

# **Consolidated Report**

## **Measurement of Women's, Household's and Community's Demand and Willingness to Pay for Renewable Energy Products and Services**

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**Submitted to**



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**Meghraj Capital Advisors Private Limited**

**In consortium with**



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**and**



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# List of Abbreviations

APL	Above Poverty Line
ALCC	Annualized Life Cycle Cost
BAU	Business-As-Usual
BDO	Block Development Officer
CRF	Capital Recovery Factor
CVM	Contingent Valuation Method
DAY-NRLM	Deen Dayal Antyodaya Yojana- National Rural Livelihoods Mission
DDUGJY	Deendayal Upadhyaya Gram Jyoti Yojana
EMI	Equally monthly Instalments
EPC	Engineering, Procurement and Construction
FGD	Focus Group Discussion
FHH	Female Headed Households
GDP	Gross Domestic Products
GGJVV	Guru Golwalkar Janbhagidari Vikas Yojana
GoI	Government of India
GoMP	Government of Madhya Pradesh
GoN	Government of Nagaland
GoR	Government of Rajasthan
GoUP	Government of Uttar Pradesh
GSDP	Gross State Domestic Product
GW	Giga Watt
ICS	Improved Cook Stoves
IIEC	International Institute For Energy Conservation
IFAD	International Fund For Agriculture Development
INDC	Intended Nationally Determined Contributions
INR	Indian National Rupee
JLGs	Joint Liability Groups
kW	Kilo Watt
kWh	Kilo Watt Hour
LPG	Liquefied Petroleum Gas
MADP	Magra Area Development Programme
MCAPL	Meghraj Capital Advisors Private Limited
MFI	Micro-Finance Institutions
MGO	Mini-grid Operator
MMR	Maternal Mortality Ratio
MNRE	Ministry of New and Renewable Energy

MoRD	Ministry of Rural Development
MP	Madhya Pradesh
MUs	Millions Unit
MW	Mega Watt
MWh	Mega Watt Hour
NEPeD	Nagaland Empowerment Of People Through Energy Development
NGO	Non-Governmental Organization
NIESBUD	National Institute of Entrepreneurship and Small Business Development
NIESBUD	National Institute Of Entrepreneurship And Small Business Development
NREGS	National Rural Employment Guarantee Scheme
NRLM	National Rural Livelihoods Mission
NSSO	National Sample Survey Organisations
O&M	Operation and Maintenance
OBC	Other Backward Caste
OPEX	Operating Expenditure
PAYG	Pay As You Go
PCB	Printed Circuit Board
PMAYG	Pradhan Mantri Awaas Yojana – Grameen
PMKVY	Pradhan Mantri Kaushal Vikas Yojana
PMUY	Pradhan Mantri Ujjawala Yojana
PNG	Pipelined Natural Gas
Qty	Quantity
RE	Renewable Energy
RES	Renewable Energy Sources
RGAVP	Rajasthan Grameen Ajeevika Vikas Parishad
RGVY	Rajiv Gandhi Gram Vidyutikaran Yojana
SAANJHI	Saansad Aadarsh Gram Yojana
SC	Schedule Caste
SHGs	Self Help Groups
SHLS	Solar Home Lighting Systems
SL	Solar Lantern
ST	Schedule Tribe
STEP	Support to Training and Empowerment Programme
SWP	Solar Water Pump
TERI	The Energy and Resources Institute
TREAD	Trade Related Entrepreneurship Assistance and Development
TTC	Think Through Consulting Private Limited
UP	Uttar Pradesh
UPERC	Uttar Pradesh Electricity Regulatory Commission
UPNEDA	Uttar Pradesh New & Renewable Energy Development Agency
VDB	Village Development Board
WACC	Weighted Average Cost of Capital
WEC	Women Energy Centre
WEI	Women Empowerment Index



WRC	Women Resource Centres
WtP	Willingness To Pay

# Executive Summary

## i. Background

Women are the developmental face of energy access. Improvement in energy availability and shift to cleaner sources of energy is expected to reduce the drudgery of women and help increase their contribution to economic development of the country. Energy access is one of the top priorities of the Government of India (GoI) and it has the mission of 'Power for All' by 2019. India's current household electrification rate is close to 75%<sup>1</sup>, implying that there are still a quarter of population that needs to be serviced. The work under 'Power for All' and other rural electrification schemes has been going on a war footing to ensure that the country is able to meet its target. India is home to maximum number of people globally without access to electricity, and with only a couple of years remaining for the country to reach its 'Power for All' target, it is imperative that innovative models are implemented to increase the reach to clean energy. Women will have a substantial role to play in meeting this challenge and this is the focus of the current Study.

## ii. About the Project

The Study "Measurement of Women's, Household's and Community's Demand and Willingness to Pay for Renewable Energy Products and Services" was commissioned to support UN Women through an analytical framework in design of the UN Women's Flagship Programme on Women's Entrepreneurship for Sustainable Energy, to be implemented in partnership with the Ministry of New and Renewable Energy (MNRE). This Study focuses on four states - Madhya Pradesh, Nagaland, Rajasthan and Uttar Pradesh. The focus of the Study is to *assess the energy access status of marginalised women and examine the role these women can play in the energy value chain or the support energy can provide to them in furthering their livelihood options*.

The study is a predominantly primary data based under which, an extensive household survey of 1600+ households was conducted to understand the socio economic profile of the most marginalized section in these four states. Along with the household survey extensive, Focus Group Discussions (FGDs) were conducted in each of the 64 villages surveyed. More than 90% of the respondents were women and majority of them represented the lower castes. The Study specifically focuses on marginalized women in these States, as this was a key requirement of the Study. To assess the scope of women to participate in renewable energy (RE) supply chain, interviews were held with local retailers and distributors in each of the states surveyed.

It was observed that the **illiteracy levels were high** across the sample size in three of the four states. While in Rajasthan 78% of the respondents were illiterates, 53% of the respondents from Madhya Pradesh

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<sup>1</sup> GARV website (<http://garv.gov.in/garv2/dashboard/garv>) - accessed on 20<sup>th</sup> July 2017

and 68% of the respondents in Uttar Pradesh were illiterate. In case of Nagaland the illiteracy levels was only 16%. In Rajasthan it was observed that for the new generation, education was considered as an important aspect and efforts were being made to educate them, irrespective of their gender.

Majority of the female respondents were homemakers or were engaged in agriculture as agri – labourers. In both the cases, the **contribution of the women to the economic value creation was unrecognized, underreported and/ or undervalued**. Agri- labourer is a seasonal occupation and the intermittent nature of the income adds to economic insecurity. Marginal portion of the sample was engaged in MSME activities or entrepreneurial activities. In Uttar Pradesh, in select districts such as Bareilly, women were engaged in home based enterprises, with small scale of interventions, primarily home based enterprises engaged in sarees or pickles making and embroidery. In Nagaland, women were engaged in agriculture and were the lead managing marketing of the agriculture produce.

### iii. Willingness to Pay for RE products and Demand Estimates

A core component of the survey was to estimate the Willingness to Pay (WtP) of the niche section of the population surveyed for ten consumptive and productive technologies including Solar Lantern, Solar Home Lighting System (SHLS), solar water pump, solar drip irrigation, solar water heaters, Improved Cook Stove (ICS), biogas stoves, solar driers, solar PV based food processing system and solar PV based chiller and Mini-grid. As the survey was of the most marginalized section, for most of the technologies there was no demand, especially the productive and capital intensive technologies such as solar drip irrigation, solar water heaters, solar driers, solar PV based food processing system and solar PV based chiller. The technologies that clearly emerged from the survey as preferred technologies were **Solar Lantern, SHLS and ICS**. In some cases solar water pump and Mini-grid were also mentioned to be preferred technologies (this was primarily mentioned in the FGDs and not in the survey). The Table below presents the state wise preferred technology that has been examined in the course of the Study.

**ES Exhibit 1: State wise preference for various RE products**

State	Solar Lantern	Solar Home Lighting Systems	Improved Cook Stoves	Mini -grid	Solar Water pumps
Madhya Pradesh	✓	✓	✓	NA	NA
Nagaland	✓	✓	NA	NA	NA
Rajasthan	✓	✓	✓	NA	NA
Uttar Pradesh	✓	✓	✓	✓	✓

An implication of the selection of niche section of the population was not only on the technology choice, but also on the WtP communicated by the respondents. In most cases it was seen that more than 65% of the respondents had expressed their WtP of the identified technologies. With limited variance in response from the respondents, running a regression equation to estimate the WtP was a challenge. Thus, an

alternate approach of cost benefit analysis – Annualized Life Cycle Cost (ALCC) was implemented. This approach was relevant from both supplier and consumer perspective.

**From a Supplier Perspective**, the ALCC value denotes the regular pay out that the supplier of the product will require under an Operating Expenditure (OPEX) or deferred payment model, such that ownership of the product will be transferred to the user after all the deferred payments are made. This model can be incorporated in a pay as you go (PAYG) model as well as into a rental model, both of which are preferred models as compared to a CAPEX model. This helps the supplier to service a larger market that cannot afford paying upfront costs of these relatively expensive products. The OPEX model is akin to the service model, which is the model that is deployed by Mini-grid Operators (MGO) for electricity supply.

**From a Consumer perspective** the model helps improve affordability of the RE products. In case of standalone lighting (Solar Lantern and SHLS) products, it is assumed that the WtP for any household for Solar Lantern and SHLS is based on the expenditure on kerosene under current scenario. Kerosene is the main source of lighting used in rural household, especially when electricity is not available. Benchmarking the pay outs to the fuel currently used also sensitizes the consumer on the utility of the RE products and the better service it provides.

The following tables present the WtP and the demand for different technologies analysed. The demand numbers that are presented are for the sample only.

**ES Exhibit 2: WtP and Sample level demand estimates for various RE products in Madhya Pradesh**

Parameters → Technologies	Benchmark Cost Current energy source used	Monthly pay- outs <sup>2</sup> (INR per month)	WtP estimates Households with benchmark cost more than monthly pay-outs	Demand estimates Households with a demand for 1 (qty) of the product	Households with a demand for 2 (qty) of the product
Solar Lantern	Monthly expenditure on kerosene	24.08	165	106	59
SHLS 25W		356.12	11	11	NA
SHLS 100W		492.06	3	3	
ICS Option I <sup>3</sup>	Monthly savings on firewood	36.92	51	50	
ICS Option II		81.22	51	1	

**ES Exhibit 3: WtP and Sample level demand estimates for various RE products in Nagaland**

<sup>2</sup> The ALCC calculations and the monthly pay outs for Nagaland differs from the other three states primarily because of the additional cost expected to be incurred in terms of freight charges

<sup>3</sup> The ICS options have been decided based on the household size they can service. The ICS Option I can service upto 8 members' household and ICS Option II can service a household with upto 15members.

Parameters →	Benchmark Cost	Monthly pay-outs <sup>2</sup>	WtP estimates	Demand estimates	
Technologies	Current energy source used	(INR per month)	Households with benchmark cost more than monthly pay-outs	Households with a demand for 1 (qty) of the product	Households with a demand for 2 (qty) of the product
Solar Lantern	Monthly expenditure on kerosene	27.08	5	2	3
SHLS 25W		378.29	1	1	NA

ES Exhibit 4: WtP and Sample level demand estimates for various RE products in Rajasthan

Parameters →	Benchmark Cost	Monthly pay-outs <sup>2</sup>	WtP estimates	Demand estimates	
Technologies	Current energy source used	(INR per month)	Households with benchmark cost more than monthly pay-outs	Households with a demand for 1 (qty) of the product	Households with a demand for 2 (qty) of the product
Solar Lantern	Monthly expenditure on kerosene	24.08	141	133	8
SHLS 25W		356.12	4	4	NA
SHLS 100W		492.06	3	3	
ICS Option I	Monthly savings on firewood	36.92	268	256	
ICS Option II		81.22	268	12	

ES Exhibit 5: WtP and Sample level demand estimates for various RE products in Uttar Pradesh

Parameters →	Benchmark Cost	Monthly pay-outs <sup>2</sup>	WtP estimates	Demand estimates	
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Technologies	Current energy source used	(INR per month)	Households with benchmark cost more than monthly pay-outs	Households with a demand for 1 (qty) of the product	Households with a demand for 2 (qty) of the product
Solar Lantern	Monthly expenditure on kerosene	24.08	296	280	16
SHLS 25W		356.12	12	4	8
SHLS 100W		492.06	8	8	NA
ICS Option I	Monthly savings on firewood	36.92	295	283	
ICS Option II		81.22	295	12	

While the above were the demand for the sample surveyed, demand estimates were also done at district level. The demand extrapolation exercise is for the marginalized section of the population of the district as that is the portion of the population explained by the sample survey. As this was a niche population segment, the demand was not extrapolated for the entire district or at the state level. The aggregate district wise demand is presented in the Table below.

**ES Exhibit 6: State-wise District level extrapolated demand for lighting and cooking solutions**

State	Solar Lantern		Solar Home Lighting Systems		Improved Cook Stoves	
	Number	% share of Total	Number	% share of total	Number	% share of Total
<b>Madhya Pradesh</b>	95254	19.86%	163	0.76%	54519	9.53%
<b>Nagaland</b>	109	0.02%	14	0.07%	NA	NA
<b>Rajasthan</b>	170385	35.52%	7354	34.37%	395769	69.17%
<b>Uttar Pradesh</b>	213885	44.59%	13866	64.80%	121877	21.30%
<b>Total</b>	<b>479633</b>	100.00%	<b>21397</b>	100.00%	<b>572165</b>	100.00%

These extrapolated numbers can be interpreted as conservative estimates of the market potential for these products for the districts in which the survey was conducted. Also, if the comparative shares of the states

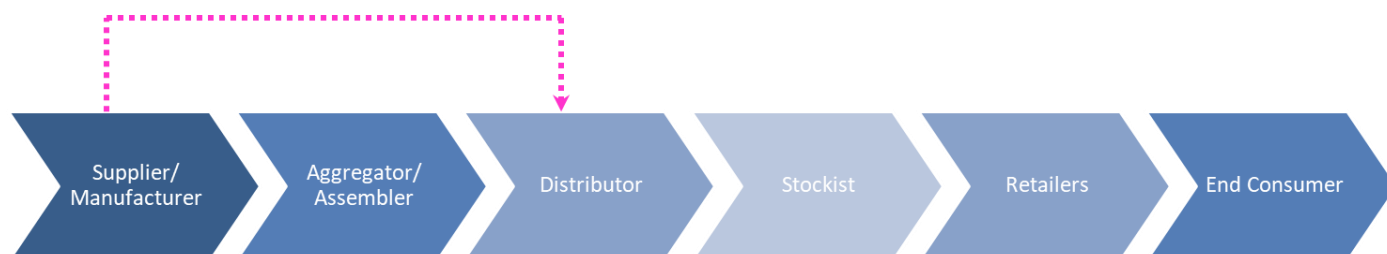
across the product categories is analysed, it is seen that districts in *Uttar Pradesh offer to be the biggest market to be tapped into*. In case of *cooking solutions*, *Rajasthan takes the lead as it has high concentration* of marginalized population (as defined for the analysis) as compared to the other states. *Nagaland*, albeit looks to be small market from the survey, however, taking in view the low electrification levels in the State, *it can be a potential market to be explored in the near to medium term*. *Madhya Pradesh* is representative of a market where electrification levels have significantly improved, however, *the market for Solar Lanterns still remains on account of poor quality of electricity delivered and the infrastructure bottle necks that exist in servicing areas through the grid*.

Thus, it can be said that *Nagaland* is a nascent market for these RE products. On the other hand, *Uttar Pradesh* is a known large market for a variety of RE products ready to be explored. *Rajasthan* presents a market case for RE products, where households are sparsely located in large arid areas. And finally, *Madhya Pradesh* presents a case for RE products where current electrification levels may be good, but the quality of supply is still a concern.

#### iv. RE Supply Chain: Engaging Women

During the FGDs and interviews with the retailers the adequacy of the existing RE supply chain was examined. The respondents were also enquired on what roles they see for women in deepening the RE supply chain. The current RE supply chain is fairly standard especially for the standalone products – Solar Lantern, SHLS and ICS. The supply chain is presented in the Figure below

ES Exhibit 7: Typical Supply Chain of the Solar Lantern, SHLS and ICS



The Survey and the interactions with the existing retailers revealed that the current RE Supply Chain is not adequate to service the market. Lack of after sales service and the large distances from the nearest point of sale and lack of innovative business models were some of the concerns highlighted during the interactions that are impacting effectiveness of the RE supply chain. There was also a concern of spurious

products penetrating the RE supply chain, which would have a long term detrimental impact of the RE market development.<sup>4</sup> In Madhya Pradesh, lack of awareness about the products and their utility was another concern that was raised by the retailers. The survey revealed that while the awareness of RE products was high (75% of the respondents in Rajasthan were aware of RE products)<sup>5</sup>, the ownership was limited (13% in case of Rajasthan). This disconnect was a function of limitation in the RE supply chain.

Engagement of women in the RE supply chain was completely missing. However, the retailers were keen to engage women in the supply chain as they are more honest and sincere workers. ***Women were also very keen in participating in the RE supply chain and other alternate livelihood options, if they are provided adequate training, skill development and hand holding.***

## v. Financial inclusion

The survey finding was that almost all the respondents (average 98%) had Aadhaar cards. Ownership of bank accounts was also medium to high across the four states. While in Nagaland nearly 70% of the households had bank accounts, in the other three states the ownership was more than 94%. Despite having a bank account, it was seen that respondents preferred to take loans from family and friends or the local money lender. Most of the loans were taken for meeting marriage expenses or for agriculture related expenses. Loan for assets were less prevalent and awareness for RE related financing products was limited. The role women played in household financial decisions was also limited, wherein in most cases it was the men who took most of the financing decision, in consultation with the women of the household.

## vi. Way Forward and Role of UN Women

A series of interventions have been identified as part of the current Study for mainstreaming women in the RE supply chain as well as for becoming energy entrepreneurs. The Table below presents the recommendations and expected role of UN Women can play in taking it forward.

S.No.	Recommendation	Role of UN Women
1.	<b>Develop Women Energy Centre (WEC):</b> It is a hub and spoke model for developing a women oriented RE supply chain. All central and strategic function will be held at the centre and the spokes will be responsible for sales, marketing, collection and after sales service.	<ul style="list-style-type: none"> <li>UN Women can implement the concept of Women Energy Centre at an identified location as a pilot to establish the business case and standard operating procedures for such a women driven supply chain model</li> <li>UN Women can liaison with the concerned agencies and government departments to sensitize them on the need for such pilot and facilitate the engagement</li> <li>UN Women to engage experts in supporting it in</li> </ul>

<sup>4</sup> This was a specific concern in Nagaland where spurious products were being sourced by neighbouring countries

<sup>5</sup> Contrary to common belief, literacy levels had little role to play in RE awareness creation, as the most prevalent source for awareness were demonstration projects at the Gram Panchayat or block level, Projects implemented in neighboring villages/ block/ states, word of mouth of friends and families, or visual media.



S.No.	Recommendation	Role of UN Women
		implementation of the pilot
2.	<p><b>Develop Women Centric Database and a Women Empowerment Index:</b> women centric database may be created to track the performance of important parameters and document the contribution done by women in economic and social development of the economy.</p> <p>The <b>Women Empowerment Index (WEI)</b> will capture a number of aspects of women empowerment such as (a) access to resources; (b) reduction in drudgery; (c) role in decision making at the household level; (d) access to market and independence to take financial decision; (e) presence of women in community leadership roles; (f) improvement in female centric health, education, energy, sanitation, water and other development parameters etc. WEI will help track the progress of mainstreaming of women in the economic and social activities in the country, and thus such an index is important.</p> <p>Development of women centric database will act as an input in developing this index and thus both of the actions are closely linked.</p>	<ul style="list-style-type: none"> <li>UN Women can institute a study that can define the framework and the modus operandi of developing the Women Centric Database</li> <li>UN Women can liaison with the concerned agencies and sensitize them on the need for such a database</li> <li>UN Women to engage experts in developing Women Empowerment Index</li> <li>Government of India is actively considering developing a Women Empowerment Index. UN Women can support GoI and NITI Aayog in developing the Index</li> </ul>
3	<p><b>Integrating women into RE supply chain:</b> There are some integral building blocks that are required to create an ecosystem to help women develop their capabilities as entrepreneurs and prosper. Areas of intervention include institutions, skill development, quality products, access to finance, technology integration, mainstreaming women oriented policies into energy access policers</p>	
3a.	<p><b>Strong and inclusive institutions: Leveraging on SHGs:</b> The most crucial aspect of building an ecosystem that promotes women engagement is to build a robust institutional structure that will support them. From the field the feedback received was that SHGs were the preferred institutional model. States have had mixed experience with SHGs, however it is structure that is well set and has well established policy support. Frameworks can be made to engage well performing SHGs.</p>	<ul style="list-style-type: none"> <li>UN Women can undertake a study on the experiences of SHGs in India to understand the drivers for their success or failures SHGs in India</li> <li>UN Women can work with experts to develop an engagement framework and strategy for on boarding SHGs for women driven enterprises</li> <li>UN Women can create a platform for experience sharing sessions and learning from each other for SHGs</li> </ul>
3b.	<p><b>Skill development and hand holding:</b> There are a number of institutes, GoI scheme and programmes, NGOs, Skill India Mission and state schemes that can be leveraged to train women on various technical and soft skills for them to become competent energy entrepreneurs</p>	<ul style="list-style-type: none"> <li>UN Women can institute a training needs assessment of the identified set of women</li> <li>UN Women can liaison with relevant training institutes for undertaking the identified training for women</li> <li>UN Women can support mapping of existing</li> </ul>

S.No.	Recommendation	Role of UN Women
		<p>Central Government and State schemes, especially those focusing on skilling and training to examine the synergies that can be established to support training and capacity building of the women folk</p> <ul style="list-style-type: none"> <li>UN Women to identify areas of synergy between training requirements of women and the Skill India and various scheme under it</li> <li>UN Women to on board NGOs to undertake the hand holding for women, their family and community to support the women in becoming entrepreneurs</li> </ul>
3c.	<p><b>Ensure access to finance:</b> Lack of access to finance implies concerns in terms of both quantity and cost of finance. Most of the rural population is still dependent upon traditional sources of funding (borrowings from friends and families and local lender). Rural population typically requires small amount loans for short duration; however banks usually do not offer such products. Paper work that goes in availing bank loans is tedious and thus acts as a deterrent to use this channel of financing. Respondents face difficulties in accessing bank loans as there could be locations, where banks do not exist. Overall the awareness level for banking sector is low and women need to be brought to speed to use the banking finance route</p>	<ul style="list-style-type: none"> <li>UN Women can support women entrepreneurs in aggregating their financing demands through SHGs. WEC can act as a platform for aggregation of</li> <li>UN Women can support organization of women centric awareness sessions for helping they understand the banking structures, products and relevant schemes</li> <li>UN Women can support preparation of a 'Women Entrepreneurs Banking Toolkit' which would act as their ready reckoner to access the bank facilities, loan process, documentation requirement all from the perspective of setting up a women owned enterprise</li> </ul>
3d.	<p><b>Ensure quality of Product:</b> Product is the interaction point between the entrepreneur and the consumer. A spurious product is a double edged sword as poor quality products do not last as long as committed and such products act as a deterrent for people to shift to RE products. Thus, it is of utmost importance that to ensure sustained shift to RE products the entrepreneur needs to build trust among the new users and retain the current users.</p>	<ul style="list-style-type: none"> <li>UN Women can organize technical training programmes to sensitise women on the technical aspects of RE products</li> <li>UN Women to on board labs that will ensure quality product are supplied in the RE supply chain.</li> </ul>
3e.	<p><b>Technology Integration:</b> Technology can be a game changer that will impact how we use electricity and pay for it. Mobile telephony as a technology intervention has changed the communication landscape, and is steadily evolving further. In the proposed system, use of IT will be required for easy coordination across the various levels of RE supply chain to perform multiple functions including easy tracking of RE sales, performance tracking,</p>	<ul style="list-style-type: none"> <li>UN Women can organize technical training programmes to train women entrepreneurs on use of technology to deliver energy services. This may also include academic training to the entrepreneurs on relevant technology infrastructure</li> <li>UN Women can work closely with women entrepreneurs in developing business models that incorporates technology intervention.</li> <li>Liaison with technology providers to help develop</li> </ul>

S.No.	Recommendation	Role of UN Women
	consumer feedback, operations & maintenance, payment and other recordkeeping etc.	the technology layer in implementing the identified business model.
3f.	<b>Mainstreaming women oriented policies into energy access:</b> There are a number of women centric policies that are currently operational. Alternatively, there are schemes where women have been integrated as the key beneficiary. For instance, Ujjwala scheme under the aegis of MoPNG, STEP, TREAD, NRLM and State Missions etc. Dovetailing on the existing policies will ensure faster on boarding of stakeholders that could help further mainstreaming of women. The stakeholders include Central and state government, NGOs operating in the area, retailers, financing agencies, if any. UN Women would have a substantial role to play here as a bridge between the entrepreneurs and the policy makers, such that issues of women led enterprises are communicated to policy makers and at the same time, these women are fully versed with the existing policy interventions and how these can be utilized in building sustainable businesses.	<ul style="list-style-type: none"> <li>UN Women to act as an advocacy agency pushing for gender mainstreaming in energy policies</li> <li>Along with energy policies, UN Women to engage with other relevant ministries, government departments and other similar bodies, to mainstream women based enterprises</li> <li>UN Women to work with the women entrepreneurs in helping them understand policy interventions and how these policies can help them in functioning of their enterprises.</li> </ul>

In conclusion, it is suggested that UN Women along with its partners can **undertake a pilot to establish a test case for women centric energy enterprise**. The **Women Energy Centre model** can be the pilot for implementation. A successful test case implementation will have impactful learning for all stakeholders including local, state and Central Government, NGOs, product suppliers, service operators, women entrepreneurs, technology providers, skilling organizations, community etc. These learning will need to be documented so that it can be replicated or improvised upon subsequently.

Another intervention that UN Women can take up on priority is **development of the WEI**. WEI is in line with the mandate of UN Women. India does not have the index at present and development of the same will be a **pioneering work led by UN Women**. Moreover, this can be an **impactful quantitative and qualitative tool for UN Women** basis which it can act as a change agent and a tool for policymakers to **roadmap for developing of women centric policies**. GoI is currently discussing the contours of such an index, and therefore this may be an opportune time to develop this index.

# Introduction



## Content Summary

This Chapter includes the project background, structure of the Report along with its scope. This also lists down the limitations of the study.



## i. Project Background

Globally around 1.1 Billion people lack access to electricity and nearly 2.9 Billion people use solid biomass for cooking and heating purpose.<sup>6</sup> In India, as on 26<sup>th</sup> June 2017, close to 44 Million rural households were still to be electrified<sup>7</sup>. In India, around 142 Million rural households<sup>8</sup>, representing almost 85% of total rural households use firewood and other solid fuels such as animal dung, charcoal, crop waste and coal, as the primary source of energy. Thus, there is high dependence on polluting fuels such as kerosene, firewood etc. to meet energy requirements of the rural poor. This dependence has severe implication on the environment of the country. More importantly, usage of these fuels has far reaching impact on the health and social well-being of the women and children of the household.



Photo Courtesy: Project Consortium

In India and in most of the developing countries, women to a large extent are responsible for household and community energy provision. Available data shows that women and girls, South Asia, spend about 20 hour or more per week in day in time-consuming and physically draining tasks of collecting biomass fuels.<sup>9</sup> In India women spend about 374 hours annually in firewood collection.<sup>9</sup> This constrains them from accessing decent wage employment, educational opportunities and livelihood enhancing options, as well as limits their options for social and political interaction outside the household. At the same time, cooking from biomass through inefficient means is particularly detrimental to the health of women and children.

Further, women's economic contribution to the energy sector, such as fuel collection, is mostly unpaid, unrecognized and undervalued; and women's engagement in providing and using energy sources for domestic and productive consumption in agriculture and micro-enterprises, where majority of rural women are concentrated, are often not reflected in national statistics. In addition, few women are engaged as stakeholders and decision-makers in policy processes in the energy sector.

<sup>6</sup> <http://www.unosd.org/index.php?page=view&type=13&nr=49&menu=229> accessed on 13<sup>th</sup> February 2017

<sup>7</sup> <http://garv.gov.in/garv2/dashboard/main>, Government of India's GARV portal, accessed on 26<sup>th</sup> June 2017

<sup>8</sup> <http://censusindia.gov.in/>, Census 2011 data accessed on 16<sup>th</sup> February, 2017.

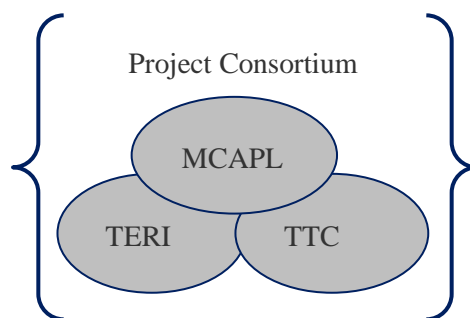
<sup>9</sup> Gender and Livelihoods Impacts of Clean Cook stoves in South Asia; Global Alliance For Clean Cook stoves, developed by Practical Action; November 2014

Strengthening role of women and giving them access to cleaner energy products, not only benefits the household they are responsible for, but also helps improve community and has generational impacts attached to it. Owing to the role that women play in energy provisioning at household and community level, their integration and involvement across the energy value chain can expand, both in scale and quality of sustainable energy initiatives and leverage better outcomes for households, communities and economy. Efforts to promote women's entrepreneurship and leadership in sustainable energy will require identifying context specific opportunities, risks and gender-disaggregated barriers.

## ii. Engagement Context and Objective

The proposed study aims to inform the design of the UN Women's Flagship Programme on Women's Entrepreneurship for Sustainable Energy, to be implemented in partnership with the Ministry of New and Renewable Energy (MNRE) in select states of Madhya Pradesh (MP), Nagaland, Rajasthan and Uttar Pradesh (UP). The objective of the Programme is to identify and remove structural gender-specific barriers facing women entrepreneurs, enhance women's productive use of sustainable energy, and increase women's participation and leadership in gender-responsive energy policy-making.

In this context, it is important to identify demand for RE based solutions and subsequently to assess WtP towards such solutions. The amount users are willing to pay for energy resources is relevant to stakeholders such as women entrepreneurs involved in assembling, marketing and selling products and services, when making decisions about the tariffs. Secondly, the estimation of aggregate willingness to pay for energy sources is critical in examining the welfare impacts of energy interventions and their viability in rural areas. This estimation will be an important factor in validating market case of investing in renewable energy interventions, as against existing approaches that are heavily dependent on subsidies and grants, thereby ensuring long term sustainability of energy interventions. Thirdly, an assessment of WtP is instrumental in determining financial products, services and instruments required to facilitate the consumers to invest in renewable energy products and services.



UN Women has mandated Meghraj Capital Advisors Private Limited (MCAPL) along with the consortium partners Think Through Consulting Private Limited (TTC) and The Energy and Resources Institute (TERI) to develop a methodology and undertake a study to measure **Women's, Household's and Community's Demand and Willingness to Pay (WtP) for Renewable Energy (RE) Products and Services**.

## iii. Scope of Work

The scope of work under this Project includes the following activities. While there are individual state reports have been prepared, this report is the consolidated report and presents the findings of all the four states. The coverage of the Report includes:

- a. Conduct desk research;
- b. Develop a detailed study methodology with a proper survey design focusing on but not limited to the following:

- Assessment of economic and social profile of customers (women, households and community);
- Assessment of awareness among women, households and community about renewable energy products and services from different energy sources (solar, hydro, wind, bio) for domestic and productive consumption;
- Identification of RE products and services from different energy sources needed and demanded by women, households and community and assessment of their accessibility and availability;
- State the method, tools and techniques proposed to be adopted for valuation of demand and willingness to pay for renewable energy products and services (including Micro/Mini-grid models) from different energy sources for domestic and productive consumption;
- State the method, tools and techniques proposed to be adopted to capture information from all key stakeholders in the energy landscape/ecosystem who play a critical role in impacting/ influencing the willingness to pay for energy products and services;
- Capture the 'willingness to participate in the supply chain' as a retailers, distributors, marketing agents and financial partners;
- Estimate the value of energy interventions in livelihood models present in the states;
- Assessment of available and proposed options for financing products and services;
- Assessment of preference, mode and method of payment for renewable energy products and services;

#### iv. Structure of the Report

The scope of this report is to present consolidated findings of the Study. There were individual State reports that were prepared, capturing the State level detailed analysis and recommendations. This Report consolidates on the State reports as well as presents areas of interventions and roadmap for UN women to take forward its mandate. The Consolidated Report has been divided into following Chapters-

##### **Chapter 1: Introduction**

This Chapter provides a glimpse of the Project background and briefs about the objective of the UN Women's Flagship Programme on Women's Entrepreneurship for Sustainable Energy. This also cites the limitations faced during the assessment of the Project.

##### **Chapter 2: Methodology, tools and techniques for the Study**

This Chapter details out the methodology adopted for various components of analysis undertaken in the Study including survey methodology, estimation of willingness to pay (WtP), demand for various RE products etc. The Chapter also describes the evolution of the analysis as during the course of the Study.

##### **Chapter 3: Profile of the States Covered**

This Chapter presents brief profile of the four Study states in terms of their socio economic profile, power sector structure and various schemes related to rural electrification, livelihoods, rural development, women empowerment etc. Here both central and state government initiatives are discussed.

#### **Chapter 4: Socio Economic Profile of Respondents and Survey Findings**

This Chapter presents socio economic profile of the respondents across the four states and discusses the key findings of the survey.

#### **Chapter 5: RE Supply Chain: Engaging women folk**

The chapter examines the current RE supply chain that is followed for supply of RE products. The Chapter also examines the role of women currently play in the supply chain and proposes a multi- level solution to improve their engagement in RE products market.

#### **Chapter 6: Willingness to pay and Demand Estimation**

This chapter focusses on the assessment of WtP for RE products and services across the four states. It also presents the demand estimates for the sample population as well as for the district for the identified RE technologies.

#### **Chapter 7: Conclusion and Way Forward**

This Chapter summarizes the key findings of the Study and presents the way forward for increasing engagement of women in these states in terms of increasing their access to RE products, and creating commercial and entrepreneurial opportunities in developing the market for RE products. It also presents contours of an Index that can be prepared to track women empowerment in India.

## **v. Activities undertaken during the Engagement**

In order to address the scope of work mentioned above, the following activities have been undertaken:

### **a. Kick off meeting**

The study started with a kick-off meeting that discussed various activities that were proposed to be undertaken for the Study. This included discussion on the detailed work plan and study methodology for the Study.

### **b. Inception Report**

The Inception Report included the survey methodology adopted in the Study. It also included various research tools used in the study such as Questionnaire for Focus Group Discussions (FGD) and interviews with rural retailers and finally the literature review that can substantiate the study for better results.

### **c. Data survey and field visits**

The team visited various blocks/ villages that were selected for surveys in the four (4) states i.e. MP, Nagaland, Rajasthan and UP. The team was deployed with specific a questionnaire prepared for the four states to help achieve the objective of the Study.



#### d. Draft Findings Report

Draft findings of the report were presented to UN Women as a preliminary assessment/ findings from the field visits conducted in the four states. This involved data analysis by controlling the sample bias that would emerge during data entry.

#### e. Stakeholder Consultation

The draft findings of the Study were presented to the stakeholders in consultation sessions held in each of the four states. The consultations were attended by agencies operating in rural areas, training institutes, banking institutions and Non-Governmental Organizations (NGOs) operating in the four states. The participants validated the findings of the reports and provided inputs on business model that would be most suited for engaging women in their respective states. The following Table presents the schedule for the various stakeholder consultations that were conducted.

**Table 1: Schedule of stakeholder consultations conducted**

S.No	State	City	Date
1.	Rajasthan	Jaipur	16 June, 2017
2.	Madhya Pradesh	Bhopal	19 June, 2017
3.	Uttar Pradesh	Varanasi	20 June, 2017
4.	Nagaland	Kohima	20 June, 2017

#### f. Preparation and submission of draft report

After analysis of the data available from survey, literature review, interviews, stakeholder consultations and discussions with UN Women staff on the various findings from data analysis, a draft report has been submitted to UN Women for their review. The report includes the energy demand estimations, willingness to pay finding for the rural women in the four states as well as recommendations for UN Women flagship programme.

The final report would be based on the various stakeholder consultation and workshops conducted in the selected sites as well as feedback from UN Women upon the draft report.

### vi. Limitations of the Project

This engagement is critical in assessing the viability of RE options for women consumers and entrepreneurs in rural areas. The systematic marginalization of women in the State makes it imperative for stakeholders such as the government and donor agencies to focus on how to improve the participation of women in the energy value chain, both as the energy entrepreneurs as well as consumers using energy to improve their livelihoods. The criteria for marginalization, shared by UN Women also included other parameters such as HIV positive women, women facing domestic/ physical abuse. However, there were practical difficulties in selecting such women at the ground level.

The main target group for this project were marginalized rural women. Marginalization has been defined in terms of caste, literacy, access to electricity and income/expenditure. The selection of the study areas as well as the sample was carried out on the basis of these parameters in order to identify the most marginalized group. However, selection of the sample on the basis of these parameters has resulted in limitation to analysis, as discussed below

- a) Increased marginalization meant that most of the women were still found to be engaged in traditional livelihoods that usually do not consume energy. In many of the districts covered, marginalized communities such as scheduled castes (SC), scheduled tribes (ST) and other backward classes (OBC) were not engaged in commercial activities or livelihood options such as weaving, spice-grinding, pottery etc. Most of the women were primarily homemakers, with some degree of engagement in agriculture usually as agri-labour. This essentially limited the assessment of their WtP to pay for energy to improve their livelihoods/ productive use.
- b) Due to the level of marginalization we found that most respondents were aware of RE products such as Solar Lanterns, solar home lighting systems (SHLS), however, they were not aware about other systems such as solar driers or solar based food processing systems. Many of those who did not use RE products had only seen it once or twice and did not know how they worked or had an idea of their benefits. Prior to seeking response on WtP for these products, the project team had put efforts to explain the usefulness and benefits of RE products to the respondents, so that they can take an informed decision regarding WtP
- c) The access to RE products of respondents was also low owing to the high levels of marginalization, as RE uptake is much higher in peri-urban areas and among economically better off classes as opposed to marginalized groups.
- d) In many of the districts surveyed it was found that women were not the decision makers when it came to asset purchase. Hence, they were not able to articulate their WtP for RE products as they did not understand the financial implications of replacing present energy resource with RE product. The WtP stated by them for RE products and services is the aspirational value they assign to such technologies. In some FGDs, it was found that women were not able to tell how much they paid for grid-connected electricity as the men of the household paid the bills.
- e) It was difficult to find a diverse sample in the villages since most villages in the state are organized along caste-lines and people belonging to the general category rarely live alongside SC and ST communities.
- f) In some states it was also observed that in the past, the respondents under marginalised category were eligible to receive RE products for free or at significantly subsidised cost under different schemes. Thus, this set a limitation in terms of estimating WtP, as the respondents were not familiar with the idea of paying for RE products.
- g) Given the specific demographics represented in the sample survey, the demand estimates that have been presented in the study are for the sample only extrapolated to the districts surveyed. As these are represented for a specific population of the State, the estimates have not been extrapolated to the State level.

