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Contents

Special Article

Activity Report of Working Group on the Supply Chain Oriented LCA Data Exchange System

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1. Introduction

LCA has spread widely to various industrial fields. Companies now carry out LCA when they externally announce the environmental impact of their products or services using Type-III Label such as the Eco-Leaf. Also, they internally utilize it Design for Environment (DfE). In Japan, during the LCA national project from FY1998 to FY2005, the LCA method was developed, inventory databases were constructed, and the Japanese version of the environmental impact assessment method was developed. In particular, a large number of industrial associations cooperated in the construction of the JLCA-LCA database and it is now used as an inventory database based on actual data.

However, it has been frequently pointed out that database does not have enough comprehensiveness for conducting LCA. Also, there have been issues where product design companies at the downstream of a supply chain ("downstream companies") meet challenges to obtain detailed data from material and parts manufacturers at the upstream of the supply chain ("upstream" or "midstream" companies) although such detailed data are needed for advanced DfE. Furthermore, there has been another issue where upstream and midstream companies become entities that simply provide data requested by downstream companies, and cannot obtain information on how the materials or parts that they manufactured are used in final products. Therefore, their data have not been used in any effective ways to contribute to enhancement of competitiveness such as advertising their approaches to environmental issues.

In order to solve the issues described above, the LCA Promotion Committee established a working group to examine the supply chain oriented LCA data exchange system working group ("WG") to discuss current issues and identify future issues for advanced LCA within a supply chain. The WG focused on identifying issues to be addressed instead of establishing specific rules or formats.

This report describes the results of the WG discussion.

2. Examination by WG

A total of 20 WG members, consisting of JLCA corporate members and LCA researchers, continued the discussions that were originally carried out by the preliminary working group since 2007. The members were divided into the operation examination team, producer-specific data examination team, and generic data examination team, and discussions among these teams were carried out concurrently. The objective of WG was to establish a data exchange system that would realize advanced environmentally-friendly design for downstream companies and that would allow midstream and upstream companies to make improvements in the environmental aspect and use these improvements to enhance competitiveness. For this purpose, upstream, midstream, and downstream companies must promote "monozukuri (art of manufacturing)" with as little environmental impact as possible throughout the product life cycle, and consequently, our discussions were based on the concept that companies in various positions must cooperate to collect and manage data, and that data must flow not only from upstream to downstream but also from downstream to upstream. Also, we made sure that small and medium-sized companies which accounted for a majority of midstream companies could participate in that data exchange system by reducing the prerequisite man-hours.

3. Overview of the Supply Chain Oriented LCA Data Exchange System

Figure 1 shows the flow of data when a downstream company implements DfE and the system that is required for that data flow. Ⅰ) The data exchange system supports data exchange between companies in the same supply chain. Ⅱ) The producer-specific data system supports the persons in charge in creation of individual product inventory data. Ⅲ) The generic data system supports creation of data to be released as the representative values in an industry. The data to be created and released by the generic data system described in Ⅲ) will be a developed version of the current JLCA-LCA database.

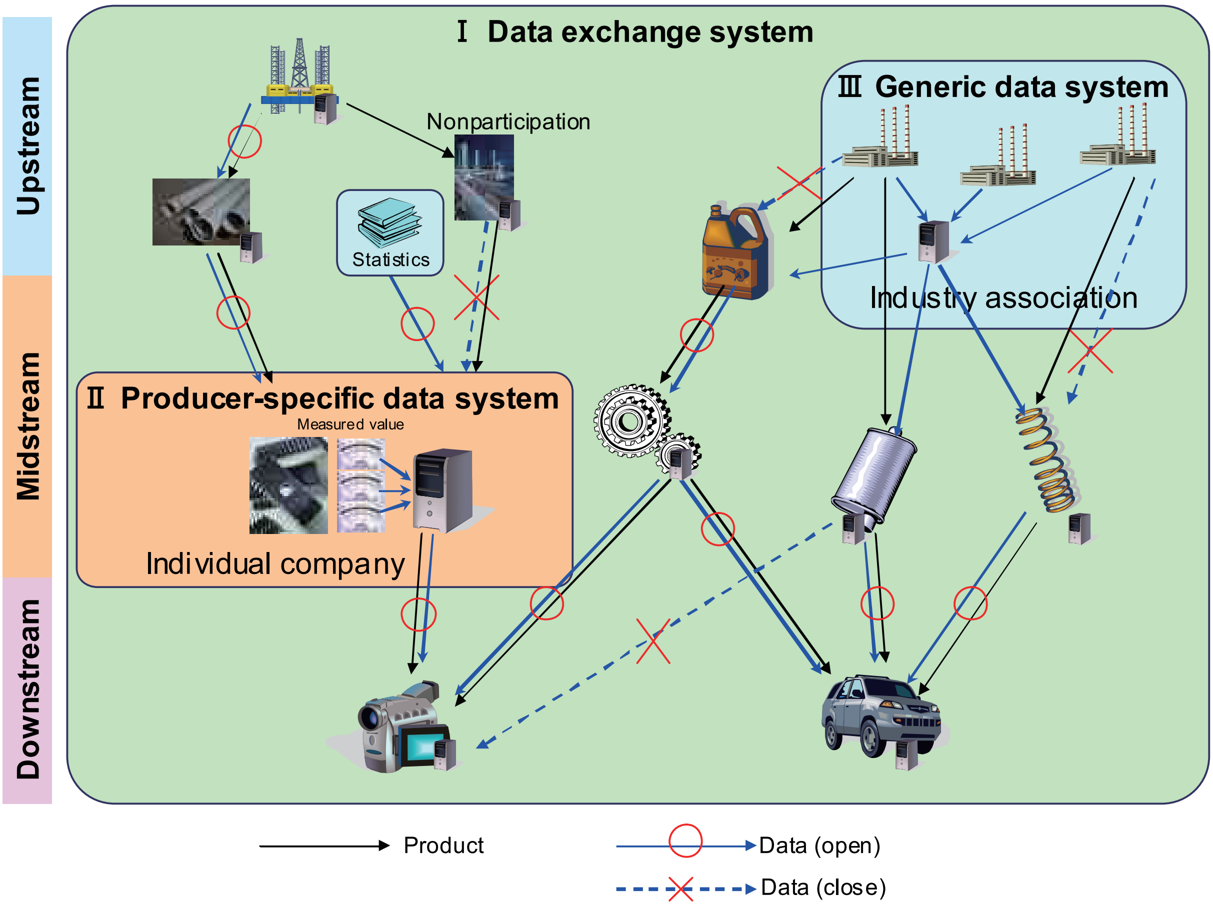

Figure 1: Data flow in the supply chain oriented LCA data exchange system and the systems used in the program

The issues related to construction of each system identified as a result of discussion by each examination team are as follows:

I) Data exchange system

For the data exchange system, we discussed the creation of a guideline so that all participating companies would follow the standardized guidelines when using this program. The guideline must establish the following principals:

(1) Data verification

As with the case of the LCA critical review established under ISO14040, for the data to be distributed in this program, too, the necessity of third-party verification and its procedure must be discussed. Verification is an effective means to improve data reliability but data supply itself incurs a cost. This may discourage medium-sized and small companies to participate in the program.

(2) Data supply guideline

Guideline for protecting data from being used for purposes other than those specified must be established. For example, the participating companies may experience profit loss if downstream companies request price reduction for products with low energy consumption or if companies use obtained data to compare a particular product with a competitor's product and make a claim of some kind as a result of the comparison without following the proper procedure.

(3) Confidentiality

Establishment of a mechanism must be considered in order to prevent data disclosure to any parties that are not designated as data recipients. Criteria and methods for designating data recipient parties must also be established. For this, we must pay attention to how information technology is now developing and request information technology professionals to construct an appropriate system. Furthermore, contingency plans for data leakage or misuse must be established.

Ⅱ) Producer-specific data system

Inventory data that companies implementing LCA wish to use is created by companies in the supply chain. The producer-specific data system needs to have functions that allow these companies to easily create inventory data in a standardized format only by inputting internal information following the data collection guideline. Issues to be addressed when constructing this system are as follows:

(1) Process data collection method

• System boundary

When creating inventory data, it is in general unclear the extent of data to be included as a unit process within the system boundary. In this program, since data of individual companies is used, a standardized guideline for the system boundary is necessary. Otherwise, the data cannot be used in business operations. The guideline therefore should propose what should be included in the system boundary and what should be excluded.

