PLAKSHA UNIVERSITY

Indorama Ventures Center for Clean Energy

ANNUAL REPORT
FY 2025-26

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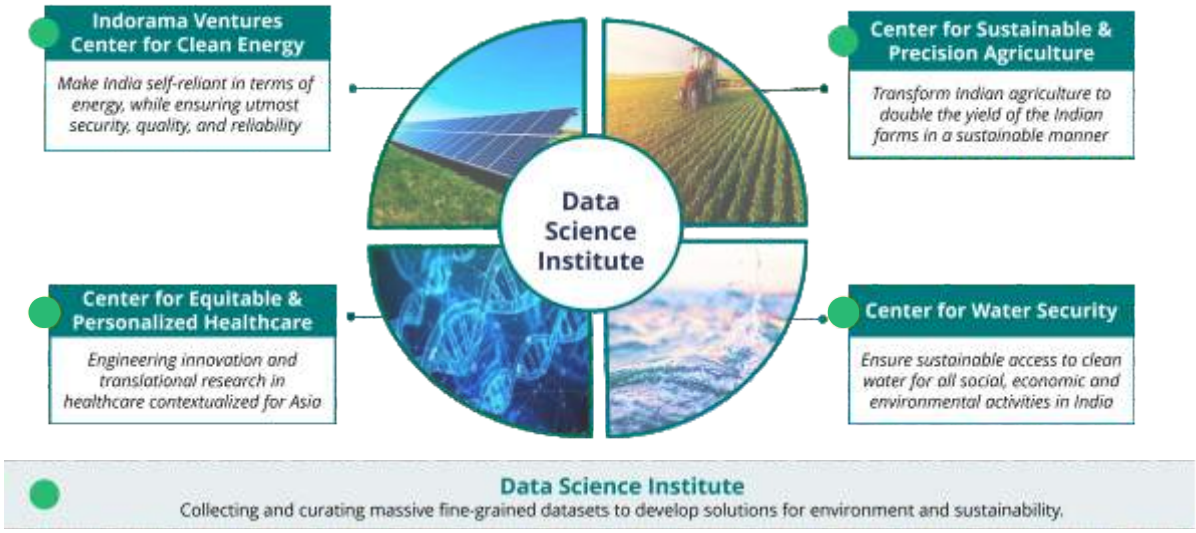
Introduction

Indorama Ventures Center for Clean Energy (IVCCE) at Plaksha was set up to lead the clean energy transition through education and research. The Center aims to operate at the intersection of energy and digitalization to enable scalable, sustainable, and affordable clean energy solutions and nurture industry-relevant professionals and entrepreneurs. It is guided by an advisory committee consisting of international experts from academia and industry.



Vision

To **Decarbonize, Democratize,** & **Digitize** Energy for India and beyond.

Mission

To accelerate India's transition to a **net zero, self-reliant,** and **digitally enabled** energy future through **interdisciplinary research** and **innovation,** evidence-based **policy leadership, strong partnerships** with industry and government, and by nurturing the next generation of energy leaders through education, capacity building, and **entrepreneurship.**

From the Director's Desk

I am delighted to present the Financial Year FY 2025-26 report, which highlights the vision, progress and impact of the Indorama Ventures Center for Clean Energy (IVCCE). This has been a year of innovation, growth and a deepened commitment to our mission of accelerating the clean energy transition in India.

I extend my sincere gratitude to Indorama Ventures for their continued trust and support in shaping the foundation of IVCCE. Their belief in our vision has enabled us to establish the Center as a hub for interdisciplinary collaboration, where we drive meaningful advancements in energy efficiency and decarbonization.

At IVCCE, we recognize that addressing climate change requires urgent action and a holistic approach. Our research goes beyond technological innovation, it integrates economic viability, cultural adapt ability, and policy alignment to ensure real world impact.

A significant milestone this year was the establishment of the state-of-the-art Thermal Energy Storage Living Laboratory, integrated with a 440-seater hostel at Plaksha. This serves as a testbed for real world applications, fostering collaboration among researchers, industry partners, and policymakers.

Our research efforts continue to progress steadily across four key focus areas, yielding tangible outcomes in the form of publications and policy support. Additionally, to strengthen capacity building we offered two courses, equipping the next generation of students and professionals with the knowledge and skills to advance the clean energy transition.

As we step into the coming year, we mark the successful conclusion of Phase I of establishing IVCCE. This foundational phase has surpassed the targets we had initially set. With key research foundations laid and a multidisciplinary team established, IVCCE is now well prepared to advance into its next phase - one that will not only continue to strengthen its research capabilities but also translate

outcomes into real-world impact and scalable clean energy solutions.

I sincerely thank our team, collaborators, supporters, and advisors for their invaluable support and contributions. I extend a heartfelt invitation to all stakeholders to join us in our pursuit of transitioning towards clean energy, ensuring an equitable and just transition every step of the way.

Prof Vishal Garg

University Chair Professor

Director

Indorama Ventures Center for Clean Energy

Plaksha University

Executive Summary

Advancing clean energy through innovation and impact, this year saw the commissioning of the Thermal Energy Storage Living Lab, expansion of our team, and steady progress in four key research areas. Our impact extended through publications, policy contributions, tool development, and capacity-building efforts.

Team

- Faculty: 7
- Research Staff: 8
- External Consultants: 3
- UG Students: 20

Infrastructure

- Thermal Energy Storage Living Lab
- Wind Tunnel Setup
- Simulation Studio
- NILM Lab

Research

Urban Microclimate

- Energy efficient open environmental wind tunnel setup is ready and flow visualization studies are in progress
- Roof of Hope community project - cool roofs installed across 100 homes in an urban poor settlement in Delhi
- Developing automated, data-driven tools for city-scale walkability, accessibility, and street infrastructure assessment in collaboration with global partners and city agencies

Decarbonizing Residential Cooling

- Thermal Energy Storage Living Laboratory installed and commissioned to meet the cooling needs of a 220-room Hostel

Smart Buildings

- Energy and indoor air quality tradeoff studies conducted
- CO_2 monitoring studies underway across Delhi and Chandigarh
- Whatsapp based nudging system developed to influence and optimize electricity demand behavior

Smart Microgrids

- Smart Microgrid procured and integration underway
- Smart Microgrid training course under development

Impact

- Publications:
  - Conferences – 6; Journals - 1
- Policy:
  - Telengana formally recognizes heatwaves as a disaster
  - Andhra Pradesh mandated ECSBC - Commercial, ECSBC - Residential (ENS) and cool roofs in its building bye-laws
- Capacity Building:
  - 2 Courses Offered

Events & Other

- 2 Books submitted for copy editing
- 1 Invitation as a Session Chair

1. Team

Over the past years, the Center has built a strong, multidisciplinary team aligned with its mission in clean energy and sustainable urban systems. The team brings together expertise across core energy domains and complementary disciplines.

Current Team Snapshot (2026):

Faculty: **7**

Research Staff: **8**

External Consultants: **3**

UG Students: **20**

Plaksha's culture of cross-disciplinary collaboration has enabled the Center to bring together faculty and professionals not only from core clean energy domains but also from complementary fields essential for translational research and real-world impact. This integrated approach has strengthened our research capacity and enhanced our ability to address complex, system-level challenges. As we move into the next year, the Center plans to strategically expand its team to strengthen translational research, industry engagement, and real-world impact.

1.1 Faculty

Vishal Garg

Professor & Director

Smart Buildings, UHI Policy, District Cooling

PhD - IIT Delhi

Areas of interest: Building energy informatics, smart energy homes, cool surfaces for Urban Heat Island (UHI) mitigation, decarbonizing residential AC energy consumption.

Prakarsh Singh

Chair Professor

Applied Microeconomics

PhD - London School of Economics

Areas of interest: Randomized Controlled Experiments, Child Undernutrition, Incentives in the Workplace

Suresh Kumar

Professor

Bayesian Data Analysis

PhD - University of Delhi

Areas of interest: Clustering, Dark Matter, Dark Energy, Cosmic Acceleration, Anisotropic Cosmological Models

Vivek Deulkar

Assistant Professor

Smart Grid Optimization

PhD - IIT Bombay

Areas of interest: Energy Informatics, Smart Grid Optimization, Managing renewable uncertainties via battery storage systems, Stochastic modeling, Reinforcement learning, Machine learning, Control & Optimization.

Shashikant Pawar

Assistant Professor

Urban Heat Island and Microclimate Studies

PhD - IISc Bangalore

Areas of interest: Urban Microclimate, Buoyancy driven (environmental) turbulent flows, Fluid dynamics and heat transfer of Bio-inspired systems, Light propagation in turbulent media.

Anupam Sobti

Assistant Professor

Geospatial and Embedded Perception

PhD - IIT Delhi

Areas of interest: Geospatial Sensing for Urban Planning and Agriculture, Urban microclimate and mobility

Praveen Kumar

Associate Professor

Quantum Materials & Devices

PhD - IIT Delhi

Areas of interest: Quantum Materials and Devices
Two-Dimensional Materials (TMDCs, MXenes, h-BN, and Oxides)

1.2 Researchers

Aviruch Bhatia

Senior Research Scientist

Building Energy Simulation

PhD - IIIT Hyderabad

Varchita Lalwani

Research Fellow

Machine Learning and Computer Vision

B.E ADIT Gujarat

Almas Siddiqui

Research Consultant

Urban Planning

M. Tech, SVNIT Surat

Piyush Kumar

Research Fellow - 1

Smart Microgrids

B.E, IIT Goa

Ritwik Agarwal
Research Associate
IAQ
MS (R), IIIT Hyderabad

Anand Sharma
Research Fellow - 1
Wind Tunnel
B.E, Mumbai University

Sahil Chilana
Research Fellow - 2
SHEMS
MS (R), IIIT Hyderabad

Akhil Goyal
Center Manager
Sustainable Capitalism
MBA, Delhi School of Economics

1.3 Consultants

Kiran Kumar Donthu
Research Consultant
Smart Homes
Faculty, IIT BHU

Sraavani Gundepudi
Research Consultant
Cool Roofs
M. Arch. JNFAU, Hyderabad

Prabhakar Rao
Project Manager
IoT and Smart Homes
M.Tech, NCET Hyderabad

1.4 UG Students

A total of 20 students are currently engaged through the Plaksha Energy Club, supported by IVCCE. These students are mapped to 10 ongoing projects, each supported by a dedicated subject-matter expert. The cohort comprises 13 first-year, 5 second year, and 2 third-year students (Figure 1), enabling effective peer learning and cross-level collaboration. In parallel, 10 students are participating in Solar Decathlon India (SDI), India's largest Net-Zero Building Challenge. The next phase of student engagement will focus on aligning academic involvement with long-term career pathways in the energy sector through sustained mentorship, project-based learning, and structured industry exposure.

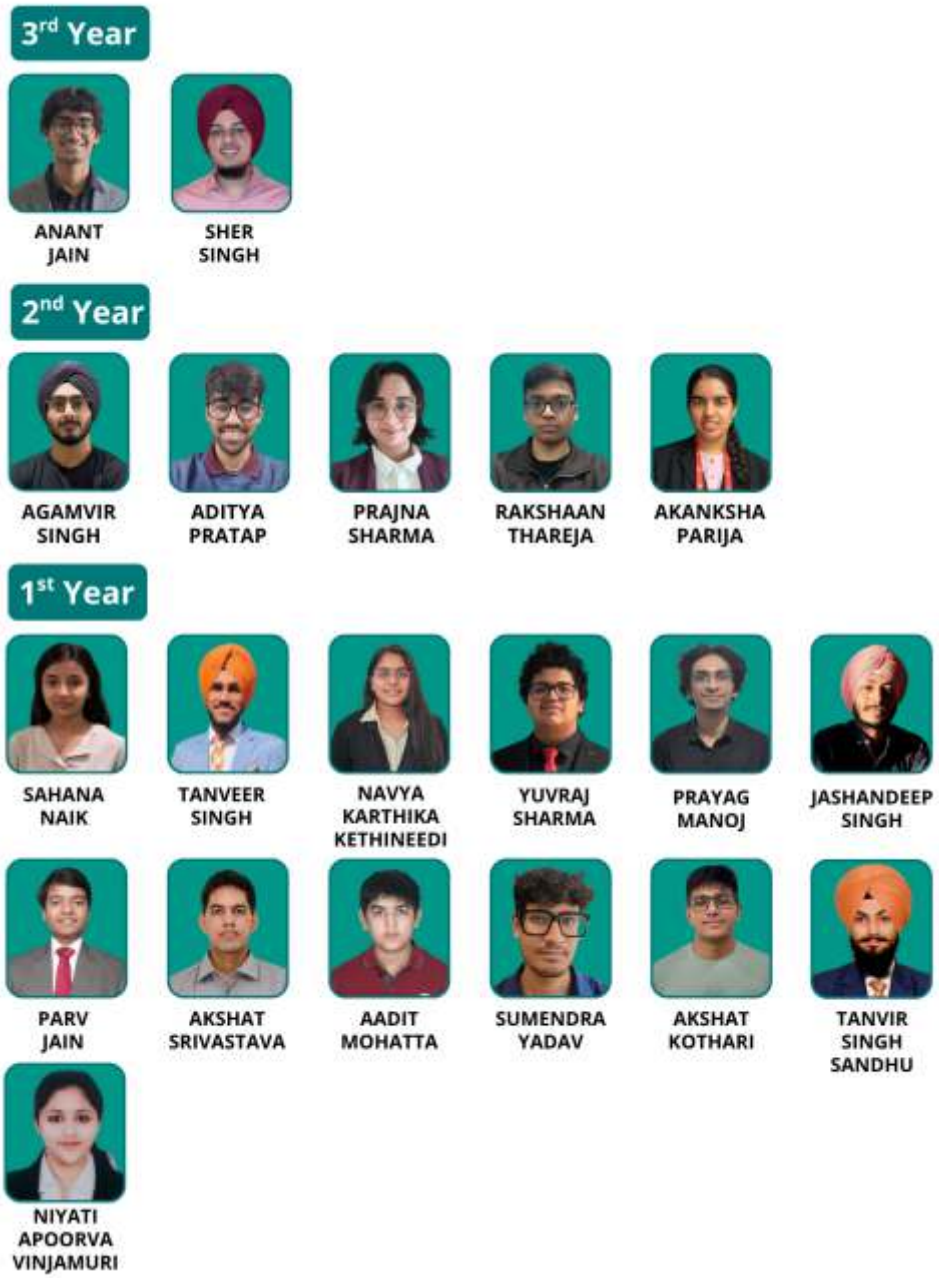


Figure 1 Student Body of Energy Club mentored by IVCCE

2. Research Updates

2. Research Updates

Our work at IVCCE continues to advance along four major thrust areas:

- Urban Microclimate
- Decarbonizing Residential Cooling
- Smart Buildings
- Smart Microgrids

The activities underway in each of these focus areas are detailed in the following section.

