SHAKTI
SUSTAINABLE ENERGY
FOUNDATION

CLEAN
Clean Energy Access Network

State of the
Decentralized Renewable Energy
Sector in India




2018/19

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FOREWORD

The Decentralized Renewable Energy (DRE) sector has been contributing to India's energy transition in many innovative ways, from local level energy generation to creating livelihoods through energy access. DRE enterprises have enabled skills training and job creation in locations that need them the most. CLEAN's members have played a pioneering role in developing innovative solutions by responding to the constantly evolving requirements for improvement the quality of life for all; the special focus of CLEAN members though, is improving lives of poor, disadvantaged communities through energy access. .

During the past five years, CLEAN has evolved from a 45-member network to a strong 220-member network in 2019. This has enabled it to position itself as a credible and trusted intermediary to develop collaborations and partnerships between DRE enterprises and others engaged in energy access in the public and private domains. CLEAN is now recognized at India's platform and the voice of the DRE sector.

CLEAN and its members are sensitive to the changing patterns of people's energy requirements and the Government's approach of meeting the energy needs of the country's large population. As the case studies in this report from CLEAN members show, DRE is adding to the diversity of energy access solutions at the local level.

As India makes rapid strides in achieving the energy access and sustainability goals that it has set for itself, DRE solutions are emerging as necessary and appropriate to meeting end user needs. This report showcases the mechanisms / approaches that all stakeholders must adopt to support the government's ambitious targets. This report highlights the role of DRE and the impact that it can create through innovation and grassroot level enterprise. The report aims to create awareness about the variety of applications and opportunities that can be enabled through

DRE. This report also provides information on market trends, technological advances and best practices in the sector. It also highlights the needs and challenges faced by the sector and makes a compelling case for a place in the sun for DRE enterprises.

We believe that the State of DRE Sector report will provide stakeholders with a whole¬some view of the role of the sector in catalysing development and improving lives.

Svati Bhogle
Chairperson
Clean Energy Access Network

PREFACE

DRE enterprises have been acting as dedicated clean energy solutions provider for the un-served and under-served segments of Indian population. It has catalyzed innumerable lives of this segment of population by creating opportunities for better livelihoods, increased income levels, safe and healthy living conditions, leap-frogged education opportunities and empowering women by eradicating drudgery at many levels.

DRE solutions have been playing the role of a 'magician' in a home where access to energy was either non-existent or a fleeting dream. These solutions play an important role in achieving universal energy access and go beyond basic access to energy by providing 24×7 reliable and quality power supply. It contributes towards building a sustainable environment and reduces carbon emissions.

The sector continues to see growth in augmenting energy generation at local levels. A dire need of adaptable, affordable, and productive end-use of energy has sparked many innovative solutions such as solar sewing machines, thermal storage, and solar dryers, which are seen in application in rural and urban markets. It has provided avenues for skilled training for both men and women at the grassroots level. The rise in community-based business models using clean energy is an evidence pointing towards the need for further standardization and incubation to achieve scalability and replicability. Tailor-made conducive policies are required to steer DRE's potential towards a position of being a formidable pillar in achieving the energy transition for India.

This third edition of the **State of Decentralized Renewable Energy Sector in India 2018/19** report presents an overview of the DRE sector, technology deployments, and covers highlights of the impact created by DRE initiatives and innovations to leapfrog development. CLEAN's survey with its members, network of financiers, government representatives, researchers, think tanks, and funders in the DRE sector has been

used to understand the sentiments of DRE enterprises in India today and expectations from the future, which have been presented in the report.

We sincerely hope that this report will be useful for relevant stakeholders in the sector including policy makers, financiers, donors, and enterprises in achieving India's national energy goals. We are optimistic that this report will generate sufficient interest and ensure accelerated investments, policy development, and capacity building support to DRE projects in India.

Adwait Joshi
Chief Executive Officer
Clean Energy Access Network

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Shakti Sustainable Energy Foundation

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- Greenway Grameen
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- Husk Power Systems
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- Pollinate Energy
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Shakti Sustainable Energy Foundation works to strengthen the energy security of India by aiding the design and implementation of policies that support renewable energy, energy efficiency and sustainable transport solutions.

LIST OF ABBREVIATIONS

AC	Alternating Current
AEEE	Alliance for Energy Efficient Economy
BIS	Bureau of Indian Standards
CEEW	Council on Energy, Environment and Water
CII	Confederation of Indian Industry
Cr	Crore (10 million)
CSIR-NEERI	Council of Scientific and Industrial Research-National Environmental Engineering Research Institute
DC	Direct Current
DFI	Development Finance Institution
DISCOM	Distribution Company
DRE	Decentralized Renewable Energy
EDP	Entrepreneurship Development Programme
EMI	Equated Monthly Instalment
ESCO	Energy Service Company
ETD	Electro Technical Department
FPO	Farmer Producing Organisation
FTE	Full Time Employment
FY	Financial Year
GI	Galvanized Iron
GSES	Global Sustainable Energy Solutions
HP	Horsepower
IAP	Indoor Air Pollution
ICCF	India Clean Cooking Forum
ICS	Improved Cook Stove
IEA	International Energy Agency
IEAS	India Energy Access Summit
IFC	International Finance Corporation
IoT	Internet of Things
IPHS	Indian Public Health Standards
ISCO	International Standard Classification of Occupation
ITEC	Indian Technical and Economic Cooperation
ITI	Industrial Training Institute
KUSUM	Kisan Urja Suraksha Evam Uhaan Mahaabhiyan
KVIC	Khadi and Village Industries Commission
kW	kilowatt
LCOE	Levelized Cost of Electricity
LED	Light Emitting Diode

LVDC	Low Voltage Direct Current
MFIs	Micro-finance Institutions
MNRE	Ministry of New and Renewable Energy
MSDE	Ministry of Skill Development and Entrepreneurship
NBMMP	National Biogas Manure Management Programme
NIESBUD	National Institute of Entrepreneurship and Small Business Development
NSDC	National Skill Development Corporation
OT	Operation Theatre
PACE-D TA	Partnership to Accelerate Clean Energy Deployment Technical Assistance
PCM	Phase Change Material
PEMS	Portable Emissions Measurement System
PHC	Primary Health Centre
PV	Photovoltaic
R&D	Research and Development
RRB	Regional Rural Bank
SCGJ	Skill Council for Green Jobs
SHG	Self-Help Group
SHS	Solar Home System
SNA	State Nodal Agency
SPV	Solar Photovoltaic
SSC	Sector Skill Council
TIDE	Technology Informatics Design Endeavour
UNSDG	United Nations Sustainable Development Goal
USD	United States Dollar
W	Watt

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Food Processing

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EXECUTIVE SUMMARY

Decentralized renewable energy (DRE) can ensure 24×7 reliable and quality energy supply through clean energy sources to all Indian households and small- and medium-sized enterprises. The maximum beneficiaries of clean energy from DRE sources have been the poor and marginalized sections of the society, propelling their economic and social growth as well. Today, the pursuance of these sections of the society for affordable and reliable sources of energy is increasing especially when they are presented with access provisions.

Like in the past two years, this year also, CLEAN conducted a survey among its members to get an idea as to how far the DRE sector has travelled over the course of the past one year. Based on the response to the survey, analysis of inputs from various sources, and speaking to several stakeholders (both members and others outside), CLEAN has put together this year's State of the Sector Report. Spread over four chapters and 27 impactful case studies, this edition captures the state of the DRE sector in India in a nutshell.

This executive summary further prunes it down to just the main highlights pulled out from the four chapters and the case studies. The list below presents the main highlights.

1. DRE enterprises have expressed their concerns on the need for a stronger policy and financial environment to help their businesses flourish and cater to the energy needs of those with limited access to it. 78% of the respondents have evolved and changed their business models and offerings as a result of the government initiatives.
2. 45% of the members surveyed reported that they have been profitable last year and 57% were able to raise capital in the past. A summary of investment taking place in the sector is highlighted.
3. 4,354 full-time jobs and 2,556 part-time jobs were created by 43 CLEAN member enterprises surveyed.

4. Over 43 lakh customers are being served by 43 CLEAN member enterprises surveyed.
5. An extensive DRE job census survey conducted by Power for All and CEEW reported creation of 95,000 direct formal jobs and 210,000 informal jobs 2017/18.
6. Standardization, testing, and benchmarking are necessary for acceptance of the consumers and the DRE market to grow.
7. An overview of the deployment of DRE technologies of the enterprises participated in the survey is presented. Mini-grid practitioners have expressed their desire to have a comprehensive mini-grid policy, explaining the role and scope of mini-grid operators in partnership with local discoms.
8. DRE enterprises have identified new market areas. Productive-use applications such as solar thermal applications, solar pumps for irrigation, solar refrigerators, solar sewing machines, and solar charkhas, clean cooking applications for households and community kitchens are some of the prospective market segments.
9. The sentiments of enterprises on challenges and opportunities are covered. While government's grid extension and LPG distribution initiatives have challenged DRE businesses, they have also opened new, underserved areas/regions for DRE businesses to tap and grow. Their perspective on the future of the DRE market is found to be positive, given the gaps identified and opportunities against the same.
10. The use of DRE applications in other areas such as food processing, health care, and agriculture has been adequately covered. Tailor-made DRE solutions that go beyond the usual lighting and clean cooking solutions have been able to capture the attention of a large range of consumers.
11. The report brings forth the strong linkages of DRE solutions with SDG 1 (No Poverty), SDG 3 (Good Health and Well Being), SDG 4 (Quality Education), and SDG 8 (Decent Work and Economic Growth).

OVERVIEW OF THE DRE SECTOR

1

CHAPTER 1

1 Overview of the DRE Sector

Conducive policy environment, availability of finance, adequate workforce, and continuous development of solutions through technology innovation play a key role in strengthening the ecosystem of the DRE sector. Strengthening of the ecosystem also entails synchronization of actions between and among the various stakeholders to use and support deployment of DRE technologies and applications. The stakeholders are the government, financiers, enterprises, and most importantly, the poor and the marginalized.

This chapter presents an overview of the sector from the focus areas of CLEAN: (a) policy, (b) finance, (c) skill and employment, and (d) technology.

1.1 Policy

The policy landscape of the renewable energy sector has gained considerable importance in recent discourse in the light of improved DRE technologies catering to large sections of rural populations and those in geographical locations that are devoid of grid-interactive power.

1.1.1 Schemes for the sector

Policies related to the DRE sector have been extensively covered in the second edition of the State of the Decentralised Renewable Energy Sector in India report. Since no new schemes have been launched, this edition includes only an overview of the policy landscape. A continuous support at par with grid-connected renewable energy projects is needed.

A few such key schemes are listed below.

- **Kisan Urja Suraksha evam Utthaan Mahabhiyan (KUSUM) Scheme:** The KUSUM scheme was launched in 2018 to support agricultural practices by installing off-grid solar pumps in rural areas and reduce dependency on grid in grid-connected areas. With the overall goal of making the farmers independent, the implementation guidelines for KUSUM scheme was announced in July 2019.

- **Pradhan Mantri Sahaj Bijli Har Ghar Yojana (Saubhagya):** Saubhagya was launched in 2017 to achieve universal household electrification in the country. Solar photovoltaic-based (SPV-based) standalone systems for un-electrified households located in remote and inaccessible villages/habitations, where grid extension is not feasible or cost

effective. Electrification of 21.4 million households took place with 18,734 willing households left to be electrified (as on 30 August 2019),

- **National Biogas and Manure Management Programme (NBMMP):** Initiated by Ministry of New and Renewable Energy in 2017, the programme provides clean cooking fuel and electricity to households in villages through family-type biogas plants. So far, 49.6 lakh biogas plants have been installed under NBMMP.

- **Scale up to Access of Clean Energy Scheme (ACE):** The Ministry of New and Renewable Energy (MNRE), is implementing a project titled "Scale Up of Access to Clean Energy (ACE) for Rural Productive Uses", an initiative to enhance the use of reliable and affordable renewable energy for rural productive uses/livelihoods in un-served and under-served areas in 3 states; Assam, Madhya Pradesh and Odisha for strengthening rural livelihoods, improving income generation and reduce use of fossil fuels.

  The estimated total project cost of this scheme is about Rs.148 Cr., with Rs.70 crore being the contribution of Government of India, Rs.31 Cr. contribution from GEF and UNDP and Rs.47 Cr. to be mobilized through sources such as State Govt. funds, CSR, beneficiary contribution, etc.

  The scheme was approved in 2018 with a target of 30,000 beneficiaries expected by 2020.

- **Solar Charkha Mission:** The Solar Charkha Mission of the Ministry of Micro Small & Medium Enterprises (MSME), was launched in June 2018. The Mission aims to cover 50 solar charkha clusters in rural areas and every cluster will employ 400 to 2000 artisans. The Mission has been approved by the Government of India and will disburse subsidy of Rs. 550 crore to the artisans.

- **Solar Study Lamp Scheme :** The Ministry of New & Renewable Energy (MNRE), Government of India had sanctioned the Solar Study Lamp Scheme in high quality, affordable clean light in the form of solar study lamps through skill transfer to local communities. So far over 65 lakh students have been benefitted from the 1 million, 70 lakhs and 5 lakhs Solar Study Lamp schemes implemented by MNRE in collaboration with EESL and IIT Bombay.

Atal Jyoti Yojana II (AJAY): Phase II of Atal Jyoti Yojana has been launched by MNRE for 2018-19 and 2019-20. It will cover the installation of 304,500 solar streetlights (SSLs) in various states covered under the Phase I of scheme and several other states have been added due to additional demand . SSLs with LED capacity of 12W will be provided as per MNRE specifications.

1.1.2 Benchmark Cost of Off-grid Solar Applications by MNRE

The benchmark cost of off-grid application for 2019/20 was notified by MNRE[1] in July 2019. The government is focused on providing latest technology as per users' requirements. Table 1 provides a commentary on the benchmark costs provided for the current year. A comparison with the previous benchmark costs notified in 2017/18 and 2018/19 can be found in Annexure 1.

TABLE 1 Benchmark Cost of Off-Grid Solar Applications

Solar Streetlights (SSLs)	No benchmark cost have been provided for SSLs with Lead Acid Batteries in 2019/20. The government has focused only on SSLs with Lithium Ion batteries. Compared to last year's cost, the benchmark cost for SSL with Li–Ion batteries is reduced by approx. 30%.
Solar Pumps	Solar pumps have been further sub-categorized into 0.5, 1, and 2 HP pumps. Earlier it was 3, 5, 7.5, and 10 HP pumps. This fits in well with the demands of small and marginal farmers with small plot sizes growing vegetables and less water-intensive crops using drip irrigation and sprinklers, pumping drinking water, and water for other household activities. It is also to be noted the benchmark cost has been reduced for surface solar pumps in comparison to submersible solar pumps. The reason behind this is to keep a check on over-utilization of groundwater and maintain a sustainable groundwater table.
Solarization of Grid-connected Agriculture Pumps	Government is providing benchmark cost for solarization of agriculture pumps, which shows its strong intent of moving towards clean energy sector and also making it affordable and easier for the agricultural community.
Streetlight through Solar Photovoltaic (SPV)	Benchmark cost for streetlight through SPV is no more provided since 2018/19. Funds are currently being provided for the Atal Jyoti Yojana (Phase II) for SSL.
Solar Lamps/Stand-alone Solar Power Plants/Packs	The benchmark costs for solar lamps and stand-alone solar power plants/packs have been reduced by 36% and 6%, respectively.

[1] *Benchmark costs for Off-grid Solar PV Systems and Grid Connected Rooftop Solar Power Plants for the Year 2018-19. Accessed from https://mnre.gov.in/sites/default/files/webform/notices/Off_Grid-&-Grid-Benchmark-Cost-2018-19.pdf*

DRE for Disaster Management

India's 2019 monsoon fury had seen red alerts being issued in the states of Gujarat, Assam, Bihar, Maharashtra, Kerala, and Karnataka. According to the Ministry of Home Affairs, over 1.6 crore people in 7,854 villages were affected by flooding in those states (until 5 August 2019).

When such natural disasters strike, energy grids are often the first to fail. Lack of electricity can delay recovery and rescue efforts. After the rescue and recovery missions, re-activating the power grid is costly and time-consuming. This often leads to communities being left without the essential supply of electricity for a long time, hampering their daily lives.

DRE provides instant, reliable, cost-effective, and portable source of power to the victims of such natural disasters. DRE solutions such as mini-grids, pico-grids, solar lanterns, and solar-powered unit boxes for charging multiple smartphones at a time are of immense use in the wake of such disasters. Energy provided by deploying such off-grid methods not just allow officials to better implement and manage disaster relief but also provide the much-needed comfort, security, and aid to victims.

