2004 Prize of Director General of Agency for Natural Resources and Energy

Project X: "Challenge to attain Zero Standby Power"

Hino Motors, Ltd., Hamura Plant
Engineering Department, Facilities Maintenance Section

◎ Outline of Theme

Electric power used during nonproductive periods of the factory includes "safety preservation power," which is consumed to maintain the functions of the factory and the production equipment, and "standby power," which is consumed by various equipment such as computers for the control panels that cannot be shut down, although the main motors of the production equipment have been shut down. We have turned our attention to this "standby power," classified the equipment into "those that should never be shut down" and "those that may take too many man-hours though it may be shut down." After having confirmed that no problems would occur if we shut down the equipment, we decided to turn off the power at its sub-transformer station in an effort to reduce standby power.

◎ Implementation Period of the said Example:

From September 2001 – December 2003

- Project planning period: September 2001 – October 2001 2 months in total
- Measures Implementation Period: October 2001 – December 2003 27 months in total
- Measures Effect Confirmation Period: February 2002 – December 2003 23 months in total

◎ Outline of the Business Establishment

- Production items: Commercial trucks (2-ton pickup trucks), Hilux Surf
- Number of employees: 3,900
- Annual energy consumption (actual record of FY 2003)

  Electricity (power received): 123,795 MWh
  City gas (P-13A): 8,404,000 Nm^3
  Heavy oil: 12,551 kL

◎ Process Flow of Target Facility

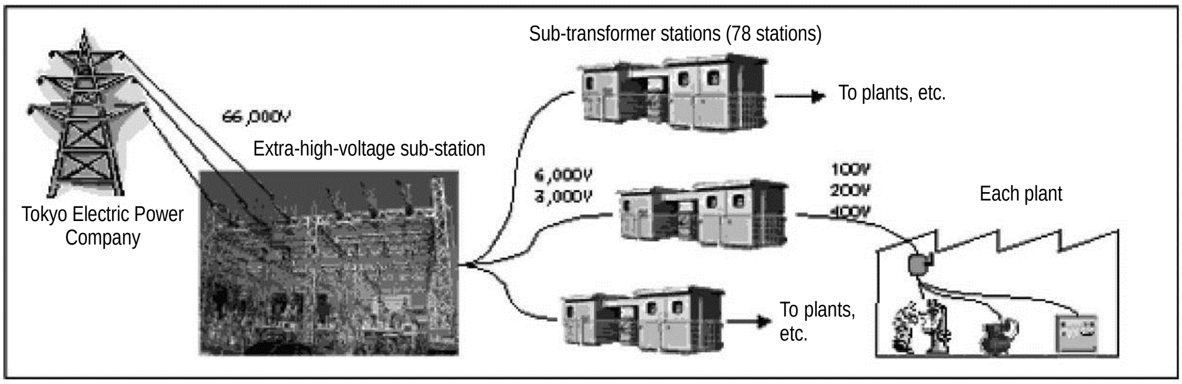

Fig. 1 Power-receiving and distribution system diagram

1. Reasons for Theme Selection

The factory manager's words to the energy-saving secretariat were: "You know something? God does not do useless jobs! In other words, do not consume energy when you are not producing anything."

We are continuing our challenge to attain the level of God's work with the ultimate goal of becoming No. 1 in terms of energy conservation. This time, as a theme, we have selected "the reduction of standby power" by turning off the power supply to certain equipment.

2. Understanding and Analysis of Current Situation

According to the records of energy costs classified by the items at our factory in the fiscal year 2000, electric power makes up the greatest portion, accounting for 52% as shown in Fig. 2. At that time, the factory consumed electric power of approx. 300,000 kWh per day. The analysis shows that electric power was used for productive purposes as well as for nonproductive activities, and that even during nonproductive periods, electric power of 46,700 kWh was consumed (Fig. 4).

Electric power used during nonproductive periods of the factory includes the “safety preservation power,” which is consumed to maintain the functions of the factory and the production equipment, and the “standby power,” which is consumed by various control equipment, although the production equipment has been shut down (refer to Table 1).

We have identified each and every piece of equipment and device that consumes such “safety preservation power”; they are shown in Fig. 3. The accumulated “safety preservation power” amounts to approx. 116,000 kWh per day.
In other words, as shown in Fig. 4, of the electric power consumption of 46,700 kWh per day, the remaining approx. 35,000 kWh per day (about 75% of the electric power consumption during nonproductive periods) is unnecessary “standby power.”