• Target environmental impact

The current JLCA-LCA database contains data on global warming, acidification, and eutrophication, each having data on the relevant 14 emission matters. However, sometimes, data has not been collected for all 14 of these emission matters; therefore, it is difficult to carry out characterization. For this reason, it is necessary to create a guideline to show for which elementary flow data collection is required and to standardize the name of these flows while prioritizing the flows that can be handled by the system in each subject environmental impact category. Note, however, in order to facilitate program participation by medium-sized and small companies, there has been an opinion that activities to disseminate the database should be implemented instead of trying to include many pieces of data at the beginning of the program operation. For example, data should be limited to CO_2 or green house gases that are directly discharged during the course of manufacturing processes.

• Allocation

Many factories manage energy consumption for the entire office or building, and they do not usually manage it for each manufacturing process of each type of product. To organize such data for each product, the procedure for an allocation is required. Allocation is often based on the relationship between the amount of product receipt and the amount of product shipment for the entire factory. However, there are cases where it is difficult to establish an allocation procedure for each type of product especially when products with different specifications are manufactured using the same manufacturing process or when manufacturing of a particular type of product requires repetition of the same process. It is necessary to support facilitation of data organization by classifying the typical process data creation procedure.

• Collection of new product data

Since there is no actual inventory record for new products, it is necessary to make an estimate. It is therefore necessary to examine the estimation method and display method. For example, data may need a tag to indicate that it is an estimated value or the data may need to be corrected based on the actual record after a certain period of time.

(2) Data distribution method

• Format

ISO/TS 14048 is an international standard for data format, but it seems too complicated to be practical. A detailed data format allows a wide variety of analysis, but at the same time, data supply becomes difficult. It is therefore necessary to understand the role of this program and to examine and propose a format that provides a good balance of being detailed and ease of data supply.

(3) Data consistency

• Consistency with overseas data

In the current manufacturing industry, it is quite rare for a supply chain to be closed domestically. Collaboration with overseas companies must be brought into view. Multiple data formats for inventory data have already been proposed around the globe, and in order to consider the possibility of collaborating with overseas companies, it is necessary to investigate the data format and database development tendencies, secure consistency, and exchange opinions.

• Establishment of a link with internal management data

Many companies are carrying out independent data collection activities in order to obtain LCA data. Therefore, repetitive data collection is difficult from both the cost and time perspectives. For this reason, having the inventory data linked with a budget control system, cost control system, or design parts list that is already used internally is believed to be effective for continuous management and updating of the inventory data. Proposing multiple possible patterns for such functional linkage should facilitate the creation of inventory data.

③Generic data system

As shown in Figure 1, obtaining all supply chain process data from the producer-specific data system is not realistic, and we believe there should be a database that can be shared as background data such as electricity, general-purpose material, and general-purpose parts. The conventional JLCA-LCA database would be qualified as the database for this background data. Note, however, instead of applying the conventional way in which each industrial association collects and calculates data from individual companies, it is desirable that the generic data system have a function of converting individual company data into representative values easily such that the inventory data would be kept updated. Also, this system will provide a new mechanism in which generic data can be provided through inter-company voluntary activities beyond the framework of industrial associations. Issues regarding this system are as follows:

(1) Generic data creation method

• Data naming method

In the 1st LCA Project, data name standardization within the industry was recommended. This worked as an advantage for data creators because they could use the terms that were commonly used in that industry; however, when LCA implementing parties from other industrial fields were using that data, they may have had different terms for the data having the same meaning. For this reason, it is necessary to establish a standardized nomenclature guideline so that data will have names that can be used both domestically and internationally.

• Data update system for upstream companies

Conventionally, an industrial association data takes into account the environmental impact of use of public power or includes the volume of emission caused by fuel combustion.

Their values however vary with the fiscal year or depending on data sources. It is therefore necessary to establish a system that would make the generic data consistent and that would correct the generic data as upstream company data is updated.

(2) Quality and adequacy for use

• Calculation and presentation of "reliability"

Although the current LCA data has reliability-related items, it is not effectively used because the there are no clear indices or standards for objectively assessing data quality. It is however necessary to show that the data is reliable such that it is interpreted appropriately. For this reason, it is necessary to examine the quantitative index or standard.

• Method of adequacy assessment when using the generic data

When carrying out LCA regarding the use of copy paper (made 70% with recycled paper), there is an issue of which data to be selected from, for example, the choices of "paper", "communication or printing paper", "communication paper", and "recycled high-quality paper (made 70% with recycled paper)". Data that is considered to have high adequacy by the LCA implementer is used, but this adequacy cannot be objectively assessed. For this reason, it is necessary to establish a standard for assessing and presenting data adequacy.

(3) Implementation of LCA

• Estimation of data for upstream companies' unclear process

When there is no clear data for components of a particular product to be assessed, the material structure of that part is first examined, and then, the inventory data for the identified materials and data on the utilities required to process these materials are multiplied and accumulated. It is however difficult to estimate data for parts with an unclear material structure or manufacturing process, or for products that do not have "parts" such as cutting oil and cleaning solutions. The volume of individual data available is expected to be extremely small when the system begins operation; therefore, the generic data is expected to prevent data exchange from being discontinued. Establishment of a guideline showing how to estimate the environmental impact of materials and processing as well as extensive upgrading of the generic database are desired.

• Assessment when recycled materials are used or provided

The LCA method for products using recycled materials or products providing their materials to other product systems through recycling after being used was organized in the 2nd LCA National Project. It is however necessary to further examine how to handle these products with the new system.

4. Dissemination of the Supply Chain Oriented LCA Data Exchange System

This program requires a large number of users in the supply chain due to its purpose. Therefore, measures to disseminate this program must be established as follows:

1) Incentive for using the systems

The inventory data must be validly recognized in B2B as well as B2C transactions for the program to be disseminated. Therefore, a social system where low environmental burden products will receive a premium in the market will act as the strongest incentive for using the systems.

2) **Benefit to upstream and midstream companies**

By participating in the data exchange system, both upstream and midstream companies can easily provide data, and man-hours required for data supply are expected to be dramatically reduced. This however will not motivate them to actively provide data to downstream companies. Meanwhile, if downstream companies provide data on assembly, processing, use, and disposal of the target product to the upstream companies, upstream and midstream companies can quantitatively assess the material, parts function, and environmental improvement, and call attention to the assessment result

3) **Dissemination of the program to medium-sized and small companies**

Measures to disseminate the program to medium-sized and small companies having relatively small management resources include: designing and provision of as simple an producer-specific data system as possible; and patient dissemination of the data creation method.

4) **Dissemination of the program overseas**

International specialization is spreading in the manufacturing industry. For this data exchange system, too, system designs taking into account overseas use and overseas dissemination activities will be important.

5. Desired Effect of the Data exchange system

Figure 2 shows the desired effect of introduction of this program. With active cooperation from industrial associations, the JLCA-LCA database now contains and discloses typical inventory data such as material data. With this data, product designers can assess particular products throughout their life cycle, and as a result, DfE has further developed. Note, however, this database contains information that should be treated as background data; therefore, even though procurement is environmentally-friendly (green procurement), changes in upstream companies will not be incorporated in assessment of final products. This also means that upstream and midstream companies are not likely to be recognized even though their manufacturing is environmentally-friendly (green manufacturing). In this program, DfE activities of all the participating companies in the supply chain are assessed, and these companies can therefore easily and quantitatively present their achievements. They can also develop not only their internal process but also green procurement with high reliability. Furthermore, by using this program as a tool to communicate with consumers, it is expected that environmental efficiency of subject products can be visualized in the market.

6. Conclusion

Study on the supply chain oriented LCA data exchange system has just started, and we are sure to encounter a large number of issues before its implementation. Still, in the situation where consideration for environmental issues has high importance, we believe this program can be a social infrastructure to provide industrial competitiveness. We understand that many participants still feel very reluctant to provide information externally, but we hope to establish through discussions a framework that is beneficial to all participants and to lead the way to implementation through presentation of this framework.

