



# 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**

- Nigeria has the **largest economy in Sub-Saharan Africa** (GDP of \$405 billion), has 180 million people, and flourishing growth (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 **\$14 billion annually on inefficient generation** that is expensive (\$0.40/kWh or ~₦140/kWh or more), poor quality, noisy, and polluting.
- Developing off-grid alternatives to complement the grid creates a **\$9.2B/year market opportunity** for minigrids and solar home systems that will **save \$4.4B/year** for Nigerian homes and businesses.
- There is **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, created the **Off-Grid Electrification Strategy** as part of the **Power Sector Recovery Programme (PSRP)**.

## EXECUTIVE SUMMARY: BUSINESS CASE

### Evaluation of specific sites shows a strong minigrad 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 already 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 minigrads, 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 **opportunity not currently found elsewhere** in Sub-Saharan Africa.
    - Many rural households spend more than \$6/month (~~~₦~~ 2,100/month) on kerosene or battery powered torches, making a **compelling case for solar home systems**.

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

## EXECUTIVE SUMMARY: PARTNERSHIPS

### **Nigeria has strong development partner support and has established the Rural Electrification Fund for off-grid development**

- REA established the **Rural Electrification Fund (REF)** to support the Federal Government of Nigeria's (FGN) Rural Electrification Strategy and Implementation Plan (RESIP), in order 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.
- There is **strong support from World Bank**, who is working with the FGN to develop a five-year Nigeria Electrification Project (NEP), expected to be finalized by The World Bank in April 2018 and implemented by REA.
  - The World Bank's contribution for NEP is expected to be \$350 million, with **\$150 million allocated to minigrids**.
  - Minigrids 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, Ogun, Sokoto, and Cross River states.
  - The NEP will be **implemented under a market-based approach**—private firms are expected to develop minigrids, with subsidies from REA, and roughly 1,200 minigrids are expected to be developed under the project.

## EXECUTIVE SUMMARY: ENABLING ENVIRONMENT

### **Government, development 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.

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- 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

# NIGERIA IS PRIORITIZING OFF-GRID SOLUTIONS AS PART OF THE COUNTRY'S OVERALL POWER SECTOR RECOVERY PLAN

## INTRODUCTION

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

## 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 the FGN over the next five 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 FGN developed the PSRP in collaboration with the World Bank Group. Holistically, the objectives of the PSRP are to:

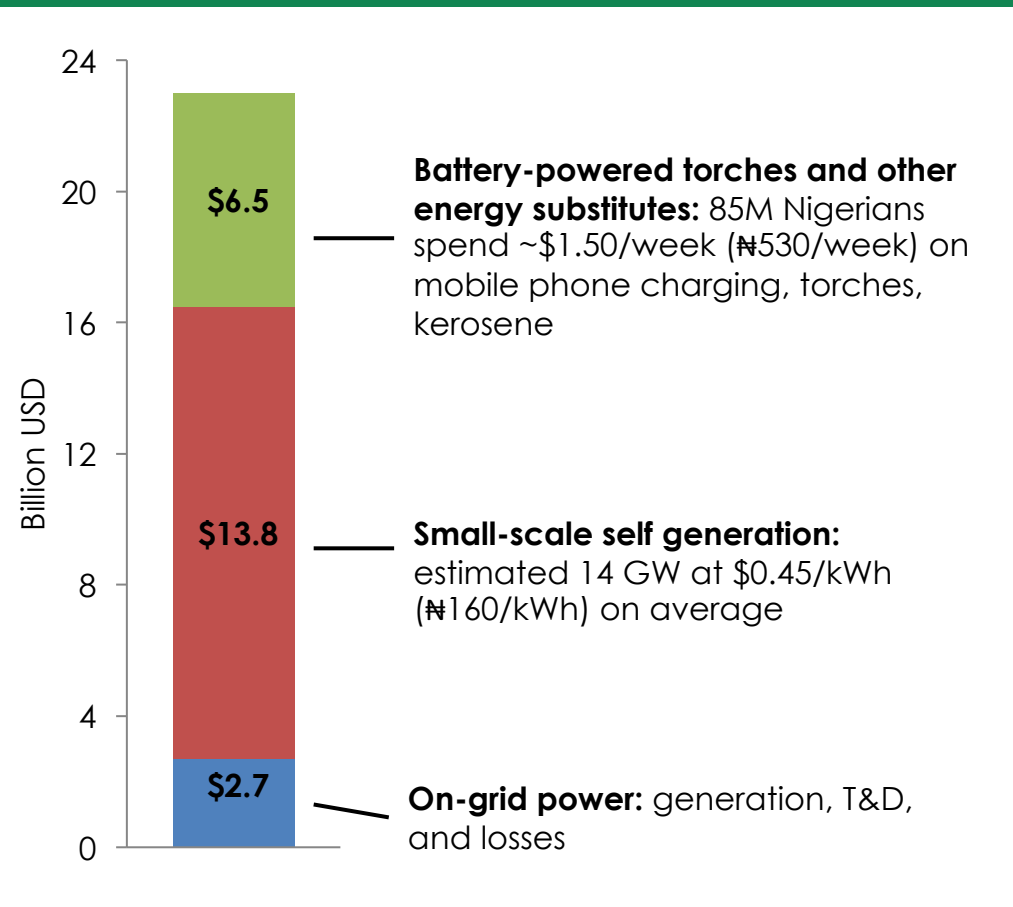
- Restore the sector's financial viability;**
- Improve power supply reliability to meet growing demand;**
- Strengthen the sector's institutional framework and increase transparency;**
- Implement clear policies that promote and encourage investor confidence in the sector; and**
- Establish a contract-based 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 (₦1.1T) annually**

