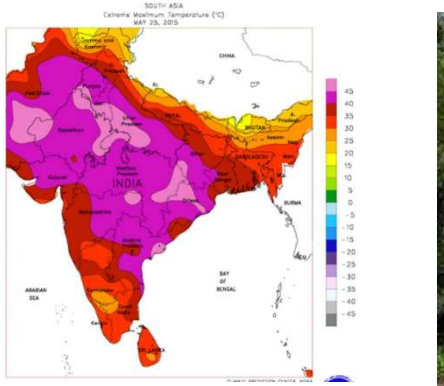
# A pathway to Net Zero Energy: Case Study of Living Laboratory at CEPT University

Dr Yash Shukla, Executive Director

2021 Asia-Pacific Forum on Green and Low-Carbon Development
Parallel Session 6: Green and Low-carbon City Construction
20 October 2021

**Centre for Advanced Research in Building Science and Energy, CEPT University**

# CONTEXT : India



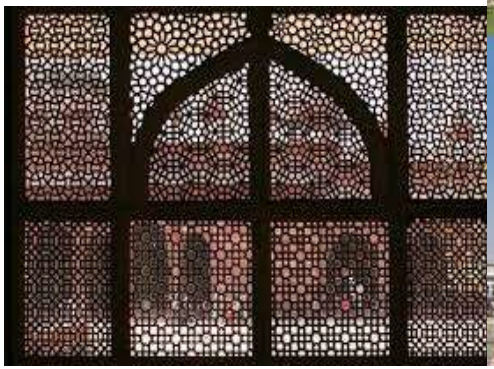





*Image Source: https://robertscribbler.com/2015/06/02/human-hothouse-death-toll-climbs-to-2300-in-india-monsoon-suppressed-delayed/*

Energy Consumption for space-cooling in India *(ICAP)*

- 135 TWh (2017-18)
- 600 TWh (2037-38)

Per Capita Cooling Consumption *(ICAP)*

- 272 kWh Global Average
- 69 kWh in India

30% of global emissions due to space cooling by 2050 as compared to 8% in 2016 *(IEA)*

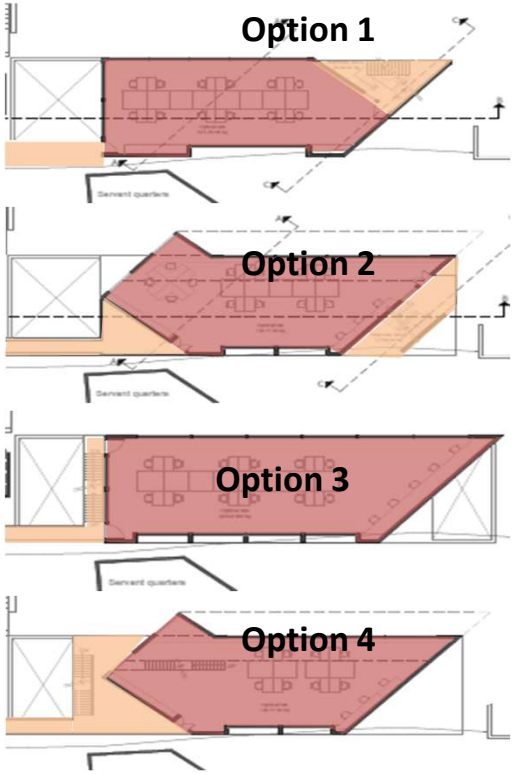
# CARBSE – Iterative Design Process

- **Predesign**
  - Climate Analysis
  - Technical Potential Analysis
- **Conceptual Design**
  - Passive Thermal Comfort
  - Building Massing
  - HVAC System Options
- **System Development**
  - Section, Windows, Shading, Daylighting
  - Active System Thermal Comfort
  - HVAC Capacity Optimization
  - Natural Ventilation Scheduling, CFD
- **Systems Optimization**

