2004 Prize of Director General of Regional Bureau of Economy, Trade and Industry

Reduction in Energy Intensity of Production Facilities by Utilizing Energy Management System

Mitsubishi Electric Corporation, Fukuyama Works
(Marukyu) Group

◎ Key Words: Rationalization of conversion of electricity to power and heat (electric power applied facilities, electric heating facilities, etc.)

◎ Outline of Theme

We have introduced and utilized the energy management system. Then, we have committed ourselves to enhancing productivity linked to activities for production innovation and energy conservation with setting the energy intensity in each printed-circuit implementation line in the factory as a management indicator and this has achieved a great result of reducing the energy intensity by 41%. These activities have been developed on a small group basis, leading into raised awareness of all employees on energy conservation.

◎ Implementation Period of the said Example

August 2003~ July 2004

Planning Period: August 2003 - October 2003, Total of 3 months

Implementation Period of Measures: November 2003 - May 2004, Total of 7 months

Confirmation Period of Measures: January 2004 - July 2004, Total of 7 months

◎ Outline of the Business Establishment

Production items: Wiring breaker, equipment for measurement control system, equipment for supporting energy conservation, fuel pump

Number of employees: 1,613

Annual energy usage (data of FY2003): Electricity: 19,051MWh

Heavy oil: 922kL

◎ Process Flow of Target Facility

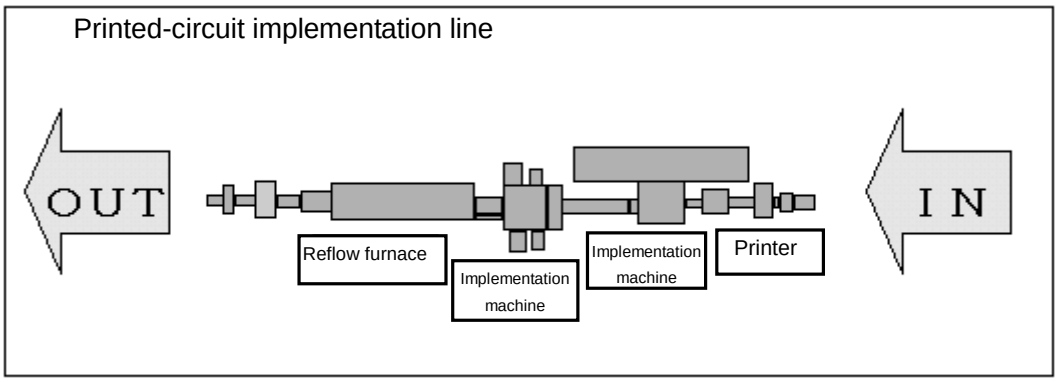

Fig.1 Target facility

1. Reasons for Theme Selection

The Fukuyama Works has obtained ISO14001 certificate in 1997 and adopted “energy conservation in the factory” as the most important environmental target. In order to achieve this target, the entire factory has promoted various activities by setting model offices in the factory. A printed-circuit factory, one of those model offices, has actively involved in energy conservation as shown in Table 1, but its reduction in the power consumption has already peaked (Fig.2). In order to make a more focused effort as a next step, the power consumption by intended purpose would be analyzed to promote focused activities for the printed-circuit implementation line (hereinafter implementation line) which has a high power consumption rate as 31% as shown in Fig.3.

Table 1 Energy conservation activities

Efforts by human factors	- Switch the light off at unattended times - Appropriate preset temperatures for air conditioners and correct turning-on and turning-off - Turn the power of computer monitor off - Adherence to no overwork days (two days per week)
Efforts by facilities factors	- Prevention of diffusion of hot exhaust air to the room - Attachment of human sensors for lighting - Automatic stop of cooling fans at unused times - Introduction of a copy machine with the power-saving mode - Reduction in idling time of soldering tank - Thermal insulation for facilities