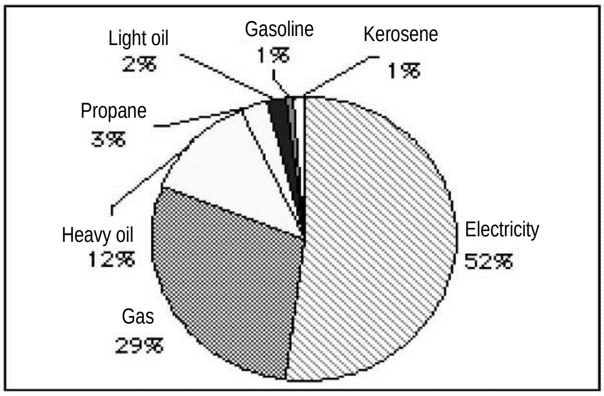

Fig. 2 Energy consumption classified by item

<table>
<tr><th>I. Safety preservation power</th><th>II. Standby power</th></tr>
<tr><td>• Fire prevention and accident prevention
(fire hydrant, automatic fire alarm system, etc.)</td><td rowspan="5">• Although the production equipment is not in operation, electric power is supplied to the control equipment (between shifts, on holidays).

(Example):
Inverters, control panels, servo motors of robots, etc.


</td></tr>
<tr><td>• Life line
(extra-high-voltage sub-transformer, automatic vending machines, gas plant, water, etc.)</td></tr>
<tr><td>• Information
(CCR, production indication equipment, etc.)</td></tr>
<tr><td>• Plant functions
(compressors, waste water treatment and painting equipment, etc.)</td></tr>
<tr><td>• Outdoor lights
(emergency lights, guide lights, night lights, etc.)</td></tr>
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Table 1 Classification of electric power consumption into “safety preservation power” and “standby power”

Breakdown of safety preservation power

No.	Description	Power consumption (kWh/day)	Electric power expense (1,000 yen/day)
1	Fire prevention and accident prevention	88	0.9
2	Life line	3,111	31.7
3	Information	500	5.1
4	Plant functions	7,650	78.0
5	Outdoor lights	296	3.0
Total		11,645	118.7

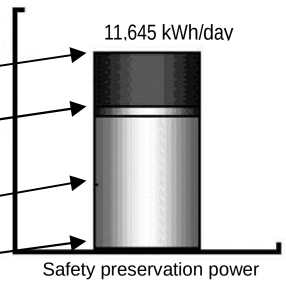

Fig. 3 Breakdown of safety preservation power

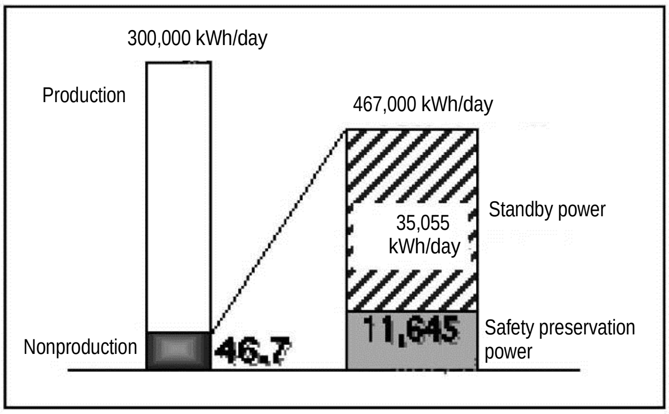

Fig. 4 Electric power consumption per day

3. Progress of Activities

(1) Implementation Structure

Each department of our factory has established an energy cost committee. The manager of each department is nominated as “the chairman” of the committee, and the chief of the Maintenance Section is nominated as “the promoting member” to prepare action plans and improvement plans. Also the foremen or group leaders who are familiar with the job site are nominated as “the responsible persons” to implement and monitor the improvement activities meticulously. In addition, the factory manager convenes the energy cost committee once a month to follow up the progress and to discuss promising plans in an effort to promote the energy conservation activities.

(2) Target Settings

We have determined to reduce electric consumption during nonproductive periods to as low as possible by setting the target to "zero."

(3) How to Implement the Reform Measures

1) Analyze how safety preservation power and standby power are used.
2) Review the operation of the sub-transformer stations that supply electric power during nonproductive periods.
3) Shut down individual equipment that can be turned off (equipment that can be turned off, but is not shut down at present).
4) Shut down the electric power supply at the sub-transformer station that supplies the electricity to a certain group of equipment.

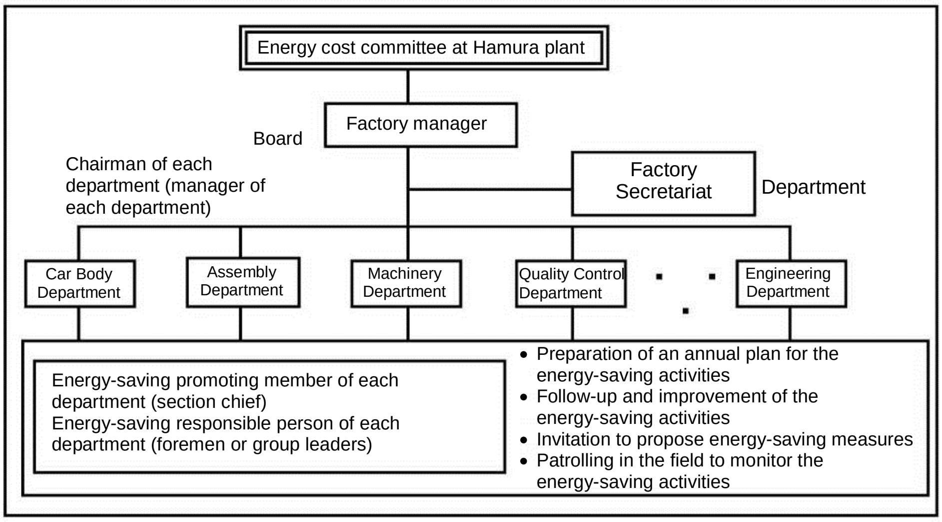

Fig. 5 Implementation structure

4. Details of Measures

(1) Target

Necessary power during nonproductive periods is only safety preservation power. Therefore, standby power should be "zero." We set this as our target.

