Environmental Load Reduction by ICT

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The first commitment period established by the Kyoto Protocol began in 2008. In Japan, CO_2 emissions for 2007 (preliminary figures) increased by 8.7% compared with the base year (1990), putting Japan in the situation where it must reduce CO_2 emissions by more than 15% by 2012. Of particular concern are emissions from commerce and office activities, which have increased by 41.7% over the base year. Believing that information and communications technology (ICT) can make a significant contribution to reducing society's environmental load, the Fujitsu Group introduced an "environmentally conscious solutions certification system" in 2004 targeting those solutions that could bring about a CO_2 reduction effect of more than 15% by reducing paper usage, the movement of people and things, the amount of office space used, etc. and developed ways of visualizing the CO_2 reduction effects of ICT. This certification system has helped raise environmental consciousness within the Fujitsu Group while also demonstrating to customers in a straightforward manner that "ICT solutions make for a better environment". After providing some background, this paper outlines the system, presents case studies of certified and provided solutions and their effects, and surveys standardization activities for methods of assessing environmental load in software solutions.

1. Introduction

The first commitment period established by the Kyoto Protocol has begun. Japan is obliged to reduce carbon-dioxide (CO_2) emissions by 6% with respect to the base year of 1990, but preliminary figures[1] by CO_2-conversion calculations for 2007 indicate total CO_2 emissions in Japan of 1371 million tons, which represents an 8.7% increase over the base year. This means that Japan has an obligation to achieve an overall reduction of more than 15% by 2012. CO_2 emissions from commercial, service, and office activities, in particular, have increased, reaching 233 million tons, an increase of 41.7% (69 million tons of CO_2) over the base year (**Figure 1**). Various reasons for this have been reported, including an increase in office and retail floor space leading to more air conditioning and lighting facilities as well as a big increase in the consumption of electricity and other forms of energy due to the proliferation of automated office systems.

In the commercial sector, services that use Internet data centers (IDCs) as a backbone of operations have been expanding as enterprises shift to application service providers (ASPs), software as a service (SaaS), etc. There is concern that this development will increase the amount of power consumed by IDCs. The Ministry of Economy, Trade and Industry (METI) calculates that the power consumed by information technology (IT) devices and IDCs, which accounted for 5% of all power consumed in Japan in 2006, will increase by five times by 2025 and by 12 times by 2050 relative to 2006 levels.[2]

It goes without saying that energy-saving measures for servers and other information and

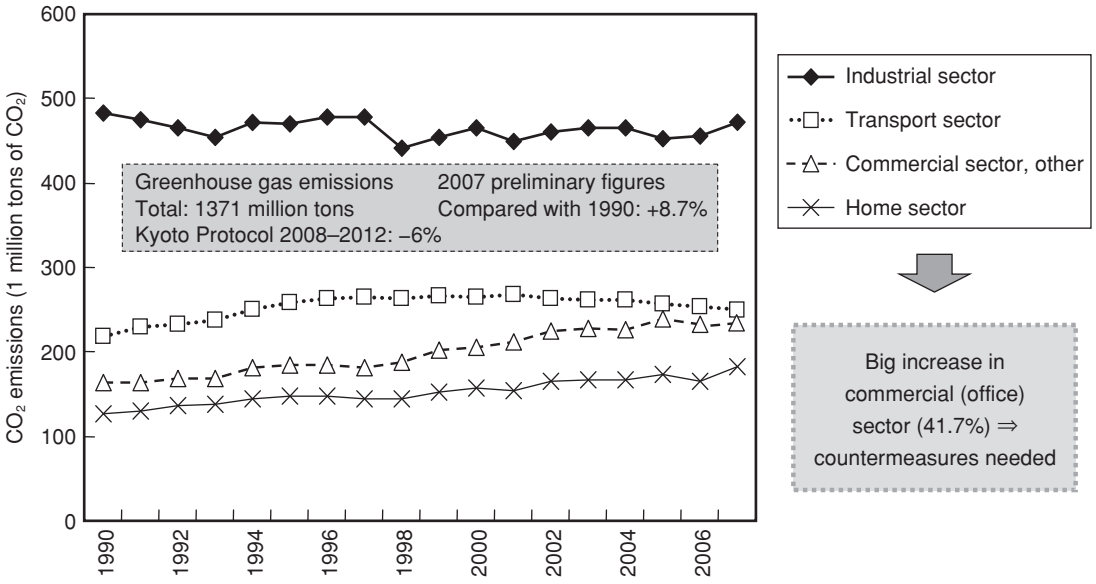
communications technology (ICT) devices are essential for reducing the amount of CO_2 emitted from IDCs. At the same time, services that use ICT can improve the efficiency of operations in business and social systems, thereby contributing indirectly to a reduction in CO_2 emissions. The Ministry of Internal Affairs and Communications (MIC) has calculated that ICT-based services can achieve a CO_2 reduction effect of 26.5 million tons by 2010.[3)]

