SATTVA
Delivering High Impact.

TATA CLEANTECH CAPITAL LIMITED

Impact Assessment of Tata Cleantech Capital's *Green Switch Project*

Insights Deck

21st October 2022

List of Abbreviations

BDO	Block Development Officer
CSR	Corporate Social Responsibility
ESG	Environmental, Social, and Governance
FGD	Focus Group Discussion
IA	Impact Assessment
KII	Key Informant Interview
OECD	Organization for Economic Co-operation and Development
PRI	Panchayati Raj Institutions
R&R	Roles and Responsibilities
TCCL	Tata Cleantech Capital Limited
TRIF	Transform Rural India Foundation
VEC	Village Electricity Committee

Contents

Background and Objectives of the Engagement

Background

Tata Cleantech Capital Limited (TCCL) is a joint venture between Tata Capital Limited (TCL) and International Finance Corporation (IFC), Washington DC, US. TCCL offers end to end business solutions in the clean technology and infrastructure space. TCCL covers the entire spectrum of financial products and services in Clean Technology and Infrastructure space and offers services such as - Project and Structure Finance, Debt Syndication, Financial Advisory/ M&A and Cleantech Advisory.

To solve the gap between demand-supply of energy, under its CSR wing, Tata Cleantech Capital designed 'The Green Switch' program driven by community partnership, with CSR investment for capital expenditure done by TCCL. The aim of the project is to provide clean electricity to unelectrified homes and community spaces, including schools, through renewable energy by adopting a community partnership model, one hamlet at a time. The design is inspired by the 'Power for All' scheme and SDG 7: Ensure access to affordable, reliable, sustainable and modern energy for all.

Decentralized solar energy has the potential to drive down costs as well as bring a significant reduction in carbon emissions, which are higher when electricity from traditional power sources is used for the electrification. These regions usually rely on sources like grid energy from fossil fuels or energy from kerosene and fuelwood (that have significantly higher carbon emissions).

Scope of Work (Impact Assessment and Carbon Emissions Evaluation)

Impact Assessment

TCCL sought to conduct an impact assessment of its Green Switch program to understand the following:

- **Relevance** of the program to meet the needs of the beneficiaries and **coherence** with national and regional priorities
- The **effectiveness** of the program in achieving the desired outcomes and creating an impact in line with the strategies defined by Tata Cleantech Capital
- The **impact** created by the program among beneficiaries
- **Sustainability** of the program in the long run
- **Recommendations of strategies** to enable the program to strengthen the impact

Evaluation of Carbon Emissions

The ESG team of Sattva assisted TCCL in:

- Evaluating the change in carbon emissions due to the transition from Kerosene (previous energy source) to Solar energy within the target hamlets for kerosene use, solar energy access and possible grid electricity[1]
- Providing insights based on an approximate analysis of reduction in carbon emissions due to the transition from traditional power sources to solar energy versus the transition from Kerosene to solar energy

The Sattva team also detailed the methodology and the overall reduction in carbon emissions for the engagement, which was plugged into the insights deck

Note: 1. Out of scope – The project does not cover emission reduction due to fuel usage (wood for cooking)

TCCL envisages improving Access to Electricity through its Green Switch Project

Geographies covered for Impact Assessment

Thematic Area: Climatic Action

Green Switch Project:

- Provided clean electricity to unelectrified homes and community spaces through decentralised solar microgrids by adopting a community collaborative model
- Commissioned the microgrid system with solar PV panels and control room (with inverters, batteries, etc.), wiring, street lighting, fittings, house wiring, individual energy meters, LED bulbs and charging points, etc.
- Provided each household with individual meter, 4 LED bulbs and 2 charging points

➢ **Geographies :** Kurdeg (Simdega, **Jharkhand**)

➢ **Implementation Partners:** Transform Rural India Foundation (NGO Partner) and Gram Oorja Pvt. Ltd (Technical Partner)

➢ **Timeline:** 3 years

Objectives of the Study

To assess *impact*

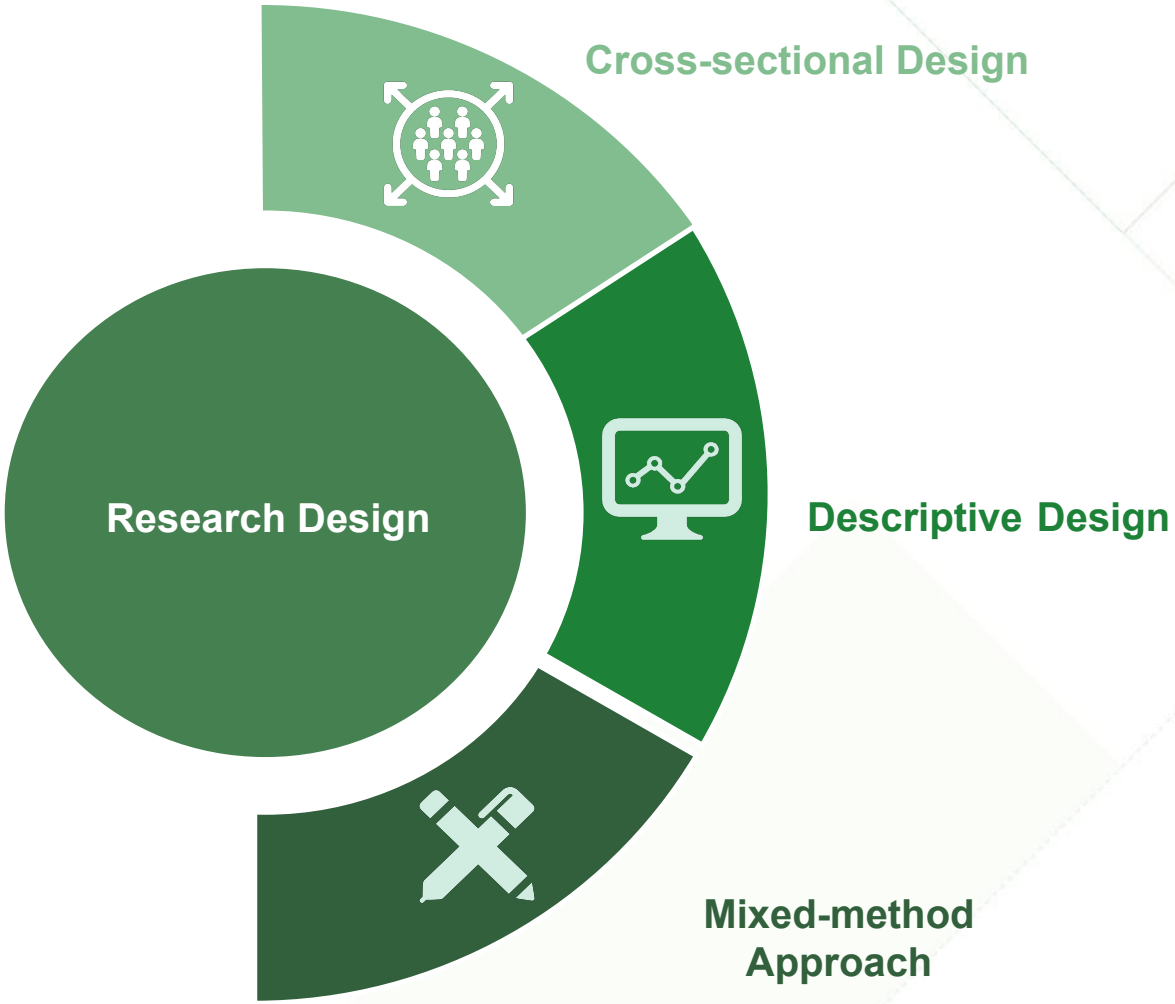
- To assess the improvement in availability of affordable electricity power at the household and at the community level
- To assess improvement in the socio-economic conditions of the beneficiaries using proxy indicators such as assets owned, increase in livelihood opportunities, etc.
- To assess the unintended translatory impact of electrification on the project beneficiaries w.r.t basic health and education outcomes

To assess *performance*

- To analyze the alignment of the need of target group and the project objectives from an outside in perspective
- To provide actionable insights and recommendations on improving the quality and effectiveness of project delivery and impact

Approach and Methodology

Sattva adopted a Descriptive Cross-Sectional Design for the Impact Assessment



The study incorporated a **descriptive cross-sectional design** from a **retrospective lens** where data was collected from a representative population of the beneficiaries to provide a snapshot of the retrospective need before intervention and the outcomes after the intervention* to understand:

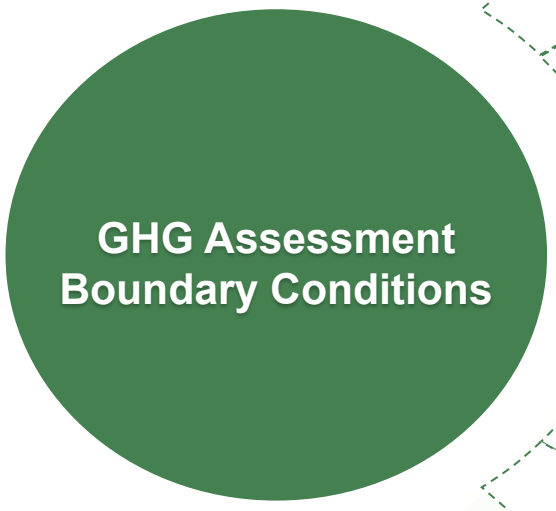
1. Whether the intervention worked as expected to achieve its objectives, and
2. How were the objectives achieved, what was the process, and what was the timeline for impact

The study incorporated a **mixed-method** approach consisting of **quantitative and qualitative** data collected from primary and secondary sources. This helped gather valuable **impact** related insights from a 360-degree perspective across the stakeholders spectrum and was instrumental in providing recommendations towards fine-tuning and scaling up of the model in the long term.

**Note: This is not a baseline-endline comparison evaluation since the baseline doesn't encompass all the indicators that need to evaluated, and was not an external assessment. The baseline data was used for referencing purposes only*

GHG Emissions Report Methodology

Standard: The assessment follows the guidelines of the GHG Protocol Project Standard and other guidelines / data sources as per requirements



Project

9 solar microgrid locations set up by Tata Cleantech Capital under its CSR intervention 'Green Switch Project' in partnership with TRIF and Gram Oorja

Geography

9 locations / hamlets in Kurdeg block, Jharkhand

Effects

Changes in usage of fossil fuels such as kerosene and diesel due to availability of solar electricity in HHs and community spaces

Sample Size

281 HHs across the above geography, with results **extrapolated for 13 microgrid locations** (extrapolated on the basis of HHs i.e. for 716HHs from data of 281 HHs)

Assessment Duration

From installation of microgrid in each location to September 2022, with results presented as annual estimations

Baseline

Baseline Scenario – Annual usage of kerosene and diesel before electrification
Baseline Procedure – Project specific procedure with static baseline estimates

Sattva conducted the study in four phases (14 weeks)

PHASE 1: DESIGN

- Methodology and Sampling
- Review of available data on project evaluation (before green energy)
- Research questions and indicators
- Data collection tools
- Field data collection plan

PHASE 2: EXECUTION

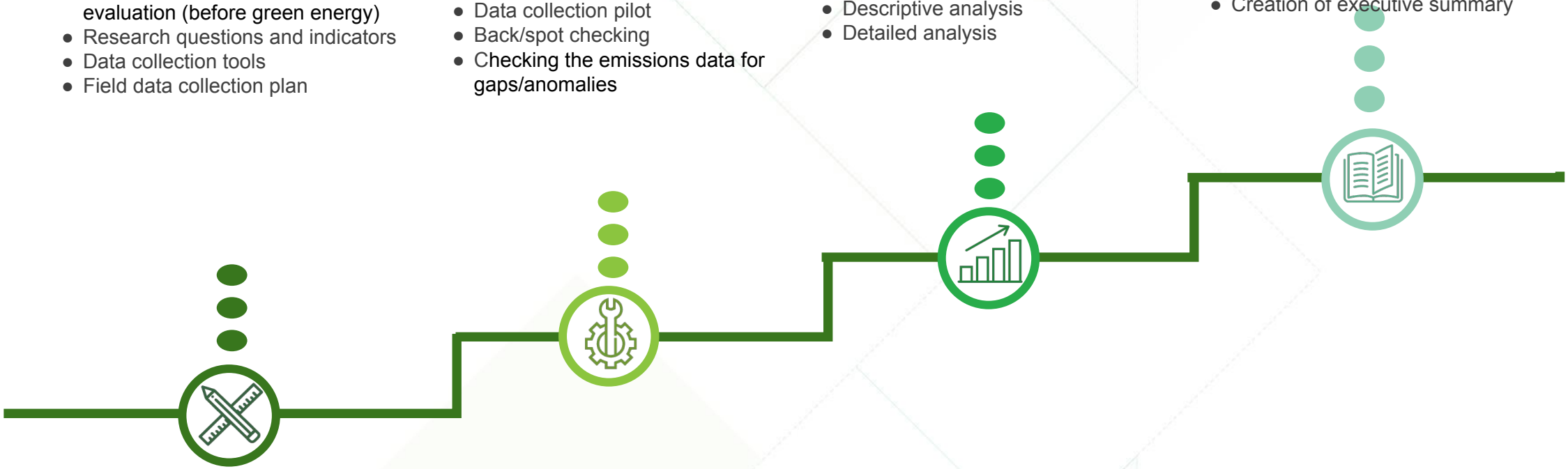
- Operation plan
- Data collection training
- Data collection pilot
- Back/spot checking
- Checking the emissions data for gaps/anomalies

PHASE 3: ANALYSIS

- Data coding
- Data cleaning
- Descriptive analysis
- Detailed analysis

PHASE 4: REPORTING

- Detailed insights deck and final presentation
- Creation of executive summary



DELIVERABLES

- Detailed Work Plan (Conception Report)
- LFA
- Data Collection Tools

6 WEEKS

DELIVERABLES

- Daily status update
- Data dashboard (where needed)

3 WEEKS

DELIVERABLES

- Quantitative raw data without PII's

2 WEEKS

DELIVERABLES

- Detailed final presentation (25-30 slides)
- Executive Summary Report (2 pager)

3 WEEKS

Area of Study and Sampling

Sampling Methodology

The population considered was based on the existing beneficiaries (HHs) covered across **13 hamlets of the Kurdeg block in Simdega district of Jharkhand**

- Sattva adopted a **random sampling** approach to ensure adequate representation of the population (HHs) in the impact study
- The total sample size for the project was calculated using the population frame (Household level beneficiaries of the interventions) based on **95% Confidence Interval and 5% Margin of Error**
- The study incorporated **mixed-method** approach consisting of **quantitative and qualitative** data collected from primary and secondary sources
- This helped Sattva gain a 360-degree perspective across the stakeholders involved and was a fundamental to provide recommendations towards fine-tuning the model and scaling up in the long term

- **Sampling Unit:** Households
- **Population:** 716 (HHs)
- **Sample:** 281 HHs (32 buffer samples have been included in the analysis)
- **Confidence level:** 95%
- **Margin of error:** 5%

- **Sample size for each location:**
- Stratified random sampling was adopted to sample hamlets ensuring at least 1 hamlet from each zone (west and north)

- **Household selection:**
- N^{th} selection process was used to randomly select the households

- **Beneficiary Selection**
- Head of the household/householder/Next available member in the household hierarchy was selected as beneficiary respondent

Sample Size and Stakeholder Mapping

Stakeholders	Data Collection Target (Sample vs. Achieved)						Mode of Data Collection
	Survey		Focus Group Discussion (FGD)		Key Informant Interview (KII)		
	Planned	Actual	Planned	Actual	Planned	Actual	
Households	249	281	-	-	7 Case Stories (Farm & Non-Farm Livelihood)	8	On-Ground
Students	-		2-3	2	-		On-Ground
Youth	-		-		2	2	On-Ground
Community Women	-		2	2	-		On-Ground
Village Electricity Committee (VEC)	-		3	4	-		On-Ground
Operators	-		-		4	4	On-Ground
PRI members (Village level elected member)	-		2-3*	0	2	3	On-Ground
NGO partner (Transform Rural India Foundation)	-		-		2	2	On-Ground and Virtual
Technical Partner (Gram Oorja Pvt. Ltd)	-		-		1	1	Virtual
Program team (Tata Cleantech Capital)	-		-		1	1	On-Ground
Government Stakeholder (BDO)	-		-		1	1	On-Ground
Total	**249**	**281**	**9**	**8**	**20**	**22**	

** Due to the unavailability of PRI members for FGDs, 1 extra KII was conducted*

Hamlet-wise Sampling

S.No	Hamlets	Zone	Sample Size		Mode of Data Collection	Project Location
			Planned	Actual*		
1	Mudamba	West	-	35	On-ground	 Block - Kurdeg (Simdega, Jharkhand) -
2.	Baraiktoli	West	36	34	On-Ground	
3.	Jharan Tangartoli	North	36	30	On-Ground	
4.	Jhimri	West	36	30	On-Ground	
5.	Orunkela	West	36	33	On-Ground	
6.	Bhijari Badi	North	35	37	On-Ground	
7.	Beejakhaman	North	35	35	On-Ground	
8	Saraipani	West	-	35	On-ground	
9.	Dabnipani	West	35	12	On-Ground	
Total			**249**	**281**	**-**	

**Due to scattered household settlements, the team was unable to achieve the planned sample in Dabnipani. To reach the target sample, 2 extra hamlets (Saraipani, Mudamba) were added to the total sample population*

Demography

District Overview: Simdega

- Simdega is one of the 19 aspirational districts of Jharkhand with **70%** of its population living in rural areas. It was carved out of Gumla district in 2001
- The district comprises of **471 villages** spread over in 87 Gram Panchayats. Simdega is the district headquarter
- The district comprises of ten blocks: Simdega, Pakar Tanr, **Kurdeg,** Kersai, Bolba, Thethaitangar, Kolebira, Jaldega, Basjor and Bano
- Kurdeg block is a **100% rural** geography consisting of 25 revenue villages belonging to 8 gram panchayats. The primarily **agrarian** block shares a border with Chhattisgarh on one side and Kersai block on the other. Around **87%** of the population is composed of the Oraon tribes

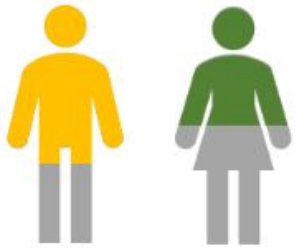
Kurdeg block overview*

Revenue Villages	25
Gram Panchayats	8
HHs	9847
Deprived HHs	8092 (out of 9847)
Population	47,984
Sex Ratio (Females per 1000 males)	1009

As of Census 2011 and SECC data 2011

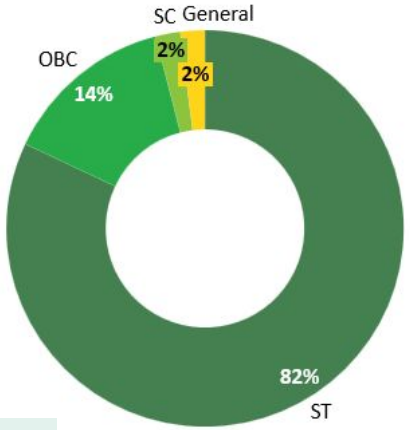
Demographics of the sample population (n=281)

Gender Composition

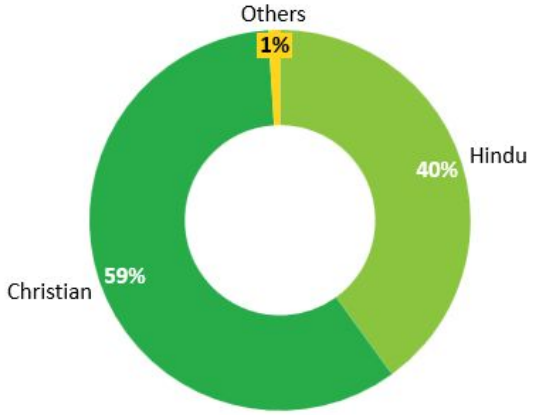


53% 47%

Caste Composition



Religious Composition

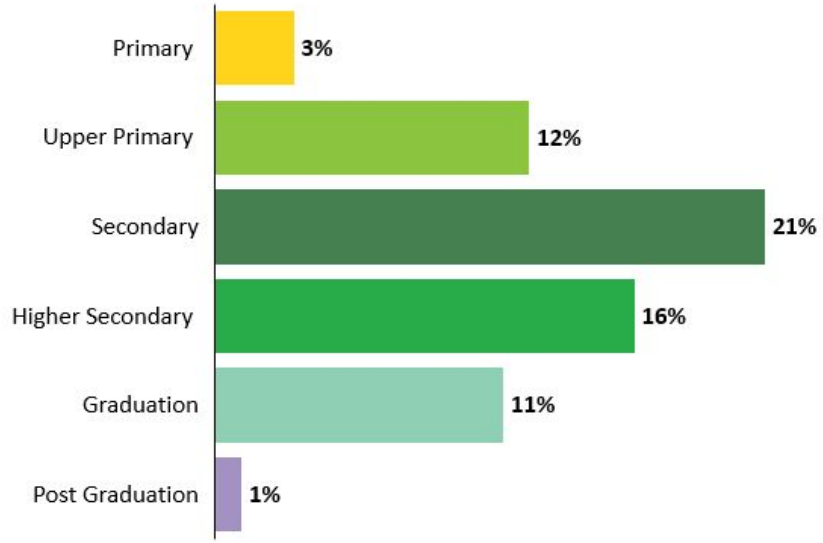


Primary Source of Income

Agriculture	78%
Daily Wage	11%
MGNREGA	3%
Others*	8%

*Other income sources: Forest resources, private sector employment, construction work, shop-keeping, poultry

Highest Education Level in Household



Type of Ration Card

Antyodaya	23%
BPL	70%
APL	3%
Not Available	4%

Impact Assessment: Framework

Sattva adopted the OECD DAC Framework

The assessment framework was based on the **Organization for Economic Cooperation and Development's (OECD) Development Assistance Committee (DAC) principles** for evaluation of Development Assistance.

INPUT & PROCESS

Relevance

Assessing to what extent the program objectives and design respond to the target group's global, country, and partner/institution needs, policies, and priorities, and continue to do so if the circumstances change

Coherence

Assessing the alignment of the program, or what it is likely to deliver with the needs of the community. Also checking its alignment with the priorities of the region, at a state, national or international level

Effectiveness

Assessing the supporting systems and processes influencing the achievement or non-achievement of program objectives, through concurrent measurement of program outputs

OUTPUT & IMPACT

Efficiency

Assessing the budget allocation versus actual spend to inform utilisation. Unit cost spend is assessed to understand the cost variance and suggest effective ways of saving costs.

Impact

Assessing the extent to which the program has generated significant positive or negative, intended or unintended impact, in terms of local, social, economic, environmental and other development indicators

Sustainability

Assessing to what extent the impact of the program is likely to continue after funding support has been withdrawn by determining operational, financial and institutional sustainability

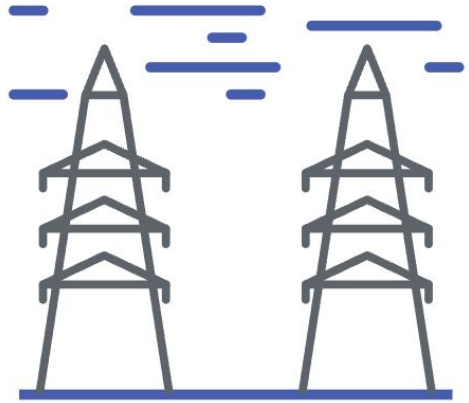
Note: Adopted Development Assistance Committee's (DAC) framework developed by Organization for Economic Cooperation and Development (OECD)

Impact Assessment: Insights

Relevance

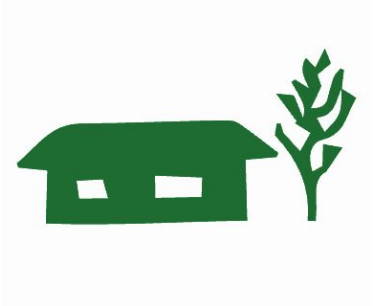
Jharkhand is an energy-deficit state, where both supply and quality of electricity are poor

- Jharkhand is the **2nd poorest state** as per Niti Aayog's Multidimensional Poverty Index (MPI-2021)[1], with **42.16%** of its population being poor, and over **18%** electricity deprived households
- It has has **19** aspirational districts, the highest in the country
- As of Census 2011, more than **75%** of Jharkhand's population lives in rural areas, and **26%** of its population is tribal
- While rural access to electricity in Jharkhand has increased from **32%** in 2011 to **87%**[2] in 2019, many tribal areas remain unelectrified.[4.] Even when connected to the grid, there are issues with the quality of supply
- Households in Jharkhand faced one of the **longest power outages,** with rural households in facing six or more hours of daily outages[2] (2020)
- The quality of supply remains a concern, with regular blackouts and few hours of effective access[5]
- The main reasons cited for poor access and quality of electricity include high dependence on Central sources for buying electricity and lack of penetration in tribal areas due to challenging terrains



1. https://www.niti.gov.in/sites/default/files/2021-11/National_MPI_India-11242021.pdf
2. https://www.ceew.in/sites/default/files/ceew-research-on-state-of-electricty-access-and-coverage-in-india.pdf
3. https://sais-isep.org/wp-content/uploads/2020/11/an-assessment-of-electricity-access-in-jharkhand-and-the-impact-of-saubhagya.pdf
4. Aklin, M., B. Blankenship, V. Nandan, and J. Urpelainen. 2020. "The Great Equalizer: Inequality in Tribal Energy Access and Policies to Address It" Working Paper.
5. https://www.ceew.in/sites/default/files/ceew-research-on-state-of-electricty-access-and-coverage-in-india.pdf

The Green Switch program identified the challenges of the community due to lack of electricity



Lack of electrification

Primary Data: Lack of government penetration, inaccessibility of villages due to terrain, remoteness, and lack of infrastructural facilities (notably, roads) act as deterrents to formal electrification in the hamlets

Challenges faced by community members

Community members faced challenges with respect to livelihoods, health, education, wildlife conflict, and mobility due to unavailability of electricity

Pre-electrification sources of energy

Primary Data: Community members used small solar panels for household usage, solar lanterns, solar batteries, and *dhibhris,* and kerosene lamps,which sufficed for only lighting and charging purposes. Fossil-fuel/kerosene-run generators and irrigation pumps were used in social events and in livelihoods

Jharkhand has a huge energy deficit. Urban electrification takes precedence over rural electrification. In our previous programs, we found that energy access is a significant limitation factor [to development].

Community members used stand-alone solar panels (10-15% of villagers used them), firewood, diesel/kerosene- run pumps, and dhibhris, which were the only source of illumination.

- *Ashok Kumar, TRIF*

People face numerous challenges due to the absence of electricity. In today's day and age, this isn't right...everyone should have access to at least the three basics- water, electricity, and roads.

