EMS for Large-Scale Commercial Facility

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ABSTRACT

In large-scale commercial facilities that consume vast amounts of energy, power conservation, energy savings, and the efficient utilization of energy are challenges requiring urgent attention, and the introduction of an EMS is being promoted as a solution.

Fuji Electric has developed a large-scale commercial facility EMS to generate optimal supply and demand management plans based upon demand forecasts and power generation forecasts, and to realize the optimal application of energy. With the introduction of this system, operation can be guided precisely toward power conserving and energy saving behaviors, energy management can be implemented by area, by application, and by basic unit or the like, and a reduction in energy consumption and CO_2 emissions can be expected.

1. Introduction

Due to the electricity shortage after the Great East Japan Earthquake, social needs for power saving and energy saving are increasing. For large-scale commercial facilities such as department stores, shopping centers, hypermarkets and complex facilities, thorough implementation of energy saving and efficient use of energy are urgent tasks and introduction of energy management system (EMS) is promoted.

Fuji Electric improved the existing EMS further and developed an EMS that is specialized for use in large-scale commercial facilities. Optimal use of energy is achieved by drawing up optimal supply and demand plans from supply and demand forecasts and electric power generation forecasts.

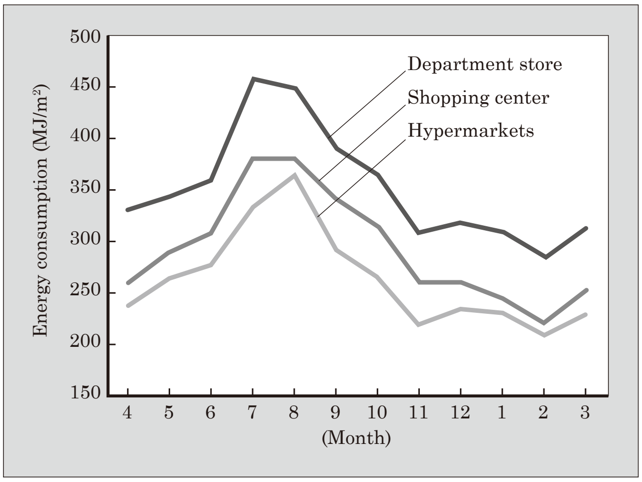

Fig.1 Energy consumption in large-scale commercial facilities by month

2. Environment Surrounding Large-Scale Commercial Facilities and Energy Management

2.1 Energy consumption trend

A large-scale commercial facility is comprised of multiple tenants in different type of industries in general, that is, large-scale store (core of the facility), specialty stores, restaurants and common-use space. Figure 1 shows energy consumption per month of the entire facility[(1)] and Fig. 2 shows a breakdown of energy consumption per business category.

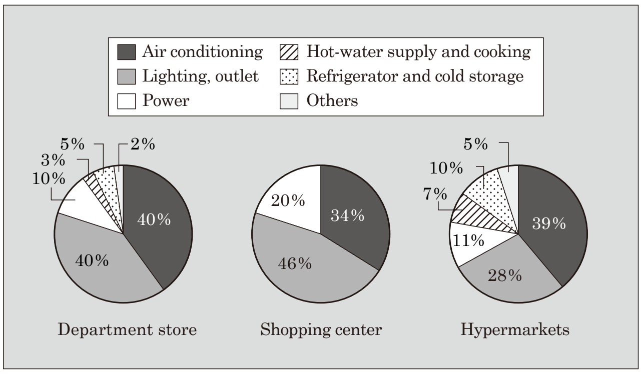

Fig.2 Breakdown of energy consumption

Although the energy consumption trend by month is similar among business categories, the breakdown differs. However, air conditioning, lighting, and, power energy consumption account for a high ratio in a facility of any business category; therefore, reduction of energy consumption is a promising solution that can be encouraged by deliberate energy management and

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energy saving actions.

