

fAIR CONDITIONING

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presents

'Sustainable Cooling and Building Energy Modelling' Workshop for Architects

(part of 'Thoughtful Cooling' workshop series)

**2nd to 4th September, 2016
Chennai, India**

City Partner: Smarter Dharma

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1 Executive Summary

The Indo-Swiss *Fairconditioning* programme held the ninth workshop in the '**Thoughtful Cooling**' series of the Building Energy Modelling and Advisory Project (BEMAP). The workshop on '**Sustainable Cooling and Building Energy Modelling**' was organized from September 2nd to 4th, 2016 in Chennai, India for architects.

The workshop aims to equip architects with knowledge in building physics, climate analysis, passive design (for cooling and daylighting) and sustainable active cooling systems. The workshop also provides basic training on energy modelling software to help participants understand impact of early-design decisions on building cooling loads and energy efficiency. All participants were provided with a free on-line course covering the above-mentioned topics. Technical theory sessions were conducted on the first day of the workshop followed by two days of hands-on training on Integrated Environmental Solutions (IES-VE) software. Each participant received a 1 month free trial license for the software post the workshop. They are also offered a 50% discount on purchase of IES-VE modules used for modelling building geometry, daylighting, envelope, HVAC systems and natural ventilation.

A total of 18 participants were a part of the workshop. The participants were architects, professors, students and engineers representing 12 different firms and universities from Chennai, Auroville, Madurai and Pondicherry. The BEMAP team received largely positive feedback from the participants about the workshop. Majority of the participants were keen to implement sustainable cooling technologies in their projects. However, only 40% of the participants felt confident of using energy modelling software for design analysis. The reasons cited for this ranged from technical competency to pricing of modelling software. The BEMAP team aims to incorporate the feedback into content upgrade and programme development for future workshops.

2 Introduction

Fairconditioning is a Building-Cooling Demand-Side-Management (DSM) related education, capacity building, and pilot implementation programme. It is designed as an evidence-based policy support programme that seeks to create a critical mass of evidence for programmes that could be scaled-up across India and other tropical climates to achieve behaviour change amongst occupants of conditioned indoor spaces, reduce building heat loads (cooling demands), reduce energy and GHG intensity of artificial cooling systems.

The program is organized into four sub-projects that focus on education (Academic Curricula Integration Project, ACIP), capacity building (Building Energy Modelling Project, BEMAP), corporate technology adoption (Technology Adoption Project, TAP), and corporate behaviour change (Corporate Thermal Comfort Policies Campaign Project, UpBy2) with the legacy of establishing a sustainable cooling eco-system and driving evidence-based policy-change.

This policy change will be created through distilling field experiences, over the program period, to establish a critical mass of evidence for additional programs that could be scaled-up across other tropical climates to achieve behaviour change amongst occupants of conditioned indoor spaces, reduce building heat loads (cooling demands), and reduce energy and GHG intensity of artificial cooling systems. Fairconditioning aims to deeply integrate sustainability and efficiency into architectural and HVAC-engineering higher education curricula, into practicing architecture & HVAC consulting firms, and into commercial enterprises.

The Fairconditioning Programme engages with architects and HVAC engineers through the Building Energy Modelling Advisory Project (BEMAP). The programme provide professionals with training, tools and processes that can help them integrate sustainable cooling in their projects. The workshop detailed below is part of the capacity-building activities for architects across the country. Architects from small, medium and large scale firms are invited to be a part of the workshop. The workshops are currently organised in 5 cities in India - Mumbai, Pune, Delhi, Bengaluru and Chennai.

3 About the Workshop

The workshop on 'Sustainable Cooling and Building Energy Modelling' was organized from September 2nd to 4th, 2016 in Chennai, India for architects. This was the first BEMAP workshop held in Chennai. The workshop training consisted of the following modules:

- Impact of energy-intensive active cooling systems and refrigerants on climate change
- Building physics and impact on indoor and outdoor environment
- Processes and techniques for climate analysis
- Passive design interventions (cooling) to help reduce building cooling loads
- Technical training for sustainable active cooling technologies
- Training on tools to aid in energy analysis of early-design decisions (building energy modeling software)

Architects from small, medium and large scale architecture firms were invited to participate in the workshop.

4 Organizers

The Fairconditioning Programme is conceived by cBalance, a social enterprise from Pune, India and Noe21, a NGO based in Geneva, Switzerland. cBalance is a knowledge-centric solutions hub that specializes in tool building and strategy development for integration of carbon ERP into institutional processes, while enabling measurable, reportable, and verifiable GHG emissions, energy, water and waste mitigation roadmaps. Noe21 is an organisation that evaluates and promotes solutions to climate change. It focuses on solutions that focus on behaviour change, innovative technology, public policy and research. The training material for the BEMAP workshop has been developed by cBalance and Noe21 in collaboration with well-known practitioners in the field of sustainable architecture and sustainable cooling. It is certified by the Indian Society of Heating Refrigeration and Air-conditioning (ISHRAE) and the Alliance for an Energy Efficient Economy (AEEE).