**Three in-person charrettes in Ahmedabad**

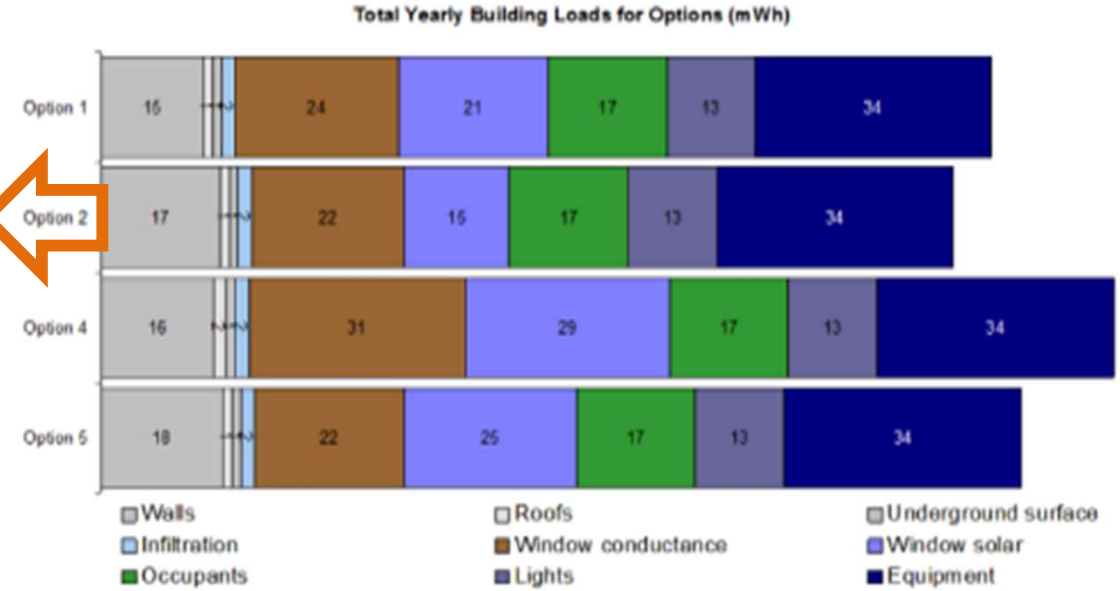
**Over 50 virtual meetings and presentations**

# CARBSE – Building Massing Exercise



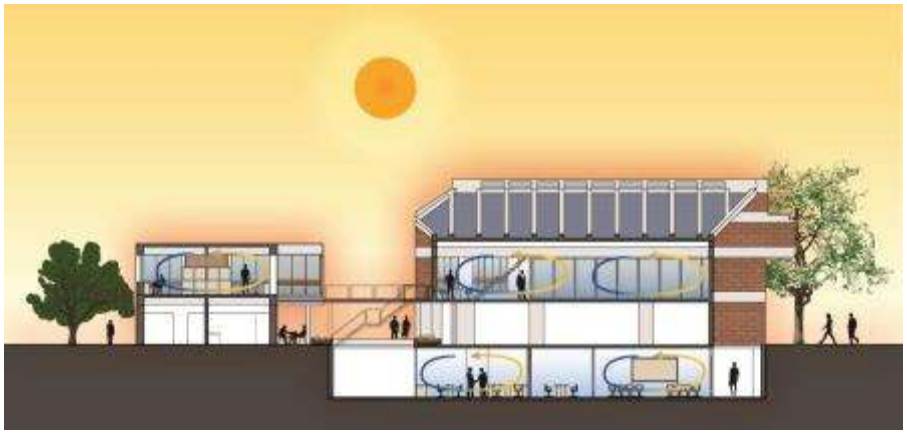

## Building Cooling Loads

Building loads vary with the building massing and orientation. The graphs below show the yearly cooling loads for each option.



