

# Home Energy Management Systems

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**Abstract.** *Popularization of smart energy consumption systems leads to optimal usage of electrical components through the Home Energy Management System (HEMS) in order to reduce end-user electricity bills and increase their comfort. This paper presents a short overview of HEMS illustratively introducing the main components that HEMS contains. The main trends of this strategy are briefly described. The focus is placed on the benefits provided by HEMS.*

**Keywords.** electric vehicles, energy storage systems, flexible devices, home energy management, intelligent energy, photovoltaic systems

## 1 Introduction

In recent years, the reduction of energy consumption as well as the term energy efficiency has captured attention primarily because of environmental protection policies and economic benefits. In that context, the smart home, although relatively small, plays a crucial role in implementing energy-efficient policies, where end-users serve as decision-makers in home energy management (HEM) systems (Dorahaki, S., Rashidinejad, M., et al. 2022). The main motivation for end-users in providing HEM is cost billing reduction and their satisfaction (Alic, O. & Filik, U. B. 2021). Researchers have shown considerable interest in clean or renewable energy sources like photovoltaic (PV) power and wind turbines, alongside flexible loads such as electric vehicles (EVs).

Paper (Kong, X., Sun, B., et al. 2020) presents a two-stage optimization model that includes distribution generation and EVs. The multi-objective model includes end-user electricity cost and risk index considering overall end-user satisfaction and respecting the constraints of different home devices. A genetic algorithm is used for solving optimization problems. Furthermore, authors (Mak, D. Choi, D.-H. 2020). propose an optimization framework that coordinates HEM systems in the low-voltage distribution network (LVDN) and PVs in the medium-voltage distribution network (MVDN) considering flexible end-user consumption and PV production. To ensure the lowest cost of electricity bills and maximum comfort for

end-users, paper (Hou, X., Wang, J., et al. 2019) propose a method for energy management that optimally schedules home appliances, distributed generations, energy storage systems, and EVs. The authors (Tang Y.) present an optimal control strategy for HEMS that schedules EVs and energy storage devices. The main goal of this paper is minimizing electricity bills and maximizing PV production.

The following paper describes the concept of the smart home energy management system and gives the conclusion and future work.

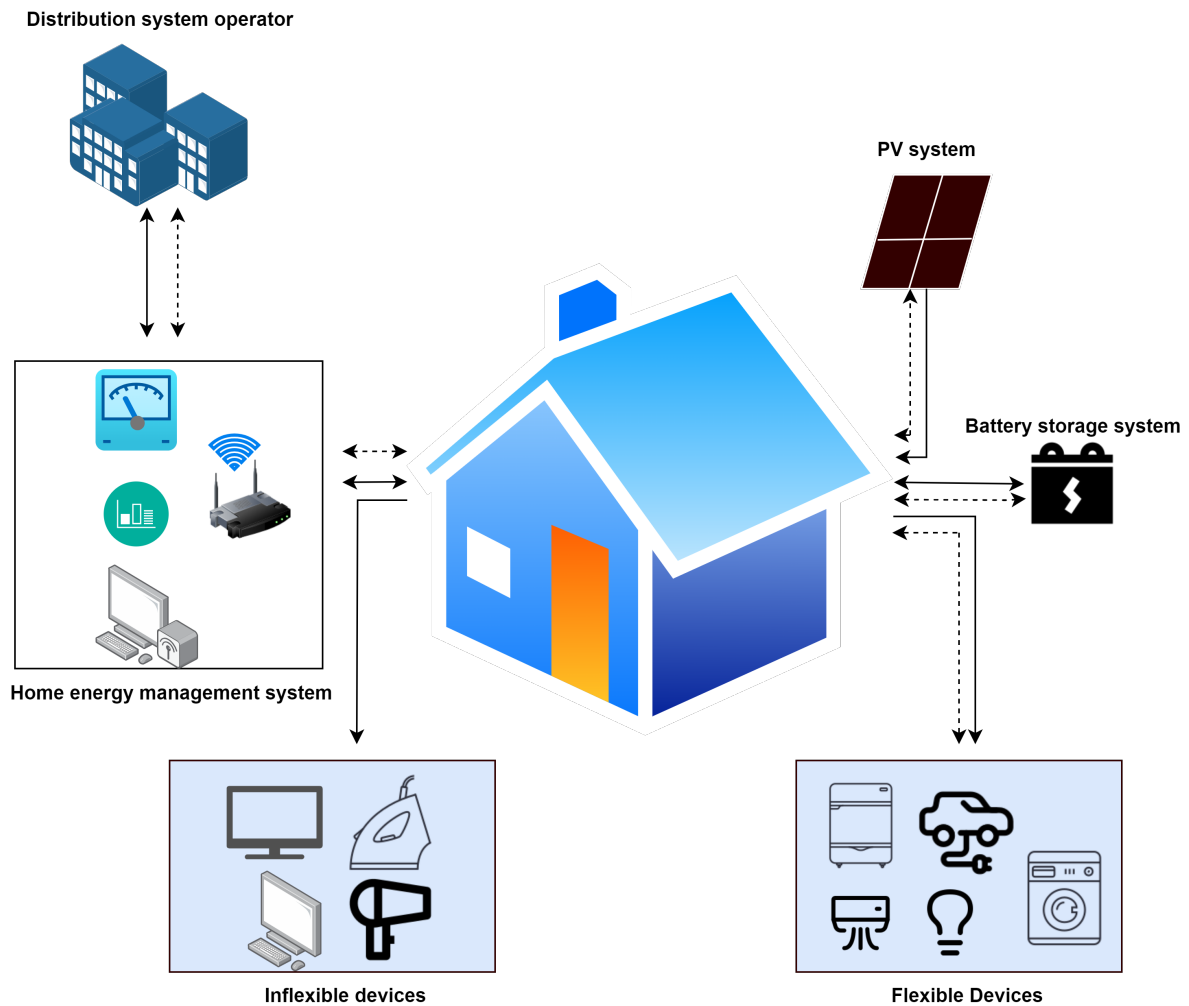
## 2 Home Energy Management System - Overview and Benefits

HEM represents a system that monitors and controls energy production from PVs, storage systems, and flexible devices. An example of HEMS behavior is shown in Fig. 1 (Kong, X., Sun, B. et al. 2020). In this figure, full arrows represent energy flows and dashed arrows represent communication. Except for elements, the main role of HEMS is a smart meter for providing real-time household consumption information, a monitoring unit for real-time visualization of energy behavior, a unit that controls flexible devices, and a built communication infrastructure.

HEMS brings many benefits in technical and economic fields. Firstly, HEMS enables households to optimize energy consumption leading to decreased waste of energy and increased energy efficiency. Secondly, HEMS promotes environmental sustainability by installing renewable energy resources in order to reduce carbon emissions. It can also support network stability and operation by participating in demand response programs. Lastly, with empowering awareness about energy, households can reduce their bills by intelligently managing energy consumption.

## 3 Conclusion

HEMS plays an important role in the transition towards more efficient and sustainable energy consumption within households. Managing smart households, which



**Figure 1:** Home energy management system.

comprise numerous appliances, represents a multidisciplinary process. To address all requirements and ensure the stable and secure operation of all components, it's essential to implement an optimization procedure. Through continuous innovation, HEMS empowers end-users to decide between their energy usage and advancing towards a more resilient energy future.

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