NIAB CAMPUS

HYDERABAD

SUSTAINABLE STRATEGIES

Presented by

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Sustainable 3M strategy to improve environmental performance

1. MEASURE

- Climate Analysis & Heat load calculations.

2. MINIMISE

- Building Orientation
- Urban Fabric & Micro Climate – Open, Transition & Built Spaces
- HVAC – Radiant Cooling System (efficient cooling system)
- Building Fabric & Air-conditioning – Double Skin Façade

3. MITIGATE

- Photovoltaic panel roof over courtyard

Climate Analysis -

<u>INTRODUCTION -</u> The data in this section is based on the weather file obtained for Hyderabad from the Energy Plus website. The climate of Hyderabas can be defined as Composite. The fig. Above shows that the annual cycle can be sub-divided into three seasons.

<u>Hot & Dry (summers)</u> – It is predominantly hot and dry and it stays so for 4 months.

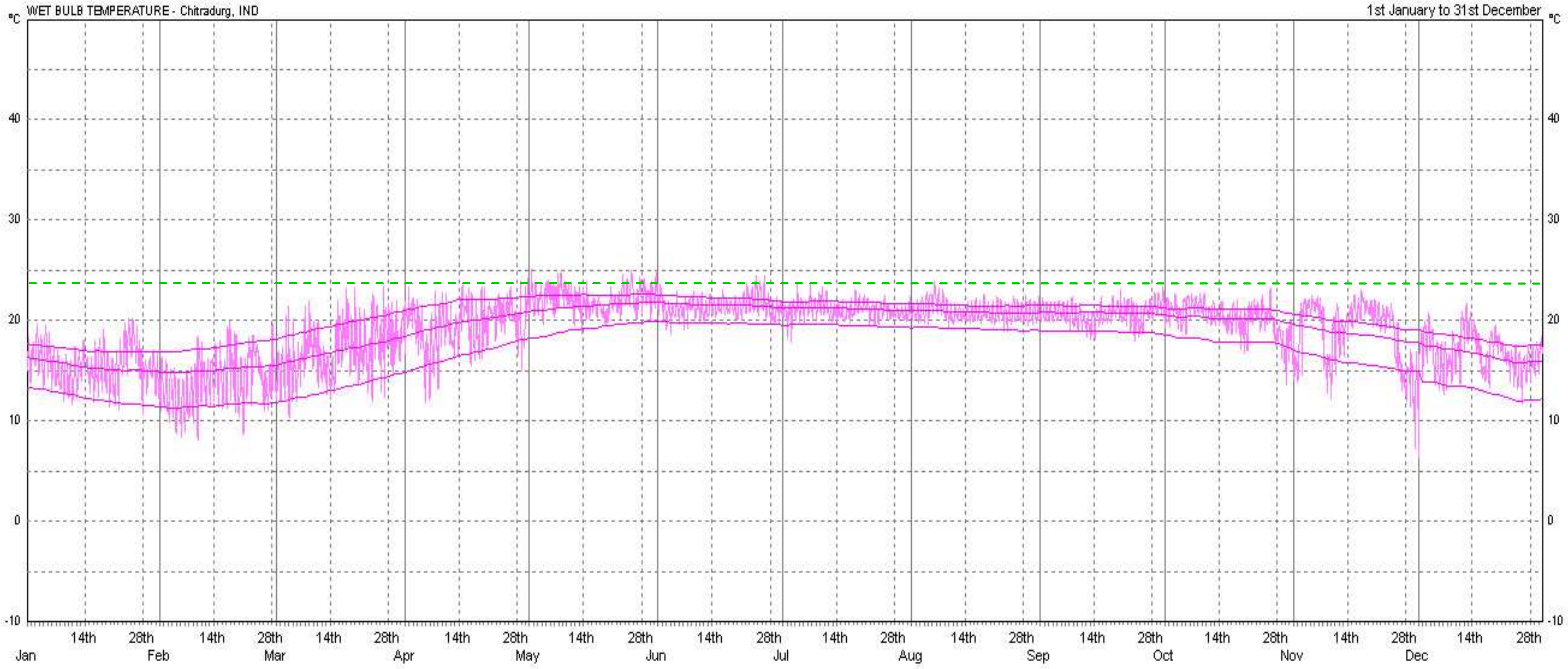
- The mean outdoor temperature during day-time in this season goes over 40 deg.
- The average diurnal range in this season is quite High ranging between 12-15 deg.
- The percentage of direct radiation in this season is as very high as compare to percentage of diffuse radiation with 10 hours of sunshine.
- The relative humidity drops down below 40% during day-time on daily basis.

<u>Warm & Humid (monsoon)</u> – The monsoon comes during month of July which brings a sigh of relief to local people as the humidity level rises above 70% on average with occasional rainfall.

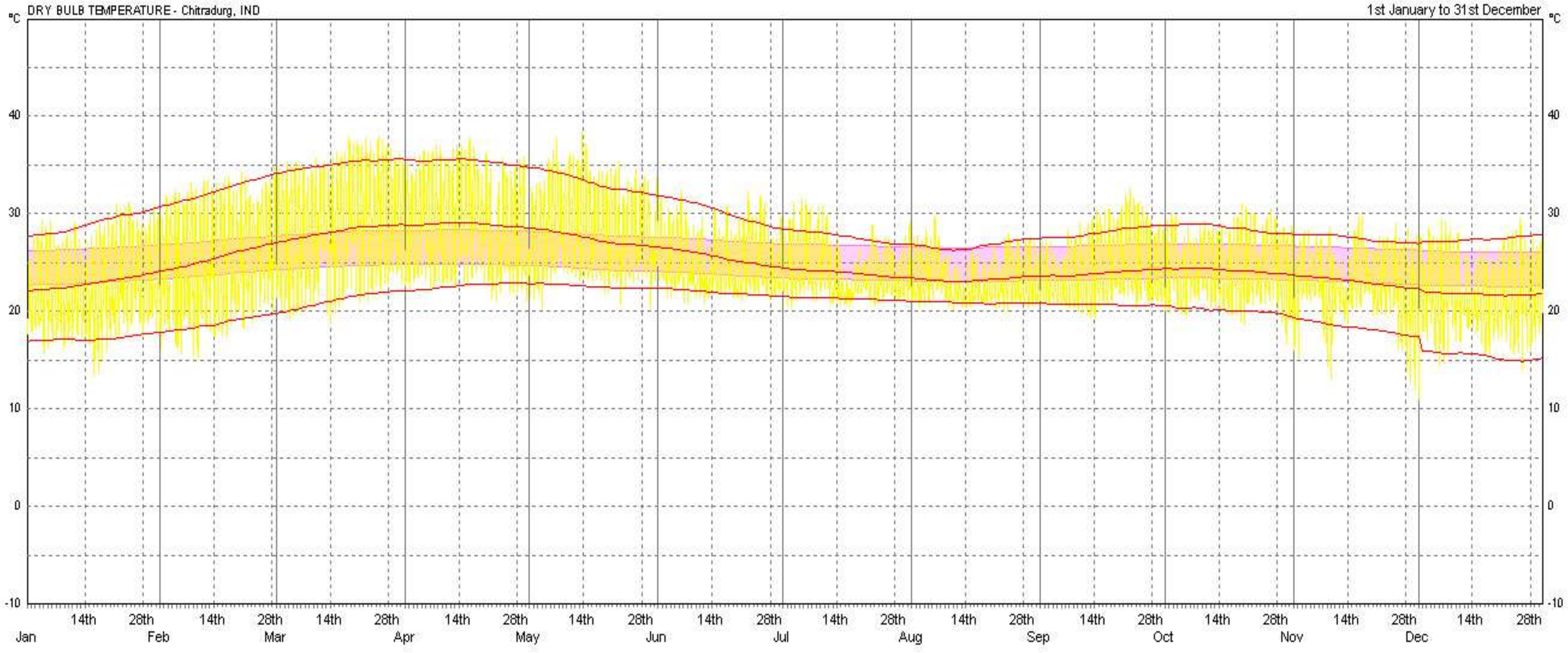
- The average diurnal range in this season is quite low ranging between 5-7 deg.
- The percentage of direct radiation in this season is quite similar to diffuse radiation.
- The average monthly wind speed during this season is quite good ranging between 4 to 5 m/s, it helps in mitigating the affects of increase in relative humidity to achieve thermal comfort.

<u>Cold & Dry (winter)</u> – In winters the outdoor temperature remains cold through-out the period of 3 months.

- The mean maximum outdoor temperature during day-time in this season occasionally goes over 25 deg.
- The mean outdoor temperature during this season remains in the comfort zone.
- Decrease in relative humidity below 60% and temperature within the comfort zone thermal comfort can be easily achieved.
- There is a strong potential of free cooling and natural ventilation during this season as the external air temperature lies predominantly within the comfort zone.



Average monthly Wet-Bulb temperature



Average monthly Dry-Bulb temperature

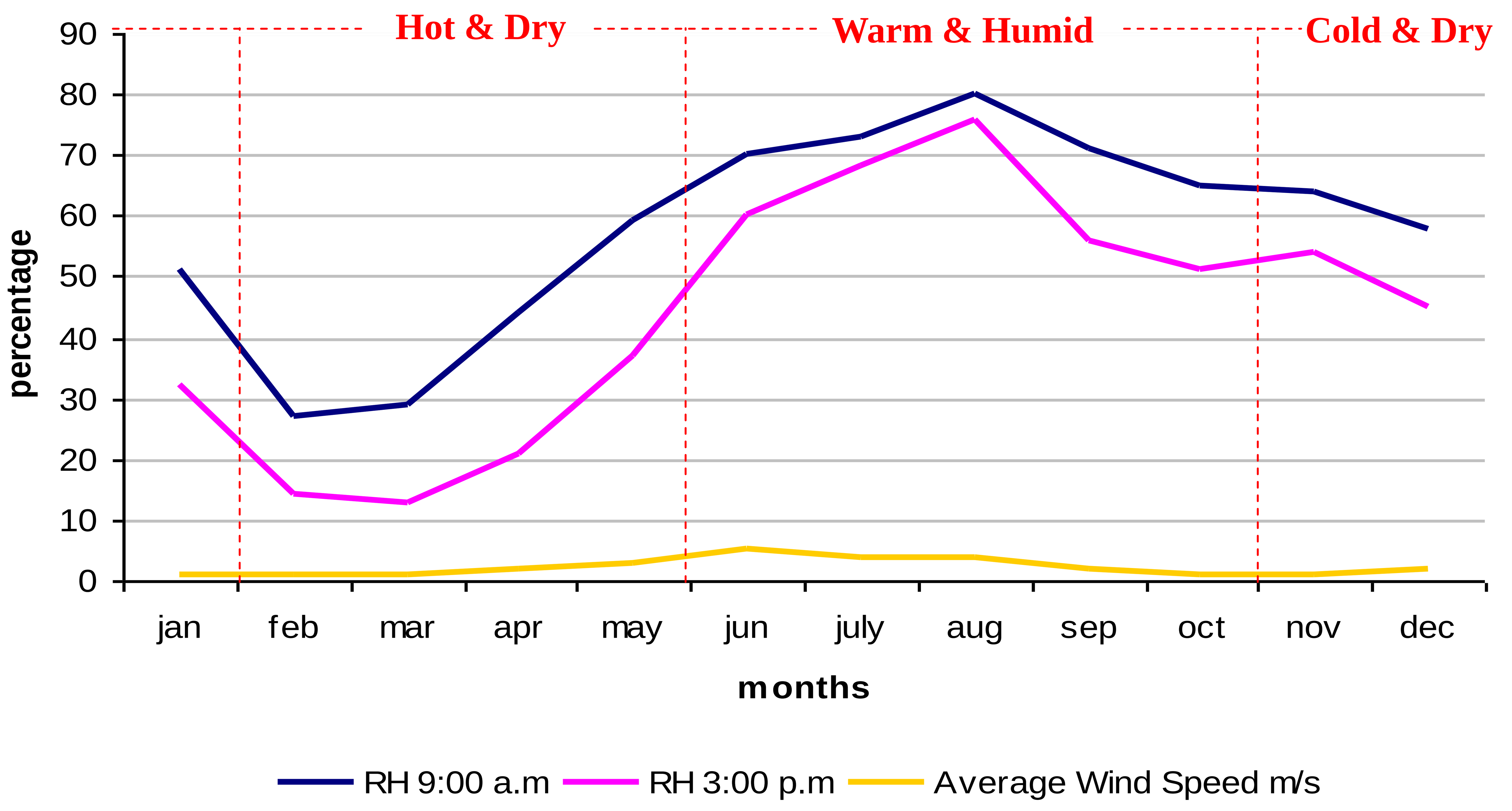
Evaporative cooling potential – Basic criteria for applicability of evaporative cooling are:

1. Wet-bulb temperature should not exceed the maximum limit of 24 deg.

2. The wet-bulb depression, which is difference between the dry-bulb temperature and wet-bulb temperature should range between 12k-15k.

Figure on the left shows that other than on few occasions in May & June the wet-bulb temperature never exceeds the upper limit of 24 deg. However, the wet-bulb depression only meets the criteria for the applicability of evaporative cooling during summers when the dry-bulb temperature exceeds 35 deg. The wet bulb depression during this season ranges between 12deg.–15deg. Hence, the evaporative can only be effective to provide outdoor or indoor comfort during these four months when the weather stays hot & dry.

