“An Evidence-based Approach to Assess the Energy Transition in Clean Cooking”

National Institute of Advanced Studies,

IISc Campus, Bengaluru-560012

Rudrodip Majumdar

Rajeev Kumar

August 2024

Led by Funded by With

Loughborough University UK Government ESMAP

THIS MATERIAL HAS BEEN FUNDED BY UK AID FROM THE UK GOVERNMENT; HOWEVER, THE VIEWS EXPRESSED DO NOT NECESSARILY REFLECT THE UK GOVERNMENT'S OFFICIAL POLICIES

Foreword

By Dr Simon Batchelor OBE MIE, MECS Director

We are delighted to present the findings of a survey of over 900 households in Bengaluru. The results are fascinating but should be used with caution.

As the authors themselves say "This is the **first of a kind study in India focused on low-to-medium-income households**. **The results cannot be compared directly** with previous studies that consider all sorts of households in completely different settings (different states, different cities, different socio-economic realities)".

This is a major step forward as a study that gives fascinating findings yet embeds a challenge for those looking to define the way forward for India. It's a step forward because it is important to understand the situation of low-income households. Yet, it presents a challenge since its selective focus makes analysis more difficult (because it can't be compared with National data).

The authors acknowledge that with **a separate 900 HH sample taken from elsewhere in and around Bengaluru City, the findings may differ by some amount**.

The findings are presented since they give interesting data and insights but should not be used as a sole source for determining national or state-wide strategies.

For instance, one of the intriguing things about this data is that a very large percentage of households **claim they only use LPG** for their cooking. At the same time, they also report a **relatively low refilling of cylinders** and a rather low annual use. This is consistent with other reports that suggest that low-income households cannot afford to or choose not to refill as much as middle to higher-income households[1]. However, while this is consistent with other surveys and reports, the statement by the household that they ONLY cook with LPG raises the question – do they eat less food, do they batch cook, do they undertake communal cooking, have they been shy of declaring ongoing alternative fuel use – what strategies do they have for cooking that enable them to use less LPG. The Authors note from their own experience that several basic food items **do not** require a lot of fuel to prepare them (i.e., they are not energy-intensive) & households have their own ways to optimize (one of the ways is to make the staple items in a single shot so that the number of major meals cooked per day comes down). Energy consumption is also dependent on the types of vessels used by the households.

[1] https://www.sciencedirect.com/science/article/pii/S2452292923000061?via%3Dihub

The quantitative survey, unfortunately, could not get information on the different foods being cooked using different vessels, since the respondents found this to be too personal and refused to share such details. Is there something we could learn for a more qualitative collection of data or an ethnographic study on the strategies low-income households employ?

Answers to questions like these would be best sought from a more qualitative/observational study. However, the study was completed within its assigned budget with no scope for a follow-up survey. MECS will seek to undertake a more qualitative survey to understand how households can use so little LPG and whether this employs energy-efficient measures.

Chapter 8 reports some innovative modelling of electricity demand attributable to an envisaged growth trajectory of the mass penetration of electricity-based residential cooking. This modelling builds on Prof Rudrodip Majumdar's wide experience in modelling many different energy systems. It takes as its starting point descriptors of a household. This is built from the data but illustrates a '***User persona***', i.e., a fictional household construct that represents the norm that the data suggests. It makes assumptions on what the households eat and when to generate their energy consumption. While it might have benefited from the qualitative data discussed in the last paragraph, the study team used their own local knowledge to fill in the gaps.

The modelling gives interesting insights, which, with a sensitivity analysis of different scenarios, enables a Year-wise Projected Annual Electricity Consumption for eCooking in Bengaluru City under five different eCooking penetration scenarios.

The report notes that Karnataka's electricity generation potential by 2030 aligns with India's Net Zero Goal by 2070 and focuses on growing variable renewable energy (VRE) capacity. With climate change, wind pattern shifts, and pollution affecting hydropower, wind, and solar energy outputs, the modelling projections suggest sufficient generation capacity only if we assume optimal utilization and affordable electricity. For Bengaluru, electricity demand in 2030 could exceed supply if the current generation remains unchanged and eCooking adoption further increases consumption. Ensuring reliable electricity through robust distribution and minimizing losses is essential. Setting a 2030 target will help decision-makers strategize for the near to medium term.

The report is a useful contribution to the growing literature on eCooking. We reiterate that the limitations on the data, some planned (a low to medium income household sample) and some unplanned (lack of matching qualitative data on foods consumed), suggest that this study be used alongside other studies and not quoted as a sole justification for strategic decisions.

The study suggests eCooking has a place in modern India even among low-income households and more work is required on how the future will unfold.

It is a great step forward, and we look forward to using its learnings in future work.

Table of Contents

List of Figures

List of Tables

Executive Summary

The National Institute of Advanced Studies (NIAS) at IISc Campus, Bengaluru, has completed the first phase of the project entitled "***An Evidence-based Approach to Access Energy Transition in Clean Cooking***" of 9-month duration funded by the Modern Energy Cooking Services (MECS) Programme of Loughborough University, UK. The project's core objective was to Evaluate Energy Transition Readiness in the Residential Cooking Sector among Low and Medium-Income Households in Bengaluru. This project germinated through the active support of the Office of the Principal Scientific Adviser (O/o PSA) to Govt' of India, which helped in forming the collaboration between the Modern Energy Cooking Services (MECS) Programme, Loughborough University (UK), and NIAS, through Finovista (in-country partner of MECS Programme in India). The close collaboration between the MECS Programme and NIAS ensured smooth and successful project execution.

Dr. **Rudrodip Majumdar**, an Assistant Professor in the Energy, Environment, and Climate Change Programme (EECP) at NIAS, spearheaded the project. Dr. Majumdar was ably supported by the Project Associate Mr. **Rajeev Kumar** in the execution. Further, to conduct the household survey, 13 field investigators were engaged from M.S. Ramaiah University of Applied Sciences (MSRUAS).

Chapter 1 of the Report discusses the **commissioning of the project and preparations** highlighting the details of the elaborate survey questionnaire prepared by the NIAS team. The questionnaire comprised six themes encompassing basic socio-economic profiling, culinary practices (current use of cooking fuel & utensils, and dietary preferences), cultural and behavioral aspects of cooking, and access to electricity. It provided a solid foundation for the analysis. For the first phase of the study, the Bruhat Bengaluru Mahanagara Palike (BBMP) area in Bengaluru City was chosen as the survey location. The **pilot survey was conducted on 62 samples** to facilitate on-field testing of the survey questionnaire along with the options. Based on the detailed feedback received, the questionnaire was modified and finalized for the large-scale survey **conducted on 910 households**.

Chapter 2 of the Report elaborates on the **Survey Locations chosen within the BBMP Area and Location-wise Key Insights**. The pilot survey conducted by NIAS Research Personnel, aimed to identify appropriate survey locations and refine the questionnaire. Amongst the respondents of the pilot survey (**N=62**), around 52% were male and 48% were female respondents. About 52% of the respondents belonged to the age bracket of 25-40 years, while 34% were from the 15-25 age group. This distribution ensured a representation of a relatively young population with aspirations for improved quality of life (QoL). Further, the field investigators (interns) from Ramaiah University collected 294 samples during the training phase, providing valuable insights into household dynamics and socio-economic profiles and affirming the expectations regarding the desired outcome. Visits to the two locations Laggere and Mathikere highlighted the diverse cooking practices and socioeconomic challenges faced by low-to-medium-income families. Two distinct socio-economic groups were observed in Laggere. In the locality with a higher prevalence of poorer families (daily-wage earners), people were found to rely on government-provided housing and electricity. Many of these households reported not utilizing the Karnataka Gruha Jyothi Scheme due to local arrangements for free electricity. These homes are LPG users and typically have all basic amenities access. However, most of these low-income households also use traditional chulhas (clay ovens) for boiling water (*used in miscellaneous household activities*). Power cuts are frequent, and residents face challenges such as a lack of awareness about government schemes and essential documentation. Concerns about frequent power cuts and misconceptions about the safety of electric cooking appliances were prevalent. Many people were unaware of the Government-run schemes, such as Gruha Jyothi, and PMUY. **Some people even did not have a bank account**, as well as important identification documents such as **Aadhar Cards**.

In Mathikere, a diverse socio-economic mix was observed, with both basic housing and furnished high-rise apartments. A few low-income households lacked access to electricity and sanitation, and household members were relying on solar bulbs and public toilets. The use of chulhas was common among the surveyed households, with people using LPG occasionally. The area's diversity highlighted varied perspectives on cooking practices, influenced by socio-economic status. Awareness of electric cooking appliances was found to be generally low. Respondents exhibited concerns about high electricity bills, safety risks including fear of electrocution, and the inability of eCooking devices to cook traditional dishes properly. However, higher-income and educated respondents mentioned the perceived convenience of electric cooking including time-saving features attributable to faster cooking. Some respondents appreciated the electric cooking as a backup option when LPG runs out. These insights informed the design and execution of a large-scale household survey (N=910) across 13 selected locations within the BBMP area, ensuring a comprehensive understanding of the needs and behaviors of the surveyed Bengaluru households toward energy transition in the residential cooking sector.

Chapter 3 of the Report elaborates on the **Socio-Economic Profiles of the Surveyed Households** summarizing the findings of the large-scale survey over 910 households. The '***Basic Profiling of the Respondent***' section captured demographics, family composition, and household decision-making dynamics. The '***Income and Education Levels***' section provided insights into educational qualifications, household income, and savings. The '***Know-how of Daily-life Technologies***' section assessed the respondents' comfort with electronic gadgets, usage of online payments, and internet browsing habits.

Most respondents (49%) were aged 25-40 years emphasizing the predominance of the households run by young couples in the survey sample. Female respondents comprised 78% of the total respondents (N=910), which was a conscious choice made by the NIAS research team owing to the detailed knowledge the women possess regarding household cooking activities. Educationally, 75% of the respondents reported studying up to at least matriculation level, and about 20% of the respondents reported an educational qualification of graduation level or above. The extent of familiarity with daily-life technologies was found to be moderate, with 61.9% using mobile phones for browsing through the internet, and 32% using digital payment methods regularly. Analysis of monthly income levels revealed that about 56% of the surveyed households earned ₹25,000 or less monthly, and 81% of the respondents reported monthly savings of ₹2,500 or less, highlighting the economic constraints within the surveyed population. About, 73% of the respondents attributed all major household decisions to the man of the house (patriarch), while 19% attributed them to the woman of the house (matriarch). Interestingly, matriarchs/ women of the house were key stakeholders (94%) in kitchen-related decision-making, while patriarchs/ men of the house played a minor role (less than 6%).

Chapter 4 of the Report presents an **Analysis of the Transition Readiness of Households toward Modern Cooking Solutions** drawing insights from a comprehensive survey of 910 households. The chapter examines the influence of key socioeconomic variables such as monthly income, average savings, household size, education level, caste, and occupation on the attitude toward adopting modern cooking appliances. ***The data reveals a clear correlation between higher income levels and the willingness to purchase modern cooking devices***. When the respondents were asked specifically regarding the willingness to spend a certain amount for a new cooking device or experience the responses varied substantially. About 33.3% of the households with a monthly income per capita in the range of ₹500-2000, and 37% of the households with a monthly income per capita in the range of ₹2000-6000 showed a willingness to pay for new cooking appliances. About 29.5% of the households with a monthly income per capita in the range of ₹6000 and above showed a willingness to pay for new modern energy devices. Similarly, households with higher average monthly savings demonstrate greater readiness to adopt modern energy cooking devices. This analysis was also done for different household sizes. The results indicate that amongst household sizes ranging between 4 to 6 members (N= 543) (i.e., 59.7% of the total survey respondents (N=910)), about 25% population is willing to pay some amount (less than Rupees 1500) for a new modern cooking device, while another 23% population is willing to pay in the range of Rupees 1500 to 3000 for the same. This granular account of willingness to spend for new modern cooking devices is disaggregated by household size. Such information would be crucial for planning purposes while rolling out a transition strategy in the residential cooking sector. This underscores the potential market segment for energy-efficient cooking technologies in urban Bengaluru.

The analysis by caste reveals an aspirational trend among the households belonging to the marginalized communities (Scheduled Castes, Scheduled Tribes, and Other Backward Classes) (N=625). About 35.8% of these households indicated keenness to purchase modern cooking devices, while an additional 25.9% expressed the openness to consider the possibility. This granular breakdown helps comprehend how various elements influence the lifestyle decisions of different demographic groups.

Chapter 5 of the Report analyses the **Current Usage of Cooking Fuels, Appliances, and Utensils in Surveyed Households.** This chapter provides a comprehensive analysis of the current usage of cooking fuels, appliances, and utensils in surveyed households in Bengaluru, providing crucial insights regarding the readiness for transitioning to modern cooking solutions. The analysis reveals that 84.7% of households (N=910) exclusively use Liquid Petroleum Gas (LPG). About 6.9% of the respondents were found using a combination of LPG and clay ovens, while 8.4% reported using both LPG (dominant coking fuel) and some form of electric cooking (eCooking). About 1.1% of the respondents (mainly from marginalized communities) are still relying on clay ovens. Economic factors heavily influence the actual LPG consumption by the households, with subsidies provided under the Pradhan Mantri Ujjwala Yojana (PMUY) covering only 20% of the current cylinder price. *Recent price hikes and inadequate area coverage of LPG distribution networks (i.e., accessibility constraints) have led to reduced refill rates*. The low-income groups face additional barriers such as the lack of identification documents and bank accounts, impeding access to PMUY benefits.

Despite a large fraction of the survey sample being from the low-income group, a low number of PMUY beneficiaries is observed among exclusive LPG users. On being asked during the trial and mass-scale surveys, most of the respondents in the large slums and low-cost housing areas mentioned not receiving the benefits of the PMUY scheme since the times of the COVID-19 pandemic. This indicates that the benefits PMUY stopped reaching the marginalized people more than 2 years back. One possible explanation is the erosion of disposable income which eventually discouraged the households to pursue expensive refills by paying the upfront cost. Many of the female respondents from the low-cost housing areas (about 40-50%) mentioned not having proper personal identification documents (e.g., an Aadhaar Card), and bank accounts. This needs attention from the policymakers and interventions may be required to remove the possible inhibiting factors.

Around 59.9% of households reported preparing meals twice daily, while 35.5% mentioned cooking major meals thrice daily. Interestingly, about 64% reported taking less than one hour to prepare each meal, while 36% indicated a meal preparation time of 1-2 hours. Households run by young couples, often with smaller family sizes of 2-5 members, would possibly require less cooking time. Additionally, many young working couples reported eating out at least once daily, which could also lead to lower overall cooking energy consumption. Overall, the average number of LPG cylinders consumed per household annually is found to be on a bit lower side. While the observed low LPG consumption is a bit surprising, the insights mentioned above are some of the possible explanations for the same.

By understanding current usage patterns and economic realities, policymakers can design interventions that enhance the quality of life and ensure a sustainable and inclusive transition to modern cooking solutions. This highlights the necessity of taking into account the factors affecting people's quality of life and convenience when introducing a new technological solution for the mass market, aiming to initiate a fundamental behavioral change to collectively transform lifestyles.

Chapter 6 of the Report presents an **Assessment of Access to Reliable Electricity in the Surveyed Bengaluru Households and Prevailing Perceptions Regarding Electric Cooking**. From the survey responses, reliable access to electricity emerged as an important factor for households to shift from LPG to electric cooking. In marginalized areas like Lakshmi Devi Nagar, 28.6% of households lack metered connections. About 21% of households belonging to the mass-scale survey sample (N=910) mentioned experiencing load-shedding at least once daily, and 41% reported facing power cuts several times a week. Frequent power cuts and transformer bursts were reported by a large number of respondents belonging to different localities surveyed, highlighting the need for substantial improvements in the sub-distribution infrastructure.

From the survey responses, the load-carrying capacity and access to electricity in the kitchens were found to be notably inadequate. About 13% of households lacked any small plug points (***5 Amps***), and 64% had only a single small plug point. Furthermore, 46.9% of households did not have any large plug points (***15-20 Amps***) in their kitchens, and 46.7% reported having only one large plug point. *The lack of proper wiring and plug points poses a significant barrier to electric cooking adoption, even if there are no power cuts*.

About 48% of the total respondents (N=910) believed they were aware of the benefits and challenges associated with eCooking. When inquired regarding the willingness to purchase (or own) electric cooking appliances, 33% expressed a definite interest, another 29% were open to the idea based on affordability and other household conveniences, and the remaining 38% responded negatively.

Chapter 7 of the Report elaborates on the **Taste Perceptions, Weekly Menu Patterns, and Kitchen Amenities in Bengaluru Households**. To facilitate a nuanced and granular understanding of people's taste perception associated with cooking fuels as well as their perceptions of the ability (or inability) of electric cooking devices to replicate the performances of the conventional pathways, the captured views were analyzed in detail disaggregated by current fuel use type. The analysis focused on **two groups**: the **first group** comprised people currently using some form of electric cooking along with LPG. This group was further disintegrated into finer sub-groups to understand people's views on individual prominent electric cooking appliance types. *This group's view is important since they possess basic hands-on experience in using electric cooking devices and are aware of the benefits & limitations*. The **second group** chosen for granular analysis comprised individuals currently using either a combination of LPG and traditional clay ovens or exclusively traditional clay ovens for household cooking purposes. This group's view is important since these people are currently far away from using LPG. *However, their views on perceived challenges can be converted to opportunities if aspirations can be instilled through imparting knowledge and continued engagement at the community level*.

Benefits commonly cited across all types of electric appliances included faster cooking and convenience. However, concerns about high electricity consumption, the need for specific vessels, and the perceived inability of eCooking appliances to match the cooking experience of LPG gas or traditional methods were prevalent. Regarding the perceptions of cooking fuel and taste of food items, approximately 40% of exclusive LPG users (N=771) believed that the choice of cooking fuel (gas ovens versus charcoal/wood in Chulha) affects the taste of food.

Among the respondents who use both LPG and eCooking, about 58% believed that gas ovens and traditional chulhas add special textures to certain food items.

The extensive survey highlighted that a significant concern regarding eCooking among respondents is the requirement for specific flat-bottom utensils. With the majority of households (N=899) relying on LPG for cooking, the composition and quantity of current kitchen utensils play a crucial role in shaping the transition towards electricity-based cooking. The material composition of utensils strongly influences their cost, impacting household readiness to adopt new cooking technologies. A detailed analysis of utensil types, numbers, and materials owned by current LPG users (N=771) underscores their inertia toward adopting new cooking solutions.

Respondents using traditional clay ovens and LPG for daily cooking highlighted limited awareness and experience with electric cooking appliances. Their concerns included higher electricity bills, appliance durability, the need for continuous supervision, and challenges in cooking certain dishes. Considering the diverse dietary patterns indicated in the mass-scale survey, a separate focused interaction was conducted with 65 selected households to capture weekly food consumption patterns, revealing staple breakfast, lunch, dinner, and snack items. The transition readiness to electricity-based cooking in Bengaluru households needs to be evaluated considering the intertwined factors of cooking fuel, utensil types, and dietary preferences, that collectively shape the feasibility and acceptance of modern cooking solutions. Understanding these factors will guide decision-makers in assessing affordability, accessibility, and the potential barriers to transitioning to modern energy cooking paradigms.

Chapter 8 of the Report elaborately discusses the **Electricity Supply-Demand Analysis for Bengaluru City in the Backdrop of Generation and Availability in the State of Karnataka.** While aiming for a large-scale transition to eCooking, *two key things that need serious consideration from the preparation point of view are the estimation of electricity demand attributable to the envisaged growth trajectory of the mass penetration of electricity-based residential cooking, and the assessment of the adequacy of generation sources* (considering both currently installed capacities as well as the planned expansion in the near to medium term). A granular analysis has been conducted to capture the source-wise electricity generation potential in the State of Karnataka. Also, the total average electricity consumption level of Bengaluru City has been obtained from reliable open-source literature. Finally, a bottom-up calculation has been conducted to assess the average daily cooking energy requirement at the household level.

To simulate the possible variabilities on the generation side, four scenarios have been created as below (see **Fig. 75**, p. 123 in the main report):

Scenario G1: This scenario assumes that only a 50% Realization of the Envisaged RE Capacity Increase will take place by 2030 and the generation during the period 2024-30 will take place at the current levels of average PLFs (for conventional generation) and CUFs (for renewable power). This is the most pessimistic scenario among the four.

Scenario G2: This scenario also assumes a 50% Realization of the Envisaged RE Capacity Increase by 2030. However, this scenario considers a certain increase in generation over the period 2024-30 through a progressive increase in average PLFs (for conventional generation) **and CUFs** (for renewable power).

Scenario G3: This scenario assumes a 100% Realization of the Envisaged RE Capacity Increase will take place by 2030. However, the generation during the period 2024-30 will take place at the current levels of average plant load factors or **PLFs** (for conventional generation**),** and capacity utilization factors or **CUFs** (for renewable power).

Scenario G4: This scenario also assumes a 100% Realization of the Envisaged RE Capacity Increase will take place by 2030. However, this scenario considers a certain increase in generation over the period 2024-30 through a progressive increase in average PLFs (for conventional generation) and CUFs (for renewable power). This is the most optimistic scenario among the four. From the estimated current annual generation potential of 108779.27 GWh, the potential annual generation levels in Scenarios G1 to G4 are estimated to reach **145000**, **192000**, **167000**, and **221000 GWh**, respectively, in 2030.

Open-source literature suggests that *Bengaluru consumes about 35% of the state's power*. This trend is assumed to continue till 2030, and therefore, the *share of the projected electricity generation should be made available to this extent for Bengaluru City*. Because of the sheer size of electricity demand and generation figures in India, it is often convenient to express the electricity demand and generation in terms of **Terra Watt-hour (TWh)** or **Billion Units (BU)**. The projected annual electricity allocation for Bengaluru city in 2030 under different generation scenarios (**G1** to **G4**) are estimated to be **50.64**, **67.08**, **58.52**, and **77.31** TWh, respectively, compared to the current level (base year 2024) of **38.07 TWh**. (see **Fig. 76**, p. 124 in the main report):

The *annual average electricity consumption per capita in Bengaluru* (aggregated over the whole city) stands at **1387.64 kWh**, with a mean SD of **1087.20 kWh**. **Three scenarios** are created to project the possible variabilities in the total household electricity consumption in

Bengaluru City between **2024** and **2030**, as described below (see **Fig. 77**, p. 126 in the main report):

Scenario EC1: The per capita electricity consumption in Bengaluru City remains constant at **1387.64 kWh** between **2024** and **2030**. *However, the overall consumption increases due to the projected population growth*.

Scenario EC2: The per capita electricity consumption in Bengaluru City increases gradually at a CAGR of 5.66% to reach **1931.24 kWh** (i.e., ***Mean +0.5SD***) by **2030**, from the current level of **1387.64 kWh** in **2024**. *Further increases in overall consumption will emerge from the projected population growth*.

Scenario EC3: The per capita electricity consumption in Bengaluru City increases gradually at a CAGR of 10.12% to reach **2474.84 kWh** (i.e., ***Mean + SD***) by **2030**, from the current level of **1387.64 kWh** in **2024**. *Further increases in overall consumption will emerge from the projected population growth*.

A recent projection by ***World Population Review*** mentions the urban population (2024) in Bengaluru as **14 million** (i.e., 1.4 crores). ***We have used this as the*** *baseline for further projections*. Based on the growth rate suggested by the *World Population Review*, the population is assumed to grow at a *CAGR of 2.94% between now and 2030*. The projected total annual electricity demand levels in 2030 are estimated to be **23.1**, **32.2**, and **41.2 TWh**, respectively, under Scenarios **EC1**, **EC2**, and **EC3**.

The mass-scale survey indicated an average household size of four members. A detailed bottom-up calculation shows that if household practices shift completely toward electricity-based cooking, the maximum electrical energy consumed for cooking and allied activities per household per year would be **1034.8 TWh**. The bottom-up calculation considers the typical cooking load rather than individual food items, addressing energy consumption patterns for a wide array of commonly prepared dishes. This approach accounts for the use of LPG for non-cooking activities, such as heating water, to provide a comprehensive estimate of energy use.

The large-scale household survey (N=910) conducted in the BBMP area of Bengaluru city indicated that about **8%** of the survey sample has been using some form of major electric cooking appliances for daily residential cooking as well as reheating leftovers. As mentioned before, when the respondents were asked about their willingness to purchase electric cooking appliances, **33%** responded positively (said **Yes** in the survey response), **29%** indicated a tentative possibility (said **Maybe** in the survey response), and **38%** responded negatively (said **No** in the survey response).

Therefore, from the current level of population penetration of eCooking (~8%), a realistic target would be to reach a population penetration level of **33%** by 2030 (*the timeline decided by the United Nations toward the reasonable realization of Sustainable Development Goals*). This would amount to achieving a low-hanging fruit. Further, optimistic scenarios would involve attaining an eCooking population penetration level of more than 33%, up to a possible upper limit of **62%** (***highly optimistic scenario***).

A total of five simulated scenarios are described to capture the expected rise in the electricity demand attributable to the large-scale adoption of eCooking for different assumed penetration levels. Out of these, the slow & moderate growth scenarios, where the mass penetration of eCooking appliances reach 20%, and 33%, respectively, by 2030 aimed for. *However, even with the most optimistic transition scenarios, the electricity demand arising out of the residential cooking needs does not appear to be a problem provided the losses in the distribution system are minimized to ensure adequate effective availability from the supply side. Setting a target for 2030 would be useful for decision-makers in formulating a strategy for the near to medium term.*

Chapter 9 of the Report presents the salient **Insights from Appliance and Vessel Manufacturers, a Summary of Findings, and the Way Forward**. Insights derived from interactions with two eCooking appliance and vessel manufacturers (who were willing to engage and interact) indicated a few areas that require further attention toward a successful eCooking transition at the mass scale. Understanding manufacturers' readiness to meet consumer expectations is pivotal for the success of the possible energy transition in residential cooking.

A broad analysis of the responses from the two prominent appliance and vessel manufacturers identifies key areas requiring focused attention from policymakers and stakeholders within the eCooking ecosystem. Expanding the product range of eCooking appliances is essential to cater to diverse consumer segments and cooking needs. Secondly, intensifying marketing efforts through targeted campaigns will educate consumers about the benefits and performance of eCooking appliances, leveraging existing retail networks. Enhanced engagement with government bodies is crucial to secure support and incentives that encourage consumer adoption of eCooking. Exploring local manufacturing opportunities can reduce dependence on international suppliers, enhancing the resilience of the eCooking ecosystem through an Indigenous supply chain. Continuous efforts to reduce costs are also imperative to maintain consumer interest and competitiveness against traditional cooking methods.

The chapter also addresses the cost implications of transitioning to eCooking. It highlights that incentives may be necessary to facilitate a significant shift in kitchen utensil usage. Investments would be required toward creating dedicated training facilities for appliance servicing and repair. Investments would be required to engage domain experts and full-time educators who would inform the consumer community about the ongoing developments and provide feedback to the supplier side regarding the concerns posed by the consumers. For the eCooking transition to be successful, a greater emphasis is required on strengthening the sub-distribution infrastructure (cabling and augmenting transformer capacity) to ensure households' uninterrupted access to reliable electricity. Additionally, the concealed wiring in the households also needs to be strengthened to facilitate adequate load-carrying capacity. Since low-income households may not be able to spend for such upgradation, the Government may need to find suitable financial partners to unlock funds necessary for electrical sub-distribution infrastructure enhancement activities focused on robust last-mile connectivity of electricity distribution networks.

Household cooking activities reside on the complex interactions of three intricately linked elements, choice of cooking fuel, choice of kitchen utensils, and dietary preferences. Since dietary preferences are deep-rooted in behavioral and cultural practices, the interventions from the eCooking system should be aimed at the direction of cooking fuel (and appliances) and the cooking vessels. Understanding the differing mindsets between urban and rural settings in India would be vital while planning for the transition. Urban residents prioritize time-saving and convenience, while affordability is paramount in rural areas. Collaborative efforts need to be emphasized among the various stakeholders including appliance & vessel manufacturers, policymakers, and consumers to navigate the challenges and leverage opportunities in this transformative journey toward a sustainable residential cooking landscape.

The following policy directions are recommended by the NIAS team to facilitate a smooth mass-scale transition to electric cooking and address the identified gaps:

1. **Consumer-Centric Customization**: Develop electric cooking solutions that align with traditional cooking practices (i.e., deep-rooted behavioral and socio-cultural traits) to ensure cultural acceptance and ease of transition.

2. **Trust-Building Measures**: Implement community engagement programs to build trust and ensure transparency, for effective exchange of knowledge and concerns.

3. **Awareness Initiatives for Sensitization of Health and Environmental Benefits**: Launch comprehensive awareness campaigns and community engagement programs to disseminate the far-reaching beneficial impacts of the envisaged eCooking transition. Promote the health and

environmental benefits of electric cooking through dedicated Public Relations (PR) channels by engaging professional educators to enhance public awareness.

4. **Inclusion of Clean Cooking in Academic Curriculum:** The energy-efficiency of eCooking, and its far-reaching beneficial impacts should become a part of the mainstream academic curriculum in Schools and Colleges as part of larger energy education, and energy-efficient sustainable solutions.

5. **Financial Incentives**: Introduce incentives and innovative financing schemes (including micro-financing options), and monthly installment plans to alleviate the upfront financial burden on the consumers. Financial incentives would also be required for OEM enterprises to customize devices and scale up manufacturing.

6. **Investment in Sub-distribution Infrastructure and Enhancement of DISCOM Efficiency**: Investment is required to upgrade the local electricity sub-distribution infrastructure (including augmentation of transformer capacity) to ensure a stable and reliable power supply for the mass-scale adoption of electric cooking. Also, there is an urgent need to enhance the managerial performance of DISCOMs to ensure power dispatch reliability.

Through a detailed thematic survey of 910 households, the NIAS team unearthed several not-so-obvious socio-economic realities that dictate lifestyle choices, such as the choices made by households for residential cooking. These socio-economic determinants often remain unexplored, with scarce and fragmented information available in the open-source domain. Therefore, the results brought forth by the NIAS team, both in qualitative and quantitative forms, add significantly to the body of existing knowledge. The research also points at several gap areas that need attention from policymakers for the overall upliftment of society through appropriate interventions aimed at low-to-medium-income households. This study also aims to initiate informed engagements among the eCooking industry stakeholders, policymakers, and the consumer community. The objectives and the outcome of the project are aligned with India's larger goals of energy transition, energy security, and self-reliance. The template created by the NIAS team provides an approach to look at the eCooking transition possibilities in different parts of India in subsequent phases.

Chapter 1

Commissioning of the Project and Preparations

1.1 Introduction

The Energy, Environment, and Climate Change Programme at NIAS is pursuing a 2-year research project on the evidence-based assessment of the enablers and resource requirements for the Energy Transition in the Residential Cooking Sector in India. The core research objectives as agreed between the MECS team and NIAS are enumerated below.

1. To identify suitable locations that promise to provide invaluable insights regarding the current cooking practices in households and the possibilities of the energy transition in residential cooking.
2. To conduct on-ground surveys in select areas to understand the status of access to electricity in the households, the current practices of residential cooking in those households, availability of LPG connection and usage, and how the households look at the envisaged transition to electric cooking.
3. To assess the sub-distribution infrastructure prevalent in the chosen areas (including the cabling and their carrying capacities), since the use of the cooking appliances would require a reliable supply of electricity to the households.
4. To assess the increase in electricity demand owing to the envisaged transition into electric cooking.
5. To assess the current electricity generation capacities in light of the increased demand for electricity, with a specific focus on the peak demand hours, and evaluate the possible supply-demand gap.
6. To understand the customization needed in the electric cooking appliances, and the scale for attaining affordability.
7. To understand the cost of transition to electric residential cooking in select regions.
8. To develop a framework based on the case studies of select areas, which can serve as a template to look at similar transitions in other regions of India.

In view of the objectives, the project work started with identifying the study area. The Bangalore Electricity Supply Company Limited (BESCOM) Coverage Area within the Bruhat Bengaluru Mahanagara Palike (BBMP) administrative boundary was chosen to be the starting point for the household-level ground survey in the **9-month long Phase I of the MECS-NIAS Project** (Ref. ***Grant Disbursement Form*** issued by Loughborough University, UK).

1.2 Key Deliverables (at the End of the Initial 9-month Period)

The MECS team and NIAS agreed on the following key deliverables at the end of the 9 months following the completion of Phase I of the project.

A. Analytical report based on one on-ground survey conducted at **Location 1** identified (BESCOM License area-Bengaluru, Karnataka) regarding consumer access. ***Emphasis will be given to documenting the potential consumer-based barriers as well as the drivers that can facilitate the uptake of e-cooking***. This covers Objectives 2, 6, and 7 based on Objective 1, and points to Objective 8 (Refer to the **core objectives** highlighted in the **Introduction** section). **Timeline - By the end of 9 Months**

B. Analytical report on the ***current state of electricity sub-distribution infrastructure*** at **Location 1** regarding its reliability, generation implications, and the potential for hosting e-cooking uptake. This covers Objectives 3, 4, and 5 based on Objective 1, and points to Objective 8 (Refer to the **core objectives** highlighted in the **Introduction** section). **Timeline - By the end of 9 Months**

C. ***Draft report comprising data trend analysis*** with ***at least 3 scenarios*** that build on and draw from the above analytical reports and show ***how a larger dataset will lead to a deeper trend analysis***. This report will aim towards unlocking further funds. **Timeline - By the end of 9 Months**

Further, a consolidated outline will be presented at the end of 9 months regarding the wider plans for effective stakeholder consultation and the plans for data collection at another location (**Location 2**).

1.3 Kick-off Meeting and Commencement of Project Work

Upon receiving the grant amount associated with the contract signing on 25 July 2023, the NIAS team proposed to have a kick-off meeting with the MECS counterpart. On 14 August 2023, Finovista (in-country partner of MECS Programme in India) / MECS team shared with NIAS a brief write-up suggesting approaches for the study. It was agreed that NIAS would respond with a consolidated document that provides a comprehensive overview of these suggestions. The MECS team also shared a proposed template for the ***Gantt chart***, aimed at guiding the different tasks and timelines associated with the project. The kick-off meeting between the MECS team and NIAS representatives took place on 17 August 2023.

After this meeting, an email circulated by the Finovista/ MECS team on 18 August 2023 articulated the approach to be adopted for analyzing the possibility of energy transition in the residential cooking sector in India. The salient aspects of the approach are mentioned below:

- Determining the size of the transition to eCooking both in terms of – a) the proportion of households that might shift to eCooking and b) how much of their cooking they might shift to electricity – will be based on the primary as well as secondary data collected during the study.
- The transition will be determined using a holistic approach that acknowledges various factors including (but not limited to) socio-cultural (e.g., cooking practices), technological attributes, availability of cooking appliances and component supply chains, reliability of electricity supply reliability, economic considerations at the consumer end, etc.
- The data collected during the survey will be used to assess and estimate possible transitions at larger scales, i.e., a mapping will be done at the State level (by creating multiple plausible scenarios) based on the insights received from the household-level survey conducted in the BESCOM area. ***These assessments will of course need to be heavily caveated given the large variabilities in the local conditions***.

In connection with the time-bound project activities, a ***revised Gantt chart*** (***Annexure I***) was circulated from the NIAS side on 04 September 2023 along with explanations against the clarifications sought by the MECS team.

1.4 Design and Deployment of the Household (HH) Survey

Once the survey location was chosen, it was decided as per the original proposal that a household survey comprising 900 households (HHs) would be conducted. Based on the discussions between the MECS and the NIAS team, a first draft of the survey questionnaire was shared with the MECS team on 14 September 2023. Based on the comments received from the MECS team, a revised questionnaire was shared with the MECS team on 26 September 2023. The NIAS team further mentioned that the survey questionnaire will be improved based on on-ground insights received during the ***Pilot Survey***. A "Google Form"-based survey questionnaire was created for conducting the pilot survey in connection with the project entitled "***An Evidence-based Approach to Access Energy Transition in Clean Cooking***". The survey was aimed at household-level data collection regarding cooking habits and access to electricity. ***The pilot survey comprised 93 questions*** to be answered by an individual. Most of the questions were designed to ensure minimal pressure on the respondent. Plenty of options were provided for the key questions related to culinary habits, kitchen amenities, and access to reliable electricity so that the respondents could choose from the pool provided to them. This was done to alleviate the hassle and to facilitate efficient time management during the surveys.

The **pilot survey was conducted on 62 samples** in the **first half of October 2023** to facilitate on-field testing of the survey questionnaire along with the options. The key findings of the pilot survey were communicated with the MECS team in the form of an **Interim Report on 29 October 2023** for comments and suggestions. Based on the detailed feedback received on 22 November, the questionnaire was modified and finalized for the large-scale survey. Meanwhile, a total of 13 field investigators (interns) were engaged from the B.Sc. (Hons) program of the Department of Data Sciences and Analysis at Ramaiah University of Applied Sciences (MSRUAS), Bengaluru, by the Principal Investigator at NIAS. Following an **elaborate initial training spanning over 3 sessions** ***aimed at familiarizing the interns with the broad theme of the project and the significance of the thematic segregation of the survey questionnaire***, the interns were tasked with trial surveys as part of the survey training. The trial survey of the interns took place between **10 October 2023** and **23 November 2023.** During this period 13 interns collected a small number of samples from various locations keeping in mind the **focus on low-to-medium-income households**. **Representative samples from the medium and upper-medium income groups** were also collected for a qualitative understanding of existing variabilities in the lifestyles as well as behavioral patterns. Learning from the field experiences of the interns, the options corresponding to a few survey questions were further fine-tuned. Thereafter, interns were sensitized about the changes made in the questionnaire based on the feedback from the MECS team. A second round of trial surveys was conducted by the interns along with the NIAS team between **03 December** and **19 December 2023** to get familiarized with the anticipated toil and logistical challenges associated with the large-scale survey.

The final survey questionnaire comprised a total of 98 questions. The survey questions are categorically organized under six broad themes. The survey starts with the "***Basic Profiling of the Respondent***". This ***section comprises 11 questions*** aimed at developing a basic understanding of the household structure to which the respondent belongs. This section also gathers basic data concerning the respondent. Following this introductory section, the next segment (***comprising 8 questions***) aims to understand the "***Income and Education Levels***" of the Households along with the ***Aspirations at the Household Level***. The third segment (***comprising 7 questions***) aims to assess the respondent's ***know-how of daily-life technologies***. This segment also seeks to understand the ***extent of vernacularity*** in the respondent's ***internet***

browsing activities. Further, it aims to assess the eagerness of the respondent towards acquiring a new skill (e.g., learning simple instructions in English). The fourth segment (***comprising 32 questions***) aims to capture the ***house chore information with a specific focus on cooking activities***. This section mainly focuses on questions regarding ***culinary habits***, the ***regular menu***, and ***how the major meals are prepared***. Additionally, this segment also comprises questions regarding the ***behavioral aspects associated with cooking activities***. The fifth segment (***comprising 14 questions***) aims to understand the ***deeper features emanating from the interconnection between culinary practices and cultural traits***. The final segment (***comprising 26 questions***) addresses the ***household configuration and the extent of access to electricity***. This segment also aims to understand the reliability of the electricity distribution in the chosen ***Study Area,*** since access to electricity is of paramount importance in the context of the eCooking transition. The detailed **final questionnaire** is available in ***Annexure II***.

The structured questionnaire aimed to capture the required information without much hindrance and in the minimum possible time. The sequence of the different sections in the survey questionnaire was planned such that ample familiarity and a certain comfort level are formed between the surveyor and the respondent before engaging in the discussions pertinent to the actual household-level issues.

During the trial survey, multiple discussions took place with the interns and other resource persons from within and outside the NIAS community to identify the survey locations within the study area. **The large-scale survey was conducted over 13 major locations within the BBMP area**. A detailed account of the choice of locations during the pilot as well as the large-scale surveys and the salient insights from each of these locations are provided in **Chapter 2.** Further, to understand the weekly food consumption patterns amongst the surveyed population, a smaller sample (**N=65**) was selected from the larger database (**N=910**), and a weekly menu survey was conducted between 19 March 2023 and 29 March 2023. A detailed analysis of the Weekly Menu Data and the salient takeaways are presented in **Chapter 7.**

1.5 Preliminary Review of Relevant Literature

To formulate the survey questions and to arrive at suitable options for capturing the ground data, Project Associate Mr. ***Rajeev Kumar*** (joined NIAS on 12 September 2023) and the Principal Investigator Dr. ***Rudrodip Majumdar*** jointly conducted a thorough scrutiny of ***open-source literature on the income scenario in Bengaluru***. The brief report on the *review of the income scenario in Bengaluru* is provided in ***Annexure III***. The NIAS team also conducted a review of the ***Bengaluru power distribution situation*** based on open-source information as well as secondary data, since access to reliable electricity is crucial for the e-transition of residential cooking. The review of the current electricity distribution in Bengaluru brought forth the major bottlenecks that have hindered the growth of BESCOM. A summary of the recent developments and future initiatives was captured in this review. The review highlighted the energy transition opportunities while considering the challenges associated with Bengaluru's power distribution. Literature suggests that a multi-dimensional intervention would be needed to improve the current state of affairs. The initiatives should encompass infrastructure upgrades, deployment of smart meters and other improved technologies, and adoption of a sustainable energy mix with a specific focus on reliability. The upliftment in Bengaluru's power distribution would require continuous monitoring and investments along with necessary course-correcting measures. The brief report on the *review of the status of electricity distribution in Bengaluru* is provided in ***Annexure IV***.

Further, to understand the ***demographic composition in the BBMP area***, an analysis of the population mix was carried out based on age, religion, caste, and occupation. This analysis supplemented the ***review of the income scenario in Bengaluru*** and ***provided crucial inputs for designing the Survey Questionnaire.*** The summary of the *analysis of demographic composition in the BBMP* is provided in ***Annexure V***.

In connection with the Weekly Menu Analysis (**N=65**), the ***basic description of the prominent local food items*** is provided in ***Annexure VI.*** A ***brief explanation of the prominent cooking methods*** used in preparing the predominant dishes by the surveyed Bengaluru households is provided in ***Annexure VII.***

Chapter 2

Identification of Survey Locations within the BBMP Area and Location-wise Key Insights

2.1 Pilot Survey within the BBMP area in Bengaluru

The initial pilot survey (**N=62**) conducted by *the NIAS Research Personnel* aimed at identifying multiple locations in line with the project objectives. The locations were scanned keeping in mind the target population, i.e., low-to-medium-income households. A few locations were also scanned to identify areas where people belonging to the upper medium income levels have been residing since about 20% of the large-scale survey population was expected from the medium-to-upper medium-income groups. The scanning of the locations commenced in the vicinity of the host institute, the National Institute of Advanced Studies (NIAS), IISc campus, since it was convenient as a starting point. The familiarity of the NIAS research personnel with the nearby locality as well as the community helped in breaking the ground for the Pilot Survey (**N=62**). Based on the guidance received from the native Kannada-speaking NIAS staff members, several locations for the pilot survey were chosen to have comprehensive feedback on the questionnaire. This initial pilot encompassed individuals primarily from Mathikere, Yeshwanthpur, and a few other neighboring areas including Singasandra, Tata New Heaven in Dasanapura, Sanjay Nagar, Singapura Layout in North Bangalore, Kasturba Nagar, Banashankari, Subedarpalya, MRJ Colony in Mathikere, MSR Road in Mathikere and Yeshwanthpur, Whitefield, Kumaraswamy Layout, KR Puram, Byatarayanapura, RMV Extension, etc. The pilot survey conducted over a wide range of localities helped us understand the household dynamics and decision-making, aspirations, energy usage, and culinary habits across different residential settings within the BBMP area in Bengaluru City. A few samples (**N=2**) from the Bengaluru Rural district were also captured to make sense of the findings as well as to have a comparative understanding between the urban and the rural settings. People traveling to urban centres from households located in rural areas exhibit interesting insights regarding lifestyles and general aspirations.

The responses from Pilot Survey respondents helped the first-level enhancement of the ***Survey Questionnair*e**. The changes were mainly related to simplifying the options and providing further necessary possibilities for capturing the diversities prevailing within the sample of the targeted survey population.

Amongst the respondents of the pilot survey (**N=62**), around 52% were male and 48% were female respondents. About 52% of the respondents belonged to the age bracket of 25-40 years, while 34% were from the 15-25 age group. This distribution ensured a representation of a relatively young population with aspirations for improved quality of life (QoL). Such a mix was important, since the energy transition in an important mass segment, such as the residential cooking sector, would be driven by aspirations as well as inquisitiveness toward new options in general. It has been observed from socio and techno-economic trends, that the large-scale transitions are triggered by the population segments that are ready to come out of their comfort zone to experience something novel and different.

2.2 Engagement of field investigators (interns), Training, and Capacity Building

After conducting initial pilot surveys in diverse locations, NIAS engaged **13 interns** from the B.Sc. (Hons) program of the ***Department of Data Sciences and Analysis*** at Ramaiah University of Applied Sciences (MSRUAS), Bengaluru. The group of interns comprised 9 girls and 4 boys. Of these, 8 girls, and 2 boys were native Kannada speakers. We also chose 3 non-Kannada speaking interns to ensure diversity in the mix since Bengaluru is a cosmopolitan Metro city, with people from all the Indian states, and almost all the linguistic groups in different localities forming mixed population societies. In the group of interns, we had two girls fluent in Tamil, one boy fluent in Telugu, and one boy and a girl fluent in Malayalam. In general, most of the interns were adequately fluent in Hindi.

The interns were provided three training sessions in October 2023, during which they were asked to fill up the survey form to develop familiarity with the research theme as a whole as well as the survey questionnaire. The interns were asked to do a pilot survey of 12 samples each from their respective places of residence in Bengaluru. Once the first trial sample collection by the interns was over, they came down to NIAS to share the survey experience with the principal investigator and the NIAS research personnel. Based on the feedback from the interns, a few questions had to be tweaked along with necessary modifications in the options provided. With this refinement, the interns were further tasked with the collection of 8 samples each to ensure an appropriate and reliable collection of household survey data. The NIAS research personnel also collected a few samples for training the interns.

During the training period, multiple review sessions were held to bring all the interns to the same level and to create efficient cooperative coordination within the whole group. The engagement of interns proved invaluable since many of them are natives of Bengaluru and are familiar with the demographic mix of different localities within the BBMP area and the broad socio-economic realities of localities. A total of **356 samples** were successfully collected from various localities during the pilot and training phases and analyzed for quality and validation of the questionnaire. The insights gained during the pilot and training phases of the Survey helped us affirm the expectations regarding the desired outcome.

Figure 1 pictorially presents the locations within the BBMP area where the trial surveys were conducted during the pilot and training phases. **Table 1** presents the details of the surveyed locations subsumed under various clusters shown on the map (see **Figure 1**). **Section 2.3** describes the insights from the major site visits that took place during ***the training phase of the interns***. **Section 2.4** describes the insights from the major sites visited during the large-scale survey.

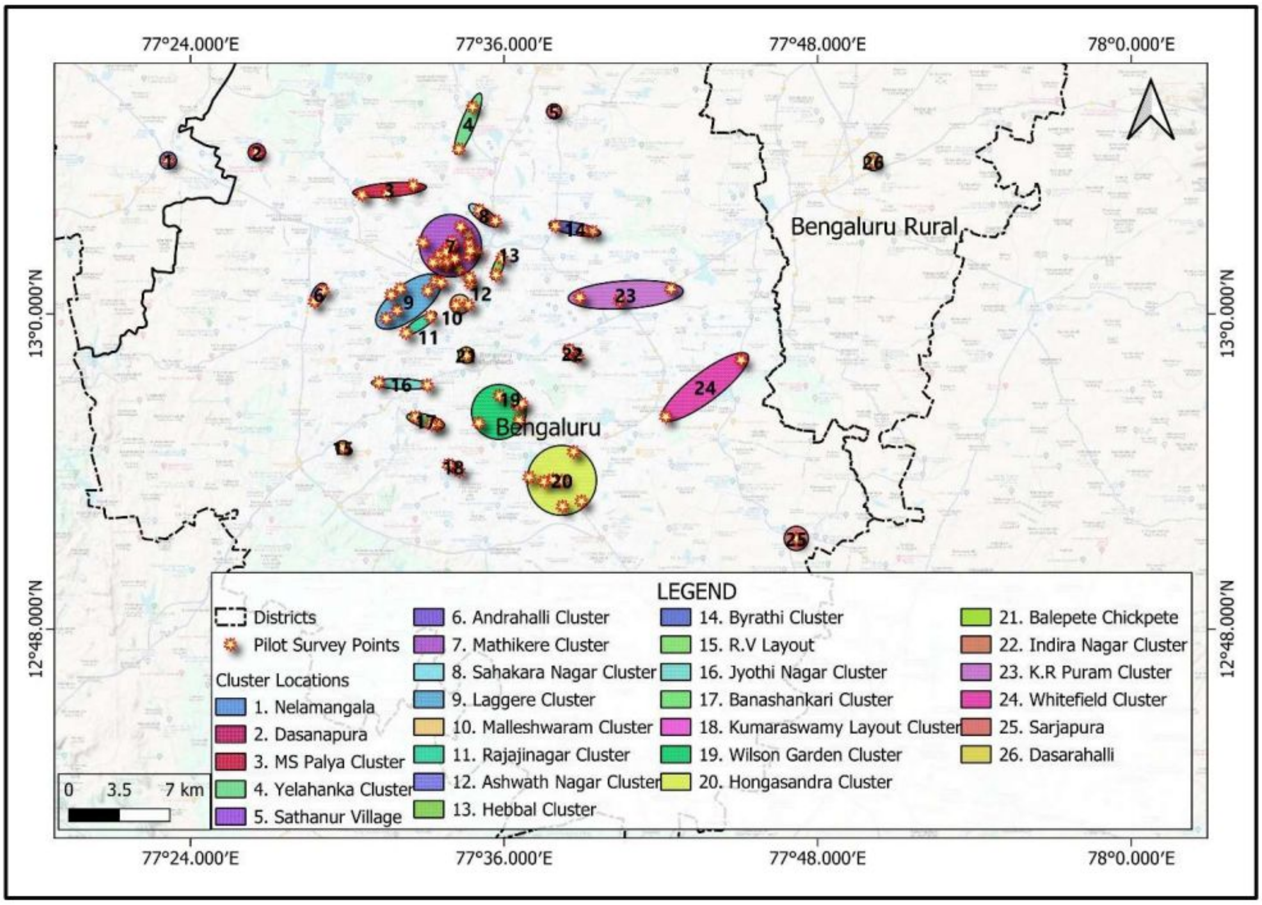

Figure 1: Pictorial presentation of the locations within the BBMP area surveyed during the pilot and training phases

Table 1: Locations Surveyed during Pilot and Training Phases

Sl. No.	Location Clusters	Locations
1	**Nelamangala**	Nelamangala
2	**Dasanapura**	Dasanapura
3	**MS Palya Cluster**	MS Palya

		Chikabanapara
		Abbigere
4	**Yelahanka Cluster**	Harohalli
		Yelahanka
5	**Sathnur Village**	Sathnur Village
6	**Andrahalli Cluster**	Balaji Nagar
		Andrahalli
7	**Mathikere Cluster**	Jalahalli
		MRJ Colony
		Mathikere extension
		Near Shah Diagnostic Center, Mathikere
		Mathikere
		Netaji Circle Mathikere
		Ramchandrapura, Near JP Park Mathikere
		New BEL Road
		Chikkamaranahalli, Bengaluru
		Venkatachary Nagar, Bangalore
		Lottegollahalli
		S.V. Layout, Sanjaynagara, Bengaluru-560094
		Tata New Haven, Dasanapura
		Badrappa Layout
		RMV Extension
		RMV 2nd stage, Geddalahalli, Sanjay Nagar, Bangalore-94
		Sanjaynagar
		Tatanagar
8	**Sahakarnagar Cluster**	Ramanna Layout, Byrathi - 560077
		Sahakarnagar
		Byatarayanapura
9	**Laggere Cluster**	Laggere, Basaveshwara Nagar, Bengaluru, Karnataka
		Laggere (Nandini Layout 4th Block)
		Kurubara halli
		Mahalakshmi Layout
		Vinayakapura, Yeshwanthpur
		Subedarpalya
		4th Block, Nandini Layout
10	**Malleshwaram Cluster**	Malleswaram
		H.G. Balajinagar
11	**Rajaji Nagar Cluster**	Rajaji Nagar
		Basaveshwar Nagar
12	**Ashwathnagar Cluster**	Ashwath Nagar
		Basaveshwar Nagar
13	**Hebbal Cluster**	Hebbal
		RT Nagar
14	**Byrathi Cluster**	Thanisandra
		Byrathi

15	**RV Layout**	RV Layout
16	**Jyothi Nagar Cluster**	Jyothi Nagar Kasturba Nagar
17	**Banashankari Cluster**	Banashankari Cluster
		Vivekanandha Nagar
		Kathriguppe
18	**Kumaraswamy Layout Cluster**	Kumaraswamy Layout
		Yelechenahalli, Bangalore
19	**Wilson Garden Cluster**	Jayanagar
		Wilson Garden
		Sunkal Farm, Adugodi
		Adugodi
		SG Palya
20	**Hongasandra Layout**	Okalipuram
		Hongasandra
		Om Shakti Layout
		Gharbhavipalya
		HSR Layout
		Begur
		Singasandra
21	**Balepet, Chickpet**	Balepet, Chickpet
22	**Indira Nagar Cluster**	Indira Nagar
		80 feet Road
23	**K.R. Puram Layout Cluster**	K.R. Puram Layout
		Basanwadi
		Rammurthy Nagar
24	**Whitefield Cluster**	Whitefield
		Parimala Trinity, Kadubeesanahalli - 560103
25	**Sarjapur**	Sarjapur
26	**Dasarahalli**	Dasarahalli

2.3 Insights derived from site visits during the training phase

Particularly, **two locations** surveyed during the training phase provided useful insights associated with the household-level variabilities existing amongst the low-to-medium income groups.

2.3.1 Salient Insights from Visit to Laggere, Bengaluru

The visit to Laggere was a strategic choice for training the interns. Both the interns familiar with Bengaluru localities as well as a few staff workers at NIAS highlighted this as a potential location for the pilot and training activities. Near the well-known ***Laggere Bridge*** (a flyover), clusters of local low-to-medium-income families (*mostly Scheduled Caste (SC) community people*) are known to reside, who are predominantly daily wage earners. The residents of ***Laggere*** provided valuable insights sharing a detailed account of their lifestyles, household configurations, cooking habits & culinary preferences, access to different government support schemes, and exposure to modern cooking solutions. Since the two different localities in the Laggere area comprised families with distinctly different socio-economic profiles, this particular visit enriched the group of interns as well as the initial database with comprehensive information critical to understanding the household dynamics and behavioral attributes within the low-to-medium-income bracket. In the locality (within the Laggere area) where the prevalence of poorer families is higher, it was found that none of the families are utilizing the ***Karnataka Gruha Jyothi Scheme*** (which allows for free electricity to every household up to a limit of 200 units per month). Since the elected local representative has made arrangements to provide free electricity to poor families, ***people are not interested in applying for the Gruha Jyothi Scheme***.

People are residing in houses constructed and provided by the State Government. Each house has one bedroom, one hall, one kitchen, and one bathroom. A few families reported that they shifted to this area since the Government was providing free housing and electricity. ***These families own houses elsewhere (in remote suburbs) and have rented their respective houses to generate additional income***. A few respondents mentioned that they have only small plug points in the house (i.e., no big plug points). The NIAS team found that these houses had lights and ceiling fans.

Every house has an LPG connection, which is NOT covered under the Pradhan Mantri Ujjwala Yojana (PMUY). The majority (70%) of the households have a '***traditional chulha***' (Clay Oven or Oley) outside the house. Most people are using chulhas for boiling water for miscellaneous domestic purposes, including washing clothes. People are using wood for the chulhas. Some people reported purchasing wood, while others have been collecting the same from nearby locations.

The people reported frequent power cuts and tripping. As mentioned by the respondents, usually power cuts occur 2-3 times a day. The timing for the power cuts varies from day to day, the duration varies from 10 min to 2 hours.

In terms of occupation, in the locality with a higher prevalence of poor families, some of the ladies mentioned that they have been working as housemaids. The males are engaged in different types of work, such as plumbing. There are also male garage mechanics, auto-rickshaw drivers, and daily wage earners. People who have been driving auto rickshaws indicated that they do not own one, and they access the same against a monthly payment.

In some of the poor houses, comfort amenities were absent such as ceiling fans. Many people were unaware of the Government-run schemes, such as Gruha Jyothi, and PMUY. ***Some***

people even did not have a bank account, as well as important identification documents such as ***Aadhar Cards***.

Many of the poorer families mentioned that ***they use Chulha for cooking when it needs to be done on a large scale*** (e.g., during family functions and festivals). Some poor families welcomed the idea of electric cooking as a backup option in case the LPG runs out. However, their main concern is frequent power cuts in the area. Some families reported frequent transformer bursting in the vicinity (about twice a month). Women of poor families, who have been working as maids in the houses of higher-income strata, mentioned that they have seen electric cooking appliances. However, they do not own such devices.

Amongst the samples that were from the medium-income group, a few individuals indicated the presence of heavy consumer durables, such as laundry washing machines (LWMs), and refrigerators in the house. Most of the medium-income households had a mixer/grinder in the kitchen. About 18.75% of the medium-income sample clustered in a particular location (**N=16**) indicated having electric cook stoves in the house. However, only one respondent mentioned using the electric cook stove, but only as a backup option. The family reported that it is mostly used during festival times. One female respondent from the medium-income group responded that earlier she was using an induction cooktop comfortably. However, once the top glass of the appliance got broken and the device got damaged, she did not continue with electric cooking.

Some of the shopkeepers and the people running small-scale local businesses mentioned that they are aware of electric cooking. However, they perceived negatively about electric cooking since they felt that the water used in electric cooking and the electricity flowing through the device would electrocute the user.

2.3.2 Salient Insights from Visit to Mathikere, Bengaluru

Mathikere emerged as a significant location for the pilot survey due to its diverse population mix. There is a heterogeneous mix of income levels amongst the residents in the area. However, the majority belongs to the low-to-medium-income category. The socio-economic diversity is evident from the presence of basic housing (even slums) as well as furnished high-rise apartments, catering to a varied range of socio-economic strata. One of the very poor respondents indicated the absence of electricity in the house. The respondent mentioned having a solar bulb that provides light during the night hours upon being charged during the daytime. The respondent indicated that the members of the family use a public toilet since there is no sanitation in the house. The family is also using chulha for cooking. They have recently shifted to LPG gas, which they rarely use. From the survey conducted at Mathikere, the NIAS team could capture varied perspectives and practices related to residential cooking, which also reflected the intricate connection between different household types and socio-economic profiles prevailing in the area.

The insightful responses gathered from Laggere and Mathikere underscored the importance of designing customized surveys and strategizing the deployment following an appropriate trial comprising the pilot and the training phases. The survey should account for the unique demographic profiles of each locality, to capture a nuanced understanding of different lifestyles and behavioral attributes, including household culinary habits and their connections with socio-economic determinants, such as monthly income levels and savings.

2.4 Insights derived from the locations of Large-Scale Household Survey (N=910)

Based on the detailed insights obtained during the pilot and training phases, and feedback from the native Kannada-speaking interns, 13 locations were carefully identified for the Large-Scale Household Survey. **Figure 2** pictorially presents the locations within the BBMP area that were considered for the large-scale survey. **Table 2** presents the locations surveyed during the large-scale survey that are shown on the map in **Figure 2**.

Table 2: Locations Surveyed during the Large-Scale Survey

Sl. No.	Locations
1	**Sanjay Nagar**
2	**Arundathi Nagar, Srirampura**
3	**Lakshmi Devi Nagar**
4	**Subedar Palya**
5	**JP Park, Mathikere**
6	**Kadugodi Park, Whitefield**
7	**Hongasandra**
8	**Begur**
9	**Vinayaka Nagar**
10	**Chamundi Nagar (Rajajinagar)**
11	**Dasanapura**
12	**BHEL, Marappanpalya, Mahalakshmi Layout**
13	**Nandini Layout**

14	**Konanakunte Cross**
15	**Dollars Colony**
16	**Padmanabhanagar**
17	**Kamakya Layout**

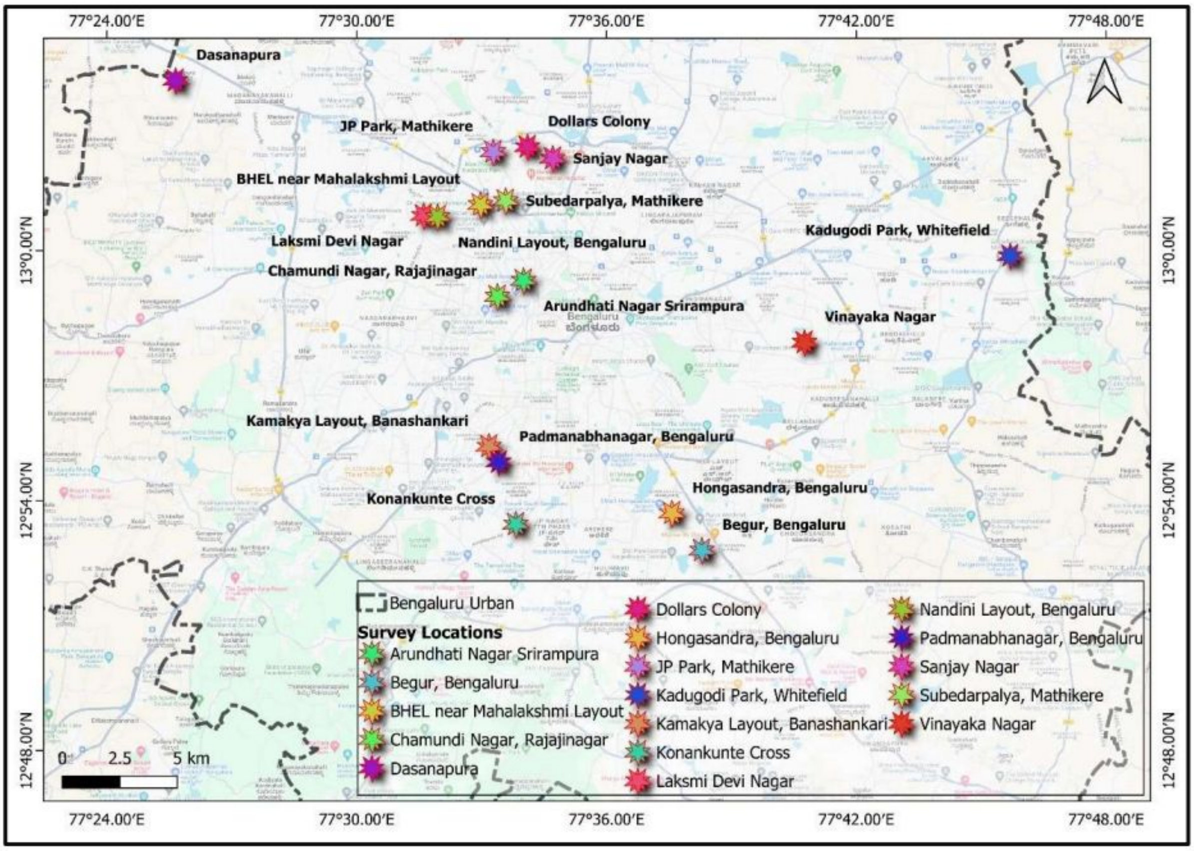

Figure 2: Pictorial presentation of the locations within the BBMP area considered for the Large-Scale Survey (**N=910**)

2.4.1 Insights from Sanjay Nagar

Sanjay Nagar was the location visited on the first day of the large-scale survey. This location was chosen due to the predominance of low-to-medium-income families with diverse occupations in the locality. Amongst the respondents from the low-income group were daily wage earners, shopkeepers (self-employed individuals), contractual employees (working in municipalities and urban local bodies), and individuals engaged in small-scale farming. Among the respondents belonging to the medium-income group were corporate employees as well as government employees. Owing to the location's proximity to multiple educational institutions and commercial establishments, Sanjay Nagar emerges as an ideal community setting for capturing a representative snapshot of Bengaluru's diverse socio-economic landscape. The decision to commence the large-scale survey in this vibrant locality was attributable to the valuable feedback from interns who are thoroughly familiar with this area. The familiarity ensured a focused and insightful beginning to the data collection process. The respondents from this area were mostly females (housewives) who indicated familiarity with electric cooking appliances. However, the respondents expressed an inability to purchase modern cooking devices due to the lack of money. The total no. of samples collected from the Sanjay Nagar area is **N=70**.

