

# STRATEGIES TO PROMOTE RENEWABLE ENERGY SOLUTIONS IN OFF-GRID AREAS OF INDIA

Manab Chakraborty<sup>1</sup>, Deepa Gupta<sup>2</sup>

<sup>1</sup> Researcher, Indian Institute of Management (IIM), Kashipur, Uttarakhand, India

<sup>2</sup> Researcher, Indian Institute of Management (IIM), Kashipur, Uttarakhand, India

## ABSTRACT

India has fifth largest power generation portfolio worldwide with power generation capacity of 329.20 GW (30 April 2017). Still, around 50% of India's rural population has little or no access to grid-based electricity and relies on kerosene as its primary source of lighting. States with highest number of underserved population are Uttar Pradesh, Odisha, Bihar, West Bengal and Madhya Pradesh. Promoting renewable energy (RE) in off grid areas will not only solve electricity problem but also reduce climate vulnerability, increase adaptive capacity towards climate change and lead to social equity.

The aim of this paper is to propose strategies to promote RE solutions in off-grid areas and recommendations to make RE in off-grid areas financially feasible and socially sustainable. Government of India (GoI) should restructure the sanctioning of subsidies and authorize private organizations for expediting the process. An independent "Technical Standards Committee" should be formed for determining technical standards, certification and accreditation of the equipments. It should also maintain "Monitoring and Evaluation System" to ensure funds are being used for the intended purpose. GoI should encourage and allocate funds for local manufacturing of Solar Home Systems (SHS) products. Standards and tariff structures should be introduced for feeding electricity into the central grid in 'Draft Grid Integration Policy'. Furthermore, Microfinance Institutions (MFIs) can play a key role in developing an instalment based financing scheme which reduces monthly cost of SHS to that of kerosene. Hence, efforts taken deliberately in addressing RE will help increase affordability and accessibility in off grid areas.

**Keyword :** - Solar, RE, Microfinance, MFIs, DRE systems, Grid extension

## 1. INTRODUCTION

Off-grid energy refers to areas that lacks connectivity to the central electrical grid or are underserved by the grid (receive less than four hours of electricity per day). According to Census of India (2011), 81 million households or close to 400 million people do not have access to electricity as their 'main source of lighting'. Of these, over 90% residing in rural areas form the biggest market segment for off-grid energy services. The least electrified States which have households greater than 5 million are Uttar Pradesh, Bihar, Odisha, West Bengal and Madhya Pradesh, followed by Assam, Jharkhand, Maharashtra and Rajasthan (2-5 million households).

Even if rural areas are electrified, electricity supply is poor and inconsistent with frequent power outages. This leads to dependence on kerosene for lighting and solid fuels (like fire wood and dung) for cooking needs. Such practices leads to air pollution causing health problems. Furthermore, over harvesting of fire wood leads to biodiversity loss and soil erosion. Such loss of forest cover along with unsustainable utilization of fossil fuels ultimately leads to global warming and climate change due to increase in Green House Gas (GHG) emissions.

Government provides subsidy for people below poverty line (BPL) on kerosene for cooking. But people use kerosene for lighting instead and continue using solid fuel for cooking. Furthermore, clean energy product suppliers refrain themselves from providing their products to rural areas with poor connectivity or areas where grid connectivity extension is uncertain. Hence, accessibility of clean energy is reduced in such areas.

Other than accessibility, affordability and awareness generation are barriers in penetrating renewable energy (RE) off-grid solutions in India. The high final cost of RE products including logistics and transportation cost, bars low income groups to own these products. Awareness is required to shift from conventional ways of meeting energy needs to clean energy.

Energy access for all must go beyond electricity to ensure that people have access to clean fuels for meeting their heating and cooking requirements, and also help in livelihood enhancement and diversification. In order to meet India's large energy need for both household and commercial consumption, RE such as solar, wind and biomass should be tapped for power generation. Out of various forms of RE, tapping solar energy is more dominant due to current government regulations.

