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Accelerating urban action for a carbon-free world

World Habitat Day

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Accelerating Urban Action for a Carbon-Free World

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निर्माण सामग्री एवं प्रौद्योगिकी संवर्द्धन परिषद्
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BUILDING MATERIALS & TECHNOLOGY PROMOTION COUNCIL
Ministry of Housing & Urban Affairs, Government of India

"Creating Enabling Environment for Affordable Housing for All"

Accelerating adoption of thermally comfortable homes



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Rapid urbanization is creating an unprecedented demand for the construction of buildings. Today, India is at a unique crossroads where **two-thirds of the commercial and residential structures that will exist in 2030, are yet to be built**. A lot of this demand lies in the affordable housing segment, which has taken a major leap in India after the launch of the Pradhan Mantri Awas Yojana (PMAY) in 2015. Affordable housing essentially means bringing low-cost housing in the market with purchase prices that are within reach for the various income segments in society, primarily focusing on Economically Weaker Sections (EWS) & Low Income Groups (LIG). As an outcome of PMAY-U, 11.3 million houses are being constructed within the Mission period. The houses built under the Mission will last at least 50-60 years and thus have a potential to impact resource usage during their life span. A major energy saving potential lies in reducing the energy demand in the housing stock being built today.

The mission needs to go beyond fulfilling the basic need of shelter and ensure an improved living environment for a better quality of life. Occupant comfort is the prime goal and thermal comfort is a major contributor in this regard. With climate change and rising temperatures on one hand and the rising aspirational demands on the other, more and more households will move towards air-conditioning in the coming years. The massive housing stock generated today is bound to put a lot of pressure on the energy demand in the future. Projections show that **electricity consumption in residential buildings alone is expected to increase seven-fold during the period 2012-2032**[1]. It is critical to anticipate these needs and to integrate thermal comfort in affordable housing today to ensure that it remains sustainable and affordable for its occupants in the future. The government's mission to provide housing for all has to go hand in hand with the commitment towards Sustainable Development Goals and the commitments towards climate change mitigation (COP21). This calls for keeping a check on the Embodied energy as well as the Operational energy without compromising on comfort.

Figure 1 Energy demand from the building sector

To meet its climate targets The Ministry of Environment, Forest and Climate change (MoEF&CC) launched the India Cooling Action Plan (ICAP) in 2019. The plan provides a 20 year perspective with a target to reduce cooling demand across sectors by 20%-25% and reduce cooling energy requirements by 25%-40% by 2037-38[2]. The plan goes beyond energy efficient technologies and looks to manage cooling demands through design, passive strategies and adopting

1 *Guidelines for multistory residential buildings (https://beeindia.gov.in/sites/default/files/Design%20Guideline_Book_0.pdf)*

2 India Cooling Action Plan (http://ozonecell.nic.in/wp-content/uploads/2019/03/INDIA-COOLING-ACTION-PLAN-e-circulation-version080319.pdf)

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Figure 2 Sustainable Development Goals and Nationally Determined Contributions

Figure 3 Environmental & Behavioral parameters impacting thermal comfort

the adaptive thermal comfort standards. This is a major move in steering away from rigid temperature set points and towards ranges of thermal comfort based on climate and context. National Building Code defines Thermal comfort as that condition of thermal environment under which a person can maintain a body heat balance at normal body temperature and without perceptible sweating. The perception of thermal comfort depends on a number of environmental and behavioral parameters.

Achieving thermal comfort in Affordable housing

The refrigerant based HVAC systems are not the only solution to achieve thermal comfort. The adaptive comfort model puts forward separate temperature ranges of comfort for non-air-conditioned, mixed mode and air-conditioned buildings. This sets realistic comfort standards which can be achieved through energy efficient design, passive strategies and mixed mode cooling. A combination of these strategies can bring down the hours of discomfort within a home which can then be tackled with mixed mode strategies like evaporative cooling thereby reducing/ eliminating the need for refrigerant based air-conditioning. The study conducted by Environmental Design Solutions (EDS)[3] shows that the percentage share of embodied energy to operational energy for air conditioned affordable housing shifts to 68% as compared to 40% for non-Air-conditioned housing for a life span of 20 years.

3 (http://cdn.cseindia.org/userfiles/tanmay-climate-responsive-affordable-housing-cse-mar2016.pdf)

Principles of energy efficiency:

Compactness of building plan: The principle is to reduce the wall surface area to minimum for a given floor area. This reduces the area exposed to heat gain or loss to the environment. Thus buildings with simple rectangular configurations and shared walls perform better.

