RMI INDIA FOUNDATION

LODHA NET ZERO URBAN ACCELERATOR

UrjaAnk

Catalysing Change in Residential Energy Consumption

WHITE PAPER: INSIGHTS FROM RESIDENTIAL ENERGY SURVEY AT PALAVA

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Abbreviations

AC	Air Conditioner
BEE	Bureau of Energy Efficiency
CLASP	Collaborative Labelling and Appliance Standards Program
DISCOMs	Distribution Company
EDGE	Excellence in Design for Greater Efficiency
ENS	Eco Niwas Samhita
EPC	Energy Performance Certificates
EPI	Energy Performance Index
ESCOs	Energy Service Companies
EUI	Energy Use Intensity
GDP	Gross Domestic Product
GEM	Government e-Marketplace
GRIHA	Green Rating for Integrated Habitat Assessment
HERS	Home Energy Rating System
HVAC	Heating, Ventilation and Air Conditioning
IGBC	Indian Green Building Council
KYEC	Know Your Energy Consumption
LEED	Leadership in Energy and Environmental Design
NDC	Nationally Determined Contributions
NZUA	Net Zero Urban Accelerator
PV	Photo Voltaic
RMI	Rocky Mountain Institute

Executive Summary

The **UrjaAnk programme** under the Net Zero Urban Accelerator, developed in partnership with Lodha and RMI India Foundation, addresses the urgent need to reduce residential energy consumption and associated emissions across India. Recognising that residential buildings contribute significantly to India's total energy demand, UrjaAnk aims to fill the current data gaps by benchmarking energy use and catalysing behavioural change among urban households. This programme uses Lodha's **Palava City as a "living lab"** to experiment with and understand the factors that affect energy use patterns and develop actionable insights to shape India's pathway toward more sustainable residential energy practices.

Motivation and Challenges

The residential sector in India is rapidly expanding, with urban housing needs expected to double in floor space by 2040. This growth comes with a sharp increase in demand for energy-intensive appliances, especially cooling equipment, putting pressure on India's energy infrastructure. While metrics like the **Energy Performance Index (EPI)** are established globally, their relevance and implementation within India remain limited due to the lack of localised, operational energy data and standards. Existing benchmarks and rating systems (e.g., Eco Niwas Samhita, GRIHA) focus on the design phase rather than actual operational performance. UrjaAnk addresses this by developing comprehensive datasets and proposing practical interventions based on real-world energy use in Indian households.

Objectives of UrjaAnk

UrjaAnk's primary goals include:

1. **Developing Energy Use Models**: Develop calibrated energy models tailored to Indian households to provide designers with evidence-based insights for strategy selection, design optimisation, and evaluating the impact of key interventions.
2. **Establishing New Benchmarks**: Set realistic, location-specific standards for energy use intensity in residential buildings across varying climates.
3. **Supporting Policy and Standards**: Provide data-backed recommendations to strengthen India's energy labelling and building standards, making them more applicable for operational settings.
4. **Promoting Behavioural Change**: Encourage sustainable energy use practices among residents through educational initiatives and accessible, transparent energy consumption data.

Methodology

The survey under the UrjaAnk programme was conceptualised initially by assessing the energy performance across **9568 households in Palava City**. Following this, an in-depth door-to-door survey was conducted across 400 households to gather data on demographics, appliance usage, and occupancy behaviours. This survey helped assess the **Energy Performance Index (EPI)**, explored appliance-specific consumption trends, identified key behavioural patterns, and established a baseline for energy use. With a focus on cooling loads, occupancy rates, and appliance efficiency ratings, the survey provided insights into the impacts of design and usage choices on energy consumption.

The methodology also encompassed:

- **Data Collection**: Detailed questionnaires covered appliance ownership, household routines, and energy-saving practices.
- **Sampling**: Stratified random sampling was used, focusing on 2BHK units in seven building clusters with varied appliance efficiency ratings.
- **Analysis Techniques**: Both quantitative (e.g., EPI calculations) and qualitative (behavioural coding) methods were employed to understand consumption patterns.

Key Findings of the Survey

The survey conducted by UrjaAnk revealed several significant trends among households in Palava:

1. **Household Energy Performance:** An initial analysis of energy data from 9568 households provided valuable insights into the energy performance index (measured in $kWh/m^2/year$) for Palava residences. The study found that the median energy performance index stood at 41 $kWh/m^2/year$, which is considerably lower than the industry benchmark data available for similar climatic conditions in India.
2. **Dominance of Cooling Loads**: Air conditioners account for 36% of daily household energy use, with fans contributing an additional 18%. This highlights the critical role that energy-efficient cooling solutions could play in reducing household energy demand.
3. **Higher Appliance Penetration and Efficiency Awareness**: Compared to the national average, Palava residents exhibit significantly higher appliance ownership rates, with 90% of appliances having at least a 3-star efficiency rating. Notably, 40% of fans in these households are 5-star rated, indicating a strong preference for energy-efficient options.
4. **Energy Use Patterns Aligned with Occupancy**: Occupancy is concentrated in the evenings and weekends, with natural ventilation favoured during the day and air conditioning preferred in the late afternoon and evening. This temporal pattern suggests specific windows for demand response measures that could optimise energy use.
5. **Younger Demographic and Engagement Potential**: Nearly 70% of Palava households are young families, indicating an opportunity to cultivate long-term energy-saving habits through tailored educational initiatives.

Strategic Interventions

The UrjaAnk whitepaper outlines several targeted strategies to drive energy efficiency improvements in the residential sector:

- **Establishing Benchmarking Standards**: Introducing Energy Use Intensity (EUI) metrics in utility bills or other public communications to increase transparency and motivate energy-conscious behaviours.
- **Enhancing Building Envelope Design**: Leveraging performance-enhancing passive design interventions like natural ventilation, shading, insulation, reflective surfaces, and nature-based solutions to reduce indoor cooling demand.
- **Driving Consumer Awareness**: Launch community-based awareness campaigns and mobile apps to help residents understand their energy use patterns, compare with peers, and access energy-saving tips.
- **Encouraging Super-Efficient Equipment**: Promote bulk procurement and adoption of highly efficient appliances, especially for high-load categories like air conditioning, to reduce overall energy consumption.

Recommendations for Sector-Wide Impact

In light of the survey findings, UrjaAnk has developed key recommendations to support sector-wide transformation:

1. **Developing India-Specific EUI Standards**: Establish EUI metrics tailored to Indian climates, lifestyles, and socio-economic factors, allowing for more nuanced benchmarks.
2. **Establishing a Centralised Energy Database**: Create a repository of energy use patterns across urban residential sectors to aid in policy formulation and enable data-driven decision-making.
3. **Incentivizing Energy-Efficient Upgrades**: Collaborate with financial institutions to offer green loans that reward energy-efficient home improvements, aligning with consumer incentives for long-term energy savings.
4. **Encouraging Industry Collaboration**: Form partnerships with developers, financial institutions, and technology providers to co-develop financing models, retrofitting solutions, and innovative energy-saving products.
5. **Incorporating Energy Metrics in Real Estate Listings**: UrjaAnk proposes integrating real-time energy data into property listings to empower buyers and renters to consider energy efficiency as a core part of their decision-making.

Looking Ahead: Next Steps

The UrjaAnk programme, as part of the Lodha Net Zero Urban Accelerator, is designed to be a catalyst for scalable energy efficiency across India's residential real estate market. The next phase will focus on:

- **Creating a Robust Energy Performance Metric**: Pilot an energy performance label specific to Lodha developments that can serve as a benchmark for the broader market.
- **Collaborating with Local Authorities**: Engage with municipal and state bodies to incorporate energy performance metrics into urban regulations and building codes.
- **Establishing a Nationwide Residential Energy Database**: Collaborate with technology partners to develop a centralised database and track energy use patterns in households.
- **Piloting Projects in Key Urban Centres**: Implement pilots to validate energy performance transparency and consumer engagement strategies.

Conclusion

UrjaAnk's work in Palava City has established a foundation for transforming India's residential real estate sector by advancing energy transparency, establishing robust benchmarks, and promoting consumer engagement. The programme is well-positioned to support India's sustainability goals, especially its Nationally Determined Contributions (NDCs) and the 2070 net-zero target.

UrjaAnk aims to:

- **Normalise Energy Efficiency**: Incorporate energy metrics into design development, consumer practices and, property valuation.
- **Support Data-Backed Policymaking**: Facilitate including operational energy data in regulatory frameworks to drive sustainable urban development.
- **Build Industry Collaboration**: Foster partnerships that create an ecosystem for scalable energy-efficient housing solutions.

The survey's approach offers a replicable model, showcasing how India's urban residential sector can transition to more sustainable energy practices while enhancing occupant comfort and affordability.

Introduction

Globally, buildings account for 34% of total energy demand, with residential buildings contributing 21%. In 2021, operational energy-related CO_2 emissions from buildings surged by 5%, reaching a record 10 $GtCO_2$[1]. These statistics underscore the urgent need to improve energy efficiency in both new and existing buildings to address the escalating climate crisis.

In India, the building sector holds substantial economic and environmental significance, contributing 9% of the country's GDP and employing over 51 million people.[2] However, this growth comes with notable environmental challenges. The sector accounts for 33% of the nation's electricity consumption and 25% of its emissions.[3] Rapid urbanisation is intensifying these impacts, with the residential building sector projected to experience a doubling of total floor space from 16 billion square metres in 2020 to approximately 34 billion square metres by 2040[4]. This expansion is accompanied by an unprecedented increase in demand for appliances, particularly air conditioners, fans, and coolers which are expected to witness an 11-fold increase in energy demand by 2050[5]. The growing reliance on such appliances places immense pressure on India's energy infrastructure and emissions targets. Without effective interventions, the anticipated surge in energy demand will challenge the nation's ability to meet its sustainability and climate goals.

