2007 Prize of Director General of Regional Bureau of Economy, Trade and Industry

Energy Conservation Activities Tackled Throughout the Factory by Introducing Energy Management Monitor

Nissan Motor Co. Ltd. Oppama Plant
Environment Energy section, Energy Conservation Group

◎ Keyword：Energy Management Structure in Each Facility

◎ Outline of Theme

In this division, sections of technology, maintenance and manufacturing cooperate together to tackle energy saving as a family activity based on Nissan Green Program 2010. Under the circumstance, report of energy consumption was made on an ex post facto basis in the energy using sections; therefore the timely response was not taken regardless of the amount of energy consumption. This time, an energy management monitor (graphical analysis software) was developed to realize "visualization of energy consumption" which enabled each worker of the energy using sections to confirm the amount of energy consumed. In this activity, aiming at "synchronized costing (thorough elimination of waste)" which was included in the NISSAN production policy, energy saving was realized.

◎ Implementation period for the Said Example

April2006~August2007

- The period for planning: April 2006 - March 2007 (12 months in total)
- The period for implementation of the improvement measure: March 2007~August 2007 (6 months in total)
- The period for verification of improvement effects: April 2007~ August, 2007 (5 months in total)

◎ Outline of the Business Establishment

- Production items: Manufacturing of passenger car (CUBE, MARCH, TIIDA, NOTE, SYLPHY)
- Number of employees: 2,711
- Annual energy consumption (results in fiscal 2006):

Electricity: 73,403MWh, City gas: 17,290km3

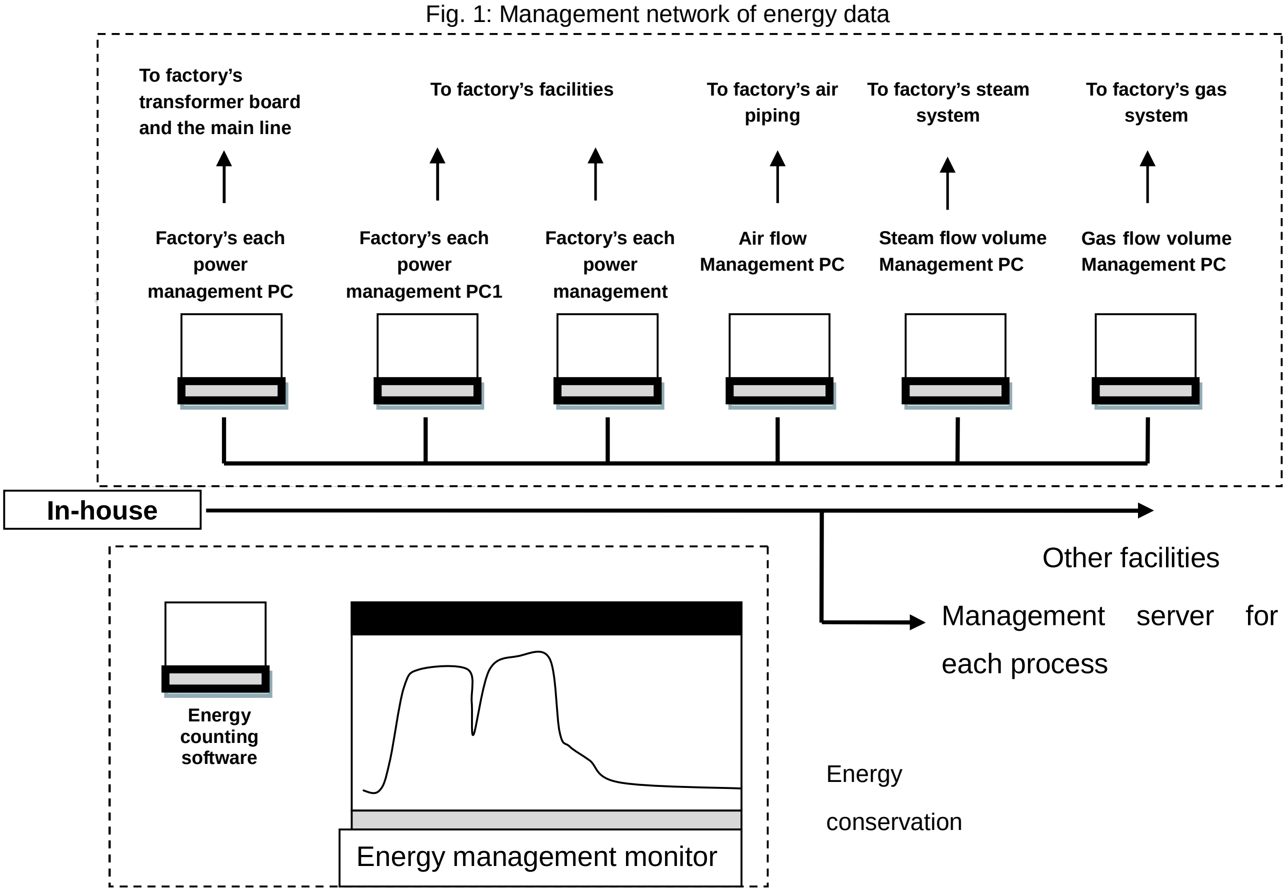
Kerosene : 491 kL, Heavy fuel oil A: 76kL

