

PowerPod Lite

Rapid Deployment Mobile Microgrid for Disaster Relief Applications

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Hurricane Helene Flooding Damage, 2024

Problem

- Natural disasters damage critical power infrastructure
- Hurricane Helene (2024): 200,000+ residents lost power for up to 14 days
- Emergency power solutions rely heavily on fuel-based generators, requiring continuous fuel logistics
- Portable solar systems exist but are often expensive or not modular in design

Challenge: Emergency Power

Limitations of Existing Emergency Power Solutions:

Diesel Generator

70–90 dB noise
Emissions &
Maintenance Burden
Fuel Logistics Required

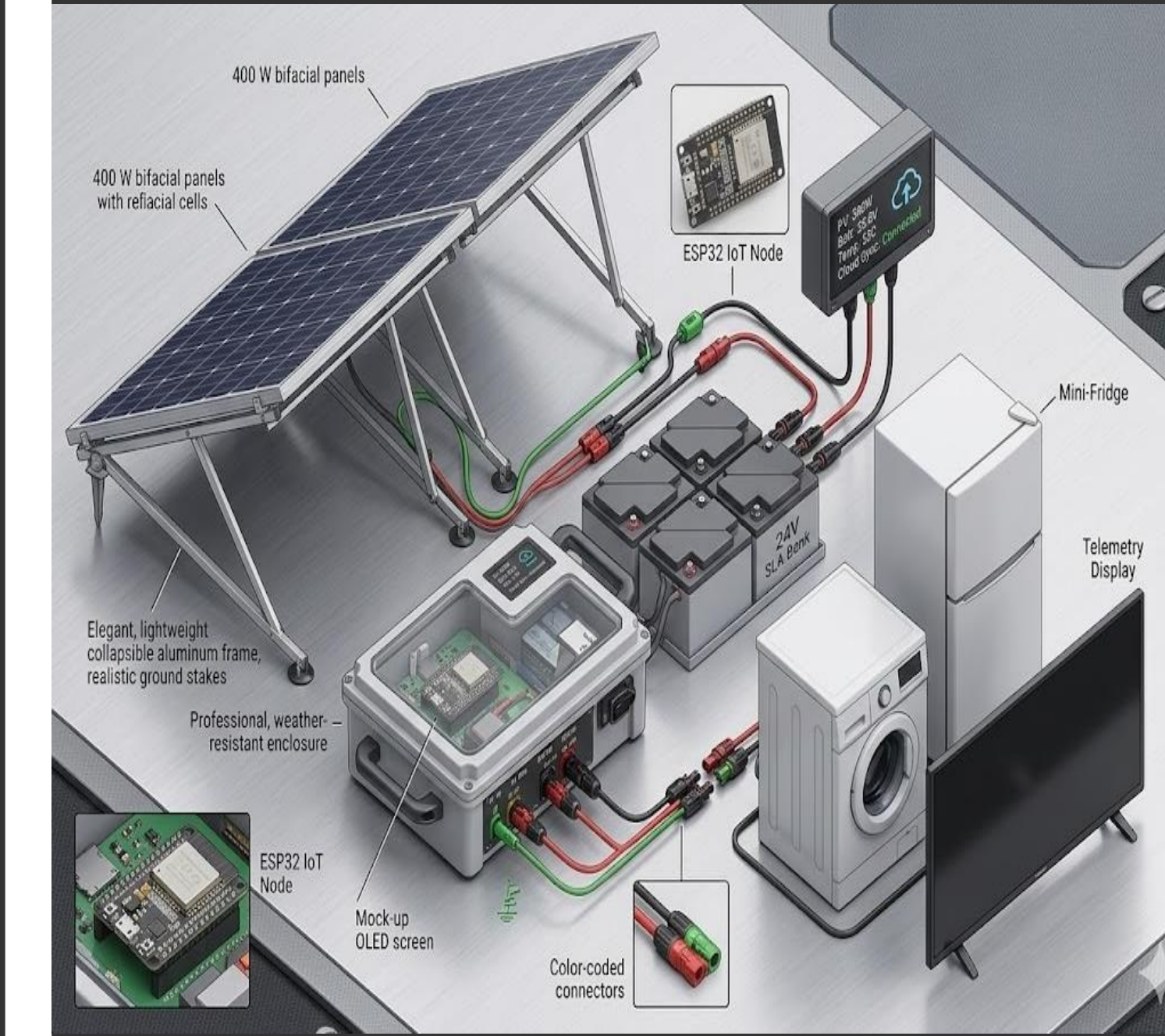
Commercial Portable Solar

Limited Scalability
Limited Field Serviceability

Fixed PV + Battery System

Expensive
Complex Install
NOT Portable

Solution: "PowerPod Lite"