2.2 Energy management situation

Energy management in large-scale commercial facilities is performed by monitoring and controlling individual equipment such as power source, heat source, air conditioning, lighting and elevator, by using building automation system (BAS). However, the existing central monitoring system lacks functions to perform energy management efficiently, and there were many cases where an operation manager carried out the following measures manually.

(a) Curtailing some lighting appliances in the building
(b) Controlling air conditioning in the building
(c) Stopping elevators etc.
(d) Controlling heat sources

By introducing an EMS for large-scale commercial facilities, it is possible to automate these operations, gather and analyze operational information of the equipment, and achieve optimal operation with consideration to energy efficiency.

2.3 Challenges in energy management

(1) Subdivision of energy management and full participation in energy saving actions

Since in most cases, facility management division performs energy management tasks along with their ordinary jobs, energy management is not united with the energy demand side. Energy management and energy saving actions where the supply and demand sides are unified is required. For example, the demand side operates energy while being aware of the supply side, and the supply side provides an optimal supply while being aware of load fluctuations[2].

In shopping center, there are many tenants, who are the demand side, and these tenants account for a large proportion of the total energy consumption. It is necessary to perform detailed management that links to feasible measures by analyzing the energy using situation by energy category and type of business, and clarifying the challenge for improving efficiency of energy use. In order to do this, it is required to have a mechanism to share energy information between tenants, who are on the demand side, and the facility division, which is on the supply side, and to allow everyone to participate in energy saving activities.

(2) Optimal operation of electricity, heat (fuel) and new energy

Due to the energy situation, power rates and fuel rates tend to show a medium-to long-term increase. Therefore, it is required to positively operate electricity and heat (fuel) in the facility through the best mix. Optimal operation of equipment is becoming more and more important in order to minimize CO_2 emissions and running costs, by considering the unit price of electricity and heat (fuel) rate.

(3) Achieving peak cut and peak shift of electric power load

Since the Great East Japan Earthquake, the maximum supply capacity of power companies has decreased due to the suspension of nuclear power plants, and as a result, a situation occurred in which the power supply becomes tight. In order to suppress power demand peaks in addition to the amount of power demand, restriction on use of electricity was enforced by the "Electricity Business Act" and large-volume utility customers are required to correspond to peak cuts and peak shifts of electricity demand.

Using renewable energy (solar power generation, wind generation etc.) and introducing electricity storage system and/or thermal storage system are effective ways to respond to such situation. However, energy managers are required to judge which equipment needs to be operated in which time period, and the operation of these equipment becomes very complicated.

It is necessary to forecast the energy load of the facility considering temperature, humidity, day of the week, and the number of visitors in advance; and at the same time, to predict the amount of electric power generated by solar and wind power, which are influenced by the weather. After that, it is required to schedule electricity storage and discharge, and heat storage and discharge, as well as operation of load facilities.

(4) Supporting energy saving actions

It is necessary to enable energy management and energy saving actions to be implemented without burdening the person in charge.

It is ideal to provide support functions in terms of software for the energy manager and person in charge of tenants such as sending demand adjustment guidance and energy saving action messages accurately, by utilizing past results and operation know-how.

(5) Visualization of energy

In general, since the equipment management division performs energy analysis and management tasks while carrying out operation and management tasks of equipment, it is required to perform the task efficiently. In particular, environmental enhancement for visualization of energy, which enables analysis and management of the energy usage situation from various angles, is important.

3. Fuji Electric EMS for Large-Scale Commercial Facilities

In order to resolve such issues on energy management as mentioned in Section 2.3, Fuji Electric applied the "Integrated EMS platform" technology and developed EMS for large-scale commercial facilities[3].

There are the following four main functions in the integrated EMS platform.

(a) Data access function of devices, which gathers measurement information of various types such as electric power, gas, water and heat.

