

# INFORMATION SHEET

## Victorian Greenhouse Gas Inventory – 2004

### Introduction

This document provides an overview of the 2004 Victorian Greenhouse Gas Inventory (VGGI), together with emission trends and comparative information for the years 1990 to 2004. The Australian Greenhouse Office (AGO) developed the methodologies and prepared the data for the 2004 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<sub>2</sub>)
- methane (CH<sub>4</sub>)
- nitrous oxide (N<sub>2</sub>O)
- hydrofluorocarbons (HFCs)
- perfluorocarbons (PFCs) (eg. CF<sub>4</sub>, C<sub>2</sub>F<sub>6</sub>, C<sub>3</sub>F<sub>8</sub>)
- sulphur hexafluoride (SF<sub>6</sub>)
- oxides of nitrogen (NO<sub>x</sub>)\*
- carbon monoxide (CO)\*
- non-methane volatile organic compounds (NMVOCs)\*
- sulphur dioxide (SO<sub>2</sub>) \*

\* These are indirect greenhouse gases for which Global Warming Potentials (see below) are not available.

HFCs, PFCs and SF<sub>6</sub> are not reported as individual gases in the VGGI because of commercial-in-

confidence considerations. These emissions are, however, included as CO<sub>2</sub>-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<sub>2</sub> – 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 <sub>4</sub>	6,500
C <sub>2</sub> F <sub>6</sub>	9,200
HFC-23	11,700
SF <sub>6</sub>	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<sub>2</sub> equivalence (CO<sub>2</sub>-e). For example, if emissions of CO<sub>2</sub> were 100 tonnes, and emissions of methane were 1 tonne, total CO<sub>2</sub>-e emissions would be 121 tonnes – that is (100 x 1) + (1 x 21).

As shown in Table 2, CO<sub>2</sub> is the most significant greenhouse gas. In 2004 it contributed 80.9% of Victoria's total net emissions. Methane contributed 14.5% and nitrous oxide 3.8%. The remaining 0.8% was comprised of HFC, PFC and SF<sub>6</sub> emissions.

**Table 2 Estimates for Victorian emissions of various greenhouses gases**

Gas	2004 emissions (kt)	CO <sub>2</sub> -equivalent (kt)
CO <sub>2</sub>	99,532	99,532
CH <sub>4</sub>	852	17,890
N <sub>2</sub> O	15	4,647
HFCs	NR	826
PFCs	NR	NR
SF <sub>6</sub>	NR	129
<b>Total CO<sub>2</sub>-e</b>		<b>123,024</b>
NO <sub>x</sub>	281	-
CO	1,200	-
NMVOCs	185	-
SO <sub>2</sub>	183	-

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<sup>1</sup> 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<sub>2</sub> 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<sub>2</sub> 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<sub>2</sub> 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<sub>2</sub> 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.

## Victoria’s Greenhouse Gas Emissions Profile

Table 3 presents a summary of Victoria’s net greenhouse gas emissions by sector in 1990, 1995, 2000 and 2004. It also shows the sectoral share of total Victorian emissions for 1990 and 2004, as well as the increase in emissions between 1990 and 2004.

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<sup>1</sup> CO<sub>2</sub> is absorbed by plants in the process of photosynthesis. Activities that result in the removal of CO<sub>2</sub> 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.

