



# RURAL ELECTRIFICATION AGENCY

ENERGY ≡ EMPOWERMENT ≡ EFFICIENCY

## NIGERIA MINIGRID INVESTMENT BRIEF

December 2017

## EXECUTIVE SUMMARY: THE OPPORTUNITY

### **Nigeria is the biggest and most attractive off-grid opportunity in Africa, and one of the best locations in the world for minigrids and solar home systems**

- Nigeria has the **largest economy in Sub-Saharan Africa** (GDP of \$405 billion), has 180 million people, and a flourishing economy (CAGR of 15% since 2000).
- A significant amount of the economy is powered largely by small-scale generators (10–15 GW) and almost 50% of the population have limited or no access to the grid.
- As a result Nigerians and their businesses spend almost **\$14B USD annually on inefficient generation** that is expensive (\$0.40/kWh or more), poor quality, noisy, and polluting.
- Developing off-grid alternatives to complement the grid creates a **\$10B/year market opportunity** for minigrids and solar home systems that will **save \$6B/year** for Nigerian homes and businesses.
- There is a **large potential for scaling**—installing 10,000 minigrids of 100 kW each can occur for 10 years and only meet 30% of anticipated demand.
- Getting off-grid solutions to scale and commercial viability in Nigeria will **unlock an enormous market opportunity in Sub-Saharan Africa** across 350 million people in countries with smaller demand and/or less-robust economies.
- The Rural Electrification Agency (REA) tasked with developing the Nigerian off-grid power market has created the **Off Grid Electrification Strategy** which is part of the **Power Sector Recovery Programme (PSRP)**.

## EXECUTIVE SUMMARY: BUSINESS CASE

### Evaluation of specific sites shows a strong minigrid business case for typical locations in Nigeria and indicates there are thousands of high potential sites

- Unlike many regions in Africa, Nigeria's **economy and strong entrepreneurship** mean that millions of commercially-viable businesses are powered with expensive and/or unreliable power.
- Consequently, there are high densities of power use, large latent demand, and a strong **willingness to switch to more effective alternatives**.
- Recent efforts by REA have identified **hundreds of high potential sites** for investment and demonstrated potential for commercial viability.
  - **Deep dive analyses** in Ogun and Cross River states show numerous sites that are ready for large-, medium-, and small-scale minigrids, and a significant opportunity to meet more remedial needs with solar home systems.
    - For example, a medium-scale system (e.g., 200 kW) can make commercial returns while covering its cost of capital, creating a **return on investment of 3 years**—this is a **situation not currently found elsewhere** in Sub-Saharan Africa.
    - Many rural households spend more than \$6/month on kerosene or battery powered torches, making a **compelling case for solar home systems**.

This independent assessment of the Nigeria minigrid market is a result of a partnership between Rural Electrification Agency (REA), The World Bank (Energy team) and Rocky Mountain Institute (RMI).

## EXECUTIVE SUMMARY: PARTNERSHIPS

### **Strong donor support and the establishment of Rural Electrification fund for Off Grid Development**

- **Rural Electrification Fund.** To support FGN's rural electrification strategy outlined in the Rural Electrification Strategy and Implementation Plan (RESIP), the Rural Electrification Agency (REA) has been authorized to establish a Rural Electrification Fund (REF) to help finance rural electrification expansion in Nigeria. The REF has a legal mandate to promote "fast and cost-effective expansion of electricity access in un-electrified rural areas evenly across the different geopolitical zones in Nigeria" through both off-grid and on-grid electrification solutions.
- **Strong World Bank Support.** The World Bank is working with the Federal Government of Nigeria to develop a new five-year project: Nigeria Electrification Project (NEP). It is expected that NEP will be finally approved by the World Bank in April 2018. NEP will be implemented by the Rural Electrification Agency.
- The World Bank's contribution for NEP is expected to be \$350 million, of which about \$150 million would be allocated to mini grids. Mini grids developed under NEP are expected to serve 200,000 households and 50,000 local enterprises. The project is nationwide in scope, with early activities expected in Niger, Plateau, Kaduna, Sokoto and River states.
- **Development Modalities.** The component will be implemented under a market based approach. Private firms are expected to develop mini grids, with subsidies from REA. It is expected that about 1,200 mini grids will be developed under the project.

## EXECUTIVE SUMMARY: ENABLING ENVIRONMENT

### Government, donor partners, and the private sector are actively working together in Nigeria to create enabling conditions for successful minigrid development

- Nigeria is providing an **enabling environment for off-grid market growth**, including:
  - **Developer protection** through the NERC Minigrid Regulations.
  - An innovative and **best practice site-selection process** to de-risk projects has already identified over 250 promising sites.
  - The selection process has also screened for baseload demand (e.g., schools), population/energy density and productive use.
  - Partnering with World Bank to line up finance, **streamline competitive tendering**, and to provide technical assistance.
- The **government and development partners are inviting the private sector** to work with them to capture this opportunity, while saving Nigerians money and powering economic development to further expand the market.
- With an enabling environment, continued cost reductions, and targeted finance, the **Nigerian minigrid market can scale rapidly** to over 10,000 sites by 2023, powering 14% of the population with capacity up to 3,000 MW and creating an investment potential of nearly \$20 billion and annual revenue opportunity exceeding \$3 billion.

- 1 THE OFF-GRID OPPORTUNITY IN NIGERIA**
- 2 CASE STUDIES: POTENTIAL MINIGRID SITES
- 3 ENABLING CONDITIONS FOR MINIGRID DEVELOPMENT
- 4 BRINGING THE MINIGRID MARKET TO SCALE
- 5 MOVING FORWARD

## INTRODUCTION

- The Nigerian Rural Electrification Agency (REA) has developed the **Off Grid Electrification Strategy**. The primary objective is to increase electricity access to rural and underserved clusters.
- Part of this strategy is to fast track development initiatives towards achieving the overall objective of the FGN Economic and Recovery Growth Plan (ERGP) and the Power Sector Recovery Programme (PSRP).

## POWER SECTOR RECOVERY PROGRAMME

The Power Sector Recovery Programme (“PSRP”) is a series of policy actions, operational, governance and financial interventions to be implemented by Federal Government of Nigeria over the next five (5) years to restore the financial viability of Nigeria’s power sector, improve transparency and service delivery, resolve consumer complaints, reduce losses and energy theft and **RESET** the Nigerian Electricity Supply Industry for future growth.

The Federal Government of Nigeria developed the PSRP in collaboration with the World Bank Group. Holistically, the objectives of the Power Sector Recovery Programme are to

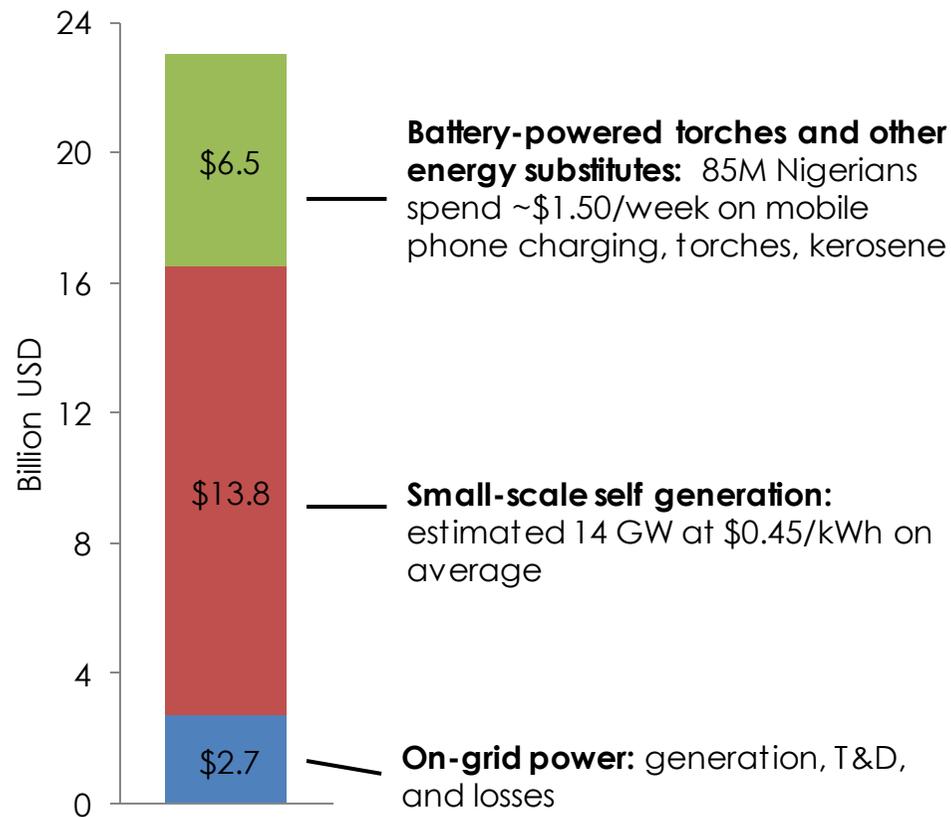
- i) Restore the sector's financial viability;**
- ii) Improve power supply reliability to meet growing demand;**
- iii) Strengthen the sector's institutional framework and increase transparency;**
- iv) Implement clear policies that promote and encourage investor confidence in the sector; and**
- v) Establish a contract-based electricity market.**