Average Relative Humidity



Relative Humidity -

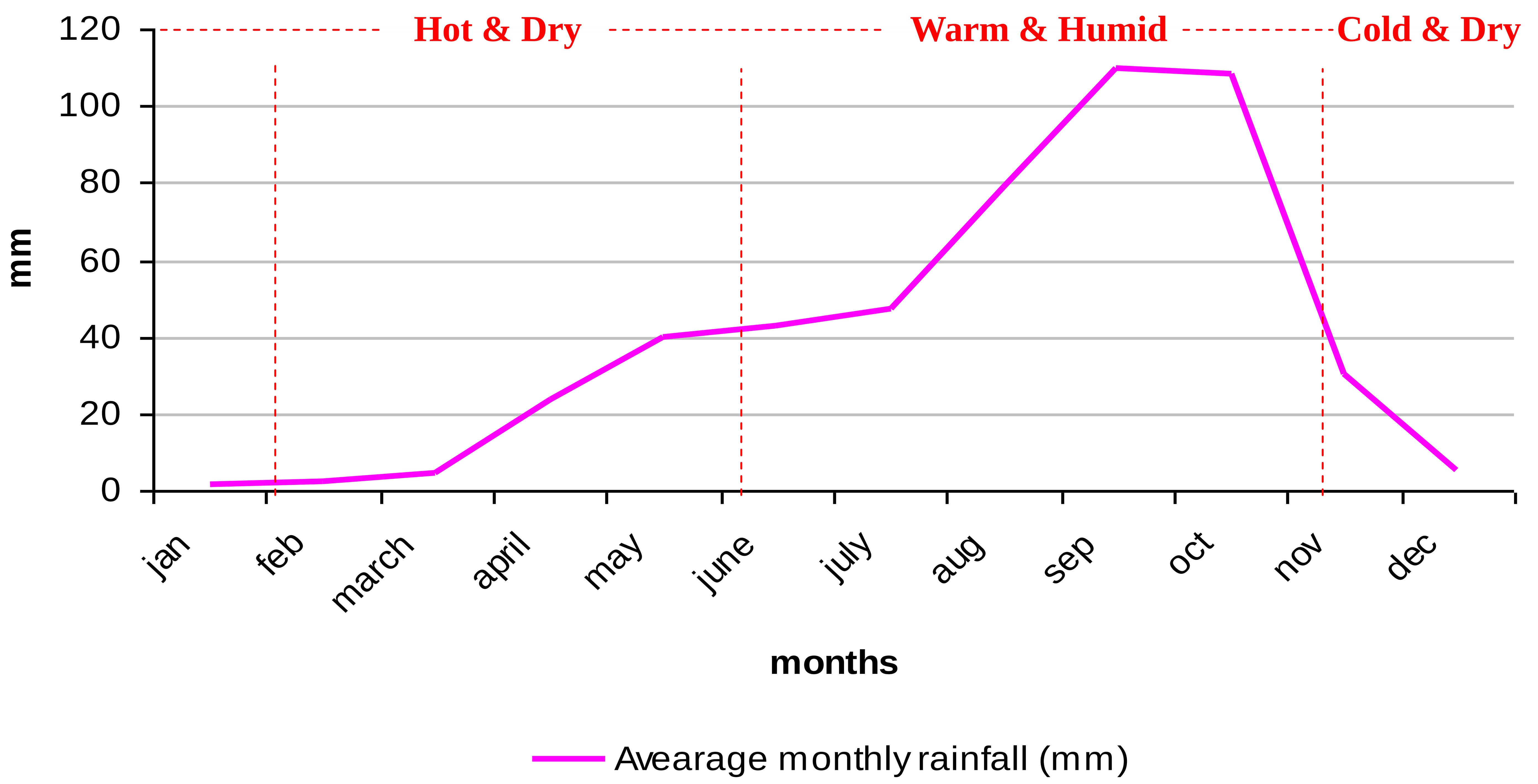
- In summers relative humidity drops down below 40%. Hence, quite often results in discomfort. There is a tremendous potential of evaporative cooling in such situation to provide outdoor as well as indoor comfort.

- The relative humidity in monsoon increases beyond 70% decreasing the potential of evaporative or radiative cooling during this period.

- Increased ventilation can be an idol strategy in such warm & humid conditions.

- During Warm & Dry winters humidity level varies between the desirable range of 50-60%, which enhances the potential of achieving thermal comfort through natural ventilation or free cooling.

Avearage monthly rainfall (mm)



Rainfall –

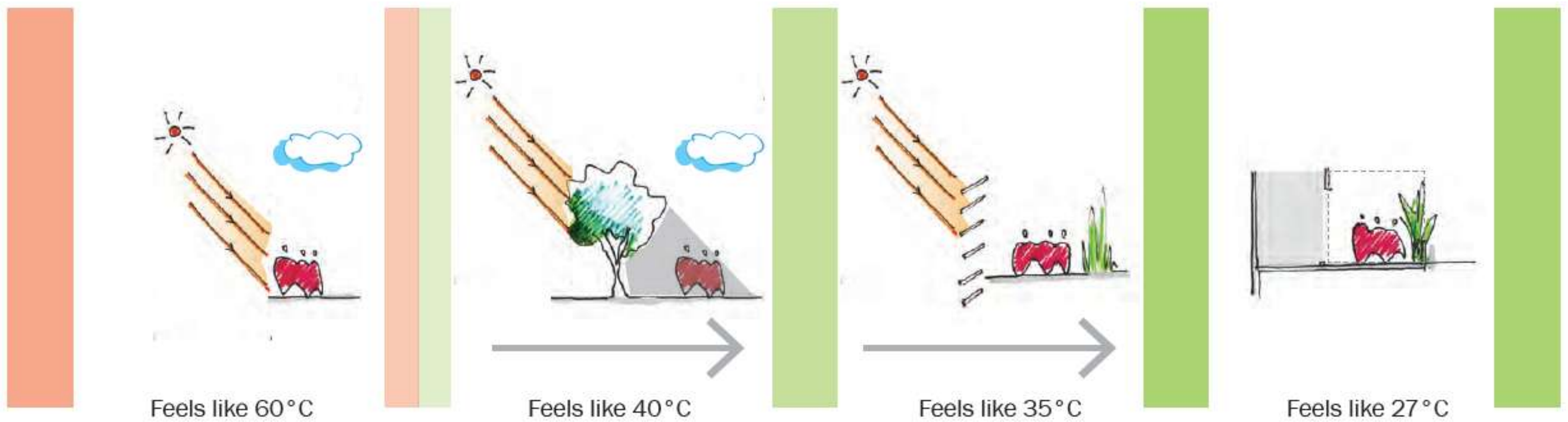
- Majority of the rainfall is received during the monsoon period and remains dry though out rest of the year.

- This shows a need for rain-water harvesting as a potential solution to optimise the usage of potable water during dry season.

- Green or brown roof, pervious paving, landscaping and SUDS can help in water retention.

SITE ANALYSIS

Courtyard – transition space - 1



Feels like 60°C

Outdoor (Unprotected)
(Minimize)
Unshaded, unprotected, un -controlled

Onsite open public spaces should be kept under shade and controlled

Feels like 40°C

Outdoor (Protected)
(Maximize)
Shaded and Protected but uncontrolled, Non Conditioned, Public Space

Feels like 35°C

Semi - Outdoor

Controlled, Non Conditioned Public Space
Public spaces within the building blanket

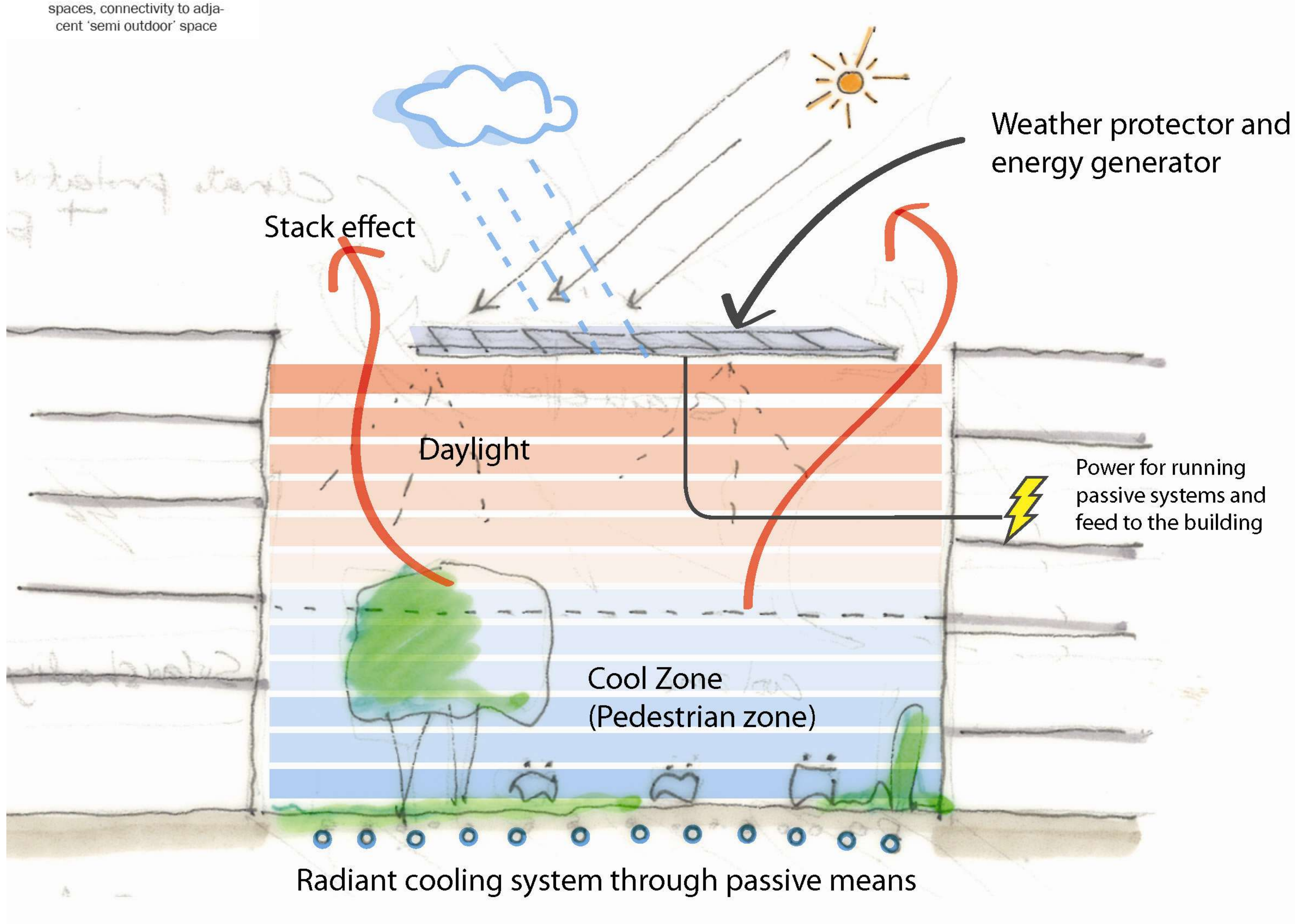
Social / interactive spaces as building entrances

Feels like 27°C

Indoor

Controlled, Conditioned using passive means

To consider orientation, occupancy - function of spaces, connectivity to adjacent 'semi outdoor' space




HOSTEL BLOCK
UNSHADED COURTYARD –
TO ALLOW FOR RADIANT
COOLING DURING NIGHT TIME.
SHADED COURTYARD –
TO PROVIDE SHADE DURING
DAYTIME & GENERATE
CLEAN ENERGY AS WELL.
ACADEMIC
BLOCK

