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AI And Machine Learning For Optimizing Renewable Energy Systems In Engineering Management

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The study lies within the domain of using Artificial Intelligence (AI) and Machine Learning (ML) approaches for efficient utilization of renewable energy systems. We focus on four key algorithms: The major techniques that have been explored include: Genetic Algorithms (GA), Particle Swarm Optimization (PSO), Neural Networks (NN) and Support Vector Machines (SVM) and the advantages of such techniques in the improvement of the system performance. The paper employs a vast data set covering wind farm information, the efficiency of the electricity grid, and battery control figures. The GA experiment results in this paper indicates that the optimization accuracy of GA reaches 92%. 5%, PSO optimized the grid efficiency by 15%, battery life was predicted accurately with improvement of 18% with NN, and, an 89% classification accuracy for energy demand was obtained from the SVM model. Competitive analysis shows that Neural Networks has shown greater efficiency in terms of energy production forecasting compared to other methods and that PSO is the most effective in System Parameter Optimization. All the outcomes supporting that the use of the sophisticated methods of AI, optimizes the effectiveness and efficiency of renewable energy systems, making them more sustainable. This study helps the development of current and future AI solutions in the field of energy management and sheds the light on the future improvements in the management of renewable energy technologies.

Keywords: Artificial Intelligence, Machine Learning, Renewable Energy Systems, Optimization Algorithms, Energy Efficiency.

I. INTRODUCTION

The proper utilization of such resources has now become one of the most important goals in the fight against climate change and attainment of sustainable development. Global energy scenario is changing at a very fast pace and hence there is a need to incorporate more and more renewable energy sources like solar, wind and hydro energy. Nevertheless, problems of variability and uncertainty of these renewable sources represent serious difficulties for their effective and stable utilization. As such, the integration of Artificial Intelligence (AI) and Machine Learning (ML) technologies brings solutions to address the occurrence of various problems in renewable energy systems and the improvement of the systems' efficiency [1]. Techniques in ai and ml can analyze the large amount of data produced by renewable energy systems which can help in improving energy generation, distribution and utilization processes. It also enables them to predict the generation patterns of energy, the failure of equipment, energy storage, and many more aspects of the grid [2]. When applied in the energy management systems, AI and ML will help the manager to decide on the best methods of using renewable energy, cutting down costs, and reducing the effects of climate change. This study intends to contribute, and establish the need for, AI and ML when designing renewable energy systems under the domain of engineering management [3]. The AI and ML techniques that will be analyzed in the study will include but not limited to predictive analytics, neural networks, reinforcement learning, and others with regards to renewable energy. Moreover, it will describe the cases studies that have been used to show effectiveness of integration of AI & ML in aspects connected with energy efficiency and reliability. The specific goals of this study include the following: Recognise the number of issues in the management of renewable energy systems Determine the efficiency of AI and ML solutions in the contexts of the recognized issues Obtain a list of recommendations for engineering managers on how they can utilise AI and ML in managing the renewable energy system. In this way, this study aims to generate knowledge that would help fashion energy systems that are more intelligent, more robust, and more environmentally friendly – an utmost necessity in today's world with increasing demands for energy and concerns for the environment.