# SUSTAINABLE OFF GRID POWER SOLUTIONS CAN ACCELERATE ECONOMIC GROWTH

**Nigeria offers the best off-grid market opportunity in Africa—there is relatively high economic activity, latent demand, and ability to pay in rural areas:**

- Nigeria has the **largest population and GDP** in Africa with significant rural economic activity
- **14 GW served by small petrol and diesel gen-sets**
- Nigerians already spend **\$14B annually on off-grid power** from small self generators
- There are **85 million people underserved and/or unconnected** to the grid, which is an enormous investment opportunity
- On-grid costs are **nearly \$3B annually**

**Annual on- and off-grid electricity expenditures in Nigeria, 2016**

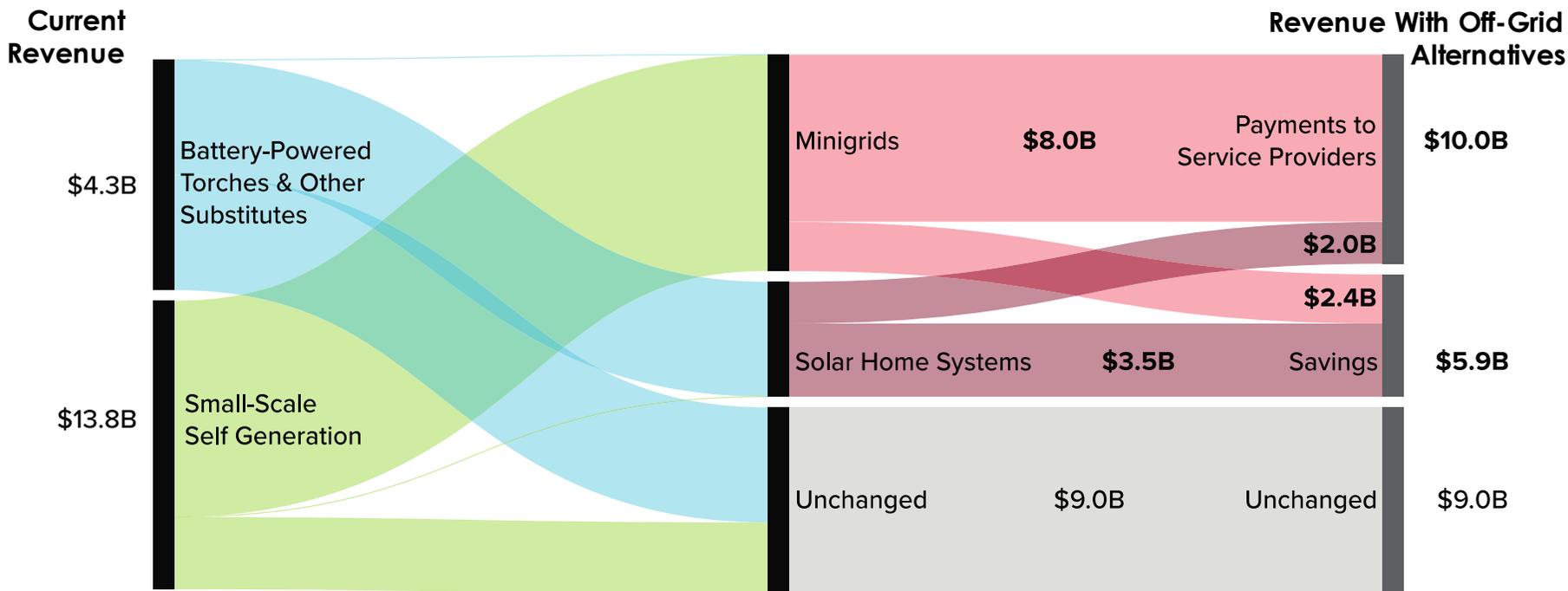


Source: RMI analysis

# THERE IS A \$10B/YR MARKET OPPORTUNITY TODAY FOR MINIGRIDS AND SOLAR HOME SYSTEMS THAT WILL SAVE NIGERIANS \$6B/YR

- **\$10 billion annual market opportunity** to supply off-grid and underserved customers with minigrids and solar home systems\*
- With 8% economic growth through 2030 there is an **additional \$670 billion** value proposition
- This estimate is based on current expenditures, but customers **may pay more for superior service**
- This shift from expensive generating sets would **save Nigerians customers \$6B/yr** over current energy costs

## Today's off-grid and underserved annual market size in Nigeria, by off-grid technology\*



Source: RMI analysis

# MINIGRIDS ARE A CRITICAL COMPONENT OF REA'S PROGRAMMES TO SUPPORT ECONOMIC DEVELOPMENT AND ENERGY ACCESS

REA programmes				
	Stand-Alone Systems	Minigrids	Energizing Education	Energizing Economies
<b>Who will be served?</b>	Remote customers with low load or low ability to pay	Communities with load less than 1 MW	37 universities, 7 teaching hospitals, and the surrounding communities	Economic clusters: areas with high commercial activity and high growth impact on the economy
<b>What is REA's role?</b>	Promote development and roll-out	Promote community, private development	Develop independent power plants to serve	Intervene to provide power under eligible customer policy directive
<b>Benefits to community</b>	Provide critical basic services; cheaper than kerosene or other energy alternatives; create jobs	Promotes economic activity; interconnection potential	Provide nearly 100 MW generation across 6 geo-political zones; improve educational quality	Replace costly, inefficient, polluting diesel with centralized power source; promote MSME growth
<b>Benefits to developer</b>	Supportive regulatory environment, coordination around market expansion, education and awareness	10,000+ potential sites offer high customer density, clustering; access and scaling in Africa's largest market	Solar hybrid and gas engine plant generation opportunities	High load and customer concentration; clear value proposition to customers
<p><b>Crosscutting energy database</b> – online visualization of resources for energy development</p>				

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# THE NIGERIAN MINIGRID MARKET IS UNDERPINNED BY THE MOST APPEALING MINIGRID SITES IN AFRICA

	Case Study #1: Small Off-Grid Obot Ekpene, Cross River	Case Study #2: Medium Off-Grid Onyen-Okpon, Cross River	Case Study #3: Medium Underserved Peri-urban Mokoloki, Ogun	Case Study #4: Large Underserved Peri-urban Okun-Owa, Ogun
Peak Load	16 kW	200 kW	85 kW	1.8 MW
Current Cost, Diesel Generation*	\$0.75/kWh	\$0.52/kWh	\$0.39/kWh	\$0.25 (industrial)
<b>Estimated Tariff Today (15% IRR)**</b>	<b>\$0.51/kWh</b>	<b>\$0.40/kWh</b>	<b>\$0.42/kWh</b>	<b>\$0.33/kWh</b>
Customer Savings	\$0.24/kWh	\$0.12/kWh	-\$0.03/kWh	-\$0.08/kWh
<b>IRR if Tariff Matches Current Cost</b>	<b>26%</b>	<b>22%</b>	<b>13%</b>	<b>6%</b>
Capital Cost	\$130,000	\$1.1 M	\$600,000	\$9.7 M
Consumption per Day	200 kWh	2,500 kWh	1,300 kWh	27,000 kWh

These types of sites are fully commercially viable now with a 15% project IRR

These sites are very good relative to most minigrid sites elsewhere in Africa (typically \$0.60+/kWh) and provide superior service relative to self-generation

## KEY TAKEAWAYS

- Off-grid sites show opportunities today for **significant customer savings** while providing **developer returns**
- Minigrids can provide **reliable electricity** to underserved peri-urban sites at or below current costs
- These economics **do not account for additional minigrid benefits**, such as increased reliability and reduced environmental pollution

The pages that follow contain a detailed exploration of each case study

# ELECTRICITY COSTS NEARLY \$0.75/kWh IN OBOT EKPENE, AND MOST HOUSEHOLDS SPEND \$9/MONTH ON ALTERNATIVES

## OBOT EKPENE, CROSS RIVER

### Context

- 30 households, currently with no electricity access
- 10 km away from nearest grid connection and 3 km away from road access
- 15 kW of existing self generation is used to process agricultural products, including cassava and palm oil
- No reliable, affordable power solutions are available, especially to remote areas
- There are thousands or tens of thousands of such sites in Nigeria**

Consumer type	Load
30 households	3 kW
Commercial/Productive use	15 kW

### Ability and Willingness to Pay

- Higher-income Obot Ekpene residents currently pay \$0.75/kWh for diesel generators
- Most households are unelectrified and spend around \$3/month for kerosene as well as \$6/month to charge cell phones, torches, and other devices
- Regular income from palm oil and gari sales



Local farmers use diesel generators to run machines that process palm oil, cassava/gari, and other crops

