SEPTEMBER 2013

Financing Decentralized Renewable Energy Mini-Grids in India

Opportunities, Gaps and Directions

Prepared by:

ckinetics

Decentralized Renewable Energy (DRE) based rural electrification is a rapidly emerging sector in India. Investors are just beginning to understand the business model, commercial viability, risks and opportunities that this sector presents.This report provides a perspective on opportunities, gaps and directions for financing in this emerging sector. It is not only meant to be a primer but also serve as a resource guide. For the latest updates please visit www.cKinetics.com/DRE-Financing

The cKinetics team is thankful to the Rockefeller Foundation for supporting this effort. In particular we are thankful to Brinda Ganguly, Suman Sureshbabu from the foundation for their inputs throughout the project.

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cKinetics is a specialized sustainability advisory firm working with investors and businesses in emerging markets. With offices in New Delhi and Palo Alto, the team comprises cross-functional specialists that combine insights in strategy, operations and financing to carve sustainable growth oriented solutions.

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EXECUTIVE SUMMARY

Context: DRE mini-grids as an emerging opportunity for private sector

As an emerging economy, India is currently faced with a dichotomy – while urban India is witnessing the benefits of economic development, large parts of rural India remain untouched by productive economic activity. In most cases, these are also the very areas that remain under or un-electrified.

Given the fact that economic progress and electrification go hand-in-hand; it only follows that electrification needs to be invested in so that development can progress in these rural areas.

This establishes the urgent need for rural electrification programs; a need which presents opportunity for the private sector in an erstwhile government dominated field. Decentralized Renewable Energy (DRE)[1] systems are increasingly becoming a solution to explore, especially in rural areas. The timing is ripe for a private sector engagement at scale: increasing uncertainty around availability and costs of fossil fuels in rural regions combined with falling technology costs of non-fossil fuel sources; as also challenges associated with extending the central electricity grid and providing reliable, steady supply of electricity to rural areas; all point towards a decentralized renewable energy oriented model as the need of the space. Of the various solutions available for rural energy access, DRE mini-grids come closest to delivering on the extent of service desired from the central grid in successfully providing power to not only meet the lighting and consumption needs of rural India but also to run productive enterprises which exist in villages.

However, rural DRE mini-grid[2] is a very nascent solution albeit with an ability to address the large opportunity of rural electrification in a viable manner. Hence both Energy Supply Companies (ESCOs)[3] and investors are just beginning to understand the business model, commercial viability, risks and opportunities that this sector presents.

This report has been written, with the aforementioned backdrop, to estimate the potential of this emerging business opportunity for rural DRE mini grid projects India; as also to analyze the capital potentially available for investment in this sector. This report is a part of a larger study to determine the types of capital needed to accelerate establishment of scalable, replicable and commercially viable micro /mini-grid DRE electrification projects in the Indian rural landscape, which can in-turn spur rural enterprise development.

Sizing the emerging rural DRE mini-grid opportunity

Before studying the landscape of supply of capital, it is crucial to understand potential size of the rural DRE mini-grid market in India, both in capacity terms (MW[4]- megawatts) and the capital requirement. Analysis of the top 4 states in India which are most deficient in electricity supply (namely Bihar, Uttar Pradesh, Odisha and Jharkhand) reveals that there exists an immediate power requirement of atleast 553MW in around 30,000 villages which can be met through rural DRE mini-grids. This demand goes up to 4,628 MW if we consider electricity needs equal to the state average per capita consumption and to 7,629 MW if we consider the national average.

[1] **Decentralized Renewable Energy (DRE)**: All off-grid generation and distribution projects based on renewable energy including both captive and micro-grid led projects as well as stand-alone renewable energy based devices such as solar lanterns, solar irrigation pumps, biomass based cook stoves and solar home lighting systems

[2] **Rural DRE mini-grid**: Decentralized generation and distribution projects based on renewable energy, primarily set up in rural areas to provide electricity access through a decentralized distribution grid. DRE Mini-grid systems are typically above 10 KW in size and are aimed at supporting atleast 200 HHs through a single installation.

[3] **ESCO**: Energy Supply Company providing electricity to households, micro-enterprises and other loads

[4] **Megawatt (symbol MW)**: a unit of power, equal to one million watts

Shortlisted States	Shortlisted villages[5]	Households with electrification potential for mini-grids	Power capacity required to meet total electricity requirement equal to national average (MW)	Power capacity required to meet total electricity requirement equal to state average (MW)	Power capacity required to meet immediate electricity requirement as per ckinetics field estimates (MW)[6]
Bihar	10,034	3,570,416	2,718	505	188
Jharkhand	1,081	354,461	270	366	19
Odisha	1,682	542,366	413	458	29
UP	17,429	5,553,879	4,228	3,298	317
Grand Total	30,226	10,021,121	7,629	4,628	553

The capital requirement to meet this potential demand is estimated to be ranging from USD 922 million to USD 12.7 billion depending on the scenario chosen for potential electricity consumption by rural households.

Mapping the landscape of supply of capital

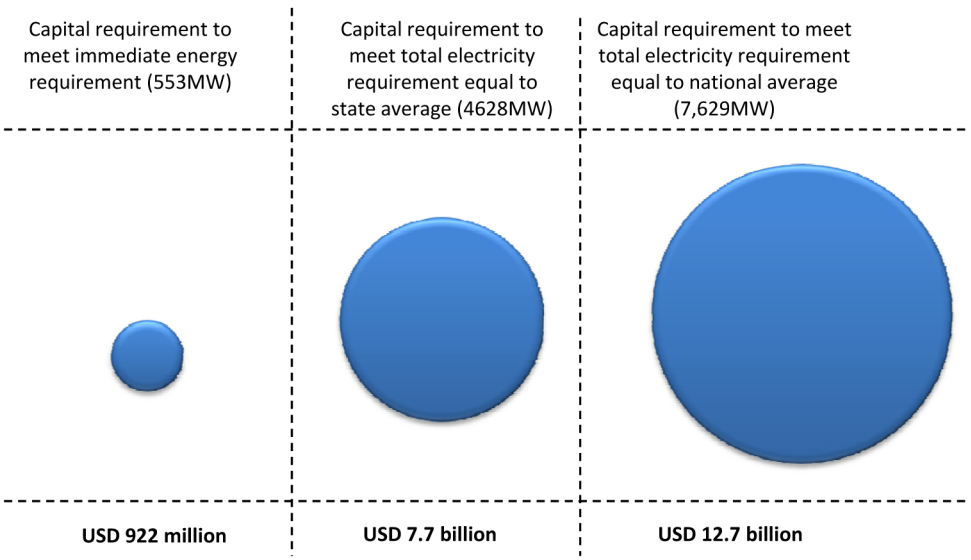
The study has entailed significant engagement with the investors to understand their outlook towards rural mini - grid DRE projects and estimate the amount of (a) direct capital[7] that is available and accessible for deployment in DRE (b) enabling capital[8] which can be used to catalyze rural mini-grid DRE electrification projects.

Different types of capital is available

Broadly, capital (both direct and enabling) falls into two distinct categories – Returnable[9] and Non-Returnable[10]. Moreover, based on the sources of funds / nature of investors, capital can also be categorized as being public (including government and development financial institutions) or private.

Different types of capital have been examined and quantified in this report. The table below provides estimates of the various kinds of capital available and their sources.

While on the surface it may appear that upto USD 71m of grant/donor capital has the potential to be accessible annually for rural mini-grid DRE projects, it is unlikely to get deployed unless more private capital is mobilized. The terms of deployment of several grant capital sources usually limits it to between 20% and 30% of the project cost.



[5]These include a subset of rural villages where less than 30% of households are electrified. Details provided in Annexure 6.

[6]0.75 kWh/ household/day assumed as immediate power requirement (based on extensive field data collected by cKinetics in the shortlisted states)

[7]**Direct capital**: Capital which will be deployed/ invested directly in the projects or companies

[8]**Enabling capital**: Capital which doesn't get deployed directly in projects or companies but which can be used to catalyze forms of direct capital to be invested in the projects or companies

[9]**Returnable capital**: Capital which expects repayment of the investment amount eg: equity investment, loans (subsidized or not) etc.

[10]**Non-returnable capital**: Capital which doesn't have to be repaid and is given as a means to build the business case and foster industry development eg: grants, subsidies etc.

Type of capital	Likely providers	Capital potentially available annually for DRE as a whole (USDm)	Capital potentially available annually to seed DRE mini-grid investments (USDm)
Technical Assistance (TA)	Government, donor agencies, DFIs, Corporates from CSR funds, Climate funds	27	10
Subsidies (for capex/interest)	Government	131	61
Total donor capital		**158**	**71**
Commercial loans (short term and long term)	DFI, commercial banks, NBFCs, RRB	20	4.3
Subsidized loans	DFIs, EXIM banks	2.5	0.4
Equipment Finance	DFIs, Commercial banks, NBFCs	3.4	0.9
Equity investment	Equity funds, impact investors, DFIs, HNIs	23	5.7
Total Returnable Capital		**49**	**11**

USD 82 million of capital is estimated to be available for deployment in the rural DRE mini-grid sector in India, of which USD 71 million is grant/donor capital and only USD 11 million is available from non-grant sources. Considering the estimated demand for capital, it is evident that currently there is a low level of interest from private mainstream capital providers to invest in this space.

Financing gaps in the landscape to meet the emerging opportunity

While DRE mini-grids designed to support productive loads mimic the grid and as such are expected to perform as infrastructure assets, given the nascent stage, they are yet to be treated as infrastructure class. This presents a key challenge to the sector: infrastructure projects have had a traditional reliance on debt as a source of finance whereas the (perceived) high risk of DRE mini-grid projects makes them less attractive to debt providers. The potential available capital in the form of debt for DRE mini-grid projects is estimated to be USD5.6m annually (out of the USD 26m indicated above) from lenders such as Developmental Financial Institutions (DFIs), Non-Banking Financial Companies, Export-Import Banks and Commercial Banks. However, there is reluctance to lend to these projects which is why even the more mature amongst the developers are unable to arrange for debt for their projects.

On the other hand, potential equity capital worth USD 5.7 m (out of the USD 23m indicated above) is estimated to be available annually for DRE mini-grid projects from traditional private equity and venture capital funds, Developmental Financial Institutions (DFIs) or impact investment funds. It was found that equity ismore easily available for new companies venturing into DRE mini-grids than debt. Debt for the most part is likely to be available in limited quantities and that too only to established firms with proven credit-worthiness.

Gaps to be bridged to attract capital into rural DRE mini-grids

Given the nascence of the field, rural DRE mini-grid projects present certain risks to investors which add to their challenges of capital deployment. The key reason for reluctance by FIs to lend to rural DRE mini-grid projects is the unfamiliarity with risks associated with the sector, be it technology uncertainty, business model uncertainty or regulatory uncertainty. These gaps need to be addressed to attract more private participation in this sector.

Key Gaps	Potential measures to mitigate challenges
Uncertainty of revenue from consumer- currently there is limited formal evidence regarding the revenue collection from end customers /rural users even though informal mechanisms exist.	3- 6 months of payment taken as advance security deposit from rural customers to ensure revenue visibility for the Energy Services Company (ESCO) may provide comfort to investors.
Revenue and pricing risk - rural DRE mini-grid projects still do not have an established business model, sufficient track record of operations and uncertainties abound around load/demand prediction, pricing mechanism and revenue collection.	Combination of solutions such as pre-paid metering and institutional Power Purchase Agreements (PPAs) with an anchor client in rural areas to assure certain minimum off-take from the power plant; as also provide longer term visibility and assurance.
Regulatory risk - uncertainty around government's outlook on rural DRE mini-grid projects, power pricing and expansion of the central grid.	Policy disruption to tariff is presently an unaddressed risk. Mechanisms to be grid interactive and feed back to the central grid once it arrives in the region of plant operation can help address this risk.
Long pay-back period - long pay back periods due to high initial investment and lack of ability to earn very high returns.	Blended capital (grants combined with returnable investment capital) instruments which provide long tenure capital is a pre-requisite to help address this gap.

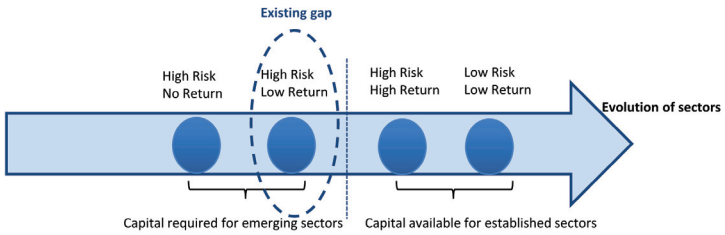
Mismatch between accessible capital and what is needed

Assessment of the landscape of capital supply and the demand for capital reveals that there seems to exist a mismatch between the type of funds that the rural mini-grid DRE projects need and what is available from the various sources of capital.

What is available is capital that is either meant for established business models (low-risk and low-return capital) or where the businesses provide attractive returns with a potential for an upside (high-risk and high-return).

In addition, grants and subsidies (high-risk and no-return capital) are available to help test business models in the rural mini-grid DRE space however 'bridging capital' (high-risk and low-return) required to support high-risk DRE mini-grid ventures and enable them to create a track record (that can then be supported by mainstream capital) is missing.

This 'bridging capital' is what the rural mini-grid DRE sector presently needs: i.e. capital with high risk appetite, low return expectations (given the risk) and a long tenure (given the nature of the projects). Unfortunately not many capital providers fall under this bucket.



Potential capital available annually for DRE as a whole (USDm)	158	-	23	26
Potential capital available annually for rural DRE mini-grid (USDm)	71	-	6	5

Directions for financing DRE mini-grids and going beyond this report

In an on-going exercise through 2013 and 2014, cKinetics is leading an effort to identify pathways to bridge the apparent mismatch and gap between the supply of capital and the (known) demand of capital for rural DRE mini-grids. The desired outcome is that the proposed financing interventions would not only attract investors and donors to the rural mini-grid DRE space but also help project developers achieve target IRRs[11] and make them investment-worthy of the different types of capital that maybe accessible. Some of the potential interventions/ facilities being ideated upon include: Co-developer equity facility*; Long term, low cost loan facility and Asset owner facility that owns the mini-grid amongst others. Due to the requirement of low cost funds, different models of blended capital structures that are supported by CSR or other donorsare being evaluated.

Engaging to define future directions

cKinetics is working with a select group of investors and ESCOs to define the future directions for financing interventions in the rural DRE mini-grid space. Some key reasons and drivers for different stakeholders to engage in the work are summarized below.

We are looking to connect with…	who are looking to…
Equity investors	Create pathway for their portfolio companies to raise capital from additional sources once their models are proven as also those who are willing to explore investments in upcoming enterprises
Commercial/Mainstream lenders	Develop early presence in a new emerging market segment; and defray risk through capital from Donors, CSR Capital, etc
Developmental Financial Institutions	Work with mainstream capital providers and find ways of leveraging their capital to attract more private sector participants
CSR capital	Identify opportunities for deployment and creating leverage for their grant/ subsidy capital that creates social as well as economic impact in areas of interest.
Foundations and large institutional donors	Explore blended capital models that help create 'bridging capital': high-risk, low-return and long term capital that will develop the rural DRE mini-grid sector; which in turn will promote enterprise development and economic development
Angel investors/ Angel networks/ HNIs with an 'impact' outlook	Invest capital that can take high risk for a meaningful social return and modest financial returns
Individual philanthropic capital/ philanthropic networks	Deploy own donor-capital in a regional manner and support/ spawn entrepreneurs
Government/ policy designers	Align policy actions with private sector interests, which in-turn can be used to meet policy goals around rural electrification and economic development
Energy Services Companies (ESCOs) putting up DRE minigrids	Get insight into outlook of capital providers and ideally get access to long-term capital; and looking to lower cost of capital by tapping appropriate mix of capital from different sources

In order to get engaged and know more about this study, please contact Shradha Kapur (skapur@ckinetics.com) in the cKinetics New Delhi office.

