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Tailoring Personalized IoT Services for Smart Buildings in Sustainable Environments Through Energy-Optimized Strategies

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Abstract

In response to the rising global energy consumption attributed to domestic appliances, there is an urgent call to enhance sustainability in residential settings. While previous efforts have introduced the concepts of green and smart buildings, this paper sets out to offer a holistic solution for curbing energy consumption by pinpointing and rectifying irregular energy usage patterns. The central goal is to establish an eco-conscious smart building capable of adapting to a range of lifestyles. This is achieved through the implementation of an integrated network of Internet of Things (IoT) sensors, allowing for the monitoring and regulation of energy efficiency. The research delves into an in-depth analysis of various pivotal factors that influence energy consumption, with a particular emphasis on the identification and prediction of anomalies in energy usage. The objective is to optimize energy consumption patterns and achieve substantial energy savings through these predictive and corrective measures.

1. Introduction

The rise of smart buildings has revolutionized the way we interact with and manage built environments [1]. These buildings leverage cutting-edge technologies, including IoT, to enhance energy efficiency, resource management, and user experience [2]. This paper focuses on analyzing the data collected by IoT devices within smart buildings and using intelligent algorithms to optimize energy consumption and ensure sustainable resource utilization [3].

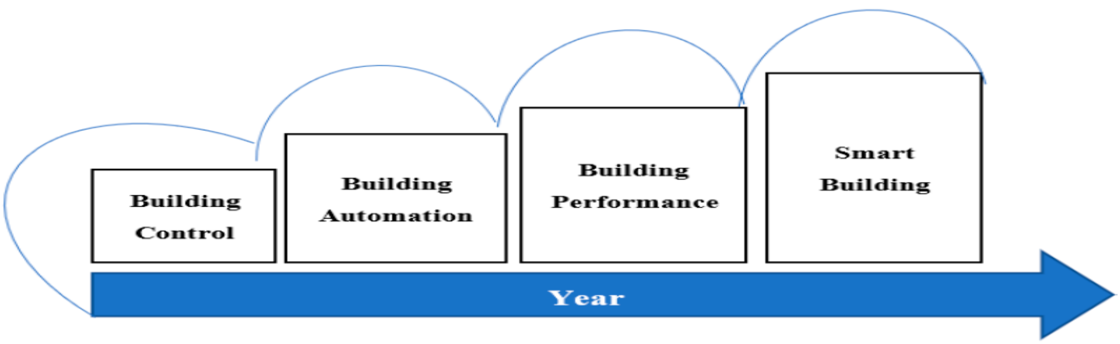

Figure 2. Challenges facing smart buildings.

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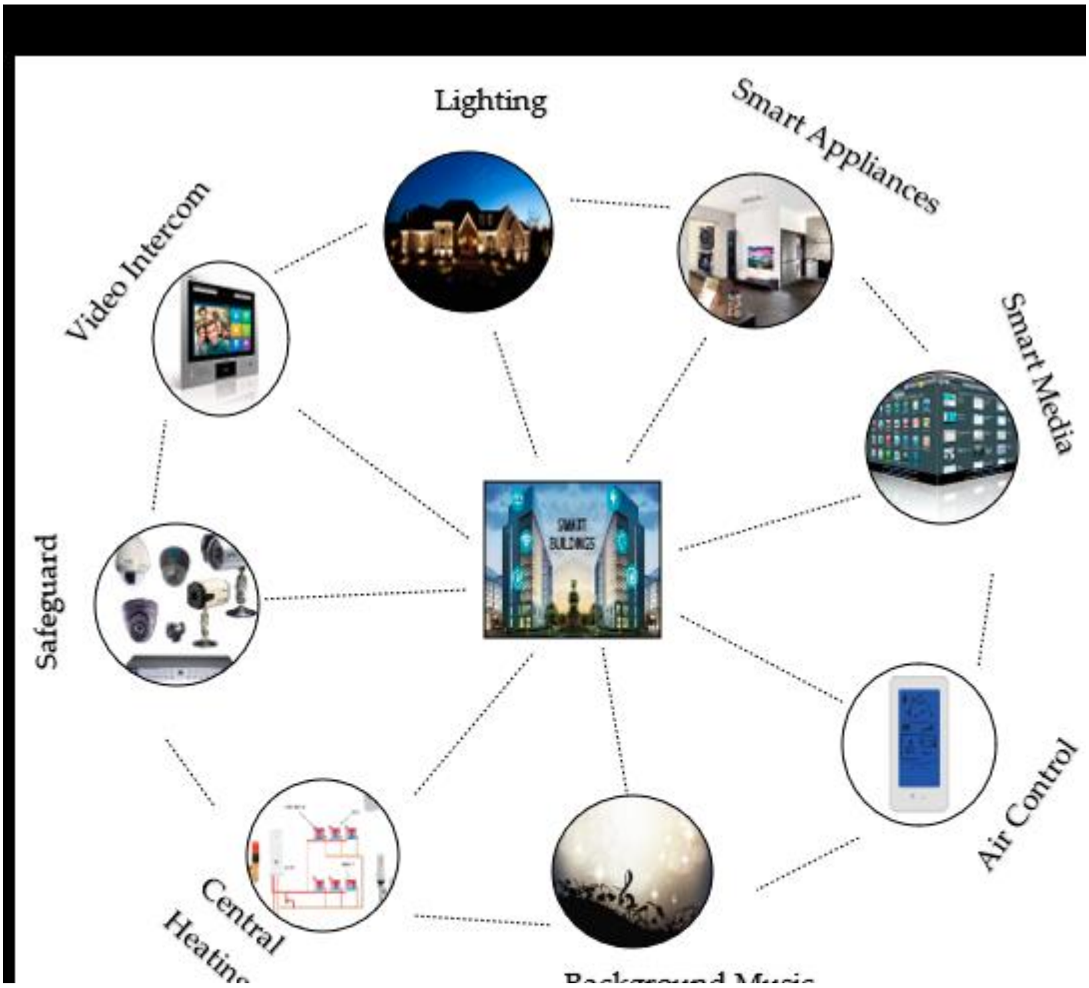

