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Global Warming Initiatives by the Information Services Industry

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The first commitment period of the Kyoto Protocol kicks off on January 1, 2008. Under the Kyoto Protocol, Japan is committed to reducing emissions of greenhouse gases by an average of 6 percent by 2012, compared with the levels of 1990. However, Japan's actual emissions of greenhouse gases rose by 6.4 percent in 2006. If Japan were to make up for the difference through carbon emissions trading, it would cost the nation approximately two trillion yen over five years.

The industrial and transportation sectors in Japan are reducing their emissions as part of the nation's initiatives to reduce emissions of greenhouse gases. However, emissions from the commercial and residential sectors continue to rise due to a lack of effective countermeasures in these sectors.

The use of information technology (IT) can have both positive and negative effects on reducing emissions from the commercial and residential sectors. The use of IT can have a positive effect on reducing energy consumption by enabling corporations to conduct activities more efficiently. At the same time, greater use of IT can have a negative effect through the increased use of energy by IT equipment. Some forecasts estimate that power consumption from IT equipment in Japan will increase to five times its current level by 2025. Therefore, Japan must first concentrate on reducing energy consumption caused by the use of IT equipment.

Data centers contain large volumes of IT equipment, and so should endeavor to improve energy efficiency. Accordingly, data centers should deploy high efficiency servers while simultaneously improving their overall energy efficiency. Some data centers in Japan are known to operate at higher levels of efficiency than those in the United States. Japan's energy efficiency technologies could potentially be used for global initiatives to increase energy efficiency.

Japan could eventually set energy efficiency targets for each corporation, which would lead to a scenario under which CO_2 emissions could become a limiting factor for corporate growth. Information service providers (ISPs) operate data centers that corporations use to house their servers, and so should endeavor to develop and adopt technologies that improve energy efficiency in order to help corporations overcome factors that could limit their corporate growth. At the same time, ISPs should contribute to addressing the issue of global warming.

I Global Warming: Current Situation and Measures Looking Ahead to 2020

1 Start of First Year of Commitment to Reduce Emissions of Greenhouse Gases

The Kyoto Protocol was agreed on in December 1997 and entered into force in February 2005, specifying that the first year of commitment to reduce emissions of greenhouse gases would start on January 1, 2008. Japan's commitment under the Kyoto Protocol is to reduce emissions of greenhouse gases by an average of 6 percent during the five-year period from 2008 to 2012, compared with the levels in 1990. Should Japan fail to meet these commitments, certain penalties have been decided under the Meeting of the Parties to the Kyoto Protocol in Montreal, Canada that took place in November 2005.

Under the Montreal meeting, it was decided that any Party that fails to achieve its target during the 5-year period would be required to make up the difference plus an additional 30 percent. The penalty is enforced through a deduction from the assigned amount of allowable emissions for the second commitment period, equal to 1.3 times the amount of excess emissions. In addition, the Party's eligibility to transfer units of emissions allowances through carbon trading is suspended for a specified period.

Japan is proud of its image as a global leader in addressing environmental issues. If Japan fails to meet its commitments under the Kyoto Protocol, this image would be tarnished and national prestige would be lowered, not even considering the penalties that would be levied against Japan. However, if Japan is able to meet its reduction targets during the first commitment period, it will further bolster the reputation of Japan and its corporations as environmental leaders. In turn, this will enable Japan to take a leadership role in the setting of future global targets for reducing greenhouse gas emissions in the post-Kyoto Protocol period after 2013, looking ahead to 2020 and 2050.

This paper primarily focuses on carbon dioxide (CO_2) emissions, which encompass the largest share of greenhouse gas emissions by volume at approximately 90 percent.

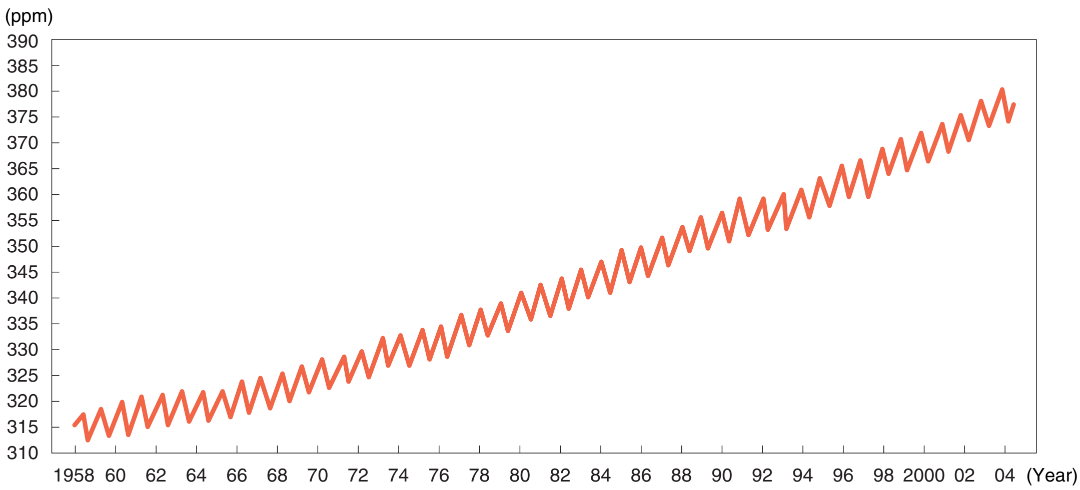
2 Impact of Increased CO_2 Emissions on Global Warming

Extensive research has been conducted into the relationship between global warming and increases in the concentration of atmospheric CO_2. One well-known data point is based on measurements collected from atop the Mauna Loa volcano in Hawaii by the US National Oceanic & Atmospheric Administration (NOAA), which clearly points to such a relationship based on historical observations of atmospheric CO_2 concentrations (Figure 1). When this author was still a student, the concentration of atmospheric CO_2 was recorded at 0.03 percent or 330 parts per million (ppm). This concentration has been increasing every year to its present level of 0.04 percent or 380 ppm, which is a 15 percent increase.

Global annual CO_2 emissions grew by approximately 80 percent from 1970 to 2004 as part of a cumulative increase in emissions starting from the industrial revolution that have increased the concentration of the earth's atmospheric CO_2. There has been extensive debate over the relationship between global warming and rising CO_2 concentrations. However, the Intergovernmental Panel on Climate Change (IPCC) concluded in its Fourth Assessment Report released in February 2007 that such a relationship probably does exist.

In its analysis, the IPCC report finds that there is a greater than 90 percent likelihood that mankind's CO_2

Figure 1. Atmospheric Carbon Dioxide (CO_2) Concentration Based on Monthly Data



Source: Data from Mauna Loa Observatory, Hawaii, published on May 19, 2005, by the US National Oceanic & Atmospheric Administration (NOAA) emissions have caused increases in global temperatures. The report also suggests that unless appropriate measures are taken to address global warming, global temperatures by the end of the 21st century will rise by an average of approximately 4˚C while sea levels will rise by 59 cm, compared with levels at the end of the 20th century. The rises in temperature and sea level would have a particularly strong impact on tropical and subtropical regions, which are high in biodiversity. According to the report, there is a possibility that 20-30 percent of biological species would be at increased risk of extinction if temperature rises were to exceed 1.5-2.5˚C.

In addition to the impact on ecosystems, the IPCC report identifies other potential effects including exposure to increased water stress affecting tens of millions of people, damage to agriculture, increased incidence of infectious disease and intensification of disasters. The report concludes that global losses will expand unless the temperature rise is held to within 2-3˚C, stating that greenhouse gas emissions must be cut in half by 2050 in order to limit the impact.

However, even if appropriate measures are taken to address global warming, temperatures are projected to increase by 1.8˚C by the end of the 21st century. An average temperature rise of around 2˚C would increase the average temperature of Tokyo to about the same current average temperature of Kagoshima. Data collected by the Japan Meteorological Agency indicates that average temperatures in Japan have risen by approximately 1.07˚C in the last 100 years, so a future rise in temperature of around 2˚C would amount to a twofold increase.

The current level of CO_2 emissions is approximately double the amount of CO_2 that the earth is capable of absorbing. In effect, the equilibrium of the atmospheric CO_2 balance between emissions and absorption is in a state of disorder, which is causing temperatures to rise. Consequently, it is considered necessary to limit emissions to a level that the earth can absorb in order to achieve a balance between CO_2 emissions and absorption. Former Japanese Prime Minister Shinzo Abe introduced the Cool Earth 50 proposal, which recommends cutting CO_2 emissions by half from their current levels by 2050, a recommendation that is consistent with the findings of the IPCC report.

The 2007 G8 Summit in Heiligendamm, Germany also agreed that it would seriously consider the decisions made by the European Union, Canada and Japan to at least halve global emissions by 2050. Meanwhile, at the Thirteenth Meeting of the Conference of the Parties (CoP13) to the United Nations Climate Change Conference held in Bali, Indonesia during December 2007, it was agreed to study the decision process and respective reduction targets for developed and developing country Parties by the end of 2009, with a view toward halving emissions by 2050.

However, it must be noted that global temperatures will still rise above their current levels in spite of these initiatives since they will only bring the CO_2 balance between emissions and absorption into equilibrium. These initiatives do not account for the cumulative excess of CO_2 emissions that have been released until now.

II Initiatives by Countries to Reduce CO_2 Emissions

1 Initiatives by Japan and Progress to Date

The Japanese government established the Global Warming Prevention Headquarters in 2005 and has formulated the Kyoto Protocol Target Achievement Plan based on work initiated by the Central Environmental Council and Industrial Structure Council.

