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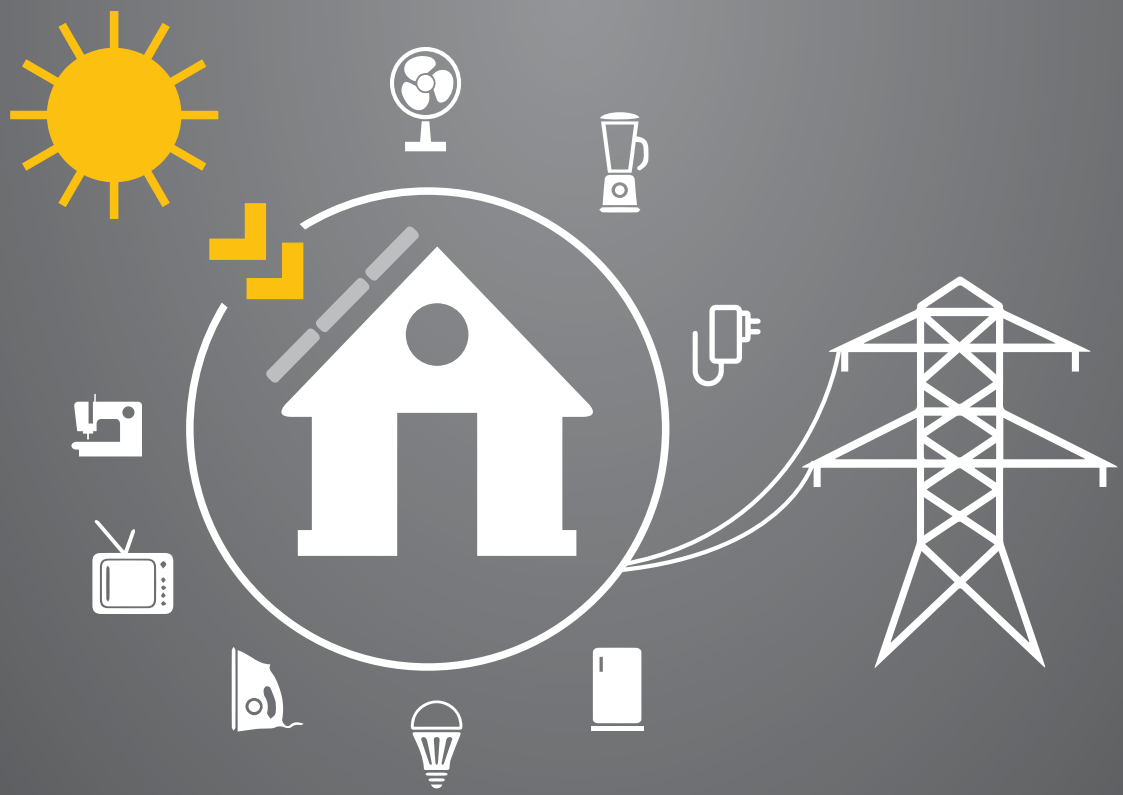
Alliance for an Energy Efficient Economy

Increasing Energy Access by Using Super-Efficient Appliances in Rural Homes and Productive Businesses

INDIA STAKEHOLDERS MAPPING REPORT

February 2020



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India Stakeholders Mapping Report

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About Alliance for an Energy Efficient Economy:
Alliance for an Energy Efficient Economy (AEEE) is a leading energy efficiency think tank and industry platform. AEEE was closely involved in the development of India Cooling Action Plan, India's first State Energy Efficiency Index and the national R&D initiative to promote building and habitat energy efficiency to create a cadre of well-trained building energy efficiency professionals. AEEE advocates for Thermal Comfort for All, Lean-Mean-Green philosophy to design and construct net-zero energy-water-waste built environment, Sustainable Transportation, Energy Data Framework for better policymaking and implementation, Energy Efficiency as a resource and to create a culture of energy efficiency in India.

About Good Energies Foundation:
Good Energies Foundation believes that reversing climate change and alleviating poverty go hand in hand. The goal is to help prevent climate change and mitigate its harm, especially to people who live in poverty. One specific objective is to give the poor access to clean, sustainable energy. Good Energies Foundation focuses on rural areas that have low rates of electrification, primarily in India and sub-Saharan Africa. It supports programmes that bring distributed electricity generation to underserved communities.

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The views/analyses expressed in this report/document do not necessarily reflect the views of Good Energies Foundation. This report is based on the primary data collected from the SHS & DRE system providers and appliance manufacturers and information available in the public domain. Every attempt has been made to ensure the correctness of data. AEEE and Good Energies Foundation do not guarantee the accuracy of any data included in this publication nor do they accept any responsibility for the consequences of its use.

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This study was guided by Dr Satish Kumar and undertaken by Ms Sudha Setty, Ms Bhawna Tyagi, Ms Srishti Sharma and Ms Sangeeta Mathew at AEEE.

Abbreviations and Acronyms

AC	Alternating Current
BEE	Bureau of Energy Efficiency
BIS	Bureau of Indian Standards
BLDC	Brushless DC
BOOND	Boond Engineering and Development Pvt Ltd
BoS	Balance of System
CEEW	Council on Energy, Environment and Water
CLASP	Collaborative Labeling and Appliance Standards Program
CLEAN	Clean Energy Access Network
DC	Direct Current
DDUGJY	Deen Dayal Upadhyaya Gram Jyoti Yojana
DRE	Distributed Renewable Energy
EESL	Energy Efficiency Services Limited
FGD	Focused Group Discussion
G20	Group of 20
GDP	Gross Domestic Product
GoI	Government of India
HDI	Human Development Index
IEA	International Energy Agency
ISEP	Initiative for Sustainable Energy Policy
kW	kilowatt
kWh	kilowatt hour
kWp	kilowatt peak
LEAP	Lighting and Energy Access Partnership
LED	Light Emitting Diode
MFIs	Microfinance Institutions
MNRE	Ministry of New and Renewable Energy
OECD	Organisation for Economic Co-operation and Development
OEMs	Original Equipment Manufacturers
PMDC	Permanent Magnet DC Motor
RGGVY	Rajiv Gandhi Grameen Vidyutikaran Yojana
S&L	Standards and Labelling
SDG	Sustainable Development Goal
SHG	Self Help Group
SHS	Solar Home System
UNDP	United Nations Development Programme
UP	Uttar Pradesh
USD	US Dollar
W	Watts
Wp	Watts peak

Key Definitions

1. Super-efficient Appliances Data Portal	A portal cataloguing the efficient appliances available for the Indian off-grid[1] community is one of the outputs of this study. The portal provides technical specifications of efficient appliances along with the details of the manufacturers/ technology providers. This portal will be useful to various key actors such as government bodies, manufacturers, SHS & DRE system providers, end-consumers and peer organisations working in energy efficiency and energy access.
2. Household appliances	Appliances that are used by households for their basic requirements such as lighting, heating, cooking, and do not contribute directly to income-generation.
3. Productive appliances	Appliances that are used for livelihood opportunities and contribute directly towards income generation such as rice hullers, blacksmith blowers and sewing machines.
4. Productive businesses	Small businesses who use appliances for income generation in a rural community.
5. Super-efficient appliances	Appliances that when coupled with an off-grid system, result in overall cost reduction of electricity supply service by consuming less power (Phadke et al., 2017). Global LEAP (Lighting and Energy Access Partnership) in their 2016 report 'The State of the Off-Grid Appliance Market' states that these appliances result in significant energy savings when used with an SHS/DRE system in a rural household/small business, without necessitating additional energy supply.
6. Weak grid	The weak-grid refers to households and businesses that have sporadic, low-quality grid connectivity, typically only a few hours daily with a high degree of intermittency, i.e. frequent and unpredictable power outages (Efficiency for Access, 2019).

1 In the report, for convenience, all the references related to off-grid refers to both off-grid and weak-grid.

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EXECUTIVE SUMMARY

To ensure sustainable and reliable energy access for all, it is essential to follow a sustainable development model which focuses on reducing energy intensity

Access to affordable electricity for every household is crucial for the socio-economic development of a country. To achieve energy access for all, the Government of India (GoI) has been undertaking several initiatives for the past decade and a half. According to the Saubhagya dashboard, only 0.01% of rural households are unelectrified. However, the success of electrification should not be measured solely based on connections provided, but also on the reliability and quality of the power supply during peak hours. According to the Ministry of Power (2019), power supply varies from 14.3 hours in Arunachal Pradesh to 24 hours in Gujarat, Himachal Pradesh, Punjab, Maharashtra and Tamil Nadu.

India's share in the world's primary energy consumption is only 6% even though 18% of the world's population lives in India. India's per capita energy consumption is one-third of the global per capita average of 1.8 tonnes of oil equivalent (Economic Survey, 2019). Energy poverty is more pervasive than income poverty in India. There is also a wide disparity between rural and urban areas in energy access. To persevere on the high growth path and meet the aspirations of its people for overall development, India needs to quadruple its per-capita energy consumption (Economic Survey, 2019).

To ensure sustainable and reliable energy access for all, it is essential to follow a sustainable development model which focuses on reducing energy intensity [2]. One of the sustainable ways to approach the challenges of energy access is through energy efficiency measures that yield the same output, with less energy. The saved energy could be used to provide access to additional households and productive businesses requiring energy access and could also contribute towards a better quality of supply. The energy saving potential from energy efficiency measures for India is estimated to be around 7.21 % of net electricity consumption in 2017-18 (Economic Survey, 2019). As a result, energy efficiency is a crucial resource for energy access. However, the fact that energy efficiency could lead to enhanced energy access has often been overlooked.

One of the ways to tap into the benefits of end-use energy efficiency is by using super-efficient appliances [3] in off-grid rural households and productive businesses. These appliances require less power and can be operated on small off-grid systems. According to the

2 Energy intensity is usually defined as "the amount of energy required to produce one unit of Gross Domestic Product (GDP)" or energy consumption per GDP.

3 Super-efficient appliances are those appliances which when coupled with off-grid system results in overall cost reduction of electricity supply service by consuming less power and being compatible with smaller sized systems.

The majority of players are now present in the northern and southern regions of India

Global LEAP Report (2016), solar home systems (SHS) equipped with super-efficient appliances would use 75% less energy than SHS with conventional appliances.

The deployment of these super-efficient appliances in rural communities would enable the use of more appliances for additional hours with the same or less power supply. This brings about additional benefits, such as improved quality of life, safety, increased income generation, access to education, and so on. Thus, the time is ripe for utilising the opportunity of increasing energy access through the use of super-efficient appliances which use less power than conventional appliances.

The super-efficient appliance market in rural India is yet to develop to its full potential. Therefore, to facilitate the penetration of these super-efficient appliances in rural communities for increasing energy access; there is a need to identify the appliances that are available in the Indian off-grid market and likely to grow in demand in the near future. It is also imperative to map all the key players that operate and provide power at the grassroots level.

The present study aims to identify super-efficient appliances, their manufacturers and SHS and distributed renewable energy (DRE) system providers supplying these appliances. The study further identifies and evaluates the challenges faced by all the key actors in the super-efficient appliance market and recommends measures to overcome these challenges.

The time is ripe for utilising the opportunity of increasing energy access through the use of these super-efficient appliances as a resource which use less power than conventional appliances

The study also catalogues the technical specifications of the appliances by conducting extensive primary surveys and secondary research. It also incorporates stakeholder consultations to capture the perspectives of the key actors. Field visits were carried out in the rural areas near Lucknow (in Unnao and Sitapur) in Uttar Pradesh (UP) and Hubli in Karnataka to interact with the end consumers of the appliances and identify the challenges faced by them in their usage and procurement.

The survey results showed that more than 70% of system providers cater to both households and productive businesses. The majority of players are present in the northern and southern regions of India. Their presence in the eastern and western regions is comparatively lower.

In the northern parts of India, the players mainly cater to UP and Rajasthan. The key players (such as Boond, Oorja, OMC Power, and SoULS) continue to focus on UP because it has the highest number of households without grid connections. Out of 3.9 crore unelectrified households in the country, 1.4 crore lie in UP (Rajya Sabha Data, 2018).

In the southern region, Karnataka and Tamil Nadu are the two states with the maximum number of system providers and manufacturers. In India, system providers and manufacturers supply to both weak-grid and off-grid areas. Despite the improvement in electricity connections, the availability of reliable power supply remains a challenge in many areas. In the weak-grid areas, they cater primarily to those areas where grid power is available for more than 8 hours a day.

Most of the surveyed system providers offer appliances along with their systems, as it is convenient for system integrators to bundle appliances based on their system capacities. About 72% of the system providers source their appliances from original equipment manufacturers (OEMs) and 14% manufacture appliances in-house. At present, bundling of appliances mostly includes household appliances such as light emitting diode (LED) lights, fans and in some cases, TV. However, productive appliances are usually offered by DRE enterprises as a package, tailored to a specific requirement.

In the case of household appliances, most players offer LED bulbs and tube lights followed by brushless DC (BLDC) ceiling and pedestal fans. These results also corroborate field visit findings

Lighting is the primary requirement for households, followed by demand for space cooling appliances

and interactions with consumers that lighting is the primary requirement for households, followed by the demand for space cooling appliances. The other set of appliances offered in this segment includes water purifier, DC TV, mobile chargers, mixer grinder, induction stoves and refrigerators.

One of the key findings is that, after meeting the primary requirement of lighting, households demand productive appliances which could generate income. Among productive appliances, most system providers offer solar water pumps, followed by sewing machines and blacksmith blowers.

After analysing the survey responses and understanding the appliance offerings of various system providers and manufacturers, the study identified 2-3 super-efficient appliances with high growth potential in household and productive business segments.

Among household appliances, DC TV, air cooler, mixer grinder, BLDC ceiling and pedestal fans, and small refrigerators have the highest market penetration potential. Appliances offered by system providers are mainly procured from manufacturers, such as Signify (formerly Philips), Halonix, Eveready, Atomberg, Superfan, Alphasine.

Only 5% of the system providers encountered delayed and outstanding payments while selling the appliances

Among productive appliances, solar water pumps and sewing machines have maximum penetration potential, whereas silk rearing, reeling and spinning machines have high growth potential. However, the number of suppliers is limited as productive appliances require customisation based on the local requirements. The big players that supply solar water pumps are Shakti Pumps and Grundfos, and those for spinning machines are Dev Nrgee and Resham Sutra. Other appliances such as blacksmith blowers, roti rolling machines, photocopy machines, sewing machines and milking machines are supplied by Selco Foundation.

The study also estimated the energy saving potential of super-efficient appliances. For example, if all the new fans purchased in 2017-18 were BLDC fans rather than BEE 5-star, then these new fans would save up to 0.3% of net electricity consumption in 2017-18 compared to 0.16% in case of BEE star-rated fans. Therefore, overall energy saving potential due to the use of super-efficient appliances could contribute significantly towards sustainable energy access.

The study also identified the challenges faced by system providers and manufacturers while increasing the penetration of appliances in the off-grid market. These system providers and manufacturers emphasised the lack of consumer awareness, consumer affordability and market competition as significant challenges, rather than lack of demand.