(2) Steps for Improvements

"Step 1"

1) Conduct a survey on the equipment that currently receives electric power from the sub-transformer stations.
2) Shut down the sub-transformer stations whose operation can be stopped.

"Step 2"

1) Identify and classify the equipment in operation.
2) Decide on the persons responsible for shutting down the equipment.
3) Shut down the power supply to the equipment during nonproductive periods.

"Step 3"

1) Rearrange the sub-transformer stations so that they can supply electricity separately to the equipment that requires safety preservation power and to equipment that does not.
2) Cut the supply of electric power at the sub-transformer station.

We will make our best efforts to attain our goal of making standby power "zero" during nonproductive periods in accordance with the steps shown above.

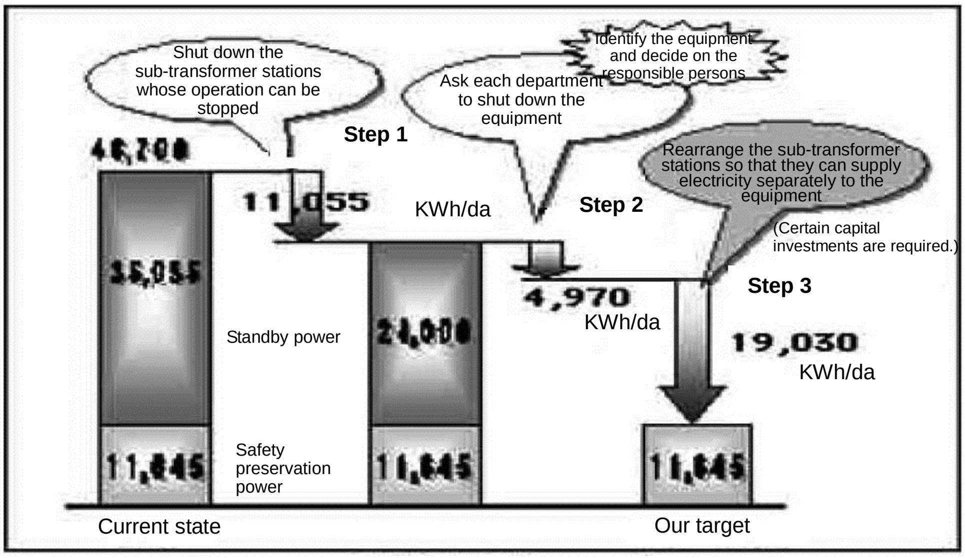

Fig. 6 Steps to reduce standby power

(3) Contents of Improvement

"Step 1": We conducted a survey on the equipment that currently receives electric power from the sub-transformer stations and then shut down some of the substations.

- In our factory, there are 78 sub-transformer stations as shown in Fig. 7.
- We have conducted a survey on all the sub-transformer stations to confirm electric loads and their results are shown in Table 2.
- The sub-transformer stations that do not supply electricity to the equipment that requires safety preservation power can be shut down. After consulting with the departments that have equipment receiving electricity from such substations, we could stop the operation of 43 substations as shown in Fig. 8.

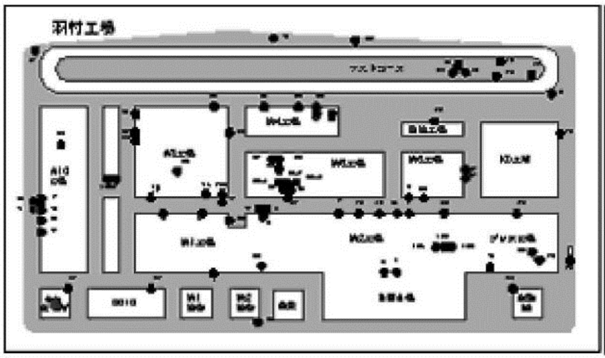

Fig. 7 Layout of the sub-transformer stations (before improvement)

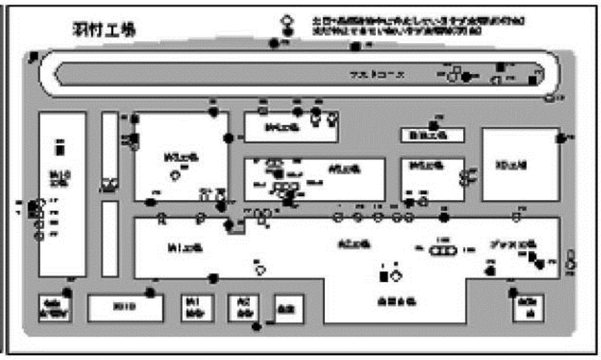

Fig. 8 Layout of the sub-transformer stations (after improvement)