It can be seen that DRE provides flood victims with the most essential need of electricity. While governments supply disaster-struck areas with food and funds, they should also turn to enterprises that can provide DRE solutions to assist their recovery missions.

Solar-powered streetlight in Odisha after Cyclone Fani

A micro grid for quick restoration of electricity

The DRE sector has tremendous potential with the number of enterprises growing every year. At CLEAN, we believe that extensive policy support is required to harness the potential of the sector. The past schemes have been beneficial for the sector and more remains to be done. Micro, Small and Medium Enterprises (MSME) from the sector need to be included more widely under the schemes.

As electricity and LPG cylinders reached households, the demand for affordable and reliable energy sources has increased, especially the last-mile consumers. Conducive policies and schemes are required for market expansion in the productive use segment. The KUSUM and ACE scheme are right step in this direction. This will not only help the sector but will also help in generating income in unserved and underserved segments of the population.

1.2 Finance

This section of the report covers a) updates on investment in the sector in the year 2018-19 b) CLEAN member survey analysis on financing requirements and updates on financial performance from the last year.

1.2.1 Investment in the Sector[2]

The DRE enterprises have been in the radar of investors, particularly from investors supporting Impact Fund initiatives in the country. Though there are a large number of DRE enterprises, very few enterprises and financiers ended up with a deal. Below are DRE enterprises that were able to raise money for their India operations in the last two years (Table 2).

Table 2. Investment in the DRE sector

Name of Enterprise	Name of Investors	Estimated Amount Raised	Year
Cygni Energy	Endiya Partners & Indusland Bank	INR 15 crore	2018
Simpa Energy	Acquired by Engie	Undisclosed	2018
SELCO	DOEN Participaties	Undisclosed	2018
Husk Power	Shell Ventures	INR 138 crore	2018
Sistema Bio	Investment Round	INR 86 crore	2019
Atomberg Technologies	Hero Group	Undisclosed	2019
Ecozen	Hivos-Tridos, Caspian	Undisclosed	2019
Punjab Renewable Energy Systems	SBICAPS Neev Fund (SBI+SBICAPS+ SIDBI+DFID UK) & Shell Ventures BV	INR 55 crore	2019
Mlinda	Indian Renewable Energy Development Agency	Undisclosed	2019

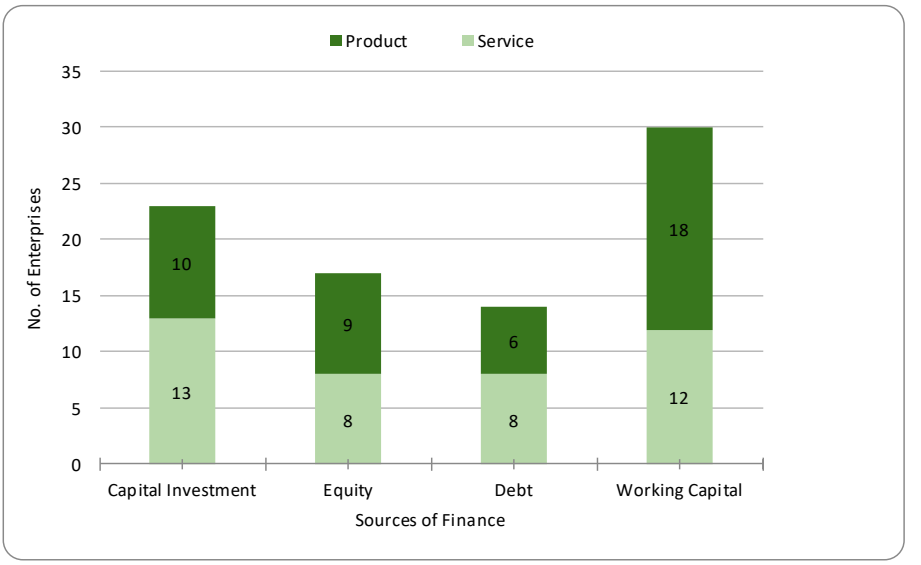
2 *Sources: News articles, Crunchbase, Vccircle, As confirmed by enterprises*

1.2.2 CLEAN Member Survey Analysis

Access to finance for different types of DRE businesses and technologies has always been a challenging task for the financiers to understand. CLEAN conducted a member survey to provide a clearer picture of what the financial landscape of the DRE sector looks like and what are the present financial needs of enterprises. A total of 44 enterprises were surveyed. This may not be a representation of the entire sector considering the limited sample size.

Respondents were segmented into product manufacturers and service providers to have an understanding of the differences in their needs. Enterprises manufacturing their own products were put into the category of 'Product', even if they provide after-sale services. The category 'Service' comprised system integrators. These enterprises do not manufacture their own products. Their services could include electricity, biogas, etc.

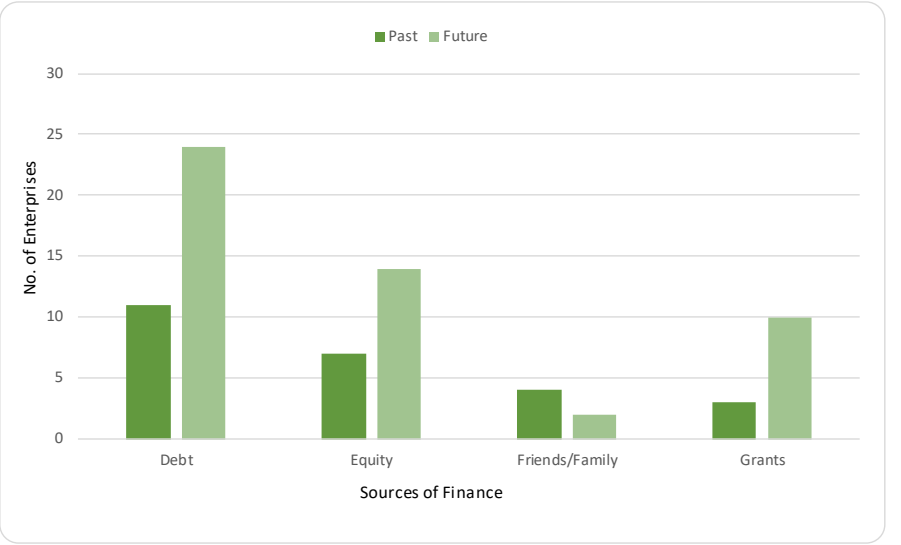
Figure 1.1 *Financial needs of enterprises*



Sample Size-42. Source: CLEAN Survey and Analysis, 2019

Highlighted below are the results of the analysis of the survey conducted. Figure 1.1 brings out the financial needs of enterprises belonging to both categories. Working capital has been the major source of finance required by DRE enterprises. 30 enterprises explicitly expressed the need for working capital. 17 opted for equity and rest showcased short- and long-term debt. Product-oriented enterprises are looking for working capital.

Figure 1.2 *Sources of finance*

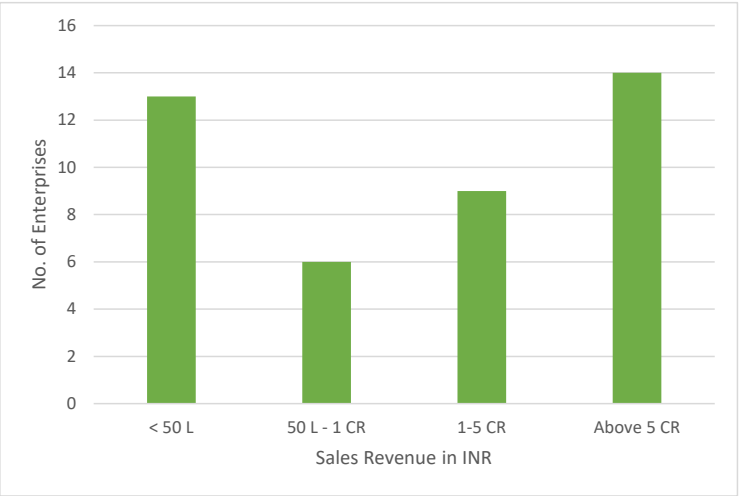


Sample Size-36. Source: CLEAN Survey and Analysis, 2019

CLEAN's analysis also shed some light on the source of funds (Figure 1.2). Both debt and equity remained the major sources of financing in the past. The enterprises also expressed the need for both these sources to continue in the future as well. However, there is an increasing interest to access finances from impact funds, corporate social responsibility (CSR) funds, grants, and microfinance institutions (MFIs). Eleven enterprises have expressed their interest to draw funds from impact funders.

Most organizations that were at the initial level of operations were self-funded. Those who did manage to get loans in the initial phase could only get them for a short term. Challenges include limited end-user financing, lack of outreach of MFIs in specific regions, and MFIs' tie-up with specific brands. High interest rates charged by MFIs and banks seeking collateral for sanctioning loans were also cited as major challenges.

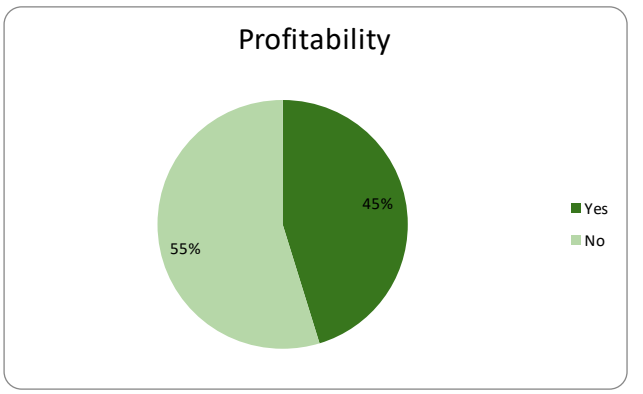
Figure 1.3 *Sales revenue of enterprises in 2018/19*



Sample Size-42. Source: CLEAN Survey and Analysis, 2019

Revenue, also referred to as sales, is the amount of money a company brings in or earns before any expenses are taken out. From an accounting perspective, revenue typically consists of product and service sales on account or where the customer paid in cash. CLEAN members, who have responded, are majorly falling into two categories: small enterpreneurs (revenue of <INR 50 lakh) and medium players (revenue of >INR 5 crore).

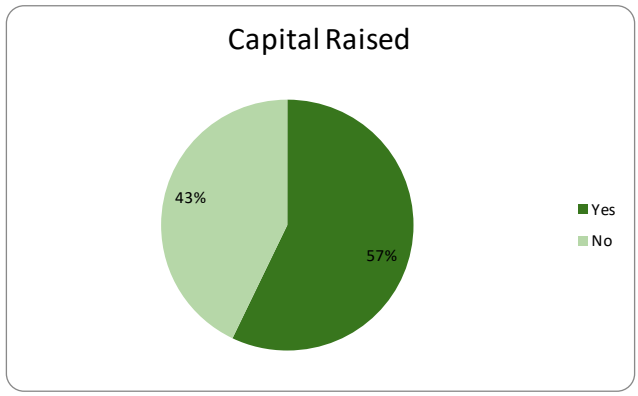
Figure 1.4 *Profitability of enterprises*



Sample Size-42. Source: CLEAN Survey and Analysis, 2019

Figure 1.4 indicates that 45% of CLEAN members surveyed have made profits in 2018/19. According to CLEAN's analysis, smaller players in the market have been able to generate profits this year.

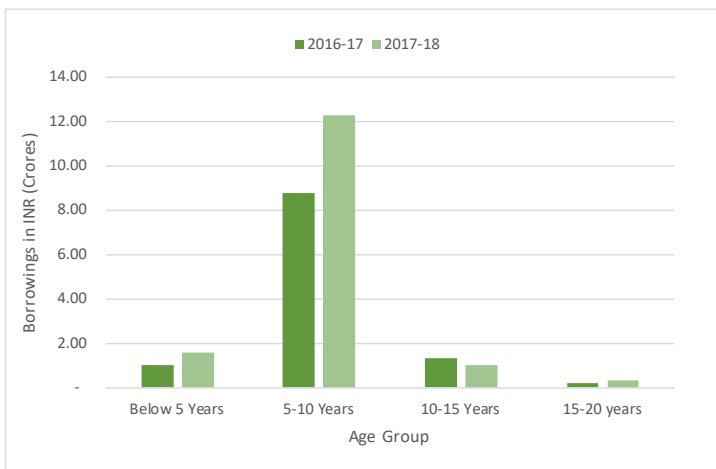
Figure 1.5 *Ability of raising finance in the past*



Sample Size-42. Source: CLEAN Survey and Analysis, 2019

The capital requirement could be for various needs such as daily operations, purchase of materials, and payment of wages. 57% of enterprises surveyed had met with success in the past (Figure 1.5). This may or may not be indicative of the overall ability of the sector to raise capital given the size of the sample.

Figure 1.6 *Age-wise borrowings from 2016 to 2018*



Sample Size-30. Source: Annual Reports of CLEAN member enterprises.

Practitioners Views on Finance

Practitioners are of the opinion that financiers still lack exposure to the sector, resulting in reluctance to investing. They have stated that social impact should be the key parameter in deciding viability of the business model. There is also a need for more transparency and equitable partnership between enterprise and financing entities.

Asks from Financiers

- Finance to support technology development to bring down capital costs, soft capital to scale business, and skilled human capital for sustaining growth
- Support in innovative structuring of revenue for enterprise and end consumers
- Make end-user finance easily available
- Returns expected by impact investors need to be low and for a longer term
- Viability of an impact-based business model should be determined keeping in mind the quality of impact created rather than quantitative metrics

Source: CLEAN survey and analysis, 2019

Figure 6 shows the pattern of average borrowings made by CLEAN members between 2016/17 and 2017/18. While there has been a growth in the average borrowings across all age groups, a dip can be seen in the age group of 10–15 years. This could be due to the category comprising a limited number of enterprises.

1.2.3 DRE financing ecosystem

Interesting and insightful take-aways from the survey include the opinions of investors and the practitioners on the DRE financing ecosystem.

1.3 Skills and Employment

1.3.1 Powering Job Census 2019: The Energy Access Workforce by Power for All

Power for All, in collaboration with the Council on Energy, Environment and Water (CEEW) in India, released the first comprehensive survey to present data on jobs and skills in the DRE sector. The annual survey, *Powering Jobs Census 2019: The Energy Access Workforce*, provides findings based on research conducted in India as well as Nigeria and Kenya. Key findings from India include the ones listed below.

Summary of Investors Survey

Ticket Size

Ticket size may vary from INR 50 lakh to INR 15 crore. Some financing entities prefer not to invest directly and choose to invest in enterprises by various global or country level funds. Crowd funding platforms are also available for DRE enterprises.

Outlook of DRE Market

- For regular investments to flow into DRE space, there has to be long-term continuity of policy, both at the centre and states.
- The market is shifting towards augmenting generation at the local level rather than generation of power.Global stress on renewable energy seems to be growing. This, in turn, is linked to the realization of impact energy usage on climate change. India has also set ambitious carbon reduction goals for itself due to which there will be a growth in the DRE market.
- There are differing views on growth of the market. Different investors feel differently about which segments within the sector will be growing. Some feel that segments like productive application and solar irrigation pumps are going to grow in the future and do not see scope for basic energy access applications like lighting, mobile charging etc. While the analysis of other investors points to a growth in outdoor and portable lighting market and AC/DC compatible appliances. There is also huge potential seen for livelihood-linked productive loads, which DRE enterprises provide.

What Financiers Require from Enterprises

- A good business model and plan beyond manufacturing and R&D
- Commercial scalability of product and the ability to do well outside the incubation environment
- Continuity in the supply chain of the product
- Low dependence on government subsidies
- Adapting to the changing needs and preferences of customers

Due Diligence Recommendations

- *Quality and sustainability issues of products and services:* The products of DRE sector are yet to acquire the mark of a mainstream product, as such these enterprises will be subjected to more rigorous due diligence processes. The enterprises should ensure that the products perform well even in non-ideal conditions.
- *Viable business models and long-term plans:*Clear mission/vision of the company, strategy for client acquisition, production/execution process flow, and have 5–10 years vision for scaling.
- *Creating better systems for financiers to stay connected:* Keeping investors up to date on the progress being made on ground via enabling technologies such as dashboards from which investors can stay connected to the ground level without being directly involved. Have functioning MIS reports for sales and operations updated on a periodic basis (minimum on a monthly basis).
- *Good clarity of markets and customers.*
- *Governance systems:* Have external board members (independent directors or investment directors). Having a domain expert and/or reputed board of directors or board members with diverse backgrounds.

