

Chapter 4

Projections and the Total Effect of Policies and Measures

4.1 Basic approach

Japan was charged by the Kyoto Protocol with the task of realizing a 6% reduction in overall emissions of greenhouse gases by 6% below the base year (1990 for carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O) and 1995 for hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆)) in the first commitment period from 2008 to 2012. On the other hand, our total greenhouse gas emissions in 1999 had already increased by 6.8% over the base year, thus requiring a reduction equivalent to 12.8%.

The Guideline of Measures to Prevent Global Warming (“old Guideline”) was established in 1998 and measures had just been adopted for the purpose of reducing greenhouse gases; however, reflecting changes in various corporate circumstances, it is not necessarily possible to expect that emissions will be reduced as planned. Therefore, a reexamination of global warming countermeasures was promoted by the concerned government ministries beginning in 2000 and, by March 2002, new Guideline of Measures to Prevent Global Warming was established setting forth quantitative targets for each measure.

In this task, emissions were predicted as of 2010, the central year of the first commitment period, premised on currently existing measures and additional measures were formulated and examined to cover insufficiencies in the goals set for each sector.

Cases for the future outlook are listed as indicated below in the same manner as those items in the Report Guideline.

Table 4.1 Setting of cases in the estimation of future outlook

Cases	Meaning
With measures	Future forecast premised on the implementation of policies and measures decided prior to the time of assessment (estimate under the old Guideline)
With additional measures	Future forecast premised on additional policies and measures expected after the time of assessment (estimate under the new Guideline)
Without measures	Future forecast with no policies or measures

The case without measures is reckoned from 1998 taking into account the fact that the major measures were drafted at that time in the old Guideline, the case with measures is reckoned from 1999 when the most recent inventory data was obtained and the case with additional measures is reckoned from 2002 when measures under the new Guideline were launched. It is moreover necessary to be aware that the case without measures, is not fixed but is revised frequently in response to changes in forecasts of the future taking into account frequent revisions of future forecasts (with no direct connection to global warming measures) for 2010 relating to various socioeconomic activities.

4.2 Future Outlook

Japanese aggregate anthropogenic carbon dioxide equivalent emissions of greenhouse gases listed in Annex A of Kyoto Protocol (hereafter, 'total greenhouse gas emissions') is 1,314 million tons of CO₂* in 1999. When the old Guideline was established, it was estimated that greenhouse gas emissions would increase significantly if no special measures were taken. As a result of promoting various measures based on the old Guideline, total greenhouse gas emissions in 2010 (assuming existing measures) is estimated at about 1,320 million tons of CO₂, and it is expected to be reduced to about a 7% increase compared to the base year.

On the other hand, our total greenhouse gas emissions in the base year is 1,229 million tons of CO₂*. In order to achieve the 6% reduction commitment for Japan stipulated in the Kyoto Protocol, a reduction to 1,155 million tons of CO₂ (6% off the above value) is required. Thus, in order to achieve the 6% reduction commitment stipulated in the Kyoto Protocol, we must also strive to reduce emissions by about 13% (approximately 165 million tons of CO₂) over and above existing measures.

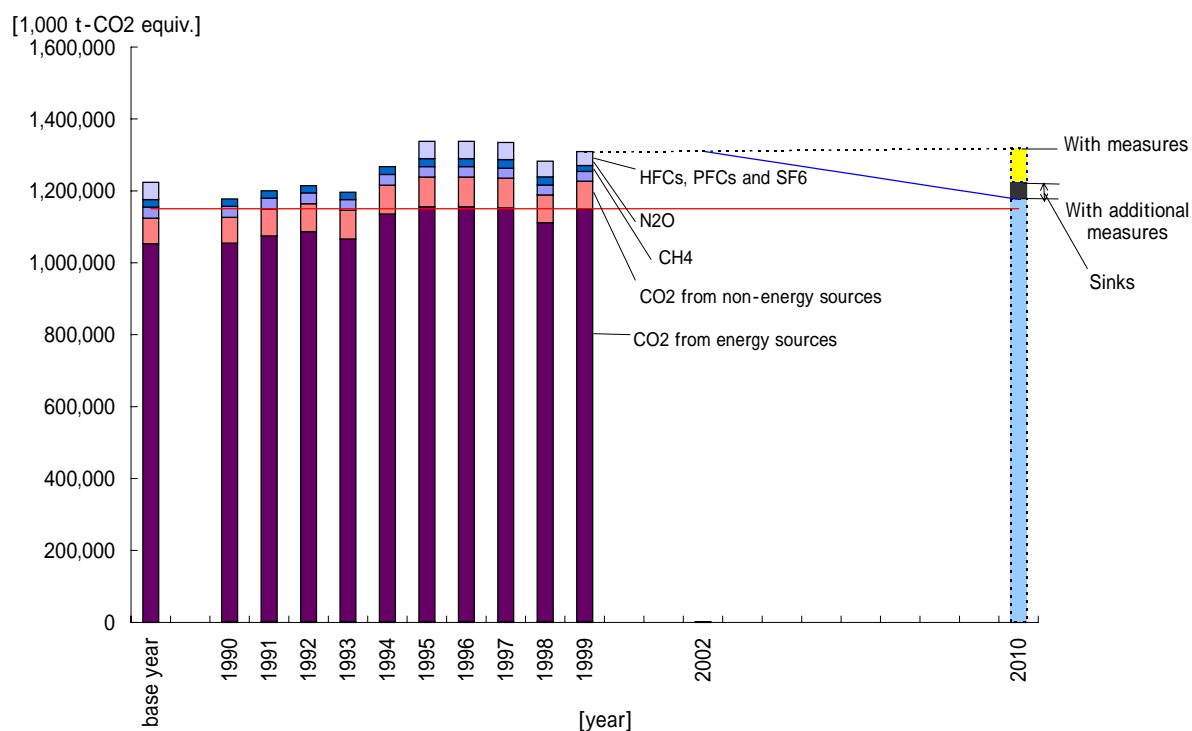


Fig. 4.1. Future outlook for the emissions of greenhouse gases

Note: Emissions from "the land-use change and forestry sector" are excluded from all gases.

