

UJALA

(UNNAT JYOTI BY AFFORDABLE LEDs FOR ALL)

YOJNA

IN UTTAR PRADESH

INSIGHTS FROM RAPID IMPACT ASSESSMENT STUDY

SUBMITTED TO

UTTAR PRADESH POWER CORPORATION LIMITED (UPPCL)
LUCKNOW, UTTAR PRADESH



The Energy and Resources Institute

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Special thanks to

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Citation

UJALA (Unnat Jyoti by Affordable LEDs for All) Yojna in Uttar Pradesh: Insights from Rapid Impact Assessment Study. New Delhi: The Energy and Resources Institute.

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Published by

The Energy and Resources Institute (TERI), Website: www.teriin.org

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CONTENTS

<i>Acknowledgement</i>	1
<i>Executive Summary</i>	2
1. About the UJALA Scheme	4
1.1 Background	4
1.2 UJALA Scheme in Uttar Pradesh	5
1.3 About the study	6
2. Approach & Methodology	7
3. Findings	10
3.1 LED bulb distributed in Uttar Pradesh	10
3.2 About the respondents profile	11
3.3 Distribution & Usage pattern of bulbs	12
3.4 Awareness about UJALA Scheme	15
3.5 Consumer perception about LED bulbs	15
3.6 Replacement of bulbs	18
3.7 Disposal of damaged bulbs	18
3.8 Deemed energy savings	19
3.9 Quality of bulbs	20
3.10 Qualitative insights	20
4. Discussion	22
4.1 Access to LED bulb	22
4.2 Building the market sentiment	22
4.3 Triggering the shift	22
5. Way forward	23
<i>Annexure 1</i>	<i>24</i>
<i>Annexure 2</i>	<i>29</i>
<i>Annexure 3</i>	<i>31</i>



LIST OF FIGURES

Figure 1 : Sample selection	8
Figure 2 : Education level of respondents	11
Figure 3 : Bill amount of respondents (in %) who reported the last bill received in March 2018	12
Figure 4 : Phase-wise distribution of respondents	12
Figure 5 : Transition towards the LED bulb	13
Figure 6 : Percentage of respondents using bulbs in the households and time-slot of usage	14
Figure 7 : Percentage of bulbs purchased from UJALA Scheme and from Retailers	15
Figure 8 : Percentage of respondents who were aware of the name of LED Scheme	15
Figure 9 : Source of awareness about UJALA Scheme	16
Figure 10 : Percentage of respondents who feel LED bulbs are better than other bulbs	16
Figure 11 : Reasons attributed to the preference of LED bulbs	17
Figure 12 : Drivers for the purchase of UJALA bulbs	17
Figure 13 : Preferred mode(s) for replacement of the faulty bulb	18
Figure 14 : Feedback about replacement mechanism	18
Figure 15 : Disposal method for damaged LED bulbs	19
Figure 16 : Continued usage and adoption are indicative of the quality of bulbs	20

LIST OF TABLES

Table 1 : Achievements of UJALA Scheme in India	5
Table 2 : Achievements of UJALA Scheme in Uttar Pradesh	6
Table 3 : Distribution of sample across districts	9
Table 4 : Deemed energy savings from the usage of LED bulbs	19

ACKNOWLEDGEMENTS

At the outset, we wish to express our gratitude to the Uttar Pradesh Power Corporation Ltd (UPPCL) for commissioning the study entitled "Impact Assessment of Unnat Jyoti by Affordable Lighting for All (UJALA) Yojana in Uttar Pradesh". As part of the study, this report provides detailed insights from a rapid assessment undertaken by The Energy and Resources Institute (TERI) team.

We wish to express our special thanks to Mr Alok Kumar (Chairman, UPPCL), Ms Aparna U (MD, UPPCL), and Ms Varalika Dubey (Chief Engineer, UPPCL) for their unstinted support and guidance for undertaking this work.

As part of the study, primary surveys were undertaken across 9 districts of Uttar Pradesh and 400+ household surveys were administered. Additionally, this work has extremely benefited from views shared by household consumers and retailers. The focus group discussions (FGDs) and retailer interviews, undertaken as part of this study, have immensely helped in capturing qualitative insights about the transition of households to energy efficient LED bulbs. We are grateful to all household consumers, FGD participants, and the retailers who have participated in the study. Also, we are thankful to the Electric Lamp and Component Manufacturers Association (ELCOMA) for sharing insights about the evolution of the LED lighting industry in the country and the benefits of LED lighting at the household levels. It was not an easy task to gain field-level insights without the support from DISCOM staff and the representatives of the UJALA Scheme who are deputed at the kiosks, designated for sales of LED bulbs as part of the UJALA Scheme.

We wish to express our gratitude to Mr K Ramanathan (Distinguished Fellow, TERI), Mr Amit Kumar (Senior Director, Social Transformation, TERI), Mr A K Saxena, (Director, Electricity and Fuels Division, TERI), Mr Debajit Palit (Associate Director, Rural Energy and Livelihoods, TERI), and the leadership of TERI for constantly guiding the team.

Undertaking the rapid assessment would have never been possible without personal motivation, diligence, and expertise of the research team comprising Mr Alekhya Datta, Mr S Narayan Kumar, Mr P B Singh, Dr Syed Arif Wali, Mohd. Asim Mirza, Dr Shashank Vyas, Ms Vidhu Kapur, Mr Ubhay Singh, Mr Ashish Sharma, Mr Sandeep Thakre, and Mr S Narayan Kumar. We are also very grateful to the administrative staff at TERI and the field volunteers who have supported this work. Finally, we wish to thank the TERI Press team for designing and developing this insightful report.



EXECUTIVE SUMMARY

India is leveraging all opportunities to meet its Intended Nationally Determined Contributions (INDCs) submitted to the United Nations Framework Convention on Climate Change (UNFCCC). In this quest, the government is implementing the Unnat Jyoti by Affordable LEDs for All (UJALA) Scheme in the country. The Scheme targeted the lighting load across the country and facilitated the replacement of the traditional incandescent bulbs (ICL) with the modern energy efficient LED bulbs. It has emerged as the world's largest zero-subsidy based LED bulbs initiative.

As a key instrument for introducing energy efficiency into daily lives of its citizens, the Government of Uttar Pradesh (UP) is implementing the UJALA Scheme across all 75 districts. Being the third largest state in terms of the number of domestic electricity consumers, UP has a huge potential to reduce its energy demand through the UJALA Scheme. As per the estimates available on the UJALA dashboard, which is maintained by the Energy Efficiency Services Limited (EESL), UP has already harnessed energy savings of 31,17584MWh per year through the Scheme.

With a broader goal of understanding opportunities for further improving the implementation so as to enhance the benefits to existing and prospective consumers of the UJALA Scheme in UP, the Uttar Pradesh Power Corporation Limited (UPPCL) had commissioned the study entitled "Assessment study of LED bulb distribution under UJALA Scheme in Uttar Pradesh". As part of the study, a rapid impact assessment of the Scheme was undertaken by The Energy and Resources Institute (TERI), New Delhi during late March and early April in 2018.

The methodology

At the outset, identification of five districts each where highest and least number of LED bulbs were distributed during the financial year 2017-2018, in the jurisdiction of electricity distributions

companies (DISCOMs) namely Dakshinanchal Vidyut Vitran Nigam Limited (DVVNL), Madhyanchal Vidyut Vitran Nigam Limited (MVVNL), Paschimanchal Vidyut Vitran Nigam Limited (PVVNL), Purvanchal Vidyut Vitran Nigam Limited (PVVNL) was undertaken. Next, a random selection of one district in each category and across each DISCOM was undertaken. In case of Kanpur Electricity Supply Company Ltd (KESCO), Kanpur City was directly selected as it is the only region where LED bulbs have been distributed by the company. As this analysis centers on household consumers of the UJALA LED bulbs, within each of the districts, households were identified using snowballing technique due to unavailability of the complete address of consumers of the UJALA bulbs. A total of 480 surveys were administered across 9 districts — Aligarh, Azamgarh, Baghpat, Ghaziabad, Kasganj, Kanpur (Kanpur City only), Lucknow, Sant Ravidas Nagar and Sitapur. Additionally, one focus group discussion (FGD) with users of LED bulbs was organized and retailers were interviewed. The project team also met the Electric Lamp and Component Manufacturers Association (ELCOMA) to seek their inputs on the LED bulbs and the role of the industry.

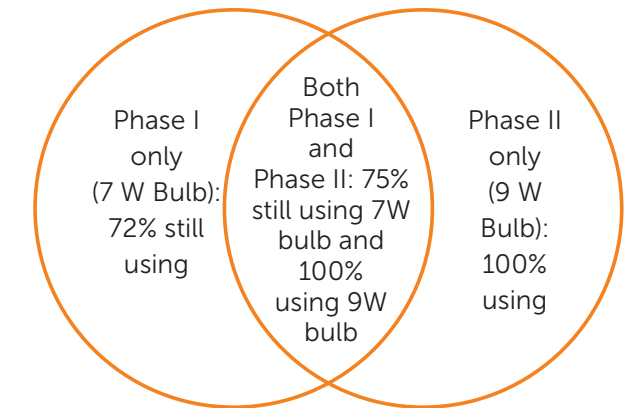
Key findings

The UJALA LED bulbs are distributed through kiosks and DISCOM offices that have been designated for the purpose. A household consumer can purchase LED bulbs from the kiosk or from the DISCOM office. At the time of purchase, the consumer is informed about the warranty policy and is handed over an invoice wherein the total quantity of bulbs purchased and the amount is clearly mentioned. This bill has to be produced at the time of availing replacement service. For awareness generation about the Scheme, a range of tools are being leveraged — mobile vans, advertisement in newspaper and television (TV). One of the most successful means has been

the "word of mouth" marketing tool, wherein a relative or a friend informed a household about the Scheme and benefits to his/her relative and this triggered decision to purchase and use LED bulbs. Among respondents, 86% reported that they are aware of UJALA Scheme and the remaining referred to it as the LED Scheme. The distribution of only government-approved LED bulbs models and brands have been undertaken as part of the UJALA Scheme— Phase 1(7W bulb) and Phase 2 (9W bulb), which is currently on-going. During the FGDs, participants mentioned that availing purchase and replacement service is only possible if the stocks for LED bulbs are available at any particular DISCOM office. Also, the replacement is majorly processed on the production of the purchase invoice and if there are stock available for the brand of the bulbs which has to be replaced. A majority (76%) respondents reported "Contact DISCOM office" as their preferred mode for availing replacement service and 70% mentioned that the bulbs are immediately replaced.

All survey respondents were over 18 years of age and 34% were at least a graduate. The respondents included both males (77%) and females (23%). Also, 18%, 36% and 46% respondents reported having purchased UJALA LED bulbs during Phase 1, Phase 2 and both Phases respectively. The survey respondents reported continuity of use of LED bulbs —72% (Phase 1 only: 7W bulb), 75%(Both Phase1 and Phase 2: 7W bulb) and 100% (Phase 2 only; Phase 1 and Phase 2 both: 9W bulb). This is also indicative of the quality of bulbs distributed. A majority of the respondent households reported using LED bulbs during across bedroom, drawing room, toilet, common space and kitchen between 6 am and 10 pm. In the survey, it was found that the respondents did not mention of the cost of bulb as the most important reason for their preference of LED bulbs, savings on the electricity bill, warranty and brightness and life of LED bulbs were among top answers. Among respondents who had reported damaged bulbs, 47% mentioned disposing of it in waste bins and only 5% mentioned using e-waste bins. Among all districts where the primary survey was administered, the deemed energy savings

corresponding to the transition to the LED bulbs was estimated as highest in Lucknow.