Result of the survey on the equipment that currently receives electric power from the sub-transformer

		Sub-transformer stations at No. 1 plant				Sub-transformer stations at No. 2 plant						
		No. 1	No. 2	No. 3	No. 65	No. 4	No. 5	No. 6	No. 7	No. 8	No. 10	No. 18
Production equipment		○	○	○	○	○	○	○	○	○	○	○
Lighting system		○	○	○				○	○	○	○	
Safety preservation power	Drainage pump	○	○			○				○	○	
	Fire pump	○				○					○	
	Emergency lights and guide lights	○		○				○				
	Automatic vending machines	○	○	○				○				

Substations that can be stopped: No. 65, No. 5, No. 7, No. 18

Table 2 List of equipment that receives electricity from sub-transformer stations (excerpt)

We could reduce electric consumption by 11,055 kWh per day as shown in Fig. 9.

Electric consumption during nonproductive periods

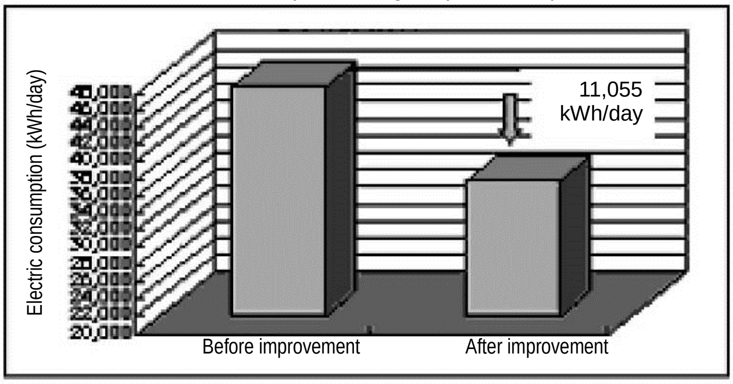

Fig. 9 Effect of stopping the operation of the sub-transformer stations

“Step 2”: We shut down the power supply to the equipment during nonproductive periods.

Since there are some sub-transformer stations whose operation cannot be shut down, a significantly large amount of electricity has been consumed as standby power (required to control the equipment) in addition to safety preservation power.

In order to reduce this standby power, we asked all departments and lines to “identify and classify the equipment in operation.” An example is shown in Fig. 9. We requested them to clarify in the list whether it is possible to shut down the power supply of each piece of equipment .Then if the power supply can be shut down, we decided on the person responsible for turning it off individually. Moreover, it has been decided to attach a label as shown in Fig. 10 to each piece of equipment so as to avoid forgetting to shut down the equipment that should be turned off and shutting down the equipment that should not be turned off by mistake.