2.4.2 Insights from Arundathi Nagar, Srirampura

Arundathi Nagar in Srirampura predominantly comprises a slum area with limited access to essential facilities, such as drinking water supply (available only once in three days). The population exhibits a mix of various occupations, comprising daily wage earners, domestic help & maids, drivers, and small business owners. Given the prevalent demographic of low-to-medium-income families, this location was recommended by one of the interns, who is familiar with the area. Most of the respondents from this area indicated the perceived difficulties associated with electric cooking. Some expressed the fear of electrocution, while few others were worried about higher electricity consumption, and consequently high electricity bills. Overall, the respondents highlighted the difficulties of eCooking in light of frequent power cuts. One respondent highlighted the need for special cooking vessels as a key perceived challenge. Another respondent opined that non-veg items require the right amount of flame for appropriate cooking, which can be provided only by the LPG. Another respondent feels that in electric cooking, either the food would get overcooked, or would remain undercooked since an easy way to control the heating is not available in electric cooking appliances as it can be done with LPG gas stoves. The total no. of samples collected from the Arundathi Nagar, Srirampura area is **N=96**.

2.4.3 Insights from Lakshmi Devi Nagar

The location called Lakshmi Devi Nagar was suggested by the interns engaged in the survey since the area houses several low-to-medium-income families. A significant portion of the families residing in this location is engaged in daily wage work, especially in construction activities. Most of the people are ***migrants from the Gulbarga region***, located in the northern part (Kalaburagi) of the State of Karnataka. Most of the houses in the locality were found of makeshift type (including ***kutcha houses*** and ***tent-like temporary shelters***). A few respondents reside in the free housing provided by the government. Most of the respondents rely on traditional chulhas fuelled by wood which they collect daily after work hours, as they typically cook in the evening after their day's work. ***The community's utility bills are covered by the local mayor***. Some of the female respondents residing in Government-provided housing mentioned their dependence on Anganwadi centers for their meals. The respondents were mostly unaware of electric cooking, they were not interested in modern energy cooking. One particular respondent perceived electric cooking appliances as very technical and difficult to operate. The total no. of samples collected from the Lakshmi Devi Nagar area is **N=56**.

2.4.4 Insights from Subedar Palya

Subedar Palya was selected as a key location for the large-scale survey due to its substantial representation of low-to-medium-income families engaged in diverse occupations. The area is home to a mixed population comprising shopkeepers, garage workers, furniture makers, security personnel, vegetable vendors, and cloth pressers, from the low-income group. The medium-income population in the area comprises working staff from prominent educational institutions located in the vicinity, such as the Ramaiah Institute of Technology, the National Institute of Advanced Studies, and the IISc Campus. The diverse occupational landscape of this locality holds significant potential to provide valuable insights for the project. The poor families indicated a rather strong view against the adoption of electric cooking or modern energy cooking. They also mentioned that they are unaware of the eCooking appliances. Some expressed concerns regarding high energy bills, as well as the fear of electrocution when asked about their views and perceptions regarding electric cooking. One female respondent from the Scheduled Caste community (aged between 25 and 40 years), expressed interesting views on the taste of food cooked using electricity highlighting that the taste differs from the food cooked on LPG. She also mentioned that these eCooking appliances could save cooking time, but she was not very sure of the same. Regarding challenges, she mentioned that these appliances have high power consumption levels. She also showed interest in shifting toward modern electricity-based cooking and expressed the aspiration to own appliances like an Electric Rice cooker, an Electric Pressure cooker, an Electric oven, and a Microwave Oven. She mentioned seeing these appliances at her workplace (she is a contractual employee). She also indicated the ability to spend up to Rs. 1500 for a new, modern energy cooking appliance. Such diverse views made this survey location a crucial inclusion. The total no. of samples collected from the Subedar Palya area is **N=106**.

2.4.5 Insights from JP Park, Mathikere

The JP Park locality in the Mathikere area was selected as a significant location for collecting samples belonging to the low-to-medium income group. This locality houses a diverse population, ranging from affluent residents with prosperous occupations (e.g., Government employees, corporate employees, and well-to-do businessmen, etc.) to individuals involved in odd jobs like daily wage earning and auto driving. Despite this contrast, households with varying economic profiles benefit from reasonable access to essential amenities such as water and food. Among the low-income families, a few reside in small houses, and shady shelters. None of the households in this area had a size of more than 5 people. Mostly the household sizes varied between 4 to 5 members. The respondents from this locality were found to be mostly unaware of the electric cooking. They showed no interest in purchasing modern energy cooking or eCooking appliances. Few of the respondents mentioned that non-veg food needs the flame of a natural fire for appropriate cooking, which cannot be achieved by eCooking. Some of the respondents expressed fear of electrocution, while a few others highlighted high cost as an inhibiting factor. The total no. of samples collected from the JP Park area is **N=63**.

2.4.6 Insights from Kadugodi Park, Whitefield

The Kadugodi Park locality in the Whitefield area (located in the ***eastern part of Bengaluru City***) was strategically chosen as a significant location for gathering samples since this area is traditionally known for medium-to-high income groups (e.g., IT professionals). Additionally, the NIAS survey team identified certain small pockets with a prevalence of low-income families (daily wage labourers, and construction workers). Since this is a developing area within Bengaluru City, it provides daily wage-based work opportunities to several low-income families. An intern's familiarity with the area revealed that it predominantly consists of nuclear families comprising members aged below 35 years, which added to the uniqueness of this location. Notably, some residents use traditional cooking methods, such as chulhas fuelled by wood collected from the vicinity. This showcases an interesting social mosaic exhibiting a blend of high-class lifestyles surrounded by a modest quality of life marked by traditional household cooking practices. One particular respondent from a low-income family (Caste-Scheduled Tribe) highlighted that the electric cooking appliances and vessels are small and can cater to only small requirements. Another female respondent (**Caste**-SC, ***Education Level***-Graduate, ***Small business Owner***) indicated that the curries, such as Aloo curries, Sambhar, Chicken curry, Fish curry, Mixed Veg, and Leafy vegetables, are difficult to make on electric cooking appliances. A few respondents indicated high cost as an inhibiting factor for eCooking adoption, while a few others expressed concerns regarding the electrocution risks if not used properly. Interestingly, a girl (aged between 15 and 25 years) presented a very interesting insight. She mentioned that by using electric cooking one could avoid the risks of LPG cylinder burst-type accidents. This also shows a particular type of experience, where possibly the LPG cylinders are not stored properly. These diverse insights helped the NIAS team capture several interesting views from a diverse locality in terms of lifestyles. The total no. of samples collected from the Kadugodi Park area is **N=98**.

2.4.7 Insights from Hongasandra

Hongasandra was identified as a potential survey location due to the prevalence of medium-income population in this area. The locality is primarily a commercial area comprising mostly corporate employees and well-to-do businessmen. The well-to-do respondents were found to have higher education qualifications (graduate and postgraduate levels). The respondents overall had some views regarding electric cooking. Many of the respondents felt that eCooking helps prepare food faster, and it can come in handy at times when LPG gas gets over. Few respondents opined that the food prepared using electric cooking is not healthy. One respondent highlighted that rice could get burnt at the bottom of the pan while cooking on electricity. A female respondent (***Caste-SC***, aged between 25 and 40 years) opined that the heat coming from the induction cooktop is not adequate for making chapathi (roti), while another female respondent (Caste-General, aged between 40 and 65 years, Education level: ***Graduation***, owning a small business), the heat distribution in the induction cooktop is not even, and therefore, It cannot be used to make items like Dosa, Idli, and Omelette. However, she opined that electric cooking would support multi-tasking in households, and the appliances need to be handled carefully to avoid the risk of electrocution. The total no. of samples collected from the Hongasandra area is **N=33**.

2.4.8 Insights from Begur

Begur is a densely populated locality comprising predominantly low-to-medium-income households. The respondents belonging to this area have a diverse mix of daily wage-based occupations (e.g., contractual employers, and small businesses (self-employed)). Few respondents belonged to the medium-income group (e.g., corporate employees, Government employees). The low-income individuals exhibited almost no awareness of electric cooking and appliances, and most of them are not interested in considering eCooking as an option. A few respondents expressed concerns regarding electric shocks and difficulties in using the devices. Some of the respondents highlighted the high cost of the appliances and the need for specific vessels as a major inhibiting factor. The total no. of samples collected from the Begur area is **N=75**.

2.4.9 Insights from Vinayaka Nagar

Vinayaka Nagar was identified as an insightful survey location due to its blend of low-to-medium-income families, with a higher prevalence of middle-income households. About 35.8% of the respondents in the Vinayaka Nagar locality belonged to the Other Backward Classes (OBC) Category, followed by 31.1% from the Scheduled Caste community. The local OBC community people are mostly self-employed (running small businesses), while a few respondents were corporate employees. Overall, this location comprises mostly well-to-do households having decent income and savings levels. The presence of well-maintained proper houses alongside commercial establishments like shops and vendor stalls catering to low-income groups provides a diverse landscape for large-scale surveys. A male respondent (Caste-OBC, aged between 40 and 65 years, Education level: ***Intermediate***, owning a small business) opined that an electric oven is useful, but induction cannot be effectively used for *making Idli*, since the Idli vessels are large. He also expressed a concern that eCooking can be time-consuming. Another respondent (a female aged between 25 and 40 years) expressed concerns that an induction cooktop gets heated quickly and the heat cannot be removed immediately. She also opined that the induction cooktops are not suitable for making curry, and fry (Bhaji) items. She expressed her concerns regarding the need for continuous supervision while cooking on electricity. An old woman (aged above 65 years) respondent indicated that the traditional finger millet ball (Mudde) cannot be prepared using electricity since this item requires a high amount of heat as well as time. Such diverse insights and concerns captured from the respondents enriched the survey database. The total no. of samples collected from the Vinayaka Nagar area is **N=106**.

2.4.10 Insights from Chamundi Nagar (Rajajinagar)

The Chamundi Nagar locality in the Rajajinagar area comprises predominantly low-to-medium-income families residing in small houses. About 81% of the respondents (**N=77**) from this locality were women. The female respondents indicated a wide array of occupational engagements. Some are working in Beauty parlours, shopping malls & Marts, and as nurses in hospitals. Amongst the male respondents were daily wage earners (e.g., drivers, and contractual workers) and self-employed individuals. ***Most of the respondents in this locality had an education level not exceeding matriculation***. The respondents from this locality had practically no idea about electric cooking. One female respondent (aged between 15 and 25 years, Caste: General, education level: matriculation) highlighted that electric cooking does not yield the correct taste of cooked food, and it leads to higher electricity bills. The respondent further mentioned that eCooking appliances may cause electric shocks, and cannot be used during power cuts. Another female respondent (aged between 40 and 65 years, Education level: Graduation, Caste: General) expressed views that nothing can be cooked properly in the absence of heat and flame. She also mentioned that electric cooking appliances cannot be used during power cuts. ***However, she felt that carrying the eCooking appliances for picnics may be a convenient option***. The total no. of samples collected from the Chamundi Nagar (Rajajinagar) area is **N=95**.

2.4.11 Insights from Dasanapura

The Dasanapura locality, having a striking similarity with the socio-economic settings of Laxmi Devi Nagar (i.e., the predominance of low-to-medium-income group households), was strategically chosen for the validation of the findings as well as to explore the possible comparative features. The similarities observed were in terms of housing conditions, patterns of livelihood, and the broad socio-economic dynamics. Many of the respondents and their families were residing in makeshift shelters and they relied on daily wage earnings as a primary source of income. About 70% of the respondents in Dasanapura comprise daily wage earners and a few individuals running small-scale businesses. About 30% of respondents in Dasanapura comprise individuals working in the Corporate and Government sectors and the owners of big businesses. Most of the respondents are unaware of electricity-based cooking and are not interested in purchasing it. One low-earning female respondent (*aged between 40 and 65 years, Caste: Scheduled Tribe, education level: studied till 8th standard*) perceived electricity-based cooking as risky if not used properly. She also mentioned that food prepared using electricity changes the taste and sometimes food can get burnt as well. She mentioned one benefit of electricity-based cooking is that food can be prepared easily and faster, leading to time-saving. Another female respondent (*aged between 15 and 25 years, Caste: Scheduled Tribe, education level: matriculation*) found electric cooking faster and easier than other modes of cooking. She also opined that there is not much difference in taste for the food cooked using electricity. The same respondent perceived electric cooking as risky with the kids around the kitchen. The total no. of samples collected from the Dasanapura area is **N=54**.

2.4.12 Insights from BHEL, Marappanpalya, Mahalakshmi Layout

The BHEL, Marappanpalya, Mahalakshmi Layout, is known for housing high-income individuals, and the data collection from this location was important to complete the quota of samples from the medium-to-high-income strata. This choice was influenced by the recommendation of a senior professor at NIAS who has spent his lifetime in Bengaluru and is familiar with high-income societies. The respondents comprised employees in the Corporate and Government sectors, PhD research scholars as well as Doctors. All the respondents were found to be educated, with graduation being the minimum qualification. The respondents provided a mixed view regarding the perceived benefits and challenges of electric cooking. Some of the respondents found eCooking to be a faster mode of meal preparation and found it convenient because of its automatic nature. A few others highlighted that eCooking devices are easy to clean and maintain, and they also mentioned it as a safe cooking option. Overall, there were inhibitions amongst the respondents due to the perceived high cost, the absence of multiple burner equivalents, the fragility of the glass tops, and the need for specific vessels. A few individuals also highlighted the higher consumption of electricity as one of the deterring factors. The total no. of samples collected from the BHEL, Marappanpalya, Mahalakshmi Layout area is **N=25**.

2.4.13 Insights from Nandini Layout

Nandini Layout was chosen for the survey due to the prevalence of medium-income families. The respondents comprised government employees residing in furnished quarters, a few corporate employees, doctors, and well-to-do business owners. The respondents provided a mixed view regarding the perceived benefits and challenges of electric cooking. Some of the respondents mentioned electric cooking appliances as environment-friendly options, easy to clean, and safe options. They opined that electric cooking leads to timesaving and comes in handy for reheating leftovers. Electric cooking also helps as a backup option when LPG gets over. The need for specific vessels, perceived high consumption of electricity, high cost, and fragility of the glass tops were some of the major inhibiting aspects. Few respondents also indicated eCooking as unfit for preparing large quantities of non-veg items. They also found eCooking inadequate for cooking **'*hard vegetables*' (***the ones that take a long time to soften up***)**. The total number of samples collected from the Nandini Layout area is **N=27**.

2.4.14 Few Samples in the Upper-Medium Income Group from Other Areas

In addition to the above 13 main locations, four more locations were surveyed Konanakunte Cross, Dollars Colony, Padmanabhanagar, and Kamakya Layout for some additional samples in the medium-to-high income group. The no. of samples collected from the Konanakunte Cross area is **N=2**, the no. of samples collected from the Dollars Colony area is **N=1**, the no. of samples collected from the Padmanabhanagar area is **N=1**, and the no. of samples collected from the Kamakya Layout area is **N=2**. All the respondents surveyed from these four locations were aware of the electric cooking. Four respondents had an educational qualification of graduation or postgraduation level, while the remaining two were found to have education of matriculation level or less. Some of the respondents perceived the electric cooking appliances as items easy to carry and handle, and eCooking as a faster mode of preparing meals. Some of the inhibiting factors that emerged from the responses include the perceived risk of electric shock, perceived high consumption of electricity, and the need for specific vessels. Most of the respondents believed that all the dishes could be prepared using electricity. Two respondents mentioned that the food does not taste as well when prepared using electricity. None of the respondents was sure about purchasing an electric (modern energy) cooking device.

Chapter 3

Socio-Economic Profiles of the Surveyed Households

3.1 Background

The large-scale survey was conducted in the BBMP area in Bengaluru on **910 households** (one respondent from each household was surveyed). The survey responses recorded through the Google Form were cleaned and segregated for further analysis.

The **first section** called ' ***Basic Profiling of the Respondent'*** captured *the respondents' age distribution, the number of members in the respondent's family, the composition of the family (male/ female; adults/ children), and caste. This section also captured the basic information on who is the head of the family, and whether his/ her decision is the final in all the matters related to the household. Also, the survey questionnaire captured the decision-maker in the house for all the major purchases above Rs. 3000.*

From the responses obtained for the **second section** of the survey questionnaire called '***Income and Education Levels***', the information regarding *education qualification*, *total monthly income of the households*, and *average monthly savings* have been analyzed.

From the responses obtained for the **third section** of the survey questionnaire called '***Know-how of Daily-life Technologies***', a nuanced analysis has been carried out to understand various qualitative and personal attributes, such as comfortability *with electronic gadgets & equipment*, *usage of QR Code payment / online payment in daily life*, *mode of searching for information on the internet*, and *extent of vernacularity in the respondent's internet browsing activities*. The salient findings from the detailed analysis are provided in the following sections.

3.2 Age Group Distribution (N=910)

An analysis of the age captured from the respondents indicated that the majority of the samples belonged to the age group of 25 to 40 years (**49%**). About 38% of the respondents were aged above 40 years. The remaining population (survey respondents) belongs to the age group of 15 to 25 years. Such a mix is useful since the younger generation is usually the segment that is interested more in new developments (or experiences) and is inclined toward innovations. **Figure 3** shows the age group distribution of the respondents of the large-scale survey.

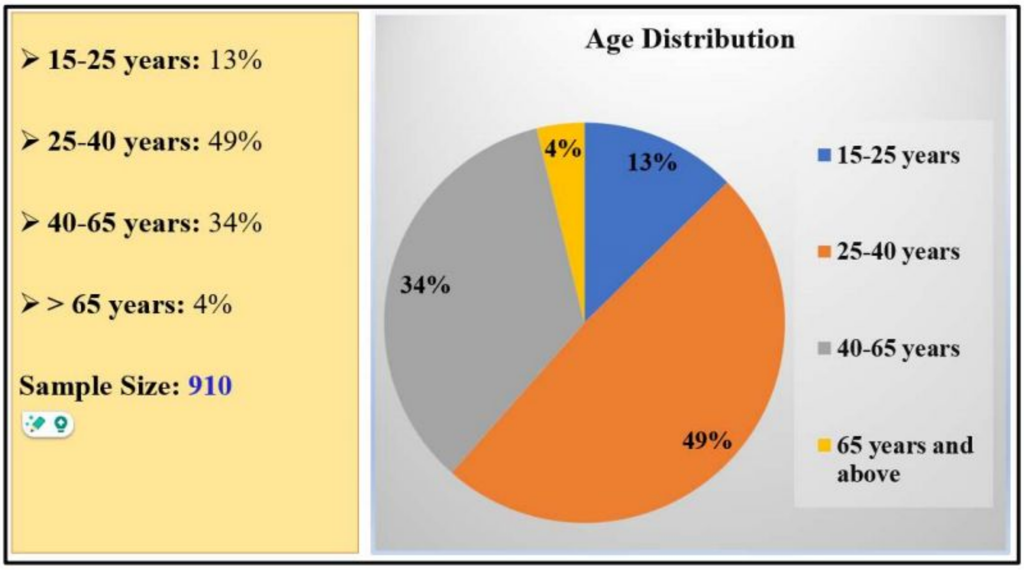

Figure 3: Age group distribution of the respondents of the large-scale survey (**N=910**)

3.3 Household Sizes and the Total Numbers of Adults & Children Captured in the Large-Scale Survey (N=910)

Figure 4 depicts the distribution of household sizes reported by the respondents of the large-scale survey (**N=910**). The total number of members reported by the 910 respondents is calculated to be **3637**. Among these, the numbers of adults and children are **2850** and **787**, respectively. Adults comprise 78% of the total population (including all the household members) in the surveyed households, while children account for only 22% (see **Figure 5**).

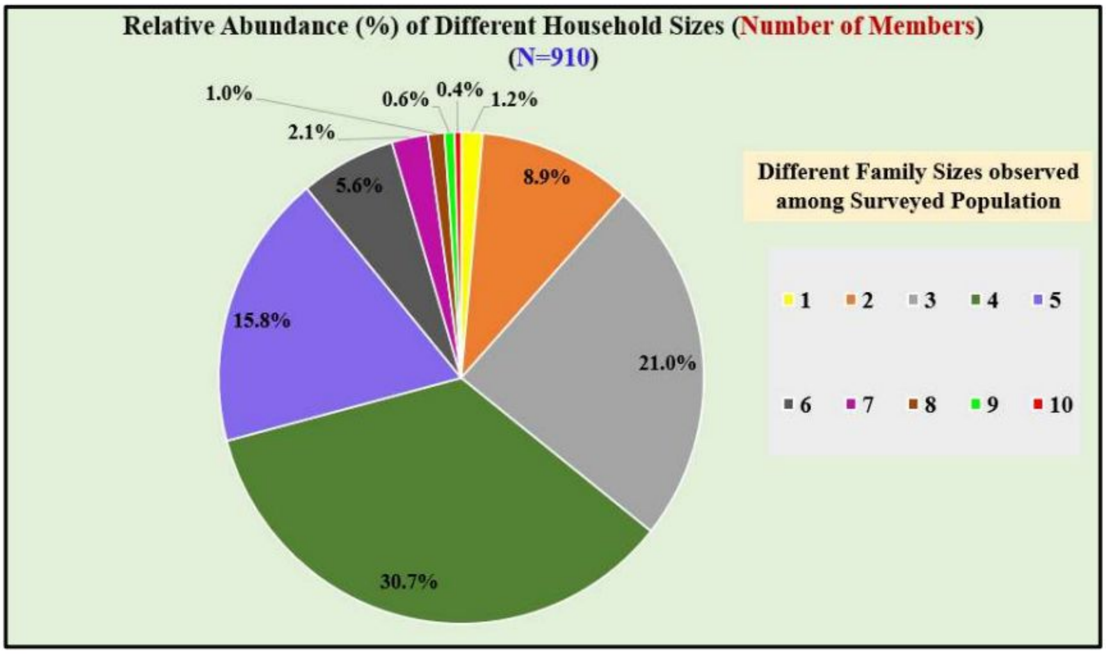

Figure 4: Distribution of household sizes reported by the respondents of the large-scale survey (**N=910**)

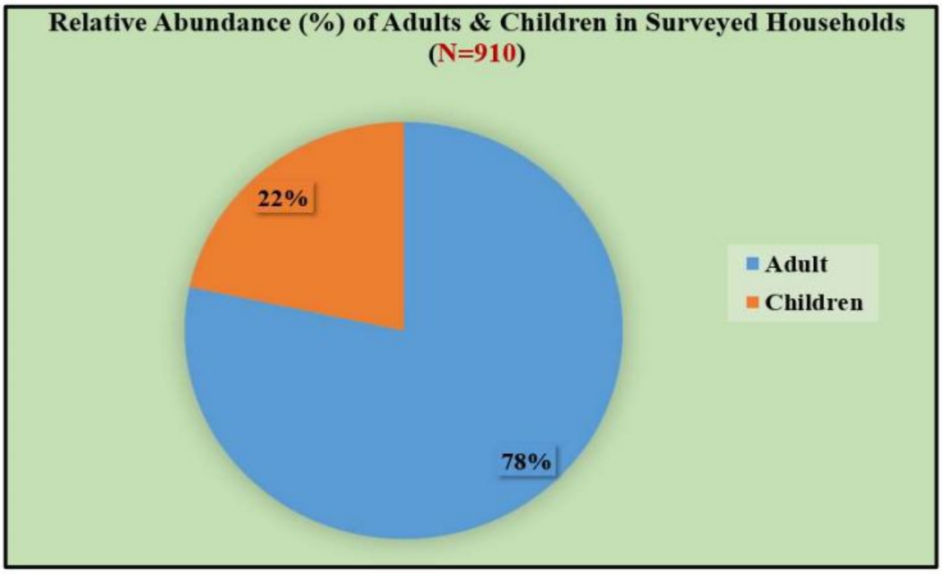

Figure 5: Distribution of adults and children in the total number of members reported by the respondents of the large-scale survey (**N=910**)

3.4 Gender Distribution of the Survey Respondents (N=910)

During the pilot survey, the percentage of male respondents was chosen to be **52%**, and that of female respondents was **48%** considering the overall gender composition of the BBMP area available in the open-source domain. However, the pilot survey responses indicated that the women are inclined toward providing more nuanced and detailed information regarding the kitchen configurations and culinary practices of the households. Therefore, it was a conscious decision to choose samples such that there is a predominance of female respondents in the survey sample (**N=910**) during the large-scale survey conducted in Bengaluru. **Figure 6** shows the gender composition of the respondents of the large-scale survey.

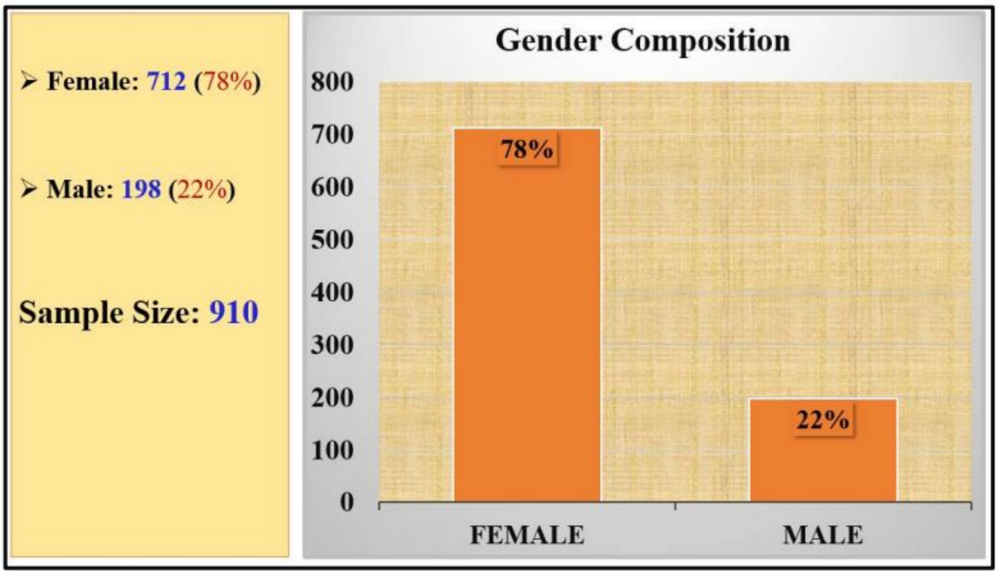

Figure 6: Gender composition of the respondents of the large-scale survey (**N=910**)

3.5 Caste Composition

The respondents of the large-scale survey belong to a diverse mix of different caste categories. This is typically expected from a non-deliberate choice of sample in a cosmopolitan Metro City in India, such as Bengaluru. The caste composition captured in the figure gives an interesting insight since the target population was low-to-medium-income households. However, the caste composition observed in the survey sample cannot be generalized for a populous large Indian city like Bengaluru where the extent of heterogeneities is very high. **Figure 7** shows the caste composition captured in the large-scale survey sample (**N=910**).

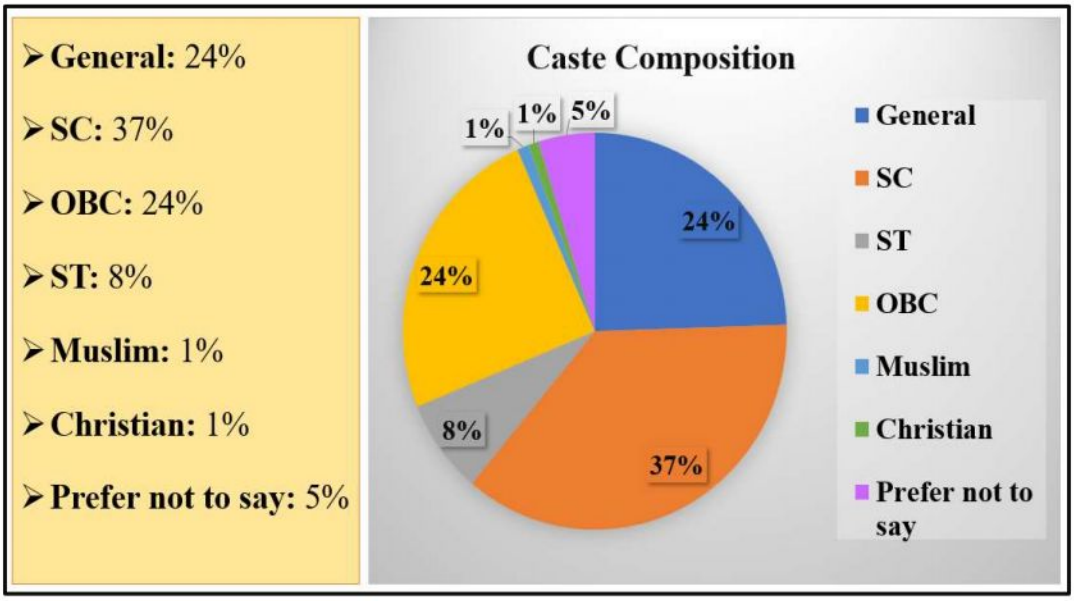

Figure 7: Caste composition captured from the respondents of the large-scale survey (**N=910**)

3.6 Educational Qualification and Know-how of Daily-life Technologies

The majority (**75%**) of the respondents of the large-scale survey (**N=910**) reported an educational qualification of ***Matriculation (10th Standard Equivalent) and above***. About **20%** of the respondents reported an educational qualification of ***Graduation level and above***. This ensures that the population surveyed by the NIAS team was adequately capable of communicating their thoughts based on a quick mental assessment of the reality that exists in the household as well as in their respective lives. This renders the recorded responses a certain level of inherent reliability. **Figure 8** depicts the mix of educational qualifications captured in the large-scale survey sample (**N=910**).

The data indicates that about 76.9% of the respondents are comfortable using various daily-life electrical and electronic gadgets & appliances (see **Figure 9**). *However, the absence of technology familiarity among 23% of the survey respondents is an aspect that needs to be* *addressed as part of larger social upliftment and capacity building.* About 61.9% of the total respondents mentioned that they search for information on the Internet using their own mobile phones (see **Figure 10**). However, there is also a substantial population (30.7%) (Mostly from the middle-aged or older population group) who take help from children or other family members for Internet searching.

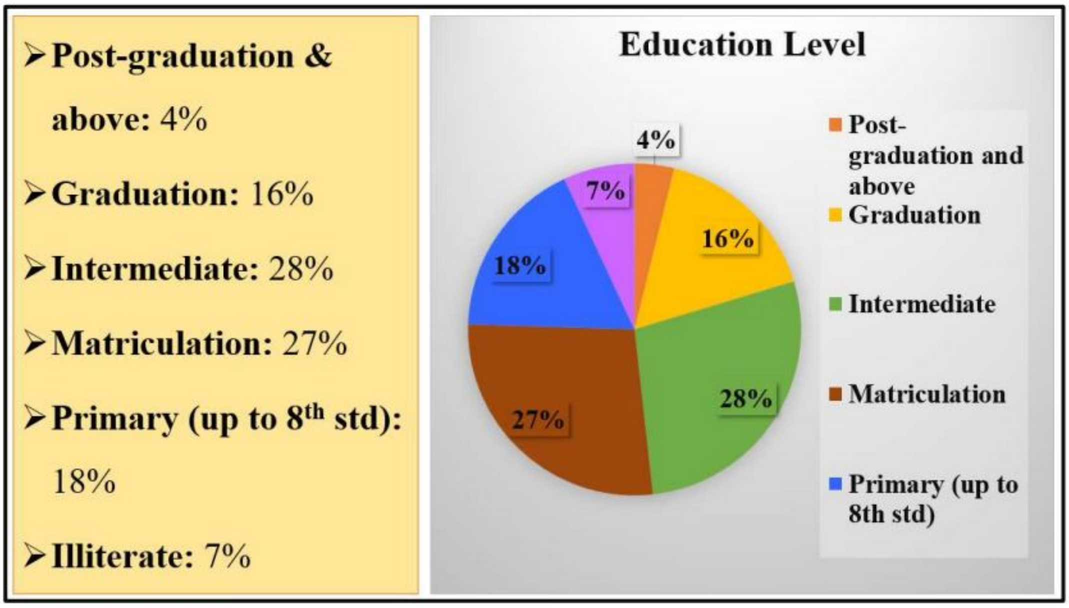

Figure 8: Education qualifications reported by the respondents of the large-scale survey (**N=910**)

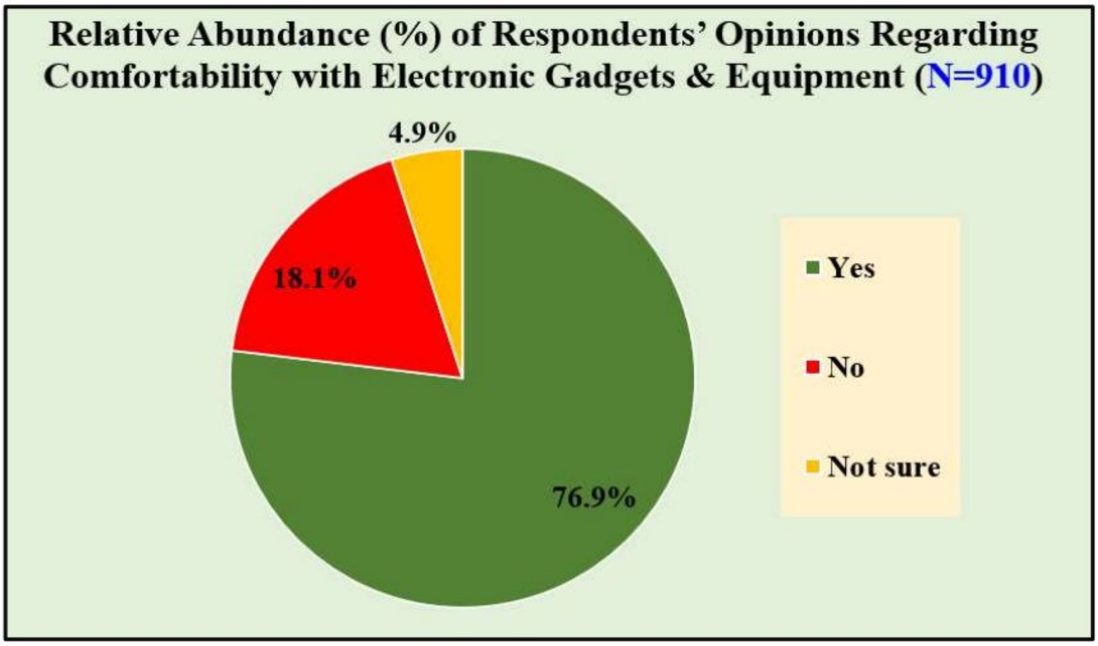

Figure 9: Comfortability of respondents in using various daily-life electrical and electronic gadgets & appliances (**N=910**)

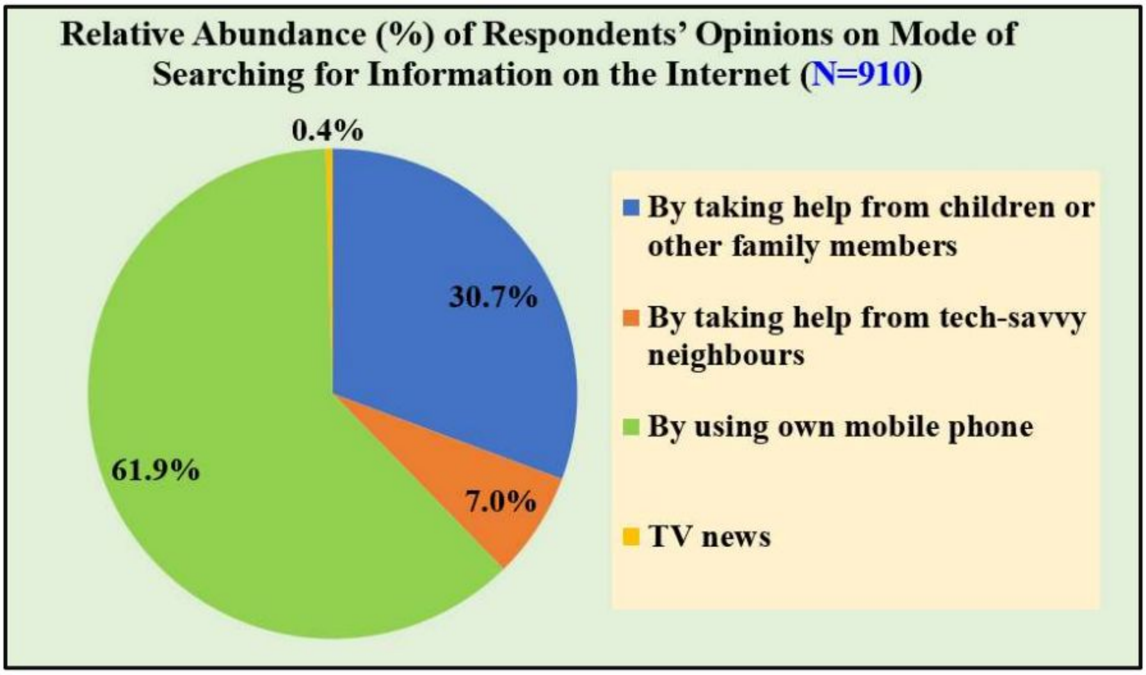

Figure 10: Modes adopted by the respondents in searching for information on the Internet (N=910)

Figure 11 depicts the extent of vernacularity in Internet browsing activities among the respondents of the large-scale survey.

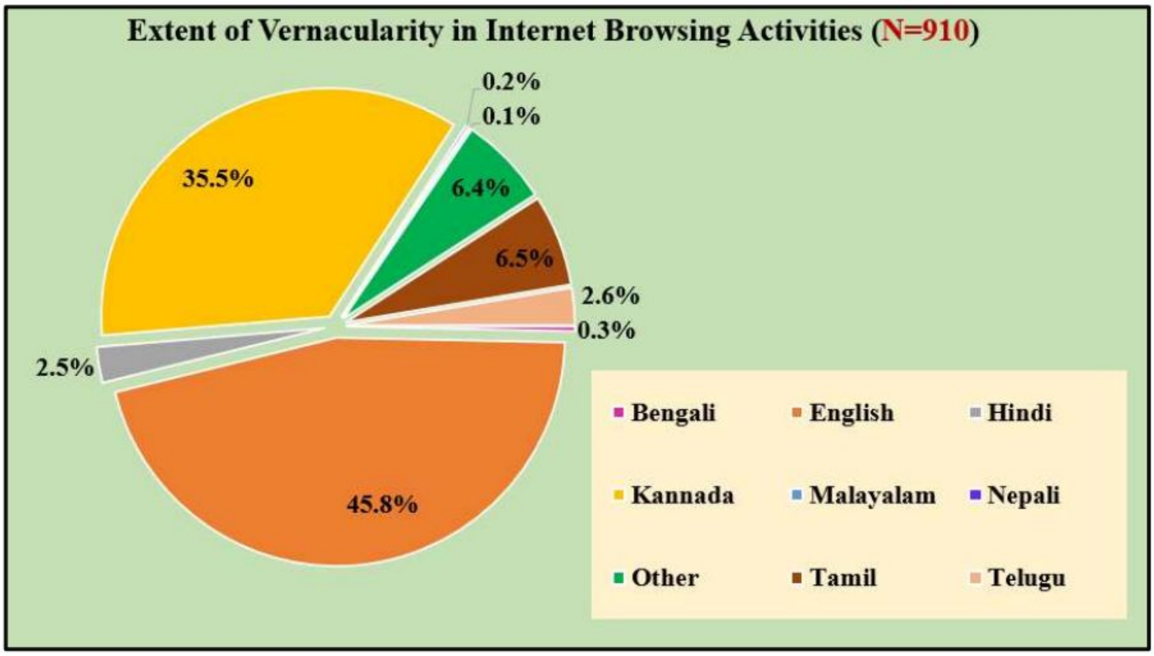

Figure 11: Extent of vernacularity in Internet browsing activities among the respondents of the large-scale survey (N=910)

Although 45.8% of the population use English while browsing the Internet, there is a substantial presence of the different regional languages in Internet searching by the people. Interestingly, 35.5% of the survey respondents mentioned using Kannada while surfing the

Internet. *This indicates the possible need for translating the eCooking appliance instruction manuals into regional languages*.

Only 32% of the large-scale survey respondents mentioned using QR codes or online payments for all daily-life transactions (see **Figure 12**). Another 32% of the respondents mentioned using these modes occasionally. The remaining 36% of the respondents mentioned never using the online or QR code payment modes. This gives a tentative idea regarding the level of tech-savviness amongst the surveyed population. *Although basic know-how about the latest technologies may be present among the surveyed population, there is an implied lack of initiative in adopting and implementing them promptly in daily life*.

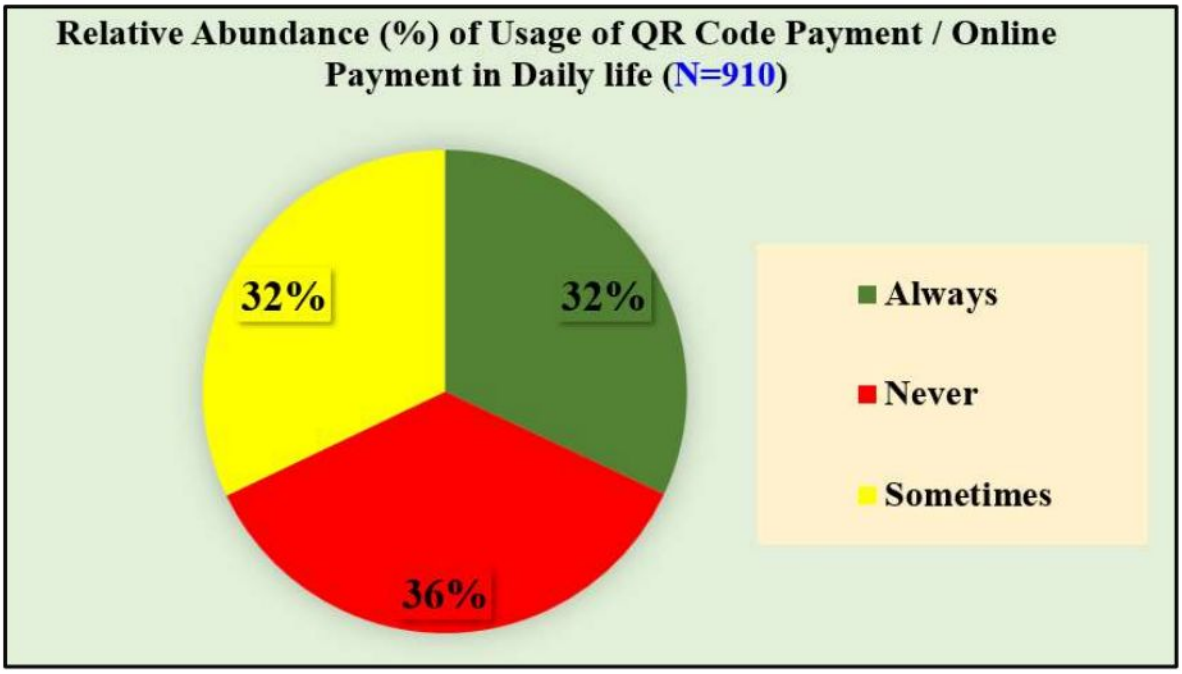

Figure 12: Usage of QR codes & online payment in daily life by the respondents of the large-scale survey (**N=910**)

3.6 Monthly Income Levels

The majority (**56%**) of the respondents of the large-scale survey (**N=910**) reported a total monthly income level of ***Rupees 25000 or below***, while about **35%** of the respondents reported a total monthly income level ***between Rupees 25000 and 60000***. About **9%** of the respondents reported a total monthly income level of ***Rupees 60000 or more***. *This gives a good spectrum of monthly income levels with a predominance of low-to-medium-income households accompanied by a noteworthy presence of medium-to-high-income households.* **Figure 13** exhibits the mix of total monthly income levels captured in the large-scale survey sample (**N=910**).

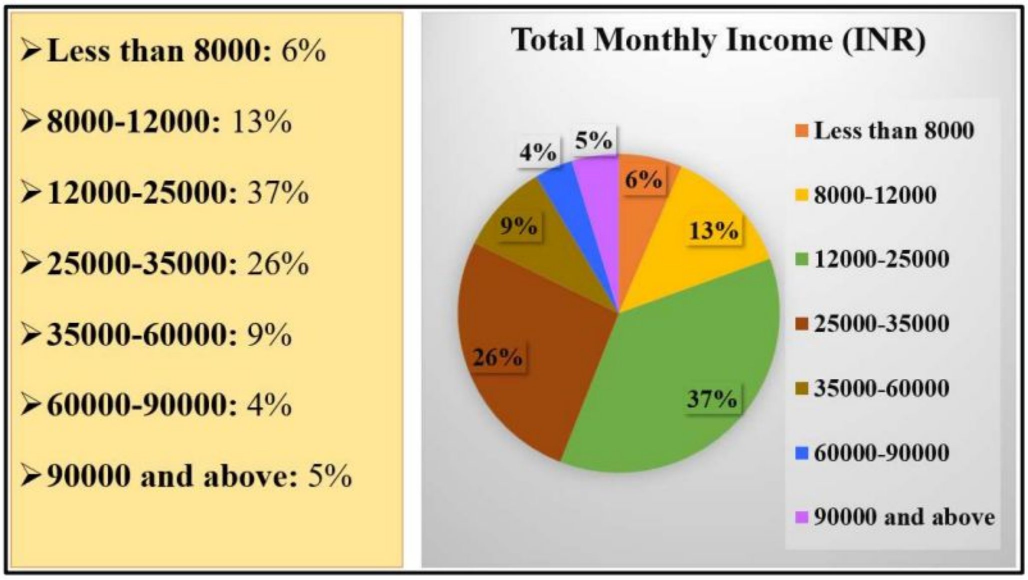

Figure 13: Total monthly income levels captured in the large-scale survey sample (**N=910**)

3.7 Average Monthly Savings

The majority (**81%**) of the respondents of the large-scale survey (**N=910**) reported an average monthly savings of ***Rupees 2500 or below***, while about **11%** of the respondents reported an average monthly savings ***between Rupees 2500 and 6500***. About **8%** of the respondents reported average monthly savings of ***Rupees 6500 or more***. *The savings levels are in good agreement with the observed total monthly income levels.* **Figure 14** exhibits the mix of average monthly savings levels captured in the large-scale survey sample (**N=910**).

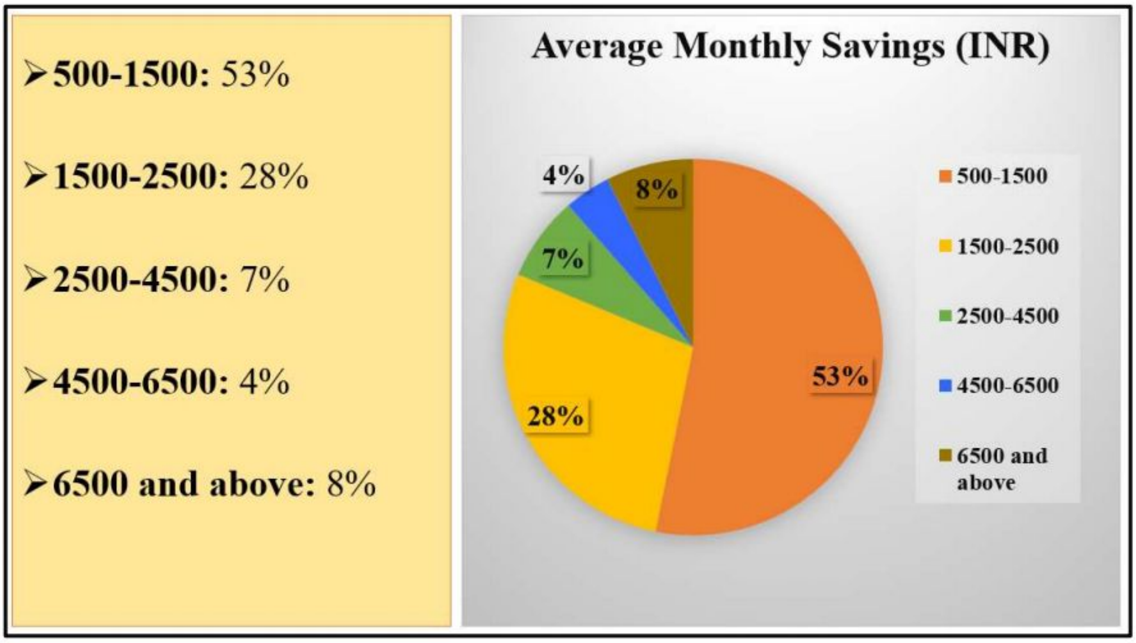

Figure 14: Average monthly savings levels captured in the large-scale survey sample (**N=910**)

The monthly savings data is important since people will more likely commit resources to any new cooking solution (including modern energy devices) if the prices are comparable or less than what they are saving every month on average.

3.8 Household Decision-Making for Major Purchases

The majority (**73%**) of 910 respondents attributed all major household decisions to the ***Man of the House***. About **19%** of the total Survey Respondents attributed all major household decisions to the ***Woman of the House***. Interestingly, only 6% of the survey sample indicated young males (unmarried) as the ***household decision-makers***, while grandparents and young females (unmarried) contributed to decision-making minimally (**1%**). **Figure 15** depicts the mix obtained from the large-scale survey (**N=910**) in connection with household decision-making for major purchases.

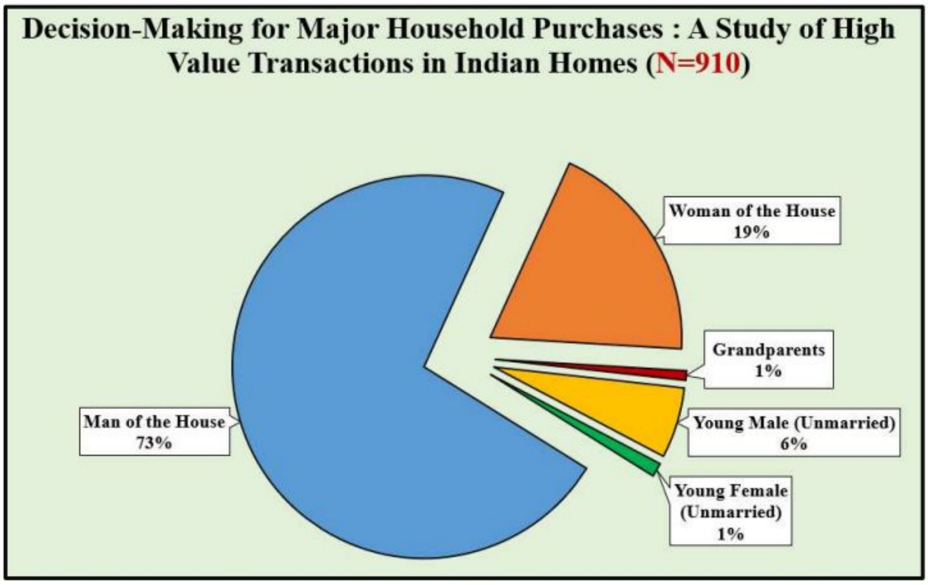

Figure 15: Household decision-making for **major purchases** as captured from respondents (**N=910**)

3.9 Household Decision-Making Regarding Kitchen Purchases

The study uncovers detailed insights into kitchen purchase decision-making in low-to-medium-income households in a cosmopolitan Megacity in India. *Matriarchs or Women of the House emerged as predominant and key stakeholders (**94%** of the Total Survey Sample) in kitchen-related decisions. The Patriarchs or Men of the House played a minor role in kitchen-related decision-making (as indicated by less than **6%** of total survey samples)*. **Figure 16** depicts the mix obtained from the large-scale survey (**N=910**) in connection with household decision-making for kitchen purchases.

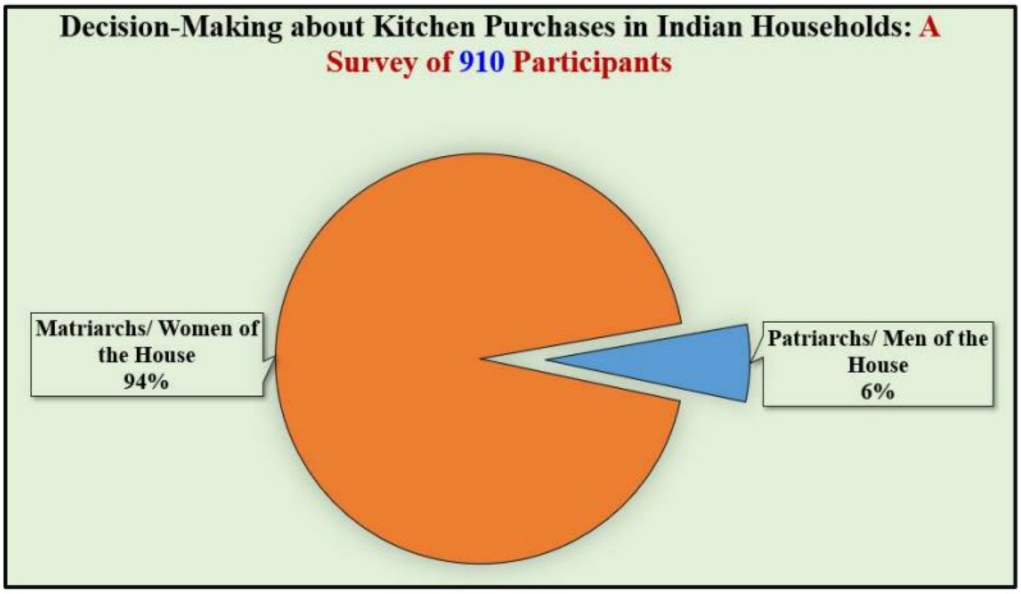

Figure 16: Household decision-making for **kitchen purchases** as captured from respondents (**N=910**)

Chapter 4

Analysis of Transition Readiness of Households toward Modern Cooking Solutions – Reflections from Large-Scale Survey Data

4.1 Background

To arrive at an appropriate conclusion regarding the transition readiness of the household toward modern cooking solutions, it is important to dissect the large-scale survey data from various socioeconomic attributes for a granular understanding of patterns emerging from different sub-segments. Such a granular disaggregation would also help understand the relative impact of various parameters on the lifestyle choices made by the groups of people. The key attributes chosen in this segment are *total monthly income levels*, *average monthly savings*, *household size*, *education level*, *caste*, and *occupation*. A detailed discussion of the survey findings is presented in the following sections.

4.2 Analysis of Willingness to Purchase New Modern Cooking Devices Disaggregated by Monthly Income Levels

One of the key parameters that drive the willingness of households to purchase new modern cooking devices is the total monthly income level since the ability to accommodate a new purchase is contingent upon the household income levels. From the survey data, the willingness of the respondents to purchase modern energy cooking devices (e.g., eCooking devices) was analyzed for different monthly income levels. **Figure 14** presents an illustrative account of willingness to purchase modern cooking devices for different monthly income levels normalized to household sizes.

The normalization was important since the general household expenses tend to be higher for larger household sizes. Therefore, the income relative to household size would provide a more realistic picture. *The willingness of the respondents to own a new modern cooking device was found to be higher with increasing total monthly income levels*.

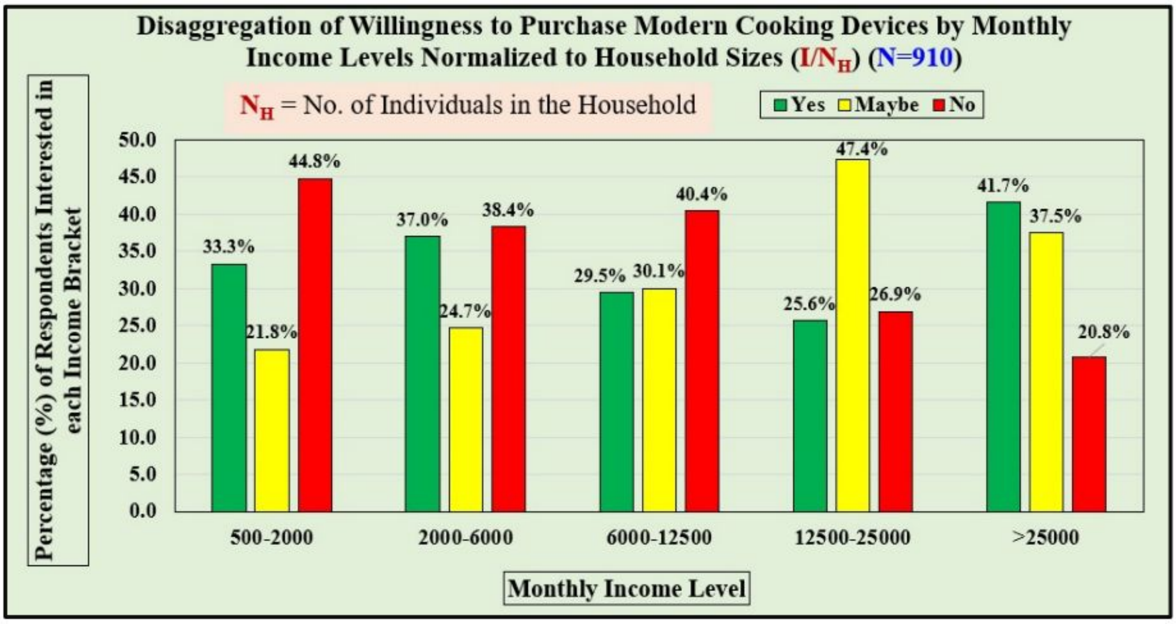

Figure 17: Willingness to Purchase Modern Cooking Devices by Monthly Income Levels Normalized to Household Sizes (*I/N_H*) (**N=910**)

4.3 Analysis of Willingness to Purchase New Modern Cooking Devices Disaggregated by Average Monthly Savings

Apart from the total monthly income levels of the households, the propensity to purchase new modern cooking devices is also contingent upon the average monthly savings. People usually commit resources considering the monthly savings after accounting for the current essential household expenses, and any unavoidable foreseeable expenditure. Therefore, from the survey data, the willingness of the respondents to purchase modern energy cooking devices (e.g., eCooking devices) was analyzed for different monthly savings levels. **Figure 18** presents an illustrative account of willingness to purchase modern cooking devices for different monthly savings levels normalized to household sizes. *The willingness of the respondents to own a new modern cooking device was found to be substantially higher with increasing monthly savings levels. The decisiveness was absent in the lower monthly savings range for obvious reasons (familial priorities in committing resources)*.

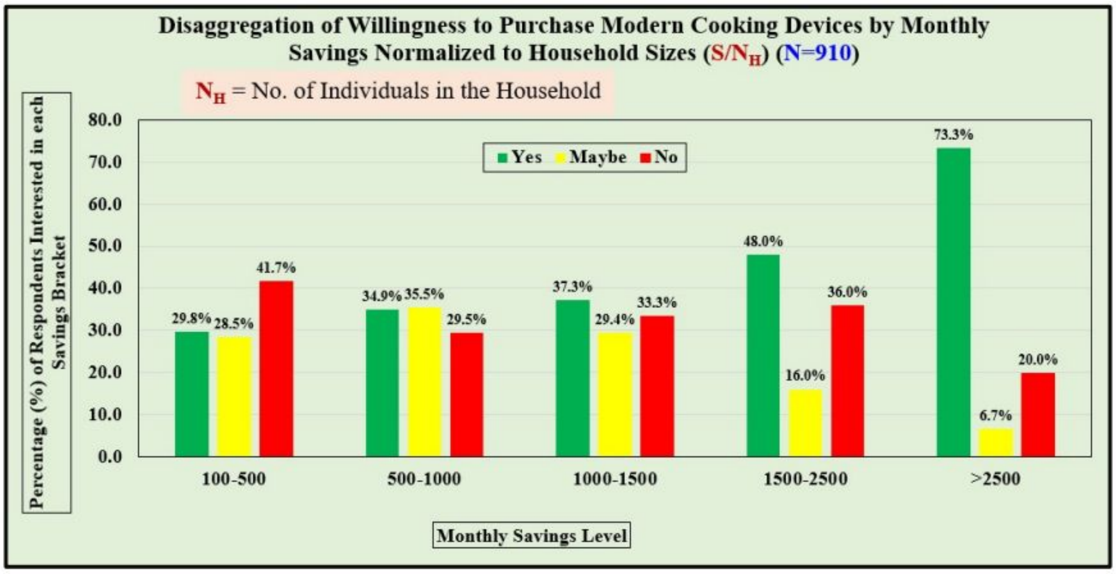

Figure 18: Willingness to Purchase Modern Cooking Devices by Monthly Savings Levels Normalized to Household Sizes (***S/N_H***) (**N=910**)

4.4 Analysis of Willingness to Purchase New Modern Cooking Devices Disaggregated by Household Sizes

Interesting trends were obtained from the analysis of willingness to purchase new modern cooking devices disaggregated by household size. The willingness was found to be the maximum for household sizes ranging between 4 to 6 members. Since the average household size of the surveyed large-scale sample (**N=910**) is 4, *this result indicates a good potential for modern cooking energy devices in an average household in Bengaluru, provided other enablers are in place*. **Figure 19** presents a granular account of willingness to purchase new modern cooking devices disaggregated by household size.

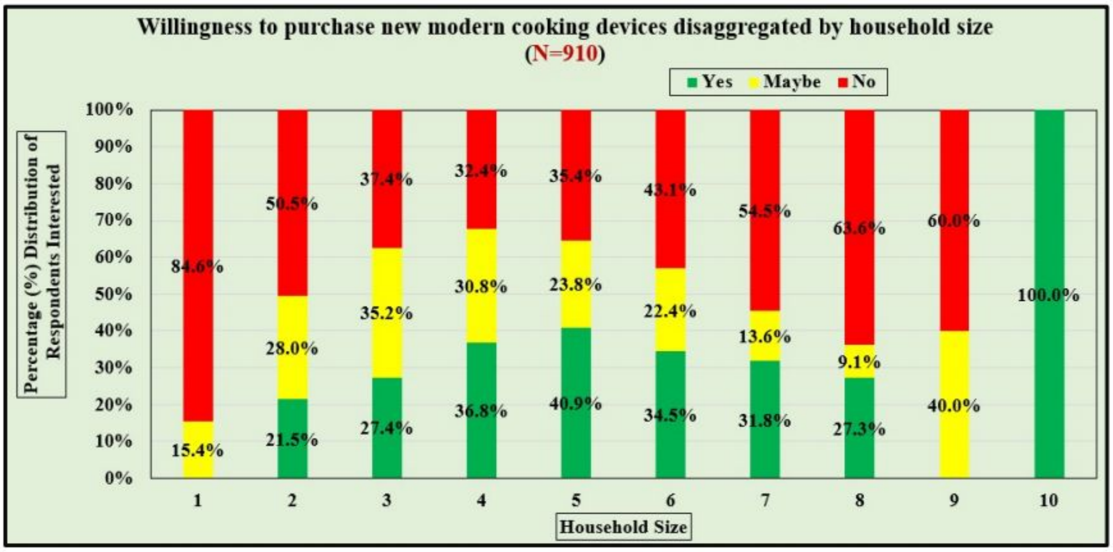

Figure 19: Willingness to purchase new modern cooking devices disaggregated by household size (**N=910**)

Further, the data was analyzed to assess the amount people were willing to pay for a new modern cooking device. This analysis was also done for different household sizes. The results indicate *that amongst household sizes ranging between 4 to 6 members* (**N= 543**) (i.e., **59.7%** of the total survey respondents (**N=910**)), *about 25% population is willing to pay some amount (less than Rupees 1500) for a new modern cooking device, while another 23% population is willing to pay in the range of Rupees 1500 to 3000 for the same*. **Figure 20** illustrates the granular account of willingness to spend for new modern cooking devices disaggregated by household size. *Such information would be crucial for planning purposes while rolling out a transition strategy in the residential cooking sector*.

