Heat Energy Data based Energy Efficiency and Error Detection Service in Complex Apartment

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***Abstract*—This paper describes a study on a heat energy efficiency service that collects heat energy usage data from a system that supplies heat to apartment buildings and provides error situation information to household users and utility operators. This service will provide both reliability and security on the collected heat energy data and this is expected to have a synergistic effect through the integrated big data energy platform of energy-related data such as electricity, gas, and heat. In the future, we applying this service to a demonstration site and analysis the feedbacks from various energy customers. And based on the analyzed results, optimization will be made to the service**

Keywords*— *Heat, Energy Data, Complex Apartment, Energy Service, Error Detection

I. INTRODUCTION

Recently, the digitization of the energy sector has been actively progressing, and a large amount of energy-related data such as electricity, gas, and heat is being collected for homes. However, in the case of such energy data, it is difficult to share and distribute the energy related data due to different utilization entities and ownership entities, resulting in the absence of new energy data utilization services and delays in infrastructure construction.

To overcome these problems, we propose efficient utilization of heat energy data and energy data error detection service that supports rational energy consumption, fair billing, and system stability.

In general, heat energy is prone to losses in transmission, so the closer the energy supplier and the demanders are to each other, the more efficient it is, and the higher the density of multiple demanders, so services are mainly provided for apartment buildings and complex apartment areas.

In this paper, we introduce a service that provides heat energy consumption information to household users and facility managers related to energy supply and distribution in an apartment building environment using such heat energy, and notifies them whenever an error occurs immediately.

Section 2 of this paper shows the overall organization and interfaces of the energy efficiency and error detection service, Section 3 describes the respective functions provided by the energy usage service, Section 4 shows the function and procedures of the error detection module, and Section 5 summarizes the service and presents future research[1].

II. ENERGY EFFICIENCY AND ERROR DETECTION SERVICE ARCHITECTURE FOR HEAT ENERGY METER DATA

The energy efficiency and error detection service proposed in this paper consists of a server side that collects and analyzes heat energy data and a client side that provides various functions for energy usage data, and the overall configuration is shown in Figure 1.

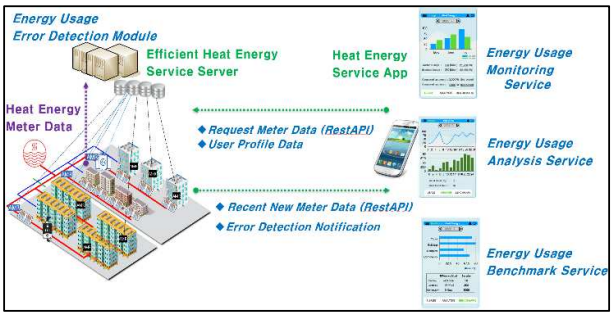

Figure 1. Energy Efficiency and Error Detection Service Architecture

As shown in Figure 1, the server side of the service is responsible for collecting heat energy meter data in an apartment building environment, managing the collected data, and checking the energy data for errors. It also handles responses to energy data request messages from client apps, provides appropriate energy information using user profile information, and notifies when errors occur in energy meter data[2][3].

The Heat Energy Service app in Figure 1 processes energy information received from the server and provides 3 main functions such as energy usage monitoring, energy usage analysis, and benchmark for energy usage comparison with others.

The data exchange between server and client is done through RestAPI, which provides a reliable connection with authentication and encryption over the Internet.

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III. ENERGY EFFICIENCY FUCNTIONS OF THE SERVICE

The Heat Energy Service app will update its local database by requesting meter data to the server newly collected data from the energy data currently stored in the app, and provide energy usage status information, analytics information, and benchmark information to the app users.

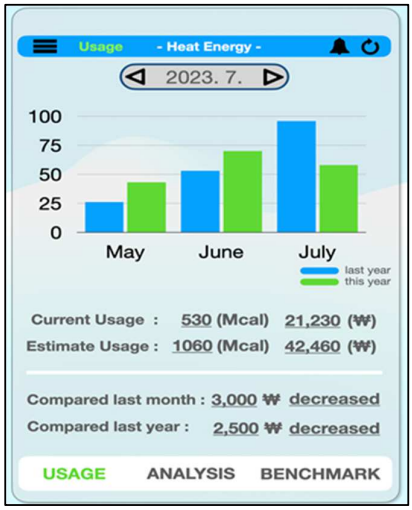

Figure 2. Heat Energy Data Usage Function

The energy usage function in Figure 2 provides energy usage information for the recent three months, along with the previous year, so that you can recognize patterns of energy usage, and also helps you prepare for energy savings by providing estimated usage and billing information for the current month. In particular, cross-comparison with last year's information has the advantage of increasing the effectiveness by providing information on the difference in usage on the same date.

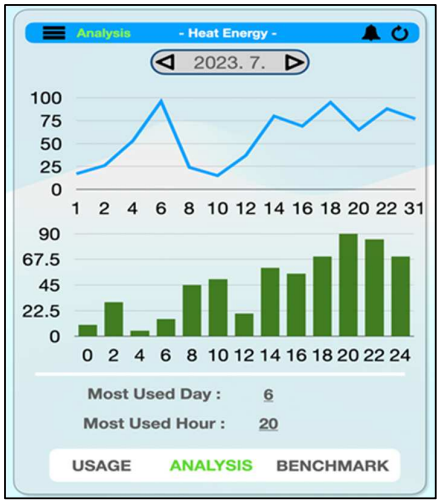

Figure 3. Heat Energy Data Analysis Function

Figure 3 shows a feature that tells you which days and times of day you used the most energy over a month, so you know which days and times of day you can most effectively energy saving. You can also set the month to analyze recent or historical usage patterns.

