GIPC Survey and Estimation Committee Report

FY2009

［Outline of the Calculation Methods］

--Contricution of Green IT to Realization of Low Carbon Society--

March 2011

Green IT Promotion Council (GIPC)

The Survey and Estimation Committee

Introduction

More than two years have passed as of April 2010 since the Survey and Estimation Committee of GIPC started its activities in February 2008. Upon the inception of GIPC in February 2008, the Survey and Estimation Committee was also established with an aim to formulate metrics for specifying the quantitative contribution to Green IT and evaluation of the energy saving, and to survey the Green IT activities worldwide. With a support of many participants and organizations involved in “Green IT” extended to this date, GIPC has grown and reached a publication of the Performance of Advanced efforts and Research activities. This committee expressed gratitude for those who have supported.

Based on the performance of activities of 2008, this committee further expanded the content of its activities and worked on a survey and study in 2009. The summary of the content of its activities in the Fiscal Year 2009 is provided in this "FY2009 Survey and Estimation Committee of GIPC Report."

Worldwide activities for “Global Warming Prevention” are considered to have progressed greatly in last one year. The long-term goal proposed by the Japanese government in 2007, i.e., "to reduce global Greenhouse gas emissions by one half from the current level by the year 2050," has become a goal for the entire world. Moreover, the framework of the post-Kyoto Protocol was discussed at the “Conference of Parties” (COP) for the United Nations’ Framework Convention on Climate Change known as "COP15" held in Copenhagen, Denmark, in December 2009. Unfortunately, the Conference could not reach the agreement on the entire framework and a new protocol. However, "Copenhagen Accord" was proposed in order for many countries to establish targets for reducing Greenhouse Gas emission. As a result, in addition to the developed countries, including Japan, the U.S., and the EU countries, many newly emerging countries and developing countries have declared their quantitative targets concerning the Greenhouse Gas emissions. It is a very tough target for the world to achieve this target of Greenhouse Gas emissions while keeping sound economic activities. However, this could 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 their life style, work style, way of traveling, way of using resources, way of manufacturing, etc. and is also significant to change the sense of a value in the society. To realize 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 the Green IT Promotion Council, the Survey and Estimation Committee of the GIPC has been continuously working on this study since the first survey in Fiscal Year 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 and invest, in order to achieve the target?" To proceed into the discussion of these themes, the Committee considered 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 realize the 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 whole Industrial wide emissions in Japan is said to be rather limited value at 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 a society, as well as the utilization of IT solutions. "Energy saving of IT equipment ("Green of IT")" and "Entire society's Energy Saving by IT ("Green by IT")" -- these two pillars greatly contribute to the Green IT. The Survey and Estimaton Committee of GIPC has been working on the quantitative study of contribution to the Green IT, considering the significance of formulating "a measure"- (evaluation method) for quantitative measurement of a contribution to the Green IT in individual fields and of clarifying "To what extent and Until when is it possible to contribute to the CO2 reduction?" using this measure.

In Fiscal Year 2009, the Committee established three working groups (WGs) according to issues and worked on studies with focus on five 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 work groups in Fiscal Year 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, the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and etc. are conducting advanced activities. In Europe, activities concerning Green IT are also becoming very active, mainly led by the EU Committee (EU Code of Conduct by EU Joint Research Center – JRC). In Asia, discussion about Green IT has begun mainly in 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, this committee developed survey and study activities.

WG2, as an independent group, engaged in concentrating in the survey and study of "Datacenter Performance Per Energy (DPPE)," which was newly proposed in Fiscal Year

2008 as a reinforced version of the "Energy saving concerning datacenter," which has been studied in Fiscal Year 2008 as a part of the sub working group.

WG3 developed survey and study activities with the theme of "Quantity of Contribution of Enterprise Developments / Providing Green IT Equipments / Solutions" -- this theme continued from Fiscal Year 2008. A 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 are also expected to reduce energy use in various fields of the society. In such supply chain of the Green IT, visualization of the contribution of contributors to energy saving by Green IT for the entire chain is considered necessary for the sound activation of this cycle of the development, manufacturing, sales, and consumption of Green IT, as a positive spiral to be achieved.

The Survey and Estimation Committee of GIPC has been developing activities, including survey and study in Green IT from various viewpoints, for the purposes of realizing evaluation of the Green IT effect with a common measure and clarifying contribution quantitatively using this measure. As regards to the quantity of a contribution, the Committee has been forecasting the quantity of a future contribution. In addition to the forecast made in Fiscal Year 2008 for the quantities of contribution in the year 2025 and 2050, the Committee made a complimentary forecast for the Fiscal Year 2020, which is an important target year, based on the forecast data of Fiscal Year 2025 and 2050. This FY 2009 Survey and Estimation Committee of GIPC Report summarize the result of the foregoing studies with focus on the five themes mentioned in the above. In order to deepen the understanding of the entire flow concerning the Green IT and definitions concerning its evaluation methods, each chapter continuously describes the results of study and trial computation conducted in the Fiscal Year 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 from the Fiscal Year 2009.

What should the entire world, entire society, and individual companies and persons do in order to reduce Global Greenhouse Gas emissions by 50% of the current level in 2050, including targets for the milestone years of both 2020 and 2025? And to what extent and from what is the expected specific effect? In order to clarify these questions, study results were summarized with focus on the quantification. Needless to say, cooperation with participants in other industries and sectors, as well as IT industry and IT companies, are necessary in formulation and operation of measures to realize the contribution to the Green IT effort. Results of studies in Fiscals Year 2008 and 2009 would serve to help people in various fields of society in understanding "What should people do to reduce the energy use and CO_2 emissions and how much can people reduce the amount?" or "What is the most effective thing people could do?"

In promoting activities of the Survey and Estimation Committee of GIPC, this committee received support in Fiscal Year 2009 as in Fiscal Year 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 working groups took their time for surveys and studies, as well as involved in useful and active discussions. Furthermore, in conducting quantitative studies, this committee referred to the results of surveys and researches by many predecessors concerned with the Green IT. These were done by exchanging views from different time periods with participants' relevant organizations and institutions. In particular, 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 this committee's deep gratitude again for their contribution and cooperation

In the future, the Survey and Estimation Committee of GIPC will continue quantitative surveys concerning the great potential of Green IT, and contribute to establishment of a system which will provide and disseminate such potential to the real world. This committee hopes that this Report can be of service to many people engaging in activities in various fields to achieve the Low Carbon Society.

June 2010

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

Michinori Kutami

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This report is Fisical Year 2009 summary for survey and estimation committee of GIPC (Green IT Promotion Council) report. Chapter numbers/Figure numbers etc are the same as original version in Japanese.

Executive Summary

1. Background of Survey (Part I)

In order to achieve the goal proposed by Japanese Government that the Global Greenhouse Gas emissions must be reduced by one 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, an 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 whole industry's emissions in Japan is rather limited value at 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 household appliances widely used in the society ("Energy saving of IT equipment ("Green 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 (“Green by IT”)").

Japan is developing a Green IT Initiative in order to promote changes in wide areas, including production, society, and people's lifestyle 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 industries, academia and government.

Based on a long-term vision extending to the 2050, the GIPC is developing activities with the understanding that a discussion on a mid-term period evaluation basis, i.e., what should be done from the year 2020 to 2025, this is particularly important. Specific activities being promoted by the GIPC include penetration and awareness raising for the concern of the Green IT, International cooperation, holding International Symposiums, identifying the Green IT technologies / preparation of the roadmap, quantitative survey / analysis of Green IT effect, and forecast of the quantity of future contributions.

From the Fiscal Year 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 more specific, the following five activities were promoted:

1. Quantification of energy saving of IT equipment and a medium-to-long term forecasting
2. Quantification of energy saving of data centers and a medium-to-long term forecasting
3. Quantification of society's energy saving by IT and a medium-to-long term forecasting
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 throughout the world.

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

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

Energy usage in household and industry sectors have been in continuing increases in the trend. Since IT and electronic equipment account for the considerable percentage of a 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 the 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, this committee 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 unit and 5 electronic products: Television, non-commercial recorder / player (DVD etc.), refrigerator, lightings, and air-conditioning unit.

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 ("stays at the baseline"). Note that difference is needed to be measured between the products with the same performance in comparison to the power consumption of each product between the cases where technical innovation makes a progress and where it will not make any progress. For example, television sets with the same screen size (one metric of performance) must be chosen when 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 energy efficiency metric.

		Energy efficiency metrics	Items first considered in forecast: Performance	Items first considered in forecast: Electric power	Additional consideration items
IT equipment	PC	Power consumption / CPU processing capability	CPU processing capability	Power consumption (Annual power consumption)	Classification of notebook /desktop
	Server	Power consumption / CPU processing capability	CPU processing capability		Classification of high-end / mid range / volume
	Storage	Power consumption / Storage capacity	Storage capacity		Transfer rate, classification of server-use / PC-use
	Router	Power consumption / Throughput performance	Throughput performance		Classification of business use (3+2 classification) / home use
	Display	Power consumption / Screen size	Screen size		Resolution
Electronic products	Television	Power consumption / Screen size	Screen size		Resolution
	Home-use recorder / player	Power consumption / Recording time	Recording time		Volume of recorded i Formation, resolution
	Refrigerator	Power consumption / Capacity	Capacity		
	Lighting	Power consumption / Illumination	Floor area / illumination		Lamp type
	Air conditioner	Power consumption / Cooling capacity (COP / AFP)	Cooling capacity (floor area)		Classification of business use / home use

Figure 0-1: Target Products and Energy Efficiency Metrics

Next, this committee 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 with 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 purposes. [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 the 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 tons of -CO2 in 2025 but technical innovation is expected to reduce emissions by 20-70 million tons of -CO2. Globally, total emissions may increase to 1200-3400 million tons of -CO2 in 2025 but technical innovation is expected to reduce emissions by 360-1160 million tons of -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 needed room for the 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

[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.

	increased power consumption of IT equipment
Scenario C	Low penetration rate / Low rate of increased power consumption of IT equipment

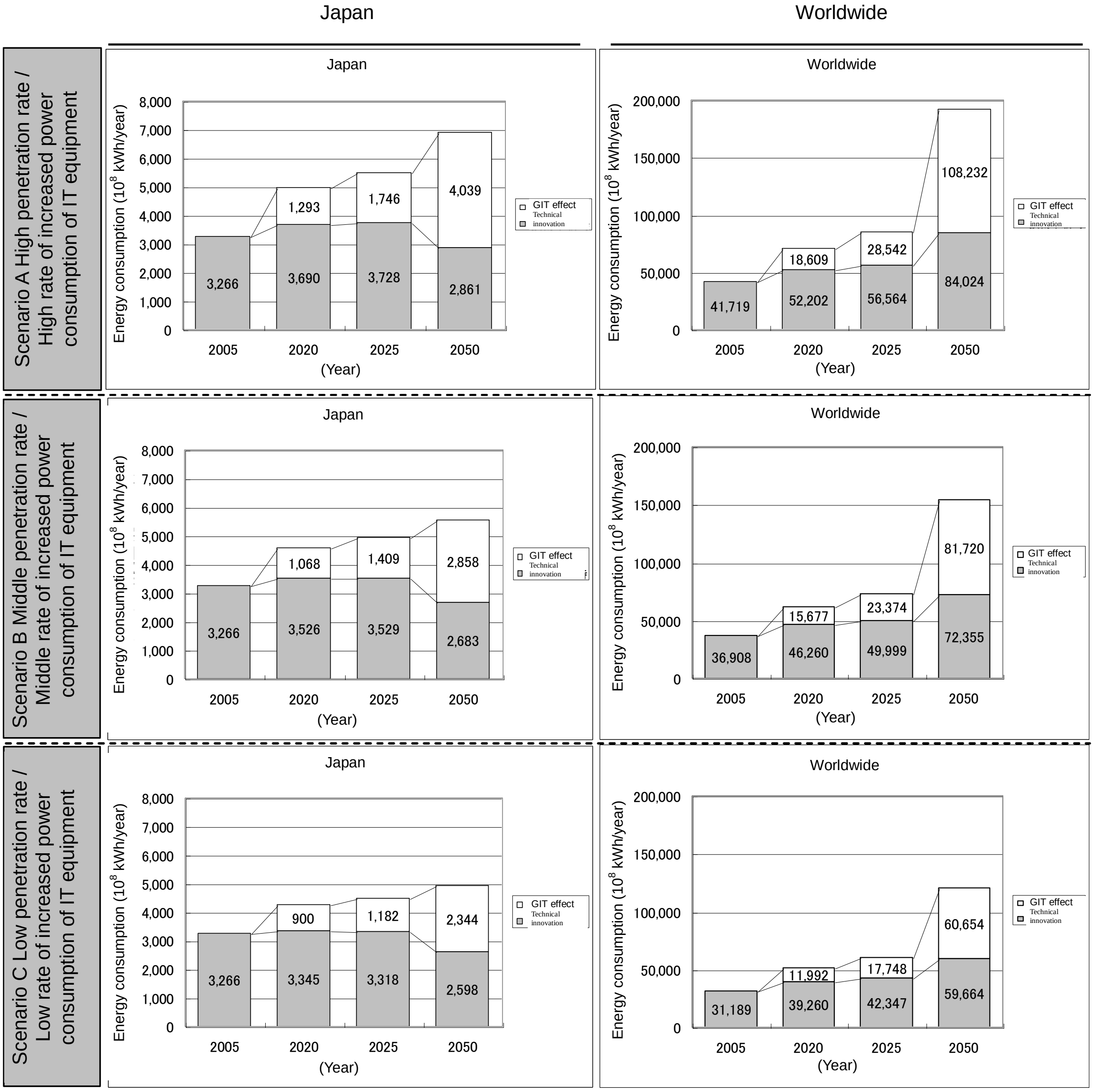

Figure 0-2: Forecast of Trend in Energy Consumption and Energy Reduction Effect for 10 Products [3](Left: Japan, Right: Worldwide)

