Time-Series Forecasting Model Evaluation for Cost-Effectiveness Assessment of Power-Distribution Equipment Systems in Senegal

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Published: 03 December 2010 | **Received:** 11 September 2010 | **Accepted:** 30 October 2010

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DOI: 10.5281/zenodo.18908946

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Abstract

The efficient operation of power distribution systems is crucial for sustainable energy supply in developing countries like Senegal. Current models often overlook time-series data analysis, which can lead to suboptimal equipment selection and maintenance strategies. A hybrid ARIMA-GARCH model was developed and applied to historical electricity consumption data from Senegal. Model robustness was assessed through cross-validation, with uncertainty quantified using bootstrapping techniques. The forecasted demand trend indicated a steady increase over the next five years, necessitating proportional upgrades in equipment capacity. This finding suggests a need for more frequent maintenance schedules to prevent unexpected failures. The hybrid ARIMA-GARCH model provided reliable forecasts of electricity demand and cost savings potential, facilitating informed decision-making in power distribution system management. Senegalese utilities should implement the recommended equipment upgrades and scheduling protocols based on this study's findings to enhance operational efficiency and reduce long-term costs. The maintenance outcome was modelled as $Y\{\} = beta0 + beta1\,X\{\} + ui + varepsilon\{\}$, with robustness checked using heteroskedasticity-consistent errors.

Keywords: *Sub-Saharan, econometrics, ARIMA, Monte Carlo, reliability, stochastic modelling, predictive analytics*

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