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Viability of Electricity as a Cooking Solution on a large scale for Rapid Cooking Energy Access

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Final Report

Viability of Electricity as a Cooking Solution on a large scale for Rapid Cooking Energy Access

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List of Abbreviations

BPCL- Bharat Petroleum Corporation Limited

COPD -Chronic Obstructive Pulmonary Disease

DDUGJY- Deen Dayal Upadhyaya Gram Jyoti Yojana

HPCL- Hindustan Petroleum Corporation Limited

IAP - Indoor-air pollution

IOCL- Indian Oil Corporation Ltd.

KG- Kilo gram

KWh- Kilo Watt Hour

LPG- Liquefied Petroleum Gas

PPAC- Petroleum Planning and Analysis Cell

RGGLV- Rajiv Gandhi Gramin LPG Vitaran

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Executive Summary

Background

Clean cooking solution for rural Indian households that largely rely on biomass requires a multi-pronged approach. The Government Launched Ujjwala scheme to reach out to 50 millions households with LPG is one of the largest clean energy Access programme to augment LPG uses especially in rural and remote areas. Delivering LPG requires setting up a massive additional supply infrastructure, recruitment of many more LPG distributors etc.

At the same time, India nears universal electrification by 2019 through Saubhagaya scheme. This open up possibility of using electricity as clean cooking energy, which is at a nascent stage in policy discourse. India's LPG import dependence and its price volatility further make electricity more viable and desirable. In any case supplying energy through pipelines, cylinders and trucks is energy inefficient compare to sending it through wires. We report on a pilot experiment to test the potential of electricity in providing a viable option for clean cooking. The study explores the practicality of cooking with induction cooktop in the rural and peri-urban areas.

Analysis of LPG supply status for study location selection

Based on the analysis of LPG penetration level in rural and peri urban areas, and supply of LPG two states Rajasthan and Chhattisgarh were selected for a detailed analysis. Further, since the objective of study was to understand the cooking issues at rural and peri urban area therefore three villages from each of the two districts in each state was selected. There has been a steady increase in the annual growth rate of LPG consumers in the study villages whereas LPG supply is not commensurate. Consumers have to travel 15-20 km for LPG refill, which are often a responsibility of male member of the households. This implies a male member of the household would forgo a day's work and lose wages to collect an LPG cylinder, besides travel and transportation cost, which often are not factored in the cost of LPG use. Providing doorstep delivery of LPG or increasing the number of distributors has its own resource challenges. As per Petroleum Planning and Analysis Cell on January 2018, 1080 distributors were serving 13.26 million households in Rajasthan and 427 distributors were serving 4.31 million households in Chhattisgarh. On average, a distributor served 12,278 households in Rajasthan and 10,094 households in Chhattisgarh against a national average of 13188 households a distributor. LPG distributors tend to congregate around the cities only.

Methodology

The study involves three stages:

a) In first stage, a household survey was conducted to **identify households** for induction cooktop intervention.

b) Survey was followed by a **training, demonstration and distribution of induction cooktop** to identified beneficiary households.

c) Finally, **feedback from the intervention households** were collected for evaluation and analysis.

Identification of intervention household: To identify households who are willing to accept or consider electric cooking as a viable cooking energy we conducted a household survey using a structured questionnaire. We carried out the pilot study of 200 rural households (50 households in each district) of the 2 states, 4 districts and 12 villages in Rajasthan and Chhattisgar. The survey gathered information on the socioeconomic conditions, energy-use patterns, willingness to adapt to clean cooking, status of electricity supply in rural and peri urban areas. Of the 200 surveyed households, 40 households, 20 each in Rajasthan and Chhattisgarh, were identified based on a set of predetermined criteria's listed below:

1. A metered electricity connection
2. Willingness to use the electric cooktop
3. Ability to pay for the additional electric bill due to electric cooking
4. Ability and willingness to purchase induction cooktop and compatible utensils

Availability and quality of electricity supply in surveyed villages

The selected village has 100 percent electrification in Rajasthan and 94 percent in Chhattisgarh. All households had a metered electricity connection and most of them reported timely payment of their electricity dues. The villagers reported uninterrupted power supply of more than 18 hours a day with regular availability in the morning and evening hours. Merely 10 percent households in Chhattisgarh and 30 percent households in Rajasthan said that power blackout is an issue whereas 10 percent households has complain about voltage fluctuation. There was hardly any complaint of low voltage or inflated bills.

Evaluation: Survey of the intervention households for their experience

These selected 40 households were provided with induction cooktop and a set of compatible utensils each. Before the observation period in technical collaboration with M/S TTK Prestige, we trained the beneficiaries in induction cooking method and essential user know-how and briefed than on health, environmental and cost benefits. After the training and demonstration session, the study followed 40 households cooking experience through cooking sessions and monitoring schedule which comprising 2-4 cooking sessions a day to study practical aspects of its usability. Therefore, 15 days monitoring schedule was prepared to record observations on experience of cooking with induction cooktop for each beneficiary's households. The purpose was to analyse the problems with respect to operation of the induction cooker, namely ease of operation, compatibility of cooking utensils, food preparation, taste satisfaction and

comparison of Induction cooktop. vis-à-vis LPG and biomass cook stoves. Further to check, the ability and willingness to purchase induction cooktop and compatible utensils a token sum of Rs.500 were collected from all 40 beneficiaries' households.

Induction cook top is different from other traditional cooking stoves and new to Indian households especially for rural households. During the observation period, the intervention households used induction cooktops for boiling and frying cooking procedures. In Rajasthan 90% households, prepared lunch and 85 % households prepared dinner while 100% households prepared lunch and dinner in Chhattisgarh. Breakfast and evening snacks prepared by 100 % households in both the states during observation period. Induction cooktop used for boiling by 100% households in both states. In Chhattisgarh, 85 percent households said that induction cooktop full fill major cooking needs as compared 65 percent households in Rajasthan. In Rajasthan 95 percent and in Chhattisgarh 50 percent households showed their interest to buy new induction cooktop compatible utensils in upcoming days to fulfil all cooking needs showed their interest due to higher income. No incidence of electrocution was reported while operation of induction cooktop and no unsafe incidents took place removing the fears of safety. Following the observation period, beneficiary households expressed overall satisfaction with induction cooking; they also noted a significant reduction in their biomass/LPG fuel consumption and unaltered quality of food taste. About 80 per cent of them expressed their willingness to pay for the cooktop unit set they had received under the pilot study and express willingness to recommend the cooktop device to others in the community.

Concluding remarks from the pilot study

The pilot study though limited in scope, points out that induction cooktop can be a promising solution for clean cooking even in rural areas, peri-urban and urban areas. The potential seen was encouraging with time can overcome psychological barriers and technical barriers. It reduces LPG or biomass consumption substantially. The pilot study encountered a widespread misconception that electric cooktops are not adaptable to Indian cooking. The study successfully quashed those misconceptions with live demonstrations.

In general, the following conclusions emerge:

- Induction cooktop is comparable option in terms of efficiency and operating costs as LPG.
- It was felt that cooking through induction cooktop may not be an alternative to biomass but also to LPG, where the distributors were far away.
- Taste of food, cooking patterns and safety-related aspects were found to be good as compared to other devices. Therefore, targeted campaigns can remove misconceptions of nonusers.
- Induction cooktop addresses the problems of health, cleanliness of kitchen, safety, long preparation time involved in cooking with biomass etc.

Recommendations and roadmap for upscaling:

The strategies for enhancing adoption of induction cooktop at large-scale require addressing the following critical points:

- Reduction in upfront capital cost with financial support for purchasing the Induction cooktops with compatible utensils, particularly for low-income households either by EMI or by one time DBT.
- Promotion campaign, mass awareness program and user template should be prepared in local language for rapid adoption
- A comprehensive analysis with bigger sample and well spread out is required to understand the problems of the local people in varying situation with adoption of electricity as a clean cooking solution at pan India level. Other states such as North East may be explored for adoption.
- We have carried out a brief economic analysis from consumer's point of view but a detailed analysis of two value chains for delivering 1) electricity and 2) LPG cylinders should be carried out for various scenarios and situations. Detailed cost competitiveness analysis for different electricity and LPG prices need to studied.
- How Saubhagaya and Ujjawala scheme can complement each other need to be studied.
- Currently, the devices is not marketed as rural product, which should be safe and sturdy, have infographics to follow instruction and with manuals in local languages rather in English.
- Mass procurement of induction cooktop may possibly reduce prices as done in LED bulbs like EESl Led Schemes.
- Once the market expands, repairs and advisory services should be available.
- Women themselves should be engaged as sales persons who can also give trainings to other women.

1. INTRODUCTION

Clean cooking energy programmes in India in past focused on providing quality clean cooking solutions, were mostly about improved cook stove, LPG, biogas etc. As per Census 2011, LPG access in India is merely 29 percent. There is a large-scale reliance on solid fuels. About 87 per cent households fully or partially use firewood, crop residues, dung, and charcoal. In spite of many, clean cooking programmes of the government and demonstration projects of the non-governmental organizations, a widespread dependence on unclean cooking fuel calls for a review of strategy to achieve the universal access to clean cooking fuels. While such efforts continue, India must also explore use of electricity for clean cooking. This is viable given its better reach and coverage.

Providing LPG access to a new set of consumers would require provision for additional infrastructure such as tankers, bottling plants, distributors, trucks, warehouses for storage, road space, cook stoves, cylinders, etc. On the other hand, access to electricity by 77.6 per cent rural population in India (World Bank, 2016) can be leveraged for clean cooking. The government is also in the process of electrifying the last remaining villages and households through grid or renewable energy. Considering the number of households still to be provided clean cooking fuel, it is expedient to explore multiple energy sources including electricity. Electrical appliances like electric hot plate, induction cookers, microwave oven, rice cookers etc. can be used with high cost and time efficiency.

With this background, IRADe conducted a study in the rural Chhattisgarh and Rajasthan to understand the feasibility of electric cooking at large scale in India. The broad objectives of this study were as follows:

- To analyse the current LPG supply strategies, including supply, distribution expansion plans, and the implications of cylinder-based delivery on the time, costs and resources needed (LPG bottling plants, cylinders, and transportation) and the scalability of LPG access
- Analyse the availability of electricity, quality of supply, issues and constraints
- Conduct a field survey to capture the user perception of the clean cooking options of LPG and electric cookers, and their willingness to accept the Clean Energy Technology for cooking. The survey primarily focused on the economically poor households in the rural and peri-rural areas.
- Field demonstration of electric cooking in a few select households
- Bring out specific recommendations for the policy formulation for the region, and scale up the strategies to encourage use of Clean Energy Technology

The subsequent chapters in the report cover energy profile of Chhattisgarh and Rajasthan, the two states considered for the pilot study; detailed methodology for research and surveys; survey analysis and results; distribution of induction cooking devices and the user training; and end-line survey results, discussion, and conclusion. Chapter 4 compares the cost of multiple available clean cooking options. Chapter 5 details the methodology adopted for the analysis. Chapter 6 analyses the results of the household survey.

