

DIVIDE BY NET-ZERO:

INFINITE POTENTIAL OR CALCULATION ERROR? A QUASI-ACADEMIC DESIGN AND CONSTRUCTION PROJECT IN INDIA

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CEPT UNIVERSITY

- understanding
- designing
- planning
- constructing
- managing
- Teaching programs
- Research
- Advisory
- Thematic Centres

*CEPT Research and Development
Foundation – dedicated entity to
manage projects*

**FOCUS ON
HUMAN HABITATS**

Ahmedabad: Architectural Context



- 600 year old living cities
- Traditional Housing Precinct 'Pol'
- Traditional Public Buildings
- Modern Architecture
- Post Modern Architecture



Legacy of Climate Responsive Architecture



CEPT University : Architectural Context



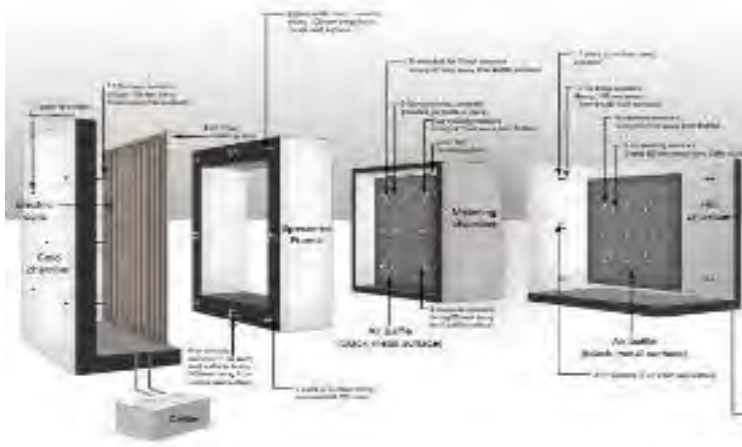
- Design Studios
- Class rooms – Seminar Rooms
- Workshops and Laboratories
- Open Spaces
- Strong architectural expression

**Thermal Mass, High Volumes.
Daylight – stack ventilation**

CARBSE at CEPT University : Activities

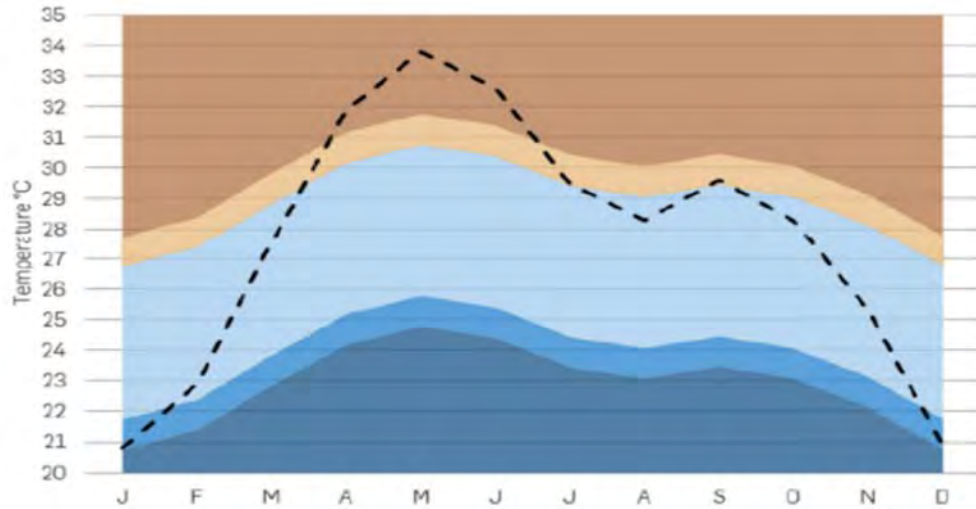


- Building Material Characterization
- Thermal Comfort Studies
- Daylighting studies
- Information tech. for buildings
- Building Codes and Policy
- Renewable Energy Integration