Courtyard – transition space - 1

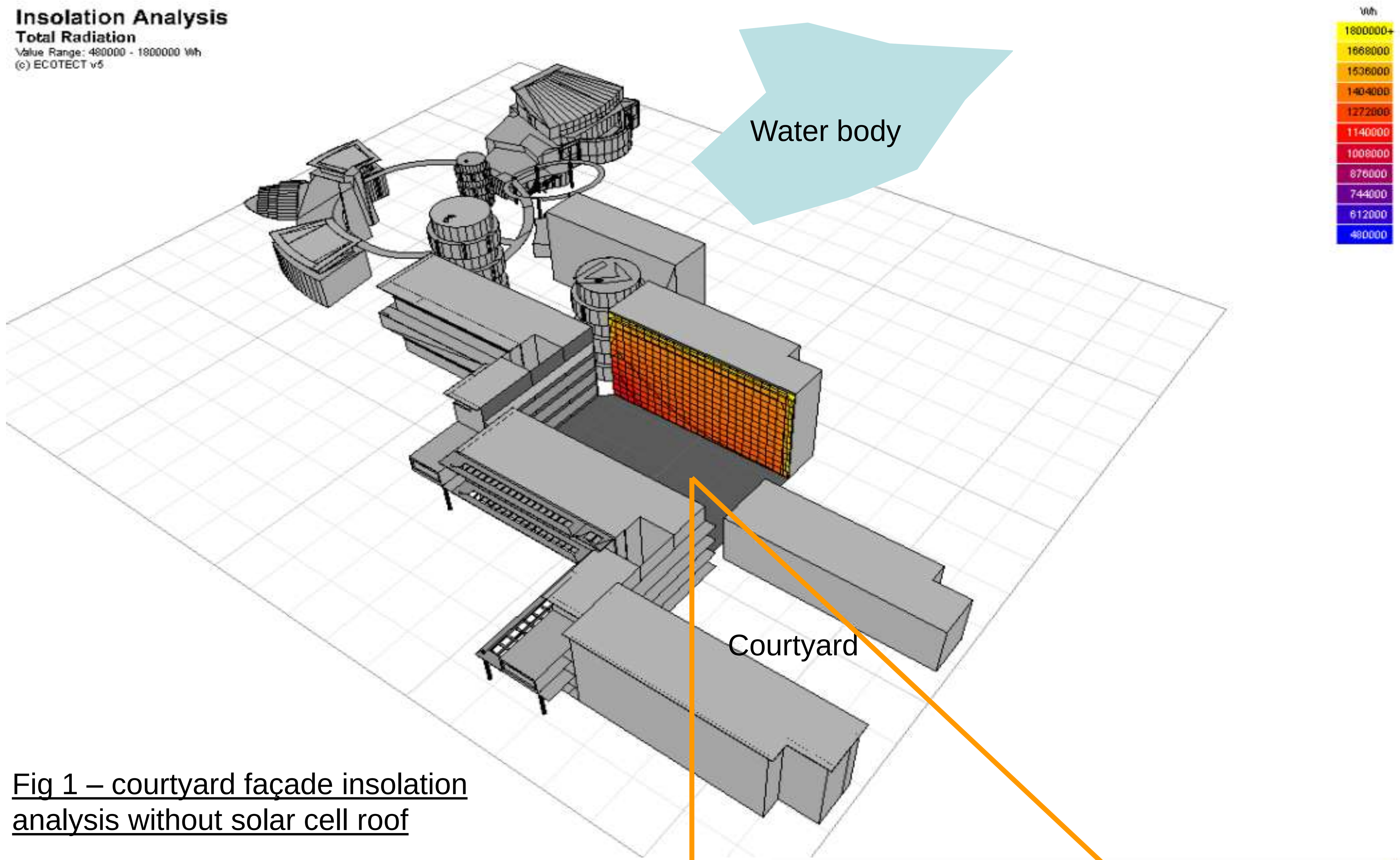
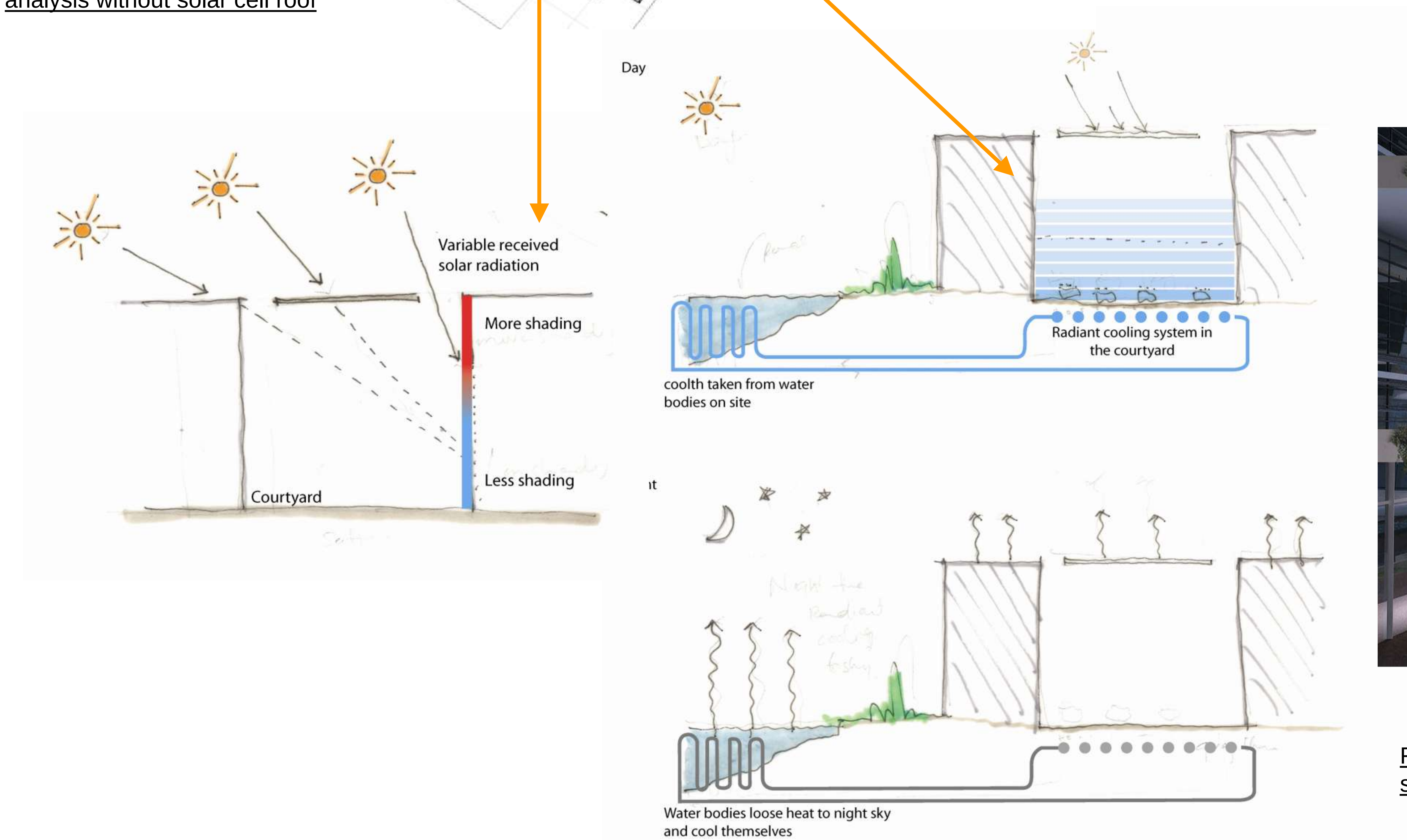


Fig 1 – courtyard façade insolation analysis without solar cell roof

Courtyard was designed as transition space which allows for smooth transition from an air-conditioned space to totally exposed environment, hence aids in preventing heat-shock.

Water tubes were laid under the cement block flooring in the courtyard to create flow of water from water body to courtyard. The flowing water helps in absorbing heat from the courtyard & produced radiant cooling effect to create ambient microclimate.

Insolation analysis were done on the façade facing the courtyard. Based on the analysis a shading device was plan at the roof lvl. to reduce direct & diffuse radiation impact on the courtyard & building facades.



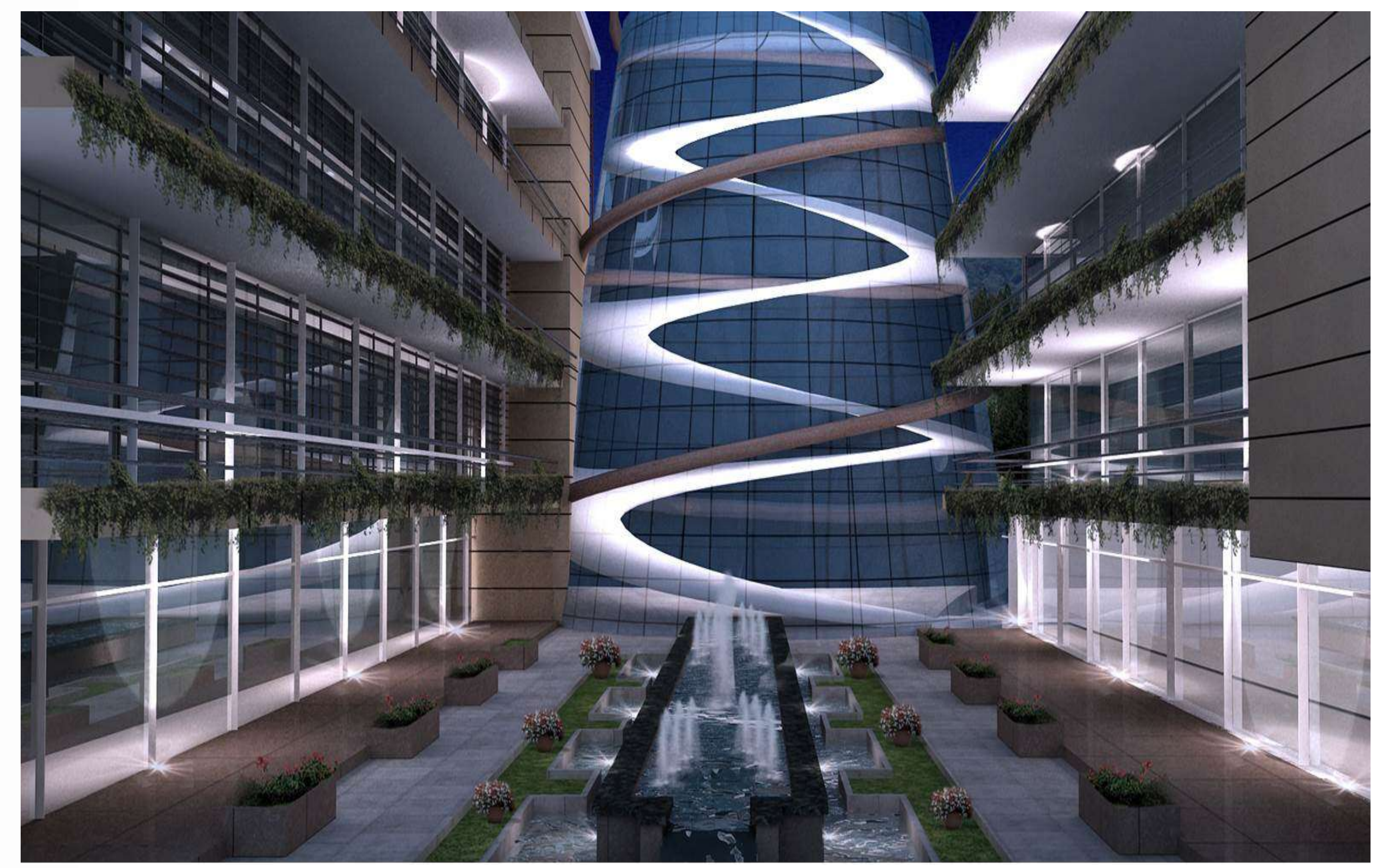


Fig 2 – Environmental section of courtyard showing stack ventilation, shading, power generation & radiant cooling through water tubes

Courtyard – transition space – 2

Courtyard roof was envisaged as the source of electricity generation to power all outdoor, corridor, toilets & staircase lighting.

-This will reduce the load on the grid & back-up generator.

- It will also absorb heat from direct & diffuse solar radiation to produce electricity & will prevent the over-heating of the courtyards during day-time to provide favorable micro-climate for outdoor interaction even during day-time.

Electricity generation through solar cell roof over every courtyard.

-Total roof area per courtyard – 6180 sq.ft

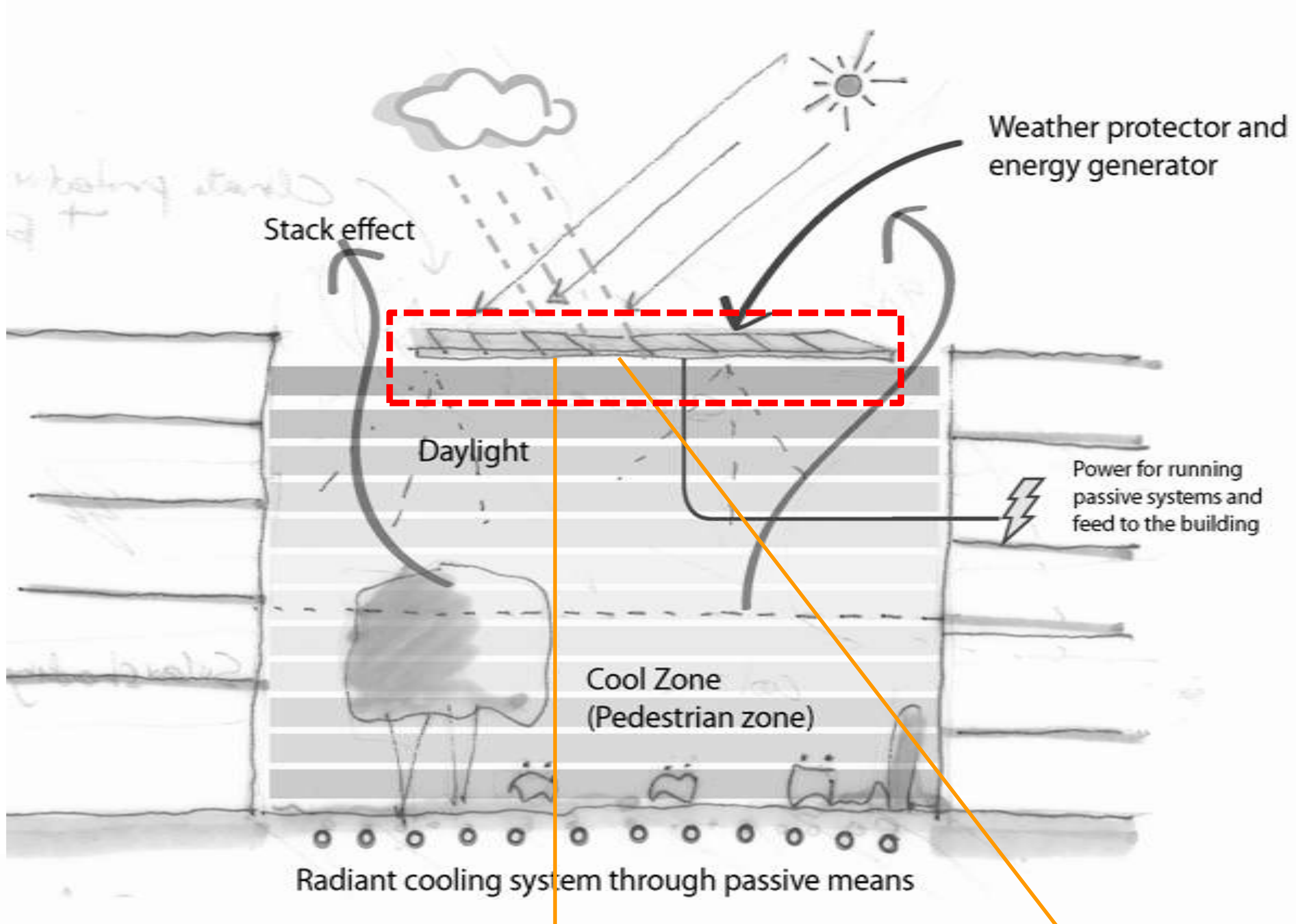
- Area required for 1kw electricity generation through p.v = 100 sq.ft