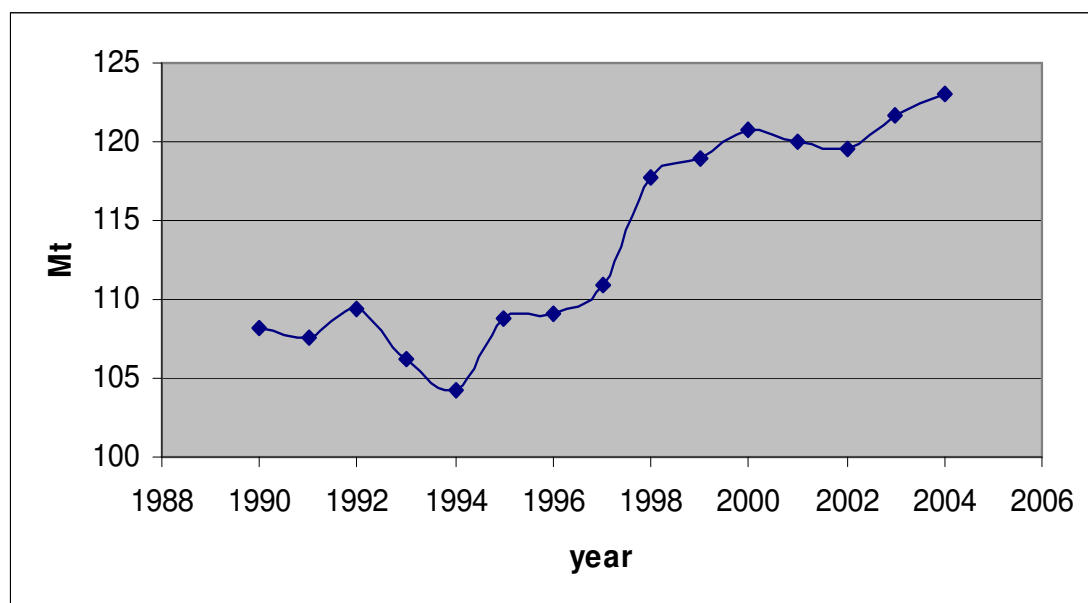
**Table 3 Net greenhouse gas emissions by sector, Victoria: 1990, 1995, 2000 and 2004**

Sectors / subsectors	Net emissions Megatonnes (Mt) CO <sub>2</sub> -equivalent				% contribution of sector to total emissions		Change in emissions, 1990 to 2004	
	1990	1995	2000	2004	1990	2004	Mt	%
<b>Energy</b>	<b>79.99</b>	<b>84.36</b>	<b>99.98</b>	<b>103.30</b>	<b>73.9</b>	<b>84.0</b>	<b>23.31</b>	<b>29.1</b>
Energy industries	47.14	51.01	66.13	68.91	43.5	56.0	21.77	46.2
Manufacturing industries and construction	6.76	6.16	5.71	5.27	6.3	4.3	- 1.49	- 22.0
Transport	16.21	16.83	18.24	18.87	15.0	15.4	2.66	16.4
Fugitive emissions from oil and natural gas	3.68	3.48	2.41	1.76	3.4	1.4	- 1.92	- 52.1
Other (including 'other sectors' and 'lubricants')	6.19	6.88	7.48	8.48	5.7	6.9	2.29	37.0
<b>Industrial processes</b>	<b>3.53</b>	<b>2.14</b>	<b>2.04</b>	<b>2.58</b>	<b>3.3</b>	<b>2.1</b>	<b>- 0.95</b>	<b>- 27.0</b>
<b>Agriculture</b>	<b>14.96</b>	<b>15.10</b>	<b>15.69</b>	<b>15.42</b>	<b>13.9</b>	<b>12.5</b>	<b>0.46</b>	<b>3.0</b>
Livestock	11.85	11.69	12.00	11.70	11.0	9.5	- 0.15	- 1.3
Agricultural soils	3.07	3.36	3.63	3.65	2.9	2.9	0.58	18.8
Other	0.04	0.04	0.05	0.07	0.0	0.0	0.03	65.8
<b>Land use, land use change and forestry (LULUCF)</b>	<b>4.65</b>	<b>2.20</b>	<b>- 1.35</b>	<b>- 2.86</b>	<b>4.3</b>	<b>- 2.3</b>	<b>- 7.51</b>	<b>#</b>
Afforestation & reforestation	0.00	- 0.84	- 3.74	- 6.10	0	- 5.0	- 6.10	#
Land clearing	4.65	3.04	2.38	3.24	4.3	2.6	- 1.41	- 30.3
<b>Waste</b>	<b>5.04</b>	<b>4.95</b>	<b>4.39</b>	<b>4.59</b>	<b>4.6</b>	<b>3.7</b>	<b>- 0.45</b>	<b>- 9.0</b>
<b>Total emissions/removals including LULUCF</b>	<b>108.17</b>	<b>108.75</b>	<b>120.74</b>	<b>123.03</b>	<b>100</b>	<b>100</b>	<b>14.86</b>	<b>13.7</b>
<b>Total emissions excluding LULUCF</b>	<b>103.52</b>	<b>106.56</b>	<b>122.10</b>	<b>125.88</b>	<b>95.7</b>	<b>102.4</b>	<b>22.36</b>	<b>21.6</b>