Under this study, Induction cooktops and compatible utensils were distributed to the households selected based on analysis of data from baseline survey. Households were briefed about the method of their use and benefits. Chapter 7 captures the details of capacity building and training programme. Chapter 8 deals with the result of the end-line survey. Chapter 9 concludes the study outcome and discusses the way forward.

2. LITERATURE REVIEW

Access to clean energy is recognized as a critical input for sustainable development. The United Nations Sustainable Development Goal -7 stipulates universal access to modern fuels by 2030. Globally, rural women spend much of their income and time on trying to access energy sources. –Rural Women and young girls spend almost six hours a day gathering fuel wood and water (Meisen and Akin, 2008, Gupta, Bist-Joshi, and Singh, 2013). Cooking with biomass exposes the household members to health hazards (Parikh and Laxmi 2000). Indoor-air pollution (IAP) causes a variety of respiratory illnesses such as chronic obstructive pulmonary disease (COPD), asthma, bronchitis, and pneumonia (Bruce et al., 2000). Of the estimated two million annual deaths attributed to indoor air pollution generated by fuels such as coal, wood, charcoal and dung, 85 per cent are women and children who die from cancer, acute respiratory infections and lung disease (UNDP, 2006). Direct health impacts of dirty energy use and indoor air pollution include life-long or chronic diseases like asthma; burns to children; injuries to women from carrying wood (ESMAP, 2004).

Several studies carried out in different regions of India have emphasized the disproportionate time allocation and distance travelled by women and children for fuel collection (Parikh and Laxmi, 2000; Shailaja, 2000; Laxmi et al., 2003; Parikh, 2011). The time spent for collecting fuel will vary from one agro climatic region to another and also depending upon the availability of fuel commonly collected in the region. Better access to household cooking fuel will release time that can be be gainfully employed in other welfare enhancing behaviours such as income generation, education (especially for school-aged girls) and leisure.

In the past, interventions in access to clean cooking options primatily focused on improved cook stove, LPG, biogas, solar cookers, etc. with limited success in reducing the women's drudgery. Electricity as an option for clean cooking at large scale in India is still untested. As per Census 2011, only 0.10% household's use electricity for cooking, of which 0.07% are rural households and 0.15% are urban households. Use of electricity for cooking is now gaining popularity with new age appliances such as electric kettles, rice cookers, ovens and microwaves in areas where power supply is reliable (Smith and Sagar, 2014). However, electric cooking appliances have a limitation as these can only be used for a specific cooking, whereas new generation induction cook stoves can be used for a broadrange of cooking needs. New generation induction cook stove can be used for all-purpose cooking and are considered 50% more efficient than the traditional coil based electric stove (Smith and Sagar, 2014).

3. ENERGY PROFILE OF THE STATES

This chapter discusses cooking fuel profile of Rajasthan and Chhattisgarh states.

3.1. Cooking Energy Profile of Rajasthan

In Rajasthan, 22.84 per cent households use LPG for cooking, majority of them in the urban areas. In rural areas a mere 7.68 per cent households have access to LPG, whereas in the urban areas of the state 69.37 per cent households use LPG for cooking. Apart from LPG, firewood, crop residues and dung cakes are the other major cooking fuels used. Use of kerosene, biogas and electricity for cooking is insignificant (see Table 1).

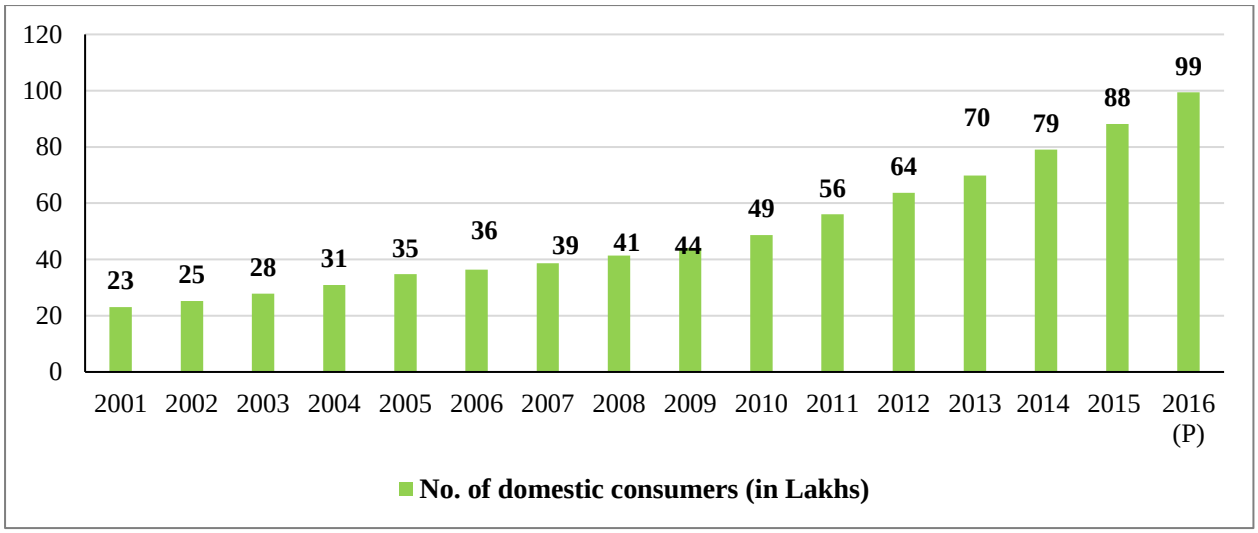
Type of HH	Total number of household	Type of Fuel used for Cooking									
		Fire-Wood	Crop residue	Cow dung cake	Coal, Lignite, Charcoal	Kero sene	LPG/ PNG	Electri-city	Bio gas	Any other	No cooking
Total	12,581.3	7,776.6	1,381.7	372.7	13.7	112.1	2,873.3	3.7	12.1	7.5	27.4
	percent Share	61.8	11.0	3.0	0.1	0.9	22.8	0.0	0.1	0.1	0.2
Rural	9,490.4	7,056.7	1,323.1	322.1	5.4	23.5	728.9	2.9	6.9	5.4	14.9
	percent Share	74.4	13.9	3.4	0.1	0.2	7.7	0.0	0.1	0.1	0.2
Urban	3,090.9	719.9	58.5	50.5	8.2	88.5	2,144.3	0.8	5.2	2.1	12.5
	percent Share	23.3	1.9	1.6	0.3	2.9	69.4	0.0	0.2	0.1	0.4

Table 1: Households in Rajasthan ('000) by the type of fuel used for cooking
Source: Census 2011

LPG Profile of Rajasthan

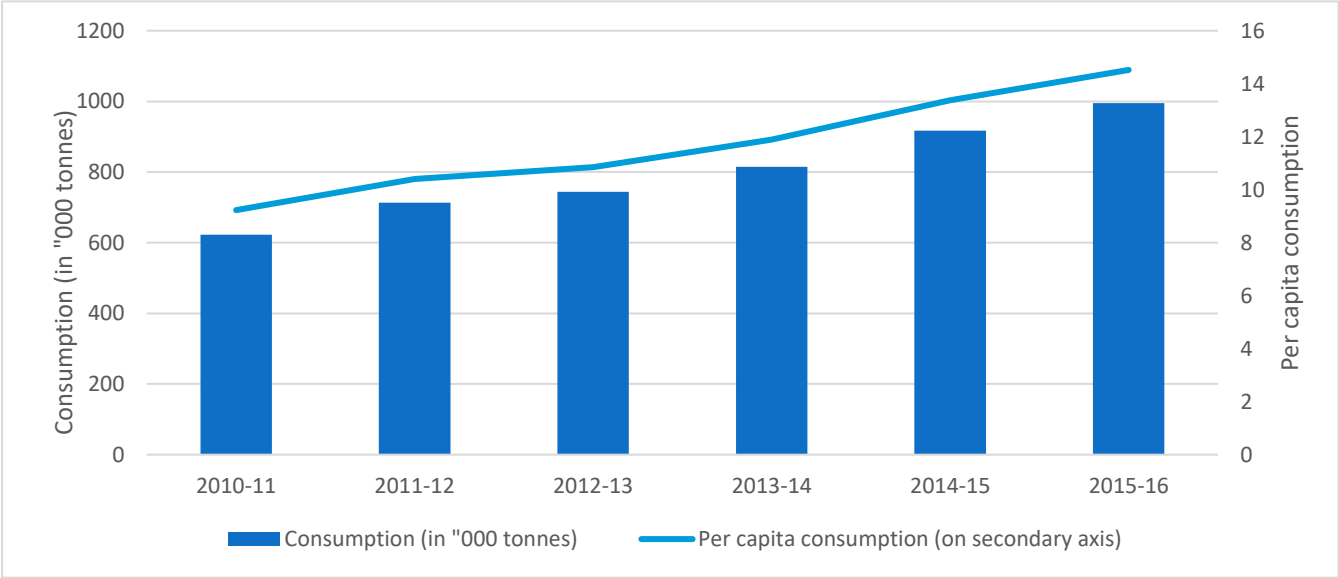
There is a steady increase in the annual growth rate of LPG consumer registered with the three Oil Marketing Companies (Public Sector Undertakings-IOCL, BPCL and HPCL) over the years (figure 1). Average year on year growth in LPG consumer from 2001 to 2005 was more than 10 per cent, which reduced to 7 per cent for period 2006 to 2009. From 2010 onwards, its annual growth rate is pegged at over 10 percent. With the growing LPG consumer base, the overall LPG consumption as well as per capita LPG consumption in the state has significantly shot up since 2010 (fig.1 & 2).

