
**Japan's Second National
Communication Under
the United Nations Framework
Convention on Climate Change**

The Government of Japan

1997

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Summary

Chapter 1: The Japanese Context

Japan is an archipelago stretching approximately from 24 degrees to 46 degrees north latitude. As of 1994, its territory extends over 37,780,000 hectares, of which approximately 80 percent covered by forest and agricultural land. Japan's climatic zones range from subtropical to subarctic, with four clearly defined seasons. As of 1995, Japan has a population of approximately 126 million; its real GDP in fiscal 1995 was ¥467 trillion.

Against the background of a healthy economy, the volume of domestic transport (both passengers and freight) increased dramatically in Japan during the second half of the 1980s. Since 1990, however, passenger volume has remained essentially steady, and freight transport has declined. Automobile ownership, on the other hand, has consistently risen since the 1960s. This trend has not changed since 1990.

In recent years, growth in electric power consumption has exceeded growth in overall final energy consumption, so that there has been a rise in the proportion of the total primary energy supply used for electric power generation. Meanwhile, dependence on foreign sources of energy has also risen to around 80 percent, leaving Japan vulnerable to supply fluctuations.

Japan's per capita energy consumption is equivalent to about 4,620 liters of crude oil per annum (about 42,700,000 kcal). The ratio of total primary energy supply to unit GNP has declined and leveled off in recent years. The leveling off is attributed to the fact that investment in large-scale energy-conserving technologies has essentially run its course in the industrial sector, while energy consumption in the residential/commercial and transport sectors is on the rise.

Chapter 2: National Inventory of Greenhouse Gas Emissions and Removals

In accordance with Article 4. 1(a) of the United Nations Framework Convention on Climate Change, all parties to the Convention are requested to periodically update and report on the national inventory of anthropogenic emissions and removals of greenhouse gases. Japan's national inventory of emissions and removals of greenhouse gases outlined in this report is based on the Guidelines for the Preparation of National Communications by ANNEX 1 Parties and the Guidelines for National Greenhouse Gas Inventories prepared by the IPCC/OECD. The basic method of calculation is to multiply the activity data according to gas and sector by the emission/removal factors of the gas in question.

The types of greenhouse gases and precursors and the years of the reports are shown in Table 1. The data for emissions and removals of a total of ten types are reported from 1990 to the most recent date available.

Table 1. Gases and Years of Emission/Removal Reports

Gas	Chemical formula (generic name)	Years of emission/removal reports	Gas type
Carbon dioxide	CO ₂	FY1990 to FY1995	Greenhouse gas
Methane	CH ₄	FY1990 to FY1994	Greenhouse gas
Nitrous oxide	N ₂ O	FY1990 to FY1994	Greenhouse gas
Hydrofluorocarbons	(HFC)	1990 to 1995	Greenhouse gas
Perfluorocarbons	(PFC)	1990 to 1995	Greenhouse gas
Sulfur hexafluoride	SF ₆	1990 to 1995	Greenhouse gas
Nitrogen oxide	NO _x	FY1990 to FY1994	Precursor
Carbon monoxide	CO	FY1990 to FY1994	Precursor
Non-methane volatile organic compounds	(NMVOC)	FY1990 to FY1994	Precursor
Sulfur dioxide	SO ₂	FY1990 to FY1994	Precursor

Note: The fiscal year in Japan begins in April and ends the following March.

Policies and Measures

Table 2 shows the amounts of the gases emitted and removed in fiscal 1994.

Table 2. FY 1994 Emissions/Removals of Greenhouse Gases etc.

(Unit: Gg)

Greenhouse gas source and sink categories	CO ₂ emissions	CO ₂ removals	CH ₄	N ₂ O	NO _x	CO	NMVOG	SO ₂	HFCs	PFCs	SF ₆
Total national emissions and removals	1,211,740	90,834	1,548	110.0	2,237	3,862	1,873	847	9.7	1.6	1.9
1. All Energy	1,133,291		274	69.0	2,153	3,336	460	769			
1A. Fuel combustion activities	1,133,291		105	69.0	2,153	3,336	242	769			
1B. Fugitive emissions from fuels			169				218				
2. Industrial processes	61,303		47	23.9	22		79	37	9.7	1.6	1.9
3. Solvent and other product use				1.4			1,333				
4. Agriculture			849	9.1		172					
5. Land-use change & forestry		90,834	4	0.0	1	35					
6. Waste	17,146		373	6.6	61	300	0	41			
7. Other						18					
International bunkers	37,494		2	0.4	440	63	15				

Note: HFC, PFC and SF₆ emissions are potential emissions (amount of domestic supply).

Chapter 3: Policies and Measures

Japan adopted the Action Program to Arrest Global Warming in October 1990 and has been promoting measures to control carbon dioxide emissions, methane, and other greenhouse gas emissions; measures to enhance carbon dioxide sinks; surveys and research; observation and monitoring; technical development and dissemination; efforts to raise public awareness; and international cooperation.

Currently, Japan's environmental policies are based on the Basic Environment Law (enforced in November 1993) and on the Basic Environment Plan (decided by the Cabinet in December 1994), which is itself based on the Basic Environment Law. The Basic Environment Law was promulgated in response to the need to appropriately handle global warming and other worldwide environmental problems, and environmental problems associated with waste. Moreover, the Basic Environment Plan cites four concepts as the long-term goals of Japan's environmental policy: "sound material cycle"; "harmonious coexistence"; "participation"; and "international activities." Countermeasures against global warming fall within the category of measures designed to foster a "sound material cycle" socioeconomic system.

Many local public organizations have their own regional programs to arrest global warming and are implementing policies accordingly.

1. Policies and Measures on Carbon Dioxide

In the energy conversion sector, steps are being taken to improve the efficiency of energy conversion, to promote the formation of an energy supply structure that reduces carbon dioxide emissions, and to undertake "demand side management." Efforts are being made to raise the efficiency of electric power generation and to introduce energy sources that produce little or no carbon dioxide emissions. Policies are also being formulated to help energy suppliers curb demand.

The industrial sector has implemented various energy conservation measures since the oil crises of the 1970s. In addition to promoting the adoption by factories and business offices of common, cross-industry measures designed to improve the efficiency of energy use and conversion, energy-conservation measures are being supported through legal measures and financial measures targeted mainly at industries that consume large amounts of energy.

In the residential and commercial sector, measures being taken to reduce emissions include: enhancing the insulation properties of construction materials; introducing natural energy sources, energy-efficient devices and facilities, and cogeneration technologies; implementing district heat supply systems that use currently untapped energy sources; and alleviating the heat island phenomenon by planting greenery and using permeable paving materials

in urban areas. In addition, steps are being taken to achieve a lifestyle that produces fewer carbon dioxide emissions.

In the transport sector, efforts are being made to enhance energy efficiency through the use of new technologies focusing on automobiles; to promote the introduction of low-emission vehicles; to raise the efficiency of both passenger and freight transport; and to facilitate automobile traffic flow.

Recycling is an effective means for reducing greenhouse gas emissions. In addition to minimizing the amount of waste generated, Japan is also promoting material recycling and thermal recycling. The introduction of economic measures such as carbon tax and emissions trading which are expected to be effective was considered.

In the area of carbon dioxide sinks and carbon fixation, Japan will continue measures to conserve forests, and efforts will be made to actively protect greenery in urban environments.

2. Policies and Measures to Reduce Methane Emissions

To control methane emissions from landfill disposal of waste, waste reduction and recycling are being conducted, and any remaining combustible waste is being incinerated whenever possible. In the agricultural sector, the status and mechanisms of methane emitted from enteric fermentation in livestock, manure management, and rice paddy field farming are being surveyed to create the basis for emission control methods.

3. Policies and Measures to Reduce Nitrous Oxide Emissions

The installation of equipment to control nitrous oxide emissions in the manufacture of adipic acid is planned. In the agricultural sector, reduction of the use of nitrogenous fertilizers and raising of the efficiency of fertilizer application are being considered as measures to reduce nitrous oxide emissions.

4. Policies and Measures to Control HFC, PFC, and SF₆ Emissions

The Japanese government recognizes that the control of hydrofluorocarbon (HFC), perfluorocarbon (PFC), and sulfur hexafluoride (SF₆) emissions is an important component of efforts to curb global warming. While keeping in mind the need to harmonize policies with other measures aimed at protecting the ozone layer, efforts will be made to formulate measures in accordance with the following basic policies: limiting fields of use; adopting closed systems; promoting recovery, reuse, and destruction; and promoting the development of alternative substances and technologies.

5. Policies and Measures to Control Precursor Emissions

Emissions of nitrogen oxide, carbon monoxide, non-methane volatile organic compounds, and sulfur oxides are systematically regulated on the basis of standards set forth in the Air Pollution Control Act.

Chapter 4: Forecast of Greenhouse Gas Emissions and Removals

Carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O) emissions and removals were estimated by establishing a “standard scenario” that does not take into consideration the possible effects of new policies and measures.

Carbon dioxide emissions in the 2010 fiscal year are forecast to exceed fiscal 1990 levels by approximately 20 percent, reaching 369 million tons of carbon equivalents (1,353 million tons of carbon dioxide equivalents).

Carbon dioxide removals in the land-use change and forestry sector are estimated to decline to 67 million tons of carbon dioxide equivalents in fiscal 2000 and 56 million tons in fiscal 2010.

Methane emissions are forecast at 1.58 million tons in fiscal 2000, remaining at fiscal 1990 levels and 1.49 million tons in fiscal 2010, down 6 percent from fiscal 1990 levels.

Nitrous oxide emissions are projected to increase by 15 percent from fiscal 1990 levels to 120,000 tons in fiscal 2000 and to 130,000 tons in fiscal 2010 – a 24 percent rise over fiscal 1990 figures.

Chapter 5: Projected Impacts of Climate Change and Vulnerability Assessment

To clarify the impacts that climate change might have on Japan, efforts have been made to review major research conducted in Japan related to climate change and to quantitatively evaluate possible impacts on the basis of the review results.

Research to date demonstrates that climate change will have a major impact on Japan's agriculture, forestry, fisheries, water resources, coastal management, natural ecosystems, and human health.

For example, in the summer months areas that receive large quantities of precipitation may be subjected to still more rain, while rainfall may decline in regions that receive little precipitation. In western Japan, the harvests of rice and wheat may decline, and in southern Japan scientists suggest a growing risk of malaria and other tropical infectious diseases because of the northward advance of vectors. Meanwhile, as sea levels rise the area of land below sea level will increase, and the damage from storms will grow. Scientists also expect additional erosion. If the sea level rises by just 65 cm, over 80 percent of Japan's sandy beaches will be lost.

Several important items are considered to be issues for future research but are not addressed in this report. These include natural effects on phenomena such as changes in typhoons and Baiu rain fronts (which are important from the standpoint of disaster prevention), and indirect effects on Japan's increasingly complex and globalized socioeconomic system (such as problems with importing foodstuffs, energy, and other resources). It is also clear that climate change will have a massive effect on natural ecosystems, but at the present time it is extremely difficult to conduct a quantitative assessment of this effect.

Chapter 6: Adaptive Measures

Japan is studying adaptive measures to deal with sea level rise and changing conditions in agricultural production. Regarding sea level rise, consideration will be given to the anticipated durability of new harbor facilities when they are built, and the impacts of future rises will be included as an element in facility design. For existing facilities, sea levels will be constantly monitored and appropriate measures will be taken when deemed necessary.

Regarding agricultural production, research is being pursued on ways to avoid declines in crop yield by adopting new agricultural technologies, such as introducing new crop varieties and changing planting times.

Chapter 7: Financial Assistance and Technology Transfer

With regard to international cooperation for the conservation of the global environment, efforts are being made to give greater consideration to environmental issues when implementing ODA programs, including increasing official development assistance (ODA) for environmental issues, and promoting the development and the transfer of technologies which suit the needs of developing countries. To that end, Japan has been cooperating to promote the overall increase of environment-related ODA disbursements and to strengthen environmental considerations in the implementation of ODA programs.

At the United Nations Conference on Environment and Development, Japan announced that it would endeavor to significantly expand its ODA in the field of the environment to around ¥900 billion to ¥1 trillion during the five-year period starting from fiscal 1992. During the next four years, to fiscal 1995, Japan contributed 980 billion yen, thus reaching its declared goal one year early. Also, in June 1992, the Cabinet adopted Japan's Official Development Assistance Charter (ODA Charter), which spells out the philosophy and principles of Japan's official development assistance. This document identifies environmental conservation as one of the basic philosophies of ODA and states that "the pursuit of environmental conservation and development in tandem" must be one of the basic principles of ODA. Furthermore, it states that efforts will be made to achieve sustainable development on a global scale by assisting the self-help efforts of developing countries.

Chapter 8: Research, Systematic Observation, and Technology Development

In dealing with climate change and global warming, Japan is committed to conducting surveys and research on topics such as the following: global phenomena related to climate change and global warming; the impact of human activities on climate and global warming; the impact of climate change and global warming on human health and ecosystems; and the formulation of policies to control climate change and global warming. To that end, Japan promotes joint research and other activities through participation and cooperation with international programs, including the Intergovernmental Panel on Climate Change (IPCC) and the World Climate Research Programme (WCRP).

Because the observation and monitoring are widely ranged in fields, topics, locations, and methods, the Government of Japan is working to maintain conformity with international observation and monitoring programs. Japanese institutions implementing observation programs share their observation results with counterpart institutions in other nations.

To promote sustainable development, the Government of Japan is developing technologies to mitigate global environment change. These include the efficient use of energy and resources; the environment-friendly agriculture and materials manufacturing; and technology for the utilization of new and renewable energy resources.

Chapter 9: Education and Awareness Campaigns

Carbon dioxide emissions have been consistently increasing in recent years in the residential/ commercial and transport sectors, which are closely related to citizen lifestyles. To arrest global warming, all citizens must shift from a lifestyle of mass consumption and disposal to one of resource and energy conservation and recycling. At the same time, consideration should be given to using non-fossil fuel energy, including new and renewable energy and nuclear energy. To that end, opportunities to learn about the global warming problem, as well as the energy issues that are the primary cause of it, are provided in homes, schools, and society at large. In addition, awareness campaigns are being mounted through mass media, pamphlets, symposiums, and other means of dissemination. Also, Japan is committed to increasing the support to environmental NGOs, which promise to play a leading role as advisors in citizen efforts to address the global warming problem.

Chapter 1

The Japanese Context

1.1. National Land Use

Japan is an archipelago located at the far eastern end of the Eurasian continent stretching from about 24 degrees to 46 degrees north latitude and consisting of four major islands – from north to south, Hokkaido, Honshu, Shikoku, and Kyushu – as well as more than 6,800 smaller islands.

Please see Figure 1.1 at the end of the chapter 1.

Japanese territory as of 1994 extends over 37,780,000 hectares, or about 0.3 percent of the earth's land area; over 80 percent is covered by forest (25,160,000 hectares (66.6 percent)) and agricultural land (5,170,000 hectares (13.7 percent)). In recent years, the area left as agricultural land has diminished, and the area occupied by building land and roads has increased.

1.2. The Climate

Japan stretches over a great distance from north to south, the nation spans a vast range of climatic zones, from subtropical in the south to subarctic in the north, and Japan has four sharply distinct seasons. The mountainous backbone in the middle of Japan's main islands also enhances the climatic varieties between different regions of Japan. In winter, the prevailing northerly winds bring cold air down from Siberia, and the areas facing the Japan Sea receive large amounts of snowfall. In summer, the prevailing southerly winds, make the climate hot and humid.

The climate (yearly averages from 1961 to 1990) is shown in Table 1.1 at several meteorological stations where the effects of urbanization are considered to be limited.

Table 1.1 Climatological Elements

		Latitude (N)	Longitude (E)	Range of Altitude (meters)	Annual Mean Temperature (°C)	Average Maximum Temperature (°C)	Average Minimum Temperature (°C)	Annual Amount of Precipitation (mm)
Northern Japan	Abashiri	44°01'	144°17'	37.6	6.0	9.9	2.4	815.3
	Nemuro	43°20'	145°35'	25.8	5.9	9.3	2.7	1,035.4
	Yamagata	38°15'	140°21'	152.5	11.2	16.2	6.8	1,126.3
	Ishinomaki	38°26'	141°18'	42.5	11.2	15.2	7.7	1,047.7
Eastern Japan	Fushiki	36°47'	137°03'	11.6	13.6	17.6	10.1	2,282.8
	Mito	36°23'	140°28'	29.3	13.2	18.4	8.7	1,307.8
	Iida	35°31'	137°50'	482.3	12.3	18.4	7.2	1,591.6
	Hamamatsu	34°42'	137°43'	31.7	15.7	19.9	12.1	1,884.0
Western Japan	Sakai	35°33'	133°14'	2.0	14.6	18.8	10.8	1,984.6
	Hamada	34°54'	132°04'	19.0	15.1	18.9	11.3	1,730.6
	Hikone	35°16'	136°15'	87.3	14.1	18.4	10.4	1,653.7
	Miyazaki	31°55'	131°25'	6.3	17.0	21.9	12.6	2,434.6
	Tadotsu	34°16'	133°45'	3.7	15.7	19.7	12.0	1,132.2
Nansei Islands	Naze	28°23'	129°30'	2.8	21.3	24.6	18.3	2,870.7
	Ishigakijima	24°20'	124°10'	5.7	23.8	26.5	21.6	2,065.8

Source: Japan Meteorological Agency, "Climate Tables of Japan"

Over the past 100 years, annual mean temperatures were generally low through the mid-1940s, from which time they began to rise, tending to be high for a few years before and after 1960; there followed a relatively cold period, then a new rise beginning in the latter half of the 1980s. The temperature has increased at a rate of 0.9°C per 100 years.

The temperature has rapidly increased since the late 1980s, especially in the northern part of Japan.

1.3. The Population

Please see Figure 1.2 at the end of the chapter 1.

1.3. The Population

According to the latest census figures, as of October 1, 1995, Japan's population was 125,570,246, marking a 1.6 percent increase over the previous census (October 1990). The population density was 337 inhabitants per square kilometer. Because of the decline in the birth rate following the Second World War, the percentage of elderly Japanese has now begun to rise.

Please see Figure 1.3 at the end of the chapter 1.

Please see Figure 1.4 at the end of the chapter 1.

During the Japanese economic miracle years of the 1960s, when the economy was growing very rapidly, major internal migrations swelled the population of Japan's three metropolitan areas, and the net immigration into the areas reached approximately 500,000 persons per year. But the net immigration into the three metropolitan areas decreased in the 1970s. Nationwide, however, the number of individuals living in Densely Inhabited Districts (DIDs) continues to rise. As of October 1995, 64.7 percent of the population lived in such districts, showing the continued concentration of the population into metropolitan areas.

Please see Figure 1.5 at the end of the chapter 1.

1.4. Households and Houses

In 1995, there were 43,900,000 ordinary households in Japan, 7.9 percent more than in 1990. The average number of related people living together under one roof was 2.81 in 1995. Since 1970 the number of ordinary households has continued to increase and the number of family members living under the same roof to decrease, reflecting changes in household formation patterns and the shifting composition of the population accompanying the aging society.

Please see Figure 1.6 at the end of the chapter 1.

The housing survey from 1993 indicates the existence of 45,880,000 dwellings, more than enough quantitatively to house the total of 41,160,000 households nationwide. Qualitatively, the average area of floor space per dwelling is 91.92 square meters; though this is an increase with respect to previous decades, it is not yet regarded as sufficient.

Please see Figure 1.7 at the end of the chapter 1.

1.5. Japan's Industry and Economy

From fiscal 1970 to fiscal 1995, Japan's real gross domestic product (GDP) increased 2.5 times from 190 trillion yen to 467 trillion yen (calculated at market prices in calendar year 1990). During the same period, per capita real GDP increased by about 2.0 times from 1.83 million yen to 3.72 million yen.

Please see Figure 1.8 at the end of the chapter 1.

Japan's economy grew extremely rapidly in the 1960s resulting in the development of heavy industry, producing mainly such key materials as steel and chemicals. Along with this, the Japanese economy came to consume a large volume of resources and energy, particularly oil.

During the same period, labor shifted from primary to secondary and tertiary industries. Agricultural production volume increased despite a reduction in the agricultural labor force. Nevertheless, because of the growing income gap versus other industries and other factors, the number of younger workers working in agriculture villages decreased and the average age among the nation's farmers increased.

At that time, Japanese forestry was primarily practiced by highly dispersed, extremely small businesses operating in steep mountainous areas. It was difficult to improve labor productivity, and forestry faced various problems including the price gap versus imported lumber and other industries. As a result, the depopulation of mountain villages continued, the average age of forestry workers increased, and production activities stagnated.

Following the first oil crisis of 1973, Japan's economy recorded the first negative growth since the war in 1974. Economic growth remained slow for some time thereafter. After the two oil crises in 1973 and 1979, manufacturing in particular began efforts to increase the efficiency of energy use. At the same time, the focus of the nation's manufacturing shifted from energy-intensive basic industries such as steel and chemicals to high value-added processing and assembly industries such as electric appliances and machinery.

As income levels rose, the growth of the economy's services and software components was expanded. Tertiary industry (services) came to account for over 50 percent of gross domestic product and total employment. In agriculture, the constituent shares of vegetables and dairy products increased as Japanese dietary habits changed and the nation produced a surplus of rice and other items.

Following the Plaza Accord of 1985, the yen began to grow much stronger on exchange markets, severely hurting Japanese industry, which in general was very dependent on exports. With the subsequent structural adjustment of the Japanese economy, however, domestic demand expanded, business boomed, the sectorial shares of the financial, wholesale, and retail industries increased, and the prices of land, securities, and other assets skyrocketed.

Then, in the early 1990s, the prices of land, securities, and other assets nosedived due to monetary tightening and other factors. Combined with the adjustment in consumer durables and capital stock, the "reverse asset effect" from this asset deflation led to the stagnation of economic activities and to a large volume of unrecoverable debts at the nation's financial institutions. Also, the yen continued to appreciate from the spring of 1990 through the spring of 1995, weakening the processing and assembly industries and spurring on the structural shift among Japanese firms toward greater overseas production. Information, telecommunications, and other sunrise industries recorded large growth, and the growth of the economy's services and software components was expanded further. In agriculture, competition with foreign producers intensified as the volume of imports increased sharply. In response, Japanese farmers have been strengthening their operations by moving toward larger-scale production and pursuing other rationalization measures.

Please see Figure 1.9 at the end of the chapter 1.

Please see Figure 1.10 at the end of the chapter 1.

1.6. Transport

1.6. Transport

1.6.1. Passenger Transport

Domestic passenger traffic grew significantly throughout the period of rapid economic growth as a result of rising income levels, upgrading of the industrial structure, increasing leisure activities, and ensuing growth in demand for higher speed, more comfort, and greater mobility; transport system improvement and network expansion helped to shorten travelling and to build motorization capacity. With cars available and income levels rising, private automobile ownership began to grow from about 1960. As a result, rail traffic decreased as road traffic increased significantly in the 1960s. Air traffic is a tiny fraction of the whole, but its growth is significant, and its time-saving features and the introduction of jetplanes for domestic flights gave airlines faster and bigger-capacity service, which significantly.

After the first oil crisis, growth in domestic passenger traffic began to taper off. Throughout the 1970s, however, the rising national standard of living and more free time to enjoy it helped to increase domestic passenger travel by motor vehicles, especially by private cars. Air transport saw the introduction of jumbo jets and relatively cheaper airfares as well as a growing preference for faster means of transportation; thus the volume of traffic and its share of total traffic expanded. During that decade, rail saw its share shrink. As a result, by the end of the 1970s, rail transport's share was only about one-half what it had been 20 years earlier.

The rate of passenger traffic growth was lower during the early 1980s, but it suddenly increased in the latter 1980s along with the economic expansion accompanying the bubble economy. Together with greater automobile use, railway passenger traffic was also up significantly. The long decline in the modal share of railways began to level off from 1990. Since 1990, however, passenger traffic volumes and the relative shares of all transportation modes have remained essentially flat.

Please see Figure 1.11 at the end of the chapter 1.

1.6.2. Freight Transport

Domestic freight traffic followed the GNP's upward path during the rapid economic growth phase. Freight transport by road showed especially rapid growth, because of higher demand of metals, machinery, manufacturing, and other industries for relatively small shipment lots with high-value products, and the ability to bear higher freight rates. Trucking also benefited because it met the demand for shorter-distance transport arising from the changing location of industry, particularly the demand from industrial complexes sited along coastal areas nearby major cities. With the shift from coal to oil as an energy source and the development of heavy industry along coastal areas, freight traffic in coastal shipping grew due to the increase of industrial cargo, principally raw materials for the petrochemical, steel, cement, and other key heavy industries. In contrast, the growth of freight traffic in railway cargo volume barely increased at all.

Under the impact of the first oil crisis, domestic freight traffic decreased sharply in 1974 and 1975. Freight traffic then gradually increased through 1979, primarily led by higher demand for civil engineering and construction-related cargo from active public works expenditures implemented as economic stimulus measures. When the second oil crisis struck, however, domestic demand and shipments by materials industries again stagnated and freight traffic shrank as oil consumption decreased with the conversion to other forms of energy.

From the 1980s, industrial restructuring, including the shift within secondary industry from basic materials to processing and assembly, the growth of knowledge-intensive industries, and the transformation of the industrial structure toward tertiary industry, which were triggered by the oil crises, and the shift to a services-oriented economy and a weakening of industrial activity's transport-demand-inducing effect led to slow or no

growth at all in freight traffic, while GNP rose, now unharnessed from freight traffic. In the latter 1980s, however, freight traffic showed signs of increasing under the effect of the major, domestic-demand-led economic expansion. The characteristics of truck transport met the need for small-lot, high-frequency shipments brought on by greater product differentiation from changes in consumer demand and by the advance of the small-volume production of a wide diversity of products. At the same time, the services offered by package delivery companies were upgraded. As a result, the modal share of road freight traffic surpassed 50 percent in 1987. As a consequence of smokestack industries' decline, growth in coastal shipping has remained rather slack, but with the economic expansion in the latter 1980s, it has shown some growth; in 1990, coastal shippers exceeded their second-oil-crisis freight traffic level. Thanks to the growing preference for speedy transport, caused by the increased value of time, and the relative decline in the value of freight tariffs due to rising income levels, air freight is now used to ship machine parts, fresh foods, books, and other relatively small, light items, its volume is growing, although its share of the total is small. Rail has seen its share steadily decline, but this decline has been limited by the advance of containerized transport and the growth of container and intermodal "piggy-back" container shipments.

Total freight traffic has decreased since the peak in 1991 due to the recession following the collapse of the bubble economy. Road freight traffic of commercial trucks has remained flat, and that of private trucks has declined. Freight traffic in coastal shipping declined slightly from 1992 but began to rebound from 1994.

Please see Figure 1.12 at the end of the chapter 1.

1.6.3. Motor Vehicle Ownership

Road transport accounts for a large share of both passenger and freight traffic. Total motor vehicle ownership has increased consistently ever since the 1960s. Even though passenger traffic and freight traffic have been flat since 1990, the number of motor vehicles has continued to increase.

By category, the number of passenger cars and mini-sized cars has increased continuously. In contrast, the number of trucks (which account for a major share of freight transport) has remained flat since the 1980s.

Please see Figure 1.13 at the end of the chapter 1.

1.7. Energy

1.7.1. Consumption

End-user energy consumption continued to increase significantly with the Japanese economy's rapid growth during the 1960s and until the first oil crisis in 1973 (phase I), after which it leveled off and eventually decreased (phase II). From 1986 on (phase III), however, the economic pickup primed new growth in energy consumption, to the equivalent of 376 million kiloliters of oil ($347,798 \times 10^{10}$ kcal, gross calorific value, as below) in fiscal 1994.

These trends can be summarized for different sectors as follows: until the first oil crisis in 1973 (phase I), industrial, residential and commercial, and transport sector energy consumption grew rapidly. From fiscal 1973 until 1986 (phase II), residential and commercial and transport sector energy consumption continued to grow, but industrial energy consumption began to decrease. After 1986 (phase III), the strong economy boosted energy consumption in all three sectors – industrial, residential and commercial, and transport – and the growth was especially great in energy consumption by the residential and commercial and transport sectors.

In fiscal 1994, the industrial sector's share of total energy consumption (including the use of oil, etc., for other than energy purposes) was 50 percent; the residential and com-

1.7. Energy

mercial sector's was 25.8 percent; and transport's was 24.2 percent.

Energy consumption trends differ according to the form of energy in question. Electricity and gas consumption have been growing uninterruptedly: in 1994, they were respectively 2 times and 2.5 times their fiscal 1973 level. Coal consumption has been increasing, albeit very gradually. Oil consumption grew rapidly during phase I, leveled off during phase II, and has begun to grow again since Japan entered phase III.

Recent growth in demand has been higher for electricity than for other forms of energy consumed by end-users; as a result, the proportion of energy consumed to make electricity rose from 27 percent of the total primary energy supply in fiscal 1973 to 39 percent in fiscal 1994.

Please see Figure 1.14 at the end of the chapter 1.

1.7.2. Supplies

Japan has almost no indigenous energy resources: its dependence on foreign sources peaked in fiscal 1973 at 89.4 percent of its energy supply; since then, this dependence has been reduced by efforts to find substitutes for oil; in recent years, foreign dependence has remained slightly above 80 percent. Japan is dependent on foreign sources for more than 99 percent of its oil, however, leaving the nation in an extremely vulnerable energy supply situation.

Japan's total primary energy supplies reflect end-user energy consumption increases; supplies continued to grow at a substantial rate until fiscal 1973 but leveled off after the first oil crisis, then began to shrink until 1986, when there was again a surge of growth; in fiscal 1994, Japan's total primary energy supply was the equivalent of 577 million kiloliters ($533,979 \times 10^{10}$ kcal) of oil.

Oil supplies grew continually during phase I, shrank during phase II, and again grew steadily during phase III. Coal supplies are increasing very gradually. Supplies of natural gas and nuclear energy are growing at a substantial rate.

Different energy sources contribute different shares of the total primary energy supply: during phase I, oil increased its share while coal and hydroelectric power decreased theirs. As a result, oil's share of total primary energy (the "oil dependency" rate) rose to a peak of 77 percent in fiscal 1973. Oil's share then began to decrease during phase II, and it bottomed out during phase III. As of fiscal 1994, it was 57 percent. Coal gradually increased its share following the second oil crisis in 1979 but has remained basically level; in fiscal 1994, its contribution was about 16 percent. The introduction of alternatives to oil beginning in fiscal 1973 swiftly increased the shares of natural gas and nuclear power, to approximately 11 percent each in fiscal 1994.

Please see Figure 1.15 at the end of the chapter 1.

1.7.3. Per Capita Total Primary Energy Supply and Total Primary Energy Supply per Unit of GDP

Japan's annual per capita energy consumption is the equivalent of 4,620 liters of oil (about 42.7 million kcal).

Japan's total primary energy supply per unit of GNP, a measure of how efficiently energy is used to produce goods and services, increased (worsened) during phase I but has improved since phase II. Though it has tended to improve during phase III also, more recently it has leveled off and then began to rise from 1991. This is due both to the significant contribution by industry's massive energy-saving investments to the reduction already achieved in energy input per unit of output and to the increase in residential and commercial and transport energy consumption due to greater national affluence and a higher standard of living.

Please see Figure 1.16 at the end of the chapter 1.

1.7.4. Prices

Imported energy was cheap and supplies were plentiful during phase I; prices skyrocketed as a result of the two oil crises, peaked in fiscal 1981 then began to fall, and have been steady since fiscal 1986. If imported energy prices are denominated in yen and calculated on a real basis using the GDP deflator, the fiscal 1990 yen-denominated price of crude oil (partially due to the substantial appreciation of the yen) is only slightly higher than it was prior to the oil crises.

Crude oil prices did shoot up temporarily when the Gulf crisis broke out in 1990 but then returned to the levels prevailing prior to the Gulf War. In 1996, however, the price of crude oil went over \$20 per barrel because of the strong growth of worldwide oil demand, the low inventory system for crude oil and oil products adopted by Western petroleum companies in an effort to reduce costs, and the unstable political situation in the Persian Gulf region.

1.7.5. National Energy Budget and Taxation System

Today, Japan finds it necessary to reform its energy supply-demand structure via measures addressing both energy supply and energy demand in order to increase national energy security and positively address global environmental problems.

On the demand side, the government is striving to promote thoroughly efficient energy usage, beginning with energy conservation measures. In terms of supply, efforts are being made to promote the introduction of oil substitutes and to strengthen measures to secure a stable supply of crude oil. In order to further advance these policies, the funds for energy-related measures in the national budget are secured via special accounts. For example, the fiscal 1996 budget allocates 108.1 billion yen (an increase of 7.7 percent over the previous year) for the following measures to upgrade the nation's energy supply-demand structure: technological development for oil substitutes and energy conservation; promoting the formation of environmentally sound energy communities; international energy conservation measures; conversion to facilities for oil substitutes and energy conservation; the spread of solar-energy systems; and promoting facilities for the prospecting and development of overseas coal sources. The fiscal 1996 budget also allocates 244.2 billion yen for the diversification of electric power sources (up 6 percent over the previous year). The growth rates for both of these budget categories were higher than that for the overall budget, which was 5.8 percent.

Table 1.2 Special Account for Coal, Oil, and Measures to Upgrade
the Energy Supply-Demand Structure

(Unit: billion yen)

[Please shift all absolute figures one decimal point to the left (i.e., 109.8, 110.9, and 1.1), but please leave the percentage figures as they are.]

Account Name	Fiscal 1995 Budget	Fiscal 1996 Budget	Year-on-Year Growth	
Coal Account	109.8	110.9	+11	+1.0%
Account for Oil Measures and Measures to Upgrade the Energy Supply-Demand Structure	591.4	613.2	+218	+3.7%
Oil Measures	491.0	505.1	+140	+2.9%
Measures to Upgrade the Energy Supply-Demand Structure	100.4	108.1	+77	+7.7%
Total	701.2	724.1	+229	+3.3%

1.8. Information and Telecommunications

Table 1.3 Special Account for Measures to Promote the Development of Electric Power Sources

(Unit: billion yen)

[Please shift all absolute figures one decimal point to the left (i.e., 222.3, 223.4, and 1.1), but please leave the percentage figures as they are.]

Account Name	Fiscal 1995 Budget	Fiscal 1996 Budget	Year-on-Year Growth	
Electric Power Source Siting Account	222.3	223.4	+11	+0.5%
Electric Power Source Diversification Account	230.3	244.2	+139	+6.0%
Total	452.6	467.6	+150	+3.3%

Japan has a system of energy-related taxes which serve as the primary financial sources for national energy budgets. These include the petroleum tax, oil tariffs (which are applied to crude oil and oil products imports), and the electric power source development promotion tax. As of March 1997, the petroleum tax is 2,040 yen/kl, the customs tariff on crude oil 315 yen/kl, and the electric power source development promotion tax 0.445 yen/kWh. Revenues from the petroleum tax are allocated for oil measures and measures to upgrade the energy supply-demand structure; revenues from the customs tariff on crude oil are allocated for measures related to the coal industry; and revenues from the electric power source development promotion tax are allocated for electric power source siting and electric power source diversification.

In fiscal 1992, Japan also introduced a tax system to promote investment aimed at reforming the energy supply-demand structure. This system provides tax incentives to promote the introduction of energy conservation equipment and facilities that utilize oil substitutes.

1.8. Information and Telecommunications

Japan will have to upgrade its nationwide network infrastructure to realize an advanced information and telecommunications society. Fiber optic networks are perceived as the most promising option because of their high speed and large capacity. As of the end of March 1996, the fiber optic ratio (cable length) was 60.3 percent for the domestic trunk system and 6.4 percent for the subscriber system. The Telecommunications Council of the Ministry of Posts and Telecommunications has set 2010 as the target year for the completion of a national fiber optic network.

The number of Japanese utilizing the Internet has been increasing. Corporations and government offices have begun using the Internet as a means of providing information in addition to the conventional printing of pamphlets, etc. Also, with the advent of E-mail and other developments the provision and exchange of information among individuals and corporations is shifting from paper-based to electronic-based modes of communication.

New modes of working from remote distances that utilize information and telecommunications technologies (such as telecommuting) are beginning to be adopted. The number of "teleworkers" in Japan is estimated to have reached approximately 950,000 in 1995. According to analyses by the Institute for Posts and Telecommunications Policy of the Ministry of Posts and Telecommunications, in the year 2010, 13.4 million Japanese, or approximately 20 percent of the work force, will be telecommuters, assuming that the expansion of the information/telecommunications infrastructure proceeds smoothly.

1.9. Government Administration and Finances

1.9.1. Government Administration

Under the Japanese Constitution enacted 1947, sovereign power resides with the people while the judicial, legislative, and executive powers of government are vested, respectively, in the mutually independent Supreme Court, Diet, and Cabinet. The Constitution establishes a parliamentary cabinet linking the Cabinet to the Diet; the Diet designates the Prime Minister; the Prime Minister and a majority of the Ministers of state must be Diet members; and the Cabinet is collectively responsible to the Diet.

Organs of national administration under Cabinet jurisdiction are established – the Prime

Minister's Office and (currently) twelve ministries: Justice; Foreign Affairs; Finance; Education, Culture, and Science; Agriculture, Forestry, and Fisheries; International Trade and Industry; Transport; Posts and Telecommunications; Health and Welfare; Labor; Construction; and Home Affairs. As the chief ministers of state, the Prime Minister and the individual ministers divide the responsibility for national administrative duties. Duties that are conspicuously too great to be dealt with by internal ministry bureaus but not sufficient for the establishment of separate ministries are handled by commissions and agencies, which are established by the Prime Minister's Office and the individual ministries as external bureaus. Those similar in nature to a ministry are placed under the direction of ministers of state; these Cabinet members include the director generals of the Management and Coordination Agency, Defense Agency, Economic Planning Agency, Science and Technology Agency, Environment Agency, and National Land Agency.

Councils are among the representative organs established under law with the object of ensuring that specialists' knowledge and people's views are reflected in administrative actions. The main duty of councils and other advisory bodies is to investigate and deliberate on the jurisdiction and stipulations of laws and inform administrative organs of their views. As of July 1994, there were 217 councils and similar organs in existence.

Global environmental problems, including global warming, are addressed by closely coordinating policies among the administrative organs most concerned. To ensure effective overall coordination, the Cabinet convenes the Council of Ministers for Global Environment Conservation. Non-Cabinet members of the Diet may be asked, if necessary, to attend these meetings, which are intended to be a forum for the free exchange of opinions and information. Experts may also be asked to attend these meetings to present their views regarding global environmental protection. This Council makes decisions on the Japanese government's Action Program to Arrest Global Warming, which is Japan's national program on global warming; under this program, annual reports are submitted to meetings regarding the status of implementation of environmental policies; on the basis of those reports, the Council examines ways to further promote the action program.

As of March 31, 1995, local public entities included 47 prefectures and 3,232 municipalities (cities, towns, and villages); local assemblies serve as their legislatures; their executive branches are headed by a governor in the case of prefectures and by a mayor in the case of municipalities. The size of the prefectures and municipalities varies.

Because measures to address global warming are intimately related with all socioeconomic activities, in addition to the policies of national government organs, the policies and measures implemented by regional and local governments (and efforts to induce appropriate behavior on the part of local communities and individual citizens in their daily lives) are also extremely important. Considering the key roles played by regional and local governments in global warming countermeasures, ever since fiscal 1994 the Japanese government has been encouraging the drafting of regional plans for measures to address global warming.

Japan's regional and local governments have been actively tackling the global warming issue. In October 1995, the International Council for Local Environmental Initiatives (ICLEI) held the Third Local Government Leaders' Summit on Climate Change in Saitama Prefecture. This conference was chaired by Saitama Prefecture, and many local Japanese government bodies attended. The conference participants adopted the Local Government Leaders' Declaration on Climate Change (the Saitama Declaration), which encourages the leadership of local government bodies in addressing global warming. In January 1996, an environmental summit of Japan's "ordinance-designated" (major) cities was held in Kita Kyushu City, Fukuoka Prefecture. At this meeting, reports were presented about forming linkages among local government organs, businesses, citizens, and non-governmental organizations (NGOs), and discussions were held regarding inter-city cooperation. In this manner, Japan's regional and local governments are steadily increasing their efforts to address global warming.

1.9. Government Administration and Finances

1.9.2. Finances

Japan's national finances are administered as follows: every fiscal year (April 1 to March 31) the government prepares a budget which must be approved by the Diet before it is implemented by the executive branch. The national budget consists of three parts: the general account, special accounts, and government-related operating accounts. In addition, fiscal investment and loans are made as determined by fund investment plans established in the course of budget preparation.

The general account is the record of the national government's ordinary revenues and outlays. Sources of funds are taxes and, when necessary, borrowing by the national government. This account covers the most basic national expenses, such as social welfare, education, and defense. In fiscal 1996, ordinary expenditures totaled 43.1409 trillion yen, up 2.4 percent over the initial budget for the previous year. The general account totaled 75.1049 trillion yen, an increase of 5.8 percent. Special accounts are specially established under the Finance Law independently of the general account in cases where the national government runs certain enterprises, invests certain funds, or allots certain revenues to certain expenditures. There are 38 such special accounts, including the Special Account for Government Enterprises, the Special Account for Food Controls, and the Special Account for Insurance. Government-related operations are wholly state-owned financial institutions established via special legislation; People's Finance Corporation, Japan Finance Corporation for Small Business, and the Japan Development Bank are among the nine finance corporations and two banks set up in this way. They are special corporations with independent juridical status granted by the national government in order to facilitate flexible budgeting and increase the efficiency of their corporate management. Fiscal investment and loans use postal savings, employees' pension insurance premiums, and other public funds gathered through the national government's credit and savings institutions as the basis for making investments in and loans to the national government's special accounts, finance corporations, public corporations, and other corporations and agencies as well as loans to local public bodies.

The global environmental protection-related component, either having global environmental protection as a direct goal or contributing especially significantly to global environmental protection, was allocated 568.8 billion yen in fiscal 1996 (compared to 566 billion yen in the initial budget for the previous year see Table 1.5); the global warming countermeasures program accounted for 460.5 billion yen of this total (compared to 462.9 billion yen in the previous year). Thus, the fiscal 1996 budget allocations for global warming countermeasures account for 1.1 percent of total ordinary expenditures.

Table 1.4 Fiscal 1996 Budget General Expenditures – Main Items

(Unit: billion yen)

[Please shift all absolute figures one decimal point to the left (i.e., 14,287.9 and 363.5), but please leave the percentage figures as they are.]

