

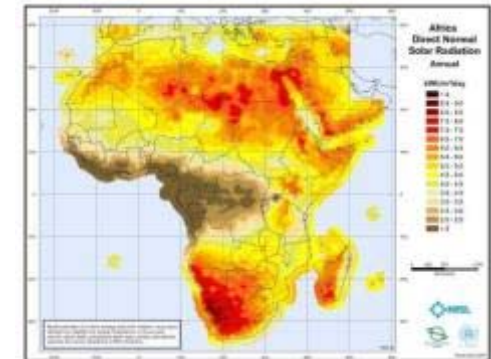


Overview of Performance Monitoring and NREL's Quality Assurance Framework

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Power Africa Beyond the Grid Program Support Summary

- **Summary:** NREL is supporting Power Africa's Beyond the Grid Program with developing 8-10 million new electrical connections from mini and micro grids focused on implementing the QAF
- **Specific Support Areas**
 - Technical assistance to developers
 - Publication of reports to support micro-grid stakeholders
 - Support to government entities to develop the enabling environment



Quality Assurance Framework

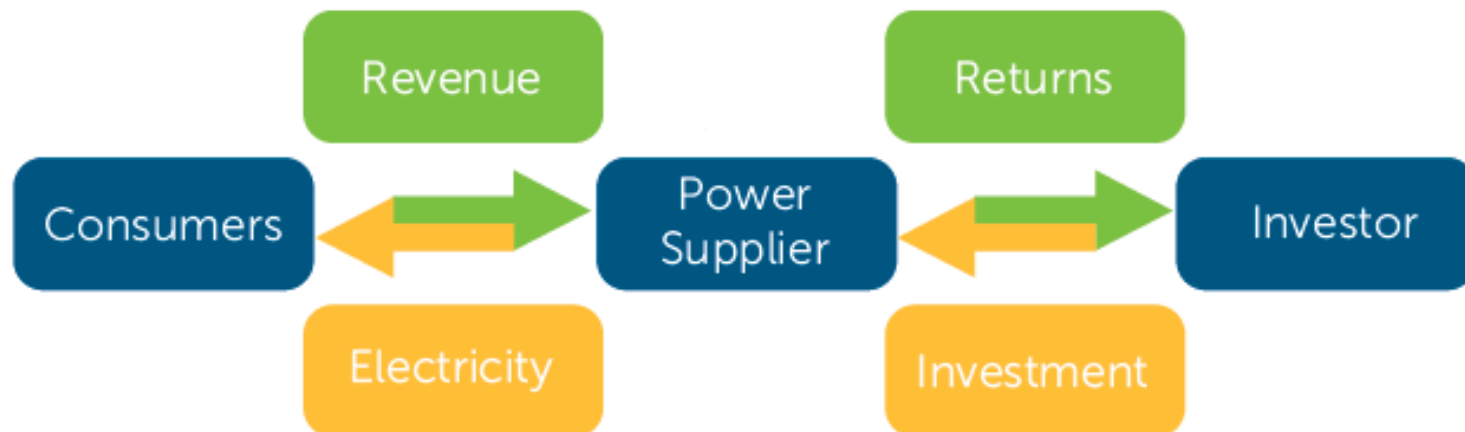
- **Purpose:** Provide structure and transparency for mini/micro-grid sector, based on successful utility models, while reflecting the broad range of service levels required to meet the needs of various segments of the off-grid consumer base
- **Importance:** Help lay the foundation for successful business models in the mini/micro-grid space



The Utility Model

Business models for commercially viable utilities must address the needs of the three key stakeholder groups:

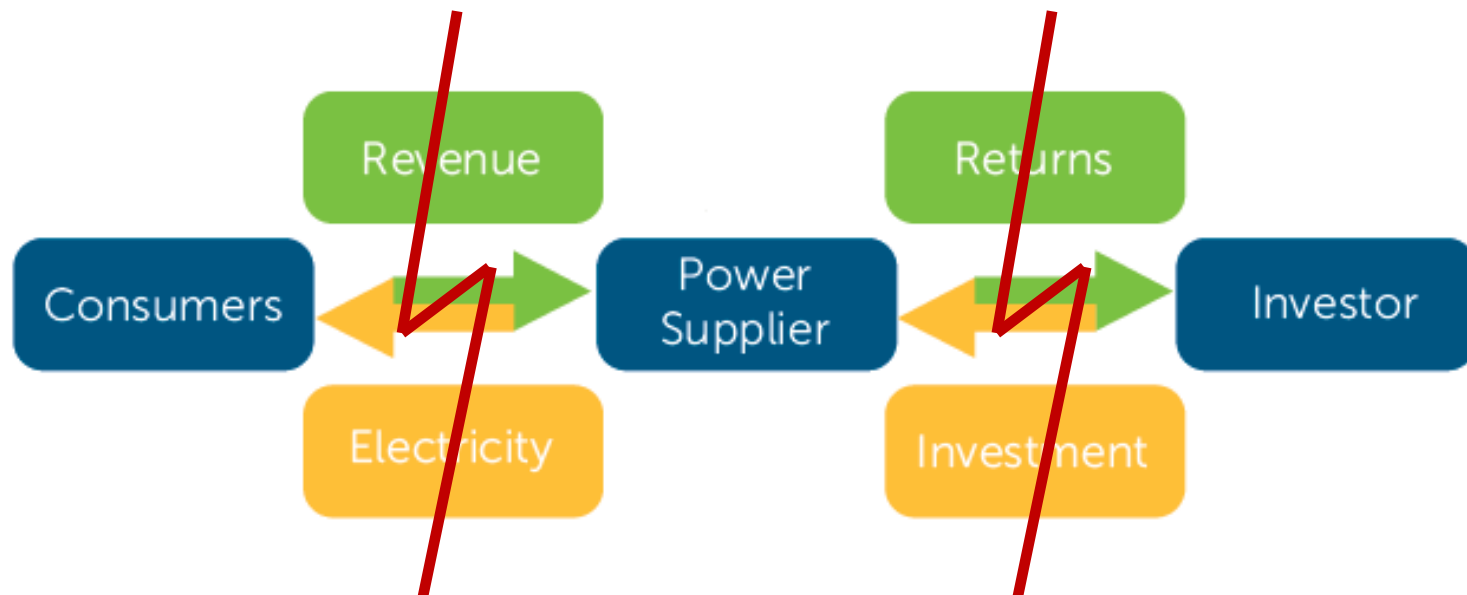
- **Customer:** Need a guarantee of useable service that they can afford and are willing to pay for
- **Power Suppliers:** Need to guarantee a rate of return to their investors while covering operational costs
- **Investors:** Need to understand and be confident of the risks they are taking



The Mini-grid “Utility” Model

Utility model breaks down in the case of rural electrification as a result of three main challenges:

- High cost of power provision to remote customers
- Lack of consistent cash flows from customers
- Poorly understood investment risk profile



Elements of a Quality Assurance Framework for Minigrids

1. Define levels of service

- Tailored to different tiers of consumer need and ability to pay, including reasonable thresholds for:
 - Power quality
 - Power availability
 - Power reliability

