Standards & Technology to Support Benin's Energy Backbone: Energy Storage and Energy Efficiency

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Cotonou, Benin
Three Key Topics

2. Building the Future Power System of Africa
3. Paths to Africa’s Distributed Energy Future
Transforming Lives through Smarter Power
Excellence in East Africa for 7+ years

**Proven Track Record & Capabilities**

• Founded in **2011**

• 95+ full-time employees with offices Nairobi, Kenya and Arusha, Tanzania

• Leading micro-grid company in Africa, by installed grids (65+) and homes and business (6,000+)

• 200+ renewable energy systems installed across 7 countries

• Operational capabilities across the full project life cycle

**Country Experience**

- Kenya
- Somalia
- Tanzania
- Mozambique
- Uganda
- Rwanda
- Zambia
- Uganda

**Past & Current Partners**

- Micro-grid Development
- Engineering, Procurement, Construction
- Customer & Asset Management

- Engie
- E.on
- SunEdison
- AMDA
- Philips
- Finlays
Renewable minigrids are the core of PowerGen’s private micro-utility model, which is supported by three key pillars.

**PowerGen’s Private Micro-Utilities**

- **Capacity:** 3kWp to 60kWp (larger possible)
- **Payments:** Pay-As-You-Go (PAYG) technology
- **Metering:** Advanced Metering Infrastructure (AMI)
- **Business:** Vertically integrated with three pillars
  1. Minigrid Development
  2. EPC implementation
  3. Customer & Asset Management
Mini-grid photos
PowerGen operates smart, Pay-As-You-Go mini-grids

Remote Monitoring

Cloud Software System

Performance & Payment Data

Mobile Money Payments

SOLAR ENERGY

BATTERY STORAGE

AC Power 24hr/day

Smart Metering Infrastructure

PowerGen

Remote Monitoring

Cloud Software System

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SOLAR ENERGY

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AC Power 24hr/day

Smart Metering Infrastructure

PowerGen
Our mini-grid software platform allows power system control and optimized customer service.
Our mini-grid customers are homeowners and entrepreneurs in villages across Kenya and Tanzania...
... and agricultural estates through the region.

**Case Study: Village Electrification at Finlay’s Tea Estate**

>7,000 customers

80+ villages

>\$4m Project Value
PowerGen is the leader in the East African micro-grid market

*Includes sites built for E.On, Engie, SteamaCo, and other clients.

**PH is currently actively building its first batch of sites with GMG funding in Kenya so this number is rising
The Africa Enterprise Challenge Fund awarded PowerGen a grant and concessional debt in 2015.

The Energy and Environmental Partnership awarded PowerGen a grant for microgrids in 2015.

The Kenya Climate Innovation Centre awarded PowerGen a grant in 2014.

The Challenge Cup named PowerGen the winner for Kenya in 2015, and PowerGen was invited to speak at the White House about its work with microgrids.

The Global Entrepreneurship Summit 2015 invited PowerGen to exhibit to President Obama’s Nairobi delegation in 2015.

The Sankalp Forum named PowerGen runner-up in 2015.

Awarded grant from OPIC’s ACEF program in 2017.

Awarded grant from USAID DIV program in 2017 for demand stimulation promotion.

Notable awards and recognition received
2. Building the Future Power System of Africa
Long-term, global power markets are shifting toward a smart, distributed energy system...
...giving Africa the opportunity to “leapfrog” the old utility architecture with modern technologies...

**Developed Country Grid**

**Less-Developed Country Grid**

Existing infrastructure slows transition to future grid challenging

Less infrastructure provides a fresh start to build the power system architecture of the future
Minigrids can operate autonomously or grid-connected, offering reliability and flexibility to consumers.
Ultimately this will allow African grids to converge with their evolving developed market counterparts.
Where does energy storage fit?
Energy storage allows systems to shift supply to match demand.

**Energy Storage**
In residential contexts, peak load on a minigrid often occurs in the evening when customers return home from work. Because solar PV panels only generate during the day, **batteries or generators are needed to serve this demand.**
Energy storage can strengthen the grid in many ways.

**BENEFITS OF BATTERY STORAGE**


- **Load shifting ($$)**
- **Load shifting / backup**
- **Load shifting / power adding**
- **Grid stabilization**
- **Renewables firming**

- **Reduced demand access charge**
- **Replace conventional (non RES) sources**
- **Benefits from legislation & incentive programs**
- **Reduction of the need for new electricity generation plants**
Various types of energy services can provide valuable services to the grid.

