

The “ECOMAX Controller” Realizes an EMS for Use in Stores

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ABSTRACT

According to energy consumption trends by sector in Japan, energy consumption in the consumer product sector, which includes retail business, is increasing at a high rate. Moreover, 85% of the energy consumed by retail business activities is in the form of electric power, and power savings is increasingly being requested. Fuji Electric has developed the “ECOMAX Controller” that collectively manages and controls refrigeration, freezer, air conditioning and lighting equipment inside a store to realize comprehensive energy savings. A configuration that is compatible with various interfaces is used in order to enable collective control of the equipment, to reduce installation costs, and to increase the efficiency of the management and operation of the equipment. Additionally, infrastructure management functions for electricity, water and gas are incorporated so that a store-use EMS may be configured easily with a single controller.

1. Introduction

Looking at energy consumption state in Japan by sector such as industry, transportation and consumer, increase in the energy consumption rate of the operation division in the consumer sector (the tertiary industries excluding household division etc.) stands out at 41%. Among them, electric power in the wholesale and retail division, which occupies 23% of the total, accounts for about 85% of the energy consumption, and demand for power saving is increasing (see Fig. 1).

The retail industry is a typical domestic demand industry where domestic trend of the time is strongly reflected. In particular, recently, there has been great interest in making efforts for an energy management

system (EMS) in response to an obligation for energy management by the enforcement of the revised Act on the Rational Use of Energy (Energy Saving Act), and energy supply issue after the Great East Japan Earthquake. However, it is very difficult for a small-scale retail business to invest large capital in introducing energy measurement devices and improving energy saving performance.

Fuji Electric has been providing to the market an energy saving linkage control system “ECOMAX V” to perform energy saving operations for showcases and refrigerators with small capital investment. This time, Fuji Electric expanded this system further and developed the “ECOMAX Controller” enabling comprehensive management of overall store equipment.

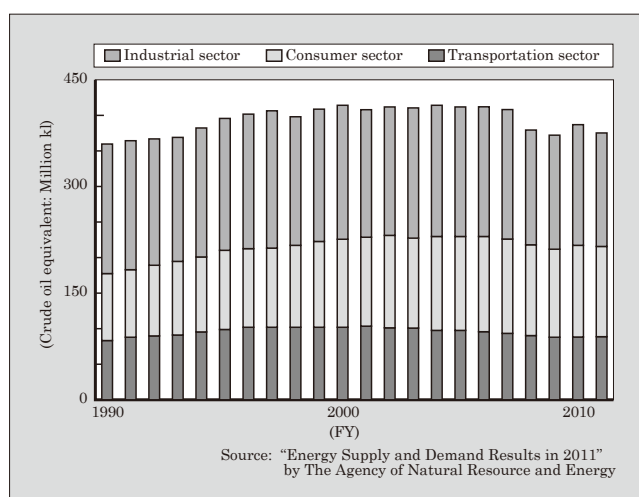


Fig.1 Transition of energy consumption by field

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2. Overview of “ECOMAX Controller”

Figure 2 shows system configuration of store equip-

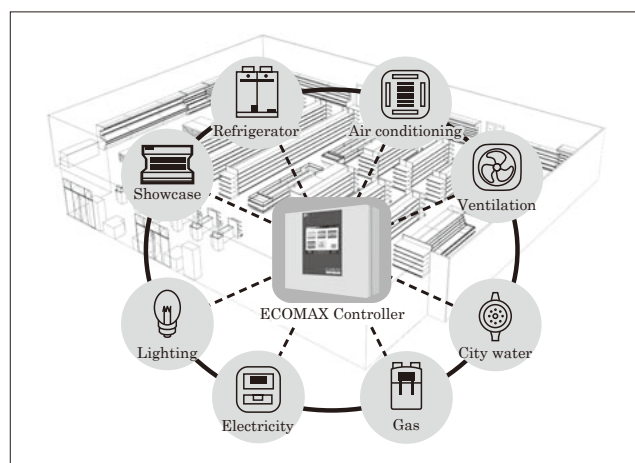


Fig.2 System configuration of store equipment management using “ECOMAX Controller”

ment management using the ECOMAX Controller. By focusing on and achieving the following points at the time of development, it became possible to realize an EMS for use in stores easily with one controller.