[11] **Internal Rate of Return (IRR)** - The discount rate often used in capital budgeting that makes the net present value of all cash flows from a particular project equal to zero. Generally speaking, the higher a project's internal rate of return, the more desirable it is to undertake the project (http://www.investopedia.com/terms/i/irr.asp)

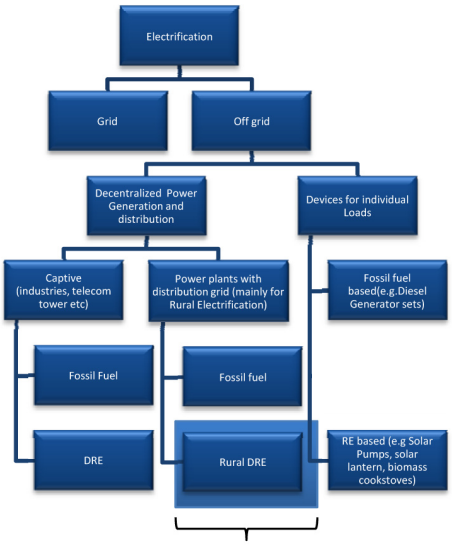
* Co-developer model explained in detail in section on 'Field building efforts required to shape a sustained and expedited uptake' (pg 28)

Audience lens

Focus

Aim of this report is to assess the existing landscape of opportunities for rural electrification through DRE micro-mini grid projects in India, map the supply of capital likely to be accessible to such projects and define the gap that exists between the quantum and type of capital that is needed vis-a-vis what's available.

Figure 1: Schematic of available models of electrification in India



Segment of focus for estimating potential opportunities and capital availability

For the purpose of this report we are focused on decentralized renewable energy (DRE) based projects/solutions in India, particularly rural mini-grid decentralized renewable energy projects. The figure below represents the schematics of electrification in India and helps illustrate the focus of this report.

This report forms part of an extended research seeking to define interventions which will help bridge the financing gap between the need of ESCOs/project developers for setting up rural mini grid projects and the existing supply of capital.

The goal of these financing interventions would be twofold:

1. To unlock capital for project developers that is presently available, but is inaccessible due to a variety of reasons such as lack of track record, uncertainty of business models, lack of revenue assurance, technology risk, regulatory risk etc.
2. To bring newer capital into the market as the opportunity for DRE led mini-grid electrification emerges. This would help address the financing gap that remains unmet even after funds from existing facilities have been made available.

This report estimates the amount of capital that is (a)potentially available and accessible for deployment and (b) can be used to catalyze private rural mini-grid decentralized renewable energy (DRE) electrification projects in India.

Scope of the report

Mapping the electricity deficit rural areas in India

This report maps the potential demand for rural DRE mini-grid projects in un-served and under-deserved villages of India, primarily focusing on the five most affected states of Bihar, Uttar Pradesh, Odisha and Jharkhand . It estimates the size of the DRE mini-grid market and the potential investment opportunity that it presents.

Figure 2: Focus states for estimating potential demand for rural DRE

Mapping sources of capital and types of Instruments

The landscape of existing sources of capital that can be tapped into for financing decentralized renewable energy projects to meet the electricity needs of rural population in India includes various kinds and sources of capital:

(a) 'direct capital' used to finance projects (i.e. capital invested directly into the projects) as well as 'enabling capital' in the form of supporting instruments such as guarantees etc. which can be used to catalyze increased flow of capital into the space (i.e. capital used to enable other investors to invest into project);

(b) capital across the risk return continuum, from non-returnable capital (grants) to low interest rate concessional capital to market rate commercial capital;

(c) capital from both public and private sources; and

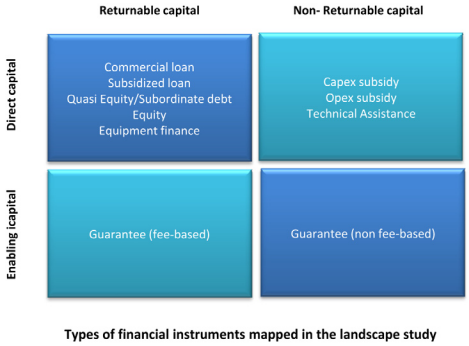
(d) capital from domestic and international investors ready to be deployed in India.

Different kinds of capital are accessible to developers depending on the maturity of the company, business models, project size, associated risk-return etc.

The report has considered financial instruments across the risk return continuum, starting from grants on one end to high cost commercial capital in the form of debt and equity on the other end of the continuum. The instruments mapped include both direct and enabling capital instruments as represented in the figure 3 below. These instruments vary as per tenure and expected return.

The report has also mapped many different kinds of investors who provide different forms of capital which reflect their risk return tolerance and social impact goals (if any).

Figure 3: Types of capital and sources mapped



Types of financial instruments mapped in the landscape study

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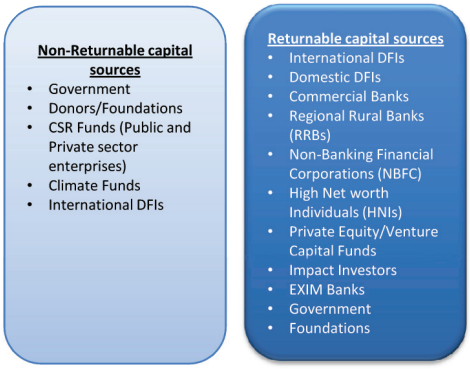


Sources of capital mapped landscape study

The sources of capital mapped in the study include:

Table 1: Sources of capital

Sources of capital	Number of active players in India
Ministry of New and Renewable Energy (Government of India)	Multiple schemes
Ministry of Power (Government of India)	Multiple schemes
Global Foundations	11
Development Finance Institutions (Domestic and International)	13
Commercial Banks (Private and Public sector)	21
Regional Rural Banks (RRBs)	Uncertain
Non-Banking Financial Companies (NBFCs)	15
Equity funds (including private equity, venture capital, impact equity investors, seed capital)	31
Climate Funds	2
High Net Worth Individuals (HNIs) and Indian Foundations	Uncertain
Corporate CSR (both public and private companies) and Corporate Foundations	Uncertain
EXIM banks	2

Lens and audience for this report

This document has been prepared keeping in mind the investors and ESCOs/ project developers that are looking to explore the DRE led mini-grid opportunity in India.

It is relevant for mainstream private investors, donors, developers/Energy Supply Companies (ESCOs) and government agencies as it provides them a landscape of the existing opportunity in rural electrification which can be met through DRE mini-grid. This report also captures the amount, sources and type of capital available for such projects and itsease of access to the ESCOs.

Methodology

The methodology for this landscape assessment included a combination of secondary research as well as primary interviews covering Financial Institutions (FIs) and government agencies that are active in the Decentralized Renewable Energy (DRE) and/or Rural Electrification space in India.

In order to estimate demand, in depth secondary research was used to collate data on un-electrified and under-electrified areas of India. This was followed by detailed discussions with relevant government ministries, regulatory authorities related to the electrification domain as well as nodal agencies responsible for implementation of existing government schemes related to rural electrification in the shortlisted areas to build a detailed model for sizing the existing opportunity of rural DRE mini-grid projects.

As a first step to estimate the capital potentially available, financial institutions (including private mainstream financiers, donors and government agencies) that are active or likely to be interested in participating in the decentralized renewable energy projects were identified through secondary research. Next, in-depth interviews were conducted with select FIs to get more details of the active lines/funds available within their organization as well as details about the eligibility conditions/requirements for accessing those funds. More than 25 financial institutions were engaged at this stage (list in Annexure 1).

These included:

- International and Indian Development Financial Institutions for soft capital as well as for enabling capital
- Commercial capital from banks already active in this space including private sector banks, Indian government banks and Regional Rural Banks (RRBs)
- Equity and quasi equity capital represented by impact investors and private equity, particularly cleantech investors
- Foundations for grant capital that are promoting rural enterprises and / or clean energy

Context and background

There can be no sustainable development without sustainable energy development - Margot Wallstrom, European Union Environmental Commissioner (2004)

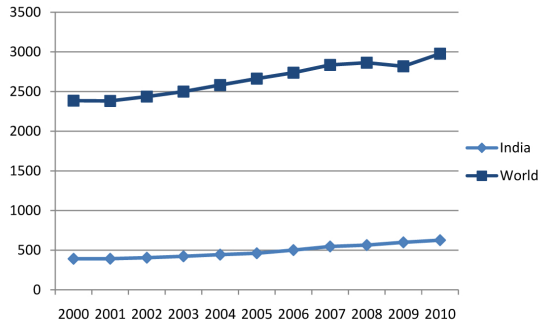
Understanding the electricity deficit

Electricity has been recognized as a basic human need, essential for accelerating economic growth and human development, generation of employment and elimination of poverty, especially in rural areas.[12] As per International Energy Agency (IEA) Energy Development Index, India ranked 34th out of 64 developing countries. As per national population census data of 2011, 45% of India's rural households are still living without electricity. If reliable, affordable and accessible electricity can be supplied to village communities then, electrification programs can contribute significantly to rural economic development.[13]

Current state of rural electrification in India

The per capita electric power consumption of India in 2010 was 778kWh[14,15] , compared to the global average of 2977kWh. This large difference in per capita electricity consumption exists not only because of lifestyle differences but also because a majority of the Indian rural population has limited access to electricity. Electricity access is skewed geographically and rural electrification is still below 50% in some states including Uttar Pradesh, Bihar, Jharkhand, Assam, Odisha and West Bengal.

Figure 4: Annual Per capita electricity consumption (kWh)



Source: World Bank Database

In April 2005, Government of India launched a new electrification program, Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) under which all on-going schemes were merged. The RGGVY scheme had a target of electrifying 117,700 un-electrified villages by extending and intensifying the conventional state electricity grid. Since inception till March 2013, 106,788 villages have been electrified (90% of target) and about 20 million BPL households (83.5% of target) have been provided electricity connections.

INR 28,826 crores (USD 5.2bn) has been released under RGGVY till March 15, 2013. Though the Indian government has invested considerable amount of capital for tackling the issue of rural electrification by extending the central grid into remote rural areas, it has not yielded the desiredresults in rural electrificationand many challenges still remain. It should be noted that electrification of a village does not guarantee a reliable and assured supply of electricity.[16] India is expected to have a 6.7%[17] deficit in its energy supply compared to demand in FY 2013-14.

Power supply is quite often erratic, inadequate and of poor quality. Also, electricity maybe supplied at inconvenient times of the day like late at night or very early in the morning when it can't be used for running productive loads such as irrigation pumps or micro-enterprises such as flour mill, rice mill, oil expeller, etc. Moreover, many remote rural villages still remain un-electrified as the costs of grid-extension to those villages are prohibitive due to challenging terrain and inaccessibility, thus making it an unviable proposition.

DRE: an option that is being explored

Considering the existing state of rural electrification based on extending the central grid, decentralized solutions are being increasingly looked at as a solution for solving the issue of rural energy access.

Moreover, India being a country with most parts receiving more than 200 days of sun in a year

[12]Rural Electrification Policy, 2006, Ministry of Power, http://www.powermin.nic.in/whats_new/pdf/RE%20Policy.pdf
[13]PES 2012 Waddle
[14]http://pib.nic.in/newsite/erelease.aspx?relid=84206
[15]kilowatt hour (symbol kWh) Is the amount of energy consumed by 1 kW load when run for one hour. It is most commonly known as a billing unit for energy delivered to consumers by electric utilities.
[16]IEA, Understanding Energy Challenges in India, 2012, Pg 31
[17]Central Electricity Authority (Ministry of Power-Government of India), Load Generation Balance Report 2013-14

and having fertile land with extensive growth of biomass, renewable energy potential is significant. According to MNRE, India's total renewable energy potential for power generation (excluding solar) is estimated to be approximately 90 GW[18] . Wind has the largest potential at 49 GW followed by bio-power (including biomass power, bagasse cogeneration, urban and industrial waste to energy) at 24 GW.

Thus, decentralized renewable energy based solutions are being explored by many as a panacea for energy access challenges in un-served and under-served parts of rural India.

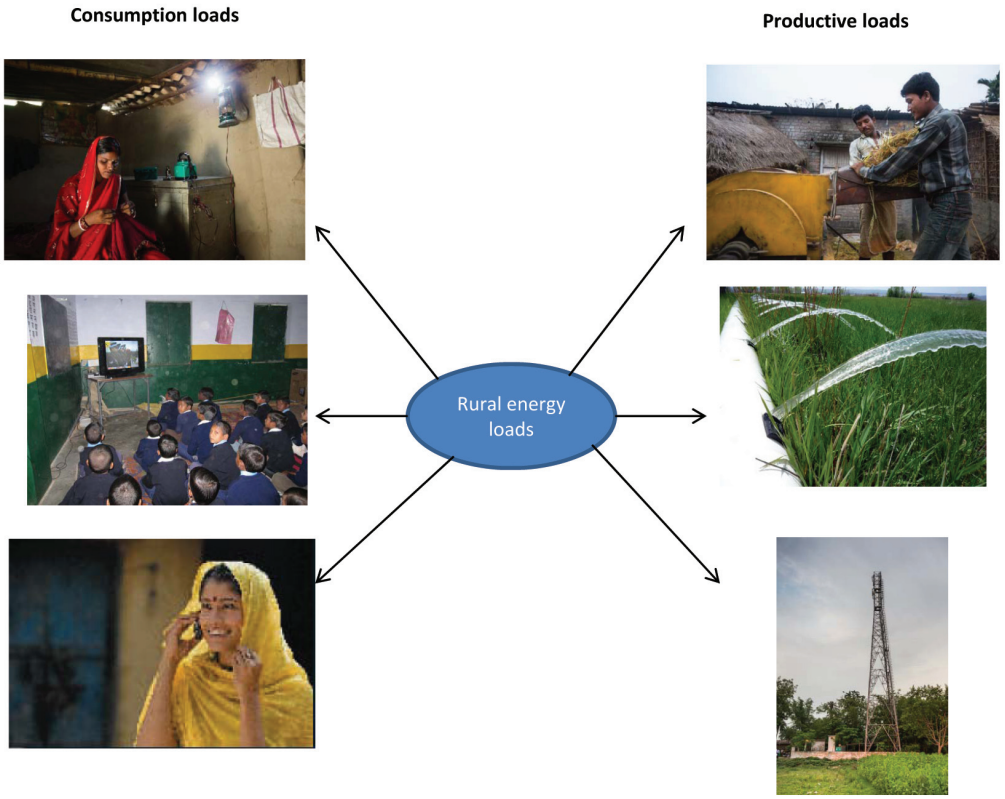
DRE solutions are needed for addressing different types of loads, which exist in un-electrified and under electrified rural areas. These can be broadly be classified as (a) household load which is primarily consumption load and includes lighting, cooking energy, entertainment systems (TV), electrical appliances (fan, refrigerator, mobile charging etc) and (b) productive loads which includes irrigation pumps, micro-enterprises such as flour mill, oil expeller, oil thresher etc. and telecom towers.

