**2005 Prize of the Chairman of ECCJ**

# Reduction of Standby Electricity Corresponding to Production Change

NEC Semiconductor Package Solutions Co., Ltd.
Kumamoto Plant, Engineering (Energy Conservation Team)

◎ **Keywords: Rationalization of electromotive power and conversion to heat (Electric power application equipment, electric heating equipment, etc.)**
**Rationalization of electromotive power and conversion to heat (Lighting equipment, elevators, office equipment)**

## ◎ Outline of Theme

To reduce the electricity loss which happens when the production equipment is standing by, we, as identified above, implemented the activities including improvement of the way to stop the production equipment on a planned basis and reduction of the electricity consumed by the production equipment. Besides, we also tried to reduce the electricity of the lights which were lit even when there was nobody in the office (standby electricity waiting for people to come). These activities were made possible by the close cooperation of each professional division which made them result in the reduction of the electricity energy.

## ◎ Implementation Period of the said Example

September 2001 – August 2004

- Project Planning Period — September 2001 – September 2003 — Total of 24 months
- Measures Implementation Period — June 2002 – April 2004 — Total of 22 months
- Measures Effect Verification Period — September 2002 – August 2004 — Total of 23 months

## ◎ Outline of the Business Establishment

- Items Produced　　Production of LSI
- No. of Employees　　455
- Annual Energy Usage Amount (Actual results for fiscal year 2004)

| | |
|---|---|
| Heavy oil | 451 kL |
| Electricity | 29,513 MWh |

## ◎ Process Flow of Target Facility

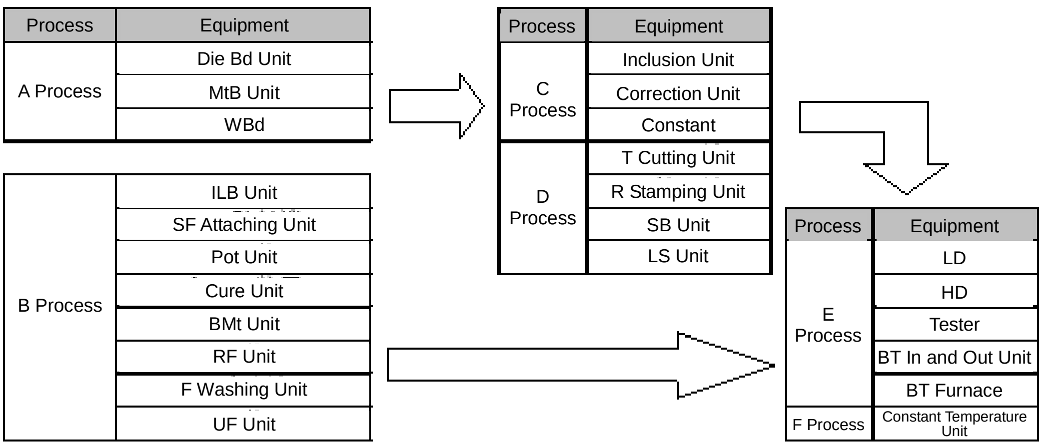



Fig. 1 Outline of the Process Chart of the Facility

## 1. Reasons for Theme Selection

As Fig. 2 shows, the electricity intensity per production unit of our production equipment was far short of the factory target (aimed to reduce 1% or more compared with the previous year) in FY2001. The cause was thought to be the standby time of the production equipment which became longer due to the big production decrease since FY2001, as Fig. 3 shows. Besides, the standby frequency of the production equipment further increased because the number of production processes decreased and it became possible to deliver the products in a short period of time as the production ratio of high-reliability products (of multiple pins and high performance) increased and the production system was improved.

So we selected the reduction of the production equipment's standby electricity corresponding to the production change as our theme of this case study and decided to implement the activities to reduce the use of electricity throughout the company.