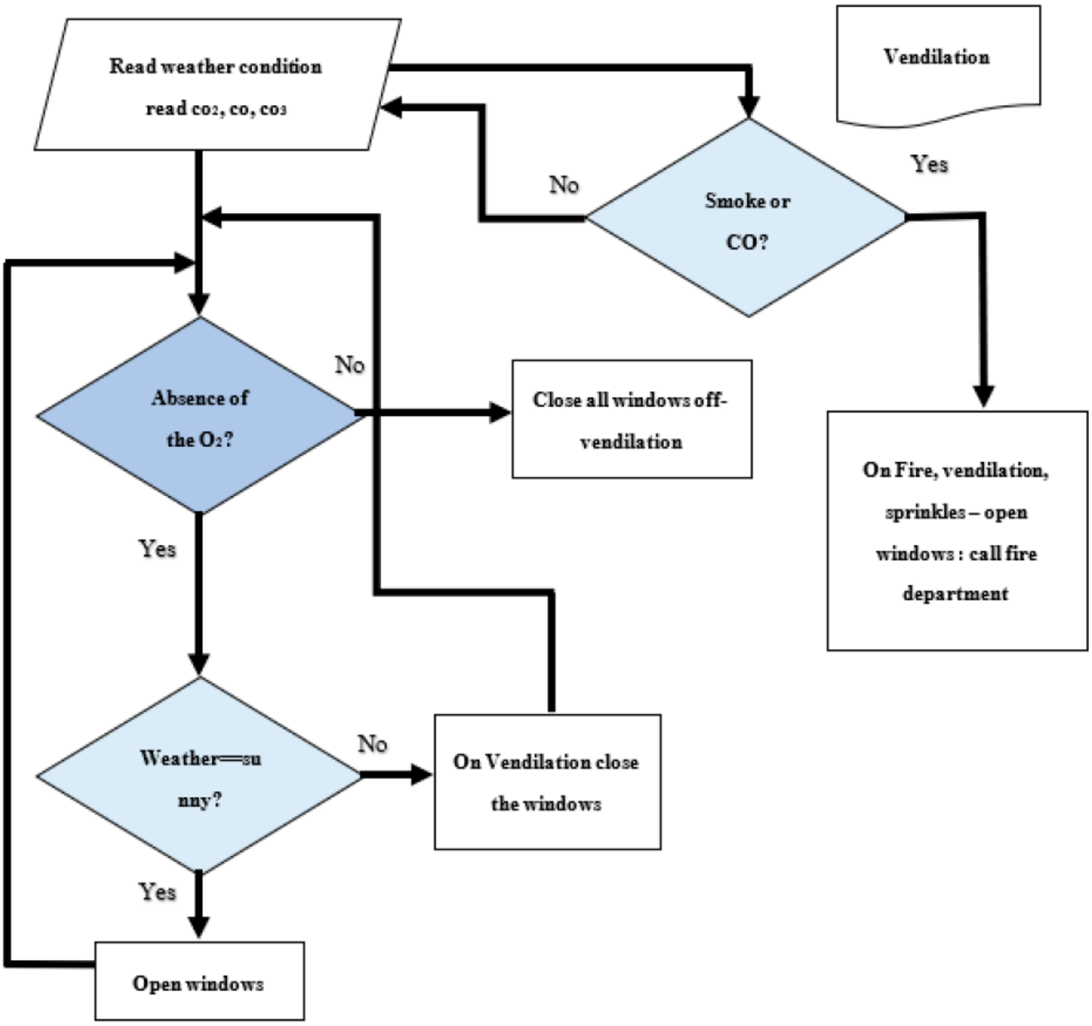

Figure 3. A Common Model of a Smart Building System.

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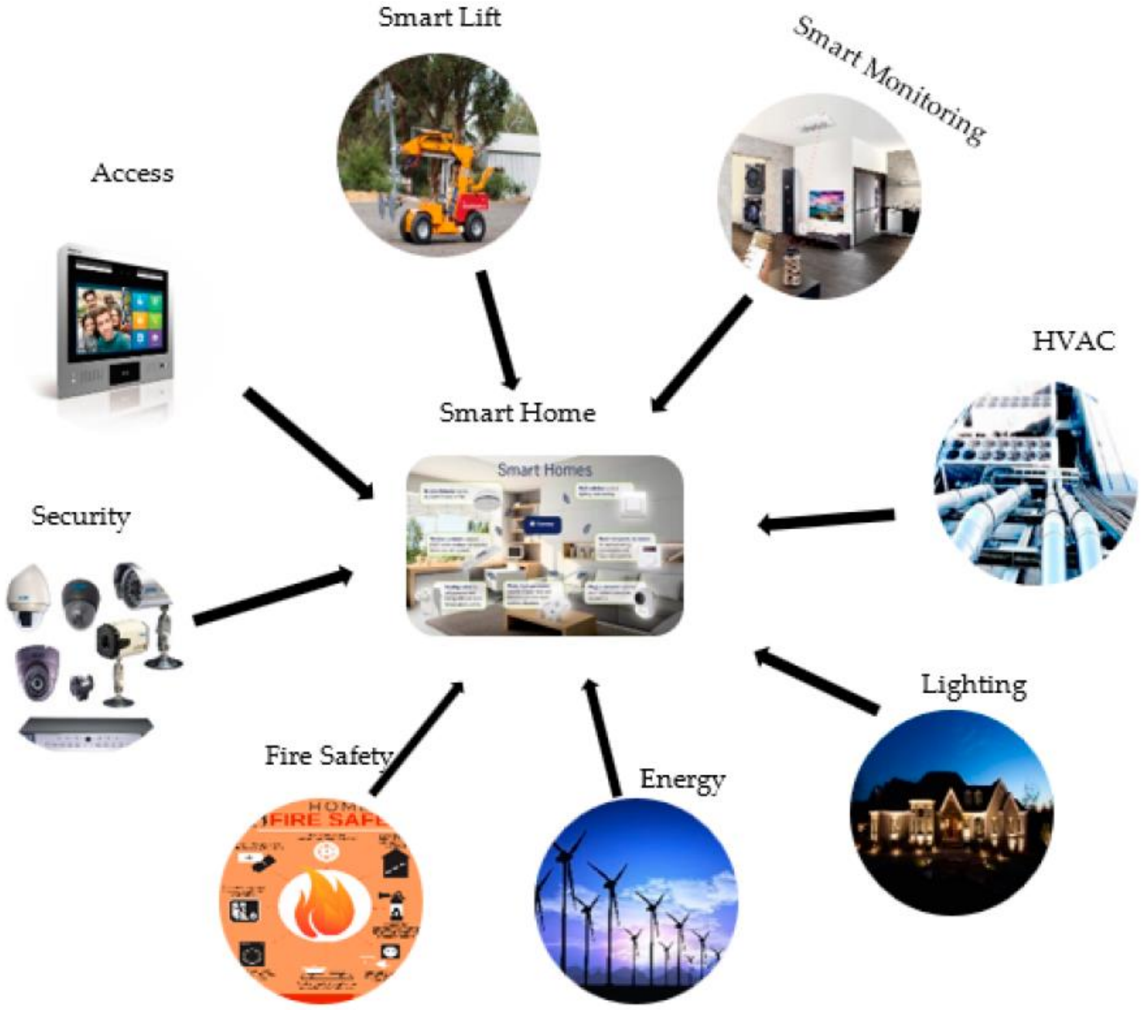

Figure 4. Network Convergence.

