

Developing More Super Green Products and Achieving Eco-efficiency Factor

● Haruo Takayama ● Yoshiko Shinomura ● Yoshimasa Nakagami
● Masataka Fujii

(Manuscript received June 20, 2008)

The Fujitsu Group has promoted the development of eco-friendly products by conducting environmental assessments on products since 1993. In line with the latest Fujitsu Group Environmental Protection Program (Stage V) launched in fiscal 2007, we have been working on two programs to improve the environmental values of our products. The first program aims to increase the number of Super Green Products with top-class environmental characteristics, which have been created since the previous stage IV (fiscal 2004 to 2006). In order to achieve this goal, we have expanded the scope of developing Super Green Products across our group companies. The second program, which introduces the eco-efficiency factor as our new approach, strives to double the eco-efficiency of new products as compared with the products in fiscal 2005 by the end of fiscal 2009. Both approaches are aimed not only at reducing environmental burden throughout the entire product life cycle, but also offering customers high-performance products. This paper illustrates our promotion activities, cites examples of Super Green Products, and describes the efforts we are making toward achieving the eco-efficiency factor.

1. Introduction

In recent years, notable movements have been seen in the area of environmental conservation including the reinforcement of product-related regulations in Europe such as the RoHS Directive,^{note 1)} WEEE Directive,^{note 2)} EuP Directive^{note 3)} and

REACH regulation^{note 4)} as well as the propagation of Green Product procurement in government organizations based on EPEAT^{note 5)} and the establishment of the consortium of ICT industry for energy-saving countermeasures applicable to products and data centers in North America. In the domestic arena, consumers' awareness for the environment has been enhanced since the establishment of the Law on Promoting Green Purchasing in 2001. The movements of promoting

note 1) Abbreviation of Restriction of the use of certain hazardous substances in electrical and electronic equipment. An EU directive regulating the specific hazardous substances contained in electric and electronic equipments.

note 2) Abbreviation of Waste electrical and electronic equipment. An EU directive for waste of electrical and electronic equipment, it stipulates mandatory collection and recycling of electrical and electronic equipments by manufacturers.

note 3) Abbreviation of eco-design of Energy-using Products. An EU directive concerning environmentally friendly designs.

note 4) Abbreviation of Registration, Evaluation, Authorization and restriction of CHemicals. An EU regulation to stipulate mandatory registration and evaluation by operators who manufacture and/or import chemical substances.

note 5) Abbreviation of Electronic Product Environmental Assessment Tool. A system to promote green procurement in government organizations, industries and private consumers in North America.

green procurements to buy products with excellent environmental friendliness have been accelerated not only in government and public organizations but also among businesses and personal consumers. Further, the revision of the Law Concerning the Rational Use of Energy in 2006 contributed to the reinforcement of energy efficiency and disclosure about the use of certain hazardous substances was added in the revised version of Law for Promotion of Effective Utilization of Resources. Through these movements, product manufacturers are being asked to make extra commitments to develop more environmentally friendly products and disclose information.

To address these requirements, the Fujitsu Group decided to increase the number of Super Green Products and introduce a new approach, called the “eco-efficiency factor”. We started these activities in fiscal 2007 based on the Fujitsu Group Environmental Protection Program (Stage V). The Group will further activate its approaches to minimizing environmental burden and to enhancing product values across all stages of the product life cycle (material procurement, manufacturing, logistics, usage, and disposal and recycling of products) aiming to offer customers more products that can contribute to the sustainable development of society.

This paper describes the development and examples of Green Products and Super Green Products that are the eco-friendly products presented by the Fujitsu Group as well as Fujitsu’s approach toward the eco-efficiency factor.

2. Development of eco-friendly products

The Fujitsu Group makes consolidated efforts as a group to promote ecological designs when developing new products, trying to minimize environmental burden and to enhance product values across all stages of the product life cycle.

Fujitsu started implementing voluntary environmental assessments of products in 1993 to promote the development of eco-friendly prod-

ucts that can address environmental regulations, environment conservation, resource saving, material recycling, energy saving and information disclosure.¹⁾ Besides, we have been implementing “Rules for Green Product Evaluation” with reinforced emphasis on eco-friendly products since 1998, and we have positioned products that conform to these rules as Green Products. In 2004, we established a consolidated and revised version of these rules, “Rules for Product Environmental Green Assessment”. In this system, we upgraded environmental standards aiming to reinforce and rationalize Green Products (**Table 1**).