- *Gyanmani Ekka, BDO, Kurdeg*

The Green Switch Program identified the needs of the community with respect to electrification

Identification of program geographies

Hamlets which were

(i) Remote and home to sizeable vulnerable groups (Identified using TRIF's Vulnerability Index),

(ii) Unelectrified, and

(iii) Unlikely to be electrified in the near future by government efforts

Identification of beneficiaries

Community members willing to subscribe to TCCL's community-based collaborative model

Identification of needs

A Baseline Study was conducted by TRIF to understand the socio-economic composition of communities, and their energy usage patterns and aspirations

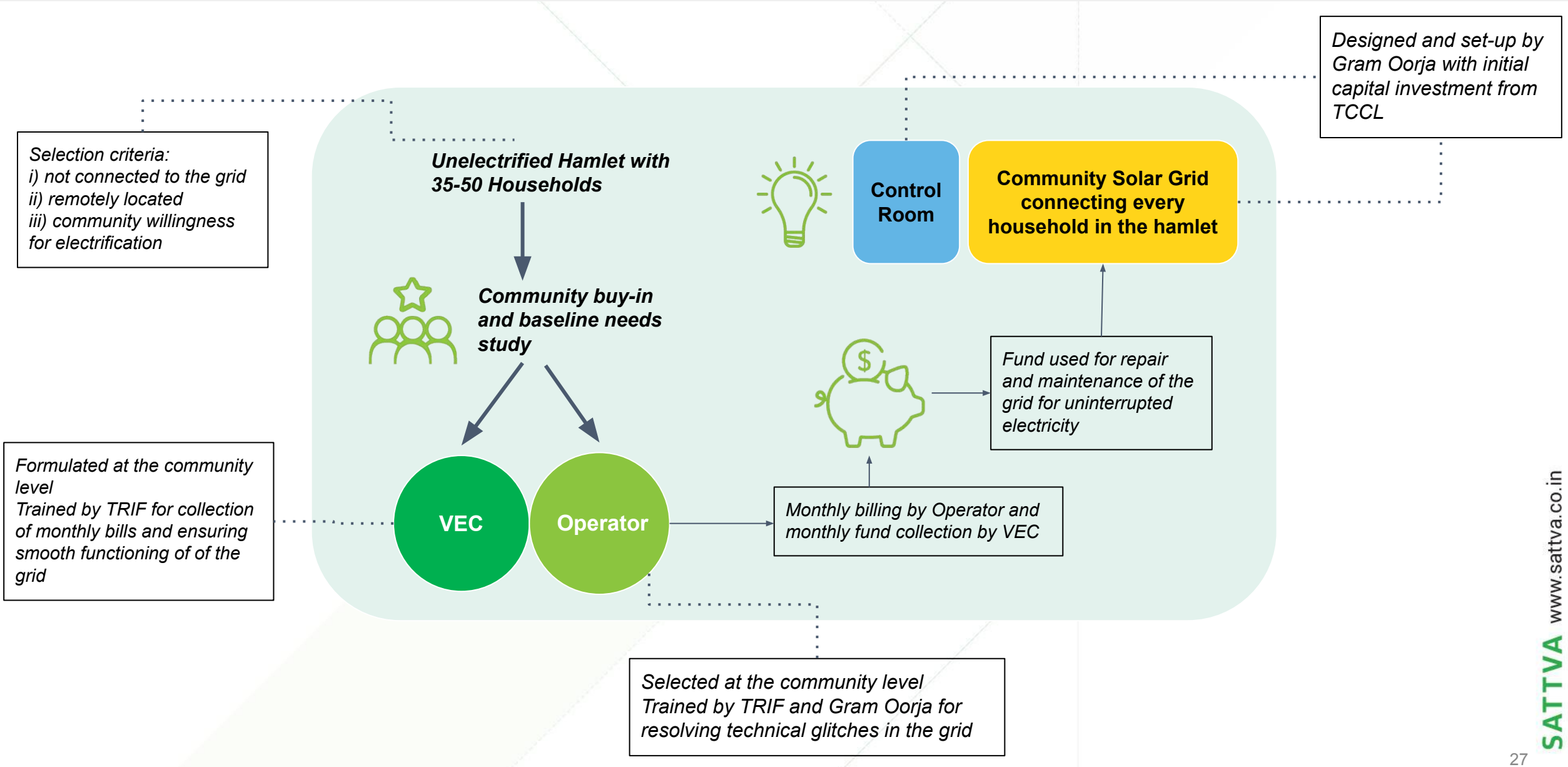
After our pilot in Maharashtra, we also wanted to expand to other locations with a dire need of electricity. TCCL selected Jharkhand for two reasons, one it has the highest number of aspirational districts as per NITI Aayog and our Gram Oorja and TRIF are strong on ground partners. We considered previously unelectrified rural households in the most remote areas where electricity is difficult to reach. The hamlets we serve in the Simdega district in Jharkhand fall on the border of Jharkhand and Chattisgarh, and are very remote areas.

- *Neha Bhagtani, TCCL*

The Baseline Study helped to set the payment model for the project i.e. one-time registration fee and a unit rate for generating monthly bills. We can analyse if the collections over a period of 5 years will suffice the replacement of batteries.

- *Ashok Kumar, TRIF*

A collaborative community model was adopted for electrification



Coherence

The program is in coherence with international and national priorities

SDG 7

Affordable and clean energy

The Paris Agreement

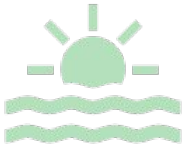
Climate change mitigation, adaptation & finance

National Solar Mission

Promote solar power

DDUGJY

Provide continuous electricity supply to rural India

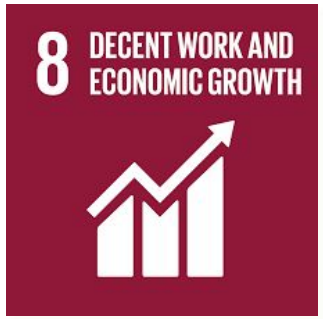


Jharkhand Solar Policy

Jharkhand Targets 4 GW of Solar Installations in Five Years

SDG 3

Good Health and Well-Being



SDG 8

Decent Work and Economic Growth

SDG 11

Sustainable Cities and Communities

SDG 13

Climate Action

Human Development Index

Impact

Access Availability & Affordability of Electricity

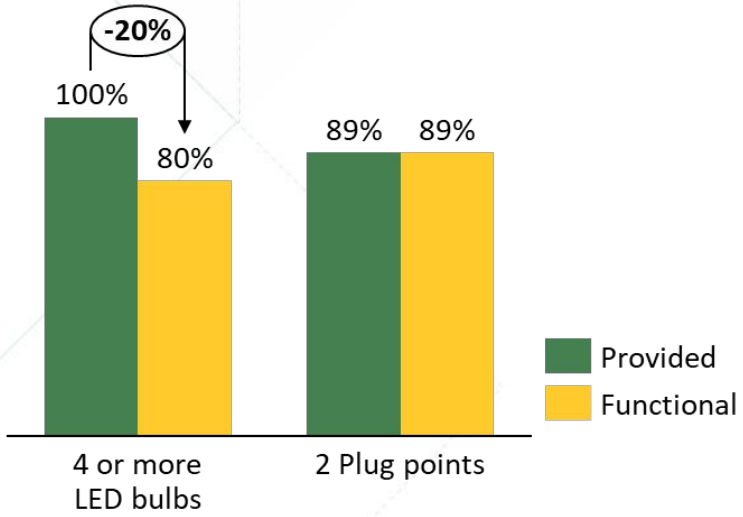
95% of the households report that the solar grid adequately meets their basic electricity needs

Availability

- Before the implementation of the program, the energy requirements of the hamlets were estimated by TRIF, ensuring that micro solar plants generate sufficient electricity for the basic needs of hamlets, as well as hold an additional capacity for commercial usage
- **99.6%** of the households state to having LED bulbs installed in their households. **97.5%** of the households had at least one charging socket fitted into their house
- More than **98%** **households received 4 LED bulbs and 2 charging sockets** and close to **80%** **of the households have fully functional 4 LED bulbs and 2 Charging sockets,** which is *sufficient* for their current electricity requirements
- Only **5%** of the households reported that some of their electricity needs were unmet, of which, the major unmet need was that of access to farm and irrigation equipment like solar-run water pumps

> *The Green Switch Program has provided electricity in the remotest part of Kurdeg block, and it has helped people fulfill their basic electricity needs. Going forward the program can focus on agricultural development in this area, since economic empowerment is essential to development.*
>
> - Gyanmani Ekka
> (BDO, Kurdeg Block)

Functional LED bulbs and plug points in Households (n=281)



Basic electricity needs of the households are met (n=281)

Yes	95%
No	4%
Partially	1%

96% beneficiaries are satisfied with the quality of the electricity supply, attributable to constant and reliable electricity supply

- Along with **98%** HHs, VEC members and operators concurred that electricity is available 24x7 with occasional power-cuts that lasted in between few hours to upto 5 days

- The reasons for power-cuts are:
  - Thunder and lightning: Precautionary shut downs and technical glitches
  - System overload due to simultaneous over-usage of hullers
  - Occasional technical glitches in household level distribution system caused due to faulty internal wiring, normal wear and tear in switchboards, and power outlets, and reparation work on electrical poles which causes glitches in households in the nearby vicinity

- Emergency battery light (35%), solar battery lamps (19%), and kerosene lamps (9%) are the major sources of lighting used by the HHs during power outages

> *Before electrification we lived in darkness, with limited mobility post sunset but now we have a stable electricity supply.*
>
> - Sangeeta Kiskotta
> (PRI member, Bhijari Badi)

Number of hours electricity is available in a day (n=281)

98% of HHs reported 24X7 hrs

Satisfaction level of households with quality of electricity supply (n=281)

While 79% of the households find electricity affordable, 14% of the households perceive monthly fixed charge of INR 100 expensive

Registration Fees

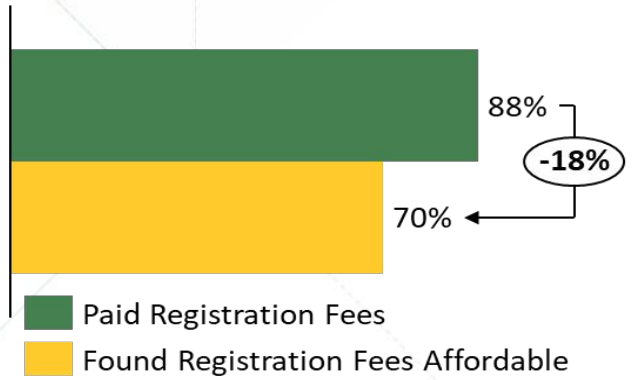
- A one-time registration fees of INR 1000 was required to be paid by each household to avail of the grid connection
- **88%** of the HHs paid the registration fees and **70%** of the HHs found it affordable
    - Of the 12% of the HHs who did not pay the registration fees, 52% said that they did not have to pay the fees, while the rest claimed that they were not aware of being required to pay the fees

Monthly Bills

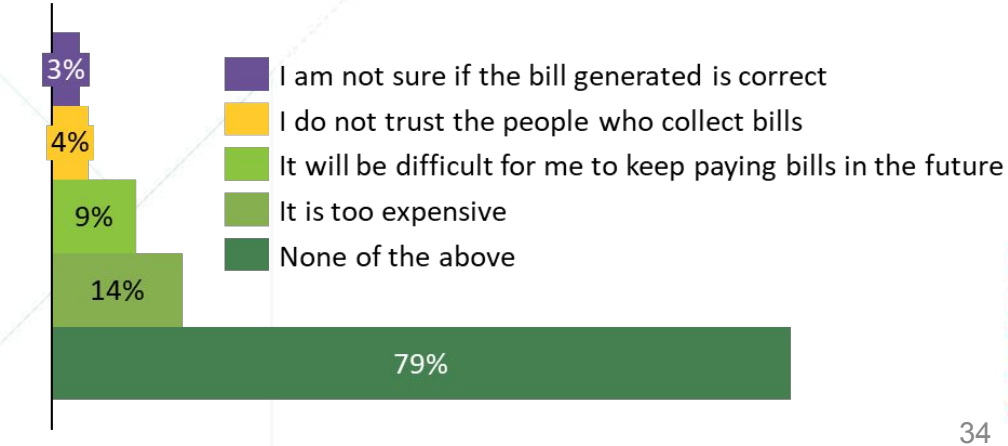
- The monthly bills paid by the HHs consists of the sum of a fixed charge of INR 100 and INR 10 per unit charge for the electricity consumption, which collectively augments the VEC fund
    - **79%** of the HHs find the electricity bills affordable and do not envision any difficulty in paying the bills in future
    - **14%** of the HHs along with stakeholders like VEC and SHG women stated that since the majority of the households belong to a low-income class, it becomes difficult to afford INR 100 fixed charge every month

> *INR 1000 is a significant sum of money. It served as a litmus test for the readiness of community members to embrace the collaborative community-model of electrification*
>
> - Ashok Kumar, TRIF

Payment of registration fees (n=281)



Which of these statements do you think to be correct regarding your electricity bill? (n=281)



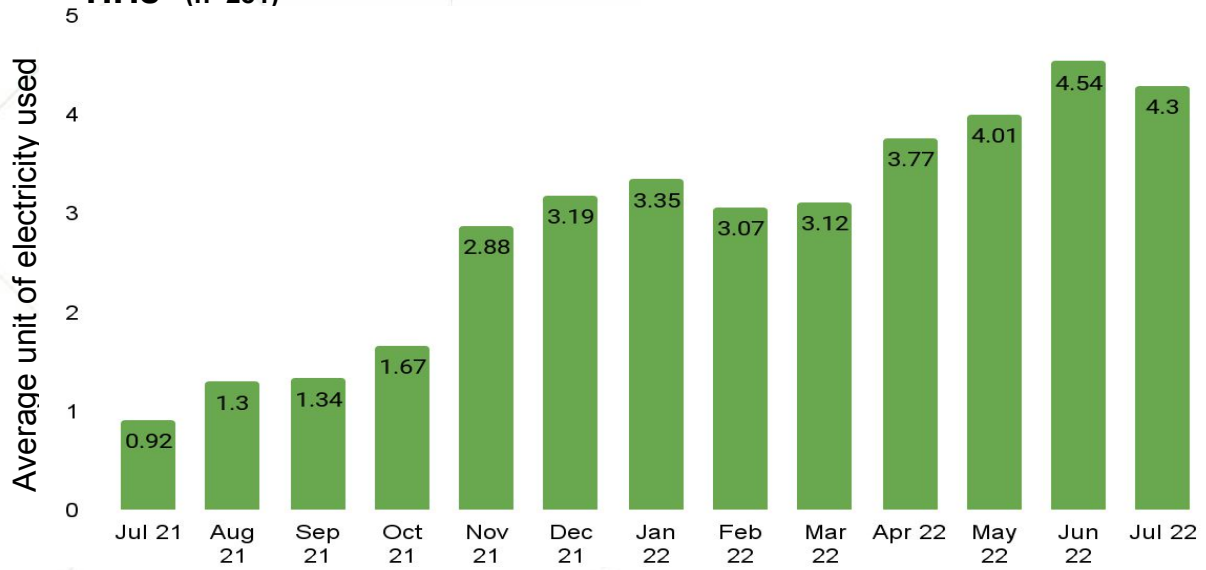
Electricity Usage

The average units consumed per household have **increased** from **0.92 kWh/month** in July 2021 to **4.3 kWh/month** in July 2022

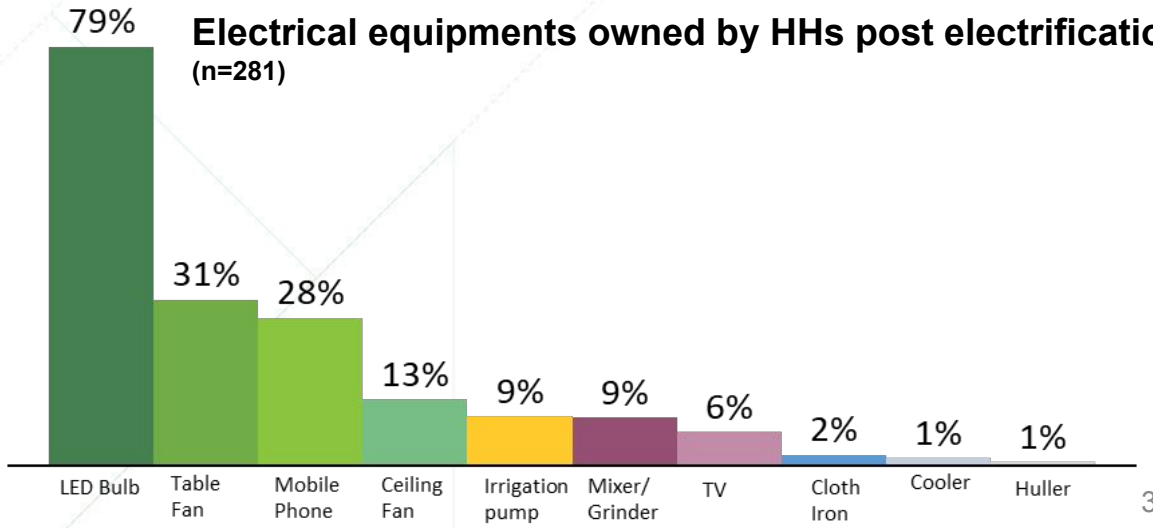
- On average **92% of the HHs use electricity for their illumination and charging requirements**, and **44% of the HHs reported using electricity to run fans**
- **An average Increase of 3.38 kWh/month unit of** electricity consumption by each household is observed*
  - Bulbs, fans and mobile phones are the main electricity-run equipment that a majority of HHs have started using post-electrification
  - Additionally, a few HHs (<10%) have started using other kitchen & home appliances and agricultural equipments like irrigation pumps and huller
  - 1% of the HHs have started using electricity for micro-business purpose like flour mill, huller, shops etc.

Households aspire to buy fridges, and electric sewing machines that can help supplement the household income

A gradual increase in average unit/month of electricity used by HHs* (n=281)



Electrical equipments owned by HHs post electrification (n=281)



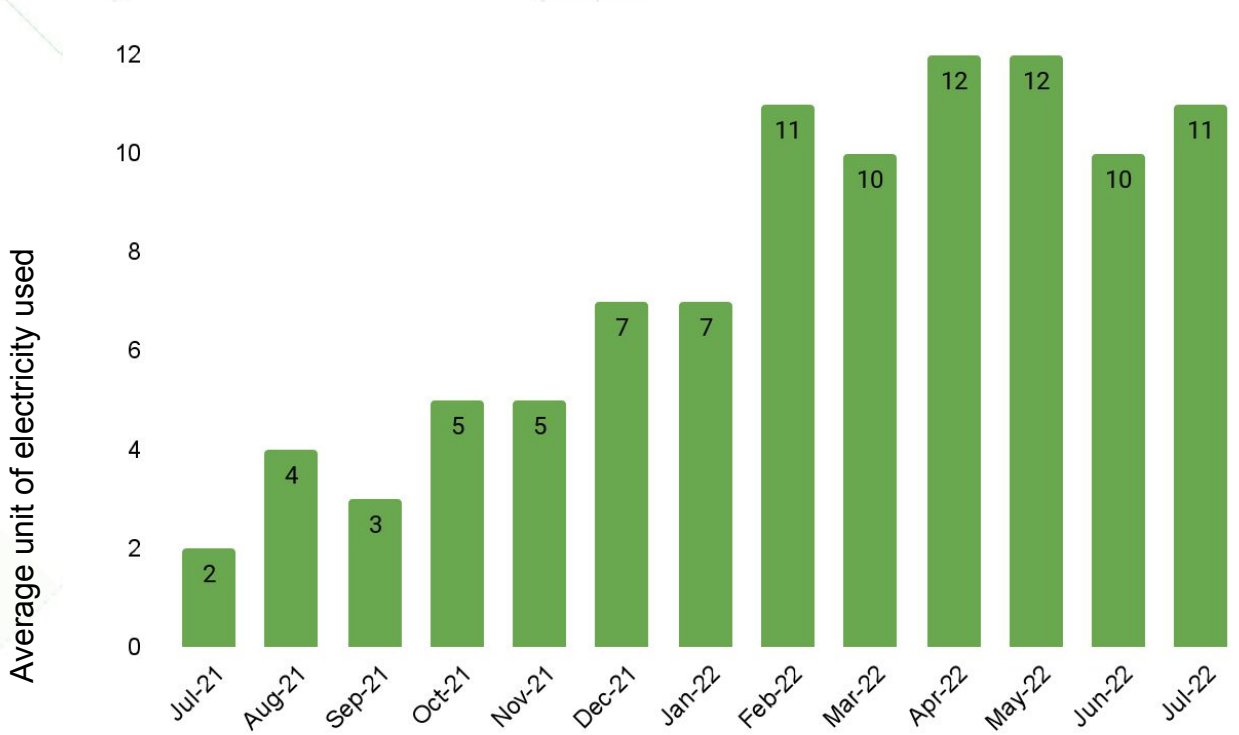
Note: In many hamlets, there are no separate commercial and HH level meters. Commercial usage of over 20 kWh is omitted from average calculation to get a sense of average HH level usage increase.
*Calculation methodology mentioned in annexure I

The average units consumed per household for commercial purpose have **increased** from **2 kWh/month** in July 2021 to **11 kWh/month** in July 2022

- **An average increase of 8 kWh unit of** electricity consumption for commercial purpose by each household is observed
- **10%** of the HHs (29/281) use electricity for commercial purpose such as usage of hullers, millers, motor pump, and shops
  - 1% (3/281) of the HHs reported using electricity for usage of hullers, millers, and micro business purpose, while other HHs reported using it for farm related purpose

> *Post-electrification, two of us (Me, and Deepak) own and operate hullers in the hamlet. Electricity huller is affordable and supplements my farm income*
>
> *- Alman Kindo,*
> *Micro entrepreneur, Jharan Tangartoli*

A gradual increase in average unit of electricity used for commercial purpose* **(n=29)**



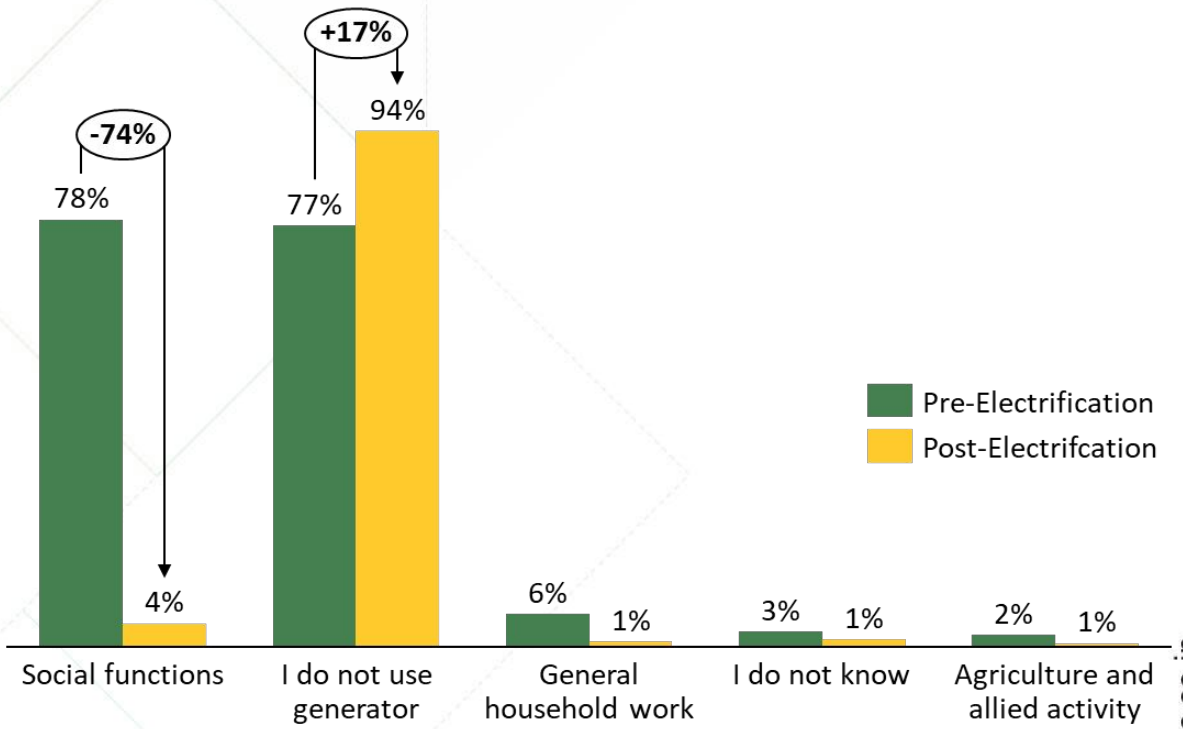
* Calculation methodology mentioned in annexure I

Availability of electricity in the hamlets has led to a significant **decrease in the usage of generators**, especially in social functions

- **94%** of the HHs don't use generators for any purpose
- **4%** of HHs use generators for social functions
    - FGDs with the VEC and community members revealed that the significant reduction in usage of generators is attributed to the cheaper cost of grid electricity, vis-a-vis kerosene/diesel/petrol-run generators (which have higher costs due to the higher costs of fuels)

> *Diesel-run generators were used for weddings, DJs, etc. Renting a generator costs INR 1500. The expenses incurred on diesel for three days ranges from INR 3000 to INR 4500. Now, no generators are used post-electrification. Using grid-generated electricity costs only INR 500-700, for the same time duration which is quite affordable. Even the poorest of the poor can now illuminate their house during celebrations.*
>
> *- Surendra Painkra,*
> *Ward Member, Dabnipani (Panchayat: Kutumakchar)*

Usage of generator at household level (n=281)



57% of the respondents perceive an increase in the frequency of social events after electrification

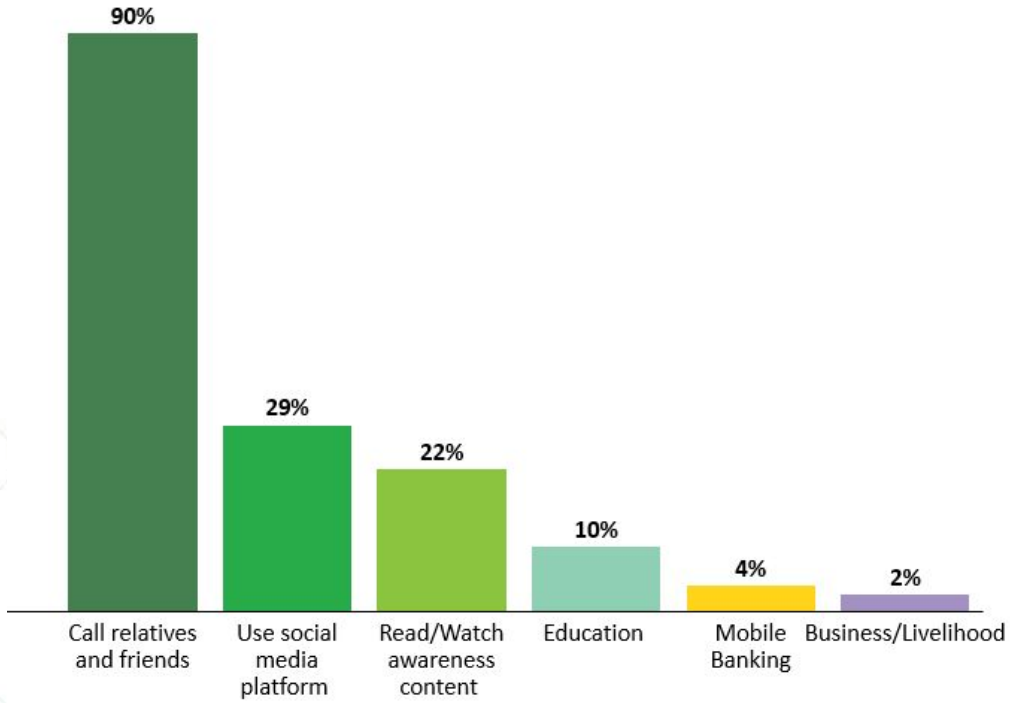
Increased use of mobile phones post electrification has **strengthened communication** and **socialising** among community members

- Even though households owned mobile phones prior to the intervention, their usage was limited due to limited charging facilities. Only households that owned a solar battery could charge their phones; others had to make alternative arrangements such as go to the nearest marketplace, or other electrified places

- Electrification has empowered community members to use phones for calling relatives and friends, using social media platforms, entertainment, and for watching/reading news

> *Smaller phones would only require batteries, but smartphones would require intensive charging. We would have to go to govt-electrified locations, such as marketplaces and pay INR 10-15 for the charging service. Smartphones would be charged 1-2 times on a weekly basis, but it was not sufficient to meet our requirements. We could only avail of the most basic of facilities, such as making and receiving calls, and too, only sparingly. Now, with electrification, we can charge our phones with ease, and use them as much as we want.*
>
> - *Community woman, Jharan Tangartoli*

Purposes for which mobile phones are used (n = 281)