The energy sector in India is undergoing an uprising by shifting from fossil fuels to renewable energy (RE). Benefits of renewable energy are not limited to environment but social development and economy generation as well. One of the possible solution to increase rural electrification is tapping renewable energy and installing decentralized renewable energy systems. Hence, the study was planned with an objective to propose strategies to minimize the upfront capital cost of installing these systems, providing such financing schemes to the end users to increase their affordability and also to increase accessibility in off-grid areas.

Research questions are as follows:

1. What are the gaps in RE promotion?
2. What are the various sources of investments in RE in India?
3. How microfinance can help increase accessibility and affordability of RE in rural or off-grid areas?

## 2. METHODS

The study was conducted from December, 2015 to June, 2017. It is based on secondary data analysis. The market size of RE has been analysed followed by role of microfinance in RE promotion. In addition, emphasis has been given on demand and supply mismatch in RE and constraints in RE promotion has been indicated. Eventually, New and Innovative Mechanism for RE Financing has been discussed.

### 2.1 Size of RE Market

Off-grid energy solutions include solar lanterns, solar home systems (SHS) and decentralized renewable energy (DRE) (micro/mini grid) systems. Solar lanterns can be used for basic lighting and mobile charging. SHSs consist of solar panels and an energy storage device (battery) that power a nearby home or business. Systems can also include a charge controller and/or an inverter for AC connections. DRE systems are classified into micro and mini grid systems. Installations less than 10 kW are considered as micro grids and systems above 10 kW are classified as mini grids.

An average simple solar lantern is priced at US\$13 (INR 800), a multiple functional lantern with added features on average is priced at US\$23 (INR 1,400) and a smaller SHS is priced at US\$65 (INR 4,000). Better models for consumer finance alongside large demand and rising incomes, will drive the current potential SHS market of 3.3 million households (2014) to more than 7.2 million households by 2018. For a DRE connection, depending on

consumption and the pricing mechanism, consumers pay between US\$1.7–10 (INR 100-600) per month. In 2014, around 100,000 households were served by a DRE utility.

Based on the report of International Finance Corporation the current annual market size for solar lanterns in India could range between 300,000 and 500,000 units per annum. Similarly, annual sales of SHS could be approx. 100,000 units.

Product 1: Lantern: Rs. 800 x 20% of 500,000 households in need = Rs. 80,000,000 per annum

Product 2: Chullah (Box Type): Rs.5000 x 20% of 600,000 users = Rs. 600,000,000

Product 3: SHS: Rs.4000 x 5% of 100,000 units =Rs. 20,000,000 per annum

Product 4: Water heater (100 litres capacity): 15000 x 5% of 7 lakh users = Rs. 525,000,000

## 2.2 Role of Microfinance in RE promotion

Microfinance plays a key role in promoting RE in low income groups or rural people. Affordability of energy services can be improved with the help of microfinance loans. Microfinance will simultaneously help alleviate poverty and promote modern and efficient energy use. It acts as a tool for livelihood improvement by increasing earnings and savings for the future.

Suppliers and funders providing clean energy products mostly partner with Micro Finance Institutions (MFIs) who are highly active in remote areas to market their services. MFIs can provide new and innovative financing mechanisms to fund and impulse RE sector. MFIs provides microloans to consumers for buying off-grid RE products such as solar lighting systems and improved cook stoves. They also act as last-mile delivery agents and after-sales service providers. They provide both individual and group loans like Self Help Groups (SHGs) for short tenures (six months to one year, depending on the capital cost). However, group loans were found to be more common for decentralised RE products. In short, MFIs can address the issues related to affordability, accessibility and awareness generation to a large extent, by providing the necessary channel and platform for provision of clean energy products.



**Fig -1:** Credit Penetration at State Level

**Source:** CRISIL Inclusix Report, Volume 3 (June 2015)

Figure 1 indicates credit penetration in various states of India. It highlights the level of financial inclusion in states in four categories. Among the least electrified states Madhya Pradesh, Bihar and Uttar Pradesh have below average financial inclusion. Whereas, West Bengal and Odisha have above average financial inclusion.

