Eco-efficiency Factor of Personal Computer Utilizing EcoLeaf and LIME

*Fuse, K.[1], Oikawa, S. [1], and Ebisu, K. [2]

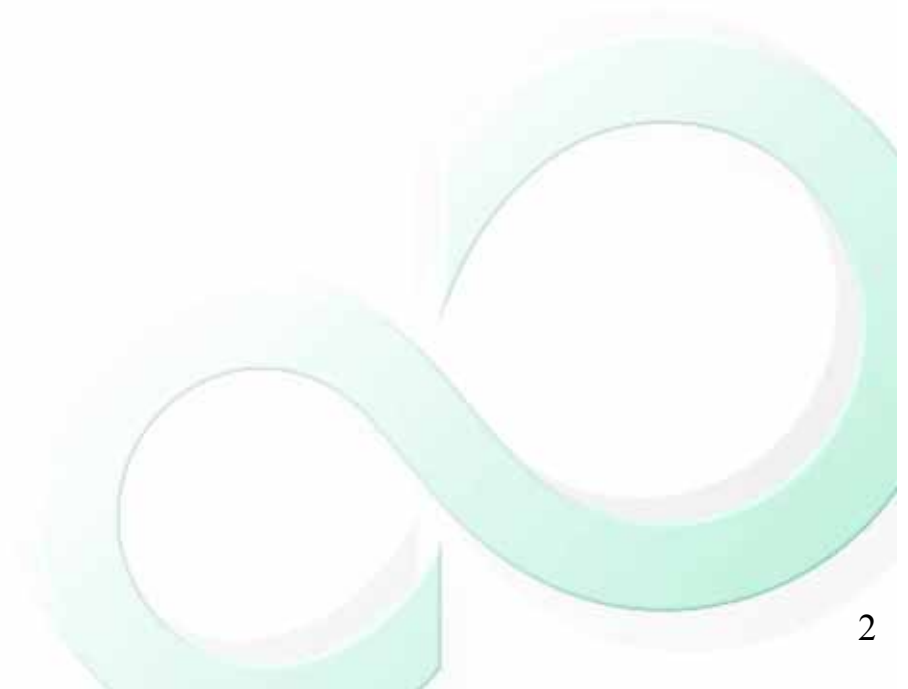Fujitsu LTD.[1] and Fujitsu Laboratories LTD[2]

Outline

1. Introduction
2. Fujitsu's Activities toward Eco-efficiency
3. Case study
4. Discussion
5. Conclusion

1. Introduction
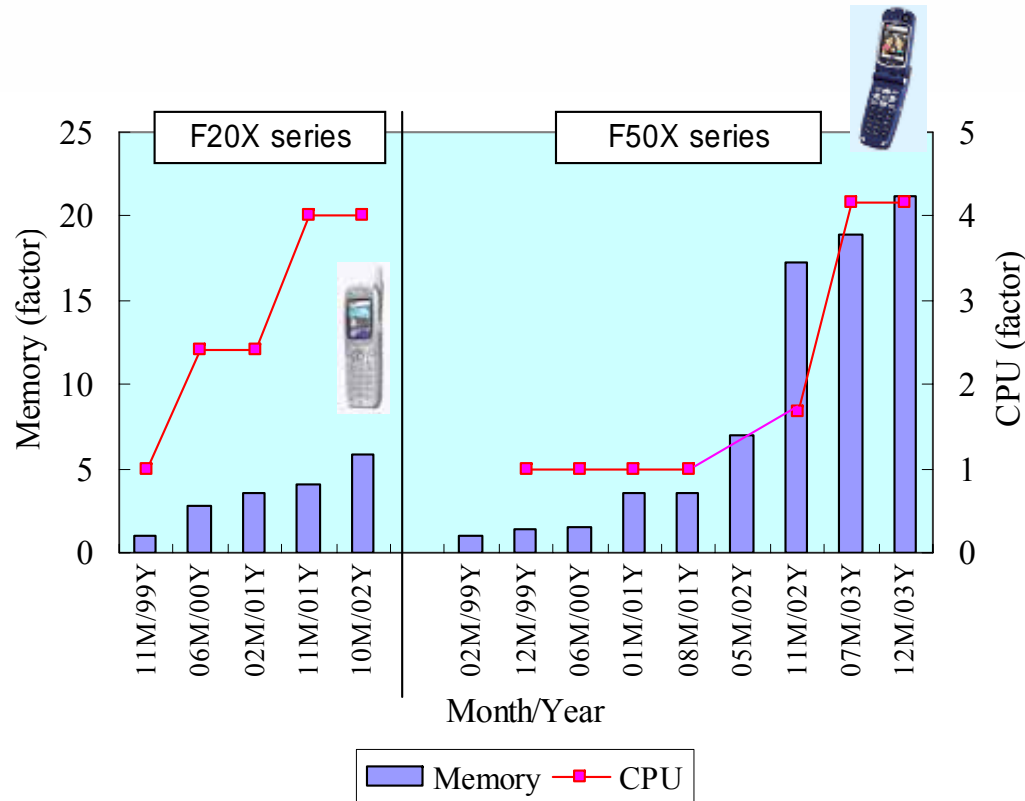
[Why applying the Eco-efficiency for IT-Products?]

Fig: Transitions of CPU and Memory for mobile phone

- **Sustainable Development**
  1: Maintaining the value of life
  2: Reducing the environmental loads

$$\text{Eco-efficiency} = \frac{\text{Service}}{\text{Environmental Loads}}$$

*JEAMI 2002 Eco-Efficiency Examination Report

- **Development of IT products**
  1: Rapid increase in the product performance
  2: Eco-Design

2. Fujitsu's Activities toward Eco-efficiency

[Eco-efficiency/Factor X]

- Member of the Eco-efficiency Examination Committee sponsored by Ministry of Economy, Trade and Industry (METI)

- Eco-efficiency Factor (by Fujitsu) =

$$\frac{Service\ (New\ product/Old\ product)}{Environmental\ loads\ (New\ product/Old\ product)}$$

