MICROGRID
INVESTMENT ACCELERATOR

Microgrid Market Analysis & Investment Opportunities

IN INDIA, INDONESIA, AND TANZANIA

allotrope PARTNERS | Microgrid Investment Accelerator

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Report Overview & Key Findings

THE MICROGRID INVESTMENT ACCELERATOR

According to the International Energy Agency (IEA), 1.1 billion people lack access to electricity. More than 95% of these people are in sub-Saharan Africa or developing Asia and around 80% are in rural areas. Distributed renewable energy microgrids hold significant potential as a key driver to increase energy access for these populations. To address this need and meet electrification targets private sector investment flows must increase into the microgrid market segment.

Microgrid (and solar home system) solutions powered by renewables provide electricity to nearly 90 million people.[1] To achieve universal electricity access by 2030, the current pace of expansion will have to double. It is estimated that off-grid solutions will supply 50-60% of the additional generation needed to achieve universal electricity access by 2030.[2]

1 *BNEF, 2016 / Lightsglobal, 2016.*

2 *IRENA, 2017. REthinking Energy: http://www.irena.org/DocumentDownloads/Publications/IRENA_REthinking_Energy_2017.pdf*

The Microgrid Investment Accelerator (MIA) will advance investment in energy access and renewable energy microgrid deployment in emerging, underserved markets. MIA seeks to catalyze energy access partnerships through a blended capital facility that will leverage grant and concessionary finance from governments and philanthropies to mobilize private sector investors. MIA will deploy catalytic capital into the microgrid market through: 1) direct investments in microgrid projects, and 2) innovative co-financing and partnership arrangements with other pools of capital. MIA will initially target opportunities over 5 kilowatts (KW), in **India** (the States of Bihar and Uttar Pradesh)**, Indonesia, and Tanzania.** MIA will develop a replicable and scalable model that can be applied in other geographies as soon as possible.

Between September 2016 and February 2017, the MIA team at Allotrope Partners conducted extensive market research to inform the design of the MIA facility by evaluating microgrid conditions, drivers and policies, and by identifying areas where further research is needed. To these ends, the MIA team conducted desk research, field visits, and structured interviews with experts and practitioners in target microgrid markets. This analysis will inform the initial stages of the MIA design process.

Overall, this assessment highlighted numerous, promising opportunities in the microgrid market, but challenges related to business models, policy and finance have dampened private investment flows and thus far prevented developers from reaching market potential. Key findings from this analysis are included below and discussed in greater detail in the forthcoming report. Building on these findings, Allotrope Partners will continue to engage microgrid practitioners, investors, and other experts to inform the design of the MIA facility.

THE MARKET IS TRENDING IN THE RIGHT DIRECTION

Microgrid markets are on the rise. This is due in large part to project capital cost reductions (e.g. declining costs of renewable energy technologies and battery storage), increased government commitment to universal electrification, and improving policy conditions.

Viable business opportunities are emerging. Microgrid energy service companies (ESCOs) in the sector are broadly confident that they can provide a compelling value proposition to customers and investors underpinned by the reliable delivery of energy at a rate that is affordable to consumers and lower cost and less polluting than current alternatives. Returns on investment for microgrids are principally dependent on project installation costs, operating expenses, and the amount of revenue generated. To improve investment returns and lower tariff rates for potential customers, reductions in equipment, finance, and soft costs (site/customer acquisition and permitting), will be critical as the market develops.

Regulatory and policy conditions are improving. Policy conditions, on many fronts, are advancing in the three selected geographies. In 2016, both Indonesia and the Indian state of Uttar Pradesh (UP) adopted microgrid-specific policies, and Tanzania updated its 2009 electrification policy. Tariff rates are negotiable with customers in all three markets and reviewed by government agencies.

Microgrids offer opportunity for sustained market growth. The total addressable market (in the selected geographies) that could be served by MIA is approximately 212 million people, accounting for grid extensions and inaccessible remote homes. ESCOs interviewed in these markets reported that, with access to capital, they will be on track to develop 7 MWs of microgrids - serving approximately

300 villages, and 63,000 homes and community organizations within 12-18 months. Assuming 50% of ESCOs reported pipelines for 2017 are realized (commissioned), about $20 million in capital expenditures would be needed to build the projects. These projects are in various stages of development, with most in the "pre-permit" stage and still in need of funding. Although this initial (identified) market size could be viewed as modest, by 2020 these ESCOs aim to deploy over 30 MWs of projects, serving an estimated 1.3 million households.

BUSINESS MODEL UNCERTAINTY PREVAILS

Overall, the microgrid market is nascent and characterized by high variability. As a result, drawing conclusions about ESCO readiness and business model viability can be challenging. For example, active developers interviewed for this analysis varied widely in terms of tenure (1-22 years of operation) and number of projects installed (1-84). Reported end-user electricity tariff prices varied significantly across developers, even within the same market. In general, new entrants abound and business model experimentation is the norm.

Small projects are the norm and costs vary significantly. Projects analyzed in this report ranged from 3 KW to 75 KW (with the average for the pool at 26 KW) and about 60-70 KWH or more of storage. They also reported a wide range of installation costs, from $1.50-$15/watt or $1,500 to $15,000 per KW, an enormous difference. Component costs seemed to be largest explanatory variable in installation costs. Projects that target an anchor client (or handful of small businesses) first tended to be larger than average, but still too small to attract investment from large financing institutions, including concessionary sources. A limited number of ESCOs reported pooling projects in a special purpose company to increase the ticket size of their offering in Africa and in India, though further research in this area is needed.

Changing policies affect business viability. For example, grid extension regulations allow for some uncertainty, leaving ESCOs (and their investors) open to risks of competition with subsidized grid electricity in their service areas. Also, ownership regulations in Indonesia may preclude some investment options.

FINANCIAL CHALLENGES ABOUND

Overall market immaturity is a barrier to private and commercial investment in the microgrid segment. Investors are uncertain about the early stage of the market and report that lack of access to business model data and difficulty evaluating and comparing consistent business model metrics across investment opportunities and markets is hampering their ability to deploy capital. Ongoing policy and regulatory uncertainty was also reported as a detractor from investor confidence. Reported project income data was not robust enough to provide accurate revenue estimates and model economic returns; further research and analysis is needed in this area to better understand the business case and financial performance of microgrids in these markets.

Lack of access to capital is a significant impediment to growth. The majority of ESCOs interviewed reported difficulties in securing capital. They indicated a need for low-cost, long-term project capital, preferably as project equity or debt (while a few sought corporate equity). Patient impact-oriented investments that provide favorable project finance terms in the range of 4-9% interest rate for 7-12 years could help spur the market.

Increased investment is required to jumpstart these markets. In 2017, a preliminary investment opportunity of $20-40 million was identified, which could climb to over $100 million by 2020.

KEY FINDINGS

Efficiencies in accessing and deploying capital are needed. A platform that provides more streamlined access to financing from multiple sources of capital was highlighted as a possible and desirable solution to the due diligence requirements facing investors, donors, and ESCOs. ESCOs reported that the "near-constant" fundraising process from multiple sources detracted from their core focus of deploying microgrids and increasing energy access. Also, pooling projects can help scale the market and reduce risks. A project bundling service would help increase financial flows and scale across markets.

Increased philanthropic and government support is needed to scale private sector investment in microgrids. Grant and highly concessionary debt from Mission and Program Related Investments from philanthropies and government donors will be necessary to de-risk and attract private sector investment in the near to medium term.

This analysis points to a clear need for continued, scaled and sustained engagement from the philanthropic, government and impact investment communities in the coming years in order to accelerate private finance flows into the microgrid market and deliver clean, reliable power through distributed renewable energy microgrids.

Rural Electrification:

FROM AID TO MARKET OPPORTUNITY

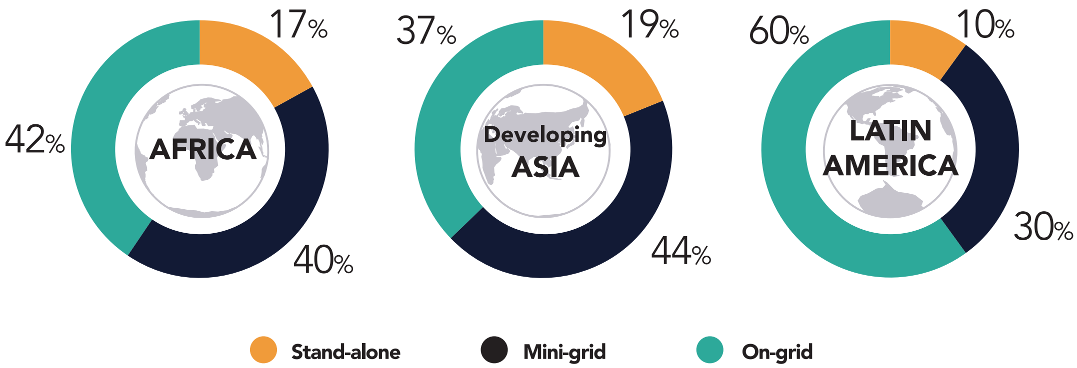
According to the International Energy Agency (IEA), 1.1 billion people lack access to electricity. More than 95% of these people are in sub-Saharan Africa or developing Asia and around 80% are in rural areas. Distributed renewable energy microgrids hold significant potential as a key driver to increase energy access across these populations. Progress has been made under the United Nations' Millennium Development Goals and now the successor Sustainable Development Goals , which seek to achieve access to affordable, reliable, sustainable, and modern energy for all by 2030.[3] As this work has evolved, the microgrid market opportunity has become more attractive to the private sector, enabled by a confluence of environmental, social, economic, policy, technology, and capital drivers.

