INFORMATION SHEET

Victorian Greenhouse Gas Inventory – 2005

Introduction

This document provides an overview of the 2005 Victorian Greenhouse Gas Inventory (VGGI), together with emission trends and comparative information for the years 1990 to 2005. The Australian Greenhouse Office (AGO) developed the methodologies and prepared the data for the 2005 VGGI in accordance with Kyoto Protocol-consistent guidelines.

What is a Greenhouse Gas Inventory?

Greenhouse gas inventories present data on emissions of a range of greenhouse gases, and on the removal of these gases from the atmosphere by 'sinks'. The emissions and removals recorded in these inventories relate to human activity. The data are categorised and presented for different industry/activity sectors.

There is typically a one to two year lag between the publication of a greenhouse gas inventory and the year to which it relates. This is due to the time taken to acquire and process the wide range of data needed for the compilation of an inventory.

Greenhouse Gases, Sources and Sinks

Gases

The VGGI reports emissions of the following major greenhouse gases:

- carbon dioxide (CO_2)
- methane (CH_4)
- nitrous oxide (N_2O)
- hydrofluorocarbons (HFCs)
- perfluorocarbons (PFCs) (eg. CF_4, C_2F_6, C_3F_8)
- sulphur hexafluouride (SF_6)

HFCs and PFCs are not reported as individual gases in the VGGI because of commercial-in-confidence considerations. These emissions are, however, included as CO_2-equivalents in total emissions figures for the subsector for which they are relevant – ie. 'industrial processes'.

Global Warming Potentials

The impact of each greenhouse gas varies in terms of its effectiveness in trapping solar radiation and, consequently, its contribution to global warming. The extent of this variation is indicated by the Global Warming Potential (GWP) of each gas relative to CO_2 – as shown in Table 1.

Table 1 Global warming potential of various greenhouse gases

Gas	GWP
Carbon dioxide	1
Methane	21
Nitrous oxide	310
CF_4	6,500
C_2F_6	9,200
HFC-23	11,700
SF_6	23,900

Global Warming Potentials provide a means of combining the emissions of different greenhouse gases to calculate a total emissions figure expressed in terms of CO_2 equivalence (CO_2-e). For example, if emissions of CO_2 were 100 tonnes, and emissions of methane were 1 tonne, total CO_2-e emissions would be 121 tonnes – that is (100 x 1) + (1 x 21).

As shown in Table 2, CO_2 is the most significant greenhouse gas. In 2005 it contributed 80.8% of Victoria's total net emissions. Methane contributed 14.3% and nitrous oxide 4.0%. The remaining 0.9% was comprised of HFC, PFC and SF_6 emissions.

Table 2 Estimates for Victorian emissions of various greenhouses gases

Gas	2005 emissions (kt)	CO_2-equivalent (kt)
CO_2	98,416	98,416
CH_4	827	17,372
N_20	16	4,904
HFCs	NR	NR
PFCs	NR	NR
SF_6	0.005	128.8
Total CO_2-e		121,873

NR = not reported (commercial-in-confidence)

Sources and Sinks

The VGGI reports on human-induced greenhouse gas emissions from five sectors:

Energy – comprises six subsectors:

- *Energy industries* – emissions from electricity generation, petroleum refining and the production and processing of briquettes and natural gas
- *Manufacturing industries and construction* – emissions from on-site combustion of fossil fuels by the manufacturing and construction industries, but not including emissions from industrial processes, which are accounted for separately
- *Transport* – emissions from motor vehicles, rail, civil aviation, shipping and recreational vehicles
- *Fugitive emissions* – emissions from the exploration, processing and distribution of oil and natural gas
- *Other sectors* – emissions from on-site combustion of fossil fuels in the residential, commercial, institutional, agricultural, forestry and fishery sectors
- *Other* - emissions from lubricants.

Industrial processes – such as emissions from aluminium smelting and cement clinker manufacture.

Agriculture – including emissions from livestock (enteric fermentation and the decomposition of animal manure); the disturbance of agricultural lands by cropping, animal production and the application of fertilisers; and the burning of agricultural residues (eg. stubble).

