GIPC Survey and Estimation Committee Report

FY2009

(**Summary**)

-- Contribution of Green IT to Realization of a Low Carbon Society --

June 2010

Green IT Promotion Council (GIPC)

Survey and Estimation Committee

Introduction

More than 2 years have elapsed in April 2010 since the Survey and Estimation Committee of GIPC started its activities in February 2008. Upon the foundation of the GIPC in February 2008, its Survey and Estimation Committee was also established with the aim to formulate metrics for specifying the quantity of contribution to Green IT and evaluating energy saving, and to survey Green IT activities abroad. With the support of many people and organizations involved in Green IT extended to date, GIPC has grown so as to publish the performance of advanced efforts and research activities. We express our gratitude for their support.

Based on the performance of activities in 2008, we further expanded the content of our activities and worked on survey and study in 2009. The summary of the content of our activities in fiscal 2009 is provided as this "2009 Survey and Estimaton Committee of GIPC Report."

Worldwide activities for global warming prevention are considered to have progressed greatly in last year. The long-term goal proposed by the Japanese government in 2007, i.e., "to reduce global Greenhouse gas emissions by half from the current level by 2050," has become the goal for the entire world. Moreover, the framework of the post-Kyoto Protocol was discussed in the Conference of Parties to the United Nations Framework Convention on Climate Change ("COP15") held in Copenhagen, Denmark, in December 2009. Unfortunately, the Conference failed to reach agreement on entire framework and new protocol. However, "Copenhagen Accord" was proposed in order for many countries to establish targets for reducing Greenhouse gas emissions. As a result, in addition to the developed countries, including Japan, U.S., and EU, many newly emerging countries and developing countries have declared their quantitative targets concerning Greenhouse gas emissions. It is a very tough target for the world to achieve the targets of Greenhouse gas emissions while keeping sound economic activities. However, this would be achieved with various innovations, such as development of innovative / advanced technologies, design of new social systems / institutions, and new market mechanisms. It is also necessary for the entire society to make substantial change to life style, work style, way of traveling, way of using resources, way of manufacturing, etc. and is also significant to change the sense of values in society. For realization of such changes in the sense of values and society, Green IT is expected to make a great contribution.

With focus on the quantitative evaluation of contribution to this Green IT Promotion Council, the Survey and Estimaton Committee of GIPC has been consistently working on study since the first survey in fiscal 2008. In global warming prevention measures, it is particularly important to clarify "How specifically will the world reduce Greenhouse gas?"

and "Where are technologies, funds, and human resources in the world invested in order to achieve the target?" In proceeding to a discussion of these themes, the Committee considers that substantial study will not progress without examining IT effect, and is therefore working on quantitative survey / study of the contribution and potential of measures concerning Green IT, such as "What can this Green IT do for the realization of a low carbon society?" and "And to what extent can Green IT contribute?"

As a contribution of the IT industry to realization of a low carbon society, reduction of emissions arising from the production / business activities of IT-related companies is mentioned first. Since emissions reduction is the most fundamental activity, consistent efforts are required, while the ratio of the IT industry's CO2 emissions to the total industry's emissions in Japan is said to be rather limited --- about 1.5%. On the other hand, it has a very great influence to encourage efficiency increase in the use of energy and resources in overall social through the low power consumption of various IT and electronic equipment and household electrical appliances widely used in society, as well as the utilization of IT solutions. "Energy saving of IT equipment ("of IT")" and "Entire society's energy saving by IT" -- these two pillars greatly contribute to Green IT. The Survey and Estimaton Committee of GIPC has been working on the quantitative study of contribution to Green IT, considering the significance of formulating "a measure (evaluation method)" for quantitative measurement of contribution to Green IT in individual fields and of clarifying "To what extent and until when is it possible to contribute to CO2 reduction?" using that measure.

In fiscal 2009, the Committee installed three working groups (WGs) according to issues and worked on study with focus on 5 themes. WG1 deeply discussed the three themes of "Energy saving of IT equipment", "Entire society's energy saving by IT", which were both discussed by multiple WGs in fiscal 2008, and "Survey and analysis of overseas Green IT." Now, activities concerning Green IT are spreading in the whole world. In the U.S., Green Grid, Department of Energy (DOE), Environmental Protection Agency (EPA), etc. are conducting advanced activities. In Europe, activities concerning Green IT are also becoming active, mainly led by the EU Committee. In Asia, discussion about Green IT has begun mainly in South Korea and China. Considering the utilization of results of the survey and analysis of such worldwide activities for further promotion of activities and reinforcement of global cooperation in Japan, we developed survey and study activities.

WG2, as an independent group, engages in concentrated survey and study of "Datacenter Performance Per Energy (DPPE)," which was newly proposed in fiscal 2008 as a reinforced version of "Energy saving concerning datacenter," which it had been studying in fiscal 2008 as a subworking group.

WG3 developed survey and study activities with the theme of "Quantity of Contribution of Enterprises Developing / Providing Green IT Equipment / Solutions" -- a theme continued

from fiscal 2008. Provision of Green IT to society by IT vendors and other IT providers contributes to reduced energy consumption in the use of IT equipment or data centers, and introduction of IT solutions is also expected to reduce energy use in various fields of society. In such supply chain of Green IT, visualization of the contribution of contributors to energy saving by Green IT for the entire chain is considered necessary for sound activation of the cycle of the development, manufacturing, sales, and consumption of Green IT as a positive spiral.

The Survey and Estimation Committee of GIPC has been developing activities, including survey and study if Green IT from various viewpoints, for the purposes of realizing evaluation of Green IT effect with a common measure and clarifying contribution quantitatively using that measure. As regards the quantity of contribution, the Committee has been forecasting the quantity of future contribution. In addition to the forecast made in fiscal 2008 for the quantities of contribution in 2025 and 2050, the Committee made a complimentary forecast for fiscal 2020, which is an important target year, based on the forecast data of fiscals 2025 and 2050. This FY 2009 Survey and Estimation Committee of GIPC Report summarized results of the foregoing studies with focus on the five themes so far mentioned. In order to deepen the understanding of the entire flow concerning Green IT and definitions concerning its evaluation methods, each chapter continuously describes the results of study and trial computation conducted in fiscal 2008, including many definitions, evaluation methods, data, evaluation examples, and forecast results concerning Green IT. Consideration was made to ensure that the content of study about Green IT can be easily and systematically understood by even those who read only the Report of fiscal 2009 version.

What should the entire world, entire society, and individual companies and persons do in order to reduce global greenhouse gas emissions to 50% of the current level in 2050, including targets for the milestone years of 2020 and 2025? And to what extent and from what is specific effect expected? In order to clarify these questions, study results were summarized with focus on quantification. Needless to say, cooperation with people in other industries and sectors, as well as IT industry and IT companies, is necessary in formulation and operation of measures to realize contribution to Green IT. Results of studies in fiscals 2008 and 2009 would serve to help people in various fields of society in understanding "What should we do to reduce energy use and CO2 emissions and how much can we reduce them?" or "What is the most effective thing we should do?"