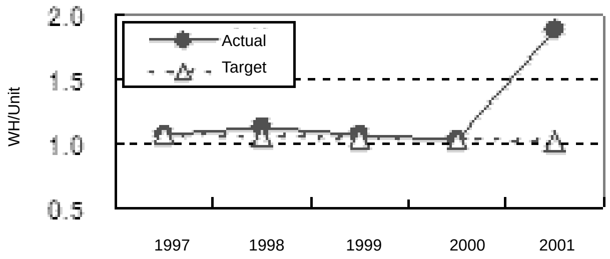



Fig. 2 Electricity Intensity (Production Equipment)

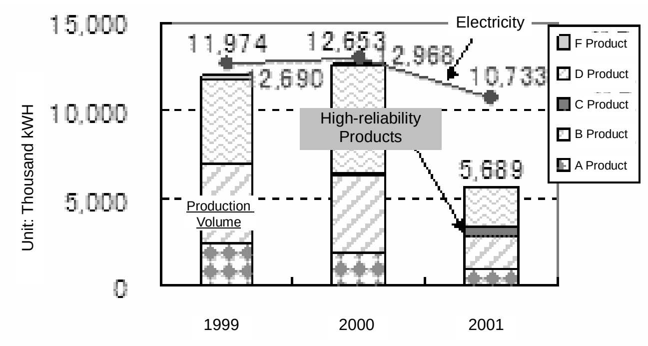



Fig. 3 Electricity consumed by Production Equipment and Production Volume

## 2. Understanding of Current Situation

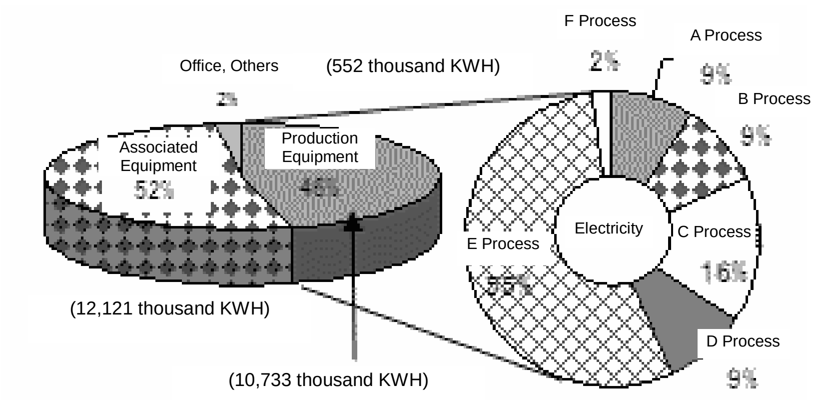



Fig. 4 Electricity Consumption (FU2001)

Table 1 Standby Electricity of Production Equipment

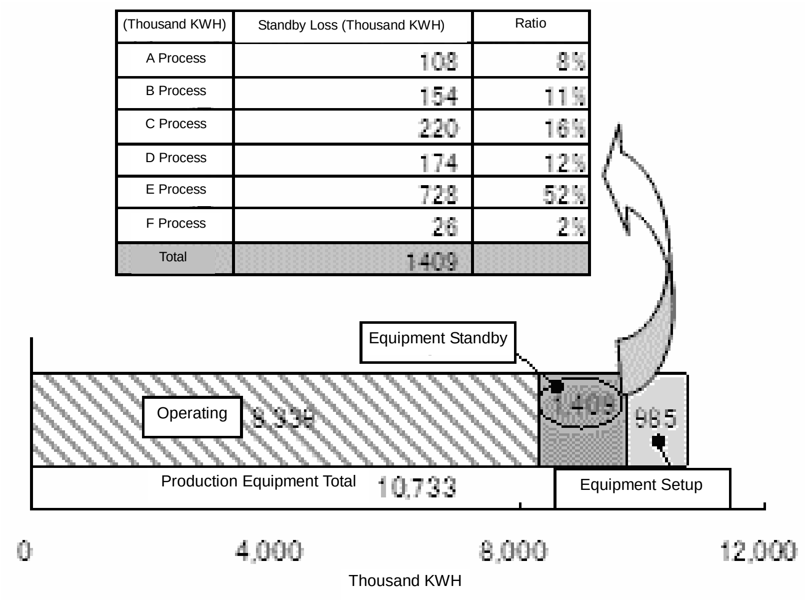



Fig. 5 Breakdown of Electricity Consumption by Production Equipment

## (1) Breakdown of Electricity Consumption

As Fig. 4 shows, the production equipment accounts for 46% of the electricity consumption of the factory. So we looked into the breakdown of the standby electricity and as Fig. 5 shows, found that there were two types of the standby electricity (power is supplied but the equipment is not operating), i.e. the standby waiting for the production and the standby during equipment setup, and both of the standby electricity amounted to 2,394 thousand KWH, accounting for 22.3% of the total electricity used by the production equipment. This is equivalent to 10.2% of the total electricity consumption of this factory. This figure was much bigger than our prediction, indicating that a great deal of electricity was being lost.