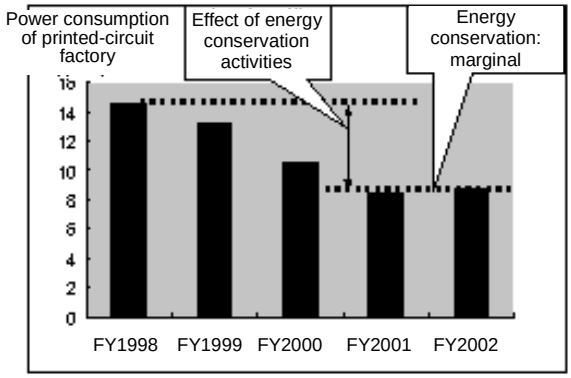

Fig. 2 Transition of power consumption used in the printed-circuit factory by year

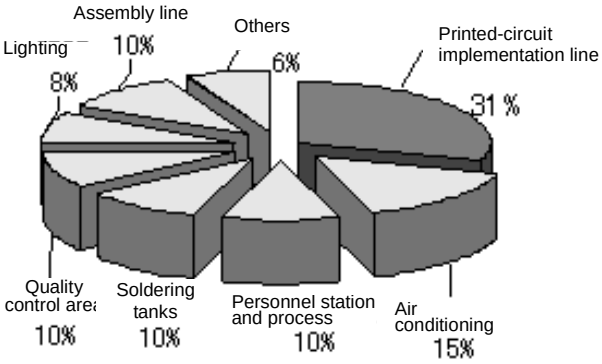

Fig. 3 Power consumption by intended purpose

2. Understanding and Analysis of Current Situation

2-1 Understanding of current situation

Figure 4 shows transition of the power consumption of the implementation line which was targeted by energy conservation activities. As shown in this figure, the power consumption increases nearly in proportion to increase in the number of circuits produced. It was found out therefore that it is difficult to promote energy conservation activities only by managing the power consumption because it is hard to manage targets and that it is necessary to analyze the relationship between the power consumption and the number of circuits produced (energy intensity: Table 2).

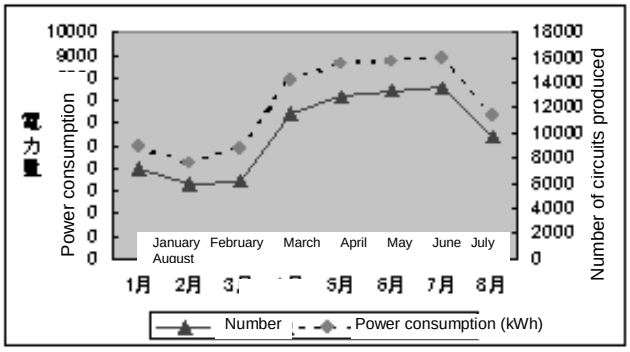

Figure 4 Implementation line: Transitions of power consumption and the number of circuits produced

Table 2 Explanation of intensity

Energy Intensity:
Energy required for producing a circuit
Power consumption (kWh) / Number of circuits produced

2-2 Analysis on current situation

As a tool to implement energy conservation activities, a system to create graphs of energy intensity by time (Fig. 5) was introduced this time, because the existing energy management system only displays the power consumption and it is difficult to grasp the energy intensity. Looking at a graph (Fig.6) of the energy intensity by time of each facility, time zones in which the energy intensity deteriorates (power is consumed but the number of circuits produced is decreasing) are evident.

System overview: This system measures the power consumption and the number of circuits produced by hour to display the energy intensity, the power consumption and the number of circuits produced automatically in graphs, making it possible to compare with an optional set date and to create records by incorporation of data.

