"Smart Buildings" (BEMS) to Optimize the Energy Supply and Demand Control of Buildings

HARA Akihiro, KITAMURA Mitsuhiro

Abstract

The Great East Japan Earthquake of March 11, 2011 has changed our attitude regarding energy supply in Japan. In the past, we needed only to follow the guidelines of the annual energy usage amount indicated in the "Revised Act on the Energy Saving." However, we are now and in the future requested to personally comprehend the per-hour energy usage amount per building and even for each area or section of a building. The summer of 2011 was the so-called "summer of patience," and enterprises were asked to reduce their investment in facilities, etc. However, for the winter of 2011 towards the summer of 2012 and into the future we have been requested to introduce systems to monitor energy wastage and to control energy usage for optimum saving. NEC offers solutions for the "visualization" and "optimum controls for saving energy" as well as "Smart Buildings" (BEMS) to provide optimum energy supply and demand by developing grid interconnection control systems. These solutions are intended to support energy storage and to enable the creation of stable energy supply.

Keywords

saving power, amount of energy usage, visualizations, exhibiting, EMS, BEMS, EcoForest, Butics

1. Introduction

With regard to its obligations under the Energy Saving Act and the regulations defined under national and local government legislation, Japan is currently endeavoring to achieve greenhouse gas emission reductions and power usage savings targets.

In FY 2011, NEC developed a system for visualizing energy usage amounts (hereinafter referred to as the "Facility Energy Saving System" or "EcoForest") as an energy saving solution based on a centralized monitoring system called "Butics (Building total information and control system)." To cope with power shortages caused by unexpected disasters, it is urgently required to establish countermeasures against power shortages and outages by carrying out the visualization of power usage amounts at all business offices. Along with promoting visualization of the total amount of CO_2 emissions of entire buildings, NEC has developed a "consumed power indicator" to visualize the amount of power usage as an energy saving measure, and has also developed an "energy saving control system (BCP energy saving support system)" as a countermeasure against power outage. Moreover, from the winter of 2011, we have introduced an energy visualization system to monitor energy wastage and control energy usage for optimum energy savings towards the summer of 2012 and for the future. NEC will offer solutions for "visualization" and "optimum controls for saving energy" as well as for "Smart Buildings" (BEMS: Building Energy Management System) aimed at achieving optimum energy supply and demand by developing grid interconnected control systems to support energy storage and even for energy creation.

2. EcoForest, Realizing Power Saving by Visualization

The following scenarios (**Fig. 1**) illustrate the carrying out of energy saving activities. This section describes "EcoForest," which is positioned to achieve energy-saving work styles by introducing visualization functions at the stage of "Energy Saving 2" in Fig. 1. Features of "EcoForest" are explained below.

- **System configuration**

(1) Using conventional facilities including a centralized monitoring system

(2) Standalone system configuration of "EcoForest"

- **Various functions to cope with different environments (recommended functions)**

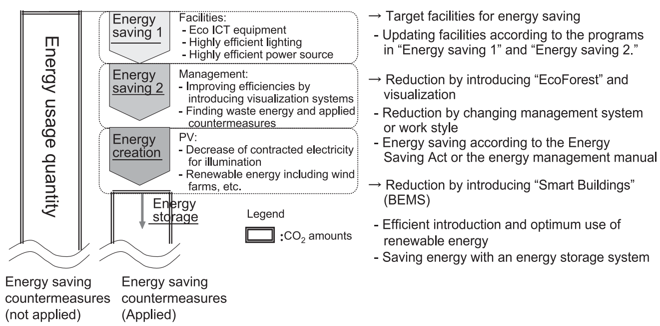


Fig. 1 Practical scenario for energy saving.