For embodiment of this program, in the future, we need to conduct demonstration experiments using simple case examples, check the desired effect, approach to and collaboration with overseas entities, and to examine how to distribute information on the concept of this program. We hope that JLCA member companies will actively participate in this program.

We would like to conclude this article by expressing our appreciation to all WG members, especially the team leaders who chaired discussions and the office members who work hard to coordinate all the activities.

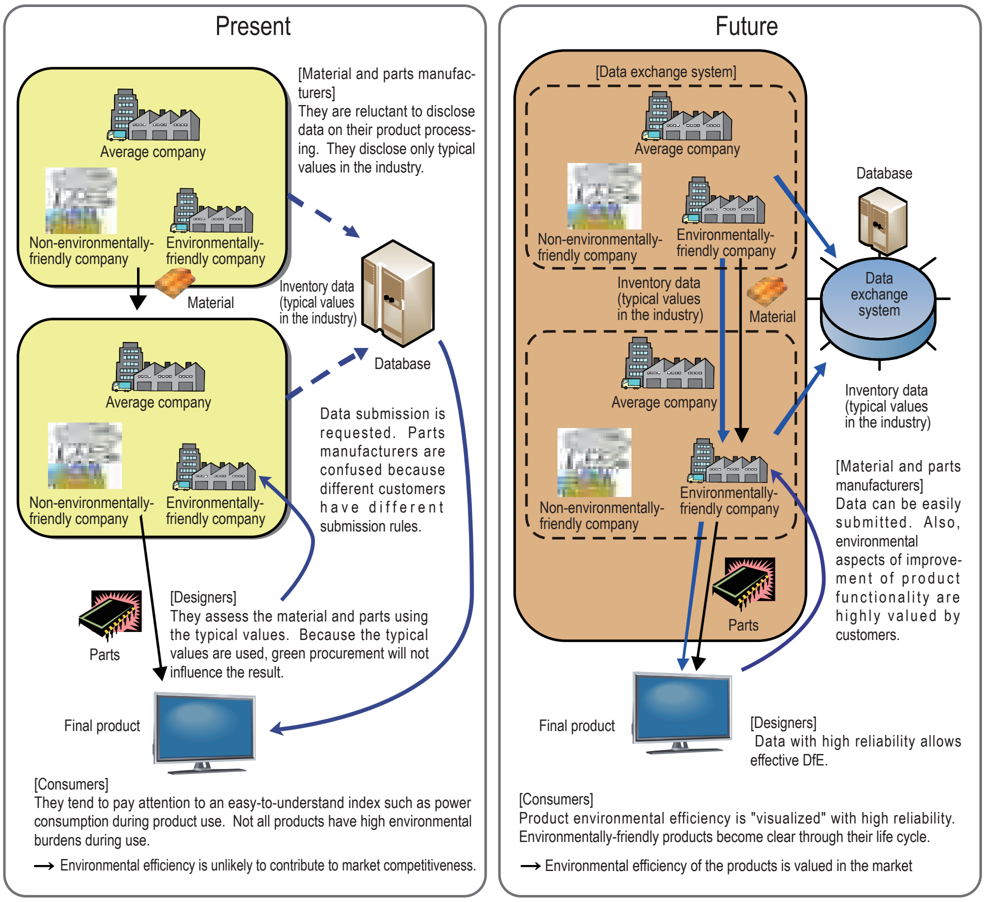

Figure 2: Desired effect of the data exchange system

Examination of Environmental Burden in Relation to the Plastic Container and Package Recycling Method

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1. Background

In Japan, 72% of waste plastic is now effectively used including for the purpose of energy recovery. As for recycling of plastic containers and packages ("plastic containers", collectively), however, the commission price is high because material recyclers can preferentially win the contract when the Japan Containers and Packaging Recycling Association invites recycling companies to bid for recycling operations. Combined with the fact that the amount of plastic containers for recycling collected by local governments is increasing, the commission price continues to increase. For this reason, stakeholders have been discussing whether or not material recycling should continue to be prioritized.

2. Objective

Under these circumstances, the Plastic Waste Management Institute conducted life cycle assessment (LCA) to examine the environmental burden of various plastic container recycling methods and eco efficiency thereof while taking economic efficiency into account. As a result we reported that material recycling was not necessarily the best solution. Since many committee members commented at the FY2006 Central Environmental Council meeting that the environmental burden of plastic container recycling methods would have to be assessed, the Japan Containers and Packaging Recycling Association served as the secretariat to organize the "Committee for Examining the Environmental Burden in Relation to the Plastic Container and Package Recycling Method" with university professors and intellectuals from national research institutes as committee members in order to conduct environmental burden assessment with higher accuracy. The Committee then conducted environmental burden assessment based on LCA data of various plastic container recycling methods. The Plastic Waste Management Institute made a contribution as a secretariat member.

3. Life Cycle Assessment (LCA) Method

The assessment target was the plastic container recycling methods currently in use. The system boundary included the operations from inputting of baled plastic containers into the recycling process to final processing of recycled products (landfill, incineration with residual dross landfill) via the recycling process.

The environmental burden reduction effect was shown as the difference between the environmental burden of the system (recycling system) when recycling took place and the environmental burden of the system (original system) when recycling did not take place. Here, the recycling system and the original system were designed such that they would have the same function (output). This assessment method is called the basket method. While recycling generates an output (recycled product) in the recycling system, the original system does not produce any output (recycled product). In order to fill this output gap, we added a process to the original system to manufacture new products created from natural products in the recycling system (fossil resource and wood) that were considered equivalent to recycled products. Also, since plastic containers waste were consumed by recycling in the recycling system, we assumed plastic containers were incinerated and converted into CO_2 and water in the original system.

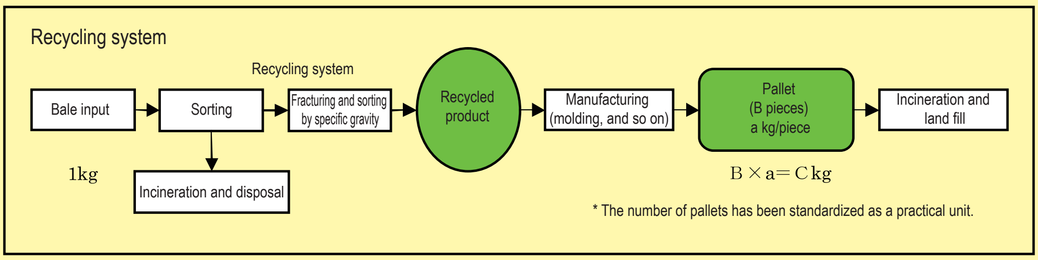

Figure 1: Material recycling (one-way pallet)

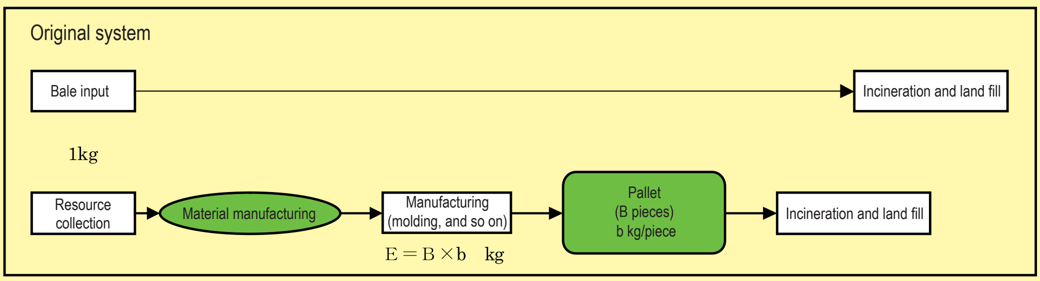

Figure 2: Material recycling (one-way pallet)

Particularly, in material recycling, the environmental burden reduction effect largely relies on: use of recycled resins (shredded films/sheets or pallets) which are the recycled products (one-way pallets, returnable pallets, plastic plates Note 1)); simulated substitutes (new resin pallets and wooden pallets); and the ratio of the life between a concrete panel made with recycled resins and a concrete panel made of plywood. Conventionally, in the eco efficiency analysis conducted by the Plastic Waste Management Institute, a one-way pallet was used as the typical application of the product recycled in material recycling and its environmental burden was assessed using a new resin pallet as the substitute. In the present study, however, we used multiple applications and substitutes. Among all the recycled plastic container products that went through the material recycling process, 35% of the material was used as pallets and 15% was used as concrete panels. These two applications accounted for 50% and it meant that a sufficient amount of recycled plastic container products were used as large-size products.

