# MACHINE LEARNING FOR INTELLIGENT ENERGY CONSUMPTION IN SMART HOMES

*Asem Alzoubi*

*International Energy Consultant INTEC & Hamm-Lippstadt University of Applied Sciences, Germany, asem.alzoubi@gopa-intec.de*

## ABSTRACT

The growth of personal pleasure is a direct result of a person's ability to provide themselves with energy. Since people may construct and enhance their way of life more swiftly with current innovation, valuable energy has become a sought-after expansion for many years due to the utilization of smart houses and structures. The demand for energy is greater than the supply, resulting in a lack of energy. In order to keep up with the demand for energy, new strategies are being developed. Many areas' residential energy use is between 30 and 40 percent. There has been an increase in the need for intelligence in applications like as asset management, energy-efficient automating, safety, and healthcare monitoring as a result of smart homes coming into existence and expanding. Energy consumption optimization is being tackled with the use of an energy management approach in this study. There has been a recent surge in interest in data fusion in the context of building energy efficiency. Accuracy and miss rate of energy consumption predictions were calculated utilizing the data fusion technique presented by the proposed study. Simulated findings are being compared with those of previously reported methods. It also has a prediction accuracy of 92 percent, which is greater than that of any other technique that has been previously reported. It's becoming increasingly important for households to keep their power costs down as the amount of electricity they consume rises and dispersed new energy sources are introduced. The installation of a home energy management system is a practical solution to these issues.

**Keywords:** Intelligent, Energy Consumption, Smart Homes , Fused Machine.

## INTRODUCTION

The model of home energy management given in this research aims to optimize the energy mix in the house. Electric cars, household appliances, distributed generation, energy storage, and electric vehicle charging, and discharging are all taken into account. Self-regulating hems is able to adapt to changes in rates and household power use [1,2,3,4]. Hem's structure and method for optimum scheduling are described. Discussed include the smart grid and demand response, smart home technology, new energy production, energy storage, and other related technologies. It is also discussed and examined how the hems and other future development paths may best schedule and use power consumption devices and energy sources to maximize efficiency. On the basis of advanced metering infrastructure, a hems architecture is given. Data storage and scheduling in the house are handled by a local information management terminal. It is possible to create an optimum simulation model for the scheduling of a new home energy management system based on timely grid purchases and power production in conjunction with photovoltaics. It is also discussed how artificial intelligence may be used in the hems [5,6].

The smart grid, house, and meters of the hems make it an intelligent network control system. An all-in-one management and control system for power production, consumption, and energy storage. hems can help consumers save money on their power costs by increasing the efficiency of their home's renewable energy sources [7,8,9,10]. The conventional power market lacks consumer engagement and has a single electricity pricing structure, resulting in both an inadequate supply of energy during peak hours and wasted electricity during low hours. As a result, the peak and off-peak rate system is implemented, which aids consumers in adjusting their power usage schedules [11]. Nevertheless, it lacks the ability to adapt to changes in demand and supply, making it less accurate. In addition, hems can fully interact with the power grid to obtain an accurate real-time price, cooperate with generation, and load forecasting, perform an intelligent allocation of household energy, optimize the allocation of household load in the time dimension, achieve demand response on the customer side, relieve grid pressure during peak hours, and improve grid stability. This new generation of information technologies, including internet of things and cloud computing, mobile internet, and big data — coupled with the home as a carrier to create a low-carbon and safe family lifestyle is called a "Smart grid," And hems is its smallest component. Flexible control of numerous home appliances is achieved by integrating distributed power technologies such as photovoltaics and energy storage [12,13,14,15,16]. An increasing number of researchers are looking at how to make hems more efficient in terms of cost, comfort, and load shedding [18,19].

**Problem definition:**

According to extensive study, a smart model for a house's electrical consumption has been developed that aims to maximize peak load-shedding and minimize cost. A different approach is to examine how home appliances and household power use are linked, with the objective of reducing electricity costs and increasing comfort [20,21,22,23,24,25]. The influence of electric cars and energy storage devices on the optimization of smart houses is also being studied by researchers to suggest a real-time control strategy for energy storage devices. Studies on smart home energy management, charging and discharging procedures for energy storage devices, as well as rational allocation approaches have been mostly absent from the literature. Optimal scheduling of power consumption devices and energy in the hems is examined in this study, as are smart grid and demand response, smart home, new energy production, and energy storage technologies; and an analysis of the hems is presented. The hems framework is also discussed in this paper because of the importance of this technology. Optimized simulation model for hems scheduling is designed based on timely grid purchases and system production. Artificial intelligence in the hems is being suggested as a potential use [27].