Type I designated energy management factory

◎ Process Flow of Target Facility

Energy sources used in this factory are electricity, compressed air, steam, and city gas. Fig. 1 shows the network of those energy sources, and using an energy management monitor, factory workers can confirm a daily energy change or energy waste from any personal computer on a steady basis.

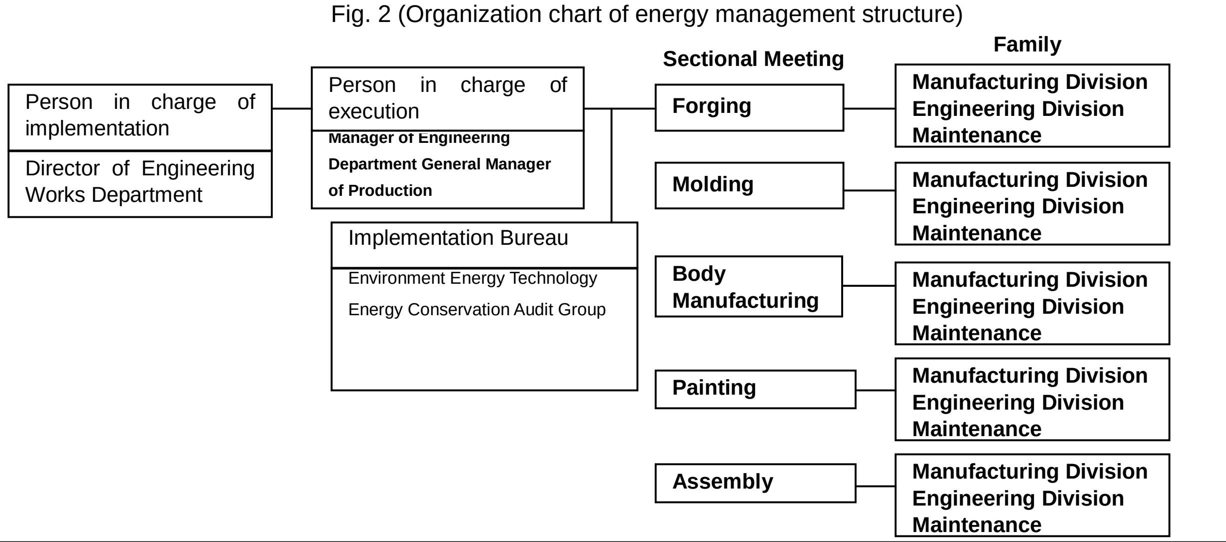
Fig. 1: Management network of energy data



1. Reasons for Theme Selection

In this factory, the energy management section (Implementation Bureau) drafts an energy consumption budget, compiles past results of energy consumed and reports them to the energy using sections. In the energy using sections, the manufacturing section, engineering section, and maintenance section cooperate as a family in drawing a plan for achieving the energy budget and carrying out energy saving activity as well as production work. However, past results of energy consumption were usually reported by the Implementation Bureau only once a month, and fluctuation factors for daily changes of energy consumption were unknown, therefore the energy using sections could not take timely measures for saving. Energy management sections and energy using sections wanted to develop a device with which it became possible to check energy consumption as needed and to take timely measures for energy management, therefore, development of a new device was chosen as a theme.

Fig. 2 (Organization chart of energy management structure)



2. Understanding and Analysis of Current Situation

(1) Understanding of Current Situation

At present, data of ready-made monitoring software which the energy supply sections use has been altered (making them into graphs), and deployed to energy using sections for use. However, the recent reports show that waste can not be get hold of and that it is not easy to check daily energy consumption and reduction effects of energy saving in energy using sections. Realization of “visualization of energy consumption” is necessary in order to make it possible for every worker of each section to check the amount of energy consumed any time they wanted.

1) Present issues

Fig. 3 is a graph which is actually deployed to energy using sections. Though changes of energy consumed according to the state of production were able to be observed in this graph, it was difficult to grasp the waste of energy.

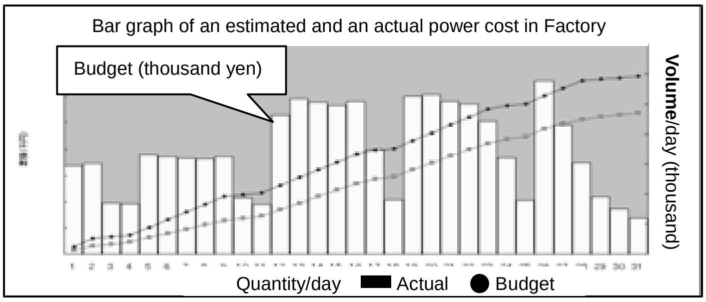
Then, the issue of what kind of monitor should be offered to energy using sections was examined in Implementation Bureau.