In promoting activities of the Survey and Estimation Committee of GIPC, we received support in fiscal 2009 as in fiscal 2008 from the member companies / organizations of Information and Communications Division of the Commerce and Information Policy Bureau

of METI, Japan Electronics and Information Technology Industries Association (JEITA), and the GIPC. Also, the members of Survey and Estimation Committee of GIPC and the heads and members of the three WGs took the time for surveys and studies, as well as useful and active discussions. Further, in conducting quantitative studies, we referred to the results of surveys and researches by many predecessors concerning Green IT, and exchanged views from time to time with people of relevant organizations and institutions. Particularly, we received many direct findings from the Agency of Natural Resources and Energy of METI, Electrical & Electronic Industries Liaison Conference for Global Warming Prevention Measures, National Institute for Environmental Studies, and Japan Environmental Management Association for Industry. We like to take this opportunity to express our deep gratitude again for their cooperation

In the future, the Survey and Estimation Commitee of GIPC will continue quantitative surveys concerning the great potential of Green IT, and contribute to establishment of a system in order to provide and disseminate such potential to the real world. We hope that this Report can be of service to many people engaging in activities in various fields for realization of a low carbon society.

June 2010

Chairman of the Survey and Estimation Committee of
Green IT Promotion Council

Michinori Kutami

Executive Summary

1. Background of Survey (Part I)

In order to achieve the goal proposed by Japan that global greenhouse gas emissions must be reduced by half of the current level by 2050, it is said that developed countries need to reduce greenhouse gas emissions by 60 to 80%. To this end, innovation is necessary and IT is expected to contribute to such innovation.

Reducing emissions from in-house production is first mentioned as a possible contribution of the IT industry. Such contribution is made in almost all industrial fields, while the ratio of the IT industry's CO2 emissions to the total industry's emissions in Japan is rather limited --- about 1.5%. On the other hand, it has a very great influence to encourage the low power consumption of various IT and electronic equipment and home appliances widely used in society ("Energy saving of IT equipment ("of IT")") and efficiency increase in the use of energy and resources in overall social through the utilization of IT solutions ("Entire society's energy saving by IT").

Japan is developing Green IT Initiative in order to promote changes in wide areas, including production, society, and people's lives aiming for construction of "a society where the environment and the economy coexist," which is appropriate for the 21st century. Under such circumstances, the GIPC was founded with a particular aim to strengthen cooperation among industry, academia and government.

Based on a long-term vision extending to 2050, the GIPC is developing activities with the understanding that discussion on a mid-term basis, i.e., what should be done from 2020 to 2025, is particularly important. Specific activities being promoted by the GIPC include penetration and awareness raising concerning Green IT, international cooperation, holding of international symposiums, identification of Green IT technologies / preparation of roadmap, quantitative survey / analysis of Green IT effect, and forecast of the quantity of future contribution.

From fiscal 2008 to 2009, with the mission of specifying effective measures for CO2 reduction and clarifying approach to be taken promptly through the quantitative grasp of the effect and quantity of contribution of Green IT, the Survey and Estimation Committee of GIPC carried out "establishment of the evaluation method (measure) for Green IT, and visualization and quantification of Green IT effect (quantity of contribution)", and "medium-to-long-term forecast of Green IT effect (CO2 reduction effect)." To be specific, the following five activities were promoted:

1. Quantification of energy saving of IT equipment and a medium-to-long term forecast
2. Quantification of energy saving of data centers and a medium-to-long term forecast
3. Quantification of society's energy saving by IT and a medium-to-long term forecast
4. Study on visualization of the quantity of contribution to other industries / sectors by companies that develop / provide Green IT.
5. Collection of information about approach to Green IT in the world.

This Report provides the summary of the results of surveys and researches conducted by the GIPC Survey and Estimation Committee in fiscal 2009.

2. Measurement / forecast of the effect of energy saving of IT (Part 2)

Energy usage in household and industry sectors has been continuing the trend of increase. Since IT and electronic equipment account for a considerable percentage of total energy consumption in these sectors, it is greatly expected to develop technologies for improving the energy saving performance of IT and electronic equipment in accelerating energy saving in household and industry sectors.

Part 2 provides quantitative forecasts for the trend of energy consumption through 2050 and the effect of reduced energy consumption resulting from technical innovation ("energy reduction effect") with regard to the 10 IT / electronic products that consume energy in large amounts. Also, as a prior condition of these forecasts, we reviewed the concept of energy use efficiency in these products. The target 10 products consist of 5 IT products: PC, server, storage, router switch, and display and 5 electronic products: Television, home-use recorder / player (DVD etc.), refrigerator, lighting, and air-conditioner.

The energy reduction effect of IT and electronic products in the future can be defined as the difference of power consumption between the cases where technical innovation makes progress ("case of technical innovation") and where technical innovation makes no progress ("baseline"). Note that difference needs to be measured between the products with the same performance in comparing the power consumption of each product between the cases where technical innovation makes progress and where it makes no progress. For example, television sets with the same screen size (one metric of performance) must be chosen in comparing the same television products. In fact, out of the various characteristics that provide the performance of products, the most important characteristic was chosen consistently from each product to calculate reduction effect (Fig. 0-1). Other necessary characteristics were additionally taken into consideration, such as using them for classification. In addition, since power consumption per unit capability of each product is considered to represent energy efficiency, the ratio of "performance" to power consumption is also provided as an energy efficiency metric.

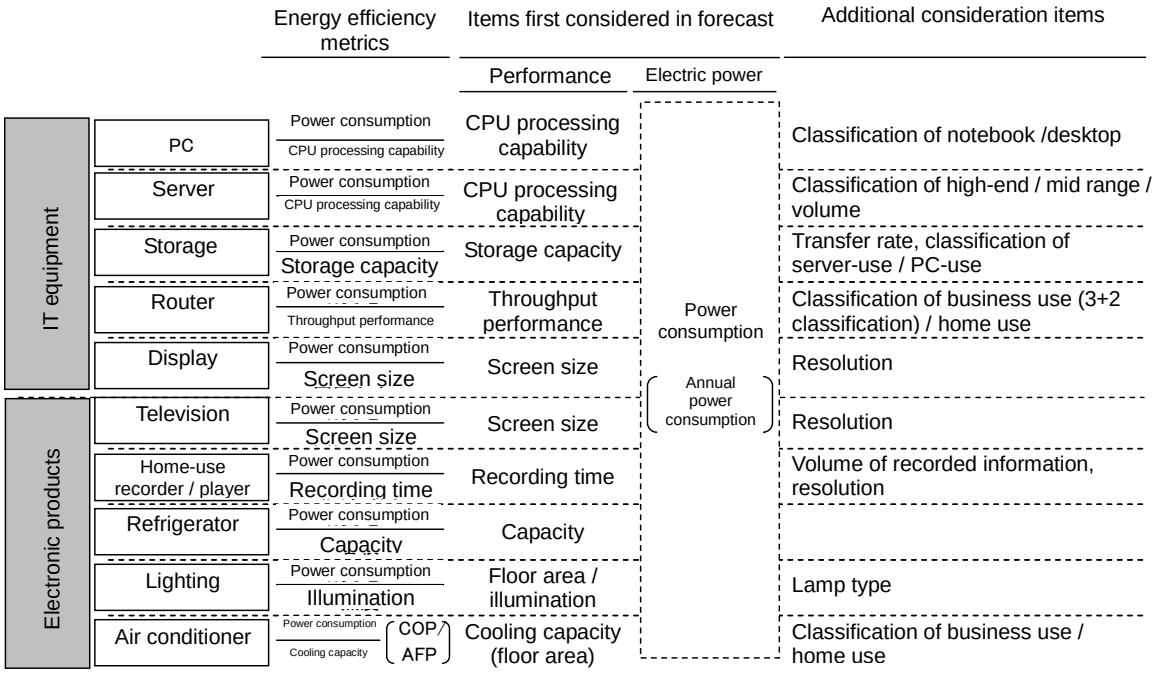

Figure 0-1: Target Products and Energy Efficiency Metrics

Next, we forecasted energy consumption on each baseline (electronic power consumption) and energy reduction effect by technical innovation for each of the 10 products.