14.4% beneficiaries started using mobile phones post-electrification

Livelihoods

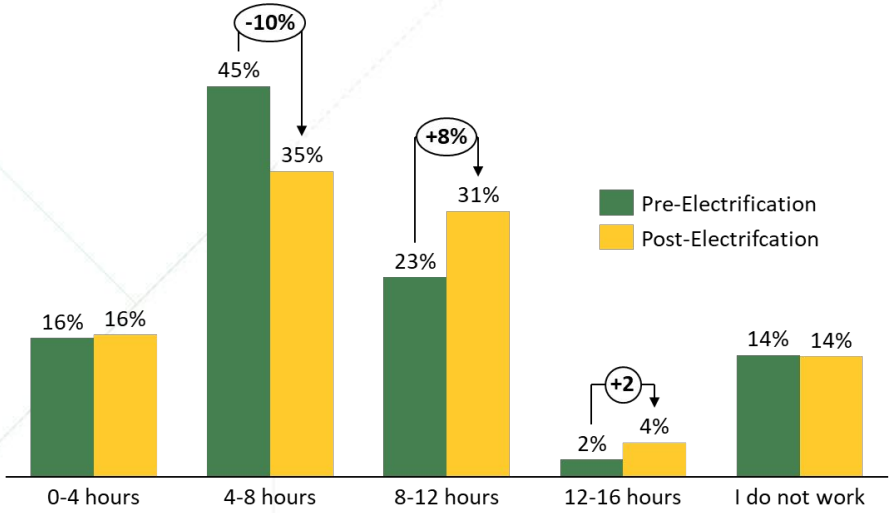
Reliable electricity supply has **improved** work efficiency, usage of livelihood assets, and livelihood options at the community level

- **66%** of the respondents stated that electrification has *enabled them to complete their livelihood activities in lesser time, and effort*, which is indicative of increased efficiency
- Electrification has enabled beneficiaries to *engage in income-generating activities for a longer duration*
- There is an **8% increase in respondents who perceive that they can now work for 8-12 hours**. Similarly, there's an increase by 2% of respondents who claim to work for 12-16 hours. This is corroborated by the **10% decrease in households engaging in income-generating activities for 4-8 hours**
- **65% of HHs have observed an increase in livelihood options** in their community, which are predominantly in agricultural and allied activities
  - **10%** HHs started using appliances such as **rice huller, flour mills and irrigation pumps** in agriculture post-electrification
  - Analysis of case stories related to setting of flour mill exhibit an average **increase in INR 1500 income per month**
  - It must be noted the income varies across different micro-enterprises depending on factors such as financial investment, location, and seasonal nature of work

Electrification has helped households in performing livelihood activity in less time/effort? (n=281)

Yes	66%
No	14%
I do not know	12%
I do not work	18%

No. of hours engaged in income-generating work (n=281)



Increased access to solar-run water pumps empowered 17% of the households to cultivate additional crops and 5% of the households to increase area under cultivation

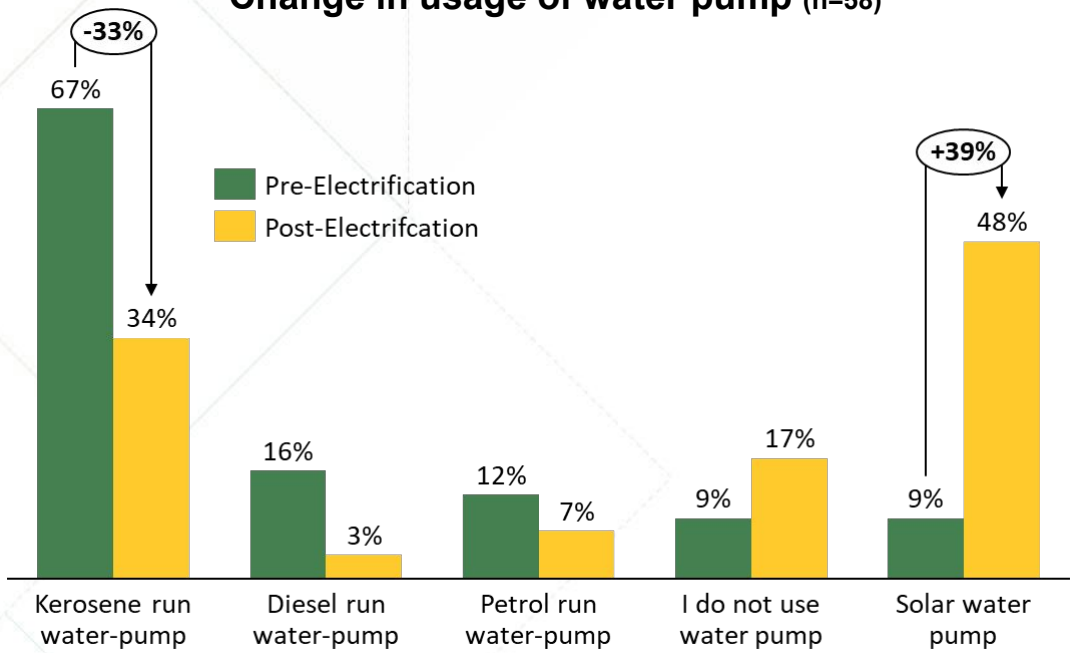
- A reliable supply of electricity has enabled HHs to own as well as switch from fossil-fuels based water pumps to solar-run water pumps which have lower operating costs as compared to kerosene/diesel-run water pumps
    - Among 21% of HHs (58/281) who use water pump for irrigation an increase of 39% HHs (28/58) accessing solar water pumps is observed
- Access to solar water pumps enables irrigation facilities for the farmers leading to a considerable increase of 17% HHs and 5% HHs that have started cultivating additional crops and increased area under cultivation, respectively
    - Case studies of farm livelihoods highlight that the usage of solar-run irrigation pumps has enabled users to practice crop diversification, and increase land under cultivation. Coupled with a reduction in operating costs, and an increase in cultivation, there is potential for increasing the profitability in agriculture-driven livelihoods

Due to Access to solar water pumps (n=281)

17% HHs have started practicing crop diversification

5% HHs have increased area under cultivation

Change in usage of water pump (n=58)



Sahay Kindo, Jharan Tangartoli (Case Study)

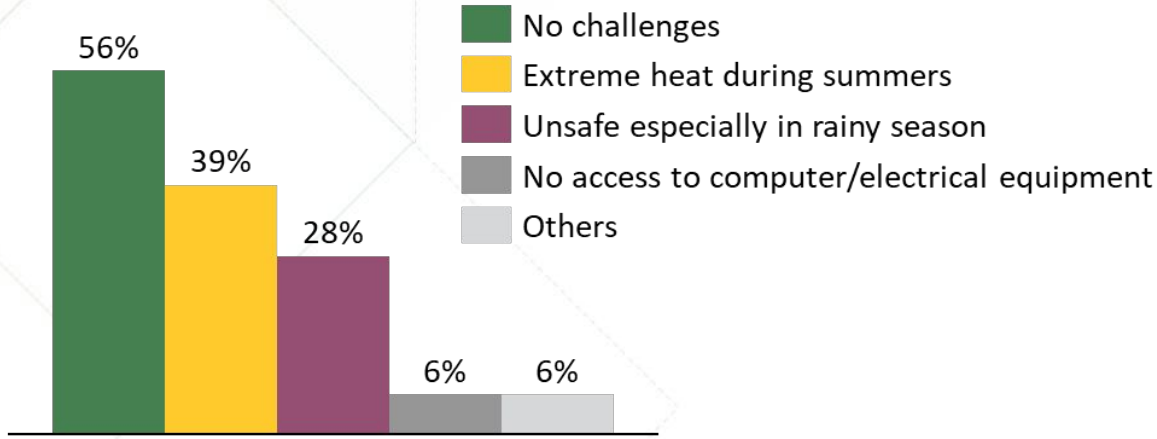
Water Pump	Operating cost (per hr)
Kerosene	INR 100
	- 80 INR
Solar	INR 20

Education

Electrification of households and schools has enabled students to use **digital devices for learning** and has led to an **increase in time spent on learning**

- Over half of the households **(56%)** did not consider un-electrified schools as a challenge. Two prominent challenges that parents cited facing in sending their children to unelectrified schools were *(i) Extreme heat faced during summers, and (ii) Safety concerns during monsoon.* Electrification of schools has addressed these concerns
- Reliable charging facilities at HH level encourages students to use mobile phones for learning purposes, as corroborated by **13%** of HHs reporting the usage of mobile phones by children for learning purposes
- Increase in number of learning hours differed across households, with **(28%) of HHs reporting an increase of more than 6 hours per week**

Key challenges in sending students to unelectrified schools
(n=281)



47%

HHs reported an increase in children's studying hours post-electrification

Increase in hours spent/per week on study post electrification (n=281)

More than 6 hrs : 28%
3-4 hrs: 5%
0-1 hrs: 4%
2-3 hrs: 3%
1-2 hrs: 3%
5-6 hrs: 2%
4-5 hrs: 2%

Without light, numerous education purposes and aspirations remain unfulfilled, such as general awareness about the world, ability to study when one pleases, etc.

- Youth, Jharan Tangartoli

Youth used smartphones to attend online classes during the pandemic. They acknowledged the transformational impact of electrification on their village such as illumination and the possibility of communicating using smartphones.

Impact on women

Electrification has **reduced the health discomforts and ailments** caused due to usage of *dhibhris,* and other pre-electrification sources of illumination

- In qualitative discussions with women (n=2), it was found that pre-electrification, *dhibhris* or kerosene lamps (a source of illumination that is used by burning kerosene in a closed container with an outlet for light) were the main source of illumination, with the exception being some households which used solar lanterns and bulbs. Only **9.25%** HHs still continue using kerosene lamps post-electrification

- The light emitted by *dhibhris* is dim, and is contingent on the quantity of kerosene consumed, and thus, they work only for a limited amount of time

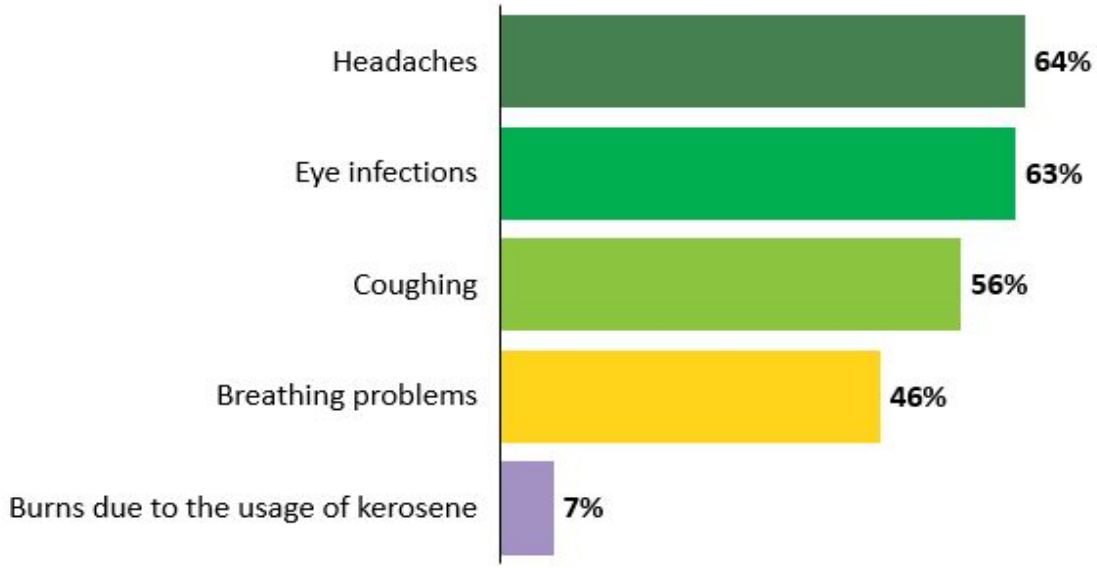
A home-made dhibhri

Due to availability of electricity, have you observed any change in your health conditions that you experienced during cooking or any other usage of kerosene? (n=223)

40% **(91/223) of women perceived changes in health conditions due availability of electricity**

In qualitative discussions, women emphasized, that while usage of *dhibhris* lead to headaches, and irritation in eyes, and throat, and coughing

Women who perceive a reduction in various health ailments due to electrification (n = 91)



Electrification has led to an **increase in ease and time available** for completion of household chores

- The program geographies are highly agrarian in nature, with both men and women working on fields
- In qualitative discussions with community women (n=2), it was found that they often worked late on the field, and therefore, returned home late in the evening. Thus, little to inadequate illumination posed challenges in the completion of household chores, most significantly, cooking
- Electrification of households has enabled women to complete their household chores post-sunset

42 % (55/131)

of female respondents believe that they have more time to complete their household chores due to electrification

> *We faced numerous hardships in the completion of household chores. First, was the challenge of cooking. We made do with dhibhris, and lanterns as sources of illumination. But the light was very dim, and would cause a strain in our eyes. This was especially taxing since we come late to our houses after working in the field; cooking after that is stressful due to little to no illumination. Second, even going to the loo, and washing utensils in darkness was a big challenge for us.*
>
> *However, the installation of lights in our houses have mitigated these challenges.*
>
> - *Community women, Dabnipani*

> *We primarily used kerosene to meet our requirements for cooking and illumination. The hefty price of kerosene was unaffordable for us.*
>
> *Moreover, we only had 2-3 lanterns, which were insufficient to meet our needs, and often, were unavailable when we wanted to use them. We would use firewood as a source of illumination during cooking. Such circumstances made completing household chores quite cumbersome and challenging. Post electrification, we have no need of using dhibhris and lanterns.*
>
> - *Community women, Jharan Tangartoli*

Health and Safety

98% respondents feel safe due to consistent illumination, which has led to an **increase in mobility post darkness**

- Due to absence of street lighting prior the intervention, community members felt unsafe in venturing out of their homes in darkness. Women faced challenges not only while travelling, but also for completing household chores, or going to the loo. Torches, and lanterns were used as sources of illumination, but were not reliable sources

- There were also fears of encountering snakes and scorpions which are common sightings in the hamlets. **44.1%** of female respondents (n=131) and **91%** of the male (n=150) respondents reported a reduction in encounters with animals and snakes post-electrification

98.6% of males (n=150) and **99.2%** of females (n=131) agree with the statement that they feel safe and secure due to consistent illumination

"

Before the electrification of our hamlets, we would use a walking cane/stick while we stepped out, and tap the ground in front of us repeatedly to drive away snakes/animals, etc. that might cross our paths, and essentially protect ourselves. In fact, a [respondent] and her daughter were bitten on the foot while travelling in the evening. We would also face issues even while fetching water, but now, that is no longer an issue. We can also wash utensils, and relieve ourselves without fear/discomfort due to illumination.

On that note, even our encounters (Not the sightings) of snakes, and scorpions have reduced. Constant illumination has enabled us to step out of our homes more frequently, and that too, without torches. We can protect ourselves, and feel very safe at the community level.

- *Community women, Jharan Tangartoli*

"

"

One is definitely safe at night. Pre-electrification, it was very likely that one would cross paths with snakes and scorpions- in darkness, people might step on them mistakenly due to low visibility, leading to accidents, that have been fatal on numerous occasions. Now, one is definitely safe at night..even the number of cases of deaths have reduced.
Moreover, earlier in such instances, people could not call for help, despite owing phones since there were no sources of charging in their home, and they had to come to Kurdeg/Simdega for the same. However, now villagers can charge phones at ease, which has made communication much easier. Now, they can call an ambulance and dial in the medical helpline too.

- *Gyanmani Ekka, BDO, Kurdeg*

"

"

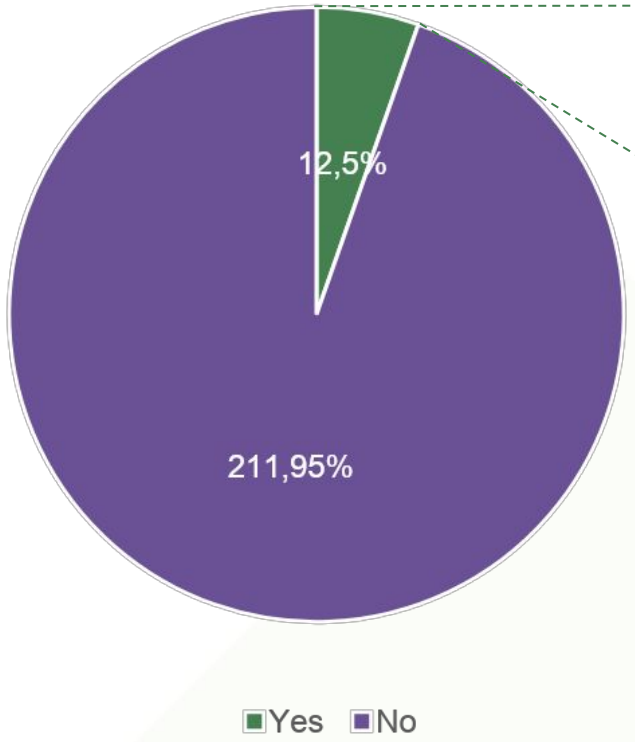
Before electrification, the instances of people venturing out during evenings were lower. After electrification, women do not fear venturing out in the evenings due to street light illumination.

- *VEC, Bhijari Badi*

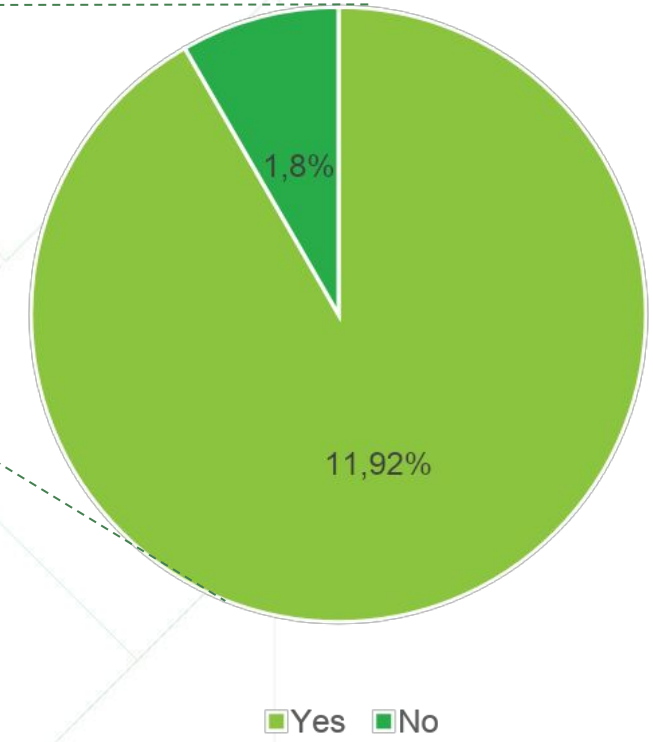
"

12% HHs had **experienced accidents** due to kerosene / firewood usage, which are **now thwarted** due to electrification

Accidents Experienced Due to Kerosene / Firewood Usage [n=223]



Reduction in Accidents Due to Electrification [n=12]



- The area of inquiry had only 223 responses as it was asked to a female household member, and few households did not have a female member present at the time
- Only 5% (n=12) HHs experienced accidents due to kerosene / firewood usage, and 92% (n=11) of those have experienced reduction due to electrification

Sustainability

The sustainability of the program is contingent on the following 3 factors

1 Awareness

Awareness of community members regarding the collaborative community model

2 Monthly Bill Payments

The willingness of households to continue paying bills for their electricity consumption

3 Capacity of VECs and Operators

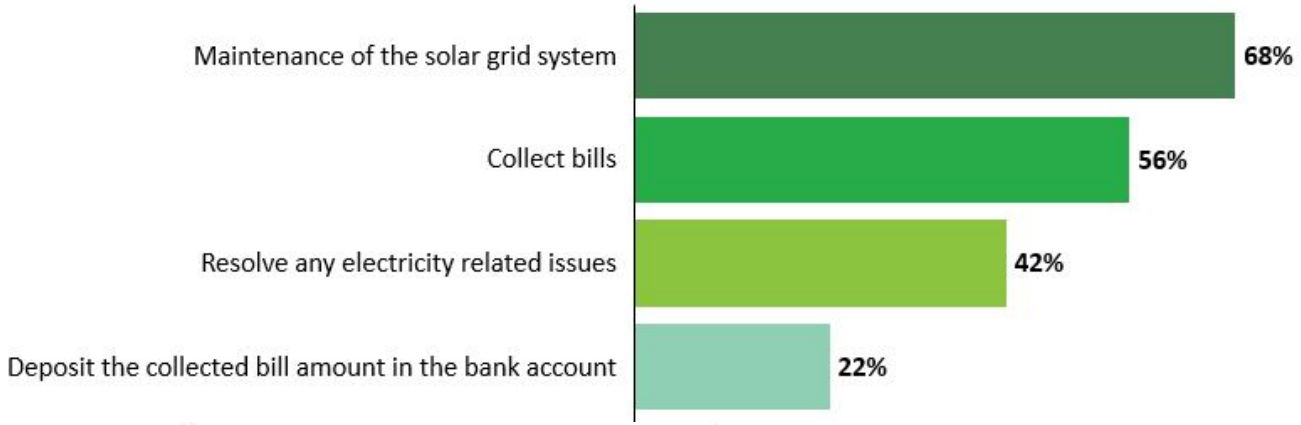
Ability of VECs and operators to effectively function, and undertake their tasks; the perception of VECs and operators by stakeholders

71% households understand village-level processes embedded in the program, and are aware of the VEC and its functions

Awareness

- **91%** of the respondents know that the solar microgrid runs on solar energy, while **53%** of the respondents acknowledged an increase in their overall understanding of clean and renewable sources of energy like solar energy
- **84%** of the households are aware of the VEC formed in their hamlet. In qualitative discussions, it was observed that households know the VEC simply as "Committee", or *"Samhiti"* members

What are the functions of the VECs that you are aware of? (n=199, out of the 71% who are aware of the VEC functions)



> *All of us in the village understand that the VEC model [TCCL's collaborative community model] is important for us to be able to pay for the repairs and maintenance of the micro-grid, and with time be able to replace it at its end of life.*
>
> - *Community Member, Bhijari Badi*

While 98% households believe that it's important to pay bills on time, 52% understand the purpose of the VEC fund

- Household bills are generated by the operator who takes readings from the household and commercial meters on a monthly basis, and feeds them into a passbook for each household
- Households then make bill payments in the monthly VEC meetings. Those who are unable to pay, clear their dues in subsequent months. Supply is generally cut-off if 3 consecutive bills are not paid
- 98% of the respondents *understand the importance of paying electricity bills on time*
- **52%** of households state that paying electricity bills is vital for *the repair and maintenance of the solar microgrids which is done using the VEC funds*
- This highlights that households are aware that the collection from the monthly electricity bills maintains the VEC fund, and they understand the purpose of the VEC fund
- In 4 qualitative discussions with VECs and community women (n=4), it was observed that community members are keen on the rates of electricity (both the fixed charge of INR 100, and the variable charge of INR 10/unit) to be reduced

Why do you think it's important for you to pay your bills on time? (n=275)

> *Beneficiaries certainly understand the importance of paying bills on time. They know that the monthly bill collections augment the VEC fund (which is utilized for maintenance, reparation, making payments to the operator, etc.) and that if they default for more than three months, their grid connection will be cut off.*
>
> - *Operator, Beejakhaman*

> *Many households cannot afford the high fixed cost of INR 100 per month due to low earnings and limited sources of income. After consensus from the village, we set the variable (per unit) cost of electricity as INR 5, but we were told by Mr.Anil [TRIF POC] to revise it to INR 10. We feel that it's a high rate for us.*
>
> - *VEC, Mudamba*

VECs perceive their **role to be crucial** in the smooth functioning of the program, and **understand their roles and responsibilities** (1/2)

Formation

Members from the VECs were nominated by the community itself. No qualifications were required of VEC members, except that such individuals be willing to be associated with the program, and take up leadership roles

3/4 VECs are headed by women. Women members opine that their thoughts and opinions are taken into consideration during meetings and decision-taking

Training

All 4 VECs agree that they were apprised of their roles and responsibilities, and solar microgrid-related information was provided to them, but only 1/4 VECs report to have been given formal training

Understanding of r&r

The VECs collect bills on a fixed date in a village-level meeting, and are proactive in ensuring that grid-related technical issues are resolved and that there are minimal changes of power outages. To prevent power outages caused due to the simultaneous usage of heavy appliances such as hullers, flour mills, and irrigation pumps, many VECs have set fixed hours for their usage. Moreover, VEC and operators also take precautionary measures of turning off the solar microgrid during heavy rains and lightning sprees

All 4 VECs perceive having a thorough understanding of village-level processes of the program, and their roles and responsibilities. **They acknowledge their roles to be crucial in the smooth functioning and sustainability of the program**

> *We do not face difficulties in discharging our duties, everyone's opinions in the VEC meeting are heard and resolved, regardless of gender and caste.*
>
> - *VEC, Beejakhaman*

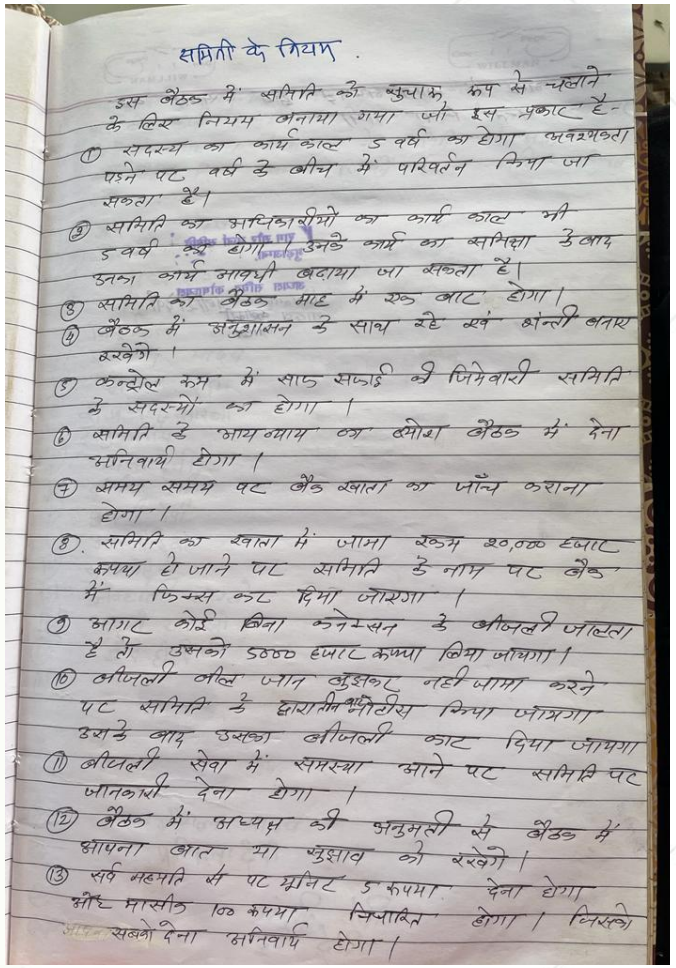
> *We believe that the VEC plays an important role in maintaining the microgrid and ensuring collection of funds from households. The committee is responsible for managing the fund, supervising the operator and supporting the village with any issues relating to the micro-grid system*
>
> - *VEC, Beejakhaman*

VECs perceive their **role to be crucial** in the smooth functioning of the program, and **understand their roles and responsibilities** (2/2)

- There is a system of reporting and monitoring with the VECs maintaining a ledger of monthly bill collections, defaulters, and utilization of VEC funds. The VECs also have a written mandate, and they record the agenda of their monthly meetings, attendance in the meetings, and any important decisions taken in the meetings

- The VECs and Operators do find it challenging to maintain the energy passbooks, and regularly update them based on the meter readings. It was observed that in many hamlets the energy books at the HH level were not updated and the data could only be found in the village-level ledgers

- The two dedicated TRIF staff on ground also attend monthly meetings to get updates on the functioning of the solar microgrid, and to provide guidance to the VEC members, if required


समिति के नियम

इस बैठक में समिति को सुचारू रूप से चलाने के लिए नियम बनाया गया जो इस प्रकार है-

① सदस्य का कार्य काल 5 वर्ष का होगा आवश्यकता पड़ने पर वर्ष के बीच में परिवर्तन किया जा सकता है।

② समिति का अधिकारीयों का कार्य काल भी 5 वर्ष का होगा उनके कार्य का समिक्षा के बाद उनका कार्य अवधी बढ़ाया जा सकता है।

