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Time Series Analysis for Renewable Energy Forecasting in the Philippines: Enhancing the Reliability and Efficiency of Intermittent Energy Sources

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Abstract The Philippines is rapidly expanding its renewable energy (RE) capacity to meet ambitious targets of 35% RE in the power generation mix by 2030 and 50% by 2040. However, the increasing penetration of intermittent sources like solar and wind poses significant challenges to grid stability and operational efficiency, particularly in an archipelagic nation prone to extreme weather. This paper reviews the application of time series analysis for RE forecasting in the Philippine context. It examines key methodologies, including ARIMA, SARIMA, Prophet, and LSTM models, alongside hybrid approaches, and discusses their suitability for predicting variable RE generation. The paper synthesizes findings from local studies, highlighting the impacts of forecasting on grid management and the specific challenges related to data availability and quality. Accurate RE forecasting is identified as a critical enabler for enhancing power system reliability, optimizing resource dispatch, and supporting the Philippines' transition towards a sustainable energy future. Collaborative efforts in data infrastructure development, localized model refinement, and adaptive forecasting strategies for events like typhoons are crucial for maximizing the benefits of the nation's abundant renewable resources.

Keywords: Time Series,Philippines, Energy, AI models

1. Introduction

The Philippines is transitioning towards greater energy security and decarbonization, targeting 35% renewable energy (RE) by 2030 and 50% by 2040. Recent growth in RE, especially solar, is driven by policies like the Renewable Portfolio Standard (RPS) and 100% foreign ownership of RE projects. However, integrating variable RE (VRE) like solar and wind presents challenges to grid stability due to their intermittency. These issues are magnified by the Philippines' archipelagic geography with fragmented grids. Accurate RE forecasting is thus essential for managing high VRE penetration, enabling better grid operations and efficiency. This paper reviews time series analysis for RE forecasting in the Philippine context.

2. Methodological Approaches for RE Forecasting

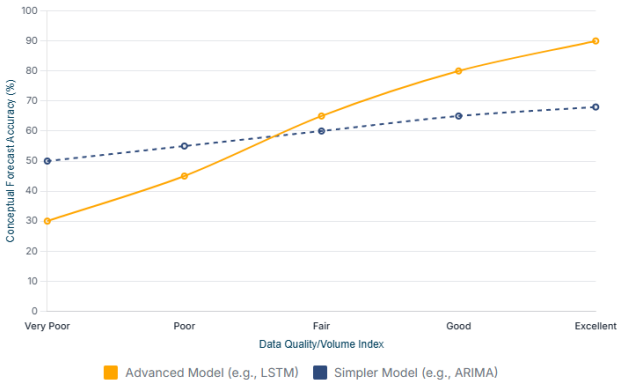
RE forecasting uses time series models like ARIMA, SARIMA (capturing seasonality), Prophet (handling trends and holidays), and LSTMs (for complex non-linear patterns). Hybrid models also exist but their superiority isn't consistently proven in local studies. Key inputs include historical generation data and meteorological variables (solar irradiance, temperature, cloud cover for solar; wind speed, direction, pressure for wind).

Data challenges in the Philippines include restricted access to private generation data, and issues with meteorological data quality, granularity (especially sub-hourly data), and representativeness of PAGASA station data for specific RE plant locations. PAGASA's modernization and platforms like ClimDatPh aim to improve data accessibility and quality, crucial for advanced models. Satellite-derived data is increasingly used to bridge gaps.

3. Results and Applications in the Philippines

Philippine studies on solar PV forecasting using SARIMAX, LSTM, and XGBoost show performance varies by location and season, needing localized models. Wind forecasting has utilized VAR models, with SARIMA also showing suitability for seasonal wind patterns. In Figure 1 advanced models may underperform with poor data but can significantly outperform simpler models when high-quality, granular data is available. Data challenges are a key concern in the Philippines.

Figure 1. Model Performance vs. Data Quality

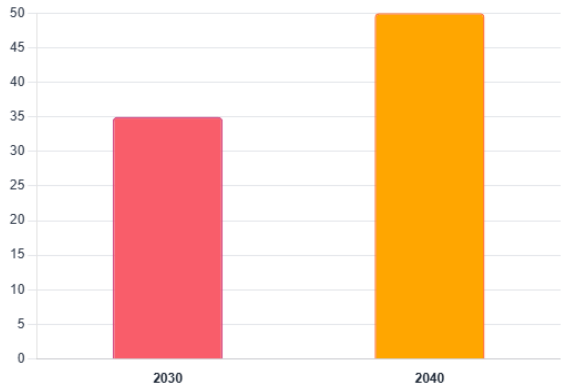


Accurate forecasting improves grid stability by enabling better supply-demand balancing, efficient dispatch, and reduced reserve needs. The NGCP has a wind and solar forecasting program. The archipelagic nature demands localized models, and typhoon proneness requires adaptive forecasting capable of integrating severe weather alerts, as typhoons significantly impact RE output.

4. Discussion

Effective RE integration in the Philippines hinges on advanced forecasting. Accurate predictions help NGCP manage the grid, optimize dispatch, schedule storage (like BESS), and reduce curtailment. However, limitations include model performance dependency on local data and conditions, the "black box" nature of some AI models, and significant data deficiencies (availability, granularity, quality). Standard models may also struggle with archipelagic complexities and typhoon impacts without adaptation. Figure 1 represents the government's increasing commitment to sustainable energy sources as outlined in the national energy transition plan. An optional callout could highlight the Renewable Portfolio Standard (RPS) annual increase change from 1% to 2.52%.

Figure 1. RE Share targets (2030 and 2040)



Recommendations include:

- **DOE:** Mandate standardized RE data sharing, support R&D in localized and typhoon-resilient models, and integrate forecasting requirements into RE programs.
- **NGCP:** Invest in grid modernization (smart grids, BESS) and enhance collaboration with PAGASA and RE generators.
- **PAGASA:** Improve meteorological data resolution, accuracy, and accessibility for RE forecasting, developing energy-sector-specific products.

Future research should focus on robust hybrid models, intra-hour forecasting (with better data), spatio-temporal models for archipelagic conditions, quantifying economic benefits of accurate forecasting, and integrating dynamic typhoon predictions. Collaboration is key.

5. Conclusion

Advancing time series forecasting is crucial for the Philippines' RE goals. Accurate forecasts are a strategic imperative for a stable, efficient, and resilient power system. Despite data and modeling challenges, ongoing efforts in research, policy, and infrastructure offer a path to harness the nation's RE potential. Success depends on mastering the predictability of intermittent resources through collaborative efforts.

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