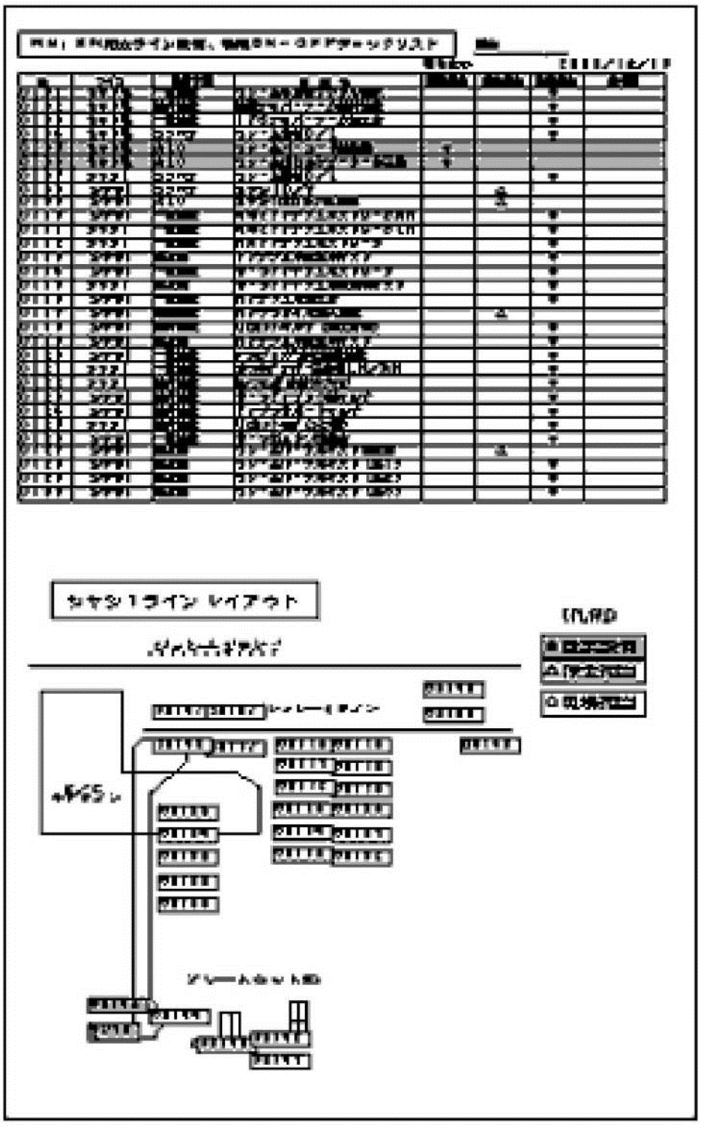

Fig. 9 List of the equipment that is to be shut down

Name of equipment

Category	Must not be turned off	Must be turned off
Saturdays and Sundays	○	
Day on which the electric supply is stopped	○	
Long consecutive holidays		●
Day on which all the power supply lines are cut off		●

Person responsible for turning off the power supply

Fig. 10 Label showing whether the power supply to the equipment should be cut off or not

Furthermore, we are conducting “patrol to confirm that the equipment that should be shut down is actually turned off" in the entire factory during long consecutive holidays. The results are shown in Fig. 11. As you can see, the awareness of members of the Manufacturing Department has improved and, as a result, an increased amount of equipment has been shut down.

In addition to the effect obtained from "Step 1," we could further reduce electric consumption by 4,970 kWh per day (Fig. 12).

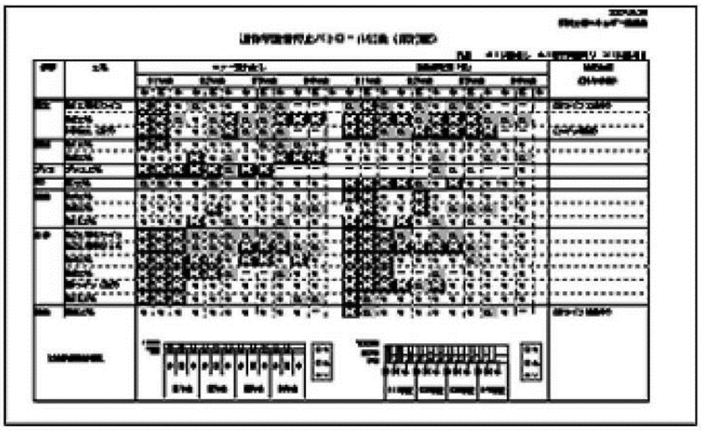

Fig. 11 Result of patrol to confirm that the equipment that should be shut down is actually turned off

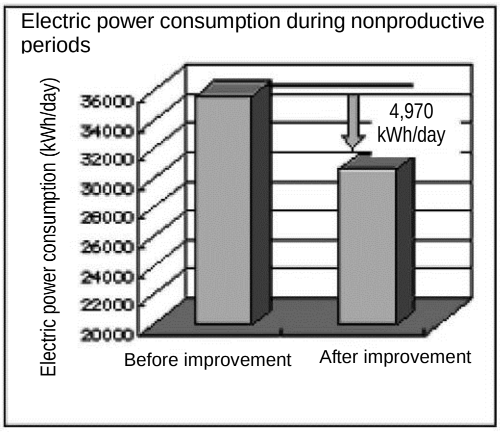

Fig. 12 Effect of stopping the equipment

"Step 3": We rearranged the sub-transformer stations so that they could supply electricity separately to the equipment that requires safety preservation power and to the equipment that does not, and then shut down the sub-transformers that supply electricity to the equipment that does not require safety preservation power.

We have divided 35 sub-transformer stations that cannot be shut down because they supply electricity to the equipment that requires safety preservation power into 12 blocks as shown in Fig. 13, and we are currently trying to connect the equipment that requires safety preservation power to one sub-transformer station located in each block.

Currently, we have completed this rearrangement in six blocks out of 12 blocks. We will explain the example of No. 3 plant below.

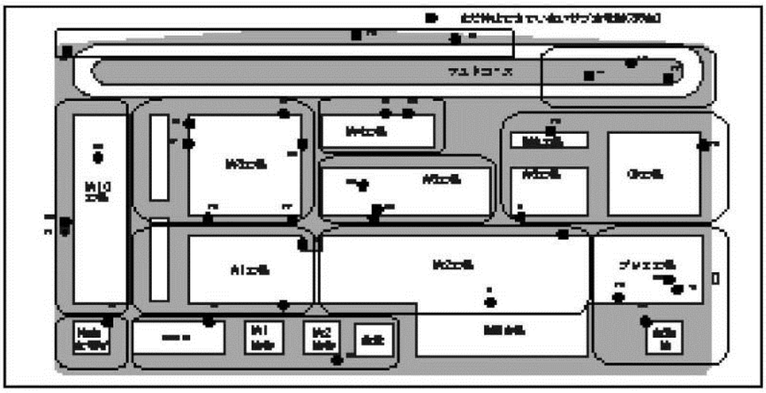

Fig. 13 Rearrangement of sub-transformer stations into blocks

(4) Example of Improvement

Example of a rearrangement: “Rearrangement of the sub-transformer stations at No. 3 plant”

(Before improvement)

No. 3 plant received electric power from six sub-transformer stations during nonproductive periods (Fig. 14).