2.1 Urban Microclimate

2.1.1 Cool Roofs

Cool roofs reflect solar radiation and reduce heat absorption in buildings, offering benefits that extend across all sections of society by lowering both indoor and outdoor heat stress. They provide immediate relief to vulnerable and low-income households without access to air conditioning, while large-scale adoption reduces ambient temperatures and heat exposure for outdoor workers such as street vendors and construction laborers. In hospitals and healthcare facilities, cooler indoor environments improve patient comfort, support recovery, and reduce heat-related health risks. At the city level, cool roofs contribute to energy savings, reduced grid demand and emissions, and enhanced overall urban climate resilience.

2.1.1.1 Cool Roof Policy

The Cool Roof Policy initiative aims to position cool roof solutions as a mainstream strategy for climate adaptation and heat mitigation across India. Building on sustained policy engagement and successful advocacy efforts led by the IVCCE team in Telangana, heatwaves were officially recognized as a disaster on 15 April 2025 (Figure 2), marking a significant policy milestone.

HOME / NEWS / INDIA / TELANGANA

Telangana notifies heatwave as 'State-specific disaster', enhances ex-gratia to ₹4 lakh

Deaths will be considered eligible only if they meet the IMD's criteria

Updated - April 15, 2025 01:21 pm IST - HYDERABAD

THE HINDU BUREAU

Figure 2 Telangana recognized Heat Waves as a Disaster

Director IVCCE participated in a high-level meeting convened by the Disaster Management Department of Government of Telangana and Natural Resources Defense Council (NRDC) on 20th August 2025 (Figure 3). The meeting focused on the development of the Hyderabad Heat Action Plan (HHAP), planned for release before the 2026 heat season, and on outlining an impact assessment methodology. It also discussed plans to conduct Heat Action Plan trainings, in collaboration with Administrative Staff College of India (ASCI), for 145 urban local bodies across Telangana.

Figure 3 Prof. Vishal Garg participated in the meeting for developing Heat Action Plan of Hyderabad

Director, IVCCE delivered a presentation on the Science of Cool Roofs (Figure 4) at the Workshop on Cool Roof Adoption in Andhra Pradesh on 25th April 2025, engaging state stakeholders on strategies for large-scale implementation.

"WORKSHOP ON COOL ROOF ADOPTION IN ANDHRA PRADESH"

PROGRAMME AGENDA

25th April 2025, Friday
Hotel Fortune Murali Park, Vijayawada, Andhra Pradesh

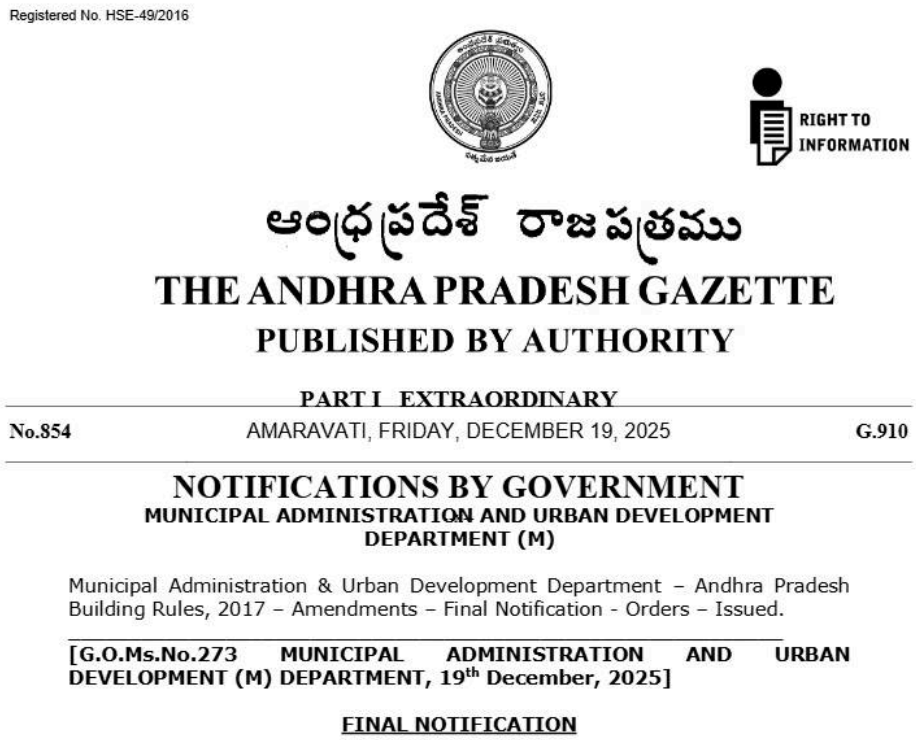
Objective of the Roundtable Discussion:

The roundtable discussion intends to comprehensively examine opportunities associated with the adoption and implementation of cool roof solutions in Andhra Pradesh. With the state's cool roof policy imminent, **this presents a timely opportunity to explore strategic solutions and actions tailored to** different stakeholders that can boost the uptake of cool roofs. By gathering experts, solution providers, architects, real estate developers, and other key stakeholders, the discussion aims to focus on identifying and highlighting potential growth drivers and exploring strategies to accelerate the adoption of this sustainable and energy-efficient technology in the region.

TIME (in hours)	PROGRAMME DETAILS
1330-1430 hrs	**Registration and Networking Lunch**
1430-1450 hrs	Inaugural Session
	Welcome Address & Context Setting: Mr Anupam Buttan, Senior Manager, GRIHA Council
	Special Remarks: *Smt. R.J. Vidyullatha, Director, Directorate of Town and Country Planning (DTCP), Government of Andhra Pradesh
	Inaugural Address: *Mr. B.A.V.P Kumara Reddy, Joint Secretary, Energy, and I & I Department &Chief Executive Officer, Andhra Pradesh State Energy Conservation Mission (APSECM) & Director, New & Renewable Energy Development Corporation of Andhra Pradesh Ltd, Government of Andhra Pradesh
1450-1515 hrs	Technical Session: Scaling Cool Roof Technology Implementation
	Presentation on the Science of Cool Roofs: **Dr Vishal Garg**, University Chair Professor and Director, Indorama Ventures Center for Clean Energy, Plaksha University
	Presentation by NRDC: **Mr Gerry, George,** Cooling & Energy Efficiency Specialist, NDRC India
1515-1715 hrs	**Open Floor Discussion**: *Unlocking the Potential of Cool Roofs: Seizing Opportunities in Andhra Pradesh* **Moderator: Mr Rajkiran Bilolikar,** Professor and Director, Centre for Energy Studies, Administrative Staff College of India (ASCI), Hyderabad

Figure 4 Agenda for Workshop on Cool Roof Adoption in Andhra Pradesh

These continuous advocacy efforts led to another major milestone on 19th December 2025 (Figure 5), when the Government of Andhra Pradesh officially released the notification mandating the Energy Conservation and Sustainable Building Code (ECSBC), Eco-Niwas Samhita (ENS), and Cool Roof provisions as part of the state's building bye-laws.



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THE ANDHRA PRADESH GAZETTE

PUBLISHED BY AUTHORITY

PART I EXTRAORDINARY

No.854 AMARAVATI, FRIDAY, DECEMBER 19, 2025 G.910

NOTIFICATIONS BY GOVERNMENT

MUNICIPAL ADMINISTRATION AND URBAN DEVELOPMENT DEPARTMENT (M)

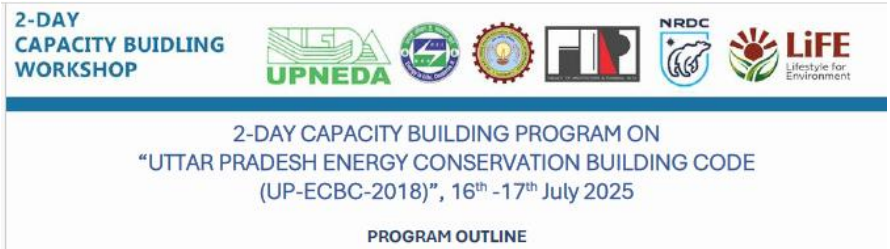
Municipal Administration & Urban Development Department – Andhra Pradesh Building Rules, 2017 – Amendments – Final Notification - Orders – Issued.

[G.O.Ms.No.273 MUNICIPAL ADMINISTRATION AND URBAN DEVELOPMENT (M) DEPARTMENT, 19th December, 2025]

FINAL NOTIFICATION

Figure 5 Draft notification for public comments by AP Government

IVCCE team is extending technical support for the formulation of cool roof policy in Uttar Pradesh. IVCCE director presented at the Capacity Building Program on the Uttar Pradesh Energy Conservation Building Code held from 16th–17th July 2025 (Figure 6 and 7), contributing to strengthening technical awareness and adoption of cool-roof practices



2-DAY CAPACITY BUIDLING WORKSHOP

UPNEDA

NRDC

LiFE Lifestyle for Environment

2-DAY CAPACITY BUILDING PROGRAM ON "UTTAR PRADESH ENERGY CONSERVATION BUILDING CODE (UP-ECBC-2018)", 16th -17th July 2025

PROGRAM OUTLINE

Figure 6 Capacity Building Program

Day-2 - 17.07.25

10:00-12:00	Components of Uttar Pradesh Energy Conservation Building Code-2018 3) Comfort system and controls (HVAC) 4) Electrical and Renewable Energy Systems	ECBC Master Trainer (Mr. Sandeep Verma)
12:00-12:30	Introduction to ECSBC (Online session)	Mr. Anurag Bajpai
12:30 – 13:00	Eco-Niwas Samhita	ECBC Master Trainer
13:00-14:00	Lunch Break	
14:00-15:00	Urban cool roofs (Online session)	Dr. Vishal Garg
15:00-16.30	Urban cooling policy	N.R.D.C.
16:30-16:55	General Discussion	
16:55-17:00	Vote of Thanks	Dr. Ritu Gulati
	High Tea	

Figure 7 Agenda for Capacity Building Program on "UP Energy Conservation Building Code"

The broader objective of these efforts is to establish heatwaves as a nationally recognized disaster, thereby enabling stronger policy frameworks, improved resource allocation, and large-scale implementation of heat mitigation strategies across the country

2.1.1.2 Cool Roof Calculator

The Cool Roof Calculator developed earlier in IIIT Hyderabad, has been updated and re-hosted at Plaksha domain and is now live for use (Figure 8). This tool works on EnergyPlus and does online simulations for Indian cities for which weather data files are available. It also has the capability of simulating an un-conditioned building for which the increased comfort achieved by using cool roof is reported. It is being regularly used by stakeholders across the community.

Link for Cool Roof Calculator: https://coolroof.atplaksha.in

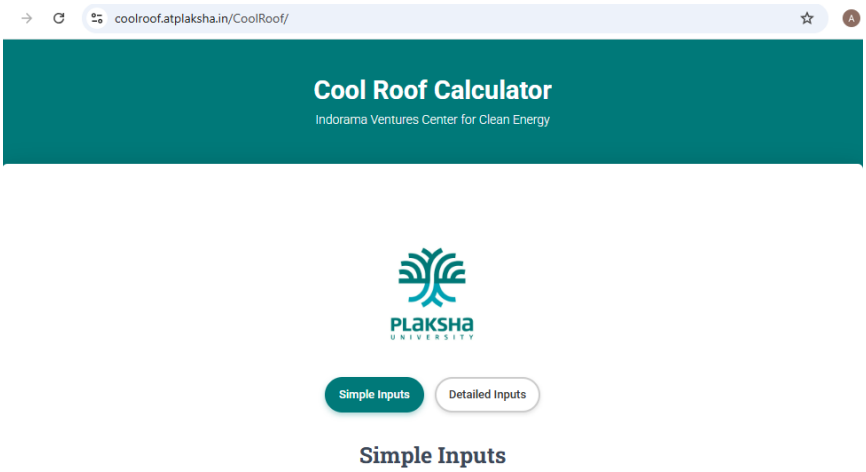


Figure 8 Cool Roof Calculator Snapshot

2.1.1.3 Roof of Hope

A community initiative called "Roof of Hope" was piloted in Delhi to demonstrate the on-ground impact of cool roof interventions. Under this activity, reflective tarpaulin sheets were installed across 100 homes in the Bakkarwala Resettlement Colony, West Delhi (Figure 9). This is a low-income community with limited infrastructure (Figure 10), where residents endure extreme heat stress during peak summer months. The study was implemented with support from the Mahila Housing Trust.