(b) Function to comprehensively manage time-series forecasts and result information related to energy.
(c) Modeling function of an energy system that is customizable according to the scale of the target facility.
(d) Operation management function of the EMS business application that achieves energy saving optimal control

By having an integrated EMS platform with excellent flexibility and extensibility, application to a wide range of business areas from implementing to a single large-scale commercial facility to linkage with other systems in Smart Community is achieved.

3.1 Function of EMS for large-scale commercial facilities

Energy management tasks are carried out primarily with the EMS implemented in large-scale commercial facilities. Figure 3 shows the overall structure of EMS for large-scale commercial facilities and Fig. 4 shows its functional configuration.

EMS for a large-scale commercial facility judges each type of condition that occurs inside and outside of the facility, controls devices at the optimal timing, and gives instructions to managers and employees of the tenants. EMS for large-scale commercial facilities provides the following characteristic functions.

(1) Demand forecast

Demand forecast (see Fig. 4-A) makes it possible to calculate micro forecast values per area by using load results accumulated from each area having different consumption properties. By summing up the forecast values of each area, macro demand forecasts of an entire facility are calculated with high accuracy. In addition, in order to improve the forecast accuracy further, a correction function specialized in large-scale commercial facilities is available.

Figure 5 shows a screen of the entire facility. A facility is divided into several areas and forecast demand of the target area is shown. In this screen, it is possible to grasp energy demand and supply plan, the results, and the electric power usage situation of the tenants with a bird's-eye view and easily display detailed information of the area and tenants with a drill-down operation.

(2) Optimal operation plan

An optimal operation plan (see Fig. 4-B) makes it possible to draw up a supply and demand plan and control schedule to carry out highly efficient operations (to reduce cost and CO_2). This is achieved by conducting a simulation of energy supply and demand based on the modeling information and forecast information of the energy system that is composed of various unit of equipment such as power generation, electricity storage, power transmission, load and heat source. Figure 6 shows input and output information of the optimal operation plan (see Fig. 4-B). According to the drawn up supply and demand plan and control schedule, and by implementing control and setting of each device at the optimal timing, highly efficient operation of energy is enabled, and optimal operation of electricity, heat (fuel), and new energy is achieved.

In addition, an engineering tool for modeling of energy system that depicts types of equipment and re-