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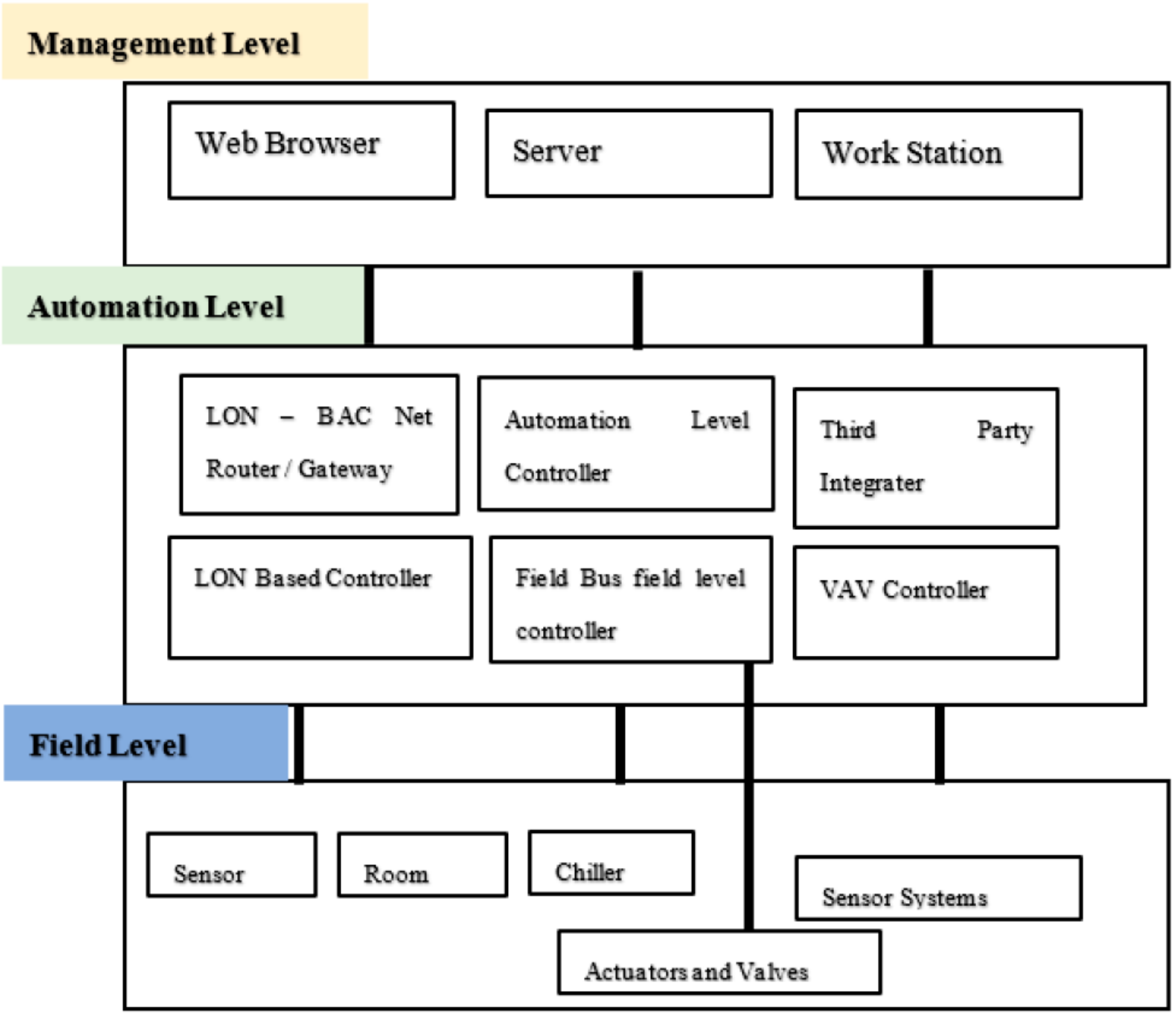

Figure 5. Integrated Control Systems.

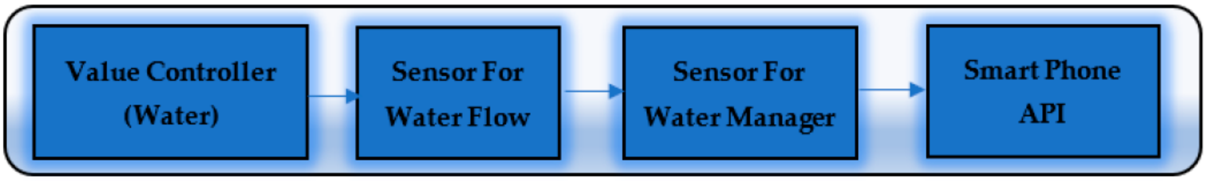

Figure 6. Water Conservation Method.

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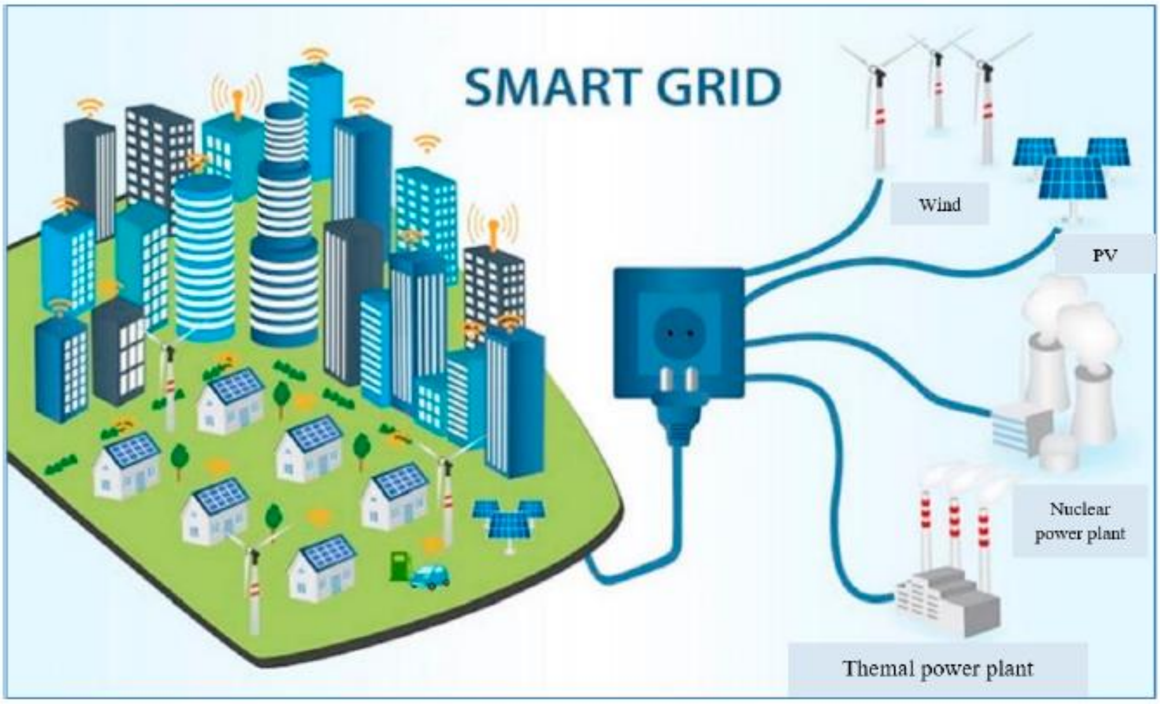