**Research Objectives:**

Rising focus has been paid to decreasing the cost of electricity for residential users as a result of increased home power usage and the introduction of distributed new sources of energy. These problems may easily be solved by installing a home energy management system (hems). As a result of this study, a model for optimizing the residential energy mix is provided. There are considerations for electric vehicle charging and discharging, as well as the operation of household power consumption equipment, distributed generation systems, and energy storage devices [28,29,30]. It is possible for hems to adapt to variations in energy costs and use patterns inside the home. The construction of hems and the most effective scheduling method are discussed. It includes smart grid and demand response, in addition to smart houses and other essential technologies like novel energy production, energy storage and more. Also mentioned and investigated are the optimal scheduling of power consumption devices and energy sources in the hems. The advanced metering infrastructure serves as the foundation for a hems design (ami). Homeowners may access their personal data through a local information management interface. A simulation model for the scheduling of a new home energy management system is created based on the timely purchase of power from the grid and the generation of electricity in combination with pv systems. The hems may potentially benefit from the usage of artificial intelligence.

**Solution suggested:**

A distributed intelligent solution may be built in a given way. Self-contained object with semantic interoperability and protocol interaction. It is a distributed technique in the field of artificial intelligence. Because of its adaptability and openness, it has a promising future in today's dispatching automation systems. There are two modules: One for actions and objectives to be accomplished, and one for external information. Data from the sensor is processed by the information processing module, which makes suitable decisions based on the information. In order for the agents to cooperate, the communication module provides the essential conditions. For more flexibility and effectiveness, the agent makes use of its own rule library. The mobile agent server (mas) accomplishes the overall system goal by coordinating and guiding each agent. There are three basic forms of mas system architecture, as previously mentioned: Centralized, decentralized, and hybrid [31,32].

Our edge-based energy forecasting system for smart grids, as well as the subsequent contributions, are designed to address these issues in regulated networks utilizing deep learning algorithms quickly and effectively.by using an edge intelligence-based unique and adaptable architecture, we control energy demand changes by connecting suppliers and consumers to one platform for effective communication based on our algorithm's future projections [33,64,65,66,67,68].

or the deployment of resource-constrained devices at various consumer locations (smart homes or industries), we offer an architecture that uses an iot network to connect to a cloud supervisor server and upload current demands and inform about future requirements. To provide effective energy management, smart grids transfer the precise amount of energy necessary in response to cloud server requests from homes and businesses. In order to identify any unexpected energy usage by users, the cloud server filters out all requests. As a bonus, it stores energy projection data that may be used for further investigation [69,70,71,72,73,74,75,76,78].

We show that our framework provides a paradigm for future edge-intelligence-based energy forecasting systems based on our thorough testing. After picking a normalization method and a sequential model, we evaluate our framework's performance to that of each model. Series learning models are studied in terms of their execution times to identify the correlation between model running time and accuracy [79,80,81].

## METHODOLOGY:

Two load prediction datasets were used to try out this new research method, and the results reveal that it outperforms the current state of the art. Follow-up research on stiff used wavelet transform and evolutionary elm to forecast energy. An algorithm that predicts up to 24 hours in the future using elm and a modified artificial bee colony algorithm has been proposed. With the artificial bee colony approach, a set of input weights is used to help the elm pick the best parameters. The authors used ISO new England and North American electric utility data to produce new, cutting-edge results. The full structure is shown, which divides industrial and household energy usage into two basic tiers. For example, the first layer depicts energy management in terms of demand and supply in both the household and industrial. The resources (windmills and solar plants) provide energy to grid stations, which distribute it to a wide range of customers, mainly in residential and industrial areas. Predicting and controlling energy use is the primary responsibility of the energy management layer, with a cloud server serving as a middleman between clients and smart grids [34,35].

The cloud server saves, processes, and delivers energy demands from families and businesses to the grid station for distribution to the relevant consumer. It is essential to our strategy because it supplies consumers with a resource-constrained gadget for forecasting future energy demand. For now, we can only assume that the grid station will acquire enough energy from the available resources, as we have no way of knowing for sure [81,82,83,84]. As a component of the iot personal and social application sector, home automation provides a wealth of possibilities for new and helpful applications. It is possible to automate a house's security, energy management, and well-being by using a variety of home automation systems. In a home automation system, the term "Comfort" Refers to all of the actions taken to enhance the way residents of a home feel while in it. Despite this, iot-based home automation confronts a significant obstacle [85,86,87]: The lack of interoperability amongst communication technologies [50]. Unified protocols and various lifestyles among users in smart cities are to blame for this dilemma. Our system, hems-iot, is described in the following sections, and a case study is discussed in which our system is used.