It was interesting to note that only 5% of the system providers encountered delayed and outstanding payments while selling the appliances. This implies the positive intention of consumers to pay for the appliances purchased without delay or default. These observations also corroborate findings from the field visits, that energy-efficient appliances allowed consumers with limited power supply to use multiple appliances for longer hours, and increase productivity and income.

To overcome the challenge of lack of consumer awareness, systems providers could spread awareness among consumers using innovative approaches such as appliance display through mobile vans or live demonstrations. Policymakers could identify the appliances with maximum penetration potential and could reduce their cost through bulk procurement to address the challenge of consumer affordability. The government could also help develop business models and financing schemes. This will build an eco-system for the use of these appliances and incentivise the production of BLDC motors, which will significantly reduce the energy requirement.

A data repository of SHS and DRE system providers could be maintained by an appropriate agency with their product offerings and areas of operation. This will help the system providers to collaborate and reduce duplication of efforts. Overall, these key actors could play a crucial role in utilising India's energy efficiency potential by contributing to the need for energy access in rural India.

An appliance data portal, "Super-Efficient Appliances Data Portal", has been developed. It catalogues the details of appliances, manufacturers, SHS and DRE system providers. The portal will act as a catalyst to boost energy access by upscaling the penetration of super-efficient appliances in the rural off-grid community. The portal is hosted on the AEEE website and also linked to the CLEAN website. By providing holistic information, this report helps policymakers, government bodies and other key actors to make informed decisions to advance the penetration of super-efficient appliances.

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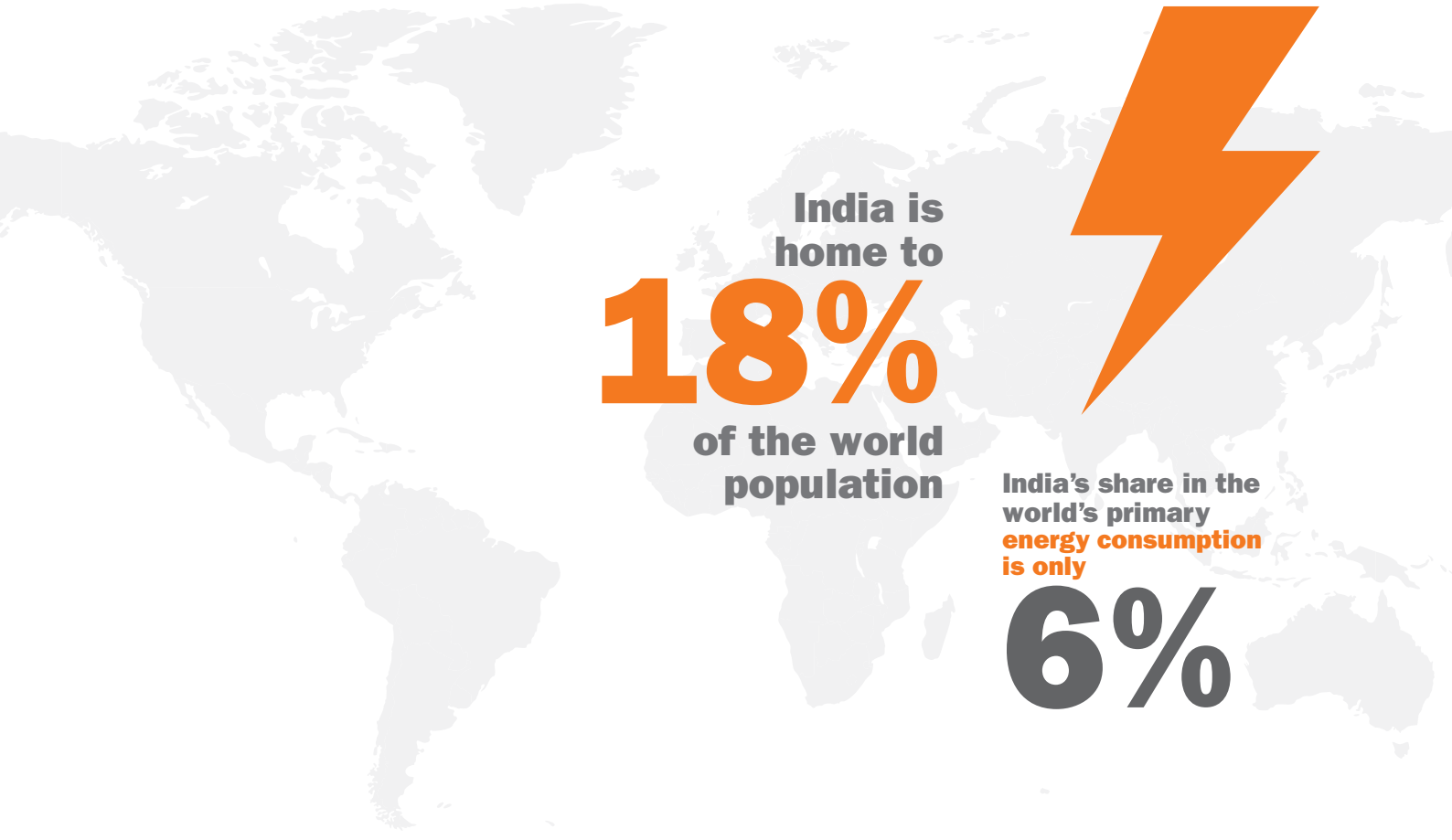


1. INTRODUCTION

Background

Energy is a strategic commodity that is critical to the development and prosperity of an economy. There is also a strong relationship between energy and economic output that has been validated by several studies [Asongu, Montasser, and Toumi (2015); Palamalai, Ravindrab and Prakasam (2015); Saidi and Hammami (2015)]. According to the Economic Survey of India (2019), one gigajoule increase in per capita energy consumption correlates with 145 USD increase in per capita Gross Domestic Product (GDP) of an economy. Despite being home to 18% of the world's population, India's share in the world's primary energy consumption is only 6%. India's per capita energy consumption is one-third of the global per capita average of 1.8 tonnes of oil equivalent (Economic Survey, 2019). To persevere on the high growth path and meet the aspiration of its people for their overall development, India needs to quadruple its per-capita energy consumption (Economic Survey, 2019).

According to Rajya Sabha Data (2018), around 21.7% i.e. 3.9 crores out of a total of 18.1 crore rural households are still unelectrified

Access to affordable and reliable electricity for every household is a necessary condition for socio-economic development and a significant increase in per capita GDP. International Energy Agency (IEA) in its Energy Access Outlook 2017 states that "Energy access is the 'golden thread' that weaves together economic growth, human development and environmental sustainability". Sustainable Development Goal (SDG) 7 on affordable and clean energy is interlinked with all other SDGs, as substantiated by the strong relationship between per capita energy consumption and Human Development Index (HDI), especially at low levels of energy consumption. Despite being the fastest growing economy amongst the G20 countries, India ranks 130 out of 189 countries in HDI ranking, with an HDI value of 0.64 in 2017 [Anand, 2019; Organisation for Economic Co-operation and Development (OECD), 2018; and United Nations Development Programme (UNDP), 2018].

Energy poverty is more pervasive than income poverty in India (Economic Survey, 2019). There is even a wide disparity between rural and urban areas in terms of energy access. To ensure rural electrification, the Government of India (GoI) has been undertaking various measures for the past 15 years, such as Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY), Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY), Saubhagya Scheme, among others. According to Saubhagya scheme, almost all the rural households are electrified till date, and only 0.01% are left unelectrified.

However, the success of rural electrification should not be measured solely based on connections provided, but also on the basis of the provision of reliable and quality power supply during peak hours (Chaudhury and Tyagi, 2018). According to Rajya Sabha Data (2018), around 21.7 %, i.e. 3.9 crores[4] out of a total of 18.1 crore rural households are still unelectrified.

4 1 crore is equivalent to 10 million

Energy saving potential from energy efficiency measures for India is estimated to be around

7.21 %

of net electricity consumption in 2017-18

Therefore, 100% energy access with reliable power supply is yet to be achieved in India.

To achieve this target of energy access for all, it is essential to follow a sustainable development model which focuses on reducing energy intensity. One of the sustainable ways to approach the challenges of energy access is through energy efficiency measures. Through these, the saved energy can provide access to more households and productive businesses.

In India, energy intensity started declining at per capita GDP of USD 578 since 1991 whilst that in the US started declining at USD 23,309 from 1970 onwards (Economic Survey, 2019). Energy saving potential from energy efficiency measures for India is estimated to be around 7.21% of net electricity consumption in 2017-18 (Economic Survey, 2019). As a result, savings through energy efficiency is a crucial resource for energy access. However, the fact that energy efficiency leads to enhanced energy access has often been overlooked.

One of the ways to tap into the benefits of end-use energy efficiency is by using super-efficient appliances in off-grid rural households and productive businesses. Theses appliances require less power and can be operated on a comparatively small sized off-grid as well as grid systems.

As per a Lawrence Berkeley National Laboratory 2017 study, total power requirement of super-efficient appliances - four DC light emitting diode (LED) lamps, a colour television, a radio and a phone charger is around 18 watts (W) with total daily load of 77 Wh/day as compared to 86 W and 349 Wh/day in the case of conventional appliances. The former can be operated on a small off-grid system at 27 watts peak (Wp) as compared to the 121 Wp in case of conventional appliances. The study concluded that super-efficient appliances could increase energy access in rural communities by increasing the affordability of the off-grid systems and associated balance of system (BOS) components, such as wiring and switches. (Phadke et al., 2017)

Solar Home Systems (SHS) equipped with super-efficient appliances would use 75% less energy than SHS with normal appliances

Global LEAP Report (2016) states that energy requirement in the case of SHS equipped with super-efficient appliances is 75% less than SHS with conventional appliances.

Deployment of super-efficient appliances that are substantially more efficient than conventional appliances in rural communities can resolve the issue of energy access. This brings about additional benefits such as improved quality of life, safety, increased income-generating opportunities, access to education, and so on. Yet, the super-efficient appliance market in rural India is not developed to its full potential compared to other countries. Thus, the time is ripe for utilising the opportunity of increasing energy access by using super-efficient appliances as a resource which uses less power than conventional appliances.

To facilitate the penetration of super-efficient appliances in rural communities for increasing energy access, there is a need to identify the appliances that are available in the Indian off-grid market and likely to grow in demand in the near future. It is also imperative to map all the key players that operate and provide power at the grassroots level.

The study aims to identify super-efficient appliances, manufacturers and SHS and DRE system providers that supply these appliances. The study further identifies and evaluates the challenges faced by all the key actors in the super-efficient appliance market and recommends measures to overcome these challenges. The study helps policymakers and peer organisations working in the off-grid, energy efficiency or energy access sector, manufacturers and SHS and DRE system providers.

Literature Review

The role of energy efficiency in energy access is underexplored in India. There are a few studies which have looked into super-efficient appliances as a catalyst for providing energy access to rural communities and eradicating rural energy poverty. But, there are few studies that have focused on the supply side for boosting access through super-efficient appliances to the rural end-consumers. Therefore, this study has reviewed the relevant literature for key learnings, developing recommendations and identifying gaps in the present understanding.

Global Leap in their 2016 report 'The State of the Off-Grid Appliance Market' focused on the status of the appliance market, prevailing market trends, potential opportunities and associated challenges. The report highlights the positive relation between low-income rural households' increase in purchasing power and off-grid appliance market growth. It illustrates that using super-efficient appliances equipped with SHS would use significantly less energy than SHS with conventional mainstream appliances. It also states that development in the off-grid appliance market will have a positive impact on the entire eco-system, resulting in improved living standards of rural communities. The report has further mentioned the challenges related to consumer financing and low-quality products in the Indian off-grid market. The report has recommended the need for partnership with microfinance institutions (MFIs) and implementation of product quality control guidelines. However, the report has mainly examined the appliance market and associated challenges from the consumer's point of view, while the perspective of manufacturers or system providers was not considered.

Prayas studied the potential savings from the use of the most energy-efficient appliances in Indian households (Boegle, Singh and Sant, 2011). They studied the stock along with the energy consumption of various household appliances in India and then estimated the potential of savings from the most energy-efficient appliances.

In another study, Prayas focused on selected super-efficient appliances' penetration in the Indian market and their potential savings (Chunekar et al., 2011). They have also emphasised the requirement of a firm policy or an incentive mechanism that could enable manufacturers in supplying super-efficient appliances. In a policy brief, Council on Energy, Environment and Water (CEEW) and Initiative for Sustainable Energy Policy (ISEP) stated that policy support is required to address the challenges faced by the rural end-consumers related to affordability and availability of off-grid systems and appliances in areas with unreliable electricity supply (Leong, Rupelian and Jain, 2018). However, these studies have not dealt with challenges faced by the SHS & DRE system providers and manufacturers in supplying super-efficient appliances in the rural off-grid community.

There are studies which examined the challenges faced by end-consumers in seeking access to electricity through off-grid systems. A recent report by Brookings emphasised the challenges faced by end-consumers who rely on mini and micro grids/DRE systems for reliable electricity supply (Tongia, 2018). The report has highlighted issues such as last-mile connectivity, high cost of micro-grids, sizing of micro-grids, translating system design between energy (kWh) and capacity (kW). The study recommended the use of super-efficient appliances, flexibility in the connectivity of the regular grid with the off-grid system and the requirement for cross-subsidy mechanisms.

Another study also focused on challenges faced in increasing energy access through micro-grids (Institute for Transformative Technologies, 2016), such as the cost of micro-grids, limited usability of storage units due to associated technological challenges and the high cost of smart meters. To overcome these challenges, the study suggested the development of

an integrated approach consisting of innovative technologies, financial support from the private sector, public-private partnerships and incentives to rural households for community electrification through off-grid systems.

Surprisingly none of the previous studies has considered the perspective of SHS or DRE system providers and manufacturers, who play a key role in providing an efficient and effective solution to the off-grid rural community through a combination of off-grid system and super-efficient appliances. Most significantly, none of the studies has identified the super-efficient appliances available in the market or has highlighted the need of integrating SHS & DRE systems with super-efficient appliances along with the importance of having flexibility for connecting them to the grid and eliminating energy poverty.

Therefore, the present study attains significance as it adds perspectives not covered before. The study identifies super-efficient appliances, challenges faced by SHS & DRE system providers and manufacturers in the off-grid market and suggests measures to overcome them. The findings also complement the existing studies by providing information from the supply-side perspective. By providing holistic information, this report enables informed decision making by policymakers, government bodies and other key actors that facilitate penetration of super-efficient appliances in Indian rural households and productive businesses.

2. OBJECTIVE AND APPROACH

Objective

With the goal of undertaking stakeholders mapping for scaling the penetration of super-efficient appliances, the study was carried out to meet the following objectives –

- To create a database of super-efficient appliances and manufacturers available in the Indian market
- To identify gaps and suggest recommendations based on stakeholders mapping
- To identify opportunities in the rural, renewable-energy and appliance markets for a transformative action

The study has the following expected long-term outcomes:

- Greater choice and availability of affordable super-efficient appliances in the market for rural households and productive businesses
- Higher penetration of super-efficient appliances enabling improved quality of life and creation of new employment opportunities in rural off-grid communities
- Feasibility of inclusion of selected super-efficient appliances in the standards and labelling programme
- Possibility of designing bulk procurement programmes for selected super-efficient appliances

Approach

The study followed an integrated approach for achieving the above listed objectives, i.e. by identifying super-efficient appliances, system providers and manufacturers, cataloguing appliance technical specifications by conducting extensive primary and secondary research and carrying out stakeholder consultations for capturing the perspectives of key actors.

