Out of sight, out of mind:
The importance of remote monitoring for off-grid and mini-grid energy systems

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Outline

- Introduction
- The impact of remote monitoring
- Operational improvement case studies
- Broadening the scope of value
- Examples from AMMP monitoring platform
Introduction

Bridging the energy access gap is operationally challenging

- >1 billion unelectrified people globally
- Increasingly served by off-grid renewable energy systems
- Yet running these systems is operationally challenging

- Complex systems with sensitive components
- Remote sites difficult to access
- Lack of near-site technical skills
From: Dr. Harald Richter, *Are Mini-grids instrumental in fostering development in India?*, 16 Oct 2018

- 7.5 MW not used
- 20 MW Status unknown
- 14.5 MW used
Effective remote monitoring and management are increasingly within reach, and can have major impact.

Owner or operator of off-grid systems

~30% operational cost reduction

- Fewer site trips
- Longer component lifetime
- Improved performance
Key drivers of availability of remote monitoring

• Mobile connectivity—and mobile data—increasingly available in remote areas
• Satellite connections increasingly affordable (e.g. ~$50-100/month)

• Availability of data interfaces on inverter systems improving
• In some cases direct cloud connections/online portals

Barriers:
• Not always easy to set up reliable connection
• Lack of standardization of data interfaces across vendors
For effective monitoring, need to acquire data from multiple vendors and device types.
The platform contains a rich set of features to assist with streamlining asset operations:

- **Data visualization**: High quality time-series data visualization
- **Asset portfolio monitoring**: Algorithms based on more than 30 performance indicators
- **Dynamic alerting**: SMS/e-mail based for fast response times
- **Remote meter controls**: For advanced demand side management
- **KPI reporting**: Identification of long-term trends
- **Smart consumption analytics**: Extensive customer insights
AMMP creates business value instead of just gathering data

Higher end-customer satisfaction through better customers service

Reduction of O&M costs through system monitoring

Reduction in system design costs through improved load estimations and system benchmarking

More transparency for project stakeholders and financiers through automated reports
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Recently published white paper on impact of remote monitoring

Reducing the cost of operations and maintenance for remote off-grid systems — *The impact of remote monitoring*

- Impact analysis based on Rafiki Power grids in Tanzania
- Assessed impact on three O&M cost components:
  - **Labor** (44% of costs; 20–45% saving)
  - **Logistics** (30% of costs; 10–20% saving)
  - **Component replacement** (26% of costs; 10–20% saving)
→ Overall: 15–30% of O&M costs saved

Impact of remote monitoring

- Operating temperature reduction of 5°C extends lifetime by 10%
- Reducing average depth of discharge by 5% extends lifetime by 10%
- 10–20% benefit overall

Source: Hoppecke installation, commissioning and operating manual
Impact of remote monitoring

Logistics costs reduced by cutting down technical site trips

- Enhanced remote analysis and troubleshooting of issues
- Possible to delegate to local tech
- Can intervene remotely to set operating parameters

10–20% site trips avoided
Impact of remote monitoring

Labor: Break down of man-hours spent by an operations engineer, in the absence of remote monitoring (baseline scenario)

- Remote issue identification, 50%
- Site trip execution, 14%
- Resolution planning, 11%
- Procurement of components, 10%
- Site trip planning, 8%
- Reporting, 5%
- Validation, 2%
Labor costs reduced by cutting down time spent on issue detection and troubleshooting

- Monitoring allows easier remote issue analysis; less time interfacing with local tech
- Though even when remote monitoring is present, hard to obtain single source of truth; value in unified monitoring

20–45% overall time saving
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Case studies

Case 1: Remotely and proactively pinpointing fault location in distribution grid

- Voltage data from numerous points on distribution grid (e.g. smart meters) monitored
- Mapping over time and across locations allowed central team to detect damaged cable, and pinpoint location of fault
- Site team able to quickly carry out repairs
Case 2: Extending battery life through remotely managed, automated load shedding

Low PV output during rainy season leading to reduced SoC

Instituted temporary load shedding to restore SoC

Meanwhile, battery health can be maintained over long term

Scheduled nightly load shedding allows sufficient charge to be preserved for power to be turned on from 4am, which is when customers need it
Case 3: Extending lifetime and improving performance through temperature management

After an on-site investigation, additional shading structure was installed to block previously direct sunshine on one wall of containerized system. AMMP showed high overall battery temperature values. Decrease of average temperature from 29°C to 25°C, with corresponding battery lifetime impact.
Case 4: Fulfilling reporting requirements by project stakeholders

Automated and reliable reporting to stakeholders

Better chances to attract investors and win tenders

Proof of impact
Case 5: Granular consumption data allows better expansion planning

https://www.youtube.com/watch?v=s5f3bdy6rtk&feature=youtu.be
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Scope of value

Outlook / Way forward: More opportunity to recognize value of remote monitoring, by relevant stakeholders

- **Issue**: Primary focus for optimization is often CAPEX; OPEX often neglected
- Investing in monitoring leads to lower operating costs, and thus better economics
- Ability to make data-driven decisions regarding roll-out

- **Issue**: Subsidies often focus on CAPEX, and are based on e.g. number of connections; should potentially also be tied to longer-term operational quality
- Important to have visibility over operations of systems in portfolio

- More transparency over (mini-grid) operations in country/region
- Ability to better integrate mini-grids into national electrification plan
Partnership to offer customers a complete, end-to-end solution for financing, developing, operating, and monitoring mini-grid projects.
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Dashboard Examples

Portfolio Level - Overview

Portfolio PV Energy
- 13.54 MWh

Portfolio non-PV Energy
- 134.89 kWh

Portfolio CO2 Offset
- 22.99 t

Systems
- 8

Distribution Grids
- 5

End-Consumers
- 419

PV Generation

- Banova: 82 kWh
- Biringan City: 70 kWh
- Camelot: 81 kWh
- El Dorado: 166 kWh
- Elionov Rog: 169 kWh
- Garden of Eden: 102 kWh
- Garna Voda: 130 kWh
- Shangri-La: 233 kWh
Portfolio Level - Overview
# Dashboard Examples

## Portfolio Level – Operational State

<table>
<thead>
<tr>
<th>Site</th>
<th>Generation</th>
<th>Battery</th>
<th>Output</th>
<th>Metering</th>
<th>Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banovo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biringan City</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Camelot</td>
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<tr>
<td>El Dorado</td>
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<td>Elonov Rog</td>
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</tr>
</tbody>
</table>

- **Connection**
  - Last connection: 1.20 min
  - Last connection: 54.09 s
  - Last connection: 59.10 s
  - Last connection: 1.16 min
  - Last connection: 1.82 min
## Portfolio Level - KPIs

<table>
<thead>
<tr>
<th>Site</th>
<th>Generation</th>
<th>Battery</th>
<th>Grid</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ASG (kWh/day)</td>
<td>REF (%)</td>
<td>Avg SoC (%)</td>
<td>Min SoC (%)</td>
</tr>
<tr>
<td>Banovo</td>
<td>12.20</td>
<td>100.00%</td>
<td>85</td>
<td>61</td>
</tr>
<tr>
<td>Biringan City</td>
<td>10.24</td>
<td>100.00%</td>
<td>88</td>
<td>59</td>
</tr>
<tr>
<td>Camelot</td>
<td>11.90</td>
<td>100.00%</td>
<td>88</td>
<td>70</td>
</tr>
</tbody>
</table>
System Level – Overview
Dashboard Examples

System Level – Operational State
Dashboard Examples

System Level – Operational State

[Image of a dashboard displaying system level operational state data]
Dashboard Examples

System Level – Distribution Grid