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

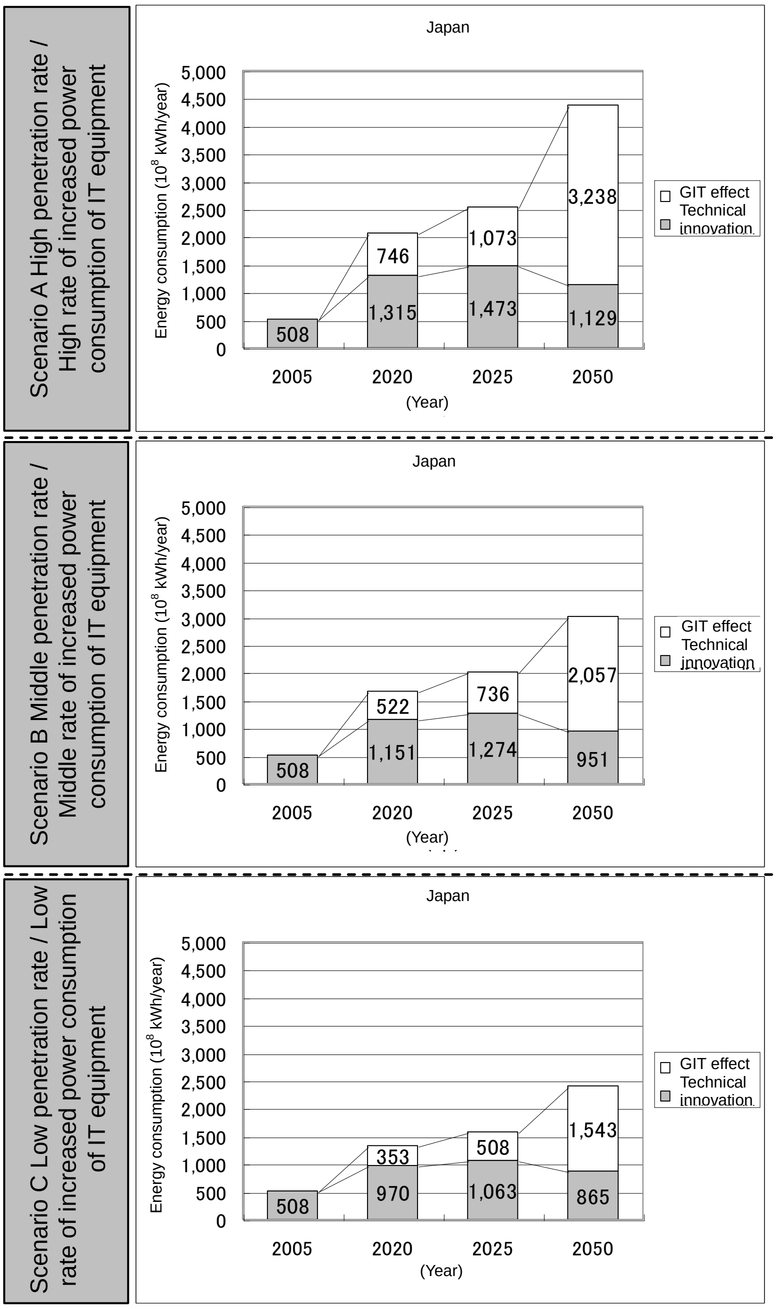

Figure 0-3: Forecast of Japan's Energy Consumption and Energy Reduction Effect for IT Products

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

It is expected to eliminate waste and inconsistency in society and thereby producing 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 at 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 indivisuals	Airplane, automobile, train, etc.	(Reduced travel of indivisuals) x (Basic unit of travel)
(iii) Movement of goods	Truck, railroad, cargo, etc.	(Reduced travel distance of goods) x (Basic unit of travel)
(iv) Office space	Space occupied by wokers (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 an introduction of IT solutions, but in some cases, it will decrease due to the integration of servers or for other reasons.

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 measured data collected from IT solutions as the input information. As for (b), values (measurement data) may be updated according to the 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 extended for the future in consideration of the penetration rate. [4] Since the subject solutions are limited, the data represents part of the quantity of contribution by the 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
Tele Video 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.

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

Part2　Measurement / forecast of the effect of energy saving of IT

1.　Background of the Survey

Energy usage in household and industry sectors has been in continuing increase trends. Since IT and electronic equipment account for a considerable percentage of the total energy consumption in these sectors, it is greatly expected to develop technologies for improving the energy saving performance of the IT and electronic equipments 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, this committee 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 unit and 5 electronic products: Television, non-commercial recorder / player (DVD etc.), refrigerator, lightings, and air-conditioning unit.

2.　Energy efficiency meric of target products

First of all, this committee reviewed the concept of energy use efficiency of the targeted products.

When this committee compared energy use efficiency on specific products, it is appropriate to compare energy consumption using the same performance products. For example, when one is to compare power consumption of a Television, it is meaningful to compare power consumption with two Televisions with the same screen size, while it cannot be said that energy efficiency of Television with 20 inches screen size is higher by comparing the power consumption of 20 inches screen size against 65 inches screen size. Like this example, it is necessary to consider performance of products besides energy consumption when comparing the energy efficiency of products.

Characteristics showing products performance differ by products, and normally one product has several characteristics. For instance, screen size is important for a performance of Television, while capacity is important for the refrigerator. Also strictly speaking, as the screen resolution is another characteristic performance for Television besides the screen size, and this characteristic is supposed to be considered as well.

Therefore, this committee listed important characteristics as “Performance” by each targeting 10 products (figure 2.2-1). For those which have several characteristics for showing performance, this committee listed most important characteristic as “Performance”, and additional variable as “Additional consideration items”.

Also this committee listed energy consumption[5] per unit performance as “Energy Efficiency metrics[6]”.

[5] This study uses the word “Power consumption” in this figure in accordance with energy efficiency metric of Data Center. To be precise, it is preferable to use the word “Energy consumption”.

[6] It is necessary to review in detail based on data of actual product, in order to make concrete metric for actual product.

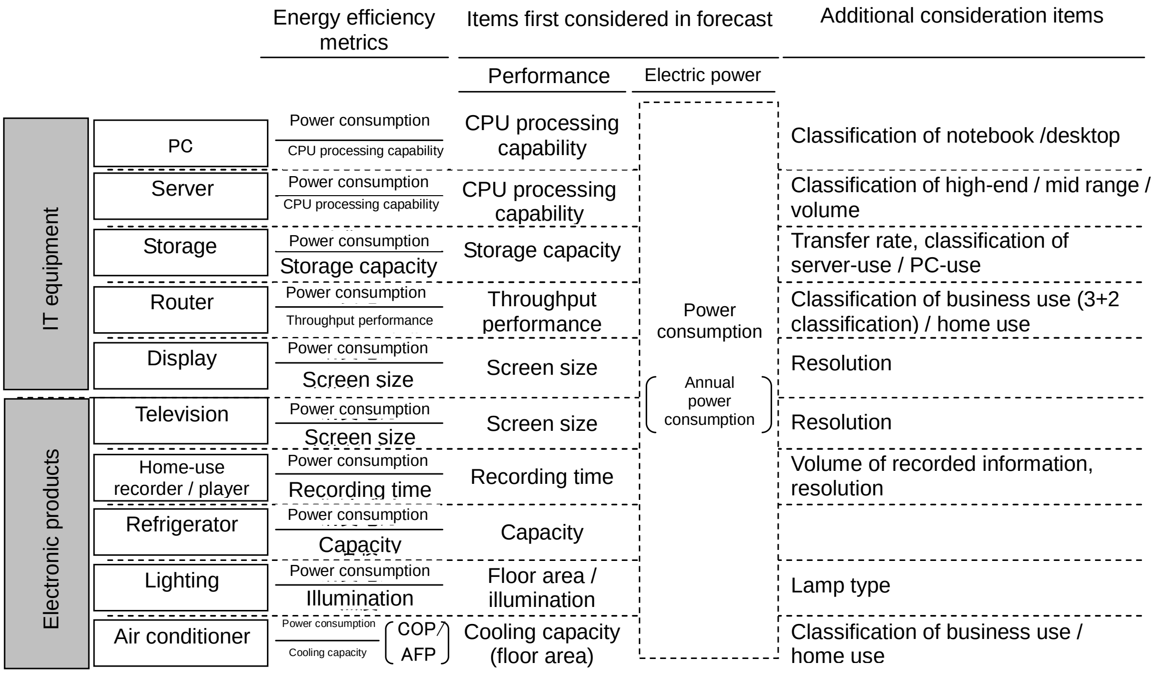

Figure 2.2-1：Target Products and Energy Efficiency Metrics

For future forecast of energy reduction effect, this committee compared power consumption where technical innovation makes progress and where it will not make any progress, using the same metric of "Performance" of Figure 2.2-1. In another words, this committee compared products with high energy use efficiency by technical innovation and products with current energy use efficiency without any technical innovation.

3. Mesurement of forecast of energy reduction effect

10 targeted products of the forecast of energy reduction effect; these times include both household equipments and commercial equipments. Among 10 products, Television and non-commercial recorder / player (DVD etc.) are considered to be the household products, while server is only categorized as a commercial product. Targets of other equipments cover both for household and commercial. Note that commercial equipment of air-conditioning unit covers only one part of the whole commercial air-conditioning units, as a commercial air-conditioning unit here only covers the package and multi air-conditioning unit, and not covering other air-conditioning units.

Below is the procedure for the measurement of the forecast of energy consumption and energy reduction effect.

1. Set the scenario for the "Most penetrated product" among targeted products.
2. Estimate the power consumption of "Most penetrated product" between the cases where technical innovation makes no progress (hereafter "baseline") and where it makes progress (hereafter "case of technical innovation"). Further, calculate "reduction effect" as the gap between the power consumption of "baseline" and "case

of technical innovation”.

(1) To set the scenario of the “Most penetration product”

To make the forecast simple, this committee set the scenario of the most penetrated product per equipments, which represents the whole products. In case of a refrigerator, for an example, products with various storage capacities exist in the market.

This committee did choose only one product to disseminate “the most used in the market” (e.g. refrigerator with 400Litters storage capacity.) Assuming that all refrigerators in the market are similar type, this committee made this forecast. A penetration difference of products are different depending on a time period, this committee set the equipment scenario which would be most disseminated in the year 2005, 2025, and 2050 respectively (figure 2.3-1).

		2005	2025	2050	
IT equipment	PC	Notebook(14inch)／Desktop(mail unit)	Notebook(14inch)／Desktop(mail unit)	Notebook(14inch)／Desktop(mail unit)	Power consumption per unit Processing Capacity
	Server	3 Range(Volume, mid range, high-end range)	3 Range(Volume, mid range, high-end range)	3 Range(Volume, mid range, high-end range)	Power consumption per unit Processing Capacity
	Storage	PC-use／ High-end Data Center(DC)-use	PC-use／High-end DC-use	PC-use／High-end DC-use	Power consumption per unit Processing Capacity(R/W speed)
	Router	Home-use／ DC-use(3+2ranges)	Home-use／ DC-use(3+2ranges)	Home-use／ DC-use(3+2ranges)	Power consumption per unit Maximum throughput performance
	Display	Screen size :17inch	Screen size :24inch wide	Screen size :24inch wide	Power consumption per unit (Resolution)
Electronics equipment	Television	CRT screen:25inch, Liquid crystal screen:32inch	Screen size : 32inch, 42inch	Screen size : 42inch	Power consumption per unit (Resolution)
	Home-use recorder/player	Recorder/Player	Recorder/Player	Recorder/Player	Power consumption per unit Recorded information capacity
	Refrigerator	Storage capacity:200L, 300L, 400L	Storage capacity:200L, 300L, 400L	Storage capacity:200L, 300L	Power consumption per unit
	Lighteng[1)]	Spot illumination, Panel illumination for home-use, office-use, store-use	Spot illumination, Panel illumination for home-use, office-use, store-use	Spot illumination, Panel illumination for home-use, office-use, store-use	Power consumption per a unit Number of use per unit area
	Air-conditioner[2)]		Room AC: 2.8kW(6-8mat room) Package AC:12.5kW	Room AC: 2.8kW(6-8mat room) Package AC:12.5kW	Power consumption per unit

Figure 2.3-1：List of the product category for the future forecasts, and the main scenario

In the scenario, this committee chose the most penetrated products in 2005 based on the several market data. While for the most penetrated products in the year 2025 and 2050, this committee set certain products by considering products trend, change of the household size and influence of the aging society.