2.1 Implementation of environmental assessment of products

Our development division performs the environmental assessment of products from a product’s development stage in order to minimize environmental burden and prevent environmental pollution throughout the life cycle of the products and their packages, from delivery to customers to the end-of-life products after usage.

The criteria for the environmental assessment of products are comprised of 10 major categories including 39 minor items (**Table 2**). Products that achieve 70 points or higher are defined as eco-friendly products.

2.2 Development of Green Products

When evaluating Green Products, we do so during the design and development phases concerning the ecological items of Green Product standards established by the Fujitsu Group such as energy saving, 3Rs (Reduce, Reuse, Recycle) design and technology, and countermeasures for hazardous chemical substances. The requirement for Green Product accreditation is to achieve 90 points or higher in the general evaluation of environmental assessment of products and to be compliant with all the applicable items of common standards, as well as product category standards for Green Products (**Figure 1**).

We continuously update standards, reflect-

Table 1
Approach toward eco-friendly products of Fujitsu Group.

Environment protection program	Target and measures	Establishment of rules (establishment year)
Stage I (FY 1993 to 1995)	• Increase of 50% in potential of material recycling rate compared with FY 1992	Guideline for Environmental Assessment of Products (1993)
Stage II (FY 1996 to 2000)	• Product recycle countermeasures • Promotion of Green Product development	Rules for Green Product Evaluation and Rules of LCA (1998)
Stage III (FY 2001 to 2003)	• All new developments shall be of Green Products	Rules for Environmental Assessment for OEM Products (2003)
Stage IV (FY 2004 to 2006)	• Offer Super Green Products from main product groups of all divisions	Rules for Product Environmental Green Assessment and Super Green Product operation rules (2004)
Stage V (FY 2007 to 2009)	• At least 20% of new developments from all divisions shall be of Super Green Products • Achievement of Eco-efficiency Factor 2	Rules for Eco-efficiency Factor Evaluation (2007)

Table 2
Items for environmental assessment of products.

Major items for environmental assessment of products	
• Environmental regulations (7) • Environment conservation (1) • Resource saving (3) • Long-term service (1) • Energy saving (3)	• Material recycling (7) • Ease of disposal (4) • Ease of collection and transportation (1) • Information disclosure (3) • Packaging (9)

Figures in parentheses indicate number of minor items

ing domestic and international laws and regulations, environmental labels and market trends as necessary, such as adding an understanding of environmental burden evaluated by life cycle assessment (LCA) and formulating disassembling manuals.

Our brochures and packages for those products accredited as Green Products indicate the environmental emblem of the Fujitsu Group (**Figure 2**).

Taking PC products as examples, facts about Green Products are described below, for which the Fujitsu Group applies its advanced ecological scheme in design, technology and approaches (**Figure 3**).

1) Notebook PCs

- Use of recycled magnesium alloy recovered from the collected waste products of the Fujitsu Group.

- Use of bio-based plastics made from plants (such as corn) in large housings.
- Use of halogen-free plastic housings and recycled plastic.
- Acquisition of Ecoleaf label based on third-party certification as the first approach in the PC industry and disclosure of information of environmental burden.

2) Desktop PCs

- Use of coating material that allows recycling without removing the coating film.
- Arrangement of an outlet power line that is cut off when the PC unit is turned off. An energy-saving design that disconnects the power supply to the display when the power supply to the main unit is switched off.
- Use of recycled plastic and tool-less maintenance are possible.
- Integration of automatic brightness sensor