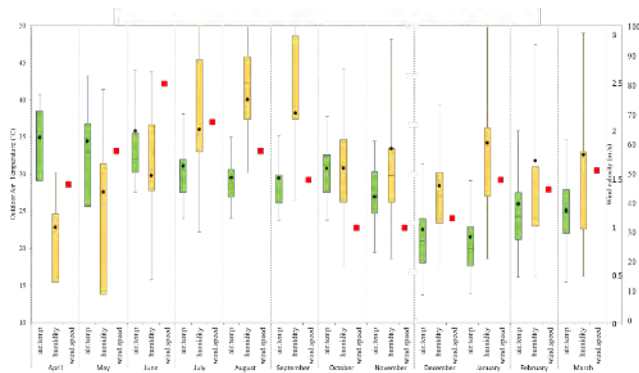


- **Extension of floor space – a living laboratory**

NZEB: Early Design Process

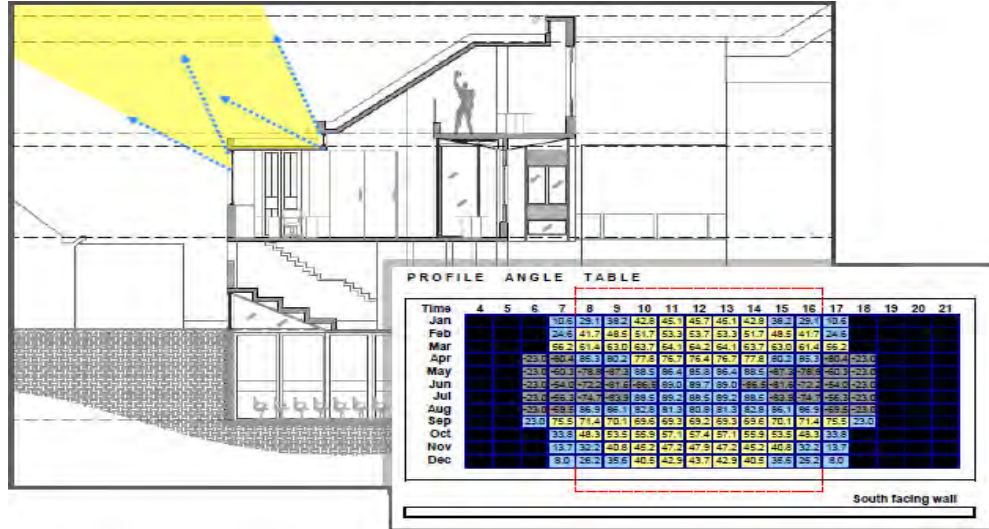


- **Predesign:** climate analysis; site analysis, shading
- **Conceptual design:** passive thermal comfort analysis; building massing/orientation energy analysis; HVAC
- **System development:** building envelop optimization; active system thermal comfort analysis; HVAC sizing and capacity optimization analysis; natural ventilation scheduling, CFD analysis
- **Systems optimization:** individual energy conservation measures (ECM) energy analysis; bundled ECM energy analysis.

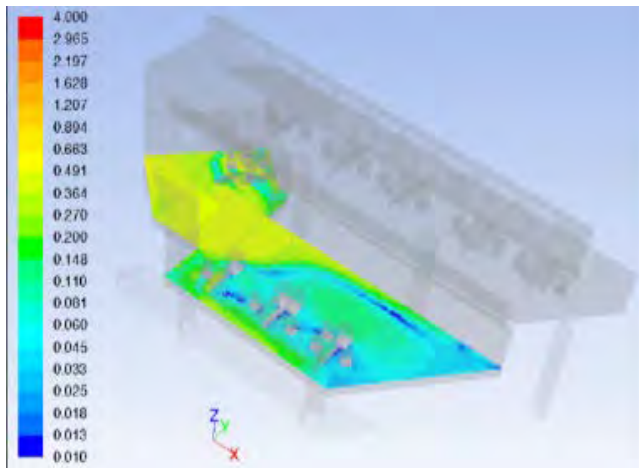


- **BAU EPI 237 kWh/m².year - Proposed EPI 54 kWh/m².year**

NZEB: Advanced Design Process



- Day lighting Analysis
- Natural Ventilation Analysis
- HVAC & lighting system
- Building Energy Management System
 - Environmental Monitoring
 - Energy Monitoring
 - Renewable Energy Monitoring