Also, when there are big differences in equipment characteristics or energy consumption depending on categories like Notebook PC and Desktop PC for an example, this committee divided this into 2-5 categories per equipment, and made the scenario of most penetration products per each. In addition, considering the fact that the products level would be different per country, this committee set the different scenario for each and then evaluated.

(2) Estimation of the power consumption and the reduction effect

Next, with a regard to the most penetrated products which this committee chose, and this was for the estimated effect of the energy consumption and the energy reduction. This committee defined the energy consumption where a technical innovation makes no progress as the “baseline energy consumption (hereafter “baseline”)”, and where technical innovation makes progress as the “energy consumption case of technical innovation (hereafter “case of technical innovation”)”, and a gap between them as “energy reduction effect” (figure 2.3-2).

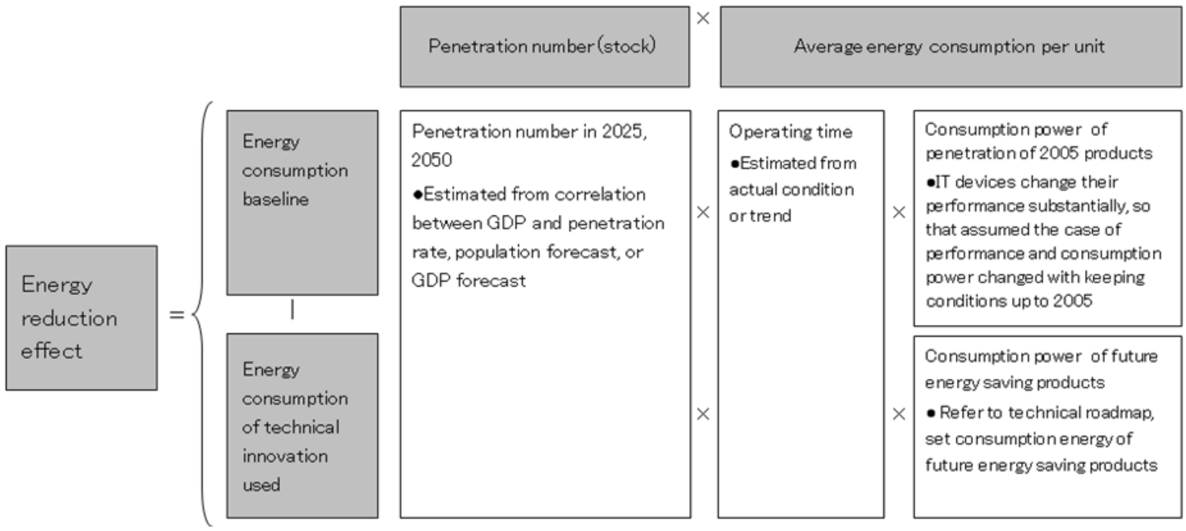

Figure 2.3-2: Calculation logic of Energy reduction effect

At first, energy consumption of both “baseline” and “case of technical innovation” were forecasted in reference to the product of the penetration number and average energy consumption per unit. Average energy consumption was broken down into “Consumed power” and “Operating time”.

Power consumption per unit for “case of technical innovation” was forecasted toward the products of previous scenario, in reference to the technology roadmap[7] by the technological examination committee, etc. With a regard to the power consumption per unit of “baseline”, power consumption where products in 2005 will penetrate, was utilized for the forecast in a case of electronics equipment, while for the power consumption where “performance and power consumption” will change along with the trend before 2005, which was utilized in the IT equipment.

7 Green IT promotion office, 2009: Survey and Estimation Committee Report of FY2008

The reason why changes for both performance and power consumption were made for the consideration of the IT equipment is that direct comparison of the equipment at different two time period (e.g. PC in 2005 and 2025) would be meaningless as the performance of IT equipments like PC greatly change in a short time. Furthermore, as it is conceivable that an approach towards energy saving has been already taken in current technology development, this committee utilized not current trend but past trends which were put on a priority for the performance improvement.

Next, this committee set the operating time (duration) of the equipment in reference to current operation time and trend based on statistics.

Lastly, the penetration number of products was forecasted using the correlation between product penetration rate and the GDP. In many products, positive correlation between product penetration rate and the GDP can be seen. For an example, figure 2.3-3 shows the GDP per capita and penetration rate of PC per capita in each country. As shown here, the positive correlation between GDP and PC penetration rate – higher GDP per capita with higher PC penetration rate. Therefore, it could be possible to make formula to forecast PC penetration late with GDP per capita by fitting relationship between GDP per capita and PC penetration rate using a straight line. By applying this formula into existing GDP forecast result, this committee forecasted penetration rate of those countries which do not have penetration data or future penetration rates. In addition, this committee estimated the penetration number of the equipments in each country/region by utilizing existing forecast result of the population or household numbers.

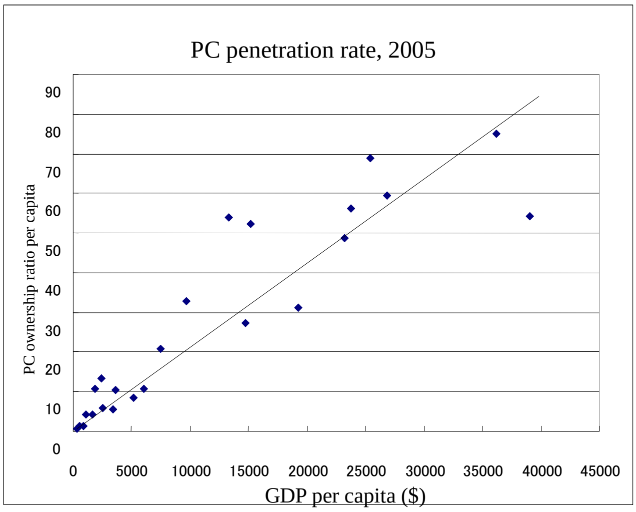

Figure 2.3-3: GDP per capita and PC penetration rate

Future population or GDP were referred by the scenario[8] of the Research Institute of Innovative Technology for the Earth. This scenario was made based on the forecast scenario of the United Nations or IPCC, indicating that the economies will growth in the future in emerging countries with a very large population like India and China.

4. Prior condition and Result of Forecast per products (abstruct)

This part shows the result of the forecast of the energy consumption and the energy reduction effectiveness per equipment. Although this forecast had been done with three scenarios considering uncertainty, result of the scenario B (middle of the penetration rate, middle of the increased power consumption) [9]will be shown as below. Note that this result was the target product themselves of excluding a facility contribution.

4.1 Personal Computer (PC)

(1)Prior condition of the Forecast

Power consumption of a Personal Computer (hereafter PC) has been increasing as well with its rapid improvement of the performance. During this period, while digital data volume has been increasing along with the increased usage of digital images, “e-mail”, “WEB Page browsing, Searching information” and “creating documents” have kept dominant for the usage[10]. Also CPU-hogging time can be shortened even when authoring digital images nowadays. In fact, according to the survey of the power consumption or CPU utilization on using a PC[11], time duration of 100% utilization of the CPU became very short and the idle time is more dominants. Especially, power consumption of a desktop PC has already reached 100Watts, and further increase of the power consumption at home would be small considering the limitation of the power capacity.

Considering above situations, this committee estimate the power consumption per one PC will remain roughly flat in the future even in the baseline case (an improvement based on the current technology), and the power consumption at most of the will be at an idle time of the OS. On the other hand, power consumption where technology innovation makes further progress in the future; it will be 5Watts per one desktop PC in the year 2025, and 15Watts per one Notebook PC including power consumption of a display in the year 2025. In 2050, power consumption will remain unchanged, while performance of the PC will be improved.

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[8] Systems Analysis Group, Research Institute of Innovative Technology for the Earth, 2008: Overview of DNE21+Model- Population, GDP estimation (www.rite.or.jp/Japanese/labo/sysken/about-global-warming/download-data/DNE21+_Population+GDP.pdf)

[9] Ref Figure. 2.5-1

[10] Nikkei PC Aug 27, 2007; TIS, 2002: The Third TIS PC Utilization Survey (http://www.tis.co.jp/news/2002/pdf/020802_2.pdf)

The Energy Conservation Center, Report on various actions of “Check 25 of Energy Saving Life-style”, and effect of energy saving, FY2004, (http://www.eccj.or.jp/lifestyle/04/index.html)

Furthermore, PC operating time will increase in the year 2025 and 2050, compared with the year 2005. According to the report[12] of Ministry of Internal Affairs and Communication, PC operating time was 0.4 hour per one day in 2004 and 1.2 hour in 2008, which has increased in triple during this period. Considering limitation of an available time for the personal use per person at home as well, this committee set that PC usage time duration at home is to be 4 hours per week and idle time is 5 hours per week in 2005, while PC usage time duration at home will be 14 hours per week and idle time will be still 5 hours per week in the year 2025 and 2050. This committee estimate PC usage utilization days at offices will be 240 days per year, PC usage time will be 3.5 hours per day, and its idle time will be 5.5 hours, this is in reference to the standard[13] of the Energy Conservation Center. The ratio of the number of PCs at home and offices is set at 4:6[14].

Also in recent trends, PC has shift from a desktop PC to a Notebook PC worldwide. Currently market share of the Notebook PC is about high-60% in Japan, while 25% in worldwide. However, a Notebook PC will penetrate more in the world in the future, as the market share of the Notebook PC has been increasing worldwide. Therefore, when applying the logistic curve into the current trend and assume that market share of the Notebook PC, it will increase with a current pace, and the market share of the Notebook PC is estimated to be 65% in the year 2025 and 2050 both in Japan and worldwide.

Regarding the scenario of the disseminated product, this committee estimate standard priced products will be the mainstream for the desktop PC, while the current most distributed product A4 type[15] will be the one for a Notebook PC.

Furthermore, penetration number of the PC is estimated from forecasted formula of a penetration rate (figure 2.3-3). This committee prospected future penetration rate of the PC in each country and region in reference to the forecasted GDP figure[16] based on the existing report, and future penetration number in reference to the forecasted population[16]. Note that maximum PC penetration number has been estimated as a double of the working age population, considering a range of the age of most frequent users of PCs is from 15 to 65 years old[17], and PC is used both at offices and at home.

On above conditions, Figure 2.4-1 shows the power consumption per each PC.