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

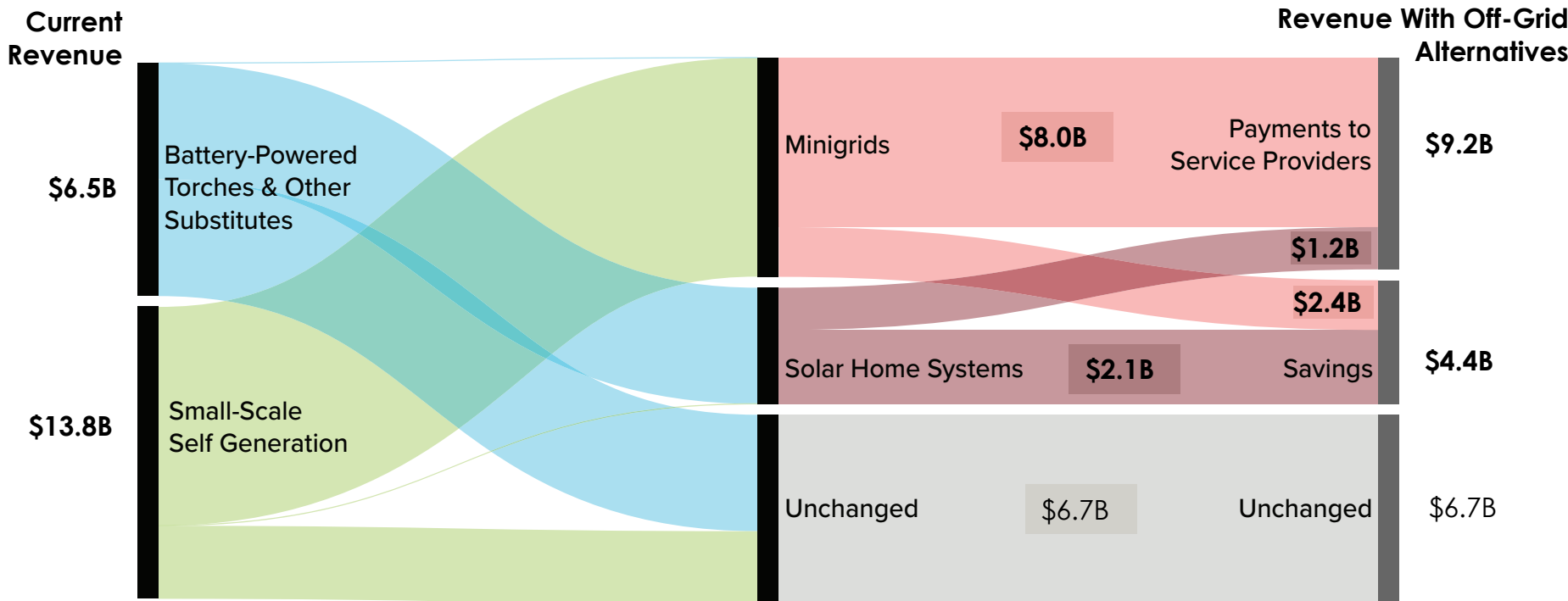




# THERE IS A \$9.2B/YR MARKET OPPORTUNITY TODAY FOR MINIGRIDS AND SOLAR HOME SYSTEMS THAT WILL SAVE NIGERIANS \$4.4B/YR

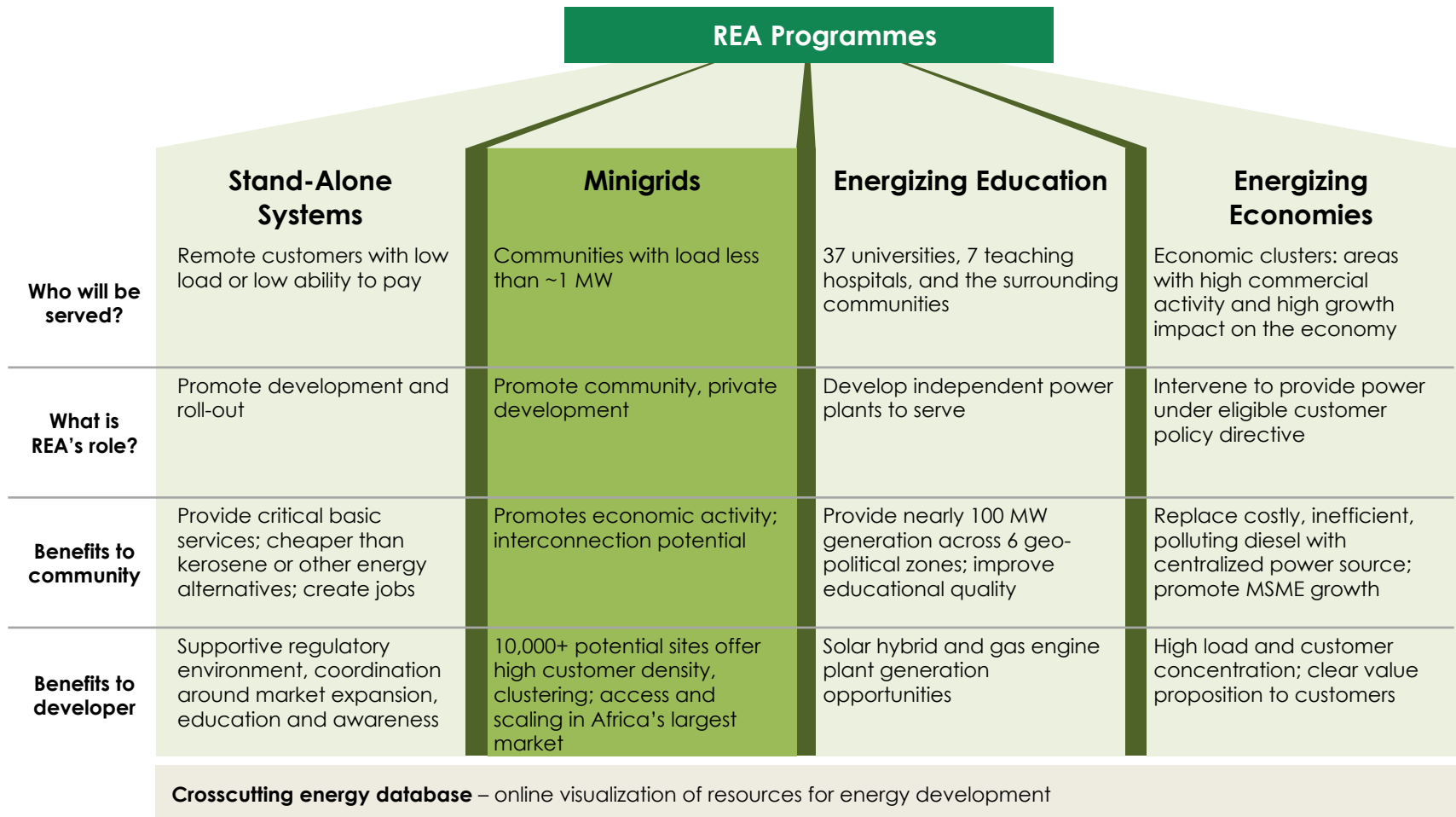
- **\$9.2 billion (₦3.2 trillion) annual market opportunity** to supply off-grid and underserved customers with minigrids and solar home systems\*
- With 8% economic growth through 2030 there is an **additional \$670 billion (₦235 trillion)** value proposition
- This estimate is based on current expenditures, but customers **may pay more for superior service**
- This shift would **save Nigerians customers \$4.4B/yr (₦1.5T/yr)** over current energy costs

## Today's off-grid and under-grid 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



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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

## 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

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 or ₦210+/kWh) and provide superior service relative to self-generation

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

Source: RMI analysis; Fuel price vary by region (N200-250) and case studies reflect field visit prices

