

# **Towards Higher Energy Efficiency of IT-Products: The Japanese Approach**

## ***1. Background***

In Japan, energy consumption in the industrial sector has proceeded at a modest growth rate, while energy consumption in commercial and residential sectors has been exhibiting rapid growth. The reason for the above is that numerous energy consuming appliances and equipments are in widespread use; in particular, in recent years, IT-products have been cited as an example. One reason why IT-products have become prevalent is its relationship to the popularity of the Internet in recent years. With the Internet penetrating various sectors of society, use of PC servers, routers, and hubs is increasing. Such increased use of Internet-related equipment is one reason for growing energy consumption. To contain increased energy consumption, it is essential to improve the energy efficiency of IT-products. In this report, we will try to review the reality of energy consumed by PCs as a leader of IT-products for Internet, and also review energy conservation for the above.

## ***2. Standard for Energy Conservation of PC***

The standard for energy consumption of IT-products is mainly established by two authorizations, which are the “Law for Energy Conservation Use (Enforcement Regulations for the Law Concerning Rational Use of Energy)” and the “International Energy Star Program”. The “Law for Energy Conservation Use” establishes the standard for energy consumption of PCs in operation mode but not processor

(arithmetical operating) mode, while the “International Energy Star Program” establishes the standard for energy consumption of PCs in low power mode.

The standard outlined by the former authorization targets electricity consumption when a PC is not in processor mode (although it is consumption when the PC is in actual operation), in addition to targeting the value of the above electricity consumption divided by processor capacity. That is to say, the targeted consumption is consumption equivalent to the electricity consumption of PC in non-processor mode divided by the PCs’ processor capacity. Therefore, there are two faults with this standard. First, since the targeted consumption is the consumption of a PC in non-processor mode, the electricity consumption in processor mode cannot be evaluated. This means that the manufacturer only saves the electricity consumption of a PC in non-processor mode. Theoretically, if the capacity of a PC is improved and CPU clock increases, electricity consumption must increase. However, electricity consumption in non-processor mode can be saved easily with a low capacity-operating ratio. In addition, when improvements in processor capacity exceed the accrual of electricity consumption, energy conservation is apparent. Under the recent notable improvement in processor capacities of PCs, present and actual electricity consumption can be increased.

The second fault can be found in the standard established by the Energy Star Program. This fault is that the targeted electricity consumption is consumption in low power mode; electricity consumption in other modes is not evaluated. We will mention no more on the details of the above standards and yield to these points in other reports.

### ***3. Status of Popularization of PC in Japan***

Until 1993, the number of shipments of PC in Japan<sup>i</sup> was approximately 2 million per

year. From 1994, it saw a rapid increase and in 1999, was approximately 10 million per year. In dividing these into PCs for residential use and non-residential use, we can see that most for commercial use, with shipments in 1993 numbering 1.4 million per year. From 1994, this rate increased rapidly and in 1999, totaled approximately 4.8 million per year. Then the rate of increase was not so large, about a few percents per year, with shipments of PC in 1995 totaling 5.5 million per year. Until 1995, shipments of PCs for residential use numbered 0.8-0.9 million per year. From 1996, with the sale of Windows 95, this number has increased rapidly, totaling 2.4 millions per year. Following that, shipments of PC grew slowly. In 1999 when the Internet penetrated the residential sector in leaps and bounds, shipments numbered 4.7 million per year. The number of residential sector shipments of PCs is approximately equal to the number of shipments in the commercial sector (Figure 1).

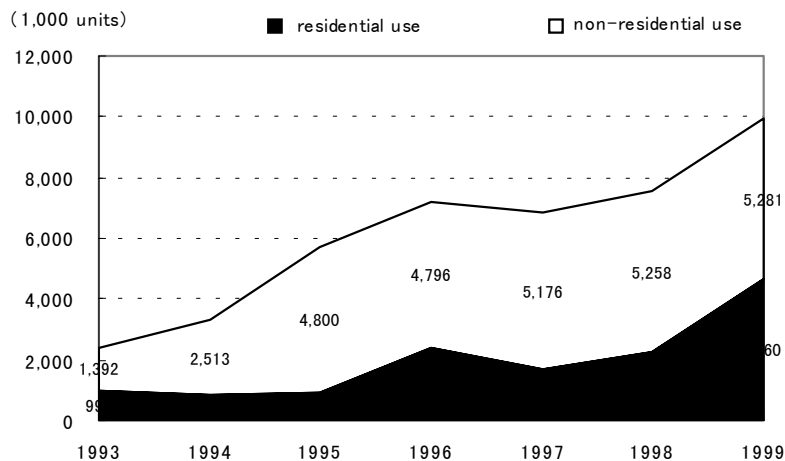


Fig 1 Trends in PC domestic shipments (estimated by Jyuri from shipment data)

According to the actual condition survey for energy consumption of Office Automation in commercial buildings<sup>ii</sup>, the number of PCs per employee was 0.83 sets, mostly saturated. In the

future, increasing the rate of PC shipments for the commercial sector seems to be small. From this report, we can see that 17 million sets of PCs are now in use.