- Total power generated = 62 kw

- Cost of 1 kw solar p.v plant = 1.5 – 2 lakhs

- Cost of generating 62 kw of electricity over each courtyard = Rs 1 crore

- Payback period considering rebates & deprecation benefits = 8-10 years



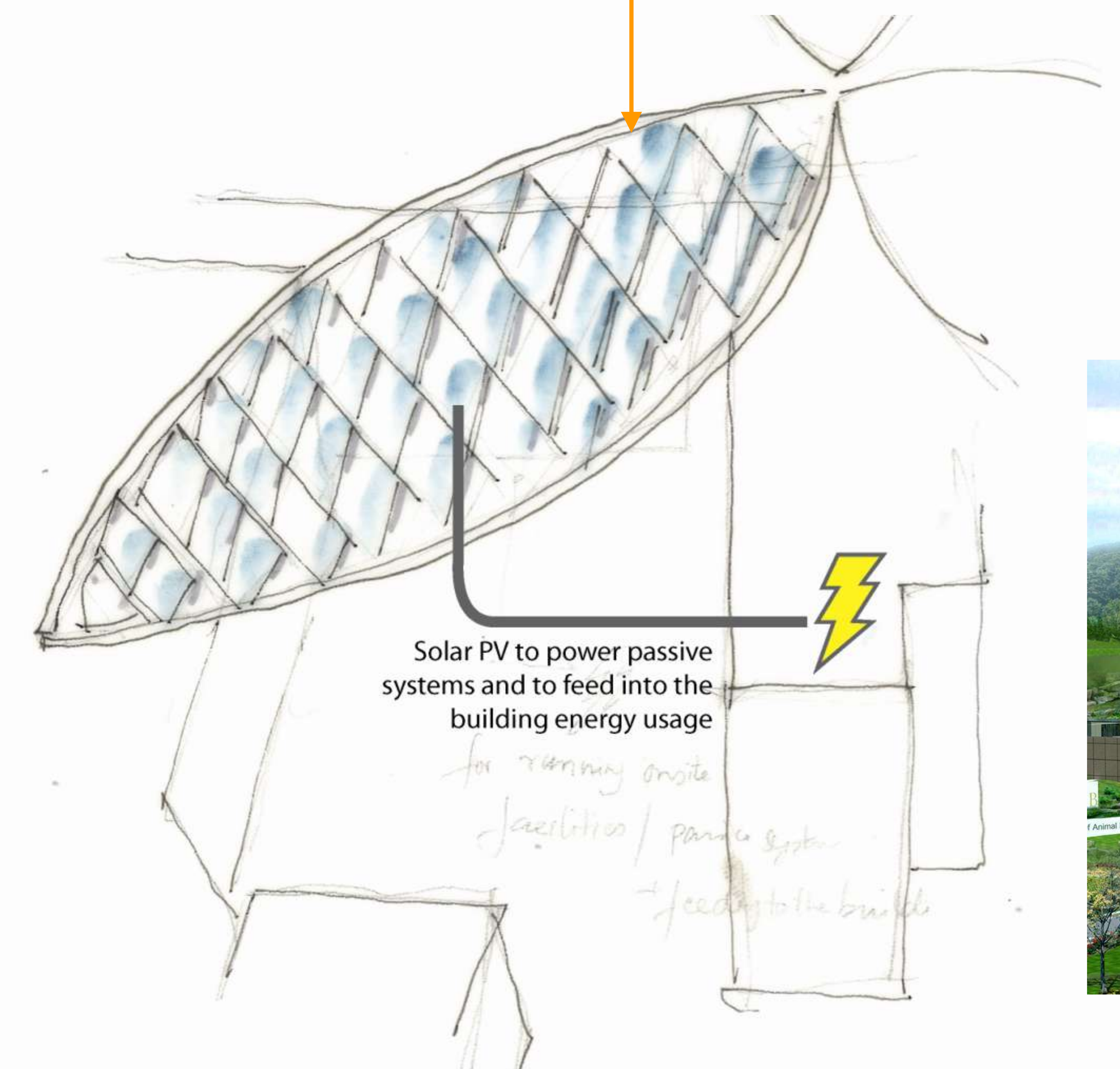


Fig 1 – Atrium roof as source of electricity generation & environmental protection.

Fig 2 – Detail roof 3d over the courtyard with solar panels.

Fig 3 – Reference picture of the solar cell

Façade environmental strategy -2

Based on the principal of Le-Corbusier a double Skin façade air-conditioned at mean temperature between outside & inside by the return air from the conditioned spaces indoor @ 26 deg.c. was designed to reduce the overall air-conditioning load of the building by 30% over a conventional building.

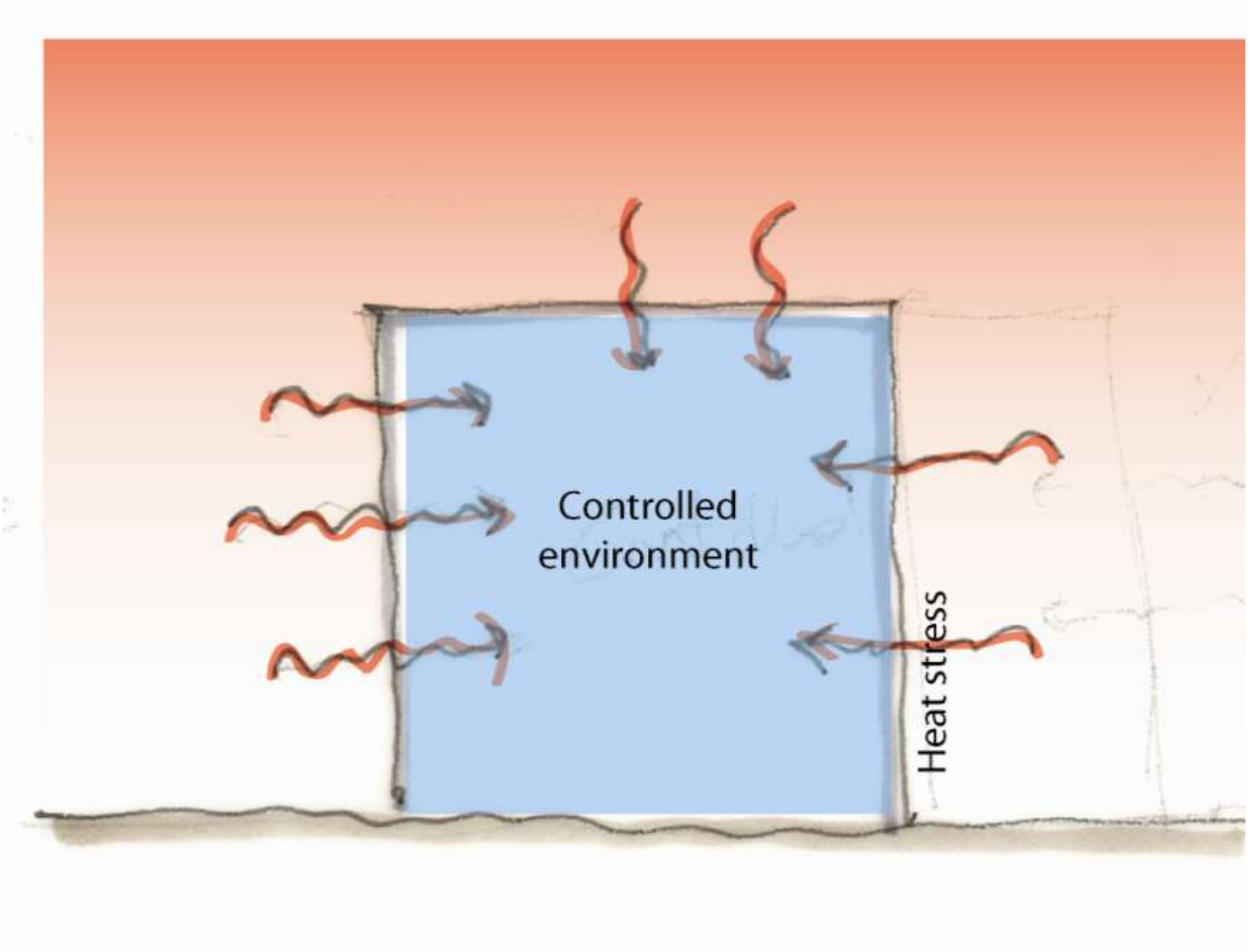


Fig 2 – Insolation analysis before shading

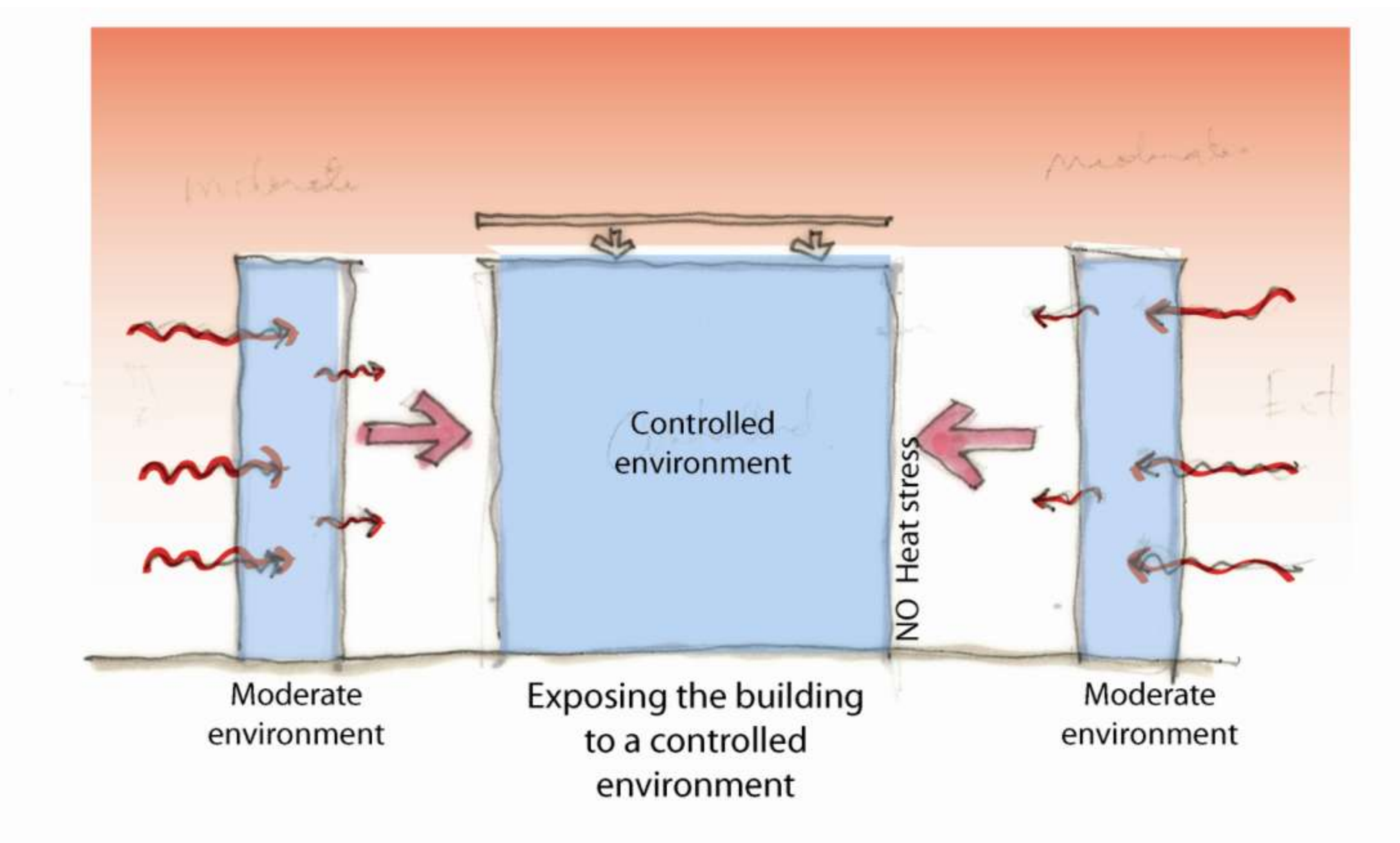
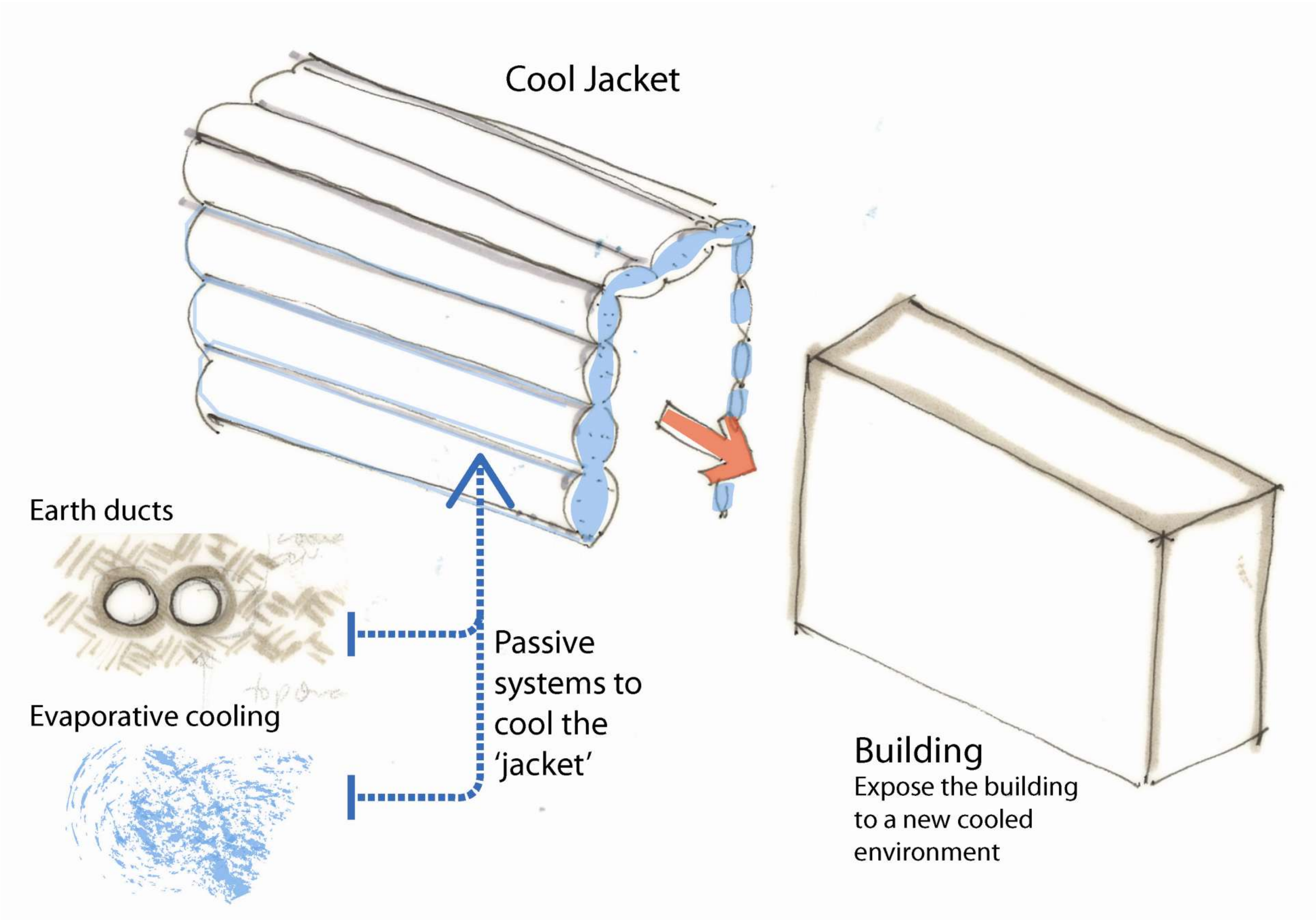