3 *UN-DESA, 2016. Sustainable Development Goal 7: https://sustainabledevelopment.un.org/sdg7*

Microgrid (and solar home system) solutions powered by renewables already provide electricity to nearly 90 million people.[4] To achieve universal electricity access by 2030, the current pace of expansion will have to double. It is estimated that off-grid solutions will supply 50-60% of the additional generation needed to achieve universal electricity access by 2030.[5]

Most microgrid projects to date have been funded by government and foundation grant programs as well as private and family office grantmakers. Increasingly, ESCOs in the sector appear to be confident that they can provide a compelling value proposition to customers (and investors) that boils down to providing energy at a rate that is affordable, lower cost, and less polluting than alternatives, such as kerosene and diesel fuel. As the 'Addressable Market' section of this report shows, this amounts to millions of households that could benefit from renewable energy microgrids in India, Indonesia, and Tanzania. However, a lack of readily available, favorable project finance terms and equity investments is dampening the pace and scale of microgrid market expansion.

Estimated source of additional generation required to achieve universal electricity access by 2030 (by region)



Note: Figures are rounded. Total generation requirements: 468 TWh in Developing Asian, 463 TWh in Africa, and 10 TWh in Latin America.
Source: Based on IEA, UNDP, and UNIDO, 2010

MARKET ANALYSIS & INVESTMENT OPPORTUNITIES OVERVIEW

This section of the report provides an overview and analysis of the current state of microgrid markets. The scope is limited to rural renewable energy (RE) microgrid market conditions and preliminary investment opportunities in the States of Bihar and Uttar Pradesh in **India,** and in I**ndonesia, and Tanzania.** Data from desk research, site visits, conferences, informal interviews, and structured interviews with **ESCOs** provide the basis of the findings presented. Twenty companies participated in structured interviews. The firms that were interviewed varied significantly in terms of years in business, number of projects installed, installation costs, and other key variables. A discussion of the research approach can be found in Appendix II of this document. Survey questions are in Appendix IV.

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4 *BNEF, 2016 / Lightsglobal, 2016.*

5 *IRENA, 2017. REthinking Energy: http://www.irena.org/DocumentDownloads/Publications/IRENA_REthinking_Energy_2017.pdf*

The addressable market that could be served by the Microgrid Investment Accelerator (MIA) is approximately 212 million people. Optimistically, we identified over $100 million in potential projects (over 3 years) that would result in an estimated 250,000 households and community organizations gaining new access to power. In the near term, a preliminary $20-40 million investment opportunity in 2017 was identified; that number could grow to over $100 million by 2020. Along with project pipeline optimism, most ESCOs expressed a need for capital, often in the form of longer-term, lower-cost project debt and equity via a single streamlined source, and secondarily corporate and/or project equity. A need for project cost efficiency gains, loan guarantees, currency hedging products, and other financial instruments in the market was also identified in the field and literature. Scaling of the market(s) may also be aided by pooling projects for investments, bulk purchase commitments, predictable capital subsidies, a standardized project submission platform, and uniform project and equipment quality assurance guidelines.

THE UN-ELECTRIFIED MARKET: SIZE AND VALUE

Nearly 500 million people in rural India, Indonesia, and Tanzania had little to no access to electricity in 2015[6]. Limiting this tally to Bihar and Uttar Pradesh (UP), India and the other two countries, the number of people in rural households without access to energy is estimated to be around 360 million.[7] With an assumed 10% increase in central grid access over the next 10 years factored in and 35% of rural areas estimated to be inaccessible to community microgrids due to location, density, and other factors, the total initial addressable market for MIA across the three geographies is estimated to be 212 million people or approximately 43 million homes, businesses, and organizations.[8]

In the selected geographies, ESCOs reported a total of nearly 7 Megawatts (MW) of microgrids were at various stages of development and expected to be built in 2017. Optimistically, ESCOs reported plans to serve over 1 million people with 32 MW microgrids across 1,600 communities by 2020. If 25% of future anticipated projects are realized, an additional 8 MWs would be deployed by 2020.

Microgrids in Development Across MIA Markets 2017-2020

	RE Tech	Shovel Ready 2017	Projected 2018-2019	Projected @ 25% conversion
India, UP & Bihar	Solar, Bio & Wind	2,865 KW	14.7 MW	3.7 MW
Indonesia	Hydro & Solar	2,500 KW	6.5 MW	1.2 MW
Tanzania	Solar	1,776 KW	10.5 MW	2.6 MW

6 *WEO, 2015; World Bank, 2016, SE4All 2016.*

7 *CEEW, 2015. Access to Clean Cooking Energy and Electricity: http://ceew.in/pdf/CEEW-ACCESS-Report-29Sep15.pdf*

8 *See Appendix for more information on addressable market size estimates.*

Globally, markets saw $276 million invested in off-grid solar in 2015, a 15-fold increase since 2012, serving an additional 90 million people in Asia and Africa.[9] Since 2015, BNEF reported an additional 1.4-2 Gigawatts of microgrid deployment in the off-grid sector - including all systems under 1 MW.[10] Growth in the broader sector could be brisk and substantial. The quality of future market value estimates for the respective countries is fairly good in India but varies widely in Indonesia.

Total Market Value Estimated 2020

India*	Indonesia**	Tanzania***
$10B	$3-18B	$1.7B

*Climate Group. 2016.**ADB, 2016, pg 43 (Sumba only). ***AfDB, 2015. Estimated for rural portion of unelectrified.

PRELIMINARY MIA PORTFOLIO OPPORTUNITIES

In the near term, about 7 MW of installed microgrid projects serving around 300 communities could be deployed in the selected geographies. Assuming 50% of ESCOs reported pipelines for 2017 are realized (commissioned), about $20 million in capital expenditures would be needed to build the projects. These projects are in various stages of development, with most in the "pre-permit" stage and still in need of funding. For aspirational projects in 2018 and 2019, about $40 million could be deployed - assuming 25% are commissioned.

Microgrid Market Investment Opportunities ($1000s)

	Total Project Capital 2017	Project Capital @ 50% Commissioned	Total Project Capital 2018-19	Project Capital @ 25% Commissioned
India, UP	$10,123	$5,062	$46,746	$11,687
Indonesia	$20,208	$10,104	$47,178	$11,795
Tanzania	$11,929	$5,964	$63,263	$15,816
Total	$42,260	$21,130	$157,187	$39,297

PROJECT-LEVEL CHARACTERISTICS

Each of the markets vary in terms of project costs, revenue potential, technology deployed, and a host of other factors that could impact investment decisions. To simplify and help illustrate what a project and corresponding capital needs might look like for the respective markets in focus here, several of key data points are presented in the following table. Reported project income data was not robust enough to provide accurate revenue estimates and model economic returns; further research and analysis is needed in this area to better understand the business case for microgrids in these markets.

9 *Lightsglobal, 2016 & BNEF, 2016.*
10 *BNEF, 2017, pg. 1.*

Project sizes ranged from 3 KW to 75 KW (pool average was 26 KW of peak generating capacity), and about 60-70 KWH or more of storage. Projects that target an anchor client (or handful of small businesses) first, tended to be larger than average. Where there were larger day-time business loads the generation to storage ratio was lower, requiring less storage.

Project Characteristics 2017

	Average System Size	Average Households Served	Average Cost per Installed KW	Business Model
India, UP	29 KW	250	$3,500	Anchor > HH
Indonesia	18 KW	191	$8,100	Grants
Tanzania	30 KW	220	$6,700	HH First + SMEs
Range	3-75 KW	74-1000	$1.5K - $15K	

Market Conditions Brief

This section provides a snapshot of market conditions in each geography and barriers identified by ESCOs across MIA selected geographies.

The renewable energy market in **India** is expected to grow at least 90% in 2017.[11] In Bihar and Uttar Pradesh (UP), market participants reported having access to high quality UL-listed international and lower-cost domestically produced renewable energy equipment, the exact tradeoff was not possible to determine at the time of this study. Installation costs and electricity tariff rates were found to be lower in India compared to Africa or Indonesia.[12] This is, in part, achieved by using lower cost local generation components. Demand management, monitoring, and payment processing technology use appeared to lag behind the trend toward digital in Africa, except in the DC microgrid space.

Indonesia's renewable energy market is not as vibrant compared to India and Tanzania, and government programs with minimal private sector investment have historically driven it. There are far fewer private developers and less activity with solar PV plus storage generally. Supply chains for non-hydro resources can make importing solar panels, batteries, and other hardware challenging. Turnkey installation costs are reported to average $8/watt in the field. In regions where the government and utility have provided diesel generators (or renewable energy subsidies) to advance energy access, off-take prices (paid by consumers) of less than $0.50/KWH have been reported (see NREL, 2013). Depending on project installation costs, this may be a barrier to entry for private microgrid developers / ESCOs in Indonesia. The country has been through several rounds of public and private attempts to electrify rural areas, with varying degrees of success and failure. The current government effort, *Indonesia Terang* (Bright Indonesia), was launched in February 2016 and shows promise, though limited progress has been made since the program's launch. However, new regulations released in December 2016 have reinvigorated private sector interest in the microgrid sector.

Tanzania's estimate for the size of the microgrid market was recently reduced in size due to grid extension plans introduced by the government and World Bank in 2016. However, several ESCOs expressed skepticism about utility and government's ability to meet stated expansion goals. And, many regions would still be hundreds of miles from the nearest planned transmission lines, making grid expansion unlikely and costly. With adequate funding, ESCOs anticipate a vibrant market with hundreds of projects in the coming years. Installation costs can be 2-3 times more expensive in Tanzania, compared to Bihar/UP, though larger anchor and SME approaches were reported to be below $4/Watt. Projects tend to utilize third party or self-developed monitoring and payment tools. Major system components can only be imported into the market, adding to project costs.