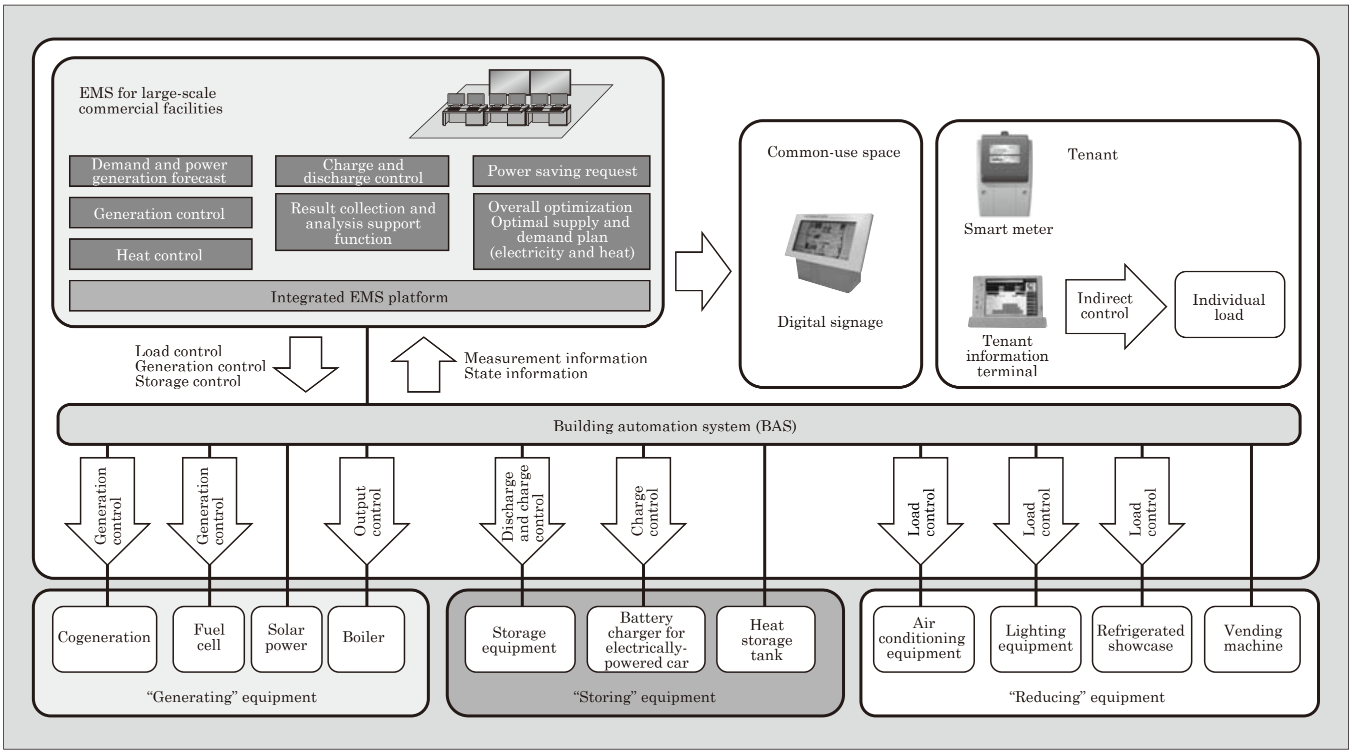

Fig.3 Overall structure of EMS for large-scale commercial facilities

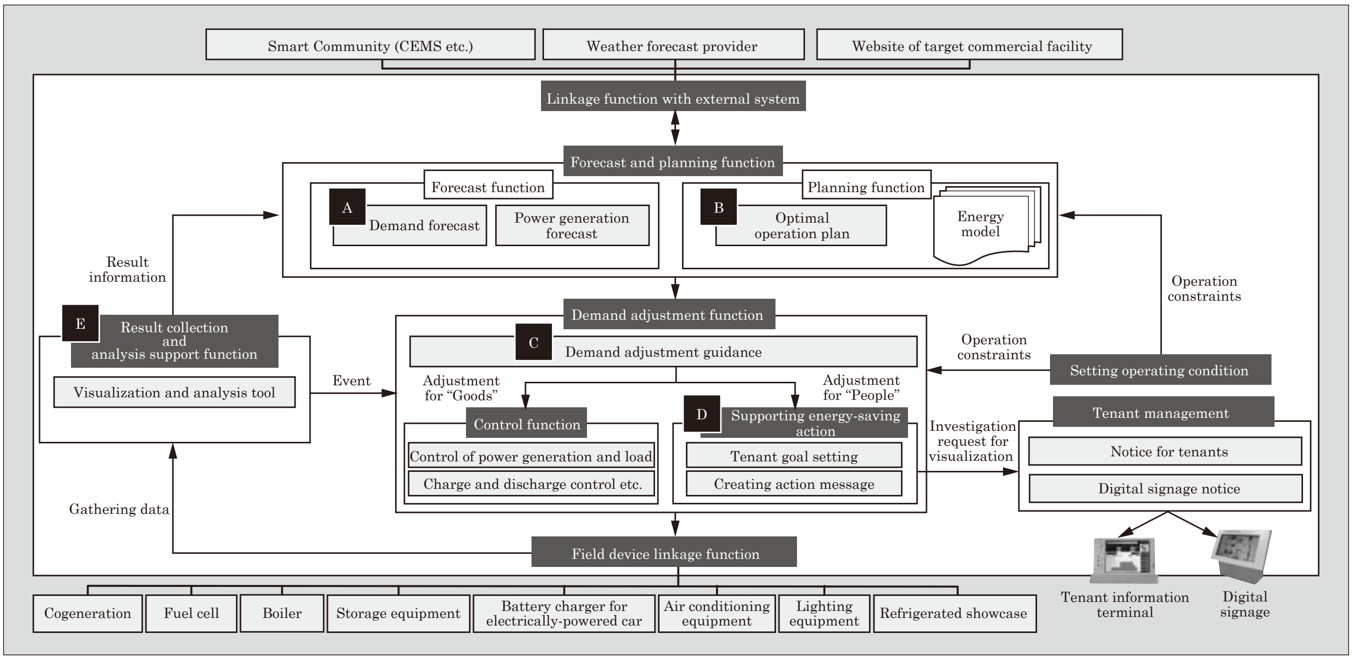

Fig.4 Overall functional structure of EMS for large-scale commercial facilities

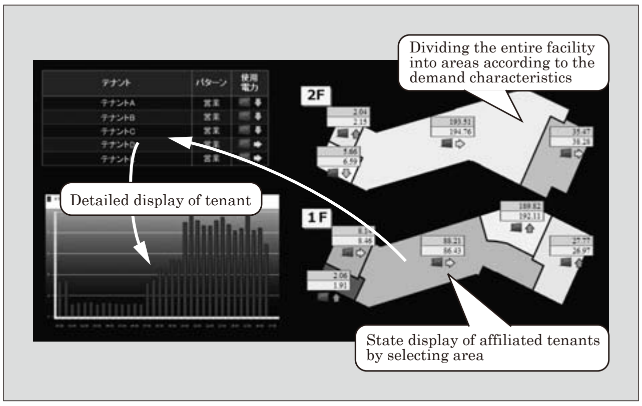

Fig.5 Screen for entire facility

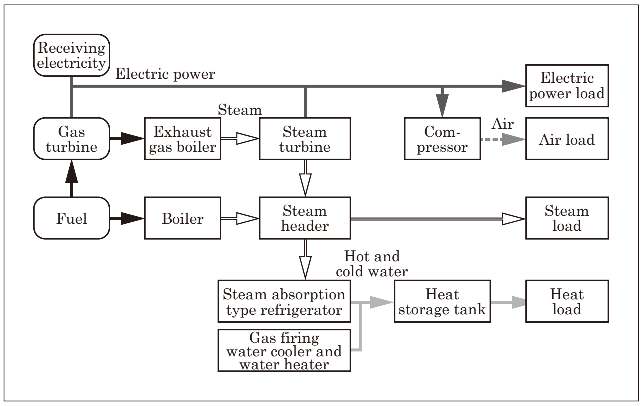

Fig.7 Model of energy system

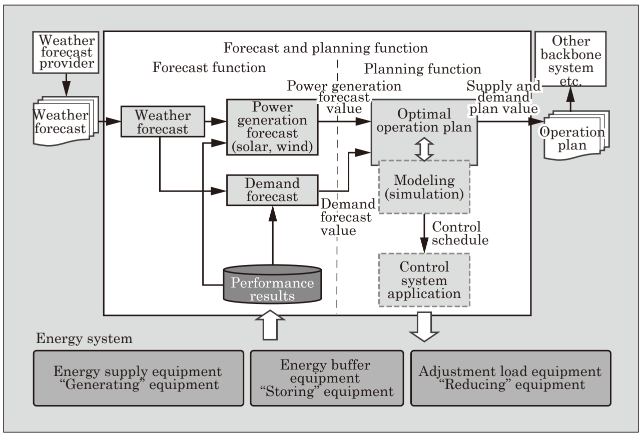

Fig.6 Input and output information for optimal operation plan

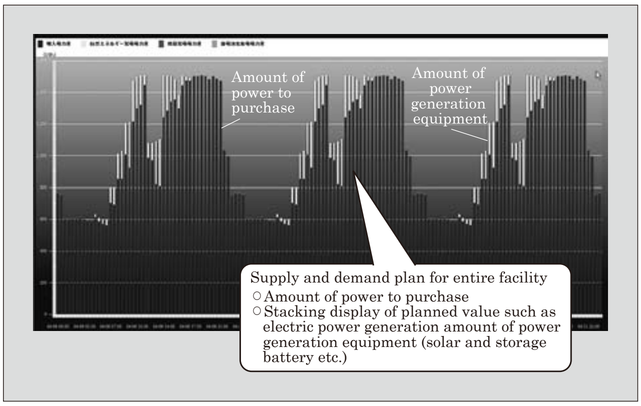

Fig.8 Supply plan for three days based on optimal operation plan

lationships (input and output of energy), which become basic data of optimal operation plan, is implemented. From this, it is possible to use the system to draw up capital investment plan by creating a model for equipment replacement off-line and by simulating the effect.

Figure 7 shows a model of an energy system and Fig. 8 shows a supply plan for three days using optimal operation planning.

(3) Demand adjustment guidance

Demand adjustment guidance (see Fig. 4-C) makes it possible to create recommended operation guidance for the operation manager by detecting changes in the operation state of devices and supply and demand state of energy.