- (a) By collective control of store equipment, system introduction cost suppressed, achieving more efficient management operation of devices.
- (b) An optimal system is provided corresponding to the store equipment scale and device configuration.
- (c) By linking control of cooling equipment such as showcases and refrigerators with air conditioning and lighting equipment, comprehensive energy saving is achieved at the store.
- (d) Monitoring function for infrastructure such as electricity, water and gas is installed.
- (e) A structure easily applicable to equipment other than retail stores is employed.

3. Configuration and Characteristics of ECOMAX Controller

3.1 Software configuration

(1) Platform

Figure 3 shows the software configuration of the ECOMAX Controller. Combined management of store equipment was achieved by building a platform.

This platform consists of the following three layers.

(a) Kernel layer

It performs direct control of hardware resources such as device drivers and resource allocation management for software.

(b) Standard library service layer

It provides versatile network communication services such as Web server, FTP server and e-mail.

(c) Application framework layer

It provides an interface that an application program directly uses such as input and output control, communication control, screen display and opera-

tion, and log.

(2) Application for stores

An application program is built as an independent process for individual function and made it possible to operate each process efficiently.

An application program that controls store equipment was built by using a service provided by the platform and it was built in units of function such as refrigerator control and air conditioning control. This enables to append or update required functions easily.

(3) Avoidance of control interference

When multiple controls are performed for one unit of equipment, mutual control interference becomes an issue.

For example, such a case is considered that the following two requests occurred at the same time: a power suppression request resulting from the demand control forecast that the target electricity will exceed, and a request for increasing the output resulting from the air conditioning optimal operation control detecting deterioration of amenity in the store are provided to one air conditioner.

Originally, in order to avoid such control interference, a restriction has been employed so as not to perform multiple controls for the same equipment. However, with the ECOMAX Controller, such restriction was eliminated by installing a mechanism to judge the priority output for control requests from each application program.

In the above-mentioned example, if “Demand control prioritizes air conditioning optimal operation” has been set, the platform executes control output according to the request of demand control to suppress power control even if air conditioning optimal operation control requests an increase in operation output.

This software configuration allows for utilizing various energy saving control functions effectively, and a high energy effect can be expected.

3.2 Characteristics

(1) Various interface support

With the general store equipment, there are many cases where the connection method differs depending on the type of the device and the quantity of equipment to be implemented differs depending on the store. In order to correspond to these cases, installation and extension of dedicated interface devices were required.

The ECOMAX Controller is equipped with multiple interfaces such as digital input and output, general-purpose serial communication (RS-485), network communication (Ethernet^{*1}), and provides a mechanism that makes it possible to change the interface flexibly according to the specification of equipment.

For connection with an air conditioner, it sup-

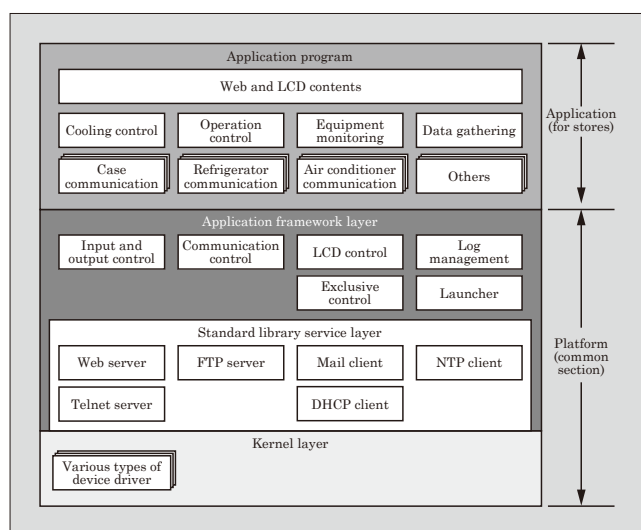


Fig.3 Software configuration of “ECOMAX Controller”

*1: Ethernet: Trademark or registered trademark of Fuji Xerox Co., Ltd.

ports LonWorks^{*2}, which is widely disseminated as a network connection technology for equipment management, and the air conditioning system HTTP interface, which specification was drawn up by The Japan Refrigeration and Air Conditioning Industry Association for small and medium-size building management.

Based on these, it is possible to connect to various units of equipment without implementing or appending a dedicated interface device.

(2) Improvement of operability

Figure 4 shows the user interface of the ECOMAX Controller. By installing a touch panel type liquid crystal display (LCD), it is possible to grasp the state of store equipment and perform operation easily.