# 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 2004**



Victoria's total net greenhouse gas emissions increased slightly between 1990 and 1995. This was due to the fact that the increase in emissions from the energy industries, transport and agricultural sectors more than offset the reduction in emissions from industrial processes, manufacturing industries and construction, land clearing and fugitive emissions from oil and natural gas over this period.

Between 1995 and 2004 Victoria's total net greenhouse gas emissions grew from 108.8 to 123.0 megatonnes<sup>2</sup> (Mt). This growth was primarily due to an increase of 17.9 Mt in emissions from the energy industries subsector.

Due to the steep increase in emissions between 1995 and 2004, Victoria's total net greenhouse gas emissions were 14.8 Mt or 13.7% higher in 2004 compared with 1990.

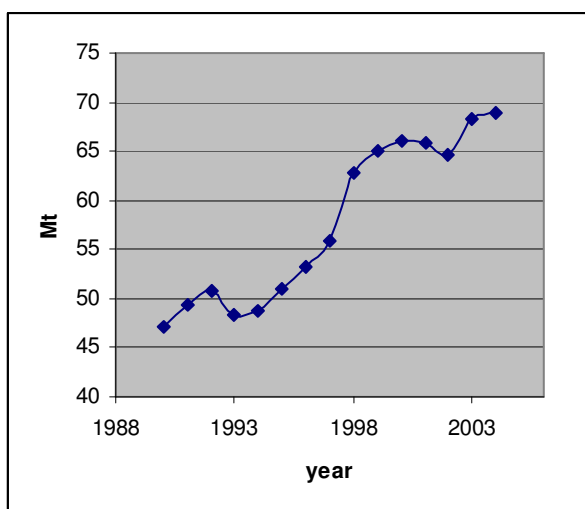
#### Previous inventories superseded

Due to changes in methodology and data inputs, emissions estimates in this Inventory differ from corresponding values in previously published VGGI data - especially with respect to stationary energy, fugitive emissions, agriculture, land clearing and forestry. Consequently, this inventory supersedes all previously published versions of the VGGI.

### Energy industries

In 2004, the energy industries subsector contributed 56.0% (68.9 Mt) of Victoria's total net greenhouse gas emissions - compared with 43.5% in 1990. Emissions from this subsector increased by 21.8 Mt (46.2%) between 1990 and 2004, and the steepest increase occurred between 1995 and 2000.

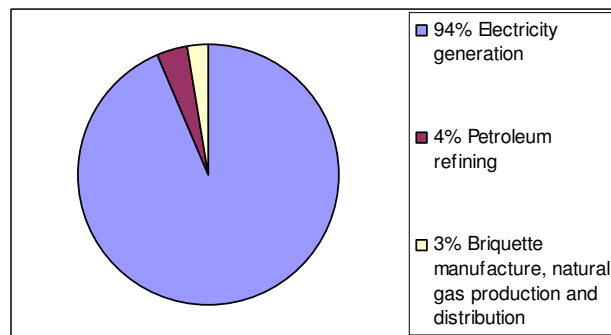
**Figure 2 Trends in Victoria's energy industries emissions - 1990 to 2004**



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 64.5 Mt in 2004 (94% of energy industries emissions or 52% of total net Victorian emissions). Emissions from electricity generation increased by 20.5 Mt (47%) between 1990 and 2004.

