Centre for Excellence

Solar Passive Architecture and Green Building Technologies

CEPT University, Ahmedabad

N.K.Bansal
Rajan Rawal
Yash Shukla

RD & D project Appraisal Committee,
Ministry of New and Renewable Energy, Government of India
Monday, June 13, 2016

Fact Sheet

Project Title:

To Set up Centre for Excellence in area of Solar Passive Architecture and Green Building Technologies" at CEPT University – Ahmedabad.

MNRE Sanction Order No & Date:

No 15/35/2010-11/ST dated February 15, 2011

Name and complete address of PI & Co-PI:

Dr. N K. Bansal, Principle Investigator,
Professor Emeritus, CEPT University, Navrangpura, Ahmedabad – 380 009

Prof. Rajan U. Rawal, Co-Principle Investigator
Asst. Professor, CEPT University, Navrangpura, Ahmedabad – 380 009

Date of start of the project and scheduled completion date:

Project Start Date: March 2011
Scheduled Completion Date: March 2016

Objectives

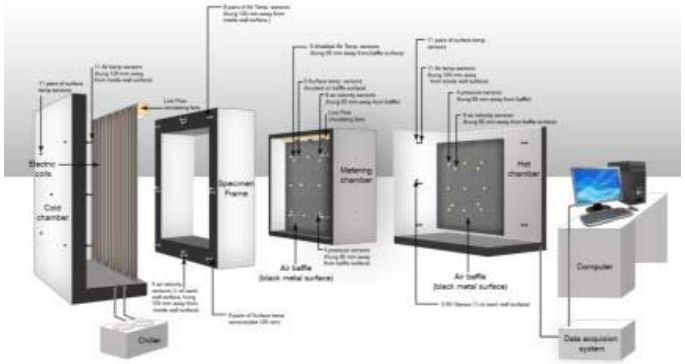
- Enhance knowledge of construction materials methods and practices for energy efficient solar passive architecture
- Support policy implementation, technical feedback for policy design
- Demonstration building and establishment of living laboratory, develop business plan for its successful operations
- Develop capacity within country, develop courses and curriculum

Proposed Activities*

- Building construction material database – thermo-optical properties
- Development of thermal comfort mode
- Advance knowledge of calibrated simulation models
- Studies for Policy support – ECBC, Window Labelling, GRIHA LD, Solar city
- Study performance of vernacular settlements
- Model design - demonstration of integrated building design process
- Training program for solar passive architecture, Workshops and Conferences

** At the time of proposal*

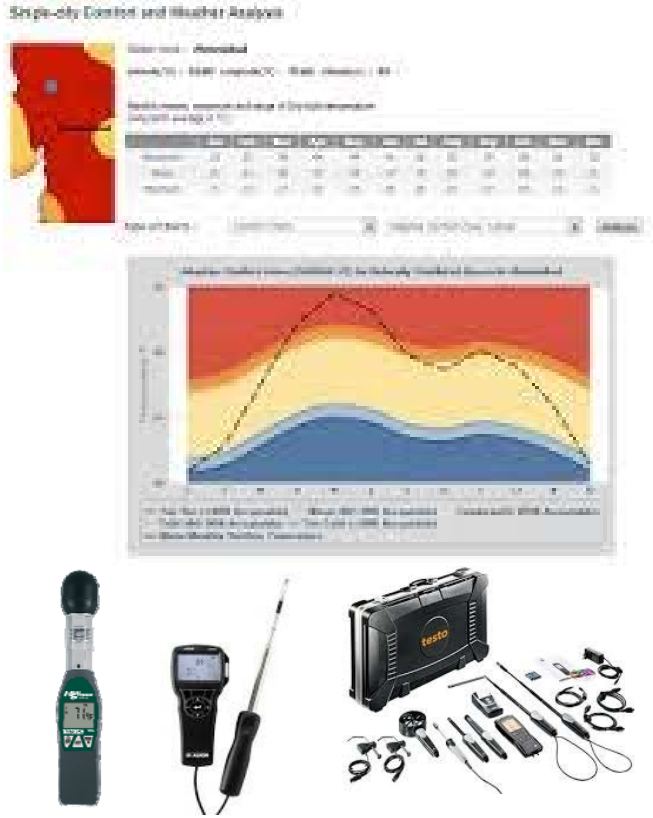
Material database



- 200+ Generic building material characterized
  Clay Bricks, Cement, Stones, Clay tiles, mud blocks
- 275+ Industrial building material characterized
  Glass, Paints, Coatings, Insulation
- Database in public domain
- Online U Value calculator on www.carbse.org