Fig. 3: Reporting graph of an estimated cost and an actual cost

- Bar graph of an estimated and an actual power cost in Factory
- Estimated cost (thousand yen)
- Daily consumption (thousand yen)
- Actual performance

[1] Graph of the quantity consumed classified by energy sources

図 Fig. 3 (Reporting graph of an estimated cost and an actual cost)



Results of examination (required functions) were as follows:

(electricity, air, steam and gas).

[2] Comparison graph between estimated energy cost and actual performance

[3] Hourly transition graph of the quantity consumed by divisions (the graph in which daily changes can be compared for 1 month)

[4] Hourly transition graph of the quantity consumed by systems and facilities (the graph in which daily changes can be compared for 1 month)

[5] Integration of existing data

[6] The quantity consumed per motor-car and evaluation function

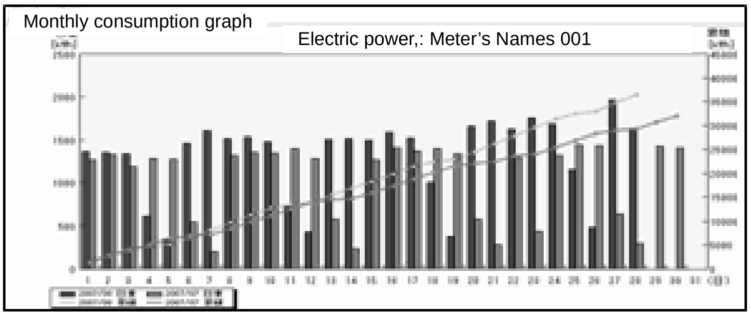
2) Examination of monitoring software

Based on previously described examination results, monitoring software products on the market were examined, and there were some problems found in them. The largest problem was that required functions were not satisfactory.

Concretely,

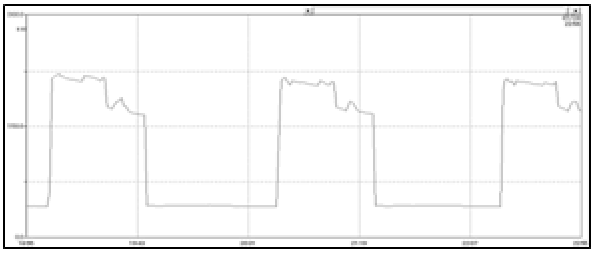
[1] Fig. 4 is a sample of Company A in which energy consumption is compared between the present month and the previous month. However, in the factory, comparison in this way is meaningless, since there is production fluctuation as well as seasonal variation; therefore the quantity of energy consumed is not the same. In this factory, management on whether estimated energy cost has been fulfilled or not should be carried out in comparison with the energy budget.

Fig. 4 (Company A's daily quantity trend graph)



[2] Fig. 5 is a sample of the continuous trend graph of Company B. Though daily changes was able to be confirmed here, a graph of superimposed trends that was the best for confirming changes in energy consumption or the effectiveness was needed. Though there were some products that were suitable for such confirmation, there were only 6 data for comparison. In our factory, it is desirable to compare at least 31 data (daily) for monthly management.

Fig. 5: Real-time trend in Company B



There were some other problems. In order to fulfill "synchronized costing (thorough elimination of waste)", compromise can not be made for "required functions". However, the quoting price for custom-made software with all those functions was enormous.

3) Development of monitoring software

As a result of examining the previously described problems in Implementation Bureau, they decided to set up a project team for developing monitoring software. The operation period was decided from April 2006 to March 2007, while the team was consisted of 2 persons, 1 data administrator for displaying trend graphs and 1 person for developing the monitoring software.

Introduction of the energy management monitor (own product)
Following are trend graphical representation functions;
[1] Hourly transition graph of quantity consumed in each division
[2] Hourly transition graph of quantity consumed that is classified by systems and facilities
[3] Comparison graph between estimated energy cost and actual performance
[4] Graph of quantity consumed per motor-car in each division
[5] Transition graph in the non-operation time zone.
[6] Ranking Pareto diagram of quantity consumed that is classified by facilities.