**Figure 3 - Composition of energy industries emissions**

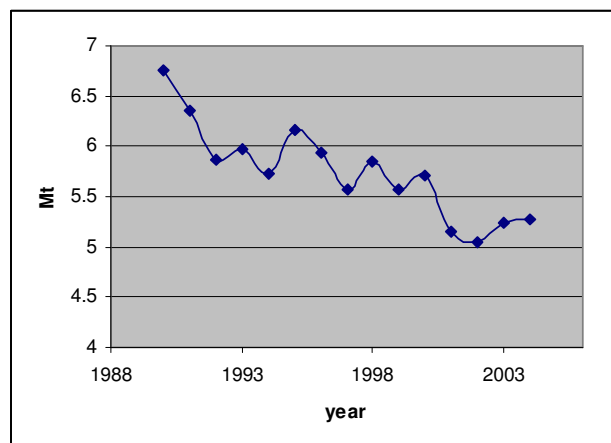


### Manufacturing industries and construction

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 2004, energy-related emissions from manufacturing industries and construction declined by 1.5 Mt (22.0%).

**Figure 4 Trends in energy-related emissions from Victorian manufacturing and construction - 1990 to 2004**

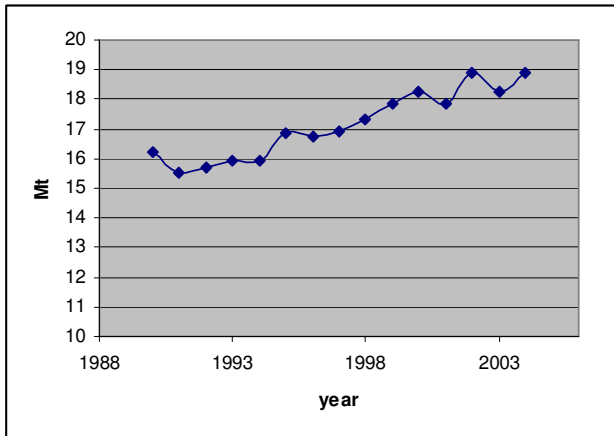


<sup>2</sup> Unless otherwise stated, references to megatonnes of emissions in this section of the Information Sheet relate to 'megatonnes CO<sub>2</sub>-equivalent'.

## Transport

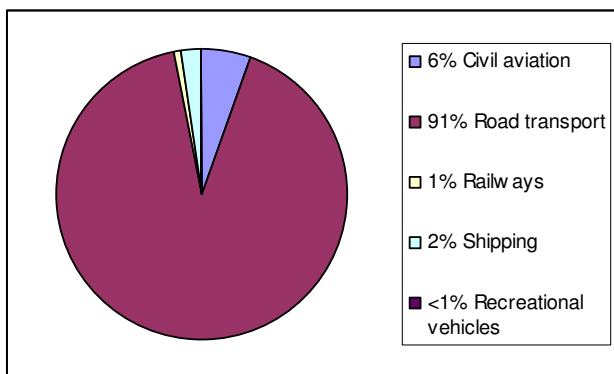
Transport was the second largest contributor to Victoria's total net greenhouse gas emissions in 2004, with emissions of 18.9 Mt (15.4% of the State total). Emissions increases in this subsector were significant – growing by 16.4% from 1990 to 2004.

**Figure 5 Trends in Victoria's transport emissions – 1990 to 2004**



As shown in Figure 6, road transportation was responsible for 91% of emissions from the transport subsector in 2004. It should be noted 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.

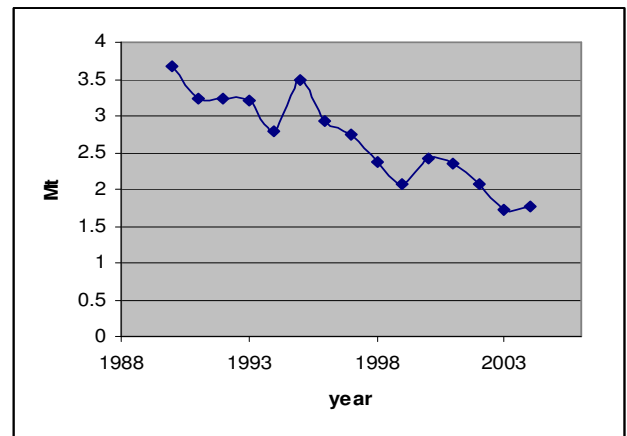
**Figure 6 Composition of transport emissions**



## Fugitive emissions

Fugitive emissions from oil and natural gas contributed 1.8% of Victoria's total net emissions in 2004. Emissions from this subsector fell by 1.9 Mt (52.1%) compared with 1990.