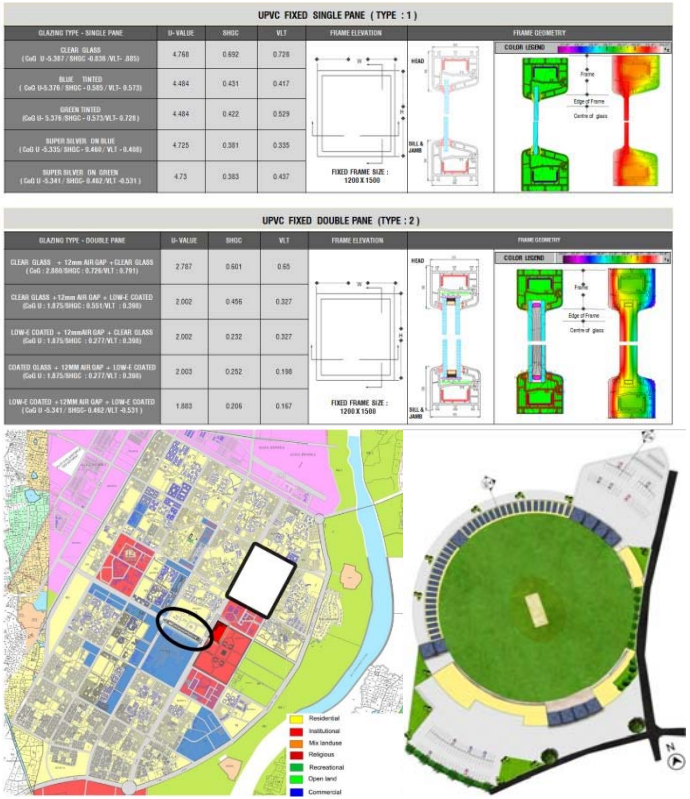
- *Third Party Android Based App*
- *GRIHA – LEED Facilitation*
- *Extension of work under US-India R&D, PCM and Cool roof*

Adaptive Thermal Comfort



- India Model for Adaptive Thermal Comfort (IMAC)
  Naturally Ventilated, Mixed Mode and Air Conditioned Bldg
- IMAC inclusion under National Building Code, ECBC and GRIHA – NV and MM equations
- International Energy Agency Annex 69 to include this in Global database – ASHRAE Database II
- Online IMAC assistant calculator on www.carbse.org
  - *International Expert support from Shakti Foundation*
  - *Thermal Comfort Chamber for US-India Project*

Policy Support



UPVC FIXED SINGLE PANE (TYPE : 1)

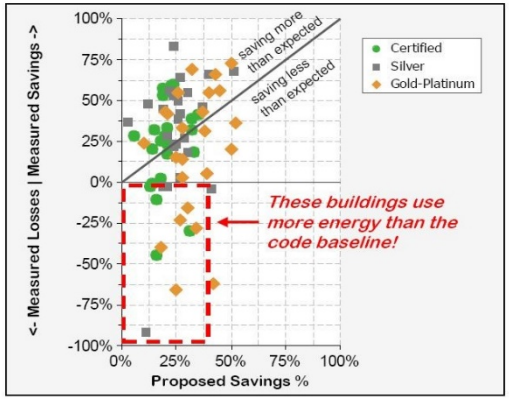
GLAZING TYPE - SINGLE PANE	U- VALUE	SHGC	VLT	FRAME ELEVATION	FRAME GEOMETRY
CLEAR GLASS (Go) U-5.387 / SHGC -0.836 /VLT- .805)	4.768	0.692	0.728		
BLUE TINTED (Go) U-5.376 / SHGC - 0.585 / VLT- 0.573)	4.484	0.431	0.417		
GREEN TINTED (Go) U- 5.376 /SHGC - 0.573/VLT- 0.729)	4.484	0.422	0.529		
SUPER SILVER ON BLUE (Go) U -5.335/ SHGC - 0.460 / VLT - 0.400)	4.725	0.381	0.335		
SUPER SILVER ON GREEN (Go) U -5.341 / SHGC- 0.482 /VLT -0.531)	4.73	0.383	0.437	FIXED FRAME SIZE : 1200 X 1500	

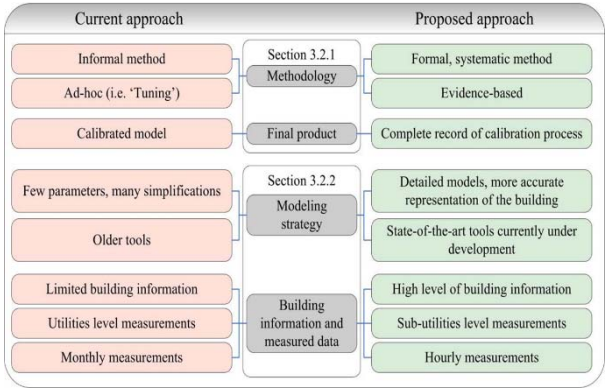
UPVC FIXED DOUBLE PANE (TYPE : 2)

