heatwaves in summer

By GT staff reporters

Hot air has blanketed many parts of China including Shanghai, Southwest China's Sichuan Province and East China's Jiangsu and Zhejiang provinces, affecting more than 900 million people and over half of the national territory as of this week, with many cities in the grip of a heatwave for more than a month and temperatures soaring to above 44 C, according to the meteorological authority.

The prolonged heatwaves have threatened crops and people's lives and pushed China's power usage to record-breaking levels. Despite the challenges, key industries in China have not experienced power cuts and the Chinese government has been taking measures including drawing up off-peak power use plans, and helping farmers install more cooling machines.

However, meteorologists warned that climate change will lead to global heatwaves that are longer, more extreme, more frequent and that affect more people, and this will become a new normal even if we achieve global climate targets.

The heatwave in 2022 has come earlier, and the average temperatures for June have hit the highest since 1873, Sun Shao, a senior researcher at the National Climate Center affiliated with the China Meteorological Administration, told the Global Times on Thursday.

Since June, China has experienced this year's first re-

▶ 2 Power

Regulator vows guidance to help address mortgage default risks

By GT staff reporters

Coincidentally, Central China's Henan Province, a major agricultural production province that blazed the trail of the country's village banking push, has been in the news lately, as troubles at several local village banks and multiple local undelivered property projects, according to market observers, flag the need for a tougher stance on regulation over rural banks and presale homes.

Inadequate oversight of village bank operations and developers' presale funds have been pinpointed as central to the isolated incidents that also sparsely occur in other provinces, experts claimed. They called for continued efforts to bridge any remaining loopholes and address weak links in the domestic banking and housing regulatory framework.

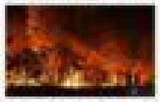
This, adding to an unwavering endeavor to battle corruption in the financial sector, will surely beef up the overall financial robustness, analysts have claimed, arguing against Western media overhyping risks with the country's banking system. In a fresh injection of confidence, the country's banking and insurance watchdog vowed late Thursday to ensure project delivery, as it's keenly watching the issue surrounding defaulting mortgage repayments.

Describing the incidents as representing only a fraction of the entire banking sector and total mortgage loans, the analysts based their sobriety on compelling estimates and numbers that portray a safe and sound financial landscape at large.

Although Henan didn't make a list of the initial six provinces including South-

▶ 2 Tougher

Climate change could lead to a loss of 4 percent of European GDP by 2030



Deadly heatwaves could hit India: Climate change report

'1.5°C Temp Rise May Happen As Early As 2030'

Manka.Behl@timesgroup.com

Nagpur: India could face an annual threat of deadly heatwaves, like the one in 2015 that killed at least 2,500 people, if the world gets warmer by 2 degrees Celsius over pre-industrial levels, says the much-anticipated world's biggest review report on climate change. The report is to be released by the Intergovernmental Panel on Climate Change (IPCC) on Monday.

TOI had a sneak preview of the report to be released internationally on Monday morning. The implications of the report will be discussed at the Katowice climate change conference in Poland this December, where governments will review the Paris Agreement to tackle climate change. Being one of the largest carbon-emitting nations, India is expected to be a key player in the global event.

Ringing the alarm bells on runaway rise in temperatures, the Special Report on Global Warming of 1.5 degrees C warns that average global temperatures could breach the 1.5 degree level as early as 2030. "Global warming is likely to reach 1.5 degree Celsius (above pre-industrial levels) between 2030 and 2052 if it continues to increase at the same rate," the report said.

▶Kolkata threat, P 10

KEY FINDINGS

2°C RISE IN GLOBAL TEMP WILL MEAN

- Deadlier heatwaves in India, Pakistan
- Rise in vector-borne diseases like malaria and dengue
- Many megacities becoming heat-stressed, exposing more than 350 million more people to deadly heat by 2050
- Increase in poverty

GAINS OF LIMITING WARMING TO 1.5°C

- Several hundred million people will escape climate risks and be less susceptible to poverty by 2050
- Reduced losses in yields of maize, rice, wheat and other cereal crops in many countries

1.5°C global temperature rise likely between 2030 and 2052 (at current rate)

Even a 0.5° increase in global warming can adversely affect human health

THE HEAT IS ON

Temp rise (°C) in last 150 yrs

	Temp rise (°C)
Delhi	1
Mumbai	0.7
Kolkata	1.2
Chennai	0.6

Study: Global warming to cause erratic monsoon rain in India

About 5% Increase In Rainfall For Every Degree Celsius Of Warming

Rokibuz Zaman | TNN

The study shows an increase in mean summer monsoon rainfall contributing to precipitation, especially in 6 northeast states

Guwahati: If global warming continues unchecked, summer monsoon rainfall in India will become stronger and more erratic, revealed a research that predicts more extremely wet years in the future with potentially grave consequences for more than one billion people's well-being, economy, food systems and agriculture.

The study shows an increase in mean summer monsoon rainfall contributing to precipitation, especially in the Himalaya region — Arunachal Pradesh, Meghalaya, Nagaland, Manipur, Mizoram, Tripura, and hill regions of Assam. Precipitation is water released from clouds in the form of rain, freezing rain, sleet, snow or hail.

Monsoon rains will likely increase by about 5% for every degrees Celsius of warming, found the study published in the journal "Earth System Dynamics" by a team of German researchers that compared more than 30 state-of-the-art climate models from all around the world.

"We have found robust evidence for an exponential dependence: For every degree Celsius of warming, monsoon rainfall will likely increase by about 5%," says lead author Anja Katzenberger from the Potsdam Institute for Climate Impact Research (PIK) and Ludwig-Maximilian University in Munich, Germany (LMU). "Hereby, we were also able to confirm previous studies but find that global warming is increasing monsoon rainfall in India even more than previously thought. It is dominating monsoon dynamics in the 21st century."

The researchers observed that more rainfall is not necessarily a good thing for the farming sector in India and its neighboring countries. Co-author Julia Pongratz from LMU explains: "Crops need water, especially in the initial growing period, but too much rainfall during other growing states can harm plants, including rice, on which the majority of India's population is depending for sustenance. This makes the Indian economy and food system highly sensitive to volatile monsoon patterns." A look into the past underlines that human behaviour is behind the intensification of rainfall, according to the researchers.

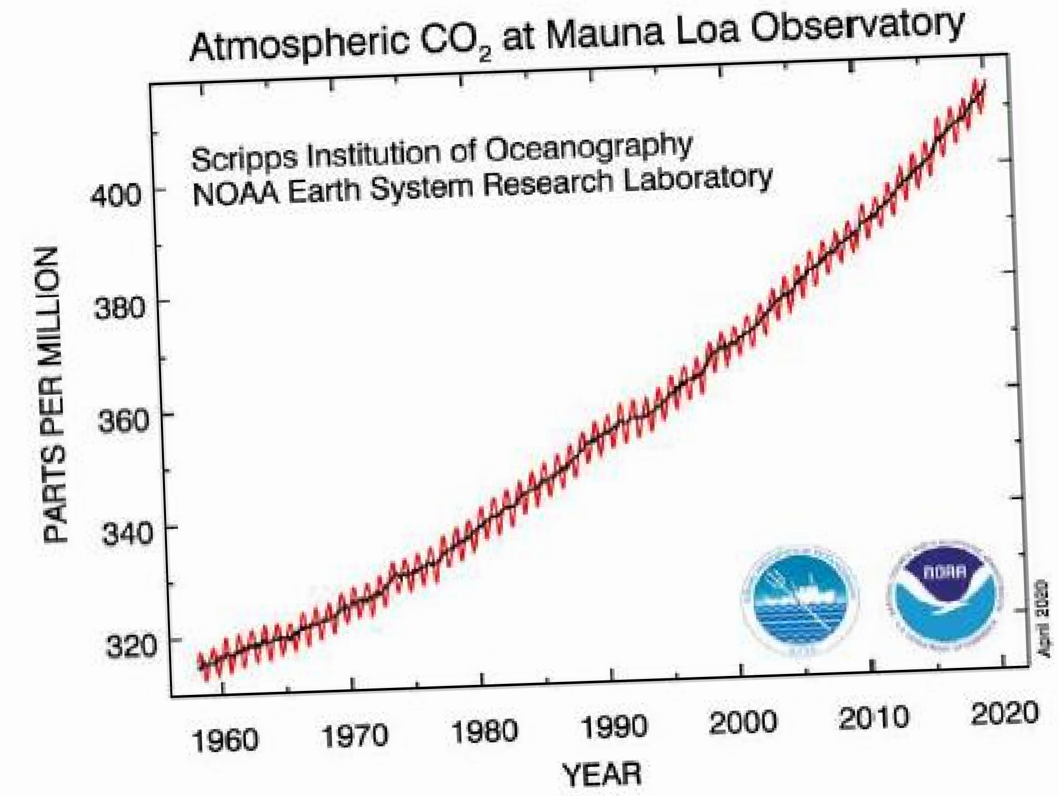
Starting in the 1950s, human-made forcings have begun to overtake slow natural changes occurring over many millennia, they said. At first, high sun-light blocking aerosol loadings led to subdued warming and thus a decline in rainfall, but since then, from 1980 onwards, greenhouse gas-induced warming has become the deciding driver for stronger and more erratic monsoon seasons, they noted.

"We see more and more that climate change is about unpredictable weather extremes and their serious consequences," comments group leader and co-author Anders Levermann from PIK and Columbia University, New York/USA on the findings of the study published in the journal Earth System Dynamics. "Because what is really on the line is the socio-economic well-being of the Indian subcontinent. A more chaotic monsoon season poses a threat to the agriculture and economy in the region and should be a wakeup call for policy makers to drastically cut greenhouse gas emissions worldwide."

The researchers used 32 CMIP6 models to analyze the Indian summer monsoon's response to climate change and the majority of models project that the increase will contribute to the precipitation, especially in the Himalaya region, the northeast of the Bay of Bengal and to the west coast of India. The Indian Himalayan region is spread across 12 states (Jammu & Kashmir, Uttarakhand, Himachal Pradesh, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, two districts of Assam namely Dima Hasao and Karbi Anglong and Darjeeling and Kalimpong in West Bengal) stretching across a length of 2,500 km and width of 250 to 300 km.


CO2

The most compelling evidence…



<u>Monthly Average</u>

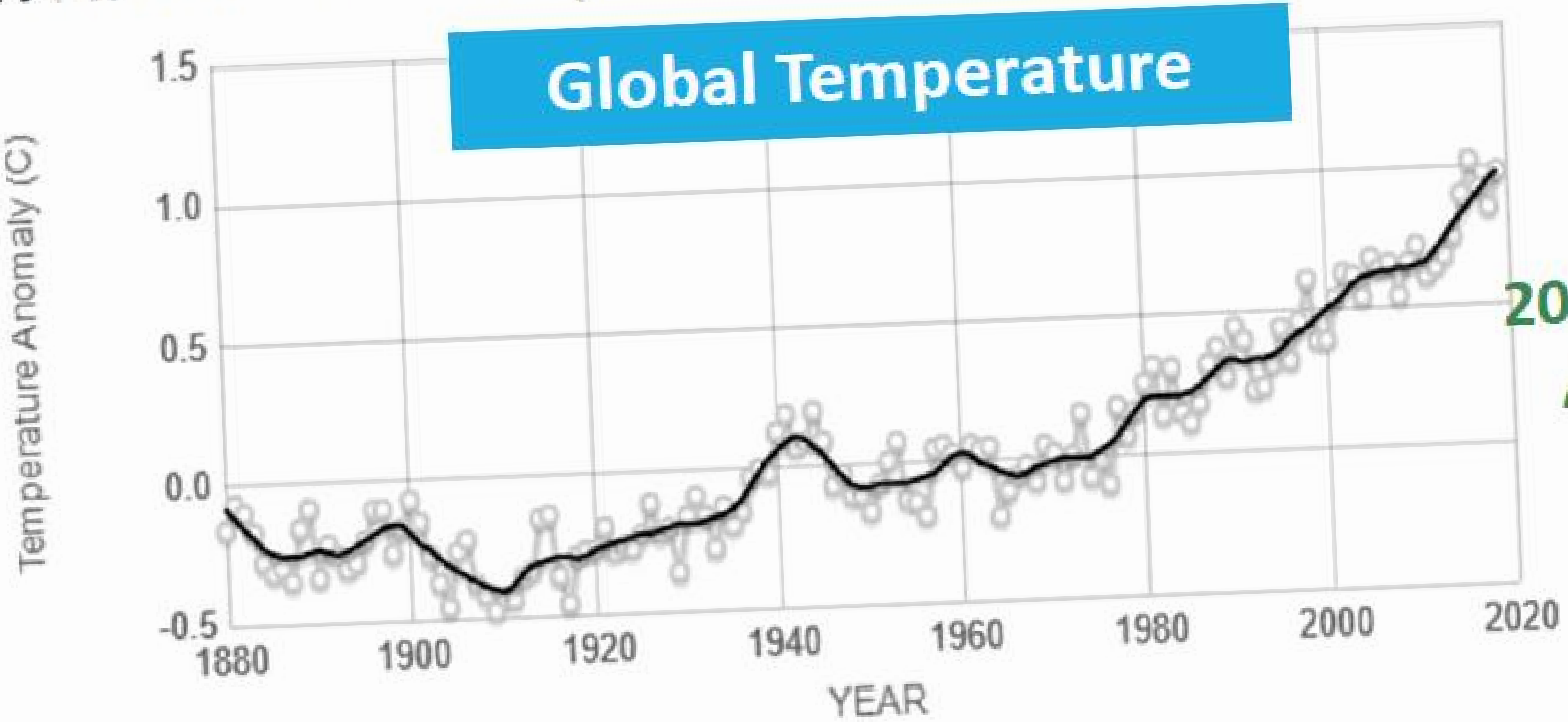
March 2020: 414.50 ppm
March 2019: 411.97 ppm
Last updated: April 6, 2020

<u>Recent Daily Average</u>

April 23: 415.62 ppm
April 22: 415.60 ppm
April 21: 416.28 ppm
April 20: 416.29 ppm
April 19: 416.05 ppm
Last Updated: April 24, 2020

Courtesy: NOAA, Global Monitoring Laboratory, Earth System Research

Evidences & Impacts of Climate Change



2019 ANNUAL AVERAGE: 0.98 °C

Source: climate.nasa.gov

The Paris agreement set out a common global goal

The Paris Agreement set the global objective of limiting global temperature rise to

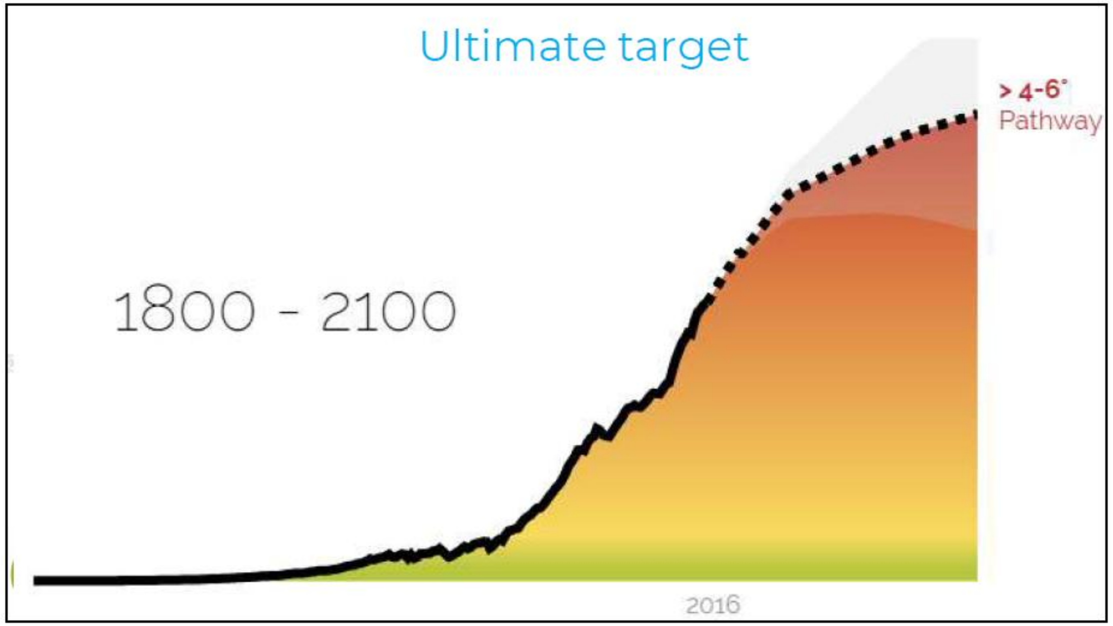
no more than 2°C

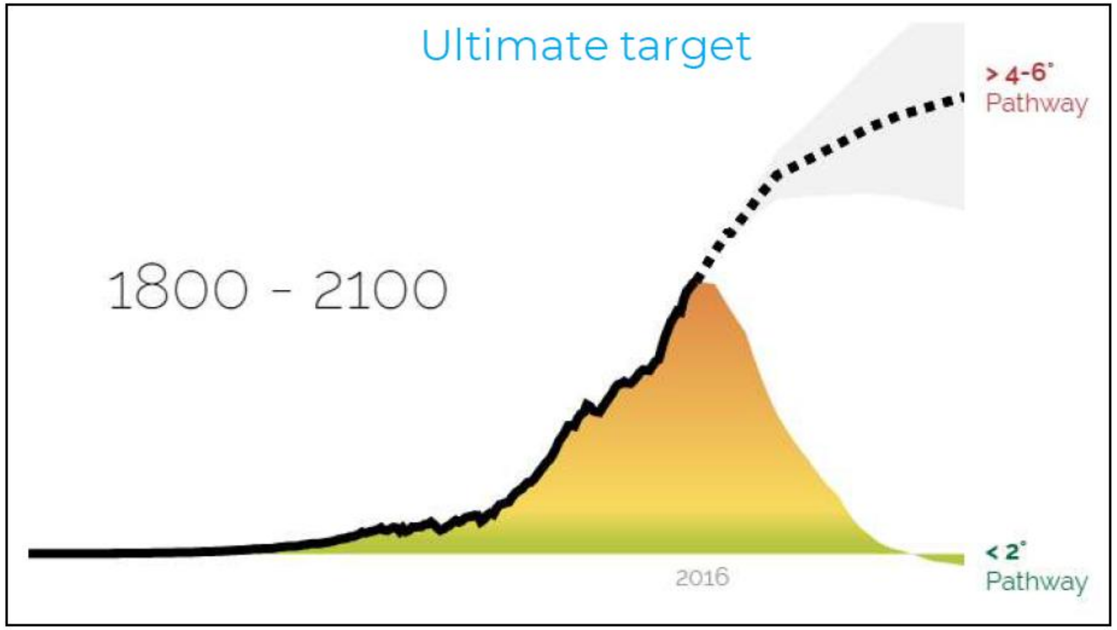
above pre-industrial levels and to pursue efforts to limit global temperature increase to

1.5°C

above pre-industrial levels.