Figure 8. Intelligent Cabling System.

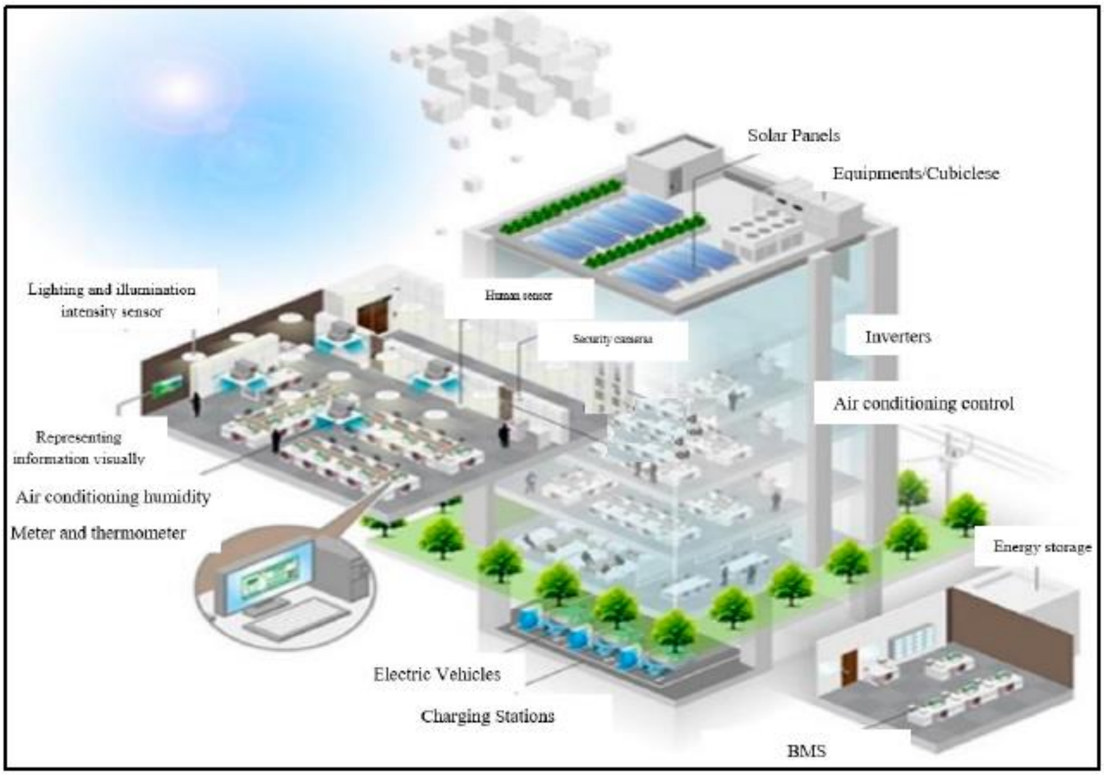

Figure 9. IoT-Based Energy Management Semantic Model (IoT-Energy).

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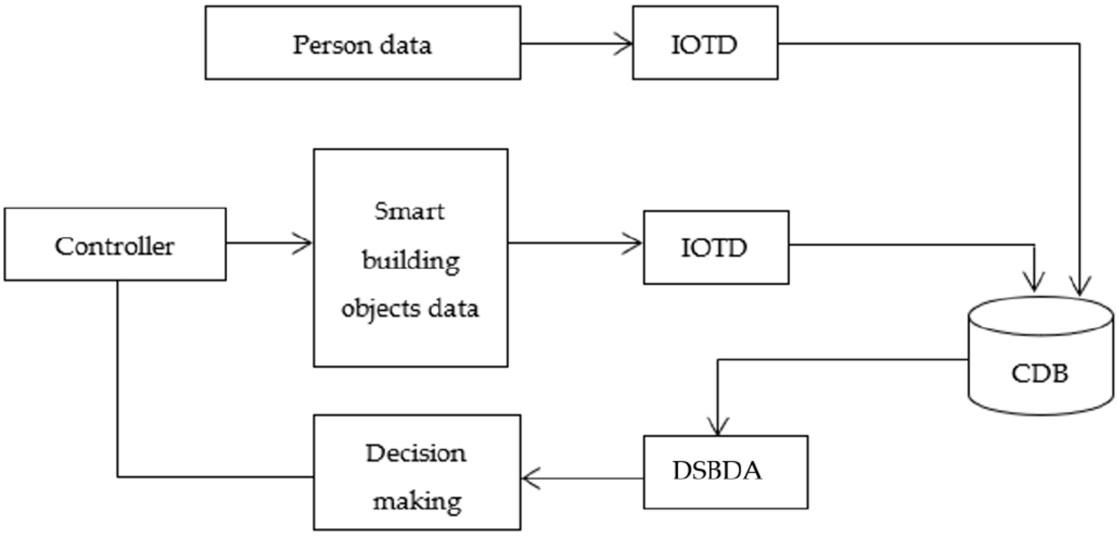

Figure 10. IoT-Incorporated Smart Building Creation.