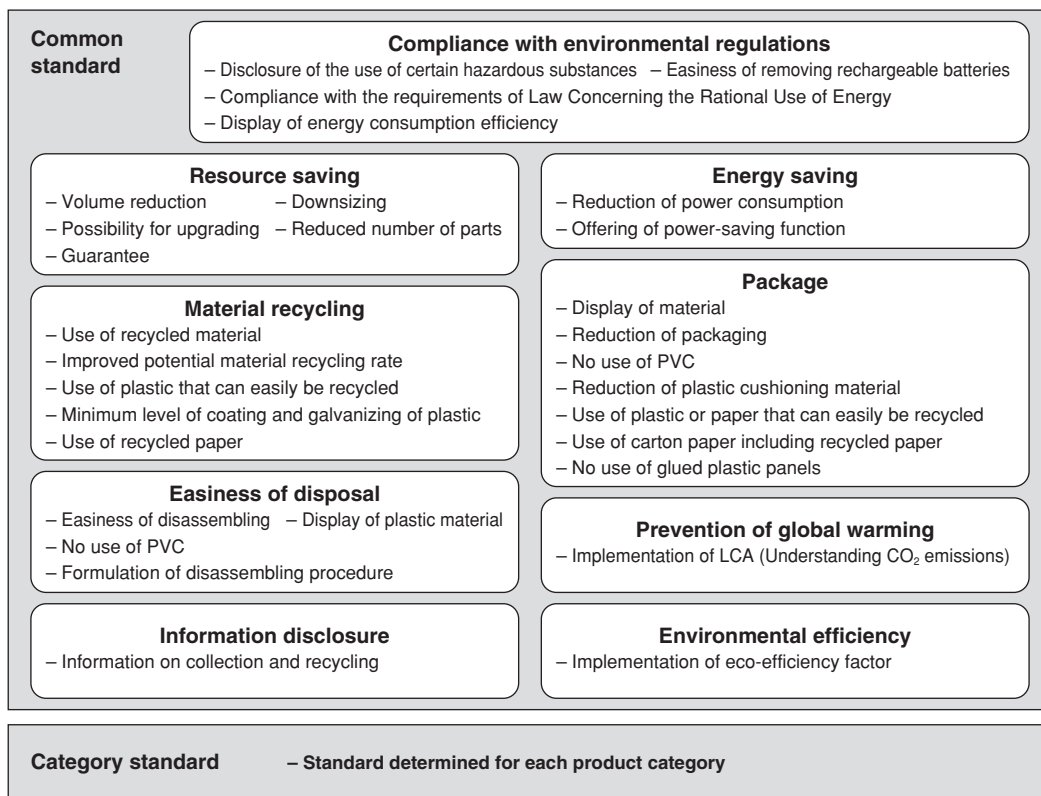


Figure 1
Standards of Green Products.



Figure 2
Fujitsu Group's environmental emblem.

that adjusts the display brightness automatically.

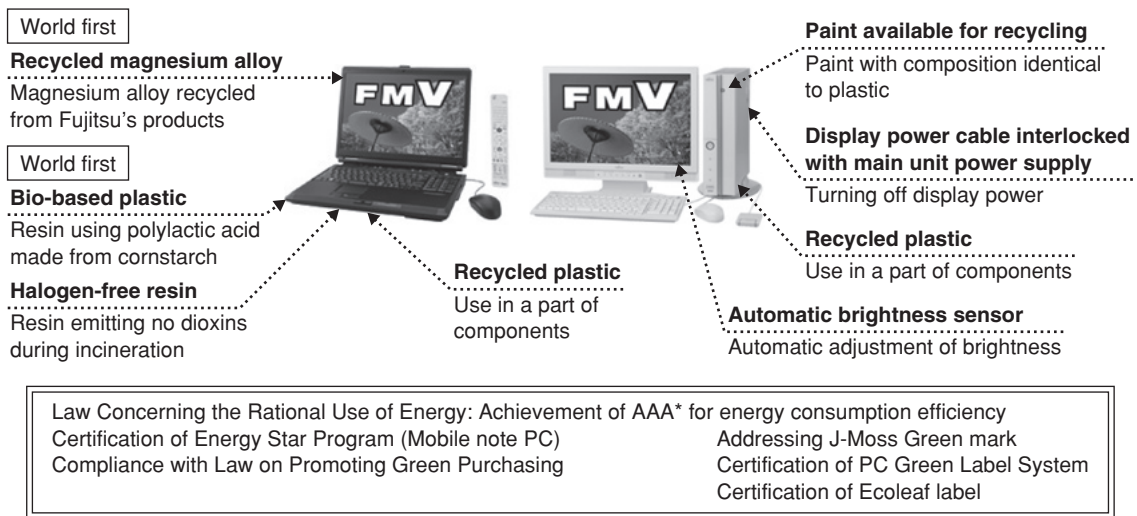
3. Development of Super Green Products

Super Green Products are the products or systems with top-class environmental friendli-

ness among the products that conform to the requirements of Green Products of the Fujitsu Group. The operation of its definition and requirements for applicability is based on "Super Green Product operation rules", the same as with Green Products.

Within the previous framework of the Environment Protection Program (Stage IV), the Fujitsu Group sets a target to develop at least one Super Green Product in each product division by the end of fiscal 2006. As a consequence, we were able to achieve that target with 54 Super Green Products developed in total by 35 product divisions (Figure 4).

To further propagate this initiative, the Environment Protection Program (Stage V) has been established. The target, definition and examples of developed products are described below.



AAA: Higher than 500% based on the standard as of FY2007

Figure 3
Examples of PC Green Products.