LIMITING AMBIENT TEMPERATURE





We are on the brink of missing the opportunity to limit global warming to 1.5°C…

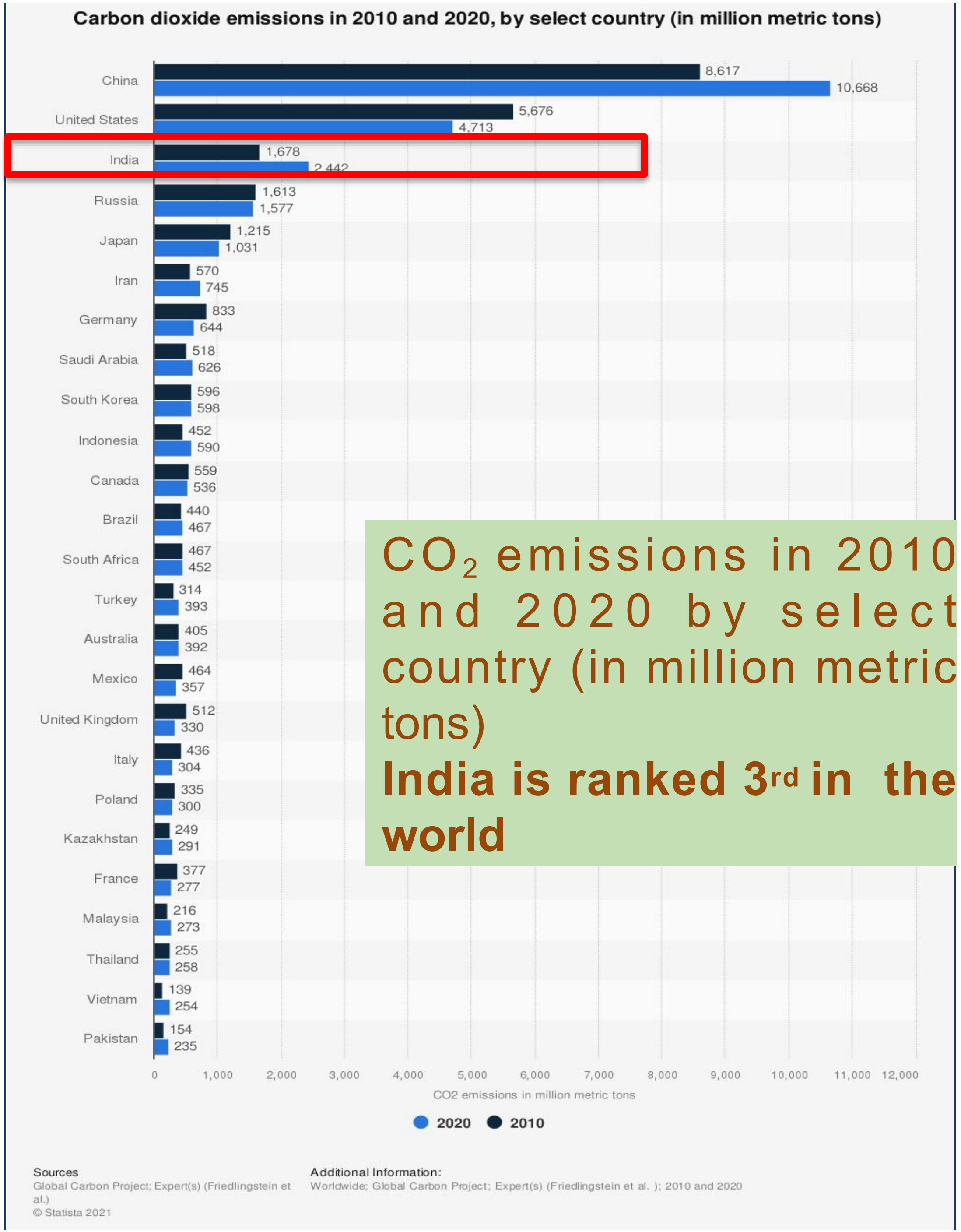
1.5°C — Every fraction of additional warming beyond 1.5°C will result in increasingly severe and expensive impacts.

25 Gt — To get on track to limit global temperature rise to 1.5°C, emissions must drop rapidly to <u>25 gigatons by 2030</u>

56 Gt — Challenge: As per today's commitments, emissions would reach 56 Gt CO2e by 2030, over <u>twice what they should be</u>

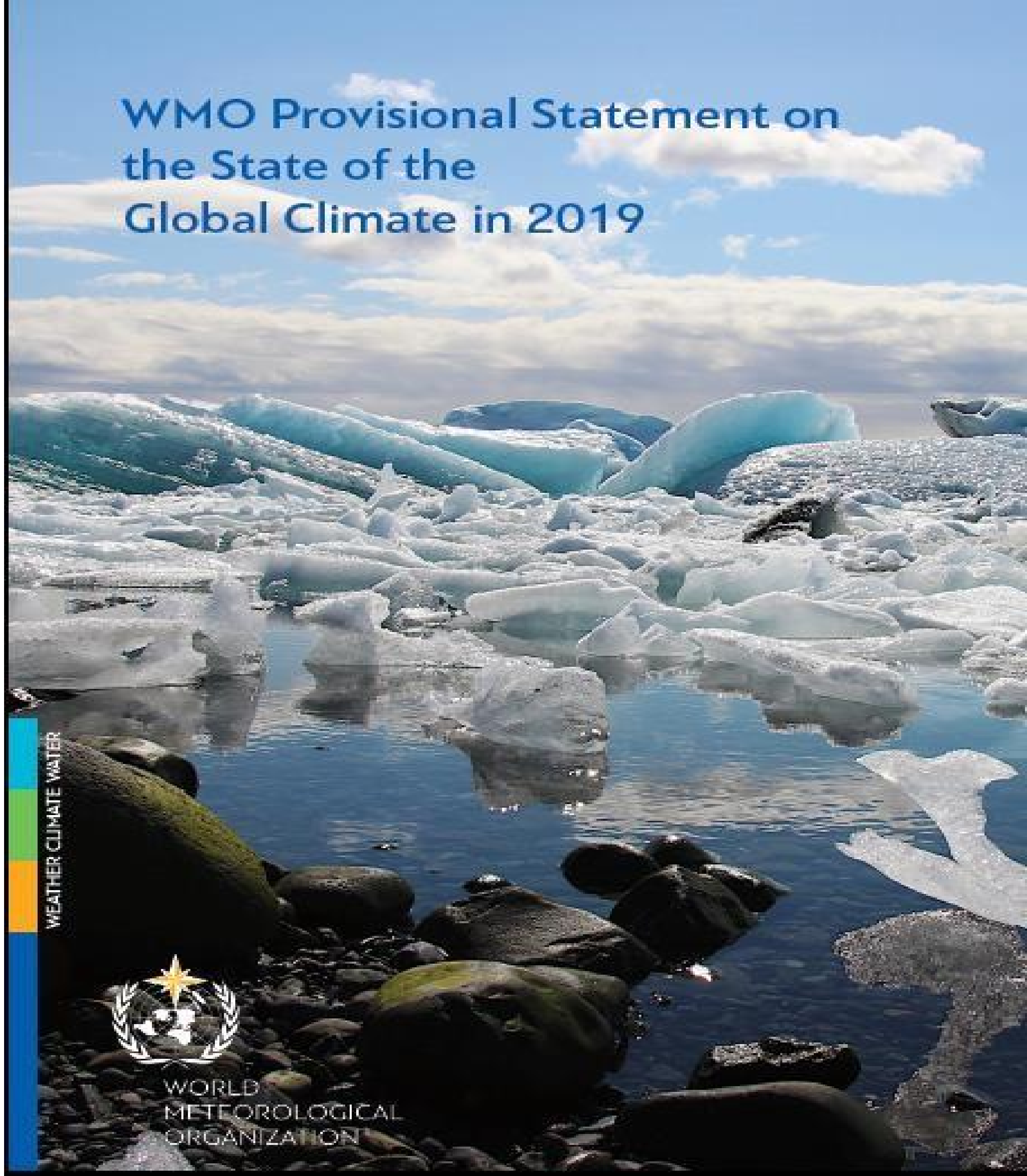
7.6% — Solution: If we can deliver a <u>7.6% reduction every year</u> between 2020 & 2030, we CAN limit global warming to 1.5°C

Source: EGR, 2019

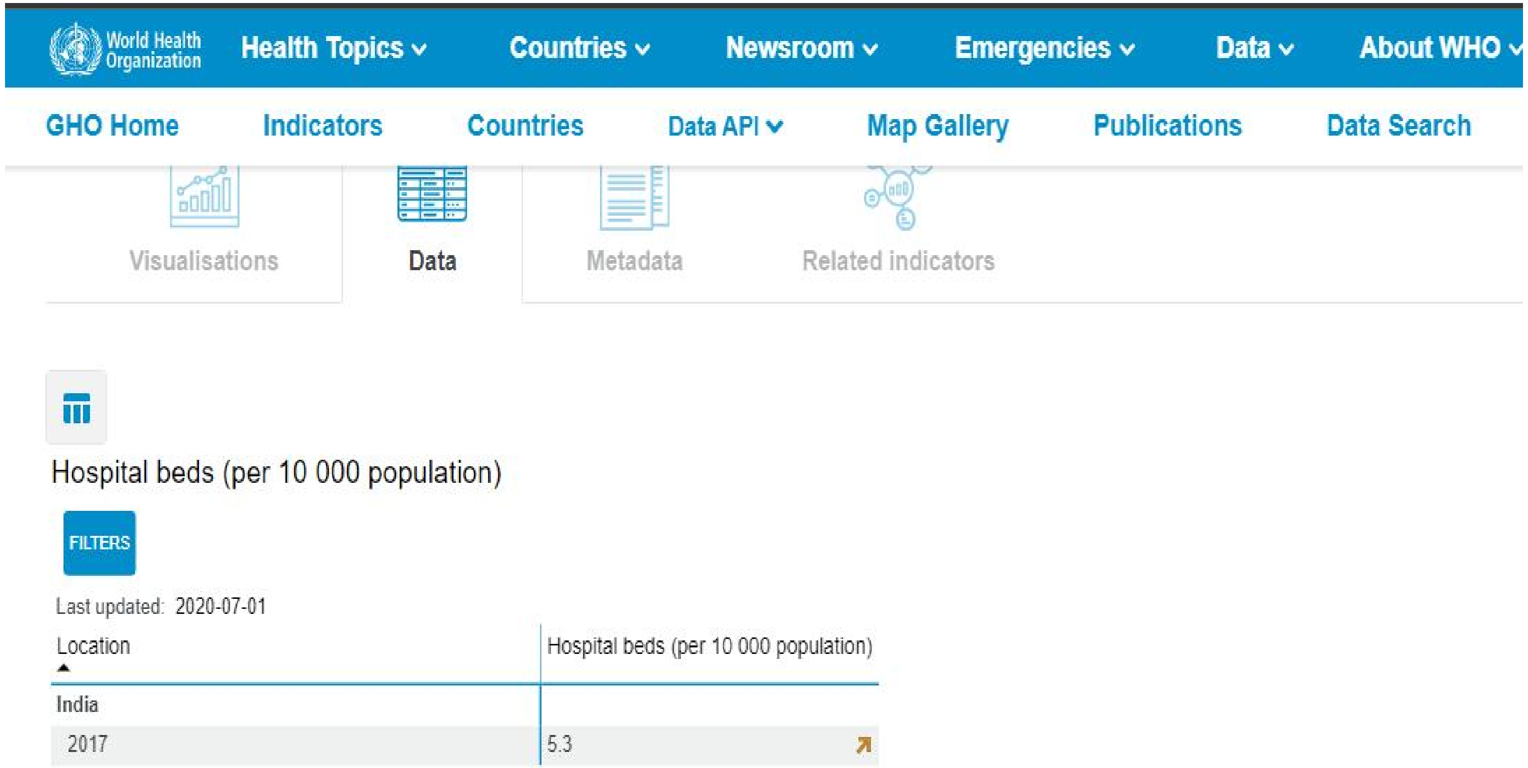


CO_2 emissions in 2010 and 2020 by select country (in million metric tons)

India is ranked 3rd in the world



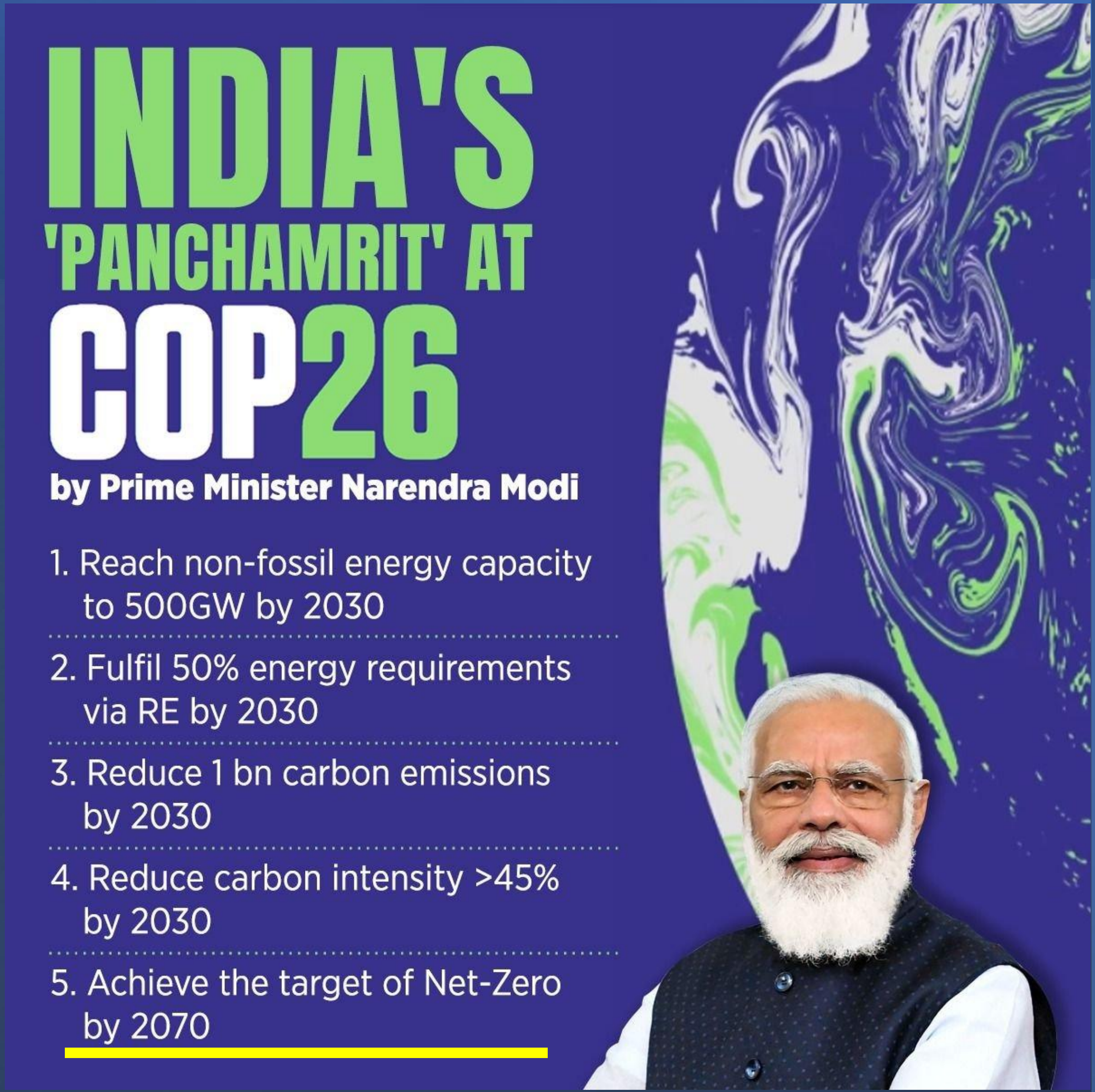
"WHO" – On Hospital Bed Requirements in India



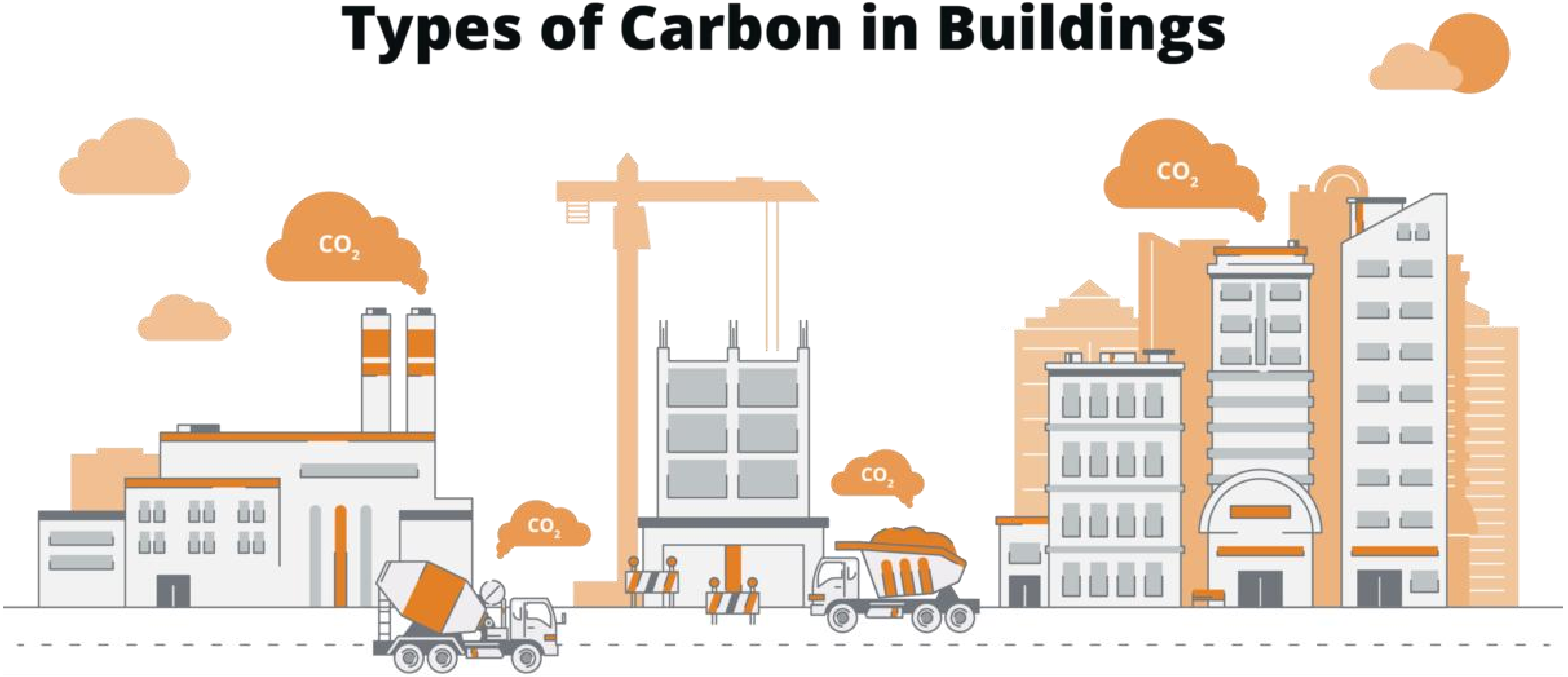
530 Beds per million of people which is only **15%** of world average i.e. **3960.**

In India hospitals contribute **23%** of total energy consumption and the hospital building growth rate **12–15% in last decade.** The World Health Organization estimated that India need 80,000 additional hospital beds every year to meet the demands of India's population.

Source: WHO website & 10th International Conference on Energy

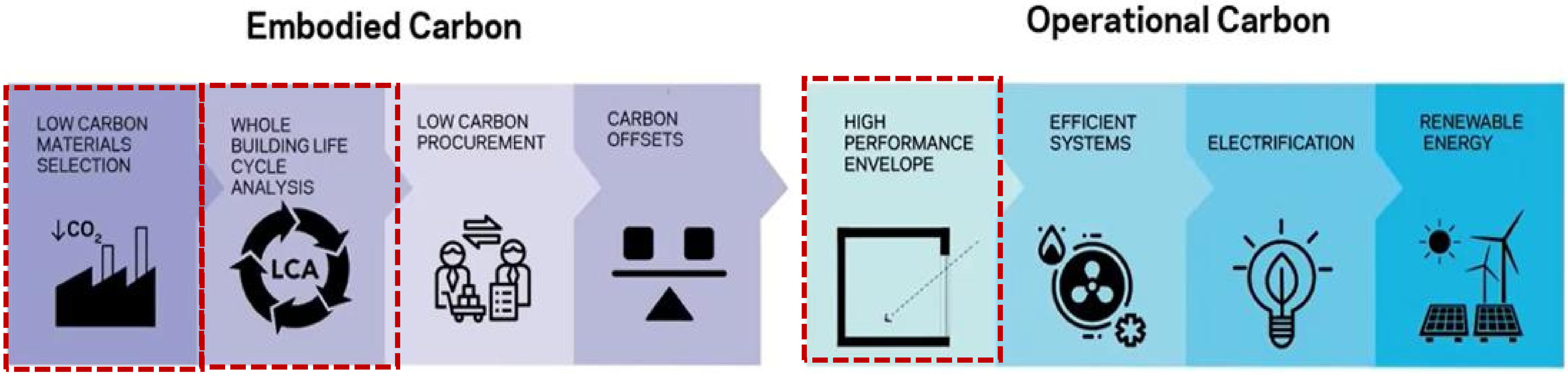

INDIA'S
'PANCHAMRIT' AT
COP26
by Prime Minister Narendra Modi
1. Reach non-fossil energy capacity to 500GW by 2030
2. Fulfil 50% energy requirements via RE by 2030
3. Reduce 1 bn carbon emissions by 2030
4. Reduce carbon intensity >45% by 2030
5. Achieve the target of Net-Zero by 2070

Types of Carbon in Buildings



Embodied Carbon
The emissions from manufacturing, transportation, and installation of building materials.