Taking into account these limitations of the study, the analysis of the data and feedback received is presented in the following Chapters.



## Chapter Summary: Key highlights

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- a. A significant proportion of the Indian population do not have access to energy, with close to 44 Million households still to be electrified and more than 142 Million households depending on solid biomass fuels for cooking electricity.
- b. Women play a major role in household related chores and thus are more exposed to such polluting sources of lighting and cooking.
- c. Women's economic contribution in form of fuel collection is also un/under recognised.
- d. Owing to important role of women in providing energy both household and community level, UN Women as part of UN Women's Flagship Programme on Women's Entrepreneurship for Sustainable Energy has proposed to undertake a study- Women's, Household's and Community's Demand and Willingness to Pay (WtP) for Renewable Energy (RE) Products and Services.
- e. This report is the consolidated report which presents the findings of all the four states - Madhya Pradesh, Nagaland, Rajasthan and Uttar Pradesh - studied as part of the report.

# Methodology, Tools and Techniques for the Study



## Content Summary

This Chapter details out the methodology adopted for various components of analysis undertaken in the Study including survey methodology, estimation of WtP, demand for various RE products etc. The Chapter also describes the evolution of the analysis as during the course of the Study.

## i. Introduction

A household's energy choices are subject to the socio-economic conditions, physical access and availability of the fuel, price of the fuel and cultural factors of the households. These energy choices have substantial gender implications, as women spend long hours in collection and processing of traditional fuels and inefficient burning of fuels (used for cooking and lighting) impacts the health of women and children of the households.

A patriarchal society structure also has a bearing on energy choices and transition<sup>10</sup>. Generally the male members are the head of the household and they take financial decisions, which may/may not take into account health and drudgery impacts of these energy choices on women folk of the household. Women are primarily responsible for cooking in developing countries<sup>11</sup>, and they are exposed to indoor air pollution resulting from smoke from firewood burning and the fumes emitted from traditional kerosene lamps usually used for lighting by un-electrified and underserved households.

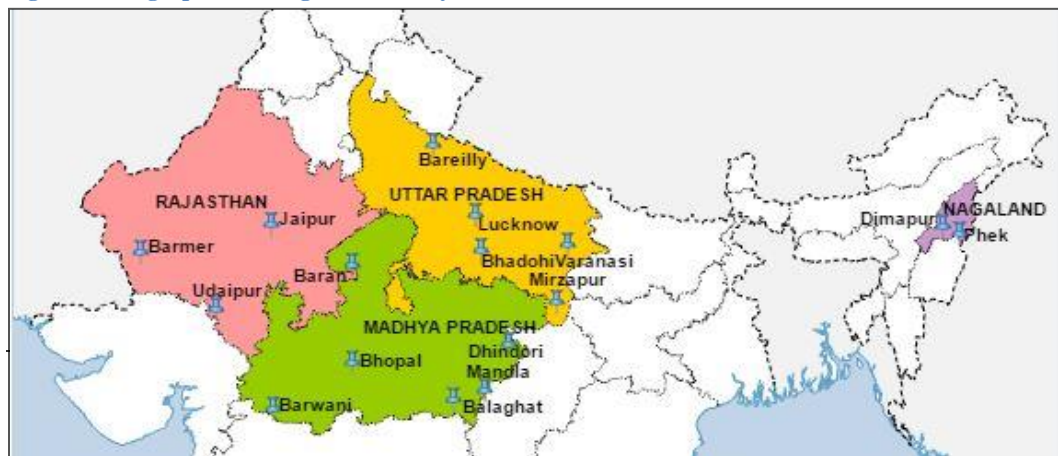
## ii. Objective

This Study recognizes the above biases and aims to estimate the demand of clean renewable energy (RE) products by the women in rural India and map their willingness to pay (WtP) for these RE products to meet their consumptive and productive energy needs. The demand and WtP have been estimated for the household. The Study identifies the bottlenecks in the current energy resources and availability of the clean energy solutions. It further examines the role of women can play in improving RE supply chain and developing as energy entrepreneurs.

## iii. Geographies Selected

The Study covers four states - Madhya Pradesh, Nagaland, Rajasthan and Uttar Pradesh (see map below). An extensive household level survey, covering more than 1600+ households (across 16 districts) was conducted as part of the study.

**Figure 1: Geographic coverage of the Study**



<sup>10</sup> El Tayeb Muneer, S. & (E. W. (2003)). Adoption of biomass improved cookstoves in a patriarchal society: An example of Sudan. The Science of the Total Environment, 259–266.

<sup>11</sup> <http://www.who.int/mediacentre/factsheets/fs292/en/> accessed on 15<sup>th</sup> July 2017



This section presents a detailed discussion on the methodology that has been adopted for conducting the Study. It presents some key insights of the existing literature and the methodology adopted for (a) determination of WtP for select technologies; (b) demand for the selected technologies and (c) extrapolation of the estimated demand at the district level.

## iv. Review of literature

### a. The Energy transitions at the household level

#### ***Energy Ladder Model and Energy Stacking Model***

The energy ladder describes the model of household economic decisions to substitute or switch between fuel options available to the households. The energy ladder concept was the prominent model of explaining household energy choice in developing countries.<sup>12</sup> The main driver that determines the movement up the energy ladder is hypothesized to be income and relative fuel prices.<sup>13</sup> The “traditional energy ladder” proposes that as families gain socioeconomic status, they abandon technologies that are inefficient, less costly and more polluting such as the energy choices at the “lower” end of the energy ladder, such as dung, fuel wood and charcoal.<sup>14</sup>

However, energy ladder movements are not linear in nature. Past studies have observed that household fuel choice decision is a multidimensional process and is not unidirectional. It has been seen that not only income and relative fuel prices play a part in energy choices, but also cultural factors, size of the household, education level of the households, community factors, etc. affect these decisions. Therefore, it has been seen that households consume a portfolio of the energy sources, resulting in an energy stacking.<sup>15</sup> The Table below describes the factors that impact the energy choice at household level.

**Table 2: Factors impacting energy choices**

Categories	Factors
<b>Endogenous factors(Household characteristics)</b>	
Economic characteristics	Income, expenditure, landholding,
Non-economic characteristics	Household size, gender, age, household composition, education, labour, information
Behavioural and cultural characteristics	Preferences (e.g. food taste), practices, lifestyle, social status, ethnicity

<sup>15</sup> Masera, O. S. (2000). From linear fuel switching to multiple cooking strategies: A critique and alternative to the energy ladder model. World Development, 28(12), 2083–2103.

Categories	Factors
Economic characteristics	Income, expenditure, landholding
<b>Exogenous factors(external conditions)</b>	
Physical environment	Geographic location, climatic condition,
Policies	Energy policy, subsidies, market and trade policies
Energy supply factors	Affordability, availability, accessibility, reliability of energy supplies
Energy device characteristics	Conversion efficiency, cost and payment method, complexity of operation

Source: Kowsari, R., & Zerriff, H. (2011). Three dimensional energy profile:A conceptual framework for assessing household energy use. *Energy Policy*, 7505–7517.

The Table above indicates the factors that influence the household energy basket. RE technologies can be good options to address energy access concerns. Decentralized RE technologies can also be suitable options for the rural areas which are yet to be electrified, or do not have the requisite quality of grid supply. Taking cognizance of the factors that determine the energy choice, these RE products need to be supplied through a suitable supply chain, backed by series of awareness programmes to create awareness among the rural population of benefits of RE products and make them affordable through innovative business models. Women have a role to play both as users of these RE products, as well as, as suppliers of these products. This Study examines these aspects of energy transitions and proposes a roadmap for engaging women proactively.

## **b. Literature on methodologies for calculating Willingness to Pay of Rural Households for RE products**

WtP for a product can be elicited either directly by asking the users, or indirectly by examining the market prices of the identified products and their substitutes. WtP is the economic value assigned to a good under a given set of conditions.<sup>16</sup> For determining the WtP, Contingent Valuation Method (CVM) is the most widely adopted method for eliciting the household level preferences for goods, which have lesser demand or are provided by public utilities at administered prices. It is a survey based technique used generally used in the areas of environmental economics to estimate WtP for public goods.<sup>17</sup> CVM is often referred as the stated preference method, as it asks directly consumers the WTP for a given good by building a hypothetical market scenario, thus the responses or the elicited WtP is contingent upon the hypothetical market situation. Net economic benefits of a good is estimated as the difference between household's WtP and the actual cost of providing that good.

Sabah and Wilner (2011)<sup>18</sup> used CVM to estimate WtP for electricity service by rural households in Kenya. The findings of the study were that respondents are willing to pay more for grid electricity

<sup>16</sup> Referred to Herath Gunatilake, N. M. (November 2012). Willingness to Pay for Good Quality, Uninterrupted PowerSupply in Madhya Pradesh, India. *Asian Development Bank Economics and Research Department*.

<sup>17</sup> Cummings, Brookshire, and Shulze 1986; Mitchell and Carson 1989

<sup>18</sup> Sabah, A., & Wilner Jeanty, P. (August 2011, volume 15, Issue 6). Willingness to pay for renewable energy: Evidence from a contingent valuation survey in Kenya. *Elsevier*, Pages 2974-2983.

services than RE, and the households prefer monthly connection payments over a lump sum amount. In another study, Nomura and Akai (2004)<sup>19</sup> undertook a CVM based survey for Japanese households to estimate the WtP for RE. They found that Japanese households are willing to pay about ¥2000 yen (around\$17 at the exchange rate of ¥115 per \$) per month per household in the form of a flat monthly surcharge for RE.<sup>20</sup>

The studies have also shown that the WtP values from CVM based surveys are more robust than the WtP values based on a revealed preference survey.<sup>21</sup>

In view of the existing literature, for the Study, CVM was selected as the methodology for survey and WtP was to be estimated through Probit Regression Modelling. A detailed household survey for 1600+ households, spread over four states, 16 districts and 64 villages was conducted as part of the Study.<sup>22</sup>

In order to run the Probit model, it is imperative that there is variance in the dependable variable in order to establish the key independent variables that have a significant relation with the dependent variable. In case of the Study, the dependent variable is willingness to pay of the household for the selected product. However, based on the survey results it was observed that the variance for the dependent variable is low and thus the Probit did not provide required results. The detailed discussions on the reasons for lack of variance are discussed in the modelling section subsequently.

An alternate approach was adopted for determining the WtP - Annualized life Cycle Cost Analysis (ALCC) was selected. ALCC is a cost and benefit approach, wherein ALCC is calculated taking into consideration the capital cost incurred over the entire life of the product (i.e. including battery replacement and other component replacement costs over the life of the product) and multiplying it with the CRF<sup>23</sup> to arrive at the annualized capital cost. The equation for determination of ALCC is presented below:

$$ALCC = C0_{pv} \times CRF_{pv} + C0_{batt} \times CRF_{batt} + C0_{cfl} \times CRF_{cfl} + C0_{pcb} \times CRF_{pcb}$$

In the above equation, C0 and CRF with their respective subscripts, represent capital costs and capital recovery factors for PV, battery, CFL and Printed Circuit Board (PCB). CRF for each component is calculated at a discount rate and the useful life of that particular component. The detailed methodology for ALCC calculations is discussed in modelling section.

<sup>19</sup> Nomura, N., & Akai, M. (2004). Willingness to Pay for Green Electricity in Japan as Estimated Through Contingent Valuation Method. *Applied Energy*, 78(4): 453-463

<sup>20</sup> Referred to Gunatilake, H., Yang, J.-C., & Pattanayak, S. (December 2007). Good Practices for Estimating Reliable Willingness to Pay Values in the Water Supply and Sanitation Sector. *Asian Development Bank(ADB) Economics and Research Department*.

<sup>21</sup> Choe, K. D. (1996). *The Economic Benefits of Surface Water Quality Improvements in Developing Countries: A Case Study of Davao, Philippines*. Land Economics, 519-537.

<sup>22</sup> Details of the survey are discussed subsequently

<sup>23</sup> CRF is calculated using the expression  $\{i(1+i)^n/[(1+i)^n-1]\}$ , where i represents the discount rate and n is the life of the particular component being considered.



## v. Methodology and sampling technique for block and village selection

The states and districts were pre-selected by UN Women. The Study focused upon identification of the blocks and villages in each of the districts in the identified states. In order to arrive at the sample size per state, stratified random sampling<sup>24</sup> methodology was selected. *Stratified random sampling is a technique that attempts to restrict the possible samples to those which are "less extreme" by ensuring that all parts of the population are represented in the sample in order to increase the efficiency (that is to decrease the error in the estimation).* In stratified sampling the population is first divided into disjoint groups respectively. These sub-groups, called strata, together comprise the entire population. From each stratum, a sample, of pre-specified size, is drawn independently in different strata. Collections of these samples constitute a stratified sample. If a simple random sample selection scheme is used in each stratum then the corresponding sample is called a stratified random sample. The advantage of the stratified random sampling is that it captures the key population characteristics in the sample.

Based on the sample technique, a sample of 1655 households was selected from 64 villages in the four states. The Table below presents the State wise number of districts, blocks, villages and households surveyed.

**Table 3: State-wise, district-wise sample selected**

State	Madhya Pradesh	Nagaland	Rajasthan	Uttar Pradesh	Total
<b>Sample size per State</b>	508	210	432	505	1655
<b>Districts per State</b>	5	2	4	5	16
<b>Blocks selected per State</b>	10	4	8	10	32
<b>Villages selected per Block</b>	2	2	2	2	64

### a. Block selection methodology

For each of the district, blocks were ranked based on their population as per Census of India, 2011. One of the key requirements while selecting the sample for the survey was to represent marginalized population. In order to do so, data was collected for each of the block on the following parameters. Each of these parameters represents one aspect of marginalization of the population. These parameters were finalized in discussion with UN Women at the Inception of the Study. Blocks were ranked based on these parameters mentioned in the Figure below.

**Figure 2: Parameters considered for identifying blocks for sample selection**

<sup>24</sup> <http://www.stat.ualberta.ca/~prasad/361/STRATIFIED%20RANDOM%20SAMPLING.pdf> accessed on 10th June 2017

➔	Total female population
➔	Population of Women belong to Scheduled Caste (SC)
➔	Population of Women belong to Scheduled Tribe (ST)
➔	Number of households with an SC member as head of household
➔	Number of households with an ST member as head of household
➔	Solar Penetration rate*
➔	Female Literacy rate
➔	Electrification rate

\*- solar penetration rate is the number of households using solar as they primary source of lighting

Further during village selection, it was ensured that religious minorities and ethnicity factors are taken in to account. Of the above mentioned parameters, first six parameters were ranked in descending order and last two were ranked in ascending order (i.e. the block with the highest value is assigned Rank 1) for each block. Once the ranks were assigned across each parameter for each of the blocks, the final ranks were aggregated and the blocks with the lowest scores were selected. No weights were assigned to the parameters as this would result in biasness in the sample, as each parameter is an important indicator.

The Annexure 1 presents a snapshot of the selection of blocks in in Sant Ravidas Bhadohi district in Uttar Pradesh.

Based on the above mentioned methodology, the following blocks were selected for each state.

**Table 4: Final list of blocks selected for the Study**

Districts	Blocks	Districts	Blocks
<b>Uttar Pradesh</b>		<b>Madhya Pradesh</b>	
Bhadohi	<ul style="list-style-type: none"> <li>• Aurai</li> <li>• Bhadohi</li> </ul>	Balaghat	<ul style="list-style-type: none"> <li>• Balaghat</li> <li>• Paraswada</li> </ul>
Varanasi	<ul style="list-style-type: none"> <li>• Arajiline</li> <li>• Chirai Gaon</li> </ul>	Barwani	<ul style="list-style-type: none"> <li>• Barwani</li> <li>• Sendhwa</li> </ul>
Mirzapur	<ul style="list-style-type: none"> <li>• Hallia</li> <li>• Rajgarh</li> </ul>	Mandla	<ul style="list-style-type: none"> <li>• Mandla</li> <li>• Bichhiya</li> </ul>
Lucknow	<ul style="list-style-type: none"> <li>• Sarojininagar</li> <li>• Mohanlalganj</li> </ul>	Dhindori	<ul style="list-style-type: none"> <li>• Shahpura</li> <li>• Dindori</li> </ul>

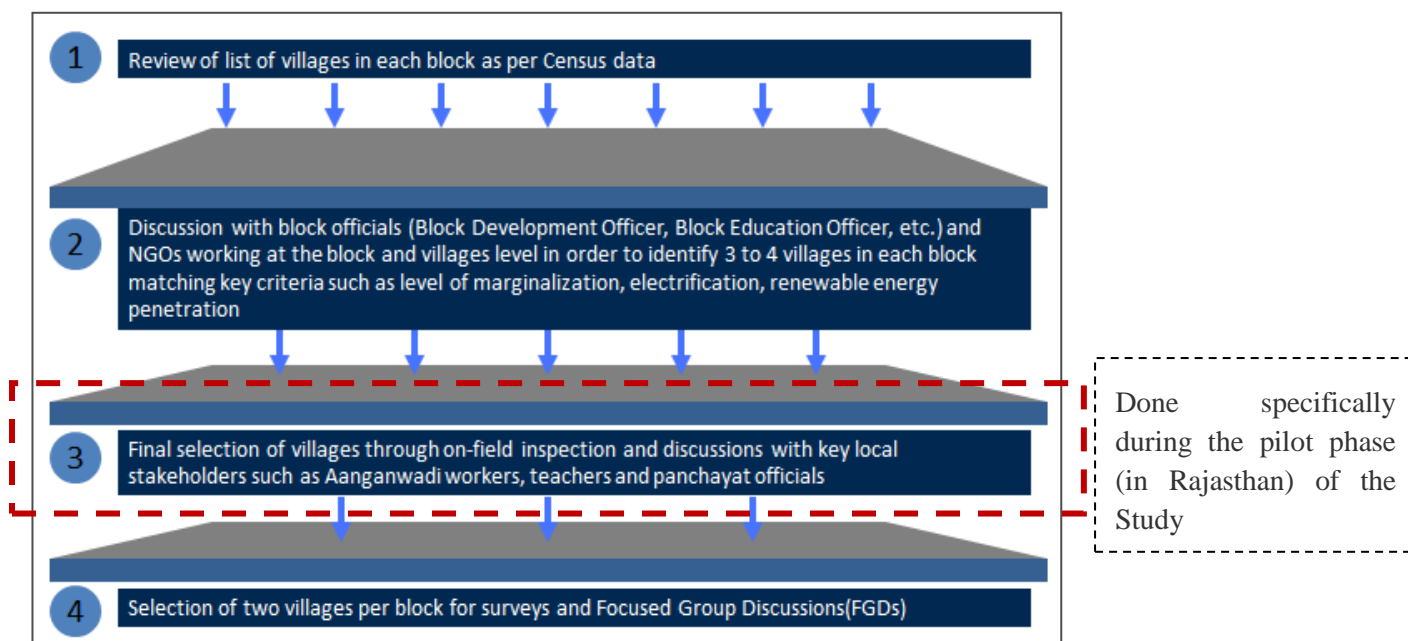
Districts	Blocks	Districts	Blocks
Bareilly	<ul style="list-style-type: none"> <li>Chainpur</li> <li>Nawabganj</li> </ul>	Bhopal	<ul style="list-style-type: none"> <li>Berasia</li> <li>Phanda (Bhopal)</li> </ul>
<b>Rajasthan</b>		<b>Nagaland</b>	
Udaipur	<ul style="list-style-type: none"> <li>Kotra</li> <li>Kherwara</li> </ul>	Dimapur	<ul style="list-style-type: none"> <li>Medziphema</li> <li>Dhansiripar</li> </ul>
Jaipur	<ul style="list-style-type: none"> <li>Jamwa Ramgarh</li> <li>Bassi</li> </ul>	Phek	<ul style="list-style-type: none"> <li>Pfutsero</li> <li>Phek</li> </ul>
Baran	<ul style="list-style-type: none"> <li>Shahbad</li> <li>Kishanganj</li> </ul>		
Barmer	<ul style="list-style-type: none"> <li>Barmer</li> <li>Chohtan</li> </ul>		

The final list of blocks was prepared in consultation with the UN Women

## b. Village selection methodology

Two villages in each block were chosen ensuring that they are from different Gram Panchayats. The selection was done based on the marginalization parameters (as defined earlier) at the village level using Census of India, 2011 data. Based on this four to five potential gram panchayats in each district were identified. Block level officials and Non-Governmental Organizations (NGOs) working at the block level were consulted for the final selection of villages. During selection, it was ensured that religious minorities and ethnicity were taken into account. Post the sample selection, the team undertook field inspections to identify the two villages to be covered in the Study. The village selection process has been summarized in the figure below:

Figure 3: Village Selection Methodology



## vi. Questionnaire Survey

On the basis of findings from literature review, the 61<sup>st</sup> and 66<sup>th</sup> rounds of National Sample Survey Organisations (NSSO), Government of India (GoI)<sup>25</sup> and study titled Needs Assessment Study for UN Women's Flagship Program on Women's Entrepreneurship for Sustainable Energy undertaken by International Institute for Energy Conservation (IIEC) for each State from where the RE products/services were selected, a pilot questionnaire was developed and pilot testing was conducted in Bassi block, Jaipur district in Rajasthan. Based on the findings of the pilot survey, the final questionnaire was prepared. Thereafter, survey was conducted in the identified villages across the four states. The final Questionnaire is annexed in Annexure 2.

The questionnaire was categorized into 3 sub headings:

### 1. General Information

A close ended questions to understand the socio-economic profile of the household, female literacy levels, current energy consumption patterns monthly fuel consumptions and expenditure, proxies of income - household expenditure, ownership of assets, livestock, type of house, level of financial inclusion etc.

### 2. Awareness about RE products

Questions focused on current level of select RE products awareness, their source of awareness, reasons for RE products adoption etc.

<sup>25</sup> Government of India. (2015,). *Energy sources of Indian households for cooking and lighting, 2011–12*. New Delhi: GoI: National Sample Survey Organisation Report No.567.

### 3. Access to RE products

Questions focused on household's existing RE products ownership, their current expenditures on RE products, awareness about the financing options available for RE products, their willingness for the RE products and reasons for opting and not opting for RE products.

In line with the focus of the study, it was ensured that majority of the respondents were women and representation is made of female headed households.

#### vii. Focused Group Discussion and Interviews

In each village surveyed, FGDs were conducted with only women participants (about 8-15 participants in each FGD). The aim of the FGDs was to validate findings of the survey, gather a community level perspective on basic energy needs and seek inputs from the participants on their willingness to participate in the RE value chain and women based entrepreneurship.

Interviews were also conducted with retailers, distributors and manufacturers engaged in RE product business in each district. The interviews provided insights on understanding the supply chain of RE products, current bottlenecks in providing RE products to households, and the likely possibility of the women participation in the supply chain system. The retailers were also asked to comment on the adequacy of the existing supply chain. *The number of interviews conducted with rural retail units selling RE products state-wise were Madhya Pradesh -2; Nagaland – 2; Rajasthan – 4 and Uttar Pradesh – 4.*

#### viii. Survey and Modelling Analysis

Detailed analysis has been done for each component for which data was obtained through the survey. This includes analysis of the socio economic profile of the respondents, asset ownership and financial inclusion. The key responses received from the survey were related to current awareness and ownership level of RE products, willingness to pay for RE products, reasons for using RE products and barriers to RE product use. The WtP analysis was done through a detailed modelling exercise discussed subsequently.

##### a. Modelling Analysis

As mentioned in the literature review there are several empirical studies analysing WtP estimations through a multivariate regression model. For this Study, Probit regression modelling was adopted as most of the responses on WtP for renewable energy product/services from the survey were binary responses (Yes/No). WtP was done for RE products for which the respondents elicited a willingness to pay. These included Solar Lanterns, SHLS and improved cook stove. In Uttar Pradesh during FGDs willingness was expressed for solar pumps and Mini-grid.

Based on the data received, following were independent variables on which the Probit modelling was done. For each of the variable, the hypothesis with which it was modelled in Probit is presented below:

1. **Gender of the Household Head:** It is expected a female headed household will be more willing to move to RE products as compared to male headed households as they spend more time in kitchen and understand the effects of indoor air pollution.

2. **Household Head Literacy Level:** It is expected that as the education of the household head increases, the demand for RE products increases.
3. **Caste:** The probability of willingness to purchase a RE product for a General category household will be more than the probability of SC category household, assuming that general category households are well-off.
4. **Livestock Ownership and agricultural land:** These parameters assess the household paying capacity and hence possible influence on WtP
5. **Household expenditure on fuel and light:** Higher the expenditure on fuel and light, higher will be the willingness to switch to efficient products, hence it is positively related to WtP.

The multivariate regression was followed by the validity test. Validity tests examine whether an instrument actually measures what it is intended to measure. If the independent variables show high statistically significant values, then the hypothesized relationship built is valid, following which the WtP values can be estimated from the Probit model.<sup>26</sup> The independent variables were selected based on their economic significance and impact on dependent variable.

**WTP (Renewable Energy Products) = f** (household head gender, household head literacy level, caste, house type, livestock ownership and agricultural land ownership, renewable energy product current demand, Households expenditure on fuel and light)

However, due to the lack of the sufficient variance in the dependent variable, the Probit regression modelling did not provide required results. The Table below indicates the responses received from survey where respondents were asked about their WtP for RE products and most preferred products. In Rajasthan, 92% of the households reported that they were willing to buy Solar Lantern, 86% willing to buy SHLS and 28% are willing to buy for improved cook stoves. Similar trends were observed for other states as well. The low level of variance in willingness to buy highlights an overwhelming agreement of the respondents to buy the product. This also implies the willingness to buy among the respondents will remain despite the independent variables in consideration. In such a scenario, regression would not present the requisite results.

**Table 5: Willingness to Buy response from survey for all states (RE products)<sup>27</sup>**

States	Solar Lantern	Solar home lighting System	Improved Cook stoves
Madhya Pradesh	59%	26%	14%
Nagaland	63%	47%	16%

<sup>26</sup> <https://www.adb.org/sites/default/files/page/149401/estimation-willingness-pay-oct2013.pdf> accessed on 20th June 2017

<sup>27</sup> Based on survey results for Question no. 39 of Questionnaire

States	Solar Lantern	Solar home lighting System	Improved Cook stoves
Rajasthan	92%	86%	28%
Uttar Pradesh	67%	19%	4%

From a modelling perspective, lack of variance implies:

1. The binary response for willingness to pay had a high proportion of “Yes” as a response. For instance, in case of willingness to pay for Solar Lantern in Rajasthan, nearly 92% of the respondents said yes. Such one sided responses results in limited the validity of a regression run.
2. Such high level of WtP in itself establishes the willingness of the population to purchase the product. Here identifying variables that significantly impact this willingness is a futile exercise as the willingness is established with such an overwhelming response.
3. The respondents of our survey where mostly women, who in most cases are not the economic decision makers of the family. Thus, the WtP expressed by them in most cases does not take into cognizance the financial position of the household. To that extent, the WtP expressed in the survey could be an overestimate. However, this is consequent to the survey design methodology in line with the objective of the study, and thus a bias that could not be corrected.

### Cost benefit approach for estimating willingness to pay for RE products

In light of the above, Annualized life Cycle Cost Analysis (ALCC) was selected as the alternate methodology for estimating the WtP for RE products. The ALCC methodology is a cost and benefit approach for estimating WtP. The ALCC presents the annualized pay out required to be paid by the user of the product such that its total costs are spread over the life of the product. For our analysis ALCC was further divided into monthly pay outs to arrive at the monthly instalments the consumer will be required to pay, to own the product over a period of time. ALCC is relevant from both supplier and consumer perspective.

**From a Supplier Perspective**, the ALCC value denotes the regular pay out that the supplier of the product will require under an Operating Expenditure (OPEX) or deferred payment model, such that its ownership will be transferred to the user after all the payments are made. This model can be incorporated in a pay as you go (PAYG) model as well as into a rental model. The OPEX model (PAYG and rental model both included) is a preferred model for products that have high capital costs such as SHLS, solar water pumps. This helps the supplier to service a larger market that cannot afford paying upfront costs of these relatively expensive products. The OPEX model is akin to the service model, which is the model that is deployed by Mini-grid operators (MGO) for electricity supply. The supplier will charge a monthly usage fee taking into consideration ALCC.

**From a Consumer perspective** the model helps improve affordability of the RE products. In case of standalone lighting (Solar Lantern and SHLS) products, it is assumed that the WtP for any household for Solar Lantern and SHLS is based on the expenditure on kerosene under Business-as-Usual (BAU) scenario. Kerosene is the main source of lighting used in rural household, especially when electricity is

not available. Benchmarking the pay outs to the fuel currently used also sensitizes the consumer on the utility of the RE products and the better service it provides.

The methodology adopted for computation of ALCC is briefly cited below:

ALCC is computed based on the cost of the components of different products. The Capital Recovery Factor (CRF) is computed, which is the ratio of constant annuity to the present value of receiving that annuity for a given length of time. This is computed as per the formula given in the box below:

$$CRF = [i(1+i)^n / \{(1+i)^n - 1\}]$$

Where,

i = Weighted Average Cost of Capital (WACC), with a Debt: Equity Ratio – 70: 30

Cost of Debt = base Rate + 1% (10.10%)<sup>28</sup>; Cost of Equity = 16% (Post tax return)

(Debt% \* Return on Interest loan + Equity% \* post tax Return on Equity)

n = Useful life of the equipment of the product

ALCC represents Annualized Life Cycle Cost of any product (i.e. annual instalments to recover the total cost of the product). ALCC for each component of the product is computed by multiplying CRF and cost of the product. ALCC for the product is calculated as summation of ALCC of individual components

$$ALCC_1 = [CRF \times C_0]$$

Where,

ALCC<sub>1</sub> = ALCC for one component of a particular product

C<sub>0</sub> = Capital Cost of the component in beginning of 1st year

$$ALCC_{\text{product}} = \text{sum} [ALCC_1, ALCC_2, ALCC_3, \dots]$$

Where, ALCC<sub>1</sub>, ALCC<sub>2</sub>, ALCC<sub>3</sub> refers to ALCC of different components of a particular product

#### Note:

ALCC computed for a product also includes installation cost and replacement cost for any product. These are assessed based on the following method:

$$C_5 = C_0 * \{(1+IR)/(1+i)\}^n$$

Where,

C<sub>5</sub> = Capital cost after end of year 5

C<sub>0</sub> = Capital cost at the beginning of year 1

<sup>28</sup> <https://www.sbi.co.in/portal/web/interest-rates> accessed on 22<sup>nd</sup> July 2017



IR= Inflation Rate (assumed as 3%)

i = discount rate or WACC

For instance, cost of battery for 100W SHLS is INR 5500 (denoted as C<sub>0</sub>). The capital cost of the battery is assessed after factoring inflation of 3%. Since the life of the battery is taken as 5 years, thus it will be replaced after an interval of every 5 years till the life of the Product. The computation of the replacement cost of the battery after every 5 years is shown below

**Table 6: Computation for replacement cost (Illustrative)**

Battery replacement	Year of replacement	Capital cost at time of replacement (C)	CRF	ALCC
		$=C_0 \cdot \{(1+IR)/(1+i)\}^n$	$= [i(1+i)^n / \{(1+i)^n - 1\}]$	$= (CRF \cdot C)$
At end of 5 years	5	3639	0.28	1006.24
At end of 10 years	10	2408	0.18	423.86
At end of 15 years	15	1593	0.15	232.27
At end of 20 years	20	1054	0.13	139.96
Total ALCC for battery replacement				1802.33

Similarly, the replacement cost of other components of a particular product is computed and added to the total ALCC of the product. While computing the annual maintenance cost of the product for the life of the product, annual escalation of 5.72%<sup>29</sup> and WACC of 11.87%, is taken into consideration. Thus, ALCC for any product is the summation of cost of its components, replacement costs of the components, installation cost and annual maintenance cost. ALCC represents the ALCC, which is divided by 12 to compute the monthly instalments for any product.

ALCC has been calculated for the technologies listed below. These technologies have been shortlisted based on the feedback received from the survey. Capital Cost has been estimated based on feedback from the market and industry experts.

1. Solar Lanterns
2. Solar Home Lighting System (SHLS)
3. Solar Water Pumps

<sup>29</sup> as per CERC 2017-18 benchmark tariff for RE projects (Determination of levellised generic tariff for FY 2017-18 under Regulation 8 of the Central Electricity Regulatory Commission (Terms and Conditions for Tariff determination from Renewable Energy Sources) Regulations, 2017)

4. Improved Cook Stoves
5. Mini-grid

For estimating the WtP, the ALCC for these products and services has been benchmarked with fuels/savings from fuels that are currently used by the households to meet their energy requirements. These benchmarks are presented in the Table below.

**Table 7: Benchmarks used to measure WtP for various technologies**

Identified technologies		Suggested benchmark for WtP
<b>Solar Lantern</b>	3 W	Monthly kerosene expenditure
<b>SHLS</b>	25 W	Monthly kerosene expenditure
	100 W	
<b>Solar Water Pumps<sup>30</sup></b>	3 HP	Hourly rental paid for diesel water pumps
	5 HP	
<b>ICS <sup>31</sup></b>	Option1	Monthly savings on firewood expenditure
	Option2	
<b>Mini-grid</b>	30 kW	Monthly expenditure on electricity

The ALCC estimated was mapped on the benchmarks mentioned above. Based on the estimates, transitions were prepared across the sample population for each technology to determine the number of households that will have the WtP for the identified technology. The findings are presented in Chapter 6.

## ix. Demand Estimations

The demand for RE products has been estimated for two consumptive energy requirements – lighting and cooking. The demand has first been estimated at the household level and then at the district level, representing only the marginal sections of the population. Methodologies for all the demand estimates are discussed below.

### a. Lighting demand estimations

The demand estimates have been done for lighting i.e. Solar Lantern and solar home lighting system. Factors such household's socio-economic profile, household's monthly kerosene expenditure, current RE

<sup>30</sup> It is assumed that solar water pumps are used for 6 months in a year and 8 hours in a day

<sup>31</sup> Option I is considered for household size of up to 8 members and Option II for household size of greater than 8members

products usage, type of house and number of rooms have been considered in estimating the number of Solar Lanterns and SHLS for the households. The scenario considered is if only one of the products is selected by the household – either Solar Lantern or SHLS. This is based on the field experience; where we found that rural households from the most marginalised sections seldom have 2 different RE based lighting products.

For each State, given the monthly pay out for Solar Lantern and SHLS respectively, the demand has been calculated based on their current kerosene expenditure. If a household's kerosene expenditure is higher than the monthly pay out, then the household will shift to clean energy product and procure it under the OPEX model. In most cases the number of lanterns has been capped at the number of rooms per household.

### ***Extrapolating Lighting Demand to District Level***

Given that our data represents a niche section of the population, the extrapolation of the demand for lighting and cooking energy has been done at the district level, but for only that population that is representative of survey sample. As discussed earlier there are 8 parameters on which the population has been classified as marginal.

Analysis was done on all the eight parameters to see which data point was available for both the sample set as well as for the respective district. Based on the analysis, SC and ST population for the sample level and SC and ST population for the district were the identified parameter on which extrapolation has been done.

The source for the district level data is Census of India 2011 and it also provides details of the primary source of lighting for SC/ ST households at the district level. Similar granularity of data is not provided for the OBC in Census of India 2011 and hence that proportion of the sample has not been extrapolated.

Based on the demand estimates for the sample, percentage of SC and ST households that can demand Solar Lanterns and SHLS has been estimated. While in case of Solar Lanterns, household expenditure is not a key determinant<sup>32</sup>, in case of SHLS those SC/ST households that have an expenditure of greater than INR 500/month has been considered for extrapolation.

There is a wide variation in the percentage of SC and ST population at the district level that can have a demand for the lighting solutions. An important determinant of the percentage of district SC and ST population serviced by these solutions is the percentage of sample that have demand for these solutions. Thus, where the sample level percentage is low for a particular lighting solution, the same is reflected at the district level.

The demand extrapolation estimates can be considered as conservative numbers of estimation as they represent demand for only the marginalized section of the district<sup>33</sup>. Moreover, the key determinant for the

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<sup>32</sup> Primarily because that monthly pay out for solar lanterns (as determined in the WtP section) is INR 24.08/ household and INR 27.08 per month for households in Nagaland, which is comparatively smaller outlay for using a lighting solution as compared to SHLS where the pay-out ranges from INR 356/ month or INR 378.29 per month in Nagaland (for a 25 W SHLS) and INR 492.06/month (for a 100 W SHLS)

<sup>33</sup> Proxy for marginalized is SC and ST population

district level demand is the percentage demand emanating from the household survey, which as discussed in the foregoing sections, represents niche section of the district. The district population beyond SC and ST have not been examined as part our survey.

### **b. Cooking demand estimations**

As observed from international studies<sup>34</sup> and the ground work undertaken by TERI, with adoption of improved cook stoves, a household has a fuel saving of 50% as compared to using mud chulhas (traditional chulhas). This in turn will lead to saving in the monthly firewood expenditure. The saving of firewood expenditure has been compared with the monthly pay out (determined from ALCC) of the two improved cook stove options. On the basis of the potential savings, the demand for ICS has been estimated. To select between Option 1 and Option 2, household size has been taken as the determinant. The households with equal to or less than 8 household members are expected to opt for Option 1 and the households with a family size of greater than 8 members (upto 15 members) is expected to select Option 2.

#### ***Extrapolating Cooking Demand to District Level***

The parameters that were selected for extrapolation were –SC/ ST share in population at the district level. The source for the district level data is Census of India 2011, which provides details of the primary source of cooking for SC/ ST households at the district level. Similar, granularity of data is not provided for the OBCs in Census of India 2011 and hence that proportion of the sample has not been extrapolated. This is therefore a conservative estimate of demand. The key factor for consideration while extrapolating the cooking demand to district level, is the percentage of households buying firewood for cooking in the sample size. Only those households which have a monetary spend on firewood will be willing to transition to improved cook stoves. This is primarily because using improved cook stove does not imply a direct substitution of the fuel, but makes the fuel consumption more efficient. Households that do not have a monetary expense for procuring firewood will have no incentive to make the fuel procurement process more efficient.