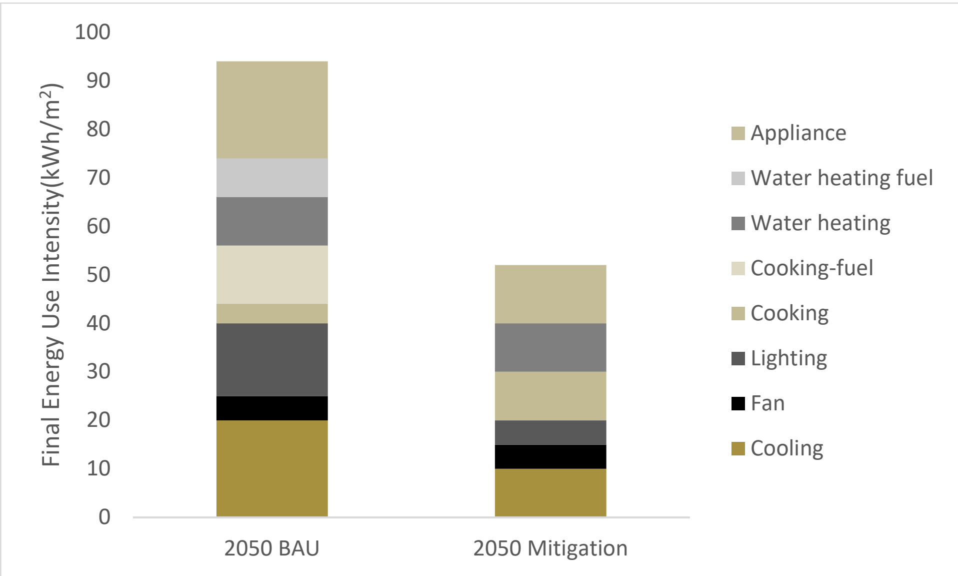


Exhibit 1: Urban residential building final energy use intensity (From the Ground Up, RMI)

[1] U. N. Environment, "Global Status Report for Buildings and Construction | UNEP - UN Environment Programme," March 6, 2024.
[2] Invest India, "Construction Sector Insights", October 2024, https://www.investindia.gov.in/sector/construction
[3] Ministry of Statistics and Program Implementation, "Energy Statistics India 2024", March, 2024.
[4] *"National Institute of Urban Affairs and RMI. From the Ground Up: A whole-system approach to decarbonizing India's buildings sector, November 2022 https://rmi.org/insight/wholesystem-approach-to-decarbonize-India's-buildings/.*
[5] Ministry of Environment, Forest & Climate Change. "India Cooling Action Plan. New Delhi: Ministry of Environment, Forest & Climate Change

Current Landscape and Challenges

Building energy performance standards are globally recognised as effective tools for reducing energy consumption in the built environment. These standards rely on energy performance metrics to measure, analyse, and compare energy use in buildings. In India, policies and frameworks such as the Eco Niwas Samhita, Green Rating for Integrated Habitat Assessment (GRIHA), and the Indian Green Building Council (IGBC) have significantly advanced sustainable construction practices. However, these frameworks focus primarily on the design phase of buildings, paying limited attention to actual operational performance. This oversight creates challenges in integrating operational energy metrics into these initiatives, reducing their overall effectiveness in driving long-term energy efficiency.

S.No.	Initiative Name	Minimum EPI Values for Warm and Humid Climate Zone	Objective and Scope of the Initiative	How the Energy performance of the building has been evaluated- Metric and criterion
1	**Eco Niwas Samhita – (BEE labelling scheme for buildings)**	**64 kWh/m^2. year**	The Eco Niwas Samhita has a star labelling scheme for residential buildings. The minimum energy performance is 58 EPI and the best energy performance is 30 EPI for Warm and Humid Climates. An additional EPI of 7 – 9 is to be considered for operating loads	Energy performance Index (EPI) i.e., annual energy consumption and floor area ratio is the metric that is used for the performance evaluation of the building.
2	**Green Rating for Integrated Habitat Assessment (GRIHA)**	**70 kWh/m^2.year**	GRIHA has multiple ratings depending on building typologies. A large portion of the rating points are provided to the energy and comfort section. For residential category projects, it mandates the minimum performance criteria at 70kwh/m^2/year.	Energy performance Index (EPI) i.e., annual energy consumption and floor area ratio is the metric that is used for the performance evaluation of the building.
3	**Indian Green Building Council (IGBC) And LEED Homes**	**Not Applicable**	IGBC and LEED Homes, do not mandate any minimum energy performance in absolute numbers, but provide relative requirements for meeting the performance benchmark from baseline	EPI reduction is the energy metric, which is based on the design case.

			to improved design cases.	

Exhibit 2: Rating Systems in India at a Glance from Building Energy Performance Perspective

Understanding Different Building Energy Performance Metrics

Building energy performance metrics are essential tools for quantifying, analysing, and comparing energy consumption across residential and commercial buildings. They provide standardised measures that allow stakeholders to identify inefficiencies, track progress, and implement targeted interventions for improved energy efficiency. However, the selection and application of these metrics vary widely, depending on the context, building type, and desired outcomes.

Commonly Used Energy Metrics

This section explores the most commonly used metrics, strengths, limitations, and potential for driving meaningful energy efficiency improvements in India's residential sector.

Metric	Strengths	Limitations
kWh/m². Yr. (Energy per square meter per year)	1. **Scalable**: Allows energy use comparisons across buildings of different sizes. It provides a per-unit area metric, which is crucial for designers and architects to optimise building energy performance. 2. **Standardisation**: This metric is widely recognised and used in energy performance certificates (EPCs), making it the industry standard in many countries (e.g., EU member states). 3. **Design Evaluation**: Excellent for use during the design and retrofit phases to evaluate the impact of materials, HVAC systems, and insulation.	1. **Ignores Occupancy**: This does not account for the number of occupants and the socio-economic factors, leading to an inaccurate reflection of actual energy demand in high or low occupancy scenarios. 2. **Limited Usage Information**: Focuses on building envelope performance but does not directly reflect usage patterns like appliance loads or varying occupant behaviour. 3. **Seasonal Insensitivity**: It does not fully capture variations in energy use due to seasonal changes, which can be significant in residential buildings.
kWh/ person (Energy per person)	1. **Human-Centric**: This metric provides a more accurate reflection of energy consumption based on the number of occupants, which aligns with real-world usage and can better highlight inefficiencies. 2. **Social Insight**: Especially useful in understanding energy inequalities between populations, for example, by identifying where high-income households might have high per capita energy consumption, leading to better-targeted policies.	1. **Ignores Building size**: It does not consider the size or energy efficiency of the building, which can skew results between small, energy-efficient apartments and larger, energy-inefficient homes. 2. **Multi-Tenant Complexity**: This metric becomes difficult to apply accurately in multi-family dwellings or apartment buildings where energy use is not easily attributable to individual occupants. 3. **Data Collection**: Requires accurate

	3. **Behavioural Indicator**: Provides valuable insights into energy usage behaviours, offering an indicator of potential savings through behavioural change and smart technology interventions.	and continuous data on occupancy, which may be challenging to collect consistently over time, especially in larger residential setups.
kWh/ household (Energy per household)	1. **Simplified Communication**: Easy to understand for policymakers, homeowners, and energy service providers. It communicates the total household energy consumption in a straightforward manner 2. **Holistic Overview**: Captures the entire household energy demand, including appliances, heating/cooling, and lighting, which gives a more complete picture of the energy footprint of a dwelling. 3. **Targeted Efficiency**: Effective in identifying inefficiencies at the household level, enabling energy-saving measures like appliance upgrades or renewable energy installations (e.g., solar PV).	1. **Household Size Variation**: This does not account for the number of people living in the household, leading to skewed comparisons between large families and single-occupancy homes. 2. **Generalisation**: Fails to account for individual household-specific factors like income levels, occupancy behaviour, or appliance usage patterns. This can lead to misleading energy comparisons. 3. **Appliance Load Overshadowing**: High appliance usage (e.g., HVAC, home entertainment systems) can overshadow building efficiency, providing an incomplete assessment of the overall energy performance of the household.

Exhibit 3: Strengths and Limitations of different energy performance metrics for the residential sector in India

Rethinking Energy Performance Metrics for Residential Buildings

India's growing residential sector requires energy performance metrics that capture the complexities of real-world energy use. The current reliance on **kWh/m² per year** effectively assesses design-phase efficiency but neglects critical factors like occupant behaviour, household size, and appliance usage. To address these limitations, incorporating alternative metrics such as **kWh per person** or **kWh per household** can provide more nuanced insights and support targeted energy efficiency interventions.

The Need for Comprehensive Metrics

Frameworks such as Eco Niwas Samhita, GRIHA, IGBC, and LEED Homes have advanced sustainable construction practices but remain limited in addressing operational realities. As urbanisation accelerates, new metrics are needed to address the following challenges:

1. **Gap Between Design and Operational Performance**
    - **Occupant Behaviour**: Variations in how residents use appliances and manage energy-intensive activities.
    - **Equipment Performance**: Differences in the efficiency and usage of appliances.
    - **Climatic Influences**: Urban heat islands and temperature fluctuations increase energy demands for cooling and heating, highlighting discrepancies between design-phase assumptions and operational outcomes.
2. **Limitations of Design-Centric Metrics**

    - **Household Size**: Larger families may consume more energy overall but could be more efficient per person.
    - **Behavioural Patterns**: Variations in lighting, cooling, and appliance usage are not captured by metrics like **kWh/m² per year**.
    - **Appliance Loads**: High-energy appliances often overshadow building envelope efficiencies, skewing evaluations.
3. **Lack of Operational Data**
    - **Energy Monitoring**: Limited adoption of systems to track real-time household energy consumption.
    - **Behavioural Insights**: Insufficient data on how occupant preferences influence energy use.
    - **Comparative Benchmarks**: The absence of centralised, region-specific databases prevents meaningful comparisons across climatic and geographic contexts.

Proposed Hybrid Metrics Framework

A hybrid approach that combines multiple metrics can offer a comprehensive view of residential energy performance:

1. **Primary Metric**:
    - **kWh/m² per year** for assessing building-level design efficiency.
2. **Supplementary Metrics**:
    - **kWh/person** to incorporate behavioural and socio-economic factors.
    - **kWh/household** for a holistic understanding of total energy demand.
3. **Normalisation Variables**:
    - Adjust metrics for **household size**, **climatic zones**, **seasonal variations**, and **appliance ownership** to ensure equitable comparisons across diverse contexts.

Under UrjaAnk, further work will be initiated to develop a matrix for evaluating the energy performance of residential buildings.