GLAZING TYPE - DOUBLE PANE	U- VALUE	SHGC	VLT	FRAME ELEVATION	FRAME GEOMETRY
CLEAR GLASS + 12mm AIR GAP +CLEAR GLASS (Go) : 2.888/SHGC : 0.726/VLT : 0.791)	2.787	0.601	0.65		
CLEAR GLASS +12mm AIR GAP + LOW-E COATED (Go) U : 1.875/SHGC : 0.551/VLT : 0.398)	2.002	0.456	0.327		
LOW-E COATED + 12mmAIR GAP + CLEAR GLASS (Go) U : 1.875/SHGC : 0.277/VLT : 0.398)	2.002	0.232	0.327		
COATED GLASS + 12MM AIR GAP + LOW-E COATED (Go) U : 1.875/SHGC : 0.277/VLT : 0.398)	2.003	0.252	0.198		
LOW-E COATED + 12MM AIR GAP + LOW-E COATED (Go) U -5.341 / SHGC- 0.482 /VLT -0.531)	1.883	0.206	0.167	FIXED FRAME SIZE : 1200 X 1500	

- Energy Conservation Building Code at State level
  Support to Gujarat, Haryana, Maharashtra & Madhya Pradesh
- Window Labelling Program
- Insulation labelling program
  Inter laboratory comparison for BEE
- Solar City Master Plan for Gandhinagar

Calibrated Models

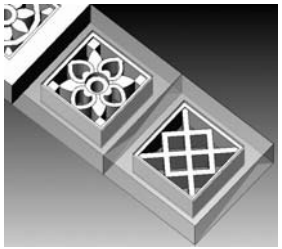


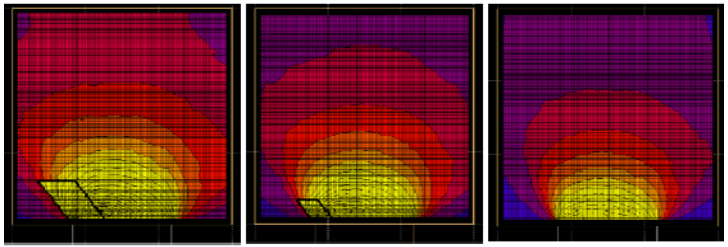


- Calibrated Simulation Model for Air-conditioned Buildings
- Calibrated Simulation of Prototypes – Commercial Buildings
- Data analysis from Controlled Experiment & 'In use' Building
- Whole Building Versus Granular Approach
  - Sequential versus iterative

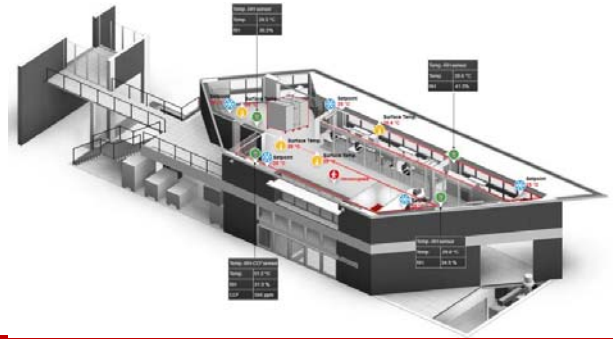
Vernacular Settlements

- Year round monitoring of vernacular settlement of Ahmedabad
- Thermal Comfort and Environmental conditions
- Daylight Analysis of Window / façade configuration
- Daylight analysis of Stone *Jaali*





Model Design Demonstration



- Solar Passive Architecture Concepts in NZEB
  - Orientation, Daylight, Insulation & Mass, Stack effect
- Integration of Active Systems
  - Efficient LED lights, VRV With Radiant Cooling
- Building Controls and Solar PV to reach NZEB
- Integrated Design process

  - *Design Support by USAID*
  - *Building Construction Support by Government of Gujarat*
  - *Building Material and System support by Industry Partners*

Training & Capacity Building

- International Conference

Passive Low Energy Architecture – 2014, 400 delegates, 27 countries

- Simulation Training programs for Professionals
- Summer and Winter Workshops for Students
- Faculty Development Program
- M.Tech in Building Energy Performance
  - *Additional Support from MNRE for FDP and workshops*

Infrastructure Created

- Field Measurement Capabilities for thermal comfort – hardware and software
- Thermo-Optical Characterization
  - TPS, Heat Flow meter, Guarded Hot Box
- Energy Simulation Lab
- Thermal Comfort Chamber for Controlled Experiments
- Net Zero Energy Building with BMS and SPV
- Handhelds for research and education