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12 Ministry of Internal Affairs and Communication, ICT White Paper, each year
13 The Energy Conservation Center, Japan, 2008: Catalog of Energy Serving performance 2008 Winter
14 IDC, 2008: Presslerease
15 Fuji Chimera Research Institute, 2006: 2006 Most advanced electronics product roadmap.
16 Systems Analysis Group, Research Institute of Innovative Technology for the Earth, 2008: Overview of DNE21+Model- Population, GDP estimation (www.rite.or.jp/Japanese/labo/sysken/about-global-warming/download-data/DNE21+_Population+GDP.pdf)
17 Ministry of Internal Affairs and Communication, 2008: Trend of Communication Usage in 2007

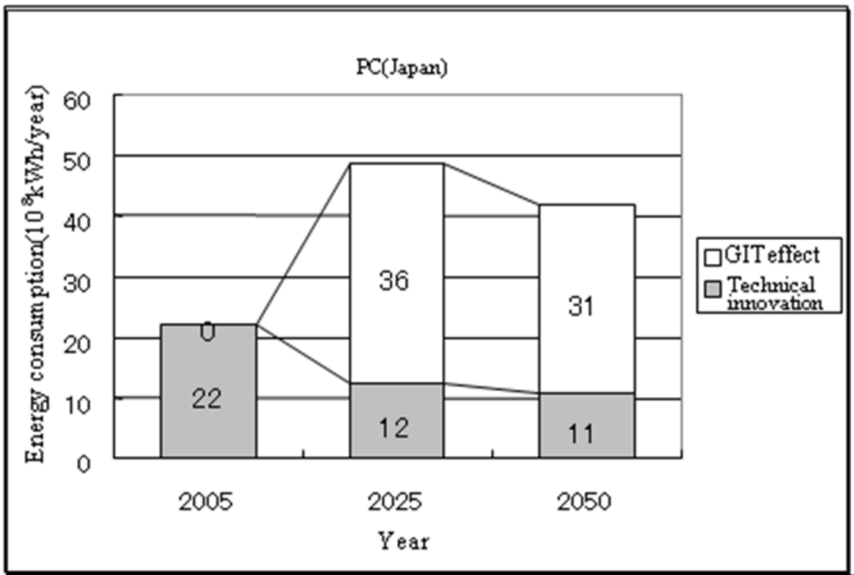
Classification		Annual power consumption per unit: Desktop (kWh/year)	Annual power consumption per unit: Notebook (kWh/year)	Premise: Desktop	Premise: Notebook
2005	Baseline	50	19	Main unit and Main unit separable from display unit – Operating state: 80W, Standby state: 3W – Home: 208 hrs/year, Office: 840 hrs/year	Typical power consumption of A4-size Notebook – Operating state: 30W, Standby state : 1.6W – Home: 208 hrs/year, Office: 840 hrs/year
2025	Baseline	67	26	Power consumption is assumed to enlarge the increase in operating time – Operating state: 80W, Standby state: 3W – Home: 728 hrs/year, Office: 840 hrs/year	Power consumption is assumed to enlarge the increase in operating time – Operating state: 30W, Standby state: 1.6W – Home: 728 hrs/year, Office: 840 hrs/year
	Technical innovation	5	13	Technical roadmap – Operating state: 5W, Standby state: 1W	Technical roadmap – Operating state: 15W, Standby state: 1W
	Baseline	67	26	Power consumption is assumed to enlarge the increase in operating time – Operating state: 80W, Standby state: 3W – Home: 728 hrs/year, Office: 840 hrs/year	Power consumption is assumed to enlarge the increase in operating time – Operating state: 30W, Standby state: 1.6W – Home: 728 hrs/p.a., Office: 840 hrs/year
		5	13	Technical roadmap (same as 2025) – Operating state: 5W, Standby state: 1W	Technical roadmap (same as 2025) – Operating state: 5W, Standby state: 1W

Figure 2.4-1: Scenario of PC product and power consumption per one

(2) Summary of the forecasted result

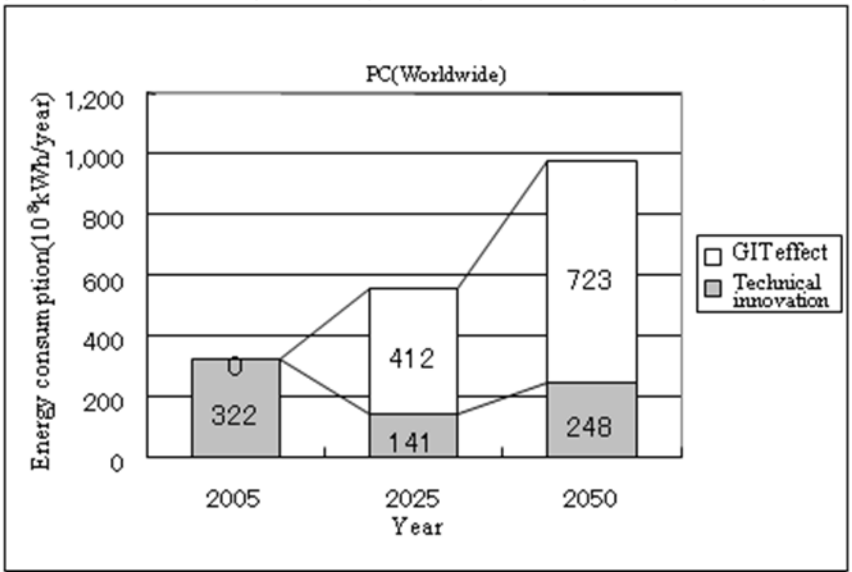
On above conditions, figure 2.4-2 shows future energy consumption of a PC and its energy reduction effect. Upper figure is for Japan, and lower is for worldwide. Height of the whole bar graph shows the case where technical innovation makes no progress (Baseline), grey part of the bar graph for the case where technical innovation makes progress (Case of technical innovation), and the white part between these gaps for the energy reduction effect.

Japan



			Unit	2005	2025	2050
Penetration number		Desktop	10^4 unit	2,849	4,263	3,666
		Notebook	10^4 unit	4,096	7,916	6,809
Power consumption per unit	Desktop	Baseline	kWh/year, unit	50	67	67
		[illegible]	kWh/year, unit	50	5	5
	Notebook	Baseline	kWh/year, unit	19	26	26
		[illegible]	kWh/year, unit	19	13	13
Total power consumption	Baseline		10^4kWh/year	22	49	42
	[illegible]		10^4kWh/year	22	12	11
	[illegible]		10^4kWh/year	0	36	31

Worldwide



			Unit	2005	2025	2050
Penetration number		Desktop	10^4 unit	59,112	48,556	85,075
		Notebook	10^4 unit	13,537	89,654	157,996
Power consumption per unit	Desktop	Baseline	kWh/year, unit	50	67	67
		[illegible]	kWh/year, unit	50	5	5
	Notebook	Baseline	kWh/year, unit	19	26	26
		[illegible]	kWh/year, unit	19	13	13
Total power consumption	Baseline		10^4kWh/year	322	553	971
	技術革新時		10^4kWh/year	322	141	248
	差		10^4kWh/year	0	412	723

Figure 2.4-2: Forecast result of Energy consumption of PC and Energy reduction effect

In Japan, while “baseline” energy consumption will increase from 49 hundred million kWh/year to 42 hundred million kWh/year, energy consumption will be reduced to 74% (36 hundred million kWh/year) in the year 2025 and 74%(31 hundred million kWh/year) in the year 2050 by the energy reduction effect. In worldwide, while “baseline” energy consumption will increase from 553 hundred million kWh/year to 971 hundred million kWh/year along with a huge increase of an energy consumption, the energy consumption will be reduced to 75% (412 hundred million kWh/year) in the year 2025 and 74% (723 hundred million kWh/year) in the year 2050 by the nergy reduction effect.

In this figure, the increase of energy consumption of baseline from 2005 to 2025 in Japan can be ascribed to the increase of Operating time and Penetration number. Penetration number will increase about 1.7 times from 70 million to 120 million, which means almost one Japanese will have one PC. PC usage time at home will be tripled during this period as well.

5. Summary of the prospect of the energy reduction effect

This part shows review of two points regarding forecast result of 10 products so far; (1) uncertainty of the forecast, (2) power consumption in 2020, as well as whole result.

(1) Review of uncertainty of the forecast

First of all, in order to review uncertainty of the forecast, this committee indicated the range of the forecast in reference to 3 scenarios (A –C) of which increasing rates of the penertarion number and consumption power per equipment are different.

The penetration number for the forecast could have a margin of an error. One of the reason for this was the gap between the forecased data, based on forecasted formula to calculate penetration number using GDP, and the actual data.

For instance in forecasted formula of a PC (Figure 2.3-3), as an actual data of penetration rate has variation in distribution along with the line of forecasted formula, and a line with big (or small) slope would be appropriate for the forecasted formula. The actual Data's least square approximation value plotting line is shown as the scenario "A", the High side Presumption diffusion plotting line is shown as the scenario "B", and the Low side Presumption diffusion plotting line is shown as the scenario "C", respectively. For other equipments, this committee set "forecasted formula by fitting" as Scenario B, "forecasted formula with higher penetration rate" as Scenario A, "forecasted formula with lower penetration" as Scenario C (refer to attached A.2 for the penetration curve). Similarly, this committee considered a range of the estimated curve for workers at offices, and storage number would vary per server for the storage capacity (table 2.5-1).

Also, consumption power per equipment can have a margin of an error. As in a past trend which was utilized for the forecast of future power consumption and increasing rate were estimated based on the limited samples, therfore a gap between the actual data exists. This committee adopted a senario with high increasing rate of power consumption as "Scenario A", a scenario with middle inreasing rate as "Scenario B", and a scenario with low inreasing rate as "Scenario C".

(2)Forecast of Power Consumption in 2020

The year 2020 is an important midterm milestone for the study of CO2 emission reduction. Therefore, this committee estimated the power consumption and energy reduction effect in 2020 by using the result of years; 2005, 2025 and 2050. Assumption was based on each plotted ends' second derived function to be set as "0" with the third spline interpolationset as; year 2005, 2025, and 2050 intervals, and by this the application of the expected consumption of electricity was achived.

Figure 2.5-1 and 2.5.2 as well as table 2.5-1 shows the forecasted result.

Table 2.5-1: Several Scenarios detailed for the uncertainty study

		Scenario A High penetration rate High rate of increased power	Scenario B Middle penetration rate Middle rate of increased power	Scenario C Low penetration rate Low rate of increased power
PC	Penetration rate [18]	High	Middle	Low
server	Penetration rate	High	Middle	Low
	Increase rate of Consumption power per volume server	2.5%	1.5%	0.75%
	Increase rate or Consumption power per server (except volume server)	6 %	3 %	1.5 %
storage	Increase rate or Consumption power per unit	6%	3%	1.5%
	Number of penetration (PC,server penetration)	High	Middle	Low
	Number of storage per server	2025： 7.3 units／per server 2050： 15 units／per server	2025： 5.3 units／per server 2050 年： 10 units／per server	2025： 3.3 units／per server 2050 年： 5.8 units／per server

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[18] Ref attached A.2 for the detail

Continued from the previous page

		Scenario A	Scenario B	Scenario C
Router	Penetration rate	High	Middle	Low
	Consumption power per router (Popular type)	2005～2025 5% 2025～2050 : 2.5%	2005～2025 3% 2025～2050 1.5%	2005～2025 1.5% 2025～2050 0.75%
	Consumption power per router (High-end type)	2005～2025 30% 2025～2050 15%	2005～2025 25% 2025～2050 12.5%	2005～2025 20% 2025～2050 10%
display	Penetration number （Desktop PC）	High	Middle	Low
Television	Out of rate setting			
Home-use recorder/ player (DVD etc.)	Penetration rate	High	Middle	Low
lighting	Penetration rate	High	Middle	Low
refrigerator	Out of rate setting			
air-conditioner	Penetration rate	High	Middle	Low

Figure 2.5-1 shows the total energy (Electrical Power) consumption of the 10 products from 2005 to 2050 and a trend of energy reduction effect.

This committee consider that environment load of the IT equipment includes necessary facility to operate IT equipment (power, air-conditioner etc), and also that servers, storages and network routers utilized mainly for business purposes include a facility contribution. “Power Usage Effectiveness” (PUE) in years; 2005, 2025 and 2050 is settled to be 1.9, 1.8 and 1.7 respectively, and the energy consumption and energy reduction effect of these have added to the effect of IT equipment itself[19].

In Japan, a 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 the year 2025 if the current situation continues. However, this is expected to decrease about 120-170 billion kWh/year (about 140 billion kWh/year) in 2025 as a result of expected 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 the technical innovation. Each scenario was prepared to take into an account of the range from minimum to maximum values for per-unit energy consumption and the penetration rate (Parenthesized figures represent the Scenario B).

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

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[19] Although contribution of the facility air-conditioner is party crossover to the “air-conditioner” of electronics equipment, percentage of air-conditioner for business purpose at data center is considered to be small.

[20] In considered of future uncertainty, conversion factors were set to 0.2-0.4 [kgCO2/kWh].