Discussion

The mega transition of households to LED bulbs has been triggered by joint efforts of the government agencies, and the private sector. A strong political will has provided the right push and direction to the overall implementation of UJALA Scheme in the state. The Scheme has been successful in setting LED bulbs a part of everyday lives of consumers in the state of UP. At present, due to the availability of a range of LED bulbs at competitive prices, the cost of UJALA bulb is not anymore the top incentive for end users to purchase only from the Scheme. Nevertheless, a higher warranty period (3 years) is still a strong attraction for a majority of the household consumers.

Way forward

It is likely that expanding the portfolio of lighting products by introducing higher wattage LED bulbs as part of the UJALA Scheme will enhance the interest of end users. At the same time strengthening the mechanisms for replacement service will give an extra push to the overall scale-up of the Scheme in the state. Also, targeted awareness drives for safe disposal of bulbs (after the end-of-life) and replacements of zero watt bulbs will be beneficial in the long run. Further, a statistically robust experiment (randomized control trials and before-after-experiments) is likely to yield deeper insights about consumer behavior at the household levels.



ABOUT THE UJALA SCHEME

1.1 Background

Owing to its firm commitment to reduce its energy intensity by promoting cleaner and energy efficient technology solutions, India, in 2015, launched one of the world's largest zero-subsidy based LED bulb distribution initiative in the country.¹ The Unnat Jyoti by Affordable LEDs for All (UJALA) Scheme aims at provisioning access to affordable LED bulbs for all.² The UJALA Scheme replaced the earlier "Bachat Lamp Yojana". Earlier, this scheme was announced as "Domestic Efficient Lighting Programme (DELP)". The benefits of this initiative include reduction in energy consumption in the lighting sector to help the electricity distribution companies manage peak demand; promotion of usage of most efficient lighting technology at affordable rates; increase in awareness of consumers about energy efficient appliances; and increase in demand of LED lights by aggregating requirements across the country thereby providing an impetus to domestic lighting industry through economies of size.³ As part of the Scheme, the government aims to replace the usage of 770 million inefficient incandescent (ICL) bulbs in the country by March 2019.

The introduction of UJALA Scheme is estimated to have contributed to over 35,000 million units of annual energy savings due to large-scale adoption of the energy efficient LED bulbs. As of December 2017, over 290 million LED bulbs have already been distributed across the country as part of the

¹ Prayas, 2017. Understanding the impacts of India's LED bulb programme, UJALA. Last accessed online from <http://www.prayas pune.org/peg/publications/item/354-understanding-the-impacts-of-india-s-led-bulb-programme-ujala.html> on 20 March 2018

² <http://www.recindia.nic.in/eesl>

³ Lok Sabha. 2017. Unstarred Question No.3967. Answered On 10.08.2017. Subsidized Led Bulbs. Accessed online on 12 April 2018 from https://powermin.nic.in/sites/default/files/uploads/LS10082017_Eng.pdf

Scheme.⁴ The progress on the Scheme is monitored through an online dashboard which is publicly accessible. During Phase 1 of the Scheme, the 7W bulbs were distributed and in Phase 2,⁵ which is currently on-going, 9W LED bulb are being distributed. The Scheme has already triggered an estimated mitigation of 30 million tonnes of carbon dioxide per year⁶.

Table 1: Achievements of UJALA Scheme in India⁷

38,447 mn kWh Energy saved per year	INR 15,379 Cr Cost saving per year	7,697 MW Avoided Peak Demand	3,11,41,818 t CO ₂ Reduction per year
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1.2 UJALA Scheme in Uttar Pradesh

Uttar Pradesh (UP) is the second largest Indian state in terms of gross development product and it has a huge electricity consumer base in the country. As per the "Electricity Sector General Review 2016" report of the Central Electricity Authority (CEA), UP has 10.7% of India's residential electricity consumers. As per the "24x7 POver for All Uttar Pradesh" report, in the financial year 2017-18, the energy requirement and peak demand of the state stood at 1,07,448 MU and 17,183 MW, respectively. Also, as per the report, the peak demand in the state is estimated to rise⁸ from 17,355 MW in FY17 to around 18,918 MW in FY19. Hence, the state government is harnessing projects and schemes for providing reliable & affordable power supply across the state, energy efficiency catalyze these efforts In this quest, the state is facilitating large-scale deployment of LED bulbs through the UJALA Scheme. The peak load in the state occurs between late evening till early morning both in summer and winter months, mainly due to air-conditioning and heater loads. As per the 24x7 Power for All report of UP, the state has set a vision to distribute 100 million LED bulbs. As on 20 March 2018, over 20 million LEDs have been already distributed in the state⁹. The distribution of the bulbs is facilitated by the electricity distribution companies namely – Dakshinanchal Vidyut Vitran Nigam Ltd (DVVNL), Madhyanchal Vidyut Vitran Nigam Ltd (Lucknow DISCOM, or MVVNL), Paschimanchal Vidyut Vitran Nigam Ltd (Meerut DISCOM, or PVVNL), Purvanchal Vidyut Vitran Nigam Limited (Varanasi DISCOM, or PuVVNL), and Kanpur Electricity Supply Company (KESCO), which are operating in the state. In Uttar Pradesh, the Phase 2 of the Scheme was initiated in the financial year 2017-2018. The Uttar Pradesh Power Corporation Ltd (UPPCL)¹⁰, which is responsible for transmission



⁴ Also, the overall LED industry, which comprises the private sector, is estimated to have sold over 600 million LED bulbs. Source: National UJALA Dashboard. Last accessed online on 18 April 2018 from <http://www.ujala.gov.in/>

⁵ As part of UJALA Scheme energy efficient fans and tube lights are also being offered. However, this study was limited to LED bulbs only.

⁶ National UJALA Dashboard. Last accessed online on 18 April 2018 from <http://www.ujala.gov.in/>

⁷ National UJALA Dashboard. Last accessed online on 18 April 2018 from <http://www.ujala.gov.in/>

⁸ After inclusion of energy efficiency measures and electrification of all households.

⁹ Inclusive of phase 1 and phase 2 of UJALA Scheme in UP. Source: <http://www.ujala.gov.in/state-dashboard/uttar-pradesh> last accessed online on 20 March 2018

¹⁰ The power is purchased centrally at UPPCL for the state owned DISCOMs – MVVNL, DVVNL, PVVNL, PuVVNL, and KESCO.



and distribution of electricity in the state, aims to document the learning from the UJALA Scheme to develop future strategies.

Table 2: Achievements of UJALA Scheme in Uttar Pradesh¹¹

31,17,584 MWh Energy saved per year	INR 1,247 cr Cost saving per year	624 MW Avoided Peak Demand	25,25,243 t CO ₂ Reduction per year
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1.3 About the study

Against the above backdrop, The Energy and Resources Institute (TERI), New Delhi undertook a study entitled "Assessment study of LED bulb distribution under UJALA Scheme in Uttar Pradesh" supported by the Uttar Pradesh Power Corporation Ltd (UPPCL).¹²

The broad objectives of this study were as follows:

- Methodology for LED Bulb Distribution.
- How Awareness about UJALA YOJANA was made in Uttar Pradesh.
- What is the perception of users about LED Bulbs?
- Usage pattern for LED Bulbs.
- Estimation of Energy Savings.
- Quality of LED Bulbs Distributed.
- How effective is the LED replacement mechanism in case it goes defective during the warranty period.
- Any other point of improvement substance.



¹¹ Source: Inclusive of phase 1 and phase 2 of UJALA Scheme in UP. Source: <http://www.ujala.gov.in/state-dashboard/uttar-pradesh> last accessed online on 20 March 2018

¹² The UPPCL is responsible for electricity transmission and distribution in the state.



APPROACH & METHODOLOGY

In order to gather insights about the UJALA Scheme in general and its implementation in Uttar Pradesh, secondary research was undertaken by the project team. As part of the secondary research, reports of the government agencies, think-tanks, International Energy Agency, and the World Bank were referred.

The design of the primary research is enumerated as follows:

- **Selection of district:** Within the licensee area/ jurisdiction of each electric distribution company (DISCOM) operating in the state, one district out of the top five districts (in terms of LED bulbs distributed) and one district out of the top five districts (where the least number of LED bulbs were distributed) were randomly selected (Figure 1). For Kanpur Electricity Supply Company Ltd, only 1 district/city was selected as there is only one district/city where distributed has been undertaken. The names of the identified districts were communicated to UPPCL prior to administration of the primary surveys.



- A sample size of 400 was calculated using the formula below:

$$n = \left[\frac{z^2 * p * (1 - p)}{e^2} \right] / [1 + (z^2 * p * (1 - p) / e^2 * N)]$$

Where:

- » n = sample size or number of households that must be surveyed
- » z = z-statistics corresponding to the level of confidence desired. The commonly used confidence level for social research projects is 95% for which z is 1.96.
- » p = population proportion that has specific characteristic of interest
- » e = Margin of error, sampling errors or level of precision. It depends very much on the size of the sample, and very little on the size of the population.
- » N = the value for Population

- The door to door survey of 480 household consumers, who were residing in proximity¹³ to Scheme kiosks/ office of local distribution utility, was administered (Annexure 2). The number of households surveyed in each of the districts was distributed proportionally based on the overall LED bulb dissemination undertaken, during the financial year 2017-2018. The results from the study, to a large extent, represent findings of household LED bulb consumers who are living in

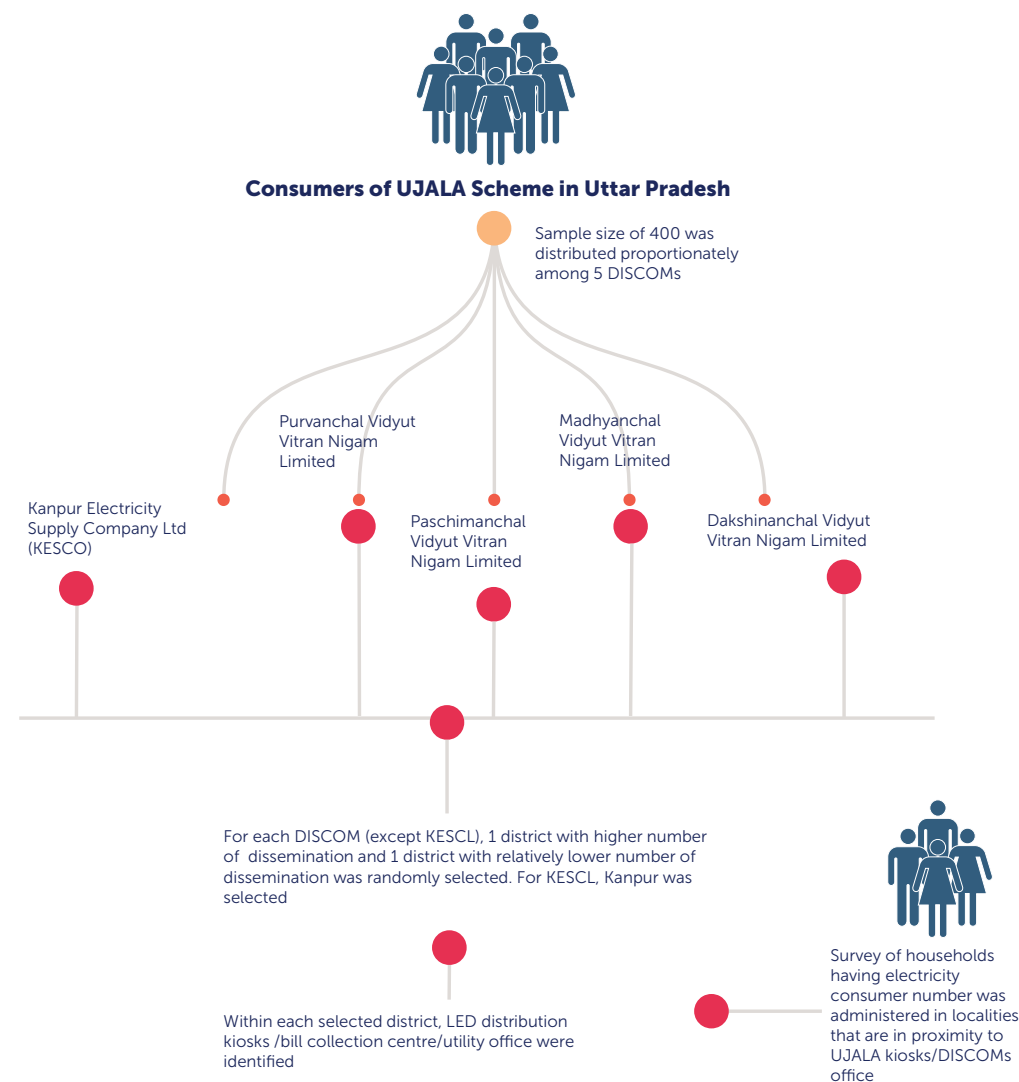


Figure 1: Sample selection

¹³ Due to paucity of time and unavailability of complete address of actual consumers of UJALA bulbs, the team had to undertake the survey only in localities that were in proximity (within a radius of five km) to DISCOMs office and UJALA kiosks. It was assumed that the probability for finding a UJALA bulb user in such localities was higher because of ease of availability of LED bulbs to consumers.



