INSTITUTE OF AGRICULTURAL ENGINEERING
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Use of real-time load profile measurement to optimize photovoltaic systems dimensioning in shea butter production

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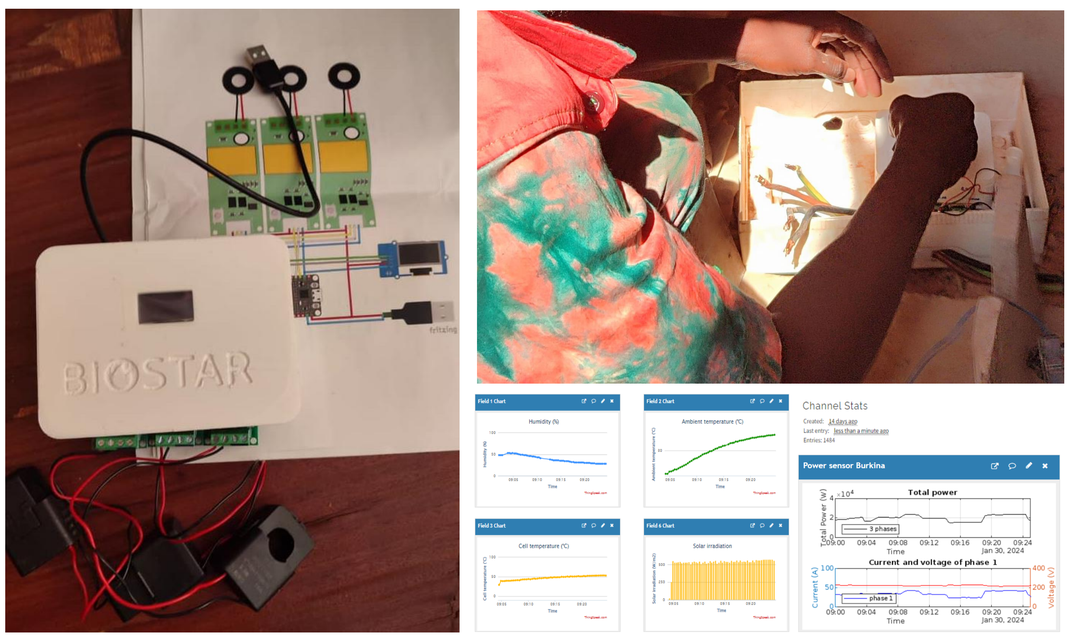
Problem and Objective

- Accurate energy consumption data is crucial for correctly sizing solar power systems, in resource-constrained regions like Sub-Saharan Africa.
- Traditional sizing methods overestimate requirements making systems costly and lack accuracy in dynamic consumption patterns.
- Shea butter production in Sub-Saharan Africa is transitioning from traditional methods to mechanical presses for extraction.
- The study develops a remote measurement system to monitor power consumption in a shea butter production facility in Burkina Faso for photovoltaic sizing.

Material and Methods

- The system developed comprises two Arduino based devices: a weather station and a power sensor. Solar irradiation, ambient temperature, relative humidity, and active power, voltage, current, frequency and power factor were recorded.
- Data were transmitted to an online platform via a Wi-Fi network over a two-month period.



- Sizing was performed using HOMER Pro software (UL Solutions, Boulder, USA), incorporating the measured load profile, meteorological data, and solar component costs to identify the most cost-effective photovoltaic system for the facility.

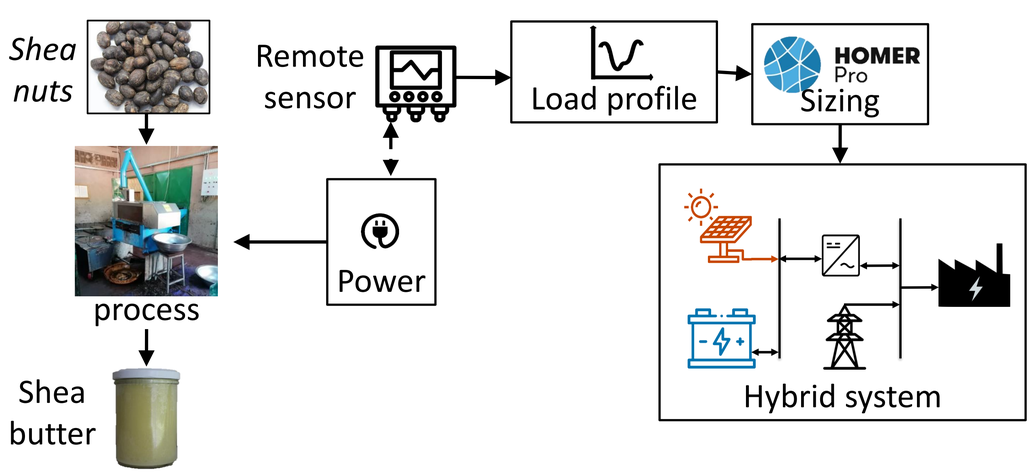


Fig. 1. Hybrid system sizing approach through remote sensor of load profile

Results

- The monitored load profile allowed matching different operation mode on the production unit (Fig. 2).

