Alliance for an Energy Efficient Economy

energise 2023

Lifestyle, Energy Efficiency, and Climate Action

1 – 4 November 2023

Goa, India

BOOK OF ABSTRACTS

Day 2

09:30 - 11:00	Technical Session Theme: Buildings Sub-Themes: Building Design and Construction Practices

Paper ID: 312

Futureproofing with Passive Buildings: Is it cost-effective and is it thermally adequate?

Amanda Thounaojam[1], Prasad Vaidya[1], Sanjay Prakash[2]
[1]Indian Institute for Human Settlements, Bangalore, India
[2]SHiFt- Studio For Habitat Futures, Delhi, India

Abstract

This paper emphasizes the robust LCC method integrating future weather files and a calibrated model for accurate long-term cost-effectiveness assessment. By comparing LCC calculations using future weather with TMY files, a precise evaluation is achieved. The study includes the calibration of an Energy Plus model using hourly data for an experimental building in India with a significant diurnal variation. The ASHRAE Guideline 14 thresholds for MBE and RMSE were met (at 9% and 14% respectively) through the calibration process. Preliminary results using TMY files reveal the cost-effectiveness of an insulated envelope for fully air-conditioned buildings over a 50-year lifecycle. However, in mixed-mode operations, energy savings decrease, making an uninsulated envelope more cost-effective despite increased energy costs. The analysis demonstrates that future weather files affect the lifecycle costs of insulated walls, showing variations in cost-effectiveness and highlighting the need for further investigation in achieving thermal comfort and cost-effectiveness trade-offs.

Paper ID: 299

Thermal Properties of Indian Masonry Units & Masonry for Eco-Niwas Samhita Implementation

Sameer Maithel[1], Rajan Rawal[2], Yash Shukla[2]
[1]Independent Expert, Bangalore, India
[2]CEPT University, Ahmedabad, India

Abstract

A majority of the residential buildings in India have masonry external walls. Heat gain and loss due to the conduction of heat from the external walls have a significant influence on indoor thermal comfort and cooling requirements. Design U-value of the external wall assembly is required for calculating Residential Envelope Transmission Value (RETV) to check compliance with the building energy code, Eco-Niwas Samhita (ENS). Lack of a comprehensive Indian database on thermal conductivity of masonry units that reflect regional and process variations leads to substantial uncertainties in the determination of RETV and is a key barrier in ENS implementation. The paper presents measured thermal conductivity and dry density of 62 samples of 10 types of solid masonry units collected from 14 Indian states. The study proposes a scalable and affordable method based on new correlations to estimate thermal conductivity using measured dry density for both fired and non-fired solid bricks.

Paper ID: 303

Study on Evaluating Net-Zero Energy Potential For a Proposed Apartment Building

GVS Raghavendra Rao[1], Swati Puchalapalli[2]
[1]CEPT University, Ahmedabad, India
[2]TerraViridis, Hyderabad, India

Abstract

Aim and Approach
The aim of the study is to assess net-zero energy potential for a proposed apartment building, suggest effective energy conservative measures, and see the financial achievability of the same by reporting the payback period and internal rate of return (IRR). The study covers the economic feasibility of each energy conservative measure and the potential of photovoltaics. The study is conducted for a proposed G+12 apartment building located in Sonipat, NCR. The plug load data to calculate equipment power density is gathered by conducting a survey.
Conclusions
The Study resulted in a near net-zero building (proposed case) operating with an EPI of 3 to 6 kWh/m2-year (Figure 2), with solar photovoltaics offsetting about 84% of the energy consumption. This proposed case has an IRR of 69% (calculated for 20 years) and a payback period of 2 years 8 months.

Paper ID: 305

Effect of thermal mass and insulation position in walls on the thermal performance of residential buildings in a cold climate

Neha Das[1], E. Rajasekar[1], Prabhjot Chani[1], Krishan Sharma[2]
[1]Indian Institute of Technology, Roorkee, India
[2]Alliance for Energy Efficient Economy, New Delhi, India

Abstract

This study investigates the effect of thermal mass position and insulation thickness on the thermal performance of residential buildings in a cold climate. A combination of numerical simulations and field measurements is employed to assess the impact of different wall configurations on heating demands and comfort. Configurations with thermal mass placed on the interior side of walls exhibit better thermal performance, reducing temperature fluctuations and enhancing thermal comfort. Additionally, thicker insulation contributes to lower heat loss, reducing energy demands. The study also explores the influence of climate severities, changing the window-to-wall ratio and building orientation on energy savings and comfort for various wall configurations. Wall B (thermal mass inside thick insulation outside) reduces HED by 4% and HDD by 3% across different locations. Wall B reduced HED by 9.8% and HDD by 1.4% for a south facing building, and reduced HED by 3.2% and HDD by 2.2% for 10% WWR.

09:30 - 11:00	Technical Session Theme: Cities Sub-Theme: Planning and Design, Net-Zero Communities, Climate Impact, Mitigation and Adaption

Paper ID: 305

Optimizing Urban Morphology To Mitigate Urban Heat Islands: A Case Of Hyderabad

Amuktamalyada Pothamsetty[1], Faiz Ahmed Chundeli[2]
[1]Terra Viridis Consultants LLP, Hyderabad, India
[2]School of Planning and Architecture, Vijayawada, India

Abstract

Urbanization forms temperature hotspots called Urban heat islands and several studies are conducted to understand its cause, intensity, and impact on urban microclimate. The current study attempts to assess the impact of the urban morphology of multiple residential urban blocks in Hyderabad on Urban heat island intensity. It explores the possibility of UHI mitigation by modifying morphology constructed on policy measures like zoning regulations. Six urban residential blocks under the city's peri-urban belt are studied for their morphology and microclimate. Field study, 2D building database, and satellite imagery are used to develop urban built geometry of the blocks. The microclimate is determined using a numerical model, ENVI-met. The simulated microclimate data is used to compute UHI intensity based on reference climate data. The urban morphology is modified to reduce UHI intensity. The modified urban geometry with a significant reduction in UHI intensity is used to suggest recommendations in zoning regulations.

Paper ID: 289

Analyzing the impact of Neighbourhood geometry for improving outdoor thermal comfort

Archana Singh[1], Tarush Chandra[2], Sanjay Mathur[3], Jyotirmay Mathur[4]
[1]Ph.D. Scholar, Centre for Energy & Environment, MNIT, Jaipur, India
[2]Professor at Department of Architecture & Planning, MNIT, Jaipur, India
[3]Professor at Department of Civil Engineering, MNIT, Jaipur, India
[4]Professor at Department of Mechanical Engineering, MNIT, Jaipur, India

Abstract

Adaptation to climate change in cities is a necessity; thus, research is needed on an efficient spatial planning of urban areas. This review aims to investigate, both qualitatively and quantitatively, the efficacy of designing of residential built form types and to determine how different urban geometries, explained by H/W ratio, SVF and the solar orientation can be used to lessen the severe effects of micro-meteorological conditions. In-situ instantaneous microclimate measurements are carried out at pedestrian level in the representative month of summer for selected built form types for the city of Jaipur to find out inter and intra-thermal variations. The current study evaluated SVF and the Thermal comfort Index PET using Ray Man Pro. The differences in OTC between different built form types highlight the significance of morphological variables. The results of the research will provide scientific framework for comprehending the interaction between the built environment and urban climate.

Paper ID: 300

'Fit for Purpose' Urban Heat Island Effect Study Methodology for Indian Cities

Rajan Rawal[1], Yash Shukla[1], Subham Das[1], Tej Chavda[1], Rahul Agnihotri[2], Lily Riahi[2], Benjamin Hickman[2], Parimita Mohanty[2]
[1]CEPT University, Ahmedabad, India
[2]Cool Coalition at UN Environment Programme, Paris, France

Abstract

The paper acknowledges that Urban Heat Island Effect (UHIE) occurs due to urbanization impacting earth surface characteristics, changes in the vegetation profile within urban regions, and increased anthropogenic heat. This paper proposes a common agreeable methodology and underpins its argument on two frameworks, 'Fit for the Purpose' and 'Level of Details,' making it easy to adopt. Such efforts are expected to help cities account for UHIE assessment with objectives they define with the available level of resources. The paper relies on a systematic literature review and considers the ground realities to propose the methodology. The framework could be one of a kind to be adopted in a country, helping cities evaluate their context and solution on the same platform. It aims to balance the suitable trade-off between data fidelity and decision-making efficiency, tailored to the specific needs and constraints.

Paper ID: 313

Quantifying the thermal variance index and regulating trends effectuated by green infrastructure in a dense urban context: A case of Mumbai, India

Divya Subramanian[1]
[1]DS Urban Analytics, Mumbai, India

Abstract

Cities in the Global South are increasingly experiencing rapid urban sprawl. Urban development permanently alters the local ecology, negatively impacting the living environment. Green Infrastructure (GI) provide multiple ecosystem services including regulating services and helps improve the urban quality of life. Studies evaluating the regulating services of GI are mainly from the Global North, with limited studies addressing the challenges of the Global South. To address this knowledge gap, the present study investigates the regulating services of climate regulation and micro-climate cooling prospects of three playgrounds in Mumbai, India. GIS was used to process the satellite imagery and derive land-use indices of the NDVI, NDBI, MNDWI, LST, and Thermal Variance Index (TVI) using the ESRI ArcGIS program. The TVI profile graph for the GI within densely built surroundings exhibited a significant cooling effect over Park 2. TVI decreased in buffer areas of parks which showed an increase in the NDBI.

09:30 - 11:00	Technical Session Theme: Governance and Markets Sub-Theme: Barriers, Enablers and Emerging Evidence

Paper ID: 306

Shifting Household Energy Use in Bangalore, India: Using Behaviorally Informed Energy Reports

Mindy Hernandez[1], Kiran Bhagvatula[2], Santhosh Cibi[2], Ravichandran K[2], Sumathy Krishnan[2], Sumedha Malaviya[3], Bharath Jairaj[3]
[1]World Resources Institute;
[2]Technology, Informatics, Design, Endeavour (TIDE) India;
[3]WRI India

Abstract

Home Energy Reports (HERs) have been used by electric utilities in developed countries for informing and changing consumer behaviors towards more energy efficient choices. This paper describes the impact of HERs under the Vidyut Rakshaka (VR) program implemented in Bangalore between 2015 and 2021. A quasi-experimental study was done via a pre-post design analyzing the energy use data of over 2000 households in VR to assess the impact on households' energy savings. Surveys and one-on-one interviews were done to explore the specific aspects of the report that might be driving energy-saving behaviors. We find a 7% decrease in average monthly energy consumption per household over the course of 12 months, compared to the monthly average consumption of the same households before receiving HERs. The paper also provides suggestions to improve VR's HERs which are also relevant for India's utilities more broadly when planning to introduce HERs in their service territory.