Currently, these loads are being met through different solutions including devices based such as solar lanterns, solar home lighting systems, biomass cook stoves, solar irrigation pumps etc. and decentralized mini-grid based power plants using various RE technologies such as solar, biomass, wind, small hydro etc.

Case for DRE mini –grids and the need to electrify productive loads

Though the stand-alone renewable energy based devices meet some of the energy needs of rural population, they have clear limitations and may not be the best solution in a lot of situations. Renewable Energy (RE) devices may be a useful part of a holistic solution for rural energy access and could serve as a stepping stone to a mini-grid based solution.

Figure 5: Types of Rural energy loads

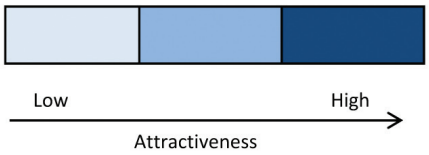


[18]MNRE, Strategic Plan for New and Renewable Energy Sector for the period 2011-17, Feb 2011, Pg 10, http://mnre.gov.in/file-manager/UserFiles/strategic_plan_mnre_2011_17.pdf

Devices provide a short –term, rapid execution, not so complicated solution to energy access. However, unlike the decentralized grid (pico/ micro/mini grid) based renewable energy plants, renewable energy devices meet only a limited needs of the rural consumers. **Barring a few innovations like the solar based irrigation pump, devices are not able to serve productive loads in rural areas which remains a key lacuna in their offering.**

Figure 6: Comparison of existing renewable energy based energy access solutions

	RE Devices (solar lantern, biomass cookstoves etc)	RE systems (solar home lighting systems)	Decentralized grid based RE power plants
Loads served			
Lighting load			
Cooking energy			
Productive loads			
Capex investment from end user			
Price for end user			
Ease of execution			
Assurance of supply			



RE devices are an individual asset (and responsibility) which require initial investment from the end consumer (especially for submersible water pumps, solar home lighting systems etc.) unlike power plants which require the end user to pay only for the service provided.

Typical DRE mini-grid solution

In order to illustrate a typical rural DRE mini-grid solution, we can take the example of an ESCO which sets up a 40kW biomass plant in a village to serve 300 households (for lighting needs), telecom towers, irrigation needs of the farmers in the village and productive enterprises such as flour mill, oil expeller, shops in the village market requires investment of approx USD87,000. For this investment, ESCO will earn a modest rate of return of 17.5% and will recover his/her investment in a little over 7 years (payback). As is evident, rural DRE mini-grid projects mimic infrastructure investments and require long term capital with a high risk appetite given the nascence of this sector.

In this report we would be estimating the need as well as the availability of capital for DRE solutions in India with a particular focus on rural mini-grid DRE electrification projects.

Sizing the opportunity for rural DRE mini-grids

The emerging DRE mini-grid opportunity

The Indian rural landscape is vastly un/under electrified. More that ¼ of the Indian population, i.e. a staggering 293 million people do not have access to energy and a significant proportion of this population resides in India's rural heartland. As per 2011 census data, on an average only 55% of rural households in India have access to electricity. There are 8 states which are below or equal to this national average with Bihar and UP being abysmally low with only 10% and 28% of rural households having access to electricity respectively. In addition to the number of people with no access to electricity, there exists a substantive population where supply of electricity is at best, sporadic and unreliable.There are many households in rural India which do not meet the minimum electricity consumption threshold of 1 unit/household/day (as defined in the National Electricity Policy, Government of India).

The annual per capita electricity consumption data for different states of India also presents a gloomy picture with about 13 states being below the national average of 788 kWh. The maps below depict states which fall below the national average in terms of (a) annual per capita electricity consumption and (b) percentage of rural households having access to electricity.

Figure7:Access to electricity and per capita electricity consumption inIndia

States with lowest annual per capita electricity consumption (below national average)

States with lowest percentage rural HH having access to electricity (below national average)

Scope of market

Based on the size of the state (population) along with the existing state of electrification (including adequacy of supply) and average consumption of electricity, the states with maximum potential (excluding north eastern states due to difficulty of terrain) include: Bihar, Uttar Pradesh, Jharkhand and Odisha.

Table 2: Current state of electricity access and consumption in selected states

Shortlisted states	Total population (in million)	% of rural population below poverty	% of rural HH having electricity access	Annual per capita electricity consumption (kWh)
Bihar	103.8	55.3%	10%	117.5
Uttar Pradesh	199.6	39.4%	24%	386.9
Jharkhand	33.0	41.6%	32%	750.5
Odisha	41.9	39.2%	36%	837.5
National Average			**55%**	**778.6**

Source: Ministry of Power (Govt. of India), Census data 2011

Estimated potential demand for rural DRE mini-grids ranges from 553MW to 7.6GW in the selected states of U.P, Bihar, Orissa and Jharkhand

The demand potential for DRE mini-grids detailed in this report is ascribed to the 4 priority states that house the most number of un/under-electrified villages/households in India. However, the scope of the total rural DRE market in India is not restricted to these states as the problem of insufficient energy access is being grappled by most of the Indian states.

Sizing the potential demand and capital requirement for rural DRE mini-grids

Although significant potential is foreseen, the overall market for Distributed Renewable Energy (DRE) based rural electricity supply is still nascent and primarily unstructured. Most of the focus in recent times has been on captive requirements and co-generation, typically in the range of a few megawatts (MW). Sub-Megawatt (MW) scale off-grid RE technologies have only started maturing in the last few years.

While different estimates of the likely market size of the Indian rural electricity market are floating around, there is consensus that rural DRE mini-grid is an emerging market waiting to be explored. In order to adequately evaluate the demand on ground and quantify the opportunity, it is imperative to look at both existing demand as well as latent demand which will begin to emerge, once a solution is identified and proven.

Approach adopted

The potential for rural DRE mini-grid market can be estimated in multiple ways. A bottom up approach has been adopted in this report in order to estimate the potential for rural DRE mini-grids in the 4 shortlisted states of India. As a first step, all un-electrified and under-electrified villages were enumerated district wise for each state totalling to about 210,000 villages. Districts where electrified rural households were less than 30% were shortlisted. Since DRE mini-grids are not economically viable in extremely small village clusters, the shortlist was narrowed to only include villages with greater than 300 households but less than 1000 households, totalling 30,226 villages (detailed assumptions and village level data are provided in Annexure 6). The electricity requirement of these 30,000 shortlisted villages was calculated on the basis of three scenarios:

a) 0.75kWh/ household/day assumed as immediate power requirement (based on extensive field data collected by cKinetics in the shortlisted states)
b) Between 2 kWh to 10 kWh/ household/ day to meet the average annual per capita electricity consumption of the state
c) 10.6 kWh/ household/ day to meet the average national annual per capita electricity consumption

A corresponding generation capacity has been estimated in Megawatt (MW) terms for each of these scenarios to arrive at the market potential for rural DRE mini-grids in the four most underserved states of India.

Estimated demand potential

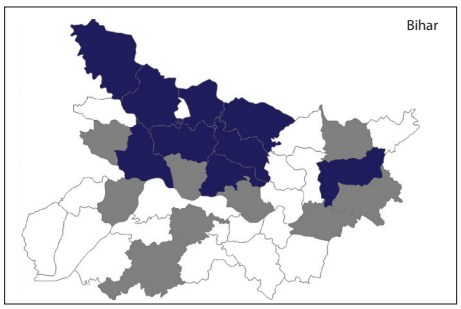
The analysis of the four shortlisted states reveals that the potential demand from the target 30,226 villages ranges from 553 MW (needed for immediate consumption) at the lower end

Shortlisted States	Shortlisted villages	Households with electrification potential for mini-grids	Power required for total energy requirement for national average (MW)	Power required for total energy requirement for state average (MW)	Power required for immediate energy requirement for cKinetics estimates (MW)
Bihar	10,034	3,570,416	2,718	505	188
Jharkhand	1,081	354,461	270	366	19
Odisha	1,682	542,366	413	458	29
UP	17,429	5,553,879	4,228	3,298	317
G. Total	**30,226**	**10,021,121**	**7,629**	**4,628**	**553**

Bihar

Out of a total of 38 districts in Bihar, 36 were shortlisted (listed in Annexure 6) based on the percentage of electrified rural households in each district being less than 30%. In a state housing 45,067 villages,around 10,000 villages (with more than 3 million households) were identified in these selected districts as having potential for DRE mini-grid projects ranging from 188MW to 2718MW cumulatively depending on the consumption scenario chosen. The map below represents the high potential districts for DRE mini-grids in Bihar.

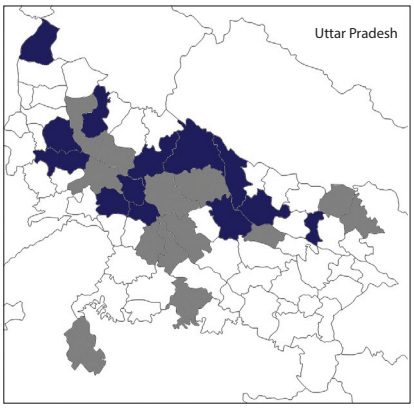
Figure 8: Districts with high potential demand in Bihar



Uttar Pradesh

51 out of 71 districts were shortlisted in Uttar Pradesh (listed in Annexure 6), the most populous state in India housing close to 200 million people. 17,429 villages with 5.5 million households represent an estimated DRE mini-grid demand potential ranging from 317MW to 4,228MW. Amongst the chosen four states, Uttar Pradesh has the maximum potential for DRE mini-grids since it represents large densely populated areas with extremely low or nil electrification.

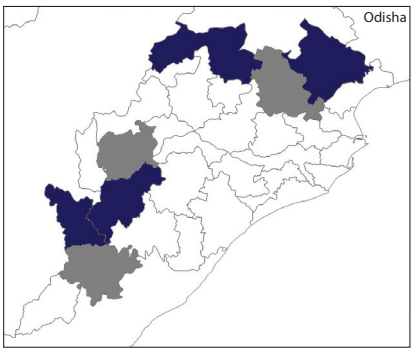
Figure 9: Districts with high potential demand in Uttar Pradesh



Odisha

Though Odisha has about 51,000 thousand villages, only 1,682 villages have been estimated to have potential for DRE mini-grids as most villages in the state are small and fragmented and do not meet the viability criteria of having greater than 300 households per village. Out of the chosen 14 districts (listed in Annexure 6)

Figure 10: Districts with high potential demand in Odisha

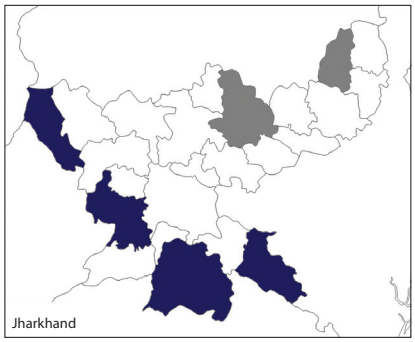


(from a total of 31), the estimated demand potential for DRE mini-grids in Odisha ranges from 29MW at the lower end to 413 MW at the upper end of the spectrum.

Jharkhand

Jharkhand with 32 million population across 24 districts is amongst the recently formed states in the country and has an estimated demand potential of 19MW to 270MW in 10 of those districts (listed in Annexure 6). Jharkhand being a much smaller state than Bihar and Uttar Pradesh has much lesser potential demand in absolute terms compared to these states.

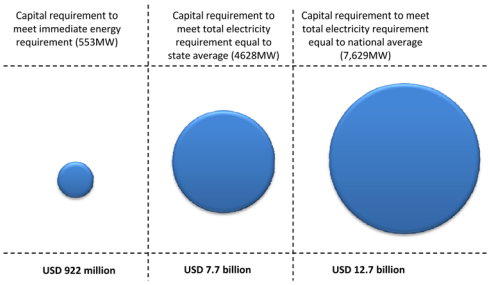
Figure 11: Districts with high potential demand in Jharkhand



Estimated capital requirement for rural DRE mini-grids in India

Significant capital will be required in order to satisfy the potential demand estimated for rural DRE-mini grids in these four states of Uttar Pradesh, Bihar, Odisha and Jharkhand. It is estimated that atleast USD 922million is required to meet the immediate power requirements through rural DRE mini-grids in the selected states. The capital requirement increases to USD 12.7 billion assuming the highest electricity requirement per household equals the national per capita consumption.

Figure 12: Estimated potential capital requirement for rural DRE mini-grids in India (UP, Bihar, Odisha and Jharkhand)



Nature and profile of firms engaging in the emerging mini-grid opportunity

Although the rural DRE mini-grid market is nascent with only a few ESCOs present currently, it is fragmented with different players. One reason for this can be that existing players are experimenting with different business models to identify and finalize the ones that are sustainable, scalable and replicable.

ESCO Characteristics and models

ESCO business models for rural DRE mini grid projects are based on the following key drivers:

1. **Scope of activities**

   ESCOs can undertake different components of a DRE based mini-grid and their underlying activities, and this in-turn, is key in determining the plant risk, contribution margins, organizational setup and the business value chain.

   The following are the broad buckets under which an ESCO operates Most service

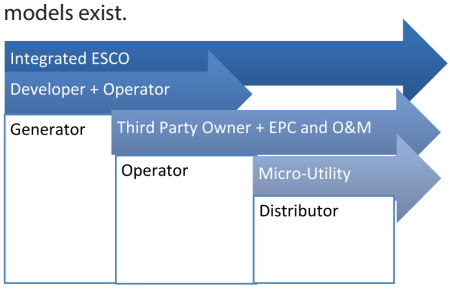
Generation of Power	Distribution of power
1. Plant Engineering Procurement and Construction 2. Plant Operations & Maintenance 3. Technology provider	1. Grid Engineering Procurement and Construction 2. Grid Operations & Maintenance 3. Micro-utility 4. Technology provider

   providers presently prefer being responsible for generation Engineering, Procurement and Construction (EPC) and Operations and Maintenance (O&M) and seek partnerships with local entrepreneurs or Village Community entities for the distribution and revenue collection purposes.

2. **Participation in Asset Ownership**

   An ESCO may or may not decide to hold the generation and/or distribution asset on their books depending on their financial strength. An ESCO may choose to work with a third party owner (TPO) for generation asset (which is a large proportion of the capex) and the distribution asset (which is relatively small) and in turn pay the TPO and annual fees.

Based on these 2 factors, the following business models exist.



3. **Nature and Financial strength of ESCOs**

Depending on the maturity of the organization, an ESCO can be classified as one of the following:

- Nascent ESCO: A relatively new organization which is yet to establish a track record and a proven business model
- Growth Stage ESCO: An organization with a track record for plant operations but still in the process of building scale and refining its business model
- Corporate Entrant: An organization whose main line of business is not that of an ESCO and is entering the ESCO business to diversify and gain benefits from fiscal incentives (e.g.: accelerated depreciation)

Different ESCOs represent different financing needs and have different asks from the investor community. ESCOs which are just entering the business without any track record or business model need a combination of donor capital and concessional equity financing. ESCOs which have an established track record need a combination of growth capital in the form of equity and debt for scaling up. ESCOs emerging from established business pedigree have proven track record and financials due to their primary business typically desire project financing to finance their rural DRE mini-grid projects.