The study entailed the following activities:

Primary survey of SHS and DRE system providers

- AEEE and CLEAN Energy Access Network (CLEAN) conducted a survey of SHS and DRE system providers[5] who provide appliances to the rural community.
- The survey gathered information related to their product offerings, appliance technical specifications and the challenges faced by both end-consumers and system providers in the off-grid appliance community.
- AEEE and CLEAN visited the rural areas of Lucknow (Unnao, Sitapur) in Uttar Pradesh (UP), and Hubli in Karnataka, interacted with the end consumers using the appliances that were identified through this study, identified challenges faced by them in using and procuring the appliances, and current and future demand for different appliances.

5 SHS and DRE system providers will be referred as "system providers" hereafter in this study.

Study of super-efficient appliance manufacturers through primary and secondary research.

- In partnership with CLASP, information was collected from CLASP database "Equip Data" on efficient appliances and manufacturers that manufacture and/or sell appliances in India. Further secondary research was also carried out to identify other manufacturers in India.
- AEEE surveyed various appliance manufacturers operating in India and globally and sought their insights on the super-efficient appliances currently available in India's off-grid market along with the super-efficient appliances that are likely to be in demand in the next 3-5 years.

AEEE analysed the data from both surveys to identify 2-3 super-efficient appliances with the highest potential for penetration in rural communities in the next few years.

Government consultations were undertaken to explore the feasibility of select super-efficient appliances being included in the standards and labelling programme and their potential for bulk procurement.

The energy required to provide energy access to all households was broadly estimated along with the calculation of savings in energy consumption, which could accrue from using the super-efficient appliances.

Methodology

The project team conducted an extensive survey of system providers and manufacturers to collect and collate information on their appliance offerings for household and productive businesses. It was observed that appliances are supplied in the off-grid market mainly through two channels – either by the manufacturer directly or through intermediaries such as SHS and DRE system providers. Therefore, the survey was carried out in two parts. In the first part, SHS and DRE system providers catering primarily to the off-grid rural market were surveyed. In the second part, manufacturers of household and productive appliances were surveyed.

The questionnaire included both quantitative and qualitative questions to collect the following information:

- Type of service providers
- Type of customers served
- Areas of operation
- Appliance offerings
- Challenges faced and gaps in the penetration of energy-efficient appliances
- Units sold
- Factors impacting the sale of appliances
- Potential for future growth

A pilot survey was conducted to test the response to the questionnaire. Based on the feedback from the stakeholders, the questionnaire was further modified. The surveys were conducted through emails, in-person interviews and telephonic conversations. The results of the survey were analysed using Microsoft excel.

3. MARKET ANALYSIS

This section provides a detailed description of the survey conducted (targeted audience, response and limitation), and delves further into the findings of the survey.

Survey Responses

The first survey of SHS and DRE system providers was conducted to obtain an overview of the market – the key players, the types of customers they serve, their areas of operation and the appliances they offer. After studying the overview of the market, manufacturers were surveyed to delve deeper into the technical specifications and efficiency of appliances, quality control and so on.

In the first survey, the questionnaire was sent to 389 SHS and DRE system providers as shown in Figure 1. To make the survey comprehensive, large and small players working in this domain from several states were targeted. Responses were received from 43 system providers which comprise 65% of the total market share (Figure 1).

In the second survey, the questionnaire was shared with 40 manufacturers including national and international players (Figure 1). Out of them, 20 were SHS and DRE system providers that were a part of the first survey. They were included in the manufacturers' survey as well since they were manufacturing appliances in-house.

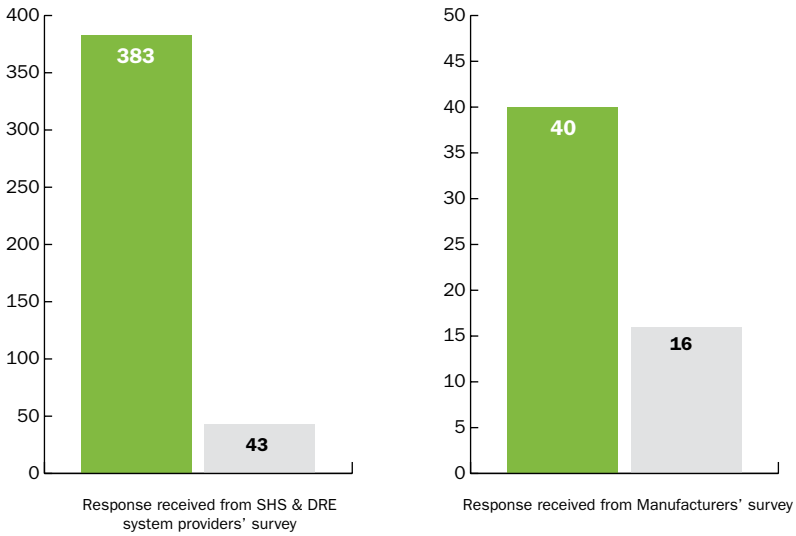
The detailed results of the surveys are presented in section 3.2.

Limitations

Challenges or limitations faced in carrying out the surveys are listed below:

- In many cases, it was a challenge to reach out to the system providers/manufacturers due to the unavailability of contact information such as email id, website, and phone number.
- In many cases, the company had shut down, or the website was non-functional, or email id did not exist.

Figure 1:
Number of SHS and DRE system providers and manufacturers surveyed and responded
Source: AEEE Analysis



- Passive feedback or reluctance was observed from manufacturers as well as system providers in sharing the requisite information while responding to the survey.
- Incomplete information was received from manufacturers/ system providers that made data difficult to interpret and draw inferences.
- The appliances specifications such as output, capacity and input power received in the survey responses from manufacturers/system providers have been considered at face value since it is beyond the purview of this study to cross-validate the numbers by testing each appliance in a test laboratory.
- The study observed significant data gaps in technical specifications shared by system providers and manufacturers, especially on the efficiency parameters. Thus, a separate extensive exercise needs to be carried out for gathering information on technical specifications of appliances including their efficiency parameters. This could be additionally supported by testing appliances in labs to assess their efficiency levels.

Discussion and Analysis

This section focuses on the profile of the survey participants – the system providers and manufacturers, detailing the list of appliances available in the market and recommending 2-3 efficient appliances with growth potential over the next 3-5 years.

Profile Summary of the Survey Participants

Out of 47 respondents, 75% cater to both households and productive businesses, as shown in Figure 2. Demand for basic lighting continues to dominate among underprivileged communities. It is interesting to note that livelihood opportunities are also growing in rural geographies. These system providers by providing basic lighting along with productive appliances to small businesses are enabling extra income generation opportunities for underprivileged communities. Lighting enables them to run the business for longer hours, and use of productive appliances improves their productivity.

At present, most players are in the northern and southern regions followed

Figure 2
Type of customers served by system providers and manufacturers
Source: AEEE Analysis

n *denotes number of system providers and manufacturers participated in the survey*

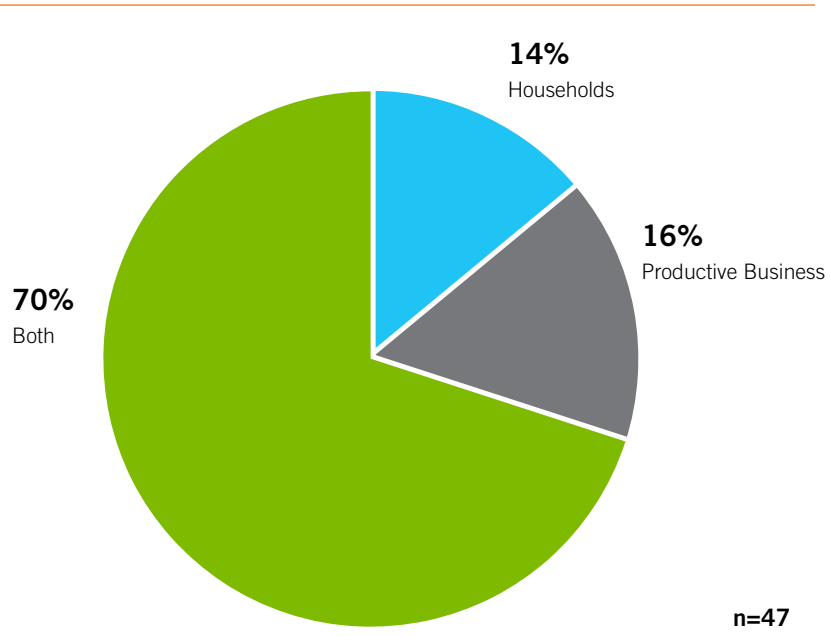
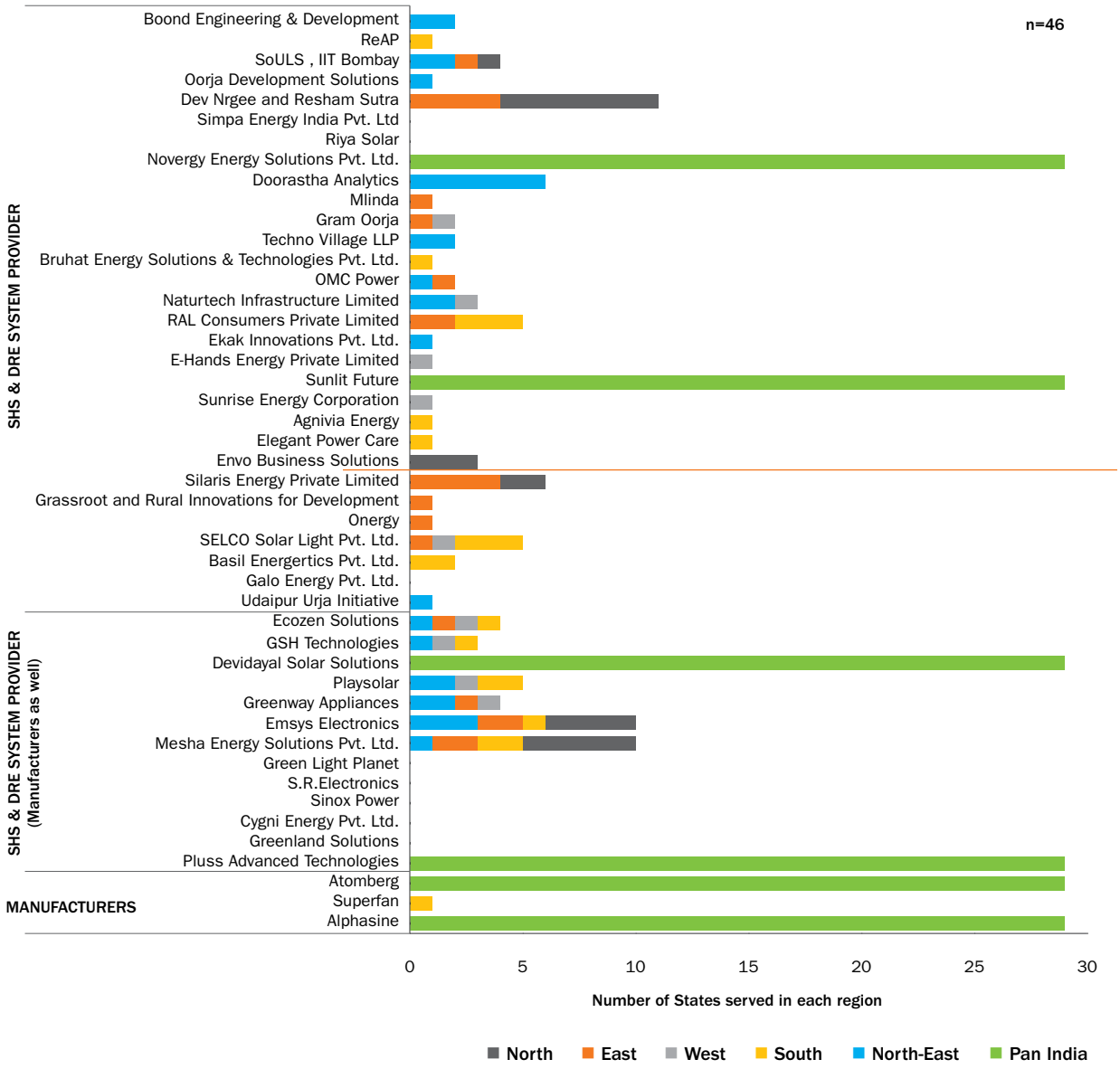


Figure 3

Region-wise number of states served by system providers and manufacturers

Source: AEEE Analysis



Karnataka and Tamil Nadu are favoured as an experimental ground for off-grid interventions by key stakeholders

by eastern and western regions (Figure 3). Four system providers and two manufacturers are supplying their appliances pan-India.

Figure 4 indicates the number of companies among those surveyed who operate in each state. In the northern region of India, players mainly cater to UP, followed by Rajasthan . Key players (such as Boond, Oorja, OMC Power and SoULS) continue to focus on Uttar Pradesh since out of 3.9 crores un-electrified households, 1.4 crore are in Uttar Pradesh (Rajya Sabha Data, 2018). In the southern region, Karnataka and Tamil Nadu are the two states with the most players. Karnataka and Tamil Nadu are also favoured as an experimental ground for off-grid interventions by key stakeholders such as SELCO Foundation which is working closely with local communities to converge energy and development goals. Players are also considering states like Assam, Bihar, Maharashtra and Odisha as the next potential areas for exploring new business opportunities.