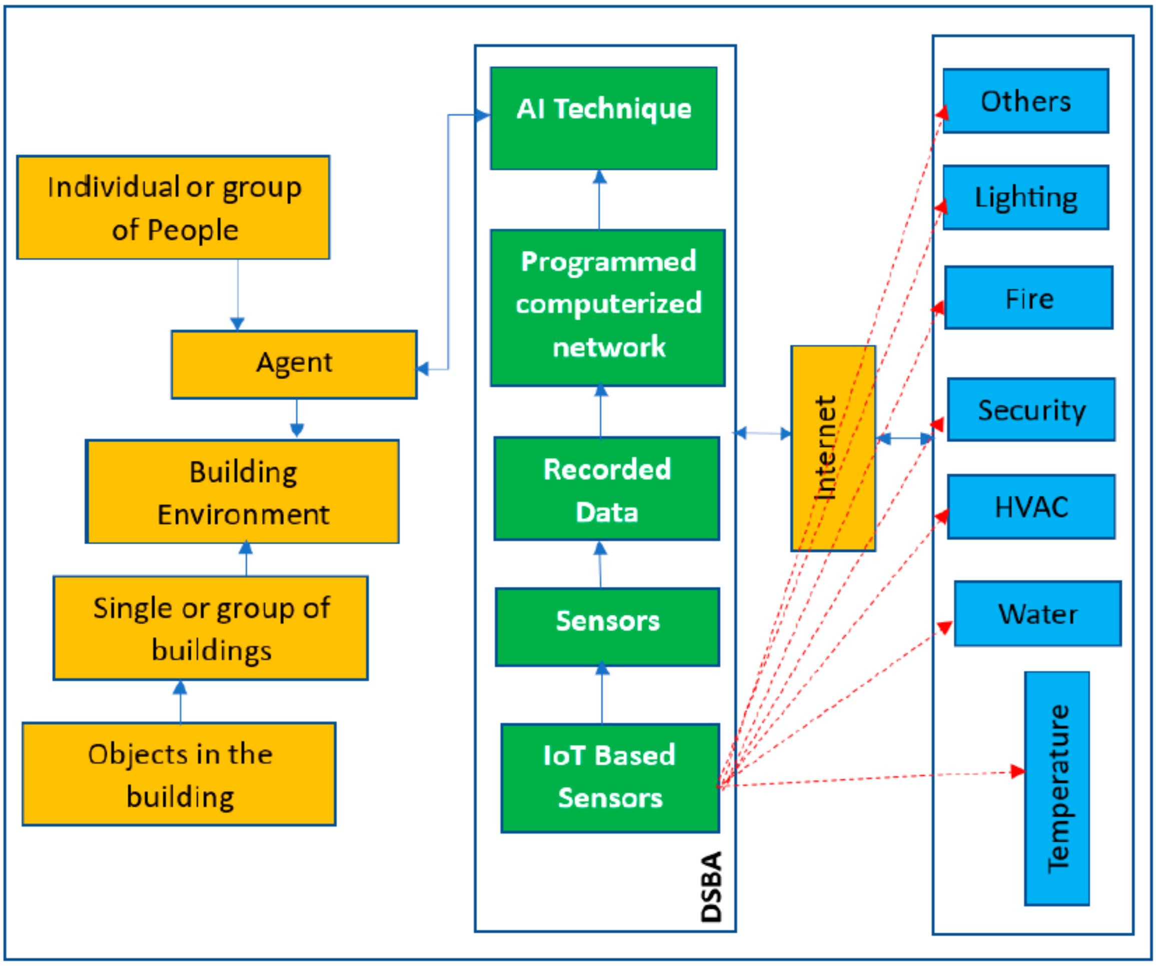

Figure 11. DSBDA Model.

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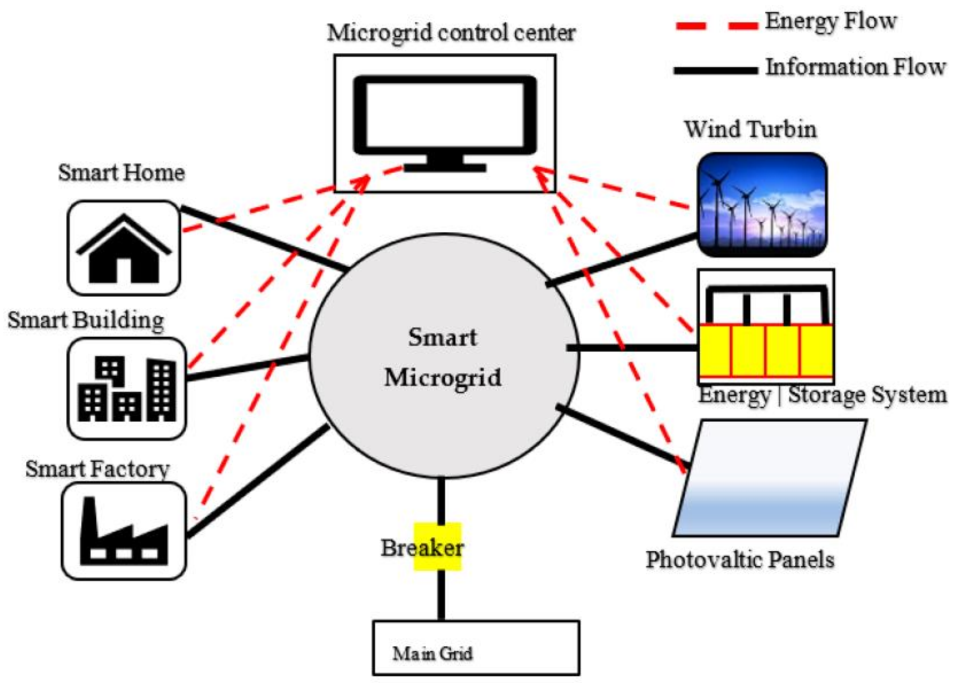

Figure 7. Advanced Communication Control System for Smart Buildings.

Results and Discussion

Many IoT devices are used for monitoring and recording different parameters related to energy efficiency in smart buildings. Each IoT provides the monitored data that the decision tree algorithm can optimize. DT is a supervised learning algorithm that analyzes all the parameters with defined constraints. A DT algorithm is created through a training process based on the minimum or maximum values, lower or upper bounds, and equal and unequal constraints over the data for predicting abnormal energy usage in the smart building. This paper incorporated various advanced technologies, IoT devices, and intelligent sensors to monitor and control prime factors such as energy, water, air, and communication to convert standard buildings into smart buildings and optimize them through a decision tree algorithm. Based on the proposed model, some benchmark datasets [39,40] have experimented with Python software to verify its performance.