Energy consumption was forecasted in reference to the product of the number of products penetrated and power consumption per unit. The number of products distributed was forecasted using the positive correlation between GDP and product penetration rate. Power consumption per unit was forecasted in reference to the technology roadmap by the technological examination committee, etc. for the case where technical innovation makes progress, or was set to the power consumption of the product as of 2005 (power consumption assuming that the past trend of performance and power consumption of IT products continues in the future) for the case where technical innovation makes no progress.

Figure 0-2 shows the total energy (electric power) consumption of the 10 products from 2005 to 2050 and trend of energy reduction effect. The energy consumption of 2020 was estimated from the energy consumption in 2005, 2025, and 2050. Contribution of facility is also taken into consideration for server and storage router, which are often used for industrial purpose. [1] In Japan, total energy consumption of the 10 products as of 2005 was about 330 billion kWh/year, but it will increase to about 450-500 billion kWh/year (about 490 billion kWh/year) in 2025 if the current status continues. However, this is expected to decrease about 120-170 billion kWh/year (about 140 billion kWh/year) in 2025 as a result of technical innovation. On a global scale, energy consumption will increase faster from about 3.1-4.2 trillion kWh/year (about 3.7 trillion kWh/year) in 2005 to about 6.0-8.5 trillion kWh/year (about 7.1 trillion kWh/year) in 2025. However, this is also expected to reduce about 1.8-2.9 trillion kWh/year (about 2.4 trillion kWh/year) in 2025 as a result of technical innovation. (Results of Scenarios A to C are provided considering the range of forecast resulting from uncertainty. Each scenario was prepared taking into account the range from minimum to maximum values for per-unit energy consumption and penetration rate (Table 0-1). Parenthesized figures represent Scenario B.)

Where the foregoing energy consumption data is converted to CO2 emissions, Japan's total emissions may increase to 90-200 million t-CO2 in 2025 but technical innovation is expected to reduce emissions by 20-70 million t-CO2. Globally, total emissions may increase to 1200-3400 million t-CO2 in 2025 but technical innovation is expected to reduce emissions by 360-1160 million t-CO2. [2]

In Figure 0-2, the increasing rate of energy consumption in Japan is lower than worldwide consumption. This is attributable to the high ratio of air conditioners and lighting products, which are almost fully penetrated. However, if limited to the five IT products and television, Japan's energy consumption will increase at a high rate, reaching about 3-5 times the 2005 level in 2025 (Figure 0-3). Further, the percentage of the 6 products including IT products to total energy consumption in 2025 will be 38%, while the percentage of these 6 products to the reduction effect accounts for about 50%, which shows much room for reduction.

Table 0-1: Three Scenarios Studied (refer to Table 2.5-1 for details)

Scenario A	High penetration rate / High rate of increased power consumption of IT equipment
Scenario B	Middle penetration rate / Middle rate of increased power consumption of IT equipment
Scenario C	Low penetration rate / Low rate of increased power consumption of IT equipment

[1] Effect of facility improvement was computed using the stand Power Usage Effectiveness (PUE; refer to Section 2, Part 3) of each year. PUE values used are 1.9, 1.8, and 1.7 for 2005, 2025, and 2050, respectively.

[2] In considered of future uncertainty, conversion factors were set to 0.2-0.4 [kgCO2/kWh]. The value of 0.4 is based on the assumption that the ratio of non-fossil power sources ratio and power generation efficiency remain at the current level. The value of 0.2 is based on the assumption that the same ratio and efficiency continue improvement.