**Varieties of Energy Storage**

<table>
<thead>
<tr>
<th>Electrochemical</th>
<th>Mechanical</th>
<th>Electrical</th>
<th>Thermal</th>
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<tbody>
<tr>
<td>• Battery</td>
<td>• Flywheels</td>
<td>• Capacitors</td>
<td>• Hot water storage</td>
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<td>• Flow Batteries</td>
<td>• Compressed air</td>
<td>• Magnets</td>
<td>• Thermal fluid storage</td>
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<td>• Hydrogen</td>
<td>• Pumped Hydro</td>
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Trend: Distributed Renewables

Increased Residential Solar further strains grid.
Trend: Energy storage allows shifting supply to meet demand

Decreasing Battery Prices → More distributed energy storage.

→ Storage provides **significant value to the grid**.
Trend: Distributed Energy Resources (DER’s)

DER’s can help **reduce the strain** on the grid.
Trend: Distributed Energy Resources (DER’s)

DER’s can help **reduce the strain** on the grid.
Trend: Global Minigrid Growth

Global Minigrid Growth driven by security and resilience.
3. Paths to Africa’s Distributed Energy Future
A Path Forward

1. Policy
2. Tools
3. Dialog
Policy: Binary perceptions of electrification are damaging to innovative problem-solving
Policy: Energy leadership requires nuanced approaches to energy policy.
Policy: Leap-frogging to a distributed energy systems requires smart policy decisions now.

1. **Incentives for DER providers** that align with the country’s goals for electrification.  
   → Clear $/connection subsidy on par with grid extension subsidies.

2. **Framework for DER interconnection** (especially energy storage) that recognizes the value they provide to the grid.

3. **Efficient disbursement mechanisms** for DER providers.
Tools: Data rich systems enable control and analysis at an unprecedented level of granularity.

Smart appliances & devices

Smart power systems
Tools: Blockchain as a means of aggregating small-scale storage.

Blockchain technology provides a means of aggregating energy storage in a highly efficient way.

“Smart contracts” automate multiple important features:

- Storage dispatch according to market behavior
- Incentive disbursement when milestones are achieved
- Coordinated control over many small-scale energy storage units across an entire network
Dialog: Engage with on-the-ground private sector players to formulate policy.

African Mini-grid Developers Association
• Formed in 2017
• Active chapters in Kenya, Tanzania, & Nigeria

Roles
• AMDA provides advocacy, promotion, and coordination for developers across the continent
• Creates unified voice to engage policy makers and financiers

africamda.org
A Path Forward

1. Policy
   • Direct incentives for deployment of DER’s
   • Clear framework for interconnection between Distributed Energy Resources (DER’s) and the national grid

2. Tools
   • Smart infrastructure
   • Global standards

3. Dialog
   • African Mini-Grid Developers Association
Appendix
Micro-grid Development
PowerGen is a leader in site selection and customer acquisition

PowerGen is the unparalleled leader in site selection and customer acquisition the African micro-grid market with a proven track record operating on-the-ground 5+ years in East Africa:

- Fully dedicated Customer and Sites team
- 2,000+ customers connected
- Highly robust and granular database tracking 250+ community and customer metrics
- Proprietary methodologies and systems to manage customer prospects
- In-house expertise on:
  - Geographic and GIS analysis
  - Site selection and surveying
  - Data analytics
  - Tariffs structuring
  - Customer selection
  - Customer signup
  - Training and on-boarding
PowerGen Site Selection and Customer Acquisition Funnel

**Surveys and Large Datasets**
PowerGen database captures demographic information and GIS data from various sources to get a high-level understanding of each site and plan surveying trips.

**On-Ground Site Survey**
Experienced Site Surveyors gather permits and licenses for each district, town and site and then conduct full survey of location with community leadership.

**Database and Analytics**
Sites are narrowed down through a systematic scoring methodology that analyzes 250+ data points about the demand, logistics, social impact and grid connection.

**Customer Application**
Customer team conducts application process and gathers 40+ data point per customer to inform connectivity, reticulation, distribution, and tariffs.

**Customer Sign-up**
While full microgrid infrastructure is installed, the customer team works with customers to sign into system, make first payment, and try electricity.

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500 rural sites in Northern/Central TZ

150 site prioritized pipeline
Tiered metrics and a refined analytical approach allows the PowerGen Customer and Site Acquisition team to narrow down potential sites through key criteria within a systematic scoring methodology.

**Scoring Categories**

- **Demand**
  - Number of Customers
  - Current Usage
  - Tourism
  - Business metrics

- **Logistics**
  - Mobile access
  - Road quality
  - Leadership support
  - Road Maintenance Frequency

- **Grid Connection**
  - Nearest grid connection
  - KPLC/TANESCO future electricity plan
  - Local government grid plans

- **Impact**
  - School impact
  - Health care impact
  - Economic empowerment
  - Social empowerment
Using software tools and databases to design optimized systems

1. Geographical Resource evaluation

2. Generation Design & optimization

3. Reticulation technical & economic assessment
Engineering, Procurement, Construction
PowerGen’s ~11,000 sq. ft. workshop in Nairobi, Kenya
Engineering, Design, Procurement, and Installation
Equipment Design Overview

(1) Layout Plan

(2) Dimensions & Material Specs

(3) Electrical Wiring

(4) Electrical Equipment Layout

(5) PowerBox Construction & Standardization
Project Coordination Overview

Project Coordination supports all teams across the Grid Execution division to schedule and track both projects and resources.