Source: CLEAN Survey and Analysis, 2019

Figure 1.7 *Number of direct, formal,[3] and informal[4] jobs created (2017/18) and expected projections for 2022/23*

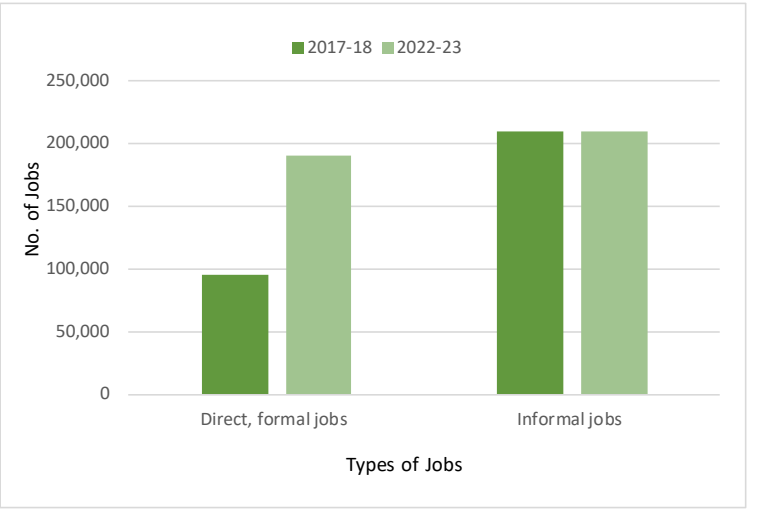


Figure 1.7 shows the overall job market in the DRE sector.

It highlights 95,000 direct formal jobs and 210,000 informal jobs in the year 2017/18.

A 100% increase is expected in direct, formal jobs which translates into 190,000 jobs in year 2022/23. Jobs in informal sector are expected to remain constant.

Notes:

1. Productive use jobs[5] for the year 2017/18 have been estimated to be 470,000 jobs, five times higher than the direct, formal jobs created.
2. According Smart Power India, three new enterprises are set up for every new mini-grid, each employing three people, i.e., each new mini-grid would enable the creation of 9 productive use jobs.

[3] *Direct, formal jobs: Direct formal jobs are those created through contractual engagement with an incorporated company in the DRE sector. For example, an IT professional and project manager.*

[4] *Informal jobs: Informal jobs are created through contractual or non-contractual engagement with an incorporated company in the DRE sector. For example, a home business owner who works as a village sales representative for an SHS company.*

[5] *Productive use jobs are those created by the DRE end users themselves as a result of newly acquired or enhanced electricity access. For the purpose of this study, productive use is defined as any income-generating application of a DRE product or service. For example, the new jobs created by the purchase of a solar milling plant.*

3. In 2018, SELCO Foundation India study reported that there was an additional value chain created ranging from 20%–400%, for 1,500 standalone SHS users in 50 livelihood areas.

Women and Youth Participation in DRE

1. Women make up 25% of workforce.
2. There is a higher representation of women in the pico-solar and SHS companies as informal workers. However, gender bias is still prevalent.
3. Youth participation in the direct, formal DRE workforce is as high as 44%.
4. Direct engagement with formal education can improve youth participation.
5. Suryamitra has certified 20,000 young electricians in the country.

Indirect Jobs

Sector Services: These services include awareness and consumer education programmes, software, metering, consultancy, research and advocacy, etc. In India, with every 1000 DRE products sold, three related jobs in education and consumer awareness are required. And for every 1 MW of DRE products installed or operated, five jobs are needed in advocacy, education, and research.

Retention and Level of Engagement

There is a higher retention time span in DRE end-user product providers and mini-grid operators. In addition, these organizations also provide more full-time opportunities that offer better job stability.

Compensation Levels

DRE wages are higher than the national median level wage.

Job Type and Function

1. A majority of the DRE jobs are skilled, with an International Standard Classification of Occupation (ISCO) skill level greater than or equal to 3.

2. One-third of the DRE labour force is engaged in sales and distribution, predominantly serving the pico-solar appliances and SHS market.
3. 15% of the DRE jobs are in management and business administration.

Gaps in Recruitment

1. Business and managerial talents represent the main skills gap in India. These are the skills that are reportedly most difficult to recruit for.
2. Limited talent pool and lack of experiences are some of the main recruitment challenges that the industry faces.
3. Concerns over the quality of existing training programmes, different curricula and level of accreditation persist.
4. There is a gap of information about existing training services. Such a gap makes it challenging for companies to know where to source trained technicians.

Recommendations

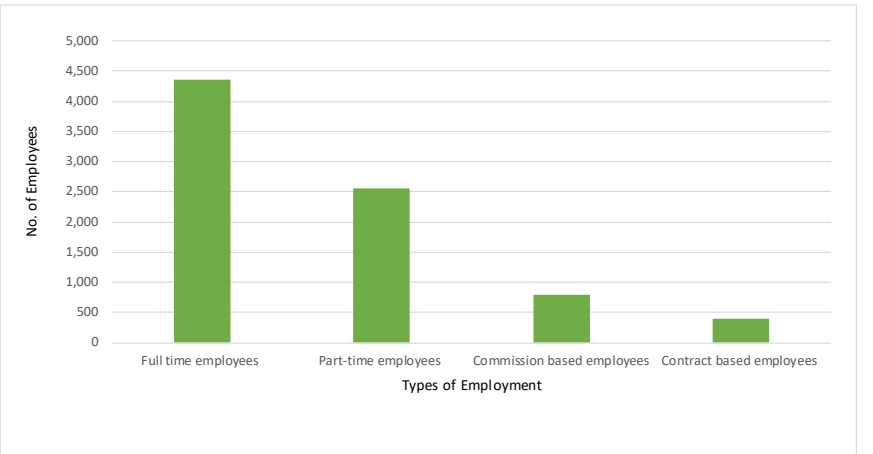
The recommendations of the report for a stronger DRE workforce are listed below.

1. Developing a standardized, accredited, industry-relevant curricula through stronger collaboration between government, industry, and academia will be a helpful resource.
2. Promotion of soft skills and rural micro-enterprise training helps close the skills gap.
3. Proper recruitment channels and improved recruitment policies can lead a growth in youth employment in the sector.
4. Greater participation of women is required.
5. Formalization of informal labour with decent local and international standards will help ensure job security and social protection.

1.3.2 CLEAN survey and analysis on employment

Figure 1.8 shows the break-up of full time[6], part time[7], commission based[8] and contract based[9] employees hired by CLEAN member enterprises. Full-time jobs account for 4,354 jobs and part-time for 2,556 jobs. Commission and contrat-based employees form a much smaller share in comparison. Out the enterprises surveyed 40% have reported of that they have women working in their organization.

Figure 1.8 *Employment generated by CLEAN members*



Sample Size-42. Source: CLEAN Survey and Analysis, 2019

1.3.3 Outreach of DRE Enterprises

More than 43 lakh consumers are being served by the 42 enterprises surveyed. This mainly includes rural households, beneficiaries of productive applications, and commercial consumers. The enterprises have been instrumental in providing electricity and clean cooking solutions to such a large customer base.

[6] *A full-time employee is on the payroll with a registered company, enjoys benefits as an employee, and works full-time hours, which is generally more than 35 hours per week, but may differ according to company policy.*

[7] *A part time employee is on the payroll with a registered company but does not work full-time hours, which is defined according to company policy.*

[8] *A commission-based employee is given paid a sum of money upon completion of a task. This task usually comprises of selling a certain amount of goods or services. They are not on the payroll of the registered company*

[9] *A contract-based employee is hired for a specific job at a specific rate of pay. She or he does not become a regular addition to the staff.*

1.4 Technology

1.4.1 Necessary Standards and Specifications to Support DRE Technologies

Low-quality products and after-supply services have always been the concerns of DRE consumers. It is important to certify the DRE technologies and applications to ensure good products are provided to the consumers. The enterprises have largely agreed to have authoritative bodies to certify their products. The certificate should also be required to be submitted to the banks so that they provide loans to end consumers.

Focus on product quality is required as there are solar lighting products of varying levels of quality in the market today. Many of these products do not meet any quality standards. A focus on internationally recognized quality assurance frameworks[10] can protect end consumers, push manufacturers to design products that are safe and durable and help build a globally competitive market of high-performing products.

1.4.2 Cookstove R&D Testing Facility by CSIR-NEERI

In recent years, various clean cookstove developers have emerged in the market. Despite the existence of clean cookstoves in the market, their performance needs to be studied and evaluated on several technical parameters.

The aim is to inform cookstove manufacturers about their cookstove emissions and energy efficiency and help them in the development of cleaner sustainable cooking technologies. Providing information on emissions and energy efficiency of various cookstoves will also enable the end-users to make informed buying decisions based on comparative performance benchmarks.

CLEAN promotes improved clean cooking stoves to mitigate economic, environmental, and social implications of conventional cookstoves. With a vision to ensure their universal access, CLEAN, in collaboration with CSIR-NEERI, has come up with a 'Cookstove R&D Testing Facility' for its practitioners.

[10] *https://webstore.iec.ch/publication/59747*

After completing a few formalities, practitioners can dispatch cookstoves to CSIR-NEERI, Nagpur, for laboratory testing and can get the results within 15–20 days.

The testing is performed strictly as per the BIS protocol for PM2.5, CO, CO_2 and thermal efficiency. Once the R&D results meet the benchmark, the concerned clean cooking practitioner gets test report certified by CSIR-NEERI CLEAN certified for complying with the improved cooking energy standards.

(The R&D results are provided for information and R&D purpose. These cannot be used as a certificate from CSIR-NEERI of BIS compliance.)

1.4.2.1 Roadmap for DC Applications

With the rise in demand for DC micro-grid applications, an attempt is being made to develop a sector outlook map for DC mini-grid applications through a consultative process for which a Working Group (WG) was formed by the Bureau of Indian Standards (BIS).

1. India has a growing appetite for DC devices.
2. DC power system is not a new technology in the country or globally.
3. Owing to supply reliability and power quality issues (such as voltage fluctuation), DC power system has relevance even though India has attained universal electrification. This mandates the need for identification of opportunities for scaling-up DC power supply system.

The broad objectives of the working group includes.

- To develop a roadmap for the expansion of DC power systems in India
- To identify DC applications and appliances for which standardization is important

RECOMMENDATIONS

- Standardization of products is essential to ensure that end-users get access to high-quality equipment, which has a good life and is safe to use. Therefore, all device manufacturers should be encouraged that their devices are compatible with BIS standards of DC supply (i.e. 48 V)

The Working Group proposed the following definition of timeframes for prioritization of standards development:

Short term (less than one year)	DC Tube Light (including standardization of its length), DC Bulb, BLDC Ceiling Fan, Pedestal Fan/Table Fan, DC-DC Adaptors, Mobile Charger, Plugs and Sockets, DC MCB, Fuse, Isolators, Cables Energy Meter, Televisions, Set Top Box for TV, DC Water Pump
Medium term (1–3 years	DC Cooler/Refrigerator, DC Mixer-Grinder, Air-conditioners, Computer and Monitor, Deep Freezer
Long term (>3 years)	DC Motor, DC Machines for productive use such as spinning (charkha), weaving/looms, agro-processing, etc.

The above table can be viewed as a recommendation for developing standardized products limiting idiosyncrasies in the implementation of DC mini-grid applications.

- Further, to push the market for DC appliances, an enabling environment will be necessary. This will require interventions from businesses, research institutions, financial institutions, and government agencies. The businesses and research institutions may focus on areas such as improving product design, the energy efficiency of products, reduction of manufacturing and retail costs and expansion of supply chain networks. At the same time, financial institutions may support innovation by facilitating access to low-cost finance to small players that have the potential to develop disruptive products and appliances.

It is understood that DC appliances would exist and expand, due to their efficiency gains, even though AC grids are more popular currently. To adequately promote DC power systems, standardization of both – line voltage and key components such as plugs/sockets/safety devices – is important, as well as developing the ecosystem for responsive post-installation maintenance network and services.

1.5 Concluding Remarks

The sector is currently undergoing an energy transition and it is unclear yet as to what is at the end of the tunnel. Tailor-made conducive policies are the need of the hour to steer the transition in a positive direction.

With previously energy-starved regions getting access to electricity, their energy aspirations are growing. DRE enterprises have augmented this

need by providing innovative solutions to fulfil these requirements as reliability remains a challenge.

A lot remains to be done to fulfil the financial requirements of the enterprises. Both practitioners and financiers have put forth their requirements. Engaging conversations with both enterprises and financial organizations are required to reach a consensus on the determining factors of viable business models.

DRE enterprises have played an active role in generating livelihood, employment, and micro entrepreneurs. They have played a key role in providing skilled training to women and enabling them to earn a respectable income.

On the technology side, there has been a rise in community-based business models and technology innovations that generate revenue and increase productivity. It is important to ensure that products in the DRE sector adhere to standards and benchmarks of authorised bodies. It is equally important to get it certified to maintain quality assurance to the consumers. Reliable post sales services are required to protect the end consumers as well as help build market of high performing products.

Overall, there is complete acknowledgement from all stakeholders of the potential that the DRE sector holds. At the same time, optimal utilization of this potential is the key for which the sector looks forward to the right kind of support.

CASE STUDY 1

Biogas-based Cooking Grid - Gram Oorja

Villagers in Dhopeshwar, Pune, did not have access to modern facilities due to its remoteness. For instance, to procure LPG, they would have to travel to Aurangabad, which is about 16 km away. To make matters worse, firewood was not available. That left the villagers with the only option of using agri-based biomass for cooking.

To address this problem, Gram Oorja constructed 'Biogas cooking grid' at Dhopeshwar wadi. This biogas plant is operated with cattle dung as feeding material. The village community has more than 250 cattle, producing over 2 tonnes of cattle dung.

Piped biogas is provided to each household. GI pipe and fittings were used for internal fittings at user ends. Regulator, flowmeter, and different valves were fitted as part of internal gas fittings. Biogas burner was also provided to each beneficiary. Distribution grid of about 1200 metres has been laid down in the village. Gram Oorja also estimated the usage of biogas to be in the range of 1.0–1.2 cubic metres per day per family. So far, 130 households and one primary school have been connected to the grid. The Village Energy Committee (VEC), established by Gram Oorja, maintains billing and controls daily operations.

This case study establishes that fact a biogas-based cooking grid model using firewood can be effectively used by any community in India, especially in remote places where LPG cylinders cannot be reached easily.

CASE STUDY 2

Bijlee Boqx: Going Beyond Basic Access - Bombay Bijlee

Bombay Bijlee's Bijlee Boqx allowes rural households to have access to off-grid electricity.

Bijlee Boqx is an IoT-based (Internet of Things-based) smart solar energy harvester, storage, and delivery device. It consists of a 75-watt solar panel, a TV and set-top box, and 3 LED bulbs. The television set is made in-house, from refurbished e-waste of old desktop monitors.

Along with a sustainable solution, the innovative technology also includes Pay-As-You-Go model for a more fluid and easy purchase of appliances. It also comes with self-diagnostic hardware and back-end cloud software system, which detects any fault in the system and automatically sends an alert to the local representative technician.

Usage pattern and battery is also monitored to scale the power back-up of the system without over-sizing the system thus saving rural customers' money.

Impact

- A reduction of INR 108,000 in customers' expenditure on kerosene/ year
- 3000 kg annual reduction in CO2 emissions
- 1000 hours of clean electricity supplied

CASE STUDY 3

SolBox: An Innovative Approach to Reliability - SolShare

Due to the national grid in Bangladesh constantly being overloaded, SolShare has designed a platform with 48,000 PV capacity (Wp) that interconnects users with and without solar home systems to a smart direct-current grid.

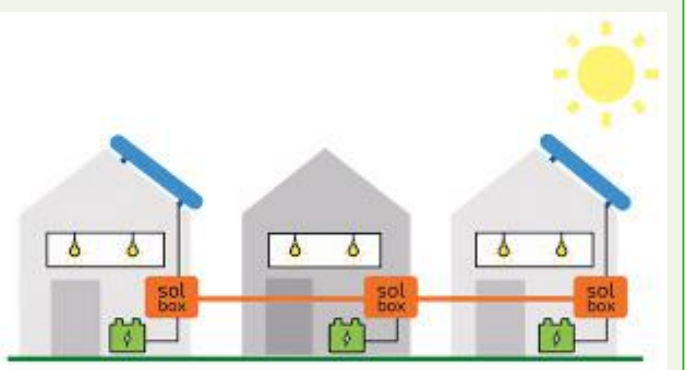
Using SOLBoxes based on Internet of Things (IoT) (bidirectional smart energy meters), households are connected to each other (with or without sources of power). It creates a peer-to-peer marketplace where households can sell their excess, unused energy within the micro grids to households that do not have access to electricity or during peak demand hours.

SolShare has developed SolBazaar, an IoT-driven trading platform, which enables people to trade the excess solar energy generated by solar home systems. SolBazaar acts as a marketplace where SHS users (solar home system users) come to sell their excess energy to non-SHS users, or people who cannot afford such a home system.

