A Design of Demand Response Energy Optimization System for Micro Grid

Sooyoung Jung and Jun-Ho Huh

Abstract This study proposes a demand response energy optimization system for the smart grid focusing on the commercial buildings. The system is effective and efficient in optimizing the energy used by the commercial buildings as it can control the energy use according to the characteristics of electric power load arranged on each floor when reduction of energy use has been requested by the demand response server.

Keywords Demand response · Energy optimization · Commercial buildings
Smart grid · Micro grid

1 Introductions

The demand response energy optimization system for the commercial buildings may include a multiple number of sub-energy managers that monitor and control one or more power loads arranged on each floor, one or more main energy managers that monitor and control one or more power loads by communicating with a number of sub-energy managers, an energy management system server that stores the information about these loads by communicating with one or more main energy managers, and a demand response server that communicates with one or more main energy manager and transmits the information about the external demand reduction request to the sub-energy manager. The system is effective and efficient in

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optimizing the energy used by the commercial buildings as it can control the energy use according to the electric power load arranged on each floor when reduction of energy use has been requested by the demand response server.

2 Related Research

In Republic of Korea, there is a need to build an IoT energy technology-based smart micro grid platform to cope with the zero-energy era and arrival of the future hyper-connectivity era. Likewise, industry requirements include the top-priority technology development items of participating companies in projects such as smart grid demonstration/distribution projects and areas where there are difficulties in direct development including the optimization of production/consumption energy and optimal operation of facilities. Securing these future source technologies and global competitiveness necessitated acquiring leading technology related to the optimal operation of Micro Grid and energy sharing in Smart Grid according to the paradigm shift of distributed energy) [1–3]. The Micro Grid sector is an area for solving global climate change and energy shortage problem, and the competition for market preemption has been intense among global companies. The micro grid-based real-time energy sharing and trade area has remained at the initial stage; hence the need to develop initial technology to a field that is available for pre-emptive market occupation through the concentration of domestic technology capability [3–7].

Also, Since Republic of Korea depends on nuclear power plants, there is a need to secure an innovative energy paradigm support system through the development of real-time energy resource management system based on IoE (Internet of Energy) for energy self-support/sharing centered on C2C (Community to Community).

The ZEC-SES integrated management server system manages the power generation and storage resource status based on the energy resources distributed in adjacent areas of the customers and provides a method of responding to distributed resources based on priority so that energy can be supplied to customers stably and economically. It also performs periodic monitoring of the distributed energy resources to check if they can respond statistically. In addition, it provides energy to an energy-vulnerable area by clustering on a priority basis. Meanwhile, incentives are allocated for the distributed resources used for energy supply and demand based on priority and energy demand [7–11].

Multi-MG/EMS interlocking interface technology is interfacing technology for the Inter/Intra-MG and H/B/F-EMS system in the Micro grid for operation/management in the multi-micro grid environment.

3 A Design of Demand Response Energy Optimization System

The system model introduced in this study is shown in Fig. 1. The main energy manager (105) monitors the information such as power consumption for each load (120), hours/time slots of power use. Such monitoring can be carried out via

