

# Chapter 13

## Machine Learning–Integrated IoT–Based Smart Home Energy Management System

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### ABSTRACT

*The internet of things (IoT) is an important data source for data science technology, providing easy trends and patterns identification, enhanced automation, constant development, ease of handling multi-dimensional data, and low computational cost. Prediction in energy consumption is essential for the enhancement of sustainable cities and urban planning, as buildings are the world's largest consumer of energy due to population growth, development, and structural shifts in the economy. This study explored and exploited deep learning-based techniques in the domain of energy consumption in smart residential buildings. It found that optimal window size is an important factor in predicting prediction performance, best N window size, and model uncertainty estimation. Deep learning models for household energy consumption in smart residential buildings are an optimal model for estimation of prediction performance and uncertainty.*

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## **INTRODUCTION**

The Internet of Things (IoT) is a vast network made up of billions of intelligent physical items that are connected to other connected devices and the Internet via sensors, software, and other embedded technologies. In 2025, the IoT will have a considerable economic influence, with the energy industry accounting for 33% of the market. Given that a large portion of the population spends more than 90% of their time inside buildings, the rapid rise of the population, economy, and industrialization has increased energy consumption. The building industry is the largest energy user in the world, accounting for 39% of global energy consumption and 38% of CO<sub>2</sub> emissions. Up to 2040, the demand for electricity is anticipated to increase at a pace of 2.1% annually, which is twice as fast as that for primary energy. Heating and cooling systems have a major influence on how much energy is used in residential buildings, necessitating the best possible energy management. In order to lower electricity costs and optimize power usage, smart grid and smart house technology are gaining popularity. These technologies are crucial to the sustainable growth of smart cities, societies, and urban planning. Residential energy consumption forecasting is difficult and adds value to the field of energy efficiency and management research, which strives to advance smart urbanization in terms of planning for the management of the power grid and electric utility resources. By creating a reliable and sustainable energy consumption prediction model that can be used to control load management, defect detection, energy demand, and pollution mitigation, smart residential buildings may be enhanced (Amer et al., 2014).

Deep learning approaches have made it possible for analysts and researchers to create and train robust models for a variety of applications, including edge computing, robotics, sentiment analysis, computer vision, and more. The application of deep learning models to forecast energy consumption in buildings is highlighted in this section.

- Model deep learning Identify complicated linkages and understand hidden information using deep neural networks to forecast future energy consumption.
- Traditional machine learning methods concentrate on temporal information, but deep learning methods are better at modeling both temporal and spatial connections.
- To increase model accuracy, deep learning models include feature engineering.
- Large datasets can be handled by deep learning models, however this is dependent on their depth and particular architectures.

A sustainable machine learning model for estimating household electric energy usage using an improved sliding window technique is presented. It focuses on quantifying model uncertainty and evaluating the suggested work in comparison to the base model and competitive benchmark using the considered energy dataset (Chen et al., 2021).

Ninety-six percent of businesses are using IoT-based technology to better monitor and manage their physical resources, while 67 percent of developers are creating IoT-based technology owing to its adaptability and effectiveness. But for the Internet of Things to succeed, several technologies must work together to provide an additional layer of intelligence. Smart cities, transportation systems, and manufacturing applications are driving the IoT, and it's predicted that 50 billion gadgets will be connected in the next 5 to 6 years. Validating the large number forecast by Cisco, IDC, and Gartner is difficult, though. The Internet of Things (IoT) is a platform that enables sensor-based objects to communicate and exchange data in an intelligent setting (Jeevanantham et al., 2023). The true value of the IoT lies in creating intelligent

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