ESMO TOOL FOR TECHNO-ECONOMIC ANALYSIS AND OUTAGE MITIGATION IN RURAL MICROGRIDS

EL RITO WEST MICROGRID CASE STUDY

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PROJECT PROFILE

Topic: Demonstration Projects | Vertical: Grid Integration and Field Validation

Strategic Pathways: Optimize

Project start and finish: FY25 – FY26

PROBLEM

Background & Significance

- Kit Carson Electric Cooperative (KCEC) serves about 30,000 customers across **rural** northern New Mexico (area with high risk from wildfires).
- Three community microgrids are being upgraded with battery energy storage systems (BESSs) to strengthen **grid reliability and security** → Focus: El Rito West (ERW).
- KCEC's BESSs are resilience-first assets deployed to address **wildfire-driven outage risk**.

Objectives

- Quantify BESS economic value: tariff savings (via **peak load shaping**) + **outage mitigation**.
- Evaluate BESS economic value across multiple sizing configurations.

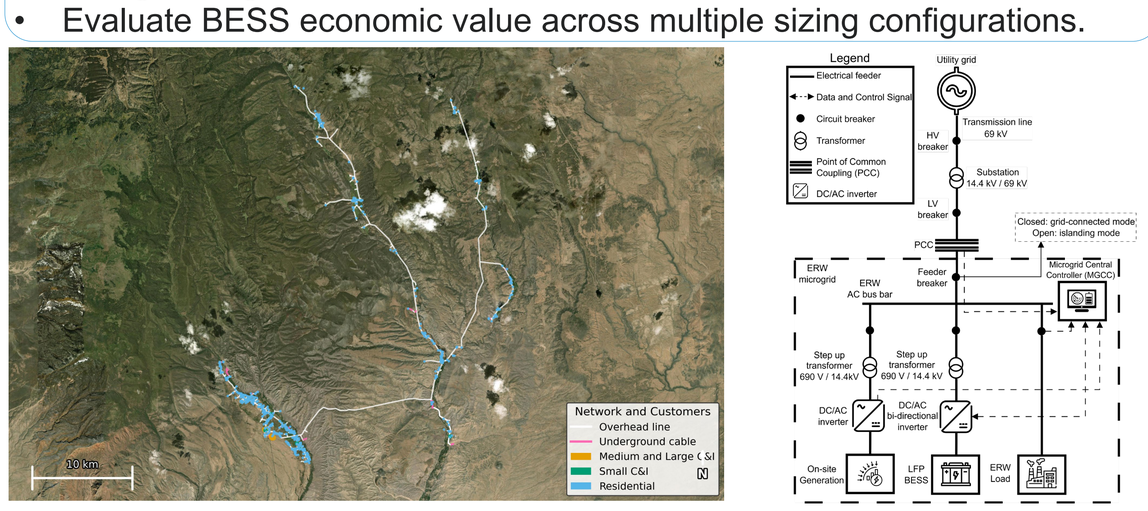


Fig. 1. ERW microgrid network: satellite view (left) and electrical scheme (right).

APPROACH

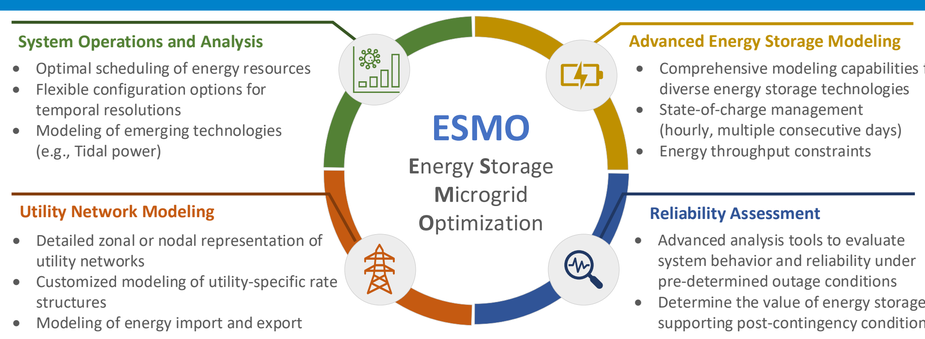


Fig.2. Energy Storage Microgrid Optimization (ESMO) framework [1].