proximity (within a radius of 5 km) to the kiosks or local office of the DISCOM that is operating in the region.

The primary survey was administered in Azamgarh, Aligarh, Baghpat, Ghaziabad, Kanpur, Kasganj, Lucknow, Sant Ravidas Nagar, and Sitapur.¹⁴ Also, interview of five retailers/industry experts (including ELCOMA) was undertaken and 5 focus group discussions (FGDs) were conducted with household consumers of LED bulbs in one district (Aligarh, Azamgarh, Ghaziabad, Kanpur, and Lucknow) from licensee area of each distribution utility. A distribution of the sample across all the 9 districts is given in Table 3. As part of this rapid impact assessment study, surveys were administered between 28 March 2018 and 5 April 2018.

Table 3: Distribution of sample across districts

DISCOM	Total LED distribution in FY 2017–18 (Nos.)	Total distribution during FY 2017–18 (%)	Surveyed households (Nos.)	Districts where surveys were administered
Kanpur Electricity Supply Company (KESCO)	497,832 (6.2%)	6.2	31	Kanpur City
Purvanchal Vidyut Vitran Nigam Ltd	17,76,493	22.2	110	Azamgarh and Sant Ravidas Nagar
Pachimanchal Vidyut Vitran Nigam Ltd	2,037,260	25.4	103	Baghpat and Ghaziabad
Madhyanchal Vidyut Vitran Nigam Ltd	1,574,315	19.6	113	Lucknow and Sitapur
Dakshinanchal Vidyut Vitran Nigam Ltd	2,110,863	26.3	123	Kasganj and Aligarh

One of the key limitations of the study is that there is no baseline data available for before and after comparisons of benefits incurred by household consumers from usage of LED bulbs. The respondents who participated in the study were identified through snowballing technique. The snowballing is non-probability sampling technique where existing study subjects recruit future subjects from among their acquaintances.

¹⁴ Kanpur City only



FINDINGS

In this section of the report, the findings from the study have been outlined. The findings from the study have been grouped into specific themes –(a) LED bulb distribution mechanism; (b) About the respondent profile; (c) Usage pattern of bulbs; (d) Awareness about UJALA Scheme; (e) Consumer perception about LED bulbs; (f) Replacement of bulbs; (g) Disposal of damaged bulbs; (h) Quality of bulbs; (i) Deemed energy savings; and (j) Qualitative insights.

3.1 LED bulb distributed in Uttar Pradesh

The bulk procurement of LED bulbs is done by the Energy Efficiency Services Ltd (EESL) which is a subsidiary of the Bureau of Energy Efficiency (BEE) of the Government of India (GoI) through competitive bidding¹⁵. The EESL has partnered with the electricity distribution companies (DISCOMs) in the state for distribution of the UJALA bulbs. The DISCOMs facilitate the distribution of LED bulbs through their offices. Also, kiosks have been setup for creating awareness and for the distribution of UJALA bulbs. At each of these kiosks, Scheme banners have been placed and trained staff has been deployed to inform consumers about the Scheme.

The price of the bulb (including GST) has been fixed by the central government as INR 70 for a 9 W bulb, irrespective of the brand. At the time of purchase, consumers are provided with a payment receipt. In this receipt, the name of the buyer, buyer's cell phone number, quantity of bulbs procured, total payment received, and the city where purchase was made are entered by the sales representative. As part of the Scheme, households are provided a replacement warranty for a period of 3 years from the date of purchase of the bulb. The purchase receipt has to be retained by the consumer for availing warranty service within 3 years from the date of purchase. In case of any defects, bulbs are replaced (if the warranty policy has not

¹⁵ Prayas. 2017. Understanding the impacts of India's LED bulb programme, "UJALA". Last accessed online from file:///C:/Users/This%20pc/Downloads/02-PEG-Report-on-impacts-of-UJALA%20(2).pdf on 30 April 2018.

lapsed). However, both purchase and replacement requests can only be processed if stocks are available. If bulb stock is not available at any particular distribution center, then the consumer is informed about other centers in the city from where the UJALA bulbs can be purchased. The EESL has also set a national helpline number for the convenience of consumers.

The location of DISCOM offices/ kiosks where LED bulbs can be purchased is mentioned on the UJALA dashboard. During the primary survey, it was found that the prominent brands of the bulbs which have been distributed in the surveyed districts include – Philips, Crompton, and HPL. During FGDs, several participants informed that if the bulb of a particular brand that was sold in the past is discontinued, then replacement is deferred.

3.2 About the respondent profile

A total of 480 surveys were administered. All the respondents were over 18 years of age. Out of the total number of respondents, 34% were at least graduates (Figure 2).

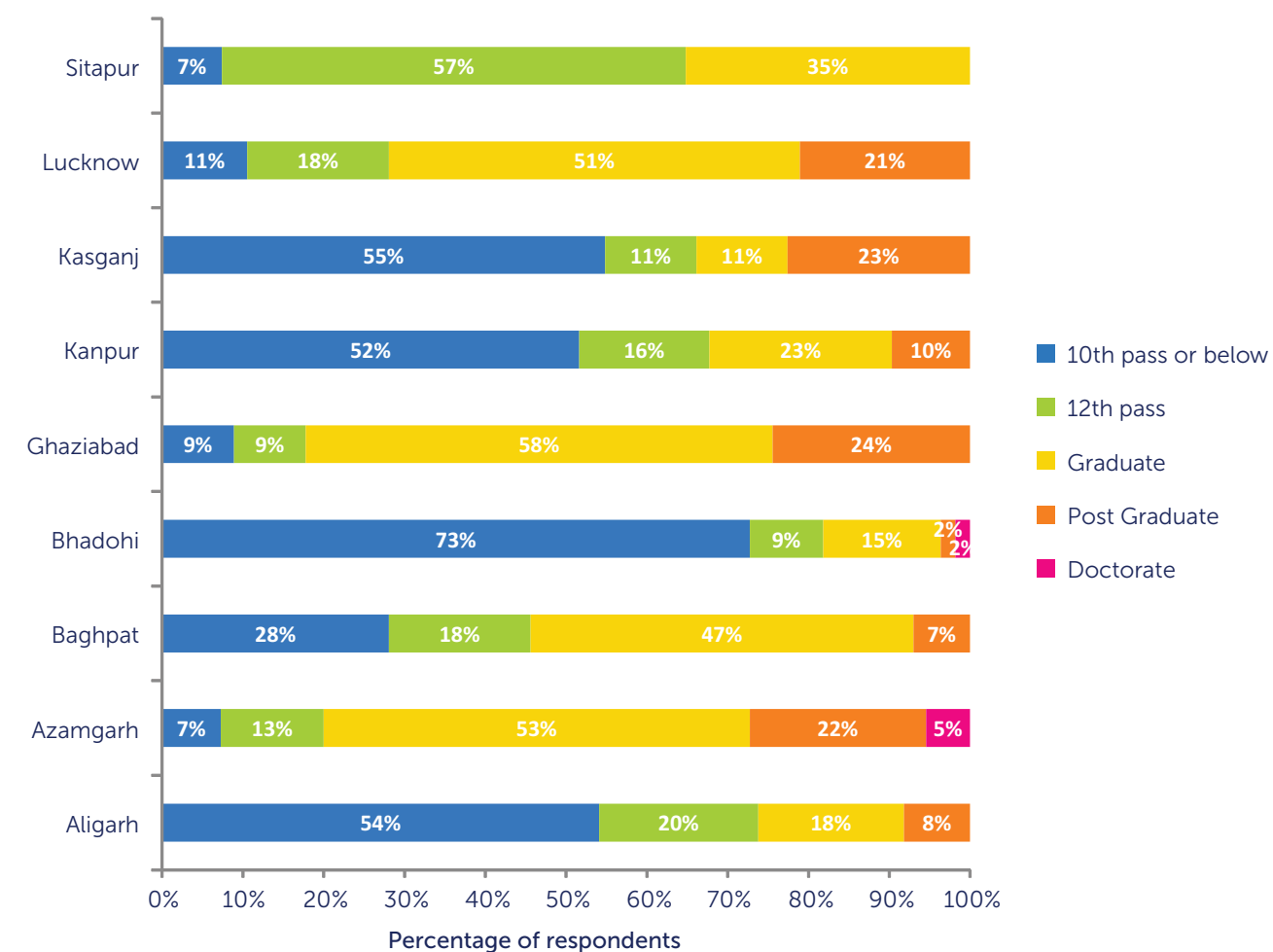


Figure 2: Education level of respondents

The respondents included both males and females. The male respondents constituted 77% of the total respondents.

Further, the electricity bill amount of 52% respondents¹⁶ who reported the same for the month of March 2018 was analysed¹⁷. A majority (44%) of reported bill amount was between INR (0-1600). This indicates that the respondents were from different socio-economic backgrounds and that their energy consumption varied.

3.3 Distribution & Usage pattern of bulbs

The distribution of respondents according to Phase 1 and Phase 2 of the UJALA Scheme is illustrated in Figure 4 below.

A majority (36%) of the respondents reported having purchased bulbs only in Phase 2 of the UJALA Scheme. Out of the total respondents, 18% mentioned that they purchased LED bulbs during Phase 1 only and 46% respondents mentioned that they purchased LED bulbs during both the phases of the Scheme (Figure 3). The respondents who had purchased during Phase 1 and did not feel the need for extra bulbs preferred to not purchase bulbs during Phase 2¹⁸. Nevertheless, a higher percentage of repeat consumers indicate that the LED bulbs offered as part of the Scheme are to the satisfaction of end-users (Figure 4).

An important element of the study was to learn what kinds of primary¹⁹ electrical lighting bulbs/tube lights are the respondent households currently using. An analysis of data reported by survey respondents revealed that a good percentage of Phase 1 consumers continue to use the UJALA bulb (Figure 5). Also, among respondents who have purchased LED bulbs during both Phase 1 and Phase 2, 75% are using 7W LED bulb which were distributed during the Phase 1 of the Scheme. It is also evident that among both Phase 1 and Phase 2 respondents, certain percentage of respondents have purchased LED bulbs from local retailers²⁰ as well.