In 2004, Fujitsu introduced an environmentally conscious solutions certification system to recognize those solutions that could bring about a CO_2 reduction effect of more than 15% by reducing paper usage, the movement of people and things, the amount of office space used, etc. This certification system has brought about a radical change in environmental awareness in systems engineering and sales while the attaching of certification labels to solution packages has generated interest and a favorable response from customers.

This paper describes the background to the environmentally conscious solutions certification system, outlines the system, presents case studies of two solutions that have been certified and provided and the customer response to them, and surveys efforts to standardize methods for assessing environmental load in solutions.

2. Environmentally conscious solutions certification system

In addition to reducing paper usage, trash, and power usage as targets of an environmental management system, there has been increasing momentum at Fujitsu to adopt environmental measures in its core business. Thus, in the case of hardware, it has become obligatory to perform a life cycle assessment (LCA) as one requirement in the certification of green products. The software area, however, has lagged behind in addressing environmental issues. To rectify this situation, it was decided that the same LCA concept should be applied in certifying solutions; however, given the unique properties of software solutions and the fact that their effects are greatest after introduction by the customer, Fujitsu has developed



Source: "Preliminary Figures for FY2007 Greenhouse Gas Emission"[1)] (MOE Press Release, November 12, 2008)

Figure 1
CO_2 emissions by sector.

a system that will focus on changes in business activities before and after solution introduction and certify those solutions that should achieve a certain environmental effect in terms of reduced CO_2 emissions (environmentally conscious solutions certification system).

This system evaluates the environmental contribution of an ICT solution considering its potential for saving energy and resources as well as raising operating efficiency. It certifies the solution as "environmentally conscious" if it achieves a CO_2-emissions reduction effect of 15% or more after introduction (**Figure 2**).

The basic idea of this certification system is to convert the introduction effects of an ICT solution into environmental effects using environmental measures. For example, the system can quantify for the customer the effects of introducing ICT solutions such as eliminating paper, improving productivity, and improving work efficiency; convert those effects to environmental load using CO_2 emissions as an index; and present that environmental load in visual form (**Figure 3**). An ICT solution is actually a process consisting of planning, developing, operating, and disposing of items (system upgrading, etc.), so it can be treated as a life cycle. The certification system described here, however, targets the customer's operation phase for evaluation.

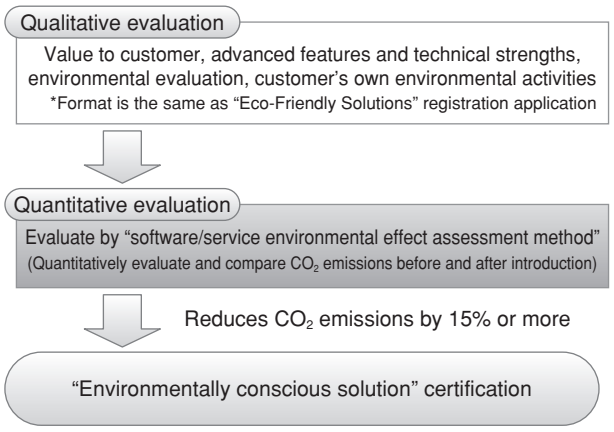


Figure 2
Procedure for certifying environmentally conscious solutions.

3. Evaluation of environmental load of ICT solutions

3.1 Effect assessment factors

To quantitatively evaluate the environmental contribution effect of a solution, we consider seven factors, including resource consumption, human movement, and office space (**Table 1**). These factors have either a directly recognizable CO_2 reduction effect or are deemed to have the potential for a CO_2 reduction effect.