The touch panel type LCD is devised to perform intuitive operations without the need for the instructions manual etc. Therefore, it is possible for employees without any specialized knowledge to perform equipment management easily.

In addition, when an abnormality is detected from store equipment, there is a function to immediately switch the screen to the operation information monitoring display of the relevant equipment and notify by an alarm buzzer and e-mail. This improves the efficiency of management operation for the equipment. A built-in Web server function enables more detailed information management from a personal computer via an Ethernet.

Furthermore, by supporting tablets, which have become very popular recently, various operation styles are available such as enlarging the operation screen or performing information management while carrying the device.

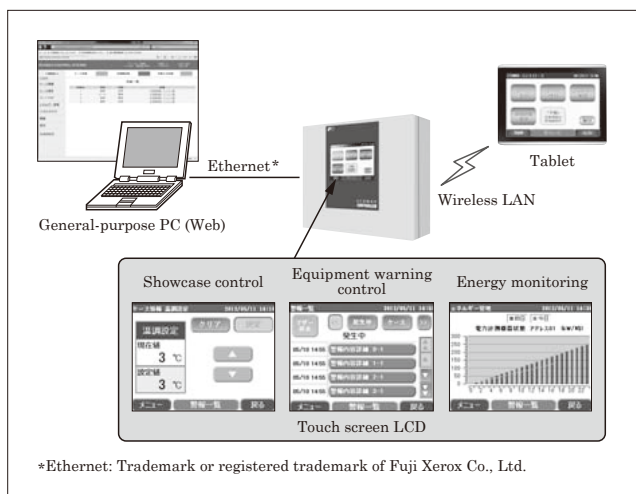


Fig.4 User interface of “ECOMAX Controller”

^{*2}: LonWorks: Trademark or registered trademark of Echelon Corporation (US).

4. Function at Retail Stores

4.1 Satisfying energy saving function

The ECOMAX Controller is equipped with the following four energy functions in addition to the energy saving operation functions for refrigerators and show-cases that were achieved with the existing “ECOMAX V.”

(1) Air conditioner optimal operation function

This function is used to adjust the operation mode and temperature & air flow of an air conditioner so that the total power consumption of air conditioner and refrigerator becomes the minimum value, based on the air temperature and humidity of outside and inside of the store, and the ventilation operation state of the store. In this way, it becomes possible to reduce power consumption when there are many fluctuations in the temperature and humidity of the outside air such as at change of seasons.

When changing the setting of air conditioner, evaluation by Predicted Mean Vote (PMV) was introduced considering the influence on showcase cooling and heating load, as well as amenity in the store. PMV is an indicator of warm-cold sensing by six elements: temperature, humidity, air current, radiation, amount of wearing cloths and amount of one's activity.

(2) Intake and exhaust control function

This is a function to optimally control the amount of ventilation according to the air circumstances in the store such as the CO₂ concentration. By controlling the airflow of the fan, it is possible to suppress the heat-entering amount due to outside air that becomes a load on the air conditioner, and to save energy.

(3) Demand control function

This is a function to control the power consumption in the entire store so that the amount does not exceed the target value. The ECOMAX Controller enables detailed power control according to the state of customer's equipment operation because of collective control of store equipment.

(4) Scheduled operation function

Reducing the unnecessary operation time of the equipment is an efficient measure for energy saving. Therefore, it is necessary to have a function to set an operation schedule of the equipment easily and optimally in accordance with the schedule of the store activity.

The ECOMAX Controller can register multiple schedules as sales patterns, such as store opening and closing time for each selling area and by day of the week, and can change them as necessary. In addition, master setting is performed so that a sales pattern will work simultaneously with an operation schedule of the equipment. Therefore, by changing sales patterns, the setting of an equipment operation schedule can be changed at once and detailed schedule operation becomes possible in accordance with the operation type

of the store.

4.2 Energy management function

The ECOMAX Controller can provide a service to monitor the energy use situation of an entire store chain because it can link with the center monitoring system, “ECOMAX Net,” which Fuji Electric has already deployed.

In addition, for the store to carry out energy saving activities independently and effectively, energy use situation can be acquired with a touch panel type LCD.

Specifically, display of the energy use situation per day or per hour, and comparison with a past energy use amount can be performed by simple operation.

Such data as the energy use situation accumulated by the ECOMAX Controller and operation state condition of equipment can be acquired using network communication via the standard library service of the platform. In this way, a customer can build its own energy management system easily without carrying out dedicated customization development.