The diffusion ratio of PCs for residential use<sup>iii</sup> is still large as shown in Figure 2. With respect to the situation of popularization of Internet in residential sector<sup>iv</sup>, the diffusion ratio of the Internet for residential use was 20% in 1998, comprising 60% of households intending to use the Internet. As shown in Figure 3, the Internet is now on the stage of diffusion. Therefore, the number of shipments of PCs, as a terminal of the Internet, will undergo additional increases.

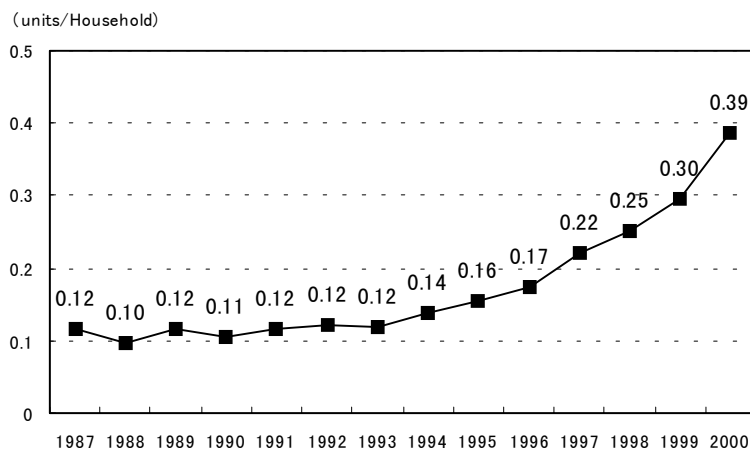


Fig 2 Diffusion ratio of PCs for residential use

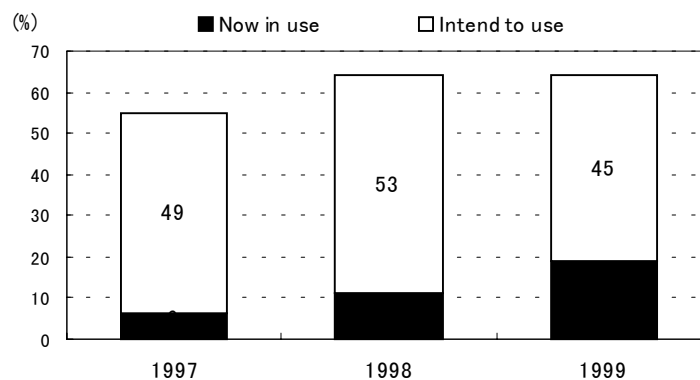


Fig 3 Popularization of Internet in residential sector in Japan

In conclusion, although shipments for the commercial sector will not be increasing rapidly due to the sharp increase in the residential sector, the total number of PC shipments in both the commercial and residential sector will see continuous increases.

Table 1 Number of PCs in Japanese Offices

(1,000 units)

|                             | Office with LAN | Office without LAN | Total  |
|-----------------------------|-----------------|--------------------|--------|
| Over Midrange Computers     | 497             | 0                  | 497    |
| Personal Computer           | 17,150          | 246                | 17,398 |
| PC for server               | 661             | 0                  | 661    |
| Desktop PC with CRT Monitor | 8,513           | 131                | 8,645  |
| Desktop PC with LCD Monitor | 1,384           | 6                  | 1,391  |
| Note PC                     | 6,592           | 109                | 6,701  |
| Word Processor              | 921             | 149                | 1,070  |

#### 4. *Energy Conservation of PCs*

##### 4.1 **Breakdown of electricity consumption by each type of PC**

The average electricity consumption of a PC in operating mode in each type is shown in Figure 4. Average electricity consumption differs between Desktop PCs and Notebook PCs. Additionally, the average consumption of Desktop PC differs with the type of monitor display. The average total electricity consumption of a Note PC is equal to 19% of that of a Desktop PC with a CRT monitor display, in addition to 27% of that of a Desktop PC with an LCD monitor display. In addition, the total average electricity consumption of a Desktop PC with an LCD monitor display in operating mode is equal to 69% of that of a Desktop PC with a CRT monitor display.