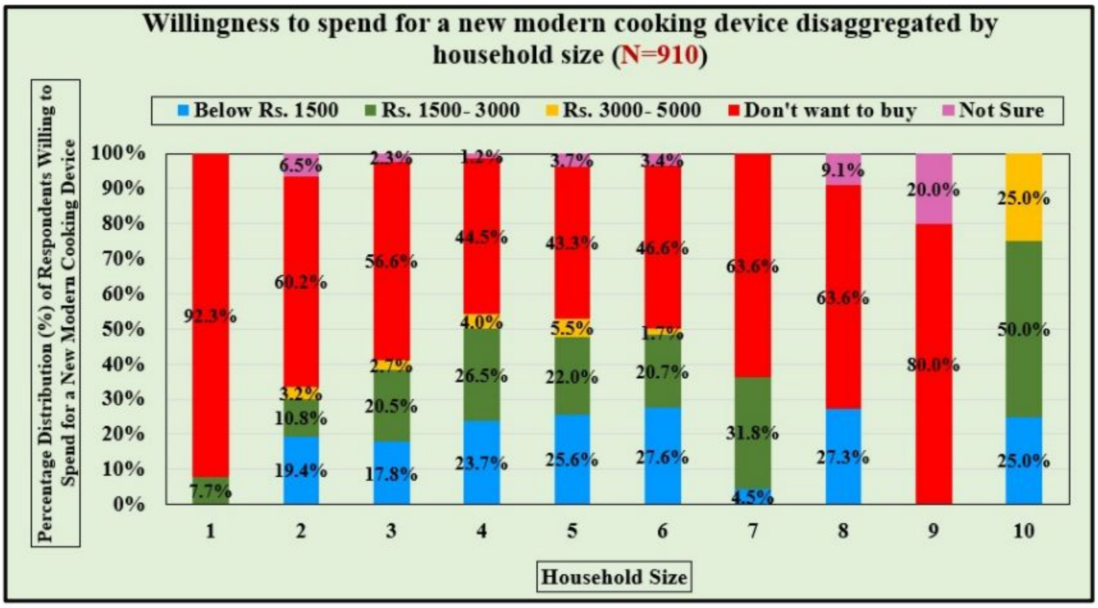

Figure 20: Willingness to spend for a new modern cooking device disaggregated by household size (**N=910**)

4.5 Analysis of Willingness to Purchase New Modern Cooking Devices Disaggregated by Education Level

Analysis of willingness to purchase new modern cooking devices disaggregated by education level was conducted to assess whether educational qualifications have any impact on the choices made by people for the cooking devices since cooking is a major lifestyle attribute and choices made for the preparation of daily food has a direct bearing on the quality of life. Simultaneously, the disaggregation of the population has been done to inspect the granular information for the ***two age groups*** (25 to 40 years, and 40 to 65 years) separately to capture the effect of ***generational attitude***.

Figures 21 and **22** depict the willingness shown by the people to purchase new modern cooking devices disaggregated by education level for the two age groups, respectively. In our analysis, on average people in the age group of **25 to 40 years** (34.4%) exhibited a higher willingness to purchase new modern cooking devices, compared to the older age group (**40 to 65 years**) (30.5%).

A considerably larger fraction of the younger group 25 to 40 years (**31.4%**) *has indicated a tentative possibility of adopting new modern cooking devices, compared to the older group* (40 to 65 years) (**20.75%**). About *34.2%* of the *younger population* (25 to 40 years, **N=428**) *is not keen to adopt* a *new modern cooking device*. In the older group (40 to 65 years, **N=482**), *48.7 % of respondents did not want to adopt a new modern cooking device. Overall, education level does not appear to have a strong influence on the choice of modern cooking devices in the analysis. However, the younger generation is more inclined toward adopting these new solutions.*

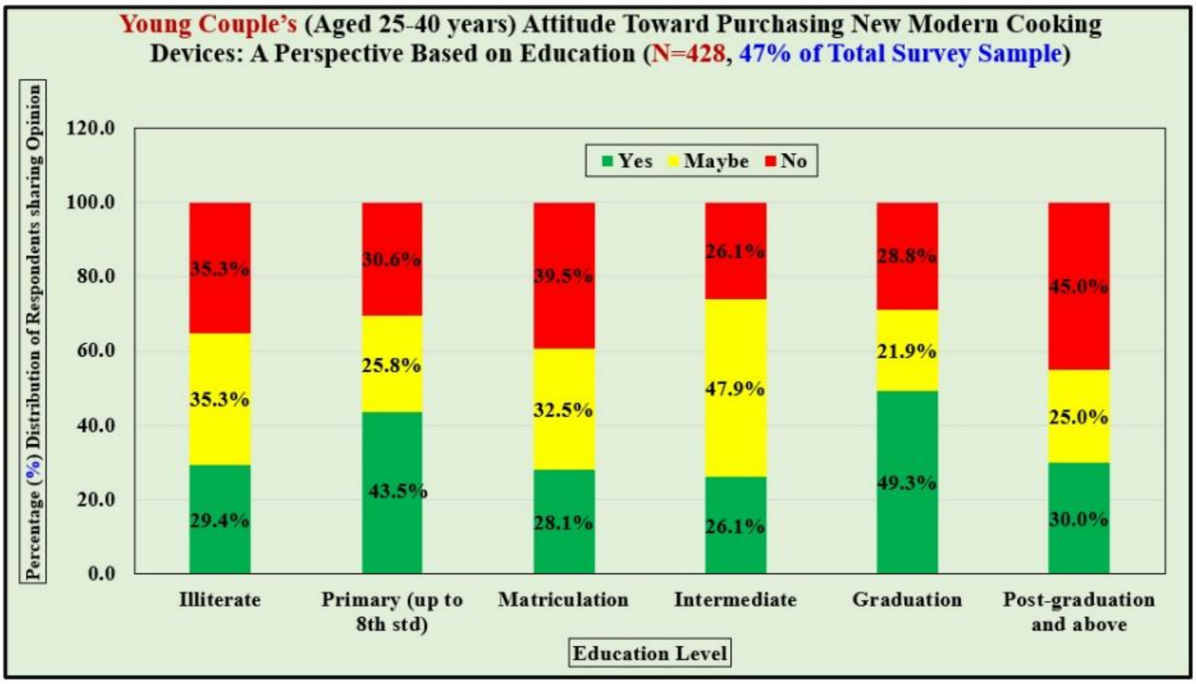

Figure 21: Willingness amongst Young Couples (**N=428**) to purchase a new modern cooking device disaggregated by education level

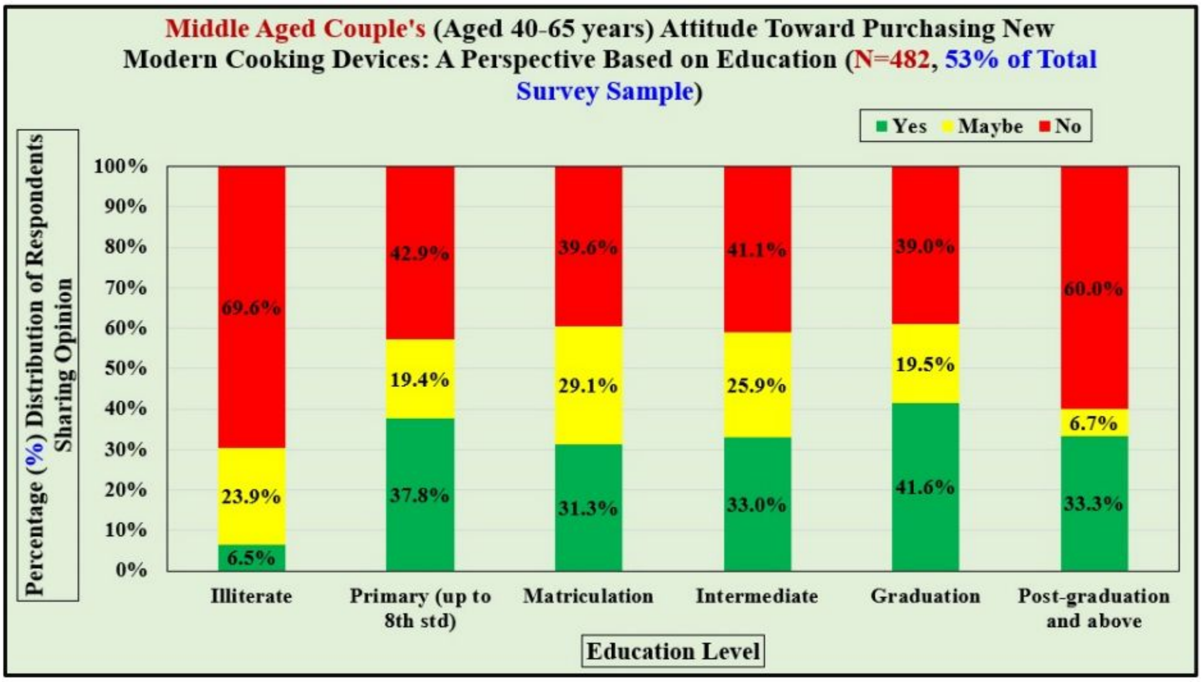

Figure 22: Willingness amongst Middle-Aged Couples (N=482) to purchase a new modern cooking device disaggregated by education level

4.5 Analysis of Willingness to Purchase New Modern Cooking Devices Disaggregated by Occupation

Analysis of willingness to purchase new modern cooking devices disaggregated by occupation was conducted to assess its possible impact on the choices made by people for cooking devices since occupation often dictates an individual's lifestyle. Further, the income levels of the individuals are often linked with the occupation, and therefore it is chosen as an important socioeconomic indicator for assessing willingness toward transition. Simultaneously, the disaggregation of the population has been done to inspect the granular information for the ***two age groups*** (25 to 40 years, **N=428**; and 40 to 65 years, **N=482**) separately to capture the effect of ***generational attitude***. In the younger group (25 to 40 years), *the low-wage earners (e.g., daily-wage earning people & contractual workers) currently show a low inclination* (22.9%) toward purchasing new modern cooking devices. This could be highly attributable to their monthly income and savings levels. However, *a large fraction of them* (38.9%) *indicated a tentative possibility of adopting a new modern cooking device, which shows people's aspiration to own modern devices and have a better quality of life.*

Self-employed people, corporate employees, and business owners in the younger group **(25 to 40 years)** showed a substantial inclination **(39.4%)** toward new modern cooking devices. Amongst the government employees and people working in the urban local bodies, the inclination was found to be rather low for both age groups (25 to 40 years, and 40 to 65 years), despite these people having by and large an assured and continued monthly income. *Overall, the aspiration to own a new modern cooking device was found to be higher among the age group of 25 to 40 years*. **Figures 23** and **24** depict the willingness shown by the people to purchase new modern cooking devices disaggregated by occupation for the two age groups, respectively.

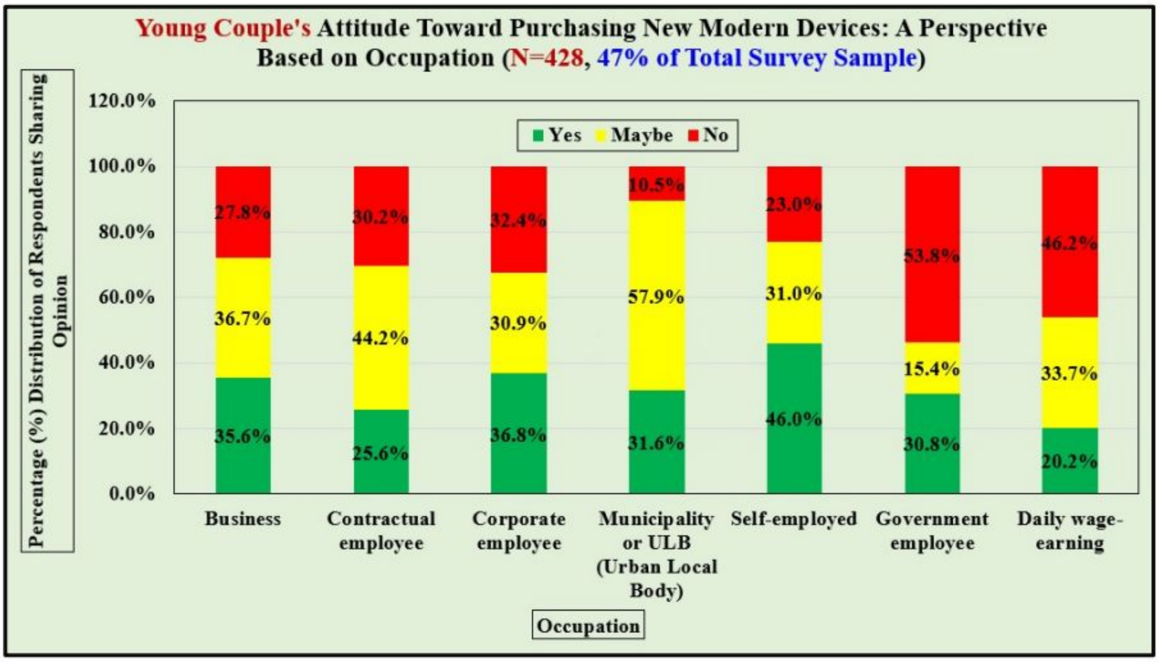

Figure 23: Willingness amongst Young Couples (N=428) to purchase a new modern cooking device disaggregated by occupation

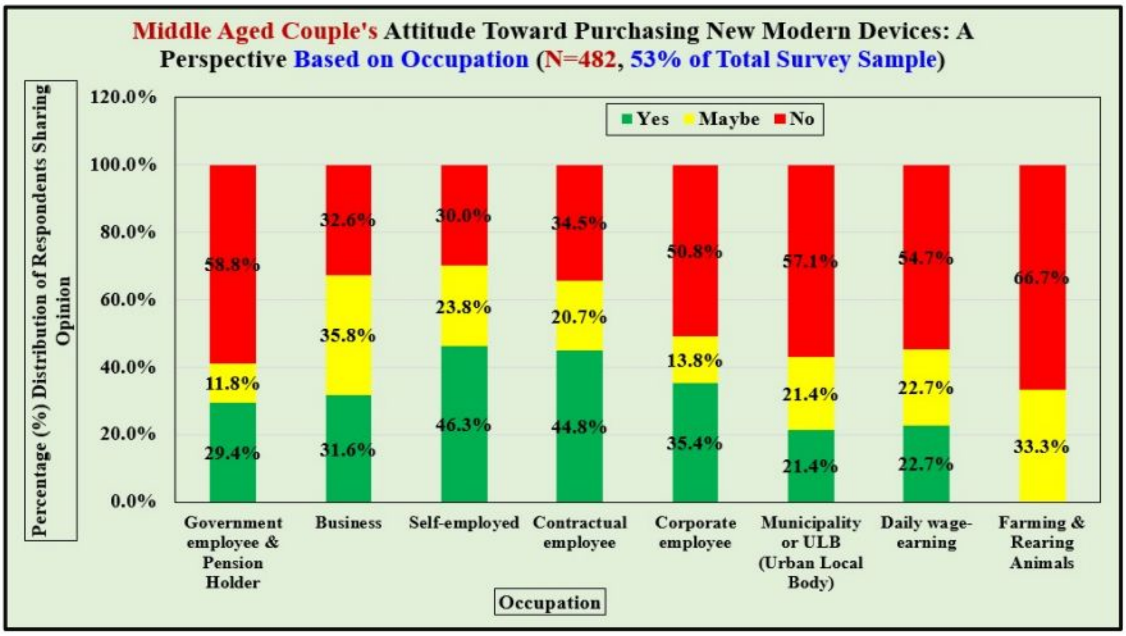

Figure 24: Willingness amongst Middle-Aged Couples (N=482) to purchase a new modern cooking device disaggregated by occupation

4.6 Analysis of Willingness to Purchase New Modern Cooking Devices Disaggregated by Caste

Analysis of willingness to purchase new modern cooking devices disaggregated by caste was conducted to assess the possible impact of social standing on the choices made by people for cooking devices since social standings (part of which is governed by the individual's position in the social hierarchy marked by the caste system) often dictate an individual's lifestyle and mindset. *Interestingly, our analysis shows an aspirational trend amongst the people from marginalized and backward sections*. About **35.8%** of the respondents from underprivileged and backward communities (comprising people belonging to Scheduled Caste (SC), Scheduled Tribe (ST), and Other Backward Classes (OBC) categories; **N=625** (three categories combined), ***68.6% of the total surveyed population***), showed an inclination toward purchasing new modern cooking devices. Another **25.9%** from this category indicated a tentative possibility to purchase modern cooking devices. Such observations are important to initiate further scrutiny of the possible measures aimed at enhancing the quality of life for the marginalized communities residing in cities and towns of India. There is a predominant prevalence of the aforesaid marginalized communities in Bengaluru. Therefore, the findings are in accordance with the larger ground reality of the Metro City. **Figure 25** depicts the willingness shown by the people to purchase new modern cooking devices disaggregated by caste.

Willingness to purchase new modern cooking devices (Percentage Distribution)

Caste	Yes	Maybe	No
General	34.7%	29.3%	36.0%
SC	32.2%	29.2%	38.6%
ST	44.3%	17.1%	38.6%
OBC	30.9%	31.4%	37.7%
Others	25.0%	30.0%	45.0%
Prefer Not to say (Caste not disclosed)	23.3%	27.9%	48.8%

*Others include **Marathi, Nepali, and Bengali***

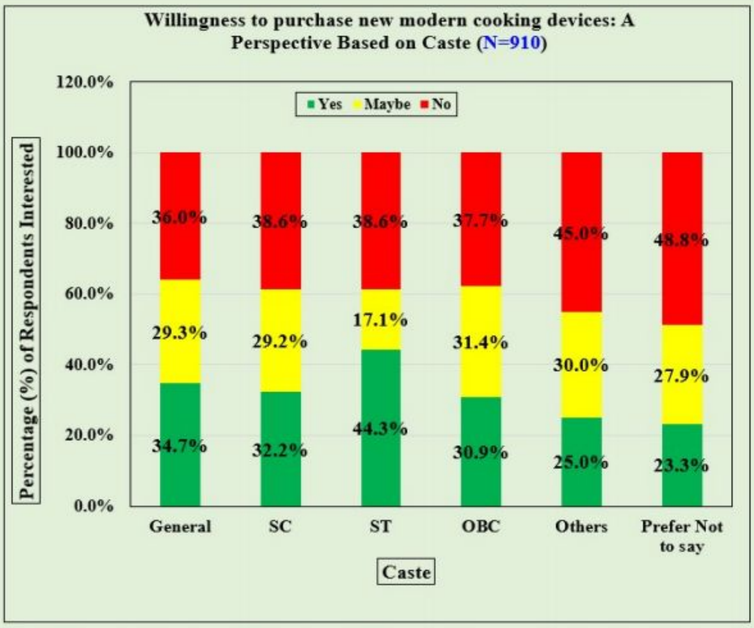

Figure 25: Willingness to purchase new modern cooking devices disaggregated by caste (**N=910**)

Chapter 5

Current Usage of Cooking Fuels, Appliances, and Utensils in Surveyed Households

5.1 Background

To assess the readiness of people to progressively transition toward a new household cooking energy paradigm, it is of paramount importance to understand the current trends of cooking fuel usage, the appliances used by people, and the utensils that are prevailing in the houses for daily use. This is particularly important since the dominant modern energy cooking devices (e.g., different eCooking devices) necessitate using specific vessels. Any large-scale transition should be such that it incrementally deviates from the current practices in a gradual manner. Any abrupt shift may jeopardize the core objective of the transition which aims to enhance the quality of life for people at the mass scale. A disruptive change in the cooking ecosystem would also be injurious to the financial health of the enterprises engaged in the different parts of supply chains associated with household cooking appliances, fuel, utensils, spare parts & components, and servicing & repairing. The following sections describe in detail the current usage of cooking fuels, appliances, and vessels in the surveyed households and its implications for the envisaged transition to eCooking.

5.2 Cooking Fuels and Appliances Currently Used in Bengaluru Households

A detailed analysis of the survey data indicates that 84.7% of the total surveyed population (**N=910**) are exclusive Liquid Petroleum Gas (LPG) users. The remaining 15.3% of the survey sample comprises a diverse mix of electric cooking, LPG-based cooking, and even traditional clay oven (Oley) -based cooking. **Figure 26** presents a broad view of the cooking fuels and appliances currently being used in Bengaluru households. Further, **Figure 27** provides a more granular look into the fuel and appliance usage by the population which is not exclusively using LPG for residential cooking. Such diversities reflect the different lifestyles and choices made by the people based on access to resources and facilities, economic profiles, as well as social standing. Although the share of the survey population that still uses traditional clay ovens for cooking is small (**N=10**, about 1.1% of the total survey population), there is an urgent need to take into consideration the realities of the life of the underprivileged, and marginalized communities (*all the clay oven users belong to either SC/ST or OBC* *communities*) in the low-income group for strategizing the interventions that uplift their quality of life.

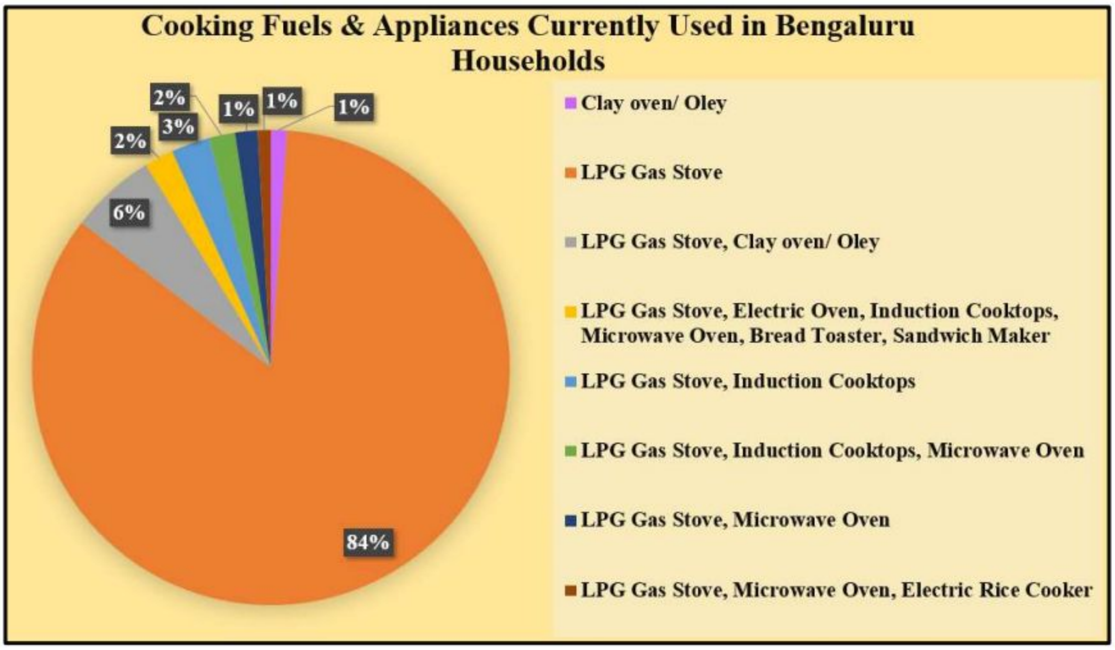

Figure 26: Share of different cooking fuels and appliances currently being used in Bengaluru households (**N=910**)

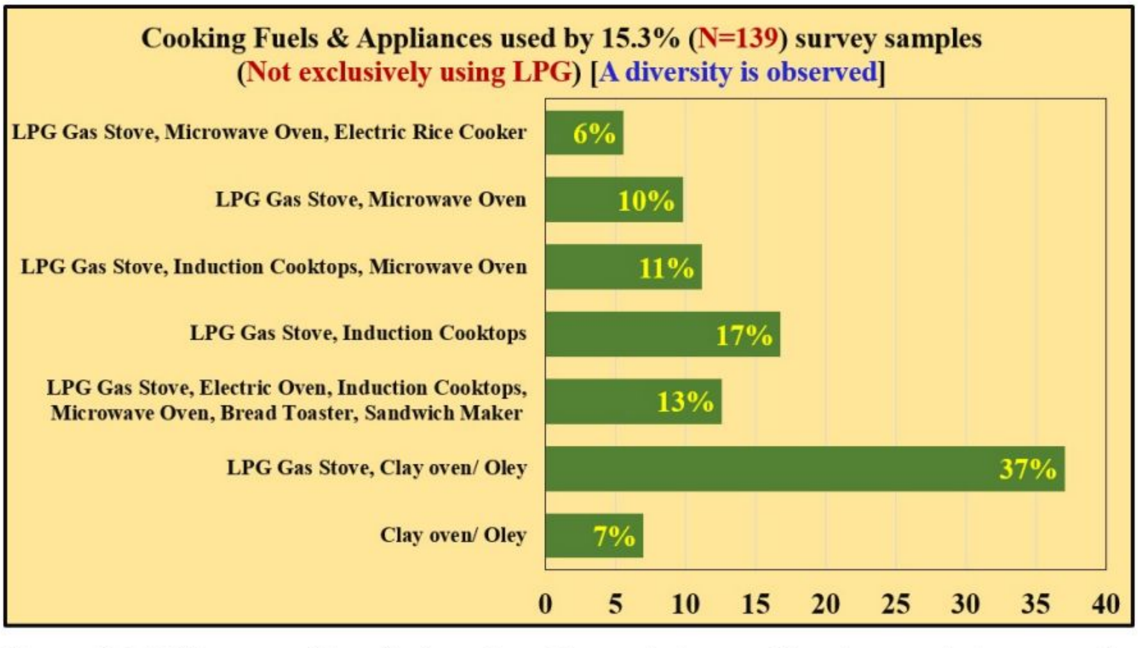

Figure 27: Different cooking fuels and appliances being used by the population not using LPG exclusively for cooking (**N=139**)

5.3 Cooking Fuels and Appliances Currently Used for Reheating Leftovers in Bengaluru Households

Amongst the population not exclusively using LPG for household cooking, about **70 respondents** mentioned reheating leftovers. A wide array of different cooking appliances and fuels are being used by people based on the availability of resources, culinary practices, and behavioral traits. Interestingly, the people in the lowest income groups (i.e. marginalized) are using traditional clay ovens for reheating food. These are the people who possess only traditional clay ovens in the house for cooking purposes and do not have access to any other means. The population that uses both LPG gas stoves and clay ovens for household cooking are also using both means to reheat the leftovers. The medium-income households that possess different kinds of modern electric cooking appliances, such as induction cooktops and microwave ovens, are using the same for reheating food. A small population from the survey sample uses only microwave ovens for reheating food. *Evidently, people are using options based on the access they have to those options and the convenience these offer to their existing lifestyles. Notably, the access to various options is rooted in the socioeconomic realities around each household*. **Figure 28** depicts the cooking fuels and appliances currently being used for reheating food/ leftovers by a fraction of Bengaluru households.

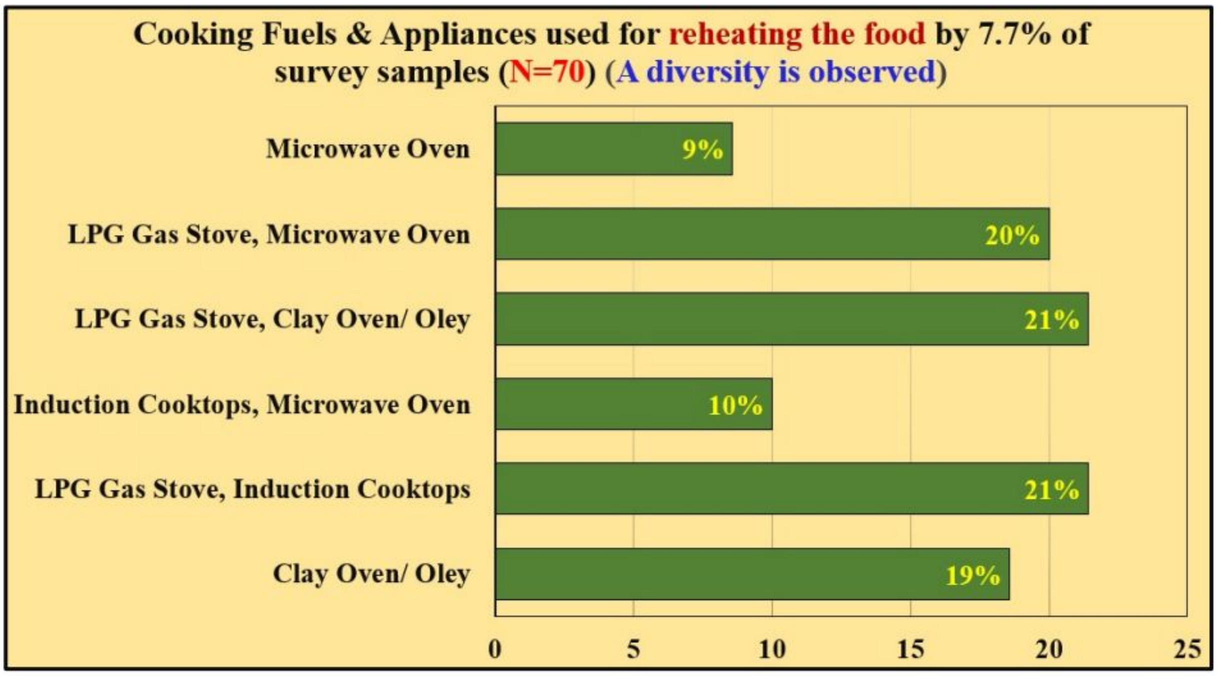

Figure 28: Different cooking fuels and appliances being used for reheating food/ leftovers by a fraction of the population not using LPG exclusively for cooking (N=70)

5.4 Current Status of LPG Usage in Bengaluru Households

Since 84.7% of the respondents (**N=771**) in the large-scale survey were found to be exclusive LPG users, a granular look at the current LPG usage was necessary. The Pradhan Mantri Ujjwala Yojana (PMUY) beneficiaries are eligible to receive ₹ **200** for a cylinder as a subsidy if the annual income is below ₹10 lakhs and this subsidy is provided for a maximum of 12 cylinders per year. The price of a non-subsidized 14.2 kg LPG Cylinder (averaged over the four cities – Delhi, Mumbai, Chennai, and Kolkata) has increased by about ₹ 358.7 over the 18 months between December 2020 and May 2022 (the average price of cylinder increased from ₹ 654.6 on 02 December 2020 to ₹ 1013.3 on 19 May 2022). The subsidy provided (₹ 200) covers only about 20% of the current non-subsidized cylinder price (~₹ 1050). Because of the sharp price rise over the past few years, the number of non-subsidized beneficiaries has drastically come down.

Apart from the high costs of refill, an additional factor that caused a low refill rate is the inadequate area coverage of the LPG cylinder distribution networks. Considering these realities, a detailed analysis was conducted on LPG usage separately for the households run by young-aged (25-40 years) couples and middle-aged (40-65 years) couples. **Figure 29** depicts the share of respondents exclusively using LPG (**N=771**) covered by the PMUY scheme.

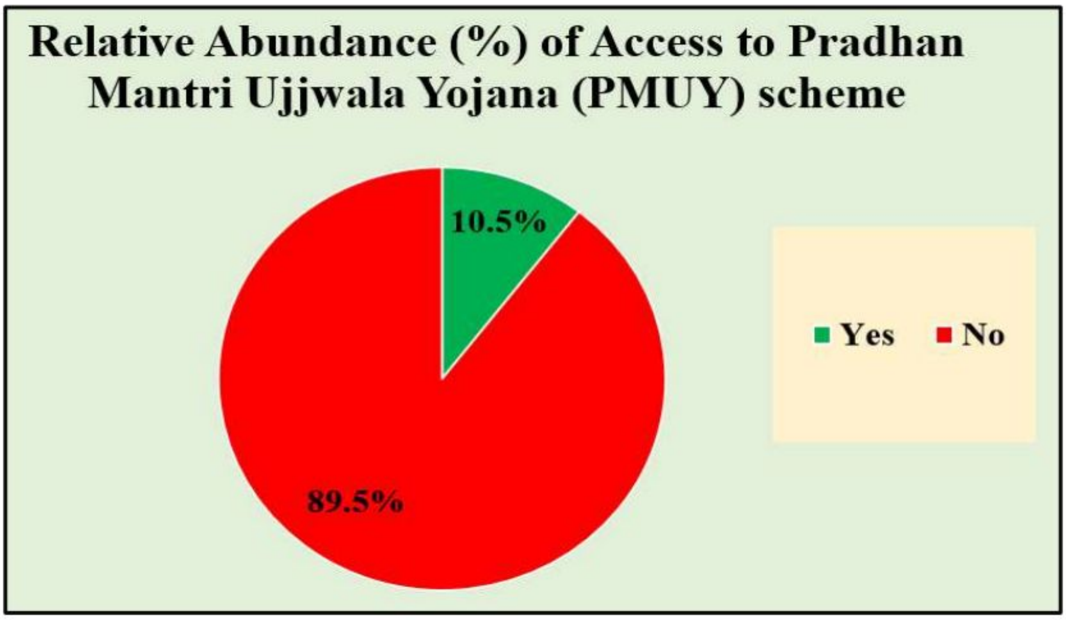

Figure 29: Share of respondents exclusively using LPG (**N=771**) covered by the PMUY scheme

Despite a large fraction of the survey sample being from the low-income group, a low number of PMUY beneficiaries is observed among exclusive LPG users. On being asked during the trial and mass-scale surveys, most of the respondents in the large slums and low-cost *housing areas mentioned not receiving the benefits of the PMUY scheme since the times of the COVID-19 pandemic. This indicates that the benefits PMUY stopped reaching the marginalized people more than 2 years back. One possible explanation is the erosion of disposable income which eventually discouraged the households to pursue expensive refills by paying the upfront cost. Many of the female respondents from the low-cost housing areas (about 40-50%) mentioned not having proper personal identification documents (e.g., an Aadhaar Card), and bank accounts*. This needs attention from the policymakers and interventions may be required to remove the possible inhibiting factors.

Analysis showed that among the households run by young-aged couples (**N=428**), a major fraction (67.7%; **N=290**) belonged to the monthly income range of Rupees 12000 to 35000. Among this sample (**N=290**), **37.9%** reported consuming 3 to 4 LPG cylinders per year, **36.5%** reported consuming 4 to 6 LPG cylinders per year, and **23.7 %** reported consuming more than 6 LPG cylinders per year. Among the households run by middle-aged couples (**N=482**), about 58.5 %; (**N=282**) belonged to the monthly income range of Rupees 12000 to 35000. Among this sample (**N=282**), 27.3% reported consuming 3 to 4 LPG cylinders per year, 40.7 % reported consuming 4 to 6 LPG cylinders per year, and 30.5 % reported consuming more than 6 LPG cylinders per year. Data shows that the household level LPG consumption increases with increasing income levels. Households run by middle-aged couples are found to consume a larger number of LPG cylinders on average. *The consumption depends on several factors including family size, and the purposes for which LPG is being used in the households*. **Figures 30** and **31** depict the LPG consumption patterns for households run by young-aged (25-40 years) and middle-aged (40-65 years) couples as a function of monthly income levels.

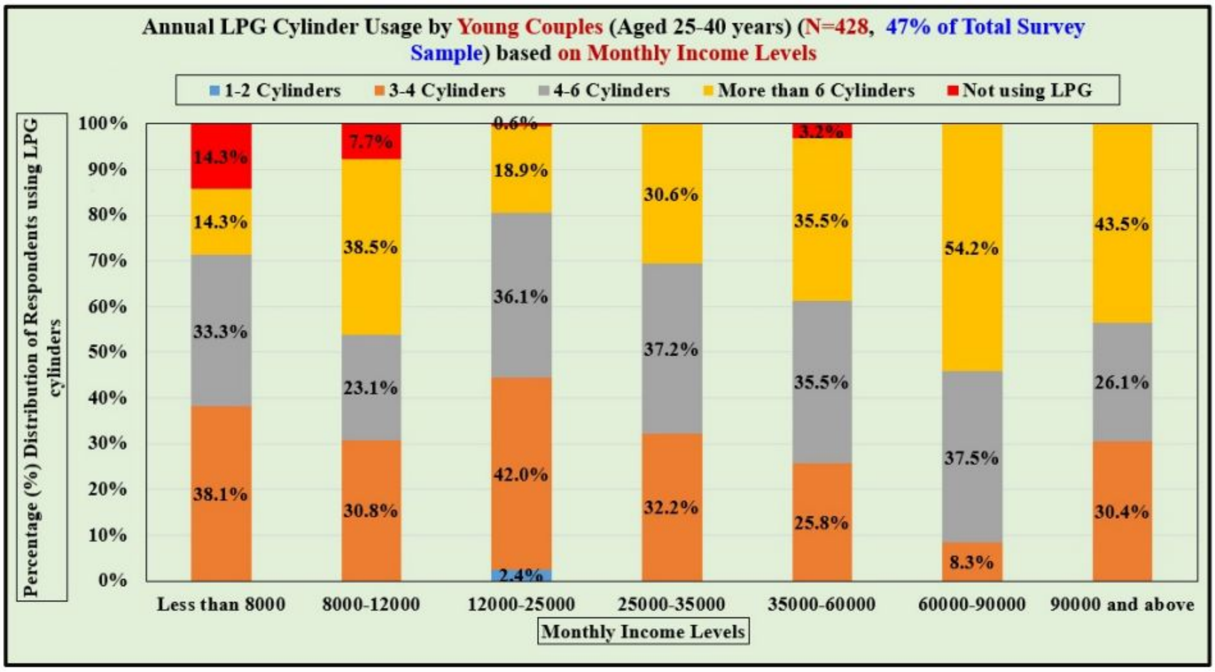

Figure 30: LPG consumption patterns in the households run by young-aged couples (25-40 years) as a function of monthly income levels (N=428)

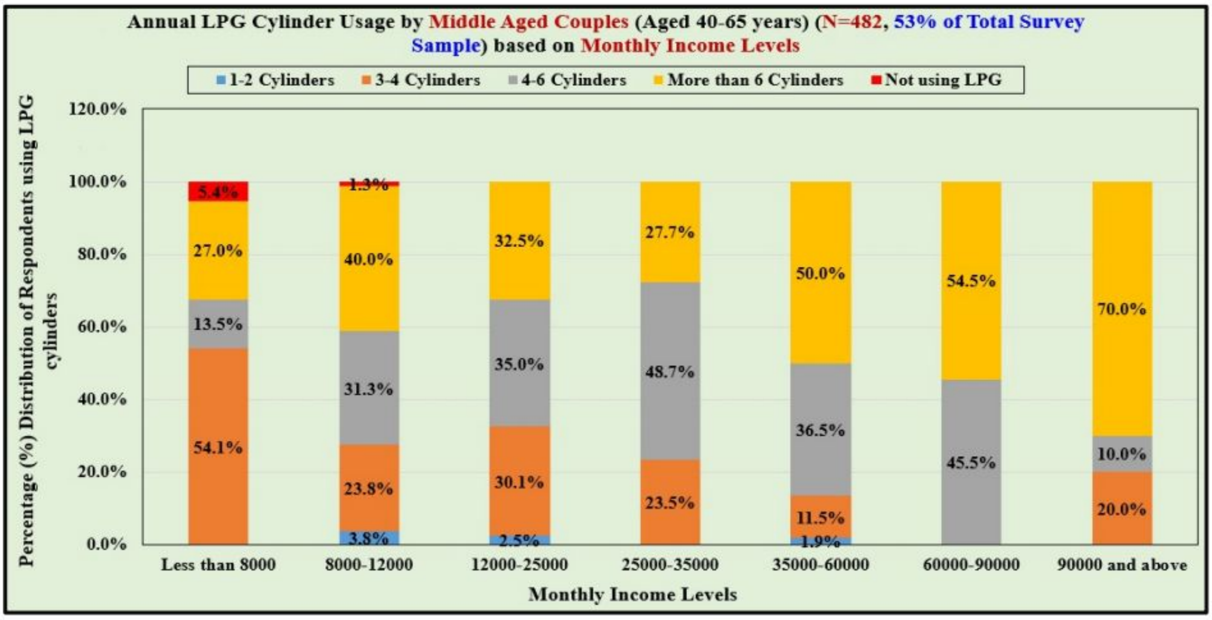

Figure 31: LPG consumption patterns in the households run by middle-aged couples (40-65 years) as a function of monthly income levels (N=482)

5.5 Expenses Incurred by the LPG users in Bengaluru

To delve into the household expenses to ensure uninterrupted availability of primary cooking fuel at home, a granular analysis was conducted on the average annual LPG consumption and the approximate cost associated with it. **Figure 32** provides a detailed account of annual LPG usage levels and the associated expenses incurred by the surveyed households that use LPG for cooking activities (**N=899**). *The cost estimates reflect the households' propensity to spend on cooking solutions (energy source)*.

No. of LPG-using respondents (families)	Approx. no. of cylinders used at home	Percentage of samples using respective no. of cylinders	Average no. of cylinders used	Price of 14.2 kg cylinders (Rs. 905.50)	Total Annual Expense (INR) on LPG
12	1-2 Cylinders	1%	2	905.50	1811
273	3-4 Cylinders	30%	4	905.50	3622
319	4-6 Cylinders	36%	6	905.50	5433
295	More than 6 Cylinders	33%	8	905.50	7244

Total=899

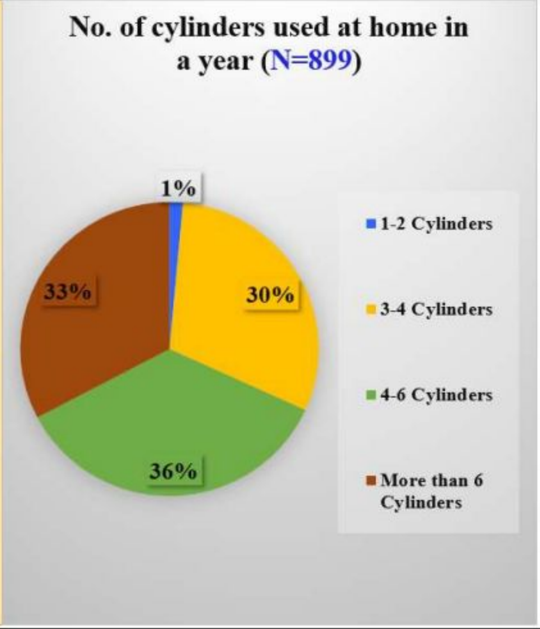

Figure 32: Detailed account of annual LPG usage levels and the associated expenses incurred by the surveyed households that use LPG for cooking activities (**N=899**)

5.6 Cooking Duration and Perception Regarding Utility of Reduced Cooking Time

Upon being asked about the duration of cooking, *64% of the respondents mentioned that they finished each round of cooking within an hour*. The remaining 36% indicated that the time required to finish each round of cooking is more than an hour, but less than two hours. **Figure 33** exhibits the distribution of the duration taken by the respondents to prepare each major meal.

Further, about 59.9% of the total survey sample (**N=910**) mentioned making major meals at home twice daily, and about 35.6% of the surveyed population reported cooking major meals three times daily. **Figure 34** depicts the distribution of the number of times major meals are prepared daily by the respondents in their houses.

While around 59.9% of households reported preparing meals twice daily, and 35.5% mentioned cooking major meals thrice daily indicating substantial cooking taking place in the households; interestingly, about 64% reported taking less than one hour to prepare each meal, and 36% reported a meal preparation time of 1-2 hours. Households run by young couples, often with smaller family sizes of 2-5 members, would possibly require less cooking time, and therefore, less energy for cooking.

Additionally, many young working couples reported eating out at least once daily, which could also lead to lower overall cooking energy consumption. Overall, the average number of LPG cylinders consumed per household annually is found to be on a bit lower side in the mass-scale survey. The abovementioned insights are some of the possible explanations for the same.

- **Less than 1 hour:** 64%
- **1 hour-2 hours:** 36%

Most families belonging to young couples have a family size of 2-5 members, so they require less cooking time.

Also, several working young couples eat outside at least once a day.

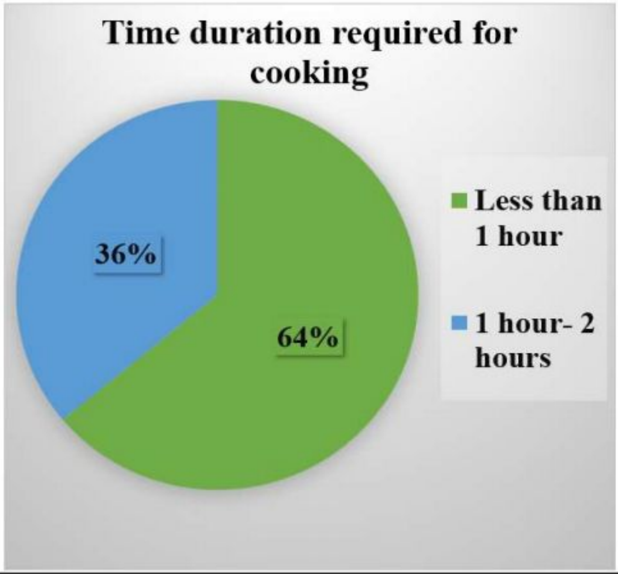

Figure 33: Distribution of the duration taken by the respondents to prepare each major meal (**N=910**)

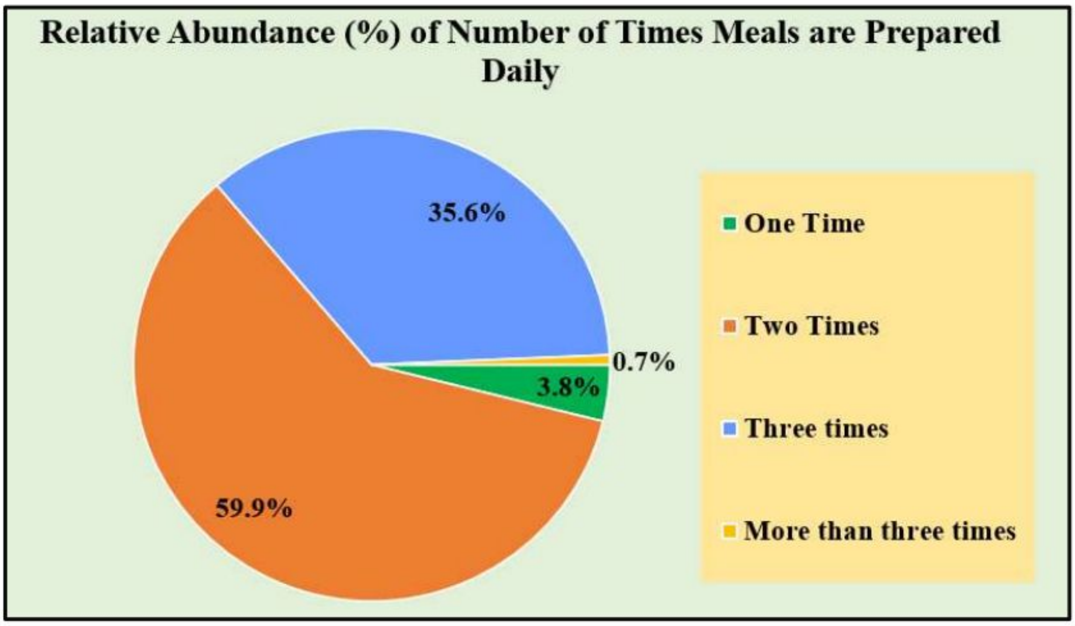

Figure 34: Distribution of the number of times major meals are prepared daily by the respondents (**N=910**)

When the respondents were asked regarding their views on whether it would be useful for them if there were means to reduce the daily cooking time, 87.3% responded that they would be happy if they could save time by reducing the duration of cooking daily meals. *This emphasizes the importance of considering the aspects related to people's quality of life and convenience while planning to roll out a new technological solution for the mass segment, envisaging a fundamental behavioral shift aimed at transforming lifestyles at the collective level*. **Figure 35** captures the opinion of respondents on the utility of reduced cooking time in their lives (**N=910**).

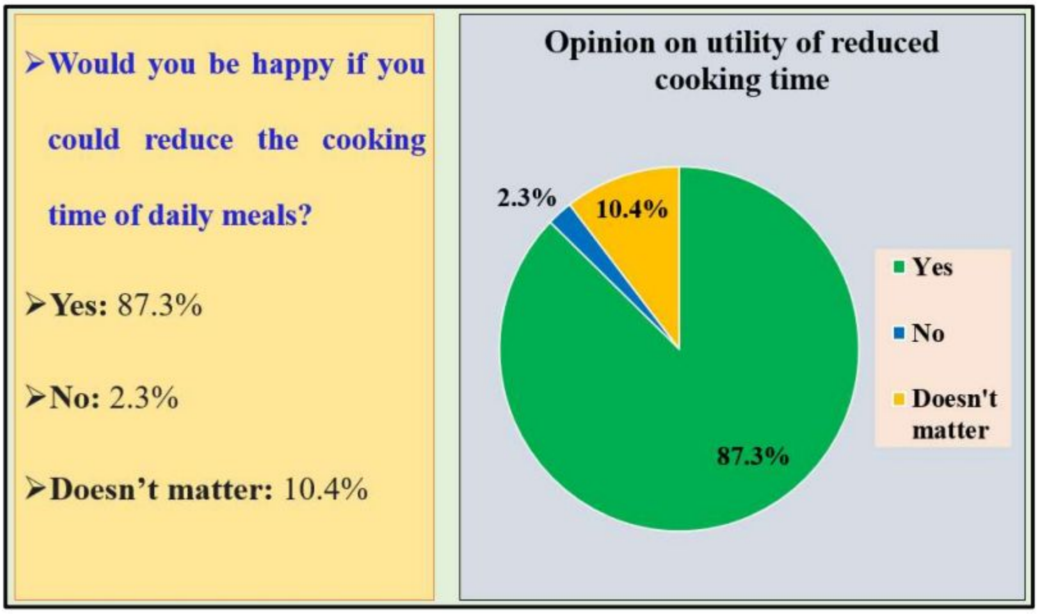

Figure 35: Opinion of respondents on the utility of reduced cooking time in their lives (**N=910**)

Chapter 6

Assessment of Access to Reliable Electricity in the Surveyed Bengaluru Households and Prevailing Perceptions Regarding Electric Cooking

6.1 Background

To realize the transition of residential cooking from the current LPG-heavy regime to the electricity-based cooking regime, the foremost requirement is household-level access to reliable electricity. Assuming the supply end is adequately catering to the electricity demand for the cities (as indicated by the 15-month data from ***January 2023 to March 2024*** regarding the percentage of the peak demand met in the State of Karnataka, see **Table 3** below), the primary driver toward ensuring the access to reliable electricity at the household levels would be the local sub-distribution infrastructure. *Metered connections are a reasonable and measurable proxy to understand the households' access to electricity*. Moreover, while cabling work is important for the last-mile connectivity of the electricity distribution network, *the load-carrying capacity is better understood from the health of transformers in the various localities in a city*.

Table 3: Karnataka Peak Demand Record (January 2023 – March 2024)

(**Source**: Central Electricity Authority (CEA) - Dashboard)

Month/ Year	Peak Demand (MW)	Peak Demand Met (%)
Jan-23	14972	**100%**
Feb-23	15543	**100%**
Mar-23	15828	**100%**
Apr-23	16110	**100%**
May-23	15111	**100%**
Jun-23	14198	**100%**
Jul-23	12358.67	**100%**
Aug-23	16958.46	**99.95%**
Sep-23	14814.24	**99.22%**
Oct-23	15978	**100%**
Nov-23	15300.76	**99.36%**
Dec-23	15005	**100%**
Jan-24	15668.45	**100%**
Feb-24	16632.35	**100%**

Mar-24	17212.48	**100%**

The frequency and duration of power cuts, and the frequency of transformer bursting are the first-level indicators to understand the reliability of electricity sub-distribution systems catering to the various localities. Further, the arrangements at the household level in terms of wiring (*reflected through plug-point connections*), and *the electrical appliances currently in use,* would prove to be useful indicators for a nuanced understanding of the households' access to reliable electricity.

6.2 Electricity Access in the Survey Locations Measured by Metered Connections

For the **13 locations surveyed during the large-scale survey**, useful insights were derived from the respondents regarding the existing electricity connections they are subscribed to. **Figure 36** provides a granular look at the location-wise distribution of metered connections for the large-scale sample (**N=910**).

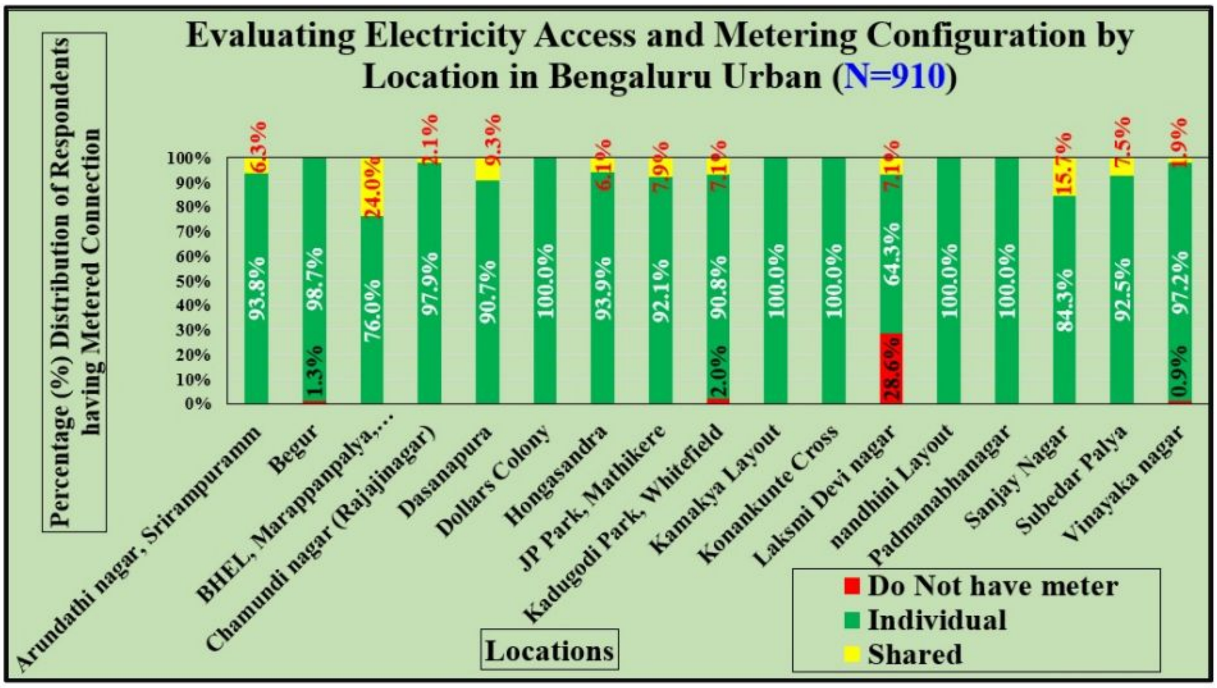

Figure 36: Location-wise distribution of metered connections for the large-scale sample (**N=910**)

Lakshmi Devi Nagar, being a locality of marginalized and underprivileged population, exhibited a substantial fraction of surveyed households (28.6%) *without any metered connection*. Interestingly, despite the BHEL apartments comprising people from medium and upper-medium-income households, a noteworthy share of the population (24%) is currently using shared meters. *This is because the apartment is still under construction and the project developer is providing the households with the essential services.*

6.3 Occurrence of Power Cuts Disaggregated by Locations

To assess the broad reliability of electricity distribution in the 13 surveyed locations, an analysis was performed on people's experience regarding the occurrence of power cuts for each location. In every location surveyed, a substantial fraction of the respondents mentioned experiencing power cuts. This necessitates a relook into the sub-distribution infrastructure of the populous localities within the BBMP area in Bengaluru City. **Figure 37** summarizes *the occurrence of power cuts in the 13 survey locations, as described by the respondents* (**N=910**). Since the total number of samples collected from the additional locations (***Padmanabhanagar***, ***Dollars Colony***, and ***Konanakunte Cross***) is too small, *the occurrences of power cuts in these areas can be assumed to follow the average trends observed at other locations for practical purposes*.

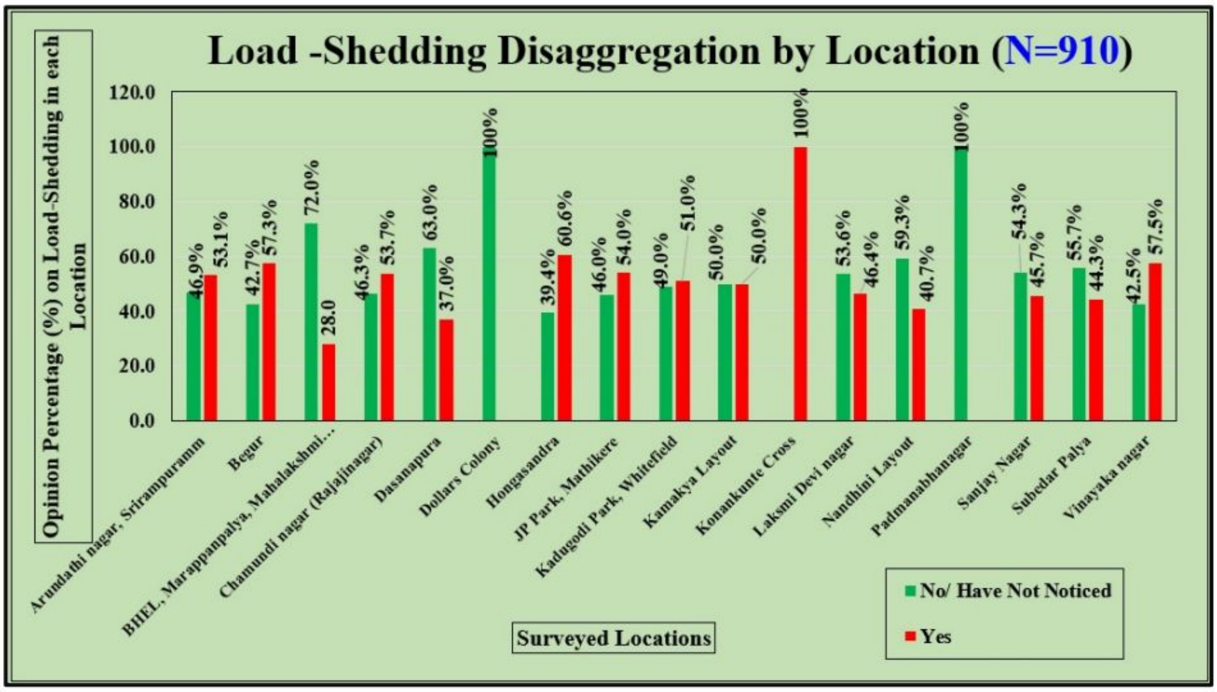

Figure 37: Occurrence of power cuts in the 13 survey locations, as described by the respondents (**N=910**)

6.4 Occurrence of Transformer Bursting Before Power Cuts

The leading causes for the occurrence of transformer bursting include overheating, power surges, lightning strikes, damage to the electrical system along the power line, wear and corrosion, and moisture. The internal short-circuit caused by an insulation failure, leads the local temperature to rise to as high as 1200 ^{o}C. The high temperature vaporizes the oil in the transformer tank, creating explosive gases. The resulting explosion can be quite loud and can cause visible damage to the transformer housing. Transformer bursting often leads to power outages and fire hazards. To understand the prevailing overall health of the transformers, a key component of electricity sub-distribution infrastructure, the respondents were asked about the transformer bursting before the power cuts. Interestingly, the experience reported by them was found to be equally divided. Therefore, *revisiting and strengthening the sub-distribution infrastructure in various populous localities of Bengaluru needs to be taken up on a priority basis*. **Figure 38** shows the respondents' experiences regarding the transformer bursting before the power cuts.

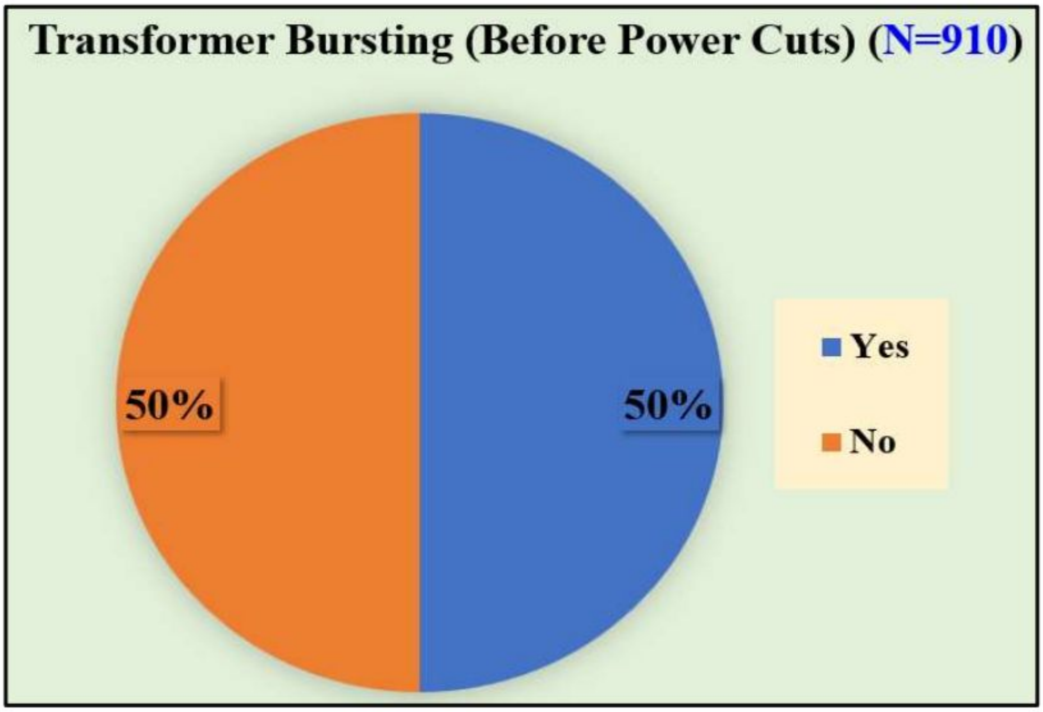

Figure 38: Respondent's experiences regarding the transformer bursting before the power cuts (**N=910**)

6.5 Frequency of Power Cuts in Bengaluru Households (N=910)

Upon being asked about the frequency of power cuts in the respective localities, about **21%** of the large-scale survey respondents **(N=910)** mentioned experiencing power cuts at least once daily. About **41%** of the respondents mentioned experiencing power cuts several times a week, while **29%** mentioned experiencing power cuts several times a month. Only 9% of the total respondents indicated not experiencing noteworthy disruption in power. Although the levels of power disruptions vary across different localities, the overall prevalence of power cuts in the city continues to be substantial. This necessitates upgrades in the distribution infrastructure and measures for mitigating power losses during transmission & distribution (T&D) from the DISCOM side (i.e., BESCOM). **Figure 39** depicts the frequency of power cuts, as described by the respondents (**N=910**).

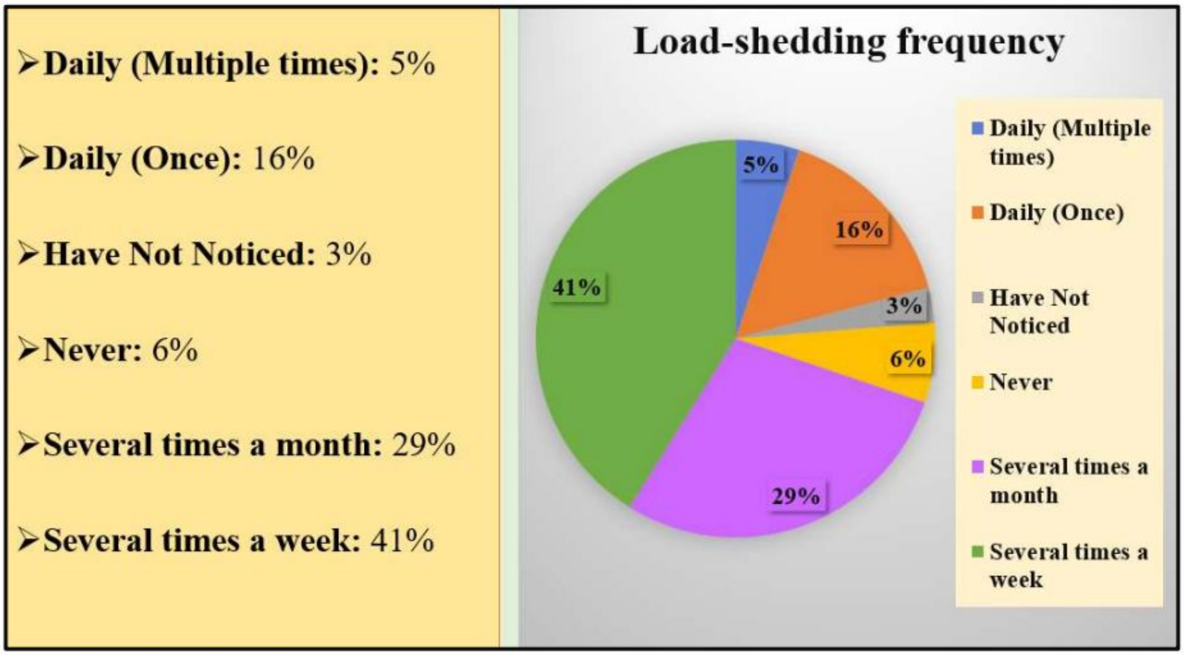

Figure 39: Frequency of power cuts, as described by the respondents (**N=910**)

6.6 Analysis of Load-Shedding Frequency Disaggregated by Cooking Fuel Choice

In order to transform a large population from using fossil-based cooking fuels (LPG or biomass) to modern energy cooking (or eCooking), it is important to understand the current status of the households' access to reliable electricity, since uninterrupted reliable power is a stepping stone toward ensuring people's trust on electricity as the main fuel for daily cooking which is a key residential activity around which the lifestyles of Indian families revolve. In view of this, a granular analysis of the load-shedding frequencies was conducted disaggregated by the households' choice of cooking fuels (**N=910**). **Figure 40** depicts the power cuts experienced by the exclusive LPG users (**N=771**) among the total survey respondents. About 22% of the exclusive LPG users report experiencing power cuts at least once daily. Another 44% of this group reported experiencing power cuts several times a week. This may pose a problem if a family wants to transition to electricity-based cooking (eCooking) since the *occurrence of power cuts during a typical day is random in nature, and it may sometimes coincide with the cooking time of the households*. Therefore, the *frequent power cuts appear to be an inhibiting factor for the envisaged eCooking transition*. Similar trends are observed for the individuals using both LPG Ovens and traditional chulhas (clay ovens) or exclusively clay ovens for cooking (**N=63**) (see **Figure 41**). Interestingly, substantially better access to reliable electricity is reflected in the case of respondents using some form of electric cooking daily (**N=76**). Among the respondents currently using some form of electric cooking in their households, about 62% mentioned not experiencing any noteworthy power cuts (see **Figure**

42). Therefore, *reliable access to uninterrupted electricity at the household level would be a key driver of the eCooking transition in India*.

