Integrated energy management

These environments play an important role in the Smart Grid. Smart grids consist of two parts, the supply-side and the demand-side, which optimize the energy production, transmission, distribution and consumption (Mir et al. 2021). Smart homes are a necessity for the demand-side of these grids because even if the supply-side is successfully optimized, a faulty demand-side, e.g. a conventional home/building, will decrease the total effectiveness of the system.

An immediate conversion of all residential and commercial buildings from conventional to smart, is a costly and time-consuming procedure. Even if governments around the world wanted to carry out this plan, the high deployment costs remain an impediment (Garc?a et al. 2017; Shigeyoshi et al. 2013). Therefore, research was expanded towards lower or no-cost energy saving solutions based on information and communication technologies (ICT) (Luo et al. 2017).

Before referring to IEMS, it would be useful to discuss about efficient energy consumption. There are multiple influential factors that cause energy overconsumption both in residential and in commercial environments. Moreover, a small discussion about various approaches towards energy efficiency. Our goal was to figure out which are the ways to achieve energy saving results and which implementations seem more promising for each installation environment.

Next, we wanted to proceed with the presentation of the IEMS architecture, and provide the reader with a categorization of their components and a classification of their sub-parts. During our research, a classification occurred for the IEMS in Direct Control IEMS and Indirect Control IEMS. Every IEMS can be classified in one of these classes based on the design of its actuation part. Besides various state-of-the-artcomponents we wanted also to show state-of-the-artcomplete prototypes that have been developed by research teams.

In the final parts of this article, we wanted to discuss about the advantages and disadvantages of each class of IEMS, compare their different aspects, investigate their major open problems and discuss about research gaps and future research orientations that will be helpful for researchers.

The first step to achieve energy waste reduction is to understand where it originates from. According to Ashouri et al. (2018), there are four major influential factors of this phenomenon:

Building characteristics Construction materials and insulation levels are obvious factors that increase energy waste in all types of buildings. van den Brom et al. (2018) conducted a research on performance gaps in energy consumption, revealing that recent buildings, constructed with modern materials, consume less energy than recently renovated older buildings. Furthermore, a difference between actual and theoretical (simulated) consumption was also noticed.

Occupants behavior Occupants affect the overall energy consumption, especially in residential buildings (Bourgeois 2005). Even in buildings with the same energy labeling, discrepancies can occur in consumption, depending on heater/cooler set temperature, hot water wastage, requirements of indoor environmental quality, lighting usage, etc.

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