**Architecture Description:**

Home energy management system (hems-IoT) is a technology that aims to improve the safety and security of smart homes while also reducing their use of electricity. Machine learning and big data technologies are used to control energy usage in hems-IoT. Home sensors and demotic devices may be monitored in real time using hems-IoT. Energy usage and user activity patterns are assessed using machine learning algorithms, and suitable suggestions are made for reducing energy waste [88,89,90,91,92,93,94,95].

**Hems-IoT: Design and usability of a wireless sensor network:**

In order to keep the system running smoothly, hems-IoT employs a seven-layered design. As shown in figure 1, the hems-IoT architecture includes the presentation layer, the IoT services layer, the security layer, the management layer, the communication layer, the data layer, and the device layer. Each layer has a distinct purpose and contains many components that each serve a specific purpose inside their own layer. In the same vein

Using the internet of things (IoT), people are migrating from conventional homes to smart homes. Control, monitoring, and management of energy use according to personal preferences are all possible in modern "Smart" Homes [32,33,34]. Here, we'll take a look at some of the IoT-based efforts being made to improve energy efficiency in modern homes. We pay special attention to efforts that make use of big data and machine learning. According to kang et al., an IoT-based system that leverages an environment-sensitive service context generation model in the demotic space was presented. As an IoT platform, ims was built using open source software and hardware. Ims-based smart home services for health care and disaster management were also tried using the system. Additionally, a smart home design was used to develop a wsn optimization protocol. An access point connects the outdoor and interior surroundings of this structure. A smart phone may be used to operate the user's house from any location at any time. The SQLite [50,51,52,53] database system was utilized for the implementation, and several tests were run to verify the results. For home service settings, a web services architecture was suggested. The structure is made up of three layers:

- Information Layer
- Management Layer
- Presentation Layer

New IoT service composition was generated using the service overlay network. Montesdeoca- Contreras, on the other hand, created an internet of things (IoT) application to manage and monitor smart dwellings. In other words, the app gives customers the ability to keep an eye on and operate demotic devices through voice or tactile features, as well as a safety net. App inventor and android studio were used to create the app [35,36,37,54,55,56].

An IoT application model-creation technique was presented to help create robust, energy-efficient systems for home protection. To save energy, the model leveraged the overlap between device features to temporarily deactivate portion of them. Smart home energy management system architecture and shedding algorithm for house energy consumption based on domestic renewable energy sources, wireless connection between demotic devices, a control system, and a home management system, and on grid management [57,58,59]. It also provided an efficient and intelligent approach for saving power the heat dispersion in the kitchen area of IoT-based houses with a cooling system was presented using a virtual model of flow. When a person leaves or enters the kitchen, the system remotely adjusts the temperature and lighting. They developed a smart home energy management system (ems). The ems depends on mqtt (message queue telemetry transport) [60,61,62,63], which is driven by business intelligence (bi) and analytic, and employs big data to make sense of the information. The h vac (heating, ventilation, and air conditioning) system was used to test the system in a modest residential area.

## The management of energy in smart homes

Neural fuzzy networks have been used to regulate household appliances. Matlab was used to build a neural fuzzy logic controller, which was then translated into a tool using hardware and internet technologies. Using this method, household appliances may be programmed to operate at certain times and consume less energy. In essence, it mimics a human's behaviour by watching and perceiving the actions of its residents within the house and providing them with the services they need. It is possible for household equipment to keep track of occupants' daily schedules. These activities are coordinated in such a manner that the residents feel safe and secure. Makes use of an energy-saving technique based on data gleaned from household appliances. Ip, XML, and java-based networks are used by most home appliance manufacturers in order to manage and control devices that operate on the basis of operational information from the user. To communicate code, XML is utilized to send data, while java is used to develop software for appliances. By replicating 100 households with 16 distinct home appliances, an experiment has been carried out to see how one item affects the other. The simulation findings revealed that the appliances reduced energy usage by 15.6 percent when compared to manually operated equipment. As a result, smart homes were shown to be an effective way to cut down on energy waste by employing equipment that run on their own. Another benefit of conserving energy is that it may be put to good use elsewhere.