Meanwhile, if we look at the standby electricity waiting for the production of each process, we can know that E process accounts for 56% of the total, followed by C process accounting for 17%, indicating that special measures must be taken for E and C processes (Table 1).

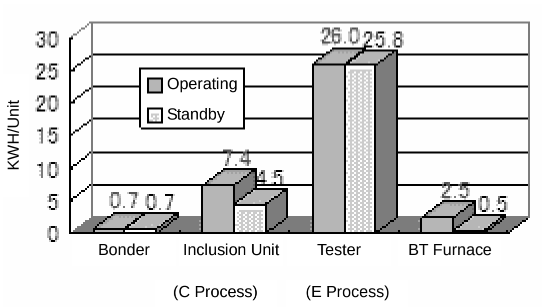



Fig. 6 Standby Electricity of Each Process

Fig. 6 shows the operating electricity and standby electricity of the main equipment. It shows that although the difference between the operating electricity and the standby electricity varies depending on the type of the unit, there is little difference in case of the tester of E process.

## (2) Survey of Current Situation regarding Planned Stop of Production Equipment

Although there had been rules at the production site, the implementation was different from section to section, so there were various ways to do the planned stop. Meanwhile, the responsibility for reporting and managing the planned stop was not clear, so there was equipment which was supplied with electricity when standing by.

## (3) Survey of Standby State of Office (Lights and Office Equipment)

- The office lights had been lit when there was nobody.
- The corridor lights had been lit when nobody was passing.
- As regards the OA equipment, especially personal computers which accounted for most of the electricity consumption of the office, it was the obligation to install screen savers.

Table-2 Analysis and Study Results Regarding Standby Electricity of Production Equipment

| Order | Equipment | Consumption Ratio | Planned Stop | Setup Time | Standby Reforming | Note (Equipment Function) |
|---|---|---|---|---|---|---|
| 1 | Tester | 35.7% | △ | ○ | × | If stopped, it takes long time to restart. |
| 2 | BT Furnace | 18.6% | △ | × | × | |
| 3 | Inclusion Machine | 12.5% | △ | ○ | × | It takes time to heat up the mold. |
| 4 | Constant Temperature Tank | 4.8% | △ | × | × | It takes time to heat up the tank. |
| 5 | F Washing Machine | 3.3% | ○ | × | × | |
| 6 | R Unit | 2.5% | △ | × | × | It takes time to heat up the furnace. |
| 7 | Bd Unit | 2.4% | ○ | ○ | × | |
| 8 | HD Unit | 2.2% | ○ | × | × | |
| 9 | SB Machine | 1.9% | ○ | ○ | × | |
| 10 | Cure Furnace | 1.9% | △ | × | × | It takes time to heat up the furnace. |
| 11 | LS Machine | 1.8% | ○ | ○ | × | |
| 12 | [illegible] | 1.5% | △ | × | [illegible] | It takes time to heat up. |
| [illegible] | [illegible] | 1.0% | △ | ○ | [illegible] | It takes time to heat up. |
| [illegible] | [illegible] | [illegible]4% | ○ | [illegible] | [illegible] | [illegible] |

# 3. Problem Points and their Investigation

## (1) Investigation of Production Equipment

Based on the understanding of the current situation, to reduce the standby time waiting for the production and to reduce the time for setup, we, the team as a whole, extracted the problems and studied them (Table-2).

### ◆ Results of investigation

#### 1) Adequacy of routine planned stop

To study the adequacy of stopping the power supply during standby, the function of the equipment matters. Considering this, we decided to make a system which can fully manage the routine planned stop for the equipment marked ○ above.
As regards the equipment marked △ which takes time to restart after being stopped, we decided to reduce the standby time by scheduling the planned stop taking the starting time into consideration.

#### 2) Reduction of standby time for changeover set-up

There are two types of setup, i.e. lot change and product model changeover. We decided to investigate the equipment which frequently does the changeover and shorten the changeover time.

#### 3) Reforming of equipment

We studied the merits of the reforming for each of 24 types of the production equipment, but we didn't find any merit in light of cost performance. So we decided not to reform each type of the equipment to reduce the standby electricity. Instead, we decided that when replacing the equipment or introducing new equipment, we introduce top runner equipment and develop energy conservation technologies.