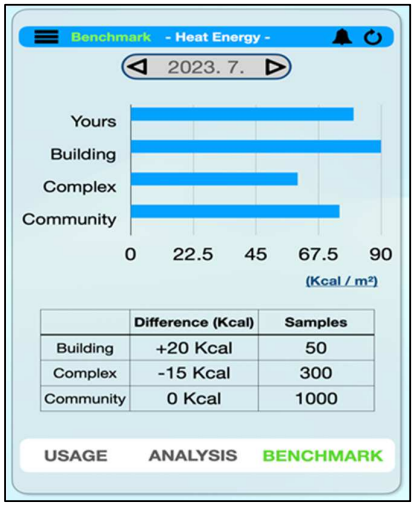

Figure 4. Heat Energy Data Benchmark Function

Figure 4 shows the benchmark results for heat energy usage information, which reflects the characteristics of apartment buildings and compares the energy usage per unit area with the usage of buildings, complexes, and communities.

This function shows the difference in energy usage under the same conditions and environment, and provides the need for energy savings actions.

Figure 5 shows the structures and profiles of the heat energy information used in this service.

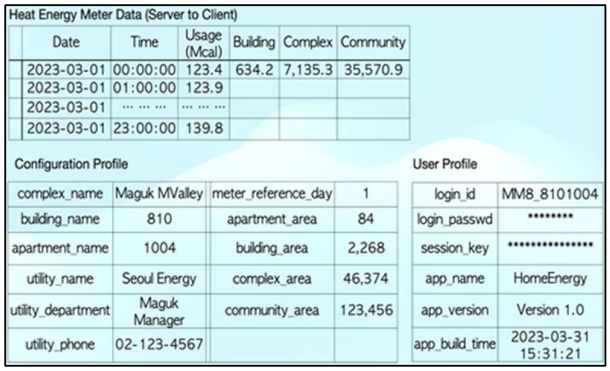

Figure 5. Heat Energy Data Structure and Profiles

For heat energy data passed from the server to the client app, usage information is passed along with the data of the building/complex/community for benchmarking, and energy data sorted by hour is used.

In addition, in the configuration profile, information about the apartment and individual users is stored, and in the user profile, information about app usage is stored for updating, user authentication.

IV. HEAT ENERGY DATA ERROR DETECTION FUNCTION

The heat energy data collected by the server is checked for data errors to ensure accurate billing and to determine whether the energy equipment is faulty. Figure 6 shows the overall configuration of the heat energy data error detection module.

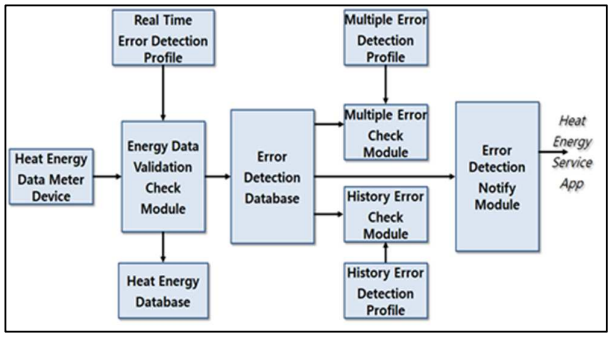

Figure 6. Architecture of the Energy Meter Data Error Detection

In Figure 6, the valid range check module determines whether the data received in real time is an error value by referring to the valid data range value of the energy data defined in the profile for real-time energy detection, and stores the error data in a separate error detection local database.

The multiple error detection module and the historical error detection module in Figure 6 provide the ability to predict more serious error situations by checking the number of cases where multiple errors have occurred and the frequency of error occurrence. Each error detection module operates according to the detection rules defined in its profile, providing a structure where new detection functions can be applied by simply updating the rules.

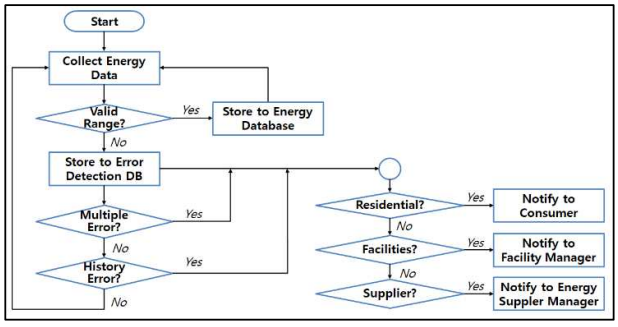

Figure 7. Procedure of the Energy Meter Data Error Detection

Figure 7 shows the operation procedure of the error detection module, in which real time error detection, multiple error detection, and history-based detection are performed sequentially, and the multiple and history-based error detection functions are operated from the local error database that stores the error occurrence history after real-time detection.

In addition, this module inspects the source of the error data in Figure 7 and notifies users, facility managers, supply managers, etc. through the app's notification function so that they can respond to the error immediately.

V. SUMMARY

This paper introduced a heat energy data based energy efficiency and error detection service that utilizes heat energy data to provide energy usage information through various functions to induce efficient use of the heat energy, and provides reliable billing settlement and facility error checking functions through data error detection functions. The overall client-server configuration, types and advantages of energy efficiency support usage information services provided, and detailed configuration and operation procedures of the error detection service module were presented.

The energy efficiency and fault detection services presented in this paper can be applied to various energy usage fields other than heat energy, and the energy usage information analyzed from various perspectives can support more active energy saving, and the fault detection information service can provide fair billing and effective energy equipment fault management.

In the future, we will apply the service presented in this paper to a demonstration site to derive operational results and improve service quality by reflecting user feedback to promote commercialization and dissemination.

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