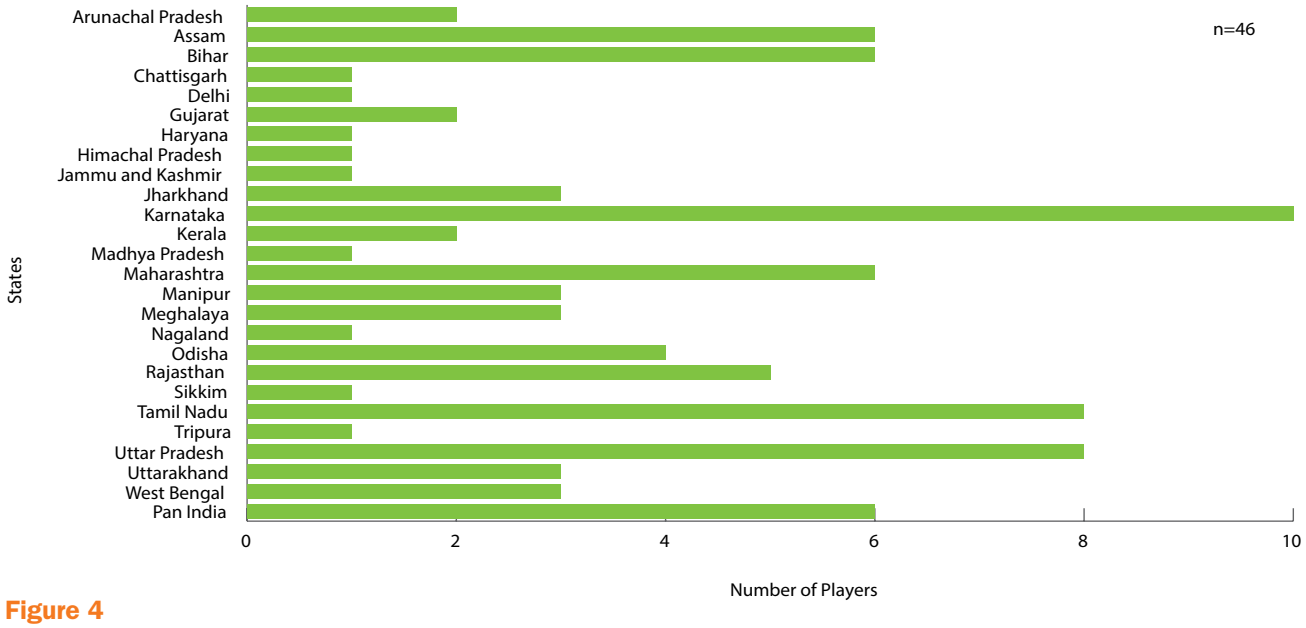


Figure 4

Areas of operation: Number of players in each state[6]

Source: AEEE Analysis

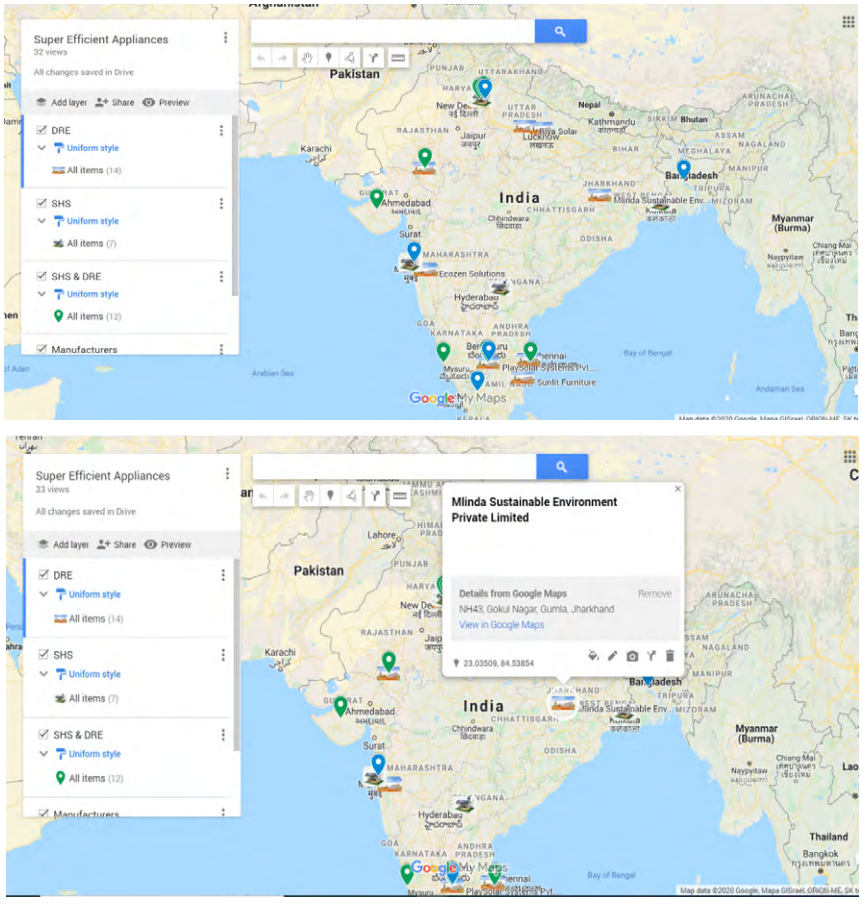
Note: n=46 as one international player is not catering to India

To provide more information on the geographic spread of all the players that participated in the survey, the headquarters of system providers and manufacturers have been mapped on the Google Maps. The players are separated into four categories – SHS, DRE, SHS & DRE and Manufacturers, as shown in Figures 5. The link of the map is also given in the footnote[7].

Figure 5

Map showing the headquarter location of players participated in the survey

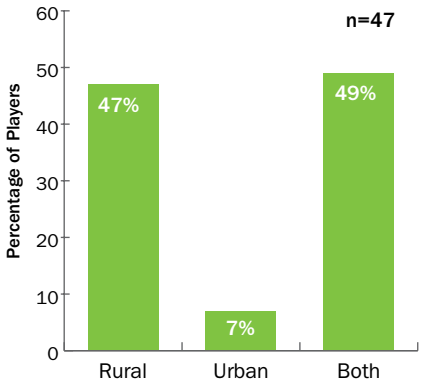
Source: AEEE Analysis



6 Out of 46 surveyed players, many of them serve multiple states. Therefore, addition of total number of players across all states will be more than 46.

7 https://www.google.com/maps/d/u/1/edit?hl=en&mid=1x-Bpj5Ixyy08Uc2w6CcnHCDdRAxQ3Pkd&ll=19.655516584969632%2C80.20366820000004&z=5

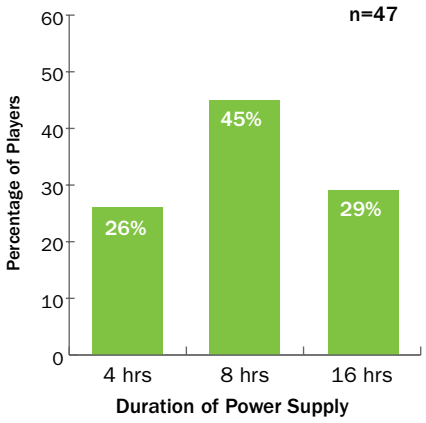
Figure 6
Areas of operation: Rural and Urban
Source: AEEE Analysis



In terms of rural-urban penetration, 49% of the players serve in both rural and urban areas, followed by 47% serving only in rural areas (Figure 6). It has been observed that in both rural and urban areas, the majority of the system providers are serving both households and productive businesses.

System providers and manufacturers cater primarily to the areas where grid power is available for more than 8 hours a day, as shown in Figure 7. However, it is equally important to note that 26% of system providers that participated in the survey operate in areas where power availability is 4 hours per day. The states that have power supply for 4 to 8 hours a day are UP, Bihar, Jharkhand, Odisha, Madhya Pradesh and Assam. As the system providers cater to low-income households with low affordability, the information on hours of supply is crucial as it enables them to bundle super-efficient appliances with adequately sized systems. It is also important from the point of view of system capacity (watts), battery capacity (if any), AC/DC interoperability of appliances, and the need for converter/inverter.

Figure 7
Areas of Operation based on the duration of power supply
Source: AEEE Analysis



At present, 45% of the system providers have deployed SHS/DRE systems which are connected to the grid. The remaining 55% system providers have deployed standalone SHS/DRE systems that are not connected to the grid. However, 75% of the installed standalone systems have the flexibility to connect to the grid, if required (Figure 8). Most of the systems that are deployed are still predominantly DC systems. However, enterprises have recognised that grid power will be available in future. Thus, interoperability with the grid will be a necessary design feature in SHS and DRE systems in the years to come.

Figure 8
Areas of Operation based on the grid connectivity
Source: AEEE Analysis

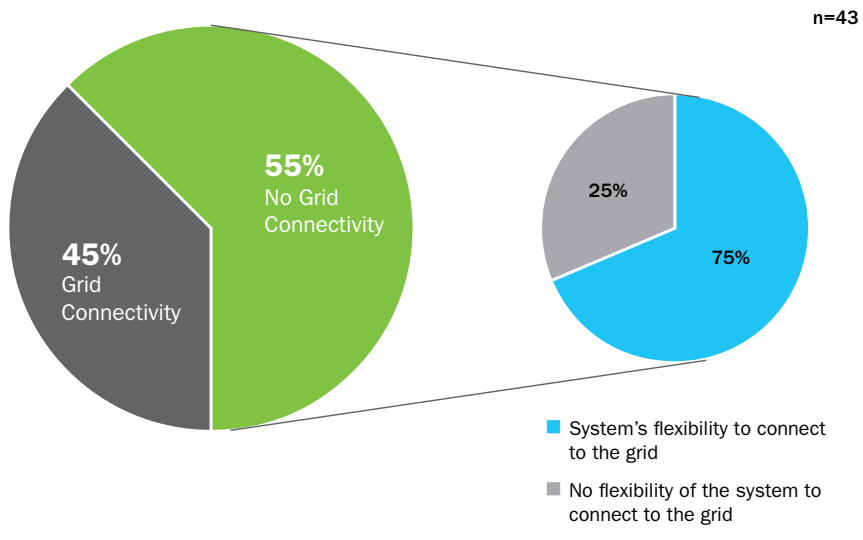


Figure 9
System capacity of SHS system providers
Source: AEEE Analysis

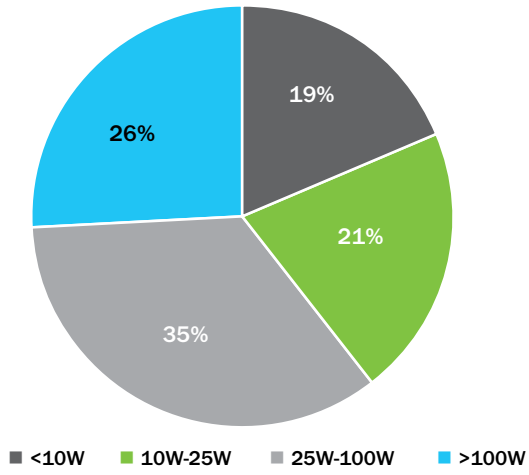
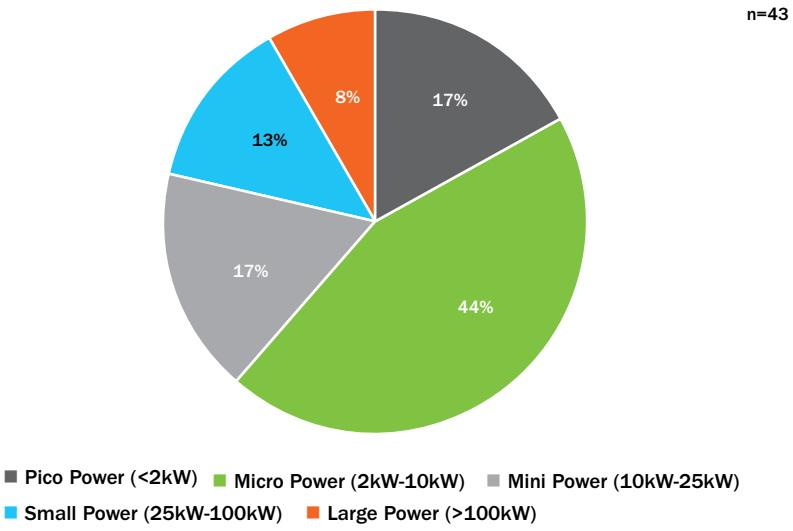


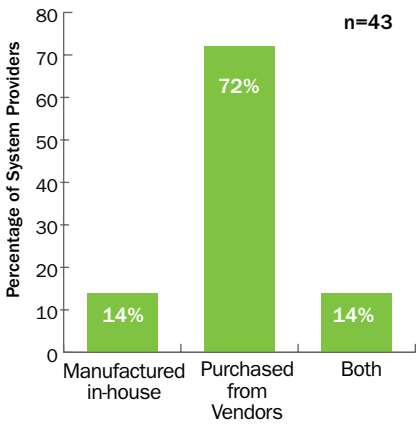
Figure 10
System capacity of DRE system providers
Source: AEEE Analysis



In terms of capacity, more than 70% of the SHS enterprises offer a system of less than 100 W (Figure 9). However, in case of DRE, 44% of the enterprises offer capacity in the range of 2-10 kW (Micro Power) followed by Pico Power (<2 kW) and Mini Power (10-25 kW) as shown in Figure 10. The capacity of the system is critical in determining the number of appliances that can be used together and for how many hours they can be used. One of the key factors influencing the capacity of the system offered is the affordability for the consumers in the off-grid market.

Most of the surveyed system providers offer appliances along with their systems. 72% of the system providers source their appliances from original equipment manufacturers (OEMs) and 14% manufacture appliances in-house, as shown in Figure 11. It was noted that system providers which procure appliances from OEMs primarily source from two to three vendors. Presently, bundling of appliances mostly includes household appliances such as LED lights, fans and TVs. However, productive appliances are usually offered by DRE system providers as a package based on consumer requirements.

Figure 11
Channels of appliance procurement adopted by system providers
Source: AEEE Analysis



Identification of Household and Productive Appliances Available in the Off-grid Market

The appliances offered by system providers in the off-grid market are of two types – those meant for household and productive uses. Household appliances are those which are used by households for their basic requirements such as lighting, heating and cooking, and do not contribute directly to income-generation. Productive appliances are those which are used for livelihood opportunities and contribute directly to income generation.

The number of units sold for each product varies significantly depending on the purpose and usage. For example, 3 LED lights could be used by a household with only 1 water purifier. For most of the appliances, the number of units used per household is 1. However, in the case of fans, it is about 1.8 units per household pan India for grid connected homes (Boegle, Singh and Sant, 2011). Thus, to adjust for such variation in the number of units sold under different product categories, the values have been normalised by converting into a logarithmic scale.

In the case of household appliances, most players offer LED bulbs and tube lights followed by BLDC ceiling and pedestal fans, as shown in Table 1 and Figure 12. The other set of appliances offered in this segment includes water purifier, DC TV, solar lamps, mobile chargers, air coolers, solar AC, mixer grinder, induction stoves and refrigerators.

In the case of appliances demanded by households, LED lights (bulb and tube light) continue to dominate, followed by space cooling appliances (BLDC ceiling and pedestal fans) and water purifiers (Figure 13). These results also corroborate field visits and interactions with consumers in the Hubli region of Karnataka and Unnao and Sitapur regions in UP, as discussed in detail in section 4.4. . The demand for cooking and refrigeration continue to lie at the bottom of the appliance pyramid for households in this market.