	FY2004	FY2005	FY2006
Fujitsu	7 products	11 products	14 products
Fujitsu Group	5 products	10 products	7 products
Total	12 products	21 products	21 products
Representative product	IPCOM S Series  – CO₂ emissions Reduction by 40% versus conventional product by consolidation of functions. – 3R design Installation area/number of cables reduced by 1/3 versus conventional product.	FMV-BIBLO NB  – Bio-based plastic Use in large parts of housing. – CO₂ emissions Reduction by 15% versus conventional product across product life cycle.	PRIMERGY TX120  – 3R design/Energy saving Volume reduced by 1/4, installation area reduced by 1/3, and power consumption reduced by 39% compared with conventional product. – CO₂ emissions Reduction by 37% versus conventional product across product life cycle.

Figure 4
Achievement of Super Green Products.

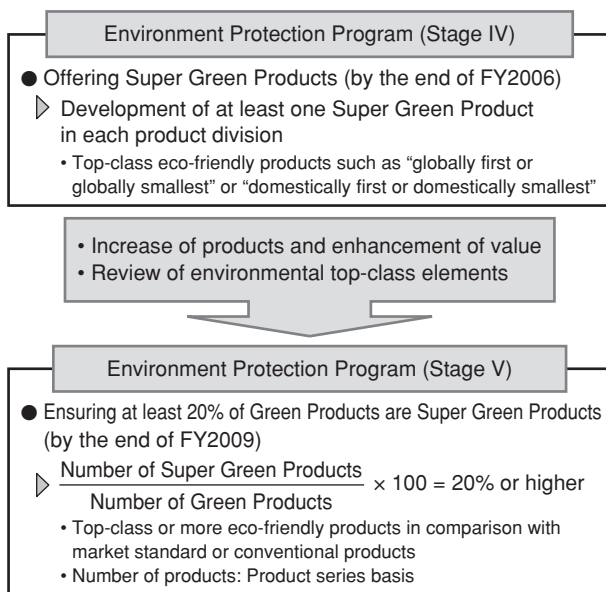


Figure 5
Activity target of Super Green Products.

3.1 Target of activity

This initiative is applicable to hardware, electronic components and semiconductor products for information or communication equipment developed by Fujitsu’s original specification in all divisions involving the product development. The achievement of the target is evaluated based on accumulated data for three years from fiscal 2007 to the end of fiscal 2009. We have set the series-based commercialization percentage of Super Green Products versus the newly developed Green Products by the end of fiscal 2009 at 20 percent or higher¹⁾ (**Figure 5**).

The target of this activity is to offer more Super Green Products based on enhanced development of eco-friendly products through the development of Super Green Products in the design divisions responsible for the fundamental part of *monozukuri* (product making) with an extended scope of activity and setting of numerical targets.

Further, to support product development, the research division develops materials and technologies that contribute to the environment while reinforcing tie-ups with public relation and advertisement divisions to promote the disclosure

of environmental information about Fujitsu’s products to the customers.

3.2 Definition

To further activate the combination of lower environment burden throughout the whole product life cycle and the enhancement of product values, we have defined Super Green Products as those products with top-class environmental characteristics that are compliant with the following requirements (**Figure 6**).

- Significantly superior product and system with top-class environmental friendliness in comparison with other products of the own brand or competitors in either of the environmental elements such as energy saving, 3R design and technology, and countermeasures for hazardous chemical substances.
- Products adopting a globally first, domestically first or industry-first material or technology which is advantageous to the environment.

We update the top-class environmental elements and targeted standard of the Super Green Products at a suitable frequency, depending on the market trends. Basically, we determine standards on a quantitative basis.

3.3 Organization

All divisions involving product development are planning and implementing programs for developing Super Green Products. This activity is promoted by the Green Product Committee, which is one of the committees established to address each of the environment-related issues. This Committee is comprised of representatives from each product division and serves also as a relaying committee to promote horizontal development of the environment technologies developed by each division.²⁾