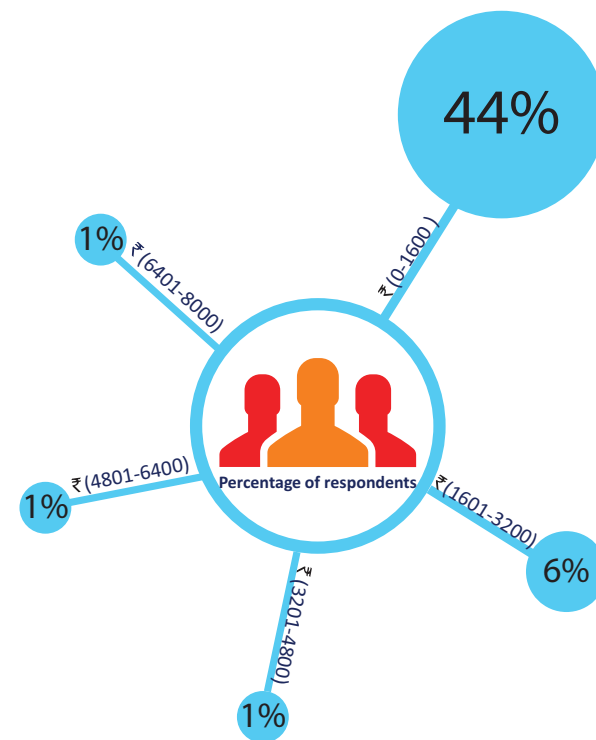


Figure 3: Bill amount of respondents (in %) who reported the last bill received in March 2018

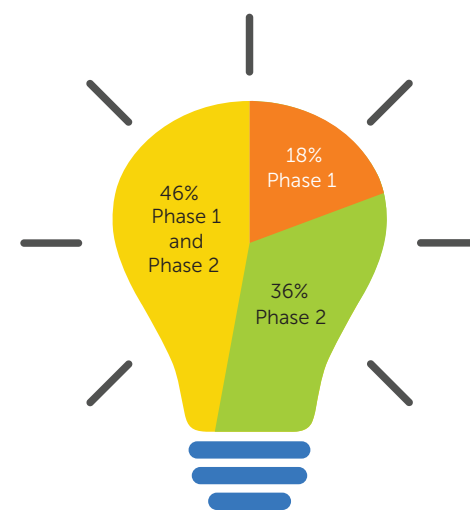


Figure 4: Phase-wise distribution of respondents

¹⁶ The rest of the respondents reported bill amount for other months/years that were mostly not very recent or the number of respondents for that particular month/year was too less

¹⁷ The billing cycle of all respondents is monthly

¹⁸ There is no capping on the number of UJALA bulbs which an individual residential consumer can purchase. Source : <http://www.tatapower-ddl.com/UploadedDocuments/FREQUENTLY%20ASKED%20QUESTIONS%20ON%20UJALA%20SCHEME%20FINAL.PDF>

¹⁹ Primary implies there lighting equipment are used on a daily basis and not as a back-up option such as emergency lights that are used only when there are power cuts

²⁰ Outside the UJALA Scheme

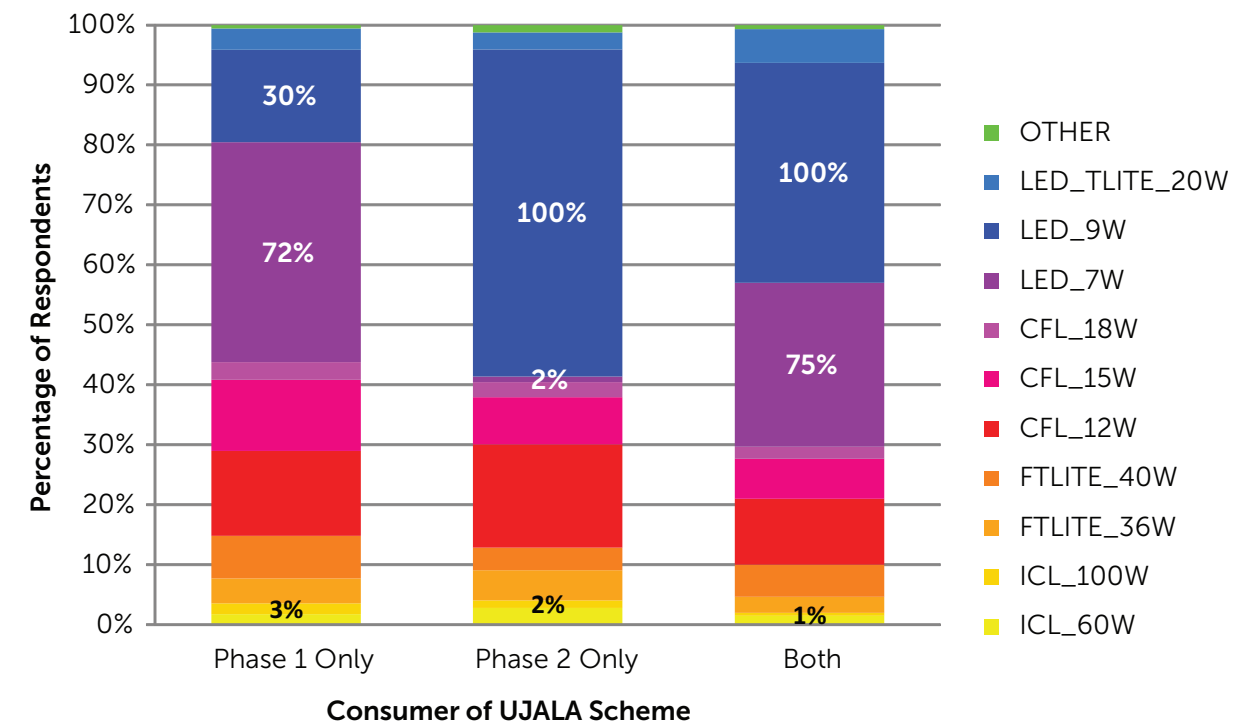


Figure 5: Transition towards the LED bulb

From the above, it is evident that the respondent households are transitioning to efficient lighting bulbs. The percentage of respondent households that reported using ICL bulbs was less for "Phase 2 only (2%)" in comparison to "Phase 1 only (3%)" respondents.

Further, an analysis was undertaken to determine the usage of ICL, Compact fluorescent lamp (CFL), and Light Emitting Diode (LED) bulbs²¹ in the drawing room, bedroom, kitchen, toilet, and common space during four time-slots on a daily basis.²² Figure 6 illustrates the findings from the study. Out of the total respondents, 50% and 72% reported using LED bulbs between 6 am – 10 am and 6 pm – 10 pm, respectively, in the drawing room. Between 10 am – 6 pm, very few respondents reported using any kind of bulbs in the drawing room.

Out of the total respondents, 55% and 87% reported using LED bulbs between (6 am– 10 am) and (6 pm – 10 pm), respectively, in their bedrooms. Between (10 am – 6 pm), very few respondents reported using any kind of bulbs in the bedroom.

In the toilets, a majority of the respondent mentioned that they use LED bulbs. Out of the total respondents, 51% and 74% reported using LED bulbs between (6 am – 10 am) and (6 pm – 10 pm). For the common space such as verandah, garage, *gaushala*, terrace garden, and terrace, lighting was reported to be majorly used after the daylight hours. A very small percentage of respondents mentioned that they use ICL bulbs during all the four timeslots, in the common space.

In the kitchen, 81% and 59% of the respondents reported using LED bulbs between (6 am – 10 am) and (6 pm – 10 pm) respectively. From the above, it is evident that a majority of the households have reported the use of electric bulbs between 6 am – 10 am and 6 pm – 10 pm. Also, the usage of ICL bulbs has been

²¹ LED bulbs purchased from all sources (Phase 1, Phase 2 and retailers who are not part of the UJALA Scheme).

²² The usage of lighting might change during winter season, summer season, and rainy season and during festivals. These seasonal aspects have not been covered a part of this study.

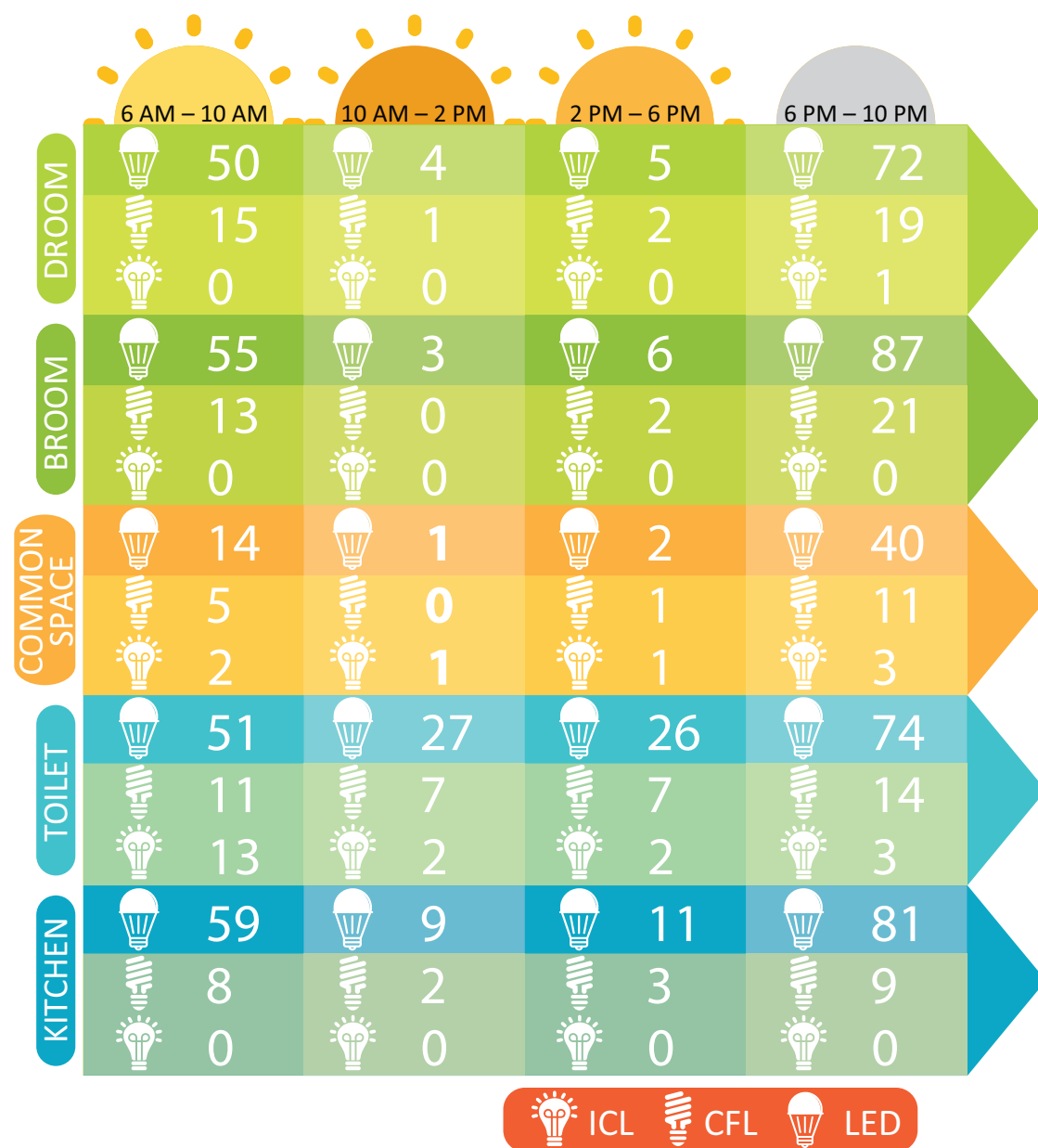


Figure 6: Percentage of respondents using bulbs in the households and time-slot of usage

reported only in the drawing space, toilets and in the common space within the household premise. Further, across all categories (living space, common space, toilet, kitchen, and drawing space), in comparison to other bulbs, a relatively higher percentage of respondents have reported using LED bulbs. The above is indicative of the adoption of LED bulbs by a majority of the respondent households.