# 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

# A \$130,000 MINIGRID THIS SITE GENERATES A 15% PROJECT IRR, SAVES \$18,000/YEAR, AND PROVIDES BETTER SERVICE

## Minigrad Solution

- **Final consumer tariff of \$0.51/kWh** Minigrad 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 minigrad sites, smart meters that allow for remote monitoring and control, remote revenue collection

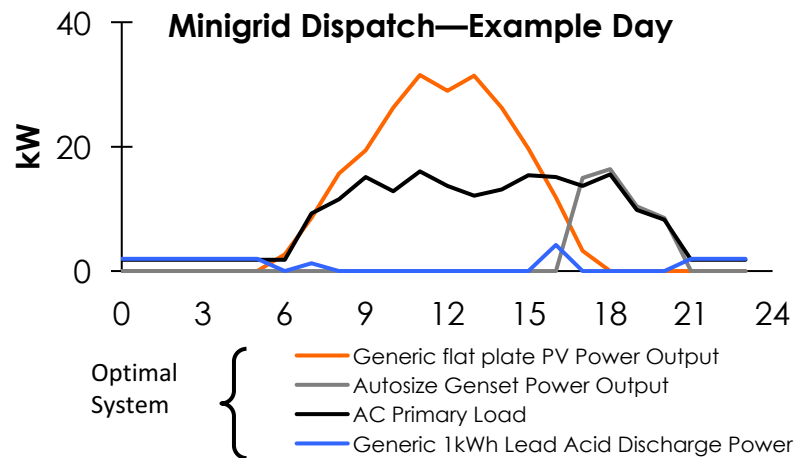
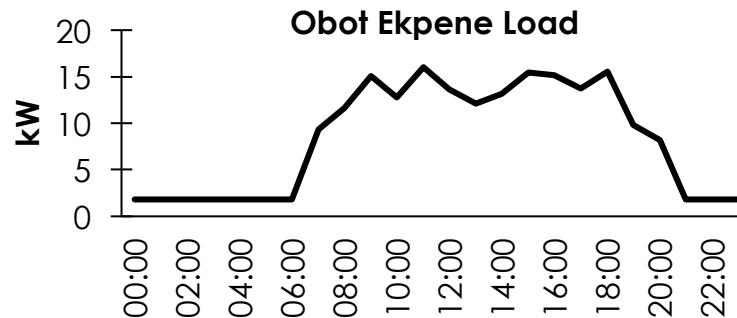
## Customer Savings and Benefits

- Future economic viability should be considered, but **need for electricity access** to drive development in such communities is the greatest in the countryside
- 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 (₦1M) 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 (60% of total)

Commercial/productive use

### Load

60 kW

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 (₦150/kWh) for petrol generation or \$0.52/kWh (₦180/kWh) for diesel, or up to \$25/month (₦8,900/month)
- Unelectrified households spend ~\$6/month (₦2,100/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, local fuel costs based on interviews at site  
 Source: RMI interviews and analysis

# A \$1.1M MINIGRID AT THIS SITE GENERATES A 15% PROJECT IRR, SAVES \$110,000/YEAR AND PROVIDES BETTER SERVICE

## Minigrid Solution

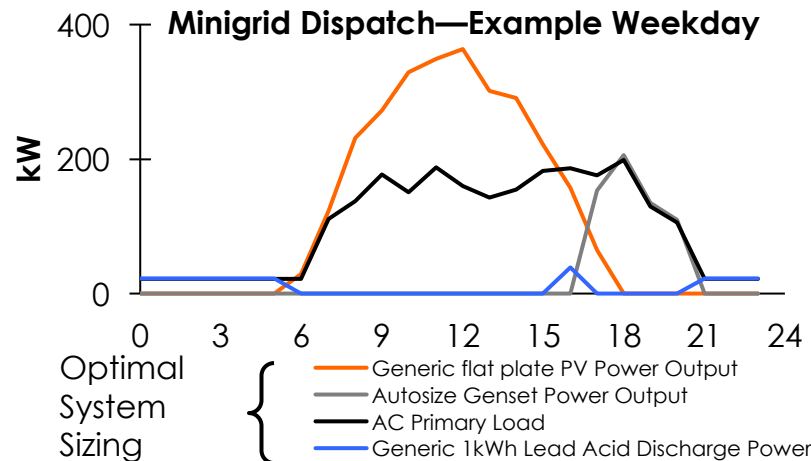
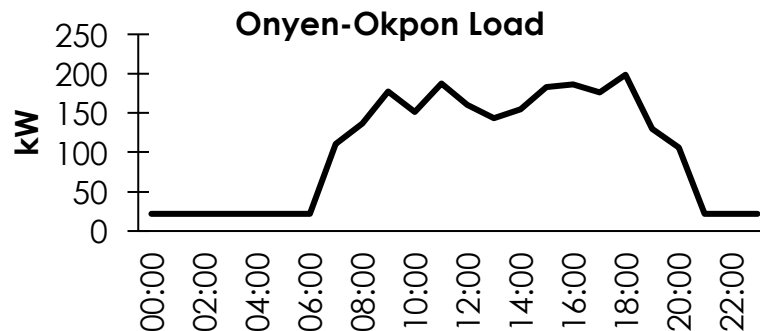
- Final consumer tariff of **\$0.40/kWh**
- Minigrid with 470 kW solar, 668 kWh battery, and 220 kW diesel backup can meet overlapping load of residential and commercial loads
- 5 km low-voltage distribution system
- Upfront capital cost of **\$1.1 million** Optimized operations and maintenance with 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 (₦11/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

## 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 (50% 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 (₦1,050/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, that is vital to the local economy*

Due to the low cost of intermittent grid 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