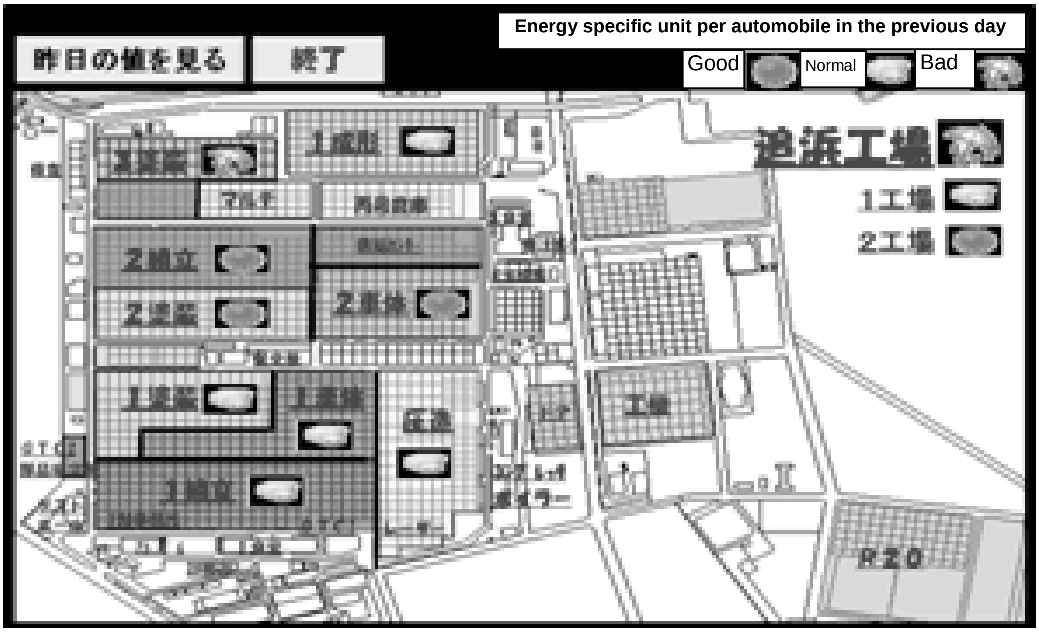


Fig. 6: Main screen of energy management monitor

(2) Analysis of Current Situation

"The energy management monitor" produced was deployed to the energy using sections from November 2006. Implementation Bureau and energy using sections analyzed the data, and then began to use the management monitor as management tools for finding out items for which energy should be reduced and for confirming improvement effects and continuing energy saving efforts.

Table 1 shows items, for which energy should be reduced, actually found by “the energy management monitor”. At present, Implementation Bureau and energy using sections continue to use this monitor to find out other items. The following are cases of No.1 to No.3 among those items.

Table 1 (Items for energy conservation by using monitor)

	Name
No.1	Reduction of electric power used during the non-operating time in the factories
No.2	Halt of operation of cooling water pumps for welding in Body Shop 1
No.3	Reduction of air leakage in body shop 1
No.4	Disconnect of power from cooling equipment in the T3040 office
No.5	Improvement of equipment for injection molding machine No.3 in the molding shop
No.6	Reduction of air pressure during the non-operating time in the factories
No.7	To power off the main line for welding after operating hours in body shops
No.8	To power off the cranes during the non-operating time in the forging factory
No.9	Introduction of INV for air conditioning in the painting factory

1) Reduction of electric consumption during the non-operating time in factories

Fig. 7 is a graph that compares hourly variation of electric power consumption.

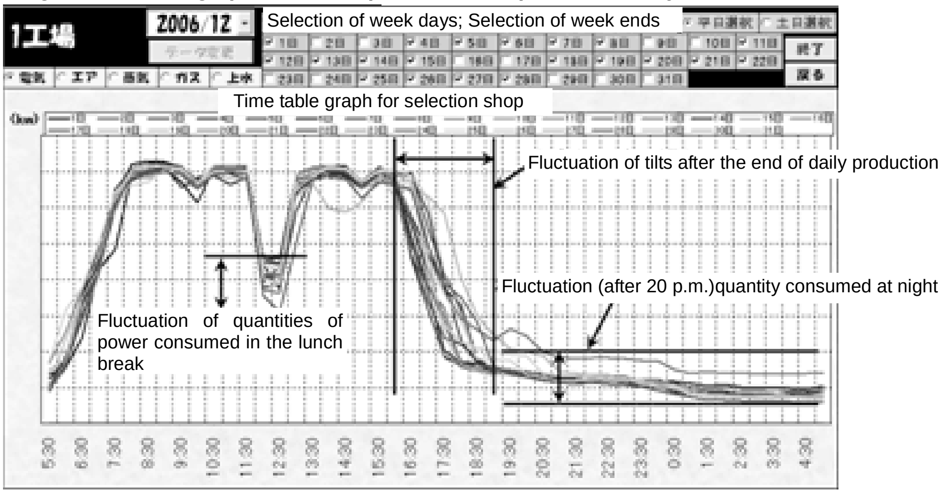
As a result, the following trends were found:

[1] Fluctuation of electric power consumption in the lunch break

[2] Fluctuation of electric power consumption at night

[3] Difference in the tilt of the consumption curve after the end of daily production