[Application Examples]

- Personal Computer
  - *: 2002 Fujitsu Group Environmental Report*
  - *: EcoDesign 2002*
  - *: 2004 Fujitsu Group Sustainable Report*

- Scanner
  - *: ENVIRO-SHIGA 2003*
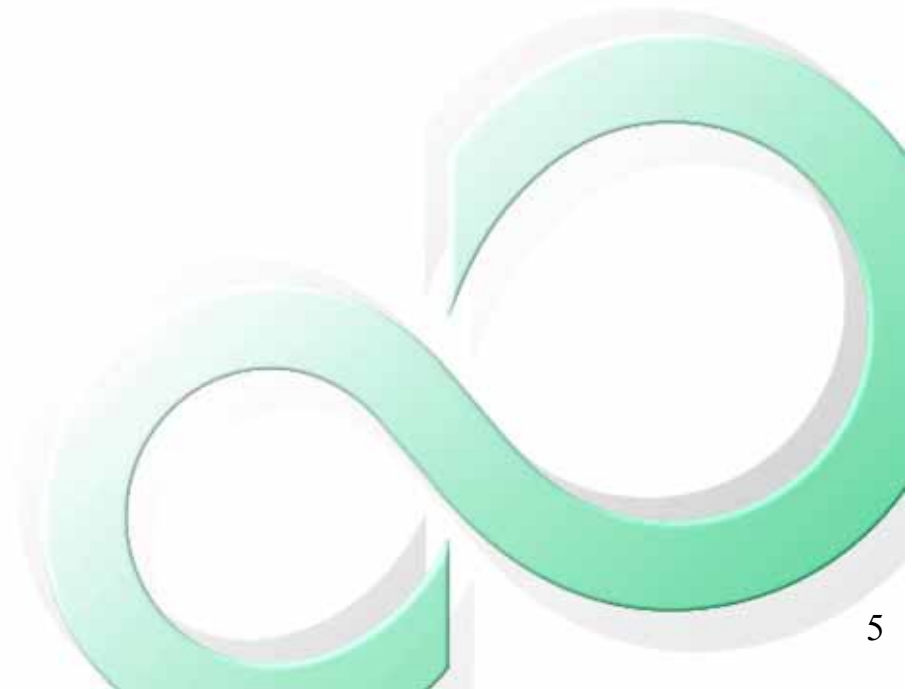 - *: 2003 Fujitsu Group Sustainable Report*

- Mobile Phone
  - *: EcoDesign 2003*
  - *: 2004 Fujitsu Group Sustainable Report*

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3. Case Study :
Notebook Personal Computer

3-1. Product Selection

A: FMV-5120NA/X

- Released : the year **1996**
- Display size: 10.4 inch
- Weight (main body): 4.6 kg

B: FMV-718NU4/B

- Released : the year **2003**
- Display size: 14.1 inch
- Weight (main body): 3.4 kg

3-2. Environmental Loads

[Various Eco-Label in accordance with ISO]

Type Ⅰ

The results of the label is expressed by passed/failed and the label is certified by the third party.

Type Ⅲ

Companies/Organizations assess and declare the environmental loads individually.

Type Ⅲ

The quantitative results of environmental loads based on Life Cycle Assessment (LCA) method.

Examples...