## (2) Study of Lighting

We found it was difficult to do energy conservation only with the electricity saving instructions or campaign notes which were attached to the lighting switches in the past. So we decided to try to reduce the electricity consumption of the lighting in the hardware aspect too.

# 4. Target Settings and Implementation Structure

We set up a target which aimed to reduce the electricity by 11.2% compared with the FY2001 level. This reduction is equivalent to half of the standby electricity of the production equipment and office.

| |
|---|
| Target of electricity reduction: 1.2 million KWH/year (Equivalent to 5.1% of the total electricity consumption of the factory) |

## ◆ Implementation structure and role assignment

We organized the following 4 teams for each role assignment, and they started to work cooperating with each other.

### 1) Production team

To make a system for the routine management of the planned stop of the equipment.

### 2) Equipment maintenance team

To reduce the changeover setup time.

### 3) Technical team

To promote activities to develop and introduce energy conservation equipment.

### 4) Engineering team

- To activate energy conservation by the routine management of the planned stop and electricity consumption and by energy conservation campaign.
- To reduce the standby electricity of lighting waiting for people to come.

◆ Table 3 Activity Schedule

| | | Team | Target | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|---|
| 1 | System of Planned Stop | Production | 6 Processes of Production Site | | Study of Current State and Content | Study, Measures | Operation |
| 2 | Reduction of Setup Time | Equipment Maintenance | 8 Models | Study of Content and Time of Changeover Setup | Study, Measures | | Confirmation of Effect |
| 3 | Introduction and Development of Energy Conservation Equipment | Technology | Inclusion Machine (C Process)<br>Tester (E Process) | Development of Inclusion Machine | Debug<br>Study of Introduction of Energy Conservation Tester | Introduction | Introduction |
| 4 | Energy Conservation of Lighting | Engineering | Office, Corridor, Production Worksite | Study of Current State | Study, Measures | Measures | |

# 5. Examples of Improvement

## (1) Example 1 "Routine Management of Planned Stop of Production Equipment"

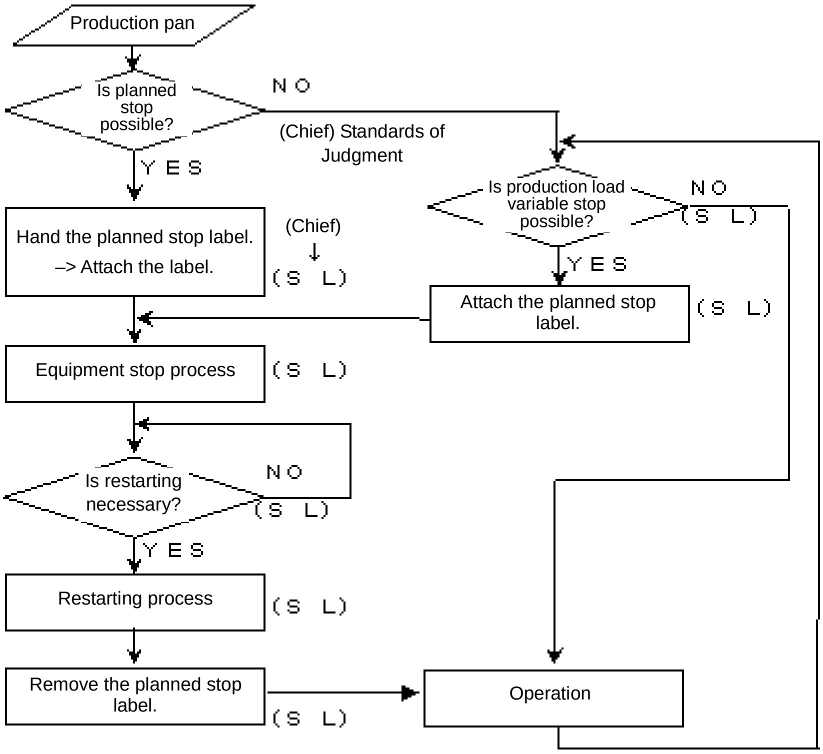



Fig. 7 Flow of Planned Stop

Table 4 Standards for Planned Stop when Production Load Changes

| No | Equipment | Standards of Judgment for Equipment Stop | Person Making Judgment | Action |
|---|---|---|---|---|
| 1 | Tester | The equipment is not working for 3 days or more. | Sorting SL | Power Supply Breaker OFF |
| 2 | BT Furnace | The equipment is not working for 8 H or more. | Sorting SL | Power Supply Breaker OFF |
| 3 | Inclusion Machine | The equipment is not working for 3 days or more. | Inclusion SL | Power Supply Breaker OFF |
| 4 | Cure Furnace | The equipment is not working for 8 H or more. | BGA SL | Power Supply Breaker OFF |
| 5 | Reflow | The equipment is not working for 8 H or more. | BGA SL | Dry Air Valve Close, Nitrogen Valve Close |