In 2007, the Japanese government set out to measure the nation's progress in reducing emissions and to consider measures in anticipation of the kickoff of the Kyoto Protocol's first commitment period in 2008. However, preliminary FY2006 data released by the Japanese government in November 2007 indicated that Japan had made poor progress in reducing CO_2 emissions. According to the preliminary data, Japan's emissions of greenhouse gases in FY2006 were 1.341 billion tons converted to a CO_2 equivalent, which is an increase of 6.4 percent compared with the 0.6 percent reduction target set for the base year (Table 1).

The breakdown of the provisional data released by the Japanese government shows that the industrial sector, which chiefly consists of factories and other facilities, recorded a 5.6 percent reduction in emissions at 27 million tons of CO_2 equivalent. Meanwhile, emissions from the commercial sector, primarily consisting of offices, increased by 41.7 percent to 69 million tons of CO_2 equivalent. Residential emissions increased by 30.4 percent to 39 million tons of CO_2 equivalent, while emissions from the transportation sector increased by 17.0 percent to 37 million tons of CO_2 equivalent. Overall, Japan's emissions were up in most sectors. Although it has been pointed out that Japan's emission levels in FY2006 are down compared with FY2005, the dip in emissions is attributed to mild winter weather in FY2006 that caused a drop in the consumption of oil used for heating. Consequently, emissions are expected to increase year-on-year in FY2007 assuming that normal winter temperatures are experienced in Japan.

At the same time, Japan's emissions of three non-CO_2 greenhouse gases, consisting of methane, alternative fluorocarbons and nitrous oxide, are down significantly due to initiatives taken by the industrial sector. The effect of shutting down the country's nuclear plants in 2002 is said to have caused an increase in Japan's CO_2 emissions of approximately 39 million tons (3.3 % of all emissions) in FY2006.

The annual change in CO_2 emissions from energy use in Japan is shown in Figure 2. CO_2 emissions in the

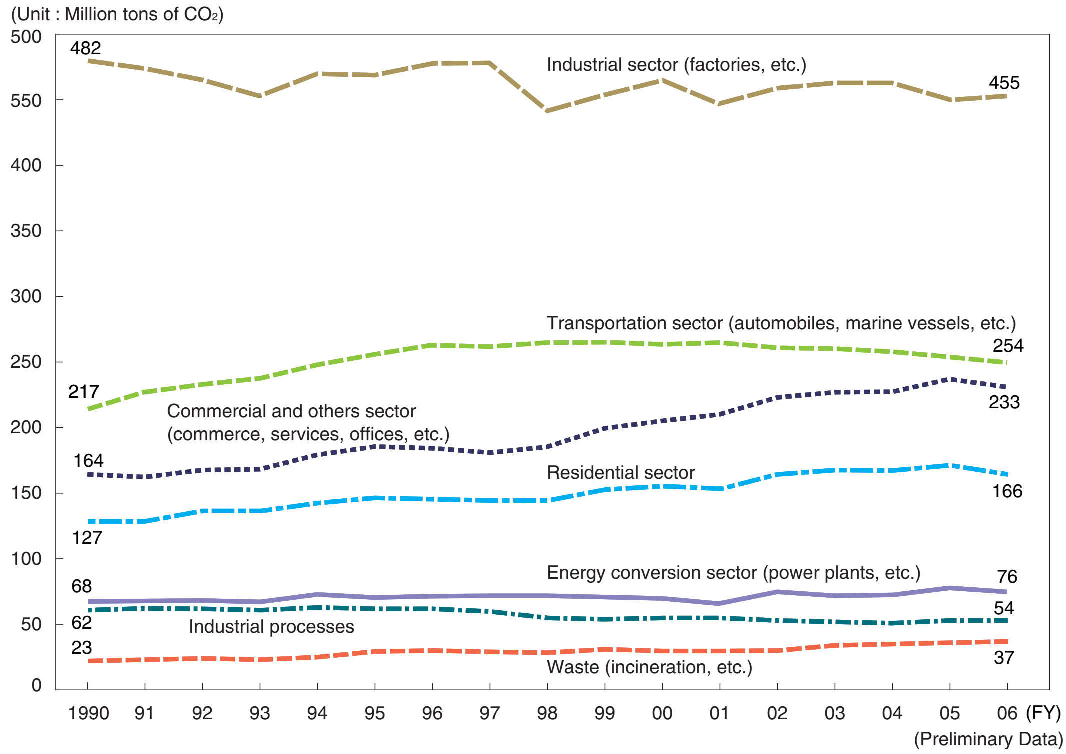
Table 1. Summary of Japan's Greenhouse Gas Emissions

Unit: Million tons of CO_2

	Base Year (FY1990)	% Total	FY2006 (Preliminary Data)	% Change from Base Year	+/- Change from Base Year
CO_2 from energy use	1,059	(84%)	1,184	(+11.8%)	+125
Industrial sector	482	(38%)	455	(-5.6%)	-27
Commercial and others sector	164	(13%)	233	(+41.7%)	+69
Residential sector	127	(10%)	166	(+30.4%)	+39
Transportation sector	217	(17%)	254	(+17.0%)	+37
Energy conversion sector	67.9	(5%)	75.5	(+11.3%)	+7.6
CO_2 from other than energy use	85.1	(7%)	91.1	(+7.1%)	+6
Methane	33.4	(3%)	23.8	(-28.7%)	-9.6
Nitrous oxide	32.6	(3%)	25.4	(-22.0%)	-7.2
Alternative fluorocarbons (three types)	51.2	(4%)	17.3	(-66.2%)	-33.9
Total	1,261	(100.0%)	1,341	(+6.4%)	+80

Source: *Interim Report on Assessment and Review of Kyoto Protocol Target Achievement Plan*, November 2007; prepared by Global Environment Subcommittee, Central Environmental Council and Global Environment Subcommittee, Environmental Committee, Industrial Structure Council

Figure 2. CO_2 Emissions in Japan from Energy Use, by Sector



manufacturing sector have steadily decreased due to the influence of various initiatives such as voluntary action plans initiated in 1997 by Nippon Keidanren (Japan Business Federation) and similar plans initiated in 1998 by the Japanese Ministry of Economy Trade and Industry (METI). In addition, CO_2 emissions in the transportation sector are now decreasing, reversing the previous trend of rising emissions from this sector.

However, Japan's CO_2 emissions from the commercial and others sector and residential sector are increasing every year. Although the nation's emissions temporarily dipped in FY2006 due to mild winter conditions, there is no indication of an overall declining trend in emissions. The commercial and others sector includes regular offices as well as retail stores and service facilities, while also encompassing data centers that belong to the information services industry. These data centers operate and house large amounts of computer equipment.

The biggest challenge for Japanese industry is to reduce CO_2 emissions from the commercial and others sector. The Japanese government is implementing national initiatives and asking industry to step up voluntary action plans in order to achieve the country's emissions targets. With Japan's reputation at stake, the nation must work collectively to achieve its emissions targets through contributions from non-manufacturing industries as well as manufacturing industries.

Table 2. Trial Calculations of Cost of CO_2 Emissions Should Japan Fall Short of Targets in First Commitment Period of Kyoto Protocol

(Unit: Million tons of CO_2)

	Emissions in Base Year (FY1990)	FY2006 Emissions (Provisional Data)	2010 Target	Shortfall Amount Based on Current Emission Levels	5-Year Cost Based on Current Emission Levels (Billion Yen)
Industrial sector	482	455	435	20	356
Commercial and others sector	164	233	165	68	1,209
Residential sector	127	166	137	29	516
Transportation sector	217	254	250	4	710
Energy conversion sector	68	76	69	7	116
Total CO_2 Emissions from Energy Use	1,059	1,184	1,056	128	2,276

	2010 Projection (Best-Case Scenario)	Shortfall Amount under Best-Case Scenario	5-Year Cost under Best-Case Scenario (Billion Yen)	2010 Projection (Worst-Case Scenario)	Shortfall Amount under Worst-Case Scenario	5-Year Cost under Worst-Case Scenario (Billion Yen)
Industrial sector	438	3	53	441	6	107
Commercial and others sector	211	46	818	215	50	889
Residential sector	145	8	142	148	11	196
Transportation sector	245	-5	-89	249	-1	-18
Energy conversion sector	68	-1	-18	69	0	0
Total CO_2 Emissions from Energy Use	1,107	51	907	1,122	66	1,173

Note: Price of CO_2 calculated at ¥3,556 per ton of CO_2 (based on price of €21.55 per ton of CO_2 converted at exchange rate of ¥165 per euro)

The data in Table 2 illustrates the scale of Japan's increases in CO_2 emissions measured by the converted financial cost of the excess emissions. Based on these calculations, the cost to the nation could be as high as one or two trillion yen during the first five-year commitment period of the Kyoto Protocol.

According to the trial calculations shown in Table 2, if Japan's emissions in 2010 remain at the level of the FY2006 provisional data, the nation would fall short of its targets by 128 million tons of CO_2. Carbon in the European carbon trading market currently trades at around €21.55 per ton of CO_2 (as of December 2007). Based on current carbon prices, the overall price tag for the excess emissions would amount to ¥2.3 trillion over five years. In its latest reduction plan announced in September 2007, the Japanese government outlined both the best- and worst-case scenarios for projected reduction levels in 2010. Even if Japan were to successfully meet the government's best- or worst-case scenarios for measures to reduce emissions, the nation would still fall short of its target commitment under the Kyoto Protocol at an overall cost of around ¥900 billion to ¥1.2 trillion.