Window to wall ratio & ventilation: The openings in the building envelope are more prone to heat gains/ losses than wall masonry therefore the window sizes should be optimised to reduce glazing without compromising daylight and ventilation.

Insulation: Large exposed surfaces such as end walls and roofs contibute to heat gains inside the units and insulation at these locations is effective in reducing discomfort hours substancially, specially in worst affected units such at top floor units or end units in a residential block.

Shading: Direct sunshine and indirect sky radiation entering a room through a glazed window is the largest contributor to discomfort during warm and hot seasons. Appropriate shading elements designed as per orientation and location of the opening can cut down solar gains in a cost effective manner.

Figure 4 Compactness depends on the geometry of the building. In this figure the surface to volume ratio increases from A to C

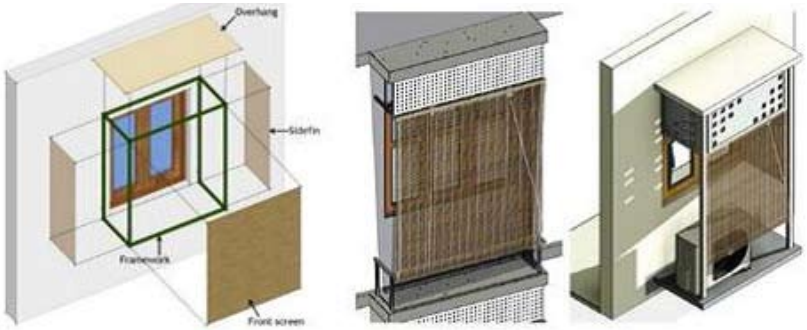

Figure 5 Protection of openings through shading

Figure 6 Replicable Design Handbook & Tool awailable at www.econiwas.com

In order to achieve thermal comfort in Affordable housing it is imperative to break the myth that providing thermal comfort comes at an increased cost. Good passive design measures like the right envelop design, optimizing opening location and sizes for ventilation make an enormous contribution in improving the thermal performance of a building before we even consider expensive products like double glazed windows or insulation. Programs to educate, incentivize and empower the investor market, the service providers, be it the government sector or the private developers, and the end users can help in this domain.

The selection of materials also plays an important role in defining the carbon footprint of the buildings. The construction materials not only contribute to the embodied energy but also impact thermal comfort and need for air-conditioning. This in turn adds to the operational energy demand and costs. A mandate to achieve set standards of thermal comfort in affordable housing can bring about a change in the selection criteria for building materials. Thermal performance needs to become a key indicator for material selection for mass affordable housing projects.

Catalogue of Replicable designs for Energy Efficient Residential Buildings

Architectural design services that are available for the majority of mass housing construction are yet to develop the knowledge and skills to integrate energy efficiency and thermal comfort into the design. The Catalogue of replicable designs for energy efficient residential buildings is launched by Bureau of Energy Efficiency (BEE) in order to fast-track the adoption of energy efficient, thermally comfortable residential buildings for a wide user-base. This catalogue is a ready to use directory of thermally comfortable, energy efficient house designs. It offers a range of residential layouts addressing single family plotted development as well as multi-family apartments. The house designs developed in this catalogue carefully correlate various unit sizes and typologies that can be adopted in different climatic zones. The unit sizes range from 40sqm to 250 sqm in a combination of low-rise, mid-rise and high-rise buildings.

The catalogue has 2 design sets:

Set 1 : Designed for Hot-dry, Warm-humid, Composite and Temperate climatic zones. The primary strategy is to reduce solar heat gain and to optimize ventilation, thereby, removing internal heat.

Set 2: Set of plans designed for the Cold Climate. Here the strategy focuses on capturing solar heat gains and restricting heat loss.