	Fiscal 1996		
		Increase from Fiscal 1995	Growth Rate (%)
Social security expenses	14,287.9	363.5	2.6
Education and science expenses	6,227.0	150.5	2.5
Pensions and other expenses	1,659.0	▲ 67.5	▲ 3.9
National defense expenses	4,845.5	121.9	2.58
Public works expenses	8,489.9	377.6	4.7
(Including transfers to the Industrial Investment Special Account)	9,719.9	377.6	4.0
Economic cooperation expenses	1,071.5	36.4	3.5
(Official Development Assistance)	1,145.2	39.0	3.5
Measures for small business expenses	185.5	▲ 0.2	▲ 0.1
Energy measures expenses	692.3	10.4	1.5
Foodstuff control expenses	270.5	▲ 1.8	▲ 0.7
Other items expenses	5,061.8	8.4	0.2
Contingencies	350.0	0.0	0.0
Total ordinary expenses	43,140.9	999.2	2.4
Transfers to industrial investment special account, etc.	1,300.0	▲ 1,108.7	▲ 46.0

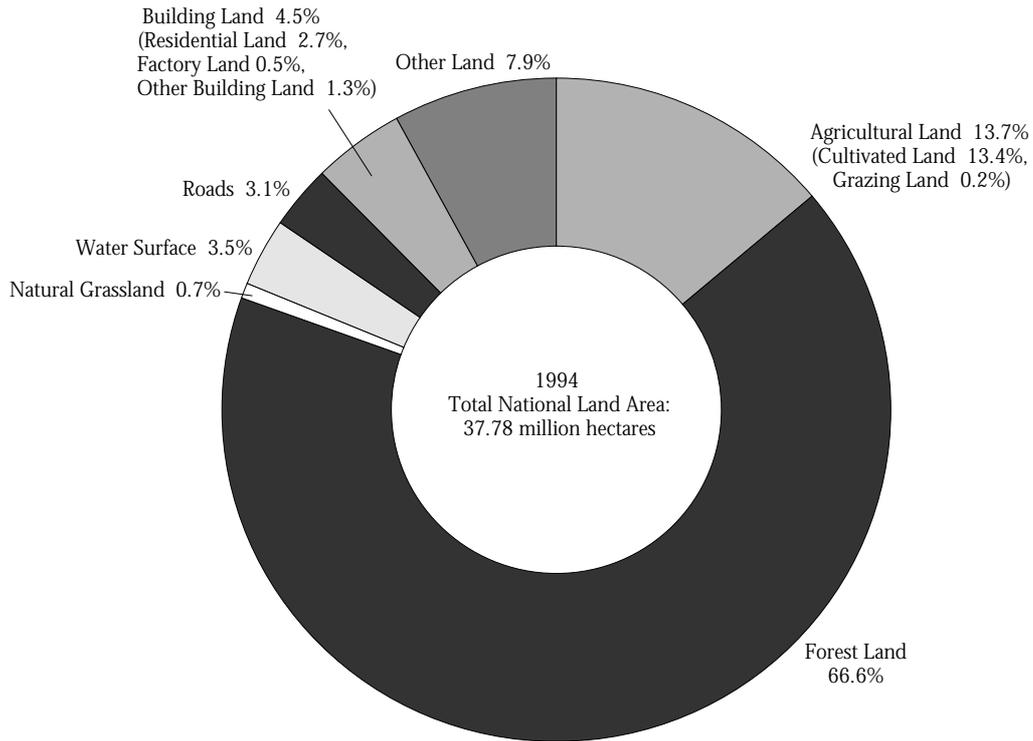
Note: In accordance with the Law for Special Measures for Infrastructure Enhancement, among those public construction works that were implemented using loans up until fiscal 1991, the 1,300 billion yen fiscal 1996 figure for "transfers to the Industrial Investment Special Account" includes 1,128.5 billion yen in works implemented for the time being using financial resources other than the sales of applicable government stock holdings.

Table 1.5 Fiscal 1996 Budget for Global Environment Conservation Projects

(Unit: billion yen)

	Fiscal 1996		
		Increase from Fiscal 1995	Growth Rate (%)
Global warming	4,605	▲ 24	▲ 1
Ozone layer depletion	24	2	12
Acid deposition	66	▲ 8	▲ 11
Marine pollution	28	▲ 1	▲ 4
Transboundary movement of toxic waste	3	2	389
Tropical deforestation	20	2	14
Decline in number of species	16	2	16
Desertification	11	2	15
Environmental pollution in developing countries	36	0	0
Unable to classify	879	50	6
Total	5,688	28	0.5

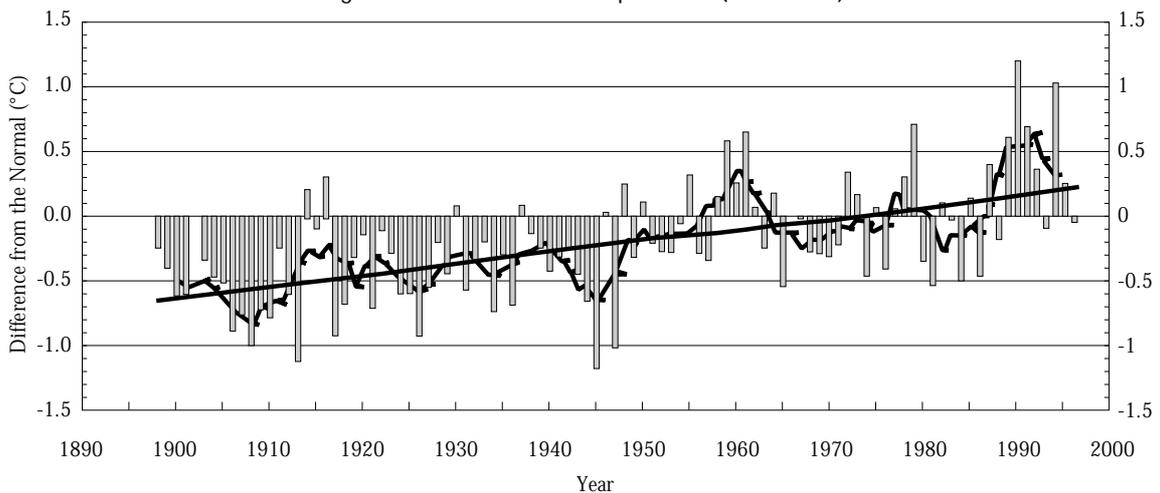
Figure 1.1 Land Use in Japan



- Notes: 1. Roads include farm and forest roads.
2. Data are estimates based on readily available statistics from different sources compiled by the National Land Agency.

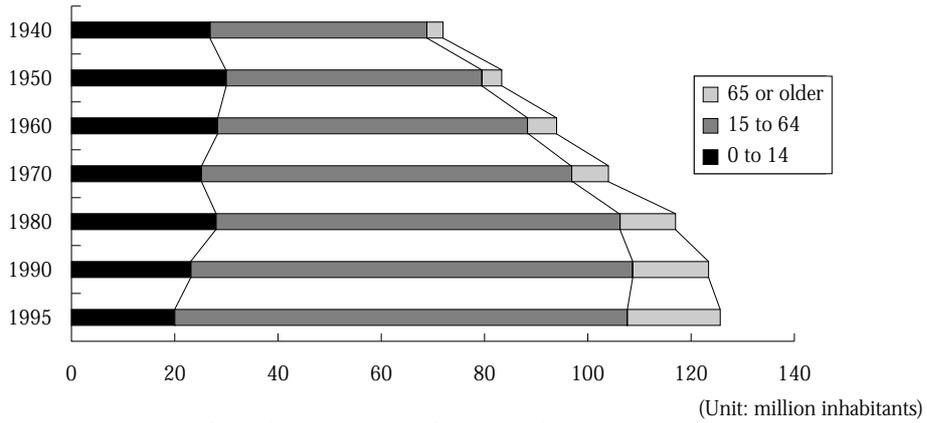
Source: National Land Agency

Figure 1.2 Annual Mean Temperatures (1896-1996)



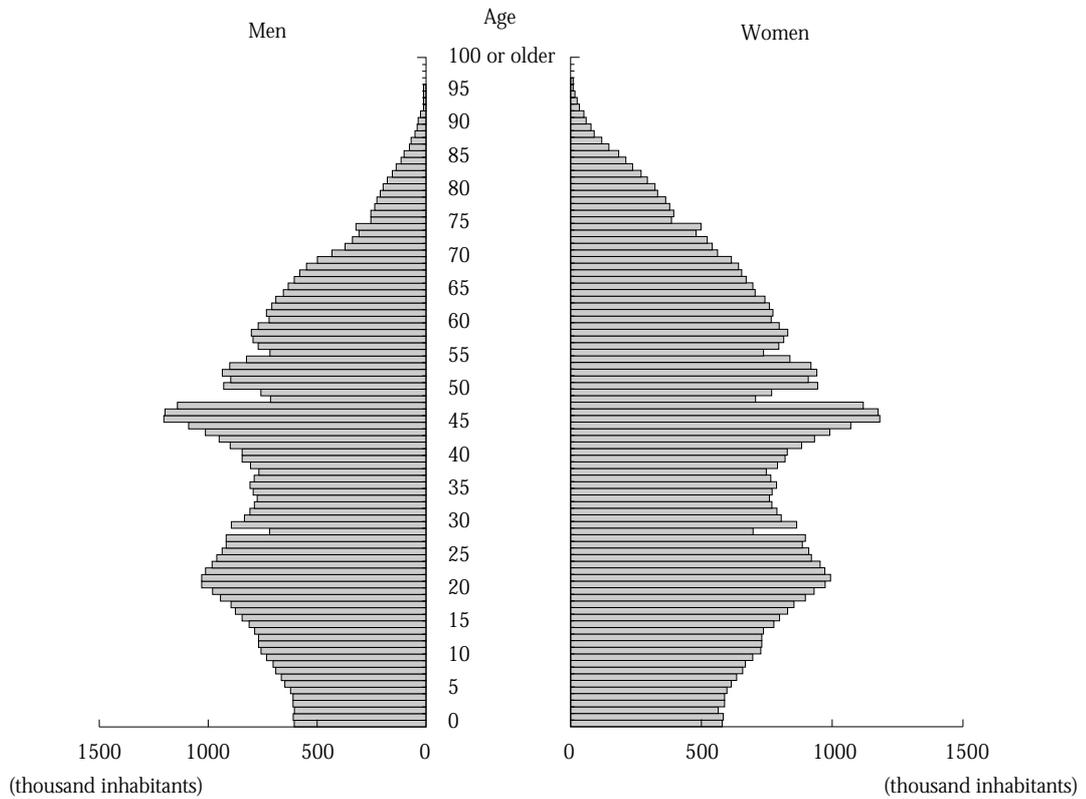
Note: The ordinate shows the annual mean temperature anomalies relative to the normal (1960-1990) averaged at the 15 stations presented in Table 1.1. The abscissa shows calendar years. Bars are the anomalies for each year. The solid line indicates five-year running mean. The dashed line shows the long-term trend.

Figure 1.3 Age Distribution of the Japanese Population from 1940 to 1995



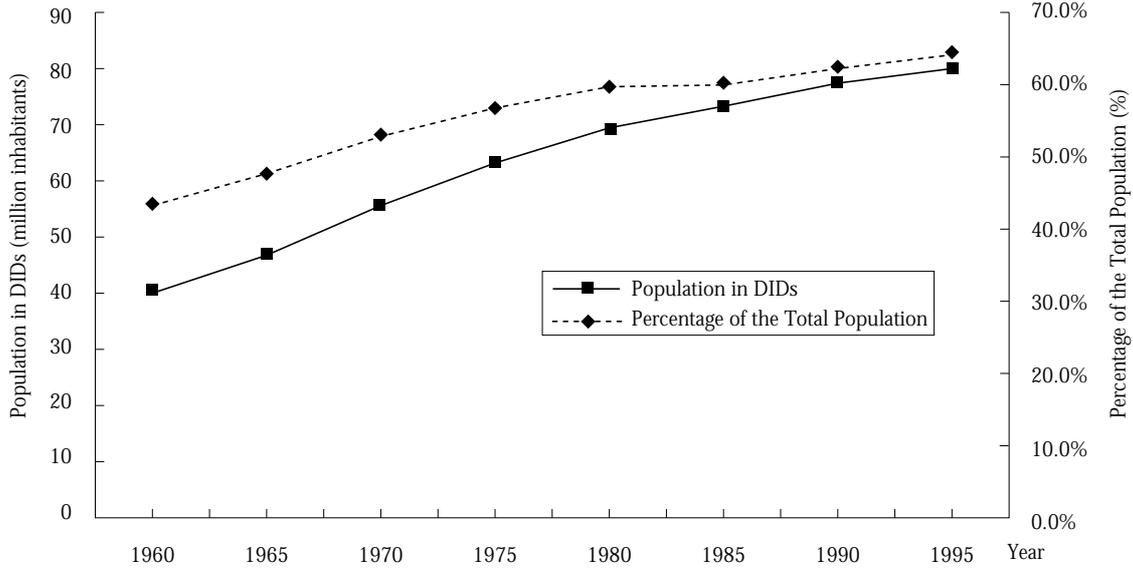
Source: Management and Coordination Agency, "The Census of Japan."

Figure 1.4 Japanese Population Pyramid in 1995



Source: Management and Coordination Agency, "The Census of Japan."

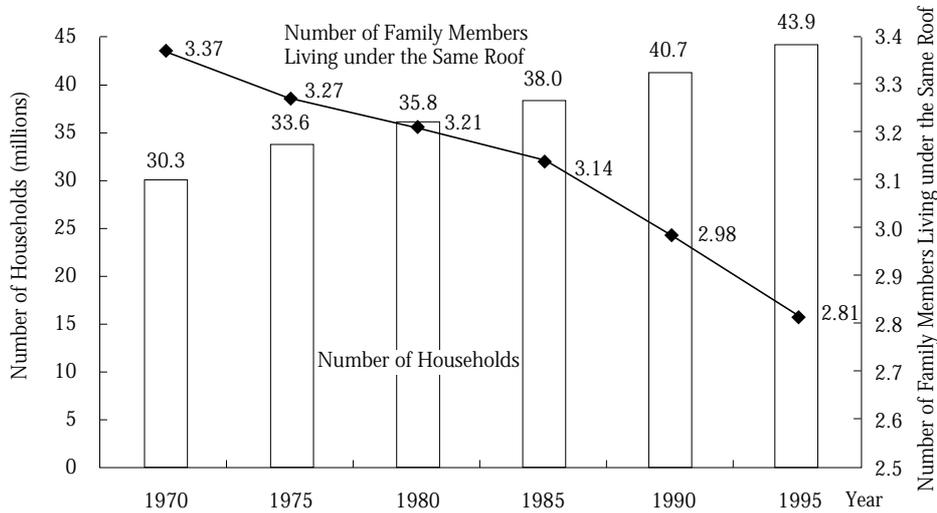
Figure 1.5 Population Residing in Densely Inhabited Districts (DIDs)



- Notes:
- Densely Inhabited Districts (DIDs) are defined based on the following three criteria.
 - The standard units (districts) are the same as those used for the national census.
 - At least one adjacent standard unit located within the same municipality has with a high population density (in principle, a population density of at least 4,000 inhabitants per square kilometer).
 - The district population is at least 5,000.
 - No DIDs were designated for Okinawa Prefecture in 1960 and 1965, so the prefectural population is not included in the calculation of the "percentage of the total population" figures for those years.

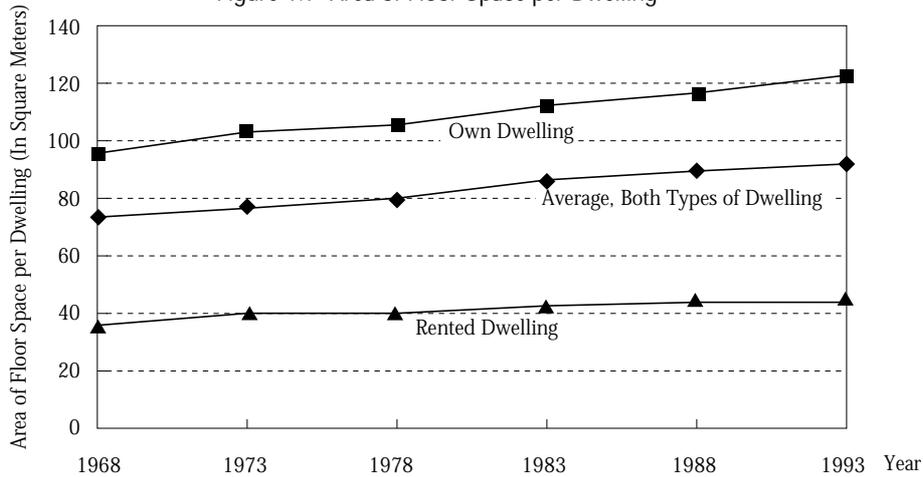
Source: Management and Coordination Agency, "The Census of Japan."

Figure 1.6 Number and Average Size of Japanese Households



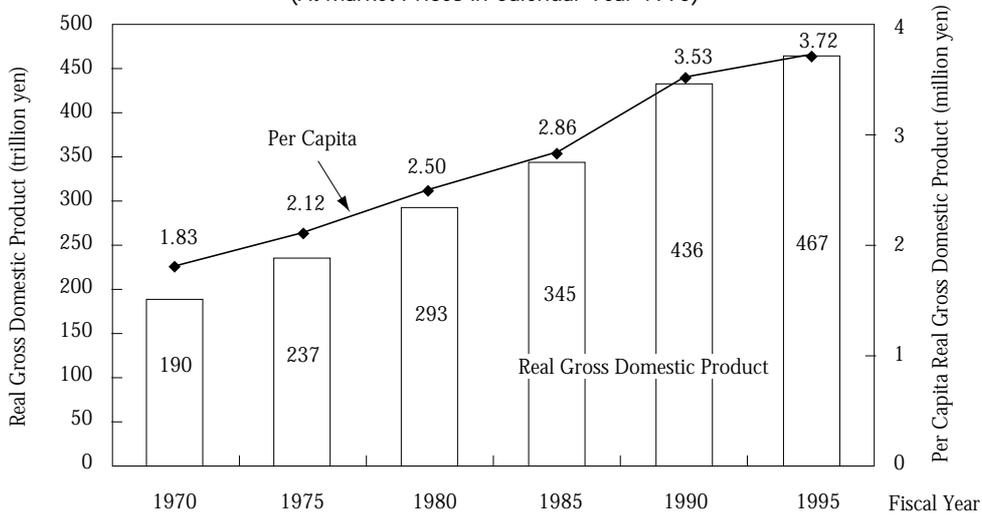
Source: Management and Coordination Agency, "The Census of Japan."

Figure 1.7 Area of Floor Space per Dwelling



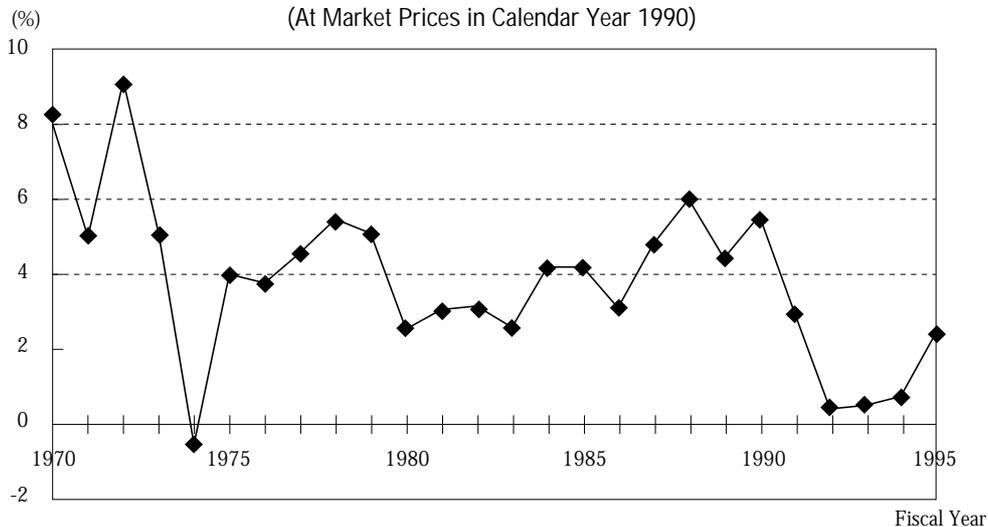
Source: Management and Coordination Agency, "1993 Housing Statistics Survey."

Figure 1.8 Gross Domestic Product from Fiscal 1970 to Fiscal 1995
(At Market Prices in Calendar Year 1990)



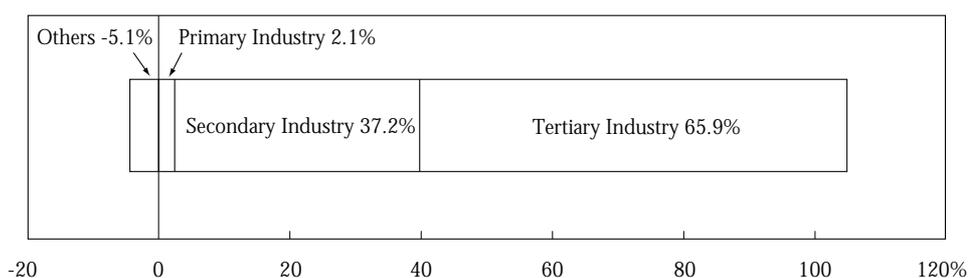
Source: Economic Planning Agency, "Report on National Accounts."

Figure 1.9 Gross Domestic Product (Percent Changes from Previous Fiscal Year)
(At Market Prices in Calendar Year 1990)



Source: Economic Planning Agency, "Report on National Accounts."

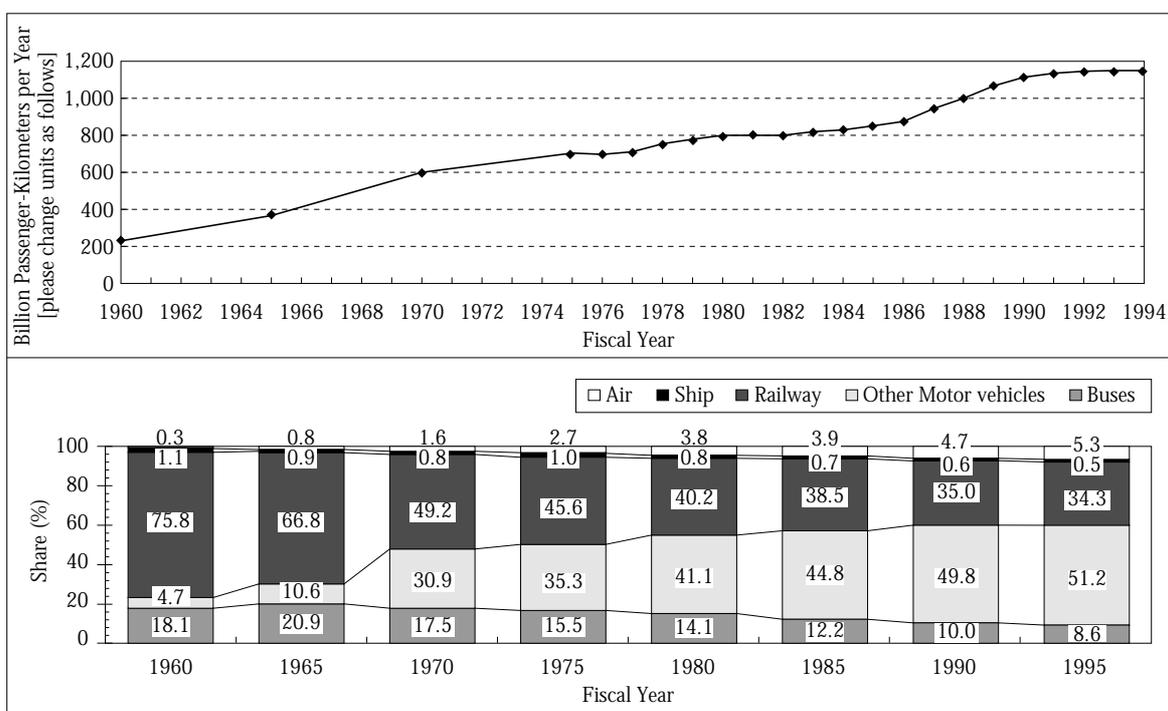
Figure 1.10 Sectorial Composition of Gross Domestic Product by Kind of Economic Activity in 1995
(At Market Prices in Calendar Year 1990)



Note: The -5.1% figure includes import duty of 0.9%, economic discrepancies of 0.7%, (less) miscellaneous of 0.4%, (less) imputed bank service charges of 4.8%.

Source: Economic Planning Agency, "Report on National Accounts."

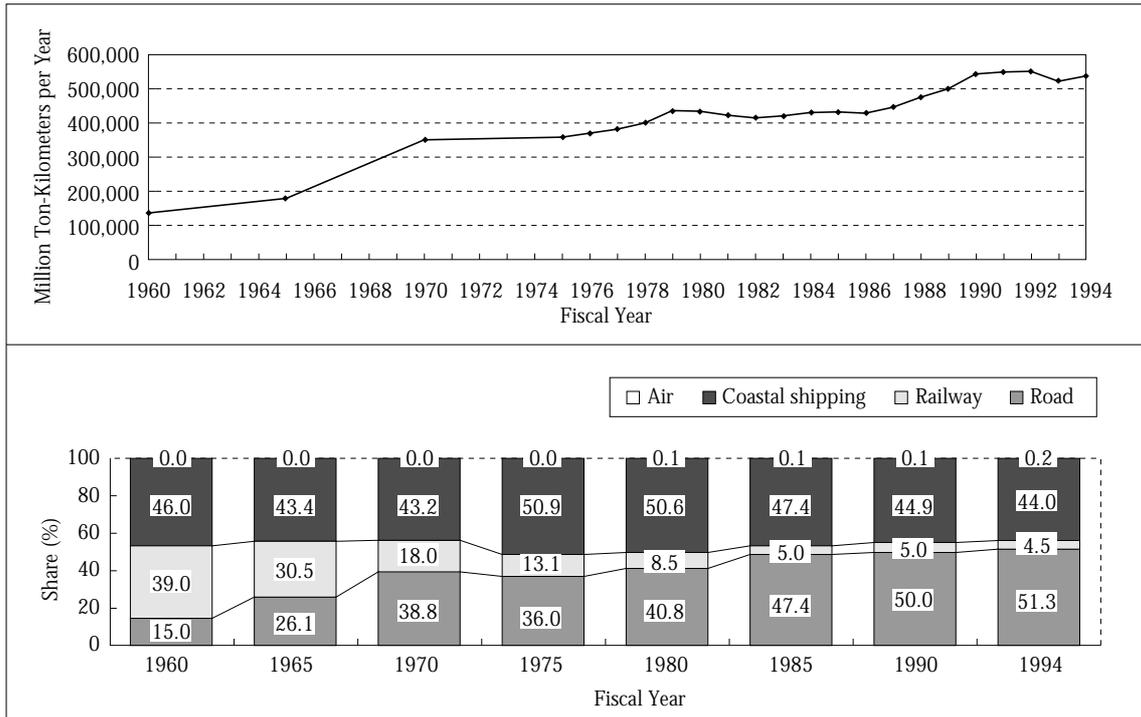
Figure 1.11 Volume of Domestic Passenger Traffic (above)
and Modal Shares (below) (in Passenger-Kilometers)



Notes: 1. "Other Motor vehicles" does not include mini-sized and utility cars.
2. Because of the Hanshin-Awaji Earthquake, the fiscal year 1994 motor vehicle figures do not include data from Hyogo Prefecture in January-March 1995.

Source: Ministry of Transportation, "Statistical Handbook of Land Transport."

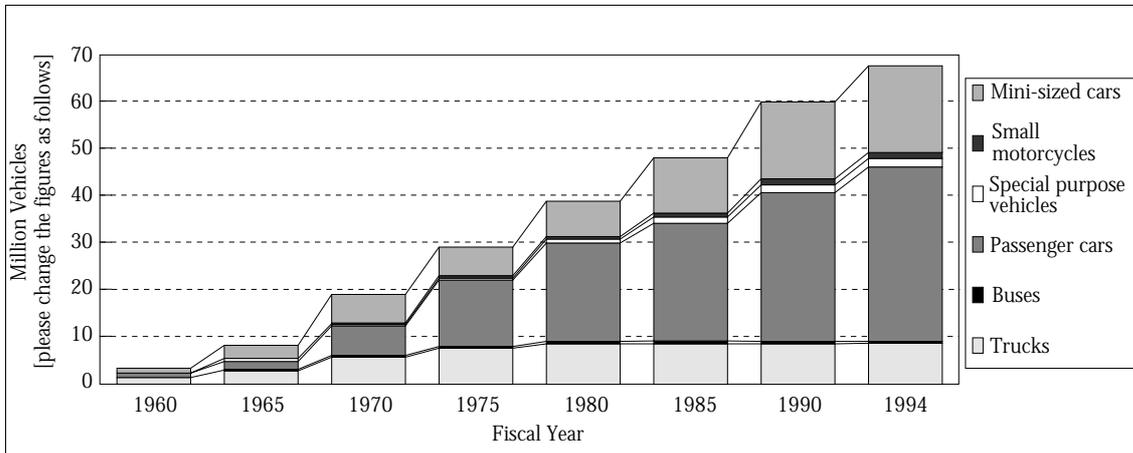
Figure 1.12 Domestic Freight Traffic (above) and Modal Shares (below) (in Ton-Kilometers)



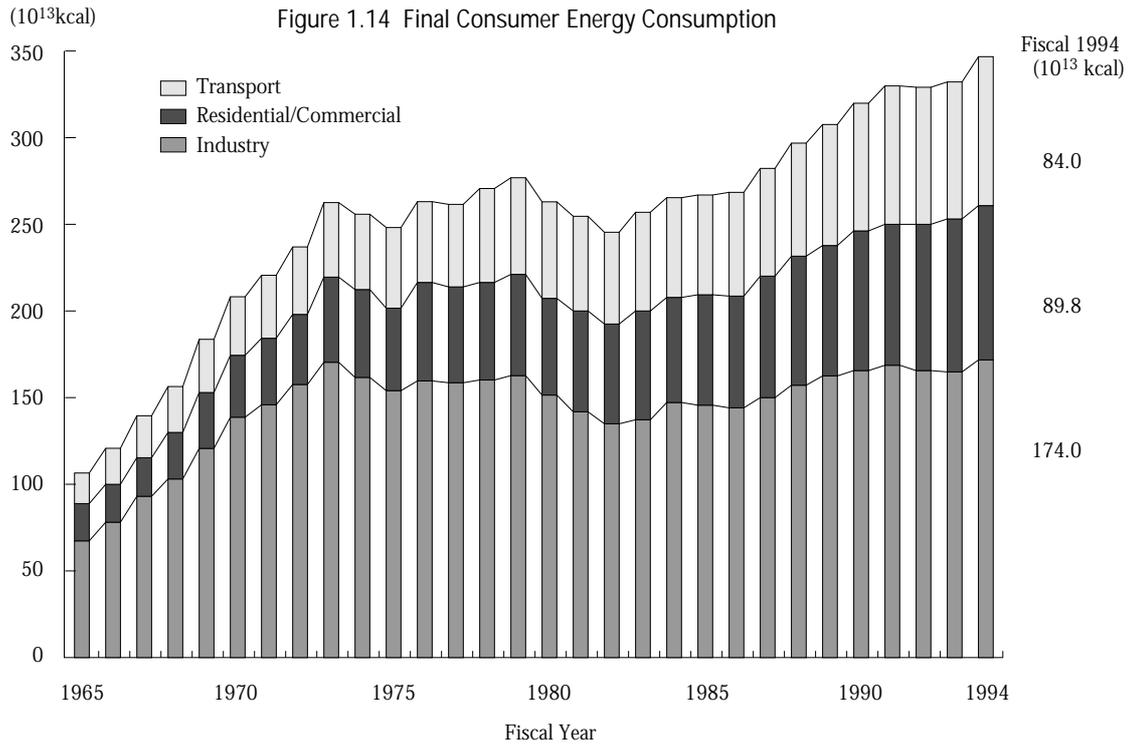
Notes: 1. "Motor vehicles" from fiscal 1987 forward does not include mini-sized cars and utility cars.
 2. Because of the Hanshin-Awaji Earthquake, the fiscal year 1994 road share does not include data from Hyogo Prefecture in January-March 1995.

Source: Ministry of Transport, "Statistical Handbook of Land Transport."

Figure 1.13 Motor Vehicle Ownership

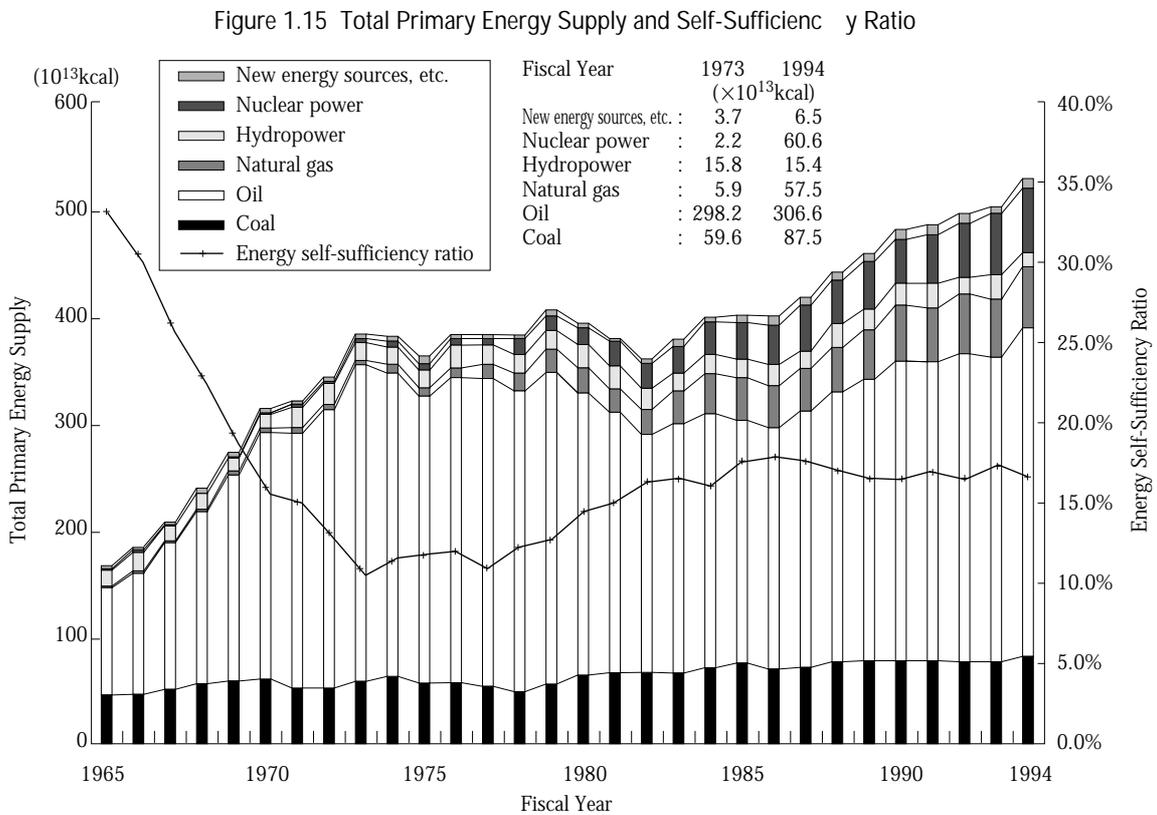


Source: Ministry of Transport, "Statistical Handbook of Land Transport."



Note: Industrial sector figures include non-energy applications.

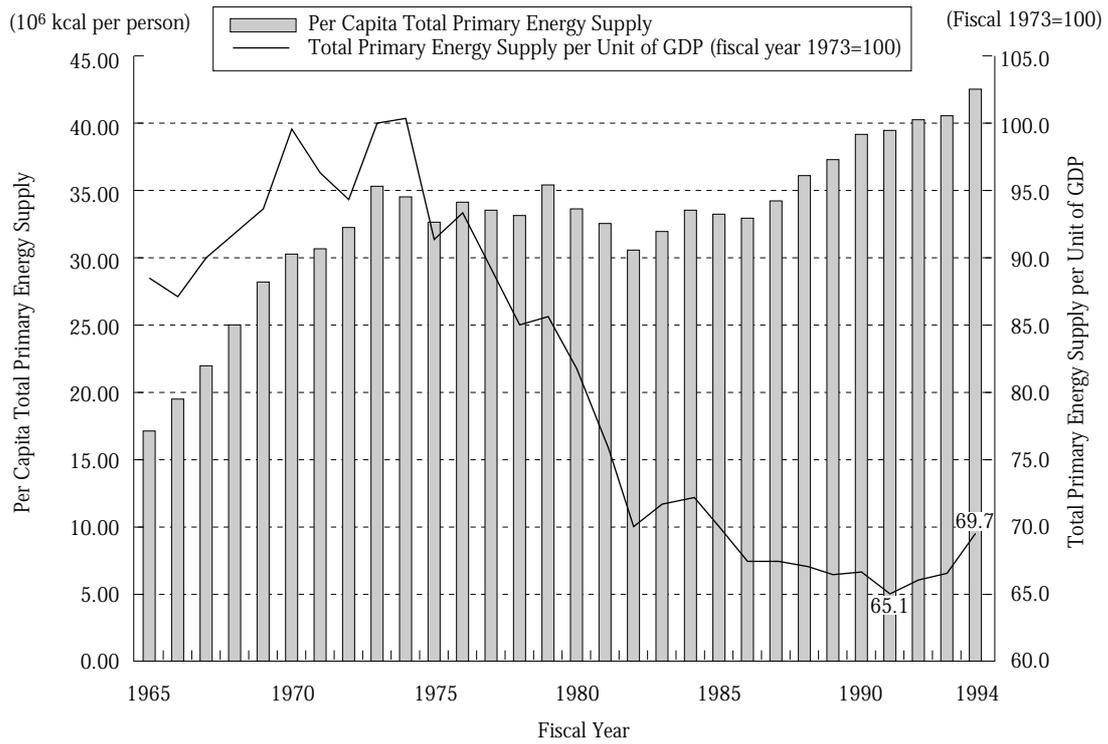
Source: Agency of National Resources and Energy, "Comprehensive Energy Statistics."



Note: "New energy sources, etc." includes geothermal energy.

Source: Agency of Natural Resources and Energy, "Comprehensive Energy Statistics."

Figure 1.16 Per Capita Total Primary Energy Supply and Total Primary Energy Supply per Unit of GDP



Source: Agency of Natural Resources and Energy, "Comprehensive Energy Statistics"; Economic Planning Agency, "Report on National Accounts"; Management and Coordination Agency, "The Census of Japan" and "Estimated Population."

Chapter 2

National Inventory of Greenhouse Gas Emissions and Removals

2.1. Outline

On the basis of Article 4. 1(a) of the United Nations Framework Convention on Climate Change, all Parties to the Convention are required to submit national inventories of greenhouse gas emissions and removals to the Secretariat of the Convention. This chapter summarizes Japan's national inventories of emissions and removals of greenhouse gases and precursors from 1990 through 1994 (and through 1995 for CO₂, HFCs, PFCs, and SF₆).

The calculation methods and the reporting format of the inventories are in accordance with the Guidelines for National Greenhouse Gas Inventories, prepared by the IPCC/OECD (hereafter, "IPCC/OECD Guidelines")^{1) 2)}.

In general, this inventory was calculated and reported in accordance with the revised IPCC/OECD Guidelines of 1996. However, some portions were calculated using methods that differ from the default methods indicated in the IPCC/OECD Guidelines in order to ensure that the results would reflect actual conditions in Japan. These differences are explained in the relevant sections of this chapter.

In keeping with the Guidelines for the Preparation of the Second National Communications by ANNEX I Parties, as well as the Subsidiary Body for Scientific and Technological Advice (SBSTA), emissions from international bunkers were calculated separately and not included in total greenhouse gas emissions.

The greenhouse gas source and sink categories and the uncertainties of estimates are shown in Table 2.1.

The IPCC/OECD Guidelines suggest applying a three-tiered ranking system [H (High), M (Medium), and L (Low)] to evaluate the quality of estimates for each source and sink category. However, these levels are not concretely defined. Because the activity data and emission/removal factors that provide the basis for inventory calculations have widely varying characteristics, it is difficult to evaluate the accuracy of estimates using a single, uniform standard. Therefore, the compilers of this inventory have consulted with experts and provided accuracy rankings based on multiple criteria, as shown in Table 2.1.

This chapter presents a comprehensive inventory table of the different target gases treated in each section, based on data dating from 1990 up to the most recent data available. A summary is given concerning emissions and removals of each gas, and an explanation is given concerning how the main items were estimated. The tables used in this chapter either conform completely to the standard forms indicated in the IPCC/OECD Guidelines or contain minor alterations. For detailed information concerning how the inventory on greenhouse gases was compiled and the different emission and removal categories used, please consult the IPCC/OECD Guidelines.

The amounts of emissions and removals are measured in 1Gg (=1,000t) units, except for N₂O, HFCs, PFCs, and SF₆, which are measured in 0.1Gg units due to the relatively small amounts involved. This is because each type of gas has its own special characteristics in terms of estimate quality, and it is difficult to establish effective numbers that apply to all types. Table 2.1 can be consulted for information concerning the estimate quality for each category of gas. Totals may not agree because of rounding.

2.1. Outline

Table 2.1 Greenhouse Gas Source and Sink Categories, and Quality of Estimates

Greenhouse Gas Source and Sink Categories	CO ₂		CH ₄		N ₂ O		Nox		CO		NMVOC		HFCs		PFCs		SF ₆		SOx	
	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality
Total National Emissions and Removals		H	L	L	L	H	M	M	M	M	M	H	H	H	H	H	H	H	H	H
1. All Energy	ALL	H	L	L	L	H	M	M	M	M	M	L	NA	NA	NA	NA	NA	NA	PART	H
1A. Fuel Combustion Activities	ALL	H	L	L	L	H	M	M	M	M	M	L	NA	NA	NA	NA	NA	NA	PART	H
1A1. Energy Industries	ALL	H	M	M	L	H	M	M	M	M	L	NA	NA	NA	NA	NA	NA	NA	ALL	H
1A2. Manufacturing Industries and Construction	ALL	H	L	L	L	H	M	M	M	M	L	NA	NA	NA	NA	NA	NA	NA	ALL	H
1A3. Transport	ALL	H	L	L	L	H	M	M	M	M	L	NA	NA	NA	NA	NA	NA	NA	PART	H
1A4. Other Sectors	ALL	H	L	L	L	M	M	M	M	M	L	NA	NA	NA	NA	NA	NA	NA	ALL	H
1A5. Other	ALL	H	NA	NA	NA	M	M	M	M	M	L	NA	NA	NA	NA	NA	NA	NA	ALL	H
1B. Fugitive Emissions from Fuels	NA		L	L	NA	NA	NA	NA	NE	NE	PART	L	NA	NA	NA	NA	NA	NA	NA	NA
1B1. Solid Fuels	NA		L	L	NA	NA	NA	NA	NE	NE	PART	L	NA	NA	NA	NA	NA	NA	NA	NA
1B2. Oil and Natural Gas	NA		L	L	NA	NA	NA	NA	NE	NE	PART	L	NA	NA	NA	NA	NA	NA	NA	NA
2. Industrial Processes	PART	H	L	L	L	H	M	M	NA	NA	PART	L	NA	NA	NA	NA	NA	NA	PART	H
3. Solvent and Other Product Use	NA		NA	NA	ALL	H	M	M	NA	NA	PART	M	NA	NA	NA	NA	NA	NA	NA	NA
4. Agriculture	NE		L	L	L	NE	M	M	NA	NA	PART	M	NA	NA	NA	NA	NA	NA	NA	NA
4A. Enteric Fermentation	NE		L	L	L	NE	M	M	NA	NA	PART	M	NA	NA	NA	NA	NA	NA	NA	NA
4B. Manure Management	NE		L	L	L	NE	M	M	NA	NA	PART	M	NA	NA	NA	NA	NA	NA	NA	NA
4C. Rice Cultivation	NE		L	L	L	NE	M	M	NA	NA	PART	M	NA	NA	NA	NA	NA	NA	NA	NA
4D. Agricultural Soils	NA		L	L	L	NE	M	M	NA	NA	PART	M	NA	NA	NA	NA	NA	NA	NA	NA
4E. Prescribed Burning of Savannas	NO		L	L	L	NO	M	M	NA	NA	PART	M	NA	NA	NA	NA	NA	NA	NO	NO
4F. Field Burning of Agricultural Residues	NE		L	L	L	NE	M	M	NA	NA	PART	M	NA	NA	NA	NA	NA	NA	NE	NE
4G. Other	NA		L	L	L	NE	M	M	NA	NA	PART	M	NA	NA	NA	NA	NA	NA	NE	NE
5. Land-Use Change & Forestry	PART	M	L	L	L	NA	M	M	NA	NA	PART	M	NA	NA	NA	NA	NA	NA	NA	NA
5A. Changes in Forest and Other Woody Biomass Stocks	PART	M	L	L	L	NA	M	M	NA	NA	PART	M	NA	NA	NA	NA	NA	NA	NA	NA
5B. Forest and Grassland Conversion	PART	M	L	L	L	NA	M	M	NA	NA	PART	M	NA	NA	NA	NA	NA	NA	NA	NA
5C. Abandonment of Managed Lands	NE		L	L	L	NA	M	M	NA	NA	PART	M	NA	NA	NA	NA	NA	NA	NA	NA
5D. CO ₂ Emissions and Removals from Soil	PART	M	L	L	L	NA	M	M	NA	NA	PART	M	NA	NA	NA	NA	NA	NA	NA	NA
5E. Other	NA		L	L	L	NA	M	M	NA	NA	PART	M	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	PART	H	M	M	L	H	M	M	ALL	L	L	L	NA	NA	NA	NA	NA	NA	ALL	H
6A. Solid Waste Disposal on Land	IE		L	L	L	NA	M	M	NA	NA	PART	M	NA	NA	NA	NA	NA	NA	NA	NA
6B. Wastewater Handling	NE		L	L	L	NA	M	M	NA	NA	PART	M	NA	NA	NA	NA	NA	NA	NA	NA
6C. Waste Incineration	ALL	H	L	L	L	H	M	M	ALL	L	L	L	NA	NA	NA	NA	NA	NA	ALL	H
6D. Other	NA		L	L	L	NA	M	M	NA	NA	PART	M	NA	NA	NA	NA	NA	NA	NA	NA
7. Other	NE		L	L	L	NA	M	M	ALL	M	M	M	NA	NA	NA	NA	NA	NA	NA	NA
International Bankers	ALL	H	L	L	L	L	L	L	ALL	L	L	L	NA	NA	NA	NA	NA	NA	NE	NE

Note: The codes used above are explained in the table below.

