fAIR CONDITIONING

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Introduces

THOUGHTFUL COOLING

A *'deep-dive'* Training of Trainers (ToT) workshop to integrate building energy efficiency into engineering academic curricula

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WORKSHOP AGENDA

Venue: Nagarjuna College of Engineering, Bengaluru
Address: Nagarjuna Engineering College Mudugurki, Venkatagiri Kote Post, Devanhalli, Bengaluru, Karnataka 562164

Date: *30th November to 3rd December, 2018*

1. BACKGROUND

Cooling and refrigeration for buildings is by far the most significant source of energy demand throughout the country, and these needs and demands are rising at the same rapid pace as economic development. The amount of energy (and related GHG emissions) necessary to cool Indian building interiors in the years ahead will depend on how they are designed and built today and in the coming years, the technology used for cooling, as well as the behaviour and operation of the equipment by occupants of air-conditioned spaces.

Only one subject in 45 total subjects of mechanical engineering addresses Heating, Ventilation and Air Conditioning systems. As less than 5% of India's engineering curricula is focused on learning concepts, technologies and strategies (including sustainable cooling technologies, orientation of the building, using building materials that provide better insulation, appropriate shading devices and ratio of window to wall area that allows daylight to enter without exacerbating the load on the air conditioner, natural ventilation methods etc) to reduce the environmental impact of buildings, it is difficult for participants to assess and imbibe these practices in their designs. Considering that there are over 10,369 registered engineering colleges in India, a total of 14,73,871 participants graduate annually with deficient skills to design environmentally responsible buildings.[1]

Furthermore, professors across engineering colleges are left to grapple with a dearth of high-quality teaching aids: physical scale-models and virtual (animations etc.). Even the professor's that have realized the lacunae that must be plugged if we are to transform the trajectory of energy consumption from India's relentless growing cities, are faced with unsurmountable administrative complacency from decision making executives in colleges and academic regulatory bodies. There are no punitive consequences, financial incentives, and peer-pressure amongst colleges to transform curricula.

Moreover, the Energy Conservation Building Code (ECBC) and the Bureau of Energy Efficiency (BEE) Commercial Building Energy Performance Benchmarking Programme have established the concept of '*Benchmark Energy Performance Index*' values (kWh/m2/year) for various building usages and climatic conditions. However, these concepts have not yet transformed the Indian building energy consumption scenario due to a lack of awareness, skilled-capacity and insufficient emphasis on increasing uptake of these codes. This dearth of skilled-capacity can only be addressed, most swiftly by augmenting the existing architecture and engineering (RAC course) curricula.

Today, architecture and engineering participants are not well versed with concepts of building EE, owing to lack of comprehension towards fundamental concepts of building physics, psychrometry, comfort cooling techniques & technologies, adaptive thermal comfort, etc. This lack of understanding comes from a dearth of teaching aids, innovative learning methods, and content delivery mechanisms that can significantly boost learning and the application of these concepts. As there exists a lack of awareness and/or understanding, building EE uptake has been rather slow. Therefore, even if ECBC becomes mandatory, presently, there isnt enough workforce that will be able to adequately handle its implementation.

The only way to address the aforementioned concerns, is to build capacity within India's architecture and engineering colleges (those that teach Refrigeration & Air Conditioning – RAC design) to focus

[1] Internal cBalance study,2016.

on horizontal and vertical integration, where relevant subjects are infused with sustainable design principles, abstracted subtly so that the changes go unnoticed, with the goal of thematically expanding the breadth of knowledge imparted from a current two-dimensional focus of ‘space’ and ‘structure’, to a three-dimensional realm wherein ‘sustainability’ is legitimized and centralized as an equal third-axis that shapes the building design process.

2. ITINERARY:

Reporting Time: 15 mins prior to 1st session		
Day 1: 10:00 am – 5:30 pm		
Number	Time	Title
1.1	10:00 am – 11:30 am	Climate Justice and the Built Space: An Introduction to Fairconditioning Trainer: Vivek Gilani Session Jockey: Hasan ul Banna Khan In this session, participants are introduced to the Fairconditioning Program, focusing on the Academic Curricula Integration project (ACIP). The participants are exposed to relationship between the existing problems with our Built Space and Climate Change, further underpinning the guiding principles of the overarching program, and the underlying reasons for devising this specific intervention. The realm of curricula integration as viewed by the Program's Executive Board and Board of Advisors is further highlighted.
Break 1	11:30 am – 11:45 am	Recess for the mind
1.2	11:45 am – 12:00 pm	Workshop Objectives and Participant Expectations Trainer: Vivek Gilani Session Jockey: Hasan ul Banna Khan The overarching workshop structure, content, activities and objectives are explained to the participants. The key takeaways are highlighted - all in the context of embedding efficiency and sustainability within the existing concepts, to bridge the gap between knowledge and action and improve the cooling design skills and software simulation skills.
1.3	12:00 pm – 1:00 pm	Thermal Comfort and Indoor Air Quality Trainer: Vivek Gilani Session Jockey: Hasan ul Banna Khan This session focuses on establishing thermal comfort as the goal with respect to artificial cooling, explores recent evolutions in the understanding of adaptive comfort criteria and models, and the energy and environmental conservation benefits of it. The session also explores Indoor Air Quality and its intersection with Thermal Comfort, Energy Efficiency, and the often divergent goals of efficiency thermal comfort and Indoor Air Quality.