Figure 1: LPG domestic customers in Rajasthan registered with the public sector oil marketing companies as on 1 April 2017



Data Source: Petroleum Planning and Analysis Cell, MoPNG

Figure 2: Total consumption of LPG

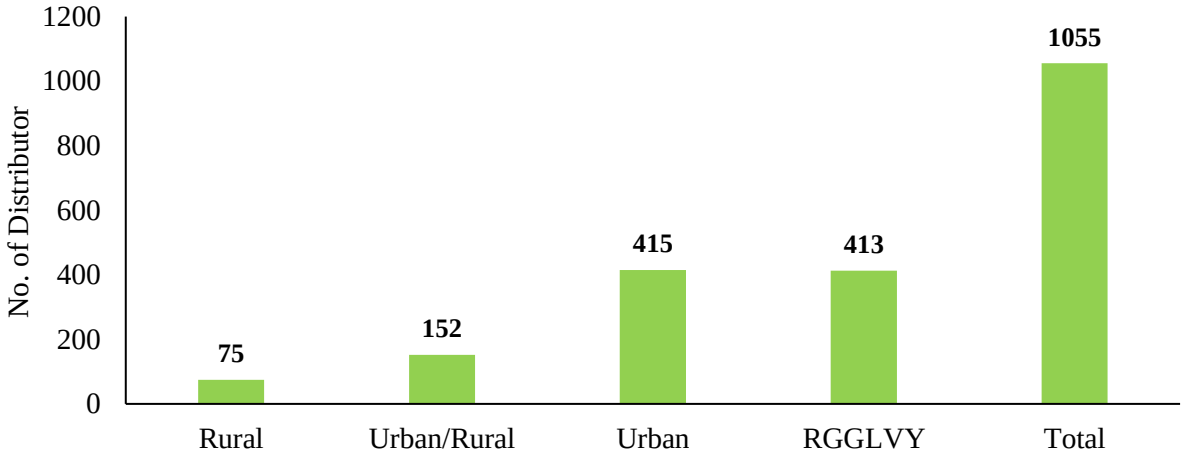


Data source: Petroleum Planning and Analysis Cell, MoPNG

Figure-3 presents the number of LPG distributors in Rajasthan. The chart shows that the availability of LPG distributors in the rural and remote/backward areas is relatively poor. As compared to the rural region, urban region of Rajasthan has better LPG distribution network. Approximately 14.40 per cent (152 distributors) distributors supply LPG cylinder in both rural and urban areas of Rajasthan. If we consider average number of households per distributor as a benchmark, Rajasthan has on average 13,362 households served by an LPG distributor. Banswara district has the poorest LPG distribution within the state with a dependency of 33,436 households per LPG distributor (figure 4). Since regular distributorship requires certain minimum infrastructure and operating requirements to viably, operate in a particular location. Under Rajiv Gandhi Gramin LPG Vitran Yojna (RGGLVY), 413 distributors were appointed to serve the under-

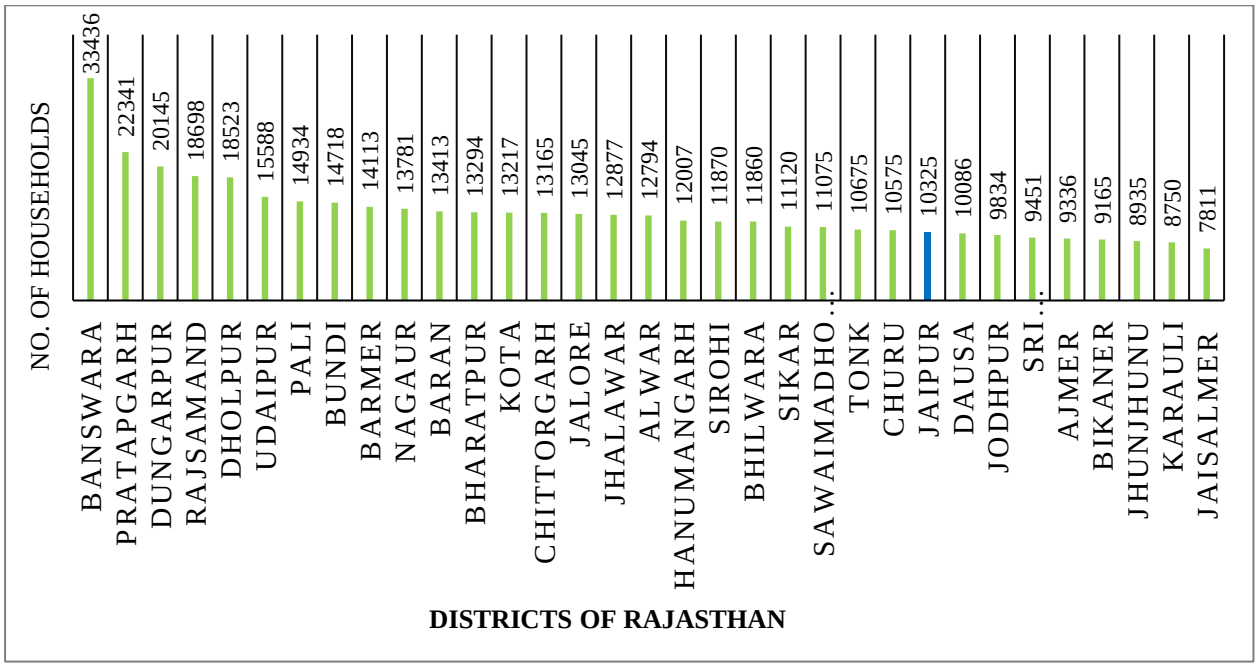
served areas. This type of distributor are not mandated to provide doorstep delivery to customer. The whole idea of introducing a new distributor format to serve rural area was to ensure economic viability for distributorship and enhanced customer service and satisfaction.

Figure 3: Number of LPG distributors in Rajasthan



Source: Petroleum Planning & Analysis Cell, 01/01/2017

Figure 4: Number of households served by LPG distributors in Rajasthan districts



Source: Household from Census, 2011 and Number of distributors from OMC's (HPCL, BPCL and IOCL)

3.2. Cooking Energy Profile of Chhattisgarh

Compared to Rajasthan, LPG penetration in Chhattisgarh is relatively poor. Merely 11 per cent households in the state use LPG. In the rural Chhattisgarh, less than 2 per cent rural population uses LPG (table.2). Firewood usage in the state is around 81 per cent and crop residues 0.9 per cent. In the rural areas of the state, firewood use is at 92 per cent, crop residues use at 1 per cent.

Type of HH	Total No. of households	Type of Fuel used for Cooking									
		Fire-Wood	Crop residue	Cow dung cake	Coal, Lignite, Char-coal	Kero-sene	LPG/ PNG	Electricity	Bio gas	Any other	No Cooking
T	5,622.9	4,545.1	49.9	209.2	129.2	28.5	628.6	6.1	10.5	4.8	11.1
	Percentage	80.83	0.89	3.72	2.30	0.51	11.18	0.11	0.19	0.09	0.20
R	4,384.1	4,039.9	38.1	193.4	15.1	6.2	71.2	2.2	9.4	1.7	6.9
	Percentage	92.15	0.87	4.41	0.34	0.14	1.62	0.05	0.21	0.04	0.16
U	1,238.7	505.2	11.7	15.8	114.1	22.2	557.4	3.9	1.1	3.2	4.2
	Percentage	40.78	0.95	1.27	9.21	1.79	45.00	0.32	0.09	0.26	0.34

Table 2 Households by type of fuel used for cooking Chhattisgarh ('000)

Source: Census, 2011

Similar to the LPG consumption trends in Rajasthan, number of LPG consumers and their per capita LPG consumption has increased in Chhattisgarh (see figure 5 & 6). The rate of increase in LPG customer-base was relatively high in the recent years. With the increased consumer-base, total consumption of LPG in the state has significantly gone up since 2010.

Figure 5 LPG domestic customers in Chhattisgarh registered with the public sector oil marketing companies as on 1 April 2017

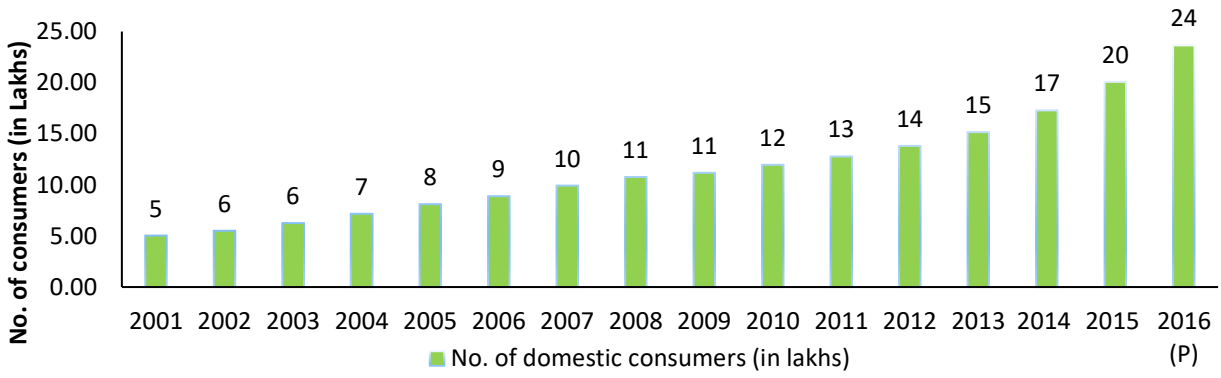
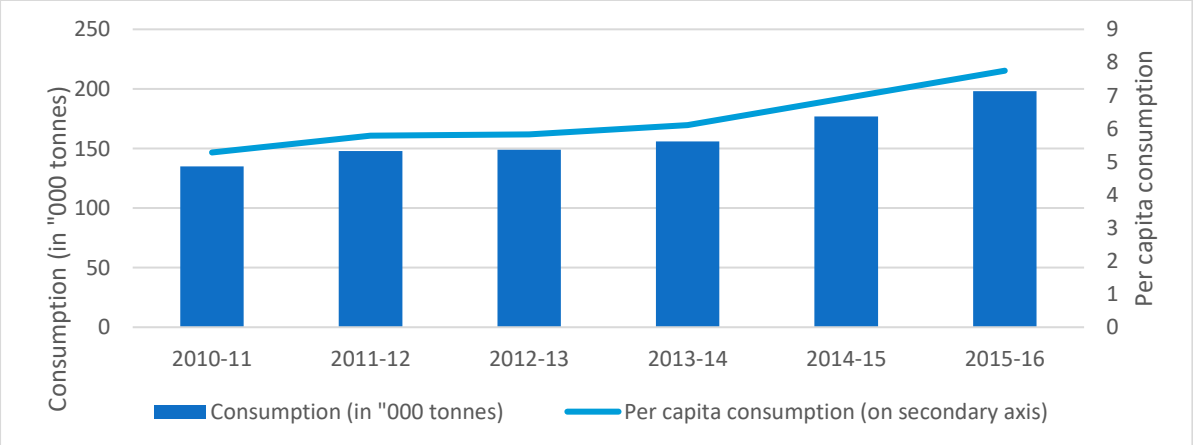


Figure 6: LPG consumption in Chhattisgarh



Data Source: Petroleum Planning and Analysis Cell (PPAC)

In Chhattisgarh, LPG distribution in the rural and semi-urban areas is very poor. In Raipur, households to LPG distributor ratio is 14,052 i.e. on average one LPG distributor serves 14,052 households. The household to LPG distributor ratio in Bastar district is highest 34,615 per distributor. The high households to LPG distributor ratio in rural area of Chhattisgarh shows deficient LPG distribution network in the rural areas of Chhattisgarh.

