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Contents

LCA-Based Development of Eco-Friendly Products and Disclosure of Environmental Information

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1. Introduction

Established in 1943 in Isezaki-City, Gunma, the Sanden Group has been using its cooling and heating technologies to operate a car device business by developing car air conditioners and their compressors and also to operate a food distribution device business by developing freezers for commercial use or refrigerated display cases and vending machines. With 'prompt response to customer requests in production' as the policy, we have been actively aiming towards globalization of the business. Currently, we are operating at 53 bases in 23 countries.

Also, within our corporate philosophy, we regard eco-friendliness as a universal value and carry out business activities to preserve the environment based on the approach and actions established by the employees. In 1993, we established the Sanden Environmental Charter as our voluntary plan. Then in 1997, we revised our Environmental Charter and applied it to all domestic as well as international group companies as a consequence of the environmental management system provided by the establishing in 1997 of ISO14001 as an international standard, as well as the consequence of our realization of the importance of environmental preservation activities.

Furthermore, as a corporate citizen that is expanding its business globally, we established goals shared by all employees which are 'Environmental Vision: Eco Excellent 2010' as shown in Figure 1 and 'Environmental Action Guideline' as shown in Figure 2 in order to ensure that all of our corporate activities are eco-friendly. These goals have been incorporated into our environmental action plan.

Promotion of development of eco-friendly products and development of environmental technologies is our lifeline. Therefore, while aiming for value generation and reduction of environmental burdens and while continuing to examine what kind of products can make customers' lives better, we are developing products that can contribute to the realization of a sustainable society through saving energy, saving resources, and reduction of use of toxic chemicals. Among these activities, we are also actively implementing a method to properly assess products and technologies.

This article will provide an overview of LCA-based development of eco-friendly products and disclosure of environmental information by the Sanden Group

Figure 1 Sanden Environmental Vision2010

Figure 2 Environmental Action Guideline

2. Objectives of LCA

Our objectives of conducting LCA are as follows:

① Visualization of environmental burdens (CO_2 emission) throughout the life cycle of a product
② Identification of processes and parts generating high environmental burdens
③ Provision of environmental information to customers
④ Benchmarking of target values for developed technologies and products, and management of these at each design review (DR)

3. Examples of Effective Use of LCA in Products

3.1 Vending machines

Our LCA for vending machines dates back to a joint study with Mr. Otsuma of the National Institute of Environmental Studies in 1992. At the time, the media reported that vending machines were damaging the cityscape and that bright lighting of vending machines across the country was using the power equivalent to power generated by one nuclear power plant. Therefore, it was our urgent task to develop energy-saving vending machines.

Around that time, CO_2 emission by a vending machine was 7,330kg (for 5 years of use) and the product use stage accounted for 94% of it (Figure 3).

Figure 3 Vending machine LCA result (1992)

Figure 4 Analysis of environmental burdens in the vending machine use stage

Based on the LCA result, Figure 4 shows the more detailed breakdown of environmental burdens during the vending machine use stage. As shown in Figure 4, in addition to compressor operations for cooling and heating as well as power consumption for lighting, we found a lot of unnecessary power consumption such as thermal losses by the heat of the machine and excessive lighting for displays. Complete elimination of such waste became our technical development theme eventually leading to development of energy-saving vending machines.

As implementation of environmental burden reduction technologies, we adopted the zone heating system, adopted the heat pump system, improved air tightness, adopted vacuum heat insulating materials, and promoted learning operation control for saving energy. At the same time, the Energy-Saving Top Runner standard for vending machines was implemented, and as a result, as shown in Figure 5, in 2009, we were able to reduce the power consumption by the heat pump used in the 30-selection model, which is the most frequently used vending machine model, by 71% compared to 2000.

Also, as shown in Figure 6, the result of LCA in 2009 for the latest vending machine model indicated that the CO_2 emission of the heat pump used in the 30-selection model was 3,158kg (for 5 years of use), which meant that the CO_2 emission was reduced by approximately 64% in the product use stage.

Figure 5 Power consumption by a vending machine

Figure 6 Vending machine LCA result (2009)

3.2 Compressors for a Car Air Conditioners

We started LCA for a car air conditioner compressors in 2002 under the supervision of Mr. Inaba, the former Manager of the Research Centre for Life Cycle Assessment of the National Institute of Advanced Industrial Science and Technology (currently a professor at Research into Artifacts, Center for Engineering, the University of Tokyo), Mr. Narita of the Japan Environmental Management Association for Industry (currently a professor at Nagoya Sangyo University), and Mr. Aoki.

Also, from 2007, we have been conducting LCA based on the Product Environmental Indicator Guideline (http://www.japia.or.jp/work/2007/09/guideline.html) compiled by the Japan Auto Parts Industries Association.

As shown in Figure 7, the scope of LCA included the material process, supplier process, transportation between the supplier and Sanden, processing and assembly at Sanden, transportation between a customer (car manufacturer) and Sanden, and the product use process.

The disposal stage was excluded from the scope of assessment because it was handled by the car manufacturer.

Figure 7 Scope of LCA for compressors for a car air conditioners

Table 1 shows the LCA results for car air conditioner compressors. As the compressor changed from the fixed volume type to the internal variable volume type and then to the externally variable volume type, the environmental burdens (which influence global warming) decreased. While the CO_2 emission of the fixed volume type was 3,234kg-CO_2, it was 2,232kg-CO_2 for the external variable volume type, achieving reduction to 62%.

Table 1 LCA results for car air conditioner compressors

4. Disclosure of LCA Results

Environmental information on vending machines is disclosed through EcoLeaf Type III of the environmental labeling program (http://www.jemai.or.jp/ecoleaf/prodbycmp_companyobj119.cfm).

Environmental information on car air conditioner compressors is disclosed though our CSR report (http://www.sanden.co.jp/environment/index.html)

5. Conclusion

The management policy of the Sanden Group is to grow to the next level while focusing on environmental conservation using our current strength, which is the creation of corporate value from the environment, as the foundation. Based on this management policy, we plan to develop technologies to achieve eco-friendly products and to completely eliminate waste at factories. At the same time, we will create and implement the next environmental vision and also mid-term targets by observing the trends of GHG emission targets discussed at COP15 and in international society.

Establishment of a Quantitative Assessment Method through Printing Service LCA and Proposals of Eco-Friendly Actions

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1. Introduction

Assessment of eco-friendliness in printing services used to be mathematically unsupported qualitative assessment for stereotypical activities such as use of recycled paper and use of soy ink. Recently, printing businesses are expected by other fields of business to reduce environmental loads, and in order to respond to such expectations in terms of mathematical figures, we have created the printing service LCA system based on the quantitative assessment method.

We conducted printing service LCA to reduce environmental loads by implementing the following three steps:

① Numerical expression of environmental loads in the material, production, and disposal and recycling stages = visualization

② Development of eco-friendly designs by reviewing the current material types, production process, and structural design

③ Use of LCA results as base figures for calculation of the amount of carbon offset and carbon footprints

2. Analysis method

2.1 System boundary

Figure 1 shows the system boundary in printing service LCA. We calculated environmental loads for procurement of the main materials such as paper, ink, and printing plates, transportation of finished products to consumers, disposal of used products, and recycling of waste materials generated from production factories.

2.2 Raw material procurement stage

In the raw material procurement stage, paper, ink, and printing plates were the subject of environmental load calculation. We used the LCA Japan Forum database (DB) and estimates provided by material manufacturers to obtain the basic emission unit, and calculated the amount of these materials used and environmental loads generated during transportation.

① Rolled materials

The amount of rolled materials (paper or plastic) used was the sum of the number of sheets used in actual printing and the number of sheets to be used for pre-printing color adjustment or position adjustment. When a product had an irregular shape such as packaging or a booklet, we used a CAD program to calculate the ratio of the product area to the entire sheet area in order to divide the amount of rolled materials into this ratio by weight.

② Ink and varnish

The amount of ink and varnish used was estimated by obtaining the thicknesses of the ink transferred onto the rolled materials based on the actual job performance values, obtaining the average ink thickness, and multiplying the ratio

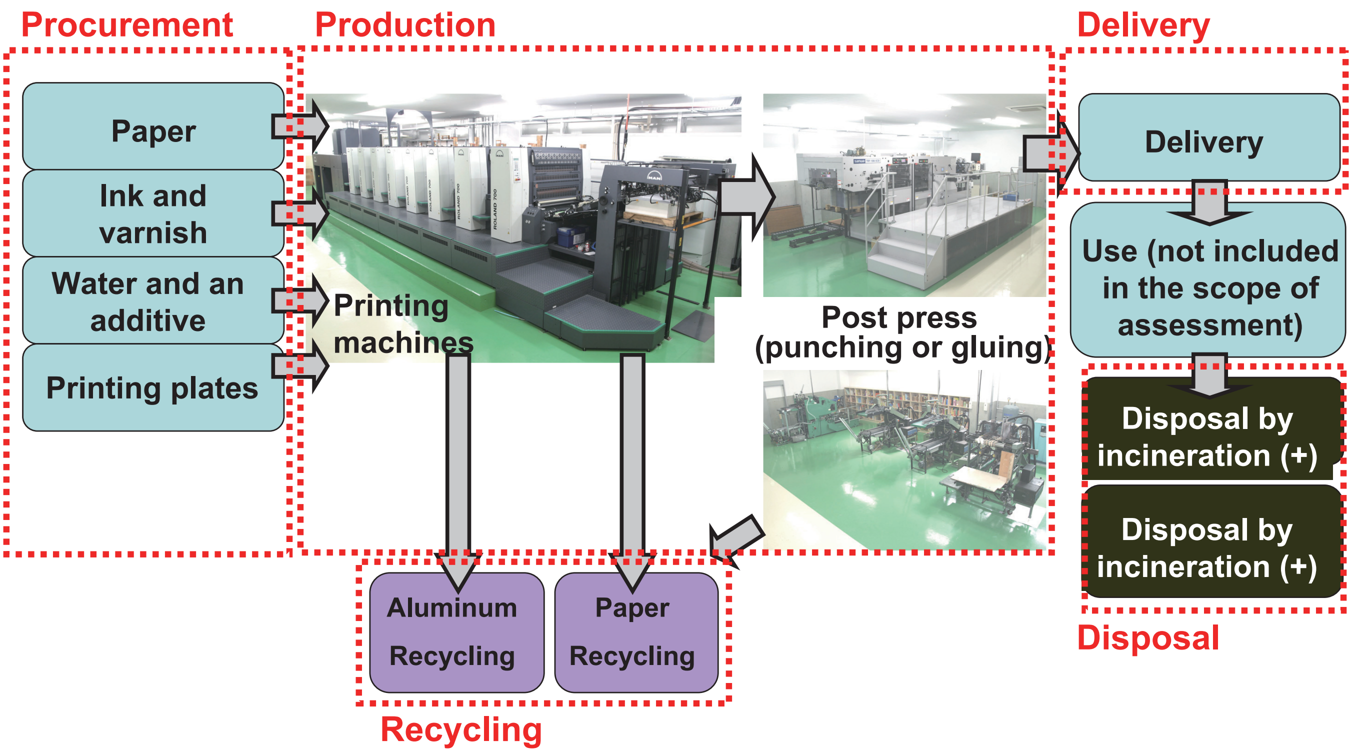

Figure 1 Printing service LCA system boundary

of area with ink by the rolled material size. If an accurate ratio of the area with ink cannot be obtained, the maximum value for generation printing was used as a hypothetical value so that the calculated area would not be smaller than what it should be. As for the basic emission unit, it was extremely difficult to obtain it using only the summation method because a large number of types of ink pigments were used and the supply chain extended overseas, and also the method was underdeveloped. Therefore, we requested an ink manufacturer to make an estimate using a combination of the summation method and input-output analysis. As a result, we established and used the basic emission units for the four primary colors essential in color printing and also for coating varnish used to protect printed surfaces.