As of 31st Mar 2017, NBFC-MFIs provided microcredit to around 2.75 Cr clients, an increase of 30% over Quarter 4 FY 15-16 (MFIN Micrometer, March 2017). Among the study area states Madhya Pradesh has the maximum number of MFIs followed by Bihar. But, Uttar Pradesh has maximum number of clients followed by Madhya Pradesh as mentioned in Table 1.

**Table -1:** Credit Penetration by MFIs in selected States

State	No. of MFIs	Gross Loan Portfolio (Rs. Cr)	Clients (lakhs)
West Bengal	12	2979	17
Uttar Pradesh	17	4888	32
Bihar	18	3469	22
Madhya Pradesh	21	3502	25
Odisha	13	3256	20
Rajasthan	16	1122	7
Jharkhand	13	1084	7
Chhattisgarh	17	1030	7
<b>Total</b>	<b>127</b>	<b>21336</b>	<b>137</b>

**Source:** MFIN Micrometer, Issue 21, 23rd May 2017 (Data as of 31st March 2017)

For promotion of RE at the grass root level MFIs and NBFCs could be an option. So are regional rural banks (RRBs). RRBs are local level banking organizations operating in different States of India. RRBs are the banking financial intermediaries working especially for the development of rural sector of Indian economy. The main aim of establishing these institutions was to facilitate the rural people with core banking functions in general and loaning to those landless and marginal farmers, artisans, field workers etc., who could not access to other sources of organised financial system. RRBs not only work for providing finances but also cater additional responsibilities of developing rural areas through various development programmes like rural employment schemes, women entrepreneurship, rural infrastructural development, SHGs, etc.

One of the largest RRB in India is Uttar Bihar Grameen Bank in Bihar. It is largest in terms of customer base, staff strength and branch network. It is headquartered at Muzaffarpur, sponsored by Central Bank of India and has its presence in eighteen districts across the state.

### 2.3 Demand and Supply Mismatch

Almost 85% of rural households depend on solid fuel for their cooking needs and only 55% of all rural households have access to electricity. The per capita energy consumption of India is the lowest among BRICS Nations. During the year 2015-16, the per capita electricity consumption in India was 1075 kWh with total electricity consumption (utilities and non-utilities) of 1031.642 billion kWh. India is among the least energy-intensive economies in the world due to its low industrial base and more agriculture dependent population.

India's current capacity from renewable sources of energy stands at 44.812 GW which is ~14.7% of the total installed power generation capacity as on 31.07.2016. The Government of India has set targets which will take the total renewable capacity to 175 GW by the end of 2022. This includes 60 GW from wind power, 100 GW from solar

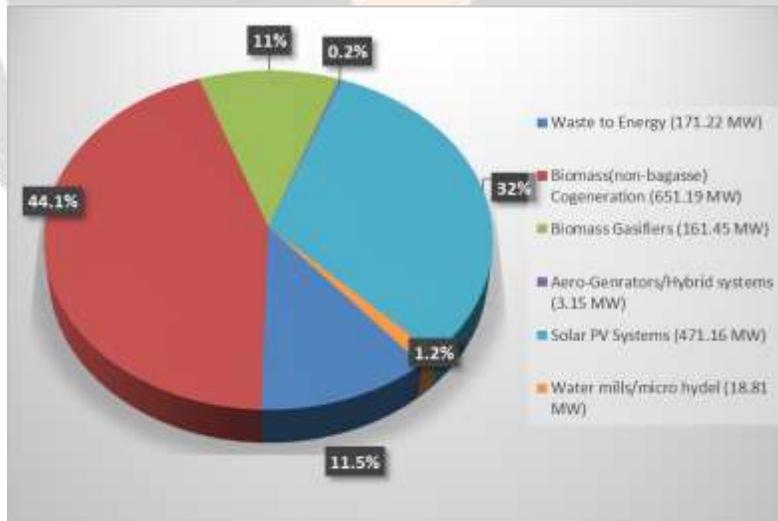
power, 10 GW from biomass power and 5 GW from small hydro power. India has RE potential such as wind, solar, biomass, small hydro, etc., as mentioned in Table 2.