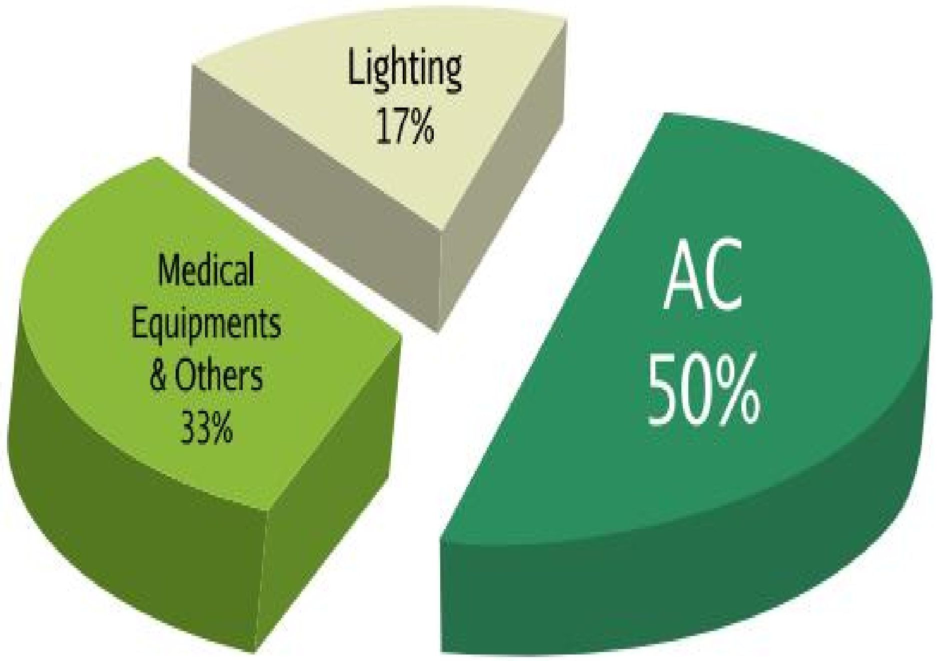
Operational Carbon
The emissions from a building's energy consumption.



CARBON INVOLVED IN BUILDINGS

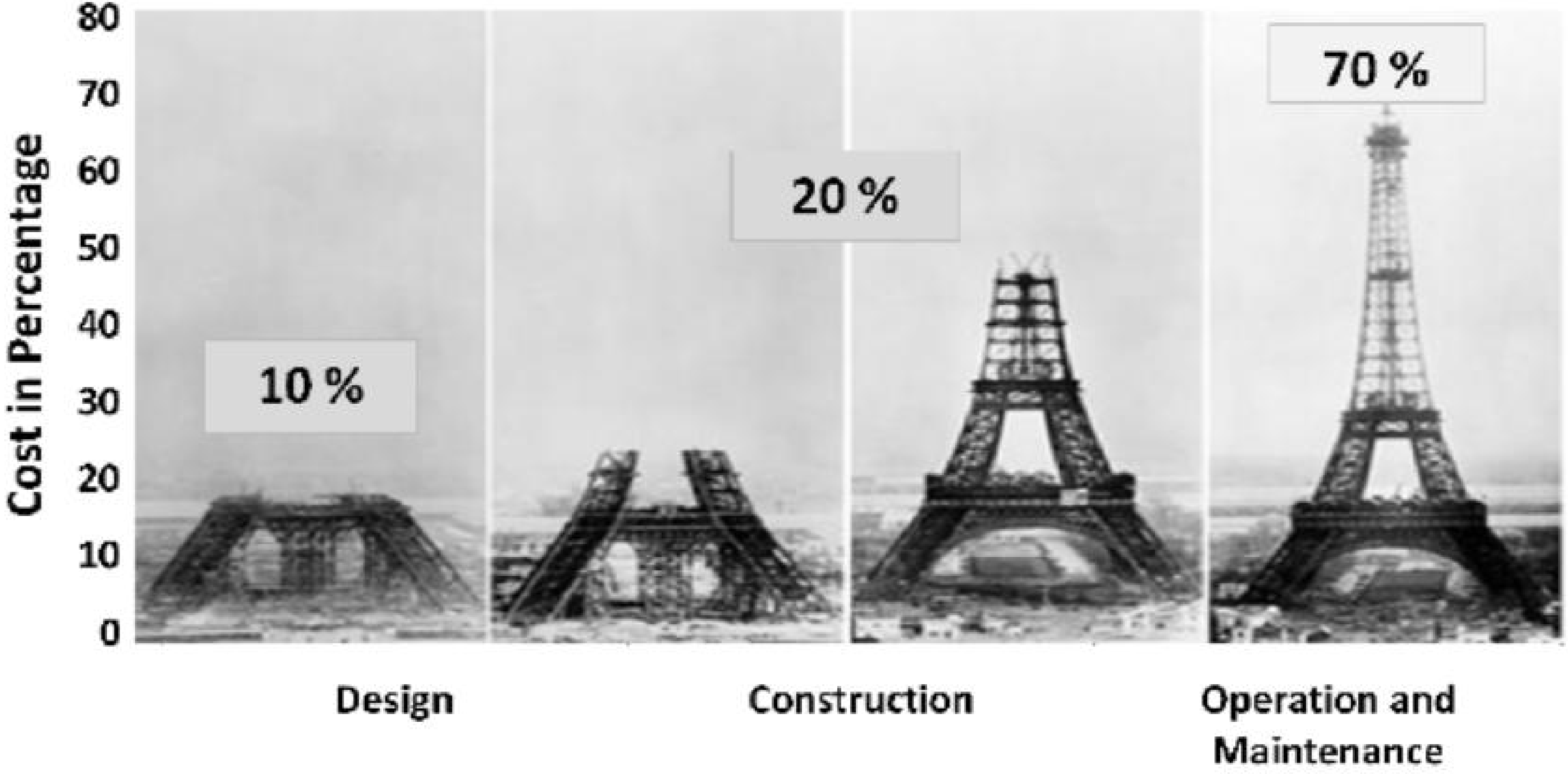
Energy Consumption in Hospitals (23 Participating Hospital)

- Bhopal
- Pune
- Mumbai
- Navi Mumbai
- Kolkata,
- Ludhiana

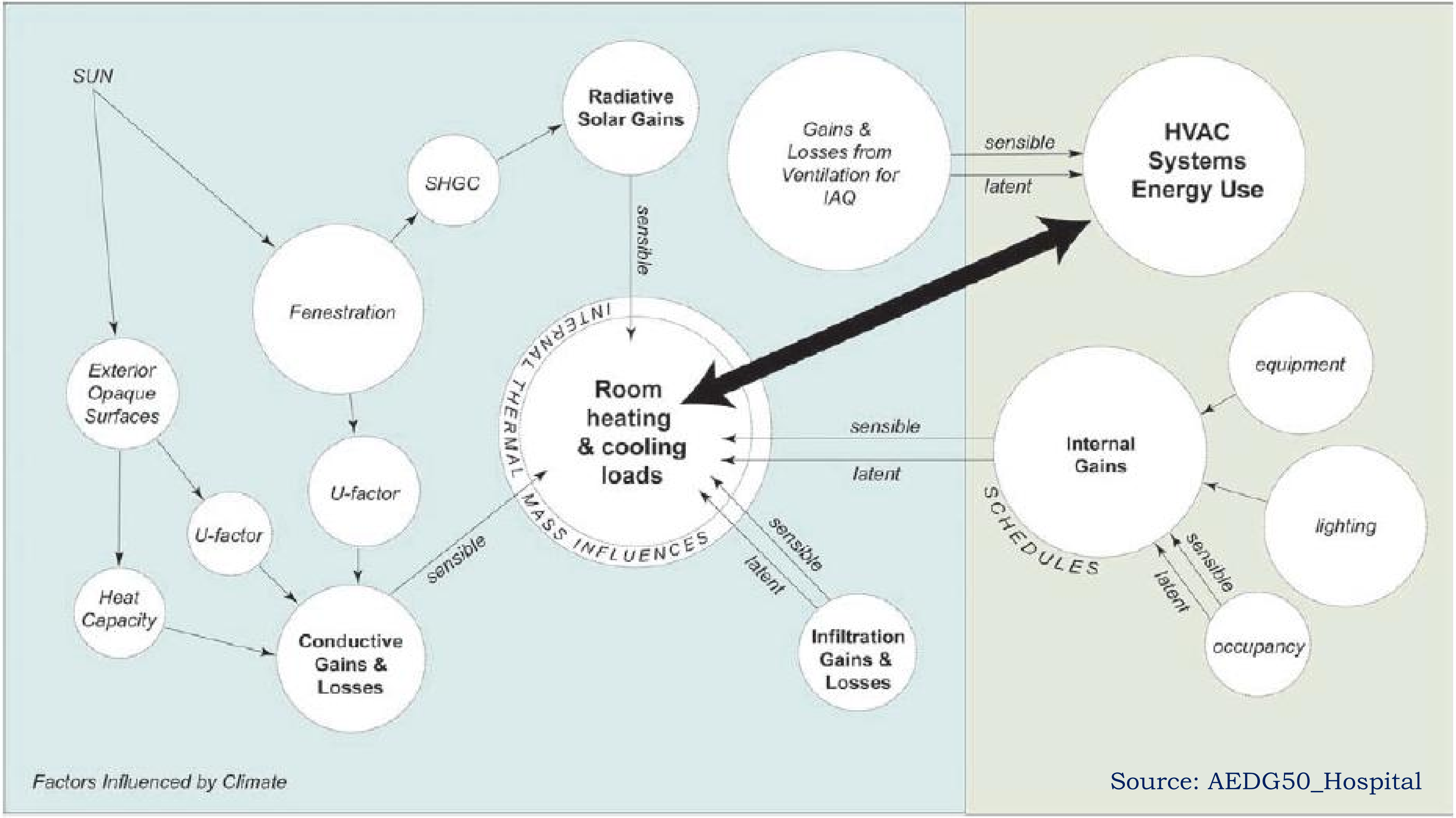


Source: A Report on Energy Efficient Hospitals – visiting the realities by CII & schneider

Building Life Cycle Cost Analysis (LCCA):



APPROCH TO
ENERGY EFFICIENT BUILDING
DESIGN



Source: AEDG50_Hospital

Energy Efficient Buildings

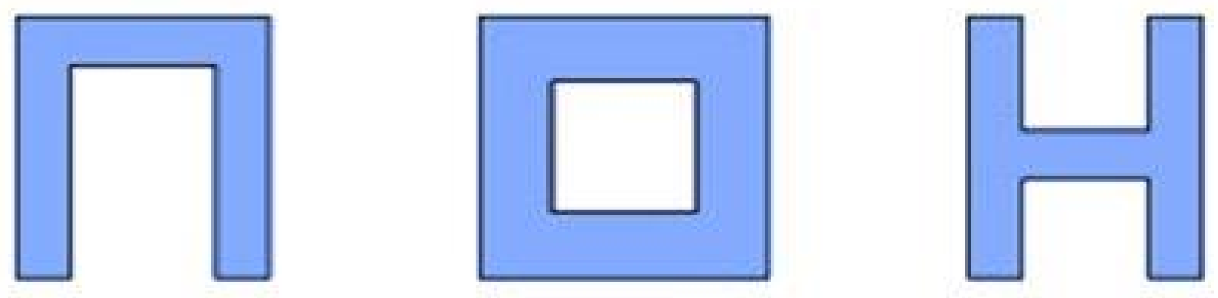
Best Practices for Energy Efficient Building Systems

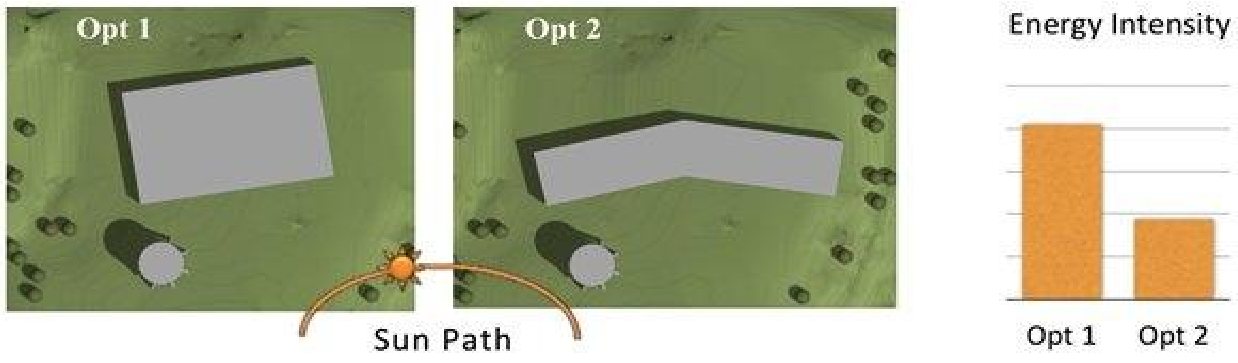
Envelope and Passive Systems:

- Optimizing massing and orientation using building energy simulation
- Decreasing envelope heat gain through appropriate construction assemblies, passive construction, insulation, phase change materials, shading, and reflective ‘cool’ surfaces
- Optimizing fenestration and window-to-wall ratios
- Maximizing daylight autonomy without glare

Passive Architecture

- Mass and form

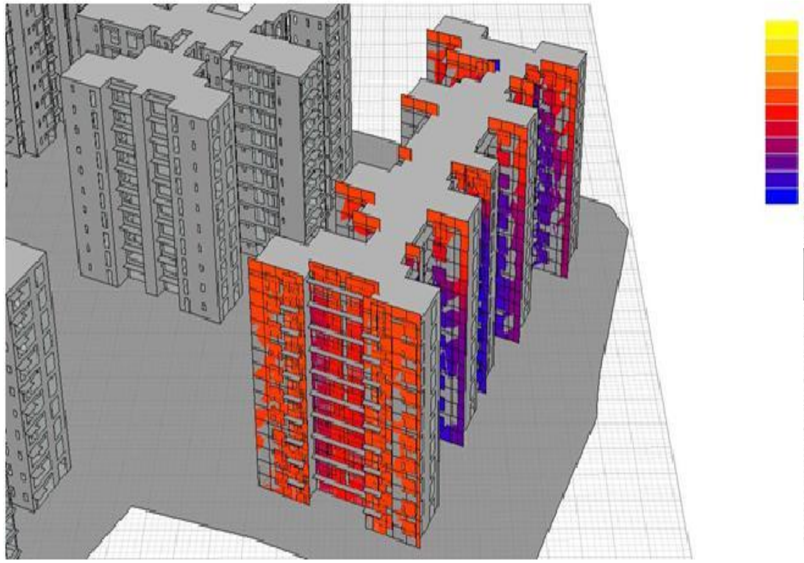


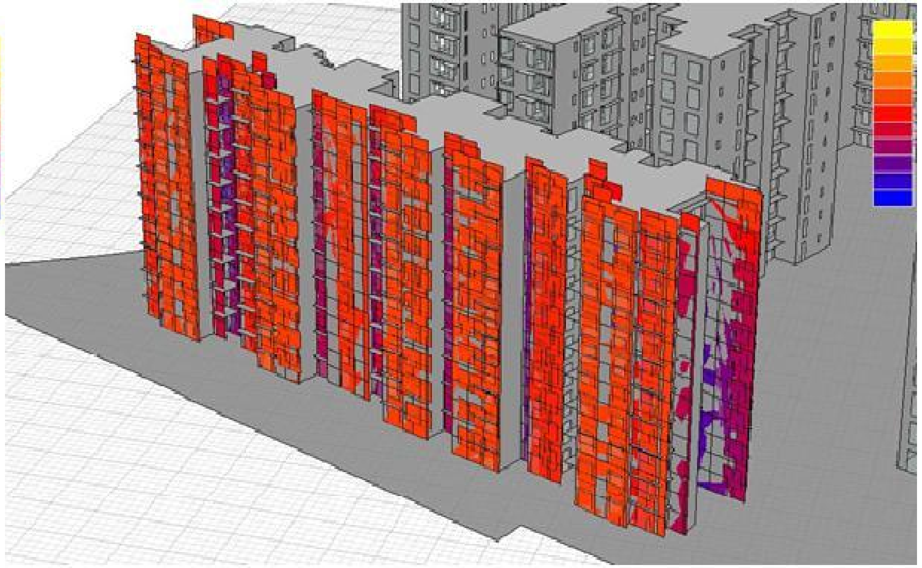


Passive Architecture

- Mass and form

  Reduce Insolation

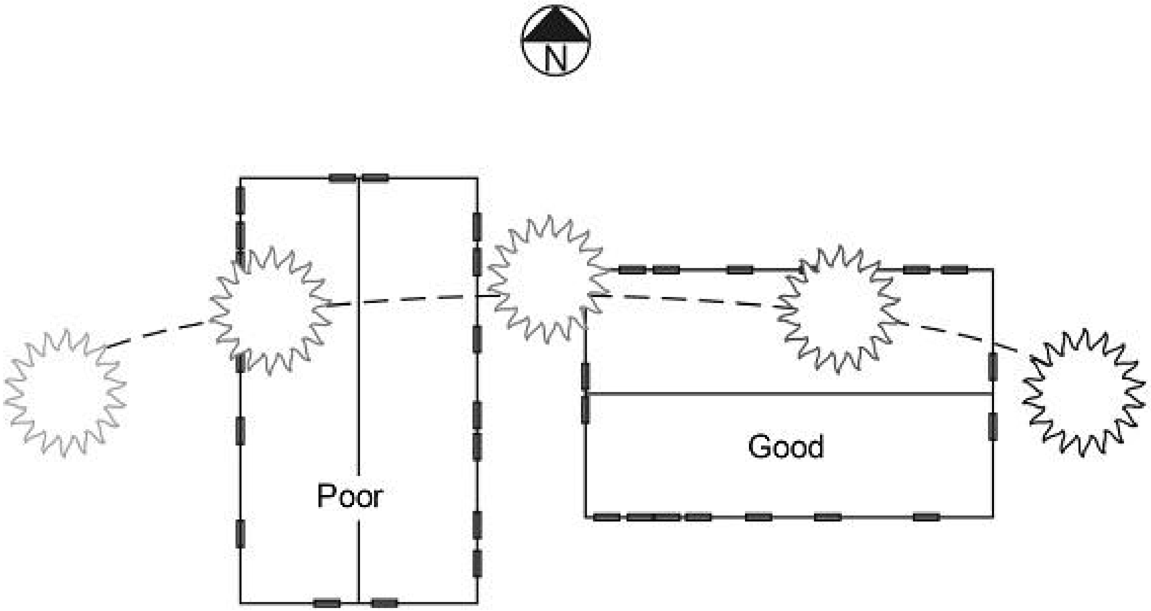


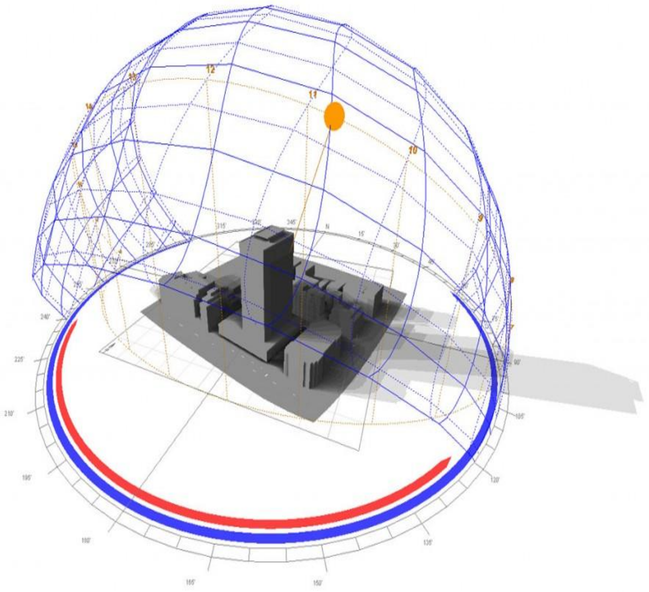


Passive Architecture

- Which is the best orientation?