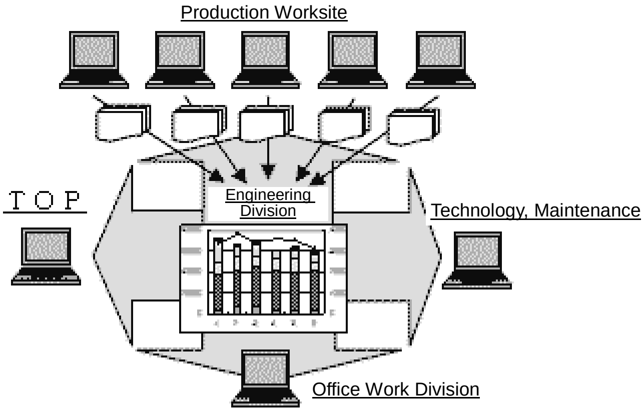


Fig. 8 Sending and Feedback of Information

### 1) Systematization of planned stop

We determine the planned stop flow (Fig. 7) and the planned stop criteria (Table 4) which are common to the production worksite and, based on them, implement the planned stop of the production equipment according to the daily production plan. Furthermore, we report the state of the planned stop of each equipment model in each process to the Engineering Division everyday (Fig. 8). The Engineering Division visualizes (with graphs and comments) the actual electricity consumption and the planned stop (stop electricity waiting for production) and announces them to the top management of the factory and every division (Fig. 9).

If the Engineering Division or other divisions concerned finds a change to the electricity consumption in the daily production, it instructs the division causing the change to check if there is electricity loss due to abnormal events.

Meanwhile, we included the information on the state of the energy use in the information feedback system to fully implement the planned stop and to make the system useful for the machine operator.

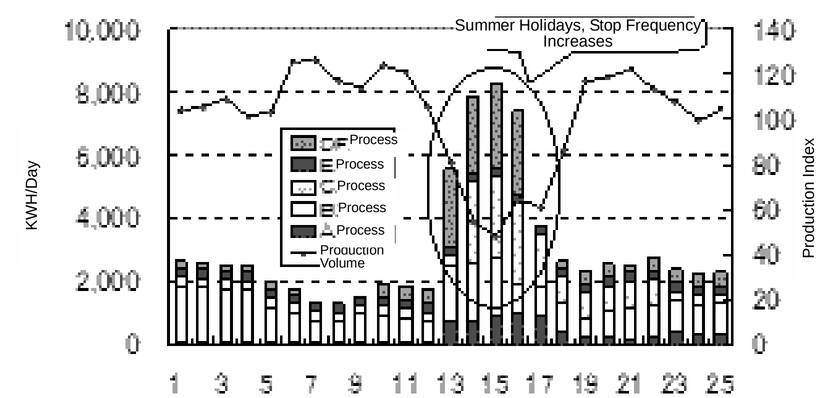


Fig. 9 Visualization of Data

## 2) Effects of Measures

Reduction of electricity in a year：▲787 thousand KWH/year

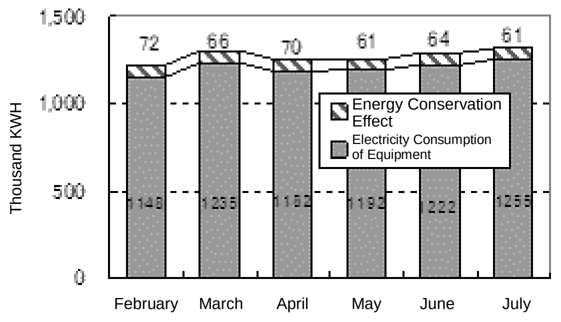



Fig. 10 Transition of Electricity Reduction (2004)

### ◆ Intangible effect

As we everyday announced the state of the daily energy conservation activities, the awareness of the employees of the energy conservation was enhanced. The mind of the machine operator changed from that before implementing the measures, becoming aware of energy conservation. So the energy conservation activities by everybody were realized.

