

Case Study: Off-Grid BESS Prototype Development (Pakistan)

GIBES INOV – Embedded R&D and Renewable Energy Innovation

Industry Overview

The renewable energy sector in Pakistan is rapidly expanding, with startups focusing on off-grid solutions. Reliable Battery Energy Storage Systems (BESS) are critical to:

- Demonstrate commercial viability to investors
- Enable energy storage and peak-shaving solutions
- Reduce development time for proof-of-concept prototypes

Client Background

A Pakistani renewable energy startup aimed to:

- Rapidly develop a reliable BESS prototype
- Implement a safe and efficient Battery Management System (BMS)
- Present a functional, investor-ready platform within a tight timeline

Key Metrics

Metric	Before GIBES INOV	After GIBES INOV
Development Cycle (BMS)	4 Months (internal attempts)	8 Weeks
Battery Management Reliability	Unverified, High risk	Verified, Over-current protection
Data Visualization	Console logs only	Real-time Web Dashboard

Challenges & Constraints

- Tight timeline to develop a fully functional BESS prototype.

- Need for robust battery safety algorithms including cell balancing and thermal management.
- Limited resources for hardware and firmware development.

GIBES INOV Solution Architecture

Hardware Setup

- Custom PCB design optimized for current path efficiency and thermal dissipation.
- ESP32 core controller providing integrated WiFi and cloud connectivity.

Control Logic

- Firmware in C/C++ implementing safety-critical algorithms: cell balancing, over-current protection, and thermal shutdown.
- Real-time monitoring for enhanced battery reliability and safety.

UI/Data Integration

- Lightweight web server hosted on ESP32 for local control and monitoring.
- Secure cloud MQTT connection enabling remote access and investor-ready dashboards.
- Real-time visualizations to demonstrate system performance to stakeholders.

Deliverables

- Production-ready PCB Gerber files.
- Verified firmware package with integrated safety features.
- Remote monitoring API and investor-ready dashboard documentation.

Implementation Timeline

- **Week 1–4:** PCB design, component sourcing, and firmware architecture.
- **Week 5–8:** Assembly, firmware deployment, testing, and remote dashboard setup.

Results & Impact

- Reduced development cycle from 4 months to 8 weeks.
- Delivered a fully operational, safe, and reliable BESS prototype.
- Investor-ready platform with real-time monitoring and cloud connectivity.
- Enabled rapid commercialization potential for the startup.

About GIBES INOV

GIBES INOV specializes in embedded R&D, custom electronics, and renewable energy solutions. Our focus is on rapid prototyping, safety-critical firmware, and measurable ROI for startups and industrial clients.