Land use change and forestry – comprises emissions and sinks[1] from:

- *Forest and grassland conversion* (also referred to as *land clearing*) – includes emissions from the burning and decay of cleared vegetation and from soil disturbance; and the removal of CO_2 due to the regrowth of vegetation on previously cleared land
- *Changes in forest and other woody biomass stocks* – including emissions from the harvesting of timbers and the burning and decay of forest; and the removal of CO_2 by growing forests, plantations and vegetation establishment
- *Other* – including emissions from prescribed burning and wildfires.

Waste – predominantly methane emissions from landfills and wastewater treatment facilities.

Net emissions

By combining data on the level of emissions with the level of CO_2 removals due to carbon sinks, we are able to determine the level of *net greenhouse gas emissions*. That is, net emissions = emissions minus removals. Where an activity results in CO_2 removals that are greater than the emissions associated with that activity, it is referred to as providing a net greenhouse sink.

Why are Greenhouse Gas Inventories Important?

Greenhouse gas inventories are important for a number of reasons. They provide a 'stocktake' of the net emissions for the geographic area being considered (eg. for an individual State or for Australia as a whole). This information provides a basis for identifying the contribution made to global greenhouse gas emissions. It also is central to Australia's reporting to the international community on our progress in meeting commitments under the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol.

The sectoral breakdown of greenhouse gas inventories enables the relative contribution of different sectors to total emissions to be determined. Such information is an important consideration in developing policies and programs to reduce net emissions.

The production of inventories on a regular basis reveals trends in net emissions. The effectiveness of policies and programs in reducing emissions and enhancing carbon sinks can then be assessed.

Inventory information is the starting point for preparing projections of future net emissions. Such projections are important for identifying the likely future path of net emissions and the extent to which additional policies and programs need to be implemented to reduce those emissions.

[1] CO_2 is absorbed by plants in the process of photosynthesis. Activities that result in the removal of CO_2 from the atmosphere are described as carbon sinks and include the management of forests, and pasture improvement in agriculture. Forestry and agriculture are both a source of, and sink for, greenhouse gas emissions.

Victoria's Greenhouse Gas Emissions Profile

Table 3 presents a summary of Victoria's net greenhouse gas emissions by sector in selected years between 1990 and 2005. Table 4 shows the sectoral share of total Victorian emissions as well as the change in emissions between 1990 and 2005.

Table 3 Net greenhouse gas emissions by sector, Victoria: 1990 to 2005

Sectors / subsectors	Net emissions Mt CO_2-e[2]							
	1990	**1995**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Energy	**80.28**	**83.84**	**99.60**	**98.98**	**98.02**	**102.31**	**103.83**	**102.85**
Energy industries	47.18	50.91	65.82	65.46	63.73	67.35	67.96	66.77
Manufacturing industries and construction	6.89	6.15	5.77	5.15	5.03	5.24	5.35	5.29
Transport	16.26	16.34	18.26	18.07	19.09	19.20	20.24	20.57
Fugitive emissions from oil and natural gas	3.69	3.53	2.49	2.42	2.15	1.78	1.83	1.76
Other (including 'other sectors' and 'lubricants')	6.26	6.91	7.26	7.88	8.02	8.74	8.45	8.46
Industrial processes	**3.55**	**2.29**	**2.20**	**2.35**	**2.50**	**2.62**	**2.72**	**2.76**
Agriculture	**14.97**	**15.11**	**15.72**	**16.11**	**16.09**	**15.81**	**15.73**	**15.73**
Livestock	11.85	11.69	12.00	12.21	12.16	11.96	11.91	11.92
Agricultural soils	3.09	3.39	3.66	3.83	3.85	3.79	3.75	3.77
Other	0.03	0.03	0.06	0.07	0.08	0.06	0.07	0.04
Land use, land use change and forestry (LULUCF)	**4.65**	**2.20**	**– 1.35**	**– 1.90**	**– 2.08**	**– 3.30**	**– 2.86**	**– 3.49**
Afforestation & reforestation	0.00	– 0.84	– 3.74	– 4.09	– 4.77	– 5.44	– 6.10	– 6.73
Land clearing	4.65	3.04	2.39	2.19	2.68	2.13	3.24	3.24
Waste	**4.78**	**4.55**	**3.87**	**3.92**	**4.08**	**4.08**	**4.05**	**4.03**
Total emissions/removals including LULUCF	**108.23**	**108.00**	**120.02**	**119.46**	**118.61**	**121.52**	**123.46**	**121.87**
Total emissions excluding LULUCF	**103.58**	**105.80**	**121.38**	**121.36**	**120.69**	**124.82**	**126.32**	**125.36**