**Table -2:** India’s Renewable Energy Potential

S.No.	Technology	Potential
1.	Wind	102,800 (80m hub height)
2.	Biomass including bagasse cogeneration	22500
3.	Solar	748.98 GWp
4.	Small Hydro (up to 25MW)	19700
5.	Hybrid/Aero Generators	-

**Source:** Off-grid Renewable Energy in India Technology & Service Overview, GIZ, IGEF, 2015 -16

India’s total off-grid/captive renewable power capacity is 1477.7 MW (as on 30.04.2017) which shows a 10% increase since last year (1329.74 MW). The share of various technologies in overall installed off-grid capacity can be seen from following Chart 1. It indicates that Biomass (non-bagasse) Cogeneration has the largest share of 44% followed by Solar PV Systems 32%.



**Chart -1:** Share of various sources in installed off-grid capacity (1477.7 MW total capacity), April, 2017

**Source:** Ministry of New & Renewable Energy

**2.4 Constraints in RE promotion**

The market size of RE is still untapped due to four broad reasons. Firstly, government’s poor will has neglected the RE arena. India does not have an overarching energy strategy, instead it has a number of disparate policies. To date,

India has developed a cluster of energy business models and policies that have not been productive. These policies are definitely affecting RE expansion plans. The present business model needs to be changed from a centralized to a decentralized structure that allows all stakeholders. Government provides subsidies for developers for installing decentralized energy systems but does not provide similar incentives for operation in the long run. Subsidies are difficult to obtain and timelines for disbursement of funds are also not certain. This discourages small and new entrepreneurs to pitch in. Lack of clarity is also seen in government's grid extension plans and potential for interactivity with DRE utilities. This has led to doubt on long term viability of RE enterprises. It is difficult to find out when and where the government will actually extend the grid and whether such extension can be complemented by off-grid solutions like DRE utilities. Also, Off-Grid Energy (OGE) enterprises cannot directly compete with cheaper, subsidized grid power, and in many cases would face substantial losses if the grid were extended to areas where they operate. This risk makes financial institutions even more hesitant to finance RE projects and firms. There are various challenges in both receiving loans as an OGE enterprises and in lending to OGE enterprises. Enterprises face interest rates of 13-18% in the domestic market, which are perceived as prohibitively high. On the other hand, foreign lenders such as impact investors have a hard time getting RBI approval to lend in the Indian market. Foreign loans can also only be used on a project basis. So enterprises must look elsewhere to finance needs such as working capital. Most banks are not willing to lend to OGE enterprises even at higher interest rates because the ticket sizes of loans is too small. Banks and other financial institutions willing to lend to OGE enterprises have found it difficult and time consuming to get approval for projects and apply for benefits like subsidies.

Additionally, owners of the enterprises are not sure whether they will get returns on their investment in future or not. Lack of awareness, market information and capacity building of both financial institutions and enterprises is a limitation in investing in RE products. Furthermore, questions related to ownership of systems are also unanswered which makes private companies reluctant in investing in off-grid areas. Also, scope for a public-private partnership are not explored.

Secondly, from the investor or business point of view there are other opportunities or businesses which are more profitable for long term than the RE market. Thirdly, from the consumer point of view, considering the high capital cost of RE system, people are not able to afford it. And fourthly, utilization of RE depends on geographical location. Households located near farms or forest or with easy access are more likely to use biomass like wood or crop residue instead of RE.

Regarding public and private energy investment, Indian government targets a total investment of US\$250 billion over the next five years considering the population growth and expand access to off-grid households. Of this amount, US\$100 billion will need to be investment in RE. According to the Planning Commission, this means that India's annual investments in RE would need to grow to US\$18 billion by 2016. However, public sector investment is likely to grow to only US\$2 billion by that year. Therefore, close to 90% of RE investment, US\$16 billion, will have to come from the private sector.