Quantification of the number of ESCOs emerging and estimates of the demand for capital are being carried out by the cKinetics team as this document is being written. For additional details please contact the authors.

Table 4: ESCO characteristics and financing needs

Type	Type A Nascent ESCO	Type B Growth stage ESCO	Type C Corporate Diversification
Description	An entrepreneur looking to establish operations	Company with existing DRE businesses and an established operational capability but lack of scale and firmed up business model	An existing Corporate Group looking to diversify their existing businesses and enter a new sector.
Track record and collateral	These ESCOs have limited track record for both operations and profitability	These ESCOs have - proven operational track record - limited collateral due to limited depth of balance sheet – thus limited ability to raise debt	These ESCOs have - proven track record of profitability over many years - relatively strong balance sheets
Typical Financing needs	Grants and equity	Growth stage capital including a combination of both equity and debt	Debt financing preferred on stand-alone project basis

Current state and experience of capital accessible for the mini-grid led DRE sector

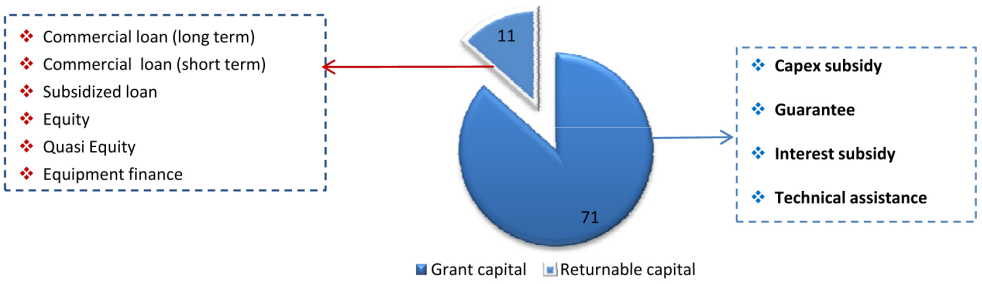
Currently there exists a potential annual available capital flow of USD 82m which is ready to be deployed in the rural Decentralized Renewable Energy (DRE) mini-grid sector in India

Quantifying potentialcapital available for rural DRE mini-grids in India

Given the nascent stage of the rural DRE mini-grid industry and lack of a structured market, most investors are still shaping up their interventions to address the opportunities presented by such a portfolio.

As per our landscape assessment, USD 82m of capital is potentially available annually for deployment in the rural DRE led mini-grid sector in India: for both large and small projects. Of this, 86% is grant capital received from government, Development Financial Institutions (DFIs), corporate social responsibility funds, etc. and only 14% is returnable capital available from private mainstream investors in the form of equity, loans (commercial loans, equipment financing, subsidized loans etc.).

Figure 13: Potential Annual Available capital flow for rural DRE mini-grid (USD82m)



cKinetics examined the kinds of and quantum of capital that can be potentially tapped by developers of DRE projects. We then narrowed our assessment to focus on the type and quantum of capital that can be potentially available for rural DRE mini-grid projects only.

Availability of different types of capital for rural DRE mini-grids from different sources is estimated based on the average ticket size of investment which the Financial Institution is comfortable in investing and the eligibility conditions of the FI for investing in/lending to an ESCO.

Financial institutions have investment criteria which may include elements such as strength of the balance sheet of the firm, track record of operations, a certain minimum return/IRR expectation from the project, strength and background of the promoters of the firm, profitability ratios and in cases of debt, additional conditions such as collateral, guarantees (either from the promoter of the firm or a third party), adequate debt service coverage ratio etc.

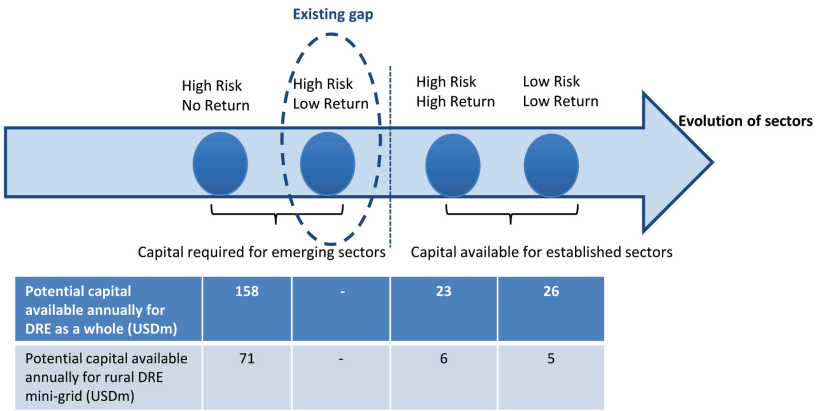
Applying these filtering criteria we determined the capital which can potentially be available for rural DRE mini-grid projects in India. In the following section we describe the different capital providers and the quantum of capital that is potentially available in each bucket.

Based on primary conversations with over 30 investors, the landscape of investors for DRE led mini-grid consists of the following types of capital providers:

Table 5: Estimated capital potentially available annually for DRE mini-grids

Type of capital	Likely providers	Capital potentially available annually for DRE as a whole (USDm)	Capital potentially available annually to seed DRE led mini-grid investments (USDm)
Technical Assistance (TA)	Government, donor agencies, DFIs, Corporates from CSR funds, Climate funds	27	10
Subsidies (for capex/interest)	Government	131	61
Total donor capital		158	71
Commercial loans (short term and long term)	DFI, commercial banks, NBFCs, RRB	20	4.3
Subsidized loans	DFIs, EXIM banks	2.5	0.4
Equipment Finance	DFIs, Commercial banks, NBFCs	3.4	0.9
Equity investment	Equity funds, impact investors, DFIs, HNIs	23	5.7
Total returnable capital		**49**	**11**

Figure 12: USD11m - Potential capital available annually for rural mini-grid DRE (excluding grant capital)



Potential capital available annually for DRE as a whole (USDm)	158	-	23	26
Potential capital available annually for rural DRE mini-grid (USDm)	71	-	6	5

Note: The dotted circles depict the potential available capital for DRE sector as a whole and the solid circles depict the potential available capital specifically for rural DRE mini-grid sector.

Profile of different capital providers

Different investors have different risk-return profiles, as well as different social objectives and these expectations affect the type of capital they provide to renewable energy projects.

The next table summarizes the characteristics of different instrument types and investor expectations.

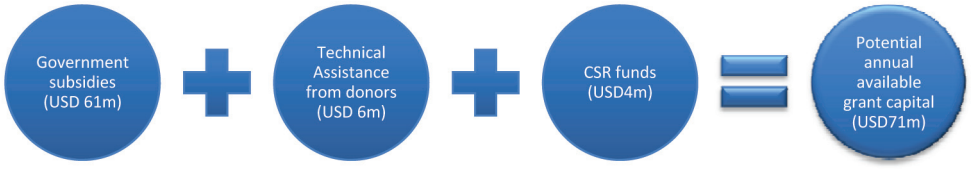
HNIs, Angel investors and Networks are a potential source of capital (both returnable as well as non-returnable). While not much significant capital has been deployed by them as yet in the DRE sector, they have a propensity to do so. (Details in Annexure 2)

	Grants	Equity and quasi-equity		Debt	
	Subsidies/technical assistance/guarantees	Commercial equity	Impact capital	Short term debt	Long term debt
Sources of capital	Government, Global Foundations and donor agencies, CSR funds	Private equity and venture capital funds, HNIs	Social venture funds, impact investors, International DFIs, HNIs	Regional rural banks, NBFCs, Equipment financers, Indian DFIs	Commercial banks, EXIM banks, Intern-ational DFIs, Indian DFIs
Terms and conditions of financing	Impact created, nascent sector which needs to be developed	Business model, track record, promoters, balance sheet	Impact created, business model, promoters	Balance sheet, track record, collaterals	Balance sheet, Profitability/ Debt service coverage ratios, track record, collaterals, guarantee
Tenure	N/A	4 – 5 years	4 – 5 years	6 months – 3 years	7 – 15 years
Risk appetite	High	Medium	Medium and High	Low	Low
Return expect-ation (in Rupee denom-ination)	Not Applicable	20%-35%	5%-35%	16%-18%	12%-16%

1. **Grant/donor capital: Seeding the emerging sector**

Out of USD 82m of capital that is potentially available annually for rural DRE mini-grids, USD71m is in the form of grants i.e. non-returnable capital. The renewable energy sector has been receiving the attention of global foundations as well as government agencies which have been making efforts to support this nascent sector. Grants are required not only for supporting the initial investment costs of the power plants but also to promote capacity building and training programs at all levels (including developer, operator, etc.)

There is almost USD6m in the form of technical assistance funds potentially available annually from few global foundations who are concentrating their efforts in the renewable energy and energy access domain. Another significant source of non-returnable funds is the Corporate Social Responsibility budgets of both public sector and private sector companies in the country which have been set aside for sustainable development or betterment of society. It is estimated that USD4m will be potentially available for renewable energy projects from this pool.



Government major contributor, though schemes yet to achieve scale

USD61m worth of annual non-returnable capital is potentially available to rural DRE mini-grid projects in India in the form of subsidies from capital expenditure as also low interest bearing loans from the government.

Government of India has instituted specific schemes for decentralized renewable energy projects to provide support to the project developers either through capex subsidies or interest subsidies for loans. The level of subsidy varies with each renewable energy technology (solar/wind/biomass/biogas etc.), ranging from 10%-90% of the initial investment, depending on the maturity, of that technology and the nature of project itself (Government commissioned or catalyzed by private sector efforts).

Though the government has made significant effort to deploy decentralized renewable energy solutions to provide energy access through its multiple schemes, it has yet to find a scalable model. Schemes such as Village Energy Security Program (VESP), Remote Village Electrification Program (RVEP) and Decentralized Distributed Generation (DDG) have been initiated by the government starting as early as 2003. Slow release of funds, operational barriers, lack of business case for implementation agencies etc. are some of the factors which led to the stymied progress of these government schemes. An overview of the schemes, their status and key learnings are listed in Annexure 4.

Though the grant capital that is potentially available annually to be deployed in the DRE mini-grid sector in India is relatively significant, one needs to be cognizant of the limitations of such kind of capital. For the donor segment, fatigue is slowly setting in and donors are more willing to engage as providers of enabling capital such as guarantee schemes, rather than direct finance support for rural DRE mini-grid projects. Also, lack of policy clarity coupled with inefficient delivery mechanisms render government support schemes less useful. Moreover, public finance is limited and therefore needs to be channelled effectively. Non-returnable capital is necessary for handholding and buttressing the growth of the nascent DRE sector, especially rural DRE mini-grid but desired scale can be achieved only through the participation of mainstream private capital.

Waiting Spectators

Another potential source of capital which may become available for DRE projects in the near future could be 'strategic capital'. This would come from renewable energy equipment providers who would invest in DRE to expand the market for their products; conventional power generation companies such as NTPC, Reliance Power, Tata Power etc and even global Energy companies like BP, Shell, EDF Energy who would invest in the form of strategic CSR or for strategic marketing. It would be difficult to quantify this 'strategic capital' at this stage, though this may emerge as a source of both returnable and non-returnable capital in the near future.

2. Debt: Available but more for low risk projects, established companies

No. of active players	No. of players sampled in the study	Potential debt capital available annuallyfor DRE as a whole (USDm)	Potential debt capital available annually for rural DRE mini-grid (USDm)
35	24	26	5.6

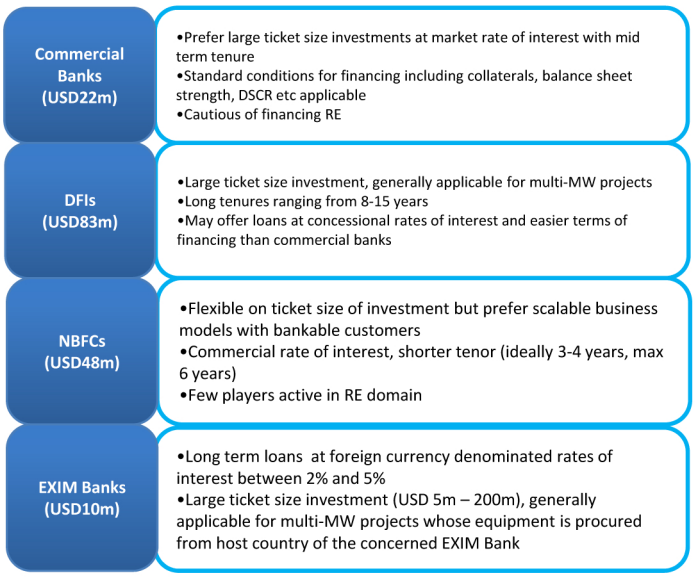
Debt is essential in any infrastructure project financing. DRE projects are no exception. As per our study, approximately USD26m of debt (both short term and long term) is potentially available for decentralized renewable energy projects in India. Though credit lines exist exclusively for renewable energy projects, most developers face a challenge in arranging debt for their DRE projects. Debt for DRE is available from commercial banks, Developmental Financial Institutions (DFIs), Non-Banking Finance Companies (NBFCs) and EXIM Banks. Out of

these lenders, DFIs and NBFCs are more willing to lend to rural DRE mini-grid projects and have a comparatively higher risk appetite than commercial banks.

Debt is also available from Regional Rural Banks (RRBs) and few foreign commercial banks based on-balance sheet lending. However, these two are not predictable sources capital and hence have not been included in our model estimates.

We estimate that about USD 5.6 m of debt is potentially available annually for DRE mini-grid projects from the sources listed in Fig 11.

Figure 15: Characteristics and outlook of different sources of debt for rural DRE mini-grid



Key take-aways from conversations with lenders regarding rural DRE mini-grid investments include:

- Most lenders prefer lending to sectors with established business models, known performance characteristics, and quantifiable risks due to their low risk appetite and hence a nascent sector like rural DRE mini-grids doesn't fall in their top priority list.
- Excluding some sectors such as infrastructure and power, lenders typically offer loans for 5-6 years which is shorter than the ideal tenure for DRE-mini grids which are long term investments.
- Also, lenders ideally like to lend to established companies with a strong balance sheet, track record, ability to provide collateral etc. DRE mini-grid still being a nascent sector has a lot of new and emerging entrepreneurs who don't meet the above criteria and hence don't have access to these loans.

3. Equity: More amenable to new companies and business models

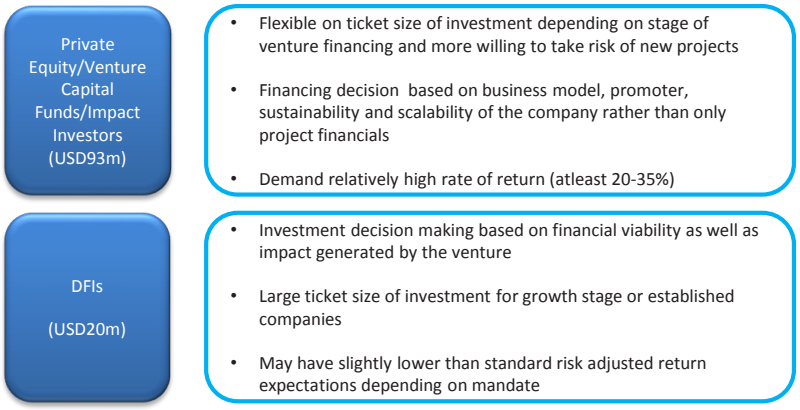
No. of active players	No. of players sampled in the study	Potential equity capital available annually for DRE as a whole (USDm)	Potential equity capital available annually for rural DRE mini-grid (USDm)
37	30	23	5.7

As per our landscape assessment, USD23m of funds are potentially available to be invested as equity in decentralized renewable energy projects in India. Out of this, USD5.7m is potentially available annually for rural DRE mini-grid projects in India from traditional private equity and venture capital funds or DFIs.