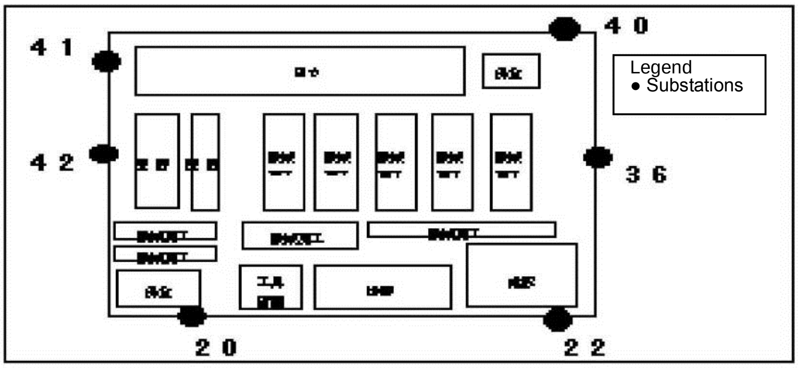

Fig. 14 Sub-transformer stations at No. 3 plant

(After improvement)

We conducted a survey on the six sub-transformer stations to examine how they supply electricity to the equipment and rearranged the substations (Fig. 15).

1) Since no wiring diagrams for drainage pumps were available, we examined the “installation locations,” “pump capacities,” and “wiring route” based on the information obtained from the departments and sections, and decided that all the pumps should receive electricity from No. 42 and that three substations (No. 22, No. 40, and No. 41)

should be shut down.

2) Bus ducts were added to the emergency lights and guide lights; No. 20 and No. 36 were looped, and No. 36 was shut down.

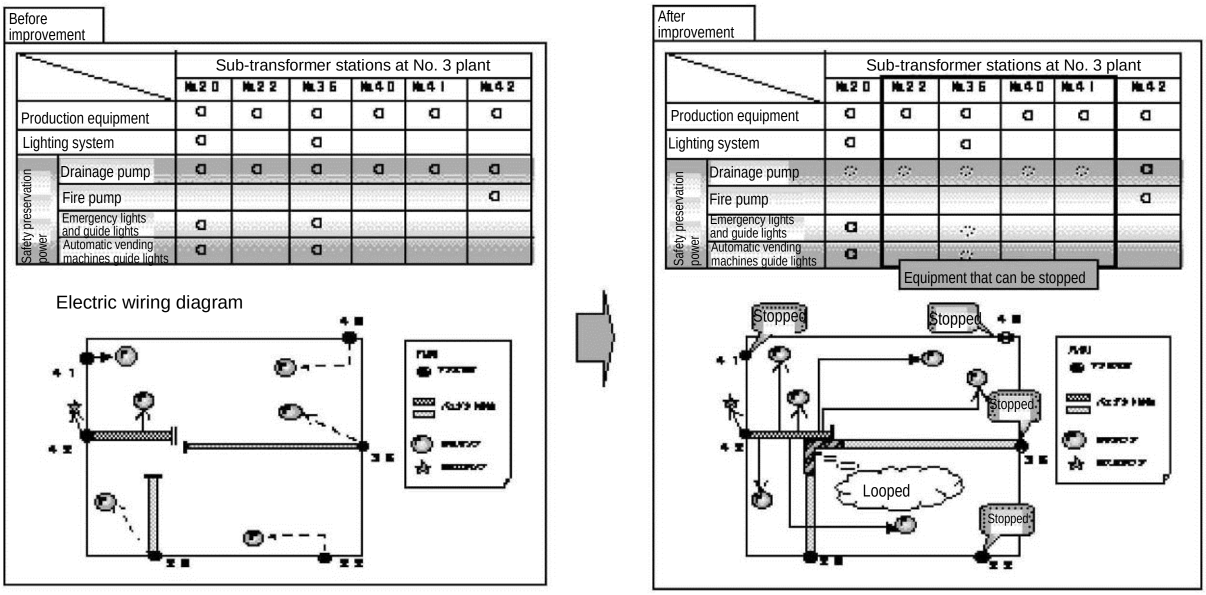

Fig. 15 How electric power is supplied to the equipment in No. 3 plant and rearrangement of the sub-transformer stations

(Capital investment and effects)

As shown in Fig. 16, we could achieve an effect equivalent to 1,327,000 yen per year with capital investment of 2,500,000 yen. In addition, we could achieve other effects of rearrangement of the sub-transformer stations; they are shown in Fig. 17.

We could also achieve an effect equivalent to 3,263,000 yen per year, since we completed the above-mentioned rearrangement in six blocks out of 12 blocks as mentioned in “Step 2.”

[Capital investment]

Installation of bus ducts and renewal of the wiring for the drainage pumps, etc.: 2,500,000 yen

[Effects]

Operation of transformers for power and lighting are shut down.