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

## Minigrid Solution

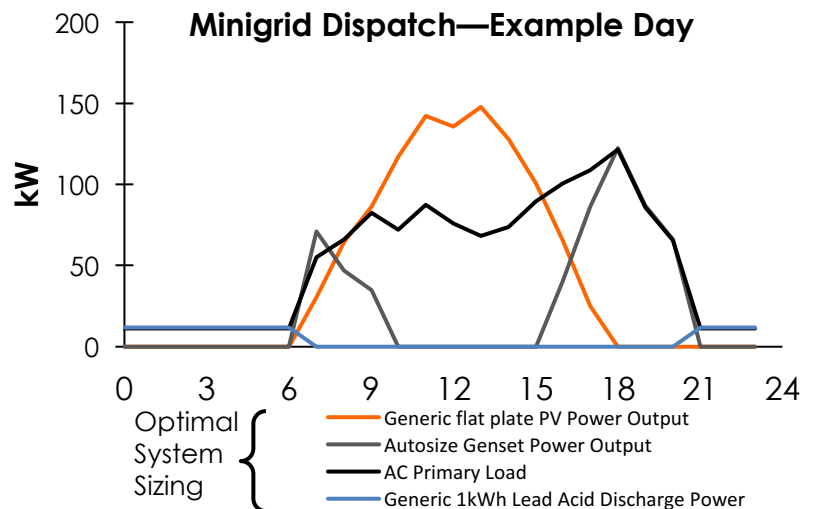
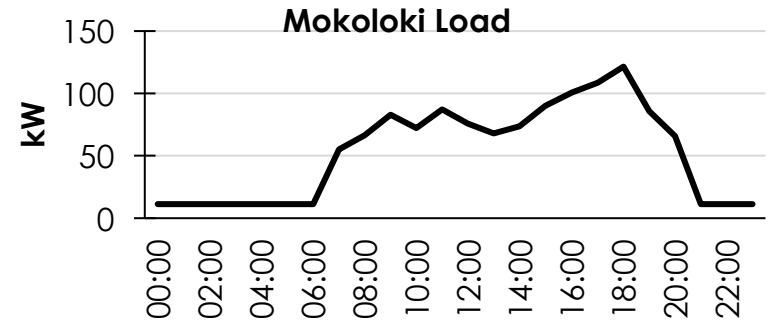
- Tariff can **meet current costs** with a **13% IRR**
- Final consumer tariff is **\$0.42/kWh** with a **15% IRR**
- Minigrid with 156 kW solar, 212 kWh battery, and 140 kW diesel component
- 5 km distribution system reaching 300 households, 20 small shops, and a peak 85 kW including 75 kW of productive 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 much greater uptime and reliability allowing businesses to plan their work on growth

## Project Economics

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



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

## OKUN-OWA, OGUN

### Context

- ~5 factories running entirely on diesel generators, 1.5 MW 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 is present, provides a few hours a week or less, sometimes at low power quality. 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 (₦2,100/week) to run diesel gensets plus \$10/month (₦3,500/month) for grid power



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

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

## Proposed Solution

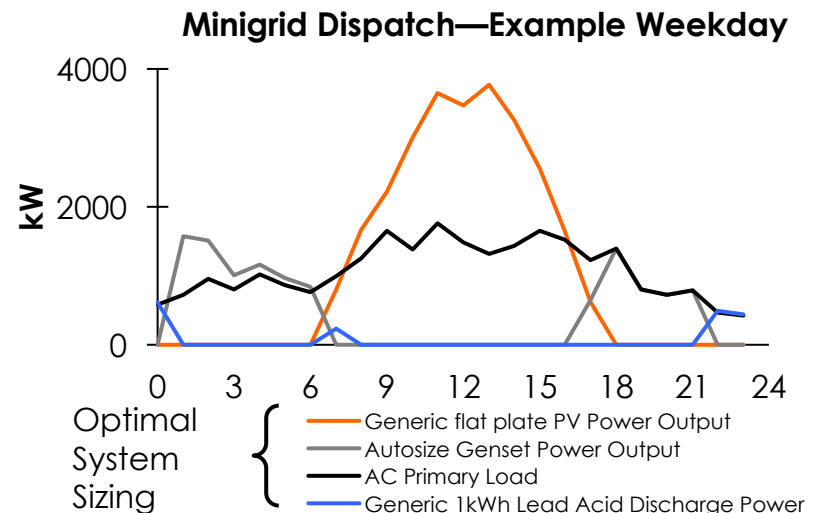
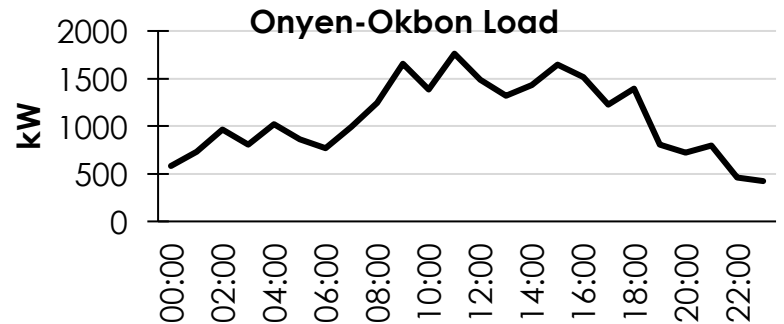
- Tariff can **meet current costs** with a **6% IRR**
- Consumer **tariff of \$0.33/kWh** with **15% IRR**
- Minigrid with 4 MW solar, 3.6 MWh LA battery, and 2 MW diesel backup can meet overlapping load of residential and commercial loads
- 6 km distribution system
- Upfront capital cost of **\$9.7 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



# 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 75 kW 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 is seen as the primary need for increased economic activity in peri-urban areas**
- Interviews suggest lack of consistent grid power has affected artisans and others, or they have 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 & development partners exploring the best types of sites and working with NERC to de-risk the process

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



# THE ENERGIZING ECONOMIES PROGRAMME SIMILARLY TARGETS LARGE MARKETS FOR COST-EFFECTIVE CONVERSION TO MINIGRIDS



One of the general generators used within a market



Distribution lines within a market

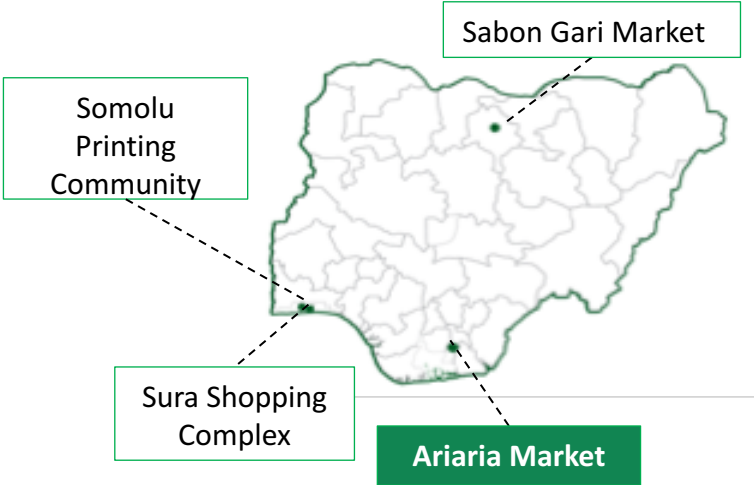


Private generators used to augment supply from the general generators

## Status Quo Observations

- 4 large markets have >50,000 shops paying >\$70K/day (₦24.5M/day) for power
- Higher energy cost compared to renewable and other gas-fired solutions
- Noise pollution from heavy duty diesel generators and small generators
- Potential Health, Safety, and Environment (HSE) infringement resulting from ad hoc installations
- Shoddy overhead distribution lines

# ARIARIA MARKET IS ONE EXAMPLE OF THE ATTRACTIVE ECONOMICS AT MARKETS TARGETED FOR TRANSFORMATION



## Context

- **37,000 shops**, 16,000 of which currently use electricity
- Currently spend **\$21,000/day (₦7.4M/day)** on electricity
- Currently underserved and qualified as **eligible customers**