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11 *From 2016, Bridge to India expects 90% growth in 2017 (BTI, 2017). Dalberg, 2016 estimates 47% growth in Indian MG sector by 2022, or 135 MW. However, India will continue to have a large demand for off-grid electricity - an estimated 75 million households will still lack access to the grid by 2024 (Ibid). Over a longer time period, BNEF (2016) expects that electrifying the additional 133,000 bastis, paras, and hamlets will require 4-5 Gigawatts (pg 5): http://www.solartoday.co.in/News/India's-solar-market-expected-to-grow-by-90percent-in-2017-%7C-BTI/104213#sthash.ggJysQcw.dpbs*

12 *For more information on tariffs, please see the Policy subsection: Tariffs.*

BARRIERS:

Interviews with ESCOs in the three target regions substantiate findings in a number of reports: a lack of access to low cost (longer term) project equity and financing is a major impediment to their success. Based on current findings, a facility that provides terms approaching 7-12 years at an interest rate of 4-9% would likely be well received in these markets, representing a 50%-70% discount to financing options currently available to most developers in these markets. A few others indicated they preferred corporate equity to project equity or conditional loans.

When asked to identify their most significant barriers to success (even with full funding in-hand for respective pipelines), ESCOs answered along the following themes. To paraphrase:

- **Policy/Grid Extension:** When they realize grid-extension won't work in these areas, they'll support microgrids [in Tanzania]. In UP, grid extension plans are vague or uncertain. Discussions in Indonesia are in the early stages, and the tenure of a "Business Area" concession is not yet draft policy.

- **Business Model:** "The business model is broken. Too many are focused on the technology and getting money, in a field where few, if any, have taken up a proven business to business and consumers model that works."

- **Payment Systems:** Monitoring and payment processes in India have "a ways to go".

- **Execution:** "Policy in UP is good, now we have to continue to hire and execute".

Barriers faced in the current microgrid market, from ESCOs and the literature, included:

- **Capitalization:** Commercial Investors (and even impact investors) are hesitant to invest in the microgrid market due to a perceived lack of viability, market maturity, and ability to scale.[13]

- **Project fundraising and transaction costs:** Developers noted that requests by organizations for data and multiple due diligence 'asks' from investors and funders can be cumbersome, which some developers felt detracted from core business efforts. However, this is necessary for donors and investors to evaluate companies and projects adequately. A more streamlined single point of access platform for financing from multiple sources of capital was highlighted as a possible solution.

- **Ticket Size:** Single projects can be hard to fund from an investor's perspective, a pooling facility could help address this.

- **Low Local Capacity**: Selecting and working with reliable developers and installers in the field is one of the most challenging issues larger projects face.

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13 *Dalberg, 2016.*

Microgrid Project Economics

Returns on investment for microgrids are principally dependent on project installation costs, operation expenses, and the amount of revenue generated. To improve investment returns and lower tariff rates for potential customers, reductions in equipment, finance, and soft costs (site/customer acquisition and permitting), will be critical as the market develops.

Project costs depend on a variety of factors, including but not limited to: the major hardware components, population density, location, permitting, taxes, and land costs. The literature and surveys that were conducted did not always align on these costs. For India, a relatively low cost per installed watt held on both accounts. Tanzania installation costs in the field were found to be higher - double in some instances compared to what was otherwise being reported in the literature. Project costs data for Indonesia was limited, but findings suggests higher than average costs, particularly for solar, which ranged from $4 to $15 per watt installed. Soft costs, especially project origination and finance are relatively high across the geographies.[14]

Capital Costs
The following table provides an indicative summary of capital costs for a microgrid installation, based on reported primary data and the literature. Data in the first row (Turnkey Microgrid) includes all major components, engineering, installation, transmission, distribution, monitoring, and land costs. The subsequent rows do not include distribution/transmission or land, thereby limiting comparability. The data after the first row provides some insights into component costs vs. actual turnkey projects.

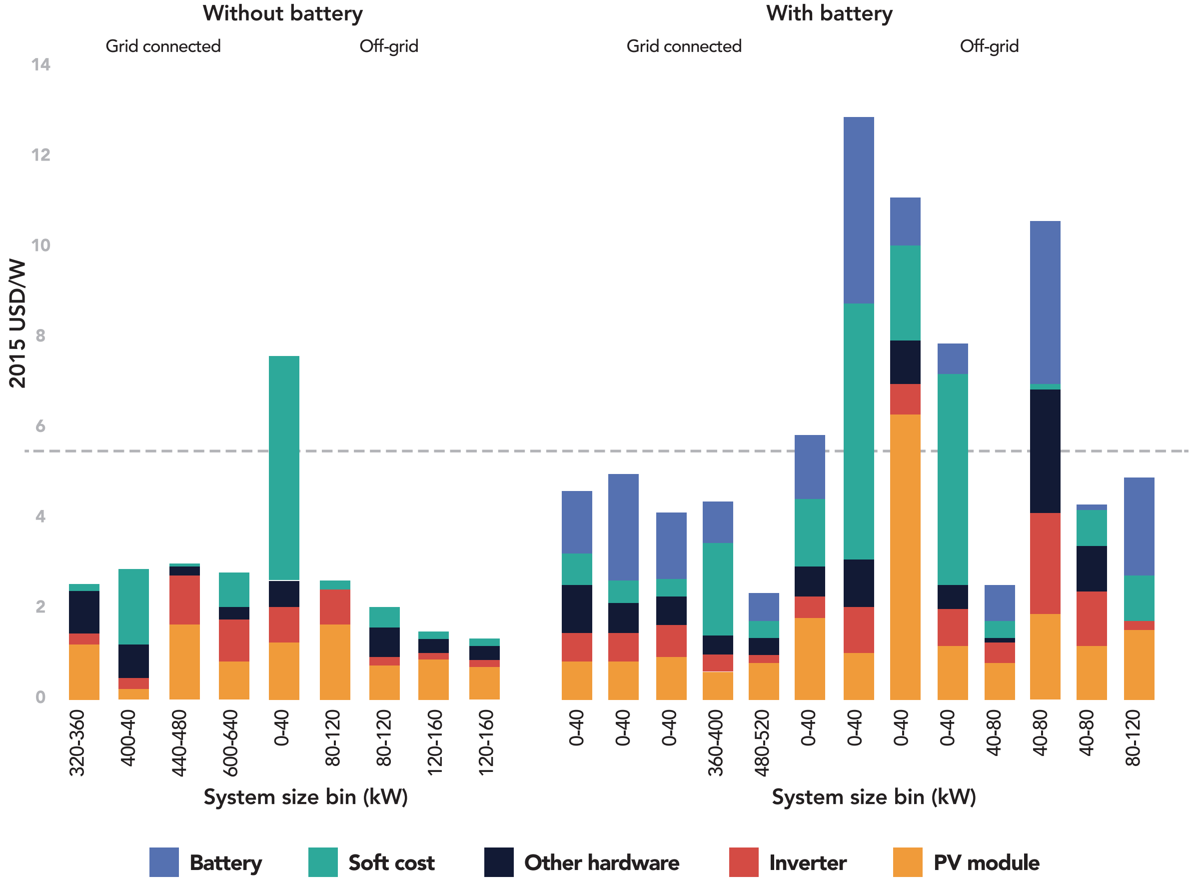
INSTALLED COST OF MICROGRIDS BY REGION $/KW

	India	Indonesia	Tanzania
Turnkey Microgrid	$1.5 - $6.6K	$4 - $15K	$3-$11K
PV + Storage	$1.7 - $3K*	$5 - 9K**	$4.8K***
Micro-hydro	$2.7 - $5K****	--	$2.2K
Biomass	$0.750K******	--	$3.0K
Diesel	$1.45K	$1.5K	--

Notes: Turnkey Microgrid: Survey of ESCOs 2016-2017, Allotrope Partners, 2017. *BNEF Off-Grid Solar Market Trends Report, 2016. Best case scenario pricing. See Tables 14 & 15, pg 21 of BNEF report. Elsewhere in the report, installed price is referenced at $7,000/KW (pg. 8). (BNEF, 2016). Dalberg, 2016 estimate cost at $2,500-$3000 per KW in India. **Based on private sector proposal for PV, storage, and generator for Karampuang Island, Indonesia. ***IRENA, 2016. Sample size is small with significant variation due to remote location of some systems and other factors. (pg. 58.) The figures used here is an estimated average for approximating Tanzania PV and storage costs. IRENA, 2012: Hydro and biomass costs approximated from graphical data, biogasifer global data, pg. 35. ****WRI, 2016 ******Prayas Energy Group, 2012.

14 Component costs breakdown in Africa is 26% PV, 13% Invtr/CC, 13% BoS, 26% Batteries, and 13% Soft (Irena, 2016. pgs. 58-60). Further data is needed for UP, Indonesia, and Tanzania specific estimates.

There is wide variation in component costs, which can range from $1.5/Watt to $8/Watt on average for solar PV systems without batteries, and $2-$12/Watt with batteries. Larger system sizes often have lower per unit ($/W) costs due to economies of scale (bulk purchasing, soft cost reduction per KW, etc.). Regional pricing variations make it difficult to develop a more detailed estimate at the global level, as the following chart illustrates.[15]



Note: All system sizes have been rounded.

Electricity Costs

Comparing the cost of electricity across microgrids and incumbent sources of electricity is difficult. The fundamental value proposition offered by rural renewable energy powered systems is that they produce power that is cleaner, safer, and more cost-effective than incumbent fuel sources. As such, kerosene and diesel often set the ceiling price for offgrid service providers. Kerosene and diesel costs vary widely, though they typically increase proportionally to remoteness. Consequently, microgrid developers look for sites where they can provide electricity at or below the cost of kerosene and diesel. However, this is not always possible, especially when a diesel generator (which is typically provided to a community via a grant) provides power that uses subsidized fuel, as is the case in some parts of Indonesia.

15 IRENA, 2016. Solar PV in Africa: Costs and Markets -2016: https://www.irena.org/DocumentDownloads/Publications/IRENA_Solar_PV_Costs_Africa_2016.pdf

Currently, it appears that it is governments, not communities that are pushing back on the electricity tariffs being offered by microgrid owners. As the market develops, more robust price competition is likely to emerge as market share concentrates in the more successful companies. The following table compares grid and diesel generator electricity rates to microgrid rates, and the **levelized cost of electricity** (LCOE). Diesel costs only include marginal fuel costs, thereby limiting comparisons.