PowerPod Lite system architecture

- Modular, portable DC-coupled solar microgrid
- 400 W continuous AC output
- <30 min deployment 2-person team
- Tool-free, color-coded electrical connections
- 400 W Bifacial PV + 24 V SLA battery
- ESP32 IoT monitoring & telemetry

System Specifications

400 W

PV
4 × 100 W
Bifacial
(2S2P)

840 Wh

Battery
24 V 35 Ah
SLA AGM

100 / 30

MPPT
Victron
SmartSolar

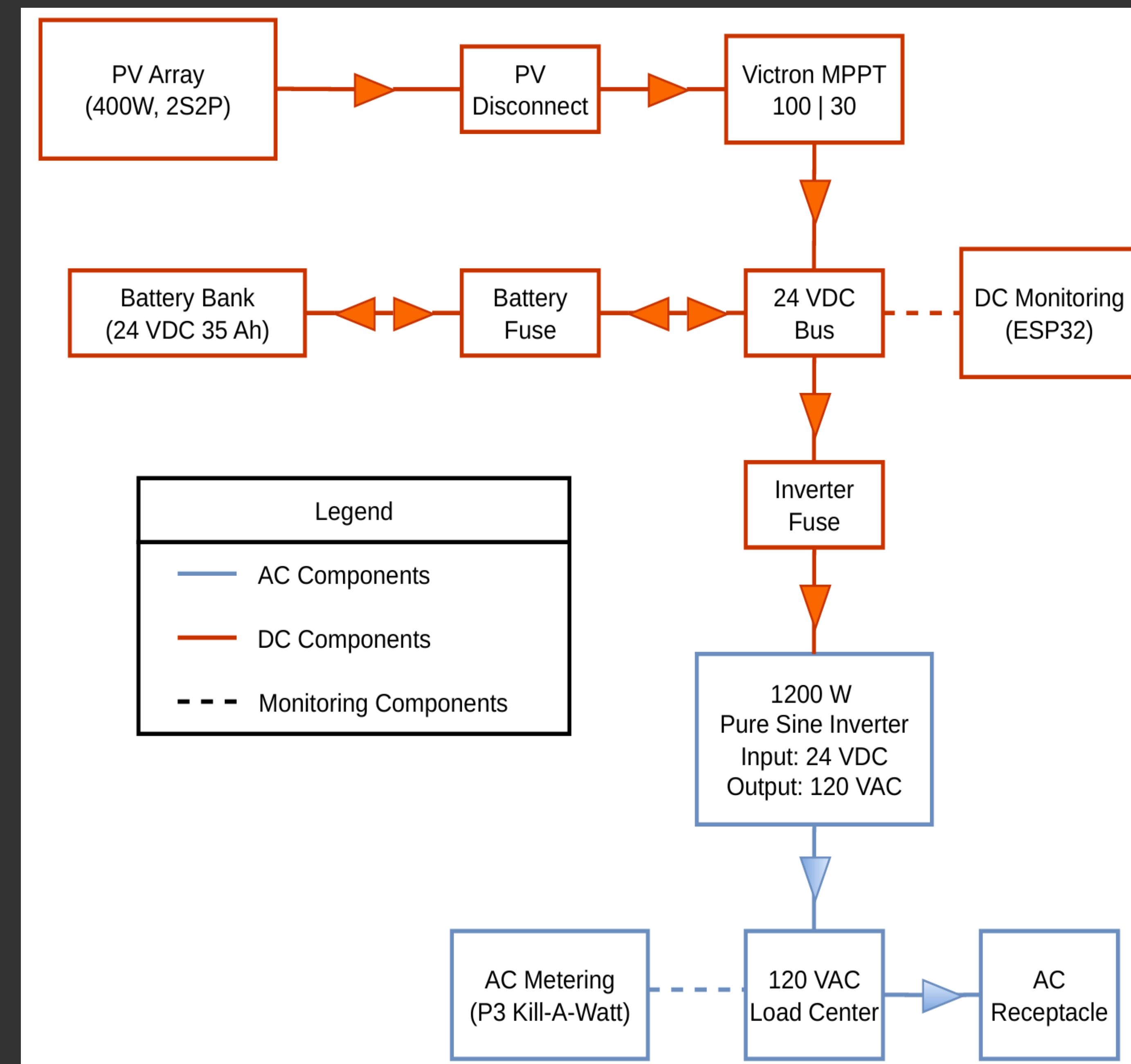
1200 W

Inverter
120 VAC,
Pure Sine
(2400 W surge)