③ Water and an additive

In general printing, repellency between ink (oil) and water creates parts that are printed and not printed (parts where ink is transferred and not transferred). Therefore, the water here is a substance used in the printing process and is called dampening water. There were no examples that provided an official formula to allow us to predict in advance the amount of dampening water used in each printing job. For this reason, we conducted data analysis using our printing machine in order to find the relationship between the amount of ink used and the amount of dampening water used. However, we have not been able to obtain the accurate water absorption rate by a rolled material or the rate of water evaporation due to the raised temperature inside the printing machine. Currently, we set a tentative ink to water ratio for each type of rolled material to calculate the amount of water used.

An additive (isopropyl alcohol: IPA) lowers the surface tension of water so that detailed parts printed and not printed can be formed clearly. As a general rule, the amount of IPA added to the water is approximately 5% of the water volume.

Recently, waterless printing is spreading, in which neither water nor IPA is used, no toxic strong alkaline waste solution is generated during the printing plate exposure process, and printing quality is expected to improve. We are also preparing to switch to 100% waterless printing.

④ Printing plates

Printing plate manufacturers have been studying environmental loads generated in the procurement of printing plates; therefore, there were values available for our study.

2.3 Production Stage

In the production stage, electricity use in production of printing and post press machines, and electricity use in air conditioning and lighting for these machines were the subjects of calculation. Although ideally the primary data on electricity use was collected, we used the rated output values where it was impossible. As for the basic emission units, we referred to the LCA Japan Forum DB.

① Printing plates

A printing plate is created by reproducing digital data created on a PC with a laser and then carrying out the exposure process. Here, electricity use by an output machine that produced an image on the printing plate, a developing machine, an air conditioner, and lighting was measured. When electricity use could not be measured for any particular facility, rated output values were used.

Electricity use of lighting was about the same as the value obtained using the rated output value. For air conditioning, however, it would be dramatically different from what would be obtained using the rated output value because of seasonal temperature changes or heat released from production facility. Therefore, electricity use was measured for each of the facility types listed above. Electricity use for air conditioning and lighting for other production facility was calculated based on the same idea.

② Printing

We set the average electricity use per hour for our printing machines based on the actual measurement values recorded for over a year. Because the time spent on preparing paper or ink, time required to get ready for the next job, and cleaning time were all included in printing machine operating time, time other than the machine being stopped for no particular purpose would be regarded as operating time. Analysis of the actual electricity use measurement value indicated that its power output was much lower than its rated output value. This was because the machine operated at 70% to 80% of its rated value even when it was operating at its full capacity, and also because the addition of preparatory and cleaning time described above lowered the resulting value. We would like to add here that calculation of electricity use must be comprehensive, including electricity use of a compressor or other optional devices.

③ Post press

There are multiple types of post press machines such as a gluing machine and a binding machine, and electricity use of these machines was calculated in the same way as the production facility described above.

2.4 Distribution and Use Stages

In the distribution stage, electricity use was calculated based on the weight of finished products. In the use stage, there was no need to calculate electricity use for analog printing services. However, it must be calculated in digital printing services such as website viewing. As for the basic emission units, we referred to the LCA Japan Forum DB.

① Delivery

Electricity use in product delivery was calculated by multiplying the delivery distance and the product weight, which was obtained by subtracting the amount that did not become products from the amount of rolled materials used. Distance to destination was obtained by a web-based calculation tool that automatically calculated the distance when the start point and destination were inputted.

② Use

In product use, electricity use associated with the use of analog media such as packages and booklets was not included in the study. However, electricity use associated with the use of digital media such as electronic books must be taken into consideration. Although environmental loads obtained here would be marginal, we still always calculate them because these loads would be the important points for comparison or examination purposes.

2.5 Disposal and Recycling Stages

In the disposal stage, electricity use was calculated based on the weight of products disposed of by consumers, and in the recycling stage, electricity use was calculated based on the weight of materials that did not become products and that were disposed of from the factory. As for the basic emission units, we referred to the LCA Japan Forum DB and estimated values provided by waste disposal services.

① Disposal

Electricity use must be calculated for some of the products that were procured by consumers and disposed of as household waste to be incinerated and also for unsold products that were disposed of by distributors. For calculation of incineration of rolled paper materials, the weight of plant-derived material (biomass ratio), which would be other than the coated layer, could be registered as a negative figure base on the concept of carbon neutrality. Here, carbon neutrality is the idea that, because CO_2 emitted due to incineration of plant-derived materials is used in photosynthesis by trees, the amount of CO_2 does not increase in the overall life cycle.

Electricity use for waste materials from the factory was based on values provided by special waste material collectors for specially-controlled waste materials such as waste developer for printing plates used in printing that used water (waste developer in waterless printing would not apply here).

② Recycling

In recycling, electricity use associated with all printing plates and the amount of material obtained by subtracting products from rolled materials (materials that did not become products and spare materials for pre-printing adjustments) were calculated. Electricity use associated with product recycling by consumers could also be calculated if there were reliable scenarios.

	Item	A: Normal	B: WL	C: FM	D: PaperWS
Procurement	Paper	1,890.0	1,890.0	1,890.0	1,650.0
	Ink and varnish	57.1	57.1	45.9	57.1
	Water and additive	0.2	0.0	0.1	0.2
	Printing plate	36.6	36.6	36.6	36.6
Production	Printing	86.8	86.8	86.8	86.8
	Cutting and gluing	146.0	146.0	146.0	146.0
Delivery	Delivery	25.8	25.8	25.8	22.6
Disposal	Disposal by incineration (+)	2,290.0	2,290.0	2,290.0	2,010.0
	Disposal by incineration (-)	-2,170.0	-2,170.0	-2,170.0	-1,880.0
Recycling	Recycling of paper	94.6	94.6	94.6	82.2
	Recycling of aluminum	8.0	8.0	8.0	8.0
	Total GWP:	2,465.1	2,464.9	2,453.8	2,219.5
	Comparison with Condition A:	-	99.99%	99.54%	90.04%

(kg-CO_2e)

* Calculated using SimpleLCA, the LCA software developed by the Japan Environmental Management Association for Industry

* Item A: normal practice, B: waterless printing, C: high definition printing, D: paper weight reduction

Table 1 GWP summary by condition for printing and manufacturing 100,000 paper CD packages

3. Conclusion

As a result of the establishment of printing service LCA:

I. The shift from qualitative studies to quantitative studies allowed internal and external disclosure of environmental load information in mathematical values.
II. By understanding environmental loads for each material and process, important points in specification changes could be identified and also mathematically-supported eco-friendly designs increased.
III. Results of LCA were used as the basic values for calculating the amount of carbon offset or carbon footprints, whose concepts were rapidly spreading in the industry.

Therefore, we were able to successfully achieve the objectives that we set before carrying out LCA.

As an example, we would like to introduce the case of paper CD packages which are our leading products (133mm x 133mm x 9mm, 100,000 pieces). Among impact categories, we focused on GWP (greenhouse gases converted into the amount of CO_2) and summarized the environmental analysis results for: the case of waterless printing with no use of water; the case where the use of ink was reduced by 30% for high definition printing; and the case where the weight of paper was reduced. In analog printing services, environmental loads of paper accounted for over 75% of the environmental loads of the entire life cycle and for the rest, there were not any factors other than disposal that required attention. Although we expected that waterless printing, which is the most advanced printing technology, and reduction of use of ink by using extremely small dots would be effective in reduction of environmental loads, they did not have much of an impact because they accounted only for small percentages of the entire environmental loads. In this example, we found that we need to improve opposing qualities, namely reduction of paper weight and improvement of load capacity.

Re-acknowledging the fact that LCA-based refinement does not necessarily lead to greater sophistication of environment assessment, we will continue to examine how printing service LCA should be carried out.

LCA Japan Forum Chairman's Award Winning Article

LCA Activities for Environmentally-Conscious Designs in the Field of Power Systems

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1. Introduction

At Toshiba Corporation, we are engaged in LCA researches in the Power and Industrial System R&D Center. In doing so, we have effectively constructed internal database and know-how on LCA analysis, and promoted LCA on various types of apparatuses in the field of power systems. This article will provide overviews of our activities: ① LCA studies for the purpose of environmentally-conscious designs; ② Publication and standardization to support LCA activity; and ③ developing method for the purpose of response to a wide variety of assessment needs.

2. Characteristics of Power System Apparatuses and Points to be Considered for LCA

As shown in Figure 1, power systems are composed of various types of apparatuses, such as, waterwheel, turbine, power generator, transformer, switchgear, arrester and other attached components.

These apparatuses have characteristics as shown in Figure 2 that consumer products do not have, and there are 3 points to conduct LCA.

First, these apparatuses should concern not only consumption but also convert and control energy in their operation phase, it is important to clearly identify the decisive points for environmentally-conscious designs.

Second, for these apparatuses, it is usually difficult to collect LCA data for the recycling phase and specific and various materials included in apparatus. Therefore, it is important to calculate these types of data.

Third, new methodology should be needed to meet a wide variety of assessment needs, such as reliability or safety assessment in addition to environmental impact assessment.

3. Toshiba's Activities

This section shows Toshiba's activities to successfully carry out the points listed above.

3.1 LCA studies

To accomplish the first point, focusing decisive points for environmentally-conscious designs in an easy-to-understand way, LCA studies were performed for various

Figure 1 Various types of apparatuses in power systems

Characteristics of power system apparatuses

	Power system Apparatuses	Consumer Products
Manufacturing phase	Materials are often specific and valuable	Materials are often standard and inexpensive
Operation phase	Long usage Relations with energy are valuable (energy conversion, control, and consumption)	Short usage Relations with energy is mostly consumption use
Disposal phase	Utilities manage and control after usage	Recycle system functions under extended producer responsibility

Points to be considered for LCA

(1) Proposals of decisive points for environmentally-conscious designs
(2) Calculation of LCA data that is difficult to find
(3) Fulfillment of a wide variety of assessment needs

Promotion of LCA studies, publication, and developing method

Figure 2 Characteristics of power system apparatuses and points to be considered for LCA

apparatuses.(1)-(3)

Figure 3 shows the typical examples of LCA results and the decisive points for environmentally-conscious designs. The figure suggests that the environmental impact in the operation phase caused by generators and transformers account for more than 90% of the overall environmental impact (I). In this case, the point of environmentally-conscious design is improvement of operational efficiency. Meanwhile, both high voltage switchgears and low voltage switchgears generates the same level of environmental impact throughout the life cycle (II). In this case, the points of environmentally-conscious designs are reduction of the amount of material use, replacement of materials that reduce environmental impact, and current loss reduction in the operation phase.