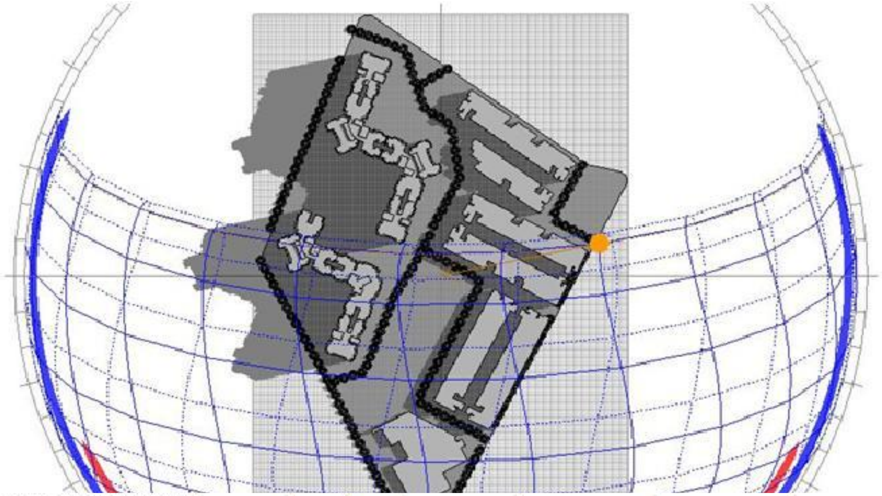
  North – South ? East –West ?

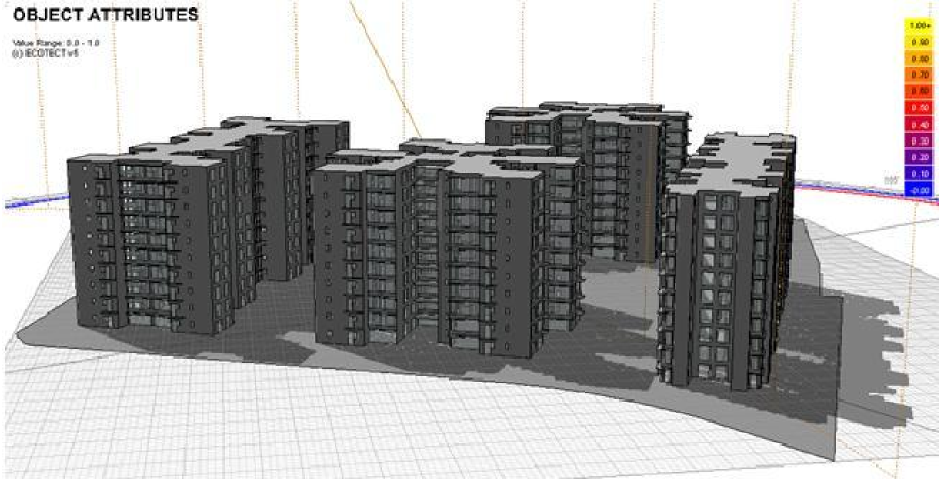


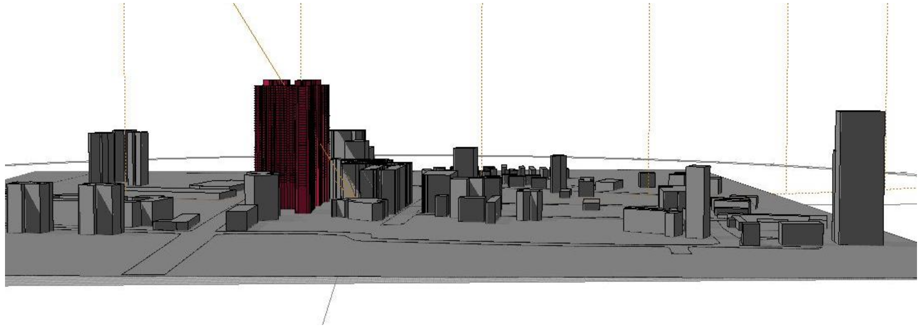


Passive Architecture

- Sun-path Analysis

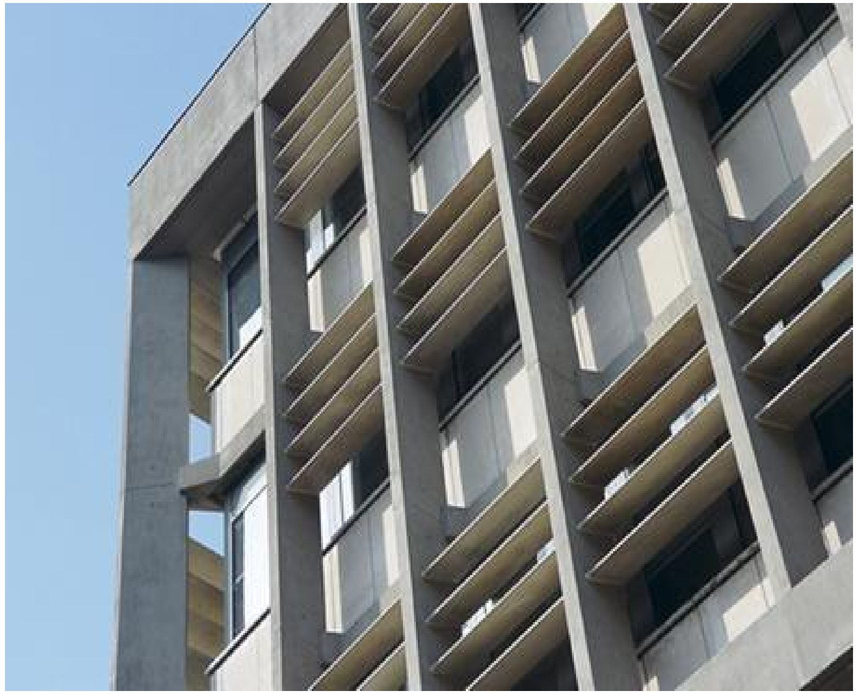


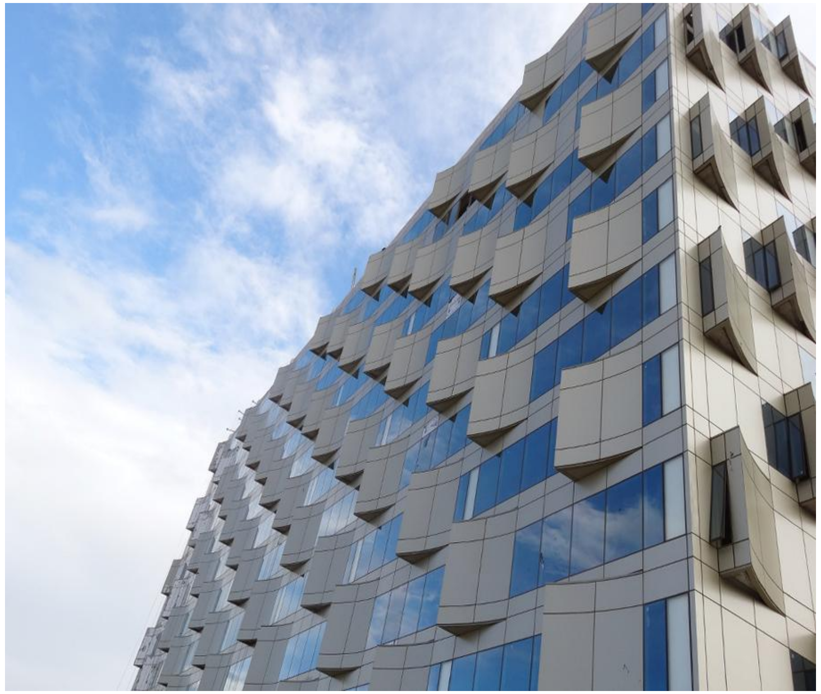




Passive Architecture

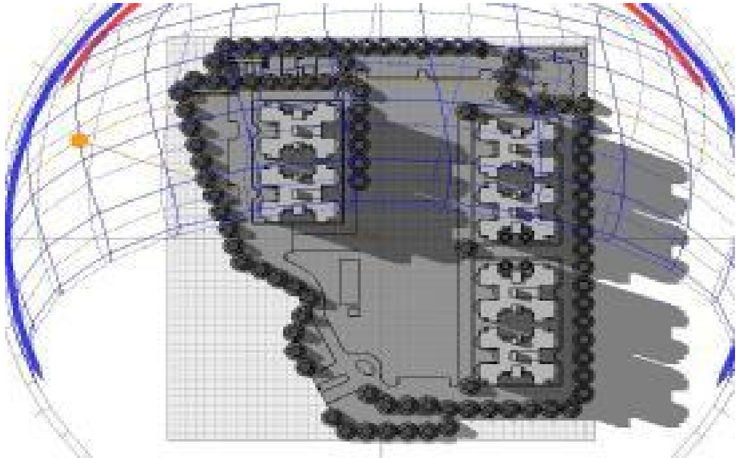
- Shading
  - Self–shading
  - Horizontal/ Vertical overhangs
  - Motorised louvers / venetian blinds



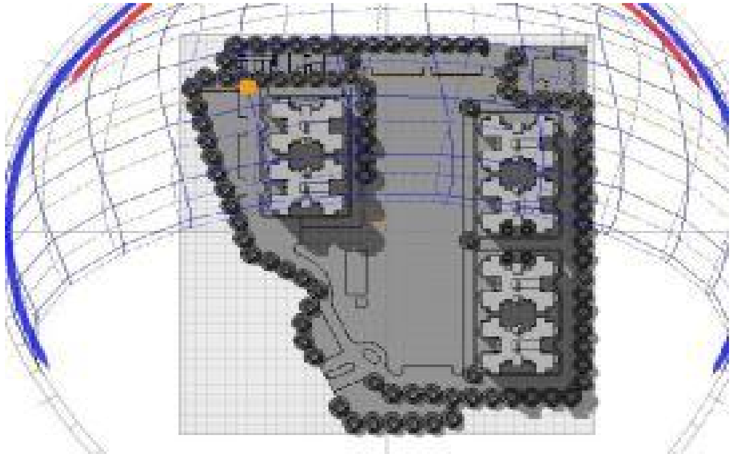


Passive Architecture

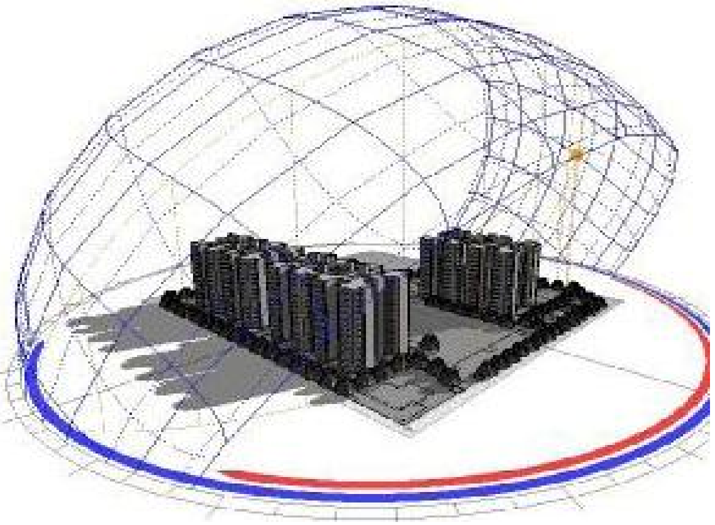
- Shading Analysis



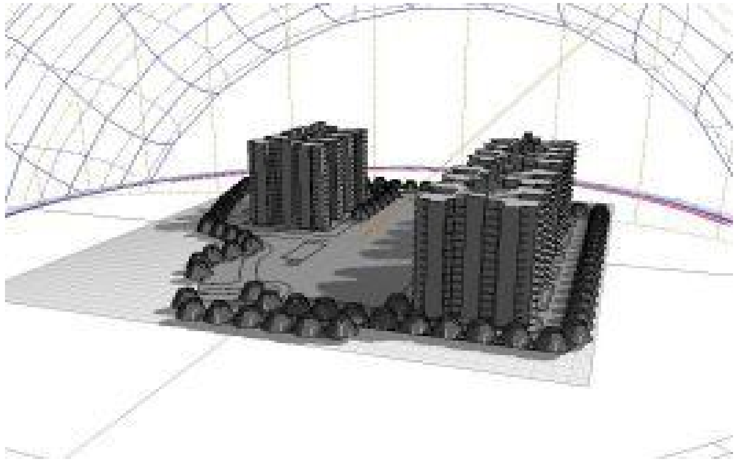
At 09:00 Hrs



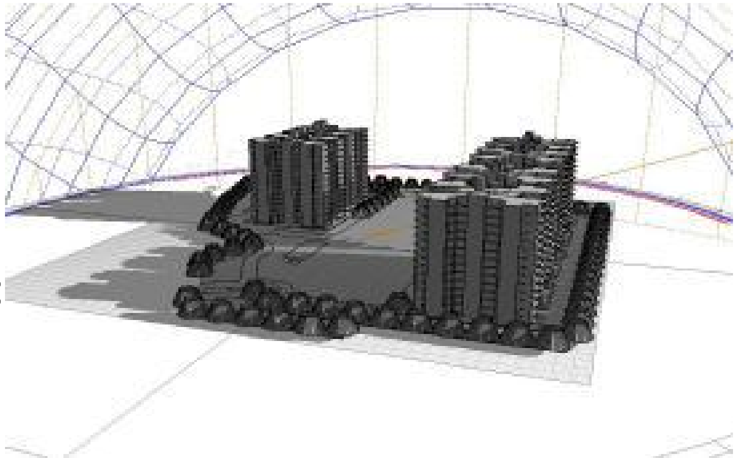
At 11:00 Hrs



Study of shadows and orientation at different times on 21st June.



At 15:00 Hrs



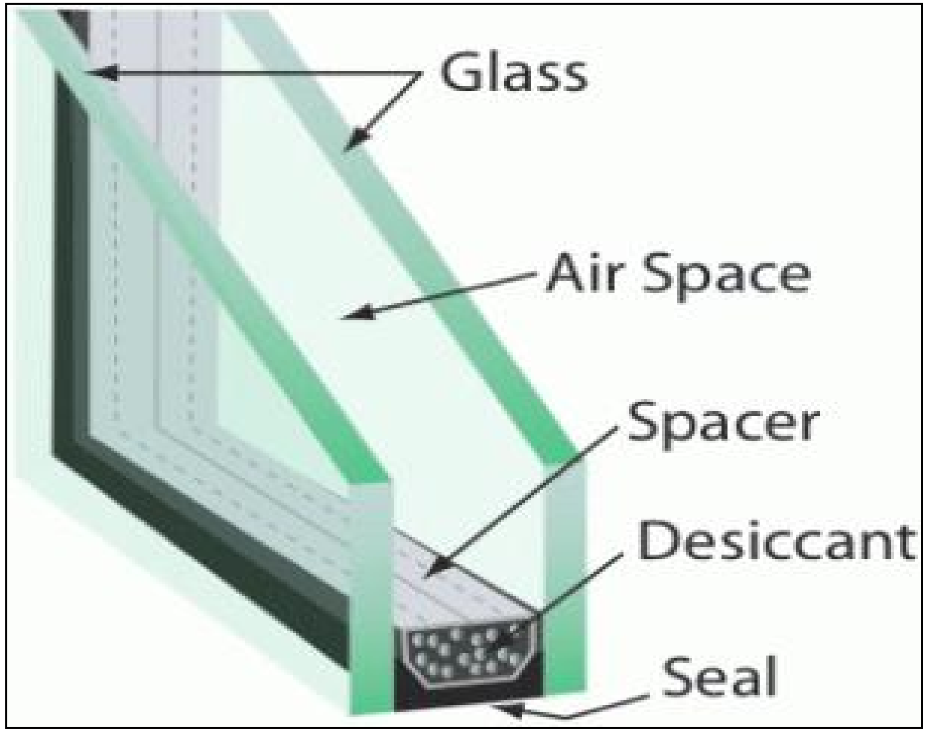
At 17:00 Hrs

Passive Architecture

- Optimize Window – Wall Ratio
  - Around 40% is ideal
  - Introduce spandrels
  - Punched windows
  - Fritting

Building Envelope

- Glazing
  - High performance glazing
  - Trade-off between light and heat ingress
  - Electro-chromic glass – dynamically changes properties



Building Envelope

- Wall
  - low conductivity blocks
  - Hollow blocks, flyash blocks, AAC blocks
  - Cavity walls

Fired Clay Bricks

Concrete Blocks

Hollow Concrete Blocks

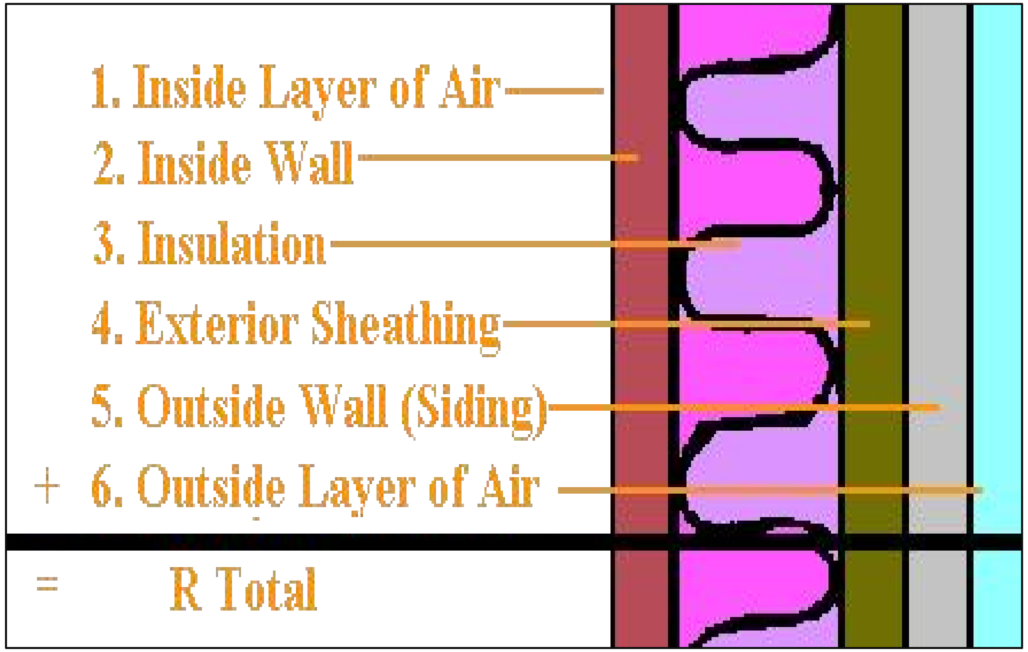
AAC blocks

Building Envelope

- Wall

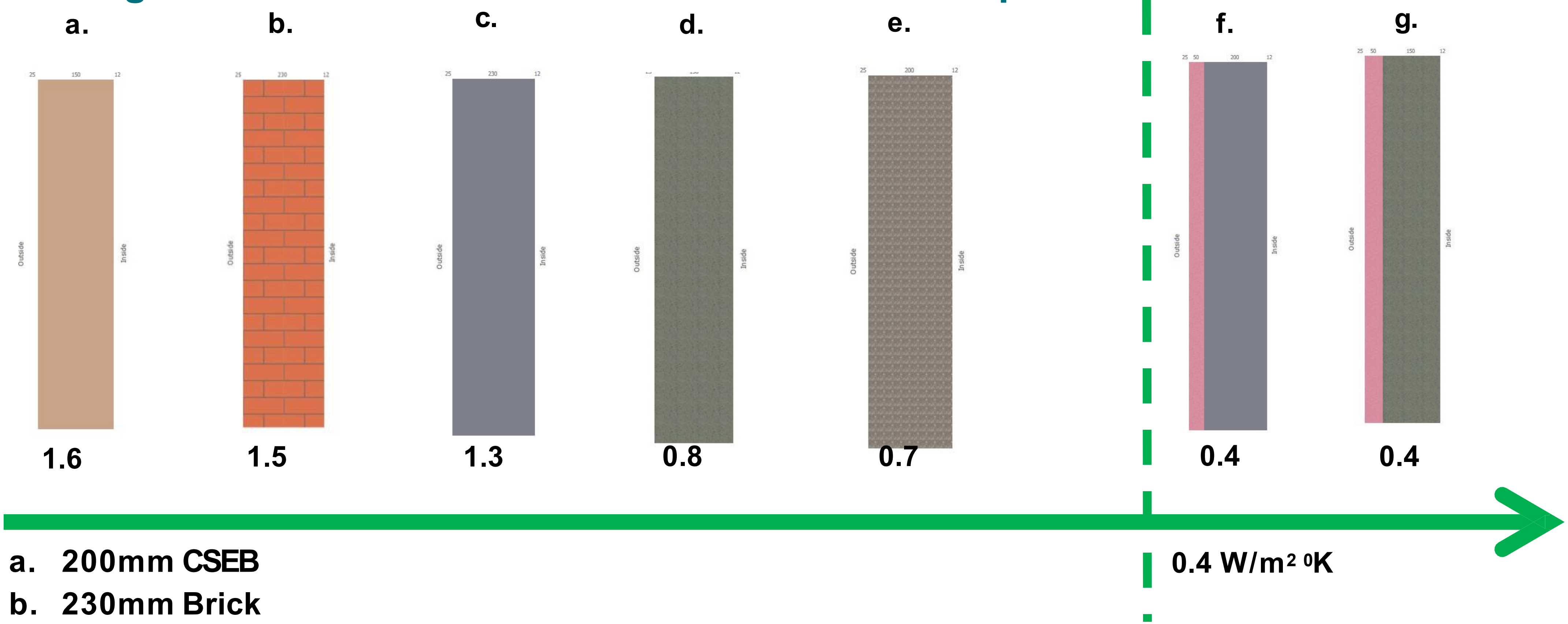
Insulation

- Insulation materials - XPS, EPS, Rock wool etc



Challenges for Energy Efficient Wall Assembly

Achieving U-value or Thermal Transmittance value as per standards



a. 200mm CSEB
b. 230mm Brick
c. 200mm Fly ash Brick
d. 200mm AAC Block
e. 200mm Concrete Block with EPS balls
f. 150mm Fly ash Brick with 50mm Extruded Polystyrene (XPS)
g. 150mm AAC Block with 50mm Extruded Polystyrene (XPS)