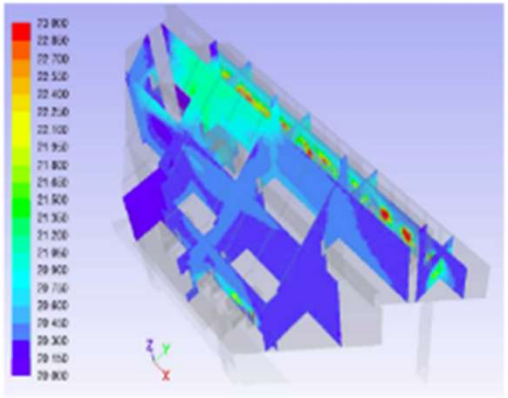
# CARBSE – Net Zero Energy Building

Comfortable Outdoor Environment

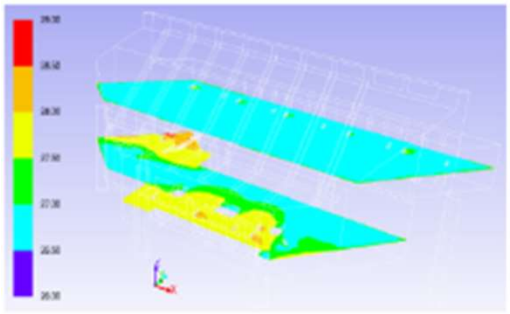


Hot Outdoor Environment

# CARBSE – Thermal Comfort and NV Potential



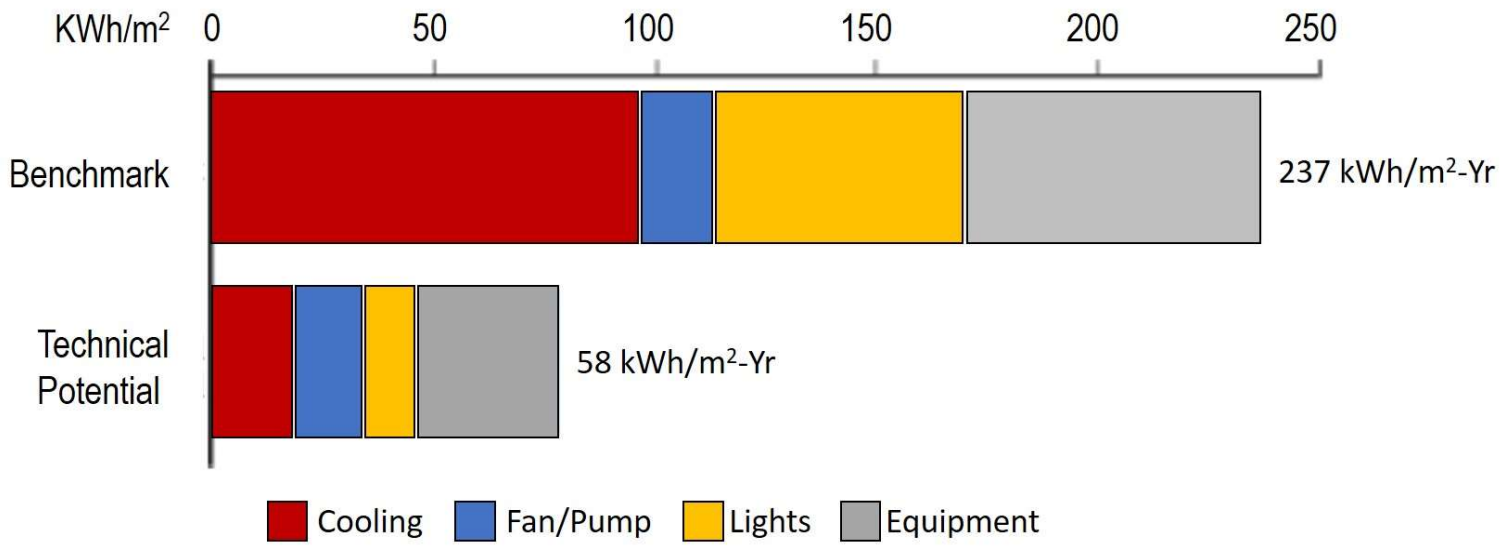
Jan Morning



Feb Evening

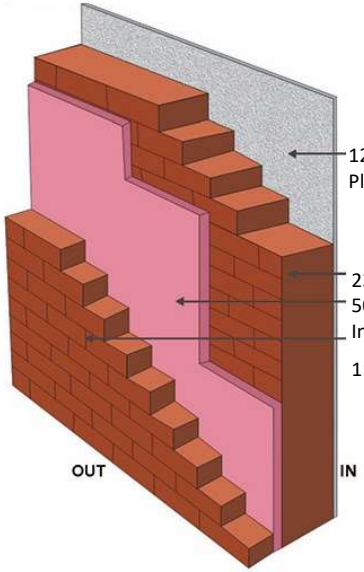
| Month | Morning | Afternoon | Evening |
|---|---|---|---|
| Jan | Windows Closed | Windows Open | Windows Open |
| Feb | Windows Closed | Windows Open | Windows Open |
| Mar | Windows Open | No | No |
| Apr | No | No | No |
| May | No | No | No |
| Jun | No | No | No |
| Jul | No | No | No |
| Aug | No | No | No |
| Oct | Windows Open | No | No |
| Nov | Windows Open | No | Windows Open |
| Dec | Windows Closed | Windows Open | Windows Open |