3.4 Example of developed Super Green Products

In fiscal 2007, 32 products were developed as

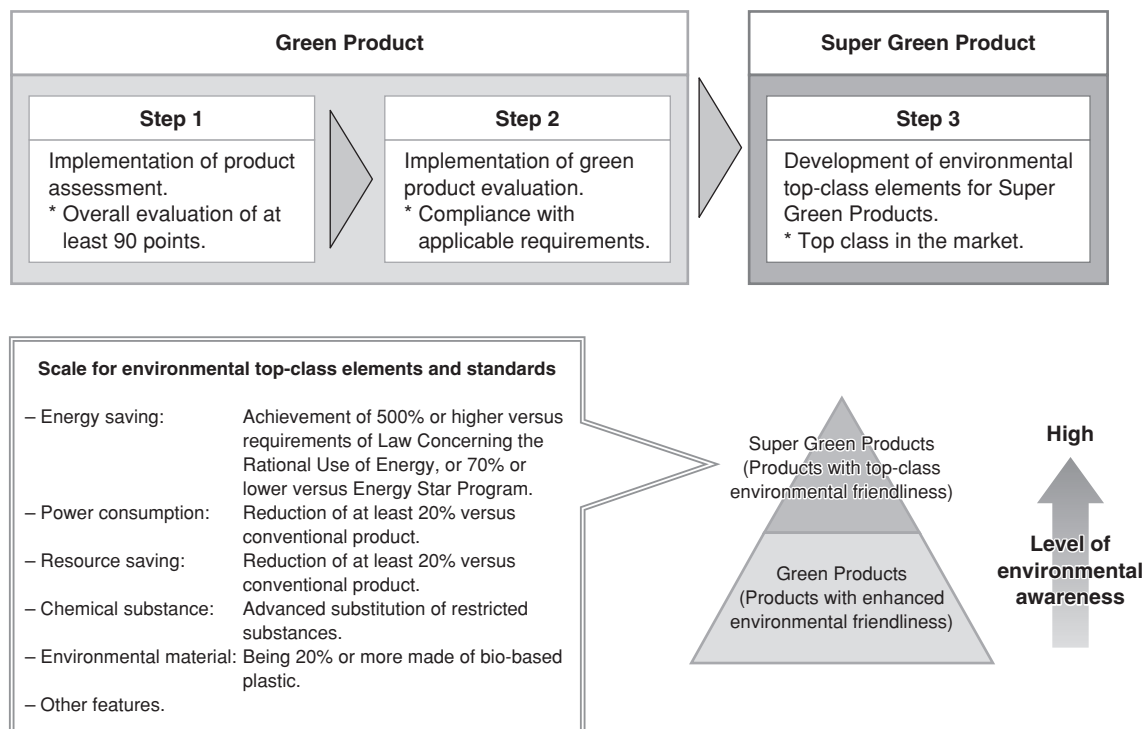


Figure 6
Structure of Super Green Products.

Super Green Products. The representative developments among them are explained in the following paragraphs (**Figure 7**).

1) Notebook PC: FMV-BIBLO NX series

Notebook PC using bio-based material as environmentally friendly material for large plastic housing.

- As a material with less effect on the global environment that serves as a substitute for limited petroleum resources, bio-based plastics (PLA stands for “polylactic acid”) are used for about 30 percent of the plastic parts in the notebook PC housing (lower cover, hard disk drive [HDD] cover and DIMM cover). Plastics need to have specific characteristics such as flame resistance in this application. Because about 50 percent of the material is a natural material (including bio-based material), consumption of petroleum resources can be suppressed. In comparison with conventional petroleum-based resins

(PC-ABS), CO₂ emissions can be reduced by about 15 percent across the whole product life cycle (estimation by Fujitsu).

2) Disk array: ETERNUS2000 series

Disk array that can drastically decrease consumption power, weight, volume and number of parts in comparison with the level achieved by conventional products.

- Adoption of single chip specifications for RAID^{note 6)} controller and eco-mode that controls fan rotation and schedules disk rotation. Compared with the conventional product (ETERNUS4000), power consumption has been reduced by about 40 percent, weight by about 30 percent, volume by about 50 percent and number of parts by about 60 percent.

note 6) Abbreviation of Redundant Array of Inexpensive Disks. A technology to manage a redundant HDD which is comprised of a combination of multiple, inexpensive HDDs.

FMV-BIBLO NX Series PC using bio-based plastic – Bio-based plastic Applied to three components of housing – Law Concerning the Rational Use of Energy Energy consumption efficiency Achievement of 0.00067 (AA*)  *AA: Achieving at least 200% of energy saving standard	ETERNUS2000 series Space-saving, lightweight and energy-saving disk array system – 3R design Volume reduced by 50%, weight reduced by 30% and number of parts reduced by 60% versus conventional product – Power consumption Reduction by 15% versus conventional product in eco-mode – Quietness 42 dB in operation 
ScanSnap S300 World's smallest, lightest and most energy efficient ADF scanner of A4 size, both-sided – 3R design/Energy saving Volume reduced by 30%, weight reduced by 50% and power consumption reduced by 30% versus upper-level product – Compliance with Energy Star Program – No mercury included (substituted by LED) 	MHY2 BH/BS Series Energy-saving, quiet HDD – Law Concerning the Rational Use of Energy Energy consumption efficiency Achievement of 0.0060 (AAA*) (MHY2100BH 100 GB) – Achieving eco-efficiency factor of 2.3 – Quietness 2.4 B when idling  *AAA: Achieving at least 500% of energy saving standard

Figure 7
Examples of Super Green Products.