Note: Figures have been rounded

Previous inventories superseded

Due to changes in methodology and data inputs, emissions estimates in this Inventory differ from corresponding values in previously published VGGI data. Consequently, this inventory supersedes all previously published versions of the VGGI.

[2] Unless otherwise stated, references to megatonnes of emissions in this Information Sheet relate to 'megatonnes CO_2-equivalent'.

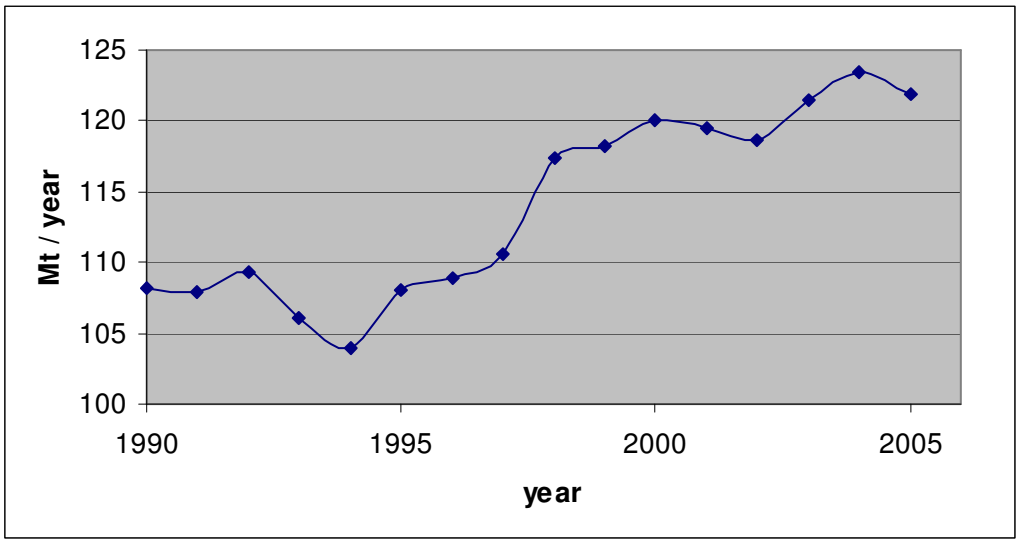
Table 4 Changes in greenhouse gas emissions by sector, Victoria

Sectors / subsectors	% contribution of sector to total emissions				Change in emissions, 1990 to 2005		Change in emissions, 2004 to 2005	
	1990	2000	2004	2005	Mt	%	Mt	%
Energy	**74.2**	**83.0**	**84.1**	**84.4**	**22.57**	**28.1**	**– 1.0**	**– 0.9**
Energy industries	43.6	54.8	55.0	54.8	19.59	40.2	– 1.2	– 1.8
Manufacturing industries and construction	6.4	4.8	4.3	4.3	– 1.60	– 23.2	– 0.1	– 1.1
Transport	15.0	15.2	16.4	16.9	4.31	26.5	0.3	1.6
Fugitive emissions from oil and natural gas	3.4	2.1	1.5	1.4	– 1.93	– 52.3	– 0.1	–3.8
Other (including 'other sectors' and 'lubricants')	5.8	6.0	6.8	6.9	2.20	35.1	0.0	0.1
Industrial processes	**3.3**	**1.8**	**2.2**	**2.3**	**– 0.79**	**– 22.3**	**0.0**	**1.5**
Agriculture	**13.8**	**13.1**	**12.7**	**12.9**	**0.76**	**5.1**	**0.0**	**0.0**
Livestock	10.9	10.0	9.6	9.8	0.07	0.6	0.0	0.8
Agricultural soils	2.9	3.0	3.0	3.1	0.68	22.0	0.0	0.5
Other	0.0	0.0	0.1	0.0	0.01	5.0	0.0	– 28.8
Land use, land use change and forestry (LULUCF)	**4.3**	**– 1.1**	**– 2.3**	**– 2.9**	**– 8.14**	**#**	**– 0.6**	**22.0**
Afforestation & reforestation	0	– 3.1	– 4.9	– 5.5	– 6.73	#	– 0.6	10.3
Land clearing	4.3	2.0	2.6	2.7	– 1.41	– 30.3	0.0	0.0
Waste	**4.4**	**3.2**	**3.3**	**3.3**	**– 0.75**	**– 15.7**	**0.0**	**– 0.5**
Total emissions/removals including LULUCF	**100**	**100**	**100**	**100**	**13.64**	**12.6**	**– 1.6**	**– 1.3**
Total emissions excluding LULUCF	**95.7**	**101.1**	**102.3**	**102.9**	**21.78**	**21.0**	**– 1.0**	**– 0.8**

