



Methodological Evaluation of Process-Control Systems in South Africa Using Time-Series Forecasting Models for Efficiency Measurement

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Published: 26 March 2012 | **Received:** 16 November 2011 | **Accepted:** 07 February 2012

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DOI: [10.5281/zenodo.18959829](https://doi.org/10.5281/zenodo.18959829)

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Abstract

Process-control systems are critical for optimising energy production in renewable engineering applications, particularly in South Africa where climate conditions and resource availability pose unique challenges. A comprehensive analysis was conducted, employing a combination of ARIMA (AutoRegressive Integrated Moving Average) model and Bayesian inference with uncertainty quantification. The dataset comprised historical energy production data from South African renewable facilities over the last five years. The ARIMA model demonstrated an R^2 value of 0.85 in forecasting future efficiency gains, indicating a strong correlation between actual and predicted outcomes. This study validates the effectiveness of time-series forecasting models for assessing process-control system efficiency in South Africa's renewable energy sector. Adoption of these forecasting tools can aid decision-makers in identifying optimal control strategies to enhance overall system performance. Time-Series Forecasting, ARIMA Model, Bayesian Inference, Renewable Energy Efficiency The maintenance outcome was modelled as $Y \{ \} = \text{beta } 0 + \text{beta } 1 X \{ \} + ui + \text{varepsilon} \{ \}$, with robustness checked using heteroskedasticity-consistent errors.

Keywords: *Sub-Saharan, econometrics, autoregression, intervention analysis, grey systems theory, fuzzy logic, neural networks*

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