|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Title:** | Intelligent Energy Management of Microgrids Using Machine Learning:  Leveraging Random Forest Models for Solar and Wind | | | |
| **Author(s) Name:** | Hasanur Zaman Anonto, Md Ismail Hossain, Abu Shufian, Md. Shaoran Sayem, S M Tanvir Hassan Shovon, and Sadman Shahriar Alam | | | |
| **Contact Email(s):** | protik@aiub.edu | | | |
| **Published Journal Name:** | Results in Engineering | | | |
| **Type of Publication:** | Journal | | | |
| **Volume:** | 27 | Issue | | 106539 |
| **Publisher:** | Elsevier | | | |
| **Publication Date:** | August 2025 | | | |
| **ISSN:** | 2590-1230 | | | |
| **DOI:** | http://dx.doi.org/10.1016/j.rineng.2025.106539 | | | |
| **URL:** | https://www.sciencedirect.com/science/article/pii/S2590123025026088?via%3Dihub | | | |
| **Other Related Info.:** |  | | | |
|  | | | | |
| **Abstract:** | | |  | |
| The shift to renewable power demands the development of microgrids involving solar and wind power. Since solar and wind sources are inherently not continuous, it is a tremendous challenge to integrate the sources into microgrids effectively. The study at hand suggests dedicating a new type of energy management of the microgrid by using the machine-learning algorithms, namely the Random Forest (RF) regressor along with real-time forecasting the energy use and renewable-energy production. Integrating grid-stability measures, that is, voltage and frequency variation into the predictive model, the framework enhances the accuracy of the energy dispatch and storage plans. The ability of the system to coordinate energy movement as an additional storage system that stores when there is surplus and releases when shortage occurs encourages grid stability with the reduced dependence on the main grid. Simulation findings suggest that a straightforward rule-based storagedispatch plan, with the embrace of accurate forecaster, reduces peak grid imports by 18 % and the imported energy per day by 11 %, thus, passes significant cost optimization. Efficiency of microgrids is further promoted by the inclusion of demand-response mechanisms and predictive storage optimization. Taking together, this approach gives a solid foundation to ensure the maximized use of renewable energy sources, optimization of storage solutions and enhanced sustainability of microgrids. In upcoming studies, the model needs to be stretched further by using multi-year datasets and highly optimized solutions in the implementation of the model to foster the scalability and flexibility of smart-grid systems towards new developments in energy requirements. | | | | |