Estimate		Quality	
Code	Meaning	Code	Meaning
PART	Partly estimated	H	a) Cases in which there are adequate measured or documented values for numerical emission factors and it is clear that the variation factors (standard deviation, mean value) are less than 30%.
ALL	Full estimate of all possible sources		b) Cases in which it is theoretically clear that the emission factor has a small range of variation.
NE	Not estimated		c) Cases in which, despite individual differences in emission factors, the actual emission amounts are ascertained through continuous data from statistics, survey reports, etc. based on actual measurements of the majority of emission sources.
IE	Estimated but included elsewhere	M	When neither H nor L apply.
NO	Not occurring	L	a) Cases in which: 1) it is theoretically impossible to estimate the value of the emission factor or its range of variation, and 2) there are either no actual measurements or documentary data on emission values applicable to Japan, or there are only single values.
NA	Not applicable		b) Cases in which there are actual measurements or documented values available for multiple emission factors, but each factor differs by more than three times.
			c) Cases in which there are actual measurements or documented values available for multiple emission factors and each factor differs by less than three times but ultimate emission amounts have a margin of error in excess of a factor of three because of the addition of factors arising from activity-amount data and other sources.

2.2. Revisions in Inventory Calculation Methods

The inventory included in this report is a revised version of the inventory reported in the First National Communication (submitted in September 1994). This revision is based on: 1) the In-depth Review for the First National Communication of Japan (1995-1996); 2) the revised IPCC/OECD Guidelines (1996); and 3) advances in knowledge concerning the emission and removal of greenhouse gases.

Table 2.2 compares the values for six greenhouse gases reported in the First National Communication and the Second National Communication, respectively. The main revisions are summarized in Table 2.3. Comments concerning these revisions are included in the following sections.

Four gases have been newly added in this report: HFCs (hydrofluorocarbons); PFCs (perfluorocarbons); SF₆ (sulfur hexafluoride); and SO₂ (sulfur dioxide).

A resolution of the SBSTA requires that two approaches be used in reporting emissions for HFCs, PFCs, and SF₆: 1) the actual emission approach, which estimates actual emission amounts during the year in question; and 2) the potential emission approach, which takes into account potential future emissions by estimating amounts enclosed in machinery, etc. in the year in question. However, since there are technical difficulties involved in estimating actual emissions, only potential emissions are reported.

Calculations for each item have been made using methods that are currently considered the best. These methods may change in the future as a result of advances in knowledge, changes in statistical formulas, revisions to the IPCC/OECD Guidelines, etc.

2.2. Revisions in Inventory Calculation Methods

Table 2.2 Comparison of Values for Greenhouse Gas Emissions Reported in the First and Second National Communications

(Unit: Gg)

Greenhouse Gas Source and Sink Categories	CO ₂		CH ₄		N ₂ O		NO _x		CO		NMVOC	
	First National Communication	Second National Communication										
Total National Emissions	1,173,000	1,124,532	1,380	1,575	48.0	105.3	1,898	2,212	2,809	3,888	2,060	1,966
Total National Removals	90,000	83,341										
1. All Energy	1,075,000	1,052,964	125	285	22.0	65.6	1,844	2,134	2,792	3,441	560	497
1A. Fuel Combustion Activities	1,075,000	1,052,964	25	119	22.0	65.6	1,844	2,134	2,792	3,441	340	297
1B. Fugitive Emissions from Fuels			100	166							220	200
2. Industrial Processes	53,000	58,796	48	48	15.0	23.8	1	24			60	81
3. Solvent and Other Product Use						0.9					1,440	1,388
4. Agriculture			790	843	5.0	9.7				162		
5. Land-Use Change & Forestry	-90,000	-83,341	3	3		0.0		1		22		
6. Waste	45,000	12,773	465	397	6.0	5.3	53	54	17	245		0
7. Other										18		
International Bankers	31,000	30,806		2		0.4		390		56		13

Note: Values are for fiscal 1990.

Figures from the First National Communication are rounded off to the following units: CO₂ – 1,000Gg; CH₄; NMVOC – 10Gg; and N₂O – 1Gg. The “Total National Removals” figure for CO₂ includes the removals indicated for the “Land-Use Change & Forestry” sector.

Table 2.3 Main Revisions Made in Inventory Calculation Methods

Category	Gas	Method Used in First National Communication	Method Used in Second National Communication	Reason for Revision
Energy	CO ₂	Emissions from autoproducers (power generated for their own use) were included in the "Energy & Transformation Industries" sector.	Emissions from auto producers (power generated for their own use) were allocated to the various sectors in which the generated electricity was used.	Revisions in the IPCC/OECD Guidelines
	CO ₂	Emissions from biomass burning were included in emission amounts.	Emissions from biomass burning were not included in net emission amounts.	Conformity with IPCC/OECD Guidelines.
	CH ₄ ,N ₂ O	Top-down calculation method used.	Bottom-up calculation method used.	Application of emission factors that matched actual conditions
	CH ₄ ,NMVO	No consideration given to emissions from ships.	Ship emissions newly added.	Expansion of scope
	CH ₄ , N ₂ O, precursors	No consideration given to railways (diesel railcars).	Railway emissions newly added.	Expansion of scope
	SO ₂	No consideration given.	Stationary sources and automotive vehicle emissions added.	Expansion of scope
	CO ₂ , CH ₄ , N ₂ O, precursors	Emissions from agriculture, forestry and fishery included in the Industry sector (1A2).	Emissions from the Agriculture, Forestry and Fishery sector (33,908Gg, FY 1995, CO ₂) included in other sectors (1A4).	Conformity with the IPCC/OECD Guidelines
Industrial Processes	CO ₂	Consideration given only to emissions from the chemical decomposition of limestone.	Consideration given to emissions from ammonia production.	Greater accuracy.
	CH ₄	No consideration given.	Consideration given to emissions from industrial processes.	Expansion of scope
	N ₂ O	Consideration given only to emissions from adipic acid production.	Consideration given to emissions from adipic acid and nitric acid production.	Greater accuracy
	HFCs, PFCs, SF ₆	No consideration given.	Newly added	Added as new types of greenhouse gas
Solvent and Other Product Use	N ₂ O	No consideration given.	Use of gas for medical treatment (laughing gas) added.	Greater accuracy
Agriculture	CH ₄	Used default emission factors provided by the IPCC/OECD Guidelines for emissions from manure.	Used emission factors actually measured in Japan for emissions from manure.	Application of emission factors that matched actual conditions
Land-Use Change & Forestry	CO ₂	Carbon in cut timber was considered fixed and therefore included in the removals category.	Carbon in cut timber was included in the emissions category.	Conformity with IPCC/OECD Guidelines
Waste	CO ₂	Emissions from the incineration and decomposition of biomass wastes included.	Emissions from biomass incineration and decomposition were not included in net emissions.	Conformity with IPCC/OECD Guidelines
	CH ₄	Methane emissions from organic matter in landfills calculated for a single year.	Model adopted that postulates methane emissions from organic matter in landfills over the course of several years.	Greater accuracy
Other	CO	No consideration given.	Emissions from tobacco smoke added.	Expansion of scope
International Bunkers	CH ₄ , N ₂ O, precursors	No consideration given.	Newly added	Expansion of scope

2.3. Carbon Dioxide

2.3. Carbon Dioxide

2.3.1. Outline of Emissions and Removals

Carbon dioxide (CO₂) is the most plentiful greenhouse gas in Japan in terms of both emissions and removals and is therefore a top policy priority. As shown in Table 2.4, carbon dioxide is considered in the following emission and removal sectors: Energy (1); Industrial Processes (2); Land-Use Change & Forestry (5); and Waste (6). Table 2.4 indicates that emissions total more than 1 billion tons (full molecular weight basis, here and below) per year.

Table 2.4 shows that carbon dioxide emissions for fiscal years 1990 through 1995 have risen every year except for 1993. Increases in the other sectors (1A4) and Transport (1A3) subsectors of the Fuel Combustion Activities (1A) sector are greater than the increase observed in the Manufacturing Industries and Construction (1A2) subsector. Increases have also occurred in the Industrial Processes (2) and Waste (6) sectors. Calculations for emission and removal amounts in the Land-Use Change & Forestry (5) sector were based on default methods established in the IPCC/OECD Guidelines. Calculation methods used in this sector are expected to change as more knowledge is acquired; in this report, however, total removals account for slightly less than 10% of total emissions.

In Table 2.5, emissions from electric power generation in the Energy Industries (1A1) subsector have been distributed among subsectors 1A2 through 1A4 according to where the electricity was ultimately consumed. These values can be said to reflect the actual conditions and changes occurring in carbon dioxide emissions in these respective end-use sectors.

Table 2.6 presents a summary of emissions and removals for all the subsectors in the Land-Use Change & Forestry (5) sector. Emission and removal values are given for each subsector. Emissions and removals were highest in the Changes in Forest and Other Woody Biomass Stocks (5A) sector.

The left side of Figure 2.1 shows the breakdown of emissions by sector (fiscal 1995). The Fuel Combustion Activities (1A) sector is further broken down into subsectors. The subsector with the highest emissions is Energy Industries (1A1), which accounts for about 30% of the total. This is followed by Manufacturing Industries and Construction (1A2), Transport (1A3), and other sectors (1A4) in descending order. The Industrial Processes (2) sector, which primarily uses limestone, accounts for 5% of the total, and the Waste (6) sector, which primarily focuses on the burning of waste derived from fossil fuels, accounts for 2%. The right side of Figure 2.1 shows emissions from electric power generation distributed to the end-use sectors that ultimately consume the generated electricity. The Manufacturing Industries and Construction (1A2) subsector emits the most, followed in descending order by other sectors (1A4) and Transport (1A3).

Figure 2.2 and Figure 2.3 show changes in emission amounts in each sector from fiscal 1990 through fiscal 1995. With the exception of 1993, when an unusually cool summer resulted in reduced emissions, emission levels rose consistently from year to year.

Emission figures for international bunkers have been kept separate as shown at the bottom of Table 2.4. This continues the practice adopted in the First National Communication and is consistent with the Communication Guidelines. Emissions from international bunkers have risen each year.

2.3.2. Methods of Estimating Emissions and Removals

Energy (1): Figures for the Fuel Combustion Activities (1A) sector were calculated by multiplying the total primary energy supply in each fuel³⁾ by carbon dioxide emission factors⁴⁾. This is called the “supply-based top-down calculating method.” Figures for all other sectors were derived by multiplying the amounts of each type of fuel consumed by each sector³⁾ by their respective carbon dioxide factors⁴⁾. This is called the “consumption-based top-down calculating method.” These two methods generate statistical errors that are allocated to the Other (1A5) subsector. Items that could not be classified into specific sub-sect-

tors were also included in the Other (1A5) subsector. Five percent of the carbons in “coking coal” and “petroleum coke” and 80% of the carbons in “naptha,” “lubricating oil,” “other petroleum products (asphalt, etc.),” and “LPG” were assumed to be fixed in products. Carbon dioxide emissions from “naptha,” “LPG,” “natural gas,” “LNG,” “coal,” and “petroleum coke” for use in ammonia production are allocated to the Industrial Processes (2) sector. Emissions from auto producers (power generated for their own use) were allocated not to the Energy Industries (1A1) subsector but rather divided among all relevant sectors according to how much electricity each sector consumed. This approach is consistent with the revised 1996 IPCC/OECD Guidelines. However, these figures do not reflect the different fuel mixes of each sector. Instead, the amount of carbon dioxide emitted per unit of electricity generated was calculated by using an average emission factor.

Industrial Processes (2): Carbon dioxide generated through the heat decomposition of limestone and other materials was calculated by multiplying the amounts of material consumed^{5) 6)} by their respective emission factors. Similarly, the amounts used to make ammonia⁷⁾ were multiplied by the appropriate emission factors⁴⁾.

Land-Use Change & Forestry (5): Calculations were made in accordance with the default methods prescribed by the IPCC/OECD Guidelines. The necessary data concerning the amount of cut timber, forest area, and amount of new growth were taken from the “Statistical Handbook of Forestry”⁸⁾.

Waste (6): Calculations were also made for Waste Incineration (6C). For municipal solid waste, the amount of waste burned was multiplied by the percentage of waste derived from fossil fuels⁹⁾, with the result further multiplied by the appropriate emission factors. For industrial solid waste, emission amounts were calculated by multiplying the amounts of incinerated waste oil and waste plastic¹⁰⁾ by the appropriate emission factors.

The main differences in inventory calculations between the First National Communication and this Second National Communication are explained below.

In the consumption-based top-down calculations used for the Fuel Combustion Activities (1A) sector, the aggregate fuel category and weighted average emission factors were used in the First National Communication. In the Second National Communication, detailed fuel categories and emission factors in each category were applied. Therefore, the new calculations reflect the different fuel mixes of each sector (e.g., the proportion of heavy oil use).

In the First National Communication, carbon dioxide emissions generated from the burning of biomass attributed to the Fuel Combustion Activities (1A) and Waste Incineration (6C) subsectors and decomposition of biomass attributed to the Solid Waste Disposal on Land (6A) subsector were included in total emissions. However, in accordance with recommendations based on an in-depth review of the First National Communication, as well as directions given by the IPCC/OECD Guidelines, biomass emissions are not included in total emissions in the Second National Communication. As far as the Framework Convention is concerned, no decision has yet been made regarding how to allocate emissions generated by the incineration or decomposition of wood products that are exported or imported. In preparation for such a decision, however, in the Second National Communication biomass has been broken down into four categories for calculations: long-cycle biomass such as paper and timber (domestic and imported), and short-cycle biomass such as grains (domestic and imported).

In the First National Communication, calculations in the Changes in Forest and Other Woody Biomass Stocks (5A) sector were based on the assumption that cut timber would be 100% preserved, so that cut timber was considered a sink. In accordance with the methodology prescribed by the IPCC/OECD Guidelines, however, cut timber is calculated as an emissions source in the Second National Communication. Concerning carbon dioxide emissions calculated in the Forest and Grassland Convention (5B) and CO₂ Emissions

2.3. Carbon Dioxide

and Removals from Soil (5D) subsectors, these values were considered negligible and were not calculated in the First National Communication; but they are given consideration in the Second National Communication.

Table 2.4 Carbon Dioxide Emissions and Removals (Fiscal 1990-1995) (Unit: Gg)

Fiscal Year	1990	1991	1992	1993	1994	1995
Total Emissions	1,124,532	1,147,845	1,162,314	1,141,369	1,211,740	1,218,377
Total Removals	83,341	82,654	83,702	87,797	90,834	94,619
1. All Energy	1,052,964	1,072,762	1,085,214	1,064,392	1,133,291	1,138,478
1A. Fuel Combustion Activities	1,052,964	1,072,762	1,085,214	1,064,392	1,133,291	1,138,478
1A1. Energy Industries	339,065	341,875	349,569	331,734	369,363	359,385
1A2. Manufacturing Industries and Construction	339,378	337,429	327,837	332,191	340,796	346,492
1A3. Transport	207,431	216,894	221,729	223,932	234,676	242,123
1A4. Other Sectors	158,298	164,617	169,764	168,965	166,961	177,084
1A5. Other	8,792	11,946	16,314	7,570	21,495	13,393
1B. Fugitive Emissions from Fuels						
1B1. Solid Fuels						
1B2. Oil and Natural Gas						
2. Industrial Processes	58,795	60,381	60,998	60,333	61,303	61,236
3. Solvent and Other Product Use						
4. Agriculture						
4A. Enteric Fermentation						
4B. Manure Management						
4C. Rice Cultivation						
4D. Agricultural Soils						
4E. Prescribed Burning of Savannas						
4F. Field Burning of Agricultural Residues						
4G. Other						
5. Land-Use Change & Forestry	-83,341	-82,654	-83,702	-87,797	-90,834	-94,619
5A. Changes in Forest and Other Woody Biomass Stocks	-84,392	-84,679	-86,379	-90,899	-94,362	-97,533
5B. Forest and Grassland Conversion	579	908	915	922	929	942
5C. Abandonment of Managed Lands						
5D. CO ₂ Emissions and Removals from Soil	471	1,116	1,762	2,181	2,599	1,971
5E. Other						
6. Waste	12,773	14,701	16,102	16,645	17,146	18,663
6A. Solid Waste Disposal on Land						
6B. Wastewater Handling						
6C. Waste Incineration	12,773	14,701	16,102	16,645	17,146	18,663
6D. Other						
7. Other						
International Bunkers	30,806	33,036	34,095	36,688	37,494	37,328

Note: The "Total National Removals" figure includes the removals indicated for the "Land-Use Change & Forestry" sector.

Table 2.5 Carbon Dioxide Emissions (Fiscal 1990-1995)

Carbon Dioxide Emissions (Fiscal 1990-1995)

(Emissions from electric power generation that is part of the Energy Industries (1A1) subsector are allocated to subsectors (1A2-1A4) under the Fuel Combustion Activities (1A) sector according to the amount of electric power consumed in each subsector.)

(Unit: Gg)

Fiscal Year	1990	1991	1992	1993	1994	1995
1A. Fuel Combustion Activities						
1A1. Energy Industries	77,449	78,491	79,608	78,966	83,216	82,694
1A2. Manufacturing Industries and Construction	455,647	452,381	441,981	435,865	454,921	455,317
1A3. Transport	213,780	223,251	228,317	230,127	241,368	248,522
1A4. Other Sectors	297,292	306,692	318,989	311,868	332,295	338,547
1A5. Other	8,792	11,946	16,314	7,570	21,495	13,393

Table 2.6 Summary of Emissions and Removals in the Land-Use Change & Forestry (5) Sector

(Unit: Gg)

Fiscal Year	1995				
	Emissions	Sources	Removals	Sinks	Total Values
5. Land-Use Change & Forestry	47,528		142,148		-94,619
5A. Changes in Forest and Other Woody Biomass Stocks	44,615	Cut Timber	142,148	Incremental Growth	-97,533
5B. Forest and Grassland Conversion	942	Biomass burned when forests are converted to other land uses	—	None	942
5C. Abandonment of Managed Land	—	Not considered	—	Not considered	—
5D. CO ₂ Emissions and Removals from Soil	1,971	CO ₂ emitted from forest soil that has been converted to other land uses	—	Not considered	1,971

Please see Figure 2.1 at the end of the chapter 2.

Please see Figure 2.2 at the end of the chapter 2.

Please see Figure 2.3 at the end of the chapter 2.

2.4. Methane

2.4.1. Outline of Emissions

Japan emitted approximately 1.55 million tons of anthropogenic methane in fiscal 1994, primarily from activities in the Energy (1), Agriculture (4), and Waste (6) sectors.

Table 2.7 shows changes in methane emissions in each sector from fiscal 1990 through fiscal 1994. Total emissions have remained essentially stable since fiscal 1990. Emissions have declined in the Solid Fuels (1B1) and Solid Waste Disposal on Land (6A) subsectors, reflecting declines in the amount of coal mined and the amount of organic solid waste entering landfills. In contrast, emissions have increased in the Oil and Natural Gas (1B2) subsector, reflecting increases in the amounts of these fuels being handled. A slow but steady increase is also occurring in the Rice Cultivation (4C) subsector. No clear increases or decreases are found in any of the other sectors.

Figure 2.4 shows the breakdown of emissions by sector. The most important sector is Agriculture (4), which accounts for about 55% of the total. Within this sector, the main subsectors are Enteric Fermentation (4A), Manure Management (4B), and Rice Cultivation (4C). Under Energy (1), Fuel Combustion Activities (1A) and Fugitive Emissions from Fuels (1B) account for 7% and 11% of the total, respectively. Under Waste (6), the main subsector is Solid Waste Disposal on Land (6A), which accounts for 24% of the total.

2.4. Methane

2.4.2. Methods of Estimating Emissions

Energy (1): For the Energy Industries (1A1), Manufacturing Industries and Construction (1A2), and part of the Other Sectors (1A4) subsectors of the Fuel Combustion Activities (1A) sector, emissions were calculated for each soot and smoke emitting facility designated by the Air Pollution Control Law by multiplying the amount of fuel consumed (broken down by type of furnace and type of fuel) by the appropriate emission factors¹¹⁾. This is a “bottom-up” approach. The remainder of the Other Sectors (1A4) subsector involves small boilers and fuel facilities, and emissions were calculated by multiplying the emission factors for different types of fuel and their applications by the amount of fuel consumed. The figure shown in the Transport (1A3) subsector includes emissions from motor vehicles, ships, aircraft, and railways (diesel railcars). Emissions falling under the Solid Fuels (1B1) subsector of Fugitive Emissions from Fuels (1B) were calculated by multiplying the amount of coal mined¹²⁾ by the appropriate methane emission factor. For the Oil and Natural Gas (1B2) subsector, the amounts of each fuel produced and handled³⁾ were multiplied by the default emission factors of the IPCC/OECD Guidelines.

Industrial Processes (2): The amounts of different chemical products manufactured were multiplied by their respective default emission factors from the IPCC/OECD Guidelines. Emissions of Methane in industrial processes in Japan were not estimated in the First National Communication because of the obligation to keep specified facilities in airtight conditions under the High Pressure Gas Safety Law.

Agriculture (4): For the Enteric Fermentation (4A) subsector, emissions were calculated by multiplying the numbers of each type of animal¹³⁾ by the appropriate emission factors. Emissions in the Manure Management (4B) subsector are calculated by using the method¹⁴⁾ that reflects the Japanese situation in this subsector. Methane emissions in the Rice Cultivation (4C) subsector were calculated by multiplying the area of cultivated rice paddies¹⁵⁾ (broken down by soil type) by the appropriate emission factors.

Land-Use Change & Forestry (5): Consideration was given to the burning of biomass that accompanies the conversion of forest land to other uses, and calculations were made on the basis of default methods indicated in the IPCC/OECD Guidelines.

Waste (6): For the Solid Waste Disposal on Land (6A) subsector, emissions were calculated using a model that gives consideration to the methane emission process as it occurs over the course of several years after the waste is buried in landfill¹⁶⁾. For the Waste Incineration (6C) subsector, the amount of waste processed in the Waste Incinerator designated by the Air Pollution Control Law was multiplied by the appropriate emission factor¹¹⁾.

Table 2.7 Methane Emissions (Fiscal 1990-1994)

(Unit: Gg)

Fiscal Year	1990	1991	1992	1993	1994
Total	1575	1565	1559	1557	1548
1. All Energy	285	281	281	279	274
1A. Fuel Combustion Activities	119	110	107	105	105
1A1. Energy Industries	5	5	4	4	4
1A2. Manufacturing Industries and Construction	35	24	22	22	21
1A3. Transport	78	80	80	79	79
1A4. Other Sectors	1	1	1	1	1
1A5. Other					
1B. Fugitive Emissions from Fuels	166	171	174	173	169
1B1. Solid Fuels	107	107	107	101	94
1B2. Oil and Natural Gas	59	64	68	72	75
2. Industrial Processes	48	48	46	45	47
3. Solvent and Other Product Use					
4. Agriculture	843	846	850	856	849
4A. Enteric Fermentation	346	350	352	349	345
4B. Manure Management	119	117	115	113	110
4C. Rice Cultivation	373	374	378	388	389
4D. Agricultural Soils					
4E. Prescribed Burning of Savannas					
4F. Field Burning of Agricultural Residues	5	5	5	6	5
4G. Other					
5. Land-Use Change & Forestry	3	4	4	4	4
5A. Changes in Forest and Other Woody Biomass Stocks					
5B. Forest and Grassland Conversion	3	4	4	4	4
5C. Abandonment of Managed Lands					
5D. CO ₂ Emissions and Removals from Soil					
5E. Other					
6. Waste	397	386	379	375	373
6A. Solid Waste Disposal on Land	388	377	370	365	364
6B. Wastewater Handling	6	6	6	7	6
6C. Waste Incineration	3	3	3	3	3
6D. Other					
7. Other					
International Bunkers	2	2	2	2	2

Please see Figure 2.4 at the end of the chapter 2.

2.5. Nitrous Oxide

2.5. Nitrous Oxide

2.5.1. Outline of Emissions

Nitrous oxide (N₂O) emissions in Japan are ascertained for all sectors except Other (7). Nitrous oxide emissions totaled 110,000 tons in fiscal 1994.

Table 2.8 shows emissions in all sectors from fiscal 1990 through fiscal 1994. Total emissions have remained essentially unchanged. Increases have occurred in the following sectors: Transport (1A3); Solvent and Other Product Use (3); and Waste (6). These rises reflect increases in road traffic, greater use of medical gases (laughing gas), and greater amounts of incinerated waste. Declines have occurred in the following sectors: Fuel Combustion Activities (1A) (except for the Transport (1A3) subsector); and Manure Management (4B). These can be attributed to improved fuel combustion conditions and a reduction in the number of livestock animals. No clear increases or decreases are found in any of the other sectors.

Figure 2.5 breaks down nitrous oxide emissions in fiscal 1994 according to sector. The Energy (1) sector accounted for 63% of the emissions, followed in descending order by the Industrial Processes (2) [22%], Agriculture (4) [8%], and Waste (6) [6%] sectors.

2.5.2. Methods of Estimating Emissions

Energy (1): For the Energy Industries (1A1), Manufacturing and Construction (1A2), and part of the Other Sectors (1A4) subsectors of the Fuel Combustion (1A) sector, emissions were calculated for each soot and smoke emitting facility designated by the Air Pollution Control Law by multiplying the amount of fuel consumed (broken down by type of furnace and type of fuel) by the appropriate emission factor¹¹⁾. This is a “bottom-up” approach. The remainder of the Other Sectors (1A4) subsector involves small boilers and fuel facilities, and emissions were calculated by multiplying the emission factors for different types of fuel and their applications by the amount of fuel consumed. The figure shown in the Transport (1A3) subsector includes emissions from motor vehicles, ships, aircraft, and railways (diesel railcars).

Industrial Processes (2): Emissions from the manufacture of adipic acid¹⁷⁾ and nitric acid¹⁸⁾ were calculated by multiplying the respective amounts manufactured by the appropriate emission factor.

Solvent and Other Product Use (3): The amount of nitrous oxide shipped as medical gas (laughing gas)¹⁹⁾ was considered equal to the amount of emissions.

Agriculture (4): For the Manure Management (4B) subsector, emissions were calculated by multiplying the number of each type of animal by the appropriate emission factor, taking into account different waste management conditions^{13) 14)}. For the Agricultural Soils (4D) subsector, emissions were calculated by multiplying the amount of nitrogen fertilizer used (other than in rice paddies) by the appropriate emission factor²⁰⁾.

Land-Use Change & Forestry (5): Consideration was given to the burning of biomass that accompanies the conversion of forest land to other uses, and calculations were made on the basis of default methods indicated in the IPCC/OECD Guidelines.

Waste (6): For the Waste Incineration (6C) subsector, the amount of waste processed in the Waste Incinerator designated by the Air Pollution Control Law was multiplied by the appropriate emission factor¹¹⁾. Separate consideration was given to sewage sludge because it is a major source of nitrous oxide emissions²¹⁾.

Table 2.8 Nitrous Oxide Emissions (Fiscal 1990-1994)

(Unit: Gg)

Fiscal Year	1990	1991	1992	1993	1994
Total	105.3	108.8	106.8	106.9	110.0
1. All Energy	65.6	70.7	68.6	69.3	69.0
1A. Fuel Combustion Activities	65.6	70.7	68.6	69.3	69.0
1A1. Energy Industries	24.0	25.0	25.8	26.4	26.2
1A2. Manufacturing Industries and Construction	27.4	31.0	27.9	28.0	27.9
1A3. Transport	12.9	13.4	13.7	13.7	13.8
1A4. Other Sectors	1.3	1.3	1.2	1.1	1.2
1A5. Other					
1B. Fugitive Emissions from Fuels					
1B1. Solid Fuels					
1B2. Oil and Natural Gas					
2. Industrial Processes	23.8	21.7	21.5	21.0	23.9
3. Solvent and Other Product Use	0.9	1.2	1.3	1.3	1.4
4. Agriculture	9.7	9.5	9.3	9.2	9.1
4A. Enteric Fermentation					
4B. Manure Management	5.0	5.0	4.9	4.8	4.7
4C. Rice Cultivation					
4D. Agricultural Soils	4.0	3.8	3.6	3.6	3.6
4E. Prescribed Burning of Savannas					
4F. Field Burning of Agricultural Residues	0.7	0.7	0.8	0.8	0.8
4G. Other					
5. Land-Use Change & Forestry	0.0	0.0	0.0	0.0	0.0
5A. Changes in Forest and Other Woody Biomass Stocks					
5B. Forest and Grassland Conversion	0.0	0.0	0.0	0.0	0.0
5C. Abandonment of Managed Lands					
5D. CO ₂ Emissions and Removals from Soil					
5E. Other					
6. Waste	5.3	5.7	6.0	6.1	6.6
6A. Solid Waste Disposal on Land					
6B. Wastewater Handling					
6C. Waste Incineration	5.3	5.7	6.0	6.1	6.6
6D. Other					
7. Other					
International Bunkers	0.4	0.4	0.4	0.4	0.4

Please see Figure 2.5 at the end of the chapter 2.

2.6. Hydrofluorocarbons

2.6. Hydrofluorocarbons

2.6.1. Outline of Emissions

Hydrofluorocarbons (HFCs) have been used in refrigerants, aerosols, and other goods in recent years. The total volume of HFC emissions (potential emissions volume) in Japan was about 11,000 tons in 1995.

Table 2.9 outlines potential HFC emissions since 1990. Use of HFC-134a as a substitute for chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) in refrigerants and other goods has increased dramatically. The category "total emissions of other HFCs" includes HFC-152a and HFC-32. HFC-23 is a by-product released during the manufacture of HCFC-22.

2.6.2. Methods of Estimating Emissions

Data regarding the production, import, and export volumes were gathered and compiled from hearings with various businesses. Figures do not include HFCs in imported or exported equipment.

Table 2.9 Potential Hydrofluorocarbon Emissions (1990-1995)

(Unit: Gg)

Year	1990	1991	1992	1993	1994	1995
Total	1.6	1.9	3.0	5.7	9.7	11.2
2 Industrial Processes	1.6	1.9	3.0	5.7	9.7	11.2
Total HFC-134a Emissions	0.0	0.4	1.4	4.4	8.1	9.3
Volume Produced	0.0	0.2	2.5	11.1	18.4	22.0
Volume Imported	0.0	0.2	0.3	0.2	0.0	0.0
Volume Exported	0.0	0.0	1.4	6.9	10.3	12.7
Volume Destroyed	NE	NE	NE	NE	NE	NE
Total Emissions of Other HFCs	0.1	0.0	0.1	0.0	0.1	0.3
Volume Produced	0.0	0.0	0.0	0.1	0.2	0.3
Volume Imported	0.1	0.0	0.1	0.0	0.0	0.1
Volume Exported	0.0	0.0	0.0	0.1	0.1	0.1
Volume Destroyed	NE	NE	NE	NE	NE	NE
Total HFC-23 Emissions	1.5	1.5	1.5	1.3	1.5	1.6

Note: Volume Destroyed is not estimated (NE).

2.7. Perfluorocarbons

2.7.1. Outline of Emissions

Perfluorocarbons (PFCs) have been used for about 20 years as semiconductor etching gas and in inert liquids. The total PFC emissions volume (potential emissions volume) in Japan was about 2,100 tons in 1995.

Table 2.10 outlines potential PFC emissions since 1990. Separate figures have been given for PFC-14 (CF₄), which is used in semiconductor etching; PFC-116 (C₂F₆), which is used in CVD cleaning; and "other PFCs" (including C₆F₁₄ and C₇F₁₆), which are used in inert liquids. The emissions volume of these PFCs is increasing in all areas of use.

2.7.2. Methods of Estimating Emissions

Data regarding the production, import, and export volumes were gathered and compiled from hearings with various businesses. Figures do not include the volume destroyed (which is included in CFC figures) or PFCs in imported or exported equipment.

Table 2.10 Potential Perfluorocarbons Emissions (1990-1995) (Unit: Gg)

Year	1990	1991	1992	1993	1994	1995
Total	0.8	0.9	0.9	1.2	1.6	2.1
2 Industrial Processes	0.8	0.9	0.9	1.2	1.6	2.1
Total PFC-14 Emissions	0.3	0.3	0.3	0.3	0.4	0.5
Volume Produced	0.4	0.4	0.4	0.5	0.6	0.7
Volume Imported	0.0	0.0	0.0	0.0	0.0	0.0
Volume Exported	0.1	0.1	0.1	0.1	0.2	0.3
Volume Destroyed	NE	NE	NE	NE	NE	NE
Total PFC-116 Emissions	0.1	0.1	0.1	0.1	0.2	0.3
Volume Produced	0.1	0.1	0.1	0.1	0.2	0.3
Volume Imported	0.0	0.0	0.0	0.0	0.1	0.1
Volume Exported	0.0	0.0	0.0	0.0	0.0	0.1
Volume Destroyed	NE	NE	NE	NE	NE	NE
Total Emissions of Other PFCs	0.4	0.5	0.5	0.8	1.0	1.3
Volume Produced	0.0	0.0	0.0	0.0	0.0	0.0
Volume Imported	0.4	0.5	0.5	0.8	1.0	1.3
Volume Exported	0.0	0.0	0.0	0.0	0.0	0.0
Volume Destroyed	NE	NE	NE	NE	NE	NE

Note: Volume Destroyed is not estimated (NE).

2.8. Sulfur Hexafluoride

2.8.1. Outline of Emissions

Sulfur hexafluoride (SF₆) has been used as an electric power insulation gas since around 1969. It has also been used as a semiconductor etching gas in recent years. The total SF₆ emissions volume (potential emissions volume) in Japan was about 2,200 tons in 1995.

Table 2.11 outlines potential SF₆ emissions since 1990.

2.8.2. Methods of Estimating Emissions

Data regarding the production, import, and export volumes were gathered and compiled from hearings with various businesses. Figures do not include the volume destroyed (which is included in CFC figures) or SF₆ in imported or exported equipment.

Table 2.11 Potential Sulfur Hexafluoride Emissions (1990-1995) (Unit: Gg)

Year	1990	1991	1992	1993	1994	1995
Total	1.6	1.8	2.0	1.9	1.9	2.2
2 Industrial Processes	1.6	1.8	2.0	1.9	1.9	2.2
Total SF ₆ Emissions	1.6	1.8	2.0	1.9	1.9	2.2
Volume Produced	1.9	2.1	2.3	2.2	2.2	2.4
Volume Imported	0.0	0.1	0.0	0.0	0.0	0.0
Volume Exported	0.3	0.3	0.3	0.3	0.3	0.2
Volume Destroyed	NE	NE	NE	NE	NE	NE

Note: Volume Destroyed is not estimated (NE).

2.9. Nitrogen Oxide

2.9. Nitrogen Oxide

2.9.1. Outline of Emissions

Japan emitted approximately 2.2 million tons of nitrogen oxide (NO_x) in fiscal 1994, primarily from activities in the Energy (1), Industrial Processes (2), and Waste (6) sectors. NO_x emissions are calculated as NO₂ equivalent weights.

Table 2.12 shows emissions from fiscal 1990 through fiscal 1994. Although there have been fluctuations, the overall amount of emissions has remained essentially stable. Increases have occurred in the following sectors: Transport (1A3) and Waste Incineration (6C). These rises reflect increases in automotive traffic and greater amounts of incinerated waste. No clear increases or decreases are found in any of the other sectors.

Figure 2.6 breaks down nitrogen oxide emissions in fiscal 1994 according to sector. The Fuel Combustion Activities (1A) sector accounted for 96% of all emissions, broken down in descending order into the following subsectors: Transport (1A3), Manufacturing Industries and Construction (1A2), Other Sectors (1A4), and Energy Industries (1A1). The Industrial Processes (2) sector accounted for 1% of the total, and the Waste (6) sector accounted for 3%.

2.9.2. Methods of Estimating Emissions

Energy (1): For the Energy Industries (1A1), Manufacturing Industries and Construction (1A2), and part of the Other Sectors (1A4) subsectors of the Fuel Combustion Activities (1A) sector, emissions were calculated for each soot and smoke emitting facility designated by the Air Pollution Control Law by multiplying the amount of fuel consumed (broken down by type of furnace and type of fuel) by the appropriate emission factor¹¹⁾. This is a "bottom-up" approach. The remainder of the Other Sectors (1A4) subsector involves small boilers and fuel facilities, and emissions were calculated by multiplying the emission factors for different types of fuel and their applications by the amount of fuel consumed. The figure shown in the Transport (1A3) subsector includes emissions from motor vehicles, ships, aircraft, and railways (diesel railcars). Emissions for motor vehicles were calculated by determining the total distance traveled by each type of vehicle and multiplying by the appropriate emission factor²²⁾. In all others, the default emission factors of the IPCC/OECD Guidelines were used.

Industrial Processes (2): Estimates were made for nitrogen oxide emissions from soot and smoke emitting facilities designated by the Air Pollution Control Law (1).

Land-Use Change & Forestry (5): Consideration was given to the burning of biomass that accompanies the conversion of forest land to other uses, and calculations were made on the basis of default methods indicated in the IPCC/OECD Guidelines.

Waste (6): For the Waste Incineration (6C) subsector, the amount of waste processed in the Waste Incinerator designated by the Air Pollution Control Law was multiplied by the appropriate emission factor¹¹⁾.

Table 2.12 Nitrogen Oxide Emissions (Fiscal 1990-1994)

(Unit: Gg)

Fiscal Year	1990	1991	1992	1993	1994
Total	2212	2271	2222	2163	2237
1. All Energy	2134	2187	2141	2083	2153
1A. Fuel Combustion Activities	2134	2187	2141	2083	2153
1A1. Energy Industries	282	292	273	258	285
1A2. Manufacturing Industries and Construction	468	492	470	463	490
1A3. Transport	1012	1032	1038	1030	1049
1A4. Other Sectors	372	371	360	332	329
1A5. Other					
1B. Fugitive Emissions from Fuels					
1B1. Solid Fuels					
1B2. Oil and Natural Gas					
2. Industrial Processes	24	26	21	21	22
3. Solvent and Other Product Use					
4. Agriculture					
4A. Enteric Fermentation					
4B. Manure Management					
4C. Rice Cultivation					
4D. Agricultural Soils					
4E. Prescribed Burning of Savannas					
4F. Field Burning of Agricultural Residues					
4G. Other					
5. Land-Use Change & Forestry	1	1	1	1	1
5A. Changes in Forest and Other Woody Biomass Stocks					
5B. Forest and Grassland Conversion	1	1	1	1	1
5C. Abandonment of Managed Lands					
5D. CO ₂ Emissions and Removals from Soil					
5E. Other					
6. Waste	54	57	59	57	61
6A. Solid Waste Disposal on Land					
6B. Wastewater Handling					
6C. Waste Incineration	54	57	59	57	61
6D. Other					
7. Other					
International Bunkers	390	410	417	421	440

Please see Figure 2.6 at the end of the chapter 2.

2.10. Carbon Monoxide

2.10. Carbon Monoxide

2.10.1. Outline of Emissions

Japan emitted approximately 3.9 million tons of carbon monoxide (CO) in fiscal 1994, almost all of which came from the Fuel Combustion Activities (1A) sector.

Table 2.13 shows emissions from fiscal 1990 through fiscal 1994. The overall amount of emissions has remained essentially stable. About 60% is emitted from the Transport (1A3) sector, of which 98% is generated by motor vehicles. Increases have been observed in the Waste Incineration (6C) subsector. Declines have occurred in the following subsectors: Energy Industries (1A1), Manufacturing Industries and Construction (1A2), and Other Sectors (1A4).

Figure 2.7 breaks down carbon monoxide emissions in fiscal 1994 according to sector. The Fuel Combustion Activities (1A) sector under Energy (1) accounted for 87% of all emissions, broken down in descending order into the following subsectors: Transport (1A3), Manufacturing Industries and Construction (1A2), Other Sectors (1A4), and Energy Industries (1A1). Nearly all of the emissions in the Transport (1A3) sector were from motor vehicles (2.31 million tons), which accounted for about 60% of total emissions in fiscal 1994. The Waste (6) sector accounted for 8% of total emissions, taking into account emissions generated in the Waste Incineration (6C) subsector.

2.10.2. Methods of Estimating Emissions

Energy (1): For the Energy Industries (1A1), Manufacturing Industries and Construction (1A2), and part of the Other Sectors (1A4) subsectors of the Fuel Combustion Activities (1A) sector, emissions were calculated for each soot and smoke emitting facility designated by the Air Pollution Control Law by multiplying the amount of fuel consumed (broken down by type of furnace and type of fuel) by the appropriate emission factor¹¹). This is a "bottom-up" approach. The remainder of the Other Sectors (1A4) subsector involves small boilers and fuel facilities, and emissions were calculated by multiplying the emission factors for different types of fuel and their applications by the amount of fuel consumed. The figure shown in the Transport (1A3) subsector includes emissions from motor vehicles, ships, aircraft, and railways (diesel railcars). Emissions for automotive vehicles were calculated by determining the total distance traveled by each type of vehicle and multiplying by the appropriate emission factor²²). In all others, the default emission factors from the IPCC/OECD Guidelines were used.

Agriculture (4): Values shown take into account carbon monoxide emissions generated in the Field Burning of Agricultural Residues (4F) subsector.

Land-Use Change & Forestry (5): Consideration was given to the burning of biomass that accompanies the conversion of forest land to other uses, and calculations were made on the basis of default methods indicated in the IPCC/OECD Guidelines.

Waste (6): For the Waste Incineration (6C) subsector, the amount of waste processed in the Waste Incinerator designated by the Air Pollution Control Law was multiplied by the appropriate emission factor¹¹).

Other (7): Carbon monoxide emissions from tobacco smoke were calculated by multiplying the amount of carbon monoxide generated by each smoked item²³) by the total number of items smoked²⁴).

Table 2.13 Carbon Monoxide Emissions (Fiscal 1990-1994)

(Unit: Gg)

Fiscal Year	1990	1991	1992	1993	1994
Total	3888	3850	3821	3824	3862
1. All Energy	3441	3356	3326	3308	3336
1A. Fuel Combustion Activities	3441	3356	3326	3308	3336
1A1. Energy Industries	85	80	70	69	69
1A2. Manufacturing Industries and Construction	888	873	804	798	823
1A3. Transport	2370	2311	2361	2352	2358
1A4. Other Sectors	98	94	92	89	86
1A5. Other					
1B. Fugitive Emissions from Fuels					
1B1. Solid Fuels					
1B2. Oil and Natural Gas					
2. Industrial Processes					
3. Solvent and Other Product Use					
4. Agriculture	162	165	161	174	172
4A. Enteric Fermentation					
4B. Manure Management					
4C. Rice Cultivation					
4D. Agricultural Soils					
4E. Prescribed Burning of Savannas					
4F. Field Burning of Agricultural Residues	162	165	161	174	172
4G. Other					
5. Land-Use Change & Forestry	22	35	35	35	35
5A. Changes in Forest and Other Woody Biomass Stocks					
5B. Forest and Grassland Conversion	22	35	35	35	35
5C. Abandonment of Managed Lands					
5D. CO ₂ Emissions and Removals from Soil					
5E. Other					
6. Waste	245	276	281	287	300
6A. Solid Waste Disposal on Land					
6B. Wastewater Handling					
6C. Waste Incineration	245	276	281	287	300
6D. Other					
7. Other	18	18	18	18	18
International Bunkers	56	59	60	60	63

Please see Figure 2.7 at the end of the chapter 2.

2.11. Non-Methane Volatile Organic Compounds

2.11. Non-Methane Volatile Organic Compounds

2.11.1. Outline of Emissions

Japan generated approximately 1.9 million tons of non-methane volatile organic compounds (NMVOC) emissions in fiscal 1994, generated primarily in the Energy (1), Industrial Processes (2), and Solvent and Other Product Use (3) sectors.