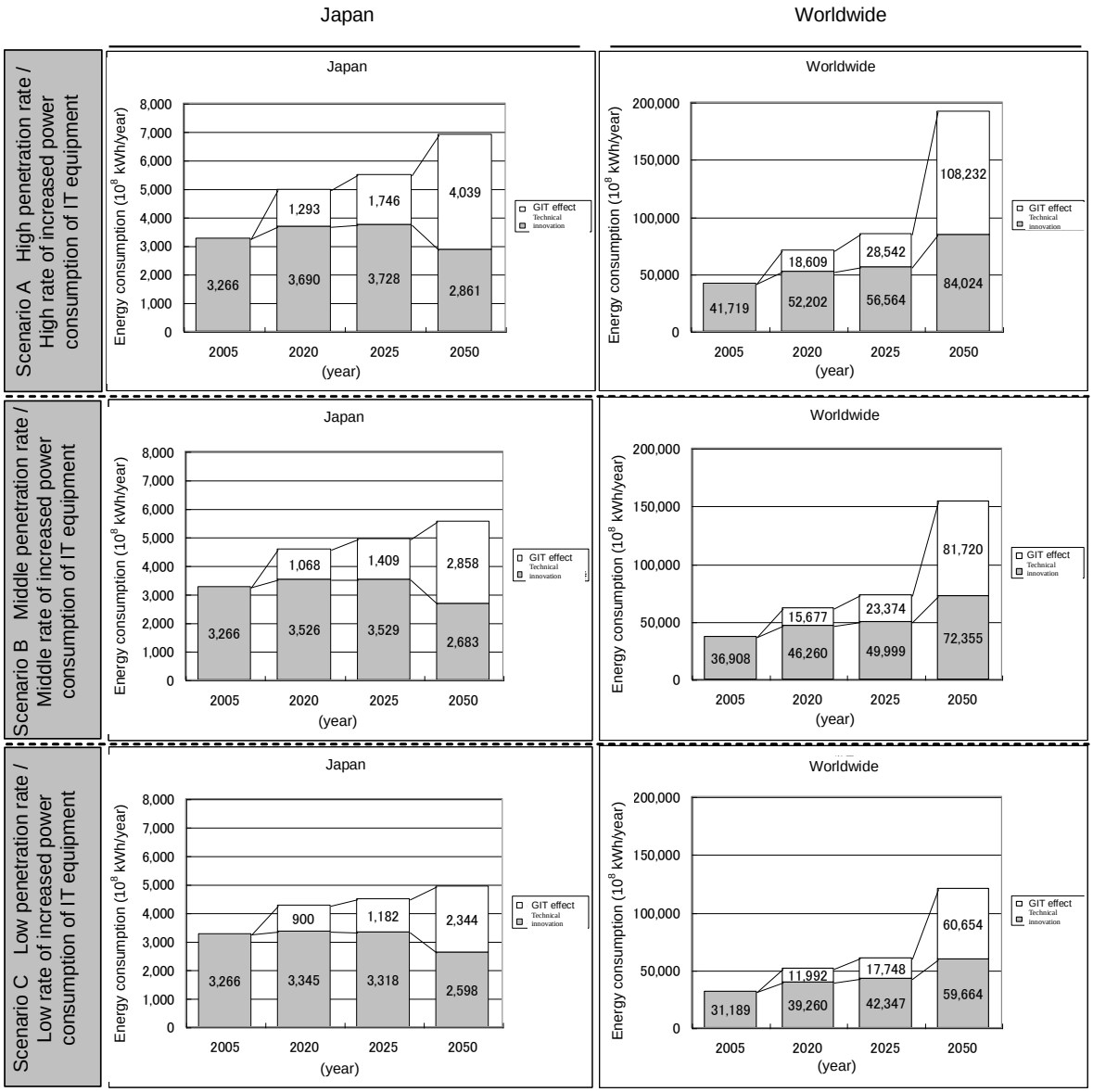

Figure 0-2: Forecast of Trend in Energy Consumption and Energy Reduction Effect for 10 Products [3](Left: Japan, Right: Worldwide)

[3] Since the number of products penetrated in the world in 2005 was estimated using the prediction formula, energy consumption varies according to scenarios.

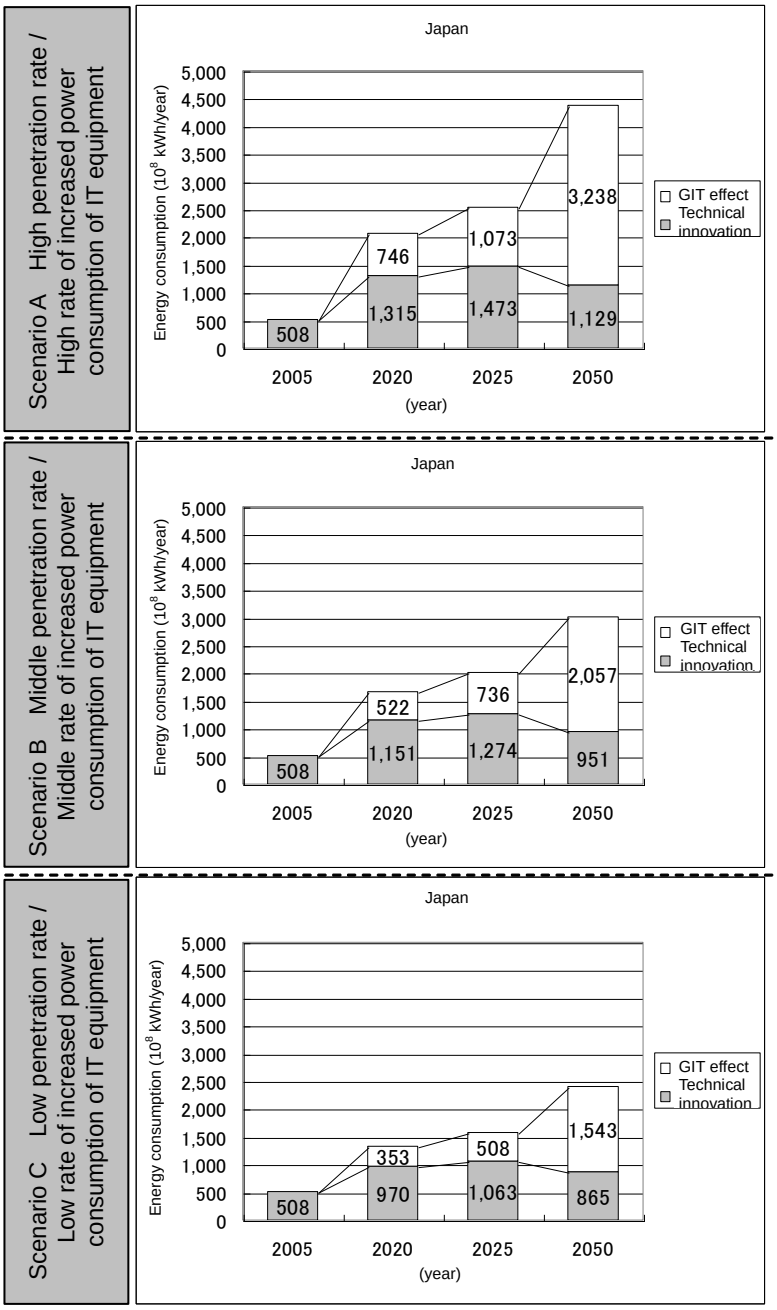

Figure 0-3: Forecast of Japan's Energy Consumption and Energy Reduction Effect for IT Products

3. Measurement / forecast of the effect of energy saving of data centers (Part 3)

Since energy consumption of the data center is rapidly growing worldwide in accordance with the information explosion, it is urgently required to improve energy efficiency of the data centers. This Report attempted a forecast about energy consumption and energy reduction effect of the data centers. Moreover, as metrics for encouraging achievement of Green IT effect in this forecast, unique metrics for energy efficiency of the data centers were studied. This Report summarized the progress in this study.

Results of the forecast of energy consumption of the data centers

Electric power consumed of the data centers is classified into power for IT equipment and for facility such as building. In forecasting energy consumption of the data centers, Power Usage Effectiveness (PUE) [4] was used for facility, while power consumption and performance of servers, storage, and networking equipment were considered for IT equipment.

As regards power consumption of IT equipment, of the servers, storage, and networking equipment studied in Part 2, those included of the data center were used for forecast. For forecast of power consumption in facility, PUE was used. For baselines, PUE as of 2005 was set to 1.9, and PUE as of 2025 and 2050 was set to about 1.8 and 1.7, respectively. In the case of technical innovation, PUE, which was 1.9 as of 2005, was assumed to be about 1.28 and 1.14 in 2025 and 2050, respectively. Power consumption in 2020 was forecasted in reference to power consumption in 2005, 2025, and 2050.

Figure 0-4 shows the trend of energy consumption and energy reduction effect of the data center. Energy consumption of the data center will increase considerably in 2025 and 2050, but increase can be fairly controlled by the effect of technical innovation. Japan's energy consumption as of 2005 was about 15 billion kWh/year, but will increase to about 60 billion kWh/year in 2025 if the current state continues. However, this is expected to decrease about 44 billion kWh/year in 2025 as a result of technical innovation. Even if efforts for technical innovation are advanced, power consumption of IT equipment will be about 1.5 times the 2005 level in 2025, but total energy consumption remains at a level of slight increase since the value of PUE falls as a result of improved efficiency of facility.