Figure 7: Number of households served by LPG distributors in Chhattisgarh districts

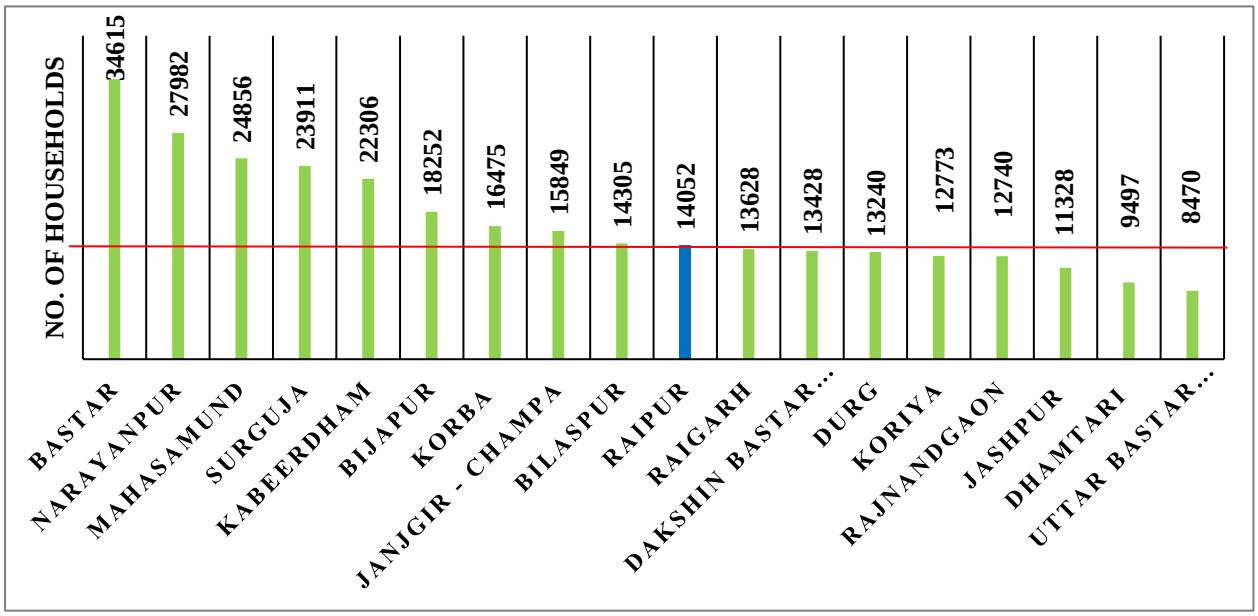
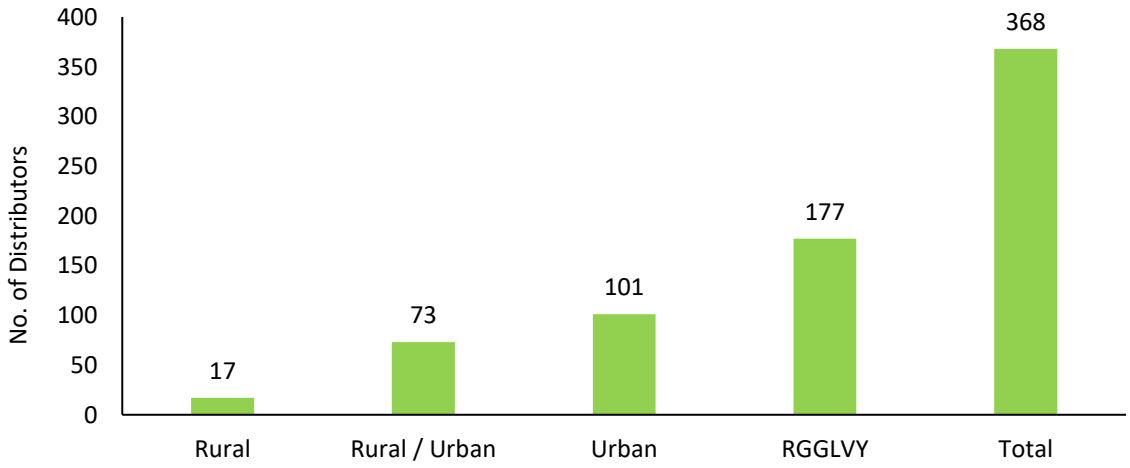


Figure 8: Number of LPG distributors in Chhattisgarh



Source: Petroleum Planning & Analysis Cell, 01/01/2017

4. Cost comparison of LPG vs electricity based cooking

Cooking is a major component of a poor household's energy consumption, The rising LPG costs and the urgency to provide clean cooking technology solution to each household necessitate need to explore other available clean cooking energy alternatives. In this chapter, we have compared the cost competitiveness of LPG and electricity for cooking.

In India, most LPG stoves are fitted with standard burner hence in our calculation we have considered efficiency for LPG with standard burner. For electric cooking, we have considered induction cooktop only as electric coil is neither economical nor safe to use. LPG cylinder to the poor households is available at subsidized price of approximately Rs.450 for a 14.2 kg cylinder. However, for the purpose of cost-comparison, we took LPG rates without the subsidy. Induction stoves are usually available in the range of 1 kW, which requires stable electricity supply. Electricity tariff are progressive in nature i.e. tariff rates change with the consumption band. A household with electricity consumption at a lower band is charged average lower price per unit compare to a house, which has electricity consumption at higher band. For simplicity of calculation, average tariff per units is *considered* Rs. 5 per kWh.

	LPG (with high efficiency burner	LPG with standard burner	Electric with Coil	Induction
Efficiency	42 %	39.9 %	73.7	74.2

Table 3: Efficiency of cooktop

Source: Adapted from Atlantic Consulting, 2009

Table 4: Cost comparison of cooking energy from LPG and electricity

	LPG	Induction
Efficiency	39.9	74.2
Unit Definition	1 Cylinder (14.2 kg LPG)	1 kWh
Energy (in Joules) per unit	(50.4 MJ X14.2KG) = 751.68 MJ	3.6 MJ
Energy (in Joules) per unit factoring efficiency	299.92	2.6712
Cost of Unit	Unsubsidized cylinder Rs 800	Rs 5 per unit
Cost per MJ of effective energy	Rs. 2.66	Rs.1.87

Note: 1 kg LPG gas = 50.4 MJ (Source: http://www.aussiehomeenergy.com.au/WhatDoYouKnowAboutYourLPGGasSupply.pdf)

Our analysis shows that efficiency of an induction cook-top is twice that of a LPG gas cook stove (Table 4 – Cost comparison of cooking energy from LPG and electricity). Electricity operated induction cooking is relatively cheaper than LPG. However, the values of effective cooking energy cost obtained from the above analysis may vary because of following:

1) Cost of various energy sources available to a consumer are subject to change due to multiple factors – cost of unsubsidized LPG changes with change in oil price in the international market; price of electricity also changes with changing input prices and other factors
2) Efficiency of both LPG and induction stove is also subject to change in future with technological evolution

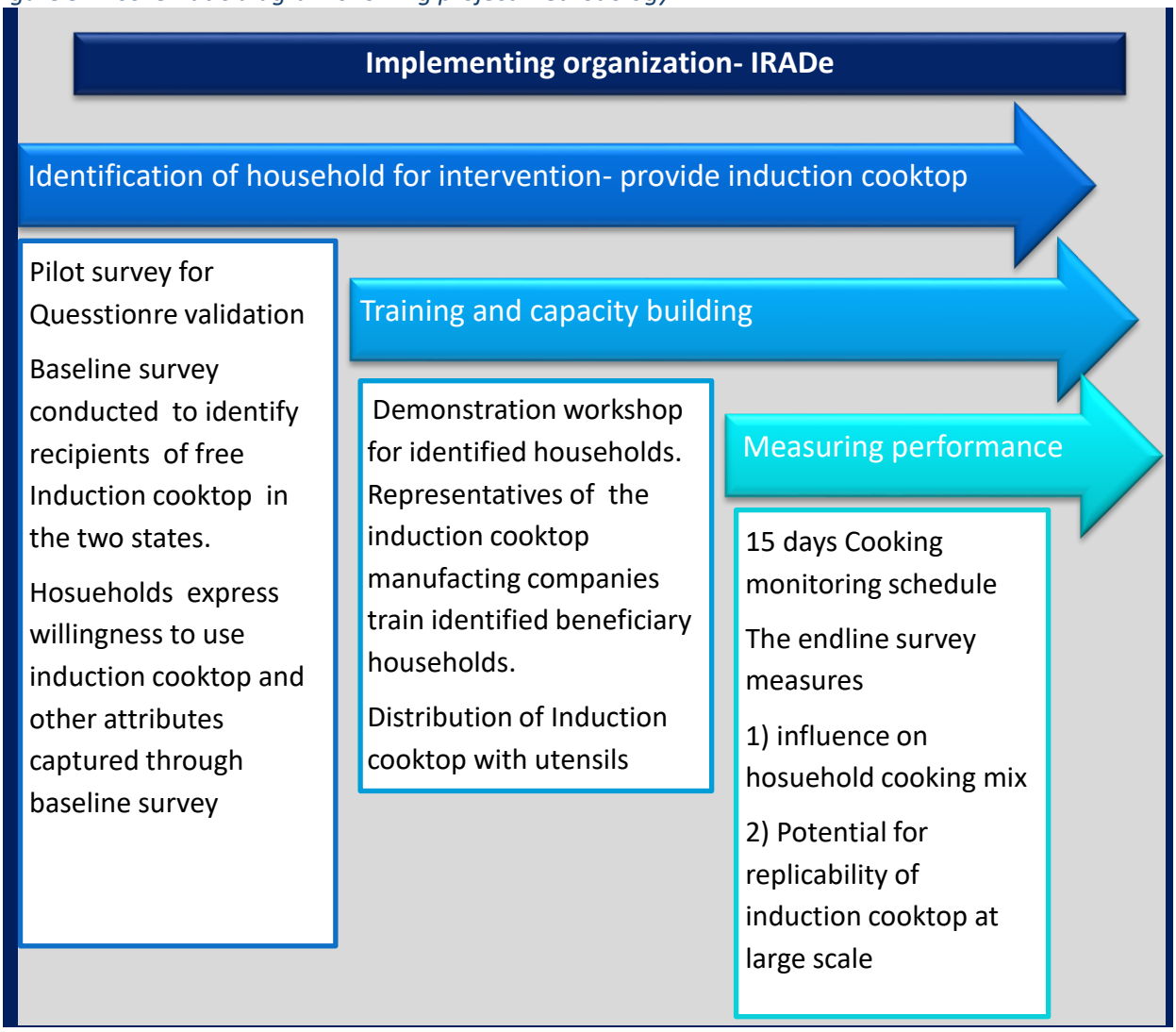
5.METHODOLOGY

The methodology adopted comprised of the baseline survey, training and capacity building of the local communities, and the end line survey for monitoring and the performance. The study involves three stages:

a) In first stage, a household survey was conducted to **identify households** for induction cooktop intervention.
b) Survey was followed by a **training and distribution** of induction cooktop to identified beneficiary households.
c) Finally, **feedback from the intervention households** were collected for evaluation and analysis.

The methodology adopted for this study is diagrammatically depicted in figure 9

Figure 9: A schematic diagram showing project methodology



5.1 Baseline and end line Surveys

This research study does a comprehensive analysis of households with high potential to buy and use induction cooktops. Study adopted both quantitative and qualitative techniques for households profiling to explore the opportunities to scale-up electric cooking technology. Considering the purpose of this study, the survey was designed to evaluate whether induction cooktops can be a viable clean cooking technological solution with a potential to replicate at large scale. Therefore, data was collected across the key stages in the study process and not just on the outcomes.

Baseline survey was conducted in two stages. In the first stage, a pilot survey was carried out in Alwar district of Rajasthan. This pilot survey was used to test the questionnaire. The pilot survey questionnaire was administered to 10 selected households. For this, convenience-sampling method was adopted for the selection of households. Feedback from pilot survey was used to improve the baseline questionnaire. In the second stage, the survey was conducted to identify the households for the study intervention - to receive induction cooktop and compatible utensils. This survey gathered information on the household's willingness to accept electric cooktop and utensils, willingness to buy these devices etc. The end line survey gathered the feedback of the households on utility and convenience of induction cooktops used during the monitoring period of 15 days.

5.2 Sample

To select the households for survey, we use stratified random sampling technique where stratification was done based on geographical location of households. A total of 200 households (50 households from each district and 2 districts from each state) were surveyed in Rajasthan and Chhattisgarh. Of the 200 surveyed households, 40 households, 20 each in Rajasthan and Chhattisgarh, were identified based on a set of predetermined criteria's listed below:

1. A metered electricity connection
2. Willingness to use the electric cooktop
3. Ability to pay for the additional electric bill due to electric cooking
4. Ability and willingness to purchase induction cooktop and compatible utensils

5.3 Training and capacity development

The women member of the households, who are generally responsible for cooking, were briefed in detail about the use of induction cooktops, health benefits of smoke-less cooking, adaptability of induction cooktops to local cooking needs, ease of operation, overall expenditure, and other benefits such as time saving, owners pride etc. Capacity building workshop of the households for operation and maintenance of the devices and setting up of local skill for repair and maintenance of device was conducted by the representatives of induction cooktop manufacturers.

5.4 Manufacturer/Technology supplier partnership development

Device manufacturers were approached and asked to submit the list of cooking devices manufactured by them along with their complete technical data like technology used, time needed for cooking, single piece rate and bulk purchase rate, taxes if any, etc. Based on the technical and financial feasibility, vendors were finalized for devices purchase. BEE star rating and other BIS specifications were taken consideration of in the device selection process.

Three manufacturers namely Bajaj Electricals, TTK-Prestige and Usha Appliances were identified for the procurement. A positive response was received only from Prestige and it was then chosen as the technology provider. The technology provider was requested to provide discount to keep the procurement costs at the minimum. A total of 40 pressure cookers were procured. The technology partner also sent its representatives for the product use demonstration at the project location in Chhattisgarh and Rajasthan.

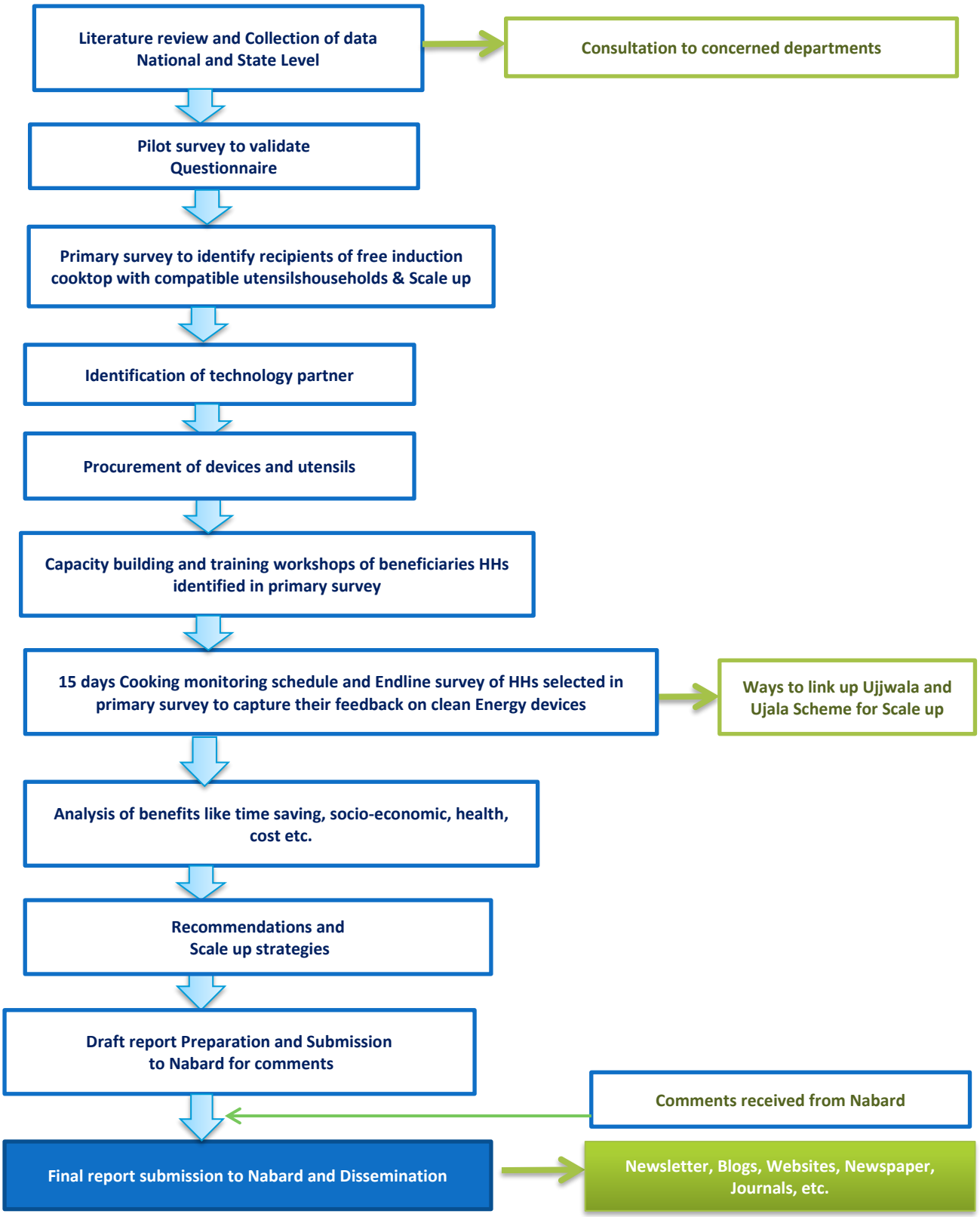
5.5 Project implementation

The ground implementation of the project was led by a local grass root organisation. It administered the questionnaires and monitored the project progress etc. As local people share better understanding of their culture, communities, way of life and resources, local field staff was engaged for communication with female members of the households. In addition, engagement of a local organisation ensures participation of beneficiary households and helps in undertaking extensive monitoring and evaluation activities. Besides, it is economical as it cuts down on travel, boarding and lodging expenses.

5.6 Work plan and approach

The detailed work plan of the project and project approach flow chart is given below. The entire project duration was divided into different quarters for better management and flexibility of operations, and the related tasks envisaged in that duration are highlighted in each column. All the tasks envisaged for the project are detailed in the column “Tasks and Activities”. The tasks have been planned as per the need and the project progress envisaged taking into account the project management schedule. Some activities were independent of each other some may have a link to a prior activity for starting and completion. Project management chart for the pilot study is presented below.

Flow chart of Activity of Pilot Study



6. Primary survey analysis and results

This chapter highlights the results of the baseline survey from the two states. The household survey findings were recorded on printed structured questionnaire. The questionnaire included information on socio-economic profile of the survey households, fuel used for cooking, and fuel and cooking devices used by the households.

6.1. Primary Data Analysis and Results

Household survey was conducted in Alwar and Jaipur districts in Rajasthan, and Raipur and Balodabazar district in Chhattisgarh. In Rajasthan, survey was conducted in Mirchooni, Bub-Ka-Hera and Meethiyawas villages in Tijara Block of Alwar district and Buchaheda, Chaturbhuj, Saroond villages in Kotputli block and Kotputli town area in Jaipur district. In Chhattisgarh, it was conducted in Balodabazar district, Ahilda, Tarasiv, Damru, Saloni, Rasedi and Khamhardih villages and Balodabazar town. In Raipur district survey was conducted in Tilda- urban area, and Sungera, Alda and Mohda villages.

Socio-economic status

Alwar district being close to Delhi has seen a rapid growth in infrastructure and industry. About 84 per cent of the sample households in the district were of APL category and 16 per cent were of BPL category. Whereas, in Jaipur 88 per cent households were of APL category and 12 per cent BPL category.