Comparative Energy Costs

	India	Indonesia	Tanzania
Microgrid tariff	$2-4/month	$5-$25/month	$3-$15/month
Microgrid LCOE	$.25-$.70/KWH*	--	$.35/KWH****
Public Utility	$.054/KWH**	$.08/KWH***	$.16/KWH
Diesel Fuel*****	$.26/KWH ($.91/liter)	$.18/KWH ($.62/ liter)	$.34/KWH ($1.20/ liter)

*India Microgrid: Climate Group, 2016. Public Utility (PU): Indian Government, 2016.
**Based on India average (3.62 INR). Residential rates: http://data.gov.in/catalog/state-wise-average-rate-electricity-domestic-and-industrial-consumers
***Indonesia PU: Energypedia, 2016.
****Tanzania MG: Lights Global, 2016 (Africa wide 2014 estimate based on IEA data). PU: AfDB, 2015.
***** Diesel fuel does not account for cost of generator, maintenance, repairs, or the higher cost of fuel in rural areas.
Global Diesel cost per liter: World Bank, 2016. http://data.worldbank.org. $/KWh were derived from the literature where available, and using the formula 1 liter of diesel fuel produces (on average) = 3.5 KWh of electricity.

Levelized Cost of Electricity (LCOE): The LCOE is the total cost of installing and operating a microgrid represented in a price per KWH of electricity generated by the system over the system life. LCOE is used, in part, to evaluate and compare microgrid costs and to establish tariff rates. LCOE varies significantly by project (capacity, interest rates, etc.). For example, the LCOE of a solar PV-diesel mini-grid that serves 100 users can range from US$0.46/KWH to $0.74/KWH, while a 100% solar PV mini-grid can vary from US $0.467/ KWH to $0.714/KWH (Norplan, 2013). A 2014 project in India found that a 100 KWp solar PV mini-grid had an LCOE of US $0.50/KWH (IRENA, 2016).

Microgrid Policies

This section provides background on government agencies and policies related to microgrid development in Indian, Indonesian, and Tanzanian markets.[16]

Over the past ten years, rural electrification policies in India, Indonesia, and Tanzania have been unique to their respective markets and circumstances and thus difficult to compare. However, with national and international efforts concentrated on 100% electrification in these target countries, 2016 marked a milestone year for the adoption and revision of new and existing microgrid frameworks. Last year, both Indonesia and the Indian state of Uttar Pradesh (UP) adopted microgrid-specific policies, and the Tanzanian electrification policy that was issued in 2009 was updated under the Electricity Development of Small Power Project Rules.

16 *In India, MIA will direct its initial efforts on the states of Uttar Pradesh and Bihar. While there is some information available on Bihar's draft minigrid framework, this report focuses on Uttar Pradesh and its ratified microgrid policy.*

As summarized below in Table 1, these policies vary in terms of system size, tenure of project, minimum KWH production, land-use, monitoring, and reporting requirements.[17] While these frameworks provide guidelines and parameters for investors and ESCOs to finance and develop projects, some significant uncertainties related to **grid extension** and **negotiating and setting tariffs** (electricity rates for customers) remain. In each of the three markets, tariff rates are negotiable with customers though they are submitted to government agencies for final review. Grid extension regulations may need more refinement for ESCOs to scale over time and provide more certainty for investors. In Indonesia, ownership rules may preclude some investment opportunities. At this time, Tanzania and the Indian state of Uttar Pradesh appear to demonstrate less policy risk and more attractive and comprehensive processes for microgrid project developers and investors than Indonesia and the Indian state of Bihar.[18]

TABLE 1: HIGH-LEVEL OVERVIEW OF KEY INFORMATION RELATED TO MICROGRID DEVELOPMENT IN TARGET MARKETS

	Grid Extension	Tariff Rates	System Size	Tenure of Project[1]	ESIA
Uttar Pradesh, India Independent Developer	Negotiable	Negotiable	<500 KW	N/A	TBD
State Subsidy Program	Yes	Set by Government	<500 KW	10 Years	Yes
Indonesia	Negotiable	Set by Government	<50 MW	1 Year	No
Tanzania Very Small Power Provider	Negotiable	Negotiable	<100 KW	No	No[1]
Small Power Provider	Yes	Yes	>100 KW	25 Years	Yes

"Yes" = regulation exists; "Negotiable" = regulations exists, but it does not specify outcome; "No" = regulation does not exist; ESIA = Environmental and Social Impact Assessment; "TBD" = to be determine

GRID EXTENSION

At current technology and installation prices, microgrids are not typically cost competitive with the (often subsidized) electricity from the central power grid.[19] Consequently, grid expansion and the subsequent loss of customers pose one of the greatest risks to microgrid development. Project developers and investors can mitigate this risk by conferring with governing agencies early on to understand pertinent project viability information (e.g. minimum project distance to the grid, the process for selling (excess) power to the grid, the process for selling assets to the utility, the valuation of the assets, etc.) and standardizing, to the extent possible, due diligence processes for each project.

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17 *Duration which the system owner must maintain the system (when participating in the state subsidy program).*

18 *Analyses included desk research, conversations with key stakeholders (e.g. experts in the field, in-country advisors, regulators), and structured interviews with in-country developers*

19 *Public subsidies for electricity prices on grids tend to result in a cost ($/kWH) to consumers that is lower than prices offered by ESCOs. At $.04/KWH, UP offers the 'lowest cost' for grid power. Utilities in developing countries often run financial deficits with public funds as recourse -microgrid owners don't have this option. Along with other factors, these help explain the relatively higher cost per kWh charged to customers for power from renewable energy microgrids.*

TABLE 2. OVERVIEW OF GRID EXTENSION AND TARIFF REGULATIONS IN TARGET MARKETS

	Grid Extension	Tariff Rules
India Uttar Pradesh	System owner can: Sell power to utility at mutually agreed tariff[2] Sell system on a net cost-benefit basis	Without government subsidy: ESCO & community agreement With 30% CAPEX subsidy: > $ 3 a month for 23 KWH/month Over 800 Watts a day, negotiable tariff
Indonesia	Government can provide concession area ESCOs may receive exclusivity (in a Business Area)	Requires a provincial Governor or Ministry level approval Or revert to utility (450 VA) tariff schedule
Tanzania	System owner has 3 options: 1. Negotiate off-take rates with Utility 2. Sell system to utility 3. Continue to sell electricity to community	For system under 100 KW: Negotiable between ESCO & community Reviewed by REA/EWURA[3]

Uttar Pradesh and Tanzania have similar policies in the case of grid-extension (Table 2). Both policies allow for the energy (KWH) or the entire system to be sold to the utility at a negotiated rate (to-be-determined at time of sale). Guiding principles in the policies for both markets call for purchase prices to be determined on a cost-reflective basis. Given that these markets are still in relatively nascent stages of project development, there are few, if any, examples of how and the frequency at which this process will actually play out. In Tanzania, where the World Bank has recently provided $200 million in funding for grid enhancement projects, ESCOs go through an application process that allows the governing bodies (EWURA/REA) to evaluate the proposed project locations against planned grid extension, thereby reducing the risk of developing a project where there are plans to extend the grid.[20]

Under current Indonesian law, a licensed Private Power Utility (PPU) can be granted exclusivity in a region not served by the national utility (PLN) and sell electricity to a customer base at negotiated rates. This could be similar to the microgrid policy that stipulates the granting of "Business Areas". However, the language in the policy is not definitive and thus may not align with the PPU precedent.

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TARIFFS

Tariffs, the cost of electricity to end users, are commonly expressed as $/KWH (cents per kilowatt-hour). While some ESCOs use this approach when setting a tariff, most negotiate monthly (or seasonally adjusted) agreements with customers, e.g. $10 per month for an agreed upon amount of power. Tariffs are typically pre-paid either in-person or through mobile money applications. Alternatively, local or national governments can set tariff rates that can vary by different factors such as system size and location.

In Indonesia, UP and Tanzania, under existing policy, it is possible for ESCOs to negotiate tariff rates directly with community members. Once negotiated, the written agreement typically has to be reviewed and approved by the appropriate government agency. Given these provisions, project developers can and are negotiating service and payment terms directly with households, businesses, and community organizations.

In UP, when a project is developed 'independently' (projects not eligible for the state subsidy program), the owners can negotiate tariff rates directly with the local community being served by the microgrid.[21] Developers also have the option of developing projects in state-designated areas, in which case they have to meet a certain set of criteria to be considered for the 30% CAPEX project subsidy - systems must produce at least 800 watt-hours per day (with designated service hours), meet specific technology criteria, and commit to a project tenure of 10 years. For connections with over 24 KWH/month, tariff rates can be negotiated between the system owner and the end customer, with subsequent approval by the Government. Discussions with ESCOs operating in these markets suggest that the tariff rates for subsidy-eligible projects are a primary concern for moving minigrid projects forward. Namely, the pre-set rates are too low to generate viable returns. Consequently, some companies have opted to develop projects (independently without subsidies) in non-state designated areas. Based on a limited sample of local developers, economically viable tariff rates were generally two times more than the subsidy-eligible projects or >120 INR/month for 50 Watts and >240 INR/month for 100 Watts (~ $2-4/month). [22]

In Indonesia, the new policy stipulates that the government and ESCOs must mutually agree on a tariff, presumably after the developer and possibly government representatives consult with the local community.