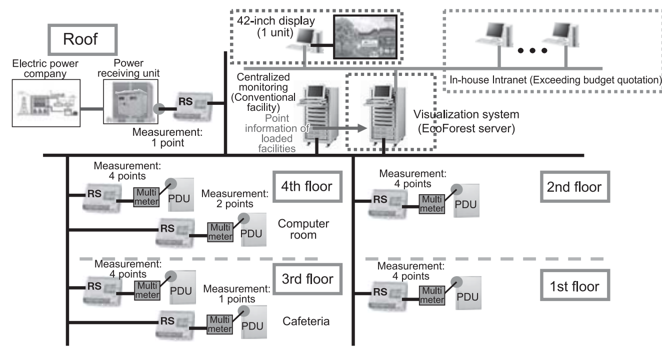


Fig. 2 System configuration example of linking with conventional systems.

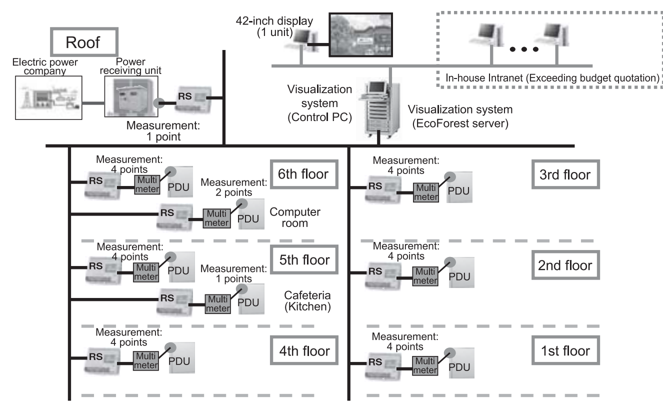


Fig. 3 Example of independent "EcoForest" system configuration.

(1) "Revised Act on the Energy Saving" (Visualization of the total CO_2 emission amount of an entire building)
(2) Energy saving (Visualization of power usage quantities)
(3) Demand monitoring (Consumption prediction and "peak cut" of incoming power)

2.1 System Configuration

(1) "EcoForest" can be linked with conventional facilities such as via a centralized monitoring system, so that the cost of configuring an entire system can be minimized (**Fig. 2**).
(2) "EcoForest" can be configured by itself without linking with a centralized monitoring system such as Butics. It can collect the requisite information and analyze it to visualize the energy usage status ("visualization" and "exhibiting") (**Fig. 3**).

2.2 A variety of Functions to Meet Different Environments

(1) Conforming to the "Revised Act on the Energy Saving"(Visualizing the total CO2 emission amount of a building)

The "Revised Act on Energy Saving" specifies the total CO_2 emission amount of an entire building. Electricity, gas, water and oil are included in the revised Act.

"EcoForest" collects energy information via locally located sensors. It converts acquired data into "specific units (g-CO_2 /kWh)" in order to analyze them and displays the results. Its GUI display employs universal designs to provide a human-friendly display environment. Its mascot characters may be also displayed on the screen using Flash technology. **Fig. 4** shows the front page of "EcoForest" and describes the results achieved

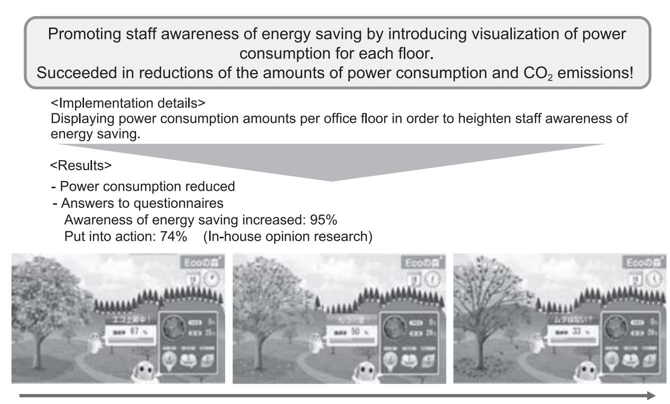


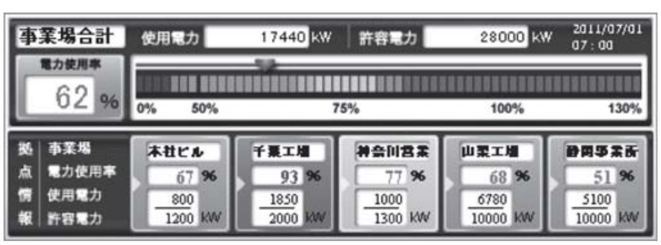
Fig. 4 "EcoForest" standard front page and the effectiveness of "EcoForest" implementation.

at the NEC Tamagawa Solution Center by implementing “EcoForest”.