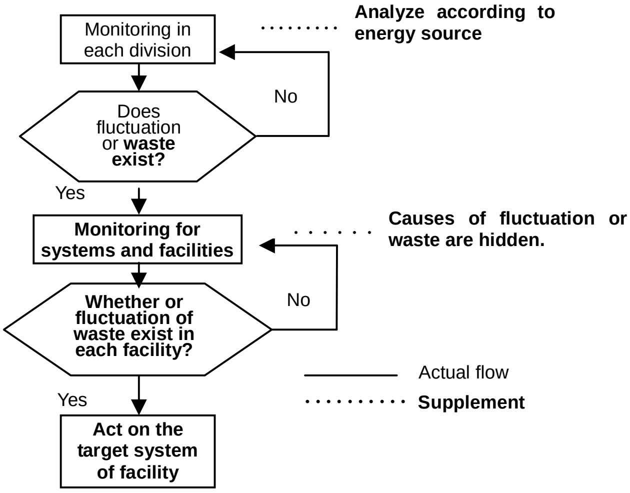
Fig. 7: Transition graph of electric power consumption in Factory 1



Considering various kinds of transition curve shown in **Fig.** 7, the subcommittee composed of manufacturing, maintenance, and technology sections of each division began to play a main role in working on reduction of energy consumption of the whole Factory in the non-operating time.

Fig. 8 is an actual flow chart of item finding, analysis of data is carried out in each source of energy, section and facility by using the energy management monitor so as to confirm on whether there is any waste of energy.

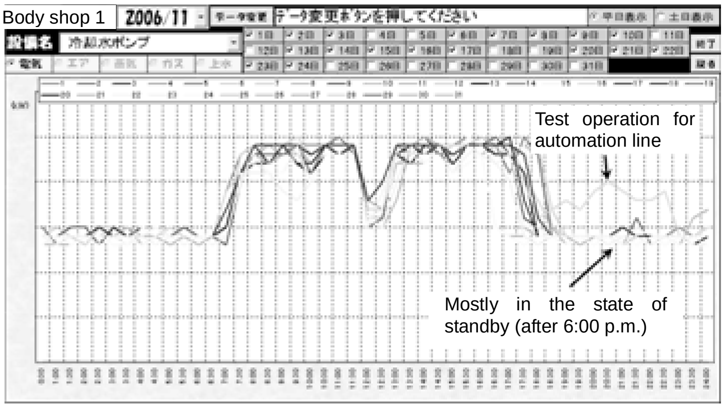
Fig. 8 Items finding flow



2) Reduction of standby power of cooling water pump in Body Shop 1

This problem was found based on the items finding flow chart in **Fig.** 8 and fluctuation of electric power of the cooling water pump on operating days is shown in **Fig.** 9. The cooling water pump is equipment for cooling water for a car body automation line, and it was indicated that the electric energy did not decrease even in non-operating hours of the factory after 18 o'clock. The result of investigation showed that operation of the automation line in the non-operating time was only carried out on occasions of inspection; therefore it was rare to operate it at night. It was found as the items, because it might be possible to stop operation of the cooling water pump in the non-operating time.

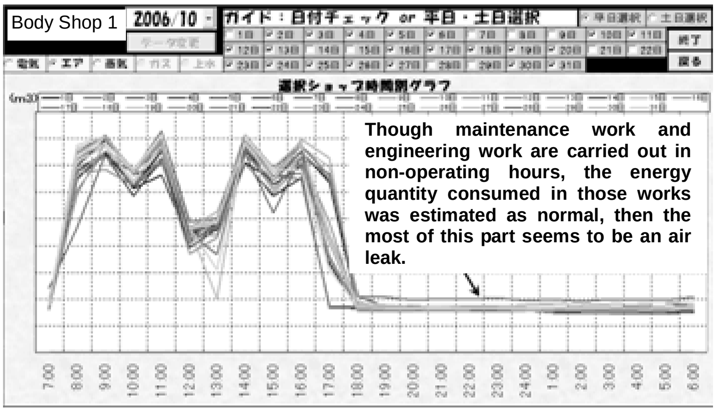
Fig. 9: Power transition f graph of cooling pump in Body Shop 1



3) Reduction of air leak in the Body Shop 1

Fig. of 10 shows transition of air flow in the Body Shop 1. Flow was lowered and the fixed transition was maintained after daily production work finished. Though maintenance work and engineering works in the engineering divisions were carried out in non-operating hours, the energy quantity consumed in those works was estimated as nominal. The stabilized transition part seemed to be air leak, and this amount was added to daily quantity consumed. Therefore, it was decided to work on the reduction of air leak.