Note 1: A plastic plate to substitute for plywood for a concrete formwork

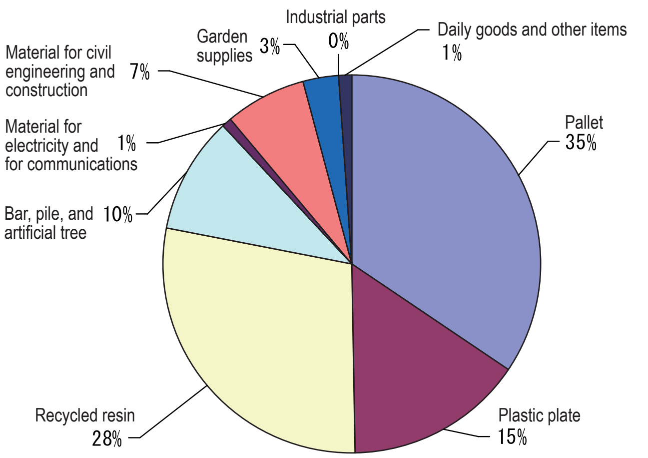

Figure 3: Breakdown of applications of products recycled in the material recycling process(based on the results from April to August, 2006)

4. Result of LCA of the Environmental Burden Reduction Effect

Figure 4 shows the energy resource consumption reduction effect, and Figure 5 shows the CO_2 reduction effect.

The energy resource consumption reduction effect surrounded by the green lines is attributed to material recycling. In the same manner, the one surrounded by the red lines is attributed to chemical recycling, and the one surrounded by the blue lines is attributed to thermal recycling (energy recovery). In material recycling, for both one-way and returnable pallets, the energy resource consumption reduction effect is very small or almost zero in fact when wood is used as a substitute material. The figures show not only the average values but also the minimum and maximum values due to the compositional variability of recycled plastic containers and the variability of treatment methods of residual dross discharged from material recycling. The energy resource consumption reduction effect was the largest (30 MJ per kg of recycled plastic container) when the life of a concrete panel is set as 5 times longer than that of plywood. This is due to the fact that the energy required to manufacture plywood which is a substitute for a concrete panel is large and that the life of a concrete panel is set to be 5 times longer than that of plywood resulting in assessment that the energy required to manufacture a concrete panel is 1/5 of what is required to manufacture plywood. In chemical recycling, the energy resource consumption reduction effect was the smallest (approximately 15 MJ per kg of recycled plastic container) when CO_2, generated during gasification to produce ammonia raw materials, is discharged as it is without being made into dry ice. There are in fact some cases where CO_2 is sold as dry ice as a result of the gasification, and in this case, the energy resource consumption reduction effect is large (approximately 39 MJ per kg of recycled plastic container). Use of plastic as a chemical raw material for incineration by coke ovens produces about the same level of energy resource consumption reduction effect. Although the data on use of RPF and cement incineration which were calculated based on assumed data instead of the actual data still shows a relatively large energy resource consumption reduction effect (approximately 28 MJ per kg to 35 MJ per kg of recycled plastic container).

In the same manner as the energy resource consumption reduction effect, the CO_2 reduction effect surrounded by the green lines is attributed to material recycling. The one surrounded by the red lines is attributed to chemical recycling, and the one surrounded by the blue lines is attributed to thermal recycling (energy recovery). The tendency of the CO_2 reduction effect is similar to that of the energy resource consumption reduction effect. Although the use of plastic as a chemical raw material for incineration by coke ovens produced the largest energy resource consumption reduction effect for chemical recycling, in the case of the CO_2 reduction effect, the largest effect (approximately 3.3 kg per kg of recycled plastic container) was observed when using coke as a substitute for a recycled product obtained through reduction in the blast furnace.

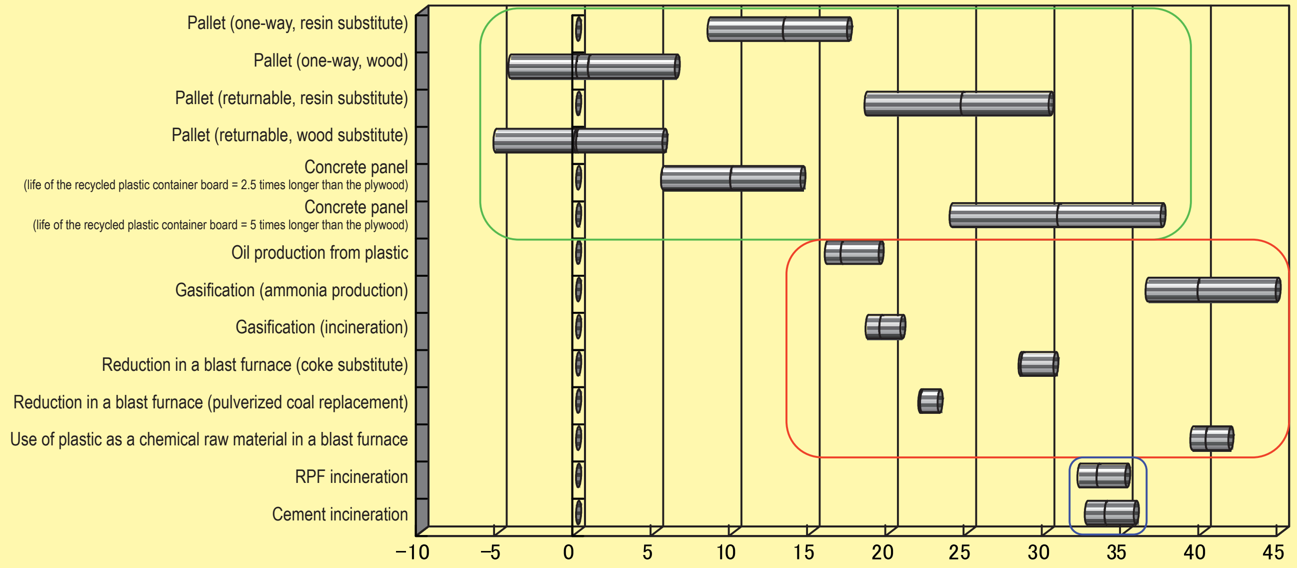

Figure 4: Energy resource consumption reduction effect (in MJ per kg for recycled plastic containers)

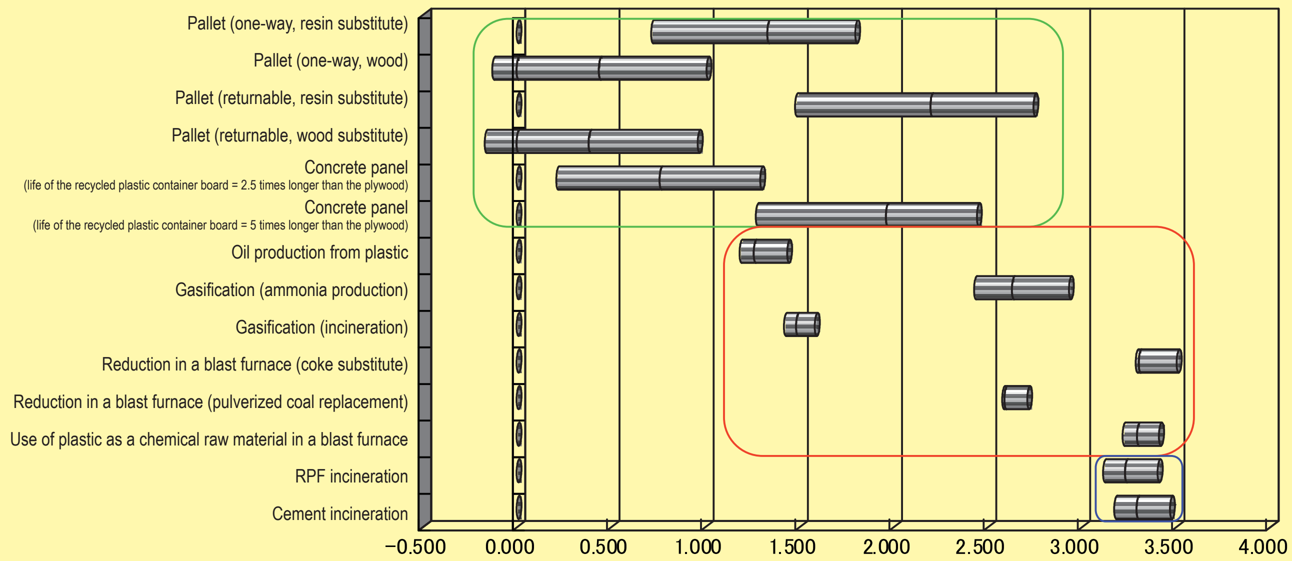

Figure 5: CO_2 reduction effect (in kg per kg for recycled plastic containers)