## Proposed Solution

- Phase 1: **5 MW** of natural gas and diesel capacity
- Initial capital cost of **\$12M**
- **12,000 shops** electrified with average load of 100–200 W
- **Independent Distribution Network**
- Dense market area minimizes distribution costs, and smart meters allow for remote monitoring and control
- **\$0.22/kWh solution** is competitive with alternatives

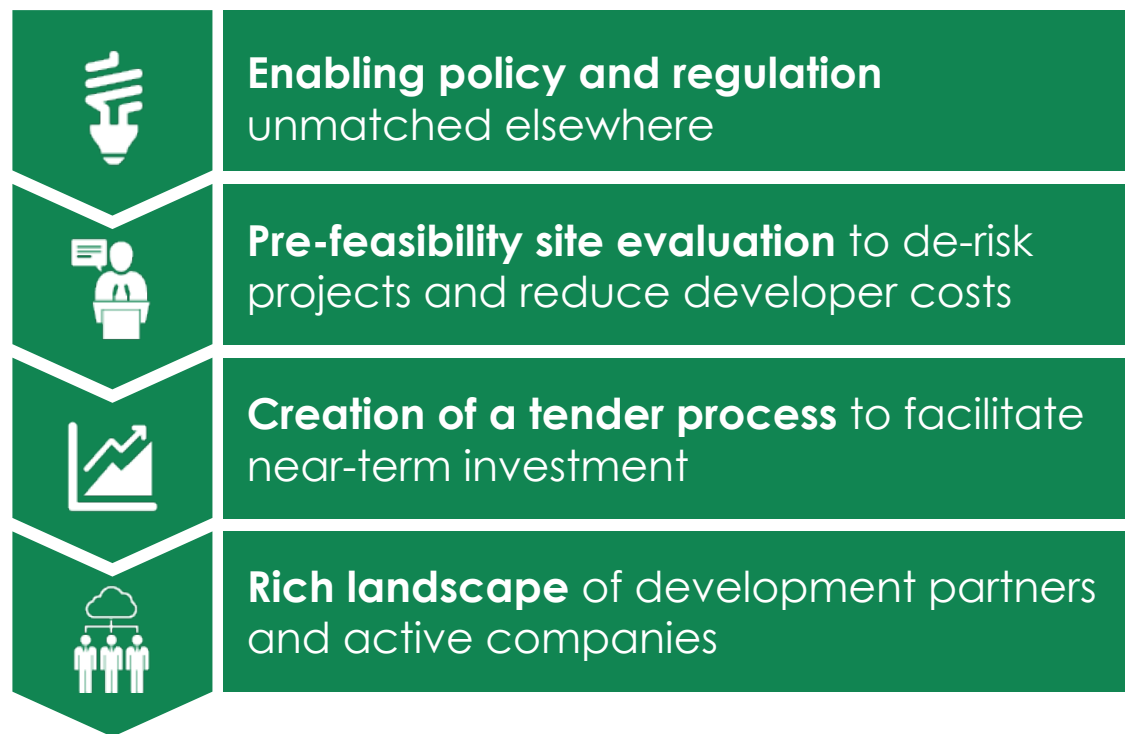
The **private sector** is responsible for funding, generation, distribution, metering, and collections and the **REA** will manage and facilitate all interactions with the various state and federal level ministries, departments, and agencies

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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

### Setting Tariffs

- Tariff flexibility currently allowed
- Minigrids under 1 MW allowed to set cost-reflective tariffs

### 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

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

## 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 100 kW demand



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

### REA teams prioritized sites by:

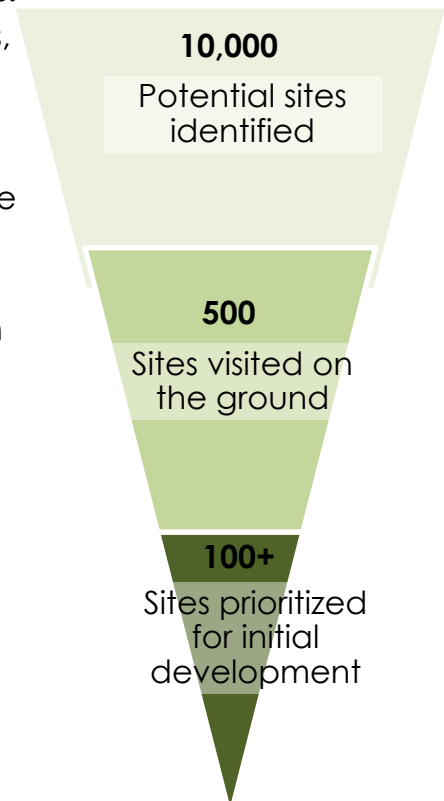
- Sufficient load/density
- Productive-use, daytime, and flexible loads
- Supportive local and state government
- Community engagement
- Solar resource and availability of gas
- Accessibility

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

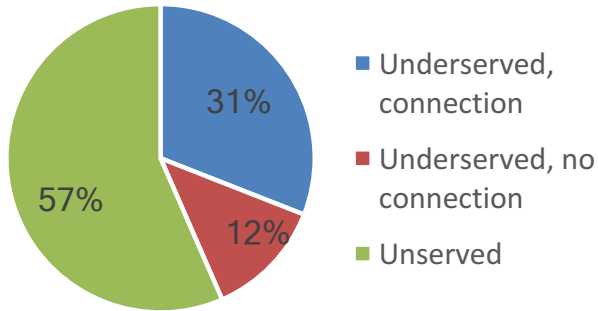
### REA survey data includes:

- 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

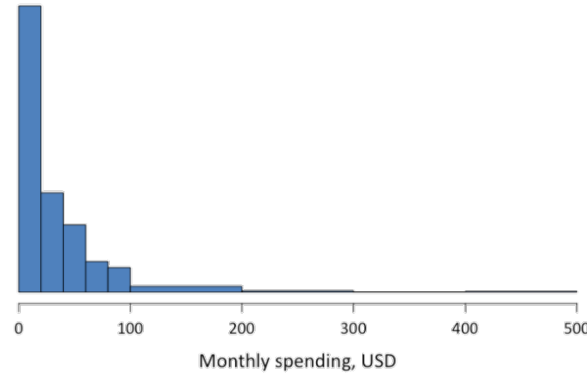


# REA SURVEYS OF 200 SITES IN 5 STATES PROVIDE QUANTITATIVE EVIDENCE FOR MINIGRID OPPORTUNITY

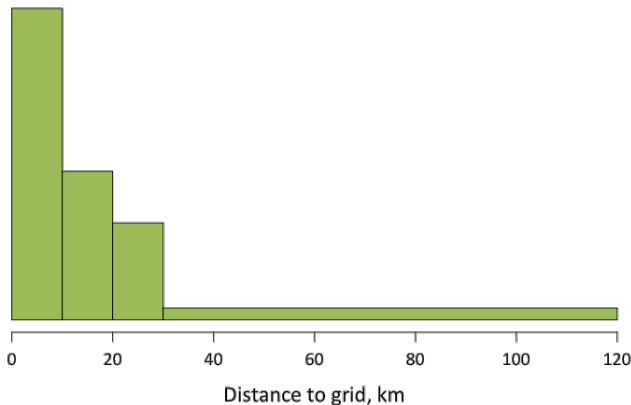
## Access to distribution infrastructure by community