In terms of the cost of emissions by sector, Japan's industrial sector including factories would fall short of the 2010 target commitment by 3-6 million tons of CO_2 at a cost of around ¥5-10 billion. The commercial sector including commerce and services as well as offices is projected to generate around 50 million tons of excess CO_2 compared with that of the base year at a cost of approximately ¥800-900 billion over five years. These costs are calculated by multiplying the shortfall amount by the current price of ¥3,556 per ton of CO_2 in the carbon trading market assuming that the shortfall would be completely covered through the purchase of emissions allowances. Although Japan could invest in emissions-reduction projects in developing countries in order to receive emission reduction units to compensate for its excess emissions, the cost would be comparable to purchasing the emissions allowances outright.

If Japan falls significantly short of its target commitments under the Kyoto Protocol, the price of emissions credits in the carbon trading market is expected to rise, which would further increase the overall cost to the nation. As these figures show, the biggest hurdle for Japan in terms of reducing CO_2 emissions is to reduce emissions from the commercial sector, where there is a shortage of specific measures to address emissions.

2 Urgent Measures by Japan

As it stands, the initial set of measures that Japan has formulated to reduce emissions will place the country at risk of falling short of its targets during the first commitment period of the Kyoto Protocol. Since further reduction targets are expected to be introduced for 2013 and beyond, the Japanese government is considering seven urgent measures to reduce emissions, as outlined below.

(1) Increase targets of voluntary action plans
(2) Promote adoption of new energy sources such as solar energy
(3) Introduce a Japanese scheme for emissions trading
(4) Introduce measures to reduce emissions from retail stores, such as reviewing business hours
(5) Introduce an environmental tax
(6) Introduce daylight saving time
(7) Introduce measures to reduce emissions from residential buildings, such as toughening standards for building insulation

Of the measures that are being considered by the Japanese government, a scheme for emissions trading and an environmental tax would have the biggest economic impact on all corporations in Japan if implemented at the national level. The possibility of introducing a Japanese scheme for emissions trading is being closely watched because it would ensure achievement of emissions reduction targets at minimal cost and because it would encourage creative solutions in the private sector by attaching a price to carbon. However, there are some potential issues with the introduction of a Japanese emissions trading scheme, such as the difficulty of determining emissions allotments for individual entities that produce emissions and the possibility that it could encourage "carbon leakage," referring to an outflow of Japanese industry abroad.

In addition, the effectiveness of introducing an environmental tax has been questioned in terms of addressing emissions from Japan's commercial and residential sectors, whose emissions have increased significantly. An environmental tax would be aimed at reducing the emissions of greenhouse gases by taxing the sources of emissions such as petroleum, coal, gasoline and electricity. Any such tax would generally be levied against Japanese citizens and corporations, and would require careful study of its possible effect on the nation's economy and on the international competitiveness of Japanese corporations.

Japan is currently using voluntary plans to implement reductions of greenhouse gas emissions. However, if voluntary plans are not sufficiently effective in reducing emissions, Japan may need to consider introducing policies for emissions trading and an environmental tax. These strategies are already being adopted in the European Union and are starting to be considered in the United States.

3 Initiatives by the European Union

The European Union (EU) has chosen to introduce a scheme for emissions trading, called the EU Emission Trading Scheme or EU ETS. The decision to adopt the scheme was made after a process of examining and comparing the respective advantages of an emissions trading scheme and an environmental tax, with the EU reaching the conclusion that an emissions trading scheme would enable reductions of greenhouse gas emissions at minimal cost. Some EU member states have also chosen to introduce environmental taxes.

The EU member states that have ratified the Kyoto Protocol are the so-called EU15 countries that originally made up the EU. The EU15 is committed to reducing the emissions of greenhouse gases by an average of 8 percent during the first commitment period from 2008 to 2012, compared with levels in 1990. By 2002, the EU15 had recorded a 2.9 percent reduction in emissions. It is aiming to achieve a 20 percent reduction by 2020 and a 60-80 percent reduction by 2050.

In Phase I of the EU ETS scheme, which kicked off on January 1, 2005, the EU allocated a total of 2.2 billion tons of CO_2 emissions allowances by nation and place of business. This amount represents approximately half of all CO_2 emissions in the EU. If the allocations are exceeded, a "cap-and-trade" system exists to enable the purchase of emissions allowances from the market. The scheme covers 11,000 large-scale industrial facilities that produce CO_2 emissions in 27 EU member states, including facilities such as power plants and steel and cement factories.

Creating a market for the trading of emissions allowances established the price of CO_2 emissions, which currently stands at approximately €22 per ton of CO_2 emissions (as of December 2007). Through the EU ETS scheme, the EU is hoping to encourage the development of technology and investment to improve energy efficiency and to encourage a shift in public mindset in terms of how emissions are perceived. In fact, it is estimated that more than US$3.5 billion has recently been invested in the EU to improve energy efficiency through the reduction of CO_2 emissions.

Critics have pointed out certain problems with the EU scheme. In particular, there are concerns about the difficulties of ensuring consistency, fairness and transparency in allocating the initial emissions allowances and ensuring the reliability of the allocations, both in terms of the initial allocations by nation and each nation's allocations by places of business.

The allocation of emissions allowances can be determined in a number of ways, including allocation based on benchmarks or by auction. For its scheme, the EU has chosen a grandfathering method of allocation based on past CO_2 emissions. However, the problem with this approach is that it penalizes corporations that have already taken the initiative to reduce emissions by only giving them small allocations, while companies that have not taken the same initiative to reduce emissions receive large allocations. Current assessments indicate that the EU scheme has not encouraged a significant overall reduction in emissions, with emission levels having changed very little due to the large size of the initial allotment.

In fact, the EU scheme has caused a uniform hike in electricity rates due to the purchase of emissions allowances by power utilities, which has in turn caused concerns that it could hurt the international competitiveness of companies in the EU. Furthermore, companies that manufacture globally traded goods such as aluminum and cement claim that the scheme is unfair because member states apply different methods to allocate emissions depending on the sector. In Phase II of the EU scheme, which kicks off in 2008, the EU has revised its allocation method and is expected to reduce the overall allocation of emissions allowances by 14 percent compared with the Phase I implementation.

4 Initiatives by the United States

Led by President George W. Bush, the US administration has taken the basic stance of opposing mandatory targets for emissions reductions, as well as opposing cap-and-trade systems and the globalization of carbon markets. Based on this stance, the US government has not moved to ratify the Kyoto Protocol and is generally perceived to have a lukewarm attitude toward global warming. However, the US stance toward global warming appears to be changing as the Democratic Party gains political strength. Much of the shift in US public opinion is, of course, due to the efforts of former Vice-President Al Gore, who was awarded the Nobel Peace Prize in 2007 for his activism on the issue of global warming. Amid such developments, state governments and industry consortiums in the US have started to implement initiatives to improve energy efficiency.

At the state government level, nine US states including California, New York, Oregon and Massachusetts announced in 2007 that they would sign an international carbon trading agreement with the European Commission, which would pave the way for the trading of emissions allowances. In particular, the State of California has already passed the California Global Warming Solutions Act (Bill AB 32) in September 2006 and is forging ahead with plans for implementation of the Act. Starting in 2012, under Bill AB 32, California will adopt a CO_2 emissions limit that is equivalent to 1990 emission levels, to be achieved by 2020. Presently, major emitters of CO_2 emissions in California are required to report their emissions to the state government.

In addition, seven western US states and two Canadian provinces have formed the Western Climate Initiative (WCI), which has announced a target of achieving a 15 percent reduction of CO_2 emissions by 2020, compared with 2005. In the private sector, 33 corporations and non-governmental organizations have formed the United States Climate Action Partnership (USCAP) led by companies such as General Electric and DuPont. Formed in January 2007, USCAP has pledged its support for the setting of mandatory emissions reduction targets and the introduction of a cap-and-trade system. USCAP is calling for an emissions reduction target of 0-10 percent within 10 years compared with current levels, and a target of 10-30 percent reductions within 15 years compared with current levels.

These initiatives clearly show that that there is a movement among US state governments and the private sector to call for the introduction of mandatory emissions reduction targets and a trading scheme for emissions allowances, with the expectation that there will be a major shift in US federal policy in the future.

III Contributions by the IT Sector

1 Three Ways for the IT Sector to Contribute

The IT sector can help address the issue of global warming in a number of ways, both through direct reduction of CO_2 emissions and indirectly in accordance with initiatives by user corporations. The commercial, residential and transportation sectors in Japan have made limited progress in reducing CO_2 emissions, which represents a significant hurdle for the country. By reducing CO_2 emissions, both directly and indirectly, the IT sector can assist the commercial, residential and transportation sectors to reduce their emissions. Specifically, the IT sector can contribute to emissions reductions through the following measures:

(1) Develop energy efficiency technologies and deploy them to improve the energy efficiency of IT facilities in order to reduce CO_2 emissions.
(2) Use IT to improve the efficiency of industrial activities as well as logistics and office activities in order to reduce energy use and CO_2 emissions of corporations.
(3) Use IT to disseminate current information about global warming and raise public awareness about the importance of reducing CO_2 emissions in order to influence public behavior.

In terms of influencing public behavior, the Japanese government has previously issued the statement that "The nation must make a collective effort to reduce emissions of greenhouse gases by considering lifestyle changes and changes in business customs as a means of strengthening existing measures to reduce greenhouse gas emissions." IT can play a significant role in promoting the widespread adoption of this strategy.