4.3 BEMS aggregator project

Building and energy management system (BEMS) aggregator project is a subsidized project run by the Ministry of Economy, Trade and Industry for high-voltage small-size utility customers such as small and medium-size buildings and commercial facilities, and is aimed at reducing contract demand by 10%. A BEMS aggregator means an information managing operator using energy who promotes power saving of utility customers, by helping them to implement a BEMS and installing a centralized management system using cloud technology by himself.

Fuji Electric is registered as a BEMS aggregator and promotes implementation of BEMS. To implement BEMS to commercial facilities such as small and medium-size supermarkets, an energy monitoring function, demand control function, and energy-saving operation control function of the ECOMAX Controller are utilized. The following functions become available by linking a BEMS aggregator server that has an energy management service function as mentioned in Section 4.2, and the ECOMAX Controller.

- (a) Device schedule operation control function that performs automatic on-off control for registered devices
- (b) Demand forecast function to perform demand forecast based on the past data and weather forecast of the current day, for setting target power consumption

4.4 Kitakyushu Smart Community Project

“Next Generation Energy and Social System Demonstration” is positioned as a new growth strategy of the government, and it involves efforts to establish a Japanese style Smart Grid and expand it overseas. One of such efforts is the “Kitakyushu Smart

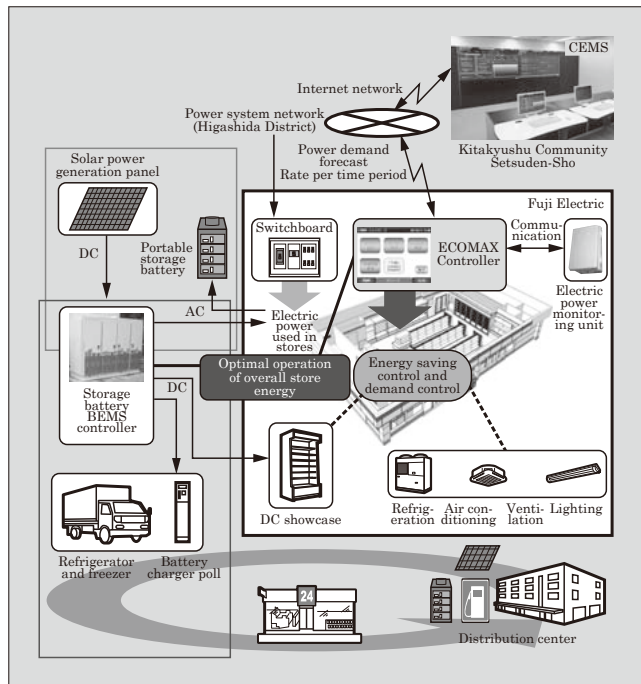


Fig.5 Configuration of Kitakyushu smart store demonstration verification project

Community Project.”

As one of the participant companies, Fuji Electric developed an EMS for use in stores that is linked to a regional energy management system (CEMS: cluster energy management system), and carried out demonstration verification to contribute toward peak cutting, peak shifting and reduction of electric power consumption for power demand supply stabilization within the region in Higashida District of Yahata-higashi Ward in the city of Kitakyushu. Figure 5 shows the configuration of Kitakyushu smart store demonstration verification within the project.

The EMS in the store draws up device operation plan and charge & discharge plan of a storage battery system to always minimize the power consumption, based on a power supply forecast and solar power generation forecast in the store. In addition, according to the demand and supply adjustment request and dynamic pricing request sent from the CEMS, it draws up a power supply and demand plan again, and deploys it to the equipment operation plan in the store, and controls equipment in the store.

In demonstration verification, optimal operation control of air conditioning, ventilation and lighting equipment, storage battery charge and discharge control, as well as cooling equipment operation control such as showcase are performed. The operation began in the summer of 2013, and the ECOMAX Controller is working as the core system of the equipment control in the store.

5. Postscript

The “ECOMAX Controller” achieves comprehensive management of overall store equipment such as air conditioning and lighting, not only cooling equipment. In this way, it became possible for retail stores to reduce equipment maintenance management cost and reduce energy consumption at low cost.

In addition, the ECOMAX Controller makes it pos-

sible to provide services by flexibly corresponding to equipment size and equipment configuration of individual utility customers because the structure allows easy application to equipment other than those in a retail store.

In the future, to promote expansion of application to various types of utility customers, Fuji Electric will make an effort to establish an optimal system that conforms to individual needs.





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