③ समिति का बैठक माह में एक बार होगा।

④ बैठक में अनुशासन के साथ रहे एवं शांती बनाए रखेंगे।

⑤ कन्ट्रोल रूम में साफ सफाई की जिम्मेवारी समिति के सदस्यों का होगा।

⑥ समिति के आय व्यय का ब्योरा बैठक में देना अनिवार्य होगा।

⑦ समय समय पर बैंक खाता का जाँच कराना होगा।

⑧ समिति का खाता में जमा रकम 30,000 हजार रुपया हो जाने पर समिति के नाम पर बैंक में फिक्स कर दिया जायगा।

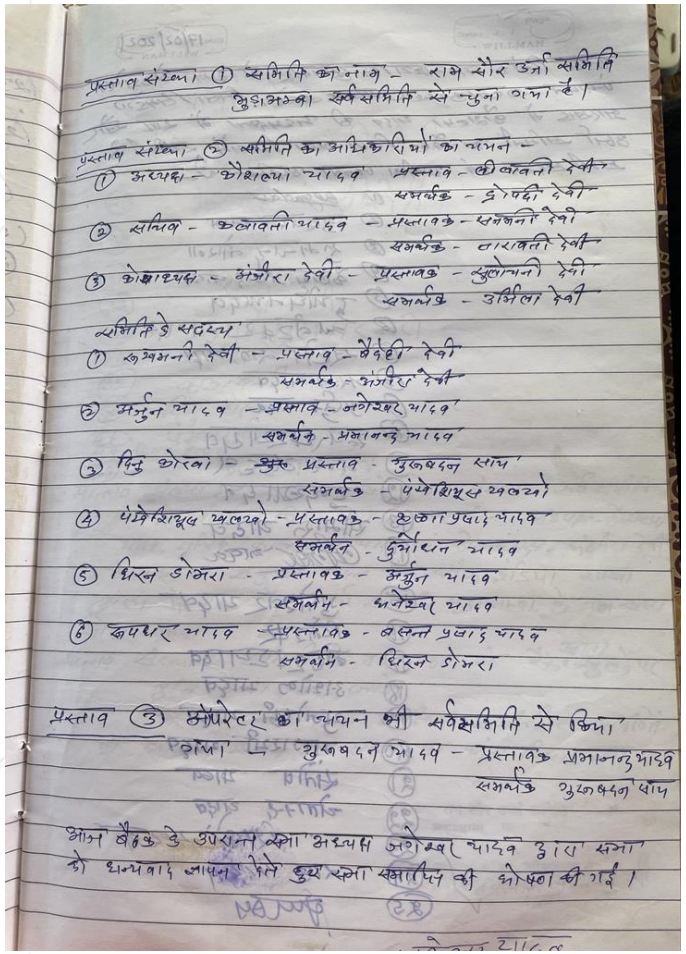
⑨ अगर कोई बिना कनेक्शन के बीजली जलता है तो उसको 5000 हजार रुपया लिया जायगा।

⑩ बीजली बील जान बुझकर नहीं जमा करने पर समिति के द्वारा तीन नोटीस भेजा जायगा उसके बाद उसका बीजली काट दिया जायगा

⑪ बीजली सेवा में समस्या आने पर समिति पर जानकारी देना होगा।

⑫ बैठक में अध्यक्ष की अनुमती से बैठक में बोधना बात या सुझाव को रखेंगे।

⑬ सभी सदस्य से पर मीटर 5 रुपया देना होगा और मासीक 100 रुपया निर्धारित होगा। जिसको सबको देना अनिवार्य होगा।


प्रस्ताव संख्या ① समिति का नाम - राजे सौर ऊर्जा समिति
सुझाव को सर्वसमिति से चुना गया है।

प्रस्ताव संख्या ② समिति का अधिकारीयों का चयन -

① अध्यक्ष - कौशल्या यादव प्रस्ताव - कीर्तनी देवी
समर्थक - द्रोपदी देवी

② सचिव - कलावती यादव - प्रस्तावक - सजनी देवी
समर्थक - तारावती देवी

③ कोषाध्यक्ष - अंजोरा देवी - प्रस्तावक - सुलोचनी देवी
समर्थक - उर्मिला देवी

समिति के सदस्य

① रूपमनी देवी - प्रस्ताव - बैदेही देवी
समर्थक - अंजोरा देवी

② अर्जुन यादव - प्रस्ताव - जगेश्वर यादव
समर्थक - प्रभानन्द यादव

③ दिनु डोमरा - ~~अर्जुन~~ प्रस्ताव - सुखदेव साव
समर्थक - पंचेश्वर ~~यादव~~ डोमरा

④ पंचेश्वर डोमरा - प्रस्तावक - इच्छा प्रसाद यादव
समर्थन - दुर्योधन यादव

⑤ धिरन डोमरा - प्रस्तावक - अर्जुन यादव
समर्थन - जगेश्वर यादव

⑥ कपधर यादव - प्रस्तावक - बसन्त प्रसाद यादव
समर्थन - धिरन डोमरा

प्रस्ताव ③ ~~कोषाध्यक्ष~~ का चयन भी सर्वसमिति से किया
गया। सुखदेव यादव - प्रस्तावक प्रभानन्द यादव
समर्थक सुखदेव साव

आज बैठक के उपरान्त सभा अध्यक्ष जगेश्वर यादव द्वारा सभा को धन्यवाद ज्ञापन तथा कुछ सभा संबंधित की घोषणा की गई।

Snippets from a VEC's book of records

VECs are **confident in their ability** to discharge their duties, but **desire a refresher training course**

- VECs understand that the success of the program hinges on community ownership, and on continuous bill collection for the maintenance and upkeep of the solar microgrid
- In instances of more advanced technical issues, the operator and the VECs get in touch with either of the two TRIF POCs on ground or Gram Oorja to receive assistance in resolving the issues
- Another important observation is that VECs **are confident in their ability to discharge their duties effectively**
- VECs understand the processes of basic troubleshooting. For more advanced issues, they seek the support of TRIF and Gram Oorja, which has an office in Ranchi. **3/4** of the VECs concur that the advisory support of TRIF and Gram Oorja are vital in resolving more advanced technical issues
- 2/4 VECs desire a refresher training course, focused on how to replace and repair solar panels, and where to source new solar panels from

> *We do not remember everything informed to us about the microgrid earlier, and we believe a refresher training is required for us and the operator in this regard. Currently, we reach out to TRIF in case of any issues/questions.*
>
> - *VEC, Beejakhaman*

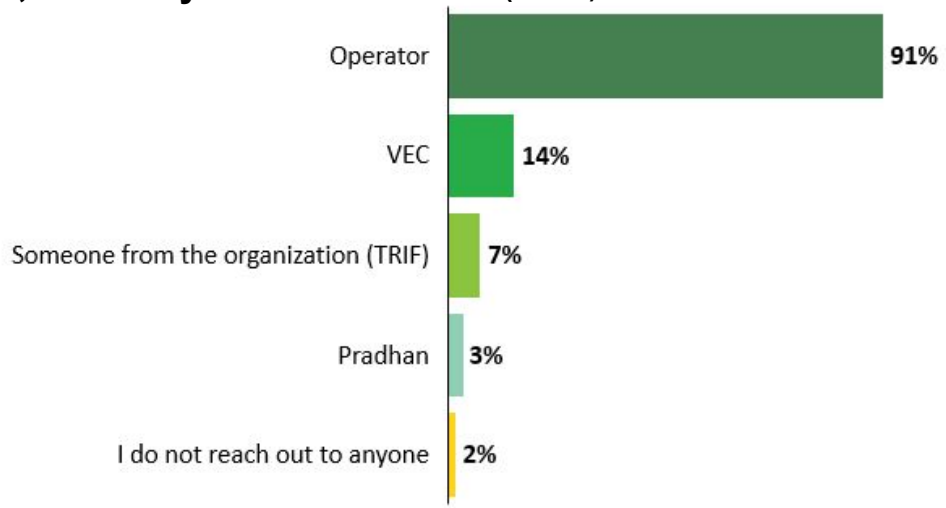
> *We may not be fully able to fulfil our roles and responsibilities if TRIF no longer provides assistance. We require their support for resolving grid-related issues that may arise and advisory support during meetings.*
>
> - *VEC, Bhijari Badi**
>
> **Bhijari Badi is a new hamlet that has been incorporated into the program. The TRIF SPOC noted that they are yet to have a formal training session with the VEC, post which the VEC will have more clarity regarding the program*

Households reach out to the operators in instances of technical issues and are **satisfied with the services** rendered by the VEC and the operator

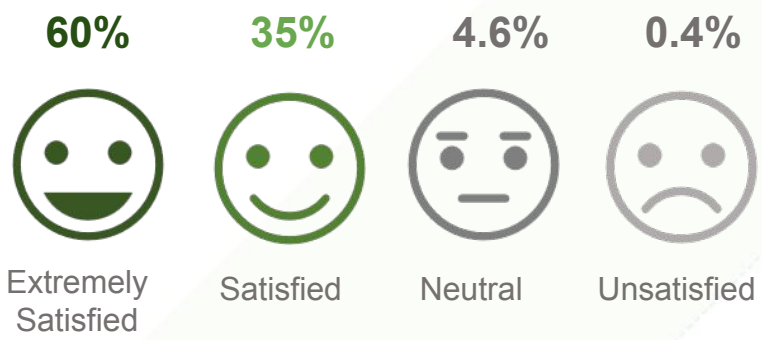
- **91%** of the respondents state that they reach out to the operator in instances of any technical issues faced by them in their house
- **79%** of the respondents state that they are aware of technical issues related to the solar microgrid being resolved by the VEC and the operator
- Community members are satisfied with the services rendered by the VEC and the operator

> *"I remind community members to inform me about electricity-related issues when I visit each HH on a monthly basis."*
>
> - *Operator, Bhijari Badi*

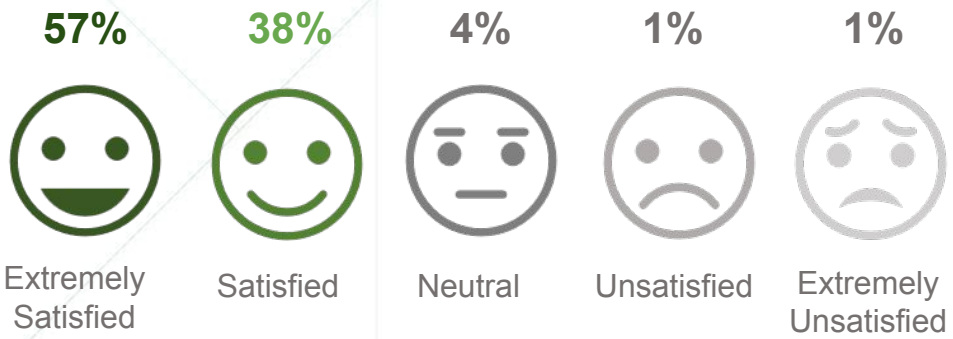
In case there is a power outage or any other electricity-related issue, who do you reach out to? (n=281)



Satisfaction with the services of the VEC (n=236)



Satisfaction with the services of the operator (n=281)



Operators **understand their R&R**, are capable of **resolving grid-related technical issues**, and do not feel that they require any additional training support

Capacity of Operators

Selection Criteria

The VECs were responsible for choosing two operators in their respective hamlets. Though there were no formal selection criteria for the post of an operator, individuals who (i) resided in the same village, (ii) were unlikely to migrate out of the village, and (iii) had some degree of technical aptitude, and exhibited willingness to work with technical equipment were chosen as operators. In qualitative discussions with 4 operators, it was noted that 2 operators had prior technical experience

Training

Operators were apprised of their roles and responsibilities, and trained by TRIF and Gram Oorja. In qualitative discussions, operators acknowledged that they were imparted with information about the solar microgrid, and their R&R as an operator, but only 1/4 operators claim to have received formal training from the program partners

Understanding of r&r

The operators have a thorough understanding of their R&R. The operator in Bhijari Badi demonstrated to the Sattva team taking readings from the electricity meter, installed in a church

The operators seek the assistance of TRIF, and Gram Oorja in instances of more advanced technical glitches. **The operators work in tandem with the VEC to ensure the operability of the solar microgrids**

> *In my role as an operator, I resolve any issues with the microgrid (frequency of queries being once or twice a month), maintain the control room, resolve wiring and switchboard-related issues faced by households, and support the monthly collection of bill payments from households.*
>
> *In instances where I can resolve issues on my own, I reach out to TRIF for support. For instance, some time ago, the grid was erroneously set on a 'self-timer mode' where electricity would only be transmitted during specific hours. This was resolved with the support of the TRIF team.*
>
> - *Operator, Jhimri*

> *We do not receive grid maintenance and repair requests [from the operators] very often. On average, we make about 2 to 3 visits per village in a year*
>
> - *Sameer Nair, Gram Oorja*

Please state your level of ease in undertaking the tasks of an operator (n=4)

The **effective functioning of VECs and operators**, and the **willingness of households** to **participate in the community model** and **pay for their electricity usage** are **crucial for the sustainability** of the program

- The sustainability of the collaborative community-model is contingent on the effective **undertaking of duties by the VECs and the operators**, and the **participation of community members in the community model**

- The sustenance of the VEC fund hinges on both the effectiveness of VECs, and the willingness of households to continue paying bills for their electricity usage in the future when the program partners transition out of the program. A majority of VECs, and Operators believe that **households will continue to pay monthly bills in the future** which is vital for maintaining the VEC fund

- According to the exit timelines, Gram Oorja will transition out of the program after 2 years, while TRIF will act in an advisory capacity and assist community members for a minimum of 4-5 years. According to Mr.Ashok from TRIF, **hand-holding of the VECs is required** for that amount of time to make them truly independent, and to reinforce the discipline of collecting bills, reporting, and other r&r of VECs

> *The insurance for the solar microgrid was paid from the VEC funds. We strongly believe that this is the building block of establishing ownership- I've paid the premium, so I'll take the first step when some damage is done. We transferred all the assets to the VECs- all the claims are in their names now. We also had a special event where we discussed the ownership of these assets: The VEC owns them.*
>
> - *Ashok Kumar, TRIF*

> *I feel confident in the VEC and the operator to carry out their duties. They will require a little guidance once TRIF transitions out. For example, when the solar microgrid breaks down, or when certain components need to be repaired/replaced.*
>
> - *Surendra Painkra, Ward Member, Dabnipani (Panchayat: Kukutamachar)*

GHG Emissions – Calculations and Result

GHG Emissions – Calculations and Result

Sr No	Particulars	Measurement unit	Pre as per Survey (281 HH, 9L)	Post as per Survey (281 HH, 9L)	Extrapolated Pre (716 HH, 13L)	Extrapolated Post (716 HH, 13L)	Emission Factor	Baseline Emissions in kg CO2e	Current Emissions in kg CO2e	Emission Reductions / (Emission Increases)
1	Kerosene consumption per annum	Litres	12,672.00	2,484.00	32,288.80	6,329.34	2.52 kg CO2e/litre	81,335.48	15,943.60	65,391.88
2	Motorcycle transportation for kerosene procurement per annum	Kilometres	4,653.00	2,791.80	11,856.04	7,113.63	0.04 kg CO2e/km	474.24	284.55	189.70
3	Diesel consumption per annum	Litres	1,272.00	1,188.00	3,241.11	3,027.07	2.64 kg CO2e/litre	8,556.53	7,991.48	565.05
4	**One-time** grid construction related emissions - Travel	Kilometres	0.00	960.00	0.00	1,340.00	0.59 kg CO2e/km	0.00	786.13	(786.13)
5	**One-time** grid construction related emissions - Cement	Kilograms	0.00	11,700.00	0.00	16,900.00	0.58 kg CO2e/kg	0.00	9,734.40	(9,734.40)
6	**Annual** grid maintenance-related travel	Kilometres	0.00	12,960.00	0.00	18,720.00	0.04 kg CO2e/km	0.00	748.80	(748.80)
7	**Annual** grid monitoring-related travel	Kilometres	0.00	3,240.00	0.00	4,680.00	0.04 kg CO2e/km	0.00	187.20	(187.20)
	TOTAL									**54,690.09**

Result: Based on our assessment, TCCL's 'Greenswitch' Microgrid Solar Electrification Project spanning across 716 HHs and 13 locations in Kurdeg, Jharkhand has contributed to GHG emission reductions of approximately **54,690.09 kg CO2e (or 54.69 tonnes CO2e) per annum**

Note 1: Motorcycle transportation for kerosene is assumed to be a two wheeler motorcycle with an engine of less than 200 CC
Note 2: For grid construction, the GO team transports the requisite equipments by truck (about 3 truck loads for 9 set ups and 4 truck loads for 13 set ups) to a location in Simdega, which is about 140 kilometres away. The equipments are then transported to the respective location (1 truck load per location or less) and each location is on average about 50-60 kilometres from Simdega
Note 3: Based on observations, we estimate that the control room measures 10 feet height, 10 feet length and has a 4 inch thick brickwall. Accordingly, its construction is assumed to require about 1,300 kgs of cement (https://dailycivil.com/quantity-of-brick-cement-sand-and-aggregates-required-to-build-10ft-x-10ft-room/)
Note 4: Based on qualitative interviews, it is known that the GO team travels from Ranchi to each location covering about 150 km distance one-way on a quarterly basis
Note 5: Based on qualitative interviews, it is known that the TRIF team travels from Kurdeg to each location covering about 15 km distance one-way on a monthly basis

Reference: Emission Factor Sources

GHG Emissions – Summary of Insights

Summary of Insights (1/2)

	Contribution to GHG Emissions	Change in Usage	Measurement Units	Insights				
Kerosene	✓	▼	**Litres**	**80%** Reduction in monthly kerosene usage **from 1056 to 207 litres**	**All 281 HHs** switched to electricity as their primary source of light	**90% HHs (n=253)** completely stopped using **kerosene as a source of light**	**57% HHs (n=160)** still use **kerosene for cooking** as a starter fuel for firewood	**96% HHs (n=270)** procure kerosene from **fair price shops under PDS** i.e. the cheapest source
				90% HHs (n=253) quoted a price of **more than INR 51 per litre;** averaging to about **INR 90 per litre**	Most households either **travel on foot or through bicycle** to procure kerosene	**17% HHs (n=48)** use GHG emitting modes of private travel such as motorcycles to procure kerosene	**5 Km** **average distance travelled** one-way to procure kerosene	**40%** Reduction in average **monthly trips to procure kerosene**

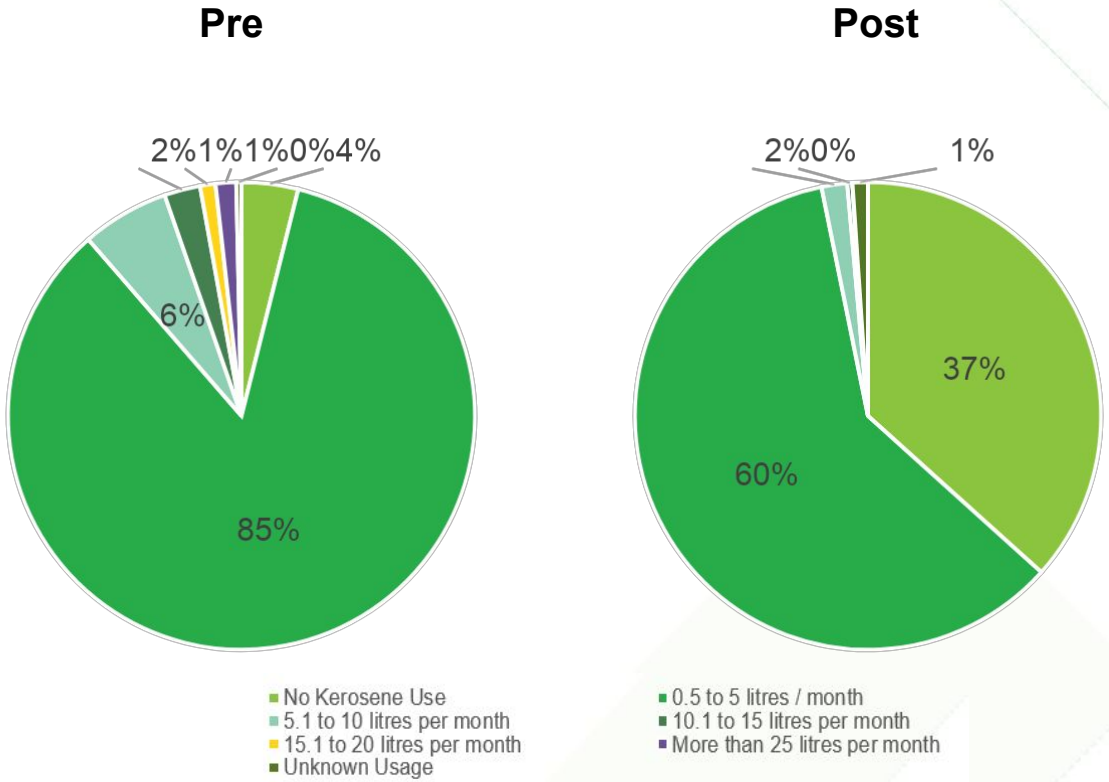
Summary of Insights (2/2)

	Contribution to GHG Emissions	Change in Usage	Measurement Units	Insights
Microgrid Electricity	✕	▲	**Units (kWh)**	**0.2** kWh/ day Average units consumed by a HH **0.6** kWh/ day Average units generated per HH by Microgrid **34%** Average Microgrid Capacity Utilisation Minor discrepancies in unit consumption data recorded in passbooks **12,280** kWh Average Annual Energy Generation Potential Per Location
Diesel	✓	▼	**Litres**	**6%** Reduction in overall usage of diesel (lower usage of generators and pumps) **84** litres Annual reduction in overall usage of diesel (lower usage of generators and pumps)
Solar Lamp	✓	▼	**Units (kWh)**	**40%** Reduction in solar lamp usage (only 20% HHs using it for back-up)
Solar Pumps	✕	▲	**NA**	**500%** increase in solar pumps post electrification indicates the awareness of benefits and the value of solar pumps among HHs
Other Pumps	✓	▼	**NA**	**50%** Reduction in the number of irrigation pumps powered by diesel, petrol and kerosene (n=27) 10% decrease in irrigation pump users (n=5) i.e. Electrification has NOT led to an overall increase in quantity of irrigation pumps used

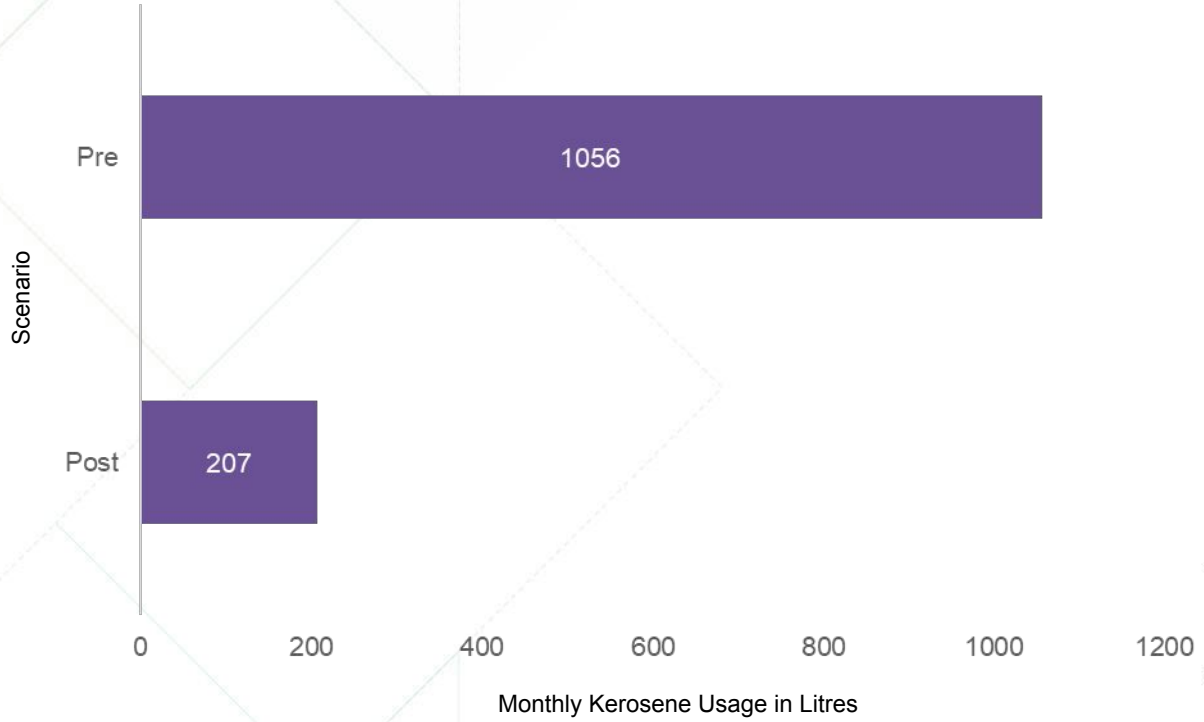
Insights: Kerosene Usage

The overall use of kerosene has **reduced by 80%** due to electrification

Pre vs Post Electrification Monthly Usage of Kerosene (Categorised) [n=281 HH]



Pre vs Post Electrification Monthly Usage of Kerosene (Quantified) [n=281 HH]



- Pre-electrification, **11 HHs did not use any kerosene**, 238 HHs used 0.5 to 5 litres of kerosene per month, and 31 HHs used more than 5 litres kerosene per month
- Post-electrification, 103 HHs did not use any kerosene, 169 HHs used 0.5 to 5 litres kerosene per month, and only 6 HHs used more than 5 litres kerosene per month

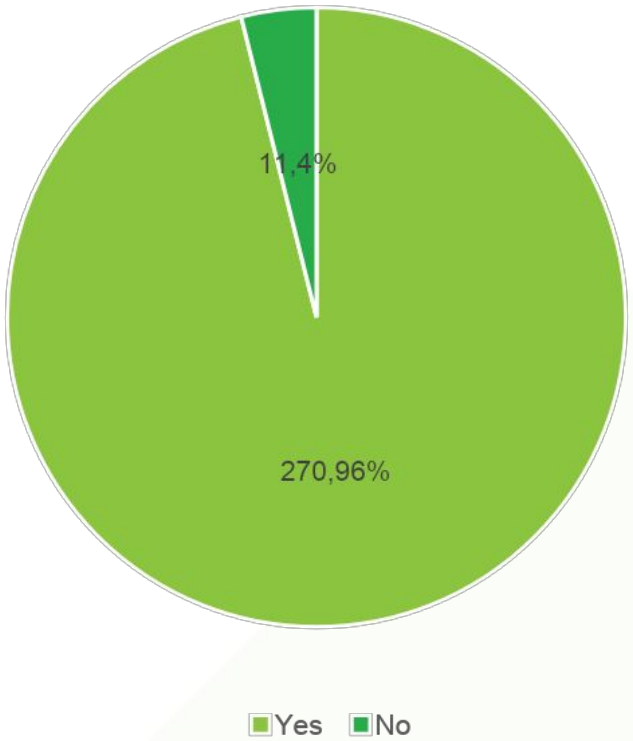
- Overall monthly household usage of kerosene dropped by 80% from 1056 litres per month to 207 litres per month due to electrification
- Average kerosene usage per HH pre-electrification is 3.76 litres

*Additional Observation: As per the baseline data shared by the TRIF team for all 716 HHs, the average monthly usage of kerosene was **2.4 litres per HH**, slightly lower than that as per our baseline assessment of 3.76 litres*