About UrjaAnk

UrjaAnk is a pioneering programme under the Lodha Net Zero Urban Accelerator developed in collaboration between Lodha and RMI India Foundation. It addresses the urgent need to optimise energy consumption in India's residential sector by bridging data gaps, promoting energy-efficient behaviours, and creating actionable frameworks for sustainable living. Using Lodha's Palava City as a "living laboratory," UrjaAnk focuses on developing operational benchmarks, scaling practical interventions, and catalysing transformation in urban residential energy performance.

The programme aims to establish an urban blueprint for energy-efficient housing by integrating real-world energy use data, occupant behaviour insights, and regional climatic factors into its analysis. By disaggregating residential energy consumption patterns, UrjaAnk identifies critical areas for improvement and implements targeted interventions that can reduce energy demand without compromising comfort or functionality. Based on the findings from UrjaAnk, the accelerator will focus on five key interventions, as mentioned below, to reduce residential energy consumption.

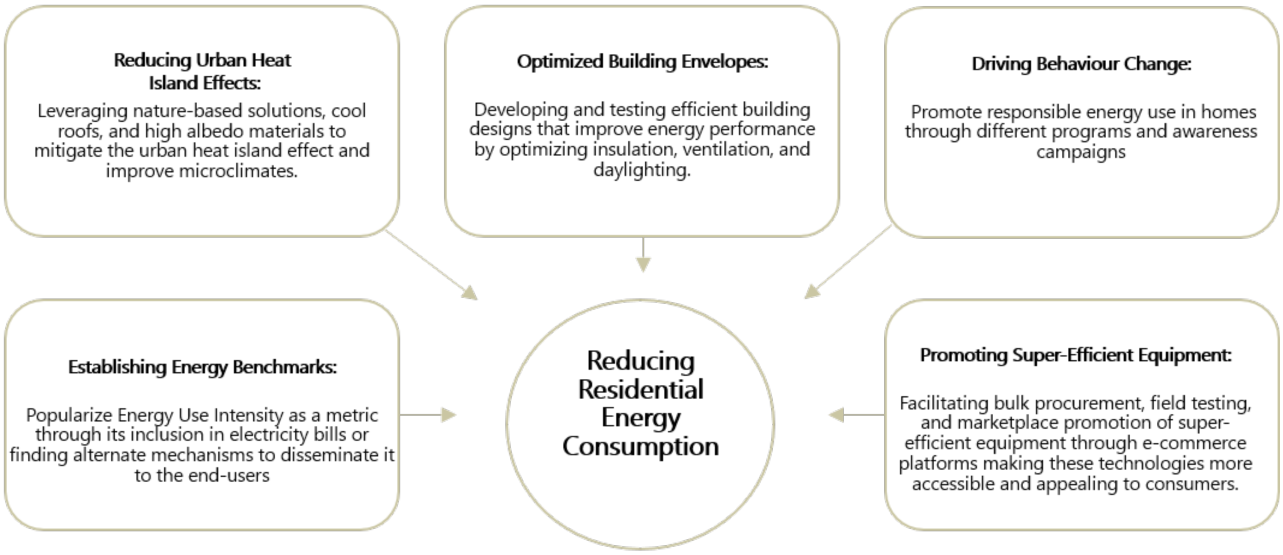


Exhibit 3: Levers for reducing residential energy consumption (Net Zero Urban Accelerator, RMI)

Key Objectives of UrjaAnk

Energy Performance Benchmarking: Establish operational energy benchmarks tailored to India's diverse climates, housing typologies, and socio-economic realities.

1. **Developing Energy Use Models**: Creating calibrated models of household energy consumption patterns in partnership with residents to guide decision-making.
2. **Establishing New Benchmarks**: Setting realistic, location-specific standards for energy use intensity in residential buildings across varying climates.
3. **Supporting Policy and Standards**: Providing data-backed recommendations to strengthen India's energy labelling and building standards, making them more applicable for operational settings.
4. **Promoting Behavioural Change**: Encouraging sustainable energy use practices among residents through educational initiatives and accessible, transparent energy consumption data.

UrjaAnk exemplifies a holistic approach to addressing residential energy challenges, combining innovative design solutions, robust data analytics, and consumer empowerment. By leveraging insights from Lodha's

Palava City, it aims to create a scalable framework that can redefine energy efficiency standards across India's residential sector and contribute meaningfully to the nation's net-zero targets.

Objectives of the Household Energy Survey under UrjaAnk

The household energy survey under UrjaAnk serves as a cornerstone for understanding and addressing the energy consumption patterns of urban residential units in India. Conducted with Palava City as a "living lab," this survey provides the foundational data necessary to benchmark energy performance, promote sustainable practices, and guide policy and market interventions. The framework and findings are designed to be scalable across diverse Indian climates and housing typologies, enabling targeted energy efficiency improvements at a national level.

Primary Objectives

Standardise Energy Data Collection:

- Develop a comprehensive, regionally adaptable household energy survey template that captures diverse variables, including energy use patterns, operational schedules, and occupant preferences.
- Create a reliable baseline for residential energy benchmarking, paving the way for actionable interventions.

Build Energy Models for Decision-Making:

- Create calibrated energy and thermal simulation models to inform decisions on energy-saving measures.
- Utilize insights to enhance building envelope designs, optimise cooling systems, and identify behavioural interventions.

Support National Energy Standards:

- Provide operational energy consumption data to refine existing residential rating systems, such as LEED, GRIHA, IGBC, EDGE, GEM, ENS, and the BEE Star labelling System.
- Align findings with ongoing energy labelling initiatives to promote widespread adoption.

Promote Consumer Awareness and Engagement:

- Develop initiatives like "Know Your Energy Consumption" (KYEC) and the Home Energy Rating System (HERS) Index to encourage residents to adopt energy-efficient practices.
- Provide residents with clear energy performance insights to support informed decision-making.

Strategic Importance

The survey quantifies energy consumption patterns and contextualises them within household behaviours, appliance penetration, and environmental conditions. By engaging residents directly, the survey identifies actionable opportunities to enhance energy efficiency while maintaining comfort and convenience.

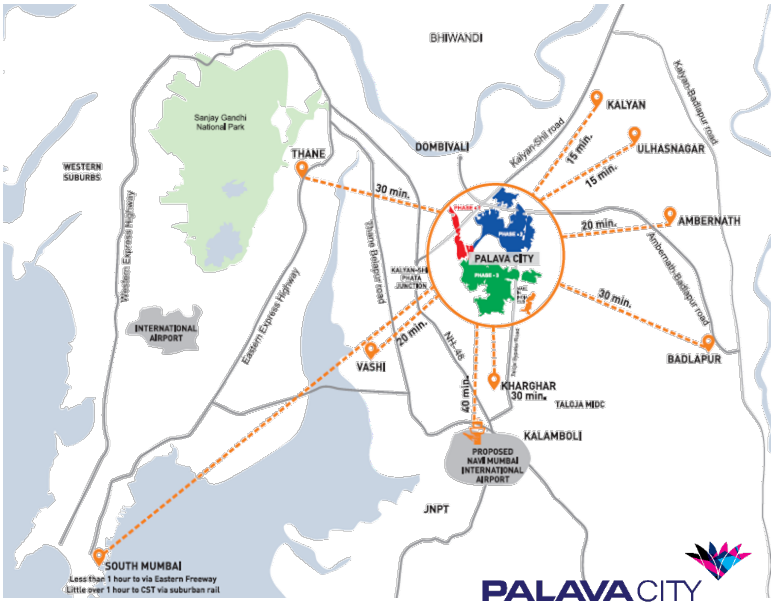
National Scaling Potential

The survey framework is designed for replication beyond Palava City, creating opportunities for:

- **Nationwide Benchmarks:** Establishing comparative energy performance data across urban and rural households.
- **Policy Development:** Informing region-specific energy efficiency policies for the residential sector and incentives to drive consumer and developer adoption.
- **Digital Integration:** Leveraging technology to scale survey implementation through digital platforms and smart metring.

The UrjaAnk survey demonstrates how systematic data collection, combined with community engagement, can create a blueprint for scaling residential energy efficiency solutions across India.

Palava City as a Living Lab



Palava City, a 4,500-acre smart city development located in Dombivli East within the Mumbai Metropolitan Region, serves as the ideal "living lab" for UrjaAnk. Developed by Lodha, Palava is designed with sustainability and modern urban living in mind, incorporating innovative building designs, energy-efficient infrastructure, and advanced urban planning.

Phase I of Palava was completed in 2016, encompassing approximately 300 acres and delivering 18,026 residential units by 2017 according to Lodha's official reports.t 15i6. The second phase is currently underway, with a vision to deliver 100,000 residential units by 2030 making it one of India's most ambitious urban projects.7. Its unique demographic and urban design features make it a representative microcosm for studying energy use patterns and testing scalable interventions in India's rapidly urbanising landscape.

Exhibit 4: Palava city layout and master plan

Geographical and Climatic Context

Palava City is situated within a warm and humid climatic zone, characterised by:

- Latitude and Longitude: 19.21°N, 73.08°E
- Elevation: 10 metres above mean sea level8
- Environmental Challenges: High cooling loads driven by climatic conditions and urban heat island effects.

These attributes make Palava a relevant testing ground for energy efficiency strategies, particularly those related to cooling and ventilation.

Urban Design Features

Palava's design incorporates several elements aimed at reducing energy demand and enhancing sustainability:

a) Reflective Surfaces: Light-coloured facades and reflective materials to reduce cooling loads.
b) Passive Design:
   - North-south building orientation to minimise heat gain.
   - Energy-efficient glazing and window shading to improve thermal comfort.
c) Green Spaces: Strategically placed water bodies, parks, and green areas to mitigate urban heat.

These features set a baseline for evaluating the impact of design on operational energy consumption.

[6] *Lodha Annual Report, 2017*

[7] *Economic Times, 2019: "Lodha's Vision for Palava City"*

[8] India Meteorological Department (IMD), 2020: "Climate Data for Dombivli Region"

Methodology of the Household Survey

The household survey conducted under the UrjaAnk programme was meticulously designed to gather in-depth insights into energy consumption patterns, appliance usage, and resident behaviours in Palava City. The survey methodology ensured the collection of comprehensive, high-quality data while engaging residents to foster awareness about energy efficiency. The data serves as the foundation for creating benchmarks, calibrating energy performance models, and identifying targeted interventions to improve residential energy efficiency.