NZEB: Design Strategies Deployed

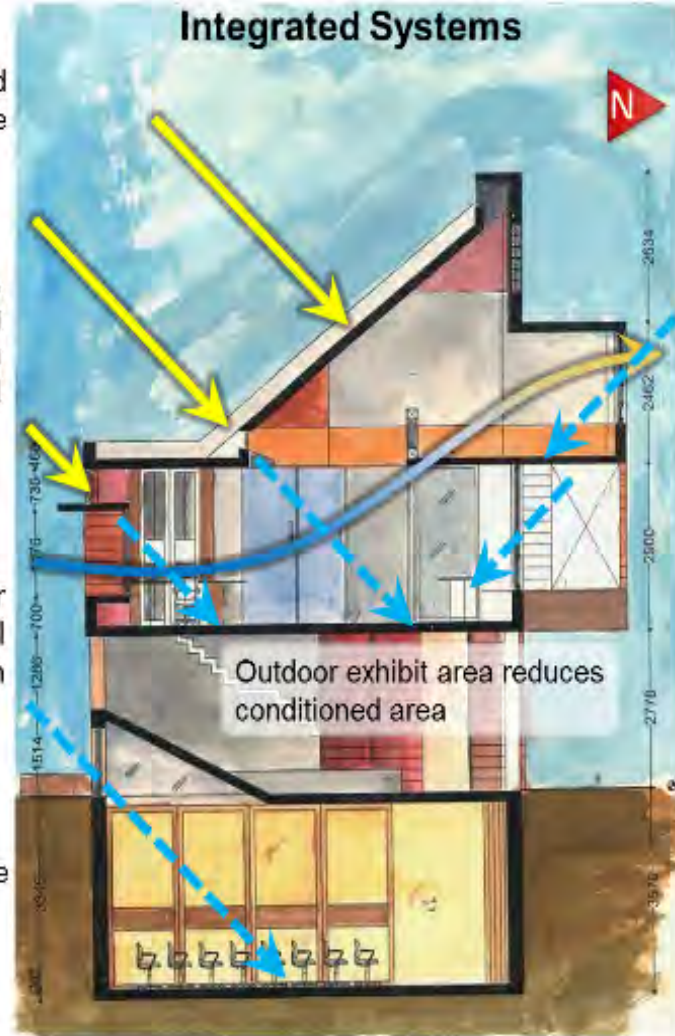


South facing PV panels tilted to latitude angle

Vision, clerestories, lightshelves on south bring in diffuse daylight with occupant control

Stack effect design, solar chimney for natural ventilation

Ground heat exchange



North light for daylighting

Radiant cooling and DOAS integrates with natural ventilation

Lighting LPD at 4.7 w/m² and vacancy and daylighting controls

Climate controlled spaces zoned separately

Optimized envelope: Insulated walls and roof, efficient windows with separate properties for vision and clerestory



NZEB: Post Occupancy Monitoring

System	Key monitoring and control points	Key control strategies
Envelope	Temp, heat flux	Monitoring only
Environment	Air & globe temp, RH, CO ₂ , room pressure	Adaptive, PMV, and temp/RH based algorithm; optimum building mode
Energy	Voltage, current, power factor, ETC,	Monitoring only; energy signatures for system operation
Behaviour	Window contacts, vacancy, fan operation, comfort vote	Light control, personalized control
Radiant	Surface temp, dew point, valves	Variable flow constant setpoint, constant flow variable setpoint
Supply and ventilation fans	Pressure, flow, status, current, and temp	Demand based ventilation
Variable refrigerant units	loading, operation, power and efficiency	System operation optimization based on energy and comfort
Air cooled chiller, DX scroll, DOAS	loading, operation, power and efficiency, Temp, RH	System optimization based on efficiency curve and building demand
Chilled water loop	Operation, power, temp	Supply temp setpoint reset
Outdoor	Temp, RH, wind velocity & direction, solar radiation, rain gauge	Economizer mode; optimum building mode
PV generation	Temp, power, efficiency	Load distribution based on demand

NZEB: Conclusion

- Promoter, Designer, Contractor, Facilitator, User – Occupants
- Collaboration with academic and industry is key
- International – Local Expertise
- Respond to strong architectural context – follow lines
- CapEx, RoI, Payback, Internal Rate of Return – Economics of NZEB
- Selection of technologies
 - Incremental investment
 - Scale and Size
 - Experimentation – Operation, Monitoring

Living Laboratory in academic environment



Kaminsky, 1990

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Thank You

Prasad Vaidya



Rajan Rawal



Sanyogita Manu



Yash Shukla