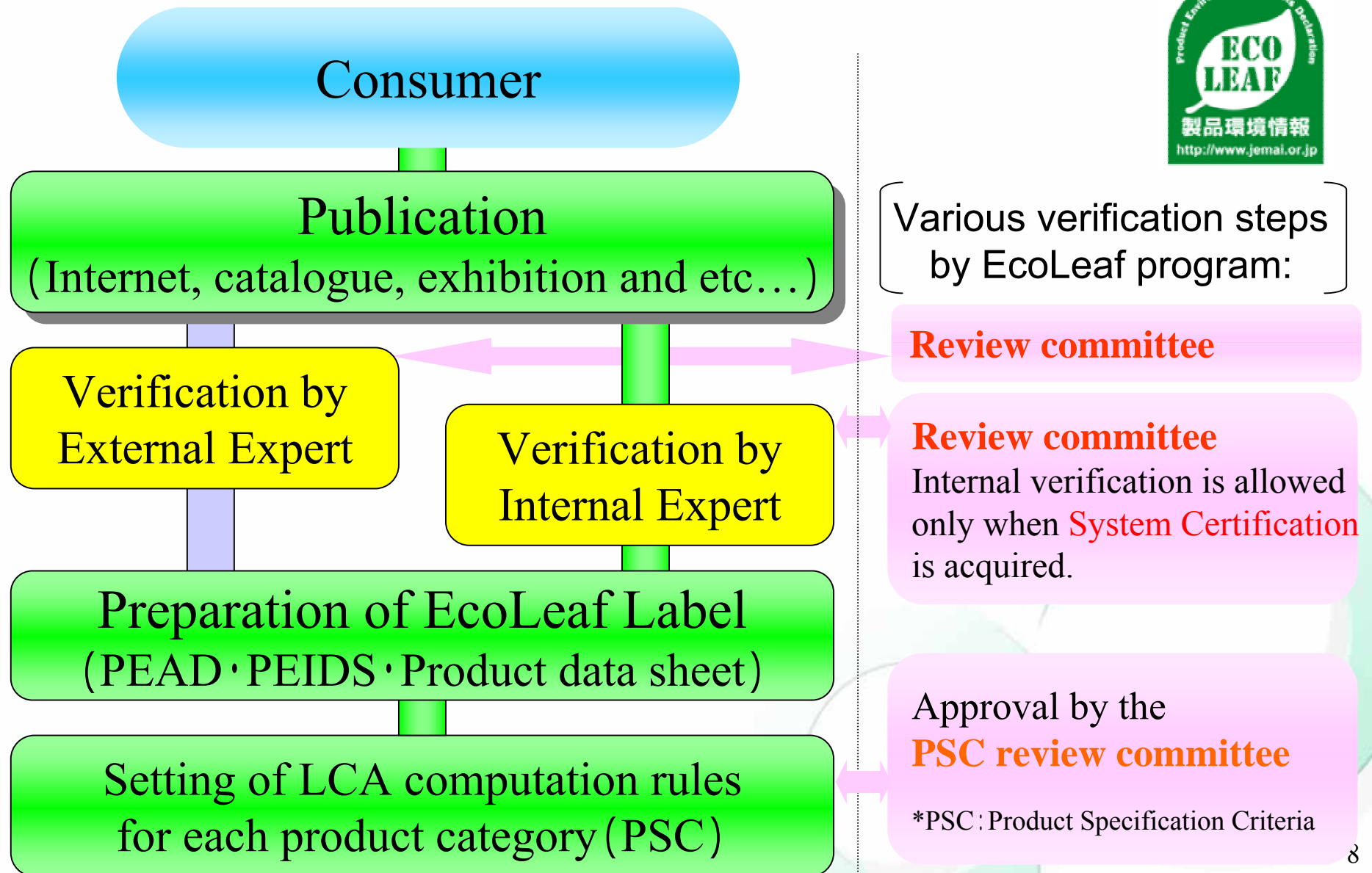*The Eco Mark Program: by JEA*

Environmental Emblem: by Fujitsu

EcoLeaf

Promoted by the Japan Environmental Management Association for Industry (JEMAI)

Started from June 2002
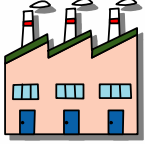
Registered by 30 companies and 200 products
(by Oct. 2004)

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Framework of EcoLeaf Env. Label

Consumer

Publication
Internet, catalogue, exhibition and etc…

Verification by External Expert

Verification by Internal Expert

Preparation of EcoLeaf Label
PEAD PEIDS Product data sheet

Setting of LCA computation rules
for each product category PSC

Various verification steps
by EcoLeaf program:

Review committee

Review committee
Internal verification is allowed
only when System Certification
is acquired.

Approval by the
PSC review committee

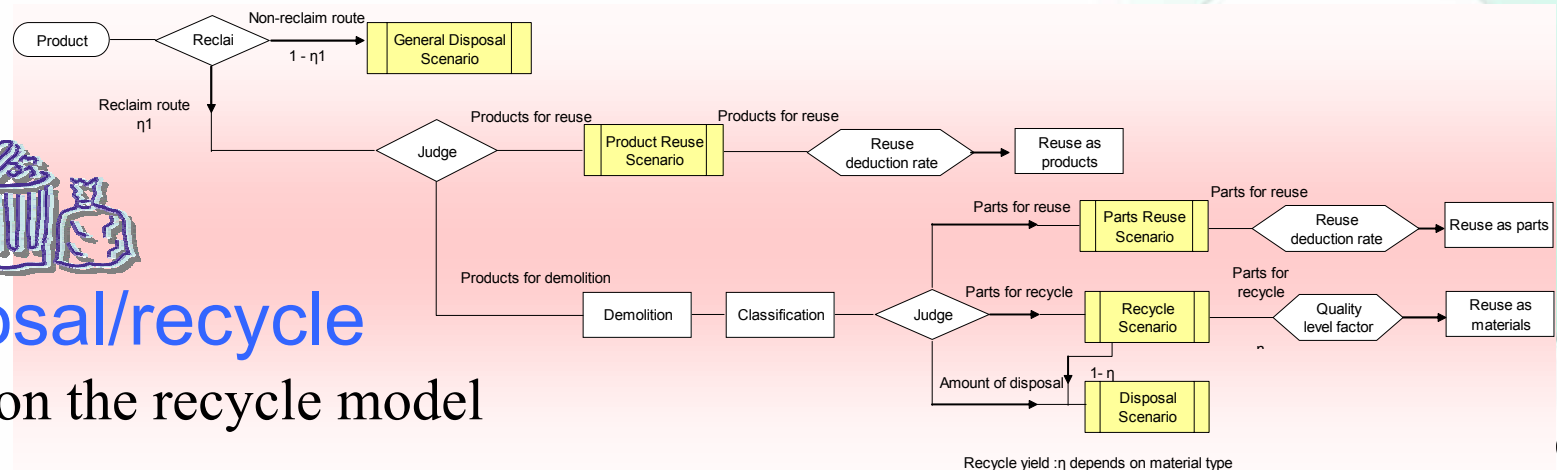*PSC Product Specification Criteria

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PSC for Notebook PC

- **Material Mfg**: Acquisition of materials using base unit

  Background data

- **Product Mfg**: LCD panel mfg, mounting of main printed circuit board, and product assembly   Foreground data

- **Transportation**: Distance from mfg site to customer is set as 500km. Add overseas transportation if applicable.

- **Use**: Operation/standby=4.5H/day, Energy saving mode=4.5H/day
  Operation days=240days/yr, operation yrs=4yrs

- **Disposal/recycle**
  : Based on the recycle model

Recycle yield :η depends on material type

Results from the EcoLeaf (1)

Product Environmental Aspects Declaration

- **Obtained in June 2003**
- **First** in the PC industry

Product Environmental Information Data Sheet

Product Data Sheet

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Results from the EcoLeaf (2)

- CO_2 emission of the each stage (FMV-718NU4/B)

The chart shows kg-CO_2/Unit on the vertical axis (from -10 to 60) across five stages: Material mfg, Product mfg, Trans., Use, and Disposal/Recycle.

Labels on the Material mfg bar: Paper, Battery, Printed circuit board, Plastics, Non-ferrous, Ferrous.

Labels on the Product mfg bar: Other processing, LCD panel mfg, PCB mounting, Product assembly.

Labels on the Use bar: OFF, Energy saving, Operation/Standby.

Labels on the Disposal/Recycle bar: Treatment(+), Deduction(-).