But due to lack of reliable data and little technical expertise, private sector and financial institutions wary themselves of investing in RE sector. For most traditional financial institutions, RE is not a space they have historically invested in. The lack of quality data related to RE in public domain on the current gap between demand and supply, benchmarks on costs and projected returns, and case studies of successful renewables enterprises has discouraged investors, especially commercial investors. Combined with a lack of internal expertise to evaluate RE firms, this makes financial institutions less willing to invest in RE products. Financial institutions do not understand the nuances of the market, including viability of different technologies, implications of different business models and ways to assess future profitability of specific investments. Because of the low perceived value of the sector, financial institutions are not prioritizing it as an area to develop technical expertise.

### **2.5 New and Innovative Mechanism for Renewable Energy Financing**

Government of India has evolved innovative financial models for funding and promoting RE in off-grid areas. Apart from that, Government is taking steps to incentivize schemes and promoting foreign investment. Few of the initiatives are listed below.

- **Priority Sector lending policy of RBI 2015:** An Internal Working Group (IWG) was set up in July 2014 to revisit the existing priority sector lending guidelines. RE category has been added as one of the priority sector. According to the guidelines, bank loans up to a limit of Rs.15 crore to borrowers can be given for purposes like solar based power generators, biomass based power generators, wind mills, micro-hydel plants and for non-conventional energy based public utilities viz. street lighting systems, and remote village electrification. For individual households, the loan limit will be Rs.10 lakh per borrower.
- **PACEsetter Fund:** In June, 2015 Governments of the Republic of India and the United States of America established the PACEsetter Fund. The mission of the PACEsetter Fund is to accelerate the commercialization of innovative off-grid clean energy access solutions by providing early-stage grant funding that would allow businesses to develop and test innovative products, business models and systems. The Fund's main purpose is to improve the viability of off-grid RE businesses that sell small scale (under 1 megawatt) clean energy systems to individuals and communities without access to grid connected power or with limited/intermittent access (less than 8 hours per day). The grants will target companies that sell small-scale clean energy systems to individuals and communities without access to grid-connected power or with limited or intermittent access to power. The PACEsetter Fund is INR 50 crore (USD 7.9 million) fund jointly capitalized by the Governments of the Republic of India and the United States of America.
- **Green Bonds:** Based on 'Jawaharlal Nehru National Solar Mission (JNNSM) guidelines on off-grid and decentralized solar applications', Green bonds are considered as flexible funding approach for promoting off-grid systems. The off-grid systems include hybrid systems to meet/supplement power, heating and cooling energy requirements. These systems still require interventions to bring down costs but the key challenge is to provide an enabling framework and support for entrepreneurs to develop markets. India's YES Bank and Export-Import Bank successfully issued green bonds in 2015.

Green bonds enable refinancing of RE projects, which increases liquidity and reduces the overall cost of the funds. The advantages of green bonds could include access to domestic and foreign capital as well as relatively low interest rates. Issuers of green bonds may include governments (including state governments and export-import banks), intergovernmental organizations such as the World Bank or regional development banks, financial institutions, and other corporations. A recent study indicates that India could reduce its clean energy cost by as much as 25 percent by issuing green bonds. With green bonds, the government could offer funds that are one-third cheaper than commercial bank loans with double the tenure, given the government's higher domestic credit rating.

- **Currency Hedging:** GoI is working on a plan to reduce borrowing costs and improve the viability of solar and wind power projects by extending hedging support for foreign loans, leveraging the National Clean Energy Fund (NCEF). Developers want to borrow overseas as they are cheaper than those offered by local banks and financial institutions. Hedging helps firms with foreign currency exposure to protect themselves from unfavorable fluctuations in exchange rates.
- **Incentives and tax exemptions:** Various incentive schemes have been facilitated by both Central and State Governments under wind energy, solar energy and other RE projects. The incentives for wind energy include 80 per cent accelerated depreciation on equipments in the first year, 100 per cent Tax Holiday on the earnings for 10 years, over a 15 year period to be taken consecutively (Section 80IA of Income Tax Act), Soft loan for setting up RE enterprises, concessional customs duty on select equipment imported and excise duty exemption. In the Solar energy sector, incentives includes 10-year tax holiday for photovoltaic (PV) and thermal solar plants set up by 2020, reduced customs duty and zero excise duty on specific capital equipment, critical materials and project imports, besides loans at cheap interest rates.