Recognitions

- National Accreditation Board of Laboratories
- Round Robin for International Glass Database
- BEE Recognized test lab*
- Glazing Society of India & India Insulation Forum
- IGBC, GRIHA, AAI, CPWD
- Testing Samples from SAARC Countries, Afghanistan and Vientnam

Research Linkages

GEDA
ગુજરાત ઊર્જા વિકાસ એજન્સી
GUJARAT ENERGY DEVELOPMENT AGENCY

Loughborough University

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Agency for Development and Cooperation SDC

- Gujarat Energy Development Agency
- Lawrence Berkeley National Lab
- Swiss Development Corporation in India
- University of Loughborough
- National Fenestration Council, USA
- Shakti Sustainable Energy Foundation
- SINTEX, UPONOR, PIDILITE, OWENS CORNING

Outcome

- 26 Conference and Journal papers
- 12 Articles in Magazine, Newspapers
- 03 Online tools
- 19 Postgraduate and Undergraduate thesis support
- Vibrant website – www.carbse.org

Core Team

Dr N.K. Bansal
Mentor and Professor Emeritus

Late Dr.Vinod Patel
Technical Director

Rajan Rawal
Executive Director

Yashkumar Shukla
Technical Director

Sanyogita Manu
Senior Research Associate

Agam Shah
Senior Research Associate

Asha B. Joshi
Admin Manager

Mona Galsar
Communication Expert

Jaymin Patel
Laboratory Technician

Jigar B. Patel
Laboratory Technician

Financials

Total Funds Released by MNRE up to May 31, 2016

Sr. No	Particulars	Date of Receipt	Amount Received (Rs.) in lakhs
1	1st Installment	1.04.2011	100.08
2	2nd Installment	11.04.2012	142.67
3	3rd Installment	31.03.2015	131.71
4	4th Installment	29.05.2015	154.48
	Total Amount Received		**528.95**
	Total Approved Budget		**617.76**
	Outstanding		***88.80***

Current Balance appx. (- 40.03 Lacs)
Committed Expense up to November 2017 appx. 45.23 lacs

Next Steps and Future

- Publish papers and document work conducted
- Database for wall assemblies – nonhomogeneous
- Hydrothermal material database
- Mixed Mode Building Modelling and Operations
- Stock modelling for EE and RE – align Research with ongoing national activities on cities
- Support more NZEBs

Thank You

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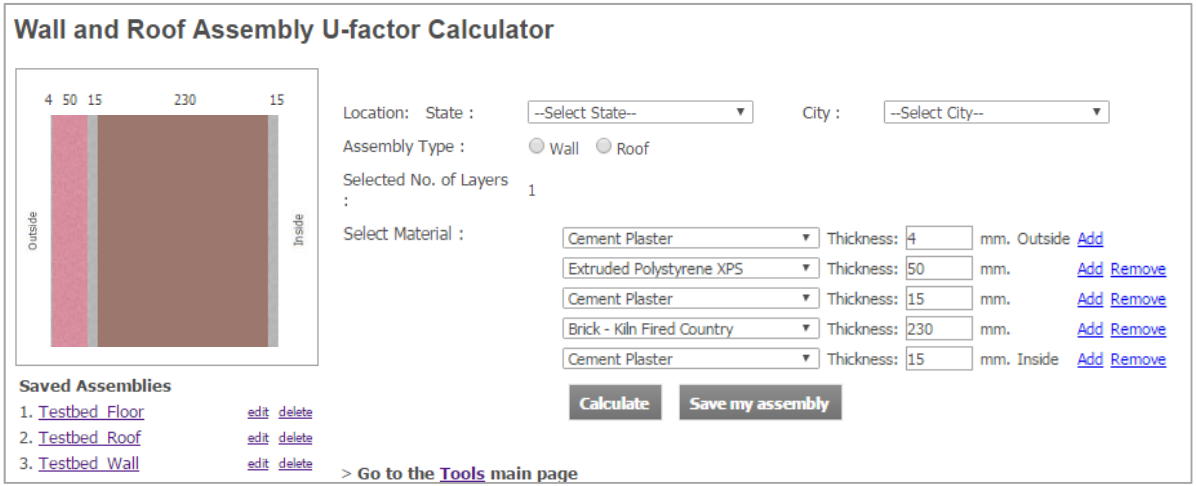
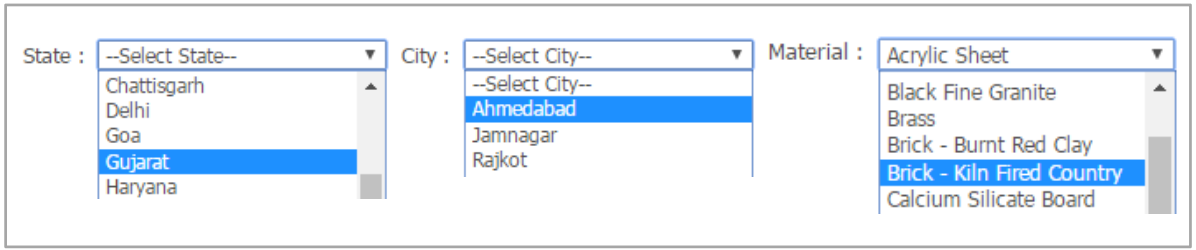
Backup Slides