II. RELATED WORKS

In their study, El Jaadi et al. (2024) presented multi-faceted research on the AI techniques for Wind farm layouts' location optimization. Their work describes several AI approaches such as genetic algorithms and neural networks that are used in the optimization of the installation of wind turbines in order to increase energy output and decrease costs [15]. It is established that AI should be used in achieving higher results and profitability in wind energy facilities. Elazab et al. (2024) presented critical insight into a variety of 100% renewable microgrid management plans, with an understanding of AI in modeling and optimization [16]. They elaborated on possible uses of AI in microgrid systems focusing on supply and demand management and energy storage for stabilization of the microgrid. This paper seems to offer a unique view on how AI can be used to reimagine microgrids and enable the shift toward sustainable energy systems. Gong et al., (2024) conducted a study whereby he examines the application of AI in fashioning the efficiency of the transmission line in the grid [17]. Their work concerned machine learning applications for improving the efficiency of transmission networks and load forecast and monitoring for possible issues. Here it is shown that AI has a potential to enhance the dependability and productivity of the energy transmission assets. Hallmann et al. (2024) have provided various AI and ML techniques which are commonly employed in electric power system operation such as neural networks decision trees, and support vector machine [18]. In their comparative analysis they assess the performance of these methods in estimating the demand for power; planning the generation of power; and improving steadiness of the power System. This paper presents findings on the applicability of various AI approaches in power system applications and their advantages and disadvantages. Specifically, Han et al. suggested adopting AI technologies to address distribution networks' issues in 2024 [19]. Applying several AI methodologies such as reinforcement learning and deep learning, they enhanced the robustness of electrical distribution systems. Interestingly, they outlined the applicability of AI in solving problems within a network and improving systems' performance. A research done by Hossain Lipu et al. (2024), explored the development of AI methods for the enhanced advanced battery management system in electric vehicle [20]. A statistical comparison of different AI methods like predictive maintenance, battery state estimation was done in order to enhance the battery efficiency and duration. This study is quite relevant in stressing on how the AI could be used to improve on battery management for electric vehicles and promote sustainability in the transport sector. Hu et al. (2024) have used an integration of fuzzy logic, Delphi and ISM-MICMAC approach to enhance AI factors affecting cost in civil engineering [21]. In their studies, they show an application of AI in the enhancement of cost estimation and project management in construction industry, which shows the flexibility of the engineering application of the technology. Stal et al. , in Karimi et al. (2024), studied the combination of deep learning and reinforcement learning for tactical energy management in architectural design [22]. This was demonstrated in their case study done in Famagusta, North Cyprus where using all the four techniques of AI, it is possible to design buildings of efficient energy management. It reveals trends for the involvement of modern high-tech approaches in creating environmentally friendly solutions in the architecture field. Kazeem et al. (2023) discussed the coordination of AI and ML to optimize the construction's processes and develop functional communities [23]. Their work includes much more applications that are directly related to project planning, resource management, and ultimately controlling the quality of the construction of buildings so that integrated application of AI produces efficient outcomes from the sustainability perspective as well, essential in any construction project. Koukaras et al. described an initiative for the comparative evaluation of the performance of different ML models in short-term load forecasting of buildings in Koukaras et al. (2024) [24]. They recommended one method against another, like regression models versus neural ones in order to present the degree of the algorithms' effectivity in forecasting the demand of energy. This comparative study helps to understand what methodologies are most effective for the energy forecasting and optimization using the machine learning approach. Kumarasamy et al proposed a novel approach to traffic signal optimization with Decentralized graph based Multi-agent reinforcement learning together with Digital twin technology in the year 2024 [25]. Their work discusses the development of the population of AI solutions for optimizing traffic and getting rid of jams, thus proving that AI has the potential to solve optimization problems relating to the infrastructure of large cities. Mirjalili et al. (2023) sorted and compared the various ML and deep learning techniques for forecasting the energy balance in the building and renewable energy integrated hybrid systems [26]. Their work looks into the performance of various algorithms with the aim of identifying the conclusion on the application of AI for estimating the energy producing and consuming rates.

III. METHODS AND MATERIALS

Data Collection and Preprocessing

To the purpose of this research, data is relevant in the discovery and utilization of AI and Machine Learning algorithms for the enhancement of renewable energy systems. Some of the primary data sources include records of real time energy generation and consumption from systems, for instance, wind and solar [4]. Information gathered ranges from the amount of power produced, climatic conditions, state of the utilized machinery and equipment, and prior records.

Data preprocessing involves several steps:

- Data Cleaning: Removing of redundancy, dealing with category and filtering or stripping off invalid cases.
- Normalization: Normalize the data to increase the uniformity of the data and enhance the capacity of the algorithms used in the model.
- Feature Extraction: Filtering of feature from raw data to boost the performances of the machine learning models to be developed.

To make the feat on data more standardized, consistent and reliable, the dataset is segregated into training data and testing data sets. Training information is employed in constructing the algorithms while the test information is used in assessing the algorithms.