3) Image scanner: ScanSnap S300

The world's smallest and most lightweight scanner of A4 size with ADF (automatic paper-feeder mechanism). An image scanner with excellent energy-saving characteristics that addresses chemical substance countermeasures.

- Compared with the upper-level product (ScanSnap S510), equipment volume has been reduced by about 30 percent and weight by about 50 percent.
- The energy-saving design is compliant with the Energy Star Program after the revision in 2007. Power consumption during sleep mode is 3.2 W or less, achieving a level below 70 percent of the standard level for scanners (which is 5 W).
- Adoption of LED instead of mercury-containing cold cathode tube as a light source.

4) HDD: MHY2 BH/BS series

A 2.5-inch HDD with top-of-the-industry

energy-saving and quietness characteristics.

- MHY2100BH (100 Gbyte) achieved an energy consumption efficiency of 0.0060 W/Gbyte versus the targeted standard of energy consumption efficiency (0.05 W/Gbyte) stipulated in the Law Concerning the Rational Use of Energy as of fiscal 2007. The percentage of achievement versus the standard is higher than 800 percent.
- Power consumption at reading and writing is suppressed to 1.9 W and the tranquility at idling is achieved (2.4 dB).

4. Introduction of eco-efficiency factor

To quantitatively understand the environmental burden of a product, the Fujitsu Group carries out LCA on all of its new developments by integrating LCA requirements into Green Product assessment.

The quantitative data on environmental bur-

den obtained through LCA are used to create products with good environmental characteristics. On the other hand, many of the IT products offered by the Fujitsu Group tend to consume more electric power in order to realize a drastic increase in performance and functions that are being developed with accelerating speed. Therefore, one of the main emphases is to suppress power consumption at the design stage. However, because LCA focuses on the evaluation of environmental burden, it is difficult to numerically express such an effort in the design stage. The difficulty of expressing improvements in eco-design technology only from the evaluation of environmental burden poses a serious problem.

Accordingly, a new concept “Eco-efficiency” has been introduced since fiscal 2007 to evaluate efforts in the design stage by numerically expressing the product performance and functions and then combining the result with LCA. The eco-efficiency is an index that indicates the status of both ecological and economic activities. It is a concept to seek the development of a sustainable society and industries by creating more benefits (i.e., improving value) with less environmental burden.^{3),4)} Eco-efficiency can be expressed as below:

$$\text{Eco-efficiency} = \frac{\text{Product value}}{\text{Environmental burden}}$$

There is a point to consider when introducing the eco-efficiency. Namely, it is essential to present a clear explanation with the purpose of eliminating misunderstandings such as “the company might be using the eco-efficiency to hide the actual increase of environmental burden and to lead to an outcome that is convenient for itself”. In calculating the eco-efficiency, the definition should be clearly identified and the items for which transparency and reliability are ensured should be used. As a basic policy of the Fujitsu Group, we give priority to the environmental burden evaluation using Fujitsu LCA or LCA based on the Ecoleaf label program.

4.1 Eco-efficiency factor of the Fujitsu Group

The Fujitsu Group has introduced the eco-efficiency factor based on the concept of eco-efficiency. The eco-efficiency factor indicates the level of improvement in eco-efficiency.⁵⁾ By using this concept, it is possible to indicate how many times eco-efficiency has been improved for a new product in comparison with the eco-efficiency achieved by a standard product (conventional product). The factor is calculated as below, after obtaining the ratio versus the standard product regarding the value or service and the environmental burden, respectively.

Eco-efficiency factor =

$$\frac{\begin{array}{c} \text{Value and service} \\ \text{(ratio of new product versus conventional product)} \end{array}}{\begin{array}{c} \text{Environmental burden} \\ \text{(ratio of new product versus conventional product)} \end{array}}$$

Basically, the LCA result is used to compare the environmental burden in the denominator. In this case, the ratio is calculated based on the CO₂ emissions throughout the product life cycle. The values and services in the numerator are quantified for each product category based on public data such as specifications and functions shown in brochures to ensure transparency.