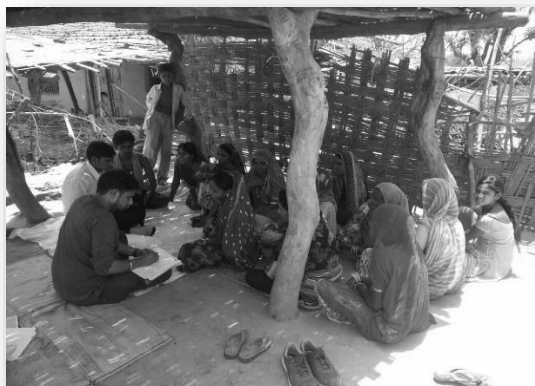
The above is a detailed discussion on the research and analysis methodology that has been adopted in the current Study. The Figure below is a summary snapshot of the methodology discussed in the foregoing sections.

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<sup>34</sup> Impact Evaluation of Improved Cooking Stoves in Burkina Faso; The impact of two activities supported by the Promoting Renewable Energy Programme, Ministry of Foreign Affairs, the Netherlands, November 2013

Figure 4: Snapshot of the methodology adopted

1	<b>Criteria for Block &amp; Village selections in each state</b> <ul style="list-style-type: none"> <li>➤ Block/ village selection criteria in discussion with BDO, NGOs and other officials:- <ul style="list-style-type: none"> <li><input type="checkbox"/> SC member as head of the household</li> <li><input type="checkbox"/> ST member as head of the household</li> <li><input type="checkbox"/> Population of women belonging to Scheduled Caste (SC)</li> <li><input type="checkbox"/> Population of women belonging to Scheduled Tribe (ST)</li> <li><input type="checkbox"/> Solar penetration rate</li> <li><input type="checkbox"/> Female literacy rate</li> <li><input type="checkbox"/> Electrification rate</li> </ul> </li> </ul>	
	<b>Questionnaire</b>	2
3	<b>FGDs with women and retailers, distributors and manufactures</b> <ul style="list-style-type: none"> <li>➤ Questionnaire utility :- <ul style="list-style-type: none"> <li><input type="checkbox"/> Quantitative numbers on crucial factors such as households' monthly consumption of various fuels, household lighting load, overall energy consumption, current RE product ownership, Caste - SC/ST/OBC, APL or BPL household, current usage of RE products</li> <li><input type="checkbox"/> Qualitative information on important factors such as utility from RE products, livestock, WtP for RE products, drivers for adoption to RE product, barriers or problem faced while using RE products.</li> </ul> </li> <li>➤ Utility of FGDs with women households <ul style="list-style-type: none"> <li><input type="checkbox"/> The FGDs conducted with only women as participants</li> <li><input type="checkbox"/> Responses from group of participants (8-15) provided vital insights into cultural issues that are important for building effective communications and discussing households issues.</li> <li><input type="checkbox"/> Community level approach towards: <ul style="list-style-type: none"> <li><input type="checkbox"/> Energy needs</li> <li><input type="checkbox"/> Implementations of government schemes/ Programmes</li> </ul> </li> <li><input type="checkbox"/> Identify major constraints to households demand for lighting, cooking, income generation opportunities.</li> </ul> </li> <li>➤ Utility of interviews with retailers, suppliers and distributors <ul style="list-style-type: none"> <li><input type="checkbox"/> Understand entire supply chain for each RE product for each state</li> <li><input type="checkbox"/> Helped in identifying gaps in the supply chain.</li> <li><input type="checkbox"/> Supported analysis of role women can play in the supply chain</li> </ul> </li> </ul>	
	<b>Survey Analysis</b>	4
5	<b>Modelling RE Willingness to pay</b> <ul style="list-style-type: none"> <li>➤ Survey Analysis <ul style="list-style-type: none"> <li><input type="checkbox"/> Number of Female and Male Headed Households</li> <li><input type="checkbox"/> Socio economic profile of the households</li> <li><input type="checkbox"/> Pattern of energy choices</li> <li><input type="checkbox"/> Individual's households fuel and lighting consumption</li> <li><input type="checkbox"/> Households RE awareness level</li> <li><input type="checkbox"/> Households current renewable energy products consumption</li> <li><input type="checkbox"/> Education level of the female in the households</li> </ul> </li> <li>➤ Willingness to pay Modelling <ul style="list-style-type: none"> <li><input type="checkbox"/> Contingent valuation method with Probit modelling for WtP analysis</li> <li><input type="checkbox"/> Limited variance in dependent variable – limitation of using Probit</li> <li><input type="checkbox"/> Alternate approach: Annualized life Cycle Cost Analysis (ALCC)</li> <li><input type="checkbox"/> Comparison of monthly pay out (ALCC based) with the household's monthly kerosene, consumption, firewood savings fuel &amp; light expenditure</li> <li><input type="checkbox"/> Kerosene expenditure – Solar lantern &amp; SHLS benchmark</li> <li><input type="checkbox"/> Fuel and light – mini-grid benchmark</li> <li><input type="checkbox"/> Rental on diesel pump set – solar water pump benchmark</li> <li><input type="checkbox"/> Saving on firewood expenditure – Improved cook stove benchmark</li> </ul> </li> </ul>	
	<b>Demand Estimations for RE products</b>	6



## Chapter Summary: Key highlights

- a. The study is based on a combination of research tools including survey of 1600+ households in four states, FGDs and interviews with rural retailers and financial institutions.
- b. The survey covered 4 states, 16 districts, 32 blocks and 64 villages. FGDs were conducted in each of the 64 villages.
- c. The methodology adopted for the study consists of desk reviews on energy transitions including the 'Energy ladder' concept which discusses the energy transitions of households. Further, different approaches to assess WTP including Contingent Valuation Method (CVM) were also part of the methodology.
- d. The Energy ladder concept is based on the premise that energy transitions are unidirectional in nature. It hypothesizes that transitions are primarily dependent on the income and relative fuel prices and that as the economic condition of households improves, they abandon inefficient traditional fuels to adopt better and cleaner fuels.
- e. Evidence through various studies, however, shows that energy choices of a household are multi-dimensional. In addition to the factors highlighted above, energy choices depend on cultural factors, household size, education etc. and more often than not, a rural household (in particular), uses a range of options (e.g. mud chulhas, LPG stoves etc.)
- f. CVM approach was initially chosen to assess WtP as it is the most widely adopted approach to estimate WtP. It is a survey based technique where consumers are directly asked about the WtP for a given good by building a hypothetical market scenario.
- g. While the initial approach was based on CVM, due to lack of variance in the responses from survey, an alternate cost benefit approach known as the Annualized Life Cycle Cost (ALCC) approach was adopted
- h. ALCC computes the annual instalments to recover the total cost of the product. ALCC considers the capital cost incurred over the entire life of the product (i.e. including battery replacement and other component replacement costs over the life of the product) and multiplies it with the CRF to arrive at the annualized capital cost.
- i. The ALCC was computed for five key technologies identified from survey responses and FGDs – Solar lanterns, SHLS, Improved Cook Stoves, Solar pumps and Mini-grid.
- j. ALCC was benchmarked to alternate fuels/savings from fuels as shown in the table below. Based on estimations, transitions were prepared for each technology to determine the number of households that will have a WtP for the identified technology.

**Table 8: Benchmarks used to measure WtP for various technologies**

Identified technologies		Suggested benchmark for WtP
<b>Solar Lantern</b>	3 W	Monthly kerosene expenditure
<b>SHLS</b>	25 W	Monthly kerosene expenditure
	100 W	
<b>Solar Water Pumps</b>	3 HP	Hourly rental paid for diesel water pumps
	5 HP	
<b>ICS</b>	Option1	Monthly saving on firewood expenditure
	Option 2	
<b>Mini-grid</b>	30 KW	Monthly expenditure on electricity

- k. Demand for lighting (Solar Lanterns and SHLS) and cooking (Improved Cook Stove) was estimated for the sample and extrapolated to the district level. The parameters selected for extrapolation were SC and ST population at the district level. For SHLS household expenditure was also considered for extrapolation.



# Profile of the States Covered



## Content Summary

This Chapter presents brief profile of the four Study states in terms of their socio economic profile, power sector structure and various schemes related to rural electrification, livelihoods, rural development, women empowerment etc. Here both central and state government initiatives are discussed.

## i. Overview of the States

The Study covers four states namely – Madhya Pradesh, Nagaland, Rajasthan and Uttar Pradesh. These states are some of the most populous and largest (in terms of area) in India. These states represent close to a third of the total population as well as the area covered of the country. Three of these four states are large populous states of the country and have had similar trajectory of development. Nagaland presents a case for areas that have limited energy access and high dependence on traditional sources of energy. The State also presents a case of a socio-economic structure where women are engaged in livelihood options more actively, as compared to the other three states.

In the subsequent sections, we undertake detailed discussions of the demographics of each of the states, survey findings, RE product supply chain and feedback from stakeholders for each of the state to examine the hypothesis presented above.

## ii. Demographic Profile of the States

The four states covered in the Study are home to close to 343 Million people<sup>35</sup>, which is close to 28% of the total population of the country. Among the four states, UP is the most populous state with a total population of close to 200 Million, accounting for 17% of the country's population. In terms of decadal growth rates, Madhya Pradesh, Rajasthan and Uttar Pradesh have growth rates higher than the all India average of 17.70%. Nagaland on the other had a negative decadal growth (-0.57%) in the decade 2001 to 2011. The three states – Madhya Pradesh, Rajasthan and Uttar Pradesh are among the ten fastest growing states in India.

Uttar Pradesh is the most densely populated state, of the four states, with a density of 829 people/ sq km. This is close to double of all India density of 382 people/ sq km. The other three states are lower than the national average, with Nagaland being the least densely populated state at 119 people/ sq km. The Table below presents that key demographic indicators of the four states, as well as that of all India.

**Table 9: Key demographic indicators of the 4 states and India**

Geography	Area (sq.km)	Population (in Million)	Decadal growth rate -2001 to 2011- (in %)	Density of population (people per sq. km)
Madhya Pradesh	308252	72.63	20.35%	236
Nagaland	16579	1.98	-0.58%	119
Rajasthan	342239	68.54	21.31%	200

<sup>35</sup> Census of India 2011

Geography	Area (sq.km)	Population (in Million)	Decadal growth rate -2001 to 2011- (in %)	Density of population (people per sq. km)
Uttar Pradesh	240928	199.81	20.23%	829
India	3287000	1210.86	17.70%	382

Source: Census of India, 2011

### iii. Social Profile of the States

#### a. Rural population

All the States under the Study are primarily rural based states, wherein more than 70% of the population is rural. The share of rural population in the total population is higher than the average rural population of the country at 69%. In terms of per capita income, all the four states have lower per capital income as compared to the all India average. While Nagaland and Rajasthan are close to the Indian average of INR 86879 per person, at INR 76679 per person and INR 76881 per person respectively<sup>36</sup>; Madhya Pradesh (INR 51371 per person) and Uttar Pradesh (INR 44197 per person) have some ground to cover.<sup>36</sup> Thus, there is a potential in these rural dominated states to look at economic activities that will help improve the per capita income levels in the respective states.

#### b. Poverty

A key socio economic indicator is population below the poverty line. For the states under the Study, the poverty line varies. As per the Handbook of Statistics on Indian States, for the year 2011-12, Rajasthan performed the best, with only 14.71%<sup>36</sup> population below the poverty line. It was followed by Nagaland with close to 19%<sup>36</sup> under the poverty line. Uttar Pradesh had about 30% of the population under the poverty line and lastly, Madhya Pradesh had close to 32%<sup>36</sup> of the population under the poverty line. As a benchmark of comparison the all India average for population under poverty line is 21.92%<sup>36</sup>. Thus, two of the states were more prosperous as compared to the national average and two states still had some ground to cover to move its population above the poverty line.

#### c. Marginalized societal status

While the all India average for sex ratio (number of females per 1000 males) is 943, all the states under the Study have a sex ratio lower than the country average (see Table below). All the Study states being under the national average are a cause of concern, highlighting a definite area for these states to work on, however, a positive trend that has been observed is that all these for states have been steadily improving on this metric over the last couple of decades. In term of Maternal Mortality Ratio (MMR) (per 100000

<sup>36</sup> Source: RBI Handbooks for States 2016-17

live births), a similar trend is seen, wherein, three of the four states<sup>37</sup> have MMR higher than the national average of 167<sup>38</sup>.

**Table 10: State wise key socio economic indicators**

Geography	Sex Ratio (per 1000 males) (2011)	Maternal Mortality Ratio (per 100000 live births) (2013)	Infant Mortality Ratio (per 100000) (2015)
Madhya Pradesh	931	221	50
Nagaland	931	NA	12
Rajasthan	928	244	43
Uttar Pradesh	912	285	46
All India	943	167	37

Source: RBI Handbooks for States 2016-17; NITI Aayog

Note: NA – Not available

#### d. Literacy

In terms of literacy levels, except for Nagaland (~90%)<sup>36</sup>; all the other three states have a substantial ground to cover as compared to national average (~73%)<sup>36</sup>. Rajasthan has the lowest literacy level at 66%, followed by Uttar Pradesh at 68%<sup>36</sup> and finally Madhya Pradesh at 69%<sup>36</sup>. In terms of female literacy levels also, these states (except Nagaland (Rank 6)) are among the lowest performing states nationally with Rajasthan (Rank 29) having the lowest levels, followed by Uttar Pradesh (Rank 25) and then Madhya Pradesh (Rank 22).<sup>39</sup> These indicators highlight the need to focus on the education in these states, with special focus on female population.

<sup>37</sup> Data for Nagaland not available

<sup>38</sup> NITI Aayog

<sup>39</sup> NITI Aayog (<https://data.gov.in/catalog/major-socio-economic-indicators-states-india>) accessed on 11<sup>th</sup> July 2017

## iv. Economic Profile of the States

### a. Income and contributing sectors

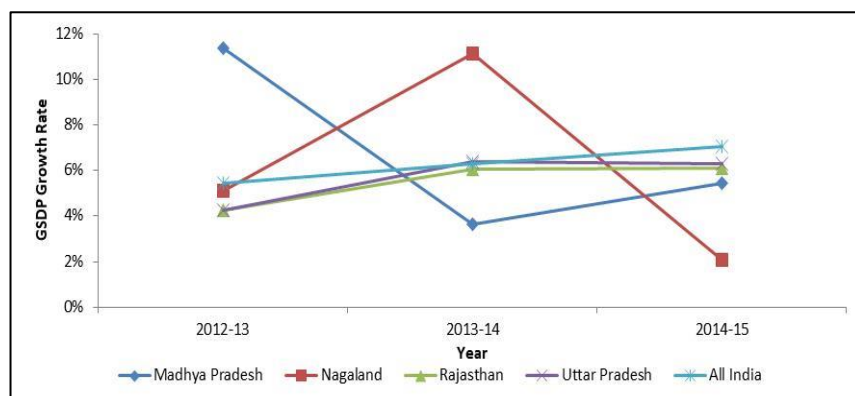
Uttar Pradesh is one of the biggest state economies in the country. With a Gross State Domestic Product (GSDP) of INR 8539 Billion<sup>40</sup>, it accounts for 9% of the total India GDP. Between 2012 and 2015, the State has grown at an average of 5.66% per annum. Rajasthan is the second biggest economy among the four states with a GSDP of INR 5121 Billion<sup>40</sup> in 2014-15. The State grew at a slower pace as compared to Uttar Pradesh

at 5.47%. Madhya Pradesh may be third

in terms of size of economy (at INR 3840 Billion); however, its average growth rate between 2012 and 2015 was a healthy 6.81%. Nagaland is the smallest economy among the four states with a GDP of INR 141 Billion in 2014-15<sup>40</sup>, and the State has observed an erratic growth pattern since 2011-12. The Figure alongside presents the GSDP growth trend observed in the four states.

In terms of the contribution of various sectors to the GSDP, the trend has remained same across the states, where bulk of the income accrues from the Services sector. In Madhya Pradesh Services sector contributes 39% of the total GSDP and in case of Nagaland the contribution of Services sector is much higher at 57%.

Figure 5: Annual GSDP growth rates for the four states



Source: RBI State Handbook 2016-17

## v. Access to basic amenities in the states

Along with understanding the socio-economic profiles of the states that have been examined in the Study, it is imperative to understand the existing status to various basic amenities in these states. This will help us develop a baseline understanding of these amenities and their access levels in these states. There is detailed analysis of these amenities in the sample size surveyed.

### a. Access to cooking fuel<sup>41</sup>

A large chunk of the households across the country are still dependent on traditional sources of fuels to meet their cooking requirement. Dependence on these traditional sources of fuel has severe implications on the indoor air pollution levels of the households and also the health of the women and children of the households. In all the four states covered in the Study, 75% to 80% are still dependent on traditional sources of cooking, thus highlighting need for an immediate intervention.

<sup>40</sup> Source: RBI Handbook for the States 2016-17. Numbers are for 2014-15 at constant prices with 2011-12 as the base

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**b. Access to electricity<sup>41</sup>**

Access to electricity has significant development linkages. Electricity not only meets the consumptive requirements of the households, but also helps meet the productive energy requirements. On an all India basis, while the electrification levels stand at about 75%; the electrification levels in our study states are much lower, with only 45% households electrified in Nagaland.

**c. Access to water facilities<sup>41</sup>**

While access to water is one of the key amenities, its access levels are currently low. In Nagaland, around 47% of the households have access to drinking water (tap supply), and in Rajasthan, around 43% have access to drinking water; but in case of the Madhya Pradesh and Uttar Pradesh the access levels are lower at 23% and 27% respectively.<sup>41</sup> Accessibility of water continues to be a concern, where less than a quarter of population in all four states have access to water within their premises.

**d. Access to sanitation<sup>41</sup>**

Access to sanitation is a major concern at an all India level, and the same is reflected in each of the four states covered in the Study. Except Nagaland, where around 17% of the households, which do not have access to any sanitation facility and defecate in open. In case of other states, this percentage is much higher – Uttar Pradesh (63%), Rajasthan (64%) and Madhya Pradesh (70%). Lack proper sanitation facility again has a substantial gender implication, wherein women need to travel long distances in the dark to defecate and there are safety implications to it.

In terms of access to basic amenities, all these states are in similar position and require systematic interventions to improve access. This report focuses on two of these amenities – cooking fuel and electricity for these four states and the role women can play in furthering reach to these amenities. It is noteworthy to mention here that these basic amenities cannot be looked in isolation, as access to one of the amenities improves; it is expected to favourably impact the other.

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<sup>41</sup> Census of India, 2011

## vi. Power Sector Scenario

### a. Power scenario at national level

**Installed Capacity and Energy Mix-** India has a total installed capacity of 327 GW<sup>42</sup> (as on April 30, 2017), which is dominated by thermal sources of power generation (~67%), followed by 17% contribution from Renewable Energy Sources (RES).

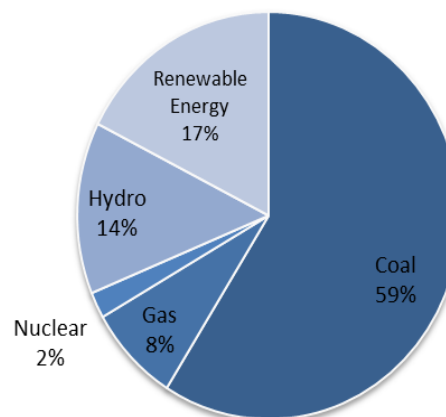
**Peak and Energy Deficit-** Energy and peak deficits in the country have significantly declined. In 2016-17 the energy deficit of the country was 0.7% and 1.6%, which translates to an energy shortage of around 7500 MUs and a peak shortage of around 2.6 GW. In the previous financial year (2015-16) the energy deficit of the country was 2.1% (about 23558 MUs) and a peak deficit of 3.2% (4.9 GW).

In line with our Central Government ambitions of 175 GW of renewable energy by 2022 and our international commitments as in the Intended Nationally Determined Contributions (INDCs) wherein by 2030, 40% of the cumulative installed capacity is targeted to be from non-fossil fuel energy resources; it is expected that bulk of the capacity addition going forward will be renewable energy based. Table below shows the resource wise existing installed against the country's potential to harness the resource.

**Table 11: Renewable Energy potential and installed capacity in India**

Renewable Energy Resource	Potential (MW)	Installed Capacity (MW)
Wind	102772	32280
SHP	19749	4380
Biomass	17536	8182
Waste to Energy	2554	130
Solar	748990	12289

**Figure 6: Installed capacity of India**



Source: CEA installed capacity report for month of April 2017)

<sup>42</sup> [http://www.cea.nic.in/reports/monthly/installedcapacity/2017/installed\\_capacity-04.pdf](http://www.cea.nic.in/reports/monthly/installedcapacity/2017/installed_capacity-04.pdf), accessed on 6th June 2017

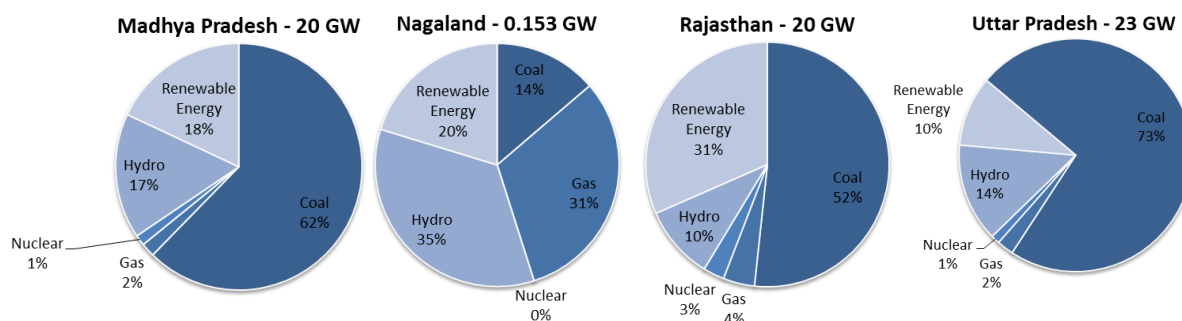


Source: MNRE Annual Report 2016-17

## b. Power scenario at State level

**Installed Capacity and Energy Mix-** The four states together have an aggregate installed capacity of close to 63 GW, accounting for more than 19% of the capacity. Within the states, Uttar Pradesh has the largest installed capacity of 23660 MW. Nagaland has a small electrical system of 153 MW, which is primarily based on hydro based generation. In the Figure below the resource wise split of the installed capacity of the four states is presented.

Figure 7: State wise installed capacity



Source: CEA, 2017

All the four states have less than 2% energy deficits, with Madhya Pradesh being surplus state a zero energy deficit. Nagaland has the highest energy deficit at 1.9% (15 MUs), followed by Uttar Pradesh at 1.7% (1869 MUs) and then Rajasthan at 0.6% (421 MUs)<sup>43</sup>. In terms of peak deficit there is still some distance to cover, especially in case of Uttar Pradesh with a peak deficit of 6.2% (1073 MW), followed by Rajasthan at 2.5% (265 MW). Madhya Pradesh has a marginal 0.1% (11 MW) and Nagaland at 0.7% (1 MW).

While the power sector infrastructure is developed in these states, access continues to be a concern. Access can be measured through two parameters (a) per capita electricity consumption and (b) household electrification rate. For both these measures, the three states Madhya Pradesh, Nagaland and Uttar Pradesh are below national averages. The Table below presents the per capita electricity consumption for the states and their household electrification levels.

Table 12: Per capita electricity consumption and household electrification level for the four states

Geography	Per capita electricity consumption (units/person)	Household electrification level (%)
Madhya Pradesh	858.1	60%
Nagaland	373.1	45%
Rajasthan	979.2	76%

<sup>43</sup> Figures for 2016-17 (Source: CEA, India)

Geography	Per capita electricity consumption (units/person)	Household electrification level (%)
Uttar Pradesh	466.2	50%
All India	901.3	75%

**Note:** Per capita electricity consumption is for 2015-16 and household electrification rate

**Source:** RBI State Handbook 2016-17 and the GARV Dashboard, Ministry of Power

Nagaland and Uttar Pradesh have particularly low levels of per capita electricity consumption, low electrification levels is one of the contributing factors for this trend. There are a number of schemes that are currently functional on ground in the four states for improving electricity access. These are schemes of both Central Government and state governments. The Box below mentions key Central Government schemes to promote rural electrification.

**Box 1: Key initiatives of Government of India (GoI) to promote rural electrification**

**24x7 Power for All Initiative** is one of the key initiatives undertaken by Government of India (GoI) in coordination with the state governments to ensure round the clock electricity supply to all households by 2019. A holistic initiative, it covers the entire electricity value chain including electricity demand, generation, transmission, distribution, renewable energy, energy efficiency and financial health of the Discoms. All states have signed agreements with GoI, detailing intervention wise targets as well as financial requirements for achieving the targets.

**Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY)** is another flagship scheme of GoI to support rural electrification. The scheme launched in July, 2015, subsumes Rajiv Gandhi Gram Vidyutikaran Yojana (RGGVY), the earlier rural electrification programme. The key components under the scheme include- feeder separation (rural households and agricultural), strengthening of sub-transmission and distribution infrastructure including metering at all levels in rural areas, Micro grid and off grid distribution network and rural electrification initiatives already sanctioned under RGGVY that are to be completed. The scheme had proposed an outlay of INR 76,000 Crores with GoI contributing grant of INR 63,000 Crores<sup>44</sup> and rest to be sourced by the states. Among other measure, performance is monitored under three heads (a) electrification of un-electrified villages; (b) intensive electrification of villages and (c) coverage of BPL households. By June 2017, the achievement against the targets for these three measures was 96%, 55% and 60% respectively.

**Source:** Executive Summary Of RE Component of DDUGJY (June 2017), <http://pib.nic.in/newsite/PrintRelease.aspx?relid=123595> accessed on 15th July 2017

Along with the central scheme mentioned above, states also have their dedicated scheme focusing on rural electrification. For instance, the Discom Apke Dwaar scheme in Rajasthan that attempts to provide electricity access to the maximum possible households in the State for which the state Discoms have

<sup>44</sup> <http://pib.nic.in/newsite/PrintRelease.aspx?relid=123595>, accessed on 2<sup>nd</sup> July 2017

organized electrification camps under the program 'Har Ghar Bijli Discom Aapke Dwaar'. Under this, nearly 2.84 lakh domestic connections (both rural and urban) were released during these camps.

The Government of Uttar Pradesh has the Dr Ram Manohar Lohia Samgra Gram Vikas Scheme, which aims to provide basic amenities in the most backward revenue villages of Uttar Pradesh. It includes the provision of rural electrification amongst other infrastructure such as sanitation, roads, safe drinking water etc. The State is also the pioneering State in India to have a dedicated Mini-grid Policy and Regulations. A snapshot of the Mini-grid Regulations of the State is presented in the Box below.

**Box 2: Snapshot of Mini-grid Renewable Energy Generation and Supply) Regulations, 2016**

- MGO can operate as a standalone system, without the grid and when the grid arrives, it could connect to the grid and feed power to it or even operate independently.
- Regulations allow flexibility to MGOs to switch between different operational models (feed/receive power from the grid or operate independently) as per their convenience.
- Uttar Pradesh Electricity Regulatory Commission (UPERC) will not regulate using the traditional tariff. Rather, it will regulate the quality of supply parameters such as assured number of supply hours or that if the household is located with 40 meters of the grid, the operator is obliged to provide the household with a connection
- Exit options are also specified in the regulations such that if the grid reaches an un-served area, the Discom and MGO can negotiate terms such that the Discom takes over the assets of the MGO and the MGO feeds power to the grid at a mutually decided feed-in tariff.

**Source: Uttar Pradesh Electricity Regulatory Commission (Mini-grid Renewable Energy Generation and Supply) Regulations, 2016**

Similar to rural electrification schemes, GoI as well as State Government have initiatives focusing specifically on women empowerment and engagement. It is relevant to understand the broad contours of these schemes to examine how RE and access related initiatives can be dovetailed in them to make them gender inclusive.

## vii. Central and State level initiatives/ schemes for women

### a. Central level initiatives/schemes for women

There are a number of schemes that are currently being implemented by GoI, which either directly impact women livelihoods or have a specific components dedicated for women. There are some energy schemes as well that have a gender perspective in them. Following are some of the policies that are currently relevant for gender livelihoods and empowerment.

**Support to Training and Empowerment Programme (STEP)** is three decades old programme of GoI, with an aim to provide skill to women to improve their capability and employability as entrepreneurs. It focuses on providing training to a group of women (200 to 10,000 in number) across sectors such as agriculture, handicrafts, dairy, etc. for trade. The programme covers skill development for both technical and soft skills.

**National Rural Employment Guarantee Scheme (NREGS)** is a flagship programme of GoI that guarantees to provide at least 100 days of wage employment in a financial year. The scheme is an

important step towards realization of right to work and to enhance people's livelihood on sustained basis, by developing the social and economic infrastructure in rural areas. The guarantee is a legal guarantee of 100 days of employment to adult members volunteering to do un-skilled labour, which if not provided within 15 days; he/she is entitled to unemployment allowance. The average ongoing number of workers in each Gram Panchayat is around 10-15. The funding done is such that 90% of the investment is borne by Centre and rest 10% by State. Women engagement has been core to the scheme and around half of the person days services are women person days.<sup>45</sup> It is noteworthy to mention here that NREGS is an employment guarantee scheme; however, skill development or developing entrepreneurship capabilities is not under the purview of the Scheme.

**National Rural Livelihoods Mission (NRLM):** NRLM, renamed as the Deen Dayal Antyodaya Yojana-National Rural Livelihoods Mission (DAY-NRLM) was launched at the national level in 2011. This programme is primarily aimed towards women from poor households and supporting them in creating sustainable livelihood options. The Mission has strong inclusive livelihood development focus. Under it, the Self Help Groups (SHGs) have been formulated, and the long term the vision of the Mission is to have at least one representation from each household under the Scheme. While identifying the households, inclusion of the marginalized is a key consideration. Marginalization is defined in terms of SC/ST, single women and women headed households, disabled, landless, migrant labour, isolated communities and communities living in remote, hilly and disturbed areas etc. Recognizing the enormity of the tasks entailed in the programme, the Mission is being implemented at the State level, through a State specific Livelihood Missions. In all the four states of the Study, the State Missions are currently operational. Key components of the NRLM are:

- **Revolving Fund** – A revolving fund (INR 15,000) is provided to SHGs (where more than 70% members are from DAY-NRLM) to encourage thrift and savings among women. This would enable them to meet credit needs in the long run and also help them to meet their immediate consumption needs.
- **Mahila Kisan Sashaktikaran Pariyojana** – Investment is made to enhance the capacities of women in agriculture and increase their participation in agriculture and allied activities.
- **Start-up Village Entrepreneurship Programme** – Support is provided to artisans and weavers in terms of business skills, exposure, loans for starting an enterprise and handholding support to such enterprises in the first six months through the NRLM SHGs
- **Deen Dayal Grameen Kaushalya Yojana** – This is aimed at scaling up the skill sets of youth and providing them livelihood opportunities.

**Trade Related Entrepreneurship Assistance and Development (TREAD) Scheme for Women:** This scheme aims for economic empowerment of women, especially in the rural areas, through trade related training, information and counselling extension activities related to trades, products, services etc. Credit is provided to NGOs who will facilitate loan disbursement to women and counsel them to set up enterprises.

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<sup>45</sup> [http://mnregaweb4.nic.in/netnrega/all\\_lv1\\_details\\_dashboard\\_new.aspx](http://mnregaweb4.nic.in/netnrega/all_lv1_details_dashboard_new.aspx) accessed on 16<sup>th</sup> July 2017

Government grant up to 30% of the total project cost and 70% as loan assistance is provided to applicant women, who have no easy access to credit from banks due to their cumbersome procedures.

**Pradhan Mantri Ujjawala Yojana (PMUY)<sup>46</sup>:** This GoI scheme was introduced to provide Liquefied Petroleum Gas (LPG) connections to BPL households. The intent of the scheme is to support the BPL households move away from traditional sources of cooking – firewood, crop residue etc. – to modern fuels for cooking – LPG. The scheme is gender inclusive as the connections are issued in the name of the women of the households. Under it, the GoI bears the total cost (INR 1600) of a new connection on behalf of the beneficiary. Further, the beneficiary may make payments for refill, etc. through Equal Monthly Instalments (EMIs).

**Pradhan Mantri Awaas Yojana – Grameen (PMAY-G)** is aimed at providing pucca house, with basic amenities to all houseless families and to those, who live in kuccha and dilapidated house, by the year 2022. Also, other schemes for construction of toilets, MGNREGA for employment, access to safe drinking water under National Rural Drinking Water Programme, DDUGJY for electricity connection, with MNRE for Solar Lanterns, SHLS, benefits from National Bio-Mass Cook stoves Programme, LPG connections under PMUY, have also been converged with this scheme to allow for holistic development for backward community. One of the parameters for allocation of households is to ensure that the marginalized are well represented, which include female headed households. For developing the employment opportunities also skills development of women masons and sensitization of the existing masons and other labourers on inclusion of women in these activities is part of the Scheme.

**Gender Budgeting** is a tool adopted by Central Government or some state governments including Madhya Pradesh, aims to mainstream gender into current policy and programme formulation. A separate classification for women is introduced under the gender budgeting to tackle gender imbalances, promote gender equality and development. Three of our four Study states have adopted gender budgeting – Madhya Pradesh, Rajasthan and Uttar Pradesh. While Madhya Pradesh has made progressing in adopting gender budgeting, in Uttar Pradesh the progress has been rather slow.

## **b. State level initiatives/schemes for women**

Each of the four states under the Study has specific interventions focused towards women. Some of these schemes are presented below:

### ***Madhya Pradesh***

**Madhya Pradesh Women Finance and Development Corporation<sup>47</sup>** was established to improve economic condition and provide social empowerment of women and to make them self-dependent and self-reliant. Under this department, various plans have been executed such as:

- **Mamatva Mela** is an annual event of the celebrated by the Madhya Pradesh Women Finance and Development Corporation, in which various products made by women SHGs, rural/ urban women entrepreneurs, are demonstrated and sold.

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<sup>46</sup> <http://pib.nic.in/newsite/PrintRelease.aspx?relid=137647>, accessed on 12<sup>th</sup> July, 2017

<sup>47</sup> <http://www.mpwcd.nic.in/en/inst-gov> accessed on 10<sup>th</sup> June 2017

- **Haat Bazar Operating Plan** at the district level was launched in 1999 to make market available to products prepared by women and to launch products prepared by women SHGs and women entrepreneurs of rural areas. It was aimed to empower the rural women to fully utilize different economic, social and political opportunities for their development. This program is based on the Madhya Pradesh Government's policy for women and their experience of empowerment through SHGs. The program is being implemented with the support of International Fund For Agriculture Development (IFAD) in the State and is being operated in six (6) districts - Panna, Chhatarpur, Tikamgarh, Dindori, Mandla and Balaghat. The ground for the selection of these districts is plurality of tribal, widespread poverty and inequality in the status of women. The objective if this scheme is to:
  - Develop SHGs having strong and consistent growth,
  - Connect these groups and institutions to microfinance facilities,
  - Strengthen these groups to make better livelihood opportunities and utilizing them,
  - Strengthen these groups for social justice and development activities, such as education, full participation in panchayats and elimination of violence and crime against women.
- **Joint Liability Groups (JLGs)** is for financing the rural poor through the JLG mode is another tool available with the banks for providing loans to the small/marginal/tenant farmers, share croppers etc. It enables the banks to reach the farmers through a group approach, adopt cluster approach, and facilitate peer education and credit discipline. As against a target for linking 40,000 JLGs during 2014-15, the achievement was around 42,100 for the year 2015-16.
- **Mahila e-Haat** is a unique online platform where women participants can display their products. It is an initiative for women across the country as a part of 'Digital India' where women members of the SHGs can register with this portal free of cost and can sell their products. With the launch of the site, it is envisaged that more than 1.2Lac women are likely to benefit.
- **Participation of women in agriculture (Kisan Didi training program)** - The scheme has been launched in 2007 for ensuring women's participation in agriculture under the 11<sup>th</sup> five year plan of Madhya Pradesh. The women are imbued with leadership qualities and trained by science extension activists and farmers to work efficiently in the field of agriculture. Apart from helping women farmers in understanding and acquiring lost cost technologies, general agricultural systems are also made available to them. Through this program the women farmers are being fully informed about ways to improve and maintain their agricultural crop yield through training tours, group formations and formation of women cultivation groups.
- **Mukhiya Mantri Majdoor Suraksha Yojana** will provide financial aid to nearly 3 Million landless agricultural workers in the State. Under the scheme, women labourers receive benefits like payment of maternity expenses and wages for six weeks, whereas men get two weeks wages during paternity leave. The scheme also includes scholarships to wards of labourers from class 1 to post-graduation.



## **Nagaland**

In order to advance empowerment of women, the Government of Nagaland (GoN) adopted gender budgeting in the year 2009 and institutionalization of women SHGs promoted as part of various schemes. For example, during 2015-16, as part of the Pradhan Mantri Krishi Sinchayee Yojana, 182 SHGs were formed in the State. Similarly, as part of the state government's "Women in Agriculture" programme, 40 SHGs comprising 703 farm women were formed in the districts of Wokha, Zunheboto, Longleng and Mon. Also, as part of the Rural Backyard Poultry, 20 % all beneficiaries were women. In order to advance skill development opportunities for women, an ITI exclusively for women has been recently established in Dimapur. Similarly, as part of the **"Promotion of Women in Innovative Enterprises programme"**, interest-free loan of INR 0.5 Million per beneficiary was provided to 38 women entrepreneurs. State government also supports 3000 destitute women and in 2015-2016, INR 7.2 Million was sanctioned for this purpose. Further, government has set-up Women Resource Centres (WRC) at Mokokchung and Phek districts, which provide room for various programmes for learning new skills, marketing complex for women entrepreneurs irrespective of their enterprise, etc.

The Department of Rural Development, GoN is implementing eight major programmes which are directed towards upliftment of communities living in rural areas<sup>48</sup>. Most of the development schemes are implemented through the Village Development Board (VDB). On allocation of funds, VDBs identify relevant schemes based on priorities in the region. Local governance structures have an important role to play in implementation of schemes including those focusing on rural development, electricity supply and women empowerment.

## **Rajasthan**

- **Guru Golvalkar Janbhagidari Vikas Yojana (GGJVY):** The objective of the scheme is to ensure public participation in rural areas for development, employment generation, construction and maintenance of community assets. The scheme is funded by the State and is being implemented in the rural areas of the State only. During the year 2016-17, INR 830 Million have been spent and 706 works have been completed up to December 2016
- **Magra Area Development Programme (MADP):** To improve social and economic status of residents, the "Magra Area Development Programme" was initiated since 2005-06 in 14 Blocks and 5 districts in Rajasthan. During the year 2016-17, an allocation of INR 500 Million has been earmarked, against which, INR 25.93 Million have been spent and 552 works have been completed up to December 2016.
- **Rajasthan Grameen Ajeevika Vikas Parishad (RGAVP)** is an autonomous body formed under GoR that implements rural livelihood programmes associated with SHGs based institutional architecture. The key initiatives take up under projects undertaken by RAJEEVIKA include – institution building, capacity building, financial inclusion, livelihood intervention and convergence.