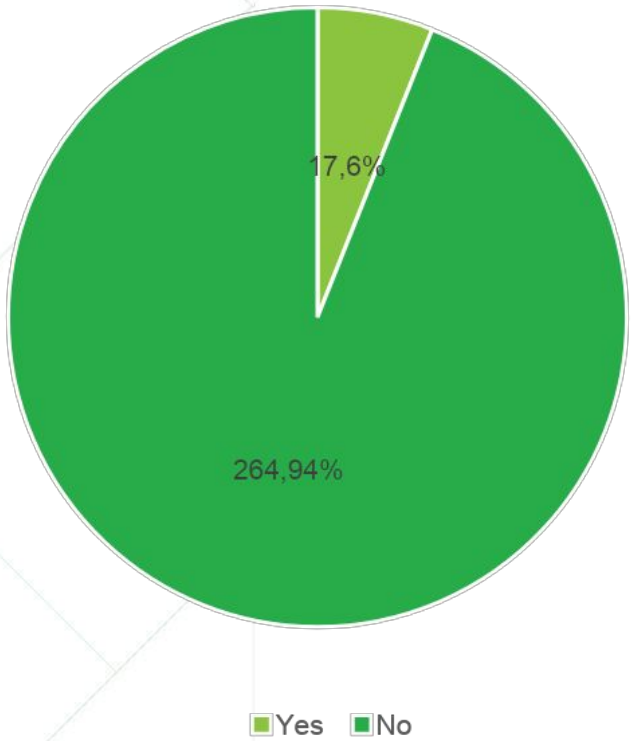
The use of kerosene **as a source of lighting** has **reduced significantly** due to electrification

HHs Using Kerosene for Lighting [n=281 HH]

Pre Electrification



Post Electrification

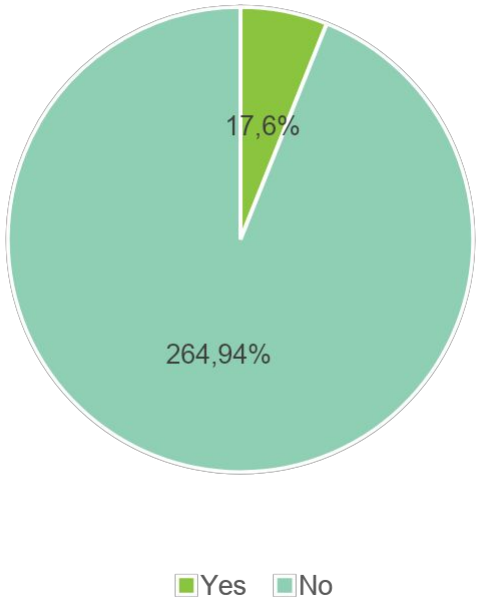


- While all 281 HHs switched to electricity as their primary source of lighting due to electrification, about 90% additional HHs (n=253) stopped using kerosene as a source of lighting, whether primary or secondary

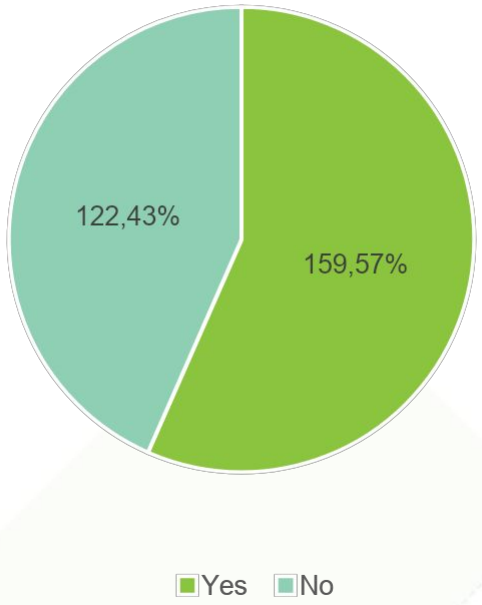
Additional Observation: As per the baseline data shared by the TRIF team for all 716 HHs, only 35% HHs used kerosene as a source of lighting in the pre electrification scenario, much lower than that as per our baseline assessment

Post electrification, **kerosene** has been **used** primarily **for back up lamps**, as a **starter fuel** for firewood and for **water pumps**

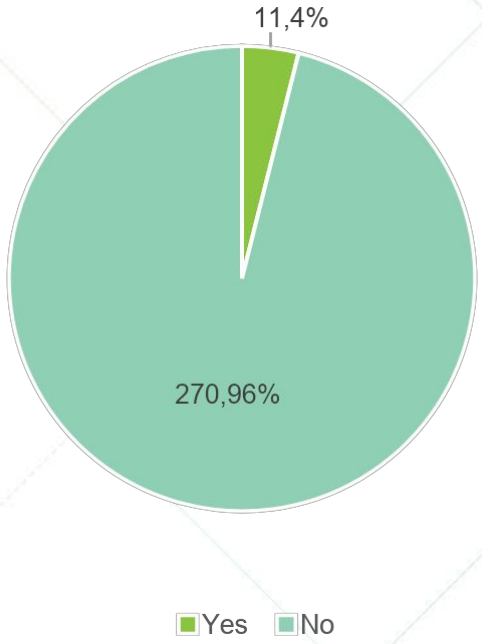
Lighting – Backup Lamps [n=281]



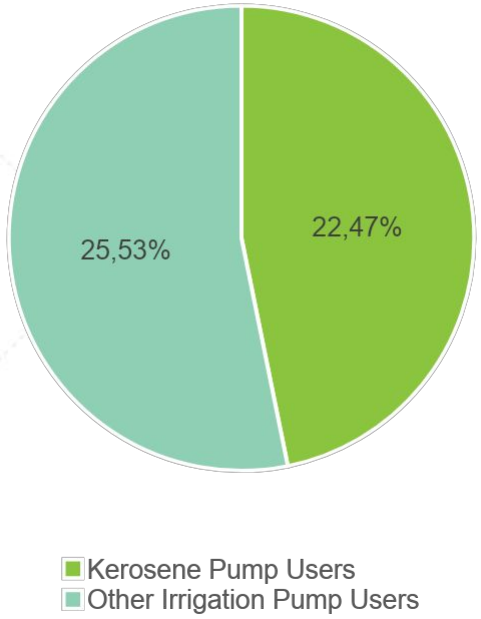
Cooking – Starter Fuel for Firewood [n=281]



Heating – Starter Fuel for Firewood [n=281]



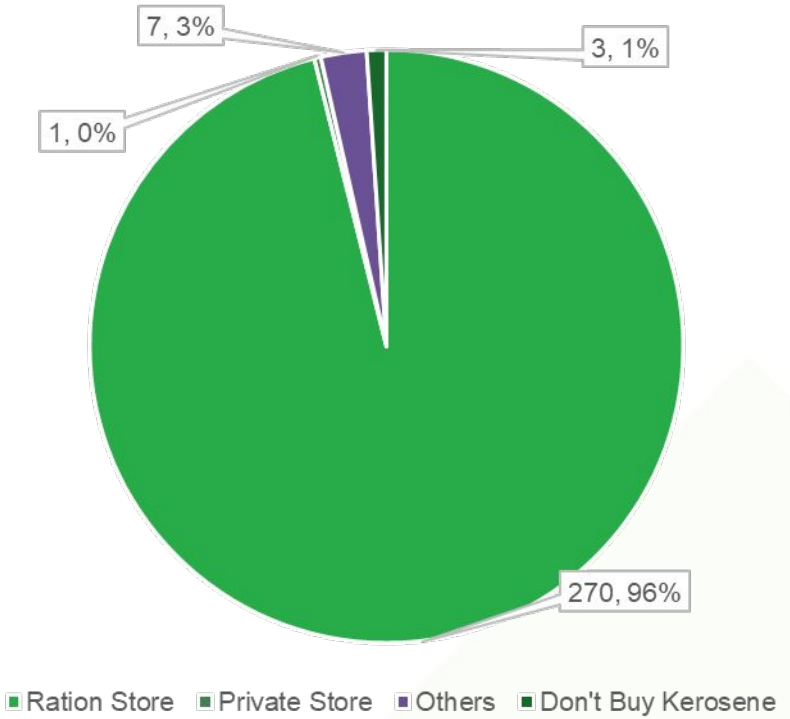
Others – Water Pump [n=47]



- Most HHs (57%) still use kerosene for cooking as a starter fuel for firewood since usage of firewood has largely remained the same pre and post electrification
- Some HHs (n=9) still use kerosene as a fuel for irrigation pumps

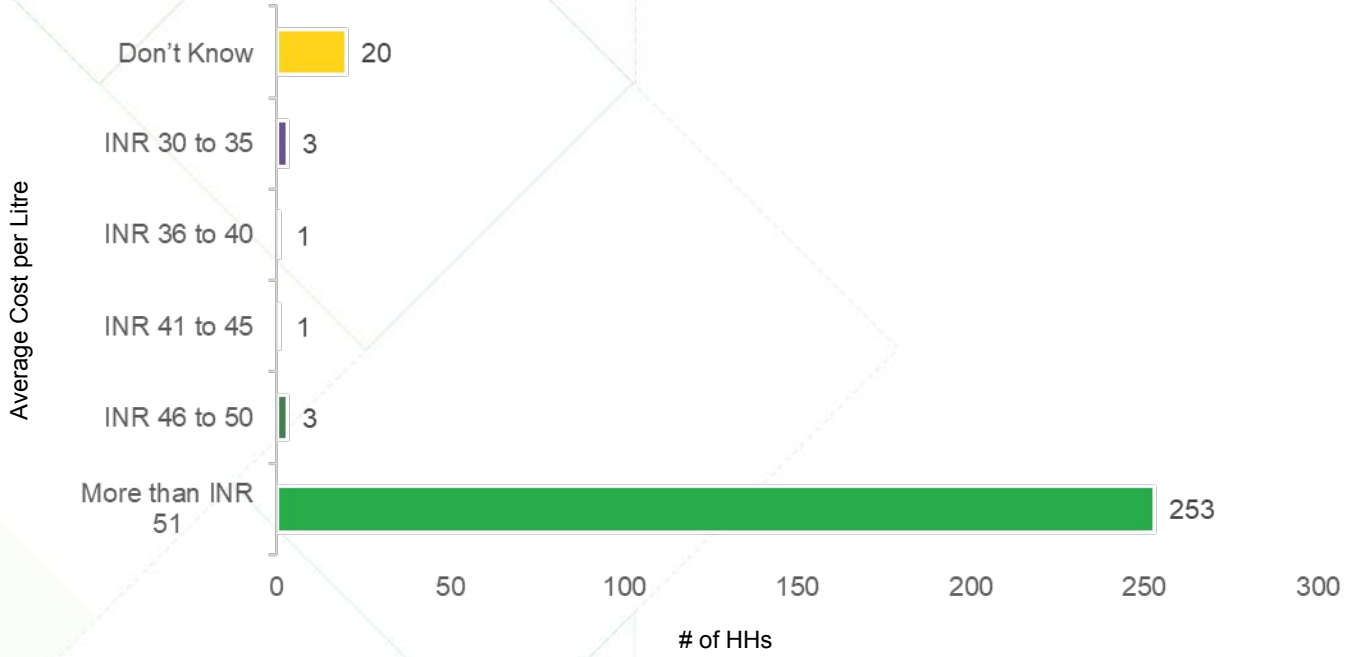
Kerosene is mainly **procured from ration stores** and the **average cost** per litre kerosene is **more than INR 51**

Kerosene Procurement Sources [n=281 HH]



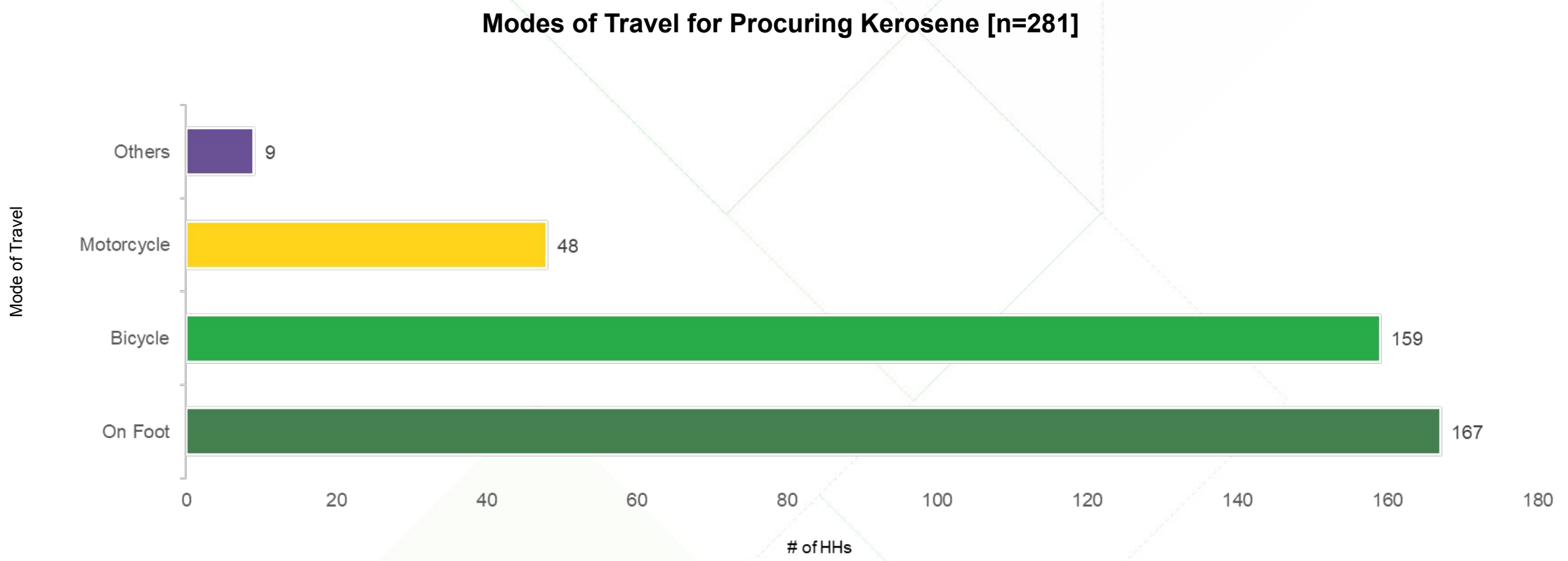
- We have assumed that there have been no significant change in kerosene procurement sources pre and post electrification
- Most households (n=270, 96%) procure kerosene from ration stores, which are expected to be the cheapest sources of kerosene

Kerosene Average Cost Per Litre (Categorised) [n=281 HH]



- 90% HHs (n=253) have quoted a price of more than INR 51 per litre kerosene
- **Based on qualitative interviews, we anticipate the average price of kerosene to be around INR 90 per litre**

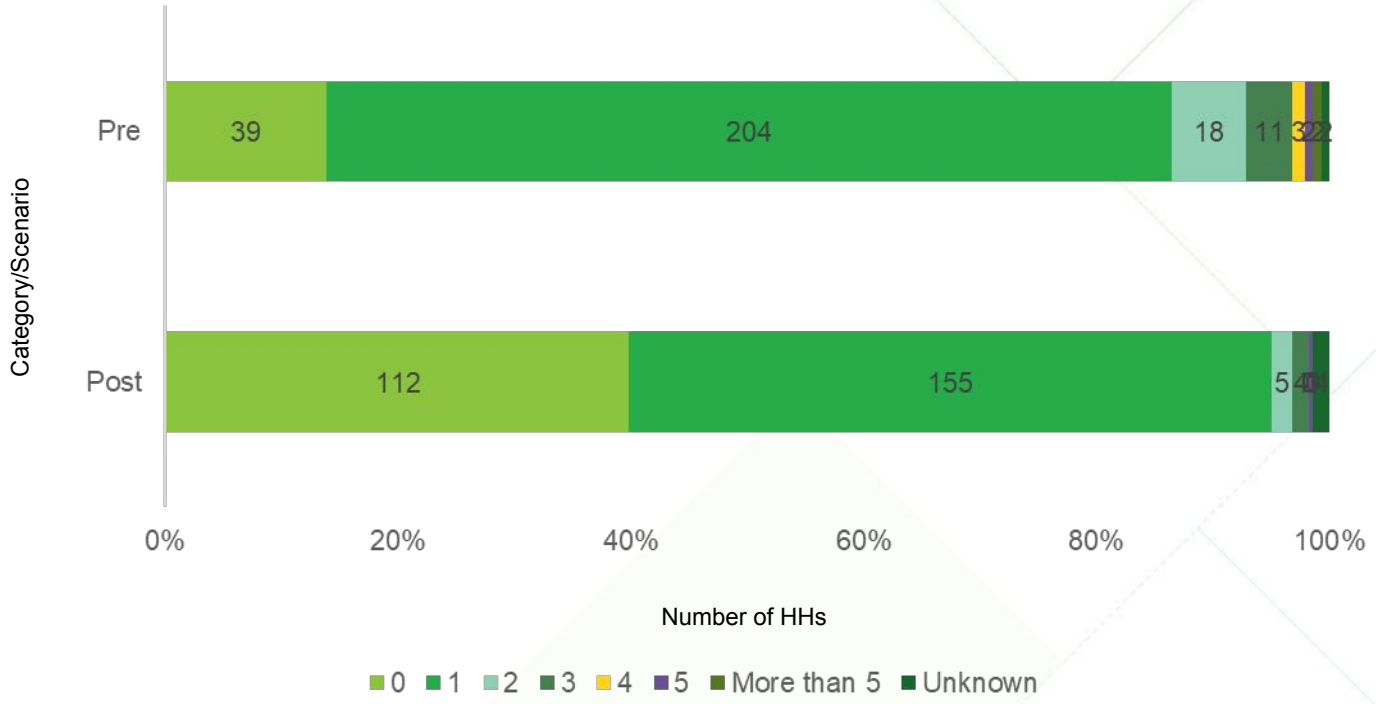
While the most frequently used modes of travel for procurement are carbon neutral, **48 HHs use GHG emitting modes** of transport



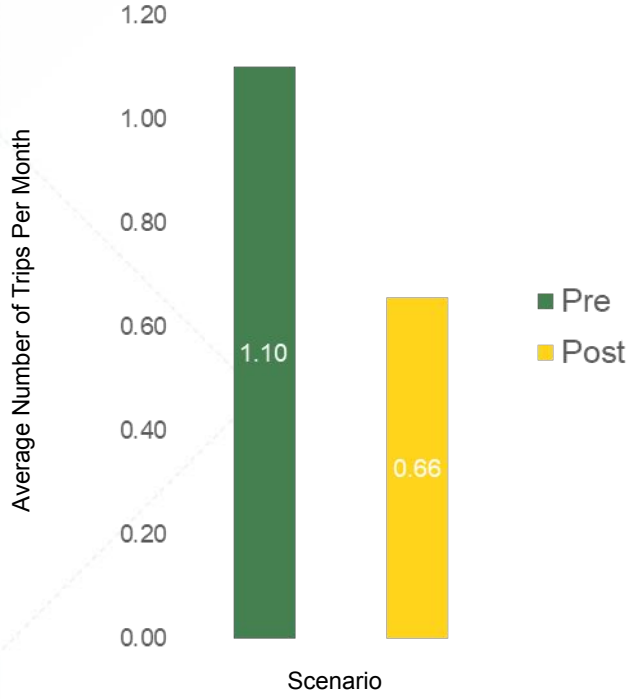
- For our assessment, It is assumed that the modes of travel have not undergone significant change in the pre and post electrification scenario
- Most households either travel on foot or through bicycle for procurement of kerosene
- 17% HHs (n=48) use GHG emitting modes of private travel such as motorcycles for procuring kerosene, which is **relevant** for our assessment
- Only 3% HHs (n=9) use other GHG emitting modes of public travel such as bus, autorickshaw, tempo, etc. for procuring kerosene; due to its negligible impact in comparison with overall emissions, it is considered **immaterial** for our assessment

Electrification led to a **40% overall reduction** in average number of monthly trips for procuring kerosene

Number of Monthly Trips for Procuring Kerosene (Categorised) [n=281 HH]

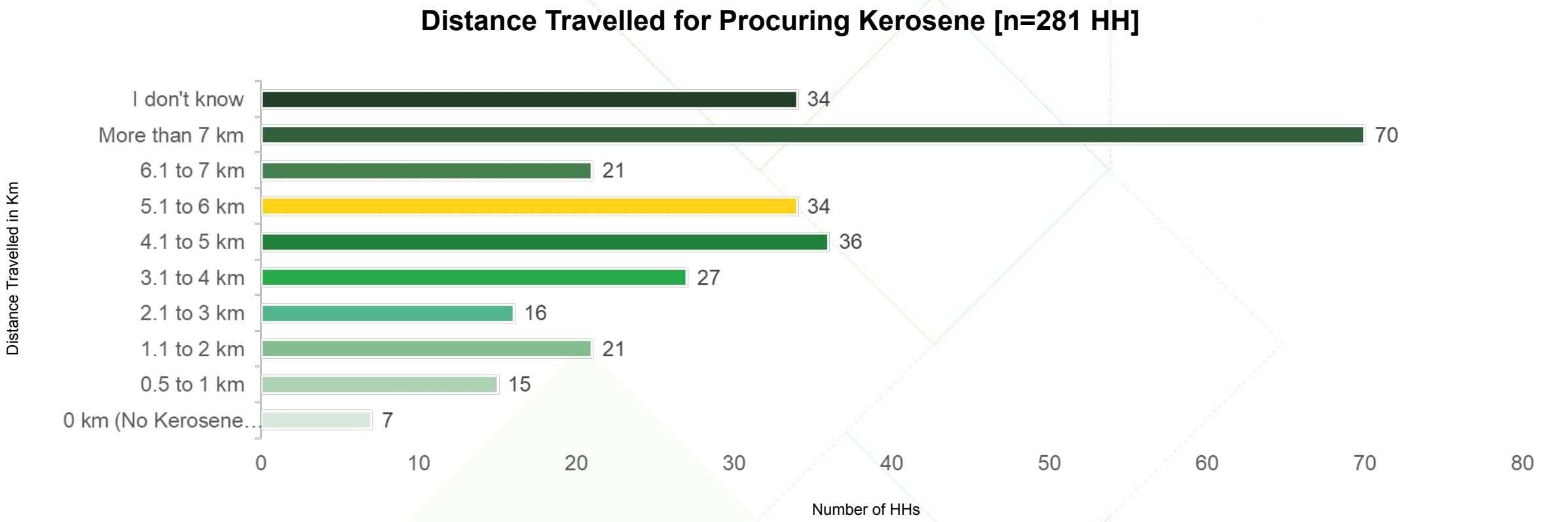


Overall Average Monthly Trips Per Month for Procuring Kerosene [n=281 HH]



- Pre electrification, 14% HHs (n=39) did not make any trips for kerosene procurement, 72% HHs (n=204) made 1 trip per month and 13.5% (n=38) made more than 1 trip per month
- Post electrification, 40% HHs (n=112) did not make any trips for kerosene procurement, 55% HHs (n=155) made 1 trip per month and only 5% (n=14) made more than 1 trip per month
- Electrification has led to about 8.5% (n=24) more HHs to reduce their trips to 1 per month for kerosene procurement
- The overall average monthly trips per month for procuring kerosene have reduced **by 40% post electrification**, from 1.1 to 0.66

HHs travel **5 kilometres** on average per trip one-way to procure kerosene

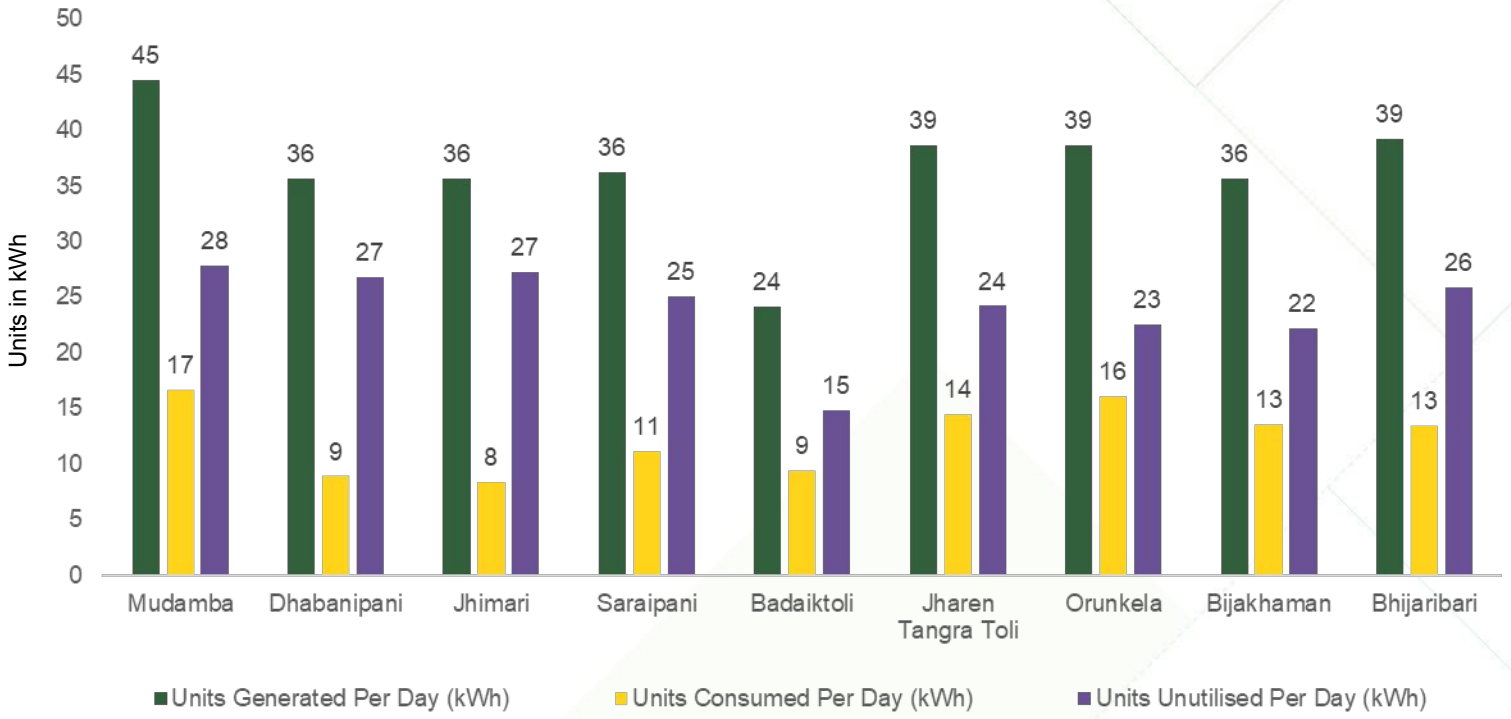


- For our assessment, It is assumed that the travel distance has not undergone material change in the pre and post electrification scenario
- Most households travel between 4 to 7 kilometres one-way to procure kerosene
- The average distance travelled one-way to procure kerosene is **5 kilometres**

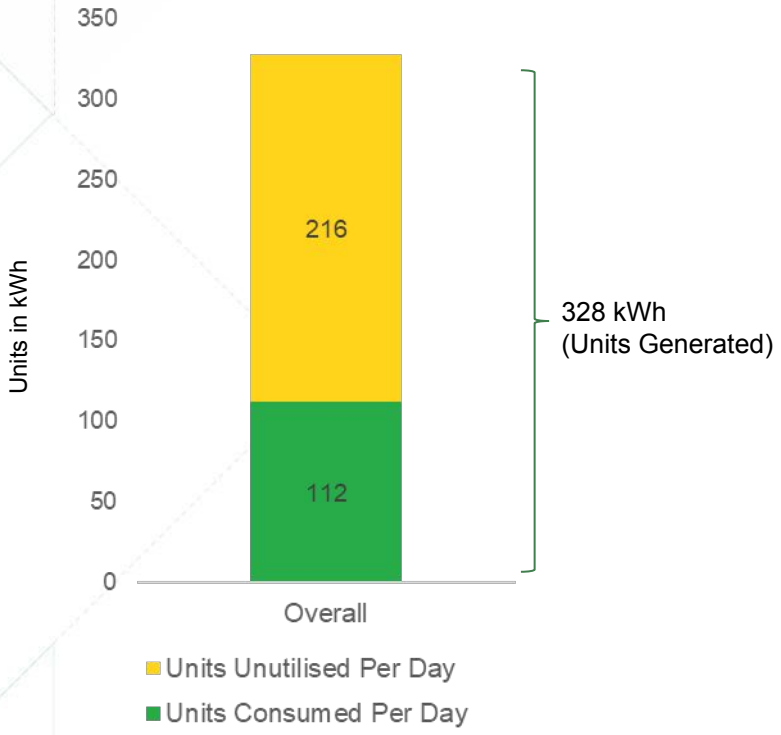
Insights – Microgrid Electricity

The microgrid systems have an **unutilised energy potential of about 1,59,640 kWh per annum** which can be **productively leveraged** by the HHs in the future