## Efficiency in the use of zigbee in the question for efficient energy resources

Residential power usage has skyrocketed in recent years as a result of rising energy prices and the proliferation of unnecessary household equipment. Humans have had to develop new sources of energy due to increasing power use and depletion of natural supplies. Many environmental issues, such as rising global temperatures, ozone depletion caused by pollution, and more, have raised demand for natural resources that are not abundant. In order to develop an efficient source of energy, we will need to change both the way energy is delivered and the way it is used [18]. In order for the devices being utilized to deliver uninterrupted service, an effective and continuous communication protocol is required. When wireless technology and output optimization are combined, the end user may reap the benefits of wireless technology in most power-related applications. Home energy management systems often use the zigbee wireless network. As a generic communication protocol, it uses less power and is more cost-effective than most others.

## DISCUSSION

Researchers in the field of energy monitoring utilizing different energy sensing devices are interested in accurately predicting future energy use. Many academics have turned to machine learning, deep learning, and their many in variants to help them accurately anticipate the future energy needs of various real-world situations. A few researchers have been able to provide findings that can be used in the real world, despite the difficulties in the ilf domain. Researchers found that ilf approaches focused on smart grid synchronization and residential structures are lacking. For effective and instantaneous decision-making, there is no existing literature on transforming energy forecasting methodologies into edge nodes [38,39,40.41].

The evaluated literature includes open research topics about the practical use of functional algorithms. Energy forecasting-related research articles need remote sensing capabilities with implementation potentials that can demonstrate the practical application of these algorithms in residential and industrial buildings. The adaptability of any method for various time horizons is another research question in the reviewed literature. When it comes to long-term sequences and series, for example, how will an stiff technique perform? In the same vein, consider the accuracy of any forecasting method under conditions where weather conditions, government policies, local resident behavior, and a host of other influencing factors are highly variable [42,43,44].

First and foremost, we hope to conduct a comparative study of the currently used techniques by putting their algorithms into practice. Next, we'll look at how if can be used in smart cities, smart homes, and smart industries with resource-constrained devices. Similarly, there aren't any methods for predicting consumption over the long term, so we plan to look into this in the near future [445,46,47,48,49].

## CONCLUSION

With a broad range of applications, energy forecasting methods play an important role in energy management, from tiny residential consumption and production prediction to big industrial/smart networks. These methods aid in the planning of energy production and consumption, the control of the duration of power loads, and the scheduling of grid systems to guarantee dependable and stable functioning. Modern energy utilization necessitates the use of ilf methods to keep things running smoothly. For this reason, we conduct a complete review of the current literature on load forecasting, which spans from 2011 to the present day.

In this study, we looked at ilf methods from a variety of angles and discussed their benefits and drawbacks. It is important to note that we began by looking at the ilf domain as a whole, including its origins and uses. Next, we discussed divisions of ilf techniques on the basis of prediction duration and supported each category with appropriate references from the related literature. Our introductory part concluded with a discussion of the ilf domain's issues and the need for our review paper and its unique contributions. As we progressed, we covered the ilf literature year-by-year trends, followed by a complete overview of the current surveys, before presenting the ilf methodologies' working flow. Next, we discussed how ilf datasets may be used in a variety of ways, as well as the strategic information that can be gleaned from their utilization. The section on performance assessment of load forecasting methods follows, in which we highlight the key measures used in literature to compare ilf systems and assess their practical acceptability. For the last half of our work, we used past information and derivations from a thorough analysis of ilf methodologies to propose future research paths and present new trending components of research in the ilf area.

## Future Work

Sb's have a bright future ahead of them. The alarm will wake you up, and the sensors accessible will be aware of your waking up as well. In addition to the thermostat warming the space you are going to use, additional sensors such as light sensors switch on the lights in the building automatically. As you wait for your coffee to brew, a weather alert will appear on your phone. Other sensors in the kitchen and refrigerator will remind you of what you'll need to buy on your way home from work to prepare supper. When you leave the home, all you have to do is push a button on your phone to activate your car's self-driving capabilities. It will then begin monitoring and regulating your residence. As a result, the doors will be locked by themselves. As a result, appliances will be put into an energy-saving mode. A geofencing system may be used to detect that you've returned and prepare your house for your arrival. The thermostat warms things up, your garage door opens as you drive up, and your favourite music begins to play as soon as you step in.

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