Conversations with investors regarding rural DRE mini-grid investments reveal:

- Most equity funds interested in participating in the DRE mini-grid sector expect high equity returns (approx. 20-35%) from these projects and prefer to invest in growth stage companies with established business models and successful implementation of several pilots on ground.
- Equity investors would ideally like to exit within 4-5 years. However, funds solely focused on renewable energy often have longer investment periods which may go upto 10 years.
- Most India focused equity funds do not have a geographical preference amongst the various states in the country.
- Very few funds are focused on a particular technology and in most cases they are agnostic amongst the various renewable sources, though some may have a pecking order of preference amongst the various technologies.
- Currently, the biggest challenge faced by equity investors is the lack of debt financing for their existing investments so that they can pursue scale.

Figure 16:Characteristics and outlook of different sources of equity for rural DRE mini-grid



Field Building Efforts required to shape a sustained and expedited uptake

Gaps to be addressed to help build the rural DRE mini-grid market

DRE mini-grid based rural electrification represents an investment opportunity in an emerging and much needed infrastructure sub-segment but key concerns need to be addressed for the sectorto evolve.

Currently, there exists a mismatch between the type of funds that ESCOs setting up rural mini-grid DRE projects need and what is available from the various sources of capital.

Gaps to be bridged to attract capital

The key reason for reluctance by investors to provide capital to rural DRE projects is the unfamiliarity with risks associated with the sector, be it technology uncertainty, business model uncertainty or regulatory uncertainty. There has been a cautious engagement by the private sector till date primarily due to concerns on upfront capital expenditure vs. expectationof Return on Investment (RoI), uncertain outlook on bankability of projects and exit options, smaller ticket sizes and relatively high due diligence costs, limited information on maturity of technology and lack of clarity on the policy regime around the operating environment for these projects.

Interventions are needed to mitigate some of the key challenges in order to forge a connect with the mainstream investors.

Some of the key challenges which plague the rural mini-grid DRE sector from an investor's perspective are:

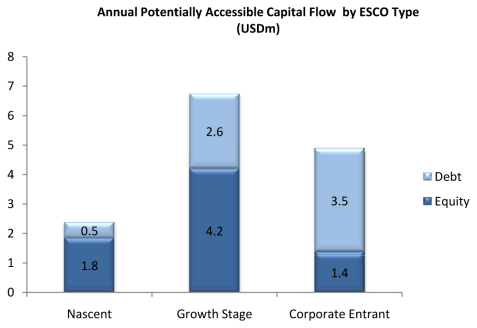
Table 7: Key gaps which need to be bridged in DRE mini-grid sector

Key Gaps	Potential measures to mitigate challenges
Uncertainty of revenue from consumer-currently there is limited formal evidence regarding the revenue collection from end customers /rural users even though informal mechanisms exist	3-6 months of payment taken as advance security deposit from rural customers to ensure revenue visibility for the Energy Services Company (ESCO) may provide comfort to investors.
Revenue and pricing risk-rural DRE mini-grid projects still do not have an established business model, sufficient track record of operationsand uncertainties around load/ demand prediction, pricing mechanism and revenue collection.	Combination of solutions such as pre-paid metering, institutional Power Purchase Agreements (PPAs) with an anchor client in rural areas to assure certain minimum off-take from the power plant. They also provide longer term visibility and assurance.
Regulatory risk-uncertainty around government's outlook on rural DRE mini-grid projects, power pricing and expansion of the central grid	Policy disruption to tariff is presently an unaddressed risk. Mechanisms to be grid interactive and feed back to the central grid once it arrives in the region of plant operation can help address this risk.
Long pay-back period-long pay back periods due to high initial investment and lack of ability to earn very high returns	Blended capital (grants combined with returnable investment capital) instruments which provide long tenure capital.

Gaps to be bridged to attract ESCOs

Most of the presently known demand for capital is from Nascent ESCOs, i.e. new, emerging firms which have just entered the DRE mini-grid market; whereas most of the supply of capital is for established firms and projects with proven business models.

Figure 17: Potential capital available annually for rural DRE mini-grid as per ESCO Type



Gap of capital for Nascent ESCOs

Due to high due diligence, transaction and monitoring costs, large equity funds are hesitant to invest in less than USD1m ticket size. **Nascent ESCOs form a part of the 'missing middle' segment where the investment requirement is more than angel financing but less than traditional venture capital financing.** Even Development Finance Institutions and socially minded venture funds prefer relatively larger deals than those required by nascent ESCOs.

As with any emerging sector, commercial lenders are sceptical of extending debt to rural mini-grid DRE projects. Thus the accessibility of debt finance to nascent ESCOs is extremely poor and is unlikely to improve till they reach a certain scale of operations and prove their business model.

Gap of capital for Growth Stage ESCOs

Access to equity financing becomes easier for Growth stage ESCOs who have some track record and tested business models. Moreover, the investment requirement of such firms is more in line with what the investors prefer.

However, even growth stage ESCOs with some track record and relatively robust operating models find it difficult to access debt as in most cases, they are yet to establish commercial viability and demonstrate profitable business operations for a continuous 2 – 3 year period.

Gap of capital for Corporate Entrant ESCOs

Debt is comparatively easily available for corporate entrants who have a strong parent balance sheet and an established track record of primary business. As seen in Figure 15 almost 80% of the total potential accessible capital for corporate entrants is debt funding. While on the surface it may appear that this capital is available, Corporate Entrant ESCOs are looking for debt without recourse. One of the key reasons for that is that their existing balance sheet almost always is already secured by a lender for an alternate purpose.

Risk mitigants needed to make the market attractive

In order to meet the financing needs of this emerging sector it is important to address the following gaps:

a. **Tenure of capital is a challenge for all ESCO types**: presently most potentially accessible capital is looking for tenure between 4-6 years; whereas the rural mini-grid DRE projects that serve a productive load have long term paybacks- typically in the 6-8 year window (and some possibly longer). These are infrastructure type investments and capital that is looking for returns in a 10+ year range is ideally what ESCOs are looking for.

b. **High-risk but low-return till the industry develops**: there is a need for high-risk capital that may be content with returns typical of infrastructure projects till the industry goes past its learning phase. More risk mitigating instruments such as guarantees which provide comfort to financial institutions and enable them to fund emerging sectors such as decentralized RE are required in order to catalyze private capital into the sector. Interest subsidies or blended forms or capital that reduce the cost of capital are also required.

c. **Size needs to be addressed for the Nascent ESCOs**: Gap of the "missing middle" sources of capital – which target deals between the "too small" (USD50,000 to USD100,000) investments and the "too big" (USD3 million to USD5 million) investments.[19]

Debt is most easily accessible to corporate entrants who have a strong balance sheet and an established track record of primary business. However they are looking for debt without recourse to their balance sheet.

Mismatch between capital supply and capital demand

As seen in the previous sections, there exists capital which can potentially be available for investment in rural DRE mini-grid projects in India. This potential pool includes various forms of capital with differing risk appetite and return expectations. As evident from our analysis, most of the returnable capital which may be potentially interested in rural DRE mini-grid projects is on two sides of the risk-return continuum:

1. Either it is grant or subsidy capital that has to be matched

[19]IFC, From Gap to Opportunity: Business Models for Scaling Up Energy Access, 2012

2. Or it is looking for a high-return to compensate for the high risk. Here too the capital has a limited tenure where there is a mis-match with the long-term paybacks of typical rural mini-grid DRE opportunities.

What is missing is the 'bridging capital' (high-risk and low-return)that will support high-risk DRE ventures and enable them to create a track record. This will then allow them to be then supported by mainstream capital. This evolution path is true of any evolving sector.

A new sector is usually initially supported by R&D, government funds, donors or other subsidies that usually help test various approaches of seeding a sector. This capital does not seek to be returned (high-risk and no-return in figure 16). As ideas begin to take form of solutions that can be tested in the market, capital is then required which can bear high risk with modest return expectations (high-risk and low-return in figure 16). This capital usually complements high-risk and high-return capital that is waiting to invest in the most promising approaches. And once a market matures and the risk is ascertained, capital providers who provide low-risk and also seek low-return deploy their capital.

This 'bridging capital', i.e. capital with high risk appetite, low return expectations (given the risk, is what the rural mini-grid DRE sector presently needs coupled with the fact that this capital needs to have a long tenure of 10+ years like infrastructure projects (given the nature of the projects).

Learnings from other emerging sectors: Factors and engagement models affecting availabilityof capital

As outlined in the previous section there is a need for high risk, low return and high tenure capital to be available in appropriate sizes as demanded by the ESCOs today.

Moreover, as shown in table 5, a disproportionately large amount of the potential annual capital flow for rural mini-grid DRE sector can be made available from public sources. However in order to leverage that capital, the private sector needs to be brought to the table.

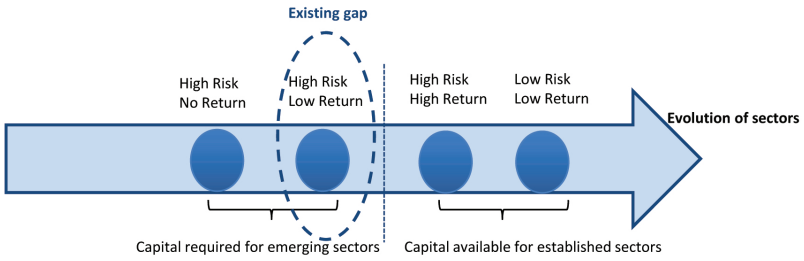
Many of the challenges limiting private sector involvement in the ecosystem have been described in table 7. While evident, it also needs to be highlighted, that many of these risks and challenges have been common across several other emerging sectors.

In this section, we look at solutions and models being adopted by other emerging sectors that have had related situations.

Attracting debt by distributing risks: Risk sharing facilities can encourage the provision of debt[20]

Risk-sharing facilities (RSFs) are sometimes used to encourage funding of early-stage companies where banks are hesitant to lend to a new sector. RSFs are in essence a loss-sharing agreement between an originator, such as a bank or other lending institution, and a commercial guarantor-such as IFC or KfW-or a donor. The guarantor, or donor in cases where a commercial guarantor cannot assume the first loss, reimburses the

Figure 18: Capital providers along the risk-return continuum



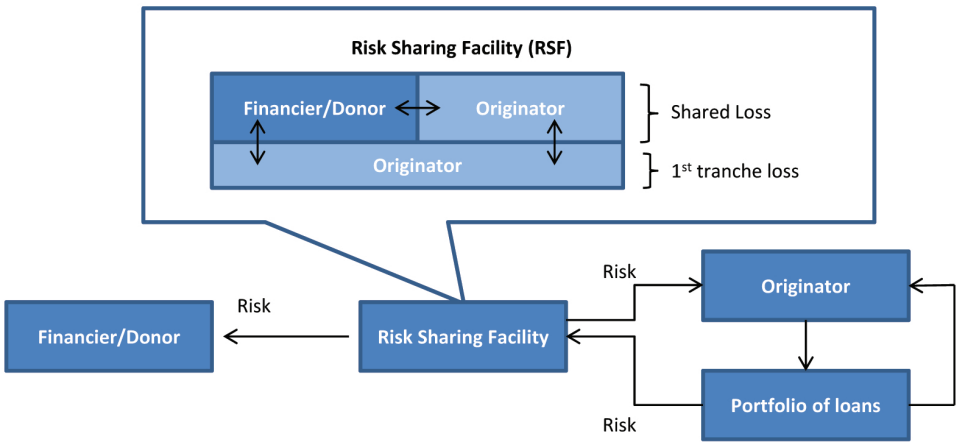
Potential capital available annually for DRE as a whole (USDm)	158	-	23	26
Potential capital available annually for rural DRE mini-grid (USDm)	71	-	6	5

originator for a portion of the losses it incurs on loans in a sector or line of credit that is of interest to them.

RSFs are typically provided as guarantees, but they could also be implemented as funded transactions. RSFs are portfolio mechanisms and they typically have an impact when a bank wants to enter a certain market segment but is wary of the risk of these borrowers and an RSF would reduce this risk somewhat. This is also applicable to the rural mini-grid DRE sector.

The DRE mini-grid sector could potentially greatly benefit from a risk-sharing facility in India, where many of the companies are starting up and are in need of growth or expansion capital and financiers are vary of undertaking risks associated with a nascent sector.

Figure 19: Risk sharing facility mechanism



Source: IFC, From Gap to Opportunity: Business Models for Scaling Up Energy Access, 2012

System design: Examples of eco-system development in other emerging sectors to attract capital

Eco-system development that includes right-sizing, replicability and scale is necessary to attract mainstream capital into emerging sectors. Many emerging sectors that involve infrastructure developments, as does rural mini-grid led electrification, require capital that is high-risk, low-return and long-tenure.

Table 8: Models to attract capital

Model	
Private sector driven models, catalyzed by donors and/or corporates	• Attracting capital in emerging sectors through specialized co-developer funds that develop opportunities and mitigate operational risk
Policy led models of engagement	• Attracting capital and developers into a new sector: for Renewable Energy based electrification under the Jawaharlal Nehru National Solar Mission (JNNSM)

Attracting capital in emerging sectors through specialized co-developer funds that develop opportunities and mitigate operational risk

Engaging in emerging infrastructure sectors has also been driven by co-developer funds that specialize in the sector. Co-developer funds raise capital from several investors and enable them to hold a portfolio. The key value-propositions include:

1. Specialized teams that are able to assess opportunities efficiently.

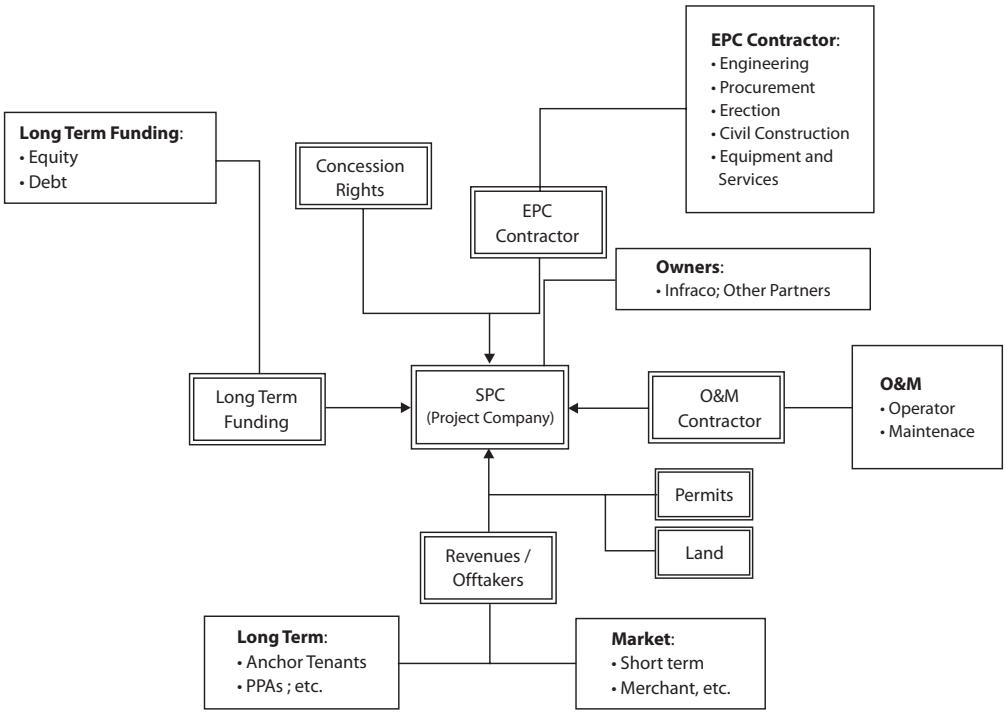
[20]IFC, From Gap to Opportunity: Business Models for Scaling Up Energy Access, 2012, Pg 139

2. Co-developer funds assume the most risk and provide low-risk opportunities for other investors that may want lower risks.
3. Co-developer funds diversify their risk by holding a portfolio.
4. They also provide an opportunity for investors with different risk appetites to hold a portfolio, by providing an opportunity to invest in the co-developer fund. Stratification of risk and return is possible by allowing different classes of capital providers: debt, equity, donors, etc. This also includes the ability to blend capital where required.
5. Aggregating projects and serving as vehicles for investors seeking different investment sizes.