HFCs, PFCs and SF6 were first recorded in 1995.

The horizontal solid line indicates the emission volume reduced 6% against the base year.

* Total emissions and removals of greenhouse gases in base years (1990 for CO₂, CH₄ and NO₂ and 1995 for HFCs, PFCs and SF₆) and total emissions in 1999 were set as 1,223.8 million tons and 1,300.7 million tons, respectively, in the greenhouse gas emissions and removals inventory submitted in 2001 and in Chapter 2. However, it has become clear that the volume of waste incineration and cement production have been underestimated in the examination of emissions in the task of formulating the new Guideline and, therefore, revised figures are used.

The total effect of the additional policies and measures is 144.0 million tons of CO₂ in 2010 (corresponding to the difference between the case with measures and the case with additional measures).

Table 4.2. Actual emissions and future outlook for greenhouse gases by sector

(unit: million tons of CO₂)

Sector	Actual emissions			2010 projection			
	Base year	1999	% Change	Without measures	With measures	With additional measures	% Change
CO ₂ from energy sources	1,053	1,148	9.0%	²	1,126	1,052	-0.1%
Following 3 substances	128 (123)	127 (121)	-0.1%	140	122 ³	122 ³	-4.8%
CO ₂ from non-energy sources	77 (72)	77 (77)	-0.3%	88	85	85	10.1%
CH ₄	29 (30)	25 (27)	-12.4%	25	24	24	-18.2%
N ₂ O	22 (21)	25 (17)	10.6%	27	16	16	-27.1%
Other greenhouse gases	48	39	-19.3%	107	73	73	51.4%
HFC	20	19	-2.7%				
PFC	11	11	-3.4%				
SF ₆	17	8	-50.1%				
Development of innovative technology, further extensive efforts by the public	-	-	-		-4	-26	-
Sinks	-	-	-		-	-48	-
Total	1,229 (1,224)	1,314 (1,307)	6.9% (6.8%)		1,317	1,173	-4.6%

1 : Figures in parentheses () are the reported values (Chapter 2) of the inventory submitted in 2001 (refer to the footnote of 4.2. Future outlook)

2 : Forecast for 2010 of CO₂ from energy sources (case without measures) has not been carried out.

3 : The reason why it is 3 million tons of CO₂ less than total CO₂ from non-energy sources, CH₄ and N₂O is because there is considered to be a reduction of 2.60 million tons of CO₂ due to measures that do not specify the amount of reductions resulting from the expanded use of mixed cement, etc., in this sector in the Guideline.

4.2.1 Future outlook for CO₂ from energy sources

In the old Guideline of 1998, it has been estimated that CO₂ emissions from energy sources in fiscal 2010 will represent more than 20% increase on fiscal 1990 levels if the measures mentioned in the old Guideline were not implemented. Since 1998, we have been actively promoting measures related to energy supply and demand based on the old Guideline, but even though the framework of the existing policies will be maintained, it is estimated that CO₂ emissions from energy sources in fiscal 2010 will be approximately 1,126 million tons of CO₂, which is about 73 million tons of CO₂ compared to fiscal 1990 (about 1,053 million tons of CO₂). The reason on the demand side is that energy demand mainly in the residential/commercial and transportation (passenger vehicle) sectors have increased significantly compared to fiscal 1990. The reason on the supply side is that the introduction of non-fossil energy such as nuclear power has not progressed as much as anticipated when the old Guideline was established, and use of coal – which relatively cheap – is expected to increase significantly.