Tanzanian policy states that in order to qualify for a negotiated tariff rate, a system must be less than 100 KW in peak generating capacity. Under these circumstances, current tariffs range from $0.75/KWH to $10 flat fee for ~5 KWH per month. Tariffs for these Very Small Power Producer (VSPPs) are negotiated via a written agreement between the system owner and the community - with at least 15% of community customer base as signatories; the tariff is then reviewed by the Rural Energy Agency (REA). For systems larger than 100 KW (Small Power Producers), rates can first be

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21 *"Independently" is used in UP's legislation to simply mean a microgrid project owner is not participating in the subsidy program, and is developing and building the self identified project 'independent' of the state program -though some restrictions still apply, e.g. maximum system size <500 kW.*

22 *Tariffs are dependent on system size, techology. For larger system FiT are usually awarded through a low cost bidding process.*

negotiated on a project-cost basis with end users and then submitted to REA for approval.[23] Should the grid arrive, KWHs can be sold on a cost basis or via the government-set FiT, which is currently about $0.15 -$0.20/KWH) and varies by technology.[24]

FOREIGN OWNERSHIP

Generally, India allows for up to 100% foreign ownership of companies. Foreign ownership for projects over 10 MW in Indonesia can be up to 95% foreign owned, depending on the type of company. However, systems under 1 MW appear to fall under category 35101 of the Foreign Direct investment Policy, where 100% domestic capital is stipulated and thus may precluded some types of private sector investment.[25] A foreign majority stake in a domestic Special Purpose Company in Tanzania is allowed, though up to what percent is not explicit.

ANALYSIS

The recently updated Electricity Development of Small Power Projects regulations in Tanzania primarily focus on systems over 100 KW. Under these guidelines, these small power producers (SPPs) can qualify for retail rates/public Feed-in-Tariffs or they can be negotiated on the basis of project costs principles.[26] The Tanzanian policy touches on several key regulations for systems less than 100 KW but leaves some of the legal language vague and thus unclear, specifically around what steps developers are exempt from (e.g. to what extent/development steps/locations VSPPs are exempt from when considering the environmental impact assessment). The VSPP section goes on to recommend VSPPs fulfill the provisions of the SPP rules in order to minimize risks of competing claims on resources, further calling into question the seemingly straightforward development process for VSPPs (<100 KW).

Relative to the other target markets, Uttar Pradesh's microgrid-specific policy is the most comprehensive and favorable for developers and investors interested in developing projects in non-state designated areas. This is primarily due to the fact that when projects are developed outside of these state-designated areas, developers are free to negotiate tariff rates directly with the local community that the microgrid will serve rather than be locked into the tariff rates set by state.[27] Additionally, the framework articulates the process for and expectations of the developer should the grid arrive within 100 meters of the minigrid project.

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23 *Electricity Act 2009, revised 2016. http://144.76.33.232/wp-content/uploads/2016/01/THE-ELECTRICITY-SYSTEM-OPERATIONS-SERVICES-RULES-2016.pdf*

24 *GIZ, 2015. Plans for Grid Extension 2033, slide 23: https://www.giz.de/fachexpertise/downloads/2015-tanesco-presentation-tansania.pdf*

25 *BKPM. LISTS OF BUSINESS FIELDS THAT ARE CLOSED TO AND BUSINESS FIELDS THAT ARE OPEN WITH CONDITIONS TO INVESTMENT: http://www2.bkpm.go.id/images/uploads/prosedur_investasi/file_upload/REGULATION-OF-THE-PRESIDENT-OF-THE-REPUBLIC-OF-INDONESIA-NUMBER-44-YEAR-2016.pdf FDI: Negative Investment List, Pg. 15*

26 *The Electricity Act, The (Electricity Development of Small Power Projects) Rules, 2016 Part VII, 5(3)d(ii): http://www.minigrids.go.tz/Files/The_Electricity_Development_of_Small_Power_Projects_Rules_2016.pdf*

27 *Projects developed in state-designated areas are eligible to receive a 30% subsidy if the projects meet specified criteria, however in this situation tariffs rates are predetermined (INR 60/month [$.88/month] - 50 watts, INR 120/month [$1.76/month] - 100 watts); INR: Indian Rupee 100 = $1.47 (1/17)*

Microgrid Governance

INDIA

As mentioned above, India's policy and regulatory environment concerning renewable energy microgrids is largely under the purview of the individual Indian states, as are their respective centralized grids. In addition to tax incentives for renewable energy companies and import exemptions for most distributed renewable energy components, there are several national frameworks and initiatives that act to inform the Indian states' respective regulations; however most decision-making power has been delegated from the central government to the local or regional governments. Table 3 below outlines key relevant ministries and governing bodies that oversee one or several aspects of the renewable energy microgrid project development life cycle.[28]

In addition to favorable foreign investment conditions, most renewable energy component imports are exempt from duty and distributed renewable energy companies may be eligible for tax incentives.

TABLE 3: NATIONAL INDIAN MINISTRIES, GOVERNING AGENCIES AND INSTITUTIONS

Ministry of New and Renewable Energy	Nodal ministry for all matters related to new and renewable energy[4]
The Indian Renewable Energy Development Agency	Non-banking financial institution - promotes, develops and extends financial assistance to renewable energy and energy efficiency projects[5]
Rural Electrification Corp.	Non-banking financial company with 'Infrastructure Finance Company' status; main objective is to finance and promote power sector projects. Nodal agency for Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY) implementation[6]
Ministry of Power	Manages the development of energy resources – oversees planning, policy formulation, processing of projects for investment decision, monitoring and implementation of projects, training and development, administration and enactment of legislation for thermal, hydro power generation, transmission and distribution; responsible for Administration of the Electricity Act, 2003 and the Energy Conservation Act, 2001[7]
Central Electricity Regulatory Commission/ Authority	Regulates [central government] tariffs, interstate transmission, access information; formulation of the National Electricity Policy and Tariff Policy; promotion of competition, efficiency and economy of electricity activities, promotion of investment in electricity industry[8]
Central Institute for Rural Electrification	Training institute – caters to the training and development needs of technical and managerial personnel of power utilities as well as in-house programs for REC personnel round the year[9]

28 *This list is not intended to be exhaustive, but rather serve as a starting point for analysis and country-specific due diligence.*

Table 4 outlines the policies, regulations, and initiatives related to renewable energy and microgrid development in India.

TABLE 4: INDIAN NATIONAL POLICIES AND PROGRAMS FOR RURAL RENEWABLE ENERGY MICROGRIDS

National Electricity Policy	Lays guidelines for accelerated development of the power sector, providing supply of electricity to all areas and protecting interests of consumers and other stakeholders[10]
Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY)	India's active rural electrification scheme. Flagship program under the Ministry of Power that will aim to facilitate country-wide 24/7 power[11]
Jawaharlal Nehru National Solar Mission (JNNSM)	Aims to set up an enabling environment for both centralized and decentralized solar technology[12]
National Smart Grid Mission (Microgrids)	Promotes development of microgrids in islands, SEZs, institutions and commercial hubs that would dovetail the existing projects under renewable energy projects and other international support programs[13]
National Draft Policy on Renewable Energy based Mini/Micro grids (2016)	Mainstreams renewable energy-based microgrids by building a supportive ecosystem for developers and financiers; 500 MW over 5 years[14]
Rural Electrification Policy, 2006	Aims for provision of access to electricity to all households by 2009; quality and reliable power supply at reasonable rates; minimum consumption of 1 unit/household/day by 2012[15]
Revised National Tariff Policy	Mandates compulsory purchase of power into the grid from the microgrids at a set tariff rate; promotes renewable energy as viable energy solution; increases Renewable Purchase Obligation (RPO) to 8% by 2022; removes inter-state transmission loss charge for renewable energy[16]
Electricity Act, 2003	Removed licensing requirements for electricity generation and distribution in rural areas[17]

*Piyush Goyal is the Minister of State (IC) for Power, Coal, and Renewable Energy and Mines

STATE GOVERNANCE

Although this report focuses more heavily on the Indian state of UP, this section provides some background on the status of Bihar's minigrid framework and relevant governing agencies in both states. Table 5 outlines the key agencies and governing bodies that oversee microgrid development in Bihar and UP.

TABLE 5. STATE-LEVEL GOVERNING BODIES RELATED TO MICROGRID DEVELOPMENT

	State Utility	Governing Agencies
Bihar	Bihar State Power Holding Company	Bihar Electricity Regulatory Agency
		Bihar Renewable Energy Development Agency
Uttar Pradesh	Uttar Pradesh Power Company Ltd. – Transmission and Distribution	UP Electricity Regulatory Commission UP New and Renewable Energy Development Agency

BIHAR

Census data from 2011 shows that almost 90%[29] of Bihar's population lives in rural areas, and as of February 2017 the World Bank reported that more than two-thirds of the state's population lacked access to electricity.[30] Grid extension is slow and costly, and the Government of India is under increasing pressure to provide power to rural communities. Bihar, and the country more broadly, view microgrids as a near-term, cost-effective opportunity to electrify rural populations.

Microgrid Policies and Regulations

Bihar Electricity Regulatory Commission (BERC) has not formally adopted the proposed Mini Grid Renewable Energy Generation and Supply Framework Regulations for the state. A draft framework is currently undergoing review and comment, and formal adoption of it is expected in 2017. Insights were drawn from Bihar's 2016 draft microgrid policy, which has since been taken offline.

Microgrid Framework Overview

- Project Size Limits: 10 KW – 1,000 KW
- Tariff: Negotiable (approved by BERC)
- Subsidy: Not stipulated

Grid Expansion

The microgrid owner has several options in the event of grid expansion:

- Negotiate sale "at book value" with the utility (system must conform to utility standards);
- Distribute and supply electricity to existing consumers at their request; or
- Sell power to the utility

Barriers

At this time the primary policy barrier MIA faces in Bihar is the lack of an adopted microgrid policy.

29 *Bihar Government, 2011. Rural and Urban Population Bihar and India: 1902-2011: http://gov.bih.nic.in/Statistics/Table-011.pdf*

30 *The World Bank Report, 2015. Bihar Needs to Ramp up Power Infrastructure to Provide Access for All: http://www.worldbank.org/en/news/press-release/2015/02/27/bihar-needs-ramp-up-power-infrastructure-provide-access-all*

UTTAR PRADESH

Uttar Pradesh (UP) has the largest population in the nation, with over 200 million people residing in the state. Demonstrating its commitment to achieving widespread electrification and delivering energy to its remote population, Uttar Pradesh was the first Indian state to draft and ratify its Mini Grid Renewable Energy Generation and Supply Framework. This framework came into effect in June 2016.[31] To reduce transaction costs for microgrid developers, a single point of clearance system has been established through Udyog Bandhu, a state organization.[32]

Microgrid Policies and Regulations

Uttar Pradesh Electricity Regulatory Commission (UPERC) governs the Mini Grid Renewable Energy Generation and Supply Framework Regulations for the state. The policy stipulates limits on system sizes, tariffs, and options for the minigrid owner in the event of grid extension. Where developers have self-identified projects and are not participating in the state subsidy project, there are minimal restrictions.