# CARBSE – Net Zero Energy Building

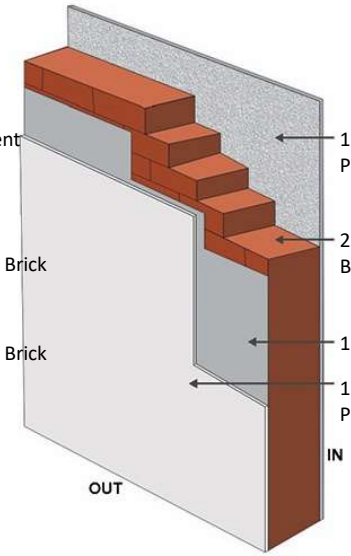


# CARBSE – Wall Construction

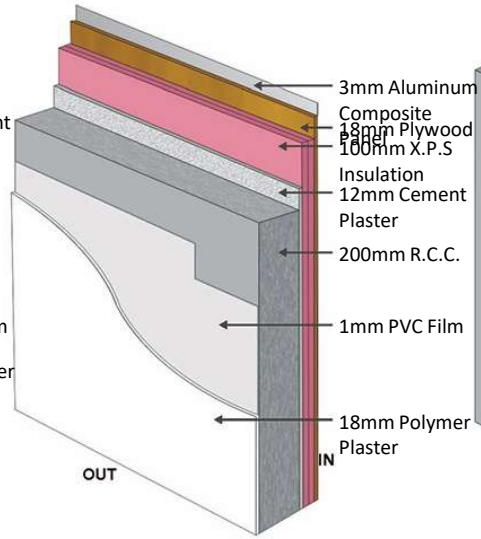
**3.1 WALL SUPER STRUCTURE**
**u - VALUE (W/m²)=0.42**
**R - VALUE (m².K/W)=2.38**



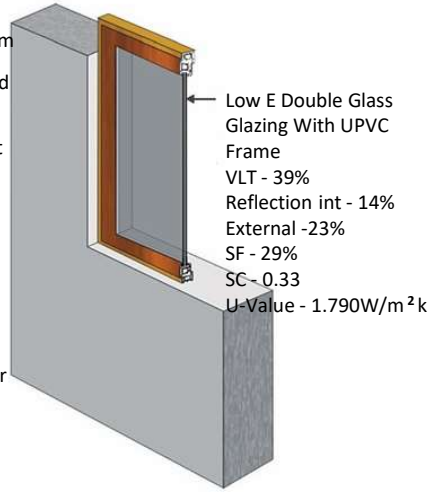

**3.2 WALL BASEMENT**
**u - VALUE (W/m²)=2.01**
**R - VALUE (m².K/W)=0.50**




**3.3 WALL BASEMENT**
**u - VALUE (W/m²)=0.28**
**R - VALUE (m².K/W)=3.59**

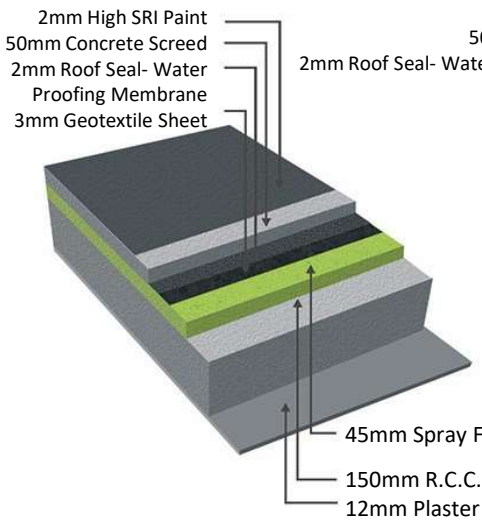



**3.4 WINDOW**
**u - VALUE (W/m²)=1.70**
**R - VALUE (m².K/W)=0.588**

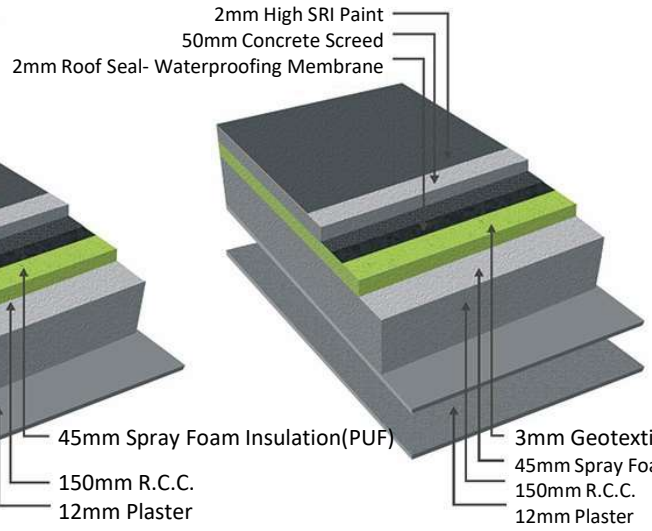


# CARBSE – Roof Construction

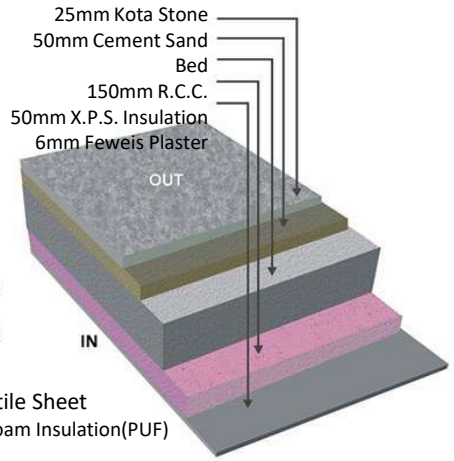
**1.1 ROOF ASSEMBLY**
**u - VALUE (W/m²)=0.38**
**R - VALUE (m².K/W)=2.654**