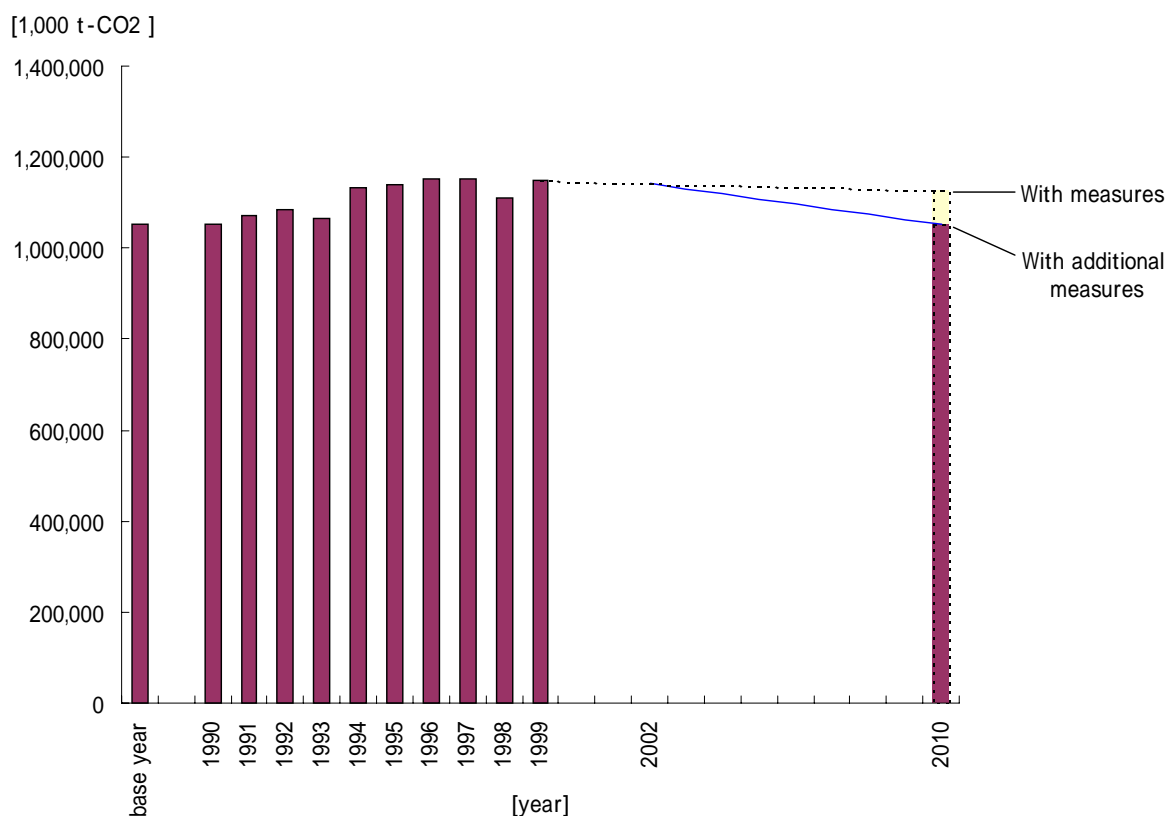


Fig. 4.2. Future outlook for CO₂ emissions from energy sources

Table 4.3. Actual emissions and future outlook for CO₂ from energy sources

(unit: million tons of CO₂)

Sector	Actual emissions			2010 projection		
	Base year	1999	% Change	Without measures	With measures	With additional measures
CO ₂ from energy sources	1,053	1,148	9.0%		1,126	1,052

Forecast for 2010 of CO₂ from energy sources (case without measures) has not been carried out.

The reduction of emissions in fiscal 2010 as a result of the additional measures is about 22 million tons of CO₂ due to measures to restrain emissions in terms of demand (energy conservation measures), about 34 million tons of CO₂ for new energy measures and about 18 million tons of CO₂ for fuel switching. In addition, emissions in fiscal 2010 in each sector when these measures are implemented are about 462 million tons of CO₂ in the industrial sector (-7%), about 260 million tons CO₂ in the residential and commercial sector (-2%) and about 250 million tons of CO₂ in the transport sector (+17%) (the figures in parentheses () are the percentage of reduced emissions in each sector from fiscal 1990 to 2010). The emission reduction targets in each sector are set as benchmarks estimated to be achievable in the event that the promotion of nuclear power conditioned on safety, measures for the introduction of new energy, fuel switching and other measures on the energy supply side demonstrate their intended effect and that the measures in each sector on the energy demand side achieve their intended effect as economic growth in Japan is achieved in line with the latent growth rate.

4.2.2 Future outlook for CO₂ from non-energy sources

CO₂ emitted through the processing of limestone and production of ammonia in industrial processes for fiscal 1999 (54 million t-CO₂) was reduced by 12.8% compared to the same emissions in fiscal 1990. The primary reason is a 12.4% reduction in cement production for fiscal 1999 compared to fiscal 1990.

CO₂ emissions through incineration of waste originating from fossil fuels (waste oil and plastics, etc.) only accounts for about 2% of total CO₂ emissions, but a comparison of fiscal 1999 emissions (23 million t-CO₂) against the same for fiscal 1990 shows an increase of about 1.5 times.