3.2 Deemed effect

When talking about the effects of reducing resources (especially paper) and movement (especially by car), we can safely say that achieving an actual reduction in the amount of paper used and limiting the use of private cars will bring about a reduction in CO_2 emissions. However, in the case of a public transportation system, there will be no reduction in CO_2 emissions unless the number of people transported and the frequency of trips are significantly reduced and the schedule is revised. Similarly, in the case of an office, a reduction in the number of man-hours will not be readily apparent right after a solution has been introduced. Nevertheless, the introduction of software solutions has great potential for changing the way that work is performed and for changing the structure of society. Today, in the Internet society, E-mail, Web-based shopping, and various types of Web-based reservation systems have become commonplace. It is also common knowledge from news reports that a power outage or other problems in the infrastructure supporting the Internet can wreak havoc in society. For example, the crashing of a reservation system has been known to prevent passengers from boarding airplanes despite good weather for flying. Accordingly, the potential of a solution to bring about future changes in social systems should be taken into account as a deemed effect when talking about CO_2 reduction.

3.3 Method for assessing environmental effect

The following procedure is used to assess environmental load in ICT.

1) Establish functional unit

In this step, the main function or functions of the solution to be assessed must be quantified using a certain numerical unit. In other words, what exactly is to be assessed in this solution must be defined and the assessment period clarified. To provide the customer with a tangible ICT-introduction effect, this method takes one year to be the basic period for assessing changes in the environmental load after ICT introduction.

2) Establish assessment scope and collect evidence

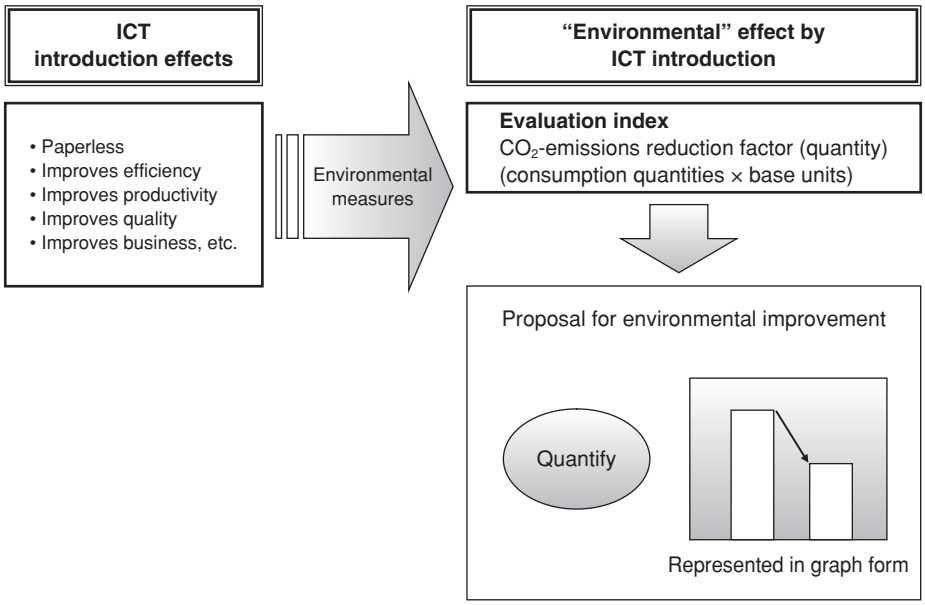


Figure 3
Basic idea of environmentally conscious solutions certification system.

Table 1
Effect assessment factors.