Fig. 10: Air flow graph in Body Division 1



3. Progress of Activities

(1) Implementation Structure

Table 2: Schedule for items activity

Item of activity	2006		2007				
	First half	Latter	April	May	June	July	August
Management for energy data	—	—	—	—	—	—	→
Manufacturing of energy monitor		→ →					
Finding of items for energy reduction		—	—	→			
Example 1: Reduction of electric power in the non –operating time at factory			—	—	—	—	→
Example 2: Halt of operation of cooling water pump for welding in Body Shop 1		→					
Example 3: Reduction in the air leakage sites in Body Shop 1					—	—	→
Confirmation of results			—	—	—	—	→

(2) Target settings

[1] Reduction of electric power consumption in the factory in the non-operating time

- Reduction of electric power by 20% from the same month last year

[2] Reduction of standby power for the cooling water pump in Body Shop 1

- Reduction of electric power in non-operating hours to zero (except for periodical inspection days)

[3] Reduction of air leak in Body Shop 1

- Reduction of air leak by 30%

(3) Problem Points and their Investigation

1) Reduction of electric power in the factory in the non-operating time

Unevenness in power quantity consumed in the non-operating time in the factory seem to show that lighting, air conditioning and equipment are sometimes stopped and sometimes not. There is a lack of consciousness of energy saving in workers. Moreover, in the plant for production, there is no rule on whether workers can stop equipment or who has authority to stop the equipment concerned; therefore mostly workers can not decide when to stop equipment.

2) Reduction of standby power for the cooling water pump in Body Shop 1

There are also some anxieties over stopping operation of the cooling water pump, such as whether it brings adverse effects on the automation line, or whether inspection workers begin operation on other occasions than maintenance work. As the result of inspection, it was found out that there is an interlock for operation of the cooling water pump in the automation line and that operation of the automation line is completely stopped when operation of the main line for welding is stopped at night. Other than inspection and improvement work among maintenance work, there is sometimes emergency work (equipment failure) in the non-operating time, but its frequency is low.

3) Reduction of air leak in Body Shop 1

There are many facilities using air as motive power in the factory. But details of air leakage have not been known yet. In daily maintenance, manufacturing divisions have found the sites of leakage and asked the maintenance sections to repair them. As the manufacturing divisions have not realized the importance of solving the trouble, maintenance has not been actively carried out. In order to make them realize the importance of the issue, the state of air leakage was shown to manufacturing divisions by monitor. Afterwards workers of those divisions began to play a main role in investigating air leakage sites. As the result, it was found that there were 30 air leakage sites in Body Shop 1.

4. Details of Measures

(1) Measures for the non-operating time in the factory

[1]To put a sticker on each facility that says stoppage of operation is either permitted or not permitted

[2]To display the name of a person in charge of turning off the lighting system

[3] To put a safety sticker on lighting SW in the non-operating time (even other workers can turn off lights during operating hours if is necessary)

[4] Operational management of air conditioning in the guard post (setting of temperature and operating standards)

[5] Execution of patrols and calling for energy saving (one patrol/week by persons in charge)

[6] Execution of energy saving broadcasting at the lunch time and the end of daily operation

(2) Reduction of standby power for the cooling water pump in Body Shop 1

[1] To turn off the power supply at the end of daily operation in manufacturing divisions

[2] Operation of the pump only in necessity in maintenance sections

(3) Reduction of air leak in Body Shop 1

[1]Execution of a repair plan and management of the progress

[2] Investigation on sites of air leakage and the plan for repair (once/month patrol).
In order to continue the efforts of energy saving, the energy management monitor is used to be checked, and Implementation Bureau works with energy using sections whenever there is any change in energy consumption in order to continue the efforts of energy saving.