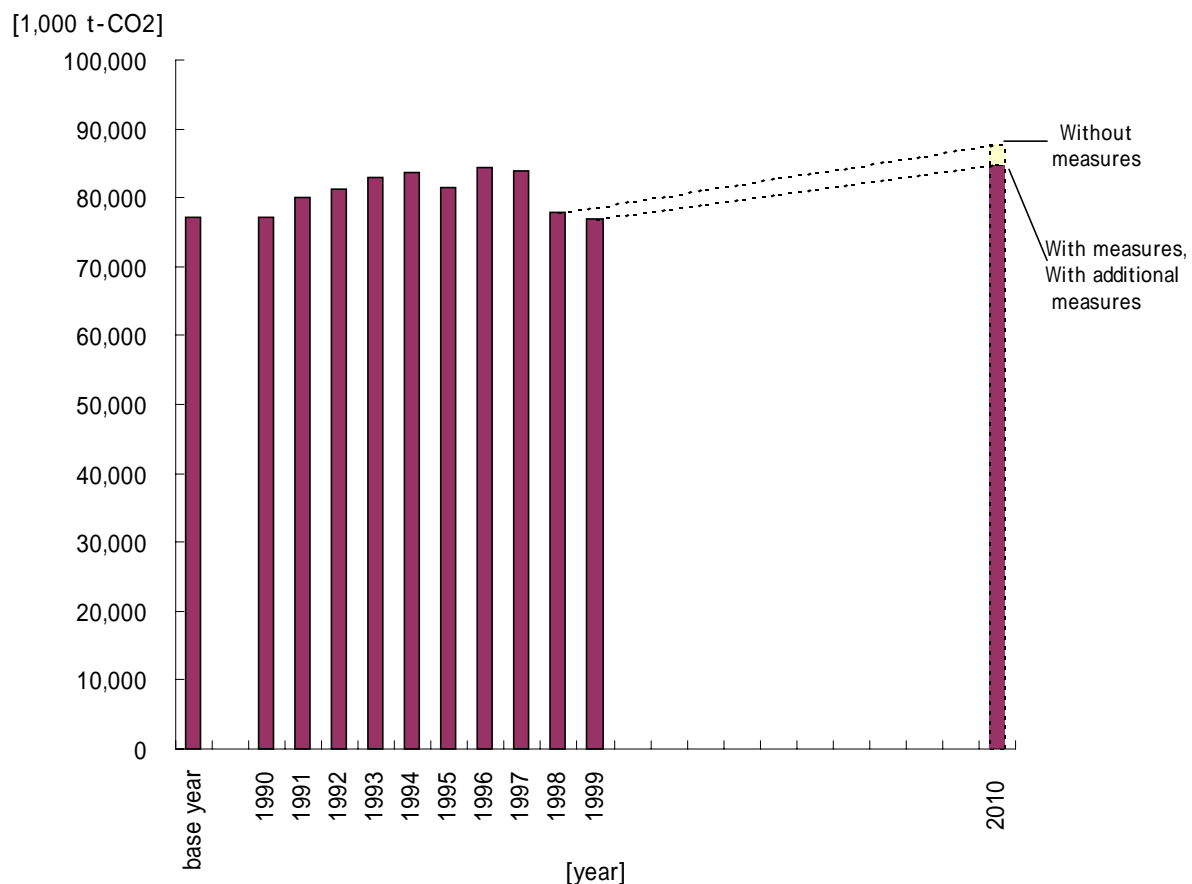


Fig. 4.3. Future outlook for CO₂ emissions from non-energy sources

Note: Though there are some additional measures in the new Guideline, individual reductions are not specified and, therefore, both the case with measures and the case with additional measures are combined here into one line.

Table 4.4 Actual emissions and future outlook for CO₂ from non-energy sources

(unit: thousand tons of CO₂)

Category	Actual emissions			2010 projection			
	1990	1999	% Change	Without measures	With measures	With additional measures	% Change
Industrial processes	61,867 (58,795)	53,969 (53,233)	-12.8%	64,109	64,109	64,109	3.6%
Waste (Waste Incineration)	15,119 (12,773)	22,816 (23,802)	50.9%	23,619	20,643	20,643	36.5%
Total	76,986 (71,568)	76,785 (77,035)	-0.3%	87,728	84,752 (Note2)	84,752 (Note2)	10.1%

Note1 : Figures in parentheses () are the reported values (Chapter 2) of the inventory submitted in 2001 (refer to the footnote of 4.2. Future outlook)

Note2 : In the same sectors as in the Guideline, a further reduction of 2.6 million tons of CO₂ is expected as a result of measures that do not specify the reduction amount resulting from the expanded use of mixed cement, etc.; however, this reduction is not subtracted from the total. CO₂ emissions in agricultural areas are not yet included in the inventories but are expected to be as soon as the calculation method is established. Measures for the reduction of these emissions are indicated in the Guideline.

The overall effect as of 2010 in the event that the current policies and measures are implemented is about 3 million tons of CO₂ (equivalent to the difference between the case with measures and the case without measures), but, as indicated in the footnote, more 2.6 million tons of CO₂ is expected as a result of the current policies and measures and additional policies and measures.

4.2.3 Future outlook for methane emissions

Methane emissions in fiscal 1999 were 25 million tons of CO₂ and there was a reduction of 12.4% compared to fiscal 1990 associated with the reduction in coal production, the reduction of rice cultivation acreage and other measures. This trend is expected to continue.