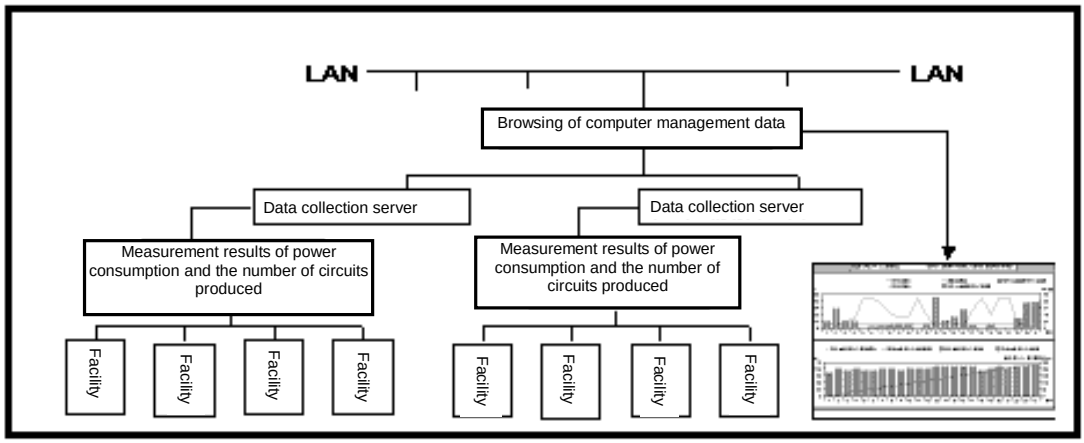

Fig. 5 Energy intensity management system

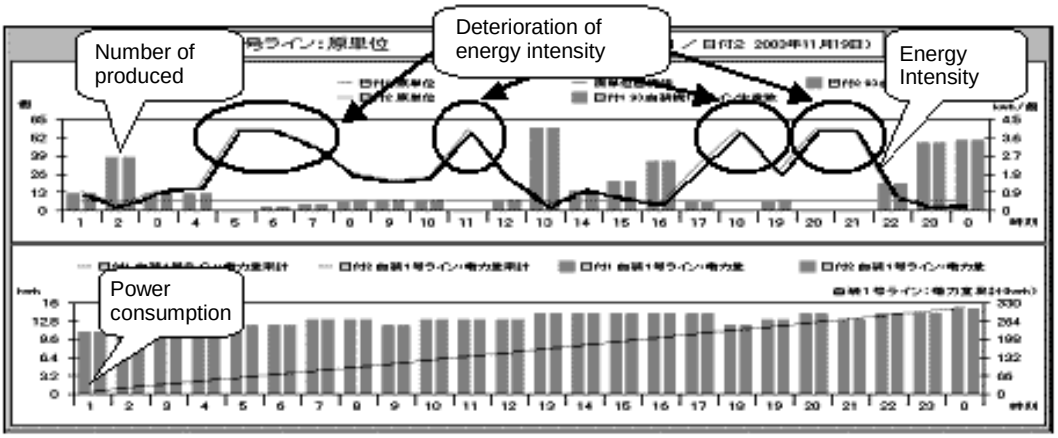

Fig. 6 Example of energy intensity graphs of the implementation line by time

3. Progress of Activities

3-1 Implementation Structure (Fig.7)

In the Fukuyama Works, improvement activities have been implemented on a small group basis for the purpose of reduction in product quality loss by half, improvement of energy conservations, reduction in term of works, and saving of space. Also in the printed-circuit factory, the Marukyu group, one of six groups shown in Fig.7, has made efforts for improving productivity and reduction in the energy intensity by utilizing the energy intensity management system (grasping, analysis, countermeasures, improvement and check of data every day).

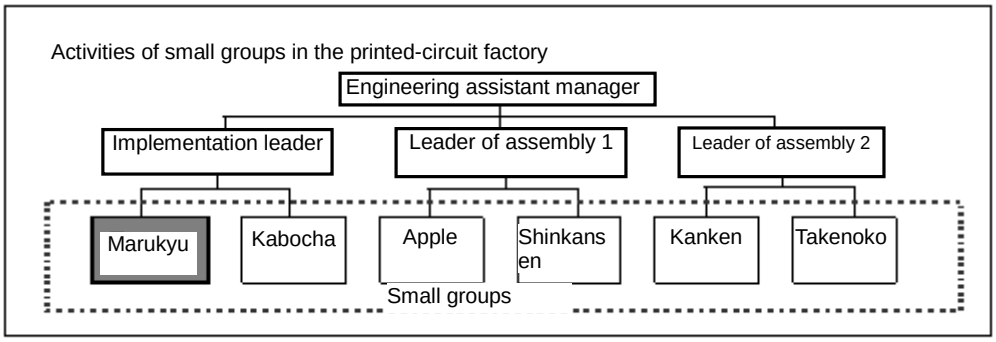

Fig. 7 Implementation Structure

3-2 Target Setting

(1) The implementation line first machine was selected as a model whose energy intensity largely fluctuates (easy to achieve improvement effect). Currently, the first to the fourth implementation line machines are owned.