Paper ID: 316

Introduction to State-wide Rebate based Incentive Program for Utility Companies for Promoting Energy Efficiency in India

Swapnil Lotake[1], Himanshu Haridas[1], Salil Gogte[1]
[1]EcoMetric Consulting, Pune, India

Abstract

Energy efficiency penetration in the Indian market is driven by the policies and schemes implemented by Bureau of Energy Efficiency, Energy Efficiency Services Ltd., and various state governments. The aim of this paper is to introduce a rebate-based incentive program for achieving energy efficiency in India. This paper also delves into the current demand side management activities in India. The different steps involved in the evaluation of rebate-based energy efficiency program have been presented in this paper. A case study has been provided to estimate the amount energy savings and the avoided CO2 emissions that could be achieved by the implementation of rebate-based energy efficiency programs for the states of Maharashtra, Gujrat, and Tamil Nadu. It is estimated that the proposed energy efficiency programs could achieve 5,346 million units of electric savings and 3.8 million tons of avoided CO2 emissions across the three states.

Paper ID: 323

Decoding numbers, inspiring action: Using equivalence to bridge the gap between jargon and meaningful energy communication

Alisha Abraham[1], Meghaa Gangahar[1], Akash Goenka[1], Satish Kumar[1]
[1]Alliance for an Energy Efficient Economy, New Delhi, India

Abstract

Effective communication is a key behavioural intervention to promote energy efficiency. By providing contextualized energy savings numbers, individuals, policymakers, and the broader non-expert audience can better understand their potential contributions to energy savings. This paper introduces energy equivalents like households, passenger cars, and coal-based thermal power plants to make energy figures more familiar. Comparisons with other examples, such as energy consumption by an Indian state or all households in a city, and the number of trees needed for carbon sequestration, help in getting a sense of scale. This paper introduces the framework for "EquiTool," an energy and emissions equivalence tool developed to address the need for effective communication in the Indian context. The framework can be replicated by other countries in the Global South to nudge behavioural changes in driving the clean energy transition.

11:30 - 13:00	Technical Session Theme: Buildings Sub-Themes: Building Design and Construction Practices

Paper ID: 308

An investigation into adoption of green measures within Green Building Rating Programs for affordable housing in India

Sneha Asrani[1], Rajan Rawal[1], Yash Shukla[1], Ravi Chaudhary[2], Monu Ratra[2], Ajay Jaiswal[2]
[1]Centre for Advanced Research in Building Science and Energy (CARBSE), CEPT University, Ahmedabad, India
[2]IIFL Home Finance Limited, Gurgaon, India

Abstract

Green Buildings were a market initiative to propel sustainability in the built environment. Various national and international Green Building Rating Agencies have formulated several region- and building typology-specific Green Building Rating Programs (GBRP). Prevailing GBRPs encompass intent-based criteria that judge a building's performance based on optimizing the following aspects: 'Site,' 'Environment,' 'Energy,' 'Water,' 'Material,' 'Waste,' and 'Practices.' This study assessed the prevailing GBRPs from the lens of four Key Parameters – Climate Response, Climate Resilience, Gender Sensitivity, and Affordability, representative of Environmental, Social, and Financial Sustainability – ascertaining whether and to what extent the GBRPs embody the Key Parameters. Moreover, inputs regarding the on-ground execution of GBRPs were gathered from Green Building Rating Agencies and Consultants. This study illuminates the gaps in the prevailing GBRPs; and the requirement of a rating framework anchored to absolute design baselines and operational performance benchmarks. This study concludes with guidance for enhancing the GBRPs.

Paper ID: 309

Comparative assessment of a residential building's envelope based on embodied energy

Mansi Sood[1], Rajasekar Elangovan[1], P.S. Chani[1]
[1]Indian Institute of Technology Roorkee, Roorkee, India

Abstract

This paper focuses on estimating the embodied energy of a residential building using real-time data and assessing the impact of different infill wall materials on the building's embodied energy. The study considers a 10-storey residential building situated in the composite climate of Roorkee, India. Embodied energy calculation encompasses both the initial embodied energy derived from the bill of quantities and the recurrent embodied energy based on maintenance and replacement cycles. A comparison is made between the calculated embodied energy of the real-time building and existing studies in the literature. Additionally, the embodied energy of selected alternate building envelopes is calculated and compared. The results demonstrate that using fly ash lime brick as an infill wall material results in the lowest embodied energy. This research provides valuable insights into estimating and comparing the embodied energy of residential buildings and highlights the potential energy efficiency benefits of specific building envelope choices.

Paper ID: 310

Evaluation of Embodied Energy for Building Construction under Urban Renewal Schemes in Core City Area- A case Of Rasta Peth, Pune.

Anushka Rudrabhate[1], Prajakta Dalal-Kulkarni[2]
[1]Dr. B. N. College of Architecture, Pune, India

Abstract

Building construction accounted for more than 40% of global energy consumption and 30% of greenhouse gas emissions. It is essential to understand embodied carbon in buildings at neighbourhood level as after construction, it will be locked there for several years. The aim of this study is to analyse the embodied energy (EE) of neighbourhood for redevelopment scenarios using Urban Building Energy Modelling (UBEM). The study area chosen was Rasta Peth, Pune. The primary sources of embodied energy were discovered by analysing existing dense neighbourhoods. Massing cases for redevelopment scenarios were created according to UDCPR guidelines. A comparative analysis of EE between the redeveloped 2030 scenarios was conducted. The research results that low carbon 2030 scenario has 27.9% lower EE than conventional scenario. The findings emphasized the importance of embodied energy in sustainability strategies for urban planners and policymakers. This research contributed valuable insights for reducing embodied energy in urban areas.

Paper ID: 329

Developing an Embodied Energy Database of Construction Materials in India

Rajan Rawal[1], Yash Shukla[1], Shivani S[1], Sakshi Nathani[2], Sachin Kumar[2], Sneha Asrani[1]
[1]Centre for Advanced Research in Building Science and Energy, CEPT University, India;
[2]Shakti Sustainable Energy Foundation

Abstract

Optimizing operational energy in buildings can increase the significance of embodied energy and associated carbon emissions. Promoting low embodied energy materials and construction processes is crucial for achieving low-carbon development while reducing operational energy. However, accessing reliable embodied energy data for construction materials in India poses a major challenge for conducting Life Cycle Assessments (LCA) to quantify the environmental impact. The proprietary nature of these datasets limits their availability in LCA studies, leading to uncertainties in building LCA results. Thus, this study aims to develop a construction material embodied energy database in India. A uniform data collection framework adapted for the building and construction sector and confidence level measurements for the embodied energy datasets will be used. This database will help reduce uncertainty in LCA studies and supports informed decision-making.

11:30 - 13:00	Technical Session Theme: Cities Sub-Theme: Planning and Design, Net-Zero Communities, Climate Impact, Mitigation and Adaption

Paper ID: 318

Identifying the high urban heat vulnerability zones of a city for prioritizing mitigation measures.

Sonal Gangrade[1], Jay Dhariwal[1]
[1]Indian institute of technology Delhi, India

Abstract

Climate warming is raising global temperatures by 0.2°C every decade, generating severe heat waves and health risks. In India, urbanization has increased heat and humidity. The Urban Heat Island effect in Delhi puts many people at risk for heat-related health issues. This research identifies Delhi's high-vulnerability zones based on people's environmental, demographic, and socioeconomic conditions. The study analyzed vulnerability variables such as land surface temperature, land use, land cover, population density, and income level to identify high-risk zones in Delhi using the "unweighted additive overlay" approach. It is found that heat stress is most prevalent in 40 wards in Delhi's central-western and eastern regions. These findings underline the necessity for adaption methods and specialized urban design strategies and policies for heat reduction for those with weak adaptive ability. The study would assist officials in giving heat relief to high-vulnerability wards and include heat mitigation methods in Delhi's new master plan.

Paper ID: 321

Climate Resilient WASH Infrastructure in Chennai: Development Vs Water Conservation

Saman Jain[1], Saswat Bandyopadhyay[1]
[1]CEPT University, India

Abstract

Chennai's natural and hydraulic water infrastructure has been consumed by the ever-expanding urban fabric of the city. This expansion accompanied by excessive groundwater pumping and surface water sourcing resulted in a range of environmental and social problems. To understand this, a desk-based study was conducted by examining various classes of literature and data on development and water. This was accompanied by household surveys consisting of critical interviews & focused group discussions to understand the water footprint and resilient practices adopted by the inhabitants. As per the research, the inhabitants of the front-line community, especially the fishermen communities along the coast are affected by the situation of water vs development, depending on multiple sources without basic reliability, thereby lacking any water security. The research envisions a future where blue infrastructure is preserved in a similar demeanor rare wildlife, for a sustainable future.

Paper ID: 340

Exploring the potential of neighbourhood approach to low carbon development in India.

Teenu J Thaikatti[1], Snowy Christophel[2], Josna Raphael[3]
[1]Alliance for an Energy Efficient Economy, New Delhi, India
[2]Department of Environment and Climate Change, Govt. of Tamil Nadu, Chennai, India
[3]School of Architecture & Planning, Govt. Engineering College Thrissur, Thrissur, India

Abstract

India has committed to addressing climate change through its Nationally Determined Contributions (NDC) and has set a target of achieving net-zero emissions by 2070. The National Action Plan on Climate Change (NAPCC) and Low carbon strategies for Long-Term Low Emission Development Strategy (LT-LEDS) and State Action Plans on Climate Change (SAPCCs) provide a framework for addressing climate change. However, there is a lack of emphasis on climate change action in the development plans of urban local bodies. This research aims to extend the findings from government documents at the city scale that are aligned with SAPCCs in promoting low-carbon development and explore how local governments can utilize urban design to integrate climate action plans into local area development plans. The study analyses city climate-related documents from 128 cities in India and proposes various urban design interventions to achieve low-carbon development goals.

Paper ID: 288

A case study of AC usage in residential district cooling system using operational data.

Madhan Kumar K[1] , Vishal Garg[2] , Jyotirmay Mathur[3] , Srinivas Valluri[4]
[1]International Institute of Information Technology, Hyderabad, India
[2]Plaksha University, Mohali, India
[3]Malaviya National Institute of Technology, Jaipur, India
[4]Synergy infra consultants Pvt Ltd, Hyderabad, India

Abstract

Load diversity is a critical factor in understanding the user group for estimating the total cooling load in any area/township for the feasibility/impact of a District Cooling System (DCS). A typical residential DCS that supplies chilled water to a 5-towered apartment group containing 387 residences for space cooling is considered for this study. This paper aims to analyze the performance of residential DCS for the summer of May 2022, which is the month for peak design conditions in Hyderabad, India. By analyzing the cooling data of residences and electricity data of DCS alongside the installed system detail, the study shows average daily AC consumption during May is 34.3 thermal kWh per residence. At peak, the thermal loading on the chiller comes to around 75.8% of the total capacity of the running chiller and on an average day, it varies from 21% to 61% of chiller capacity.