This workshop was planned and conducted by members from the cBalance team along with members from Smarter Dharma, a social enterprise from Bengaluru, India. As city partners for the workshop, the sustainability focused enterprise assisted cBalance and Noe21 with planning and outreach for the workshop.

5 Date and timing of the workshop

The workshop was scheduled from 2nd to 4th of September, 2016 from 10 am to 6 pm daily.

6 Venue of the workshop

The venue for the workshop was:

Innoart Technologies

116, Chamiers Road, Nandanam.
Chennai - 600035
Tamil Nadu

Care was taken to ensure that the workshop was planned to have a low-carbon footprint. Use of natural lighting and ventilation, use of non-disposable cutlery, reuse of stationary where applicable, travel using public transport etc. are measures that are followed by the team.

7 Fees

Fairconditioning is a non-profit programme funded by the State of Geneva, Switzerland, OAK Foundation, and Shakti Sustainable Energy Foundation. The workshop is free-of-charge for all participants contingent on completing an on-line course specially developed by Fairconditioning and bringing their own laptop for the training. A registration fee of Rs.5000/- was applied to all participants. The fee was returned to the participants post the workshop.

8 Topics Covered

Different subjects related to building physics, climate and solar geometry analysis, passive design for cooling and sustainable active cooling technologies were covered.

8.1 Pre Workshop

A brief on-line course is provided to participants on registration. The online course (MOOC) has been developed especially for the Fairconditioning Programme workshops. This is an open-book quiz format with presentations provided to participants with quiz questions.

The 10 hour course has a total of 7 sections on:

1. Introduction to Buildings and Climate Change
2. Heat transfer in Buildings
3. Psychrometrics
4. Climate Analysis
5. Thermal Comfort
6. Passive Building Design
7. Fundamentals of Solar Geometry

8.2 During Workshop

A workshop outline for all three days is provided below.

The first day was reserved for training in theory. Several exercises are conducted on the theory subjects-

- i. Plotting Climate Data on Psychrometric Chart
- ii. Climate identification based on Weather Psychrometry Chart
- iii. Plotting Sun Path for Different Cities at Different Times
- iv. Identifying Shading Requirements using Average Dry Bulb Temperature, Average Global Horizontal Radiation
- v. Creating Shadow Masks

The second and third day involved hand-on energy modeling training on IES-VE software. The participants were also encouraged to build energy model of their own projects during the software practice session.

8.3 Post Workshop

Participants were given a practical assignment on building energy modeling to complete within 2 weeks of the workshop. The assignment comprised of a modeling a base building model and comparing to proposed model with design iterations. Comparisons are to be made based on total energy consumption, HVAC consumption, building's EPI and annual operating energy cost.

Table 1- Details of the workshop schedule

	DAY 1:THEORY MODULES 9.30 AM TO 6.00 PM	DAY 2:BEM MODULES 9.30 AM TO 6.00 PM	DAY 3: BEM MODULES 9.30 AM TO 6.00 PM
1	Warming Up	Theory Evaluation Review	Methodologies/Iterations Introduction to Different Softwares
2	Introduction to the Fairconditioning Program	Introduction to Energy Simulation	Simulation Results- Part 2
3	Relevance to Architecture Practice	Introduction to IES	
4	Buildings and Heat: Understanding Heat Flows and Forms	Building Geometry- Part 1	
RECESS FOR THE MIND			
5	Psychrometrics and Climate Analysis	Building Geometry- Part 2	HVAC Systems
6	Solar Geometry: Studying the Sun for Better Architecture		
FUEL UP (LUNCH, WALK, BREATHE)			
7	Animations/ Interactive Session	Animations/ Interactive	Feedback
8	Passive Design Techniques: Concepts and Case-Studies- Part 1	Visualization of Building Envelope Performance	Natural Ventilation
9	Passive Design Techniques: Concepts and Case-Studies- Part 2	Internal Loads and Operational Schedules	Daylighting
RECESS FOR THE MIND			
10	Sustainable Cooling Technologies: Principles and Applications	Simulation Results-Part 1	Software Practice, Q&A
11	Quiz - Evaluation of Learnings/ Feedback	Quiz - Evaluation of Learnings	Quiz - Evaluation of Learnings
12	Update for Next Day events/Flow time	Update for next day events/ Flow time	Key Takeaways of BEM, Introduce Roundtable

9 Participants

The participants in this workshop were from diverse field and of different age group. A total of 18 architects, engineers and students from Chennai, Madurai and Pondicherry participated in the workshop.