Location-Wise Average Daily Unit Generation and Consumption [n=546 HH]



Overall Average Daily Unit Generation and Consumption [n=546 HH]

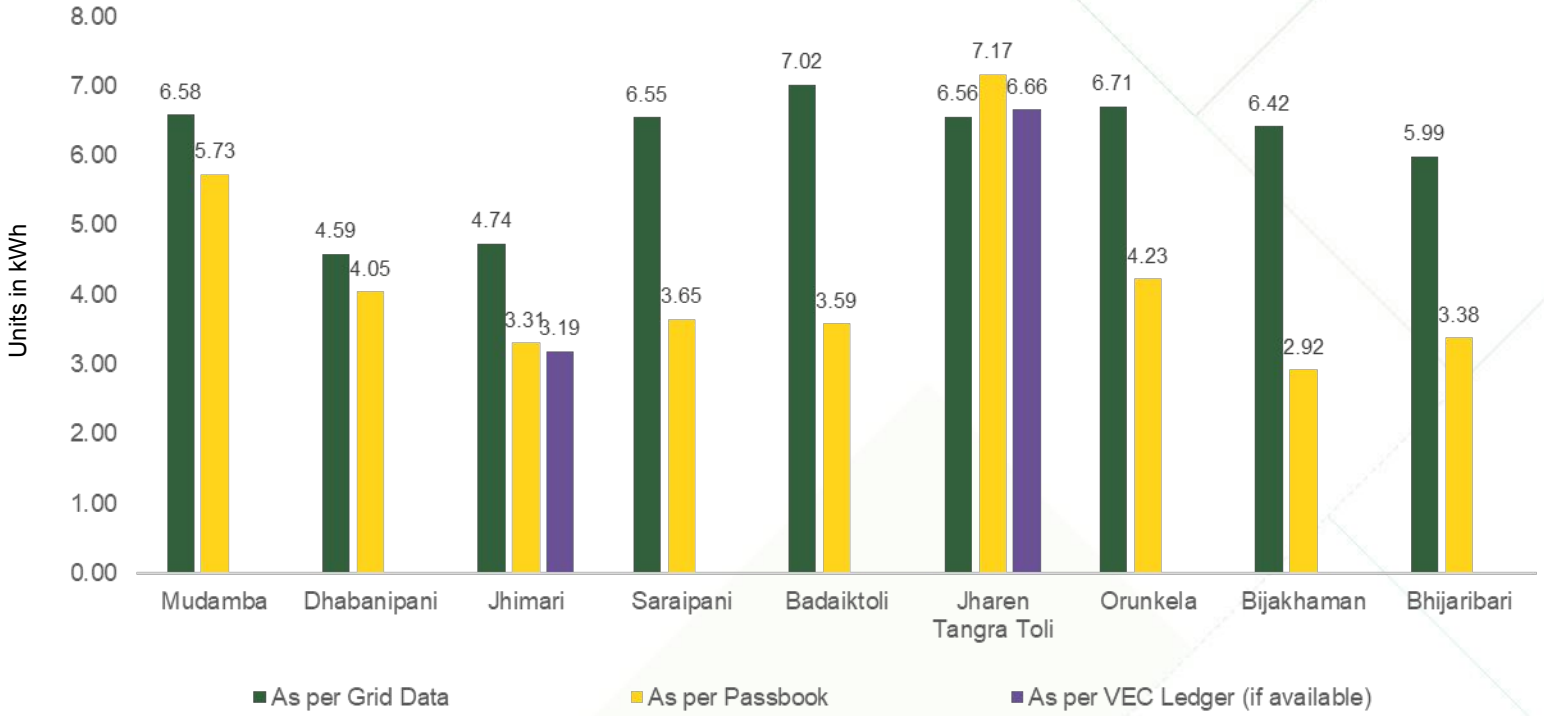


- The average units consumed per HH per day is **0.2 kWh,** while the microgrid generates an average of **0.58 kWh** per HH per day; the average household only **consumes only 34% of the total capacity generated** by the microgrid. These figures are based on the average daily unit generation of 328 kWh received from the GO team and the average daily unit consumption of 112 kWh calculated from the survey data for 9 locations
- Using extrapolation based on the data received for 9 locations, the energy generation potential for all 13 locations totals about **1,59,640 kWh per annum** (or 437.37 kWh per day)

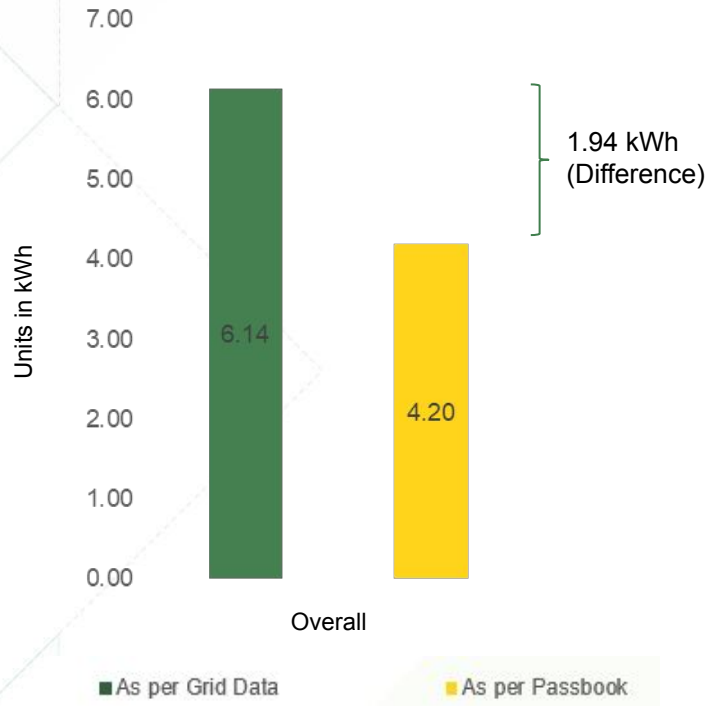
Note: The above data has been received from the Gram Oorja team after the team's visit in September, and has the latest available information for our assessment
Reference: Grid data received from Gram Oorja team

We saw **minor discrepancies** in unit consumption **data recorded in passbooks** across locations

Location-Wise Average Monthly Unit Consumption As Per Various Sources [n=546 HH]



Overall Average Monthly Unit Consumption [n=546 HH]



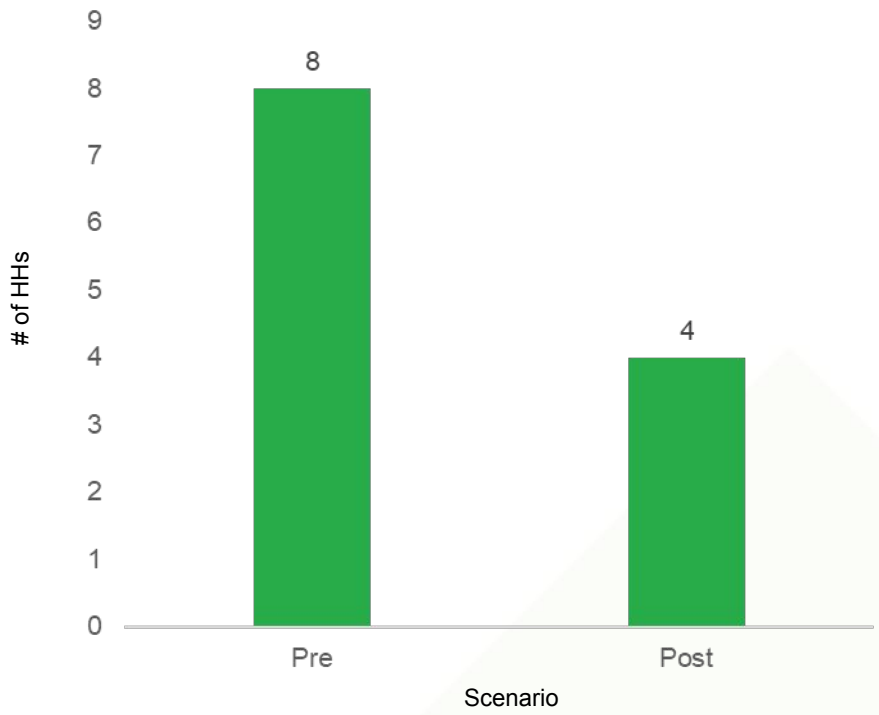
- The average units consumed per HH per day is **0.14 kWh as per passbook entries,** as compared to **0.2kWh** as per control unit data received from the microgrid
- The data was also confirmed by checking sample VEC ledger books for 2 locations, which also showed roughly equivalent data to the corresponding passbook averages
- This discrepancy may exist due to multiple reasons, a few of which were observed on the ground during interviews and data collection
- The reasons include missing entries in many passbooks (which was considered as zero unit usage during surveys), changes in some passbook entries (observed as whitener marks during surveys) and community space usage (which is reflected in microgrid data but not in the passbook data); however, the precise sources of the mismatch remain unknown

Note: The per day calculations are made considering 30 days in a month

Other Insights

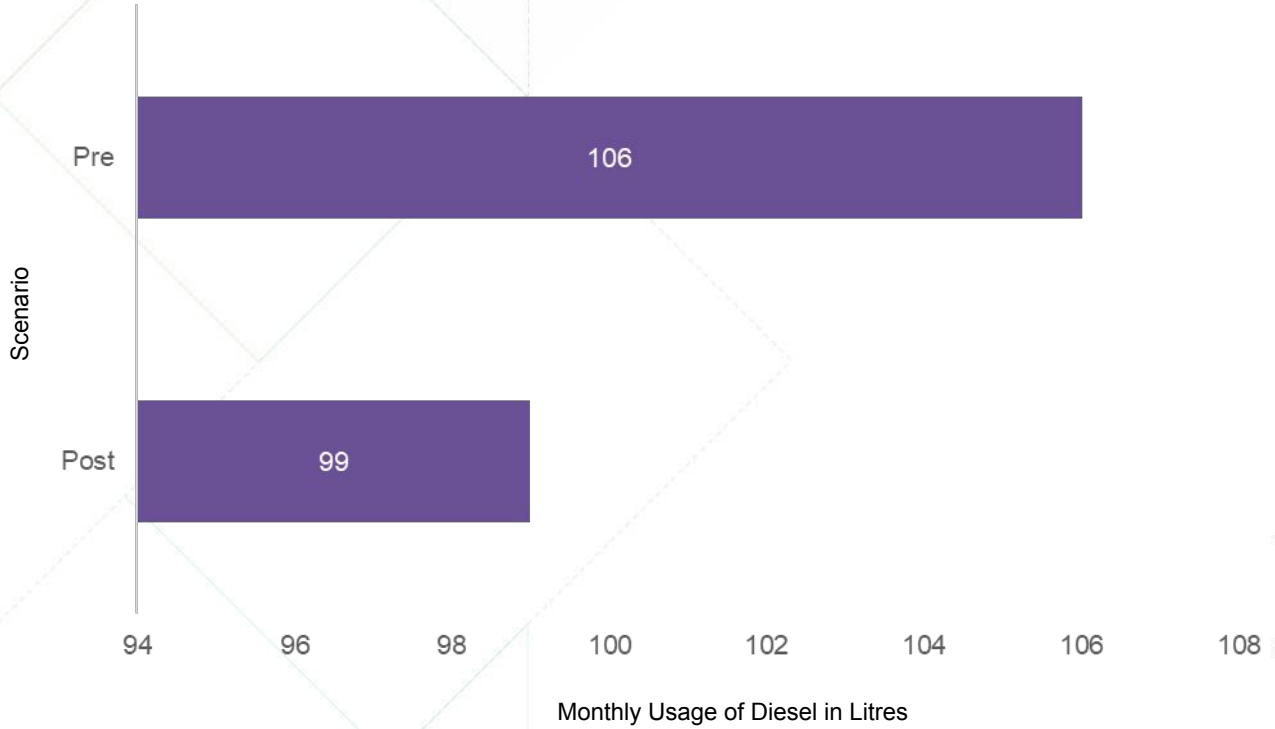
6% reduction in the overall **usage of diesel** post electrification due to decreased usage of generators and pumps

Pre vs Post Electrification HH Users of Diesel [n=281 HH]



- Electrification led to a 50% (n=4) decrease in HHs using diesel
- While we have not inquired about causes of this reduction, we hypothesize that the same is largely due to reduction of usage of diesel-run generators for lighting for social functions and water pumps

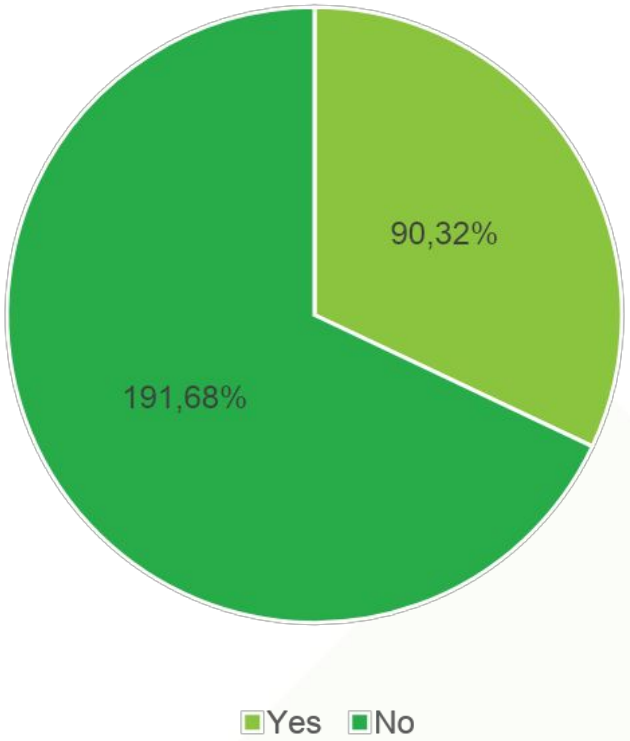
Pre vs Post Electrification Monthly Usage of Diesel (Quantified) [n=281 HH]



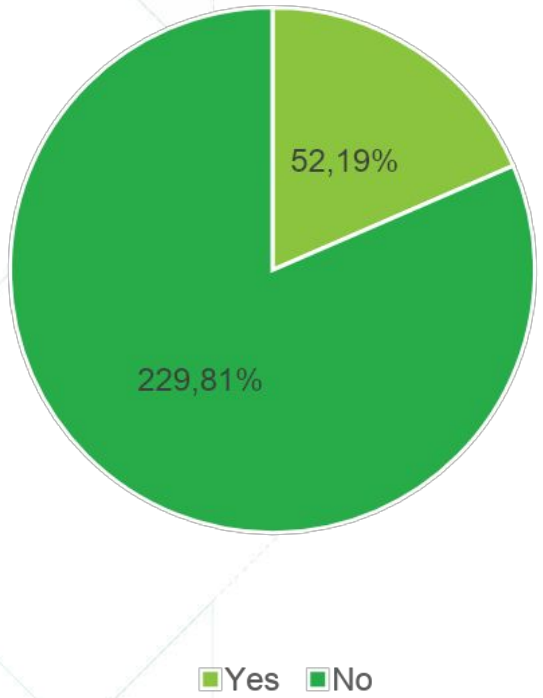
- Overall monthly household usage of diesel dropped by 6% from 106 litres per month to 99 litres per month due to electrification
- While the users of diesel reduced by 50% (from 8 to 4), the overall usage only reduced by 7 litres per month due to an outlier response that drastically increased their diesel consumption by **2.67 times**

Usage of solar lamps has **reduced by 42%** post electrification, with only about 20% HHs now using it for back-up

Usage of Solar Lamps Pre Electrification [n=281]



Usage of Solar Lamps Post Electrification [n=281]



- Although we have not explicitly inquired about pre-electrification usage of solar lamps, an alternative inquiry has helped use deduce the above response
- The usage of solar lamp for electricity has been discontinued in 13% (n=38) HHs due to electricity
- While remaining 19% (n=52) HHs still use solar lamps for electricity, they are primarily used as back-up sources in the event of microgrid outage
- The absolute change in solar lamp usage is not relevant for our assessment

Additional Observation: As per the baseline data shared by the TRIF team for all 716 HHs, only 20% HHs used solar lamps in the pre electrification scenario, much lower than that as per our baseline assessment

A **quintuple increase** in solar pumps post electrification indicates the **awareness of benefits** and the **value of solar pumps** among HHs

	# of Irrigation Pump User HHs [n=281]	# of Total Pumps		# of Diesel Pumps		# of Petrol Pumps		# of Kerosene Pumps		# of Solar Pumps
Pre	**52**	**60**	=	**9**	+	**7**	+	**39**	+	**5**
Post	**47**	**58**	=	**2**	+	**4**	+	**22**	+	**30***
Change	**5**	**2**	=	**7**	+	**3**	+	**17**	–	**25**

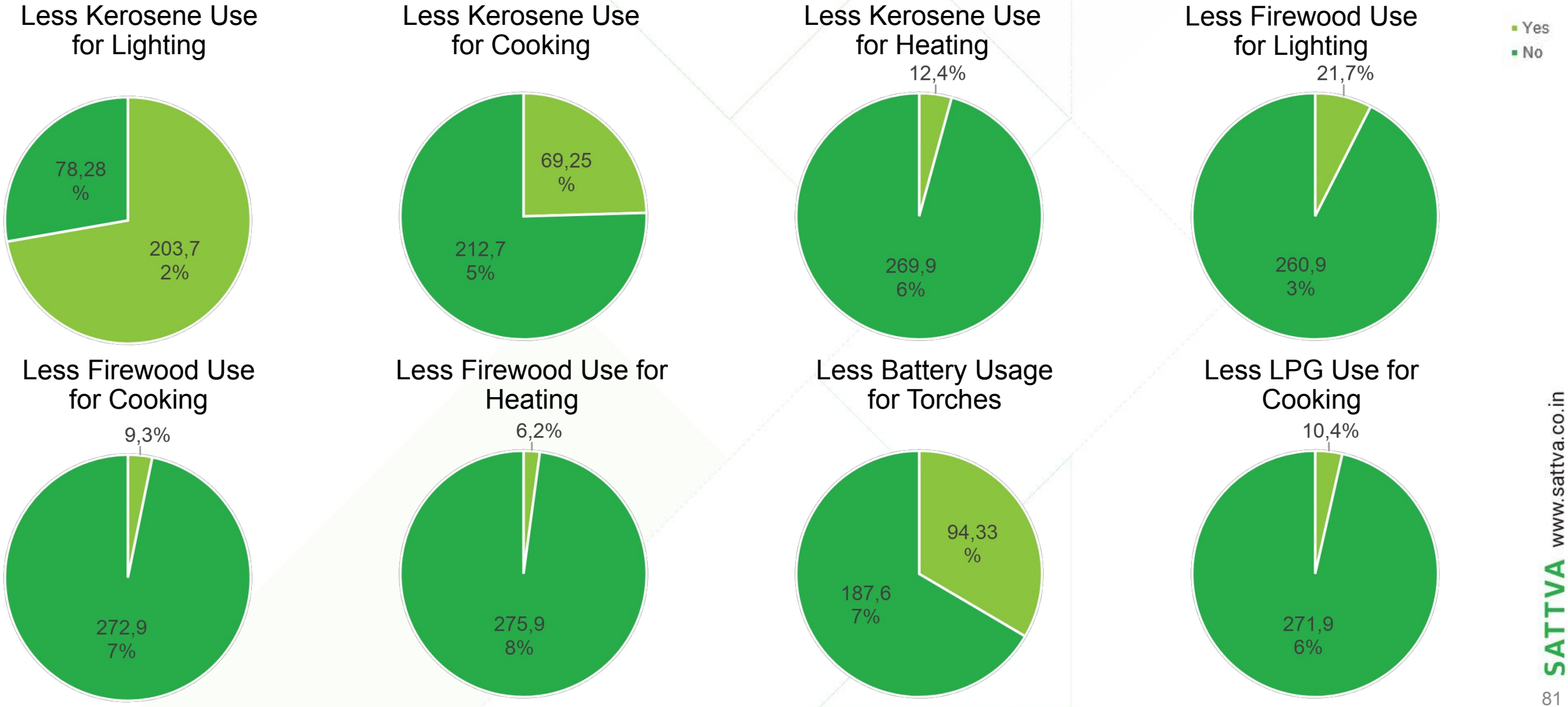
- Post electrification, HHs have seen an **overall decrease in irrigation pump users by 10**% (n=5); Electrification has NOT led to an overall increase in quantity of irrigation pumps used in HHs
- Post electrification, the number of irrigation pumps powered by diesel, petrol and kerosene have **reduced by 50%** (n=27)
- Electrification increased the quantity of solar pumps used by **5 times i.e. 500%** (through displacement of traditional irrigation pumps or new users)

* Of the 30 who use solar pumps, 6 have started cultivating additional crops and 11 have increased the area of cultivated land (total increase of average increase of 25 dismal land)

Additional Observation: As per the baseline data shared by the TRIF team for all 716 HHs, 23 HHs used kerosene pumps and 23 HHs used diesel pumps in the pre electrification scenario

Most HHs strongly perceive **reduction** in usage of **kerosene for lighting** due to electrification

Changes Perceived In Energy Usage Due to Electrification



Recommendations

Recommendations for the Green Switch Program going forward (1/4)

Capacity Building of the VEC's and Operators	
Context	**Recommendation**
Lack of confidence among VECs and Operators	Refresher trainings of VECs and Operators to be able to carry out their duties and resolving technical glitches/maintenance issues
Minor discrepancies observed in unit consumption data recorded in passbooks and VEC ledgers vis-à-vis control room data across locations	This discrepancy can be resolved in the future by ensuring regularity and accuracy in updation of records by the operator (supervised by VEC) and further validation of HH data with the control room data

Community Understanding of the Collaborative Model	
Context	**Recommendation**
The collaborative model is an important pillar for the sustainability of the program and there exists a need for the community members to understand it	Consistent capacity building of all community members on the **importance of paying bills to keep the system running** can be conducted by the VEC on a regular basis. This process can be built-in to the roles and responsibilities of the VEC

Recommendations for the Green Switch Program going forward (2/4)

Revisit the pricing model based on the maturity of the project	
Context	**Recommendation**
Currently, all members are paying the same amount for household and commercial usage. This might be unfair to those using lesser units in the long run and paying the same costs (both fixed and variable)	Introduce a capping system (higher costs for those using more than the capped units) after the project's maturity, when more people are using a considerably higher amount of units, for a more equitable distribution in the pricing

Unutilized Microgrid Capacity/ Potential	
Context	**Recommendation**
The microgrid systems have an unutilized energy potential which can be productively leveraged by the community in the future The average annual energy generation potential per microgrid was about 12,280 kWh, of which only **34%** is currently being utilized	Facilitating community members to own and use assets for increasing agricultural allied livelihoods, and generating awareness around the same is recommended*

**Note: Since the project is just a year old, optimal utilization of the grid capacity might happen organically as the project matures*

Recommendations for the Green Switch Program going forward (4/4)

GHG Emission Reduction Potential	
Context	**Recommendation**
While kerosene and diesel usage has reduced in the communities due to electrification, the usage of fossil-fuel based irrigation pumps and generators still persists in the communities	This presents a potential opportunity to further reduce GHG emissions in the near future by replacing them with renewable energy There exists a scope to reduce usage of kerosene and firewood for cooking and heating by increasing awareness of alternatives and helping households plan adoption of such alternatives

Awareness of Solar Electricity and its Benefits	
Context	**Recommendation**
While awareness of solar electricity has certainly increased within the communities due to electrification, 47% community members still remain unaware of the benefits of solar energy	Awareness generation programs and informational sessions on solar electrification are recommended for community members Further, continuing the facilitation of converting to solar irrigation pumps from fossil fuel based ones will also immensely benefit the community by meeting it irrigation needs through clean energy at a lower cost

Ethical Considerations

Ethical Considerations

The assessment will follow the ethical protocols in all aspects and at all stages of the engagement:

- **Informed consent:** All respondents and participants will be given appropriate and accessible information about the purpose, methods and intended uses of the research, what their participation in the research entails, and what risks and benefits, if any, are involved. The assessment will be undertaken only after consent, free from coercion or undue pressure, is received from the respondents

- **Interactions with minors:** Ethical data collection from minors will be ensured by explaining the purpose of study, including the presence of adults in the case of respondents under the age of 18 years (parents, teachers and community elders) and ensuring informed consent from the participants

- **Descriptive data collection**: The data collected through the baseline study will be descriptive in nature and not diagnostic in nature – for thematic areas like health

- **Voluntary participation:** The interview sessions will be conducted in an environment that ensures the privacy of the respondents as per their convenience and comfort. They will be made aware of their right to refuse participation whenever and for whatever reason they wish, without fear of penalization or victimization. Consent will be taken regarding the recording and usage of all information acquired - written, verbal, photographic

- **Anonymity and confidentiality:** The identity of research participants will always be protected through anonymity or confidentiality, unless research participants explicitly agree to, or request the publication of their personal information

Limitations of the study

Limitations of the Study

Voluntary Participation and Honesty

- As our assessment involved collection of information from the respondents, it relied on their voluntary participation and willingness to share information
- In some cases, respondents may not feel encouraged to provide accurate responses or those that present themselves unfavorably

Subjectivity / Estimation

- Information such as usage data shared by the respondents may be approximations and is based on their ability to accurately estimate/recollect information
- While the assessment team has conducted a logic check of the responses to ensure data sanity, there may still be inaccuracies in the data shared by the respondents

Non Responses

- Data errors may exist due to absence of any responses for certain questions
- Further, the number of respondents who choose to respond to a survey question may be different from those who chose not to respond

Comprehension by Respondents

- The responses are based on the comprehension of the question by the respondent
- While the interview questions were delivered in a simple and comprehensible format and the assessment team also clarified questions that were not understood by the respondents, instances of misunderstanding by respondents may still exist

Case Studies

Alman Kindo | Combined Mill and Huller Machine | Jharan Tangartoli

Sources of income: Farming, and household help | Christan, Male, Scheduled Tribe

For 28 years-old Alman Kindo, owning a rice huller seemed a lucrative prospect. He envisaged a rice huller which would supplement his family income. Though there was a diesel-run huller operating in his village, Alman realised that the operating costs of it were high due to the high price of diesel. In contrast, an electric huller was cheaper, and more affordable. His dream was realised post the electrification of his hamlet.

Alman Kindo uses his combined flour and hull machine, which is connected to a commercial meter, for 2-3 hours, and sees an average footfall of 5-6 people daily. The demand for rice hulling in his village is split two ways- more than half of the customers go to Deepak, another villager who owns a rice huller. This is because he lives in a nodal location, which attracts more customers, whereas Alman lives on the very fringes of the hamlet. To prevent outages caused by the simultaneous usage of heavy appliances such as hullers, and flour mills, Deepak and Alman co-ordinate with each other while using their respective appliances. People from other hamlets do not yet come to Alman for processing and hulling their rice.

In a good month, when demand is more, especially during reaping seasons, Alman earns anywhere between INR 1600-1700. His total household expenditure on electricity amounts to INR 1100-1200. Additional expenses of INR 550 are incurred everytime the *jali* of the huller needs replacement, which has been 6-7 times so far.

Alman intends to focus more on his hulling enterprise, and plans to reduce his agricultural activities. He also aspires to purchase an electric sewing machine for his wife, which was previously not possible. This is indicative of households leveraging new livelihood opportunities facilitated by electrification.

> *I cannot give you an estimate of the daily quantity of rice that is hulled. When there's demand, I operate the machine, otherwise, it sits idle. Income earned via the huller is contingent on the demand, which is not uniform. I have no idea about the per-hour operating cost of a diesel-run huller but I know that the electric huller is far more affordable for me, since it only costs INR 50-60/hour.*
>
> *The usage of the combined mill and hulling machine enables me to supplement my household income, and pay for my children's education.*

500+
monthly profit

No usage of digital platforms for transactions

No usage of the internet for learning how to improve business skills

Expectations:

1. Reduction in the fixed charge and the per-unit charge of electricity which will aid him in increasing his profits
2. Increase in the capacity of the solar microgrid to support the simultaneous usage of appliances
3. Guidance on which new appliances to buy, and how to take advantage of livelihood opportunities

Nomita Lakda | Combined Mill and Huller Machine | Beejakhaman

Sources of income: Agriculture, Rice processing and Hulling | Christian, Female

Nomita Lakda started operating the rice huller and flour mill a few months after the microgrid was operationalized. She purchased the machine at a cost of INR 35,000, through her savings.