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<sup>48</sup> Department of Rural development, Government of Nagaland (GoN). <http://nagard.nic.in/schemes.aspx> accessed on 23<sup>rd</sup> June, 2017



- **Co-operative credit structure** - At present, there are 29 Central Cooperative Banks, 21 Milk Unions, 37 Upbhokta Wholesale Bhandars, 36 Primary Land Development Banks, 6,485 Primary Agriculture Credit Co-operative Societies and 268 Marketing Fruit and Vegetable Societies in the State. For the empowerment of women in rural areas, cooperative societies are playing an important role. Approximately 4,000 women cooperative societies have been formed by co-operative department. During 2016-17, INR 1.5 Million has been provided as financial assistance to women cooperative societies.<sup>9</sup> Rajasthan Rajya Sahkari Upbhokta Sangh Ltd and District Wholesale Consumer Cooperative Stores have opened 19 Mahila Uphaar Super Stores and organic marketing stores in Jaipur, Udaipur, Jodhpur and Kota districts. These stores are run and managed entirely by women.
- **Women Development Credit Scheme:** Land Development Banks through Women Development Credit Scheme are creating sources of income for women by providing loan of INR 50,000 for non-agricultural and dairy business through guarantee of 2 persons, even without security on agricultural land. In 2016-17, loans worth INR 213 Million were distributed to 965 women;

### ***Uttar Pradesh***

- **Women Policy, 2006:** This policy was formulated by Government of Uttar Pradesh (GoUP) in 2006 and it provides broad directions for the initiatives towards welfare of women and schemes for their social and economic empowerment. The Policy also brought out the need for adopting gender budgeting and highlighted the strengthening of SHGs.
- **Mahila Udyami Protsahan Yojana:** This is a State scheme launched by GoUP under the Infrastructure and Investment Promotion Policy, 2012. The scheme is aimed at greater participation of educated women in the industrial sector, especially those that have passed intermediate level exam (Class 12). Under this scheme a subsidy on the interest of loan, taken by women entrepreneurs, at 5% subject to a maximum of INR 50,000 per unit per year is provided to them.

Thus, from above, it emerges that there are a number of GoI and Study states have a number level schemes where women engagement, empowerment and their livelihoods is either core part or one of the components for the scheme. The role women can play in economic development is well recognised and also the areas of support they require to develop are covered as part of various schemes. The Table below provides a brief summary.

**Table 13: Summary of key state and central policies**

Scheme Name				Parameter						
Central or State schemes	Focus on marginalized section	Women empowerment	Financial inclusion	Improved interventions		Women employment/ livelihood	Market linkage	Training, Capacity building and awareness	Promotion of RE products	Rural development
				Cooking	Lighting					
Central level schemes										
MGNREGA (Ministry of Rural Development)	✓	✓	✓			✓				✓
PMAY-G (Ministry of Rural Development)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMUY (Ministry of Petroleum and Natural Gas)	✓	✓	✓	✓			✓			✓
Mahila e-Haat (MoWCD)	✓	✓				✓	✓	✓		
NRLM (Ministry of Rural Development, implemented through	✓		✓			✓.	✓	✓.		✓

Scheme Name		Parameter								
Central or State schemes	Focus on marginalized section	Women empowerment	Financial inclusion	Improved interventions		Women employment/ livelihood	Market linkage	Training, Capacity building and awareness	Promotion of RE products	Rural development
				Cooking	Lighting					
<b>District Rural Development Agencies and funded by Ministry of Rural Development)</b>										
<b>Support to Training and Employment Programme for Women (STEP)</b>		✓				✓		✓		✓
<b>DDUGJY (Ministry of Power)</b>					✓				✓	✓
<b>Trade Related Entrepreneurship Assistance and Development (TREAD) Scheme for Women</b>	✓	✓	✓			✓		✓		
<b>State level schemes</b>										

Scheme Name				Parameter						
Central or State schemes	Focus on marginalized section	Women empowerment	Financial inclusion	Improved interventions		Women employment/ livelihood	Market linkage	Training, Capacity building and awareness	Promotion of RE products	Rural development
				Cooking	Lighting					
Mamatva Mela (GoMP – Women and Child Development Department)		✓				✓	✓			
Haat Bazaar Operating Plan (GoMP – Women and Child Development Department)			✓			✓	✓			
Tejaswini Rural Women Empowerment Program (GoMP - MP Mahila Vitta Evam Vikas Nigam)		✓	✓			✓	✓	✓		✓
CM Awas Yojana (Panchayat and Rural Development)	✓		✓							✓

Scheme Name		Parameter								
Central or State schemes	Focus on marginalized section	Women empowerment	Financial inclusion	Improved interventions		Women employment/ livelihood	Market linkage	Training, Capacity building and awareness	Promotion of RE products	Rural development
				Cooking	Lighting					
<b>Department, GoMP)</b>										
<b>Mahila Udyami Protsahan Yojana (GoUP)</b>		✓	✓			✓				
<b>Guru Golvalkar Janbhagidari Vikas Yojana (GoR)</b>	✓									✓
<b>Rajasthan Grameen Aajeevika Vikas Parishad (RGAVP)</b>		✓	✓				✓	✓		✓

Of the schemes mentioned above, there are a number of schemes, which can be leveraged to support women empowerment along with capacity development as well as respective sector development. For instance, the MGNREGA of Ministry of Rural Development can be seen as a measure for women engagement through assured employment for 100 days in a year. Schemes such as STEP and TREAD create a facilitative environment for capacity development of women, who can then engage in different livelihood options. NRLM is another policy, which along with its state mission chapters can be helpful on setting up SHGs that can be an employment oriented or support in financial linkages to support the members gain access to finance. SHGs can be delved into deeper as a preferred institutional structure for developing a pilot supporting engagement of women in energy centric business focusing on increasing reach of RE products in rural areas. This is discussed in the last chapter of the Report.



## Chapter Summary: Key highlights

- a. The four states covered in the study consist of the most populous states of India home to about 343 Million, about 28% of the total population. All the states have a substantial rural population with a share of more than 70%.
- b. In terms of poverty, Rajasthan performed the best with around 15% BPL population followed by Nagaland (19%). UP and MP were the worst performing states with 30% and 32% BPL population respectively.
- c. In all the four states, 75-80% of the population is dependent on traditional sources of fuel for cooking such as firewood, dung cakes, crop residues etc. In terms of access to electricity, while the all India electrification rate stands at 75%, the electrification levels are much lower in the study states, with only 45% electrification in Nagaland.
- d. Uttar Pradesh, Madhya Pradesh and Rajasthan have similar installed capacities ranging between 20-23 GW. Nagaland has the lowest installed capacity of less than one 1 GW.
- e. There are several Central and State schemes for promoting energy access in all the four states including the Ujjwala Scheme for LPG connections. Further, UP is the first state to release a Mini-grid Policy and Mini-grid Regulations in 2016 which promotes different operational models for Mini-grid Operators (MGOs) such as grid feed and independent operation.
- f. At the same time, there are many schemes promoting livelihoods and entrepreneurship at both the Central and State level. The most notable Central schemes are STEP, NRLM and TREAD Scheme. STEP is a three decades old programme of GoI, with an aim to provide skill to women to improve their capability and employability as entrepreneurs. NRLM is a very large programme with multiple components, where setting up of SHGs and village entrepreneurship schemes are most important in terms of promoting women entrepreneurship. TREAD scheme focusses on the assistance to women through training and capacity building and facilitating access to finance.
- g. In terms of State level schemes promoting women entrepreneurship and livelihoods, some states such as MP and Nagaland have been more pro-active than others by instituting more number of programmes targeting women. For example programme targeting women farmers (Kisan Didi Training Programme – MP), Promotion of Women in Innovative Enterprises (Nagaland).
- h. Gender budgeting has been adopted by most of the states. However, in terms of practical implementation, UP lags far behind as gender budgeting has not been implemented in the state.

# Socio Economic Profile of Respondents and Survey Findings



## Chapter contents

This Chapter presents socio economic profile of the respondents across the four states and discusses the key findings of the survey



## i. Socio-economic profile of the sample

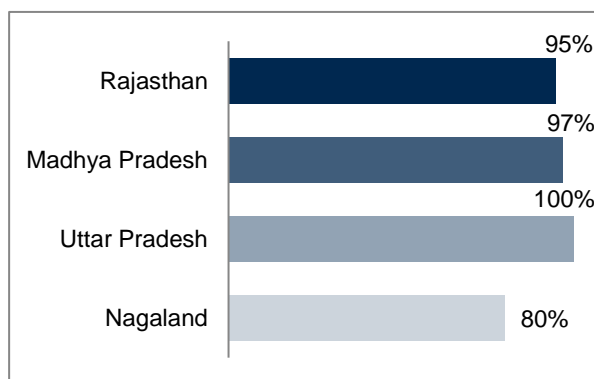
In this section we discuss the socio-economic profile of the respondents of the Survey. Subsequently the survey findings for RE awareness, WtP and ownership are also discussed.

### a. Survey Participants

As discussed in the methodology section, the sample for all four study states namely Madhya Pradesh, Nagaland, Rajasthan and Uttar Pradesh, had been selected such that the marginalized section of the population is well represented with a focus on female participants. The same is represented in the Figure alongside, which highlights that most of the respondents for the 1600+ households were women.

The second parameter for representing marginalized population was inclusion of SC/ST and OBC population and our sample was well represented in terms of this (see Figure alongside).

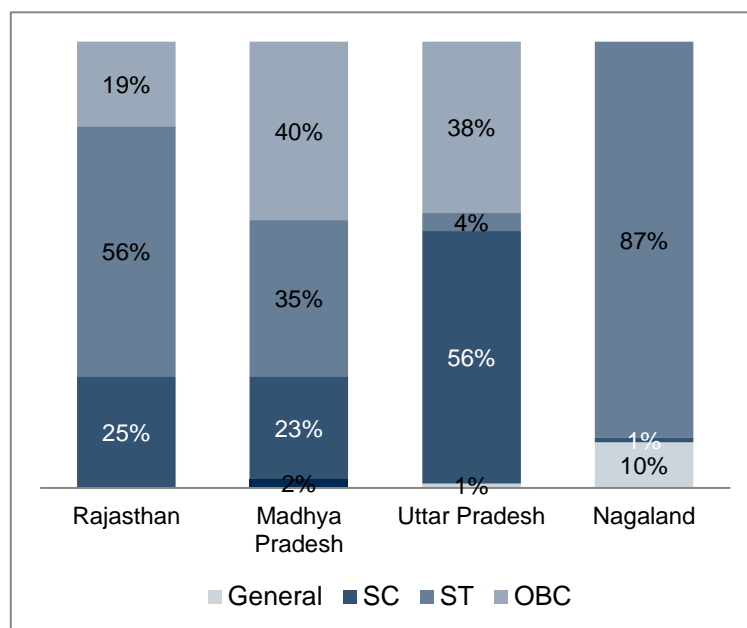
**Figure 8: Female Participation in the Survey**

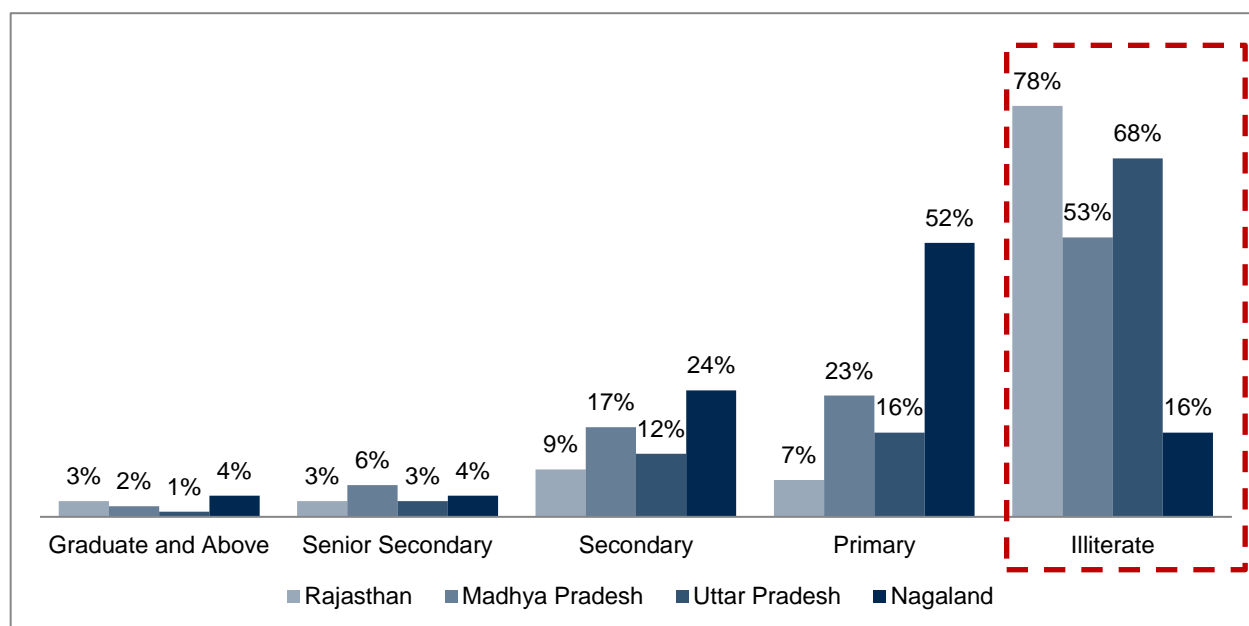


**Figure 9: Caste wise distribution of the Respondent**

### b. Literacy level of the respondents

Literacy level of the respondents is a critical parameter as it has direct relation with livelihood option, income and expenditure, savings etc. The literacy level of the sample was categorized into - illiterate, primary (Class 1 to 5), secondary (Class 5 to 10), senior secondary (Class 11 and 12), and graduation and above. The literacy level of the respondents is presented below.

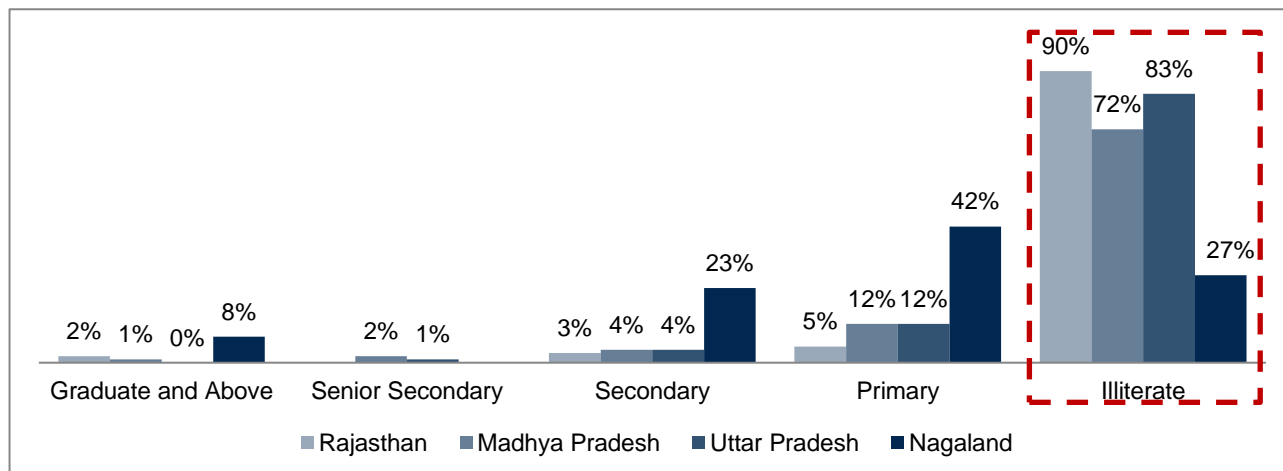


**Figure 10: Literacy level of all the respondents**


It was found that the incidence of illiteracy in all the selected villages of the four states was high (except Nagaland). Rajasthan and Uttar Pradesh have a higher incidence of illiteracy as compared to the national average of 70%<sup>49</sup> whereas Nagaland, comparatively, has performed better on this parameter by containing illiteracy levels to close to 16%. Further, it was observed that the literacy rate in female headed households is lower in all the four states (figure below) as compared to overall literacy rate of these states. In all the four states, small proportions of respondents have pursued education beyond secondary school. It was observed that (a) higher preference to employment opportunities and (b) lack of school infrastructure were the key reasons reported in survey for discontinuing education. This can be attributed to the fact that the selected respondents belonged to poor/marginalized households (monthly expenditure less than INR 5,000) and employed in agriculture and allied activities.

<sup>49</sup> Census 2011

**Figure 11: Literacy level of female headed households**



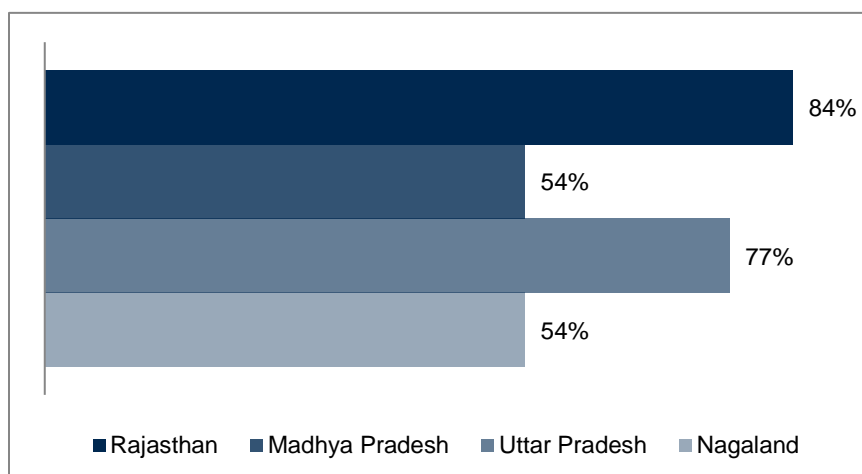
In terms of literacy level, an encouraging trend that was observed across the four states was that increasing number of girls were being sent to school. For instance in Rajasthan, in all the villages where the survey was conducted, it was observed that there were schools to cater to the educational requirements of the village. Moreover, during FGDs it was mentioned and observed, that for the younger generation, the push to be educated was higher, and hence, majority of the younger girls were educated as compared to the older generation. The older generation had limited access to infrastructure that limited their options for education, but its importance of has now been recognized and younger generation, including girls are being educated.

However, in Madhya Pradesh the challenge of lack of school in the vicinity was reported, severely impacting participation of the girl child at school. Another observation, were the high dropout rates of children in search of job opportunities. Finally, it was observed that a preference is given to the boys as compared to the girls due to variety of reasons including financial constraints, responsibility of girl child towards household jobs, etc.

### c. Livelihood

**Figure 12: Percentage of respondents dependent on agriculture sector for livelihood**

Sample covered across the four states were engaged in agriculture and related activities (Figure alongside). About 84% respondents in Rajasthan were engaged in agriculture sector (50.5% were engaged in agriculture sector and 33.6% were agri-labours). Similarly in Madhya Pradesh 54% households were dependent on agriculture/agri-labour. On the other hand, in



Uttar Pradesh, 77% respondents were primarily engaged in agriculture industry and 23% in service sectors. Similar to Madhya Pradesh, 54% respondents in Nagaland also reported that agriculture as their primary source of income whereas 19% of them were engaged in service industry.

#### **d. Status of Women Employment**

Majority of the women were either home makers or were working on agriculture fields as agri- labourers. In Rajasthan, among the female respondents, about 88% were homemakers of which about 52% were also involved in agriculture related activities. The agriculture related activities included assistance at farm land, where the household owns land, and, agri-labour, in case of landless households and cattle rearing. The work done by women involved in agriculture and related activities mostly remained unpaid, unrecognized or undervalued. Apart from agro related employment, very few women were found to be involved in other productive activities. Only about 2% of the respondents were involved in MSMEs.

Likewise in Uttar Pradesh, about 87% female respondents are homemakers. Some of them were agri-labourers or worked in the factories in the vicinity. The Forest Department also employed the women and paid INR 50-100 for labour. In a few villages, young girls and young women were found to be engaged in pickle making and embroidery.

As compared to Rajasthan and Uttar Pradesh, females as homemakers are relatively less in Madhya Pradesh at about 65%. Out of the total respondents, about 13% are engaged in agriculture sector as well. Nagaland has least amount of homemakers with only 13% respondents. About 61% are engaged in agriculture sector.

As can be seen from above, majority of the female respondents were homemakers or were engaged in agriculture as agri – labourers. In both the cases the contribution of the women to the economic value creation is unrecognized, underreported and undervalued, especially in case of homemakers. Agri-labourers was a seasonal occupation and the intermittent nature of the income adds to economic insecurity of the respondents.

Nagaland is an exception as compared to the other states, where the engagement of women is more proactive. The women engaged in the agriculture sector, and they lead the marketing of the produce, which is key monetary activity in the agriculture value chain. Weaving is natural skill in Nagaland, and women know it, but very few practice it commercially.

#### **e. Expenditure Levels of Respondents**

The monthly expenditure is a function of income generated. Based on the interaction with respondents, it was reported that 96% of the households have expenditure higher than INR 1,500 per month in Rajasthan. As compared to Rajasthan, almost half of households in Madhya Pradesh (54%) have the household expenditure higher than INR 1,500 per month. In Uttar Pradesh, three of the five districts, had monthly expenditures less than INR 5,000. Except Lucknow, none of the other districts had households with monthly expenditure greater than INR 15,000. Lucknow is the State's capital and an urban hub therefore the spending patterns in these villages reflect those of peri-urban households. Moreover, we found that over half of the households engaged in primary occupations have expenditures below INR 5,000 and more than 55% of those engaged in tertiary activities have an expenditure ranging between INR 5,000 – INR 10,000. In Nagaland, 75% of the respondents reported their monthly expenditure to be more than INR 1500.

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#### **f. Access to cooking energy**

The majority of the respondents in Rajasthan are heavily dependent on firewood as a source of cooking fuel for their traditional mud chulhas. In Rajasthan it was seen that households had two chulhas – one inside the house and sector located outside the house on the front stoop. The one inside the house was used in the morning, and the outside one was usually used in the evening<sup>50</sup> as that was the time for the women to interact socially. Over 96% of respondents use firewood for cooking (63% use only firewood stoves, while 34% use it in combination with LPG and kerosene stoves). Dependence on firewood continues despite ownership of LPG, which is used sparingly, usually during emergencies or to make tea. A little more than 1% of the respondents are dependent only on LPG as a source of fuel. More than 20 kgs of firewood is used per month by 89% households. Over 62% of the respondents purchase firewood over and above the firewood they collect from neighbouring forests and scrubland. Around 88% of respondents spent more than two hours- a- day in collecting firewood. This reduces their productive time during the day, which has an opportunity cost associated with it.

In Madhya Pradesh, all the 508 survey respondents had mud chulhas in their house. About 67% of them solely depended on mud chulha for cooking purpose, whereas about 30% households also had LPG connection and a little more than 1% of the respondents have access to biogas. More than 55% of the households consume over 20 kgs of firewood monthly and about 10% respondents said that they buy firewood. Around 60% respondents spent about 1-2 hours in firewood collection and about 80% spent 30 minutes to 2 hours in processing the firewood.

Similarly in Uttar Pradesh, firewood is still a dominant fuel for cooking in rural areas and the same is evident from our sample survey. Over 95% of households use firewood for cooking and more than 70% used 150-250 kgs of firewood per month. Around 70% use only mud chulhas, while 23% use mud chulhas with LPG. Of those using mud chulhas, only 15% were female headed. Households used firewood, dung cakes and crop residue for cooking food in mud chulhas. While majority use dung cakes free of cost (62% have livestock), dung cakes are also bought in some districts such as Varanasi, Bhadohi, Lucknow etc. About 60% of the population purchased firewood from the market. LPG was exclusively used for cooking only by 6% of the sample. The rest used biogas and mud chulhas in combination with induction stove or kerosene.

In Nagaland, 68% of the participating households reported that their primary reliance was on traditional mud stove for cooking. Out of these, 38 % of them also reported usage of LPG as a secondary cooking fuel. The remaining 62% households reported complete reliance on only the traditional cook stoves. Similarly, in the study villages, a total of 21% households reported primary reliance on LPG as cooking fuel. Analysis of survey data revealed that, 61% households collect firewood and 37% households buy firewood. Also, the households reported consumption of (1.5 — 4) tonnes of firewood per year, depending upon family size and thermal requirements. The traditional chulha used in Nagaland is different from that used in the other states. Firewood was not only used for cooking, but also, it is community and family activity, wherein the people come together around a firewood fire.

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<sup>50</sup> Depending on weather conditions

## g. Access to Water

In Rajasthan, almost all the respondents were dependent on a single source of potable water, and a third of these depended on government hand pumps and tube wells, and only 26% relied on rivers or ponds. The respondents were not satisfied with the state of water supply and this was one of the major issues raised during the FGDs in each of the sixteen villages surveyed. The issue was not only with the quantity but also with the quality of water, which was reported to be almost undrinkable in certain areas such as Kelnor village in the Chohtan block of Barmer district. In Madhya Pradesh, about 48% of the respondents had access to drinking water through Government hand pump/tubewell. Wells and government water supply were other sources of potable drinking water.

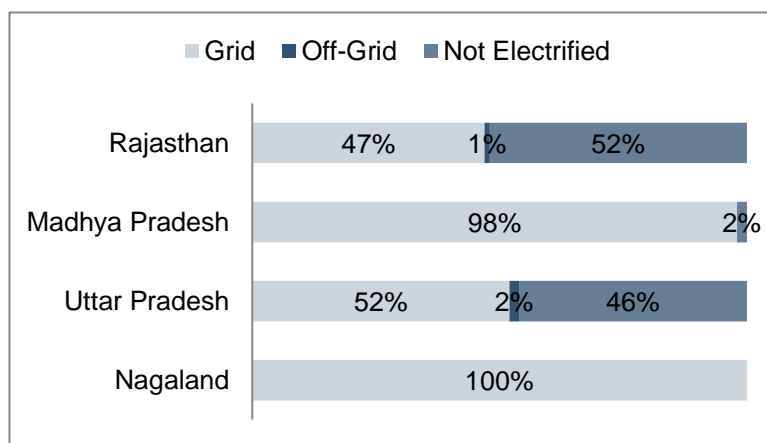
Unlike Madhya Pradesh, in Uttar Pradesh it was found that over 40% of the respondents had their own hand pumps for potable water supply and other household purposes. An almost equal share of respondents reported using the government installed hand pumps. A small proportion went to the rivers or ponds for collecting water. Collection of water, similar to firewood collection is a source of drudgery for women in rural areas. In Nagaland, majority of the women mentioned about ease of access to potable water during the FGDs conducted in the village. In Phek district, all villages were reported to have state government funded community water supply system at a central location. In addition, piped water supply was provided by the village council. Unlike Phek, in Dimapur district, every household had an individual well. In Dimapur, community tanks have been setup in villages. Also, households that do not have their own well can draw water from neighbour's well, which indicates a strong cohesion among villagers. Provisions for access to potable water were present in all villages except Socunoma.

## h. Electrification Status

### Access to Electricity

Figure 13: Access to Electricity

Electricity is considered as one of the basic necessities for any household, which helps in undertaking daily household activities and also supports economic activities. From the perspective of the Study, electrification status is a key metric to understand the access levels and the market for RE products. The respondents were inquired on the status of electrification of their households. It was reported in



Rajasthan that only 48% respondents have access to electricity with 47% of them being grid connected and 1% using off grid electricity sources. Around 66% of the households that were without access to electricity were dependent on kerosene for their lighting needs.

In terms of spending on grid based power, it was seen that about 34% households that had access to electricity spent less than INR 500 per month and about 42% households with access to electricity spent between INR 500-1000 per month on electricity. A plausible reason for such high expenditure on

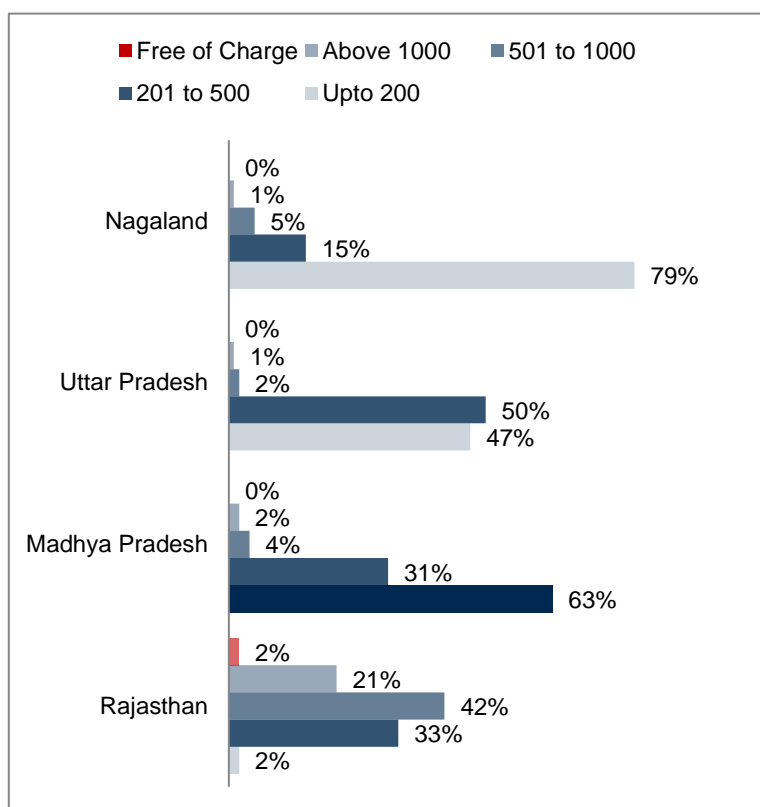
electricity could be that in select areas the ST community of the sample survey was economically empowered.

In Madhya Pradesh, it was observed that about 98% households are grid connected. These villages received more than 18 hours of electricity supply. During the power cuts the households relied on kerosene for lighting purpose. About 94% households reported that their monthly electricity expenditure is less than INR 500.<sup>51</sup> The outages were usually more during the monsoon season. Another reason for an outage was in case of a DT failure, the outage could last as long as ten days as that was the time taken for replacement of the DT.

About 45% respondents were connected through grid in Uttar Pradesh and received electricity from 11 to 18 hours a day. About 5% households had access to off grid sources and 49% households had no access to electricity. About 78% households that did not have access to electricity reportedly used kerosene as their primary source of lighting. About 97% of the 237 respondents who provided the information about the monthly electricity expenditure reported spending of less than INR 500 per month on electricity.

Figure 14: Average Expenditure on electricity

In Nagaland, all the households in the selected villages were grid connected and reported the availability of electricity for more than 20 hours a day. However, one village namely Socunoma has only 15 plus hours of power cut and the residents used candles or kerosene lamps for lighting purpose during those hours. Also, economically under-privileged residents of Phek village use pinewood for lighting purpose. It was also observed that the villages had a robust institutional mechanism for electricity bill collection wherein the Village Council collected the payments from the households for the State Electricity Board. It was reported by 71% of the respondents spent less than INR 200 per month on electricity in the villages.



### Awareness of RE

Awareness about RE again is an important parameter to understand as it has a bearing on the willingness to pay for the product. Also, it is important to understand the means through which the awareness is generated across the four states. Such an insight will be useful in planning RE Product communication strategy for marginalized households.

<sup>51</sup> Most of the respondents reported that their monthly expenditure is in the range of INR 280 to 290 per month

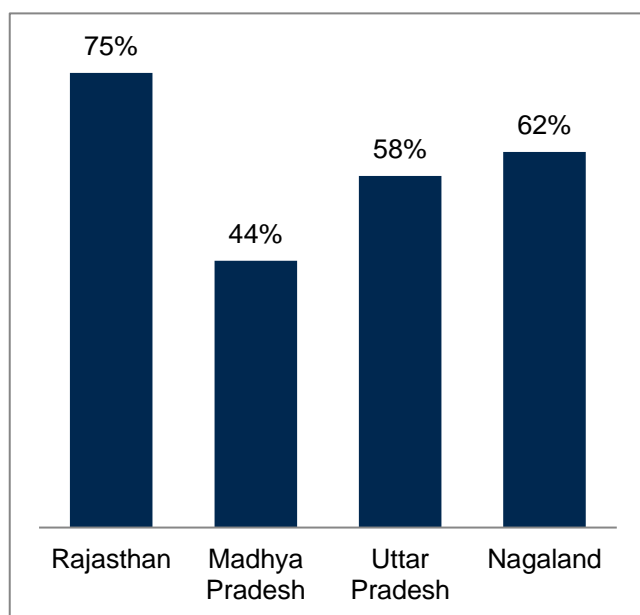


On an overall basis, the RE awareness level was close to 58% across the four states, however, across the states, the awareness levels varied substantially.

The RE awareness levels was the highest in Rajasthan with 75% of respondents being aware of at least one RE product. The key contributing factor for high awareness level was the proliferation of RE at Gram Panchayat and Block headquarters. Also, a few years back, Solar Lanterns were distributed in these areas free of cost. Use of RE products by gram panchayats and word of mouth by friends/neighbours/family was the most cited mode of awareness (88% of the respondents). Respondents belonging to ST, SC and OBC categories were more dependent on informal channels of RE awareness than respondents from the general category. This was also true for illiterate respondents as compared to literate ones. This highlights that the awareness campaigns that were literacy agnostic (not based on written content) had a higher impact with the marginalized communities.

The products with the highest levels of awareness were Solar Lanterns, SHLS, solar pumps and improved cook stoves. The RE products with the highest level of awareness also happen to be the same ones for which WtP assessment was possible, which is critical to the validity of the results of the WtP assessment. It was also observed that awareness of RE is not being generated through formal channels, which could be due to the illiteracy and marginalization of the respondent. The level of awareness was also found to be quite high on account of solar street lights and rooftop solar installations on government buildings.

**Figure 15: RE Awareness Level of Respondents**



In contrast to Rajasthan, awareness level of RE was relatively low in Madhya Pradesh. More than half of the respondent (about 56%) respondents were not aware of the RE products or services. For those who were aware of RE, the mode was their social circle such as friends, family, relatives or neighbours. TV/Radio also had an important role to play when it came to spreading awareness, as about 30% of respondents cited their source of awareness as TV/Radio. In Madhya Pradesh the migrating labour also reported seeing RE installation in Gujarat, consequent to which they were aware of the RE products. The high level of electrification could be one of the reasons of low level of RE awareness seen in Madhya Pradesh.

Gram Panchayat and Gram Sabha also offer one of the modes of spreading awareness to the villagers. Since, over 75% of the respondents were either illiterate or were able to get education till primary; hence newspapers could contribute in only about 3% for awareness. It has been observed that only 27% of illiterate respondents were aware about RE products and services. With increase in literacy level, the level of awareness increased in Madhya Pradesh, given that awareness penetration increased from 57% to 82% for respondents who had received education till primary level to the respondents who were graduates and above. Based on the discussion with participants during FGDs, it was observed that women were aware about RE products and services such as solar street lights, solar pumps installed in the nearby areas, however awareness about household RE products was limited. The survey team explained the benefits of

various products, including Solar Lanterns and SHLS, post which women did shown interest in purchasing Solar Lanterns and solar lights to help them with light when electricity is not available from the grid. Utility for these products was seen especially for uninterrupted light for children in the household to study in the night or for cooking in the household in the night, even in case of a power outage or a DT failure. In case of the latter, the outages lasted for as long as ten days and in such circumstances the utility of the RE products were immense.

In Uttar Pradesh, 58% of the respondents were aware about RE products and services; however the awareness was limited to Solar Lanterns and SHLS. In one village in Uttar Pradesh - Jayapur village in Varanasi were getting power supply from Mini-grid installed in the village. The box below presents a snapshot of the Jayapur Mini-grid.

#### **Box 3: Mini-grid in Village Jayapur, Varanasi**

Village Jayapur in Varanasi District has a 25 kW Mini-grid, set up by Uttar Pradesh New & Renewable Energy Development Agency (UPNEDA) in association with a private company. It has been set up under the Model village or the *Saansad Aadarsh Gram Yojana (SAANJHI)*. The village was adopted by Prime Minister Narendra Modi. The Mini-grid is a subsidised project and the villagers pay INR 20 per month for the O&M of the plant, though the power supply is free. The electricity is used for powering bulbs and mobile charging points by the villagers. Supply is given from 6 pm till early morning

As seen in other states, the main source of awareness for RE products in the state was family/friends and relatives followed by live demonstrations, again reinstating the point that RE awareness can be created without literacy being a key parameter. TV and Gram Panchayats or Gram Sabhas were other sources through which respondents had heard about RE systems.

In Nagaland also, there was a good level of RE awareness with 62% households confirming their awareness about RE products in Nagaland. However, awareness was largely restricted to Solar Lanterns, SHLS and street lights – all being consumptive uses of RE. In addition, farming communities in the mountainous regions used an indigenous technology for irrigation — hydroger. As literacy levels were high on an overall basis in Nagaland only 15% of the respondents, who were aware of RE products were illiterate and 25% of the respondents were educated till secondary. As shared by majority of the respondents, friends, relatives and government agencies have been major sources for awareness generation on renewables. Given that that most of the respondents were literate (unlike the other states), but the preferred source for awareness generation is same, highlighting a clear preference that people have for accessing information regarding RE products.

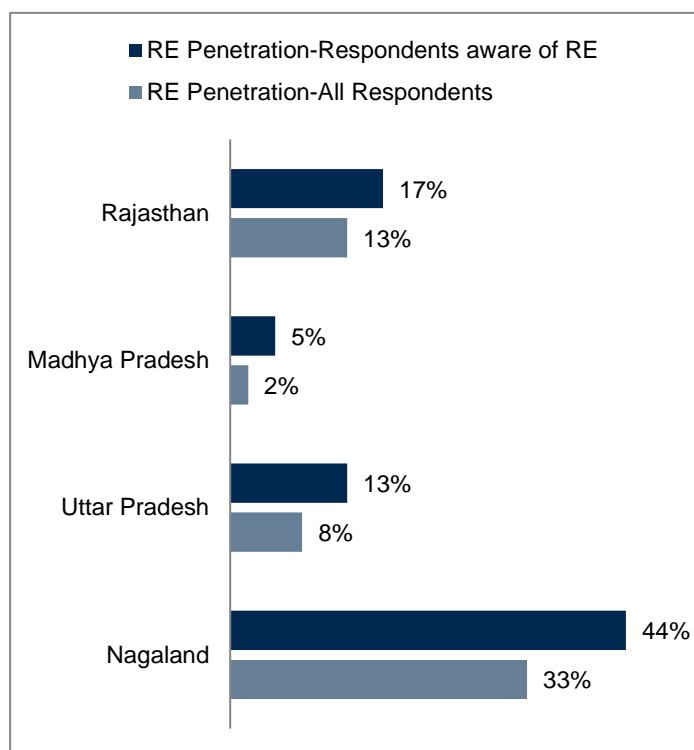
#### **Penetration of RE**

In Rajasthan, the penetration level of RE products was about 13%. Even though awareness of RE was high, it was not accompanied by a high access to RE products. Only 17% of the respondents who were aware of RE were found to be using RE products. In terms of usage, around 92% of RE users reported using Solar Lanterns and it had the highest penetration followed by SHLS. Most of the Solar Lanterns were being used for last one to two years, implying that access to these products is recent. Also, these lanterns were provided for free to the respondents as part of government initiative.