**1.2 ROOF ASSEMBLY**
**u - VALUE (W/m²)=0.38**
**R - VALUE (m².K/W)=2.654**




**2.1 FLOOR- First Floor**
**u - VALUE (W/m²)=0.55**
**R - VALUE (m².K/W)=1.82**

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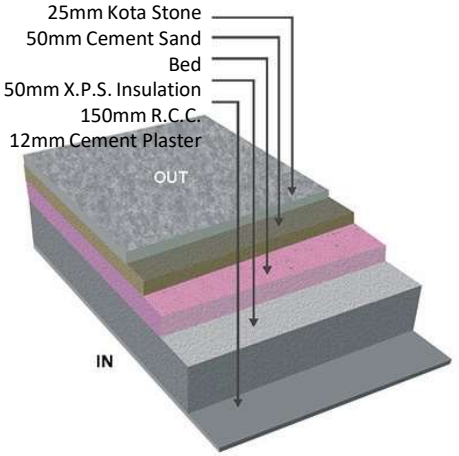

# CARBSE – Net Zero Energy Building

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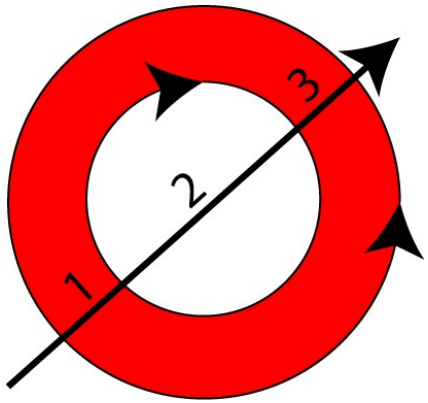
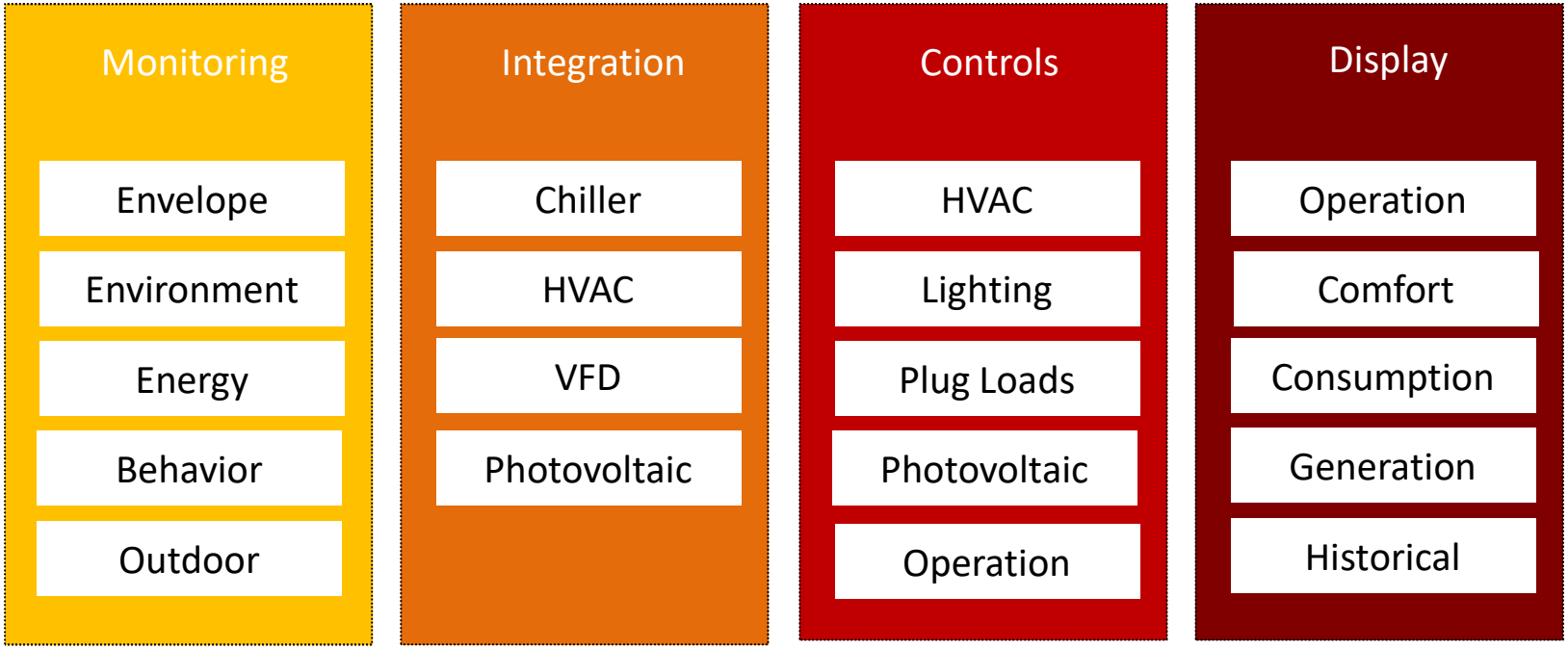
# CARBSE – Monitoring Strategies