5. Conclusion and the Future Theme

As described above, among various plastic container recycling methods, material recycling was not any better than other methods in terms of the energy resource consumption reduction effect as well as the CO_2 reduction effect. Therefore, at least from the environmental burden point of view, there is no convincing reason why material recycling should be given priority over other types of recycling in the bidding for plastic container recycling operations. In the future, we hope to publish as many "Examination of Environmental Burden in Relation to the Plastic Container and Package Recycling Method" results as possible so that we can promote them to be used as the basic data for discussions of the necessity to prioritize material recycling in the bidding described above.

Chairman's Award

Application of the System Product LCA "SI-LCA" to Product Development by the Hitachi Group

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1. Business Description of the Hitachi Group

The Hitachi group manufactures and sells a wide variety of products such as: electricity and industrial systems such as power generators, digital media and consumer devices such as plasma TVs; high-tech materials to be used in these consumer devices; information system solutions; financial services; and logistics services. The Information and Communication Group provides IT devices, such as servers, storage, software, and services.

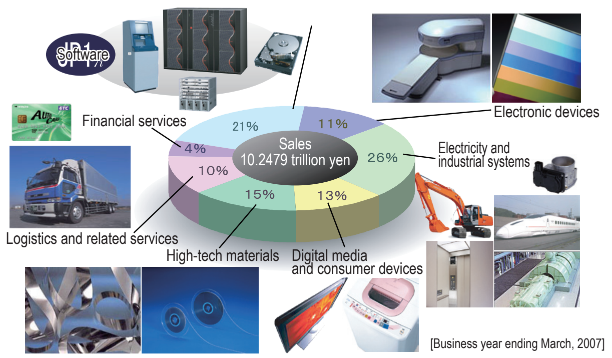


Figure 1 Business description of the Hitachi group

2. Environmental Practice "Environmental Vision 2015"

The Hitachi group is promoting its environmental practice based on Environmental Vision 2015[1]. The practice is called Green Compass (Figure 2) which is divided into four areas that are "Eco-Mind and Global", "Next-Generation Products & Services", "Super Eco-Factories & offices", "Worldwide Environmental Partnerships".

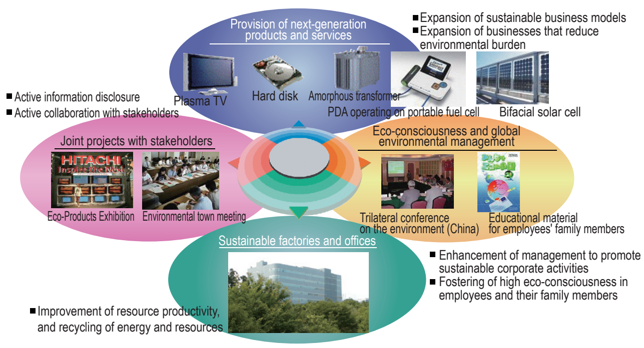


Figure 2 Hitachi group's environmental practice (Green Compass)

System Integration-LCA (SI-LCA)[2)-4)] introduced in this article relates to "Next-Generation Products & Services", The objective of "Next-Generation Products & Services", is to create environment-friendly products and to become environment-friendly through provision of social infrastructure products in order to contribute to establishment of a sustainable society. Green procurement, provision of green products that allow energy saving, saving energy of data centers by implementing the IT energy-saving plan, and becoming environment-friendly through the use of social system products such as traffic or city systems are some of the examples.

3. Approach to Environment-Friendliness through the Use of Information and Communication Devices

The Information and Telecommunication Systems Group has established the IT energy-saving plan[5)] as an approach to environment-friendliness through the use of hardware products and will use its comprehensive capability to help prevent global warming. More specifically, the group plans to implement the CoolCenter50[6)] to reduce CO_2 emission by 50% in the next 5 years.

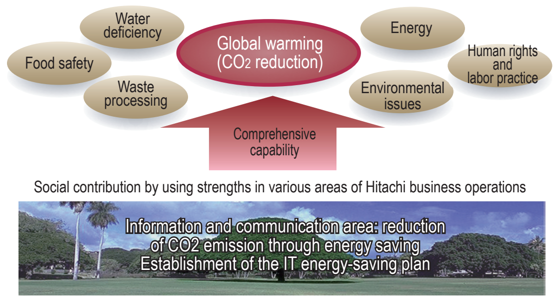


Figure 3 Contribution to prevention of global warming by implementing the IT energy-saving plan

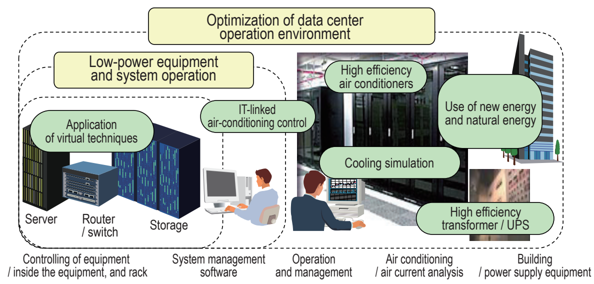


Figure 4 CoolCenter50 project

4. Major examples of approach to reduction of product environmental burden

Our approach to the reduction of environmental burden of individual products such as servers is to use "Assessment for Design for Environment",[7)] which has been conducted since 1999, and the "eco-efficiency index"[8)] in order to develop products with low environmental burden.

Meanwhile, we assess system, software, and service products ("System Products") based on "Assessment for Design for Environment". At the same time, by using SI-LCA that we developed in 2003, the effect of introduction of System Products has been quantitatively assessed.

The following section provides a description of SI-LCA.

5. What is SI-LCA?

SI-LCA is a method to quantitatively assess the environmental burden in a System Product life cycle. While introduction of System Products causes resource consumption for manufacturing of necessary PCs and servers and also causes an increase in environmental burden due to energy consumption during operation, there is an advantage that resource consumption and traveling by people or objects can be reduced. SI-LCA assesses these positive and negative aspects in terms of the entire life cycle.

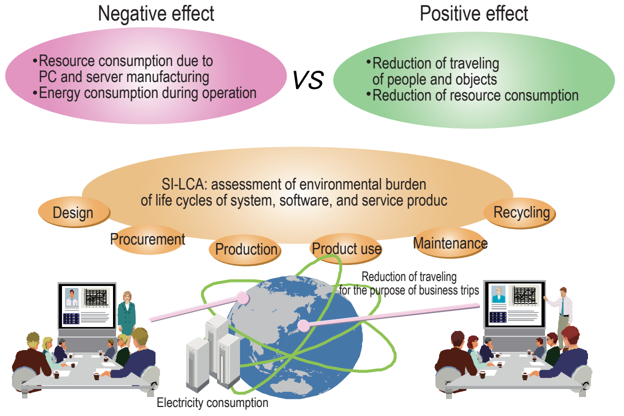


Figure 5 Basic concept of SI-LCA

6. Stages and Environmental burden to be Assessed

A total of 10 stages such as the "design and development", "hardware product procurement", "product use", and "disposal and recycling" stages are assessed. Environmental burden for these stages is assessed in terms of CO_2.