Table 2.14 shows emissions from fiscal 1990 through fiscal 1994, broken down by sector. Overall emissions have declined slightly, reflecting a decline in the Solvent and Other Product Use (3) sector, which is the main source of emissions. A slight decline has also occurred in the Fuel Combustion Activities (1A) subsector, while a slight increase has occurred in the Fugitive Emissions from Fuels (1B) subsector. Other sectors have remained stable.

Figure 2.8 breaks down non-methane volatile organic compounds emissions in fiscal 1994 according to sector. Emissions were greatest in the Solvent and Other Product Use (3) sector, followed in descending order by the Energy (1) and Industrial Processes (2) sectors. The Solvent and Other Product Use (3) sector accounts for 71% of the total and includes emissions generated through the use of paints, oil removers and dry cleaning, and chemical products. The subsectors Fuel Combustion Activities (1A) and Fugitive Emissions from Fuels (1B) of the Energy (1) sector account for 13% and 12% of the total, respectively.

2.11.2. Methods of Estimating Emissions

Energy (1): For the Energy Industries (1A1), Manufacturing Industries and Construction (1A2), and part of the Other Sectors (1A4) subsectors of the Fuel Combustion Activities (1A) sector, emissions were calculated for each soot and smoke emitting facility designated by the Air Pollution Control Law by multiplying the amount of fuel consumed (broken down by type of furnace and type of fuel) by the appropriate emission factor¹¹⁾. This is a “bottom-up” approach. The remainder of the Other Sectors (1A4) subsector involves small boilers and fuel facilities, and emissions were calculated by multiplying the emission factors for different types of fuel and their applications by the amount of fuel consumed. The figure shown in the Transport (1A3) subsector includes emissions from motor vehicles, ships, aircraft, and railways (diesel railcars). Emissions for motor vehicles were calculated by determining the total distance traveled by each type of vehicle and multiplying by the appropriate emission factor²²⁾. In all others, the default emission factors of the IPCC/OECD Guidelines were used. Values shown in the Fugitive Emissions from Fuels (1B) subsector represent emissions from evaporation occurring during the handling of crude oil and petroleum products. The activity for this subsector included the amounts handled or the amounts shipped¹²⁾, which were multiplied by the appropriate emission factor in accordance with how the materials were handled²⁵⁾.

Industrial Processes (2): The amounts emitted through the manufacture of petroleum products (primarily in the petrochemical industry) were considered. The amounts of such products produced²⁶⁾ were multiplied by the appropriate emission factor²⁵⁾.

Solvent and Other Product Use (3): The amounts of products produced or consumed in each application²⁶⁾ were multiplied by the appropriate emission factor²⁵⁾.

Waste (6): For the Waste Incineration (6C) subsector, the amount of waste processed in the Waste Incinerator designated by the Air Pollution Control Law was multiplied by the appropriate emission factor¹¹⁾.

Table 2.14 Non-Methane Volatile Organic Compounds Emissions (Fiscal 1990-1994) (Unit: Gg)

Fiscal Year	1990	1991	1992	1993	1994
Total	1966	1894	1865	1823	1873
1. All Energy	497	448	453	449	460
1A. Fuel Combustion Activities	297	245	244	240	242
1A1. Energy Industries	8	8	7	7	7
1A2. Manufacturing Industries and Construction	23	10	9	9	9
1A3. Transport	238	199	202	200	202
1A4. Other Sectors	28	28	26	24	23
1A5. Other					
1B. Fugitive Emissions from Fuels	200	204	208	210	218
1B1. Solid Fuels					
1B2. Oil and Natural Gas	200	204	208	210	218
2. Industrial Processes	81	81	80	76	79
3. Solvent and Other Product Use	1388	1364	1333	1297	1333
4. Agriculture					
4A. Enteric Fermentation					
4B. Manure Management					
4C. Rice Cultivation					
4D. Agricultural Soils					
4E. Prescribed Burning of Savannas					
4F. Field Burning of Agricultural Residues					
4G. Other					
5. Land-Use Change & Forestry					
5A. Changes in Forest and Other Woody Biomass Stocks					
5B. Forest and Grassland Conversion					
5C. Abandonment of Managed Lands					
5D. CO ₂ Emissions and Removals from Soil					
5E. Other					
6. Waste	0	0	0	0	0
6A. Solid Waste Disposal on Land					
6B. Wastewater Handling					
6C. Waste Incineration	0	0	0	0	0
6D. Other					
7. Other					
International Bunkers	13	14	14	14	15

Please see Figure 2.8 at the end of the chapter 2.

2.12. Sulfur Dioxide

2.12. Sulfur Dioxide

2.12.1. Outline of Emissions

Sulfur dioxide (SO₂) is a precursor related to the formation of aerosols in the atmosphere. Sulfur dioxide is included in the greenhouse gas inventory for the first time. Japan emitted approximately 850,000 tons of sulfur dioxide in fiscal 1994.

Table 2.15 shows emissions from fiscal 1990 through fiscal 1994, broken down by sector. Overall emissions have declined slightly, reflecting slight declines in the following sectors and subsectors: Manufacturing Industries and Construction (1A2); Transport (1A3); Other Sectors (1A4); and Industrial Processes (2). The Energy Industries (1A1) sector has shown fluctuation, and the Waste Incineration (6C) subsector has shown a steady increase.

Figure 2.9 breaks down sulfur dioxide emissions in fiscal 1994 according to sector. Emissions were greatest in the Manufacturing Industries and Construction (1A2) subsector, accounting for 42% of the total. The Energy Industries (1A1) subsector accounted for 30%. The Industrial Processes (2) sector includes emissions generated when sulfide minerals are smelted, accounting for 4% of the total.

2.12.2. Methods of Estimating Emissions

Energy (1): For the Energy Industries (1A1), Manufacturing Industries and Construction (1A2), and part of the Other Sectors (1A4) subsectors of the Fuel Combustion Activities (1A) sector, emissions were calculated for each soot and smoke emitting facility designed by the Air Pollution Control Law by multiplying the amount of fuel consumed (broken down by type of furnace and type of fuel) by the appropriate emission factor¹¹⁾. This is a "bottom-up" approach. The remainder of the Other Sectors (1A4) subsector involves small boilers and fuel facilities, and emissions were calculated by multiplying the emission factors for different types of fuel and their applications by the amount of fuel consumed. The figure shown in the Transport (1A3) subsector includes emissions from automotive vehicles only.

Industrial Processes (2): Estimates were made for sulfur dioxide emissions from soot and smoke emitting facilities designated by the Air Pollution Control Law¹¹⁾.

Waste (6): For the Waste Incineration (6C) subsector, the amount of waste processed in the Waste Incinerator designated by the Air Pollution Control Law was multiplied by appropriate emission factor¹¹⁾.

Table 2.15 Sulfur Dioxide Emissions (Fiscal 1990-1994)

(Unit: Gg)

Fiscal Year	1990	1991	1992	1993	1994
Total	966	976	895	814	847
1. All Energy	886	890	819	738	769
1A. Fuel Combustion Activities	886	890	819	738	769
1A1. Energy Industries	243	246	251	230	258
1A2. Manufacturing Industries and Construction	389	371	349	353	351
1A3. Transport	186	202	150	88	91
1A4. Other Sectors	69	72	69	67	69
1A5. Other					
1B. Fugitive Emissions from Fuels					
1B1. Solid Fuels					
1B2. Oil and Natural Gas	43	51	36	37	37
2. Industrial Processes					
3. Solvent and Other Product Use					
4. Agriculture					
4A. Enteric Fermentation					
4B. Manure Management					
4C. Rice Cultivation					
4D. Agricultural Soils					
4E. Prescribed Burning of Savannas					
4F. Field Burning of Agricultural Residues					
4G. Other					
5. Land-Use Change & Forestry					
5A. Changes in Forest and Other Woody Biomass Stocks					
5B. Forest and Grassland Conversion					
5C. Abandonment of Managed Lands					
5D. CO ₂ Emissions and Removals from Soil					
5E. Other					
6. Waste	37	34	39	39	41
6A. Solid Waste Disposal on Land					
6B. Wastewater Handling					
6C. Waste Incineration	37	34	39	39	41
6D. Other					
7. Other					
International Bunkers					

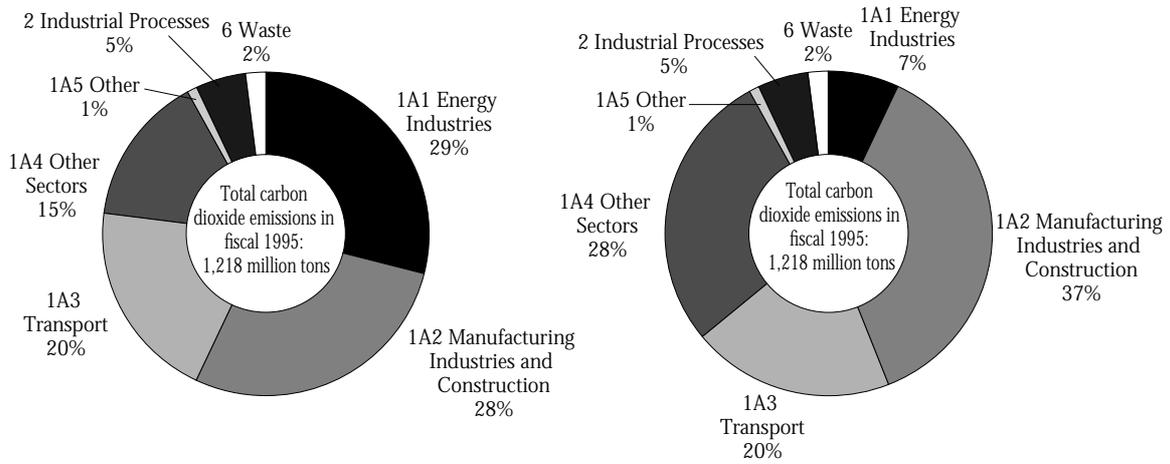
Please see Figure 2.9 at the end of the chapter 2.

Source

Source

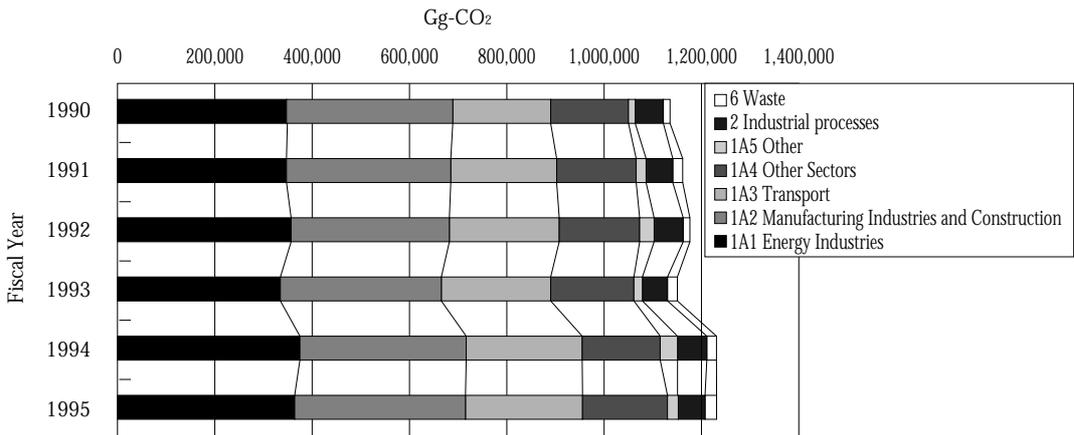
- 1) IPCC (1995): IPCC Guidelines for National Greenhouse Gas Inventories.
- 2) IPCC (1997): Revised IPCC 1996 Guidelines for National Greenhouse Gas Inventories (in printing).
- 3) Agency of Natural Resources and Energy: "Comprehensive Energy Statistics."
- 4) Environment Agency: "The Estimation of CO₂ Emission in Japan (1992)."
- 5) Ministry of International Trade and Industry (MITI): "Statistical Yearbook of Resources."
- 6) MITI: "Statistical Yearbook for the Ceramics and Building Materials Industries."
- 7) MITI: "Current Survey of Energy Consumption in Commerce, Mining and Manufacturing."
- 8) Forestry Agency: "Statistical Handbook of Forestry."
- 9) Japan Environmental Sanitation Center (Incorporated Foundation): "Municipal Waste Composition Analysis."
- 10) Ministry of Health and Welfare (MHW): "Industrial Waste Administration Research."
- 11) Environment Agency: "Research of Air Pollutants Emissions from Stationary Sources."
- 12) MITI: "Statistical Yearbook on Energy Supply and Demand."
- 13) Ministry of Agriculture, Forestry and Fisheries (MAFF): "Report of Livestock."
- 14) Japan Livestock Technology Association: "Control of Emissions of Greenhouse Gases from Livestock Farming (1st Ed.) (1996)."
- 15) MAFF: "Crop Statistics."
- 16) Y. Matsuzawa et al: "Estimate of the Methane Emissions from Final Disposal Landfill Site," from the proceedings of the 4th Annual Conference of the Japan Society of Waste Management Experts, pp 433-436 (1993).
- 17) Production amounts were determined through manufacturer hearings; emission factors were derived from a study conducted by Miyazaki Prefecture and the Environment Agency (1995) entitled: "Study of Greenhouse Gases Emission Factor from Stationary Sources."
- 18) Production amounts from MITI: "Statistical Yearbook on the Chemical Industry." Emission factors determined through manufacturer hearings.
- 19) MHW: "Statistics of Production by Pharmaceutical Industry."
- 20) Amounts of fertilizer used determined through the MAFF: "Pocket Handbook of Fertilizers." Emissions factors determined through studies by the MAFF
- 21) The amount of incinerated sewage sludge determined through studies by the Japan Sewage Works Association. Emissions factors determined by the Public Works Research Institute of the Ministry of Construction (1994): "Technical Memorandum of PWRI No. 3374."
- 22) Distances traveled were based on data from the Ministry of Transport: "Statistical Yearbook of Motor Vehicle Transport." Emissions factors were based on Environment Agency materials.
- 23) Data from manufacturer hearings.
- 24) Tobacco Institute of Japan: "Total Domestic Cigarette Consumption."
- 25) Environment Agency materials.
- 26) MITI: mostly from the "Statistical Yearbook on the Chemical Industry."

Figure 2.1 Breakdown of Carbon Dioxide Emissions
(Values in the figure at right allocate power-generation emissions to the end-use sectors where the power is ultimately consumed.)



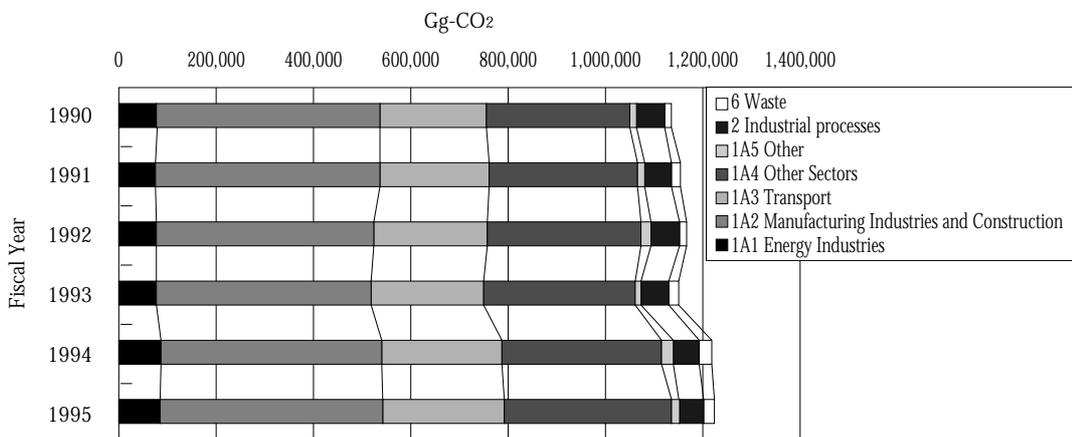
Note: Emissions and removals from Land-Use Change & Forestry (5) are not included.

Figure 2.2 Breakdown of Carbon Dioxide Emissions by Sector (Fiscal 1990-1995)



Note: Emissions and removals from Land-Use Change & Forestry (5) are not included.

Figure 2.3 Breakdown of Carbon Dioxide Emissions by Sector (Fiscal 1990-1995)



Note: (Values allocate power-generation emissions to the end-use sectors where the power is ultimately consumed.) Emissions and removals from Land-Use Change & Forestry (5) are not included.

Figure 2.4 Breakdown of Methane Emissions (Fiscal 1994)

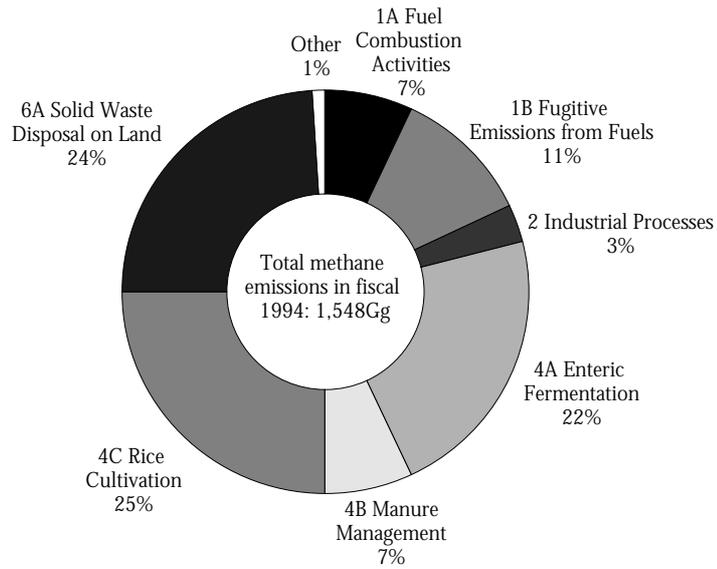


Figure 2.5 Breakdown of Nitrous Oxide Emissions (Fiscal 1994)

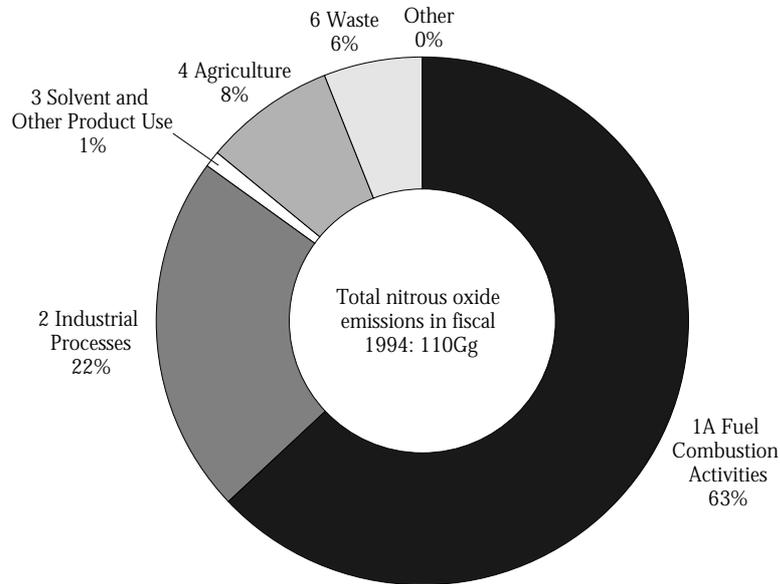


Figure 2.6 Breakdown of Nitrogen Oxide Emissions (Fiscal 1994)

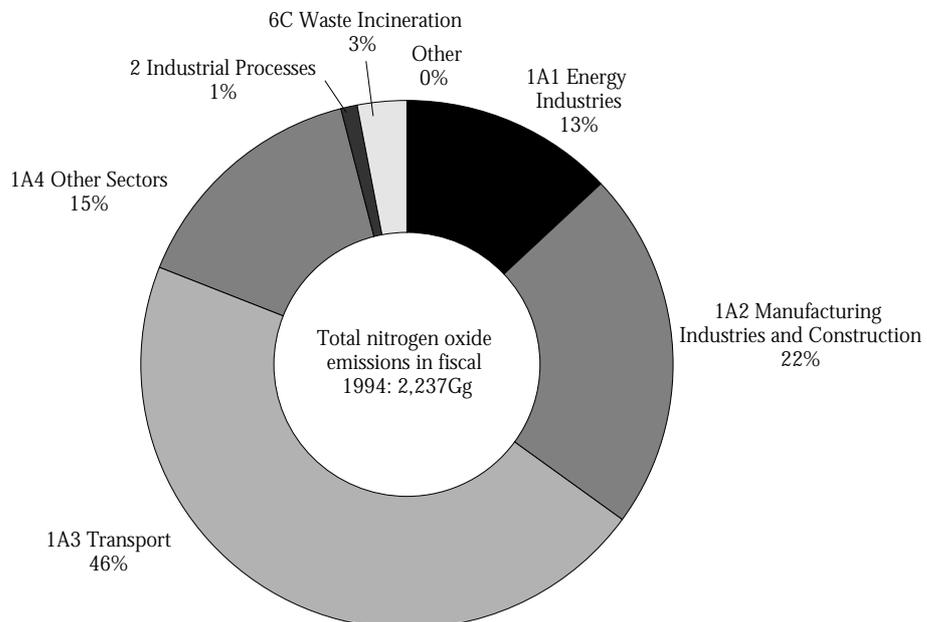


Figure 2.7 Breakdown of Carbon Monoxide Emissions (Fiscal 1994)

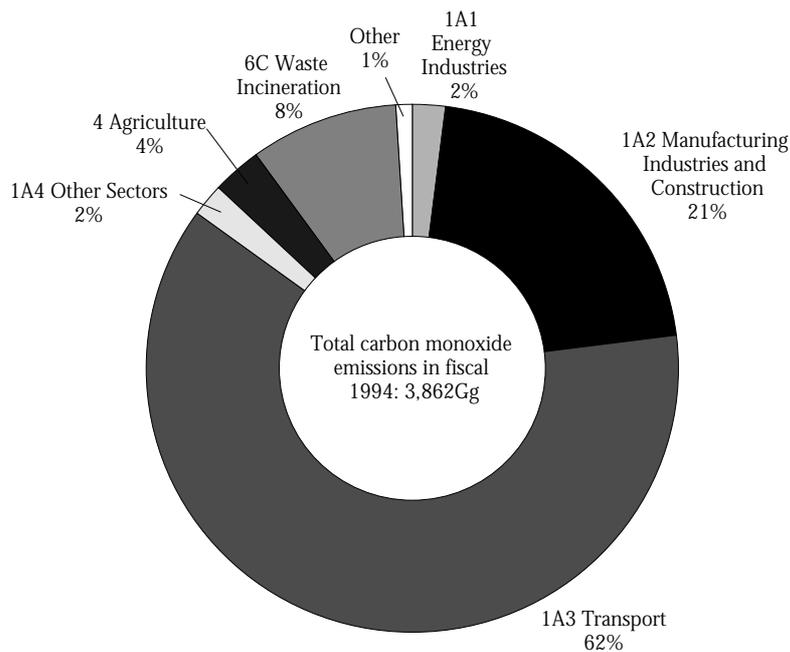


Figure 2.8 Breakdown of Non-Methane Volatile Organic Compounds Emissions (Fiscal 1994)

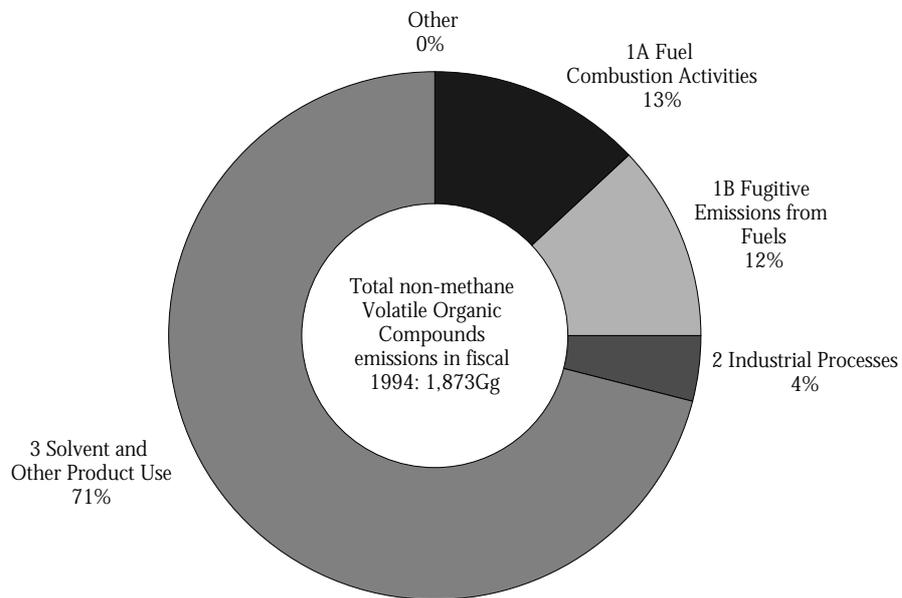
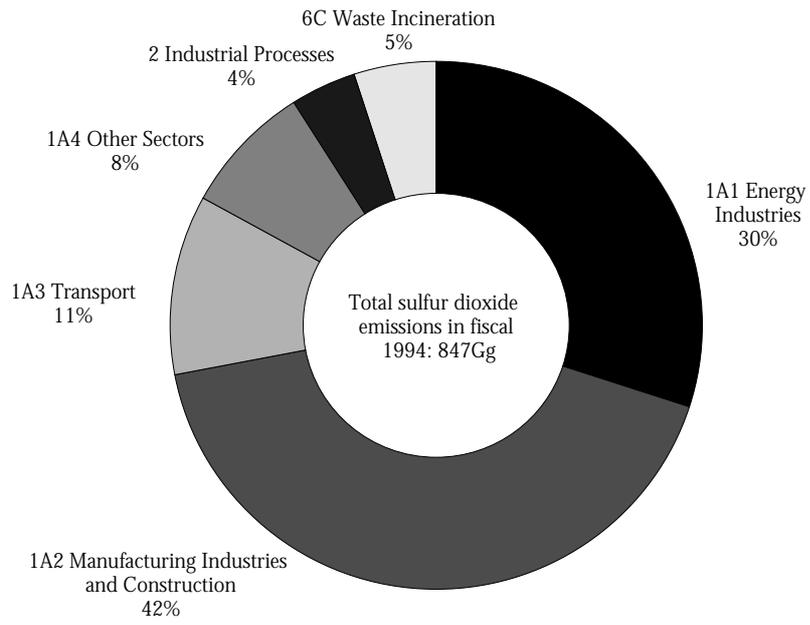


Figure 2.9 Breakdown of Sulfur Dioxide Emissions (Fiscal 19 94)



Chapter 3

Policies and Measures

■ *Japan's System for Addressing Global Warming*

1. **The Japanese Government's Action Program to Arrest Global Warming**

To systematically and comprehensively formulate countermeasures against global warming, the Council of Ministers for Global Environment Conservation (See Chapter 1, "Government Administration" section) adopted an Action Program to Arrest Global Warming in October 1990. This Action Program corresponds to Japan's plan as stipulated by Article 4.1(b) of the United Nations Framework Convention on Climate Change.

The Action Program extends through the year 2010, but also establishes the following interim goals for the year 2000:

(1) Carbon dioxide

- ① Through the utmost efforts of both the public and private sectors, the wide-ranging measures included in this Program should be steadily implemented, as they become feasible, so that carbon dioxide emissions on a per capita basis in the year 2000 and beyond will be stabilized at approximately the same level as in 1990.
- ② In conjunction with ① above, efforts should be made to stabilize carbon dioxide emission in the year 2000 and beyond at approximately the same level as in 1990 through progress in developing innovative technologies, etc., such as solar, hydrogen, and other new forms of energy, as well as carbon-dioxide fixing technologies, more rapidly and on a broader scale than currently forecasted.

(2) Methane

Methane emissions should not exceed the present level. All possible means will also be employed to prevent further rises in nitrous oxide and other greenhouse gases emissions.

In addition, Japan is committed to taking steps to establish carbon dioxide sinks through the domestic conservation and development of forests and greenery in urban areas, while actively participating in efforts to protect and expand forests on a global scale.

The Action Program contains provisions in the following areas: measures to control carbon dioxide emissions; measures to control methane and other greenhouse gases emissions; measures to enhance carbon dioxide sinks; surveys and research; observation and monitoring; technical development and dissemination; promotion of public awareness; and international cooperation. The specific content is discussed in this chapter and in chapters 7, 8, and 9. Progress reports regarding all measures are submitted every year to the Council of Ministers for Global Environment Conservation. As for the results in fiscal 1996, reports were submitted concerning 406 measures, of which 57 were newly formulated.

2. **Basic Environment Law and Basic Environment Plan**

Currently, Japan's environmental policies are based on the Basic Environment Law (enforced in November 1993) and on the Basic Environment Plan (decided by the Cabinet in December 1994), which is itself based on the Basic Environment Law.

The Basic Environment Law was promulgated because it was realized that the existing Basic Law for Environmental Pollution Control and Nature Conservation Law could not sufficiently cope with global warming and other worldwide environmental problems, or with problems associated with waste. The Basic Environment Law clarifies Japan's fundamental principle concerning environment conservation and publicly states the fundamental principles underlying the policies stipulated in the Basic Environment Plan concerning environmental conservation. Other basic

issues covered by the plan include: formulating environmental standards; implementing Regional Environmental Pollution Control Programs; giving consideration to environmental concerns in national policies; promoting environmental impact assessment; formulating economic subsidiary measures on surcharges that prevent obstructions to environmental conservation; promoting facility installation and other activities related to environmental conservation; encouraging the use of products and other items that contribute to lightening the load on the environment; fostering environmental education; encouraging voluntary activities in the private sector; promoting science and technology; and formulating measures regarding international cooperation, cost burdens and financial arrangements in connection with global environmental conservation.

The Basic Plan cites four concepts that are the long-term goals of Japan's environmental policy: 1) the realization of a "sound material cycle" socioeconomic system that minimizes the burden on the environment; 2) the promotion of "harmonious coexistence" between human beings and the many other forms of nature and life on the planet; 3) the "participation" of people from all walks of life in the effort to conserve the environment; and 4) an "international activities." Countermeasures against global warming fall within the category of measures designed to foster a "sound material cycle" socioeconomic system within the context of atmospheric environmental conservation. Specifically, the Basic Plan states the following:

"Climate change is a global problem that cannot be fully addressed by any single country. Ultimately, therefore, Japan seeks to achieve the following goal in conjunction with other countries, as stipulated in the United Nations Framework Convention on Climate Change: the 'stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.' (lacuna)

"In the mid-term, the advanced industrialized countries recognize that the participation of all parties to the Framework Convention is essential and that further consideration must be given to clarifying measures to be implemented after 2000. Therefore, Japan will work to build an international framework while making even greater positive efforts to implement appropriate policies in conjunction with other countries.

In the short-term (lacuna), Japan is committed to achieving the goals set forth in the Action Program to Arrest Global Warming. Therefore, it will make active efforts to pursue the following measures based on an understanding of the implementation status of the Program and an accumulation of its results and scientific findings, etc." (remainder omitted)

3. Efforts by Local Public Organizations

As noted in the "Government Administration" section of Chapter 1, local public organizations play an extremely important role in Japan's efforts to curb global warming. Although countermeasures against global warming are not included in official descriptions of these organizations' duties, many of them have their own regional programs to arrest global warming and are implementing policies accordingly. They are also steadily broadening their activities through participation in such forums as the Local Government Leaders' Summit on Climate Change and the Environment Summit of Designated Cities, which provide opportunities for discussion concerning global warming. It should therefore be noted that many of the policies discussed in this chapter are being actively implemented not just by the central government but also these local public organizations.

3.1. Carbon Dioxide Countermeasures

3.1.1. The Energy Conversion Sector

◆ The Approach of Policies and Measures

The energy conversion sector is where primary energy sources such as oil and coal are used to produce secondary energy sources such as electricity and city gas. Three steps are being taken in this sector to improve the efficiency of energy use, promote the formation of an energy supply structure that reduces carbon dioxide emissions, and, more recently, to undertake “demand side management” (DSM) to help level peak electric power loads during the summer months: first, efforts are being made to improve the efficiency of electric power generation; second, efforts are being undertaken to introduce energy sources that produce little or no carbon dioxide emissions; and third, policies are being formulated that will help energy suppliers curb demand.

3.1.1.1. Introduction of More Efficient Thermal Electric Power Generation

Improving the efficiency of thermal electric power generation is one of the effective ways to arrest global warming because it reduces the relative consumption of fossil fuels.

Until now, countermeasures for improving efficiency have also been promoted for economic reasons, and the efficiency has been improved by increasing the capacity of power-generating facilities, raising the temperatures and pressures used to produce steam, and introducing combined-cycle systems. As a result, the combined heat efficiency of thermal power plants (gross) improved from about 24% in the mid-1950s to about 37% in the mid-1960s, and now to about 39% in the mid-1990s. Because the improvement in thermal power plant efficiency contributes greatly to Japan’s overall energy efficiency, efforts must be continued to achieve further improvement in this area.

(1) Countermeasures for coal-fired power plants

Compared with other fossil fuels, coal emits high amounts of carbon dioxide per unit energy and is therefore in particular need of efficiency-improving measures. One of the effective ways to control carbon dioxide emissions from coal-fired plants is to introduce ultra-super-critical (USC) technology, pressurized fluidized-bed combustion (PFBC) technology, or integrated coal-gas combined cycle (IGCC) technology every time a new facility is built or an old facility is replaced.

In addition, the Japan Development Bank has established a system of low-interest financing for the construction of high-efficiency coal-fired thermal power plants.

(2) Countermeasures for LNG power plants

Because LNG emits less carbon dioxide per unit energy than those of other fossil fuels, its aggressive use in power generation is another effective way to combat global warming.

Current combined-cycle systems (which combine the use of gas and steam turbines) have achieved a heat efficiency in excess of 48% (with a gas-turbine intake temperature in the 1,300°C class). Furthermore, technical development is currently being pursued with the aim of achieving a heat efficiency of 50% or higher by further raising the gas-turbine intake temperature.

In addition, the Japan Development Bank has established a system of low-interest financing for the construction of high-efficiency LNG-fired thermal power plants.

3.1. Carbon Dioxide Countermeasures

(3) Development of Efficient Energy Supply Systems

High-efficiency energy supply systems currently under technical development include: more efficient power generation and electrothermal supply systems that improve overall efficiency; energy storage systems that boost the efficiency of facility operations; and systems that make use of dispersed energy sources.

Work on these various technologies is being conducted as part of the New Sunshine Project, a comprehensive development plan for energy-related environmental technologies. (From 1978 through 1992, this activity fell under the framework of the Moonlight Project, a plan dedicated to developing energy-conserving technologies).

For information concerning the utilization of urban waste heat and other underutilized energy sources, refer to the sections dealing with the commercial and residential sectors.

① Superconducting Technologies

Practical superconducting technologies are being developed to enable the expansion of power-source capacities, and to alleviate problems (such as locating power-line construction sites and suffering increased power loss during transmission) that are encountered as power plants are built further away from the areas where the energy is consumed. Research and development is also being carried out on superconducting generators, total systems, and refrigeration systems.

② Distributed Electrical Energy Storage System

It is also necessary to study ways of controlling carbon dioxide emissions throughout the entire power supply and consumption system by improving the efficiency of power storage technologies. Specifically, this means taking such steps as: developing power storage systems that use the high-performance characteristics of lithium batteries; reassessing low-efficiency storage systems such as pumped-water power generation plants located in the mountains far from where the power is consumed; establishing power storage plants that use NaS batteries and other technologies that can be located close to consumers; and encouraging consumers to install their own high-efficiency storage systems.

3.1.1.2. Introduction of Energy Sources That Produce Little or No Carbon Dioxide Emissions

(1) Development and Use of Nuclear Power Premised on the Assurance of Safety

Nuclear power has already been one of Japan's main sources of electricity, accounting for 29.4% of total power output in fiscal 1995. It is also the most practical of all energy sources that do not rely on fossil fuels, and features a power-generating process that does not emit carbon dioxide.

The IPCC Second Assessment Report states that nuclear power could potentially replace fossil fuel power generation for base-load in many regions of the world if measures can be formulated to gain public acceptance regarding such issues as reactor safety and the disposal of radioactive waste. On the basis of the Atomic Energy Basic Law and other legislation, Japan continues to enhance its abilities to process and dispose of radioactive waste and, premised on the assurance of safety, is forging ahead with the development and use of nuclear power while working to gain public understanding by ensuring transparency through the full disclosure of information.

(2) Hydroelectric Power

Given Japan's steep, mountainous topography, hydroelectric power is Japan's greatest domestic energy resources, and also has the advantage of not emitting carbon dioxide. In fiscal 1996, Japan possessed a hydroelectric power-generating capacity of approximately 44.4 million kW, representing about 19.0% of total capacity.

(3) Geothermal Power

Japan's wealth of volcanic activity makes geothermal power another valuable source of clean energy that does not produce carbon dioxide, sulfur oxide, or nitrogen oxide. As of fiscal 1996, Japan had a geothermal power-generating capacity of 530,000 kW, accounting for 0.2% of total capacity.

Efforts are currently being made to develop the following technologies: investigative technologies that will reduce the risks associated with finding new geothermal power resources; technologies that enable the use of such potential energy sources that have not yet been exploited as medium-hot water and hot dry rocks, and deep geothermal resource survey and extraction technologies that will have an immediate effect in expanding the production capacities of existing geothermal sites. In these and other ways, the amount of electricity generated by geothermal means is expected to expand.

(4) Development and Dissemination of New Energy Sources

The development and dissemination of new energy sources is an important element in efforts to curb carbon dioxide emissions because it reduces reliance on fossil fuels. Therefore, efforts must be made to promote technical development and provide financial support for the introduction of new and renewable energy technologies.

The expansion and dissemination of solar power and other new energy sources is an extremely important part of efforts to control carbon dioxide emissions. Therefore, efforts are being made in various fields on the basis of the Basic Guideline for New Energy Introduction (adopted by the Ministerial Council for Comprehensive Energy Measures in December 1994) and other programs.

The development of new energy sources is also being pursued as part of the New Sunshine Project, a comprehensive development plan for energy-related environmental technologies (and, from 1974 to 1992, under the Sunshine Project, a program dedicated to developing new energy technologies).

① Solar and Solar-thermal Power Generation

The introduction of solar power helps combat global warming in two ways: first, solar power plants do not emit pollutants into the atmosphere when the electricity is generated; and second, the "life cycle" of solar power systems (which takes into account the various manufacturing processes involved) generates less carbon dioxide than power generation systems that depend on fossil fuels. The basic technologies for solar power generation are essentially already developed. As of the end of March 1996, Japan had a solar power generating capacity of about 39,000 kW. Cost is the main obstacle to further dissemination, as solar-generated power is three to four times more expensive than thermal-generated power for the average household. Efforts are therefore being made to lower costs and to offer incentives for the initial introduction of solar power.

To promote the introduction of solar power generating systems, the gov-

3.1. Carbon Dioxide Countermeasures

ernment offers large-scale assistance for residential solar systems and supports the introduction of such systems in public facilities. It has also compiled a manual to encourage regional public organizations to introduce solar power systems, and is conducting research concerning various applications for solar power, including noise barrier walls and other road-related facilities, and beverage vending machines. Also, efforts are being made to raise public awareness of the purchasing system for surplus electricity that power companies have established through the use of special time-of-day residential lighting contracts; to use the purchasing system more fully; and to improve the practicality of solar power generation systems that are built into construction materials.

For more information about the commercial and residential use of solar power systems, refer to the sections dealing with the commercial and residential sectors. Technical development is under way for industrial use.

② Wind Power Generation

Research has been conducted on 100 kW wind-activated power plants, and the technology for small and midsize wind-activated power plants has essentially been established. Applications, however, are still limited to testing and research, isolated islands, and demonstrations, with a total generating capacity of about 9,500 kW as of the end of March 1996. Future issues that must be addressed include: concentrating facilities in locations with favorable wind conditions; improving efficiency by increasing the size of the generating facilities; establishing aggregate wind-power generation systems that can generate electrical power on an appropriate scale; improving system reliability and durability; and reducing noise. Since fiscal 1990, control technology has been developed for large-scale, 500 kW class power generation systems and for concentrated power generation systems (consisting of two 250 kW generators and three 400/100 kW generators). Since fiscal 1995, surveys have been conducted on wind conditions and verification tests implemented on system designs. In addition, a map of wind conditions is being prepared that shows the average annual wind speed in all regions of Japan, and a manual compiled to promote the introduction of wind-activated systems. The electric power companies, too, are continuing to implement a system for purchasing surplus electricity in order to stabilize and facilitate the operations of wind-activated facilities until they can be successfully commercialized.

Because of Japan's unique climatic and geographical conditions, however, the areas where wind power can be introduced are somewhat limited. Despite these, the efforts outlined above have had some effect in reducing the cost of wind power (which is currently two to three times more expensive than thermal power).

③ Waste Power Generation

Burning waste instead of fossil fuels in thermal power plants is one of the important ways Japan can reduce carbon dioxide emissions as a whole. The maximum generating efficiency of conventional waste-fired plants is a low 15%, however, because the steam temperature must be set below 300°C to prevent corrosion in the boiler and other equipment. Improvement in generating efficiency would permit an expansion of waste-generated power output capacity, thus making waste a more viable alternative to fossil fuels.

Four types of technology currently hold promise as practical ways to improve generating efficiency: (1) high-temperature, high-pressure waste

power generation; (2) super refuse power generation (waste power generation combined with gas turbine); (3) refuse derived fuel (RDF) power generation (which uses waste that has been converted to solid fuel); and (4) steam spray type waste power generation (conventional type of waste power generation). Japan aims to introduce these technologies to expand the nation's total waste-fired generating capacity to about 2 million kW by around 2000 and to about 4 million kW by around 2010.

As part of its efforts to establish more waste-fired power generating facilities, the central government provides support to regional public organizations for the construction, expansion and renovation of facilities, as well as for the construction of plants that convert waste into solid fuel. Also, in fiscal 1995, for the purpose of reducing costs of generation and promoting the introduction of waste-fired power generation, it established a subsidy system to help cover waste-fired plant costs according to the output capacity of the plant in question. Similarly, subsidies are available to help cover construction costs for parts of power generating plants using digestive gas from sewage treatment in sewer facilities. In addition, the unit purchase price for waste-fired power was raised as part of the purchasing program for surplus electricity implemented by the electric power companies.

Local public organizations have also been permitted to issue local bonds for the business part in the case of waste power generating facilities (since fiscal 1992) and super refuse power generating facilities (since fiscal 1993) constructed inside municipal solid waste treatment plants. Since fiscal 1994, it has been permitted for local bonds to be issued for RDF power generation undertakings, with further local finance measures formulated in fiscal 1996.

In fiscal 1992, the Japan Development Bank began providing financing to operators who introduced waste-burning power-generating facilities in their plants. In addition, it established an interest-subsidy system for operators who installed equipment that utilizes heat generated from burning waste. The Japan Environment Corporation similarly provides loans to operators who install equipment built into industrial waste disposal facilities that make efficient use of surplus heat.

④ Fuel Cells

Regardless of the scale of the facility in which they're used, fuel cells have a high electrical power generating efficiency ranging from 40% to 60%. When used in combination with a system that utilizes waste heat, overall efficiency increases to 80%. Either way, fuel cells generate relatively little carbon dioxide. Also, because the size of the facility can be freely chosen, fuel cells are useful in a wide range of applications. At one extreme, they can replace midsize and large thermal power plants; at the other, they can be used as on-site power plants for facilities capable of accommodating in-house electrothermal supply, or even as a portable power source. Field tests are currently being conducted on phosphoric acid fuel cells and molten carbonate fuel cells with the aim of developing new technologies, improving equipment, and enhancing performance. Although phosphoric acid fuel cells are not yet in full-fledged use, they are currently generating 30,000 kW in Japan, which is more than in any other country.

3.1. Carbon Dioxide Countermeasures

⑤ Ocean Energy

Various kinds of wave power-generation technologies are being developed, including: floating oscillating-water-column systems; shore-fixed systems; pendulum systems; and wave-energy-absorption breakwater systems that convert the energy of the waves into the flow of air. Approximately 1,000 wave-activated generators are currently used on navigational buoys etc. in Japan.