Stipulations for Projects in state-designated areas:

- Project size: Maximum of 500 KW.
- Subsidy: 30% capital subsidy for state-identified villages[33]
- Tariffs: Pre-set under state program w/ subsidized project
    - INR[34] 60/month ($.88/month) - 50 Watts
    - INR[15] 120/month ($1.76/month) - 100 Watts X 8 hrs. required delivery
    - Negotiable for >100 Watts X 8 hrs. a day

Grid Expansion

Depending on the status of the central grid at the time the microgrid was built, microgrid owner operators (MGOs) have one of several options. If the grid was not present at the time the project was built, the MGO can choose to:

(1) continue to operate as before if customers agree;

(2) sell excess power to the Indian distribution companies ("DISCOM", hereafter) at mandated rate (R7.06/KWH ($0.118 in 2016/17)) via a PPA;

(3) sell electricity generated to the DISCOM at the state mandated FiT via a PPA; or

(4) transfer the distribution network assets (though not the generating assets) to the DISCOM – the cost of the distribution assets will be based on the depreciated value of the assets, which are calculated according to the straight-line rule.

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31 *UPERC, 2016. Mini-Grid Renewable Energy Generation and Supply) Regulations, 2016: http://upneda.org.in/sites/default/files/all/section/MiniGrid%20regulations%202016.pdf*

32 *Department of Infrastructure & Industrial Development, Udyog Bandh: http://upneda.org.in/sites/default/files/all/section/MiniGrid%20regulations%202016.pdf*

33 *State subsidized projects must adhere to technical standards and compulsory supply for residential and commercial hours (8 and 6 hours, respectively)*

34 *INR: Indian Rupee 100 = $1.47 (1/17)*

If there is an existing DISCOM interconnection at the time the mini-grid was constructed, the MGO can choose between options (1) and (2) above. Option (3) becomes available only after a subsequent three-year
waiting period. For option (4), the policy does not specify a valuation rule for the assets.[35,36]

INDONESIA

With more than 17,000 islands, the archipelago nation of Indonesia faces unique infrastructure constraints when it comes to electrifying its geographically diverse population. In early 2016, the Government of Indonesia launched the "Indonesia Terang" (Bright Indonesia) initiative, which seeks to electrify the remaining 15% of its population that does not have access to electricity. Indonesia adopted the Accelerating Electrification in Rural Areas policy in December of 2016, which outlines an initial policy framework for private sector investment and development of government-sanctioned microgrids in currently unelectrified areas and/or areas without reliable access to electricity.[37]

Microgrid Policies and Regulations

The primary governing agency for rural electrification, and consequently microgrids, in Indonesia is the Ministry of Energy and Mineral Resources (EBTKE). As referenced above, the recently issued policy for accelerating rural electrification stipulates that energy companies seeking to develop projects outside of the national utility-served areas can apply for and be granted a "Business Area" concession.[8] While being granted a "Business Area" implies that the national grid will not impede on the company's service area, the approval process and project requirements (e.g. projects must serve 95% of the population within five years of commissioning the system) pose a potential risk to developers and investors. Furthermore, it is unclear how enforcement will be carried out. Table 6 outlines key Indonesian government ministries agencies and institutions that oversee one or several steps of renewable energy microgrid project development.

TABLE 6: INDONESIAN MINISTRIES, GOVERNING AGENCIES AND INSTITUTIONS

Ministry of Energy and Natural Resources	Oversees all matters related to new and renewable energy [1]8
Perusahaan Listrik Negara (PLN)	Indonesian government-owned corporation which has a monopoly on electricity distribution in Indonesia [1]9
Local Government Offices	Permitting and approvals for land rights, project development, etc.; varies by region

35 *Comello et al., 2016. Enabling Mini-grid Development in Rural India - 2016: https://www-cdn.law.stanford.edu/wp-content/uploads/2016/04/IndiaMinigrid_Working_Paper2.pdf*

36 *Udyogbandhu. Fiscal Incentives Available in the State of Bihar: http://udyogbandhu.com/topics.aspx?mid=Fiscal%20Incentives*

37 *Accelerating Electrification in Undeveloped Rural Areas, Remote Regions, Border Areas, and Small Island Through the Implementation of Small Scale Electricity Provision Enterprises. Unofficial USAID ICED translation.*

Table 7 outlines the country's national rural electrification policies and programs.

TABLE 7: INDONESIAN NATIONAL POLICIES AND PROGRAMS

Accelerating Electrification in Rural Areas	Small projects in rural areas national policy
Indonesia Terang[2]	Government initiative to electrify remote villages

Microgrid Framework Overview
Indonesia's microgrid framework regulates projects up to 50 MW. To be eligible for the government subsidy, systems must comply to preset requirements.

The subsidy calculation is laid out below, and while the variables are defined in the regulation, their actual values are not all listed in the regulation. Additionally, some of these variables change on a quarterly basis, resulting in a highly unpredictable outcome for investors.

Subsidy = - (TTL – BPP(1+M)) x V

The policy states:

- S = Subsidy
- TTL = PLN Household Consumer Tariff with 450 connected power capacity (Rp/KWH)
- BPP = Low Voltage Provision Main Cost (Rp/KWH)
- M = Margin (%)
- V = Volume of electricity usage per connection point per month

TTL and BPP are dynamic variables updated monthly and published on PLN webpage.[38] For businesses providing electricity power without using the subsidy – a proposed tariff (by the project owner) can be approved by the regional Governor or EBTKE Minister.

Grid Expansion
Under current Indonesian law, a licensed Private Power Utility (PPU) can be granted exclusivity in a region not served by the national utility (PLN) and sell electricity to a customer base at negotiated rates. This could be similar to the microgrid policy that stipulates the granting of "Business Areas". However, it is not made clear in the policy and may not align with the PPU precedent. Given the remoteness of these areas, it may turn out that geographic barriers (e.g. Java Sea) will be sufficient to inhibit grid extension.

Barriers
Historically, investors and local project developers have indicated that working with the state utility (PLN) is one of the most challenging aspects of doing business in Indonesia's electricity sector. Additionally, the newly released framework is vague regarding grid extension and an ESCOs' tenure

38 PLN Tariff Rate schedules http://www.pln.co.id/2017/02/01/tarif-tenaga-listrik/

with respect to a given 'business area.' Furthermore, renewable energy systems under 1 MW may fall under category 35101 of the Foreign Direct investment Policy, in which case 100% domestic capital is stipulated and thus precludes foreign private sector investment.[39] These uncertainties may prove challenging for ESCOs, investors, and MIA's success in the country. Further policy research and expert legal counsel will be vital as the policy and its subsequent implementation evolves.

Indonesia offers some import exemptions and tax incentives if the products and/or investors in the projects meet specific criteria.

- Import Duty Exemption[40]:
    - Exempt from import duty on the import of machines, goods and materials for production period of two (2) years.
    - Import duty exemption granted for two (2) years based on the installed machine capacity for production purpose available for 1-year exemption.
    - If the company uses at least 30% local machineries, import duty exemption is available for the product for an additional four (4) years.
      **REQUIREMENTS: Imported machine, goods and raw material are:
- Not yet being produced locally
- If the local machines are available but are unable to fulfill criteria of required machines.
- If the local machines are available but are unable to fulfill the total required machines.

TANZANIA

In an effort to attract private sector and foreign investment, the Government of Tanzania issued an energy access framework that showcases the country's strong commitment toward achieving its goal of universal energy access by 2030. As part of this effort the 2009 Electricity Development of Small Power Project Rules, was updated in 2016.[41]

Microgrid Policies and Regulations The Ministry of Energy and Minerals formulates and oversees policy development for the state-owned utility TANESCO. The Energy and Water Utilities Regulatory Authority (EWURA) govern policy and Rural Energy Agency (REA) serves as the implementing agency on the ground in Tanzania (Table 8). The Second Generation Small Power Producer framework regulates system sizes: (i) less than 100 KW and (ii) 100 KW up to 10 MW

Tariffs

Tariff rates for VSPPs are negotiated between the minigrid operator and the local community (at least 15% of customer base as signatories); the tariff is then reviewed by REA. For systems larger than 100 KW (SPPs), rates can first be negotiated on a project-cost basis with end users and then be submitted to REA for approval.[42]

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39 *President of the Republic of Indonesia, 2016. Lists of Business Fields that are Closed to and Business Fields that are Open with Conditions to Investments, Pg.15: http://www2.bkpm.go.id/images/uploads/prosedur_investasi/file_upload/REGULATION-OF-THE-PRESIDENT-OF-THE-REPUBLIC-OF-INDONESIA-NUMBER-44-YEAR-2016.pdf*

40 *BKPM. Regulation of Ministry of Finance No. 76/PMK.011/2012 jo. No 176/PMK.011/2009 Investment Incentives: http://www2.bkpm.go.id/en/investment-procedures/investment-incentives*

41 *SPP Policy*

42 *Electricity Act 2009, revised 2016.*

Table 9 outlines Tanzania's key policies and programs for rural electrification and microgrids.