- **Infrastructure Debt Funds (IDFs):** IDFs are investment vehicles which can be sponsored by commercial banks and Non-Banking Financial Companies (NBFCs) in off-grid areas of India in which domestic/offshore institutional investors, specially insurance and pension funds can invest through units and bonds issued by the IDFs. This would help banks to finance green-field projects (project/investment which is started from scratch level) such as RE projects in off-grid rural areas.

### 3. CONCLUSIONS

The least electrified states of India are Uttar Pradesh, Bihar, Odisha, West Bengal and Madhya Pradesh with un-electrified households greater than 5 million. Government of India's policies and plans related to grid extension are not certain. Therefore investors, private sectors and banks are reluctant in investing in off-grid areas. The subsidy approval process is slow and cumbersome which demotivates new and small scale entrepreneurs. Promotion and investment in RE is important to reduce the gap between demand and supply of electricity. A decentralized approach is the need of the hour to maximize benefits from RE which includes stakeholder from local, regional, state and national level, along with creating opportunities in RE sector for private sector, banks, developers, investors, MFIs, SHGs and local community. In order to meet India's growing needs on RE investment around 90% is required to be investment from private players. For maximum penetration of RE systems, MFIs and RRBs network in the least electrified states cannot be ignored. MFIs and developers require empowerment related to grants, capacity building and should be made channel partners. Reduction in use of fossil fuel use and utilizing RE leads to social, economic and environment benefits. Early action on climate change mitigation and adaptation would cost less than repairing the damage caused by climate change impacts.

### 4. RECOMMENDATIONS

Following are the recommendations made to make RE in off-grid areas financially feasible and socially & environmentally sustainable:

#### 4.1 Nature of Action

- GoI has formulated "Draft Grid Integration Policy" to make better informed investment. The policy will allow clean energy power suppliers (mini/micro grid) to integrate with the central grid once it arrives and continue their service. Thus, resolving issues related to ownership. Once central grid has been installed both grids should run in parallel and mini/micro grid should feed the central grid. The Central Electricity Authority and State Electricity Regulatory Commissions should introduce standards and tariff structures for feeding electricity into the central grid. The projects that meets such standards, Ministry of Power should agree to purchase electricity from them. In 2015, the feed in tariff is about Rs. 7.50 (USD 0.125)/kWh and is mostly applicable at utility level. The feed-in tariff for roof top PV plants should be introduced.
- IREDA can act as a leading agency for issuing green bonds. IREDA should also form an independent "Technical Standards Committee" for determining technical standards, certification and accreditation of the equipment. It should also maintain "Monitoring and Evaluation System" to ensure funds are being used for the intended purpose; sponsors comply with established technical, after-sales service, and consumer protection standards; customers are satisfied with the services; and hazardous wastes such as used batteries are safely recycled.
- Various ministries such as RBI, MNRE, Power, Coal and Finance should integrate and catalyze the financing of RE sector.
- GoI should encourage and allocate funds for local manufacturing of SHS products.