(2) Energy saving (Visualization of power usage amounts)

Since the Great East Japan Earthquake, Tohoku electric Power Co., Inc. and Tokyo Electric Power Company (TEPCO) have requested customers to limit power consumption in their business areas. To deal with such requests, enterprises have carried out countermeasures for saving energy since the summer of 2011. This experience has created a trend toward energy saving among enterprises and countermeasures have been examined with the intention of implementation from June 2012. During FY 2011, most of the energy saving monitoring operations were performed manually because the requisite automation systems for effective monitoring could not be prepared due to the suddenness of the government announcements. We are now facing the issue of fully comprehending the scale of the power supply situation for the summer of 2012, which may lead to increased demand for power indicators in the market.

As a part of NEC’s energy saving activities started since June 2011, the power usage amount is automatically collected every 10 minutes and the collected data is displayed on the power indicators together with the target values for energy saving of the entire office setup of the NEC Group (**Fig. 5**). The system that the power consumption of each staff can be monitored each other via the intranet was introduced in the office. This system and the staff’s awareness regarding energy saving created synergy effects, and significantly preferable results are thereby achieved.

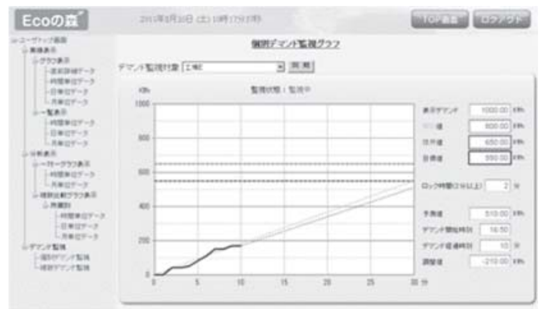


* Numerical values are examples.

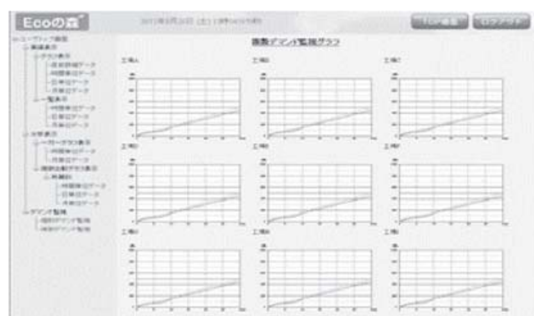
Total for all offices: Power consumption status of entire company
Status of individual offices: Power consumption status in individual offices (created with INI file format)
Display functions: Power consumption amount, threshold level settings and alarm status

* Per-hour power consumption amount will be displayed in a chart by clicking the indicator.

Fig. 5 Power indicator.



Single demand screen



Multiple demand screen

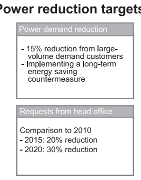
Fig. 6 Demand monitoring windows.

Electricity charge = Contract ampere + Power consumption amounts

TEPCO contract electricity charge for business users
Demand charge: 1,638 yen/kW
Summer: 13.75 yen/kWh
Other season: 12.65 yen/kWh

Present situation: Contract power	Present situation: Power consumption amount *Assuming 90% of the contract power	Present situation: Estimated electricity charge (per month)	After power reduction: Contract power	After power reduction: Power consumption amount (15% reduction)	After power reduction: Estimated electricity charge (per month charge after power reduction)	Efficiency per month by power reduction
140kW	126kW	¥231,053	120kW	107kW	¥198,033	¥33,020
300kW	270kW	¥495,113	260kW	230kW	¥429,036	¥66,077
500kW	450kW	¥825,188	430kW	383kW	¥709,599	¥115,588

[Power reduction targets]



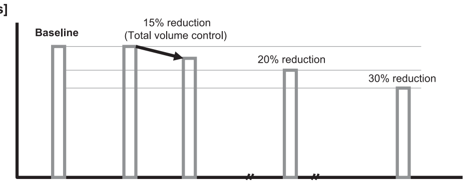


Fig. 7 Power reduction provisional estimations for the business areas of TEPCO.