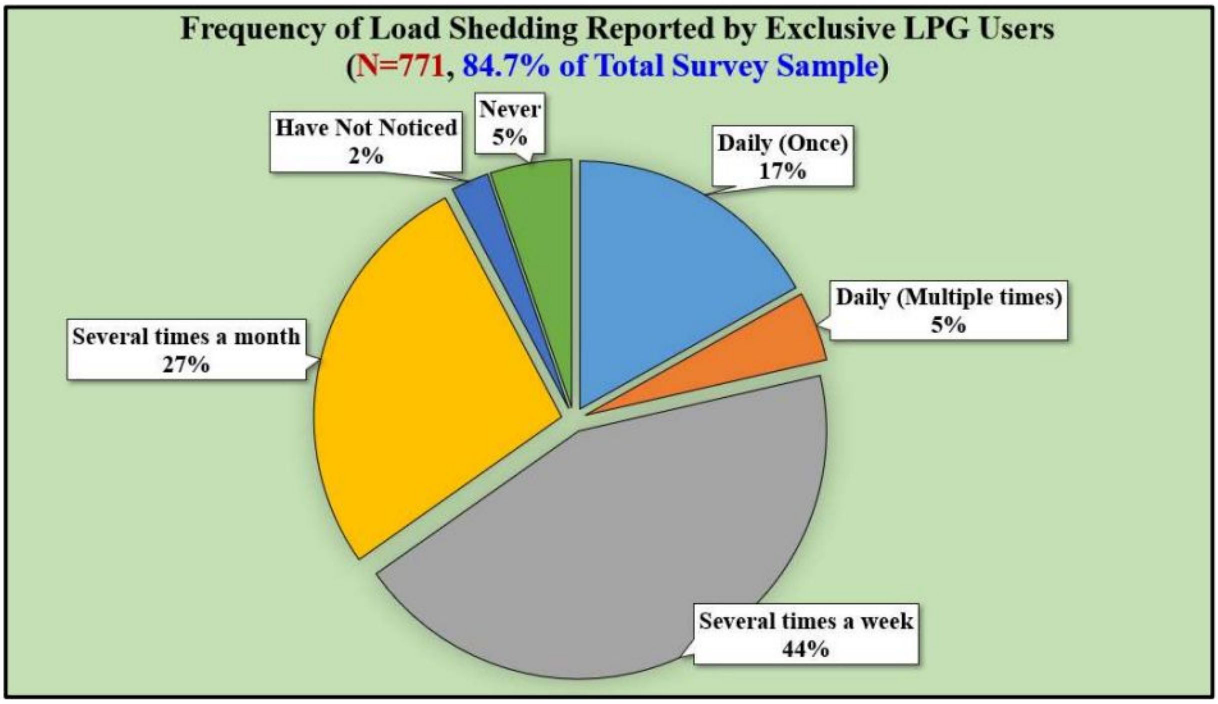

Figure 40: Load-shedding frequencies experienced by exclusive LPG users (**N=771**)

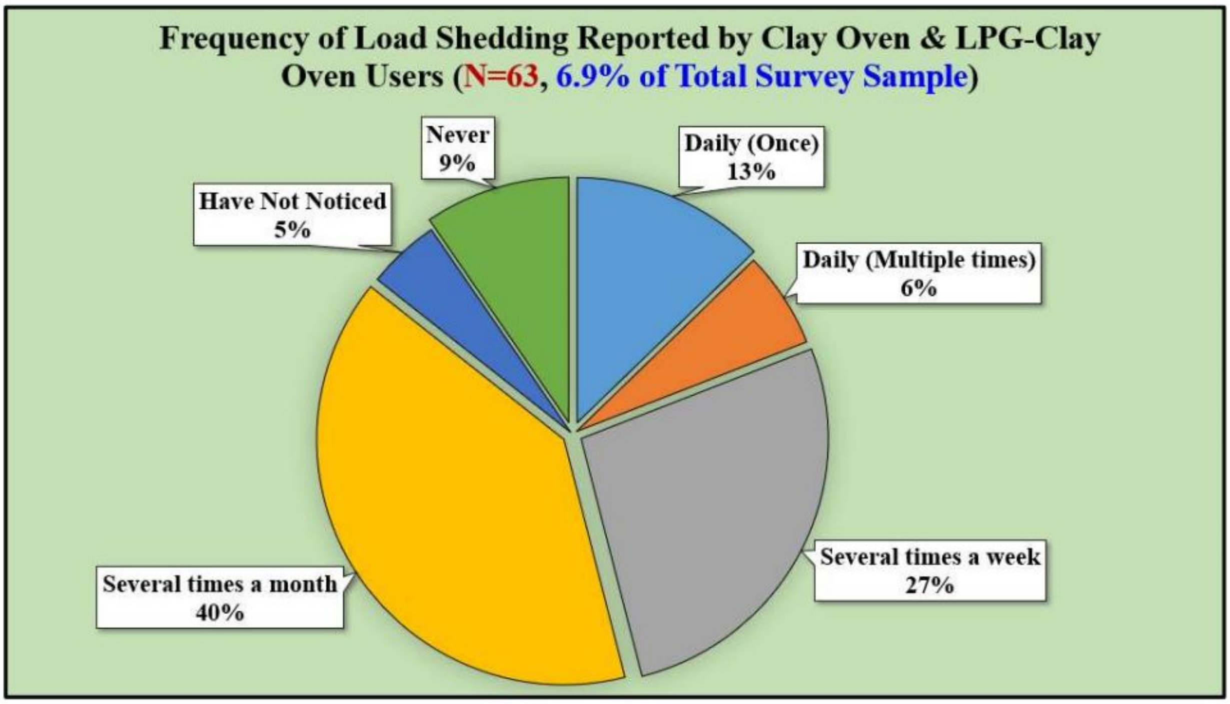

Figure 41: Load-shedding frequencies experienced by respondents using both LPG ovens & clay ovens and exclusively clay ovens (**N=63**)

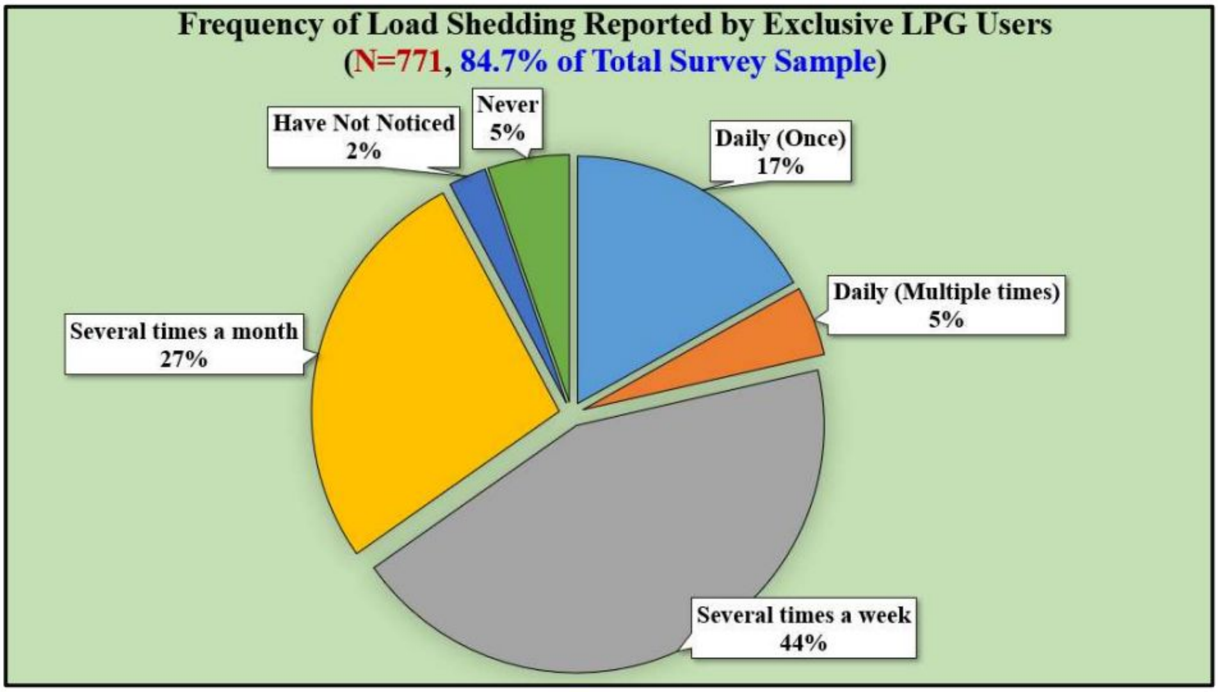

Figure 42: Load-shedding frequencies experienced by respondents using some form of electric cooking (N=76)

6.7Analysis of Load-Shedding Duration Disaggregated by Cooking Fuel Choice

In conjunction with the load-shedding frequency, it is also important to identify the duration of the power cuts since minor power cuts of less than 30 minutes duration may not create any major inconvenience for the households, whereas power cuts typically ranging between 30 minutes to two hours are known to disrupt several activities that are integral to daily routines, such as water heating by geysers for bathing, reheating of food using microwave oven before packing the tiffin for office, etc. **Figure 43** depicts the distribution of load-shedding durations experienced by the exclusive LPG users (N=771) among the total survey respondents. About 80% of the exclusive LPG users (N=615) reported experiencing power cuts of more than 30 minutes duration quite often. **Figure 44** exhibits the distribution of load-shedding durations experienced by the individuals using both LPG Ovens and traditional chulhas (clay ovens) or exclusively clay ovens for cooking (N=63). Among this group, 75% of the respondents (N=47) reported experiencing power cuts of more than 30 minutes duration quite often. Interestingly, none of the electric cooking users among the survey respondents (N=76) reported a power cut duration of more than 2 hours (see **Figure 45**), and the share of no-load shedding is comparatively higher for this group compared to the other two categories of cooking fuel users.

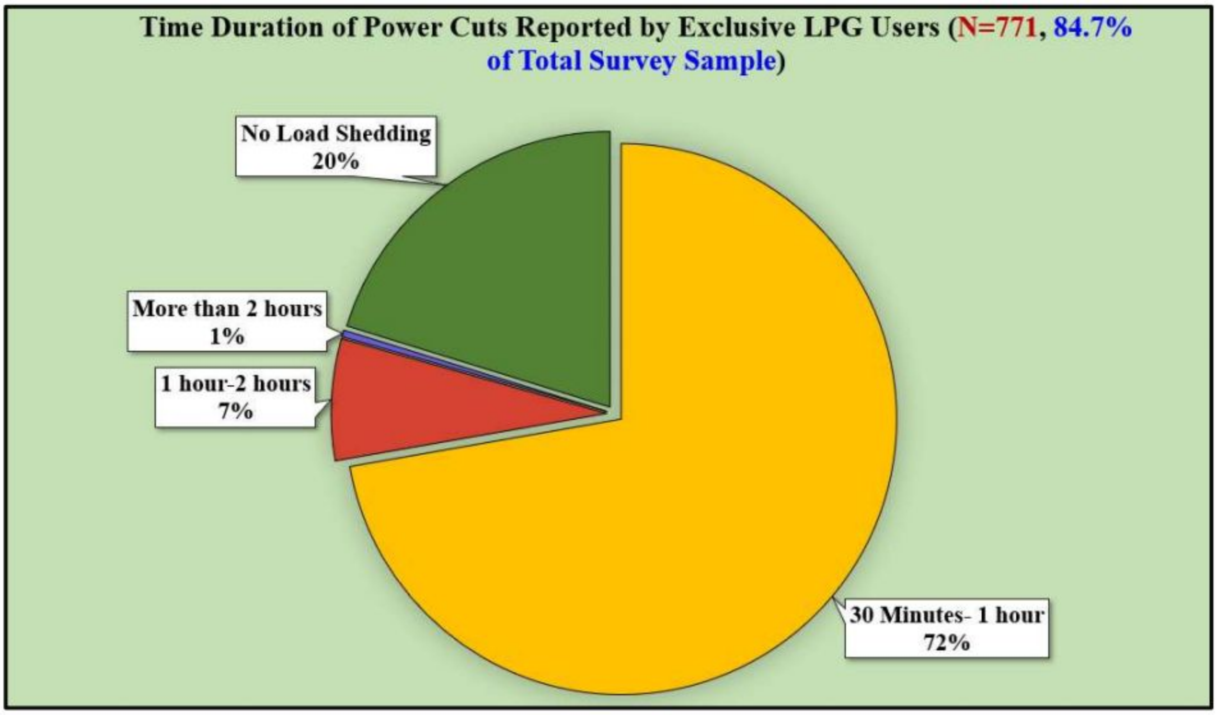

Figure 43: Load-shedding durations experienced by exclusive LPG users (**N=771**)

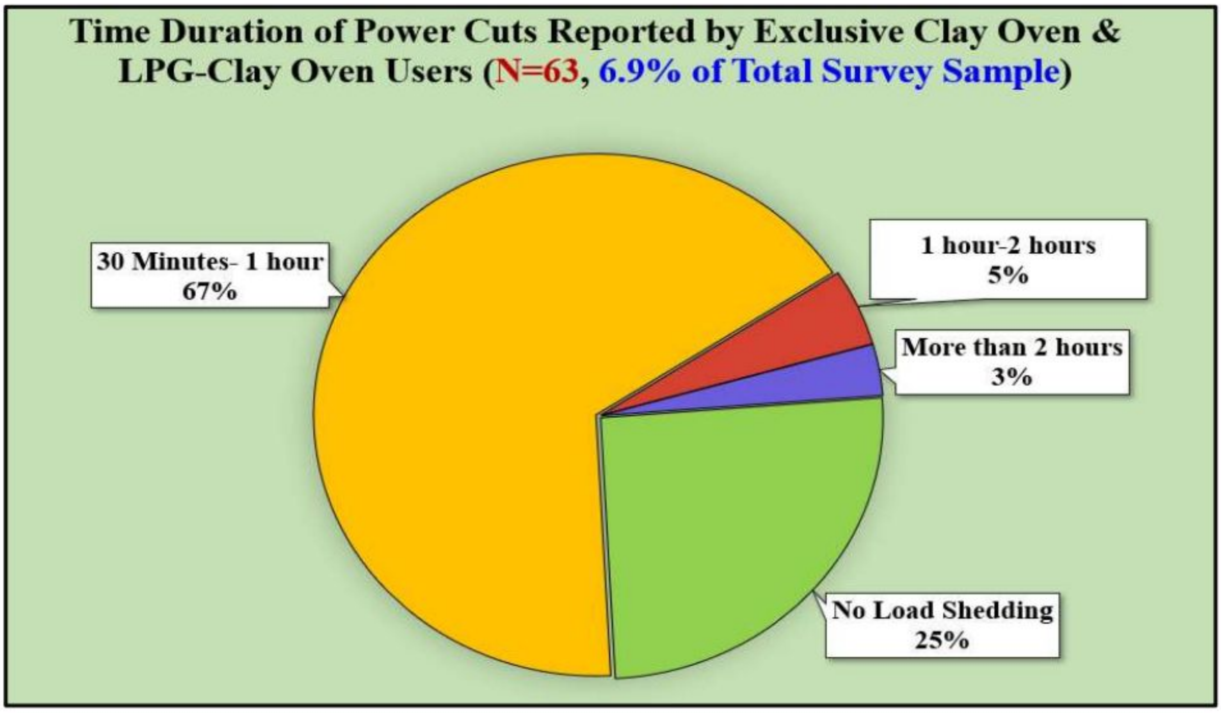

Figure 44: Load-shedding durations experienced by respondents using both LPG ovens & clay ovens and exclusively clay ovens (**N=63**)

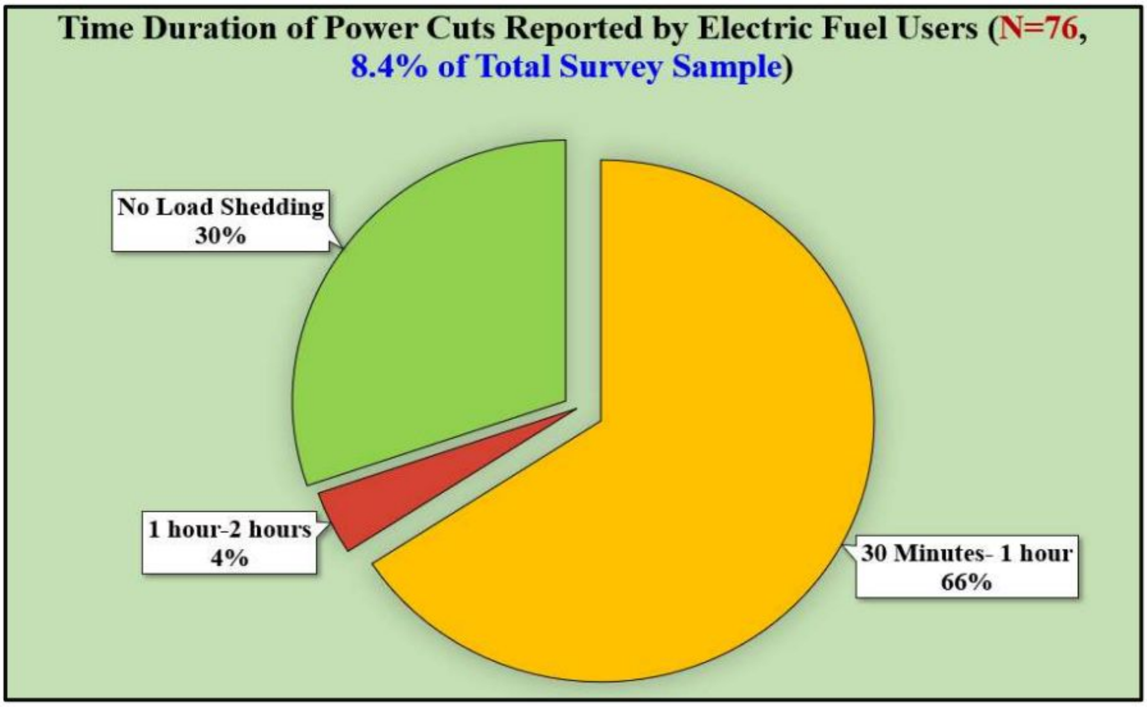

Figure 45: Load-shedding frequencies experienced by respondents using some form of electric cooking (**N=76**)

6.8 Number of Plug Points Available in the Kitchen of the Surveyed Households

Amongst the total surveyed households (**N=910**), the prevalence of smaller plug points (with a load capacity of 5 amps or below) in the kitchen is considerably higher. About 86.9% of the respondents mentioned having at least one small plug point in their kitchens, while 22.9% reported two or more small plug points in their respective kitchens. About 13% of the respondents reported having no small plug points in their kitchens. This is an important finding in the context of the envisaged eCooking transition. The overall access to electricity in the kitchens of several Bengaluru households' needs to improve since one small plug point would not be sufficient to bear the load for any major cooking activity using electricity. About 53% of the total surveyed households (**N=483**) reported having at least one large plug point in their kitchens (with a load capacity of 15 -20 amps), while only 6.4% (**N=58**) reported having two or more plug points in their respective kitchens. Interestingly, 46.9% of the total surveyed households (**N=427**) have no large plug-points in their kitchens. This seriously limits the household-level capability to switch to eCooking even if the households do not witness frequent power cuts. *Therefore, along with the external enablers (enhanced transformer capacity and reinforced sub-distribution infrastructure), the kitchen configuration in terms of internal wiring and availability of an ample number of small and large plug points would be a* *key step toward removing a crucial inhibiting factor*. **Figures 46** and **47** exhibit the current status of small and large plug points in the kitchens of the surveyed households, respectively.

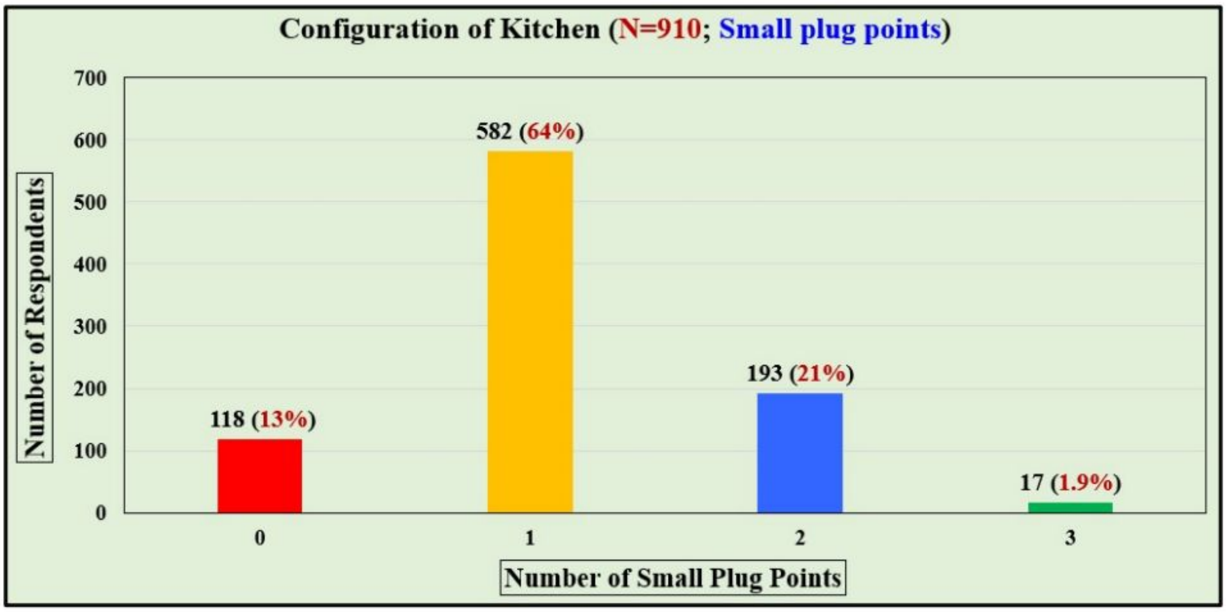

Figure 46: Current status of small plug points in the kitchens of the surveyed households (**N=910**)

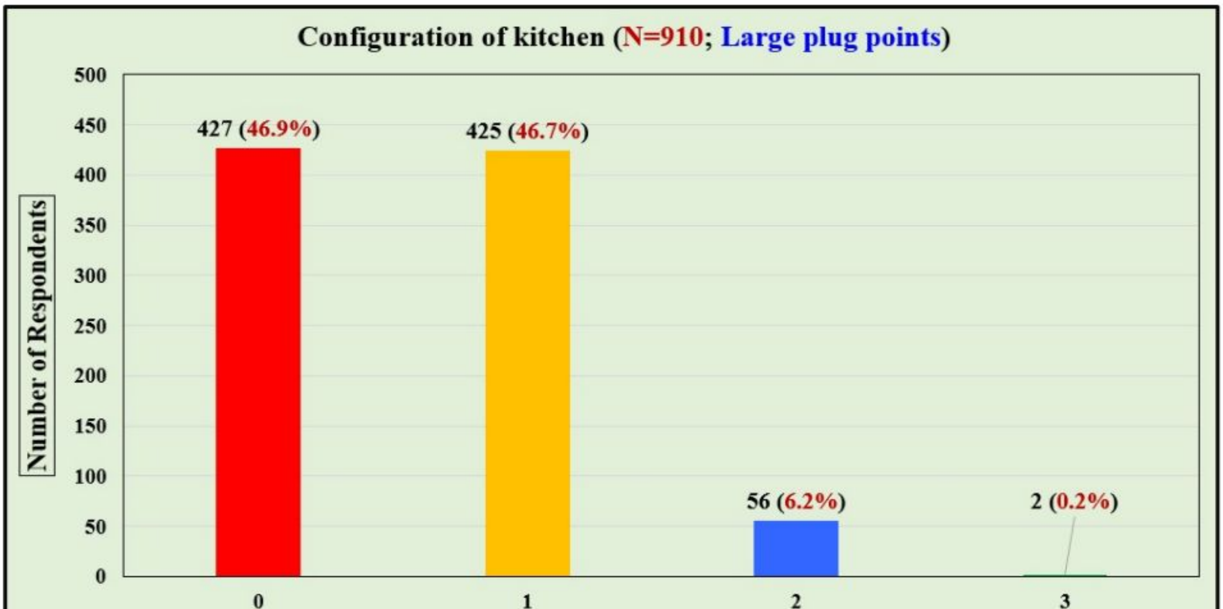

Figure 47: Current status of large plug points in the kitchens of the surveyed households (**N=910**)

6.9 Willingness of People to Purchase Electric Cooking Appliances and Propensity to Spend (Disaggregated by Cooking Fuel Choice)

Analysis of the large-scale household survey data (**N=910**) indicated that 33% of the respondents are willing to purchase a new modern cooking device (i.e., eCooking device). This level of willingness is a positive picture emanating from the large-scale survey given the current level of active eCooking users among the respondents (**N=76**, about 8.4% of the total survey sample). It is interesting to note that while 38% of the total respondents indicated their unwillingness to own a new modern cooking device, the remaining 29% indicated a tentative possibility of adopting electricity-based cooking. *Considering the willingness and the tentative willingness together as the aspirational possibility block, there is a huge potential for modern energy cooking devices, with a possible peak penetration level of 62% provided the right incentives, robust supply-chain & after-sales supports, and appropriate sensitization are in place*. **Figure 48** depicts the current level of willingness to purchase a new modern cooking device as reported by the respondents of the large-scale survey (**N=910**).

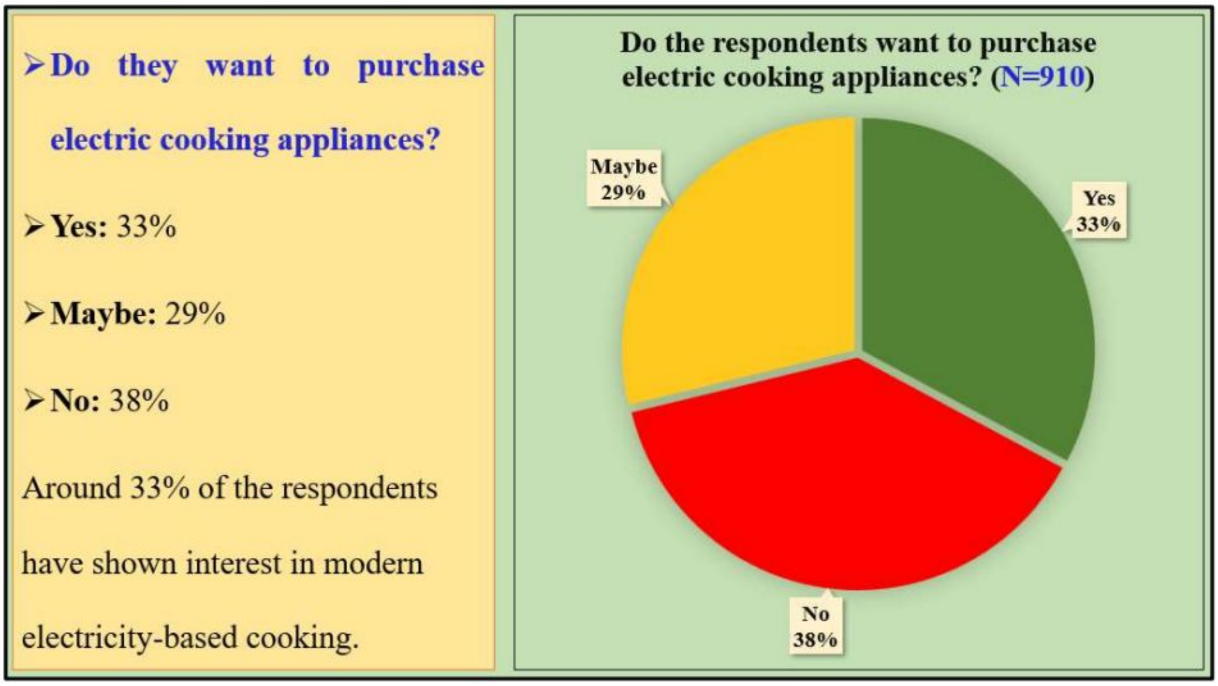

Figure 48: Current level of willingness to purchase a new modern cooking device as reported by the respondents (**N=910**)

Since the eCooking transition that is envisaged to take place at a mass scale will necessitate a shift from the current cooking fuels, and therefore a perceived level of comfort as well as convenience, it is important to analyze the propensity of the households (consumers) to spend for a new modern cooking device disaggregated by current cooking fuel choices. This would inform the policymakers regarding the mindsets of different groups toward an envisaged transition since the current cooking fuel choices are dictated by the socioeconomic realities of individual households, such as monthly income levels & savings, family size, easy access to certain cooking fuels, lifestyle choices, and various cultural & ethnic influences. **Figure 49** depicts the distribution of propensity shown by the exclusive LPG users (**N=771**) for purchasing a new modern cooking device. Interestingly, about 53% of the exclusive LPG users have indicated unwillingness to purchase any new modern cooking device. However, *about 22% of respondents in this group indicated their willingness to spend between Rupees 1500 and 3000 for a new cooking device & experience*.

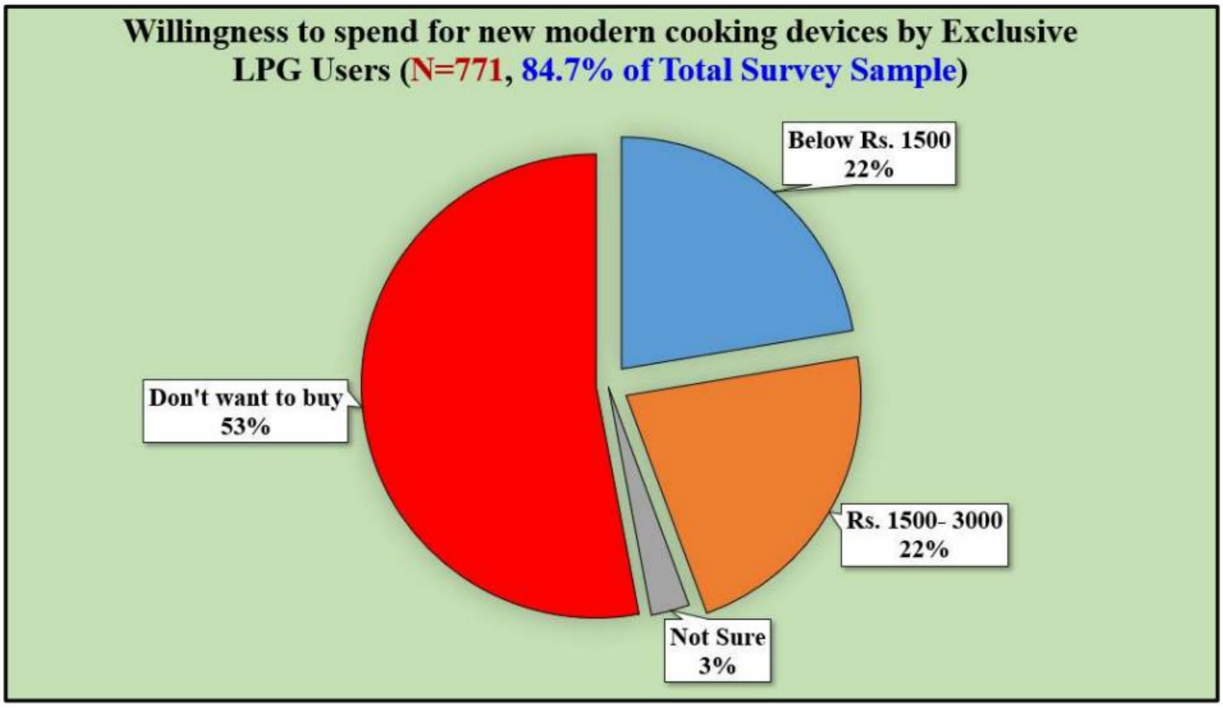

Figure 49: Distribution of propensity shown by the exclusive LPG users (**N=771**) for purchasing a modern cooking device

Figure 50 exhibits the distribution of propensity shown by the individuals using both LPG Ovens and traditional chulhas (clay ovens) or exclusively clay ovens for cooking (**N=63**) toward purchasing a new modern cooking device. In this group, *only 8% of the respondents showed their willingness to spend between Rupees 1500 and 3000 for a new cooking device & experience. However, in this marginalized group, about 35% of the respondents indicated their willingness to spend up to Rupees 1500 for a new cooking experience*.

Figure 51 exhibits the distribution of propensity shown by the individuals already using some form of eCooking in their households (**N=76**) for purchasing further modern cooking devices. Among this group, a larger fraction (38%) indicated a willingness to spend between Rupees 1500 and 3000 for a new cooking device & experience. *This is quite expected since* *this group is already aware regarding the utility of at least some form of eCooking, and people are familiar with using them as per their lifestyle needs*.

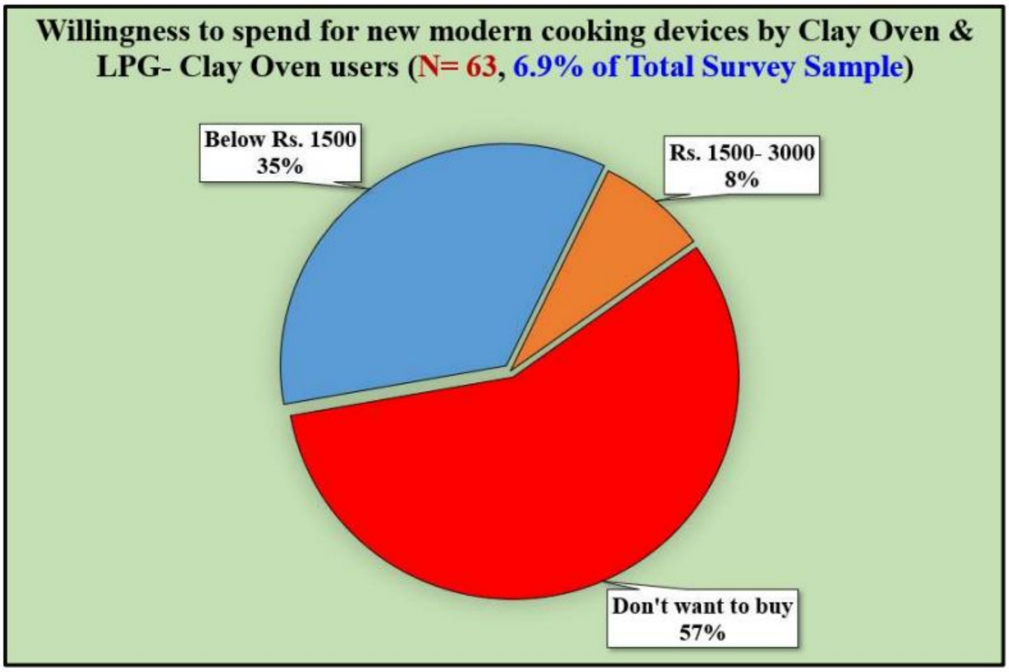

Figure 50: Distribution of propensity shown by the individuals using both LPG Ovens and traditional chulhas (clay ovens) or exclusively clay ovens for cooking (N=63) toward purchasing a modern cooking device

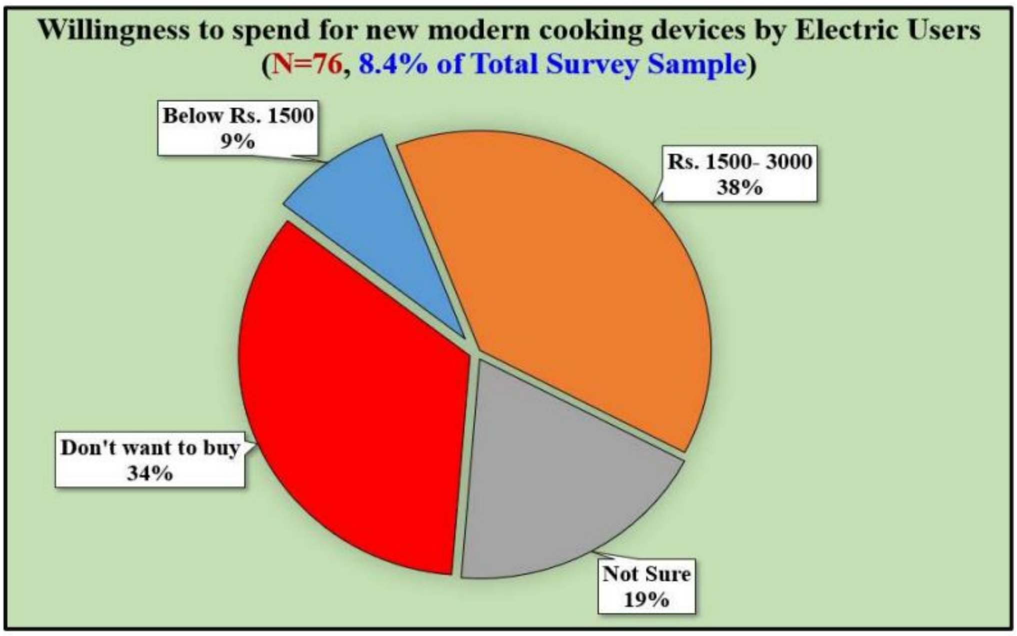

Figure 51: Distribution of propensity shown by the individuals already using some form of eCooking in their households (N=76) for purchasing further modern cooking devices

6.10 Electrical Gadgets and Appliances Owned by the Surveyed Households and Impact of Income & Savings for Making Choices

While evaluating the willingness and propensity of households to purchase new modern cooking devices, it is also important to take stock of the electrical gadgets and appliances owned by the surveyed households. **Figure 52** summarizes the various consumer goods and appliances owned by the surveyed households, and the weighted average monthly income and savings levels associated with each appliance. The figure clearly shows that the refrigerator is the most owned consumer durable by the surveyed households (**N=678**), followed by the washing machine (**N=500**). These appliances are present in households with average monthly income levels of less than Rupees 36000, and an average monthly savings level of around Rupees 2500. On the other hand, the average monthly income and savings levels associated with any major electric cooking appliance are Rupees 50,000-66,000, and around Rupees 4500, respectively. Therefore, *there is an urgent need to consider the possible pathways and mechanisms to bring the prices of multi-utility eCooking appliances that can serve a major portion of the cooking requirements of an average Indian household*. In this context, it is also important to consider the sophistication level of different devices since a large population is generally expected to be equipped with only basic exposure to the different types of modern gadgets and appliances.

Electric Appliances used at home	No. of Respondents using it	Average Total Monthly Income (INR) (conservative)	Average Monthly Savings (INR) (conservative)
Refrigerator	N=678 (74.5%)	30940	2265
Washing Machine	N=500 (54.9%)	35660	2520
Heater/Geyser	N=271 (29.7%)	41505	3025
Electric Oven	N=84 (9.2%)	62795	4530
Electric Cook Stove	N=59 (6.4%)	50090	4055
Induction Cooktops	N=42 (4.6%)	61900	4550
Electric Rice Cooker	N=12 (1.3%)	66625	4560

Figure 52: Various consumer goods and appliances owned by the surveyed households, and the weighted average monthly income & savings levels associated with each appliance

6.11 Awareness Regarding Benefits and Challenges of eCooking among Survey Respondents

In order to evaluate the extent of awareness regarding eCooking among survey respondents (N=910), three categories were created. The **first category** comprises the population that knows about eCooking (**Y1**) and is also aware of the benefits & challenges of eCooking (**Y2**). The **second category** comprises the population that knows about eCooking (**Y1**) but is unaware of the benefits & challenges of eCooking (**N2**). The third category comprises the population that neither knows about eCooking (**N1**) nor is aware of the benefits & challenges of eCooking (**N2**).

Figure 53 depicts the relative share of survey respondents in each of the above three categories. The first category indicated a relative abundance of **48%**, while that of the second category was **34%**. Only **18%** of the total respondents were found to be completely unaware of eCooking and the benefits & challenges associated with it. *Overall, about half of the surveyed population requires more information regarding eCooking to make informed choices. This emphasizes the urgent need for enhanced knowledge sharing and sensitization at the community level through different information channels*.

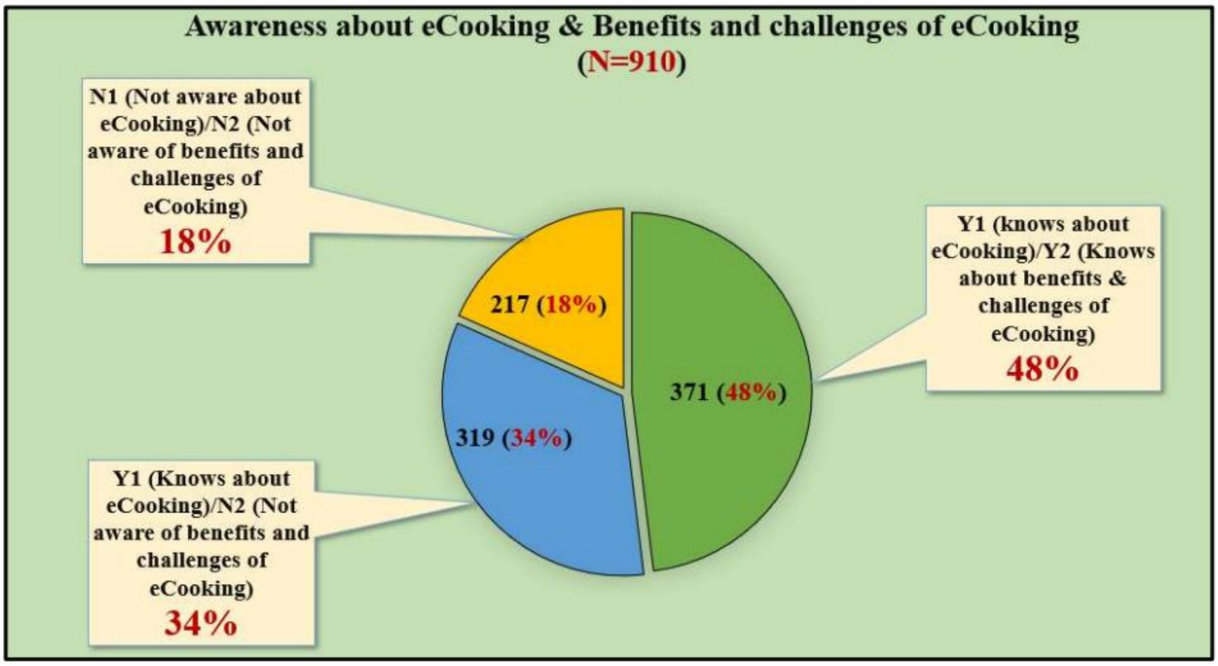

Figure 53: Relative share of survey respondents under **three defined categories**

Upon being asked during the large-scale survey (**N=910**), About 450 respondents mentioned different types of ***perceived benefits*** associated with eCooking, while 485 respondents highlighted the various perceived challenges associated with eCooking. **Figures 54** and **55** capture the perceived benefits and the challenges of eCooking as mentioned by the survey respondents, respectively. The respondents who highlighted the perceived benefits highlighted the ease of cooking and maintaining offered by the eCooking appliances as a key positive aspect. A significant population also highlighted features such as the potential to save time, safety, and portability as beneficial factors. *The larger number of respondents highlighting perceived challenges of eCooking indicates that currently, a negative opinion regarding this modern solution exists in society which needs to be removed through continuous engagement and interactions*.

➢ **Benefits of Electric Cooking as Perceived by Respondents (A data-driven ranking based on relative abundance) (N=450)**

- **Efficient** (Faster Cooking) (**24%**)
- **Convenient** (Easy to cook, use and maintain; affordable) (**22%**)
- **Versatile and Modern** (Alternative for LPG) (**15%**)
- **Time-saving (12%)**
- **Safety** (Safe to use) (**11%**)
- **Portable** (Easy to carry and clean) (**7%**)
- **Cost-effective** (consumes less current and saves money) (**7%**)
- **Environment-friendly (2%)**

Figure 54: Perceived benefits of eCooking as mentioned by the survey respondents

➢ **Challenges of Electric Cooking Indicated by Respondents (A data-driven ranking based on relative abundance) (N=485)**

- **Electricity cost considerations** (Higher power consumption & High electricity bills) (**27%**)
- **Perceived risks** (Fear of electric shocks) (**18%**)
- **Functionality** (Not easy to operate) (**13%**)
- **Adaptation** (Can't cook all dishes) and **Adoption** (No multiple burners for large dishes) (**9%**)
- **Practicality** (Need specific vessels) (**7%**)
- **Safety concerns** (May cause accidents) (**7%**)
- **Reliability** (Disruption in food preparation due to Power-cuts) (**6%**)
- **Taste factors** (Taste changes & can burn the food) (**6%**)
- **Maintenance and durability** (Difficult to maintain) (**4%**)
- **No Benefits (2%)**
- **Accessibility and affordability** (Costly devices; Not as efficient as LPG) (**1%**)

Figure 55: Perceived challenges of eCooking as mentioned by the survey respondents

The respondents who highlighted perceived challenges mentioned high power consumption and energy bills as a key inhibiting factor. A substantial population also indicated the fear of electric shocks, the inability to cook all the dishes, and the need for specific vessels as additional deterring factors.

Chapter 7

Taste Perceptions, Weekly Menu Patterns, and Kitchen Amenities in Bengaluru Households

7.1 Background

The questionnaire prepared for the large survey (**N=910**) contained specific questions (**Q64 to Q66**) aimed at a nuanced understanding of people's attitudes toward modern cooking devices (or eCooking appliances) *through their perceptions regarding the possibilities and limitations of these devices*. The key objective was to unearth the people's perception regarding the ability (or inability) of electric cooking devices to make the items consumed daily by households. Along with the perception, the respondents were asked about the reason behind their individual opinions. Further, the respondents were asked about their taste perception of the food items made using the conventional way (i.e., LPG gas stoves and/or traditional clay ovens) aimed at understanding people's perception regarding the flavor of food items made in a particular way. Strong cultural adherence to particular ways of making traditional food items, accompanied by taste perceptions attached to the food preparation methods may prove to be a sociocultural barrier for the envisaged mass transition to electricity-based cooking. *To facilitate a nuanced and granular understanding of people's taste perception associated with cooking fuels as well as their perceptions of the ability (or inability) of electric cooking devices to replicate the performances of the conventional pathways, the captured views were analyzed in detail disaggregated by current fuel use type*. In this exercise, our focus was on **two groups**, the ***first group*** *comprises people currently using some form of electric cooking along with LPG*. We disintegrated this group into finer sub-groups to understand people's views on individual prominent electric cooking appliance types. *This group's view is important since they possess basic hands-on experience in using electric cooking devices and are aware of the benefits & limitations*. The ***second group*** *chosen for granular analysis comprises individuals currently using either a combination of LPG and traditional clay ovens or exclusively traditional clay ovens for household cooking purposes*. This group's view is important since these people are currently far away from using LPG. *However, their views on perceived challenges can be converted to opportunities if aspirations can be instilled through imparting knowledge and continued engagement at the community level*. The following sections discuss the salient findings from the analysis.

7.2 Insights from Respondents using some form of electric cooking along with LPG (N=76)

7.2.1 Insights from Respondents Using Both LPG Gas Stove and Bread Toaster/Sandwich Maker (Minor form of eCooking) (N=2, *0.22% of the total survey sample*)

The level of exposure to eCooking for this negligible sub-sample is limited, and the insights provided by the respondents are to be considered as general remarks devoid of any specific consumer experience.

- *The main perceived benefit of eCooking as indicated by the respondents is that it facilitates faster cooking.*
- *No significant challenges or drawbacks were mentioned by the respondents.*

7.2.2 Insights from Respondents Using Both LPG Gas Stove and Electric Oven (N=1, *0.11% of the total survey sample*)

The insights provided by the respondent are to be considered as remarks bearing a certain level of specific consumer experience emanating from using a major eCooking appliance. The concern highlighted by the respondent is quite expected from an average Indian household. Such concerns need to be addressed through enhanced knowledge-sharing, community-level interactions, and confidence-building.

- *The main perceived benefits of eCooking as indicated by the respondent include fast cooking and the use of fewer vessels.*
- *One particular concern associated with the electric oven, as highlighted by the respondent, is that kids in the house might get an electric shock upon touching the oven when it is on.*

7.2.3 Insights from Respondents Using Both LPG Gas Stove and Induction Cooktop (N=24, *2.64% of the total survey sample*)

Since these respondents are somewhat serious about eCooking and are adequately informed regarding the potential benefits, the concerns raised by them need to be understood in-depth. Some of the concerns raised by the respondents may be rooted in culinary behavior. The possible misconceptions need to be addressed through enhanced knowledge-sharing, community-level interactions, and confidence-building.

- *The benefits of eCooking, as frequently cited by the respondents, include faster cooking, the convenience of meal preparation, ease of use, and safety features of appliances, cost-effectiveness, portability, and the flexibility it offers as a backup for LPG gas.*

- *Challenges mentioned by the respondents include the need for separate vessels, the potential for higher-than-normal electricity consumption, the inability to cook certain dishes effectively, and the need for constant supervision while cooking.*

7.2.4 Insights from Respondents Using Both LPG Gas Stove and Microwave Oven (N=14, *1.54% of the total survey sample*)

Since these respondents are somewhat informed regarding the potential benefits of eCooking but possess limited exposure to eCooking, concerns raised by them need to be understood in-depth. Some of the concerns raised by the respondents may be rooted in culinary behavior and eating habits. The possible misconceptions need to be addressed through enhanced knowledge-sharing, community-level interactions, and confidence-building.

- *The perceived benefits of eCooking, as indicated by the respondents, include faster cooking, convenience (helpful especially for working professionals, and during festivals when large quantities of time-consuming food items are prepared), the ability to use it as a backup for LPG gas, and the ability to reheat leftovers.*
- *The challenges mentioned were the inability to cook certain dishes properly, the dependence on electricity (which may witness fluctuations), and the potential for increased electricity bills. A few individuals highlighted their fear of electric shocks attributable to eCooking appliances used for meal preparation (e.g., induction cooktops, electric ovens, etc.). According to these people, the microwave oven is a comfortable and safe appliance for the current level of limited use.*

7.2.5 Insights from Respondents Using Both LPG Gas Stove and Electric Pressure Cooker/Rice Cooker (N=8, *0.88% of the total survey sample*)

- *The perceived benefits of eCooking, as indicated by the respondents, include faster cooking, convenience (especially during emergencies or when running out of LPG gas), the ability to cook without constant supervision, and the perception of being safer than LPG gas.*
- *The respondents were tentative while indicating the perceived challenges. The respondents in general highlighted a lack of perceived benefits. A medium-income individual (corporate employee) perceived eCooking as expensive and difficult to use. The individual highlighted that the taste of food changes with eCooking and mentioned the inability of eCooking to prepare certain dishes effectively.* ***The individual was not willing to spend any further money on any of the eCooking options*.**

7.2.6 Respondents' view on the kind of Dishes that can be prepared using eCooking (Appliance-wise) (Aggregated view based on the responses collected from N=76)

- **LPG Gas Stove**: *Can cook dishes like Dosa, Upma, Idly, Aloo curry, Omelette, Sambhar, Pulses, Leafy vegetables, Mixed-veg, Chicken curry, Fish curry, Chapati/Roti, Kebabs, Biryani, Puliyogare.*
- **Induction Cooktops**: *Can cook most dishes mentioned above (except Dosa, Upma, Idly, and Biryani), but some responses indicate a preference for using an LPG Gas Stove for cooking certain dishes (e.g., Sambhar, Leafy vegetables, Chicken / Fish curry, Chapati/Roti, Kebabs).*
- **Electric Pressure Cooker**: *Can cook dishes like Pulses, Leafy vegetables, Mixed-veg, Chicken curry, and Fish curry.*
- **Electric Rice Cooker**: *Can cook dishes like Idly, Biryani, and Rice.*
- **Microwave Oven**: *Can cook dishes like Kebabs, Biryani, Chicken curry, Fish curry, mixed veg, and Pulses.*
- **Electric Oven**: *Can cook dishes like Kebabs, Chicken curry, and Fish curry.*
- **Bread Toaster**: *Can toast bread and make dishes like sandwiches.*
- **Sandwich Maker**: *Can make sandwiches.*
- **Chapati Maker**: *Can make Chapati/Roti.*

7.2.7 Respondents' overall view on the kind of Dishes that cannot be prepared using eCooking (Aggregated view based on the responses collected from N=76)

Some responses indicated that certain dishes are better cooked on LPG Gas stoves, suggesting that electricity-based cooking may not be suitable for those dishes. Very few individuals indicated that all dishes can be cooked using electricity-based cooking. ***There is a wide mix of different views among the respondents***.

Overall, the respondents mentioned that the ***desired output cannot be achieved for the following dishes using electric cooking***:

- *Dosa, Upma, Idly, Aloo curry, Omelette, Sambhar, Puliyogare, Roti/Chapati, Biryani, Kebabs, and Leafy Vegetables.*

7.2.8 Summary of Insights from Respondents using some form of electric cooking

1. *Faster cooking and convenience were the most commonly cited benefits across all types of electric appliances.*

2. *Induction cooktops were perceived as more versatile and convenient, but concerns were raised about their limitations in cooking certain dishes effectively.*

3. *Microwave ovens were seen as useful for heating leftovers and as a backup for LPG gas, but there were concerns about their inability to cook certain dishes properly.*

4. *Electric pressure cookers and rice cookers were appreciated for their hands-off cooking capabilities and perceived safety. However, some respondents felt they lacked benefits or had limitations.*

5. *Bread toasters and sandwich makers were primarily valued for their faster cooking abilities, with no significant challenges mentioned.*

6. *Concerns about high electricity consumption, the need for specific vessels, and the inability to match the cooking experience of LPG gas or traditional methods were common across all electric appliance types.*

Overall, while the perceived benefits of electric cooking were acknowledged, respondents expressed a range of concerns and limitations specific to each type of appliance, suggesting a need for further education and awareness to address these concerns and promote wider adoption of electric cooking.

7.3 Insights from the Respondents Using Traditional Clay Oven and LPG for Daily Cooking

The following sections depict an analysis of the attitude toward electric cooking among users of clay ovens/chulhas as well as the individuals who use both LPG gas stoves and clay ovens/chulhas. The analysis is disaggregated by fuel type used (as indicated by the respondents) and dishes that are perceived as difficult to cook using electricity.

7.3.1 Attitude toward electric cooking among exclusive users of clay ovens/chulhas (N=10)

- **Benefits of eCooking as indicated/ perceived by Clay Oven/Chulha Users**: *Only one respondent (male) mentioned that eCooking facilitates fast cooking.*
- **Challenges of eCooking as indicated/ perceived by Clay Oven/Chulha Users**: *One of the nine individuals who mentioned challenges indicated concerns about higher*

electricity bills. Two other respondents highlighted the inability of eCooking appliances to make staple items like roti/chapati. Two individuals opined that dishes such as Dosa, Idly, pulses, leafy vegetables, and mixed vegetables are difficult to make using eCooking. Another respondent indicated perceived difficulties with eCooking in the context of preparing dishes such as Dosa, Upma, leafy vegetables, mixed vegetables, Puliyogare, and roti/chapati.

7.3.2 Attitude toward electric cooking among individuals who use both LPG gas stoves and clay ovens/chulhas (N=53)

***A. Benefits of eCooking as indicated/ perceived by the Respondents*:**

- Faster/efficient cooking (2 responses)
- Ease of use and faster cooking (1 response)
- Portability of electric appliances (1 response)
- Potential for less work compared to LPG (1 response)
- Belief that most dishes can be cooked using electricity (2 responses)

***B. Challenges of eCooking as indicated/ perceived by the Respondents*:**

- Potential for higher electricity bills (3 responses)
- Difficulty in learning to use electric appliances (1 response)
- Continuous supervision required (1 response)
- Inability to cook during power cuts (1 response)
- Appliances getting damaged easily (2 responses)
- Inability to cook certain dishes properly (3 responses)
- Shock hazard from electric appliances (1 response)
- Expensive appliances (2 responses)

***C. Dishes Perceived as Difficult to Cook Using Electricity*:**

- Non-vegetarian dishes like chicken curry, fish curry, biryani, kebabs (9 responses)
- Dosa, idly, aloo curry, omelette, sambhar, pulses, leafy vegetables, mixed vegetables, rice, Puliyogare, roti/chapati (5 responses)
- Aloo curry, pulses, mixed vegetables, biryani, kebabs (1 response)
- Idly, sambhar, mixed vegetables, chicken curry (1 response)
- Aloo curry, chicken curry (1 response)

- Dosa, idly, sambhar (1 response)
- Dosa, omelette, pulses, chicken curry, fish curry, roti/chapati (1 response)

7.3.3 Summary of Insights from the Respondents Using Traditional Clay Oven and LPG for Daily Cooking

1. *Clay oven/chulha users had limited awareness and experience with electric cooking appliances, leading to concerns about higher electricity bills and the inability to make certain dishes like roti/chapati.*

2. *Respondents involved in cooking using both LPG gas stove and clay oven/chulha acknowledged some benefits of electric cooking (e.g., faster cooking and convenience), but expressed more concerns and perceived limitations.*

3. *Common concerns included higher electricity bills, appliances getting damaged easily, the need for continuous supervision, and the inability to cook during power cuts.*

4. *The non-vegetarian dishes like chicken curry, fish curry, biryani, and kebabs were frequently cited as difficult to cook using electricity, along with traditional dishes like dosa, idly, aloo curry, sambhar, and roti/chapati.*

Addressing these concerns would require spreading awareness about the capabilities of modern electric cooking appliances through knowledge dissemination as well as hands-on cooking demonstrations.

7.4 A Qualitative Comparison of Attitudes Toward Electric Cooking

Based on the responses, there are some notable differences in the attitudes toward electric cooking between the users of eCooking appliances and the users of LPG gas stoves/clay ovens (chulhas). The salient insights are summarized below.

A. **Awareness and Experience**:
   a. *Electricity-based cooking users seem to have more direct experience and awareness of electric cooking appliances, their benefits, and challenges.*
   b. *Many LPG/chulha users expressed a lack of awareness or knowledge about electric cooking appliances and their capabilities.*

B. **Perceived Benefits**:
   a. *Users of eCooking frequently cited benefits like faster cooking, convenience, and the ability to use eCooking as a backup or alternative to LPG.*

b. *LPG/ Traditional chulha users rarely mentioned any perceived benefits of electric cooking, except for a few who saw it as a potential backup option. Only a few reported eCooking as a faster and more convenient way of cooking.*

C. **Concerns and Challenges**:

a. *Both groups expressed concerns about the higher cost and electricity consumption associated with electric cooking.*

b. *LPG/chulha users more frequently raised concerns about the inability of electric cooking to match the taste and cooking experience of traditional methods like LPG or chulha.*

c. *Many LPG/chulha users believed that especially non-vegetarian items cannot be cooked properly using electricity.*

D. **Versatility and Limitations**:

a. *Electricity-based cooking users generally felt that most dishes could be cooked using electric appliances, albeit with some limitations (e.g., the need for specific vessels).*

b. *LPG/chulha users more commonly expressed the belief that electric cooking has significant limitations and cannot adequately cook certain dishes (esp., non-vegetarian items or dishes requiring long cooking times). The users also expressed concerns regarding the inability of eCooking to prepare dishes during power cuts.*

E. **Acceptance and Adoption**:

a. *Electricity-based cooking users seemed more open to adopting electric cooking as a supplementary option or even as a primary method, albeit with some reservations in a few cases.*

b. *LPG/chulha users appeared more skeptical and resistant to fully adopting electric cooking as a replacement for traditional methods, often expressing a strong preference for LPG or chulha.*

Overall, while electricity-based cooking users acknowledged both benefits and challenges, LPG/chulha users tended to be more skeptical and focused on the perceived limitations and inability of electric cooking to match traditional methods in terms of taste, versatility, and cooking experience.

7.5 Analysis of Weekly Menu Patterns

The respondents' views regarding a new cooking solution were found to be anchored on their *perceptions of the ability (or inability) of electric cooking devices to replicate the performances of the conventional pathways in terms of producing the familiar taste and texture of traditional food items*. Therefore, it was necessary to have a detailed look into the weekly patterns of food intake to facilitate an informed and nuanced understanding of the merit of perceptions being carried by the majority of the surveyed population (**N=910**). To achieve this, a separate survey was conducted on a selective small subset (**N=65**) of the larger household survey sample. In the Weekly Menu Survey, the food items consumed at different times of the day during a typical week were recorded for the chosen households.

*The selection of **65** respondents for capturing weekly menu patterns in Bengaluru was meticulously planned to ensure a comprehensive and representative coverage of the culinary diversities governed by regional and ethnocultural influences*.

The basis for this selection is detailed below:

1. **Income Considerations**: *All 65 respondents predominantly belong to low-to-medium income households, aligning with the primary focus of the larger survey.*

2. **Ethnicity and Location Variability**: *The selected respondents belong to diverse ethnic backgrounds and are spread across different locations such as Subedar Palya, JP Park in Mathikere, Lakshmi Devi Nagar, etc. These geographical and cultural diversities are expected to provide insights into the food choices of the different communities anchored on cultural traditions and lifestyle attributes*.

3. **Household and Caste Composition**: *Family and caste compositions were key factors in the sample selection process aimed at capturing the culinary preferences across different socioeconomic groups of interest*.

4. **Cooking Methods**: *The households use a variety of cooking methods, including LPG ovens, induction cooktops, electric rice cookers, microwave ovens, and even traditional clay ovens (Oley). This variety is supposed to allow for comparing cooking fuel usage among different groups of households using different cooking fuels and appliances and help evaluate readiness toward transitioning to a new cooking paradigm.*

5. **Age Groups**: *Respondents from all age groups were considered, providing a comprehensive view of food preferences and habits across different stages of life (personally and occupationally/ professionally).*

6. **Monthly Income and Savings**: *Monthly income and savings levels were also considered, providing insights regarding the influence of economic factors (monthly income and savings) on the choices of cooking fuel as well as menu.*

7. **Indicative Responses from the Larger Survey regarding culinary/ dietary preferences**: *The respondents chosen for the Weekly Menu Analysis (**N=65**) provided valuable insights during the larger survey, particularly in response to questions about the feasibility of cooking certain dishes using electricity and the impact of cooking methods on taste. Their level of engagement, frankness, and understanding of the context prompted us to pursue further insights into their detailed weekly dietary choices, which proved insightful considering the objectives of the current project*.

7.5.1 Salient Findings from the Weekly Menu Analysis (N=65)

Detailed analysis of the Weekly Menu brought forth the four major instances of daily food consumption in the surveyed households (**N=65**): Breakfast, Lunch, Evening Snacks, and Dinner.

For each of these food consumption instances, a separate and granular day-to-day menu analysis was conducted for a typical week. The respondents confirmed that by and large households adhere to the set dietary patterns to facilitate the convenience of food material procurement and planning for the cooking (especially, for the time-consuming items).

The top dishes (the items with high relative abundance across a typical week) were identified from the aggregate menu analysis for the abovementioned four major instances. Subsequently, the occurrence of the top dishes across the seven days of the representative week was counted, and the final frequencies of the predominant food items have been reported in this study.

Section A (Analysis of Aggregate Weekly Breakfast Menu) (**N=65**)

Figure 56 summarizes the dominant breakfast dishes along with the relative abundances measured across the seven days in a week. A 100 % relative abundance indicates that an item is consumed by the majority of people every day in a typical week. Similarly, a relative abundance of 14% for an item indicates that the item is consumed by the majority of people only once (on any of the days; the day of occurrence may not be fixed) in a typical week.

From the weekly breakfast menu analysis, items such as Idli, Sambhar, Roti/ Chapati, and Chutney emerge as staples, whereas Chitranna (Lemon Rice), Puliyogare (Tamarind Rice), Upma, Dosa, Bisi Bele Bath (Mix of lentils and rice along with spices; served hot), Seasonal vegetables emerge as prime accompaniments. **Table 4** highlights the top breakfast dishes, along with weekly relative abundances and the cooking methods involved to provide the decision-makers with key pointers for assessing the possibility of preparing most of these items using electric cooking appliances.