In January 2006, the Japanese government's IT Strategic Headquarters released The New IT Reform Strategy, which introduces the theme of "An environmentally friendly society that utilizes IT—Efficient use of energy and resources" as a priority policy. The Japanese government later introduced the Priority Policy Program 2007 in July 2007, which is based on the New IT Reform Strategy.

The basic approach of the Priority Policy Program 2007 is summarized in the following text of the document:

"In the area of global warming, we are implementing various environmental measures that utilize IT for energy management in order to meet the target set in the Kyoto Protocol. However, we must increase our efforts in order to reach the reduction level drawn in the Kyoto Protocol. In addition, we must also engage in efforts to minimize higher CO_2 emissions from the increased volume of IT equipment and their advanced functions."

Specifically, the Priority Policy Program 2007 outlines the following five strategies:

(1) Collect, organize, analyze, accumulate and provide environmental information using IT
(2) Advanced energy management and efficient physical distribution/traffic flow through IT
(3) Control energy usage of IT equipment
(4) Promote electronic manifests (industrial waste management documents)
(5) Promote resource recycling by utilizing IT for improving waste traceability

Examples of implementing advanced energy management include Building Energy Management Systems (BEMS) and Home Energy Management Systems (HEMS), which are aimed at improving efficiency through initiatives to reduce energy use from building infrastructure such as heating/cooling and elevators. Meanwhile, efficient physical distribution/traffic flow through IT can be achieved through initiatives such as consolidation of physical distribution.

BEMS initiatives in Japan have been shown to successfully reduce power consumption from building heating and cooling by as much as 40 percent or even more. This is being achieved through measures such as centralized operational management of freezers and heating/cooling infrastructure in supermarkets and other facilities, and the adoption of systems for optimal integrated operation. In addition, Japan's world-leading energy efficiency technology has been used during the past ten years in the home to reduce power consumption by 40-50 percent by equipment such as air-conditioning units and refrigerators. Home energy use is also being reduced through the deployment of systems for comprehensive home management using devices such as motion detection sensors.

In the transportation sector, IT can be used to improve the efficiency of physical distribution, such as optimizing distribution volume and improving the efficiency of distribution processes as well as utilizing more efficient transport routes. One way to improve efficiency in distribution volume is by optimizing the distribution of goods from manufacturers and wholesalers to the retail level. By enabling retailers to order just the right amount of goods from wholesalers based on variables such as the day's temperature or events, the volume of distribution for returning unsold products can be reduced.

For example, in order to optimize their daily orders and physical distribution, Japanese convenience stores are refining their orders based on information ranging from past point of sale (POS) data to temperatures and events. In the book market, Nippon Shuppan Hanbai, Inc. has initiated the www.project (Triple Win Project) initiative, which discloses book POS data to publishers so that they can optimize the volume of books they supply to stores. The initiative is said to have resulted in a 5 percent reduction in the volume of returned books[1].

To improve distribution efficiency and reduce overall truck deliveries, manufacturers have taken the initiative to use centralized distribution centers. Previously, manufacturers would send out their own trucks to deliver to individual retailers directly. Under this initiative, trucks sent from centralized distribution centers use collection routes to pick up goods from manufacturers, taking them back to the distribution centers for sorting by destination. The distribution centers then deliver a mix of items to individual retailers by truck. Steps are also being taken to improve the efficiency of truck routes by using intelligent transportation systems (ITS) to select optimal routes and times for delivery, using it in combination with other information such as historical daily traffic data and VICS (Vehicle Information and Communication System) data. These initiatives are reported to have led to a 5 percent reduction in energy use.

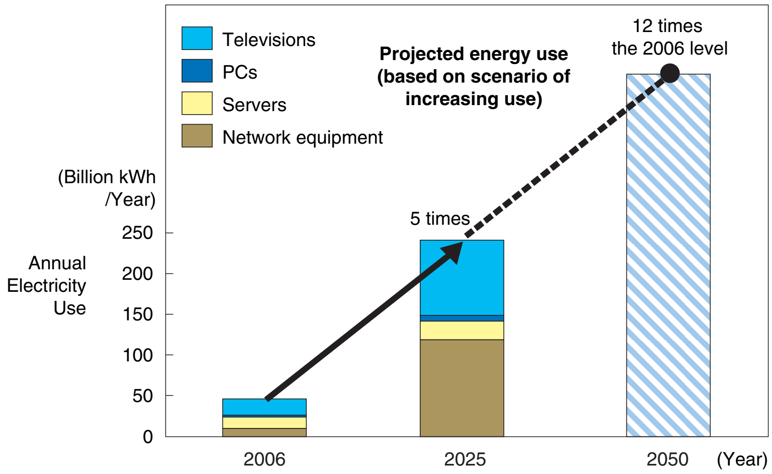
2 Initiatives by the IT Sector in Japan

In the preceding sections, we described how user corporations are accelerating their initiatives to reduce CO_2 emissions by using IT. However, it is also becoming important to promote initiatives that improve the actual energy efficiency of IT equipment.

According to a study group report on the energy efficiency and enhancement of the competitiveness of IT equipment released by the Japanese Ministry of Economy, Trade and Industry (METI), IT equipment in Japan is estimated to have consumed approximately 47 billion kilowatt-hours (kWh) of energy in 2006, equivalent to around 5 percent of Japan's total energy use. The report predicts that energy consumption from IT equipment will grow to approximately five times its current level by 2025, increasing to 240 billion kWh and accounting for 15-20 percent of Japan's total energy consumption. By 2050, energy consumption from IT equipment is projected to grow to 500 billion kWh (Figure 3).

The METI report covers a wide range of IT-related equipment, ranging from household televisions and public outdoor television installations to computers used by corporations and network equipment used by

Figure 3. Projected Energy Use from IT-Related Equipment in Japan



Note: Kilowatt-hour (kWh): A unit of energy used to indicate the amount of energy consumed or produced in an hour, often expressed as kilowatt-hours for a given time period or per day.
Source: *Expectations Concerning Innovative Energy Efficiency Technologies for IT Equipment,* April 2007; prepared by Japanese Ministry of Economy Trade and Industry (METI)

telecommunications carriers. Nevertheless, it is clear from the report that relevant industries and corporations must do their part as a whole to promote initiatives to improve energy efficiency.

(1) Initiatives by Four of Japan's Electrical and Electronics Industry Associations

Under the Keidanren Voluntary Action Plan on the Environment implemented by Nippon Keidanren (Japan Business Federation), four of Japan's electrical and electronics industry associations have been engaging in initiatives to address global warming through energy-saving measures since 1997. The four industry associations are the Japan Electronics and Information Technology Industries Association (JEITA), Communications and Information Network Association of Japan (CIAJ), Japan Business Machine and Information System Industries Association (JBMIA) and The Japan Electrical Manufacturers' Association (JEMA).

These initiatives were initially implemented with the target of reducing CO_2 emissions per unit of manufacturing output (intensity) by 25 percent compared with 1990 levels, but the target was later raised to 28 percent in FY2006 and to 35 percent in September 2007. The latest increase is significant, accounting for 15 percent of the total target increase across all industries in FY2007. However, it should be noted that although the target has been increased to 35 percent by unit of manufacturing output, actual manufacturing output is projected to grow by 294 percent through FY2010, which would result in a net increase of around 10 million tons of CO_2 emissions or a 193 percent increase in emissions.

The electrical and electronics industry manufactures a wide range of products that also vary by weight and shape. As a standard benchmark, the industry chose to use an index based on units of manufacturing output (CO_2 emissions divided by manufacturing output). The actual benchmark index in FY2006 was 0.214, outperforming both the previous target index of 0.243 and the newest target index of 0.233.

However, actual CO_2 emissions from the electrical and electronics industry were 18.46 million tons in FY2006, which is an increase of 66 percent from the 11.12 million tons of emissions in the base year of FY1990. The increase is due to a significant rise in actual manufacturing output, mainly driven by two factors. The first factor is the sharp growth since 2000 of the market for digital consumer electronics such as LCD televisions, plasma televisions and DVD recorders. The second factor is the growth in the production of devices and assembled products (up 250% and 120%, respectively, compared with 1990 levels), driven by the recovery of Japanese manufacturing as a result of a robust digital consumer electronics market. Although investment to improve energy efficiency has resulted in a 30 percent decrease in emissions by energy intensity, net CO_2 emissions from the electrical and electronics industry have increased. While many Japanese industries have made progress in reducing their net CO_2 emissions, the IT industry is actually increasing its net emissions, which points to the need for further measures to reduce emissions.

Two areas of investment have proven to be most effective in terms of improving energy efficiency in Japan's electrical and electronics industry. One is the improvement of production processes and quality. The other is the adoption of technologies such as high efficiency equipment, cogeneration (simultaneous heat and electricity supply) systems and thermal storage. Both areas of investment capitalize on the expertise and strengths of Japan's manufacturing industry.

In addition to improving energy efficiency in production, the electrical and electronics industry in Japan is also engaged in initiatives to reduce the actual energy consumption of the equipment it manufactures. At the same time, the Japanese government through METI is encouraging the development of technology to address the explosive growth in the volume of Internet traffic and data. These initiatives include the development of technology to improve the efficiency of routers, which are expected to grow significantly in number, and development of technology to reduce energy consumption from LCD and plasma display panels, which are used to display Internet data. METI has also launched the Top Runner Program that is aimed at developing the best energy-efficient equipment and encouraging its adoption.

In FY2008, METI will launch an initiative called the Green IT Project with a budget of approximately ¥4.8 billion. Under the initiative, METI will fund technology development in areas such as innovative energy-efficient devices, energy-efficient hard disk drives and organic electroluminescent (EL) display technology. The goal of the Green IT Project is to reduce the energy consumption of data centers (servers and storage) and networks by 30 percent while cutting the energy consumption of user displays in half.