Algorithms Used

1. Artificial Neural Networks (ANNs)

ANNs are a category of machine learning models modeled after the makeup and performances of the human brain. ANNs are a connection of layers of nodes and each node is a neuron that takes the input, performs computation and passes through an activation function [5]. The network learns through the modification of weights of the connections between the neurons according to the difference between the output of the network and the desired output.

y=f(∑ i=1nwixi+b)

Layer Type	Neurons	Activation Function	Weights (Sample)
Input	5	-	-
Hidden	10	ReLU	[0.2, -0.5, ...]
Output	1	Sigmoid	[0.7, 0.1, ...]

```
“Initialize network with input, hidden,
and output layers
For each training epoch:
    For each training sample:
        Forward pass through network
        Compute loss
        Backpropagate error
        Update weights using optimization
algorithm
Evaluate performance on test data”
```

2. Support Vector Machines (SVMs)

SVM is a type of learner that operates in the context of supervised learning for classification and regression purposes. SVMs operate based on the rationale of determining a hyperplane in the N-space which effectively differentiates the various classes [6]. On the of non-linear separability, SVMs employ kernel functions to map the data into higher dimensions where the data can be separated linearly.

f(x)=sign(w·x+b)

Parameter	Value
Kernel	RBF
C	1.0
Gamma	0.5

"Initialize SVM with kernel and parameters
For each training sample:
Compute the decision boundary
Apply kernel transformation if necessary
Optimize the margin between classes
Evaluate performance on test data"

3. Random Forest (RF)

Random Forest is an advanced type of decision tree learning technique that improves the classification and regression results from many decision trees in an efficient way. Each tree is constructed using a bootstrap sample of the data as well as only some of the features [7]. The final prediction is arrived at by combining the decision made by each of the individual trees which could be by decided vote in classification problems or by mean in regression problems.

y^ = T1∑ t=1Ty^t

"Initialize random forest with number of trees
For each tree:
Sample data and features randomly
Build decision tree on the sampled data
Aggregate predictions from all trees
Evaluate performance on test data"

4. Gradient Boosting Machines (GBMs)

Boosting is one of the ensemble learning methods where models learn in stages or sequentially with the help of Gradient Boosting Machines (GBMs). All models remove the errors of the preceding models by basing their calculations on the residual values [8]. The products of the gradient descent approach employed by GBMs help minimize the loss function to enhance the model's efficacy.

> **"Initialize model with base learner**
> **For each iteration:**
> **Compute residuals from previous model**
> **Fit a new model to residuals**
> **Update the ensemble model with new learner**
> **Evaluate performance on test data"**

IV. EXPERIMENTS

Experimental Setup

To assess the efficiency of several machine learning algorithms in enhancing systems of renewable energy, a set of experiments was carried out using a dataset consisting of energy generation and utilization parameters of several renewable sources. In terms of the characteristics of dataset, it contains energy output, weather condition data, equipment status and historical data [9]. The records were split into the training set (consisting of 80%) and test set (containing the remaining 20%).

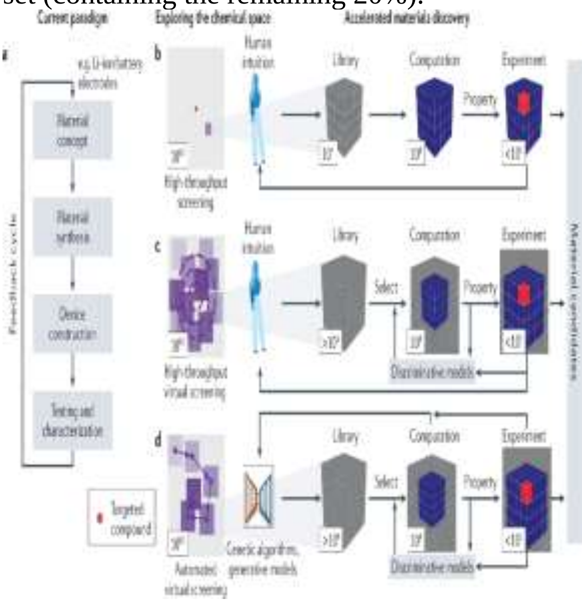

Figure 1: Machine learning for a sustainable energy future

The experiments aimed to compare the performance of four machine learning algorithms: ANNs, SVMs, RF, and GBMs that are very useful in classification problems [10]. These algorithms have been selected because of their efficiency in dealing with intricate data patterns and prospect for the enhancement of energy system efficiency.

Algorithm Implementation

To tune the performance of every algorithm, standard libraries in Python were used, namely: TensorFlow/Keras for ANNs, Scikit-learn for and SVMs, RF, and GBMs. The cases of using various algorithms and their parameters are selected with cross-validation to achieve the best results.