Effect assessment factor	Basic data needed for calculating CO_2 emissions	Factor trend
Resource consumption	Paper, CDs, documents, etc.	Factors that (generally) reduce CO_2 emissions
Human movement	Airplanes, commuter trains, buses, private cars, etc.	
Goods transportation	Compact trucks, business trucks, railroads, freight, airline cargo, etc.	
Office space	Space per person, space for servers, etc.	
Warehouse space	Ordinary warehouses, cold storage, etc.	
Power consumption of IT/network equipment	Power consumed by IT/network devices	Factors that (generally) increase CO_2 emissions
Network data communication	Amount of data flowing through network (including LAN-transmitted data)	

CD: Compact disc
LAN: Local area network

The LCA process includes a step for establishing system scope and collecting evidence within that scope. In evaluating a solution, however, one must sufficiently study whether that solution will replace all business tasks or just some of them. Here, it is important to understand well the features of the solution to be introduced and to decide on the assessment scope according to the types of evidence to be obtained. There are cases, however, in which evidence was not collected even when an ideal assessment scope was established beforehand. This is because collecting evidence at the customer's target site via systems engineering and sales is not necessarily easy. In such a situation, personnel in the systems engineering and sales departments will use their many years of experience to estimate and quantify the extent to which the solution will change the customer's business and treat the figures so obtained as evidence. In other words, in this step, the assessment scope will inevitably depend on the evidence that can be collected. In the end, however, a decision will be made by experienced environmental load assessors in consultation with each other. The above problems explain why ICT environmental load assessment is not an automatic process. The process of establishing the assessment scope and collecting evidence is the most important step in assessing environmental load, and adequate time and personnel must be allocated accordingly. To describe the amount of change, the figure before ICT introduction is set to a nominal value of 100 and the figure after introduction is, hopefully, a smaller value that might even be 0. For example, consider the case where the total amount of consumable goods required by a certain business task before ICT has been set to 100 and a value of 70 has been determined after introduction. The total amount represented by 100 and the remaining amount of 70 will be treated as evidence without the difference between them being calculated.

3) Calculate environmental load and display graph

In this step, each piece of collected evidence is multiplied by a basic unit (unit environmental load expressed here in terms of CO_2 emissions) and CO_2 emissions are tabulated by environmental effect factors. Total CO_2 emissions for all environmental effect factors are then computed and the environmental loads before and after ICT introduction are finally calculated. This process uses an in-house tool featuring spreadsheet software that accepts evidence as input and automatically displays a graph of before and after results.

4) Certify as an environmentally conscious solution

A checklist has been created to examine the suitability of the functional unit and assessment scope established for the ICT solution in question, the accuracy of collected evidence and tabulations, and other items. Using this checklist, supervisors in related departments within Fujitsu check solutions estimated to produce a 15% or greater reduction effect. Finally, after approval by higher management, the solution is certified as an environmentally conscious solution. Certified solutions are announced on the Fujitsu Website.

3.4 Basic unit and office space

To evaluate solutions, Fujitsu uses basic units obtained by calculating CO_2 emissions per million yen from a fiscal-2000 inter-industry input-output table and then referring to physical quantity tables to convert those values into units that express physical quantities (such as CO_2 emissions per kg, m^2, or m^3 in the case of materials or per item in the case of components or products) for ease of use.

In particular, office space, which is one of the seven effect assessment factors, can be broadly divided into space that can be directly converted, such as the space occupied by servers and personal computers, and space that can be indirectly converted as described later.

The floor space in an office building occupied by one person for office work[4] can be multiplied by the amount of CO_2 emissions per unit area gen-

erated by the consumption of energy resources for building maintenance.[5] This converts the amount of work done by one person per year into a certain amount of CO_2 emissions, which can be used for assessing environmental load (**Figure 4**).

3.5 Examples of environmental load reduction by ICT solutions

3.5.1 Case Study 1: GLOVIA/SCP FA[6]

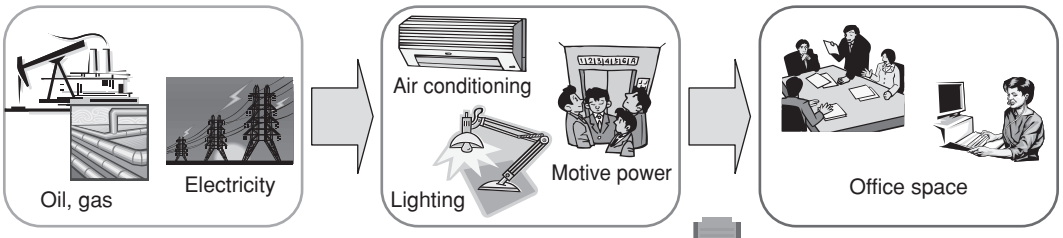
GLOVIA/SCP FA is a production planning package that optimizes the supply chain within a plant (procurement, production, and shipping) and helps to increase profits for the customer. It can create plans and schedules quickly taking into account limitations and conditions unique to different types of businesses and can visual the manufacturing process. Introducing GLOVIA/SCP FA can solve many issues affecting production planning. For example, it can reduce inventory, improve production efficiency, make personnel allocation more efficient, provide a mechanism for dealing with demand fluctuations, improve the accuracy of the available-to-promise (ATP) process, share production-progress status information, standardize work, and save on labor.