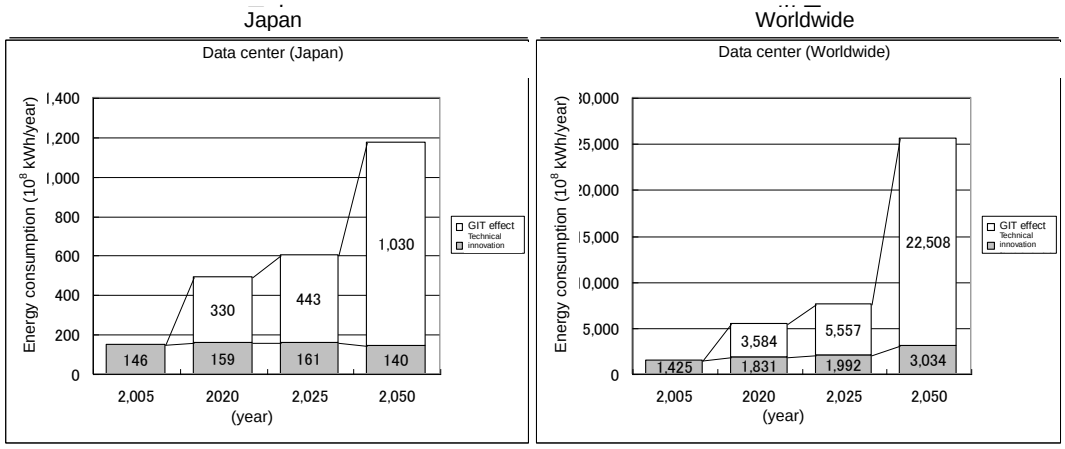

Figure 0-4: Energy Consumption and Energy Reduction Effect of the data center

[4] PUE is a metric proposed by Green Grid in the U.S., defined as (Power consumption of the entire data center) / (Power consumption of IT equipment), and represents data center energy efficiency of the facility.

Study on energy efficiency metrics

As a metric indicating the data center energy efficiency, Power Usage Effectiveness (PUE), developed by Green Grid, is being widely acknowledged. However, in order to improve energy consumption of the data center, it is not enough, as shown in the forecast of energy consumption, to use only the PUE metric, which encourages improvement in power consumption in facility. GIPC is therefore considering the introduction of Datacenter Performance Per Energy (DPPE) as a new metric indicating the data center energy efficiency on the whole. Defining the calculation method of DPPE, we computed the metric using the data of an actual data center.

Basic concept of new metrics

In principle, GIPC is studying metrics to find appropriate ones that indicate the productivity per power consumption of the data center. The starting point of the study is based on the formula: DPPE = (Production volume of the data center) / (Power consumption). In defining DPPE, it is necessary to determine how to define productivity, range of power consumption, etc., which should be linked to the effect of energy saving measures in the data center. Then, we defined sub-metrics with focus on the 4 energy saving measures in the data center.

Sub-metrics	Formula	Responsive actions
ITEU (IT Equipment Utilization)	= Operational Utilization of IT Equipment of data center	- Effective operation of IT equipment
ITEE (IT Equipment Energy Efficiency)	= Total rated capacity of IT equipment / Total rated energy consumption of IT equipment	- Introduction of energy-saving IT equipment
PUE (Power Usage Effectiveness)	Total energy consumption of data center / Total energy consumption of IT equipment	- Energy saving of facility
GEC (Green Energy Coefficient)	Green (natural energy) power / Total energy consumption of data center	- Use of green power

Using these sub-metrics, DPPE can be represented as follows:

DPPE ＝ｆ (ITEU, ITEE, PUE, GEC)

Where the sub-metrics we defined are applied, DPPE can be represented as follows:

DPPE = ITEUx ITEE x 1/PUE x1/(1-GEC)

Therefore,

DPPE = (Operational Utilization of IT Equipment x Total Performance of IT Equipment) / (DC Total Power Consumption - Green Power)

Example of new metric computation

We computed DPPE using the data of an actual data center. Where ITEU = 0.36, ITEE = 3.9, PUE = 1.6, and GEC = 0.062, DPPE is 0.936, which shows that the metric is computable for actual data centers.

Dissemination to the world

The Japan-US-EU Workshop discussed the development of DPPE and agreed on the direction for the examination of metrics for data center energy efficiency, as well as continuation of discussion on the same theme. Moreover, we developed activities to disseminate DPPE in Europe and Asian countries. DPPE was introduced in the ICT4EE (ICT for Energy Efficiency) Forum held in Brussels, Belgium, in February 2010. DPPE was also introduced in the Green IT Seminar, held in Singapore and Bangkok, Thailand, in February of the same year.

4. Measurement and forecast of energy saving effect by IT (Part 4)

It is expected to eliminate waste and inconsistency in society and thereby produce energy reduction effect (CO2 reduction effect). Part 4 discusses methods for estimating the effect of the "energy saving by IT" solution and introduces actual cases using this solution.

Classification of IT solutions

The solution for reducing environmental load by utilizing IT equipment is expected to disseminate in the following wide categories.

Categories	Sub-categories	IT solutions
Industry	Production process	FEMS, high-efficiency in lighting / air conditioner / motor / power generator, efficiency in production process
Business	Building, indoor	BEMS, electronic tag / distribution system, paperless office, IT introduction into business, telework, TV conference, telemedicine / electronic medical recod, electronic bidding / electronic application
Household	Building, indoor	HEMS, electronic money, electronic publishing / electronic paper, music / software distribution, online shopping
Transportation	Infrastructure, activitis	Use of LED signals, fuel economy improvement in automobiles, efficiency improvement in transportation means (railroad, air transport, marine transport), ITS, eco-drive, SCM

Method of computing energy consumption reducing effect by IT solution

When estimating the effect of IT solutions, it should be first grasped what factors constitute the effect. Introduction of IT solutions can produce the following eight main effects.

Component	Subject of component	Formula of components
(i) Consumption of goods	Paper, CD, books, etc.	(Reduced consumption of goods) x (Basic unit of goods consumption)
(ii) Travel of men	Airplane, automobile, train, etc.	(Reduced travel of men) x (Basic unit of travel)
(iii) Travel of goods	Truck, railroad, cargo, etc.	(Reduced travel distance of goods) x (Basic unit of travel)
(iv) Office space	Space occupied by men (including working efficiency), spece occupied by IT equipment, etc.	(Reduced space) x (Basic unit of energy consumption per space)
(v) Warehouse space	Warehouse, cold storage, etc.	(Reduced space) x (Basic unit of energy consumption per space)
(vi) Power / energy consumption (IT / network (NW) equipment)	Power consumption of server, PC, etc.	(Power consumption variation) x (Basic unit of of system power)
(vii) Quantity of NW data communication	Quantity of NW data communication	(Data communication variation) x (Basic unit of communication)
(viii) Other	Activities other than the above	(Variation by activity) x (Basic unit concerning variation)

Note: For the foregoing factors, the quantity of contribution (expectation) by IT solutions is taken into consideration including the ones expected to produce effect in the long run, not immediately.

It is also necessary to take the following points into account in computing the effect of IT solutions.