ESP32

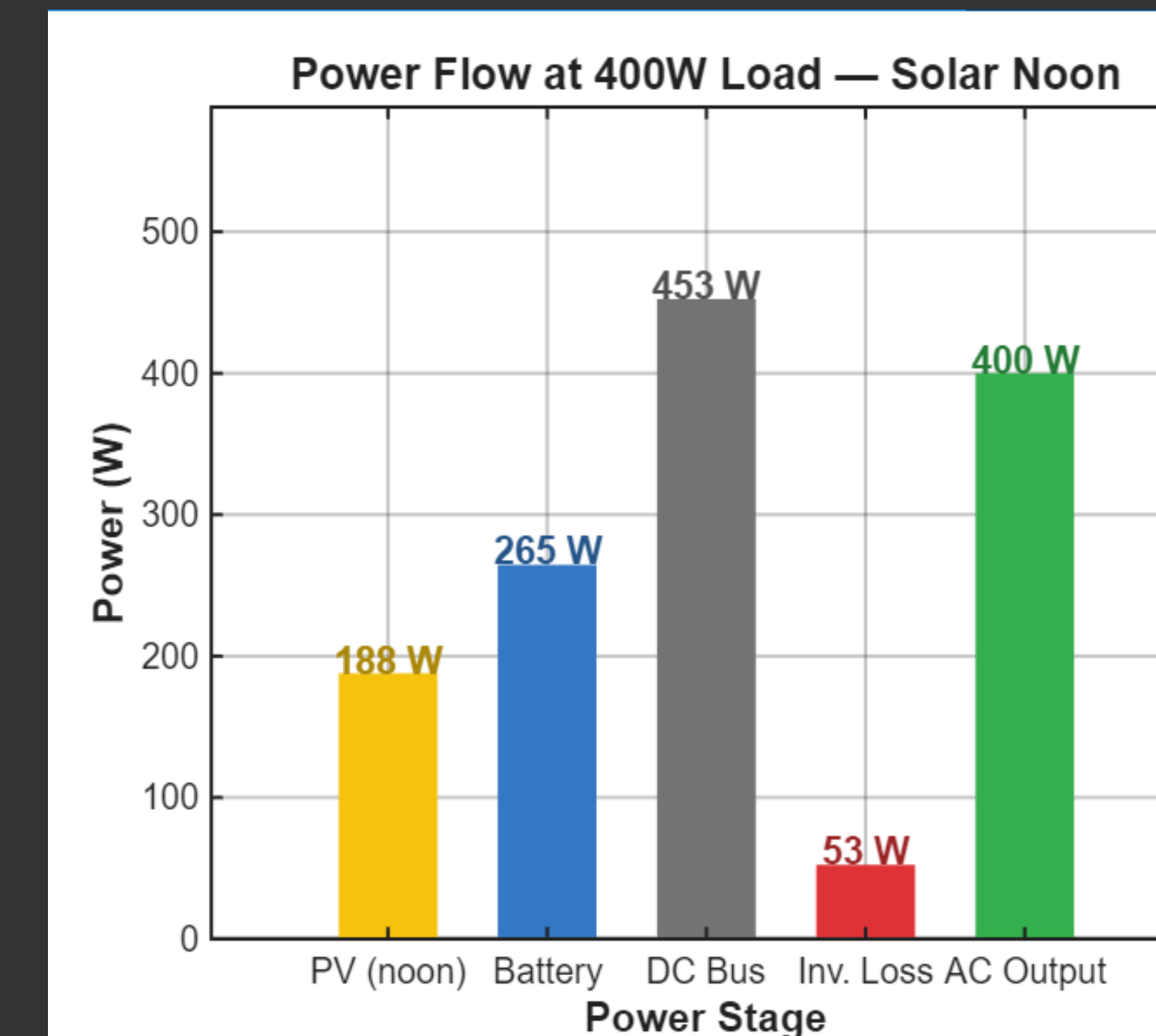
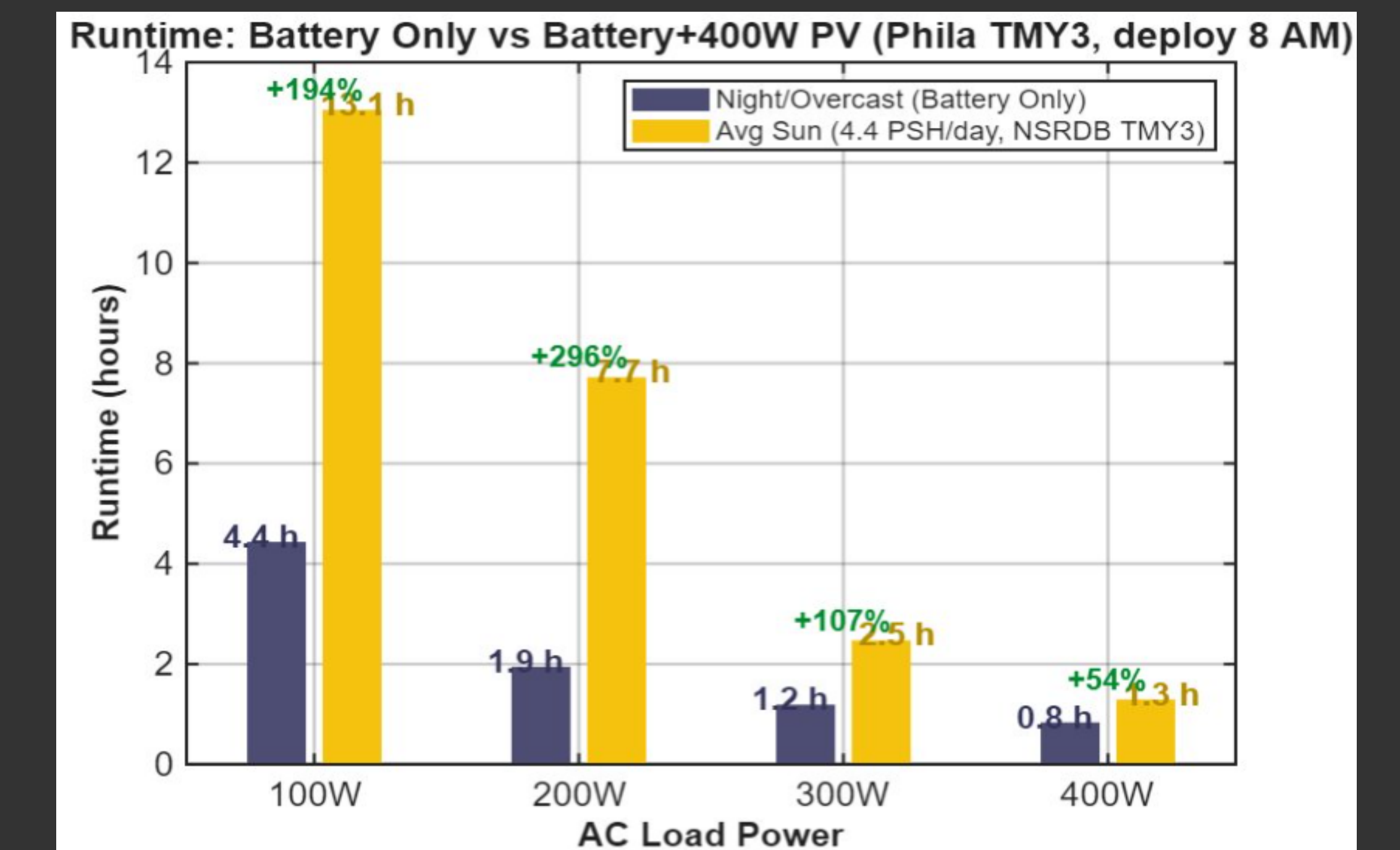
Monitoring
VE.Direct
Telemetry

Electrical Block Diagram



Note: Arrows indicate power flow

Simulation Results



Efficiency @ 400W (Noon Snapshot)

Inverter: $\eta = 88.4\%$
 Conv. loss: 44.4W + Standby: 8W
 MPPT: $\eta = 98\%$ (Victron SmartSolar)
 PV at noon: 188W (covers 42% of DC load)
 Battery: 265W

System $\eta = 87.4\%$

Daily PV: 1464 Wh (4.4 PSH)
 Daily load @400W: 10859 Wh
 Solar fraction: 13%

System Design Process

CONCEPT → EVALUATION → SIMULATION → PROTOTYPE

Four Candidate Architectures

MCDA Decision Matrix

MATLAB / Simulink Modeling

Hardware Implementation

Conclusion

PowerPod Lite demonstrates a low-cost (\$1.2k) portable solar-battery microgrid for emergency power. The system delivers 400 W continuous AC (800 W surge) with 83–86% efficiency. Simulations using Philadelphia NSRDB solar data show 0.8–4.4 h battery runtime, extended to 1.3–13.1 h with PV, providing quiet, zero-emission emergency power.