Table 5 Study of Measures for Changeover Setup

| Equipment | Work | Current State | Target | Setup Time/Day, All Unit | | Measures |
|---|---|---|---|---|---|---|
| | | Index/Time | Index/Time | Current State | Target | |
| DBd | Lot Change | 2.3 | 2.0 | 1250 | 810 | - Simple recognition adjustment<br>- Rationalization of confirmation method of temperature condition<br>- Shortening of time for checking leakage after changeover |
| | Changeover Setup | 18.0 | 9.7 | | | |
| Bd | Lot Change | 3.1 | 2.0 | 2260 | 1157 | - Shortening of time for continually changing magazines<br>- Tool installation, improvement of accuracy of Bd load measurement |
| | Changeover Setup | 28.7 | 12.8 | | | |
| Inclusion Machine | Lot Change | 5.3 | 2.0 | 2180 | 538 | - Easy removal of heaters and thermocouples<br>- Simple loading and unloading of mold holding blocks<br>- Simple change of storing magazine units |
| | Changeover Setup | 23.4 | 16.0 | | | |
| T Machine | Lot Change | 2.2 | 1.0 | 520 | 298 | - One-touch mold mechanism<br>- Collation of molds, collation of CIM |
| | Changeover Setup | 4.3 | 2.0 | | | |
| Tester | Lot Change | 12.6 | 4.0 | 2260 | 1251 | - No-adjustment by improving accuracy after changeover<br>- Organization and enhancement of jig tools |
| | Changeover Setup | 10.3 | 2.0 | | | |

## (2) Example 2 “Shortening of Changeover Setup Time”

We found that we were spending 5,810H in a month in total for the “lot change” and “product model changeover” and there was 985 thousand KWH electricity loss (Table 5).

### 1) Problems

Since the production equipment was mainly the existing equipment, it was difficult to obtain the know-how of the equipment. Besides, since we had to consider the influence to the production process and quality, we needed the cooperation of the Technical Division and the Quality Management Division. Therefore, it was anticipated that the improvement would take a long time.

### 2) Details of Measures

To avoid the improvement taking a long time or stagnating, we organized a "setup minimizing project" in the Equipment Maintenance Team and implemented measures for each equipment model (Table 5).

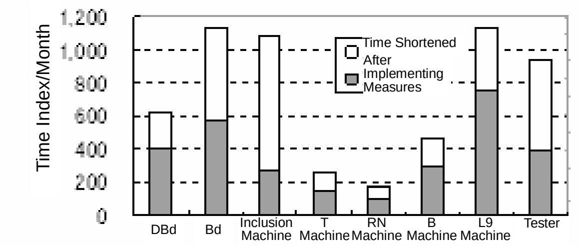



Fig. 11 Changeover Setup Time

### 3) Measures Effect

Annual electricity reduction：▲398 thousand KWH/year

Setup time before improvement：　5,810 H/month

Time improved：　▲2,863 H/month (▲49%)

## (3) Example 3 "Improvement of E Process and Introduction of Energy Conservation Tester"

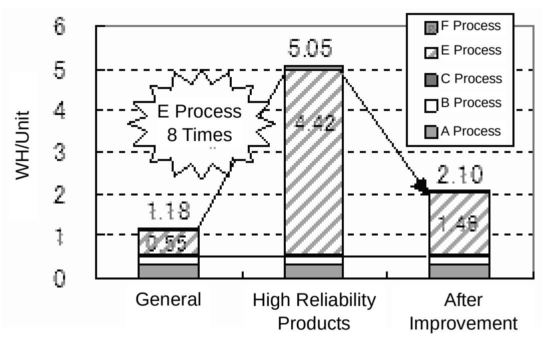



Fig. 12 Comparison of Electricity Consumption of Each Product

## 1) Analysis of electricity consumption of products

As Fig. 12 shows, the electricity consumption of the high reliability products in E process was 8 times greater than the existing general products. Therefore, it was thought that there was correlation between the cause of the worsening electricity intensity and the production increase of the high reliability products. And, as the cause making it happen, it was found that the difference of the electricity consumption was great for both conditions and equipment, as Table 6 shows.

Table 6 Ratio of Electricity Consumption of E Process

| Cause | General Products | High Reliability Products |
|---|---|---|
| Selected A Condition | 1 | 4.0 |
| Selected B Condition | 1 | 12.0 |
| Applicable Equipment | 1 | 3.9 |
| Total | 1 | 8.0 |

## 2) Details of Measures

### a. Change of conditions

Rationalization of test, adding of the number of tests, reduction of operational loss time.