1,580 kWh/day × 5 times/month × 12 months × 14 yen = 1,327,000 yen/year

[Pay back time]

2,500,000 yen÷1,327,000 yen = Approx. 1.9 years

Fig. 16 Capital investment for and the effect of rearrangement at No. 3 plant

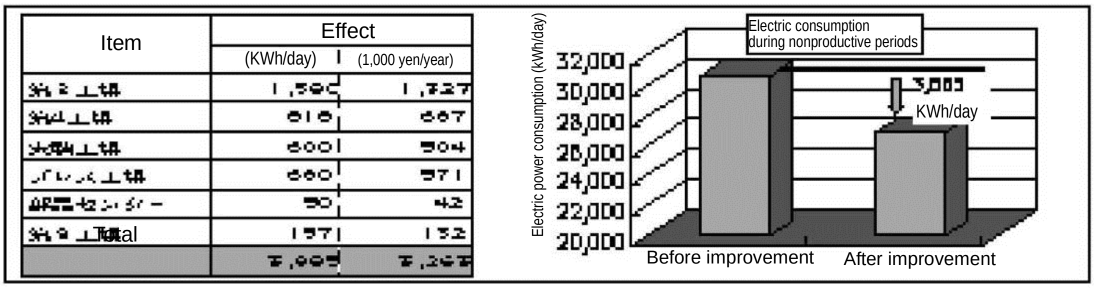

Fig. 17 Other effects of rearrangements that have already been made

[Effects of reducing standby power]

Now, we summarize the effects of “reduction of standby power” that we have achieved in several steps. We succeeded in reducing electric consumption by approx. 20,000 kWh per day, which is equivalent to 16,724,000 yen per year as shown in Table 4 and Fig. 18.

Step	Description	Effect	
		(kWh/day)	(1,000 yen/year)
Step 1	Shut down the sub-transformer stations.	11,055	9,286
Step 2	Shut down the power supply to the equipment during nonproductive periods.	4,970	4,175
Step 3	Rearrange the sub-transformer stations.	3,885	3,263
Total		19,910	16,724

Table 4 Effect of each step to reduce standby power

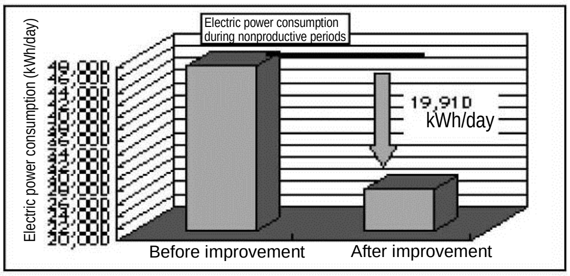

Fig. 18 Total effect of standby power reduction

“Further improvement”: Reduction of safety preservation power

The ultimate goal is to reduce electric power consumption to “zero” during nonproductive periods. In parallel with our efforts to reduce standby power, we have devised and examined plans to reduce the safety preservation power supplied to the automatic vending machines in an attempt to achieve the above-mentioned goal. We have succeeded in this improvement as follows.

(Before improvement)

Paper cups were used in the automatic vending machines because they could be incinerated in our factory and the effect on the environment could be minimized. However, it was always necessary to supply electricity to the vending machines; otherwise, the milk in the vending machines would curdle. Therefore when all the power supply lines are stopped twice a year, the vending machine operators remove the contents.

(After improvement)

1) Recyclable “cans and PET bottles” have been adopted.(refer to Fig. 19).

2) Because of adopting cans and PET bottles, the vending machines do not require safety preservation power any longer and the power supply can be shut down during nonproductive periods (refer to Fig. 20).

3) In addition, automatic vending machines of the energy-saving type were introduced when the containers were changed from paper cups to cans and PET bottles, so that electric consumption decreased (refer to Fig. 21).

		Before improvement	After improvement	Electric consumption
Safety preservation power	Paper cups	162 units	88 units	2.0 kV/unit
	Packs	87 units	87 units	0.5 kV/unit
Cans and PET bottles		-	74 units	1.4 kV/unit
Total		193 units	193 units	–

Fig. 19 Number of automatic vending machines

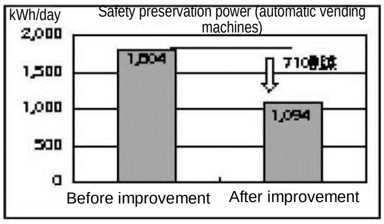

Fig. 20 Safety preservation power reduction effect

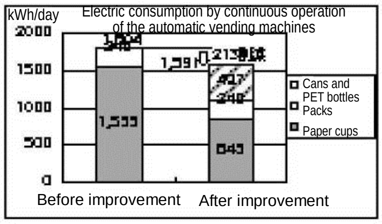

Fig. 21 Continuous power consumption reduction effect

5. Further Countermeasures

After the improvements shown above, we could shut down 50 units out of 78 sub-transformer stations. However, when maintenance works or preparatory operations for production are to be conducted on holidays, electricity must be supplied from these sub-transformer stations even though they can be shut down. In order to avoid this situation to the extent possible, our factory has established days on which all the power supply lines are stopped as shown in Fig. 22.