Safety, reliability, affordability, absence of pollution, and lower electricity bill were the key drivers for RE product purchase. However, lack of RE service centres (as reported by 67% of the respondents) was the key deterrent in uptake of RE products.

**Figure 16: RE Penetration**

In Madhya Pradesh, only about 2% of the sample surveyed were using RE products. This reflects that though there is awareness amongst people, but adoption of these products and services is still low. Solar Lanterns and biogas stove were the most popular RE products, with the usage being reported by 56% and 44% respondents, respectively. This also indicated that adoption of RE products and services were still at an early stage and its utility was limited to basic household requirements. It was observed that Solar Lantern was comparatively a newer product being purchased by the respondents; whereas use of biogas stove was initiated more than three years back by one of the respondents. But the usage of biogas has not been able to create substantial footprint in meeting the energy requirements of the household.



The reasons for using biogas stoves varies for users such as pollution free, safe to use, better performance in comparison with conventional mud chulhas, and affordability. For purchasing Solar Lantern, lower electricity bill and the product being pollution free were one of the major reasons along with affordability, good quality of these products, reliability were some of the reasons contributing to their off-take in market.

In Uttar Pradesh, the survey findings revealed that there is only 8% penetration of RE products and services. Further, only 13% of respondents who were aware of RE were using RE products and services. Further, the usage was restricted to Solar Lanterns, SHLS and Mini-grid. Twenty three respondents (all from Village Jayapur) used electricity from Mini-grid, 10 used SHLS and another 10 respondents used Solar Lanterns.

Nagaland reportedly has the highest penetration of RE products as compared to all the other three study states. About 33% respondents were using RE products in the sample surveyed. Among those respondents who were aware of RE products and services, about 44% respondents were using RE products. Solar Lanterns, SHLS was found to be the most popular RE technologies and biomass cook stove or solar water heater were also being used in the state. None of the respondents confirmed about owning biogas stove, solar pump, solar chillers, solar driers and solar based food processing systems. This clearly outlines that the marginalized communities that are engaged primarily into subsistence farming use electricity mostly for basis purposes.

The reasons for high penetration of RE products and services can be attributed to the easy and comparatively cheaper availability of RE products that were being sourced from the neighbouring areas such as Myanmar. Reliability for electricity supply, pollution free, low electricity bill, and affordability were major reasons for using Solar Lanterns. Better quality of electricity than conventional power, reliability and low electricity bills were some of the reasons for using SHLS. On the other hand, users of solar water heaters and biomass cook stove cited lower electricity bills as the reason for buying these RE products.

### **RE Financing**

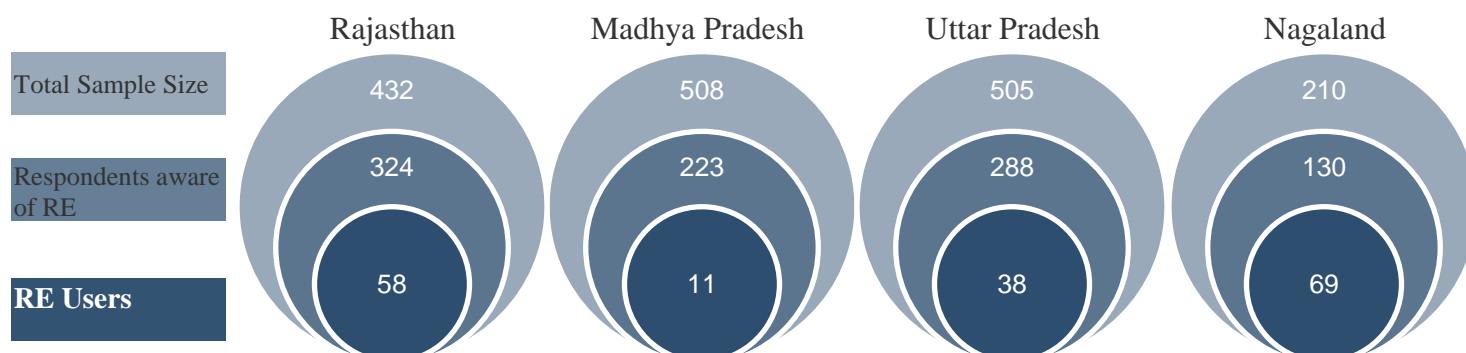
Nearly three fourth of the respondents in Rajasthan, were aware about RE products and services and 58 respondents were using RE products and services in Rajasthan. However, only 5 respondents (including 3 RE users) were aware of the financing options available for RE products, a meagre 1.5% awareness.

Out of the 58 RE users, 66% had cash as the preferred choice of payment whereas about 12% respondents availed funds from neighbours/family/friends which have been classified under 'other' in our questionnaire. Less than 10% respondents preferred taking loan from SHG for making the purchase. As discussed previously, Solar Lanterns were found to be the most popular RE products in Rajasthan which are low cost products; hence the preference for cash payments is implicit in the state.

**Table 14: Access to RE Financing**

State	Number of Respondents aware of RE products/ services	Number of RE Users among the Respondents
Madhya Pradesh	223	11
Nagaland	130	69
Rajasthan	324	58
Uttar Pradesh	288	38

In Madhya Pradesh, the RE users were just about 2% of the total survey size whereas the awareness level was relatively high to about 44%. About 8% of the respondents who had awareness of RE products and services were aware of the financing options available for RE products. Out of the 17 respondents who were aware of RE, more than 50% (9 out of 17) respondents had the preferred mode of financing as "others" that included neighbours/family/friends etc. Local lenders and MFI/SHG were other preferred options. Three out of eleven users preferred loan from SHG, two preferred cash payment and one respondent had a preference for other sources and 5 respondents did not provide the information regarding the preferred mode of financing RE products.

**Figure 17: Awareness level of RE Options and Users**


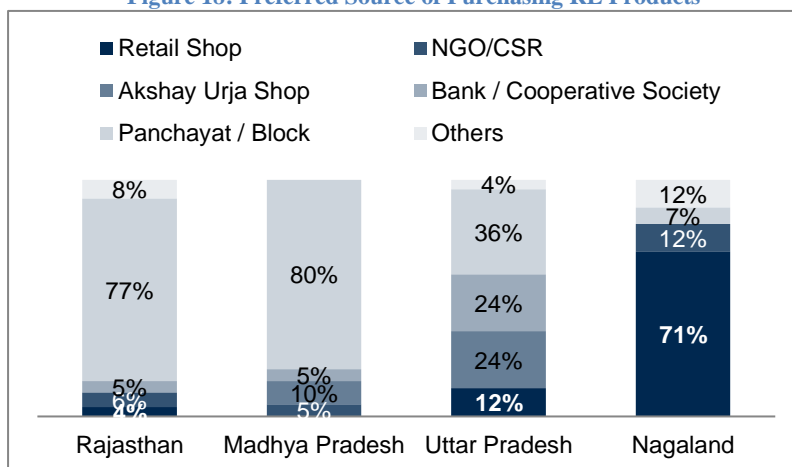
In Uttar Pradesh, 288 out of 505, that is 57% respondents were aware of RE products and services but only 8% were using the RE products. SHGs were the most preferred source of financing as 43% respondents preferred this mode. Banks and MFIs were favoured by close to 17% respondents each whereas local lenders were preferred by about 10% respondents.

Around 50% RE users reported that they used banking sources to finance the purchase of RE products while the other 50% used cash as down-payment which was either financed on their own or through money from SHGs and MFIs. Of the 38 RE users, 10 respondents did not provide this information.

In Nagaland, 62% respondents were aware of RE products or services and about 58 respondents reported that they are using RE products. On the issue of financing of RE products, survey respondents reported limited awareness about any kind of consumer financing options available for RE products. Of the 130 respondents, only 13 respondents<sup>52</sup> (including 10 users), i.e. 10%, reported that they are aware of financing options. However, the respondents reported government led interventions for promoting RE products in rural areas for community usage. For example, the Department of New and Renewable Energy, GoN has commissioned solar street lights in the study villages and the respondents were aware of the same

### Preferred source of purchasing

In Rajasthan, procurement from Panchayat/block as the most preferred choice in Rajasthan as it is favoured by 77% of the respondents. About 10% of the respondents who were aware of RE chose to respond about the preferred source of purchasing RE products in Madhya Pradesh. On the same lines as Rajasthan, 80% respondents in Madhya Pradesh chose Panchayat/block as the preferred choice of

**Figure 18: Preferred Source of Purchasing RE Products**


<sup>52</sup> 6% of the total users

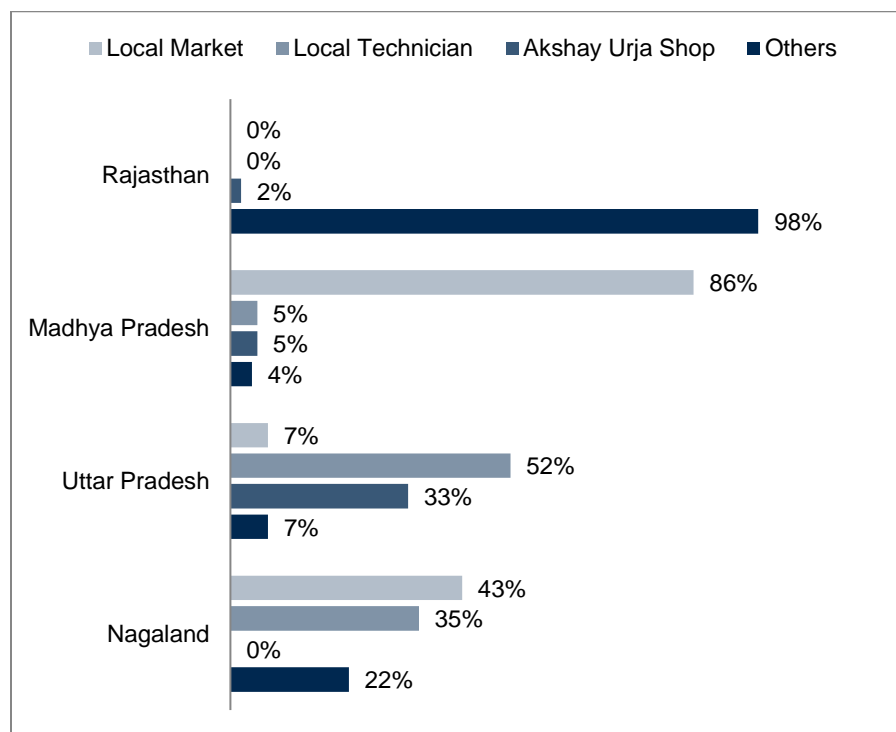
source for RE products.

In Uttar Pradesh, 25 respondents communicated their preferred source for purchasing RE products. Even though Panchayat/block is preferred by 36% of the respondents, however, Akshay Urja Shops and Bank/cooperative society were also favoured by 24% respondents each. On the contrary Retails shops are most preferred in Nagaland with about 71% of 28 respondents choosing the same and Panchayat/block is favoured by least number of respondents with only 7% choosing it.

### i. Source of maintenance

Out of all the respondents aware of the RE products, local market or technician are not preferred by any of the 46 respondents in Rajasthan whereas it is most popular source of maintenance of RE products in Madhya Pradesh as 86% of the 21 respondents have quoted local market as the preferred choice for RE product maintenance. Even though 59% of the 27 respondents preferred to get their RE products maintained from local market or local technicians, about 33% preferred Akshay Urja Shops, as preferred choice of purchase of RE products. In Nagaland also local market and local technicians are most preferred for RE maintenance by 43% and 35% respectively, out of total 23 respondents.

**Figure 19: Preferred Source of Maintenance of RE Products**



Based on the analysis for the socio economic profile of the respondents and the feedback received during the survey and FGDs, their WtP for the preferred technologies is presented in the next Chapter. The analysis has also been a key input in developing the recommendations for the Study.





## Chapter Summary: Key highlights

- a. The literacy levels of respondents (primarily women) in all the states except Nagaland are at very low levels. The share of Illiterate respondents ranged between 53% (Madhya Pradesh) – 78% (Rajasthan) of the total sample. Nagaland has a high share of educated women and the illiteracy levels were around 16%.
- b. Increasing number of girl children are being sent to school. All the villages had primary schools and there is an increasing awareness among women to send girl children to schools
- c. Majority of the women across all the four states were either home makers or had some involvement in agriculture (either as agriculture labourers or farmers). Women in Rajasthan and Uttar Pradesh had similar profiles, with an overwhelming majority as homemakers (87-88%). In MP, around 65% of the women were homemakers, 13% were engaged in agriculture. Nagaland in contrast, had the highest number women engaged in agriculture (87%).
- d. Majority of the households across all the states had monthly expenditures in excess of INR 1500. In Uttar Pradesh, majority had monthly expenditure less than INR 5000.
- e. In terms of access to electricity, Rajasthan and UP showed low levels of access to grid electricity with only 47% connected to grid in Rajasthan and 45% in Uttar Pradesh. Madhya Pradesh and Nagaland had high levels of electricity access, with 98% connected to the grid in Madhya Pradesh and all except one village (Socunoma) connected to the grid in Nagaland.
- f. In all the states, a high reliance on firewood for cooking was observed. The share of population using traditional cook stoves “Chulhas” (mud stoves) in all the states ranged from 62%-70%. LPG is also used in conjunction with mud chulhas for cooking limited meals, boiling water, making tea etc. The traditional cook stove used in Nagaland is different from that in other states, where the cook stove is not only used for cooking but also used as a place for communal gathering.
- g. Across all the states, a high level of awareness regarding RE products and services were observed (55%-75%). Rajasthan had the highest level of awareness where about 75% of the respondents were aware.
- h. Awareness levels do not necessarily translate to product ownership and the same was observed across all the states. In Rajasthan 13% of the sample were using RE products as compared to 8% in Uttar Pradesh. Among the RE product/service users, village Jayapur in Uttar Pradesh had households getting electricity from Mini-grid. In MP only 2% of the sample were using RE. Nagaland had the highest share of respondents using RE (33%), primarily Solar Lanterns and SHLS. Most of the states had product ownership of either Solar Lanterns or SHLS.



- i. In terms of RE financing, cash was the most preferred form of purchase in Rajasthan. In other states such as Nagaland, there was limited awareness regarding consumer financing options for RE. While Uttar Pradesh very limited responses were received for RE financing, and those that reported preferred either cash down payment or banks.

# RE Supply Chain: Engaging women folk



## Chapter Contents

The Chapter examines the current RE supply chain that is followed for supply of RE products. The Chapter also examines the role of women currently play in the supply chain and proposes a multi- level solution to improve their engagement in RE products market.

## i. Availability and Accessibility of RE products and services

In this section of the Report, the focus is upon understanding the supply chain for various RE products that are being considered in this Study. The supply chain captures the flow a product needs to follow to reach from its origination (manufacturer) to destination (consumer). It is imperative to understand the RE supply chain so that it can be suitably de-bottlenecked to ensure smooth delivery of the product.

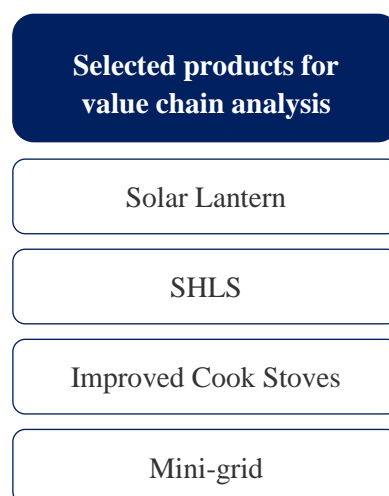
### a. RE value supply chain

**Figure 20: Selected products for value chain analysis**

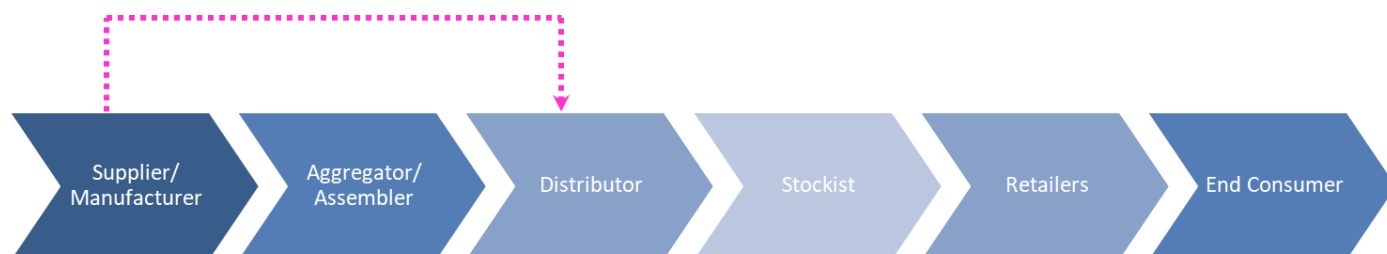
The supply chain of the RE products has been examined for those products for which WtP assessment has been carried out. Detailed discussions and interviews were held with RE retailers and dealer distributors to examine and understand the supply chain. Along with that literature was examined and on ground experience of the consortium was used to determine the supply chain. The products for which the supply chain was examined include Solar Lanterns, SHLS, improved cook stoves and Mini-grid.

#### **Typical Supply Chain for RE Products**

The figure below presents the supply chain for a Solar Lantern. This is almost the same for supply of SHLS and Improved Cook Stoves.



**Figure 21: Typical Supply Chain of the Solar Lantern, SHLS and ICS**



The supply chain includes the procurement of individual components or the entire product, assembling the product or manufacturing, supply and logistics, etc. Following stakeholders are involved in the entire supply chain:

- Supplier/ Manufacturer-** The starting point of value chain, the supplier will procure the product either from within India or import from outside. The Supplier can procure the assembled product and supply directly to the distributor or it can procure components and then supply it to an assembler to put together the product. The manufacturer will manufacture the components or the component and basis than connect to the next level of the value chain.

- b. **Assembler-** An aggregator, the assembler puts the product together from the components procured from the supplier or manufacturer.
- c. **Distributor-** The first level of the distribution network, it is an intermediary between the Supplier and the last mile rural retailer. In some cases the distributor can also procure directly from the supplier or the manufacturer and assemble on its own.
- d. **Last mile rural retailer-** This is link between the end consumer and the rest of the retail chain. This link is the last mile connectivity and thus from a reach perspective a very important part of the retail chain. There are a number of options for the last mile connectivity including - small retailer shops, NGOs, Micro-Finance Institutions (MFIs), SHGs, etc. At times states government can also be involved in providing the last mile connectivity in collaboration with the NGOs or other local agencies.
- e. **End users-** Consumers or the beneficiary or the user of the product. In our current Study this is represented by the marginalised section.

Effective supply chain is indispensable to ensure sustainable offtake of products. Here local government structures such as Panchayat/block offices can also play a role as the last mile supplier of the products. There are number of limitation under which the distribution system in a rural setting needs to be planned. These include - lack of transportation, limited communication and connectivity channels, sparsely located distribution centres/ retail shops , inadequate availability of dealers etc.

#### ***Supply chain for Mini-grid***

The supply chain for Mini-grid consists of Engineering, Procurement and Construction (EPC) companies, Operation and Maintenance (O&M) companies and Mini-grid operators (MGO). MGOs can be private developer or rural energy entrepreneur from the village. In India and Uttar Pradesh, most of the companies are engaged in all three verticals (E.g. Mera Gao Power, OMC etc.).

## **ii. Gaps in the existing supply chain**

During the field data collection, the team interacted with RE product retailers in all the villages where the survey was conducted. During the interactions, following the gaps were identified by the retailers that limit establishment of a sustainable RE supply chain.

1. **Lack of consumer demand due to awareness deficit and improved grid supply** – In areas where the grid supply was good, as in case of Madhya Pradesh, the awareness for RE products was low. During surveys when enumerators briefed the respondents about the benefits of different products; they saw the utility of the product and were willing to pay for the products. Thus, there is a need to plan awareness programmes to facilitate market development in areas where the grid supply is good, but outages or infrastructure bottlenecks limit quality supply. The awareness program can be product (such as lantern, SHLS, solar pumps, solar water heating system etc.) or energy need (lighting, cooking, productive etc.) based.
2. **Lack of distributors and retailers** – As mentioned earlier, there is a shortage of physical distribution network in terms of distributors and retailers that has limited the reach of the RE products. A case in point is Madhya Pradesh, where it was reported that the number of distributors was inadequate and products had to be sourced from the dealers in Agra and Bhopal. Further, it was also perceived that rural retailer's shops in the select areas are not sufficient. Thus, there is a need to bridge the gap of distributors and retailers in the chain.

3. **Lack of innovative business and financing models** – There is lack of business models that have been implemented on ground. This was a feedback received in two states – Madhya Pradesh and Rajasthan. Most of the RE product market is currently cash based, which limits the off take of capital intensive RE products including SHLS. It was suggested that different business models need to be applied in the rural setting such as Pay As You Go (PAYG), deferred payment, rental model etc. Also, linkages need to be drawn with financial institutions to bridge this gap.
4. **Limited engagement of women:** On gender mainstreaming while the retailers communicated that they were keen to engage women, following were the reasons that no women was engaged in any of the state in the RE product supply chain:
  - a. **Lack of education and technical knowledge regarding RE products**
  - b. **Lack of capacity in terms of conducting a business:** It was opined that women do not understand the contours of setting up of small businesses or the agencies to approach for finance for setting up the business as well as how to maintain accounts and ledgers etc.
  - c. **Lack of strong functioning SHGs to facilitate women entrepreneurship:** SHG experience has been mixed in the four states studied, while it has been a success in Madhya Pradesh, Uttar Pradesh has had a mixed experience and in Rajasthan the SHGs have failed (in the areas that were surveyed).<sup>53</sup> Institutional strengthening may be required to promote SHGs as a means for improved women engagement in the RE supply chain

### iii. Developing a solution for RE Supply Chain

From the FGDs we also discovered that women had a high willingness to participate in the supply chain as a means to improve livelihoods. Most women said they would start a business if given the right guidance and hand holding support from key stakeholders such as the government, NGOs and RE suppliers. This was a common feedback received from women across all the four states of the Study.

The high willingness of the women to participate in the supply chain as a means to improve livelihoods needs to be tapped into, as it can be double beneficial. It can help in expanding the RE supply chain and at the same time help in women empowerment. The same was corroborated by the feedback received during the stakeholder consultations. Taking a cognizance of this suggestion the concept of Women Energy Centre (WEC) is suggested in the last Chapter of this Report. Please see the section for details of WEC and the role UN Women can play in implementing it.

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<sup>53</sup> This is with reference to the study villages only.



## Chapter Summary: Key highlights

- a. The supply chain captures the flow a product needs to follow to reach from its origination (manufacturer) to destination (consumer).
- b. The products for which the supply chain was examined include Solar Lanterns, SHLS, Improved Cook Stoves and Mini-grid.
- c. A typical RE supply chain consists of a supplier/ manufacturer, assembler/ aggregator, Distributor, Stockist, Retailer and End Consumer
- d. The supply chain for Mini-grid consists of EPC companies, O&M companies and MGO
- e. The current RE Supply Chain is not adequate and has limited reach in rural areas. Some of the reasons for this trend are - lack of consumer demand due to awareness deficit and improved grid supply, lack of distributors and retailers, and lack of innovative business and financing models. In light of these limitations the solution needs to be developed for developing the RE supply chain
- f. Engagement of women in the RE supply is absent. Reason for limited women participation is lack of education and technical knowledge regarding RE products, lack of capacity in terms of conducting a business and lack of strong functioning SHGs to facilitate women entrepreneurship
- g. During FGDs, women communicated their strong willingness to participate in the RE supply chain as a means to improve livelihoods. The concept of WEC is suggested in Report. It is a women centric multi-level distribution channel to supply RE products. Refer to the Way forward for details of the model and the role UN Women can play in implementing it.



# Willingness to Pay and Demand Estimation



## Chapter Contents

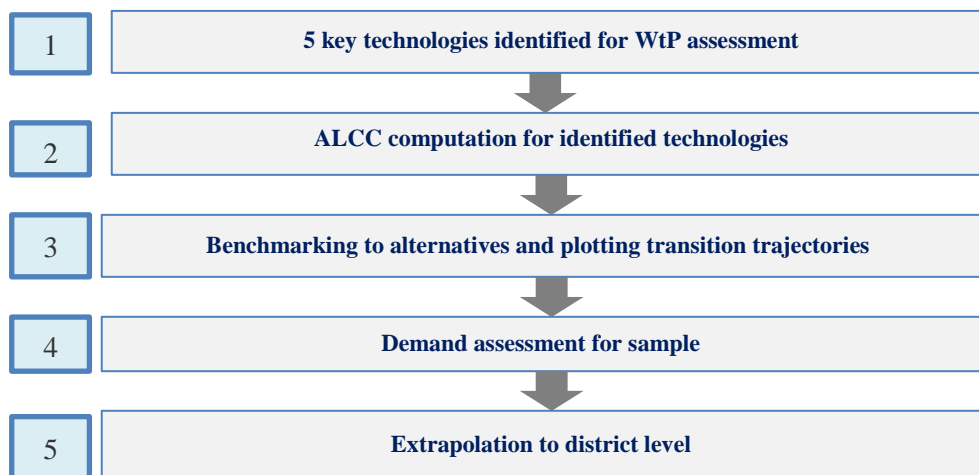
This Chapter focusses on the assessment of WtP for RE products and services across the four states. It also presents the demand estimates for the sample population as well as for the district for the identified RE technologies.



## i. Methodology for WtP assessment

The overall methodology that has been adopted for the Study has been elaborated in Chapter 2 of this report. The aim of this chapter is to present the technology wise WtP and demand estimates for the selected technologies. A brief of the methodology for WtP assessment (based on ALCC analysis) and the corresponding demand estimation for lighting and cooking technologies is presented in the diagram below. Findings based on this methodology are presented in the Chapter subsequently.

**Figure 22: Approach for WtP assessment and demand estimation**



The ALCC analysis was undertaken as explained Chapter 2. As mentioned there, the utility of ALCC is immense as it presents both supplier and consumer perspectives for the technology analysed. Before a discussion on technology wise WtP assessment, the first step is technology selection for which the analysis has been done. This is discussed in the next section.

## ii. Technologies identified for WtP assessment

At the beginning of the Study, ten technologies were identified in consultation with UN Women. These technologies were listed based on a previous study done by consultants of UN Women. The technologies included - Solar Lanterns, SHLS, solar water pumps, solar driers, Improved Cook Stoves, biogas plants, solar drip irrigation, solar water heaters, solar PV based food processing system and solar PV based chiller. However, based on the survey responses, feedback received during FGDs and stakeholder consultations, five key technologies have been considered for the WtP assessment. These technologies include - Solar Lanterns, SHLS, solar water pumps, Mini-grid and Improved Cook Stoves. Technologies such as solar driers, solar PV based chillers were not seen to be used in the districts surveyed mainly because of the marginalized nature of the sample, who are not engaged in productive activities that utilizes such capital intensive RE products.

The technologies options considered differ from state to state based on the survey responses of that particular state and its specificities. The technology options considered for each state are shown in the Table below.

**Table 15: Technologies identified for different states**

Technologies identified		Madhya Pradesh	Nagaland	Rajasthan	Uttar Pradesh
<b>Solar lantern</b>		✓	✓	✓	✓
<b>SHLS (25 W)</b>		✓	✓	✓	✓
<b>SHLS (100 W)</b>		✓		✓	✓
<b>Improved cook stoves (Option 1)</b>		✓		✓	✓
<b>Improved cook stoves (Option 2)</b>		✓		✓	✓
<b>Mini-grid</b>					✓
<b>Solar Water pumps</b>		✓			✓

Mini-grid was identified as a technology relevant only for Uttar Pradesh in view of its low electrification levels, high population density and prevalence of Mini-grid in different parts of the State. Rajasthan on the other hand, did not have favourable responses for Mini-grid during stakeholder consultations, who pointed out the low population density of the State. For Nagaland, the difficult terrain and low radiation

levels were cited as the key factors during stakeholder consultations, which did not make Mini-grid a suitable option.

### iii. ALCC computation of identified technologies

#### a. Solar Lantern

The ALCC of a Solar Lantern and the monthly pay-out is shown in the Table below. It is estimated to be INR 24.08 per month and the benchmark against which the ALCC is compared to the current household level monthly kerosene expenditure. A comparison of ALCC with the monthly kerosene expenditure implies that it is perceived that households with the monthly kerosene expenditure greater than INR 24.08 per month will have the WtP for a Solar Lantern. The estimation of the ALCC is presented in the Table below.

**Table 16: ALCC computation for Solar Lantern (for Madhya Pradesh, Rajasthan and Uttar Pradesh)**

Component	Price of component (INR)	Life (years)	CRF	ALCC (INR)
Module 3Wp	50	5	0.277	13.83
Battery - 6 V, 4.5 Ah	250	5	0.277	69.13
LED 2.5 W	150	5	0.277	41.48
PCB	370	5	0.277	102.31
Cable	225	5	0.277	62.22
ALCC (Total)	1045			288.96
Monthly Pay out				24.08

In case of Nagaland, as a result of the terrain and the distance, the cost of solar products is expected to increase slightly. In the Table below and then in the subsequent section where SHLS discussed the Nagaland specific lantern and SHLS costs are presented.

**Table 17: ALCC computation for Solar Lantern (for Nagaland)**

Component	Price of component (INR)	Life (years)	CRF	ALCC (INR)
Module 3Wp	50	5	0.277	13.83
Battery - 6 V, 4.5 Ah	350	5	0.277	96.78
LED 2.5 W	160	5	0.277	44.24
PCB	380	5	0.277	105.08
Cable	235	5	0.277	64.98
ALCC (Total)	1175			324.91
Monthly pay out				27.08

#### b. Solar Home Lighting Systems (SHLS)

There are two variants of SHLS that have been considered for the analysis – 25 W SHLS and 100 W SHLS. The ALCC and monthly pay-outs for the two variants (25 W and 100 W SHLS) are shown in the Tables below. A 25 W home lighting system provides 2 light points and one mobile charging point. The 100 W SHLS caters to the higher energy needs of a household. It can power two light points, a mobile charging point, a television and a fan.

**Table 18: ALCC computation for 25W SHLS (for Madhya Pradesh, Rajasthan and Uttar Pradesh)**

Component	Price of component (INR)	Life (years)	CRF	ALCC (INR)
Module 25 W	1200	25	0.126	151.62
Battery - 12 V, 24 Ah	3900	5	0.277	1050.76
Battery replacement cost				1245.24
LED 3 W lights (2)	400	5	0.277	110.61
LED 3 W lights (2) – replacement				131.08
Charge controller (10 Amp)	500	5	0.277	138.26
Charge controller (10 Amp) – replacement				163.85

Component	Price of component (INR)	Life (years)	CRF	ALCC (INR)
Wiring structure	300	5	0.2765	110.61
Wiring structure – replacement				131.08
Installation cost	220	1	1.1187	246.11
Annual Maintenance cost	57			794.28
ALCC	6577			4273.49
Monthly pay out (INR)				356.12

**Table 19: ALCC computation for 25W SHLS (for Nagaland)**

Component	Price of component (INR)	Life (years)	CRF	ALCC (INR)
Module 25 W	3000	25	0.126	379.05
Battery - 12 V, 24 Ah	2400	5	0.277	663.64
Battery replacement cost				786.47
LED 3 W lights (2)	330	5	0.277	91.25
LED 3 W lights (2) - replacement				108.14
Charge controller (10 Amp)	600	5	0.277	165.91
Charge controller (10 Amp) - replacement				196.62
Wiring structure	450	5	0.277	124.43
Wiring structure - replacement				147.46
Installation cost	300	1	1.119	335.61
Annual Maintenance cost	110			1540.92

Component	Price of component (INR)	Life (years)	CRF	ALCC (INR)
ALCC	7190			4539.51
Monthly				378.29

**Table 20: ALCC computation for 100W SHLS (for Madhya Pradesh, Rajasthan and Uttar Pradesh)**

Component	Price of component (INR)	Life (years)	CRF	ALCC (INR)
Module 100 W	3500	25	0.1263	442.23
Battery - 12 V, 75 Ah	5500	5	0.2765	1520.84
Battery replacement cost				1802.33
LED 3 W lights (2)	400	5	0.2765	110.61
LED 3 W lights (2) - replacement				131.08
Charge controller (10 Amp)	500	5	0.2765	138.26
Charge controller (10 Amp) - replacement				163.85
Wiring structure	400	5	0.2765	110.61
Wiring structure - replacement				131.08
Installation cost	200	5	0.2765	55.30
Annual Maintenance cost	93			1298.58
ALCC	10593			5904.75
Monthly pay out				492.06

### c. Solar Water Pumps

While during the survey, the awareness and the ownership of solar pumps was found to be less, at the time of FGDs and discussions with stakeholders during the workshop, it was highlighted in Uttar Pradesh that solar pumps (especially as a community owned asset), would be a useful technology. Hence, analysis

of solar pumps has been included in this section. The tables below show the ALCC of a 3HP and a 5HP solar pump.

**Table 21: ALCC computation for 3HP SWPS**

Component	Price of component (INR)	Life (years)	CRF	ALCC (INR)
3 HP Solar Pump	36000	5	0.277	9955
3 HP Solar Pump Starter	36000	5	0.277	9955
Module Mounting structure	25000	5	0.277	6913
Submersible cable of 80 meter per unit	6400	5	0.277	1770
Water chamber for hand pump	2500	5	0.277	691
Wire for hanging pump	3000	5	0.277	830
Hand pump brass cylinder	2000	5	0.277	553
32mm PVC Column Pipe	5000	5	0.277	1383
32mm Adaptor	600	5	0.277	166
Solar Module of 3kWp	36000	5	0.277	9955
Nut Bolt for structure	10000	5	0.277	2765
Pipes and Sanitary item	20000	5	0.277	5530
Installation	30000	1	1.119	33561
CMC for 5 years	112500			91028
ALCC	325000			175053
Hourly pay out <sup>54</sup>				<b>122</b>

<sup>54</sup> The hourly pay-out has been calculated based on the assumption that the solar pump will run for 6 months in a year and for 8 hours daily in those six months.



**Table 22: ALCC computation for 5HP SWPS**

Component	Price of component (INR)	Life (years)	CRF	ALCC (INR)
5 HP Solar Pump	45000	5	0.277	12443
5 HP Solar Pump Starter	36000	5	0.277	9955
Module Mounting structure	25000	5	0.277	6913
Submersible cable of 100 meter per unit	8000	5	0.277	2212
Water chamber for hand pump	2500	5	0.277	691
Wire for hanging pump	3000	5	0.277	830
Hand pump brass cylinder	2000	5	0.277	553
32mm PVC Column Pipe	5000	5	0.277	1383
32mm Adaptor	600	5	0.277	166
Solar Module of 5kWp	60000	5	0.277	16591
Nut Bolt for structure	10000	5	0.277	2765
Pipes and Sanitary item	20000	5	0.277	5530
Installation	30000	1	1.119	33561
CMC for 5 years	115000			93051
ALCC	362100			186644
Hourly <sup>54</sup> (INR)				<b>130</b>

#### d. Mini-grid

The Mini-grid will cater to the lighting and space conditioning requirements of a household and power two lights and one fan per household. Mini-grid is an important intervention as it can meet both consumptive as well as productive needs of the area serviced. From a gender perspective, a Mini-grid also has role to play in improving livelihood provisioning, and can have a substantial impact on the well-being of women. The Table below shows the ALCC calculated for a 30 kW Mini-grid.

**Table 23: ALCC computation of a 30kW Mini-grid**

Sl. No.	Components	Specificati on	Value	GST (%)	GST	Freigh t	Total	Life	CRF	Annual Cost
1	Solar Panels	250 Wp	1125000	5	56250		1181250	25	0.13	149253
2	Inverter and Charge Controllers									
A	Charge Controller	150V,60A	204000	5	10200		214200	5	0.28	59230
B	Inverters	6/8.5 KW	121900	5	6095		127995	5	0.28	35393
C	Combox and System Control Panel		15000	5	750		15750	5	0.28	4355
3	Battery Bank along with Rack	48V, 1200AH	873600	5	43680		917280	5	0.28	253643
4	Replacement cost inverter and Battery (4 replacements)									415622
5	Solar Structures	Galvanised	200000	5	10000	30000	240000	25	0.13	30324
6	System Integration Cost	Integration Service	75000	5	3750		78750	1	1.12	88098
7	Lighting Arrestor		100000				100000	5	0.28	27652
8	Replacement cost Lighting Arrestor									32592
9	O&M cost maintenance schedule									1237143
Total for a 30 KW Mini-grid							2875225			2333305
10	Mini-grid Distribution Network						476224			60171.6
<b>Grand Total</b>							<b>3351449</b>			<b>2393476.6</b>

The ALCC for the Mini-grid can be interpreted as the minimum revenue a Mini-grid Operator (MGO) needs to generate from the plant in order to recover the investment made over the life of the project. Thus, the MGO needs to earn INR 23,93,477 annually. This implies a monthly revenue requirement of close to INR 1,99,456 per month to keep the business viable.

#### e. Improved cook stoves

For improved cook stove two types of front loading Improved Cook Stoves have been considered. The cook stoves are capable of catering to small/medium households as well as large households. **Option 1** is a low cost improved cook stove, which can cater to about 8 members household. **Option 2** is a larger improved cook stove that can cater to a family of 8 to 15 members. In the Table below, the estimated monthly pay-out has been estimated for both these cook stoves.