(2) Initiatives by the NTT Group

The NTT Group has announced a target of reducing CO_2 emissions by at least 35 percent per subscriber for all NTT telecommunication carriers, and by at least 25 percent per unit of sales for all other NTT Group companies, to be achieved by 2010.

The NTT Group bases its CO_2 emissions targets for its telecommunication carriers on number of subscribers since the size of the subscriber base determines the scale of building and operating the company's communications infrastructure. In FY2005, the NTT Group switched to a new coefficient for converting its power consumption into a CO_2 equivalent. Because of the change in coefficient, the company's CO_2 emissions intensity for telecommunication carriers rose by 47 percent in FY2005, which was a significant increase from FY2004 levels and equivalent to FY1990 levels. However, using the coefficient from the previous fiscal year (FY2004), the emissions intensity was actually down by 30 percent in FY2005 compared with FY1990 levels, while remaining approximately level since FY2004. Similarly, the CO_2 emissions intensity for other NTT Group companies was approximately at FY1990 levels based on the new coefficient, but was actually down by 27 percent based on the previous coefficient from FY2004. Had the company used the previous coefficient, it would have met its 25 percent reduction target for NTT Group companies.

The Total Power Revolution (TPR) Campaign is one of the strategies that the NTT Group is implementing to reduce CO_2 emissions. The company reports that the TPR Campaign led to a 170 million kWh reduction in energy consumption in FY2005. Under the TPR Campaign, the NTT Group has implemented the following initiatives:

- Implementation of energy management for about 4,000 NTT Group buildings across Japan
- Installation of energy-efficient power supply equipment and air-conditioning equipment
- Reduction of power consumption by directly feeding power to IP (Internet Protocol) related equipment, such as servers and routers
- Improvement in the rate of self-sufficiency for electricity, through utilization of clean sources of energy such as solar power and wind power generation

The NTT Group is particularly focusing on reducing the power consumption of equipment used by the information services industry, such as servers and routers. For example, the company is switching over to the use of 48 VDC power instead of standard 100 VAC power, which reduces AC-DC conversion from four steps to two to deliver a 20 percent improvement in power supply efficiency. Making such a switchover requires that power supplies of equipment such as servers and routers be specifically designed to use DC power, which manufacturers are starting to offer on their equipment.

In addition, the NTT Group has recorded a 4 percent reduction in power consumption from air-conditioning equipment through the use of concentrated cooling of equipment racks to improve efficiency over the complete cooling of rooms housing telecommunications equipment. Under this approach, the company uses remote temperature sensors to finely control cooling.

The NTT Group is also looking beyond reducing its own CO_2 emissions by endeavoring to reduce the emissions of its customers. In May 2006, the company established the NTT Group Vision for Environmental Contribution to promote initiatives that contribute to reducing environmental effects on society as a whole through the provision of information and communications technology (ICT) services. The vision states that "The NTT Group is helping to reduce the environmental impacts of its customers and society as a whole by developing and disseminating ubiquitous broadband-based ICT services that promote positive changes in lifestyles and business models." Under the vision, the company has set a numerical target of reducing one million tons of CO_2 emissions through ICT services based on net CO_2 emissions reduced after subtracting the emissions necessary to provide ICT services.

3 Initiatives by the IT Industry in the United States

In the US, restrictions on the construction of new power plants have fueled concerns over the sharp increase in power consumption from IT equipment. In December

2006, the US Congress requested that the Environmental Protection Agency (EPA) develop a report to examine the energy use of data centers and servers. In response, the EPA issued a Report to Congress in August 2007 that sheds further light on the need to improve the energy efficiency of data centers.

According to the EPA report, US servers and data centers consumed 61.4 billion kWh of energy in 2006, which is more than double the level in 2000 and accounts for 1.5 percent of all US electricity consumption (Figure 4). In particular, relatively low-cost volume servers based on Intel x86 architecture and equipped with one or two CPUs have grown significantly at a compound annual growth rate of 17 percent. Energy use by volume servers has grown to encompass 34 percent of overall electricity consumption from US servers and data centers, and 68 percent of electricity use by servers and related IT equipment. In addition, air-conditioning systems and other infrastructure systems of data centers encompass 50 percent of their total annual electricity use. At the same time, large-scale enterprise-class data centers account for 38 percent of electricity consumption by space type, growing significantly as a segment.

The EPA report suggests that increasing demand for data processing and storage is driving the growth in electricity consumption of data centers. Specifically, the report cites the following factors:

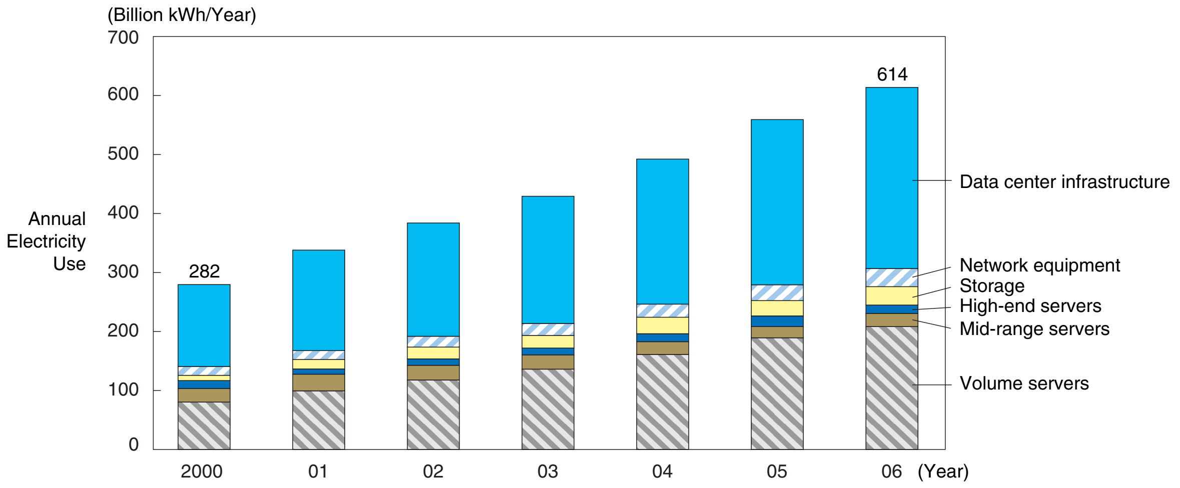
- Increased use of electronic transactions in financial services
- Growing use of Internet communication and entertainment
- Shift to use of electronic medical records for healthcare
- Growth in global commerce and services
- Increase in data from the adoption of global positioning system (GPS) and radio-frequency identification (RFID) technologies

The EPA report maintains that electricity consumption from storage for data retention is growing at a compound annual growth rate of 20 percent, which is higher than the growth rate of servers. The same trend is also anticipated in Japan.

Table 3 summarizes the EPA's five energy efficiency scenarios for US data centers including one in the absence of any gains in efficiency, with projections for future electricity use. Assuming the scenario that current historical trends will continue (Scenario A), electricity consumption is projected to double to 125 billion kWh in 2011. Even assuming that current energy efficiency trends continue (Scenario B), electricity consumption is still projected to nearly double to 100 billion kWh, or about 2.5 percent of overall US electricity consumption. This increase alone would require the construction of 10 new base load power plants.

Of the five scenarios outlined by the EPA, the "state-of-the-art" scenario (Scenario E) assumes the most energy efficiency gains based on using all measures available today. Although this scenario would require

Figure 4. US Data Center Electricity Use by End-Use Component



End-Use Component	2000		2006		2000 – 2006
	Electricity Use (Billion kWh)	Percent Total (%)	Electricity Use (Billion kWh)	Percent Total (%)	Electricity Use CAGR (%)
Data center infrastructure	14.1	50	30.7	50	14
Network equipment	1.4	5	3	5	14
Storage	1.1	4	3.2	5	20
High-end servers	1.1	4	1.5	2	5
Mid-range servers	2.5	9	2.2	4	-2
Volume servers	8.0	29	20.9	34	17
Total	282	100	61.4	100	14