**All wall assemblies have 25mm external plaster and 12mm internal plaster*

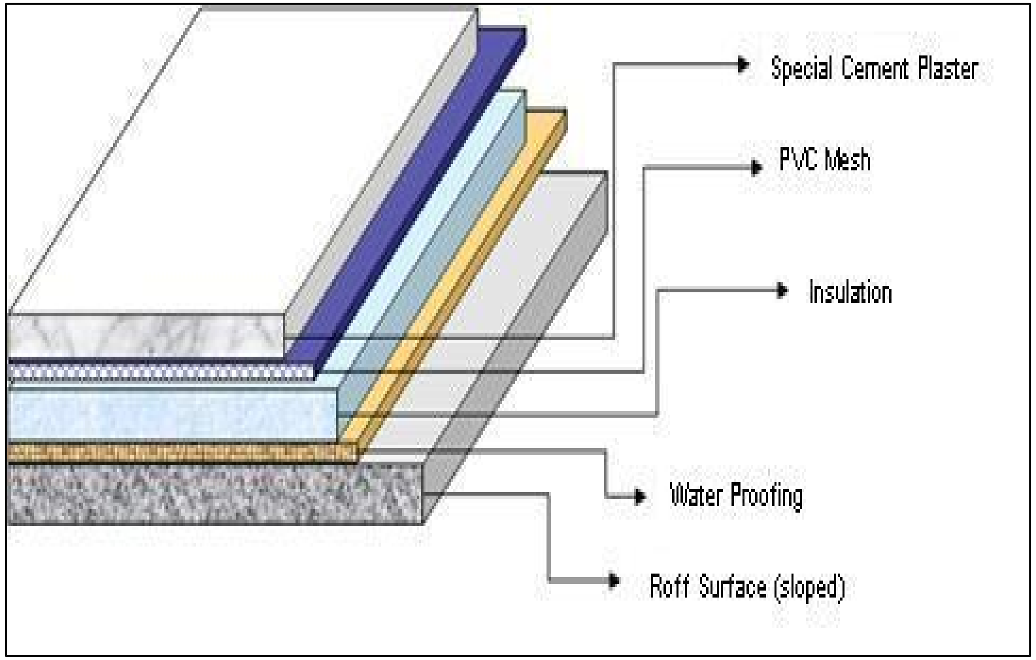
Source: www.carbse.org

Building Envelope

- Roof

Insulation

- ❑ over-deck / under-deck
- ❑ Insulation materials - XPS, EPS, PUF etc.



Building Envelope

- Roof

  Terrace Garden

Building Envelope

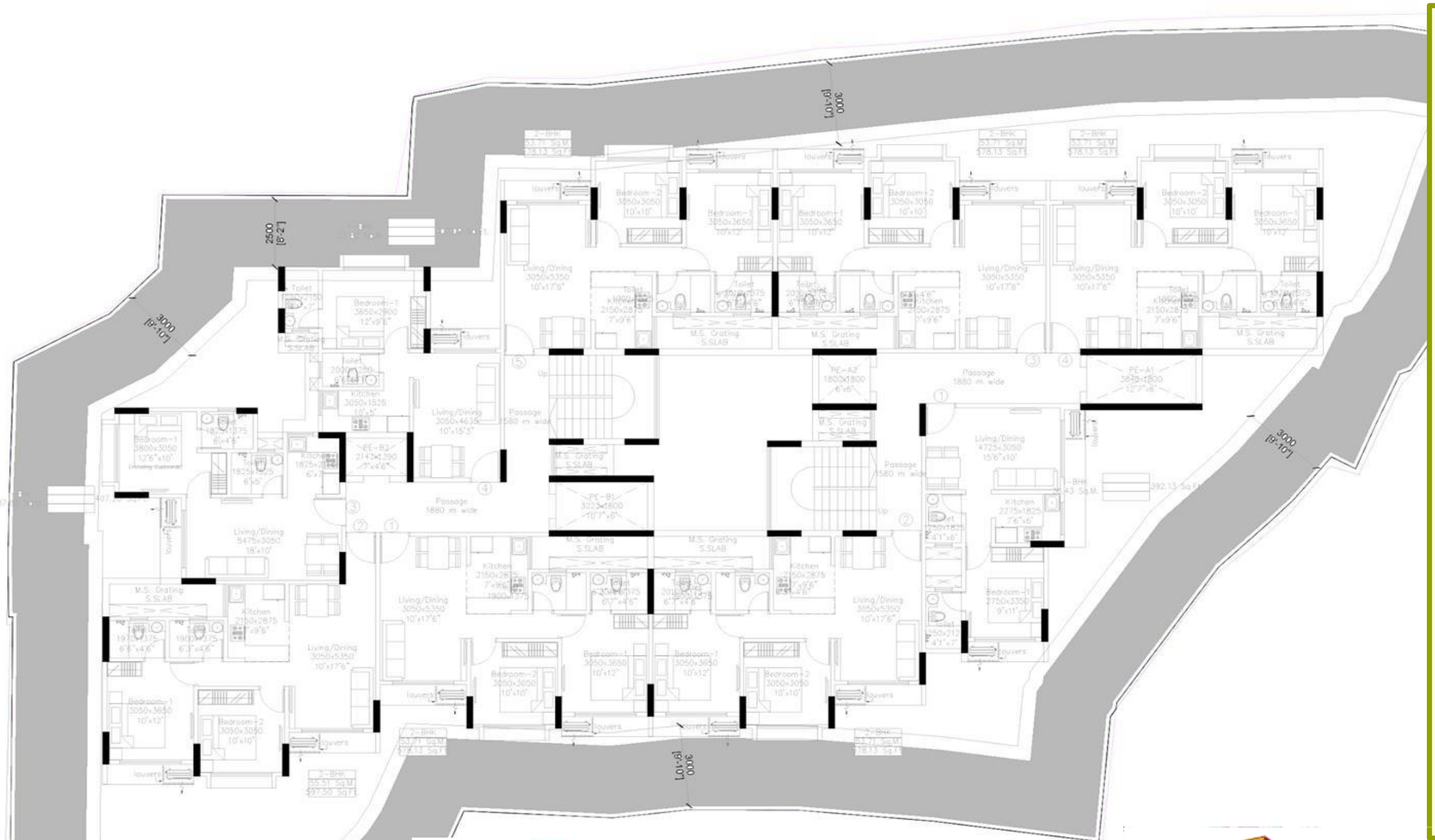
- Roof

Terrace Garden – mitigates Heat Island effect

Building Envelope

- Roof
  - High reflective coating– mitigates Heat Island effect
  - Select roof coating /materials with high SRI value (SRI > 80)

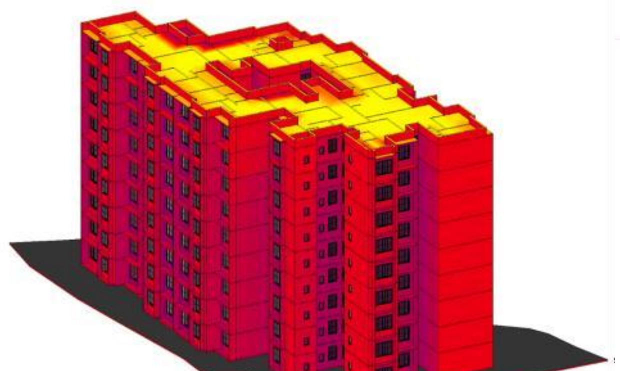
Building Envelope –Shading Design – Case Study



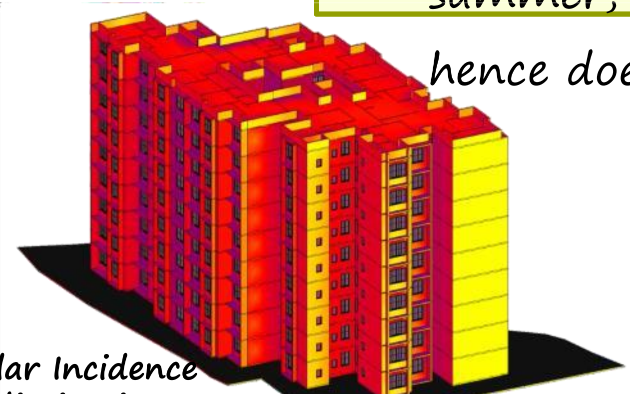
Key points:

- East and West facades are not shaded by surrounding forms in critical period
- Need to provide shading on East and West facades during critical months and times of the day (March to June)
- North façade is exposed to summer sun. However, it is shaded by adjacent building and existing horizontal shading devices of 750mm are sufficient.
- South façade is shaded in critical times in summer,

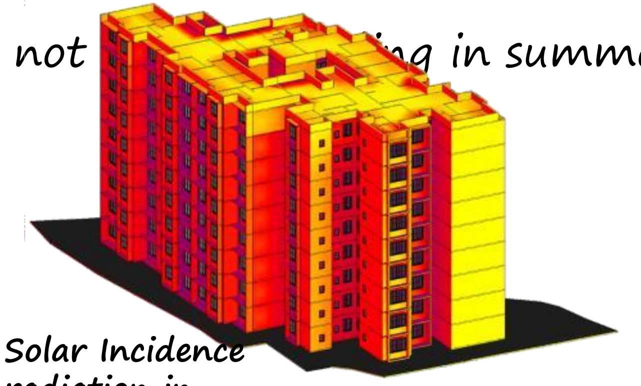
hence does not ... ing in summer.



Solar Incidence radiation in Summer



Solar Incidence radiation in winter

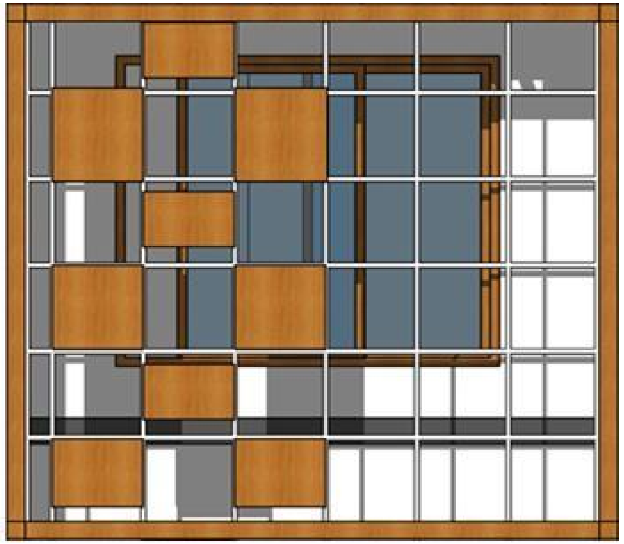


Solar Incidence radiation in Spring

Facade Design options considered

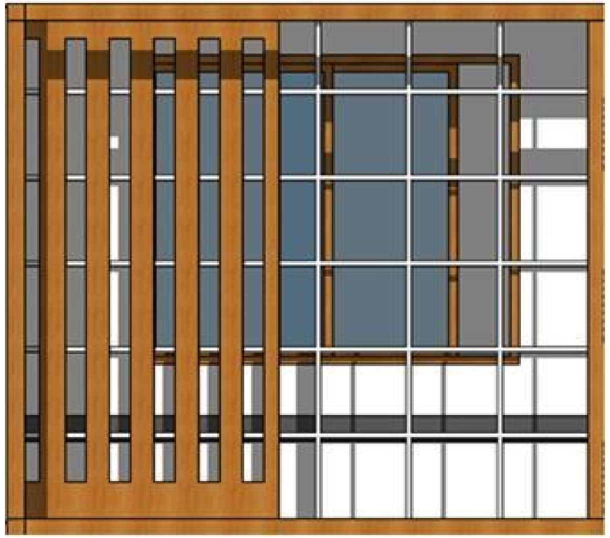
Vertical Shading Panel 1.50mx3.00 m

Option 1 – 35% opening 65% shading



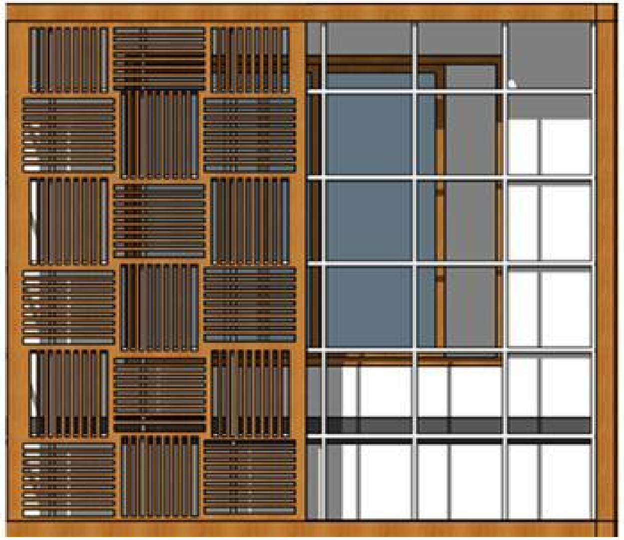
Vertical Shading Panel 1.50mx3.00 m

Option 2 – 57% opening 43% shading



Vertical Shading Panel 1.50mx3.00 m

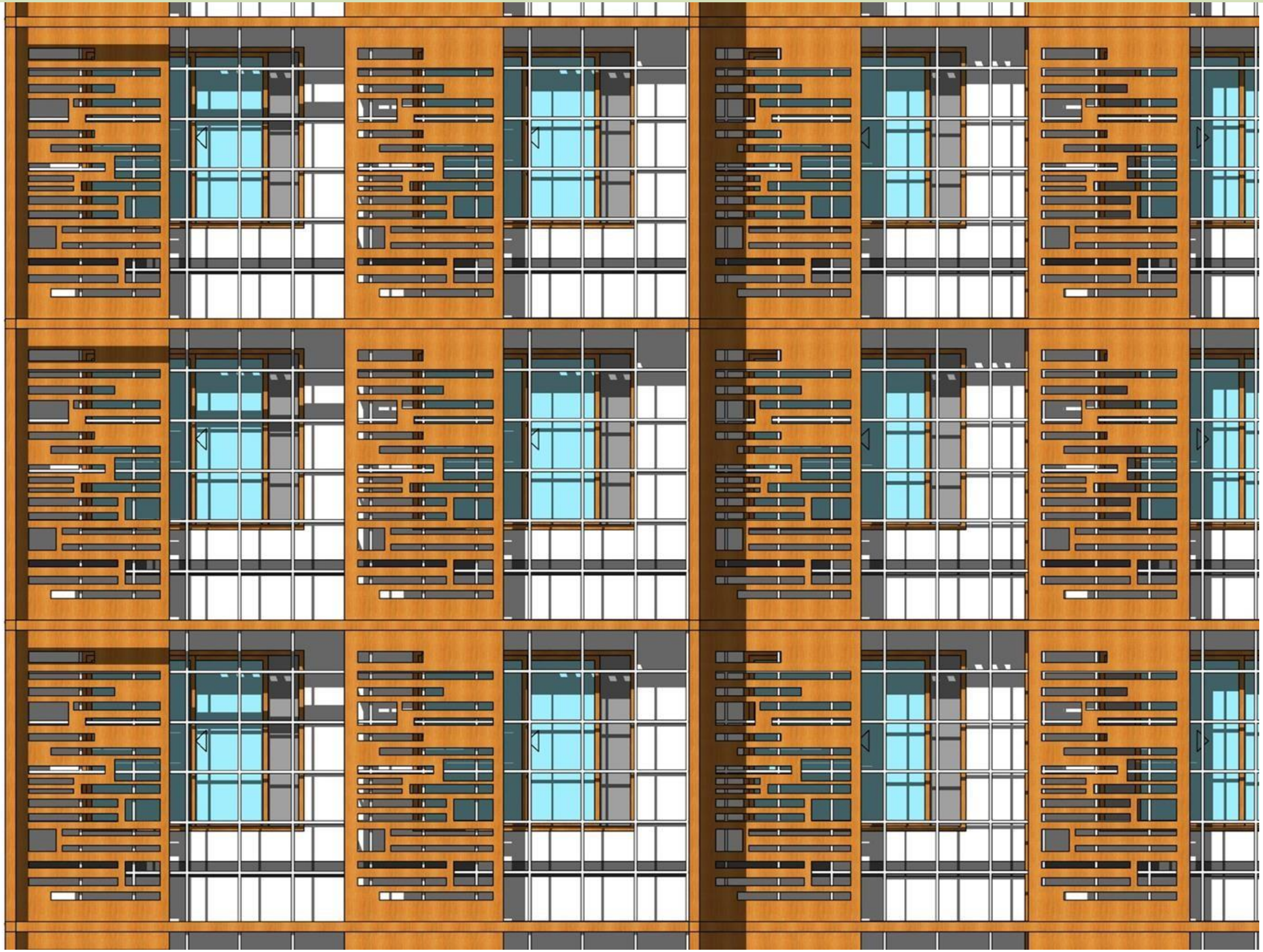
Option 3 – 37% opening



Vertical Shading Panel 1.50mx3.00 m

Option 4 – 50% opening

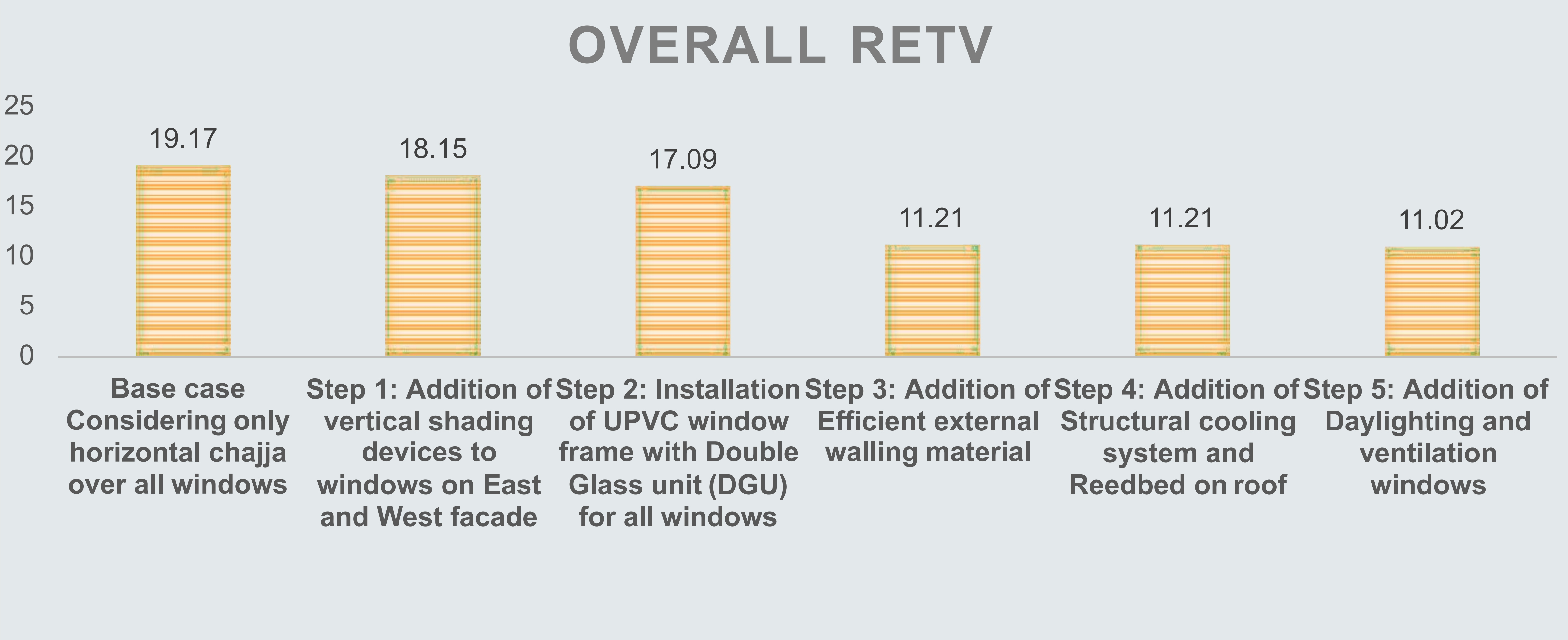
Shortlisted Shade Design for East & West