Due to the fact that they assume significant project risk, co-developer funds also play an active role in project selection and project management.

InfraCo Africa and PTC Energy Ltd are examples of co-developer funds.

Figure 20: Deal structure viewed by InfraCo Africa



PTC Energy Limited (PEL) was set-up in India in 2008 as a co-developer fund in the power sector. It takes upto 26% stakes in projects that need support and hand-holding. PEL also goes beyond investing and provides active operational support.

Based on the involvement of co-developers, other capital providers are more comfortable investing in projects in emerging sectors for two reasons: co-developers assume the most significant risk and also bring a track record of experience across a larger portfolio.

Co-developer fund models mitigate risk and at the same time build operating capacity in emerging sectors. Some learnings for rural mini-grid DRE electrification are:

1. Operational risk can be addressed by having the fund assume a quasi-developer role thereby taking on part of the operational risk.
2. The fund can leverage its portfolio to be of sufficient economic scale to negotiate tariffs, PPAs, support securing equipment, etc.
3. By having the co-developer funds take the highest level of risk, it is able to attract other capital providers.

Attracting capital and developers into a new sector: For renewable energy based electrification under the Jawaharlal Nehru National Solar Mission (JNNSM)

The Jawaharlal Nehru National Solar Mission (JNNSM) was conceived to provide a kick-start to the grid-connected solar industry in India. It was driven by a policy desire to increase the mix of renewable sources in India's energy mix. The JNNSM was launched in 2010 with an objective to install 20GW of power by 2022. The first phase of the JNNSM is presently in progress (2010-13) and envisages around 1GW of solar power being set up with a capital investment of INR 11,500 crores (~USD2 billion).

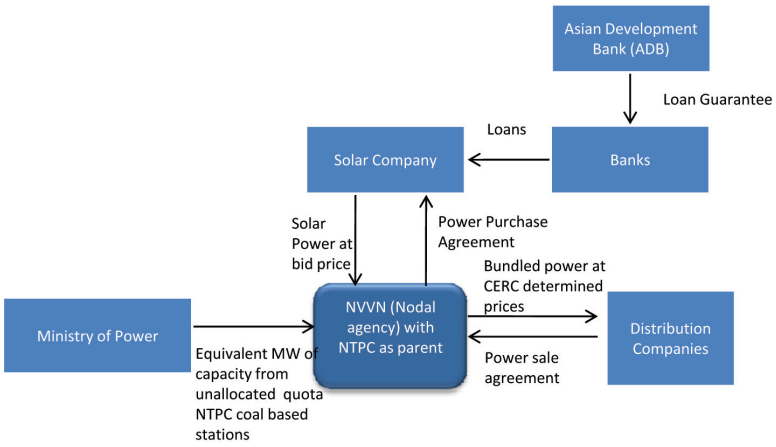
On the surface the JNNSM is similar to many infrastructure development programs, and yet has some key differences.

Table 9: Comparing JNNSM with infrastructure development programs

Similarities between JNNSM with infrastructure projects	Key differences from other infrastructure projects
• Risky in construction and set-up: unpredictable cost overruns • Stable and long term operating phase cash flow • Less sensitive to cyclicality of interest rates and business cycles • Positively correlated to inflation	• Emerging industry: consequently there are no players with track-records. • Cost of harnessing solar power is still significantly higher than its comparable alternatives, namely coal, hydro-power, wind, etc.

Due to the newness of the sector, the policy had to go beyond providing a bankable power-purchase-agreement (PPAs). In order to help mitigate risk, a partial credit guarantee (PCG) was created through the ADB. Further in order to address the issue of the high price of solar, the policy created a structure that bought the power at a high price, but sold it to the grid at a significantly lower price by bundling with unallocated thermal power.

Figure 21: Jawaharlal Nehru National Solar Mission (JNNSM)



As of February 2013, 340MW (130MW in batch 1 and 210MW in batch 2) new solar PV projects have been commissioned in India out of the 500MW (150MW in batch 1 and 350MW in batch 2) allotted.

On the flip-side however, only 30% of the total debt capital mobilized has been from commercial banks with the key sources being from Exim banks and Development Finance Institutions (DFIs). These are typically players that are

investing in high-risk and long-tenure operations. In other words even after the policy push, the market development is still being supported by investors that have a long-tenure outlook and high-risk appetite.

A few learnings from the JNNSM case are relevant to the rural mini-grid DRE electrification:

1. Attracting mainstream capital into an emerging infrastructure sector will require support from investors with a long-term and high-risk outlook that will assure other investors.
2. While in the case of the JNNSM, bundling was done to lower the effective price of solar power to electricity distribution company (discoms) and ensure a minimal impact to discom purchasing a solar unit and in turn the end-consumer, the logic could be extended to shape an integrated end-consumer tariff where the entire additional investment burden for RE is spread across the entire consumer base.

Matching what's needed to what's available

cKinetics is working with a select group of investors and ESCOs to define the future directions for financing interventions in the rural DRE mini-grid space. The aim is to identify ways of addressing the mismatch and gap between the supply of Capital and the (known) demand of capital. The approach is to define financing interventions (related to both - direct and enabling capital) that would aim to:

1. Unlock capital for project developers that is presently available, but is inaccessible.
2. Address the financing gap that remains unmet even after funds from existing facilities have been made available.

Some of the potential interventions/facilities being ideated upon include:

1. Co-developer equity facility
2. Long term, low cost loan facility
3. Asset owner facility that owns the mini-grid
4. Blended capital structures that are supported by CSR or other donors due to the requirement of low cost funds

The co-developer facility would take a stake in the DRE mini-grid project in the form of an equity investment. Typically such an investment is operationalized through setting up of a Special Purpose Vehicle which is co-owned by the ESCO and the co-developer fund. The profits are also shared between the two entities as per a pre-determined ratio or the percentage of ownership. The co-developer fund is more than just a passive investor in the project and helps in operational hand holding of the project since it has experience in the domain. It also helps attract other investors and lenders with a lower risk appetite to the project since it assumes the maximum risk.

As analysed in the earlier sections of this report, there is a gap in availability of high risk, low return and long term capital. A facility which provides long term debt (tenure of greater than 8 years) to DRE mini-grid projects at lesser than market interest rates may help bridge this gap. Such a facility would also help these projects attract greater participation from other mainstream capital providers (lenders and/or equity investors).

For some DRE mini-grid projects in remote rural areas with very little economic development, establishing financial viability is not very easy and both ESCOs and investors are vary of getting involved in them. In such cases, an asset owner facility which invests and assumes ownership of the micro-utility can help attract more ESCOs who can invest in the power generation asset (which is movable) and derive modest returns. Such a facility could be supported by Corporate Social Responsibility (CSR) funds or other donor funds in order to be sustainable. Such an intervention would help expand the scope of the rural DRE mini-grid market to the most underserved areas, create the requisite impact as also help in attracting private participation (of both ESCOs and investors).

The desired outcome is that the proposed financing interventions would not only attract investors and donors to the rural mini-grid DRE space but also help project developers achieve target IRRs and make them 'worthy' of the different types of capital that is made available. Learnings from other related sectors, some of which have been listed in this report would be taken into account in order to identify financial interventions for the rural mini-grid DRE industry.

Engaging in defining financing interventions to develop the rural DRE mini-grid industry

Outlined below are reasons for you to engage and should you wish to do so, please contact us.

We are looking to connect with…	who are looking to…
Equity investors	Create pathway for their portfolio companies to raise capital from additional sources once their models are proven as also those who are willing to explore investments in upcoming enterprises.
Commercial/Mainstream lenders	Develop early presence in a new emerging market segment; and defray risk through capital from Donors, CSR Capital etc.
Developmental Financial Institutions	Work with mainstream capital providers and find ways of leveraging their capital to attract more private sector participants
CSR capital	Identify opportunities for deployment and creating leverage for their grant/ subsidy capital that creates social as well as economic impact in areas of interest.
Foundations and large institutional donors	Explore blended capital models that help create 'bridging capital': high-risk, low-return and long term capital that will develop the rural DRE mini-grid sector; which in turn will promote enterprise development and economic development
Angel investors/ Angel networks/ HNIs with an 'impact' outlook	Invest capital that can take high risk for a meaningful social return and modest financial returns
Individual philanthropic capital/ philanthropic networks	Deploy own donor-capital in a regional manner and support/ spawn entrepreneurs
Government/ policy designers	Align policy actions with private sector interests, which in-turn can be used to meet policy goals around rural electrification and economic development
Energy Services Companies (ESCOs) putting up DRE mini-grids	Get insight into outlook of capital providers and ideally get access to long-term capital; and looking to lower cost of capital by tapping appropriate mix of capital from different sources

In order to get engaged and know more about this study, please contact Shradha Kapur (skapur@ckinetis.com) from cKinetics.

Glossary

Decentralized Renewable Energy (DRE): All off-grid generation and distribution projects based on renewable energy including both captive and micro-grid led projects as well as stand-alone renewable energy based devices such as solar lanterns, solar irrigation pumps, biomass based cook stoves and solar home lighting systems.

Rural DRE mini-grids: Decentralized generation and distribution projects based on renewable energy, primarily set up in rural areas to provide electricity access through a decentralized distribution grid.

Capital Expenditure (CAPEX): Expenditure incurred to acquire or upgrade fixed assets such as property, plant and equipment.

Development Finance Institution (DFI): Financial institutions that provide finance development projects undertaken by private sector.

Decentralized Distributed Generation (DDG): It is the on-site generation of electricity using many small energy sources like micro-hydro plants, windmills, biomass gasifiers etc.

Energy Service Company (ESCO): provides a broad range of comprehensive energy solutions including designs and implementation of energy-savings projects, etc.

Gigawatt (GW): Unit of power, defined as one joule per second. 1 GW equals 1 billion $(10)^9$ watts.

Grid: It is a network that supports electricity generation, transmission and distribution.

Kilowatt hour (kWh): Is the amount of energy consumed by 1 kW load when run for one hour. It is most commonly known as a billing unit for energy delivered to consumers by electric utilities.

Off-grid: Any electricity network not connected to the grid.

Patient capital: Long-term capital investment where investor is willing to forgo short-term profits for long-term value maximization.

Power Purchase Agreement (PPA): Is a contract between two parties, one that generates electricity for the purpose of sale and one that is looking to purchase electricity.

Direct capital: Capital which will be deployed/ invested directly in the projects or companies

Enabling capital: Capital which doesn't get deployed directly in projects or companies but which can be used to catalyze forms of direct capital to be invested in the projects or companies (eg: loss default guarantees etc.)

Returnable capital: Capital which is deployed/ invested in a project/company on the condition that it has to be returned to the investor at zero/ some rate of interest. (eg: equity investment, loans etc.)

Non-returnable capital: Capital which is deployed/invested in a project/company and doesn't have to be returned to the investor (eg: grants/donor funds, subsidies)

Potential total available capital: The estimated total potential available capital that is ready to be invested in DRE over in the coming few years (3-5 years)

Potential annual available capital: The estimated amount of capital that is likely to be available annually for investing in DRE.

Potential total accessible capital: The estimated total potential capital that is likely to be accessible by developers for mini-grid DRE projects focussed on rural electrification in the coming few years (3-5 years).

Potential annual accessible capital: The estimated amount of capital that is likely to be accessible annually by developers for rural mini-grid DRE electrification projects.

Annexures

Annexure 1: List of financial institutions and investors mapped for this report

S.No.	Name of Institution	Type of Organization
1	Aavishkaar*	Equity Fund
2	Accelerator First Light*	Equity Fund
3	Actis*	Equity Fund
4	Acumen*	Equity Fund
5	ADB	International DFI
6	ADFD/IRENA	Climate Fund
7	Aditya Birla NBFC	Large NBFC
8	AFD	International DFI
9	Aga Khan Foundation	Global Foundation
10	Allahabad Bank	Commercial Bank
11	Aloe Environment Fund III	Equity Fund
12	Artha Platform	Angelinvestors/angel networks
13	Axis Bank	Commercial Bank
14	Bajaj Finance	Large NBFC
15	Bank of Baroda	Commercial Bank
16	Bank of India	Commercial Bank
17	Berkley Partners LLP	Equity Fund
18	Bessemer Venture Partners*	Equity Fund
19	Breathe India Advisors Pty. Ltd.	Equity Fund
20	Calvert Foundation	Global Foundation
21	Canara Bank	Commercial Bank
22	Central Bank of India	Commercial Bank
23	China EXIM	EXIM
24	Citi Foundation	Global Foundation
25	Climate Works Foundation	Global Foundation
26	DENA Bank	Commercial Bank
27	DFID*	International DFI
28	Elevar Equity	Equity Fund
29	GEF	Climate Fund
30	GEF Management Corp.	Equity Fund
31	Grassroots Business Fund*	Equity Fund
32	Gray Ghost Ventures	Equity Fund
33	Hewlett Foundation	Global Foundation
34	I3N	Angelinvestors/angel networks