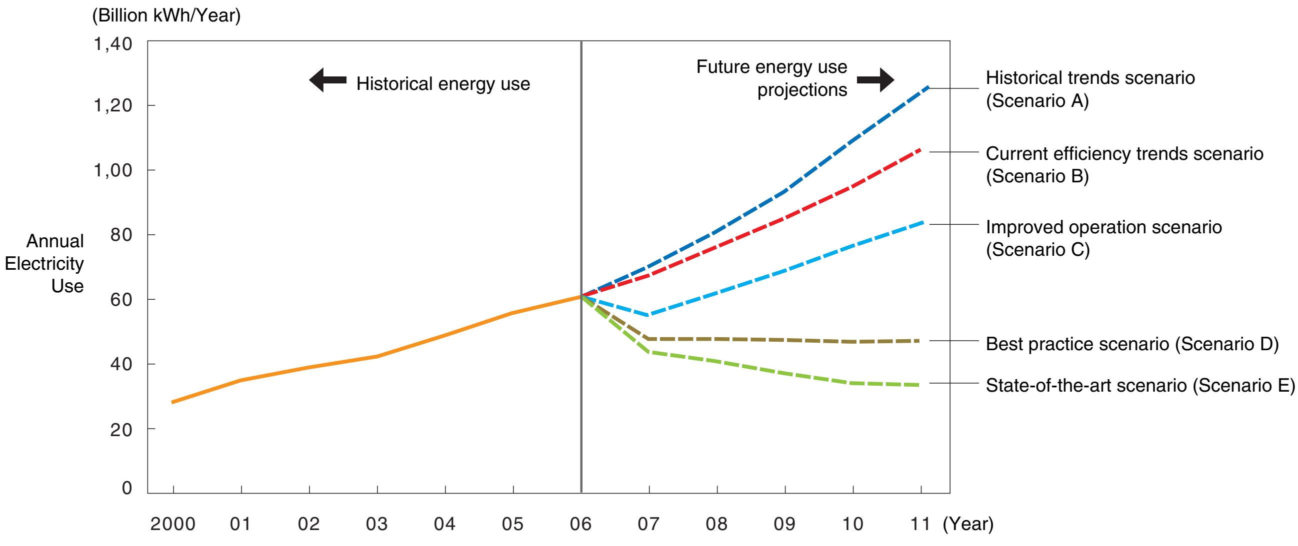
Note: CAGR: Compound annual growth rate

Table 3. Projected Scenarios for US Data Center Energy Use

Scenario	Energy Efficiency Measures for IT Equipment	Energy Efficiency Measures for Data Center Infrastructure Systems	Target Power Usage Effectiveness (PUE) of Data Centers
Scenario A: Historical trends (continuation of 2000 to 2006 energy use trends)	Continuation of 2000 to 2006 energy use trends	• Infrastructure efficiency at current levels	2.0 (all data center space types)
Scenario B: Current efficiency trends	• Volume server virtualization leading to a physical server reduction ratio of 1.04 to 1 and 1.08 to 1 • Energy efficient servers represent 5 percent of volume server shipments in 2007, increasing to 15 percent of shipments in 2011	• Improved technological and operation performance for all data centers, leading to better efficiency	1.9 (all data center space types)
Scenario C: Improved operation (operational improvements to current infrastructure and equipment, requiring little or no investment)	• Volume server virtualization leading to a physical server reduction ratio of 1.04 to 1 and 1.08 to 1 • Power management enabled on 100 percent of applicable servers	• Use of high efficiency switch gear and UPS systems • Use of airflow management	1.7 (all data center space types)
Scenario D: Best practice (assuming adoption of "best in class" technologies and management practices available today)	• Volume server virtualization leading to a physical server reduction ratio of 1.33 to 1 and 2 to 1. Power management enabled on 100 percent of applicable servers • Consolidation of storage devices leading to a reduction ratio of 1.5 to 1	• Use of high efficiency switch gear and UPS systems • Use of high efficiency chillers (free cooling, variable-speed fans and pumps)	1.7 (server closets and server rooms) 1.5 (mid-tier and enterprise-class data centers)
Scenario E: State-of-the-art (assuming maximum energy efficiency using only the most efficient technology and management practices available today)	• Volume server virtualization leading to a physical server reduction ratio of 1.66 to 1 and 5 to 1 • Consolidation of storage devices leading to a reduction ratio of 1.24 to 1	• Use of variable-speed fans and pumps • Use of direct liquid cooling of racks (cogeneration)	1.7 (server closets and server rooms) 1.5 (mid-tier data centers) 1.4 (enterprise-class data centers)

Source: *Report to Congress on Server and Data Center Energy Efficiency Public Law 109-431*, August 2007; prepared by US Environmental Protection Agency (EPA)

Figure 5. Projected Electricity Use of US Data Centers by Scenario, 2007 to 2011



investment in US data center infrastructure and IT equipment, it could cut electricity consumption in 2011 by 55 percent to around half the current level, effectively lowering it to the levels of 2000 (Figure 5).

The next best scenario is the "best practice" scenario (Scenario D), representing efficiency gains through combined use of the most effective technologies available today. Even the best practice scenario would reduce electricity consumption by 45 percent, lowering it to the levels of 2004.

The third best scenario is the "improved operation" scenario (Scenario C), representing only improvements that are operational in nature and require little or no capital investment. The improved operation scenario would only reduce electricity consumption by 20 percent, leading to an increase of approximately 40 percent in electricity use by 2011, compared with current levels.

Technologies highlighted under the EPA's state-of-the-art scenario include distributed power generation through cogeneration (combined heat and power), and other technologies such as fuel cells and solar power generation. Cogeneration systems enable waste heat from power generation to be used for cooling, making the technology suitable for data centers, which require a stable supply of both electricity and cooling. At the same time, fuel cells could be used to deliver a direct supply of DC power to servers and routers for efficient supply of power without conversion loss. However, fuel cells are still expensive and require the offering of considerable incentives to encourage their adoption.

The EPA is working on several fronts to promote improvement of the energy efficiency of US data centers, such as establishing a benchmark index for measuring the efficiency of data centers and taking a leadership role at the national level. In addition, the EPA publishes information about the best practices and promotes the adoption of energy-efficient equipment by US data centers.

In the private sector, a large group of US companies in the IT industry has launched a consortium called Green Grid, led by corporations such as IBM, Intel, AMD, Sun Microsystems and Hewlett-Packard (HP). Formed in February 2007 as a non-profit organization, Green Grid has approximately 120 member companies and organizations. The consortium is dedicated to reducing the electricity consumption of all data centers by publishing and sharing information, and promoting the following initiatives:

(1) Collect and analyze data concerning the performance of data centers
(2) Test new technologies for increasing energy efficiency
(3) Develop scenarios for optimizing data center operations
(4) Define metrics for data center performance

In addition, in June 2007, a group of companies led by Google, Intel, Dell and Microsoft launched the Climate Savers Computing Initiative with the aim of reducing the electricity consumption of servers and other IT equipment, and reducing greenhouse gas emissions worldwide. The group currently has more than 100 companies and organizations as members. The initiative has set a 90 percent efficiency target for internal power supplies of computers which, if achieved worldwide, would by 2010 improve power efficiency by 50 percent and reduce greenhouse gas emissions by 54 million tons per year at a savings of US$5.5 billion in energy costs. To achieve these goals, the initiative will set aggressive power efficiency targets for computers and components, and will encourage consumers and corporations alike to adopt energy-efficient computers and power management tools.

IV Global Warming Initiatives by Data Centers

1 Importance of Energy Efficiency Measures by Data Centers

In order to address the issue of global warming, the IT sector must begin reducing CO_2 emissions and improving efficiency through the development and adoption of energy-efficiency technologies that reduce the energy use of IT equipment. In particular, the information services industry must endeavor to improve the energy efficiency of data centers. These initiatives are necessary not only to reduce direct CO_2 emissions, but also to limit increases in CO_2 emissions by using IT to promote improvements in business efficiency among user corporations.

The Japan Information Technology Services Industry Association (JISA) conducted a survey of its members including Japanese information service companies that operate large-scale data centers. The survey found that electricity consumption from data centers constituted 44 percent of overall electricity consumption by JISA member companies in FY2006, even though data centers only occupied 18 percent of the overall floor space of the companies surveyed. Electricity consumption by data centers is significantly higher than that for offices, which consumed 36 percent of electricity. JISA, which has formulated a voluntary action plan to reduce CO_2 emissions based on floor space, has made it a priority to reduce the electricity consumption of data centers.

At the same time, Japanese corporations are accelerating the pace of server consolidation at data centers, replacing servers that were previously spread across offices and other locations. Server consolidation at data centers is being driven by recent trends in corporate management including increased emphasis on corporate governance and information security, and an emphasis on business continuity. These trends have stimulated the Japanese information services industry to find ways to best reduce electricity consumption from concentrated servers.

Nomura Research Institute, Ltd. (NRI) estimates that data center operators in Japan dedicated approximately 960,000 square meters of floor space to their data centers in FY2006, which is more than a threefold increase from the 300,000 square meters of floor space occupied by data centers in FY2000. NRI further projects that the floor space occupied by Japanese data centers will increase by approximately 30 percent to 1.26 million square meters by FY2010 (Figure 6). In order to meet the expectations of growing numbers of data center users, data centers must promote initiatives to improve energy efficiency.

Figure 6 Total Floor Space of Japanese Data Centers

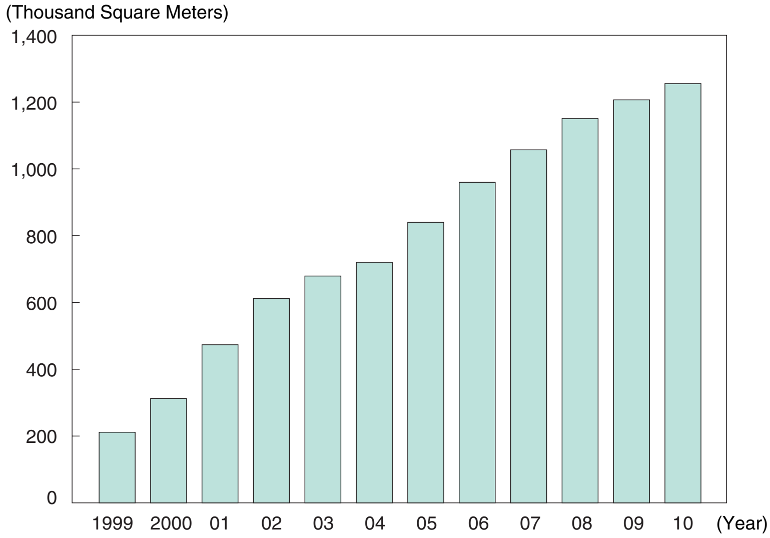


Table 4. Items Contributing to Data Center Power Usage Effectiveness (PUE)