Household appliances that system providers are planning to add or supply in future include DC TV, air cooler, mixer grinder, BLDC ceiling and pedestal fans. At present, these appliances are being supplied by a few players only

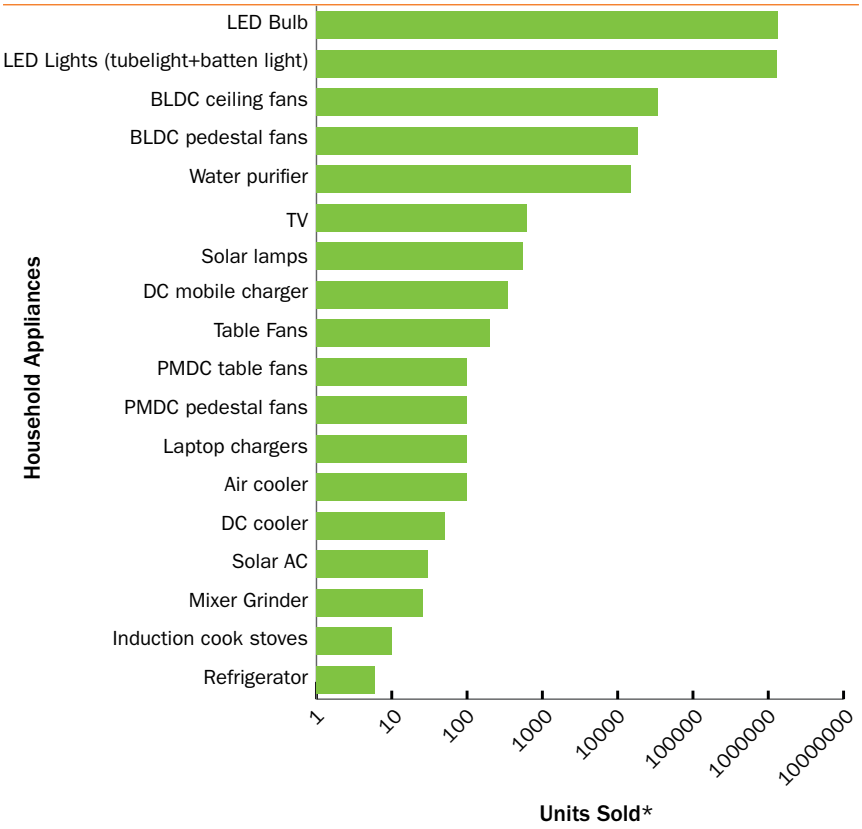
One of the key findings from the field visits and stakeholder interactions is that, after meeting primary requirements such as lighting, households demand productive appliances which could generate income. Table 2 and Figure 13 provide a list of appliances currently demanded by productive businesses such as silk spinning machine, sewing machine and solar water pumps. These productive appliances may be installed in houses, but the purpose is for business and income generation. This is not an exhaustive list and the figure only depicts the most sold appliances by system providers. Other productive appliances available in the market include rice huller, hammer mill, grain grinder, photocopy machine and honey processing plant. Due to high power load, productive appliances are usually

Table 1
Key appliances supplied by players in the off-grid market

Appliances	AC/DC	Power Requirement	After Sales Service	Product Life (in years)	Warranty (in years)	Number of Suppliers
LED Bulb	DC	3-9 W	Yes	5	1-2	18
LED Tube light	DC	5-10 W	Yes	5-8	1-2	10
BLDC Ceiling Fan	DC	24-30 W	Yes	2-5	2	16
BLDC Pedestal Fan	DC	13-33 W	Yes	2-5	1-2	14
Water Purifier	DC	45-60 W	Yes	2-5	-	4
DC TV	DC	40-60 W	Yes	5+	1-2	4
Solar Lamp	DC	2-6	Yes	3-5	1	2

Source: AEEE Analysis

Figure 12
Types of household appliances supplied by players in the off-grid market
Source: AEEE Analysis
**Units sold are converted into logarithmic scale*



offered along with a DRE system. Most respondents offer solar water pumps followed by sewing machines and blacksmith blowers (Table 2). The appliances that system providers would most likely include in the future are milk chilling units, cold storage units, solar inverters, solar dryers, poultry incubators, pottery wheels and flour mills. These appliances are presently supplied by only one or two players in the market.

As evident from Tables 1 and 2, all the listed appliances are super-efficient appliances that consume less power than conventional appliances, and hence can be used on small sized systems. The BLDC fans have a power requirement as low as 24 W (Table 1) as compared to a conventional fan and BEE star-rated fans with a power requirement of 70 W and 50 W respectively (MoEF&CC, 2019). In the case of silk reeling and spinning machines, the power requirement is as low as 15 W, as shown in Table 2.

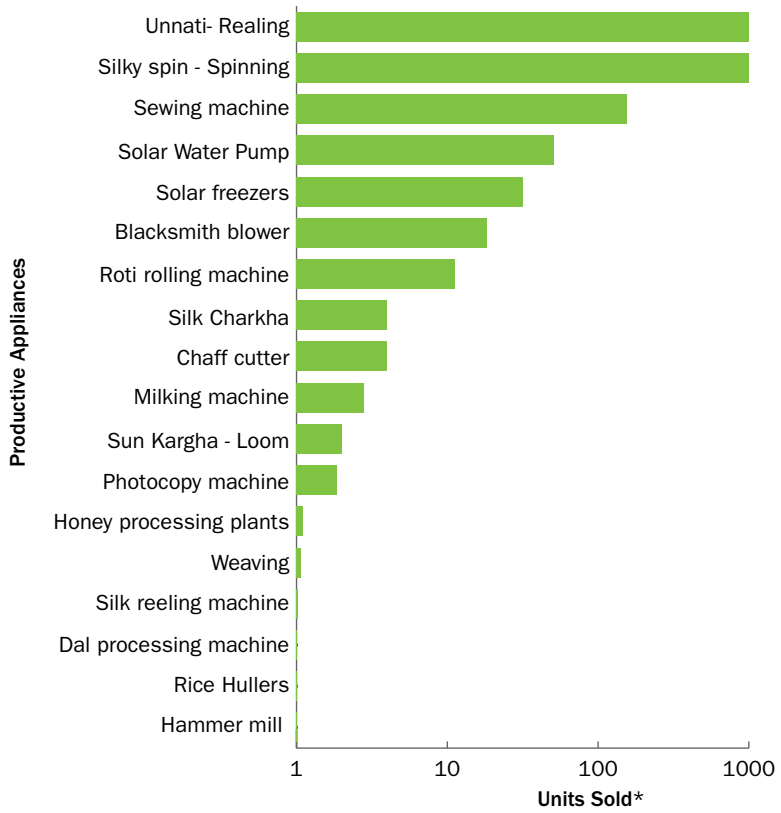
In the case of DC appliances, product level conversion is required to reduce the voltage as per the appliance requirement. However, these conversion losses are minimal compared to losses in the case of DC-to-AC or AC-to-DC conversion. Therefore, DC appliances are inherently efficient when the power

Table 2
Key productive appliances supplied by players in the off-grid market

Appliances	AC/DC	Power Requirement	After Sales Service	Product Life (in years)	Warranty (in years)	Number of Suppliers
Unnati – Realing	DC	15 W	Yes	10	1	1
Silk Spinning	DC	15 W	Yes	10	1	1
Solar water pumps	DC	0.5-10HP	Yes	7-10	5	7
Sewing machine	DC	60W	Yes	5-10	1-2	2
Solar freezers	DC	65-110W	Yes	7-10	3	1
Blacksmith blowers	DC	60-80W	Yes	5-7	1	2

Source: AEEE Analysis

Figure 13
Types of productive appliances supplied by SHS and DRE enterprises in the off-grid market
Source: AEEE Analysis
**Units sold are converted into logarithmic scale*



supply is DC. It was observed from the survey responses that a few system providers offer appliances that work on DC and AC. However, the efficiency of these appliances requires further investigation.

For penetration of any product, the availability of warranty and after-sales services is critical to boost consumer confidence about product. In most of the cases, players offer after-sales service for the appliances sold by them, as shown in Table 1 and Table 2. As most of the appliances are procured from OEMs, the system providers can provide a replacement in case of failure. However, to retain consumer confidence, 33% of system providers offer to repair or retrofit the defunct appliances at consumer premises. This also helps in cutting down the replacement period and building consumer confidence and retaining consumer loyalty in the products which system providers offer. The importance of after-sales service has also been emphasised during our field visits. It was interesting to note that one of the system providers, Selco Solar Light Private Limited offers after-sales service even for appliances supplied by other players to retain consumer confidence in the off-grid market.

After analysing the survey responses and understanding the appliance offerings of different players, the study identified 2-3 efficient appliances with high market penetration potential in both household and productive business segments.

In the case of household appliances LED lights will continue to be in high demand, followed by BLDC fans (ceiling and pedestal). Water purifiers and DC TVs have been identified as appliances with the highest market growth potential. All these appliances run on DC power and have a power consumption of less than 60 W (Table 1). Thus, they could easily be bundled with SHS as well as small DRE systems. Apart from this, mobile chargers has also been identified as important appliances demanded by households. This was also evident in the stakeholder interactions during field visits.

In the case of household appliances, after LED lights, BLDC fan (both ceiling and pedestal), followed by water purifier and DC TV have been identified and suggested as appliances with the highest market penetration potential. All these appliances run on DC power and have a power consumption of less than 60 W

Unlike household appliances, demand for productive appliances varies from region to region depending on the types of available livelihood opportunities. For example, rice hullers are / will be relevant in rice-producing states such as West Bengal, Uttar Pradesh and Punjab, whereas silk reeling is in demand in silk-producing states such as Andhra Pradesh, Assam, Jharkhand, Karnataka, Tamil Nadu and West Bengal. The main appliances with market penetration potential in the productive appliance category are silk rearing, reeling and spinning machines, solar water pumps, sewing machines, solar freezers and blacksmith blowers.

For all these productive appliances, the product life is 5-10 years and after-sales service is available. This encourages the consumer to invest in such appliances. The results also corroborate findings from field visits. It was observed that the use of such appliances, improved productivity significantly, reduced physical labour and enabled the consumers to recover their costs in a short period. However, the number of suppliers of such appliances is still limited in the market, as shown in Table 2.

The validation of the technical information provided by the system providers and manufacturers is outside the scope of the existing study as the focus was on the market overview.

Key SHS/DRE system providers and manufacturers

In the case of household appliances, most of the system providers procure the appliances from 2-3 significant OEMs. The main system providers in the off-grid market based on their customer base are:

- Selco Solar Light Private Limited
- Simpa Energy Private Limited
- Cygni Energy Private Limited
- OMC Power
- Gram Oorja
- Udaipur Urja Initiative
- RAL Consumers Private Limited
- Boond Engineering Development

The appliance offering of Simpa Energy Private Limited includes LED tube lights, TV, BLDC pedestal fans and air coolers. Cygni Energy Private Limited also caters to the household segment, providing LED bulbs, ceiling fans, mixer grinders, LED tube lights, DC coolers, TV, AC, BLDC pedestal fans and laptop chargers. Boond Engineering Development caters to the states of UP and Rajasthan and provides LED lights, solar lamps, TV, table fans and DC mobile chargers. RAL Consumers Private Limited also supplies basic LED bulbs and table fans along with their systems in the states of Karnataka, Odisha, Kerala, Tamil Nadu, and Bihar. Gram Oorja and Udaipur Urja Initiative mainly offer lights, fans and water filters in the states of Maharashtra, Jharkhand and Rajasthan.

However, the appliances offered by these system providers are mainly procured from manufacturers such as Signify (formerly Philips), Halonix, Eveready, Atomberg, Superfan, Alphasine, Osram, dLight, Rotosol and Surya. The principal manufacturers in the BLDC fan segment include Atomberg, Superfan, Alphasine and Rotosol.

In the case of productive appliances, the number of suppliers is limited as productive appliances are customised based on the requirements of the particular region. Key players in the yarn and fabric machine category, are Dev Nrgee and Resham Sutra. They mainly cater to the east and north-eastern parts of India. Sewing machines are usually purchased from big players such as USHA and then retrofitted by Selco Solar Light Private Limited and others. Selco Solar Light Private Limited provides productive appliances such as blacksmith blowers, roti rolling machines, photocopy machines, sewing machines and milking machines. They are active in Karnataka, Tamil Nadu, Bihar, Maharashtra, and Kerala. In the case of solar water pumps, the significant players are Shakti Pumps and Grundfos, which are OEM's that cater to the grid-connected market as

33%

of system providers offer to repair or retrofit the defunct appliances at consumer premises

Number of suppliers is limited as productive appliances are customised based on the requirements of the particular region

BLDC fans can save up to 0.3% of net electricity consumption and could potentially provide electricity to 33% of unelectrified households

well. Another important player is OMC power which supplies weaving and honey processing plants in Bihar and Uttar Pradesh.

Energy-Saving Potential of Super-Efficient Appliances

India needs to quadruple its per capita energy consumption to boost economic development and to reach the HDI level of 0.8 (Economic Survey, 2019). India is currently witnessing dual challenges in terms of energy access and the availability of reliable energy supply. To achieve the objective of affordable, reliable and sustainable energy, both supply and demand side interventions could be deployed. On the supply side, the additional energy requirement would need to be met by generating more power through renewable sources. On the demand side, it can be complemented by using energy more efficiently.

The Economic Survey of India (2019) estimated the saving potential due to energy efficiency measures (such as PAT scheme, Standards and labelling, etc.) at 7.21% of net electricity consumption in 2017-18, results in the reduction of greenhouse gases and cost and energy savings. Apart from existing energy efficiency measures, super-efficient appliances have significant potential for sustainable energy access. For example – If all the new fans purchased in 2017-18 were BLDC fans rather than BEE 5-star, then these new fans would save up to 0.3% of net electricity consumption in as compared to 0.16% BEE star rated fans as shown in Table 3 . This saved energy could potentially provide electricity to 33% of remaining unelectrified households. Therefore, overall energy saving potential due to the usage of super-efficient appliances will be much more and could contribute significantly towards sustainable energy access. However, the energy saving potential from super-efficient appliances is estimated only for BLDC fans due to lack of data, such as a stock estimate, verified power requirement and usage hours for other appliances.

Table 3
Saving potential of BLDC fans in comparison with conventional and BEE star rated fans

Particulars	Conventional	BEE Star Rated Fan	BLDC Fan
Power(W)	70[a]	50[a]	32[b]
Number of usage days in a year[c]	200	200	200
Number of usage hours in a day (hrs)[d]	8	8	8
Energy Consumption (TWh/yr)[e]	6.16	4.40	2.82
Savings (TWh/yr)[f]		1.76	3.34
Savings as % of Net Electricity Consumption[g]		**0.16%**	**0.30%**
Savings as % of Electricity Requirement for Unelectrified Households[h]		**17.44%**	**33.13%**

Source: AEEE Analysis

Note:

a: India Cooling Action Plan (MoEF&CC, 2019)

b: Retrieved from AEEE Survey Data

c&d: Boegle, Singh and Sant (2011)

e: To calculate energy consumption, 55 million units of fans are considered. These are number of new fans purchased in 2017-18. (Mathew et al., 2019)

f: Calculated savings as difference from conventional fans.

g: Net electricity consumption is considered as 1130 TWh in 2017-18 from Energy Statistics (2019)

h: 19.09 lakh households are un-electrified (Ministry of Power, 2019). Considering per capita electricity consumption of 1149 kWh in 2017-18 (CEA, 2019) and average household size of 4.6 (Census, 2011), electricity requirement is calculated

4. STAKEHOLDER CONSULTATIONS

This section provides a detailed description of the stakeholder consultations conducted with the key actors to gather their perspective allied with the objectives of the study.

Policymakers and Government Institutions

To obtain valuable inputs from government bodies working in the domain of energy efficiency and energy access, Bureau of Energy Efficiency (BEE) and Energy Efficiency Services Limited (EESL) were identified as key actors for the stakeholder consultation. The affirmative dialogue with EESL alluded that there exists a huge scope for bulk procurement of super-efficient appliances, in the coming years. EESL is considering bulk procurement of induction stoves. It was observed that the study's objectives were on-par with EESL's philosophy of enabling "customers get more with the same energy consumption". Further discussions are required to develop the idea of bulk procurement with EESL.