In Chhattisgarh, Balodabazar district, 90 per cent of the surveyed households had an APL/BPL ration card and only 10 per cent households reported of not having any ration card. Among those who had the ration card, merely 9 per cent were from APL category and all other are from BPL category. In Raipur district, 86 per cent of the surveyed households reported having a ration card and 14 % households were without any ration card. In Raipur 35 per cent, households belonged to BPL and 65 per cent to APL category.

Table 5 Ration card details of the surveyed households

	Card type (BPL/ APL/ No card)		
District	**APL**	**BPL**	**No Card**
Alwar	42	8	0
Jaipur	44	6	0
Balodabazar	4	41	5
Raipur	15	28	7

Electricity and LPG access status

Electrification status of the surveyed households was an important aspect of this study. In Alwar and Jaipur, all surveyed households had a metered electric connection, whereas LPG access was available to only 80 percent households in Alwar and 92 per cent households in Jaipur. In Balodabazar 90 per cent households and in Raipur 98 per cent households had a metered electric connection. LPG access is rather poor in Chhattisgarh. Of the surveyed households in the state, in Balodabazar merely 6 per cent households and in Raipur about 38 per cent households had LPG connection.

Table 6 Electricity and LPG status of the surveyed households in Rajasthan and Chhattisgarh

District/Block	Electrified- having meter connection	LPG connection from Government OMC's
Alwar	50	40
Jaipur	50	46
Balodabazar	45	3
Raipur	49	19

Stove availability and use

The available cook stoves in the households surveyed indicated the fuels used. Use of traditional earthen cook stoves is still a popular practice in the villages where households use dung cakes, firewood and crop residues as feedstock. In Alwar, 92 per cent surveyed household's still use traditional biomass cook stove, while 80 per cent of them also have an LPG stove. None of the households uses kerosene for cooking or improved cook stove, biogas, solar cooker, electric hot plate, induction cooker in the sample. Stove use for cooking in the last 30 days has the similar patterns as the stove ownership. According to the survey findings, in the last 30 days, most of the households used either biomass and LPG stove or both for cooking. In Balodabazar, surveyed households used biomass cook stove and none of the households used kerosene for cooking. One induction cooktop user was reported in Balodabazar district. In Raipur 94 per cent, households used biomass cook stove and 38 percent household used LPG and only one household each used kerosene and electric induction cooker, respectively. None of the household used improved cook stove, biogas, solar cooker, electric hot plate, etc. One induction cooktop user was also reported in Raipur district.

Table 7: Stove/ Chullah Available in surveyed households

District/Block	Biomass stove / Chullah	LPG Cook stove	Electric Hot plate	Improved Cook stove	Kerosene cook stove	Biogas cook stove	Induction cooktop	Solar Cooker
Alwar	46	40	-	-	-	-	-	-
Jaipur	41	50	8	-	43	-	1	-
Balodabazar	50	3	-	-	-	-	1	-
Raipur	47	19	-	-	1	-	-	-

Willingness to use electric induction cooker and purchase of device

The surveyed household's willingness to use electric induction cooker was another significant aspect of the study. In Alwar district, only a few respondents had heard about the induction cooker. However, 80 per cent of the households expressed willingness to use it and 70 per cent expressed willingness to buy it. In Jaipur 84 per cent of the surveyed households expressed willingness to use and buy induction cooker. In Balodabazar only four per cent of households showed willingness to use and buy electric cooker. In Raipur 18 per cent of the respondents expressed willingness to use and buy electric cooker. There were households that showed willingness to buy and use electric cooker, but found its cost beyond their ability to spend.

Table 8 : Willingness to use and buy induction cooker

	Willingness to use			Willingness to buy	
District/Block	**Yes**	No	**Already have**	**Buy**	Average price
Alwar	40	10		35	443
Jaipur	42	8		42	393
Balodabazar	2	47	1	2	550
Raipur	9	41	-	9	533

Selection of households for distribution of induction cooktops and utensils

The selection of households was based upon analysis of various parameters that were captured in baseline survey. Namely, the availability of electricity in the household, positive response for using induction cooker, willingness to pay for the device in case of not distributed free, willingness to use the device during the 15-day monitoring period, willingness to pay the electricity bills, etc. This ensured aimed distribution of induction cooking devices. The selected beneficiaries were then called for a half-day training cum demonstration session in their respective blocks headquarter/local partner's office.

6.2. Field survey pictures

Local NGO Staff interviewing the respondents at Alwar

Electricity meter in a rural surveyed HH

Crop residues used for cooking

IRADe staff during pilot survey

Storage of dung cakes

A village woman with an induction cooktop

Biomass chullah in a surveyed House

7. Distribution of Induction devices: Training and Capacity building

This chapter details the training and capacity-building exercise conducted by IRADe for the local households in the project locations in Rajasthan and Chhattisgarh, and the distribution of induction cooktop and induction compatible utensils to the identified beneficiaries.

7.1. Training, Capacity building and Distribution of Devices in Rajasthan

IRADe organized a half-day training cum capacity building programme at Kotputli block in Jaipur on 21 September 2017. In Alwar district training workshop was organized at Tapukara block on 22 September 2017. In Balodabazar district at Simga block training was held on 8 December 2017. The purpose of the training at multiple locations was to build the capacity of rural women in using electric induction cooktop. The event disseminated information on multiple benefits of using induction cooktop in comparison to biomass or LPG cook stoves. This covered ease of cooking, health benefits, indoor pollution reduction, reduction in kitchen heat stress, reduction in burn incidents, cost competitiveness vis-à-vis LPG cylinder, faster cooking, etc. IRADe distributed 20 induction cook stoves and 40 compatible utensils among the selected beneficiary households at 3 project locations.

Knowledge partner and industry linkage

Under the programme, a representative from cooking device manufacturer M/s.TTK Prestige provided the training. IRADe selected the induction cooktop model (PIC.20) after a thorough review and comparison with other induction cooktop devices available in the market. Two induction compatible utensils were procured and provided to households. The utensils comprised of a combination of any two stainless steel utensils, i.e. Fry pan, boiling vessel (Bhagoni) and large saucepan (Kadhai) with flat bottoms.

Programme briefing

The programme started with the project briefing of the participants, its aim and requirements and what was expected from the participants. This was followed by a detailed briefing by the manufacturer's representative about the various functionalities of the induction cooker, namely wattage, temperature, presets, cooking options, do's and don'ts, electricity consumption both wattage and amount, plug type requirement, wiring requirements, precautions to be adhered to in operating the device, device cleaning, types of food that can be cooked, etc.

Practical demonstration

Post briefing, the participants were given a demonstration of its functions like by boiling water/milk, potato chips frying, etc. In the follow up, the participants were asked to do these activities by themselves in the presence of demonstrators. This practical based training was good to engage participants and build their confidence in using induction cooktops. An operating manual on the device use and upkeep and dos and don'ts were developed in local language to distribute among beneficiaries with the device. Participants were also briefed on the cooktop safety aspects like not to wash the cooktop with water, switch off the device when not in use, voltage fluctuations, faulty wiring in kitchen, sparking sound in switchboard, etc. This ensured that the device would function for a period as stipulated in the warranty clause and ensure safety.

Device and utensils distribution and 15-day monitoring schedule performa

The cookers and utensils were distributed to the beneficiaries identified based on the primary survey. Upon receiving the device, beneficiaries signed an undertaking of using the device and filling a 15-day monitoring activity performa. After the distribution, field visits were made to install the induction cooker in the kitchen or at an appropriate place for 3 beneficiaries.

Token money

Induction cooktop were distributed with induction compatible utensils. To check, the ability and willingness to purchase induction cooktop and compatible utensils a token sum of Rs 500 were collected from all 40 beneficiaries households at the time of distribution of induction cooktop.

Training programme at Kotputli, Jaipur District, Rajasthan

Project briefing to participants on clean cooking, positive impacts

Training by TTK Prestige induction cooker manufacturer, knowledge partner

Practical demonstration of cooking activities like boiling, frying, roasting, etc.

Proper documentation of beneficiaries prior to distribution of induction cooker

Distribution of 10 electric cookers to the beneficiaries at the project site

Installation of induction cooktops in kitchen and checking the wiring and plug points – Ensuring quality

Training Programme at Tapukara, Alwar District, Rajasthan

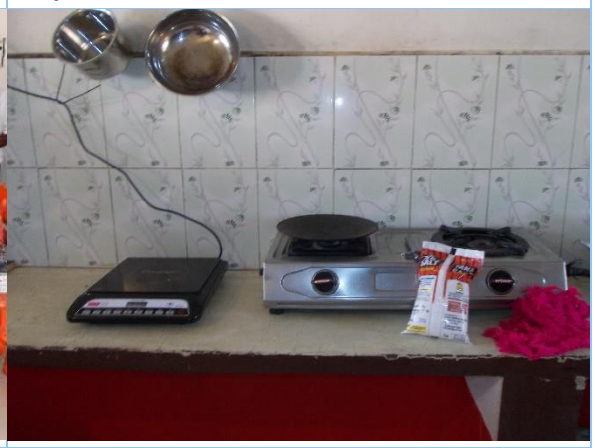
Project related briefing to participants on clean cooking, positive impacts

Training by TTK Prestige induction cooker manufacturer, knowledge partner

Practical demonstration of cooking activities like boiling, frying, roasting, etc.

Proper documentation of beneficiaries prior to distribution of induction cooker

Distribution of 10 electric cookers to beneficiaries at the project site



Installation of device in Kitchen and checking wiring and plug points – Ensuring quality

Training Programme at Sigma Block, Balodabazar District, Chhattisgarh

Briefing participants on clean cooking, positive impacts

Training by TTK Prestige induction cooker manufacturer, knowledge partner

Practical demonstration of cooking activities like boiling, frying, roasting, etc.

Practical demonstration of cooking activities like boiling, frying, roasting, etc.

Distribution to 20 electric cookers to beneficiaries at the project site

Installation of the device in kitchen and checking wiring and plug points – Ensuring quality

8. End line survey results and discussions

Daily analysis of cooking habits comprise of type of foods cooked regularly, number of meals cooked daily, seasonal variation in food habits, type of cooking procedures used such as frying, boiling, roasting, baking, etc. Rural households in India consume mostly home prepared/cooked food. A majority of the households have two major cooking sessions daily – morning and evening and a few households has three major cooking sessions.