Table 2- Details of the Participants attending the Workshop

Sr. No	Name of Participant	Firms/Colleges that the Participants Represent	Designation	Average no of projects executed in a year	Percentage breakup of their project types									
					Stand Alone Houses	Apartments	Banks	Hotels	Office Space	Retail	Hospital	Industrial	Institutional	Urban Planning
1	Abhishek Mimani	M-Cube Design Studio	Architect	7	5%	-	-	-	90%	-	5%	-	-	-
2	Aravind G	Nanda Green Associates	Architect	4	25%	25%	-	-	-	25%	-	-	-	25%
3	Aravind Sridharan	Raj and Associates	Architect	15	5%	20%	-	-	70%	-	5%	-	-	-
4	Sakthi Abirami	Thiyagarajar College of Engineering	Student	Not Applicable										
5	Liju George	Auroville Earth Institute	Architect	1	10%	30%	-	-	-	-	-	10%	50%	-
6	Madhan Raja Santhana	SIP Architects	Architect	12	50%	20%	-	10%	5%	-	-	-	5%	-
7	Mahesh Kumar	L & T	Engineer	2	-	-	10%	10%	20%	5%	5%	50%	-	-
8	Marine Rouband	Auroville Earth Institute	Architect	1	10%	30%	-	-	-	-	-	10%	50%	-

Sr. No	Name of Participant	Firms/Colleges that the Participants Represent	Designation	Average no of projects executed in a year	Percentage breakup of their project types									
					Stand Alone Houses	Apartments	Banks	Hotels	Office Space	Retail	Hospital	Industrial	Institutional	Urban Planning
9	Monisha Peter	Studio Context Architects	Architect	3	50%	20%	-	-	10%	-	-	-	20%	-
10	Monisha Y B	ShamaDalvi Architects	Architect	4	80%	-	-	-	20%	-	-	-	-	-
11	Nehaa Bhavaraju	Studio Naqshabandi	Architect	3	70%	-	-	-	-	-	-	-	30%	-
12	Radhika Soni	Auroville Earth Institute	Architect	2	5%	-	-	-	-	-	-	-	80%	10%
13	Raghav Rajagopalan	Independent	Architect	15	10%	50%	10%	-	-	-	-	10%	-	-
14	Sharanya Sreenivasan	Studio Context Architects	Architect	Data Not Available										
15	Subhashini Selvaraj	Thiyagarajar College of Engineering	Student	5	60%	20%	-	10%	-	-	10%	-	-	-
16	Thandavamoorthy	L & T	Engineer	2	20%	50%	-	-	-	-	-	30%	-	-
17	Trupt iDoshi	The Auroma Group	Architect	Data Not Available										
18	Viral Doshi	The Auroma Group	Architect	Data Not Available										

10 Trainers

Two trainers conducted training sessions in the 3-day workshop.

Table 3- Details of the Trainers

Trainer	Organization and Designation	Professional Synopsis	Sessions Conducted
Vivek Gilani	Managing Director At: cBalance Solutions Hub	Vivek is an Ashoka Fellow and an Environmental Engineer (MS Environmental Engineering, University of Massachusetts) with expertise in Water, Wastewater Treatment and GHG Inventorying, and Energy Auditing/Analytics. He is a Bureau of Energy Efficiency (India) Certified Energy Auditor and a certified Building Energy Modeller. He is Co-founder of India's first Carbon-Footprint- Calculation and Reduction movement – the NO2CO2 project at www.no2co2.in , Developer of India-specific Carbon ERP Tools and GHG Emission Factor Databases under the Climate economics Platform, Co-Founder and Member of the Steering Committee for the First Ecolabelling Program in India – 'The Green Signal'. He is also a civic-rights interventionist working to usher in an era of informed participation in democracy in India as Founder of the 'Informed Voter Project' currently on the web at www.MumbaiVotes.com	Theory sessions on first day: <ul style="list-style-type: none"> • Introduction • Psychrometrics and Climate analysis • Solar Geometry • Sustainable Cooling Technologies
Udeet Methala	Architect At: MM Project Consultants	An architect by profession, Udeet studied at KRVA an institute with a socialist school of thought. He has since worked on a 4-country research project assessing NGO-work across Cambodia, Bangladesh, India and Uganda for donor organisations in Denmark. In 2015 he was invited by the Community Development Journal, Oxford University Press to present his paper on contradictions in Cambodian politics. Passionate about sustainability issues he has worked as Project Manager of the Building Energy Modelling Advisory Project, Fair Conditioning in 2015. In 2016, he joined MM Project Consultants Pvt. Ltd. applying his learning in master planning and large housing projects for the urban poor- in India and abroad.	Sessions conducted on 2 nd and 3 rd day are: <ul style="list-style-type: none"> • Set up geometry • Assigning weather file • Shading and Solar analysis • Day lighting simulations using radiance • Design iterations to reduce thermal loads • Understanding the results, Ventilation analysis using Macroflo • Assigning space conditioning systems, assessing whole building performance • Navigator technology and IES-GAIA module • Independent working session and assessment.