Fig 3 – Insolation analysis after shading



Façade environmental strategy

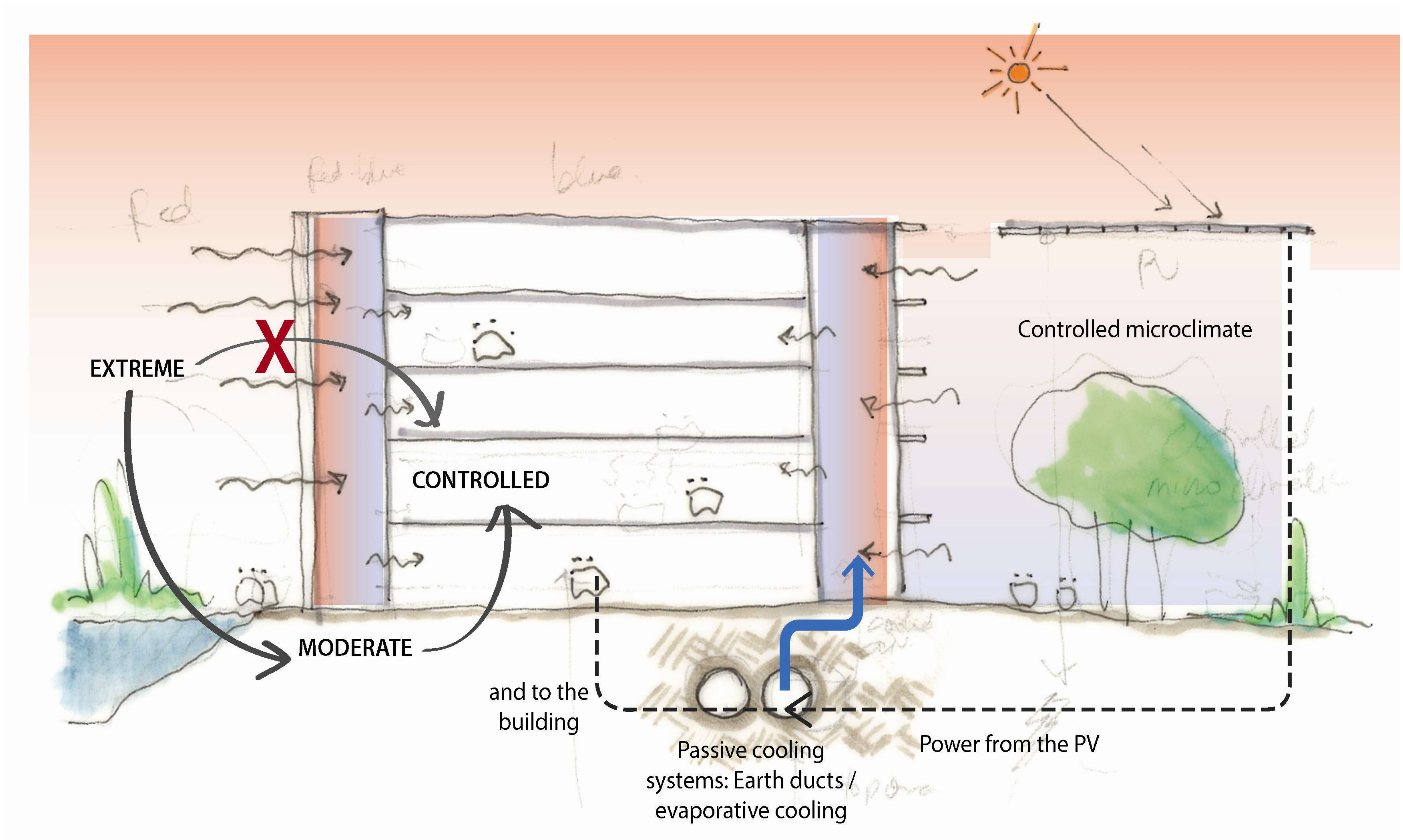
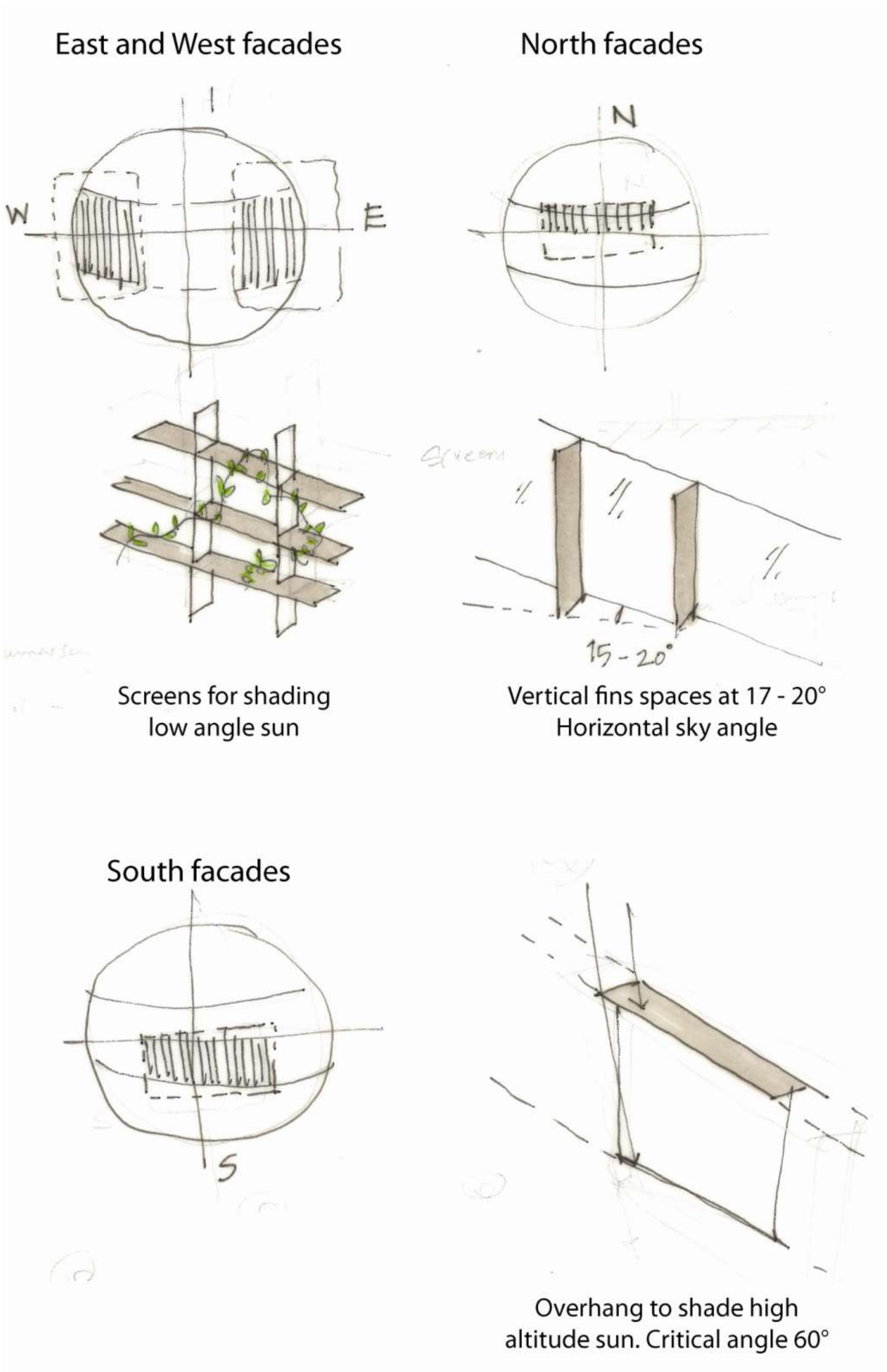


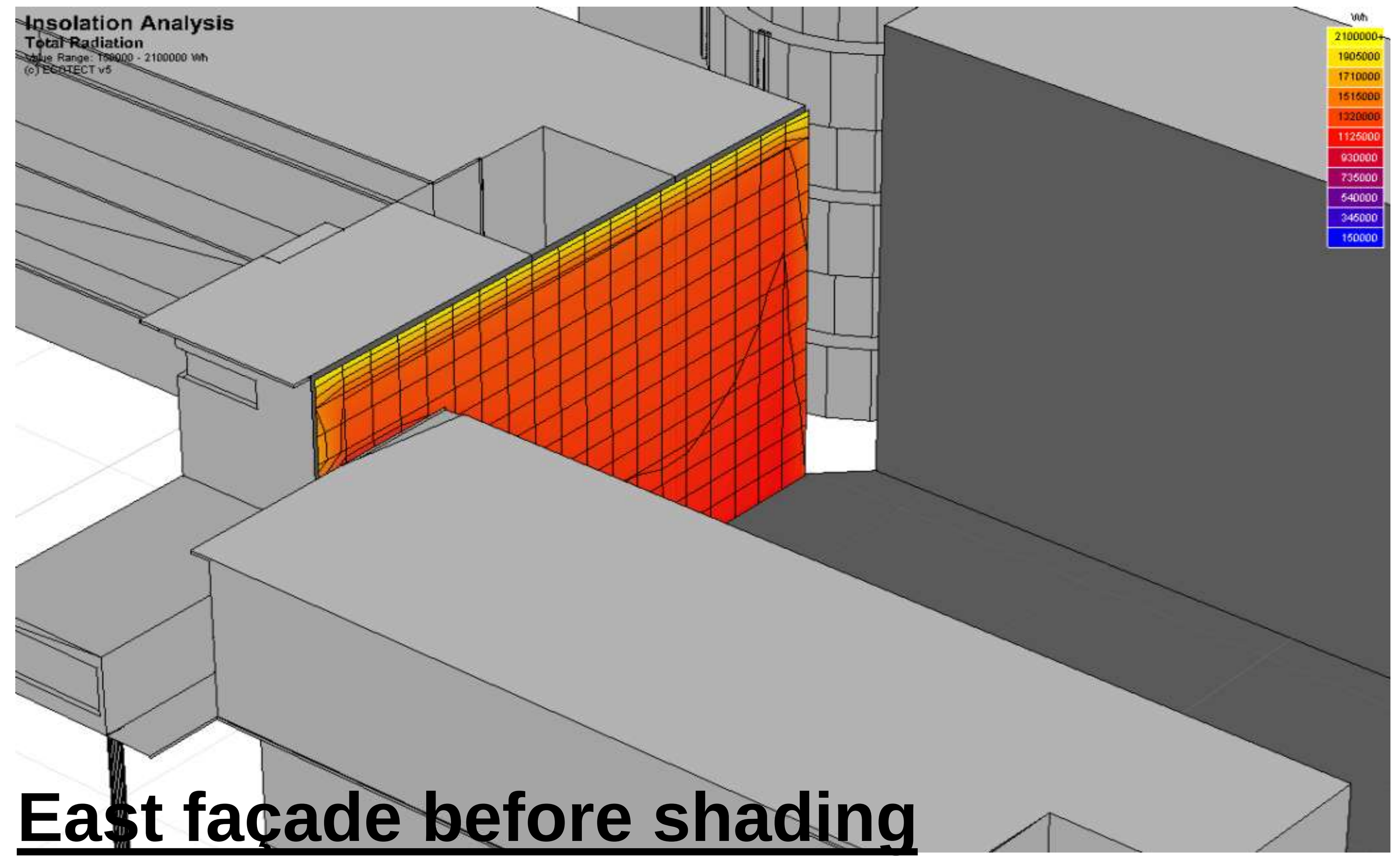
Fig 1 – External wall section displaying environmental strategies.