Under Kyoto Protocol accounting rules, net emissions associated with 'afforestation and reforestation' are set to zero in 1990. Consequently, a percentage change figure cannot be provided given the zero base for 1990.

Note: Figures have been rounded

Figure 1 Trends in Victoria's total greenhouse gas emissions (including land use, land use change and forestry) – 1990 to 2005

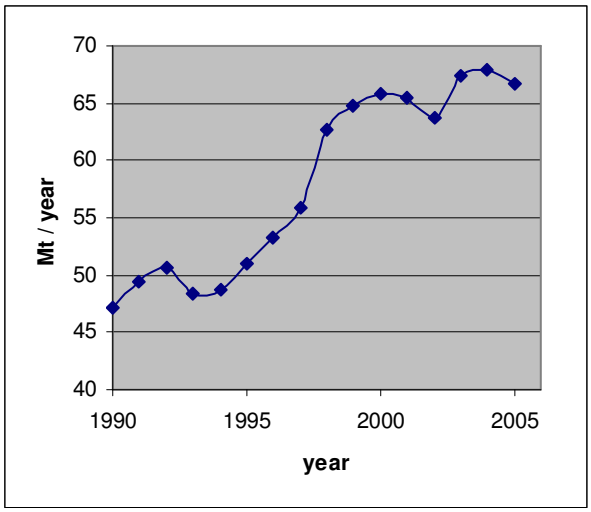


Between 1990 and 2005 Victoria's total net greenhouse gas emissions grew by 13.6 Mt (12.6%) - from 108.2 to 121.9 megatonnes (Mt). This growth was primarily due to an increase of 19.6 Mt in emissions from the energy industries subsector.

Energy industries

In 2005, the energy industries subsector contributed 54.8% (66.8 Mt) of Victoria's total net greenhouse gas emissions – compared with 43.6% in 1990. Emissions from this subsector increased by 19.6 Mt (40.2%) between 1990 and 2005. The steepest increase occurred between 1995 and 2000, coinciding with the commencement of operation of the National Electricity Market.

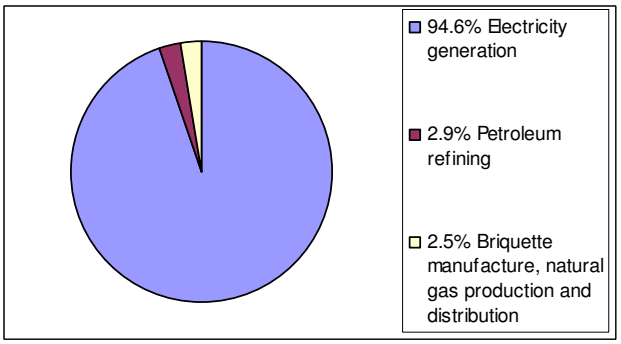
Figure 2 Trends in Victoria's energy industries emissions – 1990 to 2005



The energy industries subsector includes electricity generation, petroleum refining and the production and processing of briquettes and natural gas.

As illustrated in Figure 3, electricity generation was responsible for the majority of energy industries emissions, contributing 63.2 Mt in 2005 (94.6% of energy industries emissions or 51.9% of total net Victorian emissions). Emissions from electricity generation increased by 19.0 Mt (43.0%) from 1990 to 2005.