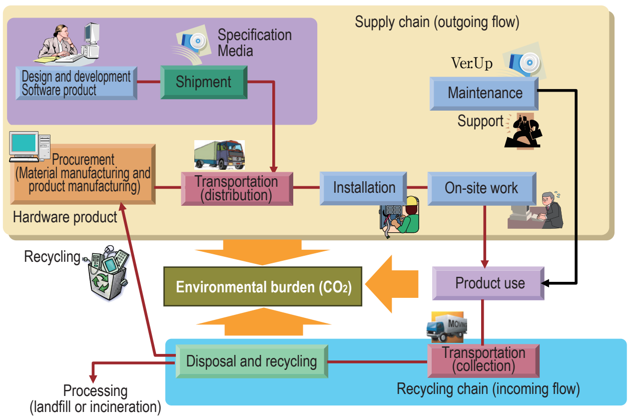


Figure 6 Stages to be Assessed by SI-LCA

7. SI-LCA Program

Figure 7 shows an input interface and an example of assessment result.

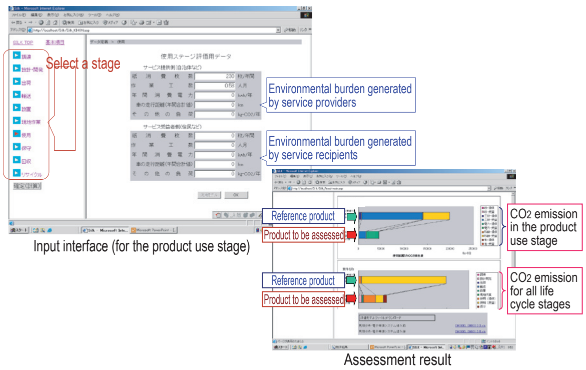


Figure 7 Input interface and an example of assessment result of SI-LCA

8. Relationship between the Eco-Efficiency Assessment Guideline and SI-LCA

In March, 2006, the Japan Forum on Eco-Efficiency published the "Eco-Efficiency Assessment Guideline for Information and Communication Technology"[9] providing a general framework, rules, and requirements for assessment and comparative assessment of information and communication technology (ICT) environmental burden and environmental effect. This guideline was created by the working group of 8 IT companies with Associate Professor Matsuno of the Graduate School of the University of Tokyo, as the technical editor. The stages to be assessed by SI-LCA and the assessment method conform to this guideline. Furthermore, in February, 2007, the instruction manual for the guideline titled "Measuring IT Society in terms of the Environment" was written by Associate Professor Matsuno and Professor Kondo of Waseda University, and published by the Japan Environmental Management Association for Industry (JEMAI).

Figure 8 Publication "Measuring IT Society in Terms of the Environment"

9. Development of Eco-Products by the Hitachi Group

The Hitachi group provides certificates for eco-products and super eco-products. System products are also eligible for these certificates. As shown in Figure 9, the "Assessment for Design for Environment" created by the Hitachi group is used as the criteria for the eco-products certificate. The products that meet the specified criteria will be certified. Super eco-products are the products that are eco-products and that meet at least one of the following conditions:

①The global warming prevention factor[8] of the product is 10 or higher.
②The resource factor[8] of the product is 10 or higher.
③The product is the leading product in the industry.
④The product has been highly recognized by third parties.

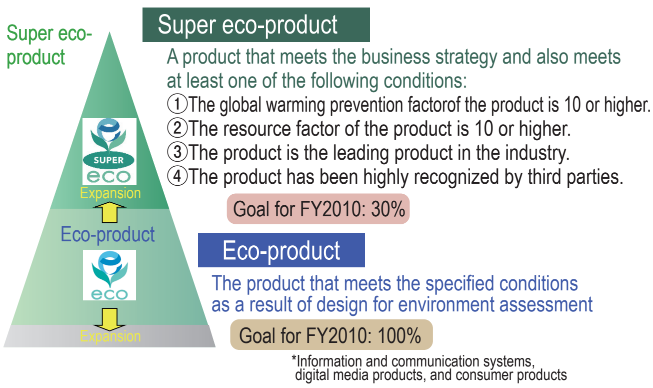


Figure 9 Criteria and goals for green and super eco-products

The Hitachi group plans to make its products 100% green products, and of which, 30% will be super eco-products by FY2010.

10. Assessment for Design for Environment for System Products

Figure 10 shows a part of the assessment for Design for Environment for System Products. Products are assessed in 9 categories containing a total of 64 items, and are assessed when they are first proposed and when the product is complete. Each item is assessed using a scale of 1 to 5, with the reference point of 2. When the average point is 2 or higher in each category and the overall average point is 3 or higher as a result of assessment at the time of completion, the product is certified as a eco-product.

Note, however, since this assessment method cannot quantitatively assess the level of environmental burden reduction attributed to introduction of System Products, SI-LCA is used to quantitatively measure CO_2 emission.

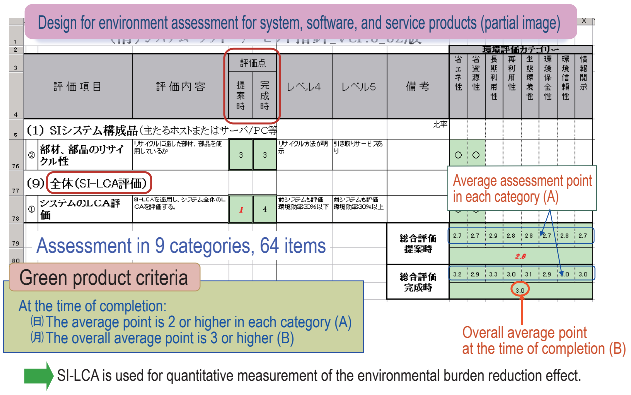


Figure 10 Assessment for Design for Environment for System Products (partial image)

11. SI-LCA Case Examples

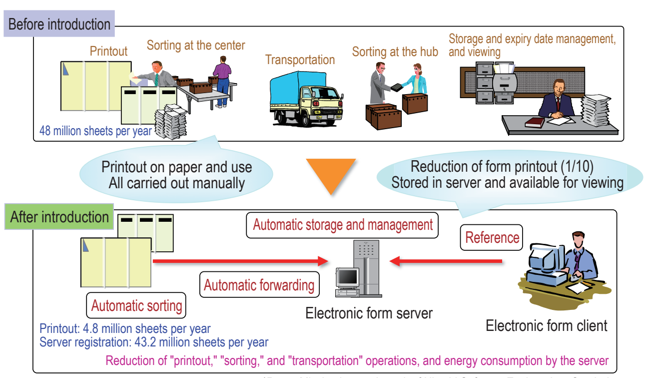
This section introduces 2 SI-LCA case examples.

(1) Assessment of an electronic form system "ReportMission"

Figure 11 shows business models at a supermarket in Tokyo, before and after introduction of the electronic form system.

Traditionally, this supermarket printed out 48 million sheets of information materials each year and distributed them to its hubs, but this form system made 90% of them available for viewing by storing them in a server while the remaining 10%, which is 4.8 million sheets, is still printed out and distributed.

The amount of paper used and transportation using vehicles were greatly reduced by the use of the electronic form system, and as a result, as shown in Figure 12, CO_2 emission was reduced by 82% (82.5% in the product use stage).



*ReportMission is a trademark of Hitachi Software Engineering, Co., Ltd.

Figure 11 Business models before and after introduction of the electronic form system

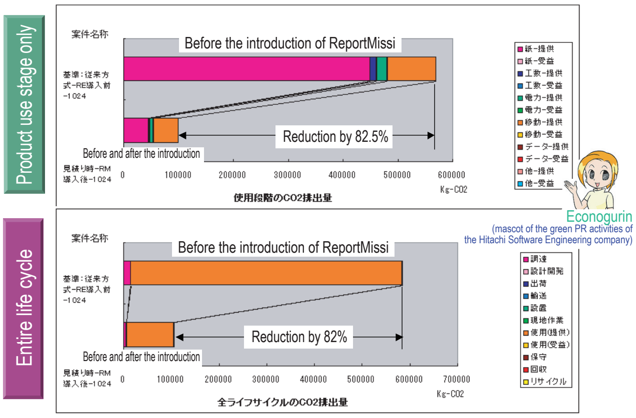


Figure 12 Comparison of assessment results between before and after introduction of the electronic form system

(2) Electronic application system

Figure 13 shows business models at an administrative agency, before and after introduction of the electronic application system.

