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EXAMPLE ENERGY ANALYSIS FOR A SOLAR MILLING CENTER **PROPOSAL IN SAHEL**

SYSTEM DESCRIPTION

It is proposed a PV off-grid solar systems to supply the following loads in Sahel belt:

1. Main load demand: a solar mill machine to grind cereals (productive use). Usage: 6h a day, full use.
2. Secondary loads: supply of a power line 230V for secondary loads such as fridge, phone charging, security lights... 24h / 7 days service upon load profile.

System configuration proposed is a PV mini-grid system that supply energy to the mill (main load) but also provides energy to side appliances 230V and charging a battery bank.

Through the hybrid all-in-one inverter proposed, direct solar radiation is used to drive the mill and deviating surplus energy to the battery bank.

The system is very efficient due any single watt the PV array produces is taken and used by the system. System can be backup also with a genset if required.

SYSTEM MAIN COMPONENTS

- PV ARRAY: Solar modules, 10 units 440Wp each.
- Hybrid PV inverter: all-in-one battery and PV Inverter 6kW rated power.

- Battery bank: 4 blocks 12V/180Ah, high temperature use.
- Zebra mill, a 2,2kW electrical mill machine.
- Electrical board with two power lines: for mill machine and 230V distribution.

SYSTEM DIAGRAM



SYSTEM PROPOSED ENERGY ANALYSIS

- PV power installed = $10 * 440\text{Wp} = 4400 \text{ Wp}$
- Average daily energy production including power losses = 24 kWh/day
- Average energy usage per day:
 - o ZEBRA MILL: $6 \text{ hours} * 2,2\text{kWh} = 13,2 \text{ kWh/day}$
 - o Secondary loads: $24 - 13,2 = 10,8 \text{ kWh/day}$
- Example of a secondary loads line usage:
 - o 1 x fridge $150 \text{ Wh} * 12 \text{ Hours} = 1800 \text{ Wh/day}$
 - o 1 x Freezer $300 \text{ Wh} * 12 \text{ Hours} = 3600\text{Wh/day}$
 - o 2 x lights $13\text{Wh} * 6\text{h} = 156 \text{ Wh/day}$
 - o 2 x security light $13\text{Wh} * 6 \text{ h} = 156 \text{ Wh/day}$
 - o 1 x fan $120\text{Wh} / 8\text{h} = 960 \text{ Wh/day}$

- 1 x Phone charging station (0,2Wh x 15 phones x 6 hours):
18Wh/day
- Total estimated wattage Secondary loads: 6690 Wh/day (6.7 kWh/day)
of which 60% can be used from battery: 4 kWh
- Battery capacity = 12V * 180Ah * 4 units = 8.6 kWh
- Usable battery capacity = 5.18 kWh (60% of total battery bank capacity).
- PV System production forecast:

Summary

Provided inputs:	
Location [Lat/Lon]:	15.377, -12.123
Horizon:	Calculated
Database used:	PVGIS-SARAH
PV technology:	Crystalline silicon
PV installed [kWp]:	4400
System loss [%]:	2
Simulation outputs:	
Slope angle [°]:	15
Azimuth angle [°]:	0
Yearly PV energy production [kWh]:	8833626.44
Yearly in-plane irradiation [kWh/m ²]:	2389.83
Year-to-year variability [kWh]:	106914.62
Changes in output due to:	
Angle of incidence [%]:	-2.54
Spectral effects [%]:	0.13
Temperature and low irradiance [%]:	-12.17
Total loss [%]:	-15.99

Monthly energy output from fix-angle PV system

