STUNTECH
Engineering & Management

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SOLAR OFF-GRID ENERGY SOLUTIONS

Introduction

Electricity is a critical component of modern society as it powers everything from homes, farms, cars, industries, etc. Sources of electricity in Kenya: Hydro-electric, geo-thermal, thermal, wind and solar. Access to electricity here in Kenya is majorly by:

- Connectivity to the grid- KPLC
- Off-grid PV system- Solar

How off-grid PV systems work

Solar energy is harvested using photovoltaic (PV) modules, commonly referred to as solar panels, during the period when sunlight is available. This energy is used to power the loads and also to charge the batteries. The energy is stored in the batteries during peak "sun-hours" will be used to meet the load requirement when sunlight will not be available i.e. at night.

The major system components are:

- PV modules (solar panels)
- Inverter charger
- Battery Energy Storage System
- Balance of system components

PV Modules

This is the component of a solar system that outputs DC electricity as a result of exposure to sunlight. The number of modules is determined by a combination of factors including: energy needs, availability of space, geographical location, etc.

Inverter charger

This component pulls DC output power from the solar panels and converts it to AC to enable utilization by the home appliances. The inverter is sized according to the following factors: load requirements, PV output, geographical location, future expansion, etc.

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Battery Energy Storage Systems (BESS)

This is a type of energy storage system that uses batteries to store electrical energy from sources such as solar or wind power. The stored energy is used to meet the load demand for the period when sunlight is not available. The battery technologies in the Kenyan market currently are:

- Super-capacitor based energy storage
- Lithium ion battery
- Lead acid battery

Comparison between lithium-ion battery and lead-acid battery

Assumptions

- Energy requirement- 5kWh

Properties of Lithium ion vs Lead acid battery

S.No	Item Description	Super-capacitor	Lithium Ion	Lead Acid
i.)	Depth of discharge (DoD)	100%	100%	50%
ii.)	Lifespan	More than 35 yrs	More than 15 yrs	Between 2 to 3 years

Battery size comparison (considering the respective permissible DoD as shown above)

S.No	Energy requirement	Super-capacitor	Lithium ion battery required	Lead acid battery required
1.	5kWh	5kWh	5kWh	10kWh

Price comparison, per kWh

S.No	Item Description	Super-capacitor	Lithium Ion (Kes)	Lead Acid (Kes)
1.	Approximate price per kWh	97,000	60,000	16,500

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Total cost of ownership comparison – over 15 year period

Calculations are based on the price comparison in the table above

Battery type	Battery size required (kWh)	Approx. Price per kWh	Total price	Battery life span (years)	Desired battery lifespan	Number of replacements	Total cost of ownership during 15 year period
Lead acid	10	16,500	165,000	3	15	4	825,000
Lithium ion	5	60,000	300,000	15	15	0	300,000
Super-capacitor	5	97,000	485,000	35	15	0	485,000

Conclusion

1. Lithium ion batteries are **cheaper** in the long term
2. Lead acid batteries are 2.75 times more expensive than Lithium ion batteries

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The End