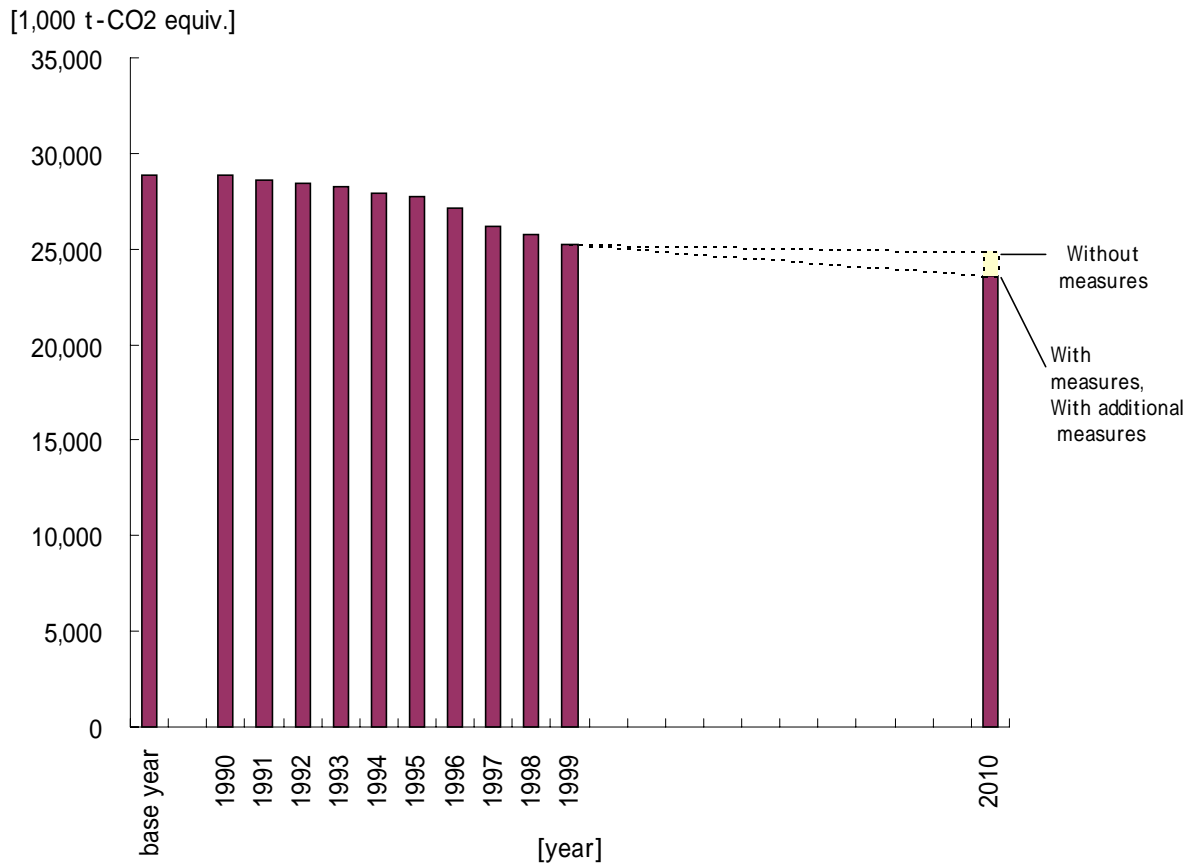


Fig. 4.4 Future outlook for methane emissions

Note: Though there are some additional measures in the new Guideline, individual reductions are not specified and, therefore, both the case with measures and the case with additional measures are combined here into one line.

Table 4.5 Actual emissions and future outlook for methane

(unit: thousand tons of CO₂)

Category	Actual emissions			2010 projection			
	1990	1999	% Change	Without measures	With measures	With additional measures	% Change
Fuel combustion activities	1,879	1,208	-35.7%	1,225	1,225	1,225	-34.8%
Fugitive emissions from fuels	3,354	2,777	-17.2%	2,693	2,693	2,693	-19.7%
Industrial processes	1,019	1,006	-1.3%	1,004	1,004	1,004	-1.5%
Agriculture	15,908	14,307	-10.1%	15,281	15,281	15,281	-3.9%
Waste	6,694 (8,279)	5,973 (7,725)	-10.8%	4,645	4,645	3,402	-49.2%
Total	28,853 (30,438)	25,272 (27,023)	-12.4%	24,848	23,605	23,605	-18.2%

Note1 Figures in parentheses () are the reported values (Chapter 2) of the inventory submitted in 2001 (refer to the footnote of 4.2. Future outlook)

The overall effect as of 2010 in the event that the current policies and measures are implemented is about 1.2 million tons of CO₂ (equivalent to the difference between the case with measures and the case with no measures). As indicated in the footnote of Table 4.4, a further reduction is expected to a certain extent.

4.2.4 Future outlook for nitrous oxide emissions

N₂O emissions in fiscal 1999 (18 million t-CO₂) fell by 21.1% compared to fiscal 1990. The main reason for the reduction in N₂O is the introduction of a decomposition equipment during the manufacture of synthetic fiber materials.