(3) Demand monitoring (Consumption prediction and "peak cut" of incoming power)

Demand monitoring is a function of the "Centralized Monitoring System," and contracted electricity is monitored in order to control power consumption at peak hours. "EcoForest" mounts a monitoring function for single demand as well as multiple demands so that it can manage the demand controls of multiple buildings (**Fig. 6**). On the single demand screen, detailed power usage management can be achieved by setting the predicted power consumption amounts of each device to values lower than the threshold values of the devices registered on the centralized monitoring system (**Fig. 7**).

3. Development of "Smart Buildings" (BEMS)

3.1 Outline

Implementation of energy saving for facilities and its effective management, "creating energy" and "storing energy" will be the next development stage. "Smart Buildings" (BEMS) are intended to solve these issues and achieve comprehensive energy saving. The development concept of "Smart Buildings" (BEMS) is to achieve optimum energy consumption by implementing "visualization," "energy saving," and "grid control" step by step.

As shown in **Fig. 8** , when energy saving is promoted only by updating facilities and implementing "visualization," actual power consumption cannot satisfy the target values. The concept of saving energy is to suppress excessive electricity usage by carrying out "visualization" and analyzing the power usage conditions. However, the concept of the present system is to cut peak time electricity usage via the demand monitoring system, and then to achieve an intelligent energy saving system by employing energy creation and storage.

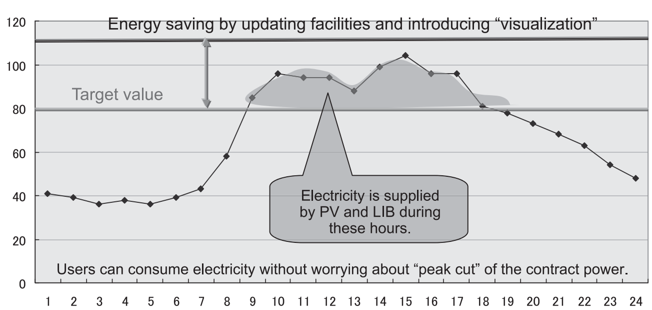


Fig. 8 Concept of the creation and storage of energy via "Smart Buildings" (BEMS).

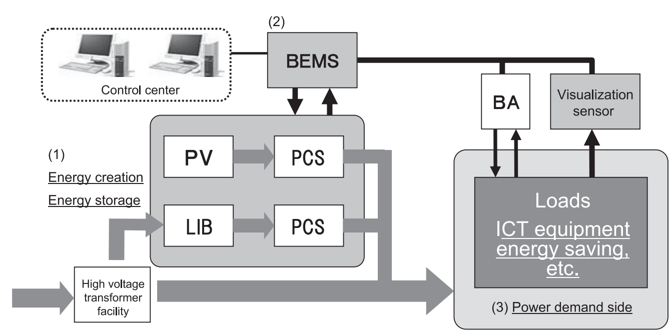
3.2 System Configuration

For the development of "Smart Buildings" (BEMS), NEC is constructing a building management system equipped with a function for controlling photovoltaic (PV) solar power generation, lithium ion batteries (LIB) and also power sources and device loads. The experiments described below were conducted in chosen fields in order to improve the quality and efficiency of "Smart Buildings" (BEMS). **Fig. 9** shows the "Smart Buildings" system configuration proposals.