In case of arrester, the environmental impact in the manufacturing phase is dominant(III). In this case, the points of environmentally-conscious designs are reduction of the amount of material use and energy-saving in the manufacturing phase.

Various types of apparatuses are categorized, as shown below.

Category I: apparatuses with dominant environmental impact in the operation phase, such as power generators and transformers
Category II: apparatuses with even environmental impact in the material and operation phases, such as switchgears
Category III: apparatuses with dominant environmental impact in the material and manufacturing phases, such as arresters

To classify the apparatuses assists designer in clarifying the decisive points for environmentally-conscious designs.

Figure 4 shows the environmental impact reduction by environmentally-conscious designs. By these are accomplished power generator operational efficiency, reduction of switchgear weight and current loss, and reduction of the number of arrester elements through performance improvement.

3.2 Publication and standardization

For the accomplishment of the second point, preparing LCA data that is difficult to collect, data maintenance was performed through this LCA studies and using data created based on the industrial input/output table. In addition, we

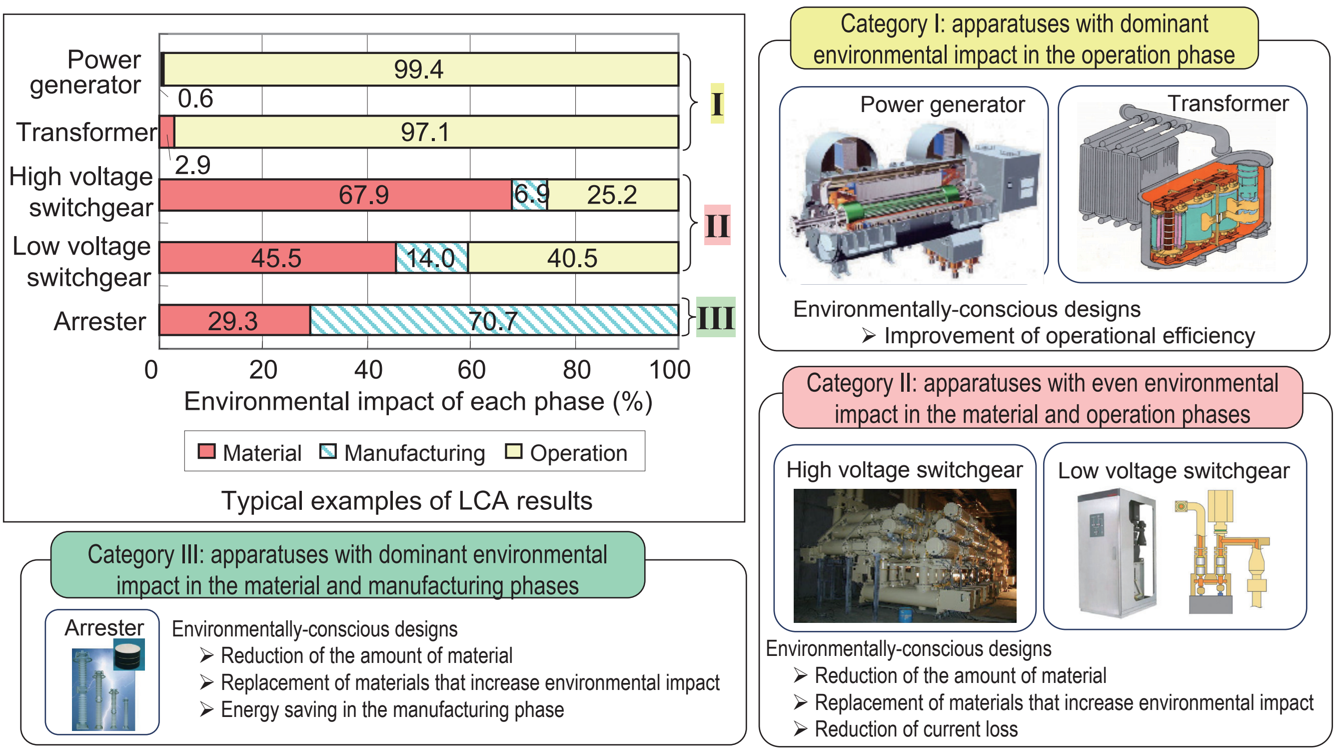


Figure 3 LCA results and important points for environmentally-conscious designs

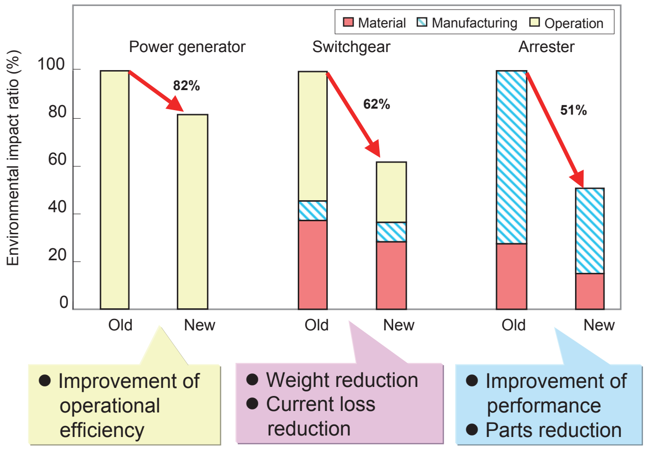


Figure 4 Examples of reduction of environmental impact

disclosed information essential to LCA analysis such as basic units for electronic circuit boards for which data would be difficult to collect and also information on standardization in the industry.(4)-(10) Figure 5 shows some examples. For power generators, recycle process was examined. For protection relays, standard LCA data for electronic circuit board was proposed. A large number of electronic circuit boards were categorized into three types of standard boards to propose a standard unit for each type of board. Transformer case study was applied to LIME and LIME2 comparison study.

Furthermore, Toshiba participated as the Sub Reader in the LCA working group (WG) for power and industrial systems hosted by the Japan Electrical Manufacturers' Association (JEMA). In this WG, together with the other participating companies, "Life cycle CO_2 emission assessment guidelines for power and industrial systems (JEMA Guideline) (March, 2008)" showing the data development procedure, and "Case studies (October, 2008)" showing the various examples were published. The participating companies were Mitsubishi Electric Corporation (Reader), Toshiba Corporation (Sub Reader), Hitachi Ltd., Fuji Electric Systems Corporation, Yasukawa Electric Corporation, and Toyo Denki Seizo K.K. (with the additional support of Toshiba Plant Systems and Services Corporation). (Figure 6).

3.3 Developing Method

For the accomplishment of the third point, to meet with a wide variety of assessment needs such as conducting reliability and safety assessment, cooperative research was performed with Chalmers University of Technology in Sweden, which had rich experience in environmental impact assessment in the field of infrastructure. Figure 7 shows the outline of two methods which are developed by our joint activities. One is the damage cost calculation method of assessing the trade-off between power failure risk and environmental impacts. Second is quantifying method of the environmental impact by organic chemicals included in insu-

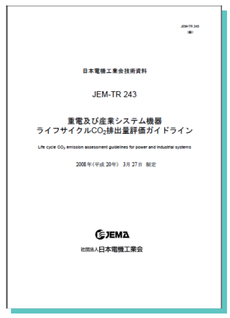
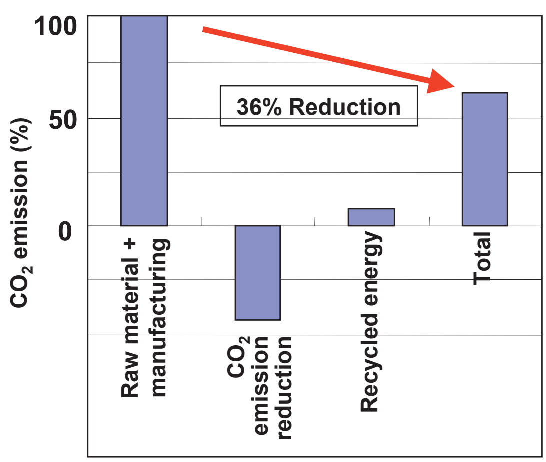


Figure 6 JEMA Guideline (March, 2008)

■ CO_2 reduction of power generator by recycling



Source: ICEE2006 DA1-09

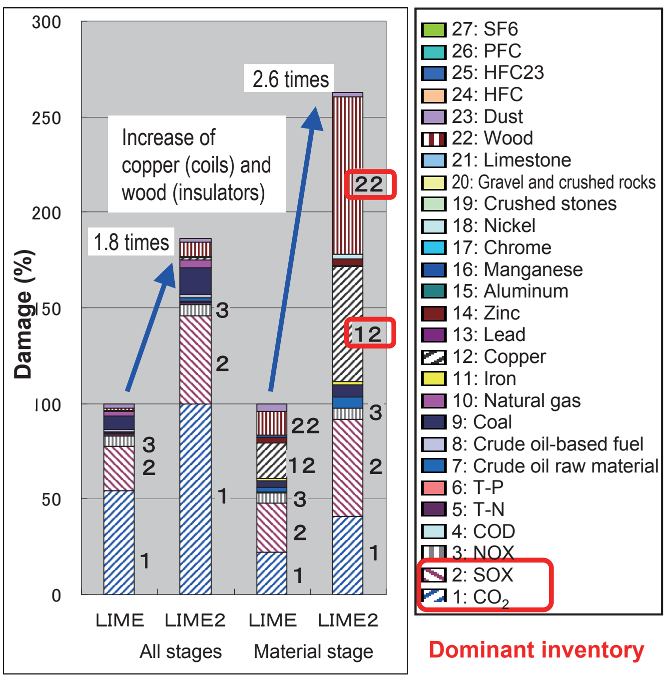
■ Calculation of standard unit for electronic circuit boards for protection relays

(g-CO_2/g)

Standard board A (highly integrated active board)	350
Standard board B (active board)	150
Standard board C (passive board)	80

Source: Proc. 2008 Annual Meeting IEEJ, 6-299

■ Damage comparison of transformer by LIME and LIME2



Source: Proc. 2009 Annual Meeting IEEJ, 6-322

Figure 5 Example of disclosed case studies

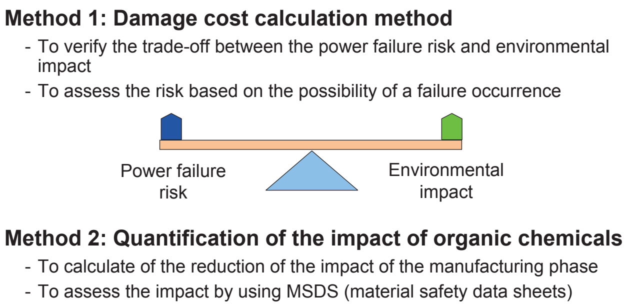


Figure 7 Outline of two methods

lators by using MSDS (material safety data sheets) information.[(11)-(14)]

4. Conclusion

In addition to conventional LCA, to conducting a wide variety of assessments such as reliability assessment and safety assessment are required in the field of power systems. Aiming for realization of a 'people lead richer lifestyles in harmony with the Earth,' Toshiba will deliberate to further reduce environmental impact and also to create new value.