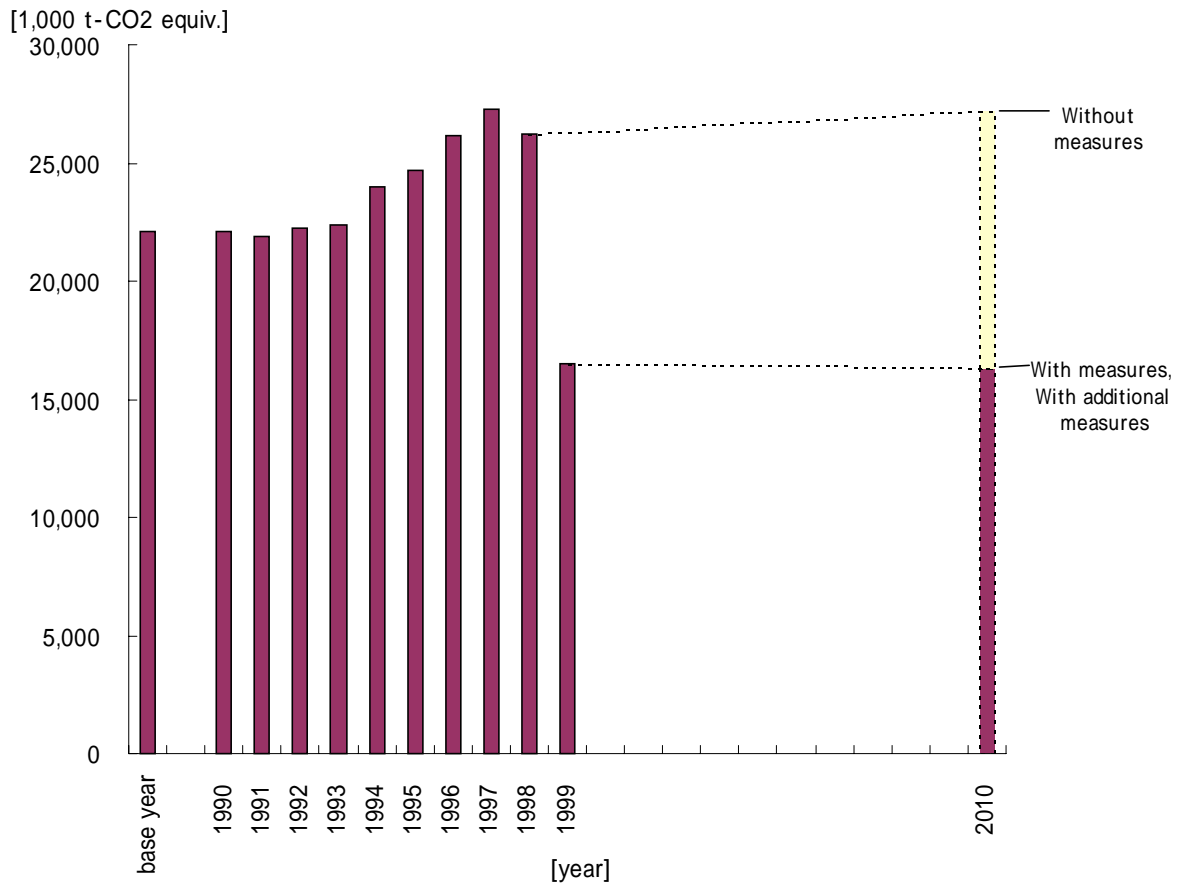


Fig. 4.5. Future outlook for nitrous oxide emissions

Table 4.6. Actual emissions and future outlook for nitrous oxide

(unit: thousand tons of CO₂)

Category	Actual emissions			2010 projection			
	1990	1999	% Change	Without measures	With measures	With additional measures	% Change
Fuel combustion activities	5,969	7,587	27.1%	7,691	7,691	7,691	28.8%
Industrial processes	7,422	1,469	-80.2%	9,980	1,238	1,238	-83.3%
Solvent and other product use	287	377	31.4%	377	377	377	31.4%
Agriculture	5,577	4,899	-12.2%	5,163	5,163	5,163	-7.4%
Waste	3,138 (1,515)	3,341 (1,952)	6.5%	3,986	1,857	1,857	-40.8%
Total	22,392 (20,769)	17,673 (16,536)	-21.1%	27,197	16,327	16,327	-27.1%

Note: Figures in parentheses () are the reported values (Chapter 2) of the inventory submitted in 2001 (refer to the footnote of 4.2. Future outlook)

The overall effect as of 2010 in the event that the current policies and measures are implemented is about 10.90 million tons of CO₂ (equivalent to the difference between the case with measures and the case without measures). As indicated in the footnote of Table 4.4, a further slight reduction is expected. Moreover, a broad reduction has already been achieved as a result of the introduction of the above decomposition equipment in 1999.

4.2.5 Future outlook for HFCs, PFCs and SF₆ emissions

Emissions of HFCs, PFCs and SF₆ have been decreasing since the base year (1995) as a result of voluntary action plans by industries; however, since they are alternatives to ozone depleting substances whose production and consumption are being phased out in accordance with the Montreal Protocol, in the event that no measures are adopted in the future, a considerable increase (total greenhouse gas emissions in the base year + 5%) would be expected as indicated in Fig. 4.6. The target is to limit the increase to total greenhouse gas emissions in the base year + 2% by 2010 by reducing the emissions by 34 million tons of CO₂.