Total Data Center Power Consumption	Power supply	Uninterruptible power supplies (UPS), switch gear, generators, power distribution units (PDUs), batteries, distribution losses
	Cooling	Chillers, computer room air-conditioners, direct expansion air handler (DX) units, pumps, cooling towers
	IT equipment	As listed below
	Other	Data center lighting, loads from other equipment
IT Equipment Power Consumption	Computers, storage, network equipment, KVM switches, monitors, workstations (for managing, monitoring and controlling data center equipment)	

Note: PUE: Total Data Center Power Consumption divided by IT Equipment Power Consumption

2 Power Usage Effectiveness (PUE) of Data Centers

The US Green Grid consortium, covered earlier in this document, advocates the use of Power Usage Effectiveness (PUE) as a metric to measure the energy efficiency of data centers. PUE represents the ratio of total data center energy use to total IT equipment energy use, and is calculated as follows:

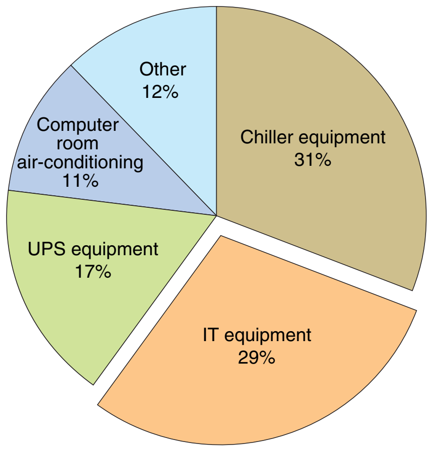
$$\text{PUE} = \frac{\text{Total Data Center Power Consumption}}{\text{IT Equipment Power Consumption}}$$

* See Table 4 for specific details

A PUE of 1.0 is obviously ideal, indicating that no additional energy is required other than the energy used by IT equipment. Typically, IT equipment makes up only 29 percent of the total power consumption of data centers, resulting in a PUE of 3.4 (Figure 7).

In the US, the Lawrence Berkeley National Laboratory (Berkeley Lab) conducted two surveys in 2003 and 2005 to measure the PUE of US data centers in order to determine the best practices for energy efficiency. In the 2003 study, the Berkeley Lab surveyed 15 data centers and found that the PUE ranged from 1.33 to 3.03, for an average PUE of 1.95. In the 2005 study, the PUE ranged from 1.3 to 2.1, for an average PUE of 1.63.

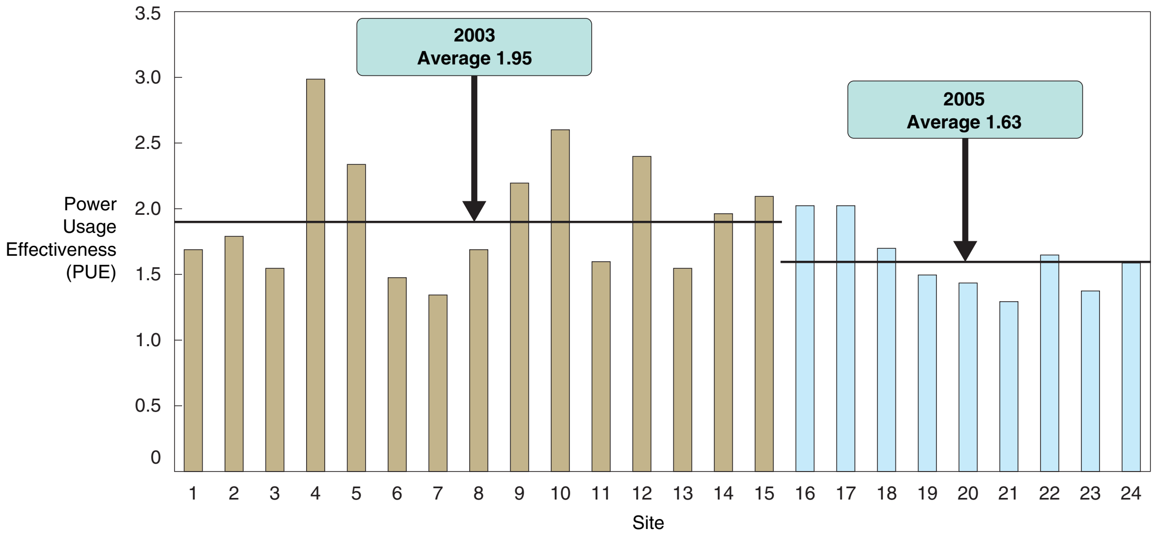
Figure 7. Typical Composition of Data Center Power Consumption



Source : Japanese Ministry of Economy Trade and Industry (METI)

In the EPA report released in August 2007, the Agency outlines simulations that set PUE targets for data centers to be achieved by 2011 by type of space. The PUE targets are based on the current PUE of 2.0 derived from benchmarking studies of the Berkeley Lab,

Figure 8. Energy Efficiency Benchmarking Results for US Data Centers



setting a PUE target of 1.7 for server rooms, 1.5 for mid-tier data centers (approximately 100-500 square meters) and 1.4 for enterprise-class data centers (more than 500 square meters). This shows how the US is beginning to use PUE as a target benchmark for measuring the efficiency of data centers.

3 Efficiency of Japanese Data Centers

Although there is no published data on the efficiency of Japanese data centers based on PUE, it is possible to estimate the PUE of Japanese data centers based on available data. Large-scale data centers in Japan are normally regulated under the Act on the Rational Use of Energy as Type 1 or Type 2 Designated Energy Management Factories. Facilities that fall under either designation are required to report their total energy consumption and production volume. For data centers, the production volume is measured by CPU processing volume, which can be used to derive the power consumption of IT equipment. Using this method, we calculated the PUE of the data centers operated by an information services company in Japan.

Table 5 shows the resulting calculations of PUE for three data centers. The highest PUE is 1.92, which is slightly better than the US average PUE of 2.0. The PUE for Data Center A is 1.59, which is close to the PUE target set by the EPA under its best practice scenario. Data Center A is notable for its high operating ratio and upgraded cooling and air-conditioning infrastructure systems based on inverter technology, which contributes to high energy efficiency. Data Centers B and C are scheduled to receive air-conditioning upgrades in order to improve their energy efficiency.

In order to implement benchmarking in the future, data centers in Japan should cooperate with the US Green Grid consortium and endeavor to share and provide information on strategies for improving energy efficiency.

Table 5. Sample Power Usage Effectiveness (PUE) of Data Centers Operated by Japanese Information Services Firm

	Year Established	Total Floor Space (m^2)	Computer Room Floor Space (m^2)	PUE
Data Center A	1990	20,000	8,700	1.59
Data Center B	1985	21,000	5,800	1.92
Data Center C	1992	18,000	5,500	1.88

4 Strategies for Improving the Energy Efficiency of Data Centers

There are three major areas for reducing overall energy consumption and CO_2 emissions of data centers, as summarized in Table 6.

(1) Reduce the power consumption of IT equipment used in data centers
(2) Improve the energy efficiency of infrastructure systems necessary to support the operation of data centers such as air-conditioning systems and uninterruptible power supply (UPS) equipment
(3) Switch to clean sources of energy that produce little or no CO_2 emissions for the energy needs of data centers

The energy efficiency of IT equipment used in data centers can be improved through a number of strategies, such as upgrading servers to machines equipped with newer energy-efficient CPUs, and reducing the power consumption of hard disk drives through miniaturization. Other strategies are to reduce the number of servers and storage systems through the use of virtualization technology, and reduce idle power consumption through the use of energy management tools for servers.

Analysis of server power consumption by end-use component shows that CPU usage accounts for approximately

Table 6. Strategies for Reducing CO_2 Emissions of All Data Centers

Area of Applicability	General Approach	Specific Strategies
1. Reduce power consumption of IT equipment	Reduce power consumption of CPUs	• Use quad core CPUs • Limit power to CPUs
	Reduce power consumption of servers	• Virtualization to reduce number of servers and improve operating ratio
	Reduce power consumption of storage systems	• Miniaturization of hard disk drives • Virtualization of storage systems to reduce number of systems and improve operating ratio
	Improve cooling of servers	• Rear door heat exchangers and closed rack systems to improve rack cooling efficiency
2. Reduce power consumption of data centers containing IT equipment	Improve airflow efficiency	• Address heat buildup and air leaks to optimize flow of cool air • Remove above- and below-floor objects that obstruct airflow • Divide paths for hot air and cold air
	Improve efficiency of air-conditioning equipment	• Use inverter air-conditioning equipment • Use air-conditioning nighttime thermal storage systems
	DC power supply	• Use routers and servers with DC power supplies to reduce loss from conversion
	Reduce power consumption of chillers	• Use routers and servers with DC power supplies to reduce loss from conversion
3. Switch to clean sources of energy	Use of solar power generation	• Usage depends on data center being located on large site
	Use of hydroelectric power	• Usage depends on location of data center
	Cogeneration	• Usage depends on surrounding environment

Note: (1)Quad core CPU: A central processing unit (CPU) with four cores. (2)Cogeneration: A system for simultaneous supply of heat and electricity

30 percent of overall power consumption, with the remaining 70 percent consumed by components such as hard disk drives, power supplies and fans. Accordingly, power consumption could be effectively reduced by either improving energy efficiency or sharing component resources. Furthermore, since server CPUs are estimated to be idle more than 70 percent of the time, server efficiency could be improved by consolidation to achieve a higher operating ratio.