The initial discussion with the Bureau of Energy Efficiency (BEE) indicated that they will extend their steadfast support for the Standards and Labelling (S&L) of select super-efficient appliances provided they hold a significant market size in rural India, substantial operation hours and savings potential. The discussion specifically emphasised the requirement for Bureau of Indian Standards (BIS) standardisation as a prerequisite for recommending any appliance under the S&L programme. Upon detailed deliberations, BEE expressed its interest in developing an S&L programme for the small capacity refrigerators. Further discussions are required to develop the idea of S&L with BEE.

Requirement of Bureau of Indian Standards (BIS) standardisation as a prerequisite for recommending any appliance under standard and labelling programme

Attempts are being made to connect with the Ministry of New and Renewable Energy (MNRE) to gather their perspective on super-efficient appliances and energy access.

On-site Interactions with Key System Providers in the Off-grid Market

Several deliberations were conducted with organisations working in energy access for the off-grid community, such as Boond Engineering and Development Pvt. Ltd. (Boond), SELCO and Simpa Energy India Pvt. Ltd., to gather their insights and get acquainted with the on-ground reality of the off-grid rural appliance market.

To understand the perspective of organisations working at the grassroots level, a dialogue was initiated with the Boond team during a site visit to their local office in Unnao, UP. Boond mentioned that they have deployed 80+ micro-grids ranging from 1 KWp to 3.7 KWp in the villages of Unnao with limited and unreliable access to grid power.

Boond's micro-grid can provide power for 30-40 individual rural households. Boond operates under two divisions, namely the commercial sector and the social development sector. Their commercial sector is focussed on earning profit by installing DRE systems. The other division focuses on improving the standard of living in rural

communities, where they install micro-grids, which have a payback period of 4-5 years.

A dialogue was held with SELCO Solar Light Pvt. Ltd. during the site visit to their local office at Hubli, Karnataka. During the discussion, the SELCO team explained their operation model for the rural communities of Hubli. The team highlighted that they provide 24x7 toll-free after-sales service for their own appliances, as well as for non-SELCO appliances, to reduce the negative perception about solar products amongst current and potential rural end-consumers. SELCO also conducts rigorous follow up on the efficacy of installed appliances.

They create awareness about off-grid systems and appliances on a large scale, which also leads to rural market creation. Their sensitisation method includes providing appliances and systems on a trial basis, collaborating with rural self-help groups (SHGs), and interaction with the village panchayat. According to them, out of all the awareness methods the most effective ones were live demonstration of appliances on a mobile unit, which helped them to gain customer confidence, and the 'street hawker model' in which one rural consumer purchases LED lights and batteries in bulk from SELCO, and then supplies 'Lighting as a Service' to individual street hawkers. This method not only helps the street hawkers to work at night but also creates a business opportunity for the person providing the appliances mentioned above on lease.

During the site visit to Lucknow, discussions were carried out with the SIMPA team to understand their operations. They mentioned that there is no distributor or third party involved in their rural supply chain. Their in-house unit provides all the services from system installation to after-sales service for the rural end-customer. In addition to this, they also assist households and productive businesses in obtaining a loan for purchasing SIMPA appliances.

Discussion with System Providers and Appliance Manufacturers

A closed door-Focused Group Discussion (FGD) on "Energy-efficient appliance penetration in the Indian off-grid market" was conducted on 12th September 2019 to bring together SHS and DRE system providers and manufacturers. The objective was to gather their insights on energy efficiency in super-efficient appliances and the current scenario of the off-grid appliance market, specifically from the supply side. The group also discussed the challenges faced by the system providers and manufacturers engaged in this sector, insights on current appliance penetration and future growth potential. This roundtable was jointly organised by Alliance for an Energy Efficient Economy

Interaction with SELCO Solar Light Pvt. Ltd., Hubli office

Stakeholder Consultation conducted with SHS and DRE system providers and appliance manufacturers, on "Energy-efficient appliance penetration in the Indian off-grid market"

System providers were witnessing a growing demand for productive appliances such as portable mixer grinder, sewing machine, solar water pumps, small refrigerators, solar dryers, air-coolers and water-purifiers.

(AEEE) and Clean Energy Access Network (CLEAN).

The roundtable provided the system providers and manufacturers with the opportunity to share information on their organisation, product offerings andareas of operation. With respect to challenges faced, most manufacturers emphasised the lack of technical knowledge amongst the personnel that install appliances and systems, specifically concerning their familiarity with the PV system and how to build a series connection. Other challenges are effectively providing after-sales service and building an eco-system of different products. The key recommendation suggested by system providers and manufacturers were the requirement of consumer awareness about the technology installed at their homes. Other recommendations include standardisation of appliances to ensure and maintain appliance quality, and government interventions and industry collaboration for the successful functioning of rural eco-system.

They also suggested a few appliances which are likely to be demanded in the next 3-5 years, namely small refrigerators, air-coolers, water-purifiers, mixer grinders, sewing machines, portable solar water pumps and solar dryers.

Altogether this FGD clearly communicated that the market is in its nascent stage and still faces many challenges. To circumvent these challenges, support from policy-makers is required. Moreover, there was consensus among the system providers and manufacturers that standardisation of off-grid appliances, including BLDC motors is the need of the hour to increase their penetration in the rural market. The system providers mentioned that a key deciding factor for the purchase of appliances for the rural consumer is after-sales services. They also indicated that support in the form of financial assistance to small scale system providers as well as consumers is essential.

Apart from household appliances, system providers are witnessing a growing demand for productive appliances such as portable mixer grinders, sewing machines, solar water pumps, small refrigerators, solar dryers, air-coolers and water-purifiers. Household appliance demand is mainly for lighting and mobile charging, followed by BLDC fans.Making these appliances energy efficient will help end-consumers use less energy and provide them with the opportunity to use more appliances with the same energy supply.

Interaction with End-users of Appliances in Rural Areas

AEEE and CLEAN visited households and productive businesses in various villages in Unnao and Sitapur in UP and Hubli in Karnataka to understand the status of the main grid-based power supply, customers' buying behaviour, their current and future aspirations concerning appliances, along with other internal and external factors which affect their buying behaviour.

The villages visited comprised of 20 to 40 households, both kuchha and pucca[8], with seven to eight family members each, inclusive of both children and adults. Most of the households used to rely on the unreliable power supply of 3-4 hours/ day from the main-grid. Due to unreliable electricity supply, they used to purchase kerosene for lighting lamps at night, which cost them around ₹ 50 per litre per month. Purchase of kerosene was not only expensive for low-income group and below poverty line villagers, but also inconvenient to use during the rainy season and floods. Women and children suffer the most due to unreliable access to electricity, specifically lack of lighting, which impacts their safety and access to education. It was observed that requirement and demand for basic lighting facility continues to persist.

The end consumers stated that, with the arrival of SHS and DRE system providers in these rural communities,, there is an increase in security for women and children along with improvement in the quality of life for the rural community. They stated that these system providers offer an off-grid system along with some basic appliances such as LED lights, mobile charging facility and DC pedestal fans, according to the demand and purchasing capacity of the consumer.

A village in Unnao, Lucknow

Door to door surveys conducted In various villages

One villager during the site visit mentioned that, *"a local vendor tends to go door-to door providing the facility of mobile phone charging, through a battery. This used to cost us around ₹ 20 for completing one full charge. Now, when we use Solar Urja, we have to pay ₹ 5 from an average weekly recharge of ₹ 10 for getting one full charge"* He also added that they cannot function **without phones and bulbs**, which **are essential for them.**

8 "Pucca house" refers to houses made with high quality materials throughout, including the floor, roof, and exterior walls. Houses made from mud, thatch, or other low-quality materials are called "kuchha house".

House of an entrepreneur in Unnao village with rooftop micro-grid

While conducting site visits in rural areas of Lucknow with un-reliable access to electricity, one of the villagers, who is also called the "**Entrepreneur**" by BOOND, explained the entire supply chain of the installed system. He explained that "BOOND designates one villager as an "**Entrepreneur**" as per his/her relation and social bonding with the fellow villagers. The condition of the house which is either kuccha or pakka also matters while selecting entrepreneur, as the off-grid system which powers the entire rural community of almost forty households along with the central meter is supposed to be installed at selected entrepreneur's house. I and my neighbours generally pay 100 INR/m, we pay this in instalments i.e. sometimes we pay 10 INR for 2 weeks or 20 INR depending on the availability of money with us. The land in which we are living is our ancestral land, many families have lived in these houses; but because it lies under the forest department, government cannot provide us power connections. Few months back we did not have access to electricity, no power, no light. Also, because kerosene is either costly or rarely available to us, we use to like in total darkness, until this organisation provided us with community micro-grid facility. That's why now everyone is using Solar Urja to become self-reliant and to reduce our dependency on main grid."

At present, most of the households run LED lights, mobile chargers on the SHS system, and appliances with higher power requirement such DC pedestal fans and TVs on the main grid as per the availability of the main grid power supply. Most essentially, most rural end-consumers also mentioned their aspiration to purchase a small refrigerator, a mixer grinder, a submersible pump and a water purifier in the near future. They added that LED lights and mobile charging are sufficient for them for now.

Rural consumers stated that the positive experience of their relatives and fellow residents persuaded them to adopt off-grid power supply. However, due to lack of penetration of efficient DC appliance in the rural appliance market they still have to travel around 40 km to purchase any appliance that is not locally available, which turns out to be an expensive proposition.

Households also emphasised that because of ease in the availability of solar urja/off-grid systems, they can utilise the appliances for income generation purposes such as using a roti making machine for selling *chapatis*[9] and flour, and a sewing machine not only to stitch clothes for household members but also for customers. Moreover, these super-efficient appliances, along with the off-grid system result in increased productivity for these businesses. A pottery maker stated that with the use of an electric

9 A flat-round bread made without yeast or any raising agent, made in India, usually made out-of whole wheat flour and then cooked.

Use of LED in rural households

During the site visit a local women entrepreneur mentioned that, “after installing SELCO chapati rolling machine I’m able to produce around 1000 chapatis a day with zero hardship. Whereas, earlier I was only able to produce around 30-40 chapatis without the roti maker which resulted in chronic wrist and back pain. Now, I’m not only producing these chapatis for my own house and nearby households but also supplying these for weddings and the local community. Its use has drastically reduced my pain. Moreover, as my business expanded I have hired 3 more women for assisting me.”

pottery wheel instead of a conventional wheel, he was able to create 100 pottery items a day, which is double the quantity he was able to create previously.

These super-efficient appliances have not only given the rural community an opportunity to earn a living but have also improved their quality of life by reducing their hardship. During the site visit to a local blacksmith blower, the owner mentioned that earlier his son was reluctant to work with the conventional blower due to the associated physical hardships. However, after purchasing a modern and efficient blower, he is willing to work regularly, and their productivity and daily income has increased significantly.

Based on discussions with key stakeholders, DC power will continue to play a vital role in fulfilling the growing demand for clean and reliable electricity, specifically in rural areas.

(Left) A lady using a roti-maker in Hubli district in Karnataka as a source of her livelihood
(Right) A grain grinder used by an entrepreneur in Hubli district in Karnataka

Product made using the efficient electric pottery wheel

5. CHALLENGES

The analysed data brought out the challenges faced by system providers and manufacturers in selling energy-efficient appliances in the market, as shown in Figure 15. About 31% system providers witness lack of consumer awareness rather than lack of demand as a hindrance in appliance penetration in rural areas. Many times, consumers are not even aware of the type of appliances they require other than lighting and mobile charging. This is also true especially in the case of productive appliances. In one of the field visits to rural areas, it has been observed that some of the system providers are deploying innovative strategies to create awareness through various means such as appliance display through mobile vans, live demonstration of appliances, providing customised products, and provision for 15 days trial period to create awareness about the appliances.

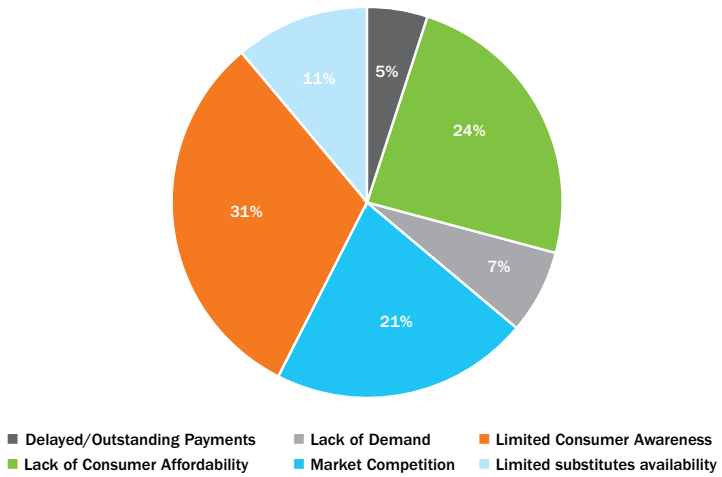
Another challenge highlighted by system providers is consumer affordability. Market competition is also associated with consumer affordability. The number of households that have the purchasing power to buy these appliances are low, and as a result, practitioners compete amongst themselves for a very small market share. However, the percentage of households requiring these appliances in this market is huge.

One of the astounding findings is that only 5% of the system providers highlighted the challenge of delayed and outstanding payments in selling appliances. This implies the positive intention of consumers to pay for the appliances purchased, without delay or default. These results are in line with the observation from the field visits that energy-efficient appliances allow consumers to use more with limited supply and increase both their productivity and income.

A few challenges were also highlighted during the stakeholder interaction with different players working in the off-grid market. There is a lack of technical knowledge amongst the technicians that install the appliances specifically concerning their familiarity with the PV system and how to build a series connection. This is an essential requirement to increase the penetration of SHS/DRE systems in the rural off-grid community. Another challenge highlighted is the lack of knowledge among consumers about how to use a system or a technology supplied in the off-grid market. This serves as a potential threat resulting in malfunctioning of the system and appliances. A few manufacturers also highlighted another critical challenge which is the lack of an energy efficiency standards and labelling program for off-grid appliances. Additionally, in the case of motive loads such as fans, mixer grinder or small fridges and productive appliances, the availability of DC motors of the suitable capacity of torque and wattage is a challenge for the system providers.

Figure 14
Challenges faced by players supplying appliances in the off-grid market

Source: AEEE Analysis



6. RECOMMENDATIONS

The following recommendations could be drawn based on the survey analysis, field visits and stakeholder interactions.

Technology Improvements and Financing

- BLDC motors are more efficient than AC motors. However, their adoption in appliances is less due to the high cost of BLDC motors. The government could consider incentivising the production of BLDC motors or create an ecosystem for BLDC motor components which will significantly reduce the cost of BLDC motors. This will enable the use of these efficient motors in appliances and reduce their energy consumption.
- Government should provide support for testing of off-grid appliances, DC and AC, to determine their energy performance. This can further lead to S&L of such products once they become mainstream.
- The cost of appliances could be reduced through bulk procurement which will help in addressing the challenge of consumer affordability. For example, EESL could extend their support by procuring off-grid appliances in bulk, and then system providers could buy these appliances at a lower rate from EESL, to further sell to their customers.

Business Development & Market Creation

- System providers and manufacturers could increase their consumer base through demonstration drives, free trials, etc, to inform consumers about appliance functionality and maintenance.
- System providers and manufacturers could help consumers by providing appliance technical specifications in their local language and include pictorial depictions on how to operate the appliance.
- System providers could involve residents as part of their innovative business model. As community members will trust a local resident more than an outsider, this person can act as a goodwill ambassador and could also help with service, if possible. Further, the availability of more local suppliers and vendors could help in minimising the logistic and procurement costs.