Assumptions: 100W/HH,  
Source: RMI interviews and analysis

# A \$130,000 MINIGRID AT THIS SITE CAN GENERATE A 15% PROJECT IRR, SAVE \$18,000/YEAR, AND PROVIDE BETTER SERVICE

## Minigrid Solution

- **Final consumer tariff of \$0.51/kWh**
- Minigrid with 34.5 kW solar, 48 kWh battery, and 18 kW diesel backup
- 5 km distribution system
- Initial capital cost of **\$130,000**
- Optimized operations and maintenance with clustered minigrid sites, smart meters that allow for remote monitoring and control, remote revenue collection

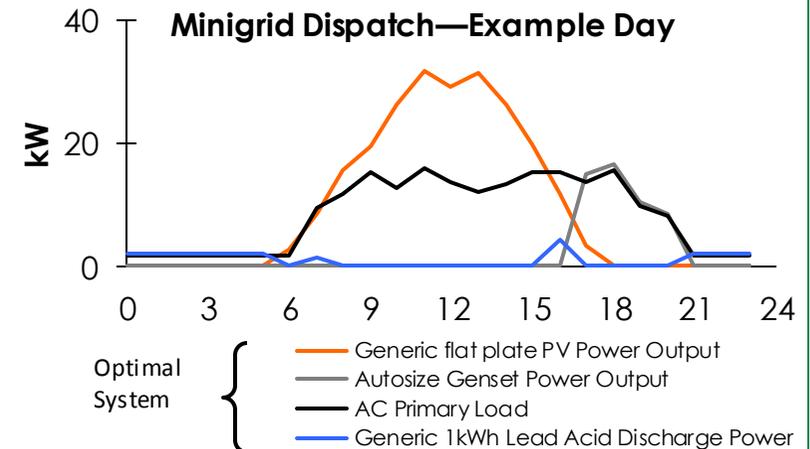
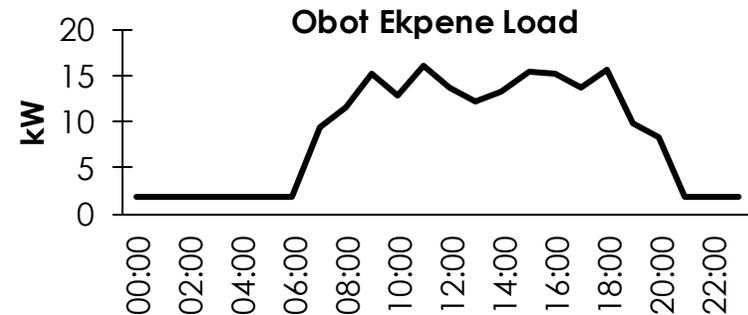
## Customer Savings and Benefits

- Future economic viability should be considered, but **need for electricity access** to drive development in such communities is the greatest in the country
- Customers **save \$0.24/kWh** compared with self generation, and **save on time and money** usually spent for operations and maintenance
- Many residents have trained and work in town as artisans or businessmen, and would move these operations—and the associated economic gains—home with access to power

Solar home systems may also be considered for many remote customers with low load

## Project Economics

- Predictable \$3,000 monthly revenue growing over time



# BUSINESSES AND HOMES PAY \$0.52/kWh IN OYEN-OKPON DESPITE LARGE PRODUCTIVE LOADS

## ONYEN-OKPON, CROSS RIVER

### Context

- 500 households, 7 km away from nearest electrified town
- At nearby towns, reliability of grid connections is low, typically just a few, unpredictable hours per day
- Medium-high income community that is a center of commerce; 100 kW existing self generation is used to process agricultural products (cocoa beans, cassava, yams) and power commerce, welding, and other artisans
- There are thousands of such sites in Nigeria**

### Consumer type

300 households (3/5 of total)

### Load

60 kW

Commercial/productive-use

170 kW

### Ability and Willingness to Pay

- Community leaders and residents stated high willingness to pay and even to contribute to capital costs for a local system
- Most residents currently pay about \$0.43/kWh for petrol generation or \$0.52/kWh for diesel, or up to \$25/month
- Unelectrified households spend ~\$6/month for kerosene, plus extra for rechargeable torches, candles, cell charging, etc.



*Diesel must be purchased in small quantities to power cocoa processing facilities, but is costly, inefficient, loud, and polluting.*



Assumptions: 225 W/HH average  
Source: RMI interviews and analysis

# A \$1.1M MINIGRID AT THIS SITE CAN GENERATE A 15% PROJECT IRR, SAVE \$110,000/YEAR, AND PROVIDE BETTER SERVICE

## Minigrid Solution

- **Final consumer tariff of \$0.40/kWh**
- Minigrid with 470 kW solar, 668 kWh battery, and 220 kW diesel backup can meet overlapping load of residential and commercial loads
- 5 km low-voltage distribution system
- Upfront capital cost of **\$1.1 million**
- Optimized operations and maintenance with clustered minigrid sites, smart meters that allow for remote monitoring and control, remote revenue collection

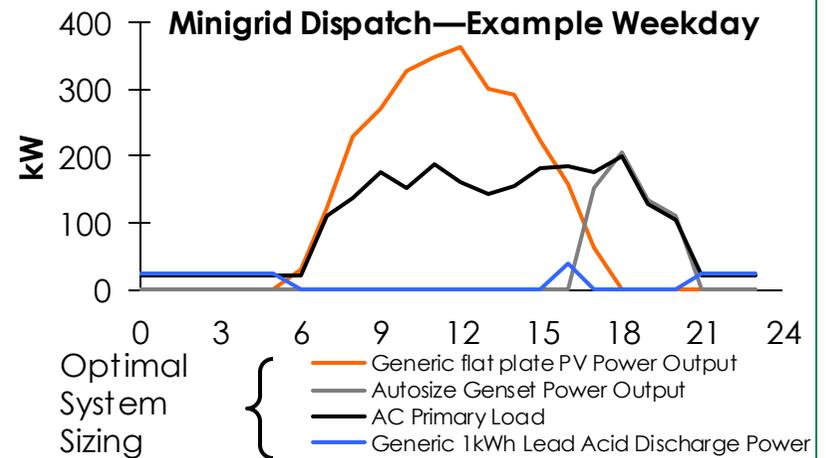
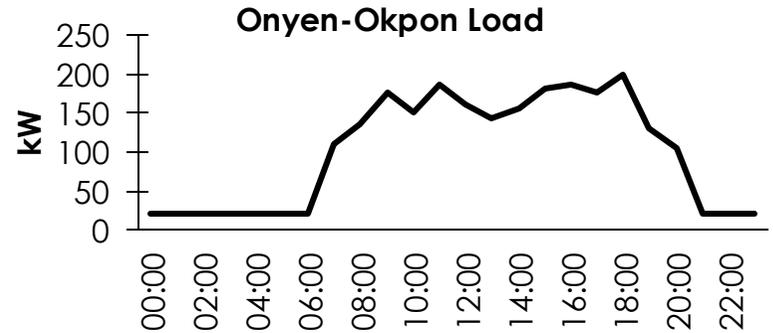
## Customer Savings and Benefits

- Customers **save up to \$0.12/kWh** compared with diesel self-generation, or \$0.03/kWh compared to petrol
- Customers save time and money usually spent on operations and maintenance
- Businesses significantly enhance productivity with **95% system uptime**
- Commercial uses can scale up, with **enhanced economic flows** to the community coming from added value through additional cocoa processing

Source: RMI analysis

## Project Economics

- Predictable \$31,000 monthly revenue that would grow over time



# IN UNDERSERVED PERI-URBAN COMMUNITIES, MINIGRIDS CAN OFFER RELIABLE SERVICE TO SUPPLEMENT THE EXISTING GRID

## MOKOLOKI, OGUN

### Context

- Population 3,000, with access to the centralized grid but receiving extremely unreliable service
- Even with connection, reliability of grid connections is low, typically just a few, unpredictable hours per day
- 80 kW of existing self generation power artisans (welders), cement block factory, agricultural processing and some households, but economic activity is currently limited by unreliable power
- **There are thousands of similar underserved sites in Nigeria**

### Consumer type

### Load

300 Households (1/2 of total)

50 kW

Commercial/Productive use

70 kW

### Ability and Willingness to Pay

- Mokoloki residents currently spend \$0.39/kWh for small-scale electricity generation to supplement the grid
- The average household spends \$3 per week on energy substitutes, especially battery-powered torches and cell phone charging



*Small diesel generators are used to power equipment, such as this cassava grinder shown, that is vital to the local economy*

Due to the low cost of power from the grid, subsidy or other intervention may be required to make minigrids competitive—until they prove their value through high reliability and consistent service, and developer costs are reduced

Assumptions: half of 600 HH connect to minigrid at an average of 175 W/HH,  
Source: RMI interviews and analysis