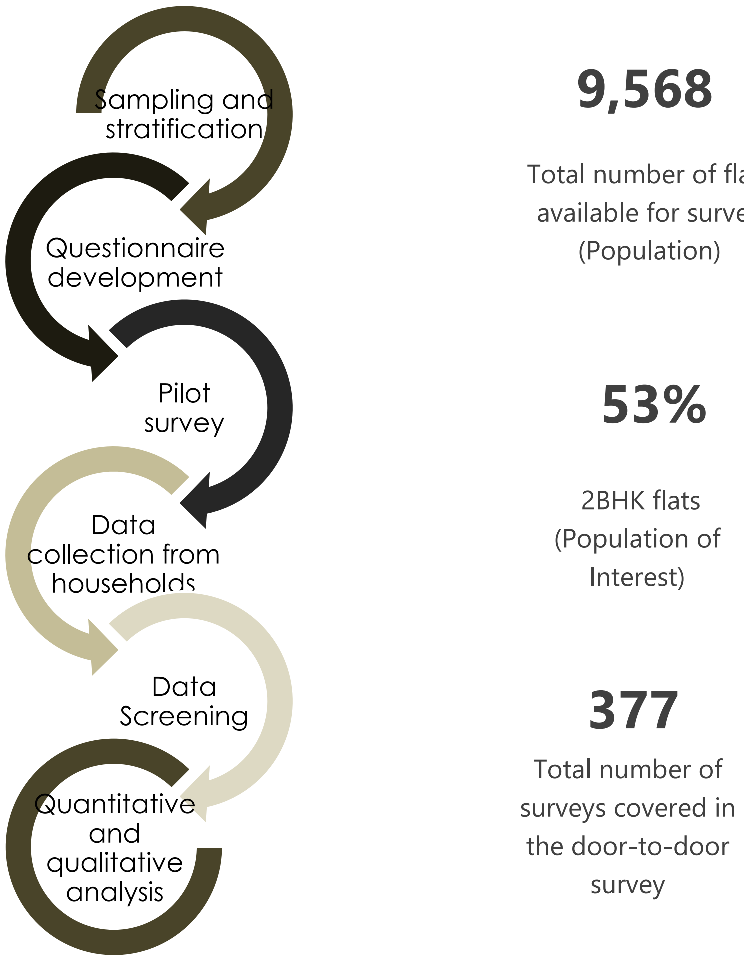


Exhibit 5: UrjaAnk's Residential survey methodology at a glance

Survey Design

The survey focused on:

- *Capturing Diverse Variables:* Appliance ownership, energy-saving practices, occupancy trends, and socio-demographic details.
- *Outcome-Oriented Questions:* Structured to identify actionable insights, such as the impact of cooling loads, appliance efficiency, and behavioural patterns on energy use.

Sampling and Stratification

The survey adopted a stratified random sampling method to ensure representation across different residential units:

- **Target Units:** Focused on 2BHK apartments, which represent 53% of Palava's housing stock and provide a controlled variable for analysis.

- **Sample Size:** Conducted door-to-door surveys across 377 households. Data from 240 households were ultimately analysed after screening for accuracy and completeness.

This stratification ensured an accurate assessment of energy consumption beyond the variability introduced by unit size.

Survey Implementation

The survey was conducted by engaging local community members, including teachers and Senior secondary grade students from Lodha World School, to foster a sense of ownership and participation:

1. Community-Led Execution:

Students were trained to conduct the surveys, serving as "energy champions" within their neighbourhoods. This approach enhanced community awareness while ensuring detailed and accurate data collection.

2. Pilot Testing:

The survey was pilot-tested to identify and resolve potential issues, ensuring the questionnaire's effectiveness and relevance.

Survey Questionnaire

The questionnaire was designed in collaboration with key stakeholders, ensuring comprehensive coverage of energy-related variables. The questionnaire provided both quantitative and qualitative insights, enabling a holistic understanding of residential energy dynamics.

Category	Description
Respondent Information	Respondent ID, Resident Name, Occupation, Ownership Type, Flat No., Block/Wing, Apartment Name/Cluster. Data Privacy: No personal data regarding individual household members beyond necessary identifiers.
Household Composition	Details on the number of household members, their gender, age bracket, and their roles. Occupancy: Information on whether the house is occupied year-round.
Space Utilisation	Space utilisation within the house during weekdays and weekends.
Equipment Utilisation, Usage patterns, and appliance categories	Appliance usage (hours) during weekdays and weekends. Specific Appliance Categories: Comfort and Convenience Appliances, Kitchen Appliances, Washroom Appliances, Miscellaneous Appliances.
Energy-Saving Practices	Information on whether the household practices switching off appliances when not in use, and who is responsible (kids, parents, grandparents).
Air Conditioner usage practice	Preferred AC set point temperature, months when AC is used, cooler usage months, fan usage months.
Lifestyle and Behaviour	Information on relaxed clothing habits at home and seasonal changes. Smart Home Devices: Use of smart devices like Alexa, Google Home, etc.
Transportation and Vehicle Use	Type of vehicle owned, and total kilometres driven.
Cooking Fuel	Amount of cooking gas used (cylinders), piped natural gas billing information.
Appliance Purchasing Preferences	Rating of factors from most to least important when purchasing home appliances.

Awareness of Energy Efficiency	Awareness of star-labelling on appliances, perceived benefits, and knowledge of star-labelling on ACs Geysers, and other appliances provided by the developer.

Exhibit 6: Topics covered in the questionnaire

Data Analysis

Following data screening, data was examined using mixed-mode approaches for quantitative and qualitative analysis:

Type of Analysis	Methods	Description	Results
Quantitative	Descriptive and inferential statistical methods	EPI determined for each flat in kWh/m^2. Year and adjusted for factors such as occupant count, appliance usage intensity, and external adjacencies of the units	Uncovered patterns in energy usage, frequency distributions, and correlations. Details available in the result section
Qualitative	Grounded theory and coding approach	Used responses from the residents to analyse qualitative data such as usage hours, housing operation patterns, awareness, etc.	Identified common themes related to residents' preferences for equipment purchases and their awareness of energy efficiency measures

Exhibit 7: Methodology for data analysis

Stakeholder Engagement

The survey was conducted in close collaboration with residents, developers, and local authorities to:

- Enhance Relevance**:** Tailor data collection to address stakeholder priorities.
- Build Trust**:** Ensure transparency and buy-in from participants.
- Drive Awareness**:** Educate residents on the importance of energy efficiency and their role in reducing energy demand.

Key Outcomes

The survey methodology allowed for:

- Reliable Benchmarks**:** Creation of an EPI baseline for Palava households.
- Scalable Framework**:** Development of a replicable survey model for urban and semi-urban settings across India.
- Resident Engagement**:** Cultivation of a sense of ownership and responsibility among residents for energy conservation.

The methodology ensured the collection of high-quality data and instilled a culture of energy efficiency within the community.

Survey Findings

The household energy survey conducted under UrjaAnk provided valuable insights into the energy consumption patterns, appliance usage, and behavioural trends of Palava City residents. These findings are critical for benchmarking energy performance, designing targeted interventions, and promoting sustainable energy practices in the residential sector.

Demographic Insights

a) Age Distribution:

The population of Palava exhibits a youthful demographic, with 68.1% of residents concentrated in the 10–20 and 30–45 age groups. Notably, approximately 40% of the population is under 20 years old, presenting a significant opportunity to instil long-term energy-saving behaviours. A balanced gender distribution across age groups further supports the potential for widespread engagement in energy efficiency initiatives.

b) Family Structure:

The majority of households (close to 60%) in Palava are nuclear families, typically comprising four members. This consistent household structure offers a manageable and relatable target group for energy awareness campaigns. The development's phased occupancy patterns—most residents having settled in since 2019, with a marked increase in 2021—highlight the growing potential for community-wide energy interventions.

c) Occupancy Trends:

Most homes in Palava are occupied year-round, with peak occupancy observed during evenings and weekends. These patterns significantly influence peak energy demand, emphasising the need for targeted energy-saving strategies during high-usage periods.

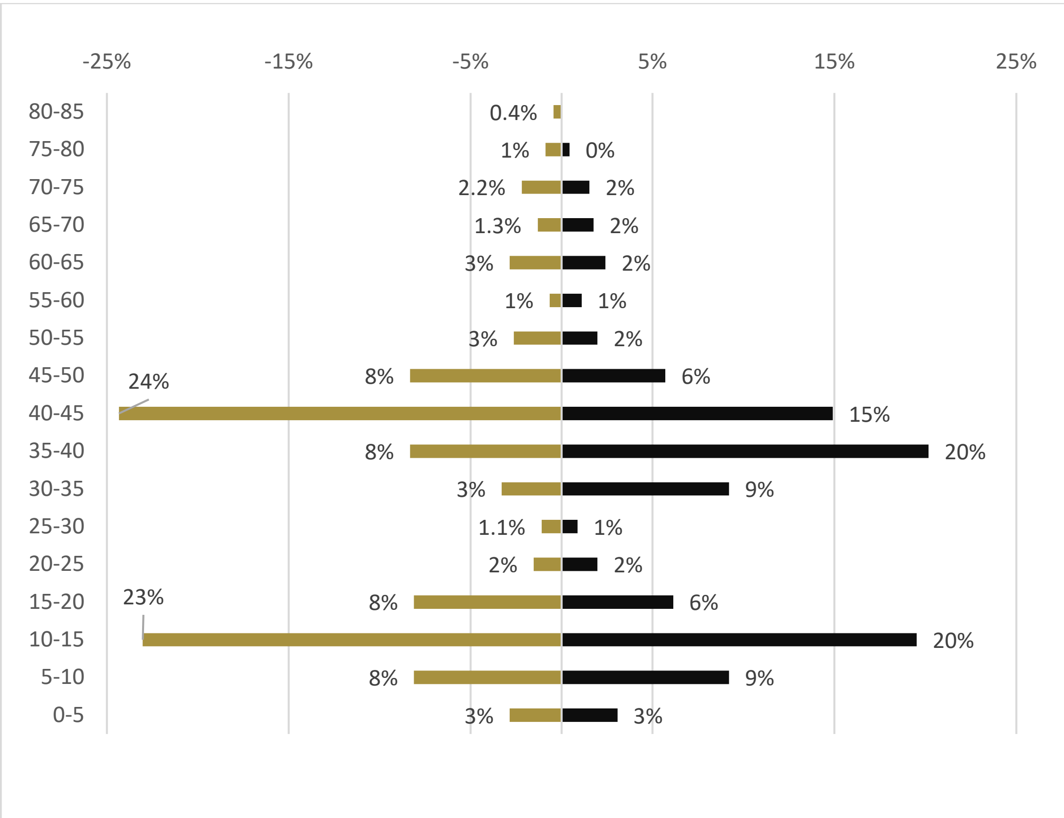


Exhibit 8: Age and gender distribution in Palava

d) Ownership Patterns:

Approximately 70% of Palava homes are owner-occupied, creating a favourable environment for implementing long-term energy efficiency measures and retrofitting initiatives. Owner-occupants have greater autonomy in making decisions related to their homes, enhancing the feasibility of adopting sustainable solutions.