1) Introduction effect

As shown in **Figure 5 (a)**, the drafting of a production plan requires advanced know-how provided by experienced personnel. It traditionally consists of much manual work combining various forms using Excel. This invites the possibility of errors caused by the re-input of data and miscalculations that require time and labor to correct. With GLOVIA/SCP FA, this work is standardized so that anyone can do it in the same way, resulting in a labor-saving effect. An appropriate inventory level can also be calculated, enabling a reduction in stock on hand.

2) Comparison of CO_2 emissions

The graph in **Figure 5 (b)** compares CO_2 emissions before and after the introduction of GLOVIA/SCP FA. These calculation results are based on actual figures from a certain chemicals manufacturer that performed daily planning and other tasks about 300 times a year. Before introduction, warehouse space at 64.7% made up the



	Consumed energy (per m²-year)	CO_2 base unit
Electricity	136 Mcal (158.1 kWh)	0.39 kg-CO_2/kWh
Gas	44 Mcal (4.4 m³)	2.22 kg-CO_2/m³
Crude oil	11 Mcal (1.2 L)	2.76 kg-CO_2/L
Heat	17 Mcal (17 Mcal)	0.34 kg-CO_2/Mcal

Base unit for 1 m² of office space
80.2 kg-CO_2/m²-year

Contracted floor space:
13.0 m²/person
(excludes parking facilities, common-use areas, and vacant rooms)
Japan Building Owners and Managers Association

Office-space environmental load
Manpower (staff) × 1045 kg-CO_2/person

Rise in efficiency due to introduction of solution is converted into manpower and reflected accordingly.

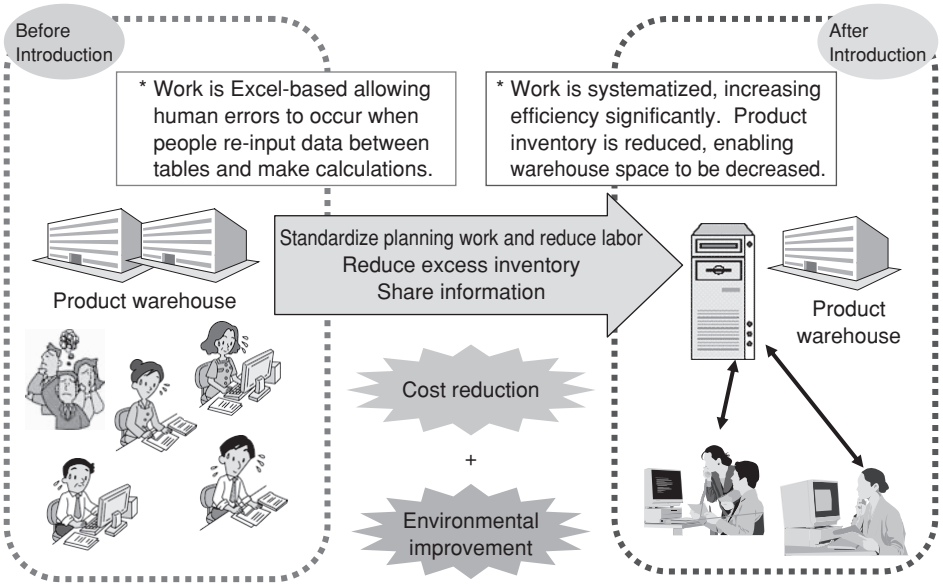
Energy used by buildings: The Institute of Energy Economics, Japan

Figure 4
Environmental load of office space.