Figure 9 Roof of Hope Implementation Site - Bakkarwala Colony, West Delhi (© Google)

Figure 10 Homes in the Bakkarwala Colony

Pre-intervention assessments revealed *roof* surface temperature of 68 °C (Figure 12), indoor ceiling temperatures as high as 52 °C and wall temperatures up to 41 °C (Figure 11), highlighting the severe heat exposure under which families were living. Post-installation measurements indicated substantial thermal comfort improvements: roof surface temperatures reduced by 15–20 °C (Figure 12 and 13), indoor ceiling temperatures by 3–8 °C, and wall

temperatures by 2–4 °C (Figure 11). Household surveys, with a 98% response rate, further validated these findings. Prior to installation, 99% of residents reported their homes as uncomfortably hot during peak summer, whereas after installation, 80% reported improved indoor comfort, reduced dependence on fans, and better sleep quality. Importantly, over 95% of households expressed overall satisfaction, reinforcing the potential of cool roofs as a scalable, low-cost solution for improving resilience in vulnerable communities.

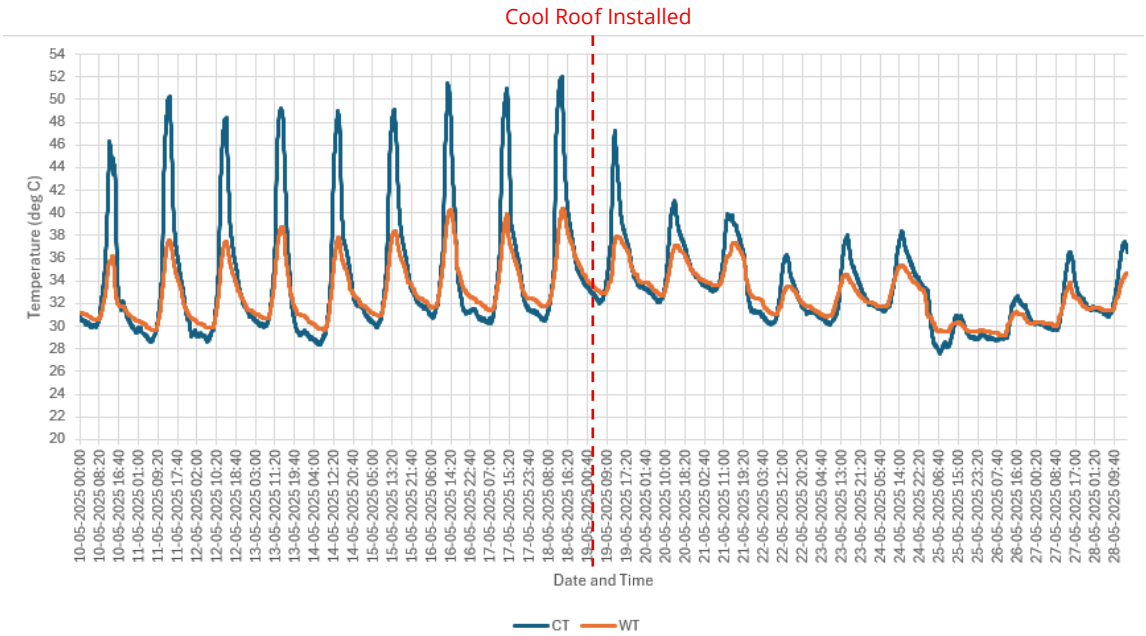


Figure 11 Impact of Cool Roof Implementation on Ceiling Temperature (CT) and Wall Temperatures (WT)

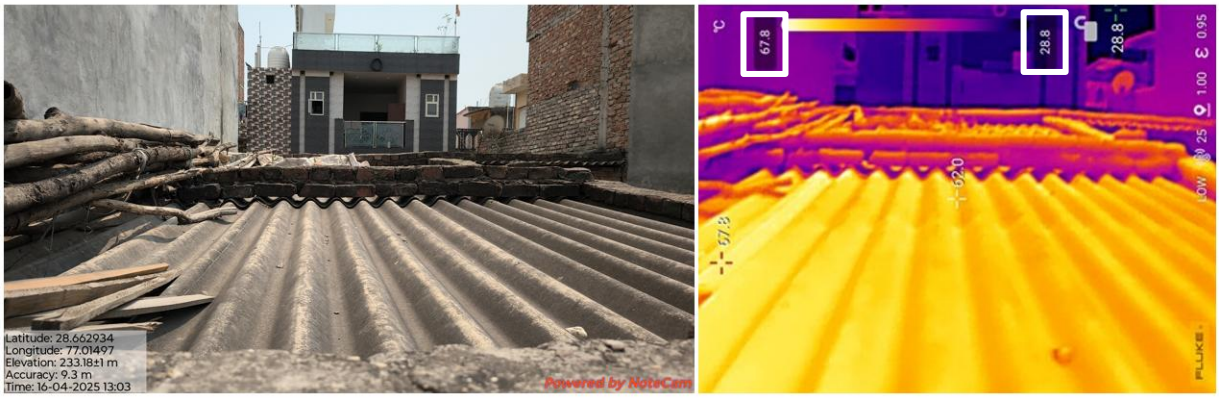


Figure 12 Thermal image showing roof surface temperature reaching 67.8 °C before cool roof installation in peak summer

Figure 13 After cool roof installation – roof surface temperature reduced to 48.3 °C, a drop of nearly 20 °C

While the pilot covered only 100 homes, the initiative has the potential to be scaled across the entire community of nearly 4000 homes in the same colony, and further expanded to other urban-poor settlements, paving the way for city-wide replication and strengthening urban heat resilience in vulnerable neighborhoods.

2.1.2 Climate Zones for Indian Districts

Over the years, with new weather datasets, advanced analytical techniques, and modern building technologies, India needed a fresh, robust, and energy-performance-oriented climate classification. Recognizing this gap, we developed a new climate classification for India (Figure 14), that reflects current weather patterns, covers the entire nation, and directly connects to building energy performance. For decades, building energy efficiency in India has been guided by codes such as the Energy Conservation Building Code (ECBC), the National Building Code (NBC), and various green building rating systems. These frameworks are based on five categories of climate zones providing recommendations for building components and design strategies across the country. However, all these codes and systems have relied on climate classifications that were last developed nearly four decades ago in the late 1980s. Those earlier classifications were based on limited weather station data, covered very few districts, and most importantly were not aligned with energy performance needs of buildings.

This development of a new climate classification marks a major milestone for the building energy efficiency ecosystem in India. This will enable better policies, smarter building designs, and greater energy savings across the country. The final classification shows

29.9% of districts fall under Composite-Dry, followed by Hot-Humid (22.1%), Hot-Dry (21.6%), Temperate (10.5%), Cold (10.4%), and Composite-Humid (5.5%). Based on the identified climate belongingness of each district, a new climate map of India has been developed using a unique criterion (Table 1).

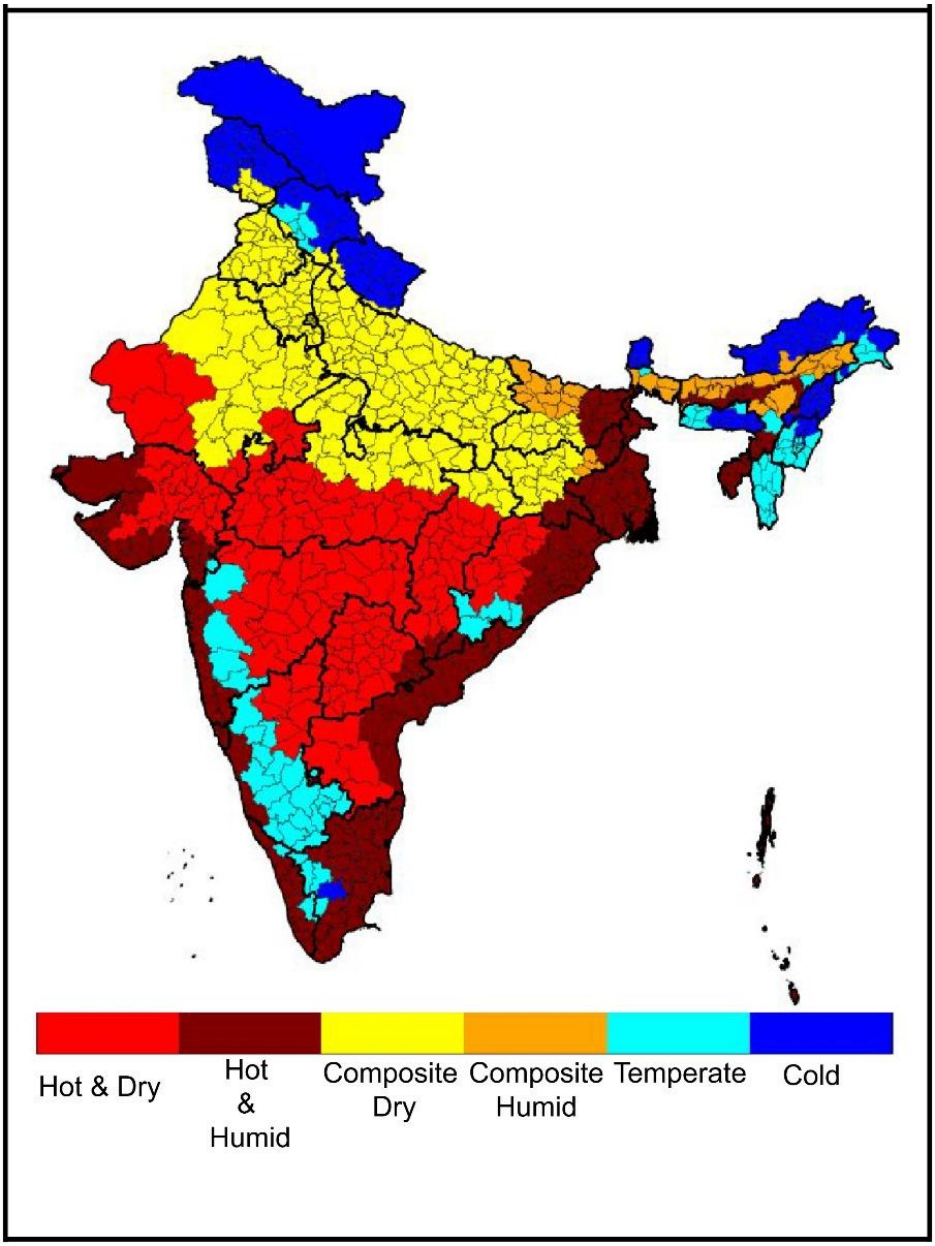


Figure 14 Proposed Climate Classification of India

Table 1 Criteria for Climate Classification of India

Climate type	Summer mean temperature (°C)	Winter mean temperature (°C)	Mean relative humidity (%) (April, May, June)
Hot-Dry	> 26.5	> 19	< 60
Hot-Humid	> 26.5	> 19	≥ 60
Composite-Dry	> 26.5	≤ 19	< 60
Composite-Humid	> 26.5	≤ 19	≥ 60
Temperature	≤ 26.5 & ≥ 21	-	-
Cold	< 21	-	-

This classification can serve as a foundation for regionalized compliance pathways and baseline performance models, benefiting policymakers and standard-setting bodies such as NBC, ECBC, and green building rating systems. It can also guide architects, engineers, urban planners, and developers, ultimately improving building comfort, reducing energy use, and supporting next generation of energy-efficient, climate-responsive buildings.

Related Publications

1. Gupta, Raj, Jyotirmay Mathur, and Vishal Garg. "A Criteria-Based Climate Classification Approach Considering Clustering and Building Thermal Performance: Case of India." Building and Environment 270 (February 2025): 112512.
2. Gupta, Raj, Jyotirmay Mathur, and Vishal Garg. "Refining India's Climate Zoning: District-Level Map Using Clustering-Derived Criteria." Building and Environment 285 (November 2025): 113633.

2.1.3 Wind Tunnel for Urban Planning

An open environmental wind tunnel has been developed in-house at IVCCE, featuring a 2' x 2' x 2' test section (Figure 15) with arrays of variable-speed DC fans on two sides, enabling controlled velocity shear profiles to simulate atmospheric conditions. Compared to conventional single-fan wind tunnels of similar size, this configuration achieves comparable performance with nearly five times lower power consumption, making it significantly more energy-efficient. The facility supports research on urban wind flows, pollutant dispersion, natural ventilation, vegetation aerodynamics, and thermal stratification, positioning it as a valuable tool for urban sustainability, climate research, and environmental engineering.

