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Randomised Field Trial of Power-Distribution System Diagnostics for Efficiency Gains in Tanzania

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ABSTRACT

Background: Power distribution losses in sub-Saharan networks are a critical engineering challenge, with technical losses exacerbated by ageing infrastructure and limited diagnostic capabilities. Existing efficiency studies often rely on modelled or aggregated data, lacking rigorous field-based causal evidence.

Purpose and objectives: This study aimed to conduct a randomised field trial to empirically evaluate the efficacy of a systematic diagnostic protocol for identifying and rectifying inefficiencies in medium-voltage distribution equipment.

Keywords: *Power distribution losses, sub-Saharan Africa, randomised controlled trial, technical losses, distribution network diagnostics, Tanzania, efficiency gains*

Article Highlights

- Cluster-randomised trial across 47 primary substations in Tanzania.
- Diagnostic protocol combined thermographic surveys, load profiling, and power-quality analysis.
- Intervention yielded a 4.7 pp loss reduction versus control (95% CI: 3.1 to 6.3).
- Thermography identified faulty connections as the most prevalent actionable fault (61%).

Methodological Note

Analysis used a mixed-effects model with cluster random effects and robust standard errors to estimate the causal impact of the diagnostic intervention.

This trial provides field-based causal evidence for a systematic engineering approach to loss reduction.