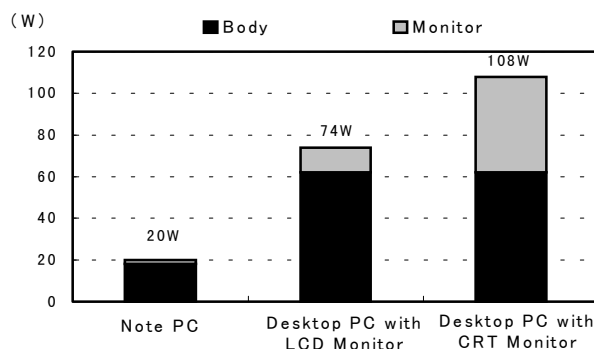


Fig 4 Average electricity consumption of PC (in operating mode)

#### 4.2 Breakdown of electricity consumption by mode

Targeted electricity consumption using the standard outlined in the International Energy Star Program is consumption in low power mode. Figure 5 indicates the load curve of electricity consumption per day of two types of PC (including monitor display) used in offices. If a PC is set to shift to low power mode, the PC will automatically shift to this mode when unused for a certain period of time. The electricity consumption of PC A in operation mode is 140-150 W; in low power mode this same consumption is 70W. PC B, on the other hand, is 100-110W and 40W respectively.

How a PC is set to segue to low power mode will depend on the user. Usage by company, type of business and job description must also be taken into account. In a situation where one employee uses the same PC for everyday work, the ratio of segueing low power mode would differ day to day. Figure 6 shows the proportions of electricity consumption and operating time of 4 sets of Desktop PC by each mode, taken from results of a 22-day survey. According to the above, the percentage of time in low power mode is very small, only 9%, compared to operating mode or off mode. Also the percentage of electricity consumption in low mode is small, only 11% similar to the above.

Considering the total energy conservation of a PC, it is essential to reduce the largest percentage of electricity in operating mode, in order to conserve total electricity consumption. The standard established by International Energy Star Program is the standard for low power mode. It is therefore difficult to conserve a large amount of energy using only this standard.

At the same time, since the main function of a PC is not used in low power and off mode, there is no effect on convenience. Accordingly, such electricity consumption should be minimized as possible.

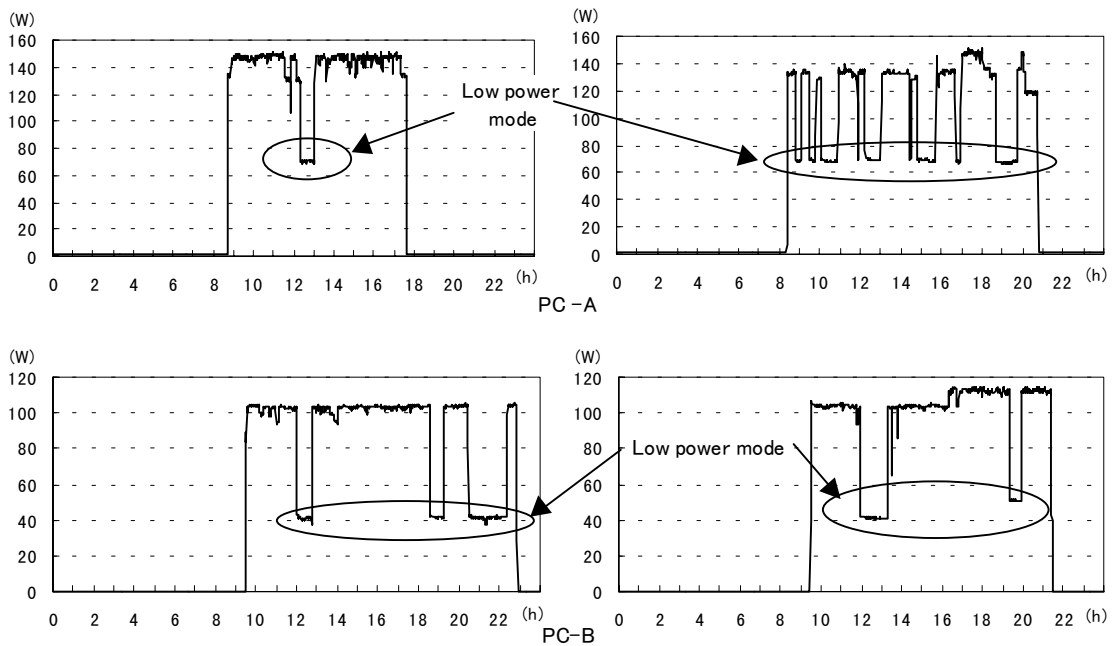


Fig 5 Load curve of electricity consumption of PC (researched by Jyuri)