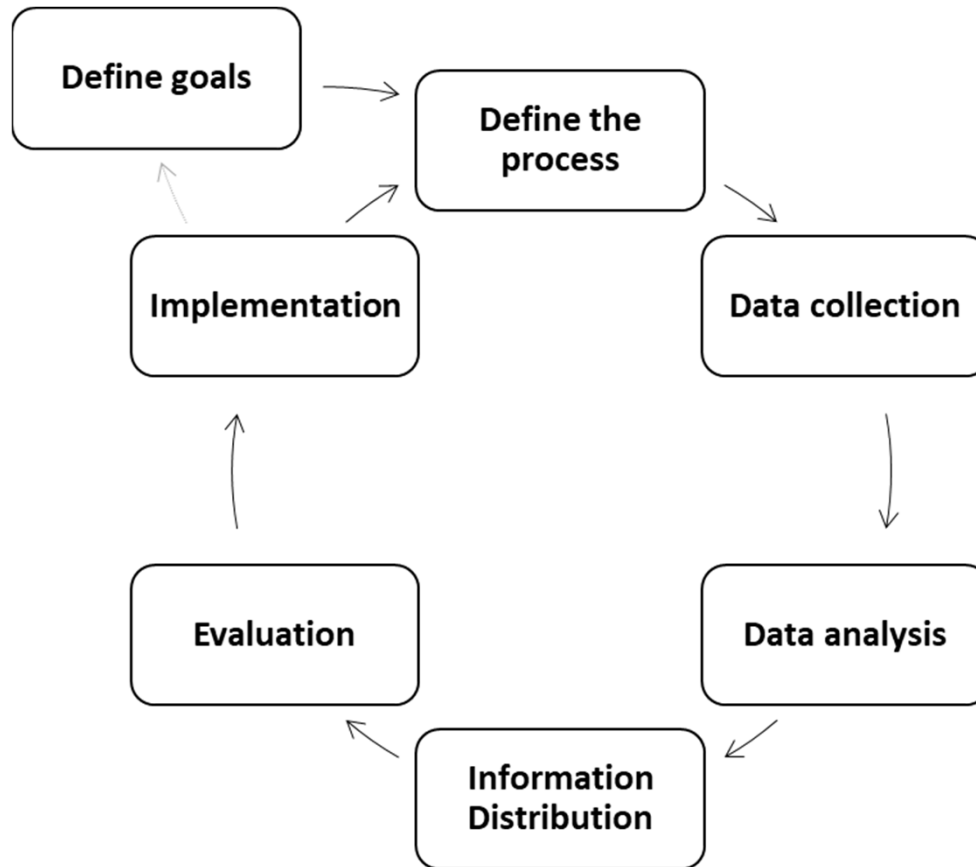


2. Define accountability framework

- Provides defined assessment, monitoring and reporting protocol for operators to improve transparency and sustainability
- Clear process for verification service delivery through trusted information to consumers, funders, and/or regulators



