Battery Electric Vehicle Charging Load Forecasting Using LSTM on STL Trend, Seasonality, and Residual Decomposition

Syahrizal Salleh, Roslinazairimah Zakaria(✉), and Siti Roslindar Yaziz

Centre for Mathematical Sciences, Universiti Malaysia Pahang Al-Sultan Abdullah, Kuantan, Pahang, Malaysia

roslinazairimah@umpsa.edu.my

Abstract. To overcome the challenge of limited high-resolution Battery Electric Vehicle (BEV) charging data, a unique feature engineering technique was implemented. The start-stop electricity charging data from the My Electric Avenue project underwent transformation into a count of concurrent active charging events at 1-min intervals. In an effort to enhance prediction accuracy, the transformed BEV charging data was subjected to decomposition into its trend, seasonality, and residual components using the Seasonal-Trend decomposition using Loess (STL) procedure. Acknowledging the nonlinear, dynamic, and noisy characteristics inherent in BEV charging behavior, the Long Short-Term Memory (LSTM) network was chosen to model electricity demand arising from multiple concurrent BEV charging events. In the model optimization process, hyperparameter tuning focused on adjusting the number of epochs at intervals of 1, 10, 20, 30, 40, and 50. The prediction values for the STL-LSTM decomposed trend, seasonality, and residual components achieved their lowest Mean Absolute Percentage Error (MAPE) values against decomposed testing data at 0.03%, 4.37%, and 27.11%, respectively. The corresponding Root Mean Squared Error (RMSE) values were 0.01, 0.08, and 0.49. Upon reconstruction and comparison against observed testing data, the resulting lowest MAPE occurred at epochs 10, 30, and 40 for trend, seasonality, and residuals, respectively, with values of 1.21% and RMSE 0.51. This is marginally lower than the forecast using the LSTM model on observed data, which recorded a MAPE of 1.38% at RMSE 0.51. The findings underscore the suitability of the STL-LSTM model, tailored for 1-min resolution electricity demand, for electric utility companies aiming to forecast very short-term loads.

Keywords: Battery Electric Vehicle · STL Decomposition · Long Short-Term Memory · Feature Engineering · Charging Behavior

1 Introduction

The Battery Electric Vehicles (BEVs) has garnered widespread acceptance as a means to mitigate global warming by reducing greenhouse gas (GHG) emissions into the atmosphere. Since 2016, carbon dioxide (CO_2) emissions from Internal Combustion Engine Vehicles (ICEVs) have constituted approximately one-quarter of global emissions [1].

R. Ghazali et al. (Eds.): SCDM 2024, LNNS 1078, pp. 327–336, 2024.
https://doi.org/10.1007/978-3-031-66965-1_32