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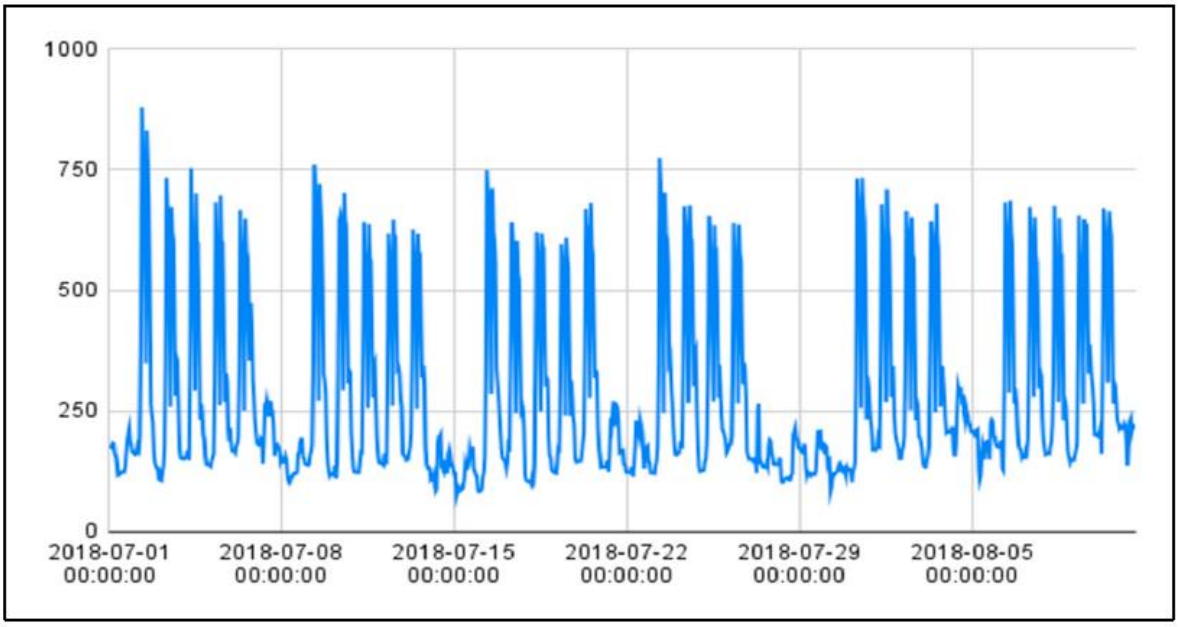


Figure 12. Power consumed in time frames.

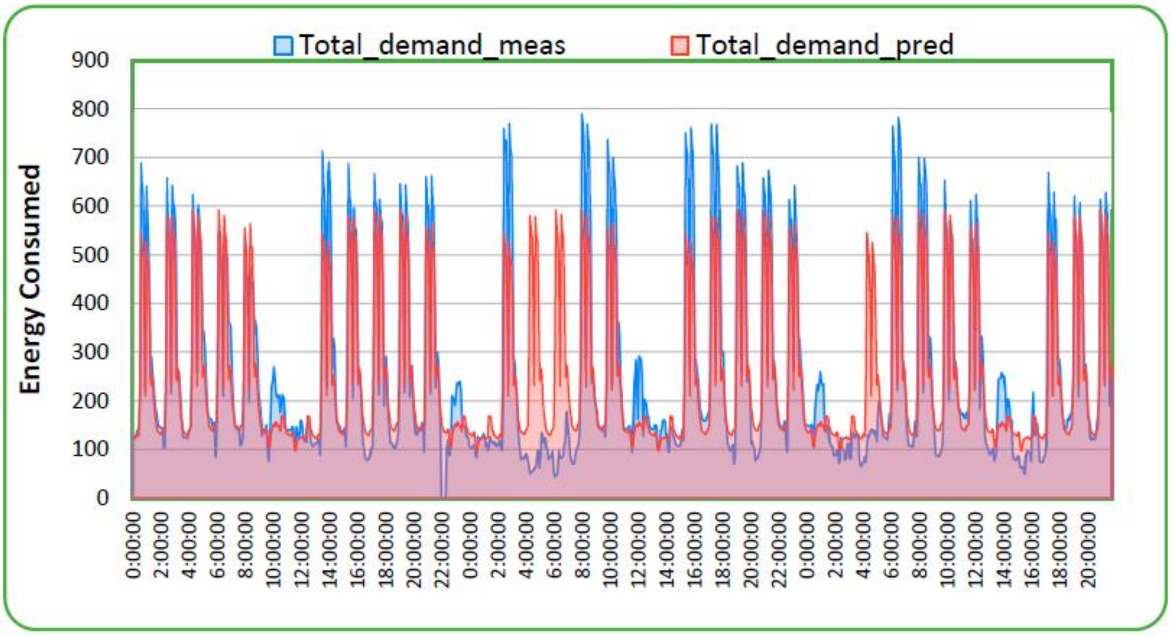


Figure 13. Prediction vs. real data.

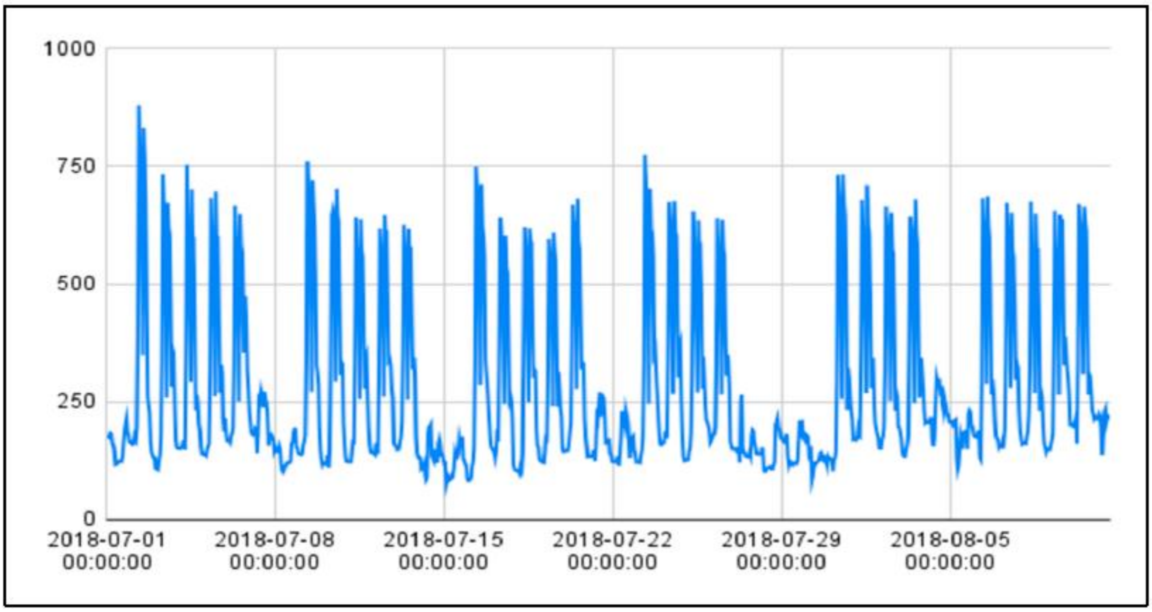


Figure 12. Power consumed in time frames.