**A comprehensive, repeatable schedule:**
- Connects dependent activities
- Outlines clear lead times
- Documents resource requirements

**Effective Workload & Team Prioritization:**
- High-level schedule of all projects, milestones and resources
- Pipeline Committee decisions to plan projects with high-level resource availability

**Template Project Checklists & Reports:**
- Tracker of activities for each executional team
- Connects team leads to changes and delays
- Produce standard documents for internal & client handoffs
**Installations Overview**

**High-level Installations process:**

### Pre-Site Work
- Aggregation of information from 3 different teams.
- Checking and Testing of Equipment
- Draw up Project Planning Documentation
  - Budget, Settings, Distribution Layout, Crew Plan, Quality Control Checklist, etc...

### On-Site Work
- Installation Broken into 4 sections
  - Power System Installation
    - Includes Metering Central Server and Communications
  - Distribution Network Installation
  - Customer Connection Points
  - Testing / Quality Control Checks
  - Progress Reporting

### Handover
- Handover Contains all Project Details
  - Site Operation information
    - Keys, Settings of Equipment, Initial Data etc...
  - As Built Information
    - Design Changes, Materials used, etc...
  - Customer Information

**Installation Team**
- Installation of Projects
  - (See Left)
- Installation Team Operations
  - Day to Day Team Management
  - Compliance
  - Quarterly Planning
- Installation Team People Operations
  - Hiring, Training, Onboarding
  - Evaluations
  - Compensation and Advancement
Grid & Customer Management
PowerGen Metering & Communication System

Rapid Refresh Process

Remote & Local Issue Resolution

Constant monitoring and optimization

Mobile Money and Cash Payments Accepted
Call Center and Customer Service

The PowerGen call center establishes comprehensive understanding of the customer issue through detailed fact-finding and implements an established procedure for correcting issue in timely fashion.

- All calls are answered by PowerGen Customer Service team in a standardized manner, providing a consistent service level across the organization.
- Basic information about the customer and issue are gathered for each call.
- Once basic situation is understood, customer issues are consistently troubleshooting using the logical approach.
- The PowerGen Customer Service team works to solve all payment, SIM and basic in-home wiring issues.
- All outcomes are documented and all data is captured from every call for analysis.
- Tool has built in ticket generation capabilities, allowing standard issue escalation with technical O&M team.

Either:
1. Customer issue is resolved
2. Ticket escalated to the Technical O&M team.

Incoming Calls

Customer Troubleshooting Tool

Standard Service & Information Gathering

Logical Troubleshooting

Data & Tickets
Operations Platform System Monitoring

Through analysis across data sources (customer demographics, payments, usage, generation, storage, and consumption), the PowerGen Grid Operations team can remotely have full visibility into technical operation and customer activity, allowing the team to act proactively.

Data Sources

- Solar & Batteries
- Inverter, Charge & Color Controller
- Smart Meters
- Customer Payments & Demographics

Analysis

Actions

- Ability to implement predictive maintenance activities
- Immediate understanding of failure events at grids
- Awareness of customer payment and usage trends
- Ability to implement proactive customer engagement
Demand Stimulation & Economic Development

*Increasing electricity usage and revenue at micro-grids requires both projects that directly increase energy consumption as well as initiatives that improve the underlying local economy.*

| 1. Identification of Poor Performance | Analytical methods for identifying poor performing grids, customer groups and other segments of the business |
| 2. Pricing and Profitability | Sustainable, Repeatable and Easy-to-understand tariffs |
| 3. Partnerships | Electricity consuming products & ancillary services |
| 4. Products and Services | Tailored products and leases to certain customer segments |
| 5. Sales and Channels | Right mix of channels & models to reach different customers |
| 6. Marketing and Brand | Increase brand value and maximize the return on marketing investments |

*Pilots with income generating appliances (IGAs) across both Kenya and Tanzania have resulted in increased electricity consumption & revenue.*
Our customers are homeowners and entrepreneurs in villages throughout Kenya and Tanzania
“PowerGen electricity helped me with my business. I can put my drinks in the fridge and watch TV. I’ve received life comforts. I feel like I’m in town!”

Bahati Juma
Cook
“From the time we were connected until now, we truly see its usefulness. There is a big benefit and without a doubt it’s a cheap price. We are truly thankful for these services.”

Wilfred Sumaye
Pharmacist