Paper ID: 295

Barrier Analysis of District Cooling in India

Trupti Yargattimath[1,2] , Zhuolun Chen[1,2] , Rahul Agnihotri[1] , Benjamin Hickman[1]
[1]UNEP, Copenhagen/Delhi/Paris, Denmark/India/France
[2]Copenhagen Centre on Energy Efficiency, Copenhagen, Denmark

Abstract

India's tropical climate and increasing extreme weather events are expected to drive up the usage of fans and air conditioners in the coming years consequently leading to high carbon emissions. To meet this cooling demand, it is essential to implement alternate technologies such as district cooling that offer competitive rates, energy efficient and more sustainable. Despite the numerous benefits, district cooling is relatively new in India and comes with challenges. This paper compiles some of the common barriers faced during district cooling deployment such as high investment costs, lack of awareness, limited technical capacities and absence of supporting policies among others, drawing on the experience gained during the development of rapid assessments in five Indian cities. By summarizing the key findings from these assessments, this paper seeks to provide insights into the challenges of implementing district cooling in India and to better prepare future project developers during the planning stage.

11:30 - 13:00	Technical Session Theme: Governance and Markets Sub-Theme: Barriers, Enablers and Emerging Evidence

Paper ID: 325

Assessment of Energy-Efficient and Clean Energy Technology in the Cold Chain Sector

Aamir Zaman[1], Gaurav Agarwal[2]
[1]Alliance for an Energy Efficient Economy (AEEE), New Delhi, India

Abstract

There is a growing need for the cold-chain sector due to the demand for fresh and frozen products. To address these demands, emphasis needs to be given to cooling solutions and efficient technologies. By utilizing these methods, expenses can be decreased, increasing the cold-chain industry's profitability and sustainability. The authors aim to identify the available technologies and focus on adopting efficient technologies to improve the cold chain's efficiency, reduce costs, and ensure product quality and safety in the cold-chain sector by reviewing relevant literature, stakeholder consultation, and case studies.

Paper ID: 326

Exploring the Challenges in Scaling Up Sustainable Cold-Chain Solutions in India via the Perspective of Ecosystem Players

Gaurav Agarwal[1], Khushboo Gupta[2]
[1]Alliance for an Energy Efficient Economy (AEEE), New Delhi, India

Abstract

Despite being the second largest producer of fruits and vegetables globally, India incurs post-harvest losses of 15 percent annually. The lack of post-harvest management facilities, especially broken cold-chain, results in huge losses, impacting rural income and employment opportunities. This paper identifies gaps in scaling sustainable cold chain solutions to exploit the full potential of horticulture perishable products in India. The authors aim to explore the challenges in scaling up cold-chain solutions by conducting key informant interviews with major ecosystem stakeholders. The authors will utilise thematic analysis (Braun and Clarke's thematic analysis framework) on secondary and primary data gathered using stakeholder consultations with governments, technology providers, farmers and facility owners. The analysis framework will categorise the transcripts of the consultations into codes and themes and draw inference from this demarcation. The study's preliminary findings will aid the identification of opportunities and responding to the existing challenges by adopting economies of scale.

Paper ID: 337

Mapping Government Interventions for Energy Efficiency in Indian Schools: Identifying Barriers and Opportunities

Rashi Sharma[1], Akhil Singhal[1]
[1]Alliance for an Energy Efficient Economy, Delhi, India

Abstract

As India strives towards accomplishing its Net-Zero goals by 2070, energy efficiency becomes the new age gospel of the robust economy. In mists of which, the role of schools as public institutions in empowering the thought leaders of tomorrow and breeding grounds of change is undeniable. Yet, regardless of the BEE's consistent efforts to improve the penetration of energy-efficient technologies and appliances, their visibility within educational institutions such as schools remains limited. This paper attempts to map the governmental interventions undertaken to enable energy efficiency in Indian schools by deploying a mixed methodology to study the status quo of energy efficiency in the educational landscape drawing on insight from a cross-sectional design survey conducted in the Lucknow and Ajmer districts of India. The key findings of the paper suggest the development of a holistic framework for advancing energy efficiency in schools to strengthen the impact and outreach of ongoing initiatives.

Paper ID: 341

An Educational Framework for a Net Zero Future

Sreejith Jayaram[1], Deepa Parekh[2], Prasad Vaidya[1], Yashima Jain[1], Jaydeep Bhadra[3]
[1]Indian Institute for Human Settlements (IIHS), Bengaluru, India
[2]Environmental Design Solutions (EDS) Pvt. Ltd., Mumbai, India
[3]Loughborough University, Loughborough, UK

Abstract

This paper evaluates the current model curricula in India for architecture and engineering colleges as well as education policy documents that will influence the coursework taught across the country, to determine if the undergraduate and post-graduate education system is aimed at creating future professionals who can respond to India's Nationally Determined Contributions and net-zero by 2070 goal. It uses literature review and survey data to identify gaps in graduate attributes and competencies that result from these curricula and policy documents. While over fifteen years of codes and rating systems, and longer for industry-led practices have introduced standards and best practices, the market has not moved towards future-proof net-zero buildings. The findings show that the model curricula does not address climate change, and that comprehensive frameworks as well as transformative education at scale is being done through other programs like Solar Decathlon India (SDI).

Day 3

09:00 - 11:00	Technical Session Theme: Buildings Sub-Theme: Sub-Themes: Building Design and Construction Practices

Paper ID: 314

Taking a Cue from Trees: Passive Cooling Building Envelopes based on Evapotranspiration

Monish Siripurapu[1], Srimayee Krishna[1], Pranjal Maheshwari[1]
[1]Ant Studio Pvt Ltd, Delhi, India

Abstract

The buildings of today suffer from uncontrolled heat gain, creating an urgent need for cooling. In hot climates like India, a growing economy with a rising per capita income is leading to an significant rise in cooling demand. This demand is currently met by harmful synthetic refrigerants, contributors of 10% of global CO2 emissions; leading to the creation of 'urban heat islands': cities are at least 3°C hotter than their surroundings.
The use of passive cooling strategies is the first step in reducing the energy demand for cooling. Adoption of climate-appropriate building envelopes has the potential to reduce cooling demand in India by 20% by 2037-38.
Trees are the 'coolers' in nature. Inspired by the process of evapotranspiration in trees, the research is aimed at exploring and designing passive cooling building envelopes using evapotranspiration and assessing its impact on the Comfort Levels and Operational Cooling Loads of the building.

Paper ID: 320

Hybrid Solution for Solar Passive Architecture in the High-Altitude Cold Climate of Leh

Amandeep Mattu[1], Anup Kumar Prasad[2]
[1]Chandigarh College of Architecture, Chandigarh, India
[2]Central Building Research Institute, Roorkee, India

Abstract

The research aims to establish a research directory of passive techniques in the field of building construction. It would provide local practitioners with the necessary skills to improve and innovate building construction technology for Leh's harsh, high-altitude cold climates. The research focuses on understanding the cold highland climate of Ladakh, integrating cultural elements into the built environment, and identifying the latest innovative construction & technologies. It will help to identify the existing architectural or structural development issues. The study extends to finding possible solutions to the non-renewable indigenous approach and gathering the new trend in the building environment or modern building techniques. Further, the research proposes adapting modern technology that efficiently works in high-altitude, cold climates. It aims to improve indoor environmental quality in harsh climatic conditions by using local materials and developing hybrid solutions. Passive solar techniques can be used to take advantage of the available energy source.

Paper ID - 330

Evaluation of thermal performance of agro-waste material for Team SHUNYA building

Prabhat Sharma[1], Priyanka Kumawat[2], Anupama Kowli[1]
[1]Indian Institute of Technology Bombay, Mumbai, India
[2]National Institute of Technology, Jaipur, India

Abstract

Using brick concrete for building envelopes is a common practice in India. These envelopes have high heat gains and experience considerable embodied energy. An agro-waste panel made up of sugarcane waste can significantly reduce cooling load for new construction due to its better u-value. A double-storey naturally ventilated building has been simulated for Mumbai's climatic condition to understand the performance of agro-waste materials. The total cooling load and temperature profile for a year have been simulated using EnergyPlus software. Thermal comfort hours are calculated using India model for adaptive comfort (IMAC) band to show the potential of agro-based panels. The thermal cooling load of the simulated building incorporated with agro-waste panel decreased by 28 % compared to the brick-concrete envelope. There is 16.4 % increase in annual thermal comfort hours compared to brick-concrete envelopes. Further, sensitivity analysis is performed to understand the effect of various parameters on wall gains.

Paper ID: 331

A wholistic housing solution for onsite construction workers

Sayali Andhare[1], Namrata Dhamankar[1]
[1]Dr. B. N. College of Architecture, Pune, India

Abstract

Construction workers are migrant service providers, and the primary reason is better job opportunities along with improved standard of living. The primary goal of the research is to design and test a prototype housing system for on-site construction workers. The research seeks to assess the parameters that impact the housing system for onsite construction workers in terms of building materials, services provided, and indoor environmental comfort, as well as to evaluate the proposed prototype of a wholistic housing system. An actual prototype of worker housing was built and tested for its thermal performance and user experience along with on-site installation. The main findings are that on-site workers living in a modular prefabricated system can achieve indoor environmental comfort by using a wall panelling system made of paper honeycomb board sandwiched between powder coated G.I. sheet can provide thermal comfort with additional aluminium bubble wrap insulation for the roof.

Paper ID: 298

Incorporating Energy Efficiency and Sustainable Energy Practices in the Renovation and Retrofitting of a 50-Year-Old Independent House

Sudha Setty[1] , Yoshita Sriram[2]
[1]Melyoura, Bangalore, India
[2]Krushi Builders, Bangalore, India

Abstract

This abstract describes the energy-efficient renovation of a 50-year-old, 3000m2 house by a homeowner and architect with no technical knowledge of energy efficiency. The approach incorporated three primary areas: Load reduction, efficiency, and renewable energy. Load reduction involved maintaining the building envelope, installing double-glazed windows (at a 15-20% window-to-floor ratio), a solar chimney, a cool roof, and plant shading. Efficient appliances and systems were installed, such as a VRF system, BLDC fans, LED lights, and a home automation system with sensors. Renewable energy was harnessed via a 4.89 kW rooftop solar panel array, and a solar water heater with a heat pump and a 300-liter storage tank. Additional measures include rainwater harvesting and material reuse for decreased embodied energy. The result is a sustainable, energy-efficient design that is also aesthetically pleasing.