For products whose product value and service can be specified (so-called single function products), we quantify the function of the products that the consumers actually use. For instance, the function of scanners can be evaluated from several aspects such as optical performance including basic resolution and reading speed, media processing performance including maximum size or maximum thickness of document to be processed, and their data-processing features including the image processing or number of compressed programs.

On the other hand, for products such as PCs that have versatile functions (word processing, spreadsheet, E-mail, Internet browsing, games, music and image reproduction, TV) it is hard to

Table 3
Comparison of function, performance and environmental burden between new and old computers.

Assessment item	Ratio of new to old ($\frac{\text{FMV-C8230}}{\text{FMV-718NU4/B}}$)
Function and performance	
Processing speed	1.7
Memory	4.0
HDD	2.0
Environmental burden	
CO ₂ emissions	0.72

specify a single function, and so specifying the hardware that plays an essential role to realize the aforementioned features should be identified and their level of improvement should be evaluated. For instance, processing speed, memory capacity and HDD capacity can be included in these evaluation items. These data are clearly mentioned in brochures and they match with the general elements to be considered when a consumer purchases a new PC.

When several types of features are available as mentioned above, a consolidated value should be obtained by conducting numerical processing. Taking a PC product by the Fujitsu Group as an example, each feature and performance of FMV-C8230 (launched in 2007), the product to be evaluated, can be described as in **Table 3**, assuming that the features of the standard product FMV-718NU4/B (launched in 2003) have a value of 1. The improvement in this value is considered to be about 2.8 times versus the value of the standard product after consolidation, while the environmental burden has decreased to 72 percent. Based on these data, the eco-efficiency factor can be calculated as 3.8 ($\approx 2.8/0.72$) (**Figure 8**).

4.2 Target of Fujitsu Group Environment Protection Program (Stage V)

The Environment Protection Program (Stage V) sets a target to achieve an eco-efficiency factor of two by fiscal 2009 as the whole Fujitsu Group through the increase of the above-mentioned Super Green Products.¹⁾ The scope of

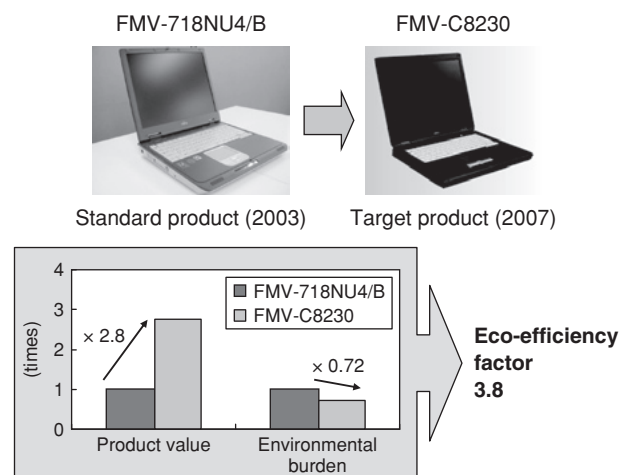


Figure 8
Eco-efficiency factor of PC.

evaluation includes the divisions involving hardware products that are to be developed based on Fujitsu's in-house specifications and design. Divisions operating dedicatedly for purchased OEM products or software development are excluded from that scope.

We set a target value for each product category. For product categories for which short-term improvement of product value is difficult, we plan to enhance the eco-efficiency factor by decreasing the environmental burden. Meanwhile, for product categories for which drastic improvement of the value can be expected, we strive for a category target higher than two. The ultimate target is to achieve an eco-efficiency factor of two by fiscal 2009 as an average of the whole Fujitsu Group.

Another important point to be considered when calculating the eco-efficiency factor is the selection of a standard product to be used as a reference for comparison. Taking a standard product from more recent years, the technical difference from the level achieved by the new product will become smaller in general, which makes it difficult to obtain a larger eco-efficiency factor. When evaluating the eco-efficiency factor, the Fujitsu Group stipulates that the standard product should be taken from those products developed in fiscal 2005.

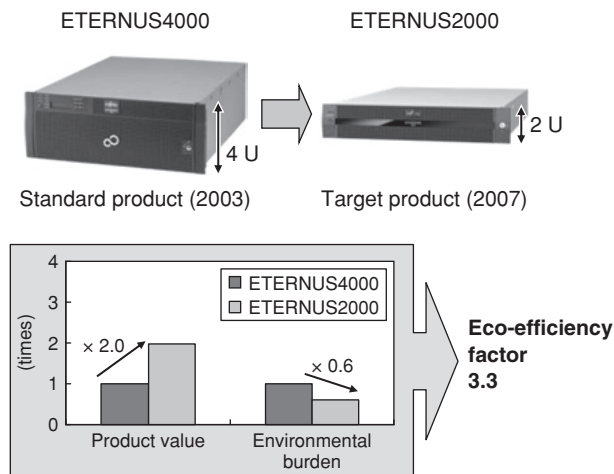


Figure 9
Eco-efficiency factor of disk array system.

