## Abstract

***Title: Deep Learning Based Optimization of Energy Management System for Microgrid with Renewable Energy Sources: A Case Study for Saint Martin Island***

The rapid integration of renewable energy sources (RES) in microgrids provides a sustainable energy management solution and has shown to be cost effective especially in remote areas. However, the fluctuating and variable nature of RES, such as solar and wind energy, makes it difficult to ensure consistent energy supply. Traditional EMSs in microgrids tend to rely on heuristic or rules-based forms of management that do not provide real-time optimization and adaptability. The latter creates a significant gap in energy reliability, storage optimization, and load distribution. Consequently, this results in more energy waste and considerable dependance on backup fossil fuel-based systems. Henceforth, this research will investigate the application of deep learning (DL) techniques to address the aforementioned challenges as well as to optimize the energy management system with a primary focus on the island of Saint Martin in Bangladesh.

In recent years, deep learning has made tremendous progress in data-based decision-making. Due to this, deep learning's success in energy management systems has been significant - more specifically in load forecasting, energy supply and demand prediction. More specifically, using deep learning in a microgrid energy management system, allows for high accuracy forecasting for energy generation and consumption. In this work, the deep learning models like the RNNs, LSTM networks, and CNNs will be explored in-depth. These models will be used to predict future energy generation from solar and wind energy sources along with energy demand patterns for Saint Martin Island. The deep learning models will be included into an optimized energy management system so that real time decisions can be made regarding energy storage, distribution, and dispatch.

Accordingly, the objective of this research is to develop a holistic data-driven EMS framework, which is focused on improving operational efficiency while minimizing energy waste in a microgrid. The system will better match energy generated and consumed with improved forecasting accuracy; thus, it will reduce reliance on conventional backup systems and maximize the use of renewable energy sources. The control system will also be adorned by reinforcement learning techniques for real-time adaptability to energy demand and supply. Hence, it will reduce the carbon footprint of energy generation due to decreased use of fossil fuels and contribute to achieving relevant sustainable development goals.

In addition, the collection of historical and real-time data of Saint Martin, such as solar radiation, wind speed, weather patterns, and energy consumption, will be accomplished along the way. These data are very important in training the proposed EMS and validating it so that it is suited to the conditions of the island. After the models have been developed and simulation tests are performed, the implementation of the system will be done.

*In conclusion, it is anticipated that this research will lead to major improvements in grid stability, improved energy distribution, and accuracy in energy forecasts. The suggested deep learning-based energy management system (EMS) will give a scalable way to control energy in isolated or off-grid locations, perhaps serving as a model for more widespread AI applications in sustainable energy systems.*