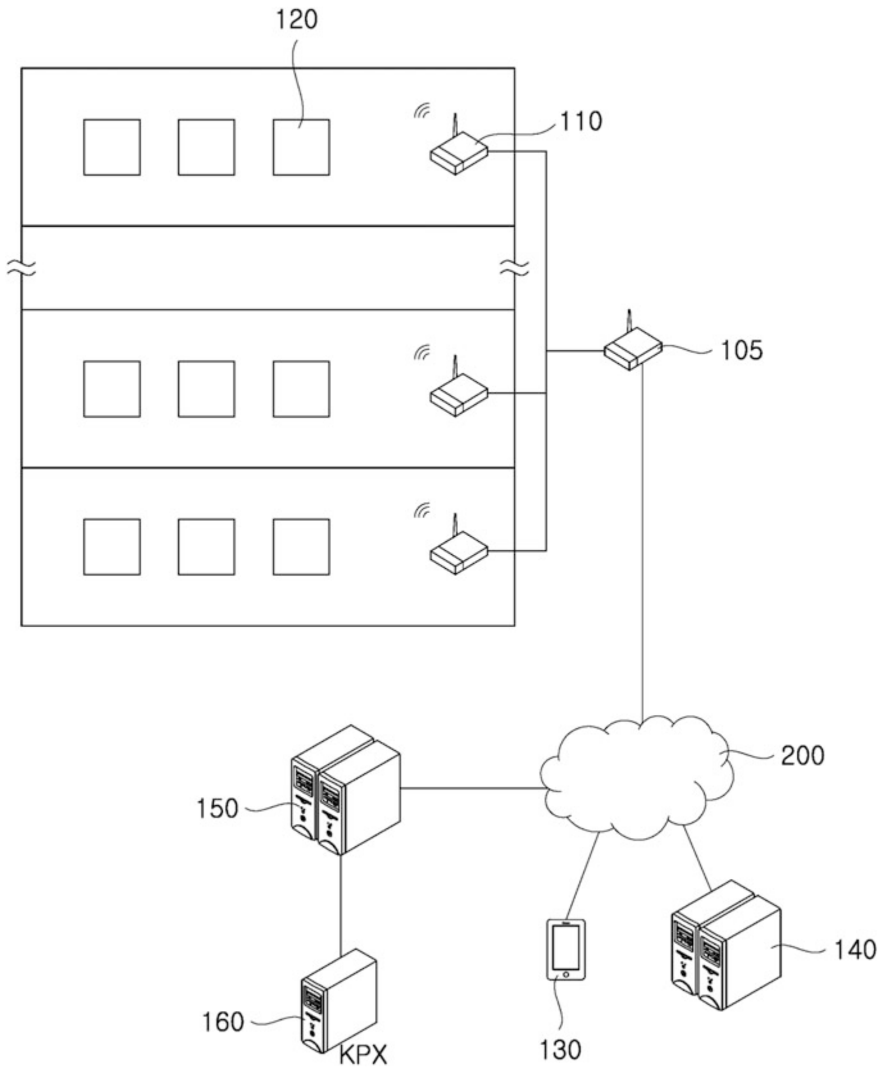

Fig. 1 Demand response energy optimization system (1)

sub-energy manager (110), or in some cases, it can only perform the function of collecting the information monitored by the sub-energy manager (110).

Figure 2 shows demand response energy optimization system. The sub-energy manager (110) is placed on each floor of a commercial building to monitor the information pertaining to the power consumption for each load (120), and hours/time slots of power use. This information is then transmitted to the main energy manager (150). The sub-energy manager (110) and each load (120) can exchange the information through wired/wireless communications. Also, the sub-energy manager (110) classifies each load (120) based on that information, selects the load (120) that would achieve demand reduction when it has been requested and control it to meet the demand. In this process, an analysis is performed to determine how much each load (120) can reduce the demand can according to the power consumptions. Based on the analysis, the process of classifying the loads that can achieve the demand reduction according to the time slots is performed as well. At this time, the main energy manager (105) and the load (120) performing demand reduction in each sub-energy manager (110) will be arranged within the commercial building, driven by the power supplied.