- The results of LCI for two products

Unit: kg
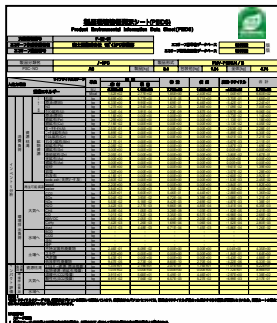
(IN)	5120NA/X (old)	718NU4/B (new)	(OUT)	5120NA/X (old)	718NU4/B (new)
Coal	22.5	16.8	CO_2	162	136
Crude oil (fuel)	28.7	22.4	SOx	0.160	0.121
Natural gas	8.27	7.00	NOx	0.180	0.138
Crude oil (ingredients)	2.33	1.14	N_2O	0.00785	0.00635
Iron ore	2.47	1.18	CH_4	0.00278	0.00241
Copper ore	0.112	0.0406	Dust	0.0173	0.0126
Bauxite	0.481	0.228	Soloid waste	5.32	4.35
Water	16900	14000	Slag	2.81	1.64
etc…			etc…		

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Application of LIME for Integration

- Life cycle Impact assessment Method based on Endpoint modeling (LIME)

  - Developed by "Research Center for Life Cycle Assessment of the National Institute of Advanced Industrial Science and Technology (AIST)

  - Japanese version of the endpoint-type life cycle impact assessment method

- The result of this case study

  - Apply inventory data from the EcoLeaf to LIME

  - Non-dimensional indicator based on conjoint analysis is selected for integration

[EcoLeaf]

Inventory data

LIME

Table: The result of integrated environmental loads

	FMV-5120NA/X	FMV-718NU4/B
Production	246.4	220.2
Distribution	7.1	3.0
Use	122.1	80.9
Disposition	-2.9	-7.0
Sum	372.7	297.2

¥642   ¥512

De-materialized design

+

Energy saving design

=

In total -20%

3-3. Service Values (1)

● **How to express the product service?**

- Fixed ?
- Market Survey ?
- Sales Price ?
- Product Functionality ?
- etc…

● **Premises for the diffusion of Eco-efficiency**

- Simplicity : Easily understood by the consumers!
- Clearness : Accessible data from the website!
- Continuity : Able to be calculated in the same criteria!
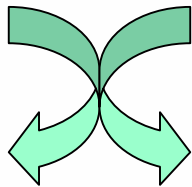
■ **Core Hardware Specifications**

Figure: Transitions of PC specification

CPU ─■─ Memory ─▲─ HDD

Service Values (2)

● Method

- ■ Apply "Hardware Specification" for service parameters

- ■ CPU clock number (GHz), Memory size (MB), and Hard Disk Drive capacity (GB) are selected as core specifications

- ■ In order to unite three different specification, the following equation is applied:

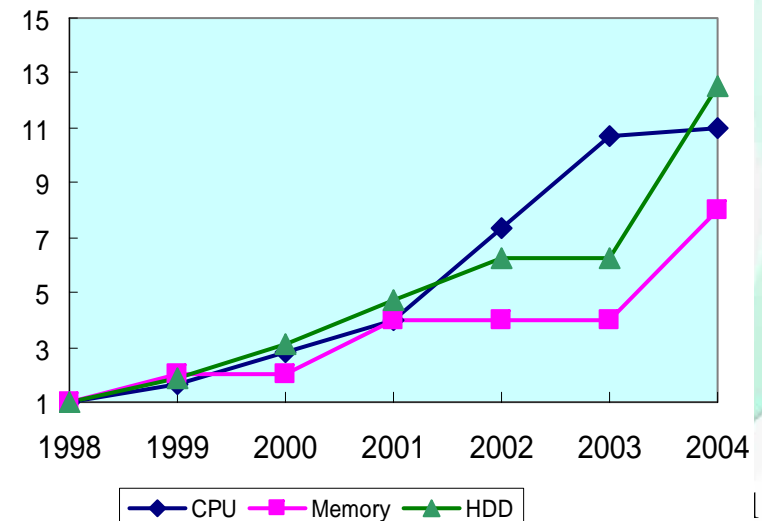 Average of square root $= \sqrt{\dfrac{1}{n} \cdot \sum_{i=1}^{n} S_i^{\,2}}$

Figure: The comparison of hardware specification

Table: The service value of notebook PC

Service	unit	FMV-5120NA/X (a)	FMV-718NU4/B (b)	=(b)/(a)
CPU	GHz	0.12	1.8	15.0
Memory	MB	8	128	16.0
HDD	GB	0.81	20	24.7