- Input data and whether such data is available should be examined before determining a formula for computing effect.
- Computing the effect of IT solutions includes consideration of not only examination about the positive effect of realizing energy consumption reduction but also increase in energy consumption, etc. concerning IT equipment or information and telecommunication infrastructure to be used as a negative effect.
- In most cases, power consumption of IT equipment will increase due to introduction of IT solutions, but in some cases, it will decrease due to integration of servers or for other reason.

Information to be collected for computing the effect of IT solutions is classified into the following two types: (a) Information for computing the amount of activity (variation produced from the use of IT solutions); and (b) Basic unit information (conversion of variation produced from the use of IT solutions into CO2 emissions). As for (a), if accurate results of IT solutions are sought, it is desirable to use actual measurement data collectable from IT solutions as input information. As for (b), values (measurement data) may be updated according to social or natural conditions, appropriate basic unit should be desirably chosen considering the purpose of using computation results.

Forecast of effect from IT solutions

Effects of introducing IT solutions were computed on a trial basis using the aforementioned measurement methods for several cases. The level of effect varies according to IT solutions. The quantity of future contribution indicated in the following table was computed on a trial basis by applying some of the solution cases for which trial computation was made to the future in consideration of the penetration rate. [5] Since the subject solutions are limited, the data represents part of the quantity of contribution by IT.

[Unit: ten thousand t-CO2/year]

IT solutions	Japan				Worldwide			
	2005	2020	2025	2050	2005	2020	2025	2050
BEMS	57	546	650	630	549	6524	8,631	20,218
Paperless office	1	14	17	14	10	179	224	340
TV conference	140	250	270	220	1,357	4928	5,913	8,970
SCM (joint distribution)	34	178	222	410	188	1060	1,400	3,555
HEMS	-	157	189	164	-	719	935	1,798
ITS (digital tacograph)	200	730	842	821	1,102	7510	9,491	17,989
Telework	19	92	110	142	71	645	924	3,110
Electronic medical record	22	27	28	28	124	392	457	556

* Since the values of the table were computed in reference to actual cases of companies, the basic unit is close to the current value.

[5] The quantity of contribution in 2020 was estimated in reference to the values of 2005, 2025, and 2050.

5. Summary of Green IT effects in 2020

This Report summarized the quantitative effect of Green IT expected in 2020 based on the measures for energy-saving effect of Green IT, which were summarized in fiscal 2008, and results of the forecasts for 2025 and 2050. The following describes results of study on the effect of Green IT in 2020.

This study was conducted comprehensively in reference to the latest study data in the electrical and electronic industries, findings of individual members of the Survey and Estimation Commitee of GIPC, and analysis by individual companies. For Green IT, the trends and forecasts of the energy-saving performance for each product and forecasts of changes in penetration rates and social behaviors are computed based on certain scenarios. However, since these are results of trial computation using limited data, it should be noted that further detailed study will be necessary to ensure more accurate forecast. Moreover, the following attentions should be paid to the sectors where Green IT contributes to CO2 reduction.

- As for the effect of solutions etc. that change office work style, not only reduction of power consumption resulting from such work style change but the effect of reduced paper usage resulting from the promotion of paperless system was produced, and this contributed to CO2 reduction in the industry sector, and in the transportation sector resulting from reduced useless travel of men. Thus, sectors for which reduction measures are implemented are in some cases different from sectors where the effect of CO2 reduction is directly produced.

As a result of the trial computation of the quantity of contribution of Green IT to CO2 reduction in 2020, regarding Japan's energy-saving "of IT," energy-saving of IT equipment can produce the reduction of 5.7- 11.3 million t-CO2/year, and energy-saving of electronic equipment can produce the reduction of 11.9- 23.8 million t-CO2/year. As for worldwide energy-saving "of IT," energy-saving of IT equipment on a single item basis can produce the reduction of 87-171 million t-CO2/year, and energy-saving of electronic equipment can produce the reduction of 293-576 million t-CO2/year.

Energy-saving "by IT", which contributes, directly or indirectly, to CO2 reduction by changing widely workstyle, lifestyle, way of manufacturing, and way of using resources in various fields of society using IT, and further by incorporating IT technologies into various advanced equipment, has a potential of contributing to the reduction of 68-137 million t-CO2/year in Japan in 2020. This potential of reduction is broken down into 7-14 million t-CO2/year in overall industry, 9-18 million t-CO2/year in business, 16-32 million t-CO2/year in households, and 36-73 million t-CO2/year in transportation. Worldwide energy-saving "by IT" is expected to contribute to the reduction of 2,041-4,009 million t-CO2/year, about 28 times that of Japan. This is broken down into 140-276 million t-CO2/year in overall industry, 122-239 million t-CO2/year in business, 200-393 million t-CO2/year in households, and 1578-3101 million t-CO2/year in transportation. IT solutions that contribute to reduction include BEMS, telework, and TV conference in the business sector, HEMS and online shopping in the household sector, and ITS, eco-drive, and supply chain management in the transportation sector.

[Results of trial computation]

(1) Trial computation of the quantity of contribution of Green IT (related to "of IT")

Forecast of the quantity of contribution of Green IT (related to IT, Japan) (million t-CO2/year)

	2020 BAU [6]	2020 After GIT introduction	Reduction effect	Remarks
5 products of IT equipment (Single item basis)	21.6-43.3 17.2-34.3 12.9-25.8	13.4-26.8 11.5-23.0 9.4-18.7	8.2-16.5 5.7-11.3 3.5-7.1	Scenario A Scenario B Scenario C
(Contribution to facility [1])	15.9-31.7 12.5-25.1 9.8-19.6	10.1-20.2 8.7-17.4 7.2-14.5	5.7-11.5 3.8-7.7 2.6-5.1	Scenario A Scenario B Scenario C
Total	29.7-59.4	20.2-40.4	9.5-19.0	Scenario B

- Trial computation with a wide range of CO2 emission factor for power generation (from 0.2-0.4kg-CO2/kWh).
  - 5 products of IT equipment: PC, server, storage, networking equipment, and display
  - Facility: Power consumption in air conditioning, lighting, power supply, etc. of the data center and server rooms

Forecast of the quantity of contribution of Green IT (related to IT, Worldwide) (million t-CO2/year)

	2020 BAU	2020 After GIT introduction	Reduction effect	Remarks
5 products of IT equipment (Single item basis)	373-733 308-604 243-477	257-505 221-434 182-357	116-228 87-171 61-120	Scenario A Scenario B Scenario C
(Contribution to facility [1])	273-36 226-443 185-363	194-381 167-328 141-276	79-155 59-115 44-87	Scenario A Scenario B Scenario C
Total	533-1048	388-762	146-286	Scenario B

- Trial computation with a wide range of CO2 emission factor for power generation (from 0.28-0.55kg-CO2/kWh).

[6]Business As Usual (BAU) is synonymous with "Baseline" referred to in Part 2.