Façade - Shading Devices

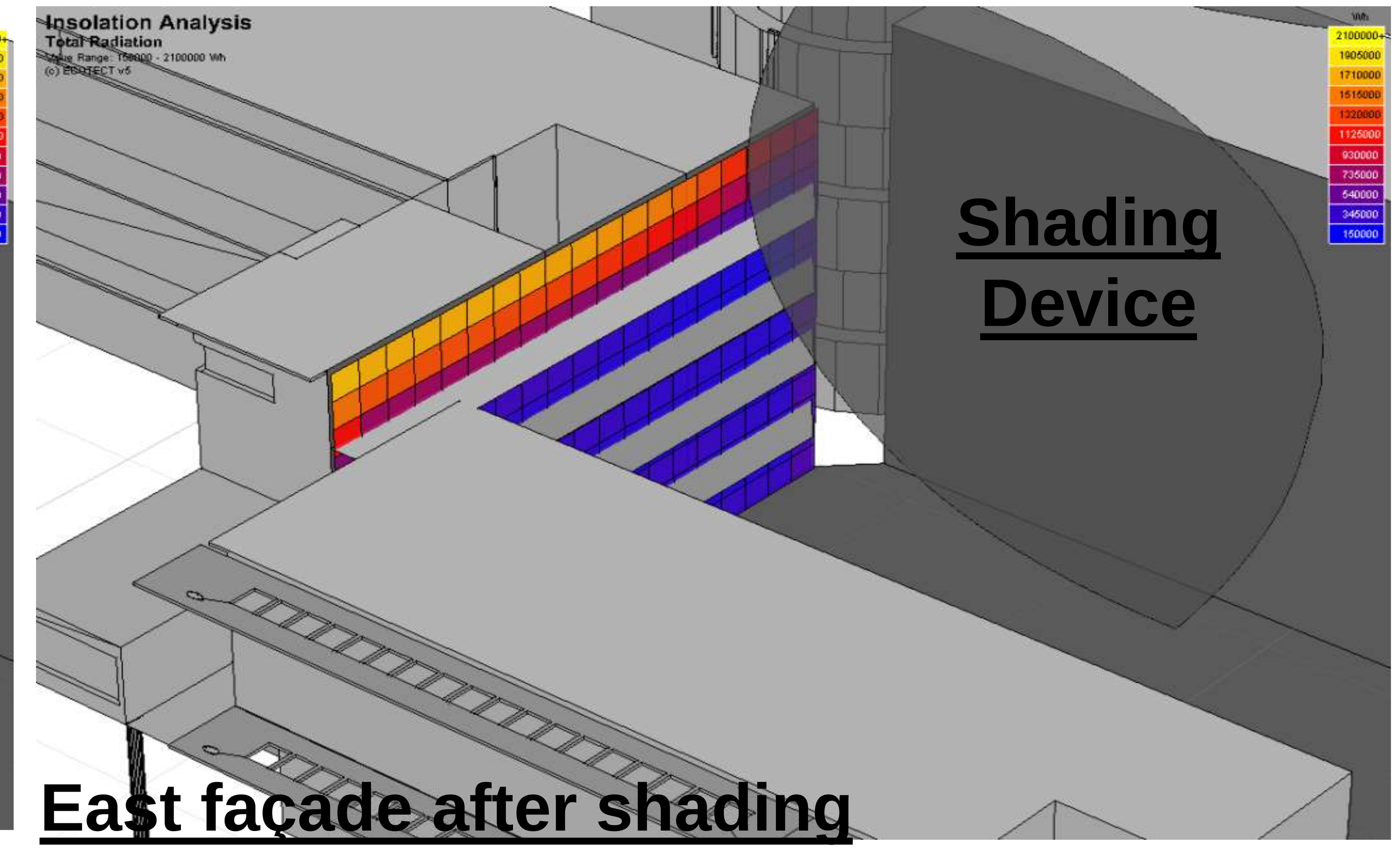
Simulation were performed on eco-tect to design optimal shading devices for façade & courtyard roof to reduce heat gain & glare from direct solar radiation.



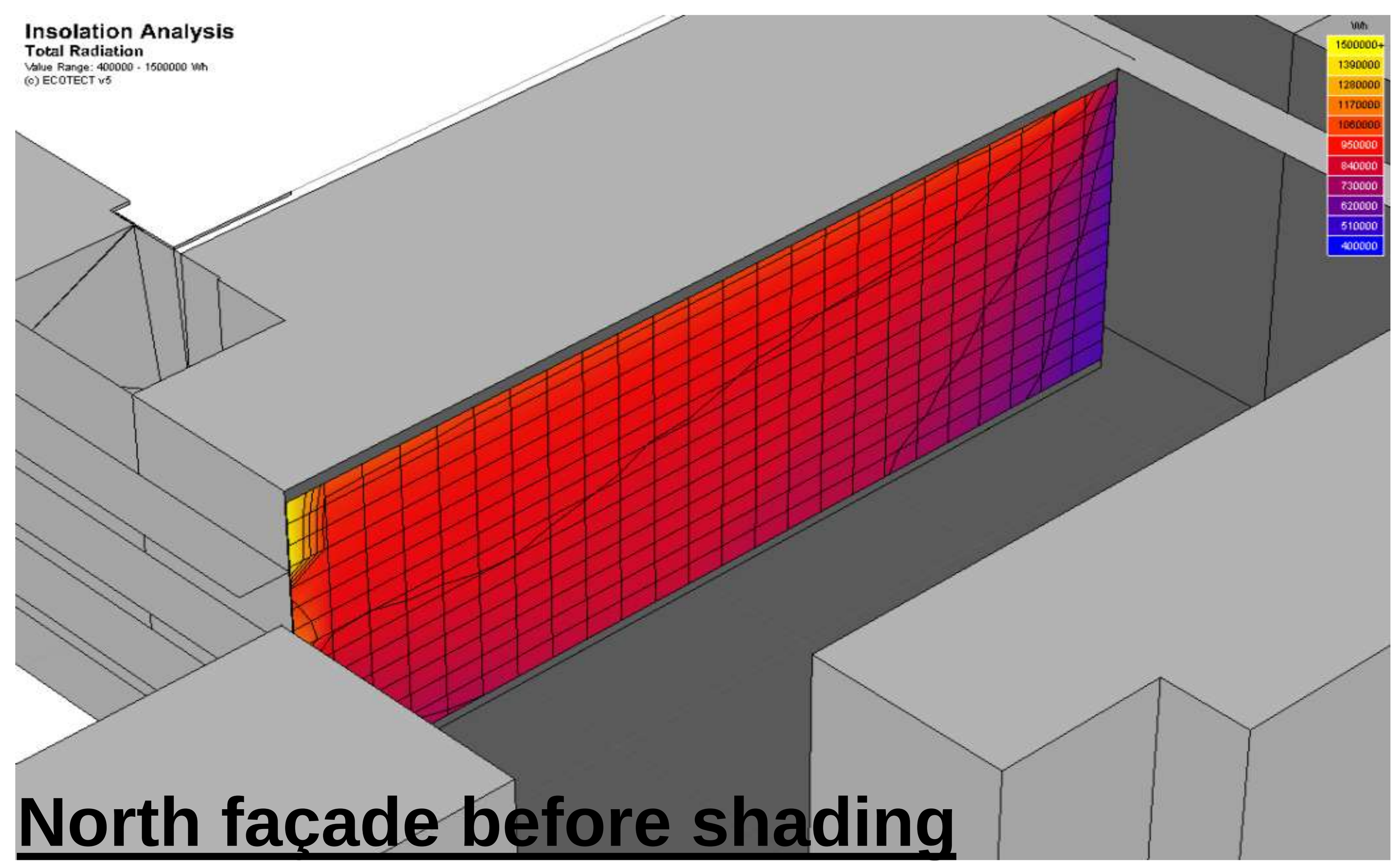
Insolation analysis before & after shading