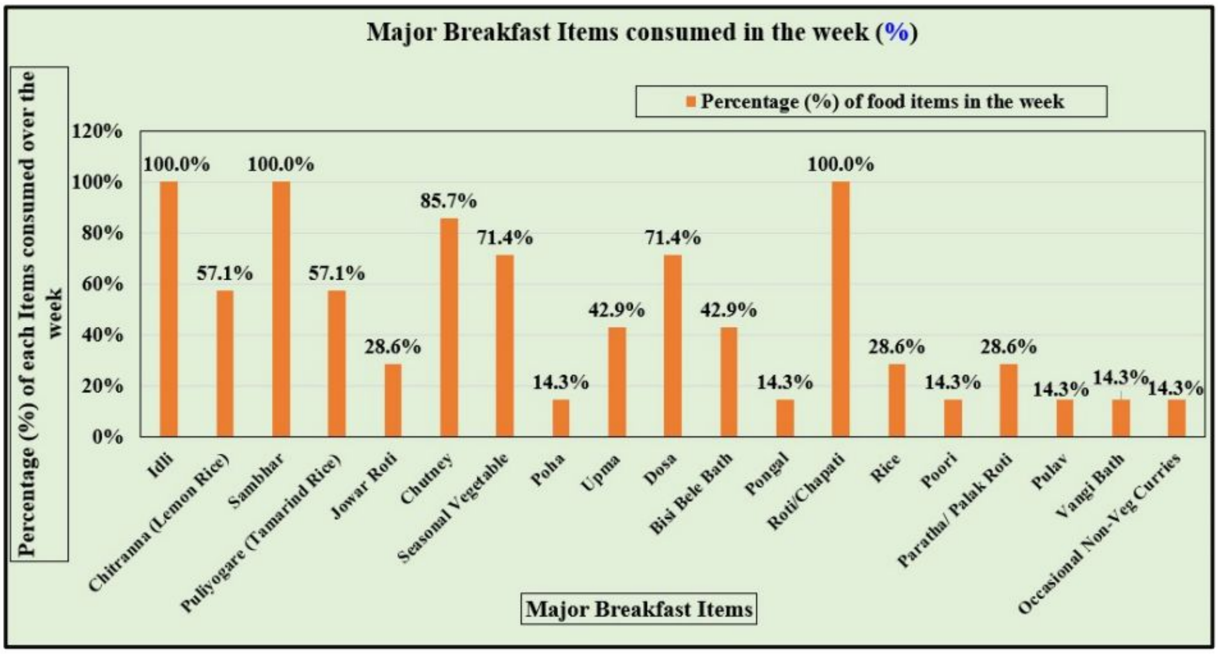

Figure 56: Dominant dishes (**Breakfast**) along with the relative abundance measured across the seven days in a week (**N=65**)

Table 4: **Top breakfast dishes, weekly relative abundances**, and **the cooking methods involved**

Breakfast Items	Frequency of occurrence during the whole week	Relative Abundance (%) of food items in the week	Process/ Methods used for cooking
Idli	7	100.0%	Steaming
Chitranna (Lemon Rice)	4	57.1%	Sauteing, Seasoning
Sambhar	7	100.0%	Boiling, Simmering
Puliyogare (Tamarind Rice)	4	57.1%	Sauteing, Seasoning
Jowar Roti	2	28.6%	Baking
Chutney	6	85.7%	Grinding
Seasonal Vegetable	5	71.4%	Sauteing, Steaming
Poha	1	14.3%	Boiling, Seasoning
Upma	3	42.9%	Boiling, Sauteing
Dosa	5	71.4%	Fermenting, Frying

Bisi Bele Bath	**3**	**42.9%**	**Boiling, Sauteing, Seasoning**
Pongal	**1**	**14.3%**	**Boiling, Seasoning**
Roti/Chapati	**7**	**100.0%**	**Baking**
Rice	**2**	**28.6%**	**Boiling**
Poori	**1**	**14.3%**	**Deep Frying**
Paratha/ Palak Roti	**2**	**28.6%**	**Baking**
Pulav	**1**	**14.3%**	**Boiling, Sauteing, Seasoning**
Vangi Bath	**1**	**14.3%**	**Boiling, Sauteing, Seasoning**
Occasional Non-Veg Curries	**1**	**14.3%**	**Braising, Roasting, Frying**

Section B (Analysis of Aggregate Weekly Lunch Menu) (**N=65**)

Figure 57 summarizes the dominant lunch dishes along with the relative abundances measured across the seven days in a week. A 100 % relative abundance indicates that an item is consumed by the majority of people every day in a typical week. Similarly, a relative abundance of 14% for an item indicates that the item is consumed by the majority of people only once (on any of the days; the day of occurrence may not be fixed) in a typical week.

From the weekly lunch menu analysis, items such as Rice, Sambhar, Seasonal Vegetables, and Roti/ Chapati/ Paratha emerge as staples, whereas Rasam, Dal (lentils), Toor Dal Sambhar, Chitranna (Lemon Rice), Chicken Curry, Chicken Fry, Chicken Biryani and Mutton Curry emerge as prime accompaniments. **Table 5** highlights the top lunch dishes, along with weekly relative abundances and the cooking methods involved to provide the decision-makers with key pointers for assessing the possibility of preparing most of these items using electric cooking appliances.

Table 5: Top **lunch dishes**, **weekly relative abundances**, and **the cooking methods involved**

Lunch Items	**Frequency of occurrence during a typical week (7 Days)**	**Relative Abundance (%) of food items in the week**	**Process/ Methods used for cooking**
Rice	**7**	**100.0%**	**Boiling**
Sambhar	**7**	**100.0%**	**Boiling, Simmering**
Seasonal Vegetable	**7**	**100.0%**	**Sauteing, Steaming**

Rasam	**5**	**71.4%**	**Boiling, Seasoning**
Toor Dal Sambhar (Lentils)	**2**	**28.6%**	**Boiling, Simmering**
Roti/ Chapati/ Paratha/ Bajre ki Roti	**6**	**85.7%**	**Baking**
Dal (Pulses)	**2**	**28.6%**	**Boiling, Simmering**
Chitranna (Lemon Rice)	**1**	**14.3%**	**Sauteing, Seasoning**
Chicken Curry and Chicken Fry	**1**	**14.3%**	**Braising, Roasting, Frying**
Chicken Biryani	**1**	**14.3%**	**Boiling, Sauteing, Seasoning**
Mutton	**1**	**14.3%**	**Boiling, Simmering**

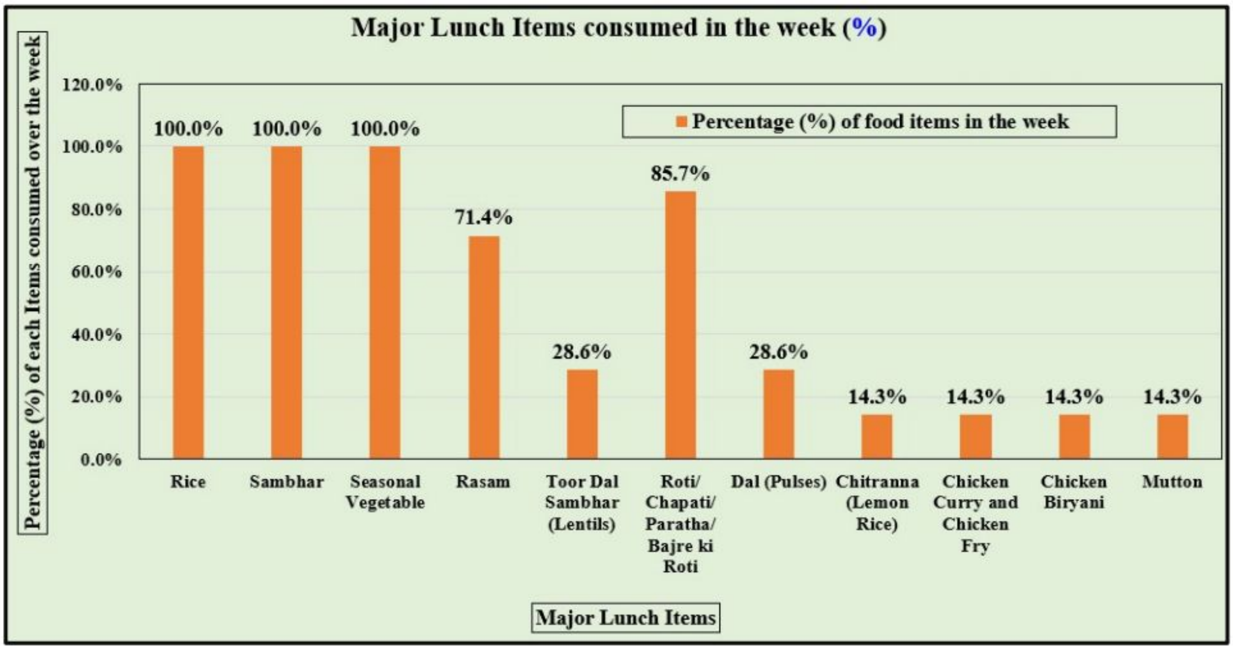

Figure 57: Dominant dishes (**Lunch**) along with the relative abundance measured across the seven days in a week (**N=65**)

Section C (Analysis of Aggregate Weekly Dinner Menu) (**N=65**)

Figure 58 summarizes the dominant dinner dishes along with the relative abundances measured across the seven days in a week. A 100 % relative abundance indicates that an item is consumed by the majority of people every day in a typical week. Similarly, a relative abundance of 14% for an item indicates that the item is consumed by the majority of people only once (on any of the days; the day of occurrence may not be fixed) in a typical week.

From the weekly dinner menu analysis, items such as Mudde (finer millet ball), Rice, Sambhar, Seasonal Vegetables, Roti/ Chapati/ Paratha, and Rasam emerge as staples, whereas Curd Rice, Chicken Curry, Chicken Fry, Chicken Biryani and Mutton Curry emerge as prime accompaniments. **Table 6** highlights the top dinner dishes, along with weekly relative abundances and the cooking methods involved to provide the decision-makers with key pointers for assessing the possibility of preparing most of these items using electric cooking appliances.

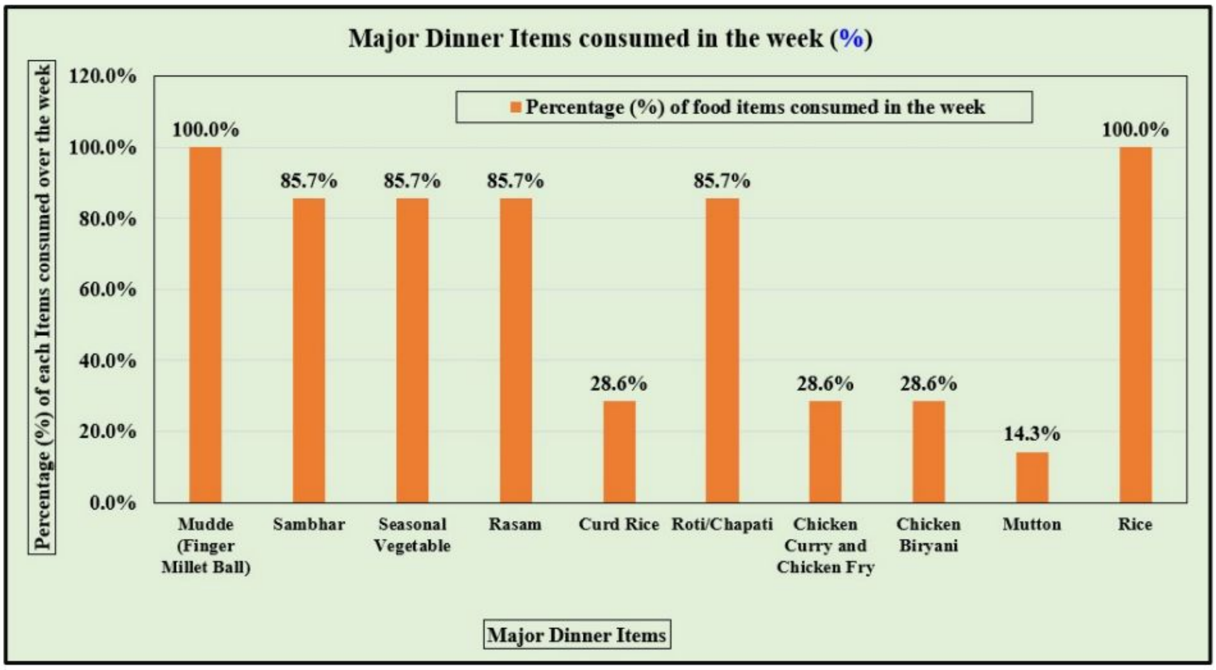

Figure 58: Dominant dishes (**Dinner**) along with the relative abundance measured across the seven days in a week (**N=65**)

Table 6: Top **dinner dishes**, **weekly relative abundances**, and **the cooking methods involved**

Dinner Items	Frequency of occurrence during a typical week (7 Days)	Relative Abundance (%) of food items in the week	Process/ Methods used for cooking
Mudde (Finger Millet Ball)	7	100.0%	Boiling
Sambhar	6	85.7%	Boiling, Simmering
Seasonal Vegetable	6	85.7%	Sauteing, Steaming

Rasam	**6**	**85.7%**	**Boiling, Seasoning**
Curd Rice	**2**	**28.6%**	**Mixing, Chilling**
Roti/Chapati	**6**	**85.7%**	**Baking**
Chicken Curry and Chicken Fry	**2**	**28.6%**	**Braising, Roasting, Frying**
Chicken Biryani	**2**	**28.6%**	**Boiling, Seasoning**
Mutton	**1**	**14.3%**	**Boiling, Simmering**
Rice	**7**	**100.0%**	**Boiling**

Section D (Analysis of Aggregate Weekly Evening Snack Menu) (**N=65**)

Figure 59 summarizes the dominant evening snack items along with the relative abundances measured across the seven days in a week. A 100 % relative abundance indicates that an item is consumed by the majority of people every day in a typical week. Similarly, a relative abundance of 14% for an item indicates that the item is consumed by the majority of people only once (on any of the days; the day of occurrence may not be fixed) in a typical week.

From the weekly evening snack item analysis, items such as Tea, Coffee, Milk, Biscuit Boost (Health Drink), Maggi, and Bhel Puri (spicy mix made of crispy Puffed Rice) emerge as the major items, whereas Chow-Chow, Samosa, Chakli (a delicacy made of gram and flour), Buns, Various kinds of homemade chips and fries, and *Khaman Dhokla* emerge as occasional accompaniments. **Table 7** highlights the top evening snack items, along with weekly relative abundances and the preparation methods involved to provide the decision-makers with key pointers for assessing the possibility of preparing most of these items using electric cooking appliances.

Table 7: Top **evening snack items**, **weekly relative abundances**, and **the preparation methods involved**

Top Snacks and Beverages	Frequency of occurrence during the whole week	Relative Abundance (%) of food items in the week	Process/ Methods used for cooking
Tea/ Coffee	**7**	**100.0%**	**Boiling, Steeping; Boiling, Brewing**
Biscuit	**7**	**100.0%**	**Baking (Not Prepared at Home)**

Boost (Health Drink/ Nutritious Beverage)	**5**	**71.4%**	**Boiling, Stirring**
Milk	**7**	**100.0%**	**Boiling, Mixing**
Bun	**3**	**42.9%**	**Baking**
Chakli	**3**	**42.9%**	**Dough-making, Light Frying, Seasoning**
Maggi	**5**	**71.4%**	**Boiling, Seasoning**
Samosa	**1**	**14.3%**	**Frying, Seasoning**
Chow-Chow (Noodles)	**2**	**28.6%**	**Boiling, Seasoning**
Bhelpuri	**4**	**57.1%**	**Mixing, Seasoning**
Potato Chips (Homemade)	**1**	**14.3%**	**Frying, Seasoning**
Bread	**1**	**14.3%**	**Baking (Not Prepared at Home)**
Fries	**1**	**14.3%**	**Frying**
Khaman Dhokla	**1**	**14.3%**	**Steaming, Seasoning**

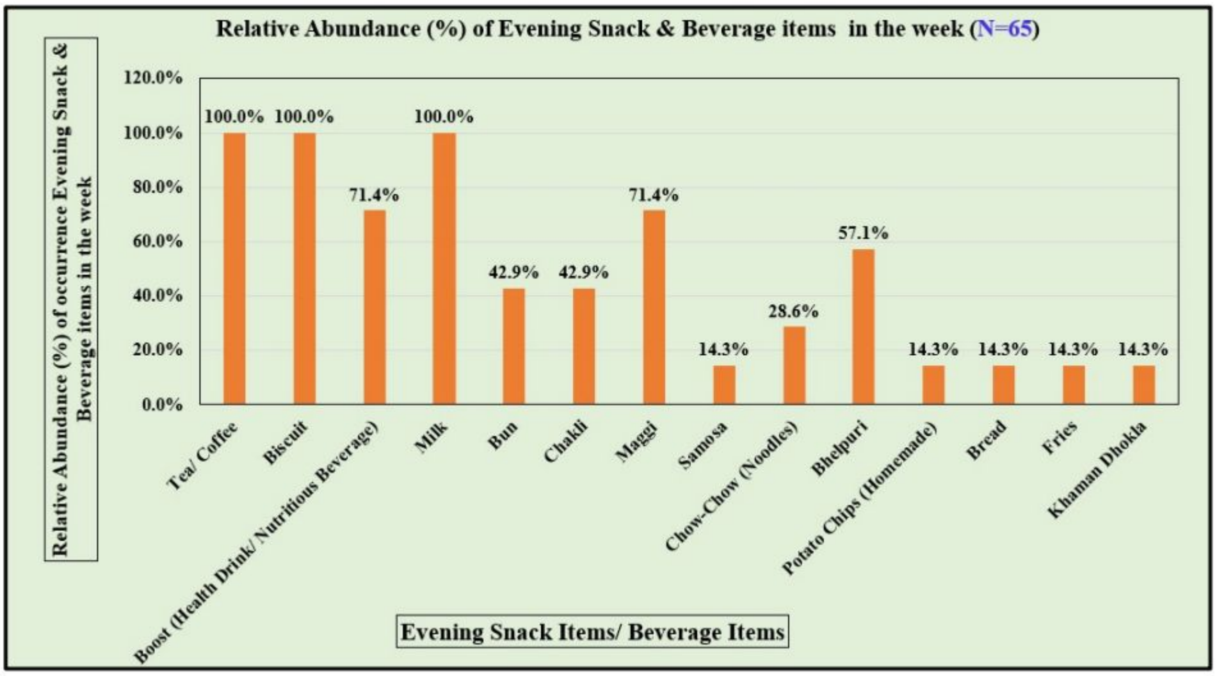

Figure 59: Dominant food items (**Evening Snack & Beverages**) along with the relative abundance measured across the seven days in a week (**N=65**)

7.6 Variations in Taste Perception among Respondents based on Cooking Method Used (Disaggregated by Current Fuel Use Types)

During the large-scale survey, the respondents were asked about their perceptions of tastes depending on how the food items are cooked. The emphasis was to understand *whether the respondents feel that cooking on LPG gas stoves and traditional clay ovens (also known as Chulha/ Oley) adds additional texture and taste to the food items, which possibly other methods cannot replicate*. Amongst the exclusive LPG users (**N=771**), about ***60% mentioned that they feel cooking on an LPG gas stove, or a traditional clay oven does not add any special texture or taste dimensions to the cooked food items***. This should be interpreted as a positive sign in terms of the flexibility of the respondents toward accepting any new, modern cooking method (fuel/appliance).

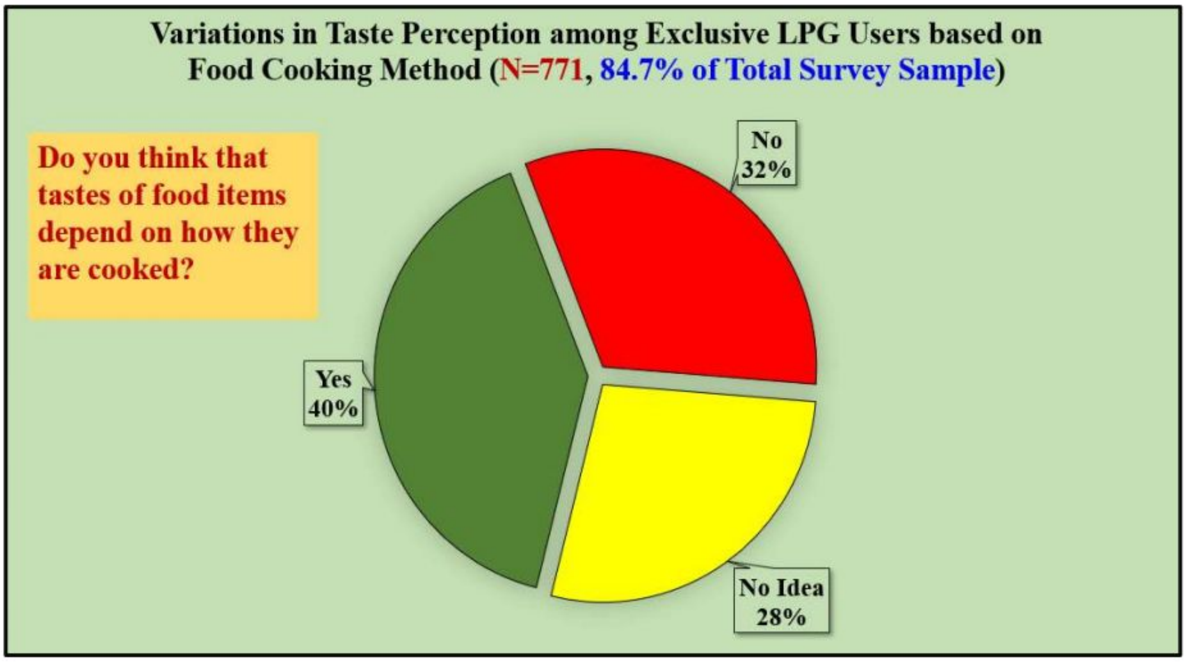

Figure 60: Variations in Taste Perception among Exclusive LPG Users based on Food Cooking Method (**N=771**)

Among the respondents who use traditional clay ovens either in tandem with LPG or exclusively (**N=63**), 67% mentioned *that they strongly feel cooking on an LPG gas stove, or a traditional clay oven certainly adds a special texture or taste dimension to the cooked food items. These people belong to the marginalized and underprivileged communities with limited or no access to modern energy options. Their exposure to the know-how of different options is also limited. Therefore, to transform the views of this group, the sharing of knowledge accompanied by hands-on cooking demonstrations would be necessary. The programs should also consider encouraging the participation of volunteers from marginalized communities during the local demonstration of cooking popular food items***.** *Interestingly, a major fraction (58%) of the respondents using some form of electric cooking (N=76) also believed that* *cooking on an LPG gas stove, or a traditional clay oven adds a special taste dimension to the cooked food items. Therefore, it is evident that they will continue to use LPG as the primary cooking fuel and use eCooking as a backup option until the nutritional value of the food items cooked using electricity is sensitized among this group. In any case, this group is the most promising segment which forms the nucleus of eCooking usage in Indian cities and will be the base for anchoring the envisaged transition in the residential cooking sector.* ***This group can potentially serve as a potent component of the public relations channels*** *if the people are equipped with authentic information regarding the holistic benefits of modern energy cooking (eCooking).* **Figures 60** to **62** depict the variations in taste perception based on the cooking methods used, as reported by the respondents (disaggregated by current fuel use types).

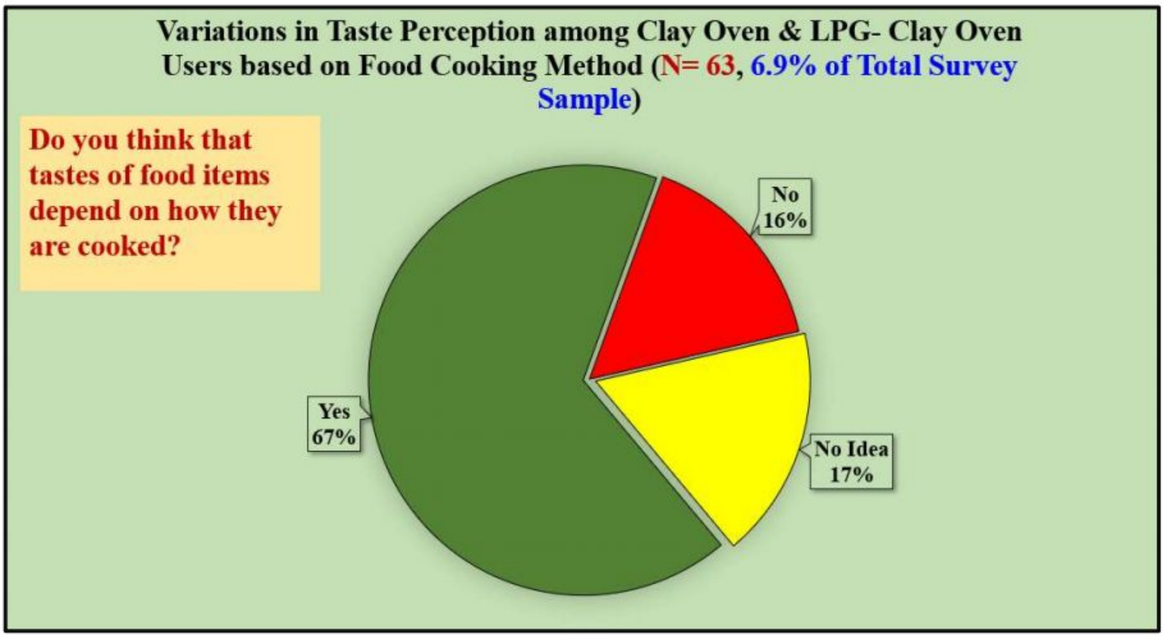

Figure 61: Variations in Taste Perception among Clay Oven & LPG- Clay Oven Users based on Food Cooking Method (**N= 63**)

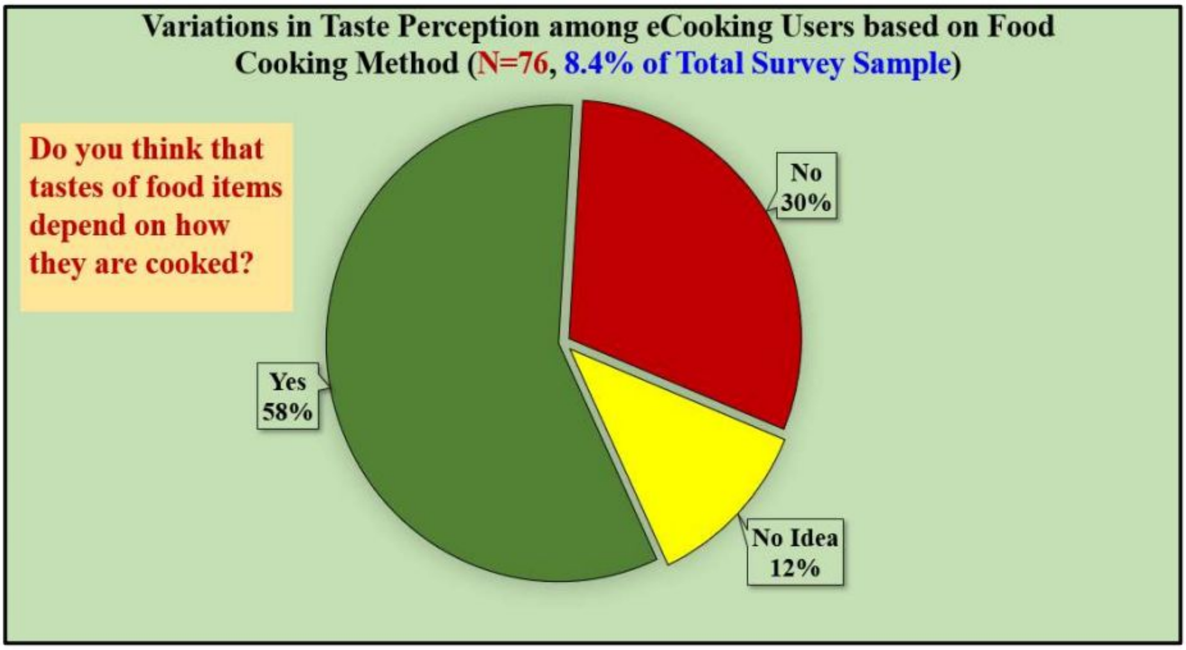

Figure 62: Variations in Taste Perception among eCooking Users based on Food Cooking Method (N=76)

7.7 Analysis of utensils (& their material compositions) used in exclusive LPG Households (N=771)

The large survey indicated that the need for specific flat-bottom utensils to cook food on eCooking devices is one of the major concerns regarding eCooking perceived by the respondents. A majority of the surveyed households (N=899) use LPG as the dominant cooking fuel. Therefore, *kitchen utensils and their material composition can prove to be a key factor in deciding the readiness and pace of the envisaged transition toward an electricity-based cooking paradigm from the currently LPG-dominated residential cooking*. The analysis of utensils and material composition has shown that material composition is a key factor in deciding the price of the utensils. *In case the households choose to shift to the modern energy cooking (eCooking paradigm), the types, numbers, and material composition of currently owned cooking vessels will reflect the household's individual as well as collective inertia to adopt a new set of solutions (both appliances & vessels)*. Therefore, a granular analysis of this aspect will help the decision-makers to assess the affordability of the transition. *The affordability and accessibility of the new cooking solutions (both appliances & vessels), the stock of currently owned vessels, household requirements (e.g., family size, number of times major meals prepared daily, and dietary choices), and economic considerations will reflect the level of inertia of individual households toward energy transition in the household cooking.*

The detailed analysis of the vessels owned by the exclusive LPG users (N=771) is presented in this section, to furnish the current patterns of vessel ownership and usage, since this segment will form the core group which needs to be transformed to achieve mass penetration of eCooking devices. *Based on the findings from the exclusive LPG users, the derived expectations of the customers from the eCooking solution providers are also summarized*.

Figure 63 shows that 98.3% of the exclusive LPG users (**N=758**) own at least one ***pressure cooker*** in their households, and 83.7% population of this group reported owning pressure cookers made of aluminium. Therefore, aluminium emerges as the preferred material for pressure cookers. Apart from aluminium, pressure cookers made of steel (27.9%), and polymer-coated metal were also owned by a small fraction of this group. *Aluminium is a better conductor of heat leading to reduced cooking time and facilitates the preparation of evenly cooked food. It is a lightweight metal and does not corrode easily. Therefore, vessels made of aluminium are durable and offer ample convenience for use. The aluminium vessels are also cheaper than their steel counterparts*.

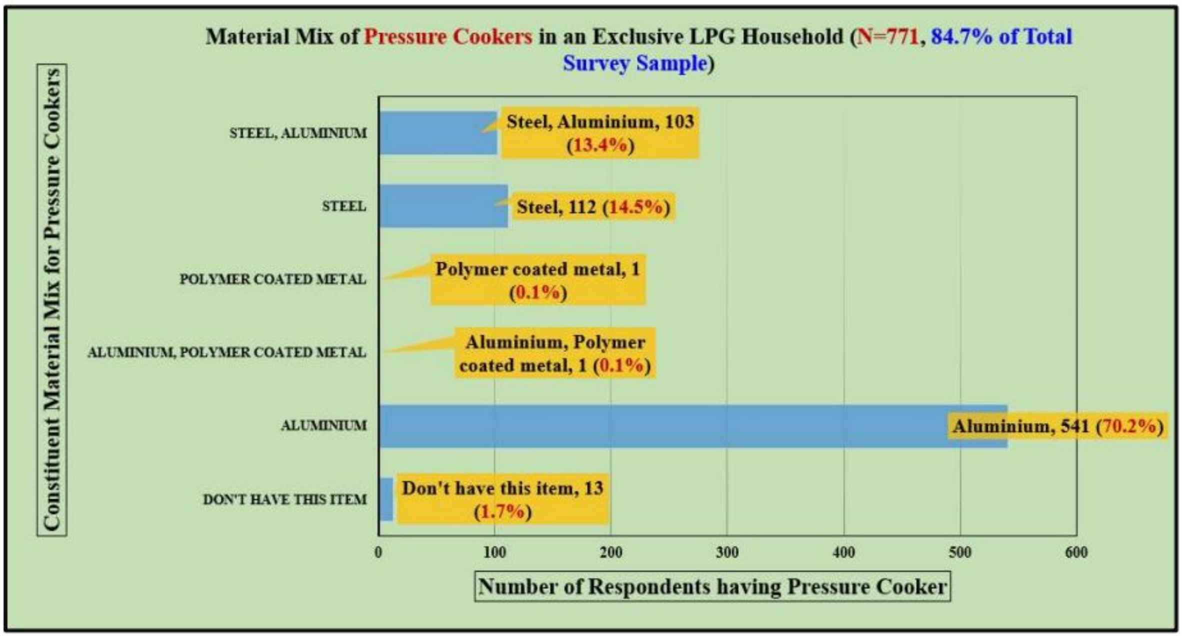

Figure 63: Material Mix of Pressure Cookers in the Exclusive LPG Households (**N=771**)

Figure 64 indicates that 42.8% of the exclusive LPG users (**N=330**) reported *using* ***round-bottom cauldrons*** made of ***steel***, while 35.9% (**N=277**) reported using ***round-bottom*** cauldrons made of ***aluminium***. Apart from these, cauldrons made of ***cast iron*** were reported by 14.3% of the respondents. Additionally, round bottom cauldrons made of *brass*, *copper*, *ceramic*, and *polymer-coated metal* were also found to be possessed by a smaller fraction of respondents. Interestingly, 15.4% of this respondent group (**N=119**) reported not having this vessel type at all.

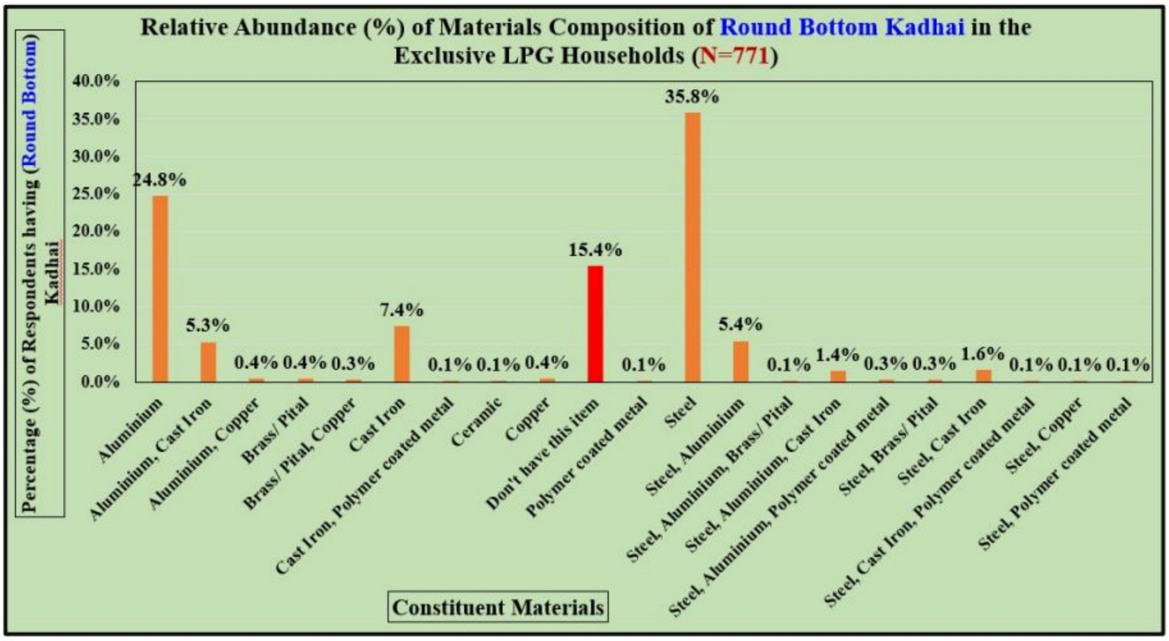

Figure 64: Material Mix of Round Bottom Kadhai in the Exclusive LPG Households (**N=771**)

Figure 65 indicates that a large fraction of the exclusive LPG users (35.5%, i.e., **N=274**) do not own a ***flat-bottom kadhai (cauldron)*** at all. About 37.2% of the respondent group (**N=287**) mentioned using ***flat-bottom cauldrons*** made of ***steel***, while 27.7% (**N=214**) reported using ***flat-bottom cauldrons*** made of ***aluminium***. Additionally, flat-bottom cauldrons made of *cast iron*, *brass*, *copper*, *ceramic*, and *polymer-coated metal* were also found to be possessed by a smaller fraction of respondents.

Figure 66 indicates that a major fraction of the exclusive LPG users (29.8%, i.e., **N=230**) do not own a ***round-bottom saucepan*** at all. About 42.7 % of the respondent group (**N=329**) mentioned using ***round-bottom saucepans*** made of ***steel***, while 30.4% (**N=234**) reported using ***round-bottom saucepans*** made of ***aluminium***. Additionally, round-bottom saucepans made of *brass, and ceramic* were also found to be possessed by a smaller fraction of respondents. *Despite the steel saucepans being a bit expensive, people tend to choose these items more often owing to the resistance to acidic corrosion and durability offered by them.*

Figure 67 indicates that a major fraction of the exclusive LPG users (30.7%, i.e., **N=237**) do not own a ***flat-bottom saucepan*** at all. About 46% of the respondent group (**N=355**) mentioned using ***flat-bottom saucepans*** made of ***steel***, while 27.3% (**N=210**) reported using ***flat-bottom saucepans*** made of ***aluminium***. Additionally, flat-bottom saucepans made of *Borosil glass, brass, polymer-coated metal, and ceramic* were also found to be possessed by a smaller fraction of respondents.

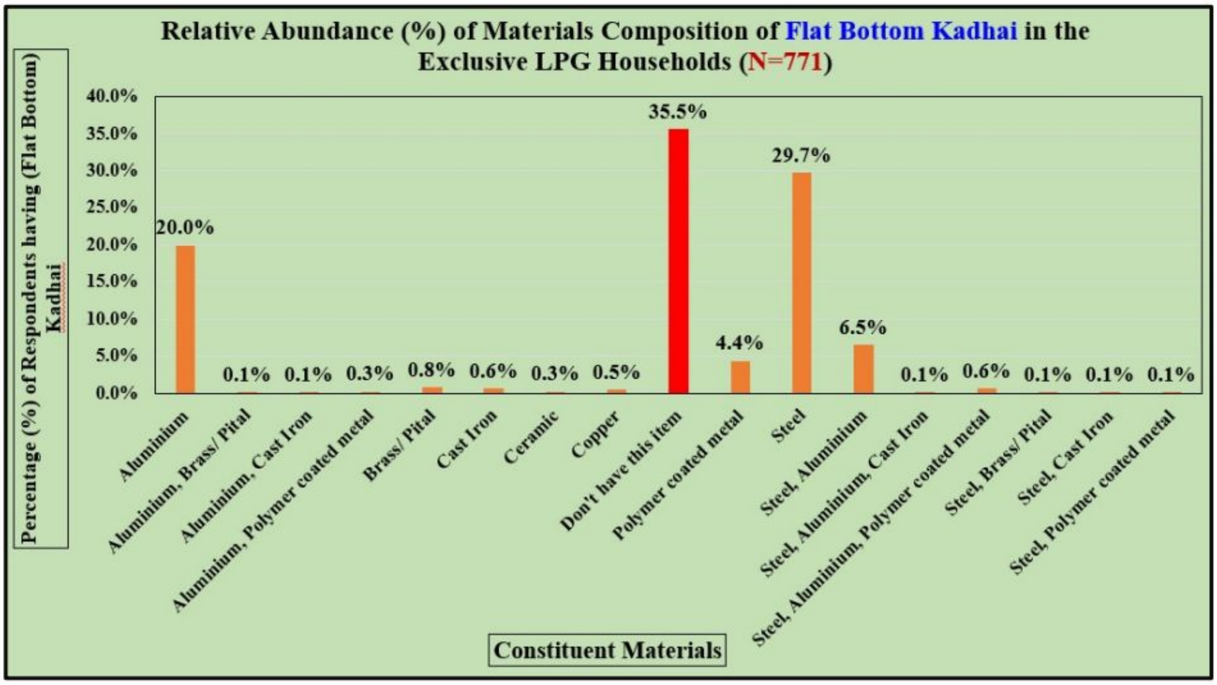

Figure 65: Material Mix of Flat-Bottom Kadhai in the Exclusive LPG Households (**N=771**)

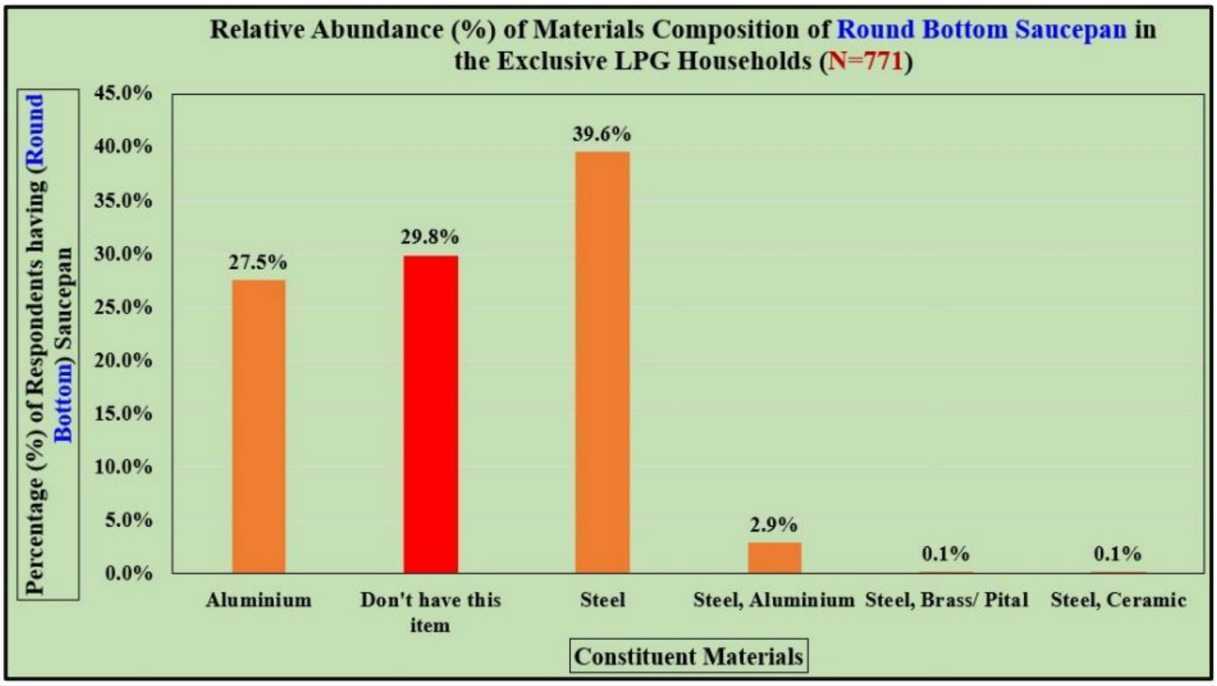

Figure 66: Material Mix of Round-Bottom Saucepan in the Exclusive LPG Households (**N=771**)

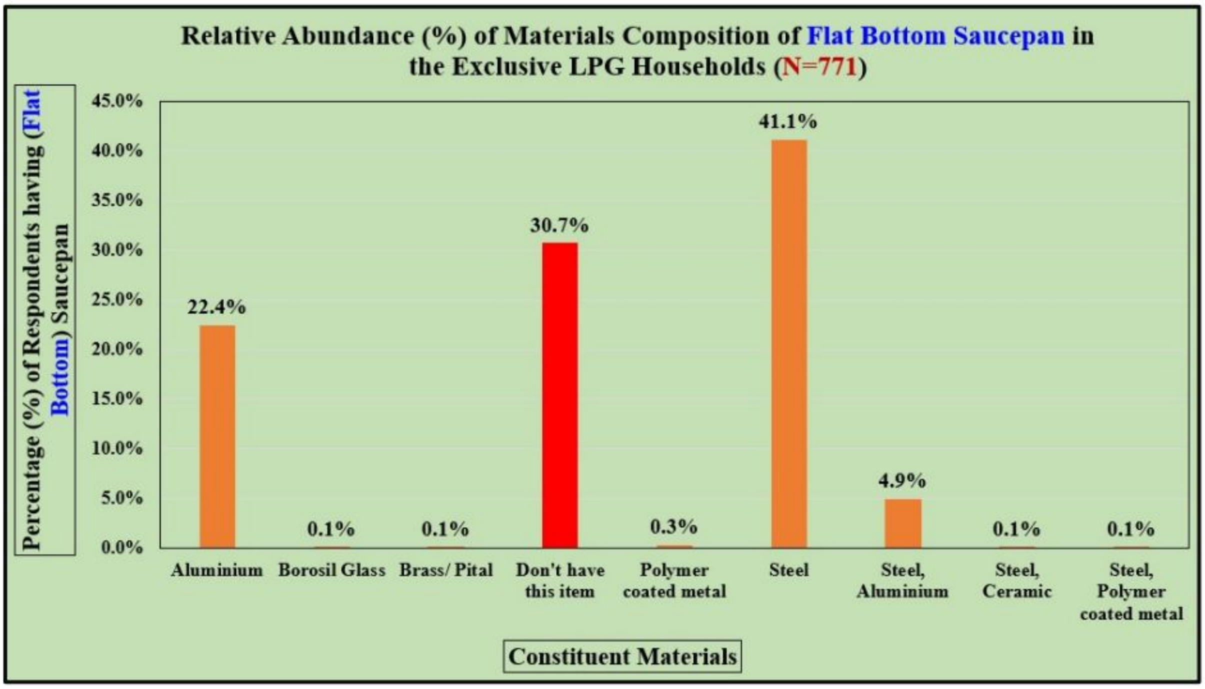

Figure 67: Material Mix of Flat-Bottom Saucepan in the Exclusive LPG Households (N=771)

Figure 68 indicates that a substantial fraction of the exclusive LPG users (17.1%, i.e., **N=132**) do not own a ***round-bottom big bowl*** at all. About 49.8% of the respondent group (**N=384**) mentioned using ***round-bottom big bowls*** made of ***steel***, while 37.5% (**N=289**) reported using ***round-bottom big bowls*** made of ***aluminium***. Additionally, round-bottom big bowls made of *cast iron*, *brass*, *copper*, *Borosil glass*, *ceramic*, and *polymer-coated metal* were also found to be possessed by a smaller fraction of respondents.

Figure 69 indicates that a major fraction of the exclusive LPG users (32%, i.e., **N=247**) do not own a ***flat-bottom big bowl*** at all. About 46.6% of the respondent group (**N=359**) mentioned using ***flat-bottom big bowls*** made of ***steel***, while 25.8% (**N=199**) reported using ***flat-bottom big bowls*** made of ***aluminium***. Additionally, flat-bottom big bowls made of *cast iron*, *brass*, *copper*, *Borosil glass*, *ceramic*, and *polymer-coated metal* were also found to be possessed by a smaller fraction of respondents.

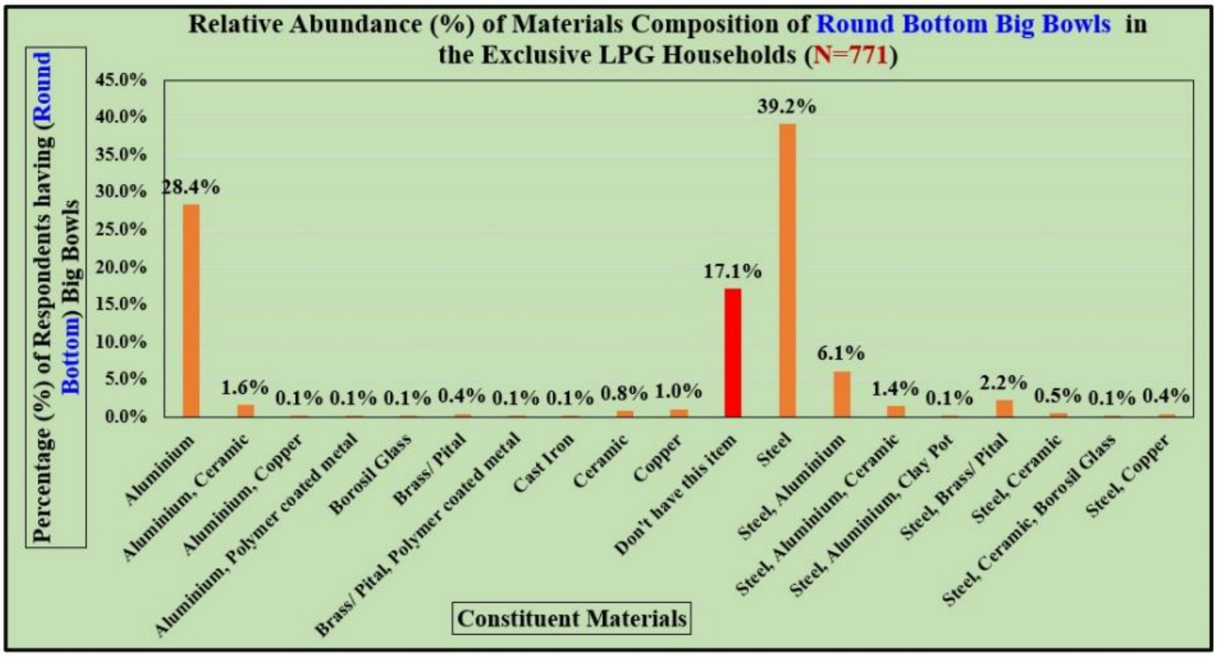

Figure 68: Material Mix of Round-Bottom Big Bowl in the Exclusive LPG Households (N=771)

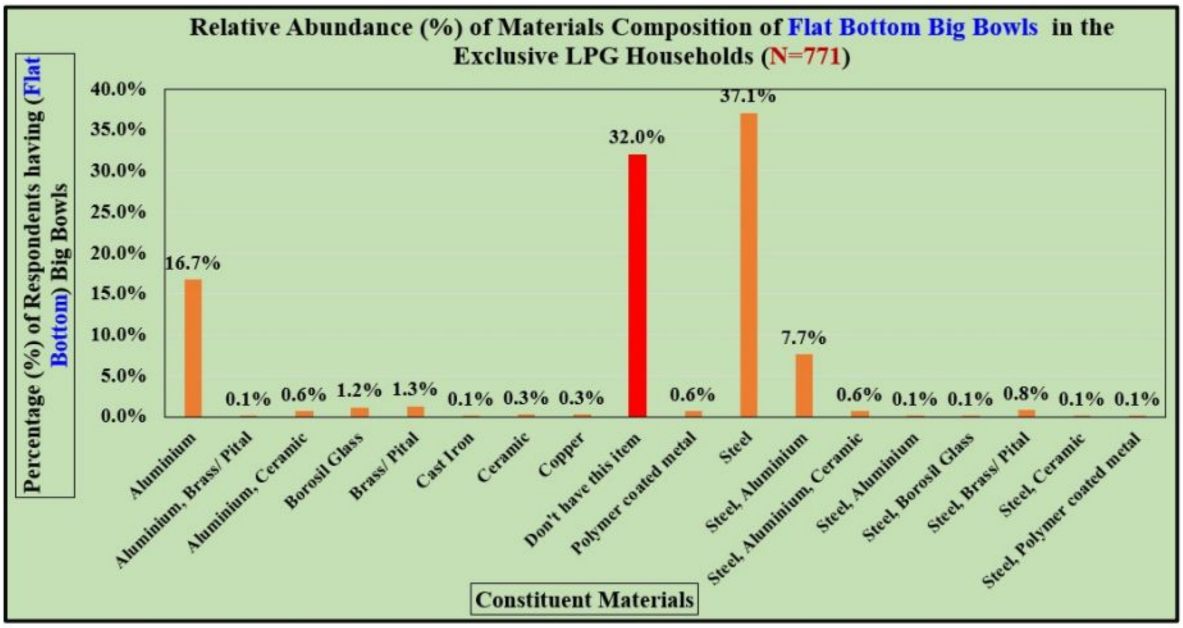

Figure 69: Material Mix of Flat-Bottom Big Bowl in the Exclusive LPG Households (N=771)

Figure 70 indicates that a substantial fraction of the exclusive LPG users (54.2%, i.e., N=418) do not own a ***round-bottom deep pan*** at all. About 19.5% of the respondent group (N=150) mentioned using ***round-bottom deep pans*** made of ***steel***, while 20% (N=154) reported using ***round-bottom deep pans*** made of ***aluminium***. Additionally, round-bottom deep pans made of *cast iron (3.3%)*, *brass*, *copper*, *Borosil glass*, *ceramic*, and *polymer-coated metal* were also found to be possessed by a smaller fraction of respondents.

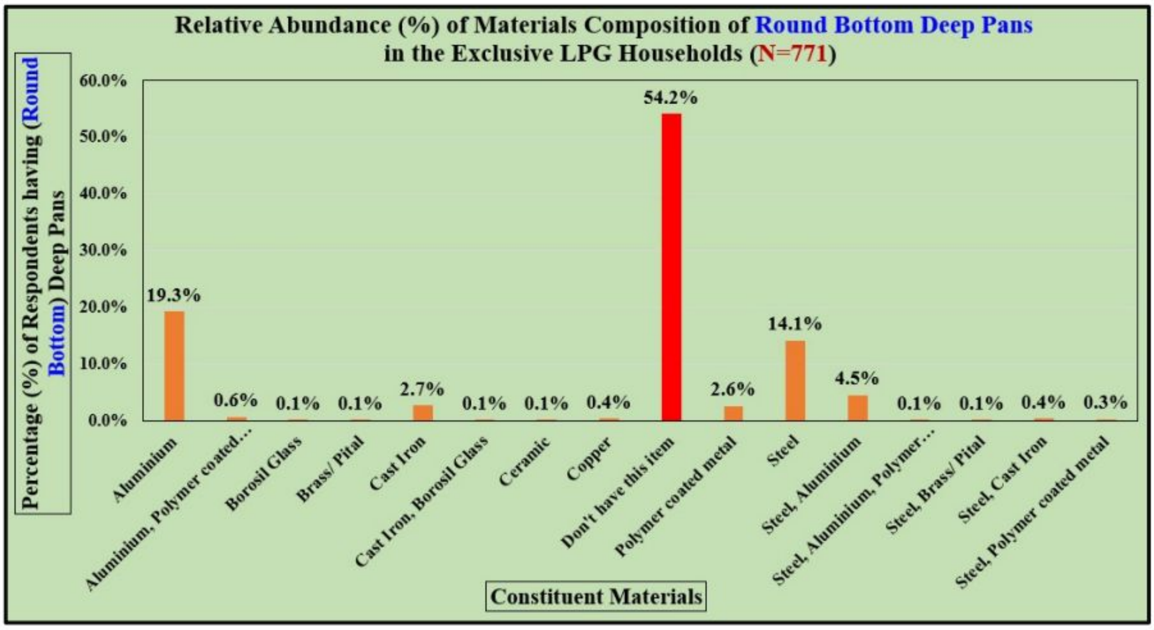

Figure 70: Material Mix of Round-Bottom Deep Pan in the Exclusive LPG Households (N=771)

Figure 71 indicates that a major fraction of the exclusive LPG users (27.2%, i.e., **N=210**) do not own a ***flat-bottom deep pan*** at all. About 16.2% of the respondent group (**N=125**) mentioned using ***flat-bottom deep pans*** made of ***steel***, while 28.3% (**N=218**) reported using ***flat-bottom deep pans*** made of ***aluminium***. Interestingly, about 24% (**N=185**) reported using ***flat-bottom deep pans*** made of ***polymer-coated metal***. Additionally, flat-bottom big bowls made of *cast iron (7.4%)*, *brass*, *copper*, and *ceramic* were also found to be possessed by a smaller fraction of respondents.

Figure 72 indicates that only a tiny fraction of the exclusive LPG users (1.8%, i.e., **N=13**) do not own a ***Tawa*** at all. About 13.7% of the respondent group (**N=106**) mentioned using ***Tawa*** made of ***steel***, while 14.6 % (**N=113**) reported using ***Tawa*** made of ***aluminium***. Interestingly, a major fraction of this respondent group (57%, **N=439**) reported using ***Tawa*** made of ***cast iron***. Additionally, Tawa made of *copper (5.4%)*, *brass*, *polymer-coated metal*, and *ceramic* were also found to be possessed by a smaller fraction of respondents.

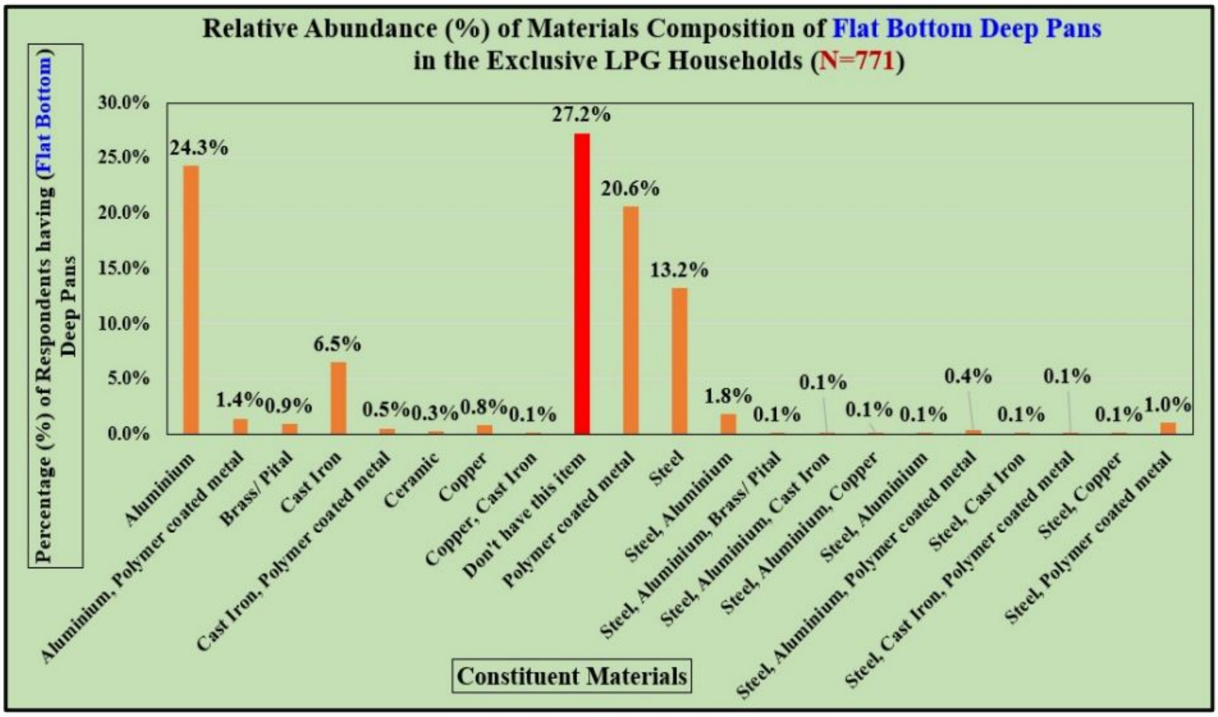

Figure 71: Material Mix of Flat-Bottom Deep Pan in the Exclusive LPG Households (N=771)

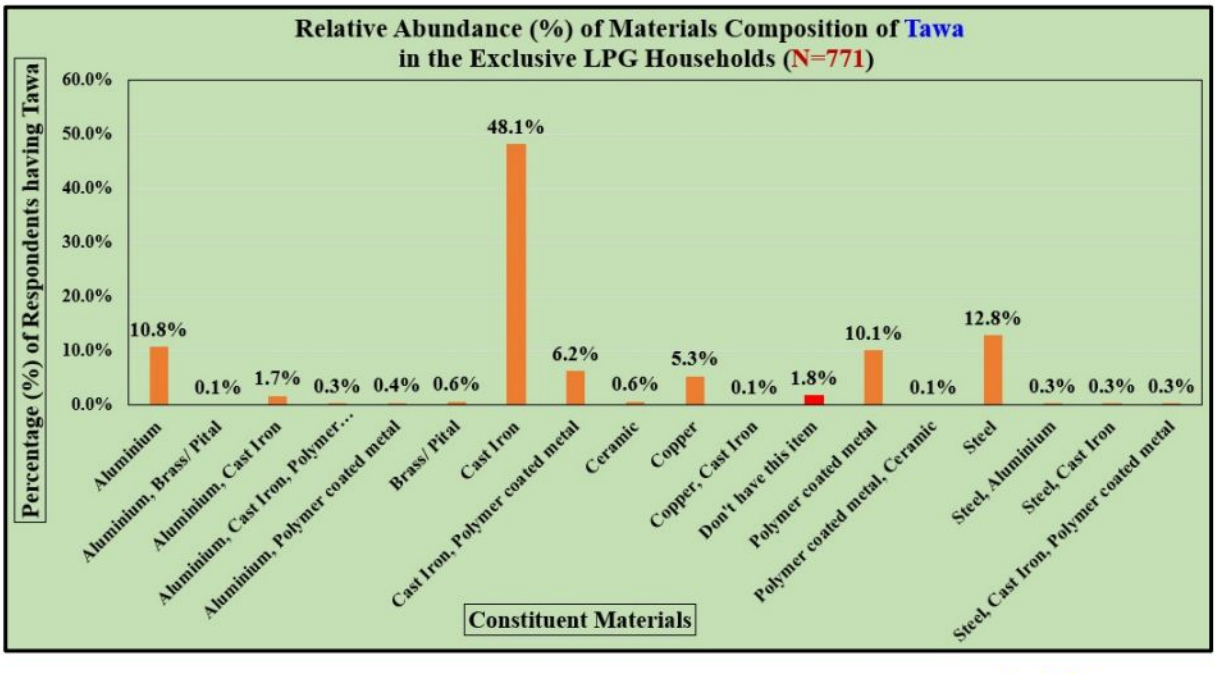

Figure 72: Material Mix of Tawa in the Exclusive LPG Households (N=771)

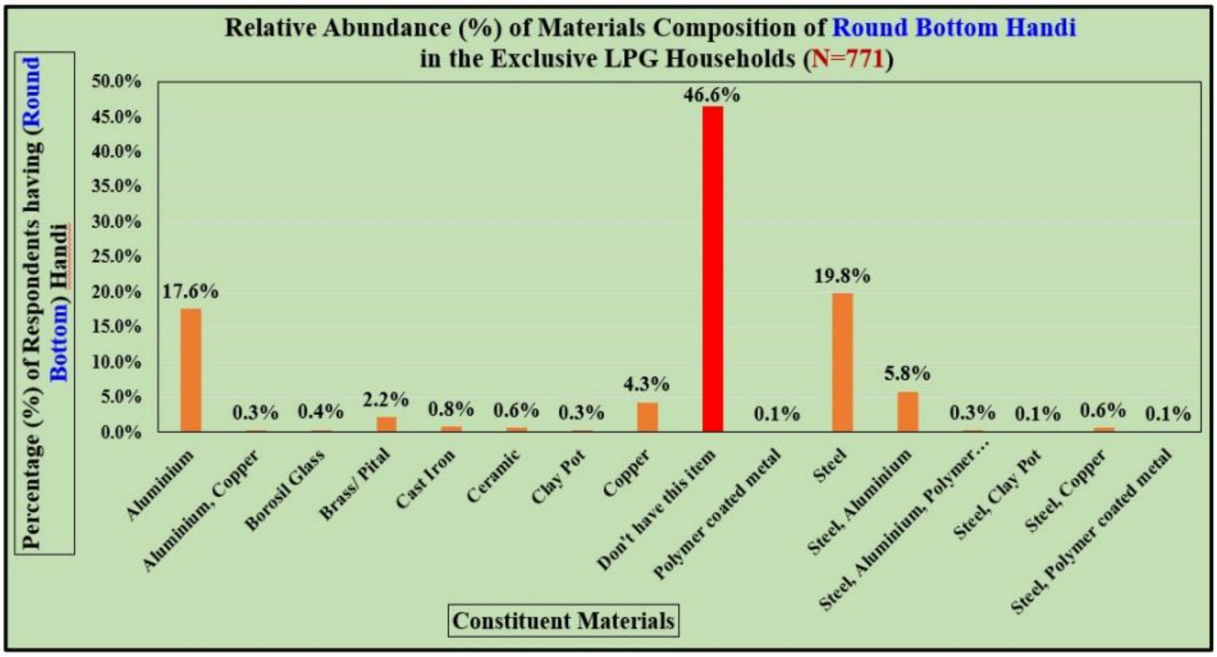

Figure 73: Material Mix of Round-Bottom Handi in the Exclusive LPG Households (N=771)

Figure 73 indicates that a substantial fraction of the exclusive LPG users (46.6%, i.e., N=359) do not own a ***round-bottom handi (basin-type vessel)*** at all. About 26.7% of the respondent group (N=206) mentioned using ***round-bottom handi*** made of ***steel***, while 24% (N=185) reported using ***round-bottom handi*** made of ***aluminium***. Additionally, round-bottom handi made of *copper (5.2%)*, *brass (2.2%)*, *cast iron, Borosil glass*, *ceramic*, *clay (earthenware)*, and *polymer-coated metal* were also found to be possessed by a smaller fraction of respondents.