**Figure 7 Trends in Victoria's fugitive emissions from oil and natural gas – 1990 to 2004**



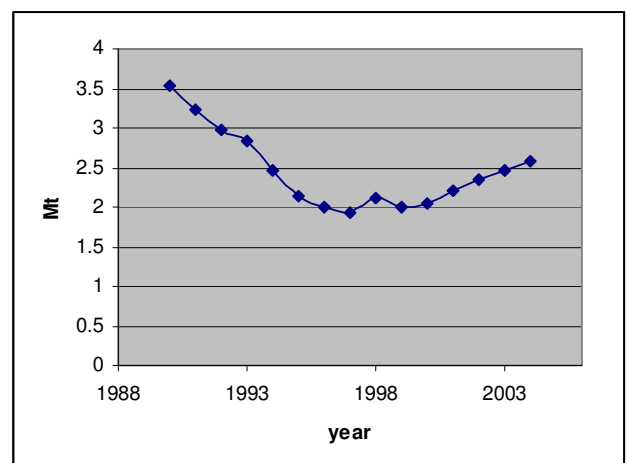
## Other

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 2.6 Mt (27.0%) between 1990 and 2004. 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 2004**



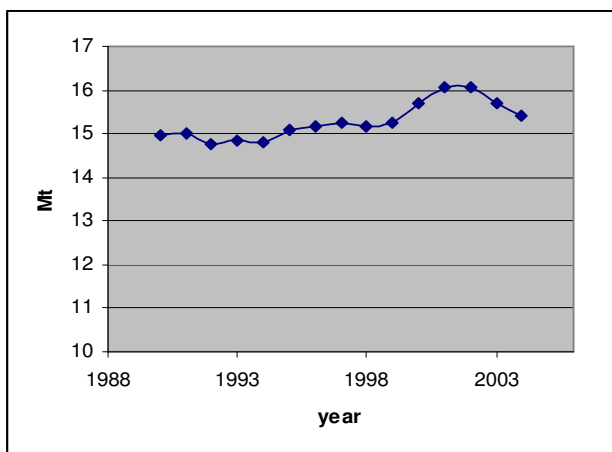
## Agriculture

The agricultural sector contributed 12.5% of Victoria's total net emissions in 2004. Emissions from the sector increased by 0.5 Mt (3.0%) over the period 1990 to 2004.

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 0.15 Mt between 1990 and 2004. Emissions from agricultural soils increased from 3.1 to 3.7 Mt (18.8%) between 1990 and 2004, and this accounted for most of the increase in net agricultural emissions.

**Figure 9 Trends in Victoria's agricultural emissions – 1990 to 2004**



## Land use change and forestry

The 'land use change and forestry' subsector provided a net sink in Victoria in 2004. In that year, emissions from land clearing were 3.2 Mt, while removals of CO<sub>2</sub> due to 'afforestation and reforestation' were 6.1 Mt – resulting in a 'net removals' figure of 2.9 Mt.

From 1990 to 2004, net emissions from land clearing declined by 1.5 Mt (30.3%). This was due to the impact of controls that have seen the rate of land clearing in Victoria reduced.

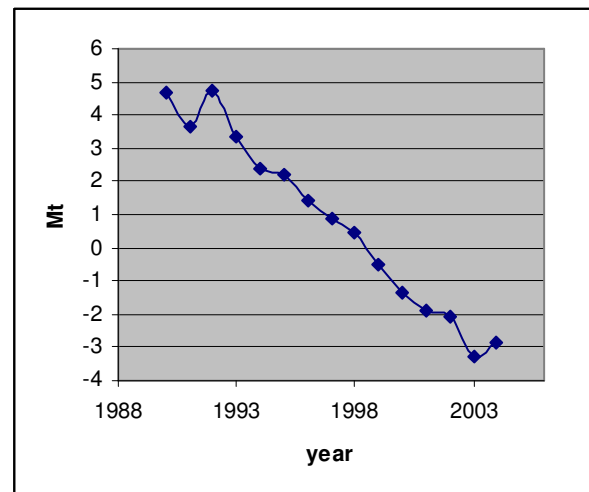
The 2004 VGGI shows:

- 'afforestation and reforestation' moving from zero in 1990 to a net sink of 6.1 Mt in 2004; 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 2.9 Mt in 2004.