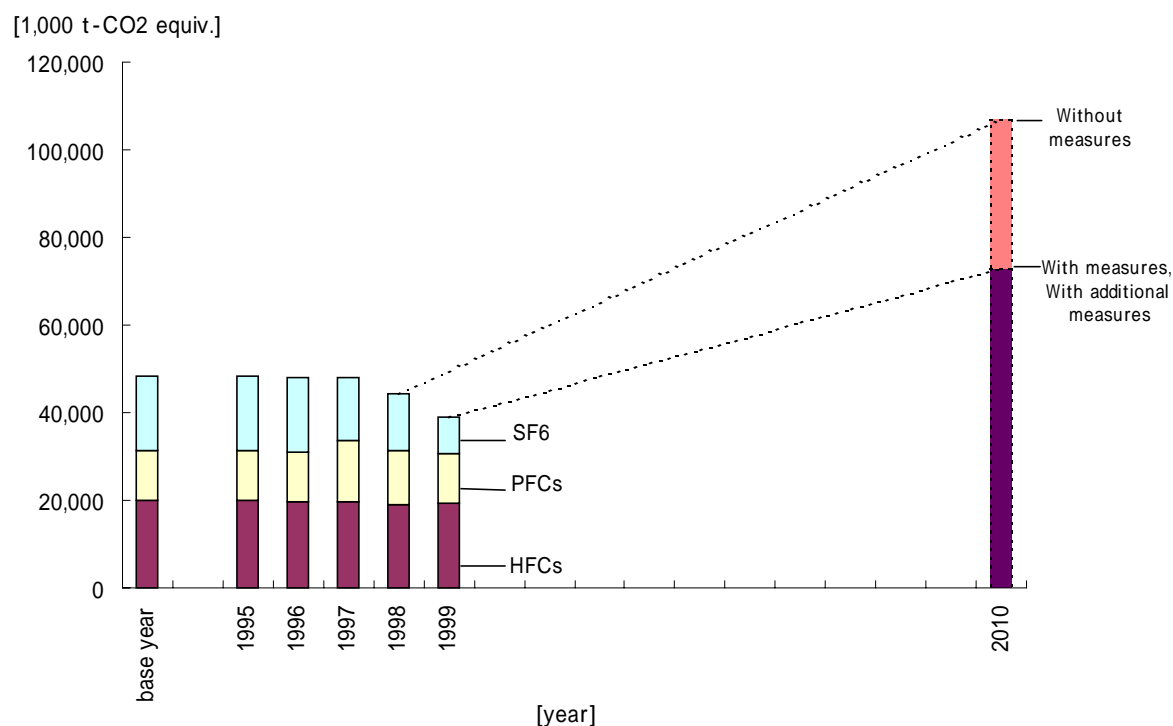


Fig. 4.6. Future outlook for HFC, PFC and SF₆ emissions

Table 4.7. Actual emissions and future outlook for HFCs, PFCs and SF₆

(unit: thousand tons of CO₂)

Category	Actual emissions			2010 projection			
	1995	1999	% Change	Without measures	With measures	With additional measures	% Change
HFCs	20,044	19,497	-2.7%	107,000	73,000	73,000	51.4%
PFCs	11,433	11,043	-3.4%				
SF ₆	16,730	8,351	-50.1%				
Total	48,207	38,891	-19.3%				

4.2.6 Future outlook for CO₂ emissions and removals in the land-use change and forestry sector

The Basic Plan on Forest and Forestry was set as a cabinet decision, in October 2001. It is approximately estimated that if the targets set forth in this plan to fulfil the multiple functions forests have and the targets pertaining to the supply and utilization of forestry products are achieved as per the plan, it is possible to ensure removals around the upper limit (47.67 million t-CO₂) of the obtainable removals through forestry management across the forests under Article 3, 3 and 4 of the Kyoto Protocol.

Since the above is an estimate based on accomplishment of the Basic Plan on Forest and Forestry and further scrutiny and examination of the calculation method is required. Also, there is a concern that if forest management, timber supply and utilization continues at current levels, the obtainable removals will fall below the above figure.

4.3 Estimation methods

4.3.1 CO₂ emissions from energy sources

Due to the need to take future economic trends as well as the balance of energy supply and demand, demand for electrical power, electrical power composition in response to fuel prices, interindustry relations and other factors into account, when estimating the emission outlook in 2010, CO₂ emissions from energy sources are calculated based primarily on the KEO model (general equilibrium model) developed at Keio University with the addition of a cumulative energy conservation factor model and an electrical power composition model and the results are verified using a regression analysis model.

The volume of emissions in 2010 in the case with measures in which the current policies and measures are implemented is estimated based on the following premises.

Table 4.8. Premises used in estimating future outlook

	Actual values		Estimated values
	1990	1999	2010
Population (per 10,000)	12,361	12,669	12,762
No. of households (per 10,000)	4,067	4,669	4,914
Working population (per 10,000)	6,384	6,779	6,953
Exchange rate level	145	114	110
Oil price (\$/bbl)	23	21	30
LNG price (\$/t)	202	183	248
Steaming coal price (\$/t)	51	35	45
Private power generation (private consumption) (%)	-	12.7	10.2

4.3.2 Emissions of CO₂ from non-energy sources, CH₄ and N₂O

Since the targets values for carbon dioxide (CO₂) from non-energy sources, methane (CH₄) and nitrous oxide (N₂O) are all stipulated together as one target value in the Guideline and industrial processes, waste, agriculture and other emission sources fluctuate virtually independently, the overall future outlook was estimated here while promoting consistency with the premises of the estimation of the future outlook for CO₂ from energy sources.

In this sector, emissions in the case without measures were first of all estimated and the case with measures was then calculated by subtracting the reduction effect of current measures. Emissions in the case with additional measures were furthermore calculated by subtracting the reduction effect of additional measures.

The following three methods suited to each emission category were used to estimate the case without measures.

The activity data of 2010 was multiplied by the emission intensity of 1999 in cases in which the activity data of 2010 was estimated and in which there was thought to be little fluctuation in the emission intensity unless some sort of measure is taken.

E.g., CO₂ emissions resulting from cement production
CH₄ and N₂O emissions resulting from fuel combustion
CH₄ emissions resulting from enteric fermentation of domestic livestock

The estimation method considered appropriate for each category was used in cases in which the activity data of 2010 was not estimated, and, if estimated, there were fluctuations in the emission intensity due to fluctuations in the component ratio of sub-categories, etc.

E.g., CO₂ emissions resulting from waste incineration

The same emission amount as 1999 was used in cases in which there was no sizable change in emission fluctuations since 1990 and no benchmark for estimating future values.