**Table 24: ALCC of an Improved Cook stove**

Options	Cost of the Stove (INR) (A)	Life of the Stove (Years) (B)	Capital Recovery Factor (CRF)	ALCC (INR) (D = A*C)	Monthly pay-out (INR/ month) (E = D/12)
Improved cook stove Option 1	750	2	0.592	444	36.92
Improved cook stove Option 2	1650	2	0.592	976	81.22

### iv. Suggested benchmarks for WtP assessment

The suggested benchmark for WtP for different products and their monthly pay outs as calculated in the foregoing sections are provided in the table below:

**Table 25: Benchmark for WtP and monthly pay outs for RE products**

Identified technologies	Suggested benchmark for WtP		Monthly pay out for the product based on ALCC (INR)
Solar Lantern		Monthly kerosene expenditure	24.08 /month/ 27.08 <sup>55</sup> /month
SHLS	25W	Monthly kerosene	356.12/month /

<sup>55</sup> For Nagaland

Identified technologies		Suggested benchmark for WtP	Monthly pay out for the product based on ALCC (INR)
		expenditure	378.29 <del>555</del> /month
	100W		492.06/month
Solar Water Pumps <sup>56</sup>	3HP	Hourly rental paid for diesel water pumps	122/hour
	5HP		130/hour
ICS <sup>57</sup>	Option1	Savings on monthly firewood expenditure	36.92/ month
	Option2		81.22/ month
Mini-grid <sup>58</sup>	30 kW	Based on survey responses and FGDs (Monthly expenditure on electricity)	INR 285/ month

## v. WtP for Solar Lanterns and SHLS

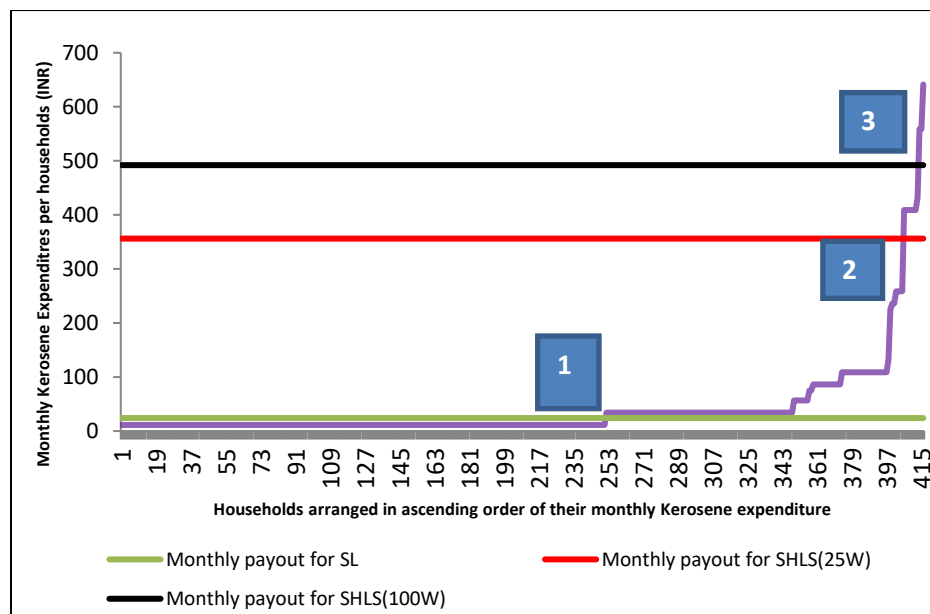
To estimate the WtP for Solar Lanterns and SHLS, only those households, who reported non-zero kerosene expenditure, were considered. The state wise WtP for Solar Lantern and SHLS have been shown in the graphs below. The transition lines (dotted line) in the graphs show the kerosene expenditure of INR 356 per month and INR 492 per month for 25 W and 100 W SHLS respectively. In case of Nagaland the transition line is at INR 378 per month for 25 W SHLS.

<sup>56</sup> It is assumed that solar water pumps are used for 6 months in a year and 8 hours in a day

<sup>57</sup> Option I is considered for household size of up to 8 and option II for household size of greater than 8

<sup>58</sup> For Mini-grid the benchmark has been arrived at based on the survey responses and FGDs

**Figure 23: WtP for Solar Lanterns and SHLS (Madhya Pradesh)**



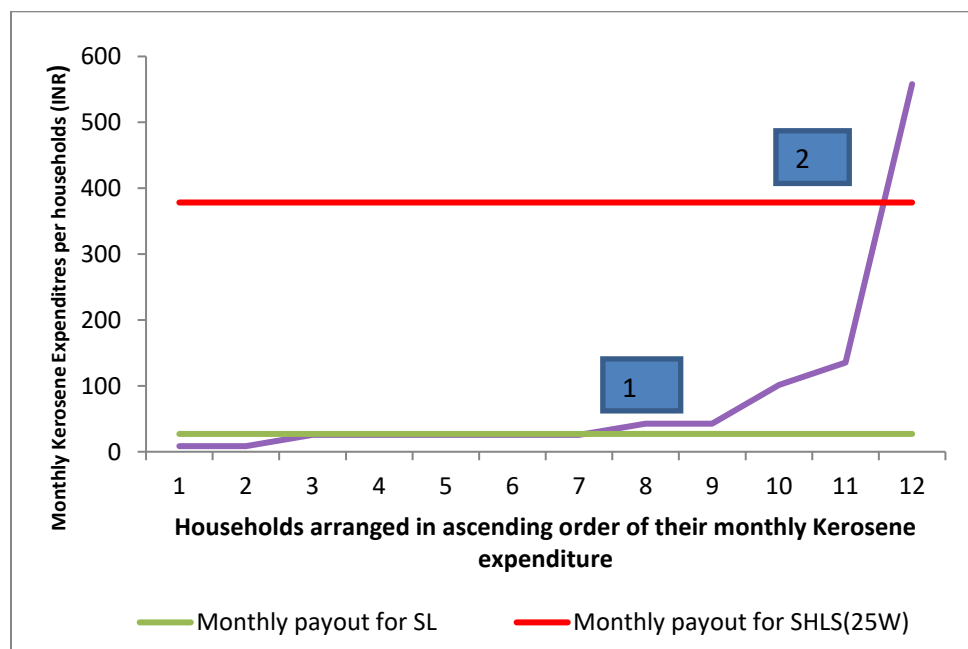
#### Transitions – Lighting (Solar Lanterns and SHLS)

1- Kerosene users with a monthly expenditure of INR 24.08 per month will be willing to move to a Solar Lantern; (165 households)

2-Household with a kerosene expenditure of INR 356.12 per month and more will be willing to move to SHLS with a capacity of 25 W; (11 households)

3- Households with a kerosene expenditure of INR 492.06 per month and more will be willing to move to solar home lighting systems with a capacity of 100 W (3 households)

**Figure 24 WtP for Solar Lantern and SHLS (Nagaland)**

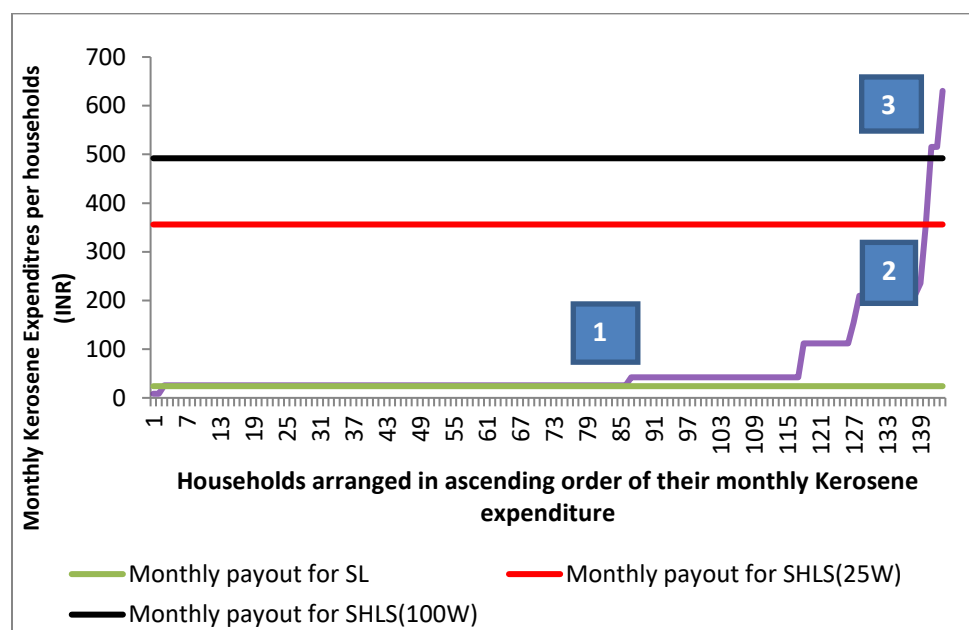


#### Transitions – Lighting (Solar Lanterns and SHLS)

1- Kerosene users with a monthly expenditure of INR 27.08 per month will be willing to move to a Solar Lantern; (5 households)

2-Household with a kerosene expenditure of INR 378.29 per month and more will be willing to move to SHLS with a capacity of 25 W (1 household)

**Figure 25: WtP for Solar Lanterns and SHLS (Rajasthan)**



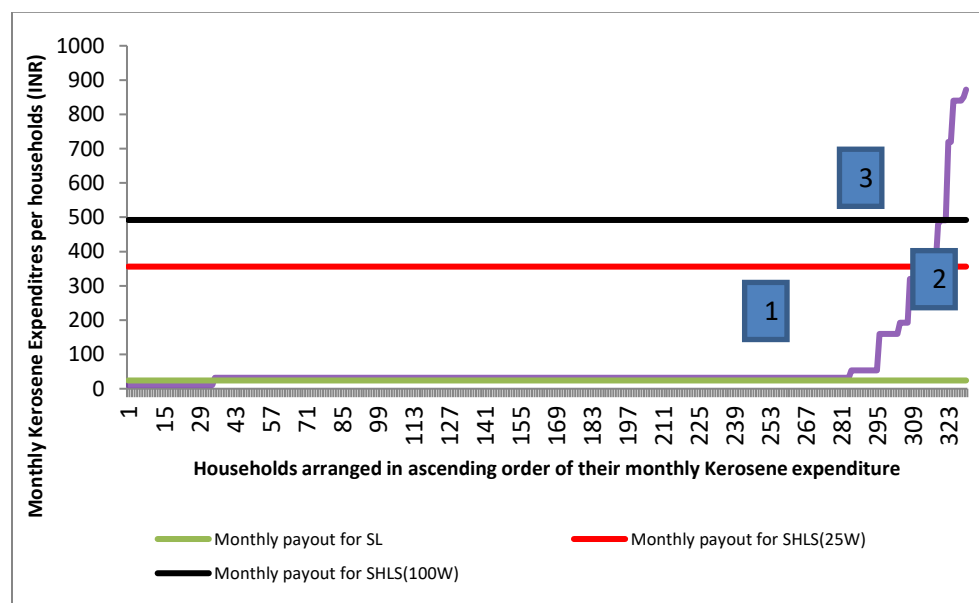
#### Transitions – Lighting (Solar Lantern and SHLS)

**1-** Kerosene users with a monthly expenditure of INR 24.08 per month will be willing to move to a Solar Lantern; (141 households)

**2-** Household with a kerosene expenditure of INR 356.12 per month and more will be willing to move to SHLS with a capacity of 25 W; (4 households)

**3-** Households with a kerosene expenditure of INR 492.06 per month and more will be willing to move to solar home lighting systems with a capacity of 100 W (3 households)

**Figure 26: WtP for Solar Lanterns and SHLS (Uttar Pradesh)**



#### Transitions – Lighting (Solar Lanterns and SHLS)

**1-** Kerosene users with a monthly expenditure of INR 24.08 per month will be willing to move to a Solar Lantern; (296 households)

**2-** Household with a kerosene expenditure of INR 356.12 per month and more will be willing to move to SHLS with a capacity of 25 W; (12 households)

**3-** Households with a kerosene expenditure of INR 492.06 per month and more will be willing to move to solar home lighting systems with a capacity of 100 W (8 households)

### a. Market potential for Solar Lanterns and SHLS

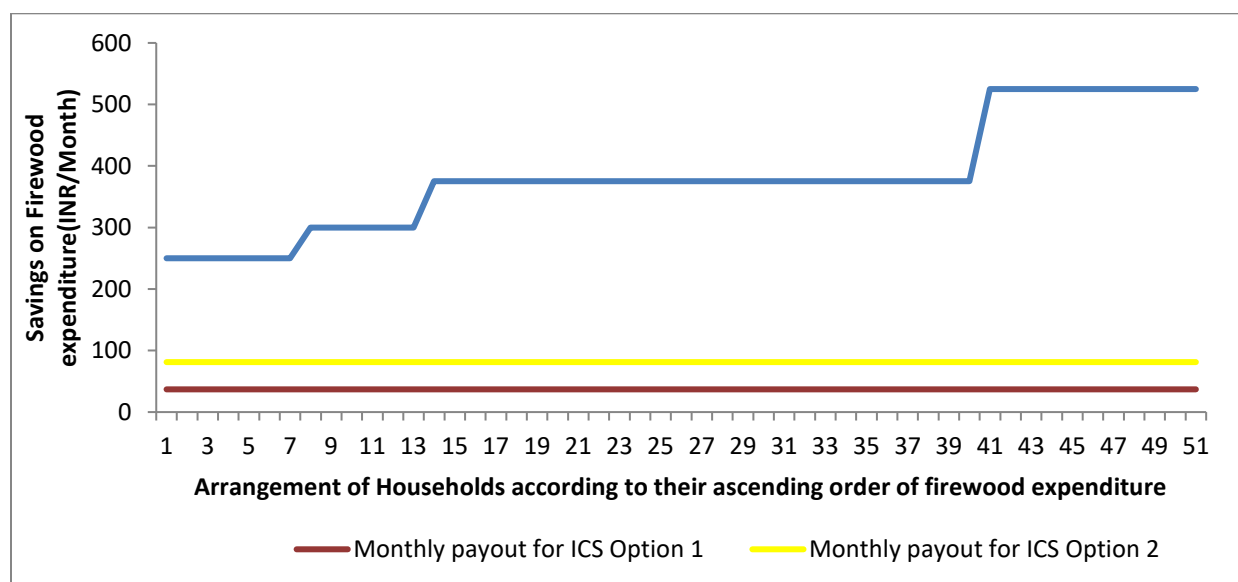
The market potential for Solar Lanterns and SHLS is summarized in the Table below. Based on the Table below, inferences cannot be drawn to the state with highest potential for lanterns as the percentage of households who reported non-zero expenditure varies widely across states.

**Table 26: Summary of the households that will have the Willingness to pay for the lighting solutions**

State	No. of households willing to shift to Solar Lanterns	No. of households willing to shift to SHLS (25 W)	No. of households willing to shift to SHLS (100 W)
Madhya Pradesh	165	11	3
Nagaland	5	1	0
Rajasthan	141	4	3
Uttar Pradesh	296	12	8

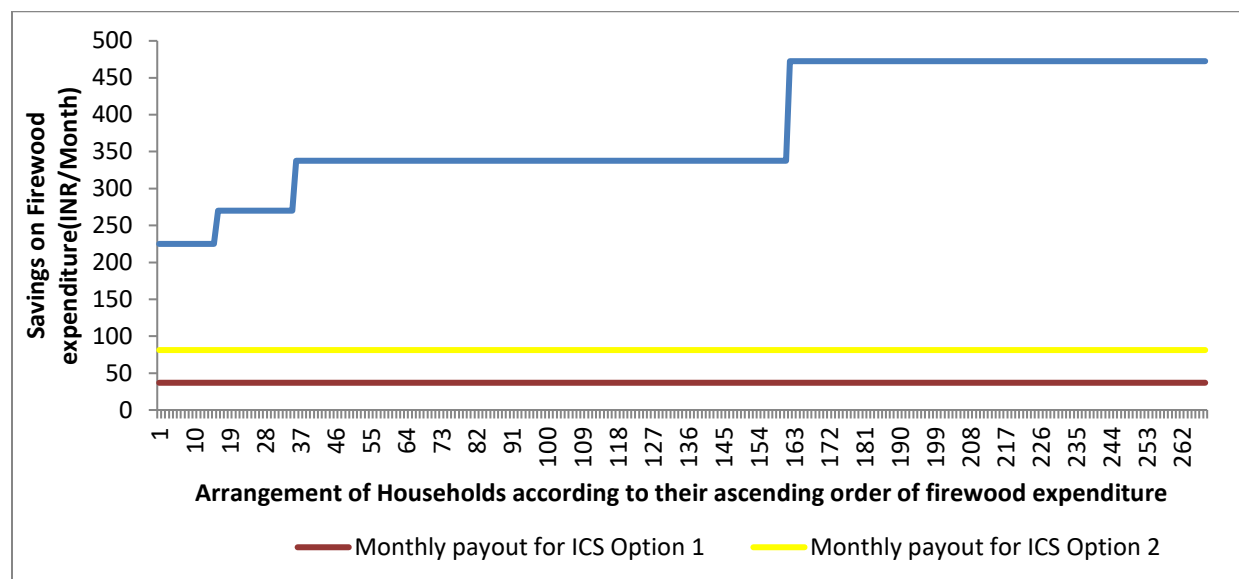
## vi. WtP for Improved Cook Stoves

To estimate the WtP for Improved Cook Stoves (Option 1 and 2), the monthly firewood savings per household has been considered. This is because, despite the health benefits and reduction in drudgery, households primarily base their decisions on the actual financial saving that will accrue to the household due to savings on firewood expenditure, after using an improved cook stove. Corollary to the above, only those households have been included which buy firewood. Households that is dependent only firewood collection will have no monetary saving with a shift to Improved Cook Stoves. Thus, those households have been excluded. The Figures below show the transitions to Improved Cook Stoves for each of the states.

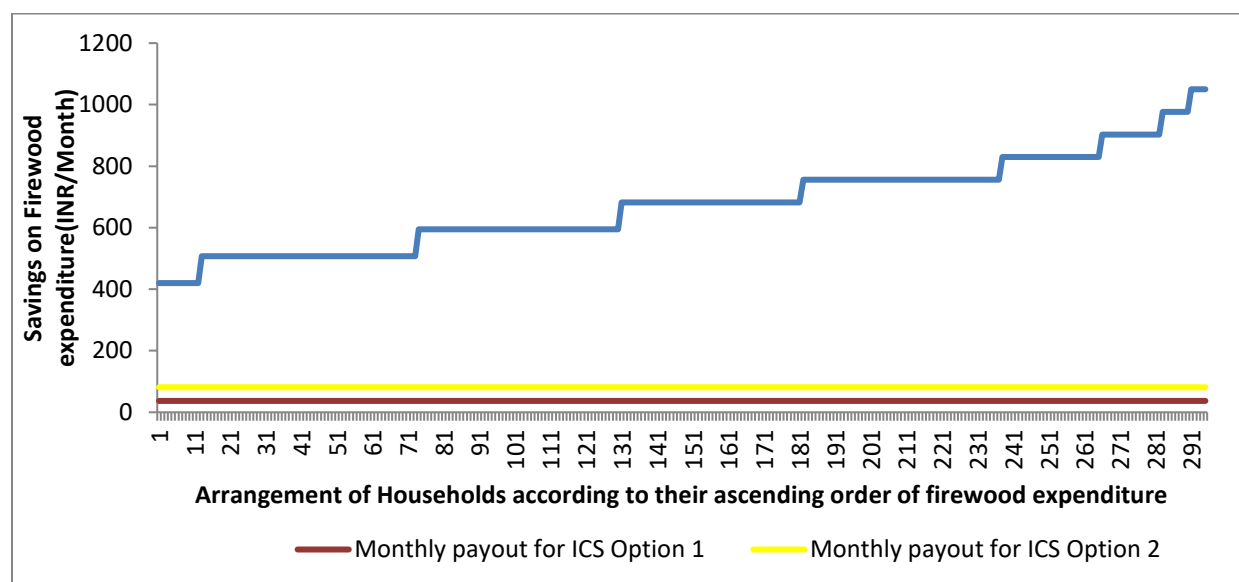
**Figure 27: WtP for Improved Cook Stoves (Madhya Pradesh)**




**Figure 28: WtP for Improved Cook Stoves (Rajasthan)**



**Figure 29 WtP for Improved Cook Stoves (Uttar Pradesh)**



In case Nagaland, it was observed that the traditional cook stove used in the State are more efficient than the mud chulhas used in the other parts of the country. Also, during the stakeholder discussions it was highlighted that firewood burning in the State is not only for cooking, but also, the fireplace is the place where family and community comes together. Thus, even if Improved Cook Stoves are installed in the State, it will not result in any change in the firewood consumption. Thus, Improved Cook Stoves have not been considered for Nagaland.

### Transitions – Cooking (Improved cook stoves)

- Households who buy firewood and have monthly firewood savings of INR 36.92 per month will be willing to move to Improved cook stove Option 1
- Households who buy firewood and have monthly firewood savings of INR 81.22 per month will be willing to move to Improved cook stove Option 2

#### a. Market potential for cook stoves

The market potential for improved cook stoves is summarized in the Table below. The Table clearly shows that due to more percentage of people buying firewood in states such as Uttar Pradesh and Rajasthan, a larger share of respondents are willing to shift to improved cook stoves. However, in Madhya Pradesh, only 51 respondents reported that they purchase firewood, therefore number of households expected to be willing to shift to improved cook stoves is lesser.

**Table 27: Market potential for Improved Cook Stoves based on WtP analysis**

State	No. of households willing to shift to improved cook stoves (Option 1)	No. of households willing to shift Improved Cook Stoves (Option 2)
Madhya Pradesh	50	1
Rajasthan	256	12
Uttar Pradesh	283	12

## vii. WtP for Solar Pumps

The WtP for solar water pumps has been assessed only for Madhya Pradesh and Uttar Pradesh primarily based on the feedback received during FGDs and stakeholder consultations, where this technology was seen to key for these states (especially as a community owned asset). Limited responses<sup>59</sup> were received for willingness towards solar water pumps during survey. The ALCC has been estimated (Table 21 and Table 22) and the monthly pay-outs (Table below) have been calculated for 3 HP and 5 HP.

<sup>59</sup> In Madhya Pradesh very few responses were received for solar water pumps; however those respondents did not report the rental paid for diesel/ electrical pump sets, while in Uttar Pradesh no responses were seen for solar water pumps. However, in both the states, during FGDs willingness was expressed by the respondents for the product. Thus, the benchmark cost has been calculated for solar water pump based on the

**Table 28: Service charge for solar pumps (3 HP and 5 HP) for a rental model**

Solar Water Pump	ALCC (INR/ year)	Service charge (INR/hour)*
3 HP	29176	122
5 HP	31107	130

\*Assumption – solar water pumps are used for 6 months, 8 hours a day

The services charges derived from ALCC can be interpreted as the rental that farmers will be willing to pay as a rent for solar water pumps in a community model. Based on the feedback received during the FGDs these service charges are in line with the rental paid by the farmers for diesel pump sets used for irrigation. The respondents had reported and expenditure of around INR 120- INR 160 per hour on diesel pump sets. However, it will be difficult to estimate the demand for solar water pumps in the absence of data regarding number of respondents who are paying the rental for diesel pump sets.

### viii. WtP for Mini-grid

The WtP for Mini-grid has been assessed only for Uttar Pradesh, as during FGDs households expressed their inclination towards getting supply from Mini-grid. One of the villages (Jayapur) covered in the survey in Varanasi district, had a Mini-grid where people were availing supply from it and were satisfied with the supply. In order to estimate the WtP for Mini-grid, we have considered that about 83% of our sample size (419 of the 505 households) will shift to Mini-grid. This is based on (a) percentage of un-electrified households in the sample and (b) share of electrified households, which are expected to move to Mini-grid in view of better quality and reliability of supply. During FGDs, a number of electrified households highlighted erratic power supply and expressed their willingness to pay for better quality of electricity. In total, this included 247 un-electrified households and an average 76% of the electrified households. Therefore, this implies a minimum pay out of INR 475.8 per household per month to make the business viable. However, based on the average grid electricity tariffs that households were paying in the areas surveyed, which is reported to be in the range of INR 280 – 290 per month and on the basis of the responses from FGDs<sup>60</sup>, INR 285 per month has been considered as the monthly pay-out a household will be willing to pay for getting supply from Mini-grid. At this tariff, the MGO would require support either in the form of subsidy from government or cross-subsidization from other categories such as commercial consumers or an anchor load, for a viable business proposition. As per the Uttar Pradesh Mini Grid Regulations, 2016, an MGO can charge tariff based on mutual consent if he/she is not availing subsidy from state government. If subsidy is being availed and the connected load is more than 100 W, again the tariff can be set by the MGO on mutual consent. Based on the energy consumption patterns of the households (Table 29), it can be inferred that the MGO can serve the remaining load to productive/commercial/anchor load on a tariff based on mutual consent. This would enable the MGO to cross subsidize the domestic consumers with power supply to productive enterprises/anchor load. In view

<sup>60</sup> During FGDs households reported that they were willing to pay INR 250-300 for getting reliable electricity supply from sources other than grid

of favourable regulatory and policy framework for Mini-grid and the electricity access situation at present, Mini-grid seem to be an apt technology for providing reliable and quality power supply to consumers. To ensure financial viability, different tariff packages can be designed by the MGO based on the load profile of the consumers in the area to be served.

**Table 29: Domestic load servicing by 30 kW Mini-grid and determination of excess capacity for commercial or anchor use**

S No	Description	Unit (MWh)
(A)	Electricity generation from 30 kW Mini-grid <sup>61</sup> = $(30 \times 19\% \times 8760) / 1000$	49.9
	Household electricity load	
(B)	- Lighting load ( 3W*2) = $(3 \times 2 \times 8 \times 365) / 10^6$	0.02
(C)	- Space conditioning load (40 W) = $(40 \times 8 \times 182) / 10^6$	0.06
(D)	Electricity load per household (B+C)	0.08
(E)	Total electricity load (419 households)	31.7
(F)	Balance to be served to productive/commercial and anchor load (A-F)	18.2

\* Assuming a CUF of 19% for Mini-grid, 8 hours of electricity supply, Fan is assumed to be used only for 182 days in a year

All the un-electrified households that have monthly fuel and light expenditure of more than INR 285 and those electrified households that want to opt for better power supply are also expected to have a WtP of INR 285 will be willing to shift to Mini-grid. Based on this, a Mini-grid plant can be planned in Uttar Pradesh.

## ix. Demand estimation

The estimation of demand has been undertaken for lighting and cooking categories. In the lighting segment, demand has been assessed for Solar Lanterns and SHLS, while in the cooking segment the demand has been assessed for Improved Cook Stoves.

### a. Lighting demand estimation for the Sample

To estimate the demand, factors such as a household's socio-economic profile, household's monthly kerosene expenditure, current RE product usage, type of house and number of rooms have been considered. The demand estimates considers if only one type of the product is selected by the household –

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<sup>61</sup> Assuming a CUF of 19%

either Solar Lantern or SHLS. This is based on field experience; where we found that rural households from the most marginalised sections seldom have 2 different RE based lighting products.

Given the ALCC for Solar Lanterns and SHLS, the demand has been calculated based on the current kerosene expenditure of the respondents. If a household's kerosene expenditure is higher than the ALCC, then the household can shift to the RE product and procure the lighting product under the OPEX model. Other household parameters have also been analysed such as number of rooms per household. In most cases, number of lanterns has been capped at the number of rooms per household. Also, the 100 W SHLS considered in the analysis caters to the lighting and space conditioning requirements of a household. Thus, for higher lighting needs, it is expected that the household will shift to SHLS. The number of Solar Lanterns has been capped to 2 per household.

The state wise demand of the sample has been shown in the Table and Figures below.

**Table 30: Lighting demand of sample**

State	No. of households with demand for 1 Solar Lantern	No. of households with demand for 2 Solar Lanterns	No. of households with demand for one 25 W SHLS	No. of households with demand for two 25 W SHLS	No. of households with demand for 100 W SHLS
Madhya Pradesh	106	59	11	NA	3
Nagaland	2	3	1	NA	NA
Rajasthan	133	8	4	NA	3
Uttar Pradesh	280	16	4	8	8

The sample data shows that Uttar Pradesh has the highest demand for Solar Lanterns, where a high percentage of population is dependent on kerosene for lighting (in absence of electricity) and they have higher expenditure on kerosene. Madhya Pradesh and Rajasthan have similar demand for Solar Lanterns. In Nagaland as a result of high electrification level of the sample, the demand for Solar Lanterns and SHLS is the least.

#### ***Extrapolating Lighting Demand to District Level***

The demand estimates for lighting have been extrapolated to the district level to present the larger picture in terms of the possible market demand for the two lighting solutions – Solar Lantern and SHLS. As discussed earlier, the sample that was surveyed represented a small subset of the total population- and it represented a niche market - marginalized section of the population. The eight parameters based on

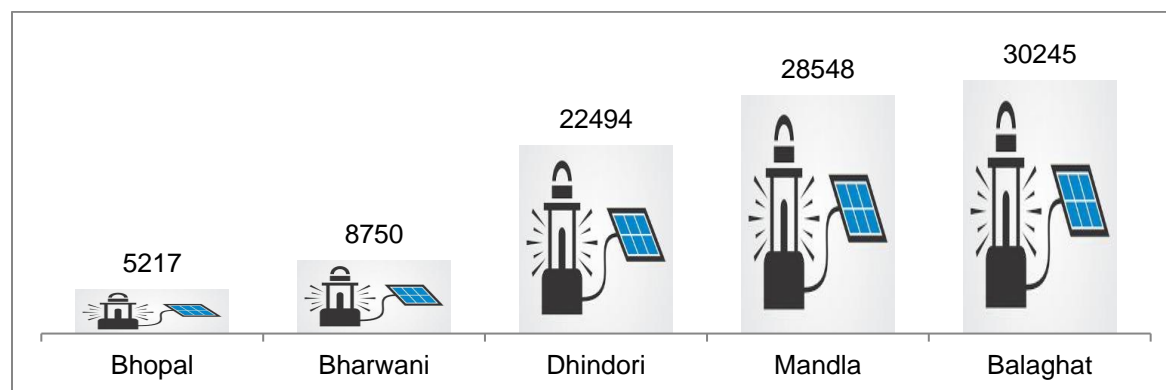
which, marginalized population was selected for the sample survey<sup>62</sup> include female population, SC/ ST population (SC/ST headed households), female SC/ST population, electrification level, solar penetration and female literacy levels. For extrapolating the demand estimates, each of these indicators were analysed to examine their suitability to represent the sample demand at the district level. Based on the availability of concomitant data at the district level, the parameters that were selected for extrapolation were –SC/ ST population at the district. The source for the district level data is Census of India 2011. Census 2011 also provides details of the primary source of lighting for SC/ ST households at the district level. Similar granularity of data is not provided for OBCs in Census of India 2011 and hence that section of the sample has not been extrapolated.

Based on the demand estimates for the sample, percentage of SC and ST households that can demand Solar Lanterns and SHLS has been estimated. While in case of Solar Lanterns household expenditure is not a key determinant<sup>63</sup>, in case of SHLS those SC/ST households that have a lighting expenditure of greater than INR 500/ month has been considered for extrapolation.

For a particular district, the percentage of SC and ST households that demand Solar Lanterns/SHLS has been extrapolated on the number of SC and ST households, respectively, at the district level that use kerosene as their primary source of lighting to estimate district level demand. As our survey explains only SC and ST households, the SC and ST households at district level have been considered and not the total number of households.

Based on the above methodology, the district level demand for Solar Lanterns and SHLS has been estimated. The figures below provide a snapshot of district wise demand of Solar Lanterns across different states.

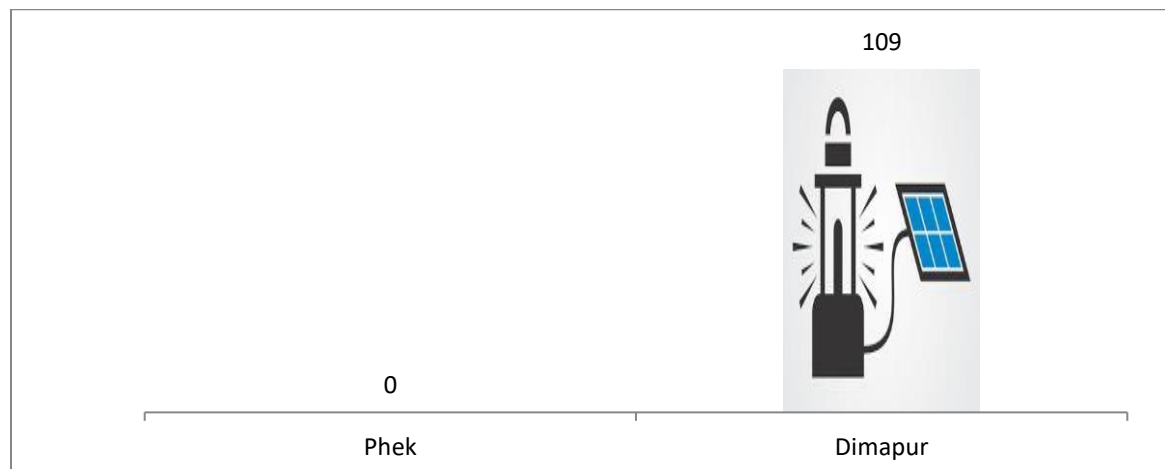
**Figure 30: District wise demand for Solar Lanterns (Madhya Pradesh)**



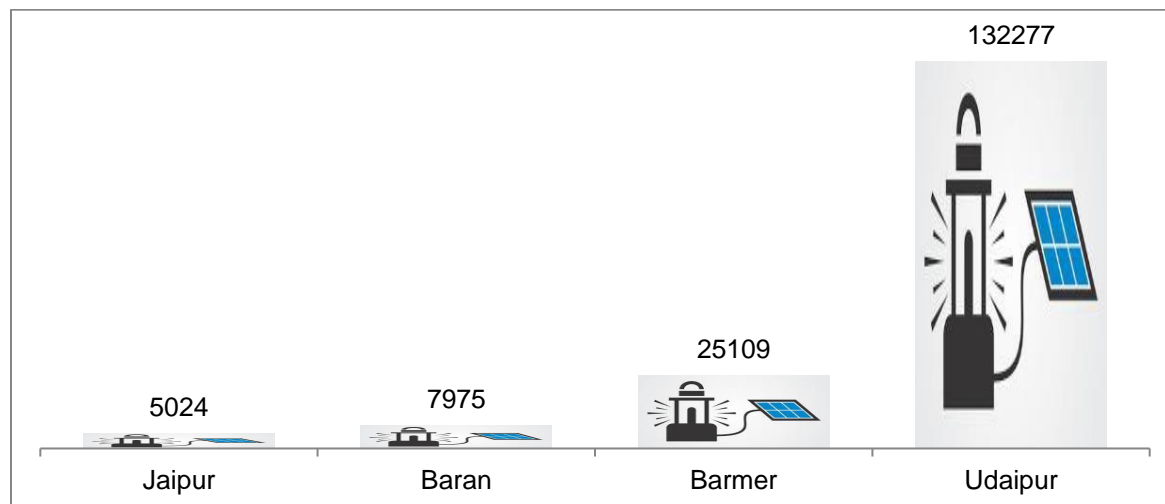
<sup>62</sup> Please see the methodology section for detailed discussion

<sup>63</sup> Primarily because that monthly pay out for Solar Lanterns (as determined in the WtP section) is INR 24.08/ household, which is comparatively smaller outlay for using a lighting solution as compared to SHLS where the pay-out ranges from INR 356.12/ month (for a 25 W SHLS) and INR 492.06/month (for a 100 W SHLS)

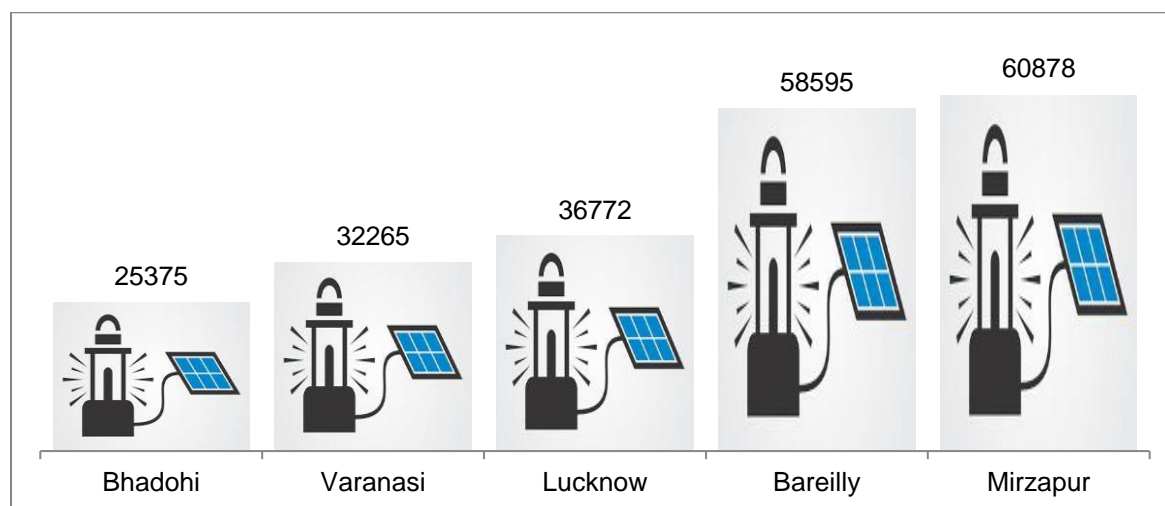
**Figure 31: District wise demand for Solar Lanterns (Nagaland)**



**Figure 32: District wise demand for Solar Lanterns (Rajasthan)**



**Figure 33: District wise demand for Solar Lanterns (Uttar Pradesh)**





The figures clearly indicate that the demand for solar lanterns is much higher in Uttar Pradesh owing to larger number of households spending on kerosene for lighting in absence of access to electricity.