Figure 3 – Composition of energy industries emissions

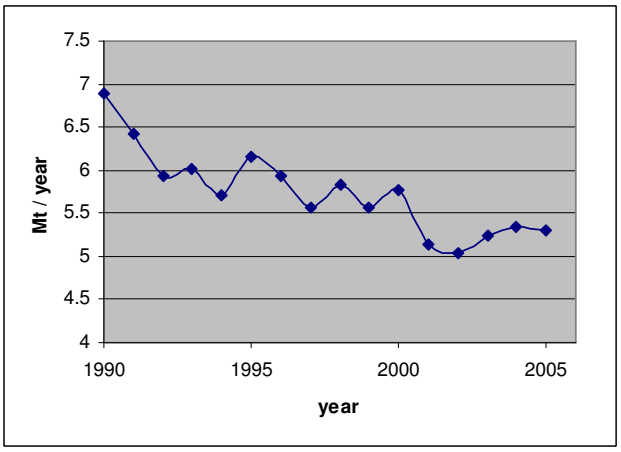


Manufacturing industries and construction

The manufacturing industries subsector includes manufacturers of pulp and paper, metal products, food and beverages, tobacco and chemicals. Emissions reported for this subsector do not include emissions attributable to consumption of electricity from the grid, but may include emissions from on-site electricity generation. Reporting of emissions within this subsector is constrained by confidentiality issues.

Between 1990 and 2005, energy-related emissions from manufacturing industries and construction declined by 1.6 Mt (23.2%).

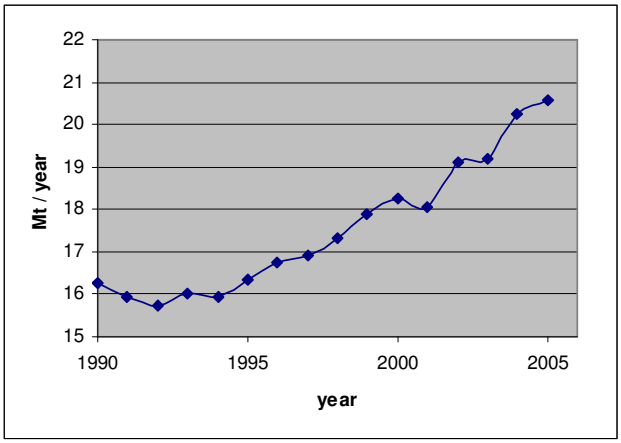
Figure 4 Trends in energy-related emissions from Victorian manufacturing and construction – 1990 to 2005



Transport

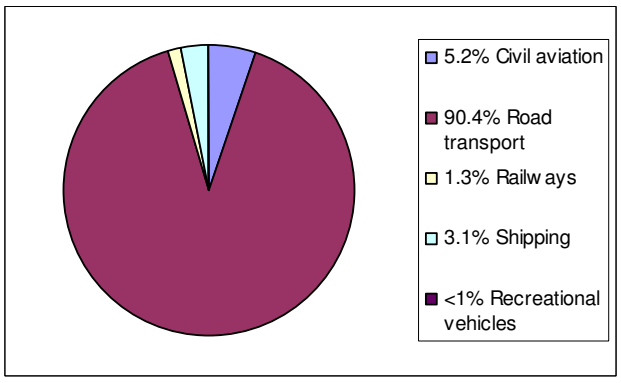
Transport was the second largest contributor to Victoria's total net greenhouse gas emissions in 2005, with emissions of 20.6 Mt (16.9% of the State total). Emissions increases in this subsector were significant – growing by 26.5% from 1990 to 2005.

Figure 5 Trends in Victoria's transport emissions – 1990 to 2005



As shown in Figure 6, road transportation was responsible for more than 90% of emissions from the transport subsector in 2005. Note that the emissions shares presented in Figure 6 do not include the emissions associated with the use of electricity by Melbourne's metropolitan train and tram system – its electricity use is accounted for within the energy industries subsector.