Further, among the total LED bulbs that were reported as purchased from all sources (during Phase 1, Phase 2, and from retailers), 50% were reported to have been purchased under Phase 2, 32% were reported as purchased under Phase 1 and 18% were reported as purchased²³ from local retailers²⁴ (Figure 7).

²³ Bulbs purchased from retailers outside the UJALA Scheme are relatively expensive even if the wattage is same as the UJALA bulb

²⁴ Outside the UJALA Scheme.

This indicates that respondents who live in proximity to kiosk/DISCOM office and who often visit the local DISCOM office have mostly purchased LED bulbs from the UJALA Scheme only.

3.4 Awareness about UJALA Scheme

It was found that 14% of the respondents were not aware of the “UJALA Scheme” per se but they were aware of the LED Scheme of the government (Figure 8). The remaining 86% of the respondents reported that they were aware of the “UJALA Scheme”.

The consumers who were not aware of the actual name of the Scheme bought the bulbs for two reasons: (a) they were present at the DISCOM office at the time of distribution; and (b) they were influenced by neighbours/friends about the distribution.

The primary survey further delved into the source of awareness about the UJALA Scheme (Figure 9).

Among the respondents, “word of mouth” emerged as the most effective means for spreading awareness about the UJALA Scheme. This was followed by “newspaper”, mobile vans and advertisements at the bill collection centers and elsewhere.

3.5 Consumer perception about LED bulbs

To understand the perception of consumers about the LED bulbs, they were asked “As compared to other bulbs, whether LED bulbs are a better source of lighting or not”. To this, across all districts where the primary survey was administered, a majority of the consumers gave an affirmative response in favour of LED bulbs (Figure 10).

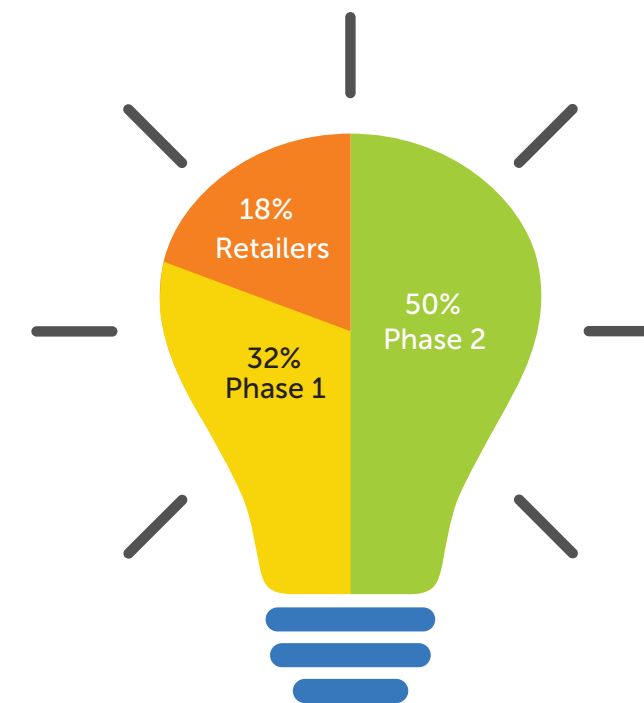


Figure 7: Percentage of bulbs purchased from UJALA Scheme and from Retailers

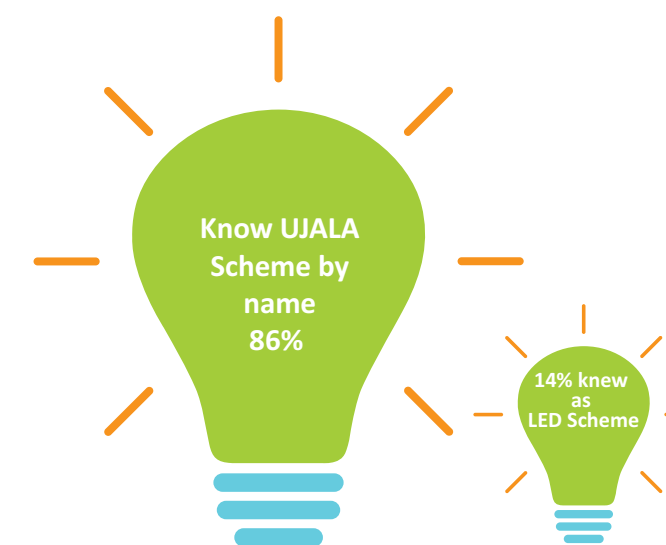


Figure 8: Percentage of respondents who were aware of the name of LED Scheme

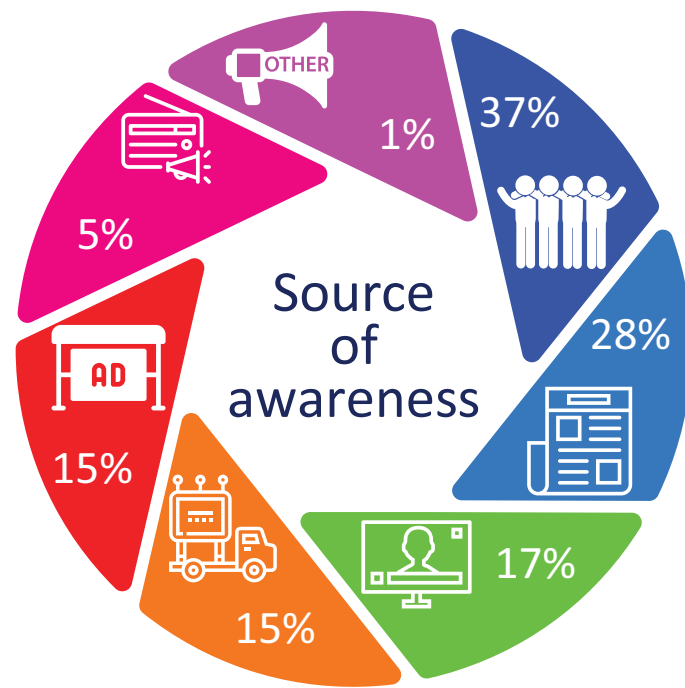
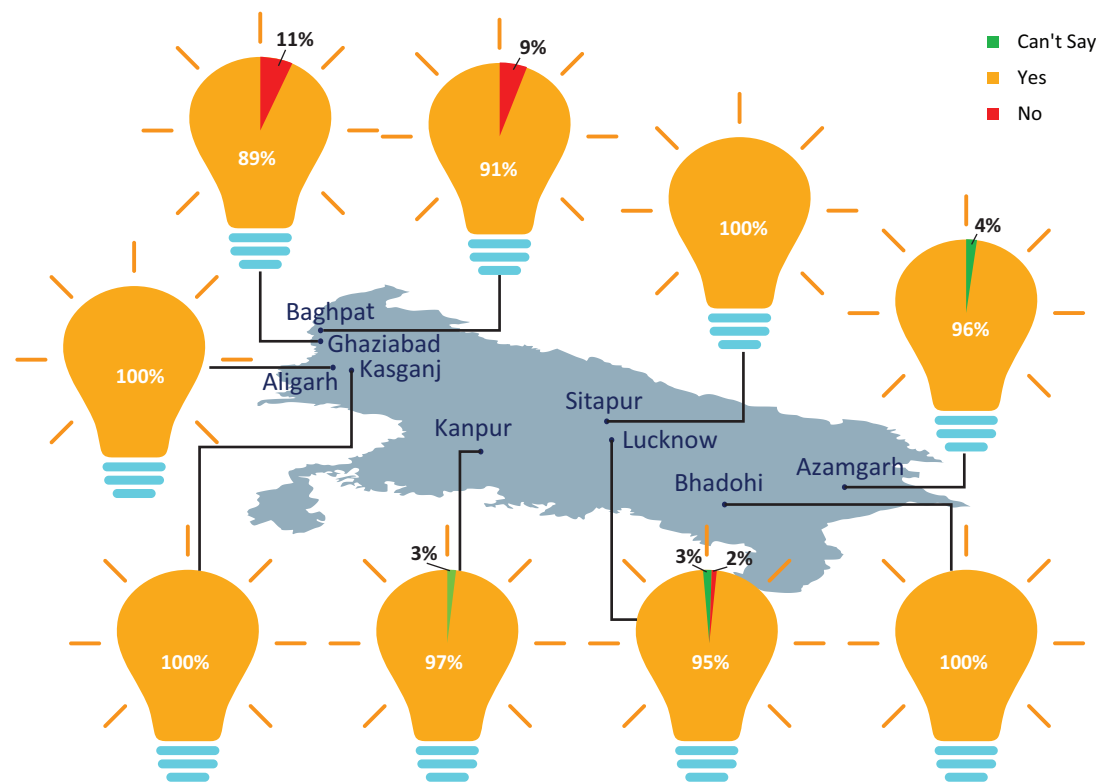


Figure 9: Source of awareness about UJALA Scheme



Map is meant only for illustrative purpose.

Figure 10: Percentage of respondents who feel LED bulbs are better than other bulbs