09:00 - 11:00	Technical Session Theme: Cities Sub-Theme: Critical infrastructure, Distributed energy sources, and Grid Interaction

Paper ID: 291

Choice of Cooking and Lighting Energy Sources in Households: Empirical Evidence from Urban India

Vidhulekha Tiwari[1], Arnab Jana[1] and Santanu Bandyopadhyay[2]
[1]Centre for Urban Science and Engineering, Indian Institute of Technology Bombay, India
[2]Department of Energy Science and Engineering, Indian Institute of Technology Bombay, India

Abstract

Household energy consumption constitutes approximately 30% of India's total energy usage. Since the fuel choice for cooking and lighting includes unclean fuels like kerosene, coal, dung cakes and firewood, studying it becomes imperative. This study examines the fuel choice for cooking and lighting in urban Indian households through Multinomial Logistic Regression Analysis. The analysis incorporates variables depicting household economy, such as land ownership, expenditure, employment type, housing ownership, meals served, and access to public distribution system. It is assumed that households make choices based on their specific household characteristics to maximise fuel utility. This study utilises data from the Household Consumer Expenditure Survey (2011-12) conducted by the National Sample Survey Office (NSSO) of India. Results show that employment type, amount of food cooked, fuel availability, and household expenditure capacity significantly influence fuel choices. Additionally, households using cleaner fuels experience lower expenses for cooking and lighting due to improved fuel efficiency.

Paper ID: 332

Analysis of Hydrogen Delivery Costs: PEM Electrolysis as a case study for India

Sukriti Sharma[1], Bhawna Chauhan[1], Asad Sahir[1]
Indian Institute of Technology Ropar, Rupnagar, India, 140001

Abstract

In its aspirations to achieve net zero goals by 2070, India is considering multiple renewable energy options. With the expectation of replacing fossil fuel-based feedstocks, hydrogen is being seen as a potential option for the transportation industry [1]. Replacing a fuel distribution infrastructure based on fossil fuel-based feedstocks to address a futuristic emerging option like hydrogen will receive an impetus if challenges on its introduction in an urban setting are duly identified through a combination of first principles engineering optimization base analyses and techno-economic analysis. Our work utilizes the H2A (Hydrogen Analysis Model) and HDSAM (Hydrogen Delivery Scenario Analysis Model) Model developed by the US Department of Energy (US-DOE) for modeling the cost of delivering hydrogen from a central production facility into a vehicle. The delivery infrastructure deploys all transport, storage, and conditioning activities from the outlet of the hydrogen production plant to the fueling station.

Paper ID: 336

Quantifying the Demand Response Potential of Residential Loads in India

Siddhant Vibhute[1], Deepti Shakya[1] and Anupama Kowli[1]
Indian Institute of Technology Bombay, Mumbai, India

Abstract

The paper investigates how residential loads in India contribute to grid peak load and how to manage such peaks. Algorithms that process smart meter data from residential loads and compute attributes that capture their contribution to the system peak are devised and demonstrated in this paper. Specifically, a hypothetical distribution system peak is considered based on a study on households in Pune City. The algorithms developed here are applied to this example system to showcase their capabilities. Specifically, we show how simple attributes such as peak amplitude and peak duration can extract sufficient information to ensure houses that contribute to system peak are appropriately identified. A demonstration of how shifting of individual peaks can significantly impact system peak is also provided. The results lay the foundation of designing meaningful demand response programs leveraging the smart meter data.

Paper ID: 338

Grid Interaction of Residential Net Zero Buildings and Communities in India

Utakarsh Thakare[1], Manish Meena[1], Abhinav Bhargava[1] and Anupama Kowli[1]
[1]Indian Institute of Technology Bombay, Mumbai, India

Abstract

The growing residential electricity consumption in India and the need for a sustainable energy future have led to interest in net-zero energy buildings (NZEBs). This paper analyzes the grid interaction of solar-based NZEBs using meter data from actual residential buildings in Pune, India. Metrics such as no-grid-interaction probability, minimum/maximum injection, and loss of supply probability are evaluated to quantify grid interaction and self-sufficiency. Additionally, how battery adoption can reduce grid reliance and optimize NZEB performance is studied. Our findings reveal variations in battery sizes for houses with similar average demands. These lower battery sizes are attributed to the alignment between load profile and solar production. We also demonstrate how clustering NZEBs for battery sharing can reduce the battery capacity requirements without worsening the grid interaction. The results emphasize the importance of load diversity, load alignment, and further exploration of NZEB cluster operation for achieving optimal grid interaction and energy efficiency.

Paper ID: 286

Performance analysis of solar integrated ejector-based CCHP system for a small commercial building

Joshua Kumar Saladi[1], Santanu Prasad Datta[1],
[1]Department of Mechanical Engineering, BITS Pilani Hyderabad, 500078, India

Abstract

Buildings are significant in the energy consumption sector since they account for most of the electricity utilization. Solar integrated organic Rankine cycle combined cooling, heating, and power system (SORC-CCHP) is a novel technology that replaces fossil fuels in traditional multigeneration systems with solar energy and enhances energy utilization efficiency. In the current study, the thermodynamic analysis of the Solar integrated organic Rankine cycle combined cooling, heating, and power system (SORC-CCHP) with ejector refrigeration is performed for a commercial building to enhance energy utilization efficiency. To examine lower evaporator temperatures (< 0°C), the primary flow in the proposed system is extracted at the first stage of expansion of the ORC turbine. The performance parameters, namely thermal efficiency, solar fraction, entrainment ratio, cooling, heating and power capacities, and coefficient of performance (COP), are investigated using R600a as a working fluid. Results indicate that the annual solar fraction for the semiarid climate is obtained as 36%.

Paper ID: 307

A control sequence for prioritising ceiling fan operation over air conditioners using machine learning to determine thermal comfort

Barathi, Siva[1]; Thounaojam, Amanda[1]; Vaidya, Prasad[1] ; A, Gopikrishna[1] ; Dalavai, Uthej[1]; Tandon, Vipin[2]
[1]Indian Institute for Human Settlements, Bangalore, India
[2]Manipal School of Architecture and Planning, Manipal, India

Abstract

This study aims to use the Corrective Power of personal comfort systems and prioritise ceiling fan operation over air-conditioning to reduce energy consumption and implement controls based on Operative temperature (OT). We use a machine learning model to predict indoor OT of a space. The predicted OT is used to determine thermal comfort according to the India Model for Adaptive Comfort. A control sequence that automates ceiling fan-speed and air-conditioning set-points is developers and tested in two different rooms; one, a passive building with an insulated envelope, and another, a typical uninsulated building. The base case is a constant 24°C setpoint, with no ceiling fans operating.
The testing shows that the control sequence that prioritises ceiling fan operation has higher comfort votes than the base case, and the control sequence provided more than 80% cooling energy savings compared to the base case.

09:00 - 11:00	Technical Session Theme: Governance and Markets Sub-Theme: Policies, Targets, Strategies, Instruments, Case studies and Emerging Model

Paper ID: 334

Implementing Dynamic Tariffs for Residential Consumers: A Literature Review

Dhruvak Aggarwal[1], Muskaan Malhotra[1], Shalu Agrawal[1]
[1]Council on Energy, Environment and Water, New Delhi, India

Abstract

Dynamic retail tariffs are expected to be a cost-effective method to integrate variable renewable energy into the electricity grid while leading to higher social welfare. However, the global uptake of dynamic tariffs among residential consumers has been tepid due to complexities in implementing tariffs that match consumer preferences and uncertainties around their distributional effects, leading to unrealised welfare gains for consumers, utilities and society. With a renewed interest in implementing dynamic tariffs in India following the large-scale rollout of smart consumer meters, this paper reviews recent literature on the attributes that affect the distribution of gains and losses among consumers and influence their uptake of dynamic tariffs. We propose a three-stage implementation framework which starts with getting a deeper understanding of the heterogeneous residential consumer segment and delineates the complementary steps required along with a change in tariff design to increase the likelihood of consumer participation.

Paper ID: 315

New Education Policy and Energy Efficiency: Understanding through the lens of a Solar Decathlon India Team

Mehak Gupta1 , Prabhjot Singh2 , Asad Sahir2,* 1MBS School of Planning and Architecture, New Delhi, India; 2 Indian Institute of Technology Ropar, India

Abstract

Academic institutions are excited about the opportunities which are showcased by the Government of India's New Education Policy 2020, regarding the potential impact which it can have on learners. Inspired by this important development, a team of engineering and architecture students took the initiative to consider exploring energy-efficient building designs through the Solar Decathlon India contest in support of the new policy. The team contributed in developing a concept for a "Student Life Centre" - a building that particularly deals with student activities for enabling them to pursue their passions along with their studies. This idea was a unique concept for an educational building as participating students got an opportunity to visualize and appreciate the economic aspects. From the author's analysis, before introducing coursework based on New Education Policy in curricula, academic institutions may benefit if they visualize the options which the built environment may offer in accelerating learning.

Paper ID: 327

Integrating Energy Efficiency in Government Institutions: Capacity Building as the Key to Good Governance

Kashmeera Patel[1] , Meghaa Gangahar[1], Priyami Dutta[1] , Snehashis Tapadar[1], Bhaskar Natarajan[1]
[1]Alliance for an Energy Efficient Economy, New Delhi, India

Abstract

Capacity building of government functionaries is crucial for good governance and accelerating energy efficiency uptake and implementation. While national and state-level administrative training institutes are the nodal points for upskilling and knowledge dissemination among civil servants, there is often a gap between government officials' existing and required competencies. Such gaps include a need for knowledge building about the importance and application of energy efficiency, a key lever in the country's energy transition. This paper examines the current state of institutional capacity for energy efficiency at the different levels of governance, identifies lacking capacity, and recommends a strategy for integrating energy efficiency into regular training and refresher programs for government functionaries, focusing on civil servants.

Paper ID: 293

Re-imagining energy efficiency in open-plan offices using Micro-zonal occupant centric control : Protocols to be considered

Jeslu Celine Jacob[1], Debapratim Pandit[1], Joy Sen[1]
[1]Indian Institute of Technology (IIT) Kharagpur, India

Abstract

Air-conditioning energy consumed in buildings can be reduced by cooling only occupied regions. With modern open-plan offices being adaptable with flexible work hours, there is a need to virtually divide thermal zones based on varying thermal requirements. Micro-Zonal Occupant-Centric Control (MZOCC) saves HVAC energy by creating micro-comfort zones around occupants through independent diffuser control. But there exist research gaps between thermal zoning for HVAC design and micro-zoning. There is lack of clarity on the method of micro-zoning and factors to be considered such as size and shape of micro-zones. The aim of this study is to delineate protocols for micro-zoning and evaluate the benefits of planned micro-zones. Characteristics of existing Indian open-plan offices are studied and a method for micro-zoning is delineated. Results indicate that planned micro-zoning saves 44% energy. The micro-zonal layout is the starting point for optimising diffuser allocation and airflow control which will further improve energy savings.