SolShare's primary objective is to provide rural-end consumers with a reliable supply of electricity while making sure it is affordable for people who are even at the lowest echelon of the society.

Impact

- 2570 lives impacted
- INR 96,668 saved/year
- 1756 litres of diesel saved/year
- 4902 kg of CO_2 saved/year



CASE STUDY 4

Bioenergy-powered Cold Storage System - GreenChill

India ranks second globally in the production of fruits and vegetables and is expecting an increase in demand of fruits by 228% and vegetables by 95% by the year 2050. As of today, post-harvest losses of such perishable farm products have been estimated to be as high as INR 92,651 crore per annum. Out of this, losses due to poor storage facilities amount to nearly INR 63,000 crore per annum.

GreenChill is an off-grid, compressor-free, environment-friendly biowaste-powered cold storage system. It uses renewable energy sources like biomass pellets/ briquettes, rice husk, hay, bagasse, bamboo, coconut shells, waste wood, biogas or any other farm waste to power the system. The running and maintenance expense of a cold storage, pre-cooler, ripening chamber, and bulk milk cooler is lower as compared to either a grid-connected or a one that is connected to diesel generating set.

GreenChill's cold storage system can be installed at the village or farm level. Storing perishable farm products is this system before transporting the products to a market or to a processing facility saves tonnes of perishable agriculture commodities. This cost-efficient technology is suitable for the agricultural sector of India.

Impact

- INR 600,000 average diesel/electricity saving per year/15 million tonnes (MT).
- More than 3500 MT of fruits and vegetables and 520 MT of fishes were saved by 15 GreenChill installations in the year 2017/18.
- Zero carbon footprint.
- Four full time jobs created with every installation.

CASE STUDY 5

Enabling Zero Waste Kitchens - Vaayu-Mitra

India generates over 150,000 tonnes of municipal solid waste per day. Only 83% of waste is collected and less than 30% is treated.1 According to a World Bank Report, India's daily waste generation will reach 377,000 tonnes by 2025.2

Vaayu-Mitra has come up with an innovative solution, Vaayu, which enables zero waste kitchens. Vaayu consists of biogas generator, biogas storage balloon, and a gas stove. Methanogens are used to convert carbohydrates in organic waste into methane gas, which is stored in a balloon. This is taken to a kitchen to light the biogas burner. The cooking experience is the same as that of a regular LPG or piped CNG.

The food waste can be put in the feeder as it is and does not need to be crushed. It requires zero running energy and no civil construction materials. It can be installed at home in less than two hours and is easy to maintain. Constant pressure in the storage balloon ensures constant flame. The contracting and expanding balloon gives visual feedback of how much gas is available. It is designed in a way that it can easily fit into a balcony, terrace or garden. In multi-storied building societies, it can be set up on the terrace and behind every 15–20 families, one family can cook completely on biogas. Waste is not a problem. It can replace five per cent of LPG usage in housing societies by a renewable fuel.

The solution comes in 2 kg and 5 kg per day modules. The enterprise also offers customised solutions for commercial kitchens. So far, a total of 170 installations have been made, which includes installation in 10 cities and 7 villages across the state of Maharashtra.

Impact

- 1.2 tonnes of waste managed per day
- 1,000 LPG cylinders saved per year
- 30 tonnes of CO_2 emissions prevented per year

Sources:

1. *Business Sustainability in Asia – Compliance, Performance, and Integrated Reporting and Assurance. Gaoguang Zhou, Judy Tsui, Peter Cheng, and Zabihollah Rezaee*
2. *http://siteresources.worldbank.org/INTURBANDEVELOPMENT/Resources/336387-1334852610766/AnnexJ.pdf*

CASE STUDY 6

Energy Storage Systems - Delectrik

Inability to store energy in a cost-efficient way and sustain is a problem faced by most of the industries. Delectrik has developed an energy storage system based on vanadium–redox flow battery chemistry.

The system is sustainable and suitable for commercial, industrial, and utility-scale applications, both on- and off-grid. The advantage of this system is that it directly mitigates the problem of gassing associated with lead–acid batteries, thereby making it a non-toxic, environment-friendly invention. Gassing of the battery leads to safety problems and to water loss from the electrolytes. It has a long shelf life with high temperature tolerance. The scale of the system used ranges from kWh to MWh.

Delectrik's products, when combined with renewables, provides 24×7 clean energy thereby making them climate-friendly. Individuals, communities, and businesses can immensely benefit from these products.

Expected Impact

- Cutting down the GHG emissions caused by lead–acid batteries during disposal
- Longer shelf life of batteries
- Cost comparable with lead–acid batteries

CASE STUDY 7

Kinetic Energy Powered Basrsha Pumps for Irrigation - aQysta

Agriculture is a major source of income for most rural households. However, due to lack of technology and energy access, people are forced to work for more than 10 hours a day to make ends meet.

The Barsha Pump, developed by Netherlands-based aQysta, is a low-cost solution for small and medium-sized farmers to irrigate their fields without the use of fuel or electricity. The system uses the kinetic energy of flowing rivers to pump water onto nearby farmlands.

Depending upon the soil, crop, climatic conditions, and irrigation technique, one Barsha Pump can irrigate up to 2 hectares of land, making it an effective product for agriculture-dependent households.

Using the EASI-Pay project, an initiative of aQysta, 21 Barsha pumps have been sold and installed in Nepal.

Impact

- Irrigation time reduced by half
- increased area of cultivable land by 0.3 hectares
- 100 tonnes of CO_2 emissions reduced

A Barsha Pump in operation

CASE STUDY 8

Solar-assisted Handlooms for Traditional Weaving - Resham Sutra

Thigh-reeling, the traditional process of reeling silk from cocoons and producing thread, is a physically demanding and undignified process. Workers, mostly rural women, struggle to produce silk in large volumes and make a good living, and their health suffers too. They also lack the resources and negotiating power to market their products or grow their business.

Resham Sutra has developed a range of affordable electric reeling machines. Many of them are powered by solar energy. These machines vastly improve the working conditions and create a predictable, dramatically higher income for over 9,000 silk workers.

Resham Sutra has silk weaving co-operatives operating in the districts of Assam, Chhattisgarh, Jharkhand, and Odisha. From teaching the women to operate the machines, these co-operatives provide training to them in weaving, yarn reeling and spinning of silk, besides enabling financial linkages for user groups.

The machines have resulted in a reduction in drudgery and improved income for users.

Resham Sutra recognises that technology is only part of what is needed to give poor rural people a better life. A holistic support system is put in place for their customers, which helps them access raw material and find markets for their products. This system draws on Resham Sutra's strong network within the textile industry, which includes cocoon producers, retailers, and India's Central Silk Board.

Impact

- 200% increase in productivity and annual income
- 10,200 machines installed
- 40,000 lives impacted
- 46 technicians trained
- INR 100 million income generated through the usage of solar- powered machines and looms

DRE MARKET

2

CHAPTER

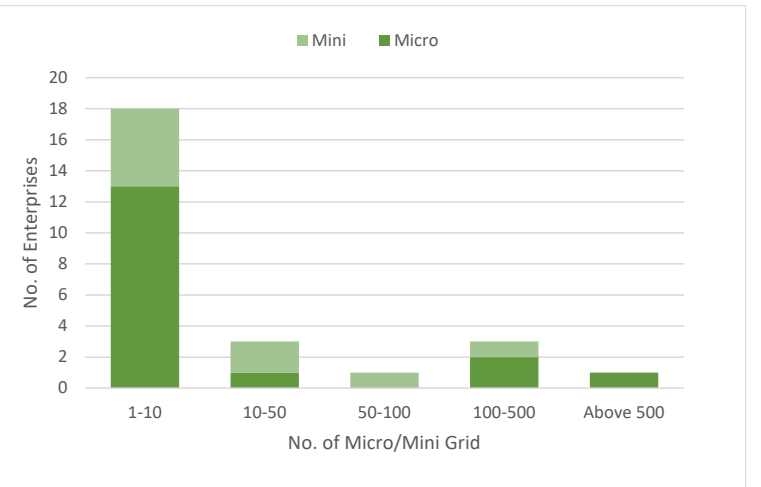
2. DRE Market

This chapter provides an overview of the key factors that drive the DRE market deployment of DRE technologies, investments, market size, challenges and opportunities, emerging markets of interest, threats and opportunities, and enterprise perspectives on the future of the DRE market.

2.1 Deployment of DRE Technologies

To provide an overview of the DRE market, the figures presented below highlight the deployment of DRE technologies by the members surveyed. Given the limited size of the sample, this is not an exhaustive overview of the market but it can give the reader a basic idea about the market.

FIGURE 2.1 *Deployment of solar micro-/mini-grid technologies*



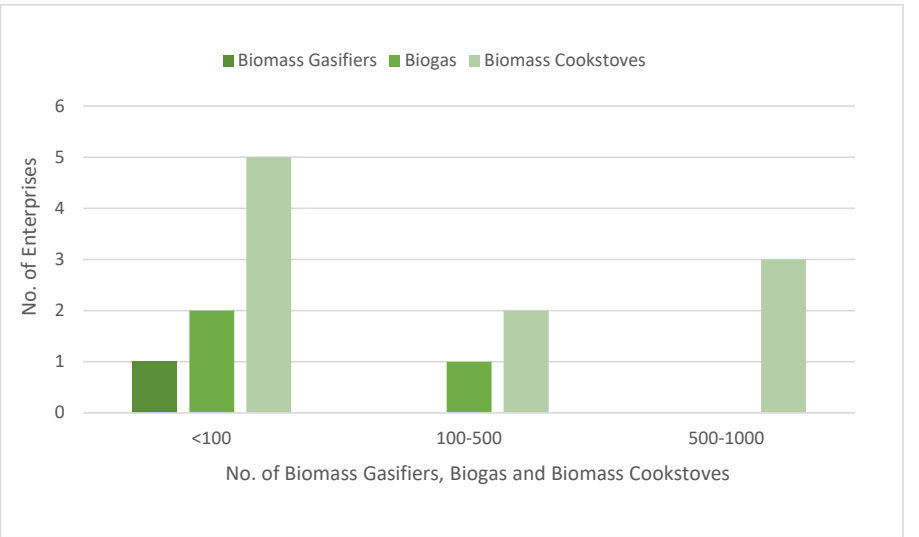
Sample Size-20. Source: CLEAN Survey and Analysis, 2019

As Figure 2.1 shows, there are very few mini-grid players who have deployed large number of mini grids in the recent years. This may be due to increased penetration of grid connectivity initiatives of the government.

Discoms may adopt a franchisee model for its retail business in rural areas and stipulate a minimum level of performance parameters, including the use of decentralized generation sources and storage systems for local

reliability and resilience.[1] In the survey, the mini-grid operators expressed their desire to have a comprehensive mini-grid policy, which outlines the role of mini-grid operators in partnership with the local discom.

FIGURE 2.2 *Deployment of biomass and biogas technologies*

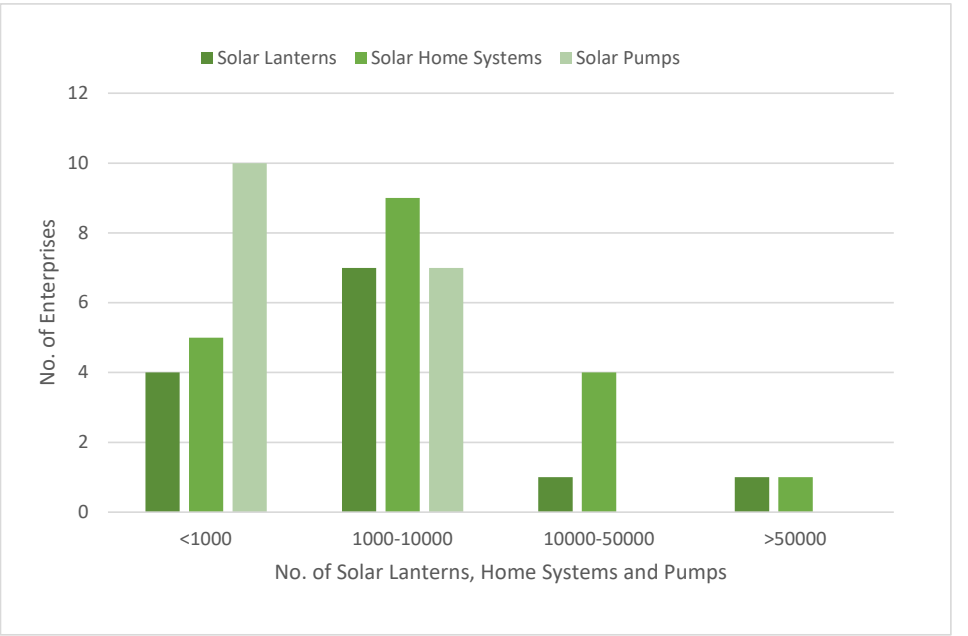


Sample Size-12. Source: CLEAN Survey and Analysis, 2019

In the bioenergy segment, among the enterprises surveyed, there are very few enterprises that have deployed large number of biomass gasifiers or biogas plants. Also, there are only a few key players who are able to sell their improved biomass cookstoves in large numbers.The members surveyed stated that the numbers have gone down due to distribution of LPG cylinders. At the same time, the enterprises in this segment also see an opportunity in areas where traditional chulhas are still in use.

1 NITI Aayog, 2018. Strategy for New India @ 75. New Delhi.

FIGURE 2.3 *Deployment of solar lanterns, solar home systems, and solar pumps*



Sample Size - 13, 19, and 17 enterprises for solar lanterns, solar home systems, and solar pumps, respectively. Source: CLEAN Survey and Analysis, 2019.

DRE enterprises have been successful in providing basic clean energy solutions like solar lanterns and solar home systems (Figure 2.3). This has been instrumental in achieving the energy access goal of the country. The policies and schemes around solar pumps are maturing and there is scope of growth under KUSUM. 17.5 Lakh standalone solar powered pumps are set to be deployed under the scheme. However, the main challenge as highlighted by the members surveyed indicates that the eligibility criteria for participation of firms in the KUSUM tenders has not provided equal space for early stage start-ups.

2.2 Solar Lamps and Lanterns Market in India

Almost 10 million solar lamps and lanterns were sold in India in the calendar years 2017 and 2018, up from 6.38 million in 2016. This is nearly 40% of the estimated global market for solar lighting solutions.[2] This sales estimate is based on imports, plus domestic manufacturing, less exports. While there is no reliable data on units manufactured in India, sector experts

2 *Off-Grid Solar Market trends report, Lighting Global International Finance Corporation, January 2019*

estimate this to be in the range of 2.5–3.0 million units per year. Data on import and export are sourced from the website of the Department of Commerce, Government of India. The volume of imported solar lamps and lanterns increased by almost 86% in 2017 (7.61 million units) over 2016 (4.09 million). However, it came down to 7.34 million in 2018. During April to June 2019, 2.5 million units were imported, which, if extrapolated over a 12-month period, surpasses the imports of 2017 and 2018 by a wide margin. Exports of these products from India remain low with only 0.09 million units exported in 2018 and 0.06 in 2017. (Source: This data and the related analysis has been shared by the Lighting Asia/India Program, International Finance Corporation).

2.3 Challenges and Opportunities

Within the DRE sector, there are different types of technology and product specializations that practitioners work in. Table 1 below highlights challenges faced by practitioners and their plan to cope with these challenges and the resulting opportunities that arose from the solutions.