Assembly U-factor Calculator



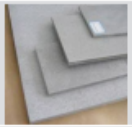


- Calculator for U-Factor for Wall and Roof Construction Assemblies with multiple layers
- Online and freely available at www.carbse.org
- Material Properties from Material Database tested at CEPT University

Assembly U-factor Calculator

Thermal Properties of Individual Layers

	Material Name	Conductivity (W/m-k)	Specific Heat (MJ/m³K)	Density (kg/m³)	Sample Source	Material Information
Layer 1	Cement Plaster	1.21	0.97	1880		More
Layer 2	Extruded Polystyrene XPS	0.03	0.04	30		More
Layer 3	Cement Plaster	1.21	0.97	1880		More
Layer 4	Brick - Kiln Fired Country	0.59	0.27	1660		More
Layer 5	Cement Plaster	1.21	0.97	1880		More

Name	Form	Density kg/m³	Thermal Conductivity W/(mK)	Specific Heat MJ/m³K	Image
Acrylic Sheet	Board	1145	0.2174	1.5839	
Armor	Insulation	270	0.0678	0.1578	
Asbestos Cement Board	Board	1404	0.4709	0.7218	

Output:

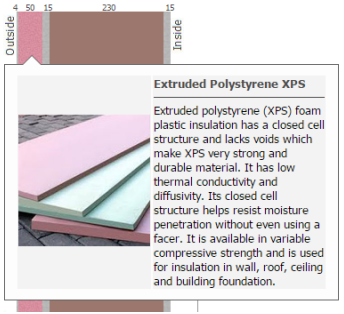
- Static and Dynamic U-Factor of Assemblies specific to location
- Thermal Properties of individual material layers

Surface Heat Transfer Coefficient Calculations

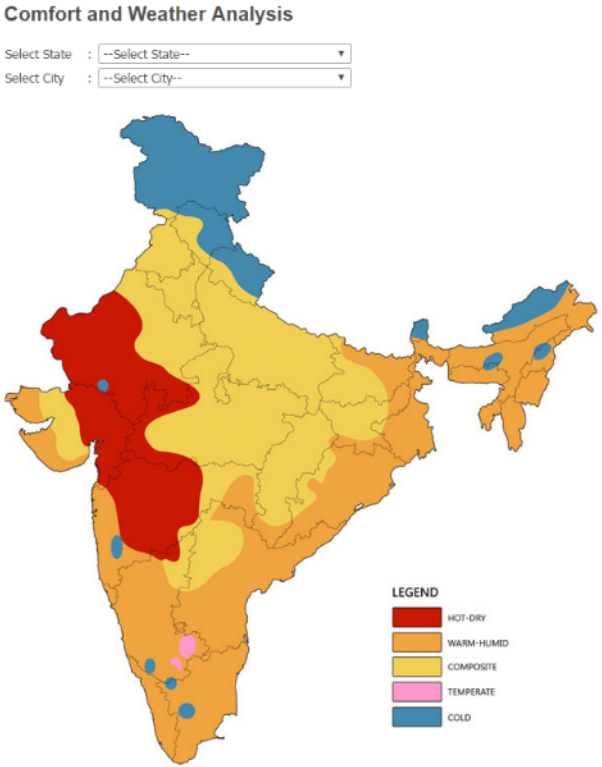
Calculation Method	State	City	Internal Surface Resistance (m²-k/w)	External Surface Resistance (m²-k/w)	Additional Information
Static	All	All	0.13	0.04	Details
Dynamic	Gujarat	Ahmedabad	0.14	0.06	Details

Thermal Properties of Assemblies

Assembly	Surf Heat Trans Coeff Calc Method	Surface to Surface U-factor (w/m²-k)	Overall U-factor (w/m²-k)
Layers 1+2+3+4+5	Static	0.5	0.5
Layers 1+2+3+4+5	Dynamic	0.5	0.5



Comfort and Weather Analysis



- Comfort and Weather Analysis tool for various cities in India – Online and freely available

- Type of Analysis and Graphs:

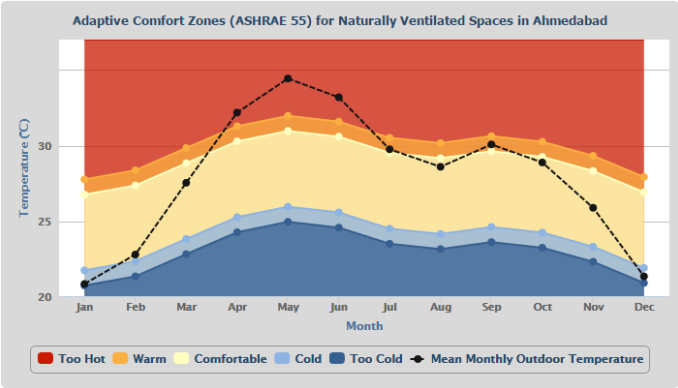
Comfort ▼ | --Type of Graphs-- ▼

- Adaptive Comfort Zone - Annual
- Adaptive Comfort Zone for 24 Hour Spaces - Monthly
- Adaptive Comfort Zone for Daytime Spaces - Monthly

Weather ▼ | --Type of Graphs-- ▼

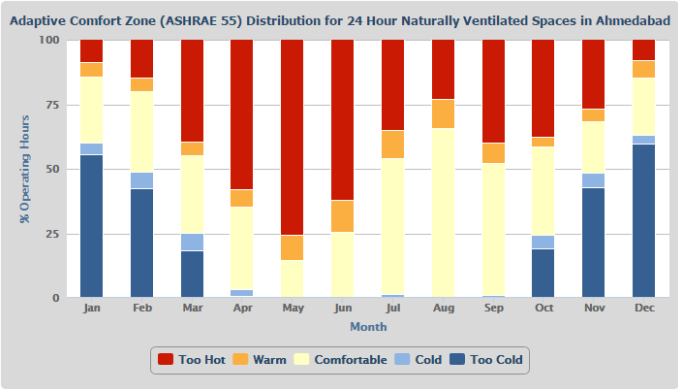
- Temperature Distribution for 24 Hour Spaces
- Temperature Distribution for Daytime Spaces
- Humidity Distribution for 24 Hour Spaces
- Humidity Distribution for Daytime Spaces
- Estimated Operation Modes for 24 Hour Spaces - Annual
- Estimated Operation Modes for Daytime Spaces - Annual
- Estimated Operation Modes for 24 Hour Spaces - Monthly
- Estimated Operation Modes for Daytime Spaces - Monthly

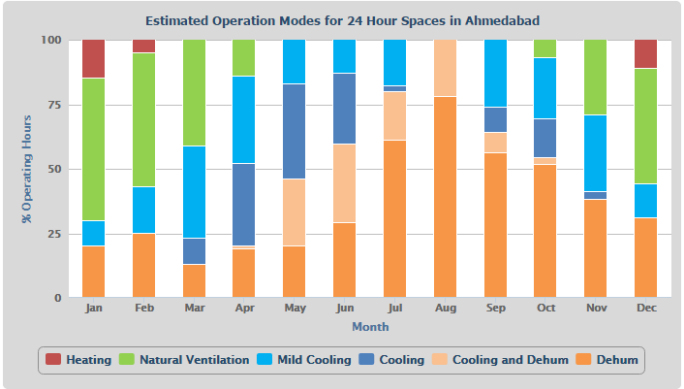
Comfort and Weather Analysis



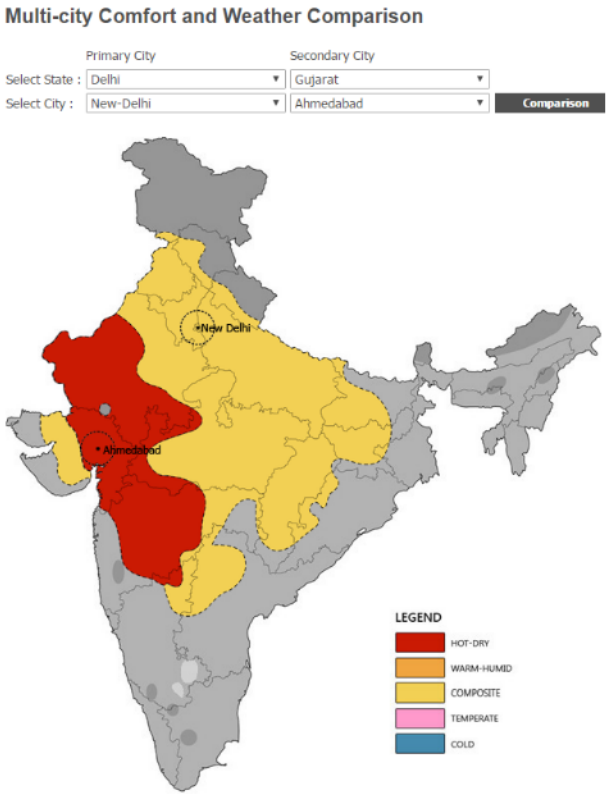
Output:

- Adaptive Comfort Zones for Naturally Ventilated Spaces
- Temperature and Humidity Distribution
- Estimated Operation modes – Annually and Monthly





Multi-city Comfort and Weather Comparison



- Comfort and Weather Analysis tool for comparing two cities in India – Online and freely available

- Type of Analysis and Graphs:

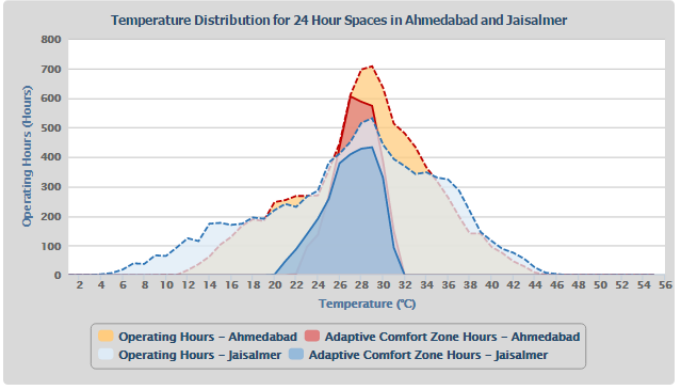
Comfort ▼ | --Type of Graphs-- ▼

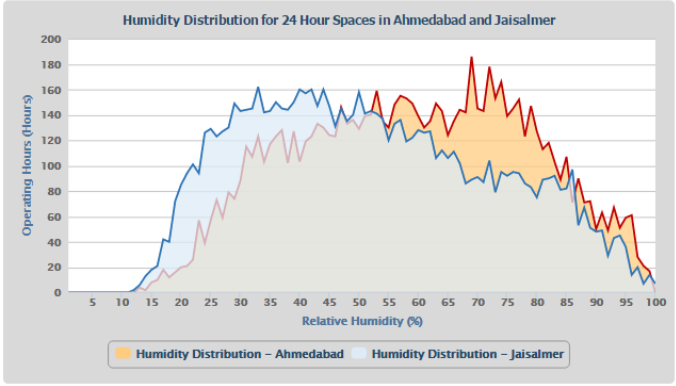
- Adaptive Comfort Zone - Annual
- Adaptive Comfort Zone for 24 Hour Spaces - Monthly
- Adaptive Comfort Zone for Daytime Spaces - Monthly

Weather ▼ | --Type of Graphs-- ▼

- Temperature Distribution for 24 Hour Spaces
- Temperature Distribution for Daytime Spaces
- Humidity Distribution for 24 Hour Spaces
- Humidity Distribution for Daytime Spaces
- Estimated Operation Modes for 24 Hour Spaces - Annual
- Estimated Operation Modes for Daytime Spaces - Annual
- Estimated Operation Modes for 24 Hour Spaces - Monthly
- Estimated Operation Modes for Daytime Spaces - Monthly

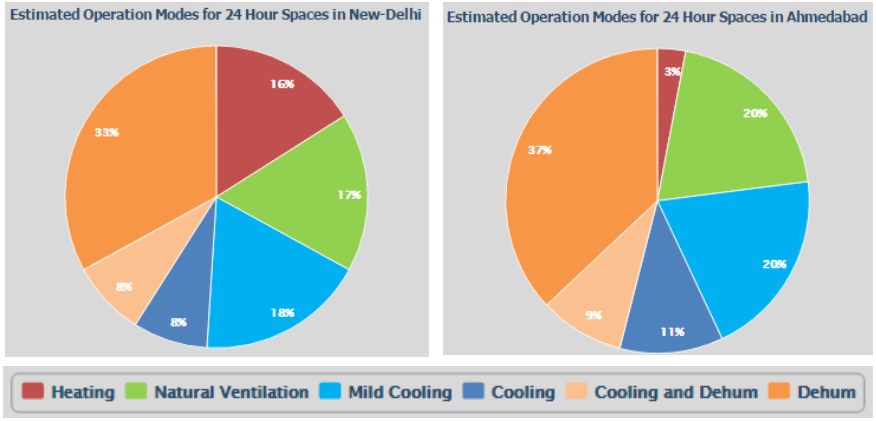
Multi-city Comfort and Weather Comparison