(2) The entire Fukuyama Works has conducted activities under the targets of reduction in productivity by 30%, term of works by 30%, and devices in the lines by 30% for “thorough improvement of productivity” since FY2003. Target values of our activities this time are set as follows in accordance with the above described targets.

1) Energy intensity: reduction by 30% (0.65⇒0.45kWh/one circuit)

2) Reduction in power consumption: 30,000kWh/year

3-3 Problems and Their Investigation

Graphs of the energy intensity of a day before were put to the notice board every day at morning meeting for a month. Fig. 8, Fig. 9 and Fig. 10 show cases in which all members of the group led by the leader extracted time zones when the energy intensity deteriorates and its factors.

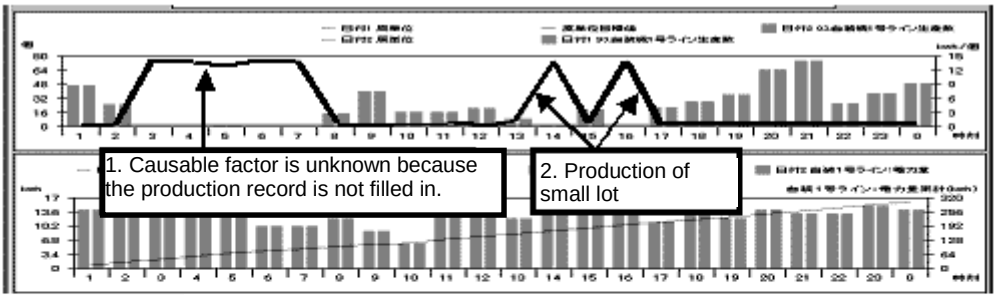

Fig. 8 Example 1 of energy intensity graph

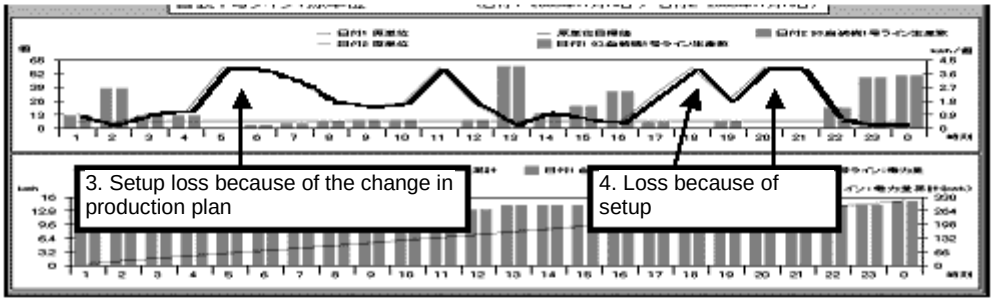

Fig. 9 Example 2 of energy intensity graph

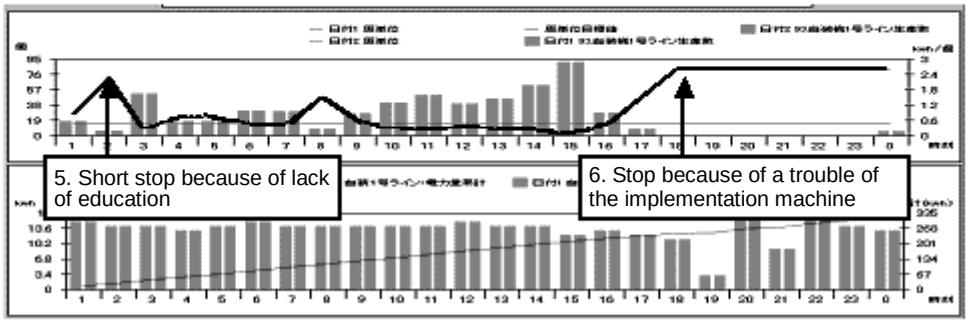

Fig. 10 Example 3 of energy intensity graph

(1) Investigation on problems

As a result of analysis based on the production plan performance (Fig. 11: number of circuits produced by type of machine, start/closing time, content of facilities' troubles, setup time, histories of change in plans) to find out causes of the energy intensity deterioration at a group member meeting with an assistant manager once a week, four causes (a. production plan/performance, b. parts setup, c. workers, d. implementation machines) came up.

