

TIEC4.0 Poster Title

Name: LUMAQ: Smart Energy Gateway Affordable Multi-Source Energy Monitoring for Off-Grid Nigeria

Affiliation : Dept. of Mechatronics Engineering, FUT Minna, Niger State

Proposed Solution

Nigeria's energy deficit costs SMEs an estimated ₦600B annually in generator fuel. Over 90 million citizens lack reliable electricity, yet existing energy monitors cost ₦720,000+, are built for industrial settings, and cannot track solar, battery, and grid sources simultaneously on one affordable device.

LUMAQ is a locally manufacturable smart energy gateway priced below ₦72,000. It monitors voltage, current, power, and temperature across three energy sources in real time, displays live readings on a built-in LCD, and transmits data wirelessly to a remote dashboard. Faults are detected and flagged automatically.

Technical Design

Arduino Mega 2560 (MCU) paired with ACS712 ×3 current sensors (solar/battery/grid), LM35 temperature sensor, 16×2 I2C LCD, and ESP8266 Wi-Fi module. Fully verified in Proteus 8 Professional.

- Arduino Mega 2560 — 54 digital I/O, central processing
- ACS712 ×3 — current sensing, ±30A
- LM35 — temperature, 0–100°C
- ESP8266 — Wi-Fi, 802.11 b/g/n Live test: Solar 18V / 2.1A | Battery 12.6V | Grid 220V