E.g., CH₄ emissions resulting from carbon black production

Table 4.9. Premises used in estimating future outlook

		Unit	Actual values		Estimated values
			1990	1999	2010
Rice cultivation acreage		1,000 ha	2,050	1,780	1,860
Domestic livestock	Milk cows	10,000 head	207	176	180
	Beef cattle	10,000 head	280	282	317
	Hogs	10,000 head	1,134	981	929
Landfilled waste		1,000 t.	2,511	997	1,098
Incinerated waste		1,000 t.	5,833	8,828	9,125
Wastewater treatment		100 million m ³	103	126	138
Energy consumption	Total	PJ	17,331	19,089	19,346
	Petroleum	PJ	11,900	12,247	10,889
	Coal	PJ	3,368	3,922	5,265
	Natural gas	PJ	2,063	2,920	3,192

Note 1: Landfilled waste includes general waste and kitchen waste, paper, cloth, wood, bamboo and straw of industrial waste.

Note 2: Incinerated waste includes waste plastic of general waste and waste oil and waste plastic of industrial waste.

4.3.3 HFCs, PFCs and SF₆

HFC, PFC and SF₆ emissions are estimated separately and calculated using either a bottom-up or top-down method, whichever is appropriate, for each emission category while referring to industry-submitted data.

Since they are to replace substances that deplete the ozone layer set for phase-out of production and use under the Montreal Protocol, if no measures are adopted in the future, a considerable increase (total greenhouse gas emissions in the base year + 5%) would be expected. Meanwhile, by promoting implementation of voluntary action plans of industries, developing alternative substances and taking other measures (refer to section 3.4.4.), it is estimated that the amounts of emission reduction will be 34 million tons of CO₂ and total emissions will be controlled (total greenhouse gas emissions in the base year + 2%) in 2010.

4.3.4 CO₂ in the land-use change and forestry sector

The specific detailed methods (Good Practice Guidance) is supposed to be developed by IPCC in calculating carbon removals by forest ecosystems. The present approximate estimation is calculated by deriving net growth by subtracting amount of harvested wood from the gross amount of growth of the target forests of Article 3.3 and 3.4 of the Kyoto Protocol based on the target values for 2010 as set forth in the Basic Plan on Forest and Forestry, and converting this value to CO₂ by multiplying conversion factor. The calculation method will require further examination taking into account the Good Practice Guidance to be prepared in the future.

Table 4.10 Primary numerical premises used in the calculation of removals outlook
(Case with additional measures)

Forest area (2010)	25.1 million ha
Timber supply (2010)	25 million m ³
CO ₂ conversion coefficient	1.25t-CO ₂ /m ³

4.4 Future outlook for CO₂ emissions from international bunker fuel sold in Japan

Carbon dioxide emissions from international aviation bunker fuel sold in Japan in 2010 were estimated.

The estimations are based on the following assumptions.

International aviation transport arriving in and departing from Japan is as indicated in the table below, when the domestic economic growth rate of Japan through 2010 is 2.2% p.a. (high case) and 1.8% p.a. (low case).

Table 4.11. Actual international air transport volume in 1995 and estimates for 2010
arriving in and departing from Japan

	No. of passengers (10,000 person)	Cargo volume (1,000 tons)
Actual figures, 1995	4,357	2,126
Low case	6,944	3,463
High case	7,818	4,009

Source: Report of Transport Policy Council, "Basic direction of comprehensive transport policies for the early 21st century"

The average transport distances of passenger and freight transport were estimated from average values for the periods 1985-1999 and 1990-1999, respectively.

Carbon dioxide emissions per revenue ton-kilometer were estimated from the average value for the period of 1985-1998.

CO₂ emissions in 2010 originating in international aviation bunker fuel sold in Japan based on the above assumptions is estimated to be 27.93 – 31.85 million tons of CO₂.

It should be noted that, for the following reasons, uncertainties exist in the above estimate.

The estimation of transport volume is based on an assumption that the annual economic growth rate through 2010 in Japan is 2.2% and 1.8%. However, these rates may have some uncertainties because (i) the economic growth rates themselves may have uncertainties, (ii) although it is expected that CO₂ emissions per revenue ton-kilometer may decrease with the technological innovation, the values were assumed to be same as the present average values. These uncertainties in the assumptions would cause uncertainties in the projections.

The transport volume used in the present estimation is the transport volume on international routes arriving in or departing from Japan. There is a possibility the effect of international transport arriving into Japan, which is fuelled overseas, is not eliminated, when CO₂ emissions are estimated from bunker fuel sold in Japan.

Regarding oceangoing shipping sector, it was not possible to find a correlation between various indices relating to oceangoing shipping arriving in or departing from Japan and the volume of sales in Japan of marine bunker fuel for oceangoing shipping. This is possibly due to the fact that locations where oceangoing vessel refuel are not necessarily at ports of arrival and departure, and the ship may select fuelling locations at low prices along its route. It is not possible therefore to report estimations of CO₂ emissions from bunker fuel for oceangoing shipping sold in Japan.

Table 4.12. Actual emissions and future outlook for CO₂ associated with international bunker fuel sold in Japan

(unit: million tons of CO₂)

Sector	Actual emissions			2010 projection			
	1990	1999	% Change	Without measures	With measures	With additional measures	% Change
International aviation	13	19	40.5 %	28 ~ 32	-	-	-
Oceangoing shipping	17	17	-0.2 %	-	-	-	-

Source: Estimates by the Ministry of Land, Infrastructure and Transport