- Design of West façade to achieve shading in critical period of March to June
- Material with low conductivity to avoid heat absorption and thermal bridging
- 65% shading achieved to maintain view factor

West Facade

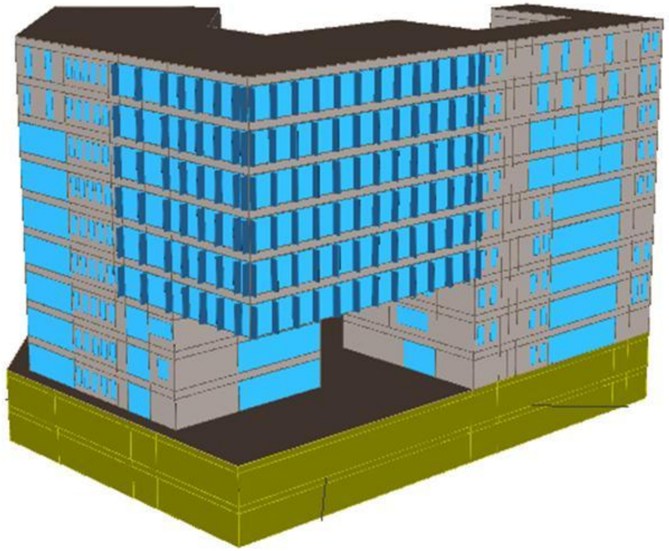
Improvement in building envelope performance

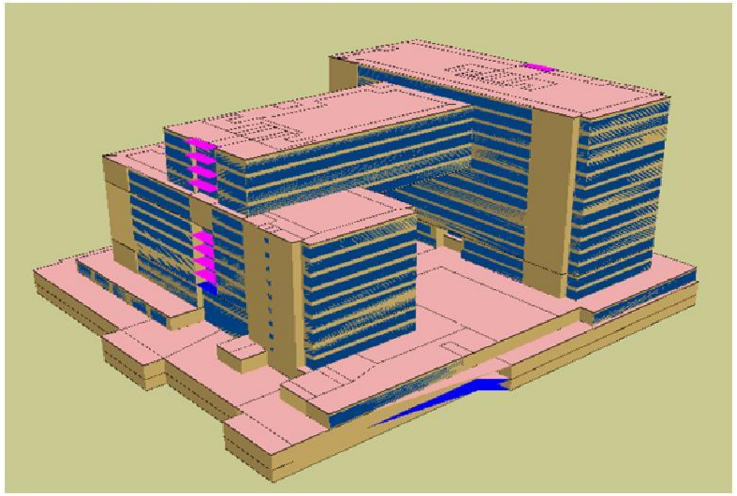


Net Heat Gain Reduced by 42% w.r.t. Base Case

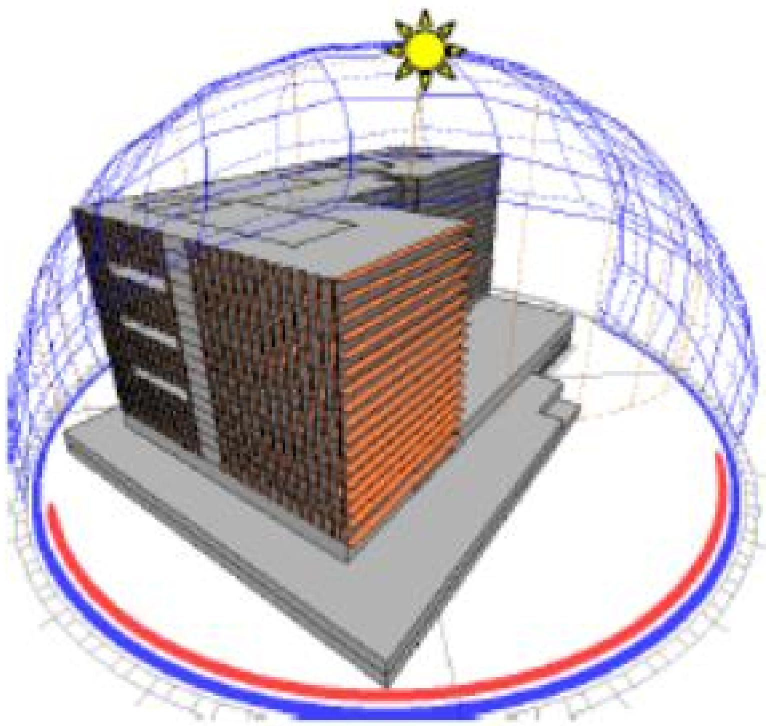
Energy Simulation

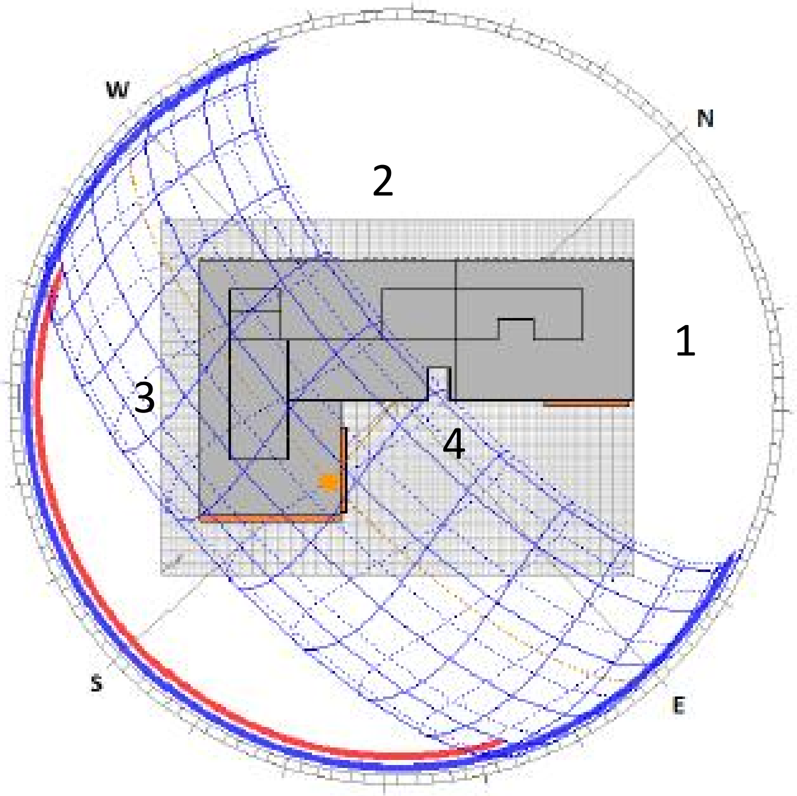
- Design assistance tool & not only a design validation tool
- Assists Architects to quantify benefits of passive design strategies
- Compare performance of different building materials
- Evaluate various Energy Conservation Measures (ECMs)
- Submission to various Green Building Rating systems.
- Softwares: EQUEST, VisDOE, Energy Plus, IES etc.





Climate Analysis (Sun-path)

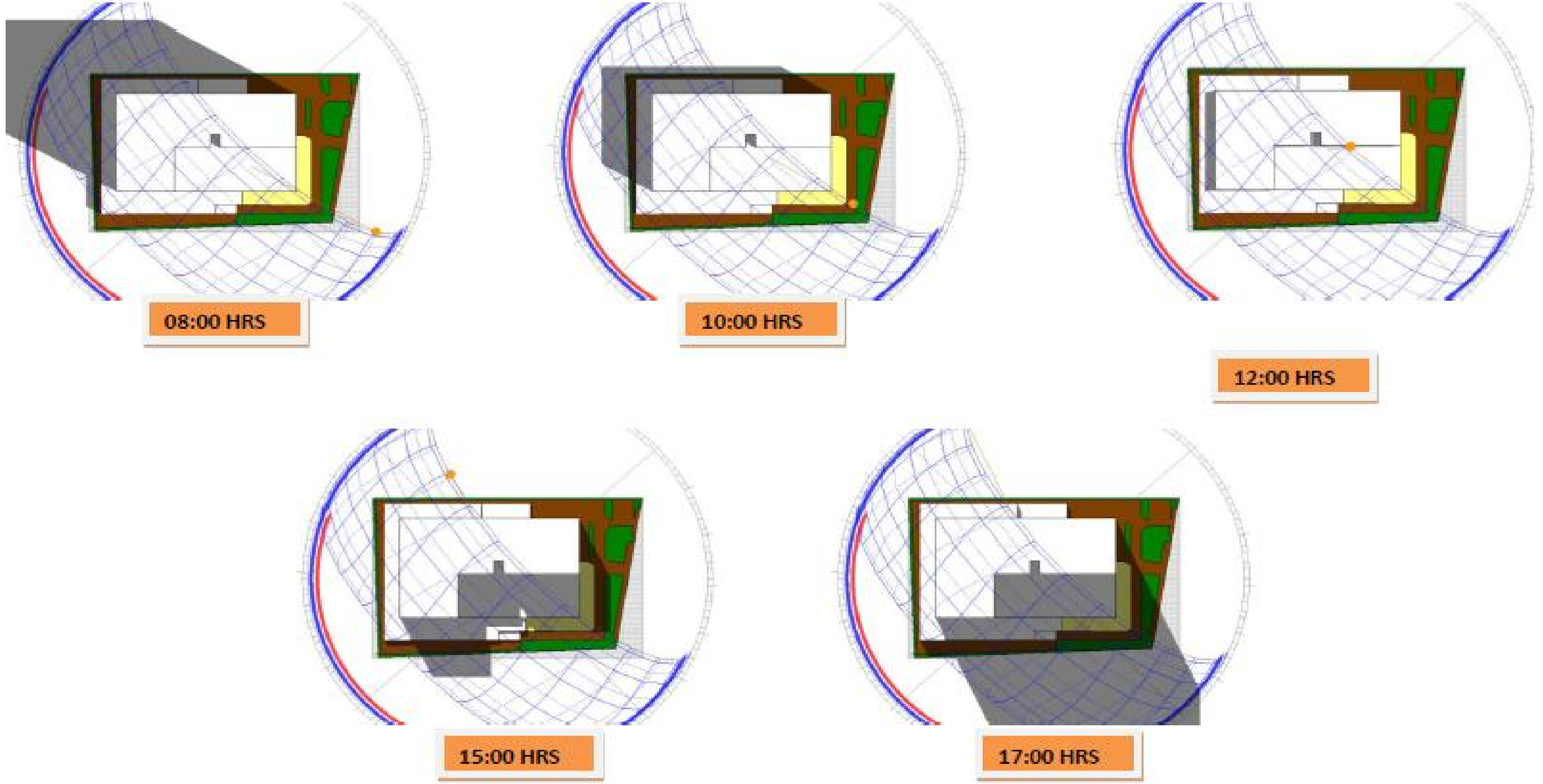




Climate Analysis (Sun-path)

Case Study

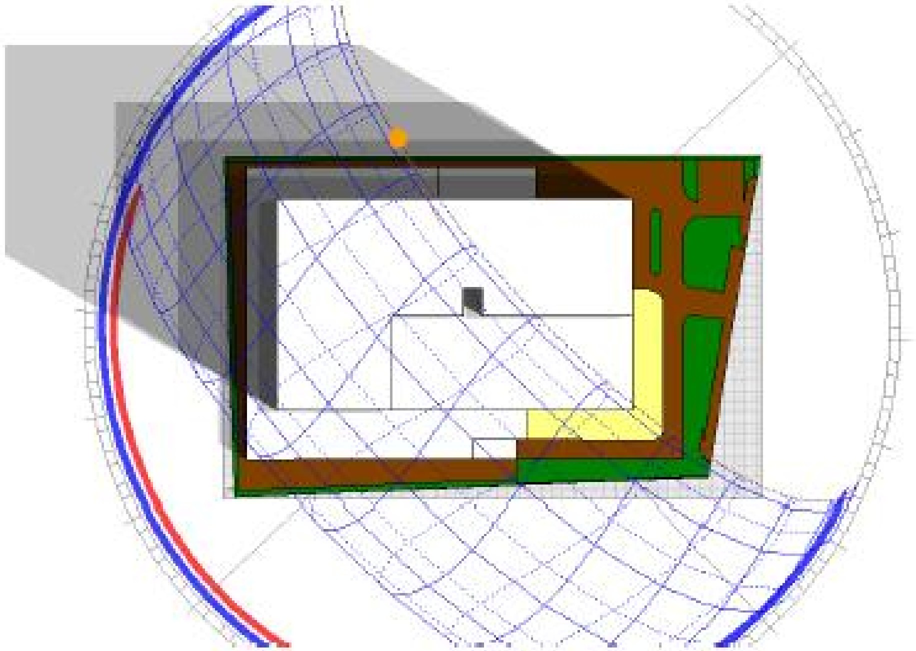
JUNE – SUMMER SOLSTICE



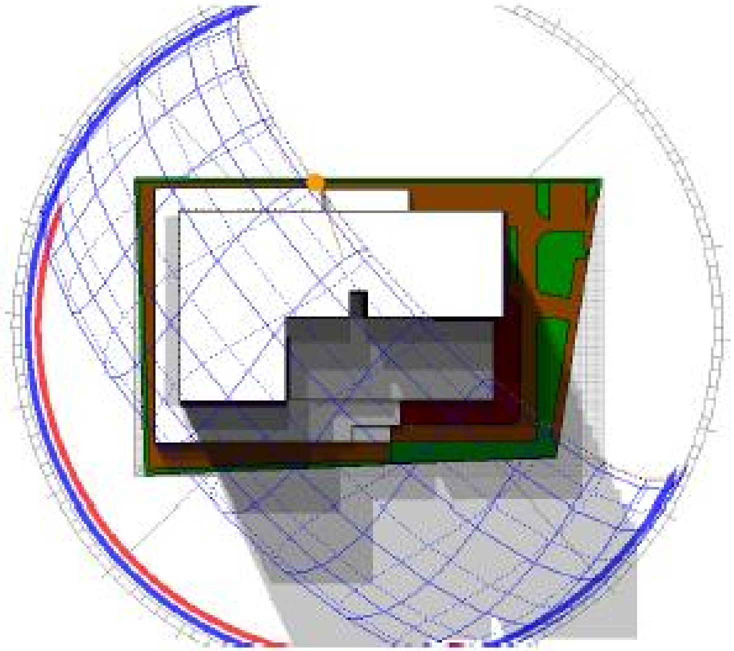
Climate Analysis (Shadow)

Case Study

JUNE – SUMMER SOLSTICE



08:00 HRS – 12:00 HRS



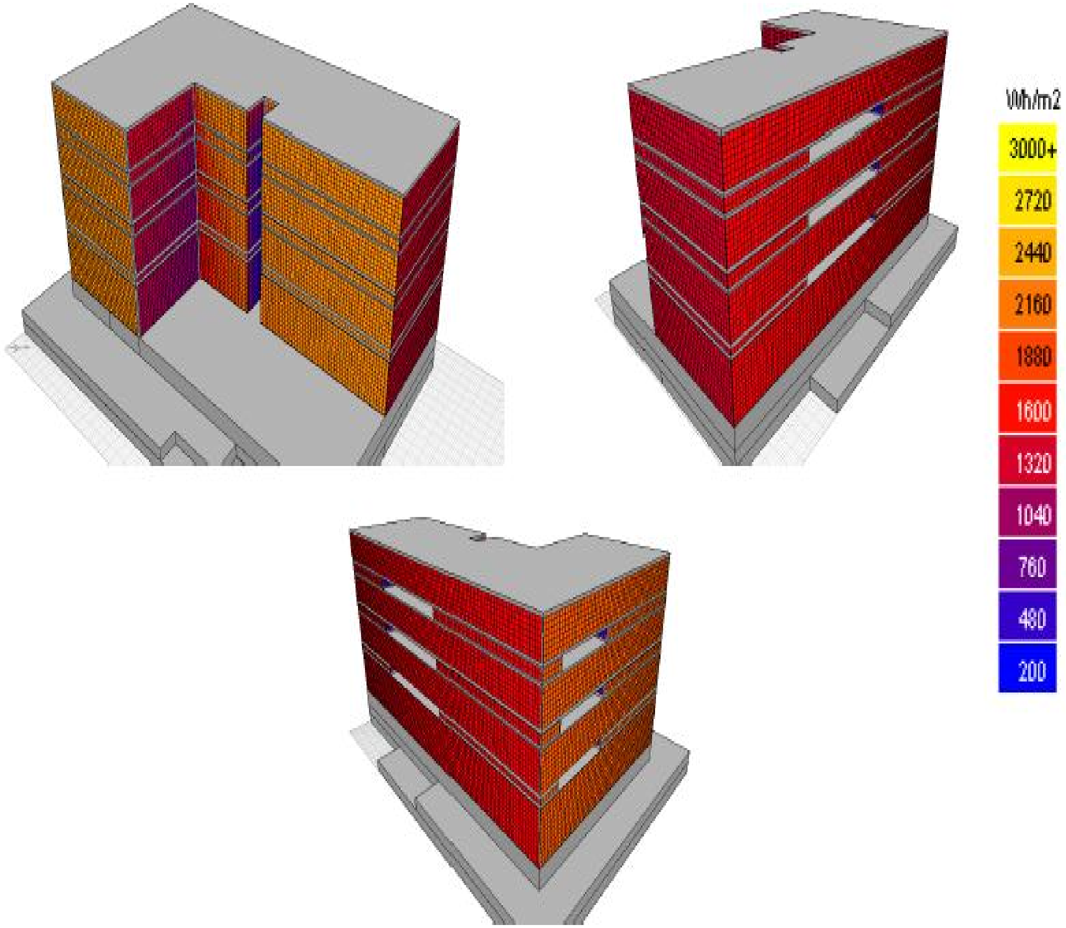
12:00 HRS TO 17:00 HRS

Climate Analysis (Solar Insolation)