S.No.	Name of Institution	Type of Organization
35	ICICI Bank*	Commercial Bank
36	IDFC	Indian DFI
37	IDFC PE*	Equity Fund
38	IFC*	International DFI
39	IFCI	Indian DFI
40	IL&FS	Indian DFI
41	Indian Angel Network	Angelinvestors/angel networks
42	India Infrastructure Finance Company (IIFC)	Large NBFC
43	Indostar	Large NBFC
44	Industrial Development Bank of India (IDBI)	Commercial Bank
45	Infuse Ventures*	Equity Fund
46	Insitor Fund*	Equity Fund
47	Intellegrow*	Small NBFC
48	IREDA*	Indian DFI
49	JICA	International DFI
50	Karnataka Bank	Commercial Bank
51	KfW*	International DFI
52	Khemka Foundation	Global Foundation
53	Kotak Mahindra	Large NBFC
54	L&T Infra Finance*	Large NBFC
55	Lemelson Foundation	Global Foundation
56	Mahindra Finance*	Large NBFC
57	Mahindra Partners*	Equity Fund
58	Middle East & Asia Capital Partners Clean Energy Fund II	Equity Fund
59	Mumbai Angels*	Angelinvestors/angel networks
60	NABARD	Indian DFI
61	Ncubate*	Equity Fund
62	Neurus capital*	Equity Fund
63	NIB	International DFI
64	Norad	International DFI
65	North Sky Capital	Equity Fund
66	Olympus Capital*	Equity Fund
67	Oriental Bank of Commerce	Commercial Bank
68	PFC-Green Energy	Large NBFC
69	Prathama Bank*	RRB
70	PTC India Financial Services (PFS)	Large NBFC
71	Punjab National Bank	Commercial Bank
72	Ratnakar Bank	Commercial Bank
73	REC*	Government
74	Reliance Capital	Large NBFC
75	Rockefeller Brothers Fund	Global Foundation
76	Rockefeller Foundation*	Global Foundation
77	S3IDF*	Small NBFC
78	Schneider VC*	Equity Fund

S.No.	Name of Institution	Type of Organization
79	Shell Foundation*	Global Foundation
80	SIDBI*	Indian DFI
81	Silicon Valley Bank	Small NBFC
82	Srei*	Large NBFC
83	State Bank of India	Commercial Bank
84	Sustainable Enterprise Fund	Equity Fund
85	Syndicate Bank	Commercial Bank
86	Tata Cleantech Capital*	Large NBFC
87	TBC Capital Impact Investing Fund-I	Equity Fund
88	TiE Entrepreneurship Acceleration Program	Angelinvestors/angel networks
89	UCO Bank	Commercial Bank
90	UNDP	Global Foundation
91	Union Bank	Commercial Bank
92	US EXIM*	EXIM Bank
93	Willow Impact Investors	Equity Fund
94	Wolfensohn Fund Management, LP	Equity Fund
95	Yes Bank*	Commercial Bank

Acronyms used above:

- DFI: Development Finance Institutions
- EXIM Bank: Export Import Bank
- NBFC: Non-Banking Financial Company
- RRB: Regional Rural Bank

Note: * Denotes the FIs engaged in the study

Annexure 2: Capital from HNIs, Angels and Networks

Capital from HNIs, Angels and Networks: has a potential to be deployed in smaller DRE investment opportunities

HNIs, Angel investors and Networks are a potential source of capital (both returnable as well as non-returnable). While not much significant capital has been deployed by them as yet in the DRE sector, they have a propensity to do so.

The capital providers are categorized into 5 groups:

1. Individual HNIs with a Venture Philanthropy type of outlook. While their core investments are driven primarily with a profit outlook, many are known to make high-risk investments with a philanthropic motive. They also have foundations which deploy capital that are non-returnable in nature.
2. Giving Circles where HNIs with a secular outlook come together in a group to deploy capital in projects that is typically non-returnable.
3. Angel investment networks: that bring together several like-minded HNIs and provide a platform for investing returnable capital. The fact that multiple investors are going in together helps to reduce the risk to any one investor
4. Ultra HNIs that typically have investment managers that manage returnable capital and foundations that separately manage non-returnable capital.
5. Family run trusts such as Tata Sons Trust, Birla Family Trusts, etc. also have large philanthropic programs that have been the mainstay of institutional giving. They also represent sources of non-returnable capital should there be an alignment with their programs.

Corporate foundations such as India Bulls Foundation, Jindal Foundation, Infosys Foundation, etc. are being covered in the report clubbed with Corporate Social Responsibility (CSR).

There have been no authoritative studies on the quantum of capital available in the above categories; as categories 1 through 4 represent a relatively recent phenomenon in India.

Through a series of interviews with 'ethical' wealth managers (Altamount Capital, Ace Wealth Management etc.), investment managers for angels (IAN, Mumbai Angel Network etc.) and secular giving organizations (like GiveIndia, Guidestar India, etc.), we have come up with the following estimates for the Capital Available and Annual Capital Flows.

Mapping HNI capital

	Approximate number	Type of capital	Potential annual capital flow
Individual HNIs with a Venture Philanthropy Outlook (domiciled in India as well as Non Resident Indians)	~2000	Non-returnable as well as returnable	USD100m
Giving Circles of HNIs with Secular outlook	~200-500 circles	Non-returnable	USD25m
Angel investment networks in India	~ 20-25	Returnable	Uncertain
Ultra HNIs (domiciled in India as well as Non Resident Indians)	~15-20	Non-returnable as well as returnable	Uncertain
Family Run Charitable Trusts	Unknown	Non-returnable capital	

Annexure 3: Sample of investor exposure in renewable energy in India

Financial Institution	Type of Organization	Types of investment	Investee	Amount
IFC	International DFI	Equity	Husk Power Applied Solar Technologies Shalivahana Green Energy Azure Power Inox Renewables*	USD1m USD6m USD15m USD10m USD40m
IFC	International DFI	Commercial Loan (LT)	Husk Power Applied Solar Technologies Mahindra Solar Sunedison/SEI Solar* NSL Wind* Green Infra* Azure Power* Inox Renewables* Mahindra Kiran*	USD0.25m USD15m USD5.6m USD34m USD19m USD50m USD4.6m USD75m USD8.6m
Intellegrow	NBFC	Commercial Loan (ST)	Husk Power Orb Energy	
Acumen	Equity Fund	Equity	Husk Power Orb Energy Avani Bio-energy d.Light	USD 0.37m USD 1.14m USD0.25m USD1.5m
Olympus Capital	Equity Fund	Equity	Orient Green Power	USD35m
Bessemer Venture Partners	Equity Fund	Equity	Applied Solar Technologies Orient Green Power	 USD10m
HNIs and Private investors		Equity	Gram Power Gram Oorja	
USAID	Donor	Grant	Mera Gaon Power	
Shell Foundation	Donor	Grant	DESI Power Husk Power	
ICICI Bank	Commercial Bank	Commercial Loan (ST)	DESI Power	
IFMR Capital	NBFC	Unsecured Loan	DESI Power	

*Proposed investments, pending signing

Annexure 4: Government schemes for decentralized renewable energy projects

Government scheme	Objective	Year of Inspection	Capital allocated	Result of implementation	Key barriers to
Village Energy Security Program (VESP)	The VESP scheme was introduced by the MNRE to deploy small biomass based systems (<25kW) in remote villages and hamlets on a test pilot basis. Target: 1000 remote and inaccessible villages	2005	Budget outlay of INR 225 crores (~USD 40m) during the 11th plan period	Since commencement, there have been 67 projects planned, out of which 67% have been commissioned and 51% have already been implemented. This represents 700 kW of installed generation capacity for a target of 2500 households in 34 villages.	1. Implementation, operational and financial barriers emerging from multiplicity of MNRE and state level stakeholders involved in small scale community driven project. 2. Lack of business case for implementation agencies as also developers 3. Inadequate biomass supply /management 4. Lack of supply chain /support from technology suppliers 5. Non-existent training and /or operational capacities at the last mile 6. Lack of private ownership: community based O &M (as also owner ship) models have not been very successful.
Remote Village Electrification Program (RVEP)	The objective of the scheme was to electrify remote census villages and remote hamlets of census villages through renewable energy sources such as solar energy, small hydro power, biomass, wind energy and hybrid systems. The target was to support lighting requirements in about 25,000 far flung remote villages	2003	Current annual outlay INR 95 crores (~USD17m) (prior to 2011-12, the outlay was INR 80 crores per annum).	Till date, about 8000 + villages /hamlets have been covered whereas projects for close to 12000+ villages /hamlets have been sanctioned	1. Implementation is dependent on village level body and through state nodal agencies whereas fund allocation is central 2. Lack of capacity building at village level as O&M is local village level 3. Lack of business case for implementation agencies as also developers
Decentralized Distributed Generation (DDG) under RGGVY	The focus of the scheme is to enable lighting via micro-grids /min-grids in remote villages where grid connectivity is either not feasible or not cost effective.	2009	Outlay of INR 540 crores in 11th Five Year Plan (~USD98m)	Less than 20% of the budgeted INR 540 crores has been sanctioned till date.	1. Slow release of fund and initial capital requirements dissuade private entrepreneurs. 2. Current guidelines do not provide for private ownership of assets after 5 years and this adds to the uncertainty that developers face in their projects 3. The O&M viability gap is to be funded by the States through the 8% administration charges provisioned to the state agencies. Adequacy and efficiency of this may not have comforted private developers (as also leaves no incentive for state agencies).

Annexure 5: Public information resources used for this report

Government schemes (non-returnable capital) available for rural electrification or for renewable energy

Name of organization	Line/ fund name	Description of the line /fund	Amount (in USD m)	References
MNRE	JNNSM Phase 1	Started in 2009, this program provides capital subsidy to solar project.	789	Scheme Notification
		From 2012, this program will provide capital subsidy to solar charging station in AP, Bihar, Chhattisgarh, Jharkhand, MP, Maharashtra, Odisha, UP, WB for two years.	15	http://mnre.gov.in/file-manager/UserFiles/solar_charging_station_scheme_jnnsm.pdf
MoP	Village Electrification through Decentralized Distributed Generation (DDG) under Rajiv Gandhi Grameen Vidyutikaran Yojana	Started in 2009, this fund will provide capital subsidy for all technologies associated with RE-RE projects	98	Scheme notification
MNRE	Biomass Gasifier based Programmes	Started in 2009, this fund will provide capital subsidy for biomass based power projects - both grid connected and captive plants	14	Scheme notification
MoP	RGGVY	Started in 2005, this program offers capital subsidy for all grid connected technologies	5216	http://rggvy.gov.in/rggvy/rggvyportal/index.html
MNRE	Biogas based Distributed / Grid Power Generation Programme	This program provides interest subsidy to biogas based DRE plants in rural areas	1	http://www.mnre.gov.in/file-manager/offgrid-solar-schemes/aa-jnnsm-2012-13.pdf
MNRE	RVEP	Started in 2003, the RVEP scheme provides capital subsidy to renewable based village energy projects (initially this was only individual systems and then expanded to cover micro and mini-grids)	17	Scheme Notification

Global Foundations and International DFI (non-returnable capital) for rural energy access

Name of organization	Line/ fund name	Description of the line /fund	Amount (in USD m)	References
Rockefeller Foundation		Donor funded technical assistance program	6.3	Annual Report 2011
Rockefeller Brothers Fund		Donor funded technical assistance program	7	http://self.org/archive-india/
Climate Works Foundation		India based donor technical assistance program	0.48	Annual Report 2011-12
Shell Foundation		Donor funded technical assistance program	3	Annual Report 2011-12
UNDP	Access to clean Energy	Donor funded technical assistance program	1	UNDP in India 2011, UNDP access to clean energy document
DFID	Access to Low Carbon Energy	Donor assisted projects in Bihar, MP, Odisha, UP, Rajasthan, Jharkhand, Chhattisgarh and West Bengal	48	DFID India 2011-15 plan document

DFIs – International and Indian (returnable capital) for rural electrification or for renewable energy electrification

Name of organization	Line/ fund name	Description of the line /fund	Amount (in USD m)	References
IFC		Long term commercial loans for pan India renewable project for 10years tenure.	200	http://www.ifc.org
JICA		Subsidized loan program in India.	364	JICA India ODA agreement doc
IFC		Equity financing at risk-adjusted return	45	http://www.ifc.org/
ADB		Commercial loan with tenor upto 15-25 years for all types of renewable projects.	850	ADB's India Business Operation Plan 2012-14
SIDBI	India Opportunities Venture Fund	Quasi equity financing at 18% interest for 7 years tenor.	909	http://www.sidbi.com/NOTICES/GEMsAnnexure.pdf

Name of organization	Line/ fund name	Description of the line /fund	Amount (in USD m)	References
SIDBI	KfW line	This is an equipment financing program for all technologies at interest rate of 15% and tenor of 5-7yeards.	68	http://pib.nic.in/newsite/erelease.aspx ?relid=87279
IREDA	IDA	Commercial loan program at interest rate between 11.5% - 13.5% for all types of renewable projects.	4	IREDA annual report
IREDA	NIB line	Commercial loan program at interest rate between 11.5% - 13.5% for all types of renewable projects.	4	IREDA annual report
IREDA	KfW line	Commercial loan program at interest rate between 11.5% - 13.5% for all types of renewable projects.	11	IREDA annual report
IREDA	IBRD	Commercial loan program at interest rate between 11.5% - 13.5% for all types of renewable projects.	3	IREDA annual report
IREDA	ADB line	Commercial loan program at interest rate between 11.5% - 13.5% for all types of renewable projects.	2	IREDA annual report
IREDA	Loans from Indian Banks (Bank of Baroda, Union Bank, Dena, OBC, Canara, SIDBI)	Commercial loan program at interest rate between 11.5% - 13.5% for all types of renewable projects.	10	IREDA annual report
IREDA	AFD	Commercial loan program at interest rate between 11.5% - 13.5% for all types of renewable projects.	4	IREDA annual report
IREDA	JICA	Commercial loan program at interest rate between 11.5% - 13.5% for all types of renewable projects.	22	IREDA annual report
NABARD	RIF	Started in 2006, the program provides long term commercial loan to biomass based power project.	26	http://www.nabard.org/fileupload/ DataBank/Newsletters/July2006.pdf

Name of organization	Line/ fund name	Description of the line /fund	Amount (in USD m)	References
IDFC	IFC line	Started in 2010, this is a commercial loan program for all types of renewable projects.	75	http://www.ifc.org
India Infrastructure Finance Company (IIFC)	World Bank line	Commercial loan program at Libor+300basis point. The tenor is larger than that of the longest tenor commercial debt by at least two years. Limited to Solar projects only.	200	http://www.iifcl.org
PFC -Green Energy		Commercial loan program for solar project at 13.5%-14% for tenor of 8.5 years.	27	http://www.pfcindia.com/
IREDA	KfW line	Commercial loan program at interest rate between 11.5% - 13.5% for all types of renewable projects.	11	IREDA annual report

Commercial banks (returnable capital) for renewable energy

Name of organization	Line/ fund name	Description of the line /fund	Amount (in USD m)	References
Yes Bank	NIB line	Started in 2011, this is a commercial loan program for all types of renewable projects.	30	http://www.nib.int/loans/agreed_loans/273/yes_bank_limited
Axis Bank	IFC line	Started in 2011, this is a commercial loan program for all types of renewable projects.	100	http://www.ifc.org
Axis Bank	NIB line	Started in 2012, this is a commercial loan program for wind projects in Tamil Nadu, Gujarat and Andhra Pradesh	50	http://www.nib.int/loans/agreed_loans/302/axis_bank_limited
ICICI	EIB line	Started in 2011, this is a commercial loan program for all types of renewable projects.	260	http://www.eib.org/projects/press/2011/2011-125-india-eur-200-million-loan-for-climate-change-mitigation-projects.htm