19.1

● Results

- ■ Service value has increased 19 times in seven years

3-4. Result of Eco-efficiency Factor

⬤ **Eco-efficiency Factor**

$$= \frac{Service\left(\sqrt{\frac{1}{n} \cdot \sum_{i=1}^{n} S_i^{\,2}}\right)}{\text{Env. loads} \quad (B/A)} = 19.1/0.8 = 23.9$$
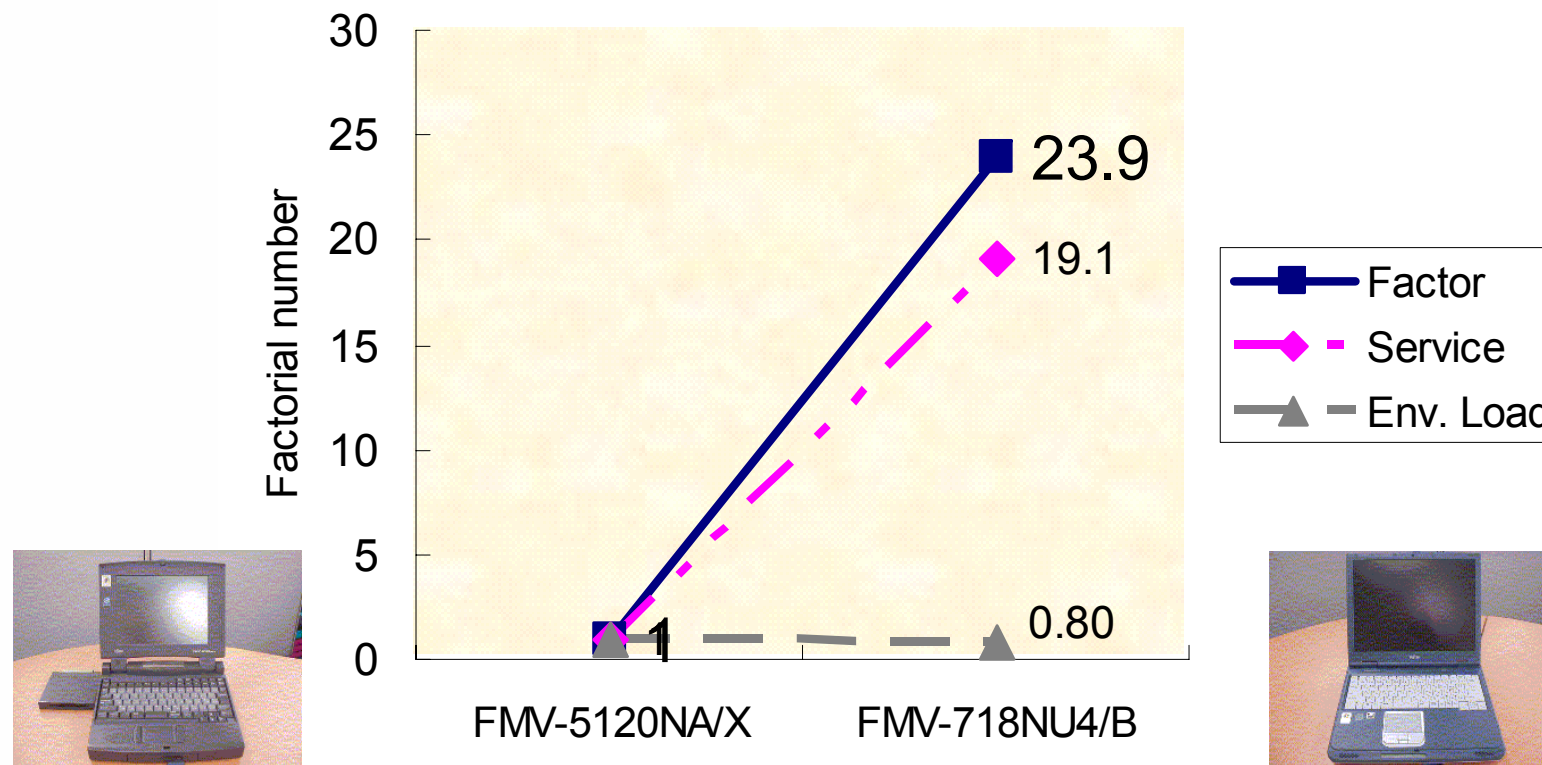
Fig. Eco-efficiency Factor of Notebook PC

4. Discussion

● Data Flow of this Case Study

Service:

| Hardware Specification | → | Service value |

→ Eco-efficiency Factor

Environmental Loads:

| EcoLeaf Type III Label | → | LIME (integration) |
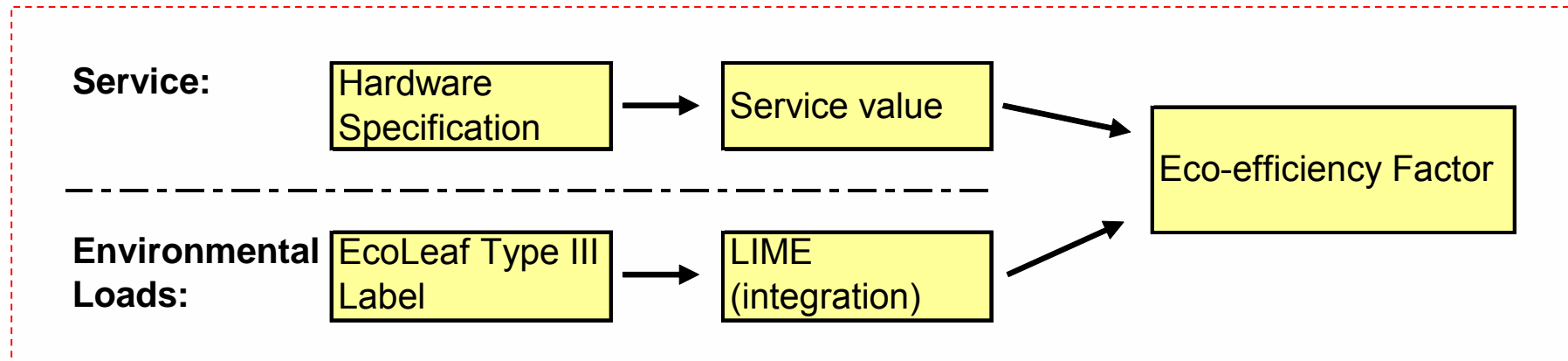
● Integration of Eco-indicators

EcoLeaf
（Type   Label）

Eco-eff.
Factor X

[Fujitsu LCA software]

[Fujitsu Basic Unit Database]