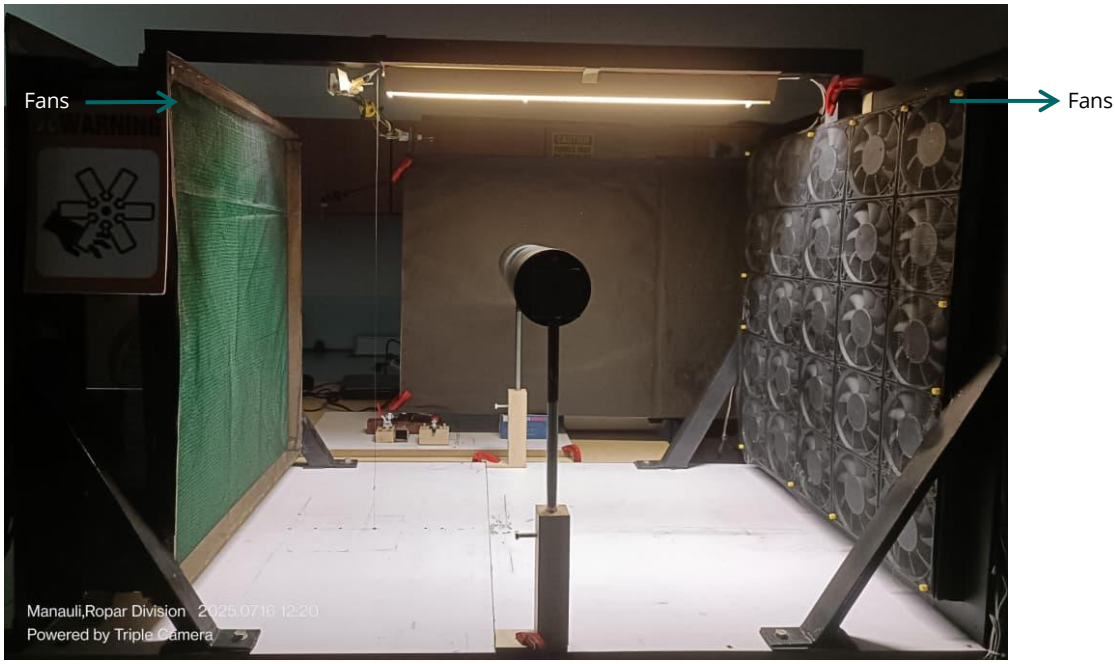


Figure 15 Wind Tunnel Facility

During the reporting period, benchmarking of velocity measurements and flow visualization was undertaken using standard prototype models across varying flow speeds and surface roughness conditions. This included model preparation, calibration, experimental measurements, smoke-based visualization, and preliminary data analysis (Figure 16).

Figure 16 Flow visualization behind a smooth cylinder at the lowest wind speed

The wind tunnel facility primarily benefits researchers, faculty, and students at IVCCE (Figure 17), with scope for expansion across the broader Plaksha campus to enable real-world validation and demonstration of airflow, ventilation, and microclimate strategies, ultimately informing urban planning and policy applications.

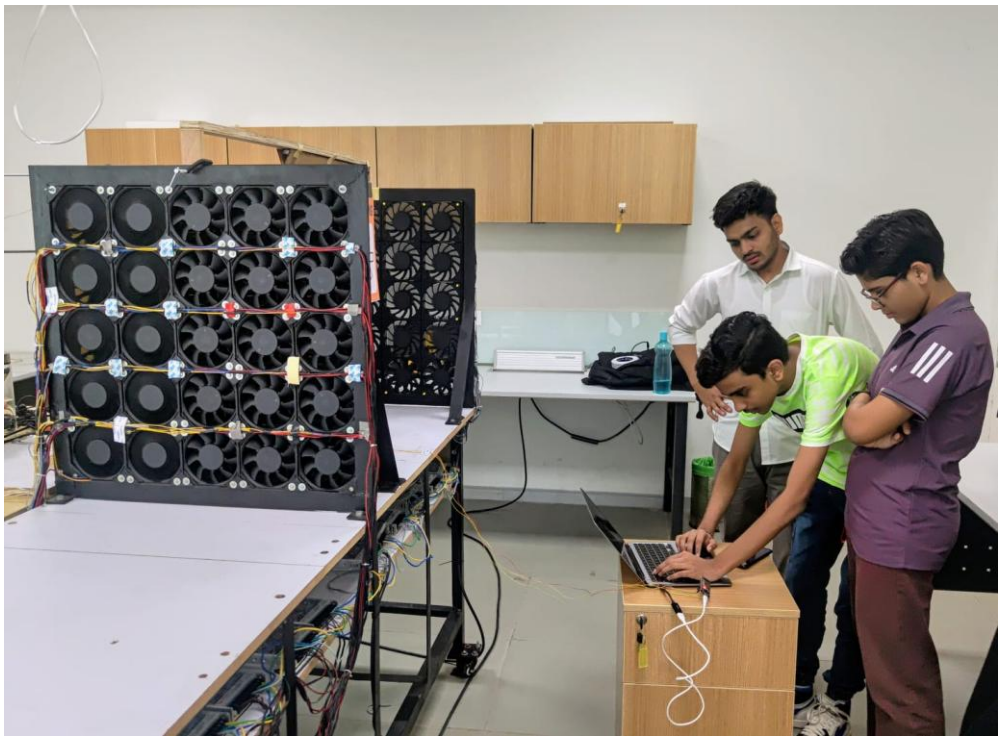


Figure 17 9th-12th grade students from Young Tech Scholars'25 using the Wind Tunnel Setup

2.1.4 Urban Mobility

2.1.4.1 Walkability

As part of its efforts to advance sustainable urban mobility, IVCCE is developing data-driven approaches to assess walkability demand, accessibility, and the condition of street infrastructure. Moving beyond time and resource-intensive manual surveys, the team has created automated pipelines that estimate walkability demand based on land-use patterns and assess existing infrastructure using satellite and street-view imagery. These methods enable city agencies to identify priority locations for pedestrian infrastructure and evaluate its performance across urban areas. The work has expanded to include

accessibility assessments in collaboration with the University of Washington, Seattle, and is complemented by city-scale tree-mapping initiatives (Figure 19) using computer vision to better understand urban microclimates and walking comfort, with active interest from forest departments in Chandigarh and Delhi.

Link to Project Sidewalk (Figure 18): https://sidewalk-chandigarh.cs.washington.edu/

Figure 18 Project Sidewalk: Chandigarh Progress

Figure 19 Project Sidewalk: Mapping of Chandigarh using this software

Building on these sensing and assessment capabilities, IVCCE has initiated translational work in partnership with Jana Urban Spaces under the CM-GRIDS (Chief Minister Green Road Infrastructure Development Scheme) of the Government of Uttar Pradesh. The collaboration supports the development of over 200 km of pedestrian-friendly roads across 17

municipal corporations through open-source software for street selection, design assistance, and a WhatsApp-based tool for data collection and guideline support (Figure 20). The field engagements conducted in cities including Ayodhya, Lucknow, and Delhi have informed both the design process and the implementation approach. The primary beneficiaries of this work include the Project Management Unit (PMU) housed within the Directorate of Urban Local Bodies, as well as road consultants, contractors, and administrative officials. Indirect benefits accrue to the wider public through improved pedestrian infrastructure that enhances safety, supports public health, enables economic activity, and contributes to greener urban environments.

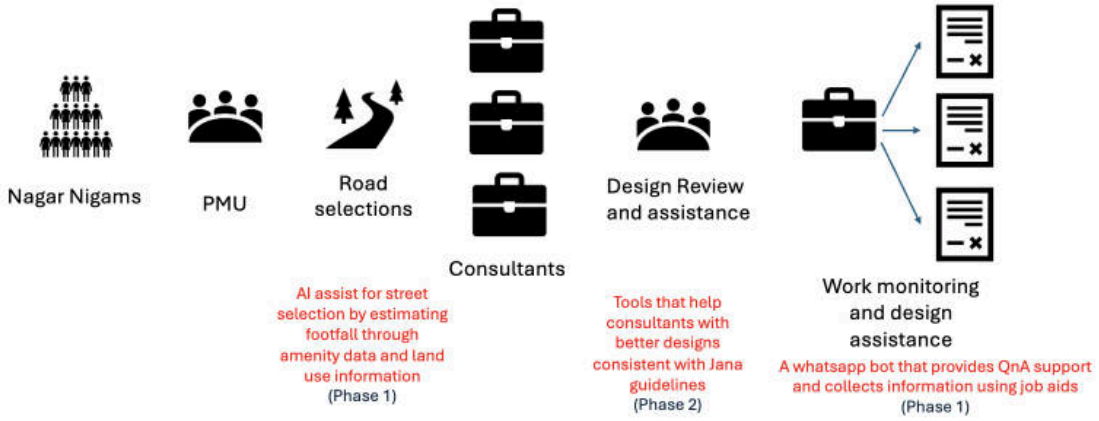


Figure 20 Our AI systems integrate into the pipeline between Nagar Nigams and PMU for the CMGRIDS project providing enhanced visibility and tools for some of the critical steps.

2.1.4.2 Geospatial Active Learning

We are using geospatial active learning to speed up the creation of city-scale datasets from satellite and street-view images. Instead of manually labeling every building, tree, road, or water body, a process that is slow and repetitive; Active learning lets the computer identify the most important images that need human input. This makes the annotation process nearly 200% more efficient, enabling us to generate high-quality datasets that support urban projects such as mapping trees, assessing walkability, detecting waterlogging, and planning for climate-resilient cities.

We presented our work at ACM COMPASS 2025 in Toronto, Canada (Figure 21).

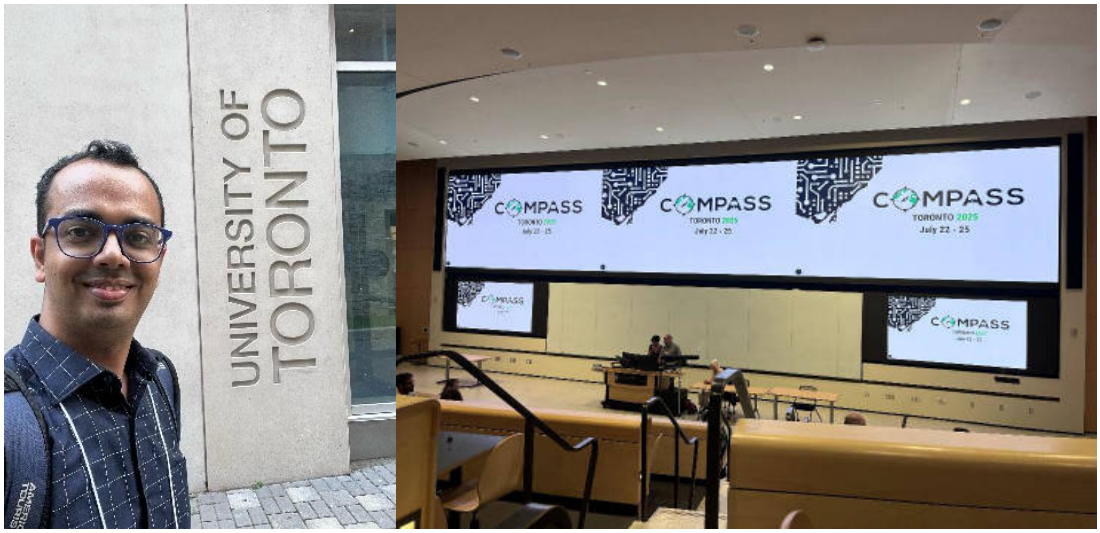


Figure 21 Prof. Anupam Sobti at ACM COMPASS 2025 in Toronto, Canada

In this work, the team devised algorithms to reduce the number of human annotations required for achieving good accuracy in machine learning algorithms.

The following Figures 22 and 23 show how the uncertainty of prediction reduces across geography in consecutive annotation sessions.

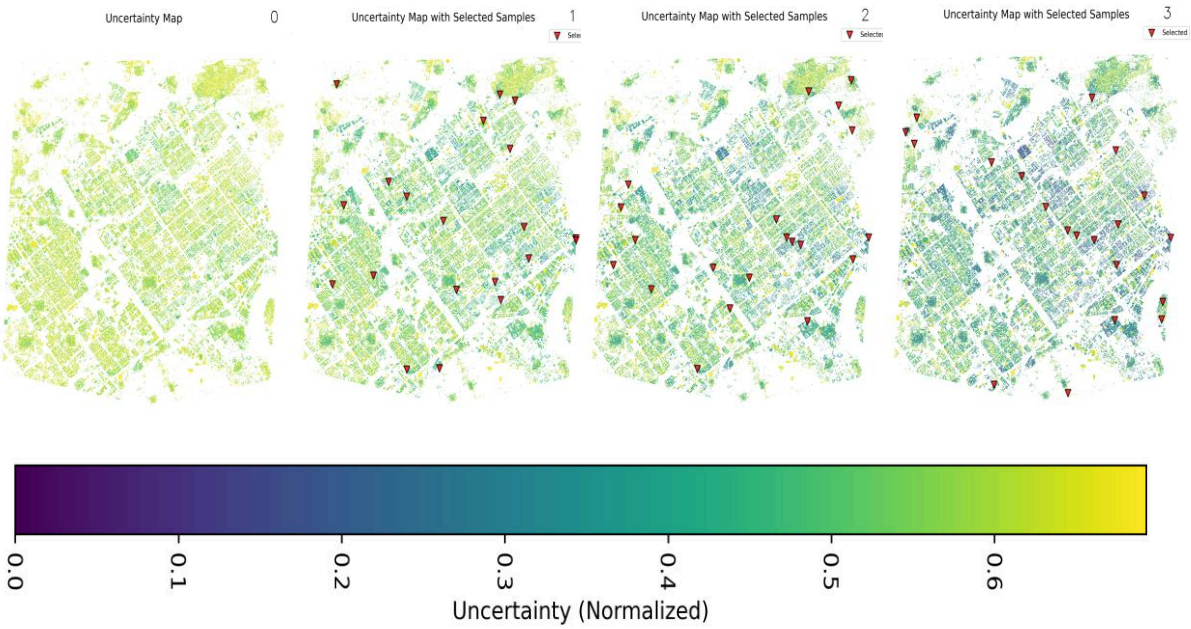


Figure 22 Demonstration of reducing uncertainty at the city scale by thoughtful sampling of labels.