Figure 10: Induction cooktop used by a beneficiary

During the Cooking-monitoring schedule, all the households reported electricity supply in the morning and evening time - when cooking generally takes place. The result presented here is based on the 15-days cooking activity monitoring schedule analysis of the induction cooktop beneficiaries' households starting from 23 August 2017 to 6 September 2017 in Rajasthan and 9 December 2017 to 23 December 2017 in Chhattisgarh. Figure 5 shows the cooking activities performed by the beneficiary households during the intervention period.

Interestingly, a majority of beneficiaries took interest in preparing food on Induction cooktops and showed their willingness to upgrade to electric cooktop for cooking. The households found induction cooktops to be particularly convenient for breakfast preparation. An analysis of the item wise food cooked showed that it was used most often for making tea, boiling milk and frying vegetables. The beneficiary households did not use it much for making roti or preparing non-vegetarian food.

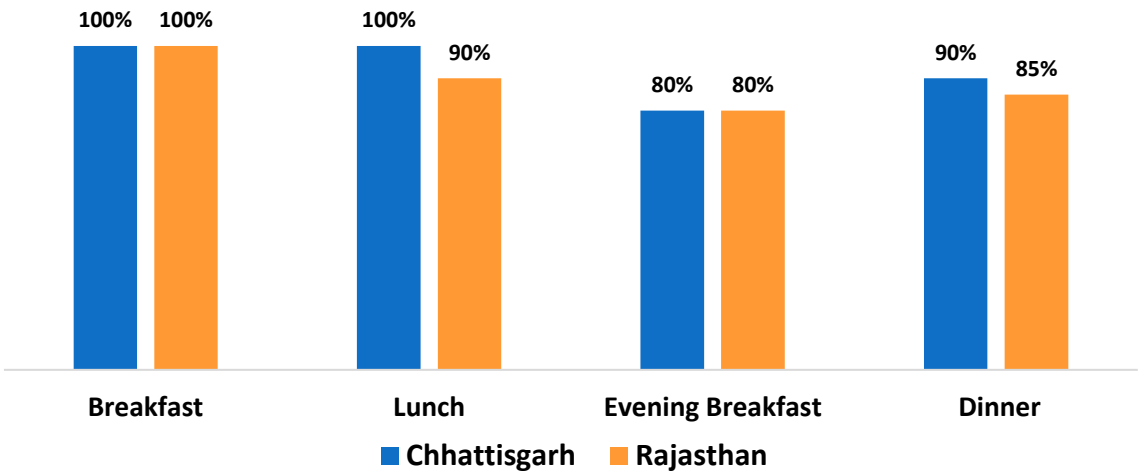


Figure 11: Session wise Food Preparation on Induction Cooktop

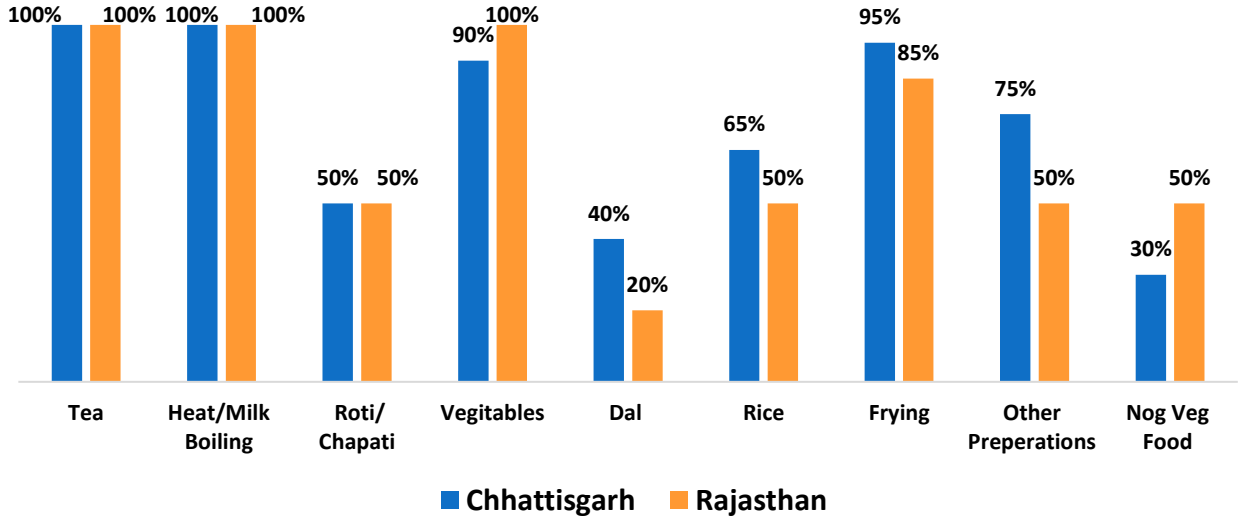


Figure 12 Use of induction cooktops for cooking a variety of food items

End line survey was conducted of 40 beneficiaries of induction cooktop in both the selected states Rajasthan and Chhattisgarh after the 15 days of monitoring cooking session activity. End line survey was done to analyze Cooking experiences especially with induction cooktop for the 40 households understand the advantage or disadvantage of electric cooking over other cooking energy fuel available with the households. We analyzed the problems with respect to operation of the induction cooker, namely ease of operation, compatibility of cooking utensils, food preparation vis-à-vis LPG and biomass cook stoves. Whether the utensils provided with induction cooktop were able to meet their cooking needs or whether they would procure more utensils to meet their cooking needs

How does economic status of household influence adoption of induction cooktop?

The demand for induction cooktops is relatively high among the APL (Above Poverty Line) users. May be it is influenced by the factors such as better purchasing power, better infrastructural facilities, and a relative better awareness about the induction cooktops and associated health and other benefits among the APL household female members. Even though the Also, households that use of electricity for cooking draw have cleaner kitchens.

Availability of Infrastructure

Availability of quality electricity supply is a precondition for use of induction cooktop. An analysis of the problems with respect to electricity supply in the villages namely, supply duration, quality of supply, voltage fluctuations, sparking, electricity billing details, type of electricity connection (fixed billing, variable billing, actual billing, etc.), is presented in this section. In Rajasthan, electricity supply has periodic outage hours as per the season: it is maximum in winter and rainy season and sporadic in summer. During the survey months of August and October 2017, electricity supply was for average of 18 to 22 hours a day. However, the households surveyed informed that there was a remarkable improvement in the supply hours in the recent years. This was contrary to the popular belief that quality of electricity supply in the villages was poor. Yet, 30 per cent of the survey respondents identified power blackout or unreliable power supply as the deterrent in use of induction cooktops for cooking. Merely 10 percent households said that voltage fluctuation was an issue. However, not a single household stated that it was facing an issue of overcharging by DISCOM (see figure 6).

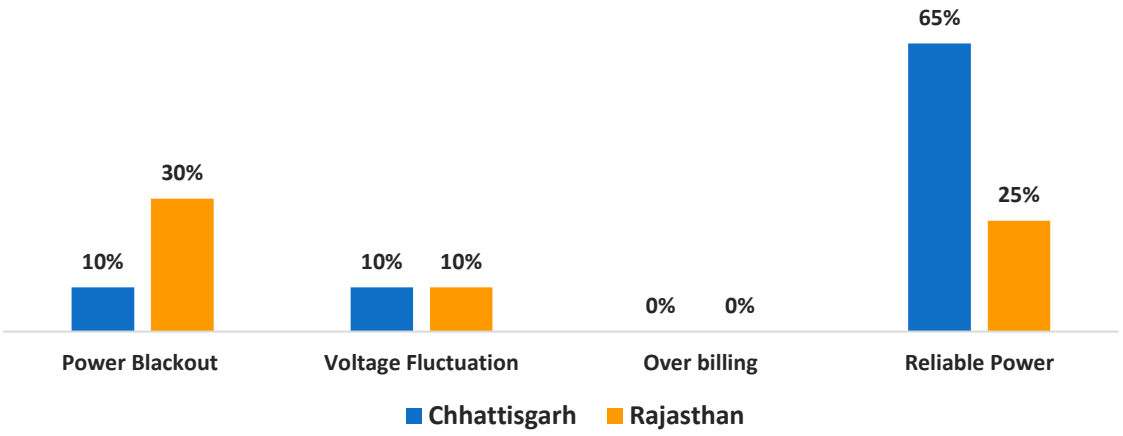


Figure 13 Electricity supply and related problems encountered in induction cooktop adoption

Problems with operation of induction cooker

Induction cooktop is different from other traditional cooking stoves. In addition, it has limitation of compatibility with traditional utensils. To cook on induction cooktop, a new set of compatible utensils are required. Therefore, we analysed the problems with respect to

operation of the induction cooker, namely ease of operation, compatibility of cooking utensils, food preparation vis-à-vis LPG and biomass cook stoves, and also whether cooking activities like frying, boiling, roasting, roti making etc. were possible with the induction device or not. Problems related to electric shock, cleaning the device, portability, etc., were also examined. These issues are important for wide scale adoption of induction cooktop. Further, IRADe also provided beneficiary households with selected induction compatible cookware. IRADe found that women were comfortable in operating induction cooktops for preparation of food and hardly anyone reported an issue with its operation.

This section also captures the household's feedback on the induction cookware, whether the utensils provided met their cooking needs, whether user would procure more utensils to meet their cooking needs.