# A \$600,000 MINIGRID CAN PROVIDE BETTER SERVICE AND MEET CURRENT COSTS WITH A 13% PROJECT IRR

## Minigrid Solution

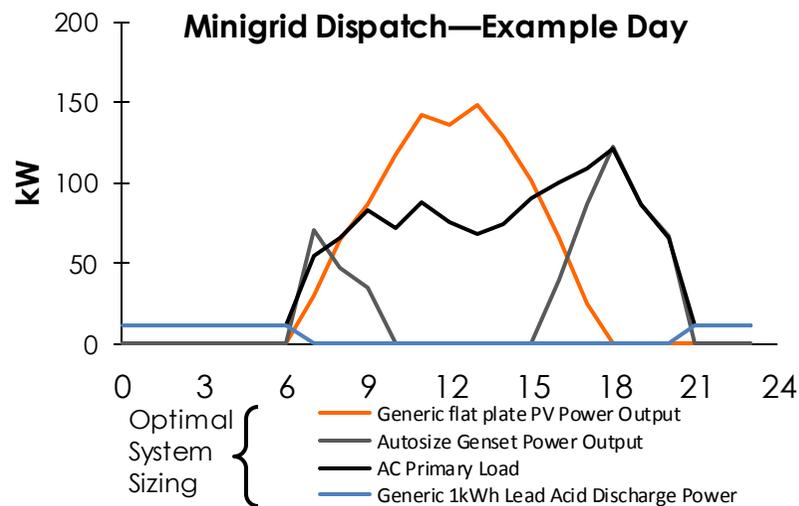
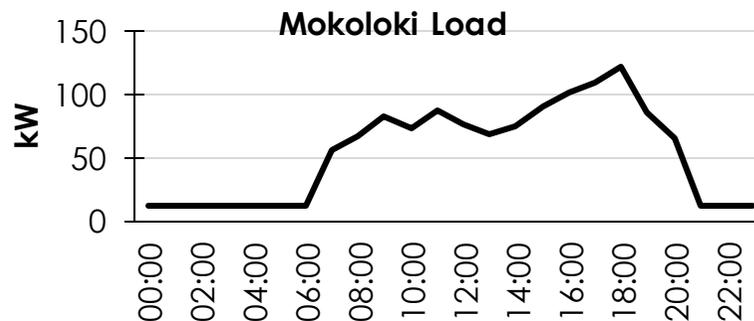
- Tariff can **meet current costs** with a **13% IRR**
- Final consumer tariff is **\$0.42/kWh** with a **15% IRR**
- Minigrid with 156 kW solar, 212 kWh battery, and 140 kW diesel component
- 5 km distribution system reaching 300 households, 20 small shops, and a peak 85 kW including 75 kW of productive daytime use
- Initial capital cost of **\$600,000**
- Optimized operations and maintenance with clustered minigrid sites, smart meters that allow for remote monitoring and control, and remote revenue collection

## Customer Benefits

- Customers **have reliable power** and **save on time and money** usually spent for operations and maintenance
- Main grid is currently operational for about 1% of the time, a minigrid would provide greater service

## Project Economics

- Predictable \$17,000 monthly revenue growing over time



Source: RMI analysis

# MORE-AFFLUENT UNDERSERVED SITES OFFER ATTRACTIVE SCALE AND HIGH PRODUCTIVE USE LOADS

## OKUN-OWA, OGUN

### Context

- ~5 factories running entirely on diesel generators, 1.5MW capacity and a relatively flat load shape, operating 24/7.
- ~100 large affluent houses with AC and high load.
- Beside large factories there is a fair amount of typical economic activity—grain mills, small shops, etc
- Grid present, provides a few hours a week or less, sometimes at half current. Both community and the large factories are extremely interested in securing reliable and lower-cost power.
- **There are thousands of similar underserved sites in Nigeria**

Consumer type	Load
100 households (100% of total)	45 kW
Commercial (Shops)	250 kW
Industrial (Factories)	1500 kW

### Ability and Willingness to Pay

- Community leaders and residents stated high willingness to pay and attract additional industry
- Factories pay ~\$0.25/kWh for diesel generation
- Small businesses currently pay about \$6/week to run diesel gensets plus \$10/month for grid power



*Large factories demand consistent, reliable power but offer significant economic benefits to the local community*

Assumptions: 225W/HH average  
Source: RMI interviews and analysis

# A \$9.7M MINIGRID CAN PROVIDE BETTER SERVICE AND MEET CURRENT COSTS WITH A 6% PROJECT IRR

## Proposed Solution

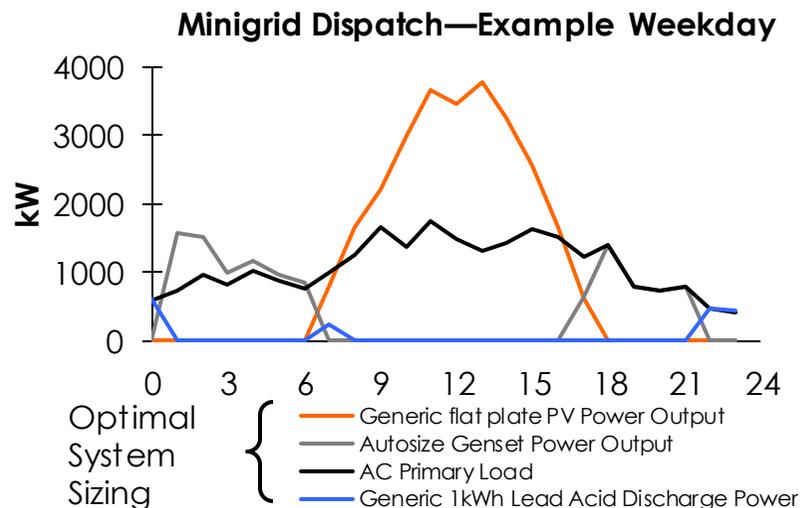
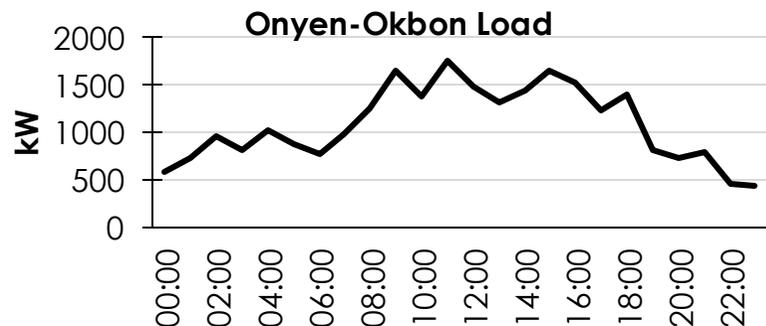
- Tariff can **meet current costs** with a **6% IRR**
- Consumer **tariff of \$0.33/kWh** with a **15% IRR**
- Minigrid with 4 MW solar, 3.6 MWh LA battery, and 2 MW diesel backup can meet overlapping load of residential and commercial loads
- 6 km distribution system
- Upfront capital cost of **\$9.7 million**
- Optimized operations and maintenance with clustered minigrid sites, smart meters that allow for remote monitoring and control, remote revenue collection

## Customer Savings and Benefits

- Customers **save time and money** usually spent on **operations and maintenance**
- Businesses significantly enhance productivity with **95% system uptime**
- **Enhanced economic flows** could result from ability to attract new industries to the area

## Project Economics

- Predictable \$270,000 monthly revenue that would grow over time



Source: RMI analysis

# UNDERSERVED SITES ARE A PROMISING MARKET OPPORTUNITY AND NIGERIA IS DE-RISKING INVESTMENT IN THESE AREAS

## Serving the greatest immediate need

- The Mokoloki load and site is typical of many of the most significant unserved and underserved loads in Nigeria – commercial demand and ability to pay are high,
- **This is true of the majority of potential minigrid sites with more than 75kW of potential peak load**
- Minigrids may be the least-cost, most reliable way to provide these sites with service

## Providing greater reliability

- Many of these sites have existing distribution network that is not energized, or have grid connections with infrequent power available – reliability provided by the grid is low
- Grid reliability is unlikely to improve significantly in the near future; even if customers switch to cheaper grid power when it is available, this will not hurt the minigrid case

## Regulatory clarity

- Minigrids are allowed to operate in underserved communities with the agreement of the DisCo and community\*. Communities are allowed to request the presence of minigrids to supplement their access to power [**NERC Mini-Grid Regulation S. 9(1), (2)**]
- Existing, recently approved regulations planning for interconnection, both technically and financially, are crucial for these sites

## Economic activity

- **Reliable power seen as primary driver of economic activity in these peri-urban areas**
- Interviews suggest lack of consistent grid power has affected artisans and others, or they've moved to urban centers
- Demand planning and productive use stimulation key as population and economic activity can swell faster in peri-urban areas