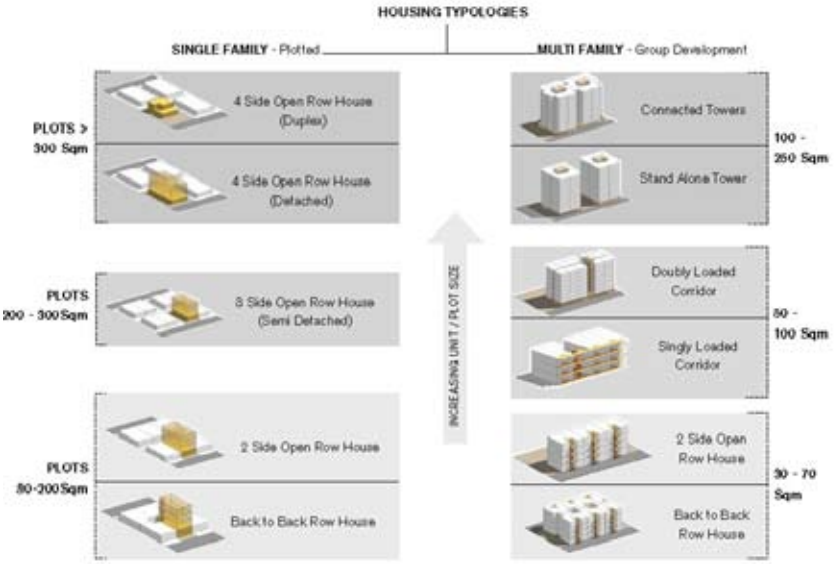

Figure 7 The catalogue caters to a range of housing typologies and dwelling unit sizes

This handbook explains the principles of energy efficient design in simple terms and demonstrates their application through the replicable designs. A defining feature of these dwelling unit designs is that it is in the planning and configuration of the building that the greatest energy efficiency gains are affected thereby incurring no additional cost.

These design options are available as an online tool offering a complete set of working drawings, cost details along with energy performance parameters in an easy to comprehend format. The users can compare across various templates and make informed choices by reviewing the energy and thermal performance of each design through its key performance indicators such as Building envelope performance (RETV), Ventilation Potential, Daylight Availability, Comfort Hours with natural Ventilation and Energy Performance Index. The techno-commercial feasibility is also assessed through Payback duration, Life Cycle Cost (LCC), Energy savings etc.

Replicable Designs tool

The online Replicable Designs tool offers Energy performance of every design layout, assessed for different orientations, Storey and locations in the building block and additional measures such as shading and insulation recommended to achieve thermal comfort in the worst affected cases. With each design there is a step by step improvement recommendation in terms of materials, insulation, shading and other modifications to achieve various levels of energy performance. The tool further offers all working files, 3D model and simulation files for each design template as a downloadable set for modification and customization by individual users, design professional, builders and other stakeholders.

The passive measures to achieve thermal comfort work with design, orientation, ventilation, insulation etc and can be incorporated only in the design and construction stages. Missing this chance today will lead to an energy guzzling housing stock in the future. Therefore there is a need to fast-track the adoption of environmentally conscious design. The way forward is to focus on resilience to meet the needs of the present with solutions that are sustainable. A lot of work, research and programs are being carried out in this domain but the implementation gap is a large one to fill. Therefore, it is important to create awareness among the end users to help them understand the long term benefits such as cost saving in operational energy, thereby creating demand by pitching it as an aspirational value. All the data, knowledge & research is still limited within a close circle of professionals in the field and

Figure 8 Layout options in various typologies for different climate zones

it needs to be brought out to the common man who is the end user that will benefit.

Many Organizations like IIFL, BMTPC, BEE and many others have started creating knowledge banks and workshops towards achieving this goal. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) is implementing the Indo-German Energy Programme (IGEN) on behalf of the German Federal Ministry for Economic Co-operation and Development (BMZ) and the Government of India. The aim of this programme is to foster sustainability in built environment in order to use sustainable materials for Thermal comfort and in turn improve the environment and climate conditions. This programme has supported Government of India in the development of Catalogue of replicable designs for energy efficient residential buildings. IGEN's new programme, Climate Smart Buildings (CSB), with Ministry of Housing and Urban Affairs (MoHUA) proposes to extend technical assistance and cooperation for main-streaming thermal comfort in Affordable Housing.

Replicable Design options for Thermally Comfortable Affordable Housing

The next phase of this project is focused on replicable design templates specifically targeting affordable housing that is yet to be constructed and encourage compliance with the best practices. This will provide a platform with a database on sustainable building design in a user-friendly format. The idea is to ensure that a wide range of users understand the strategies and are able to adopt these energy efficiency measures into the design to go beyond the existing standards. For home-owners and small developers who do not have the capacity or expertise to assess their designs with simulation software these replicable designs offer ready to use and tested solution sets to construct thermally comfortable homes. While many codes, standards and policies are in place and many more are underway to address energy efficiency and thermal comfort in buildings, this project is able to translate the objectives of these policies into simple designs that can be adopted across various platforms and stakeholders, thus bridging the gap between policy and implementation.

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Source: https://urbanoctober.unhabitat.org/whd