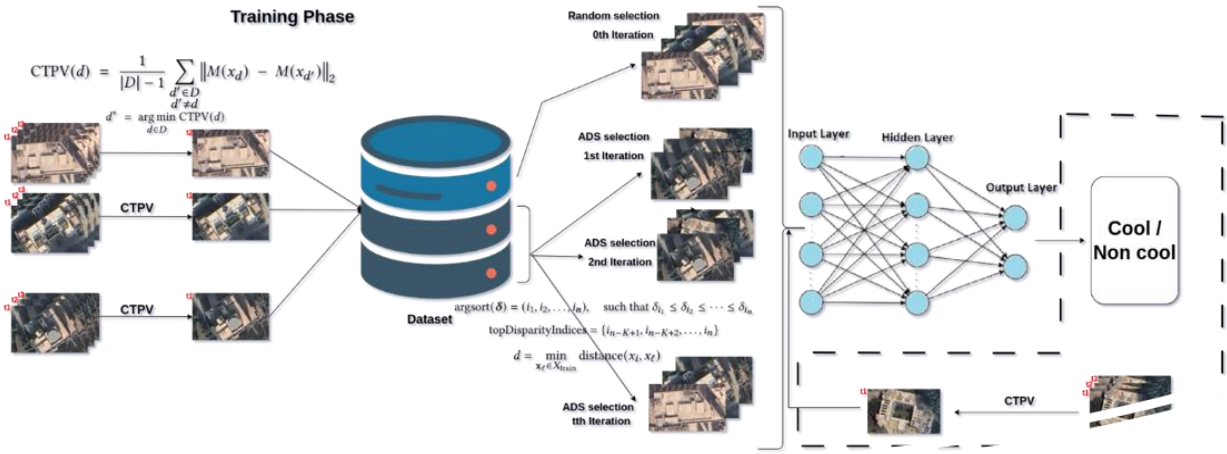


Figure 23 Demonstration of our improved pipeline which uses CTPV - Cross Time Prediction Variance to filter data from multiple dates and ADS - Adaptive Disparity Sampling to overcome overconfident mispredictions.

The project primarily benefits scientists and data engineers engaged in developing city-level datasets for urban climate analysis, including buildings, trees, parks, and water bodies. The cloud-based geospatial algorithms are designed for global deployment, enabling city planners, researchers, and policymakers worldwide to access scalable and consistent urban climate data.

2.1.5 Urban Housing

The IVCCE team has initiated work to embed good design practices that enhance thermal and visual comfort in housing while delivering co-benefits for the urban environment. As a first step, the team is supporting the Punjab Urban Development Authority (PUDA), Ludhiana, in developing an automated building plan approval system. An LLM-based platform has been developed as professional-grade software and is currently capable of validating 8 of the 25 applicable building rules, with agentic AI workflows being integrated in the backend to enable intelligent checks across a broader range of use cases. The platform has the potential to be adopted by urban development authorities nationwide, with initial benefits accruing to the public in Ludhiana through faster approvals and improved housing quality. In the next phase, the system will integrate geo-localized housing efficiency metrics, incorporate inputs from city master plans, and offer mobility planning support to homeowners, further enhancing the value delivered through the platform.

2.2 Decarbonizing Residential Cooling

Residential air conditioning presents two major challenges: a significant night-time peak in electricity demand and the widespread oversizing of installed cooling capacity in homes. To address this, we conducted a case study last year on a 387-home residential complex in Hyderabad (Figure 24), demonstrating that district cooling can reduce installed cooling capacity by up to 90% (Figure 25). Furthermore, the night-time energy demand can be met using thermally stored energy, leveraging solar power available during the day.

Figure 24 Residential Complex in Hyderabad

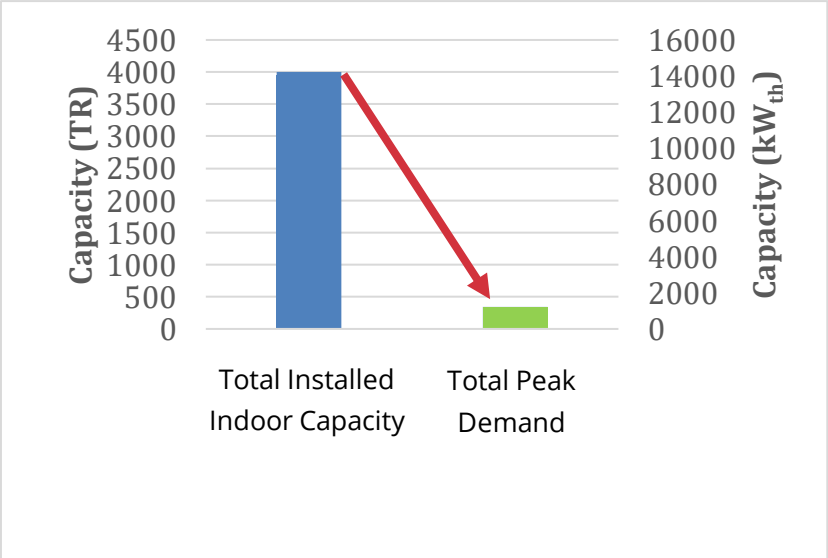


Figure 25 90% reduction in the need of installed cooling capacity

To validate this approach, we have developed India's largest academic research thermal storage testbed, coupled with the centralized chilled water-based cooling system with partial financial support from the International Finance Corporation (IFC), World Bank Group. Plaksha intends to offer this living laboratory to startups, manufacturers, and solution providers to evaluate and demonstrate their technologies in a field environment.

2.2.1 District Cooling and Thermal Storage Living Lab

The Thermal Energy Storage (TES) Living Laboratory, integrated with the district cooling system at Plaksha University, was installed and commissioned this summer. This 1,350 TRh, first-of-its-kind facility in India enables night-time cooling for 220 rooms of a Hostel (Figure 26) by storing thermal energy during the day and discharging it at night (Figure 27).

Figure 26 Hostel-1 building (220 rooms) at Plaksha using Thermal Energy Storage for night-time cooling

The system is now in the monitoring, verification, and performance optimization stage. The testbed serves as a platform for interdisciplinary research involving faculty, researchers, and students in collaboration with industry experts, covering experiments, modelling, and simulations to optimize thermal storage–based cooling systems (Figure 28 and 29).

Figure 27 Schematic of thermal storage system

Current research activities focus on performance evaluation, cost–benefit analysis, round-trip efficiency assessment, AI-based operational optimization, and user adoption studies. Technical fine-tuning is underway to address operational and heat-transfer limitations observed during trial runs. A separate experimental setup was developed to study the charging performance of PCM ball.

The TES Living Laboratory functions as a testbed to generate real-world evidence on thermal storage performance under Indian conditions. It supports research on load shifting, peak demand reduction, energy efficiency, and reduced reliance on high-GWP refrigerants, while enabling behavioral, economic, social, and environmental assessments. The facility will support the development of national thermal storage standards and demonstrates the scalability of district cooling and storage solutions for decarbonized, resilient urban cooling across Indian cities.

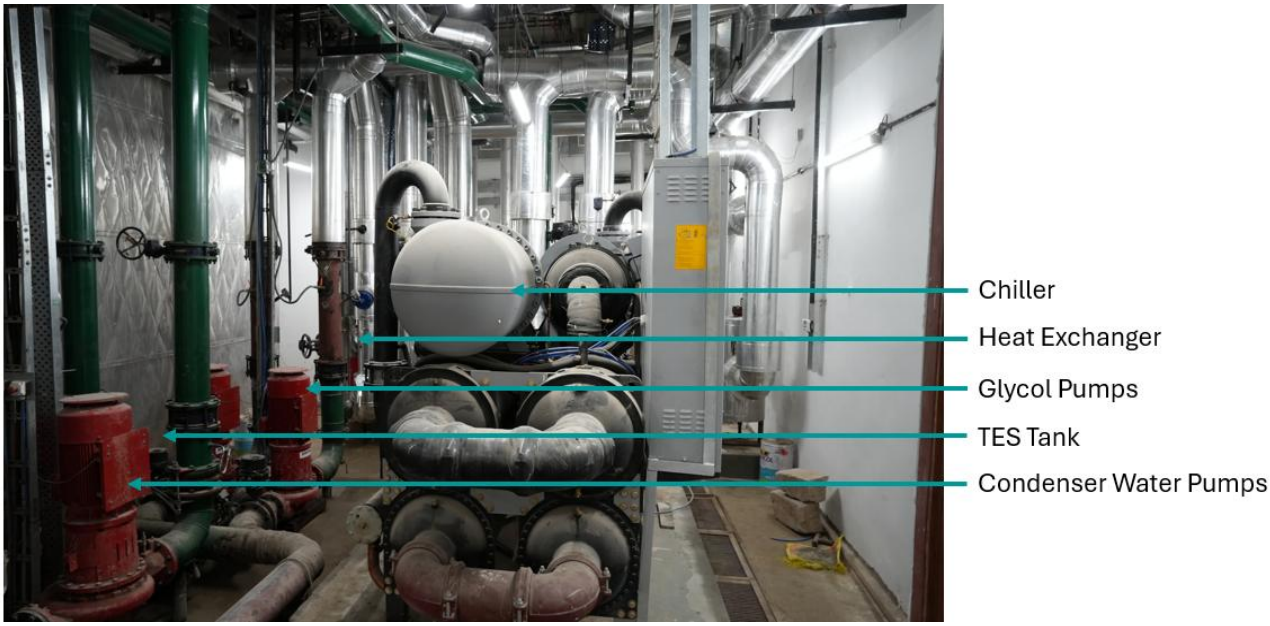


Figure 28 Thermal storage plant major components

Figure 29 Thermal storage plant piping network

2.2.2 Knowledge Dissemination

Along with this, as a part of knowledge dissemination and stakeholder engagement, an IVCCE team member presented in the session "Thermal Energy Storage: Unlocking Efficiency for Net Zero Buildings" during the Net Zero Dialogue held on 1st August 2025 at CII NR Headquarters, Chandigarh (Figure 30). The session highlighted the role of thermal storage in reducing peak demand, improving building efficiency, and supporting the transition towards net-zero energy systems.

Figure 30 Dr. Aviruch Bhatia represented IVCCE at the Net Zero Dialogue session on Thermal Energy Storage, CII NR Headquarters, Chandigarh (1st August 2025)

IVCCE director attended the seminar "Shaping a Sustainable Refrigerant Transition Pathway for India" at the Royal Norwegian Embassy, New Delhi, on 17th September. Organized under the India-Norway bilateral cooperation through the INDEE3 project, the seminar brought together government, industry, academia, and civil society to discuss pathways for phasing down high-GWP refrigerants and transitioning toward natural alternatives such as CO_2. His participation contributed to knowledge dissemination on sustainable cooling strategies and enabled valuable networking with key stakeholders to explore collaborative opportunities in advancing climate-friendly refrigerant solutions.

He also participated in the Andhra Pradesh Clean Energy Expo & Investors Conclave held on 19–20 September 2025 at India Expo City, Visakhapatnam. As part of a panel discussion on "Rewiring Energy Supply Chains," he shared insights on the role of District Cooling and Thermal Energy Storage (TES) in creating efficient, reliable, and sustainable urban energy systems (Figure 31). His participation facilitated knowledge exchange with industry leaders, policymakers, and investors, while also highlighting IVCCE's ongoing work in advancing innovative clean energy solutions for large-scale deployment.

Figure 31 Prof. Vishal Garg in a Panel Discussion at Andhra Pradesh Clean Energy Expo

2.3 Smart Buildings

Electricity demand from residential and commercial buildings is rising rapidly driven by increased device penetration and the adoption of new technologies. IVCCE aims to investigate the interaction between technology, occupant behavior, energy consumption, and indoor environmental quality to enable more efficient, healthy, and sustainable buildings. The long-term goal is to generate insights that contribute to the development of national standards for smart homes, enabling optimized building performance, reduced energy use, and more sustainable urban living.

2.3.1 Research Studies

2.3.1.1 Appliance-level Electricity Use in a Residential Household

This study examined a household in Mohali, India, over a 12-month period (July 2024 to June 2025) spanning diverse seasonal conditions. Using high-resolution data from smart plugs, a smart meter, and indoor temperature-humidity sensors, the analysis explores how appliance usage patterns reflect environmental sensitivity and behavior-driven efficiency. Key appliances, including an air conditioner, geyser, induction cooktop, and refrigerator, accounted for

the majority of household electricity consumption. Usage was strongly aligned with thermal conditions: the air conditioner was used in hot and humid conditions, the geyser was used during periods of cold, and the evaporative cooler was operated in hot and dry conditions. Hourly usage profiles across seasons and day types showed predictable peaks linked to bathing and cooking routines, sharper on weekdays and more flexible on weekends. Indoor thermal data showed that comfort was largely maintained within India-specific adaptive comfort thresholds, despite modest appliance usage. The findings (Figure 32) illustrate how season-aware, manual control of appliances, without automation, can achieve low energy use without compromising comfort. This work underscores the value of combining appliance-level monitoring with environmental data to inform policy design, recognize efficient behavior, and scale sustainable living practices in urban India.