## De-risking of sites

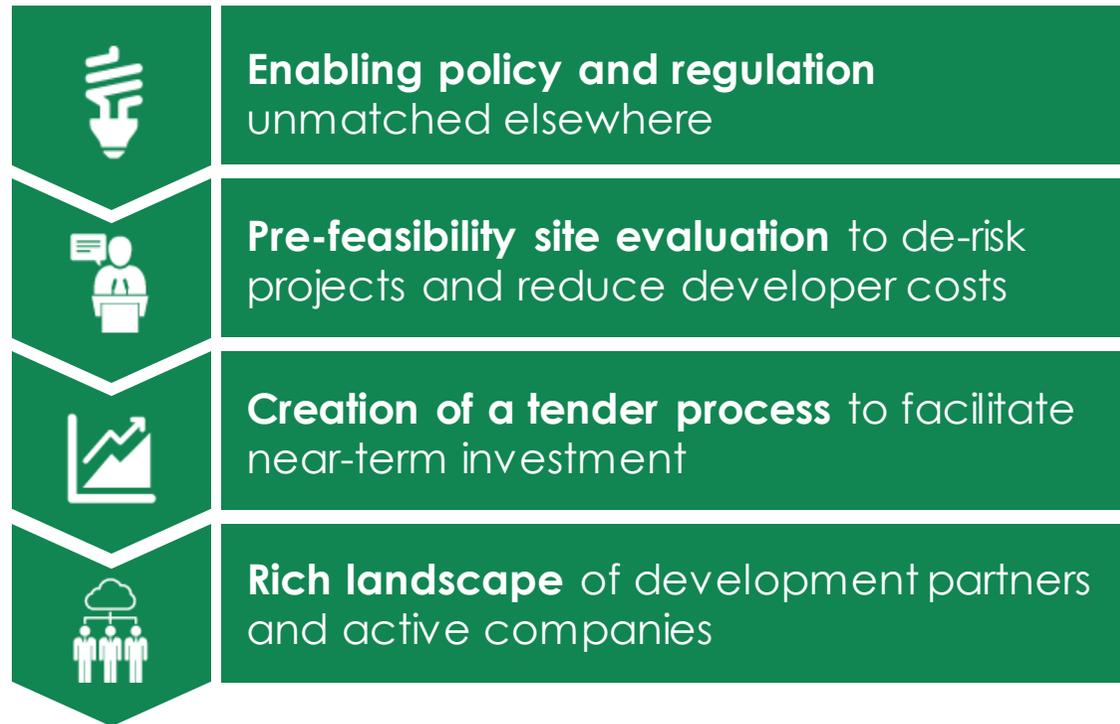
- REA & donor partners already exploring the best types of sites and working with the regulator to de-risk the process

**See appendix for additional information on relevant regulatory policies and procedures**

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# NIGERIA HAS LAID THE GROUNDWORK TO MAKE IT THE BEST LOCATION FOR MINIGRID DEVELOPMENT TODAY



# NIGERIA'S POLICY AND REGULATORY ENVIRONMENT SUPPORTS MINIGRID MARKET GROWTH



**Nigerian regulation provides more guidance, preparation, and protection for minigrid development than policies in other markets**

## **NERC Regulatory Framework for Minigrids**

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### **Setting Tariffs**

- Tariff flexibility currently allowed
- Minigrids under 1MW allowed full freedom

### **Grid Exit**

- Minigrid interconnection with the grid included in regulatory framework
- Technical preparation for interconnection
- Financial preparation for interconnection

### **Licensing & Permitting**

- Accelerated licensing and permitting process for minigrids

### **Integrated Energy Planning**

- Clear program for off-grid energy
- Clear priority to support isolated minigrids and their role in powering commercial loads

Source: Nigerian Electricity Regulatory Commission, Regulations for Mini-Grids, 2016.

# REA IS CONDUCTING UNPRECEDENTED DETAILED MINIGRID PRE-FEASIBILITY EVALUATIONS TO REDUCE DEVELOPMENT RISK

## REA site selection process provides clarity, reduces risk, and accelerates process for private minigrid development

First-cut prioritization with existing data has identified 200+ sites with at least 100kW demand



Detailed surveys completed: REA visited top 200 sites across 5 priority states (Nov. 2017)

### REA teams prioritized sites by:

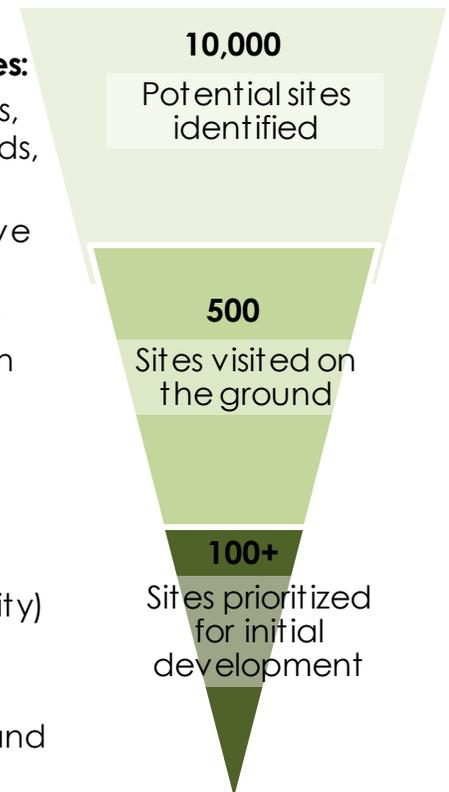
- Sufficient load/density
- Productive-use, daytime, and flexible loads
- Supportive local and state government
- Community engagement
- Solar resource and availability of gas
- Accessibility

REA surveys will provide developers with a better idea of site viability

REA teams are gathering detailed data at these sites and using that data to improve site-selection

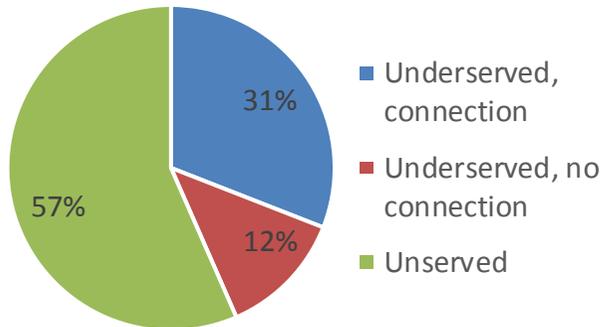
### REA survey data includes:

- Number of households, shops, productive loads, and other institutions
- Appliances, productive loads, time of use
- Estimated load profile
- Existing self generation (size and number of units)
- Fuel price and availability
- Cellular service (providers and reliability)
- Current income and willingness to pay
- GIS data for villages and potential customers

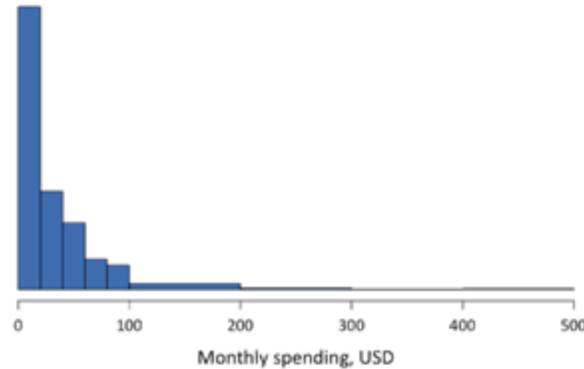


# REA SURVEYS OF 200 SITES IN 5 STATES PROVIDE QUANTITATIVE EVIDENCE FOR MINIGRID OPPORTUNITY

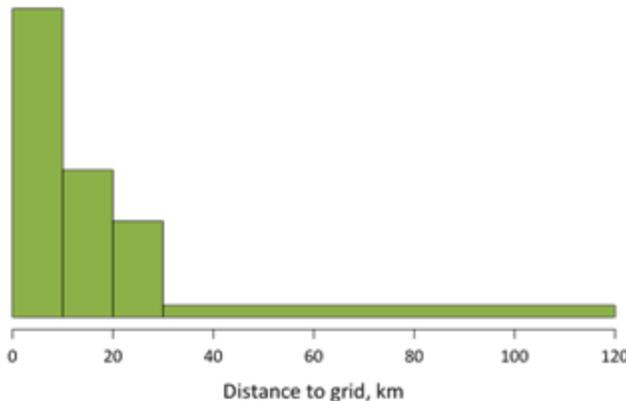
## Access to distribution infrastructure by community



## Current energy expenditures by household



## Distance to nearest grid distribution by off-grid communities



## Insights from on-the ground surveys

- Some communities indicated both the **ability and willingness to contribute** to the up-front cost of electricity infrastructure
- There is a huge **opportunity for the development of underserved areas**. The centralized grid has a far greater reach than previously anticipated by GIZ, REA, and other players; however, many of these on-grid communities are still underserved and are interested in alternative electricity sources