11:30 - 13:00	Case Study Presentations Theme: Energy Efficiency, Thermal Comfort and IAQ/IEQ

Energy efficiency vis-à-vis thermal comfort: A case study of Flipkart office building

Sumit Nawathe
75F Smart Innovations India pvt Ltd, IN

Abstract

The 75F solutions engineered to meet Flipkart's facility management objectives resulted in reduced energy consumption while ensuring superior ambient air quality. Added features such as live reporting and insight-driven data metrics with intuitive user interface dashboards optimized operational efficiency and enabled the e-commerce brand to deliver on its excellent working environment to its employees.

Incremental Saving in Energy Efficiency:

75F's smart solution has brought significant savings and efficiencies to the Flipkart campus. In July 2022, the first month post our installation, Flipkart had achieved energy savings of 66,549 kWh. That is a 27% saving as compared to the baseline consumption. In the graph below, the dotted green line represents actual energy consumption and the Red line represent baseline consumption. The difference is the monthly saving in kWh.

Fast and Uninterrupted Installation:

Installation of sensors or controllers in an operational site is a difficult task. However, due to 75F's wireless communication devices, it was relatively easily achieved. The entire end-to-end installation took merely 45 days.

Elevated Comfort Levels:

Within a short span of the project commissioning, the client witnessed a reduction in the hot and cold spot complaints from facility occupants. Additionally, the improved air quality brought the Flipkart campus accolades by earning the prestigious UL Certification for IAQ management.

Reinforcement Learning for Optimizing Chiller Plant Operations: Experiences and Lessons from Real-world Deployments

Saksham Dutta[1], Akshit Singhal[1], Amreen Parveen[1], Venu Madhav A[1], Appala Srisurya Pardhasaradhi Tupurani[1], Selvakumar K[1], Deva P Seetharam[1]
[1]Smart Joules Pvt. Ltd, India

Abstract

We have deployed CPA system in 30 different hospitals in different parts of India that experience varied weather conditions. As illustrated in Figure 9, CPA is able to improve overall chiller plant efficiency by appropriately controlling the different high-side equipment. There are two prerequisites for its effectiveness:
1. The quality (correctness) and quantity of data collected from sensors must be high so it can make right decisions. It is important that sensors are well calibrated and connected through reliable networks to RL agents.
2. The boundary conditions specified by users prevent the RL agents from taking optimal actions. For instance, if the setpoint is too low to achieve for given ambient temperature condition, an RL agent would continue to try to cool the water without success and thereby consuming energy without achieving results. We are in the process of developing a deep learning based approach to deriving the targets from historic data. Although this would not work in greenfield environments, the targets would get refined as the experiences of agents increase with time.
3. As RL agents continuously adapt to changing environments, it becomes difficult to comprehend which actions/decisions of theirs lead to the results achieved. We are thinking of ways to visualize the conditions and decisions so we can have a clear understanding of how the system functions. However, the methods are still under development as Explainable AI is still an active area of research. The results achieved give us the confidence that Reinforcement earning can be an effective approach to achieve building energy efficiency, if sufficient volume of correct data is available from the required points of sensing.

11:30 - 13:00	Case Study Presentations Theme: Energy Efficiency from the systems' components prospective

Comparative Assessment Of Vfd Driven Energy Efficient Synchronous Reluctance & Induction Motor At Partial Loads

B.M. Lokesh[1], Prashant Bekwad[1], Shruthi RN[1],
[1]ABB India Limited, Bangalore, India

Abstract

Today, 45% of all electricity is converted into motion by motors in industries and commercial buildings . The integral optimization of electric-motor-driven systems, including the use of high-efficiency, well-sized components is the key strategy to effectively maximize their overall efficiency. Equipment's are designed and sized accounting for various contingencies and extreme scenarios, resulting in under utilization of their capacities during normal operation. Though the higher cost of purchase for oversized equipment is justified, most of the equipment including motors have low efficiencies in part loads. While the standards continue to focus on rated load efficiency, any attempt to improve the part load efficiency also has major contribution towards energy savings. Using variable frequency drives has

helped mitigate this problem to a large extent by running the loads at desired duty points without mechanical controls like valves and dampers. This surely is also saving tremendous amount of energy from the driven equipment perspective. However, the popular industrial workhorse squirrel cage induction motor running at partial loads has low efficiency. Advanced motor technologies like Synchronous Reluctance motors (SynRM), Permanent magnet assisted Synchronous reluctance Motors (PMASR) allow improving energy efficiency of many industrial applications even at part loads. This case study compares VFD driven cage induction motor and SynRM at part loads. Considering the motors for variable torque loads operated with VFDs, this case study shows that SynRM motors outperform induction motors in achieving better efficiencies at part loads. Where SynRM motor and VSD packages really shine, is when the loads are running partial and saving every unit of energy is essential. This study would help to choose the right motor based on the actual load profile benefits of high-efficiency motors and drives; all stakeholders have critical roles

Device Health: Quantifications and improvements thereon

Anurag Shandilya1, Ashish Taldeokar2, Yash Patel3
1Sustainable Reference Technologies Pvt. Ltd., India; 2: Sustainable Reference Technologies Pvt. Ltd., India; 3: Sustainable Reference Technologies Pvt. Ltd., India

Abstract

Smart meters and plugs have gained quite a foothold in modern times. They help households keep a track of their energy consumption by providing real time energy consumption data as well as device level disaggregated energy data. However, they do not provide insight into long term performance of devices. It is quite possible that the performance of a device starts to deteriorate over a period of time and households are still oblivious to it. To this end we hypothesise that there is a natural decrease in the performance of devices over a long period of time. We characterise it by the term ‘health’ of an appliance(discussed in detail in later section). This study aims to quantify the ‘health’ parameters of one such major appliance, air conditioners. Furthermore, we also investigate if and how servicing of air conditioners has an impact over their health. As observed from our experiments, the health of the appliance is a real, quantifiable quantity which affects its energy consumption over long periods of time. We also observe that it is possible to reverse the health of devices through simple interventions such as servicing them in a timely manner. Furthermore, this provides us with confidence to build a machine learning model which would be able to predict current ‘health’ of an appliance as well provide possible servicing prompts to the customers. This can complement smart meters and plug to provide diagnosis rather than just data collection.

Energy Performance series: Case study | Pacific Mall

Abhilash Kumar[1]
[1]Armstrong Design Pvt Ltd, India

Abstract

Pacific Sahibabad, is a major destination for shopping, food and fun with its attractive retail outlets, entertainment venue and dining options. It is a foodie’s paradise, with a huge food court of 500 seats, and popular outlets such as Yellow Chillies, Ocean, Moti Mahal and Suruchi. Upon installation of Armstrong Design Envelope pumps, data was logged of existing and new pumps which revealed double the energy savings compared to what was estimated: a 41% savings.

Low-Cost Chiller Plant Optimisation using Tonnage Injection & Corresponding Chiller SetPoint Staging

Anandvardhan Singh[1], Yathi Ajay[1]
[1]SmartJoules Pvt. Ltd., India

Abstract

HVAC capacity in India is poised to undergo extensive growth, with installed cooling capacity expected to double in the next 6-8 years. Most of these plants are being run in small-scale setups, or family operated commercial buildings, with limited investment capabilities, or expertise to implement real-time plant optimization techniques. According to the Indian Society of Heating, Refrigeration and Air Conditioning Engineers (ISHRAE), most commercial buildings have an Energy Performance Index (EPI) of 200 to 400 kWh/sq. m per year. Heating, Ventilating, and Air Conditioning (HVAC) equipment take a major share of electricity bills for residential, commercial and industrial applications, leading to tremendous pressure on energy sources, and ultimately impacting the climate. This can be eliminated by deploying energy efficiency measures that cut substantial energy costs. HVAC systems comprise about 40 percent of the energy consumed by buildings in India; hence, HVAC remains the primary focus area for energy savings through system upgrades and optimisation.

11:30 - 13:00	Case Study Presentations Theme: Energy Efficiency from the whole building performance analysis

A Case Study: Mainstreaming the Integration of Low-Energy Cooling Systems in Conjunction with Solar Passive Design

Ar. Dr. Poorva Keskar[1], Kanchan Sidhaye[2], Sayali Kulkarni[3]
[1]PhD (Indoor Environment Quality) ECBC Master Trainer, LEED AP,GRIHA Professional, WELL AP
[2]Energy Environment and Sustainability Professional IGBC Fellow I IGBC AP I WELL AP I BEE Energy Manager I GRIHA empanelled
[3]Environmental Architect I IGBC AP I

Abstract

ENPRO Industries Pvt Ltd's headquarters in Pune, India, stands as an exemplary model of sustainable architecture. Situated within the Warm and Humid Climate Zone, this office building spans approximately 4184 sqm and proudly holds the prestigious LEED (BD+C) NC V4 Platinum rating. Its commitment to energy efficiency is a hallmark, achieved through adept utilization of passive cooling technologies. Notably, the building leverages indirect-direct evaporative cooling, harnessing water evaporation to efficiently cool the indoor environment, reducing reliance on conventional cooling systems and promoting environmental responsibility. Additionally, earth air tunneling is employed, tapping into the earth's stable temperature to naturally regulate the indoor climate, further enhancing energy efficiency. Furthermore, the headquarters embraces a holistic approach, integrating passive design strategies such as orientation, shading, and natural ventilation. This synergy between sustainable architecture and intelligent design optimizes thermal comfort and reduces the need for artificial cooling, enhancing the building's energy performance. An onsite renewable energy system harnesses abundant solar resources, generating clean power and underlining the company's commitment to sustainability. This case study aims to investigate the implementation of mixed-mode low-energy cooling systems as an alternative to conventional cooling systems in an office building. The objective is to comprehensively grasp how these

innovative cooling approaches effectively cater to the cooling requirements of the project, promoting energy efficiency and sustainability. Ensuring that the mixed-mode approach provides consistent and satisfactory comfort to occupants is paramount challenge addressed in the case study. The utilization of passive design strategies and mixed mode cooling techniques has become an imperative for the present generation. This approach not only optimizes energy consumption but also fosters advancement in the commercial sector.