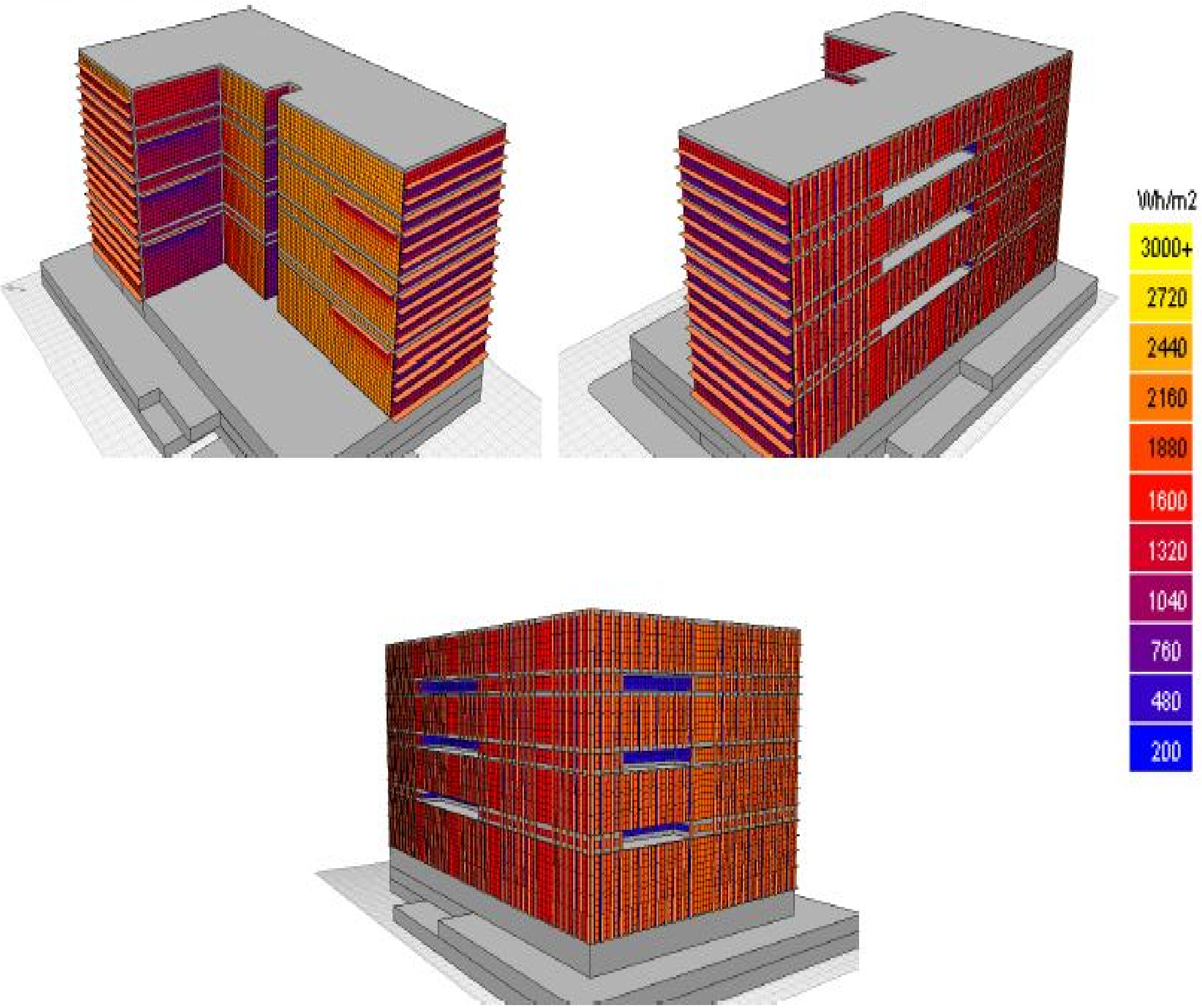
Case Study

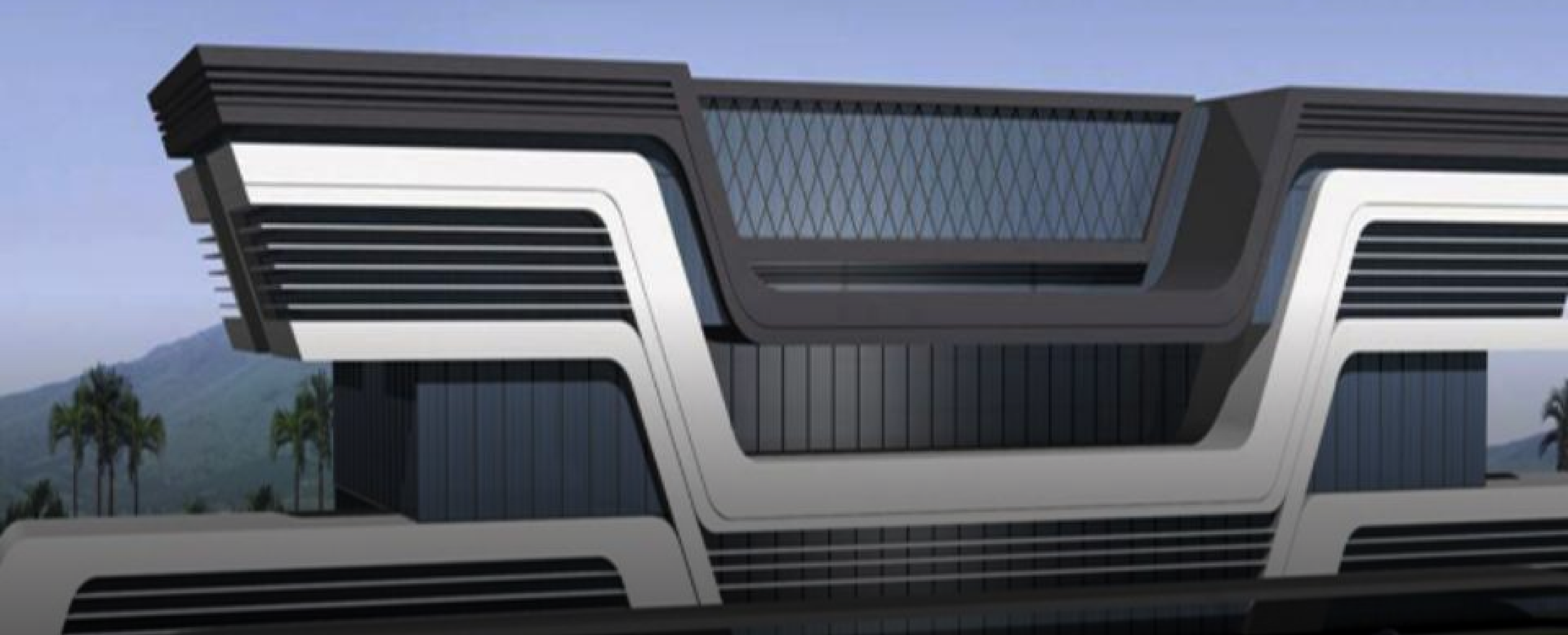
SOLAR INSOLATON ON FAÇADE:

With no shades:



With actual designed shades:





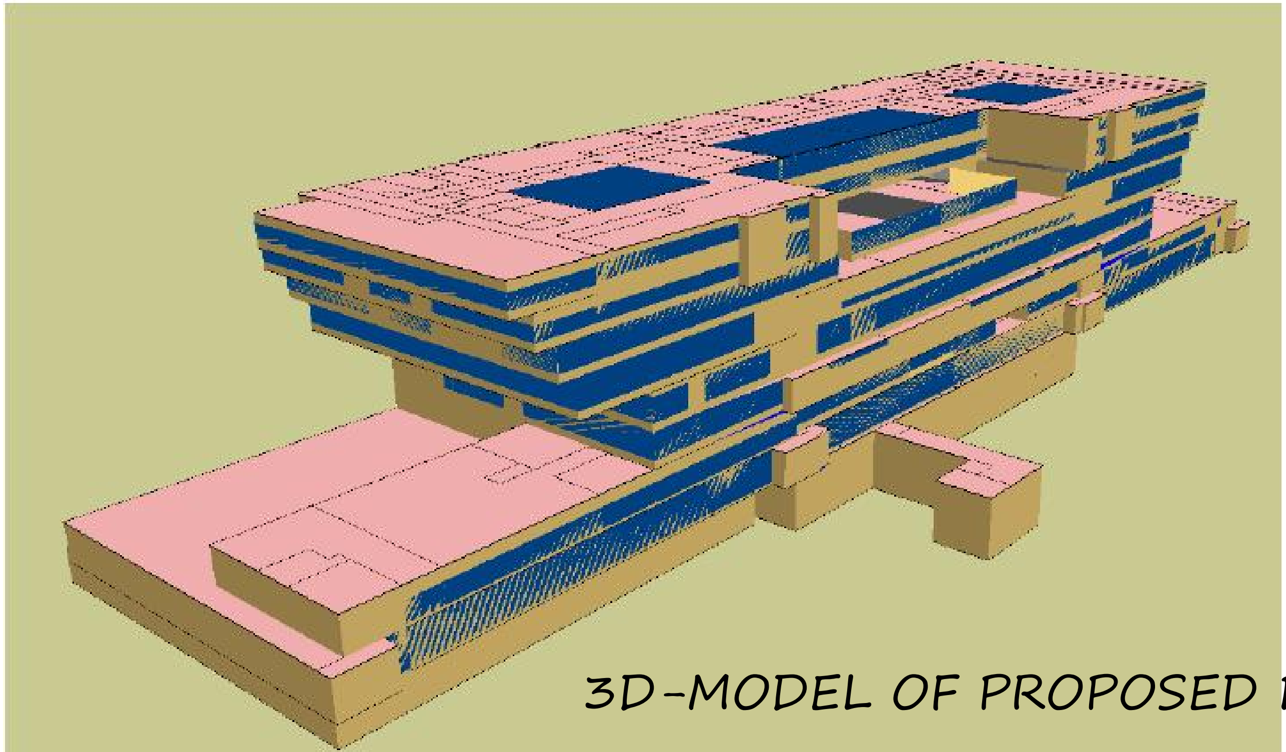
ENERGY PERFORMANCE SIMULATION

NATIONAL CANCER INSTITUTE,
NAGPUR

GLAZING CONSIDERED

BUILDING AREA DETAILS:
Gross floor area : 6,45,228 Sq.ft
Conditioned area : 347,896 Sq.ft
Unconditioned area : 297,332 Sq.ft

- Floor level:
1 basement, Mezzanine, G+ 6 floors
- Year: 2015



3D-MODEL OF PROPOSED BUILDIN

ENERGY SIMULATION (COMPARISON OF PROPOSED & BASELINE PARAMETERS)

BUILDING ELEMENT	PROPOSED CASE DESIGN INPUT	BASELINE DESIGN INPUT
ENVELOPE		
Exterior Wall Construction	• 150mm AAC wall with U-value of 0.193 Btu/hr.ft².°F • 150mm AAC wall with air-gap and spandrel glazing with U-value of 0.120 Btu/hr.ft².°F **(*Material assembly attached)**	Steel Frame Construction R-13 Insulation. U-factor = 0.124 Btu/hr.ft² °F
Roof Construction	150mm RCC Roof with 50mm Brick batt coba and 50mm overdeck insulation with an U-value of 0.08 Btu/hr.ft².°F **(*Material assembly attached)**	Insulation entirely over deck U-factor = 0.063 Btu/hr.ft².°F.
Floor / Slab Construction	6 inch slab, U = 0.350 Btu/hr.ft².°F	Steel Joist construction U-factor = 0.350 Btu/hr.ft².°F
Window-to-gross wall ratio	38 %	38%
Skylight to roof ratio	5.9%	5%
Fenestration Model/ Color	Saint Gobain-Reflectasol	ASHRAE 90.1- 2010
Fenestration U-factor	0.9 Btu/hr.ft².°F (As per ASHRAE 90.1-2010)	1.22 Btu/hr.ft².°F
Fenestration SHGC –all	0.28	0.25
Fenestration Visible Light Transmittance	18%	NA
Skylight	U-value : 1.98 Btu/hr.ft².°F; SHGC:0.19	U-value : 1.98 Btu/hr.ft².°F; SHGC:0.19
Skylight	U-value : 1.98 Btu/hr.ft².°F; SHGC:0.19	U-value : 1.98 Btu/hr.ft².°F; SHGC:0.19
Shading Devices	Building self shade considered	None

Electrical Systems & Process Loads		
Interior Lighting Power Density	Building Area Method 1. Hospital space : 0.9 W/sq.ft	Building area method – Table 9.5.1 ASHRAE 90.1-2010 as follows: 1. Hospital : 1.21 W/sq.ft
Exterior Lighting Power	Total Power of 20 kW **(As per DBR)** would be supplied through Solar	Total Power = 20 kW **(As per DBR)**
Receptacle Equipment Power Density	Different values for different areas. Electrical load sheet attached	Different values for different areas. Electrical load sheet attached
Mechanical & Plumbing Systems		
Primary HVAC System Type	• Variable Air Volume System • Evaporative cooling for laundry and kitchen using the outside air. • Cold water from heat pump of 2*35 TR capacities is directly sent to the secondary pump for building cooling.	As per Table G3.1.1.A, Non-Residential building & more than 5 floors >1,50,000 sq.ft. Baseline HVAC system type, we are considering system under the heading electric and others, which is **system 8, VAV- with PFP Boxes.**
Fan Power	Variable speed fan with 0.0008 bhp/cfm	Fan power 0.0015 bhp/cfm
Chiller Parameters	2*400 & 2*200 TR Water cooled Screw Chiller with 5.5 COP	2*400 TR & 2*500 TR water cooled centrifugal chiller with 6.1 COP
Cooling Tower	Variable speed fan	Two-speed fan
Secondary Pump	Variable speed	Variable speed
Heat Recovery Wheel	Considered with 75% effectiveness	None
Hot water	Water has been pre-heated through Solar heater before it passes to the heat pump of COP 4.0 which runs on condensate heat recovery.	Electric Heating

ENERGY SIMULATION (COMPARISON OF PROPOSED & BASELINE PARAMETERS)

TABLE 1: BASELINE PERFORMANCE – PERFORMANCE RATING METHOD COMPLIANCE								
Particulars	Energy Type	Annual Energy & Peak Demand	0° rotation	90° rotation	180° rotation	270° rotation	Average Baseline	AS IS Case
Interior Lighting	Electricity	Energy Use (kWh)	4368568	4368568	4368568	4368568	4368568	3304057
Equipment	Electricity	Energy Use (kWh)	9196800	9196800	9196800	9196800	9196800	9196800
Heating	Electricity	Energy Use (kWh)	117	94	82	113	102	22
Cooling	Electricity	Energy Use (kWh)	3530107	3572957	3524378	3576440	3550971	3099102
Tower	Electricity	Energy Use (kWh)	1381179	1387351	1377791	1388451	1383693	907451
Pumps	Electricity	Energy Use (kWh)	135925	137132	135717	137287	136515	91758
Fans	Electricity	Energy Use (kWh)	1689417	1703798	1684464	1709611	1696823	799099
Hot water	Electricity	Energy Use (kWh)	176003	176003	176003	176003	176003	17993
Exterior Lighting	Electricity	Energy Use (kWh)	118625	118625	118625	118625	118625	0
Exterior Equip.	Electricity	Energy Use (kWh)	438880	438880	438880	438880	438880	438880
Total	Electricity	Energy Use (kWh)	21035621	21100213	21021309	21110779	21066981	17855162
Total Energy Cost	**Amount (Rs / Annum)**		**168284968**	**168801704**	**168170472**	**168886232**	**168535844**	**142841296**

With the AS IS case parameters, the project achieves 15.2% energy cost savings against ASHRAE
base line building and thus achieves 5 points for Minimum Energy Performance

EPI improved from **261 to 220 kW/Sq feet/Annum**

Energy Efficiency: Benchmarking

- Not possible to incorporate all features in a project
- Constraints : Budget, Space etc.
- Follow Energy standards: ASHRAE 90.1/ECBC
- Approach
  - Prescriptive
  - Whole Building Simulation

EPI & Benchmarking Approaches

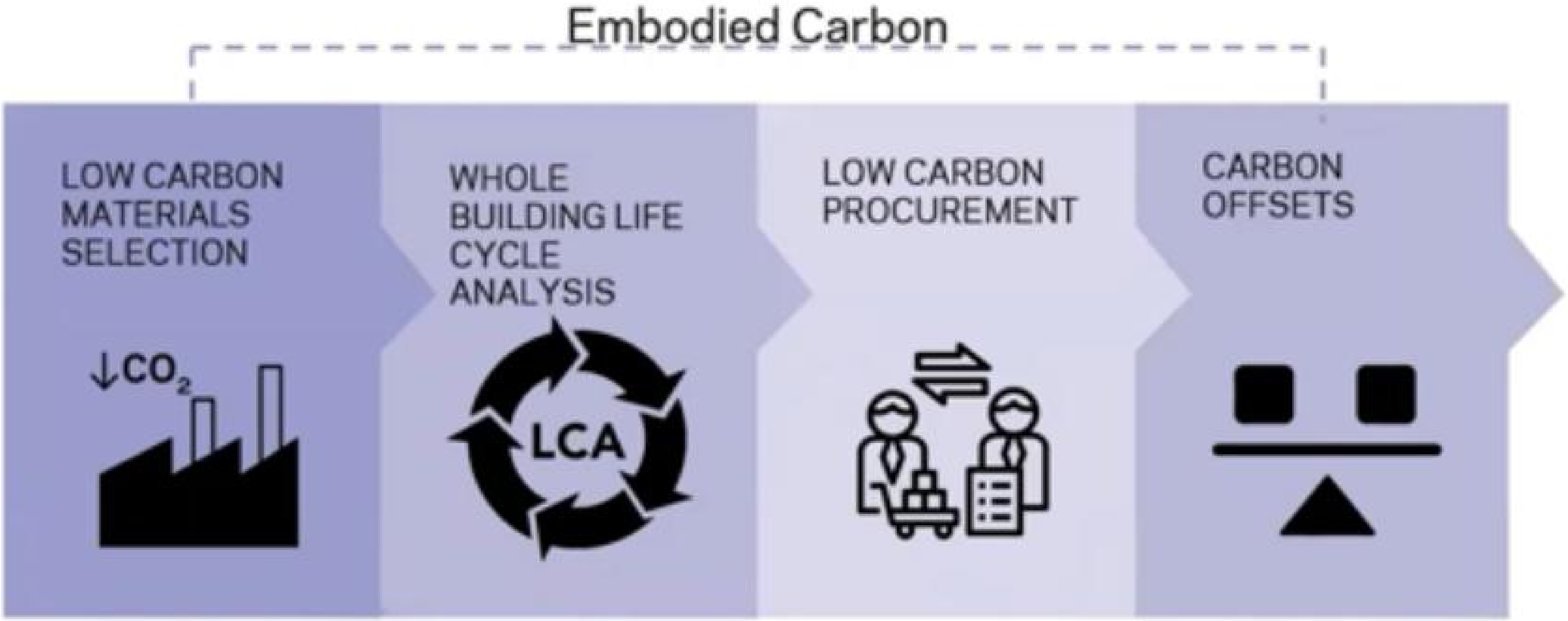
EPI (Energy Performance Index) :

- kWh/Sq m/Annum or kWh/bed/Annum w.r.t. the climatic conditions & type of hospital

- **Internal Benchmarking :** Where energy performance of a building is compared against its own previous performance over a period.