## Key Enabling Factors

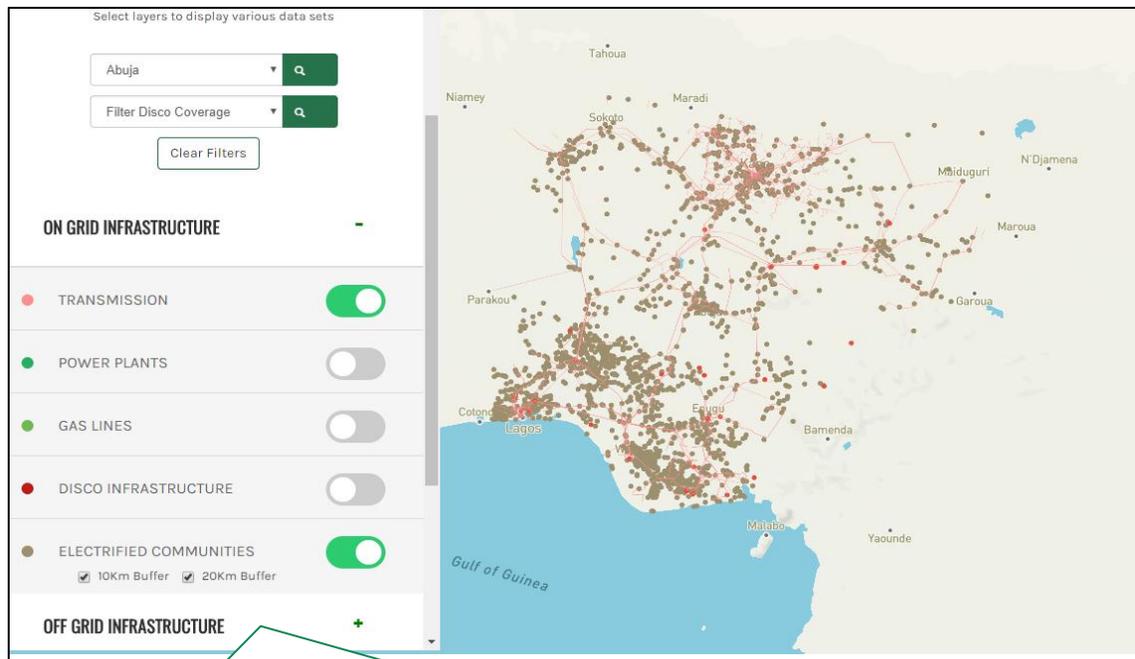
- Only 9.6% of community leaders reported that electricity needs are met in their community
- 45.6% of surveyed communities have telecom signal that would support mobile payments for a PAYG scheme
- Off-grid households spend, on average, over \$30/month on energy alternatives; and consistently spend more on energy than their on-grid counterparts.

Source: REA surveys and RMI analysis

Source: RMI analysis

# REA'S INTERACTIVE ENERGY DATABASE PROVIDES DEVELOPERS WITH A TOOL AND DATA FOR SITE ASSESSMENTS

**REA's unique tool allows developers and investors to quickly identify promising sites for development**



The availability of digital geospatial data on transmission infrastructure allows easy identification of on- and off-grid communities

- The tool will continue to be refined, and will incorporate load data from REA surveys
- REA will expand the tool for other applications (e.g., Energizing Economies, Solar Home Systems)

## Features

### On Grid Infrastructure

- Transmission
- Power Plants
- Distribution Infrastructure
- Electrified Communities

### Off Grid Infrastructure

- Potential Mini Grid Communities
  - 10 KM or 20 KM from the grid
- Potential SHS Communities
  - 10 KM or 20 KM from the grid