TABLE 2.1. Strengths, challenges, and opportunities in the DRE sector

Table 2.1a. *Solar applications*

Challenge	Plan	Linkages	Opportunities
Advertising and other human resources costs	Follow a business to business model (B2B)	Other businesses	Increased profits and reduced expenditure
System tampering	Customer training programmes	Customers	Educated customers and increase in customer base
Improving the Build-Own-Operate-Maintain model	Layered model with last-mile users being taken care of by operators who have a stake in the business	Operators	Tapping into last-mile potential

Table 2.1b. *Solar micro/mini grids*

Challenge	Plan	Linkages	Opportunities
No national- or state-level mini-grid policy	Continue providing scalable path for rural consumers to ascend the energy ladder at a pace dictated by their needs and affordability	Local bodies	Reliable and quality energy services enabling improved livelihood, entrepreneurship, education, health, and entertainment
Lack of skilled labour at the local level	Develop special skills in-house to educate community and create market linkages	Community education and subsequent expansion of customer base	Helping communities produce and market value-added organic products

Table 2.1c. *Bioenergy: biomass gasifiers, biogas, improved biomass cookstoves*

Challenges	Plan	Linkages	Opportunities
Awareness is the biggest gap	Create awareness of biogas as livelihood generating model. Not only cooking. Swacch Bharat and Swacch Sarvekshan have been positive boost	Partnerships with local bodies. Both urban and rural.	Biogas as livelihoods and savings opportunities at homes, hotels, restaurants, dhabas, etc.
	Rural promotions	Local farmers	Increased interest of individuals and a subsequent increase in sales
Marketing products to target customers	Adopting a marketing model of offering commissions to local technicians who work with the target customer base	Local technicians	Increase in customer base
Decrease in biogas prices	Purchase livestock waste at lower rates than before and sell by-products of a biogas plant to the same community	Local community	Investments can be taken from the local community as well so that they can have ownership of the plant and share profits and liabilities

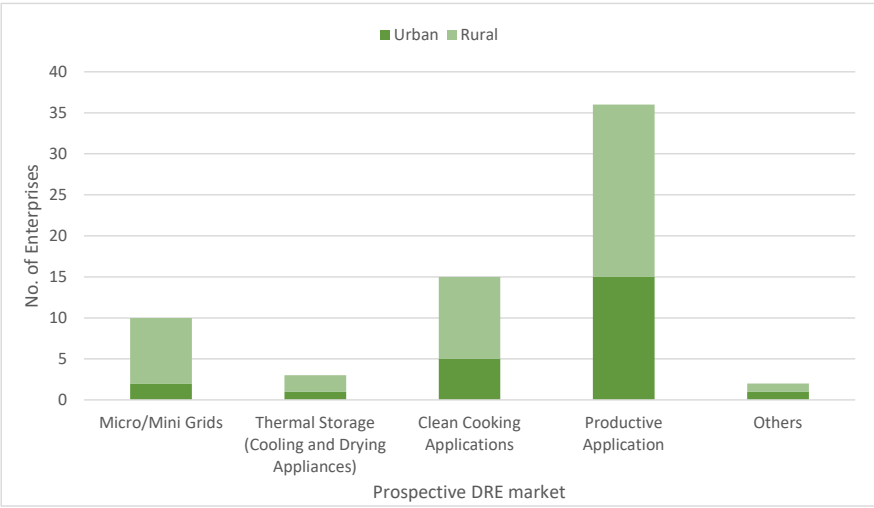
Table 2.1d. *Pico hydro*

Challenges	Plan	Linkages	Opportunities
Low awareness about hydro pumps	Working with local distribution partners with the incentive of increasing their market knowledge and providing them with marketing and technical support	Distribution partners	Increased level of customer awareness and interest in products

2.4 New Markets

Figure 2.4 highlights the types of new operations that CLEAN members have begun in 2018/19. A division has been made between urban and rural to outline that the scope of DRE applications is not limited to the rural areas. It was observed that DRE enterprises have an increased interest in expanding operations to urban areas too.

FIGURE 2.4 *New markets*



Note: A single enterprise could have selected both urban and rural options. Sample Size - 42. Source: CLEAN Survey and Analysis

Strengths and Opportunities

Strengths

- Market changes have enabled an increase in system sizing and a greater demand.
- Diversification of the agri-based and non-agri-based load mix in the villages to address seasonality and optimize revenue realization.
- Promoting user-friendly models, creating awareness about the system's potential and risks and provision of advisory services available to farmers and other end users.

Opportunities

- The market is moving towards providing energy for productive use and so are enterprises.
- Grid engagement will lead to an increase in consumer base and savings for rural customers.
- Enterprises are foreseeing to increase diversification in their product offerings.

Source:CLEAN Survey and Analysis, 2019

In the second edition of the State of the Sector report, CLEAN had estimated the market potential of the DRE sector in India to be in the range of USD 100 billion. With the market moving from access to development, it is anticipated that the market segments for (a) livelihood and productive applications, (b) DC energy-efficient appliances, (c) clean cooking solu-

tions and innovative technologies, etc. will support the growth of the DRE sector in the coming years.

What could also trigger the growth in the sector are the following two factors:

1. An increased interest among enterprises in the opportunities thrown by the rural sector in agriculture and non-agriculture-related activities.

2. Enterprises getting attracted to the potential that exists in the commercial and residential sectors in the urban and rural areas.

2.5 Threat and Opportunity

2.5.1 Grid Extension

With the expansion of national grid by the Government of India under the Saubhagya scheme, enterprises are transitioning towards productive loads and applications for customers who now have access to grid electricity. Enterprises are attempting to change their models by offering productive loads that can also be powered by the grid. They are also manufacturing products that are interoperable by AC and DC to meet the needs of customers as their expectations are now anchored on grid quality.

The needs of the people have shifted from 'access' to 'reliability and productivity'. In this context, productive use of energy and reliable energy service have become the key areas of focus for institutions offering such services related to health, education, and various other public services.

Improved grid availability has led to habituating previously energy-starved users to the uses of electricity. It has turned the latent demand into a challenge and uncovered the real cost of reliable energy access through metering.

With the changed scenario, enterprises, today, look forward to interacting with the national grid and acting as franchisee partners. They can lend their available customer services to DISCOMs to create a situation beneficial for both.

The obvious advantage for a DRE enterprise that works with the grid is that it enables them to increase its customer base, resulting in increased savings for rural customers.

While many enterprises have remained positive in their outlook towards grid expansion, they have raised a few challenges also.

Enterprises face difficulty in competing with subsidized grid tariffs due to high levelized cost of electricity. This raises the need for viable gap funding as they feel that DRE can be a good catalyst for local economic development in areas where grid connectivity is still weak.

2.5.2 LPG Distribution

Enterprises that provide clean cooking solutions such improved cook-stoves (ICS) and biogas plants neither see LPG distribution completely as a threat nor as an opportunity. It has been seen that the sale of ICS in general has gone down. However, there are still villages using traditional chulhas that offer an opportunity. The unavailability of biomass fuel can be an area of attention and a new business opportunity for enterprises. With these factors in the background, the focus of enterprises has shifted more towards areas with less or low penetration of LPG.

The enterprises are not enthusiastic about the state of the bioenergy sector given the existing government policies. Therefore, they are focused more towards driving their agenda through private investments. If the end users get financial support (loan to buy gasifier/clean combustion systems), clean cooking sector can experience fairly good growth.

Remarks by some of the biogas enterprises point out that they were not much affected by LPG distribution because the market rate of biofuel is only one-third of that for LPG. Community biogas plant is also a model where practitioners have all types of products and by-products for the community. It also instills an ownership sentiment, which results in keeping it well maintained and utilize it to its full potential.

On the other hand, lack of a level playing field for ICS as compared to LPG is a concern raised by enterprises that manufacture and service clean cooking devices. There is a lot of subsidy and investment going into LPG, which is missing in the ICS. To overcome this, enterprises are trying hard to increase their sales territories and push ICS into smaller towns.

The sector seems to be facing some crisis and demands some hand-holding and upliftment because there is strong consensus about its relevance and the impact it can create for society at large.

2.6 Members' Perspective on the Future of DRE Market

From the survey it was observed that practitioners believe that increasing awareness about the DRE products and markets among customers, financial entities, and policy-makers will be crucial for the whole sector to have a healthy future. With grid connectivity and reliability still being a challenge at the grassroots level, there could be an increased demand for DRE projects in these regions.

CLEAN members are of the opinion that the market has shifted from basic energy at household level to productive loads, diversification in productive use devices, and new distribution models.

Some members are keen on entering newer markets such as health and education. DC energy-efficient appliances such as fans, mixers, refrigerators, and livelihood applications are an emerging area of interest among DRE practitioners.

In order to make the business profitable, enterprises believe that there must be enhancement of incomes in communities through productive uses of electricity. This would enable them to purchase appliances and, in turn, add to the total demand.

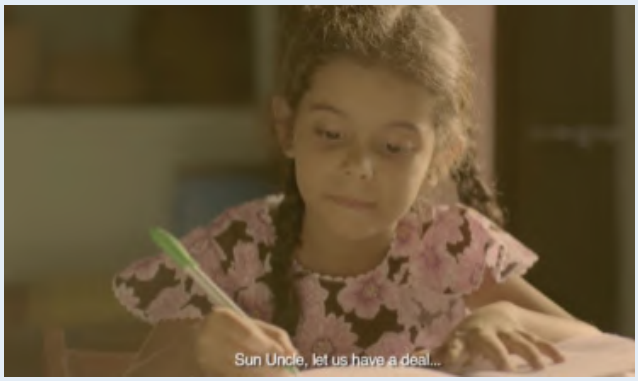
Members look forward to collaborating with government agencies and private sector organizations to expand their businesses and enter new markets and states.

CLEAN members are of the view that flexible business models and innovative solutions are two crucial factors for enterprises to be commercially viable. Additionally, to have a bright future, active support from the government and an increase in private investment are a must.

2.7 Concluding Remarks

With the recent developments in the renewable energy sector and the government initiatives to support the sector, there have been behavioural changes at the consumers' end with the latent demand of energy turning into an active demand.

IFC Consumer Awareness Campaign



Consumer education spurs product demand by creating awareness of modern solar lighting products, their functionality, benefits and advantages over the widely used kerosene and candle lighting. Lighting Asia/India works with product manufacturers and distributors to design and run experiential consumer education campaigns that introduce and showcase modern, durable solar lighting products to rural consumers.

In 2014/15, Lighting Asia/India implemented the Suryoday (meaning 'Sunrise') consumer education campaign in 9370 villages across 31 districts in Bihar, Uttar Pradesh, and Rajasthan. The campaign reached more than 200,000 people comprising men, women, children, and retailers across these. It reached rural consumers in these states through a 360-degree, integrated media approach using traditional and non-traditional media.

This included outreach through mobile van exhibitions, school contact programme, community contact programme, women group meetings, wall paintings, radio announcements, an audio-visual film: 'Suraj ki gullak' (https://youtu.be/xJI55OW50ig), a call centre, and a retail connect programme to increase rural access through a wider network of retailers. Consumers also had access to a dark room where they could experience the difference in quality and light output between kerosene and solar lighting[3]. A follow-up campaign is planned to be launched in October 2019 in Uttar Pradesh, Bihar, and Odisha to begin with; and then to include Assam and Rajasthan also.

This has resulted in the opening of more avenues for the sector. The increased customer demand requires an increase in average system size to fulfil the needs of productive load consumers.

This is the time for businesses to move from 'Access' to 'Reliability'. For turning the above opportunities into success, businesses will have to address their present concerns such as availability of finance, energy storage, R&D, and partnerships and collaborations.

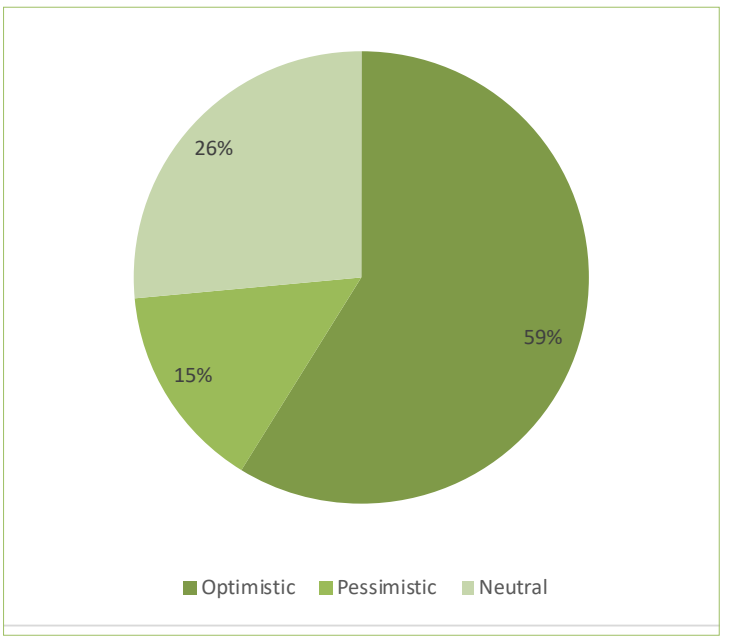
The DRE practitioners can address a few of these challenges by opting for community-based models and working with self-help groups (SHGs,) which may be lucrative for other stakeholders too.

3 *(For further details, please visit http://lightingasia.org/india/consumer-awareness).*

The sector should also tap the newer segments of customers demanding high value and customized products. Biomass cookstoves and hydro pumps are a couple of examples in this regard. For further expansion, skilling of operators, marketing of products, and educating customers would be of great value. There is opportunity for strengthening women's contribution too from remote areas, rural areas, and semi-urban places to become distributers under the sector.

In this context, the outlook of CLEAN enterprises has been captured in Figure 2.5.

FIGURE 2.5 *The outlook of the DRE sector as expressed by enterprises in the wake of recent government initiatives*



Sample Size -34 Source : CLEAN Survey and Analysis, 2019

CASE STUDY 9

Creating Women Micro-Entrepreneurs - Frontier Markets

Women seek an opportunity to generate meaningful incomes, earning respect from their families and the community. Frontier Markets has built a proven and scalable model with a network of 2,500 women entrepreneurs (Solar Sahelis). These entrepreneurs are trained in sales, marketing, technical repair, digitisation, data collection, and accessing smart phones to provide innovative solar solutions to sell to rural households.

A Solar Saheli is first selected through Frontier Markets' partnerships with local NGOs and well-established self-help-groups (SHGs) for women. There is one Saheli for each rural village, covering an average of 150 households. The Saheli reports directly to a Frontier Markets' trained Program Manager based at the block-level Branch Office, who oversees approximately 20–30 Sahelis.

Solar Sahelis have earned $2 million of income by capturing customer insights, and selling products such as solar torches, solar home systems, clean cookstoves, and renewable energy appliances to 600,000 agri households in Rajasthan. The community at large has become very knowledgeable about solar energy products and are educating their villages about solar power products.

Impact

- 500,000 households reached
- 5 million lives impacted
- 664,000 renewable energy products sold
- 2,500 micro entrepreneurs created

Solar Sahelis

CASE STUDY 10

Providing Basic Energy Access in Urban Slums

Thousands of people living in slums on the edges of India's major cities have no access to services that we would consider essential, such as electricity and clean water. The mission of Pollinate Group is to enable women to be changemakers by distributing products that improve health, save time, and save money for the world's most neglected communities.

Through its range of durable and quality products such as solar lights, solar fans, improved cookstoves, and water filters, Pollinate Group provides customers with services having affordable payment plans, and envisions energy access and women empowerment.

The solar lights, Sunking Pro and Sunking Pro2, sold, produce brighter and longer lasting light than the traditional kerosene lamps, creating safer environments and cutting down on carbon emissions. They also come with mobile chargers, enabling consumers to use it as a battery bank as well.

The business has helped about 120,000 people so far. Customers report a range of benefits, from brighter light around the home to it being easier for children to study at night. It is also helping to develop the skills of its local sales representatives and supporting the next generation of social entrepreneurs through a unique fellowship programme.

A beneficiary with Sunking Pro

Impact

- 17% more study time for children/day
- 11,800 tonnes of CO_2 saved each day
- 97,260 people impacted

CASE STUDY 11

Providing Digital Literacy to Rural Women - Dharma Life

Dharma Life through its unique entrepreneurship model provides people with potential the opportunity to earn a livelihood while driving change in their villages. These Dharma Life Entrepreneurs earn by conducting behavioural change activities in their communities. Moreover, they also earn by selling products of progress such as solar lamps, water purifiers, induction cookstoves, to name a few.

Dharma recruits people with basic education, who are in need of money and do not have a full-time job. We typically recruit subsistence farmers and women. Dharma imparts sales training to its recruits. They earn a monthly income of between INR 2000 and INR 8000 depending on their sales.

Dharma provides its recruits products that address rural needs. It sources these products from retail, FMCG and social enterprise companies. It then ships them to distribution points in a district where a local distributor (chosen by the company) and an enterprise leader (on the company's payroll) ensure that the goods reach the local entrepreneurs.

If a product fails to find traction among villagers, the entrepreneur returns the unsold items to Dharma, which bears the loss. To counter such failures – and there have been some in the past – the company has a mentoring programme: every week, an enterprise leader in the district visits members of his/her team to get feedback. It also conducts awareness drives.

Impact

- 5.3 million+ women trained in digital literacy
- 867,222 children reached with literacy campaigns
- 14,000+ livelihoods created
- INR 479 crore income generated in total

Entrepreneurs trained by Dharma Life

CASE STUDY 12

Creating Sakhis in Rural India - Solutions Using Renewable Energy (SURE)

Solutions Using Renewable Energy (SURE) provides women entrepreneurs with high-impact solutions such as solar lanterns, advanced smokeless cookstoves, water purifiers, and bio-agri inputs to enable positive impact on women's health. The training arm of the Sakhi initiative, Sakhi Social Enterprise Network, has trained Sakhis in entrepreneurship, and sales and marketing to create livelihood opportunities for the women entrepreneurs. SURE functions in five districts of Maharashtra, reaching over 50,000 families.