Server consolidation is achieved by deploying virtualization technology on large servers to create multiple virtual servers that run existing server application software. Since servers are configured based on projected peak loads, they frequently operate at an operating ratio of only 10-15 percent under normal loads. By consolidating servers and achieving higher operating ratios, data centers can improve the overall efficiency of servers. Consolidation also improves energy efficiency since idle servers can still consume 30 percent of the power they draw at peak loads. In addition, virtualization technology is starting to be deployed for storage systems, providing an effective means of improving energy efficiency.

Examining the energy efficiency of data centers reveals that power consumption from infrastructure systems such as cooling, power substations and power distribution account for most of the energy consumption of data centers, giving importance to examining ways to improve the efficiency of data center infrastructure. Strategies that can be implemented without requiring investment include removal of unnecessary wiring, piping and equipment from inside the data center, and an effective cooling supply to improve airflow and recover waste heat.

Effective strategies that require investment include the adoption of chillers that use inverter technology, and the use of "free cooling" through the intake of outside air to capitalize on cool outside temperatures, particularly during the winter. In Japan, "free cooling" might be an effective measure during winter, however construction of underground data centers is also being considered as a means of capitalizing on cold air and water underground.

The use of solar power generation is one option for supplying clean energy to data centers. US-based Web hosting company Affordable Internet Services Online, Inc. (AISO) markets its data center as being 100 percent solar powered. The company's data center is located in the California dessert and draws power from an array of 120 solar panels covering several times the area of the data center itself. However, a similar data center installation would be difficult to implement in Japan, due to a shortage of available space.

Hydroelectric power generation is also being used as a source of natural energy for data centers. To take advantage of hydroelectric power, companies such as Microsoft and Google have built data centers near hydroelectric plants in the northwestern US.

In Japan, cogeneration has established itself as a viable technology for energy supply. Although cogeneration is reliant on fossil fuels, it enables the simultaneous supply of electricity and heat to data centers to improve energy efficiency. If the PUE of Japanese data centers could be lowered from 2.0 to 1.4 with these technologies, it would reduce the energy consumption of Japanese data centers by 30 percent.

V Future Measures by the Japanese Information Services Industry

The information services industry in Japan should consider future measures to address global warming, based on the perspectives outlined in the following sections.

1 Shift from Initiatives by Plant, to Initiatives by Corporation

Until now, Japanese corporations have implemented initiatives to improve energy efficiency in accordance with the Act on the Rational Use of Energy, which stipulates that factories and places of business above a certain size (consumption of 1,500 kiloliters of crude oil equivalent) must engage in energy management.

Under revisions to the Act on the Rational Use of Energy that came into effect in April 2006, the scope of factories and places of business regulated under the Act was expanded to cover 87 percent of facilities based on energy consumption, for the industrial sector as a whole. The Japanese government has also strengthened implementation of the Act by requiring an average annual 1 percent reduction in energy intensity as a medium- and long-range target, in addition to introducing penalties for corporations that are deficient in reporting to government authorities. The Keidanren Voluntary Action Plan on the Environment implemented by Nippon Keidanren is also achieving significant results by calling for factories to improve energy efficiency and reduce CO_2 emissions.

Although Japan is implementing initiatives to improve energy consumption, offices and retail stores lag significantly behind and are actually increasing their CO_2 emissions. Under the revised Act, just 13 percent of offices in the commercial sector are required to engage in energy management. To address this situation, the Advisory Committee for Natural Resources and Energy will issue recommendations for further revisions to the Act that will strengthen the framework for the Japanese government to comprehensively assess and promote initiatives to improve energy efficiency. The changes will shift the focus to individual corporations, rather than focusing on improving energy efficiency on a factory basis.

The Japanese government is also considering the adoption of a system that will enable the objective assessment and visualization of energy efficiency initiatives by sector and corporation. As a means of comparing initiatives between corporations, the system would be implemented by adopting a common evaluation benchmark to measure the energy efficiency of factories and offices in major sectors. Once the revisions to the Act are put into effect, Japanese corporations in the manufacturing industry will be required to reduce overall CO_2 emissions for their offices in addition to reducing emissions for factories. In the services sector, offices and retail stores will also be required to reduce CO_2 emissions.

After the Japanese government strengthens its framework for promoting energy efficiency improvements among individual corporations, it will become critical for all companies to improve their energy efficiency. Corporations such as those in the finance industry and other parts of the services sector that either do not operate factories or only have small factory operations will have to improve the energy efficiency of their offices, retail stores and data centers.

Accordingly, offices will need to improve energy efficiency through the implementation of the Building Energy Management Systems (BEMS) such as for air-conditioning and lighting. As part of this process, corporations will have to make decisions about continuing to use equipment such as servers and PCs, which generate significant waste heat in offices, or to seek alternative solutions.

For example, thin client systems are currently being considered by corporations from the standpoint of improving information security, but they also offer energy efficiency advantages. Under the thin client architecture, the functions of PCs are concentrated on servers at data centers. Data processing and storage is handled by data center servers so that offices need only be equipped with basic setups consisting of a terminal, display and keyboard. In addition to the security advantages of thin client systems, corporations will begin to see the value of thin clients from the standpoint of reducing power that is otherwise consumed by office PCs, and in terms of reducing the load on air-conditioning from waste heat that is usually generated by office PCs.

The information services industry should move to reduce CO_2 emissions for all user corporations, focusing on two areas. First, the information services industry should help to reduce power consumption at offices by strongly encouraging the consolidation at data centers of IT equipment from offices, retail stores and other locations, while endeavoring to operate data centers at high levels of energy efficiency. Second, the information services industry should implement initiatives to improve the overall energy efficiency of data processing. Under the US EPA targets, the energy efficiency of server rooms is only expected to decrease to a PUE of 1.7 at best, compared with a target PUE of 1.4 for enterprise-class data centers. Therefore, the Japanese information services industry should endeavor to migrate server rooms to more efficient enterprise-class data centers, which would effectively improve overall energy efficiency.

2 Shift in Focus from Intensity to Net Emissions

Until now, many voluntary action plans were based on reducing energy consumption or CO_2 emissions by intensity, calculated as either energy intensity or CO_2 emissions intensity by sector. However, due to the increase in Japan's CO_2 emissions, there is increasing pressure to focus on reducing net emissions.

The United Nations Framework Convention on Climate Change (UNFCCC) is considering targets to reduce the total global volume of greenhouse gas emissions by 2020, under which even stricter reduction targets will be set for developed countries. Even if Japan meets its targets through the Kyoto Protocol's first commitment period ending in 2012, the new targets being considered by the UNFCCC would require Japan to achieve further significant cuts in emissions by 2020. For this reason, advisory bodies such as the Central Environmental Council and Industrial Structure Council are directing Japanese industry associations to formulate plans based on net emissions reductions, which is causing a gradual shift toward the formulation of these plans.

As mentioned above, voluntary reduction plans by the IT sector have until now focused on achieving reductions based on intensity. However, net emissions have actually increased due to growth in business activity. In the future, the IT sector will have to focus on limiting net CO_2 emissions regardless of increases in business volume.

Increased demand for IT use will cause a rise in CO_2 emissions by the information services industry, which operates data centers. Consequently, the information services industry will need to restrict net CO_2 emissions, by both reducing the power consumption of IT equipment and improving the energy efficiency of data centers.

3 Shift in Approach from CSR to Business Resources

Many corporations have approached the issue of CO_2 emissions as part of their environmental initiatives, placing it under the responsibility of internal departments in charge of corporate social responsibility (CSR). However, as corporations start to focus more on CO_2 emissions and engage in carbon trading either in Japan or abroad as a price is attached to carbon, CO_2 emissions will start to have a direct effect on corporate profits. When that happens, companies that supply outsourcing services will be positioned to market their services based on helping customers reduce CO_2 emissions as well as reducing business costs.

Reduction of CO_2 emissions represents both a business opportunity and potential limiting factor for the growth of the information service industry, as a provider of outsourced services. If mandatory restrictions on CO_2 emissions are imposed on individual corporations, data centers that exceed the mandatory restrictions will be unable to take on new business unless they reduce their CO_2 emissions.

Even without mandatory restrictions on CO_2 emissions, some data centers in the US are being prevented from expanding due to power restrictions placed on them by local power utilities. This is occurring in spite of their having the physical capacity to add more servers because of server miniaturization. Under the circumstances, the data center must find ways to improve energy efficiency in order to add new servers.

US-based Sun Microsystems opened three new data centers from January to June 2007, equipping the data centers with energy-efficient systems. By consolidating servers and hardware at the new data centers, Sun was able to cut its total worldwide data center space in half, while reducing power consumption by 30 percent. In addition, US-based IBM has launched the Project Big Green initiative, announcing that it will invest one billion dollars annually to double the energy efficiency of its own and customer's data centers by 2010, in a move to combat the data center energy crisis

If the information services industry could use such technology development to reduce CO_2 emissions through consolidation of customer's servers at data centers, it could capitalize on a major opportunity to gain outsourced business.

The term "carbon neutral" is being used today to refer to the neutral release of greenhouse gases by balancing the amount of carbon released with the amount of carbon offset through the planting of trees or use of natural energy sources. From now on, corporate management should approach CO_2 emissions as a business resource that should be managed and as a factor that can either limit corporate growth or provide opportunities for growth.

Moving forward, the Japanese information services industry should contribute to expanding the opportunities for social growth through the development and adoption of technologies that reduce CO_2 emissions.

Note:

(1) Noriaki Hino, "Suggestions for Optimizing the Overall Supply Chain in Publishing Distribution" *Chiteki shisan sozo* (Knowledge Integration and Creation), June 2007.

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