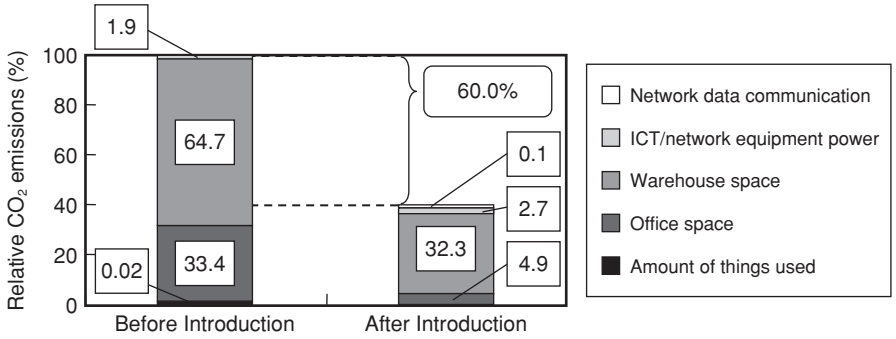
greater part of CO_2 emissions. This was because the accuracy of production planning was considered to be low, so to prevent a shortage of products in the face of sudden demand, excess product inventory was deemed necessary. Following warehouse space, office space made up 33.4% of CO_2 emissions. This high value can be attributed to the time and labor required for drafting production plans. After introduction, product inventory was cut in half and the environmental load due to warehouse space was also halved to 32.3%. Furthermore, as the work of drafting production plans became significantly more efficient, the environmental load due to office space was reduced to 4.9%. On the other hand, the environmental load due to power consumption increased from 1.9% to 2.7% and that due to network data communication accounted for 0.1%. When these figures before and after introduction were compared, it was found that CO_2 emissions could be reduced by 60% overall.

3.5.2 Case Study 2: IPKNOWLEDGE[7)]

IPKNOWLEDGE is an internal informa-



(a) Introduction effect



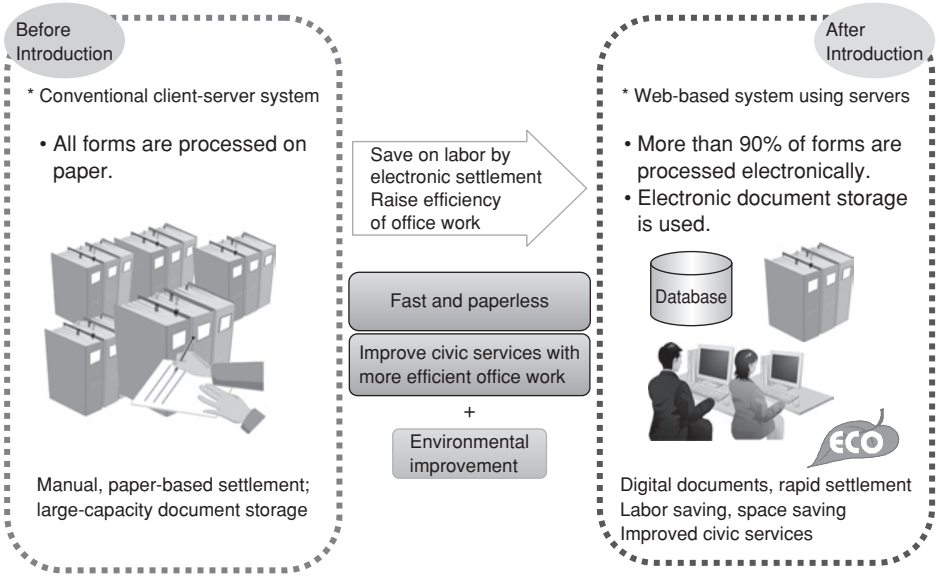
(b) Comparison of CO_2 emissions

Figure 5
Case study: GLOVIA/SCP FA.