## Current energy expenditures by household



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



## Insights from on-the ground surveys

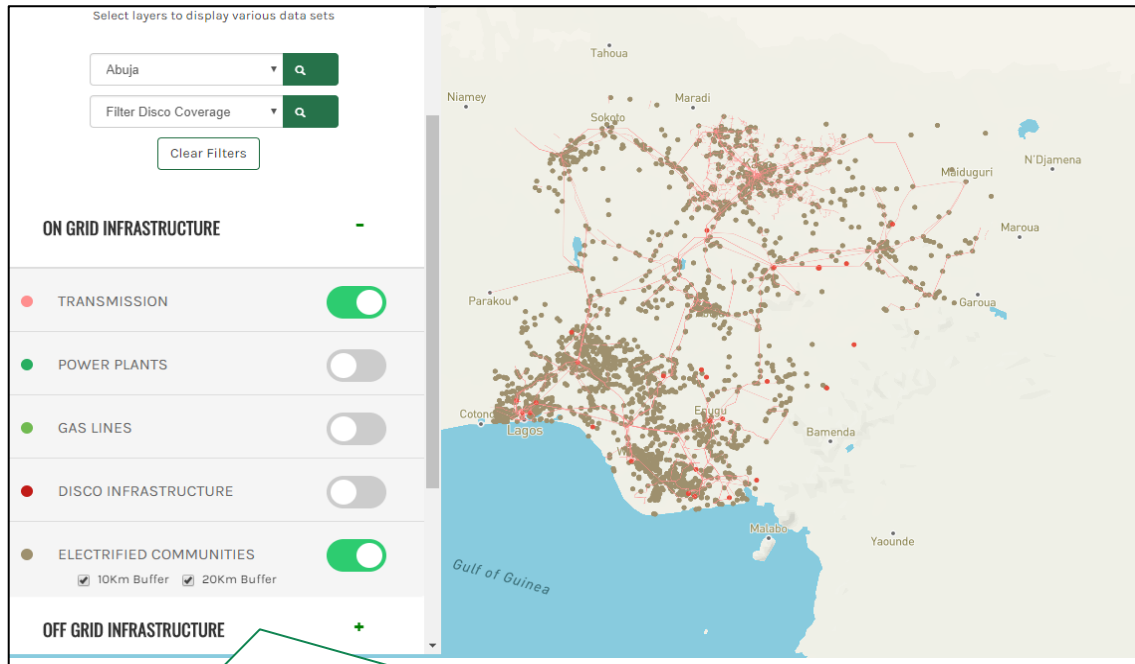
- Some communities indicated both the **ability and willingness to contribute** to the up-front cost of electricity infrastructure
- There is a huge **opportunity for the development of underserved areas**. The centralized grid has a far greater reach than previously anticipated by GIZ, REA, and others;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

## Key Enabling Factors

- Only 10% of community leaders reported that electricity needs are met in their community
- 46% of surveyed communities have telecom signal that would support mobile payments for a PAYG scheme
- Off-grid households spend, on average, over \$30/month (≈10.5k/month) on energy alternatives and consistently spend more on energy than their on-grid counterparts