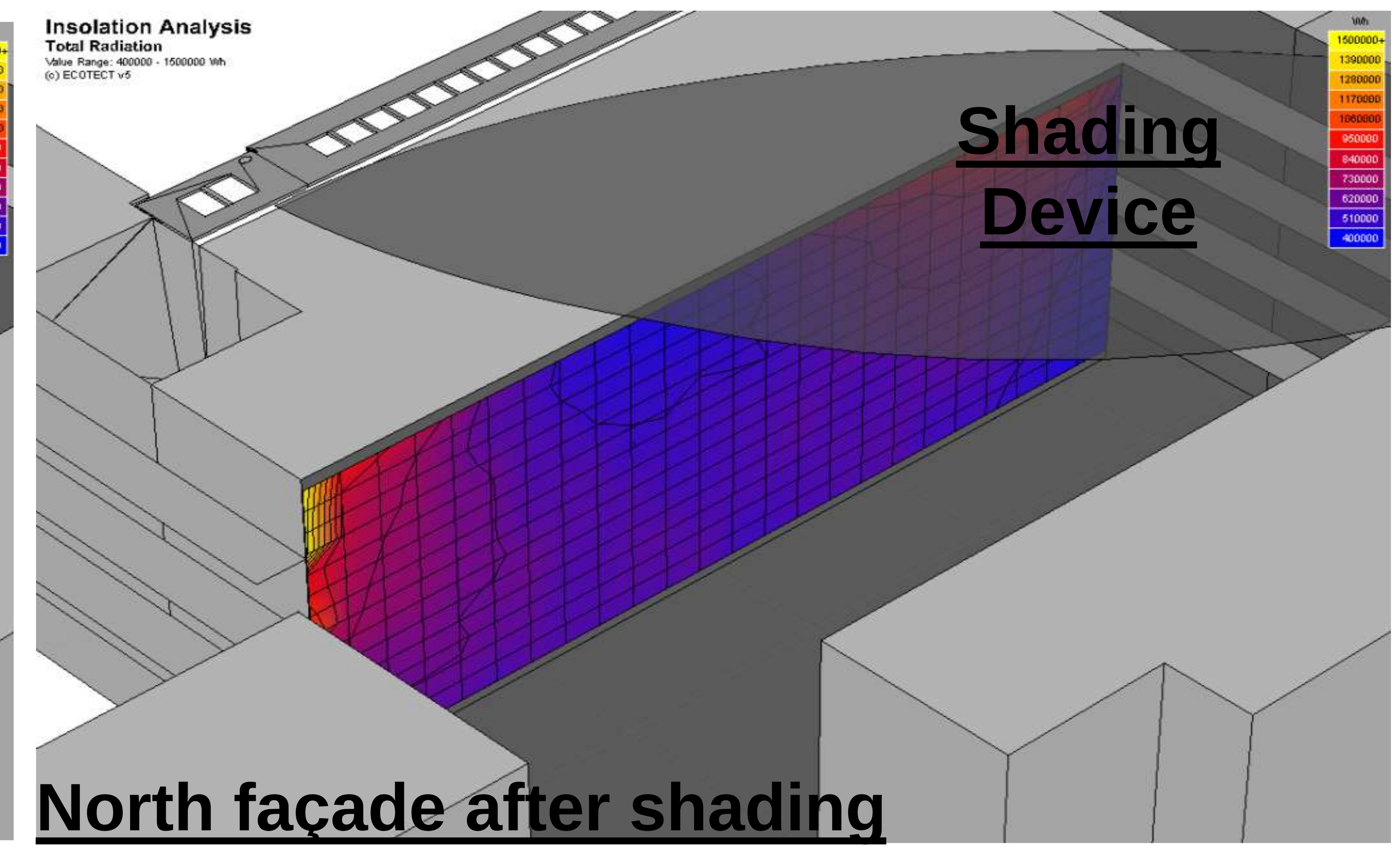
East façade before shading



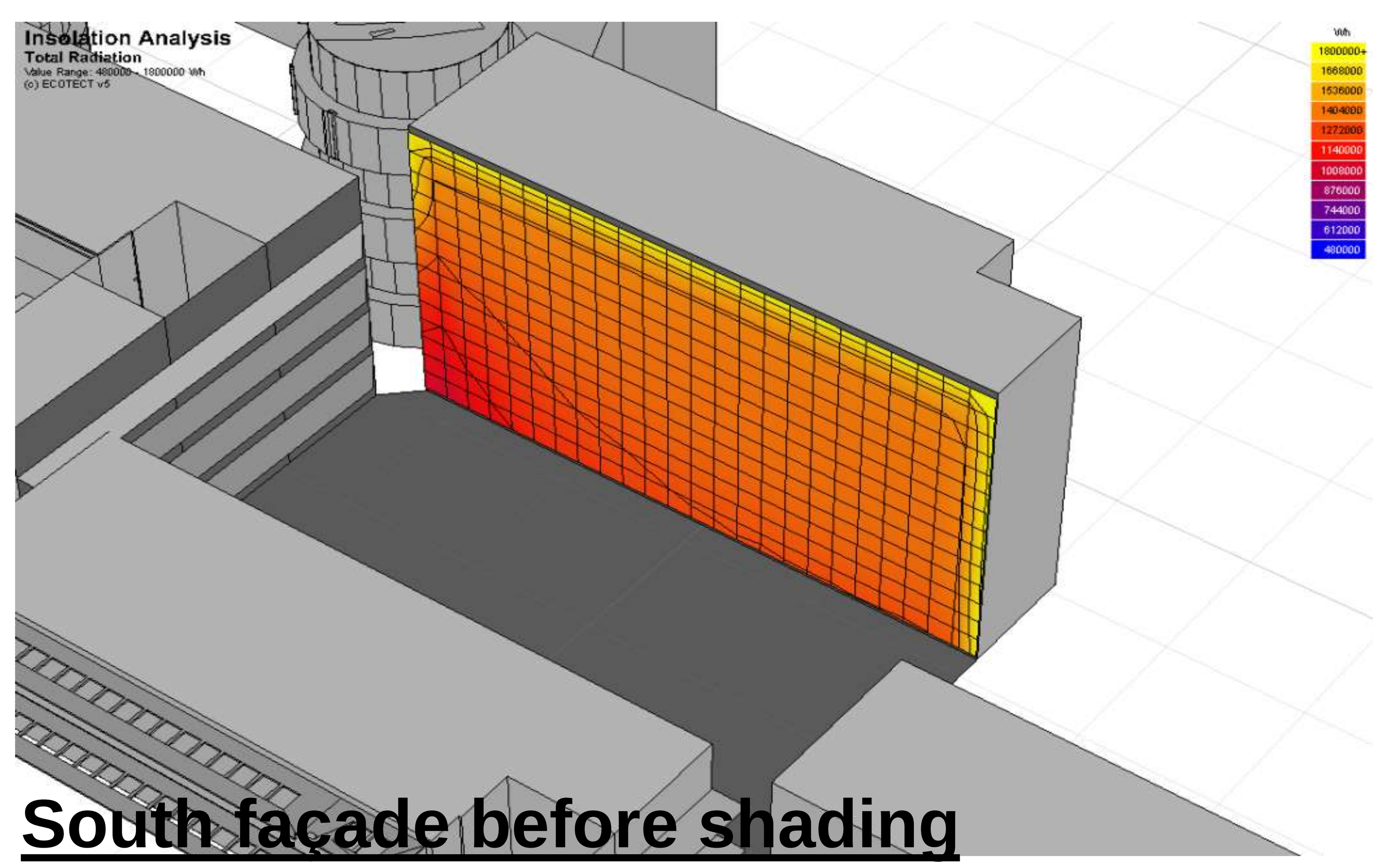
East façade after shading



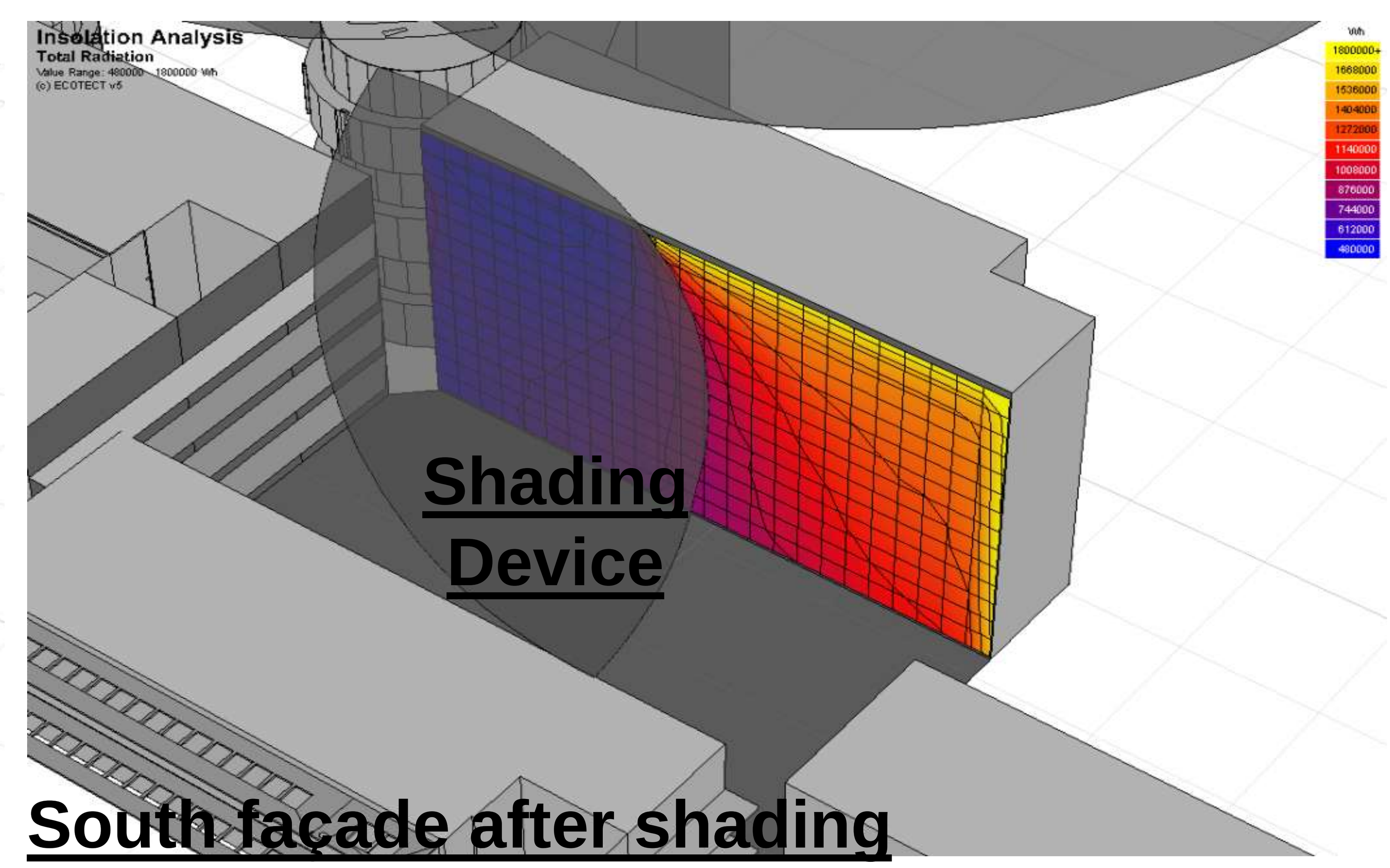
North façade before shading



North façade after shading



South façade before shading



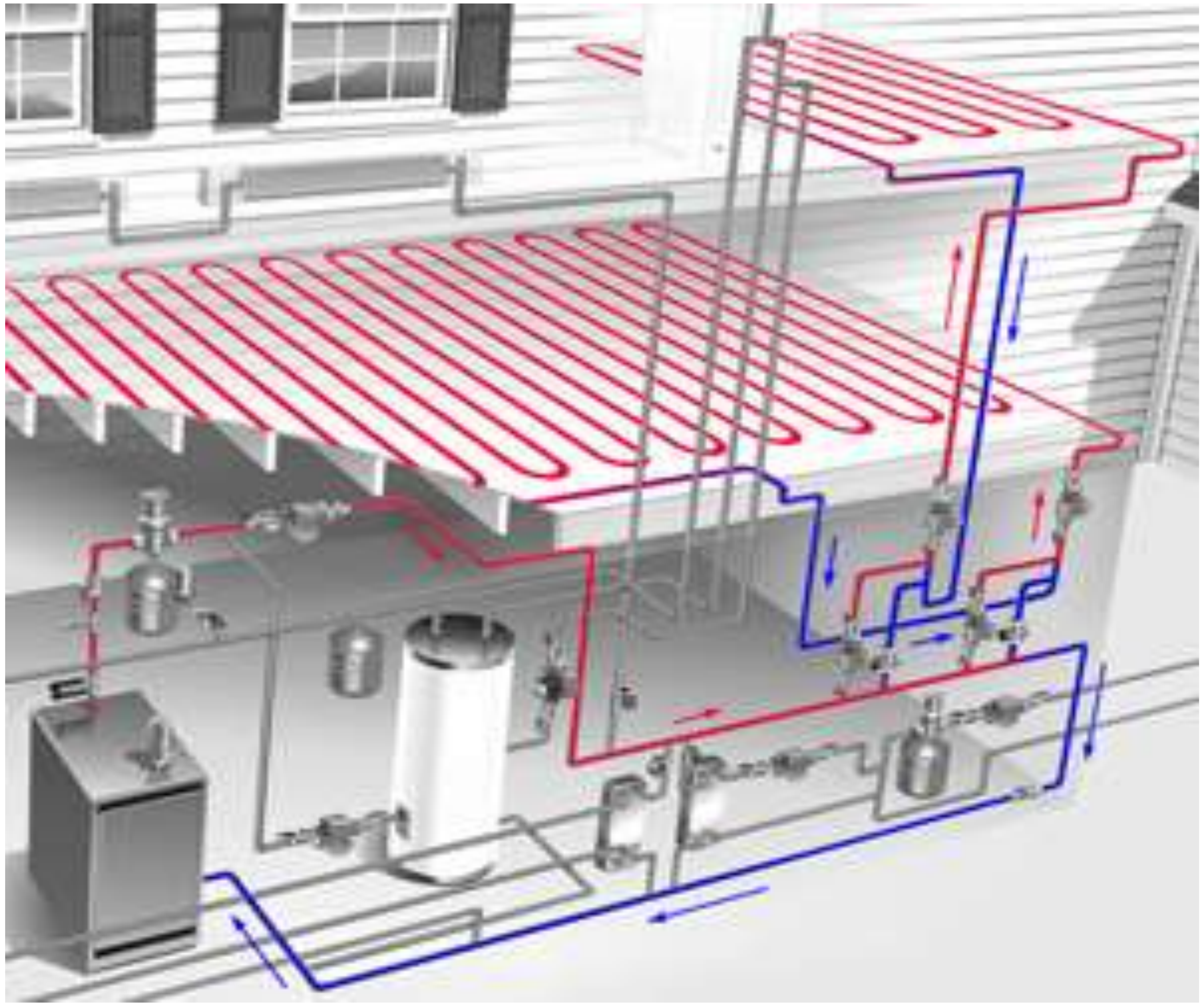
South façade after shading

Façade environmental strategy

North Façade – Vertical & horizontal louvers were planed to reduce heat gains from western sun during evening hours.

East & West facades – GRC Jali was planed to cut down heat gains & glare from low eastern & western sun. The density of the jali was designed as per the solar insolation analysis.

South facades – Horizontal shading devices were devised to cut down high sun from south while allowing view out to the occupants to enjoy expansive views outside.



RADIANT COOLING SYSTEM Regular Air-conditioning uses air & convection to cool a building which is in-efficient way of air-conditioning. By using conduction & radiation, the more effective ways of transferring heat, one can achieve better & cost effective cooling.

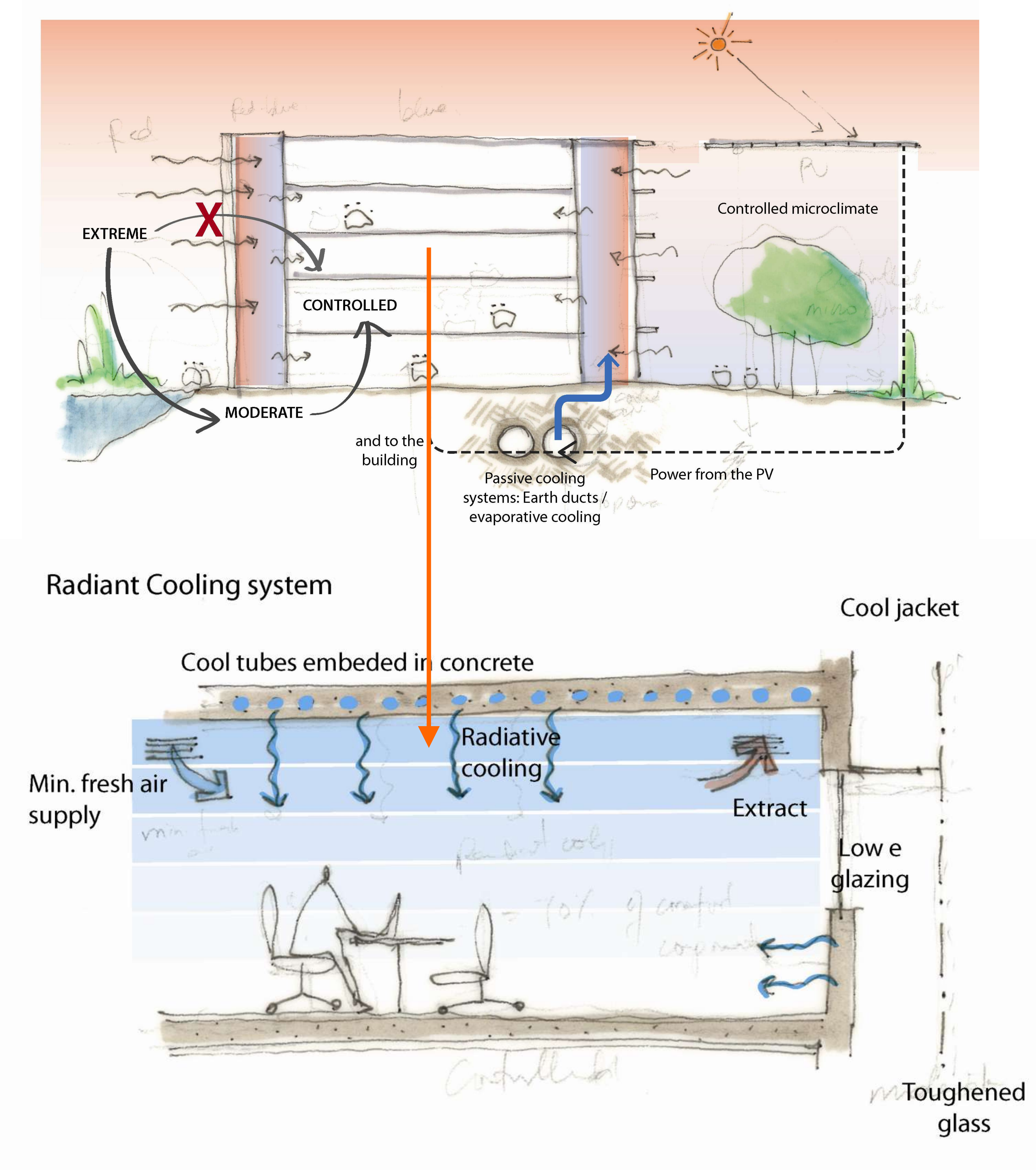


Fig 1 – Conceptual section showing radiant cooling strategies

<u>Key Benefits of Radiant Cooling System</u>

- Thermal energy storage in the panel structure, exposed walls and partitions reduces peak loads for greater energy efficiency