People traditionally visited the administrative agency to make applications, but the introduction of the electronic application system enabled them to use their PC to make various types of applications from their home or office.

Although this caused an increase of electricity consumption by PCs and servers, traveling by cars, trains, or buses, and also, use of paper application sheets were no longer necessary. Figure 14 shows the result of the effect of system introduction for the 5 years after introduction assuming that 63,000 applications were made each year. The result indicates that CO_2 emission can be reduced by 82% (85% in the product use stage).

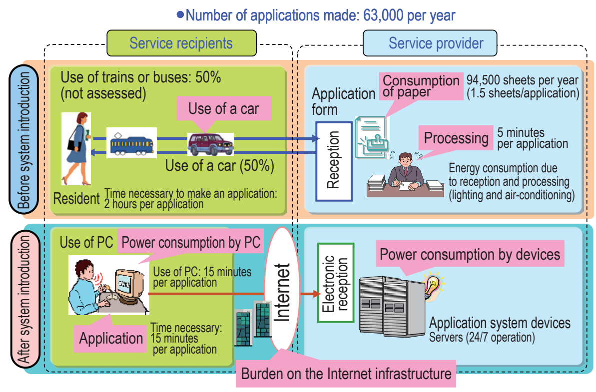


Figure 13 Business models before and after introduction of the electronic application system

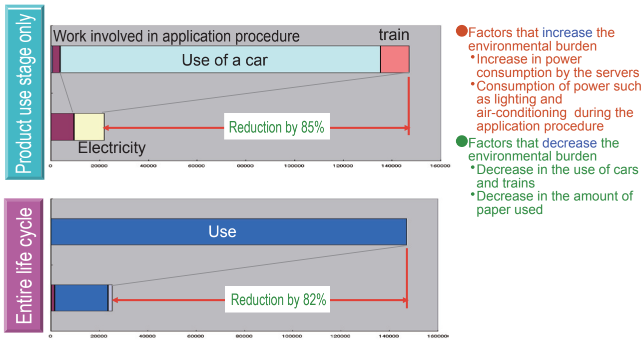


Figure 14 Comparison of assessment results before and after introduction of the electronic application system

12. Internal Introduction of SI-LCA

Environment-friendliness of System Products must be planned in an early stage of the system design and creation phase. Therefore, we have been working on the following to allow the designers, developers, and SEs within the Hitachi group to conduct assessment for Design for Environment and SI-LCA.

① Promotion of assessment, horizontal expansion of the assessment method, and creation of an assessment plan through introduction of assessment case examples at the committee consisting of members who are in charge of environment-related operations from Hitachi offices and related companies

② Assessment training using the actual product as a sample

③ Support for assessment activities and improvement of the assessment tool by the research institute

Training on SI-LCA
(Hitachi Software Engineering)

Environment-related educational program
(operating divisions)

Figure 15 Training on SI-LCA and design for environment

13. Conclusion

We believe that expectation for the reduction of the environmental burden as a result of introduction of System Products will increase in the future. Therefore, we plan to expand the provision of System Products that can contribute to the reduction of the environmental burden.

For this, while working on expansion of the use of SI-LCA across the group, we plan to conduct assessment jointly with our clients to understand the environmental burden reduction effect, and incorporate the result of the assessment into product development and the system use method so that the environmental burden reduction effect can be further enhanced. Meanwhile, as we are required to reduce the environmental burden in all product areas as global warming is increasing, we plan to expand the application of SI-LCA to social systems.

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Report

Issues in LCA in the Concrete Industry

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1. Introduction

In JLCA NEWS LETTERS NO.5(English Edition, July 2008), I focused on concrete, which is an important building material for structures, and has been used effectively as well as in a large volume, and examined the overall material flow of a concrete structure including manufacturing, building, servicing and demolition in order to understand the characteristics of the concrete material in terms of LCA.

The most serious issue there was that, in concrete structure demolition and recycling, although the current recycling rate of concrete from demolished structures was statistically high at 98%, the majority of it is reused as roadbed material and is rarely used as a material for new concrete production. In other words, compared to materials such as iron, it was difficult to recycle concrete material.

Therefore, continuing on from my article in JLCA NEWS LETTERS NO.5, I review some of the research reports and discuss recyclability of concrete such that concrete produced when concrete structures are demolished may be reused as a material for new concrete.

2. Demolition of Concrete Structures and Recycled Aggregate

Recycled aggregate can be produced by first demolishing concrete structures, sorting and collecting concrete blocks, and by crushing and grinding them. The mortar of the original concrete on the aggregate is then removed. Recently, multiple recycled aggregate manufacturing methods have been proposed.

As manufacturing of recycled aggregate has become a common practice, JIS concerning recycled aggregate has been established. Table 1 shows how recycled aggregate is recognized under JIS. High quality recycled aggregate having the same quality level as natural aggregate is defined as Recycled Aggregate H to be used in concrete. Recycled Aggregate H has its own aggregate standard since, according to JIS A 5308 (ready-mixed concrete) Appendix 1, it is intended to be used as concrete aggregate in the same manner as crushed stone, crushed sand, gravel, and sand.

Meanwhile, Recycled Aggregate M of the average quality level and Recycled Aggregate L of the low quality level are not included in JIS A 5308. As shown in Table 1, each of them is used to make concrete of its own kind; therefore, they have independent standards[1].

	Aggregate standard	Concrete standard
High quality	JIS A 5021 (Recycled Aggregate H)	JIS A 5308 (ready-mixed concrete)
Medium quality	Appendix A (Recycled Aggregate M)	JIS A 5022 (concrete using Recycled Aggregate M)
Low quality	Appendix A (Recycled Aggregate L)	JIS A 5023 (concrete using Recycled Aggregate L)

Table 1: Recycled aggregate described under JIS

To improve recycled aggregate quality, it is required to reduce the amount of mortar remaining on the aggregate and as a result of this, obtain recycled aggregate with high density and a low water absorption rate by increasing phases of removing mortar or by improving the grinding processing. The amount of energy necessary for this, however, increases as shown in Figure 1. Therefore, the basic CO_2 emission unit largely differs with the quality level of the recycled aggregate thus obtained.

Also, manufacturing recycled aggregate means production of fine by-product powder from mortar on the aggregate, and the amount of this fine powder produced increases dramatically as the grinding process becomes more sophisticated. In this article, I refer to recycled aggregate produced from concrete blocks obtained after concrete structure demolition as well as concrete made with recycled fine powder as "recycled concrete" regardless of the quality of recycled aggregate.

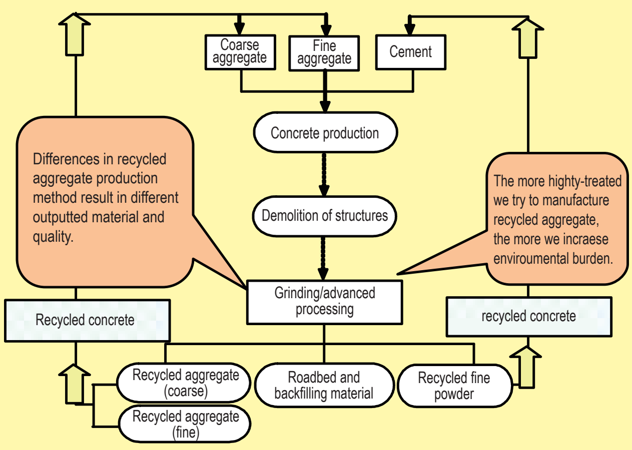

Figure 1: Flow of recycled concrete production

3. Method of Recycled Concrete Production and Environmental Impact/Burden

This section uses currently studied and reported recycled concrete production methods as examples to compare and review their environmental impact/burden assessment methods.

3.1 LCA for recycled concrete production by the eccentric rotor mill method

The eccentric rotor mill method refers to a recycled aggregate production method that uses equipment having a mechanism to remove mortar from the aggregate by applying a repeated compaction force.