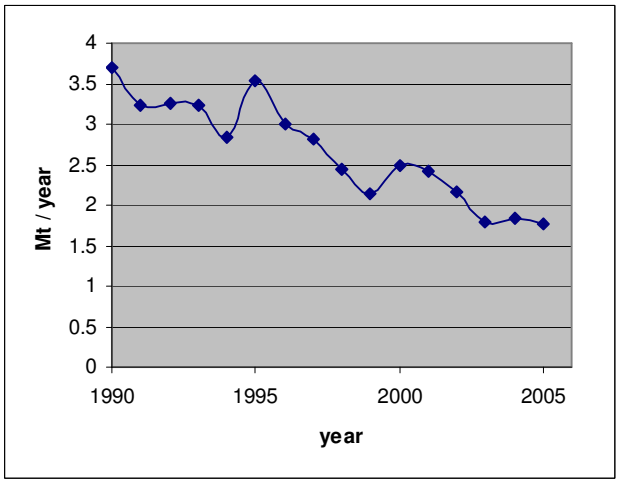
Figure 6 Composition of transport emissions



Fugitive emissions

Fugitive emissions from oil and natural gas contributed 1.8% of Victoria's total net emissions in 2005. Emissions from this subsector fell by 1.9 Mt (52.3%) compared with 1990.

Figure 7 Trends in Victoria's fugitive emissions from oil and natural gas – 1990 to 2005



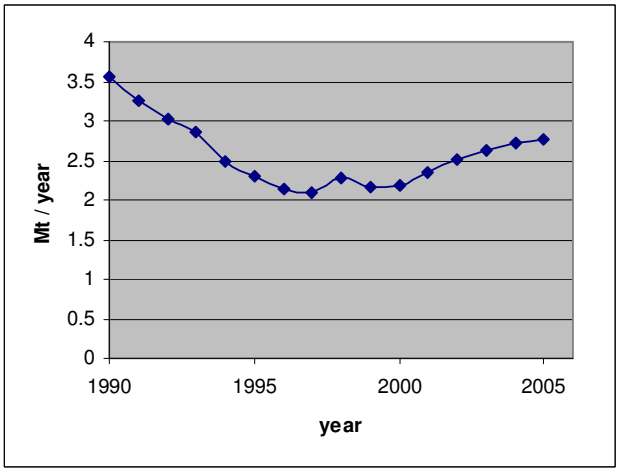
Other

In Table 3, 'Other' refers to emissions from lubricants and the on-site combustion of fossil fuels in the residential, commercial, institutional, agricultural, forestry and fisheries sectors. It does not include emissions attributable to electricity consumption in these sectors.

Industrial processes

Emissions from industrial processes declined from 3.5 to 2.8 Mt (22.3%) between 1990 and 2005. A reduction in emissions of PFCs from aluminium production due to technological changes in the industry was a key reason for this improvement.

Figure 8 Trends in Victoria's emissions from industrial processes – 1990 to 2005



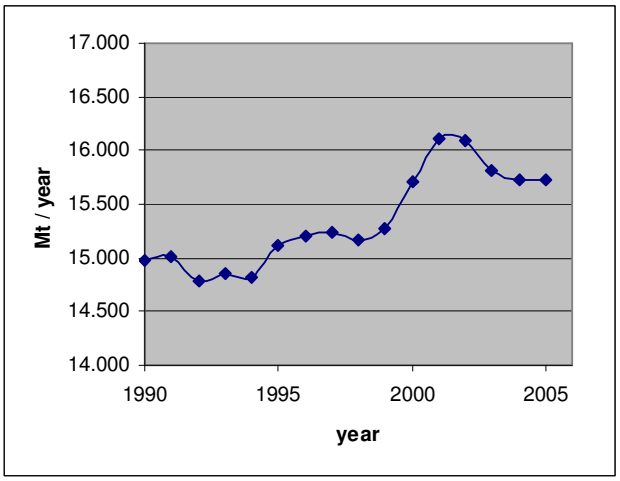
Agriculture

The agricultural sector contributed 15.7% of Victoria's total net emissions in 2005. Emissions from the sector increased by 0.8 Mt (5.1%) over the period 1990 to 2005.