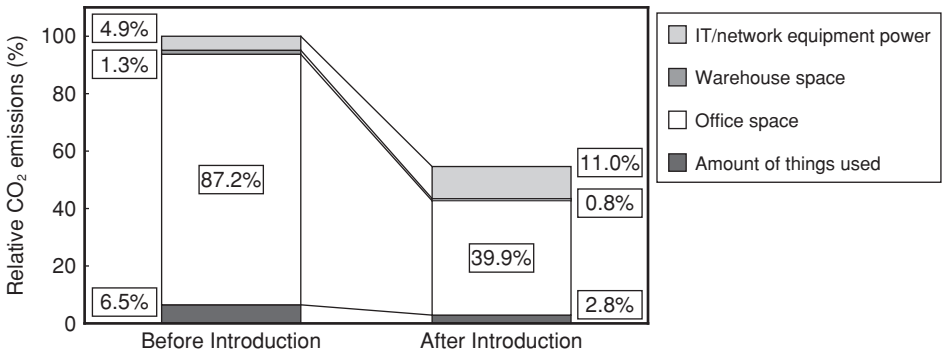
tion solutions package for local governments that integrates multiple systems such as document management, financial accounting, general affairs, electronic settlement, and personnel compensation. Since 2000 when it was first offered, it has been helping to make administrative tasks more efficient and governmental management more advanced at about 280 local governments (as of end of fiscal 2007).

1) Introduction effect

Before its introduction, a conventional client-server system was used, as shown in **Figure 6 (a)**. All forms were processed on paper, and documents were created by manual labor. Storage space was required to hold the paper-based forms and documents. The introduction of IPKNOWLEDGE led to the use of a Web-based system using servers. This enabled electronic approval and settlement to be performed, which raised work efficiency and achieved a paperless workflow. IPKNOWLEDGE also enabled the use of electronic document storage, which reduced the



(a) Introduction effect



(b) Comparison of CO_2 emissions

Figure 6
Case study: IPKNOWLEDGE.

amount of space needed for document storage.

2) Comparison of CO_2 emissions

The graph in **Figure 6 (b)** shows an example of comparing CO_2 emissions before and after the introduction of IPKNOWLEDGE. These calculation results are based on actual figures from a local municipal government having about 2500 employees where an electronic-settlement ratio of more than 90% was achieved. Before introduction, office space was responsible for 87.2% of the total environmental load, with most of that originating in man-hours. After introduction, more efficient office work reduced the environmental load for office space to 39.9%. The reduction of paper usage, meanwhile, reduced the environmental load caused by the use of things from 6.5% to 2.8%. In contrast, the power consumed by IT and network equipment rose from 4.9% to 11.0%. A comparison of the total environmental loads before and after introduction showed that a 45.4% reduction in environmental load had been achieved.

In both of these case studies, the environmental-load assessment results show that an environmental-load reduction effect was achieved by introducing ICT solutions. To put it another way, ICT solutions are environmentally friendly. Nevertheless, few customers select ICT systems from the viewpoint of environmental friendliness as yet. The majority of customers who introduce ICT systems do so to cut costs and make work more efficient.

To increase the appeal of introducing an ICT system on the basis of its environmental merits, we must try harder to instill in customers a good understanding of what exactly environmentally friendly means and in what way a system is environmentally friendly. Among the various environmental-load reduction effects of ICT, direct effects such as the elimination of paper and reduction of power consumption are relatively easy for customers to understand. Deemed effects, however, like office space reduction due to more efficient work processes, are difficult to explain to customers and are thus much less appealing. In some cases, assessment results that include deemed effects fail to induce a genuine sense of environmental friendliness in the customer.

What is important here is to make perfectly clear what viewpoint should be used in selecting an ICT system, what aspects of such systems make them environmentally friendly, and what sort of assessment method is used to make comparison studies and then to obtain recognition of this approach to ICT systems from society on the whole. A single company, however, can only do so much in this regard, so we think there is a need to standardize methods of evaluating environmental load in ICT solutions in cooperation with government agencies and academic institutions and to generate interest in customers on an ICT-industry-wide basis.

4. Standardization of environmental load evaluation methods

When we explain the results of an environmental load evaluation to a customer, we are often asked whether the results are standardized. Fujitsu is not alone in receiving such a question, and efforts are being made among industry, government, and academia to standardize environmental load evaluation methods. Some of these activities are introduced below.

4.1 Activities at the WG on ICT environmental efficiency (Japan Environmental Management Association for Industry)

A Working Group (WG) on the standardization of environmental load evaluation was established and the following items were reported.