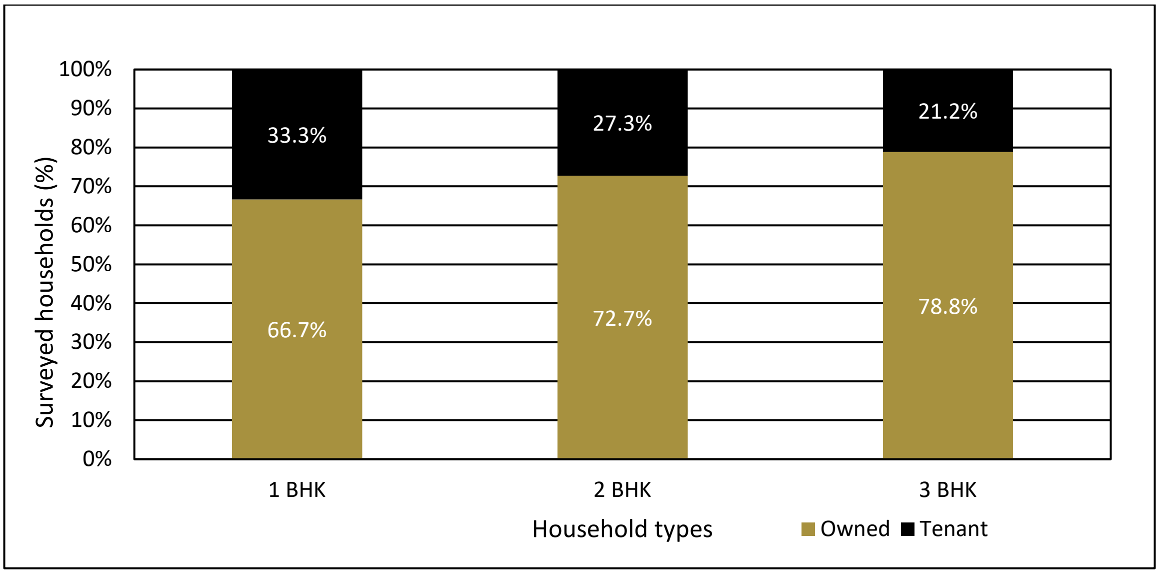


Exhibit 9: Home Ownership in Palava

Strategic Implications

- The youthful demographic and nuclear family structures provide a strong basis for designing tailored energy-saving campaigns, particularly focused on behaviour change and education.
- High ownership rates ensure direct engagement with decision-makers, enabling effective implementation of retrofitting and energy efficiency initiatives.
- Understanding occupancy trends pave the way for targeted interventions during peak demand periods, improving overall energy performance.

The survey findings underline the potential for leveraging Palava's demographic and behavioural characteristics to drive meaningful energy efficiency outcomes. These insights contribute to developing scalable models for residential energy interventions across other urban communities.

Appliance Ownership and Purchase Behaviour

Exhibit 11 below illustrates the penetration of various household appliances in Palava compared to their penetration rates across India, as reported by CLASP. The data highlights significant differences between Palava and the national average, particularly for air conditioner and refrigerator ownership, with 100% penetration in Palava compared to 31% and 80%, respectively, at the national level. Other appliances, such as laptops (93% in Palava vs. 22% in India) and washing machines (83% in Palava vs. 47% in India), also show higher penetration rates in Palava. This suggests that residents of Palava have greater access to and usage of a wide range of household appliances compared to the broader Indian population.

Appliance	Penetration in Palava	Penetration in India (CLASP)
Air Conditioner	100%	31%
Refrigerator	100%	80%
Laptop	93%	22%
Washing machine	83%	47%
Mixer	76%	60%
Mobile phone	71%	90%

Geyser	100%	30%
Cloth iron	58%	NA
Kitchen Hood/Chimney	40%	13%
Microwave/Oven	36%	15%
Vacuum cleaner	14%	6%
Induction cooker	12%	6%
Air purifier	2%	NA

Exhibit 10: Appliance penetration at Palava.

Further, exhibit 12 below, provides an idea about the penetration of different star-labelled appliances in Palava. It can be seen that around 40% of fans are 5-star rated, and 90% of appliances in Palava have at least a 3-star rating, reflecting a strong awareness of energy efficiency among residents. The air conditioning units in the households were 3-star rated in the older buildings (until 2020). The latest procurement policy of Lodha has mandated the provision of 5-star rated AC units in the new housing units at Palava.

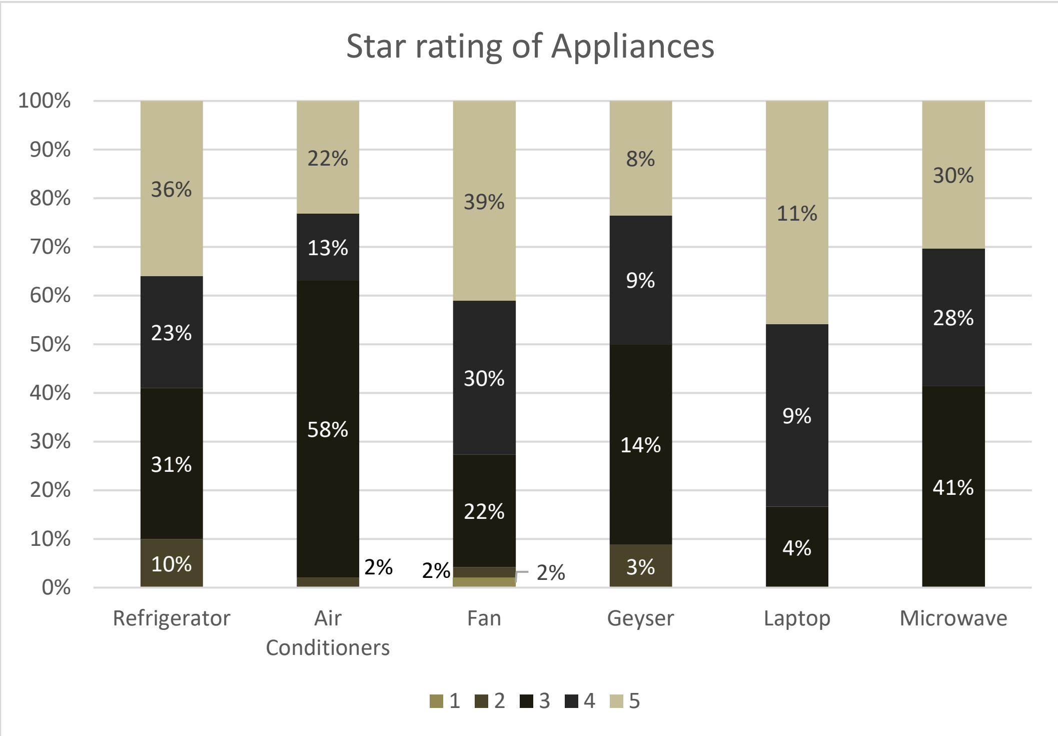


Exhibit 11: Star Ratings of different appliances

Exhibit 13 below illustrates the breakdown of average daily energy consumption in Palava households, accounting for 8.38 kWh daily. The data reveals that air conditioners are the largest energy guzzlers, accounting for 36% of total daily energy use. Refrigerators follow at 22%, while fans contribute 18%. Other significant contributors include washing machines (11%), geysers (9%), and various other appliances, which together account for 9% of daily energy consumption.[9].

This breakdown highlights the dominance of cooling appliances (air conditioners and fans) in household energy consumption, underscoring the importance of focusing on energy-efficient solutions in these areas to reduce overall energy demand. The data serves as a foundation for identifying targeted interventions that could help lower household energy use and improve efficiency. Further, it allows us to understand the

[9] Disclaimer: the share of energy consumption reported is estimated based on the data collected in the household survey, as per the recollected inputs from the residents.

daily energy consumption per household that could be compared with other large-scale developments in cities.