In conclusion, we would like to take this opportunity to express our gratitude to internal as well as external organizations and individuals who provided us with support and advice to accomplish our LCA studies.

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Case Example

Activities of the Snack PCR-WG: Hoping for Dissemination of the Concept of CFP

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We, Calbee Foods, joined the Carbon Footprint Practical Application and Dissemination Promotion Study Group (pilot project) in July, 2008. At Eco-Products 2008, with the support of the study group organizer, we exhibited our products with the Carbon Footprint Symbol attached. The exhibition hosted a wide variety of eco events by various organizations, and conducted consumer purchase surveys and trial sales at shops. By participating in the FY2008 pilot project, we gained an understanding of product environmental burdens in terms of life cycle processes and also learned which processes we should focus on in order to implement appropriate environmental burden reduction measures. Through the consumer purchase surveys and trial sales at shops, we found that, although environmentally conscious consumers were increasing, there were still many consumer comments on CO_2 emission data indicated on products from the perspectives of user friendliness, reliability, and reasons for product purchase. This led us to the realization that it was our mission to not only reduce environmental burdens through corporate activities, but also to participate in dissemination activities so that, through the use of products, people would become more environmentally conscious. For this reason, we also participated in the pilot project in FY2009.

We participated in the project by ourselves in FY2008, but in FY2009, the project was conducted in a working group (WG) style. In the snack section, we served as a contact point in advertising for participants. As a result, snack manufacturers such as KAMEDA SEIKA, KANRO, and Nestle Japan, and distributors such as AEON and KOKUBU responded and so the snack WG started with a total of six companies.

Before publicly soliciting for participating companies, we assumed that only snack manufacturers would respond. However, owing to the participation of the retailer AEON and food and alcohol beverage wholesaler KOKUBU, we were able to aim for higher accuracy in our calculations such as calculation of environmental burdens during retailing and environmental burdens in product transportation processes from wholesalers to retailers based on actual data. Note that the latter was not included in the scope of assessment in the previous year since we had no access to such data.

A meeting was held once a month and we took turns providing the venue. Holding a regular meeting allowed us to confirm at the end of each meeting the tasks to be completed by the next meeting and specific deadlines for each task. Also, by taking turns hosting the meeting, we were able to listen to the opening remarks by the top management of the hosting company, and this provided us with a better understanding of the company's environmental issues, activities addressing these issues, and corporate history, values, and culture.

In the actual work to establish Product Category Rules (PCRs), however, we encountered a difficult challenge in "1. Scope of Application: Definition of Subject Products."

According to the organizer, an upsurge of PCRs should be avoided and they should be applicable to products of similar categories. Meanwhile, the industry group wanted to establish PCRs, each of which would be applied to a specific target product. There were many comments and opinions regarding this issue, and we believe that our exchange was highly meaningful. In the end, we choose PCRs for specific target products based on our conclusion that establishment of many PCRs was important for the time being and that we should start discussing aggregation of them as the number of carbon footprint system certified products (CFP products) increased. It should be noted that the participating companies had to spend a large number of man-hours to reach to this conclusion. We hope that the organizer will establish systems or rules on product definitions to be applied in CFP system trial operation and PCR establishment.

Our first intention was to establish one PCR for all snacks. More specifically, we planned to categorize the raw material procurement process by main ingredients for calculation purposes and to consider other processes that were common to all snacks. We planned this method perhaps because, as a result of the six-party discussions, we wanted to have one PCR for all. However, categorization within the procurement process was not approved and consequently PCRs were established for each product of each manufacturer. The organizer did take our efforts into consideration however and added a PCR for all snacks for all six companies to the list of product-specific PCRs for each company in the PCR Draft Creation Program Registered Item List. We believe this shows the record of our joint effort to have our products CFP system certified.

In the previous paragraphs, we mentioned the PCRs for specific products. When we established these PCRs, we always investigated whether the same PCRs could be applied when different manufacturers created products that could be defined as the same products. As a result, these PCRs incorporated scenarios that would not necessarily be applied to us.

In the future, an examination will have to be made as to whether or not these considerations were necessary in the PCRs for specific products.

For actual calculation using the PCRs, it is important to increase the volume of secondary data available and maintain the currently existing data because the organizer promptly supplied us with the secondary data we requested but later it was pointed out by the PCR committee for certifying PCR-based calculation results that secondary data with higher accuracy actually existed.

In the pilot project in FY2008, we were the only snack manufacturer. However, the number increased to four in FY2009. Because it was a pilot program, the participating companies, government, and organizer all had to share a lot of the burden in completing each task.

The 3rd year of the pilot project starts in FY2010. In order to disseminate the CFP system, the following is essential: ① establishment and standardization of the system, ② changes in environmental awareness for both companies and general consumers, and ③ development of new technologies and implementation of environment improvement measures. In order to bring about a sustainable society, we would like many companies to participate in the project.

Case Example

Establishment of PCR for Publishing & Commercial Printing (work in process) in the Printing Industry

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1. Introduction

The printing industries proactively conduct environmental conservation activities to fulfill their social responsibilities. More specifically, they ensure compliance with laws and regulations concerning environmental conservation, establish and conform to voluntary industry standards, give awards to excellent environment-conscious factories, and establish green printing certification programs. Among worsening environmental issues, global warming is recognized as the most important one for the printing industries; therefore, they establish and reinforce their voluntary action plans.

Since printing is utilized for many products, the printing industry needed to establish a Product Category Rule (PCR) for calculating the carbon footprint of products (CFP). CFP indications on clients' products such as books, catalogs and so on are required, so that printing companies have to present the greenhouse gas (GHG) emission from printing. Among various printing products, "Publishing & Commercial Printing (work in process)" is selected to establish PCR as it is one of major printing product and also the printing process used is conventional and standardized. This PCR was approved by the PCR committee on November 10, 2009.

2. WG activities in PCR establishment for Publishing & Commercial Printing

The CFP Pilot Program (the Carbon Footprint Calculation and Labeling Pilot Program, Implement trial introduction to the market) was launched in April 2009, and METI had started to accept applications for the registration of draft PCR development plans from June 1, 2009. Japan Federation of Printing Industries (JFPI) applied the registration for publishing & commercial printing on June 3, 2009. WG members were 9 companies and one organization in total: JFPI, five printing companies, two printing plate manufactures, one company that places printing orders, and one software company related with printing. Also, as observers, one printing-related organization, three printing companies, and one printing machine manufacture participated. So, a total of 13 companies and two organizations worked on establishing this PCR.

Table 1 shows WG activities. The WG had meetings 12 times before the draft PCR was submitted to the PCR committee. At the first meeting, members introduced themselves and discussed the future direction of WG activities. Although there was no consultant in the WG, eight out of the 13 companies had LCA experiences in the past. Members and observers worked in union, and had to carry out each one's assignments. From the second meeting through the fourth, we discussed matters based on the draft PCR provided by WG secretariats and collected required technical information. Aside from these meetings, members visited a plate making factory, a printing factory, a laminating/coating processing factory and a book binding factory to study production process stages. Additionally, since one of our WG members was also working in Pre-Sensitized plates for lithographic printing (PS plate) PCR WG, we were kept informed

WG	Description
1st meeting	• Self introductions and presentations by participating companies • Briefing on the direction of the WG activities and discussion on the overall concept of PCR [Assignment] • Submit questions to the WG office (members)
2nd meeting	• Provision and description of the rough PCR plan by the WG office, and discussion and identification of issues regarding that plan • Description and discussion on EcoLeaf information regarding the raw material called PS plate [Assignment] • Submit written proposals and comments to the WG office (members)
3rd meeting	• Discussion of the life cycle flow chart and identification of issues thereof • Correction based on the issues raised regarding the rough PCR plan [Assignment] • Estimation using the flow chart (those who have past LCA experience) • Study on raw materials and their compositions to collect secondary data (WG office)
4th meeting	• Presentation on gravure printing that the members are not familiar with • Report and discussion on the progress of the PS plate WG [Assignment] • Add information in the secondary data collection chart (members) • Create scenarios for estimation (WG office)
5th meeting	• Discussion of the study results for raw materials and their compositions to collect secondary data • Discussion and correction of the rough PCR plans for raw materials • Proposition and discussion of the scenarios and estimate charts [Assignment] • Investigate which activities are required in obtaining an estimate for pamphlets (members)
6th meeting	• Discussion of both activities and secondary data required for obtaining estimates • Presentation and discussion of secondary data required for obtaining estimates [Assignment] • Study activities in order to obtain estimates for pamphlets and catalogs (members) • Review the scenarios for obtaining estimates (WG office)
7th meeting	• Inputting in the estimate charts the number of activities for pamphlets and catalogs and discussion regarding the inputted data [Assignment] • Study of activities for monthly magazines and books (members) • Create a scenario for obtaining estimates for calendars (WG office)
8th meeting	• Inputting in the estimate charts activities for monthly magazines and books • Discussion and correction of a scenario for obtaining estimates for calendars [Assignment] • Study of activities for calendars (members) • Organize the information inputted in the estimate charts (WG office)
9th meeting	• Discussion of the items to be excluded • Discussion and correction of the rough PCR plan [Assignment] • Create the "Terminology and Definition" (members) • Create a draft PCR to be filed for certification (WG office)
10th meeting	• Read-through of the draft PCR
11th meeting	• Making replies to comments and discussion of correction of the draft PCR • Report and discussion of the progress of the PS plate WG
12th meeting	• Discussion of correction of the draft PCR based on the result of the PCR interview

Table 1 WG activities for establishing the PCR for publishing & commercial printing