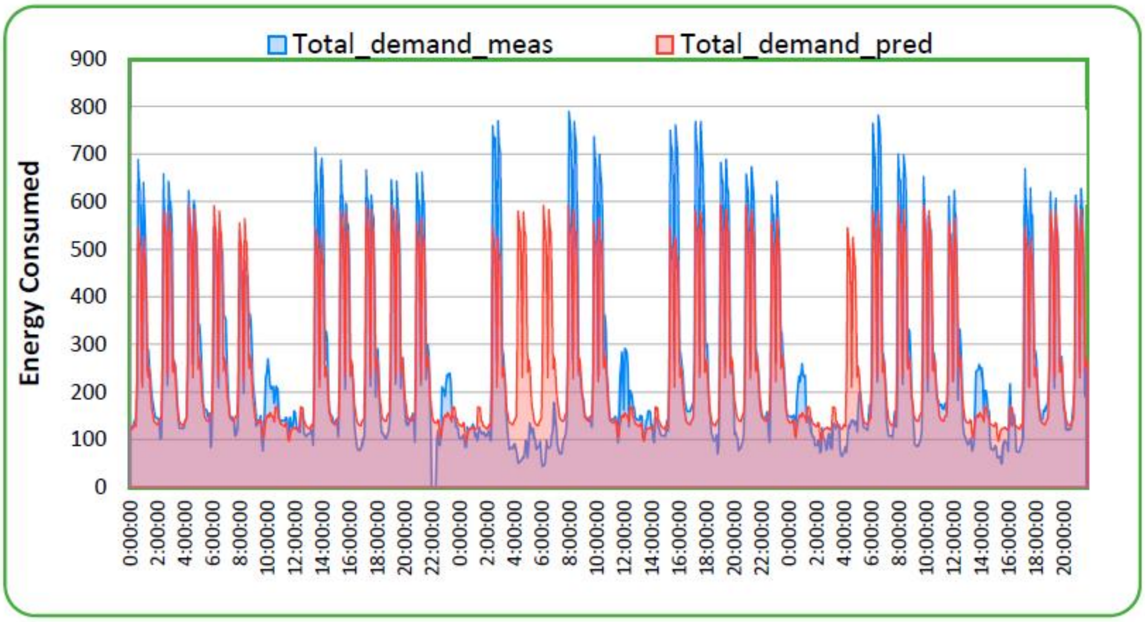


Figure 13. Prediction vs. real data.

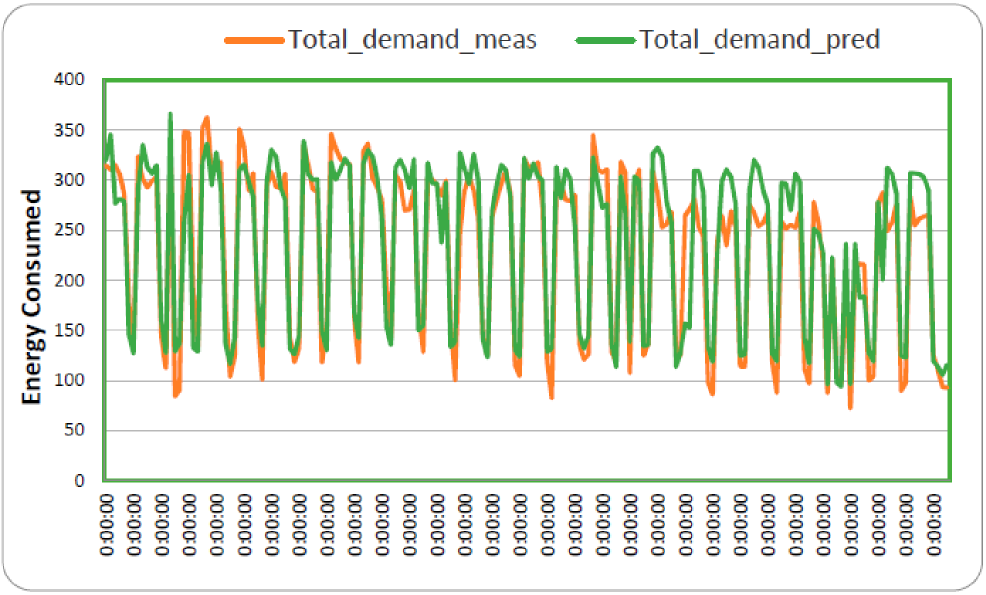


Figure 14. Total_demand_meas and Total_demand_pred comparison over time.