4.3 Example of eco-efficiency factor evaluation

The following examples indicate cases where we were able to achieve the targeted value at an early stage.

ETERNUS2000 Disk array could achieve a drastic reduction of power consumption when in eco-mode through positive use of Massive Arrays of Idle Disks (MAID) technology. In comparison with ETERNUS4000 developed in fiscal 2005, its product value indicated about a two-fold improvement and CO₂ emissions throughout the product life cycle were reduced by about 40 percent. As a consequence, we were able to achieve an eco-efficiency factor of 3.3 ($\approx 2/0.6$) (**Figure 9**).

The eco-efficiency factor is not only a tool for seeking benefits but also a tool to realize a new type of advantage based on an ecological awareness. By effective use of the eco-efficiency factor, it is possible to express corporate efforts to minimize environmental burden while improving product value in a quantitative manner. Further, it may serve as a promising new scale for customers in their decision making when purchasing a product.

5. Conclusion

This paper introduced Fujitsu's approaches

to increase the number of Super Green Products and to achieve the targeted eco-efficiency factor in association with the environmental friendliness of Fujitsu's products, within the framework of the Environmental Protection Program (Stage V). Focusing on the whole product life cycle, this initiative intends to promote the development of products that can enhance product value and minimize environmental burden through enhanced multifunctional efforts, with the purpose of producing products with top-class environmental friendliness.

Fujitsu will proactively disclose information on the outcome of this initiative so that the Group can offer benefits to customers by addressing their requests for decreasing environmental burden through support for green procurement and decrease of power consumption in product use. Fujitsu is committed to continue doing its best to realize a sustainable society.

References

- 1) Fujitsu Group Sustainability Report 2007.
<http://www.fujitsu.com/global/about/environment/report/rep2007.html>
- 2) S. Oikawa: Promoting Development of Super Green Products. *FUJITSU Sci. Tech. J.*, Vol. 41, No. 2, pp. 201–208 (2005).
- 3) S. Oikawa et al.: Fujitsu's Approach for Eco-efficiency Factor. *FUJITSU Sci. Tech. J.*, Vol. 41, No. 2, pp. 236–241 (2005).
- 4) K. Fuse: Utilization of Eco-efficiency Factor for Products in Fujitsu Group (in Japanese with English abstract). *Journal of Life Cycle Assessment*, Japan, Vol. 1, No. 3, pp. 195–200 (2005).
- 5) Japan Environmental Management Association For Industry: Handbook of Eco-efficiency Factor for products (in Japanese).
http://www.jemai.or.jp/CACHE/eco-efficiency_index.cfm



Haruo Takayama

Fujitsu Ltd.

Mr. Takayama graduated from Tsurumi Industrial High School, Yokohama, Japan in 1969. He joined Fujitsu Ltd., Kawasaki, Japan in 1969 and has been engaged in promoting development of eco-designs for products.



Yoshimasa Nakagami

Fujitsu Ltd.

Mr. Nakagami received the M.S. degree in Physics from Chiba University, Chiba, Japan in 1982. He joined Fujitsu Ltd., Kawasaki, Japan in 1982 and was engaged in development of LSI and LCD manufacturing processes until 2002. Since 2002 he has been engaged in planning and promoting of corporate environmental policies.



Yoshiko Shinomura

Fujitsu Ltd.

Ms. Shinomura received the degree of Ph.D. in Shizuoka University, Shizuoka, Japan in 2005. She was a researcher at Shizuoka University, working on oceanic ecosystems until 2007. She joined Fujitsu Ltd., Kawasaki, Japan in 2007 and has been engaged in promoting development of eco-designs for products through Life Cycle Assessment.



Masataka Fujii

Fujitsu Ltd.

Mr. Fujii received the B.S. degree in Applied Chemistry from Seikei University, Tokyo, Japan in 1982. He joined Fujitsu Ltd., Kawasaki, Japan in 1982 and engaged in manufacturing engineering for telecommunication systems. Currently, he is promoting development of environmental engineering. He is a member of the Japan institute of

Electronics Packaging (JIEP).