Break 2	1:00 pm - 1:45 pm	Fuel Up (Lunch, Walk, Breathe)
1.4	1:45 pm – 3:00 pm	Psychrometry Trainer: Vivek Gilani Session Jockey: Hasan ul Banna Khan In this session, the concept of psychrometry is introduced to the participants, explaining how the psychrometric chart for a specific climatic zone helps in designing energy efficient HVAC systems, and undertakes small classroom exercises to creatively use the psychrometric chart to calculate heat loads, estimate performance and requirements of evaporative cooling systems etc.
Break 3	3:00 pm – 3:15 pm	Break for attending critical tasks
1.5	3:15 pm – 3:45 pm	Climate Analysis & Passive Design Strategies Trainer: Vivek Gilani Session Jockey: Hasan ul Banna Khan In this session, the different climatic zones requiring different means of cooling are delved into, with the help of the psychrometric chart. This session includes an introduction to passive design strategies, and the prioritisation of cooling load reduction before exploring sustainable cooling technologies and renewable energy supply.
1.6	3:45 pm - 4:15 pm	Active Cooling - Efficient HVAC Systems Trainer: Vivek Gilani Session Jockey: Hasan ul Banna Khan The issue of growing Airconditioning demand with regards to building sector growth is emphasized. Conventional building EPI and Energy efficient building EPI & its effect on electricity consumption is also discussed. It is ensured that the participants are aware of and understand the environmental, spatial and structural implications of using this technology, in comparison the conventional HVAC systems for building design. Further, working of Refrigeration & AC – basics of enthalpy, Coefficient of Performance to evaluate the whole system, introduction to terms like Integrated Part Load Value, Energy Efficiency Ratio and cooling load estimation format – models used for simulation are also made known.
1.7	4:15 pm – 5:30 pm	Sustainable Cooling Technologies - Direct/Indirect Evaporative Cooling Trainer: Vivek Gilani Session Jockey: Hasan ul Banna Khan

		The participants are made aware of the environmental, spatial and structural implications of using this technology, in comparison the conventional HVAC systems for building design. The participants are made aware that these techniques are commercially available and easily implementable and are 'sustainable' and not alternative technologies. The environmental benefits of this technology since it avoids vapour compression, are highlighted. Along with the aforementioned points, the climatic constraints of evaporative cooling and overcoming them by blending with conventional HVAC systems to still derive energy efficiency and low f-gas benefits, are explained.
Day 2: Timing: 10:00 am – 5:30 pm		
2.1	10:00 am – 11:30 am	Sustainable Cooling Technologies - Structure Cooling Trainer: Dhrumit Parikh Session Jockey: Hasan ul Banna Khan The participants are made clear of the fundamental science concepts underlying the technology, operation principles, environmental and cost benefits, safety and technical constraints. It further aims to ensure that the participants are aware of the environmental, spatial and structural implications for using this technology in comparison to conventional HVAC systems for their building design. The environmental benefit of this technology is stressed upon as it reduces vapour compression and the partial addressing of cooling load (does not dehumidify) can be overcome by blending with conventional HVAC systems to still derive energy efficiency and low f-gas benefits.
Break 1	11:30 am – 11:45 am	Recess for the mind
2.2	11:45 pm – 1:00 pm	Sustainable Cooling Technologies - Radiant Cooling Trainer: Dhrumit Parikh Session Jockey: Hasan ul Banna Khan The participants are made aware of the environmental, spatial and structural implications of using this technology, in comparison to the conventional HVAC systems for building design. The different types of these cooling techniques, along with their application in different circumstances are also explained. The participants also are made aware that these techniques are commercially available and easily implementable, 'sustainable' and not alternative technologies. The environmental benefits of radiant and structure cooling technology are highlighted, since it reduces vapour compression. It is also explained how the partial addressing of cooling load is overcome by blending it