2. Entry of raw material acquisition stage data and calculation results

Amount of raw materials used Collected by WG members as primary data

Secondary data for estimation

GHG (or CO_2) emission ratio Indicated in %

Weight ratio Indicated in %

		Primary data (activity) W			Secondary data (emission factor) a			GHG (kg)	CO_2 emission ratio	Additional information	Activity converted to weight (kg)	Weight ratio
Operation	Process	Item	Composition (unit)	Value	Item	Value	Unit	(=a x W)		Source of the secondary data		
Prepress	DTP	Paper (printout for proofing)	OA paper (kg)	0.21	Recycled high-quality paper	1.17E+00	kg-CO_2/kg	2.46E-01	0.05%	Japan Paper Association 2006	0.21	0.06%
		Printer toner	Polyester resin 85% + pigment 15% (kg)	0.01	PET resin	2.90E+00	kg-CO_2eq/kg	2.90E-02	0.01%	Tentative CFP2008	0.01	0.00%
	Press plate	CTP plate	Aluminum plate (m^2)	19.11	Aluminum plate	1.23E+01	kg-CO_2/m^2	2.35E+02	44.04%	PSWG estimate	12.38	3.63%
		Paper (printout for proofing)	(kg)	10.00	High-class coated paper (A2)	9.19E-01	kg-CO_2/kg	9.19E+00	1.72%	Japan Paper Association 2006	10.00	2.93%
		Ink for proofing	(kg)	0.10	Offset ink	2.67E+00	kg-CO_2/kg	2.67E-01	0.05%	Japan Printing Ink Makers Association	0.10	0.03%
	Subtotal			22.70				2.35E+02	44.09%		22.70	6.65%
Printing	Printing	High-class coated paper (A2)	(kg)	314.50	High-class coated paper (A2)	9.19E-01	kg-CO_2/kg	2.89E+02	54.16%	Japan Paper Association 2006	314.50	92.17%
		Lithographic ink	(kg)	3.28	Offset ink	2.67E+00	kg-CO_2/kg	8.75E+00	1.64%	Japan Printing Ink Makers Association	3.28	0.96%
		Cleanser	(kg)	0.03	Kerosene	2.50E+00	kg-CO_2/kg	7.00E-02	0.01%	Ministry of the Environment	0.03	0.01%
		Dampening water	IPA solution (kg)	0.14	IPA solution	2.00E+00	kg-CO_2/kg	2.80E-01	0.05%	Estimate by Fujifilm	0.14	0.04%
		Powder	100% cornstarch (kg)	0.08	100% cornstarch	1.42E-01	kg-CO_2/kg	1.19E-02	0.00%	Toshiba DB	0.08	0.02%
		Wiping rag	Cotton, polyester, and so on (kg)	0.06	Recycled wiping rag	9.00E-03	kg-CO_2/kg	5.04E-04	0.00%	Ministry of Economy, Trade and Industry	0.06	0.02%
	Subtotal			318.08				2.98E+02	55.87%		318.08	93.22%
Cutting and binding	Binding and finishing	Wire	Iron or stainless (kg)	0.17	Reinforced steel	4.31E-01	kg-CO_2/kg	7.15E-02	0.01%	Forum	0.17	0.05%
	Subtotal			0.17				7.15E-02	0.01%		0.17	0.05%
Packaging	Packaging	PP band	100% PP (kg)	0.25	PP band	3.85E-01	kg-GHG/kg	9.63E-02	0.02%	Plastic Waste Management Institute	0.25	0.07%
		Kraft paper	(kg)	0.01	Material for Kraft paper bag	2.55E+00	kg-CO_2/kg	3.06E-02	0.01%	Chemical Economy Research Institute	0.01	0.00%
	Subtotal			0.26				1.27E-01	0.02%		0.26	0.08%
						Total GHG		5.34E+02	100.00%		341.22	100.00%

Collected data

GHG (or CO_2) emission estimate

Figure 1 Example GHG emission estimate chart for publishing & commercial printing

about PS plate PCR establishment and could align two WGs. From the fifth meeting through eighth, we were engaged in activities concerning the calculation of GHG emissions. We collected secondary data, and prepared scenarios (pamphlets, catalogs, magazines, books, and calendars) and the calculation chart, and then carried out calculation. Figure 1 shows a part of the calculation a trial chart example. As GHG emissions of printed materials depended heavily on the volume of productions, we conducted calculations with different production volumes. At the ninth and tenth meeting, raw materials which should be cut off were decided according to the calculation results, and the draft PCR was formulated for the application to be certificated. At the eleventh and twelfth meetings, we solicited comments on the draft PCR and examined issues raised during the interview-style review of that. The draft PCR was amended and completed to be submitted to the PCR committee.

3. Details of the PCR for publishing & commercial printing (work in process)

3-1 Scope

In order to make it clear that publishing & commercial printings are B2B products, the expression 'work in process' was added to the article title. This is because the printing industries can be involved directly up to production stage only and thus the scope is defined as work in process (B2B products). This PCR consisted of the raw material acquisition stage and the production stages as shown in Figure 2.

3-2 Characteristics of the PCR for publishing & commercial printing (work in process)

As printing industries consist mainly of small and medium sized companies, we took into consideration of following points so that the GHG calculation method to be practical for their usage.

① Cut-off criteria

According to the above mentioned calculation results, eight kinds of raw materials accounting for 0.1% or less of the total GHG emission were cut-off. Since these raw materials were excluded from the GHG emission calculation for this study the overall calculation burdens would be reduced. Note that the total GHG emission rations of these eight raw materials was up to 1%, the calculated GHG emission after cut-off was divided by 0.99 (99%) to make it 100%.

② Facilitation of data collection

In the PCR we described the details how to allocate consumption electric power of each piece of equipment when it is difficult to actually measure. For this, we showed in the PCR the process-specific factors that represented physical volumes to be allocated. In the printing process, for example, the number of pages to be printed, volume of pro-

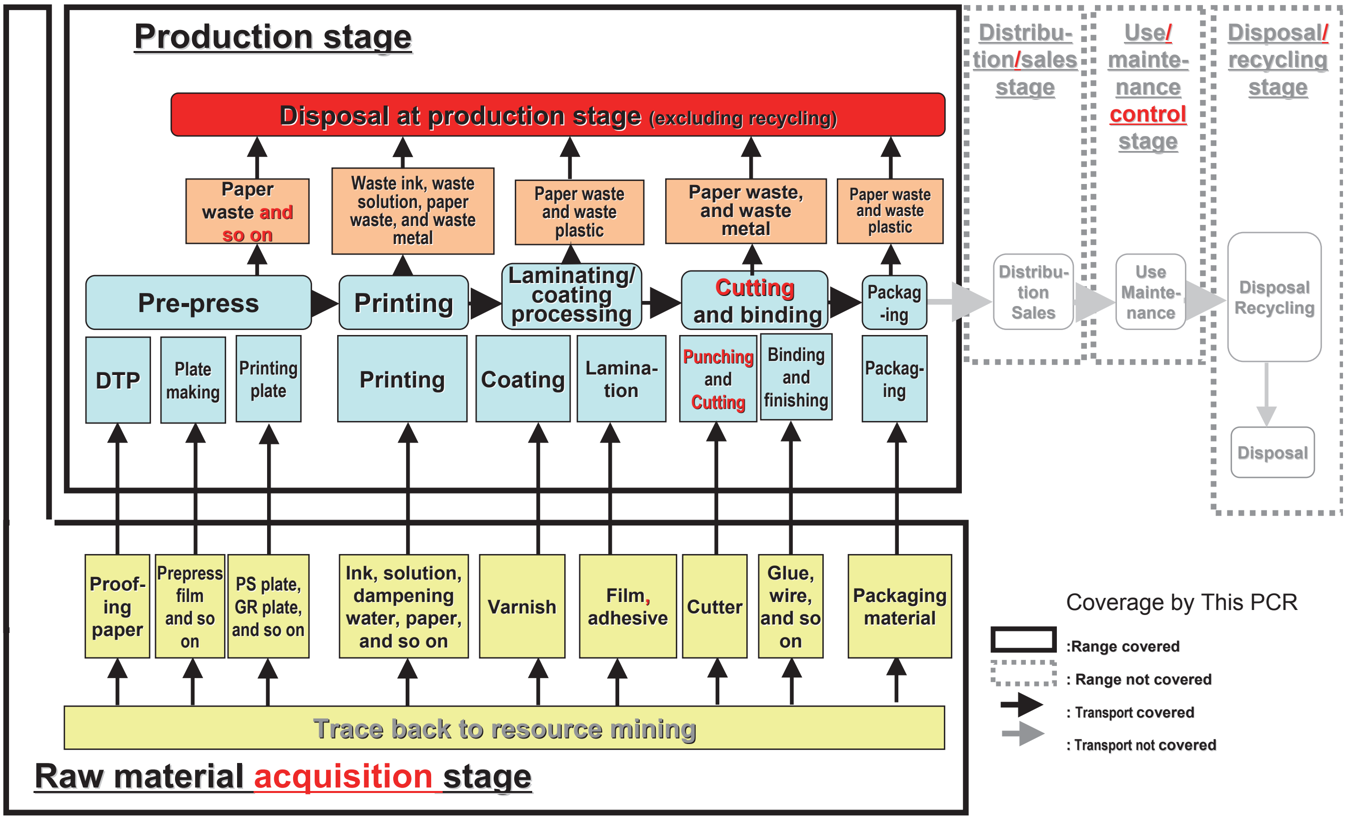

Figure 2 Life cycle flow chart

duction by a printing machine, and the weight of printed materials were defined. As the use of rated consumption electric power of equipment was approved, GHG emission can be calculated by knowing how many hours equipment are operating.

③ Collection of secondary data

Not many types of emission factor for PCR have been disclosed today. Therefore, those who calculate GHG emissions need to collect more secondary data. As a reference to search them, 'Alternate secondary data' including 47 types of raw materials were listed in the PCR appendix. Table 2 shows some examples of alternate secondary data. In this table, the items under 'Secondary Data Name' for which the Source is 'Unspecified' are alternate secondary data.

D.2 Life cycle GHG emission for supply of raw materials

Materials used	Secondary Data Name	Unit	Source
Paper for proof output	Recycled high-quality paper	kg	Unspecified (*2)
Prepress film	PET film	kg	Unspecified (*2)
Developer	Sodium hydroxide	kg	CFP emission factor DB (*1)
Fixer	Sulfuric acid (distributed in Japan)	kg	CFP emission factor DB (*1)
PS plate	PS plate	m^2	Unspecified (*2)
Developer for PS plate	Sodium hydroxide	kg	CFP emission factor DB (*1)
Rubber solution	Natural rubber	kg	Unspecified (*2)

Table 2 Secondary data and alternate secondary data

4. Issue

4-1 Issue in GHG emission indication

This PCR states that GHG emission must be indicated for each sales unit (delivery unit). This means that GHG emission must be verified for each production lot. The practical CFP issue is how GHG emission should be calculated and verified for products with a short lead time such as weekly magazines and reprinted books.

4-2 Overseas trend

CFP has been progressively standardized by ISO/TC 207/SC7 to be released in 2011. Meanwhile, at the ISO/TC130 (Graphic Technology) meeting held in September 2009, British participants proposed to provide a standard methodology for CFP calculation of printed media; it has been decided to examine the proposal for the establishment of a task force. Aside from that, the German Printing and Media Industries Federation (Bundesverbandes Druck und Medien, or bvdm) provided "CO_2 Rechner," which was a CO_2 emission calculator. Prior to establishment of international standards for CFP, international discussions are about to be initiated to determine how CFP of printed products should be calculated.

5. Future

Currently, a PS plate for lithographic printing has been approved as a raw material to be included in the PCR for publishing & commercial printing (work in process), draft PCR development plans for paper/paperboard and for lithographic ink have been registered, and draft PCR development plans for other raw materials are ready to be applied for registration. As described above, the PCR for upstream printing processes have been improved, yet the PCR for the downstream processes such as end consumer products has not been approved or registered. However we believe that it will become a common practice in the future, after the concept of CFP is disseminated. PCR for books, magazines and catalogs which referenced the PCR for publishing & commercial printing (work in process) will be approved, and the CFP label will be indicated on those products.