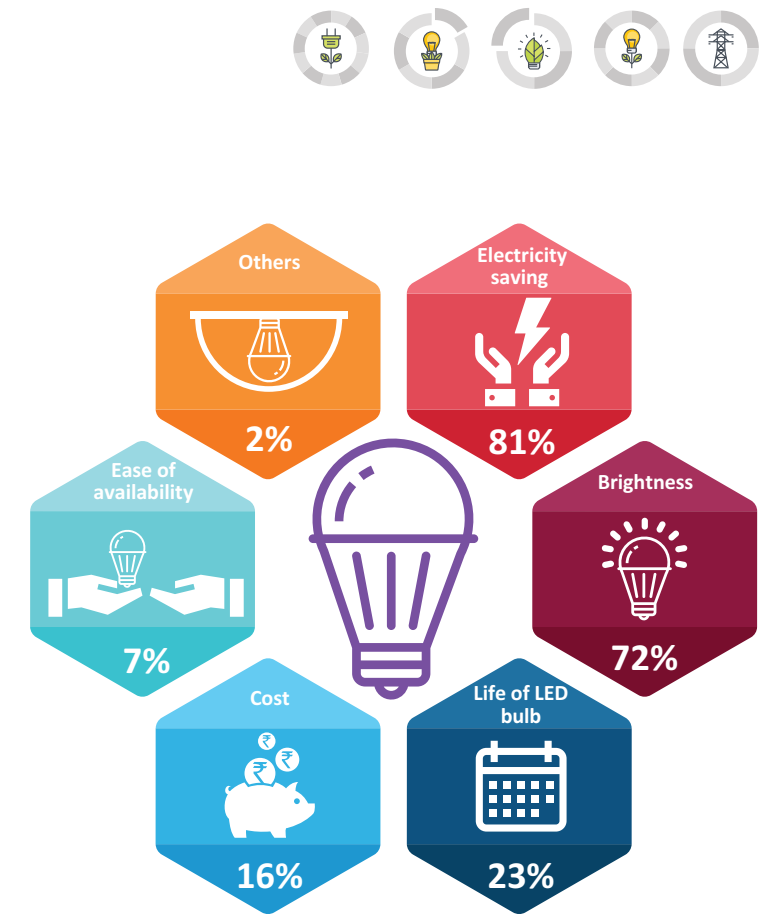


Figure 11: Why respondents like LED bulbs

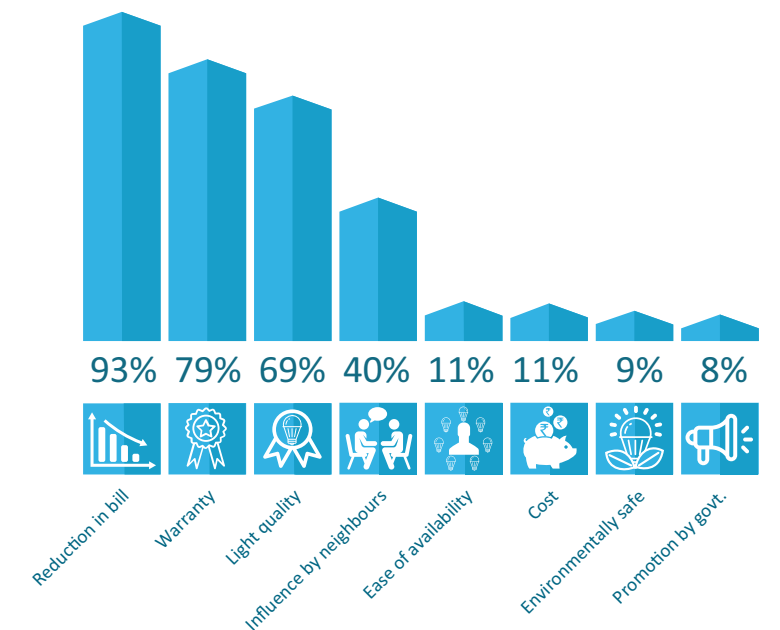


Figure 12: Drivers for the purchase of UJALA bulbs

Those who responded "No" also mentioned that the LED lighting is not sufficient for all household purposes. For example, the brightness is not sufficient for use in study rooms. Those who responded "Can't say" could not decide the better (based on brightness) option between CFL and LED bulbs. The confusion was also because CFL bulbs are expensive than UJALA bulbs and the wattage of CFLs is more than LED bulbs, which according to respondents was most likely due to the advanced technology of CFLs²⁵. This was followed by another question wherein the respondents who answered in favour of LED bulbs were asked to cite reasons for the same. From Figure 11, it is clearly evident that 81% of the respondents have mentioned "Reduction in electricity bill" as the reason for their preference of LED bulbs over other bulbs. This was followed by "Brightness of light". Unlike, these two factors, only 16% of the respondents mentioned "cost" as a reason for their preference for LED bulbs.

Similarly, as depicted in Figure 12, a majority (93%) of respondents mentioned the reduction in electricity bill as the driver for the purchase of UJALA bulbs. The other two reasons out of the top three reasons cited were – "Quality of light" and "Warranty". The cost of UJALA bulbs did not emerge among the top three reasons cited as driver for the purchase of bulbs; presumably because there is an influx of a large number of branded LED bulbs in the market. The bulbs are available at a competitive price. However, unlike UJALA bulbs that carry a warranty of 3 years, the warranty of the bulbs available in the retail market, outside the UJALA Scheme, is mostly 1 year only.

²⁵ People correlate price and wattage to performance

3.6 Replacement of bulbs

The respondents were asked about their preferred channel for replacement²⁶ of faulty bulbs. Among respondents who had availed replacement service, 76% of the respondents reported having availed replacement service through local DISCOM office. Also, 25% of the respondents reported visiting to the local kiosk for availing replacement service (Figure 13). The kiosks will not provide the replacement service forever and will remain operational only during the distribution of bulbs. During the survey, 7% of the respondents mentioned that they also contact a local retailer/electrician for replacement when the need arises. This indicates that there is a need for pronounced communication to the consumers about the various existing modes for replacement of faulty bulbs.

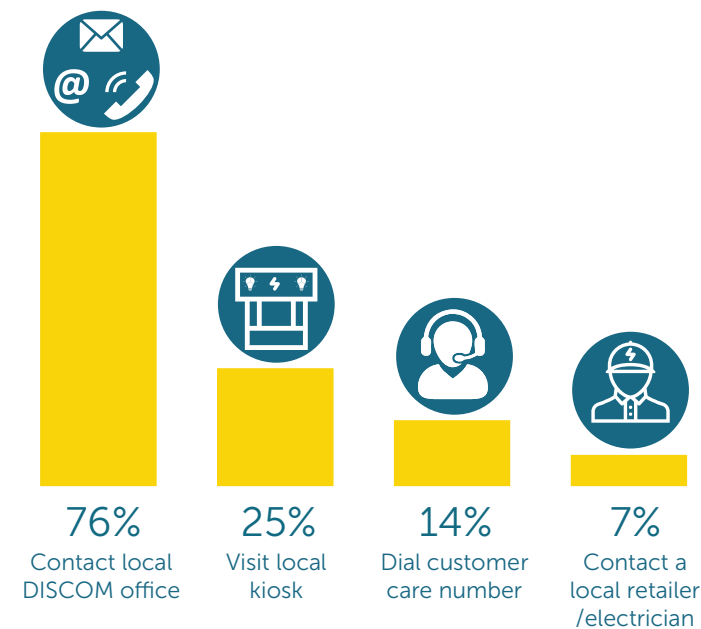


Figure 13: Preferred mode(s) for replacement of the faulty bulb

As part of the study, a feedback on replacement service was taken from respondents who have availed the service. In the study, 70% of the respondents who have availed LED bulb replacement service reported that the bulb was immediately replaced (Figure 14). Further, 24% of the respondents reported that the bulb is replaced based on the availability of stocks. From the primary survey, it appears that there is a need for strengthening the LED bulb replacement mechanism.

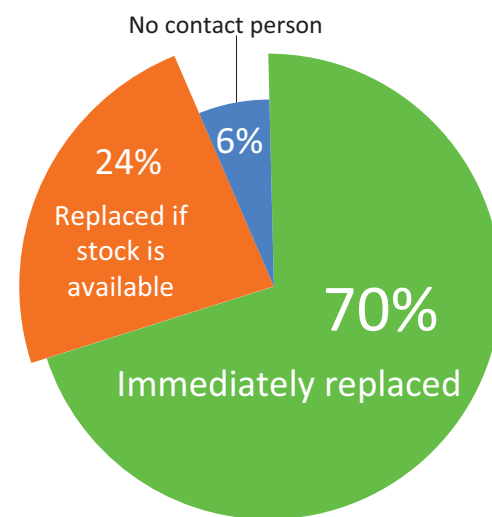


Figure 14: Feedback about replacement mechanism



²⁶ Most of the respondents could only mention that the bulb fused or it was not working and could not tell about technical reasons for failure of the bulb which they had replaced.

service to inquire about replacement and warranty policy. Hence, a need for creating awareness among end users about safe disposal methods for LED bulbs is felt.

3.8 Deemed energy savings

As part of the study, deemed energy savings were estimated based on results from the primary survey.

The methodology for calculating the estimates outlined in Table 4 was adopted from the methodology²⁷ approved by the Clean Development Mechanism (CDM) Executive Board. The details about the methodology have been mentioned in Annexure 3. In the calculations, only the bulbs that were reported as currently in use were used for calculation of deemed energy savings. In the study, relatively higher savings were estimated for Lucknow as a higher number of bulbs have been distributed in the district as compared to other districts.

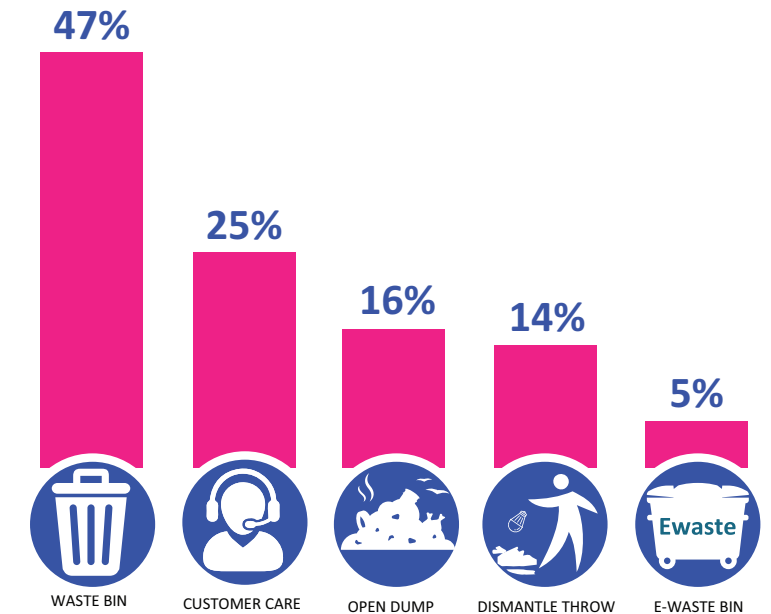


Figure 15: Disposal method for damaged LED bulbs

Table 4: Deemed energy savings from the usage of LED bulbs

District	Energy Savings	Net Electricity Savings	Reduction in GHG Emissions
	(MU per annum)	(MU per annum)	(Tonne of CO ₂ per annum)
Aligarh	15.05	17.89	17534.95
Azamgarh	13.47	15.95	15628.12
Bagpat	4.31	5.00	4901.10
Ghaziabad	21.14	24.55	24058.95
Kanpur	28.48	33.37	32703.26
Kasgunj	3.62	4.37	4282.24
Lucknow	51.71	60.76	59546.56
Sant Ravidas Nagar	0.63	0.75	732.17
Sitapur	1.13	1.33	1305.75

²⁷ CDM Executive Board (AMS-II.J.: Demand-side activities for efficient lighting technologies, Version 7.0)

3.9 Quality of bulbs

From the study, it was found that a good percentage of respondents have purchased UJALA bulbs during both Phase 1 and Phase 2. This indicates that the end-users have liked the bulb. The continued use from Phase 1 to Phase 2 and adoption of bulbs by respondents is also indicative of the quality of bulbs (Figure 16).