# 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 Minigrid 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

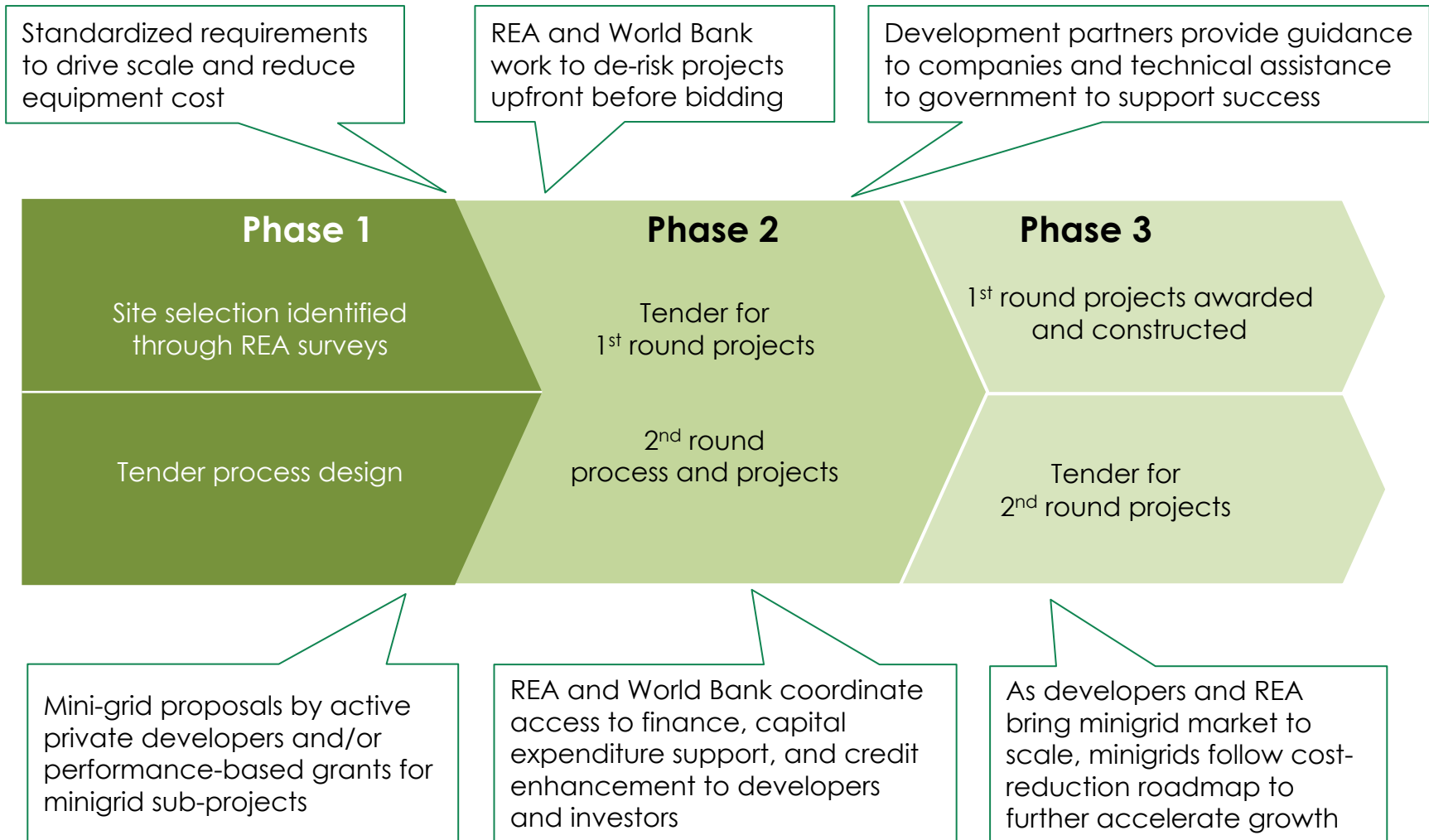
### Resources

- 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





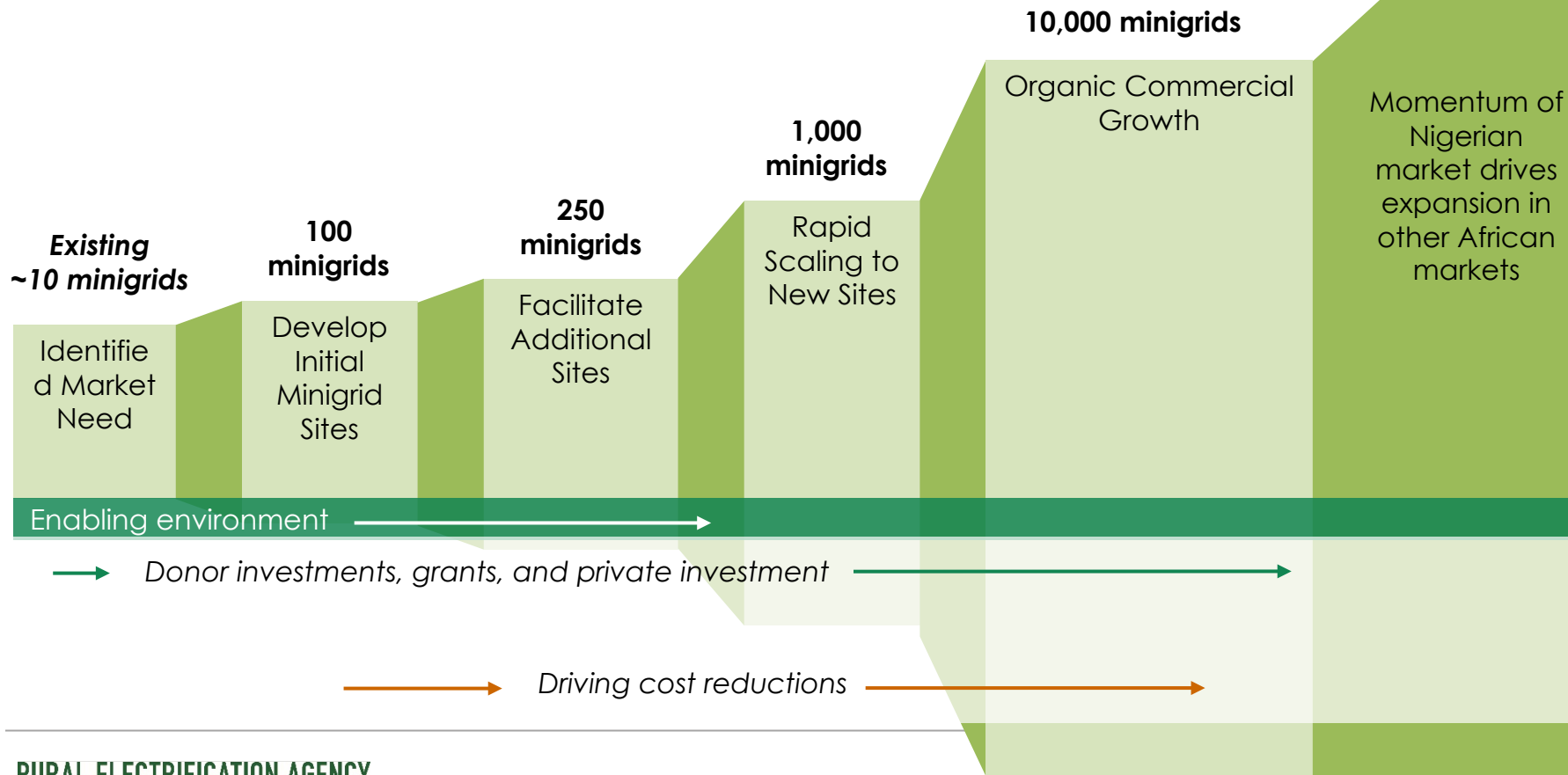
# CONTENTS

- 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



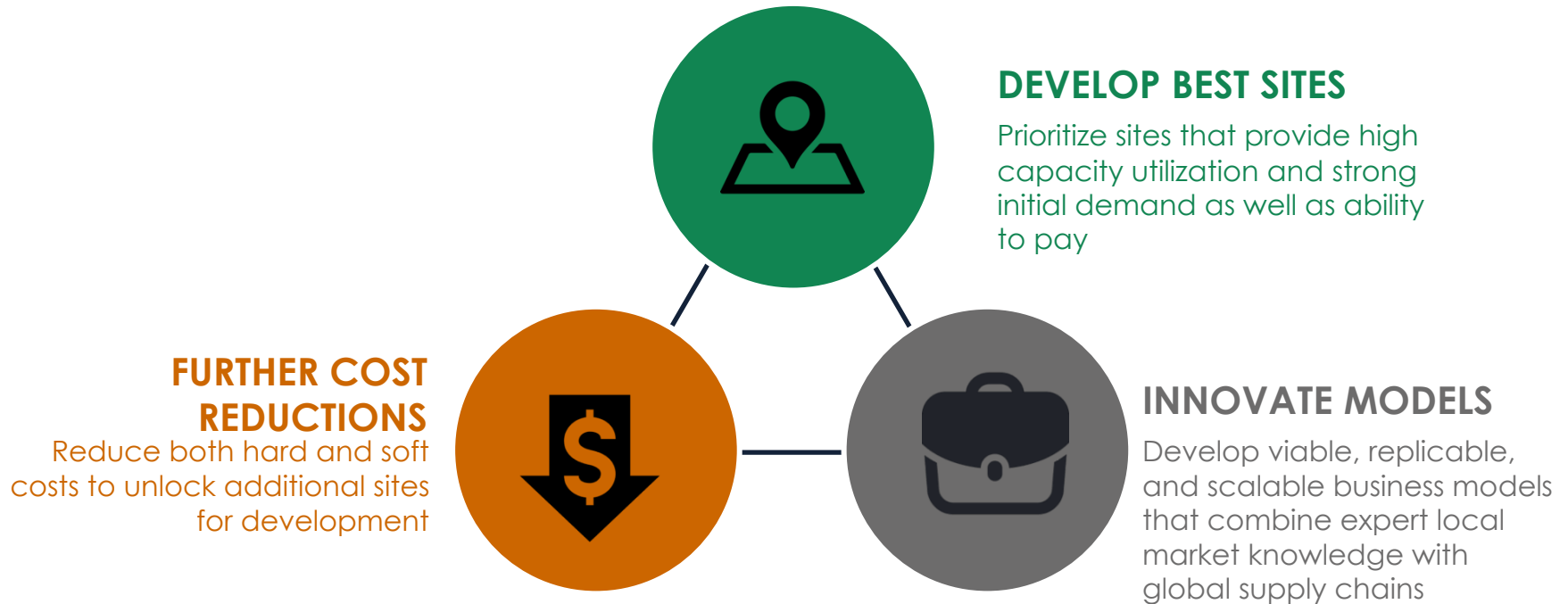
# THE NIGERIAN MARKET ALONE IS ENOUGH TO BRING MINIGRIDS TO SCALE

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.

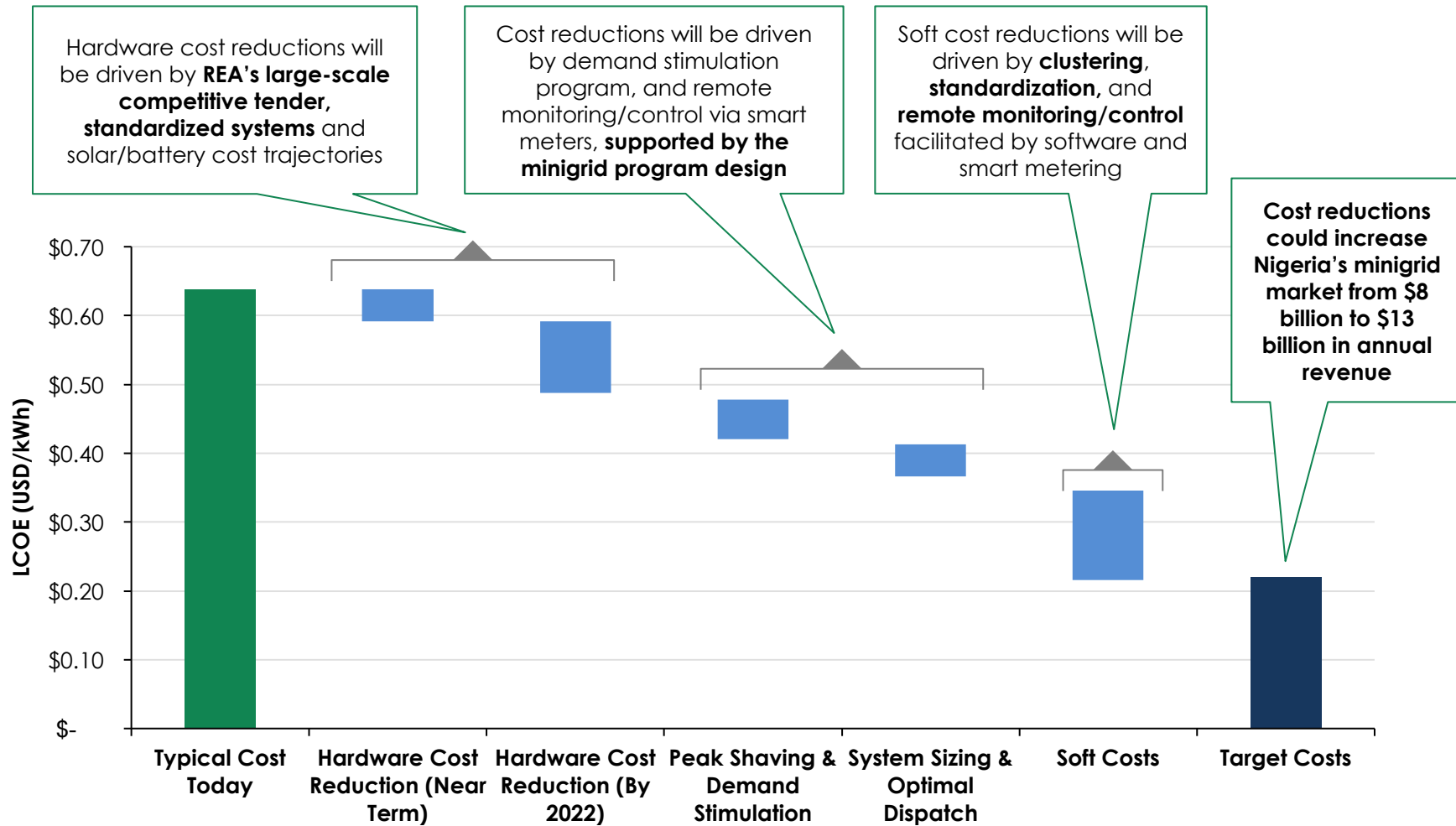


# MINIGRIDS ARE COMMERCIALY VIABLE TODAY IN NIGERIA— ADDRESSING KEY CHALLENGES WILL UNLOCK MAXIMUM SCALE

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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# DEVELOPMENT PARTNERS CAN ACCELERATE NIGERIA'S OFF-GRID MARKET BY 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

## Development 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

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

## Investors

- Next stage market development leveraging REA pre-feasibility work
- Pathways to concessional financing
- Pursue pathways to address FOREX 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
- Develop projects together with REA, then own and operate
- 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

# APPENDIX

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# Nigerian Electricity Regulatory Commission (NERC) Minigrid Regulations 2016



## What is the Minigrid Regulation?

The Minigrid 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 minigrid investments such as:

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

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


## Types of minigrids covered in the regulation

1. Isolated minigrids up to 100 kW of distributed power (**registration required**)
2. Isolated minigrids larger than 100 kW of distributed power and up to 1 MW of generation capacity (**permit required**)
3. Interconnected minigrids larger than 100 kW of distributed power and up to 1 MW 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 minigrids larger than 1 MW must apply for a full license.



# How to register an isolated minigrid project (distributed power below 100 kW)

**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 MINIGRIDS < 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

# How to get a permit for an isolated minigrid

with capacity up to 1 MW and distribution above 100 kW  
(optional for systems with distributed power <100 kW)

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

- I. Contract between the community representative and minigrid 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


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

**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 MINIGRID (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 minigrid operator
- VII. Map of plot for power generation assets
- VIII. Diagram of fixed infrastructure for generation assets
- IX. Boundary values of the distribution grid

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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