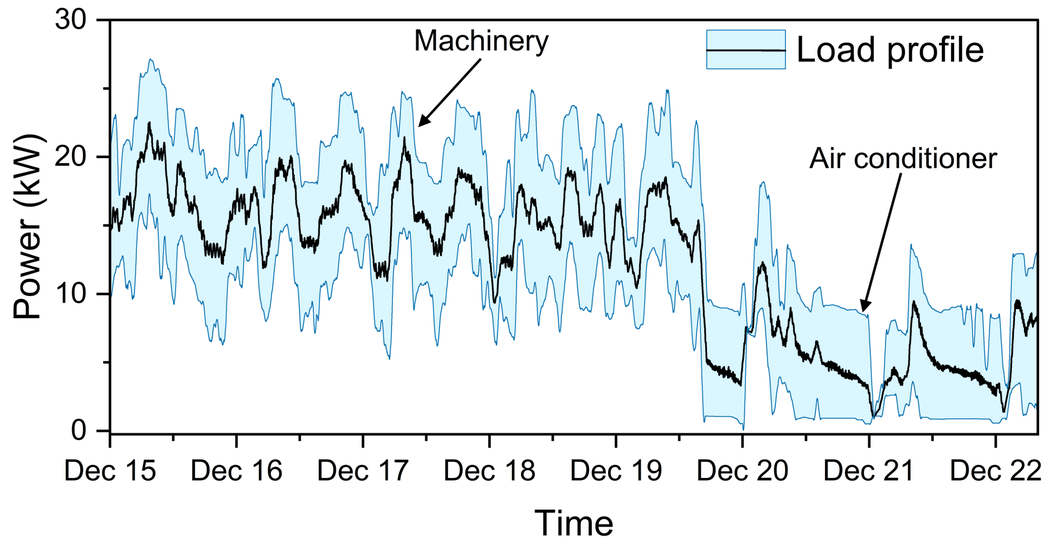


Fig. 2. One week of measured load profile via remote sensor

- Most cost-effective are hybrid grid/PV solutions

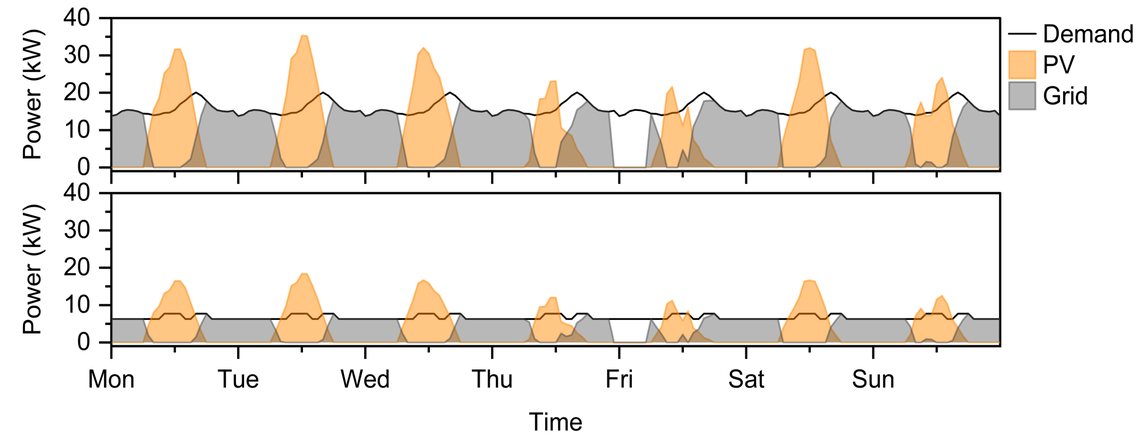


Fig. 3. One week of production under remote measurement based approach (top) and estimated by electricity bills (bottom)

- Conventional sizing procedure based on monthly electricity bills shows underestimation (Fig. 3, bottom).

Table. 2. Characteristics of the compared solution

	Grid only	Estimated	Measured
PV/Battery	-	20 kWp	39 kWp
Net present cost (CFA)	155M	78M	134M
Initial cost (CFA)	-	10.0M	18.4M
Operation cost (CFA/year)	8.0M	3.5M	6.0M
Cost of energy (CFA/kWh)	114.1	111.0	98.0

Conclusion

- The results showed that the optimal solution consists of a grid-connected system with solar panels with 35% renewable fraction and a payback period of 8 years.
- This research highlights the potential of affordable measurement tools in developing sustainable energy solutions for small and medium-sized enterprises (SME).

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