*Required internal product assessment

ICT&LCA

LCC/FCA
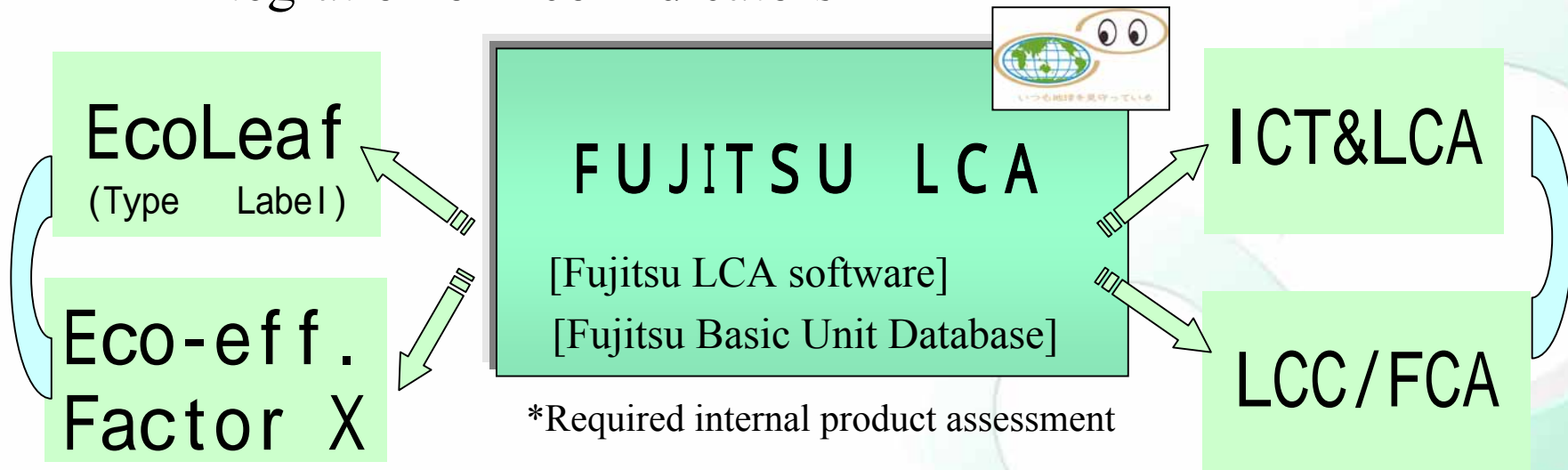
5. Conclusion

- It is essential to evaluate the <u>service value</u> in the framework of Eco-efficiency, especially for <u>IT products</u>.

- The Eco-efficiency Factor becomes <u>24 times</u> in seven years for the Notebook PC.

- <u>EcoLeaf</u> is the useful data source for inventory analysis and integration of environmental impacts is successfully done by <u>LIME</u> method.

- Factor X is <u>a crucial communication tool</u> in order to purchase excellent and environmentally sounds products.

FUJITSU
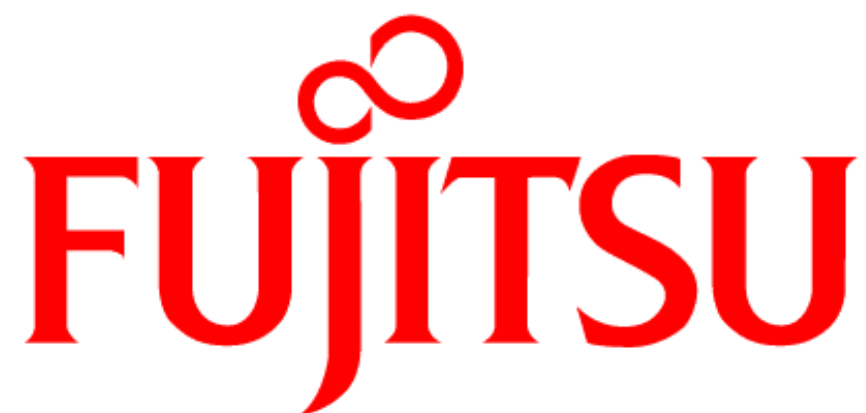
THE POSSIBILITIES ARE INFINITE

Summary of Scanner

[Environmental Loads]

Legend:
- fi-4110C
- fi-4120C

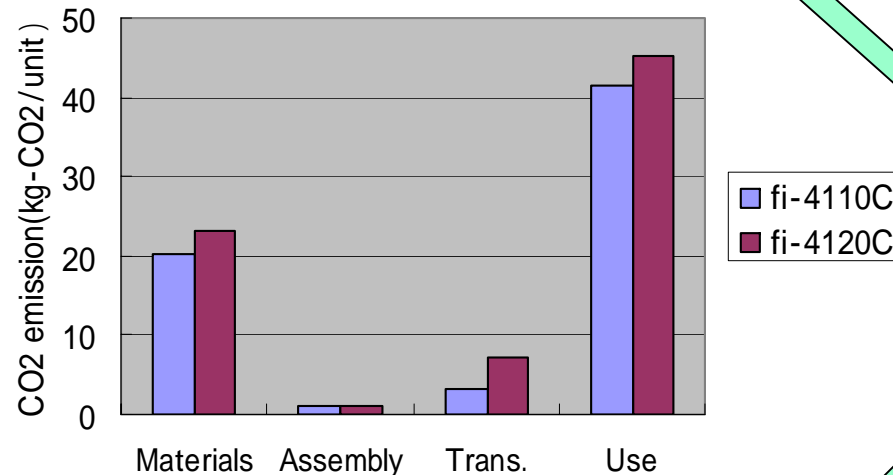Bar chart: CO2 emission(kg-CO2/unit) vs Materials, Assembly, Trans., Use

[Result]   Factor 21

Transitions in value when assumed fi-4110C =1

- Service: 2.47
- Eco-efficiency: 213
- Env. burden: 1.16

1999 vs. 2002
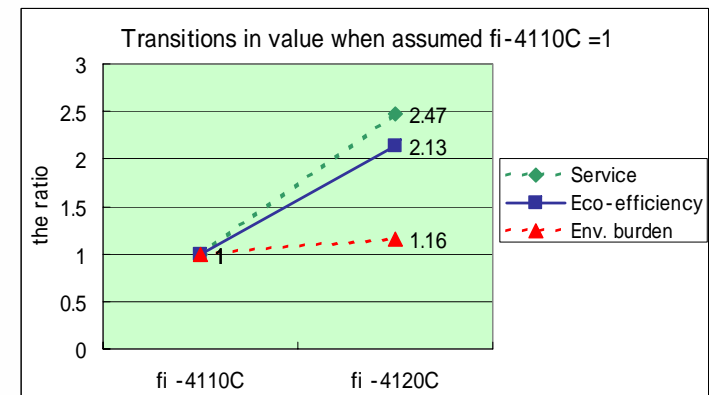
[Service]

Services		Ratio of new/old	
Item X	Item Y	=(b)/(a)	={1/n Σ ^2 ^0.5
Optical performance	Basic resolution	2.00	3.81
	Readout speed	5.00	
Media-processing performance	Max. media size	1.00	1.24
	Media thickness	1.44	
Data-processing performance	Program numbers (pre-installed)	1.50	1.50