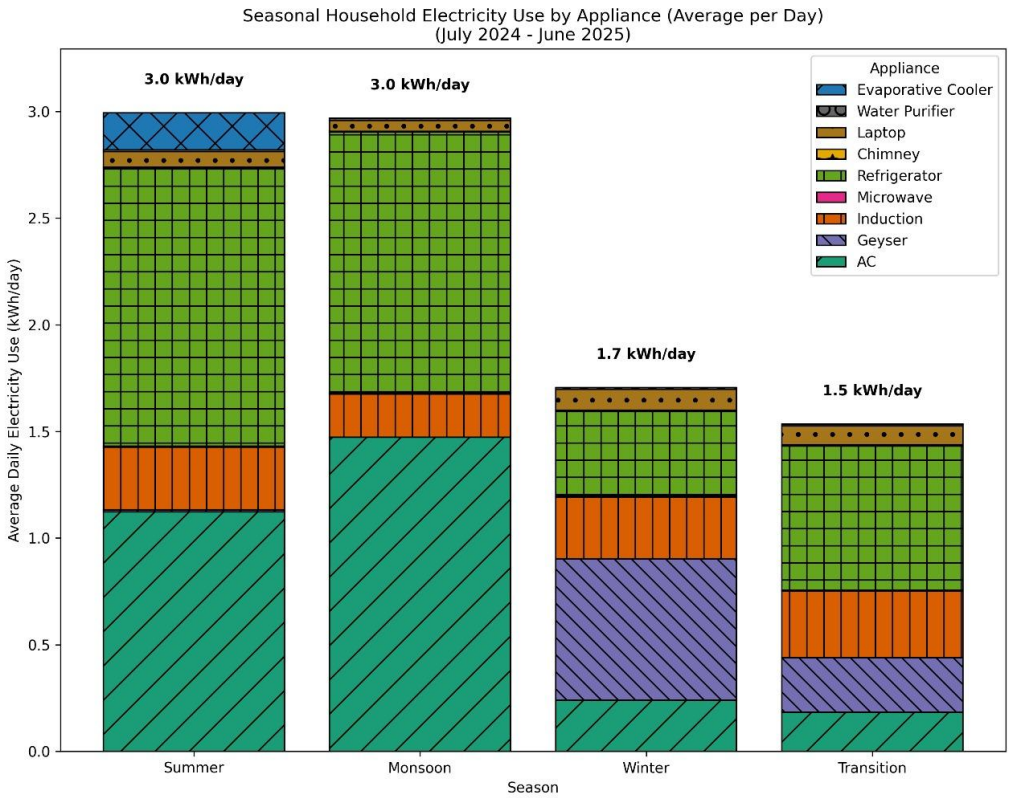


Figure 32 Seasonal variation in appliance-level electricity use, highlighting shifts in demand across different devices

2.3.1.2 Exploring Energy Implications in a Mixed-Mode Building by Linking Air Quality and Occupant Behavior

A pollution-aware natural ventilation schedule was developed by combining hourly outdoor particulate levels ($PM_{2.5}$ and PM_{10}) with EnergyPlus simulations for a representative apartment in a polluted urban setting such as Delhi-NCR. Window-opening decisions observed in household interviews were also used to represent how natural ventilation is typically avoided during pollution seasons. It was found that window closure was often driven by perceived pollution rather than hour-by-hour measurements, which tended to increase reliance on mechanical cooling. Simulation comparisons between behavior-based window patterns, temperature-driven mixed-mode operation, and pollution-aware rules showed how aligning window use with measured outdoor conditions can change both cooling energy use and indoor exposure outcomes in mixed-mode buildings.

2.3.1.3 Behavioral and Socio-Economic Dimensions of Indoor Air Quality

This study explores public awareness of air pollution and the perceived effectiveness of strategies to improve Indoor Air Quality (IAQ). Insights were gathered through in-person interviews across Delhi-NCR, representing a range of socio-economic backgrounds. Findings reveal widespread awareness of the Air Quality Index (88% of total respondents), but limited understanding of $PM_{2.5}$ and its health risks (33%). A clear behavior pattern was also observed: air purifier use was reported by respondents who were aware of AQI, whereas mask use was reported widely regardless of AQI awareness (Figure 33). Younger, educated residents are more likely to consider relocating to less polluted cities if comparable opportunities exist, highlighting migration as an adaptation strategy due to air quality concerns. Air purifiers are commonly used, though limited awareness of IAQ and effectiveness of purifiers present significant barriers (40% of non-purifier owners). These findings highlight the need for better public information on $PM_{2.5}$ and affordable indoor air quality solutions.

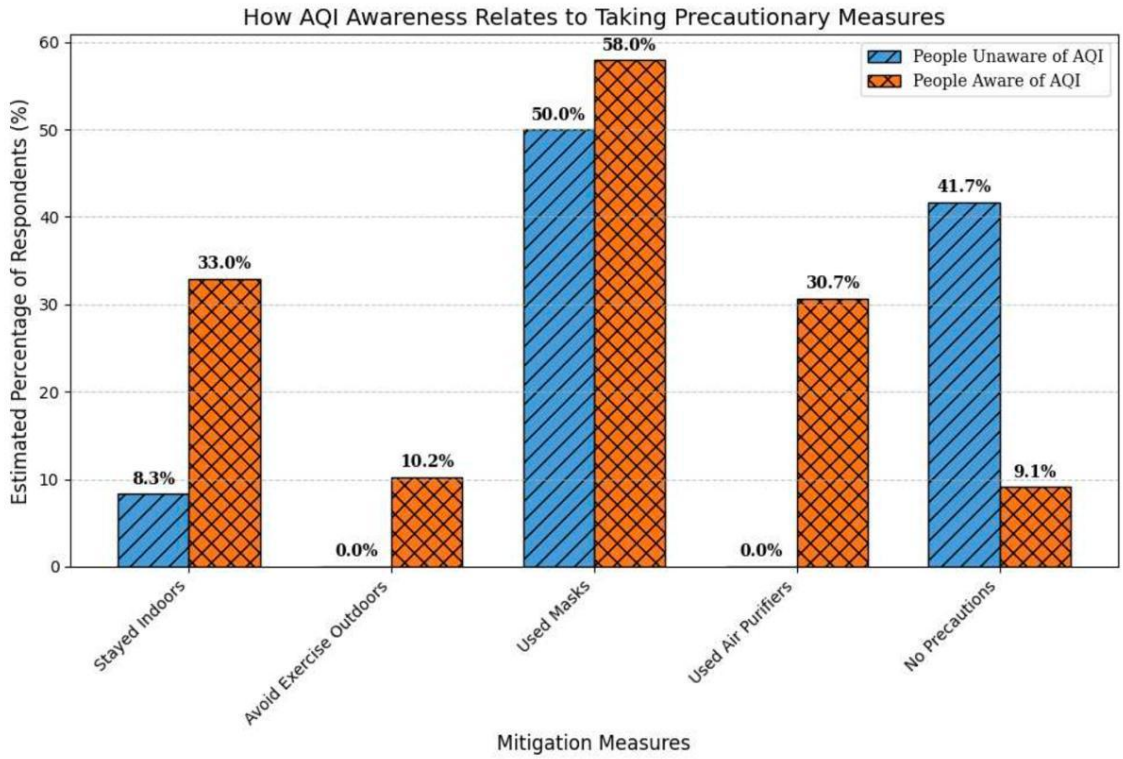


Figure 33 Precautions taken by households in accordance with AQI awareness

2.3.1.4 Energy and Indoor Air Quality Trade-offs of Personal Air Cleaners and Natural Ventilation in Urban Households

This study examines the trade-offs between reducing particulate exposure and cooling energy use under outdoor particulate pollution. These trade-offs were quantified using a combination of ethnographic interviews and building performance simulations for a residential building in New Delhi. Two mitigation strategies were assessed: (1) pollution-aware natural ventilation, in which window operation was driven by outdoor $PM_{2.5}$ thresholds, and (2) portable air cleaning combined with temperature-based window operation. At the whole-building scale, cooling energy use was estimated to increase by approximately 5% under pollution-aware natural ventilation relative to temperature-driven ventilation, including under scenarios where outdoor pollution was assumed to decrease due to broader interventions. At the bedroom scale, indoor particulate concentrations were estimated to be reduced by approximately 47% relative to outdoor levels when a high clean-air delivery rate purifier was used, while cooling electricity demand was estimated to increase by approximately 11%. Under pollution-aware natural

ventilation, cooling energy was estimated to increase by approximately 8.2%. These results quantified the energy implications of common exposure-reduction strategies and highlighted a broader tension between private household mitigation investments and the reliance on public measures for source-level air quality improvement.

2.3.1.5 Learning-Based Approach for Residential Electricity Usage Simulation (REUS)

This study addresses the scarcity of high-resolution residential electricity consumption data in India by developing a REUS to generate realistic synthetic datasets. Using hourly electricity consumption data collected over one year from 65 households across seven residential categories, along with 18 socio-technical features per home, the study employs a combination of probabilistic finite state modeling, feature selection, and machine learning techniques. Simulation models based on different Long Short-Term Memory (LSTM) networks and Transformer architectures were developed and benchmarked against traditional statistical approaches such as Markov Chains and ARIMA models. The results demonstrate that bidirectional LSTM models most effectively capture residential electricity consumption patterns, achieving the lowest prediction errors. By enabling the generation of region-specific synthetic electricity datasets, this work supports energy research, planning, and policy analysis while reducing reliance on costly, intrusive, and difficult-to-scale data collection efforts.

In addition, the Director of IVCCE was invited to serve as a Session Chair (Figure 34) for the paper session "Methods, Governance & Responsible Digitalization in Energy" at the EI.A 2025 conference.

Figure 34 Prof. Vishal Garg as a Session Chair for the paper session "Methods, Governance & Responsible Digitalization in Energy"

2.3.2 Knowledge Dissemination

Alongside its research activities, IVCCE continued its outreach and knowledge-sharing efforts, with a team member delivering presentations on the Energy Conservation & Sustainable Building Code (ECSBC 2024) during the IGBC Green League (IGL) 2025 in both Phase I (26 June 2025) and Phase II (21 August 2025). These sessions helped strengthen awareness and build capacity among stakeholders on sustainable building practices and the integration of energy-efficient standards in India's built environment. In addition, the Center Manager represented IVCCE at the Energise'25 Conference (Figure 35) on Energy Efficiency, Sustainable Habitats, and Climate resilience, engaging with industry stakeholders to strengthen partnerships and explore opportunities for collaboration, internships, and talent development pathways.

Figure 35 All participants at Energise'25 Conference

2.4 Smart Microgrids

2.4.1 Campus-wide Smart Microgrid Testbed

IVCCE is developing a campus-wide smart microgrid at Plaksha University (Figure 36) to enhance energy efficiency, improve reliability, and advance sustainability. The microgrid integrates distributed energy resources including rooftop solar PV, energy storage, and controllable loads to meet campus energy demands while reducing dependence on the utility grid and diesel generators. Designed as a living laboratory, the system supports research, innovation, and education in sustainable energy technologies, while generating real-world operational insights. The project also aligns with the Ministry of Power's Indian Energy Stack (IES) vision by embedding digital

intelligence into the microgrid to explore interoperable, secure, and scalable energy systems capable of enabling demand-side flexibility, peer-to-peer energy interactions, and integration with national digital energy platforms.

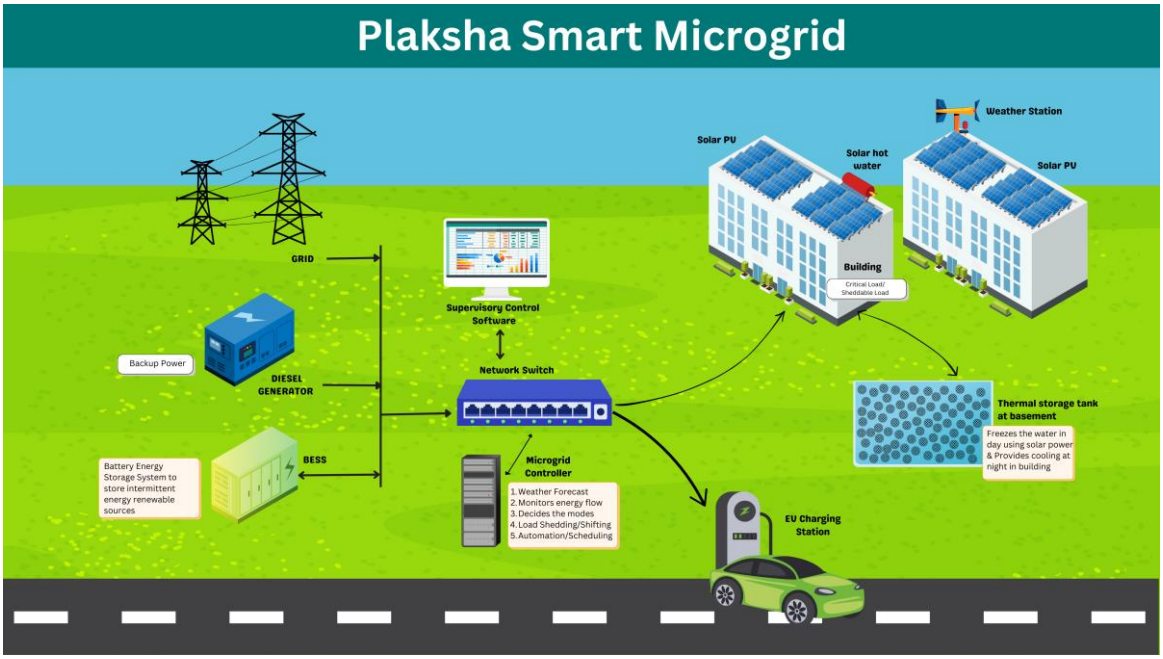


Figure 36 Architecture of Plaksha Smart Microgrid

A detailed energy audit of the campus is being conducted, which will identify key inefficiencies in energy consumption and system operations. The findings of this audit will directly inform the functionality of the smart microgrid, ensuring that it enhances energy utilization, improves reliability, and optimizes overall system performance. Two advanced Programmable Automation Controller (PAC) panels from Schneider Electric have been procured (Figure 37 and Figure 38) to serve as the supervisory and control backbone, enabling SCADA-based centralized monitoring and MODBUS-enabled interoperability across subsystems.