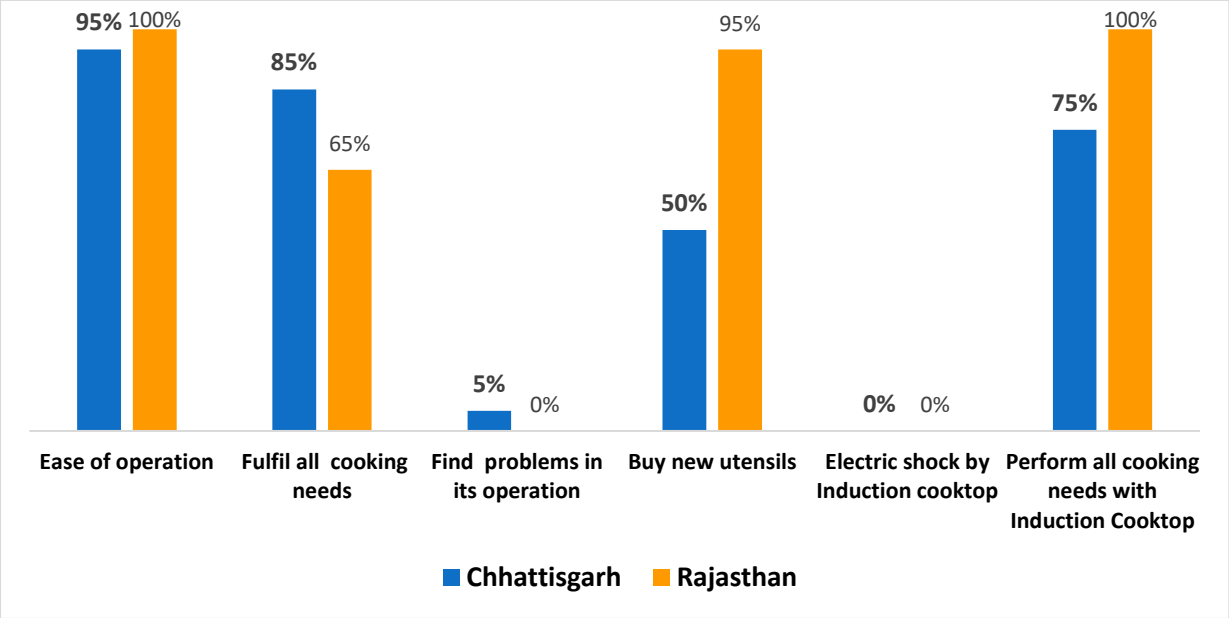


Figure 14 Operational problem of induction cooktop

Figure.9 depicts the respondent's ease of operation in using induction cooktop. Almost all the households reported ease of operation in cooking with induction cooktop. However, 65 per cent respondents found that induction cooktop did not full fill all of their major cooking needs. Use of electricity as a cooking fuel is safe and no incident of electrocution from induction cooktop was reported.

Taste of food and satisfaction from using induction cooktop

Induction cooktop received a good response from the beneficiary households. Taste of food cooked on induction cooktop was not found to be very different from the food cooked on biomass or LPG stoves. Beneficiary households expressed overall satisfaction with induction cooktop device. However, 10 per cent households reported burnt food during the initial days

of trial period. After the initial few days, when women become more attune to cooking on induction device, incidences of burnt food were reduced substantially.

In repose to a question, whether they would recommend other households from their community to buy and use induction cooktop, all the beneficiary households said yes they would recommend purchase and use of induction cooktop in their community. About 85 percent households also expressed their willingness to buy cooking device on their own.

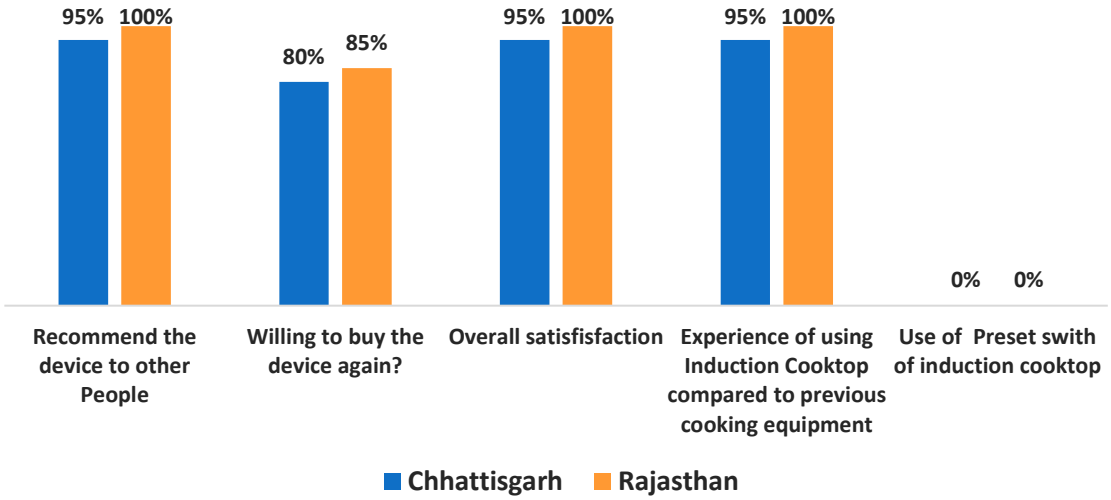


Figure 15 Satisfaction with Induction cooktop

Even though a majority of the households have found induction cooktop to be very useful, they say the available induction cooktops are not adequate to meet their entire cooking requirements and they still need to use LPG or biomass cook stove to complete their cooking. However, there were other households, which did not use their earlier biomass stove at all.

Overall satisfaction with use of induction cook top

Induction cooktop received a good response on the user satisfaction aspect. In general, people were interested in its use. It was a new experience for a majority of the villagers as they had little or no prior knowledge of induction cooktop. All the beneficiaries expressed their interest to share their induction cooktop experiences with other in the community. Majority of the beneficiaries also showed willingness to purchase induction cooktop. In response to comparison of cooking experience Vis a Vis traditional cook stove or LPG stove, respondents found it to be of good use. Beneficiaries identified its other positives likes no need to store fuel for the biomass users, besides other benefits, it saves time on fuel collection and co-storage. For LPG users, who do not have doorstep delivery, it saves time and the cost of travel and transportation.

9. Conclusions and Way forward

The Government of India (GoI) has floated Saubhagya Scheme to give electricity to all rural households by 2018. GoI has also floated Ujjwala scheme to address the challenges of clean cooking, which is largely focussed on LPG. Electricity as an option for clean cooking fuel is missing from the discourse. In the developed world, electricity is already the mainstay for cooking. Electricity, as a part of viable energy mix for cooking, has started appearing in policy discourses recently. An essay published on NITI Aayog website recently advocated that electric cooking could be seen as a viable solution for clean cooking in India. It pointed that consumption of 8 to 10 LPG cylinders (14.2 kg each) per year is equivalent to electricity consumption of nearly four kWh per day. Electricity will have a cost parity with LPG at the crude oil price of around $60 per barrel (Panagariya A. and Jain, A., 2017).

Grid power is now extending to villages at a rapid pace it is expected to reach all villages in India by 2019. On the other hand, extending LPG distribution network to supply LPG to all households, especially in the far-flung areas, requires additional infrastructure to be set up. With increased households LPG penetration, domestic consumption of LPG will increase. This will also increase the country's dependence on LPG imports for meeting domestic requirements, which will pose a different set of challenges. With adequate or even surplus electricity available, coverage in quantity and quality is likely to improve making it a very promising clean cooking solution.

The pilot study though limited in scope, points out that induction cooktop can be a promising solution for clean cooking even in rural areas, peri-urban and urban areas. The survey of households using induction cooktops in Chhattisgarh and Rajasthan clearly indicates that induction cooktop can be used for a majority of cooking processes involving boiling, frying, etc. Although the pilot study had a short observation period, it reduced LPG or biomass consumption. Given the responses we received, we conclude that electric cooking has a very good potential to meet the country's clean cooking needs.

More demonstration projects and training programmes for women in the locations with high levels of household electrification and low LPG penetration can give it a good thurst. This pilot exercise is limited in terms of time and scope, but even so, the potential seen was encouraging. It can overcome psychological and technical barriers. The pilot study encountered a widespread misconception that electric cooktops are not adaptable to Indian cooking. The study successfully quashed those misconceptions with live demonstrations.

In general, the following conclusions emerge:

- Induction cooktop is comparable option in terms of efficiency and operating costs as LPG.
- It was felt that cooking through induction cooktop may not be an alternative to biomass but also to LPG, where the distributors were far away.
- Taste of food, cooking patterns and safety-related aspects were found to be good as compared to other devices. Therefore, targeted campaigns can remove misconceptions of nonusers.
- Induction cooktop addresses the problems of health, cleanliness of kitchen, safety, long preparation time involved in cooking with biomass etc.

In the long term, providing energy through wires is better option than through trucks, cylinders and other heavy infrastructure. Moreover, electricity will soon be there in all the households, because of themselves to efforts for rural electrification and Saubhagya scheme.

The survey results point out the possibility of large-scale adoption of electricity-based cooking in India. It is a scalable option for rapid adoption. In this study, IRADe observed various benefits of cooking with induction cooktops. This depends on three basic pillars:

1. **Availability of Electricity** - Including improving last-mile connectivity (increased electrification of households)
2. **Accessibility** of Induction cooktop with compatible utensils - Improve last-mile connectivity (increase distributors) and maintain services
3. **Awareness** of use and health and environment benefits of Induction cooktop
4. **Affordability of Electricity** - including payments for LPG security deposit and the recurring unit consumption charges.

Enhance access to induction cooktop in Chhattisgarh where access to LPG is way below the national average but has better household access to electricity. This will help in reducing the dependence on polluting solid biomass and imported fossil fuels. On the other hand, electricity is becoming cleaner as the grid gets greener with increasing share of renewables.

We suggest to expand the scope of this project with a longer duration trials to observe the spread of this technology, and provide support through technical guidance, capacity building and social and moral support to new users, especially in Chhattisgarh. A thorough analysis is required to understand the problems of the local people, in varying situation, with adoption of electricity as a clean cooking solution at pan India level. Northeastern states can be explored for its adoption. Carry out the economic analysis of how national programmes Saubhagaya and Ujjawala can complement each other.

A comprehensive analysis with bigger sample and well spread out is required to understand the problems of the local people in varying situation with adoption of electricity as a clean cooking solution at pan India level. Other states such as North East can be explored for adaptation.

Recommendations and roadmap for upscaling:

The strategies for enhancing adoption of induction cooktop at large-scale require addressing the following critical points:

- Reduction in upfront capital cost with financial support for purchasing the Induction cooktops with compatible utensils, particularly for low-income households either by EMI or by one time DBT.
- Promotion campaign, mass awareness program and user template should be prepared in local language for rapid adoption
- A comprehensive analysis with bigger sample and well spread out is required to understand the problems of the local people in varying situation with adoption of electricity as a clean cooking solution at pan India level. Other states such as North East may be explored for adoption.
- We have carried out a brief economic analysis from consumer's point of view but a detailed analysis of two value chains for delivering 1) electricity and 2) LPG cylinders should be carried out for various scenarios and situations. Detailed cost competitiveness analysis for different electricity and LPG prices need to studied.
- How Saubhagaya and Ujjawala scheme can complement each other need to be studied.
- Currently, the devices is not marketed as rural product, which should be safe and sturdy, have infographics to follow instruction and with manuals in local languages rather in English.
- Mass procurement of induction cooktop may possibly reduce prices as done in LED bulbs like EESl Led Schemes.
- Once the market expands, repairs and advisory services should be available.
- Women themselves should be engaged as sales persons who can also give trainings to other women.

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