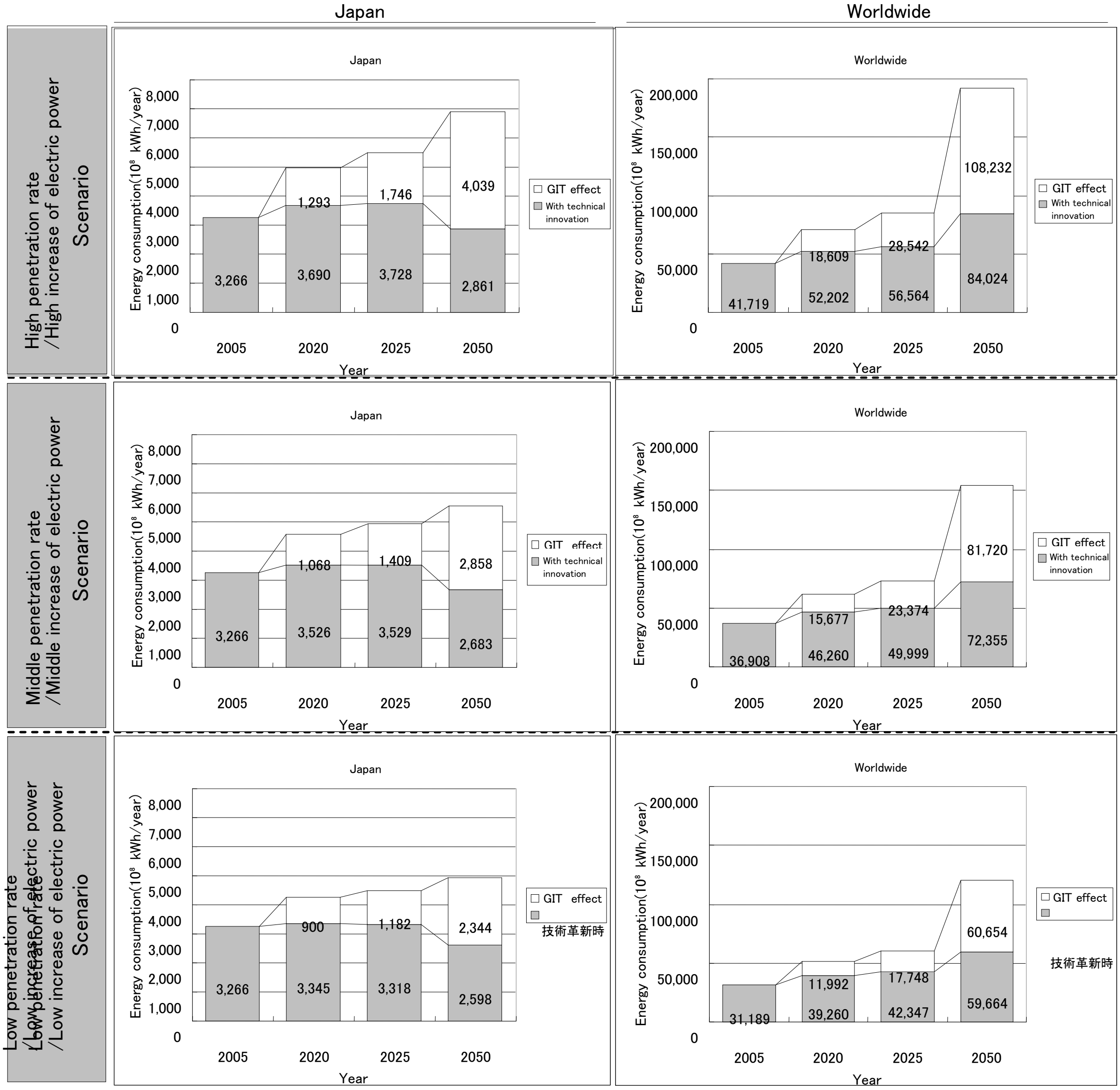

Figure 2.5-1: Energy consumption and Energy reduction effect of the 10 products

(Including facility contribution, see 0.2 figures)

Moreover, figure 2.5-2 (results in Japan) shows 5 products out of 10 products; TVs with high increaseing rate of energy consumption and IT equipments. These products are estimated that the total power consuption will increase at four times from 51 billion kWh/year in 2005 to 157-255 billion kWh/year (about 200 billion kWh/year) in 2025. Although the current energy consumption is relatively small, a concern is that the energy consumption will increase rapidly if technology innovations make no progress in the future. On the other hand, if the technology innovation will be highly concentrated, then the increase of the energy consumption can be held down to about 51 to 110 billion kWh/year (abuot 74 billion kWh/year).

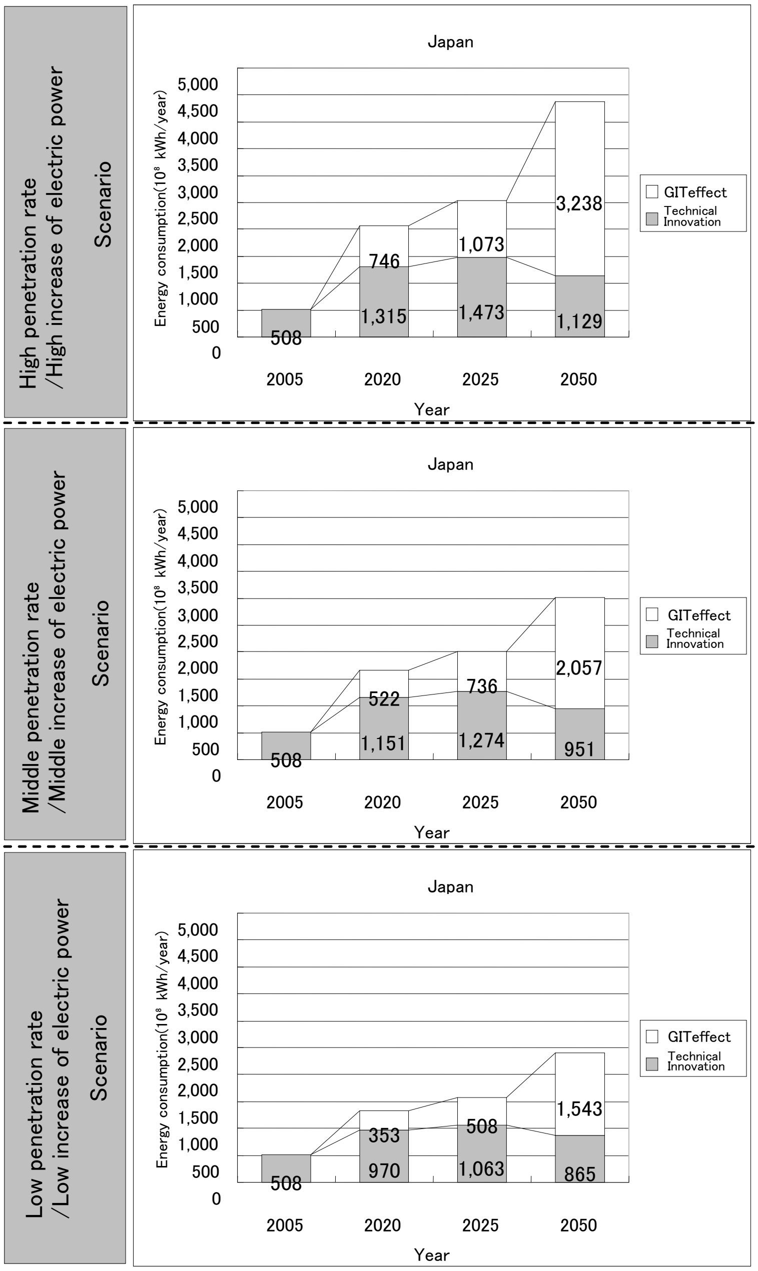

Figure 2.5-2: Forecast of Energy consumption of IT equipment and Energy reduction effect

(Including facility contribution, see figure 0, 3)

Part4 Measurement and forecast of energy saving effect by IT

1. Background of the survey

In this part 4, results of the study about "Energy saving for the whole society by utilizing IT solutions" are summarized.

By looking at the CO2 emission in Japan, an increase in CO2 emission in a different industry area has been limited by efforts for energy saving and CO2 emission level in each indistries since 1990. On the other hand, CO2 emission in Transportation sector, Private business sector and Household sector have been increasing every year. Reducing CO2 emission in these sectors are becoming very important to reduce CO2 emission in Japan.

Essence of the IT is to make all sort of process efficient, and to make things small / light / thin, and make big mechanical products computerized with softwares. Intelligent transport system (ITS) which controls cars' movement in the entire road network, for an instance, can realize energy saving in Transportation widely by utilizing the IT. Further more, wide spred of the use of Teleconference system, Electronic music distribution and e-learning can be effective to save energy consumption by reducing people's movement and unwanted consumption of the resources. Also "Building Energy Management System (BEMS)", "Home Energy Management System (HEMS)" and "Factory Energy Management System (FEMS)" could greatly contribute in reduction of the energy consumption. To utilize all kind of IT solution actively, including these softwares/services into various fields of the society, could make a realization of the big reduction effect.

The IT is expected to eliminate these waste and inconsistency in the society and thereby produce an energy reduction effect. These effects have a potential which can greatly contribute for the CO2 emission reduction in several industry areas such as Steel Industry, Power Utilities, Chemical Industry, Automotive Industry, and also Business (Office) area, Households (Homes) and Transportations.

In this part 4, the evaluation method of CO2 emission effect with IT solution which will lead to "Energy saving in whole society by IT" will be reviewed, and actual case studies of IT solutions will be introduced as well. Also with a regard to the emission reduction contribution by IT solution in each area, this committee forcasted the contribution in the Fisical Year 2020, this is the based for the forecasted result of contributions in 2025 and 2050 respectively which was originally summarized in the Fisical Year 2008 report.

2. Classification of IT solutions

2.1 Explanation of categories

Prevention measures toward Global Warming by IT, especiall on an energy saving, are not just to reduce the evergy consumption of IT equipments stated in the part 2. By utilizing IT is expected to eliminated the waste and inconsistency in the society and thereby produce some energy reduction effects. For an example, to install enery savings sensors at office buildings and to manage the energy appropriately would reduce energy usages and yield savings at offices.

Like in this example, a large effect of the energy saving could be produced by introducing a new flamework using the IT (IT solutions) into the Production activities of industrial sectors, Office activities of the private business sector, human living at home (households), and Transportation sector which support the transport of people objects and etc.

Table 4.2-1 shows the basic categorized results, based on each secene utilizing these IT solutions. Note that sectors in the below table are almost as the same as categories used by the Kyoto Protocol Target Achievement Plan.

Table4.2-1：Categories by IT solution

Categories	Sub-categories
Industry	Factory
	Production process
Business	Building
	Indoor
Household	Building
	Indoor
Transportation	Infrastructure
	Activities
Energy	Effectiveness of electronic generation
	Effectiveness of electronic transmission

2.2 Classification of IT solution in each categories

Utilization of IT solution for the energy usage in different area is becoming wider in Industrial sector to homes (household), along with an innovations in the IT equipment. Table 4.2-2 shows the classification of which IT solutions are utilized in which categories stated in the above section.

Table4.2-2: Classification of IT solution

Categories		IT Solution	Overview
Industry	Factory	FEMS (Factory Energy Management System)	System to reduce energy comsumption by operational management of equipments or facilities at the factory
	Production process	high-efficiency in lightings / air conditionings / motor / power generator	To change / repair equipment in production process (e.g. lightnings or air conditionings) from conventional one to highly effective one
		efficiency in production process	To improve productivity by cutting waste in productive process in factories etc
Business	Building	BEMS (Building Energy Management System)	System to reduce energy consumption by operational management of equipments or facilities in the building
	Indoor	electronic tag / distribution system	Efficienty improvement of stock controle or electronic tag etc in distribution system
		paperless office	To reduce paper consumption by making paper-based documents computerization at the office
		IT introduction into business	To realize business efficiency and energy saving by introducing IT equipments into conventional business at the office
		telework	To work in different place from normal place (home, business trip etc)
		TV conference	To hold realtime TV conrerence with other party in remote area though internet etc
		Tele-medicine / electronic medical recod	To question or treat to the patients in remote area, making conventional paper-based documents computerization
		electronic bidding / electronic application	To bid tender though internet, or to make each application computerized at governmental organization etc

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Categories		IT Solution	Overview
Household	Building	HEMS (Home Energy Management System)	System to reduce energy consumption byoperational management of equipments or facilities at household
	Indoor	electronic money	Expression of money value by digital data, and means of settlement of e-commerce
		electronic publishing / electronic paper	To replace paper-based publication or documents into electronic media
		music / software distribution	Music data or software distributed though internet
		online shopping	Shopping service to apply purchase though internet etc
Transportation	Infrastructure	Use of LED signals	To switch conventional bulb-type signals to LED signals with low energy consumption
	Activities	ITS (Intelligent Transport System)	To improve transportation/road problems by managing road and car using ICT, and by connecting network.
		fuel economy improvement in automobiles	To improve fuel consumption by introducing electronic automobiles and hybriad cars
		efficiency improvement in transportation means	To improve efficiecy in transportation means (through land, sea etc)
		eco-drive	To drive without using waste energy consumption along with rapid deceleration / acceleration by various controle technologies

Note: As main activities in Power Utiltiy (Energy) sector are to generating electricity and its transmission, a reduction of the power (energy) usage with IT solution could contribute to the energy saving of this sector, but this sector issue is not covered by this study.

Note that “IT solutions” listed with in the above table were based on the disucssion at “Survey and Estimation Committee Work Group - 1 of the Green IT Promotion Council (hereafter “WG1)”, and it is not covering every possible solutions. By proceeding this study further, many more various and newer IT solutions will be introduced and defined.