Model Inputs

- 8760-hour load and Variable Energy Resource (VER) generation profiles.
- KCEC tariff structure, historical outage events, and microgrid network.
- Customer Value of Lost Load (VOLL) from ICE Calculator [2].
- Scenarios: 16 BESS configurations (0.75–1.5 MW × 2–8 h), RTE = 83%.

Stage 1 — Optimal Dispatch

- Microgrid modeled as islanded (VER generation + BESS serve all load).
- Objective: minimize monthly transmission and load-shaping charges.
- Output: hourly BESS schedule + monthly Energy Not Served (ENS).

Stage 2 — Contingency Analysis

- Input: historical outage events.
- Output: avoided outage costs monetized via VOLL.

Output

Annual BESS benefit = Stage 1 tariff savings + Stage 2 avoided outage costs

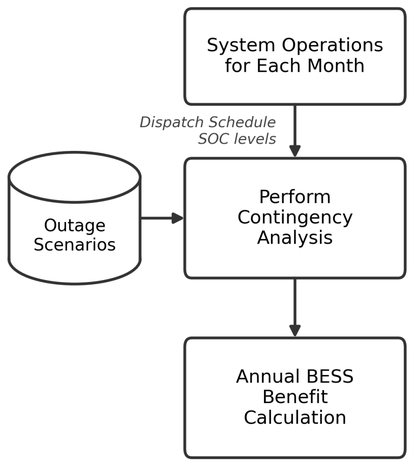
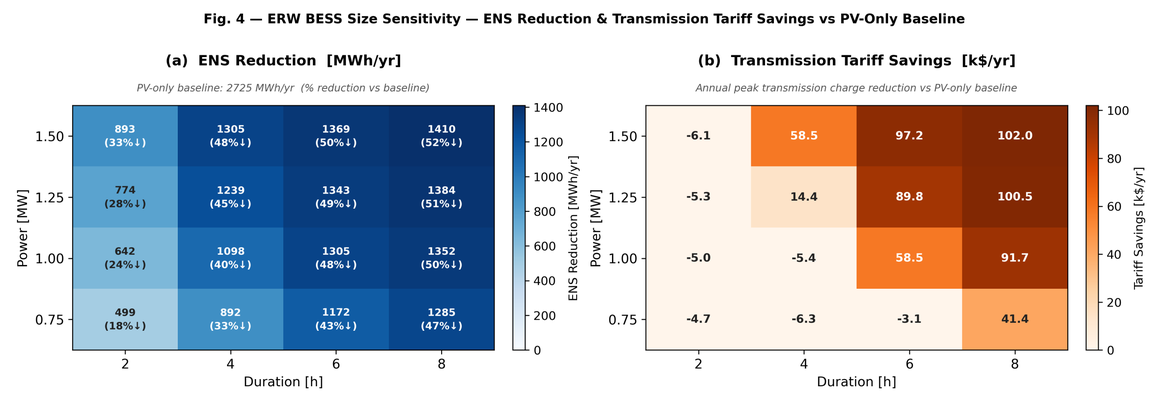
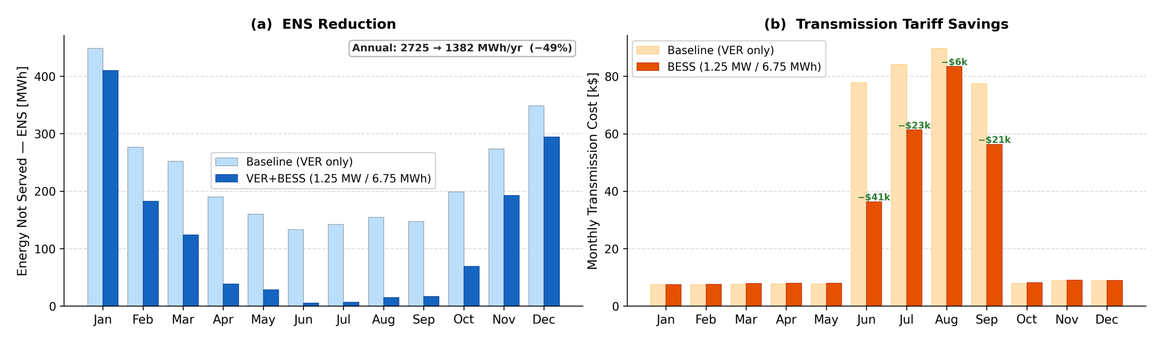
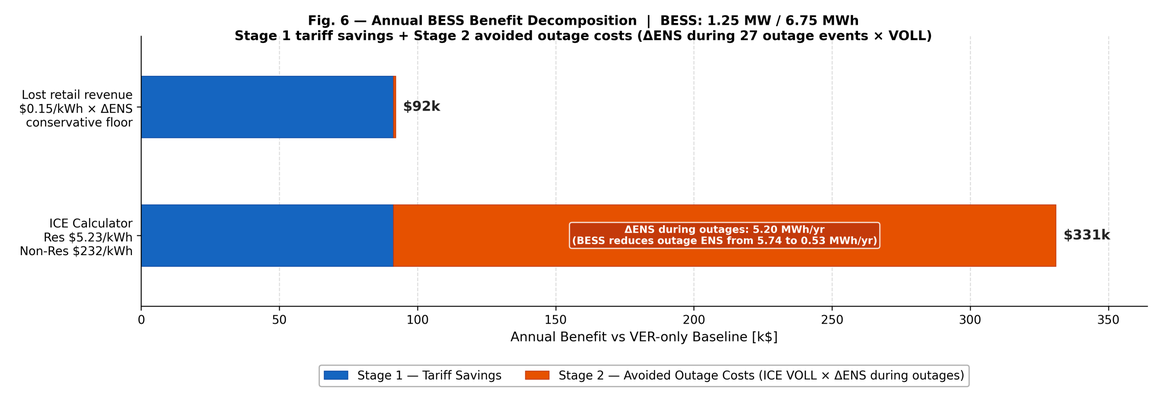