Advancement in Research & Development

- SHS & DRE systems provider should design off-grid systems optimally by considering energy efficiency as an important parameter.
- Both system provider and government bodies could together work towards enhancing research and manufacturing capabilities for energy-efficient DC motors.

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8. ANNEXURE

Questionnaires

Questionnaire for Appliances Offered by Decentralised Renewable Energy (DRE) & Solar Home Systems (SHS)

Dear Sir/Ma'am,

AEEE and CLEAN are conducting a survey of SHS and DRE system providers with the objective of collecting information on super-efficient appliances (DC/AC) powered appliances. This will help in assessing the current penetration of super-efficient appliances in the Indian market as well as their future potential.

Please also share/provide your **Product Brochure** along with the completed questionnaire.

Survey questionnaire:

BACKGROUND INFORMATION

I. Name of the Organisation			
II. Address			
III. Telephone			
IV. Email ID			
V. Years of operation			
VI. Type of Service Provider	SHS	DRE	
VII. Areas of operation (rural/ urban)	Rural	Urban	Both
VIII. Please Specify (States and Districts)			
IX. Type of Household	Tier II[10]	Tier III[11]	Tier IV[12]
X. No. of end customers			
XI. Is your system currently connected to the grid? *If yes, skip XII and XII*	Yes	No	
XII. Does your system have the flexibility to connect to the Grid?	Yes	No	
XIII. If not, what are your plans for grid connectivity in the next 3 years?			

10 Tier II: Households having 4 hours of electricity supply each day
11 Tier III: Households having 8 hours of electricity supply each day
12 Tier IV: Households having 16 hours of electricity supply each day

XIV.	What is the capacity range of your SHS system? Please select (ü) the range	< 10W 25W >25W to 100W >150W Please specify exact capacity _____
XV.	What is the capacity of your DRE system?	Pico Power (less than 2 kW) Micro Power (2 kW to 10kW) Mini Power (10kW to 25kW Small Power (25kW to 100 kW) Medium/Large Power (greater thant100 kW) Please specify the exact capacity and number of households that you supply power to _____
XVI.	Do you offer appliances with your SHS / DRE systems?	Yes No
XVII.	Are your appliances -	Manufactured in-house Purchased from vendors/ manufacturers If you purchase from a vendor/ manufacturer, please specify their details _____ _____
XVIII.	Who are your end customers	Households Small businesses Both

SECTION A

Questions applicable to SHS/DRE providers serving Households

PRODUCT INFORMATION

1. **Please list the details of the appliances you offer in the table below-**

A. LIGHTING	Product Specification			Price (in INR)	Consumption (in W)	Units sold in a year	After-Sales service Please tick (ü)		Warranty		Lifetime of product	Remark/ Speciality
	Model Number	Luminescence	Rated input [V]				Door-to-door	Designated Service Centre	Months / year	Criteria for warranty		
LED Tubelight												
LED BULB												

B. Television	Product Specification			Price (in INR)	Consumption (in W)	Units sold in a year	After-Sales service Please tick (ü)		Warranty		Lifetime of product	Remark/ Speciality
	Model Number	Screen size	Rated input power				Door-to-door	Designated Service Centre	Months / year	Criteria for warranty		
TV												

C. Media	Product Specification		Price (in INR)	Consumption (in W)	Units sold in a year	After-Sales service Please tick (ü)		Warranty		Lifetime of product	Remark/ Speciality
	Model Number	Multimedia speaker quality				Door-to-door	Designated Service Centre	Months / year	Criteria for warranty		
Radio											

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D. FANS	Product Specification				Price (in INR)	Consumption (in W)	Units sold in a year	After-Sales service Please tick (ü)		Warranty		Lifetime of product	Remark/ Speciality
	Model Number	RPM	Air Flow (m^3/ min/w)	Type of Motor[13]				Door-to-door	Designated Service Centre	Months / year	Criteria for warranty		
Pedestal fans													
Ceiling Fans													
Table Fans													
Air Cooler													

E. Water coolers & Purifiers	Product Specification		Price (in INR)	Consumption (in W)	Units sold in a year	After-Sales service Please tick (ü)		Warranty		Lifetime of product	Remark/ Speciality
	Model Number	Capacity (Per Tons/ Litre)				Door-to-door	Designated Service Centre	Months / year	Criteria for warranty		
Water Cooler											
Water Purifier											

13 BLDC/SRM/PMDC/Universal DC Motor

F. Cookstoves	Product Specification		Price (in INR)	Consumption (in W)	Units sold in a year	After-Sales service Please tick (ü)		Warranty		Lifetime of product	Remark/ Speciality
	Model Number	Capacity				Door-to-door	Designated Service Centre	Months /year	Criteria for warranty		
Electric Cookstove											
Induction Cookstove											

G. Cooling	Product Specification		Price (in INR)	Consumption (in W)	Units sold in a year	After-Sales service Please tick (ü)		Warranty		Lifetime of product	Remark/ Speciality
	Model Number	Capacity (in litres)				Door-to-door	Designated Service Centre	Months / year	Criteria for warranty		
Refrigerator											

H. Mixer/ Grinder	Product Specification			Price (in INR)	Consumption (in W)	Units sold in a year	After-Sales service Please tick (ü)		Warranty		Lifetime of product	Remark/ Speciality
	Model Number	Type of Motor[14]	Capacity (Grinding Rate/ RPM)				Door-to-door	Designated Service Centre	Months / year	Criteria for warranty		
Mixer Grinder												

14 BLDC/SRM/PMDC/Universal DC Motor

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1. **Are products offered as a bundle?**

   If yes, then please tick (✓) the appliances you supply as a bundle with or without SHS or DRE system. Also, please tick (✓) the appliances you offer as an *add on* to the system-

Name of the product	Bundle I[15]	Bundle II	Bundle III	Bundle IV	Appliances you offer as add on to the system
LED Tubelight					
LED Bulb					
TV					
Radio					
Mobile Charger					
Pedestal fans					
Ceiling Fans					
Table Fans					
Air Cooler					
Water Cooler					
Water Purifier					
Refrigerator					
Mixer Grinder					
Electric Cookstove					
Induction Cookstove					
If any other, please specify					
Total Cost (INR)					

PRODUCT FUNCTIONALITY

2. **Do your appliances work on?**

   a. AC b. DC c. c. Both

3. **If it is a DC/AC appliance, how does it run on AC/DC? Please select (ü) from below-**

   a. Using an AC-DC converter at product level
   b. Using a DC- AC inverter at product level
   c. Using an AC-DC converter at SHS level or DRE level
   d. Using a DC-AC inverter at SHS level or DRE level

LAST YEAR's ADDITIONS & FUTURE PROJECTIONS

4. **What are the new appliances that you have added in the last one year and plan to add in next three years?**

Name of the product	2017-18 (Last Year)	2019-20	2020-21	2021-22
LED Tubelight				
LED Bulb				
TV				
Radio				
Mobile Charger				
Pedestal fans				
Ceiling Fans				
Table Fans				

15 Bundle- similar/heterogeneous bunch of appliances sold together with or without SHS or DRE system. Example- Bundle 1- Tube light, Fan, LED bulb. Bundle 2- Mixer, Refrigerator and TV.

Air Cooler				
Water Cooler				
Water Purifier				
Refrigerator				
Mixer Grinder				
Electric Cookstove				
Induction Cookstove				
If any other, please specify				

6. Have you dropped any product in the last year?

a. Yes b. No

If yes, please specify the reasons-

Name of the Product	Standard/ Energy Efficient Appliance	Reasons for dropping

7. Has the price of the appliances varied over the years?

a. Yes b. No

If yes, please specify the reasons

_____

_____

_____

8. What are the challenges you face while selling your services?

a) Delayed / Outstanding payments
b) Consumer affordability
c) Lack of demand
d) Market competition
e) Limited Consumer awareness
f) Limited substitutes/alternatives available
g) Any other - please specify_____

9. What factors do you think can bring transformation in the appliances market?

a)
b)
c)

SECTION B

Questions applicable to DRE providers serving Productive Businesses

10. Number of productive businesses supported: _____

PRODUCT INFORMATION

11. Please list the appliances you offer in the table below[16]

A. Sewing Machine	Product Specification			Price (in INR)	Consumption (in Watts)	Units sold in a year	After-Sales service Please tick (ü)		Warranty		Lifetime of product	Remark/ Speciality
	Model Number	Type of Motor[17]	Rated input power				Door-to-door	Designated Service Centre	Months / year	Criteria for warranty		
Type I												
Type II												
Type III												
B. Power Looms	**Product Specification**			**Price (in INR)**	**Consumption (in Watts)**	**Units sold in a year**	**After-Sales service Please tick (ü)**		**Warranty**		**Lifetime of product**	**Remark/ Speciality**
	Model Number	Type of Motor[18]	Rated input power				Door-to-door	Designated Service Centre	Months / year	Criteria for warranty		
Type I												
Type II												
Type III												
C. Flour Mills	Product Specification			Price (in INR)	Consumption (in Watts)	Units sold in a year	After-Sales service Please tick (ü)		Warranty		Lifetime of product	Remark/ Speciality
	Model Number	Capacity (kg/hr) Milling rate	Rated Input Power				Door-to-door	Designated Service Centre	Months / year	Criteria for warranty		
Type I												
Type II												
Type III												

16 *If number of models are more than three, please provide information in the space given in appendix*
17 Semi-automatic/Full mechanized
18 Semi-automatic/Full mechanized

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D. Solar Water Pumps	Product Specification			Price (in INR)	Consumption (in Watts)	Units sold in a year	After-Sales service Please tick (ü)		Warranty		Lifetime of product	Remark/ Speciality
	Model Number	Type of Motor[19]	Water output (litres/hrs)				Door-to-door	Designated Service Centre	Months / year	Criteria for warranty		
Type I												
Type II												
Type III												

E. Rice Hullers / De-huskers	Product Specification			Price (in INR)	Consumption (in Watts)	Units sold in a year	After-Sales service Please tick (ü)		Warranty		Lifetime of product	Remark/ Speciality
	Model Number	Type of Motor[20]	Kg/hr Milling rate				Door-to-door	Designated Service Centre	Months / year	Criteria for warranty		
Type I												
Type II												
Type III												

F. Milk Chilling Units	Product Specification			Price (in INR)	Consumption (in Watts)	Units sold in a year	After-Sales service Please tick (ü)		Warranty		Lifetime of product	Remark/ Speciality
	Model Number	Cooling Capacity (in tons)	Input rated current				Door-to-door	Designated Service Centre	Months / year	Criteria for warranty		
Type I												
Type II												
Type III												

G. Poultry Incubators	Product Specification			Price (in INR)	Consumption (in Watts)	Units sold in a year	After-Sales service Please tick (ü)		Warranty		Lifetime of product	Remark/ Speciality
	Model Number	Heat delivered	Input rated current				Door-to-door	Designated Service Centre	Months /year	Criteria for warranty		
Type I												
Type II												
Type III												

19 Semi-automatic/Full mechanized
20 Semi-automatic/Full mechanized

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H. Air Blowers	Product Specification			Price (in INR)	Consumption (in Watts)	Units sold in a year	After-Sales service Please tick (ü)		Warranty		Lifetime of product	Remark/ Speciality
	Model Number	Type of Motor[21]	Airflow rate (m3/ min/w)				Door-to-door	Designated Service Centre	Months / year	Criteria for warranty		
Type I												
Type II												
Type III												

I. Soldering Irons	Product Specification		Price (in INR)	Consumption (in Watts)	Units sold in a year	After-Sales service Please tick (ü)		Warranty		Lifetime of product	Remark/ Speciality
	Model Number	Input rated current				Door-to-door	Designated Service Centre	Months / year	Criteria for warranty		
Type I											
Type II											
Type III											

J. Cold Storage Units	Product Specification		Price (in INR)	Consumption (in W)	Units sold in a year	After-Sales service Please tick (ü)		Warranty		Lifetime of product	Remark/ Speciality
	Model Number	Capacity (in tons)				Door-to-door	Designated Service Centre	Months /year	Criteria for warranty		
Type I											
Type II											
Type III											

K. Refrigerator (small)	Product Specification		Price (in INR)	Consumption (in W)	Units sold in a year	After-Sales service Please tick (ü)		Warranty		Lifetime of product	Remark/ Speciality
	Model Number	Capacity (in tons)				Door-to-door	Designated Service Centre	Months /year	Criteria for warranty		
Type I											
Type II											
Type III											

21 Semi-automatic/Full mechanized

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13. Are products offered as a bundle?

If yes, then please tick (✓) the appliances you supply as a bundle with or without SHS or DRE system. Also, please tick (✓) the appliances you offer as an *add on* to the system-

Name of the product	Bundle I[22]	Bundle II	Bundle III	Bundle IV	Appliances you offer as add on to the system
LED Tubelight					
LED Bulb					
Sewing Machine					
Power Looms					
Flour Mills					
Solar Water Pumps					
Rice Hullers/ Rice De-husker					
Milk chilling units					
Poultry Incubators					
Air Blowers					
Soldering Irons					
Cold Storage Unit					
Refrigerator (small)					
Rice Cooker					
Water cooler					
Water Purifier					
Air Cooler					
Pedestal fans					
Ceiling Fans					
Table Fans					
If any other, please specify					

PRODUCT FUNCTIONALITY

14. Do your appliances work on?

a. AC b. DC c. Both

15. If it is a DC/AC appliance, how does it run on AC/DC? Please select (ü) from below-

a. Using an AC-DC converter at product level
b. Using a DC- AC inverter at product level
c. Using an AC-DC converter at SHS level or DRE level
d. Using a DC-AC inverter at SHS level or DRE level

22 Bundle- similar/heterogeneous bunch of appliances sold together with or without SHS or DRE system. Example- Bundle 1- Tube light, Fan, LED bulb. Bundle 2- Mixer, Refrigerator and TV.

FUTURE PROJECTIONS

16. What are the new appliances that you have added in the last one year and plans to add in next three years?

Name of the product	2017-18	2019-20	2020-21	2021-22
LED Tubelight				
LED Bulb				
Sewing Machine				
Power Looms				
Flour Mills				
Solar Water Pumps				
Rice Hullers/ Rice De-husker				
Milk chilling units				
Poultry Incubators				
Air Blowers				
Soldering Irons				
Cold Storage Unit				
Refrigerator (small)				
Rice Cooker				
Water cooler				
Water Purifier				
Air Cooler				
Pedestal fans				
Ceiling Fans				
Table Fans				
If any other, please specify				

18. Have you dropped any product in the last year?

a. Yes b. No

If yes, please specify the reasons

Name of the Product	Standard/ Energy Efficient Appliance	Reasons for dropping

19. Has the price of the appliances varied over the years?

a. Yes b. No

If yes, please specify the reasons

_____

_____

_____

20. What are the challenges you face while selling your services?

a) Delayed / Outstanding payments
b) Consumer affordability
c) Lack of demand
d) Market competition
e) Limited Consumer awareness
f) Limited substitutes/alternatives available

Any other. Please specify_____

21. What factors do you think can bring transformation in the appliances market?

a)
b)
c)

Questionnaire for Manufacturers Supplying Appliances in the off-grid market

Dear Sir/Ma'am,

AEEE is conducting a survey of appliance manufacturers, with the objective of collecting information on the type(s) of appliances currently available in India's off-grid market or have a potential to be there in near future. The purpose of the survey is to develop an interactive consumer portal for off-grid appliances, as well as to get manufacturers' insights on the off-grid appliance market especially with regard to overcoming the challenges in increasing adoption of such appliances. The survey is focusing on both household (such as lights, fans, TV, refrigerator, Air cooler, other) as well as productive appliances (sewing machine, hammer mill, rice huller, dal processing machines, among others).

