Outline of "Cool Clover" Energy Management System for IT Equipment

Akihiro Someya Yoshifumi Murase
Shigeo Tachibana

Energy conservation activities are required of businesses to thwart global warming. About 30 % of the energy consumed in offices is drawn from wall outlets, making the implementation of some strategies necessary to counter this consumption. This is the motive for the creation of "Cool Clover", a system intended to conserve power through the management of energy consumed by IT equipment, such as personal computers and printers, which account for the majority of consumption and dominate the use of power drawn from wall outlets.

This paper gives an outline of "Cool Clover", providing explanations of the developed technologies.

Background of development

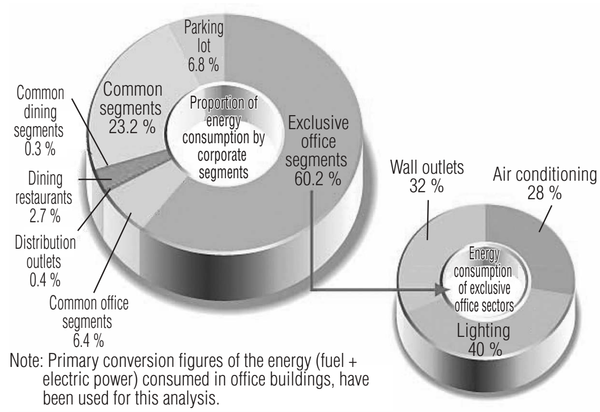
The "Law Concerning the Rational Use of Energy" (Energy Conservation Law), scheduled to be put into effect from April 2010, has expanded the scope of mandatory energy management to include operational division such as offices. As a result the number of businesses subject to this law will undoubtedly increase. Energy conservation in office buildings is not just about the implementation of strategies for air conditioning and lighting, but they must include strategies for conserving the use of power drawn from wall outlets. A review of the energy consumed exclusively by the office sector revealed the energy taken from wall outlets reached a total of 32 %[1], as shown in **Fig. 1**.

The majority of power taken from wall outlets is drawn by IT equipment, such as personal computers and printers. IT equipment is increasing in number year after year. The growing number of these units also increases the electric power consumption, which in turn leads to the generation of heat through the use of these units, increasing the loads on air conditioning. Further conservation of electric power consumed by IT equipment will be a critical issue for the future.

The conservation of electric power for IT equipment, such as personal computers and printers, is generally sought through the implementation of strategies involving a reduction in the power consumption of the equipment, based on such international standards as the Energy Star program, as well as power saving settings that detect the non-operative status of equipment before switching the equipment into a power saving mode, such as a suspended operation (sleep) mode.

These power saving settings are expected to yield large energy conservation effects, as the amount of time personal computers are actually used by office workers is reported to be only about 50 % of the time they are on[2].

Transitioning equipment into a power saving mode, however, requires some time before the equipment can be used again, which may detrimentally impact its convenience for users. Furthermore, these power saving settings are often not centrally controlled, with some reports stating that only about 44 % of users had been effectively managed these energy saving settings for their personal computers in the office[3]. As a result it was difficult to attain the kind of electric power saving effects expected for the entire office.



Note: Primary conversion figures of the energy (fuel + electric power) consumed in office buildings, have been used for this analysis.
"Energy Conservation for Office Buildings"
2. Modes of office buildings and actual conditions of energy consumption
Proportion of energy consumed by corporate segments
Pamphlet of The Energy Conservation Center, Japan: September 2005.

Fig. 1 Proportion of energy consumed by corporate segments

Energy management based on the consumption status of individual users was implemented to deal with this issue and the following technical agendas were set, targeting the realization of effective electric power conservation.

(1) Technologies centrally managing individual equipment

Technologies must be developed to centrally manage various IT equipment of the entire office, including conventional equipment, in order to effectively reduce electric power.

(2) Technologies providing controls that respond to usage conditions

The usage of personal computers varies depending on individual users and the duties they perform. Electric power conservation is sought without negatively impacting convenience through the collection and analysis of the usage conditions for personal computers and the implementation of controls that respond to conditions, such as time periods and their absence in office.

The development of the "Cool Clover" Energy Management System for IT Equipment primarily targeted these two technical objectives.

System outline

The configuration of this system is shown in **Fig. 2**. The “Cool Clover” system is an energy conserving server for controlling electric power savings and the power saving settings of personal computers through the installation of control software on personal computers operating on Windows Vista, Windows XP or Windows 2000*1). This system makes it possible to centrally control individual equipment connected to the energy conserving server through the network.