Team SHUNYA: Promoting Eco-Conscious Living with a Net Positive House

Ali Khan[1], Eshica Arya[1], Prabhat Sharma[1]
[1]Indian Institute of Technology Bombay, Mumbai, India

Abstract

Vivaan, situated within the campus of Indian Institute of Technology Bombay, Mumbai, India. Mumbai is categorized under the Tropical Savanna (Aw zone) within the Koppen Climate Classification and warm-humid climate zone as per the National Building Code of India. Vivaan is a Net Positive Energy, Net Zero Carbon, and Net Zero Water residential prototype designed and constructed by Team SHUNYA, a student technical team from IIT Bombay. The building has been awarded multiple accolades for many of its innovative aspects, aimed to create a genuinely sustainable dwelling unit, an attempt at redefining residential construction in India. Vivaan also won the 1st runner-up position out of 32 international teams at the United States Department of Energy Solar Decathlon Build Challenge 2023, held at the National Renewable Energy Laboratory, Golden, Colorado, in April 2023. The house incorporates features unique to the residential building stock in India, extensively utilizes second-life materials, and includes an in-house developed dehumidification system. A proprietary home automation system and accompanying app provide convenient controls for minimizing energy waste and maintaining adaptive thermal comfort levels in the house. The design also implements passive performance measures to maximize energy efficiency and incorporates computational simulations to achieve a data-driven approach. The major problem that this project addresses is the high demand for energy in residential buildings, which has recently started growing at a faster pace due to the effects of climate change. Moreover, Vivaan is designed with a circular economy approach, ensuring the disassembly of the structure and appropriate recycling or reuse after the end-of-life cycle. This system needs to be included in India, as traditional brick-and-mortar construction does not allow for such circularity.

Infosys Hubbali: Innovation in Sustainability & MEP Services

Sneha Murthy[1]
[1]McD Built Environment Research Laboratory, India

Abstract

The system is conceptualized based on the architectural layouts and inputs and Infosys design standards for new construction with the intention of providing good MEP services with comfortablep indoor environment with the latest standards which is based on the parameters of energy efficiency, incorporating eco-friendliness. The main goal of the project is to illustrate sustainable design strategies and concepts that focus on the appropriate and efficient use of resources —water, energy, air & materials — in order to reduce the development's environmental impact during its lifecycle, and to make the wholedevelopment a highly 'sustainable living community' space. The proposed office space consists of Ground + 5 floors. Food Court consists of 2 floors of kitchen + dining area & 1 floor of Customer care centre.

16:30 – 17:30	Poster Presentations

Paper ID: 270

Increasing Energy Efficiency of Central Cooling Systems with Engineered Nanofluids

Bernard Sagaiyaraj[1]
[1]Blue Snow Energy, Malaysia

Abstract

Buildings consume about 40% of the world's energy consumption and of that, 65% is dedicated to cooling (or heating) systems. The nanoparticle fluid suspension exhibits thermal properties superior to water.This engineered nanofluid contains a uniform and stable suspension of graphene nanoparticles (GNP) in water. Using covalent functionalization, centrifugation and high-speed dispersion, the GNP remains in a stable suspension indefinitely. The nanofluid is applied to the closed loop of the chilled water system. The Proof of Concept (POC) completed in 2019 using laboratory-derived nanofluid resulted in energy savings that averaged at 32% compared with the baseline fluid (water). In 2022, a Scaled-Up mini plant produced GNP nanofluids in a commercial process environment, showing an average energy savings of 21%. These results were further verified and validated on small chilled water plants outside of the Scaled-Up plant with 25% and 29% average savings.

Paper ID: 304

Benchmarking buildings based on their energy performance in Kerala: A case study of Kochi.

Dhilon Subramanian[1], Sumedha Malaviya[2], Bharath Jairaj[3]
[1]World Resources Institute India, Thrissur, India
[2]World Resources Institute India, Bangalore, India
[3]WRI India, Chennai, India

Abstract

Many developed countries regularly conduct building energy use benchmarking for continuous monitoring and evaluation of energy efficiency (EE) programs and policies and to inform the design of new ones. Such activities also provide an opportunity to engage with building owners, tenants, and managers on RE and EE policies and programs. Our study was aimed at developing a methodology for city-wide energy benchmarking exercises in India. We tested a novel benchmarking methodology for offices in Kochi to understand availability of data and practical challenges if benchmarking were to be scaled-up. The study was also aimed at documenting barriers to retrofits for different owner-tenant models.

Paper ID: 274

Quantitative analysis of thermal performance of vegetative green roof in composite climate of Chhattisgarh

Preeti Gupta[1], Dr. Sindhu J. Nair[1], Dr. P. K. Ghosh[2], Brajesh R. G.[2]
[1]Bhilai Institute of Technology, Durg, Chhattisgarh, India;
[2]University Teaching Department, Chhattishgarh Swami Vivekanand Technical University, Bhilai

Abstract

Environmental depletion is one of the most challenging issue in present scenario. One of the major causes for the environmental depletion is spontaneous rise of urban population which in turn escalating the demand of infrastructures and city development. Especially these developments cause local urban heat islands. Several solutions to this existing problem have been suggested in the literatures and many of them already implemented in cities but detailed experimental analysis is lacking. In this study, we have explored the effect of vegetative green roof in a building experimentally and recorded the surface temperatures at specific time on a daily basis for a period of two years and compared it with the conventional RCC roof. In addition, we also report that the heat gain pattern follows power law distribution. Overall, we present here the detailed quantitative method to compute the conductive heat transfer under vegetative green roof.

Paper ID: 277

Eco-Niwas Samhita Part-2: Energy Code for Decarbonising Residential Building Sector in India

Saurabh Diddi[1], Kanagaraj Ganesan[2]
[1]Bureau of Energy Efficiency; [2]Integrative Design Solutions, India

Abstract

Eco Niwas Samhita 2018 (Part-I: Building Envelope), the residential building energy code, was launched by the Ministry of Power in December 2018, followed by the launch of Eco Niwas Samhita 2021 (Part-II: Electro-Mechanical and Renewable Energy Systems),setting the minimum energy performance benchmark for electro-mechanical and renewable energy solutions in buildings. The code development process involved development of consultation document, stakeholder review, consultation workshops across India and the minimum energy performance standards definition, followed by life cycle cost analysis and development compliance method and toolkit. Technical analyses included parametric energy simulation for estimating energy use by air conditioning systems, pumps, lifts, lighting, transformers and minimum power distribution losses. This led to detailed definition of the MEPS for individual components of building electro-mechanical systems for the first time in India. The implementation of ENS in residential buildings can lead to energy savings potential of 125 billion units of electricity by 2030 [3].

Paper ID: 278

Plasma thermolysis of gases as a backup channel humanity into the world of green hydrogen

Victor Gilin[1]
[1]Non-commercial partnership "Club of inventors of Prikamye "Gefest", Russian Federation

Abstract

The work considers a method for obtaining green hydrogen by thermolysis of water vapor in the plasma phase, which is removed as a heat waste from low-pressure turbines of condensate power plants, as well as obtained during the disposal of municipal solid waste, sludge from urban sewage treatment plants, and plant residues arising from agricultural producers. The method for producing green hydrogen may be based on the heat of the environment, which is drawn into circulation by the Brayton cycle, which produces useful low-temperature cold. Taking into account the equivalent of electric power substitution associated with the achievement of the goals of the Government of India's "cooling" program, it opens up the possibility of supplying residential and industrial premises with binary energy supply, the basis of which is the organization of the process based on green hydrogen.

Paper ID: 335

An Analysis of Proposed Mobility Hub at Kottayam Based On Efficiency and Sustainability

Gayathri Lal[1], Mary James Kappen[2], P Amrutha Sasikumar[2], Abhijhna C S[2], Anup Kumar Prasad[3], Arun R Krishnan[2]
[1]Vellore Institute of Technology, India;
[2]College of Engineering Kidangoor;
[3]CSIR-Central Building Research Institute

Abstract

Mobility hubs serve as focal points in the transportation network. At present, the sole mobility hub operating in Kerala is the Vytilla mobility hub. Thrissur, Alappuzha, and Kottayam are the proposed future mobility hubs. The mobility center at Kodimatha will be distinguished by rail, road, and canal connectivity. This connectivity could be realized by the development of around 250 acres of land. The project intends to increase public transportation amenities while simultaneously reducing traffic congestion. Auxiliary facilities such as parking lots and recreation centers are also included. The primary goal of this study is to look at the viability of establishing a mobility hub in Kodimatha. The environmental impact assessment was conducted through the Rapid Impact Assessment Matrix. As an outcome, this research intends to generate a guideline for the planning of transit hub development considering indigenous ecosystems, traffic control, air quality, and socio-cultural and economic factors.

Paper ID: 317

Market transformation in Energy Efficiency: A success story of the MSME Sector in India

Neha Sharma[1], Mariam Megha Paul[1], Girja Shankar[2]
[1]Global Green Growth Institute, Seoul, South Korea
[2]Energy Efficiency Services Limited, New Delhi, India

Abstract

This paper illustrates successful cases of financing through bulk procurement for scale-up of standard energy-efficient technologies in the MSME sector via innovative business models. The study analyses success factors and implementation methods seen in the UNIDO-EESL-MoSME programme "Promoting Market Transformation for Energy Efficiency in the MSME Sector" under GEF-5 and will highlight its achievements, with Surat and Jorhat clusters as examples. The authors attempt to highlight the challenges and mitigation mechanisms involved, whilst exploring opportunities for involving private sector ESCOs similarly. Secondary research methods and stakeholder consultations were adopted during paper development. There is potential to scale-up these technologies in MSME clusters pan-India through programmatic models resulting in substantial emission reductions, development of indigenous supply chains, job creation and creation of green-growth pathways, making it crucial for India's net-zero and NDC targets. A similar model, developed by GGGI with EESL, addressing the barriers for replication and scale-up is also showcased.

Paper ID: 302

An Evaluation Framework for Deploying Energy-efficient, Climate-friendly Cold Rooms for Agriculture Cold-Chain in India

Sangeeta Mathew[1], Sandeep Kachhawa[1], Satish Kumar[1], Gerry George[1], Prashant Kanaujia[1]
[1]Alliance for an Energy Efficient Economy, New Delhi, India

Abstract

Post-harvest losses in India are estimated to be 6-15%, with an annual value of about Rs 1 lakh crore. Produce loss impacts farmers' incomes. Further, every wasted ton of fruit and vegetable decomposes into ~1.5 tons of greenhouse gases. Effective post-harvest protocols and integrated cold-chain infrastructure are essential to reduce post-harvest losses. However, there is a 97% gap in integrated pack-houses. Integrating sustainable technologies in the upcoming cold-chain infrastructure could contribute to a sustainable agri value chain, potentially reducing energy and refrigerant demand compared to business-as-usual scenarios. Currently, there are insufficient guidelines for assessing energy-efficient, climate-friendly technologies for cold-chain. This paper presents an evaluation framework to assess energy efficiency, energy supply and refrigerants in cold-chain product offerings. The framework was used to evaluate cold room solutions from nine vendors. The framework can be integrated into government schemes for cold-chain and enable agri-businesses to assess and deploy energy-efficient, climate-friendly cold rooms.