- Evaluation characteristics of PV and LIB
- Verification of methods for optimum energy management
- Secure interconnection with commercial grids
- Alternative power source for emergencies
- Dealing with the total emission control standard for electricity
- Device load control
- Prediction of energy generation and consumption amount
- Linkage with the cloud and other internet services
- Other

3.3 Outline of BCP Energy Saving Support System

Installation costs for PV or LIB are still expensive so that there are still many buildings that have yet to introduce these facilities. To meet the needs for such buildings to deal with the



(1) Power supply section: Power generator, Li-ion battery, PV (Photovoltaic solar power generation), etc.
(2) EMS section: BEMS
(3) Power demand section: Loaded facilities: air conditioner, lighting equipment, outlets, water supply

Fig. 9 System configuration of "Smart Buildings" (BEMS).

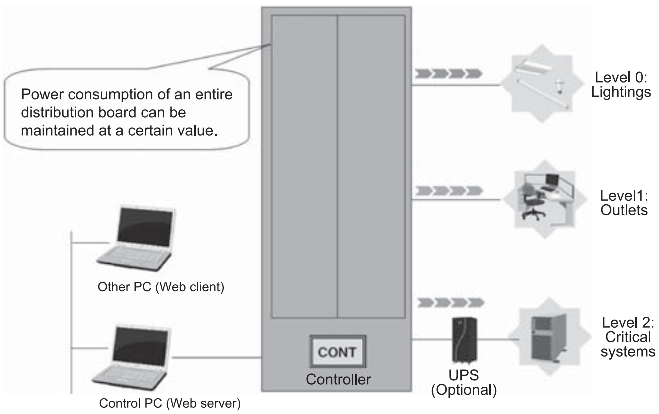


Fig. 10 Configuration of the "BCP/Energy Saving Support System."

total emission control standard for electricity and to control device loads, NEC has developed the "BCP/Energy Saving Support System."

Fig. 10 is a conceptual diagram of the "BCP/Energy Saving Support System." This system enables monitoring of the power values of each of the circuit breakers installed in a distribution board and the ON/OFF control of circuit breakers via controllers mounted in the circuit breakers. Users are allowed to execute these operations via the control PCs. Moreover, the control PC equips a Web server function so that it enables the monitoring and control of the distribution boards via other PCs connected to the network. By setting different levels (priorities) for each circuit breaker, the power values can be controlled by automatically switching off the circuit breaker that is set to a lower priority so that the total power amount to be consumed indicated on the distribution board will not exceed the allowance value that conforms to the total emission control standard.

We will deploy the results acquired from the development of the "BCP/Energy Saving Support System" to "Smart Buildings" (BEMS).

4. Future Issues

Although we are currently marketing "visualization of energy usage amounts" activities via "EcoForest" a further reinforcement of functions is required in order to assist in the anticipated severe power conditions that will affect society in the future. At the same time, accelerating the development of "Smart Buildings" (BEMS), which is an optimum power demand control system, is necessary for it to be suitable to put it to the market. "Smart Buildings" (BEMS) will be the next step of our "visualization" promotion policy as we have explained above in this paper. As the next solution for energy saving, it will be an important issue to implement upgraded "visualization" systems; such as integrating electric power and other items including humans, facilities and information, analyzing data and prediction simulations. As an environmental solution, a fusion of technologies is essential to meet the various demands including those regarding the sale of electricity, etc. that are imposed by the Energy Saving Act and the various regulations of Tokyo Metropolitan and other local cities.

5. Conclusion

In Japan, thanks to the revolution in internet technology, the interactive distribution systems of the information society have already been established, however, it seems likely that the "interactive distribution of energy" will be the next major technological innovation.

As described so far, NEC will continue to develop even more sophisticated systems that feature higher reliability in order to prepare for the imminent energy revolution.

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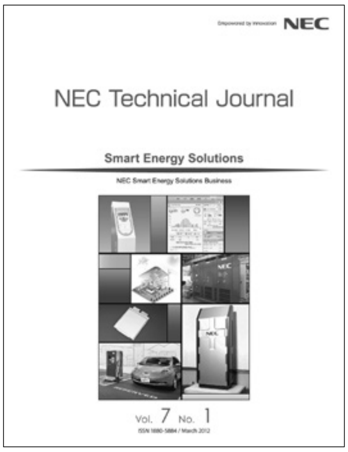

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