It notifies the operation manager of “When,” “What has occurred,” “Information that needs to be grasped” and “Recommendable action and effect,” and provides “awareness” immediately.

Shown below is an example of demand adjustment guidance that is notified before the time period when the power rate unit price goes up.

- ○ When: 30 minutes later
- ○ What has occurred: Reached time period of power rate unit price increasing
- ○ Information that needs to be grasped: Supply and demand plan, results, and rate information
- ○ Recommendable action and effect: Change lighting setting of common-use area from 100% to 75% (reduction effect: 200 kW)

By selecting “Information that needs to be grasped,” the screen is switched to a screen displaying related functions. This is a means to improve operability.

(4) Supporting energy saving actions

Supporting energy saving action (see Fig. 4-D) is aimed at promoting energy saving actions by displaying energy consumption trends and the supply and demand state. In large-scale commercial facilities, tenants account for a large proportion of the total energy consumption. Therefore, in order to realize optimal energy control (energy saving, peak cut, peak shift etc.), it is important to “change the way of thinking” of employees (people) of the tenant and enables them to carry out concrete energy-saving actions at times such as when supply and demand becomes tight. Details of how to support energy saving actions are described below.

(a) Installation of tenant information terminal

A tablet-type information terminal is installed at each tenant and a function to enable tenant employees to grasp energy consumption trends anytime. Figure 9 shows a screen example of the tenant information terminal. By linking with Smart Meter, results of each use (lighting, air conditioning, power) is gathered per tenant and visualized with display items and display scale according to the scale and characteristic of the tenant, to improve visibility of the tenant information terminal.

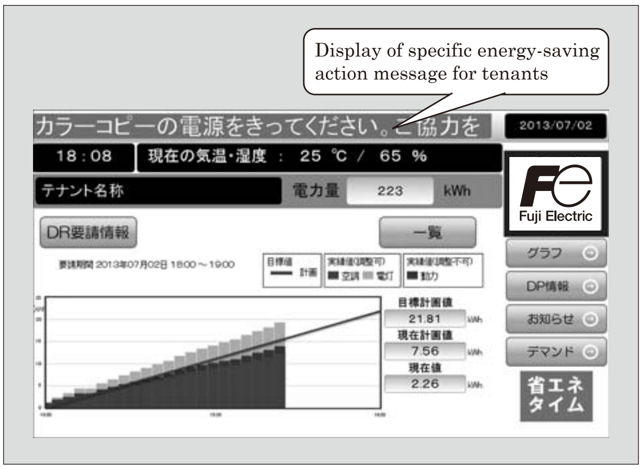

Fig.9 Screen example of tenant information terminal

(b) Display of energy saving action request message

There are various types of energy saving actions that each tenant can implement depending on the characteristics of business type, scale and operation time-zone of each tenant. EMS for large-scale commercial facilities manages and calculates specific request messages with which tenant employees can actually take action, and energy saving target values on a tenant basis, and then notifies those on tenant information terminals together with an alarm when supply and demand balance becomes tight.