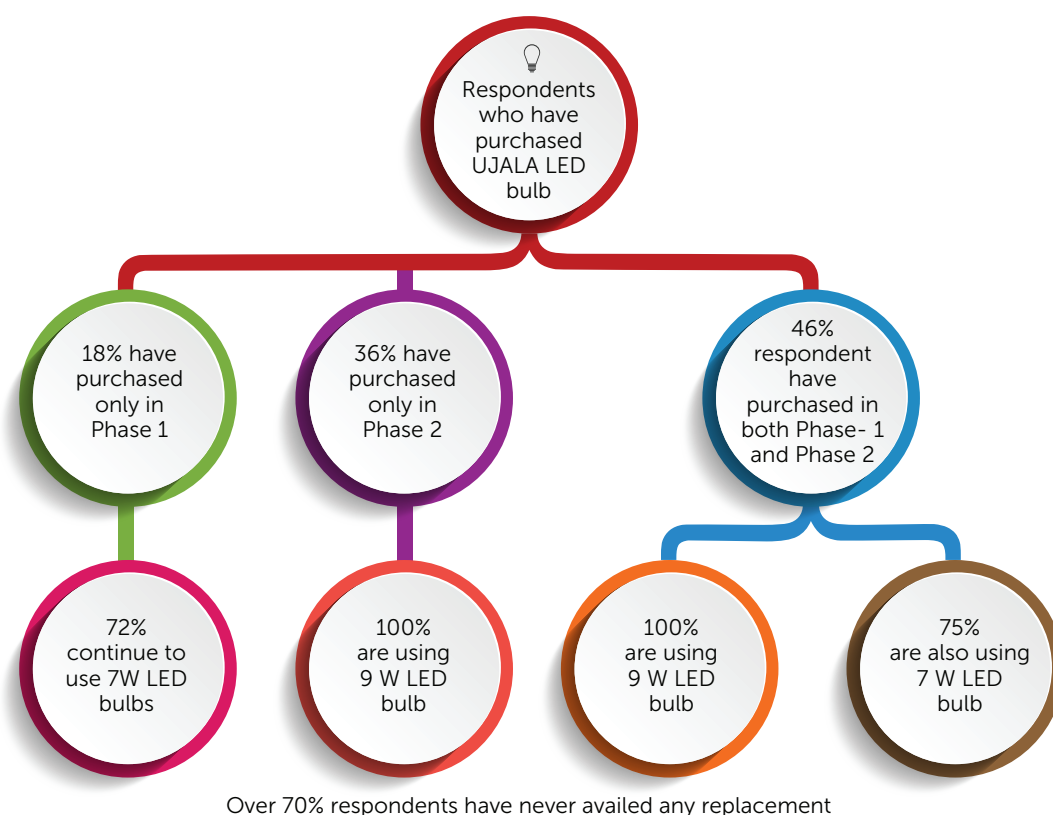


Figure 16: Continued usage and adoption are indicative of the quality of bulbs

Bulbs distributed as part of UJALA Scheme are branded bulbs (such as Philips, Crompton, and HPL) which conform to BIS specification i.e., IS 16102 (Part 1 & 2) for Self-Ballasted LED Lamps for General Lighting Services. However, verification of technical specifications/ conformity tests in a NABL accredited lab for bulbs (on sampling basis) distributed in UP was beyond the scope of this study.

3.10 Qualitative insights

This section of the report presents qualitative insights from the focus group discussions (FGDs) and interview of retailers.

Awareness about UJALA Scheme

Interaction with various consumer groups revealed that UJALA Scheme has been promoted through advertisements at local sub-station, in the newspaper, on TV, and at kiosks/camps. Additionally, "word of mouth" marketing tool has immensely helped in spreading awareness about the Scheme. The primary survey conducted as part of this study also corroborates the above (over 80% respondents were aware of such a Scheme). However, among the respondents, almost 14% were not aware of the actual name of the Scheme. Hence, some level of efforts has to be made to explicitly inform the consumers about the Scheme and its larger goal related to energy savings and climate change mitigation.



LED vs alternatives

A general feeling that most of the participants during the FGDs expressed was that while there is an increased usage of LED bulbs among all economic class of people, the upper middle class, and higher class continue to use CFL bulb and fluorescent tube lights. The participants also expressed that LED bulb has the advantage of saving repair cost that is about INR 100 for fluorescent tube-lights accessories, such as choke, frame, and push-up holder, as they are mostly replaced. The consumers also end-up paying a service charge to the electrician who provides the replacement service.

During FGDs, participants emphasized that the 7W/9W LED bulbs are not a very bright source of lighting and they have to opt fluorescent tube-lights in a study room that needs better lighting in terms of luminous intensity. There were participants who also mentioned that health issues, such as strained eyes and headache, are common due to prolonged exposure to LED bulbs during reading.

Distribution and replacement mechanism

Most of the participants during the focus group discussions (FGDs) felt that high-income households often prefer to purchase LED bulbs from the market only. This is primarily because the UJALA Scheme only offers 9W bulbs and there are several models and specifications of LED bulbs available in the market. Though warranty service of more number of years on UJALA bulbs, as compared to similar products available in the market, is a strong attraction, consumers often lose their UJALA bulb purchase receipt. Hence, several participants recommended introduction of simpler replacement mechanisms, such as signing the bulb on the date of purchase of the bulb. Respondents shared that due to non-availability (out-of-stock) of the brand of LED bulb purchased by them, replacement is sometimes delayed or not carried out at all.



DISCUSSION

4.1 Access to LED bulb

Based on findings from the study, the UJALA Scheme approach appears to have succeeded in introducing LED bulbs into homes. A strong political will of the government has facilitated cooperation between various agencies, such as the EESL, and DISCOMs, for the successful implementation of the Scheme across the state. The primary survey revealed that Phase 1 consumers continue to use LED bulbs purchased under the UJALA Scheme. This indicates satisfaction of end users.

4.2 Building the market sentiment

By launching a time-bound and targeted UJALA Scheme for provisioning access to quality and affordable LED bulbs, the government has catalyzed the creation of an economy of scale for the private sector to operate. As a consequence, there is a range of brands of LED lighting products available in the market, that are suitable for Indian conditions and also meet quality standards prescribed by the Government of India. The cost of 9W LED bulbs is now not a very strong motivator for triggering a purchase; there are several comparable options available at a competitive price in the retail market.

4.3 Triggering the shift

A strong partnership between the government and the LED lighting industry has emerged as a differentiator. While the two are a different category of stakeholders, their separate and yet a unified mission of enabling access to efficient LED bulbs has led to the distribution of over 7 million units in Uttar Pradesh. Also, the partnership has helped in domestic manufacturing of UJALA LED bulbs which is designed for Indian conditions to ensure fail-proof operations even during extreme weather conditions.



WAY FORWARD

- Expansion of portfolio: UJALA bulbs have definitely attracted price-sensitive consumers in UP who also wish to save on their electricity bills. However, the cost of the bulb in itself is not the only attribute which triggers a purchase decision. Hence, to scale-up further, expanding the portfolio of lighting bulbs by adding bulbs of higher wattage will be helpful. This will ensure that the offerings continue to attract consumers in the long run.
- Strengthen replacement service: While the UJALA Scheme has certainly played a vital role in making LED bulbs popular among common people, further push can be given by enhancing awareness about the advantages of LED bulbs in general and UJALA Scheme in particular, and by strengthening mechanisms for replacement of bulbs, wherever required.
- Awareness programme: As part of the UJALA Scheme, a targeted awareness campaign for replacement of the Zero Watt bulbs (that actually consume 15W) and for safe disposal of bulbs after end-of-life will bring added benefits; safe disposal being of critical importance.
- Commission randomized survey: A detailed survey by identifying two or more comparable groups for randomized control trials (RCT) / before and after experiments will yield deeper insights about the benefits accrued at the household level. Also, to evaluate technical performance of the bulbs distributed, a separate study can be commissioned, if required.
- Technical impact due large-scale LED lighting (including of street lights) into a distribution network (in-terms of power quality) could be assessed in a separate study, and also for health hazards.



ANNEXURE 1

Impact Assessment of LED bulbs distributed under the UJALA programme in Uttar Pradesh

Consumer Survey Questionnaire

Introduction

Namaste!
My name is and I have come on behalf of The Energy and Resources Institute (TERI), New Delhi, which is a not-for-profit research institution. TERI is currently implementing a study entitled "Assessment study of LED bulb distribution under UJALA Scheme in Uttar Pradesh". The study has been commissioned by the Uttar Pradesh Power Corporation Ltd (UPPCL), Lucknow. As part of the study we aim to learn about your perception about the LED bulbs and your awareness about the UJALA Scheme of the Government of India. We also wish to understand from you the usage pattern of LED bulbs in the house. The information shared by you will be strictly confidential and will be used only for the purpose of the study. The identity of respondents will not be revealed at any stage to project sponsors or to any other stakeholder. This survey will take 15–20 minutes of your time and you may choose to not participate in the survey at any point during the survey, if you feel uncomfortable.

Instruction for the enumerator

Please show the authorization letter to the respondent at the time of introduction. Also, please don't force any respondent to participate in the survey or to reply to any particular question. If a respondent refuses to participate in the survey then politely thank them for their time and terminate the survey.

After completing of the survey, please thank the respondent for his/her time and for participating in the study.

Consumer and Respondent Details

1. Name of the Consumer :
2. Consumer number/Account ID :
3. District :
4. Name of the respondent :
5. Gender of the respondent : Male Female
6. Address & Contact No. :
7. Are you over 18 years of age (tick appropriate option) : Yes No

If the respondent's age is less than 18 years, please request an adult in the house to respond to the questions. If no adult is available for participating in the survey, please thank the respondent and end the survey at this point.

8. Education level of the respondent:
10th pass or below 12th Pass Graduate PG Doctorate
9. Relationship with the consumer :
10. Is the consumer's family living in the house since 2 months or more? : Yes No
If the answer to 10 is "No", please thank the respondent and end the survey at this point.

Details about the dwelling unit where survey is being administered

11. Do you pay the bill directly to the DISCOM or to the landlord/house owner?
DISCOM House owner or Landlord

If the answer to 11 is "House owner/landlord", please thank the respondent and end the survey at this point.

12. How many living rooms do you have in the house?
13. No. of kitchens: No of toilets:
14. No. of other facilities/ rooms (garage/ gaushala/ store room, etc.) where lighting is used on a daily basis:
15. a) Please tell us the total units of electricity consumed during the last month for which you have received bill : No of Units : Month : Year :

OR

- b) Please tell us the total payable amount (as mentioned in bill that you have last received) :
Amount payable (INR): Month: Year:

Usage pattern for electric bulbs

16. Are you currently using LED bulbs for lighting in your house : Yes/No
17. Please indicate the various kinds of electrical lighting equipment that you use and mention their numbers:
 - a. Incandescent Bulb 60 W
 - b. Incandescent Bulb 100 W
 - c. Fluorescent Tube-light 36 W (T5).....
 - d. Fluorescent Tube-light 40 W (T8)
 - e. CFL 12 W
 - f. CFL 15 W
 - g. CFL 18 W
 - h. LED bulbs 7 W
 - i. LED bulbs 9 W
 - j. LED tube-lights 20 W
 - k. Others (please specify)



18. Please indicate the times of use and the rooms in which you use different kind of bulbs.

Please Tick () the timings.

No. of bulbs (with W)			Room (indicate number also)	Average daily hours of usage	Time of use			
ICL	CFL	LED			6 am – 10 am	10 am – 2 pm	2 pm – 6 pm	6 pm – 10 pm
			Drawing room:					
			Bedroom:					
			Kitchen:					
			Toilet:					
			Common space:					

User awareness about UJALA Scheme (Select multiple options in the following questions, where applicable)

19. (a) Do you know about UJALA (LED) Scheme of the Government of Uttar Pradesh / Government of India?

Yes No

(b) Do you know about LED Scheme of the Government of Uttar Pradesh / Government of India?

Yes No

If the respondent answered No for question no 19(a) and 19(b), Go To 21

20. How did you come to know about the UJALA Scheme?

Newspaper

Radio

Television

Neighbour/friend

Mobile Van

Promotional advertorial by DISCOM like a message on the electricity bill

Other modes (please specify)

.....

Status of LED bulbs used/ procured during the last one year (April 2017 to March 2018)

If the respondent has answered 'Yes' to question no. 16, please continue, or else go to 24

21. Kindly fill the following details regarding LED bulbs purchased by you:

(a) Total LED bulbs you have purchased	(b) LED bulbs purchased (between April 2017 and March 2018) under UJALA Scheme	(c) LED bulbs purchased (prior to April 2017 and March 2018) under UJALA Scheme	(d) LED bulbs purchased from retailer/ shopkeeper	(e) LED bulbs received as a gift from friends/ relatives/blood donation camps, etc.