### b. Change of applicable equipment

Introduction of energy conservation testers (selection of top runner models).

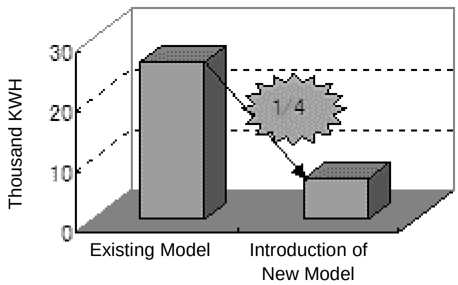



Fig. 13 Comparison of Electricity Consumption of Testers

## 3) Measures Effects

<u>Electricity reduction： ▲568 thousand KWH/year (Implementation rate 70%)</u>

<u>Intensity of E process： 4.42 => 1.46 WH/unit</u>

## (4) Example 4 "Development of Energy Conservation Pressuring System for Inclusion Machine"

### 1) Details of Measures

As Fig. 14 (left) shows, the existing machine had adopted the hydraulic press system which drives 2 driving sections, i.e. high pressure mold clamping and low pressure injection, with one pump. However, we found that there was electricity loss because when driving the low pressure section, unnecessary pressure had been supplied. So we adopted the servomotor press system for the mold clamping and the injection mechanism, as Fig. 14 (right) shows, so that necessary pressure is supplied to each driving section. As a result, the electricity consumption during operation was halved and the standby electricity was reduced (Fig. 15).

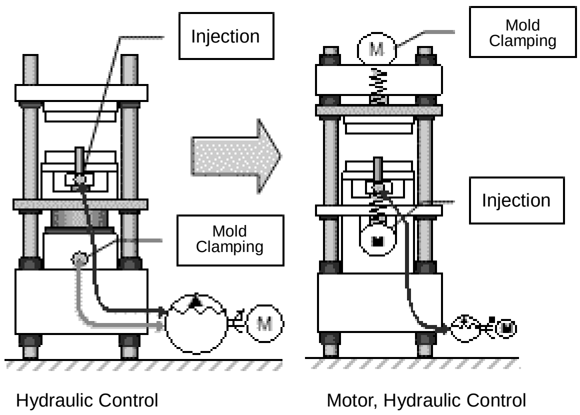



Fig. 14 Outline of Press System

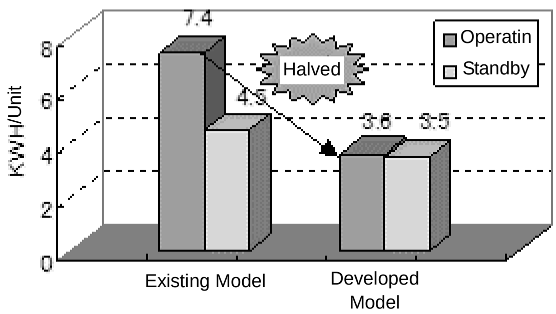



Fig. 15 Comparison of Inclusion Machine's Electricity Consumption

### 2) Measures Effects

Electricity reduction effect： 460 thousand KWH/year (Implementation rate 45%)

Other effects： The driving liquid was reduced to 1/50.

The equipment floor was reduced by 33%/unit.

## (5) Example 5 “Reduction of Lighting’s Standby Electricity Waiting for People to Come”

So far our improvement had been limited to the software aspect like turning off the lights during the break time, but we studied the improvement of the hardware aspect this time and implemented the following 4 measures to reduce the office and corridor lighting’s standby electricity waiting for people to come.

### 1) Details of Measures

**a. Improvement 1: Reduction of ceiling lights**

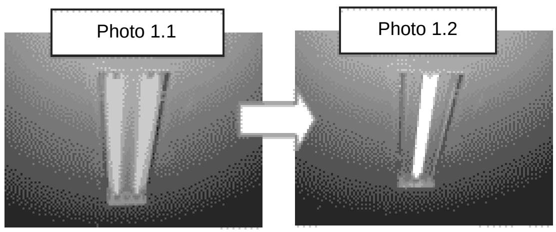
Removal of fluorescent light at 28 places in total.

<Production site, office> Although the lights had been placed evenly on the floor ceiling, we partially removed the lights within the range it did not affect the work (the regulatory brightness was secured enough).