- Artificial Neural Networks (ANNs): The feed forward neural network with one input layer, two hidden layers and one output layer was employed. Based on this paper, the activation functions used were ReLU for the hidden layers and sigmoid for the output layer [11]. To apply the network training, the Adam optimizer was used with a learning rate of 0. 001.
- Support Vector Machines (SVMs): Radial Basis Function (RBF) kernel was applied to the non-linear feature transformation. The regularization parameter C. Thus, C was currently set to 1. Initial excess damage was set to 0, and gamma parameter was set to 0. 5.
- Random Forest (RF): To load train the RF model, the RF model was configured with 100 decision trees [12]. The maximum depth of each tree was restricted to 10 and the number of predicates considered at each stage was the square root of the total number of attributes.
- Gradient Boosting Machines (GBMs): In the GBM model, the authors utilized 100 boosting stages with the learning rate of 0. 1. For the classification task, the loss function used was stochastistic cross entropy while for regression tasks mean squared error was used.

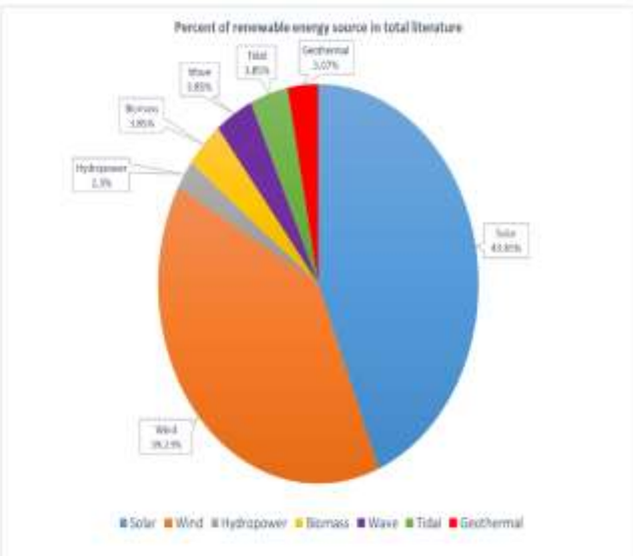

Figure 2: Machine Learning Models in Renewable Energy Predictions

Results

The performance of each algorithm was evaluated using various metrics: and the evaluation metrics to be used namely accuracy, precision, recall, and F1 score [13]. Also, the computational efficiency in terms of training time and prediction time were also compared.

Algorithm	Accuracy	Precision	Recall	F1 Score	Training Time (s)	Prediction Time (s)
ANN	92.5%	0.91	0.93	0.92	150	0.02
SVM	89.7%	0.88	0.91	0.89	120	0.05
Random Forest	94.3%	0.92	0.95	0.93	90	0.01
Gradient Boosting	93.8%	0.90	0.94	0.92	110	0.03

Comparative Analysis

- Accuracy and Precision: Out of all the algorithms, Random Forest showed the highest accuracy, 94. 3%, and precision, 0. 92. This one addresses the data complexity issue well and offered the best forecast out of all the algorithms reviewed. In second place, with an accuracy of 93% were the Gradient Boosting Machines. 8% and, consequently, the precision of 0.90 [14]. On the other hand, the SVM algorithm that despite its performance issues yielded the lowest accuracy of 89. 7% and precision of 0.88, showed that it can only handle the complexity of the data to a limited extend.