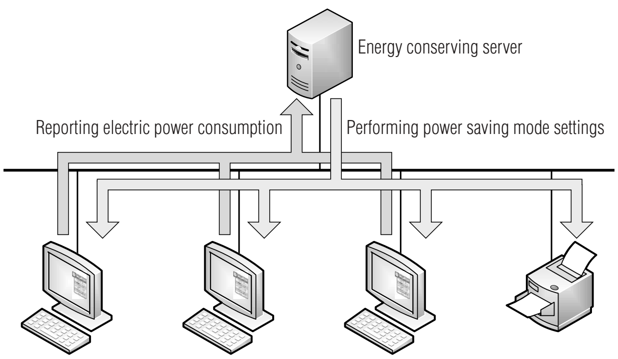


Fig. 2 System configuration

The control software installed on a personal computer also estimates the electric power consumption based on the operating status of the personal computer. This consumption information as well as the reductions in the consumption of electric power for the entire office, which has been forwarded to the server, can be acquired from a personal computer.

Furthermore, the electric power consumed by printers can be conserved by controlling the energy conservation mode of the network printers that support the SNMP protocol.

Features of system

The aim of the “Cool Clover” system is to reduce the electric power consumption of IT equipment; (1) by performing power saving settings using the convenience index; (2) by controlling the electric power consumption in line with the usage status, based on user absence forecasts; (3) by visualizing electric power consumption; (4) by promoting energy conservation activities for users through the disclosure of activity status rankings; and (5) by analyzing the power saving effects using energy management functions.

(1) Power saving settings using convenience index

The concept of electric power control by power saving settings is shown in **Fig. 3**. The horizontal axis represents the time period a user is away from his or her desk and the vertical axis represents the electric power consumed by their personal computer. The areas E0 to E4 represent the individual power status of a personal computer and constitute the amount of electric power consumed.

If the power saving setting is not activated with a personal computer it remains in an idle status at all times whenever the user is absent and it continues to consume electric power. However, once the power saving setting is activated, as soon as the setting detects that the user has not been using the personal computer for a certain period of time, a phased shift will take place to a power saving mode with lower power consumption. This makes it possible to reduce the electric power consumption that is shown by the slant-line portions of the graph.

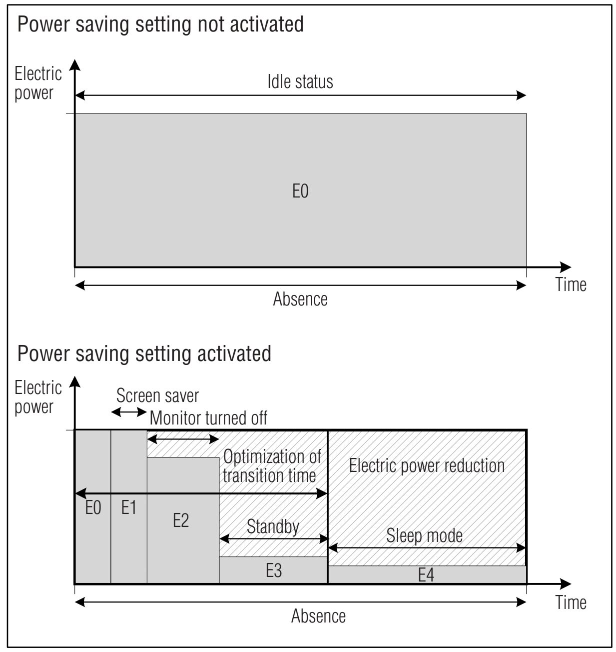


Fig. 3 Electric power control by power saving setting

The reduction amount can be increased through the shortening of time for the transition to a power saving mode, resulting in high electric power conservation effects, such as a standby or sleep mode. The power saving modes that have more effective electric power conservation require longer recovery times to return a computer back to a usable status, resulting in opposing benefits for energy conserving effects and convenience.

The relationship between the electric power conserving effects and convenience was therefore defined as follows:

The longer it takes for a personal computer to recover from a power saving mode, the more convenience deteriorates.

The longer the user is absent from his or her desk, the more tolerance to a longer recovery time can be expected from the power saving mode.

The relationship between the recovery time of personal computers that is tolerable to users and the duration of their absence from their desks was investigated based on the aforementioned definition and a convenience index was prepared. We were able to make power saving settings that use the convenience index by setting the transition time to the power saving mode, which is determined for individual personal computer specifications and operating systems, using the convenience index.

We developed a mechanism that makes it possible for users to select power saving settings on personal computers simply by specifying a convenience index for

*1) Windows 2000, Windows XP and Windows Vista are registered trademarks and trademarks of Microsoft Corporation in the United States, Japan and other countries.

individual groups and time periods on an energy conservation server. This is available even for administrators outside corporate divisions in charge of IT, such as general affairs.