On these days, all the equipment except for that required for conducting the work on these days must be turned off and the sub-transformer stations are shut down. We will devise plans to conduct these works on other days to the extent possible so as to reduce the supply loss of the stations.

In addition, during new construction works, we consult with the Manufacturing Engineering Department not to supply “safety preservation power” from the “sub-transformer stations for production.”

6. Summary and Future Challenges

We have implemented improvement measures to attain the goal of reducing standby power to “zero” and, consequently, we could reduce standby power by 57% (equivalent to

16,724,000 yen per year) as shown in Fig. 24.

In addition, as you can see from the actual change in electric consumption during the night shown in Fig. 23, electric consumption has decreased steadily.

From now, we will rearrange the sub-transformer stations that we have not yet completed to attain the goal of reducing standby power to "zero" and also promote the reduction of safety preservation power as mentioned above so as to achieve the ultimate goal of reducing "electric power consumption to 'zero' during nonproductive periods."

Lastly, we will continue our best efforts for further improvements by repeatedly returning to the words of the factory manager: "Continue our challenge to attain the level of God's work."

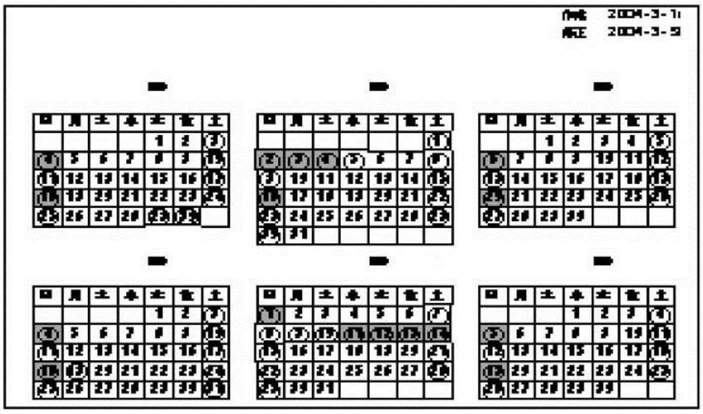

Fig. 22 Calendar showing the days on which all the power supply lines are stopped

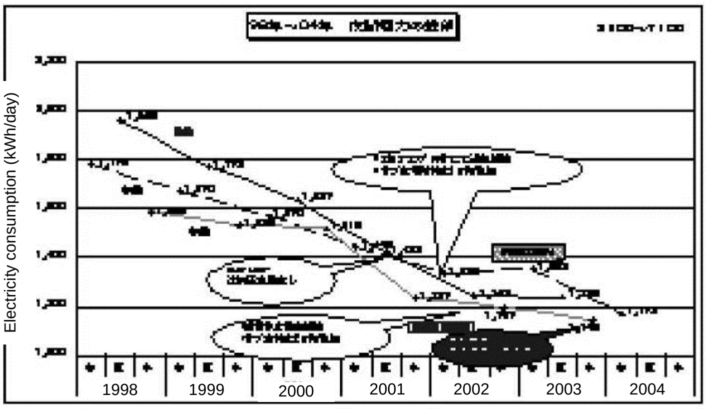

Fig. 23 Change in electric consumption during nighttime

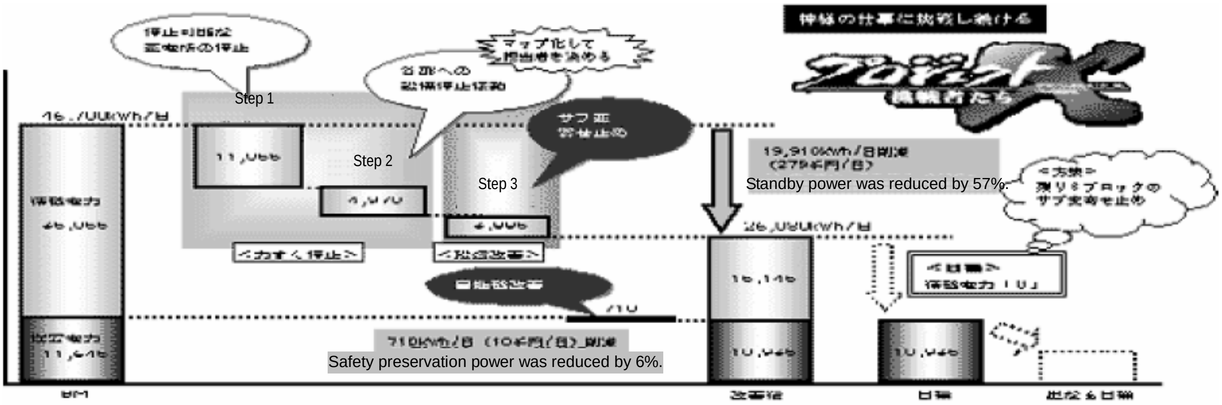

Fig. 24 Overall effect and future targets