5. Effects achieved after Implementing Measures

(1) Reduction of electric power in the factory in the non-operating time

Fig 7: Before implementation

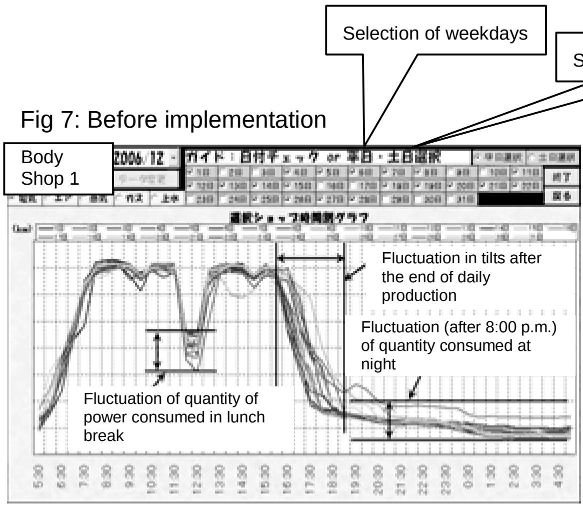


Fig 11: After implementation

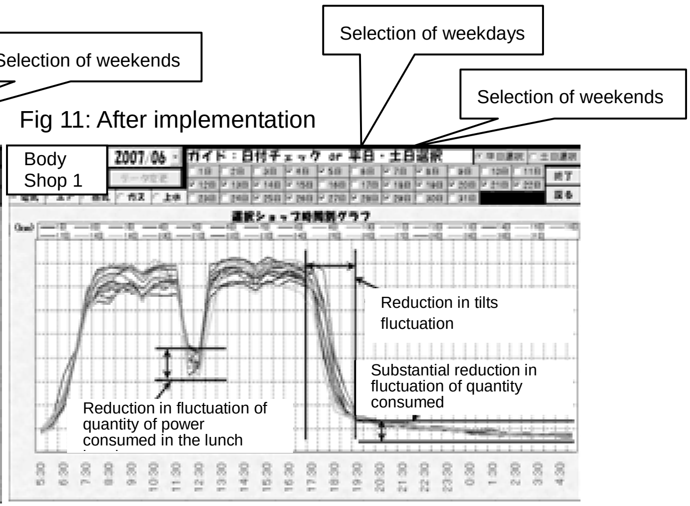


Fig. 7 and **Fig.** 8 show the graphs before and after taking countermeasures in the factory 1. As the result of taking those measures in the whole Oppama Factory, the electric consumption was down by 192,800kwh from the same month last year. (07/4~07/6 in total)

※The annual projected effect: ¥ 6,940,000 (decrease by 18%), (288 ton/year in conversion to CO2).

(2) Reduction of standby power for the cooling water pump in Body Shop 1

Fig 10: Before implementation

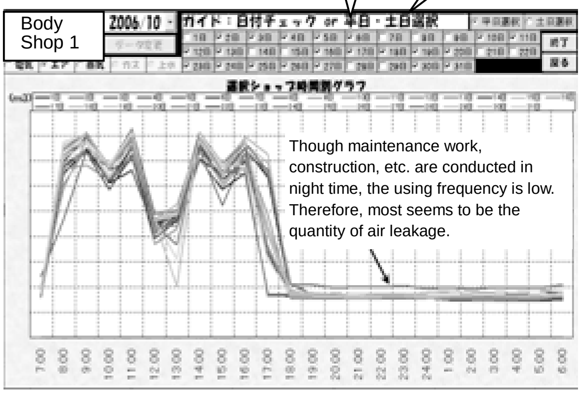


Fig 13: After implementation

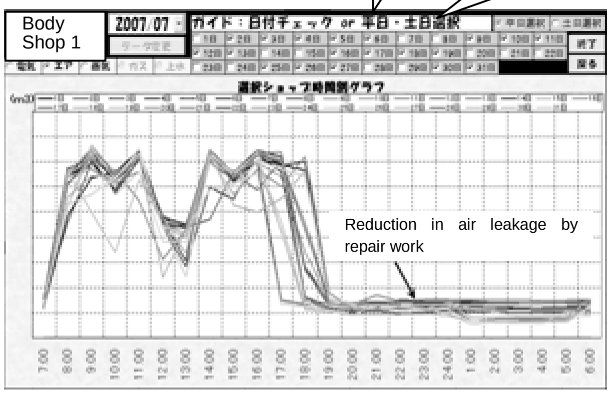


Fig. 9 and **Fig.** 12 show graphs before and after taking countermeasures for the cooling water pump. As a result of taking countermeasures, total daily electric energy was able to reduce from 812kWh to 540kWh, and targeted electric power in non-operating hours was made to be zero.

※The annual effect: ¥ 597,000/year, (24.8 ton/year in conversion to CO2)
(This reduction is included in the annual effect of “5-1. Reduction of electric power in the factory in the non-operating time”)