**“Every line is the perfect length if you don't measure it”**

***-Marty Rubin***

# CARBSE – Monitoring Strategies



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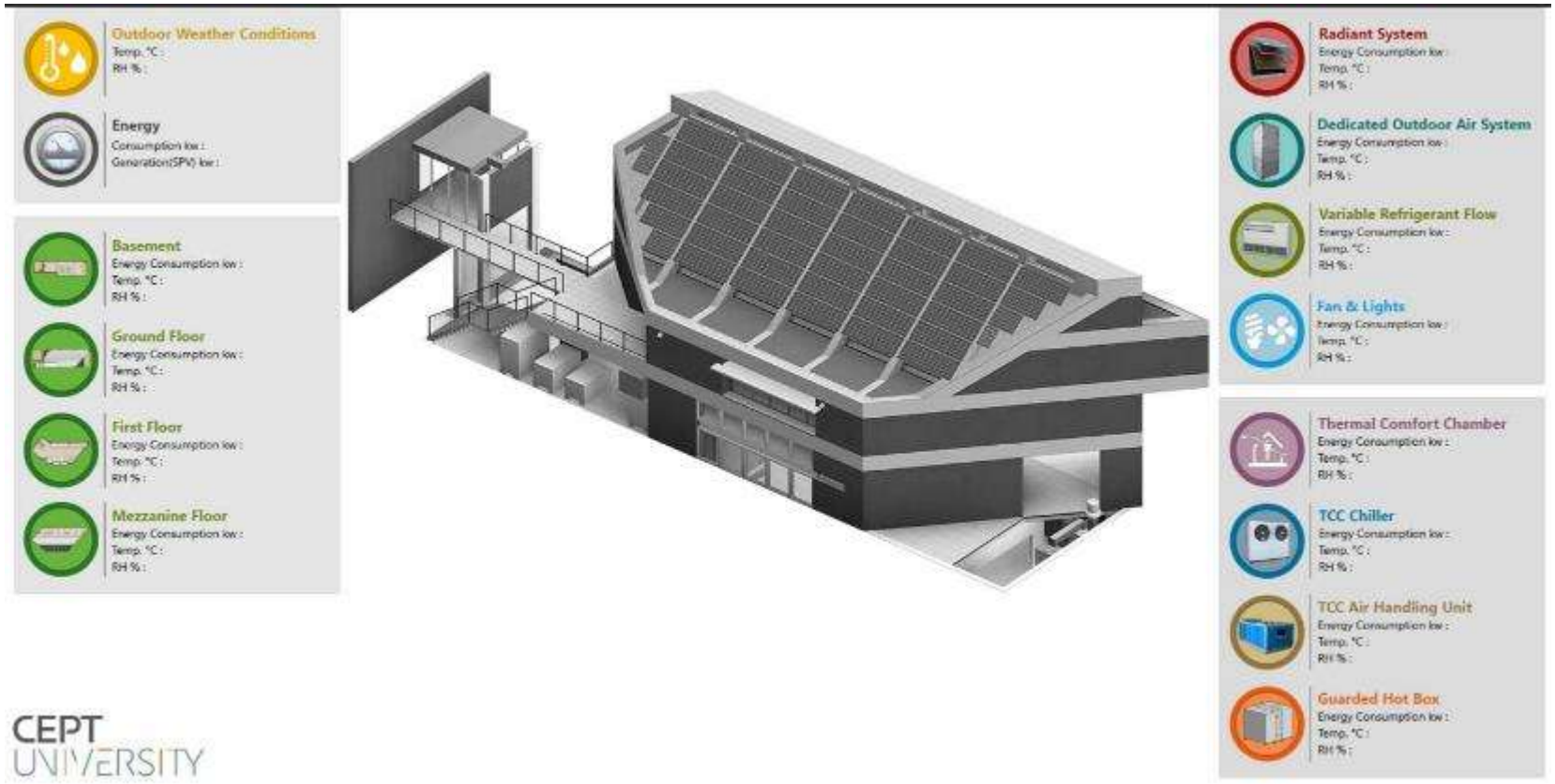
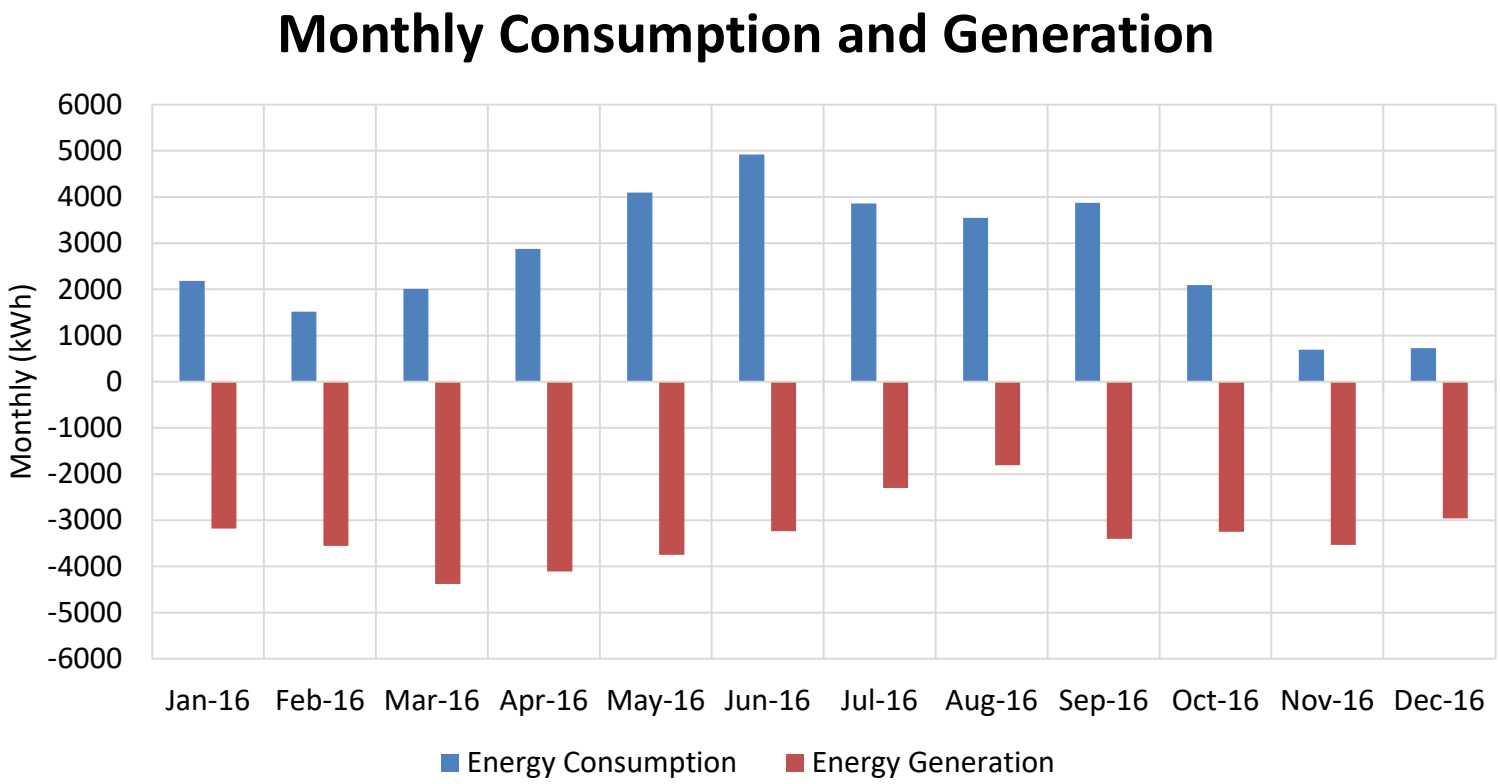