(2) Electric power control based on user absence forecasts

When a user leaves his or her desk for a prolonged period of time, for example in order to attend a meeting, and if the person's personal computer is left on the same way it was when the user departed, the power saving setting would put it through phased power saving modes. However, until it reaches the final power saving mode the electric power consumed up to that point in time is considered to be wasted. Electric power control based on absence forecasts is the technology for eliminating this type of waste.

The concept of electric power control based on absence forecasts is shown in **Fig. 4**. When the absence of a user is detected a length of absence is forecasted. When the forecast result is a long period of time the personal computer is immediately transitioned into a power saving mode with low power consumption. This makes it possible to reduce the electric power consumption that is shown by the slant-line portions on the graph, which would be wasted in a phased transition.

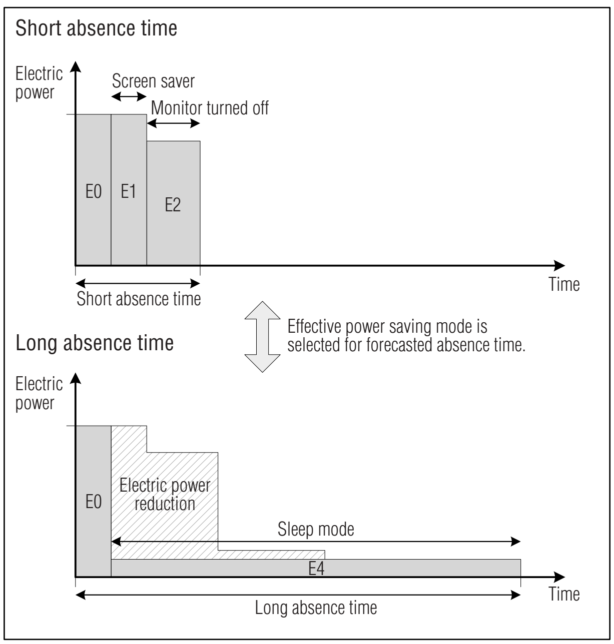


Fig. 4 Electric power control based on absence forecasts

The history of personal computer usage for each individual user is collected and a method for determining the absence time based on figures derived by a statistical process was adopted for forecasting the absence time. Characteristic behavioral patterns of a user are considered to be an integral part in the history of personal computer usage. When an identical pattern occurs, such as a status observed in the past that is recorded in the history of usage, a high probability exists for the same behavior to be repeated. We therefore decided to forecast the duration of a user's absence using a learning function for their absence status with time periods.

(3) Visualization of electric power consumption

A visualization function that displays the electric power consumed by each personal computer, as well as the amount of electric power saved, was developed to prompt energy conservation awareness on the part of the user and thereby promote participation of the user in energy conservation activities, such as voluntarily shifting the personal computer's status to a power saving mode whenever the user leaves his or her desk. An example of the visualization screen display is shown in **Fig. 5**.

Fig. 5 Example of visualization screen display

The visualization function keeps track not only of the electric power consumption but also the amount of electric power saved, the number of pages printed out with a printer, including N-up printing and double-sided printing. When a user leaves his or her desk over a prolonged period of time, without transitioning the personal computer into a power saving mode, the amount of electric power consumed during the user's absence is counted as wasteful consumption of electric power and displayed on the visualization screen.

The "Cool Button" feature developed for this system is as a function to promote voluntary user participation in energy conservation activities. Double clicking on the "Cool Button" icons when leaving a desk allows a user to easily transition the personal computer's status into a power saving mode.

Furthermore, "Cool Scores" are displayed to indicate the user's extent of voluntary participation in energy conserving activities. The "Cool Score" feature is a numerical representation of the efforts made by the user, such as the proportion of occasions that the user pressed the "Cool Button" when leaving his or her desk and the proportion of printing instances when paper was saved through the selection of N-up or double-sided printing.

The calculated Cool Score is calculated, based on the information for long and short-term energy conservation activities, and is represented by one of the nine "Cool Clover" icon varieties, depending on the status of the energy conservation activities. The icon display that represents the status of energy conservation activities is intended to make it possible for a user to gain an understanding of his or her activity trends at a glance.

(4) Ranking of activity status

This system was developed to enable functions for displaying the total electric power consumption of personal computers in an office as a whole or for comparing the electric power consumption of different corporate divisions, by placing them in a ranking screen display, based on information on the energy conservation activities of individual users, which is calculated on the energy conservation server. An example of the ranking screen display is shown in **Fig. 6**.

The promotion of communications among users and participation in energy conservation activities is sought on the ranking screen by the display of medals to the higher ranking groups, which raises the competitive awareness between groups as well as gives commendations and guidances according to internal rankings in corporate divisions.