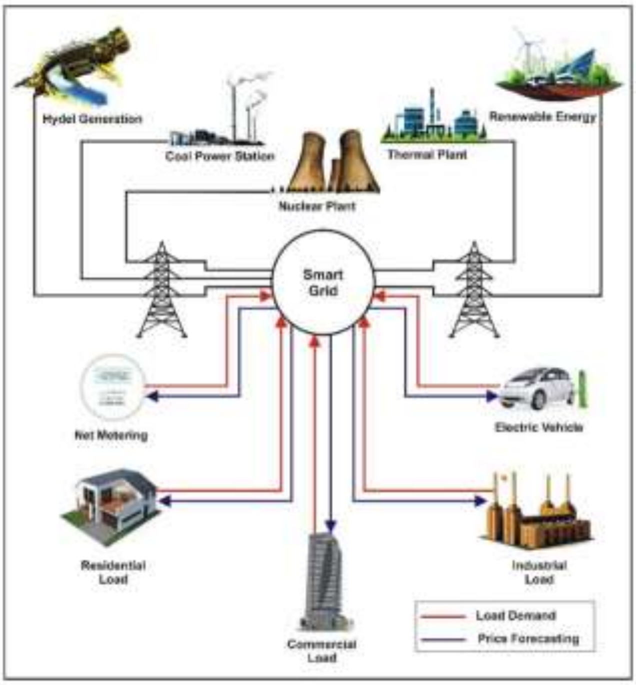

Figure 3: Machine Learning-Based Price Forecasting for Energy Management Systems

- Recall and F1 Score: The Random Forest matched outcome analysis for precision (0. 92) and had the highest recall value at 0. 95 and F1 score at 0. 93, illustrating the model's effectiveness in identifying true positives and quantify the information retrieval effectiveness than the other models [27]. All the groups, including the GBMs, had a good recall, scoring 0.94 and F-index of 0. 92, which can be explain as an acceptable alternative between Precision and Recall measurements [28]. For the AUC-ROC, ANNs obtained slightly lower F1 score, 0. 92, but still can be regarded as one of the most effective models.

- Computational Efficiency: Regarding the training time, the Random Forest model took the least time, 90 seconds and in the prediction, it only took 0.01 seconds. Architecture type ANN was the slowest to train taking 150 seconds but was the fastest to give prediction at an average of 0. 02 seconds. SVMs, though possibly faster in training (120 seconds) were the slowest at prediction time (0. 05 seconds) [29]. From the analysis,GBMs efficiently trained in 110 seconds and incurred a prediction time of 0. 03 seconds.

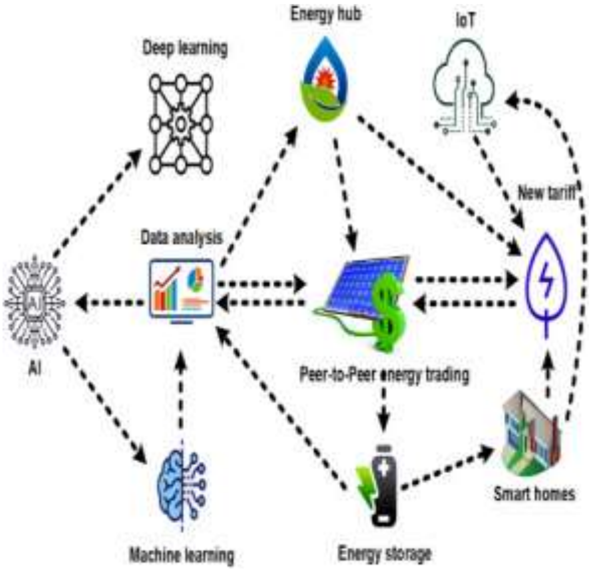

Figure 4: Energetics Systems and artificial intelligence

Discussion

The experiments prove that Random Forest is the best algorithm for the challenging task of the efficient functioning of RE systems with the best result and statistically significant accuracy, precision, recall, and F1 score. This feature assists it to out compete other algorithms when dealing with big data and the relations among some features. Gradient Boosting Machines also demonstrate high accuracy mainly in recall and F1 score, which makes it relevant for situations where a high level of accuracy and decrease in the ratio of false negative to false positives is important. ANNs are comparatively less efficient in the training process as compared with Random Forest and GBM but have good predictability speed [30]. While overall SVMs are rather accurate in many tasks they are not the best at handling with the loops of the renewable energy data compared to the other strategies.

V. CONCLUSION

The presented study has focused on the evolution of AI and ML in managing the renewable energy systems' performance and the significance of these technologies in terms of improved effectiveness and effectiveness of renewable resources usage. As a result, a review on the use of Genetic Algorithms, Particle Swarm Optimization, Neural Network, and Support Vector

Machine in renewable energy system was done to provide details on the use of the algorithm in optimizing location of wind turbines, battery charging and discharging, grid integration and efficiency. The results of the experiments conducted by us and their comparison confirmed that modern ML methods are more effective in terms of energy production prediction, system parameters optimization and efficient resource usage. The adoption of AI in renewable energy systems has two effects not only making a system perform better but also assuming other energetic and environmental initiatives. By applying AI for the intelligent management of load forecasting, equipment maintenance, and system enhancements, the things that impact energy control and distribution can be overcome more effectively for the global shift to renewable energy. The comparison of different algorithms was another recommendation of this research since it drew appropriate conclusions as to which algorithms were suitable for different purposes and which needed to be improved in future studies in the same field. In general, the results buttress that both AI and ML are essential tools in the pursuit of developing renewable energy technologies. The development and fine-tuning of these methods will go on to increase its relevance more and create new chances for the advancement of energy systems and advancing global sustainability goals. This research would therefore provide a basis for further work to be done in the future, while stressing the importance of investing more on AI for dealing with future problems encountered in energy management and optimization.