The district wise demand for SHLS is very low across all the states. All those districts which have a non-zero demand of Solar Lanterns are depicted in the table below:-

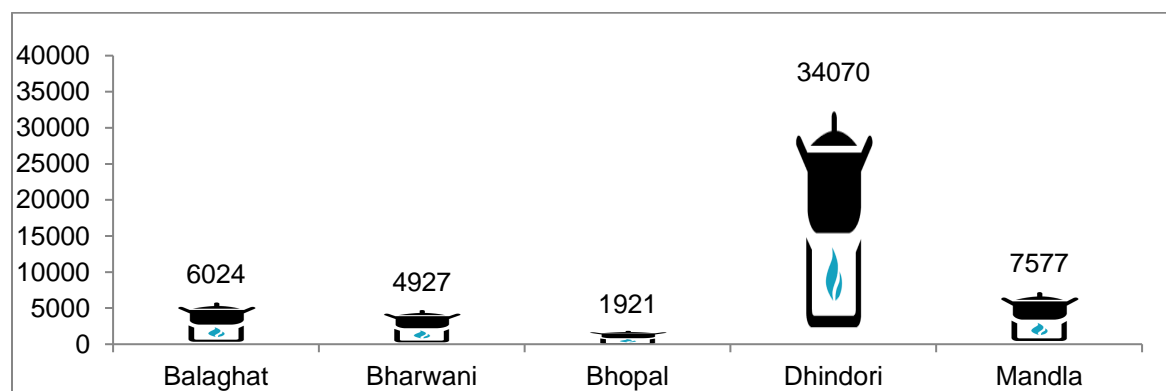
**Table 31: State wise extrapolated demand for SHLS**

State	Demand for SHLS
Madhya Pradesh	Bhopal - 163
Nagaland	Dimapur - 14
Rajasthan	Jaipur – 628 Udaipur -6726
Uttar Pradesh	Bhadohi -552 Lucknow -13314

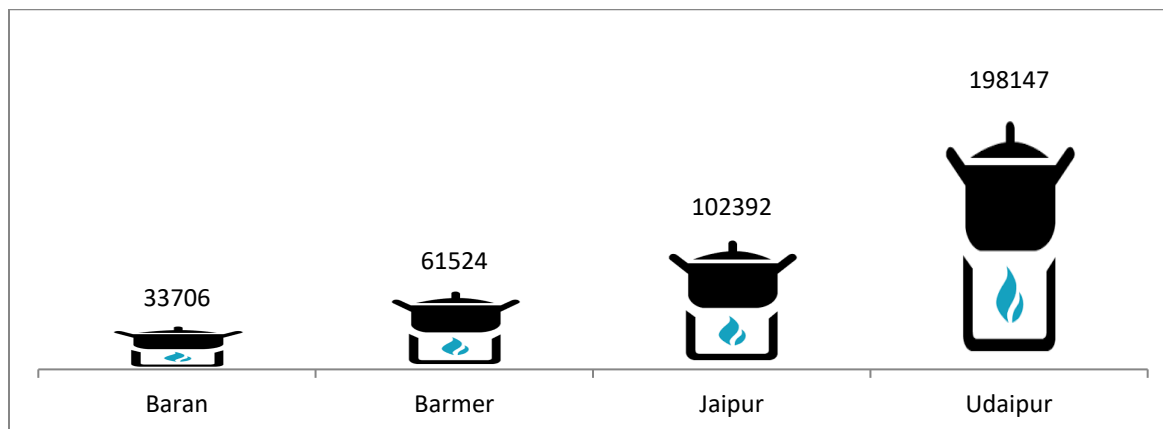
### b. Extrapolating Cooking Demand to District Level

In case of cooking, the demand extrapolation has been done to estimate the demand for improved cook stoves at the district level for the sample districts. The assumption that has been taken in estimating improved cook stoves demand is that only those household that are currently buying firewood, will shift to an improved cook stove. The Figures below summarizes district wise improved cook stove demand for the sample districts. The demand for cook stoves has been found to be the highest in Rajasthan and the lowest in Madhya Pradesh, mainly because the share of SC/ST buying firewood is very high in Rajasthan as compared to other states. In case Madhya Pradesh the number of households that reported that they buy firewood is low (51 respondents out of 508) and thus the district level demands are low.

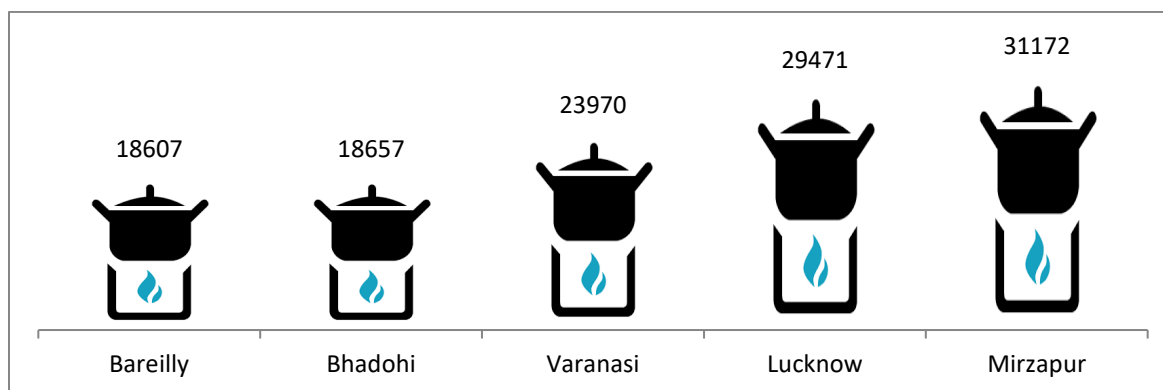
**Figure 34: District wise demand for Improved Cook Stoves (Madhya Pradesh)**



**Figure 35: District wise demand for Improved Cook Stoves (Rajasthan)**



**Figure 36: District wise demand for Improved Cook Stoves (Uttar Pradesh)**





## Chapter Summary:

### Key highlights

- a. WtP has been assessed for five key technologies – Solar lanterns, SHLS, Improved cook stove, solar pumps, Mini-grid. The demand is assessed only for lighting (solar lanterns and SHLS) and cooking technologies (improved cook stove)
- b. WtP and demand for these products is estimated to be as follows for different states:-
  - In Madhya Pradesh 165 households had the WtP for solar lanterns and 11 households were willing to pay for 25 W SHLS and 3 households for 100 W SHLS. For cooking, 51 households of the sample survey were buying firewood and all of them have the WtP to move to improved cook stove.
  - In Nagaland, 5 households had the WtP for solar lanterns and only 1 household had the WtP for a 25 W SHLS
  - In Rajasthan, 141 households had the WtP for solar lanterns and 4 households for 25 W SHLS and 3 households for 100 W SHLS. There were 256 households purchasing firewood and all had the WtP to move to improved cook stoves
  - In Uttar Pradesh, 296 households were willing to pay for solar lanterns, 12 had the WtP for 25 W SHLS and 8 had the WtP for 100 W SHLS. In Cooking, 283 households were buying firewood and all were willing to move to improved cook stoves.
- c. Lighting demand (Solar lanterns)- In terms of the total demand for solar lanterns, it was found that UP had a demand of 213885 lanterns, followed by Rajasthan which had a demand of 170385 lanterns, while MP had a demand of 95, 524 lanterns. Nagaland had hardly any demand for solar lanterns (109).
- d. Lighting demand (SHLS) - The total demand for SHLS was lesser than solar lanterns in all the states. This is because household expenditure was also considered for the extrapolation of SHLS, which was not taken for extrapolating solar lanterns. In MP, only Bhopal had a demand for 163 SHLS, while in Rajasthan, demand for SHLS was seen only in Udaipur and Jaipur (7354 SHLS). In UP, the demand was seen to be 13866 SHLS in Bhadohi and Lucknow districts.
- e. Cooking demand (ICS) - Rajasthan had the highest demand for ICS (395769 cook stoves), followed by UP (121877) and MP (54519). Nagaland had no demand for ICS.

# Conclusions and Way Forward



## Chapter Contents

This Chapter summarizes the key findings of the Study and presents the way forward for increasing engagement of women in these states in terms of increasing their access to RE products, and creating commercial and entrepreneurial opportunities in developing the market for RE products. It also presents contours of an Index that can be prepared to track women empowerment in India

The objective of the Study was to assess the **Willingness to Pay of Women and rural households for RE products and services**. Along with estimating the WtP for the selected technologies, the study also examines the role women can play in market creation and extension of these RE products. A survey based engagement, it entailed conducting a **1600+ household survey** in four states in country, across **32 blocks and 64 villages** along with FGDs with 8 to 15 women in each village and detailed interviews with the retailers and product suppliers in these areas. Majority of the household respondents were women.

The sample selection for the survey was done to ensure that the niche segment of the population – the marginalized section is well-represented. This has been one of the key considerations in the block and village selection. Eight parameters were identified based on which the selection of the marginalized sample was done. The parameters include share of women in population, share of SC/ ST Population, percentage of illiterates, solar energy penetration and electrification level etc. A detailed discussion on the methodology has been in Chapter 2.

In this last chapter of the Consolidated Report, the key findings of the Study are summarized, along with the suggested way forward for improving access to the RE products and at the same time, provide support in developing in women energy enterprise. Lastly, this Chapter suggests interventions that can be undertaken by UN Women as the next phase of the Programme.

## i. Key Findings of the Study

As mentioned earlier, study focused on a niche market – marginalized section. Following are some of the key findings of the study related to the identified the bottom of the pyramid sample. The findings include not only the survey analysis but also detailed modelling exercise that has been done to estimate the WtP as well as the demand estimates for the identified. It is noteworthy to mention here that demand estimated can be considered as minimal level of estimates given that they represent a small section of the population. Following are the key findings of the study:

- a) **Education:** It was observed that the **illiteracy levels were high** across the sample size across three of the four states. While in Rajasthan 78% of the respondents were illiterates, 53% of the respondents from Madhya Pradesh and 68% of the respondents in Uttar Pradesh were illiterate. In case of Nagaland the illiteracy levels was only 16%. For the states where illiteracy level was high, it was observed that the importance of education has been recognized by the population, and for the recent generation, efforts are being made to educate them, irrespective of their gender.
- b) **Livelihoods:** In terms of occupation, majority of the female respondents were home makers or were engaged in agriculture as agri – labourers. In both the cases the **contribution of the women to the economic value creation was underreported and undervalued**. Agri- labourers was a seasonal occupation and the intermittent nature of the income adds to economic insecurity of the respondents. Very small portion of the sample was engaged in MSME activities or entrepreneurial activities. In Uttar Pradesh, in select districts such as Bareilly, women were engaged in home based enterprises, with small scale of interventions, where they were paid on a weekly basis based on the outputs (sarees or pickles etc.) prepared. The Table below presents key livelihood options observed across the four states.

**Table 36: Different livelihood options observed across the four states**

State	Livelihood options
<b>Madhya Pradesh</b>	<ul style="list-style-type: none"> <li>• Most of the respondents were observed to be engaged in agricultural activities or agri-labours.</li> <li>• The proportion of skilled labour was as low as 13% of the total sample</li> <li>• About 70% of the total respondents who have taken up labour (agriculture, unskilled or skilled) as their livelihood option were illiterate</li> <li>• Key livelihood options for women apart from agriculture – Stitching, Patta Plate making and cattle rearing and milk sale</li> </ul>
<b>Nagaland</b>	<ul style="list-style-type: none"> <li>• About 54% of the households were dependent on agriculture as primary source of income and 19% reported service as their key source of income</li> <li>• Women were the lead in marketing of agriculture products – primary produce being bananas, horticulture etc.</li> <li>• Weaving was a common skill and almost all women have the skill</li> <li>• In cattle rearing piggery is the most common livelihood option</li> </ul>
<b>Rajasthan</b>	<ul style="list-style-type: none"> <li>• Out of all the female respondents, 88% were homemakers; of which around 52% were also involved in agriculture related activities. The agriculture related activities include help in agriculture, where the household owns land, and, agri-labour in case of landless households and cattle rearing</li> <li>• Less than 3% of the respondents reported that women in their house were involved in services and MSMEs related activities respectively</li> </ul>
<b>Uttar Pradesh</b>	<ul style="list-style-type: none"> <li>• About 77% of the households were engaged in agriculture and allied activities (agri-labour, skilled and unskilled labour, cattle rearing)</li> <li>• Nearly 87% of the respondents were homemakers. Some of them were also engaged in agri-labour on the lands owned by others in the village</li> <li>• In a few villages, young girls and young women were found to be engaged in pickle making and embroidery</li> </ul>

- c) **Role of SHGs:** SHGs have played differing roles across the four states in mainstreaming women in livelihood options and in achieving financial inclusion. While in Madhya Pradesh and Nagaland the experience had been positive, wherein SHGs has been able to create livelihood options as well as financial inclusion of its participants, however, in Rajasthan and Uttar Pradesh, SHGs have had limited success, especially those with financial linkages. There are a number of institutional and socio-economic reasons for the mixed performance of SHGs, however, there was a unanimous opinion across stakeholders of developing enterprises including home based enterprises through the SHG model.

**Table 37: SHG experience across states of The Study**

State	SHG experience
<b>Madhya Pradesh</b>	<ul style="list-style-type: none"> <li>Majority of the respondents (52%) mentioned that they preferred SHGs for RE financing options</li> <li>The state has active and well performing SHGs</li> </ul>
<b>Nagaland</b>	<ul style="list-style-type: none"> <li>Institutionalization of women based SHGs have been promoted in the State. During 2015-16, as part of the Pradhan Mantri Krishi Sinchayee Yojana, 182 SHGs were formed in the State. Similarly, as part of the state government's "Women in Agriculture" programme, 40 SHGs were formed</li> <li>In select areas, active SHGs were also found. However, not all SHGs were engaged into income generation activities.</li> <li>Nagaland Empowerment of People through Energy Development (NEPeD) provided one-time assistance of INR 15,000 to the SHGs in the village Losami</li> </ul>
<b>Rajasthan</b>	<ul style="list-style-type: none"> <li>SHGs in the State are operating well; however, in the villages surveyed, the case was different</li> <li>SHGs existed in some villages, as the primary source of credit during emergencies for the SHG members.</li> <li>Feedback received - SHGs require significant strengthening as they are not being used as a means of financing in these areas.</li> </ul>
<b>Uttar Pradesh</b>	<ul style="list-style-type: none"> <li>SHGs were the most approached financing channel for availing loan for general purposes. It was reported that while many of the SHGs were present till last year, most of them<sup>64</sup>, were not functioning.</li> <li>One of the main reasons for dissolving SHGs was the financial mismanagement by members. Many SHGs (with bank linkages) dissolved after a year. It was reported that some of the banks required the SHG to function for a year before they could avail loans. Once loan is disbursed, many SHGs lose the drive/inclination to properly maintain minutes of meetings, books of accounts etc. and slowly fall into the trap of financial mismanagement.</li> <li>Amole village in particular had the SHG running for eight years before it went defunct, because of financial mismanagement.</li> </ul>

<sup>64</sup> except in Varanasi and Mirzapur districts



State	SHG experience
	<ul style="list-style-type: none"> <li>Varanasi: Around 4-5 SHGs were functioning in Sivon village and 1 in Jayapur village. SHG in Sivon village was involved in pickle making</li> <li>Bhadohi: SHGs were functioning in Kolahalpur and Dallupur villages. The SHGs in these villages were well-developed and channelizing support to women through Govt. programmes etc. Women were pooling cash and loans were being given to them for meeting small needs etc.</li> </ul>

- d) **RE Awareness and Ownership:** The level of RE awareness varied across the four states with maximum awareness in Rajasthan at 75% households being aware of these products and the lowest was in Madhya Pradesh where only 44% of the population of the products. Contrary to common belief, literacy levels had little role to play in RE awareness creation, as the most prevalent source for awareness were demonstration projects at the Gram Panchayat or block level, Projects implemented in neighbouring villages/ block/ states, word of mouth of friends and families, or visual media. All these sources had no bearing on the respondent's literacy levels. In Madhya Pradesh, Nagaland and Rajasthan households owned RE products that were provided to them either for free under a government initiative or at a substantially discounted price again under a government scheme. The ownership was limited to solar lantern and in very few cases SHLS.
- e) **Preferred RE products:** There were 11 RE technologies, with both consumptive and productive utility, for which the respondents' WtP was examined. The first step in the process was to identify the most preferred technologies for which further analysis was done. The Table below lists the state wise preferred technologies.

**Table 32: State wise preference for various RE products**

State	Solar Lantern	Solar Home Lighting Systems	Improved Cook Stoves	Mini-grid	Solar Water pumps
Madhya Pradesh	✓	✓	✓	NA	NA
Nagaland	✓	✓	NA	NA	NA
Rajasthan	✓	✓	✓	NA	NA
Uttar Pradesh	✓	✓	✓	✓	✓

For RE products such as Solar Drip Irrigation, Solar Water Heater, Biogas Stoves, Solar Driers, Solar PV based food processing system and Solar PV based Chiller there was almost no preference elicited. Two possible reasons for this was (a) the target population under the survey were the most marginalized section of the population, who were mostly struggling to make daily ends meet and thus relevance of these expensive products was limited and (b) the respondents were primarily women with limited

involvement in economic activities (except in the case of Nagaland) and therefore saw limited utility of these products. Lighting products especially solar lantern was the most preferred RE product for all including electrified households as well.

- f) ***Willingness to Pay for the Preferred RE products:*** As discussed in Chapter 2 – methodology section, ALCC approach has been undertaken to estimate the WtP for the identified preferred technologies. The ALCC approach is a cost-benefit approach is relevant from both consumer and supplier perspective as it determines the RE product wise annual pay-out (broken down to monthly levels) that the consumer needs to pay under various business models. From the supplier perspective, the pay-out can be considered to be akin to the payments received under a deferred payment or a PAYG or a rental model for the supplier to recover its investment and to transfer in asset after all payments are made. The transfer of ownership would happen in case of a deferred payment or PAYG model. The monthly pay-outs calculated based on the ALCC estimates have been benchmarked against the current fuel consumed to estimate the number of households that will have the WtP to move these RE products. Product – wise; state wise households and their respective WtP are presented in the Tables below. Demand for the RE products (at the sample level) have also been calculated for lighting and cooking solutions. The Table below also summarize the demand numbers.

**Table 33: WtP and Sample level demand estimates for various RE products in Madhya Pradesh**

Parameters →	Benchmark Cost	Monthly pay-outs	WtP estimates	Demand estimates	
Technologies	Current energy source used	(INR per month)	Households with benchmark cost more than monthly pay-outs	Households with a demand for 1 (qty) of the product	Households with a demand for 2 (qty) of the product
Solar Lantern	Monthly expenditure on kerosene	24.08	165	106	59
SHLS 25W		356.12	11	11	NA
SHLS 100W		492.06	3	3	
ICS Option I <sup>65</sup>	Monthly savings on firewood	36.92	51	50	
ICS Option II		81.22	51	1	

<sup>65</sup> The ICS options have been decided based on the household size they can service. The ICS Option I can service upto 8 members' household and ICS Option II can service a household with more than 8 upto 15 households.

**Table 34: WtP and Sample level demand estimates for various RE products in Nagaland**

Parameters →	Benchmark Cost	Monthly pay-outs	WtP estimates	Demand estimates	
Technologies	Current energy source used	(INR per month)	Households with benchmark cost more than monthly pay-outs	Households with a demand for 1 (qty) of the product	Households with a demand for 2 (qty) of the product
Solar Lantern	Monthly expenditure on kerosene	27.08	2	2	3
SHLS 25W		378.29	1	1	NA

**Table 35: WtP and Sample level demand estimates for various RE products in Rajasthan**

Parameters →	Benchmark Cost	Monthly pay-outs	WtP estimates	Demand estimates	
Technologies	Current energy source used	(INR per month)	Households with benchmark cost more than monthly pay-outs	Households with a demand for 1 (qty) of the product	Households with a demand for 2 (qty) of the product
Solar Lantern	Monthly expenditure on kerosene	24.08	141	133	8
SHLS 25W		356.12	4	4	NA
SHLS 100W		492.06	3	3	
ICS Option I	Monthly savings on firewood	36.92	268	256	
ICS Option II		81.22	268	12	

**Table 36: WtP and Sample level demand estimates for various RE products in Uttar Pradesh**

Parameters →	Benchmark Cost	Monthly pay-outs	pay- WtP estimates	Demand estimates		
Technologies	Current energy source used	(INR month)	per	Households with benchmark cost more than monthly pay-outs	Households with a demand for 1 (qty) of the product	Households with a demand for 2 (qty) of the product
Solar Lantern	Monthly expenditure on kerosene	24.08		296	280	16
SHLS 25W		356.12		12	4	8
SHLS 100W		492.06		8	8	NA
ICS Option I	Monthly savings on firewood	36.92		295	283	
ICS Option II		81.22		295	12	

In case of Uttar Pradesh, during the FGDs respondents had elicited their WtP for products such as solar water pumps and Mini-grid. However, during the survey, the willingness was not mentioned. Thus, for both these RE products/ service the business model that can be applied has been discussed in this Report. In case of solar water pumps, a rental model is expected to be relevant as currently diesel pump sets are being used by the farmers on an hourly rent basis. In case of a solar water pump the rental is INR 122/ hour for a 3 HP pump set and INR 130/ hour for a 5 HP pump set.<sup>66</sup> These rentals are in line with the rent currently being paid in Uttar Pradesh by the farmers for diesel pump sets.

In case of Mini-grid, it is expected that it will cater to both productive and consumptive uses of the service area. It is expected that both productive and consumptive loads will co-exist in the service area, as it will give an opportunity to the MGO to provide electricity at a competitive rate to the domestic consumers by either cross subsidising them with the commercial/ anchor loads or by availing a subsidy from the government or both. During our survey, Mini-grid was mentioned to be a preferred RE technology only in Uttar Pradesh as the State has a high percentage of unserved and underserved electricity population and the co-location density of these households is high, thus minimizing the Public Distribution Network (PDN) requirement of the Mini-grid.

**g) Extrapolation of demand for the product to the district level:** As the sample survey was representative of a niche section of the population, the sample level RE demand numbers could not be extrapolated for the entire district or state. However, based on the marginalization

<sup>66</sup> Assuming that the solar pump will be used for 6 months only for 8 hours daily

parameters (SC / ST population at the district and sample level), the demand for the lighting and cooking solutions was extrapolated at the district level for each of the states. The Table below presents the extrapolated demand numbers. These are conservative numbers as they represent only a part of the population, which is also the most marginalized and thus have lower demands.

**Table 37: State-wise District level extrapolated demand for lighting and cooking solutions**

State	Solar Lantern		Solar Home Lighting Systems		Improved Cook Stoves	
	Number	% share of Total	Number	% share of total	Number	% share of Total
<b>Madhya Pradesh</b>	95254	19.86%	163	0.76%	54519	9.53%
<b>Nagaland</b>	109	0.02%	14	0.07%	NA	NA
<b>Rajasthan</b>	170385	35.52%	7354	34.37%	395769	69.17%
<b>Uttar Pradesh</b>	213885	44.59%	13866	64.80%	121877	21.30%
<b>Total</b>	<b>479633</b>	100.00%	<b>21397</b>	100.00%	<b>572165</b>	100.00%

These numbers can also be interpreted as conservative market potential for these products for the districts in which the survey was conducted. Also, if the comparative shares of the states across the product categories is analysed, it is seen that districts in Uttar Pradesh offer to be the biggest market to be tapped into. In case of cooking solutions, Rajasthan takes the lead as it has high concentration of marginalized population (as defined for the analysis) as compared to the other states. Nagaland, albeit looks to be small market from the survey, however, taking in view the low electrification levels in the State, it can be a potential market to be explored in the near to medium term. Madhya Pradesh is representative of a market where electrification levels have significantly improved, however, the market for solar lanterns still remains on account of poor quality of electricity delivered and the infrastructure bottle necks that exist in servicing areas through the grid.

In sum, it can be said that **Nagaland** is a nascent market for these RE products. On the other hand, **Uttar Pradesh** is known large market for a variety of RE products ready to be explored. **Rajasthan** presents a market case for RE products, where households are sparsely located in large arid areas. And finally, **Madhya Pradesh** presents a case for RE products where current electrification levels may be good, but the quality of supply is still a concern.

- h) **Engagement of women in RE Supply chain** – A key component of the Study was to examine the effectiveness of the current RE supply chain the districts and analyse the role women can play in deepening these supply chain and emerge as energy entrepreneurs. The Survey and the

interactions with the existing retailers revealed that the current RE Supply Chain is not adequate to service the market. Lack of after sales service and distance from the nearest point of sale were they key reasons stated by the respondents as the barriers limiting offtake of RE products.

The engagement of women in the RE supply chain was completely missing. However, the retailers are keen to engage women in the supply chain as they are more honest and sincere workers. Women were also very keen in participating in the RE supply chain and other alternate livelihood options. However, they themselves highlighted the need for adequate training, skill development and hand holding.

- i) **Financial inclusion** – Another component of the survey was to analyse the level of financial inclusion in the surveyed villages. It was found that almost all the respondents (average 98.25%) had Aadhaar cards. However, ownership of bank accounts varied across the states. While in Nagaland nearly 70% of the households had bank accounts and in the other three states the ownership was more than 94%. Despite having a bank account, it was seen that respondents preferred to take loans from family and friends or the local money lender. Most of the loans were taken for meeting marriage expenses or for agriculture related expenses. Loans for assets were less prevalent and awareness for RE related financing products was limited. The role women played in these financial decisions was also limited, wherein in most cases it was the men folk who took most of the financing decision, in consultation with the women of the household.

Given the above findings of the study, in the subsequent section we present possible solutions that can be implemented to enhance role of women in RE supply as well as create entrepreneurial opportunities for these women. The broad contours of developing a Women Energy Centre is presented in the subsequent section and following that there is a larger discussion on key parameters to be considered while developing a women centric enterprise. The section also specifies the role UN Women can play in mainstreaming gender in energy provisioning.

## ii. Way Forward and Role of UN Women

Gender is the developmental face of energy access. Engaging women is imperative to ensure sustainable use of RE products, as they are not only instrumental in making the energy choices of the current generation, but can shape the choices of future generations as well. Following are some of the suggestions that can be considered in order to mainstream women engagement into the RE supply chain.

### a. Develop a 'Women Energy Centre'

The ***Women Energy Centre (WEC) is a hub and spoke model for developing a women oriented RE supply chain.*** It is proposed that the WEC can be located at any place with road connectivity. This will be important as the centre ought to be well connected with the rest of the market players. The key activities that the centre will undertake are as underlined:

- a) Assembly and customization of RE products;
- b) Manufacturing of few of the key components of the products;
- c) Godown for raw materials;
- d) Training centres for women;
- e) Feeder to stockists/Distributors/big retailers;

- f) Responsible for the required awareness building campaigns;
- g) Establish the distribution channel;
- h) Branding of products and services;
- i) Establish and run Mini-grid projects;
- j) Support the trained women entrepreneurs – ideally the WEC Centre should provide market and credit linkages, subject to the agreement of the project stakeholders.

The WEC will be act as a feeder to the market and incubation centre for prospective women entrepreneurs

### ***Who will manage the WEC***

The WEC will be managed by a group of women who will be given a legal entity. For the initial few years the WEC will be supported by a specialized agency with a pre-defined Scope of Work. It can be made one of the tasks for the Agency to make the WEC self-dependent and to be managed by training women force after few years of hand-hold support.

### ***Fund support***

The WEC would require initial support for establishment, which may come in the form of grant to create the infrastructure and bear the costs for few years till the time this becomes self-dependent. The initial support in the form of a grant may come from UN Women with support from Central and state government agencies. The proceeds from the sales of products and services will form a revolving fund which will be ploughed back to WEC.

### ***Product***

It is proposed that the WEC will be one-stop shop to meet all the energy requirements of the area to be serviced. This will include Solar Lanterns, SHLS, Improved Cook Stoves, solar water pumps, solar cookers etc.

### ***Branding***

The initiative would require branding to make the people aware of the WEC, products and services, quality, differentiation of these products and services, etc. The exercise can be undertaken by the agency that is responsible for managing the WEC for the first few years. ***The unique selling point for WEC can be quality but affordable products and services promoted by Women*** and this should feature in most of the branding exercises. Social media should be used for this purpose as this has huge and very fast penetration even in rural and semi-urban areas.

### ***Creation of distribution network***

The WEC will be largely an assembly, customization, and supply hub for the RE products and services apart from the activities related to entrepreneurship development activities. Once the ***products are customized and assembled, these will be pushed in the market through existing chain of big and small retailers.*** In a typical rural market the big retailers act as distributors of products and supply the products to small retailers, located at the village level on cash or credit.



### **Training**

It will be the responsibility of the WEC to create skilled team for O&M services on the ground. **Training on assembly of products, manufacturing, O&M aspects will be provided to the select prospective entrepreneurs.** It is proposed that the trained team is attached to the retailers. These O&M technicians may become sales and AMC agents for retailers.

Livelihood based training programmes can also be imparted by WEC. It may start with couple of identified livelihood options that has been identified through the survey. However, the WEC may add other livelihood areas going in future. Specialised training programmes involving relevant agencies will be conducted by WEC.

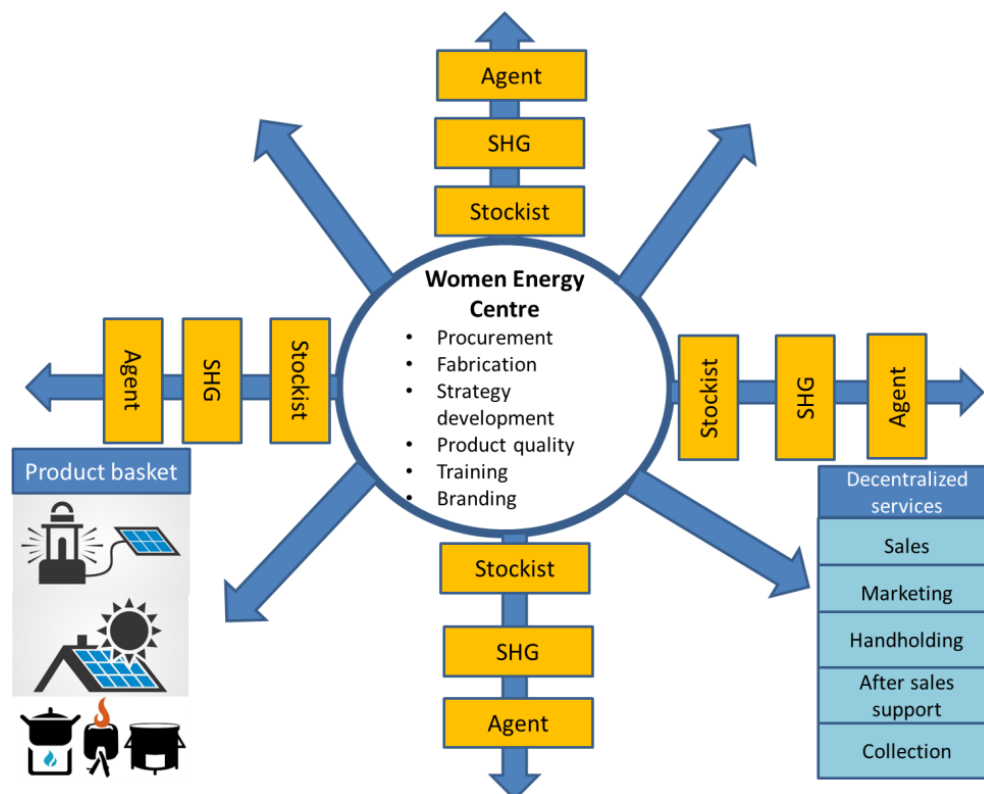
### **Mini-grid projects**

It may be noted that the MNRE is preparing a Mini-grid Policy guidelines and few of the states have taken initiatives in formulating Mini-grid Policy and Regulations. The risk of arrival of grid is being addressed in the policies and regulation. The Government of India is working towards Power for All to provide 24\*7 power to all consumers. However, in the view of low tariff in rural areas, which does not even recover the cost to supply for Discoms, supplying power 24\*7 to rural consumers still seems a distant dream. In the present context as well Mini-grid projects can be integrated well with the Power to All wherein these could act as tail end of the grid project and supplement to the grid.

**WEC will also undertake Mini-grid initiatives in unserved as well as underserved areas.** Typically the viability of the project is ensured by catering to the energy requirement of anchor loads such as telecom towers, hospitals, petrol pumps etc. and also meeting the requirement of households, commercial, and community based loads. The WEC may **train women entrepreneurs on the Mini-grid aspects, comprising technology, O&M, metering, billing, and collection.** Further, the prospective entrepreneurs could also be given exposure of the applicable approvals and NOCs, Right of Way mechanism for distribution network (if applicable), interconnectivity, book keeping and accounts etc. The Mini-grid projects can be owned by WEC and it can also provide support to prospective women entrepreneurs to set up projects.

A diagrammatic representation of the WEC is presented below.

Figure 37: Suggested structure of the Women Energy Centre



#### Role of UN Women in developing Women Energy Centre

- UN Women can implement the concept of Women Energy Centre at an identified location as a pilot to establish the business case and standard operating procedures for such a women driven supply chain model
- UN Women can liaison with the concerned agencies and government departments to sensitize them on the need for such pilot and facilitate the engagement
- UN Women to engage experts in supporting it in implementation of the pilot

#### b. Database for women centric metrics

India has a number of databases where the economic and social performance of the economy is tracked. For instance, the Census of India tracks decadal growth parameters of the economy, and National Sample Survey Organisation (NSSO) surveys, which capture select parameters such as energy growth patterns, types of housing, status of sanitation etc. through a consumption expenditure lens spread across the country, split in terms of parameters including geography (state, district, rural and urban) or economic (consumer expenditure) or caste etc. However, there are limited databases that capture women centric metrics. The Census does track some metrics on the basis of female headed households; however the granularity of the data differs from the data captured for rest of the economy. Moreover, decadal growth tracking will have limited relevance for the urgency of the interventions required to mainstream women engagement.

Thus, it is suggested that a **women centric database may be created to track the performance of important parameters** and document the contribution done by women in economic and social development of the economy. Some of the possible data points are mentioned in the Box alongside.

### Develop Women Empowerment Index (WEI)

There are challenges in developing such a women centric database. For instance, in case of a home based enterprise<sup>67</sup> there is a close overlap between enterprise role and household responsibility of women. There is a high likelihood of a possible spill over between the two, which can limit the women being able to deliver on either of the roles. Such an impact which could differ from woman to woman and enterprise to enterprise could have income impacts that typically such a database should capture. Women also at times sacrifice on potential gains in business and enterprise development in order to balance between home and work responsibilities. Women are more susceptible to sacrifice on these potential gains as compared to men of the household. Another challenge will be to quantify women empowerment. The most relevant measure for empowerment will be the level of control or involvement women in household decision making including financial and income related decision. Unlike parameters mentioned in the Box above, this is a fuzzy metric that needs to be developed and will require detailed analysis to be done with suitable proxies to develop the **Women Empowerment Index (WEI)**. The WEI will capture a number of aspects of women empowerment such as (a) access to resources; (b) reduction in drudgery; (c) role in decision making at the household level; (d) access to market and independence to take financial decision; (e) presence of women in community leadership roles; (f) improvement in female centric health, education, energy, sanitation, water and other development parameters etc. Development of women centric database will act as an input in developing this index and thus both of the actions are closely linked. Broad contours of the WEI are presented in the Box below.

#### Box 4: Illustrative list of women centric database

- Asset ownership
- Household income
- Household consumption expenditures
- Mobile technology access
- Banking access
- Access to government (Ujjwala, MNREGA etc.)
- Access to basic amenities
- Type of household
- Income from enterprise

#### Box 5: Contours of Women Empowerment Index for India

Women Empowerment Index (WEI) is a powerful tool for building awareness on the socio economic status of women and how empowerment is moving with advancement of policy and economic development. Institutions such as the United Nations Development Programme have a Gender Inequality Index to measure development of women along with human development index. UNDP considers gender inequality the biggest barriers in economic development, thus highlighting the need to track the performance of women empowerment to ensure inclusive economic development. Women centric international organizations such as The Hunger Project also have developed a global women empowerment index to track mainstreaming of women in economic

<sup>67</sup> As seen in Uttar Pradesh

development.

India has also started to consider developing a Women Empowerment Index<sup>68</sup>. At the current juncture, it is a timely proposition and needs to be taken forward and the index needs to be in line with the government priorities of gender mainstreaming. Following are the broad contours for developing such an Index:

a. **Indicators:** Women Empowerment can be measured with the following indicators<sup>69</sup>:

- *Resource:* The availability and access of resources required by women to achieve equality in the society
- *Leadership:* Women representation and participation in various policy and decision making authorities of the Government (Central Government, State Government, Local Government)
- *Employment:* The availability of equal opportunities for employment including equal wage rates, equal terms of employment, etc.
- *Income:* The freedom for women to earn livelihoods and ability to exercise control over their income
- *Agency:* The ability of women to make decisions and freely control their resources along with ability to implement their decision without any hindrance or fear of consequences
- *Time:* The number of hours spent by women in pursuing productive work or in leisure activities, reducing their drudgery rather than doing domestic work (hard / menial / dull / repetitive work)
- *Health:* Access to quality health care and proper sanitation, reduced maternal mortality rates
- *Asset Ownership:* Fixed assets such as land, house, savings, in the name of the female members of the family
- *Education:* Freedom to access to education and pursue higher education
- *Emotional Well-being:* Freedom from physical and emotional abuse, improved self-esteem, ability to take individual decisions, etc.

b. **Frequency of Calculating Index:** The frequency can vary from annual to once in five years. It is suggested that it may be in the beneficial to track it one in two years, as there is lag in the impact to set on women in case of a policy or any other intervention.

c. **Source of data:** The Index will be a mix of quantitative and qualitative indicators and the data for which may require primary data collection (interviews, surveys, FGDs) as well as data will need to be sourced from secondary sources such as Census, NSSO, Human Development Index. The secondary data may be required to be refined for the purpose of calculating this index because many times specific data is not available or the available data overlaps with each other. For instance in Census reports data regarding availability of electricity and sanitation in the Female Headed Households (FHH) overlaps with each other in the sense that number of FHH having access to both or either of the services is not determinable. It would be desirable to track access to basic amenities of women individually rather than clubbing the basic amenities together.

d. **Ownership:** The Index can be housed at the centre or with a interested state government The owners will need to be identified suitably. In case of centre NITI Aayog or Ministry of Statistics and Policy Implementation may be relevant and in case of State the requisite State Departments will need to be on

<sup>68</sup> <http://economictimes.indiatimes.com/news/politics-and-nation/government-will-soon-come-out-with-a-women-empowerment-index-for-states/articleshow/59184776.cms> accessed on 20<sup>th</sup> July 2017

<sup>69</sup> This is an indicative list

boarded.

While this will be tedious exercise, but will help bring in gender perspective in our data bases that can help make policies more gender sensitive. In order to develop such a database it is suggested that linkages can be made with *NITI Aayog* and/ or *Ministry of Statistics and Programme Implementation* on developing the database and the Index.

The WEI is perfectly in line with the mandate of UN Women. It is suggested that they take this up on priority. Moreover, as GoI is also interested in it, they can be the ready beneficiary for the project. Thus far does not have an index such as this, hence it can be an opportunity for UN Women to engage in pioneering work for gender mainstreaming in India.