3. Flamework of energy saving (CO2 emission) by IT solution

3.1 Basic computation method

Effect of the energy saving by IT solution could be introduced and managed by the combination of several factors. An evaluation could be performed by the amount of changes in reduction of CO2 emission with certain fields' "Before and After" by introduction of IT solutions.

"Telework" for an example, if amount of the travel or commute of a worker is reduced, an energy consuption on this worker's travel or commute could be reduced. Moreover, by the introduction of Telework, an office space could be reduced along with a human occupancy of the workers at offices.

This reduction of the energy consumption will be the sum of the effect by reducing travel or commute of a worker (factor 1) and the effect of reducing the office space (factor 2). On the other hand, by conducting Telework will increase the power consumption of home appliances, IT equipments, Networks usage, and etc. when working at home (factor 3), which needs to be considered. Therefore, the total energy reduction effect by Telework can be calculated by a method of "(factor 1) + (factor 2) – (factor 3)".

Therefore, effects by introducing IT solution can be calculated by the sum of component factors, and could be discribed by these 8 items in the below.

Table 4.3-1: Component factors of the effect by IT solution and their computing method

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 or commute of workers	Airplane, automobile, train, etc.	(Reduced travel or commute of workers) x (Basic unit of transport)
(iii) Transportationl of goods	Truck, railroad, cargo, etc.	(Reduced movement distance of goods) x (Basic unit of transport)
(iv) Office space	Space occupied by wokers (including work 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)

When “Work Efficiency” will be improved by introducing (or using) IT solutions, they could be expected to reduce the energy consumption (energy for lightings and/or air-conditionings, and etc.) at offices and etc. compared to their conventional way. In Table 4.3-1’s item 4 “Office space”, effects by improvement of these work enviroment related efficiencies are considered as one of the end results, because office spaces for workers or equipments could be reduced when unnecessary.

Effect by IT solution can be expressed by the combination of travel or commute of workers, consumptions of goods, energy consumption related to spaces (offices, warehouses), IT equipments, and usage of the network. Also that the effect could be calculated by the method ; “active consumption” times “basic unit of CO2 emision” per “basic unit”. Noted that list of the basic unit is summarized in the section 3.4.

For a reference, results of the effect of Telework based on the component factors listed at the above table 4.3-1 is described in the table 4.3-2 below.

Table 4.3-2: Component factors of Telework

Component	Subject of component		Explanation of component
(ii) Travel or commute of workers	A	Energy consumption on commute (in case of travel means performed by each person)	By conducting Telework, private cars could be refrained from using, and energy consumption of cars will be reduced.
	B	Energy consumption on commute (in case of the use of public transportation)	By conducting Telework, public transportation like trains or buses can be refrained from the use, and energy consumption with these transport will be reduced.
(iv) Office space	C	Energy consumption needed with office works	By conducting Telework, energy consumption at the offce for daily use will be reduced
(vi) Power/energy consumption	D	Energy consumption of IT equipment	Consumption of Energy of IT equipments which are used during Teleworking
	E	Energyconsumption along with working at home	Consumption of energy except for IT equipments for Teleworking. e.g. air-conditions and lightings at home
(vii) Ammount of the data communication	F	Energyconsumption along with the use of ICT	By introducing Telework, consumption of energy by the use of ICT will increase

Detailed component of effects by IT solution will be summarized in the next section. Also actual case study of IT solution collected at WG will be summarized in Part 4.

3.2 Computing procedure of energy savings (CO_2 reduction) by IT solution

Effect by “IT solution” has made convincing improvements of a daily life, and to made it achievable to reduce energy consumption in a visible way. Still, it is difficult for some IT solutions to grasp concrete effect of conviniencing results.

In this part, this committee will explain about method for computing effect to grasp quantified effect by the IT solution, by using the concrete case study of Telework.

When computing a reduction effect of energy consuption by IT, this committee will make computing process as the below, which is normally used;

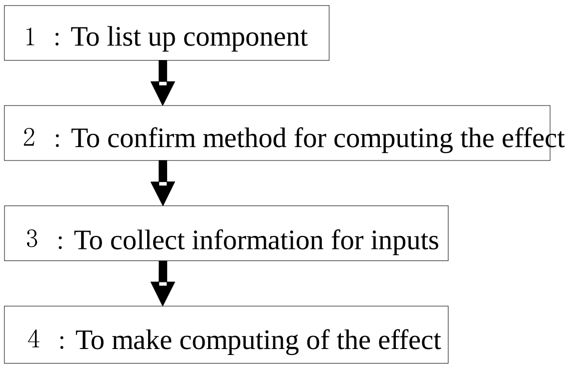

Table4.3-1: Computing flow of reduction effect of energy consumption by IT solution

3.2.1 To list up component

In order to estimate the effect of IT solution, it is necessary to grasp what kind of components construct the effect at first. Regarding each components, it is necessary to list up every possible components of energy increase/decrease on conducting and introducing of the IT solution, in reference to the components which construct the effect of IT slution shown in the above Table 4.3-1.

Below 6 components could be considered when measuring the effect of Telework.

Table 4.3-3: Component factors of Telework (same as Table 4.3-2)

Component		Subject of component	Explanation of component
(ii) Travel or commute of workers	A	Energy consumption on commute (in case of travel means performed by each person)	By conducting Telework, private cars could be refrained from using, and energy consumption of cars will be reduced.
	B	Energy consumption on commute (in case of the use of public transportation)	By conducting Telework, public transportation like trains or buses can be refrained from the use, and energy consumption with these transport will be reduced.
(iv) Office space	C	Energy consumption needed with office works	By conducting Telework, energy consumption at the offce for daily use will be reduced
(vi) Power/energy consumption	D	Energy consumption of IT equipment	Consumption of Energy of IT equipments which are used during Teleworking
	E	Energyconsumption along with working at home	Consumption of energy except for IT equipments for Teleworking. e.g. air-conditions and lightings at home
(vii) Ammount of the data communication	F	Energyconsumption along with the use of ICT	By introducing Telework, consumption of energy by the use of ICT will increase

After listing up components which will constract the effect, it is needed to clarify the prerequisite of effects of IT solution or existance of each components. Clarification of the prerequisite is equal to clarifying the condition (a baseline) before the introducing of IT solutions. By making a comparison between "consumption energy after introducing IT solution" and "consuption energy of the baseline condition", it could possible to grasp the reduction effect of the consumed energy quantitatively.

Prerequisite of each component on Telework can be summarized as below.

Table 4.3-4: Prerequisite of telework component

#	Component	Prerequisite
A	Energy consumption on commute (in case of travel means by each person)	To travel or commute means by each person to drive a private car and etc.
B	Energy consumption on commute (in case of the use of public transportation)	To use public transpotarion like trains or buses
C	Energy consumption of Office workers	At an existing office, where a possible teleworking person work full time. Also electricity (enegy) has been consumed at this office on a daily basis to be reduced.
D	Energy consumption of IT equipments	When IT equipments to be used for the Telework to exist.
E	Energy consumption when working at home	Excluding energy useage of IT Equipments for the Telework, other energy consumption is to exist.
F	Energy consumption of ICT	When conducting the Telework, an additional energy consumption needed for the use of ICT

3.2.2 Establishing the method of computing effects

Next, this committee will establish the method of computing effects in oder to grasp CO2 emission (kg of CO2 and etc.) using related data, considering whether listed components come up as what kind of “positive factors” or “minus factors”. On this regards, this committee will establish the method of computing to calculate the CO2 emission per one year (target period of the computnig) in general, in reference to the computing method of factors shown in the table 4.3-1.

This committee will explain the method of computing energy reduction effect by using the below case study on Telework, with notable considerations on computing.

【Case Study】

This committee will calculate the effect of conducting Telework for one day per week (52 days per year). This targetted Teleworking worker is assumed to be commuting by his/her own car (6km for both ways) and also riding a train (40km for both ways) normally. Also length of his/her work at home is assumed to be at 8 hours per day.

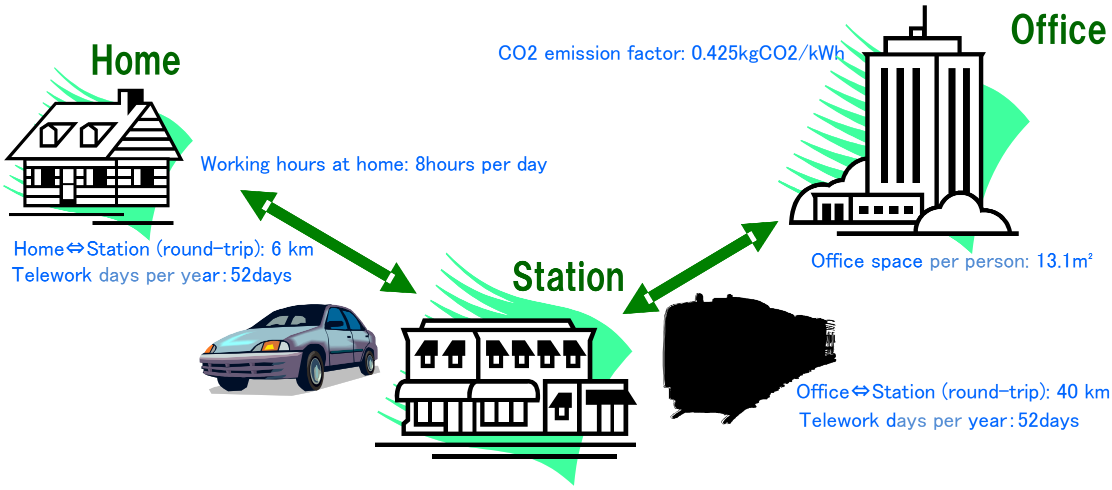

Figure 4.3-2: Case study of Telework (Overall figures)

Here as, when establishing the method for computing effect, it is necessary to check whether each listed compoment brings “plus effect” or “minus effect” in terms of reducing the energy consumption.

“Plus effect” in here means reduction of the energy consumption will be realized by conducting and introducing the IT solution. While, the energy consumption will be inevitably necessary to realize the plus effect. Otherwise, this committee consider this as the minus effect.

A：Energy consumption of Commuting (in case of travel means by each person)

Component A is the one office worker using indivisual travel means like driving a car and etc. on a commute reducing the energy consumption by replacing this commute by conducting Telework.

As this would contribute to the reduction of an energy consumption, this is “positive factor” which could be calculated with the below method.

A ＝（A1 : Reduced travel of workers）×（A2 : Basic unit of travel related to an indivisual travel）
＝（A1 : Accumulated travel distance of indvisual travels which are reduced by conducting Teleworking）×（A2：Basic unit of indivisual travel of workers)

A1 is the accumulated-travel distance which is caused by avoiding the driving of a private car along with conducting Telework for the private car user, while A2 is the CO2 emisson (basic unit) per worker per 1 km along with the use of a private car. It is also necessary to assume that, this computing method has to be modified somewhat depending on a possibility or impossibility of collecting information of necessary input data, like basic units or other data, when confirming the computing method of components.

For one example, actual time to conduct Telework per week has been published in statistics document of Telework study, while the total days conducting Telework has not been published in most cases. As the total number of commute by a private car is the main input information of the component A, it maybe necessary to calculate the total time conducted Telework to deduce the actual commuted days. Therefore, when conducting days of Telework has not been recoreded, there is a need to estimate the avarage work time per day for the calculation.

Regarding the energy consumption on commute (in case of using indivisual travel means), it will be desirable to utilize a basic unit of driving 1 km by private car and etc. per one as obtainable basic units. Noted that in case this basic unit is not obtainable, then it is necessary to calculate from the fuel consumption and etc.

By this, it maybe needed to construct the computing method with consideraion of input data beforehand.

In reference to the case study of Telework (figure 4.3-2), the computing method of an effect where office worker (one persnon) commuting 6km to and from per one day to conducts Telework for 52 days per year, this case will be shown in below. For the detail of explanation regarding the basic unit (a basic unit on commute by private car per one worker per 1 km : 0.047 [kgCO2/person・km][21]) could be seen in the item 3.4 below.

A＝（A1 : Accumulated travel distance of worker with travel means is reduced by conducting Teleworking）×（A2：Basic unit of indivisual travel for wrokers)
＝（A1 :（Frequency of conducting Telework）×（Travel distance of private car per one Telework））×（A2：Basic unit of travel of private car）
＝ （52 [day/year] × 6 [km/day]） × （0.047 [kgCO2/(person・km)]）
＝ 14.7 [kgCO2/(person・year)]

21 Ministry of Land, Infrastructure, Transport and Tourism, Directory of energy related to transportation Fiscal Year 2001-2002 (ref. private car)

B：Energy consumption on commutes (in case of the use of public transportation)

The component B is to apply computing method same as the above component A for the use of public transportation like trains or buses, and could be categolized as “positive factor” because it is a contribution to reducing energy consumption.