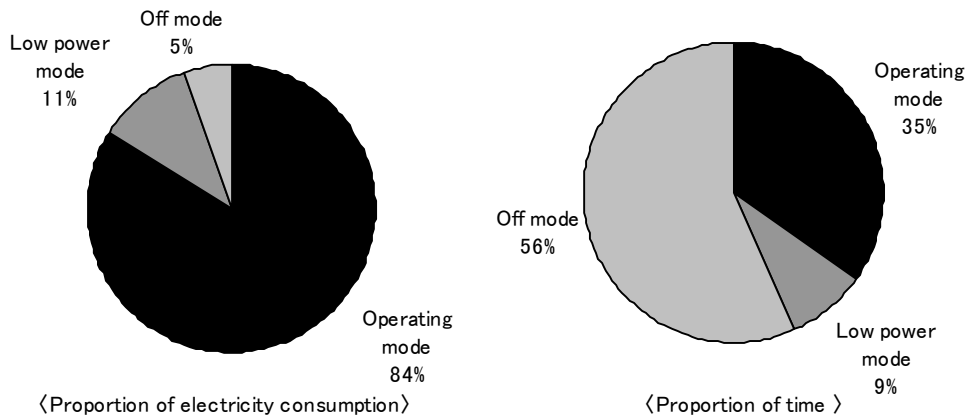


Fig 6 Proportion of each mode of PC on weekday (researched by Jyuri)

#### 4.3 Relation between electricity consumption of PC and Energy Star

Figures 7 and 8 show the plot of the value of electricity consumption in low power mode mentioned in PC catalogues in 1998 and 2000 respectively. Figure 7 shows that there were a number of PCs (without monitor display) that had electricity consumption in low power mode not applicable to the standard set by Energy Star in 1998. In 2000, such electricity consumption has been reduced and most of the PCs' electricity consumption is now in conformity with the standard (based on results from June, 2000). In other words, the above result could be regarded as an advantage brought about by the Energy Star Program.

However, a few manufacturers produced PCs with 5W or less in low power mode, far below the standard. Technically, it is possible to reduce electricity consumption in low power mode to 5W or less. On the other hand, there are some PCs that managed to only clear the standard and it cannot be denied that some manufacturers produce PCs only to do so. Actually, internal standards of electricity consumption in some companies are set on the value equal to the standard of electricity consumption established by



Energy Star (Figure 9).

Since there is no difference between a PC with electricity consumption far below the standardized value and one with electricity consumption equal to the standardized value, both PCs' electricity consumption are in compliance with the standardized value. Manufacturers will make no efforts to take additional measures to reduce electricity consumption of PC much smaller than the standardized value, although they possess the technology to drastically reduce electricity consumption. Considering the above situation, the standard provides an incentive to manufacturers to produce PCs only with the very limit of electricity consumption mentioned in the standard, not with the incentive to produce PCs with the lowest electricity consumption (which would be far below of the standardized value).

Additionally, as mentioned above, the percentage of electricity consumption of a PC in low power mode is very small. Energy Star, standardized only for low power mode, can evaluate only a part of energy conservation of PC. Most customers may misunderstand that the Energy Star Program evaluates total energy consumption, and in turn, may not select the PC with the actual greatest capacity to reduce energy consumption. It seems that the above standard needs to be reconsidered from the first stage.