Performance Monitoring Process



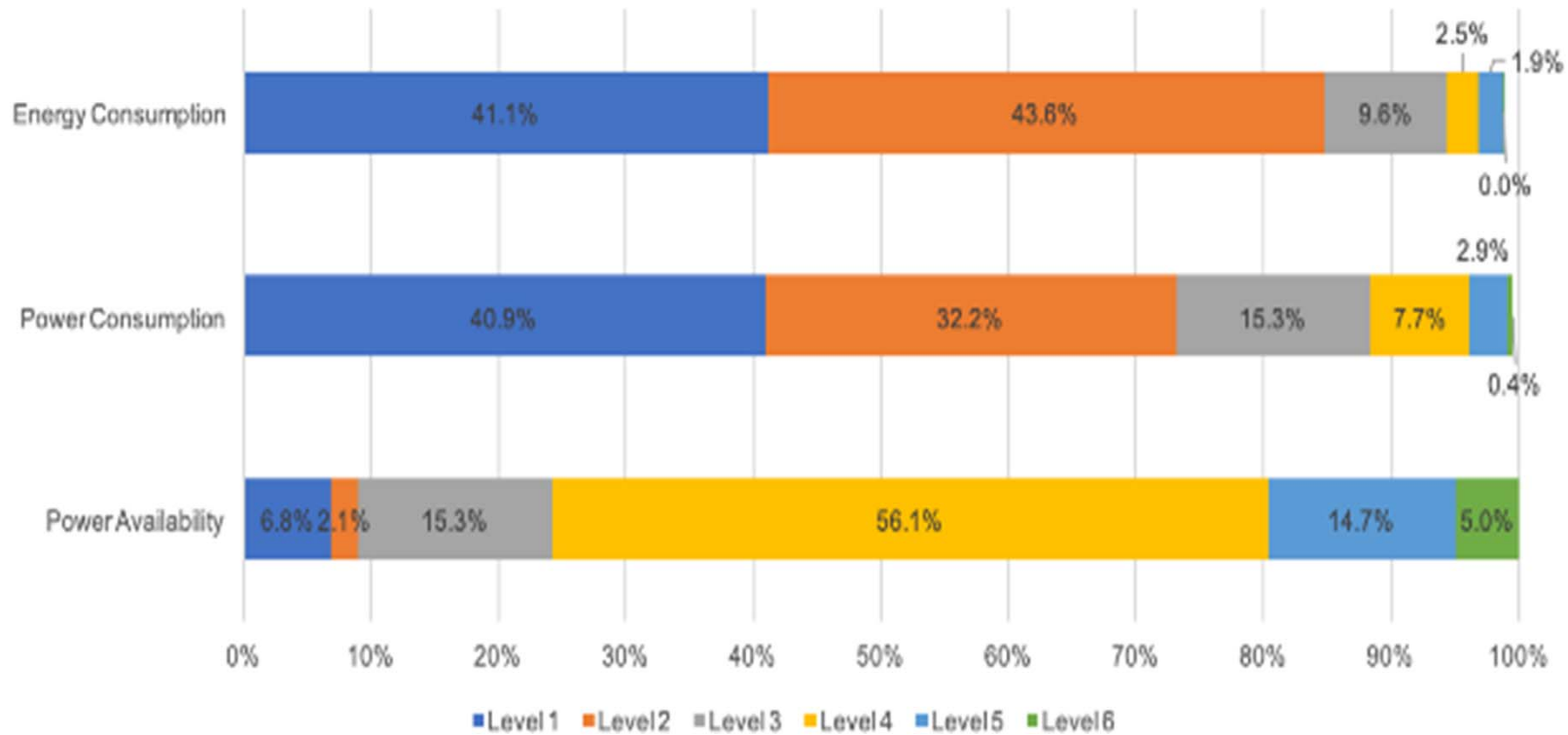
Example: Power and Energy

1. **Power:** Maximum draw in Amps or Watts
2. **Energy:** Total energy available (kWh) over a defined time period (month, year)

LEVEL OF SERVICE	QAF LABEL	DEFINITION
1	Level 1	peak power > 3 W
2	Level 2	peak power > 50 W
3	Level 3	peak power > 200 W
4	Level 4	peak power > 800 W
5	Level 5	peak power > 2,000 W
6	Level 6	peak power > 5,000 W

LEVEL OF SERVICE	QAF LABEL	DEFINITION
1	Level 1	> 4.38 kWh/year
2	Level 2	> 73 kWh/year
3	Level 3	> 365 kWh/year
4	Level 4	> 1,250 kWh/year
5	Level 5	> 3,000 kWh/year
6	Level 6	> 73,000 kWh/year