To meet the requirements of society, Japan Federation of Printing Industries is now preparing the GHG Emission Calculation Manual consistent with the PCR for publishing & commercial printing (work in process). The objective of this manual is to encourage small and medium sized enterprises to conduct GHG emission calculation. Through advanced approaches to CFP, the printing industries will carry out various activities contributing to the realization of a low-carbon society, reducing GHG emissions, contributing to the reduction of GHG emission in relevant industries where supply chains are involved, and encouraging consumers to reduce GHG emissions.

Case Example

Approach to the Carbon Footprint System by Fujifilm
- Important Points in PCR Creation for a PS Plate for Lithographic Printing -

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Graphic System Department
Fujifilm Corporation

1. Introduction

Under our green policy of "achieving customer satisfaction and contributing to sustainable development by realizing high environmental quality in products, services, and corporate activities,", one of our priorities is "the effective use of resources" through the promotion of Design for Enviroment. Through life cycle assessment (LCA), Fujifilm has analyzed environmental loads related to global warming attributable to the entire corporate group. In contrast to the products of home appliance manufacturers and car manufacturers, which themselves emit considerable CO_2 emissions during the product use stage, Fujifilm product CO_2 emissions are generated mostly in their raw materials Acquisition stage. A survey of our products revealed that the aluminum used to manufacture "PS plates for lithographic printing" (referred to hereafter simply as PS plates)*1 accounts for the majority of our CO_2 emissions. The effective use of PS plate aluminum could therefore contribute significantly to reduction of CO_2 emissions (Figure 1).

In this regard, the visualization of CO_2 emissions of products can help in the development of eco-friendly designs and point to areas key to reducing CO_2 emissions. To this end, Fujifilm, an early participant in the 2009 Carbon Footprint Calculation and Labeling Pilot Project sponsored by the Ministry of Economy, Trade and Industry, created the product category rule (PCR) for PS plates.

*1) A PS plate is a flat plate on which image areas are made lipophilic and non-image areas made hydrophilic and oil repellant. Ink, which is oil-based, then adheres only to images areas. The plate is then impressed onto paper, like a seal, to transfer the image to the paper.

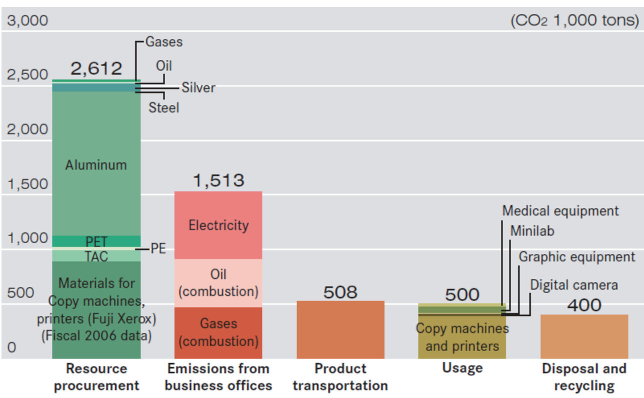

Figure 1 Overall CO_2 emissions by the Fujifilm group (FY2007)[1]

2. Important Points in PCR Creation

2-1 PCR Covered Product

While a variety of materials are used as the support of a PS plate, this PCR covers only PS plates manufactured with aluminum.

2-2 Intermediate Goods and End-User Consumables

A PS plate is an intermediate good in the production of printed matter. It contributes to the load allocation of such production's raw materials Acquisition and production stages. It is also, for printing companies, an end-user consumable (for businesses). For this reason, this PCR covers the entire life cycle of a PS plate.

Covering the entire life cycle, and therefore "visualizing" the entire life cycle, also encourages PS plate producer responsibility in making efforts to reduce CO_2 emissions. When PS plates are treated as an intermediate good for printed matter production, printed matter producers are seen as responsible for CO_2 emissions in the PS plate's distribution/sales, use/maintenance control, and disposal and recycling stages, all of which are actually in common with the production stage of printed matter. But this makes it difficult to recognize some of the efforts of PS plate producers to reduce CO_2 emissions. The effects of their CO_2 reduction activities, such as the development of plates requiring less energy to image and less or no developer to process, which appear in the use/maintenance control stage, and the effects of the method of recycling employed in the disposal and recycling stage, do not show up in the labeling meant to indicate a low carbon footprint.

As described above, different products in a supply chain may share parts of their life cycles. It is therefore necessary to have visualizations of CO_2 emissions reduction resulting from producer designs and from product use by the consumer. So if the life cycle process is one for which both can bear responsibility, each should assess the entire life cycle without one or the other cutting of stages at the intermediate goods border.

Note that when inter-relating PCRs within a supply chain, it is necessary to clearly indicate which parts of a PCR overlap those of a different PCR. Therefore, in the preface, we illustrated relationships with PCRs for 'publishing & commercial printing' and for 'Paper Containers, Packaging and Wrapping' (Figure 2).

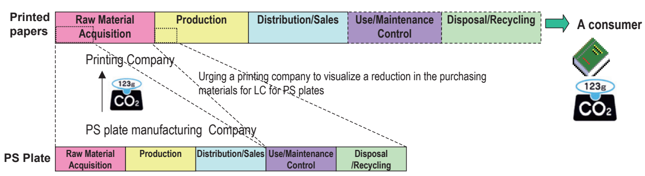

Figure 2 Relationship between printed matter LC and PS plate LC

2-3 Reduction of CO_2 Emissions in the Raw Materials Acquisition Stage

1) Characteristics of aluminum as a raw material

A PS plate is mostly aluminum, a material that requires a large volume of electricity to refine it from bauxite. To obtain 1 kg of new metal generates CO_2 emissions of 9.22 kg-CO_2 e/kg. This value for 1 kg of regenerated metal, however, is only 0.31 kg-CO_2 e/kg, approximately 3% of that of new metal.[2] Aluminum regeneration can therefore greatly contribute to reductions of CO_2 emissions.

Another characteristic of aluminum is that once trace metals are added to produce an alloy, they cannot be removed to restore the aluminum to a high state of purity.

2) Characteristics of a PS plate

The product characteristics of a PS plate are as follows. First, because plates are cut before shipment to the dimensions required by customer printing presses, a large volume of cutting waste is produced. Second, a PS plate requires aluminum of a purity of 99.5% or higher to maintain quality.

3) Reduction of aluminum-generated environmental load

For the reasons discussed above, recycling of PS plates while maintaining its purity, a process called "closed loop recycling," is essential to reducing CO_2 emissions. Fujifilm therefore established the world's first closed loop recycling technology and has started recycling of the large volumes of cutting waste back into PS plates (Figure 3).

In accordance with *Carbon Footprint Scheme Guideline*, issued by the Ministry of Economy, Trade and Industry, we determined that in this PCR, aluminum recycled in closed loop recycling would be included in the raw materials Acquisition stage as regenerated metal. Therefore, as the use of regenerated metal increases, the amount of new metal, which generates much CO_2, decreases, yielding significant reductions in CO_2 emissions in the raw materials Acquisition stage.

2-4 Production Stage

Primary data for the amount of energy used and the amount of waste produced in the production stage is to be collected.

2-5 Distribution/Sales Stage

For this stage, we have created a logistics scenario for product distribution throughout the country. Primary or secondary data is to be collected.

2-6 Use/Maintenance Management Stage

We have created a scenario of the conditions of product use. Primary data for when the plates are used according to manufacturer recommended settings (as determined by plate characteristics) at the scenario conditions is to be collected. Processing solution and waste reductions resulting from PS plate producer development efforts can be expected here.

2-7 Handling of the Disposal/Recycling Stage

Currently, because used PS plates are recycled by the cascade recycling method (Figure 4) into different products (such as car parts) with lowered purity, the environmental load for the disposal/recycling stage is not allocated. PS plate packaging materials will not be allocated either because they are recycled as paper materials. The environmental loads incurred in the cascade recycling of these materials will be included in the raw materials stage of other products.

Similarly, the closed loop recycling started by Fujifilm to recycle waste PS plates into PS plates has no input into the disposal/recycling stage. Instead, the environmental load of this recycling method will be included in the raw materials Acquisition stage for PS plates as discussed above in 2-3 Reduction of CO_2 Emission in the Raw Materials Acquisition Stage.

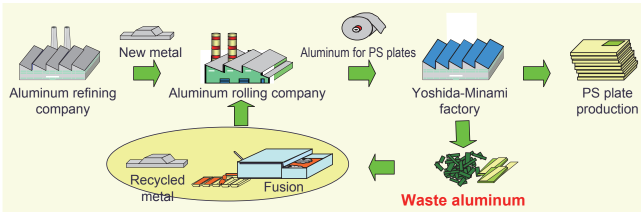

Figure 3 Closed loop recycling of cutting waste

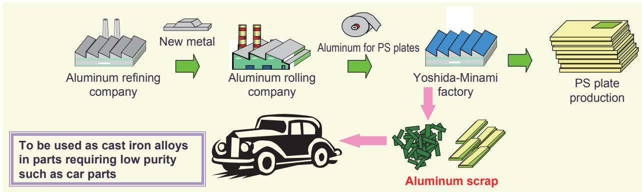

Figure 4 Conventional cutting waste recycling (cascade recycling)

2-8 Display of Additional Information

Additional information that may be displayed includes: ① indication per unit (per m^2), ② rate of reduction compared to previous products, ③ values for each process, ④ regenerated aluminum percentage, ⑤ information on closed loop recycling, ⑥ GHG emissions of similar products, and ⑦ information and remarks regarding product thickness.

Such information can show the relationships between CO_2 emissions and PS plate size in terms of numerous types, thicknesses, and dimensions. In particular, displaying the values for each process will show that CO_2 emissions are high in the raw materials stage.

Furthermore, we have made it possible to indicate CO_2 emissions when closed loop recycling is and is not employed by PS plate users.

3. Summary

Although it has been reported that used PS plates are 100% recycled[3], most of this is by the cascade recycling method. Because aluminum with reduced purity can no longer be used as PS plate material, recycling PS plates into PS plates will be crucial to the reduction of CO_2 emissions and effective use of resources.

The carbon footprint system makes available information that PS plate consumers (printing companies) can use to make choices regarding use and disposal and recycling that will lead to PS plate-generated reductions in CO_2 emissions. The end result is that these consumers will be able to use low CO_2 PS plates. We expect that such a mechanism will play an effective part in promoting closed loop recycling, thus contributing greatly to reducing the CO_2 emissions of printed matter produced using PS plates.

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Case Example

Approach to the Carbon Footprint System by the Stationery Industry
- Establishment of a Pilot PCR -

Akihiro Oonuma
Executive Director
All Japan Stationery Association

[Introduction]

Agreeing with the objective of the carbon footprint system that "through visualization of CO_2 emission, businesses aim for reduction of CO_2 emission, and consumers aim for low carbon life," the All Japan Stationery Association has developed product category rules (PCRs) for calculating the carbon footprint (CFP).

We would like to take this opportunity to report out pilot PCRs for files and binders, and pens and pencils that the industry developed and were approved by the PCR Committee last year.