Fig.3. ESMO two-stage structure of outage mitigation analysis [1].

RESULTS







CONCLUSIONS & IMPACT

- KCEC's chosen BESS (1.25 MW / 6.75 MWh) eliminates **49%** of structural unserved energy (2,725 → 1,382 MWh/yr) and **91%** of ENS during the 27 actual outage events (5.7 → 0.5 MWh/yr), delivering **$91k–$331k/yr** in combined tariff savings and avoided outage costs.
- **Storage duration**, not rated power, is the key design parameter: 6h captures 97% of achievable ENS reduction → beyond 6h, returns diminish sharply.
- **Tariff savings** ($91k/yr) are VOLL-independent → a guaranteed economic floor that partially offsets BESS capital costs even under the most conservative assumptions.
- ESMO framework enables data-driven BESS sizing for rural cooperatives that lack in-house analytical capacity → replicable pathway to **reliable**, **affordable**, and **secure energy** for underserved communities, scalable beyond KCEC nationwide.

FUTURE DIRECTIONS

- Apply ESMO to remaining KCEC microgrid sites and scale the methodology to rural, underserved, and isolated microgrids across the U.S.
- Extend contingency analysis to transmission-level events and incorporate multi-year VER/load profiles to reduce model uncertainty.
- Quantify electricity market services (energy arbitrage, ancillary services) as additional BESS revenue streams to improve investment viability.

References

[1] Balducci, Patrick, Kwon, Jonghwan, Nwadiaru, Vivian, et al., "Rosario Strait Tidal Energy plus Energy Storage — Preliminary Economic Assessment," (2024), https://doi.org/10.2172/2283071
[2] Lawrence Berkeley National laboratory, "Interruption Cost Estimate Calculator (ICE) Calculator 2", (2026), https://icecalculator.com/

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