Day 4

09:00 - 11:00	Technical Session Theme: Buildings Sub-Theme: Energy-Efficient HVAC and Smart Controls for Buildings' systems

Paper ID: 281

Assessment of the consciousness on the efficient use of electricity. Case study of some Mozambican families.

Basílio José Augusto José[1] , Rui Muchaiabande[1] , Benjamim António Curado[1]
[1]Licungo University, Faculty of Science and Technology, Beira, Mozambique

Abstract

In this study, the dimensions of energy efficiency were surveyed from 171 families selected by non-probabilistic snowball sampling. The results indicate that the television was the most used household appliance. The combination of electricity and biomass is the most preferred electricity cost management strategy. When buying appliances, energy efficiency has not been present, low price influence the purchasing. Approximately 75% of families lack participation in training about energy efficiency. Out of these, only 12.3% have the notion of alternate sources (photovoltaic systems), 26.9% (thermal generators) and 60.8% assuming to know that they only have knowledge of electricity from their provider. The high cost of the electricity unit and the provider's inefficiency in customer assistance, were determining factors in clandestine connections. There is a need to spread the use of alternative and renewable sources of electricity, as well as efficient household appliances, and increase the dissemination of energy literacy strategies.

Paper ID: 282

Renewable Energy based Space heating to mitigate fossil fuel and reduce energy demand towards heating in Northern India

Bhuvnesh Kumar[1], Apoorva Balwani[1], Nidhi Agrawal[1], Vishnu Sasidharan[1], John Victor[1]
[1]Christy CREST, Pluss Advanced Technologies Ltd., Haryana, India

Abstract

PCM (Phase Change Materials) integrated solar-powered Space heating plays crucial role in maintaining thermal comfort in cold regions where the temperature shoots down to -10°C. This paper presents the experimental results of using PCM HS22 integrated with solar energy to maintain the comfort conditions inside the experimental prototype in the cold ambient. The solar energy is stored in PCM during the daytime to use it for night-time when there is no sun. The results show that the room temperature is maintained in the 10 to 20°C temperature range when the ambient was between -10 to 0°C. The room temperature was maintained for 24 hours consistently.

Paper ID: 283

Thermal Energy Storage for Enhanced Energy-efficiency and resiliency of commercial building

Soumyadip Bhattacharyya[1], Anurag Goyal[2]
[1]Department of Civil Engineering, Indian Institute of Technology Delhi, New Delhi, India
[2]Department of Mechanical Engineering, Indian Institute of Technology Delhi, New Delhi, India

Abstract

We present a first-principles-based techno-economic evaluation of thermal energy storage (TES) systems coupled with heating, ventilating, and air-conditioning (HVAC) systems. We analyze different TES materials and operating scenarios for commercial buildings in the Indian climate. Based on a representative building cooling load profile and ambient conditions, we developed a system-level simulation using thermodynamic relations and energy balances applicable to different system components. The performance of the TES integrated system using the quasi-steady model showed a reduction in peak cooling load and demand charges by 37-47% and 35-45%, respectively. While India's existing tariff structure is inadequate for storage integration, our study also shows improved operational cost savings in a hypothetical tariff structure with a moderate increase in the peak-to-off-peak tariff ratio (40-60%), emphasizing the need to adopt aggressive pricing.

Paper ID: 284

High-efficiency membrane-based liquid desiccant air-conditioning system

Ananthakrishnan K[1], Anurag Goyal[1]
[1]Department of Mechanical Engineering, Indian Institute of Technology Delhi, New Delhi, India

Abstract

In the present study, we use a hybrid configuration of a membrane-based liquid desiccant air-conditioning system coupled with a vapor compression system (VCS) for sensible cooling and providing heat for desiccant regeneration. The overall system simulation incorporates a thermodynamic cycle model of a VCS coupled with a detailed heat and mass transfer model of a liquid desiccant dehumidifier and regenerator. The proposed system enables complete electrification of a thermally driven air-conditioning process. It improves the overall efficiency of the HVAC to reduce electrical energy consumption by up to 31% for humid regions in India. We conducted parametric analyses to determine energy savings in all major climates of India, with energy savings varying between 11.4-30.4%. We predicted the possible heat and mass transfer enhancement required to reduce the liquid desiccant air conditioner (LDAC) size by up to 30% compared to existing systems.

Paper ID: 285

Energy and exergy performance emulation of ejector refrigeration system for building applications using low GWP R134a alternatives

Ronanki Suresh[1], Santanu Prasad Datta[1]
[1]Birla Institute of Technology and Science Pilani, Hyderabad, India

Abstract

According to the Kigali Amendments (2019) to the Montreal Protocol, restrictions on using the high-GWP R134a emphasise the urgency to discover low-GWP substitutes for the ejector refrigeration system (ERS). On the other hand, the exergy analysis on low GWP-operated ERS is also barely reported. In this view, the current study establishes a 1-D thermal model based on real gas laws to examine the energy and exergy performance of the ERS employed for building space cooling applications with six zero ODP and low GWP alternates for R134a. At various operating conditions, the critical performance parameters for each refrigerant are evaluated in terms of cooling capacity, COP, exergy destruction and exergy efficiency using MATLAB. The proposed system produced 0.132 kW (4.47%) of output exergy from 2.96 kW of low-grade thermal exergy. The system can provide adequate thermal comfort for a 250-square-foot room with a maximal cooling capacity of 5.2 kW using R440a refrigerant.

Paper ID: 292

Deriving energy performance evaluation for Personal Environmental Control Systems PECS: A systematic review and meta-data analysis.

Ariba Khan[1], Rajan Rawal[1], Yash Shukla[2]
[1]Faculty of Technology, CEPT University, Ahmedabad, India
[2]Centre for Advanced Research in Building Science and Energy, CRDF, CEPT University, Ahmedabad, India

Abstract

Personal Environmental Control Systems (PECS) offer individual control of thermal conditioning in localized environments within the building. It provides an innovative solution to decentralize space comfort conditioning. Several studies have demonstrated the advantages of PECS on thermal comfort and energy saving; most of them used customized methods to study. A comparative study evaluating the efficacy of PECS has not been investigated. By conducting a systematic review and meta-analysis, this paper provides insights into the performance evaluation of the PECS compared to conventional HVAC systems. The absence of universally accepted standards for evaluating performance is a significant limitation. The paper highlights the need for further research and advancements to refine the design and operational viability of PECS technologies. The proposed framework for evaluating the energy efficiency metrics of PECS would be instrumental in obtaining universal data that can be duly documented for the widespread improvement and possible adoption of PECS.

09:00 - 11:00	Technical Session Theme: Buildings Sub-Theme: IEQ and Human Health

Paper ID: 296

Learnings from thermal comfort adaptation of Jain ascetics during heat waves

Jay Dhariwal[1], Sonal Gangrade[1]
[1]Indian Institute of Technology Delhi, New Delhi, India

Abstract

Climate change is leading to severe heat waves in India affecting a large vulnerable population impacting their health and well-being. The recent adaptive thermal comfort research for Indian climates suggested that the people living in residential buildings can adapt to indoor temperatures upto 35 °C. The Jain ascetics in India have been leading their life without the use of electricity for hundreds of years, irrespective of the temperatures. In this study, thermal comfort surveys with 20 monks and nuns were carried out during summer for the composite climate of Delhi. 90% of the subjects expressed acceptability of the thermal conditions while the indoor operative temperatures varied between 35 °C and 40 °C. Future studies would have a higher sample size in different seasons and climates to have a better sense of their thermal comfort adaptation.

Paper ID: 297

Indoor Air Quality Assessment Based on Particulate Matter Contamination

Tanya Kaur Bed[1], Shankha Pratim Bhattacharya[1]
[1]Indian Institute of Technology, Kharagpur, India

Abstract

Air pollution is one of the biggest global issues, increasing concern about the quality of the air inside different buildings. Countless contaminants produced by diverse sources enter the indoor environment. Other than ambient sources, cooking, smoking, and cleaning are anthropological activities that contribute to indoor particulate pollution. In light of this, the current study sought to evaluate the level of indoor pollution to help identify major contamination sources. Several studies have investigated indoor air quality (IAQ) in the workplace and academic buildings with a focus on air conditioning, but few have examined naturally ventilated spaces. This study is an effort to lower this gap through audit analysis of airborne circulating as well as surface-settled pollutants in naturally ventilated residential settings. The real-time air quality monitoring showed PM levels cross the WHO benchmark. As humans spend the majority of their time indoors, additional in-depth investigations of indoor air quality are vital.

Paper ID: 301

Subjective evaluation of thermal comfort of tropically acclimatized subjects in air conditioned, naturally ventilated and radiant cooling environments

Jayashree Arumugam[1], M.P. Maiya[2], S.M. Shiva Nagendra[1]
[1]EWRE Laboratory, Department of Civil Engineering, Indian Institute of Technology Madras, Chennai 600036, Tamil Nadu, India
[2]RAC Laboratory, Department of Mechanical Engineering, Indian Institute of Technology Madras, Chennai 600036, Tamil Nadu, India

Abstract

Researchers worldwide have shown that people are comfortable at higher indoor temperatures and air velocities [1 – 3]. In this study, the thermal perception of subjects is evaluated at higher indoor temperatures and air velocities in air-conditioned, naturally ventilated, and radiant cooling thermal environments to understand how tropically acclimatized subjects' thermal preferences are influenced in different thermal environments. The outcomes show that at least 80% of subjects voted as comfortable on the thermal sensation scale in AC and RC environments, at the Top/va range of 25.3–28.4°C/0.1–0.3m/s and 27.3–29.1°C/0.1–1.0m/s respectively. The outcome from NV environment indicates that subjects' free control of air movement improved their thermal acceptance more than the experimenter's control of air movement. The humidity and air quality remained unaltered in the three thermal environments. However, the acceptance of humidity and air quality is higher in AC and RC environments than in the NV environment.