Regarding ocean-thermal-conversion power-generation systems, closed cycle technologies are being developed that use ammonia and other media. Although demonstration operations have been completed at a pilot plant, it seems unlikely that a power plant based solely on this technology will be economically feasible. As for open-cycle systems that use seawater as the direct working fluid, basic research has been conducted in an effort to improve condenser performance.

⑥ Biomass Energy

Progress is being made in the technical development of methods for utilizing biomass energy, including technologies that convert biomass into liquid fuel for automotive engines and technologies that will permit the utilization of currently unused waste material. Since organic materials such as sugar beet fiber, rice straw, discarded wood material and other cellulose resources cannot compete with food, they are appropriate for use as raw material in the production of fuel alcohol. Work is therefore being conducted on technologies for producing ethanol and other alcohols by using microorganisms and enzymes to saccharify and ferment these resources. Research is also being conducted focusing on separating and concentrating biomass fuel by means of a membrane process.

⑦ Hydrogen Energy

Elemental technical development is being pursued on the use of hydrogen energy, an extremely clean secondary energy source that generates no carbon dioxide when burned.

(5) Promoting the Introduction of LNG in Gas Company Operations

The most effective ways to save energy and reduce carbon dioxide emissions in manufacturing city gas are to reduce energy consumption during the converting of raw materials (LNG, etc.) into a non-reforming state and the supply phase.

It is expected to improve the efficiency during the city gas production phase by promoting the conversion of reformed materials (oil and coal, with an efficiency ratio of 79.7%) to non-reformed materials (natural gas, with an efficiency ratio of 99.9%).

The Japan Development Bank has several programs that encourage the introduction of appropriate conversion technologies, including low-interest, long-term financing; a program of tax incentives that promotes investment in the structural improvement of energy supply systems; and an interest subsidy program that helps offset conversion costs, thereby promoting the use of natural gas by regional city gas companies.

3.1.1.3. Measures to Support the Dissemination of New and Renewable Energy Supply Systems

Various financial, tax, and systemic support measures have been formulated that 1) promote cogeneration, solar power, and other new energy technologies that are already basically established but not yet adequately disseminated because of their

high costs; 2) promote the installation of facilities that level energy demand; and 3) promote the regional introduction of new energy systems.

The national government plans to quickly establish the market autonomy of solar power generation by providing large-scale assistance over a concentrated period of time with the aim of greatly reducing costs through the effects of mass production. Also, efforts are being made to promote the use of the power companies' surplus power purchasing menus, which make use of optional time-of-day lighting contract, and studies are being pursued to promote the practical application of solar power generating systems that are built into construction materials.

(1) Financial and Tax Measures

The Japan Development Bank and other lending institutions offer low-interest, long-term financing to operators who install solar, wind, cogeneration and other new energy systems.

Similarly, a program of tax incentives that promotes investment in the structural improvement of energy supply systems has been established to encourage the installation of such facilities as: solar power generation facilities; wind power generation facilities; equipment that uses geothermal heat; equipment that uses solar heat; fuel cells; waste power generation equipment; and gas turbines used in combined-cycle generation systems. In addition, tax reductions on fixed assets are available for certain types of facilities that utilize localized energy sources such as solar and wind power.

Subsidies are also available to regional public organizations that adopt a positive stance toward introducing new energy systems in an extensive and concentrated manner. Also, an interest subsidy system has been adopted for local development and use of new and renewable energy promoted by local public organizations and/or private organizations.

(2) Deregulation and Other Systemic Measures

Japanese electric power companies are subject to regulations based on the Electricity Utilities Industry Law, including a requirement to receive government approval for the construction plans of structures used for electric power generation. In 1990, however, these regulations were relaxed for solar, wind and fuel-cell power generation plants with regard to such requirements as notification of construction plans and appointment of main engineers.

Progress has been made on establishing guidelines for technical requirements for interconnecting commercial electric power systems with power generating facilities. In October 1995, an overall review of the guidelines was conducted and requirements were clarified to ensure a higher degree of transparency and fairness.

In February 1994, a purchasing menu was established for surplus electricity produced by such dispersed sources as solar, wind, waste, and cogeneration power-generation facilities.

(3) Legislative Measures

* Law Concerning Promotion of the Use of New and Renewable Energy

To promote the development and introduction of energy-efficient systems that use fewer resources and reduce the burden on the environment, the Japanese government formulates and publicizes basic policies concerning the use of new energy sources. Based on these policies, the government also requires energy users (citizens, businesses, etc.), energy suppliers, and manufacturers and importers to make efforts to promote the use of new energy sources. In addition, the government provides guidance and advice con-

3.1. Carbon Dioxide Countermeasures

cerning how energy users can promote the use of new energy sources.

Furthermore, the government provides loan guarantees and implements other support systems to help operators that sell wind-generated electricity and otherwise attempt to utilize new energy sources.

3.1.1.4. Measures to Control Demand (Including Load Leveling)

Demand-side management (DSM), which sets different electricity usage fees depending on the time of day, has been introduced to accommodate the difference between daytime and nighttime energy demand. In addition, energy storage systems such as pumped storage generators and thermal storage tanks are being used, and studies are being conducted on a new power storage system adjacent to the area where the power is consumed such as seawater-pumped-storage generators and compressed-air-storage gas turbine generators. Technologies being researched for future use include super heat-pump energy collection systems that store waste heat and other forms of heat at high densities, and dispersed-type power storage batteries.

Other activities aimed at leveling out power loads include: the implementation of interest subsidies, low-interest loans, and tax incentives (through a program that promotes investment in the structural improvement of energy supply systems) for thermal-storage air conditioning systems and gas air conditioning systems; and the testing of load-centralized control systems that permit the energy supplier to directly control the equipment of energy consumers.

3.1.1.5. Improving the Efficiency of Petroleum Refining

The petroleum refining industry generates carbon dioxide emissions when it consumes energy to: 1) manufacture petroleum products through the refining of crude oil and other processes, and 2) transport petroleum products.

Progress is being made in introducing heat recovery systems and advanced energy-efficient equipment designed to improve the operating efficiency of present refineries. Also, revolutionary new oil refining technologies, including new high-performance catalysts, are being developed, and innovative practical technologies are being systematically introduced whenever existing facilities are renovated. Studies are also being conducted on replacing railway tank cars and tank trucks with pipelines in order to improve the long-term efficiency of the distribution system for petroleum products, reduce energy consumption, and control carbon dioxide emissions.

3.1.1.6. Mid-term Prospects for Energy Supply

Currently, petroleum products are usually transported by tank trucks and barges, with relatively little transported by railway tank cars and pipelines. The increased use of pipelines is therefore one promising way to reduce carbon dioxide emissions resulting from the transport of petroleum products. If tank trucks are replaced with pipelines, transport-related energy consumption will decrease, resulting not only in the reduction carbon dioxide, nitrogen oxide, and hydrocarbon emissions, but also in improved safety. Therefore, the conversion to pipeline distribution is an important policy being studied.

The use of pipelines for transporting natural gas is also an important way to control carbon dioxide emissions, and studies are therefore being conducted on the possibility of diversifying supply systems and expanding the domestic supply network.

3.1.2. The Industrial Sector

◆ The Approach of Policies and Measures

In fiscal 1994, the industrial sector (including the power generating industry) accounted for 51% of Japan's total carbon dioxide emissions. Although this percentage is currently in decline because energy consumption is increasing in other sectors, it is still the highest of any sector in the Japanese economy.

The industrial sector has implemented various energy conservation measures since the oil crises of the 1970s, and investments with the greatest energy-saving impact are now well under way. However, if a large number of factories and places of business in the industrial sector adopt common measures designed to improve the efficiency of energy use and conversion, it should be possible to reduce carbon dioxide emissions still further across various industrial fields. Industries that consume large amounts of energy, such as steelmakers, cement manufacturers, paper and pulp manufacturers, and petrochemical manufacturers have already implemented substantial energy-saving measures. To promote further progress, steps are now being taken to provide guidance based on legal standards for industries that consume large amounts of energy, and to offer low-interest loans for energy-saving investment in addition to special tax measures.

3.1.2.1. Cross-industry Measures

There are many common measures most factories and offices can adopt to increase the efficiency of energy use and conversion. Energy use, for example, can be made more efficient through the introduction of advanced industrial furnaces, high-efficiency boilers, high-efficiency motors, and inverters. Similarly, energy conversion can be made more efficient through the introduction of cogeneration and combined-cycle generation facilities. Energy conservation can thus be pursued across all industries by promoting the adoption of these methods in all factories and places of business. Other options include using the recreational spaces on factory roofs as sites for solar power generating facilities, or generating power using the heat from industrial waste incineration.

Further contributions to energy conservation can be made by: 1) setting up "cascade" arrangements in which factories operating in different industrial fields are built close together to avail themselves of multi-stage heat energy; and 2) introducing systems that recover low-temperature waste heat from steel mills and supply it to surrounding areas.

* Law Concerning the Rational Use of Energy

Policies have been formulated and publicly announced (revised in 1997) that establish guidelines for business operators regarding such energy-saving activities as: rationalizing fuel combustion and heating; preventing heat loss; and recovering waste heat. In addition, basic energy management guidelines and quantitative standards for facility management have been established with the goal of promoting energy conservation in factories. All business operators are expected to adhere to these guidelines.

Designated energy-management facilities (defined as a factory or place of business that consumes energy at or above a set rate) are required to appoint energy-management officers and submit regular reports. If a designated energy-management facility is deemed to have made extremely unsatisfactory progress toward rational energy use in comparison with the standards, the competent Ministers (the Minister of International Trade and Industry and the minister with jurisdiction over the particular business) can direct and order the operator to submit and implement a rationalization plan. Through the revision of the Energy Conservation Law in 1993, policies were radically strengthened to

3.1. Carbon Dioxide Countermeasures

achieve even greater energy savings. In 1997, targets were set for even further energy-conserving efforts on the part of business operators by requiring them to reduce unit energy consumption by 1% or more per year at each factory or company being operated.

* **Law Concerning Promotion of the Use of New and Renewable Energy**

To promote the development and introduction of energy-efficient systems that use fewer resources and reduce the burden on the environment, the Japanese government formulates and publicizes basic policies concerning the use of new energy sources. Based on these policies, the government also requires energy users (citizens, businesses, etc.), energy suppliers, and manufacturers and importers to make efforts to promote the use of new energy sources. In addition, the government provides guidance and advice concerning how energy users can promote the use of new energy sources.

Furthermore, the government provides loan guarantees and implements other support systems to help operators that sell wind-generated electricity and otherwise attempt to utilize new energy sources.

* **Law of Temporary Measures Concerning the Promotion of Business Activities Related to the Rationalization of Energy Use and the Utilization of Recycled Resources (Energy Conservation and Recycling Assistance Law)**

The following measures are provided to assist plant and equipment investment (e.g., converting old furnaces and boilers into new, energy-efficient ones) which has received planning approval under this law: ultra-low interest financing from the Japan Development Bank and other lending institutions (consisting of low-interest loans coupled with interest subsidies); special tax measures; and support measures for loan guarantees.

* **Low-interest loans and special tax measures**

To promote the installation of equipment that contributes to energy conservation, the Japan Development Bank and other lending institutions offer low-interest loans, and special tax measures are in place (through a program of tax incentives that promotes investment in the structural improvement of energy demand and supply systems).

3.1.2.2. *Measures Adopted in Each Industry*

Although Japanese industry has actively adopted policies designed to conserve energy and improve competitiveness, further progress can be made to reduce carbon dioxide emissions generated by such industries as steelmakers, cement manufacturers, paper and pulp manufacturers, and petrochemical manufacturers through the introduction of new process technologies. Examples of measures being considered or implemented are given below.

① **Steelmakers**

Energy-conserving measures have been introduced in the processes shown in Table 3.1. Also, not only can we expect energy savings through the increased use of scrap, inter-industrial recycling, and the burning of waste plastic in blast furnaces are reducing carbon dioxide emissions.

Energy and resource conservation during the utilization phase through higher-value-added steel, as well as the recovery of energy that is difficult to use inside the steel plant itself in the form of low-pressure steam or hot water and its supply to nearby factories or residences are being studied in the steel industry.

Table 3.1 Measures Adopted by Steelmakers

Process	Technology applied
Coke process	Coke oven coal moisture adjusting equipment Automatic fuel combustion control Coke dry quenching (CDQ) Coke oven gas sensible heat recovery Super coke oven for productivity and environment enhancement toward the 21st century
Sintering process	Sinter waste heat recovery boiler Sinter waste gas sensible heat recovery boiler
Blast furnace process	Dry-type TRT Pulverized coal injection (PCI) Blast-furnace slag sensible heat recovery Direct iron-ore smelting reduction process (DIOS)
Converter process	Linz-Donawitz converter gas recovery, OG boiler steam recovery Variable voltage/variable frequency for OG-induced draft fan Improvement of efficiency of oxygen plant
Steelmaking process (electric furnace)	Direct-current electric furnace Scrap preheating Improvement of efficiency of reheating furnace Introduction of the equipment of thermo-mechanical control process for hot strip mill Introduction of slab sizing press Introduction of coil roller adjustment Hot strip casting for sheet
Secondary squeezing process	Waste gas sensible heat recovery (equipment of recuperator) Higher-efficiency of continuous annealing equipment

② Cement Manufacturers

Progress is being made in introducing the energy-conserving technologies shown in Table 3.2 below. Energy consumption in cement industry focuses on fossil fuels used to fire the furnaces and electrical power used to operate the crushers and other equipment.

One effective way to reduce fossil fuel consumption is to expand the use of alternative fuel derived from industrial waste such as oil coke, discarded tires, used oil, and discarded plastic; one way to reduce electricity consumption is to expand the use of exhaust-heat power generation.

In addition, slag and other blast-furnace by-products with low carbon dioxide emission are increasingly being used as fuel or raw material to save energy, as are by-products and waste from other industries, including coal ash, discarded tires, used oil, and discarded construction materials.

Table 3.2 Measures Adopted by Cement Manufacturers

Applied technologies
Expanding use of by-products and waste
Introduction of high-efficiency manufacturing facilities
<ul style="list-style-type: none"> • Improving clinker cooling efficiency • Introduction of 5-cyclones calciner • Row-material grinding mill, pre-grinding mill • Vertical-type mills • Fluid bed kilns
Automatic control of weighing appliances
Rationalizing combustion control
Improving auxiliary combustion furnaces
Pre-heating with less pressure loss
Using heat-insulating bricks

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③ Pulp and paper manufacturers

Progress is being made in introducing the energy-conserving technologies shown in Table 3.3 below. In addition, progress is being made in raising the ratio of recycled paper production and introducing in-house power generation using collected black liquor.

Table 3.3 Measures Adopted by Pulp and Paper Manufacturers

Applied technologies
Pre-impregnation continuous cooking system/Counter-current continuous cooking system and isothermal cooking system
High-efficiency pulp washing equipment
Diffuser displacement bleaching system
High-efficiency size press
High-efficiency falling film plate type evaporator
High-efficiency wide nip press
High-efficiency recovery boiler
Direct causticizing process
High-consistency paper making process

④ Petrochemical manufacturers

Progress is being made in researching and introducing the energy-conserving technologies shown in Table 3.4 below. Also, the use of combined power generation and other combined energy use throughout entire petrochemical complexes are contributing to greater energy efficiency.

Table 3.4 Measures Adopted by Petrochemical Manufacturers

Applied technologies
Gas turbine power generator combined with cracking furnace in ethylene plant
Catalytic naphtha cracking technology
Best available technology in ethylene plant
Gas phase polymerization process for polyethylene production
Gas phase polymerization process for polypropylene production

Specific Measures

(Same as Cross-industry Measures, section 3.1.2.1.)

<Reference>

Table 3.5 Quantified Targets Voluntarily Announced by Japanese Industry to Reduce CO₂ and Other Emissions

Industry	Organization	Target year	Target
Mining	Japan Mining Industry Association	2010	<ul style="list-style-type: none"> Reducing energy consumption per unit of production to 12% below 1990 levels Reducing ferronickel consumption per unit of production to 5% below 1990 levels
Coal	Japan Coal Energy Center	2010	<ul style="list-style-type: none"> Increasing by 44% the amount of methane gas recovered during the mining process (compared with 1995)
		2010	<ul style="list-style-type: none"> Reducing the amount of electricity used by 57.5% (compared with 1995)
		2010	<ul style="list-style-type: none"> Reducing the amount of wood resources used by 70.4% (compared with 1995)
Housing	Federation of Residential Production Organizations (Provisional)	2010	<ul style="list-style-type: none"> Maintaining carbon dioxide emissions at 1990 levels
Sugar refining	Japan Sugar Refiners' Association	2010	<ul style="list-style-type: none"> Setting total annual carbon dioxide emissions at 500,000 t/year. Working to achieve even lower levels in the future.
Beer brewing	Brewers Association of Japan		<ul style="list-style-type: none"> Stabilizing carbon dioxide emissions per unit of production at levels below 1990 levels in beer production and distribution Stabilizing energy consumption per unit of production at levels below 1990 levels in beer manufacturing plants
Paper and Paperboard	Japan Paper Association	2010	<ul style="list-style-type: none"> Reducing purchased energy consumption per unit of paper produced to 10% below 1990 levels.
		2010	<ul style="list-style-type: none"> Promoting plantation activities at home and overseas and expanding the area of forests owned or managed to 550,000 hectares.
Chemicals	Japan Chemical Industry Association	2010	<ul style="list-style-type: none"> Reducing energy consumption per unit production to 90% of 1990 levels.
Pharmaceuticals	The Federation of Pharmaceutical Manufacturers' Associations of Japan Japan Pharmaceutical Manufacturers Association	2000	<ul style="list-style-type: none"> Reducing energy consumption per unit production to 94% of 1990 levels.
Petroleum	Petroleum Association of Japan	2010	<ul style="list-style-type: none"> Reducing the adjusted energy consumption per unit production at oil refineries to 10% below 1990 levels.
		2010	<ul style="list-style-type: none"> Reducing the amount of fuel consumption for land and sea transport of petroleum products to 9% below 1990 levels.
		2010	<ul style="list-style-type: none"> Through the dissemination of oil cogeneration systems, reducing the annual amount of oil consumed by 1 million kiloliters as compared with 1990 levels.
Rubber	The Japan Rubber Manufacturers Association	2000	<ul style="list-style-type: none"> Stabilizing energy consumption per unit of production and total carbon dioxide emissions at 1990 levels.
Flat glass	Flat Glass Manufacturers Association of Japan	2000 2010	<ul style="list-style-type: none"> Reducing energy consumption in production processes to 8% below 1990 levels. Reducing energy consumption in production processes to 10% below 1990 levels.
Iron and steel	The Japan Iron and Steel Federation	2010	<ul style="list-style-type: none"> Reducing energy consumption in production processes by about 10% (compared with 1990 levels). Through links with local communities, promoting the use of discarded plastic and other unused energy resources, thereby reducing energy consumption by about 3%. Promoting energy efficiency throughout society by supplying high-grade steel materials, thereby reducing energy consumption by about 4%.
Aluminum	Japan Aluminium Federation	2010	<ul style="list-style-type: none"> Total carbon dioxide emissions will increase because of increases in production, but efforts will be made to reduce energy consumption in (domestic) production processes by about 10% compared with 1995 levels. On a global scale, reducing carbon dioxide emissions to levels below 1990 levels through the promotion of aluminum recycling and other measures.
Wrought copper and copper alloy	Japan Brass Makers Association	2010	<ul style="list-style-type: none"> Improving energy consumption per unit production (implementing measures to achieve a 7.5% reduction compared with 1995). Making efforts to increase the ratio of scrap used.
Electric wire and cable	The Japanese Electric Wire & Cable Makers' Association	2000	<ul style="list-style-type: none"> Stabilizing energy consumption levels in the production processes for copper and aluminum wire and cable at 1990 levels.
		2000	<ul style="list-style-type: none"> Reducing by 20% (compared with 1990 levels) the amount of energy consumed in the production process for optical fiber cable per length produced.
		2010	<ul style="list-style-type: none"> Same as above, but targeting a 35% reduction (compared with 1990 levels).
Electronics	Electronic Industries Association of Japan, others	2010	<ul style="list-style-type: none"> Reducing the level of carbon dioxide emissions from places of business and other facilities by 25% or more (compared with 1990 levels). Reducing the amount of energy consumed by HDTV sets by 25% compared with 1993 levels.
Electric machinery	Japan Electrical Manufacturers' Association	2010	<ul style="list-style-type: none"> Reducing energy consumption in the manufacturing process by 25% or more (compared with 1990 levels), measured in terms of level of carbon dioxide generated per unit production.
Automobiles	Japan Automobile Manufacturers' Association	2000	<ul style="list-style-type: none"> By reducing energy consumption in the manufacturing process, stabilizing carbon dioxide emissions at 1990 levels.

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Industry	Organization	Target year	Target
Auto parts	Japan Auto Parts Industries Association	2005	• Aiming to reduce the amount of carbon dioxide emitted, or energy used, to levels below 1990 levels, measured in terms of the monetary value of physical production.
Rolling stock (tentative)	Japan Association of Rolling Stock Industries	2000	• Stabilizing carbon dioxide emissions from the production process at 1990 levels.
Optical instruments	Japan Optical Measuring Instruments Manufacturers' Association	2010	• Reducing the amount of carbon dioxide emitted, or energy used, by 25% or more as compared with 1990 levels.
	Japan Camera Industry Association	2010	• Reducing the amount of carbon dioxide emitted, or energy used, by 30% to 50% as compared with 1990 levels.
	Japan Photo and Video Accessory Association	2010	• Limiting the amount of carbon dioxide emission, or energy consumption, to the same level or less than 1990 levels. Reducing the consumption of electricity, city gas, and LPG by 30% or more.
Trade	Japan Foreign Trade Council, Inc.	2010	• Reducing office consumption of electricity, gas and water to 1990 levels.
Department stores	Japan Department Stores Association	2010	• Maintaining energy consumption at 1993 levels.
Railways	Japan Non-Government Railways Association	2005 2005	• Raising the percentage of energy-efficient railway cars to 76% (compared with 64% in fiscal 1995). • Reducing railway car energy consumption per unit requirement by 7% compared with fiscal 1995.
Electric power	The Federation of Electric Power Companies	2010	• Through the development of nuclear power and other technologies, reducing total carbon dioxide emissions from the power industry by about 20% compared with 1990 levels. Although it is estimated that Japan will be generating 1.5 times the electric power in 2010 that was generated in 1990, the increase in total carbon dioxide emissions will be kept to a factor of about 1.2.
Gas	Japan Gas Association	2010	• Combining manufacturing, supply, and consumption phases, the efficiency of energy use will be improved by 15% compared with 1990. (This will lead to a reduction equivalent to 3.3 million tons of carbon.)
Airlines	Airlines Environmental Meeting	2010	• Reducing carbon dioxide emissions by about 10% compared with 1990 levels, measured per unit of transportation (supplied seat/distance).
Other	East Japan Railway Company	2001	• Reducing energy consumption by 10% compared with 1994 levels, measured per unit of transportation. • Reducing carbon dioxide emissions from in-house thermal power plants by 10% compared with 1994 levels, measured per unit energy.

Source: "Autonomous Environmental Action Plans by Industry," published by the Japan Federation of Economic Organizations (Keidanren) in June 1997.

3.1.2.3. Measures in the Construction Industry

In the construction industry, the proportion of carbon dioxide emissions emanating from construction works is approximately 1.3% of the total for Japan as a whole, though if aspects such as the production of materials and facilities management are included, the construction industry has a strong correlation with carbon dioxide emissions. Given this situation the construction industry, in collaboration with related industries, is endeavoring to curb carbon dioxide emissions by expediting resource-saving and energy-saving, and by actively fostering other measures such as recycling.

Plans call for the setting of concrete targets for reductions in the volume of carbon dioxide emissions in the future, based upon the acquisition and collection of more detailed data.

① Loans at low interest rates

In order to foster the increasingly widespread use of construction machinery designed to reduce gas emissions, loans at low interest rates are being advanced for the acquisition of such machinery.

② Special tax measures

Special tax measures are being formulated in relation to the acquisition of construction machinery designed to make highly efficient use of energy.

③ Technology development

In 1995 a method by which energy consumption and carbon dioxide emissions throughout the life cycles of civil-engineering structures can be forecast at the design and planning stage was developed, and guidelines for the design of resource-saving and energy-saving structures were drawn up. In addition, the level of energy consumption and carbon dioxide emission for various materials and equipment were prepared, and a system was developed that made it possible to identify the extent of energy consumption and carbon dioxide emissions during construction works. Also, technologies for the use of paving at normal temperatures and for energy-saving cement have been developed, and their introduction into construction works is being promoted.

④ Action by the construction industry

The year 1996 saw the compilation of a vision for action by the construction industry, which clearly set out the basic philosophy, basic targets, and activity guidelines for action on behalf of the environment that should be taken by the entire construction industry. In addition, the Japan Federation of Construction Contractors, Inc., the Japan Civil Engineering Contractors' Association, Inc., and the Building Contractors Society, among others, have drafted a plan for independent action in the construction industry to conserve the environment, and in collaboration with related industries, action for the environment is being conducted in a planned and vigorous manner based on this document.

3.1.2.4. *Measures in the Fields of Agriculture, Forestry and Fisheries*

The main uses of energy in the fields of agriculture, forestry and fisheries include: power to run machines, fishing vessels, etc.; and energy to dry grain and to heat greenhouses. Efforts are being made to control carbon dioxide emissions through various means such as making energy use more efficient and rational, using alternative energy sources instead of oil, and conducting R&D on energy-efficient technologies.

① Subsidies and low-interest loans

Subsidies and low-interest long-term loans are available to encourage the installation of: energy-efficient greenhouses and irrigation facilities that utilize geothermal, solar, and other forms of natural energy as well as agricultural waste and other currently unused resources; and energy-efficient fishing vessels.

② Special tax measures

Special tax measures are available to encourage the introduction of soil-air heat exchange systems for greenhouses, wood-waste boilers, and energy-efficient fishing vessels.

③ Research and development

R&D is being conducted on the development of industrial materials from raw materials obtained from agricultural, forest and fisheries products; as well as on energy-efficient agricultural machines; farming methods; fishing vessels; fishing equipment; and fishing methods.

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3.1.3. The Residential and Commercial Sector

◆ The Approach of Policies and Measures

The residential and commercial sector accounted for 23.8% of Japan's total carbon dioxide emissions in fiscal 1994, with the residential constituent accounting for 12.5% and the commercial constituent accounting for 11.3%. The share of total emissions originating in this sector has shown a continuous upward trend in recent years. While it is impossible to get a detailed grasp of specific sources of emissions, it is clear that most emissions are generated by the consumption of electricity, gas, and other energy sources for purposes of heating and cooling, hot water, lighting, and other power applications. Measures being taken to reduce emissions include: enhancing the insulation properties of construction materials; introducing natural energy sources; introducing energy-efficient devices and facilities; introducing cogeneration technologies; implementing district heat supply systems that use currently untapped energy sources; and alleviating the heat island phenomenon by planting greenery in urban areas and using water-permeable pavement. Also, efforts are being made to raise public awareness of environmental conservation to help limit wasteful energy use in homes and offices.

3.1.3.1. *Enhancing the Insulation Properties of Construction Materials*

By incorporating insulating materials in wall and floor materials, using insulated glass for windows, and increasing airtightness, it is possible to prevent heat from entering or escaping buildings. In this way, the energy consumed by heating and cooling systems in homes and offices can be used more efficiently.

* Law Concerning the Rational Use of Energy

Standards have been established to serve as guidelines to home and building owners. Based on these standards, the Minister of Construction provides home and building owners with guidance and advice and, in certain cases, directives, public announcements (for buildings) and public announcement of design execution policies (for residences). Standards for residences were strengthened in 1992, and those for buildings in 1993 (the so-called "new standards"). As a result, standards for residential insulation became more stringent, and more items were added to the standards for buildings, and the scope of the standards was expanded to include more types of buildings. In addition to existing standards for residences, the government has been studying the formulation of even more inductive standards, which it publicly announced at the end of fiscal 1996 (the so-called "next-generation standards").

* Financing from the Housing Loan Corp. and the Japan Development Bank

The Housing Loan Corporation encourages high insulation efficiency in homes by: 1) requiring certain types of insulation construction as a condition for applying preferential interest rates on loans for the construction of new homes; and 2) providing higher loan amounts for new homes and renovations that incorporate certain types of insulation construction. Since fiscal 1997, it has also provided preferential rates for home-improvement projects that incorporate certain types of insulation construction. In addition, the Japan Development Bank provides similarly low-interest loans for non-residential buildings.

* Subsidies for Implementing Advanced Model Operations

Subsidies are available to support a part of the operational costs of pilot or model residences or residential areas that introduce facilities for reducing the burden on the environment.

*** Consideration Given to the Construction of Government Facilities and Other Public Buildings**

In 1995, the Cabinet adopted the “Action Plan for Greening Government Operations,” which gives consideration to the construction of government facilities.

3.1.3.2. *Introducing Natural Energy Sources in the Residential and Commercial Sector*

Efforts are being made to promote the use of solar energy and other forms of natural energy through technologies such as the following: photovoltaic power generating systems (for residential and commercial use); solar hot-water supplies (for residential and commercial use); residential passive solar systems (residences planned with the natural environment, and especially the use of solar heat, in mind so that the building itself collects and stores heat energy); and residential heat/electricity hybrid systems (high-efficiency housing that combines the use of photovoltaic power generation and solar heat).

*** Law Concerning Promotion of the Use of New and Renewable Energy**

To promote the development and introduction of new energies, including natural energy sources, the Japanese government formulates and publicizes basic policies concerning the use of new energy sources. Based on these policies, the government also requires energy users (citizens, businesses, etc.), energy suppliers, and manufacturers and importers to make efforts to promote the use of new energy sources. In addition, the government provides guidance and advice concerning how energy users can promote the use of new energy sources, and offers loan guarantees and other support systems to help operators who utilize new energy sources.

*** Relaxing Regulations of the Electricity Enterprises Act to Promote the Introduction of Solar Cells**

Safety requirements outlined in the Electricity Enterprises Act for small-capacity power generation installations such as solar cells have been abolished, making it acceptable for manufacturers to conduct autonomous safety checks in the same way as home appliance manufacturers.

*** Disseminating and Establishing Infrastructure for Residential Photovoltaic Power Generation**

Subsidies are available to assist individuals who wish to install photovoltaic power-generation systems on the roofs, etc. of single houses or apartment complexes.

*** Field Tests on Photovoltaic Power Generation Systems for Use in Public Facilities**

Subsidies are available to cover some of the expenses involved in installing and conducting field tests on photovoltaic power generation systems in public facilities such as schools and civic centers.

*** Financial and Tax-related Support for Installing Hot-water Supply Systems That Use Solar Heat**

Low-interest loans are available from the Housing Loan Corp., and a program of tax incentives that promotes investment in the structural improvement of energy supply systems is in place to promote the installation of hot-water supply systems that use solar heat.

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* **Subsidies for Photovoltaic Power Generation Systems and Other Systems That Use Solar Energy**

Through the Model Project for Developing Residential Districts That Coexist with the Environment, subsidies are available to help finance residential photovoltaic power generation systems and hot-water supply systems that use solar heat.

3.1.3.3. Introducing Energy-efficient Home Appliances

Efforts are being made to improve energy-efficient technologies and disseminate energy-efficient home appliances such as air conditioners/heaters and lighting fixtures. Consideration must be given to the fact that the appliances incorporating timers and microcomputers not only increase electricity consumption when the appliances are in use, but also when the appliances are in stand-by mode.

Specific technologies designed to reduce the amount of energy consumed by home appliances include those listed below.

(Air conditioners/heaters and hot water supply systems)

- Improving the efficiency and diversifying the functions of heat-pump air conditioners
- Improving the efficiency of gas floor heating
- Air conditioners/heaters that use radiating heat
- Improving the efficiency of gas water heaters

(Lighting fixtures)

- Inverter lights, sensor-equipped lights, compact fluorescent lights

(Other)

- Reducing the energy consumed by home appliances in stand-by mode.
- Using liquid crystal displays for televisions
- Improving the efficiency of portable gas cooking stoves

* **Law Concerning the Rational Use of Energy**

The Energy Conservation Law stipulates standards for improving the energy efficiency of certain designated types of appliances, and requires manufacturers to indicate the energy efficiency on their products. Revisions to the law enacted in 1993 led to stronger collateral measures for enforcing the mandatory indication. In addition, if an operator fails to comply with a recommendation to provide the indication, the law authorizes the Minister of International Trade and Industry to make the case public and issue an order, and to penalize any operator who fails to obey an order. Currently, air conditioners, fluorescent lights, televisions, and VCRs are designated, and refrigerators are scheduled to be added to the list.

* **Supporting the Introduction of Energy-efficient Equipment**

Low-interest loans are available from the Housing Loan Corp. for the installation of energy-efficient air conditioner/heating systems and hot water supply systems.

* **Labeling Scheme**

Consideration is being given to a labeling scheme that will help consumers make appropriate decisions concerning the energy efficiency of home appliances.

3.1.3.4. *Introducing Energy-efficient Equipment in Commercial Settings*

Efforts are being made to introduce and disseminate energy-efficient technologies in various types of commercial equipment, including air conditioning/heating systems and lighting systems. Specific energy-efficient technologies include the following.

(Air conditioners/heaters and hot water supply systems)

- Improving the efficiency of heat-pumps (including thermal-storage heat pumps)
- Reducing the delivery power of central air conditioning systems
- Improving the efficiency of heat-source facilities for air conditioning (hot-water boilers that recover latent heat, and absorption-type cool/warm water equipment)

(Lighting fixtures)

- High-frequency inverter lights, high-efficiency louvers and reflectors
- High-brightness induction lamps for exit signs
- High-frequency lighting systems with sensor control

(Other)

- Reducing the amount of energy consumed by office equipment in standby mode

* **Law Concerning the Rational Use of Energy**

As with residential appliances, the Energy Conservation Law stipulates standards for improving the energy efficiency of certain designated types of commercial equipment, and requires manufacturers to indicate the energy efficiency on their products, with provisions made for advising, publicizing, and ordering compliance. Currently, air conditioners, fluorescent lights, photocopiers, computers, electromagnetic disk devices, and VCRs are designated.

* **Low-interest Loans for Energy-efficient Equipment**

The Japan Development Bank and other lending institutions offer low-interest loans for equipment that improves energy efficiency (heat-pump type chiller-heaters, high-efficiency lighting systems, latent-heat recovery boilers, etc.).

* **Program of Tax Incentives That Promotes Investment in the Structural Improvement of Energy Demand and Supply Systems**

Concerning the installation of energy-efficient equipment such as heat-pump type chiller-heaters, floor heating devices, thermal-storage air conditioners and hot-water supply systems, and high-efficiency lighting, one of two special measures can be applied: a special tax exemption equivalent to 7% of the purchase price, or a special charge-off equivalent to 30% of the purchase price.

* **Development in Green Purchasing Network**

The Green Purchasing Network connects corporations, administrative agencies, and private organizations that endeavor to offer goods or services that minimize the burden on the environment, and conducts educational campaigns, collects and transmits necessary information concerning green purchasing in order to promote the formation of a market for environmentally friendly goods and services. Positive efforts are being made to disseminate and expand this network.

3.1. Carbon Dioxide Countermeasures

* **International Energy Star Program**

Personal computers, monitor displays, printers, facsimile machines, and photocopiers that meet common international standards for energy consumption (regarding stand-by energy consumption and the time it takes to convert to stand-by mode) are labeled with a common logo mark.

* **Supporting the Development of ESCO (Energy Service Company) Operations**

To support the development of service companies that renovate existing buildings to make them more energy-efficient, studies are being conducted on ways to disseminate such operations through the implementation of model projects.

* **Energy-efficient Labeling in Buildings**

Studies will be conducted concerning the introduction of an energy conservation labels for use in houses and buildings that display superior energy efficiency.

3.1.3.5. Introduction of Cogeneration Systems

In concentrated housing developments and office buildings, cogeneration systems can be introduced that not only supply buildings with in-house generated electricity but can also supply hot water and air conditioning/heating through the use of waste heat, thereby improving overall energy efficiency. Cogeneration systems are expected to become more efficient with the development of ceramic gas turbines. Also, through their combined use with high-efficiency fuel cells in concentrated housing developments and with gas engines or gas turbines in office buildings, even greater improvements in efficiency are anticipated.

* **Deregulation of Cogeneration Systems**

The Electricity Enterprises Act has been revised so that only notification (rather than approval) is required for operators seeking to install cogeneration facilities. Also, some of the inspection requirements have been abolished.

* **Low-interest Financing from the Japan Development Bank, etc.**

The Japan Development Bank and other lending institutions offer low-interest loans to help finance the installation of cogeneration systems, ancillary equipment, fuel cells, and other related facilities.

* **Assistance for Model Programs**

Subsidies are available to partially fund progressive model programs.

3.1.3.6. Utilization of Unused Energy Sources at the District Level

District heating and cooling (DHC) systems are designed for urban areas where heating demands are concentrated. Through pipelines, DHC systems efficiently supply all buildings in a given district with cold water, hot water, steam, etc. from a specialized heat supply facility, thus reducing carbon dioxide emissions. In addition to city gas and electricity, heat sources include unused energy sources such as thermal energy from river water, waste heat from sewer systems, trash combustion, and waste heat from sewer systems, factories, electrical substations, and subways.

* **Subsidies for Advanced DHC Systems That Utilize Unused Energy Sources**

Subsidies are available to offset part of the costs involved in introducing DHC systems that utilize unused energy sources such as urban waste heat or thermal energy from river water. Subsidies are also available to cover survey expenses.

- * **Subsidies for Facilities That Utilize High-efficiency District Heat**
Subsidies are available to offset part of the costs incurred when heat is supplied or used through a DHC system under the guidance of a regional public organization. Subsidies are also available to cover survey expenses.
- * **Financing from the Japan Development Bank and the Japan Environment Corporation**
Low-interest loans are available for facilities needed for heat supply that utilizes unused energy sources.
- * **Research and Development of Broad-Area Energy-Utilization Network Systems**
Research and development is being pursued on wide-area energy-use network systems with the aim of achieving technical breakthroughs in such fields as energy recovery, conversion, transport, storage, supply, and use. These efforts are directed toward urban and surrounding industrial facilities, and include the recovery of currently unused low-temperature waste heat from factories.
- * **Efficiently Using Heat Energy from Sewage and Sewage Treatment Water**
Subsidies are available for the construction by regional public organizations of facilities within sewage treatment plants that utilize heat energy from sewage and from the water used in sewage treatment, as well as facilities outside sewage treatment plants that promote the use of such heat energy.

3.1.3.7. Alleviating the Heat Island Phenomenon by Promoting Urban Greenery and Other Measures

The heat island phenomenon arises in urban areas because of their concentrated energy consumption, coupled with the loss of the cooling effect of moisture evaporation due to the paving over of ground surfaces, which also causes the sun's heat to be stored and released at night. A vicious cycle is thus created in which city dwellers turn up their air conditioners in the summer, which in turn makes the air temperature rise still higher. The phenomenon is being addressed mainly by increased planting of greenery to take advantage of its evaporative functions in regulating air temperature, and the increased use of permeable paving materials to improve the urban hydrological cycle.

- * **Comprehensive Urban Greening Programs Based on the "Greening Policy Outline" and "Green Plan 2000"**
Comprehensive urban greening programs are being pursued based on the "Greening Policy Outline," which targets the early 21st century, and "Green Plan 2000," which is an action program for fiscal 2000.
- * **Formulation of the "Master Plan of Parks and Open Spaces" Based on the Urban Green Space Conservation Act**
Systematic efforts are being made to formulate master plans for parks and open spaces at the city, town and village levels to conserve green spaces on the basis of the Urban Greenery Conservation Law.
- * **Systematic Establishment of Urban Parks, Etc.**
City parks form the nuclei of urban green spaces and are systematically being established in accordance with the Sixth Five-year Program for Developing Urban Parks.

3.1. Carbon Dioxide Countermeasures

*** Planting Tall Trees at Public Facilities**

On the basis of “Green Plan 2000,” progress is being made in planting tall trees at public facilities such as city parks, roadsides, riverbanks, sewage treatment plants, government facilities, and public housing.

*** Japan Environment Corporation**

The Japan Environment Corporation constructs and transfers to local public organizations green areas for air pollution control and green areas integrated with industrial waste disposal facilities.

*** Greening of Factories**

Regulatory guidance is provided concerning greenery percentages and other matters on the basis of the Factory Siting Law.

*** Planted Artificial Ground, Water-permeable Pavement, Rainwater Collection Facilities, Etc.**

To create high-quality urban environments that impose less of a burden on the natural environment and that coexist with nature, and also to create pleasant residential areas, efforts are being made to establish “eco cities” and model residential areas that incorporate planted artificial ground, water-permeable pavement, rainwater collection facilities, etc. Efforts are also being made to improve the hydrological cycle in extremely urbanized river basins through the installation of rainwater storage and permeation facilities.

3.1.3.8. Changes in Lifestyle

Various steps are being taken to achieve a lifestyle that produces fewer carbon dioxide emissions. These include using environmental marks, promoting appropriate packaging, designating “eco shops,” and encouraging the involvement of all households through the use of environmental household account books.

*** Utilizing Environmental Labeling Program**

The Eco Mark system was instituted in 1989 to promote the dissemination of products that are environmentally friendly. To date, approximately 2,000 product brands in 69 categories have been designated with the mark, including products that incorporate recycled paper pulp, hot-water supply systems that use solar heat, and heat insulating materials for construction applications. The Green Mark is used to designate paper products that use recycled paper. Under this program, schools and other institutions that collect a certain number of Green Marks become eligible to receive saplings, and products made of recycled paper. In addition, consideration is being given to expanding the JIS marking system to include “objective-specific” JIS marks that indicate such product attributes as recycled content.



* **Promoting Simplified Packaging**

Operators in the distribution industry are autonomously working to simplify packaging (controlling excessive packaging) and reducing the use of food trays and polyethylene bags.

* **Creating and Disseminating Household Eco-account Books**

Households in Japan often keep household account books to keep track of income and expenditures on a day-to-day basis. The central government, local governments, and environmental conservation groups have created dozens of different kinds of “household eco-account books” for general use by the public. These books contain information concerning various environmental issues, formulas that enable householders to calculate how much carbon dioxide is being emitted from their homes, guidelines for environmental self-assessment, and other special features.

* **Designating Eco Shops**

Some local governments designate “eco shops” based on standards such as simplified packaging, the promotion of recycling, and the handling of environmentally friendly products. Designated stores are publicized through stickers and posters and are included in guidebooks.

* **Disseminating Eco Cooking**

Eco cooking helps to reduce carbon dioxide emissions through the appropriate purchasing and preparation of food and the use of appropriate cooking utensils. The central government, local governments, and certain corporations are working to disseminate eco cooking by providing the public with information and holding cooking classes.

* **Daylight Saving Time**

Consideration is being given to adopting daylight saving time as a way to save energy through the effective use of long summertime hours.

3.1.4. The Transport Sector

◆ **The Approach of Policies and Measures**

Carbon dioxide emissions from the transport sector continue to show a consistent rise; as of fiscal 1994, they accounted for 19.2% of Japan’s total emissions. In both passenger and freight transport categories, most of the emissions are generated by the burning of petroleum products (gasoline and light oil) by automobiles. Emphasis is therefore placed on controlling these emissions through various means. First, efforts are being made to improve energy efficiency through the use of new technologies focusing on automobiles, and to promote the introduction of low-emission vehicles; second, efforts are being made to improve the efficiency of both passenger and freight transport; and third, efforts are being made to improve road traffic flow. Parallel to these efforts, promotion programs are being implemented for drivers so that they will drive only when necessary and handle their cars in ways that are kinder to the environment.

3.1. Carbon Dioxide Countermeasures

3.1.4.1. *Improving Energy Efficiency of Means of Transportation*

As noted above, most of Japan's carbon dioxide emissions in the transport sector are generated by automobiles. Improving the energy efficiency of vehicles is therefore an effective means of reducing carbon dioxide emissions. Technologically, progress is being made in the development and dissemination of direct-injection gasoline engines, lean burn engines, and other energy efficient engines. Efforts are also being made to develop and introduce energy-efficient equipment in trains, ships, and planes.