4. Content of Measures

Table 3 Content of measures

	Problem	Measure	Effect
a. Production plan b. Setup	1. Unfilled production performance	Review of production plan and performance table	It is possible to extract causes for deterioration of intensity graphs
	2. Loss because of small lot production	Test production and small lot production are planned during mass production	Reduction in the setup time
	3. Loss because of change in the production plan	- Management of start/closing time by automatic calculation (Note 1 in Fig. 11) - Sharing of stock-out information (Note 2 in Fig. 11)	- Improved plan accuracy because of decrease in the difference between planned time and actual time - Decrease in unnecessary change in plans
	4. Loss because of uncompleted setup	- Review of type of fixed cassettes - Expansion of types of fixed cassettes - Maintenance of defect cassettes - Display on cassettes	- Effective utilization of fixed cassettes - Shortened time of setup - No shortage of cassettes - Reduction in time loss for searching parts
c. Workers	5. Short stops because of lack of education	- Implementation of study on short stops - Participation in maintenance course - Implementation of energy conservation education (Tables 4-1, 4-2)	- Reduction in short stops - Shortened time for fixing failures - Enhanced awareness on energy conservation
d. Implementation machines	6. Stop because of implementation machine troubles	Implementation of regular maintenance on implementation machines (twice per year)	- Inhibition of failure - Improvement of short stops

Measurement unit	Setup completion signed by	Type / Figure number	Card name	Number of sheets	Tact (S)	Start time Note 1		Closing time	Turnaround time	Filled in by	Remarks Note 2
1	Sato	EMU	M449	27	44	Plan	9:10	9:35	0:25	Takafuku	Change in setup from 9:10 to 9:30
		LY302W107				Performance	9:10	9:30			
2	Sato	Multiple circuit EMU	M482	21	25	Plan	10:15	10:28	0:11	Takafuku	Parts for S5231 are due at 9:00
		LY200W578				Performance	10:20	11:00			
3	Fujii	Multiple circuit EMU	M483	42	103	Plan	11:08	12:39	1:33	Takafuku	Express product
		LY200Y580				Performance	11:40	13:10	1:30		
4	Sato	Multiple circuit EMU	M483	55	48	Plan	12:49	13:43	0:54	Takafuku	14:10~14:30 Occurrence of recognition trouble
		LY200Y580				Performance	13:30	15:15	1:45		
5	Kuni	4TOU	S591	200	84	Plan	17:39	22:18	4:37		02E13C13FS in stock should be enough
		LW181W001				Performance	18:20				

Fig.11 Table of production plan/performance after improvement

Table 4-1 Energy conservation education material 1

Energy conservation activities keywords:

Energy conservation: conventional energy conservation (introduction of highly-efficient facilities)

Energy: Future energy conservation (energy just in time)

Correct Energy: Management based on management standards by each facility in accordance with Law Concerning the Rational Use of Energy

Table 4-2 Energy conservation education material 2

Electricity measurement ⇒ energy conservation measurement = Measurement of energy intensity by facility

- Use energy required for production (Just in Time);
- when necessary (year, month, day, time, minute, second……..)
- where necessary (entire factory, building, department, production line, facilities) in amount necessary (technical standards, standards on use and operation)

5. Effects achieved after Implementing Measures

(1) Intangible Effect

All members could rediscover the importance of indicators for management and that improvement of productivity contributes to energy conservation by understanding that improvement of the intensity is an effect of the correlation between the power consumption and the number of circuits produced and by experiencing activities to analyze daily data. This has raised awareness of employees on energy conservation.

(2) Tangible Effect

1) Reduction in energy intensity

The energy intensity could be reduced by productivity improvement activities and the targets were achieved.