Figure 74 indicates that a major fraction of the exclusive LPG users (62%, i.e., N=478) do not own a ***flat-bottom handi (basin-type vessel)*** at all. About 21.3% of the respondent group (N=164) mentioned using ***flat-bottom handi*** made of ***steel***, while 15.5% (N=120) reported using ***flat-bottom handi*** made of ***aluminium***. Interestingly, about 4.5% (N=35) reported using ***flat-bottom handi*** made of *brass*. Additionally, flat-bottom handi made of *Borosil glass, copper*, *ceramic,* and *polymer-coated metal* were also found to be possessed by a smaller fraction of respondents.

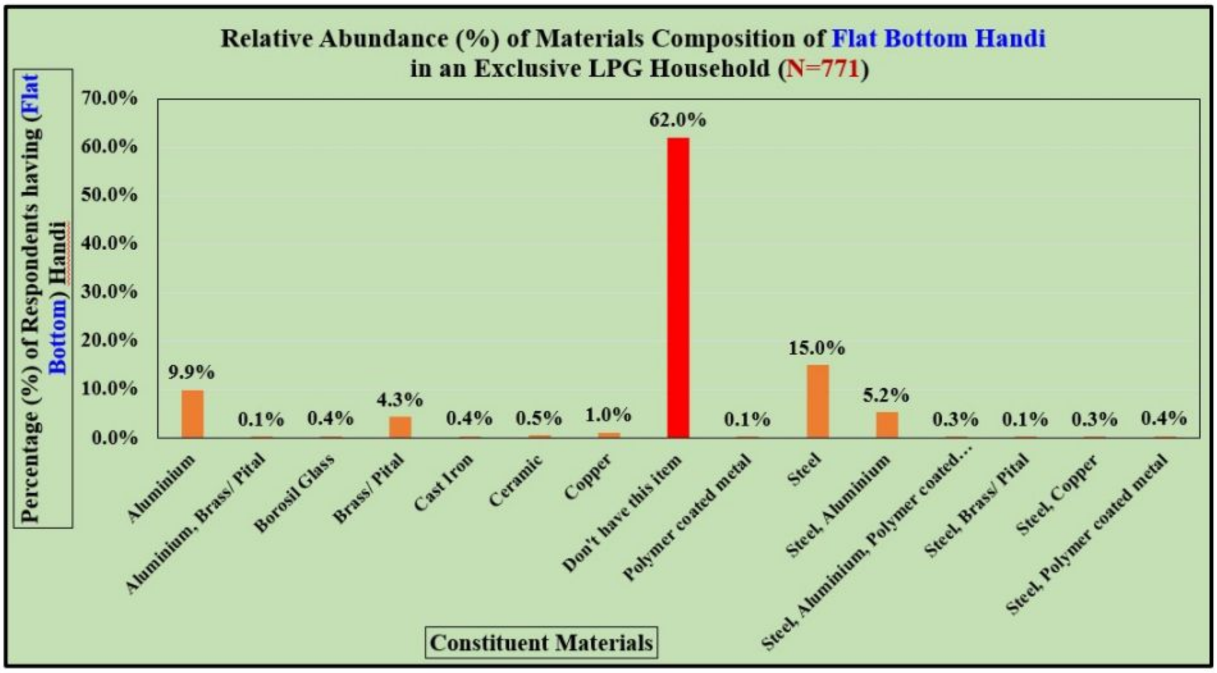

Figure 74: Material Mix of Flat-Bottom Handi in the Exclusive LPG Households (N=771)

7.7.1 Summary of Insights from Cooking Vessel Ownership & Implications

From the detailed analysis of the current status of cooking vessel ownership, it is evident that ***Pressure Cookers*** have the highest population penetration (98.3%) among all the utensil types, followed by ***Round-Bottom Cauldrons*** (84.6%). The mass penetration levels observed for ***Round-Bottom Saucepans***, ***Flat-Bottom Saucepans***, and ***Round Bottom Cauldrons*** are 70.2%, 69.3%, and 64.5%, respectively.

Round-Bottom Big Bowls, ***Flat-Bottom Big Bowls***, and ***Flat-Bottom Deep Pans*** *showed* mass penetration levels of 82.9%, 68%, and 72.8% among the surveyed respondents (N=771). Interestingly, ***Round-Bottom Deep Pans*** showed a considerably lower mass penetration level of 45.8%. This indicates that the deep pans are used more often for storing the cooked food, than as main cooking vessels. *A flat-bottom utensil renders higher convenience while serving food on the table or storing food items (esp., in the refrigerator).*

The penetration levels of basin-type large vessels with a smaller opening at the top than pans, such as ***Round-Bottom Handi***, and ***Flat-Bottom Handi*** are 53.4%, and 38%, respectively, indicating that these items may not have a prominent requirement for the kind of food items being consumed by the Bengaluru Households (N=771). *It is possible that some of the other vessels can provide the utility of these vessels, thereby effectively eliminating the need for owing them as quintessential kitchen utilities*. ***Tawa*** is almost present in all households (penetration level of 98.2% because of the utility offered by this item in frying/ sautéing vegetables and baking bread items (roti/ chapati).

The ***Pressure Cookers*** owned by the households are *predominantly made of aluminium* (83.7%), while the second highest relative abundance is observed for steel (27.9%). The dominant material used in the ***Round-Bottom Cauldrons***, ***Round-Bottom Saucepans***, ***Flat-Bottom Saucepans***, ***Round Bottom Cauldrons***, ***Round-Bottom Big Bowls***, ***Flat-Bottom Big Bowls***, ***Round-Bottom Handi***, ***and Flat-Bottom Handi*** owned by the surveyed households is **steel**. *Apart from steel, another material prominently used for making these kitchen utensils is aluminium*.

The **Deep Pans** *(both* **Round-bottom** *and* **Flat-Bottom** *variants) are predominantly made of* **aluminium** *since these utensils are often used for reheating food items. In the flat-bottom deep pan category, a substantial presence of vessels made of polymer-coated metal is observed.*

Tawa is predominantly made of cast iron (57%). However, there is a reasonable presence of Tawa made of aluminium, steel, and copper as well in the households.

The utensils made of Ceramic and Borosil glass are mainly used for storing cooked food items and heating those using microwave ovens (in case a family owns this appliance). The utensils made of brass and copper are mainly used during special occasions, such as religious festivals, and auspicious family celebrations.

The *analysis clearly shows that there is a predominance of round-bottom major cooking utensils in the current LPG-dominated cooking landscape in the surveyed Bengaluru households*. For the transition to happen toward the eCooking paradigm, a large fraction of the current vessel usage needs to be transformed.

Since the cooking landscape is a complex and intricately linked interplay between the choice of cooking fuel, utensils used for cooking purposes, and dietary preferences, any transition should consider these three angles very carefully. *While the dietary choices emerge from cultural and behavioral traits and are deep-rooted, the combination of cooking fuel/appliances and vessels would prove to be a major practical driver/ barrier for the energy transition in household cooking from the intervention point of view.*

Chapter 8

Electricity Supply-Demand Analysis for Bengaluru City in the Backdrop of Generation and Availability in the State of Karnataka

8.1 Background

While aiming for a large-scale transition to eCooking, *two key things that need serious consideration from the preparation point of view are the estimation of electricity demand attributable to the envisaged growth trajectory of the mass penetration of electricity-based residential cooking, and the assessment of the adequacy of generation sources* (considering both currently installed capacities as well as the planned expansion in the near to medium term). In view of the above, *a granular analysis has been conducted to capture the source-wise electricity generation potential in the State of Karnataka*. Also, *the total average electricity consumption level of Bengaluru City has been obtained from reliable open-source literature*. Finally, *a bottom-up calculation has been conducted to assess the average daily cooking energy requirement at the household level*.

Multiple scenarios have been created for each of these segments of analysis to capture the effect of the possible variabilities in the supply and the demand sides in the realizability of the envisaged modern energy transition in the residential cooking sector. The detailed analyses are provided in the following sections.

8.2 Analysis of Electricity Supply Side

Open-source information suggests that the total installed power generation capacity in the State of Karnataka currently stands at about 32000 GW [**1**]. We used this information for a leading daily in India as the baseline information and validated the same using further authentic sources related to the Indian Power Sector.

Table 8 provides the generation source-wise Installed Capacity in the State of Karnataka (as of **30.04.2024**) **[2-4]**. Further, *it is important to take stock of the average Plant Load Factor (PLF) (for convention generation) or Capacity Utilization Factor (CUF) (for renewable sources) to understand the further potential to increase generation from the currently installed sources*. From a wide range of open-source literature, the *source-wise average annual PLFs and CUFs recorded in India were collated and consolidated* **[2, 5-10]**. **Table 9** summarizes the average PLF and CUF values for the different generation sources for the State of Karnataka.

Table 8: Source-Wise Installed Capacity in the State of Karnataka (as of 30.04.2024) **[2-4]**

Sl. No	Generation Source	Installed Capacity (MW)
1	Hydro	3689.2
2	Thermal	5020
3	CGS	3280
4	Wind	6019.61
5	Co-Generation	1731.16
6	Mini Hydel	1280.73
7	Biomass	139.03
8	Solar	9594.97
9	Captive (Torangallu TPS I & II, and Others)	997.3
10	IPP (Adani Power)	1200
	Total	**32952**

Table 9: Source-wise average annual PLFs (conservative) recorded in India **[2, 5-11]**

Sl. No	Generation Source	Plant Load Factor (PLF), Or, Capacity Utilization Factor (CUF)		
		Jan - 2024	Feb-2024	Average
1	**Hydro**	**-**	**-**	**32.50%**
2	**Thermal (State)**	**68.96%**	**69.91%**	**69.43%**
3	**CGS**	**77.37%**	**75.83%**	**76.60%**
4	**Wind**	**-**	**-**	**26.43%**
5	**Co-Generation**	**-**	**-**	**60.0%**
6	**Mini Hydel (Small Hydro)**	**-**	**-**	**31%**
7	**Biomass**	**-**	**-**	**70.0%**
8	**Solar**	**-**	**-**	**21.0%**
9	**Captive**	**-**	**-**	**65.34 %**
10	**IPP**	**70.93%**	**69.67%**	**70.3%**

The current generation levels from different sources are also obtained from the data published by the Distribution Companies (DISCOMs), Karnataka Electricity Regulatory Commission (KERC), as well as the formal release by the Central Electricity Authority (CEA) in the form of a Graphical User Interface (GUI)-enabled Dashboard **[12, 13]**. The country-level average PLFs were used to fill the gap in the generation data associated with co-generation plants, captive power plants, and independent power producers. **Table 10** *provides the source-wise generation against the installed capacities for the base year 2024*.

The annual generation from a particular source in Million Units (MU) of Gigawatt-hour (GWh) can be calculated using the following mathematical expression (**Equation (1)**):

$$\textbf{Annual Generation } (G) \text{ (in MU or GWh)} = \textbf{Installed Capacity } (C) \text{ (in MW)} * PLF\ (\%) * 365\left(\frac{days}{year}\right) * 24\left(\frac{hours}{day}\right) * 10^{-3} \quad (1)$$

Table 10: Source-wise generation against the installed capacities for the base year 2024

Sl. No	Generation Source	Installed Capacity (MW)	Current Annual Generation (MU or GWh) from the capacity currently available (Base Year 2024)
1	**Hydro**	3689.2	**11588.54**
2	**Thermal**	5020	**22596.00**
3	**CGS**	3280	**31000.00**
4	**Wind**	6019.61	**10950.21**
5	**Co-Generation (Bagasse-based)**	1731.16	**2754.07**
6	**Mini Hydel**	1280.73	**1370.76**
7	**Biomass**	139.03	**47.05**
8	**Solar**	9594.97	**15404.08**
9	**Captive (Torangallu TPS I & II, and Others)**	997.3	**5678.63**
10	**IPP (Adani Power)**	1200	**7389.94**
	Total	**32952**	**108779.27**

8.2.1 Future Capacity Expansion Plans in Karnataka

A scrutiny of the open-source information furnished the potential capacity expansion possibilities in the State of Karnataka.

- **Solar Photovoltaic**

In the districts of Bidar, Koppal, and Gadag, three more ultra-mega solar power plants, each with a capacity of 2,500 MW, are expected to be built **[14]**. Therefore, we assume the installed solar capacity will increase by at least 7.5 GW until 2030. The Karnataka State Government plans to implement a solar generation capacity of about 1.2 GW to power 4.30 lakh irrigation pump sets **[15]**. Assuming an additional contribution of 1.8 GW from the rooftop solar segment, *a total solar PV generation capacity addition of 11 GW is considered between now and 2030.* Therefore, the assumption is the installed solar capacity in Karnataka will reach about 20.6 GW by 2030.

- **Wind Energy**

The wind potential in Karnataka has been assessed to be 11,645 MW **[16]**. Given the current trends of rapid renewable energy capacity expansion in India, *it is assumed that the installed wind capacity in Karnataka will reach 11,645 MW by 2030*, from the current level of **6019.61 GW**.

- **Hydro-Electric Power**

As per a recent assessment done by the GOI agencies, the State of Karnataka has a hydropower potential of 6459 MW (as of **28.02.23**) **[17]**. *It is assumed that the installed Hydro Electric Power capacity (above 25 MW) in Karnataka will reach 6459 MW by 2030*, from the current level of **3689.2 GW**.

- **Bagasse-based Cogeneration & Biomass Generation**

In Karnataka, 72 sugar factories and one paper mill have commissioned cogeneration plants with a cumulative installed generation capacity of **1731.16 MW [18]**, while the allotted capacity is **2177.65 MW [19]**. From the current installed capacity of 1731.16 MW in 2024, it is assumed that the co-generation installed capacity will reach the allotted capacity level of **2177.65 MW** by 2030. Subsequently, the CAGR of bagasse-based cogeneration installed capacity in the State of Karnataka works out to be 3.898%. If only 50% of the balance capacity is realized, the cogeneration-based installed capacity will reach **1954.4 MW** by 2030. In that case, the CAGR of installed bagasse-based cogeneration capacity in the State of Karnataka works out to be 2.042%.

Bagasse-based cogeneration plants generate electricity using bagasse as fuel during their operating season (when sugar is produced) and during the off-season with the available surplus bagasse **[20]**. Due to the scarcity of bagasse during the off-season, the plants often remain idle without generating electricity. Considering this, to explore the pathways of optimal utilization of the electricity generation capacity available from cogeneration plants, the Karnataka Electricity Regulatory Commission (KERC) issued a discussion paper titled

"***Utilisation of Bagasse-based Cogeneration Plants during Off-season Using Coal as Fuel***" **[20]**.

The KERC had written to the Ministry of New and Renewable Energy (MNRE) on 27.10.2014 and 03.12.2014 seeking clarification as to whether Co-generation Plants could be allowed to operate as RE generators during the main operating season using bagasse and as conventional plants during off-season using coal as fuel, without losing RE status for the period of operation during the main operating season. In response, the Ministry vide their letter dated 24.12.2014 has replied as below **[20]**:

"*In view of surplus and additional power generation capacities established in sugar mills in the State of Karnataka and to enable these sugar mills to supply power during off-season, this Ministry has 'No Objection' for operating grid-connected bagasse co-gen plants using coal as fuel during off-season without losing their RE status. However, KERC may like to place the mechanism for monitoring number of days during off-season for calculation of coal-based tariff.*"

Currently, the commissioned installed capacity biomass-based power generation (rice husk, etc.) stands at 139.03 MW, while clearance has been given for a total of 391.70 MW capacity **[21]**. From the current installed capacity of 139.03 MW in 2024, it is assumed that the installed capacity for biomass-based generation will reach the approved capacity level of **391.70 MW** by 2030. Subsequently, the CAGR of bagasse-based cogeneration installed capacity in the State of Karnataka works out to be 18.843%. If only 50% of the balance capacity is realized, the biomass-based installed capacity will reach **265.4 MW** by 2030. In that case, the CAGR of installed biomass-based generation capacity in the State of Karnataka works out to be 11.375%.

- **State Thermal Generation**

For the State Thermal Generation, it is assumed that the Yelahanka Combined Cycle plant will start generating in 2025. Therefore, the State thermal generation capacity will increase to 5390 MW from 2025 and will stay at this level till 2030, since no declaration regarding capacity addition or retirement is available as of now.

Other than the above four sources there are no declared plans for the capacity expansion looking at the 2030 timeline. Therefore, the possible increase in generation from other generation sources is expected to come from improvement in the respective PLFs or CUFs. For solar, wind, and hydropower, the enhancement in generation will come from both capacity growth as well as improvement in availability factors. For the state thermal, the enhancement will come from the high target PLF of 85% accompanied by a marginal increment in the installed capacity. For Central Generating Stations (CGSs), the increased allocation will come from possible improvements in PLFs. The projected availability of electricity from the state thermal generation is available from open source **[12]**, and the maximum possible generation (assuming a PLF of 85%) can be calculated using **Equation (1).** Thereafter, the compound annual growth rate (CAGR) of energy generation from the State Thermal Power plants can be calculated using **Equation (2)**, *assuming that the maximum possible annual generation will be achieved only by 2030*.

$$\boldsymbol{Generation_{terminal\,Year} = Generation_{base\,year} * \left(1 + 0.01 * r_g(\%)\right)^n} \qquad \textbf{(2)},$$

Where, r_g is the compound annual growth rate, and n is the difference between the terminal year and the base year.

To simulate the possible variabilities on the generation side, four scenarios have been created as below:

Scenario G1: This scenario assumes that only a 50% Realization of the Envisaged RE Capacity Increase will take place by 2030 and the generation during the period 2024-30 will take place at the current levels of average PLFs (for conventional generation) and CUFs (for renewable power). This is the most pessimistic scenario among the four.

Scenario G2: This scenario also assumes a 50% Realization of the Envisaged RE Capacity Increase by 2030. However, this scenario considers a certain increase in generation over the period 2024-30 through a progressive increase in average PLFs (for conventional generation) **and CUFs** (for renewable power).

Scenario G3: This scenario assumes a 100% Realization of the Envisaged RE Capacity Increase will take place by 2030. However, the generation during the period 2024-30 will take place at the current levels of average PLFs (for conventional generation**) and CUFs** (for renewable power).

Scenario G4: This scenario also assumes a 100% Realization of the Envisaged RE Capacity Increase will take place by 2030. However, this scenario considers a certain increase in generation over the period 2024-30 through a progressive increase in average **PLFs** (for conventional generation) and **CUFs** (for renewable power). This is the most optimistic scenario among the four.

Table 11 encapsulates the installed capacity levels for the 50*% and 100% Realization of the Envisaged RE Capacity Increase by 2030*, *respectively*. The table also captures **base year (2024) PLF & CUF values** for different generation sources, for **all four scenarios**. It also exhibits the **optimistic PLFs and CUFs** by the year 2023 for the **scenarios G2** and **G4**. *The optimistic PLFs and CUFs are based on Government mandates and other reliable open-source information* **[22, 23]**. The capacity growth trajectory for scenarios G1 & G2 is provided in **Table 12**, and for Scenarios G3 & G4 is provided in **Table 13**. The projected electricity generation (in MU or GWh) for the aforesaid four scenarios (**G1**, **G2**, **G3**, and **G4**) are provided in **Tables 14** to **17**.

Table 11: Installed capacity levels (MW) for the *50% and 100% Realization of the Envisaged RE Capacity Increase by 2030*; *PLF & CUF values for the Base Year (2024)*, and *Optimistic improvements (by 2030)*

Sl. No.	Generation Source	Installed Capacity (MW) in Karnataka (as of 30.04.2024)	Projected Capacity by 2030 (MW) (assuming 50% Realization of Envisaged Non-Fossil or RE Capacity Increase by 2030 - *Midpoint Projection*) [Scenarios G1, & G2]	Projected Capacity by 2030 (MW) (assuming *addition as per open-source information and power development announcements*) [Scenarios G3, & G4]	Current Average PLF/ CUF (For Scenarios G1, G2, G3 & G4)	Optimistic PLF/ CUF (Realizable) based on Policy Mandates and State-of-the-Art (For Scenarios G2 & G4)	CAGR of Projected Growth in Average PLF/ CUF (%)
1	**Hydro**	3689.2	5074.1	6459	**0.325**	**0.445**	**5.38%**
2	**Thermal (State)**	5020	5390	5390	**0.694**	**0.850**	**3.43%**
3	**CGS**	3280	3280	3280	**0.766**	**0.850**	**1.75%**
4	**Wind**	6019.61	8832.305	11645	**0.264**	**0.310**	**2.69%**
5	**Co-Generation (Bagasse-based)**	1731.16	1954.405	2177.65	**0.6**	**0.850**	**5.98%**
6	**Small Hydro**	1280.73	1280.73	1280.73	**0.31**	**0.445**	**6.21%**
7	**Biomass**	139.03	265.365	391.7	**0.7**	**0.750**	**1.16%**
8	**Solar**	9594.97	15094.97	20594.97	**0.21**	**0.285**	**5.22%**
9	**Captive / Private Sector Utility**	997.3	997.3	997.3	**0.65**	**0.750**	**2.33%**
10	**IPP**	1200	1200	1200	**0.703**	**0.750**	**1.08%**
	Total	**32952**	**43184**	**53416**			

Table 12: *Capacity Growth Trajectory* - **Scenarios G1 & G2**

Year / Generation Source	CAGR of Projected Installed Capacity Growth (%) for 50% Realization of Envisaged Non-Fossil /RE Capacity Increase by 2030	2024	2025	2026	2027	2028	2029	2030
Hydro	**5.456%**	**3689.2**	3890.48	4102.75	4326.59	4562.65	4811.59	**5074.11**
Thermal (State)	**1.19%; (fixed addition of 370 MW in 2025)**	**5020**	5390.00	5390.00	5390.00	5390.00	5390.00	**5390.00**
CGS	**0%; (No capacity addition, generation increases by improvement in PLF)**	**3280**	3280.00	3280.00	3280.00	3280.00	3280.00	**3280.00**
Wind	**6.60%**	**6019.61**	6416.78	6840.16	7291.48	7772.57	8285.40	**8832.07**
Co-Generation (Bagasse-based)	**2.04%**	**1731.16**	1766.51	1802.58	1839.39	1876.95	1915.28	**1954.39**
Small Hydro	**0%**	**1280.73**	1280.73	1280.73	1280.73	1280.73	1280.73	**1280.73**
Biomass	**11.38%**	**139.03**	154.84	172.46	192.08	213.92	238.26	**265.36**
Solar	**7.85%**	**9594.97**	10347.70	11159.47	12034.93	12979.07	13997.28	**15095.37**
Captive / Private Sector Utility	**0%**	**997.3**	997.30	997.30	997.30	997.30	997.30	**997.30**
IPP	**0%**	**1200**	1200.00	1200.00	1200.00	1200.00	1200.00	**1200.00**

Table 13: *Capacity Growth Trajectory* - **Scenarios G3 & G4**

Year / Generation Source	CAGR of Projected Installed Capacity Growth (%) for 100 % Realization of Envisaged Non-Fossil /RE Capacity Increase by 2030	2024	2025	2026	2027	2028	2029	2030
Hydro	**9.785%**	**3689.2**	4050.19	4446.50	4881.59	5359.25	5883.66	**6459.37**
Thermal (State)	**1.19%; (fixed addition of 370 MW in 2025)**	**5020**	5390	5390	5390	5390	5390	**5390**
CGS	**0%; (No capacity addition, generation increases by improvement in PLF)**	**3280**	3280	3280	3280	3280	3280	**3280**
Wind	**11.63%**	**6019.61**	6719.39	7500.52	8372.45	9345.75	10432.20	**11644.94**
Co-Generation	**3.90%**	**1731.16**	1798.64	1868.75	1941.60	2017.28	2095.91	**2177.61**
Small Hydro	**0%**	**1280.73**	1280.73	1280.73	1280.73	1280.73	1280.73	**1280.73**
Biomass	**18.84%**	**139.03**	165.23	196.36	233.36	277.33	329.59	**391.70**
Solar	**13.58%**	**9594.97**	10897.58	12377.04	14057.35	15965.77	18133.28	**20595.06**
Captive / Private Sector Utility	**0%**	**997.3**	997.30	997.30	997.30	997.30	997.30	**997.30**
IPP	**0%**	**1200**	1200.00	1200.00	1200.00	1200.00	1200.00	**1200.00**

Table 14: *Projection of Electricity Generation (2024-30)* - **Scenario G1**

Year / Generation Source	**Current Annual Generation (MU or GWh) (Base Year 2024)**	**2025 Annual Generation (MU or GWh)**	**2026 Annual Generation (MU or GWh)**	**2027 Annual Generation (MU or GWh)**	**2028 Annual Generation (MU or GWh)**	**2029 Annual Generation (MU or GWh)**	**2030 Annual Generation (MU or GWh)**
Hydro	11588.54	11076.20	11680.52	12317.81	12989.87	13698.60	14445.99
Thermal (State)	22596.00	22596.00	22596.00	22596.00	22596.00	22596.00	22596.00
CGS	31000.00	31000.00	31000.00	31000.00	31000.00	31000.00	31000.00
Wind	10950.21	14839.71	15818.84	16862.56	17975.15	19161.15	20425.41
Co-Generation	2754.07	9284.78	9474.37	9667.84	9865.26	10066.71	10272.27
Small Hydro	1370.76	3477.95	3477.95	3477.95	3477.95	3477.95	3477.95
Biomass	47.05	949.51	1057.51	1177.81	1311.78	1461.00	1627.19
Solar	15404.08	19035.62	20528.96	22139.46	23876.30	25749.40	27769.44
Captive / Private Sector Utility	5678.63	5678.63	5678.63	5678.63	5678.63	5678.63	5678.63
IPP	7389.94	7389.94	7389.94	7389.94	7389.94	7389.94	7389.94
Total	**108779.27**	**125328.33**	**128702.72**	**132307.99**	**136160.88**	**140279.37**	**144682.81**

Table 15: *Projection of Electricity Generation (2024-30)* - **Scenario G2**

Year / Generation Source	Current Annual Generation (MU or GWh) (Base Year 2024)	2025 Annual Generation (MU or GWh)	2026 Annual Generation (MU or GWh)	2027 Annual Generation (MU or GWh)	2028 Annual Generation (MU or GWh)	2029 Annual Generation (MU or GWh)	2030 Annual Generation (MU or GWh)
Hydro	11588.54	11671.77	12970.42	14413.55	16017.26	17799.40	19779.82
Thermal (State)	22596.00	24866.22	27364.53	30113.84	33139.38	36468.90	40132.92
CGS	31000.00	31542.19	32093.86	32655.18	33226.32	33807.45	34398.74
Wind	10950.21	15239.49	16682.63	18262.44	19991.85	21885.02	23957.48
Co-Generation	2754.07	9840.01	10641.39	11508.04	12445.26	13458.82	14554.92
Small Hydro	1370.76	3693.93	3923.32	4166.96	4425.73	4700.57	4992.47
Biomass	47.05	960.49	1082.13	1219.16	1373.55	1547.49	1743.46
Solar	15404.08	20029.28	22728.13	25790.63	29265.79	33209.21	37683.99
Captive / Private Sector Utility	5678.63	5810.65	5945.75	6083.99	6225.44	6370.19	6518.29
IPP	7389.94	7470.04	7551.02	7632.87	7715.61	7799.25	7883.79
Total	**108779.27**	**131124.08**	**140983.18**	**151846.67**	**163826.20**	**177046.30**	**191645.91**

Table 16: *Projection of Electricity Generation (2024-30)* - **Scenario G3**

Year / Generation Source	Current Annual Generation (MU or GWh) (Base Year 2024)	2025 Annual Generation (MU or GWh)	2026 Annual Generation (MU or GWh)	2027 Annual Generation (MU or GWh)	2028 Annual Generation (MU or GWh)	2029 Annual Generation (MU or GWh)	2030 Annual Generation (MU or GWh)
Hydro	11588.54	11530.89	12659.18	13897.88	15257.79	16750.77	18389.83
Thermal (State)	22596.00	22596.00	22596.00	22596.00	22596.00	22596.00	22596.00
CGS	31000.00	31000.00	31000.00	31000.00	31000.00	31000.00	31000.00
Wind	10950.21	15539.53	17346.00	19362.47	21613.36	24125.91	26930.55
Co-Generation	2754.07	9453.66	9822.16	10205.03	10602.82	11016.12	11445.52
Small Hydro	1370.76	3477.95	3477.95	3477.95	3477.95	3477.95	3477.95
Biomass	47.05	1013.17	1204.09	1430.97	1700.61	2021.06	2401.89
Solar	15404.08	20047.19	22768.80	25859.89	29370.63	33357.99	37886.67
Captive / Private Sector Utility	5678.63	5678.63	5678.63	5678.63	5678.63	5678.63	5678.63
IPP	7389.94	7389.94	7389.94	7389.94	7389.94	7389.94	7389.94
Total	**108779.27**	**127726.95**	**133942.74**	**140898.76**	**148687.73**	**157414.36**	**167196.97**

Table 17: *Projection of Electricity Generation (2024-30)* - **Scenario G4**

Year / Generation Source	Current Annual Generation (MU or GWh) (Base Year 2024)	2025 Annual Generation (MU or GWh)	2026 Annual Generation (MU or GWh)	2027 Annual Generation (MU or GWh)	2028 Annual Generation (MU or GWh)	2029 Annual Generation (MU or GWh)	2030 Annual Generation (MU or GWh)
Hydro	11588.54	12150.90	14057.15	16262.46	18813.73	21765.26	25179.82
Thermal (State)	22596.00	24866.22	27364.53	30113.84	33139.38	36468.90	40132.92
CGS	31000.00	31542.19	32093.86	32655.18	33226.32	33807.45	34398.74
Wind	10950.21	15958.16	18293.19	20969.88	24038.23	27555.55	31587.53
Co-Generation	2754.07	10018.98	11032.01	12147.47	13375.71	14728.15	16217.32
Small Hydro	1370.76	3693.93	3923.32	4166.96	4425.73	4700.57	4992.47
Biomass	47.05	1024.90	1232.11	1481.22	1780.69	2140.71	2573.52
Solar	15404.08	21093.66	25207.91	30124.62	36000.33	43022.08	51413.39
Captive / Private Sector Utility	5678.63	5810.65	5945.75	6083.99	6225.44	6370.19	6518.29
IPP	7389.94	7470.04	7551.02	7632.87	7715.61	7799.25	7883.79
Total	**108779.27**	**133629.64**	**146700.86**	**161638.51**	**178741.20**	**198358.09**	**220897.81**

Figure 75 presents the projected annual electricity generation potential (this can also be interpreted as gross availability) for the four assumed Generation Scenarios (**G1**, **G2**, **G3**, and **G4**).

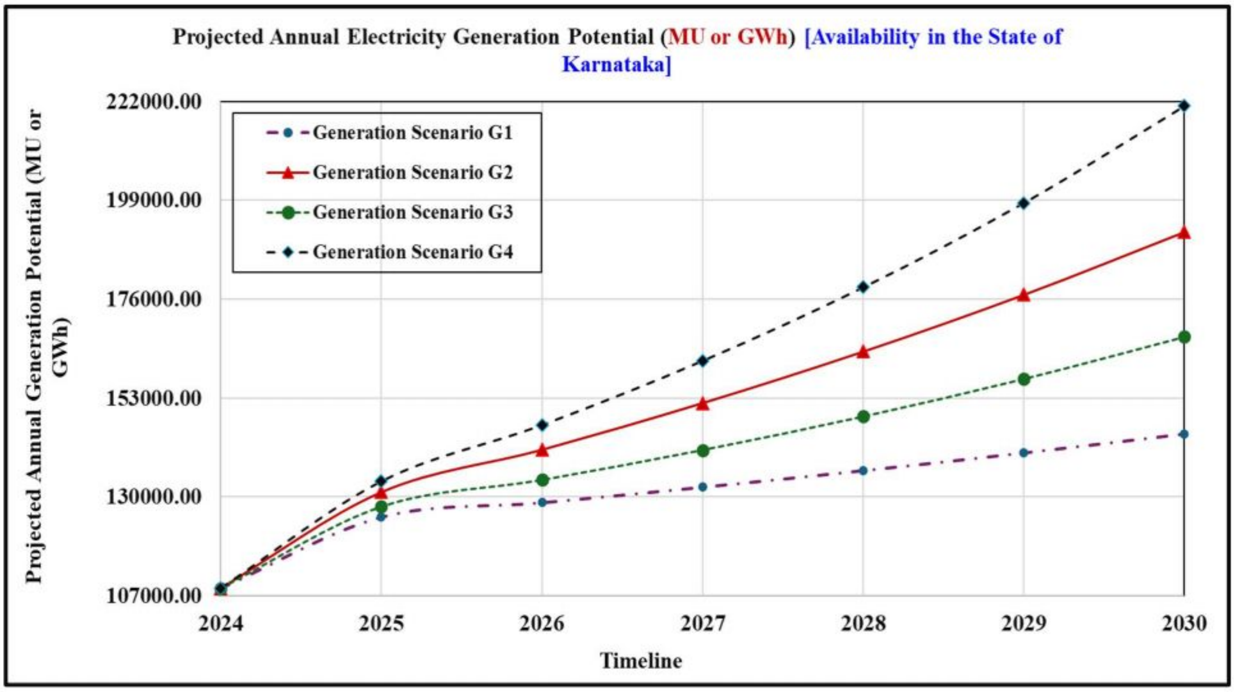

Figure 75: Projected annual electricity generation potential (**MU or GWh**) for the four assumed Generation Scenarios (**G1**, **G2**, **G3**, and **G4**) (**2024-30**)

8.3 Projections for the total Electricity Consumption in Bengaluru (2024-30)

Open-source literature suggests that *Bengaluru consumes about 35% of the state's power* **[24]**. We assume that this trend will continue till 2030, and therefore, the *share of the projected electricity generation should be made available to this extent for Bengaluru City*. Because of the sheer size of electricity demand and generation figures in India, it is often convenient to express the electricity demand and generation in terms of Terra Watt-hour (TWh) or Billion Units (BU). **Figure 76** presents the projected allocation for Bengaluru at the current share of the Metro City in the total electricity consumption of the State of Karnataka (i.e., *35%*). Further, a scrutiny of reliable open-source literature provides *the annual mean values of the per capita electricity consumption and the standard deviation in the different zones within the BBMP area* **[25]**. **Table 18** presents the mean values from different zones within Bengaluru city and individual standard deviations (SDs). The table also provides *an average annual per capita electricity consumption* aggregated over the BESCOM command area within BBMP, *along with the mean SD value*. The *annual average electricity consumption per capita in Bengaluru* (aggregated over the whole city) stands at **1387.64 kWh**, with a mean SD of **1087.20 kWh**.

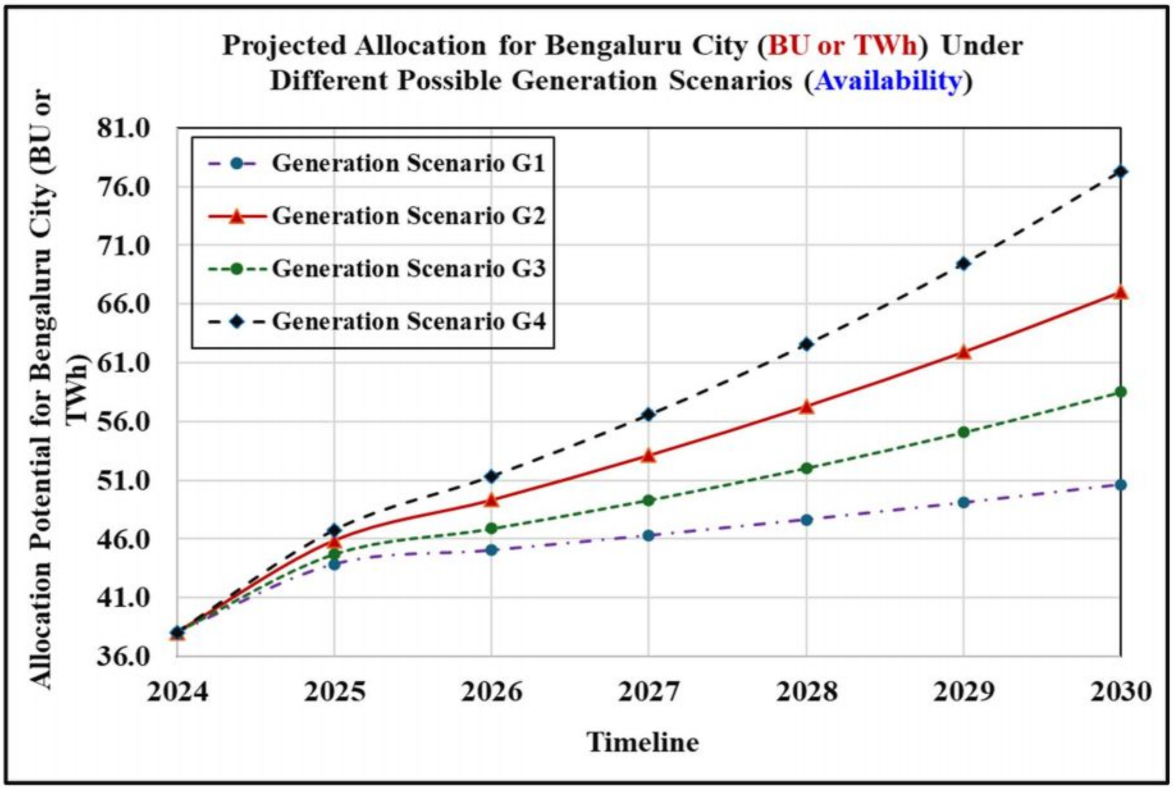

Figure 76: Projected annual total electricity allocation potential (**BU or TWh**) for Bengaluru City for the four assumed Generation Scenarios (**G1**, **G2**, **G3**, and **G4**) (**2024-30**)

Table 18: Zonal and Aggregate Average per capita electricity consumption in Bengaluru

Zones within Bengaluru City (BESCOM command area)	Mean per capita electricity consumption (kWh)	Standard Deviation (SD) (kWh)	Realizable Aspirational Electricity Consumption Level (Mean + SD)
North	1377.24	1135.77	2513.01
South	1764.03	1362.29	3126.32
East	1152.34	1226.92	2379.26
West	1420.84	1075.14	2495.98
Northeast	917.21	754.05	1671.26
Northwest	1273.28	891.61	2164.89
Southwest	1723.83	1006.52	2730.35
Southeast	1472.31	1245.31	2717.62
Overall Average (City Aggregate Level)	**1387.64**	**1087.20**	**2474.84**

We have created **three scenarios** to project the possible variabilities in the total household electricity consumption in Bengaluru City between **2024** and **2030**, as described below:

Scenario EC1: The per capita electricity consumption in Bengaluru City remains constant at **1387.64 kWh** between **2024** and **2030**. *However, the overall consumption increases due to the projected population growth.*

Scenario EC2: The per capita electricity consumption in Bengaluru City increases gradually at a CAGR of 5.66% to reach **1931.24 kWh** (i.e., ***Mean +0.5SD***) by **2030**, from the current level of **1387.64 kWh** in **2024**. *Further increases in overall consumption will emerge from the projected population growth.*

Scenario EC3: The per capita electricity consumption in Bengaluru City increases gradually at a CAGR of 10.12% to reach **2474.84 kWh** (i.e., ***Mean + SD***) by **2030**, from the current level of **1387.64 kWh** in **2024**. *Further increases in overall consumption will emerge from the projected population growth.*

A recent projection by ***World Population Review*** mentions the urban population (2024) in Bengaluru as **14 million** (i.e., 1.4 crores) **[26]**. We have used this as the baseline for further projections. Based on the growth rate suggested by the *World Population Review*, the population is assumed to grow at a *CAGR of 2.94% between now and 2030*. **Table 19** exhibits the year-wise projected per capita electricity consumption under different scenarios (**EC1**, **EC2**, **EC3**) and the projected total annual electricity demand between 2024 and 2030.

Table 19: Year-wise projected per capita electricity consumption and total annual electricity demand under different scenarios (**2024-30**)

Year	Per Capita Electricity Consumption in Bengaluru (kWh)			Population	Total Electricity Demand (TWh)		
	Scenario EC1	Scenario EC2	Scenario EC3		Scenario EC1	Scenario EC2	Scenario EC3
2024	1387.6	1387.6	1387.6	14000000	19.4	19.4	19.4
2025	1387.6	1466.2	1528.1	14411600	20.0	21.1	22.0
2026	1387.6	1549.3	1682.8	14835301	20.6	23.0	25.0
2027	1387.6	1637.0	1853.2	15271459	21.2	25.0	28.3
2028	1387.6	1729.8	2040.8	15720440	21.8	27.2	32.1
2029	1387.6	1827.7	2247.3	16182621	22.5	29.6	36.4
2030	1387.6	1931.2	2474.8	16658390	23.1	32.2	41.2

Figure 77 shows the projected trajectories of the total annual electricity consumption levels in Bengaluru between 2024 and 2030, under the three different scenarios (**EC1**, **EC2**, **and EC3**).

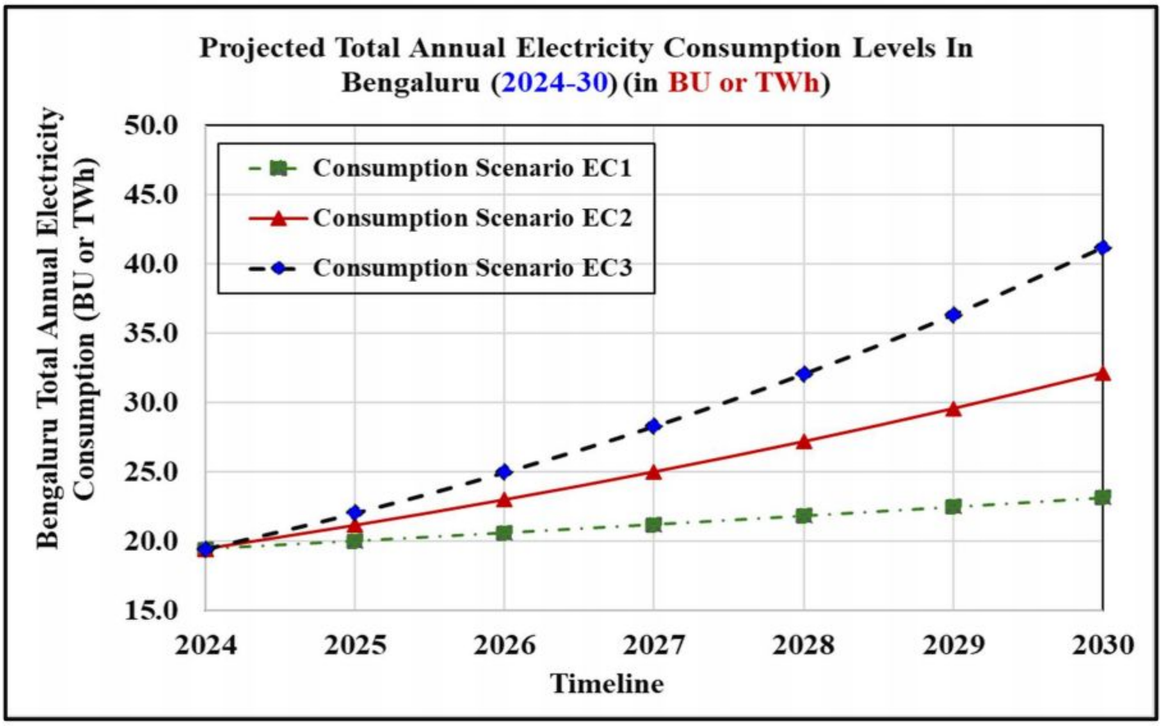

Figure 77: Projected trajectories of the total annual electricity consumption levels in Bengaluru under the three different scenarios (**EC1**, **EC2**, **EC3**) (**2024-30**)

8.4 A Bottom-up Estimation of Average Daily Energy Consumption for Household Cooking

After taking stock of the overall electricity generation (i.e., availability from the supply side) and the possible total annual electricity demand levels, *it is important to arrive at a reasonably accurate estimate for the average daily energy consumption for household cooking*.

For estimating the energy requirements for daily cooking in an average household for planning purposes, *we would need a 'unit value' emanating from a simulated household construct, which provides the most probable daily energy consumption attributable to household cooking. Planning purposes necessitate that the unit value be closer to the upper envelope of energy consumption.*

A household that makes standard meals multiple times and cooks most of the time at home would be the pivot to work out the '***representative unit consumption value***'. Scenario-building exercises cannot capture behavioral diversities in the projections explicitly. However, ***our approach comprises the following key considerations***:

- To understand the use of energy in general, and electricity in particular for cooking, in the current LPG-dominated household cooking landscape in Bengaluru, we used the information derived from the personal interviews conducted with a few representative households comprising both exclusive LPG users (**N=9**) as well as families using some form of electric cooking daily (**N=4**). Among the 13 families interviewed, six families comprise 4 members each, two families comprise 5 members each, and the remaining five families comprise two members each.

- A more detailed account of cooking activities was obtained from the families comprising two members each since most of these familial units comprised young couples and they were very keen on sharing a detailed account of the daily cooking activities. Therefore, the *basic simulated family construct for estimating average daily cooking energy demand comprises two members. The family construct approach is important since each family is unique, and to arrive at a 'representative unit' an aggregation is essential imbibing the variabilities such that the most probable energy consumption for a major instance of food/snack/ beverage preparation in a typical household is reliably captured.*
- Since our large-scale survey (**N=910**) indicated an average family size of 4 people and the smaller Weekly Menu Survey (**N=65**) indicated an average family size of 4.4 people. *Our objective is to estimate the energy consumption for catering to the daily cooking requirements for a family size of 4 to 5 persons* (with an indicative average of 4.4). Therefore, *an extrapolation was done from the two-member family construct to a family size of 4 to 5 persons and a detailed basis has been provided for the same*. A validation for the extrapolated values has also been provided.
- A ***bottom-up calculation with a detailed account of the typical cooking load*** is used to construct the '*representative unit*'. The aim is to capture the average daily energy consumption toward household cooking anchored on the cooking load, rather than looking at individual items cooked daily. Further, *low-to-medium-income households in India do not limit the use of cooking fuels only to cooking activities*. The experiences from the field suggest that LPG, the dominant cooking fuel, is also used for heating water for regular drinking. Occasionally, LPG is used to heat the water for bathing, especially during the colder months. *Therefore, an appropriate account of energy consumption specific to cooking activities is important*. The bottom-up calculation adopted in our study serves this purpose adequately.
- While estimating the cooking load, the broad food consumption patterns of a typical Bengaluru household, such as the number of meals consumed per day and the categories of items (e.g., rice, lentils, vegetables, non-veg items, beverages, etc.) consumed repetitively, were considered. The energy consumption levels for Chapatis/ rotis (a staple

food for many households) are subsumed within that of rice. This is how the cooking load-based energy demand approximation is performed for a wide array of items with similar cooking load characteristics.

- The energy consumption for each of the major cooking activities was meticulously accounted for and added up to arrive at the '*representative unit*'.
- *The latest population growth rate has been used to reflect the increase in the total energy consumption attributable to residential cooking*.
- ***Regarding the projection of electricity use in household cooking***, the terminal mass penetration levels of eCooking are informed from the large-scale survey (**N=910**). The penetration level of electricity in the daily cooking energy consumption emanates from the bottom-up calculation (i.e., the current electricity usage) in residential cooking depicted by families who are into some form of electric cooking. We have also used the envisaged aspirational shares of electricity (**80%** and **100%**) in household cooking energy use by **2030**. Blending these elements in conjunction with population growth projections provides the estimated electricity consumption.
- ***Possible*** variabilities have been accounted for in ***different mass penetration trajectories of eCooking*** and ***two different electricity share trajectories***.

8.4.1 Simulated two-member Family Construct based on Inputs from Multiple Families and Bottom-up Calculation of Average Daily Cooking Energy Demand

To have a realistic estimate for the daily average energy consumption attributable to household cooking, *a two-member family construct is simulated* based on the detailed inputs from multiple families as indicated before.

The family construct comprises the following considerations:

- A Bengaluru-based medium-income family comprising 2 persons (***a young couple***, both husband and wife are working professionals) is considered.
- The family consumes two major meals per day that are cooked at home. Both husband and wife carry their home-cooked lunch to the office. They eat dinner at home.
- The family's **usual lunch menu** comprises Rice, Dal (Lentils), Veg Curry or Omelette, and Seasonal Fruits.
- The family's **usual dinner menu** comprises Rice, Dal (Lentils), A Veg Curry (usually different from the one served during Lunch), Bhaji (***Occasionally,*** Sauteed vegetables -

Large Green Chilly, Button Mushroom, etc.), Fish Curry or Chicken Curry or Mutton Curry (either of these non-veg items).

Note: *The above menu is only provided as a reference point to facilitate ease of understanding the expected most probable cooking load since these items are popular across different places in India and involve standardized cooking procedures. They represent known levels of energy consumption based on the average time consumed to prepare these standardized meals. Also, the menu mentioned above is cooking-intensive and represents a balanced diet, which is a fair expectation while qualitatively dissecting the food consumption in an average Indian household inclined toward a wholesome diet.*

- The simulated two-member family consumes one 14.2 kg cylinder every 4.5 months (i.e., 135 days).

One 14.2 kg LPG cylinder has a heat content of about **654.6 MJ**.

Using the conversion factor of **1 MJ= 0.278 kWh**, the ***gross heating potential of a 14.2 kg LPG cylinder works out to be 181.98 kWh***.

Assuming ***99% utilization of the LPG cylinder*** (1% residual vapour is supposed to remain in an empty cylinder), the **used heat content of a domestic LPG cylinder** is (0.99* 181.98 kWh) = 180.16 kWh.

Now, this 180.16 kWh of energy from LPG is used over 4.5 months (i.e., 135 days).

Therefore, the **average daily consumption of LPG (in energy units)** is (180.16/ 135) kWh = **1.335 kWh**.

Assuming a 68% efficiency of the improved conventional gas burners and 15% heat losses, the **effective heat energy that is required to heat the food material** is estimated as (1.335*0.68*0.85) kWh ~ **0.772 kWh**.

- The ***household uses LPG for reheating bulk food since the LPG oven allows a big vessel to be put easily over the burner***. The family owns a microwave oven, primarily used for heating water to prepare tea. It is NOT used for reheating the main course food often since the cooked items need to be transferred to smaller microwave-proof bowls made of Borosil glass or Tupperware.
- ***The family uses an induction cooktop regularly to make rice every day***. The full quantity of rice is made in the morning to cater to the lunch and dinner for two people.

The induction cooktop takes about 25 minutes at 800 W to prepare the rice in a top-open saucepan. [An average value confirmed by the families interviewed]

Therefore, the electrical energy consumed daily for rice cooking is (0.8 * (25/60)) kWh = **0.333 kWh**.

Assuming an 84% average efficiency of the Induction cooktops, and 5% losses in energy, the **equivalent heat energy** is (0.333*0.84*0.95) kWh ~ **0.266 kWh**.

The mixer/ grinder of a 750 W rating is used about 5 times a week. It takes about 2 min to achieve all the required mixing/ grinding.

Therefore, the electrical power consumed per use for mixing/ grinding is (0.75 *(2/60)) kWh = **0.025 kWh**.

Consequently, the **electrical power consumed daily for mixing/ grinding** is (0.025 *(5/7)) kWh = **0.0178 kWh**. This component does not have any heat energy equivalent.

As discussed earlier, the major use of the 2200 W (peak power rating) microwave oven owned by the family is attributable to heating water for making tea.

Tea is made at least twice daily, and each time it takes about 3 min to heat the water adequately (two cups are heated together).

Therefore, the maximum electrical energy consumed daily for heating water in the microwave is (2.2 *(6/60)) kWh = **0.22 kWh**.

Assuming a 64% average efficiency of a standard microwave oven, accompanied by 10% heat losses, the **equivalent heat energy** is (0.22*0.64*0.9) kWh ~ **0.127 kWh**.

Therefore, the **total effective heat energy equivalent consumed for preparing food (cooking & leftover reheating combined) daily by the representative household (for 2 persons)** is (0.772 + 0.266 + 0.127) kWh = **1.165 kWh**.

Now, assuming an 80% average efficiency of a standard eCooking device and 10% average losses, **the electrical energy that would be required to provide the LPG-equivalent heat energy of 0.772 kWh** through eCooking is estimated as (0.772/ (0.8*0.9)) kWh = **1.072 kWh**.

Therefore, the **electricity equivalent to the average daily household consumption of energy for cooking-related activities** (***including the use of the mixer/ grinder***) is (1.072+ 0.333+0.22+ 0.0178) kWh = **1.643 kWh.**

The **estimated gross energy consumed for preparing food** (***cooking & leftover reheating combined***) **daily for a representative household (2 persons)** is (1.335 + 0.333+0.0178 +0.22) kWh = **1.9058 kWh.**

Therefore, the current **relative share of electrical energy in household cooking (representative family of 2 persons)** = (0.5708/1.9058) = 0.2995 ~ i.e., 29.95%.

Further, the current **relative share of LPG energy in household cooking (representative family of 2 persons)** = (1.335/1.9058) = 0.7005 ~ i.e., 70.05%.

8.4.2 Extrapolation of Cooking Energy Requirement to family size of 4 to 5 persons (avg. 4.4 persons)

Upon interviewing the families comprising two, four, and five members, qualitatively it was understood that for heavy loads of vegetable cooking (e.g., cabbage curry), the cooking time increases by as much as 60% when the cooking volume is doubled (adequate for catering to 4 to 5 persons instead of 2, e.g., whenever the immediate relatives visit). The cooking time does not increase by more than 20% for the lighter vegetables and sautéed items, upon doubling the cooking volume. *For practical purposes, a 40% increase in the cooking time can be assumed on average upon doubling the cooking load*.

Therefore, on average, it can be reasonably assumed that to cater to **the needs of a family size of 4 to 5 persons (avg. 4.4 persons), the daily average LPG consumption for the major cooking load** will work out to be (1.335 *1.4) kWh = **1.869 kWh**.

Assuming a 68% efficiency of the improved conventional gas burners and 15% heat losses, the **effective heat energy that is required to heat the food material** is estimated as (1.869*0.68*0.85) kWh ~ **1.08 kWh**.

The size of the rice pans usually used by Indian families, in general, is rather large (*as also verified during the large-scale household survey in Bengaluru*), and it covers the heating area of the induction cooktop almost completely.

From the personal interviews with the families, we came to know that substantial spillover happens in case the rice amount is increased beyond the serving size of 4 to 5 persons. Therefore, to prepare the rice for **4 to 5 persons**, *Rice would require to be prepared twice daily and the energy consumption will be twice compared to the two-member simulated household.*

Therefore, the **average daily electricity consumption for making rice for 4 to 5 persons** would be (2* 0.333) kWh = **0.667 kWh**.

Assuming an 84% average efficiency of the Induction cooktops, and 5% losses in energy, the **equivalent heat energy** is (0.667*0.84*0.95) kWh ~ **0.532 kWh**.

The energy consumption for mixing/ grinding will not witness any appreciable change and will remain at **0.0178 kWh**.

For heating water to prepare tea for 4-5 persons, the number of rounds of heating would increase, and **the energy consumption would double**. The numerical value works out to be **0.44 kW**.

Assuming a 64% average efficiency of a standard microwave oven, accompanied by 10% heat losses, the **equivalent heat energy** is (0.44*0.64*0.9) kWh ~ **0.253 kWh**.

The **total effective heat energy equivalent consumed for preparing food (cooking & leftover reheating combined) daily by the representative household (for 4 to 5 persons)** is (1.08 + 0.532 + 0.253) kWh = **1.865 kWh**.

Now, assuming an 80% average efficiency of a standard eCooking device and 10% average losses, **the electrical energy that would be required to provide the LPG-equivalent heat energy of 1.08 kWh** through eCooking is estimated as (1.08/ (0.8*0.9)) kWh = **1.5 kWh**.

The energy consumption for mixing/ grinding will not witness any appreciable change and will remain at **0.0178 kWh**. This component does not have any heat energy equivalent.

Therefore, the **electricity equivalent to the average daily household consumption of energy for cooking-related activities (for 4 to 5 persons** *including the use of the mixer/ grinder*) is (1.5+ 0.667+0.44+ 0.0178) kWh = **2.625 kWh**.

The **estimated gross energy consumed for preparing food (*cooking & leftover reheating combined*) daily for a representative household (4 to 5 persons)** is (1.869 + 0.667 +0.0178 +0.44) kWh = **2.9938 kWh ~ 3 kWh**.

The projected **relative share of electrical energy in household cooking (representative family of 4 to 5 persons)** = (1.1248/2.9938) = 0.3757 ~ i.e., **37.57%**.

The projected **relative share of LPG energy in household cooking (representative family of 4 to 5 persons)** = (1.869/2.9938) = 0.6243 ~ i.e., **62.43%**.

For practical purposes, it can be assumed that in the small fraction of the Bengaluru households (in the low-to-medium income bracket) which currently use some form of eCooking alongside LPG to prepare the major meals, about 35% of the gross energy used in residential cooking comes from electricity.

Also, for the sake of generalizing the estimated daily average energy consumption for cooking in a household of 4 to 5 persons, a small snack in the evening is assumed as per the observation of the Detailed Weekly Menu Survey ***(N=65)*** *conducted in the BBMP area of Bengaluru city. An additional 20% energy consumption is assumed for this minor snack.*

Therefore, the daily average generalizable gross energy consumption for household cooking (family of 4 to 5 persons) is (2.9938*1.2) kWh = ***3.593 kWh****, of which LPG is supposed to provide a gross heating energy of 2.243 kWh, and 1.35 kWh is supposed to be sourced from electricity.*

8.4.3 Validation of the Cooking Energy Consumption Estimates

To validate the generalizability of the daily average gross energy consumption of 3.6 kWh for household cooking, for a typical Indian family of 4 to 5 persons, an independent personal interview was conducted with a family settled in the State of West Bengal. Detailed discussions with the lady of the house brought forth a lot of nuanced and diverse insights.

The salient takeaways from the discussions are highlighted below:

- The family comprises three adults (two females and a male).
- The family mostly eats at home (95% of the time)
- The major cooking in the house happens during the daytime.
- The breakfast comprises 9 rotis and commensurate vegetable curry for all the members.
- Cooking for lunch is the main cooking activity in the house, and it takes more than 3 hours.
- Usually, the typical lunch menu comprises rice, lentils (dal), one vegetable curry with gravy (different from the one consumed with roti during breakfast), and a main course non-veg item (Egg curry / Chicken Curry/ Fish Curry). Mutton curry is consumed on rare occasions.
- In the dinner, usually only rice, and sometimes dal is made. Freshly made rice and dal are consumed with the leftovers from lunchtime. Sometimes soft vegetable fries (potato, okra, brinjal) are eaten with rice and dal.
- **Regularly, the main course is made for four persons**. The major leftovers are consumed on the next day. Mostly, lunchtime leftovers are consumed during the dinner.
- The house uses LPG exclusively for daily cooking purposes.
- Apart from cooking food items, LPG is used to boil water for tea/ coffee thrice a day (morning, afternoon, late evening).

- LPG is also used for boiling drinking water for the head of the family (a senior citizen) once daily (mid-day). The hot water is stored in a thermo-flask.
- The lady mentioned that a ***14.2 kg cylinder runs for 45-52 days in the house, depending on the consumption, with 50 days being the modal life period for a cylinder***.
- Now, the utilizable energy equivalent of an LPG cylinder is 180.16 kWh. Assuming 50 days of running life for a 14.2 kg LPG cylinder in a household that cooks food items for four persons daily and mostly eats at home, the average energy consumption turns out to be (180.16/50) kWh =**3.6032 kWh,** *which matches very closely with the extrapolation done earlier for 4-5 persons*.
- Even if the energy consumed toward heating water for purposes other than cooking is subtracted, the estimates obtained earlier using the extrapolation method on the bottom-up calculations performed on a two-person family construct serve as an upper envelope.

Therefore, the approach and calculations shown in this study bear reliability and validity.

8.5 Annual Average Household Energy Consumption Attributable to Cooking

- We assume that 90% of the days in a year, the cooking will happen at home. The rest of the days (i.e., 10% of days in a typical year) the families will dine out.
- About 5% of the days, people might opt for recreational personal dine-outs, and the remaining 5% may account for family gatherings at commercial places (banquets) or official invitations (working lunches/ dinners during conferences, etc.)
- Therefore, the average annual household-level energy consumption for cooking works out to be $\mathbf{E_{Anual,\,Gross,\,HH}}$ = **(0.9 * 365* 3.593) = 1180.3 kWh [for a family size of 4 to 5]**
- *In case household practices shift completely toward electricity-based cooking, the maximum electrical energy consumed for cooking and allied activities per household per year would be:* $\mathbf{E_{Anual,\,electric,\,HH}}$ **= (0.9 * 365* 1.2*2.625) = 1034.8 kWh**

8.6 Projection of Electricity Consumption Trends for eCooking (Scenario-building)

- *The large-scale household survey (**N=910**) conducted in the BBMP area of Bengaluru city indicated that **about 8% of the survey sample** has been using some form of major electric cooking appliances for daily residential cooking and reheating leftovers.*
- *Interestingly, when the respondents were asked about their willingness to purchase electric cooking appliances, **33% responded positively** (said Yes in the survey response), **29% indicated a tentative possibility** (said Maybe in the survey response), and **38% responded negatively** (said No in the survey response).*

- *Therefore, from the current level of population penetration of eCooking (~8%), a realistic target would be to reach a population penetration level of* ***33% by 2030*** *(the timeline decided by the United Nations toward the reasonable realization of Sustainable Development Goals)*. *This would amount to achieving a low-hanging fruit.*
- ***Further, optimistic scenarios would involve attaining an eCooking population penetration level of more than 33%, up to a possible upper limit of 62% (highly optimistic scenario).***
- *We assume that the average daily gross energy consumption for household cooking will remain fixed at* ***3.593 kWh*** *(for an average family size of 4.4) between 2024 and 2030.*
- *However, the relative share of electricity in cooking energy usage is assumed to increase from the current level of* ***35% to 80% by 2030 (S1 to S4).***
- *In the* ***Ambitious Adoption Scenario*** *(S5), the share of electricity in cooking energy usage is assumed to reach 100% in 2030 amongst the population projected to take up eCooking.*

In **Table 20** provided below, ***five simulated scenarios are described*** *to capture the expected rise in the electricity demand attributable to the large-scale adoption of eCooking for different assumed penetration levels. For estimating the household electricity consumption attributable to eCooking alone, the projected annual electricity consumption of 1034.8 kWh per household is used in scenario-building since different e-penetration levels will be reflected through different fractions of this number.*

Table 20: Futuristic Scenarios simulating different eCooking mass penetration levels and progressive growing shares of electricity use in household cooking simultaneously

Different eCooking Transition Scenarios	Current Penetration Level of eCooking (%)	Projected Penetration Level of eCooking by 2030 (%)	CAGR (%) of Projected Penetration Till 2030	Current Share (%) of Electricity in Cooking Energy Use	Assumed Share (%) of Electricity in Cooking Energy Use by 2030	CAGR (%) of Electricity Share in Cooking Energy Use Till 2030
Slow Growth Scenario (S1)	**8**	**20**	**16.5**	**35**	**80**	**14.772**
Moderate Mass-adoption Scenario (S2)	**8**	**33**	**26.64**	**35**	**80**	**14.772**
Accelerated Adoption Scenario (S3)	**8**	**40**	**30.77**	**35**	**80**	**14.772**
Optimistic Adoption Scenario (S4)	**8**	**50**	**35.72**	**35**	**80**	**14.772**

Ambitious Adoption Scenario (S5)	**8**	**62**	**40.675**	**35**	**100**	**19.12**

8.6.1 Population growth rate

Macro trends suggest that on average there has been annual growth of 2.29% in the urban population in India between 2017 and 2021 **[27]**. As per the 2011 Census data, the population of the Bengaluru City Municipal Corporation Area (BBMP area) is about **84.43 Lakhs**.

However, a recent projection by ***World Population Review*** mentions the urban population (2024) in Bengaluru as **14 million** (i.e., 1.4 crores) **[26]**. *We have used this as the baseline for further projections*. Based on the growth rate suggested by the ***World Population Review***, the population is assumed to grow at a **CAGR of 2.94% between now and 2030**.