- The social effects of ICT services were studied in terms of added value and their environmental load and future issues were analyzed (fiscal 2003).[8)]
- A general framework, principles, and re-

quirements for evaluating ICT environmental load and environmental efficiency as well as for comparing evaluation results were collected (fiscal 2005).[9)]

In addition, assuming that many readers of the above information would be planning to perform an ICT evaluation for the first time, it was decided to combine that information with case studies and easy-to-understand explanations in a general publication.[10)]

It should be mentioned here that the above activities helped to promote common ideas about environmental load evaluation. The information so provided included a Fujitsu case study that demonstrated the validity of Fujitsu's approach to office space in terms of calculating CO_2 emissions in conjunction with man-hours.

4.2 Basic units for environmental load calculations

We decided to forego the publishing of basic units considering that there are even businesses that market basic-unit information. We did, however, investigate publishing basic units that could be used as reference by newcomers to environmental load evaluations. In the end, we decided to provide as reference value sets of basic units obtained by starting with basic units of CO_2 data per unit price calculated by the National Institute of Environmental Studies from inter-industry input-output tables[11)] and converting those basic units into physical-quantity units from physical quantity tables.

4.3 Activities at MIC

At MIC, the Study Group on Progress in the Ubiquitous Society and the Environment was established in December 2004. It analyzed the impact of various types of ubiquitous technologies and systems on the global environmental and their use in a global environment observation system, and, using an economic model, it clarified the ripple effect on the Japanese economy. It also summarized those items that must be addressed to ensure further progress of the ubiquitous network society. These include proposals for various measures such as the development of a model system for reducing environmental load through the use of ubiquitous technologies.[3)]

In addition to the above, the Study Group on ICT Systems and Networks Contributing to Environmental Load Reduction[12)] was established in October 2006. They have stated that the "increase in the number of ICT devices due to the expansion of the ubiquitous network society and increase in energy consumption due to high-performance, high-speed operation is unavoidable, and it is therefore desirable that technology-enhancement activities toward reduced environmental load be expanded". This statement was followed up by the publication of the "Environment-Friendly ICT Use Guidebook".[13)] The findings of this SG underscore the idea that all steps of the ICT process from procurement to application must be considered in order to the reduce environmental load in society.

Also established at MIC was the Study Group on ICT Policies to Deal with Global Warming.[14)] This SG, which began meeting in September 2007, aims to specify the positive and negative aspects of the impact of ICT on global warming and to study ICT policies that contribute to the creation of "Japan—An Environmental Nation" and the easing of global warming on an international scale.

Making a wide public appeal for "case studies on reducing environmental load by ICT" from companies and local governments, the SG reported that many types of companies in addition to ICT enterprises were working to improve the efficiency of business operations through the use of ICT (April 10, 2008). The results of this public appeal reaffirmed the view that many types of businesses were enjoying the convenience and benefits of ICT and that a CO_2 reduction effect from the use of ICT could be expected.[15)]

5. Conclusion

Since 2004, Fujitsu has been actively applying an environmentally conscious solutions certification system and participating in industry-government-academia study groups with the aim of assessing how the use of ICT, Fujitsu's core business, can change the environmental load at its point of implementation and how it can affect the environmental load throughout society.

It is no exaggeration to say that ICT has become a lifeline in modern society just like water and electricity. Telecommunications and the Internet have become a factor in building interpersonal relationships that go beyond time and space, and they have become indispensible to many types of transactions such as reserving tickets, purchasing products, and downloading music and video. Today, operating a computer has become synonymous with connecting to the Internet, and people have come to use ICT much like they use air, taking it for granted and forgetting the benefits that it provides. As long as the mail server is up and running and the ICT infrastructure suffers no problems, no one pays any attention to the mechanism of E-mail delivery or considers the convenience that it offers. Without ICT, modern society would cease to exist. While the benefits of freeing workers from the drudgery of manual labor before the introduction of ICT and making work more efficient are immeasurable, environmental load evaluation technology can express and visualize those benefits through the lens of environmental effects.

The first step toward standardization is the use of common basic units. The use of different measures can only generate doubt about evaluation results. The basic-unit tables referred to in this paper are provided on an open basis. With an eye to an evaluation technique that uses these basic units, Fujitsu will continue to maintain its environmentally conscious solutions certification system based on the environmental load evaluation technology presented here while providing solutions that contribute to a reduced environmental load for customers and society on the whole.

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