Forecast of the quantity of contribution of Green IT (related to electronics, Japan) (million t-CO2/year)

	2020 BAU	2020 After GIT introduction	Reduction effect
5 products of electronics	62.2-124.4 (Household :24.5-49.1) (Business :37.7-75.3)	50.3-100.6 (Household :20.2-40.3) (Business :30.1-60.3)	11.9-23.8 (Household :4.4-8.9) (Business :7.5-14.9)

- 5 products of electronics: Television sets for household / industrial use, DVD, lighting, refrigerator, and air conditioner

Forecast of the quantity of contribution of Green IT (related to electronics, Worldwide) (million t-CO2/year)

	2020 BAU	2020 After GIT introduction	Reduction effect
5 products of electronics	1201-2359	907-1782	293-576

* In energy saving of data centers, it is also originally important to improve the efficiency of facility. Energy saving of data centers in 2020 including the effect of efficiency improvement in facility is forecasted to be 13.2 million t-CO2/year in Japan, and 143.4 million t-CO2/year in the world.

Forecast of the quantity of contribution of Green IT (data center, Japan) (million t-CO2/year)

	2020 BAU	2020 After GIT introduction	Reduction effect
Data center (including the effect of facility improvement)	9.8-19.6	3.2-6.4	6.6-13.2

Forecast of the quantity of contribution of Green IT (data center, Worldwide) (million t-CO2/year)

	2020 BAU	2020 After GIT introduction	Reduction effect
Data center (including the effect of facility improvement)	152-298	51-101	100-197

(2) Trial computation of the quantity of contribution of Green IT ("by IT")

Forecast of the quantity of contribution of Green IT ("by IT", Japan and Worldwide)

(million t-CO2/year)

Measures Subject sectors	Major solutions	2020 Effect of GIT introduction (Japan)	2020 Effect of GIT introduction (Worldwide)
Industry sector	· High-performance boiler, energy saving equipment · Energy management, energy saving business, etc.	7-14	140-276
Business sector	· BEMS (building / energy management system) · Telework, TV conference, paperless office	9-18 including other sectors	122-239
Household sector	· HEMS (house energy management system, including digital household appliances, etc.) · Online shopping, electronized contents · Introduction of recyclable energy, smart grid	16-32 including other sectors	200-393
Transportation sector	· Improved fuel consumption of automobiles · ITS (ETC, VICS), eco-drive · Efficiency increase in distribution (SCN, improved load factor, etc.)	36-73 including other sectors	1578-3101
Total		68-137	2041-4009

Trial computation of the effect from the penetration of each solution (ten thousand t-CO2/year)

	2020 Effect of GIT introduction (Japan)	2020 Effect of GIT introduction (Worldwide)
BEMS	546	6524
Paperless office	14	179
TV conference	250	4928
SCM (joint distribution / improved load efficiency)	178	1060
HEMS	157	719
ITS (digital tacograph)	730	7510
Telework	92	645
Electronic medical record	27	392

- Data of this table is extracted from the values of 2020 computed in Part 4.

(3) Percentage of contribution of Green IT to CO2 reduction in 2020 (Japan)

Contribution of Green IT (million t-CO2/year)

	Green IT (of IT)	Green IT (by IT)
Industry sector		7-14
Household sector	4.4-8.9	16-32 (including industry sector)
Business sector	17.0-33.9*	9-18 (including industry sector)
Transportation sector		36-73 (including industry sector)
Total	21.4-42.8	68-137

* Including the energy saving effect of IT facility.

[Notes to trial computation]

1. Values computed considering that energy saving of IT equipment leads to reduced load on facility and consequently decrease the energy consumption of facility. The effect of energy efficiency improvement of facility (air conditioning) is not included.

2. The range of reduction is based on the assumed range of CO2 emission factors for power generation in 2020, i.e., 0.2-0.4 kg-CO2/kWh. The value of 0.4 is based on the assumption that the ratio of non-fossil power sources ratio and power generation efficiency remain at the current level. The value of 0.2 is based on the assumption that the same ratio and efficiency continue improvement until 2020. In addition, the lower limit of the results of trial computation of "energy-saving by IT" corresponds to the case where basic unit (paper, resources, travel, space, communication, etc.), whose data is necessary for trial computation of "energy-saving by IT"(except power ganaration) is assumed to improve in 2020 to the same extent as in the CO2 emission factor for power generation.

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6. Study of methods for evaluating environmental contribution of companies (Part 5)

While the penetration and promotion of energy-saving products and services become increasingly important as global warming prevention measures, CO2 emissions of companies that provide them including component and material manufactures are increasing. Under such circumstances, little study has been made on methods for quantitatively evaluting the contribution of companies involved in manufacturing for energy-saving in use. This Part reports the methods we have developed to clarify the contribution of manufacturing companies including component and material makers to the effect of energy-saving in use.

Study of methods for quantitative evaluation of contribution to energy saving

Energy-saving effects are classified into the two types -- "of IT" (energy saving of product / service) and "by IT" (energy saving using product / service).

Methods we have developed are for quantitative evaluation of the contribution of manufacturing companies concerned with the former "of IT." For current year, contribution was estimated through case studies conducted on the products of electric bulb, liquid crystal television, data center, and server.

Concept of evaluation methods

We studied the following two possible methods of evaluation by determining energy-saving effect through comparison of new and old products and services.

(Evaluation method I)
Contribution to the realization of a low carbon society is considered in a broad sense
(Evaluation method II)
Direct contribution to the realization of a low carbon society is considered in a narrow sense

Viewpoints of allocation of contribution to energy saving effect in the former are defined as "method development", "improvement", and "all components", and "method development" and "improvement" in the latter.

Term	Definition	Evaluation method I	Evaluation method II
Method development	Product development requiring major technical innovation to achieve energy saving, such as method change	yes	yes
Improvement	Normal product improvement for achievement of energy saving	yes	yes
All components	All components necessary to form product	yes	—

Note that since the method of computing energy-saving effect is determined through the comparison of new and old products, allocation of contribution to all components, i.e., all companies involved in the product, may be logically inconsistent. However, as a result of the questionnaires and hearings we made to/from subject companies, not a few of them answered that all companies involved contribute to energy-saving effect in use, so it is sought to study a method for allocating contribution to all companies involved.

An example of case study

In the example of compact self-ballasted fluorescent lamps studied in Evaluation Method II, contribution to energy saving effect was estimated to amount to 40% in set manufactures, 21% in component manufactures, 14% in manufacturing equipment manufacturers, 13% in material manufactures, and 12% in patent holders. Thus, one of the purposes for this evaluation method, "Quantitative evaluation of the contribution of companies including component and material manufactures" was achieved.

Proposal for the future

We studied two evaluation methods in the current fiscal year. As a background of this study, we mention the awareness that accountability for CO2 emissions, which are necessarily incidental to manufacturing, will become a significant matter in the future. Therefore, it will be necessary in the future to organize views on CO2 emissions that accompany manufacturing. By doing so, it will be possible to establish an evaluation method to which more involved entities agree.

7. Survey of Green IT related policies abroad (Part 6)

The explosive penetration of the Internet and progress of IT (Information Technology) that supports it are astonishing. In the current social life, as well as in corporate activities, utilization of IT is inevitable. Meanwhile, the electric power consumed by such IT equipment is spiraling.

In such circumstances, countries in the world are reporting, together with the words of "Green IT," many cases of energy-saving in IT equipment and data centers, which hold a large amount of IT equipment, and energy-saving activities.