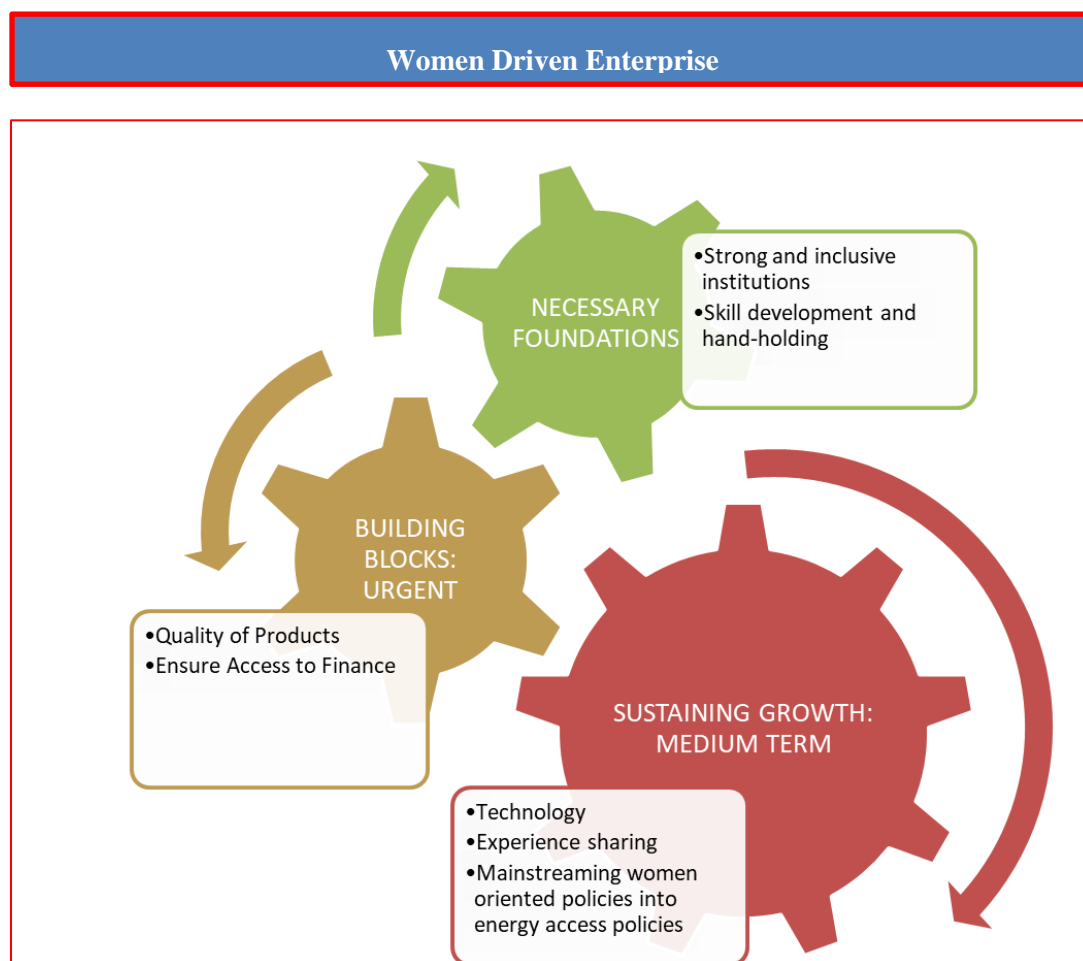
#### Role of UN Women in developing Women Centric Database

- UN Women can institute a study that can define the framework and the *modus operandi* of developing the Women Centric Database
- UN Women can liaison with the concerned agencies and sensitize them on the need for such a database
- UN Women to engage experts in developing Women Empowerment Index
- UN Women may take the WEI on priority, as is in line with GoI priorities. Thus far does not have an index such as this, hence it can be an opportunity for UN Women to engage in pioneering work for gender mainstreaming in India.

### c. Integrating women into RE supply chain

Engaging women in the RE supply chain and the benefits of the same for the women folk as well as the retailers are well understood. However, the challenge that still remains is to identify the blocks where action is required to facilitate women engagement. There are some building blocks that are required to create an ecosystem which will help women to develop their capabilities as entrepreneurs and prosper. The Figure below presents the building blocks of developing facilitative ecosystem for women driven enterprises.

Figure 38: Components of developing a Women Driven Enterprise



### ***Strong and inclusive institutions: Leveraging on SHGs***

The most crucial aspect of building an ecosystem that promotes women engagement is to build a robust institutional structure that will support them. From the field the feedback received was that SHGs were the preferred institutional model. In Madhya Pradesh close to a third of the respondents preferred SHGs as a means for financing and in Uttar Pradesh, specifically in districts of Varanasi and Bhadohi SHGs were well functioning in creating employment opportunities for the women. There are a number of government schemes, Central and state governments, which promote establishment of SHGs. Based on the review of the schemes undertaken, it is suggested that the ***SHGs that have been built under the NRLM*** and its state missions can be one of the institutional structure for developing women entrepreneurs. The SHG creates a joint pressure of the Group to perform and the peer pressure is expected to ensure performance.

A concern that was raised in our interactions in Rajasthan and in some districts of Uttar Pradesh was that SHGs with financial linkages have not been that successful. Here it is suggested that learning needs to be drawn from such SHGs to avoid replication of the mistakes.

***Learning from Past SHG Experience:*** From our understanding of the ground situation, it is suggested that SHGs should be of group of women with similar socio-economic background and skills. In such a

case it becomes an equal opportunity group with each participant having a say in its functioning and creating the much needed peer pressure to perform. Along with learning from the unsuccessful SHGs, it is suggested that detailed study needs to be done of SHG experience at an all India level to see what the factors that make them a success are. Also, parameters for defining a well performing SHG also need to be understood, to ensure that the institutional structure proposed is sustainable.

**Framework for SHG engagement and performance evaluation:** For developing the ecosystem supporting women based enterprises, an engagement strategy will need to be developed for engaging SHGs. As has been seen from the Study, the performance of SHGs has been mixed, wherein there have been successful SHGs and at the same time there have been SHGs, which have had concerns with their performance. In order to ensure well performing SHGs are roped in, it is suggested that a framework that lists parameters on which SHG performance can be evaluated and based on that the most suitable SHGs are roped in. If required a competitive process may be followed for engaging the SHGs as well as to ensure that their performance levels are maintained.

#### Role of UN Women in developing institutional structure for women driven enterprise

- UN Women can undertake a study on the experiences of SHGs in India to understand the drivers for their success or failures SHGs in India
- UN Women can work with experts to develop an engagement framework and strategy for on boarding SHGs for women driven enterprises
- UN Women can create a platform for experience sharing sessions and learning from each other for SHGs

#### Skill development and hand holding

A feedback received during the FGDs was the need to be provided adequate training and skill development for the womenfolk to look at alternate livelihood options. This is a core area of intervention to mainstream women into the RE supply chain. Training will be required in technical areas, soft skills as well as enterprise management. There are a number of on-ground training institutions that can be tapped for implementing the training. Institutes such as **National Institute of Entrepreneurship and Small Business Development (NIESBUD)**, which has programmes on entrepreneurship on solar energy, **Rural Self-employment Training Institutes** been set up under Ministry of Rural Development (MoRD) to impart skills and training to rural youth for becoming entrepreneurs are some of the options. Within the energy sector, the **Surya Mitra programme** of Ministry of New and Renewable Energy (MNRE) which provided training on operations and management of managing solar installation can be a good starting point.

There are other GoI schemes such as **STEP** and **TREAD**, discussed earlier, is an existing training platform with incentives that can be tapped on to support capacity development.

For entrepreneur activities beyond energy, livelihood specific training can be provided in coordination with relevant **employment oriented organizations** such as Rangсутra and Sewa Mandir, which provide support in developing artisans in their area of work and then marketing and sale of the products.

It is suggested that efforts are made to dovetail the skill development and training programme with the Skill India Mission. There are scheme such as the Pradhan Mantri Kaushal Vikas Yojana (PMKVY)



under which synergies can be made for providing training in the areas of soft skills, entrepreneurship, finance and digital literacy.<sup>70</sup>

Along with training, **hand holding support** will be essential to support women to pick their livelihood options. Engaging with the women and their families on a regular basis, supporting them in seeking clarifications to their questions, clarifying any doubts that women or families will have and highlighting the benefits that will accrue to the women and her family will all be part of the hand holding support. A diligent hand holding support is important to give confidence to the women and trust to the family/community of the engagement and the benefits that will accrue of them.

**Role of UN Women in undertaking skill development and hand holding for women driven enterprise**

- UN Women can institute a training needs assessment of the identified set of women
- UN Women can liaison with relevant training institutes for undertaking the identified training for women
- UN Women can support mapping of existing Central Government and State schemes, especially those focusing on skilling and training to examine the synergies that can be established to support training and capacity building of the women folk
- UN Women to identify areas of synergy between training requirements of women and the Skill India and various scheme under it
- UN Women to on board NGOs to undertake the hand holding for women, their family and community to support the women in becoming entrepreneurs

**Ensure access to finance**

While institutions and skill are the cornerstones of eco system to support entrepreneurship, access to finance is the building block for developing a facilitative ecosystem for women entrepreneurs. Lack of access to finance implies concerns in terms of both quantity and cost of finance. It has been observed that most of the rural population is still dependent upon traditional sources of funding such as borrowings from friends and families and local lender. The respondents reported that they typically require small amount loans for short duration; however banks usually do not offer such products. More so, the paper work that goes in availing bank loans are tedious and thus act as a deterrent for respondents to use this channel of financing. It was also observed that respondents face difficulties in accessing bank loans as there could be locations, where banks do not exist. In such scenario, banks the villagers preferred loans from local lenders.

In order to tide over these concerns, it is suggested that **women entrepreneurs can consider aggregating their financing requirements**. The SHG structure will be helpful in meeting this requirement. This will also help in in accessing better financing terms in the formal banking channels. Moreover, the WEC

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<sup>70</sup> <http://www.skilldevelopment.gov.in/pmkvy.html> accessed on 18th July 2017

concept discussed in the foregoing section is an ideal platform for aggregating the finance requirements over multiple levels to ensure easier and cheaper access of finance to the women entrepreneurs.

Typically the awareness level among women for the financing processes is low. Here it is suggested that **women centric awareness sessions** need to be organized to improve their familiarity and understanding about financing structure. Technology can also play an important role in supporting women accessing the financing channels. These are discussed in the detail in the technology section. Also, it is suggested that a **'Women Entrepreneurs Banking Toolkit'** can be prepared that will document banking processes that they need to be aware of to access the banking finance.

#### Role of UN Women in improving access to finance

- UN Women can support women entrepreneurs in aggregating their financing demands through SHGs
- UN Women can support organization of women centric awareness sessions for helping them understand the banking structures, products and relevant schemes
- UN Women can support preparation of a 'Women Entrepreneurs Banking Toolkit' which would act as their ready reckoner to access the bank facilities, loan process, documentation requirement all from the perspective of setting up a women owned enterprise

#### Ensure quality of product

Product is the interaction point between the entrepreneur and the consumer. A spurious product is a double edged sword as poor quality products do not last as long as committed and such products act as a deterrent for people to shift to RE products. Thus, it is of utmost importance that to ensure sustained shift to RE products the entrepreneur needs to build trust among the new users and retain the current users. While **developing capacities of women entrepreneurs**, it is essential and they are sensitized to the importance of good quality products. Here they will also need to be **trained on technical parameters to identify spurious quality products**. The quality parameters will need to be clearly specified and if while developing the eco system, **quality labs need to be integrated into the eco system to support usage of quality product**. Similar approach was adopted by IFC under its Lighting Asia programme, wherein, it had instituted quality labs to ensure supply of quality products to women entrepreneurs for sale under its flagship programme.

#### Role of UN Women in ensuring quality of the product

- UN Women can organize technical training programmes to sensitise women on the technical aspects of RE products
- UN Women to on board labs that will ensure quality product are supplied in the RE supply chain.

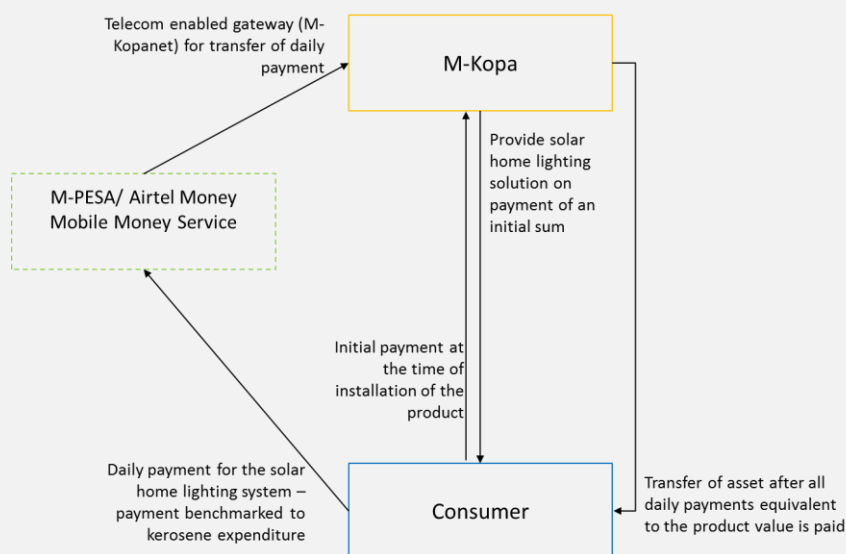
## Technology integration

Technology can be a game changer that will impact how we use electricity and pay for it. Mobile telephony as a technology intervention has changed the communication landscape, and is steadily evolving further. It can be combined with financial and banking infrastructure to support. M Kopa in Kenya used mobile technology to provide energy access. The experience is presented in the Box below.

### Box 6: M-Kopa experience of incorporating technology for service delivery

In the SHLS space, Pay As You Go (PAYG) model is one of the preferred models and it has been implemented across the world with some variations. The M-Kopa model adopted in Africa is one of the most referred business model under the PAYG model. It has combined mobile technology with energy supply to put forth a model that is sustainable, replicable as well as scalable. The model uses GSM technology for monitoring and metering usage. The Figure below provides a snapshot of the design of the business model adopted by M-Kopa to service the population.

**Figure 39: Business model adopted by M-Kopa**



The aim of the model was to make SHLS an affordable solution of the energy deprived in Kenya. At the time of purchase of the product, the consumer has to make an upfront payment and following that on a daily basis part payments are made, till the time that entire cost of the SHLS is paid. After that the product/ asset is transferred to the consumer. ***The daily pay outs are linked to the kerosene consumption of the consumer. This approach is similar to the WtP approach that has been adopted in the Study for estimating the WtP for these products.***

As of May 2017, M-KOPA has connected over 500,000 homes to affordable solar power. Current customers will make projected savings of US\$ 375 Million over the next four years. M-KOPA's customers will enjoy 62.5 Million hours of kerosene-free lighting per month. Total employment created in East Africa is 2,500 people.<sup>71</sup>

<sup>71</sup> <http://solar.m-kopa.com/about/our-impact/> accessed on 14<sup>th</sup> June 2017

With advent of Aadhaar, opening of Jan Dhan accounts and mobile wallets, it is seen that the financial infrastructure is also in place in most parts of the country. Majority of the respondents had mobile phone, albeit the use is currently limited to calling and using the flash light in the dark. Going forward this is expected to change, and ecosystem created for any business needs to incorporate the same. The same is the case for the proposed women driven enterprise ecosystem.

In the proposed system, use of IT will be required for easy coordination across the various levels of RE supply chain to perform multiple functions including easy tracking of RE sales, performance tracking, consumer feedback, operations and maintenance, payment and other recordkeeping etc. Women engaged in the enterprises will need to be brought up to speed with technology developments. Here again, training on possible technology interventions will be required. While developing business models, building a layer technology may facilitate the process of delivery of services.

#### Role of UN Women in technology integration

- UN Women can organize technical training programmes to train women entrepreneurs on use of technology to deliver energy services. This may also include academic training to the entrepreneurs on relevant technology infrastructure
- UN Women can work closely with women entrepreneurs in developing business models that incorporates technology intervention.
- Liaison with technology providers to help develop the technology layer in implementing the identified business model.

#### Mainstreaming women oriented policies into energy access

Last but not the least; conducive policy environment is a key part of building suitable women centric entrepreneurship model. As discussed earlier, there are a number of women centric policies that are currently operational. Alternatively, there are schemes where women have been integrated as the key beneficiary. For instance, in the Ujjwala scheme under the aegis of MoPNG the free LPG connections are given to BPL consumers. However, the Scheme stipulates that the connection will be in the name of the woman of the BPL household. Other schemes such as TREAD and STEP aim to provide training and capacity development support and at the same time concessional financing terms to support women owned enterprises. Similar programmes also exist at the state level and programmes such as NRLM have been decentralized at the state level Missions. This creates a good platform for engaging with central and state governments and to create a decentralised model for women engagement. ***Dovetailing on the existing policies will ensure faster on boarding of stakeholders that could help further mainstreaming of women.*** The stakeholders include Central and state government, NGOs operating in the area, retailers, financing agencies, if any. UN Women would have a substantial role to play here as a bridge between the entrepreneurs and the policy makers, such that issues of women led enterprises are communicated to policy makers and at the same time, these women are fully versed with the existing policy interventions and how these can be utilized in building sustainable businesses.

#### Role UN Women can play in mainstreaming women oriented policies in energy access

- UN Women to act as an advocacy agency pushing for gender mainstreaming in energy

#### policies

- Along with energy policies, UN Women to engage with other relevant ministries, government departments and other similar bodies, to mainstream women based enterprises
- UN Women to work with the women entrepreneurs in helping them understand policy interventions and how these policies can help them in functioning of their enterprises.

From the above, it is clearly established that UN Women has a number of areas where its interventions is required in order to main stream women into energy enterprises as well as the incentivise women led entrepreneur initiatives. It is suggested that UN Women along with its partners can consider undertaking a ***pilot to establish a test case for women centric energy enterprise***. As part of the test case UN Women can incorporate all the components of women driven enterprise discussed above. The Women Energy Centre discussed earlier can be one possible option for the pilot implementation that can be considered by UN Women. A successful test case implementation will have impactful learning for all stakeholders including local, state and Central Government, NGOs, product suppliers, service operators, women entrepreneurs, technology providers, skilling organizations, community etc. These learning will need to be documented so that it can be replicated or improvised upon subsequently.

Role women can play in energy provisioning is immense. An active engagement of women in energy provisioning will benefit not only one generation but also generations to come. Thus, UN Women has an important role to play in mainstreaming women into the energy provisioning and creating a lasting impact of bringing clean, sustainable and gender inclusive energy into the lives of many.



## Chapter Summary: Key highlights

Applying a gender lens to energy access programme design and implementation paves the way for empowerment of women. This can be done in the following ways:

- a. **Develop WEI for India:** A Women Empowerment Index for India will be pioneering and path breaking work in line with the mandate of UN Women. It is suggested that it is taken up on priority.
- b. **Developing a Women Energy Centre (WEC)** – This model is envisaged to be a hub and spoke model focusing on creating women owned and managed energy enterprises and enterprises/livelihoods using energy. It will be broadly be responsible for the following activities:-
  - Procurement of components;
  - Assembly of RE products;
  - Managing inventory;
  - Providing training for women;
  - Acting as feeder/stockists to distributors;
  - Branding of products;
  - Running Mini-grid based projects;
  - Facilitating market and credit linkages

UN Women can implement the WEC as a pilot in an identified location to establish the business case of setting up the centre. It may engage experts in supporting it in implementing the pilot


It is envisaged that initially the WEC will be operated by a group of women who will be given legal recognition. The WEC may be supported by an agency in the initial phase by providing them handholding support and later WEC can operate on its own. The funding may initially be through grants and once the Centre becomes fully operational and starts generating revenue, the proceeds from sales can be ploughed back for its sustained operation. The WEC may also be involved in the operation of Mini-grid either on their own or they may provide training to other women entrepreneurs in the state to set up Mini-grid.

- c. **Developing a database of women centric metrics:** A women centric database may be created to track the performance of important parameters measured for females (e.g. asset ownership, banking access, income from enterprise, energy access etc.). These metrics are only indicative and many more parameters can be considered for the database.

UN Women can initiate a study that will define the framework and *Modus Operandi* of developing the database. It may engage experts in developing a Women Empowerment Index.

d. **Integrating Women in the RE Supply chain:** Women can be engaged in RE supply chain through creating strong and inclusive institutions and ensuring access to finance and quality products. Further, experience sharing and dovetailing energy access and women oriented policies would ensure their sustained operation.

- To build strong institutions, SHGs that have been built under NRLM can be strengthened and leveraged for development of WEC.
- Skill development and hand holding support can be provided through the institutions created by the Govt. such as National Institute of Entrepreneurship and Small Business Development (NIESBUD), Rural Self-employment Training Institutes been set up under Ministry of Rural Development (MoRD) etc.
- Access to finance by creating awareness sessions and knowledge products such as “Women Entrepreneurs Banking Toolkit”.  
Women can also aggregate their financing requirements and approach formal financing channels such as banks.
- Quality of products can be ensured by creating quality and testing labs and training the women entrepreneurs on quality aspects. Dovetailing existing women oriented policies with energy access can ensure the stability and sustenance of women energy enterprises.



UN Women can work with experts to develop an engagement framework and strategy for on boarding SHGs for women driven enterprises. It can liaison with relevant training institutes to undertake training for an identified set of women energy entrepreneurs. It can also support in creation of a “Women Entrepreneurs Banking Toolkit” which can be a ready reckoner to understand the procedure for availing finance for setting up energy enterprises or enterprises using energy.



# Annexure 1: Illustration of Block Selection Process in Bhadohi district in Uttar Pradesh

Blocks	Population	Male Population	Female Population	SC (Male)	Ranking	% of Female Population	SC (Female)	Ranking	ST (Male)	ST (Female)	Ranking	Literate Males	Literate Females	Ranking	Female Literacy Rate	Ranking	No. households with SC as head	Ranking	No. households with ST as head	Ranking	Electrification rate	Ranking	Solar Use %	Ranking	Total Rank
Abholi	126,076	61,983	64,093	14,103	6	51%	13,838	6	53	56	6	41,639	28,950	1	41%	6	4,297	6	16	6	ND	1	ND	3	40
Suriyawan	142,218	70,135	72,083	19,505	5	51%	19,039	5	96	82	4	46,293	31,645	4	41%	5	6,185	5	30	4	ND	1	ND	3	32
Bhadohi (Rural)	296,437	151,809	144,628	38,237	2	49%	35,880	2	213	167	2	103,751	68,624	5	40%	4	11,332	2	52	3	40%	3	0.45%	1	19
Aurai	318,606	164,453	154,153	42,552	1	48%	39,275	1	170	152	3	109,158	69,536	6	39%	2	13,124	1	54	2	40%	1	0.37%	2	13

Gyanpur	228,259	116,241	112,018	26,693	3	49%	25,125	4	96	69	5	78,203	51,428	3	40%	3	8,176	4	23	5	35%	4	0.45%	1	29
Deegh	261,191	134,507	126,684	29,466	4	49%	26,482	3	307	308	1	93,185	58,784	2	39%	1	8,527	3	93	1	ND	1	ND	3	17
Total	1,372,787	699,128	673,659	170,556		49%	159,639		935	834		472,229	308,967				51,641		268						0

# Annexure-2: Questionnaire

**Enumerator introduction:** Good morning. My name is \_\_\_\_\_ and we are from \_\_\_\_\_. We are conducting a research study to understand your energy consumption patterns and awareness regarding renewable energy products and services. Would you mind helping us by answering a few questions? We guarantee that all of your answers will be completely confidential. The survey will take a few minutes of your time. Thank you for answering the survey!

Section (A) General:

Village name \_\_\_\_\_ Gram Panchayat name \_\_\_\_\_ Block \_\_\_\_\_

District \_\_\_\_\_ State \_\_\_\_\_

Respondent Details:

Name: \_\_\_\_\_ Age \_\_\_\_\_ Gender \_\_\_\_\_

Marital status: a) Married b) Widow c) Divorced d) Unmarried

W/o, D/o, S/o \_\_\_\_\_

1. Details of head of the family:

(i) Age

a) 18-25 b) 25-40 c) 40 and above

(ii) Gender

a) Male b) Female

2. Your educational Qualification:

(a) Illiterate (b) Primary (c) Secondary (d) Senior Secondary (e) Graduate & Above

3. Educational qualification of the head of the family (if respondent is different from the head of the family)

(a) Illiterate (b) Primary (c) Secondary (d) Senior Secondary (e) Graduate & Above

4. Family Details (Tick):

S.N.	Particular	Number					
		(a)	(b)	(c)	(d)	(e)	(f)
	Options						
i)	Total family members in the house	1	2	3	4	5	Above 5
ii)	Total earning members in the house	1	2	3	4	5	Above 5
iii)	Total male members in family	1	2	3	4	5	Above 5

iv)	Total female members in family	1	2	3	4	5	Above 5
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#### 5. Education Profile of female members

	Particular	b) Illiterate	c) Primary	d) Secondary	e) Senior Secondary	f) Graduate & above	g) Do not go to school
i.	Age (5-12)						
ii.							
iii.							
iv.	Age (13-18)						
v.							
vi.							
vii.	Age (19-24)						
viii.							
ix.	Age (Above 25)						
x.							
xi.							
xii.							

#### 6. Reasons for not going to school, if applicable:

- i) Lack of willingness/ encouraging employment (a) Yes (b) No
- ii) No school in vicinity (a) Yes (b) No
- iii) Household chores (a) Yes (b) No
- iv) Cultural barriers (a) Yes (b) No

#### 7. Employment and Income details of the family:

S. N.	Particular	Option
i. 8	Main Occupation	a) Agriculture

		b) Service c) Agri-labour d) Skilled labour e) Un-skilled labour f) Factory labour g) Teacher h) Petty trader i) Shop j) Cattle rearing k) Micro and small enterprise (MSME) l) Other If answer is (k) please ask (iii)
ii.	Women Employment Status	a) Homemaker b) Help in agriculture c) Agri-labour d) Service e) Cattle rearing f) Micro and small enterprise (MSME) g) Other h) None If answer is (f) please ask (iii)
iii. 10	Nature of MSME	a) Animal Husbandry b) Carpet making c) Handicrafts (Pottery/art work etc.) d) Bidis (Tendu patta) e) Leaf plates f) Basket weaving g) Handloom h) Others
iv. 11	Security of income	a) Fixed

		b) Seasonal
v. 12	Expenditure per month (in INR)	a) less than 5000 b) 5000 - 10000 c) 10000 -15000 d) greater than 15000

**8.** Do you require electricity for running your MSME/home based enterprise?

a) Yes b) No

**9.** What is the source of electricity?

(a) Grid connected (b) Mini-grid (c) Off-grid (d) DG set (e) No access to electricity

**10.** If answer to Q9 is (e) i.e. no electricity access, what is the source of lighting?

(a) Kerosene lamp (b) Solar lighting (c) DG set (d) Torch (e) Candle (f) Batteries (g) Any other

**11.** What is the type of connection?

(a) Domestic (b) Commercial (c) Both

**12.** Details of lighting load

S.N.	Incandescent bulbs	a)	b)	c)	d)	e)
(i)	No. of bulbs	1	2	3	4	>4
(ii)	Usage in hrs/day	<4 hrs	4-8 hrs	9-12 hrs	12-18 hrs	>18 hrs

S.N.	Tube lights	a)	b)	c)	d)	e)	f)
(iii)	No. of Tube lights	0	1	2	3	4	>4
(iv)	Usage in hrs/day	<4 hrs	4-8 hrs	9-12 hrs	12-18 hrs	>18 hrs	

S.N.	LED	a)	b)	c)	d)	e)	f)
(v)	No. of LEDs	0	1	2	3	4	>4
(vi)	Usage in hrs/day	<4 hrs	4-8 hrs	9-12 hrs	12-18 hrs	>18 hrs	

S.N.	CFL	a)	b)	c)	d)	e)	f)
(vii)	No. of CFLs	0	1	2	3	4	>4
(viii)	Usage in hrs/day	<4 hrs	4-8 hrs	9-12 hrs	12-18 hrs	>18 hrs	

### 13. Details of cooling load

S.N.	Fan	a)	b)	c)	d)	e)	f)
(ix)	No. of Fan	0	1	2	3	4	>4
(x)	Usage in hrs/day	<4 hrs	4-8 hrs	9-12 hrs	12-18 hrs	>18 hrs	

S.N.	Desert Coolers	a)	b)	c)	d)
(xi)	No. of Coolers	0	1	2	>2
(xii)	Usage in hrs/day	<4 hrs	4-8 hrs	9-12 hrs	12-18 hrs

S.N.	Refrigerators	a)	b)	c)	d)
(xiii)	No. of Refrigerators	0	1	2	>2

### 14. What is the sanctioned load? (Please provide a copy of the electricity bill)

(a) Up to 500 W (b) 500W to 1 kW (c) 1 to 1.5 kW (d) 1.5 to 2 kW (e) Above 2 kW

### 15. Average monthly electricity bill (INR/ month)?

(a) Up to 200 (b) 201 to 500 (c) 501 to 1000 (d) Above 1000 (e) Free of charge

### 16. Average hours of electricity received in a day in summers (Hours/ day)?

(a) Less than 6 (b) 6-10 (c) 11-15 (d) 16-18 (e) More than 18

### 17. Average hours of electricity received in a day in winters (Hours/ day)?

(a) Less than 6 (b) 6-10 (c) 11-15 (d) 16-18 (e) More than 18

### 18. Types of electrical appliances used?



(a) Fan (b) TV (c) Refrigerator (d) Inverter (e) Electrical iron

(f) Electric Cooker (g) Heating rod (h) Radio i) Mixer j) Geyser

**19.** What is the source of cooking (Tick all applicable options)?

(a) Mud chulha (fixed) (b) Kerosene stove (c) LPG stove (d) Biogas

(e) Induction stove (f) Improved cook stove (g) Any other

**20.** Do you buy firewood for cooking?

(a) Yes (b) No

**21.** If answer to Q 20 is No, then please tell us the time taken for firewood collection

(a) < 1 hour (b) 1 hour (c) 2 hours (d) 3 hours (e) >3 hours

**22.** Time taken for fire wood processing

(a) < 30 minutes (b) 30 minutes-1 hr (c) 1-2 hrs (d) > 2 hrs

**23.** Please specify monthly consumption of the following:

Sources	(a)	(b)	(c)	(d)	(e)
(i) Firewood (in kgs)	<5	5-10	10-15	15-20	>20
(ii) LPG (no. of cylinders) (14.2 kg size)	.5	1	1.5	2	
(iii) Kerosene (PDS) in litre	<1	1-2	2-3		
(iv) Kerosene (black market) in litre	<5	5-10	11-15	16-20	>20
(v) Diesel (in litre)	<10	11-20	21-35	36-50	>50
(vi) Dung cake (in Kgs)	<2	2-4	4-6	6-8	>8
(vii) Charcoal (in Kgs)	<5	6-10	11-15	16-20	>20

### Section (C) Awareness of RE products

**24.** Are you aware about RE products/ appliances? (a) Yes (b) No

**25.** If answer to Q24 is yes, source of awareness?

(a) TV/Radio (b) Newspaper (c) Friends/ Family / Relatives/ Neighbours

(d) Live demos/ Workshops (e) Gram panchayat/Gram Sabha (f) Other

**26.** What is source of financing for general purposes (crop/ poultry loans/ emergencies/marriages etc.)?

a) Local lenders b)Co-operative society c)MFI-micro credit d)SHG e) Banks f)other

## Section (D) Access to RE products

**27.** Are you using RE products/ appliances? (a) Yes (b) No

(if no, pls go to Ques 39)

**28.** Have you ever used RE product before? (a) Yes (b) No

**29.** Please tick the type of equipment you have and indicate if you are satisfied with that?

			No. of Appliances				
	(a) Satisfied	(b) Not satisfied	(c) 1	(d) 2	(e) 3	(f) 4	(g) >4
i) Solar lantern/lights							
ii) home lighting system							
iii) Solar water pump							
iv) Solar drip irrigation							
v) Solar water heaters							
vi) Improved cook stove							
vii) Biogas stoves							
viii) solar driers							
ix) solar PV based food processing system							
x) solar PV based chiller							

**30.** How long you have been using these products?

	(a) <1 year	(b) 1-2 years	(c) 2-3 years	(d) >3 years
i) Solar lantern/lights				
ii) home lighting system				
iii) Solar water pump				
iv) Solar drip irrigation				
v) Solar water heaters				
vi) Improved cook stove				
vii) Biogas stoves				
viii) solar driers				
ix) solar PV based food processing system				
x) solar PV based chiller				

**31. If not satisfied, why?**

	Reasons for not satisfied			
	(a) No service centres	(b) Lack of availability	(c) High maintenance cost	(d) Others
i) Solar lantern/lights				
ii) home lighting system				
iii) Solar water pump				
iv) Solar drip irrigation				
v) Solar water heaters				
vi) Improved cook stove				
vii) Biogas stoves				

	Reasons for not satisfied			
	(a) No service centres	(b) Lack of availability	(c) High maintenance cost	(d) Others
viii) solar driers				
ix) solar PV based food processing system				
x) solar PV based chiller				

### 32. What are the reasons to buy these products?

	(a) Pollution free	(b) Safe	(c) better quality than conventional products	(d) Low electricity bill	(e) reliable during no electricity supply	(f) Affordable
i) Solar lantern/lights						
ii) home lighting system						
iii) Solar water pump						
iv) Solar drip irrigation						
v) Solar water heaters						
vi) Improved cook stove						
vii) Biogas stoves						
viii) solar driers						
ix) solar PV based food						

processing system						
x) solar PV based chiller						

### 33. Expenses incurred for maintenance of products (in INR)?

	(a) Up to 50	(b) 50-100	(c) 101-500	(d) More than 500
i) Solar lantern/lights				
ii) home lighting system				
iii) Solar water pump				
iv) Solar drip irrigation				
v) Solar water heaters				
vi) Improved cook stove				
vii) Biogas stoves				
viii) solar driers				
ix) solar PV based food processing system				
x) solar PV based chiller				

### 34. Are you aware about available financing options for RE products for Household?

(a) Yes (b) No

### 35. If answer to Q 34 is (a) what are your preferred sources of financing for RE products?

(a) Banks (b) Local lenders (c) Co-operative society (d) MFI-Micro credit  
(d) SHG (e) Other

### 36. What is the preferred method of payment to purchase these appliances?

(a) Cash (Full down payment) (b) EMI (c) Bank loans (d) Loan through SHG  
(e) Other

**37. What is the preferred source for purchasing RE products?**

- (a) Retail shop    (b) NGO/CSR    (c) Akshay Urja Shop    (d) Bank/cooperative society  
(e) Panchayat/block    (f) Other

**38. What is the source of maintenance of products?**

- (a) Local market    (b) Local technician    (c) Akshay Urja shop    (d) Other

**39. Willingness to buy RE products?**

	(a) Yes	(b) No	(c) Unsure
i) Solar lantern/lights	397/413		
ii) Home lighting system	372/392		
iii) Solar water pump			
iv) Solar drip irrigation			
v) Solar water heaters			
vi) Improved cook stove			
vii) Biogas stoves			
viii) solar driers			
ix) solar PV based food processing system			
x) solar PV based chiller			

**40. If you are not willing to buy RE products please specify why?**

	Reasons for not purchasing RE products				
	(a) Expensive	(b) No service centres	(c) Lack of availability	(d) High maintenance cost	(e) others
i) Solar lantern/lights					
ii) home lighting					

	Reasons for not purchasing RE products				
	(a) Expensive	(b) No service centres	(c) Lack of availability	(d) High maintenance cost	(e) others
system					
iii) Solar water pump					
iv) Solar drip irrigation					
v) Solar water heaters					
vi) Improved cook stove					
vii) Biogas stoves					
viii) solar driers					
ix) solar PV based food processing system					
x) solar PV based chiller					

**41. If you are willing to purchase RE products please specify why?**

	Reasons for purchasing RE products					
	(a) Pollution free	(b) safe	(c) better quality than conventional products	(d) Low electricity bill	(e) reliable during no electricity supply	(f) Affordable
i) Solar lantern/lights						



	Reasons for purchasing RE products					
	(a) Pollution free	(b) safe	(c) better quality than conventional products	(d) Low electricity bill	(e) reliable during no electricity supply	(f) Affordable
ii) home lighting system						
iii) Solar water pump						
iv) Solar drip irrigation						
v) Solar water heaters						
vi) Improved cook stove						
vii) Biogas stoves						
viii) solar driers						
ix) solar PV based food processing system						
x) solar PV based chiller						

42. Do you own a mobile phone? (a) Yes (b) No

43. If answer to Q 42 is yes, how do you charge your phone?

(a) solar (b) electricity connection at home (c) market (d) Neighbours

44. Other family details :

S. N.	Particular	Option	S. N.	Particular	Option
(i)	Caste & religion	a) SC b) ST c) OBC d) General e) Hindu f) Muslim g) Christian h) Sikh	(ii)	Type of ration card of the family	a) BPL b) APL c) Antyodaya/Annapurna Yojana d) Does not possess
(iii)	Aadhaar card in family	a) Yes b) No	(iv)	Anyone disabled in family	a) Yes b) No
(v)	Do you have a bank account?	a) Yes b) No	(vi)	If you have bank account, type of bank account?	a) General savings account b) Jandhan Account c) Kisan credit card

45. Please select the reasons for which the bank accounts are used.

S. N.	Type of bank account	(a)General Transaction	(b)Govt. subsidy	(c)MGNREGA payment	(d)Payment from state cooperative marketing federation	(e)Others
(i)	General savings account					
(ii)	Jandhan Account					
(iii)	Other					

**46.** Do you have livestock: (a) Yes (b) No

**47.** If answer to Q46 is yes, what is the number of livestock?

S.N.	Particular	Number				
	Options	(a)	(b)	(c)	(d)	(e)
10i)	No. of cows & buffaloes	1	2	3	4	>4

**48.** Type of house:

(a) Kuchcha (mud with thatched roof)

(b) Pucca (Brick & cemented roof)

(c) Semi-pucca (stone with other roof)

**49. No. of rooms:** (a) 1 (b) 2 (c) 3 (d) 4 (e) 5 (f) >5

**50.** Do you have separate space for cooking (or kitchen)? (a) Yes (b) No

**51.** Is there a window in the cooking space? (a) Yes (b) No

**52.** Do you have source of potable drinking water? (a) Yes (b) No

**53.** What is the source of drinking water?

(a) Own hand pump (b) Govt. water supply (c) Govt. hand pump/ tubewell

(d) River/Pond (e) Well

**54.** If answer to Q53 is any of the options from (b) to (e), then please specify time spent to collect water-

a) Less than 1 hour b) 1-2 hrs c) 2-3 hrs d) more than 3 hours

**55.** Which assets you own?

(a) TV (b) Car/Jeep (c) Fridge (d) Tractor (e) Bullock cart

(f) Thresher/Huller (g) Scooter/ Motor cycle (h) Cultivable/other land

**56.** Do you own agricultural land? (a) Yes (b) No

**57.** If answer to Q56 is yes, how much land is owned? (in Acres)

i) Irrigated land

a) Below 2.5 b) 2.5-5 c) 5-7.5 d) 7.5-10 e) 10 -25 f) greater than 25

ii) Un-irrigated land

a) Below 2.5 b) 2.5-5 c) 5-7.5 d) 7.5-10 e) 10-25 f) greater than 25

**58.** Select as applicable, the land papers are in whose name?

a) Male member of the Household b) Female member of the Household