11 Feedback

Oral as well as written feedback from participants was documented. The feedback will be used to upgrade the programme as well as the training content.

- **Content:** 73% of the participants agreed that adequate information on the workshop objectives and content was provided prior to the workshop. 80% of the participants agreed that the workshop content matched the workshop objective. Mixed feedback was received about the length of the workshop. There was also mixed opinions on whether there should be more emphasis on theory modules or on software training. Several participants expressed that the software training modules needed improvement.
- **Trainers Competency:** 82% of participants agreed that the trainers made good use of the time allotted to them. The trainers for the theory sessions were knowledgeable and all sessions were well explained. However, participants that had prior experience with building energy modelling expressed that a trainer with more experience with energy simulation would be advisable.
- **Integration of climate and energy analysis techniques into practice:** Only 40% of the participants felt confident of using BEM software. Due to the workshop's emphasis on building energy modelling training, most participants did not express an opinion on practical exercises conducted on the first day.
- **Integration of sustainable cooling techniques (design, systems) into practice:** 80% of participants were keen to implement efficient cooling techniques in their projects.
- **Overall Satisfaction:** 80% of the participants agreed that they would recommend this workshop to others, and also stated that they enjoyed the workshop.
- **Participant's Comments:**
 - Liju George:* The first session was very interesting and very helping. Those session should be more elaborative, should include more examples. Try to promote the first part, giving a long demonstration of software, encourage passive technologies.
 - Raghav Rajgopalan:* Length of "Building Science" session could be reduced since MOOC courses covers most of it "if-not-all" aspects of this session. More time could be allotted to BEM training. A longer time frame to use the software (more than a month) and a larger discount towards purchase of the same.
 - Aravind S:* IES seems a good software to buy but economics seems bad. We all want to use these kind of software in day to day design but we need costing support. Overall very good!
 - Nehaa Bhavraaju:* Great work, great interaction! Loved the overall atmosphere. Would be better to explain a bit more about the "free" software as well, as that would be what most of us would be using. Would be awesome to have the network connected even after the workshop! P.S. - AC was too cold!

12 Next Steps

The following activities are identified to continue engagement with the participants and to improve the impact of the workshops:

- **Roundtable:** A half-day brainstorming session will be conducted 6 months after the workshop between architects, HVAC engineers and technology providers to identify opportunities and gaps in moving towards sustainably cooled buildings in India. The core participants for the roundtable session will be participants from the previously conducted workshops. The expected outcome of the round-table is the creation of a specific set of action-points that can be applied by participants in their respective work processes.
- All participants were informed of this event. Majority of the participants expressed keen interest in being a part of the follow-up session.
- **Fairconditioning Network:** All participants were informed of the 'Fairconditioning Network', which is an on-line eco-system for all professionals connected to the building design, construction and operation industry. All the participants will be added to a google-group to keep them posted of latest resources until the network is set up.
- **Training Content Upgrade:** The 2 main objectives of the workshop are - to help architects learn processes/techniques for climate analysis and responsive design, to increase exposure and understanding of sustainable active cooling systems. The participants were fairly confident of the latter but wanted better training for processes/techniques that could help them. Hence, the following upgrades are being considered to the training program:
 - Use of less expensive (free) software for training
 - Appointing a trainer with experience in energy simulation projects
 - Including more manual exercises
 - Preparing and conducting a modelling assignment during the training to help participants understand the different analysis options that can aid in building design (massing, openings, orientations, shading devices, materials, equipment efficiencies, passive cooling systems etc)
 - Provide cost-health-productivity benefits of these interventions
 - Provide concise resources for building physics and simulation/modeling methodologies
 - Appoint trainer with experience in practical implementation of passive design techniques for appropriate modules

13 Photographs

Figure 1: Vivek Gilani taking session on 'Climate Justice and Built Space'



Figure 2: Udeet Methala training the participants on IES:VE software



Figure 3: Trouble-shooting discussions during software training



Figure 4: Participant analysing building heat ingress