The machine is connected to a commercial meter. According to Nomita, there has been a consumption of 550 KWH in the last nine months. The demand for processing, and hulling increases seasonally, especially during social functions like wedding celebrations. There are no fixed hours for the usage of the machine.

Nomita has witnessed the usage of two hullers in her *tola*, which she attributes to electrification. Because of electrification, community members no longer have to travel to distant places for processing their rice.

The milling, and hulling enterprise has enabled nomita to supplement her family income, and she plans on continuing running the enterprise in the future, and aspires to purchase a fan and TV for her household with the increased income generated by the combined mill and huller machine.

> *Thanks to electrification, we do not use kerosene for lighting in our households. We would use a small solar panel for charging our phone batteries, but we do not need to use it anymore.*
>
> *We have been able to increase our household income by about INR 1,000 to 1,500 per month. This has been completely enabled by electricity. I am able to send my kids to school, and I hope the source of income continues in the coming years.*

₹ **1000-1500**
monthly profit

No usage of digital platforms for transactions

No usage of the internet for learning how to improve business skills

Govardhan Yadav | Flour Mill | Mudamba

Sources of income: Agriculture | Hindu, Male, OBC

A 20 year old farmer, Govardhan Yadav in Mudamba village, bought a flour mill for 25000 INR. It was his brother's aspiration to buy the flour mill, since there was a demand for it in the village. His brother got was advised by the TRIF field staff that a flour mill would be beneficial for them to increase their income. Earlier, people would either grind the flour manually, or go to Chhattisgarh for bulk quantities.

Post electrification, they bought the mill in September 2021, and use it on a regular basis. His sisters-in-law operate the mill and they get approximately 20-25 customers on a monthly basis. During the reaping season, this number goes higher. Each customer is charged Rs 5/kg of grains. However, Govardhan doesn't have an overall estimation of the increase in income.

His wife has currently migrated out of the village and on her return, Govardhan intends on buying an electric sewing machine for her to operate in order to increase their family income. They plan to keep using the mill for the near future to keep earning out of it, since there are no other livelihood opportunities available in the hamlet, except agriculture and allied ones.

> *"There will be no illumination in the village. We would not be able to charge our appliances, such as mobile phones. We would have to go back to living in darkness*
>
> *...We fiercely yearn for livelihood opportunities in this hamlet..you've seen how the entire community is dependent on farm livelihoods, but nothing besides that"*

No usage of digital platforms for transactions

No usage of the internet for learning how to improve business skills

Sahay Kindo | Electric Irrigation Pump User | Jharan Tanagrtoli

Sources of income: Agriculture | Christian, Male, ST | Antyodaya Ration Card

A 55 year-old farmer, Sahay Kindo has been practicing traditional agriculture for the last 25 years with his family. They alternate between paddy and vegetables throughout the year. They own about 3-4 acre of land and all of it is under cultivation.

Earlier, he used a kerosene pump for irrigation. He could get one liter of kerosene from the ration store which was insufficient to meet his requirements, and he would hence have to procure kerosene at inflated prices of INR 100+ from the black market. Based on his requirement the kerosene pump was cost him about INR 3600 per month. After switching to the solar pump, his monthly costs for irrigation are approximately INR 250-300, implying savings of approximately INR 3000+ on irrigation.

While there is no difference between the two pumps in terms of efficiency, there is a huge difference in the costing. The dependency on ground water remains the same, the dependency on monsoons has reduced slightly.

He believes that the sources of water for irrigation are very limited in the hamlet. In order to diversify from agriculture, he believes a photocopy machine can be bought for the hamlet. Currently, people have to travel to other hamlets for photocopies. Now, since there is electrification, it can be bought within the hamlet. It will be a good livelihood opportunity and be helpful within the hamlet.

> *I have the sole ownership of the solar-run water pump. Mr. Anil from TRIF guided me in the purchase of the pump, as to, how one can use it, what capacity is best suited to my needs, etc.*
>
> *I do not plan on increasing my farm-livelihood in the near future due to limited land available for farming, and insufficient funds.*

₹ 3000+

approximate monthly savings

Bablu Sai | Electric Irrigation Pump User | Dabnipani

Sources of income: Farming, and poultry, on small-scale| Hindu, Male, ST | Red Ration Card

A 35 year old generational farmer from Dabnipani, Bablu Sai has started using the solar run irrigation pump. Earlier, he used an irrigation pump running on kerosene which would cost him INR 100/hour of usage (1 liter/hour was used), Now, he has bought the solar pump and uses it to irrigate his farm at a much lower cost (about INR 40 per hour). The timings for usage are fixed for him (between 8 am and 4 pm), so as to not overload the grid. He has the sole ownership of the pump.

The solar pump has a lower capacity than the kerosene pump, but it can be used for a longer period of time. It is able to meet his irrigation requirements sufficiently.

He believes that electrification has had an overall impact on the hamlet. The education of children has improved, and illumination helps women in cooking and performing household chores. He expressed that electrification will enable people to buy more gadgets and devices like computers. When the equipment was ferried for the solar grid, the roads were constructed, This is also a positive impact on the development of the hamlet.

In his opinion, the village currently needs a borewell, and a hospital.

> *I would travel 5 km to procure kerosene, from a dealer at the rate of INR 60/litre. Current price is INR 90/litre. Earlier, the dealer (ration store) would give up to 3 litres, but now there's a restriction of only 1 litre . I required 5 litre on a monthly basis. I would also procure from the black market if my needs were unmet.*
>
> *I have stopped purchasing kerosene since I no longer use the kerosene-run water pump*
>
> *The solar-run water pump is easier to use. Even women can use it: They only need to switch it on, unlike the kerosene-run water pump which required strenuous manual efforts*

2000+

approximate monthly savings

Oscar Khalko | Electric Irrigation Pump User | Bhijari Badi

Sources of income: Farming, and cattle-rearing | Christian, Male, ST | Yellow, and Antyodaya Ration Cards

45 years old Oscar Khalko is a traditional farmer (cultivates crop throughout the year) whose family has been farming for more than 100 years. Before the electrification of his hamlet, Oscar used manual techniques to irrigate his field, but the quantity of water was low.

Post-electrification, Oscar has started using an electric irrigation pump, which he bought after due consultation with Mr.Anil from TRIF. He also sought the permission of the VEC for the operating of his pump.

Oscar uses his pump 2-3 times a week during summers (during sowing season), and once a week during monsoon, given current requirements. There are fixed timings for the operation of the irrigation pumps to prevent grid overload.

According to Oscar, his dependence on rainfall and tube wells remains the same regardless of the type of the irrigation pump used. There have also not been any increase in the crops, or diversification of crops due to transitioning to solar-run water pumps.

Oscar perceives that the electric pump is cheaper (INR 10 per KWH as opposed to kerosene which costs about INR 90 per litre), requires less effort and less time for irrigation, and provides more supply of water. His current requirements are met due to the usage of the electric irrigation pump.

> *While the solar-electrified irrigation pump has a smaller capacity, it can be used by us for a longer time in comparison with fuel-powered irrigation pumps due to availability of electricity at an affordable rate of INR 10 per unit. The former is also more portable, which converts a two-person job into a one-person job and makes our work more efficient. There are no differences in durability of the two.*
>
> *The solar-electrified irrigation pump is very efficient for us. We do not face any difficulties or issues in using it, and we can use it for a fair duration of 1 hour in a day. This is more than enough to fulfil our current requirements given our water supply constraints.*

Increase in cultivated land
from 10 dismil to 15 dismil

Focus Group Discussion: Electric Irrigation Pump Users |Mudamba

Durdhan Yadav | 50 years old, 40 dismil land, farming for 6-7 years
Ansur Yadav | 40 years old, 50 dismil land, farming for 5 years
Arun Yadav | 45 years old, 40 dismil land, farming for 6-7 years
Parmamil Yadav | 72 years old, 30 dismil land, farming for 15-20 years

Before the electrification of their hamlet, the four farmers used a fossil-fuel powered irrigation pump in their farming. However, the farmers faced challenges in farming due to (i) the high operating costs of irrigation pumps, (ii) extensive human labour was required for irrigation, and (iii) high dependency on rains, and groundwater for irrigation. They also had to travel as far as 10 km on foot/cycle to procure kerosene for their irrigation pumps.

Post-electrification, the four farmers bought electric-run irrigation pumps after due consultation with Mr.Deepak from TRIF. Permission was granted by the VEC for the usage of the irrigation pumps, which are to be used within fixed hours. The four ensure that there is no simultaneous usage of appliances to avoid grid overload and outages.

The irrigation pumps are primarily used from January to April. The dependence on rainfall and tube wells remains the same regardless of the type of the irrigation pump used. There have also not been any increase in the crops, or diversification of crops due to transitioning to solar-run water pumps.

The electric irrigation pump is cheaper, and easier to use. It is also portable, which converts a two-person job into a one-person job and makes our work more efficient. There are no differences in durability of the two. There is an overall sense of satisfaction among the four.

> *Our motivation to buy an electric irrigation pump was to save costs: operating an electric irrigation pump is far cheaper than the ones we used earlier. Moreover, they require less effort which is a deciding factor since there is limited availability of labour for irrigation..the electric irrigation pump is definitely affordable since it only costs INR 10/unit for usage*

> *The microgrid-electrified irrigation pump is very efficient for us. We do not face any difficulties or issues in using it, and we can use it for a fair duration of 5 hours in a day on a rotational basis. This is more than enough to fulfil our current requirements given our water supply constraints. However, we won't be able to cultivate on additional land since availability of water remains a constraint for us*

Annexures

Pictures from the Field

Pictures from the Field (1/4)

Sattva team conducting a training session for data enumerators

Sattva team in a focus group discussion with women in Jharan Tangartoli

Sattva team in discussion with the VEC of Mudamba

Pictures from the Field (2/5)

Sattva team inspecting the solar microgrid in Beejakhaman

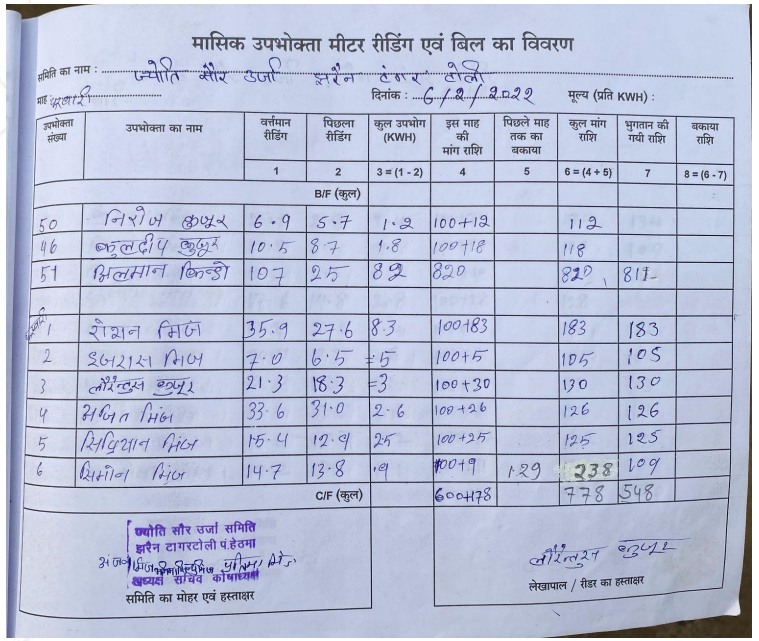
Sattva team interacting with students

Community members in Bhijari Badi welcoming the Sattva team

Pictures from the Field (3/4)

Community women in conversation with Sattva team in Dabnipani

Villagers paying the monthly electricity bills in Beejakhaman



मासिक उपभोक्ता मीटर रीडिंग एवं बिल का विवरण

समिति का नाम : ज्योति सौर उर्जा झरैन टंगरटोली

माह : फरवरी दिनांक : 6/2/2022 मूल्य (प्रति KWH) :

उपभोक्ता संख्या	उपभोक्ता का नाम	वर्तमान रीडिंग	पिछला रीडिंग	कुल उपभोग (KWH)	इस माह की मांग राशि	पिछले माह तक का बकाया	कुल मांग राशि	भुगतान की गयी राशि	बकाया राशि
		1	2	3 = (1 - 2)	4	5	6 = (4 + 5)	7	8 = (6 - 7)
	B/F (कुल)								
50	निरोध कुजूर	6.9	5.7	1.2	100+12		112		
46	बुलडीप कुजूर	10.5	8.7	1.8	100+18		118		
51	मिलमान किन्डो	107	95	82	820		820	811	
1	रोशन मिंज	35.9	27.6	8.3	100+83		183	183	
2	इंदरास मिंज	7.0	6.5	5	100+5		105	105	
3	लॉरेन्स कुजूर	21.3	18.3	3	100+30		130	130	
4	अजित मिंज	33.6	31.0	2.6	100+26		126	126	
5	सिद्रियान मिंज	15.4	12.9	25	100+25		125	125	
6	सिमोना मिंज	14.7	13.8	09	100+9	129	238	109	
	C/F (कुल)				600+178		778	548	

ज्योति सौर उर्जा समिति झरैन टांगरटोली पं.हेतमा अध्यक्ष सचिव कोषाध्यक्ष

समिति का मोहर एवं हस्ताक्षर

लॉरेन्स कुजूर

लेखापाल / रीडर का हस्ताक्षर

Record of monthly household readings in Jharan Tangartoli

Pictures from the Field (4/4)

Sattva team engaging youth and students in a focus group discussion in Bhijari Badi

The Sattva team in a discussion with the VEC of Beejakhaman

Average Calculation

Annexure I: Methodology for average calculation

Household level electricity consumption

1.	Removing Outliers: In many hamlets, there are no separate commercial and HH level meters. Commercial usage of over 20 kWh is omitted from average calculation to get a sense of average HH level usage increase.
2.	Sum of electricity usage by 281 sample households for each month
3.	Average of electricity usage by each household for each month
4.	Calculating average increase from July 21 - Jul 22

Commercial electricity consumption

1.	Filter 29 Households that are using electricity for commercial purpose
2.	Sum of electricity usage by 29 households for each month
3.	Average of electricity usage by each household for each month
4.	Calculating average increase from July 21 - Jul 22

Annexure II: Research Questions: Relevance (1/2)

DAC Attribute	Research Questions	MoV/Key Indicators
Relevance The extent to which the intervention objectives and design respond to beneficiaries	How was the need for the Green Switch intervention assessed/identified?	Secondary research, TCCL Program Team, TRIF, Gram Oorja, Baseline study
	What were the needs of the community with respect to electricity before the intervention?	Secondary research, TCCL Program Team, TRIF, Gram Oorja, Baseline study, PRI Members, BDO
	What were the reasons for the lack of electrification in the intervention locations?	Secondary research, TCCL Program Team, TRIF, Gram Oorja, PRI Members, BDO
	How did little to no availability of a grid/off-grid connection to electricity before the implementation of the Green Switch program affect community members?	Secondary research, TCCL Program Team, TRIF, Gram Oorja, Baseline study, PRI Members, BDO, HH Beneficiaries
	Were there well-defined selection criteria for the program geographies?	Secondary research, TCCL Program Team, TRIF, Gram Oorja
	Was there a comprehensive understanding of the community practices/means adopted to meet energy requirements prior to the intervention? (Practices such as burning kerosene, fuelwood, etc. to meet energy needs)	TCCL Program Team, TRIF, Gram Oorja
	Are the program objectives and activities aligned to the identified needs of the community members?	TCCL Program Team, TRIF, Gram Oorja
	Does the program have well-defined activities to achieve its objectives?	TCCL Program Team, TRIF, Gram Oorja, MoUs
	Does the program include processes to ensure that TRIF, and Gram Oorja are well-equipped to help realize intended objectives?	TCCL Program Team, TRIF, Gram Oorja
	What is the process of initiating and carrying out a community buy-in for the program in the intervention hamlets/villages?	TCCL Program Team, TRIF, Gram Oorja
	Is there a well-defined and standardized process to obtain relevant approvals and permissions from PRIs/Forest Department regarding land allocation?	TCCL Program Team, TRIF, Gram Oorja
	Does the program contain a guiding process to design the solar micro-grids to be set up in various intervention locations?	Gram Oorja, MoUs
	Are there systematic processes to establish VECs, and select/elect the members of VECs in the intervention locations?	TCCL Program Team, TRIF, Gram Oorja, VEC

Research Questions: Relevance (2/2)

DAC Attribute	Research Questions	MoV/Key Indicators
Relevance The extent to which the intervention objectives and design respond to beneficiaries	Are the roles and responsibilities of VECs well-defined?	TCCL Program Team, TRIF, Gram Oorja
	Are there established processes for the capacity-building of VECs?	TCCL Program Team, TRIF, Gram Oorja
	Is there a well-defined process for the identification and selection of operators for the program?	TCCL Program Team, TRIF, Gram Oorja, Operators
	Are the operators sufficiently trained to ensure that they are capable of resolving grid-related issues?	TCCL Program Team, TRIF, Gram Oorja, Operators
	Does the program involve processes for conducting a financial and break-even analysis for the project specifications?	TCCL Program Team, TRIF, Gram Oorja
	Does the program have well-defined and systematic processes for the installation of solar micro-grids; providing metered connections, LED bulbs, and charging sockets to the beneficiaries at the household level, and electrifying AWCs, and schools in the intervention locations?	TCCL Program Team, TRIF, Gram Oorja
	Are there well-defined guidelines and protocols for: (i) The maintenance of and resolution of glitches in the solar microgrids; (ii) Ensuring the operationality of the solar micro-grids; (iii) Monthly fee collection from the beneficiaries?	TCCL Program Team, TRIF, Gram Oorja
	Are there protocols for any conflict resolution?	TCCL Program Team, TRIF, Gram Oorja, VEC
	Are there processes for the insurance of hardware and set up, and the renewal of the insurance services?	TCCL Program Team, TRIF, Gram Oorja, VEC
	Does the program have a dedicated monitoring and evaluation function/team to map various Green Switch program activities against timelines and outcome indicators, and measure the progress of the program?	TCCL Program Team, TRIF, Gram Oorja, Program Reports
	Are the partners equipped and prepared to deal with associated risks to the program?	TCCL Program Team, TRIF, Gram Oorja

Research Questions: Coherence

DAC Attribute	Research Questions	MoV/Key Indicators
Coherence The compatibility of the intervention with other interventions in a country, sector, or institution	Are the program objectives and activities consistent with national and international priorities such as existing policies/schemes and government initiatives?/ Is the program in-line with national and international goals for rural electrification?	TCCL Program Team, TRIF, Gram Oorja, National Electricity Policy 2005, SDG 7: Affordable and Clean Energy, Niti Aayog NIF, Rural Electrification Schemes (Deen Dayal Upadhyaya Gram Jyoti Yojana, SAUBHAGYA-Pradhan Mantri Sahaj Bijli Har Ghar Yojana)
	Is there a well-defined process to identify, document, and map interventions of other organizations/governments who target the same beneficiaries in the same locations to ensure value add, and avoid duplication of effort?	TCCL Program Team, TRIF, Gram Oorja
	Are there any collaborations or partnerships with external organizations, besides the two program implementation partners to utilize synergies?	TCCL Program Team, TRIF, Gram Oorja
	Does the program have synergies and alignment with other similar programs carried out by the partners in different geographies?	TCCL Program Team, TRIF, Gram Oorja

Research Questions: Effectiveness (1/2)

DAC Attribute	Research Questions	Key Indicators
Effectiveness: The extent to which the intervention achieved, or is expected to achieve, its objectives, and its results, including any differential results across groups	Has the program led to an increase in the availability of electricity in the hamlets?	% of HHs that are electrified in the hamlet
		% of HHs who perceive their energy needs to be met for a) Cooking b) Basic lighting c) Irrigation (pumps) d) Communication (Mobile phones and television) e) Cottage industry
		% of HHs have fully functional 4 LED bulbs, and 2 charging sockets which were provided to the HHs by TCCL
	Has the program improved the access to electricity in the hamlets and at the household level?	<#> number of hours HHs receive an electricity supply in a week on an average
		<#> Instances of power outages experienced by HHs in a month on an average (Check if the solar microgrid becomes disruptive/non-functional during night-time/periods of inadequate sunlight/ monsoon, etc.)
		<#> HHs who still rely on alternative sources of power such as kerosene lamps, fuel wood, etc. despite an electricity connection (and for what purposes?)
	Is the electricity supply affordable for the HHs?	<#> HHs who perceive that the one-time registration fee was affordable
		<#> HHs who paid the one-time registration fee
		<#> HHs who find the monthly fee affordable
		<#> HHs who pay the fee on a monthly basis (monthly average bill)
		<#> HHs who default on the monthly payment of fees
	Did the training of VEC lead to improved capacity of the VEC members?	<#> of VECs become adept and require minimal hand-holding in the processes of (i) operation of the solar micro-grids; (ii) collection of monthly payment bills; (iii) depositing payments in the bank account that is used exclusively for the program; (iv) management of water pumps, etc.
		<#> VEC members who perceive an increase in confidence and understanding of various processes
		<#> female VEC members taking ownership, and having a say in decision-taking

Research Questions: Effectiveness (2/2)

DAC Attribute	Research Questions	Key Indicators
Effectiveness: The extent to which the intervention achieved, or is expected to achieve, its objectives, and its results, including any differential results across groups	Did the program lead to an improved capacity of the operators?	<#> of operators confident in discharging their R&R - Meter readings - Generate bills - Resolve minor connection issues
		% of electricity-related issues resolved by the operator since the implementation of the program (On average as reported by the operator and VEC)
		<#> of beneficiaries satisfied with the performance of the operators
		What is the process followed by operators for recording technical glitches, and their average response time for resolving microgrid-related issues?
		Skill set of operators based on the duration they have worked for
	Do the beneficiaries understand the (i) collaborative community model introduced by TCCL, and (ii) clean, and sustainable sources of energy- solar energy	<#> beneficiaries who state that they understand the processes involved in the collaborative community model- collection of monthly fees, depositing of the bills in the common bank account, r&r of VEC
		<#> beneficiaries who perceive an increased understanding of clean and sustainable sources of energy- solar energy

Research Questions: Impact (1/3)

DAC Attribute	Research Questions	Key Indicators
Impact The extent to which the intervention has generated or is expected to generate significant positive intended or unintended, higher-level effects	Has there been an overall increase in the usage of electricity?	Change in the units of electricity used by households (Analysis of the readings in the energy book)
		<#> HHs reporting a reduction in the usage of generators in (i) Businesses, (ii) Agricultural activities, (iii) Household use, and (iv) Social functions such as festivals, weddings, cultural events, etc.
	Has usage of electricity led to possibility of new livelihood opportunities and improved the outcomes of current livelihoods (farm and non-farm)?	% of HHs reporting an increase in livelihood opportunities after the intervention (Agriculture, Construction, MSME, SHG)
		Increase in units of electricity used for livelihood activities (Water pumps - Seasonal average, electricity in MSMEs and micro enterprises, Rice/Wheat miller)
		<#> of HHs started taking additional crops due to irrigation pump
		Approximate increase in the units of additional land brought under cultivation reported by HHs
		% of reduced expenditure on kerosene, coal, fuel wood, and diesel reported by HHs (estimations)
		Change in usage of diesel pumps reported by HHs and PRI members
	Has electrification improved AWC infrastructure and service delivery? Has electrification of of households and street improved health of beneficiaries and reduced accidents among community?	<#> of AWCs electrified (Reported by Program Team, verified by PRI members)
		% of HHs who are now comfortable sending children to AwC since they are now electrified, especially during summers
		% of women who report a reduction in health-related issues like headaches, eye infections, breathing problems, coughing, and burns due to the use of kerosene
		% of women reporting accidents reduced due to usage of firewood or kerosene
		% of HHs reporting reduction in accidents due to unavailability of electricity - encounters with animals, snakebites casualties in the rainy season

Research Questions: Impact (2/3)

DAC Attribute	Research Questions	Key Indicators
Impact The extent to which the intervention has generated or is expected to generate significant positive intended or unintended, higher-level effects	How has electrification of schools and HHs impacted students learning and their perception of their village?	% change in time spent (hours) by students for school study after school hours as reported by HHs
		<#> of increased hours in the usage of mobile/TV for learning reported by the HHs
		<#> of schools electrified as reported by PRI members/ Secondary data verification
		Students' perception regarding improvement of school facilities (Especially during the summer and rainy season) with respect to electricity
		School attended in their own hamlet or neighboring hamlets as reported by students
		Students' perception of using mobile/TV for learning
		Students' perception of how improved electricity (+ improved mobile access) has helped them in pursuing/aspiring for opportunities in higher education
	Has electrification of hamlets led to an increase in the physical assets, social capital and human capital?	% of households who bought any physical asset due to improved access to electricity i.Kitchen appliances (Fridge, Mixer/Grinder); ii. Fan/Cooler; iii.Television iv.Smart devices; v.Huller vi. Water pumps
		% of HH who believe access to electricity has improved their social connection - Through mobile phones and the internet - Due to better interconnectedness among villages and community
		% of HHs who report a decrease in the usage of generators for the electricity needs in social functions
		Improved perception and sense of pride for the village due to electrification of the village reported by community members, especially the youth
		<#> of beneficiaries who believe their capacity to work has improved due to improved access to electricity - Increase in working hours - Improved efficiency due to lighting

Research Questions: Impact (3/3)

DAC Attribute	Research Questions	Key Indicators
Impact The extent to which the intervention has generated or is expected to generate significant positive intended or unintended, higher-level effects	Has electrification of the hamlet led to improved working conditions, mobility, and safety of community members, especially women?	<#> of community spaces electrified (community halls/streetlights) as reported by PRI members and the Program team
		Beneficiaries (especially women and children) feel safe and secure at HHs and community level due to consistent illumination
		% of women who feel their burden has reduced due to the availability of electricity due to - More time to complete household chores - Spend more time on social interactions
		Increase in overall village infrastructure due to electrification (especially roadways) as reported by PRI members
	ESG: Reduction in GHG emissions due to transition from traditional energy sources to solar energy as a result of the intervention	
	- Has the micro-grid electricity usage by households, commercial units and commercial spaces reduced GHG emissions when compared with existing fuel sources (fossil fuel and others)? - Have households been able to consistently and sustainably use electricity for their domestic and commercial needs? - Has the change in households' fuel mix post microgrid installation helped reduce GHG emissions? - Can the installation of the micro-grid also catalyse reduction of GHG emissions across other areas of usage? - Does the micro-grid provide complete coverage across a village location without allowing for exclusions or activities which incurred significant emissions during installation? - Do the micro-grid maintenance and downtime affect GHG emissions? - Does the micro-grid installation attribute to any fugitive emissions? - Do the micro-grids generate / supply electricity in excess of aggregate demand?	# of litres of kerosene consumption reduced for lighting purposes
		# of kms of travel reduced for kerosene procurement on a weekly basis
		# of kgs of firewood consumption reduced for lighting / commercial purposes
		# of kms of travel reduced for firewood procurement on a weekly basis
		# of litres of diesel consumption reduced for commercial purposes and social functions
		# of tonnes of CO_2 equivalent emissions reduced due to the transition to solar energy
		# of hours of electricity downtime and outage

Research Questions: Sustainability (1/2)

DAC Attribute	Research Questions	MoV/Key Indicators
Sustainability The extent to which the net benefits of the intervention continue, or are likely to continue	Has a clear strategy for operational, institutional and financial sustainability of the program been defined and incorporated in the program design?	Budgetary provisions to maintain the activities by VEC, and the operator are clearly defined and understood by the VEC and team members
		% of VEC members who are confident in operating the solar electricity system without support from Gram Oorja/TRIF
		<#> of glitches/complaints received by the VEC
		<#> of glitches/complaints that were escalated to TRIF/Gram Oorja's technical team by the VEC
		% of cases of technical glitches resolved by the VEC
		Ownership responsibility of the panchayat/VEC/Community are defined, documented and understood by the stakeholders
		What is the understanding of the VEC/PRI/Block officers regarding the sustainability of the program after the transition of implementation agencies?
		% of HHs who are satisfied/dissatisfied with the VEC services
		% of HHs who are satisfied/dissatisfied with the Operators
		Amount of VEC fund deposited in the bank account (Verified through passbook)
		% of VEC funds used for the remuneration of the operator (Verified by operator, VEC, and account transaction documents)
		% of VEC funds used for any repair or maintenance work
		Budgetary provisions to maintain the activities of VEC, and the operator are clearly defined and understood by the VEC and team members (Qual)