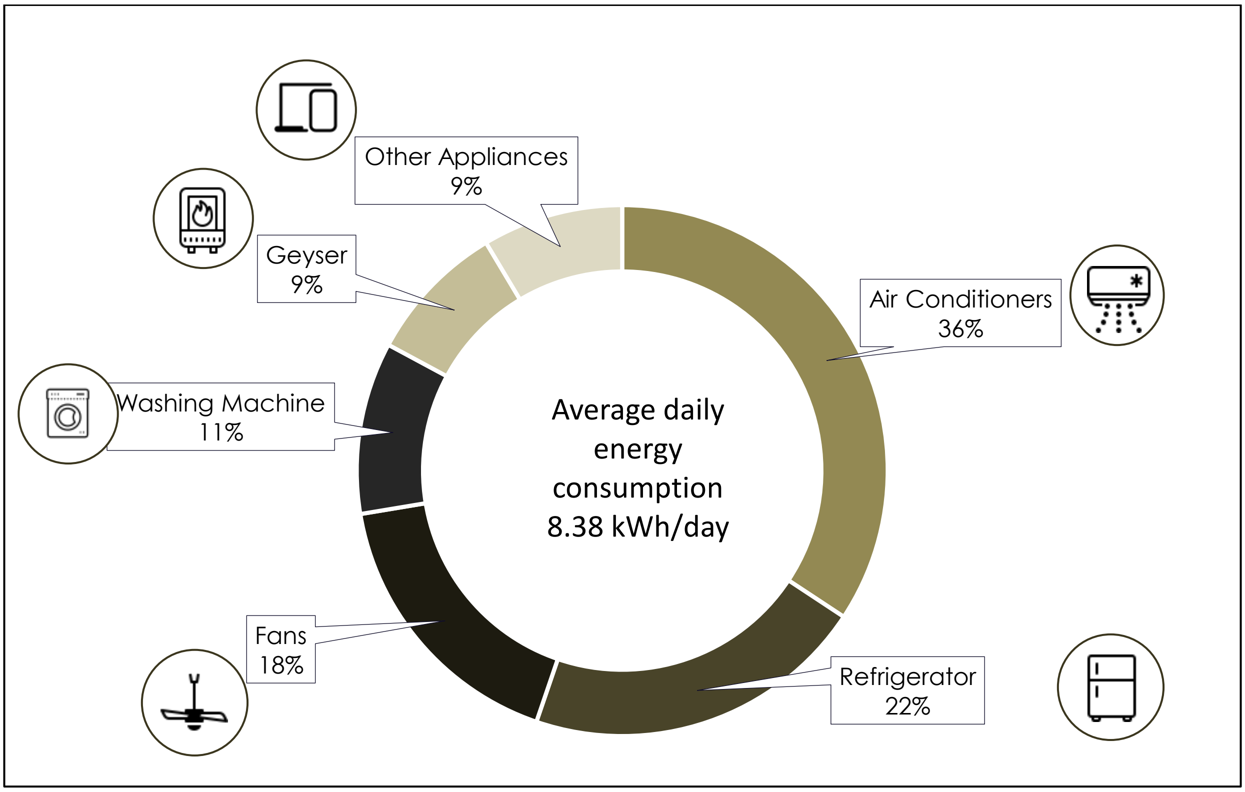


Exhibit 12: Peak daily energy use of a household.

Occupancy and Appliance Operation Schedules

The analysis shows that households are more occupied throughout the day on weekends compared to weekdays, where occupancy peaks in the evening and night as shown in Exhibit 14.

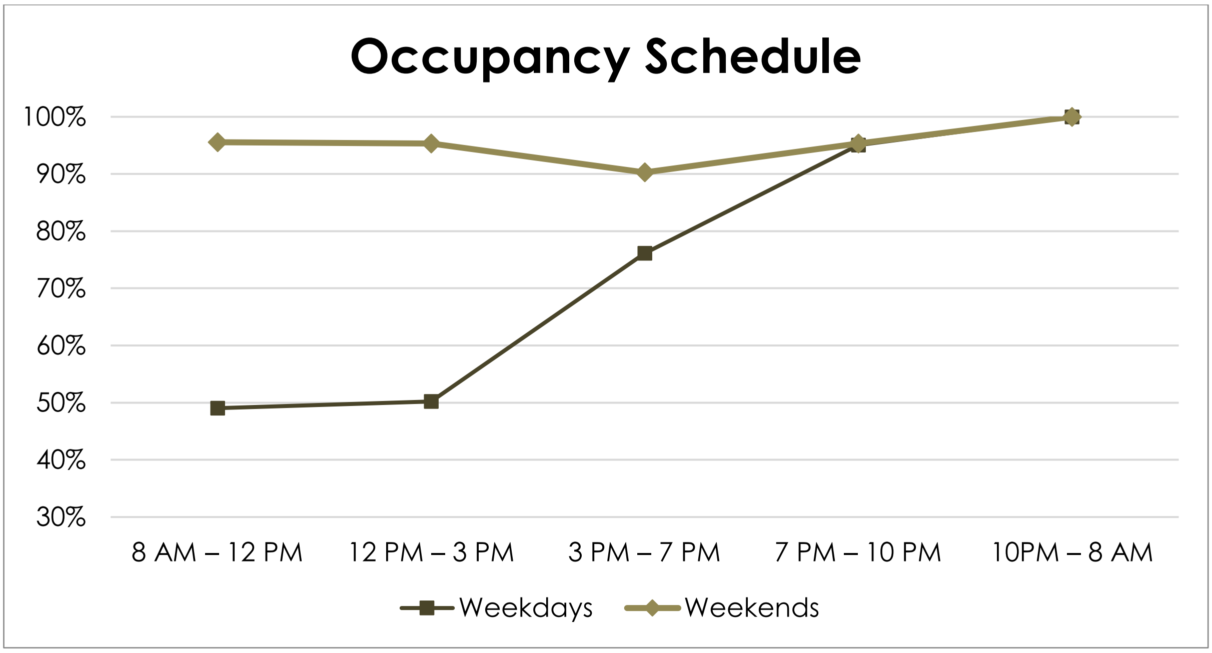


Exhibit 13: Occupant space utilisation

Exhibit 15 indicates a strategic approach to optimise thermal comfort and energy efficiency by residents of Palava. Natural ventilation through windows is predominantly used during the day, supported by fan operation. Air conditioners are utilised primarily during peak heat periods i.e., late afternoon, evening, and night hours to maintain indoor temperatures.

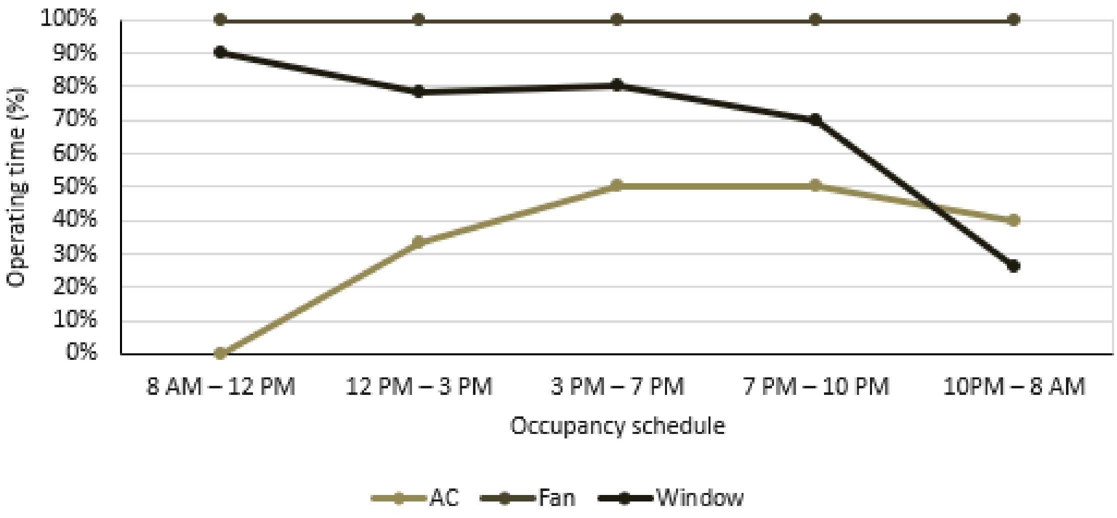


Exhibit 14: AC, Fan, and window operation

Energy Performance Analysis

Exhibit 16 shows the share of households lying in the monthly energy consumption ranges of low, medium, and high (Low energy consumers – Up to 177 kWh/month, medium energy consumers – 177 to 355 kWh/month, and High Energy Consumers – Above 355 kWh/month). Monthly energy consumption among Palava households shows seasonal variations, with up to 97% of households falling under the low to medium energy consumers during the cooler months of January to March and up to 41% of households consuming high energy during the peak summer period of April to June.

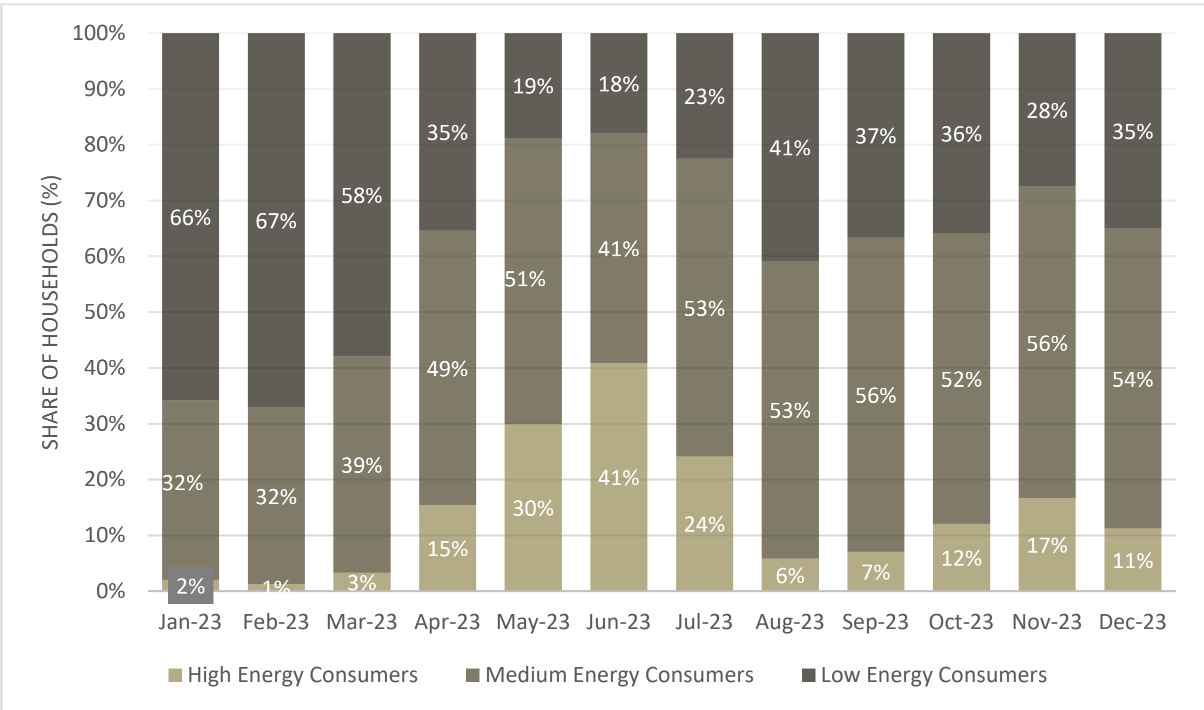


Exhibit 15: Energy consumption range for the year 2023-24 at Palava.