[Characteristics of the Stationery Industry]

Major examples of characteristics of the stationery industry are changes in modes of distribution and shortening of product life cycles. Modes of distribution have shifted from storefront sales to mail-order sales (direct delivery). Including direct delivery to public offices and large companies, the ratio between storefront sales and direct delivery in overall stationery sales ranges from 30:70 to 40:60. Such changes in modes of distribution have been taken into account as an important factor when creating scenarios of the sales process. Shortening of product cycles has posed an issue of how fast can display of the CFP symbol keep up with release of new products or products with new specifications. In order to resolve this issue, we have conducted CFP calculation based on design and actual measurement values.

[Establishment of the Working Group (WG)]

We started examining how to conform to the carbon foot print system when the basic system rules were announced by the Ministry of Economy, Trade and Industry in March, 2008. In order to create PCRs that incorporate the ideas and intentions of the entire industry, we concluded that we, as a national stationery producer, should actively take part in it. For this reason, we collaborated with KOKUYO S&T and Shachihata, who had already applied for the FY2008 Voluntary WG Support Project for Pilot PCR Creation and established a voluntary WG. Soon after, SAKURA COLOR PRODUCTS, KING JIM, Sun-Star Stationery, PLUS Stationery, and LION OFFICE PRODUCTS joined the WG. As a result, a total of seven companies and one organization together launched a WG. The number of types of stationery items produced by these seven participating companies was estimated to account for more than 90% of all types of stationery items. We started to create pilot PCRs assuming that all types of stationery items other than paper products (PCRs for notebooks and envelopes were established by the All Japan Paper Product Association) were covered by these companies.

PCR number	PCR title	Target product categories	Example of target products
PA-AS-01	Pens and pencils	Pens, pencils, and their refills defined based on the Standard Commodity Classification for Japan established by the Statistics Bureau of the Ministry of Internal Affairs and Communications	Ballpoint pens, marking pens, mechanical pencils, fountain pens, pencils, and other types of pens and pencils
PA-AR-01	Files and binders	Files, binders, and their refills defined by the File Binder Association	Ring binders, MP binders, flat files, pipe files, box files, clear files, and folders
PPR-011	Plastic stationery items	Stationery items whose main ingredient is plastic (accounting for 50% of the product weight or more)	Tape glues, whiteout tapes, card cases, plastic rulers, trays, and name tags
PPR-012	Metal stationery items	Stationery items whose main ingredient is metal (accounting for 50% of the product weight or more)	Paper clips, binder clips, paper punches, staplers, and scissors
PPR-009	Other types of stationery items	All stationery items defined by the Association that do not fall into the four categories above	Seals, glues, erasers, adhesive tapes, chalks, paints, and Chinese ink

[Note] The PCRs for the product categories 'pens and pencils' and 'files and binders' were approved as of December 24, 2009.

Figure 1 List of PCR by stationery type

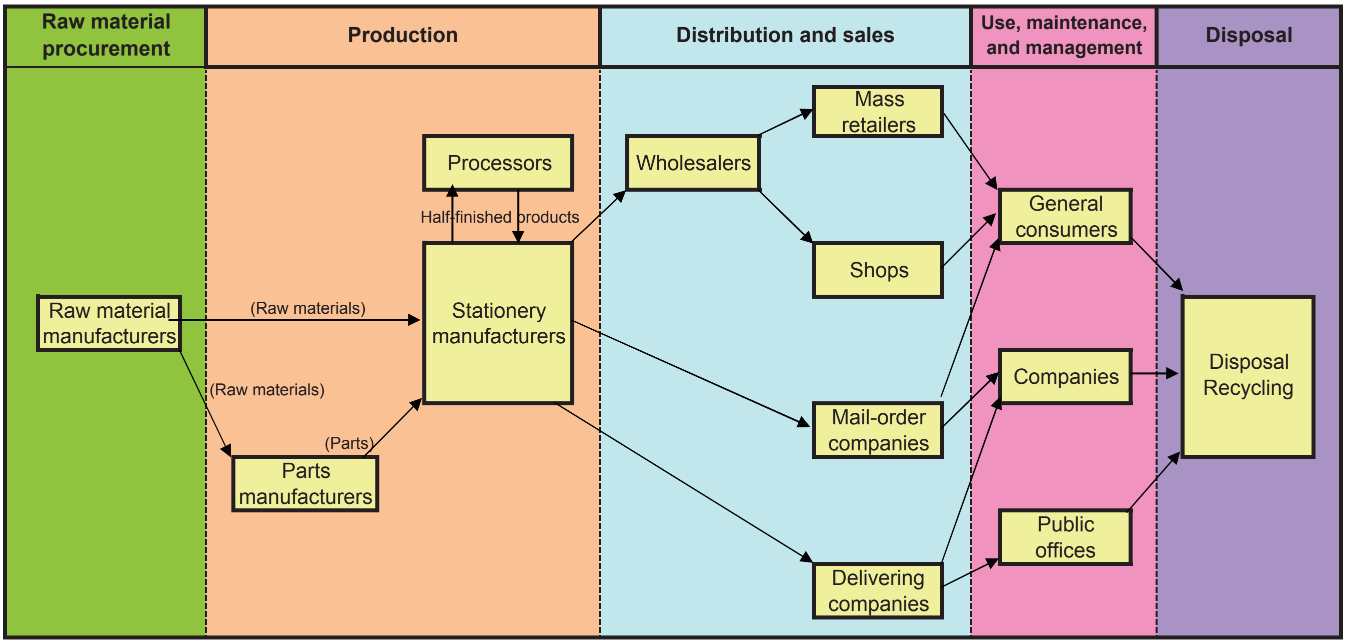


Figure 2 Modes of stationery distribution

[Important Points in PCR Creation]

During the course of creating pilot PCRs for files and binders, and pens and pencils, we identified the following as important points. We then carefully discussed them a number of times and created the PCRs. Because we obtained help from the Draft PCR Creation Support Project, we were able to receive a lot of advice and information from consultants.

(1) Categorization of product types

When categorizing stationery items, we first planned to create individual PCRs for 'pens and pencils' and 'files and binders' because they were the best selling stationery items. For other types of stationery, we categorized them by main raw material into 'plastic stationery items,' 'metal stationery items,' and 'other types of stationery items (wood or fluid)' to create PCRs for them. However, in later discussions, we decided to integrate these three PCRs because they shared many processes from the raw material procurement to disposal. The document attached to the PCRs shows detailed information for each type.

(2) Items included in CFP calculation during the pilot project period

It was difficult to calculate CFP for all types of stationery during the pilot project period; therefore, we decided to calculate CFP for the 12 types shown in Figure 3 by March, 2010, and to display the CFP symbol on the applicable products.

(3) Examination of the life cycle flow diagram

Before creating a life cycle flow diagram we focused our examination on the 12 types for which the CFP symbol is attached to products in FY2009. Inside the flow diagram, we discussed the possibility that intermediate products (parts) would be included in the raw material procurement process if parts were procured (outsourced manufacturing) from parts manufacturers but would be included in the production process if stationery manufacturers procured raw materials by themselves to manufacture parts. We then followed the policy of the PCR Committee and included it in the production process.

PCR number	PCR title	CFP calculation and symbol display
PA-AS-01	Pens and pencils	Marking pens
PA-AR-01	Files and binders	Pipe files, flat files, clear files, folders, clear paper holders
PPR-011	Plastic stationery items	Whiteout tapes, tape glues, and card cases
PPR-012	Metal stationery items	Paper clips
PPR-009	Other types of stationery items	Self-inking rubber stamps and erasers

[Note] The PCRs for the product categories 'pens and pencils' and 'files and binders' were approved as of December 24, 2009.

Figure 3 List of products subject to CFP calculation and CFP symbol display during the pilot project (to be completed in FY2009)

(4) CFP calculation for new products

For the case where it is difficult to obtain data from the previous year because products are new, for example, we have established a rule that design values can be used as data on the amount of raw materials used and actual data obtained from similar products can be used as production equipment operation data. In the stationery industry, products cycles are short and new products are released and models numbers are changed constantly. Therefore, we need a system that allows display of the CFP symbol on products at the time of product release without having to collect one-year data in the case of new products or products with revised specifications. Note, however, if data collected in the previous year is not used for a particular product, we need to provide the reason in writing, guarantee data validity if the data is not from the previous year, and submit the actual data for verification when updating the CFP value.

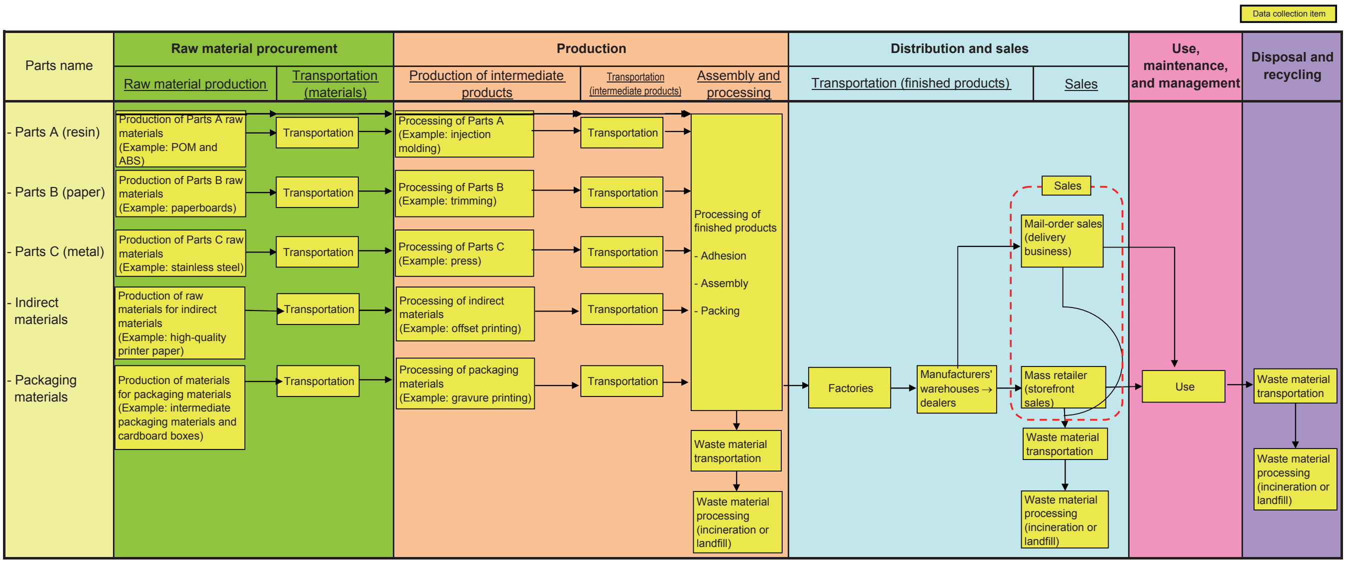


Figure 4 Life cycle flow diagram (basic image)