22. Kindly fill the following details regarding LED bulbs in use:

Total no. of LED bulbs in use	Total no. of LEDs in stock	Total no. of LEDs given to others (friends/neighbour)	Total no. of LED bulbs damaged	Total no. of LED bulbs replaced

Consumer behaviour and perception (Select multiple options in the following questions, where applicable)

23. If using LED bulbs, what is the main driving force behind your purchase of LED bulbs? (Multiple options possible)

a. Reduction in electricity bill

b. Quality of light

c. Environmental concern

d. Easy availability

e. Influence by neighbours/ community

f. Promotion of energy efficiency programmes by the government

g. Cost

h. Not Applicable

24. Do you feel that LED bulbs are a better source of lighting?

Yes

No

Can't say

25. If yes, then why do you feel so? Kindly tick the appropriate options

a. Brightness

b. Electricity savings

c. Life of LED bulb

d. Cost

e. Easy availability

f. Others (please specify)

26. If you have answered 'No' for question no. 24, then why do you feel so? Kindly tick the appropriate options

a. Light is too bright or too focused (eye irritation/glare)

b. Light is not bright enough

c. Aesthetic reasons

d. High cost

e. Some health-related effects are apprehended/experienced e.g.,

f. High failure rate

g. A headache, nausea, dizziness

h. Ease of availability

i. Others (please specify)

j. Not applicable

27. In case you have answered 'No' for question no. 16 and 'Yes' for question no 24, why are you not able to purchase LED bulbs:

a. LED bulbs are not available in proximity

b. LED bulbs are expensive

c. No government scheme/subsidy

d. Not aware of where to buy

e. Others (please specify)



28. In case a LED bulb gets defected/ damaged, how do you dispose of it off?

(Select multiple options, if relevant)

- a. Dispose of in a waste bin
- b. Dispose of in an open dump-yard
- c. Dispose of it in an e-waste bin
- d. Dismantle and throw
- e. Contact customer care center
- f. Not applicable

29. In case you require a replacement for a damaged bulb provided to you under the Scheme, what do you do?

- a. Dial a helpline number
- b. Visit a local kiosk
- c. Consult local office of DISCOM
- d. Contact a local retailer /electrician
- e. Contact customer care center
- f. Don't know what to do
- g. Not applicable

30. In case your answer is either of a, b, e for question no. 29 above, how do you find the response to be?

- a. It is immediately replaced
- b. Replaced only if the stock is available
- c. I am not entertained
- d. No one to contact
- e. Not applicable

ANNEXURE 2

List of Kiosk under UJALA Scheme/ DISCOM office around which surveys were administered in each district:

Kanpur City	
DISCOM	KESCO
Sl. No.	Kiosk/ Location
1	Parade Electricity House
2	Naubasta
3	Daheli Sujanpur
Sant Ravidas Nagar	
DISCOM	UPPCL
Sl. No.	Kiosk/ Location
1	Bhadohi Power House
2	Bhadohi Post office
3	Rly. st. near Bharat Petrol Pump
4	Indraneel Chowk
Azamgarh	
DISCOM	UPPCL Sidhari and Raidopur
Sl. No.	Kiosk/ Location
1	Sidhari Power House
2	Civil Lines Main Road (Raidopur area)
3	IOCL Petrol pump Civil Lines
Aligarh	
DISCOM	DVVNL
Sl. No.	Kiosk/ Location
1	Gantaghar
2	Laladiggi
3	Jalalpur
4	Baraduari
5	Gandhi Park
Kasganj	
DISCOM	DVVNL
Sl. No.	Kiosk/ Location
1	Bilram Gate Charra Adda
2	Soron gate Power House
3	Prabhu Park Nadrai Gate



Ghaziabad	
DISCOM	PVVNL
Sl. No.	Kiosk/ Location
1	Patel Nagar, PVVNL Substation
2	Sanjay Nagar, Blocks-B, Substation of Kamala Nehru Nagar
3	Raj Nagar, Sectors 8,9,10
4	Vasundhara
Lucknow	
DISCOM	MVVNL
Sl. No.	Kiosk/ Location
1	Sector 14, Indira Nagar Power House
2	Vishwas Khand, Gomti Nagar Power House
3	Aminabad Power House
4	MVVNL Head office, Gokhle Marg
5	Aliganj
6	Charbagh
Sitapur District	
DISCOM	MVVNL
Sl. No.	Kiosk/ Location
1	No 5 Power house
2	Kharidabad Power house
3	Siddhauri Power House
4	Leharpur Power House

ANNEXURE 3

The energy savings accrued in this project are calculated in accordance with the international standard Methodology approved by the CDM Executive Board (AMS-II.J.: Demand-side activities for efficient lighting technologies, Version 7.0). In this study, instead of 'Lamp Failure Rate', we have used 'Lamp Usage Rate'.

The steps in calculating the deemed energy savings are briefly described below:

1. The nameplate/rated power of the ICLs replaced, and LED bulbs provided are captured during survey. In this case, ICLs those are replaced mostly rated of 60W and the LED bulbs those are distributed are of 9W (Baseline technology – Incandescent lamp (ICL) of 60 Watts having Minimum light output of 715 Lumens)
2. The operating hours for each bulb are taken as weighted average (average measured value determined from measurements of a representative & random sample survey conducted) of all room types i.e., bed-rooms, drawing room, common room & kitchen.
3. The annual gross electricity savings are calculated by comparing the rated power of the ICL and LED bulb and multiplying them by annual operating hours and number of distributed LED bulbs/ replaced ICLs.
4. The annual Net Electricity savings, for each year are calculated by correcting the gross electricity savings for leakage, a net to gross adjustment factor (NTG), aggregate technical & commercial losses (AT&C), and lamp usages rate (LUR)
5. AT&C losses are considered for those 9 surveyed districts with their respected DISCOMs as approved in Tariff Order dated 1.8.2016 (Page No. 164) i.e., Approval of Business Plan, MYT ARR and Tariff for State Discoms for FY 2017-18 to FY 2019-20 and True-up of FY 2014-15 (http://pvvnl.org/RTI/TARIFF/Tarrif_order_2017/Tariff-Order_021217.pdf)
6. Avoided generation capacity is then calculated by considering the average plant load factor.
7. The emission reductions are quantified by multiplying the net Energy Savings calculated with the emission factor (EF).
8. The emission factor is 0.98 tonnes of CO₂/MWh (Source: "CO₂ Baseline Database for the Indian Power Sector. User Guide, Version 10.0, December 2014")

I. Estimated Energy Savings

The annual gross electricity savings are calculated by comparing the rated power of the ICL and LED bulb and multiplying them by Annual operating hours and number of distributed LED bulbs/replaced ICLs. Table A outlines estimated energy savings for the 9 surveyed district.

$$ES = (P_{ICL} - P_{LED}) \times O \times 365/1000 * N$$

(Refer to Table A)

Where

ES = Estimated gross annual electricity savings.

P_{ICL} = Rated power of the ICL replaced (60Watt).

P_{LED} = Rated power of the LED provided (9 Watt).

O = Operating Hours = Weighted average hours per 24 hrs. (Option 2 as per CDM)



N = Number of LED bulbs in use

Table A: Estimated Energy Savings for 9 Surveyed Districts

Sl. No.	Name of District	Number of LED bulb installed (N)	Weighted average hours per 24 hrs (O)	Annual Gross Energy savings (MU/Annum)
1	Aligarh	206290	4.13	15.05
2	Azamgarh	148967	5.2	13.47
3	Baghpat	66007	4.1	4.31
4	Ghaziabad	238029	4.5	21.14
5	Kanpur	376738	3.23	28.48
6	Kasganj	44102	4.8	3.62
7	Lucknow	578667	4.8	51.71
8	Sant Ravidas Nagar	6570	5.2	0.63
9	Sitapur	22835	2.34	1.13

II. Net Electricity Savings

The annual net energy savings (Avoided Generation capacity), for each year are calculated by correcting the gross energy savings for leakage, a net to gross adjustment factor (NTG), aggregate technical & commercial (AT&C) losses, and lamp failure rate. The net energy savings is the value of power generation avoided and this takes into account the transmission and distribution losses. Table B outlines the net electricity savings for the 9 surveyed district.

$$NES = ES * NTG * [1 / (1 - AT\&C)]$$

(Refer to Table B)

Where:

NES: Net Electricity Savings for that particular Year in kWh.

ES: Gross Energy Savings

NTG = 0.95 (Net-to-gross adjustment factor, a default value of 0.95 is to be used unless a more appropriate value based on a lighting use survey from the same region as per CDM standards.)

AT&C= AT&C losses for the respective utility

Table B: Net Electricity Savings for 9 Surveyed Districts

Sl. No.	Name of District	Name of Discom(s)	AT & C Losses*	Net Electricity Savings (NES) in MU/Annum
1	Aligarh	DVVNL	20.07	17.89
2	Azamgarh	PuVVNL	19.73	15.95
3	Baghpat	PVVNL	18.18	5.00
4	Ghaziabad	PVVNL	18.18	24.55
5	Kanpur	KESCO	18.91	33.37
6	Kasganj	DVVNL	20.07	4.37
7	Lucknow	MVVNL	19.16	60.76
8	Sant Ravidas Nagar	PuVVNL	19.73	0.75
9	Sitapur	MVVNL	19.16	1.33

* AT&C losses are considered as approved in Tariff Order dated 1.8.2016 (Page No. 164) i.e., Approval of Business Plan, MYT ARR and Tariff for State Discoms for FY 2017-18 to FY 2019-20 and True-up of FY 2014-15 (http://pvn.org/RTI/TARIFF/Tariff_order_2017/Tariff-Order_021217.pdf)

IV. Reduction in GHG Emission

The emission reductions are quantified by multiplying the net Energy savings calculated with the emission factor (EF). The emission factor is calculated in accordance with provisions under "AMS-I.D: Small-scale Methodology for Grid connected renewable electricity generation, Version 18.0, and Tool to calculate the emission factor for an electricity system, Version 6.0". Table C outlines reduction in GHG emission for the 9 surveyed district.

$$\text{GHG Emission reduction} = \text{NES} * \text{EF MWh/Annum}$$

(Refer to Table D)

NES = Net Electricity Savings

EF: Emission Factor = 0.98 tonnes of CO₂/ MWh (from CEA website)#

Table C: Reduction in GHG Emission for 9 Surveyed Districts

Sl. No.	Name of District	Net Electricity Savings (NES) in MU/Annum	GHG emission reduction (Tonne of CO ₂ /Annum)
1	Aligarh	17.89	17534.95
2	Azamgarh	15.95	15628.12
3	Baghpat	5.00	4901.10
4	Ghaziabad	24.55	24058.95
5	Kanpur	33.37	32703.26
6	Kasganj	4.37	4282.24
7	Lucknow	60.76	59546.56
8	Sant Ravidas Nagar	0.75	732.17
9	Sitapur	1.33	1305.75

V. Lamp Usage Rate (LUR)

Lamp usage rate (LUR) is the percentage of the number bulbs that are currently in use to the total bulbs purchased under UJALA Scheme. The LUR are multiplied with their respective population proportion and added up to get the overall lamp usage rate. Table D outlines lamp usage rate for the 9 surveyed district.

Table D: Lamp Usage rate in 9 Surveyed Districts

Sl. No.	Name of District	Lamp Usage Rate (%)
1	Aligarh	79.00
2	Azamgarh	93.01
3	Baghpat	79.37
4	Ghaziabad	97.86
5	Kanpur	95.16
6	Kasganj	88.07
7	Lucknow	97.15
8	Sant Ravidas Nagar	98.18
9	Sitapur	97.24

CO₂ Baseline Database for the Indian Power Sector User Guide, Version 10.0, December 2014. Last accessed online from http://cea.nic.in/reports/others/thermal/tpece/cdm_co2/user_guide_ver10.pdf on 20 May 2018

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