8.6.2 Salient Findings from Scenario Building Exercise

Table 21 presents the year-wise Projected Annual Electricity Consumption for eCooking in Bengaluru City (BBMP Area) for the five simulated scenarios **(S1 to S5)**. **Figure 78** presents the comparative trajectories for the same graphically.

The numbers in **Table 21** are calculated using the following mathematical expression:

$$\left(EC_{T,t}\right)(TWh) = HH_t * F_{el,t} * F_{E,t} * E_{HC}(kWh) * 10^{-9} \quad (3)$$

Where, $EC_{T,t}$ represents the total electricity consumption (in TWh) for cooking in the year t, HH_t represents the number of households considering 4 persons per household (based on the average value from the large-scale survey; **N=910**) in the year t, $F_{el,t}$ is the share (%) of electricity in the total cooking energy consumption in an average household in the year t, $F_{E,t}$ is the mass penetration level (as % of the population) of eCooking in the year t, and E_{HC} stands for the maximum electrical energy consumed (in kWh) for cooking and allied activities per household per year. The factor 10^{-9} *is the conversion factor between kWh and TWh.*

Table 21 shows that the total annual electricity consumption for Bengaluru city can **vary by as much as a factor of 4** by 2030 in the extreme case (S5- ambitious adoption scenario) compared to the slow growth scenario. The two **plausible scenarios** that can be chosen for realizing the energy transition in residential cooking sectors are the ***Moderate Mass-adoption Scenario (S2)***, and the ***Accelerated Adoption Scenario (S3)***.

Table 21: Year-wise Projected Annual Electricity Consumption for eCooking in Bengaluru City under five different eCooking penetration scenarios

Different eCooking Transition Scenarios	Total Electricity Consumption for eCooking (TWh)						
	2024	2025	2026	2027	2028	2029	2030
Slow Growth Scenario (S1)	0.101	0.140	0.192	0.264	0.364	0.501	0.690
Moderate Mass-adoption Scenario (S2)	0.101	0.152	0.227	0.340	0.508	0.760	1.138
Accelerated Adoption Scenario (S3)	0.101	0.157	0.242	0.374	0.578	0.893	1.379
Optimistic Adoption Scenario (S4)	0.101	0.163	0.261	0.418	0.670	1.075	1.724
Ambitious Adoption Scenario (S5)	0.101	0.175	0.302	0.521	0.898	1.549	2.672

The relative levels of annual electricity consumption at the city level provide us with an idea regarding the electricity generation planning to ensure that the supply-demand gap is mitigated. From the increasing share of electricity in the average daily energy consumption for household cooking, one gets an idea of the need for strengthening the electricity sub-distribution infrastructure within the city limits. **Table 22** presents the total projected electricity consumption in Bengaluru attributable to household eCooking between 2024 and 2030. The growing electricity demand attributable to the enhanced adoption of electric cooking household cooking emphasizes that while planning for the transformer capacity augmentation, and rehauling transmission lines for the city, the infrastructure upgradation in the peri-urban regions also needs attention since the cities are rapidly expanding in India.

Table 22: Projected total electricity consumption in Bengaluru attributable to household eCooking for the period 2024-30

Different eCooking Transition Scenarios	Total Electricity Consumption for eCooking (TWh) in Bengaluru
	Period: 2024- 2030
Slow Growth Scenario (S1)	2.252
Moderate Mass-adoption Scenario (S2)	3.226
Accelerated Adoption Scenario (S3)	3.724
Optimistic Adoption Scenario (S4)	4.412
Ambitious Adoption Scenario (S5)	6.217

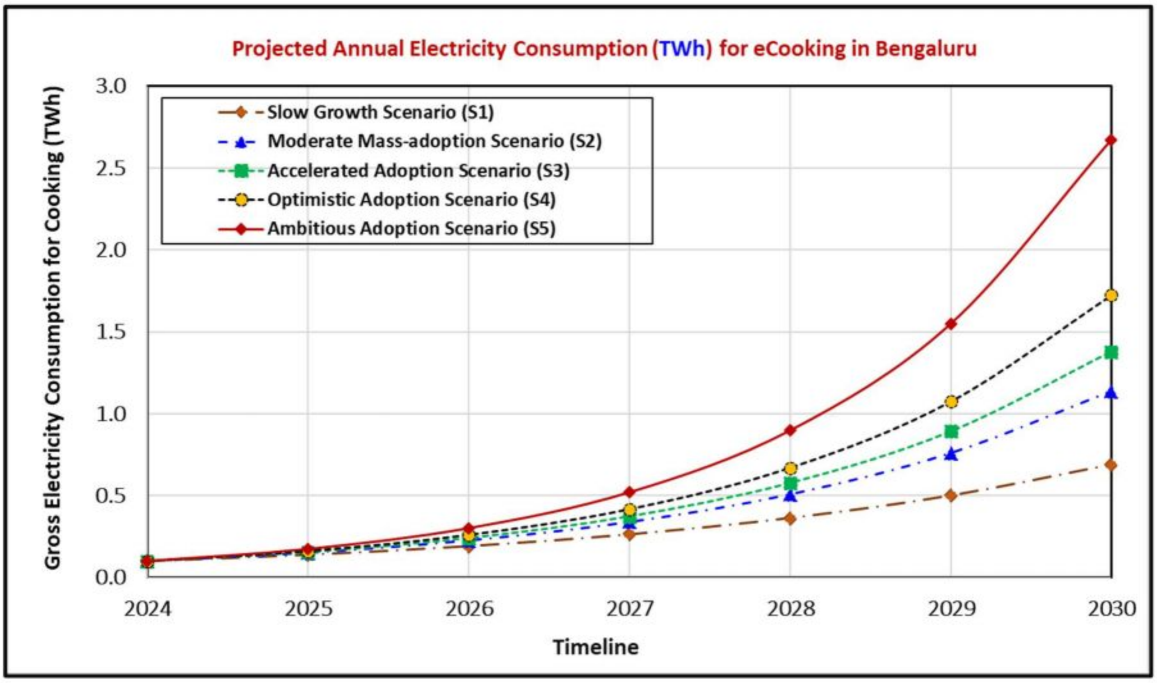

Figure 78: Year-wise Projected Annual Electricity Consumption for eCooking in Bengaluru City (2024-30)

Table 23 exhibits the year-wise projected number of Bengaluru households using e-Cooking under the different simulated scenarios. **Figure 79** presents the same trends graphically for a qualitative understanding. **Table 24** shows the year-wise number of households newly added to e-Cooking in Bengaluru for the period 2025-30. This table inherently emphasizes the scaling-up requirements in the manufacturing of eCooking appliances and vessels. A commensurate increase in the manpower and facilities dedicated toward servicing and repairing would also be required to realize and consolidate the envisaged eCooking mass penetration levels.

Table 23: Year-wise Household Numbers Projected to Use eCooking in Bengaluru City under Five Different eCooking Penetration Scenarios

Different eCooking Transition Scenarios	Projected Households using eCooking in Bengaluru City (Million)						
	2024	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Slow Growth Scenario (S1)	**0.28**	**0.34**	**0.40**	**0.48**	**0.58**	**0.69**	**0.83**
Moderate Mass-adoption Scenario (S2)	**0.28**	**0.37**	**0.48**	**0.62**	**0.81**	**1.05**	**1.37**
Accelerated Adoption Scenario (S3)	**0.28**	**0.38**	**0.51**	**0.68**	**0.92**	**1.24**	**1.67**
Optimistic Adoption Scenario (S4)	**0.28**	**0.39**	**0.55**	**0.76**	**1.07**	**1.49**	**2.08**
Ambitious Adoption Scenario (S5)	**0.28**	**0.41**	**0.59**	**0.85**	**1.23**	**1.78**	**2.58**

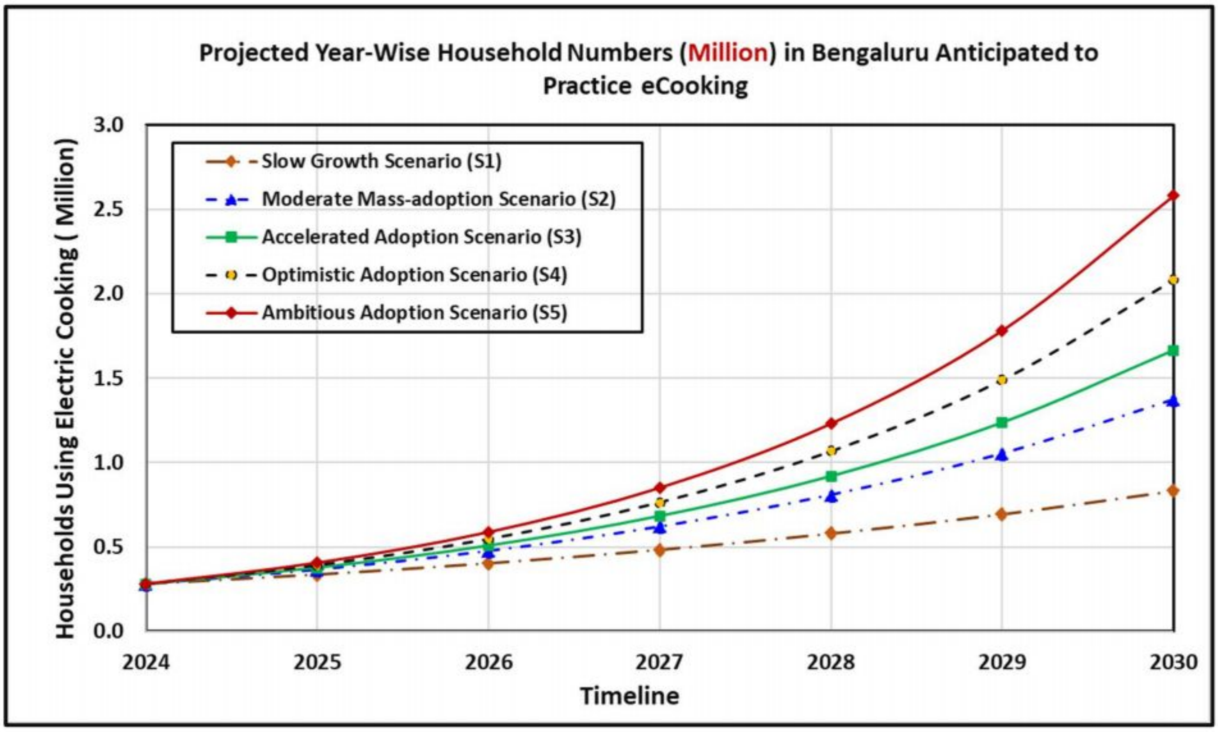

Figure 79: Projected Year-Wise Household Numbers in Bengaluru Anticipated to Practice eCooking

Table 24: Year-wise Household Numbers Newly Added to e-Cooking in Bengaluru for the Period 2025-30

Different eCooking Transition Scenarios	**Households Newly Added to eCooking in Bengaluru (Million)**					
	2025	**2026**	**2027**	**2028**	**2029**	**2030**
Slow Growth Scenario (S1)	**0.06**	**0.07**	**0.08**	**0.10**	**0.12**	**0.14**
Moderate Mass-adoption Scenario (S2)	**0.09**	**0.11**	**0.14**	**0.19**	**0.25**	**0.32**
Accelerated Adoption Scenario (S3)	**0.10**	**0.13**	**0.18**	**0.24**	**0.32**	**0.43**
Optimistic Adoption Scenario (S4)	**0.11**	**0.16**	**0.22**	**0.30**	**0.42**	**0.59**
Ambitious Adoption Scenario (S5)	**0.13**	**0.18**	**0.26**	**0.38**	**0.55**	**0.80**

8.8 Impact of eCooking Transition in Households on Total Electricity Demand in an LPG-Dominated Cooking Landscape.

Among the three Electricity Consumption scenarios simulated for Bengaluru City (**EC1**, **EC2**, and **EC3**), scenarios **EC2** and **EC3** depict considerably higher levels of electricity consumption by the households driven by 5.66% and 10.12% CAGR, respectively, in the per capita electricity consumption. Therefore, it would be pragmatic to assume that some of the household electricity consumption attributable to eCooking will be subsumed within the projected electricity consumption levels in Scenario **EC2**, while the most aspirational Scenario **EC3** would possibly include the whole household electricity consumption attributable to eCooking. Therefore, to evaluate the impact of eCooking on the household total electricity consumption, the annual household electricity demand attributable to eCooking alone has been added to the current level (of base level) of average electricity consumption observed in Bengaluru City (Scenario **EC1**). **Figure 80** exhibits the impact of different eCooking penetration scenarios on the year-wise total electricity demand. The figure suggests that the difference between the base level and the high-penetration scenarios (**S4** & **S5**) would be substantial from 2028 onwards.

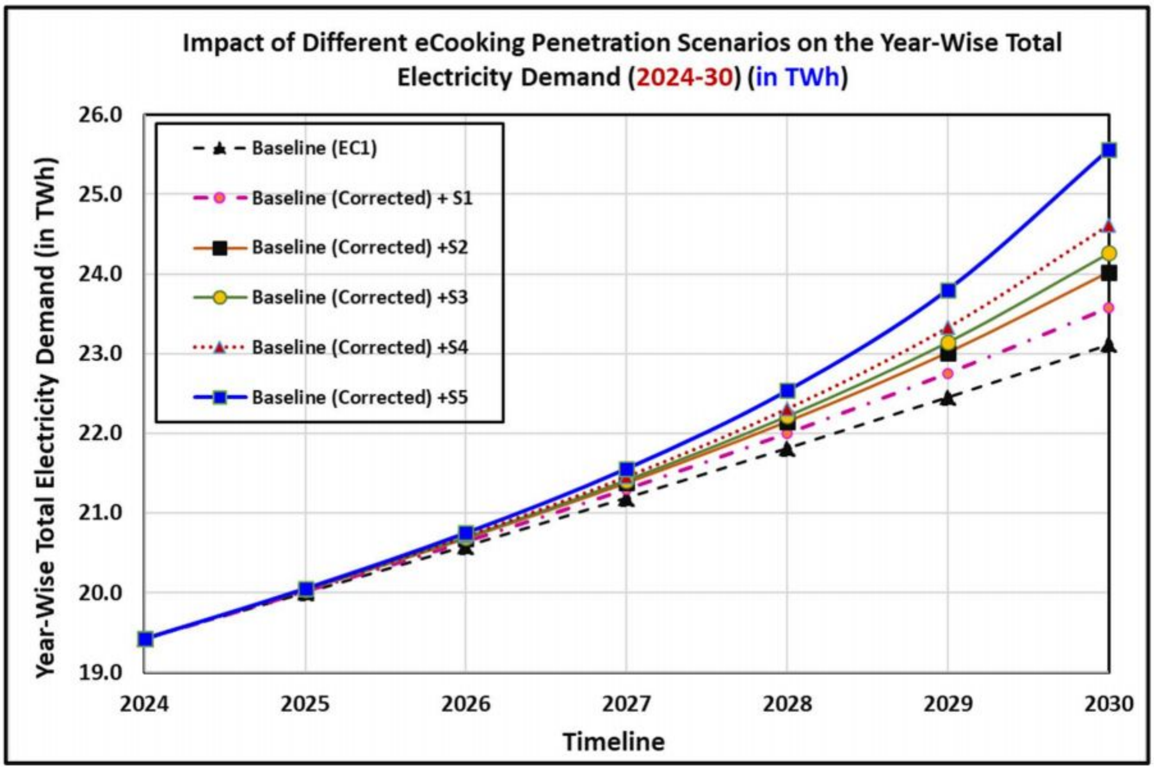

Figure 80: Impact of different eCooking penetration scenarios on the year-wise total electricity demand (2024-30)

Notably, this analysis assumes that the electricity usage trends set by a small number of households (***8% of the survey sample***), that are already into some form of major electricity-based cooking daily, will diffuse into the households that will be newly added to the eCooking between 2024 and 2030.

The numbers in **Figure 80** are calculated using the following mathematical expression:

$$\boldsymbol{E_{Demand,Scenario}(t) = E_{EC1,Demand}(t) - \{HH_{base\ year} * F_{el,t} * F_{E,base\ year} * E_{HC}(kWh) * 10^{-9}\} + \{HH_{t} * F_{el,t} * F_{E,Apritation,t} * E_{HC}(kWh) * 10^{-9}\}} \quad \textbf{(4)}$$

Where, $E_{Demand,Scenario}(t)$ denotes the total annual electricity demand per household in year t. $E_{EC1,Demand}(t)$ denotes the total annual electricity demand per household in year t in ***electricity consumption scenario*** **EC1**. HH_t represents the number of households considering 4 persons per household (based on the average value from the large-scale survey; **N=910**) in the year t. $HH_{base\ year}$ represents the number of households considering 4 persons per household (based on the average value from the large-scale survey; **N=910**) in the base year (i.e., 2024). $F_{E,Apritation,t}$ is the mass penetration level (as % of the population) of eCooking in year t in the different aspirational e-penetration scenarios (**S1** to **S5**), respectively. $F_{el,t}$ is the share (%) of electricity in the total cooking energy consumption in an average household in the different aspirational eCooking adoption scenarios (**S1** to **S5**) in the year t. $F_{E,base\ year}$ is the mass penetration level (as % of the population) of eCooking in the base year (2024) (i.e., **8%**). E_{HC} stands for the maximum electrical energy consumed (in kWh) for cooking and allied activities per household per year. The factor 10^{-9} *is the conversion factor between kWh and TWh*.

However, this enhanced usage of electricity-based cooking may be deterred by consumer behavior, since a large fraction of the surveyed population indicated their comfort in using LPG as the exclusive or dominant household cooking fuel. Therefore, realistic scenarios have been constructed to simulate the possible impact of constrained adoption of effective electric cooking in an LPG-dominated residential cooking landscape to reflect the low use of electricity in daily household cooking activities.

Since the *large mass-penetration of eCooking appliances (Scenarios **S3**, **S4**, and **S5**) is less likely to be driven by the curiosity factor alone, and ample awareness amongst consumers regarding the benefits of eCooking is expected in those scenarios* (*which would possibly be reflected through substantial use of electricity in daily household cooking activities*), slow to moderate e-penetration scenarios (***S1*** & ***S2***) have been used as pivots to assess the impact of *eCooking transition constrained by LPG domination*.

Conceptual Framework:

- *In households that use LPG as the exclusive cooking fuel, the current use of electricity in daily kitchen activities is by and large limited to running the mixer/grinder appliances. The daily energy consumption for mixing/ grinding for a four-member household is estimated* at **0.0178 kWh**.

- *Considering the current trends of eCooking appliance usage amongst a small population, rice cooking on induction cooktops appears to be a likely option that would use electricity in LPG-dominated kitchens. The daily energy consumption for rice cooking (using a standard induction cooktop) for a four-member household is estimated* at **0.667 kWh**.
- *Also, microwave ovens for reheating food or heating water for hot beverages (e*.g., tea and coffee) may emerge as a convenient option for LPG-dominated households. Therefore, this *also appears to be a likely option that would use electricity in LPG-dominated kitchens. The daily energy consumption for reheating food or heating water for hot beverages (e*.g., tea and coffee) *for a four-member household is estimated* at **0.44 kWh**.

The conceptual construct is that from the current level (or base level) of electricity use, the future usage of electricity in LPG-dominated kitchens would reach certain higher levels based on the envisaged limited use of eCooking appliances.

The following '***low electricity use scenarios***' *have been simulated to evaluate the impact of different low-penetration e-transition scenarios on the total year-wise electricity demand.*

Scenario B2RH: From base level consumption **(Mixer/ Grinder),** electricity consumption grows to **(base level + consumption for food reheating/ water heating using microwave oven) by 2030**. This indicates the increase in daily average household electricity demand attributable to eCooking from **0.0178 kWh** to **0.4578 kWh**.

Scenario B2IC: From base level consumption **(Mixer/ Grinder),** electricity consumption grows to **(base level + consumption for making rice using an induction cooktop) by 2030**. This indicates the increase in daily average household electricity demand attributable to eCooking from **0.0178 kWh** to **0.6848 kWh**.

Scenario B2ICRH: From base level consumption **(Mixer/ Grinder),** this scenario accounts for ***both rice cooking using an induction cooktop and food reheat/ water heating using a microwave oven by 2030.*** This indicates the increase in daily average household electricity demand attributable to eCooking from **0.0178 kWh** to **1.1248 kWh**.

*Any mass penetration level above 8% may follow one of these scenarios in an eCooking Transition constrained by LPG domination. The 8% population already into eCooking will follow the aspirational trajectory described before in connection with Scenarios **S1** and **S2**, respectively*.

Table 25 presents the relative share of electricity in household cooking energy use in the LPG-constrained scenarios for ***slow and moderate mass penetration*** **(S1 & S2)** ***of***

eCooking appliances during 2024-30. **Table 26** presents the year-wise total electricity demand in connection with the LPG-constrained scenarios for ***slow and moderate mass penetration*** (**S1** & **S2**) ***of eCooking appliances*** during 2024-30. *Baseline corrections are performed to avoid repetitive counting of the electricity consumption attributable to the current level of eCooking by 8% of the households*.

Figure 81 depicts the impact of the LPG-dominated moderate eCooking penetration scenario (**S2 x B2ICRH**) on the year-wise total electricity demand during 2024-30. Only one scenario (**S2 x B2ICRH**) is chosen for this study since this provides the maximum deviation with respect to the baseline demand. *All the other scenarios mentioned in* **Table 26** *would correspond to demand levels between the two extreme limits marked by the baseline at the lower end, and the chosen scenario* (**S2 x B2ICRH**) *at the higher end. Notably, the electricity demand increases only marginally in the LPG-constrained eCooking transition scenarios and may not pose a large problem in terms of electricity supply-demand mismatch*.

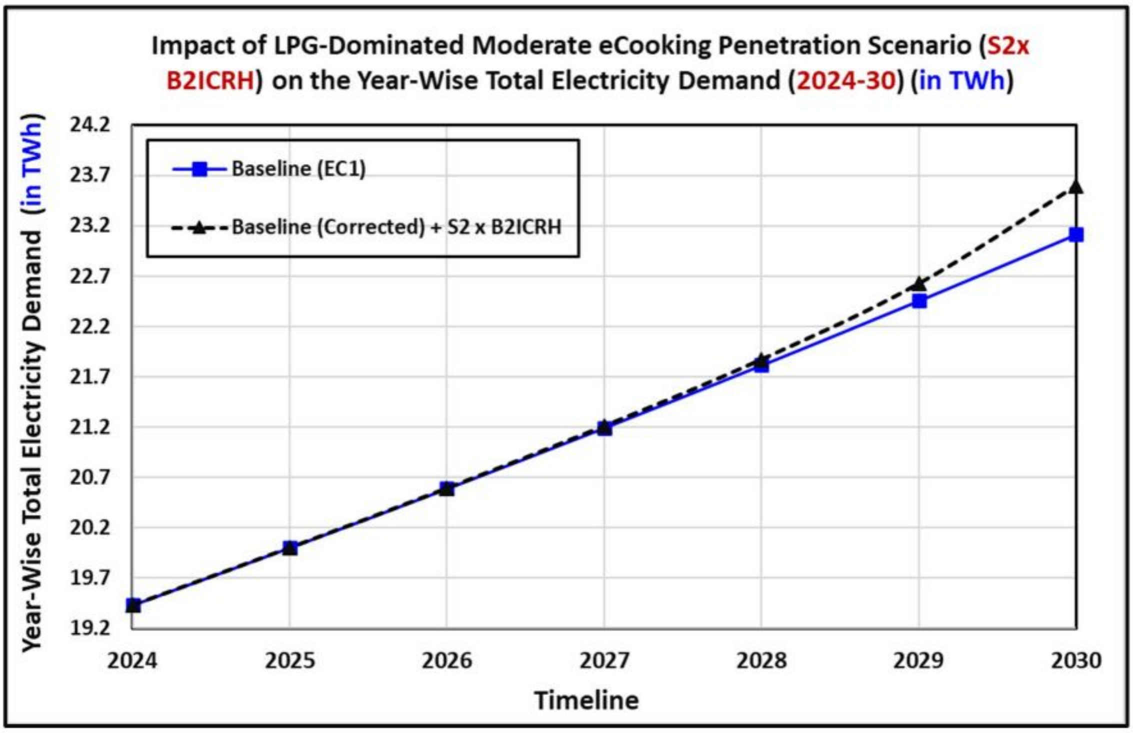

Figure 81: Impact of the LPG-dominated moderate eCooking penetration scenario (S2 x B2ICRH) on the year-wise total electricity demand (2024-30)

The numbers presented in **Table 26** are calculated using the following mathematical expression:

$$\boldsymbol{E_{Demand,Scenario}(t) = E_{EC1,Demand}(t) - \{HH_{base\ year} * F_{el,t} * F_{E,base\ year} * E_{HC}(kWh) * 10^{-9}\} + \{(HH_{base\ year} * F_{el,t} * F_{E,base\ year}) + (HH_t * F_{E,Apritation,t} - HH_{base\ year} * F_{E,base\ year}) * F_{el,t,constrscen}\} * E_{HC}(kWh) * 10^{-9}} \quad \textbf{(5)}$$

Where, $E_{Demand,Scenario}(t)$ denotes the total annual electricity demand per household in year t. $E_{EC1,Demand}(t)$ denotes the total annual electricity demand per household in year t in ***electricity consumption scenario*** **EC1**. HH_t represents the number of households considering 4 persons per household (based on the average value from the large-scale survey; **N=910**) in the year t. $HH_{base\ year}$ represents the number of households considering 4 persons per household (based on the average value from the large-scale survey; **N=910**) in the base year (i.e., 2024). $F_{E,Apritation,t}$ is the mass penetration level (as % of the population) of eCooking in year t in the slow growth and moderate aspirational e-penetration scenarios (**S1** & **S2**), respectively. $F_{el,t}$ is the share (%) of electricity in the total cooking energy consumption in an average household in the aspirational eCooking adoption scenarios (**S1** & **S2**) in the year t. $F_{E,base\ year}$ is the mass penetration level (as % of the population) of eCooking in the base year (2024) (i.e., **8%**). $F_{el,t,constrscen}$ is the share (%) of electricity in the total cooking energy consumption in an average household in the different LPG-constrained scenarios in the year t. E_{HC} stands for the maximum electrical energy consumed (in kWh) for cooking and allied activities per household per year. The factor 10^{-9} *is the conversion factor between kWh and TWh*.

Table 25: Relative share of electricity in household cooking energy use in LPG-constrained scenarios for ***slow and moderate mass penetration*** (S1 & S2) ***of eCooking appliances*** (2024-30)

Year	No. of Households (*considering 4 members per HH based on Large-scale Survey Data*)	Equivalent Electricity required for generating Effective Heat Energy Required for Complete Cooking per HH per Year (in kWh)	e-Cooking Penetration Level for Slow Growth Scenario (S1)	e-Cooking Penetration Level for Moderate Mass-adoption Scenario (S2)	Current eCooking Penetration Level (*Base Year 2024*) as observed from Large-Scale Survey	Relative Share of Electricity in Cooking Energy Use (S1 & S2) by Households that are already into some form of eCooking	Relative Share of Electricity in Cooking Energy Use in Scenario B2RH by HHs that are Exclusive LPG users	Relative Share of Electricity in Cooking Energy Use in Scenario B2IC by HHs that are Exclusive LPG users	Relative Share of Electricity in Cooking Energy Use in Scenario B2ICRH by HHs that are Exclusive LPG users
2024	**35,00,000**	**1034.8**	**0.080**	**0.080**	**0.08**	**0.350**	**0.0068**	**0.0068**	**0.0068**
2025	**36,02,900**		**0.093**	**0.101**		**0.402**	**0.0117**	**0.0125**	**0.0136**
2026	**37,08,825**		**0.109**	**0.128**		**0.461**	**0.0201**	**0.0229**	**0.0271**
2027	**38,17,865**		**0.126**	**0.162**		**0.529**	**0.0344**	**0.0421**	**0.0540**
2028	**39,30,110**		**0.147**	**0.206**		**0.607**	**0.0591**	**0.0774**	**0.1077**
2029	**40,45,655**		**0.172**	**0.261**		**0.697**	**0.1016**	**0.1421**	**0.2148**
2030	**41,64,597**		**0.200**	**0.330**		**0.800**	**0.1744**	**0.2609**	**0.4285**

Table 26: Year-wise total electricity demand in connection with the LPG-constrained scenarios for ***slow and moderate mass penetration*** (S1 & S2) ***of eCooking appliances*** during 2024-30

Year	**Baseline** (EC1)	**Projected Annual Electricity Consumption** for eCooking in Bengaluru for ***Base-level Penetration*** (i.e., 8%) **(in TWh)**	**Baseline** (e-penetration base level corrected) + **S1 x B2RH** (top-up)	**Baseline** (e-penetration base level corrected) + **S1 x B2IC** (top-up)	**Baseline** (e-penetration base level corrected) + **S1 x B2ICRH** (top-up)	**Baseline** (e-penetration base level corrected) + **S2 x B2RH** (top-up)	**Baseline** (e-penetration base level corrected) + **S2 x B2IC** (top-up)	**Baseline** (e-penetration base level corrected) + **S2 x B2ICRH** (top-up)
2024	**19.43**	**0.101**	**19.43**	**19.43**	**19.43**	**19.43**	**19.43**	**19.43**
2025	**20.00**	**0.116**	**20.00**	**20.00**	**20.00**	**20.00**	**20.00**	**20.00**
2026	**20.59**	**0.134**	**20.59**	**20.59**	**20.59**	**20.59**	**20.59**	**20.59**
2027	**21.19**	**0.153**	**21.20**	**21.20**	**21.20**	**21.20**	**21.21**	**21.21**
2028	**21.81**	**0.176**	**21.83**	**21.84**	**21.85**	**21.85**	**21.86**	**21.87**
2029	**22.46**	**0.202**	**22.50**	**22.52**	**22.55**	**22.54**	**22.57**	**22.63**
2030	**23.12**	**0.232**	**23.22**	**23.27**	**23.36**	**23.31**	**23.41**	**23.60**

8.8 Concluding Remarks on the Electricity Supply-Demand Analysis

The electricity generation potential projected for the State of Karnataka till the 2030 timeline is based on the country's green energy aspirations in line with its aim for achieving the ***Net Zero*** Goal by 2070. Since the projected generation growth is largely based upon the envisaged variable renewable energy (VRE) capacity addition, expectations must be anchored on reality. The extreme climatic trends and changing wind patterns may deter the capacity addition for hydropower and wind energy. On the other hand, increasing pollution levels may hinder the expected capacity utilization of solar photovoltaic plants. Considering all these externalities, the projections for the electricity supply side (see **Figure 75**) indicate ample availability of generation capacity assuming that the installed capacities will be utilized optimally, ensuring affordable electricity for the consumers. From the electricity availability levels estimated for Bengaluru City between 2024 and 2030 (see **Figure 76**), and the projected high electricity consumption per capita scenario (see **Figure 77**; **Scenario EC3**) it is evident that in case the total generation of the State of Karnataka and the availability for the Bengaluru City remains fixed at the current level, the demand in 2030 will most likely surpass the supply by 2030. Such kind of situations will put a limit on growth. Also, looking at **Figure 77** and **Figure 78,** it is evident that in case the **eCooking adoption scenarios S4** and **S5** are to be achieved**,** possibly the total electricity consumption in Bengaluru will be pushed toward at least **Scenario EC2**, or even beyond. For the electricity demand to increase, access to reliable electricity through a robust sub-distribution distribution needs to be ensured. *The losses in the distribution system also need to be minimized to ensure adequate effective availability from the supply side. Therefore, setting a target for 2030 would be useful for decision-makers in formulating a strategy for the near to medium term*.

References

[1] N. Kaggere (09 March 2024) *Karnataka to scale up power production to 60,000 Mw in Seven Years: CM Siddaramaiah.* Times of India. <**Retrieved from**: https://timesofindia.indiatimes.com/city/bengaluru/karnataka-to-scale-up-power-production-to-60000-mw-in-seven-years-cm-siddaramaiah/articleshow/108354971.cms> [Last Accessed on 01 June 2024]

[2] *India Energy- India Climate & Energy Dashboard.* Vasudha Foundation. <**Retrieved from**: https://iced.niti.gov.in/energy/electricity/generation > [Last Accessed on 01 June 2024]

[3] *Location-wise Southern region state-wise installed capacity as on 30/04/2024.* <**Retrieved from**: https://npp.gov.in/public-reports/cea/monthly/installcap/2024/APR/capacity2-Southern-2024-04.pdf> [Last Accessed on 01 June 2024]

[4] *Details of Renewable Energy Projects installed in Karnataka under InSTS (STU) & ISTS (CTU) Category as on April 2024.* <**Retrieved from**: https://kredl.karnataka.gov.in/storage/pdf-files/Monthrpt/STU_CTU.pdf> [Last Accessed on 01 June 2024]

[5] *Executive Summary on Power Sector – January 2024.* Central Electricity Authority (CEA), Ministry of Power (MoP), Government of India. <**Retrieved from**: https://cea.nic.in/wp-content/uploads/executive/2024/02/Executive_Summary_Jan_2024.pdf> [Last Accessed on 01 June 2024]

[6] *Executive Summary on Power Sector – February 2024.* Central Electricity Authority (CEA), Ministry of Power (MoP), Government of India. <**Retrieved from**: https://cea.nic.in/wp-content/uploads/executive/2024/02/Executive_Summary_Feb_2024.pdf> [Last Accessed on 01 June 2024]

[7] *Ash Compliance Report (for the period 1st April 2023 to 31st March 2024) to be submitted on or before 31st May.* <**Retrieved from**: https://www.grasim.com/Upload/PDF/harihar-flyash-utilization-report-2023-24.pdf> [Last Accessed on 01 June 2024]

[8] *Tariff for an 8 MW Wind Project in Kerala Reduced to ₹ 4.70/kWh, Due to Higher CUF.* Mercom Clean Energy Insights. <**Retrieved from**: https://www.mercomindia.com/tariff-for-an-8-mw-wind-project-in-kerala-reduced > [Last Accessed on 01 June 2024]

[9] *Performance Analysis of Large-Scale Solar PV Plants: Study of MW to MWh.* Indo-German Energy Forum (IGEF). <**Retrieved from**: https://www.energyforum.in/home/2021/20210401-performance-analysis-of-large-scale-solar-pv/> [Last Accessed on 01 June 2024]

[10] *COGENERATION.* Bureau of Energy Efficiency (BEE), Govt' of India. <**Retrieved from**: https://beeindia.gov.in/sites/default/files/2Ch7.pdf> [Last Accessed on 01 June 2024]

[11] *Renewable Energy – Factsheet 4 (Biomass).* Centre for Science and Environment (CSE India). <**Retrieved from**: https://cdn.cseindia.org/attachments/0.39034500_1592893934_4factsheet-biomass.pdf> [Last Accessed on 01 June 2024]

[12] *Estimation of Source-wise Energy Availability and Cost.* MESCOM (Annexure -P8). <**Retrieved from**: https://kerc.karnataka.gov.in/uploads/22061657255573.pdf > [Last Accessed on 01 June 2024]

[13] *Central Electricity Authority – Dashboard.* Central Electricity Authority, Ministry of Power. Government of India. <**Retrieved from**: https://cea.nic.in/dashboard/?lang=en > [Last Accessed on 01 June 2024]

[14] *Top Five States for Solar Power Generation Across India.* Ornate Solar. <**Retrieved from**: https://ornatesolar.com/blog/top-five-states-for-solar-power-generation> [Last Accessed on 01 June 2024]

[15] S. Ramesh (16 February 2024) *Karnataka Budget 2024: Siddaramaiah government to increase the power production capacity of the state.* <**Retrieved from**: https://www.deccanherald.com/india/karnataka/karnataka-budget-2024-siddaramaiah-government-to-increase-the-power-production-capacity-of-the-state-2897564 > [Last Accessed on 01 June 2024]

[16] *Statement in Reply to Rajya Sabha Starred Question no. 242 (priority no. 2) by Shri Rajeev Chandrasekhar on 14. 02. 2011 regarding Wind Power Potential in Karnataka.* <**Retrieved from**: https://rajeev.in/?questionasked=wind-power-potential-in-karnataka> [Last Accessed on 01 June 2024]

[17] *Utilization of Hydro Power Potential - 42104.6 MW (29%) out of 145320 MW developed and 15023.5 MW (10.3%) is under construction.* PIB Release by Ministry of Power, Government of India. <**Retrieved from**: https://pib.gov.in/PressReleasePage.aspx?PRID=1909276> [Last Accessed on 01 June 2024]

[22] *Interventions decided upon in review, by Union Minister for Power, New & Renewable Energy Shri R.K Singh, of Coal supply position in thermal power plants.* PIB Release by Ministry of Power, Government of India. <**Retrieved from**: https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1752057> [Last Accessed on 01 June 2024]

[23] *Draft guidelines for monitoring the use of coal for Power generation in Co-generation projects during the off-season for the purpose of Determination of Tariff for Bagasse based Cogeneration Plants during off season using coal as fuel.* <**Retrieved from**: https://kerc.karnataka.gov.in/storage/repo/Draft_Guidelines_Determination_of_Tariff_for_Bagasse_based_Cogeneration_Plant.pdf> [Last Accessed on 01 June 2024]

[24] P. Chahine (24 March 2017) *Electricity plan for Bengaluru – a look at BESCOM's data.* Citizen Matters. <**Retrieved from**: https://citizenmatters.in/bengaluru-karnataka-grid-a-look-at-bescom-data/> [Last Accessed on 01 June 2024]

[25] T.V. Ramachandra, Vishnu Bajpai, Gouri Kulkarni, Bharath H. Aithal, Sun Sheng Han (2017) *Economic Disparity and Greenhouse Gas Emissions: Domestic Energy Sector in Greater Bangalore, India***.** Renewable and Sustainable Energy Reviews, 67(2017): 1331–1344.

[26] *Largest Cities by Population 2024.* World Population Review. <**Retrieved from**: https://worldpopulationreview.com/world-cities> [Last Accessed on 01 June 2024]

[27] *India Urban Population 1960-2024.* Macrotrends **(**Data from World Bank). <**Retrieved from**: https://www.macrotrends.net/global-metrics/countries/IND/india/urban-population> [Last Accessed on 01 June 2024]

Chapter 9

Insights from Appliance and Vessel Manufacturers, Summary of Findings and Way Forward

9.1 Interactions with eCooking Appliance/ Vessel Manufacturers

The report is mainly focused on the characteristics of the demand side, governed by the choices made by the consumers. It is also important to take stock of the manufacturers of the electric cooking appliances and vessels since their preparedness to cater to the consumers' expectations will be a crucial factor in deciding the success of the envisaged eCooking transition in the residential cooking sector.

We interacted with a couple of private enterprises engaged in innovations associated with eCooking appliances. *Although the representative from the first enterprise urged us not to disclose the identity, the insights provided proved to be very useful*.

The salient insights derived from the interactions with the first enterprise:

1. **Market Presence:** *The Company has a strong presence in Eastern India, with a consumer base spread across various regions in India. The top 3 cities with the largest consumer base for eCooking appliances/vessels are Ranchi, Patna, and Kolkata, exhibiting a significant market in these urban areas.*

3. **Product Offerings:** *The Company primarily offers single burner eCooking appliances in the mass segment, with a 1% market share.*

4. **Pricing Strategy:** *The representative mentioned that a 10% rebate on the price of vessels is possible when purchased alongside the eCooking appliance, potentially incentivizing consumers to opt for the appliance-vessel combination.*

5. **Price Range:** *The price ranges for mass-segment eCooking appliances start at a minimum of Rupees 5000.*

6. **Demand Aggregation:** *The Company acknowledges that demand aggregation could lead to a reduction in prices for the mass segment eCooking appliances, with an indicative reduction of up to 20%.*

7. **Popular Model:** *The '**Cooka E. Cooktop Single Burner model**' stands out as a popular choice among consumers, featuring a peak power of 2 kW and an average power of 1 kW, catering to the performance and utility requirements similar to LPG gas.*

8. **Customization:** *The enterprise has incorporated major customization in its eCooking appliances based on consumer feedback, focusing on delivering the same performance and utility as traditional LPG gas stoves.*

9. **Research and Development:** *The Company has an in-house R&D facility for eCooking appliances/vessels, which contributes to product innovation and improvements based on market and consumer insights.*

10. **Manufacturing Facilities:** *While the vessel manufacturing is located in China, the company's operations and showrooms/outlets are predominantly present in Eastern and North India, indicating a distributed manufacturing and retail network.*

11. **Challenges and Support Needed:** *Lack of awareness and government acknowledgment are identified as key challenges for scaling up the eCooking business footprint, highlighting the importance of creating awareness and receiving support from stakeholders for further expansion.*

The representative signed off mentioning that *by refining its strategies, focusing on addressing consumer needs, leveraging market opportunities, and collaborating with stakeholders can overcome challenges and enhance its eCooking business in India.*

The salient insights derived from the interactions with the second enterprise (Real Flame):

1. **Regional Presence and Market Focus:** Real Flame has a significant presence in Kerala, aligning with the eCooking manufacturer's emphasis on growth in specific regions like Kerala.
2. **Product Offerings:** Real Flame focuses on electric cooking appliances like induction cookers and Electric Pressure Cookers (EPCs).
3. **Consumer Behavior and Adoption:** Real Flame's insights into consumer behavior based on location and preferences indicate the enterprise's understanding of consumer mindset and factors influencing investments in electric cooking.

4. **Challenges and Support Required**: Real Flame underscored challenges in export markets, and the enterprise acknowledges the necessity for government intervention to enhance the manufacturing and marketing of eCooking appliances.
5. **After-Sales Support and Distribution**: Real Flame's focus on after-sales support across various locations resonates with the eCooking appliance/vessel manufacturer's offering of technician training for maintenance and service. It also prioritizes customer satisfaction through effective after-sales support strategies.
6. **Technological Support**: Real Flame seeks technological support while underscoring the value of government awareness and acknowledgment for scaling up business operations.

9.2 Possible Areas Requiring Further Attention

Based on a qualitative analysis of the responses from the eCooking Appliance/Vessel Manufacturers the following points could be identified that require more intimate attention from the policymakers and the other stakeholders actively engaged in the eCooking ecosystem.

1. **Expansion of Product Range**: *There is a need to introduce various eCooking appliances to cater to diverse consumer segments and cooking needs.*

2. **Intensification of Marketing Efforts**: *Targeted awareness campaigns need to be launched to impart education among consumers on the benefits and performance of eCooking appliances, leveraging the existing retail network.*

3. **Enhanced Engagement with the Government**: *Serious efforts are needed toward meaningful advocacy and forming partnerships with government bodies to gain support and recognition, potentially leading to appropriate incentives for consumers to provide necessary nudges for the transition.*

4. **Bolstering of Local Manufacturing**: *There is a need to explore the scope of local manufacturing to reduce dependence on international suppliers. The goal should be to enhance the resilience of the eCooking ecosystem through the Indigenous supply chain.*

5. **Focus on Affordability**: *The ways to bring down the price should be continuously explored to keep the consumers interested. For the eCooking transition to happen, the objective should be toward making eCooking appliances more cost-competitive with traditional cooking methods.*

Although the information provided by the eCooking OEMs is fragmented, this needs to be reflected since the attitude of OEMs is going to be as crucial for a successful eCooking transition as the behavioral aspects of consumers.

9.3 Costs of the Envisaged eCooking Transition

Based on the case study anchored on one cosmopolitan Metro City in a country as diverse as India, it would be premature to arrive at realistic estimates of the cost of a large-scale energy transition in the residential cooking sector. However, from the different elements of this study, the directions can be identified to facilitate a preliminary assessment of the hidden costs associated with the eCooking transition in Indian households.

One of the key things that were noticed during the analysis of the vessels owned by the surveyed households in an LPG-dominated cooking landscape in Bengaluru is the predominance of round-bottom vessels made of aluminium. Therefore, to transform households toward using electricity for daily cooking, a major shift needs to take place from current patterns of using kitchen utensils. The steel vessels are being used by the households in Bengaluru. However, all the vessels made of steel may not be suitable for use in electric cooking applications, such as cooking with induction cooktops. *In case the shift to eCooking paradigm takes place, a large incentive may need to be rolled out for the consumers to initiate the uptake of the vessels even before the purchases of eCooking appliances take place*. From the interaction with the appliance manufacturers, it was evident that many of the vendors have *kept a minimum price of Rupees 5000 for the devices, whereas analysis of data from the survey of low-to-medium income households* (**N=910**) *indicates that a large fraction of this group is willing to pay up to a price limit of Rupees 3500 to even experience a new, modern energy cooking solution (eCooking appliance).* A few consumers who were found to own eCooking appliances and use some form of eCooking daily reported the absence of servicing and repairing support in case the device gets damaged or becomes operationally defective. Therefore, the creation of a pool of skilled manpower aimed at building a robust servicing and repairing support ecosystem is the need of the hour. *Investments would be required toward creating dedicated training facilities for appliance servicing and repair*. The awareness about different aspects of eCooking needs dissemination of knowledge. While eCooking should become an integral part of formal education associated with clean energy systems and applications, Public Relations channels need to be formed and strengthened for community-level dissemination of information on a regular basis. Dissemination should also include a hands-on demonstration on cooking popular items on various eCooking appliances. The dissemination of knowledge regarding appliance upkeep is also necessary. *This would require investment to engage domain experts and full-time educators who would inform the consumer community about the ongoing developments and provide feedback to the supplier side regarding the concerns posed by the consumers*.

There is also a need to understand the difference in mindsets of people in the urban and rural / semi-rural settings in India. While the busy life in the cities may prompt people to purchase eCooking appliances to save time and gain convenience, affordability will be the most important consideration in rural areas.

While the Government of India and various State Governments are working toward building large non-fossil (main variable renewable energy) generation capacity in the country in line with the country's overarching aim to achieve Net Zero Goal by 2070, for eCooking transition to be successful a greater emphasis is required toward strengthening the sub-distribution infrastructure (cabling and augmenting transformer capacity) to ensure households' uninterrupted access to reliable electricity. Additionally, the concealed wiring in the households also needs to be strengthened to facilitate adequate load-carrying capacity. *Since low-income households may not be able to spend for such upgradation, the Government may need to find suitable financial partners to unlock funds necessary for electrical sub-distribution infrastructure enhancement activities focused on robust last-mile connectivity of electricity distribution networks*. *Finally, the household cooking activities reside on the complex interactions of three intricately linked elements, choice of cooking fuel, choice of kitchen utensils, and dietary preferences. Since dietary preferences are deep-rooted in behavioral and cultural practices, the interventions from the eCooking system should be aimed at the direction of cooking fuel (and appliances) and the cooking vessels*.

9.4 Reconciliation of the Project Objectives and Findings

1. **Objective 1**: 'To identify suitable locations that promise to provide invaluable insights regarding the current cooking practices in households and the possibilities of the energy transition in residential cooking.' – A detailed discussion on the choice of locations and their significance is provided in **Chapter 2** of this Report. The socioeconomic attributes have been discussed in detail to reflect the possibilities of the energy transition in residential cooking in **Chapter 3** of this Report.
2. **Objective 2**: 'To conduct on-ground surveys in select areas to understand the status of access to electricity in the households, the current practices of residential cooking in those

households, availability of LPG connection and usage, and how the households look at the envisaged transition to electric cooking.' – A detailed discussion on the current practices of residential cooking & availability of LPG connection and usage is provided in **Chapter 5** of this Report. A detailed discussion of how the households look at the envisaged transition to electric cooking is provided in **Chapter 4** of this Report.

3. **Objective 3**: 'To assess the sub-distribution infrastructure prevalent in the chosen areas (including the cabling and their carrying capacities), since the use of the cooking appliances would require a reliable supply of electricity to the households.' – A detailed discussion on the sub-distribution infrastructure prevalent in the chosen areas (including the cabling and their carrying capacities), is provided in **Chapter 6** of this Report.
4. **Objective 4**: 'To assess the increase in electricity demand owing to the envisaged transition into electric cooking.' – A detailed discussion on the increase in electricity demand owing to the envisaged transition into electric cooking is provided in **Chapter 8** of this Report.
5. **Objective 5**: 'To assess the current electricity generation capacities in light of the increased demand for electricity, with a specific focus on the peak demand hours, and evaluate the possible supply-demand gap'. - A detailed discussion on the scenario-building for generation and evaluation of the supply-demand gap is provided in **Chapter 8** of this Report.
6. **Objective 6**: 'To understand the customization needed in the electric cooking appliances, and the scale for attaining affordability.' – The concerns of the consumers regarding eCooking and the current kitchen requirements are covered in detail in **Chapter 6** and **Chapter 7** of this Report.
7. **Objective 7**: 'To understand the cost of transition to electric residential cooking in select regions.' – Based on the case study anchored on one cosmopolitan Metro City in a country as diverse as India, it would be premature to arrive at realistic estimates of the cost of a large-scale energy transition in the residential cooking sector. However, from the different elements of this study, the directions can be identified to facilitate a preliminary assessment of the hidden costs associated with the eCooking transition in Indian households. A broad discussion on this is presented in **Chapter 9** of this Report.
8. **Objective 8**: 'To develop a framework based on the case studies of select areas, which can serve as a template to look at similar transitions in other regions of India.' – A reasonable and replicable template to look at different regions of India has been developed through rigorous research work. Suitable customizations will have to be incorporated based on specific contexts.

Acknowledgment

We extend our sincere gratitude to the following people for helping us in completing this interesting study successfully.

Dr. **Shailesh Nayak (**Director, NIAS),

Dr. **Ed Brown (**Professor of Global Energy Challenges, and Director, MECS Programme, Loughborough University, UK),

Smt. **Sheetal Rastogi (**Co-Founder, Finovista**),**

Shri **Vimal Kumar (**Co-Founder, Finovista**)**,

Dr. **Simon Batchelor** (Director of Gamos, a Research Fellow at Loughborough University, and Research Coordinator for the UK Aid-funded MECS Programme),

Dr. **Nick Rousseau** (International Liaison Manager, MECS Programme, Loughborough University, UK),

Dr. **Richard Sieff** (MECS Research Associate, Gamos Ltd., UK),

Shri **Krishna Kumar Sinha (**Former adviser to the Department of Industrial Policy and Promotion (DIPP), now known as DPIIT, Current Advisor, Finovista**),**

Prof. **A.V. Krishnan** (Dr. Raja Ramanna Chair Professor, NIAS),

Dr. **Tapasi Ghosh** (Associate Professor, and Head (I/C) of the Department of Data Sciences and Analysis, MSRUAS),

Students of the B.Sc. (Hons) program in Data Science and Analytics from the Department of Data Sciences and Analysis, MSRUAS, who worked as **field investigators** (**interns**) **for survey data collection**,

Dr. **Anshuman Behera** (Associate Professor, NIAS),

Dr. **Louise Medland** (MECS Programme Manager, Loughborough University, UK),

&

All the **Staff**, **Scholars** & **Faculty Members** of the National Institute of Advanced Studies (NIAS), IISc Campus, Bengaluru

ANNEXURE – I

Revised Gantt Chart Dated 04 September 2023

Draft Timeline (GANTT chart) for Phase-I of MECS-NIAS Project on Evidence-based Study on Transition-readiness for Residential eCooking												
Project start date: 25th July 2024 (based on when the first installment was received)												
Project duration: 10 months, end date: 25th May 2024												
		Q1			**Q2**			**Q3**			**Q4**	
		Aug	**Sept**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	
	Activity											**Remarks**
1	**Recruit project staff within 1 month from the date of receipt of the first installment (By 3rd Week of August 2023). The First Installment was received on 25 July 2023.**											
2	**Identify suitable locations for the study.**											
2.1	Background study on potential study areas											
3	**Assess the sub-distribution infrastructure and generation capacity in the potential study areas**											
3.1	Consult sector specialists											
3.2	Check cabling and carrying capacities											
4	**Select survey areas and target households**											
5	**Selection and training of survey team(s)** (We will try to finish and finalize this by the end of September 2023)											

5.1	Identification of survey team(s)											
5.2	Training of survey team(s)											
5.3	Making arrangements/logistics for carrying out the pilot and main survey											
6	**Pilot Survey for Trial (We will try to finish and finalize this by the end of October 2023)**											
6.1	Preparation of survey questionnaire for the pilot											
6.2	Carry out pilot											
6.3	Review and finalize the survey questionnaire for the main study											
6.4	Carry out any additional training of survey team(s) required following the pilot review	-	-	-	-	-	-	-	-	-	-	
7	**Submit progress report on pilot survey findings and research methods for the main study**											
8	**Data collection in the BESCOM license area in Bengaluru**											
8.1	Carry out survey with 900 residential households (HHs) to assess: a. the status of access to electricity in the households, b. current cooking practices including the availability of LPG and usage, c. how HHs look at the envisaged transition to electric cooking.											
8.2	Are any focus group discussions planned? Enter details here on Gantt											***After the household-level interviews are successfully done to a certain level,***

							■	■				***based on the locality and our access to key resource persons in the community FGDs could be planned.***
8.3	Are any key informant interviews planned? Enter details here on Gantt					■	■	■				***NIAS & MECS will jointly ponder over the suitable key informants and a few suitable individuals may be chosen for elaborate interviews to get the Stakeholder perspective.***
8.4	Is any desk-based research planned? Enter details here on Gantt			■	■	■	■	■				Desktop research is going to be an integral part of this study. Continuously scholarly materials will be reviewed to remain updated regarding the latest happenings including the government's policies and support mechanisms, Outcomes of allied pilot efforts, etc.

8.5	Are any other research methods planned? Enter details here on Gantt											Apart from qualitative interpretation of Survey results and Quantitative analysis of data (including projection of trends and scenario Building), Geospatial maps may be used to have the spatial perspective of the transition readiness by putting the outcomes of different identified metrics on the Study area map. Similar maps can be made for understanding the access to electricity in the survey areas as well
9	**Finalize data analysis approach** (by the end of December)											
10	**Data analysis**											
10.1	Data Trend Analysis and Assessment of the Enablers and Level of Readiness for											

	Transition, Scenario-based Projection for 2026 and 2030											
10.2	Validation against the available data in terms of electricity generation capacity, estimated demand-supply gap, and the other enablers											
10.3	Assess the increase in electricity demand based on the envisaged transition to electric cooking.											
10.4	Evaluate the potential supply-demand gap from an eCooking transition with a specific focus on peak demand hours											
10.5	Assess the cost of transition to electric residential cooking in the target region.											
10.6	Evaluate the need for customization of electric cooking appliances, and the scale for attaining affordability.											
10.7	Based on the data, assess the likely scale and nature of a residential transition to eCooking											
11	**Develop a framework based on the case study, which can serve as a template to look at similar transitions in other regions of India.**											
12	**Preparation of Draft Report and circulation amongst the key identified stakeholders**											
13	**Stakeholder Workshop (at the end of 9 months) (by April 2024)**											
14	**Incorporation of suggestions and comments, finalization of the report, and submission**											

Notes												
The suggested draft Gantt Chart has been developed referring to the Phase 1 Gantt chart, and the project objectives (see below) listed in the approved project proposal. Both were developed by NIAS.												
Project objectives as stated in the approved project proposal:												
	1. To identify the suitable locations which promise to provide with invaluable insights regarding the current cooking practices in the households and the possibilities of the energy transition in the residential cooking.											
	4. To assess the increase in electricity demand owing to the **envisaged** transition into electric cooking.											
	5. To assess the current electricity generation capacities in light of the increased demand for electricity, with a specific focus on the peak demand hours, and evaluate the possible supply-demand gap.											
	6. To understand the customization needed in the electric cooking appliances, and the scale for attaining affordability.											
	7. To understand the cost of transition to electric residential cooking in select regions.											
	8. To develop a framework based on the case studies of select areas, which can serve as a template to look at similar transitions in other regions of India.											

Annexure II

Bengaluru households survey form

This survey is in connection with the project “An Evidence-based Approach to Access Energy Transition in Clean Cooking" and is aimed at household-level data collection regarding cooking habits and access to electricity.

* Indicates a required question

Basic Profiling of the respondent

1. What is your name? *

____

2. Mobile number of the respondent

____

3. What is your gender? *

Mark only one oval.

- ◯ Male
- ◯ Female
- ◯ Transgender
- ◯ Prefer not to say

4. What is your age? *

Mark only one oval.

- ◯ 15-25 years
- ◯ 25-40 years
- ◯ 40-65 years
- ◯ 65 years and above

5. What is your caste? *

Mark only one oval.

- General
- SC
- ST
- OBC
- Prefer not to say.
- Other: ______________________

6. How many members are there in your family? *

Mark only one oval.

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- More than 10

7. How many Males/Females are there in your family? *

Check all that apply.

	0	1	2	3	4	5	More than 5
Males	☐	☐	☐	☐	☐	☐	☐
Females	☐	☐	☐	☐	☐	☐	☐

8. How many adults/Children are there in your family? *

Check all that apply.

	0	1	2	3	4	5	Morethan 5
Adults	☐	☐	☐	☐	☐	☐	☐
Children	☐	☐	☐	☐	☐	☐	☐

9. Who is the head of the family? *

Check all that apply.

- ☐ Husband
- ☐ Young Male
- ☐ Wife
- ☐ Young Female
- ☐ Father
- ☐ Mother
- ☐ Grandparents

10. Is his/her decision final in all matters related to the household? *

Mark only one oval.

- ◯ Yes
- ◯ No

11. Who decides the major purchases in the house? (Purchases worth more than say Rs. 3000- 5000 /-)*

Check all that apply.

- ☐ Husband
- ☐ Young Male
- ☐ Wife
- ☐ Young Female
- ☐ Father
- ☐ Mother
- ☐ Grand Parents

Information on the Education and Income

Is the household run by a young spouse? *

Mark only one oval.

- ◯ Yes *Skip to question 12*
- ◯ No *Skip to question 20*

Set 1: In the case of households run by young spouses -

12. How many earning members are there in the family? *

Mark only one oval.

- ◯ More than Two
- ◯ Two
- ◯ One
- ◯ None
- ◯ Prefer not to say

13. What is the education level? *

Mark only one oval.

- ◯ Postgraduation and above
- ◯ Graduation
- ◯ Intermediate
- ◯ Matriculation
- ◯ Primary (up to 8th std)
- ◯ Illiterate

14. Which kind of occupation the household member(s) is/are engaged in? *

Check all that apply.

- [ ] Farming
- [ ] Daily wage-earning
- [ ] Business
- [ ] Self-Employed
- [ ] Government employee
- [ ] Corporate employee
- [ ] Municipality or ULB (Urban Local Body)
- [ ] Contractual employee
- [ ] Other: ____________________

15. What is the approximate total monthly income? *

Mark only one oval.

- ◯ than 8000
- ◯ 8000-12000
- ◯ 12000- 25000
- ◯ 25000-35000
- ◯ 35000-60000
- ◯ 60000-90000
- ◯ 90000 and above

16. What is the largest single-head income of the house? *

Mark only one oval.

- ◯ 5000- 10000
- ◯ 10000-20000
- ◯ 20000-30000
- ◯ 30000-55000
- ◯ 55000-75000

75000 and above

17. What is the average monthly savings of the household? *

Mark only one oval.

500-1500

1500-2500

2500-4500

4500-6500

6500 and above

18. If there are children in your house, do they go to school? *

Mark only one oval.

Yes

No

Not all children go to school

Do not have a child

19. What basic aspirations do the household members wish to fulfill, butpresently cannot due to insufficient income?

Check all that apply.

- [ ] Buying a motorcycle
- [ ] Buying a car
- [ ] Buying an own house
- [ ] Buying refrigerator/ Washing Machine
- [ ] Buying better Kitchen Utensils
- [ ] Sending children to good schools
- [ ] Other: ____________________________

Skip to question 28

Set 2: In the case of households run by a middle-aged spouse

20. How many earning members are there in the family? *

Mark only one oval.

- More than two
- Two
- One
- None
- Prefer not to say

21. What is the education level of the earning member (s)? *

Mark only one oval.

- Post graduation and above
- Graduation
- Intermediate
- Matriculation
- Primary (up to 8th std)
- Illiterate

22. Which kind of occupation the household member(s) is/are engaged in? *

Mark only one oval.

- ⬭ Farming
- ⬭ Daily wage-earning
- ⬭ Business
- ⬭ Self-employed
- ⬭ Government employee
- ⬭ Corporate Employee
- ⬭ Municipality or ULB (Urban Local Body)
- ⬭ Contractual employee
- ⬭ Other: ______________________

23. What is the approximate total monthly income? *

Mark only one oval.

- Less than 8000
- 8000-12000
- 12000- 25000
- 25000- 35000
- 35000- 60000
- 60000- 90000
- 90000 and above

24. What is the largest single-head income of the house? *

Mark only one oval.

- 5000- 10000
- 10000-20000
- 20000-30000
- 30000- 55000
- 55000-75000
- 75000 and above

25. What is the average monthly saving of the household? *

Mark only one oval.

- 500-1500
- 1500-2500
- 2500-4500
- 4500-6500
- 6500 and above

26. Are the children going to school/ college? *

Mark only one oval.

- Yes
- No
- Not all children go to school
- Do not have a child

27. What basic aspirations do the household members wish to fulfill, but presently cannot due to insufficient income?

Check all that apply.

- Buying a motorcycle
- Buying a car
- Buying an own house
- Buying refrigerator/ Washing Machine
- Buying better kitchen utensils
- Sending children to school/ College
- Other: ______________________

Skip to question 28

Technology Familiarity

28. Are you comfortable with electronic equipment? *

Mark only one oval.

- Yes
- No
- Not sure

29. What kind of equipment do you have in your house? *

Check all that apply.

- [ ] Smartphone
- [ ] Oven
- [ ] Heater
- [ ] Electrical Cookstove
- [ ] Fridge
- [ ] Washing Machine
- [ ] Other: ______________________

30. Are you familiar with Online payment (QR Code scan payment)? *

Mark only one oval.

- ( ) Yes
- ( ) No

31. Do you use QR code payment / online payment in your daily life? *

Mark only one oval.

- ( ) Always
- ( ) Never
- ( ) Sometimes

32. In case you need any information from the internet, how do you find it?*

Mark only one oval.

- ( ) By using own Mobile phone
- ( ) By taking help from children or other family members
- ( ) By taking help from tech-savvy neighbours
- ( ) Others

33. In which language do you search for information on the internet? *

Mark only one oval.

- English
- Hindi
- Kannada
- Tamil
- Telugu
- Malayalam
- Bengali
- Odia
- Assamese
- Nepali
- Marathi
- Urdu
- Rajasthani
- Punjabi
- Others

34. Are you okay with learning simple English instructions if required for your daily life activities? *

Mark only one oval.

- Yes
- No

House Chore/ Cooking Activity Information

35. Who does the cooking in the house? *

Check all that apply.

- [ ] Housewife
- [ ] Husband
- [ ] Both wife and husband together
- [ ] Young male
- [ ] Unmarried Daughter / Daughter-in-Law
- [ ] Father
- [ ] Mother
- [ ] Hired Cook/ Maid

36. How many times a day the meals are made in the house? *

Mark only one oval.

- One Time
- Two Times
- Three times
- More than three times

37. Are Rotis / Chapatis eaten every day in the house? *

Mark only one oval.

- Everyday
- 1-3 Days a Week
- 4-6 Days a Week
- Rarely
- Rotis are not eaten in the house

38. How many Rotis/Chapatis are made per day in the house? *

Mark only one oval.

- Nil
- 5-10 Rotis
- 10-20 Rotis
- 20-30 Rotis
- More than 30 Rotis

39. How many times rice is made in the house every day? *

Mark only one oval.

- Once
- Twice
- Thrice
- Rarely in a typical week

40. When are the Rotis usually made? *

Check all that apply.

- Before Lunch
- Before Dinner
- Before Breakfast
- Roti is not made in the house

41. What sort of Curry is made in the house? *

Check all that apply.

- Sambhar
- South Indian veg curry
- Rasam
- North Indian Veg Curry
- Non-veg curry

42. Is the curry made once every day or once during every meal? *

Mark only one oval.

- Once every day
- Once every meal

43. At what times during the day the meals are made in the house? *

Check all that apply.

- Morning
- Afternoon
- Evening

44. How long does it take to prepare the meals? *

Mark only one oval.

- Less than 1 hour
- 1 hr- 2 hrs.
- More than 2 hrs.

45. Would you be happy if you could reduce the cooking time of daily meals? *

Mark only one oval.

- Yes
- No
- Doesn't matter

46. How would you utilize that extra time that you can save by reducing the cooking time? *

Check all that apply.

- [ ] Other Household Chores
- [ ] Going out for other essential works
- [ ] Teaching own children
- [ ] Pursue hobby
- [ ] Indulge in entertainment activities
- [ ] Other: ____________________

47. How do you cook the meals? *

Check all that apply.

- [ ] LPG gas
- [ ] Wood
- [ ] Charcoal
- [ ] Microwave Oven
- [ ] Ceramic heating-based electric cooking appliance
- [ ] Cow dung
- [ ] Induction cooktop

48. Do you use different means to cook different food items? *

Check all that apply.