We invite you to take part in this survey by providing your valuable inputs.

Please also share/provide your **Product Brochure** along with completed questionnaire.

SURVEY QUESTIONNAIRE

I. Background Information

Name of Organisation:	
About	
Year of Inception/Commencement of Operation	
Operation Details	
Areas of Operation	Rural Urban Both
Area(s) Served (States and Districts)	States-_____ Districts-_____
Products & Customers Information	
Types of Products Supplied	• Lights • Fans • Air Cooler • Television • Refrigerator • Other Appliances (Water Purifier, Mixer Grinder, Induction Cookstoves) • Productive Appliances (Solar Pump, Rice Huller, Rice Polisher, Dal Processing Machine, Honey Processing Plant, Handloom (Textile), Hammer Mill) • Other Productive Appliances (Sewing Machine, Solar Inverter, Roti Rolling Machine, Printer/Photocopy, Blacksmith Blower) • If any other, please specify
Most sold products	
Type of End-Consumers	Households Small Business Both
Mode of operation	Selling directly to Consumers Through Retailer/Dealer Through SHS/DRE Both
List down 2-3 large Customers (organisations)	Business to Business (SHS/DRE) _____ Business to Consumers _____
Contact Details	
Name	
Address	
Telephone/Mobile No.	
Email ID	
Website	

II. Please provide details of the appliances in the table below:

A. Lighting

Details of LED Tubelight												
S. No.	Product Specifications					Price (In INR)	Units sold in a year	After Sales service		Warranty (In years)	Lifetime of Product (In years)	Remark/ Speciality
	Model Number	Lumen level [Lumen]	Rated input [V]	Input Power [W]	Power supply (AC/ DC)			Door-to-door	Designated Service Centre			
1												
2												

Details of LED Bulb												
S. No.	Product Specifications					Price (In INR)	Units sold in a year	After Sales service		Warranty (In years)	Lifetime of Product (In years)	Remark/ Speciality
	Model Number	Lumen level [Lumen]	Rated input [V]	Input Power [W]	Power supply (AC/DC)			Door-to-door	Designated Service Centre			
1												
2												

Details of Solar Latern													
S. No.	Product Specifications								Price (In INR)	Units sold in a year	After Sales service		Warranty (In years)	Lifetime of Product (In years)	Remark/ Speciality
	Model Number	Lumen level [Lumen]	Rated input [V]	Input Power [W]	Battery size* [mAh]	Charging Time* [hr]	Usage hour* (hr)	Power supply (AC/DC)			Door-to-door	Designated Service Centre			
1															
2															

Details of Solar Torch															
S. No.	Product Specifications								Price (In INR)	Units sold in a year	After Sales service		Warranty (In years)	Lifetime of Product (In years)	Remark/ Speciality
	Model Number	Lumen level [Lumen]	Rated input [V]	Input Power [W]	Battery size* [mAh]	Charging Time* [hr]	Usage hour* (hr)	Power supply (AC/DC)			Door-to-door	Designated Service Centre			
1															
2															

B. Fans

Details of Ceiling Fan																	
S. No.	Product Specifications									Price (In INR)	Units sold in a year	After Sales service		Warranty (In years)	Lifetime of Product (In years)	Remark/ Speciality
	Model Number	Size [diameter in mm]	Air Flow [m3/min/]	Rated Input [V]	Input Power [W]	Type of motor	Motor Capacity (HP)	Motor Rating/ Efficiency (BIS/IEC)	Power supply (AC/DC)			Door-to-door	Designated Service Centre			
1																
2																

Details of Pedestal Fan																	
S. No.	Product Specifications									Price (In INR)	Units sold in a year	After Sales service		Warranty (In years)	Lifetime of Product (In years)	Remark/ Speciality
	Model Number	Size [diameter in mm]	Air Flow [m3/min/]	Rated Input [V]	Input Power [W]	Type of motor	Motor Capacity (HP)	Motor Rating/ Efficiency (BIS/IEC)	Power supply (AC/DC)			Door-to-door	Designated Service Centre			
1																
2																

Details of Table Fan																	
S. No.	Product Specifications									Price (In INR)	Units sold in a year	After Sales service		Warranty (In years)	Lifetime of Product (In years)	Remark/ Speciality
	Model Number	Size [diameter in mm]	Air Flow [m3/min/]	Rated Input [V]	Input Power [W]	Type of motor	Motor Capacity (HP)	Motor Rating/ Efficiency (BIS/IEC)	Power supply (AC/DC)			Door-to-door	Designated Service Centre			
1																
2																

C. Air Coolers

Details of Air Cooler														
S. No.	Product Specifications							Price (In INR)	Units sold in a year	After Sales service		Warranty (In years)	Lifetime of Product (In years)	Remark/ Speciality
	Model Number	Capacity [litres]	Product dimension[l*b*h]	Air Flow [m3/min/]	Rated Input [V]	Input Power [W]	Power supply (AC/DC)			Door-to-door	Designated Service Centre			
1														
2														

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D. Televisions

Details of LED Television																
S. No.	Product Specifications									Price (In INR)	Units sold in a year	After Sales service		Warranty (In years)	Lifetime of Product (In years)	Remark/ Speciality
	Model Number	Resolution	Screen size [in]	Aspect ratio	Lumen [cd/m2]	Rated Input [V]	On mode power [W]	Standby power [W]	Power supply (AC/DC)			Door-to-door	Designated Service Centre			
1																
2																

E. Refrigerators

Details of Refrigerator without freezer																
S. No.	Product Specifications									Price (In INR)	Units sold in a year	After Sales service		Warranty (In years)	Lifetime of Product (In years)	Remark/ Speciality
	Model Number	Type of Refrigerant*	Gross Capacity [L]	Net weight [Kg]	Product Dimension [L*W*H]	Rated Input [V]	Rated Input power [W]	Annual Energy consumption [kWh]	Power supply (AC/ DC)			Door-to-door	Designated Service Centre			
1																
2																

Details of Refrigerator with freezer																
S. No.	Product Specifications									Price (In INR)	Units sold in a year	After Sales service		Warranty (In years)	Lifetime of Product (In years)	Remark/ Speciality
	Model Number	Type of Refrigerant[23]	Gross Capacity [L]	Net weight [Kg]	Product Dimension [L*W*H]	Rated Input [V]	Rated Input power [W]	Annual Energy consumption [kWh]	Power supply (AC/ DC)			Door-to-door	Designated Service Centre			
1																

F. Other Appliances

Details of Water Purifier														
S. No.	Category	Product Specifications						Price (In INR)	Units sold in a year	After Sales service		Warranty (In years)	Lifetime of Product (In years)	Remark/ Speciality
		Model Number	Weight [kg]	Capacity [Litres/hr]	Input power [W]	Annual Energy consumption [kWh]	Power supply (AC/DC)			Door-to-door	Designated Service Centre			
1														
2														

23 Refrigerants such as R-134a / R404a / R507C / R22. Please specify if any other

Details of Mixed Grinder														
S. No.	Category	Product Specifications						Price (In INR)	Units sold in a year	After Sales service		Warranty (In years)	Lifetime of Product (In years)	Remark/ Speciality
		Model Number	Speed (RPM)	Type of motor	Motor Capacity (HP)	Motor Rating/ Efficiency (BIS/IEC)	Power supply (AC/DC)			Door-to-door	Designated Service Centre			
1														
2														

Details of Induction Cookstoves													
S. No.	Category	Product Specifications					Price (In INR)	Units sold in a year	After Sales service		Warranty (In years)	Lifetime of Product (In years)	Remark/ Speciality
		Model Number	Heat Rate (BTU/hr)[24]	Input power [W]	Temperature (max & min) range	Power (max & min) range			Door-to-door	Designated Service Centre			
1													
2													

G. Productive Appliances

Details of Solar Pump													
S. No.	Product Specifications						Price (In INR)	Units sold in a year	After Sales service		Warranty (In years)	Lifetime of Product (In years)	Remark/ Speciality
	Model Number	Extraction rate [Kg/hr or litre/hr]	Input power [W]	Type of motor	Motor Capacity (HP)	Motor Rating/ Efficiency (BIS/IEC)			Door-to-door	Designated Service Centre			
1													
2													

Details of Rice Huller													
S. No.	Product Specifications						Price (In INR)	Units sold in a year	After Sales service		Warranty (In years)	Lifetime of Product (In years)	Remark/ Speciality
	Model Number	Extraction rate [Kg/hr or litre/hr]	Input power [W]	Type of motor	Motor Capacity (HP)	Motor Rating/ Efficiency (BIS/IEC)			Door-to-door	Designated Service Centre			
1													
2													

24 A single BTU is the amount of energy required to increase the temperature of one pound (avoirdupois)of water by one-degree Fahrenheit (F)

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Details of Rice Polisher													
S. No.	Product Specifications						Price (In INR)	Units sold in a year	After Sales service		Warranty (In years)	Lifetime of Product (In years)	Remark/ Speciality
	Model Number	Extraction rate [Kg/hr or litre/hr]	Input power [W]	Type of motor	Motor Capacity (HP)	Motor Rating/ Efficiency (BIS/IEC)			Door-to-door	Designated Service Centre			
1													
2													

Details of Dal Processing Machine													
S. No.	Product Specifications						Price (In INR)	Units sold in a year	After Sales service		Warranty (In years)	Lifetime of Product (In years)	Remark/ Speciality
	Model Number	Extraction rate [Kg/hr or litre/hr]	Input power [W]	Type of motor	Motor Capacity (HP)	Motor Rating/ Efficiency (BIS/IEC)			Door-to-door	Designated Service Centre			
1													
2													

Details of Honey Processing Plant													
S. No.	Product Specifications						Price (In INR)	Units sold in a year	After Sales service		Warranty (In years)	Lifetime of Product (In years)	Remark/ Speciality
	Model Number	Extraction rate [Kg/hr or litre/hr]	Input power [W]	Type of motor	Motor Capacity (HP)	Motor Rating/ Efficiency (BIS/IEC)			Door-to-door	Designated Service Centre			
1													
2													

Details of Handloom (Textile)													
S. No.	Product Specifications						Price (In INR)	Units sold in a year	After Sales service		Warranty (In years)	Lifetime of Product (In years)	Remark/ Speciality
	Model Number	Extraction rate [Kg/hr or litre/hr]	Input power [W]	Type of motor	Motor Capacity (HP)	Motor Rating/ Efficiency (BIS/IEC)			Door-to-door	Designated Service Centre			
1													
2													

Details of Hammer Mill													
S. No.	Product Specifications						Price (In INR)	Units sold in a year	After Sales service		Warranty (In years)	Lifetime of Product (In years)	Remark/ Speciality
	Model Number	Extraction rate [Kg/hr or litre/ hr]	Input power [W]	Type of motor	Motor Capacity (HP)	Motor Rating/ Efficiency (BIS/IEC)			Door-to-door	Designated Service Centre			
1													
2													

H. Other Productive Appliances

Details of Roti Rolling Machine												
S. No.	Category	Product Specifications			Price (In INR)	Units sold in a year	After Sales service		Warranty (In years)	Lifetime of Product (In years)	Remark/ Speciality
		Model Number	Output [No of Roti/hr]	Input power[W]			Door-to-door	Designated Service Centre			
1											
2											
3											

Details of Blacksmith Blower											
S. No.	Category	Product Specifications			Price (In INR)	Units sold in a year	After Sales service		Warranty (In years)	Lifetime of Product (In years)	Remark/ Speciality
		Model Number	Air flow (m3/ min/W)	Input power[W]			Door-to-door	Designated Service Centre			
1											
2											

Details of Printer/Photocopy Machine													
S. No.	Category	Product Specifications					Price (In INR)	Units sold in a year	After Sales service		Warranty (In years)	Lifetime of Product (In years)	Remark/ Speciality
		Model Number	Output of Printer [No of pages/ hr]	Output of Scanner [No of pages/ hr]	Output of Photocopy [No of pages/hr]	Input power[W]			Door-to-door	Designated Service Centre			
1													
2													

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Details of Solar Invertor													
S. No.	Category	Product Specifications					Price (In INR)	Units sold in a year	After Sales service		Warranty (In years)	Lifetime of Product (In years)	Remark/ Speciality
		Model Number	Power Factor	Rated Input [V]	Rated Input Power (KVA/kW)	Charge Controller (W)			Door-to-door	Designated Service Centre			
1													
2													

Details of Sewing Machine														
S. No.	Category (Select from drop down)	Product Specifications							Price (In INR)	Units sold in a year	After Sales service		Warranty (In years)	Lifetime of Product (In years)	Remark/ Speciality
		Model Number	Output[25]	Input Power [W]	Type of motor	Motor Capacity (HP)	Motor Rating/ Efficiency (BIS/IEC)	Power supply (AC/DC)			Door-to-door	Designated Service Centre			
1															
2															

Details of Any other Appliances[26]													
S. No.	Category	Product Specifications					Price (In INR)	Units sold in a year	After Sales service		Warranty (In years)	Lifetime of Product (In years)	Remark/ Speciality
		Model Number	Output**	Rated Input [V]	Rated Input Power (KVA/ kW)	Power supply (AC/ DC)			Door-to-door	Designated Service Centre			
1													
2													

25 Please specify output of sewing machine as per your specification along with unit
26 To be filled for appliances not mentioned in our list

III. Manufacture's Perception

1. Is energy efficiency one of the attributes you consider for product designing?

   a. Yes b. No

   If yes, then what steps/interventions are you undertaking to improve the product's efficiency and why? Please elaborate.

   _____
   _____

2. What are the barriers you face in selling your products?
   - Consumer affordability
   - Lack of demand
   - Limited consumer awareness
   - Lack of energy efficiency standards and labelling program for off-grid appliances
   - If any other reason, please specify _____

3. Do you think standards and labelling program will increase acceptance of your products?

   a. Yes b. No

   If yes, please specify the reasons

   _____
   _____

4. What factors do you think can bring transformation in the off-grid appliances market with respect to energy efficiency?
   a)
   b)
   c)

5. What are the major attributes which attract the consumers to purchase your products? *(Can select multiple options)*
   - Functionality
   - Superior Performance
   - Energy saving potential
   - Lifetime of the product
   - Warranty
   - After-sales service
   - If any other reason, please specify _____

6. Please list 2-3 household appliances which you are planning to add in your product's portfolio in the next 3-5 years.
   a)
   b)
   c)

7. Please list 2-3 productive appliances (income generating appliances) which you are planning to add in your product's portfolio in the next 3-5 years.
   a)
   b)
   c)