(3) Reduction of air leak in Body Shop 1

Fig 10: Before implementation

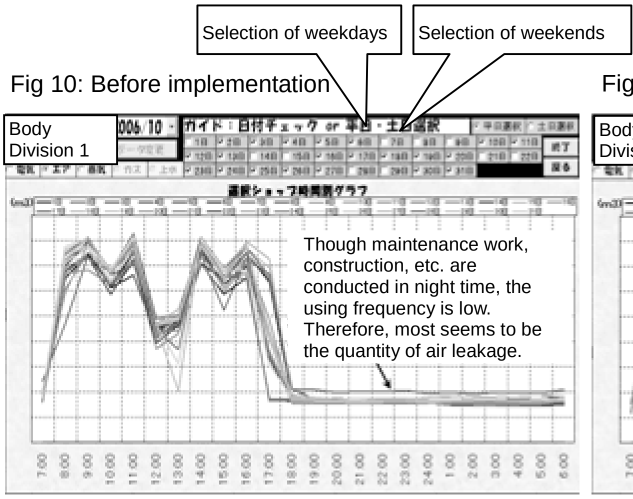


Fig 13: After implementation

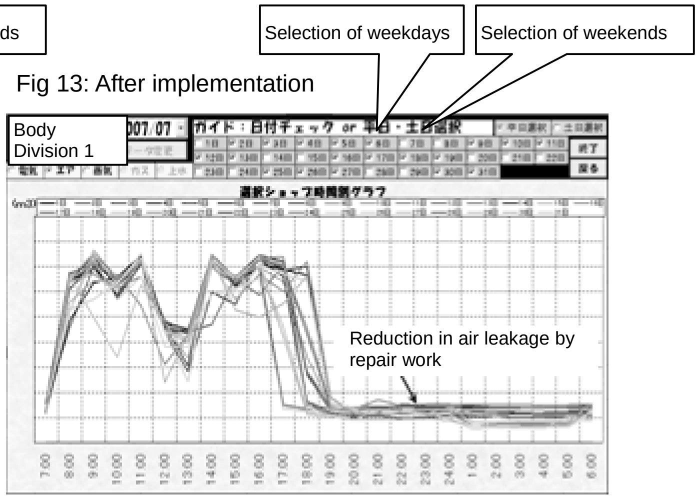


Fig. 10 and **Fig.** 13 show graphs before and after taking countermeasures for air leakage in Body Shop 1. As a result of repair work of air leakage, the average flow rate per hour was successfully reduced by 344 [Nm3] (24% reduction). Though the target was not achieved, repair work has still been underway and targeted reduction by 30% is expected with more energy saving efforts.

※The annual projected effect (decrease by 24%): ¥ 2,138,000/year (88.8ton/year in conversion to CO2)

6. Summary

[1] By introducing “visualization of energy consumption”, confirmation of waste energy consumption and energy saving effects became possible as needed.

[2] As the result of [1], the number of cases in which items for saving energy were found increased.

[3] Deployment of the management tool resulted in activation of energy saving efforts in the whole factory.

[4] Cooperation between each division and Implementation Bureau was strengthened through these efforts.

[5] Through the management of energy data, the skill of data management in the energy supply sections was improved.

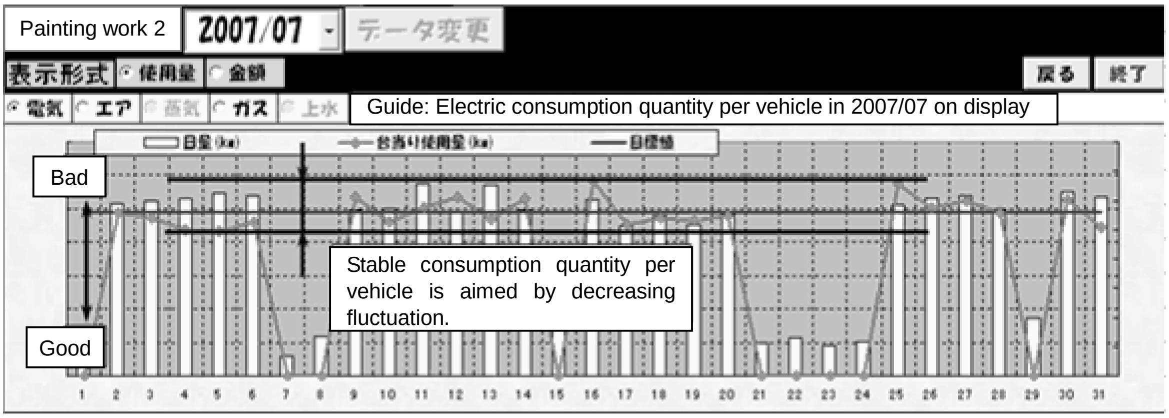
[6] It became possible for Implementation Bureau to make minute analysis on management of energy budget by introduction of the monitor.

7. Future Plans

[1] By introducing "visualization of energy consumption", confirmation of waste energy consumption and energy saving effects became possible as needed.

Fig. 13 shows a quantity consumed per vehicle. Our target is to stabilize quantity consumed per vehicle at a low level. When quantity consumed per vehicle goes up, the cause will be sought out and countermeasure will be taken so as to prevent a recurrence.

Fig. 13: Consumed quantity graph per energy management monitor



[2] "Visualization of energy consumption" from the view point of energy supplying sections (operation efficiency of equipment and so on)

At the moment, it is not possible to display operation efficiency of equipment and others on the present energy management monitor, but it will be possible in future. Anything to say, the present monitor was made for the section using energy, but improvement of the monitor is under consideration so that the energy supplying sections will be able to use this as a management tool.

[3] Increase in the number of measuring points of energy consumption (a plan for fiscal 2007-2010)

It is possible to confirm the state of energy consumption classified by facilities, or systems on the monitor as mentioned above. We will aim at increasing the number of measuring points of energy consumption in future to promote more detailed management and to find more items for energy saving.