*** Improving Automobile Fuel Economy Through the Law Concerning the Rational Use of Energy (Energy Conservation Law), Etc.**

The Energy Conservation Law designates gasoline-fueled vehicles (passenger cars and mini-sized, light-duty and medium-duty trucks) as "specified equipment," presents standards for the improvement of energy efficiency and mandates that manufacturers indicate energy efficiency. If a manufacturer fails to comply with a recommendation for indicating energy efficiency, the law also permits the government to make the case public and issue an order. A manufacturer who fails to obey an order is subject to penalty. For gasoline-fueled passenger cars, current standards set fuel economy targets for fiscal 2000 at an average improvement of 8.5% over the results for fiscal 1992; for gasoline-fueled trucks, current standards set fuel economy targets for fiscal 2003 at an average improvement of 4.8% to 5.8% over the results of 1993, depending on the type of vehicle. Consideration is also being given to designating diesel vehicles as "specified equipment," as well as to measures designed to promote the introduction of high-efficiency vehicles.

*** Improving the Energy Efficiency of Other Transportation Equipment**

To promote the introduction of energy-efficient technologies in trains and ships, special tax measures have been established through the program Tax Incentives to Promote Investment in the Structural Improvement of Energy Demand and Supply Systems. These measures apply to various types of energy-efficient equipment, including power controllers and exhaust gas boilers for ships.

3.1.4.2. *Introducing Low-emission Vehicles*

Low-emission vehicles include cars that run on electricity, natural gas, or hybrid energy systems. Progress is being made in strengthening supportive measures to promote the technical development and introduction of these vehicles with the concomitant aim of arresting global warming.

*** Law of Special Measures Concerning the Use of New Energy (New Energy Law)**

The Japanese government formulates and publicizes basic policies concerning the use of new energy sources, including clean-energy vehicles such as electric and natural gas vehicles. Based on these policies, the government also requires energy users (citizens, businesses, etc.), energy suppliers, and manufacturers and importers to make efforts to promote the use of new energy sources. In addition, the government provides guidance and advice concerning how energy users can promote the use of new energy sources.

*** Law Concerning Special Measures for Total Emission Reduction of Nitrogen Oxides from Automobiles in Specified Areas (Automobile NOx Law)**

Measures to promote the dissemination of low-emission vehicles have been given high priority and are being pursued through emission-reduction programs founded on basic policies that have been established by the central gov-

ernment with regard to the overall reduction of nitrogen oxides in automobile exhaust gas.

*** Government Initiatives**

The central government has formulated an “Action Program for the National Government to Take the Initiative in Pursuing Environmental Conservation as a Business Operator and Consumer.” Under this program, efforts are being made to increase the percentage of low-emission vehicles in the government’s fleet of vehicles for ordinary administrative service to about 10% by the year 2000. Concerning vehicles used in contexts other than ordinary administrative service, low-emission vehicles are undergoing field tests in the postal service sector, and studies are being conducted concerning the feasibility of using low-emission vehicles for public relations and mail pick-up and delivery by the post office.

*** Subsidies and Other Assistance for Local Public Organizations and Private Companies That Introduce Low-Emission Vehicles**

The national treasury provides subsidies for local public organizations or private companies that introduce electric, natural gas, or other low-emission vehicles and systems that supply fuel for these vehicles, etc. Concerning the introduction of low-emission vehicles by local public organizations, special regional-delivery tax measures have also been formulated.

*** Preferential Tax System**

The automotive sales tax has been reduced for electric, natural gas, and other low-emission vehicles, and special fixed-asset and other tax measures have been formulated to reduce the cost of systems that supply fuel for these vehicles, etc. Also, special tax measures have been established for the purchase of low-emission vehicles and natural gas fueling facilities through the program Tax Incentives to Promote Investment in the Structural Improvement of Energy Demand and Supply Systems.

*** Promoting Technical Development**

While pursuing the further development of existing low-emission vehicles, research is also being conducted on next-generation high energy-efficient vehicles. Development is also being promoted on vehicles that use LNG for fuel, which would further expand the range of applications for low-emission vehicles, including an increase in the range of continuous travel.

3.1.4.3. Improving Distribution Efficiency

Various steps are being taken to reduce carbon dioxide emissions from freight transport, including measures to improve energy efficiency of trucks, and measures for improving the efficiency of the distribution system. For medium- and long-distance arterial freight transport between distribution hubs, active efforts are being made to use railway and marine transport instead of roads. For road transport, various measures are being taken to improve efficiency, including: encouraging the active use of business trucks; promoting consolidated service; supporting the operation and control of trucks and other commercial vehicles using an Intelligent Transport System (ITS); and providing back haul information. In addition, distribution centers are being built.

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- * **Actively Using Railways and Marine Transport for Arterial Freight Transport**
To boost capacity by increasing the length of container trains on major trunk lines, the Corporation for Advanced Transport and Technology provides interest-free loans and other assistance for the construction of freight terminal facilities and enhanced electrical substations.

With regard to coastal shipping, Domestic Intermodal Transport Terminals (which can accommodate combined transport modes) are being built while taking into consideration trunk line networks and other factors. Also, to enhance marine transport, the Corporation for Advanced Transport and Technology is working to build coastal container ships and coastal roll-on/roll-off (RORO) ships. In addition, international container ship terminals are being built in strategic locations to minimize overland transport distances.

- * **Improving Truck Transport Efficiency**
Urban distribution necessarily depends on trucks. In addition to actively encouraging the use of business trucks, the government has adopted various measures to improve load efficiency, including promoting urban and intra-regional consolidated services and reducing the number of runs. Efforts are also being made to encourage business trucks to joint operations on arterial truck routes in order to improve load efficiency. Support is also provided to improve transport efficiency for: operating and controlling trucks and other commercial vehicles using an Intelligent Transport System (ITS) (see 3.1.4.5); providing back haul information; and planning optimum truck assignments.

- * **Building Distribution Centers**
In cities where road traffic is congested and distribution functions are impaired, or where such conditions are likely to develop, basic policy for the building of distribution facilities has been established according to the Law Concerning Construction of Distribution Business Centers. On this basis, distribution business zones have been designated in city plans and distribution business complexes are being built. In addition, financial support and tax incentives are available for the construction of warehouses, truck terminals, distribution centers and other strategically located facilities, as well as for multifunctional distribution centers equipped for freight and information processing and other complex operations. In this way and by effectively using advanced distribution centers with information systems, distribution is systematically being made more efficient. Also, the Japan Environment Corporation carries out programs for the construction and transfer of centralized distribution facilities.

- * **Building Access Roads to Distribution Centers and Roads Linked to Wide-area Distribution Centers**
Roads are being constructed to provide better access to airports, harbors, and other major distribution centers. Also, through the repair and reinforcement of bridges on main distribution routes, a road network is being constructed that can accommodate larger vehicles. In addition, in the vicinity of interchanges of high-standard trunk roads etc., the construction of roads and other facilities is given high priority in order to establish distribution points over a wide area. Facilities enabling vehicles to stop for unloading are also being set up.

3.1.4.4. *Promoting the Use of Public Transportation Systems in Passenger Transport*

Motor vehicles account for more than 80% of the energy consumed for passenger transport. To reduce carbon dioxide emissions, therefore, it is important to change driver behavior and promote the use of public transportation systems, walking, and bicycles. Specific measures include improving the facilities and services of trains, buses, etc., strengthening links between different modes of transportation, and building roads and other facilities that promote walking and bicycling. Other measures being pursued include staggered commuting times, park and ride systems, and other forms of transportation demand management (TDM).

* **Improving the Facilities and Services of Trains, Buses, Etc.**

A high-quality railway network is being built to promote high-speed travel on trunk lines. For urban railway travel, efforts are being made to increase capacity to reduce congestion by constructing new lines and quadrupling existing tracks and by encouraging travel during off-peak hours. The Omnibus Town Project is also being pursued to build regional transit systems in which buses play a very significant role. In addition, efforts are being made to install urban monorails and other new transit systems in conjunction with the revival and use of street trolleys.

* **Promoting Multimodal Transport**

Multimodal transport policies are being pursued, including: constructing railways and roads that improve airport access; strengthening links between railways and highway buses; building transit transfer stations; and otherwise reinforcing links between different modes of transportation.

* **Building Roads and Other Facilities to Promote Walking and Bicycling**

To promote walking and bicycling, progress is being made on constructing wider sidewalks, pedestrian roads, bicycle paths, and bicycle parking facilities, as well as introducing rental bicycle systems while keeping in mind the importance of traffic-safety and bicycle-parking measures.

* **Measures to Promote Staggered Commuting Times, Park and Ride Systems, and Other Forms of Transportation Demand Management (TDM).**

TDM policies are being used to change driver behavior and reduce the flow of passenger cars in urban areas. Such policies as promoting vehicle sharing and staggered commuting times and constructing parking facilities for park-and-ride systems are being examined. Consideration is also being given to how to promote High-Occupancy Vehicle (HOV) systems implemented overseas.

3.1.4.5. *Facilitating Automobile Traffic Flow*

Chronic traffic congestion, primarily in large urban areas, is reducing the average running speed of vehicles, and thereby impairing energy efficiency. To alleviate this problem, efforts are being made to facilitate automobile traffic flow by: building networks that incorporate loop roads and bypasses; improving intersections to ease bottlenecks; upgrading traffic control systems; promoting Intelligent Transport Systems (ITS); and reducing congestion caused by road construction and parked cars.

* **Promoting Intelligent Transport Systems (ITS)**

New traffic control systems that use advanced information technology to reduce congestion, minimize accidents, and contribute to greater driving pleasure include: VICS (Vehicle Information and Communication System, which pro-

3.1. Carbon Dioxide Countermeasures

vides real-time information on traffic conditions); ETC (Electronic Toll Collection, non-stop automated toll booths that reduce congestion on toll roads); support for public transportation through the provision of information on the use of public transportation systems, etc.; and improving the efficiency of commercial vehicles through support for operational management.

*** Building Road Networks and Easing Bottlenecks**

Various steps being actively pursued include: expanding road widths; creating road networks with loops and bypasses; and easing bottlenecks by improving intersections and railway crossings, which are often the cause of congestion.

*** Upgrading Traffic Control Systems**

Efforts are being made to upgrade traffic control systems through such means as updating traffic control centers; improving traffic signal performance; and installing systems to collect and distribute traffic information. In addition, progress is being made on the development of UTMS (Universal Traffic Management Systems), a new traffic control system designed to reduce traffic pollution and protect the environment. These innovations will help facilitate the flow of traffic on urban road networks in conformity with actual traffic conditions.

*** Implementing Comprehensive Plans to Facilitate Traffic Flow in Urban Areas**

Comprehensive plans are being formulated and implemented in urban centers that combine a variety of measures to facilitate traffic flow, including: setting specific targets aimed at reassessing traffic patterns in urban areas; expanding traffic capacity and implementing transportation demand management (TDM); and implementing multimodal transport policies.

*** Efficiently Using Road Space**

Road construction, parked cars and other obstacles limit the effective width of roads and generate traffic congestion. To make more efficient use of road space, efforts are being made to reduce construction work on roads and to avoid concentrating such work during specific periods, such as the end of the fiscal year. To cope with the problem of parked cars, efforts are also being made to construct parking lots and control illegal parking.

3.1.4.6. Changes in Lifestyle, Etc.

One of the factors contributing to the increase in carbon dioxide emissions from the transport sector is the increasing dependence of the Japanese people on the automobile. Much can therefore be done to reduce emissions by discouraging unnecessary car use and by encouraging citizens to drive in such a way as to minimize the burden on the environment. Urban restructuring and other measures are also being studied as a means of reducing traffic demand. In addition, the introduction of information technologies is expected to help reduce carbon dioxide emissions by allowing people to conduct their business online rather than commuting or being dispatched to work sites, and by reducing the need for customers to be physically present in banks, stores, and government offices.

* **Educational Programs to Encourage Environmentally Friendly Lifestyles**

Efforts are being made such as: the establishment of “no personal car” days to discourage the unnecessary use of private automobiles and encourage the use of public transportation systems; and educational programs that encourage people to walk and use bicycles rather than drive short distances. Information is also provided to encourage people to purchase low emission/energy efficient vehicles.

* **Promoting Eco-driving (environment-friendly driving)**

All drivers should make a point of driving in an environmentally friendly fashion including: refraining from idling; driving at appropriate speeds; keeping tires properly inflated; and not carrying unnecessary cargo.

* **Reducing Traffic Demand Using Information Technology**

3.1.5. Cross-over Sector

◆ **The Approach of Policies and Measures**

Recycling and economic measures such as carbon tax and emissions trading are viewed as “cross-over” policies because the agencies that implement them cross field boundaries and their effects are felt in all segments of society.

3.1.5.1. Promoting Recycling

Recycling is an effective means reducing greenhouse gas emissions not only because it reduces carbon dioxide emissions that would otherwise be generated from waste incineration, but also because it can greatly reduce the amount of energy used to process raw materials into finished materials. The Basic Environment Plan sets the following priorities with regard to waste management: first, minimize the amount of waste generated; second, reuse products after their initial use; third, recycle collected waste by using it as material for new products (material recycling); and fourth, when material recycling is not feasible, use collected waste to produce energy (thermal recycling), being careful to protect the environment while doing so.

* **Limiting the Generation of Waste**

Efforts are being made to encourage manufacturers to voluntarily refrain from manufacturing and selling disposable products and using excessive packaging. They are also being encouraged to give consideration to long product life and other environmental factors when developing, manufacturing, and distributing their products.

* **Law for Promotion of Utilization of Recyclable Resources**

Basic policies have been formulated to promote the comprehensive and systematic use of recyclable resources. Specific measures that have been adopted include: promoting the use of recycled resources as raw material in certain designated industries (paper manufacturers, glass container manufacturers, and the construction industry); promoting structural and material modifications in Category 1 designated products (20 product types, including cars, air conditioners, television receivers, electric washing machines, electric refrigerators, and power tools that use sealed nickel-cadmium batteries); labelling Category 2 products (aluminum and steel beverage cans, PET bottles, and nickel-cadmium batteries) to facilitate sorting and recovery; and promoting the use of Designated Industrial By-products (iron and steel slag, coal ash, dirt and sand, concrete chunks, asphalt/concrete chunks, wood materials) as recycled resources.

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* Law for Recycling of Containers and Packaging

In terms of volume, containers and packaging account for approximately 60% of general waste in Japan. In April 1997, the Law for Recycling of Containers and Packaging was fully implemented (having been promulgated in June 1995), providing the basis for the following recycling activities that stipulate clearly defined responsibilities for different segments of society: 1) consumers must cooperate in collecting and separating different types of trash; 2) municipalities must separate out containers and packaging from collected trash; and 3) business operators must recycle the separated containers and packaging (either by themselves or by commissioning designated corporations or recycling companies) and use them to make new products.

* Financial and Tax Support

Financial and tax support has been provided on the basis of the Temporary Legislative Measures for Promoting the Rationalization of Energy Use and the Utilization of Recycled Materials.

* Promoting the Construction of Recycling-related Facilities

Efforts are being made to promote the development and dissemination of technologies such as recycling PET bottles for use as material, converting waste plastic into oil, and melting and solidifying burned ash. Also, in November 1995, the Temporary Legislative Measures for Promoting the Construction of Designated Facilities Using the Expertise of Private Companies was amended to include recycling-related facilities, thereby promoting the construction of such facilities.

* Promoting Recycling by the Government

On the basis of the Action Plan for Greening Government Operations adopted by the Cabinet in 1995, the government itself is using its dual role as a business operator and consumer to implement recycling by utilizing recycled paper and reducing, collecting, and separating waste.

3.1.5.2. Measures That Impose Economic Burdens

Measures that impose economic burdens, such as environmental taxes, surcharges, and deposit-refund systems, are expected to be effective in reducing the environmental burden of many daily activities and in contributing to the efficient distribution of resources. Such measures were designated as policy instruments in the 1993 Basic Environment Law, as well as the 1994 Basic Environment Plan which states that investigation and research on such measures should be conducted so as to make decisions on more specific measures. In 1997 the Central Environment Council of Japan reviewed for the second time the performance of the Basic Environment Plan, including those measures that impose economic burdens.

In addition, the introduction of economic measures, such as a carbon tax and emissions trading, was considered at the Joint Conference of Relevant Advisory Councils on Domestic Measures Addressing the Global Warming Issue.

3.1.6. Measures on Carbon Dioxide Sinks and Carbon Fixation

◆ The Approach of Policies and Measures

Sixty-seven percent of Japan's land area is covered with forest, a high percentage that has been maintained over an extended period. As noted in Chapter 2, these forests absorb approximately 98 million tons of carbon dioxide (about 27 million tons of carbon equivalent) per year (as of 1995). While continuing measures to conserve the forests, efforts will be made to actively protect greenery in urban environments and to pursue the efficient use of wood resources.

3.1.6.1. *Forest Conservation Programs and the Creation of Urban Green Conservation Programs*

Japan's land is being used comprehensively and systematically on the basis of the National Land Use Plan, which makes provision for the conservation of forests. Specifically, various forest plans have been formulated on the basis of the Fundamentals of Forestry Act and the Forest Act, including: the Basic Plan Concerning Forest Resources; the Nationwide Forest Plan; and Regional Forest Plans. In addition, programs are being pursued that designate protection forests and encourage appropriate afforestation, thinning, forestry road construction, and other activities related to forestry. Progress is also being made in conserving green spaces in urban areas.

* National Land Use Plan

The National Land Use Plan serves as the foundation for the many other programs implemented by the Japanese government. The long-term goal of the National Land Use Plan is to maintain total forest area at or above current levels.

* Appropriate Application of the Forest Plan System

In accordance with the "Basic Plan for Forest Resources and Long Range Demand and Supply Projection for Important Forest Products," various plans dedicated to the systematic conservation of forests are being pursued, including: the Nationwide Forest Plan, which sets goals for forest improvement for the entire country on the basis of 15-year periods; Regional Forest Plans, which are formulated by prefectural governors or the heads of forest management offices, etc. on the basis of ten-year periods; Local Forest Improvement Plans, which are formulated by cities, towns and villages with regard to thinning, nurturing, etc. on the basis of ten-year periods; and Forest Management Plans, which are formulated by forest owners on the basis of five-year periods.

* Designating Protection Forests and Nature Conservation Areas

Important forests that require preservation are designated as protection forests, thereby placing restrictions on lumbering and requiring that permission be obtained before such forests can be used for non-designated purposes. Development is also restricted in areas designated as nature conservation areas and natural parks with a view to protecting and conserving the natural environment.

* Promoting Forest Management

For both national and private forests, systematic efforts are being made for forest and soil conservation, planting and nurturing, thinning, and constructing and improving forestry roads. Other efforts being made in this area include: improving the structure of Japan's forestry industry by procuring superior seeds and saplings, eliminating disease and insect pests, encouraging young people to

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go into forestry, and prioritizing the construction of facilities; developing and improving high-performance forestry machinery; operating forest patrols; and implementing policies to prevent forest fires.

* Preserving and Creating Urban Green Areas

As stated in 3.1.3.7., comprehensive and systematic efforts are being made to conserve and increase greenery in urban areas, as well.

Table 3.6 Forest Area and Forest Accumulation

	1970	1980	1990	2000	2010
Total forest area (1,000 hectares)	25,293	25,324	25,266	25,210	25,220
Protected forest area (1,000 hectares)	5,631	7,265	8,224	—	—
Forest accumulation (million cubic meters)	1,905	2,424	3,183	3,741	4,153

3.1.6.2. Promoting the Effective Use of Wood Resources

Unlike fossil fuels, wood resources can be used sustainably as long as forests are maintained. If the amount harvested and the amount grown are in balance, forests can also serve as a carbon dioxide sink, and appropriate harvesting techniques that thin and rejuvenate forests can help maintain or even increase the forests' capacity to fulfill this function. In addition, if wood materials are used instead of petroleum-generated products such as plastic or metals such as aluminum that require large quantities of energy to produce, they can help reduce demand for fossil fuels and make a tremendous contribution to arresting global warming. Of course, as an importer of wood materials, Japan must exercise caution to ensure that its use of wood does not lead to the destruction of tropical rain forests and other types of forest.

* Promoting the Use of Wood Resources

Efforts are being made to promote the use of wood resources through research and development on new processing and utilizing techniques for wood.

* Promoting the Utilization of Wastewood and Other Unused Wood Resources

The utilization of currently unused wood resources is being promoted through tax incentives and other measures applied to wastewood recycling equipment.

* Promoting the Construction of Centralized Wood Processing and Distribution Plants

Progress is being made in constructing and modernizing wood processing facilities and woody product centers.

* Educational Programs That Promote the Use of Wood Materials

The effective use of wood resources is being promoted through regional model operations, the provision of information, and educational programs directed toward consumers.

Table 3.7 Demand for Wood Materials

	1970	1980	1990	2000	2010
Total demand for wood materials (1,000 cubic meters)	105,207	112,211	113,240	114,000	122,000
Amount produced in Japan (1,000 cubic meters)	48,206	36,961	31,295	31,000	35,500

3.2. Policies and Measures to Reduce Methane Emissions

3.2.1. Waste Sector

3.2.1.1. Summary of Policies and Measures

Landfill disposal of waste accounts for nearly all waste-generated methane emissions in Japan. Waste disposal administration is generally regulated by the Waste Management Law, which promotes waste volume reduction and recycling, encourages wherever possible the incineration of any remaining waste that is combustible, and promotes waste circulation disposal designed for the active use of surplus heat. Through these measures, efforts are being made to control carbon dioxide, methane, and nitrous oxide emissions resulting from waste incineration, as well as methane emissions from landfills.

3.2.1.2. Promoting Waste Volume Reduction and Recycling

The Eighth Plan for Developing Waste Disposal Facilities adopted by the Cabinet in December 1996 is Japan's top operational plan for the disposal of municipal solid waste. The plan establishes the content of waste disposal activities through the end of fiscal 2000, based on an estimated annual increase in per capita waste production of 0.5%.

In terms of volume, containers and packaging account for approximately 60% of municipal solid waste in Japan. In April 1997, the Law for Recycling of Containers and Packaging was fully implemented (having been promulgated in June 1995), providing the basis for the following recycling activities that stipulate clearly defined responsibilities for different segments of society: 1) consumers (who cooperate in collecting and separating different types of trash); 2) municipalities (which separate out containers and packaging from collected trash); and 3) business operators (who recycle the separated containers and packaging either by themselves or by commissioning designated corporations or recycling companies and use them to make new products).

Intermediate incineration processing is being used for combustible waste, and efforts are being made to actively utilize the heat energy generated by incineration while taking care to ensure that the trash processing facilities themselves are protected from damage.

The results of these measures are shown in Table 3.8 below. Figures for 1995 and 2000 are taken from the Plan for Developing Waste Disposal Facilities, and those for 2005 and 2010 are estimates.

Table 3.8 Per-capita Waste and Recycling Ratio

Fiscal year	1990	1995	2000	2005	2010
Amount of waste generated per capita (g/day)	1120	1121	1149	1178	1208
Recycling ratio (%)	5	10	15	18	22

3.2.1.3. Optimizing Waste Disposal

Since the space for the final disposal of waste is running short, waste processing method is shifting from landfills to incineration, which drastically reduces trash volume. As a result, the main forms of waste going into landfills are incinerated residue and objects that can neither be recycled nor burned. Environmental safeguards are observed when this material is buried in the landfills. The progress that has been made in reducing the volume of municipal solid waste through incineration and reducing the amount of municipal solid waste buried in landfills is shown in Table 3.9 below. Figures for 1995 and 2000 are target values cited in the Plan for Developing Waste Disposal Facilities, and those for 2005 and 2010 are estimates.

3.3. Policies and Measures to Reduce Methane Emissions

Table 3.9 Percentage of Waste Treated and Amount of Waste Buried

Fiscal year	1990	1995	2000	2005	2010
Percentage of waste treated to reduce volume (%)	80	87	91	95	97
Amount of waste buried directly in landfills/total waste (municipal solid waste) (%)	11	3	1	0	0

Methane emissions from sewage treatment are also being controlled through recovery and through use as an energy source. The amount of methane recovered is shown in Table 3.10 below. Figures for 2000 and later are estimates.

Table 3.10 Amount of Methane Recovered in Sewage Treatment

Fiscal year	1990	1995	2000	2005	2010
Amount of methane recovered (Gg)	26	27	33	37	41

3.2.2. The Agricultural Sector

3.2.2.1. Summary of Policies and Measures

In fiscal 1994, the agricultural sector accounted for about 55% of all methane emissions in Japan. Nearly all of that methane was emitted from enteric fermentation in livestock, manure management, and rice paddy field farming (see Chapter 2). Although no specific measures are currently being implemented on a practical level, research and surveys are being conducted. Policies and measures being considered are described below.

3.2.2.2. Policies and Measures Related to Livestock

Since 1991, specialists have been conducting studies commissioned by livestock breeders' organizations on methane produced through enteric fermentation, etc. in ruminant livestock. The status and mechanisms of these and other greenhouse gas emissions related to livestock are being surveyed to create the basis for emission control methods, and thus the effect on methane emissions of improved rearing management, feed allocation, and other factors is gradually becoming clear.

3.2.2.3. Policies and Measures Related to Rice Paddy Field Farming

From 1992 through 1994, nationwide studies were conducted on the amount of methane generated through rice paddy field farming, as well as on the effects of organic matter application and water management on methane. The results of those studies are throwing light on how improved rice paddy drainage and cultivation management (including water management) affects methane emissions.

3.2.3. Other Sectors

3.2.3.1. Measures Against Methane Leaks from Mining

For safety reasons, the Mine Safety Law and other regulations require boring operations to remove gas from coal mines, as well as gas recovery operations to collect methane from abandoned mines. Methane recovered in this way is burned as fuel. Concentrations of methane that remains uncollected and leaks into the atmosphere are monitored so that the status of emissions is known.

Concerning the extraction of natural gas and oil, rationalized development procedures are established under the provisions of the Petroleum and Combustible Natural Gas Resources Development Law.

3.3. Policies and Measures to Reduce Nitrous Oxide Emissions

3.3.1. Summary of Policies and Measures

Policies and measures that directly target the control of nitrous oxide emissions are being implemented in the agricultural sector (the use of fertilizer) and the industrial processes sector (the manufacture of adipic acid). Indirectly, policies that control the use of fuel and limit the amount of waste generated also contribute to the reduction of nitrous oxide emissions, but these measures are discussed in the sections concerning carbon dioxide and methane emissions.

3.3.2. Policies and Measures in the Agricultural Sector

Nitrous oxide emissions from fertilized soil are still being researched and surveyed. A national survey has been conducted to determine how much nitrous oxide is emitted from each type of crop, and the effects of nitrogenous fertilizer application on emissions. There are two promising ways to reduce nitrous oxide emissions: reduce the use of nitrogenous fertilizers, and make the fertilizer application more efficient. Currently, efforts are being made to formulate standards for appropriate fertilizer use that will protect the environment, and to promote the use of slow-release fertilizer that enables efficient fertilization. The Project for Promoting the Application of Slow-release Fertilizer, which is intended to reduce the work force of fertilization, has been implemented in 29 districts in 13 prefectures as of fiscal 1995.

3.3.3. Policies and Measures in the Industrial Processing Sector

Japanese adipic acid manufacturers are working voluntarily to develop methods of controlling nitrous oxide emissions generated by their manufacturing processes. Emission control facilities, which will reduce nitrous oxide emissions from the industrial processing sector (i.e., adipic acid manufacturers) by 90%, are scheduled to be in place by fiscal 1998.

3.4. Policies and Measures to Control HFC, PFC, and SF₆ Emissions

3.4.1. The Approach of Policies and Measures

Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF₆) are greenhouse gases that have global warming potentials (GWP) ranging from several hundred to several tens of thousands of times higher than that of carbon dioxide.

HFCs use has been on the rise since 1992 because they replace chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) as refrigerants and aerosol propellants in accordance with the provisions of the Law Concerning the Protection of the Ozone Layer Through Control of Specified Substances and Other Measures (1988), which stipulates that use of CFCs and HCFCs be either abolished or reduced. Also, HFC-23, which is a greenhouse gas with a high GWP, is being generated as a by-product of the HCFC-22 manufacturing process. Although HFCs have a low GWP in comparison with CFCs, they still pose a problem, and their production is likely to increase as regulations tighten down on the production of HCFCs in the future.

PFCs have been used as an etching gas for the manufacture of semiconductors since around 1977, and the amount used has increased since the second half of the 1980s. Test applications of PFCs as inert liquids were also begun in the 1970s. They began to be used for cooling and other purposes in the 1980s, and as a substitute for CFCs for precision washing and drying processes in response to regulations on CFC use.

SF₆ has been used as an insulated gas since around 1969. More recently, it has also been used in sound-proof insulated glass, semiconductor cleaning, electron accelerators for medical treatment, and other applications.

More of these gases are being used in a widening range of applications, and it is probable that, if they are allowed to enter the atmosphere as they do now, their contribution to global warming will increase notably.

3.5. Policies and Measures to Control Precursor Emissions

The Japanese government recognizes that the control of HFC, PFC, and SF₆ emissions is an important component of efforts to curb global warming. While keeping in mind the need to harmonize policies with other measures aimed at protecting the ozone layer, and the fact that suitable alternatives to these gases have not yet been found for some applications, efforts will be made to formulate measures in accordance with the following basic policies.

- Limiting fields of use
- Adopting closed systems
- Promoting recovery, reuse, and breakdown
- Promoting the development of alternative substances and technologies

3.4.2. Specific Measures

3.4.2.1. *Emissions Resulting from HFC, PFC and SF₆ Use*

The Japanese government is studying various measures that are necessary to limit emissions generated by the use of HFCs, PFCs and SF₆ (called HFCs, etc. below). As part of those efforts, it is encouraging industries that use these gases to adopt autonomous policies such as those described below.

* In principle, HFCs will not be used unless no appropriate alternative substance or process exists, as judged in a comprehensive manner that includes safety, energy efficiency, and other factors. However, HFCs etc. may be used in the context of closed systems that, through recovery after use, appropriately prevent the gases from being released into the atmosphere.

* If HFCs, etc. are used because no appropriate alternative substance or technology is available, further efforts will be made to use closed systems whenever possible and, through recovery, reuse, and breakdown processes, minimize emissions into the atmosphere.

* In fields where no appropriate alternative substance or technology is available, efforts will be made to find appropriate alternative substances or technologies as quickly as possible.

In addition, the government will use its previous experience dealing with CFCs to study ways of recovering, reusing, and breaking down HFCs, etc. emitted from discarded equipment and other sources. Also, to get an accurate understanding of the status of production, export/import, and recovery of HFCs, etc., studies are being conducted on devising systems for collecting reports from business operators, and R&D is being pursued on new coolants, foaming agents and solvents that do not harm the ozone layer and have a smaller greenhouse effect.

3.4.2.2. *Emissions of HFC-23 from Manufacturing Processes*

The government has requested gas manufacturers to develop autonomous plans to limit by-product HFC emissions.

3.5. Policies and Measures to Control Precursor Emissions

3.5.1. Summary of Policies and Measures

Emissions of nitrogen oxide (NO_x), carbon monoxide (CO), non-methane volatile organic compounds (NMVOCs), and sulfur oxides (SO_x) are systematically regulated on the basis of standards set forth in the Air Pollution Control Act. Emission control policies and measures for these gases are divided into two categories, one for stationary sources and the other for mobile sources (primarily automobiles).

3.5.2. Details of Policies and Measures

3.5.2.1. *Policies and Measures for Stationary Sources*

Concerning stationary sources, regulatory measures based on the Air Pollution Control Act are in force for nitrogen oxide emissions from soot and smoke emit-

ting facilities such as boilers installed in factories and other places of business. Formulated in 1973, these measures set permissible emission concentrations that are calculated according to the type of facility and the size of the exhaust port. Measures were further strengthened in 1981, when total mass emission control standards were established for special districts in Tokyo, Yokohama and Osaka that have high concentrations of soot and smoke emitting facilities. As of fiscal 1996, 32 types of soot and smoke emitting facilities are regulated in this way.

Low-interest, long-term loans are also available from the Japan Environment Corporation, the Japan Development Bank, the Small Business Finance Corporation, the People's Finance Corporation, and other lending institutions, and special measures are in place to allow special charge-off advantages that are applicable to soot and smoke emitting facilities.

3.5.2.2. Policies and Measures for Mobile Sources

Concerning mobile sources (primarily automobiles), regulatory measures based on the Air Pollution Control Act are in force for carbon monoxide, hydrocarbons, and nitrogen oxide emitted from automotive vehicles. The Director General of the Environment Agency has established acceptable limits for automotive exhaust, and, to help ensure that these limits are observed, the Minister of Transport determines what rules are necessary to keep motor vehicle emissions under the safety regulations stipulated in the Road Vehicles Act.

In 1992, the "Law Concerning Special Measures for Total Emissions Reduction of Nitrogen Oxide from Motor Vehicles in Specified Areas" was enacted with the aim of reducing overall nitrogen oxide emissions throughout certain large urban areas. On the basis of this law, the Japanese government developed the Basic Policy for NO_x Reduction, a master plan dedicated to reducing car-generated nitrogen oxide emissions in specially designated districts (comprised of 196 cities, wards, towns and villages in Saitama, Chiba, Tokyo, Kanagawa, Osaka and Hyogo prefectures). Governors with designated districts within their jurisdictions set reduction targets in accordance with the basic policy and formulate overall reduction plans to achieve them. In this way, comprehensive and systematic efforts are being made to strengthen measures to reduce emissions per car unit, implement restrictions for using designated types of vehicles, promote low-emission vehicles, and formulate appropriate policies for the flow of goods, people, and traffic. In particular, a goal has been set to disseminate about 300,000 low-emission vehicles by the end of fiscal 2000. Also, a Special NO_x Emission Standard has been established for trucks and buses that are based in designated districts, and any vehicle that does not meet the standard is not granted a motor vehicle inspection certificate. This and other measures (restrictions for using designated types of vehicles) went into effect on December 1, 1993.

Concerning aircraft, the Civil Aeronautics Law was revised in 1996 to introduce engine emission regulations based on ICAO (International Civil Aviation Organization) Standards that apply to soot and smoke, hydrocarbons, carbon monoxide and nitrogen oxides generated by aircraft engines (enforced in October 1997).

Chapter 4

Forecast of Greenhouse Gas Emissions and Removals

4.1. Basic Thinking and Estimation Methods

The forecast of future greenhouse gas emissions and removals, and the assessment of the effects of government policies and measures, were conducted in accordance with the following thinking, based on the guidelines for preparing the Second National Communication. However, this communication does not include the “with measures scenario” – the scenario that incorporates the effects of various government policies and measures – because studies are currently being conducted by the government and other parties.

4.1.1. Target Year

Using 1990 as the base year, in principle the forecasts are made for the target years 2000, 2005, and 2010. In Japan statistical data is arranged according to fiscal year (April 1 to March 31 of the following year), and thus in principle the estimates here are in terms of fiscal years.

4.1.2. Targeted Greenhouse Gases

The forecasts of volumes of future emissions of greenhouse gases were made with regard to carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O). Concerning the volumes of greenhouse gases absorbed and removed, the forecasts made were for carbon dioxide.

4.2. Forecast of Emissions of Carbon Dioxide

4.2.1. Framework of estimate

In estimating future carbon dioxide emissions, the government’s latest socioeconomic framework was utilized as the framework of economic activity, taking into consideration factors such as economic-growth forecasts contained in the Ministry of Health and Welfare’s estimate of future population (January 1997), the report of the Economic Council (December 1996), and the interim report of the Subcommittee for Industrial Structure Council (November 1996). Under this framework, the future volume of carbon dioxide emissions was estimated by establishing a “standard scenario” that was based on past trends and did not take into consideration the possible effects of new policies and measures.

In view of the fact that revisions were made in order to reconcile this with Chapter 2 (Inventory) – for example the emissions from biomass combustion were formerly included in emissions, but are omitted from this communication – it must be borne in mind that there is a difference between the value of emissions in the previous fiscal year reported in the First National Communication, and the value of emissions in the previous fiscal year dealt with in this communication.

4.2. Forecast of Emissions of Carbon Dioxide

4.2.2. Assumptions for Future Estimates

Assumption regarding population and economic growth are as shown in Table 4.1 below. The figures for population are from "Population Projections for Japan: 1996-2100" (issued in January 1997 by the National Institute of Population and Social Security Research), and economic growth estimates are based on studies by the Economic Council and the Industrial Structure Council.

Table 4.1 Principal Assumptions for Future Estimates

Fiscal year	1990	1995	2010
Population (Millions)	124	126	128
Real GDP (¥ trillions; 1990 base year)	436	467	653

In addition, the volume of waste generated is as laid down in Table 4.2. The figures in that table relate to the items included in the computation of carbon dioxide emissions (synthetic resins included in municipal solid waste; [incinerated] waste oil and waste plastic included in industrial solid waste) that arise during waste incineration.

Table 4.2 Forecast of Volume of Waste Generated

(Unit: Gg)

Fiscal year	1990	1995	2010
Municipal solid waste (Synthetic resins)	4,378	5,392	5,759
Industrial solid waste ([incinerated] waste oil, waste plastic)	7,805	8,613	9,118

4.2.3. Results of Estimates

The forecast of carbon dioxide emissions using the assumptions described above is shown in Table 4.3.

The volume of emissions in the 2010 fiscal year is forecast to exceed the volume in the 1990 fiscal year by approximately 20% (Total emissions: 369 million tons of carbon equivalents [1,353 million tons of carbon-dioxide equivalents]).

Table 4.3 Forecast of Carbon Dioxide Emissions

Fiscal year	1990		1995		2010	
	Tg-CO ₂	Tg-C	Tg-CO ₂	Tg-C	Tg-CO ₂	Tg-C
Energy	1,053	287	1,138	311	1,272	347
Energy-conversion sector	77	21	83	23	92	25
Industrial sector	495	135	495	135	521	142
Commercial & residential sector	264	72	304	83	363	99
Transport sector	214	58	249	68	297	81
Industrial processes	59	16	61	17	62	17
Waste	13	4	19	5	18	5
Total	1,125	307	1,218	332	1,353	369
(% change from 1990)			+8%		+20%	

Notes:

1. Due to the different classification, figures in industrial and commercial & residential sectors do not correspond to those appeared in Table 2.4.
2. Emissions from electric power generation are allocated to each sector according to the amount of electric power consumed.
3. Due to the rounding-off, the sum of figure in each sector does not correspond to that in Total.

4.3. Forecast of Emissions and Removals of Carbon Dioxide in the Land-Use Change & Forestry Sector

With regard to the forecast of emissions and removals of carbon dioxide in the land-use change and forestry sector, based upon factors such as the estimations of deforestation and forest area set out in the Basic Plan for Forestry Resources and Long-Range Demand and Supply Projection for Important Forest Products, estimates were carried out in line with IPCC/OECD guidelines. Generally, Japan's forests are maturing, and the annual rate of removal of carbon dioxide is declining gradually.

Table 4.4 shows the change in forest area, from which it can be projected that there will be virtually no change in Japan's forest area.

Table 4.4 Forecast of Afforestation, etc.

(Thousand ha)

Fiscal year	1990	1994	2000	2005	2010
Forest area	25,266	25,160	25,210	25,220	25,220

Table 4.5 shows forecasts for the major categories of carbon dioxide emissions and removals in forest areas. In accordance with IPCC/OECD guidelines, deforestation is regarded as causing emissions. It should be noted that in the table below, removals from the atmosphere are expressed as a positive value.

Table 4.5 Forecast of Removals & Stock of Carbon Dioxide

(Unit: Gg-CO₂)

Fiscal year	1990	1994	2000	2005	2010
Removals caused by growth	146,056	142,120	128,377	123,620	119,834
Emissions caused by deforestation	-61,665	-47,758	-59,092	-62,113	-63,221
Emissions caused by change of use of forest land	-579	-929	0	0	0
Emissions from forest soil	-471	-2,599	-2,093	-1,744	-802
Total	83,341	90,834	67,192	59,762	55,811

4.4. Forecast of Methane Emissions

4.4.1. Basic Thinking

In computing forecasts of methane emissions up to the 2010 fiscal year, a "standard scenario" was adopted which was based upon the past trends of the principal sectors causing emissions in fiscal 1994 – namely Fuel Combustion, Fugitive Emissions from Fuels, Enteric Fermentation in Livestock, Manure Management, Rice Cultivation, and Solid Waste Disposal on Land – and did not take into consideration the effects of policies and measures. In view of the fact Industrial Processes, Field Burning of Agricultural Residues, Biomass Burning Caused by Land-Use Change, Wastewater Handling, and Waste Incineration mentioned in the national inventory in Chapter 2 represent only a small proportion of overall emissions, emissions in these categories are assumed to remain at fiscal 1994 levels.

4.4.2. Fuel Combustion Activities

Emissions of methane as a result of fuel combustion activities have been estimated by multiplying the volume of emissions in fiscal 1994 by the rate of increase in carbon dioxide emissions since fiscal 1994 in the standard scenario referred to in 4.2.3 above.

4.4.3. Fugitive Emissions from Fuels

Emissions of methane as a result of fugitive emissions from fuels have been estimated by multiplying the volume of emissions in fiscal 1994 by the rate of increase in carbon dioxide emissions since fiscal 1994 in the standard scenario referred to in 4.2.3 above.

4.4. Forecast of Methane Emissions

4.4.4. Enteric Fermentation in Livestock

With regard to the number of dairy and beef cattle among the total number of livestock (Table 4.6), for fiscal 2000 the number used was that in “Long-Term Prospects for the Demand and Production of Agricultural Products,” and for fiscal 2010 the number used was the number for fiscal 2005 given in that same forecast. The numbers of other livestock were regarded as being unchanged since fiscal 1994. In addition, the average methane emission factors per head was regarded as equivalent to that in fiscal 1994.

4.4.5. Manure Management

With regard to the number of dairy and beef cattle and pigs among the total number of livestock (Table 4.6), for fiscal 2000 the number used was that in “Long-Term Prospects for the Demand and Production of Agricultural Products,” and for fiscal 2010 the number used was the number for fiscal 2005 given in that same forecast. The numbers of other livestock were regarded as being unchanged since fiscal 1994. In addition, the average methane emission factors per head was regarded as equivalent to that in fiscal 1994.

Table 4.6 Forecast of Cattle Numbers (Unit: Thousands)

Fiscal year	1990	1994	2000	2005	2010
No. of dairy cattle	2,068	1,951	2,210	1,980	1,980
No. of beef cattle	2,805	2,965	4,120	4,330	4,330
No. of pigs	11,335	10,250	12,760	10,310	10,310

4.4.6. Rice Cultivation

The area of irrigated rice fields was estimated based on “Crop Statistics” and “Long-Term Prospects for the Demand and Production of Agricultural Products,” and the same emission factor was used as in the current inventory. With regard to the planted area shown in Table 4.7, the figure for fiscal 2005 given in “Long-Term Prospects for the Demand and Production of Agricultural Products” was applied to fiscal 2010.

Table 4.7 Forecast of Area of Irrigated Rice Fields (Unit: Thousand ha)

Fiscal year	1990	1994	2000	2005	2010
Planted area	2,055	2,200	1,968	1,855	1,855

4.4.7. Solid Waste Disposal on Land

Methane generated by the disposal of solid waste on land is also emitted over a period of many years following the year in which the disposal of the solid waste occurs, and thus this was estimated from a model that took into account the process of emission of methane. Table 4.8 shows organic solid waste among municipal solid waste disposed of on land.

For the volume of waste generated, estimates by the Ministry of Health and Welfare were used, and the volume of organic solid waste disposed of on land was estimated on the assumption that the proportion of solid waste that is incinerated and the proportion that is disposed of on land will remain unchanged from fiscal 1995 in the case of municipal solid waste, and from fiscal 1994 in the case of industrial solid waste, and estimates were made of the volume of emissions of methane resulting from the decomposition of this.

Table 4.8 Forecast of Organic Solid Waste Disposal on Land (Unit: Gg)

Fiscal year	1990	1994	2000	2005	2010
Organic Solid Waste Disposal on Land	5,360	2,326	1,353	1,401	1,436

4.4.8. Conclusion

A forecast of methane emissions taking the above categories into consideration is shown in Table 4.9.