- Eliminates the need for mechanical equipment within the conditioned room, increasing square-footage space (especially valuable in hospital patent rooms and other applications where space is at a premium)

- No drafts or temperature swings for the ultimate in comfort

- Eliminates the need for individual air conditioning units, especially where window-mount units are more prevalent

- Centrally located mechanical equipment offers simplified maintenance and operation

- Noisy fans and blowers dispersing dust and other allergens are eliminated, increasing indoor air quality (particularly valuable where maximum cleanliness is essential or where dictated by legal requirements)

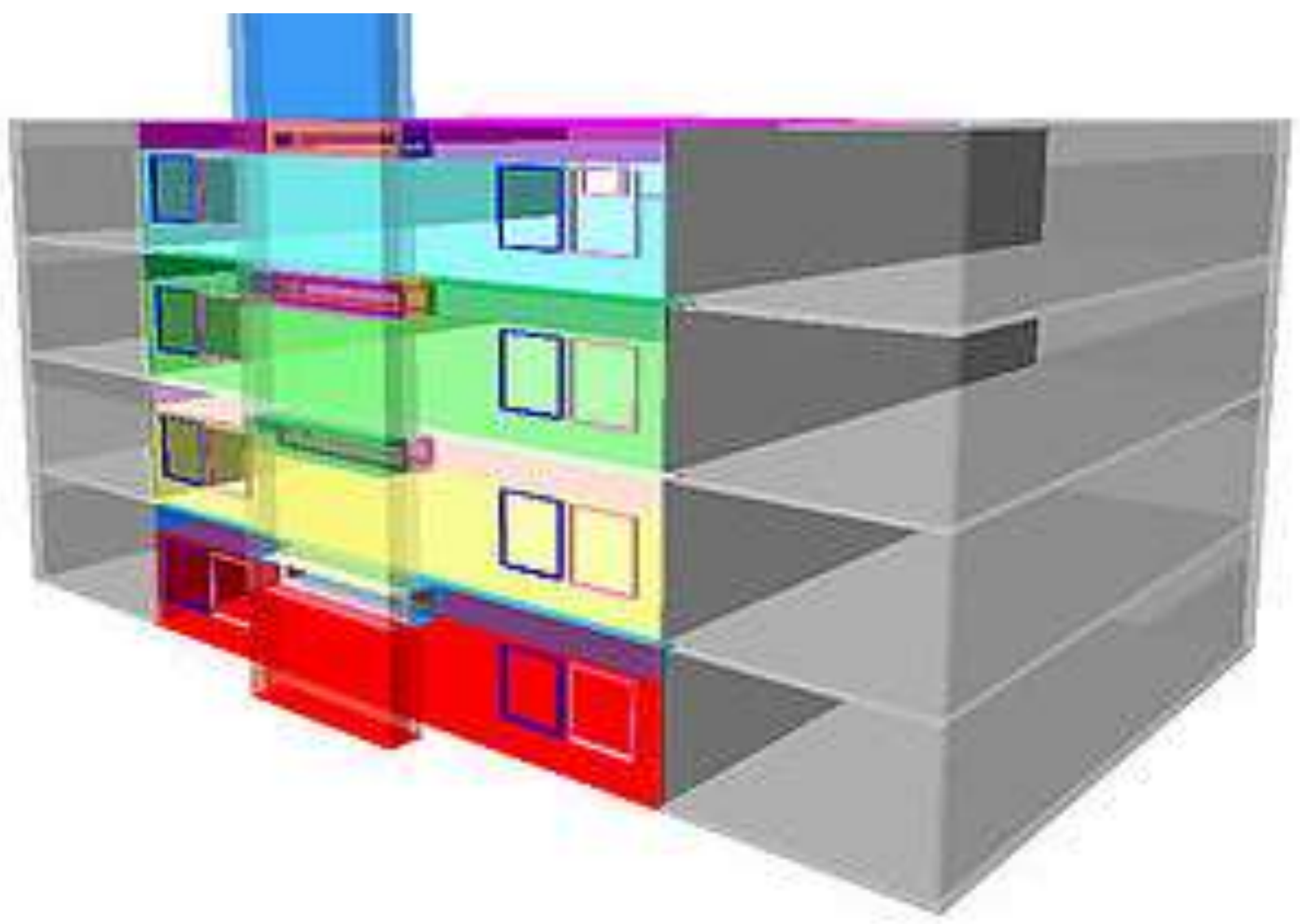


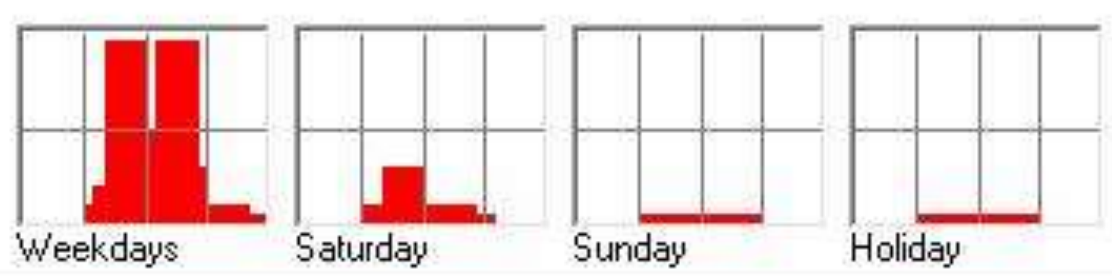
Fig 1 – TAS thermal model for energy simulation

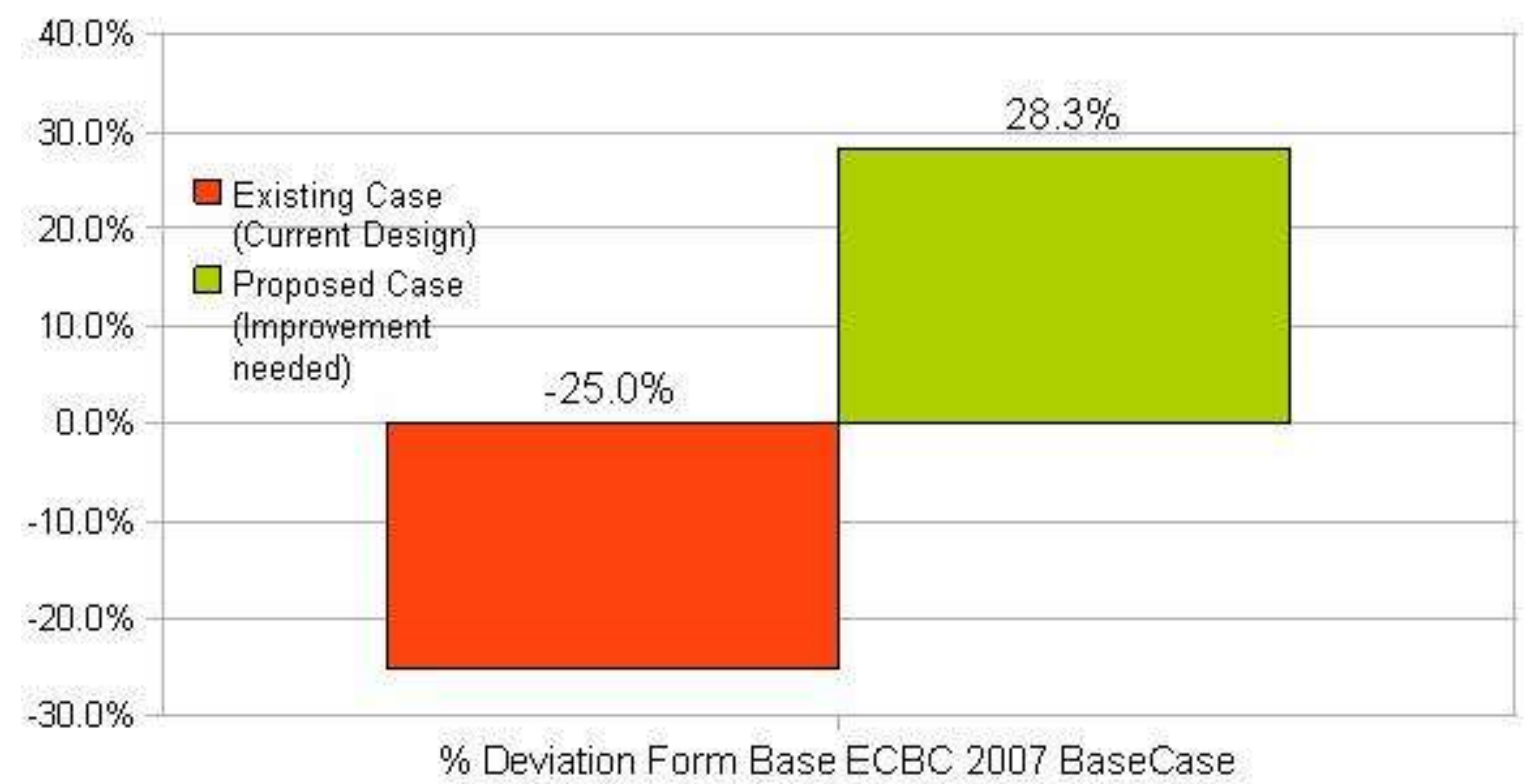
Thermal Modeling - TAS

Energy analysis was then performed considering all the below mentioned strategy on TAS to predict the energy performance of the building over ECBC base case :

- Shaded courtyard
- Jacketed façade
- radiant cooling

The results shows a saving of 50% over the ECBC base case.

S.N	Variables	Description	
1	Schedules	Standard Day time university Schedule, week day partially occupied. 	
2	Occupancies	Occupancies @ 40 ft²/ Person	
3	Out Side Design Conditions	Summer Design = 98.7 °F (37.1 °C), Mean Coincident Wet bulb = 79.8 °F (26.6 °C) @ 99.6 % time in Year	Winter Design = 52.8 °F (11.6 °C), @ 99.6 % time in Year Wind Speed = 4.5 m/ s
4	Comfort Design Temperatures	Heating Design Temperature = 72 °F Cooling Design Temperature = 75 °F	
5	Air Supply Temperatures	Minimum Zone Air Supply Temperature = 55 °F (Cooling Mode) Maximum Zone Air Supply Temperature = 95 °F (Heating Mode) Minimum Outdoor Air flow rate = 0.5CFM/ ft2	




ENERGY CENTER
The advantage of efficiency in a CHP system
Standard Power Plant
60% "Waste" heat rejected to environment
40% Useful energy produced for electricity
100% Fuel Input
District Energy/ Combined Heat and Power Plant
20% "Waste" heat rejected to environment
40% Useful energy produced for heating and/or cooling via district energy system
100% Fuel Input
40% Useful energy produced for electricity
Source: U.S. Department of Energy
CHP PLANT
Solar Irradiance from the Sun
Solar Panel(s)
Electric Current
Charge Controller
Inverter
(and/or)
Battery System
AC Power
DC Power
RENEWABLE ENERGY
NB: When possible gray water to be separated from the black water
Water entering
Black water
Gray water
Gravel
Filter
Control Box: Can be placed inside or outside
Earth
PRE AND PRIMARY TREATMENT
SECONDARY TREATMENT
Subsurface flow constructed wetland
Residence time: at least 4 days
NB: SFCW can also be designed and sized to provide TERCIARY TREATMENT
REUSE OR DISPOSAL / DRAINAGE OF TREATED WATER
Optional: Sub-surface Irrigation for additional productive green zone
SLUDGE SECONDARY TREATMENT AND REUSE
Composting, drying-bed, vermicompost, methane production, ...
CENTRAL STP
SEWAGE LINE TO STP
LT ELECTICITY SUPPLY
CHILLED WATER @ 15 DEG
CHILLED WATER @ 7 DEG

Water

- Water use reduction –Efficient and low flow water fixtures
- 100% rooftop Rainwater Storage & Recycling
- Surface rainwater to be filtered and sent to aquifer
- 100% STP water to reused on site