Considerable point of the component B is that even if general public’s one commuter is to use the public transportation and the decrease due to Telework, it does not affect the operation frequency of the public transportation including trains and does not cancell the operation. Still, if Teleworkers will increase, a decrease of operation frequency could be possible. IT solutions could be said to have these potentials.

In this manner, this committee defined that these would not have immediate effects, but expectation of saving the energy effected by IT (here, the effect where commuters will decrease by expantion of Telework , and operation frequency of the train will reduce along with), will be included into the whole “Effect” (amount of contributions by IT solution).

As seen in the above, the reduction effect of energy consumption (in case of the use of public transportation) on commutes could be calculated as shown in below. Note that computing method may needed to be modified somewhat depending on an accessibility of the basic unit as seen in the component A.

When the basic unit （0.005 [kgCO2/person・km][22]） could be obtained from the travel by by trains per 1km per one office worker, the deemed effect (amount of the contribution) of Telewoker commuting by trains for 40km to and from per one day (number of days conducting Telework per year is 52 days) could be calculated as below.

B ＝（Reduced travel of workers）×（Basic unit of travel related to the public transportation）

＝（B1：Accumulated travel distance of public transportation reduced by conducting Telework）×（B2：Basic unit of the public transportation）

＝（B1 :（Frequency of conducting Telework）×（Travel distance of commute by trains per one Telework））×（B2：Basic unit of the public transportation）

＝ （52 [date/year] × 40 [km/date] ）× （0.005 [kgCO2/(worker・km)]）

＝ 10.4 [kgCO2/(worker・year)]

The Basic Unit (B2) utilizing here means a unit amount of the energy consumption of trains’ operation with a reduced consumption per 1 km and per 1 rider along with the decrease of an operation frequency of use of the public transportation (trains).

[22] Ministry of Land, Infrastructure, Transport and Tourism, Directory of energy related to transportation Fiscal Year 2001-2002 (ref. trains)

C：Energy consumption relating to the office work

By conducting Telework, it is expected that the energy consumption of the office infrastructure (air-conditions, lightnings and etc.) will be reduced along with the decrease of the associated workers who would otherwise consume energies at the office. The component C is one example where these changes of the energy consumption have been considered. This factor could be categorized as “plus facter” as a conventional energy consumption will be reduced by conducting Telework.

In general, effect of Telework is evaluated by the number of office workers conducting Telework, or the percentage of Teleworkers among entire office workers.

For an instance, when a half of office workers would conduct Telework, the energy consumption at offices is expected to be reduced by a half in theory. However, even if some workers maybe out of the office, it is unusual to control the specific energy consuption (to reduce the half of office lightnings in use) according to to the occupants’ number at the office. Therefore, it could simply be described that the energy consumption could not be reduced to the half.

The component C could be described as the number of Teleworkers does not immidiately contribute to the reduction of the office energy consumption, but increases in Teleworkers could conbribute to the potencial of a reduction of the energy consumption at offices. As seen in the component B, this component C is defined as the contribution of “IT solutions”.

With this reference to the above scenario, a contribution amount of the energy consumption reduction can be calculated by the below formula. Here an establishement of the target office work days per year is set at 260 days (5 days per week times 52 weeks).

C ＝（Office square occupied by one worker）×（frequency of conducting Telework）
×（Basic unit of the energy consumption per unit square）

＝（C1：Office square occupied by one worker[23]）×（frequency of conducting Telework）
×（C2：Basic unit of the energy consumption per unit of square at the office[24]）
＝ 13.1 [m2/worker] × (52/260) ×76.0 [kgCO2/(m2・year)]
＝ 199.1 [kgCO2/(worker・year]]

With this, the contribution amount with a ceatain IT solution introduction at offices maybe assumed to reduce the conventional working hours at offices by 30%. This could be considered as one effect, and an effect of this working hour reduction by 30 % is expected that; “working volume can be reduced by 30% from the planned work task” → “It may be possible to reduce the working volume of the staff with this 30% reduction”, → “It may be possible to reduce the energy consumption of the office infrastructure such as air-conditions and lightnings”. But at ths same time this is not by means to reducing the work force size by 30%”, it is rather there is a possible saving value equivalent of 30% worth of work force down sizing in energy savings, this could be achived by an introduction of this IT solution. This also means the 30% energy reduction could be made possible compared to before.

[23] Research group report regarding ICT policies toward global warming, April 2008
[24] Ibid

D：Energy consumption of the IT equipments

The component D is the energy which IT equipments actually consume. Recently the energy saving of IT equipment has made some progresses, and burden of this Component has been reduced. However still, on conducting Telework, as it is essential with the use of IT equipment and these associated factors are raised and increased with the energy consumption by the Telework, this committee needed to consider these as “minus factors”.

Thoughts are that an ordinal Office work at Home when conducting Telework, is considered to be the same as the work at offices (using PC) performed at Home (using PC at Home or bringing Home a PC from the office).

This committee assumed Teleworkers will conduct work at Home using a notebook PC (the energy consumption per year is 18,734[Wh/year・unit][25]). (Consumed energy per 8 hours would be 192.1 [Wh/day] = 0.192 [kWh/day]). A Teleworker lives in Tokyo Metropolitan area would use electricity supplied by the Tokyo Electronic Power Company. （CO_2 emission coefficient：0.425 [kgCO_2/kWh][26]）

D ＝（the power consumption of IT equipment per unit）×（Basic unit of system power consumption）

＝（D1：the power consumption for Notebook PC use）

×(D2：basic unit of system power consumption）

＝（D1: Number of IT equipment × consumption of the power of IT equipment per unit × the consumption duration of IT equipment ）

×（D2：basic unit of system power consumption）

＝ （1 [unit] × 0.192 [kWh/(numbers of the use・unit)] × 52 [number of the use/year] ）×（0.425 [kgCO_2/kWh]）

＝ 4.2 [kgCO_2/year]

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25 The Energy Conservation Center: consumption power per type LED 14 type and above: saving energy mode has been settled already. Power consumption per year is the one used for 15 hours per week use, 52 weeks in total.

26 Tokyo Electric Power Company: Data from 2007

E：Energy consumption of Working at Home

As in a real life, usually even a Teleworker would conducts overtime or remaining work form the office at home by using PC and etc. On this regard, this worker will use air conditionings to cool during the Summer time, and heaters during the Winter.

In this case, the energy consumed additionaly because of the work at home is considered to be the energy consumption increases introduced by the Teleworks. This is the component E, which is considerd as “minus factor”.

With a regard to the most of the consumed power like air-conditionings and etc. among home appliances, the figure per unit square in this energy consumption at the office has not been mesured or estimated in most cases. Therefore, after culculating the power consumption in a reference to usage frequency of home appliances during this work at home, this committee is using the power usage total for the CO2 emission coefficient which is multiplied along the system of power to obtain the CO2 emisson ammount.

This committee assumed ordinal household appliances to be used during this work at home will be; air-conditionings（capable of cooling air - 2.2kW : 6～9 mats (this unit is based on the Japanese Tatami floor mat size standard)）and lightnings（6～8 mats）[27]. The consumption power formula is shown in below.

E ＝ (the power consumption of working at home) × (basic unit of the system power consumption)

＝｛(E1 :（the power consumption : air-conditionings）＋（power consumption : lightnings）×（frequency of Teleworks conducted）｝

×（E2：basic unit of the system power consumption）

＝｛(1.15 kWh/ frequency ＋ 0.54 kWh/ frequency) × 52 [frequency / year] ｝×（0.425 [kgCO2 / kWh]）

＝ 37.3 [kgCO2 / year]

F：Energy consumption by the use of ICT

IT solution has dramatically improved both a life sytle and a conventional work style at office or working at home to convenient one, especially with the use of the Internet. As IT solution including the Internet access promotes an additonal energy consumption of equipments which are related to the Internet infrustructure, and it could be considered as “minus factor” (the Component F).

As the energy consumption by the use of ICT should be decided depending on the increase and decrease of the used amount of ICT, this committee used the basic unit（0.0025 [kgCO2 / Mega bytes][28]） for this amount (per 1M bytes).

[27] The energy conservation center, Japan　Catalog of energy saving performance 2008

[28] Japan Environmental management Association for Industry：Report of discussion result on collection of case study of environmental efficiency of ICT service, and calculation standard：March 2004

Here, it would be desireble to use the latest data for this basic unit to be acculate, but this committee will use the above data because newer figures have not been published yet at the time of this report.

When using 10,000 [Mega bytes] of the ICT per one year for Telework at home, the energy consumption by the ICT usage ammount could be calculated with below formulas.

F ＝ (the amount ICT used) × (basic unit of the ICT)
＝（F1：amount of the ICT used）×（F2：basic unit of the ICT）
＝ 10,000 [Mega bytes] × 0.0025 [kgCO2 / Mega bytes]
＝ 2.5 [kgCO2 / year]

In this constantly advancing ICT fields, as the CO2 emission coefficient per unit amount of the ICT used （1 Mega bytes）has not been studied and published at this time, and an avilable information of this basic unit is very limited. While this energy savings efforts of the ICT infrustructures in recent years have been widly penetrated, the amount of Network Communication has been increasing every year. Therefore, there is a high possibility that the amount of an energy consumption will have greater influences when culculating the effect of IT solutions.

3.2.3 Calculation example of the IT solution effect

In order to grasp the effect by introducing and conducting the IT solution, this committee will categolize each factor listed and calculated in previous section into “minus” or “positive” factors, and then calculated the effect.
The below table is the culculated results of each component by conducting Telework (figure 4.3-2),which was listed here as a solid example.

Table 4.3-5：CO2 emission reduction of each conponent on Telework

[kgCO2/year/person]

#	Subject of conponent	CO2 emission reduction
Positive effect		
A	Energyconsumption on Commutes (in the case of travel means by each indivisual)	14.7
B	Energyconsumption on Ccommutes (in the case of using public transportations)	10.4
C	Energyconsumption of the office work at offices	199.1
Negative effect		
D	Energyconsumption of IT equipments	4.2
E	Energyconsumption of works peformedd at home	37.3
F	Energyconsumption of the ICT	2.5
	Total（A+B+C-D-E-F）	**180.2**

3.3 Collecting input Data information for the Formula calculation

After confirming the calculation formula of the component, it is important to collect input data into each Formula properly. In general, necessary information to evaluate the effect of the energy saving on introducing IT solutions could be divided into the two categories.

（1）Information for calculating the amount of activities

This is the chang in an amount of the energy or resource use which has ouccured on this field by utilizing the IT solution.

In Telework case, this will be the amount of a fuel consumption of the private car which has been elimited by avoiding the automotive commute, and this would be a similar concept as the amount of papers and etc. saved when the paperless office method is in use.

（2） Information of the basic unit

This is the change in an amount of the energy used by introduction of the IT solution coverted into the amount of CO2 emission. This will be the amount of the CO2 emission of a fuel consumption of private cars reduced by eliminating automotive commutes, or the amount of the CO2 emission and etc. per weighted unit on manufacturing paper products which has not occurred due to onducting the paperless office method.

By utilizing average figures or using typical figures (i.e. reference figures) into the above (1) and (2), a rough effect of the IT solution use could be observed.

The use of reference figures would be valid on estimating the effect of IT solutions, where this could not be done with a real measument. For a reference, the figure of IT solutions will be listed in the Chapter 3.5 (the Reference figure for calculating effect of IT solutions).

Regarding an effect of the IT solution (an estimate of the ammont reduced for the CO2 emission) , a large and a small basic unit used for the calculation (CO2 emission coefficient) may become the deciding factor for the CO2 emmision redcution to become a large one or a small one in many cases. Therefore, in order not to depend on the size used for the basic unit for the effect of IT solutions, a common basic unit (or a basic unit within a certain range) will be ideal to be used when comparing effects of the energy saving.

Also even if this basic unit is treated the same, the figure may be revised according to changes in the social situation or the environmental condition. For an instance, as a percentage distribution of different sources which are to produce the electrical power (Hydraulic power generation, Atomic power generation, and Steam-powered generation) could dynamically change due to an inflation of the oil prices, decreases in the ammount of of available water in reservoirs, or operational status of Atomic power plants and etc., figures of the CO2 emission coefficient of the System Power have been changing very frequently. Therefore, the CO2 emission coefficient has been reviewed annually by each Grid Electric Power service provider.

As stated, with regards to the basic unit revised annually, it would be desirable to choose appropriate basic units with a consideration of a different operational time frame for the calculation, and the utilization purpose of its calculation result.

By doing so, when this committee compared the reduction effect of energy consumptions of IT solutions between two different locals (places), an observation of differences between these could be clearly seen by utilizing a common basic unit.