Example Analysis: Power and Energy

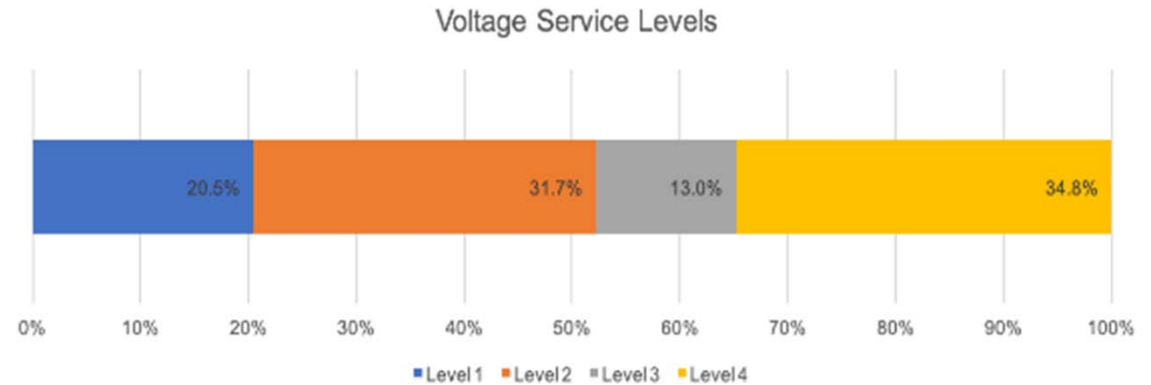


Level of power availability is generally higher levels of consumption

Example: Voltage Service Level and Importance of Definitions

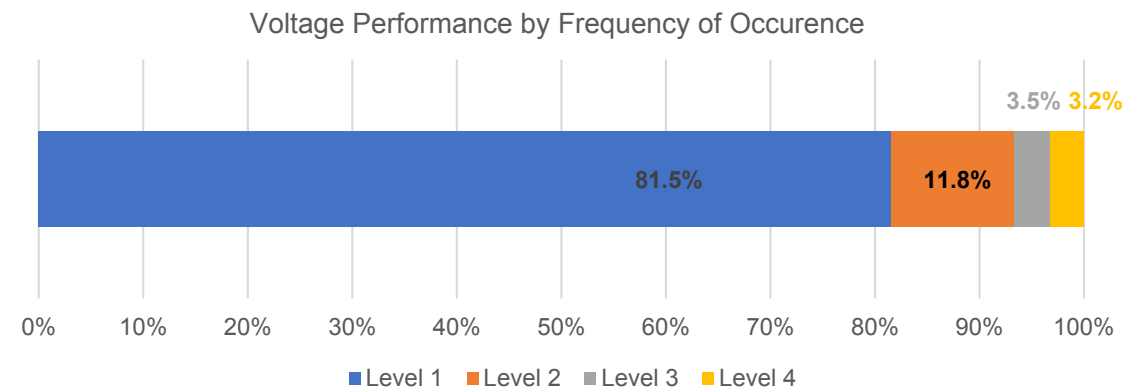
QAF Voltage Service Level Definitions (worst performing day)

LEVEL OF SERVICE	QAF LABEL	DEFINITION
1	High	<1 disturbance / day
2	Standard	<5 disturbances / day
3	Base	<10 disturbances / day
4	-	≥10 disturbances / day