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 on the website – [www.greenhouse.gov.au](http://www.greenhouse.gov.au)

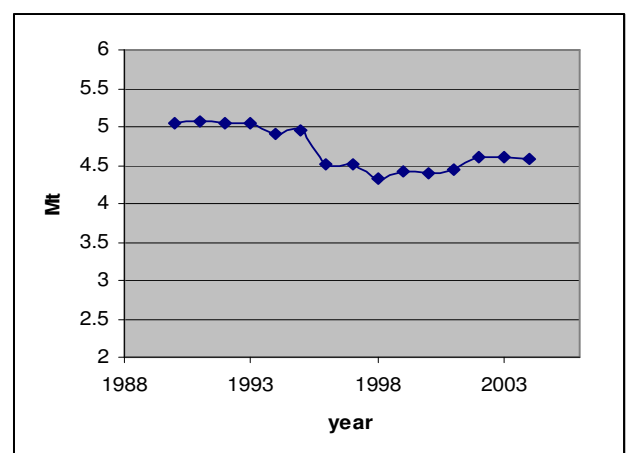
**Figure 10 Trends in emissions from Victorian land use change and forestry - 1990 to 2004**



## Waste

The waste sector was responsible for 4.6% of Victoria's total net emissions in 2004 – with emissions from landfills responsible for 69% and wastewater treatment around 31%. Emissions from the sector declined by 0.5 Mt (9.0%) between 1990 and 2004.

**Figure 11 Trends in emissions from Victorian waste – 1990 to 2004**



## The National Greenhouse Gas Inventory

The National Greenhouse Gas Inventory (NGGI) is published on an annual basis. The most recent NGGI was published in 2006 and provides emissions and sinks data for the period 1990 to 2004. The NGGI and accompanying Facts Sheets are available on the web at [www.greenhouse.gov.au](http://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 564.7 Mt in 2004 – an increase of 2.3% compared with 1990.

Victoria's 2004 total net emissions of 123.0 Mt represented 21.8% of the national total.

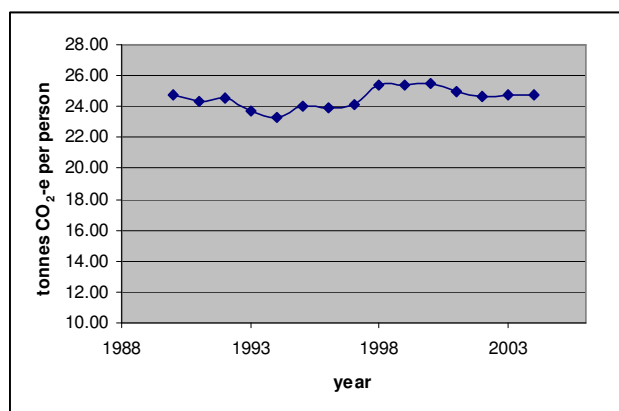
## Emissions Per Capita

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 2004, Victoria's resident population was 4,962,970 and Australia's resident population was 20,091,504.

In 2004 Victoria's per capita greenhouse gas emissions were 24.7 tonnes CO<sub>2</sub>-e per person. Australia's per capita emissions in 2004 were 28.2 tonnes CO<sub>2</sub>-e per person.

**Figure 12 Trends in Victoria's per capita greenhouse gas emissions – 1990 to 2004**



## 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.

The AGO is currently reviewing the estimates of uncertainty. Following this review an uncertainty estimate for the inventory as a whole, as well as for the trends in emissions, will be able to be calculated.

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