On the other hand, when this committee compared the effect of the same solution in different time periods, it is necessary to utilize the basic unit from different two periods.

Furthermore, when calculating the effect of the IT slution, if participants request more accurate results, it would be ideal to use the actual measured result for the input data which could be collected at the time of the installation or operational initiation of each specific IT solution.

3.4 Basic unit which is utilized for the calculation

The blow is the list of the basic units which could be utilized in many situations when calculating the reduction effect of the energy consumption by IT solutions (Figure 4.3-3 to 4.3-8). This listed items are collectioned and then summarized information publically available at this time. Although this committee listed several reference figures, this was in order to make it easier to calculate the CO2 emission reduction by utilizing IT solutions in the future, and the committee did list the ranged figure of the "basic unit" because of some possible small changes in referenced figures by different time period or the organizational structure.

	Basic unit	Product Consume	Con-assumptio	Unclear	Reference		Range of basic unit	Data update	Source
Energy Consumption	Gasoline	○			2.75 (kgCO2/liter)		---	---	Environmental load rate, NIES…Dec.2002 Ref.1
			○		2.30 (kgCO2/liter)		---	---	Act on Promotion of Global Warming Countermeasures
	Heating	○			2.65 (kgCO2/liter)		---	---	Environmental load rate, NIES…Dec.2002 Ref.1
			○		2.50 (kgCO2/liter)		---	---	Act on Promotion of Global Warming Countermeasures
	Light oil	○			2.95 (kgCO2/liter)		---	---	Environmental load rate, NIES…Dec.2002 Ref.1
			○		2.60 (kgCO2/liter)		---	---	Act on Promotion of Global Warming Countermeasures
	Heavy oil	○			2.81 (kgCO2/liter)		---	---	Environmental load rate, NIES…Dec.2002 Ref.1
	City gas	○			2.22 (kgCO2-liter)		---	---	
			○		2.10 (kgCO2-liter)		---	---	Act on Promotion of Global Warming Countermeasures
	LPG		○		3.00 (kgCO2/kg)		---	---	
			○		6.50 (kgCO2/m3)		---	---	
	Electricity	○			0.363 (kgCO2/kWh)		---	---	Global warming issue, MIC…Apr.2008 Ref.2
			○		0.425 (kgCO2/kWh)	Tokyo electric Power	0.289 – 0.550	Annual [1]	* Announcing report of each power company compiled by MOE
				○	0.555 (kgCO2/kWh)		---	---	Revised Act on Promotion of Global Warming Countermeasures default value[2]
				○	0.386 (kgCO2/kWh)		0.354 – 0.403	---	Global warming countermeasure plan, Tokyo, guideline 2007

1: As published value of CO2emission factor by each electric power company, it is picked and listed figure of TEPCO from the latest value 2007.
For range of basic unit, it is listed other electric company's figure.

2: In case of an organization emit a great amount of greenhouse effect gas (Specified effluent) calculate CO2 emission accompanied with electricity use, it is able to use CO2 emission factor by electric power company and also default value (0.555 [kgCO2/kWh]) based on "Ordinance of METI on calculation of greenhouse effect gas emission with the business activities of specified emitters".

Figure 4.3-3：Basic unit examples Eenergy Consumption 1)

3.5 Reference figures for calculating the effect of IT solutions

It is necessary to input the activity volume data for the calculation of the effect of IT solutions, as stated in the Chapter 3.2.

Although it is desirable to utilize actual figures of the activity volume data, many difficult cases do exists, when collecting the actual data at the time of the planning phase or other difficulty do exist when collecting the actual data and etc.

Therefore, for the reference, this paper listed the below rough assumptions for calculating the activity volume.

Items	Reference examples	Sources
Office spaces per person	13.1sq.-m/person	Research Group report on ICT policies toward Global Warming, April 2008
Power consumption of Notebook PC (LCD14 type and above) used at home	18,734 [kWh/year/unit] etc.	The energy conservation, Japan: Average consumption power per type LED 14type and above, auto-transition setting for low current state
Power consumption of Notebook PC (LCD14 type and above) at offices	33,876 [kWh/year/unit] etc.	The energy conservation, Japan: Average consumption power per type LED 14type and above, auto-transition setting for low current state
Power consumption of Desktop PC (LCD included) used at home	62,508 [kWh/year/unit] etc.	The energy conservation, Japan: Average consumption power per type, auto-transition setting for low current state
Power consumption of Desktop PC (LCD included) at offices	113,568 [kWh/year/unit] etc.	The energy conservation, Japan: Average consumption power per type, auto-transition setting for low current state
Weight conversion factor of Papers used at the office	0.004 kg/paper (A4 size）	Research Group report on ICT policies toward Global Warming, April 2008
Power consumption of lightings (fluorescent light)	25.88 kWh (utilization: 375h/year）	The energy conservation, Japan: Ranking list of energy efficiency performance 2008（average value）
Power consumption of air-condition	56.25 kWh (utilization: 375h/year）	The energy conservation, Japan: Ranking list of energy efficiency performance 2008（average value）
General Specification of the Medical Record Data	Paper form Medical record type 2 (L: 270mm×W: 384mm) 2.5 sheets per medical record (0.25m²per medical record)	Specification of Medical Record data format (by HAKUAI co. ltd.)
Storage space needed for paper form medical records	Cabinet capacity required for placing 300 medical records: 0.288m²	Specification of Medical Record data format (by KOKUYO Co. Ltd.)
Weight conversion factor of the Bidding Proposal documents	0.004 kg/paper (A4 size）	Research Group Report on ICT policies toward Global Warming, April 2008
Weight conversion factor of papers for Office use	0.004 kg/paper (A4 size）	Research Group Report on ICT policies toward global warming, April 2008

Conclusion

This Report mainly summarized the results of studies conducted by the Survey and Estimation Committee of GIPC in the fiscal year 2009. As main activities for the fiscal year 2009, evaluation methods for “Green IT” were studied, and the forecast of medium to long term trends using these evaluation methods, which were then further studied with references to the study result of the fiscal year 2008 by three sub-Working Groups with their collaborative works. Five themes were studied as pillars of the survey; 1)the energy saving of “IT” ("Green of IT"), 2)New energy saving metrics for data centers, 3)Society's energy saving by IT ("Green by IT"), 4)Contribution of Green IT companies, and 5)Overseas activities of “Green IT”.

In an energy saving of IT, ten types of products which consume considerable electricity when in use were chosen as the subjects, and the quantity of the contribution arising from "Green of IT" in the year 2020 was surveyed based on the forecasts of the years between 2025 and 2050. As a result of trial computations of the quantity of contribution of “Green IT” to the CO2 reduction in the year 2020, with Japan's energy saving on "Green of IT", the energy saving of IT equipments could produce a reduction of 5.7- 11.3 million tons of CO2/year, (the Trial computation under Scenario “B”, with a wide range of CO2 emission factors for the power generation (from 0.2 to 0.4kg of CO2/kWh)) and the energy saving of electronic equipments could produce the reduction of 11.9 to 23.8 million tons of CO2/year. As for the worldwide energy savings on "Green of IT", the energy saving of IT equipments on a single item basis could produce a reduction of 87 to 171 million tons of CO2/year, and the energy saving of electronic equipments could produce a reduction of 293 to 576 million tons of CO2/year.

For the energy saving of data centers, this committee has advanced studies relative to the quantity of contributions by the energy saving of data centers and new energy saving metrics which could indicate the efforts of data centers on their total energy savings. As a result, it was found that the energy consumption of a data center would increase considerably in the years between 2020, 2025 and 2050, but these increases could be fairly controllable by effects of the technical innovation. In the energy saving of data centers, it is also important to improve the efficiency of the facility. The total energy saving of data centers for the year 2020, including the effects of the energy efficiency improvement of the facility, is forecasted to be 13.2 million tons of CO2/year in Japan, and 143.4 million tons of CO2/year in the whole World.

Moreover, for the Datacenter Performance Per Energy (DPPE), which this committee continuously studied from the fiscal year 2008 as a proposed new Energy Saving Metric, this committee has studied in a detail about its 4 factors; “ITEU”, “ITEE”, “PUE”, and “GEC”. This committee did propose this “DPPE” to the world at opportunities of Japan, the U.S. and the EU workshops involving both Governments and Private Sectors, and consequently reached agreements among six major organizations in Japan, the U.S. and the EU, (which are the U.S. DOE, the U.S. EPA, the Green Grid, the EU Code of Conduct on Data Center, Japanese Ministry of Economy Trade and Industry’s “Green IT Initiative” and the Green IT Promotion Council”) as a guideline concerning “New Metric for the Energy Saving of the Data Center."

As for the energy saving by “IT” ("Green by IT"), which is expected to contributes to the CO2 reduction for the overall society more so than the energy saving of IT, this committee studied the methods for evaluating the CO2 reduction effect from utilizations of IT solutions. The committee then further forecasted with using those evaluation methods, the quantity of contribution in the year 2020 based on quantities of contributions in the year 2025 and 2050. For evaluation of the effect by IT solutions, this committee did make additional trial computations about these new IT solution cases based on the method of evaluating the CO2 reduction with “Consumption of goods”, “Travel of persons and goods”, and “Variations in Power usage of a space and IT equipments”, which this committee’s work group developed in the fiscal year 2008.

The Energy-saving "Green by IT", which contributes directly or indirectly to the CO2 reduction, by changes in a wide area of work styles, lifestyles, a way of manufacturing, and a way of using resources in various fields of societies using the IT, and in further by incorporating IT technologies into various advanced equipments, is expected to have a potential contribution of the reduction of 68 to 137 million tons of O2/year in Japan in the year 2020. This potential reduction could be broken into; 1)7 to 14 million tons of CO2/year in the overall Industries, 2)9 to18 million tons of CO2/year in Businesses, 3)16 to 32 million tons of CO2/year in Households, and 4)36 to 73 million tons of CO2/year in Transportations. The Worldwide Energy Saving "Green by IT" is expected to contribute to the reduction of 2,041 to 4,009 million tons of CO2/year, which is about 28 times in a volume that of Japan. This was broken down into; 1)140 to 276 million tons of CO2/year in the overall industries, 2)122 to 264 million tons of CO2/year in Businesses, 3)200 to 416 million tons of CO2/year in Households, and 4)1578 to 3117 million tons of CO2/year in Transportations. The IT solutions that contribute to the act of reduction includes “BEMS”,Telework, and Tele-conference in Business sectors, “HEMS” and Online Shopping with Household sector, “ITS”, Eco-drive, and Supply Chain Management with Transportation sectors.

For the theme of visualization of "Contribution to Energy Savings by IT" by Green IT companies, this committee has summarized the Basic Concept of Contribution from the current fiscal year. In particular, in terms of "Green of IT", this committee has specified methods for evaluating contributions in the entire supply chain for the four specific products (which are Lightings, Liquid Crystal Television, Servers, and Data Centers) including Product Materials, Components, Devices, and Software.

As regards to the survey and analysis of Overseas Policies and etc. related to “Green IT”, in addition to the content of activities, this committee has surveyed in the fiscal year 2008 on the U.S. DOE, the U.S. EPA, The Green Grid, “Climate Savers Computing Initiative”, and the EU Code of Conduct for Data Center. This committee has also surveyed and then introduced activities of “Digital Energy Solutions Campaign” of the U.S., “Korean Green Business IT Council”, BITKOM of Germany, “Global e-Sustainability Initiative” in Europe, ICT4EE, SiTF in Singapore, and etc. in the fiscal year 2009.

The Green IT advanced in Japan and has been studied specifically and also implemented widely in the entire World as an important measure to recognize the Low Carbon Society, focused with the two main pillars of "Green of IT" and "Green by IT." The Green IT has also been studied as one of a key measure for achieving the Japan's goal on reducing

Greenhouse Gas emissions by 25% by the year 2020. By studying such measures, it is important to clarify those specific evaluation metrics for the Green IT and to specify the quantitative contribution with use of such metrics. From this viewpoint, the roles of the Survey and Estimation Committee of the GIPC and each themes being addressed are expected to become increasingly important.

It is a common understanding in the World Community that the Green IT potentially has a great contribution to the Global CO2 reduction, and for the steady recognition of the effect of "Green IT", with a cooperation of the entire society centering the Industry, Governments, and Academia as well as the worldwide cooperation together with Japan, Asia, the EU, and the U.S. In order to make the foregoing activities more specific and fruitful, the GIPC's "Survey and Estimation Committee" will continue to make steady efforts and perform progressive activities with the support of the Ministry of Economy Trade and Industry of Japanese Government, member companies of the GIPC, associated organizations, and related sectors. This committee appreciates the participants for their understanding and support for the GIPC's "Survey and Estimation Committee" activities.