# CARBSE – Monitoring Strategies

# CARBSE – Annual Energy Consumption



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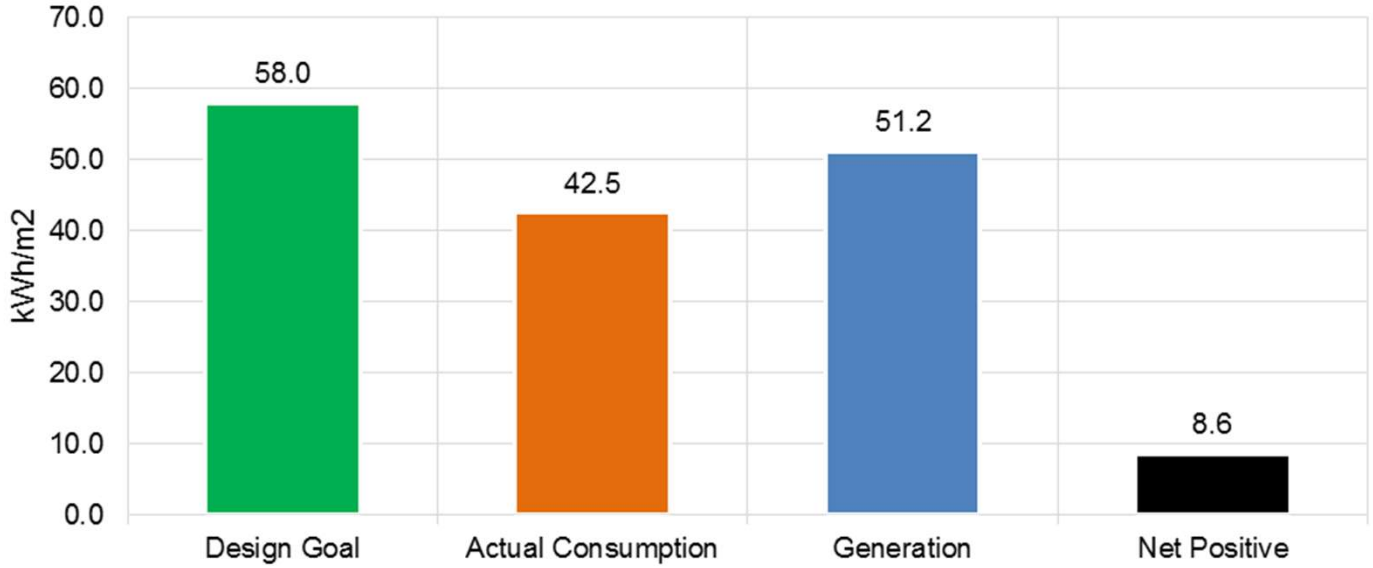
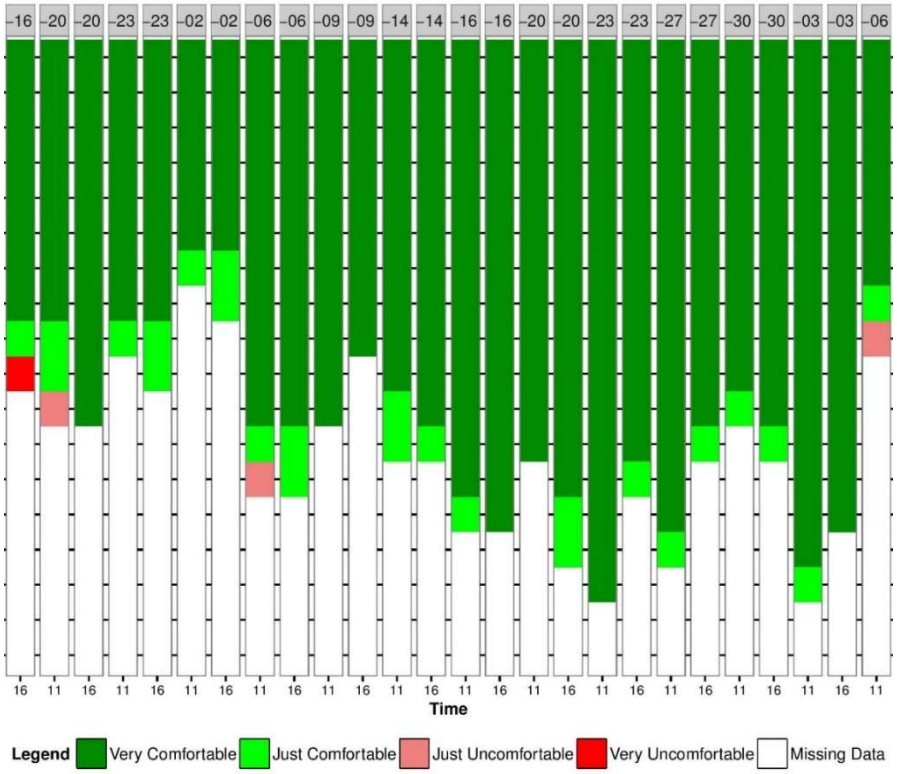



Energy generation, process consumption, and space consumption with operation and cooling loads

# CARBSE – Occupant Comfort Surveys




- Four times a week, Mondays and Thursdays, 11h00 and 16h00
- Occupants have choice to raise request for adjustment anytime
- Air Temp, RH, MRT, Clo. and MET at each cluster, Provision of desk level personal fans, pedestal fans.
- Seven point ASHRAE Scale
  - Thermal Comfort Sensation
  - Thermal Comfort Satisfaction
  - Thermal Comfort Preference

# Thank You

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