Table 4.9 Forecast of Anthropogenic Methane Emissions

(Unit: Gg)

Fiscal year	1990	1994	2000	2005	2010
Fuel combustion	119	105	113	120	127
Fugitive emissions from fuels	166	169	176	182	188
Enteric fermentation in livestock	346	345	434	406	406
Manure management	119	110	138	119	119
Rice cultivation	373	389	348	328	328
Solid waste	388	364	301	252	254
Other sectors	65	66	66	66	66
Total	1,575	1,548	1,576	1,473	1,487
(% change from fiscal 1990)		-2%	0%	-7%	-6%

4.5. Forecast of Future Emissions of Nitrous Oxide

4.5.1. Basic Thinking

In computing forecasts of future nitrous oxide emissions up to the 2010 fiscal year, a “standard scenario” was adopted which was based upon the past trends of the principal factors causing emissions in fiscal 1994 – namely Fuel Combustion, Industrial Processes, Manure, Fertilization, and Waste Incineration – and did not take into consideration the effects of policies and measures.

Other categories considered in the national inventory in addition to those above include Application of Laughing Gas, Field Burning of Agricultural Residues, and Biomass Burning Caused by Land-Use Change, but these account for only a small proportion of all emissions, and thus emissions in these categories are assumed to remain equal in the future to the volumes in fiscal 1994.

4.5.2. Fuel Combustion Activities

Emissions of nitrous oxide as a result of fuel burning have been estimated by multiplying the volume of emissions in fiscal 1994 by the rate of increase in carbon dioxide emissions since fiscal 1994 in the standard scenario referred to in 4.2.3 above.

4.5.3. Industrial Processes

Emissions of nitrous oxide due to industrial processes have been projected on the assumption that emission factors relating to the production of adipic acid and nitric acid up to the 2010 fiscal year remains at fiscal 1994 levels.

4.5.4. Manure

With regard to the number of dairy and beef cattle and pigs among the total number of livestock, for fiscal 2000 the number used was that in “Long-Term Prospects for the Demand and Production of Agricultural Products,” and for fiscal 2010 the number used was the number for fiscal 2005 given in that same forecast. The numbers of other livestock were regarded as being unchanged since fiscal 1994. In addition, the average nitrous oxide emission factors per head was regarded as equivalent to that in fiscal 1994.

4.5. Forecast of Future Emissions of Nitrous Oxide

4.5.5. Fertilization

Assuming that the average volume of nitrogenous fertilizers used per unit of land area will not change from fiscal 1995, the volume of nitrogenous fertilizers used on land other than irrigated rice fields was estimated based on sources such as “Long-Term Prospects for the Demand and Production of Agricultural Products,” and the volume of nitrous oxide emissions was estimated by multiplying this by an emission factor.

4.5.6. Waste Incineration

For the volume of waste generated, estimates by the Ministry of Health and Welfare were used, and the volume of emissions of nitrous oxide resulting from waste incineration was estimated on the assumption that the proportion of solid waste incinerated and the proportion disposed of on land will remain unchanged from fiscal 1995 in the case of municipal solid waste, and from fiscal 1994 in the case of industrial solid waste, and the additional assumption that no progress is made with recycling.

4.5.7. Conclusion

A forecast of nitrous oxide emissions taking the above categories into consideration is shown in Table 4.10.

Table 4.10 Forecast of Anthropogenic Nitrous Oxide Emissions (Unit: Gg)

Fiscal year	1990	1994	2000	2005	2010
Fuel combustion	65.6	69.0	72.6	75.5	78.4
Industrial processes	23.8	23.6	29.8	32.3	32.3
Manure	5.0	4.7	5.1	5.1	5.1
Fertilization	4.0	3.6	4.0	4.1	4.1
Waste Incineration	5.3	6.6	7.6	8.2	8.7
Other sectors	1.6	2.2	2.2	2.2	2.2
Total	105.3	109.8	121.4	127.4	130.9
(% change from fiscal 1990)		+4%	+15%	+21%	+24%

Chapter 5

Projected Impacts of Climate Change, and Vulnerability Assessment

This chapter is a summary of the present knowledge and understanding regarding the projected impacts of climate change in Japan. Specifically, this chapter reviews the results of research being conducted on climate change in Japan (please refer to Chapter 8) and presents quantitative evaluations of the projected impacts.

Research to date demonstrates that climate change will have a major effect on Japan's agriculture, forestry, fisheries, water resources, coastal management, natural ecosystems, and human health. For example, in the summer months areas that receive large quantities of precipitation may be subjected to still more rain, while rainfall may decline in regions that receive little precipitation. In western Japan, the harvests of rice and wheat may decline, and in southern Japan scientists suggest a growing risk of malaria and other tropical infectious diseases because of the northward advance of vectors. Meanwhile, as sea levels rise the area of land below sea level will increase, and the damage from storms will grow. Scientists also expect additional erosion. If the sea level rises by just 65 cm, over 80 percent of Japan's sandy beaches will be lost.

Several important items are considered to be issues for future research but are not addressed in this report. These include natural effects on phenomena such as changes in typhoons and Baiu rain fronts (which are important from the standpoint of disaster prevention), and indirect effects on Japan's increasingly complex and globalized socioeconomic system (such as problems with importing foodstuffs, energy, and other resources). It is also clear that climate change will have a massive effect on natural ecosystems, but at the present time it is extremely difficult to conduct a quantitative assessment of this effect.

Thus, among the vast and diverse impacts of global warming, this chapter only addresses a small number of items for which concrete research results have already been obtained. Accordingly, in using this report for evaluating performance under Article 4.1 (b) and (e) of the Framework Convention on Climate Change, it is important to recognize that there could be serious impacts from global warming that are not discussed herein.

5.1. Impacts on Japan's Climate

5.1.1. Impacts on Temperature and Precipitation

The potential impacts of global warming on Japan's climate are evaluated based on projections made from the experiments using seven coupled atmosphere-ocean general circulation models (CGCMs) at six of the world's leading research institutes.¹⁾

The seven models indicate that with a doubling of the atmospheric concentration of carbon dioxide, the climate changes in and around Japan will include annual mean temperature increases ranging from 1.0 to 2.5°C and changes in annual precipitation ranging from -5 to +10 percent. These projections were made using the results from transient experiments.²⁾ It is important to note that the atmospheric temperature increase results obtained with transient experiments are lower than those indicated by prior projections using equilibrium models.

5.1.2. Impacts on Sea Levels and Coastal Waters

According to the coupled atmosphere-ocean GCM of the Meteorological Research Institute of the Japan Meteorological Agency, which takes proper account of the geographical features in and around the Japanese archipelago, at the time of the atmospheric CO₂ concentration doubling, sea surface temperatures will rise by around 1.6°C in the Japan Sea, 1.2-

5.2. Impacts on Agriculture, Forestry and Fisheries

1.6°C along the Pacific coast, and 1.8°C in the Sea of Okhotsk. Sea levels are projected to rise by about 20-40 cm along the Japan Sea coast and by about 25-35 cm along the Pacific coast. (Figures are adjusted by incorporating the effect of changes in glaciers and the polar ice sheets given in the IPCC Second Assessment Report.)

5.1.3. Impacts on Unique Japanese Meteorological Phenomena

While it is impossible to make detailed judgments because the spatial resolution of the present coupled atmosphere-ocean GCMs is coarse and the number of regional climate model projections is limited, the following types of changes may be expected.

- * The outbreak of cold wind in winter season may weaken. This could lead to an increase or decrease of precipitation (snowfall) in areas facing the Japan Sea. It is impossible to predict the trend of precipitation at the present time.
- * During the summer season, the Asian monsoon may intensify. Areas that currently receive large quantities of precipitation may be subjected to still more rain, while rainfall may decline in regions that receive little precipitation. It is impossible to predict the effects on the Baiu rain front.
- * At the present time, no conclusions can be reached regarding changes in frequency, location, season, and (average and maximum) strength of typhoons and tropical storms.

Notes:

- 1) Geophysical Fluid Dynamics Laboratory (U.S.), Goddard Institute for Space Studies (U.S.), Max-Planck Institute for Meteorology (Germany), National Center for Atmospheric Research (U.S.), Hadley Centre (UK), and Meteorological Research Institute of the Japan Meteorological Agency (Japan).
- 2) Transient experiments gradually raise the atmospheric concentration of carbon dioxide in CGCMs and calculate the corresponding temperature increases. This has the advantage of projecting temporal climate change. In contrast, equilibrium experiments abruptly start calculations given a certain set of conditions, such as a doubling of the atmospheric carbon dioxide concentration, and the level at which the temperature rise levels off and reaches equilibrium is adopted as the result.

5.2. Impacts on Agriculture, Forestry and Fisheries

5.2.1. Impacts on Agriculture

Blessed with a mild climate and abundant precipitation averaging 1,800 mm per year, Japanese agriculture has supported a large population, primarily through the production of rice, despite the nation's small land area. Since 1950, Japan's agricultural technology has progressed rapidly through the development of new varieties, fertilizers, agricultural chemicals, and agricultural machinery. The advance of agriculture has also been supported by land works to upgrade the nation's fields. As a result, contemporary Japanese farming takes place under highly sophisticated management. Nevertheless, agricultural production is already significantly influenced by climate change, and future global warming is projected to have a severe effect on the nation's agriculture in general.

Research is being conducted on the physiological effects on crops from temperature increases and higher carbon dioxide levels, mostly focusing on paddy rice plants. If the atmospheric concentration of carbon dioxide doubles and there are no other environmental constraints, the photosynthesis of rice plants will be promoted and yields will increase. However, the flavor of the rice could be affected as the quantity of magnesium (and the magnesium-potassium ratio) in the rice grains may decline. Also, high temperatures may affect the spikelets of the rice plants. Research has demonstrated that spikelets decline sharply when daily highs exceed 35°C.

Researchers predict that global warming will lead to larger rice yields in northern Japan and smaller rice harvests in the west. Similarly, the climate changes are expected to result in greater stability in the quantity of rice harvested each year in northern Japan, but in

more erratic fluctuations in the annual harvests in the west. Maize yields are projected to increase in Hokkaido, decrease in Kyushu, and remain about the same in central Japan. In general, wheat yields are expected to decline.

Combining these figures, the total domestic production of rice and maize is expected to remain constant or increase slightly, but the production of wheat is likely to fall. Specifically, one research group projects that the quantitative changes in domestic production will be as follows: rice -6 to +9 percent, maize +1 to +5 percent; wheat -22 to 0 percent; and temperate grass +6 percent.

Global warming is also expected to lead to an increase in the number of generations of harmful insects per year, and to a spread in their distribution areas.

5.2.2. Impacts on Forestry

Even though the percentage of land devoted to agricultural, industrial, residential, and other non-forestry uses has increased, Japan's forests still cover a total of 252,300 km², or 67 percent of the national land area, which is far higher than the international average of 29 percent. In general, forest ecosystems are highly sensitive to climate change. Forests are particularly vulnerable to water shortages. As explained in the previous section, however, the change in annual precipitation from global warming in Japan is projected to remain within -5 to +10 percent. As long as this is not accompanied by an increase in harmful insects or other indirect damage, the effect of climate change on Japanese forestry should be minor.

5.2.3. Impacts on Fisheries

The subtropical Japan current (*Kuroshio*) and the subarctic Kurile current (*Oyashio*) meet in Japan's coastal waters, which provide the habitat for a rich variety of fish and make for some of the most productive fishing areas on Earth. The most direct effect from global warming is projected to be changes in epipelagic fish resources. Japan's future fishery production will mostly depend upon changes in the course and flow of the Japan current caused by global warming.

As for long-term changes, some researchers project that global warming will lead to reductions in the flows of both the Kurile and Japan currents, and that the thickness of the mixed layer will be reduced if marine winds also weaken. This implies a reduction in the primary production volume, which is a negative factor for the fishery industry. Based on the primary production volume offshore of Kushiro in Hokkaido during years when the waters are relatively warm versus those when it is relatively cold, it appears that in this ocean area global warming will lead to a reduction in primary production volume. Additionally, the southern edge of salmon habitats is expected to move northward as a result of global warming.

There is also research showing a relationship between higher global temperatures and an increase in sardine resources. It is believed that sardines and other surface resources will be greatly influenced by global warming. Further studies are needed in this area, including an examination of the structural "regime shift" of climates and ecosystems.

In coastal areas, the primary production volume of phytoplankton will increase from the rise of water temperatures. This represents a positive factor for fish in terms of an increased food supply, but the production efficiency may decrease because of greater motion and other factors. The quantity of cold-water seaweed may decline, and this may lead to a drop in populations of abalone, turbos, sea urchins, and other sessile creatures that feed on this type of seaweed. In coastal areas with breakwaters or other coastal protection works where the shoreline cannot move further inland, productivity may fall when sea levels rise because of the loss of tidelands and seaweed beds.

As for rivers and streams, it is estimated that if global warming causes an average temperature rise of 1 to 4°C, the habitat of *Salvelinus malma* (*oshorokoma*) will decline by 25 to 74 percent, and that of *S. leucomaenis* (*amemasu*) by 4 to 46 percent.

5.4. Impacts on Coastal Areas and Human Habitation

5.2.4. Issues Concerning the Importation of Food

As of 1993, Japan's agricultural self-sufficiency rate was 22 percent for grains, 89 percent for potatoes, and 4 percent for beans. Moreover, 40 percent of Japanese fishery consumption was caught in distant seas or imported. For Japan's food supply, (in addition to the effect on domestic agriculture) the effect of global warming on agricultural production in countries that export to Japan is extremely important. In fact, Japan's food supply is vulnerable to regional climatic changes in many parts of the world.

5.3. Impacts on Hydrological Conditions and Water Resources

Despite abundant precipitation, it is difficult for Japan to fully utilize its water resources due to physical constraints. The precipitation varies greatly by time and place, and the nation's rivers are short and steep, with relatively small catchment basins.

Three different analyses have been conducted to assess the potential hydrological effects of global warming. One uses historical meteorological and hydrological data, another combines the warming scenario with a long-term discharge model, and the third is a macro-hydrological model that takes the mutual interaction between the atmosphere and the land into account. According to the hydrological-meteorological model, which provides a detailed estimate for the area in and around Japan, global warming may lead to lower precipitation in most parts of the country, higher evaporation from the land surface, and a reduction of water resources.

The following conclusions have been gained from the hydrological research conducted so far.

- * The effects on flow from a 10 percent change in precipitation are greater than those from a 3 degree Celsius temperature increase.
- * If a 3 degree Celsius temperature rise is accompanied by a 10 percent increase in precipitation, on average the flow will not decline significantly in low-flow conditions and will increase by about 15 percent in high-flow conditions.
- * With temperature rises, snowfall will change to rainfall and winter snows will melt earlier. As a result, the flow will increase from January through March, and decrease from April through June.

5.4. Impacts on Coastal Areas and Human Habitation

5.4.1. Vulnerability of Coastal Areas

Japan is an island nation with long coastlines, and the nation's population and economic activities are concentrated in coastal areas. Accordingly, there is great concern about the possible effects of rising sea levels and increasingly frequent storm surges on the nation's natural environment and socioeconomic system. The existing social infrastructure and socioeconomic system has been optimized for the present climate conditions. With global warming, the effects from higher sea levels and temperatures and from changing precipitation and typhoon patterns would be serious and wide-ranging.

5.4.2. Impacts on Nature in Coastal Areas

The primary effect of higher sea levels on natural coastlines would be an intensification of erosion. The consequences for sandy beaches would be especially great. Over the last 70 years, Japan has lost 125 km² of sandy beaches, and beach erosion is already viewed as a serious issue. Projections indicate that if global warming causes a rise in the sea level of 30, 65, or 100 cm, Japan would lose 57, 82, or 90 percent of its remaining sandy beaches. Global warming is also likely to result in changes to the locations of alluvial deposits, rising river beds, and the submergence of wetlands and tidelands. It may also harm mangrove forests in the Southwestern Islands and have other effects on coastal geography and ecosystems. (Please refer to section 5, below, for information about the effects on ecosystems).

In the past, littoral geography has changed over time and coastal ecosystems have survived by adapting to changes in sea levels. Normally, the shoreline would simply respond to future rises in sea levels by moving inland. However it is not clear whether such a natural response will prove possible considering the speed at which sea levels may rise from

global warming, the present human land-use patterns, and the existing coastal engineering works and other coastal area management systems. To date, no definitive research results have been obtained regarding this issue.

5.4.3. Impacts on Human Society in Coastal Areas

One macro-level assessment (vulnerability evaluation) of the effects of global warming on human society in coastal areas measures increases in the area, population, and assets that may become subject to the effects of rising sea levels and flood tides. At present, about two million people reside on the 861 km² of Japanese land which is located below the high tide level, and 54 trillion yen of assets have accumulated in these areas. If sea levels rise by one meter (slightly higher than the 94 cm projected for the global mean rise in 2100 under the highest case scenario of the IPCC Second Assessment Report), the land area below the high tide level will increase by more than 2.7 times to 2,339 km². The susceptible population and assets will grow to 4.1 million people and 109 trillion yen. The area subject to damage from flood tides will also expand. Moreover, if typhoons grow larger and more powerful, high tide levels will rise along Tokyo Bay, Ise Bay, and the Inland Sea. For example, one research group found that the central pressure decline from a 15 hectopascal typhoon in Tokyo Bay would make high tide levels rise approximately 1.2 times.

5.4.4. Impacts on Social Infrastructure in Coastal Areas

Japan's total social capital stock (combined figures for the public and private sectors) was approximately 500 trillion yen as of the end of fiscal year 1988. Most of this infrastructure is located in the nation's cities and is designed to support urban life. Because many Japanese cities are located in coastal areas, the rising sea levels accompanying global warming will have a major impact on the nation's social infrastructure and facilities.

Through rising sea levels and changes in meteorological and marine conditions, global warming may have deleterious effects on the functions and stability of all types of facilities located in coastal areas including ports and harbors, fishing ports, man-made islands, reclaimed land, storm surge and tsunami disaster-prevention facilities, inland water drainage and sewerage systems, and coastal preservation works. In particular, rising subterranean water levels may lower the bearing power and the liquefaction resistance of the subsoil.

If sea levels rise by one meter, the Ministry of Transport (MOT) estimates that a minimum of 12 trillion yen will be required to maintain the functions and stability of coastal facilities at their present level, and this only covers port and harbor facilities and adjacent coastlines under MOT jurisdiction. These works include protective measures such as raising the levels of breakwaters, bulkheads, mooring quaywalls, wharves, and the sites of transit sheds, and relocating flood gates and drainage facilities.

Additional large-scale engineering works will also be necessary along the coastlines. These will include erosion countermeasures, raising the levels of embankments, bulkheads, and other facilities to preserve low-lying areas, and reconstructing flood gates and sluices. The strengthening of flood-control safety measures will be particularly important in river mouth areas that are subject to rising sea levels and have a high concentration of population and assets. The total required expenditures will increase still further because measures for fishing ports will also be necessary.

5.4.5. Impacts on Human Habitation

At present, there is little research about the ways in which global warming will directly affect human habitation in Japan. Such effects may include changes in water supply and in the demand for heating and cooling. The social infrastructure system provides multiple safeguards that protect and support Japan's contemporary housing, making it difficult to perceive the direct effects from global warming. However, global warming is a very long-

5.5. Impacts on Nature

term issue, and there is a need for additional in-depth analyses to carefully examine if there may be any potential effects.

5.5. Impacts on Nature

5.5.1. Vulnerability of Japan's Natural Environment

Japan is blessed with a great variety of natural environments. The nation's forest ecosystems occupy diverse climate zones that range from subtropical to subarctic and are located in close proximity to one another. If global warming results in an average temperature rise of 3°C over the next 100 years, existing ecosystems will have to move approximately 500 kilometers to the north or to altitudes about 500 meters higher than at present. This is equivalent to an annual movement of five kilometers or an altitude gain of five meters per year. It is not possible to make a simple projection of how the ecosystems will respond to this change because each species has a different environmental tolerance and a different capacity for migration, and because of the competition with existing ecosystems.

Moreover, there are numerous obstacles that may interfere with the migration of ecosystems. Japan is geographically complex, with many intricate mountain folds, and also geologically diverse. Other obstacles include ocean straits, cities, roads, and railroads. These may represent major restrictions when biota and ecosystems try to adapt to global warming. Species which are isolated in small habitats may find it impossible to migrate and become extinct.

Lake, marsh, and coastal ecosystems located adjacent to densely inhabited districts are already subject to stress from human activities, and experts have noted that such ecosystems are highly sensitive to the additional stresses that will be brought about by global warming.

For all of these reasons, it is currently nearly impossible to conduct a macro-scale quantitative evaluation of the effects of global warming on Japanese ecosystems.

5.5.2. Impacts on Topography in Mountainous Districts

Through rising sea levels, increased precipitation, and changes in riverbed erosion, global warming will have a substantial effect on the stability of slopes in mountainous areas. What is more, if the frequency of typhoons and torrential rains increases, landslides and gully erosion will become more frequent.

There are essentially three factors which determine the extent of such mountain slope erosion activity, and these vary greatly from one location to another: the angle of the slope, the nature of the soil, and the intensity of precipitation. Worldwide, Japan's mountain regions belong to the class which is subject to the greatest amount of erosion. Japanese researchers need to clarify the exact types of changes that occurred during the past thermal period.

5.5.3. Impacts on Forest Ecosystems

The quantity of precipitation in Japan is sufficient for the establishment of forests. There is, however, a large temperature variation from region to region because the national land area extends a great distance from north to south. Thus, temperature conditions essentially regulate the distribution patterns of Japanese forest areas. During the summer months, Japanese temperature conditions are virtually the same as those in the tropics. The northern limits of forest distribution are actually determined by low temperatures and snow accumulation during the winter. Therefore changes to winter temperatures and snow accumulation are the most important factors for evaluating the effects of global warming on Japanese forests.

If winter temperatures rise by 3°C, the southern limits of deciduous broad-leaved forests located in the mountainous regions of western Japan and the inland regions of central Japan will move northwards. Meanwhile, the range of evergreen broad-leaved forests will extend to the northern edge of Honshu island. This transition from deciduous to ever-

green broad-leaved forests will be the greatest change in the forest zones, and it will have a major impact on forest ecosystems through changes such as that to the light environment on the forest floor.

Along with winter temperatures, snowfall accumulation is another important factor that regulates the formation of Japanese forests. If snowfall accumulation does decline with global warming, the distribution of beech forests—which are well-adapted to heavy snowfalls—may be greatly affected.

Because the forests are comprised of diverse species, changes to forest zones will not proceed uniformly; and because the capacity for migration varies greatly by species, the synergism among species could lead to a new flourishing composition of vegetation. Moreover, in Japanese mountain districts the different vegetation belts are distinctive and tend to be distributed by elevation. Subtropical trees are associated with lowlands, temperate trees with the mountains, and subarctic trees with the subalpine zone. These different vegetation belts enter the mountains from different directions, like wedges. When global warming occurs, there is a possibility that certain vegetation belts will disappear.

5.5.4. Impacts on Grasslands

Natural grasslands cover just 1% of Japan's land area. They are mostly located in areas exposed to extreme conditions such as high mountains, seashores, wetlands, and high wind zones. The population of each species is small and at risk of extinction from small changes in environmental conditions. According to the Red Data Book, many of the Japanese plant species in danger of extinction are found in the nation's grasslands. In foreign countries, precipitation is an important factor determining the distribution and type of grasslands, but in Japan temperature (or a combination of temperature and precipitation) is more important.

In artificial grasslands certain species sometimes grow rank, and this will be a major problem in grassland management. Japan's artificial grasslands are comprised of transitional species. If they are left alone the biological succession progresses and carbon dioxide is rapidly fixed in the plant matter and the soil. There is a possibility that the area of Japanese grasslands may decline because of changes in agricultural conditions. So along with the effects from global warming, human factors may also have a significant effect on Japanese grassland ecosystems.

5.5.5. Impacts on Fresh-water Ecosystems

In Japan's fresh-water ecosystems, species with a low resistance to high temperatures include fish in the salmon family, *Daphnia* and other large Cladocera, Mysidacea, and Gammaridae. These species may suffer heat damage if global warming leads to higher temperatures in lakes and rivers during the summer months. With higher water temperatures, the mature sizes of many species are expected to decline. Scientists also predict that higher temperatures will result in faster maturation rates for aquatic insects and a larger number of generations per year.

Higher water temperatures may result in the dominance of blue-green algae in lakes and marshes, and in an expansion of the oxygen-poor strata. This will change the distribution of species and affect entire ecosystems via the interaction among species. In many populations average sizes decline when water temperatures rise. This changes the food chain and reduces the efficiency of energy conversion from producers at a low trophic level to producers at a high trophic level. This is expected to cause eutrophication in lakes and marshes. (For the effects on coastal ecosystems, please refer to section 2 "Effects on Agriculture, Forestry and Fisheries").

5.5.6. Impacts on Coral Reefs

Japan's coral reefs are at the northern extremity of the global distribution. Higher water temperatures from global warming will have a positive effect on coral growth. The project-

5.6. Impacts on Human Health

ed rise in sea levels is within the speed of upward coral growth, so coral reefs have the potential to keep up with the rising sea levels.

However, it is unclear whether or not Japan's coral reefs can adapt to sudden changes in temperature, especially considering that the present species composition of the coral communities is adapted to low water temperatures, and that the coral's natural reproductive capacity and tolerance to environmental change may have already declined because of pressure from human activities.

5.5.7. Impacts on Desertification

There is currently no danger of desertification in Japan. However, climate change caused by desertification on the Eurasian continent may indirectly affect the climate in Japan.

5.5.8. Impacts on Environmental Pollution

There are concerns that global warming may exacerbate air pollution, water pollution, and other localized pollution; survey research is already being conducted in certain fields.

As for air pollution, researchers project that global warming may increase the frequency of photochemical oxidant production and also expand the size of the areas effected. These predictions are based on studies of the relationship between temperature and ozone (which causes photochemical oxidants) and between temperature and PAN.

Very little research has been conducted regarding the effects of global warming on water pollution. If global warming increases the volume of organic matter deposited by rivers and streams, water pollution may worsen in coastal waters, especially in semi-enclosed bays. The effects of global warming on red tide and blue tide are not yet clear. Rivers, lakes, and marshes are already subjected to strong pollution stress, and there are concerns that climate change may lead to a further worsening of the water quality.

5.6. Impacts on Human Health

Global warming may directly affect human health via the increased heat stress from high temperatures during the summer months. The indirect effects on human health may include conditions promoting the growth of parasites, pathogens, and creatures that function as carriers of infectious diseases. Global warming may also harm human health via the increase of photochemical air pollution.

5.6.1. Direct Impacts from Increased Heat Stress

The direct effects on human health from increased heat stress include higher incidences of heat stroke and thermoplegia, and research is being conducted in these fields. Epidemiological studies show that the number of heat stroke patients will increase exponentially if the average daily temperatures and average daily highs exceed 27 and 32°C, respectively, in the Tokyo area.

5.6.2. Indirect Impacts from the Spread of Infectious Diseases via Animal Vectors

Global warming will expand the habitat and activity periods of animals that serve as carriers of infectious diseases. This may result in increases in the number of cases of malaria, dengue fever, and other infectious diseases carried via animal vectors. The areas where these diseases occur may expand.

In Japan, Ishigaki Island and Miyako Island are currently the northern edge of the habitat of the *Anopheles* mosquito (which carries malaria). With global warming, the habitat may expand northward and the mosquitoes may become more active, seriously affecting health in subtropical areas. Furthermore, a WHO report jointly issued with WMO and UNEP presents research stating that falciparum malaria may spread in temperatures lower than those previously believed to be the minimum. Analysis combining this research with climate change scenarios suggests that in the future malaria may have the potential to spread in western Japan.

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Chapter 6

Adaptive Measures

■ *Approaches to Policies and Measures*

While various measures, including the restriction of greenhouse gas emissions, are being implemented to arrest global warming, the Framework Convention also calls for measures to mitigate the adverse effects of climate change and for adaptive measures that will facilitate adaptation to climate change. With this in mind, Japan is studying adaptive measures related to sea level rise and agricultural production.

■ *Details of Policies and Measures*

6.1. Adaptive Measures Against Sea Level Rise

6.1.1. Preventing Declines in Facility Safety and Functionality

Sea level rise will adversely affect the safety and function of harbor facilities such as breakwaters and quay walls. According to the IPCC Second Assessment Report, sea levels are expected to rise approximately 50 centimeters over the next 100 years. However, no immediate decline in the safety or functionality of breakwaters, quay walls, and other harbor facilities is expected. In view of this, the following approach is considered to be appropriate for adaptive measures.

* As an adaptive measure against sea level rise, anticipated impacts of future rises will be reflected in the designs of new harbor facilities, taking into account the durability of such facilities.

* For existing facilities, sea levels will be constantly monitored and appropriate measures taken when deemed necessary.

An increase in coastal erosion and an increase in the risk of disaster caused by a decline in the safety and functionality of coastal protection facilities are expected as a result of sea level rise. With these concerns in mind, Japan is currently reviewing its plan of coastal protection and giving serious consideration to related issues.

6.1.2. Engaging in Environmental Conservation

The potential effects of sea level rise on the natural environment include the loss of sandy beaches and tidelands. These threats are not immediate, however. One way to deal with this problem is to implement an integrated coastal protection plan that will preserve and create coastal space. Over the long term, sea level rise can be expected to affect such coastal ecosystems as seaweed beds, tidelands, and coral reefs. For areas where harbor works, coastal protection works, or fishing ground enhancement works are undertaken, by promoting Eco-port Projects (which establish a symbiotic relationship between the port and its environment) and Eco-coast Works (environmentally oriented coastal protection works that help to preserve a favorable natural environment and contribute to the creation of new environments such as artificial beaches and tidelands) and by creating seaweed beds and tidelands associated with Coastal Fishing Grounds Enhancement and Development Projects, it should be possible to help coastal ecosystems adapt to the changes in living environment that are engendered by sea level rise. Japan is therefore making further efforts to promote these projects. It is also necessary to actively promote the preservation and creation of seaweed beds and coral reefs, since these play an important role in helping ecosystems adapt to sea level rise.

Six harbors, including Yokohama Harbor (Shinko District), have already been designated as model Eco-port projects, which are the focal points for efforts to build comprehensive facilities designed to preserve and create healthy environments.

6.2. Adaptations in Agriculture

6.1.3. Continuous Monitoring and Research

To ascertain sea level rise in harbors and coastal areas, it is necessary for agencies concerned to conduct continuous monitorings and evaluate observation results on a regular basis.

In addition, Japan will continue to pursue research on effective and economical ways of dealing with sea level rise.

6.1.4. Expanding Existing Projects to Enhance Safety in Coastal Areas

Measures against tsunamis and high-tide damage are extremely effective in reducing the potential for disaster generated by sea level rise. Integrated coastal protection projects are also effective in dealing with increases in wave overflow associated with sea level rise. Japan will therefore further pursue these projects, while taking into consideration their effects on the scenic beauty and ecologies of the areas concerned.

6.2. Adaptations in Agriculture

Agricultural technologies designed to help farmers adapt to changing conditions caused by global warming might include the introduction of new crop varieties and changes in planting times. Crop growth models are being used in research to determine the extent to which these technologies will help farmers avoid declines in crop yield.

In the case of wetland rice, which is an important crop for Japan, it is believed that the introduction of rice varieties now cultivated further to the south will prove to be an effective countermeasure, as well the earlier transplantation of rice seedlings to the paddies. For maize and wheat grown in northern Japan (Hokkaido), changes in planting times and the introduction of irrigation systems should prove effective, although research results indicate that such methods will not help farmers avoid a reduction in yield in other parts of the country.

Chapter 7

Financial Assistance and Technology Transfer

■ *The Approach of Policies and Measures*

With regard to international cooperation for the conservation of the global environment, the Council of Ministers for Global Environmental Conservation reached agreement in June 1989 on basic policies that give greater consideration to environmental issues when implementing ODA projects, including increasing official development assistance (ODA) for environmental issues, promoting the development and the transfer of technologies which suit the needs of developing countries, and encouraging the development of human resources in environmental fields. Following this agreement, the relevant ministries, agencies, and organizations have been cooperating to promote the overall increase of environment-related ODA disbursements and to strengthen environmental considerations in the implementation of ODA projects.

In addressing the United Nations Conference on Environment and Development in June 1992, Prime Minister Kiichi Miyazawa announced that Japan would endeavor to significantly expand its ODA in the field of the environment to around ¥900 billion to ¥1 trillion during the five-year period starting from fiscal 1992. During the next four years, to fiscal 1995, Japan contributed ¥980 billion, thus reaching its declared goal one year early. Also in June 1992, the Cabinet adopted Japan's Official Development Assistance Charter (ODA Charter), which spells out the philosophy and principles of Japan's official development assistance. This document identifies environmental conservation as one of the basic philosophies of ODA and states that "the pursuit of environmental conservation and development in tandem" must be one of the basic principles of ODA. Furthermore, it states that efforts will be made to achieve sustainable development on a global scale by assisting the self-help efforts of developing countries.

The Basic Environment Law stipulates that the government must endeavor to take the necessary measures to promote international cooperation for the conservation of the global environment.

■ *The Details of Policies and Measures*

7.1. Measures concerning new and additional financial resources to meet the agreed full costs incurred by developing country Parties in complying with their obligations under Article 12.1 of the Convention

7.1.1. Comprehensive Support for Arresting Global Warming

*** Asia-Pacific Seminar on Climate Change**

Japan has organized the Asia-Pacific Seminar on Climate Change as a forum of discussion of global warming issues and countermeasures for the Asia-Pacific region. This seminar has been held on six occasions (in Nagoya in January 1990, Bangkok in March 1993, Osaka in March 1994, Bangkok in March 1995, Sendai in January 1996, and Fiji in November 1996), with the participation of administrative officials and experts from all countries in the region as well as international organizations. During the 6th seminar, information and opinions were exchanged on the following main themes: analyses of efforts being made by each country to fulfill the terms of the Convention, including the preparation of national communications; and vulnerability assessments with a focus on South Pacific countries, along with an examination of appropriate countermeasures.

Furthermore, Japan is conducting research for developing countries in the Asia-Pacific region on the impact of global warming, the emission of greenhouse gases, and the identification of priority policies and is also working to help developing countries in the region create individual national strategies for counteracting global warming. To date, Japan has undertaken such programs in Indonesia, Fiji, and Western Samoa.

7.2. Measures concerning financial resources to meet the agreed full incremental costs incurred by developing countries in their implementation of measures covered under Article 4.1 of the Convention

7.2. Measures concerning financial resources to meet the agreed full incremental costs incurred by developing countries in their implementation of measures covered under Article 4.1 of the Convention

These measures overlap to some degree with measures related to “Financial Assistance and Technology Transfers for Arresting Global Warming (7.4.2),” so that some measures are listed more than once.

7.2.1. Comprehensive Support for Arresting Global Warming

*** Cooperation with the Global Environment Facility (GEF)**

After the successful completion of the GEF pilot phase, which extended for three years beginning in 1991, a new GEF program (GEF1) was initiated in 1994. Total funding for GEF1 is US\$2 billion, of which Japan is contributing US\$415 million.

In the pilot phase of GEF, Japan has contributed about ¥5.3 billion as well as provided a total of US\$60.58 million worth of yen loans as co-financing for the two projects (in Thailand and Morocco).

*** Cooperation with IPCC**

Japan cooperates with IPCC in terms of human and financial resources. For example, Japan provides IPCC with US\$50,000 annually through the Voluntary Cooperation Programme of the World Meteorological Organization (WMO); participates in the formulation of reports, both as a bureau member and as lead author; and hosts workshops.

*** Cooperation with the World Meteorological Organization (WMO)**

Japan transfers technology and provides equipment to the national meteorological services of developing countries to conduct global projects such as the World Weather Watch (WWW) programme and the Global Atmosphere Watch (GAW) programme.

7.2.2. Promotion of Financial Assistance and Technology Transfers for Arresting Global Warming

7.2.2.1. Energy Conservation

*** Yen loans to promote energy conservation and afforestation projects**

Japan provides long-term, low-interest yen loans (average repayment period: about 29 years and 4 months; average deferment period: about 9 years and 7 months; average interest rate: 2.54% [fiscal 1995]) as part of its ODA. These loans provide financing and support technology transfers for projects that address climate change in developing countries (energy conservation, afforestation, prevention of air pollution, public transportation organizations, etc.).

Since fiscal 1995, Japan has provided and promoted yen loans to countries with medium incomes and below (except LLDCs) for use in environmental fields with a special interest rate that is 0.2% less than that of loans made in other fields.

In addition, Japan provides Special Assistance for Project Formation to encourage developing countries to formulate their own projects, including geothermal power generation projects, energy conservation projects, and afforestation projects.

Based on the ODA Charter, Japan will continue to provide yen loans to finance activities in environmental fields, including countermeasures against climate change.

7.2.2.2. Establishment of Centers for Environmental Technology Transfers

To promote support for countermeasures against global warming in developing countries, it is important to provide information concerning a wide range of related environmental protection technologies. Therefore, Japan is actively providing

information such as the following concerning technologies for analyzing pollutants and conserving tropical rain forests and other forest ecosystems.

*** Project-Type Technical Cooperation through the Environment Protection Center Project**

To improve environmental protection technologies in developing countries, Japan cooperates in programs such as the Environment Protection Center Project by participating in comprehensive project-type technical cooperation that includes dispatch of experts, acceptance of trainees, and provision of equipment. Specific examples of this type of cooperation include: the Environmental Research and Training Center in Thailand; the Environment Management Center in Indonesia; the Japan-China Friendship Environment Protection Center in China; the National Center for the Environment in Chile; and the Environmental Research and Training Center in Mexico.

*** Project-Type Technical Cooperation for the Conservation of Biodiversity**

Japan is involved in various project-type technical cooperation programs designed to conserve biodiversity in Indonesia, including the establishment of the Nature Conservation Information Center.

*** Project-Type Technical Cooperation in Forestry Fields**

As part of the technical assistance Japan provides through ODA, and in response to requests received from developing countries, Japan operates integrated programs that include 1) dispatch of experts; 2) acceptance of trainees; and 3) provision of equipment.

Project-type technical cooperation in the forestry field is designed to protect and extend tropical rain forests and other types of forest in the developing countries, and to promote sustainable forest management practices that will contribute to the economic and social development of the country in question.

Specific examples of this type of activity include: the Tropical Rain Forest Study Plan in Indonesia and the Reforestation and Extension Project in Northeast Thailand. Future plans call for new projects to be undertaken in addition to continuing the 22 ongoing projects.

*** UNEP International Environment Technology Centers**

In October 1992, UNEP International Environment Technology Centers, which are part of the internal organization of the United Nations Environment Programme (UNEP), were established in Osaka City and Shiga Prefecture. These centers are dedicated to transferring environmentally sound technologies to developing countries by establishing a database of conservation technologies, making information available, and providing training, consulting, and other services. Japan supports these activities through such organizations as the Global Environment Center Foundation (GEC) and the International Lake Environment Committee (ILEC).

7.2.3. Support for Conservation and Development of Tropical Forests and Other Sinks for Carbon Dioxide

7.2.3.1. Supporting ITTO and TFAP

*** Support for the ITTO**

Japan is currently the largest financial contributor to ITTO among all member countries and is actively participating in promoting ITTO tropical forest conservation programs. During 1996, Japan provided ¥1,667 million in voluntary contributions, in addition to its annual allotment of ¥86 million.

7.2. Measures concerning financial resources to meet the agreed full incremental costs incurred by developing countries in their implementation of measures covered under Article 4.1 of the Convention

* Support for TFAP

Japan makes financial contributions to the FAO to support its field activities. Between fiscal 1988 and fiscal 1990, Japan annually disbursed a sum of US\$394,000 in trust funds to dispatch experts and to provide other forms of assistance to countries which had initiated the National Tropical Forestry Action Programme. Furthermore, Japan has participated in ongoing efforts to revamp TFAP (ad hoc meeting) and made annual contributions of US\$349,000 between fiscal 1991 and fiscal 1993 to the field project for formulating an emergency plan for afforestation. In fiscal 1992, Japan contributed US\$100,000 to a project for gathering information concerning TFAP.

7.2.3.2. *Support for Sustainable Forestry Management, Afforestation, and Conservation of the Ecosystem*

* Yen loans to promote energy conservation and afforestation projects

See 7.2.2.1.

* Verifying the Sustainable Management of Tropical Rain Forests

To encourage the sustainable management of tropical rain forests, Japan began working in fiscal 1996 to ascertain the validity of the standards and indexes for sustainable management that ITTO has established for specific tropical regions in the Asia-Pacific region, South and Central America, and Africa, as well as [ITTO guidelines concerning](#) the sustainable management of natural tropical forests. In fiscal 1996, Japan provided US\$650,000 to implement a verification project in the Philippines.

* Monitoring Trends in the Import and Export of Tropical Timber

Japan is monitoring the import and export of tropical timber by collecting appropriate data from the main trading companies.

7.2.4. Activities Implemented Jointly (AIJ)

In accordance with the decision adopted at COP1 of the Framework Convention on Climate Change, Japan engaged in discussions concerning the Japan Programme for Activities Implemented Jointly Under the Pilot Phase at the joint sessions of the Council of Ministers for Global Environment Conservation and the National Energy Council of Ministers on November 24, 1995. This program serves as the main implementing body for Japan's participation in AIJ projects. While encouraging the participation of a wide range of entities, including regional public bodies, general corporations, NGOs, and public corporations, Japan has also established the Inter-Ministerial/Agency Co-ordination Committee for AIJ, as well as the Secretariat for that committee, as part of efforts to establish standards for a system that will promote AIJ. At the meeting of the Inter-Ministerial/Agency Co-ordination Committee for AIJ on January 19, 1996, the following documents were formulated: Manual for AIJ Pilot Project Proposal in the Japan AIJ Pilot Program; AIJ Project Application Form; and Evaluation Guidelines for Approving AIJ Projects. Also, from April 1 through June 10, 1996, proposals were publicly solicited for the first round of projects, and 11 final projects were approved by the relevant ministries and agencies on July 5. At the same time, the Inter-Ministerial/Agency Co-ordination Committee for AIJ created a logo mark for the Japan Programme for Activities Implemented Jointly Under the Pilot Phase.

7.3. Measures concerning assistance provided for the purpose of aiding developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting the costs involved in adapting to those adverse effects

7.3.1. Comprehensive Support for Arresting Global Warming

* Asia-Pacific Seminar on Climate Change

See 7.1.1.

7.4. Measures taken to promote, facilitate, and finance, as appropriate, access to, or transfer of, environmentally sound technologies and know-how to other Parties, particularly developing country Parties

7.4.1. Comprehensive Support for Arresting Global Warming

* Asia-Pacific Seminar on Climate Change

See 7.1.1.

* **Implementing Seminars through JICA**

Since 1992, the Japan International Cooperation Agency (JICA) has hosted seminars for administrative officers in the Asia-Pacific region for the promotion of scientific understanding of global warming and related policies and countermeasures.

* **Cooperation with the World Meteorological Organization (WMO)**

Japan transfers technology and provides equipment to the national meteorological services of developing countries participating to conduct global projects such as the World Weather Watch (WWW) programme and the Global Atmosphere Watch (GAW) programme.

7.4.2. Promotion of Financial Assistance and Technology Transfers for Arresting Global Warming

7.4.2.1. Energy Conservation

* Yen loans to promote energy conservation and afforestation projects

See 7.2.2.1.

* **Implementing Various Types of Technical Cooperation**

To develop effective responses to global warming and to support the self-help efforts of developing countries in the areas of energy and environment-related problems through technical assistance in the fields of energy conservation and new energy sources, Japan is implementing the "Green Aid Plan," which effectively combines the policy tools of cooperation assistance in research and human resource development. In addition, Japan is conducting technical cooperation programs through JICA and working to promote technology transfers through the operation of energy-efficient model projects.

* **Study for Transfers of Traffic Control Technology**

From fiscal 1989 through fiscal 1995, Japan sent survey teams to 18 ODA recipient countries to transfer Japan's superior traffic control technology, which helps to relieve traffic congestion and thereby reduces automotive emissions. (Further surveys are planned for Vietnam and Brazil in fiscal 1996, and Ethiopia and India in fiscal 1997.) In addition to the studies, Japan, through JICA, also dispatched personnel from the National Police Agency to Sri Lanka in fiscal 1991, and to Indonesia as long-term JICA experts from fiscal 1995, in order to assist in the transfer of traffic control technology to those countries.