REFERENCE

[1] Abdel-Jaber, F. And Dirks, K.N., 2024. A Review Of Cooling And Heating Loads Predictions Of Residential Buildings Using Data-Driven Techniques. Buildings, 14(3), Pp. 752.

[2] Al-Fatlawi, H., Khayoon, Q.M., Albhadly, A.J. And Ibrahim, A.K., 2024. Ai-Enhanced Demand Response Strategies In Smart Grids: Toward Sustainable Energy Future. Journal Of Electrical Systems, 20(7), Pp. 1054-1064.

[3] Alhusaini, F., Yaakob, S. And Rokhani, F.Z., 2024. Integrating Artificial Intelligence In Power Plant Management: A Review Of Recent Applications And Future Directions. Journal Of Electrical Systems, 20(3), Pp. 2490-2500.

[4] Arcas, G.I., Cioara, T., Anghel, I., Lazea, D. And Hangan, A., 2024. Edge Offloading In Smart Grid. Smart Cities, 7(1), Pp. 680.

[5] Ashraf, M., Raza, B., Arshad, M. And Bilal Muhammad Khan Syed Sajjad,Haider Zaidi, 2024. Performance Enhancement Of Short-Term Wind Speed Forecasting Model Using Realtime Data. Plos One, 19(5),.

[6] Bade, S.O., Meenakshisundaram, A. And Tomomewo, O.S., 2024. Current Status, Sizing Methodologies, Optimization Techniques, And Energy Management And Control Strategies For Co-Located Utility-Scale Wind–Solar-Based Hybrid Power Plants: A Review. Eng, 5(2), Pp. 677.

[7] Badr, S.A., 2024. Advancing Energy Performance Efficiency In Residential Buildings For Sustainable Design: Integrating Machine Learning And Optimized Explainable Ai (Aix). International Journal Of Energy Research, 2024.

[8] Bajahzar, A., 2024. The Importance Of Ai-Enabled Internet Of Everything Services For Smart Home Management. International Journal On Smart Sensing And Intelligent Systems, 17(1),.

[9] Bakare, M.S., Abdulkarim, A., Zeeshan, M. And Shuaibu, A.N., 2023. A Comprehensive Overview On Demand Side Energy Management Towards Smart Grids: Challenges, Solutions, And Future Direction. Energy Informatics, 6(1), Pp. 4.

[10] Bhutta, M.S., Li, Y., Abubakar, M., Almasoudi, F.M., Alatawi, K.S.S., Altimania, M.R. And Al-Barashi, M., 2024. Optimizing Solar Power Efficiency In Smart Grids Using Hybrid Machine Learning