Impact

- SURE has reached over 250,000 households through 1250+ women entrepreneurs as of 2019
- Income growth of over 33% recorded annually per Sakhi.

Sakhis, women entrepreneurs, of Maharashtra

CASE STUDY 13

Solar Mini Grids: the Story of a Successful Community-based Model - Mlinda

Prior to the installation of mini grids by Mlinda, 32% households in Gumla district, Jharkhand, made use of the national grid as a primary source of lighting while the rest 68% depended on more expensive and hazardous fuels to meet their energy needs. However, the situation changed after the installation of a community-based solar mini grids in the locality.

Each mini grid has a capacity of 20–30 kWp equipped with remote monitoring and high-level lightning protection systems. The connected households are provided with smart prepaid meters.

Mlinda fosters local commercial activities in the farm and non-farm sectors by setting up oil expellers, cold stores, rice hullers, wheat mills, shops, non-farm manufacturing units, metal fabrication units, sewing machines, etc. The holistic vision of the electrification project has helped achieve financial, social, and environmental development in line with sustainable growth for the households and enterprises.

Impact*

- 806 tonnes of CO_2 reduction per year
- 4096 households reached (by August 2019)
- 23% average increase in household incomes
- 28% increase in micro-enterprise revenues
- 747 farm and non-farm devices powered through solar PV mini grids

**Independent study conducted by Sambodhi Research and Communications*

A community-based solar mini grid installed by Mlinda

CASE STUDY 14

Solar Branches: Making Banking Accessible in Rural India - E-Hands

Lack of reliable electricity, along with internet connectivity, is cited as one of the major obstacles for ease of access to financial services offered by banks in rural areas. Besides, mobile banking has not yet caught up in India. According to research, 'there is a fundamental mistrust in using phones or digital modes to transact, particularly in rural areas'.

To combat this, E-Hands has designed a 'solar branch', with SPV capacity ranging from 0.6 kW to 5 kW supported by a suitable battery bank. Many of these installations operate on 'off-grid' mode, running only on the energy drawn from clean energy. Installations also include the micro wind + SPV hybrid systems and small wind turbines of 1.3–2.3 metres rotor dia with 0.6–1.1 kW generation capacity, located at a wind regime of 4.5 m/s annual average wind speed, in Maharashtra, Tamil Nadu, and Karnataka.

E-Hands Energy, which began with a modest trial of powering four rural branches of a NBFC with wind/SPV hybrid in 2012, has now grown to run over 700 branches in 2019 on clean energy across 512 towns and villages.

Impact

- Affordable and clean energy access to 700 branches in 21 states
- 24 million financial transactions of over 1.4 million people

Solar Branch by E-Hands

CASE STUDY 15

Powering schools in remote Ladakh - Simpa Energy

With distances and inaccessible terrains leading to problems of access in Ladakh, solar technology has become an enabler of easier access to better education and energy.

Simpa's technical team came up with a customised solar off-grid power pack for each school. This off-grid power pack comprised a specially designed thermally insulated box that housed the battery and control circuitry. The solar panels and their installation structure were designed as per the outdoor conditions. A major emphasis was put on (a) modularity for ease of transport as most of the schools were so remote that material had to be transported by porters only, and (b) on ease of do-it-yourself through a plug and play design as trained personnel were not available for installation.

Impact

- 118 schools with solar-powered Computer Labs
- 7000 students impacted
- 500+ teachers trained to teach computers in Computer Labs

Computer Labs by Simpa

Solar Panels for Computer Labs

CASE STUDY 16

Smokeless Village: an Initiative - TIDE

Emissions from traditional cookstoves pose a big threat. According to an article published by WHO in May 2018, it is estimated that about 3.8 million people die prematurely in a year from illness attributable to household air pollution caused by the inefficient use of solid fuels and kerosene for cooking.

TIDE, a skills and training NGO based in Bengaluru, has been disseminating an improved-mud-based-cook-stove design with the help of its NGO partners in different remote locations throughout India. The improved cookstove aptly named 'Sarala Ole' is an easy-to-construct, two-pan natural draft stove, which eliminates indoor air pollution as it is fitted with a tubular chimney to vent out the smoke generated.

The smokeless village programme, pioneered by TIDE in Karnataka through rural women-entrepreneurship trainings, has now been spread all over the country as different NGOs have adopted it after undergoing TIDE's 5-day training programmes. Many NGOs working on broad themes such as forest rights, biomass conservation, rural livelihood generation, and species conservation have benefitted from this training by providing livelihood opportunities to its local populace during non-agriculture season.

Since 2005, TIDE has trained about 424 women on stove construction and has guided the construction of more than 42,982 stoves through its training programmes and direct supervision. The success of the stove dissemination model is attributed to the low cost of the stove (under Rs 1000/installation) and the extent of community participation in stove construction projects through contribution of primary material such as mud, bricks, sand, and water. About 70% of the cost of the stove is borne by the local NGO or the project funder.

As the basic features of the improved cookstove is akin to the traditional mud stove, the adaptability of the household cook to the newly built stove is faster and easier. Key features such as fuel-feed door, grates for primary air supply, ash removal port, chimney for venting out the smoke from combustion, and a design forged for higher heat transfer efficiency make it far superior to the traditional mud stove. These features help in saving more than 40% of firewood during operation compared to a conventional mud stove.

The average wood biomass in a single eucalyptus tree (a ubiquitous flora) after six years from planting is about 300–400 kg. If a village with 100 households is converted to use improved Sarala cookstove, it has the potential to save about 300–500 eucalyptus trees annually. The same 100 cookstoves can be projected to save about 4500–7500 eucalyptus trees from being cut for firewood during its lifetime.

TIDE's main achievement lies in the fact that it has transformed rural women into green-energy entrepreneurs, giving these women an independent source of livelihood. This has indeed helped them to improve their status in society as they contribute immensely to the local economy though newly gained livelihood skills.

Impact

- Firewood equivalent to 3–5 eucalyptus trees saved annually per stove
- Estimated 45–75 trees saved (in the 15-year life cycle) per stove
- 95% reduction in local emissions
- Mitigates 1.4–2.0 tonnes of CO_2 saved annually

Beneficiaries with the Sarala Stove by TIDE

1 *Source – the impact data was collected from 15 installations in 5 states by an independent surveyor*
2 *As on 1st August 2019*
3 *Impact data provided by enterprise*
4 *Business Sustainability in Asia – Compliance, Performance, and Integrated Reporting and Assurance. Gaoguang Zhou, Judy Tsui, Peter Cheng, and Zabihollah Rezaee*
5 *http://siteresources.worldbank.org/INTURBANDEVELOPMENT/Resources/336387-1334852610766/AnnexJ.pdf*

DRE APPLICATIONS FOR DEVELOPMENT

3

CHAPTER

3 DRE Applications for Development

This chapter throws some light on how available DRE technologies can be utilized to maximize growth, contribute to India's economy, and promote clean energy solutions for a sustainable future. It also elaborates as to how adoption of these technologies is intrinsically linked to the achievement of the Sustainable Development Goals (SDGs) set by the United Nations.

For the purpose of this report, CLEAN has focused on the development of DRE technologies in three sectors, namely, food processing, healthcare, and agriculture.

3.1 Food Processing

The food processing sector is one of the fastest growing sectors in India. As a result, it has become an important segment of the Indian economy due to its contribution to the nation's gross domestic product (GDP), employment generation, and investments.

The challenges identified in this sector are (a) gaps in supply chain infrastructure, (b) inadequate link between production and processing, (c) seasonality of operations and low capacity utilization, (d) inadequate focus on quality and safety standards, and (e)lack of product development and innovation. These challenges broadly fall under the categories of storage and handling, and value-added processing.

3.1.1 Storage and Handling

The inadequate logistical support from the farm to markets is the main factor behind high post-harvest losses in the food chain. A 2014 report by the National Centre for Cold-Chain Development estimates that the current gap between installed and required bulk cold storage is approximately 29 million metric tonnes.[1]

A considerable chunk of this requirement is found in small-scale food processing industries operating in rural areas with unreliable or no electricity supply. Solar-powered refrigerators and cold storages are a feasible solution for such areas.

[1] *https://nccd.gov.in/PDF/Final-ReportTFCP.pdf*

Cold storages help in (a) extending the shelf-life of products, (b) avoiding glut, (c) reducing transport bottlenecks during peak production periods, and (d) ensuring the overall quality of products. In terms of economic viability of DRE solutions, while the capital cost is currently higher as compared to conventional grid-connected options, DRE-powered units have a typical life of 15 years and have zero energy costs. This makes them more feasible than grid-powered units,as the operational costs of conventional technologies are 20%–30% higher.[2]

3.1.2 Value-Added Processing

Value-added processing comprises many activities that demand long hours of manual work. This leads to drudgery and even higher demand for labour. However, productivity and efficiency remain low in many such processing activities.

Mechanization of these processes is crucial to achieve higher productivity and profit margins, in addition to reducing the requirement of labour. It will further lead to employment creation and market innovation.

3.2 Health Care

As per the Government's 2017 Rural Health Statistics[3], about 3.6% of primary health-care centres have no access to electricity and the ones that have access to grid electricity, the availability is only intermittent. Certain basic critical services such as vaccine storages, lighting, and sterilization autoclaves need continuous access to power. This is something that DRE can offer as a back-up to the grid where it exists, or independent of it where it does not exist.

DRE, thus, offers significant opportunities in health care. Simultaneously, DRE also addresses multi-sectoral goals in in areas such as energy access, energy security, resource management, and health outcomes, which often compete for resources and political attention.

2 *CLEAN and Oxford Policy Management Analysis*

3 *http://www.mospi.gov.in/sites/default/files/statistical_year_book_india_2015/Table%2030.6_0.xlsx*

3.3 Agriculture

Lack of infrastructure at the farm level in rural India calls for some serious attention. This can be largely attributed to unreliable access to electricity, if any is available at all. The agriculture sector needs to apply solutions that can be tailored to suit their requirements.

It is essential to build sustainable supply chains, which will link the farms to the processing and marketing centres seamlessly. In the absence of on-farm cooling and grading arrangements and slow development of cold chain infrastructure, the farmer is compelled to sell his produce to brokers without waiting for a better price. If the farmer is enabled to grade and store his produce close to the farm, the farmer will be empowered to demand and obtain a better price from the processors and add value to his produce.

The benefits of the using these DRE technologies are manifold, as listed below.

- They will cater to the needs of the energy-starved links within value chains sans the negative impact in terms of pollution, carbon emissions, water and land contamination, and various other negative environmental impacts.
- They will create a wide social and economic impact by providing access to affordable energy to small-scale enterprises and farmers/ agricultural workers.
- They will help in creating jobs in underdeveloped pockets of the country and create gender equality by encouraging entrepreneurship among women.
- They will reduce the drudgery of labourers and increase productivity by cutting short the time required to complete a task.

CLEAN recommends powering multiple machines with a single energy generating asset, which would replace the need to power machines with kerosene or diesel, bringing use of mini-/micro-grids to power machines at the same cost of other fuels. Another recommendation is to promote innovations on energy-efficient machines and livelihood applications.

3.4 DRE for SDGs

DRE technologies and the SDGs of the United Nations are intrinsically linked. Table 3.1 brings out these linkages in a nutshell.

Table 3.1 DRE-linked SDGs

Themes		Key SDGs
Basic Needs	Provide access to energy services for basic needs in households and commercial spaces	
Health Care	Provide access to basic healthcare services and improve quality of services provided	
Better Working Environment	Create safe working environment and reduce drudgery	
Market, Infrastructure & Innovation	Boost Development and innovation	

Access to Affordable and Clean Energy – SDG 7

Development and deployment of DRE technologies have emerged as an important step in achieving UN SDG 7, which aims to create access to affordable and clean energy for all.

While there must be changes effected at a deeper and systemic level these changes will not act merely as drivers of SDG-7 but will facilitate the achievement of other SDGs as well. Governments and the United Nations have time and again emphasized on the importance of focusing on the interlinkages among the various SDGs. And, therefore, it is important to recognize the spill-over effect that DRE technologies will have in accelerating changes pertaining to all SDGs.

Poverty Reduction, and Decent Work and Economic Growth - SDG 1, SDG 8

For countries to advance economically and equitably, there will have to be adequate focus on developing energy and electricity systems that ensure access to clean and affordable energy to all sections of society. The economic and social benefits of these systems are vast. Deployment of renewable energy technologies include outsourcing at many levels of product and system chain management starting from procurement of raw materials, assembling, and storage to sales.All of these create numerous opportunities for employment and income-generating livelihood for populations with limited access to these.

Good Health and Well-being - SDG 3

DRE technologies have considerable potential to substantially impact health outcomes. India is characterized by high levels of infant mortality and low infant immunization. The limited electricity supply is among the main reasons for breakdown of implementation of health centers. By supplying reliable and continuous supply of electricity in primary health centers, DRE ensures that even the most marginal and remote communities in the country have access to modern healthcare facilities.

Quality Education - SDG 4

Renewable energy and solar panels as well as solar lamps have shown to be effective aids in improving learning outcomes by providing electricity to students who otherwise do not have access to the same. Unreliability of power is a significant deterrent to accessing quality education.

Climate Action - SDG 13

The Paris Agreement governs the framework of SDG 13 and require all signatory countries to 'seek to promote low-emission, resilient development pathways that limit the temperature rise to well below 2 °C, ideally 1.5 °C.' To achieve this target, all countries need to inevitably decarbonize the existing energy systems and shift to clean energy. Several DRE technologies highlighted in the report prove to be an alternative to conventional sources of energy, while also reducing the level of emissions.

3.5 Concluding Remarks

The scope of DRE has often seen as being limited providing basic energy access in areas where it is lacking. However, this is not the case. The unreliability of power in several regions of the country has been a hindrance to economic growth at the grassroot level. Moreover, it has led to poor quality of services such as health care, education, etc.

By providing these areas with reliable power and innovative solutions DRE enterprises have boosted the local economy. It has resulted in a significant increase in income and productivity and a reduction in drudgery, carbon emissions, etc. More importantly, it has ensured that individuals have access to proper healthcare facilities and improved the quality of services manifold. More number of patients are now being treated and do not have to critical procedures done under emergency conditions. Thus, with the right policy and financial support these innovations will greatly improve the quality of life of people socially, economically, and environmentally.

Food Processing

CASE STUDY 17

Regularised Production with Solar Systems - Sittilingi Organic Farmers Association

Farmers in Sittilingi, Tamil Nadu, had the issue of unreliable supply of electricity and at low voltage during day time. Therefore, the farmers used the night-time for their production process. In addition, the Association used a diesel generator for which fuel had to be procured from 60 km away. This would result in the production process being halted for an entire day.

The Sittilingi Organic Farmers Association now uses a 4.5 kWp solar system. This system powers six machines ranging from 0.5 to 2 HP, with machines up to 4 HP can be run in combination.

With DRE intervention, the farmers are able to regularise production resulting in an increase in their incomes. The expenditure on diesel has been reduced. As the production is no longer conducted during night, a greater number of women are being employed.

Women workers being gainfully employed by Sittilingi Organic Farmers Association

CASE STUDY 18

Solar Refrigerators - Devidayal Solar

Small-scale enterprises operating in areas with unreliable or no access to electricity have an unmet need of cooling appliances. These enterprises are in need of such appliances to ensure that the freshness of dairy, poultry, and meat products is retained for longer duration.

Solar refrigerators offer a viable solution for these small-scale enterprises. Based on the requirements, different capacity fridges can be used ranging from 100 litres to 240 litres. These fridges function on a relatively low wattage and consume energy as low as 0.1 kWh per day.

The addition of solar DC fridges in small-scale enterprises will enable them to maximise their sales and profits, and result in a significant increase in their incomes.

Solar Module (Wp)	200
Battery (Ah)	2400
Charge Controller	20A 12V
Capacity	65W
Back-up Hours	24 Devidayal (100 litres)
Solar Module (Wp)	750
Battery (Ah)	4800
Charge Controller	40A 24V
Capacity	155W
Backup Hours	24 Devidayal (268 litres)

A solar refrigerator

CASE STUDY 19

Solar Milking Machines - Lifeway Solar

Most dairy owners used to depend on labourers or electric milking machines to get milk from cows or buffaloes at their respective dairy farms. The goal is to supply good quality machines to farmers at an affordable price.

Milking machines reduce milking time by a third compared to manual labour. This eliminates drudgery and increases productivity. According to Lifeway Solar, a farmer can recover his or her investment in a solar-powered milking machine in less than two years after the initial set-up. The initial investment is of INR 60,000 with 60% of the cost going towards the solar panel and battery. In comparison, a kerosene-powered milking machine of the same capacity would consume one litre of fuel every hour.