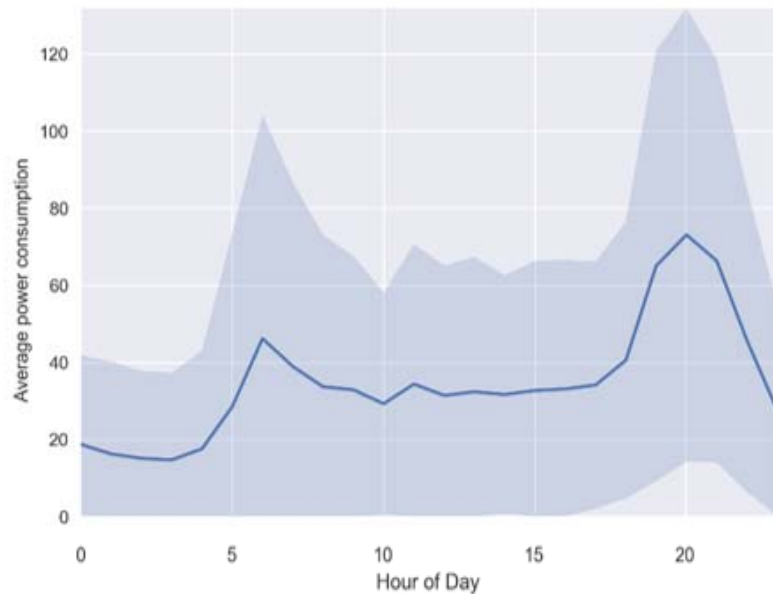
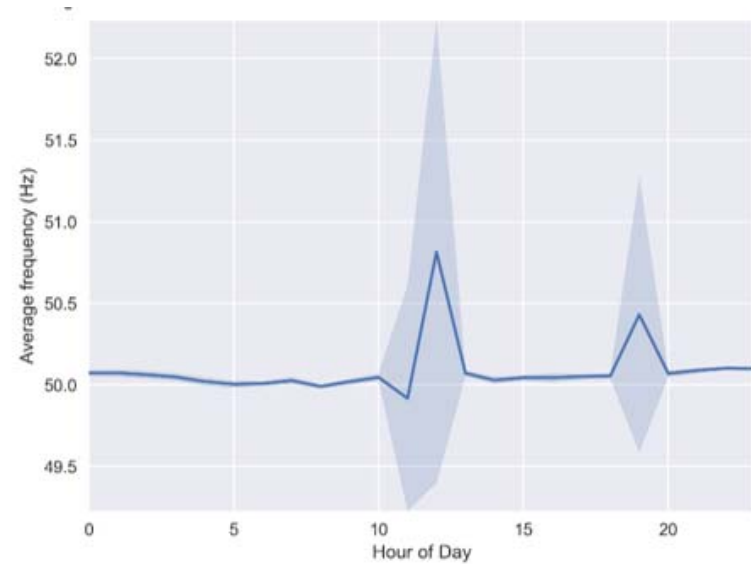
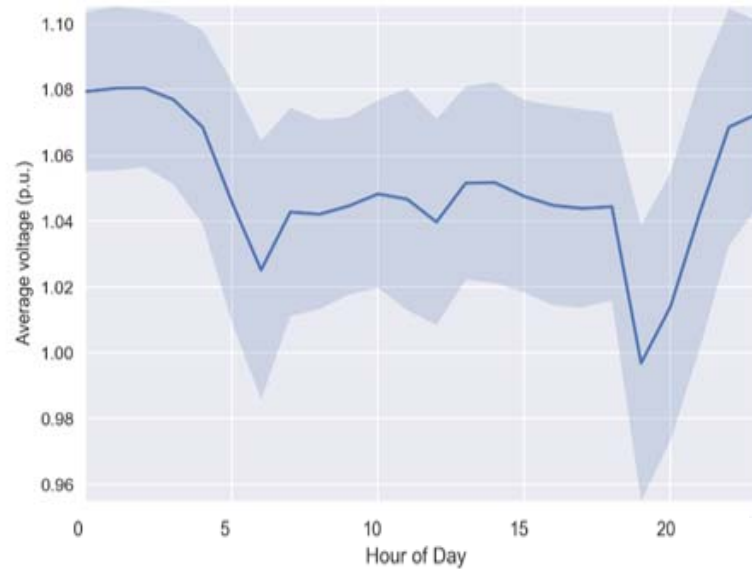


Modified Voltage Service Level Definition (daily performance)

LEVEL OF SERVICE	DEFINITION
1	No voltage violations
2	1 – 4 violations per day
3	5 – 9 violations per day
4	10+ violations per day



System Level Performance Monitoring



Example insights and actions

1. Consistently high voltage, review/adjust generator setpoints
2. Frequency spikes investigate loads during these periods
3. Explore opportunities to shift load to middle of the day

Load Level Monitoring for Productive Uses of Energy

Load Profiles



Business Case for Egg Incubator

VARIABLES	VALUES	UNITS
Size of incubator	100	eggs
Power rating of incubator	100	Watts (W)
Capital Cost	122	\$
Amount of power consumed per day	2.4	kWh/day
Operational hours	24	hours/day
Operational days per month	21	days
Tariff	0.90	\$/kWh
Cost of power	45	\$/month
Avg. Expenses per month (including electricity)	83	\$/month
Avg. Revenue of sales per month	125	\$/month
Net profit	42	\$/month
Profit Margin	34%	
Simple payback	3	months

Better understand opportunities for load growth, business cases, and impacts

Resource List

- **Tarif Considerations**
 - <https://www.nrel.gov/docs/fy18osti/69044.pdf>
- **Productive Use**
 - <https://www.nrel.gov/docs/fy18osti/71663.pdf>
- **Financial and Operational Bundling**
 - <https://www.nrel.gov/docs/fy19osti/72088.pdf>
- **Customer Agreements**
 - <https://www.nrel.gov/docs/fy18osti/70777.pdf>
- **Quality Assurance Framework (multiple documents)**
 - <https://www.cleanenergysolutions.org/qaf>
- **Coming soon:**
 - Performance monitoring
 - Battery selection
 - Surveys for demand prediction



Thank You!

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www.cleanenergysolutions/org/qaf

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