		with conventional HVAC systems to derive energy efficiency and low f-gas benefits.
Break 2	1:00 pm – 1:30 pm	Fuel Up (Lunch, Walk, Breathe)
2.3	1:30 pm – 2:30 pm	Sustainable Cooling Technologies - Natural Refrigerant Air Conditioning Trainer: Dhrumit Parikh Session Jockey: Hasan ul Banna Khan The participants are made aware of the environmental, spatial and structural implications of using this technology, in comparison the conventional HVAC systems for building design. The participants are made to realize that these are already commercially available and implementable technologies, further emphasizing that they are sustainable technologies and not alternative technologies. The environmental benefits of using this technology as it replaces f-gases, along with different safety implications and application constraints are also covered. Unitary and Centralized systems are focused upon, with a special module on R-290 based refrigerant technology. The need to leapfrog to natural refrigerants is also highlighted. The issues with usage of carbon dioxide as a natural refrigerant and lack of commercial application examples are also delved into.
2.4	2:30 pm – 3:00 pm	Sustainable Cooling Technologies - Solar Vapour Absorption Machines (ignore if already represented in syllabus) Trainer: Dhrumit Parikh Session Jockey: Hasan ul Banna Khan The participants are made aware of the environmental, spatial and structural implications of using this technology, in comparison the conventional HVAC systems for building design. The participants are made aware that these techniques are commercially available and easily implementable and are ‘sustainable’ and not alternative technologies. The environmental benefits of this technology since it avoids vapour compression are highlighted. Along with the aforementioned points, the climatic constraints of evaporative cooling and overcoming them by blending with conventional HVAC systems to still derive energy efficiency and low f-gas benefits are explained.
Break 3	3.10 pm - 3:15 pm	Break for attending critical tasks
2.5	3:15 pm – 4:15 pm	Rethinking Engineering Pedagogy Trainer: Vivek Gilani Session Jockey: Hasan ul Banna Khan

		In this session participants are introduced to the different frameworks and approaches to rethink and re-invent pedagogy to Integrate Sustainability in Engineering Curricula.
2.6	4:15 pm – 5:30 pm	Lesson Plan co-creation session (Part 1) Trainer: Vivek Gilani Session Jockey: Hasan ul Banna Khan Participants are expected to modify existing syllabus content for courses in the University mandated curricula, develop semester-long lesson plans for them, identify essential teaching methodologies, determine physical, virtual and/or classroom teaching aids and devise a sample project, test, and assignments for their course based on revised sustainability-integrated syllabus.
Day 3 Timing: 10:00 am – 6:00 pm		
3.1	10:00 am – 11:00 am	Lesson Plan co-creation session (Part 2) Trainer: Dhrumit Parikh Session Jockey: Hasan ul Banna Khan Participants are expected to modify existing syllabus content for courses in the University mandated curricula, develop semester-long lesson plans for them, identify essential teaching methodologies, determine physical, virtual and/or classroom teaching aids and devise a sample project, test, and assignments for their course based on revised sustainability-integrated syllabus.
3.2	11:00 am – 11:30 am	Introduction to Energy Modelling Trainer: Dhrumit Parikh Session Jockey: Hasan ul Banna Khan The participants are introduced to a web-based tool to calculate HVAC load and further simulate those effects on the building's performance. The need for load calculation and theory regarding heat load is discussed, along with a brief about the Energy Plus software on which major energy modelling software's are based on. Various capabilities of the Smart Energy software are also explained.
Break 1	11:30 am -11:45 am	Recess for the mind
3.2	11:45 am – 1:00 pm	Introduction to Energy Modelling - contd. Trainer: Dhrumit Parikh Session Jockey: Hasan ul Banna Khan The participants are introduced to a web-based tool to calculate HVAC load and further simulate those effects on the building's performance. The need for load calculation and theory regarding heat load is discussed,

		along with a brief about the Energy Plus software on which major energy modelling software's are based on. Various capabilities of the Smart Energy software are also explained.
Break 2	1:00 pm – 1:30 pm	Fuel Up (Lunch, Walk, Breathe)
3.3	1:30 pm – 3:00 pm	Smart Energy Tool - Modelling Sustainable Cooling Technologies Trainer: Dhrumit Parikh Session Jockey: Hasan ul Banna Khan Practice sessions with the participants on the smart energy tool are conducted in a Computer Lab.
Break 3	3:00 pm -3:15 pm	Break for attending critical tasks
3.3	3:15 pm – 4:30 pm	Smart Energy Tool - Modelling Sustainable Cooling Technologies (contd.)
3.4	4:30 – 6:00 pm	Case Study Detailing Trainer: Dhrumit Parikh Session Jockey: Hasan ul Banna Khan In this session, participants are assigned a problem statement and asked to generate heat loads and run simulations on the Smart Energy tool. The capability of the software, advantages and limitations are showcased. Further, need for these software's, basic terminologies, importance of internal load and pay back periods are discussed.
Day 4 Timing: 10:00 am – 3:30 pm		
4.1	10:00 am – 1:15 pm	Case Study Detailing (Contd.)
Break 1	1:15 pm – 1:45 pm	Fuel Up (Lunch, Walk, Breathe)
4.1	1:45 pm – 3:00 pm	Case Study Detailing (Contd.)
4.2	3:00 pm – 3:30 pm	What Next & Participant Feedback Trainer: Dhrumit Parikh Session jockey: Hasan ul Banna Khan Participants are made aware of post-workshop follow up process and the support structure offered.

3. POINT OF CONTACT

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