- SCADA Integration – Enables centralized monitoring and management of all energy resources across the campus.
- MODBUS Protocol – Ensures seamless communication and interoperability between various devices and subsystems within the microgrid.
- Modicon M580 Controller (Figure 37 and 38) – Each PAC panel is equipped with a Modicon M580 controller and comprises of 32 Digital Inputs (DI), 32 Digital Outputs (DO), 8 Analog Inputs (AI), 8 Analog Outputs (AO), 8 RTD channels.

Figure 37 Programmable Automation Controllers – Microgrid and BMS (external view)

Figure 38 Programmable Automation Controllers – Microgrid and BMS (internal components view)

We have gathered critical datasets to support the design and implementation of the smart microgrid, including

- Historical electricity consumption of the campus (both aggregated and end-use segmented).
- Electricity bills from PSPCL for demand analysis.
- Diesel Generator (DG) performance data: daily operating hours, output generation, fuel usage, and efficiency metrics.
- Signal lists and details of sensors currently integrated with the existing BMS for seamless mapping.
- Existing electrical design documentation and BMS configuration.

A rooftop solar photovoltaic (PV) system (423 kW) is installed at the campus (Table 2).

Table 2 Installed capacity of Solar Photovoltaic system

S.No.	Building Name	Installed Capacity (kW_p)
1	Academic 1	73
2	Academic 2	65
3	Academic 3	105
4	Academic 4	138
5	Utility Block	42
Total		**423**

The microgrid is expected to significantly lower the campus's carbon footprint and energy costs through energy storage integration, demand-side management, and intelligent controls, while establishing a scalable and resilient architecture for smart campuses. Beyond infrastructure, the initiative aims to support capacity-building programs for campus, building, and large-facility Energy Managers, equipping them with skills in data analytics, AI, ML, and IoT. By training professionals capable of deploying smart energy management practices at scale, the project will contribute to national decarbonization goals and advances the development of a digital public infrastructure for the power sector envisioned under the Indian Energy Stack.

2.5 Student Projects

A total of 20 students are engaged through Energy Club at Plaksha (supported by IVCCE). Each student has been assigned a project aligned with their interests and is being mentored by subject-matter experts.

Ten projects are currently underway (Figure 39). The broader aim is to nurture sustained engagement and align students with long-term career pathways in the energy sector.

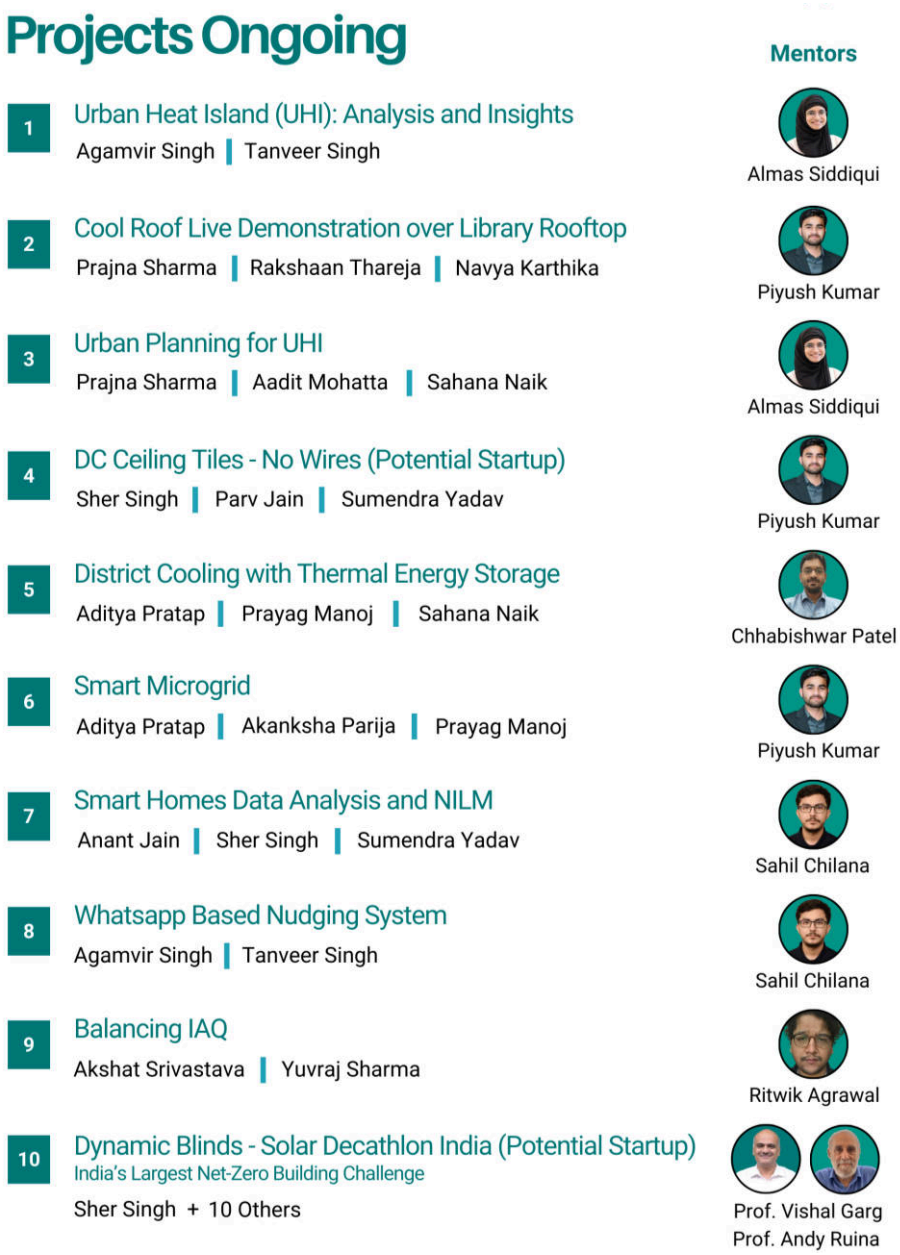


Figure 39 Student Projects in Progress with Associated Mentors

2.6 Research Publications

IVCCE is actively engaged in international academic conferences, sharing our findings and contributing to critical discussions on the future of clean energy and urban sustainability. We have published our findings in leading academic journals to further disseminate our work.

Research Publications in FY 25-26

- Gupta, Raj, Jyotirmay Mathur, and Vishal Garg. "Refining India's Climate Zoning: District-Level Map Using Clustering-Derived Criteria." Building and Environment 285 (November 2025): 113633.
- Sobti, Anupam, and Yogendra Kumar. "Geospatial Active Learning for Efficient Data Annotation: A Case Study on Cool Roof Detection." Paper presented at COMPASS, Canada. 2025.
- Agarwal, Ritwik, Vishal Garg, and Aviruch Bhatia. "Energy and Indoor Air Quality Trade-offs of Personal Air Cleaners and Natural Ventilation in Urban Households." Proceedings of the 12th ACM International Conference on Systems for Energy-Efficient Buildings, Cities, and Transportation, ACM, November 19, 2025, 465–70.
- Agarwal, Ritwik, Vishal Garg, Aviruch Bhatia, and Jyotirmay Mathur. "Exploring Energy Implications in a Mixed-Mode Building by Linking Air Quality and Occupant Behaviour." Building Simulation Conference. August 24, 2025.
- Agarwal, Ritwik, Aviruch Bhatia, Vishal Garg, Prakarsh Singh, and Jyotirmay Mathur. "Behavioural and Socio-Economic Dimensions of Indoor Air Quality: Insights into Public Perceptions and Interventions in India." Healthy Buildings. 2025.
- Gupta, Raj, Rana Veer Pratap, Jyotirmay Mathur, and Vishal Garg. "Developing Seasonal Energy Efficiency Ratio (SEER): A Climate-Specific Approach for India." Energise. 2025.
- Tejaswini, Dharani, Ashish Bharadwaj, Praveen Paruchuri, and Vishal Garg. "Learning-Based Approach for Residential Electricity Usage Simulation." Energy Informatics.Academy Conference, Malaysia. 2025.

3. Infrastructure

3. Infrastructure

Over the past year, our research infrastructure has expanded with the addition of a Thermal Storage Living Laboratory and progress in the Urban Microclimate Lab, including the development of a wind tunnel facility. Additionally, a new laboratory is under development to enable DC Ceiling Tiles, aiming to eliminate conventional wiring by enabling direct use of DC energy without conversion to AC.

Alongside these advancements, we continue to strengthen our existing facilities, which include studio areas for interactive and collaborative design and simulation, setups for urban microclimate studies, and non-intrusive load monitoring of devices.

3.1 Thermal Energy Storage Living Lab

This state-of-the-art research facility is a first-of-its-kind in India and features a 5600-kWh thermal energy storage system, coupled with the centralized chilled water-based cooling system (Figure 40 and 41). This system is designed to support the air conditioning needs of a 220-room hostel at Plaksha and will be used to conduct a range of innovative experiments. Plaksha intends to offer this living laboratory to startups, manufacturers, and solution providers to evaluate and demonstrate their technologies in a field environment.

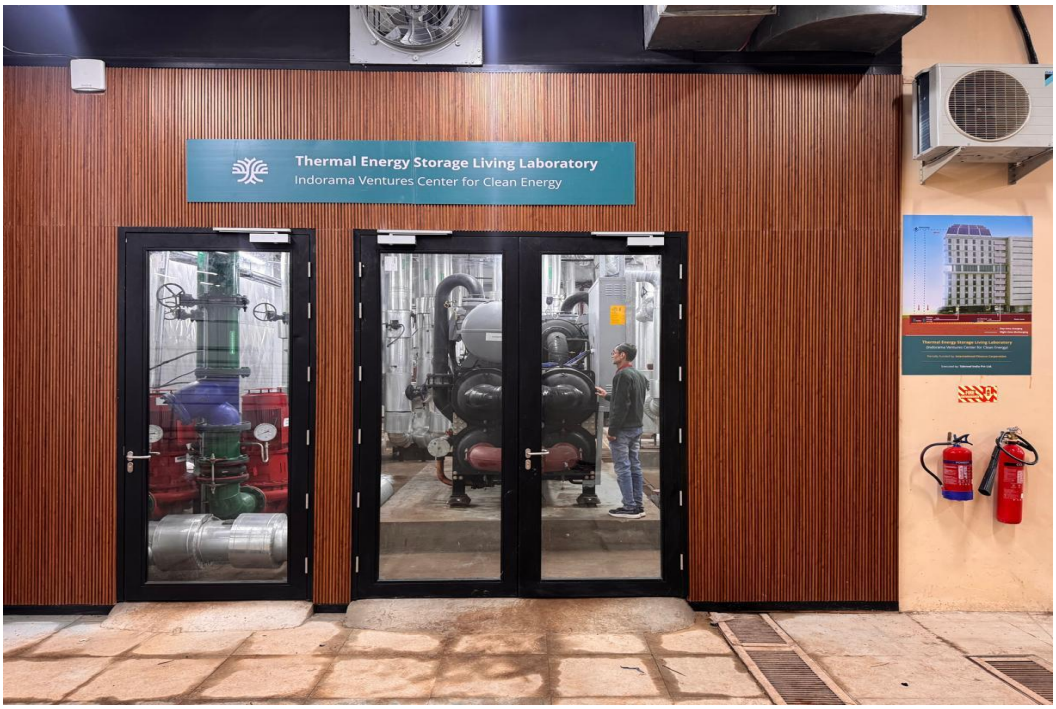


Figure 40 Thermal Energy Storage Lab

Figure 41 Thermal Energy Storage Lab

3.2 DC devices into Ceiling Tiles

A facility has been created to investigate the integration of DC devices into ceiling tiles, powered by ceiling rails. As shown in Figure 42, this setup eliminates the need for traditional wiring and switches, allowing flexibility in installation. Bluetooth Low-Energy (BLE) switches are used to control the equipment mounted on the ceiling tiles. Accurate estimation of switch location is achieved using trilateration techniques and machine learning algorithms. This research seeks to enhance energy efficiency and integration with renewable power sources.