The farmer can take this machine as per his/her requirement as it is mounted on a trolley. Theother advantage is that its battery can be charged by using electricity during monsoon.

A farmer milking a cow using a solar milking machine

Voltage of System	24 V
Capacity of solar panels	230 Wp
Motor and pump	24 V/120W/180W DC motor and suction pump
Capacity of battery @C10	200 Ah, 12 V

Health Care

CASE STUDY 20

Vaccine Refrigerators

Keeping heat-sensitive vaccines at the right temperature is crucial. However, it is difficult to do so in areas with limited or no electrical power or frequent or long-duration power outages. In such areas, grid-powered cooling appliances for vaccine storage become are virtually of no use. Damage can occur to vaccines due to even a single exposure to heat or several short exposures during power outages.

Solar-powered vaccine refrigerators minimize the thermal shock and come with a guarantee to never freeze the vaccines. They do not require a battery. Without a power source, they can keep vaccines at a constant temperature of four degrees for 10 days or more even with normal use.

A vaccine refrigerator is a necessity for hospitals not only to maintain the quality of vaccines during weather change but also to prevent bacterial contaminations.

A typical vaccine refrigerator in use

CASE STUDY 21

Portable Maternity Kits

Pregnant women in rural areas often face the challenge of getting proper check-ups done due to proper healthcare facilities being too far away and unreliable access to electricity in health centres.

Portable maternity kits developed by SELCO and Swasthya Swaraj are now being used in Kalahandi, Odisha. They come with portable solar torch lights to deliver babies instead of kerosene lamps. They also have basic diagnostic kits for testing anaemia, blood sugar levels, and malaria. The technical specifications of a maternity kit include 12-V, 18-watt solar panel, Li-Ion battery, and charge controller. These maternity kits have enabled pregnant women to get check-ups done at home, generated employment for skilled women, and have had a positive impact on mortality rates.

Skilled women using a portable maternity kit

CASE STUDY 22

Impacting Rural Health Care with Solar Power

Chhattisgarh Renewable Energy Development Agency (CREDA), Chhattisgarh

In Chhattisgarh, most public health centres (PHCs) had no reliable source of power, partly because the state is heavily forested, making grid extension difficult. To overcome this challenge, Chhattisgarh State Health Department collaborated withCREDA on a programme to provide solar power at all PHCs.

A PV system was designed and installed at each PHC following an energy audit. Energy-efficient appliances such as LED lighting, freezers, vaccine refrigerators, computers, centrifuges (for blood analysis), baby warmers, fans, and microscopes were also installed. The solar system is connected to the load with a change-over system, so that load can be shifted to the grid (where and when available), ensuring 100% energy security.

Impact

- There are 900 health centres with reliable PV power.
- 3 MW cumulative installed capacity.
- Approximate 80,000 patients benefitted in health centres per day.
- 80% reduction in energy costs compared to grid or back-up diesel.

A public health centre in Chhattisgarh

The centres now provide 24-hour healthcare and are able to treat a greater number of patients. Regular access to electricity has also enabled them to have reliable supply of water, safe refrigeration for vaccines, and powered theatre equipment, fans, and baby heaters. There has been a four-fold increase in the number of babies being delivered and deliveries can now happen safely even during the night. Digitalisation of patient services and improved operational efficiency are two other co-benefits. New smart card services allow patients to register for free medical treatment. Reliable internet services have enabled patients to order medicines online.

Power back-up	3–4 hours
Capacity	2 to 10 kWp
Battery capacity	Twenty-four 200 Ah/48 V batteries

CASE STUDY 23

Providing Tribal Communities with Health Care

Kalahandi Tribal Health Initiative

Kalahandi in Odisha faces the problem of difficult terrain and limited transport. The PHC is the only emergency care facility available in an 80-km radius. Without access to reliable electricity, lab facilities were impacted, and cold chain and emergency treatment were difficult to maintain.

To overcome these problems, rooftop solar system has been installed. This system powers an emergency treatment unit, operation theatres, labour wards, and anaesthesia and suction machines. Additionally, it also powers the ACs and lighting devices. The total cost is INR 8.5 lakh (estimate of 6 kW) and it makes a savings of minimum INR 120,000 a year on diesel.

After installing this solar system, the clinics are experiencing faster diagnosis and treatment. The microscope is consistently charged, a dryer is used for blood samples, and vaccines are preserved with a solar-powered refrigerator. Mobile teams of women trained by the clinics are also now using a solar-powered portable maternity kit with solar lights to deliver babies, instead of relying on kerosene.

A public health centre being powered by a Kalahandi Tribal Health Initiative

CASE STUDY 24

Enabling Access to Free Primary Health care

Karuna Trust, Karnataka

Karuna Trust provides free primary health care to 1.5 million people in rural parts of five Indian states in places where people experience power cuts for at least 2 hours in a day.

The Trust has worked to pilot solar-powered health centres. Using a public–private-partnership model, Karuna Trust has financed solar panels for 19 of their PHCs, providing 24x7 electricity at reduced costs. A 3.2-kW solar power unit is used to power medical equipment, operation theaters, ACs, and lighting devices.

These health centres provide treatment to the most marginalised patients and ensure that they do not need to travel long distances for special care or experience power cuts mid-treatment.

A solar-powered public health centre managed by Karuna Trust

Agriculture

CASE STUDY 25

Enhancing Farmers Income with Value Added Processing at Farm Level - Pluss Advanced Technologies

An estimate of 67 million tonnes of produce is wasted in post-harvest losses due to lack of cold storage and alternative processing facilities.

The storage of energy in Aagun dryer is achieved using advanced phase-change materials. The heat stored in the form of thermal energy storage helps to continue the drying operation during night hours. An ideal temperature range of 50–65 °C is therefore maintained throughout the 24 hours. This constant temperature is achieved without any electricity or fuel consumption.

Aagun isnow enabling farmers in India to dry pineapple, ginger, tomato, banana, and fish besides other produce,

Impact

- Shortened duration of drying; over 50% reduction in drying time compared to open sun drying
- Better nutrient retention due to slow drying process
- Better colour of the end dried product as the produce does not see fluctuation in temperatures during the drying period
- Higher market value for dried products
- Reduced wastage of produce
- Better bargaining power and prevention of distress selling by the farmers
- Entrepreneurship opportunities at rural level through value addition to fresh produce
- Grid-independent, renewable source of energy for food processing

Pluss Advanced Technologies

CASE STUDY 26

Solar Cold Storage - Ecozen

India wastes about 18% of fruits and vegetables every year due to lack of cold storage facilities (Centre for Public Policy Research, 2016). These facilities are still unavailable at farm level. In addition to that, these are also unaffordable to small and medium farmers.

Ecofrost is a portable, solar-powered cold room meant to be used for on-farm cooling and storage of produce right after harvest. With a wide range of temperature control measures, it is ideal for storing fruits, vegetables, flowers, and other perishable commodities.The product is primarily designed for energy-starved areas. It does not depend on grid electricity.With a break-even period of two years, the product can help farmers give over 40% increase in profits. This innovative product can be suitably adapted for local conditions across the world.

Cost of system (including installation)	INR 15–16 lakh (approx.)
Capacity	2.3–3.5 kW
Storage capacity	5 tonnes
Back-up period	36 hours

Ecofrost: a solar cold storage

CASE STUDY 27

Solar Rice Huller - Alto Precision

Hulling of rice requires machinery and a substantial amount of energy both of which small-scale farmers do not have access to due to availability or reliability issues. This means that they undertake the laborious task of manual hulling or travel long distances to the nearest rice mill.These mills are usually too expensive for the small-scale farmers and result in increased costs for them and lower incomes.

Alto Precision has innovated a portable solar rice huller to tackle this challenge. The huller consists of two to four solar panels 250 Wp. The huller can simply be plugged in and used. The gap between the rollers is also adjustable from 0.1 mm to 1 mm for processing different types of rice. The pressure of the huller can also be adjusted.

Solar-powered rice huller offers a solution to farmers. They can be brought by individual farmers or farmer groups and eliminate the need to travel expensive far-off mills. They will reduce drudgery and increase productivity at a cost-effective price.

Cost (including installation)	INR 65,000
Solar Panel	250Wp
Motor	0.5 HP
Hulling efficiency	97%–98%
Capacity	100 kg/hour
Usability	8 hours a day
Solar charge backup	8 hours
Voltage	220 V AC
Frequency	50 Hz

A solar rice huller

WAY FORWARD

4

CHAPTER

Decentralized renewable energy (DRE) solutions have an important role to play in achieving universal energy access. In fact, they go beyond providing just basic access to energizing livelihoods. The case studies presented in this publication go on to prove that DRE solutions are rapidly emerging as promising solutions for rural livelihoods, communities, and enterprises. They unlock the co-benefits in other areas of sustainable development goals (SDGs) such as jobs, health, food security, education, and gender. Besides, with India as the world's fourth largest carbon emitter, large-scale adoption of DRE would help India in reducing its CO2 emissions, which would be in line with the country's commitment to the Paris agreement.

CLEAN has identified four priorities to accelerate the uptake of the DRE solutions in the country. The huge potential DRE has is acknowledged by stakeholders who feel the need to come together and strengthen it further.

- **Stronger recognition of DRE sector**

  The DRE enterprises and other stakeholders have contributed to meet the overall goal of energy access. The sector would like to be noticed as an impact creator for the poor and marginalized. This calls for appreciation and recognition of the enterprises, individuals, and communities adopted DRE solutions for a cleaner and better environment. As the sector moves beyond energy access, recognition and support will make a larger impact at the grassroot level.

- **Stronger and clearer policies/schemes**

  There is a need for stronger and clearer policies/schemes to win the confidence of financiers and end consumers. Also, as the enterprises sense opportunities in such areas as food processing, health, education, a strong linkage and acknowledgment of the impact created in the energy sector is required.

  DRE enterprises have been contributing to different sections of societies based on their energy needs, geography, and best-fit technologies. An equal weightage to all DRE technologies is needed as they all are clean and support the overall goal of achieving sustainability. Conducive policies for technologies other than solar-based solutions are required.

- **Roadmap for DRE enterprises to support the growth**

  DRE enterprises have expressed the need for support towards innovations, developing technologies, accessing capital fund, and developing a strong business model. Enterprises lack resources and bandwidth to support their growth in these areas. Also, as DRE businesses are moving from 'Access' to 'Reliability', enterprises are looking for right partnerships and collaborations to support their growth.

  Consumer awareness has been critical to the journey so far. As the consumers are climbing up the energy ladder, it is important to continue to support, promote, and create awareness about the use of DRE applications. This will result in opening up new avenues for the enterprises with minimum cost and they can focus on other areas of product development.

- **Data for better representation of the sector**

  In the 2018 state of the sector report, CLEAN expressed the need for support for data collection. As an increasing number of enterprises contribute to the sector, it captures and presents data to relevant stakeholders. For the subsequent editions, CLEAN would like to access more useful data to present a holistic picture of the sector's strengths, weaknesses, opportunities, and threats.

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ANNEXURES

Annexure 1

About Member Survey

The CLEAN team undertook primary and secondary research to prepare this report. Primary sources included the inputs provided by the CLEAN's members and its stakeholders. Secondary sources comprised the published reports, newspaper articles, and the companies' websites. An Advisory Committee was formed to discuss the content of the report. Apart from this, CLEAN's own experiences and those of its partners have been instrumental in the report preparation.

A survey was conducted by CLEAN to receive inputs from member enterprises. The period of the survey was March–June 2019. Questionnaires were sent to more than 110 member enterprises, out of which 43 participated in the survey and 2 were interviewed. They shared valuable information regarding their plan, strategy, new focus areas, challenges, issues, employment generation, and how they perceive the future of this sector. Their responses were carefully recorded and analysed. Through this report, our effort is to communicate our findings to its readers.

The survey highlights operations from the below states and types of DRE technologies practised.

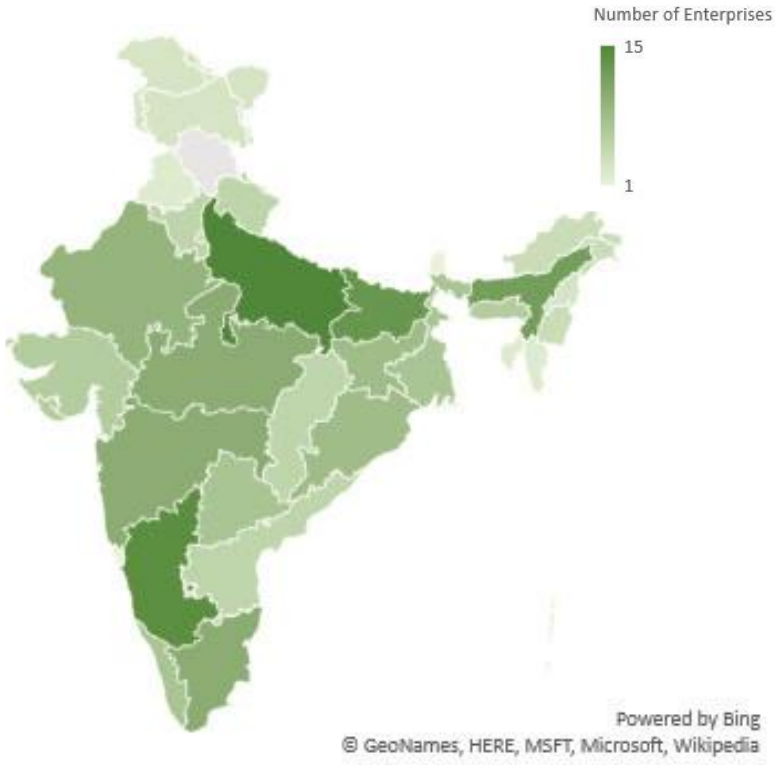


Figure A 1.1. State-wise distribution of member

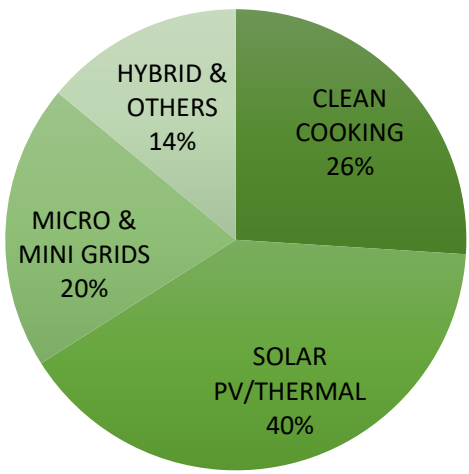


Figure A 1.2. Break-up of technological specialization of members participated in the survey

Annexure 2

Benchmark costs for Off-grid Solar PV Systems and Solarisation of Grid Connected Agricultural Pumps issued by Ministry of New and Renewable Energy

	2018-19 (General Category States/ North East States, Hill States, Island UTs)	**2019-20** (General Category States/ North East States, Hill States, Island UTs)
Street Light- Lead Acid Battery (Rs/Wp)	300/330	-
Street Light- Lithium Battery (Rs/Wp)	435/475	299/328
Solar Lamps (Rs/Wp)	250/275	160/176
Standalone Solar Power Plants/Packs (upto 10 kW)	6 hrs-100/110 3 hrs-80/88 1 hr-68/75	6hrs-94/103 3 hrs-74/81 1 hr-62/68
Standalone Solar Power Plants/Packs (>10 kW-upto 25 kW)	6 hrs-90/99 3 hrs-72/79 1 hr-61/67	6 hrs-84/92 3 hrs-66/72 1 hr-55/60
Solar Pumps (Rs/HP)	Upto 3 HP DC-85000/93500 & AC-80000/88000	0.5 HP-AC/DC Surface 53,000/58,300 AC/DC Submersible 68,000/74,800 (Benchmark cost per system instead of per HP shown for 0.5HP solar pumps)
		1HP-AC Surface 102,000/112,200 AC Submersible 113,000/124,300 DC Surface 108,000/118,800 DC Submersible 119,000/130,900
		2HP-AC Surface 65,000/71,500 AC Submersible 76,000/83,600 DC Surface 73,000/80,300 DC Submersible 86,000/94,600
		3 HP-AC Surface/ Submersible 67,000/73,700 DC Surface/ Submersible 74,000/81,400
	> 3 HP- 5 HP DC - 77000/84700 AC -65000/71500	5 HP AC Surface/ Submersible- 56,000/61,600 DC Surface/ Submersible- 66,000/72,600
	–	7.5 HP AC/DC Surface/ Submersible-56,000/61,600

	2018-19 (General Category States/ North East States, Hill States, Island UTs)	**2019-20** (General Category States/ North East States, Hill States, Island UTs)
	–	10 HP AC/DC Surface/ Submersible- 51,000/56,100
Solarization of Grid Connected Agriculture Pumps (Rs/Wp)	–	Up to 10 kW -54/59 Above 10 kW- 48/52
Grid Connected Rooftop Solar Power Plants (Rs/Wp)	Above 1 kW and up to 10 kW---60 Above 10 and up to 100 kW---55 Above 100 kW and up to 500 kW---53	–

Source:

1. https://solarrooftop.gov.in/notification/Notification-18062018-092754.pdf

2. https://mnre.gov.in/sites/default/files/webform/notices/Benchmark%20Order%20FY%202019-20.pdf

Annexure 3: DRE in News

Mini-grid next on agenda of power discom, JREDA

Wednesday, 27 February 2019 | Santosh Narayan | Ranchi

Opinion **Energy sector**

Off-grid electricity is reaching into the remotest homes

Heralded as the next big technology shift it could also change the developed world

Bengaluru firm to build smart anganwadis, solar operation theatre in Bihar's Muzaffarpur

Sunitha Rao R | TNN | Updated: Jul 27, 2019, 9:07 IST

Thanks to this startup, farmers in India save money (and the planet) by converting animal poop into energy

Mexico- and India-based Sistema.bio uses a biodigester to convert agricultural waste to generate biogas, across Gujarat, Maharashtra, Karnataka, and Bihar. It has impacted over 1,000 households so far.