<Corridor> We reduced the number of lights within the extent it did not obstruct the passage of people and turned off all of the light in the daytime and turned them of at night.

**b. Improvement 2: Enhancement of brightness**

By installing the reflection boards and by adopting the 3 wave length white fluorescent lights, we could reduce the number from 2 lights (80W) to 1 light (40W).




**c. Improvement 3: Automatic ON/OFF**

<Implementation place> Stairs landings, underground passages

There are paintings at 3 landings of the stairs. As we decided to turn off all of the lights in the daytime, it became difficult to see the paintings well. So we changed the switches from manual switches to automatic sensors to maintain the comfortable environment.

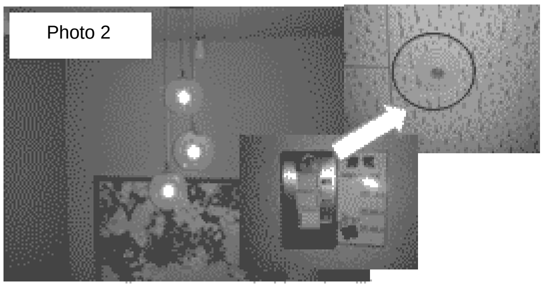
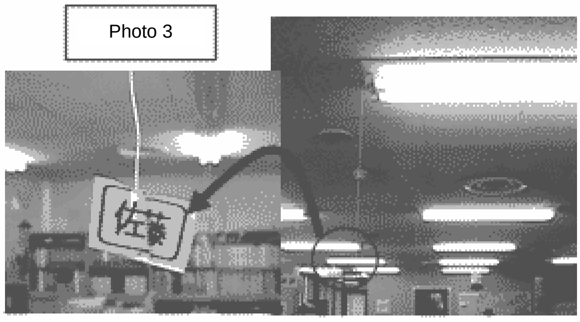


Photo 2

**d. Improvement 4: Partial turning off**

We attached individual strings to the ceiling lights in the office so that people who leave their table could turn off the lights above their table.

Photo 3




### 2) Measures effects

Electricity reduction effect: ▲23 thousand KWH/year

## 6. Measures Effects

- Electricity reduction

Reduction of production equipment's standby electricity: ▲787 thousand KWH/year

Reduction of electricity loss during production equipment's changeover setup: ▲398 thousand KWH/year

Reduction of production equipment's electricity consumption: ▲1,028 thousand KWH/year

Reduction of ceiling lighting's standby electricity: ▲23 thousand KWH/year

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Total ▲2,236 thousand KWH/year
(Reduction ratio: ▲ 9.6%)

- $CO_2$ conversion:

2,236 x 0.336 = 751 ton/year

- Monetary conversion: ▲ 17.76 million yen/year

<Monetary amount of electricity reduction>

10 yen/KWH x 2,236K = 22.36 million yen/year

<Investment amount>

Setup reforming cost : 1.2 million yen

Equipment development cost: 3.1 million yen

Lighting reforming cost: 300 thousand yen

- Summary

As regards the electricity intensity, we could reduce by 32.3% compared with the level of FY2001 in FY2004 when we implemented the measures (Fig. 16).

Besides it was a great achievement of these activities that we could greatly improve the production line whose energy conservation had been difficult before and all the employees from those in charge of technologies and equipment maintenance to the machine operator could have the awareness concerning the importance of the energy conservation.

We were especially convinced that we can by the fact that we could achieve the result which greatly exceeded the target by challenging the improvement of specialized field of each division.

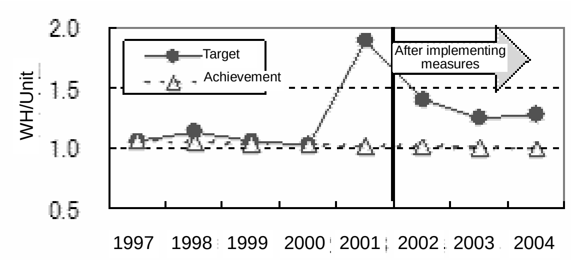


Fig. 16 Electricity Intensity (Production Equipment)

## 7. Future Plans

As regards the introduction of energy conservation equipment, we will raise the application ratio corresponding to the production in the future. As regards other equipment, we will promote the energy conservation activities based on the case study of this time while appealing the effect of the energy conservation implemented for the production equipment.

The improvement result of the changeover setup is fed back to the equipment newly introduced and horizontally deployed to other factories.