### Community Details

- Population, load profiles

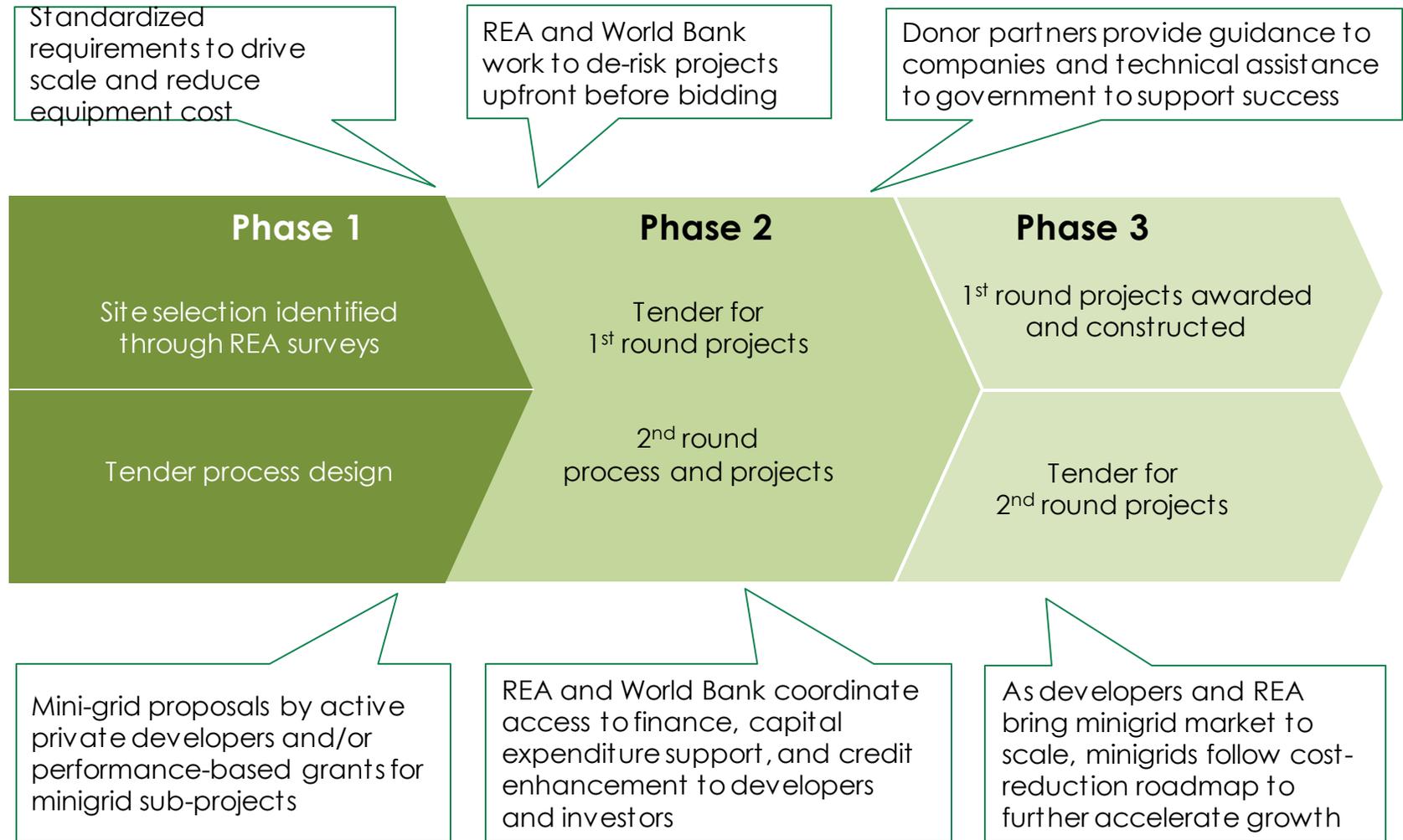
### Resources

- Mines
- Solar Irradiance
- Roads

### Amenities

- Schools
- Water Points

# REA IS WORKING WITH THE WORLD BANK TO SETUP A MINIGRID TENDER PROCESS THAT WILL STREAMLINE DEVELOPMENT



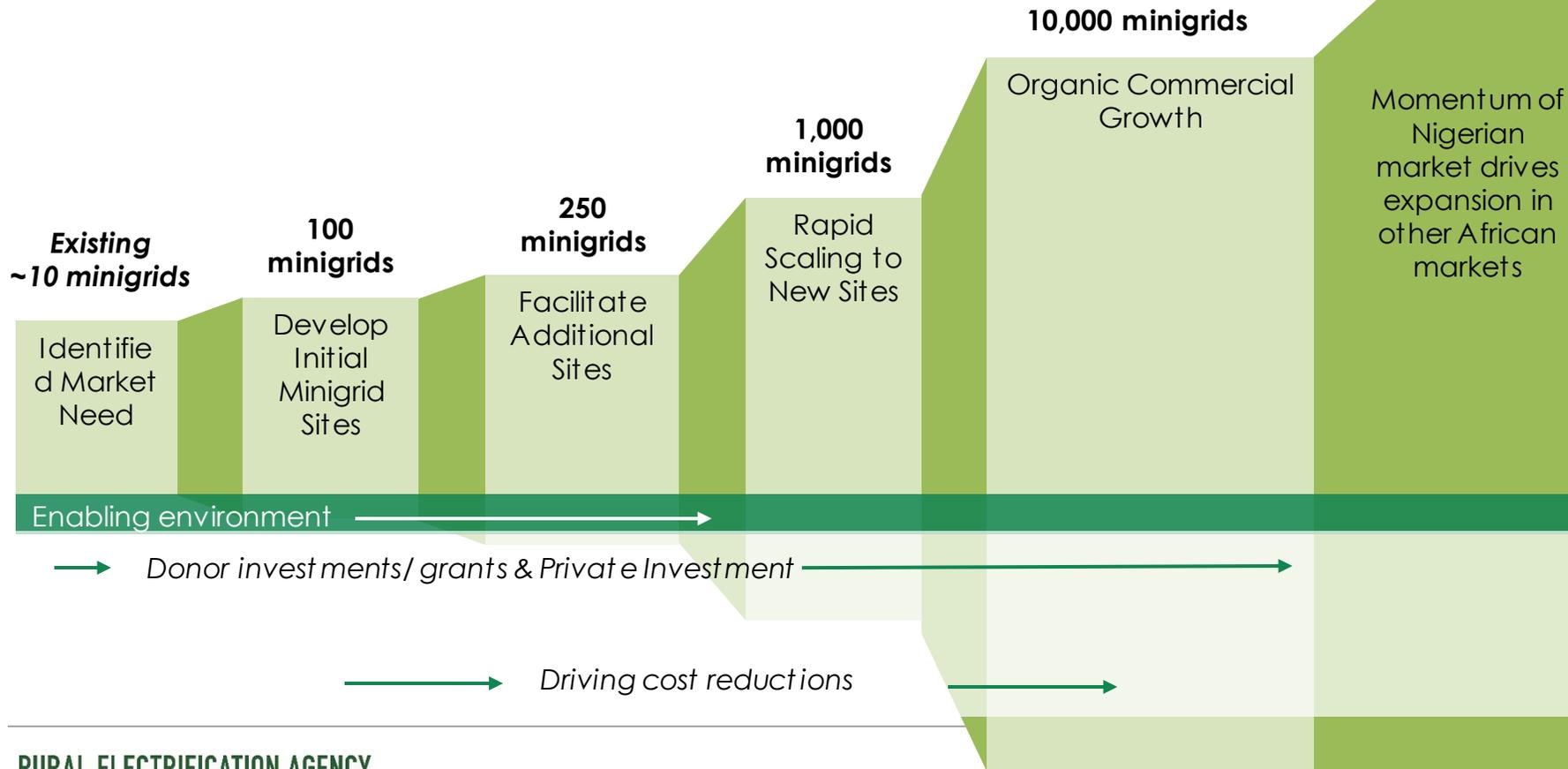


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- 3 ENABLING CONDITIONS FOR MINIGRID DEVELOPMENT
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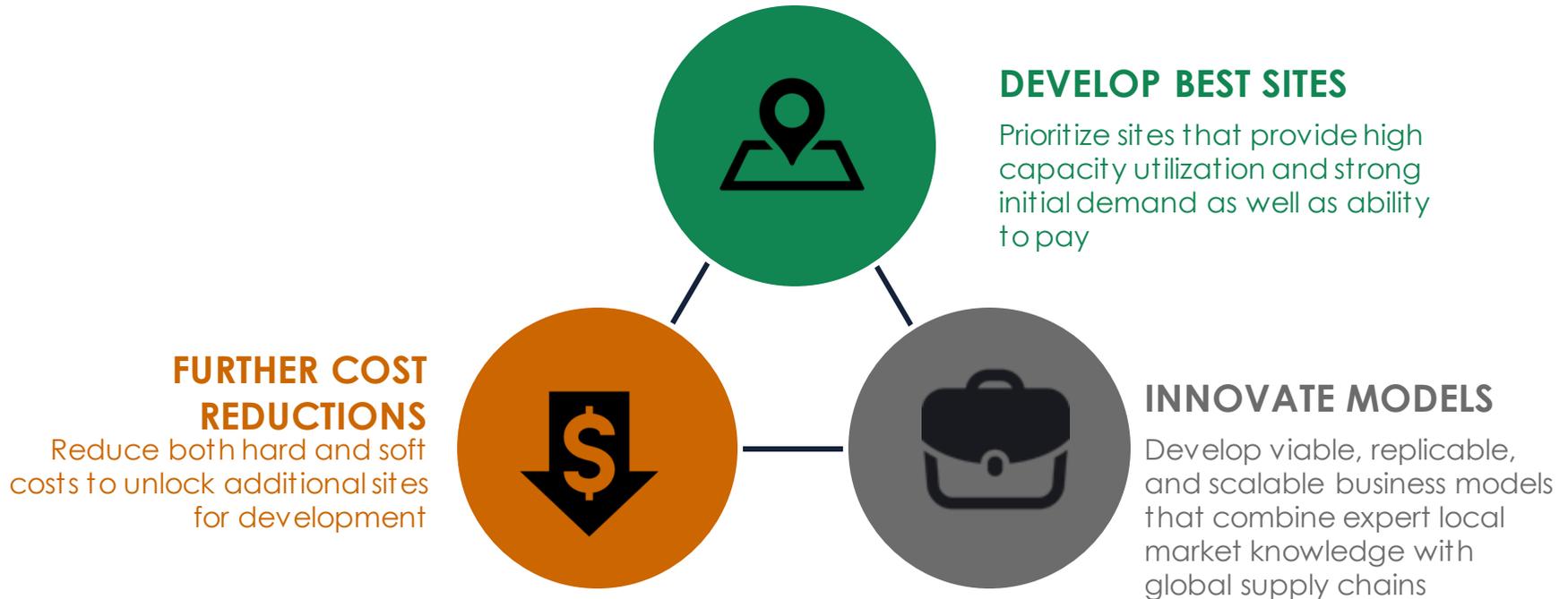
# THE NIGERIAN MARKET ALONE IS ENOUGH TO BRING MINIGRIDS TO SCALE

With an enabling environment, continued cost reductions, and targeted finance, the Nigerian minigrid market can scale rapidly to over 10,000 sites by 2023, powering 14% of the population with capacity up to 3,000 MW.

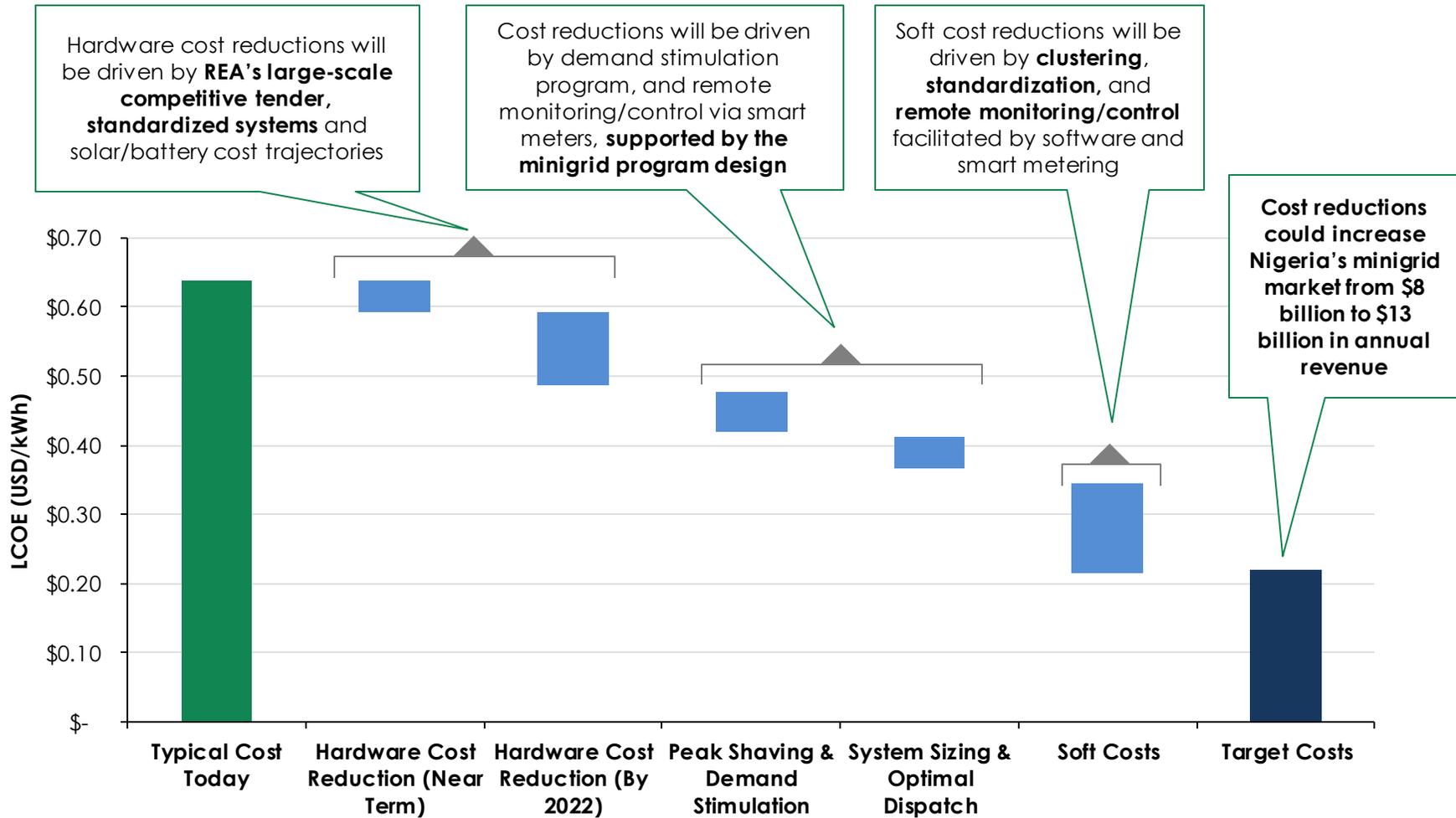


# MINIGRIDS ARE COMMERCIALY VIABLE TODAY IN NIGERIA— ADDRESSING KEY CHALLENGES WILL UNLOCK MAXIMUM SCALE

To realize the potential of Nigeria's minigrid market, developers and investors can work with the Nigerian government to make rapid progress on these challenges