In order to survey various programs for Green IT in the world, the GIPC's Survey and Estination Committee conducted surveys from September to November 2009, as it did in fiscal 2008, about programs concerning Green IT in government and private sectors in the U.S., EU, Singapore, South Korea, etc., and studied / analyzed the directions of those programs.

The programs surveyed are as follows:

(1) Programs in the U.S.

- Department of Energy (DOE)
- Environmental Protection Agency (EPA)
- The Green Grid
- Climate Savers Computing Initiative
- Digital Energy Solutions Campaign

(2) Programs in EU

- Code of Conduct on Data Centres
- Code of Conduct on Broadband equipment
- Code of Conduct on External power supply
- Global e-Sustainability Initiative
- ICT4EE
- BITKOM
- Grid Computing Now KTN/BCS/INTELLECT

(3) Programs in Singapore

- Singapore Infocomm Technology Federation (SiTF)

(4) Programs in South Korea

- Korean Green Business IT Association

(5) Other programs in Asian countries

(6) Programs in the ITU

Conclusion

This Report mainly summarized the results of studies conducted by the Survey and Estimation Commitee of GIPC in fiscal 2009. As main activities of fiscal 2009, evaluation methods for Green IT were studies, and forecast of medium-to-long-term trends using the evaluation methods was further studied in reference to study results in fiscal 2008 by 3 WGs with shared operations. Five themes were studied as pillars of the surveys, i.e., energy saving of IT ("of IT"), new energy saving metrics for data centers, society's energy saving by IT ("by IT"), contribution of Green IT companies, and overseas activities for Green IT.

In energy saving of IT, ten types of products that consume electric power considerably when in use were chosen as subjects, and the quantity of contribution arising from "of IT" in 2020 was surveyed based on the forecasts for 2025 and 2050. As a result of the trial computation of the quantity of contribution of Green IT to CO2 reduction in 2020, regarding Japan's energy-saving "of IT," energy-saving of IT equipment can produce the reduction of 5.7- 11.3 million t-CO2/year, (Trial computation under Scenario B, with a wide range of CO2 emission factor for power generation (from 0.2-0.4kg-CO2/kWh)) and energy-saving of electronic equipment can produce the reduction of 11.9- 23.8 million t-CO2/year. As for worldwide energy-saving "of IT," energy-saving of IT equipment on a single item basis can produce the reduction of 87-171 million t-CO2/year, and energy-saving of electronic equipment can produce the reduction of 293-576 million t-CO2/year.

For energy saving of the data center, we advanced studies concerning the quantity of contribution by energy saving of the data center and new energy saving metrics that can indicate the efforts of data centers on the whole for energy saving. As a result, it was found that energy consumption of the data center will increase considerably in 2020, 2025 and 2050, but increase can be fairly controlled by the effect of technical innovation. In energy saving of data centers, it is also important to improve the efficiency of facility. Energy saving of data centers on the whole in 2020 including the effect of efficiency improvement in facility is forecasted to be 13.2 million t-CO2/year in Japan, and 143.4 million t-CO2/year in the world.

Moreover, for Datacenter Performance Per Energy (DPPE), which we continuously studied from fiscal 2008 as a new energy-saving metric, we studied in detail about its 4 factors: ITEU, ITEE, PUE, and GEC. We proposed this DPPE to the world taking the opportunity of Japan-US-EU (Trilateral) workshops involving both government and private sectors, and consequently attained agreement among six major organizations in Japan, U.S., and EU, i.e., DOE, EPA, Green Grid, Code of Conduct, METI Green IT Initiative, and GIPC as "Guideline concerning a New Metric for Energy Saving in the data center."

As regards energy saving by IT ("by IT"), which is expected to contribute to CO2 reduction in overall society more than "energy saving of IT," we studied the methods for evaluating CO2 reduction effect from the utilization of IT solutions, and further forecasted, using those evaluation methods, the quantity of contribution in 2020 based on the quantities of contribution in 2025 and 2050. For evaluation of effect by IT solutions, we made additional trial computation about new IT solution cases based on the method of evaluating CO2 reduction with consumption of goods, travel of men / goods, and variation in power usage for space and IT equipment, which we developed in fiscal 2008.

Energy-saving "by IT", which contributes, directly or indirectly, to CO2 reduction by

changing widely workstyle, lifestyle, way of manufacturing, and way of using resources in various fields of society using IT, and further by incorporating IT technologies into various advanced equipment, is expected to have a potential of contributing to the reduction of 68-137 million t-CO2/year in Japan in 2020. This potential of reduction is broken down into 7-14 million t-CO2/year in overall industry, 9-18 million t-CO2/year in business, 16-32 million t-CO2/year in households, and 36-73 million t-CO2/year in transportation. Worldwide energy-saving "by IT" is expected to contribute to the reduction of 2,041-4,009 million t-CO2/year, about 28 times that of Japan. This is broken down into 140-276 million t-CO2/year in overall industry, 122-264 million t-CO2/year in business, 200-416 million t-CO2/year in households, and 1578-3117 million t-CO2/year in transportation. IT solutions that contribute to reduction include BEMS, telework, and TV conference in the business sector, HEMS and online shopping in the household sector, and ITS, eco-drive, and supply chain management in the transportation sector.

For the theme of visualization of "contribution to energy saving by IT" by Green IT companies, we summarized the basic concept of contribution in the current fiscal year. Particularly, in terms of "of IT," we specified methods for evaluating contribution in the entire supply chain for the 4 specific products (lighting, liquid crystal television, server, data center), including product materials, components, devices, and software.

As regards, the survey and analysis of overseas policies etc. related to Green IT, in addition to the content of activities we surveyed in fiscal 2008 with regard to Department of Energy, Environmental Protection Agency, Green Grid, Climate Savers Computing Initiative, in the U.S. and Code of Conduct in EU, we surveyed / introduced activities by Digital Energy Solutions Campaign in the U.S., Korean Green Business IT Council, BITKOM in Germany, Global e-Sustainability Initiative in Europe, ICT4EE, SiTF in Singapore, etc. in fiscal 2009.

Green IT advanced in Japan and has been studied specifically and implemented widely in the entire world as an important measure for realizing a low carbon society, centering on the two main pillars of "of IT" and "by IT." Green IT has also been studied as one of the key measures for achieving the Japan's goal of reducing greenhouse gas emissions by 25% by 2020. In studying such measures, it is important to clarify specific evaluation metrics for Green IT and to specify the quantitative contribution using such metrics. From this viewpoint, the roles of Survey and Estimation Committee of GIPC and each theme it is addressing are expected to become increasingly important.

It is a common understanding in the world community that Green IT has a potential of great contribution to global CO2 reduction, and for steady realization of the effect of Green IT, cooperation of the entire society centering on industry, government, and academia as well as worldwide cooperation centering on Japan, Asia, EU, and U.S. In order to make the foregoing activities more specific and fruitful, GIPC Survey and Estimation Committee will continue to make steady efforts and perform progressive activities with the support of METI, member companies of GIPC, associated organizations, and related sectors. We appreciate your understanding and support for activities GIPC Survey and Estimation Committee.