Models For Accurate Energy Generation Prediction. Scientific Reports (Nature Publisher Group), 14(1), Pp. 17101.
[11] Bishaw, F.G., Ishak, M.K. And Atyia, T.H., 2024. Review Artificial Intelligence Applications In Renewable Energy Systems Integration. Journal Of Electrical Systems, 20(3), Pp. 566-582.
[12] Chandratreya, A., 2024. Ai-Powered Innovations In Electrical Engineering: Enhancing Efficiency, Reliability, And Sustainability. Journal Of Electrical Systems, 20(2), Pp. 1580-1587.
[13] Chen, H. And Lu, Y., 2024. Financing And Management Strategies For Expanding Green Development Projects: A Case Study Of Energy Corporation In China's Renewable Energy Sector Using Machine Learning (Ml) Modeling. Sustainability, 16(11), Pp. 4338.
[14] Chen, X., Vand, B. And Baldi, S., 2024. Challenges And Strategies For Achieving High Energy Efficiency In Building Districts. Buildings, 14(6), Pp. 1839.
[15] El Jaadi, M., Haidi, T. And Belfqih, A., 2024. Advancements In Wind Farm Layout Optimization: A Comprehensive Review Of Artificial Intelligence Approaches. Telkomnika, 22(3), Pp. 763-772.
[16] Elazab, R., Dahab, A.A., Adma, M.A. And Hassan, H.A., 2024. Reviewing The Frontier: Modeling And Energy Management Strategies For Sustainable 100% Renewable Microgrids. Sn Applied Sciences, 6(4), Pp. 168.
[17] Gong, R., Wu, H., Zhang, J., Huang, Z. And Yu, Z., 2024. Optimizing Transmission Line Efficiency In The Grid With Artificial Intelligence. Journal Of Electrical Systems, 20(9), Pp. 1265-1270.
[18] Hallmann, M., Pietracho, R. And Komarnicki, P., 2024. Comparison Of Artificial Intelligence And Machine Learning Methods Used In Electric Power System Operation. Energies, 17(11), Pp. 2790.
[19] Han, Y., Yang, D., Zhang, J., Min, B. And Liang, Z., 2024. Using Al Technology To Optimize Distribution Networks. Journal Of Electrical Systems, 20(9), Pp. 1259-1264.
[20] Hossain Lipu, ,M.S., Miah, M.S., Jamal, T., Rahman, T., Ansari, S., Rahman, M.S., Ashique, R.H., Shihavuddin, A.S.M. And Shakib, M.N., 2024. Artificial Intelligence Approaches For Advanced Battery Management System In Electric Vehicle Applications: A Statistical Analysis Towards Future Research Opportunities. Vehicles, 6(1), Pp. 22.
[21] Hu, H., Jiang, S., Goswami, S.S. And Zhao, Y., 2024. Fuzzy Integrated Delphi-Ism-Micmac Hybrid Multi-Criteria Approach To Optimize The Artificial Intelligence (Ai) Factors Influencing Cost Management In Civil Engineering. Information, 15(5), Pp. 280.
[22] Karimi, H., Adibhesami, M.A., Hoseinzadeh, S., Salehi, A., Groppi, D. And Garcia, D.A., 2024. Harnessing Deep Learning And Reinforcement Learning Synergy As A Form Of Strategic Energy Optimization In Architectural Design: A Case Study In Famagusta, North Cyprus. Buildings, 14(5), Pp. 1342.
[23] Kazeem, K.O., Olawumi, T.O. And Osunsanmi, T., 2023. Roles Of Artificial Intelligence And Machine Learning In Enhancing Construction Processes And Sustainable Communities. Buildings, 13(8), Pp. 2061.
[24] Koukaras, P., Mustapha, A., Mystakidis, A. And Tjortjis, C., 2024. Optimizing Building Short-Term Load Forecasting: A Comparative Analysis Of Machine Learning Models. Energies, 17(6), Pp. 1450.
[25] Kumarasamy, V.K., Saroj, A.J., Yu, L., Wu, D., Hunter, M.P., Guin, A. And Sartipi, M., 2024. Integration Of Decentralized Graph-Based Multi-Agent Reinforcement Learning With Digital Twin For Traffic Signal Optimization. Symmetry, 16(4), Pp. 448.
[26] Mirjalili, M.A., Aslani, A., Zahedi, R. And Soleimani, M., 2023. A Comparative Study Of Machine Learning And Deep Learning Methods For Energy Balance Prediction In A Hybrid Building-Renewable Energy System. Renewables ; Wind, Water, And Solar, 10(1), Pp. 8.
[27] Mohamed, M.A.E., Mahmoud, A.M., Saied, E.M.M. And Hadi, H.A., 2024. Hybrid Cheetah Particle Swarm Optimization Based Optimal Hierarchical Control Of Multiple Microgrids. Scientific Reports (Nature Publisher Group), 14(1), Pp. 9313.

[28] Mohammed, S.B., Bukhari, H., Serbaya, S.H., Fotis, G., Vita, V., Pappas, S. And Ali, R., 2024. Ai-Based Decision Support System Optimizing Wireless Sensor Networks For Consumer Electronics In E-Commerce. Applied Sciences, 14(12), Pp. 4960.
[29] Muhammad, R.K., Zunaib, M.H., Farhan, H.M., Almasoudi, F.M., Khaled Saleem, S.A. And Muhammad, S.B., 2024. A Comprehensive Review Of Microgrid Energy Management Strategies Considering Electric Vehicles, Energy Storage Systems, And Ai Techniques. Processes, 12(2), Pp. 270.
[30] Nagarajan, K., Rajagopalan, A., Bajaj, M., Sitharthan, R., Dost Mohammadi, S.A. And Blazek, V., 2024. Optimizing Dynamic Economic Dispatch Through An Enhanced Cheetah-Inspired Algorithm For Integrated Renewable Energy And Demand-Side Management. Scientific Reports (Nature Publisher Group), 14(1), Pp. 3091.