Fig. 1: LUMAQ Prototype v1 — custom enclosure with multi-source energy display

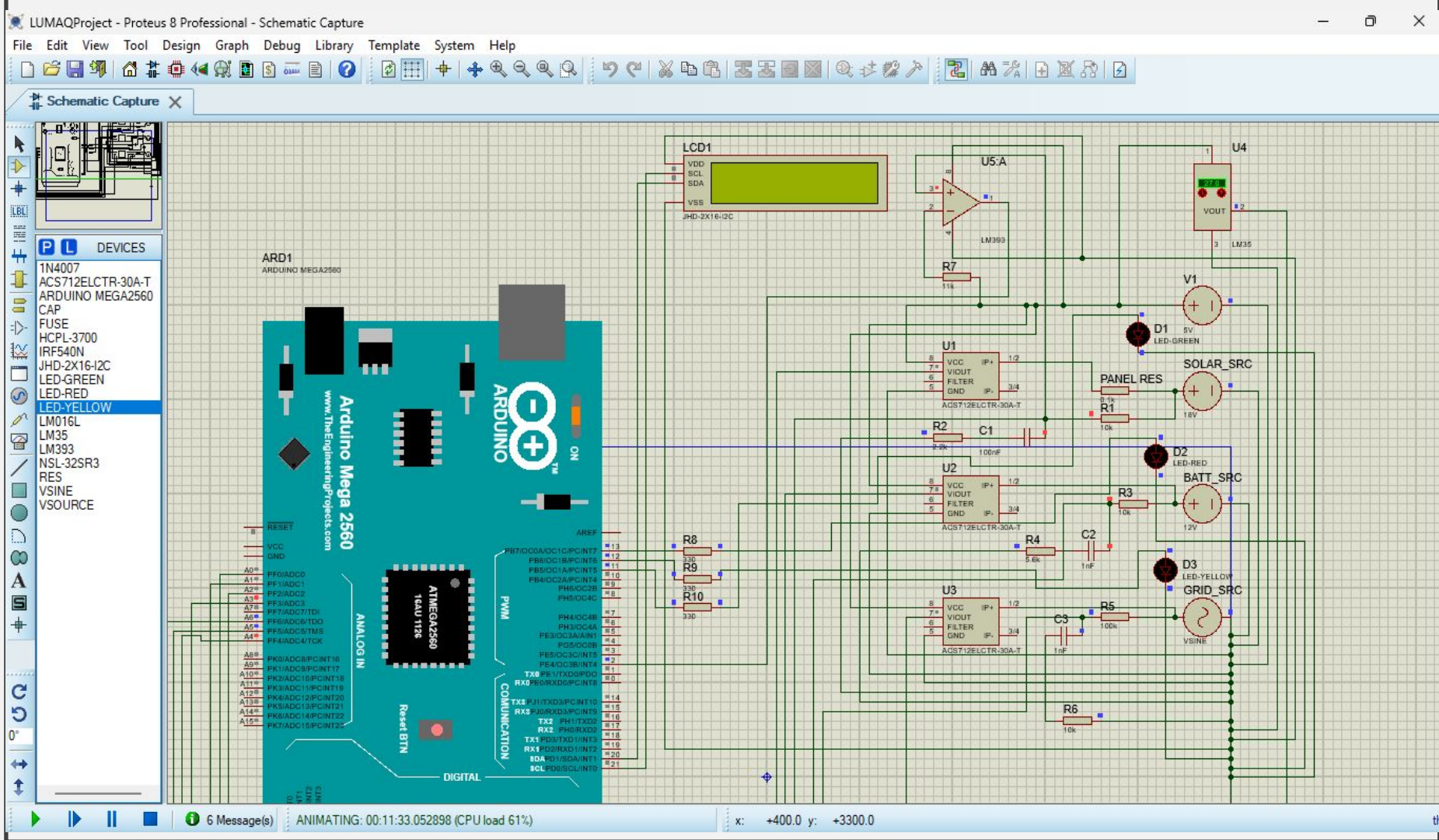


Fig. 2: LUMAQ Prototype v1 — Circuit schematic verified in Proteus 8 Professional

Economic feasibility/Proposed Business Model

BOM: <₦72,000 | Retail: ₦128,000–₦192,000 | Margin: 60–70%

Comparable solutions (Schneider EMS, SolarEdge): ₦720,000–₦3.2M+
LUMAQ delivers equivalent functionality at 10× lower cost, purpose-built for the Nigerian off-grid operator market. Nigeria's renewable energy capacity is projected to grow from 4.51 GW (2026) to 14.07 GW by 2031, creating strong demand for affordable monitoring infrastructure [2].

Revenue streams:

- Hardware sales — mini-grid operators, solar installers, NGOs
- SaaS dashboard — ₦2,500/month per site remote monitoring
- Data licensing — anonymised energy data to grid planners

Timeline for developing prototype/trial

- Q2 2026 Prototype v1 — Arduino + ACS712 ×3 + LCD complete
- Q3 2026 — ESP8266 Wi-Fi dashboard integration & firmware upgrade
- Q4 2026 — 5-unit campus pilot at FUT Minna mini-grid
- Q1 2027 — PCB miniaturisation & enclosure cost reduction
- Q2 2027 — 50-unit commercial production run
- Q3 2027 — West Africa market entry & scale

Budget & Target User/Market/Scale

Seed budget: ₦715,000 total — prototype materials (₦85,000), PCB fabrication batch ×10 (₦150,000), 5-unit pilot deployment (₦360,000), software & cloud infrastructure (₦120,000). Target users: off-grid households, mini-grid operators, SMEs running hybrid power systems, and NGOs delivering rural electrification. Nigeria's off-grid solar industry generated ₦3.5B revenue in 2024, with rapid growth forecast [1].

Scale: FUT Minna → Nigeria → West Africa → Pan-Africa.

References

- [1] Agosto & Co. Nigeria Renewable Energy Industry Report. Lagos; 2025.
- [2] Research & Markets. Nigeria Renewable Energy Market Analysis. Dublin; 2025. Available: researchandmarkets.com
- [3] Clean Technology Hub. Nigeria Energy Access Market Update 2023–2024. Abuja: CTH; 2025.
- [4] World Bank. Access to Electricity — Nigeria (SDG 7.1.1 Dataset). Washington DC: World Bank; 2024.
- [5] Allegro Microsystems. ACS712 Hall-Effect Current Sensor Datasheet (Rev. 22). Manchester NH: Allegro; 2024.

Acknowledgements

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