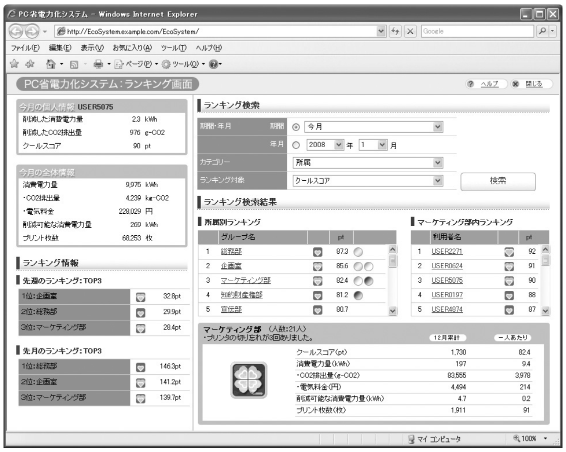


Fig. 6 Example of ranking screen

(5) Management of energy

OKI Developed functions for analyzing and managing energy consumption, such as the analysis of energy conservation activities or electric power conservation effects, the preparation of monthly and annual reports on electric power consumption, as well as energy management based on demand functions. These functions can be easily used by administrators outside the corporate divisions of IT, such as general affairs, on a web-based management screen.

An example of the screen display for analyzing waste is shown in **Fig. 7**. The displayed graph represents the amount of electric power consumed by personal computers. The upper part of the superimposed graph represents the amount of electric power that was wastefully consumed when the users were absent. This is the amount of electric power that can be saved if users voluntarily transition their personal computers into a power saving mode before they leave their desk. When the proportion of electric power consumption that can be eliminated is high, it is considered that the energy conservation awareness of users is potentially low. In such cases it would be possible to seek electric power conservation through awareness building activities.

OKI developed a demand function for supporting demand controls as an energy management function. The function referred to here as the demand control is a function for controlling a load facility to inhibit maximum demand (maximum demand power) by calling for electric power users to monitor electric power consumption and inhibit the contract demand of electric power off the grid (basic charges). The demand function temporarily sets strict electric power saving settings on personal computers to transition unused personal computers to power saving modes in a short time to reduce the maximum demand of electric power. The results of simulations indicate that 4 % more electric power conservation effects can be expected over ordinary operations.

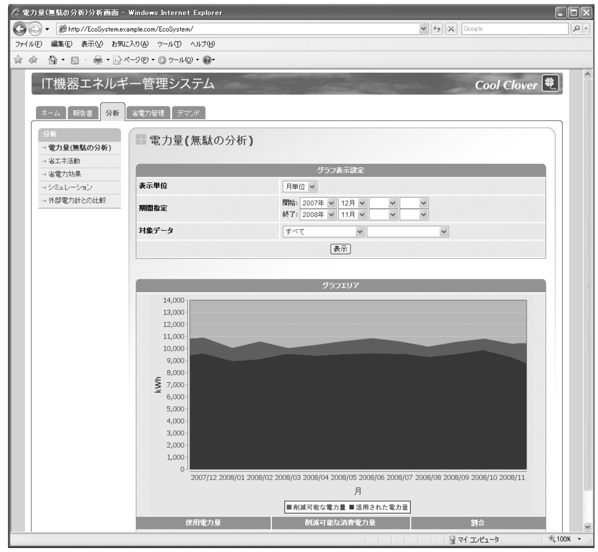


Fig. 7 Example of analysis screen

Conclusion

The internal evaluations at OKI verified that an electric power conservation effect of 18 % could be obtained through electric power controls alone. Further electric power conservation can be expected through the promotion of energy conservation activities with visualization.

We will continue with our contribution to energy conservation in the office through the development of technologies for controlling not only personal computers and printers but a wide range of IT equipment connected to networks.

References

1) Pamphlet of The Energy Conservation Center, Japan: "Energy Conservation in Office Buildings", September 2005.

2) Kenichi Yoshida: "Increased Productivity of Office Workers Brought About by Information Asset Inventory", REALCOM INC., the White Paper "VISION", August 2004.

3) Judy A. Roberson et al.: After-hours Power Status of Office Equipment and Energy Use of Miscellaneous Plug-Load Equipment, University of California at Berkeley, LBNL-53729, pp. 12, May 2004.

Authors

Akihiro Someya: Corporate Research and Development Center, Office Solution Unit, Energy Conservation Solution Team.

Yoshifumi Murase: Corporate Research and Development Center, Office Solution Unit, Energy Conservation Solution Team.

Shigeo Tachibana: Corporate Research and Development Center, Office Solution Unit, Senior Specialist.