Research Questions: Sustainability (2/2)

DAC Attribute	Research Questions	MoV/Key Indicators
Sustainability The extent to which the net benefits of the intervention continue, or are likely to continue	Is the program scalable and replicable in other areas?	Other similar large scale projects running in India
		Convergence with partners, government schemes or relevant policies like JHOHAR scheme in Jharkhand
		Records of collaborations with the government, funding agents

Annexure III: Microgrid Electricity Data – Shared by Gram Oorja Team

Microgrid Electricity Generation and Consumption Data for 9 Locations [n=546 HH]

Sr. No	Location / Hamlet	Date of Creation	PV Capacity (kWp)	Battery Capacity	Households + Community Spaces	Community Spaces	Households	Commissioning Date	Reading Date	Operational Days	Control Room Meter Reading in kWh	kWh consumed per day	kWh generated per day	Capacity utilisation
1	Mudamba	27-Mar-21	15	61	78	2	76	26-Mar-21	22-Sep-22	545	9,093	16.68	44.52	0.37
2	Dhabanipani	30-Apr-21	12	36	60	2	58	30-Jun-21	22-Sep-22	449	3,987	8.88	35.64	0.25
3	Jhimari	30-May-21	12	36	55	2	53	17-Jul-21	22-Sep-22	432	3,615	8.37	35.64	0.23
4	Saraipani	15-Apr-21	12	36	56	5	51	14-May-21	23-Sep-22	497	5,532	11.13	36.18	0.31
5	Badaiktoli	15-Apr-21	8	29	42	2	40	08-May-21	22-Sep-22	502	4,698	9.36	24.12	0.39
6	Jharen Tangra Toli	30-May-21	13	41	67	1	66	22-Jul-21	22-Sep-22	427	6,163	14.43	38.61	0.37
7	Orunkela	20-May-21	13	43	75	3	72	09-Jul-21	22-Sep-22	440	7,083	16.10	38.61	0.42
8	Bijakhaman	20-May-21	12	41	65	2	63	10-Jul-21	22-Sep-22	439	5,921	13.49	35.64	0.38
9	Bhijaribari	14-Mar-22	13		71	4	67	14-Mar-22	22-Sep-22	192	2,568	13.38	39.21	0.34
	Total		**109**	**323**	**569**	**23**	**546**			**3,923**	**48,660**	**111.81**	**328.17**	
	Average per HH											**0.20**	**0.58**	**0.34**

- The average units consumed per HH per day is **0.2 kWh,** while the microgrid generates an average of **0.58 kWh** per HH per day; the average household only **consumes only 34% of the total capacity generated** by the microgrid
- Using extrapolation, the energy generation potential for all 13 locations totals about **1,59,640 kWh per annum** (437.37 kWh per day)

Annexure IV: Microgrid Electricity Data – As Per Quantitative and Qualitative Data

Microgrid Electricity Consumption Data for 9 Locations as per Passbook Entries [n=218 HH]

Sr No	Location / Hamlet	Average Units Consumed Per HH Per Month	Average Units Consumed Per HH Per Day
1	Baraiktoli	3.59	0.12
2	Beejakhaman	2.92	0.10
3	Bhijari Badi	3.38	0.11
4	Dabnipani	4.05	0.14
5	Jharan Tangartoli	7.17	0.24
6	Jhimri	3.31	0.11
7	Mudamba	5.73	0.19
8	Orunkela	4.23	0.14
9	Saraipani	3.65	0.12
	Overall Average	4.20	**0.14**

Microgrid Electricity Consumption Data for 9 Locations as per Ledger Entries – Sample for 2 Locations

Sr No	Location / Hamlet	Average Units Consumed Per HH Per Month	Average Units Consumed Per HH Per Day
1	Baraiktoli		
2	Beejakhaman		
3	Bhijari Badi		
4	Dabnipani		
5	Jharan Tangartoli	6.66 (Based on readings of August 2022)	0.22 (Based on readings of August 2022)
6	Jhimri	3.19 (Based on readings of August 2021)	0.11 (Based on readings of August 2021)
7	Mudamba		
8	Orunkela		
9	Saraipani		

Annexure V: Emission Factor Sources

Emission Factors	Unit	Factor	Data as of	Reference link
Kerosene	kgCO2e/litre	2.52	FY 2016-17	GHG Protocol Database 2017 - https://ghgprotocol.org/sites/default/files/Emission_Factors_from_Cross_Sector_Tools_March_2017.xlsx
Diesel	kgCO2e/litre	2.64	FY 2016-17	GHG Protocol Database 2017 - https://ghgprotocol.org/sites/default/files/Emission_Factors_from_Cross_Sector_Tools_March_2017.xlsx
Two Wheeler Motorcycle With Less than 200 CC Engine	kgCO2e/km	0.04	FY 2016-17	WRI India Specific Road Transport Emission Factors - https://shaktifoundation.in/wp-content/uploads/2017/06/WRI-2015-India-Specific-Road-Transport-Emission-Factors.pdf
Truck	kgCO2e/litre	0.59	FY 2016-17	GHG Protocol Database 2017 - https://ghgprotocol.org/sites/default/files/Emission_Factors_from_Cross_Sector_Tools_March_2017.xlsx
Cement	kgCO2e/kg	0.58	FY 2018-19	https://aeee.in/emission-reduction-approaches-for-the-cement-industry/

Note: For our assessment, it is assumed that a motorcycle with less than 200 CC engine is used for motorcycle transportation

Annexure VI: Summary of Insights – Firewood

Firewood

While all 281 HHs use firewood for cooking, the focus of our assessment was on HHs that claimed a reduction in firewood usage due to electrification

11%

HHs (n=30) claimed reduction in firewood usage

No material change in firewood usage across recorded categories

Nearby trees were the only source of firewood for all HHs (n=30)

>87% (n=26) HHs collect **twigs** from the ground or cut off **tree branches**

All HHs (n=30) use firewood for cooking, and **43% HHs** (n=13) use firewood for heating

All HHs (n=30) travel on foot to procure firewood

1.5 Km

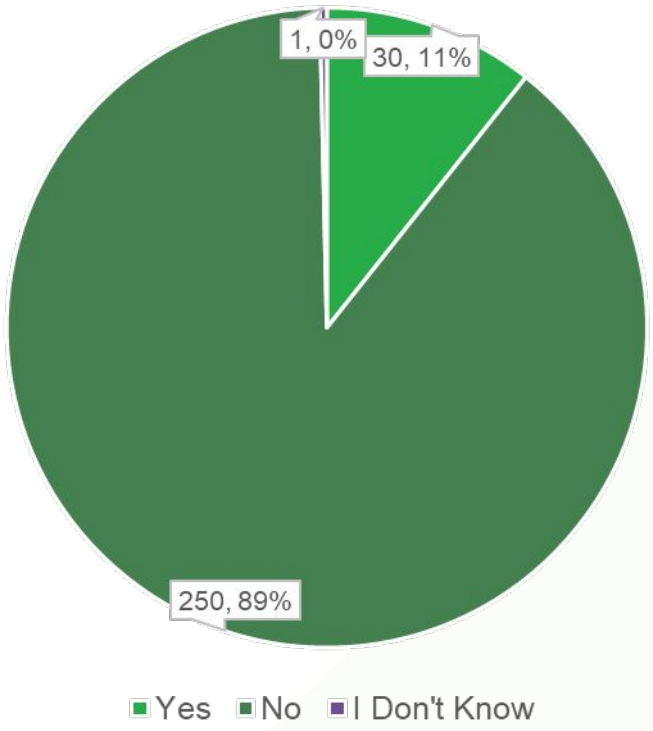
average distance travelled one-way to procure firewood (median 1.1 to 2 km)

5 Per Year

average number of trips to procure firewood (median value)

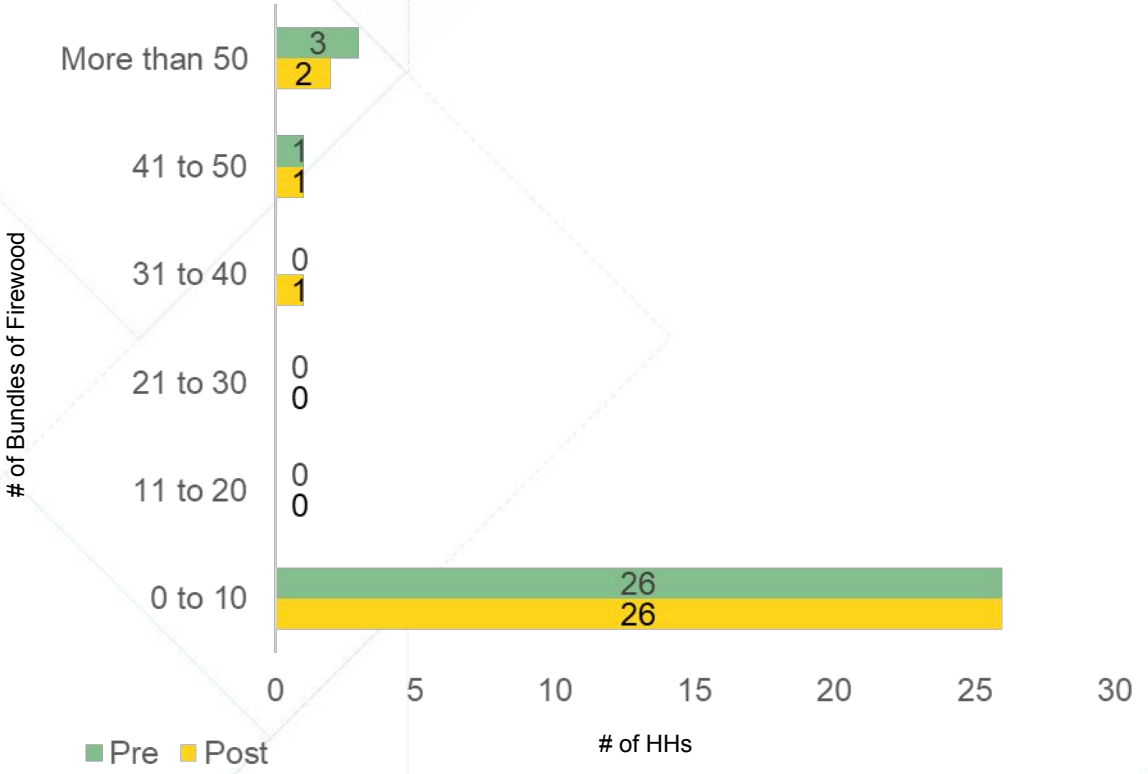
The **overall usage of firewood** has **not reduced materially** due to electrification

Reduction in Firewood Usage Due to Electrification [n=281 HH]



- 11% (n=30) HHs claimed to have experienced a reduction in firewood usage due to electrification

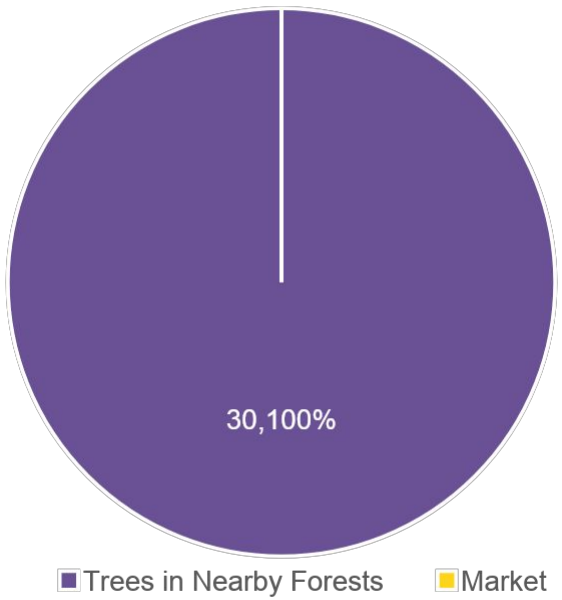
Pre vs Post Electrification Monthly Usage of Firewood (Categorized) [n=30 HH]



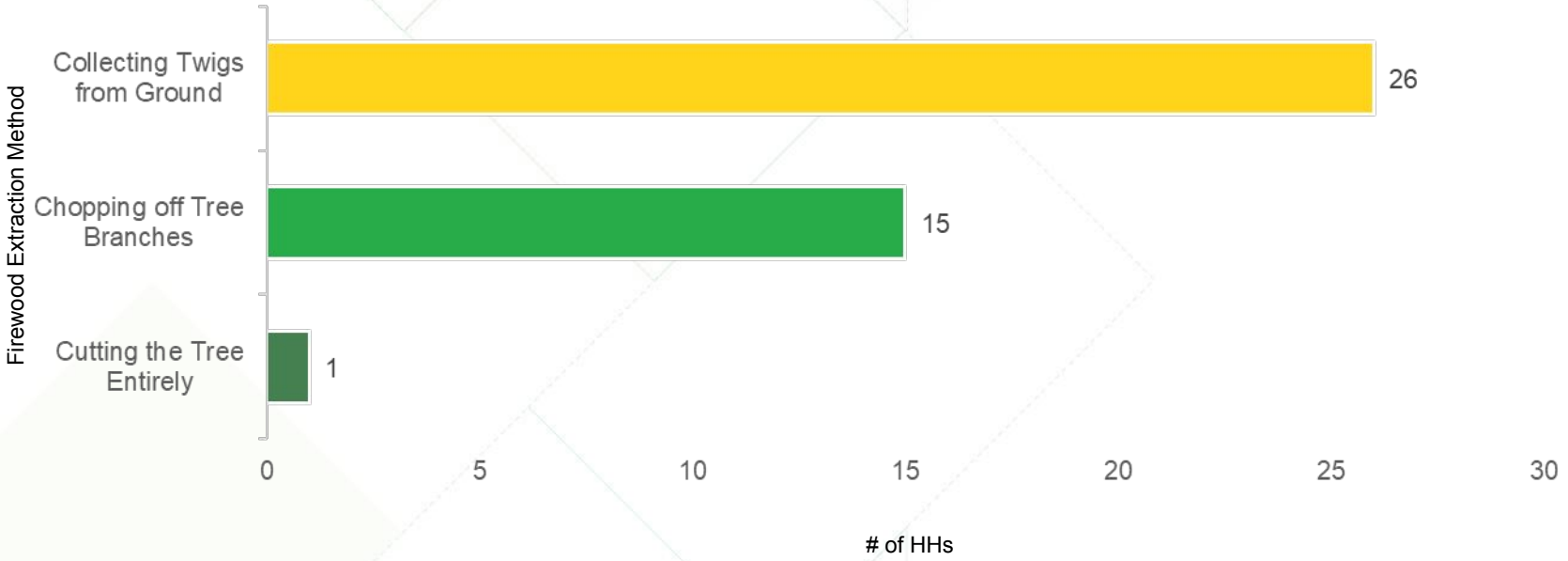
- Among the 30 HHs, however, the overall weekly household usage of firewood does not seem to have changed much across material categories
- Hence, for our assessment, the change in usage of firewood is not material / relevant

All HHs **source** firewood **from trees** in nearby forests, and extract it by either collect twigs from ground or chop off tree branches

Sources of Firewood [n=30]



Firewood Extraction Methods Employed [n=30]

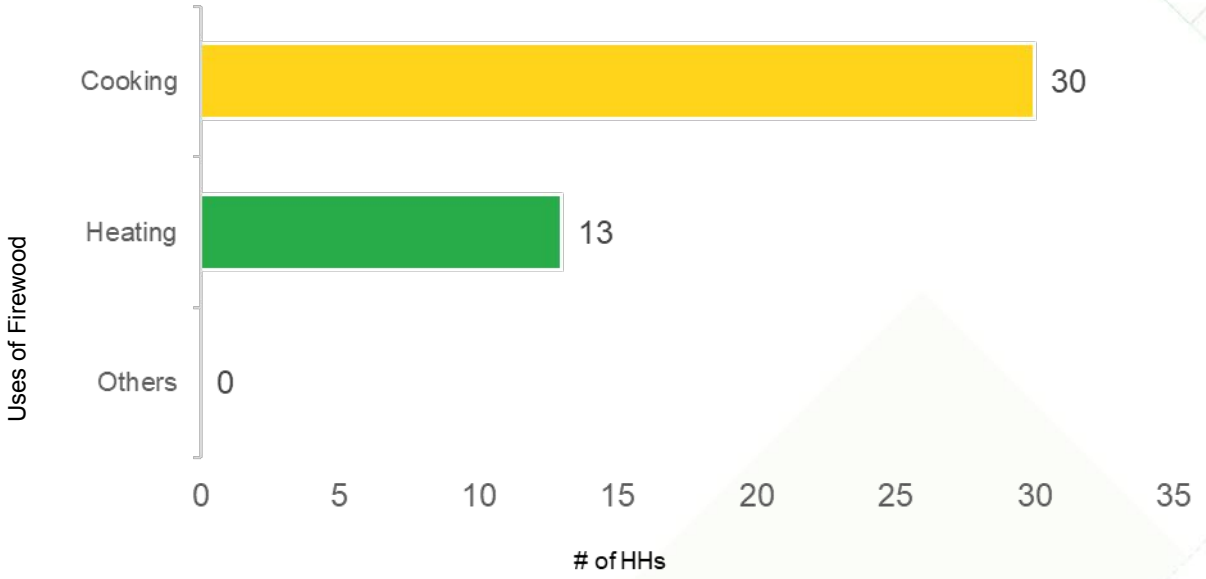


- All 30 HHs source their firewood from trees in nearby forests
- Most households either collect twigs fallen on the ground (87%, n=26) or chop off tree branches(50%,n=15); they do not cut off a tree completely

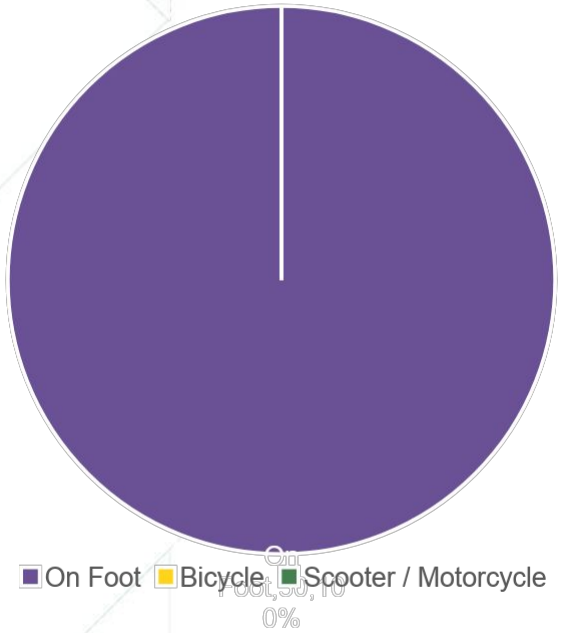
However, this data is not relevant for our assessment since the change in usage of firewood is not material / relevant (as discussed in previous slides)

Post electrification, HHs **continue to use firewood for cooking and heating** and travel by foot for procuring it

Uses of Firewood [n=30]



Mode of Travel for Procuring Firewood [n=30]

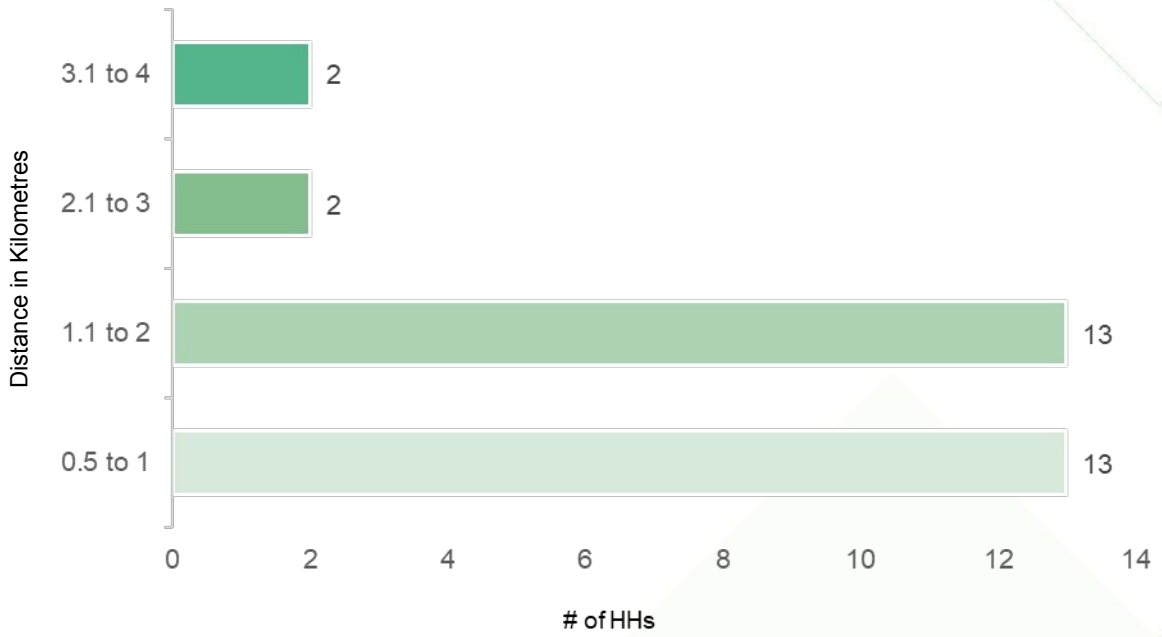


- All 30 HHs use firewood for cooking, and many (43%, n=13) use firewood for heating
- All 30 HHs travel by foot for procuring firewood

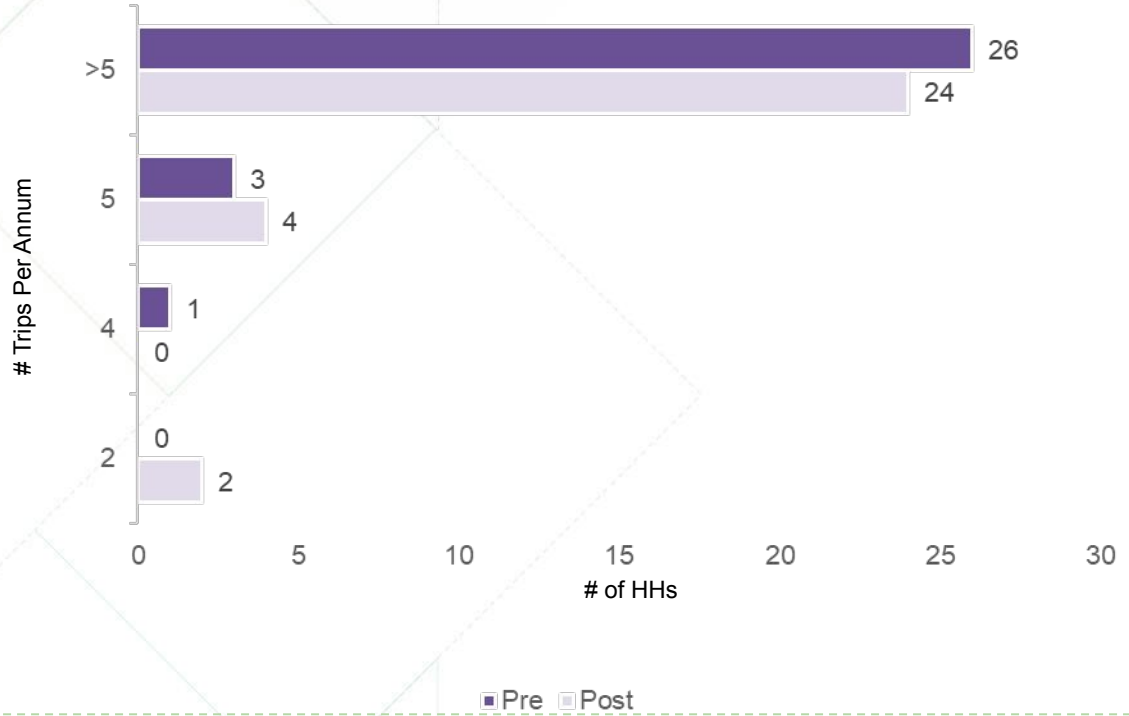
However, this data is not relevant for our assessment since the change in usage of firewood is not material / relevant (as discussed in previous slides)

HHs travel **1 to 2 kilometres on average** per trip one-way to procure firewood

Travel Distance for Procuring Firewood [n=30 HH]



of Trips Per Annum for Procuring Firewood [n=30 HH]



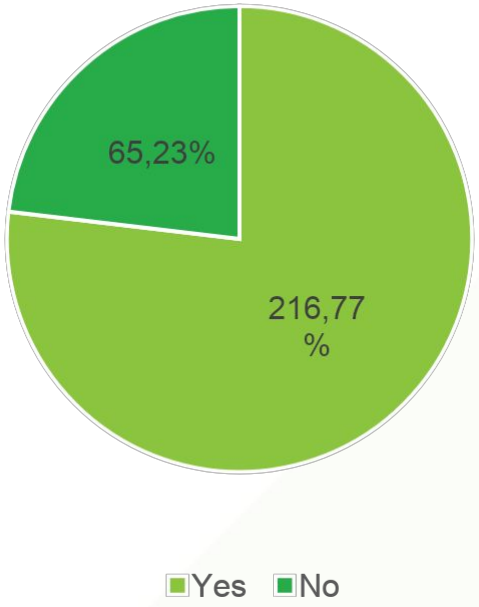
- For our assessment, It is assumed that the travel distance has not undergone material change in the pre and post electrification scenario
- Most households travel between 1 to 2 kilometres one-way to procure kerosene
- The average distance travelled one-way to procure kerosene is **1.5 kilometres** (average of the median distance 1.1 to 2 km)
- The # of trips per annum for procuring firewood has not seen a material change, with most households still making more than 5 trips per annum

However, this data is not relevant for our assessment since the change in usage of firewood is not material / relevant (as discussed in previous slides)

Additional Observation: HHs tend to collect and store large quantities of firewood in each trip (about 2-3 bundles of 5-10 kgs each)

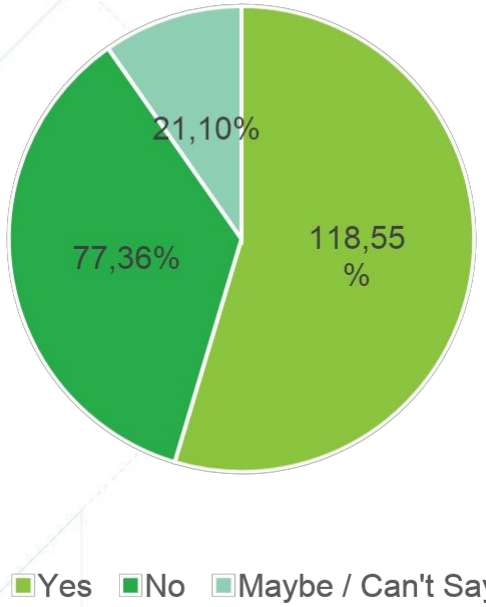
There is a **scope to increase awareness** of **alternatives to kerosene and firewood** and to help plan reduce such usages

Awareness of alternatives to kerosene and firewood for heating and cooking [n=281]



- Most HHs (77%, n=216) are aware of alternatives to kerosene for heating and cooking, such as coal, biogas, cylinder, LPG and electricity

Plan to use the alternatives as primary sources of energy for heating and cooking in the near future [n=216]



- Of the 216 HHs aware of the alternatives, 54% (n=118) plan to use them as primary sources of energy for heating and cooking the next 6 to 12 months

THANK YOU

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This year, we have helped **100+ social organisations** and **50+ corporates** achieve their sustainable development goals through proven innovations, intelligent design, implementation and monitoring of their programmes.

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