Enteric fermentation (livestock 'burps') was responsible for 71% of agricultural greenhouse gas emissions. Nitrous oxide from agricultural soils contributed 24% and emissions from manure management contributed about 5%.

Emissions from livestock were relatively stable, with a decrease of 0.07 Mt between 1990 and 2005. Emissions from agricultural soils increased from 3.1 to 3.8 Mt (22.0%) between 1990 and 2005, and this accounted for most of the increase in net agricultural emissions.

Figure 9 Trends in Victoria's agricultural emissions – 1990 to 2005



Land use change and forestry

The 'land use change and forestry' subsector provided a net sink in Victoria in 2005. In that year, emissions from land clearing were 3.2 Mt, while removals of CO_2 due to 'afforestation and reforestation' were 6.7 Mt – resulting in a 'net removals' figure of 3.5 Mt.

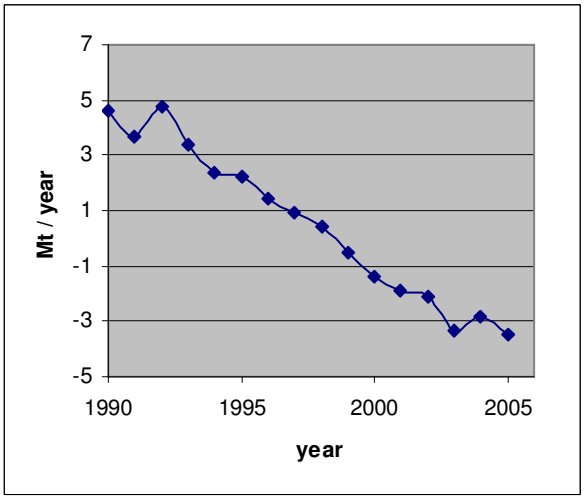
From 1990 to 2005, net emissions from land clearing declined by 1.4 Mt (30.3%). This was due to the impact of controls that have seen the rate of land clearing in Victoria reduced.

The 2005 VGGI shows:

- 'afforestation and reforestation' moving from zero in 1990 to a net sink of 6.7 Mt in 2005; and
- 'land use, land use change and forestry as a whole moving from a net source of emissions of 4.7 Mt in 1990 to a net sink of 3.5 Mt in 2005.

It is important to note that this inventory has been compiled according to Kyoto Protocol accounting rules and that under these rules net emissions associated with 'afforestation and reforestation' are set to zero in 1990. Separate estimates of emissions are compiled according to the inventory reporting requirements for the UNFCCC and for the Kyoto Protocol. The principal difference between the two approaches relates to the accounting of the forestry sink. The UNFCCC inventory also includes reporting of indirect greenhouse gases for which GWPs are not available. Further information on the Kyoto Protocol and UNFCCC accounting provisions is available at www.greenhouse.gov.au

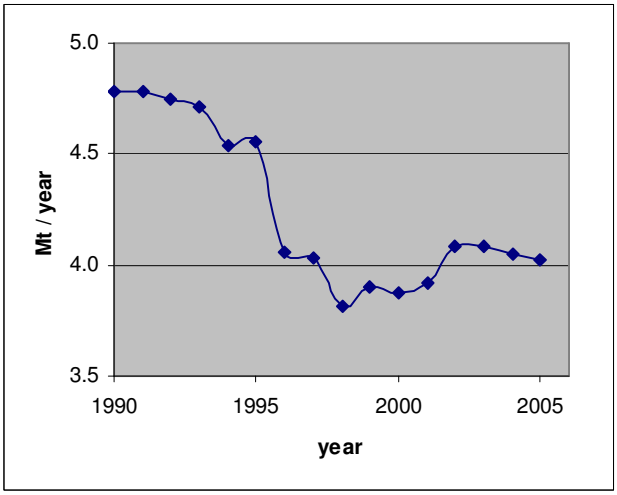
Figure 10 Trends in emissions from Victorian land use change and forestry - 1990 to 2005



Waste

The waste sector was responsible for 4.0% of Victoria's total net emissions in 2005 - with emissions from landfills responsible for 77%, wastewater treatment around 31% and waste incineration less than 1%. Emissions from the sector declined by 0.7 Mt (15.7%) between 1990 and 2005.