Output - Comparison of

- Adaptive Comfort Zones for Naturally Ventilated Spaces
- Temperature and Humidity Distribution
- Estimated Operation modes – Annually and Monthly



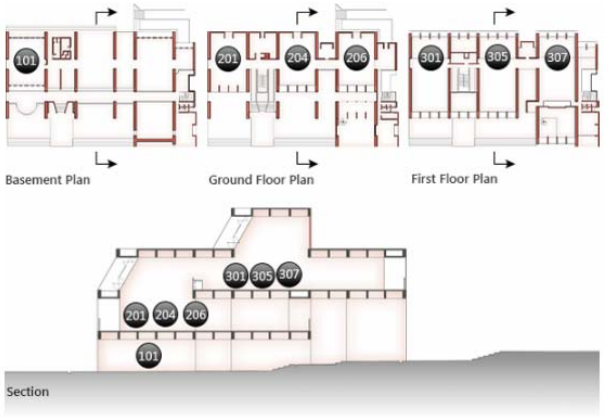
Thermal Comfort Monitoring

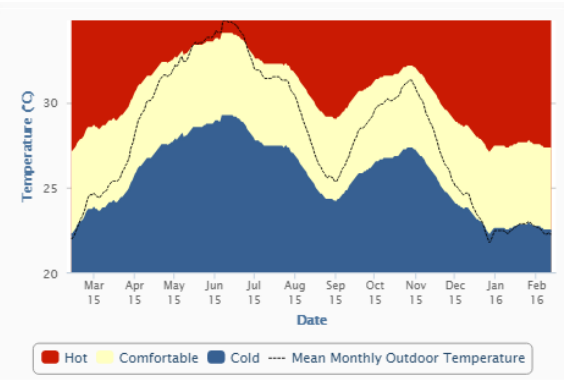
Select the time period for which you wish to see the thermal comfort conditions

From: 2016-02-06 @ 00 ▾ 00 ▾

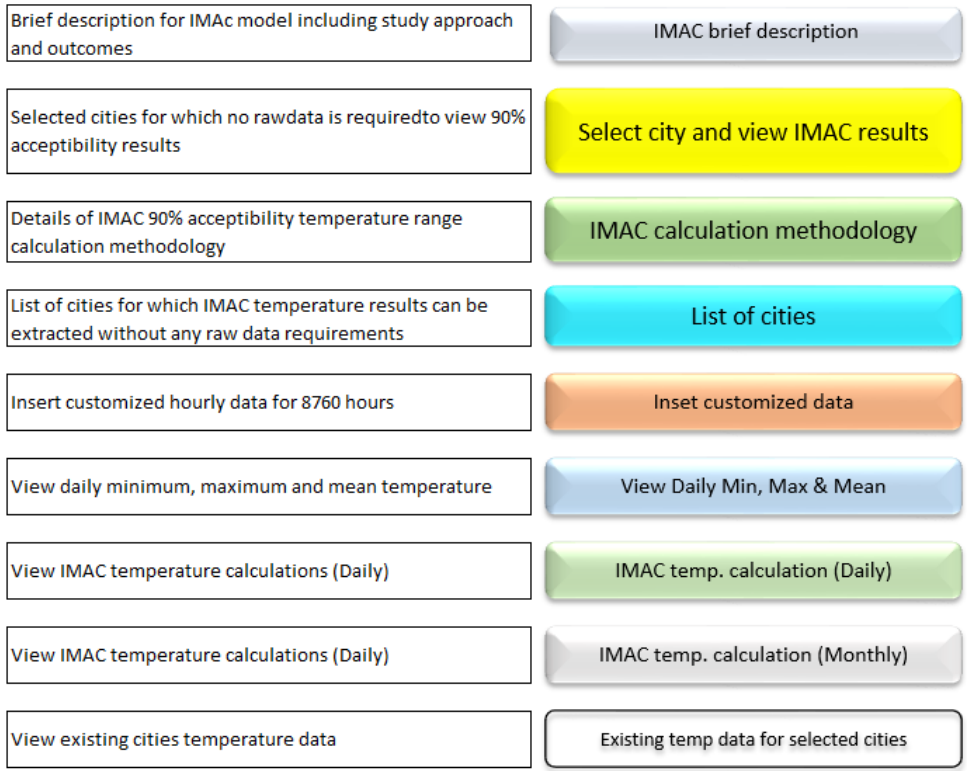
To: 2016-02-12 @ 23 ▾ 45 ▾

- India Model for Adaptive Comfort Study - IMAC
- Measurement of Environmental Conditions for spaces at CEPT Campus





IMAC Assistant



- India Model for Adaptive Comfort Study - IMAC
- IMAC Assistant Calculator – Online and Freely available
- Indoor Operative Temperature for Indian cities based on climatic conditions