The screen configuration makes it possible to confirm and actually experience the effect of the action on the spot by updating the display of results in intervals of one minute at times such as during demand and supply tight time periods. The idea is to let tenant employees feel a “sense of satisfaction” and “sense of achievement” in the facility-wide energy saving action, instead of a “sense of being forced to do something.”

(c) Quantitative evaluation on the degree of cooperation by tenants

EMS for large-scale commercial facilities makes it possible to manage the effect of energy saving actions quantitatively, and analyze the degree of cooperation of each tenant. In addition, it is possible to develop incentive systems according to the degree of cooperation to energy saving in the future.

(d) Linkage with digital signage

Linkage with digital signage contributes to improve “corporate brand value” by presenting the energy saving state of the entire facility and efforts to visitors (customers).

In addition, facilities participating in Smart Community aims at improving energy efficiency in entire region by notifying the users of special sales information in the time period when power rate within the region becomes higher due to a tight supply and demand, and attracting a large number of people from entire region.

(5) Visualization of energy

Visualization of energy (see Fig. 4-E) means the effort to make referencing and compiling energy information easier, enabling to achieve efficient and effective analysis of evaluation by the energy manager. The following two ideas were implemented.

(a) Speed-up of the time to reach information desirous to know

Figure 10 shows a hierarchical collection screen

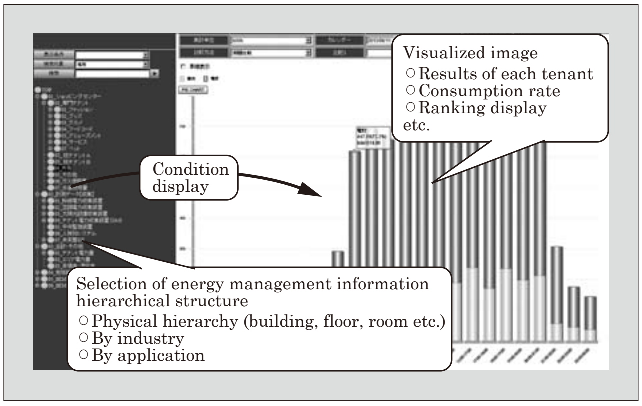

Fig.10 Hierarchical collection screen for visualization

for visualization. Information structure to search energy information was set as an interface which allows the user to search from a hierarchical tree with business type of the tenant (sale of goods, food and beverage, services, etc.) as an axis.

Managers can reference and sum up energy information (per industry, usage amount per application, consumption rate, ranking etc.), which was subdivided under a hierarchical tree, with an easy operation from various angles.

(b) Shorter time to process information desirous to know

With referenced and summed up energy information, it is possible to create an arbitrary report form by downloading the information to the personal computer of the manager, in the file format that can be used in spreadsheet software.

3.2 Future technological deployment

To optimize energy effect and investment cost for entire facility, it is necessary to introduce a mechanism that allows evaluation in a cross-sectional way including maintenance cost. For example, when a piping abnormality was detected, the optimal timing to repair is determined while considering energy loss cost, which has a trade-off relationship with maintenance management cost, and risk.

In the future, Fuji Electric will aim to build an EMS that enables further optimization of energy use in the building of a large-scale commercial facility by blending sensor technology, equipment maintenance management solution and the EMS solution that we have, and by adding an analysis environment in which task information can be evaluated in a cross-sectional way.

4 Postscript

In this paper, visualization of energy at large-scale commercial facilities and the function and features of EMS that perform optimal operation have been described.

By utilizing the results achieved up to now and by implementing further functional enhancement, Fuji Electric will realize optimal energy operation, contribute to electric power supply and demand adjustment and realize Smart Society in which efficient and rational energy usage is promoted.

Reference

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