Name of organization	Line/ fund name	Description of the line /fund	Amount (in USD m)	References
ICICI	JBIC - SMBC	Started in 2012, this is a commercial loan program for all types of renewable projects	500	http://www.jbic.go.jp/en/about/press/2011/0203-01/index.html, http://www.jbic.go.jp/en/about/press/2011/0401-03/index.html
Yes Bank	IFC line	Started in 2012, this is a commercial loan program for all types of renewable projects	75	http://www.ifc.org/ifcext/pressroom/ifcpressroom.nsf/0/436642F52342C12A852579D4003B195C?OpenDocument
ICICI	ADB line	Launched in 2012, this is a commercial loan program for all renewable projects.	100	http://www.adb.org/news/india/adb-provides-credit-line-finance-renewable-energy-and-energy-efficiency-projects-india
ICICI	JBIC	Pan India commercial loan program with 5-10years of tenor	30	http://www.jbic.go.jp/en/about/press/2012/0702-01/index.html

Equity funds (returnable capital) for rural electrification or for renewable energy

Name of organization	Line/ fund name	Description of the line /fund	Amount (in USD m)	References
Acumen		7-15 year equity financing at market return. Applicable to pan India biomass, solar, hydro and wind projects.	12	http://www.acumenfund.org/investments/countries/india.html
Insitor fund		Equity financing at 5% return expectation with tenor of 5-7 years.	5	http://www.insitorfund.com/
Accelerator First Light		Quasi equity financing at market return.	5	http://firstlight.vc/
Neurus Capital		Equity fund atmarket return with over 10 years tenor	250	http://nereuscap.com/
Actis		Equity fund at market return with tenor of 5-7years	150	Impact Base

Name of organization	Line/ fund name	Description of the line /fund	Amount (in USD m)	References
Aloe Environment Fund		Started in 2012, a south east Asia and India focused fund at market return over a tenor of 10 years	420	http://www.ifc.org/
Middle East & Asia Capital Partners Clean Energy Fund II		Started in 2012, an equity fund with focus on pan Asia at market return	150	http://www.opic.gov
Berkley Partners LLP	Renewable Energy Asia Fund LLP	Equity fund for small hydro and wind project. Their focus is India, Philippines, Sri Lanka and SE Asia at market return with 10 years tenor	187	http://www.opic.gov
GEF Management Corp.	SACEF Holdings (South Asia Clean Energy Fund)	Equity fund with SE Asia and India focus at marketreturn with tenor of 10yrs and an option to extend it to 2 more.	300	http://www.opic.gov
Grassroots Business Fund		Impact investment in Africa, Latin America and South east Asia at market return with 6-8 years tenor.	46	Impact Base
Aavishkaar	Aavishkaar II	A pan India impact investment at market return.	70	Impact Base
Breathe India Advisors Pty. Ltd.	Breathe India Fund	Pan India impact investment program with 5%return expectation for 5-7years tenor	5	Impact base
Elevar Equity	Elevar Equity II, LP	Global impact investment at market return	95	Impact base
Gray Ghost Ventures	First Light Fund	Global impact investment with return expectation of 15%.	10	Impact base
Ennovent	Sustainable Enterprise Fund	India based impact investment at below risk-adjusted market return.	2	Impact base

Name of organization	Line/ fund name	Description of the line /fund	Amount (in USD m)	References
Wolfensohn Fund Management, LP	Wolfensohn Low-Carbon Energy Fund	Global impact investment with 20% return expectation	38	Impact base
ADFD/IRENA		Climate fund for IRENA member countries at 2-6% interest and 15-20years tenor. Assume 10% allocable to India projects.	50	ADFD-IRENA doc

Annexure 6: Potential demand of rural mini-grid in four underserved states in India demand estimates

	Total short-listed villages	Total households with electrification potential for mini-grids	Immedidate Daily electricity (kWh) required as per cKinetics field estimates	Daily energy (kWh) required for national level	Daily energy (kWh) required for state level	Power capacity required to meet immediate electricity requirement as per cKinetics field estimates (MW)	Power capacity required to meet total electricity requirement equal to state average (MW)	Power capacity required to meet total electricity requirement equal to national average (MW)
Bihar	**10,034**	**3,570,416**	**2,635,284**	**38,051,829**	**7,067,358**	**188**	**505**	**2,718**
Muzaffarpur	561	194,823	143,797	2,076,333	385,637	10	28	148
Purba Champaran	531	191,225	141,141	2,037,991	378,516	10	27	146
Darbhanga	454	165,185	121,921	1,760,461	326,970	9	23	126
Saran	438	147,965	109,211	1,576,938	292,884	8	21	113
Samastipur	436	165,128	121,879	1,759,862	326,859	9	23	126
Madhubani	424	158,375	116,895	1,687,883	313,490	8	22	121
Sitamarhi	414	153,621	113,386	1,637,217	304,080	8	22	117
Pashchim Champaran	411	146,453	108,095	1,560,828	289,892	8	21	111
Purnia	388	143,505	105,919	1,529,409	284,057	8	20	109
Siwan	377	128,003	94,478	1,364,201	253,373	7	18	97
Gaya	368	119,975	88,552	1,278,636	237,481	6	17	91
Vaishali	365	127,318	93,972	1,356,898	252,016	7	18	97
Katihar	349	122,516	90,428	1,305,716	242,510	6	17	93
Nalanda	323	114,816	84,744	1,223,651	227,268	6	16	87
Araria	304	114,480	84,497	1,220,079	226,605	6	16	87
Begusarai	275	104,877	77,408	1,117,726	207,595	6	15	80
Gopalganj	269	92,010	67,912	980,602	182,127	5	13	70
Bhojpur	267	95,529	70,509	1,018,108	189,093	5	14	73
Bhagalpur	263	92,974	68,623	990,869	184,034	5	13	71
Kishanganj	234	83,403	61,559	888,872	165,090	4	12	63

	Total short-listed villages	Total households with electrification potential for mini-grids	Immedidate Daily electricity (kWh) required as per cKinetics field estimates	Daily energy (kWh) required for national level	Daily energy (kWh) required for state level	Power capacity required to meet immediate electricity requirement as per cKinetics field estimates (MW)	Power capacity required to meet total electricity requirement equal to state average (MW)	Power capacity required to meet total electricity requirement equal to national average (MW)
Banka	226	75,180	55,490	801,233	148,813	4	11	57
Rohtas	225	74,110	54,700	789,830	146,695	4	10	56
Saharsa	225	82,614	60,977	880,464	163,528	4	12	63
Supaul	221	80,763	59,610	860,734	159,864	4	11	61
Jehanabad	220	75,111	55,439	800,500	148,677	4	11	57
Nawada	206	72,795	53,729	775,811	144,091	4	10	55
Aurangabad	171	56,431	41,651	601,417	111,701	3	8	43
Jamui	170	60,068	44,336	640,177	118,900	3	8	46
Madhepura	166	63,089	46,565	672,375	124,880	3	9	48
Buxar	138	48,356	35,691	515,351	95,716	3	7	37
Munger	127	44,310	32,705	472,240	87,709	2	6	34
Kaimur (Bhabua)	114	36,888	27,226	393,133	73,017	2	5	28
Lakhisarai	111	39,088	28,851	416,586	77,372	2	6	30
Khagaria	108	43,353	31,998	462,032	85,813	2	6	33
Sheohar	97	35,161	25,952	374,730	69,598	2	5	27
Sheikhpura	58	20,918	15,439	222,936	41,406	1	3	16
Jharkhand	**1,081**	**354,461**	**265,845**	**3,777,676**	**5,130,695**	**19**	**366**	**270**
Gumla	178	58,858	44,143	627,279	851,946	3	61	45
Pashchimi Singhbhum	164	50,126	37,595	534,224	725,562	3	52	38
Garhwa	158	53,930	40,447	574,759	780,615	3	56	41
Giridih	136	46,382	34,787	494,322	671,369	2	48	35
Godda	116	36,989	27,742	394,209	535,400	2	38	28

	Total short-listed villages	Total households with electrification potential for mini-grids	Immedidate Daily electricity (kWh) required as per cKinetics field estimates	Daily energy (kWh) required for national level	Daily energy (kWh) required for state level	Power capacity required to meet immediate electricity requirement as per cKinetics field estimates (MW)	Power capacity required to meet total electricity requirement equal to state average (MW)	Power capacity required to meet total electricity requirement equal to national average (MW)
Sahibganj	99	33,147	24,860	353,261	479,786	2	34	25
Dumka	63	20,219	15,164	215,483	292,660	1	21	15
Pakaur	62	21,677	16,258	231,026	313,770	1	22	17
Chatra	61	19,720	14,790	210,164	285,437	1	20	15
Lohardaga	44	13,413	10,060	142,950	194,149	1	14	10
Odisha	**1,682**	**542,366**	**400,314**	**5,780,280**	**6,413,586**	**29**	**458**	**413**
Kalahandi	256	83,949	61,962	894,691	992,717	4	71	64
Nabarangapur	233	76,647	56,572	816,868	906,367	4	65	58
Sundargarh	197	64,811	47,836	690,723	766,401	3	55	49
Mayurbhanj	193	60,337	44,534	643,048	713,502	3	51	46
Kendujhar	165	52,317	38,615	557,570	618,659	3	44	40
Balangir	151	47,792	35,275	509,347	565,153	3	40	36
Koraput	150	48,885	36,082	520,996	578,078	3	41	37
Nuapada	92	28,851	21,295	307,483	341,171	2	24	22
Sonapur	73	23,015	16,987	245,283	272,157	1	19	18
Malkangiri	70	22,943	16,934	244,512	271,301	1	19	17
Rayagada	34	11,538	8,516	122,964	136,437	1	10	9
Kandhamal	32	10,707	7,903	114,110	126,612	1	9	8
Debagarh	22	6,393	4,719	68,138	75,603	0	5	5
Baudh	14	4,180	3,085	44,546	49,427	0	4	3

	Total short-listed villages	Total households with electrification potential for mini-grids	Immedidate Daily electricity (kWh) required as per cKinetics field estimates	Daily energy (kWh) required for national level	Daily energy (kWh) required for state level	Power capacity required to meet immediate electricity requirement as per cKinetics field estimates (MW)	Power capacity required to meet total electricity requirement equal to state average (MW)	Power capacity required to meet total electricity requirement equal to national average (MW)
UP	**17,429**	**5,553,879**	**4,224,379**	**59,190,659**	**46,178,789**	**302**	**3,298**	**4,228**
Shahjahanpur	1,606	399,700	304,019	4,259,814	3,323,380	22	237	304
Gonda	1,213	361,143	274,692	3,848,898	3,002,796	20	214	275
Sant Kabir Nagar	1,177	394,072	299,738	4,199,838	3,276,588	21	234	300
Kheri	1,106	300,782	228,780	3,205,597	2,500,911	16	179	229
Moradabad	1,064	341,062	259,418	3,634,880	2,835,825	19	203	260
Barabanki	935	252,309	191,911	2,688,990	2,097,870	14	150	192
Bahraich	918	265,352	201,831	2,827,998	2,206,320	14	158	202
Kannauj	618	170,258	129,501	1,814,526	1,415,639	9	101	130
Farrukhabad	570	218,924	166,518	2,333,194	1,820,289	12	130	167
Aligarh	563	206,392	156,985	2,199,627	1,716,083	11	123	157
Bulandshahar	415	140,045	106,521	1,492,532	1,164,429	8	83	107
Mainpuri	407	128,115	97,447	1,365,390	1,065,237	7	76	98
Muzaffarpur	358	128,168	97,487	1,365,959	1,065,681	7	76	98
Kanpur Dehat	338	116,523	88,629	1,241,844	968,849	6	69	89
Sitapur	322	104,382	79,395	1,112,453	867,902	6	62	79
Lalitpur	288	125,466	95,432	1,337,158	1,043,211	7	75	96
Hardoi	285	94,931	72,206	1,011,728	789,320	5	56	72
Kanpur Nagar	264	113,454	86,295	1,209,136	943,332	6	67	86
Jyotiba Phule Nagar	247	102,444	77,921	1,091,800	851,790	6	61	78
Faizabad	244	83,781	63,725	892,899	696,613	5	50	64
Etah	238	78,432	59,657	835,890	652,136	4	47	60

	Total short-listed villages	Total households with electrification potential for mini-grids	Immedidate Daily electricity (kWh) required as per cKinetics field estimates	Daily energy (kWh) required for national level	Daily energy (kWh) required for state level	Power capacity required to meet immediate electricity requirement as per cKinetics field estimates (MW)	Power capacity required to meet total electricity requirement equal to state average (MW)	Power capacity required to meet total electricity requirement equal to national average (MW)
Budaun	235	78,022	59,345	831,524	648,730	4	46	59
Mahrajganj	231	76,810	58,423	818,609	638,655	4	46	58
Banda	224	80,657	61,349	859,600	670,635	4	48	61
Kushinagar	202	67,734	51,520	721,882	563,191	4	40	52
Bareilly	194	64,074	48,736	682,867	532,752	3	38	49
Unnao	191	66,631	50,681	710,122	554,016	4	40	51
Ballia	186	65,147	49,552	694,306	541,677	4	39	50
Hamirpur	183	62,281	47,372	663,766	517,851	3	37	47
Shrawasti	176	58,807	44,730	626,738	488,962	3	35	45
Firozabad	174	60,344	45,899	643,120	501,743	3	36	46
Kaushambi	166	56,923	43,297	606,659	473,297	3	34	43
Pratapgarh	164	53,376	40,599	568,857	443,805	3	32	41
Etawah	159	54,594	41,525	581,842	453,936	3	32	42
Balrampur	156	50,653	38,528	539,836	421,164	3	30	39
Rampur	153	51,323	39,037	546,981	426,738	3	30	39
Jalaun	140	46,159	35,109	491,937	383,794	3	27	35
Fatehpur	134	44,843	34,108	477,912	372,852	2	27	34
Azamgarh	133	42,083	32,009	448,503	349,909	2	25	32
Ghazipur	130	44,578	33,907	475,089	370,651	2	26	34
Jaunpur	129	41,869	31,846	446,218	348,126	2	25	32
Deoria	128	42,203	32,100	449,780	350,905	2	25	32
Ambedkar Nagar	107	34,955	26,588	372,538	290,643	2	21	27
Mahoba	86	28,245	21,484	301,026	234,852	2	17	22

	Total short-listed villages	Total households with electrification potential for mini-grids	Immedidate Daily electricity (kWh) required as per cKinetics field estimates	Daily energy (kWh) required for national level	Daily energy (kWh) required for state level	Power capacity required to meet immediate electricity requirement as per cKinetics field estimates (MW)	Power capacity required to meet total electricity requirement equal to state average (MW)	Power capacity required to meet total electricity requirement equal to national average (MW)
Auraiya	84	28,628	21,775	305,108	238,036	2	17	22
Pilibhit	82	25,898	19,698	276,009	215,334	1	15	20
Chandauli	79	25,135	19,118	267,873	208,986	1	15	19
Siddharthnagar	77	26,811	20,393	285,743	222,929	1	16	20
Sonbhadra	63	20,435	15,544	217,791	169,914	1	12	16
Chitrakoot	62	20,733	15,770	220,958	172,385	1	12	16
Basti	25	8,193	6,231	87,313	68,119	0	5	6
Grand Total	**30,226**	**10,021,121**	**7,525,822**	**106,800,443**	**64,790,428**	**538**	**4,628**	**7,629**

Photo Credit: The Rockefeller Foundation and Robin Wyatt; Kartikeya Singh

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