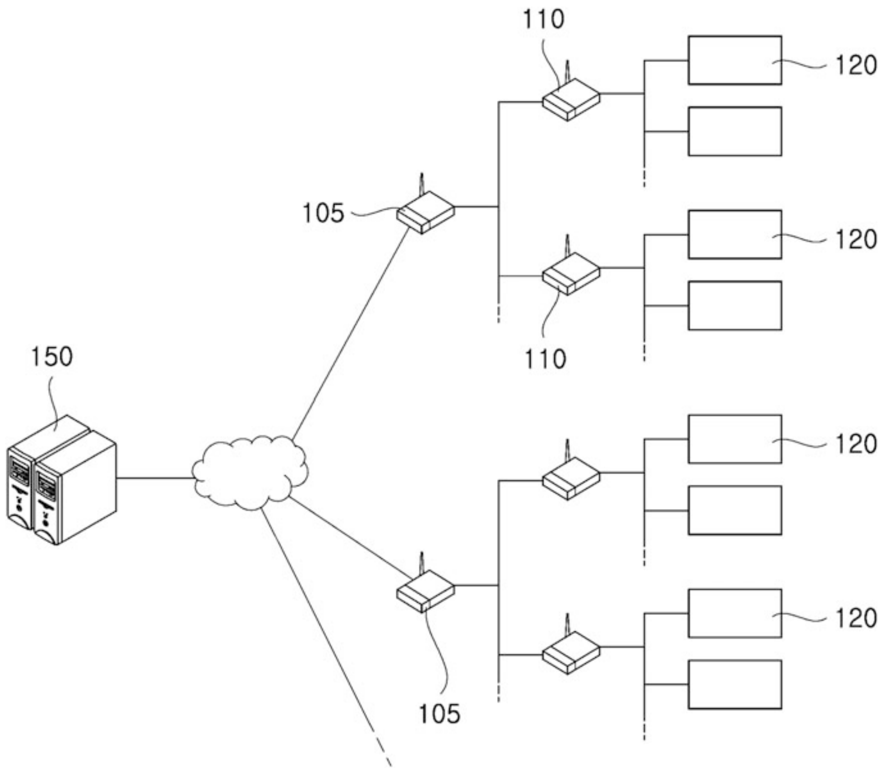

Fig. 2 Demand response energy optimization system (2)

The demand response server (150) proposed in this study receives the information from the Korea Power Exchange (KPX) server (160) and transmits the relevant information to the sub-energy manager (110) arranged on each floor. Although At this point, although the demand response server (150) is able to deliver the information through the communication with the sub-energy manager (110) directly, it is not limited to it so that it will also be able to deliver the same information to each energy manager through the energy management system server (140) and main energy manager (105). Additionally, the demand response server (150) can manage the main energy manager (105) and sub-energy manager (110) deployed in each commercial building who is responding to the demand reduction request, store the information pertaining to the degree of participation in demand reduction by each sub-energy manager (110), and perform demand reduction through the machine-learning process. based on the stored information, the participation schedule for the demand reduction will be adjusted to efficiently carry out power reduction.

The operation status of the loads (120) arranged on each floor can be checked by accessing the main energy manager (105), sub-energy manager (110) or the energy management server (140) with the user terminal (130) and when necessary, it is possible to control each load (120).

Meanwhile, the flow of signaling/control messages between KPX server (160), demand response server (150), sub/main energy managers (110, 105), and each load (120) is shown in below picture which shows that some significant roles such as calculation of demand reduction and analysis of load resource are being carried out by the demand response server (150) and sub/main energy managers (110, 105).

4 Conclusion

This study proposes a demand response resource energy optimization system for the commercial buildings and its methodology involved. It is expected that the power consumption within the building will be effectively and efficiently reduced.

At the same time, the micro grids will assume more roles as they can deal with regional power distribution issues and these grids are expected to increase not only in numbers but in sizes, creating more sub-level grids. Therefore, anticipated future networks must have a sophisticated form to satisfy consumer needs [7–11]. A better communication quality together with optimal data delivery capability is the utmost requirement but one should still consider costs.

References

1. Huh J (2017) Smart grid test bed using OPNET and power line communication. Advances in computer and electrical engineering. IGI Global, USA, pp 1–425
2. Xiao-sheng L, Liang Z, Yan Z, Dian-guo X (2011) Performance analysis of power line communication network model based on spider web. In: 8th international conference on power electronics ECCE Asia, pp 953–959
3. Sabolic D (2003) Influence of the transmission medium quality on the automatic meter reading system capacity. IEEE Trans Power Del 18:725–728
4. Rus C, Kontola K, Igor DDC, Defee I (2008) Mobile TV content to home WLAN. IEEE Trans Consum Electron 54:1038–1041
5. Peter MC, Desbonnet J, Bigioi P, Lupu L (2002) Home network infrastructure for handheld/wearable appliances. IEEE Trans Consum Electron 48:490–495
6. Hwang T, Park H, Paik E (2009) Location-aware UPnP AV session manager for smart home. In: IEEE first international conference on networked digital technologies, pp 106–109
7. Helal S, Mann W, El-Zabadani H, King J, Kaddoura Y, Jansen E (2005) The gator tech smart house: a programmable pervasive space. IEEE Computer Society, pp 50–59
8. Liau W-H, Chao-Lin W, Fu L-C (2008) Inhabitants tracking system in a cluttered home environment via floor load sensors. IEEE Trans Autom Sci Eng 5:10–20
9. Ou CZ, Lin BS, Chang CJ, Lin CT (2012) Brain computer interface-based smart environmental control system. In: Eighth international conference on intelligent information hiding and multimedia signal processing. IEEE Computer Society, pp 281–284
10. Huh J-H, Seo K (2015) Design and implementation of the basic technology for solitary senior citizen's lonely death monitoring system using PLC. J Korea Multimed Soc 18(6):742–752
11. Huh J-H, Seo K (2015) Hybrid advanced metering infrastructure design for micro grid using the game theory model. Int J Softw Eng Its Appl SERSC 9(9):257–268