The literature[2] compares Case A (30% of concrete blocks becomes recycled coarse aggregate and 70% is used as roadbed material / backfilling material / recycled sand) and Case B (30% of concrete blocks becomes recycled coarse aggregate and 70% is used as cement clinker raw material). It has been reported that CO_2 emission at the time of recycled aggregate production is [3.7 kg-CO_2 per ton of concrete block].

In this study report, they considered the possibility of replacing up to 10% of one of the cement raw materials which is limestone with recycled material, but 100% replacement is difficult. The material quantity reduction effect due to the replacement is subject to LCA, but the CO_2 reduction effect in cement production has not been assessed.

3.2 LCA for recycled concrete production by the heating and rubbing method

The heating and rubbing method refers to a recycled aggregate production method in which concrete blocks are heated to about 300℃ and ground down by friction when their attached cement paste becomes weakened such that Recycled Aggregate H having the same quality level as natural aggregate can be obtained.

In the literature[3], as shown in Figure 2, LCA is conducted for production of Recycled Aggregate H and use of its fine by-product powder as cement raw material or cement admixture. Only production of recycled aggregate, the environmental burden of production of recycled aggregate by the heating and rubbing method is [41.5 kg-CO_2 per ton of concrete block], much higher than the environmental burden generated by the eccentric rotor method. Note, however, it is possible to dramatically reduce CO_2 emission at the time of cement production by using the fine by-product powder, which is generated when recycled aggregate is produced, as cement admixture. In fact, it has been found that the overall environmental burden can be reduced as low as [-217.3 kg-CO_2 per ton of concrete block]. When a cement mortar experiment was carried out using an actual cement mill to produce cement containing approximately 5% □ recycled fine powder, cement having the same physical property as regular cement was obtained. Therefore, the heating and rubbing effect can be an effective method in terms of recycled aggregate LCA in the future.

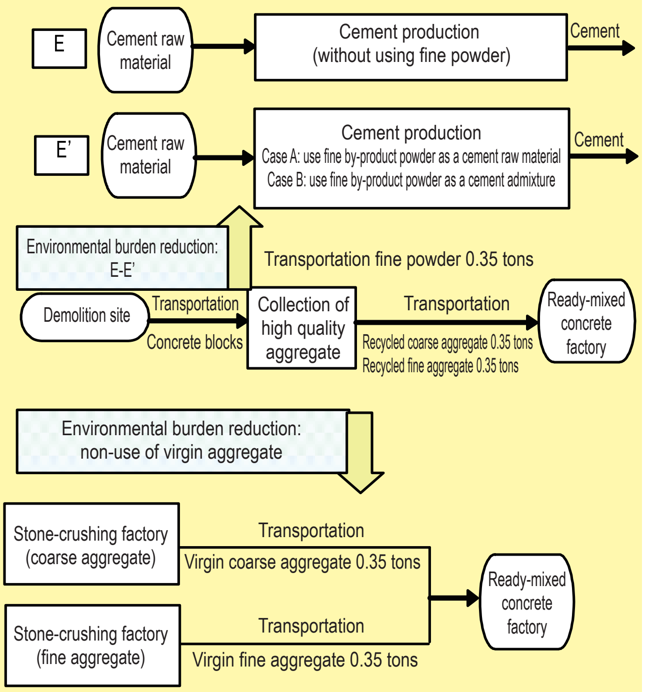

Figure 2: Heat-rubbing method and its LCA[3]

3.3 LCA when directly using concrete blocks without producing recycled aggregate

Sections 3.1 and 3.2 described the methods of establishing a recycling flow for concrete by producing recycled aggregate from concrete blocks obtained from demolished concrete structures. As shown in Figure 3, however, there have been studies and reports on a method of using concrete blocks as they are without spending any energy on them. It is difficult to apply this method to concrete in high-strength structures, but it is effective with relatively low-strength concrete such as artificial ground. This method aims to achieve a dramatic environmental burden reduction effect by using a large amount of additives such as blast-furnace fine powder and fly ash. According to a case example of construction work using this method, concrete blocks could be used at a site where a Coal-fired power station was reconstructed. This led to minimization of the amount of energy necessary for transportation. As a result, the CO_2 emission was reported to be reduced by approximately 60% as compared to the originally predicted emission in the construction work where purchase of ready-mixed concrete in town was planned[4].

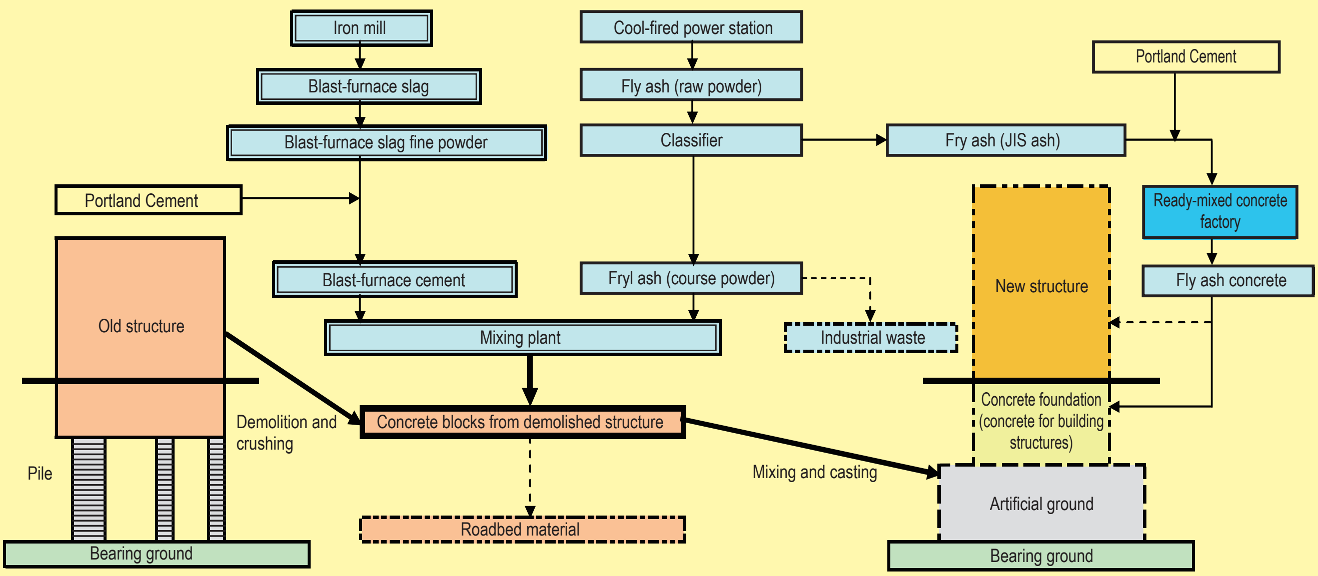

Figure 3: Schematic diagram of directly using concrete blocks

4. Conclusion

As described in the previous article, the ideal concrete industry has a closed input (material and manufacturing) and output (demolition, disposal, and recycling) system, but in reality, it is quite difficult to return the outputted material to the input position.

In this article, I examined the existing study reports on currently used recycled aggregate manufacturing methods in order to examine the possibility of solving the abovementioned LCA-related issues. We then discussed environmental impact assessment of these manufacturing methods. Environmental burdens associated with demolition of concrete structures and producing recycled aggregate from concrete blocks increases as the processing of recycled aggregate becomes more sophisticated. When the difference of CO_2 emission caused by recycled aggregate production is focused on, the heating and rubbing method generates 10 times as much CO_2 as the eccentric rotor mill method. But when the scope of LCA is expanded to cover the effective use of recycled fine powder in cement production and if the environmental impact reduction effect attributed to this effective powder use is taken into account, the overall environmental burdens can be dramatically reduced. Also, using concrete blocks from demolished structures without spending any energy on them can be one of the measures of contributing to the reduction of environmental burdens.

In the future, I believe we can find solutions to the issues described above by improving concrete recycling technologies and by expanding the system boundary setting of LCA for the concrete and cement industry so that assessment will be linked with production activities of other industrial fields.

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Information

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