7.4. Measures taken to promote, facilitate, and finance, as appropriate, access to, or transfer of, environmentally sound technologies and know-how to other Parties, particularly developing country Parties

*** Dissemination of Technologies to Reduce N₂O Gas Emissions from Fertilizers**

Japan conducts surveys in developing countries on N₂O emissions generated by fertilizers and verifies and demonstrates control technologies. In this way, Japan is working to reduce the burden on the environment as well as to disseminate technologies that will promote more efficient fertilizer use.

*** Establishing a Climate Change Monitoring Network for the Asia-Pacific Region**

With the aim of establishing a measuring, monitoring, and research network that will promote understanding of the causes behind climate change and provide highly accurate predictive results, Japan is studying ways of enhancing measurement facilities and other hardware systems in developing countries in the Asia-Pacific region, and promoting exchange among technical experts in order to raise the overall level of the implementing systems involved.

*** Cooperation in Formulating Countermeasures against Pollution from Automotive Traffic**

Using traffic and environmental simulation programs, Japan develops and proposes comprehensive methods of dealing with traffic pollution that include such steps as establishing public traffic organizations and introducing vehicle inspection systems designed to reduce automotive emissions. These efforts are aimed at easing traffic congestion and reducing traffic-generated air pollution, etc.

*** Dispatching and Inviting Researchers on the Basis of the Bilateral Science and Technology Cooperation Agreement**

Japan dispatches and invites researchers on the basis of the Bilateral Science and Technology Cooperation Agreement in an effort to provide technical guidance for the development of regional climate models that can predict climate changes in partner countries' regions.

*** Establishing the Foundation for the International Dissemination of Clean Coal Technology**

Demand for coal is expected to increase in the Asia-Pacific region. In an effort to prevent global environmental problems associated with an increase in coal use, Japan is actively using such programs as the Green Aid Plan and APEC to establish the foundation for the transfer and dissemination of clean coal technologies that will reduce the environmental burden.

*** Promoting Countermeasures against Methane Gas Generated from Coal Mining**

Through APEC, Japan is providing technical cooperation along with the U.S., China, and other countries in the Coal Mine Gas Recovery and Utilization Project in China.

*** Comprehensive Development Plan for Environmental Conservation**

Japan conducts surveys on emissions of carbon dioxide, nitrogen oxides, sulfur oxides, and other substances in various industries and regions in developing countries and compiles and proposes reform measures to the governments concerned.

* **Providing Information through the Japan Environmental Corporation**

Through the Japan Environmental Corporation, Japan is providing developing countries and regions with information that contributes to environmental conservation.

7.4.2.2. Establishment of Centers for Environmental Technology Transfers

See 7.2.2.2.

7.4.3. Support for Conservation and Development of Tropical Forests and Other Sinks for Carbon Dioxide

7.4.3.1. Support for Sustainable Forestry Management, Afforestation, and Conservation of the Ecosystem

* **Yen loans to promote energy conservation and afforestation projects**

See 7.2.2.1.

* **Promoting International Forestry Cooperation**

To help ensure the sustainable management of tropical forests and other forests of the world, Japan is engaged in the following: 1) technical and other types of bilateral cooperation with developing countries through JICA, etc.; 2) multilateral cooperation through the provision of financial support to tropical forest conservation projects undertaken by ITTO; 3) multilateral cooperation through the provision of financial support to FAO; and 4) participation in international dialogue through such forums as the UN Commission on Sustainable Development (CSD) and the Intergovernmental Panel on Forests (IPF).

Bilateral cooperation through JICA began in the Philippines in 1976. As of the end of fiscal 1995, 19 projects have been completed in 13 countries, and 22 more projects (including two verification surveys) are being implemented in 14 countries.

The following four bilateral projects will be implemented through JICA in fiscal 1996: the Forest Extension Project in the Eastern Region of Paraguay; the Forest Fire Prevention Management Project in the Republic of Indonesia; the Forest Conservation and Afforestation Project in the Lao People's Democratic Republic; and the Research Project for Higher Utilization of Forestry and Agricultural Plant Materials in Thailand. Three additional projects are scheduled for implementation in Vietnam and other countries, as well.

* **Conference of Senior Foresters**

In July 1991, Japan hosted the Conference of Senior Foresters in conjunction with ITTO to discuss ways to achieve sustainable forest management and create an information network at Yokohama. Representatives from 42 countries and 12 international organizations participated. As a follow-up project, the Seminars of Senior Foresters to Promote the Activities for the Conservation and Sustainable Management of Tropical Forests was held, where representatives gave specific consideration to practical programs on the following themes: "Reforestation and the Development of Small-Scale Forestry," "Toward the Establishment of Sustainable Management of Natural Tropical Forests," and "Conservation of Forest Biodiversity."

* **Japan International Forestry Promotion and Cooperation Center**

In the area of human resource development and the support of citizens' activities in the conservation of tropical forests, the Japan International Forestry Promotion and Cooperation Center has been established as the center of promotional activities for international greenery projects. With an annual budget of

7.4. Measures taken to promote, facilitate, and finance, as appropriate, access to, or transfer of, environmentally sound technologies and know-how to other Parties, particularly developing country Parties

approximately ¥200 million since fiscal 1991, the Center has been strengthening its organizational foundation through the support of forestry activities by NGOs and promoting the training of technical experts.

* **Tropical Forest Management and Information Center**

In the area of monitoring the conservation of tropical forests, the Tropical Forest Management and Information Center was established in 1990 with an annual budget of approximately ¥300 million. The Center is involved in the analysis of satellite information obtained from the remote sensing of forestry resources and is developing a system for the delivery of images to TV monitors. Such activities have been implemented in Thailand, Indonesia, Cambodia, the Philippines, and Myanmar. The Center also studies the damage done to tropical forests by fires and, based on the results of the study, implements the development of remote sensing technologies for formulating forest fire restoration plans. Such studies have been conducted for mountain fires in Kalimantan, Indonesia, and for landslides and sediment discharges in the Philippines.

7.4.3.2. *Prevention of Acid Rain*

Nitrogen oxides have been identified as one cause of acid rain; they are also considered a greenhouse gas that contributes to ozone formation in the troposphere. Therefore, countermeasures against acid rain also contribute to the arrest of global warming. Furthermore, by preventing damage to forests, countermeasures against acid rain contribute to the preservation of sinks for carbon dioxide, which is the most representative greenhouse gas.

* **Acid Precipitation Monitoring Networks in East Asia**

Japan hosted annual expert meetings on acid precipitation monitoring networks in East Asia over a three-year period beginning in fiscal 1993. In addition, problems related to acid rain have been the principal topic of discussion in the Northeast Asian Conference on Environmental Cooperation.

* **Surveys of Forest Damage Caused by Acid Rain**

During a five-year period beginning in fiscal 1992, Japan has been conducting various surveys that will contribute to the establishment of monitoring systems and countermeasures against damage caused by acid rain. These activities include gathering information concerning acid-rain damage to forests in developing countries, conducting monitoring surveys, and assessing actual damage to forests in coastal regions.

7.4.3.3. *Prevention of Desertification*

The loss of forests and other green land through desertification leads to the loss of important sinks for carbon dioxide. In this sense, the prevention of desertification is important as a means of preventing global warming.

Japan was an active participant in the Intergovernmental Negotiating Committee, which formulated an international convention adopted in June 1994 to combat desertification. Japan has further committed itself to actively contributing to negotiations currently being conducted for the Conference of Parties of the Convention to Combat Desertification by studying comprehensive desertification prevention policies that include social and economic aspects.

* **Cooperative Projects**

Specifically, Japan is involved in the following projects: research on the evaluation of the interaction between desertification and human activities in western

India and eastern China; international joint research on the mechanism of desertification in the areas surrounding the Takla Makan Desert in China; surveys and model afforestation concerning reforestation technologies in desertified areas in China, Mali, and Yemen; Sino-Japan joint research on the interaction of the topsoil and atmosphere in the Heife River basin; and an empirical study on desertification prevention technologies in the Saharan Sahel. In addition, Japan is involved in joint research with Egypt to improve soil by developing water-retaining agents using highly absorbent resins.

*** Projects to Promote Greenery**

In Africa, Japan is implementing the “Greenery Promotion” project with the aim of providing villagers with technical guidance concerning forestation and disseminating agroforestry.

7.4.4. Promoting International Cooperation in the Private Sector

To effectively promote countermeasures against global warming, it is necessary to encourage the cooperation of a large range of entities in the both the public and private sectors in addition to cooperation between governments. Support for private activities should take a variety of forms.

*** Cooperative Activities of Private Groups**

In Japan, many of the existing environmental conservation technologies were developed by private companies. Parallel to this, foreign direct investments by private companies to developing countries play a highly significant role in technology transfer. In addition, Japan's various domestic NGOs (including public corporations such as the Japan Wildlife Research Center, International Lake Environment Committee, Overseas Environmental Cooperation Center, and Organization for Industrial, Spiritual, Cultural Advancement International, and Federation of Economic Organizations and volunteer organizations such as the Japan International Volunteer Center and Sotosyu International Volunteer Association) promote international environmental cooperation by implementing environmental conservation programs from the governmental level down to the grassroots level, by hosting symposiums, lectures, seminars and by assisting environmental protection activities, and other events.

*** Support for Private Activities**

Activities in the private sector are supported with funding from sources such as the following: the Ministry of Foreign Affairs' Subsidy System for NGO Projects and Grant Assistance for Grassroots projects; and the Japan Environment Corporation's assistance to private organizations from its Japan Fund for the Global Environment.

*** Support for Global Environmental Conservation Using “Postcard Contributions” and Other Programs**

Japan collects contributions through postcard sales and other means and distributes them to organizations that work to conserve the global environment. In addition, it prepares booklets outlining the activities of the groups that receive contributions with the aim of deepening public awareness of global conservation efforts. From fiscal 1992 through fiscal 1995, a total of ¥706 million was distributed, and 170,000 booklets and 136,000 posters were prepared. These activities will be continued in the future in an effort to deepen public awareness of the global environment.

7.5. Other

* Debt/Environment Swaps

Private companies are beginning to participate in natural conservation swaps for the protection of forests and other natural resources. To lend support to these efforts, Japan formulated guidelines in fiscal 1993 for the appropriate implementation of such swaps. Also, to facilitate smooth debt/conservation swaps, the Overseas Environmental Cooperation Center established a network to provide needed information.

7.5. Other

7.5.1. Considerations in Undertaking International Cooperation Projects

In pursuing development assistance, it is important to take into account environmental conservation – including elements that might contribute to the mitigation of global warming – in order to promote sustainable development.

* In 1989, the Council of Ministers for Global Environment Conservation agreed that greater consideration must be given to environmental issues when implementing ODA projects.

* JICA is in charge of Japan's technical cooperation with other countries. Since 1990, JICA has formulated environmental guidelines for specific fields of international cooperation, such as the "Environmental Guidelines for Social and Economic Infrastructure Development Projects."

Similarly, the Overseas Economic Cooperation Fund (OECF), which is in charge of yen loans, has worked to secure environmental consideration in its cooperative projects on the basis of the OECF Environmental Guidelines of 1989. The Guidelines were revised in August 1995 and, based on the revised Guidelines, the following factors are now included: the provision of environmental assessments according to the rank of projects; consideration to local residents; respect for nature conservation areas; and the provision of necessary funding for environmental countermeasures and monitoring. Also, attention to environmental consideration is being further strengthened by the addition of a new, 17th sector, "Waste Disposal," to the 16 sectors that already exist in the Guidelines.

Table 7.1 Financial contributions to the operating entity or entities of the financial mechanism, regional and other multilateral institutions and programmes

	Contributions (millions of U.S. dollars)		
	1994	1995	1996
Global Environment Facility Donated government bonds Maturity Co-lending	¥11,424 million 0	¥34,273 million 0 \$35.4 million	0 ¥2,243 million
Multilateral institutions			
1. World Bank	¥20,800 million	¥20,900 million	¥21,300 million
2. International Finance Corporation (IFC)	¥100 million	¥500 million	¥500 million
3. African Development Bank	¥200 million	¥200 million	¥200 million
4. Asian Development Bank	¥10,200 million	¥11,100 million	¥11,000 million
5. European Bank for Reconstruction and Development	¥1,700 million	¥1,800 million	¥2,000 million
6. Inter-American Development Bank	¥2,000 million	¥2,400 million	¥2,400 million
7. United Nations Development Programme (UNDP)	\$100 million	\$105 million	
8. Others			
a) International Tropical Timber Organization (ITTO)	¥16.5 million	¥15.8 million	¥16.7 million
b) IPCC	\$50,000	\$50,000	\$5,000
c) United Nations Environment Programme (UNEP)	\$9 million	\$5 million	
Multilateral scientific programmes			
1.			
2.			
3.			
4.			
5.			
Multilateral technology programmes			
1.			
2.			
3.			
4.			
5.			
Multilateral training programmes			
1.			
2.			
3.			
4.			
5.			

Notes:

1. The amounts listed above are for the Japanese accounting year (April to March) and are generally in yen (rounded down to the nearest unit). However, GEF co-lending is converted with the DAC designated rate (end of December) for 1995 (¥94.07 = US\$1).
2. The amounts listed above represent the total initial budgetary provision for contributions to specific multilateral financial institutions, not the amounts used for areas related to climate change.
3. The amounts listed above represent the budgeted amounts for the fiscal year, in units of ¥1 million rounded down to the nearest ¥100 million.

7.5. Other

Table 7.2.1 Bilateral financial contributions related to the implementation of the Convention, 1994
(millions of U.S. dollars)

Recipient country	Mitigation						Adaptation	Other
	Energy	Transport	Forest	Agriculture	Waste management	Industry		
1. Albania	17.87							
2. Bulgaria						85.43		
3. India	60.22		221.88					
4. Indonesia	150.05		43.88					
5. Sri Lanka	56.15							
6. Thailand		147.58						
7. Pakistan	212.61							
8. Philippines		293.23				54.83		
9. Vietnam	234.44							
10. Morocco	35.40							
11.								
12.								
13.								
14.								
15.								
16.								
17.								
18.								
19.								
20. All other								

Notes:

1. This table contains fiscal 1995 figures for non-grant cooperation. The figures represent the estimated amounts allocated for new budget items, but there are also many continuing items that cannot be calculated. Given the difficulty in distinguishing between new and on-going items, Tables a and b contain the same information.
2. The figures in the table are estimates only of those projects having to do with global warming from among all non-grant cooperation.
3. The figures in the table are converted with the DAC designated rate (end of December) for 1995 (¥94.07 = US\$1).

Table 7.2.2 Bilateral financial contributions related to the implementation of the Convention, 1994
(millions of U.S. dollars)

Recipient country	Mitigation						Adaptation	Other
	Energy	Transport	Forest	Agriculture	Waste management	Industry		
1. Bhutan				6.24				
2. Brunei			0.62					
3. China	1.83		3.52					
4. Indonesia			24.46					
5. Iran	2.00							
6. Jordan					12.29			
7. South Korea	0.07							
8. Laos			0.34	13.30				
9. Malaysia			4.08					
10. Mongolia			0.87					
11. Myanmar			1.15					
12. Nepal	0.35		1.89					
13. Pakistan					7.24			
14. Philippines			0.29					
15. Qatar			0.16					
16. Saudi Arabia			0.22					
17. Sri Lanka					10.46			
18. Syria	1.31				6.64			
19. Thailand	0.16		1.62					
20. Turkey	1.97							
21. United Arab Emirates			0.04					
22. Vietnam			8.97					
23. Papua New Guinea			0.94					
24. Tonga			0.05					
25. Vanu Atu					1.53			
26. Egypt					0.82			
27. Ethiopia			1.61		5.50			
28. Ghana			0.05					
29. Kenya			2.71					
30. Madagascar			0.31					
31. Malawie			2.05					
32. Niger			0.61	2.27				
33. Senegal			6.60					
34. Tanzania			2.26					
35. Zambia	0.49		1.45					

7.5. Other

Recipient country	Mitigation						Adaptation	Other
	Energy	Transport	Forest	Agriculture	Waste management	Industry		
36. Zimbabwe	0.18							
37. Poland			0.04					
38. Romania	0.002		0.06					
39. Dominican Republic			0.10	0.32	3.41			
40. El Salvador				0.43				
41. Guatemala			1.80					
42. Honduras			2.13					
43. Mexico	0.18		0.38					
44. Nicaragua			0.05					
45. Panama			1.23					
46. Argentina	1.32		0.71					
47. Bolivia			0.34					
48. Brazil			3.08					
49. Chile	7.97		1.12					
50. Columbia			0.05					
51. Paraguay			0.10					
52. Peru					7.83			
53. Uruguay			1.10					
54. Others			0.22					
Total	17.83		79.38	22.56	55.72			
Grand total	175.49							

Notes:

1. This table contains fiscal 1995 figures for grant cooperation and technology cooperation.
2. The figures in the table are estimates only of those projects having to do with global warming from among all grant cooperation and technology cooperation.
3. The figures in the table are converted with the DAC designated rate (end of December) for 1995 (¥94.07 = US\$1).

Table 7.3.1 Projects or programmes that promote, facilitate, and/or finance the transfer of or access to "hard" and "soft" technologies

Project/programme title: Non-grant cooperation in environmental areas (yen loans)			
Purpose: To provide financial assistance and technology transfers for projects in climate change and other environmental areas undertaken by developing countries.			
Recipient country	Sector	Total funding	Years in operation
Eligible aid recipients from the DAC list	Energy, forestry, water and sewer, miscellaneous	¥170,820 million (fiscal 1995)	Annually
Description: This programme provides at favorable conditions (long-term, low interest) the funding needed by developing countries to engage in environmental projects. Since 1995, Japan has set the interest on yen loans for environmental projects in most developing countries 0.2 percentage points lower than the interest on yen loans in other areas.			
Ministry or company, contract person, address and phone number: Overseas Economic Cooperation Fund (OECF)			

Table 7.3.2 Projects or programmes that promote, facilitate, and/or finance the transfer of or access to "hard" and "soft" technologies

Project/programme title: Grant cooperation and technology cooperation in environmental areas			
Purpose: To provide financial assistance and technology transfers for projects in climate change and other environmental areas undertaken by developing countries.			
Recipient country	Sector	Total funding	Years in operation
Eligible aid recipients from the DAC list	Improvement of response capacity	¥65,110 million (fiscal 1995)	Annually
Description: To improve the ability of developing countries to respond to environmental conservation needs by providing funding or technology cooperation for the environmental projects of those countries without imposing a repayment obligation.			
Ministry or company, contract person, address and phone number: Japan International Cooperation Agency (JICA)			

Table 7.3.3 Projects or programmes that promote, facilitate, and/or finance the transfer of or access to "hard" and "soft" technologies

Project/programme title: Support from the Global Environment Fund for the establishment and activities of an East Asian Regional Network to respond to climate change and air pollution			
Purpose: To foster ties between NGOs in China, Taiwan, Hong Kong, Mongolia, Russia, and Japan in dealing with air pollution in the East Asian region and global warming.			
Recipient country	Sector	Total funding	Years in operation
NGOs in East Asian countries	Support for NGO activities	¥5 million (fiscal 1995)	fiscal 1995 – fiscal 1996
Description: To organize a loose network of NGOs in East Asia for the exchange of information and experience and such joint activities as are necessary in the areas of East Asian air pollution and global warming; to form the Atmosphere Action Network in East Asia (AANE) and support its activities.			
Ministry or company, contract person, address and phone number: Japan Environment Public Corporation, Environment Fund Division			

7.5. Other

Table 7.3.4 Projects or programmes that promote, facilitate, and/or finance the transfer of or access to "hard" and "soft" technologies

Project/programme title: Small Coal-Fired Boiler Efficiency Improvement Project in the City of Dalian, China			
Purpose: To contribute to the sustainable development of developing countries by promoting the transfer of environmentally sound technology.			
Recipient country	Sector	Total funding	Years in operation
China			1996-2000
Description: There are about 2,000 coal-fired boilers in Dalian. This project deals with the stoker-type small coal-fired boilers (with an evaporation amount not exceeding 30t/h) in the city. As part of the project, a small, inexpensive coal-fired boiler that has a high combustion efficiency, and is suitable for the nature low-quality coal fuel used in Dalian was designed and developed. The project seeks to promote use of developed boilers as existing boilers are replaced and developed boilers newly installed.			
Ministry or company, contract person, address and phone number: City of Kitakyushu			
Impact on greenhouse gas emissions/sinks Carbon dioxide reduction: 3,293.4 t CO ₂ (over 3 years; provisional)			

Table 7.3.5 Projects or programmes that promote, facilitate, and/or finance the transfer of or access to "hard" and "soft" technologies

Project/programme title: Model programme for coke dry quenching facilities (CDQ) in China			
Purpose: To promote the transfer and spread of CDQ technology, thereby contributing to more efficient energy use and the prevention of air pollution by the Chinese steel industry, and ultimately reducing carbon dioxide emissions.			
Recipient country	Sector	Total funding	Years in operation
China			
Description: This programme builds a CDQ model facility in which inert gas is used to extinguish and cool the red-hot coke expelled from the coke furnaces of steel plants, recovering the waste heat and using the high-temperature, high-pressure steam generated to power other parts of the plant. This facility helps to improve the energy efficiency of the steel plant and to prevent air pollution and carbon dioxide emissions. The construction and operation of the facility underscore the importance of this technology, demonstrate its effectiveness, and help to spread the technology to China.			
Ministry or company, contract person, address and phone number: New Energy and Technology Development Organization (NEDO)			
Impact on greenhouse gas emissions/sinks Carbon dioxide reduction: 87,434 t CO ₂ (provisional).			

Table 7.3.6 Projects or programmes that promote, facilitate, and/or finance the transfer of or access to "hard" and "soft" technologies

Project/programme title: Project to restore heat efficiency by improving the operation of existing thermoelectric plants in Thailand			
Purpose: To contribute to sustainable development by promoting the transfer of environmentally sound technology.			
Recipient country	Sector	Total funding	Years in operation
Thailand			1997-2000
Description: This project cooperates with the Thai electric power company (EGAT) to improve the heat efficiency of existing EGAT power plants using energy-conservation technology developed by Japanese electric power companies in the operation and maintenance of existing thermoelectric plants.			
Ministry or company, contract person, address and phone number: Kansai Electric Power, Chubu Electric Power, Electric Power Development Company.			

Table 7.3.7 Projects or programmes that promote, facilitate, and/or finance the transfer of or access to "hard" and "soft" technologies

Project/programme title: Creation of experimental forest in Kalimantan Timur, Republic of Indonesia			
Purpose: To develop technology and provide technology cooperation for the recreation of a tropical forest, aiming to restore forest lost due to mountain fires and slash-and-burn agriculture to a form close to its original ecology.			
Recipient country	Sector	Total funding	Years in operation
Indonesia			1991-2000
Description: The tropical rain forests play a major role in absorbing carbon dioxide. This project worked in cooperation with the Indonesia Ministry of Forests and Kutai Timber Corporation to create an experimental forest on 3,000 ha of land, which will be used to develop planting technologies for the Lauan trees that hold the key to rebuilding the tropical rain forests. The project will also test the commercial prospects of fast-growing varieties. In the project, forestation technology developed by Sumitomo Forestry Co., Ltd. that uses fungi to promote the growth of young trees will be utilized and transferred to Indonesia.			
Ministry or company, contract person, address and phone number: Sumitomo Forestry Co., Ltd.			
Impact on greenhouse gas emissions/sinks Carbon dioxide reduction: The trees planted in this project will, as a biomass, absorb and fix an estimated 4,300 t/year of carbon dioxide by 2000.			

Chapter 8

Research, Systematic Observation, and Technology Development

■ **Government Policies and Measures**

The Council of Ministers for Global Environment Conservation sets the Comprehensive Program for the Promotion of Global Environment Research, Monitoring and Technology Development each fiscal year. This program is designed to build a solid foundation for global environmental conservation and to clarify the priority areas that Japan should address in order to contribute positively to international initiatives. The program comprehensively promotes surveys, research, observation, monitoring, and technology development for the protection of the global environment and follows up on the implementation of efforts in these fields.

In accordance with the annual program, the Japan Environment Agency has established a budgeting system of the Global Environment Research Fund for the promotion of global environmental research. This is a system to comprehensively promote all types of surveys and research on global environmental conservation. The research is implemented through coordination among the related ministries and agencies. The budget is allocated to the Environment Agency in its entirety and is distributed to various national research institutions affiliated with the individual ministries and agencies.

In addition, some of the related surveys and research are funded under two other national budget categories: “promotion of science and technology” and “government subsidies for aiding scientific research.” The application of these funds is determined by the Science and Technology Council and the Japan Science Council, respectively.

In August 1990, the government’s basic stance and policies on research and development for global science and technology were compiled in the Basic Program for Research and Development in Global Science and Technology, which was approved by the prime minister.

Then in December 1994, the Basic Environment Plan was established by a Cabinet decision in accordance with Article 15 of the Basic Environment Law. The Basic Environment Plan sets four long-term objectives for the establishment of an environmentally sound socioeconomic system: a sound material cycle, harmonious coexistence between nature and mankind, participation by all sectors of society, and the promotion of international activities. The plan is designed to comprehensively and systematically promote policies for environmental conservation. It includes sections on “upgrading scientific research, monitoring, and observation, and promoting appropriate technology,” and “promoting international cooperation for research, monitoring, and observation.”

■ **Details of Policies and Measures**

8.1. Promotion of Research

8.1.1. Basic Principles

- (1) While regarding environmental issues as a series of related phenomena on a global scale, the Government of Japan is promoting comprehensive research on climate change in accordance with the following categories.
 - A. Surveys and research on various global phenomena related to climate change and global warming
 - B. Surveys and research on the impact of human activities on climate and global warming, and on the impact of climate change and global warming on human health, ecosystems, etc.
 - C. Surveys and research on policies to control climate change and global warming

8.1. Promotion of Research

- (2) Japan participates and cooperates in the World Climate Research Programme (WCRP), the International Geosphere-Biosphere Programme (IGBP), the International Human Dimensions Programme of Global Environmental Change (IHDP), and other international global environmental research programs, conducts surveys and research based upon an appropriate international division of tasks, and otherwise promotes joint research and other initiatives together with overseas research organs.
- (3) Based on the agreement reached among the participating nations at the First Inter-Governmental Meeting of the Asia-Pacific Network for Global Change Research (APN) held in March 1996, Japan is promoting research on global environmental change in the Asia-Pacific region in cooperation with researchers from throughout the area, as well as developing a regional research network on global environmental change.
- (4) In an effort to contribute to the development of government policy on climate change and global warming, Japan actively promotes research on global environmental problems from a human and social perspective, academic research integrating the natural and the social sciences, and research on socioeconomic systems.

In 1997, Japan launched a preliminary foundation to conduct the necessary preparatory works prior to the establishment (in early 1998) of the Institute of Global Environmental Strategies, which will be an international organization to promote this type of research. The Institute will, among other things, focus on the realization of sustainable development in the Asia-Pacific region, as well as construct an international network linking together policy research organizations and institutes around the globe.

8.1.2. Priority Fields

Considering that the Third Conference of the Parties to the United Nations Framework Convention on Climate Change (which will set the framework for the international approach to the prevention of global warming beyond the year 2000) will be held in Japan in 1997, and based upon the Action Program to Arrest Global Warming (adopted by the Council of Ministers for Global Environment Conservation on October 23, 1990), the Government of Japan is comprehensively promoting surveys and research to grasp the present conditions and predict the future impact of global warming, and to plan counter-measures. While elucidating various issues related to the mechanism of global warming, the Government of Japan will cooperate with the activities of the Intergovernmental Panel on Climate Change (IPCC). Moreover, based on the IPCC Second Assessment Report issued in December 1995, the government will give priority to promoting relevant research that will contribute to the IPCC Third Assessment Report, which is scheduled to be completed in the year 2000.

8.1.3. Main Research Fields

(1) *Research Implementation*

A. Surveys and research on various global phenomena related to climate change and global warming

The Government of Japan has been carrying out research in numerous areas including observation of the global behavior and impact of substances that cause global warming and elucidation of the following phenomena: the impact of clouds on global warming; the mechanisms and impact of El Niño and Southern Oscillation; precipitation phenomena as an integrated system; the Asian Monsoon mechanism, including participation in the GEWEX Asian Monsoon Experiment (GAME); the marine carbon cycle mechanism; and the flux of energy and substance over ocean ridges.

B. Surveys and research on the impact of human activities on climate and global warm-

ing, on technological assessments of countermeasures, and on the impact of climate change and global warming on human health, ecosystems, etc.

In cooperation with IPCC activities, the Government of Japan has been carrying out research in numerous areas including the following: climate change assessments using climate models; global warming feedback mechanisms relating to Siberian permafrost; the carbon dioxide and carbon cycles under global warming in ocean surface layers and terrestrial ecosystems; atmospheric chemistry covering the troposphere, such as studies of tropospheric ozone and the transformation of trace atmospheric elements under global warming; the impact of global warming on plants, and quantitative assessments of the forest sector's capacity to mitigate global warming; the impact of changing land-use patterns in the Asia-Pacific region on global warming, and the impact of global warming on local vegetation; forecasts and countermeasures to the impact of global warming on socioeconomic activities in coastal areas from rising sea levels, etc.; development of technological countermeasures to methane and nitrous oxide emissions to limit the impact of global warming; and the impact of global warming on the human living environment and environmental risk.

C. Surveys and research on policies to restrain climate change and global warming

To promote the Action Program to Arrest Global Warming while continuing research regarding various global warming countermeasures and assessments, the Government of Japan has been carrying out research in numerous areas including the following: determining the emission volume of greenhouse gases from stationary and mobile sources; preparation of guidelines for global warming countermeasures in water supply systems; development of the Asia-Pacific Integrated Model (AIM) for the integrated analysis of global warming; detection and assessment of the socioeconomic impacts of global warming; creation of environmentally sound cities from a long-term perspective; effects of and adaptation to global warming by communities in the Asia-Pacific region; control technologies for global environmental change factors using agricultural, sylvan, and aquatic ecosystems; technologies to restrict the emissions of greenhouse gases from the livestock industry; agricultural production methods that improve environmental conservation functions, and soil and fertilizer management technologies; measures to promote modal shift in accordance with cargo characteristics; development and promotion of traffic management methods in urban areas; measures to spread information and telecommunications systems to lessen the environmental load; economic measures such as taxes and surcharges related to the environment; and structural economic policies aimed at sustainable development.

(2) *Promotion of Research Exchange and International Cooperation*

The Government of Japan is working to promote international exchange of research on the global environment and geoscience fields and is participating in joint international research initiatives including the International Hydrological Programme (IHP), the Man and the Biosphere Programme (MAB), the IOC Subcommission for Western Pacific (WESTPAC), the International Geosphere-Biosphere Programme (IGBP), and the World Climate Research Programme (WCRP). The government is also working to expand networking activities in the field of global environment research, such as the Asia-Pacific Network for Global Change Research (APN).

8.2. Promotion of Systematic Observations and Monitoring

8.2.1. Basic Principles

- (1) Because the observation and monitoring are widely ranged in fields, topics, locations, and methods of observing global change, the Government of Japan is working to

8.2. Promotion of Systematic Observations and Monitoring

maintain conformity with international observation and monitoring programs. Japanese institutions implementing observation programs share their observation results with counterpart institutions in other nations.

- (2) The Government of Japan participates and cooperates in the Global Environmental Monitoring System (GEMS), the Global Atmosphere Watch (GAW) Program, the Global Climate Observing System (GCOS), the Global Ocean Observing System (GOOS), the Integrated Global Ocean Services System (IGOSS) and other international observation programs, and otherwise conducts wide-ranging observations based on an appropriate international sharing of tasks. The government is also working to promote the Asia-Pacific Network for Global Change Research (APN) and the smooth implementation of monitoring work throughout the Asia-Pacific region.
- (3) Coordination on a worldwide scale will be important to promote effective global observation using satellites. Accordingly, the Government of Japan is actively participating in the activities of the Committee on Earth Observation Satellites (CEOS) and other international forums and is promoting the development, launch, and operation of satellites in conformity with these activities.

8.2.2. Priority Fields

The Government of Japan places special priority on promoting the observation and monitoring of items required to identify the status and causes of global warming. Also, because global environmental observations cover the entire Earth, the government is actively promoting the development of effective methods such as the use of satellite sensors.

8.2.3. Main Systematic Observations

(1) *Implementation of Systematic Observations*

In addition to measuring meteorological parameters such as air temperature, water temperature, atmospheric pressure, precipitation, and direct solar radiation, the Government of Japan is reinforcing national efforts to measure the temporal and spatial distribution (including that in ocean water and ocean air) of carbon dioxide, methane, chlorofluorocarbons, nitrous oxide, tropospheric ozone, and other greenhouse gases. The government maintains observation stations throughout the country to monitor ongoing changes in sea levels and other phenomena caused by global warming.

The government also collects, manages, and provides greenhouse gas observation data and conducts observation data quality assessments.

(2) *Development of Observation Methods*

a. Research, Development, and Use of Earth Observation Satellites

In an effort to make international contributions in the field of global observation, the Government of Japan developed the Advanced Earth Observing Satellite (ADEOS) "Midori"; completed the development of the equipment carried on "Midori" for the observation of ocean color, ocean temperature, the stratospheric ozone layer, and greenhouse gases; and launched Midori in August 1996. In addition, the Government of Japan has been developing ADEOS-II (which is scheduled for launch in fiscal year 1999); producing the observation equipment that will be carried on this satellite; developing the rainfall radar and producing the data processing system for the Tropical Rainfall Measuring Mission (TRMM) (scheduled for launch in fiscal 1997); and utilizing the observation data from Japanese Earth Resources Satellite #1 (JERS-1), which was launched in fiscal 1991.

The government is also promoting the development of analysis processing and use technologies for Earth observation satellite data, as well as basic technologies to improve remote sensing systems with microwave sensor data.

b. Other Related Research and Development

The Government of Japan has been carrying out research in numerous areas including the following: development of systems to comprehensively grasp, analyze, and predict changes to conditions of the sun and upper atmosphere; development of instrumentation technology for trace atmospheric gases; development of observation technology to grasp the processes and clarify the mechanisms of large-scale ocean change phenomena; development of instrumentation technology for optical active sensors; joint international research for the development of comprehensive observation systems for the middle atmosphere; joint research for global environment instrumentation technology in Asia; research on high-resolution, three-dimensional microwave imaging radar; and development of basic technology for an innovative buoy system to contribute to the construction of the Global Ocean Observing System (GOOS).

(3) *Utilization and Dissemination of Observation and Monitoring Data*

The Government of Japan is engaged in the following activities on a continuous basis: arranging a catalog information database of earth observation satellite data and networking with Western databases; compiling a global environment research information directory; and developing instrumentation and information network technologies.

The Government of Japan also collects, processes, stores, and provides data via the Center for Global Environment Research, the Japan Oceanographic Data Center, and the World Meteorological Organization (WMO) World Data Centre for Greenhouse Gases (WDCGG).

(4) *Promoting International Linkages*

The Government of Japan is promoting international linkages to contribute to various international efforts including the establishment and expansion of an observation and monitoring network for climate change in the Asia-Pacific region, the Global Resource Information Database (GRID), the Global Environmental Monitoring System (GEMS), the Global Atmosphere Watch (GAW) Program, the Global Climate Observing System (GCOS), the Global Ocean Observing System (GOOS), and the production of a global environmental map.

8.3. Promotion of Technological Development for Global Environmental Conservation

8.3.1. Basic Principles

- (1) To promote sustainable development, the Government of Japan is developing technologies to mitigate global environmental change. These include the efficient use of energy and resources; environment-friendly agriculture and materials manufacturing; and technology for the utilization of new energy resources.
- (2) While ensuring, during development efforts, that technologies designed to resolve specific global environmental problems do not cause other environmental problems, the Government of Japan is promoting the development of technologies that are appropriate for the natural and social conditions of developing nations.

8.3.2. Priority Fields

The Government of Japan is working to promote research on technologies to arrest global warming. In September 1994, Japan submitted a national communication in accordance with the United Nations Framework Convention on Climate Change.

8.3. Promotion of Technological Development for Global Environmental Conservation

8.3.3. Main Technology Development Areas

(1) Implementation of Technology Development

Based on the progress achieved toward the concrete realization of the New Earth 21, the Government of Japan has been carrying out technology development in numerous areas including the following: energy conservation technologies; nuclear power use technologies (with the realization of safety as a prerequisite); carbon dioxide fixation technologies using artificial photosynthesis; carbon dioxide fixation technologies effectively using catalytic hydrogenation reactions, bacteria, algae, etc.; hydrogen production technologies using microorganisms; technologies to suppress the formation of methane from farmland in humid tropical climates; and carbon dioxide fixation technology for desert areas.

(2) Upgrading and Expanding Systems for Technology Development

The Government of Japan is promoting international research exchange while upgrading and expanding internationally open research systems whereby industry, academia, and government cooperate in conducting research and development toward the development of an industrial technology system that contributes to global environmental conservation.

The government is also actively providing support to private-sector efforts to develop technologies that contribute to global environmental conservation.

Chapter 9

Education and Awareness Campaigns

■ *Approaches to Policies and Measures*

Carbon dioxide emissions have been consistently increasing in recent years in the residential/commercial and transport sectors, which are closely related to citizen lifestyles. To arrest global warming, all citizens must shift from a lifestyle of mass consumption and disposal to one of resource and energy conservation and recycling. At the same time, consideration should be given to using non-fossil fuel energy, including new and renewable energy and nuclear energy. To that end, opportunities to learn about the global warming problem, as well as the energy issues that are the primary cause of it, are provided in homes, schools, and society at large. In addition, awareness campaigns are being mounted through mass media, pamphlets, symposiums, and other means of dissemination. Also, Japan is committed to increasing the support to environmental NGOs, which promise to play a leading role as advisors in citizen efforts to address the global warming problem.

9.1. Promoting Environmental Education and Learning

◆ Outline

To encourage citizens to address the problem of global warming in their daily lives, opportunities for people to learn about environmental issues should be provided in homes, schools, regions, companies and other situations. The content of these programs focuses on the importance of preserving the global environment, the relations between global warming and daily life, the energy issues that are the prime cause of global warming, and specific examples how to arrest global warming.

◆ Specific Measures

* Promoting Environmental Education in Schools

Japan has taken a number of steps to enhance environmental education programs in schools. These include: designating model municipalities for the promotion of environmental education; holding environmental education fairs and seminars for teachers in charge of environmental education; designating model GLOBE (Global Learning and Observation to Benefit the Environment) schools and Eco-Schools (environmentally friendly education facilities); and implementing the Environmental Investigation and Learning Network in Japan, through which young students can share observation data and other information they have gathered. Also, to deepen people's understanding of environmental problems through personal contact with nature, Japan promotes outdoor nature classes and other programs. As a means of deepening understanding of recycling, Japan also promotes the use of recycled paper in school textbooks. Furthermore, efforts will be made to enhance education programs at all schools concerning resources and energy, with a view to highlighting the close relationship between energy consumption and global warming.

* Promoting Hands-On Environmental Learning

In addition to educational programs conducted at school, Japan also promotes hands-on environmental learning through contact with nature, visits to facilities related to energy and recycling, participation in citizen workshops, and other programs.

* Junior Eco-Club

In 1995, Japan initiated the Junior Eco-Club program, which indirectly supports environmentally related activities undertaken by elementary and junior high school students. Cooperative efforts are being pursued to increase the number of clubs and enhance the

9.2. Global Warming Awareness Campaign

content of club activities.

* Sponsoring Various Types of Contests for School Students

Japan sponsors various contests for elementary and junior high school students and issues commendations for superior entries. Contests include: the Earth-Saving Idea Contest; the Environmental Poster Contest; the Essay Contest on "Energy in Everyday Life"; the Energy Conservation Poster Contest; and the Student Solar Energy Project Contest.

9.2. Global Warming Awareness Campaign

◆ Outline

Focusing primarily on such periods as Environment Month, Energy Conservation Month, Recycling Promotion Month, and Green Town Month, PR campaigns on the global warming problem are conducted through the mass media, pamphlets, and symposiums. To get citizens involved, efforts are made to engage in easy-to-understand anti-global warming measures.

◆ Specific Measures

* Activities Focusing on Environment Month

Both the national and local governments engage in various awareness campaigns for environmental conservation. These programs are often conducted in June, which is Japan's Environment Month, and particularly on June 5, which is Japan's annual Environment Day. Activities include: the Eco-Life Fair; various lectures and symposiums; the creation and distribution of pamphlets, posters, videos, etc.; the commendation of those who provide environmental conservation services; and a PR campaign conducted in such media as television, radio, newspapers, and magazines.

* Awareness Campaigns for Energy Conservation and Recycling

February is Energy Conservation Month, and the first of each month is designated Energy Conservation Day. In addition, August 1 is designated Summer General Checkup Day for Energy Conservation, and December 1 is designated General Checkup Day for Energy Conservation. In conjunction with these designations, pamphlets, symposiums, and other PR campaigns are conducted. Also, to provide criteria for public involvement in energy conservation efforts, Seasonal Guidelines for Energy Conservation are published each year.

To promote recycling activities, October is designated Recycling Promotion Month, when "idea contests" and other awareness campaigns are implemented.

* Awareness Campaigns for New and Renewable Energy and Nuclear Power

Many types of equipment related to new and renewable energy have already been developed as commercial products. For further cost reductions, initial demands are stimulated through the commendation systems for superior products and application examples, as well as through seminars, symposiums, and other awareness campaign activities.

On the premise of assured safety, nuclear powers promoted by disclosing information positively to ensure greater transparency and to better reflect public sentiment, thus building public trust. Also, by providing correct and easy-to-understand information making use of all the types of media and materials used, as well as by holding symposiums and seminars, Japan is encouraging all parties involved to work together to find an acceptable approach to nuclear power.

* Awareness Campaigns to Promote Greenery

Funds for greenery campaigns are collected on the basis of the Law for the Promotion of Forest Improvement Via Use of the Green Fund. Other examples of awareness campaigns designed to promote greenery include National Arbour Day (celebrated every spring), the Green Town Campaign (April through June every year), and Green Town Month (every October). These and similar programs form the core of Japan's various projects and activi-

ties to promote greenery.

In addition, the National Trust Movement is being expanded through symposiums and other events.

*** The Four Challenges**

To get citizens involved in efforts to arrest global warming, Japan is encouraging all individuals to make efforts in their daily lives. For example, it instituted the following “Four Challenges” beginning in June 1996: 1) Household Eco-account Books (see 3.1.3.8); 2) Green offices and Eco-shops; 3) Drive less, walk more; and 4) Stop Idling (see 3.1.4.6).

9.3. Support for Environmental NGOs

◆ Outline

The vital activity and healthy development of environmental NGOs and other private groups are indispensable for success in arresting global warming. Such groups can also play important roles as leaders or advisors in efforts to get the general public involved. However, many groups do not have the financial resources needed to operate adequately and have depended on assistance from the national and local governments. Japan is committed to strengthening financial support for environmental NGOs and other private groups while preserving the original intent of their activities.

◆ Specific Measures

*** Japan Fund for the Global Environment of the Japan Environment Corporation**

The Japan Environment Corporation handles a special fund called the Japan Fund for the Global Environment made up of contributions from the central government and private donors. Every year, the Corporation provides financial and other types of support to NGOs engaged in environmental activities such as afforestation, recycling, and nature conservation both in Japan and abroad. The Ministry of Posts and Telecommunications also collects contributions through the sale of special postcards and distributes them among private groups engaged in environmental activities.

*** Funds for the Conservation of the Local Environment in Local Governments**

Local governments also support the conservation activities of NGOs and other groups through their respective funds for the conservation of the local environment.

*** The Global Environment Information Centre (GEIC)**

In October 1996, Japan's Environment Agency and the United Nations University jointly established the Global Environment Information Centre (GEIC). In addition to compiling the results of surveys and research concerning mechanisms that will allow the opinions of NGOs to be reflected in the Framework Convention on Climate Change, GEIC promotes NGO participation in the implementation of Agenda 21. In particular, it holds international symposiums on the role NGOs can play in arresting global warming and collects and provides a wide range of materials from Japan and abroad concerning the global warming problem.

*** Registration System for Environmental Counselors**

To help answer questions posed by private groups, consumers, business people, and others concerning environmental conservation activities, Japan has established a registration system that will permit people with specialized knowledge or extensive field experience to take an examination and become certified as official “environmental counselors.” By widely publicizing the register and conducting training courses for registered environment counselors, Japan is further supporting the environmental conservation efforts of private groups.