TABLE 9: TANZANIAN PROGRAMS AND INITIATIVES FOR RURAL RENEWABLE ENERGY MICROGRIDS

National Energy Policy, 1992 (Revised 2003)	Focuses on market mechanisms as a means to create an efficient energy sector
Rural Energy Act, 2005	Promotes improved access to modern energy services in rural areas and provides grants to developers of rural energy projects and to TANESCO
Electricity Act, 2008	Liberalized electricity production and distribution in Tanzania
REA National Rural Electrification Plan	Performance-based grant support to microgrids and stand alone systems
Tanzania National Development Vision 2025	Goal is to move Tanzania from a Least Developing Country to a Middle Income Country; will integrate SE4ALL Plans
Rural Energy Fund (REF)	Established by The Rural Energy Act, 2005 to provide grants to qualified project developers
Tanzania's Energy Development Access Project (TEDAP)	Objective of TEDAP is to improve the quality and efficiency of the electricity service provision and to establish a sustainable basis for energy access expansion and renewable energy development - facilitates frameworks, grants and technical assistance (TA) for new off-grid connections by 3rd parties and can provide additional financing
Tanzania Investment Center (TIC)	Primary agency to coordinate, encourage, promote and facilitate investment in Tanzania – offers incentives for JVs with Tanzanians and wholly owned foreign projects investing a minimum of US $300,000
Renewable Energy for Rural Electrification (RERE)	Implemented by REA (supported by World Bank/IFC); aims to (i) build an efficient and responsive off-grid electrification project development infrastructure for RE-based rural electrification, and (ii) demonstrate its effectiveness by supporting a time-slice of private sector investments in off-grid electricity enterprises; provides co-financing through a credit line, transaction advisory services facility, risk mitigation instruments, capacity building for key stakeholders
SREP-Tanzania Investment Plan	Objective is to catalyze the large-scale development of renewable energy to transform the country's energy sector
SE4ALL Initiative in Tanzania	Aim of catalyzing all stakeholders into achieving sustainable energy for all. Three key goals to be achieve by 2030; 1. Ensure universal access to affordable, reliable and modern energy services; 2. Double the share of renewable energy (RE) in the global energy mix and; 3. Double the global rate of improvement in energy efficiency (EE)

Upon central grid arrival into a minigrid area, the minigrid operator has several options:

- Negotiate sale of system on a depreciated value basis to utility (TANESCO) at the time of sale;
- Continue to provide service to existing customer base at their discretion; or
- Sell electricity to utility at a negotiated rate.

Incentives Summary

Developers and investors can receive various incentives in the form of:

- Performance-based grant support
- Subsidies
- Streamlined approval process
- Preferential interest rates
- Technical assistance for TEDAP
- VAT and import tax exemption for main solar component
- Simplified procedures for SPPs
- Abundant solar resources all year
- Payments in USD
- Standardized PPAs and tariffs
- Loans from commercial banks supported by US $25 million World Bank line of Credit
- Technical Assistance to developers, REA, utility, regulator[43]

Foreign Direct Investment/Ownership

A foreign majority stake in a domestic Special Purpose Company in Tanzania is allowed, however the MIA research team is still in consultations with local developers and legal authorities regarding the laws that regulate general foreign direct investment (FDI) into Tanzania.[44]

Taxation

Limited data shows corporate tax rates could be 20-30% and that there is limited use of double taxation policy.

- Corporate tax: Income tax rate for resident and non-resident companies is 30%; newly listed companies on Dar es Salaam's Stock Exchange (at least 35% of equity share issued to the public) can benefit from a reduced rate of 25% charged for three years
- Withholding tax: Dividends (10%); on loan interest (10%)
- Import Duty and VAT exemptions on Capital / Deemed Capital Goods: Private sector investors can avail Import Duty and VAT exemptions on their Capital / Deemed Capital Goods (e.g. building materials, utility vehicles, equipment). Where VAT Exemption on Deemed Capital Goods is 45% of VAT payable, the investor pays 55% of the VAT payable
- VAT special relief on renewable energy project capital goods
- VAT Exemption on wind generators, PV, and solar thermal
- Investment Guarantee against nationalization and expropriation may be granted by the national government

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43 GiZ, 2014. Mini-grid systems on the rise in Tanzania Status of implementation and regulatory framework conditions: https://www.giz.de/fachexpertise/downloads/2014-en-greacen-pep-fachworkshop-mini-grids.pdf

44 GIZ, 2015.

CONCLUDING REMARKS

While each of the respective states and countries present different opportunities and risks, each has demonstrated intentions to meet their specific electrification goals. Though there are still areas of uncertainty around the respective policies, at this time Tanzania and Uttar Pradesh appear to offer the most viable opportunities for developers and investors in the microgrid space.

The MIA research team continues to evaluate foreign ownership, investment, and taxation policies governing these markets to determine the optimal structure that MIA takes in the respective geographies.

Beyond the shifting policy environment, the MIA research team will continue to investigate microgrid business models in the next steps of facility design. With sufficiently robust project data (including LCOE), the MIA team will conduct analysis to estimate revenues and model economic returns for pools of projects, thereby improving understanding of the business case and financial performance of microgrids in these markets. Such analysis will be made possible by a collaborative exchange of data and insights between the MIA team and microgrid practitioners, investors, and other experts.

Appendix I

GENERAL MICROGRID TERMS & CONSIDERATIONS

This section briefly describes some of the basic terms and concepts that are of concern in the development of microgrids. Topics covered include level of service, site selection, tariffs and payment process, project costs, and other factors.

Level of Service: The following seven user-focused questions can be used to help clarify level of service a community receives from a microgrid:

1. How much capacity the electricity solution can deliver
2. How many hours does the household receive electricity service every day, and in particular in the evening
3. Is the service reliable
4. Is the service of adequate quality (e.g. outages and voltage fluctuations)
5. Is the service affordable
6. Is the service provided legally
7. Is the service safe

Based on these criteria, six tiers were established by the World Bank that describe the range of service, with Tier 0 representing "no service" and Tier 5 representing "full service", as illustrated in the table below (IRENA, 2016)[45]. The focus of MIA microgrids is on Tier 4-5.

TIER CALCULATION: HOUSEHOLD ELECTRICITY SUPPLY

ATTRIBUTES		Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
Capacity	Power		Very low power Min 3 W	Low power Min 50 W	Medium power Min 200 W	High power Min 800 W	Very high power Min 2 kW
	And daily capacity		Min 12 Wh	Min 200 Wh	Min 1.0 kWh	Min 3.4 kWh	Min 8.2 kWh
	Or services		Lightning of 1,000 lumen-hours per day and phone charging	Electrical lighting, air circulation, television, and phone charging are possible			
Duration	Hours per day		Min 4 hrs	Min 4 hrs	Min 8 hrs	Min 16 hrs	Min 23 hrs
	Hours per evening		Min 1 hrs	Min 2 hrs	Min 3 hrs	Min 4 hrs	Min 4 hrs
Reliability						Max 14 disruptions per week	Max 3 disruptions per week of total duration < 2 hrs
Quality						Voltage problems do not affect the use of desired appliances	
Affordability					Cost of a standard consumption package of 365 kWh per annum is less than 5% of household income		
Legality						Bill is paid to utility, prepaid card seller, or authorized representative	
Health and safety						Absence of past accidents and low perception of risk in the future	

45 *IRENA 2016. Policies and Regulations for Private Sector Renewable Energy Mini-grids: http://www.irena.org/DocumentDownloads/Publications/IRENA_Policies_Regulations_minigrids_2016.pdf*

In addition to providing household level access, rural microgrids can (and often are) also designed to provide power for small enterprises, community organizations, and commercial anchor loads (grain mills, water pumps, telecom towers). Anchor loads can have a more predictable and stable revenue stream and thereby help attract investment in larger systems that provide access and productive use power.

ESCOs: Microgrid energy service companies (ESCOs) refer to project developers, engineering, procurement, and construction companies, and other renewable energy system owner-operators in the field.

Site Selection: Typically, ESCOs use local knowledge, or in some cases proprietary data-driven software tools, to identify a potential community that could be served by a microgrid; they then carry out a soft socio-economic assessment of the community. If the site is appears viable and community members express interest, a detailed technical feasibility study and socioeconomic survey is typically carried in order to determine energy load profile/system design, willingness (and ability) to pay (tariff structure), locating the system, land use (lease) considerations, and other factors.

System Design: ESCOs use a variety of platforms to carry out the technical design microgrids. Firms with engineering expertise tend to use in-house software to determine generation capacity required to meet loads, charge batteries, and in many cases supplement renewable generation with a diesel generator. Hybrid Optimization Model for Electric Renewables (HOMER) and other commercially available design platforms are also used; on-going improvements in this space may result in higher adoption rates by developers in the field.[46]

Tariffs: Tariffs, the cost of electricity to end users, are commonly expressed as $/KWH - cents per kilowatt-hour. While some ESCOs use this approach when setting a tariff, most have negotiated monthly (or seasonally adjusted) agreements with customers, e.g. $10 per month for an agreed upon amount of power. Further discussion on the role of policy and tariffs in provided in the 'Policy' section of this report.

Metering/Payment Collection: Most microgrids deployed to date rely on in-person payment collection, typically on a monthly basis. Increasingly, mobile-money based pay as you go and pre-paid services are being used. In addition to ESCO-developed in-house payment platforms, third party payment system providers are also entering the market to offer customer billing services for a fee. In most cases, customers are required to pre-pay for services on a regularly occurring basis. When a customer runs out of credit, they can pay for additional power or have the electricity shut off to their household or business. Seasonally adjusted payment plans aligned with the local economy (harvests, for example) can also be found in the field and are more likely to take on a lump (annual or bi-annual) payment approach.

Connection Fees: Though not applicable in every country, households or businesses may be charged an upfront "connection fee" by the ESCO ($100-$500). These fees are used to help cover upfront capital costs and some countries/states provide a subsidy to cover all or part of this fee.

Subsidies: As with renewable energy markets in non-rural areas (and traditional energy sectors)

46 *http://www.homerenergy.com/*

subsidy levels and programmatic design can be used to catalyze markets with great effect. One of the more common approaches taken by foundations or governments to help spur the deployment of rural microgrids is the use of upfront capital grants and donations that effectively reduce (or subsidize) the cost of a system. Performance based incentives (PBIs) / subsidies have also been developed to help incentivize project up-time for example. Typically PBIs are provided on an ongoing basis after the system has been commissioned and meet pre-specified periodic production/use levels. Though this approach has its merits, ESCOs have expressed a need for subsidies and grants that help overcome initial capital costs of project development and installation.