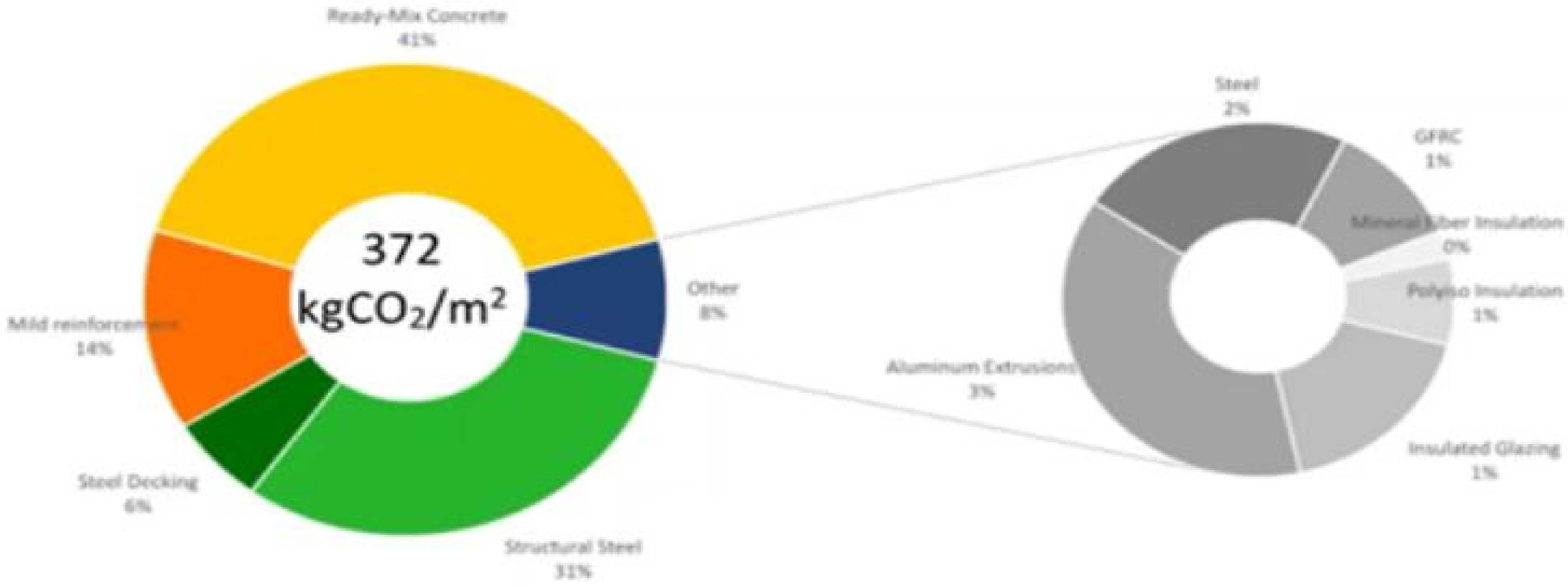
- **External Benchmarking** : Involves comparison of energy performance of similar buildings against an established standard or baseline.

Building Life Cycle Assessment



Building Life Cycle Assessment

Embodied Carbon *Performance*



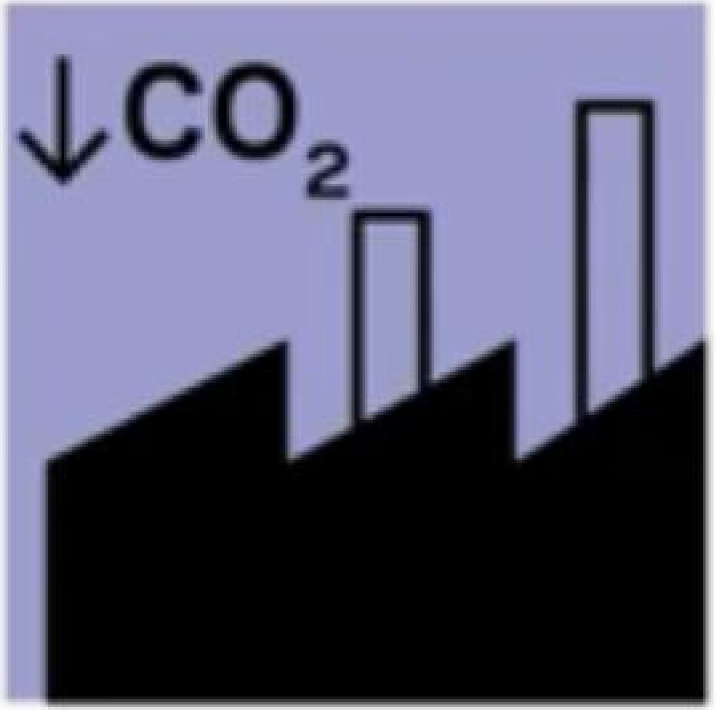
structure + façade ≅ 372 kg CO_2e/m^2 (A1-A3)

structure + façade + TI + MEP estimate ≅ 560 - 620 $kgCO_2e/m^2$ (A1-A5)

Source: Thinkstep report 2017

Embodied Carbon
(Low Carbon Materials Selection)

- Optimize ready-mix concrete design
- Recycled steel from low carbon plants
- Choose low-embodied-carbon finish materials
- Low embodied-carbon insulation



Building Material (Green Pro, EPD, Star Rating Program)

ACC

Results

LCIA result for 1000 kg average cement

LCIA Impact Category	Unit	Module A1-A3
Abiotic Depletion (ADP elements)	kg Sb-Eq.	7.38E-04
Abiotic Depletion (ADP Fossil)	MJ	3.94E+03
Acidification Potential (AP)	kg SO_2-Eq.	2.15E+00
Eutrophication Potential (EP)	kg Phosphate-Eq.	2.90E-01
Global Warming Potential (GWP)	kg CO_2-Eq.	6.88E+02
Ozone Layer Depletion Potential (ODP)	kg CFC11-Eq.	6.02E-10
Photochemical Ozone Creation Potential (POCP)	kg Ethene-Eq.	1.30E-01

Supplementary indicators for 1000 kg average cement

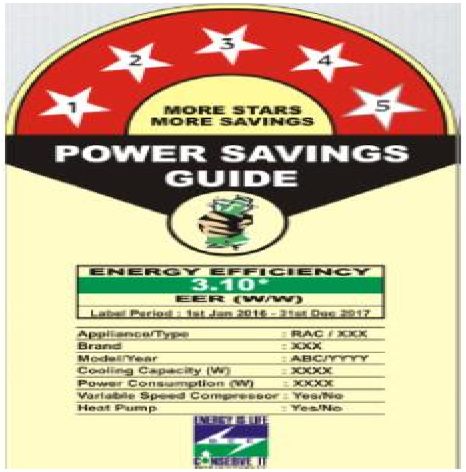
Parameters	Unit	Module A1-A3
Non-hazardous waste	kg	1.30E-01
Hazardous waste	kg	2.62E-03
Radioactive waste	kg	0.00E00

Confederation of Indian Industry

IGBC

List of GreenPro Ecolabelled Product Manufacturers - January 2021

S No	Manufacturer	Category	Contact	Email	Phone
1	AB Ceramic Services	Tiles	G.Arivazhagan	abc@abceramic.in	9047573230
2	ACC Limited	Ready Mix Concrete	Pralhad Mujumdar	pralhad.mujumdar@acclimited.com	9987578836
3	ACC Limited	Cement	Ashish Prasad	ashish.prasad@acclimited.com	9833999971
4	Aeropure	IAQ Solution	Avinash	dradk@hotmail.com	9822022921
5	AET Building Products (WI) Pvt. Ltd	Tiles	Nusrat Rasiwala	clarence.pereira@flexiblespace.in	9765778594
6	Akzo Nobel	Paints & Coatings	Varun Chhabra	varun.chhabra@akzonobel.com	9962985266
7	Anutone Acoustics Limited	Insulation Products	Gopinath	qa@anutone.com	9886523789
8	Aquatron International AB	Waste Water Treatment System	Raita Mocherla	Raita.mocherla@pangaea.co.in	9885921703
9	Armstong World Industries	Boards, Panels, False Ceiling & Plaster	Riddhi Desai	desai.riddhi@knaufarmstrong.com	8879134429
10	Asahi India Glass	High Performance Glass	Garima Kamra	garima.kamra@aisglass.com	9022111787
11	Ashok Chemicals	Cleaning Solutions	Anuj Shah	lustofab@gmail.com	9967688898
12	Berger Becker Coatings (P)Limited	Paints & Coatings	Umesh Vishwakarma	Umesh.Vishwakarma@beckers-group.com	9999164970
13	Berger Paints India Ltd.	Paints & Coatings	Sudipto Mukherjee	sudiptomukherjee@bergerindia.com	9038098326
14	Berger Paints India Ltd. - ETICS Division	Insulation Products	Barun Sanki	barunsanki@bergerindia.com	7603041014
15	Bio-Microbics Inc	Waste Water Treatment System	Shahaveer Jamshedji	shahaveer@biowater.in	9377666568
16	Bonphul Air Products Private Limited	IAQ Solution	Narendra Bisht	narendra.bisht@bonphulapl.com	9999884886
17	British Paints	Paints & Coatings	Ranjit Singh	rs@britishpaints.in	9822393769
18	Dalmia Cement	Cement	R.Rajamohan	r.rajamohan@dalmiacement.com	9842994067



Case Study :A residential building with a floor area of 1500 sq.ft and a reference study period of 50 years

Product stage			Process stage		Use stage							End-of-life stage				
A1	A2	A3	A4	A4	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Raw material supply	Transport	Manufacturing	Transport	Construction	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction	Transport	Waste processing	Disposal	Reuse-recycling-recover

Scope of LCA

Bill of materials

BOM for 1500 sq. ft residential building

S. No	Material	kg
1	Aluminium, primary, no finish	192
2	Clay brick	2798
3	Ceramic	145
4	Concrete (17.5 Mpa, in-situ and steel reinforecement, OPC)	50000
5	Glass	590
6	Gravel	25000
7	Paint (vivid white, 2 coats, Dulux, super tough low sheen)	165
8	Steel (color steel, MAX 0.4 mm)	2000

Embodied Energy

BOM for 1500 sq. ft residential building

S. No	Material	kg	GWP (kg CO2eq / kg)	Emissions (kg CO2eq / kg)
1	Aluminium, primary, no finish	192	10.8	2073.6
2	Clay brick	2798	0.26	727.48
3	Ceramic	145	0.53	76.85
4	Concrete (17.5 Mpa, in-situ and steel reinforecement, OPC)	50000	0.19	9500
5	Glass	590	1.18	696.2
6	Gravel	25000	0.1	2500
7	Paint (vivid white, 2 coats, Dulux, super tough low sheen)	165	0.5	82.5
8	Steel (color steel, MAX 0.4 mm)	2000	4.08	8160
	Total			23816.63

Usage phase emissions

- 600 months
- 150 units per month
- 0.82 kg CO2eq/kwh

Considerations (Usage phase)

- *Building is deigned for 50 years*
- *Consumes 150 units per month (0.82 kg CO2eq / kwh)*
- *No renewable energy installed*
- *Have a capacity to offset 50 units per month through RE*

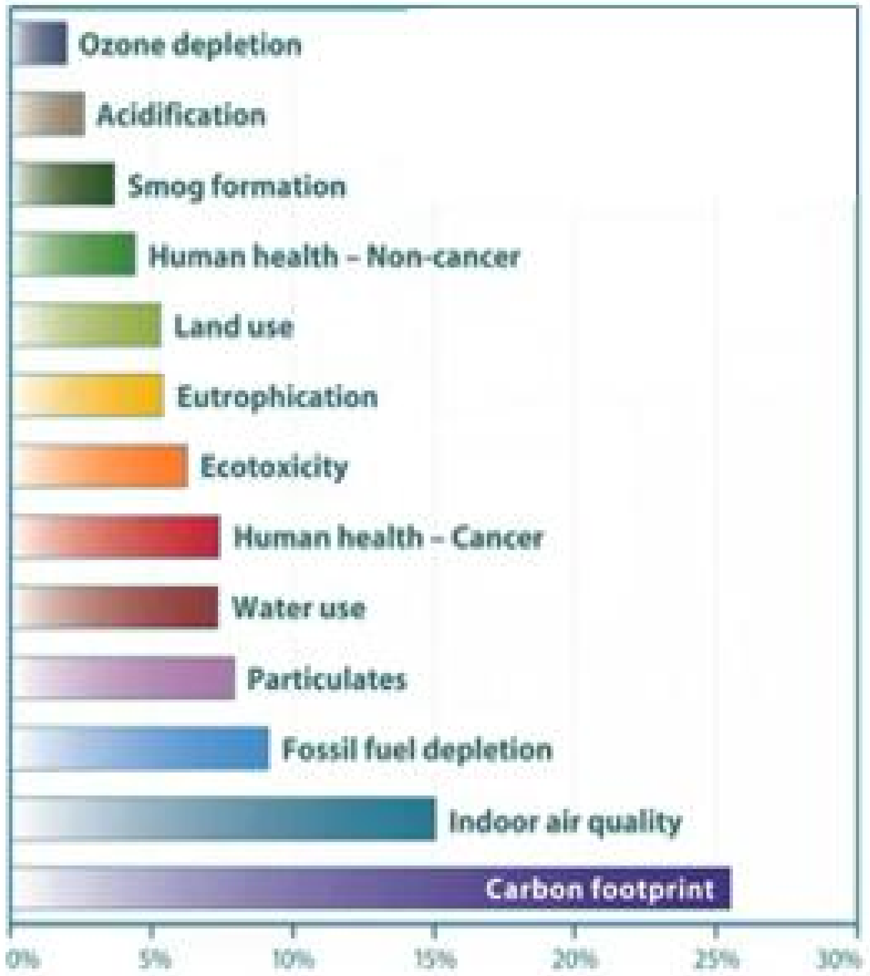
- Usage phase emissions = 150 units * 600 months * 0.82 kg CO2eq/kwh

  = 73800 kg CO2eq

Total emissions

- Embodied energy emissions = 23816 kg CO2eq
- Usage emissions = 73800 kg CO2eq

Total Emissions: 97,616 kg CO2eq

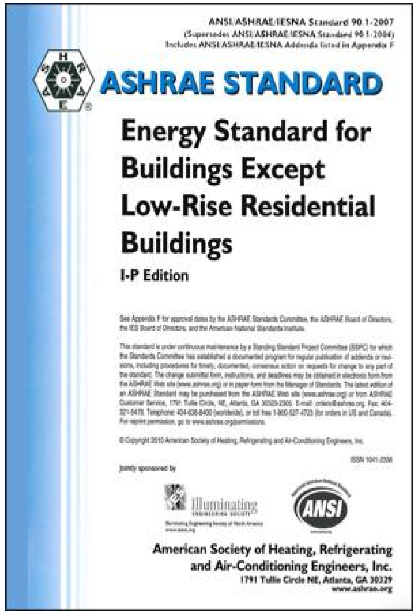


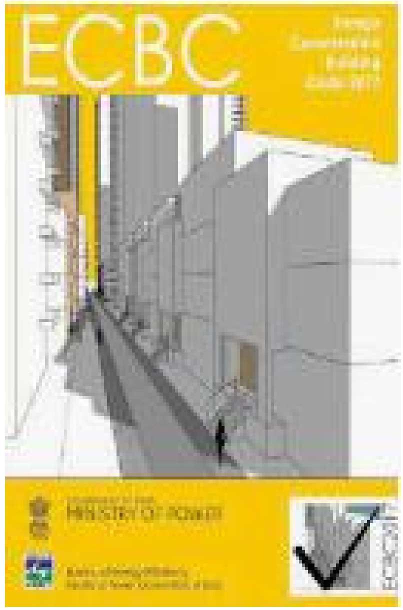
Green Building Ratings : Energy points

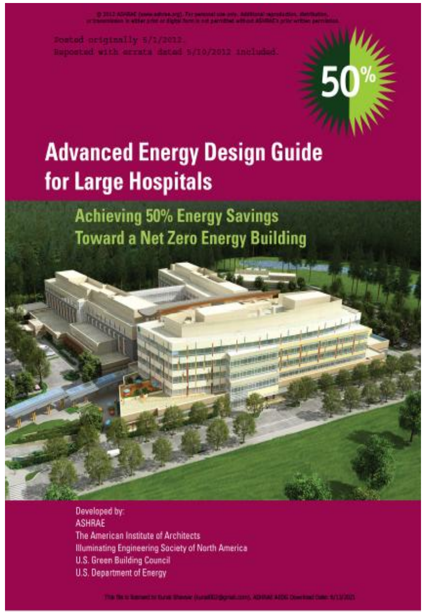
Rating	Energy Points	Percentage of Overall points
LEED	19	17%
IGBC	15	15%
GRIHA	13	13 %

Energy Standards

- ASHRAE 90.1
- Energy Conservation Building Code
  - Building Envelope
  - HVAC
  - Lighting
  - Electrical Power
  - Service Water Heating







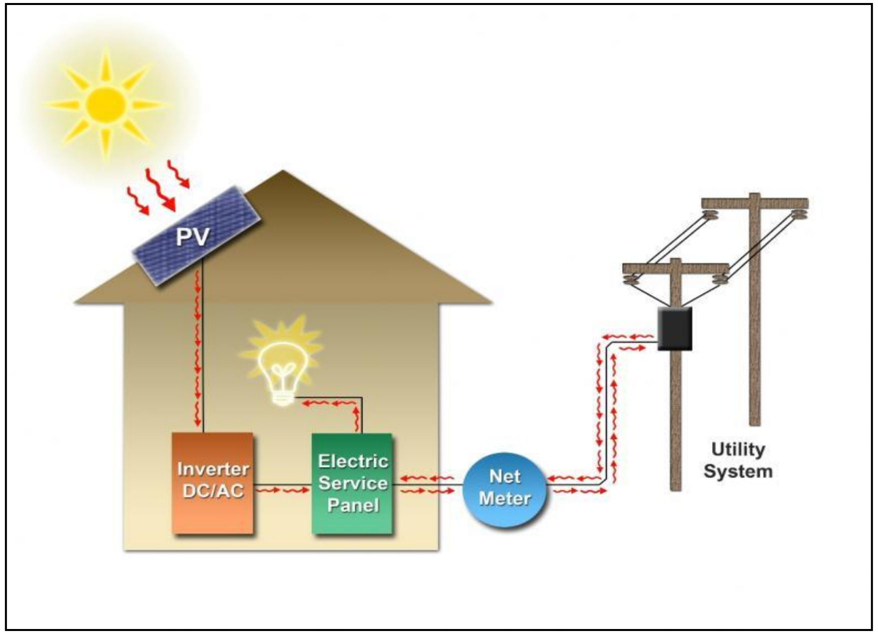
- BEE Star Rating – EPI (kWh/sq.m./annum)
- AEDG 50% for Large Hospitals

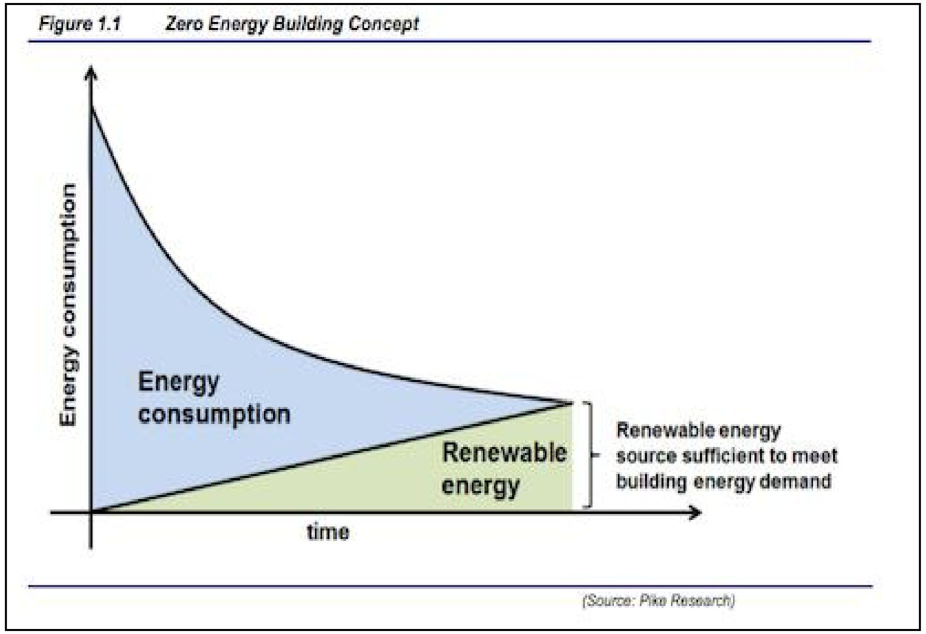

PARLE
LARGEST
SELLING
Parle-G
Original Gluco Biscuits
NET WT. 1.99 OZ (56.4g)
PARLE
Parle-G


CARBON FOOTPRINT
SHOE-MAKING +2.16
PACKAGING +0.32
TRANSPORTATION +0.09
USE +0.0
END OF LIFE +0.37
TOTAL +2.94

Net Zero Energy Buildings

- Total energy used by a ZEB annually is equal to the renewable energy generated at site
- Optimise Energy consumption to extent possible through design & operations
- Remaining energy from Renewable source
- Can be connected to grid or independent





THE CLIMATE

CAN CHANGE.

can we?

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Thank You..!!!