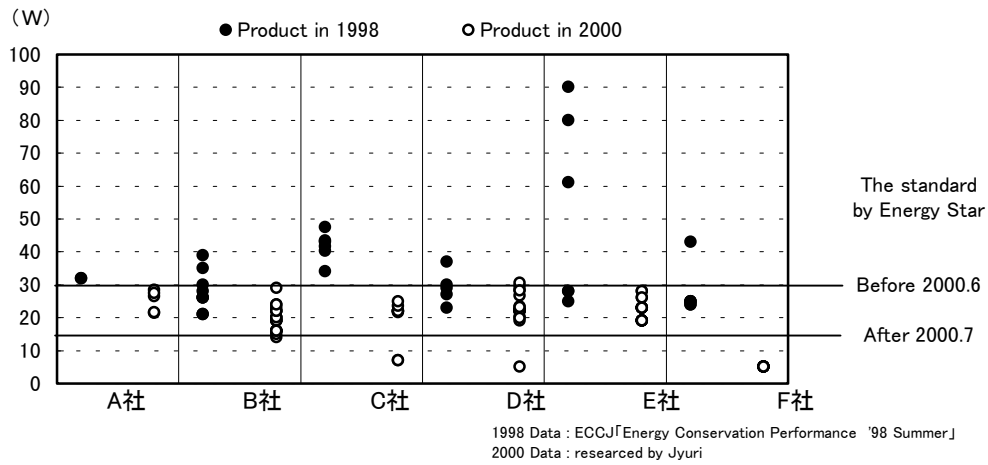


Fig 7 The trend of electricity consumption in low power mode of PC (without monitor)

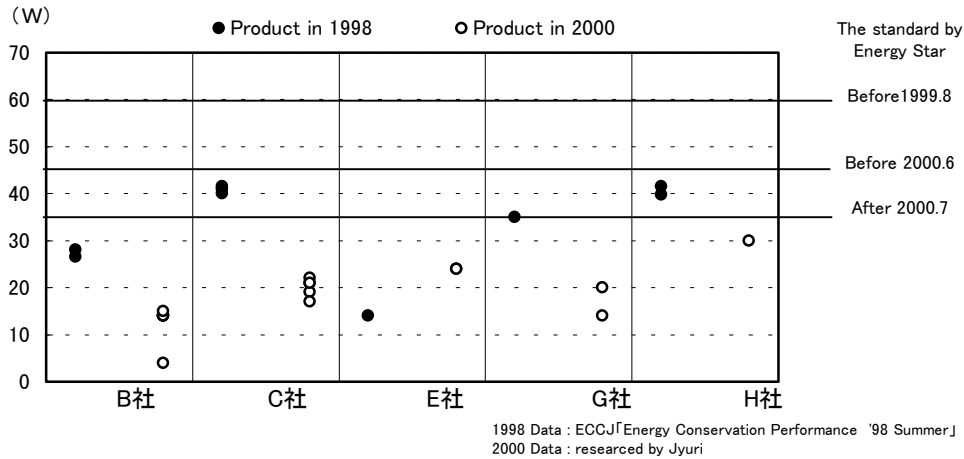


Fig 8 The trend of electricity consumption in low power mode of PC (all in one type)

|   |  |
|---|--|
| <p>Company-wide Standards for Environmental Soundness (NEC)<br/>Prevention of Global Warming (Low Electric Power Consumption)</p> <ul style="list-style-type: none"> <li>•Observe the energy saving law</li> <li>•Meet the standards of the U.S. Environmental Protection Agency's Energy Star Program</li> <li>•Reduce the product's electric power consumption when the product is in sleep mode</li> </ul> | <p>Green Product Evaluation Standard(Fujitsu)<br/>Energy Saving</p> <ul style="list-style-type: none"> <li>•Compliance Japanese Energy-saving laws</li> <li>•Compliance and registration with the International Energy Star Program</li> <li>•Power saving function</li> </ul> |
|---|--|

Fig 9 Example of standard for energy efficient products of PC

## ***5. Conclusion***

Herewith is a review of the situation of energy consumption by PC and energy conservation policies, in particular the Energy Star Program. The following are conclusions drawn from the report.

Due to the large energy consumption of PCs in operating mode, policies focusing on energy consumption in operating mode should be made effective in order to promote energy conservation.

The electricity consumption of PCs in low power mode and off mode is very small. However, as consumption in these modes is useless, such consumption should be reduced promptly.

The Energy Star Program is effective in reducing definitive the electricity consumption of PCs, however the program may also be a barrier for a voluntary effort to reduce possible and potential electricity consumption of PC on the manufacturer end, in addition to a barrier to selecting an energy efficient PC by customers.

Both of the standards specified by the “Law for Energy Conservation Use” and the “Energy Star Program” are not sufficient to evaluate the energy efficiency of PCs. To evaluate the energy efficiency of a PC objectively, we must establish a mode combining the pattern of processor and operation, as well as a scheme to evaluate the electricity consumption of PC with the mode.

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<sup>i</sup> Japan Electronic Industry Development Association "Trends in Domestic Shipment of PC s (Fiscal Year )" "

<sup>ii</sup> The Building-Energy Managers' Association of Japan " The actual condition survey for energy consumption of Office Automation in commercial building 1999"

<sup>iii</sup> Economic Planning Agency " Consumer Behavior Survey 2000"

<sup>iv</sup> Ministry of Posts and Telecommunications "Communications Usage Trend Survey 1999"