- MFIs and developers should conduct demand assessment and feasibility study of the villages for effective operation and implementation of clean energy services. Partnership between MFIs, donors, developers and local villagers is required for substantial dissemination of RE use and for overall economic, social and environment development.
- MFIs should develop an instalment based financing scheme which reduces monthly cost of a SHS to that of kerosene. The financing scheme promotes ownership and with no direct subsidy reduces dependency. They can also engage in RE product development and conduct pilot testing. They should work on scaling up small scale microfinance based RE systems. Local community should be encouraged and made partner in DRE systems. Women/SHGs should be motivated and trained to understand the RE business and also to become local technicians to market, install, repair and maintain SHSs for rural customers. Visit to ideal villages should be organized for the villagers and stakeholders involved in mini/micro-grid RE systems. Case studies and best practices related to success stories on micro financing RE should be published and awareness should be increased.
- Private sector investments are necessary for long term debt and soft loans. Private sector players include impact investors, public sector banks, development finance institutions and donor/government agencies who are currently active in the off-grid RE sector. According to planning commission around US\$16 billion investment is required from private sector for RE infrastructure to achieve India's RE targets. Financial instruments such as lease financing can be suitable option to traditional debt and equity investments which can be applicable to DRE enterprises who want to build new plants. It can be customized to the needs of investors and enterprises. Investors can set up an independent leasing company in partnership with equipment manufacturers. The leasing company buys equipment and leases to the enterprise. Enterprise pays back in installments and acquires ownership over time. Also, multilateral agencies and public institutions can engage in funding for capacity building and publishing industry reports to provide up-to-date information to entrepreneurs and investors on technology, business models and market information for both financial institutions and enterprises.
- Recycling of solar panel is important since unorganized disposal leads to leaching of lead and cadmium. A robust regulatory mechanism for safe and sustainable e-waste management with a priority for solar power generating equipments is important. E-waste (Management & Handling) Rules, 2011 has come into effect but there is no mention of a proper collection network and a financing scheme for e-waste. Government can also impose cess on recycling of e-waste generated from electrical equipments. A business model needs to be developed for collection of e-waste from consumers. Producers of RE equipments should establish collection centres for recycling.

#### 4.2 Administrative Reform

- GoI should restructure the sanctioning of subsidies and authorize private organization for speeding up the process. Subsidy should be designed separately as upfront capital cost subsidy and performance based subsidy for energy systems. Funds from NCEF can also be utilized for such task.
- Government plays a vital role in creating best environment for micro-financing RE in off-grid areas. It can reduce subsidy on kerosene and channelize that fund for MFIs/NBFCs/RRBs working in RE sector. Government can relend money from international grants to the financial institutions, banks and MFIs. This would lead to long term financing and build public-private partnership. Government should also extend currency hedging support. State governments can generate inventory of villages where at least for the next 10 years grid connectivity is not possible. In such areas SHS and DRE systems should be promoted. Also, ownership of the RE systems needs to be clearly defined. Government should encourage and engage small scale and new entrepreneurs to become channel partners in RE sector. Fund allocation for capacity building

of stakeholders (MFIs, banks, developers, enterprises and community) involved in RE sector should be a priority. Training can be technical, financial and market based.

#### 4.3 Opening Additional Capital

- Corporate Social Responsibility (CSR) funds can be channelized towards off-grid RE systems. This fund could be used in funding off-grid rural projects and energy efficiency projects. As a part of CSR, a company can set up RE systems such as solar, biogas, etc., to serve energy needs in villages that will be maintained by villagers. Considering the small amount of CSR fund (2% of company's average net profit) corporates can partner with NGOs, MFIs or academic institutes and provide grants for R&D, capacity building and awareness generating activities related to RE.

#### 4.4 Community Engagement

- Private schools, colleges and hospitals can install rooftop solar panel systems in their buildings. As an example Okhla missionary hospital is likely to be the first private or non-government building in Delhi to have a large solar rooftop system, generating 300kW. It is remarkable that without any government subsidy on solar power hospital took such initiative. To avoid the high initial cost of installing such a huge rooftop solar panel system, the hospital signed a 20-year agreement with the German company.

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## BIOGRAPHIES

	<p>Manab Chakraborty is an Independent Consultant to social enterprises and development finance institutions with over 25 years of experience. His expertise is in microfinance, microenterprise development, renewable energy lending, and finding market-based solutions for the poor. He has MBA from Kellogg Business School, MSc in Environmental Economics from University College London, and MA in Development Studies from the International Institute of Social Studies, Erasmus University, Holland.</p>
	<p>Deepa Gupta is an Environmental Research and Planning professional with 7 years of experience. Her expertise is in Environmental Impact Assessment, District Planning, Microfinance and Renewable Energy. She has Master's degree in Environmental Planning from CEPT University, India and B.E. in Environmental Engineering from University Institute of Technology, India.</p>