2.47

EcoLeaf Recycling Model

Product

Reclai

Non-reclaim route
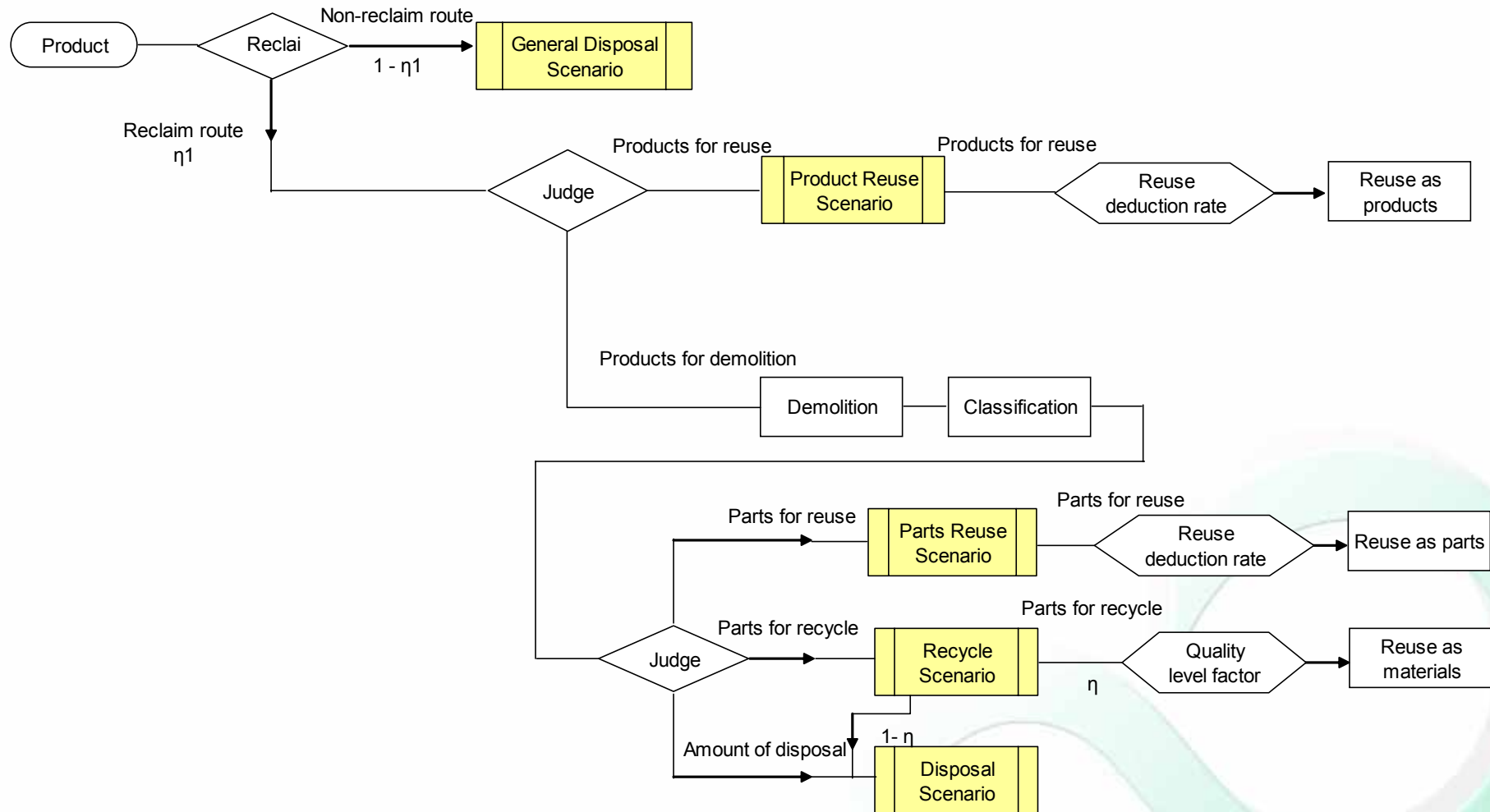
1 - η1

General Disposal Scenario

Reclaim route η1

Judge

Products for reuse

Product Reuse Scenario

Products for reuse

Reuse deduction rate

Reuse as products

Products for demolition

Demolition

Classification

Parts for reuse

Parts Reuse Scenario

Parts for reuse

Reuse deduction rate

Reuse as parts

Judge

Parts for recycle

Recycle Scenario

Parts for recycle

η

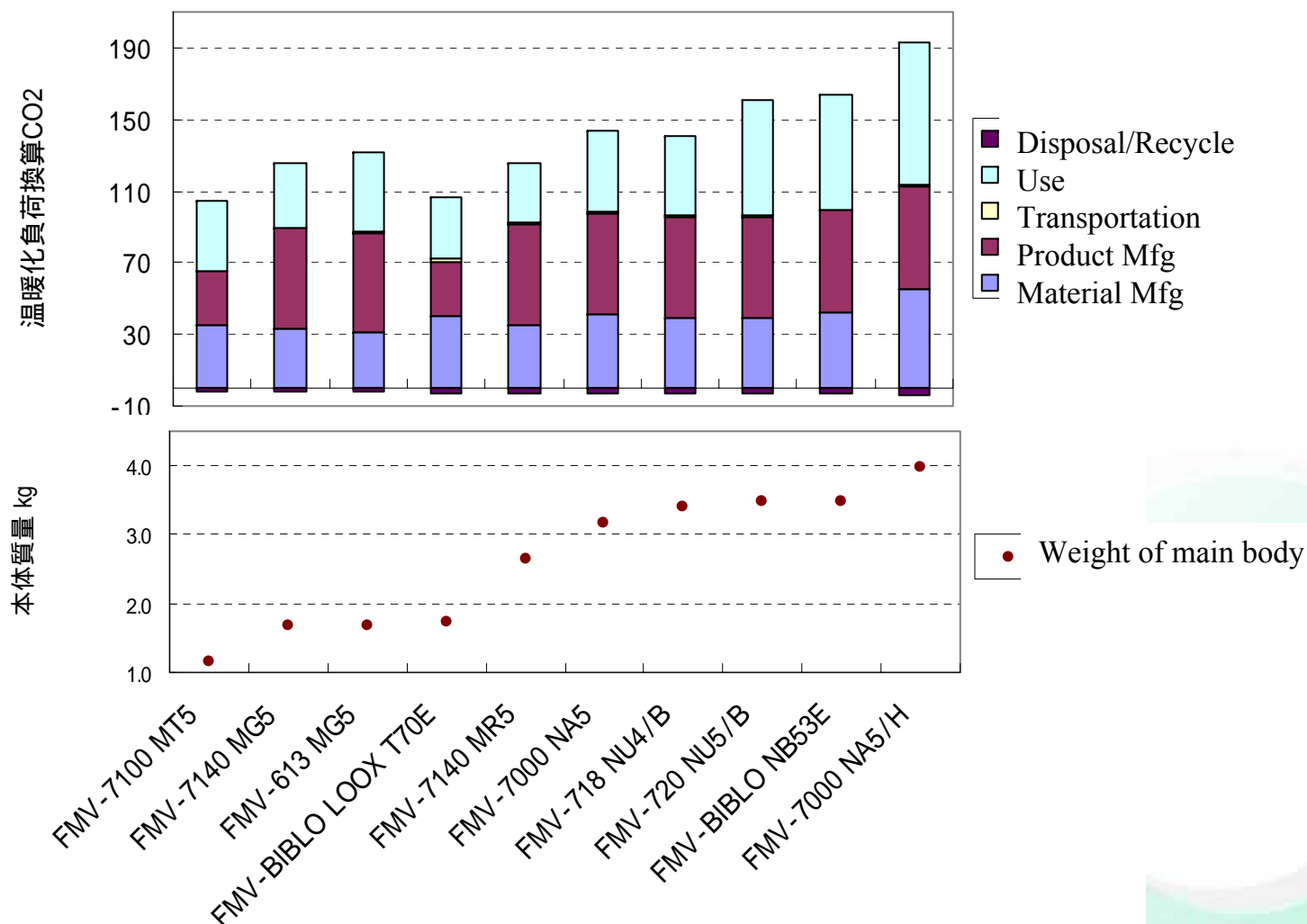Quality level factor

Reuse as materials

Amount of disposal

1- η

Disposal Scenario

Recycle yield : η depends on material type