# COST-REDUCTION OPPORTUNITIES WILL EXPAND THE REACH OF MINIGRIDS BEYOND VERY GOOD SITES



Source: Cost reduction is based on current global hardware cost trajectory and cost-savings documented and modeled by RMI that depend on remote monitoring and payment, automated software, clustering, and other measures

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# SUCCESSFUL DEVELOPERS AND INVESTORS WILL TAKE ACTION TO REALIZE THE MINIGRID OPPORTUNITY IN NIGERIA

## Investors & Development Partners

- Next stage market development leveraging REA pre-feasibility work
- Pathways to concessional financing
- Pursue pathways to address FX challenges
- Support collaboration by convening developer working groups (e.g., to unlock hardware cost reductions)

## International & Domestic Developers

- Develop standard, replicable minigrid systems and business models
- Pursue high-potential sites for initial development to refine economics, load growth approaches, and customer acquisition strategies
- Create robust supply chains
- Iterate rapidly for second generation models to get to scale by 2020
- Build relationships between Nigerian and international companies

## Power Companies & Financial Service Providers

- Explore synergies with minigrid companies to further expand market
- Engage with minigrid developers early

# DEVELOPMENT PARTNERS CAN ACCELERATE NIGERIA'S OFF-GRID MARKET WORKING TOGETHER WITH REA

## REA will enable the private sector while preserving competition

- Work with regulator to provide private sector with **enabling regulation that is clear and predictable**
- **Community engagement** to create interest and find willing local
- **Data collection** to help identify attractive sites and **de-risk projects**
- Develop **tender process** for both solicited and unsolicited projects
- Support **land acquisition, permitting, regulation, and partnering** for innovative new projects

## Private sector will implement and invest

- Minigrid companies will **develop projects** together with REA, then **own and operate**
- **Investors** ready to invest in Nigeria to unlock huge new market
- Global supply chain: deliver minigrid **hardware that is affordable and reliable, turn-key, standardized and modular**
- **Utilities** explore synergies with minigrid companies to further expand market

## Donor partners can support and accelerate the nascent off-grid market

- Immediate and flexible **funding for enabling REA activities** like data collection and community engagement
- **Concessional financing** including FOREX hedging
- Grant funding for **pilot projects**
- **Technical assistance** and **capacity building** for regulators and government

# APPENDIX



# Nigerian Electricity Regulatory Commission (NERC) Mini Grid Regulations 2016



## What is the MINI GRID Regulation ?

The Mini Grid Regulation is specifically designed to accelerate electrification in areas without any existing distribution grid (Unserved areas) and areas with an existing but poorly electrified or non-functional distribution grid, especially but not limited to rural areas. The regulation shall promote the engagement of the private sector, communities, Non Governmental Organizations and other stakeholders in achieving nationwide electrification, and it seeks to minimize major risks associated with Mini Grid investments such as:

(1) Sudden tariff changes: as tariffs would have been agreed in advance by the relevant parties; and

(2) Stranded Mini Grid Operator investments due to the connection of the main grid to Mini Grid in circumstances where the main grid has been extended to cover the Mini Grid area. In such cases, a fair compensation mechanism would be applied for Mini Grid Operators that choose to exit.

Source: REA Off Grid Electrification Strategy, 2017

## Types of MINI GRIDS Covered in the regulation

1. Isolated Mini Grids up to 100 kW of Distributed Power (**Registration required**)
2. Isolated Mini Grids larger than 100 kW of Distributed Power and up to 1MW of Generation Capacity (**Permit required**)
3. Interconnected Mini Grids larger than 100 kW of Distributed Power and up to 1MW of Generation Capacity, the Connected Community the Mini Grid Developer and The Distribution Licensee have to sign a Tripartite Contract which becomes binding for a parties upon approval by the Commission. (**Permit required**)
4. All Mini Grids larger than 1MW must apply for a full license.

# How to REGISTER AN ISOLATED MINI-GRID PROJECT (DISTRIBUTED POWER BELOW 100KW)

**Step 1**



Identification Of The Eligibility Of Underserved Area

**Step 2**



Contact With The Community To Sign Off On Exclusivity Agreement

**Step 3**



System Design

**Step 4**



Sign Commercial Agreement With Community

**Step 5**



Acquire land and Necessary Building Approvals

**Step 6**



Construct, Test and Commission Mini Grid

**Step 7**



Registration with NERC

## ISOLATED MINI GRIDS < 100 kW

### ACCOMPANYING DOCUMENTATION FOR REGISTRATION REQUIRED BY NERC

- I. Certified copy of Certificate of Incorporation, Memorandum and Articles of Association, Deed of Partnership or Deed of Trust, as applicable

Source: REA Off Grid Electrification Strategy, 2017

# How to get a permit for an isolated Mini-grid with capacity up to 1MW and distribution above 100kW (optional for systems with distributed power <100kW)

**Step 1**



Identification Of The Eligibility Of Underserved Area

**Step 2**



Contact With The Community To Sign Off On Exclusivity Agreement

**Step 3**



System Design

**Step 4**



Sign Commercial Agreement With Community

**Step 5**



Acquire land and Necessary Building Approvals

**Step 6**



Apply To NERC For Operating Permit For Intended Area

**Step 7**



Construct, Test and Commission Mini Grid

**ISOLATED MINI GRIDS (100 kW – 1MW)**  
**ACCOMPANYING DOCUMENTATION FOR PERMIT APPLICATION REQUIRED BY NERC**

- I. Contract between the Community Representative and Mini-Grid Operator, where applicable
- II. Power station layout drawings
- III. Map with position of power station and distribution network marked using indicators to distinguish single phase and three phase as well as medium voltage networks
- IV. Certified copy of Certificate of Incorporation, Memorandum and Articles of Association, Deed of Partnership or Deed of Trust, as applicable
- V. Certified copy of Certificate of Occupancy or Lease Agreement for Project Site
- VI. Certified copy of building permit
- VII. Filled Standardized Spreadsheets for Tariff Calculation

Source: REA Off Grid Electrification Strategy, 2017

# How to get a permit for an interconnected Mini-grid with capacity up to 1MW and distribution above 100kW

**Step 1**



Identification Of The Eligibility Of Underserved Area

**Step 2**



Contact The Disco And Community For Operating Agreement

**Step 3**



Contract with the DisCo and Community for Exclusivity Period

**Step 4**



Tripartite Contract and Registration

**Step 5**



System Design

**Step 6**



Sign Commercial Agreements with community and DisCo

**Step 7**



Acquire land and Necessary Building Approvals

**Step 8**



Apply to NERC for an Operating Permit for Intended Area

**Step 9**



Construct, Test and Commission Mini Grid

## INTERCONNECTED MINI-GRID (100 kW to 1 MW) ACCOMPANYING DOCUMENTATION FOR PERMIT APPLICATION REQUIRED BY NERC

Certified copy of Certificate of Incorporation, Memorandum and Articles of Association, Deed of Partnership or Deed of Trust, as applicable

- I. Certified copy of Certificate of Occupancy or Lease Agreement for Project Site
- II. Certified copies of building permit
- III. Filled Standardized Spreadsheets for Tariff Calculation
- IV. Map of the interconnected network
- V. List of deficiencies in the distribution grid
- VI. Distribution network infrastructure installed by the mini-grid operator
- VII. Map of plot for power generation assets
- VIII. Diagram of fixed infrastructure for generation assets
- IX. Boundary values of the distribution grid

Source: REA Off Grid Electrification Strategy, 2017

THIS DOCUMENT IS AN IMPARTIAL PRELIMINARY INVESTMENT BRIEF DEVELOPED BY THE RURAL ELECTRIFICATION AGENCY, THE WORLD BANK AND ROCKY MOUNTAIN INSTITUTE



**RURAL ELECTRIFICATION AGENCY**

ENERGY = EMPOWERMENT = EFFICIENCY



**THE WORLD BANK**



This independent assessment of the Nigeria minigrid market is a result of a partnership between Rural Electrification Agency (REA), The World Bank (Energy Team) and Rocky Mountain Institute (RMI)



# RURAL ELECTRIFICATION AGENCY

ENERGY ≡ EMPOWERMENT ≡ EFFICIENCY

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