Paper ID: 342

Evaluation of thermal discomfort and non-refrigerant-based cooling methods as mitigation measures in Indian school buildings

Nikhil Sharma[1], Brijesh Pandey[1], Akhil Singhal[1]
[1]Alliance for an Energy efficient Economy, New Delhi, India

Abstract

The atmospheric temperature of the Indian subcontinent is rising steadily, with maximum and minimum temperatures increasing by up to 0.9º C and 0.5º C, respectively. Heat waves are becoming more frequent, posing a threat to vulnerable communities, including students, leading to changes in school schedules or closures in northern India. Unfortunately, thermal comfort assessment in Indian schools has received limited attention to date. To address this, a study was conducted in, Ajmer (Hot and Dry climate), to evaluate thermal discomfort caused by heat stress in schools. The study investigates the relationship between students' thermal comfort and indoor/outdoor thermal conditions, the effectiveness of low-energy cooling technology, such as ceiling fans and evaporative coolers, in mitigating thermal discomfort during heat stress conditions. Data collection and evaluation have been conducted before and after the deployment of evaporative coolers to gauge their effectiveness in improving the thermal comfort of the students.

Paper ID: 322

Role of Energy recovery Ventilators on the Indoor Airborne Disease Transmission

[1]Gurubalan Annadurai
[1]Department of Energy Science and Engineering

Abstract

Energy recovery ventilators (ERVs) are commonly used in HVAC systems to reduce energy consumption. ERVs transfer the energy from the exhaust air and use it to precondition the incoming outdoor ventilation air. According to literature evidence of non-biological contaminant transfer, it is suspected that the bioaerosols (with the pathogen) may be transferred from exhaust to ventilation air during energy transfer in ERVs. This may lead to disease transmission indoors. Consequently, without any experimental/field evidence, ERVs are often bypassed in the HVAC systems during pandemic operations. To address this research gap, this study numerically analyzes the effect of ERVs on indoor airborne disease transmission in a multi-room office building. It is identified that the ERV slightly increases the infection risk only in the connected rooms (rooms without the source of infection), whereas bypassing ERV increases the infection risk in both source and connected rooms.

Paper ID: 333

Empirical examination of trends in indoor air quality in a sample of urban Indian residences

Rajat Gupta[1], Yuanhong Zhao[1], Vishal Garg[2], Jyotirmay Mathur[3]
[1]Oxford Brookes University, Oxford, UK
[2]Plaksha University, Mohali, India
[3]Malaviya National Institute of Technology, Jaipur, India

Abstract

Indoor air quality (IAQ) in residences is a complex phenomenon determined by many factors. IAQ in homes has been studied far less than air quality outdoors, especially in urban India, where outdoor air pollution frequently exceeds recommended levels. This paper empirically investigates daily trends and variation in IAQ parameters measured across a sample of eight urban Indian residences located in three cities, representing the warm-humid and composite climates. Using internet-enabled Airveda device, time-series monitoring data at 30’ intervals were gathered for indoor temperature, relative humidity, CO2, PM2.5 and PM10 for 10 days during the summer season when air conditioning was prevalent. Contextual data about residences were gathered using household surveys. The results were compared against the recommended ISHRAE and WHO standards to observe any deviations. Given the paucity of empirical data, an online interactive dashboard (RIAQ) for visualising IAQ was developed for academics, policymakers and industry to enable further research.

09:00 - 11:00	Technical Session Theme: Buildings Sub-Theme: Energy Data, Benchmarking and Building Performance

Paper ID: 271

ESCO as a tool to Improve EE in Big Indian Commercial Buildings

Abhay Bakre[1], VK Srivastava[1]
[1]Bureau of Energy Efficiency-Ministry of Power 4th Floor, Sewa Bhawan, R.K. Puram, Sector -1, New Delhi-110066

Abstract

Industry in India is relatively small and young compared with those in other nations and has so far not been able to succeed in developing a vibrant market for Energy Savings Performance Contract (ESPC) through the ESCO route. In order to make ESCOs more reliable, BEE empaneled1 149 ESCOs.
In terms of the saving potential, building sector in India offers a huge opportunity. With a very aggressive residential building energy efficiency policy, it Is Possible to Realize 57% Of Energy Savings By 2050.
Taking the note of recent Budget announcement. It was announced that EEM shall be promoted in large commercial buildings through ESCO, BEE has short listed about 200 buildings of which IGEA of 69 building completed have various findings on which further course of action shall be decided.
The paper discusses teething issues, bottle necks, barriers & learnings from successful countries.

Paper ID: 280

A baseline study for residential energy consumption using socioeconomic and physical building attributes; a case of Jaipur

Bibhu Kalyan Nayak[1,2], Jyotirmay Mathur[2], Tarush Chandra[2], Sunil Kumar Sansaniwal[2], Vishal Garg[3], Rajat Gupta[4]
[1]Manipal University Jaipur, Jaipur, India.
[2]Malaviya National Institute of Technology; Jaipur, India
[3]Plaksha University; Mohali, India
[4]Oxford Brookes University, Oxford, UK

Abstract

Indian residential energy consumption increased nearly 50 times its levels in 1971. Studies have reported a wide variation between the statistically projected and actual energy consumption values in residential buildings. Access to reliable energy consumption data is limited in Indian cities. This study aims to use primary datasets to develop a baseline for residential energy consumption in India. Its first objective is understanding the prevailing practices adopted in residential energy studies. The second is to understand the contributions of socioeconomic factors to it. This research analyzes 2327 primary survey samples from Jaipur. The dataset was analyzed using the multivariate statistical technique. The results highlighted the uptake in appliance ownership and its implications on energy consumption across income groups. The study has also compared the relevance of EPI (annual consumption/total area) and annual energy consumption as indicators in the building benchmarking process for Indian homes.

Paper ID: 311

Decarbonizing India's Residential Building Sector: Insights and Pathways from a System Dynamics Model

Sarah Khan[1], Sweta Bhushan[1]
[1]Centre for Study of Science, Technology and Policy (CSTEP), Bengaluru, India

Abstract

This paper analyses potential low-carbon pathways using the Sustainable Alternative Future for India (SAFARI) model to achieve net-zero buildings in India. With the building sector contributing to 33% of global energy-related CO2 emissions, decarbonizing it is crucial for a net-zero economy. The study uses a system dynamics model to capture sectoral interlinkages and explore the implications of meeting India's developmental goals on energy, resources, materials, and emissions. Three scenarios are developed constituting interventions from buildings, power and industry sectors known as the Business-as-usual (BAU) scenario which assumes that existing policies will persist and two decarbonisation scenarios with different levels of realistic interventions, such as electrification and behavioural shifts. The paper discusses the residential cooling demand and transition cost to high-efficiency appliances. Furthermore, it highlights the importance of considering sectoral interlinkages and resource constraints in achieving net-zero energy buildings.

Paper ID: 343

Hospital Energy Consumption Survey: The Lived Experience

Meghaa Gangahar[1], Akash Goenka[1] , Sandeep Kachhawa[1], Sangeeta Mathew[1], Satish Kumar[1], Rajita Kurup[2], Indumathi Arunan[2], Sunila Dixit[2], Poornima Prabhakaran[2]
[1]Alliance for an Energy Efficient Economy, New Delhi, India
[2]Centre for Chronic Disease Control, New Delhi, India

Abstract

To foster a more systematic approach to commercial building energy data collection and reporting, this paper aims to bring out the "lived experience" of on-ground data collection from the recently concluded Hospital Energy Consumption Survey conceptualized and conducted by the National Centre for Disease Control (NCDC), under the aegis of the National Program for Climate Change and Human Health. It was administered and overseen by Alliance for Energy Efficient Economy (AEEE) and the Centre for Chronic Disease Control (CCDC). This paper captures the authors' onground survey experience and transferable learning, typically precluded from technical survey reports. The authors believe that given the challenges in collecting relevant energy data from the buildings sector, their experiences can offer a unique insight into the on-ground realities of collecting technical data and suggest transferrable learnings that can help make future commercial building energy consumption surveys quicker, less cumbersome, less costly, and more effective

Paper ID: 279

Assessment of Residential Demand Response Potential for a Renewable-based Microgrid: A Case study of Auroville Township in India

Yogitha Miriyala[1], Jai Govind Singh[1], Martin Scherfler[2]
[1]Asian Institute of Technology, Bangkok, Thailand
[2]Auroville Consulting, Auroville, India

Abstract

Demand response (DR) can provide the flexibility services required when high capacities of variable renewable energy are grid-integrated. With increasing appliance ownership rates, the residential sector will increasingly contribute to peak load in India. Thus, this study estimates the technical potential of DR and the financial benefits of introducing residential DR to achieve 100% integration of net renewable energy in a community's microgrid in a region in Auroville, India. The technical load reduction potential of DR for the highest and lowest DR scenarios was 20.7% and 8.1%, respectively. The highest DR potential was from air conditioners and electric vehicles. The DR scenario including only these appliances was the most financially attractive scenario, with a reduction in net present cost of 3.2%. Supposing these benefits were translated into incentives paid to the customers enrolled in DR programs, the share of the incentive to their average monthly bill was estimated at 20.3%.

Paper ID: 339

Potential of energy efficiency in optimising residential electricity demand in India

Paras Bhattarai1, Sunil Mani2
[1]Alliance for an Energy Efficient Economy (AEEE), New Delhi, India; Council on Energy, Environment and Water, New Delhi, India
[2]International Institute for Sustainable Development, Manitoba, Canada; Council on Energy, Environment and Water, New Delhi, India

Abstract

Amidst growing urbanisation, rising per capita income and improved electrification, electricity demand in India is rising rapidly. Optimising residential electricity consumption—which contributes to one-fourth of India's overall electricity demand—can play a significant role in managing India's rising overall electricity demand. Using nationally representative India Residential Energy Survey (IRES) 2020, we find that the adoption of energy-efficient appliances can reduce the electricity consumption for a typical Indian household by ~41% (from 89 kWh/month to 52 kWh/month). Energy-efficient lights and fans alone can contribute to 62% of this decline. Though energy-efficiency programs such as UJALA have already significantly increased the penetration of energy-efficient lighting (LEDs) in India, our findings suggest the need to continue these efforts along with expanding them to other appliances (starting with fans). Further, these will also need to be complemented by increasing households' awareness about energy efficiency, managing electricity demand using smart electricity meters and conducting periodic assessments of residential energy consumption

Supported by

MacArthur Foundation

Co-hosts

CRDF CEPT RESEARCH AND DEVELOPMENT FOUNDATION

भारतीय प्रौद्योगिकी संस्थान दिल्ली
Indian Institute of Technology Delhi

iihs INDIAN INSTITUTE FOR HUMAN SETTLEMENTS

Platinum Sponsor

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Gold Sponsor

clasp
Efficient Appliances for People & the Planet

Associate Sponsor

Carrier

Outreach Partner

ASHRAE India Chapter

EUROVENT EUROPEAN INDUSTRY ASSOCIATION

ieema your link to electricity

ISGF India Smart Grid Forum

ISHRAE

RAMA REFRIGERATION AND AIRCONDITIONING MANUFACTURERS ASSOCIATION

KATA The Refrigeration & Air Conditioning Trades Association Ltd.

Knowledge Partner

WRI INDIA