Figure 11 Trends in emissions from Victorian waste – 1990 to 2005



The National Greenhouse Gas Inventory

The National Greenhouse Gas Inventory (NGGI) is published on an annual basis. The most recent NGGI was published in 2007 and provides emissions and sinks data for the period 1990 to 2005. The NGGI and accompanying Facts Sheets are available at www.greenhouse.gov.au

The NGGI shows that Australia's total net greenhouse gas emissions (including the best estimate of net emissions from land clearing) were 559.1 Mt in 2005 – an increase of 2.2% compared with 1990.

Victoria's 2005 total net emissions of 121.9 Mt represented 21.8% of the national total.

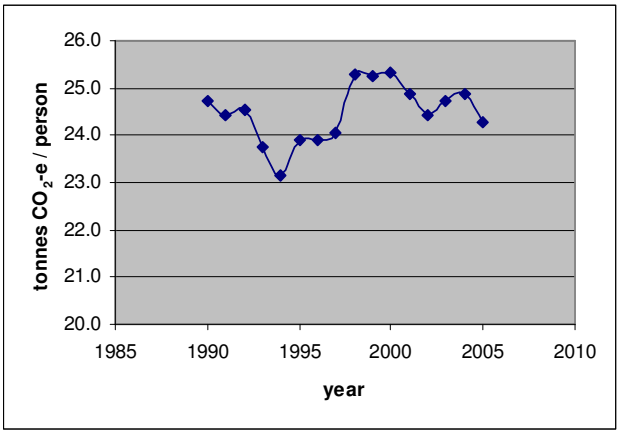
Emissions per Capita

Per capita emissions are an estimate of average greenhouse gas emissions per person and are calculated by dividing a jurisdiction's net greenhouse gas emissions by the number of persons residing in the jurisdiction.

At 30 June 2005, Victoria's resident population was 5,023,164 and Australia's resident population was 20,328,600.

In 2005 Victoria's per capita greenhouse gas emissions were 24.3 tonnes CO_2-e per person. Australia's per capita emissions in 2005 were 27.5 tonnes CO_2-e per person.

Figure 12 Trends in Victoria's per capita greenhouse gas emissions – 1990 to 2005

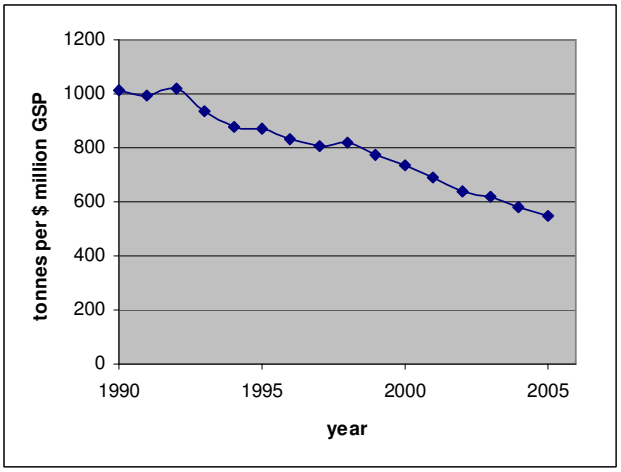


Emissions per unit of GSP

Emissions per unit of Gross State Product (GSP) are calculated by dividing a jurisdiction's net greenhouse gas emissions by the value of the jurisdiction's GSP.

Over the period 1990 to 2005 greenhouse gas emissions per $ million GSP declined from 1009.9 tonnes to 548.4 tonnes. This reduction reflects a range of factors, including structural change in the economy and improvements in energy efficiency.

Figure 13 Trends in Victoria's emissions per (2006) $ million GSP – 1990 to 2005



Uncertainty

There are uncertainties in a number of areas of National and State Greenhouse Gas Inventory compilation. While some sectors have a relatively low uncertainty attached to them, as the relationship between the source and emissions is well documented and understood, other areas carry an inherently high uncertainty due to the nature of the processes involved. This is particularly the case in the Agriculture and Land Use Change and Forestry sectors.

Refer to the NGGI (see www.greenhouse.gov.au) for further information on uncertainty estimates by sector.