Shruti Kedia

4th Mar 2019

Jobs: Distributed renewable energy sector to create 400,000 jobs in India

The census provides comprehensive data on energy access jobs created by decentralized renewable energy including solar for home and business, green mini-grids and productive use systems such as solar water pumps

ETEnergyWorld | July 15, 2019, 12:00 IST

Playing with fire: How Greenway provides a safer alternative to cook for rural India

Greenway Appliances was setup in 2011 and the idea was to come up with stoves that offered a viable replacement for the traditional mud chulhas.

By Neha Dawan, ET Online | Updated: Jan 10, 2019, 11:57 AM IST

Over 80% of mini-grid users in India satisfied with their connections: Report

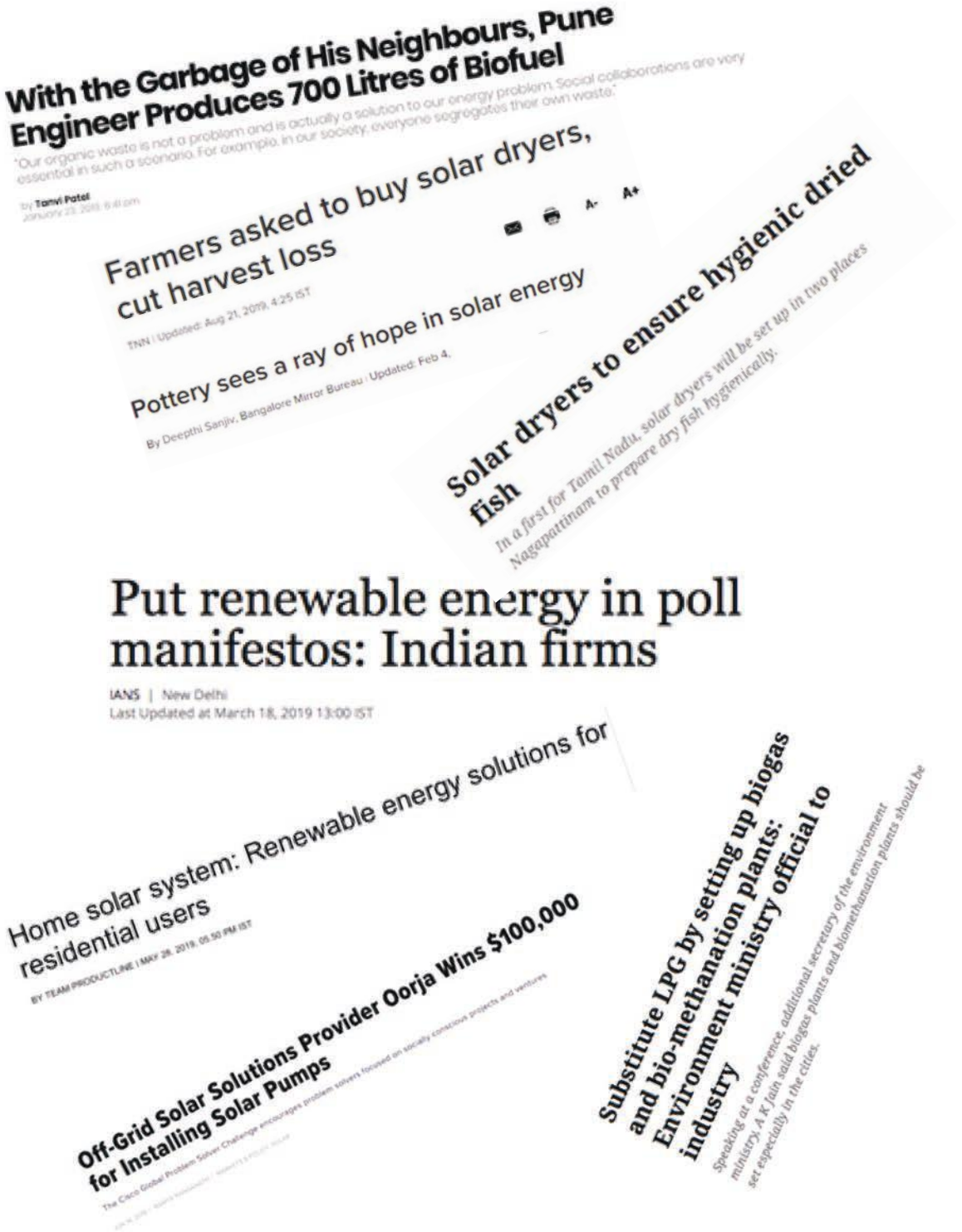
The report is based on primary data collected from over 10,000 rural households and 2,000 rural enterprises across four states – Bihar, Uttar Pradesh, Odisha and Rajasthan

Anshul Joshi | ETEnergyWorld | August 10, 2019, 21:36 IST

Mini-grids could be a boon to poor people in Africa and Asia

When allied with microfinance, "green grids" can boost economic activity

Generating electricity for millions: Husk Power bolsters Modi's dream of power to all



With the Garbage of His Neighbours, Pune Engineer Produces 700 Litres of Biofuel

'Our organic waste is not a problem and is actually a solution to our energy problem. Social collaborations are very essential in such a scenario. For example, in our society, everyone segregates their own waste.'

By Tanvi Patel
January 23, 2019, 6:41 pm

Farmers asked to buy solar dryers, cut harvest loss

TNN | Updated: Aug 21, 2019, 4:25 IST

Pottery sees a ray of hope in solar energy

By Deepthi Sanjiv, Bangalore Mirror Bureau | Updated: Feb 4,

Solar dryers to ensure hygienic dried fish

In a first for Tamil Nadu, solar dryers will be set up in two places Nagapattinam to prepare dry fish hygienically.

Put renewable energy in poll manifestos: Indian firms

IANS | New Delhi
Last Updated at March 18, 2019 13:00 IST

Home solar system: Renewable energy solutions for residential users

BY TEAM PRODUCTLINE | MAY 28, 2019, 09:50 PM IST

Off-Grid Solar Solutions Provider Oorja Wins $100,000 for Installing Solar Pumps

The Cisco Global Problem Solver Challenge encourages problem solvers focused on socially conscious projects and ventures

Substitute LPG by setting up biogas and bio-methanation plants: Environment ministry official to industry

Speaking at a conference, additional secretary of the environment ministry, A K Jain said biogas plants and biomethanation plants should be set especially in the cities.

Annexure 4: List of CLEAN members

1. Aaranyak
2. Abha Innovation
3. Abhidna Food Products
4. Adarsh Plant Protect Limited
5. ADS Global Knowledge Academy
6. Alto Precision
7. Amperehour Solar Technology
8. Amplus Energy Solutions
9. Anant Solar Systems
10. Angaza Design
11. Anthropower
12. Aqysta
13. Arc Finance
14. Arushi Green Energy India
15. Asha Impact
16. Atlanta Energy
17. Atomberg Technologies
18. Auroville
19. Aurus Lending Solutions
20. Barefoot Power
21. Bask Research Foundation
22. Billion Smiles Infi Tech Serve
23. Boond
24. Bruhat Energy Solutions & Technologies
25. Centre For Development Orientation And Trainng (CDOT)
26. Centre For Youth And Social Development
27. Chirasthayee Urja Samadhan
28. Ckinetics
29. Claro Energy
30. Clean India Ventures
31. Consortium Of Resource Person
32. CSIR-National Environmental Engineering Research Institute (NEERI)
33. Cygni Energy
34. D.Light
35. Deepa Solar Systems
36. Delectrik Systems
37. DESI Power
38. Desi Technology Solutions
39. Devidayal Solar Solutions
40. Dharma Life/ Gajam India
41. Doorastha Analytics
42. E Hands Energy
43. Ecoforge Advisors
44. Ecosense Appliances
45. Ecozen Solutions
46. Ekak Innovations
47. Elegant Power Care
48. Emsys Electronics
49. Energeia
50. Energo Labs
51. Enfros Technologies
52. Envirofit
53. ENVIRON ENERGY
54. Environmental Defense Fund
55. Envo Business Solutions
56. ENVO Renewable Energy Services
57. First Energy
58. Forum For The Future
59. Free Power Technology
60. Free Spirits Green Labs
61. Freespanz Design Build
62. Frontier Markets
63. Gautam Solar
64. Genii Engineering & Services Private Limited
65. Global Sustech International
66. GOGLA
67. Gram Bikash Kendra
68. Gram Oorja
69. Gram Power
70. Gram Swaraj
71. Grameen India Innovations
72. Gram-Utthan
73. Grassroots and Rural Innovative Development
74. Grassroots Energy
75. Green Light Planet
76. Greentech Knowledge Solutions
77. Greenway Grameen

78. GSES India Sustainable Energy
79. GTNFW-SEWA
80. Hand In Hand Inclusive Development And Services
81. Harith Avani Technologies
82. Heron Solaris
83. HHV Solar Technologies
84. Himalayan Rocket Stove
85. Human Organisation For Patronisation Of Environment(HOPE)
86. Husk Power Systems
87. Hynetic Electronics
88. India Foundation For Humanistic Development
89. India Resources Trust
90. Indian Network on Ethics And Climate Change
91. Institute For Sustainable Communities
92. Integrated Research And Action For Development
93. Iora Ecological
94. IT Power Consulting
95. Janakalyan Partisthan
96. Janasadhana
97. Jansamarth
98. JJ PV Solar
99. KGVK
100. Kirloskar Integrated Technologies
101. Lanasol Energy Solutions
102. Ledsafari Pvt Ltd
103. Lumeter Networks
104. Lytyfy
105. Machinepulse
106. Mahindra Susten
107. Mangaal Sustainable Solutions
108. Mega International
109. Mega Zing Solutions
110. Meghraj Capital Advisors
111. Mera Gao Power
112. Mesha Energy Solutons
113. Microenergy Credits
114. Millenium Synergy
115. MLINDA
116. Natural Lights
117. Naturetech Infrastructure
118. NBIRT
119. NERD Society
120. Nishant Bioenergy
121. Observer Research Foundation
122. OMC
123. Omnivoltaic Energy Solutions
124. Onergy
125. Oorja: Empowering Rural Communities
126. Ovel Education
127. Panasonic India
128. Perpetual Power Services
129. Phoenix Products
130. Playsolar Systems
131. Pluss Advanced Technologies
132. Pmanifold Business Solutions
133. Pollinate Energy
134. Practical Action Foundation
135. Prakruti Renewable Power
136. Prakti
137. Prayas Energy Group
138. Puhor Solar Centre
139. Pushan Renewable Energy
140. RAGHUNATH PATHAGAR
141. RAL Consumer Products
142. Ravi Engineering and Chemical Works
143. RCDC
144. Reconnect Energy Solutions
145. Reinenergy Infratech
146. Renewable Energy Applications And Products
147. Riya Solar
148. Rural Spark
149. S.G Foundation
150. Sadbhavana Ventures
151. Samuchit Envirotech
152. Saudagar Agro Industries
153. Selco India
154. Servals Automation
155. Seven Sisters Development Assistance
156. SEWA Bharat
157. Shramik Bharti
158. Sidhi Vinayak Solars
159. Simpa Networks
160. Sistema.Bio
161. SK Engineers
162. SKG Sangha
163. Smart Joules
164. Smart Power India
165. Smokeless Cookstove Foundation
166. Solar Hitech Solutions

167. Solar Urja Through Localization For Sustainability (Souls)
168. Sologix Energy Private Limited
169. Spektron Solar
170. Sri Anagha Green Energy
171. Sri Sri Rural Development Program Trust
172. Steel Bird Industries
173. Sun Saluter
174. Sun Zone Solar System India
175. Sunipod
176. Sun-Mitra Solar
177. Sunrise Energy Corporation
178. Supernova Technologies
179. Supreme Co.
180. SURE
181. Susconnect
182. Sustainearth Energy Solutions
183. Sustainplus
184. Sustaintech
185. Swami Samarth Electronics
186. Swayambhu Innovative Solutions
187. Swelect Energy Systems
188. Switchon
189. Synergy Engineering & Environmental Solution
190. Tarini Enterprises
191. Technology Informatics Design Endeavour
192. Tezpur University
193. The Batti Ghar Foundation
194. Udaipur Urja Initiatives Producer
195. Udyama
196. Unesar Urjaa Samadhan
197. Vayam Renewable
198. Velnet Non-Conventional Energy Systems
199. Vikram Solar
200. Village Infrastructure Angels
201. Village Renewable Energy Systems (I)
202. Villgro Innovations Foundation
203. Vishwadeep Presspart
204. Volksenergie
205. V-Spur Technologies
206. Water Energy Food Transitions (WEFT) Research
207. Wish Energy Solutions

ANNEXURE 5: CLEAN Flagship Events

India Clean Cooking Forum

The India Clean Cooking Forum is an annual event that was initiated jointly by the Ministry of New and Renewable Energy, GoI, and Deutsche GesellschaftfürInternationaleZusammenarbeit (GIZ) GmbH, operating on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ), in 2013. The ICCF aims at mainstreaming the issue of lack of access to clean cooking energy in India and providing a platform for knowledge dissemination, experience sharing for different stakeholders.

CLEAN has organised six editions of ICCF till date and has been successful in bringing out some positive outcomes for the clean cooking energy sector:

- Channelizing the efforts towards universal access to clean cooking energy in India by 2030.
- The importance was emphasized to create awareness on the dangers of the traditional option and on the alternatives available and the sustainable benefits that they offer.
- Emphasized the need to move towards a unified clean cooking energy policy, where improved cooking technologies/solutions are seen to be complementary with decentralized mechanisms for the cooking energy selection and implementation design.
- There are a few successful business models of biogas but generalization is difficult. Various models will need to be explored and developed for different contexts.
- The Forum emphasized on the fact that RE-based clean cooking options have the potential to play a key and impactful role in several niche areas in households as well as in commercial and community kitchens.

India Clean Cooking Forum, 5–6 December 2016

India Clean Cooking Forum, 24–25 October 2017, New Delhi

India Clean Cooking Forum, 7 September 2018, New Delhi

India Energy Access Summit

Clean Energy Access Network in partnership with Ministry of New and Renewable Energy (MNRE), and The Climate Group organised the first ever India Off-Grid Energy Summit in New Delhi, India in August 2015, followed by the India Energy Access Summit (renamed) in August 2016 and the third edition of the summit in February 2018. The summits brought together over 600 delegates including 100+ DRE practitioners, policy makers, donors, funders and policy and regulatory experts each time.

CLEAN has been successful in bringing out some positive outcomes by conducting the above three editions of the India Energy Access Summit::

- Adopt a holistic approach towards affordable finance by the DRE sector and other stakeholders to attract private finance. This would include finance for the consumer and implementing agency/companies.
- Innovate and develop ultra-efficient appliances that can work with low input power without compromising on the productive output.

- Grid complementary role of DRE – Looking at DRE as an integral part of national energy access plans, wherein energy access initiatives complement national grid extension and the business models take cognizance of this along with end-user satisfaction.
- The participants explored how scaling up DRE would simultaneously accelerate India's energy transition as well as support the country's commitments to deliver its Intended Nationally Determined Contributions on climate and UN Sustainable Development Goals.

India Off-Grid Energy Summit, 12-13 February New Delhi

India Off-Grid Energy Summit, 19–20 August 2015, New Delhi

India Off-Grid Energy Summit, 11 August 2016, New Delhi

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