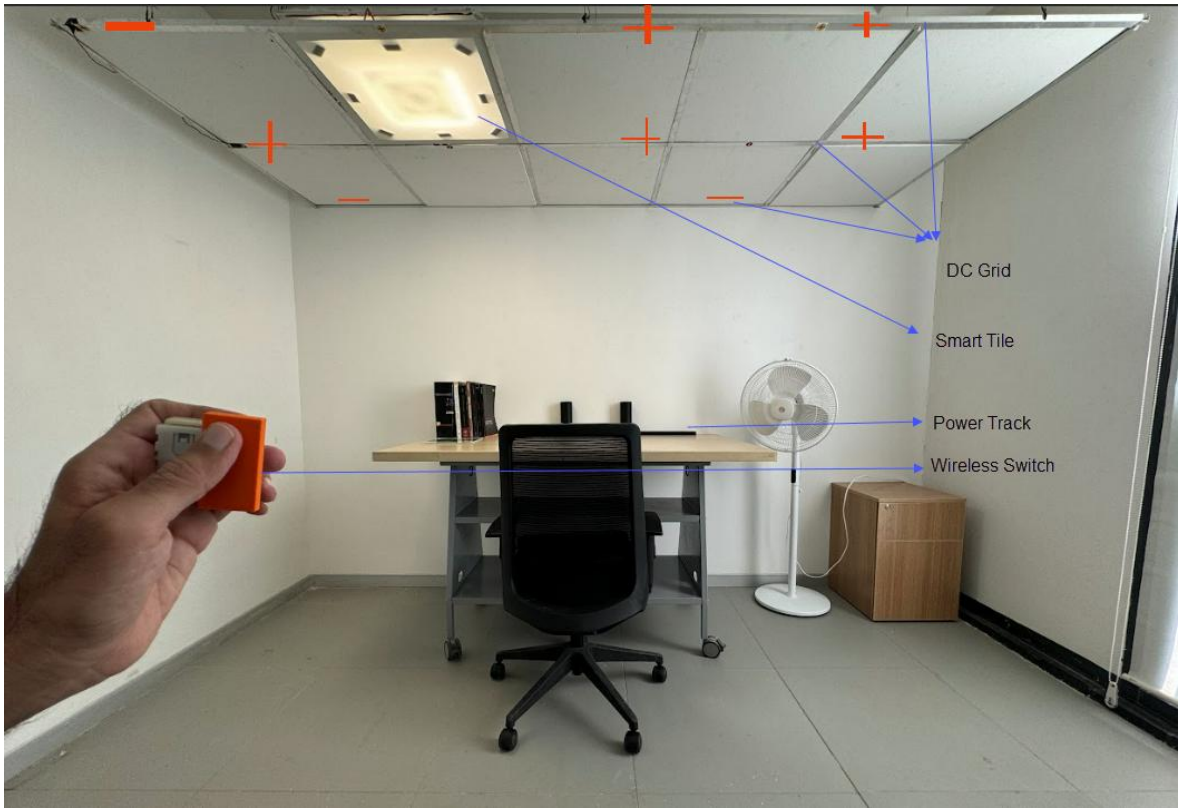


Figure 42 DC ceiling grid setup - DC LED powered by ceiling rails

3.3 Wind Tunnel Facility

The Center has established an open environmental wind tunnel facility developed in-house, featuring a 2' × 2' × 2' test section (Figure 43) with arrays of variable-speed DC fans on two sides. This configuration enables the generation of controlled velocity shear profiles to realistically simulate atmospheric flow conditions, while achieving significantly higher energy efficiency requiring nearly five times less power than conventional single-fan wind tunnels of comparable size. The facility supports research on urban wind flow patterns, pollutant dispersion, natural ventilation, aerodynamic interactions with vegetation, and thermal stratification. Currently, efforts are focused on benchmarking velocity measurements and flow visualization using standard prototype models, including calibration, experimental validation, smoke-based visualization, and preliminary data analysis.

Figure 43 Wind Tunnel Setup for Flow Visualisation

4. Capacity Building

4. Capacity Building

4.1 Course on Building Energy and Daylight Simulation

This course was planned for students and professionals (Figure 44), with the objective of enabling participants to model, simulate, and analyse building performance to optimize energy efficiency, occupant comfort, and sustainability in their designs. However, it was cancelled at short notice due to unforeseen geopolitical developments.

Energy simulation is important in building design, enabling architects, engineers, and stakeholders to understand and optimize a building's energy use over its lifespan. Through energy consumption estimates, designers can make informed decisions that can lead to significant long-term operational energy and cost savings.

No. of Registrations - 30
Mode of Teaching – In-person

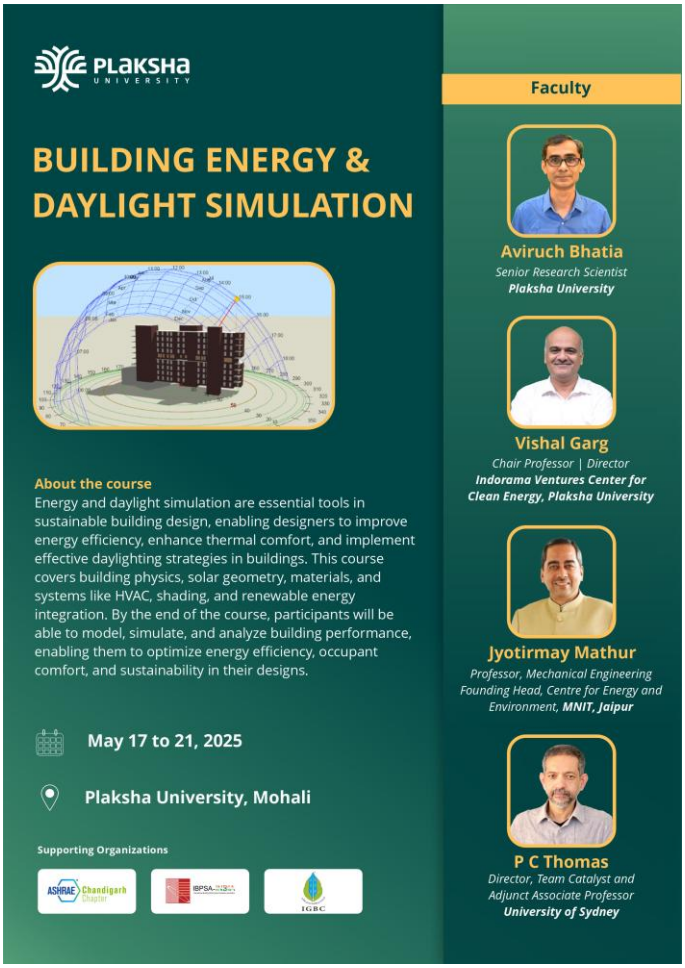


Figure 44 Building Energy and Daylight Simulation Course Poster

4.2 Course on Global Food, Energy, and Water Nexus

A course titled "Global Food, Energy, and Water Nexus – Engage the US, China, and India for Sustainable Future" offered by Cornell University was extended for undergraduate students at Plaksha University.

Important issues related to the food, energy, and water nexus and their implications for nutrition security, one health, environmental sustainability, climate change, and economic development in the US, China and India were discussed. The course served as a platform for students from USA, China, and India to learn from and interact with each other in the same class.

No. of Students – 34
Mode of Teaching – Hybrid

5. Advisory Committee

5. Advisory Committee

Our Advisory Committee hosts a span of institutional and industry leaders (Figure 45) who bring invaluable expertise, deep industry insights, and strategic guidance, shaping our vision and driving impactful advancements in clean energy innovation. The meeting provided valuable strategic insights, guiding our future direction and reinforcing our commitment to innovation and collaboration.

Ajay Mathur
Professor of Practice at School of Public Policy at IIT, Delhi Ex-DG at ISA, Ex-DG at TERI, Ex-DG at BEE

Amit Bhatt
MD India at International Council on Clean Transportation, Ex-ED at WRI India

Anjan Bose
Regents Professor in Power at Washington State University

Anthony Watanabe
Chief Sustainability Officer @ Indorama Ventures PCL, Chair of Circular Economy Taskforce

Bharat Bhargava
Ex-DG at ONGC Energy Centre, Ex-Director at Ministry of New and Renewable Energy

Devarajan Srinivasan
CTO at Poundra LLC, Faculty Associate at Arizona State University

James Abraham
Founder and Director at Mynzo Carbon, Ex-Founding Partner at BCG India

Padu Padmanabhan
International Consultant, Energy & Water Productivity, Ex-Program Director of SARI/EI & Sr Energy Advisor at USAID

Praveer Sinha
CEO & MD at The Tata Power Company Limited

Preeti Bajaj
CEO & MD at Luminous Power Technologies Ltd, Ex-CEO at The Adecco Group ANZ

Deepali Khanna
SVP at The Rockefeller Foundation, Ex-Director for Youth Learning at Mastercard Foundation

Deepesh Nanda
MD & CEO HyperVault AI Data Center Limited (TCS), Ex-MD & CEO at Tata Power Renewable Energy Limited

Saurabh Kumar
VP India at The Global Energy Alliance for People and Planet (GEAPP), Ex-Executive Vice Chairperson at EESL Group

Seema Paul
Program Director at Sequoia Climate Foundation, Ex-MD The Nature Conservancy

Shalini Sarin
Advisor, Executive Coach, Independent Director Schneider, Nagarro, Kirloskar, Sagility & Linde

Rahul Tongia
Adjunct Professor at CMU, Senior Fellow at Centre for Social and Economic Progress

Satish Kumar
Founder & President at AEEE, Ex-Berkeley Lab Scientist, LEED and ASHRAE Fellow

Shashi Buluswar
Founder and Co-CEO at Institute for Transformative Technologies, Ex-Partner at Dalberg Global Development Advisors

Venkat Garimella
VP Strategy & Sustainability at Schneider Electric

Figure 45 Advisory Committee of IVCCE

6. Plans for 2026

6. Plans for 2026

The Center aims to continue the following activities in the next year:

6.1 Research

- Report analysis and insights on the Urban Heat Island crisis in India
- Perform micro-climate simulation studies
- Conduct full summer-cycle studies on Thermal Energy Storage (TES)
- Expand field studies on indoor air quality (IAQ) to assess energy–health trade-offs
- Deployment of WhatsApp-based nudging application to influence human behavior.

6.2 Capacity Building

- Workshop on Cool Roofs for Chandigarh Citizen Foundation
- Training on Smart Grid for Campus Energy Managers

6.3 Policy

- Influence Cool Roof Policy in Punjab, Chandigarh and other states

6.4 Infrastructure

6.4.1 Campus as Smart Micro-Grid Testbed

As we plan to implement a campus-wide microgrid at Plaksha, the architecture is now finalized, and the next phase will focus on procurement and phased deployment. This smart microgrid is designed to integrate advanced technologies, ensuring an efficient, resilient, and sustainable energy ecosystem. Beyond powering our campus sustainably, it aims to serve as a dynamic testbed for research and innovation providing real-world insights into the future of decentralized energy systems.

This will encompass diverse elements, including battery storage to optimize energy usage, smart building solutions to intelligently manage energy consumption, solar hot water systems for renewable thermal energy, thermal storage for load balancing, co-generation to maximize energy output, a DC grid for improved efficiency, and the incorporation of solar power and wind energy sources, a Vehicle-to-Grid (V2G) system for integration of EV into the grid (Figure 46).

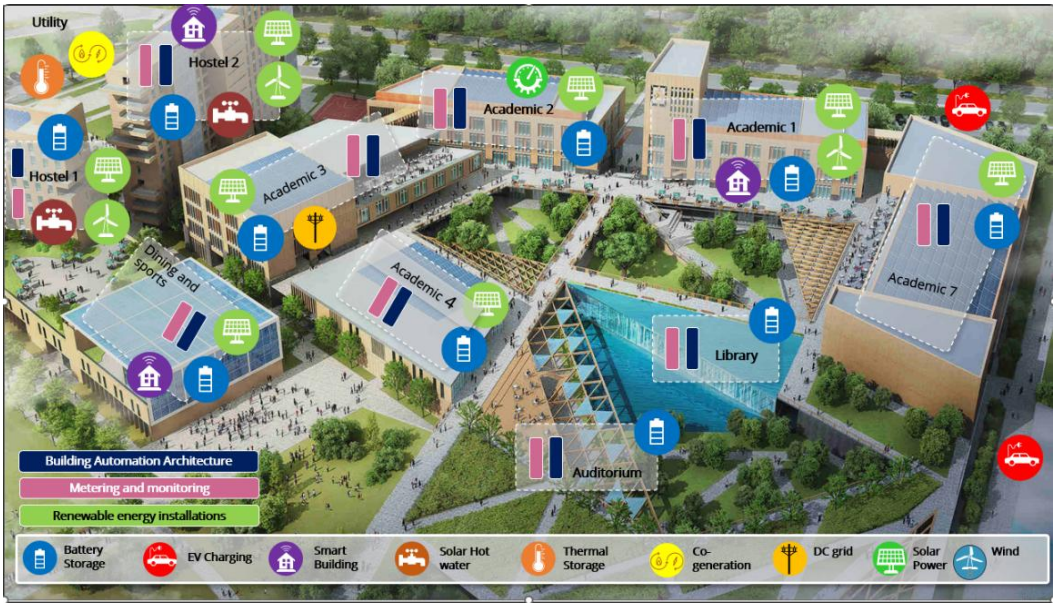


Figure 46 Plaksha Campus as Smart Micro-Grid Testbed

6.4.2 Smart Home Living Lab

The design planning is in process for establishment of a Smart Home Living Lab dedicated to advancing the capabilities and integration of smart technologies in the living environment.

Figure 47 Smart Home cum Living Lab

This facility will be developed as fully functional residential units equipped with automation and sensors to test the performance of various building products and technologies. The design will allow flexibility for future

technologies to be incorporated such as envelope systems (including roof, wall, window, shading), lighting, air conditioning and any other energy/water systems (Figure 47). It will be a complete integrated design including architectural, mechanical, electrical, plumbing, structural, and automation systems.

This living lab aims to serve as a collaborative space for industry experts, researchers, and technology enthusiasts to explore and develop creative solutions for improving efficiency, security, and overall well-being of individuals in their homes. Through real-world simulations and practical experiments, our goal is to test and refine the latest smart home devices, sensors, and automation systems. The Smart Home Living Lab will not only provide valuable insights into user experience but also encourage partnerships across different disciplines that will speed up the development of smart home technologies. By creating a dynamic environment for experimentation and collaboration, we envision this lab becoming a center for driving forward the next generation of intelligent and interconnected living spaces.

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