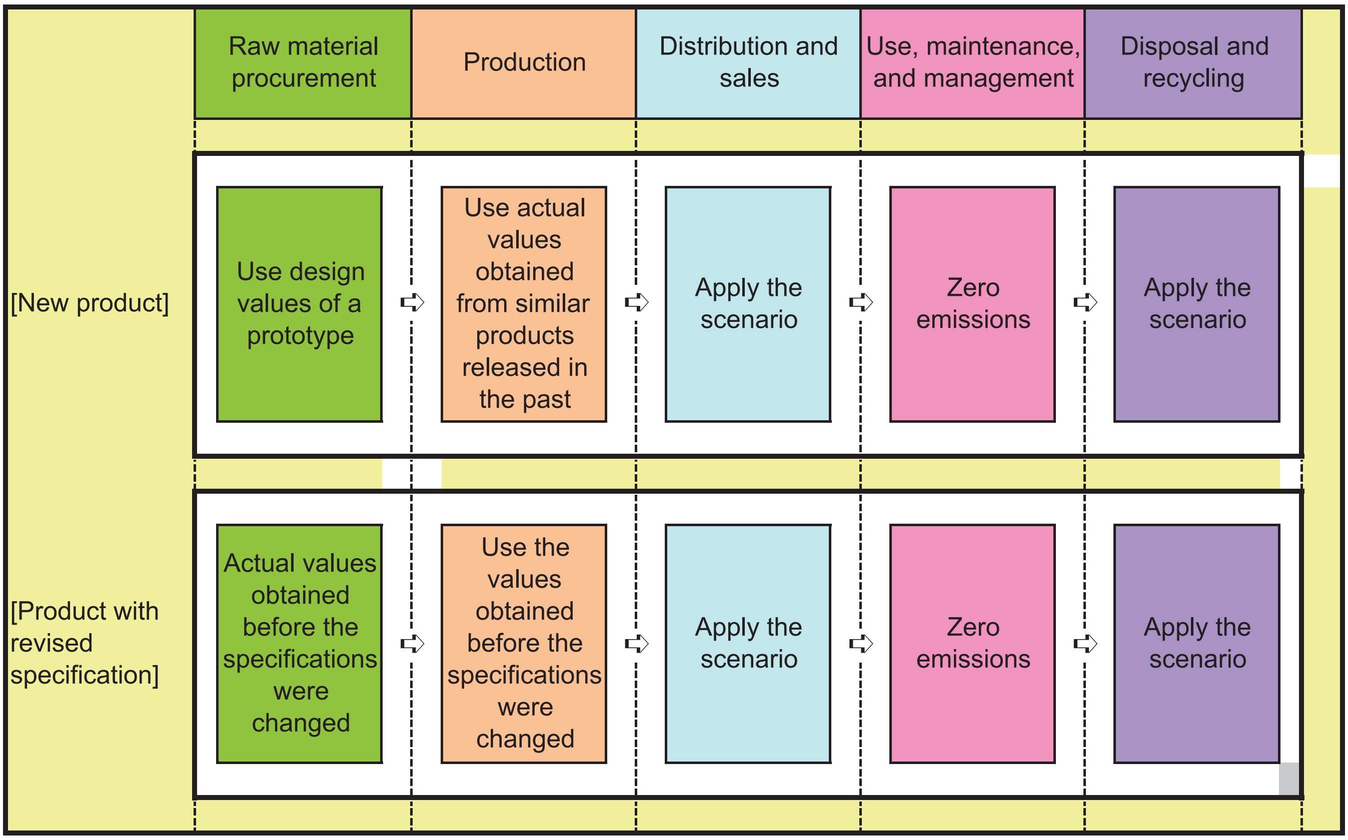


Figure 5 Image of design values and actual values

(5) Secondary data

In the PCRs, it is recommended that primary data be collected in each process. However, there are cases where cooperation of external suppliers is essential for collecting data for, for example, parts manufactured by subcontractors. Therefore, assuming that there are cases where primary data cannot be collected, we examined basic units for secondary data. As required basic units, we selected 110 types of basic units that were provided in the shared basic unit database. Some of the basic units were provided as reference data from the CFP Office, and other basic units could be used if the individuals who calculated CFP clearly indicated good reasons for using these basic units and if these units were approved by the PCR committee.

(6) Creating scenarios

① Scenarios for domestic transportation

For all domestic transportation for all processes excluding the use, maintenance, and management process, we created scenarios to be used when it was difficult to collect primary data because of variable distances or loading ratios. When creating the scenario, we assumed that the transportation distance was reasonably long, the loading ratio was reasonably low, and trucks were used for transportation in order to secure incentives for collecting primary data.

② Scenarios for the sales process

Because sales process conditions are different between storefront sales and mail-order sales, we created scenarios to be used when primary data could not be collected. The scenarios were created based on the above mentioned ratios between storefront sales and mail-order sales. For each PCR, using the best selling and most popular item as a reference product, we calculated CO_2 emission per 1g of the reference product, and used the value obtained from this calculation as the CO_2 emission for 1g of any product within that sales process (secondary data). The reference product in the files and binders category was a file with a cardboard cover (997 yen, 500g), and the reference product in the pens and pencils category was an oil-based ballpoint pen (105 yen, 10g). Based on the information provided by the WG members, the ratio between mail-order sales and storefront sales was set to 70:30 for the files and binder category, and to 60:40 for the pens and pencil category.

(7) Handling of the use, maintenance, and management process

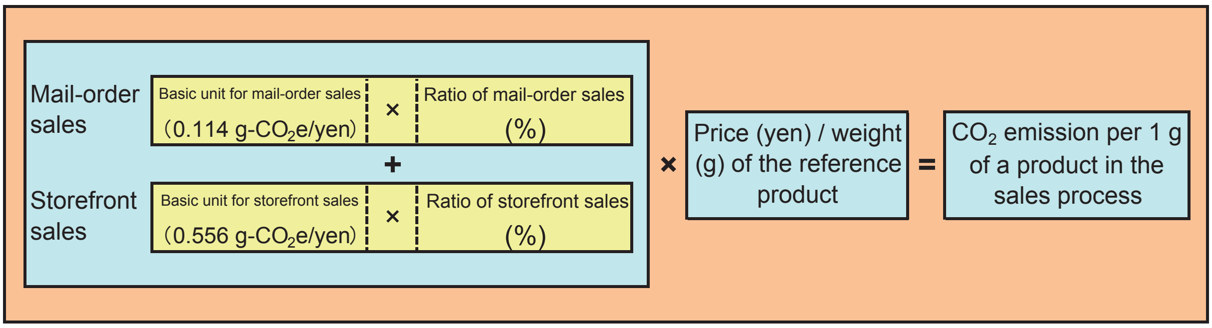
In the use, maintenance, and management process, we concluded that the CO_2 emission was zero because no electricity was required to use the products and also no maintenance such as cleaning was necessary to maintain and manage the products.

(8) Disposal of packaging materials by consumers

Packaging materials to be disposed of by consumers during the use, maintenance, and management process was regarded as being disposed of during the disposal and recycling stage in the PCRs.

Process	Scenario	Remarks
Raw material procurement	<Transportation distance> 1,000 km <Means of transportation> 4-ton truck (light oil) <Loading ratio> 50%	1. Transportation of raw materials (raw material manufacturer ⇒ intermediate product factory [finished product factory]) 2. Transportation of raw materials (domestic transportation overseas) 3. Transportation of recycled resins (waste material collector ⇒ recycled resin pellet manufacturer)
Production	<Transportation distance> 1,000 km <Means of transportation> 4-ton truck (light oil) <Loading ratio> 50% (pens and pencils) 25% (files and binders)	1. Transportation of intermediate products (intermediate product factory ⇒ finished product factory)
Distribution and sales		1. Between a factory producing a finished product and the manufacturer's warehouse 2. After product shipment from the manufacturer's warehouse
Disposal and recycling	<Transportation distance> 50 km <Means of transportation> 4-ton truck (light oil) <Loading ratio> 50%	1. Transportation of waste material from a waste collection location to a disposal center

Figure 6 Scenarios for domestic transportation



* The basic unit for storefront sales (0.556 g-CO_2e/yen) is cited from 'Carbon Footprint in the Distribution Industry (2008)' by Ikuhiro Ono.
* The basic unit for mail-order sales (0.114g-CO_2e/yen) is calculated based on the ASKUL Environmental Report and Kaunet data.

Figure 7 Scenarios for the sales process

[Future Tasks]

The PCRs for the product categories 'file and binders' and 'pens and pencils' were reviewed in November and approved in December, 2009, by the PCR Committee. We are currently working on having the PCR for 'office supplies (tentative category name)' approved early this year. In the stationery industry, we will calculate CFP for the products listed in Figure 3 in accordance with the pilot PCRs, display the CFP symbols on the applicable products, and release them to the market.

We believe we have many CFP-related issues yet to be resolved. As we proceed with the CFP project, we will examine what needs to be done to disseminate the concept of CFP throughout the stationery industry as well as to consumers and also how can calculated values guarantee reliability for consumers.

Stationery has a wide range of users, from children to the elderly. By producing and distributing products with the CFP symbol, we hope that consumers will be more aware of the concept of CFP and lead a low carbon life to reduce CO_2 emission.

Information

International Conference on Environmental Science and Technology	
July 12-16, 2010 Houston, Texas, USA	American Academy of Sciences http://www.aasci.org/conference/env/2010/index.html
7th International Conference on Life Cycle Assessment in the Agri-Food Sector	
September 22-24, 2010 Bari, Maraisia	
Brazilian LCM Conference 2010	
October 13-15, 2010	
Sustainability in Design	
September29- October 1, 2010 Bangalore, India	the Learning Network on Sustainability http://www.lensconference.polimi.it/
Life Cycle Assessment X	
November 2-4, 2010 Portland, Oregon, USA	American Center for Life Cycle Assessment http://www.lcacenter.org/
ISIE Asia-Pacific Meeting	
November 7-9, 2010 Tokyo, JAPAN	ISIE Asia-Pacific Meeting & ISIE MFA-ConAccount Meeting http://www.isieapmfa.info/index.html
SETAC North America 31st Annual Meeting	
November 7-11, 2010 Portland, Oregon, USA	SETAC North America
Sustainable Innovation 2010	
November 8-9, 2010 Rotterdam, The Netherlands	The Centre for Sustainable Design http://www.cfsd.org.uk/events/tspd15/index.html
Going Green CARE INNOVATION 2010	
November 8-11, 2010 Vienna, Austria	International CARE Electronics Office http://www.re-use.net/CARE/CI2010/
9th International Conference EcoBalance	
November, 9-12, 2010 Tokyo, JAPAN	JLCAJ http://www.sntt.or.jp/EcoBalance2010/
The 7th Australian Life Cycle Assessment Conference	
November, 15-19, 2010 Melbourne, Australia	ALCAS http://www.conference.alcas.asn.au/
The 18th CIRP Conference on Life Cycle Engineering	
May, 2-4, 2011 Braunschweig, Germany	Technische Universität Braunschweig http://www.lce2011.de/en/home
SETAC North America 32nd Annual Meeting	
November 13-17, 2011 Boston, MA, USA	SETAC North America
3rd International Conference on Green and Sustainable Innovation 2009	
December 2011 Thailand	
SETAC North America 33rd Annual Meeting	
November 11-15, 2012 Long Beach, CA, USA	SETAC North America

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