The median Energy Performance Index (EPI) of the households is estimated to be 43 kWh/m². Year as shown in Exhibit 17. Three EPI ranges are defined to classify the energy intensity in the households (Low EPI range - 0 to 30 kWh/m². year, Medium EPI range - 31 to 50 kWh/m². year, and High EPI range - Above 50 kWh/m². year). About 43% of households have High EPIs, driven by the extensive use of appliances, particularly air conditioners.

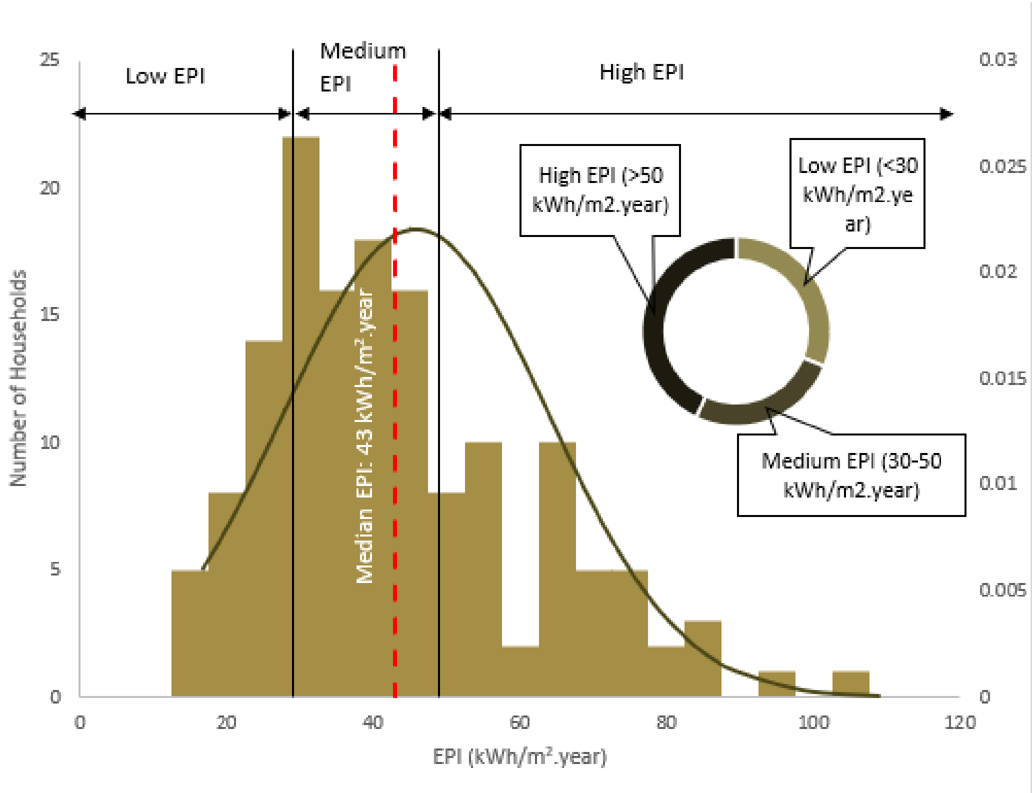


Exhibit 16: EPI distribution across the households of Palava. Energy consumption among Palava households shows seasonal variations, with 55-70% of households using low energy (less than 177.5 kWh/month) during the cooler months of January to March and up to 37% of households.

Households with three and four AC units[10] Have a wider range of EPI values, suggesting variability in energy usage based on factors such as operational habits and number of occupants per household shown in Exhibit 18. The 2 BHK households having 3 AC units show a higher intensity of EPI per AC unit, whereas there is a fall in energy use per AC unit in the households with 4 AC units, which can be attributed to not all air conditioners being operational. 62% of the households prefer a setpoint temperature of more than 24 °C while the rest of the households prefer a setpoint lower than 24 °C indicating the need for awareness raising among residents of Palava.

[10] Third and fourth air conditioning units are generally installed in the living room and study room respectively.

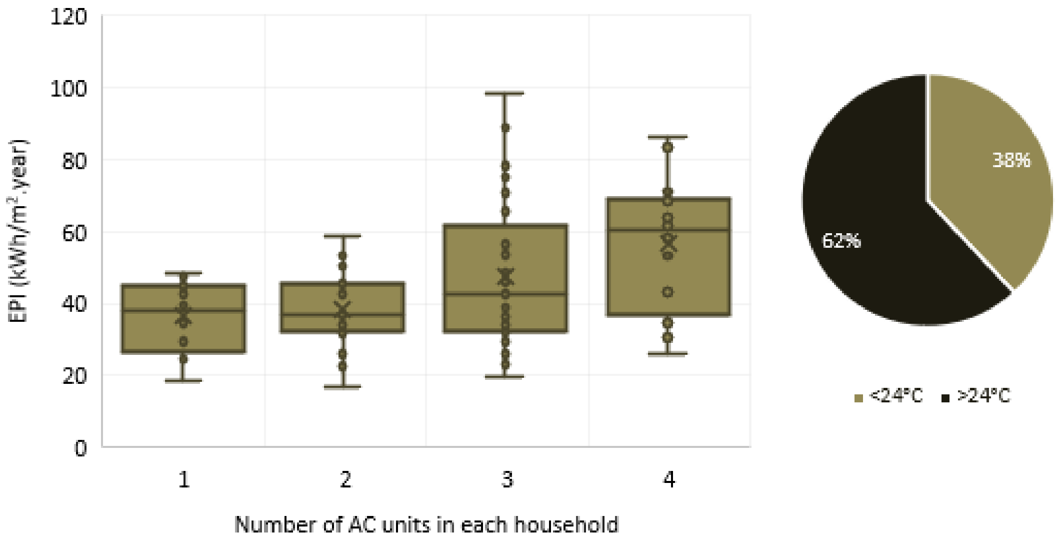


Exhibit 17: AC energy consumption and preferred setpoint.

The survey results revealed key insights into the energy consumption patterns of urban residential homes, highlighting significant areas for potential energy savings. Clear trends were observed in appliance usage, energy-intensive activities, and household behaviours that impact overall energy consumption in residential units. The findings pointed to critical areas such as optimising cooling loads, managing peak electricity consumption, and increasing awareness of energy-saving practices. These insights formed a solid basis for designing targeted interventions to reduce energy consumption while ensuring residents' comfort is ensured at all times.

Building on these findings, the next phase of the programme involved a comprehensive stakeholder consultation. The key stakeholders, including policymakers, developers, and energy experts, were invited to review and deliberate on the findings from the survey data. This consultation aimed to explore how the survey insights could inform future energy efficiency initiatives and policy frameworks at the Indian level and how large-scale developments can play an important role in achieving India's net zero goals.

Catalysing Transformation through Energy Performance Transparency in India's Real Estate Sector

The **UrjaAnk programme,** under the **Net Zero Urban Accelerator**, has identified significant opportunities for driving transformative changes in India's residential real estate sector through energy performance transparency. These recommendations provide a comprehensive roadmap for establishing a robust energy efficiency framework to support India's sustainability and climate goals, particularly achieving its Nationally Determined Contributions (NDCs) and the net-zero target by 2070.

A roundtable discussion on UrjaAnk under the **Accelerator Dialogue series** was conducted on September 4th, 2024, and attended by 18 key experts from various sectors including government institutions, academia, building sector professionals, developers, and green building rating agencies. Exhibit 19 shows a few snapshots.

Highlights from the UrjaAnk Roundtable under the Accelerator Dialogue series:

Objectives of the Roundtable

- **To Present and Discuss:** Share detailed insights into the UrjaAnk initiative's methodology, approach, and findings on residential energy consumption.
- **Develop Collaborative Ideation:** Evaluate survey methodologies and deliberate upon requirements to develop a calibrated energy model for residential building energy performance metrics and benchmarks.
- **Forge Partnerships and Strategic Alignment:** Align the initiative with national energy efficiency initiatives and enhance existing benchmarks, such as those by BEE and Green Building Rating systems.

Key questions discussed during the roundtable were:

- What should be the energy metric when considering residential energy benchmarks? - kWh/m^2, kWh/person, kWh/household or any other metric?
- What are the factors that should be kept in mind while normalising the residential energy benchmarks?
- What strategies and actions should be adopted to mainstream and popularise the preferred metric for the policymakers, utilities, developers, and residents?