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Other EcoLeaf Results of Notebook PC

Life Cycle Cost (LCC)

- Compute integrated environmental loads based on monetary units

Legend:
- Biodiversity
- Primary productivity
- Social welfare
- Human health

X-axis categories: Production, Transportation, Use, Disposal/Recycle

Y-axis: 2.50E+02, 2.00E+02, 1.50E+02, 1.00E+02, 5.00E+01, 0.00E+00, -5.00E+01
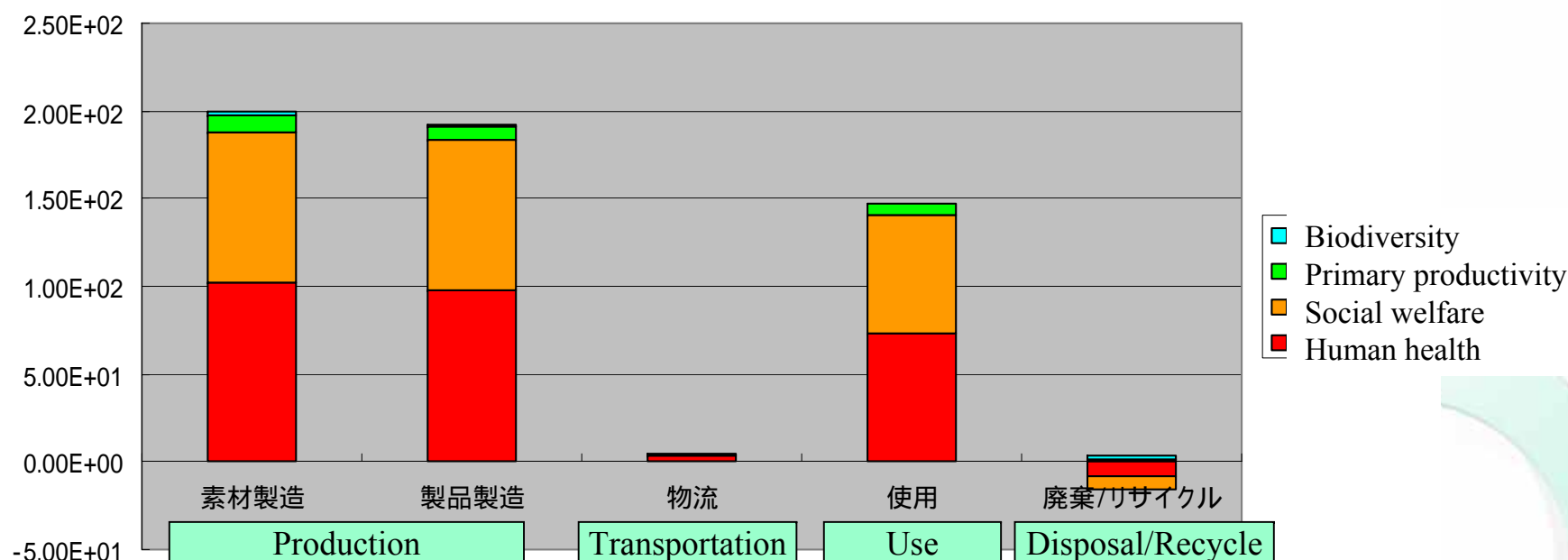
The Results of Social Cost = ¥512 (=$4.7)

* Applied LIME (Life cycle impact assessment method based on endpoint modeling) developed by the Research Center for Life Cycle Assessment of the National Institute of Advanced Industrial Science and Technology(AIST)