Business (Ownership) Model: Most ESCOs utilize a build-own-operate-maintain model, where the microgrid installer owns the system, maintains and operates the system, collects payments, and distributes proceeds. In some markets, government provisions require a build-operate-transfer model, where an organization installs a microgrid and maintains and operates it for 5-10 years and then transfers ownership to a third party (community, government, NGO, utility, or other third party) as has historically been the case in Indonesia.

Returned Value: Targeted Internal Rate of Return (IRR) can range from 5-20%. Monthly tariff costs to customers can be highly sensitive to increased IRRs. For example, based on a pro-forma calculation in Kenya, a 10% increase in IRR results in an approximate 30% increase in monthly costs for customers.[47] A discussion of project costs and revenue can be found in the 'Microgrid Economics' section of this report.

Pilots and Scale: Current private sector led microgrid development efforts often begin with pilot systems ranging from one to ten sites to demonstrate technical operation and financial viability. These systems require relatively higher capital costs due to the nature of a pilot system. ESCOs in the field reported targeting phased tranches of 10 to 100+ systems or more in the next several years. To scale, ESCOs, donors, and investors face a number of hurdles, as discussed in the 'Barriers' section of this report.

47 *Carbon Africa Limited et al., 2014.*

Appendix II

MARKET RESEARCH METHODOLOGY

To evaluate the respective markets and provide insights where appropriate, data from desk research, site visits, networking events, and structured interviews with energy service companies (ESCOs), provide the basis of the limited findings presented in this report. Nearly all twenty participants provided candid answers and participated in lively discussions. Interviews were carried out in late 2016 and early 2017. Certain data was not robust enough to provide accurate project-level investment information, underscoring the need for further project-specific due diligence and the need for publicly available data to better understand the business case and financial performance of microgrids in operation today.

A standard set of open and closed-ended questions related to business experience, technology, pipeline, communities served, and capital conditions was used for the interviews. Questions used in the interviews can be found in Appendix IV. Data presented is limited to ESCOs working in the markets. Information from the interviews was analyzed to provide the preliminary figures related to market conditions and investment opportunities presented in this study.

The firms interviewed varied in terms of tenure (1-22 years), number of projects installed (1-84), installation costs ($1.50-$15/Watt), and other factors. Component costs seemed to be largest explanatory variable in installations. System sizes were about 3 KW to 75 KW, with a simple average of 22 KW. Renewable energy technology was dominated by solar (PV) - often with lead acid batteries. Other storage technologies included lithium-ion and zinc-air. Diesel generators were utilized by about half of the firms primarily as a back up battery charging source. The interview pool included firms that have deployed biomass, hydropower, and wind microgrids. One of the main variances in the technology area was monitoring and payments - with various pre-paid technologies used for AC and DC systems, and some manual payment collections.

Data used for the addressable market size estimate is provided in Appendix III.

Appendix III

ACCESS TO ELECTRICITY

Globally, about 1.1 billion people lack adequate access to electricity in 2017. In UP and Bihar, India, Indonesia, and Tanzania, nearly 360 million people in rural areas have little to no access to power. Given that current efforts to extend central grids and microgrids see some success, we have assumed that 10% of those currently without grid access gain access in the next 5-10 years from Grid Extension, and 65% are in communities that have high enough density to be served by microgrids, which is the percentage that the IEA and SE4All 2013 use. Of the 360 million people in UP, Bihar, Indonesia, and Tanzania without access by 2027, that leaves 212 million people in the "Microgrid Market".

	Rural Population without Access	Grid expansion	Microgrid Market
India, UP	141,702,849	127,532,564	82,896,166
India, Bihar	82,005,663	73,805,097	47,973,313
Indonesia	87,571,697	78,814,527	51,229,443
Tanzania	51,331,603	46,198,443	30,028,988
MIA			**212,127,910**

India

Roughly 125,000 villages and smaller 'hamlets' are in need of more or any electricity, according to the Indian government. Of these, 18,450 have been deemed inaccessible/unfeasible for grid extension. Over half of the underserved rural households are in five states: Uttar Pradesh, Bihar, Odisha, West Bengal and Madhya Pradesh. For more information see map: Distribution of underserved households in rural India, pgs. 7/8 (Climate Group, 2016). For Bihar, 21% of 103,804,637 were estimated to have access to electricity, in Uttar Pradesh, the figures were 29% of 199,581,477 (CEEW, 2015).

Tanzania

Electrification of the rural population in Tanzania stood at 4% in 2013 (WEO, 2015). Of these, at least,1.8 million households are beyond the reach of the national grid with medium to high levels of density (AfDB, 2015).

Indonesia

The eastern provinces of Indonesia have the lowest electrification ratios; in Papua only one out of three households has access to electricity. Western Indonesia has nearly four times as many unelectrified households as eastern Indonesia in absolute terms (ADB, 2016).

Microgrids in the field

In 2014, around 100,000 households were served by renewable energy powered micro-grids in India. By 2016, the figure was estimated at 200,000 (Dalberg, 2016). Climate Group forecasts 900,000 households will receive power from microgrids generating $45 million in revenue, plus 10% penetration of mobile towers (33,000 mobile towers), generating $95 million in revenues by 2018. The main national utility in Tanzania, TANESCO, operates 20 diesel-based mini-grids, some of which are interconnected to bordering countries. Thirteen communities get electricity from small-hydro mini-grids provided by faith-based organizations. There are thousands of privately-procured or donor-supported solar home systems (SHSs) (AfDB, 2015). In 2016, IRENA found 60 projects to be in the pre-installation phase and are thus likely to come on line in the near term. Approximately 65,0000 solar home systems amount to 75% of the installed solar capacity in Tanzania (or around 4 MW), and around 4,000-8,000 systems are sold annually (IRENA. Pg. 16. 2016b.). Preliminary figures indicate that investments of about US$3.5 billion will be needed to increase the rural electrification ratio from 6.6% to 36.6%, and the urban rate from 34.2% to 75.7% (AfDB, 2015).

Most of the approximately 600 microgrids in **Indonesia** are grid-tied hydro-power and are owned and operated by independent power producers that sell power to PLN; 70% operate in Sumatra and Jawa-Bali, while the rest are in East Indonesia (ADB, 2016). Another 100+ projects with a total capacity over 600 MW are estimated to be in the financing and PPA stage. Owner operators of public power utilities (PPUs) in 'non-competitive' regions of the country have had difficulty developing projects.

Ministries, regional government, and PLN have mostly carried out numerous 'off-grid' micro-grids. The high failure rate for these projects is, in part, explained by lack of funding and technical support for operation and maintenance. Donor-based approaches have also seen challenges. Recently, a fully subsidized ADB solar microgrid pilot project proposal for four villages on Sumba (Indonesia) failed to agree on tariff rates and ownership transfer to PLN. Private sector efforts to develop public power utilities for microgrids has been ad hoc and the effort has been hindered by requirements for project-by-project regulatory approvals and a lack of subsidies. (ADB, 2016, pg. vii).

INDICATORS BY COUNTRY (2010-2012 DATA)

	India	Indonesia	Tanzania	Global
Mean Income*	$1,581	$3,346	$865	$9,995
Spent on energy	12%** ($15 / month)	8.8% ($24 / month)	6% ($4.4 / month)	10%*** ($83 / month)
Poor*	18%	11%	33%	No data

**Income data and demographic data: World Bank, 2016 http://data.worldbank.org Poor: Poverty gap % of population living on < $3.10 a day 2010-2011. **India: World Bank, 2010. Tanzania: ***Global 'spent on energy' data from: http://www.leonardo-energy.org/blog/world-energy-expenditures The limited amount of household income spent on energy in is impacted by many factors, e.g. biomass use (in Africa) can be compared to India where spending goes to relatively higher cost grid electricity. With the highest per capita income, however, the highest nominal amount spent is in Indonesia.*

Appendix IV

INTERVIEW FORM/QUESTIONS

Date of Interview:
Company Name:
Countries of Operations:
Attendees:
Track Record/About the Firm: 1. Company Track Record/Experience, 2. Systems installed, 3. Avg. system size (Gen/Storage), 4. # Households served, 5. Anchors/SME (business model), 6. Technology
2017 Pipeline: In terms of your firm's project pipeline, how many projects do you expect to install in 2017: Stages of development: Have completed feasibility studies, community approved, have tariff agreement, design, permits, land, etc. **Pipeline Profile** Type of Tech. Total and Average System size: Storage, Diesel, (Monitoring), $ /Watt installed ## Households **End User Profile:** How would you characterize a representative project? Who are the <u>end-users</u> (e.g. live on <$5/day? <$2/day, current access, level of interest) Is there typically an "<u>Anchor</u>" load? **Tariff Amount / Collection:** What is the cost per KWH or per month for households (collections: monthly, quarterly/custom)? Operations, Maintenance, Monitoring, and Payments Processes How do you handle service (warranties, O&M, etc.)? Cost of O & M and what does it cover (performance guarantee) - $/KW or % of project? How is system performance being monitored and payments processed?

2018-2019 Pipeline: In terms of your firm's project pipeline, how many projects do you expect to install in 2018 and 2019: Have completed feasibility studies, are community approved, have tariff, design, permits, land, etc. **Pipeline Profile** Type of Tech. Total and Average System size: Storage, Diesel, (Monitoring), $/Watt installed & tariff ## Households
How are you planning on funding the (2017 and future) projects? **What is your preferred investment approach, corp. equity, project equity, loans, etc.** Does your firm taking an equity position in the project? ROI expectations?
Who are your primary investors and/or what are current / expected sources of corp. and project capital?
Given 100% of your funding needs are met, what are the primary obstacles to the success for your company and for the microgrid field?

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