Exhibit 18: Snapshot from UrjaAnk roundtable

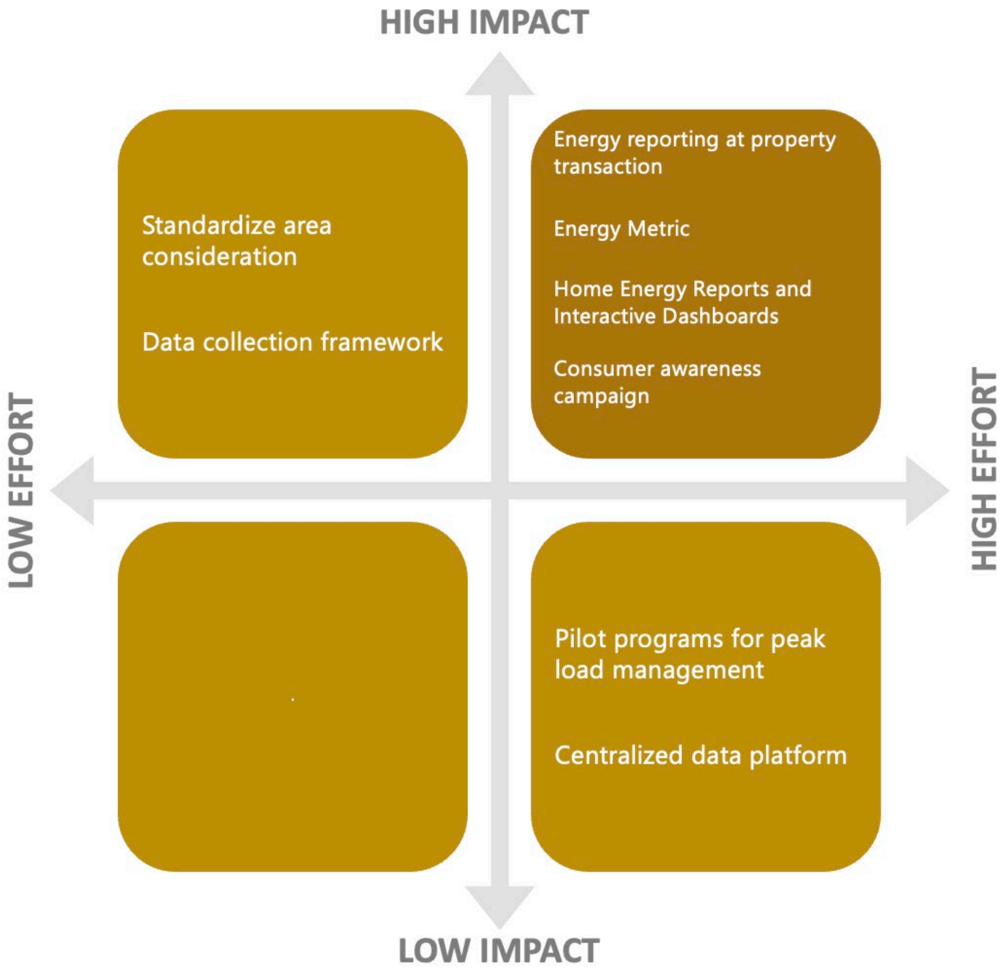
Key barriers and opportunities identified during the stakeholder Consultation:

Focus Area	Barriers	Opportunities
Energy Metrics and Data	• **Lack of Standardisation**: Standardizing metrics like kWh/m², kWh/person, and kWh/household is challenging due to the diversity of building types, functions, and occupancy patterns. One metric may not fit all scenarios, leading to potential misinterpretations. • **Varying Area Definitions**: Different definitions of building areas (carpet area vs. built-up area) create inconsistencies in energy benchmarking, making cross-comparison difficult.	• **Centralized Data Platform:** Collaborate to support the development of a centralised platform that aggregates energy data from smart meters and utilities, allowing for consistent and comprehensive data collection at the city level. • **Stakeholder-specific Energy Metrics:** Use kWh/m² for building designers, engineers, and regulatory provisions to account for physical attributes and kWh/person or kWh/household for consumer engagement in partnership with DISCOMs and developers to reflect personal consumption patterns of end-users. • **Standardize Area Considerations:** Define and standardise area measurements and calculations across the industry (e.g., carpet area, built-up area, or super-built area) to facilitate more accurate comparisons.
Data Normalisation	• **Inconsistent Data Collection formats**: Energy data comes from various sources, including smart meters, utility records, and consumer self-reporting. The inconsistency in data collection methods and reporting templates across these sources makes normalisation challenging, as it is difficult to establish a uniform baseline for comparison. • **Limited or no inclusion of demographic factors:** While geographic data for normalisation is becoming increasingly available, socioeconomic factors such as income levels, energy	• **Data Collection Framework:** Develop an inclusive data collection template that includes parameters such as household income, energy affordability, occupancy patterns, appliance ownership and usage, and energy consumption to enable comprehensive normalisation. • **Segmentation of normalisation metric:** Use segmentation by income groups (Low Income Group, Middle Income Group, High Income Group) for targeted interventions. In addition, normalisation should be categorized based on geographic and localized climate information.

	affordability, and access to energy-efficient technologies are often not fully factored in while developing the energy performance benchmarks.	
Consumer Engagement	• **Complexity in Understanding Metrics**: Consumers may find metrics like kWh/person or kWh/household challenging to understand and relate to their daily energy use. This lack of comprehension can limit the effectiveness of these metrics in driving behavioural change toward energy efficiency. • **Limited Awareness of Energy Efficiency**: There is a notable lack of awareness among consumers about energy-efficient appliances, such as 5-star rated devices. This gap in knowledge hinders the adoption of energy-efficient practices and retrofitting in residential settings.	• **Interactive Dashboards**: Develop an integrated dashboard that is interactive and user-friendly, providing households with real-time insights into their energy consumption and usage patterns. The dashboards can be integrated into the facility management mobile applications. • **Home Energy Reports**: Introduce Home Energy Reports to enable households to compare their energy performance with similar household units within the neighbourhood. • **Awareness Campaigns**: Launch awareness campaigns to educate consumers about the benefits of energy-efficient appliances and retrofitting, emphasising the long-term cost savings and environmental benefits to encourage adoption.
Peak Load Management	• **Limited understanding of benefits of peak load management**: Households often focus more on their total energy bills rather than peak demand implications; the concept of peak load management does not directly align with consumer priorities or requirements without any incentives. • **Limited Smart Meter Deployment:** The effective management of peak demand relies on the availability and accessibility of smart meters and user-friendly interfaces. The current limited deployment of such technologies restricts consumers' ability to manage	• **Pilot Schemes for Peak Load Management and incentive identification**: Develop and implement pilot schemes aimed at peak load management and demand response. These schemes should explore optimal strategies and best practices that work for reducing the household energy peak demand and benefiting both consumers and utilities. • **Increase Smart Meter Accessibility**: Expand the deployment of smart meters across residential sectors to enable more effective monitoring and management of energy consumption, allowing consumers to participate in demand response initiatives. • **Consumer Education on Peak Demand**: Educate consumers about

	their energy consumption effectively. • **Privacy and Technological Barriers**: Concerns regarding data privacy, convenience, and unfamiliarity with new technologies inhibit consumer participation in demand response and other energy-saving initiatives.	the benefits of reducing peak load, not just for the grid but also for their potential cost savings. Highlight opportunities for savings through time-of-use pricing and demand response incentives.

These discussions with key stakeholders identified strategic, high-impact interventions that can provide immediate benefits while establishing a foundation for scalable and sustainable change, driving the clean energy transition in India's building sector. The key outcomes are summarised in the following section.



Conclusion and Way Forward

The **UrjaAnk programme** has the potential to make a significant impact on India's journey toward a sustainable, energy-efficient future. The residential sector accounts for approximately 24% of the nation's total electricity consumption, making it a critical area for energy improvements. By introducing a standardised energy performance metric tailored to India's diverse housing landscape, UrjaAnk can drive the widespread adoption of energy-efficient practices, setting new benchmarks for sustainable real estate development.

Key Focus Area	Key Contributions of UrjaAnk	Way Forward
Regulatory Integration	***Supporting Regulatory Frameworks:*** Data-driven insights from UrjaAnk can inform updates to national, state, and local policies, embedding energy efficiency into urban development.	***Collaborating with Policymakers:*** Partner with national, state, and local governments to integrate UrjaAnk's insights into energy-efficient urban planning guidelines, updating building codes and encouraging green certification systems tailored to urban contexts.
Ecosystem Development	***Catalysing Industry Collaboration:*** UrjaAnk fosters collaboration between developers, ESCOs, financial institutions, and technology providers, enabling new financial products and retrofits.	***Building a Collaborative Ecosystem:*** Co-develop and pilot innovative, energy-focused consumer offerings with aligned industry stakeholders, ESCOs, and financial institutions. These include new purchases, retrofits, and financial products, all anchored in UrjaAnk's metrics as a foundation for decision-making.
Consumer Engagement	***Promoting Consumer Awareness:*** Enhances consumer awareness about energy-efficient homes, driving demand and incentivising sustainability among developers.	***Consumer-Focused Outreach:*** Develop targeted consumer campaigns to highlight the economic and environmental benefits of energy-efficient homes, leveraging UrjaAnk's insights to personalise messages based on regional consumer energy behaviour and preferences (piloting at Palava).
Data Utilisation	***Enabling Data-Driven Decision-***Making: UrjaAnk provides a comprehensive energy performance database for policymakers and developers to inform sustainable urban design and development.	***Scaling Data Utilisation:*** Use UrjaAnk's database to create predictive models for energy usage trends in urban developments. Share findings with developers and policymakers to design energy-efficient buildings and optimise infrastructure at scale.
Peak Load Management	***Managing Peak Load:*** Analysing energy benchmarking and consumption patterns can identify contributors to peak demand, helping utilities and policymakers implement	***Dynamic Demand Response Strategies:*** Design and implement demand response Schemes such as dynamic pricing and energy-efficient air conditioning initiatives to shift consumption to off-peak hours. Launch initiatives like "Know Your Energy Consumption" to educate consumers on their usage patterns and encourage behavioural changes that reduce peak demand.

	targeted demand-side interventions.	

A Model for Sustainable Urban Growth

UrjaAnk represents a transformative step toward sustainable urban living by promoting energy transparency, fostering collaboration, and empowering consumers. By addressing operational energy data gaps and driving policy innovation, UrjaAnk aligns with India's sustainability objectives, offering a scalable model for the broader residential sector.

The Lodha Net Zero Urban Accelerator, with Palava City as its living lab, will continue to pioneer integrative solutions, demonstrating how urban growth can align with low-carbon development. UrjaAnk envisions setting a benchmark for sustainable real estate practices in India and contributing meaningfully to achieving the nation's 2070 net-zero emissions target.

About Lodha Net Zero Urban Accelerator

The Lodha Net Zero Urban Accelerator, launched in July 2022, in collaboration with RMI India Foundation, is a pioneering initiative with an overarching goal to make net zero the new normal for the built environment, thereby accelerating and maximising the building sector's contribution to India's 2070 net-zero emissions target. The Accelerator focuses on enhancing resilience, health, affordability, and access to energy services for all by developing actionable initiatives in five key areas: Embodied Carbon, Passive Design Solutions, Efficient Equipment, Clean Energy, and Clean Mobility.

The flagship Palava city project by Lodha will serve as a unique living laboratory for the accelerator and a lighthouse example by bringing together industry, sector experts, end users and eventually policymakers to build integrative sustainable solutions at the city scale. The programme will enable Lodha to offer a development template that can demonstrate — to India and the world — that growth decoupled from emissions is possible. It will also be a resource hub and a go-to platform for industry and policymakers charting India’s decarbonisation journey.