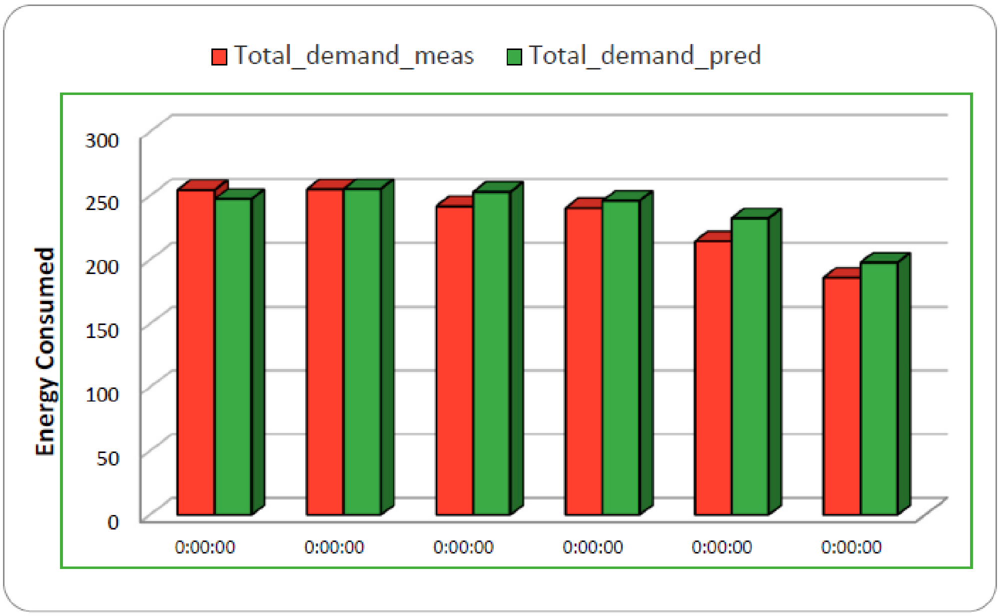
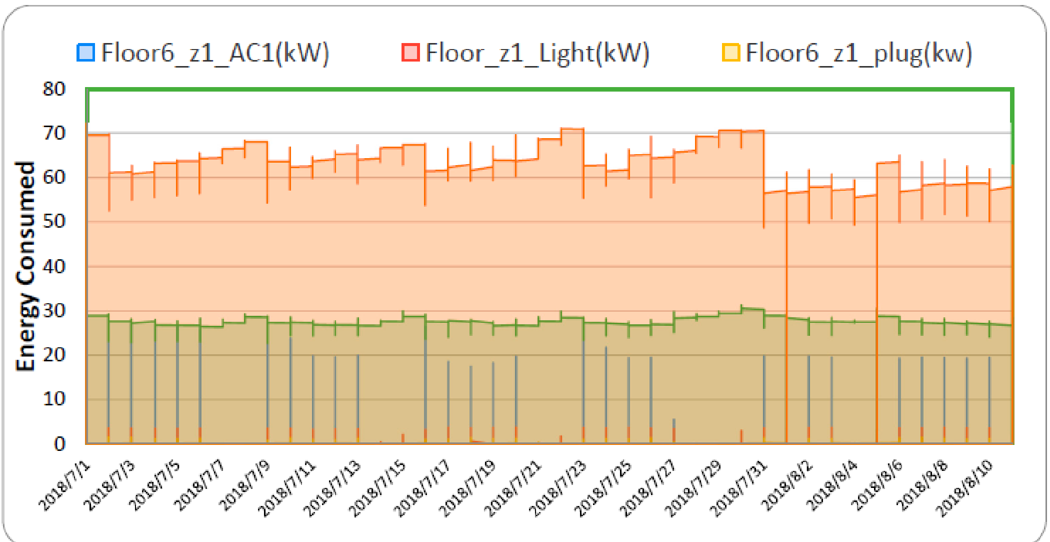


Figure 15. Comparison of Total_demand_meas and Total_demand_pred.



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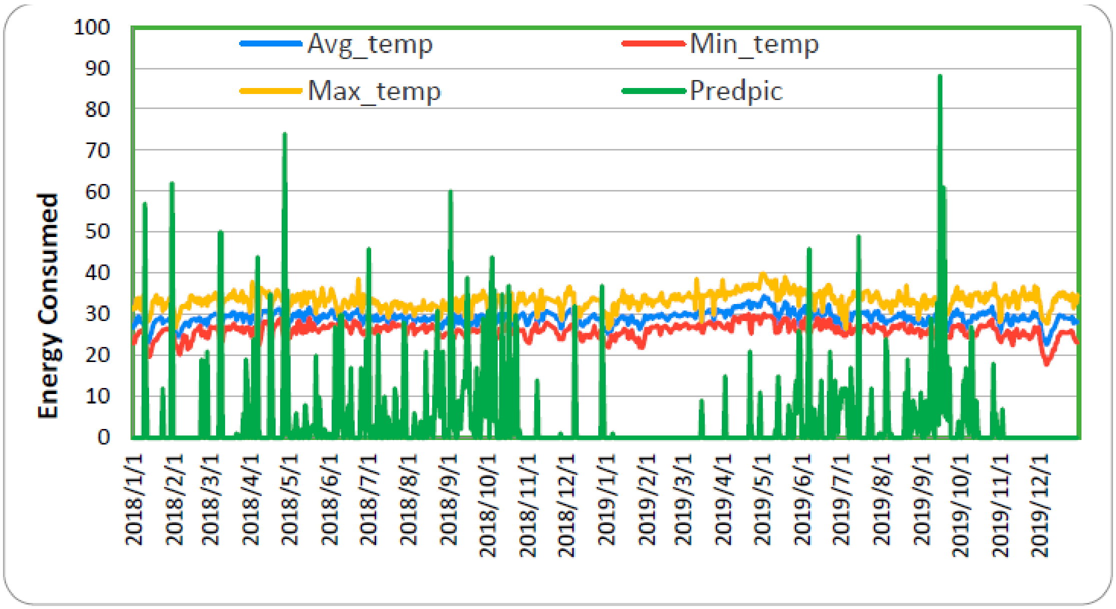

Figure 17. Temperature comparison for IoT.

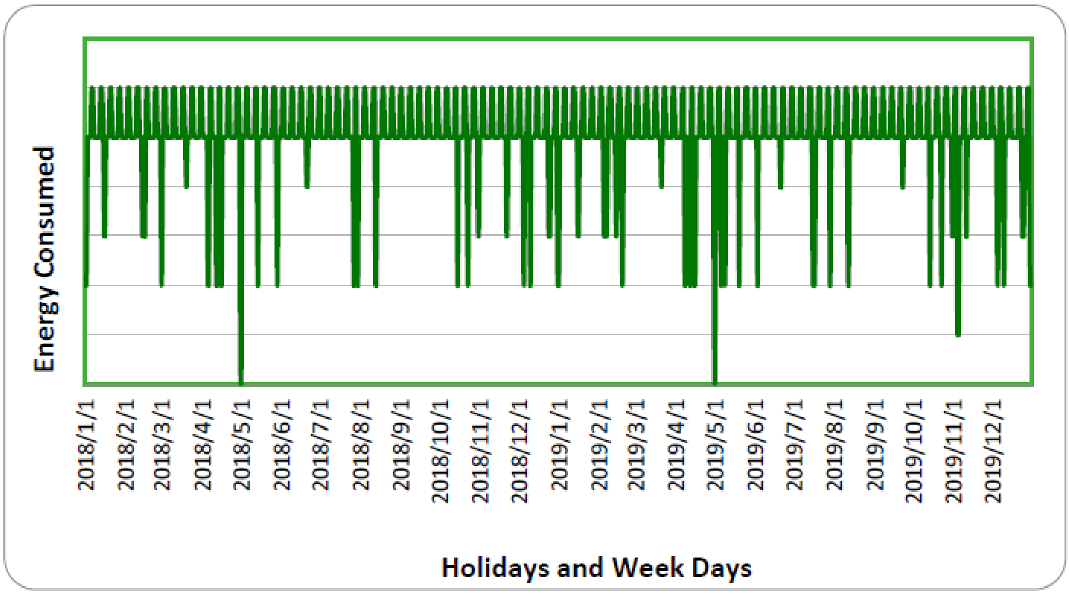

Figure 18. Energy comparison between holidays vs. weekdays.

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