	LPG Gas Stove	Electric cookstove	Induction Cooktop	Traditional Chulha	Not cooked
Roti/ Chapati	☐	☐	☐	☐	☐
Rice	☐	☐	☐	☐	☐
Curry	☐	☐	☐	☐	☐

49. What kind of cooking vessels do you have in the house? *

Check all that apply.

- ☐ Pressure cooker
- ☐ Kadhai
- ☐ Saucepan/ Tea Patre
- ☐ Big Bowls/ Dodda Patre
- ☐ Deep Pans (Frying)
- ☐ Tawa / Anchu
- ☐ Handi
- ☐ Other: ____________________

50. How many metal cooking vessels do you have at your home in total? *

Mark only one oval.

- ◯ 2-4
- ◯ 5-10
- ◯ 10-15
- ◯ More than 15

51. How many cooking vessels are used for cooking every day? *

Mark only one oval.

- Two to four cooking Vessels
- Four to Six Cooking Vessels
- More than Six Cooking Vessels

52. Does your cooked food get finished every day? *

Mark only one oval.

- Almost
- Always
- Sometimes
- Never

53. How do you manage the leftovers? *

Mark only one oval.

- Heating it again and consuming it
- Throwing it for stray animals
- Throwing into Dust Bins
- No Leftover

54. If you are using LPG, are you covered under the Pradhan Mantri Ujjwala Yojana (PMUY) scheme? *

Mark only one oval.

- Yes
- No

55. How many LPG cylinders do you need per year? *

Mark only one oval.

- 1-2 Cylinders
- 3-4 Cylinders
- 4-6 Cylinders
- More than 6 Cylinders

56. How long do you want a new LPG cylinder to serve you? *

Mark only one oval.

- 2 Months
- 2.5- 3 Months
- 3- 5 Months

57. Do you consciously try to save LPG gas in your house? *

Mark only one oval.

- Always
- Sometimes
- Never

58. How do you try to reduce daily life LPG consumption? *

Check all that apply.

- [ ] Cooking once a day
- [ ] Using other means of cooking
- [ ] Using Electric cooking (Including Induction)
- [ ] Can't save

59. When the cylinder becomes empty, how quickly do you try to get a refill? *

Mark only one oval.

- ⬭ Booking before it runs out
- ⬭ Instantly (within 2 days)
- ⬭ Within a week
- ⬭ After a week
- ⬭ 15 days to one month later

60. If you get a cheaper option for household cooking, would you be keen to take up that? *

Mark only one oval.

- ⬭ Yes
- ⬭ No
- ⬭ Maybe

61. If you are using Wood/ Charcoal/ Cow dung, approximately how much wood/charcoal (in kg or in measurable physical terms) do you require dailyto make your meals?

Check all that apply.

	0 kg	0 kg to 1 kg	1 kg to 2kg	2 kg to 4kg	4kg and Above
Not using these	☐	☐	☐	☐	☐
Wood	☐	☐	☐	☐	☐
Charcoal	☐	☐	☐	☐	☐
Cow dung	☐	☐	☐	☐	☐

62. Where are you getting this Wood/ Charcoal/ Cow dung from? *

Check all that apply.

- [ ] Through Purchase
- [ ] By Collecting
- [ ] Received from neighbors or familiar people as a goodwill gesture or against some informal service.
- [ ] Not using any of these fuels

63. How much does this Wood / Charcoal/ Cow dung cost per month?
[Our internal Ref. Wood: Rs 5- 15 Per kg; Charcoal- Rs. 25-50 /kg; Cowdung cake: Rs 4 to 8 per piece]

Check all that apply.

	Rs 0	Rs 0-Rs 500	Rs 500-Rs 1000	Rs 1000-Rs 2500	Rs 2500-Rs 4000
Nott using these fuels	☐	☐	☐	☐	☐
Wood	☐	☐	☐	☐	☐
Charcoal	☐	☐	☐	☐	☐
Cow dung	☐	☐	☐	☐	☐

64. Is your Chulha inside the house or outside? *

Mark only one oval.

- ◯ Inside
- ◯ Outside
- ◯ Do not use a traditional chulha

65. Are you (especially the woman of the house who cooks) having any breathing problems because of the smoke coming out of your Chulha?

Mark only one oval.

- Yes
- No
- Not aware

Cultural/ Behavioral Aspect

66. What are the major festivals celebrated at your home where cooking a lot of dishes is a common practice? *

Check all that apply.

- [ ] Ugadi
- [ ] Dussehra
- [ ] Maysore dasara
- [ ] Ganesh Chaturthi
- [ ] Karaga
- [ ] Kambala
- [ ] Pongal
- [ ] Gowri Festival
- [ ] Thiruvaiyaru Festival
- [ ] Thaipusam
- [ ] Natyanjali Dance Festival
- [ ] Mahamaham
- [ ] Tamil New Year's Day
- [ ] Karthigai Deepam
- [ ] Onam
- [ ] Diwali
- [ ] Chhath
- [ ] Vishu Festival
- [ ] Makar Sankranti
- [ ] Janmashtmi
- [ ] Eid
- [ ] Vara Mahalakshmi
- [ ] Other: ______________________

67. What are the major special food items made during festivals? *

Check all that apply.

- [ ] Kheer
- [ ] Bisi bele bhath
- [ ] Payasa.
- [ ] Baledindina Palya.
- [ ] Veg Pulav/ Basanti Pulav
- [ ] Non-Veg Pulav/ Biryani
- [ ] Gulab Jamun
- [ ] Chakli
- [ ] Other: ______________________

68. How long usually does it take to make the festival food items (Kheer, Palya, Puran Poli)? *

Mark only one oval.

- ( ) 1 hour
- ( ) More than 1 hour
- ( ) More than 2 hours
- ( ) Several hours
- ( ) More than a day

69. Would you be happy if you could reduce the cooking time during the festivals? * (*Mark only one oval.)*

- ( ) Yes
- ( ) No
- ( ) Maybe

70. Would you be happy to buy a new cooking device that cooks festival meals faster if it is affordable? *

Mark only one oval.

- ( ) Yes
- ( ) No
- ( ) Maybe

71. Do you believe that traditional food items can be made only in the traditional ways (Gas ovens or Chulha) Or Modern devices (such as induction cooktop/ Or improved cookstoves) can also be used? *

Mark only one oval.

- Traditional Food Cooks well only in traditional ways (on Oley)
- Traditional food can be cooked on modern devices
- Don't have any idea

72. Do you think that the taste of food items depends on how they are cooked (using gas ovens or using charcoal/ wood in Chulha)? *

Mark only one oval.

- Yes
- No
- No Idea

73. If you find that faster cooking options are available that would not compromise on taste, would you like to know more about it?

Mark only one oval.

- Yes
- No
- Maybe

74. When you go to purchase something in the market, up to what amount do you feel comfortable spending if the item satisfies your requirement? *

Mark only one oval.

- Less than 1500
- 1500-3000
- 3000-5000
- More than 5000

75. Who decides the major purchases in the house? *

Check all that apply.

- [ ] Husband/ Young Male
- [ ] Wife/ Young Female
- [ ] Father
- [ ] Mother
- [ ] Grand Parents

76. Who decides the purchases required for the kitchen (e.g., the utensils and cooking vessels)? *

Check all that apply.

- [ ] Generally, women in the house like Wife
- [ ] Mother/ Senior Lady
- [ ] Husband
- [ ] Father
- [ ] Grand Parents
- [ ] Uncle

77. What kind of vessel do you have in the Kitchen? *

Check all that apply.

	0	1	2	3	4	5	More than 5
Deep pans	☐	☐	☐	☐	☐	☐	☐
Shallow Pans	☐	☐	☐	☐	☐	☐	☐
Cauldron / Bandhi	☐	☐	☐	☐	☐	☐	☐
Pressure Cooker	☐	☐	☐	☐	☐	☐	☐
Big Bowls	☐	☐	☐	☐	☐	☐	☐

78. Are you aware of induction cooking? *

Mark only one oval.

- Yes
- No

79. If 'Yes', what have you heard/seen about it that sticks to your mind?

80. How much money would you be able to spend monthly (maximum limit) to ensure that you always have cooking fuel available at home? *

Mark only one oval.

- Less than Rs. 500
- Rs. 500 -1000
- Rs. 1000 – 2000
- Above Rs. 2000

Household Configuration & Access to Electricity

81. How many rooms do you have in the house? (Living rooms + Kitchen+ Hall)? * *Check all that apply*

	0	1	2	3	4	5
Bedroom	☐	☐	☐	☐	☐	☐
Kitchen	☐	☐	☐	☐	☐	☐
Hall	☐	☐	☐	☐	☐	☐

82. How many bathrooms do you have in the house? *

Mark only one oval.

- One
- Two
- More than two

83. Do you have an electric connection in the house? *

Mark only one oval.

- Yes
- No

84. Do you have lights in the living rooms, bathroom, and kitchen?

Check all that apply.

	Yes	No
Living Rooms	☐	☐
Bathroom	☐	☐
Kitchen	☐	☐
Hall	☐	☐

85. How many lights do you have in the house? And what types (traditional bulb, tube light, LED, CFL)? *

Check all that apply.

	0	1	2	3	4	5	More than 5
CFL	☐	☐	☐	☐	☐	☐	☐
Tube Lights	☐	☐	☐	☐	☐	☐	☐
LED	☐	☐	☐	☐	☐	☐	☐
Normal Bulb	☐	☐	☐	☐	☐	☐	☐

86. Do you have a ceiling fan in each living room? *

Mark only one oval.

◯ Yes

◯ No

87. Roughly how many small and large plug points are there in the house? *

Check all that apply

	0	1	2	3	4	5	More than 5
Small Plug Points	☐	☐	☐	☐	☐	☐	☐
Large Plug Points	☐	☐	☐	☐	☐	☐	☐

88. What do you use these plug points for (mobile charging, cloth ironing? etc.)? (Need to confirm from respondents)? *

Check all that apply.

- [ ] Mobile charging
- [ ] Ironing
- [ ] Mixer Grinder
- [ ] Washing Machine
- [ ] Refrigerator
- [ ] Microwave Oven
- [ ] Induction Cooktops
- [ ] Electric heaters and other regular appliances
- [ ] Other: ______________________

89. How many plug points do you have in the kitchen? *

Mark only one oval.

- ◯ 1-2 plug points
- ◯ 2-3 plug points
- ◯ None

90. For what purpose these plug points are used in the kitchen? *

Check all that apply.

- [ ] Running Mixer Grinder
- [ ] For Electric Cooking stoves
- [ ] For ovens and other uses
- [ ] Electrical Kettle
- [ ] Other: ______________________

91. Do you have to pay any money for electricity? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Prefer not to say

92. Do you see any major fluctuations in electricity supply? *

Mark only one oval.

- Frequently
- Sometimes
- Rarely

93. Does load-shedding (Power cuts) happen every day? *

Mark only one oval.

- Yes
- No
- Have not noticed

94. How long do you have to live with load-shedding daily (approximate duration)?

Mark only one oval.

- 30 minutes– 1 hour
- 1 hr to 2 hrs
- More than 2 hrs
- No Load shedding

95. When does load-shedding happen daily? *

Check all that apply.

- Morning and before noon
- Afternoon
- Evening time
- Night-time
- No load shedding

96. Do you face load-shedding during the cooking of the meals often? *

Mark only one oval.

- Yes
- No
- Have not noticed

97. Do you see a power cut after heavy rainfall? *

Mark only one oval.

- Yes
- No
- Have not noticed

98. Do you hear a transformer bursting often in your area just before load-shedding? *

Mark only one oval.

- Yes
- No
- Have not noticed

99. Are you getting the benefit of the Karnataka Govt's Gruha Jyothi (200 units of free electricity per month)? *

Mark only one oval.

- Yes
- No
- Yet to receive

100. If electricity is free, and an electric cooking device is cheap, would you like to have a new cooking experience? *

Mark only one oval.

- Yes
- No
- Maybe

101. If a new electric device helps you to cook faster, and it works fine with your existing vessels, up to what price you can afford to have this new device? *

Mark only one oval.

- Below Rs. 1500
- Rs. 1500- 3000
- Rs. 3000- 5000
- Not Sure

Annexure III

A Review of Income Scenario in Different Employment Sectors in Bengaluru

Rajeev Kumar, and **Rudrodip Majumdar**

EECP, National Institute of Advanced Studies, Bengaluru-560012

The National Economic Surveys only give district-level average income figures for the different districts in a State. However, for the household-level assessment of 'energy transition readiness of residential cooking' in the current project, more granular information regarding the variabilities in the income level within a district is necessary.

The following questions need to be posed in the context of the ***Study Area*** of interest, i.e., the BESCOM Coverage Area within the Bruhat Bengaluru Mahanagara Palike (BBMP) administrative boundary:

A. How many people in Bengaluru are employed?
B. What are the primary types of Employment in the urban areas of Bengaluru?

The latest economic census (Seventh Economic Census) was conducted in 2019 by the Central Statistical Organisation under the Ministry of Statistics and Program Implementation, Government of India. However, the data is not available in the public domain yet.

The Sixth Economic Census was conducted in 2013, and the data for Bengaluru, specifically the BBMP area is available **[1].**

Predominantly, there are two types of employment in Bengaluru:

1. Formal (hiring with assured wages through contractual arrangements), and
2. Informal and/or unorganized employment (devoid of definite and consistent employment conditions)

The sixth economic census (2013) counted 3,60,785 establishments in the BBMP area. These establishments employed a total of close to 15 lakh (1,498,875 to be precise) persons **[1].** Among this population size of 15 lakhs, about 11 lakhs were men (11.08 lakhs to be specific), and close to 4 lakhs were women (3.89 lakhs to be specific). **Figure 1** depicts the overall employment figures in an illustrative manner.

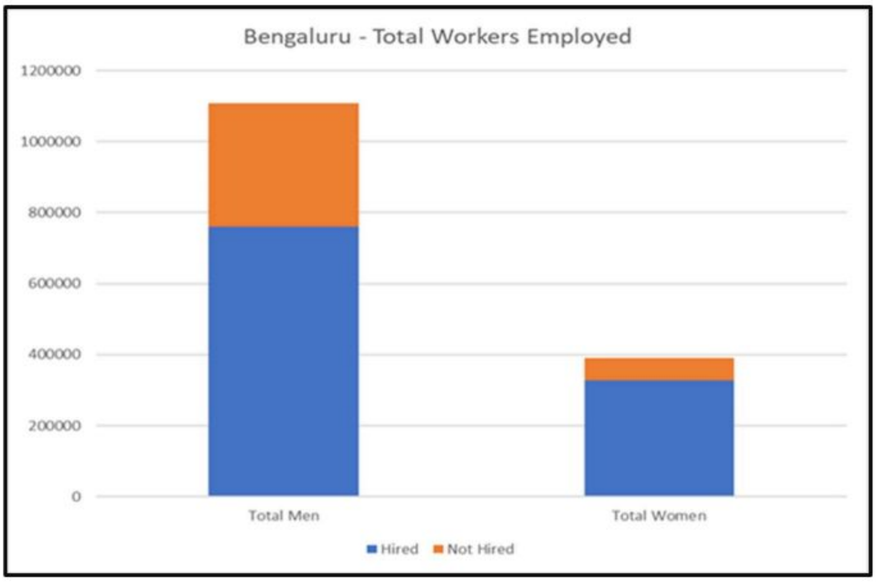

Figure 1. Overall Employment Numbers in Bengaluru (Sixth Economic Census-2013)

7.6 lakh Men were formally hired amongst the total number of 11.08 lakhs, and about 3.4 lakh women were formally hired among the total of 3.89 lakh women.

Therefore, the total number of people formally hired = (7.6+3.4) = 11 lakhs

This indicates that ~ (11/14.988) *100 % = 73.39% of the total population of 15 lakhs is formally hired.

Major employment sectors in Bengaluru

Figure 2 highlights the employment numbers in connection with the major employment sectors in Bengaluru.

Within the formal employment category, the major sectors along with the respective employment numbers are highlighted below:

A. Retail sales: 3,60,000
B. Apparel manufacture: 1,50,000
C. Food Servicing: 80,000
D. Computer programming: 45,000
E. Management Consultancy: 40,000

The two most prominent employment sectors are retail sales (providing ~24% of the total formal employment) and the apparel sector or garments industry (providing ~ 10% of the total formal employment).

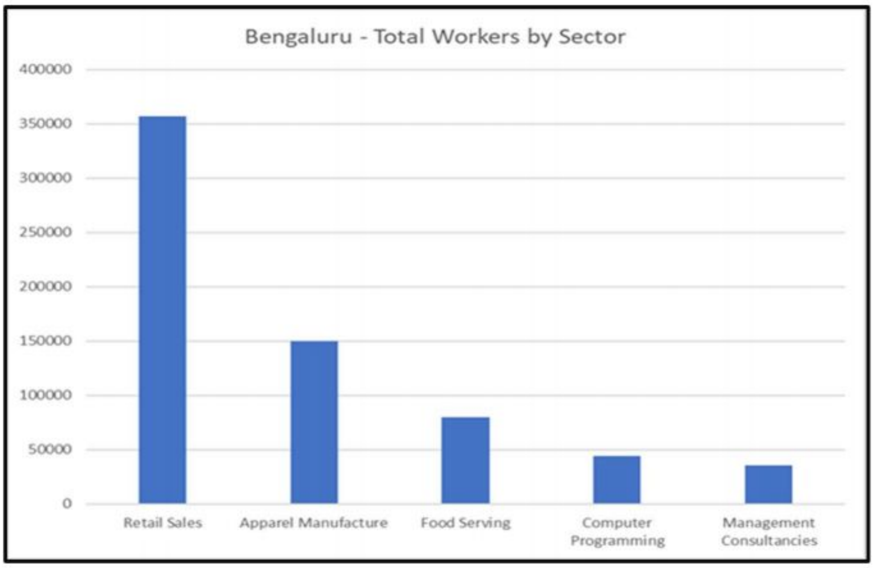

Figure 2. Employment figures in Bengaluru in the major sectors (Sixth Economic Census-2013)

The total number of people employed in the major employing sectors is estimated to be 6.75 lakhs. This indicates that ~ (6.75/11) * 100% = 61.72% of people are employed in the major employment sectors.

Figure 3 shows the ward-wise distribution of workers in the BBMP Area [1]. Data was obtained from the Sixth Economic Census (2013) conducted in the BBMP area.

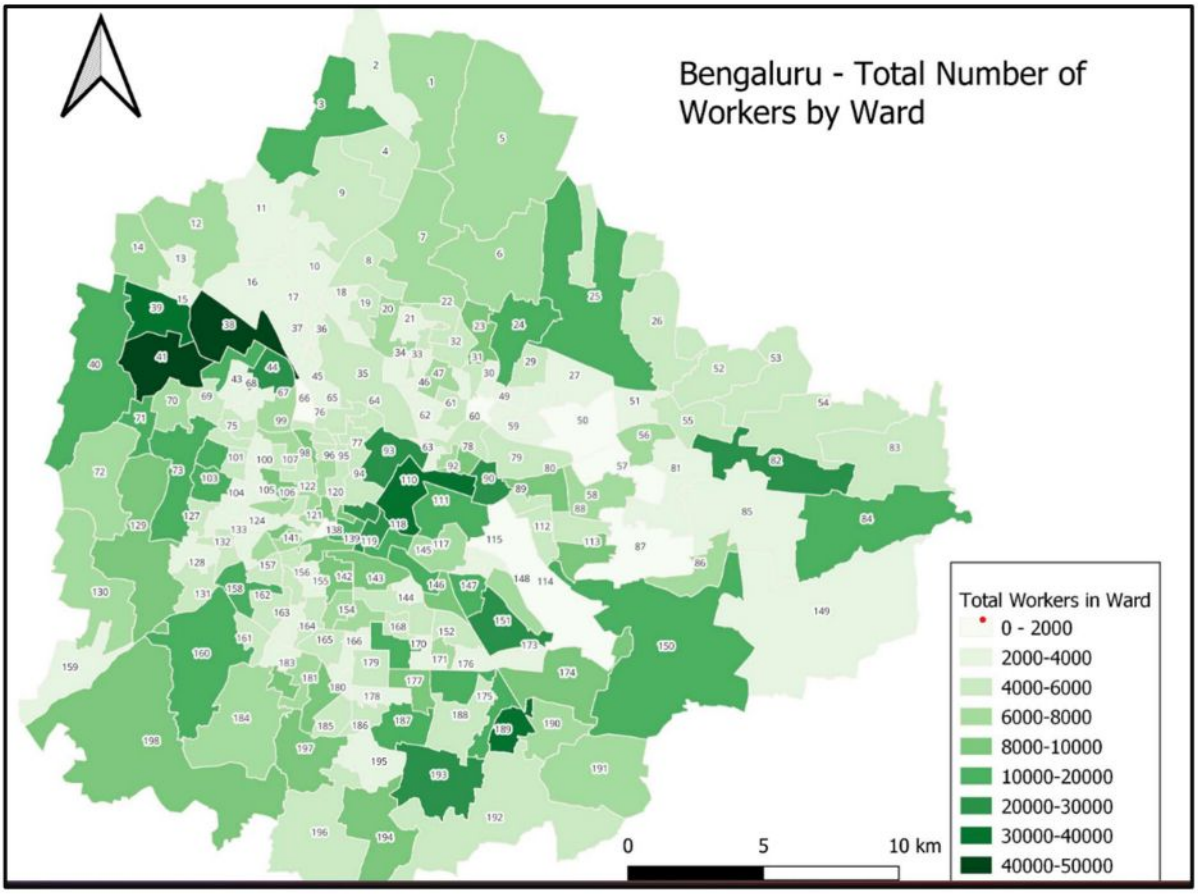

Figure 3. Ward-wise distribution of workers in the BBMP Area

Wage distribution in the major employment sectors

The average hourly wage (i.e., pay per hour) for all employees in Bangalore is around 200 INR. This is the amount that an average individual gets paid for every hour of work **[2].**

1. **Retail sales sector**

A person working in Retail Sales and Wholesale in Bangalore typically earns around 38,300 INR per month. Month salaries range from 12,900 INR (lowest average) to 74,500 INR (highest average). The actual maximum salary is higher than the estimated highest average **[3]. Figure 4** highlights the monthly salary levels of the people working in the Retail Sales sector in Bengaluru.

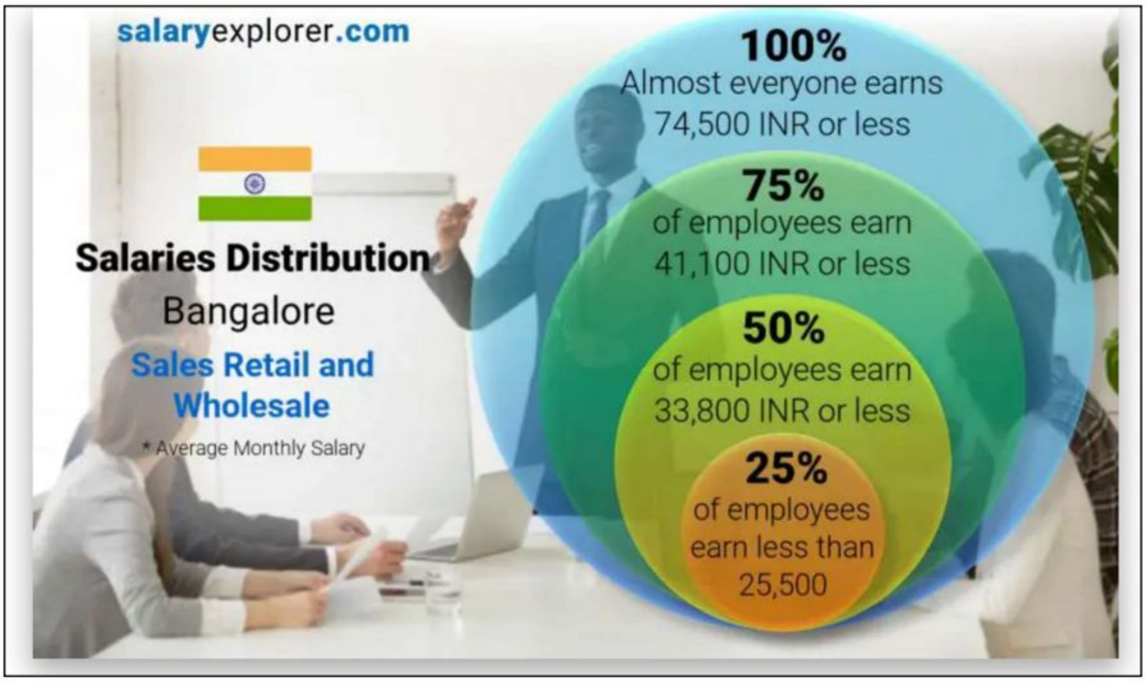

Figure 4. Monthly salary levels of the people working in the Retail Sales sector in Bengaluru

2. **Apparel manufacturer**

Karnataka is a major producer of cotton and silk and is the country's main hub for textile and garment manufacturing. The state contributes 20% of the total garment production, valued at close to US$1 billion, and is the second largest textile employer in India.

The government has actively promoted the sector by setting up apparel parks across the state, offering modern facilities and convenient infrastructure. Among these are the Doddaballapur Integrated Textile Park (Phase I) and Doddaballapur Apparel Parks (Phases II and III), located in the Bengaluru Rural District. As per the record of the Department of Handlooms & Textiles of the State of Karnataka, there are around 401 garment units in Bengaluru.

A person working in Fashion and Apparel in Bangalore typically earns around 28,500 INR per month. Monthly salaries range from 10,300 INR (lowest average) to 61,700 INR (highest average). The actual maximum salary is higher than the estimated highest average **[4]. Figure 5** highlights the monthly salary levels of the people working in the Apparel Manufacturing sector in Bengaluru.

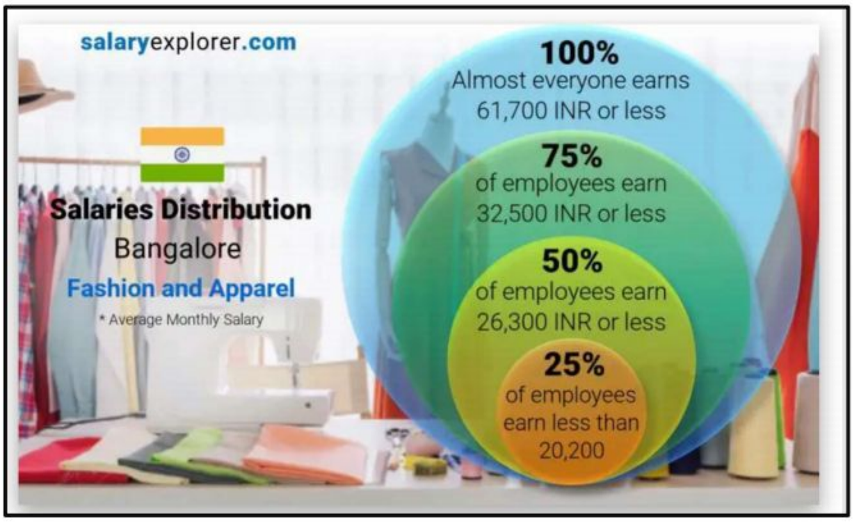

Figure 5. Monthly salary levels of the people working in the Apparel Manufacturing sector in Bengaluru

3. Food servicing

A person working in the Food / Hospitality / Tourism / Catering sector in Bangalore typically earns around 23,800 INR per month. Monthly salaries range from 8,740 INR (lowest average) to 64,300 INR (highest average). The actual maximum salary is higher than the estimated highest average **[5]. Figure 6** highlights the monthly salary levels of the people working in the Food / Hospitality / Tourism / Catering sector in Bengaluru.

Figure 6. Monthly salary levels of the people working in the Food / Hospitality / Tourism / Catering sector in Bengaluru

4. IT Sector and Computer Programming

The Bengaluru IT hub contributes about 34-40% of the total IT exports from India. Consequently, the city is among the most favored destinations for IT and other knowledge-based industries **[6].** An individual working in Information Technology in Bangalore typically earns around 35,600 INR per month. Monthly salaries range from 18,000 INR (lowest average) to 56,500 INR (highest average). The actual maximum salary is higher than the estimated highest average. **Figure 7** highlights the monthly salary levels of the people working in the IT and Computer Programming sector in Bengaluru.

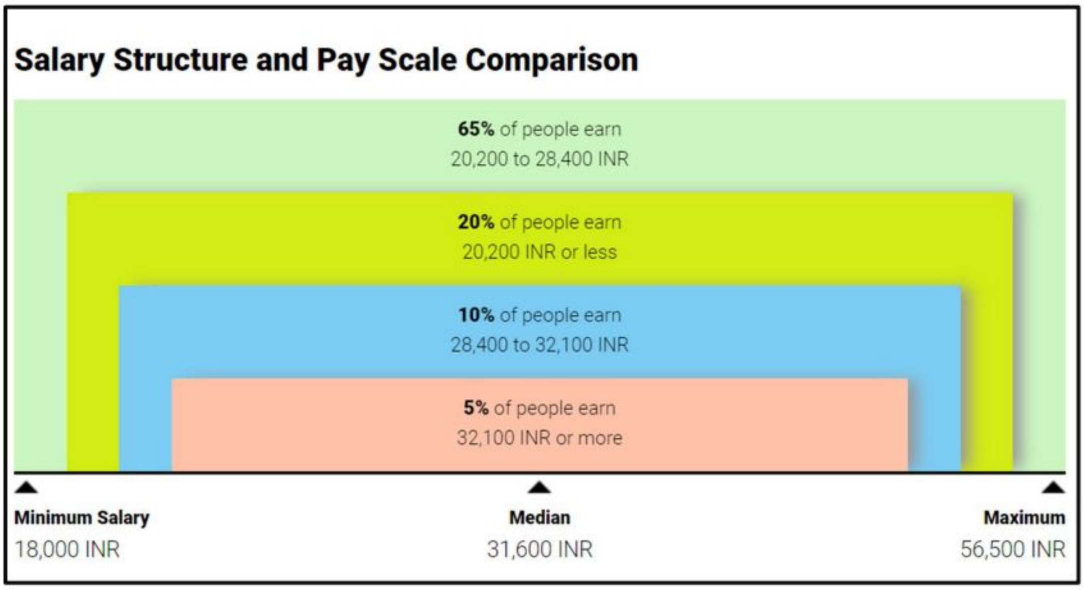

Figure 7. Monthly salary levels of the people working in the IT and Computer Programming sector in Bengaluru

5. Management Consultancy

A person working as an Executive / Management Consultant in Bengaluru typically earns around 47,200 INR per month. Monthly salaries range from 15,400 INR (lowest average) to 77,100 INR (highest average). The actual maximum salary is higher than the estimated highest average **[7]. Figure 8** highlights the monthly salary levels of the people working in the Management Consultancy sector in Bengaluru.

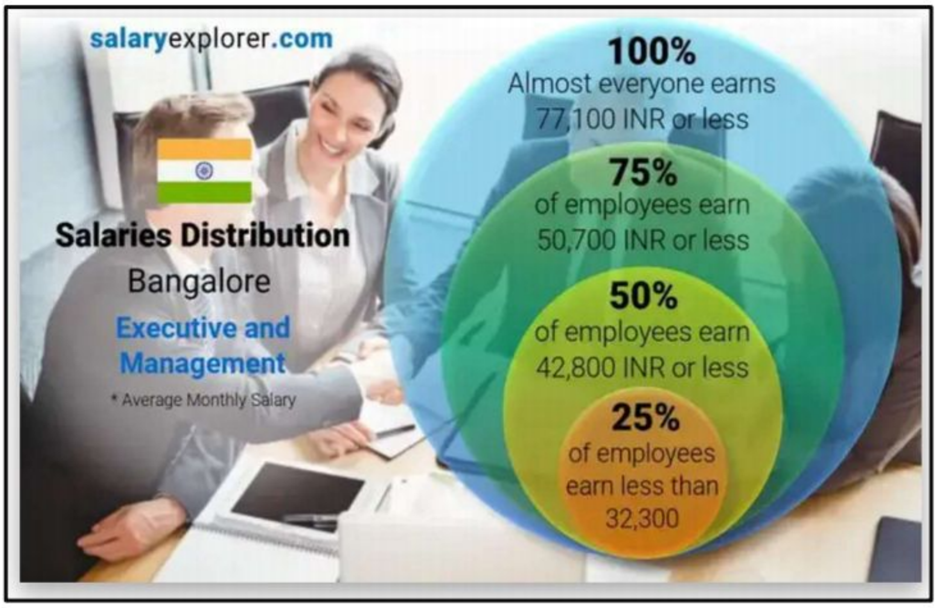

Figure 8. Monthly salary levels of the Executives and Management Consultants in Bengaluru

Evidently, the overall income scenario in Bengaluru is characterized by a wide array of sectors, with the IT sector, textile and garment manufacturing, and the retail industry being some of the major contributors. The data highlights gender imbalances in the workforce, with a majority of the formally employed population being male. Wage levels are different across the sectors, with higher wages being offered in IT and management consultancy compared to other sectors, such as food servicing and apparel manufacturing.

References

[1] What the Last Economic Census Said About Bengaluru ***(Open City).*** **< Retrieved from:** https://opencity.in/what-the-last-economic-census-said-about-bengaluru/ > [Last Accessed on October 20, 2023]

[2] Average Salary in Bangalore 2023 ***(Salary Explorer).*** **< Retrieved from:** https://www.salaryexplorer.com/average-salary-wage-comparison-bangalore-t3502?expand_article=1 > [Last Accessed on October 20, 2023]

[3] Sales Retail and Wholesale Average Salaries in Bangalore 2023 ***(Salary Explorer).*** **< Retrieved from:** https://www.salaryexplorer.com/average-salary-wage-comparison-bangalore-sales-retail-and-wholesale-t3502f48 > [Last Accessed on October 20, 2023]

[4] Fashion and Apparel Average Salaries in Bangalore 2023 ***(Salary Explorer).*** **< Retrieved from:** https://www.salaryexplorer.com/average-salary-wage-comparison-bangalore-fashion-and-apparel-t3502f25 > [Last Accessed on October 20, 2023]

[5] Food / Hospitality / Tourism / Catering Average Salaries in Bangalore 2023 ***(Salary Explorer).*** **<Retrieved from:** https://www.salaryexplorer.com/average-salary-wage-comparison-bangalore-food-hospitality-tourism-catering-t3502f28 > [Last Accessed on October 20, 2023]

[6] Information Technology Average Salaries in Bangalore 2023 ***(Salary Explorer).*** **< Retrieved from:** https://www.salaryexplorer.com/average-salary-wage-comparison-bangalore-information-technology-t3502f1 > [Last Accessed on October 20, 2023]

[7] Executive and Management Average Salaries in Bangalore 2023 ***(Salary Explorer).*** **< Retrieved from:** https://www.salaryexplorer.com/average-salary-wage-comparison-bangalore-executive-and-management-t3502f24 > [Last Accessed on October 20, 2023]

Annexure IV

A Review of the Status of Bengaluru's Power Distribution from the Reliability Perspective

Rajeev Kumar, and **Rudrodip Majumdar**

EECP, National Institute of Advanced Studies, Bengaluru-560012

Abstract

Despite Karnataka's surplus electricity generation, Bengaluru, India's tech hub, grapples with frequent power cuts. The major bottlenecks are ailing distribution infrastructure, overworked transformers, and cable faults. While unplanned outages occur due to weather conditions (e.g., excessive rainfall or windstorms) or equipment failures, planned outages are mainly attributed to the transitioning of overhead lines to underground cables and routine infrastructure upgrades. The looming coal shortage crisis has raised concerns regarding reliable baseload power supply across the country. However, Karnataka's diversified energy mix comprising contributions from thermal, renewable, nuclear, and hydro enhances the potential availability of reliable power. Further, the transition to underground power cables has led to a significant reduction in transmission losses, thereby improving reliability. Even then power interruptions are prevalent in Karnataka, especially during scorching summers when the demand peaks. Smart Meters have emerged as a promising solution in the context of efficient power management. However, the large-scale rollout is yet to be achieved. The reduction in the Fuel and Power Purchase Cost Adjustment (FPPCA) charges rolled out in September 2023 is likely to benefit the consumers. In the larger context, India's ambitious renewable energy targets, aimed at attaining Net Zero Carbon Emissions by 2070, present steep challenges in grid stability, storage, and integration. Higher penetration of the Variable Renewable Energy (VRE) sources in the overall energy mix necessitates innovative and progressive planning to achieve an optimal electricity mix. For effective utilization of the awash generation capacity created in the country, the interventions need to be multi-pronged. On a larger scale, ensuring efficient transmission corridors is a major technical intervention. At a local level, timely land allocation for sub-stations and resolving right-of-way issues are of paramount importance considering the current situation in the Bengaluru area. Additionally, reforms in the power distribution sector are also essential. Overall, Bengaluru's power distribution issues call for interventions from multiple angles, including infrastructure upgrades, deployment of smart meters and other improved technologies, and adoption of a sustainable energy mix with a specific focus on reliability.

1. Introduction

Bangalore Electricity Supply Company Limited (BESCOM) covers a total area of 41.092 sq. km with a population of over 207 Lakhs (census 2011) whereas the larger Bengaluru Metropolitan Area (BMA) spans over an area of 1294 sq. km with 90 Lakhs population (Census 2011). BESCOM has three operating Zones, Bengaluru Metropolitan Area Zone (BMAZ), Bengaluru Rural Area Zone (BRAZ), and Chitradurga Zone (CTAZ). A total of 9 Circles, 28 Divisions, 119 Sub-divisions, and 453 Section Offices come under the BESCOM command **[1]. Figure 1** presents a summary of the different power distribution control areas under BESCOM. It is to be noted that BMA and BESCOM BMAZ do not exactly correspond to each other, although the acronyms sound similar. BMA is covered by both BESCOM BMAZ and BRAZ. BMAZ of BESCOM is divided into twelve divisions which include, i) Indiranagar, ii) Shivajinagar, iii) Vidhana Soúdha, iv) Hebbal, v) Malleshwaram, vi) Peenya, vii) H.S.R. Layout, viii) Jayanagar, ix) Koramangala, x) Kengeri, xi) Rajajinagar and xii) Rajarajeshwari Nagar **[1].**

Bengaluru is powered by the same southern grid that supplies electricity to the entire state. The sources include hydel, thermal, and variable renewable sources (solar and wind). Karnataka state receives power from Central Generating Stations (CGS), hydel power stations, and thermal power stations, located within the state.

Figure 1. Organization Structure of BESCOM

	Zones	Circles	Number of Divisions	Number of Subdivisions
BESCOM	BMASZ	South	3	20
		West	3	15
	BMANZ	North	4	13
		East	4	15
	BRAZ	BRC	2	9
		RMGC	4	18
		KLRC	4	17
	CTAZ	TMKC	4	19
		DVGC	4	21
Total	4	9	32	147

BESCOM = Bangalore Electricity Supply Company Limited, BMANZ = Bangalore Metropolitan Area North Zone, BMASZ = Bangalore Metropolitan Area South Zone, BRAZ = Bangalore Rural Area Zone, CTAZ = Chitradurga Zone

Source: BESCOM

Figure 1. Profiling of different Power Distribution control areas under BESCOM

The power is supplied to the city of Bengaluru through four 400/220 kV power stations located at Hoody, Nelamangala, Bidadi, and Somanahalli, respectively **[1]**. Further, electricity is supplied to different parts of the city through 220/66 kV sub-stations, which are equally distributed to all parts of the city. The power is supplied to consumers primarily at 11 kV, after a voltage step-down through the substations. However, the 33 kV supply is also available for the bulk consumers/industries. BMAZ has 4 nos. of 400/220kV Substations, 25 nos. of 220/66kV Substations, and 52 nos. of 66/11kV Substations, amounting to a total installed capacity of 13245 MVA **[1]**. On the transmission side, BMAZ has 9690.32 ckt km and 18006.94 ckt km of HT and LT lines, respectively. There are 2801 numbers of Distribution Transformers within the BMAZ. Further, the Karnataka Power Transmission Corporation Limited (KPTCL has planned 18 sub-stations of different capacities (400kV, 220kV, 66kV sub-stations) in the BMA Zone of BESCOM **[1]**.

400 kV Substations: These substations likely play a crucial role in receiving high-voltage electricity from distant power generation sources or other high-voltage substations and stepping it down to a lower voltage level suitable for distribution within the BMA Zone.

220 kV and 66 kV Substations: These substations may further step down the voltage to levels appropriate for various distribution needs, such as industrial areas, commercial districts, or residential neighborhoods.

2. Main causes of frequent power cuts in Bengaluru (BESCOM area)

Overall, the State of Karnataka has surplus power and suffers low losses at the transmission level. However, the various system-level bottlenecks faced by Bengaluru's BESCOM weaken the overall performance **[2]**. The lack of a proper distribution network infrastructure and its inadequate operation and maintenance are the major reasons behind these power cuts. Poor network maintenance coupled with overloading and lightning during the storms result in the frequent breakdown of distribution transformers, which are the last-mile assets for dispatching electricity to consumers **[2]**.

BESCOM classifies power outages into two main categories, planned and unplanned **[2]**. Unplanned outages can occur due to various reasons, including adverse weather conditions like rain and heavy winds, which may prompt BESCOM to suspend the power supply to prevent potential damage to wires and poles. This also ensures public safety. Other unforeseen factors such as cable faults or transformer malfunctions can also lead to unplanned outages **[2]**.

However, a significant portion of power outages are planned. The BESCOM scheduled specific power cuts on each day during the month of October 2021. The General Manager of

BESCOM's Customer Relations explained that most of these planned outages in recent years are attributable to the transition from overhead power lines and transformers into underground systems **[2]**. Occasionally, power interruptions can also occur due to cable damage caused by road expansion activities or the installation of other utility lines (e.g., internet cables) **[2]**. Currently, there is a planned effort to modernize the aging infrastructure such as transformers and the ring main units **[2]**.

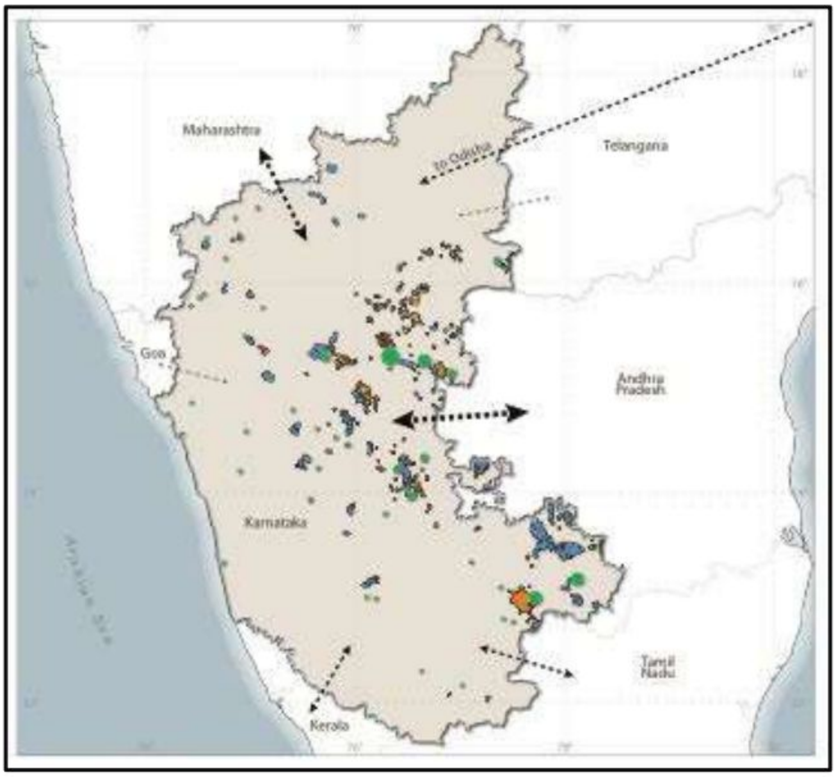

Figure 2: A schematic map showing the electric power exchange of Karnataka with other regions

Figure 2 shows the electric power exchange of Karnataka with other regions **[3].** The BESCOM officials have highlighted that shifting more than 50% of Bengaluru's power cables underground will help mitigate issues related to rain and adverse weather conditions **[2]**. However, it is noteworthy that addressing operational and maintenance challenges remains a separate and ongoing concern that would require continuous attention.

2.1 Lack of professionalism, and inefficient work culture

Many power-related issues are caused by a lack of efficiency in the way work is completed. For instance, the workers now have started placing electrical cables underground to make the power supply more reliable. However, some of these workers are not adept in their jobs, and often they are connecting the wires in the wrong order. The power is delivered to households and commercial buildings using wires color-coded as red, yellow, blue, and black, by maintaining a proper sequence. However, the line workers deployed by BESCOM are making the mistake of connecting the wires in the wrong sequence. Because of the erroneous wirings, the machines that use electricity are malfunctioning (e.g., the electric motors are shutting down unexpectedly). Even some of the households had to install a device called a single phasing protector to prevent damage to electrical equipment and needed intervention from BESCOM to get the connection redone **[2]**.

2.2 Possible impact of projected coal shortages

According to Union Power Minister Shri R.K. Singh India is facing a severe coal shortage owing to unprecedented demand attributable to post-COVID recovery and mentioned that a short-term energy crisis could be expected. However, many independent observers opine that an artificial crisis has been projected to facilitate the passing of controversial Coal Bearing Areas (Acquisition & Development) Amendment Bill, 2021 **[2]**.

Recently, the director of Karnataka Power Corporation mentioned that no major outages are expected in the State of Karnataka owing to the coal shortage, and hinted the situation is improving. Due to Karnataka's diversified energy mix, its dependence on thermal power generation is relatively less. The ample wind and solar energy generation resources available in the state bolster its energy resilience. Moreover, decent rainfall in recent times has contributed to robust hydroelectric power production, strengthening the state's energy portfolio **[2]**.

According to the experts, Karnataka as a whole is in a power surplus condition and disruptions are due to issues at the distribution end. However, if the impending coal shortages continue, the power generation in the state may face serious problems since coal provides the baseload power **[2]**.

3. Power Supply Shortages during Summer

Bengaluru City has been rapidly growing over the past two decades and this has resulted in an increasing electricity demand. The supply-demand mismatch becomes particularly acute during the summer months, resulting in frequent power cuts. Many localities have been facing sheer discomfort owing to no power supply during the night and often for long hours even in the afternoon **[4]**.

The government is trying to tackle these issues with some measures such as setting up new power plants, improving transmission lines, encouraging the use of renewable energy sources, etc. However, the problem is not alleviated yet **[4]**.

Vinod Jacob, a representative from Namma Bengaluru Foundation, emphasized the necessity of conducting regular audits and maintaining critical infrastructure for BESCOM and similar agencies. During the summer, there is a substantial rise in electricity demand, and the power supply from the grid is adequate to meet the same. However, due to inefficient infrastructure and equipment at the distribution end, BESCOM struggles to perform optimally **[4].** Therefore, the critical need of the hour is to enhance the efficiency of BESCOM's power distribution system.

Furthermore, it is also to be considered that the cumulative outage duration of all feeders in Bengaluru North and South areas in May 2018 alone was 21,248 hours. There have been many promises of uninterrupted power supply for Bengaluru. But in reality, the city has witnessed far more feeder outages than other districts served by the BESCOM **[5].**

4. Recent Developments in BESCOM

BESCOM's decision to put overhead cables underground is an impressive move since it would help mitigate problems such as the risk of electrocution, which is prevalent during rainy seasons. According to company officials, out of the 7,137 km of High Tension (HT) lines in the city, 6,769 km have been moved underground. Further, 5,668 km out of 5,957 km of Low Tension (LT) lines have also been converted to Aerial Bundled (AB) cables **[6]**.

Turning the HT (high tension) lines into underground cables would save them from getting damaged by treefalls, wind, and rain. The transformation of LT (Low Tension) wires (which supply power to end-users) into AB cables by bunching them into multiple layers of insulation will help prevent electrical accidents and electrocutions.

The old infrastructures like transformers and ring main units are being upgraded and modernized to maintain a continuous power supply in BMAZ **[6]**.

5. Smart Meters - A Future Initiative for BESCOM

Lots of Pilot Projects have been planned to adopt Smart electricity Meters on a large scale in Karnataka. The advantage of a smart meter lies in its ability of remote monitoring and usage tracking, and this promises to usher in transparency and accountability. However, since the deployment is capital-intensive, a large-scale rollout is yet to be realized. Effective deployment of smart meters requires a sound network communication system, which would take some time to be developed. Smart meters will allow for two-way communication, which facilitates remote monitoring of the meters, power disconnection as per the need, and efficient consumer interface **[7]**.

Smart meters offer numerous advantages, including real-time monitoring of electricity usage. They provide consumers with detailed information about their energy consumption patterns, helping them make informed decisions to reduce energy wastage and save on utility bills. Additionally, these meters enable utilities to monitor the grid more efficiently, detect power theft, and respond to outages promptly. The success of smart meter deployment also hinges on effective consumer engagement and education. Consumers need to understand the benefits of smart meters, how to interpret the energy data, and how to use this information to make energy-efficient choices. Utility companies often conduct outreach programs to ensure that the consumers are well-informed **[7]**.

6. Major Incentives for BMAZ consumers

BESCOM has put into effect a Fuel and Power Purchase Cost Adjustment (FPPCA) charge of ₹1.15 per unit in the billing cycle of September 2023 due to recent revisions. The revised FPPCA has come down from ₹2.05 per unit in the August 2023 billing cycle and will be applicable only for September. However, for the beneficiaries of the Gruha Jyothi scheme, even the FPPCA charges will be covered by the Karnataka government **[8]**.

7. Energy Transition: Opportunities and challenges for the Indian power sector

The country has already made significant progress with renewable energy (RE), with total installed capacity reaching about 179.3 GW as of July 2023. This includes 42.8 GW of wind energy and 67 GW of solar power **[9]**. However, to reach the target of 500 GW of non-fossil-based energy generation capacity, India still has a long way to go. To achieve the aspirational target, a concerted effort from different power sub-sectors (generation, transmission, and distribution) is required and a detailed analysis of the opportunities and challenges of each of them is needed **[10]**.

To harness the RE potential, efficient transmission corridors must be built across the country. To balance the grid with more RE, advanced technologies should also be explored to deal with the instability caused by non-synchronous generation from RE. The One Sun One World One Grid (OSOWOG) is an interesting concept and a potential alternative for utilizing solar energy globally in an equitable manner. However, the framework has its own unique challenges.

The distribution sector can be the critical link for integrating RE into the grid. However, the challenges related to the implementation of various reforms and increasing accountability and responsibility at the local levels need to be addressed carefully, in a synergistic manner **[10].**

While RE integration is an opportunity at the global level, innovations are required in terms of customized solutions suited to the local context and environment.

Some of the major challenges faced by the BMAZ that Revised Master Plan (RMP) 2031 brought forth by the Bengaluru Development Authority (BDA) intends to address are as follows:

- **Land Allocation for Sub-Stations**: Some of the distribution transformers are heavily overloaded, leading to tripping of the feeder or failure of the transformer and consequent sudden loss of power supply to consumers. Therefore, as per the RMP 2031 allocation of land for sub-stations is being considered in adjoining areas of such distribution transformers **[1]**.
- **Right of Way (RoW):** Most of the city has narrow roads without adequate space for power corridors (i.e., overhead lines or even underground cables). Since the right of way has not been planned previously, it is very difficult to obtain land from landowners for running the transmission lines. The RMP 2031 is contemplating multi-utility zones (MUZ) within the Cross Sections of Proposed Road Networks. In this MUZ, which is located within the RoW, transformers can be located without encroaching footpaths and carriageways **[1]**.
- **Transmission Line Corridor**: RMP 2031 is contemplating underground transmission lines in a big way **[1]**.

8. Bengaluru Peak Demand Projections for Planning Purposes

Several methods have been used in connection with the peak demand projections for Bengaluru, including Trend Analysis, Growth Rate (CAGR), and Per Capita Projections. These projections, validated against forecasts by Power Research and Development Consultants Pvt. Ltd. (PRDC) and approved by KPTCL, offer valuable insights:

A. **Per Capita Consumption**: The scenario based on per capita consumption for a population of 24 million closely aligns with PRDC's projections, indicating a 9.6% increase in energy sales and peak demand compared to the current situation. While the Master Plan 2031 targets a population of 20.3 million, planning for a scenario with 24 million people (8952MW peak demand) may be more prudent.

B. **Renewable Energy Potential**: Projections for renewable energy sources, such as solar and biomass, reveal substantial potential. Bengaluru can generate 14,850 million units of solar energy (rooftop) assuming a plant load factor of 0.18 and 313 million units of biomass energy with an assumed plant load factor of 0.25.

These findings emphasize the importance of forward-looking planning to accommodate a potentially larger population and harness renewable energy resources to meet the growing power demand in Bengaluru. Planning for sustainable growth and energy generation will play a pivotal role in the city's future development. In the broader context of India's energy transition, Bengaluru must overcome challenges related to transmission corridors, grid stability with increased VRE penetration, and the efficient integration of renewable sources.

To summarize, Bengaluru's power issues are multifaceted, ranging from infrastructure deficiencies to supply-demand imbalances. Addressing these challenges requires a combination of infrastructure upgrades, efficient maintenance practices, and a transition toward renewable energy sources. Bengaluru's journey toward a more reliable and sustainable power supply is ongoing and requires continuous interventions, monitoring, and investments.

References

[1] CDP Bangalore Master Plan 2031 ***(Asset Yogi)***. <**Retrieved from**: https://assetyogi.com/cdp-bangalore-master-plan/ > [Last accessed on 21 September 2023]

[2] Explained: What causes Bengaluru's frequent power cuts (***The News Minute***). < **Retrieved from**: https://www.thenewsminute.com/karnataka/explained-what-causes-bengaluru-s-frequent-power-cuts-156334 > [Last accessed on 20 September 2023]

[3] D. Palchak, J. Cochran, A. Ehlen, B. McBennett, M. Milligan, I. Chernyakhovskiy, R. Deshmukh, et al. (2017) Greening the Grid: Pathways to Integrate 175 Gigawatts of Renewable Energy into India's Electric Grid, Vol. I—National Study. <**Retrieved from**: https://www.nrel.gov/docs/fy20osti/72054.pdf > [Last accessed on 22 September 2023]

[4] Bengaluru caught in a power struggle (***Bangalore Mirror***). <**Retrieved from**: https://bangaloremirror.indiatimes.com/bangalore/others/bengaluru-caught-in-a-power-struggle/articleshow/99740530.cms > [Last accessed on 21 September 2023]

[5] The city suffers most feeder outages among BESCOM areas (***The Hindu***). < **Retrieved from**: https://www.thehindu.com/news/cities/bangalore/city-suffers-most-feeder-outages-among-BESCOM-areas-2-stories/article24474291.ece > [Last accessed on 21 September 2023]

[6] BESCOM's conversion of overhead power cables to underground nears finish line (***Deccan Herald***).<**Retrieved from**:

https://www.deccanherald.com/india/karnataka/bengaluru/BESCOM-s-conversion-of-overhead-power-cables-to-underground-nears-finish-line-1238077.html> [Last accessed on 21 September 2023]

[7] BESCOM set to install smart meters in industrial areas ***(Deccan Herald)***. < **Retrieved from:** https://www.deccanherald.com/india/karnataka/BESCOM-set-to-install-smart-meters-in-industrial-areas-1235230.html > [Last accessed on 21 September 2023]

[8] BESCOM to charge ₹1.15 per unit as FPPCA in September bill (***The Hindu***). <**Retrieved from**: https://www.thehindu.com/news/cities/bangalore/BESCOM-bills-to-be-dearer-by-115-per-unit-in-september/article67256697.ece > [Last accessed on 21 September 2023]

[9] Renewable Energy- Industry Scenario. <**Retrieved from**: https://www.investindia.gov.in/sector/renewable-energy> [Last accessed on 21 September 2023]

[10] Energy transition: opportunities and challenges for the Indian power sector (***Energy Manager-CSTEP)***. <**Retrieved from**: https://cstep.in/publications-details.php?id=2295> [Last accessed on 21 September 2023]

Annexure V

Population Segregation (Bengaluru)

Age-based classification

Age Group (Years)	**Males**	**Females**	**Total**	**% Share of Total**
15-24	855138	817056	1672194	**18.8%**
25-39	1474053	1329388	2803441	**31.6%**
40-64	1046881	943921	1990802	**22.4%**
65 and above	214716	211402	426118	**4.8%**
Total (Selected Groups)	3590788	3301767	6892555	**77.6%**
Grand Total (Bengaluru)	**4616478**	**4269020**	**8885498**	

Bengaluru's total population is 8885498. Out of this, the number of males is 4616478 and the number of females is 4269020. In our household-level survey, our target population is individuals aged above 15 years. This target group is found to have a major share of the overall population, which is around 77.6%. Precisely, our target population comprises 3590788 males and 3301767 females. The age group of 25-39 years has a significant share of 31.6%, followed by the age group of 40-64 years (22.4%). The young population age group of 15-24 years has a share of 18.8% in the overall figures.

Religion-based classification

Religion	**Males**	**Females**	**Total**	**% share of total**
Hindu	4051032	3674038	7725070	**80.29%**
Muslim	648328	599966	1248294	**12.97%**
Christian	250360	254503	504863	**5.25%**
Sikh	7436	5818	13254	**0.14%**
Buddhist	3007	2524	5531	**0.06%**
Jain	42383	40707	83090	**0.86%**
Other religion	261	237	498	**0.01%**
No Religion Specified	19854	21097	40951	**0.43%**
Total	**5022661**	**4598890**	**9621551**	

Out of a total population of 9621551, the share of Hindus is 80% which is the highest among all the religious groups; whereas Muslims and Christians comprise 6% and 5% of the total population, respectively. The population of Sikhs, Buddhists, and Jains is found to be very low, about 0.14 %, 0.06%, and 0.86% of the overall population, respectively. About 0.43% of the population reported did not have a specified religion. This segregation helps us to know the religious composition in the Bengaluru area.

Occupation-wise Classification

Workers	**Male**	**Female**	**Total**	**% Share**
Main Workers	2893953	964389	3858342	**28.6%**
Cultivators	60149	20261	80410	**0.6%**
Agriculture Labourer	51519	25775	77294	**0.6%**
Household Industries	64162	26699	90861	**0.7%**
Other Workers	2718123	891654	3609777	**26.8%**
Marginal Workers	221408	167177	388585	**2.9%**
Non-Working	1907300	3467324	5374624	**39.9%**
Total	**7916614**	**5563279**	**13479893**	

The relative abundance of Main Workers is the highest in terms of percentage (28.6%), whereas that of the cultivators and agricultural laborers is just 0.6%. Household industries and other workers comprise 0.7% and 26.8% of the overall numbers. Marginal workers comprise a share of 2.9%. Notably, the non-working population is quite significant with a share of 39.9%.

Caste-wise Population

Category	**Total**	**% Share**
SC Population	1198385	**12.46%**
ST Population	190239	**1.98%**
Others	8232927	**85.57%**
Total Population	**9621551**	

SC population comprises 12% of the total population of Bengaluru, whereas ST Population comprises about 2% of Bengaluru's total population. Other castes comprise 86% of Bengaluru's overall population.

Annexure VI

A Guide to Prominent Local Food Items Consumed by Bengaluru Households

Food Item (Local Name)	Accepted English Name	Description and Cooking Method	Cooking Processes Used
Chitranna	Lemon Rice	Cooked rice mixed with lemon juice, seasoned with spices like mustard seeds, curry leaves, and nuts like peanuts.	**Sauteing, Seasoning**
Puliyogare	Tamarind Rice	Cooked rice mixed with a special tamarind paste prepared with spices like mustard seeds, fenugreek seeds, and curry leaves.	**Sauteing, Seasoning**
Bisi Bele Bath	Hot Lentil Rice	One-pot meal made with rice, Toor dal (split pigeon peas), and vegetables, cooked together with a spice blend including cinnamon, cloves, and coriander seeds.	**Boiling, Sauteing, Seasoning**
Pongal	South Indian Rice-based Dish Cooked in Boiling Milk	Traditional rice and lentil dishes are prepared in savory (Ven Pongal) and sweet (Sakkarai Pongal) varieties.	**Boiling, Seasoning**
Vangi Bath	Brinjal Rice	Rice dish flavored with a unique spice blend and brinjals (eggplants), often served with raita or yogurt.	**Boiling, Sauteing, Seasoning**
Upma	Thick Porridge from Dry Roasted Semolina or Coarse Rice Flour	Breakfast dish made from roasted semolina (rava or suji), flavored with spices, and vegetables, and seasoned with mustard seeds and curry leaves.	**Boiling, Sauteing**
Sambhar	Lentil-based Vegetable Stew	Lentil-based stew made with toor dal (split pigeon peas), vegetables, tamarind, and a special blend of spices like coriander, cumin, and fenugreek seeds.	**Boiling, Simmering**
Rasam	Spicy South Indian Soup	Tangy soup is made with tamarind, tomatoes, and spices like black pepper, cumin, and asafoetida, often served as a side dish with rice.	**Boiling, Seasoning**

Mudde	Finger Millet Ball	Made from ragi (finger millet) flour and water, cooked to a thick consistency, and served with sambar or saaru (rasam).	**Boiling**
Khaman Dhokla	Soft and Spongy Delicacy of Gujarat Origin	This savory snack is made from fermented chickpea flour (besan), steamed and seasoned with mustard seeds and curry leaves, and served with green chutney.	**Steaming, Seasoning**
Chakli	Spiral Shaped Savoury Snack with a Spiked Surface	This savory snack is made from rice flour and urad dal (black gram dal) flour, seasoned with spices, shaped into spiral patterns using a chakli press, and deep-fried until crispy.	**Dough-making, Light Frying, Seasoning**

Annexure VII

Explanations for Prominent Cooking Methods Used in Preparing Predominant Dishes

1. Steaming

This method cooks food using steam from boiling water. The food is placed in a basket or container above the water, ensuring it doesn't touch the liquid. This method preserves nutrients, colors, and flavors, making it ideal for vegetables and fish.

2. Sautéing

Sautéing involves cooking food quickly in a small amount of oil or fat over high heat. It requires constant stirring or flipping to ensure even cooking and prevent burning. This method is great for browning and caramelizing vegetables, meats, and seafood.

3. Seasoning

Seasoning is the process of adding herbs, spices, salt, pepper, or other garnishing to food. It enhances the natural flavor and transforms the taste profile of a dish. Proper seasoning is crucial for ensuring the appropriate presentation of delicious food items.

4. Boiling

This method cooks food by immersing it in water or broth at 100°C (212°F). It is a straightforward method suitable for cooking pasta, potatoes, and hard vegetables. Although boiling can lead to some nutrient losses, this method is effective for large quantities of food.

5. Simmering

Simmering involves cooking food in liquid at a temperature just below boiling, around 85-95°C (185-205°F). It allows flavors of the ingredients to meld and is gentler than boiling, making it ideal for soups, stews, and sauces.

6. Baking

Baking uses dry heat in an oven to cook food evenly from all sides. It is used for a wide range of dishes, including breads, cakes, casseroles, and meats. Baking can create a crispy exterior while keeping the interior moist.

7. Grinding

Grinding reduces the food materials into small particles or powder using a grinder or food processor. It is used for spices, coffee beans, grains, and meat. This method enhances texture and flavor, making ingredients more versatile.

8. Deep Frying

Deep frying cooks food by immersing it completely in hot oil. The high temperature creates a crispy, golden-brown exterior while cooking the interior quickly. It is a popular method for food items like fries, chicken, and doughnuts.

9. Fermenting

Fermenting involves using bacteria, yeast, or other microorganisms to convert sugars into acids, gases, or alcohol. This process not only preserves food but also enhances its flavor and nutritional value. Food items that involve fermentation include yogurt, sauerkraut (finely cut raw cabbage fermented by lactic acid bacteria), and kimchi (a traditional Korean side dish comprising salted and fermented vegetables such as cabbage or radish).

10. Frying

This method cooks food in hot oil or fat. There are various methods, including pan-frying, deep-frying, and stir-frying. Frying adds a crispy texture and rich flavor to food items like chicken, fish, and vegetables.

11. Braising

Braising involves cooking food slowly in a small amount of liquid after initial browning. It combines both dry and moist heat, resulting in tender, flavorful dishes. This method is commonly used for tough cuts of meat and root vegetables.

12. Roasting

This method cooks food using dry heat in an oven, typically at higher temperatures than baking. It is ideal for large cuts of meat, poultry, and vegetables, creating a caramelized, crispy exterior while keeping the interior tender.

13. Chilling

Chilling is the process of lowering the temperature of food to slow down bacterial growth and preserve freshness. This is typically achieved by placing food in a refrigerator at temperatures between 0°C to 4°C (32°F to 40°F). Chilling helps extend the shelf life of perishable items like dairy products, meats, fruits, and vegetables, keeping them safe to eat and maintaining their quality.