Target: energy intensity 0.65⇒0.45 Reduction by 30% (Reduction of 0.2kWh/circuit)	⇒	Actual performance: energy intensity 0.65⇒0.38 Reduction by 41% (Reduction of 0.27kWh/circuit)

Figure 12 shows transition of the energy intensity before and after the improvement (estimation of effects on average per month in each period). Figure 13 shows an example of energy intensity graph by time after the improvement.

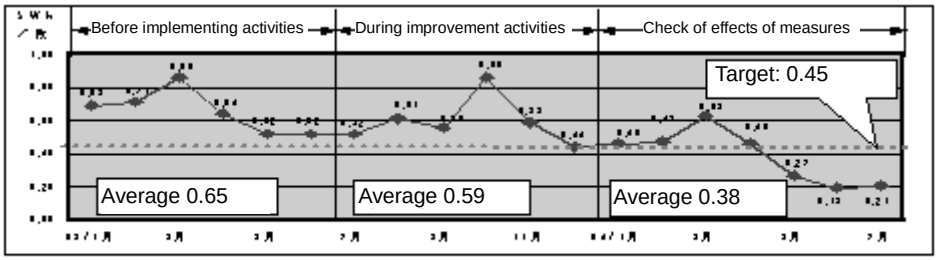

Fig. 12 Graph of energy intensity transition

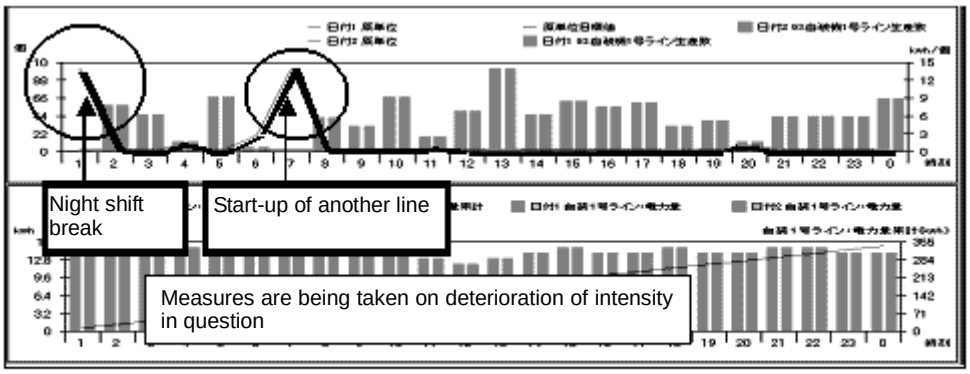

Fig. 13 Graphs of energy intensity by time after implementing measures

2) Reduction in power consumption

Although the number of circuits produced increased, the power consumption decreased so that the target was achieved.

Target: Reduced amount of power consumption 30,000kWH/year (12.7t-co2/year: 0.54 million yen/year)	⇒	Actual performance: Reduced amount of power consumption 70,000kWh/year (29.5t-co2/year: 1.26 million yen/year)

3) Improvement of productivity

Productivity per person ⇒ improvement by 49% (1,815⇒2,710/month, person)
*Productivity per person: number of circuits produced per person in certain time

6. Conclusion

The target of reducing the energy intensity by 30% was high, but it was achieved in cooperation with related departments (production technology and environmental management) and team work of all members by adding up individual improvement by means of utilization of the energy intensity management system.

Grasping of current situations of the energy intensity by time according to facility, implementation of detailed management, setting of a cycle of P, D, C and A in each facility line (P: Planning of measures, setting of targets, grasping of current situations, D: Do the measures, C: Check of effects, A: Action for revision of operational rules) are effective for energy conservation activities. The beginning of energy conservation is to understand by “measurement.” Problems are extracted by knowing current situations and this opens the way for a next step for further improvement. The newly-introduced energy intensity

management system will be monitored continuously and utilized as a tool for solving new problems, and activities will be continued so that the situation improved does not return to where it was.

7. Future Plans

Awareness of each member on energy conservation has been considerably raised because they could recognize that improvement of productivity led to decrease in the energy intensity and what's more, the power consumption.

These activities proved that management of the energy intensity by each equipment has a great effect on energy conservation. In the future, the above described method will be applied to the rest of three implementation lines of printed circuits horizontally and its effectiveness will be actively utilized in each department to accelerate and promote energy conservation activities.