Ministry for the Environment
Manatū Mō Te Taiao

New Zealand's Greenhouse Gas Inventory 1990–2005

AN OVERVIEW

JULY 2007

New Zealand Government

New Zealand's greenhouse gas emissions across all sectors for 2005 totalled 77.2 Mt CO_2-e.

Emissions are now **25 per cent higher** than the 1990 level of 61.9 Mt CO_2-e.

Prepared by the Ministry for the Environment

Published in July 2007 by the Ministry for the Environment,
Manatū Mō Te Taiao
PO Box 10 362, Wellington, New Zealand

ISBN: 978-0-478-30136-6 (print); 978-0-478-30142-7 (online)
ME number: 806

This document is available on the Ministry for the Environment's website: **www.mfe.govt.nz**

Background

Greenhouse gases in the Earth's atmosphere trap warmth from the sun and make life possible. However, over the past 50 to 100 years, the concentration of greenhouse gases such as carbon dioxide, methane and nitrous oxide has been increasing.

This increased concentration produces an 'enhanced greenhouse effect' where more of the sun's warmth is trapped by the atmosphere. The majority of experts agree that the enhanced greenhouse effect is causing global warming. Predicted changes in the climate are expected to be much greater and happen more quickly than any recent natural changes.

This document presents a summary of the latest information on New Zealand's greenhouse gas emissions and removals. The information is taken from the most recent national inventory report under the United Nations Framework Convention on Climate Change (**New Zealand's Greenhouse Gas Inventory 1990–2005)**. The inventory reports only human-induced emissions and removals of greenhouse gases. Each inventory report is 15 months in arrears allowing time for data to be collected and analysed.

There is statistical uncertainty around the values reported in national inventories. For New Zealand, the uncertainty in any one year is approximately ± 20 per cent, dominated by uncertainty in emissions from farming and forestry. Uncertainty in the trend since 1990 is only ± 5 per cent, because the uncertainty in emissions factors in any one year cancels out over time.

Greenhouse gas estimates are based on international guidance established by the Intergovernmental Panel on Climate Change (IPCC) and follow an internationally agreed reporting format that groups emissions and removals into six sectors:

- Agriculture
- Energy (including transport)
- Industrial Processes
- Solvent and Other Product Use
- Waste
- Land Use, Land-Use Change and Forestry.

The greenhouse gases estimated in the national inventory include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphur hexafluoride (SF_6), perfluorocarbons (PFCs) and hydrofluorocarbons (HFCs). To compare the warming effect of different gases, all emissions are converted to carbon dioxide equivalents (CO_2-e). This is achieved by multiplying emissions by the appropriate global warming potential. The global warming potential is the relative warming effect of a gas when compared with the same mass of carbon dioxide.

Table 1:
Units and common global warming potentials

Units

Standard metric prefixes used in this report are:

- kilo (k) = 10^3 (one thousand)
- mega (M) = 10^6 (one million)
- giga (G)= 10^9 (one thousand million)

Emissions are generally expressed in megatonnes (Mt) in this report. Numbers are rounded to one decimal place (this can lead to rounding errors in some figures)

- 1 megatonne (Mt)
  = 1,000,000 tonnes
  = 1,000 Gg

Common Global Warming Potentials

- CO_2 = 1
- CH_4 = 21
- N_2O = 310
- SF_6 = 23,900

The United Nations Framework Convention on Climate Change

The United Nations Framework Convention on Climate Change (UNFCCC) is an international agreement which addresses climate change. All countries that ratify the UNFCCC are required to tackle climate change through national or regional programmes. This includes preparing for the impacts of climate change and monitoring emission trends. Developed countries agreed to non-binding targets to reduce greenhouse gas emissions to 1990 levels by the year 2000.

Developed countries that are signatories to the UNFCCC – including New Zealand – are required to submit an annual greenhouse gas inventory. Inventory reporting covers all human-induced emissions and removals. In New Zealand, this reporting is undertaken by the Ministry for the Environment, with information collected across a number of government agencies. The inventory forms part of the nation's wider 'state of the environment' reporting.

The Kyoto Protocol

The international community recognised that the provisions of the UNFCCC alone were not enough to ensure greenhouse gases would be reduced to safe levels and that more urgent action was required. In 1997, the Kyoto Protocol was adopted, committing Annex I Parties (developed countries) that have ratified it to a legally-binding target to reduce their greenhouse gas emissions or to take responsibility for excess emissions.

New Zealand ratified the Kyoto Protocol in December 2002, with a target of 100 per cent of 1990 emissions. This means that New Zealand is liable for any emissions – above 1990 levels – for the period 2008 to 2012. The Kyoto Protocol came into force on 16 February 2005.

The national inventory report is the basis of all accounting under the Kyoto Protocol.

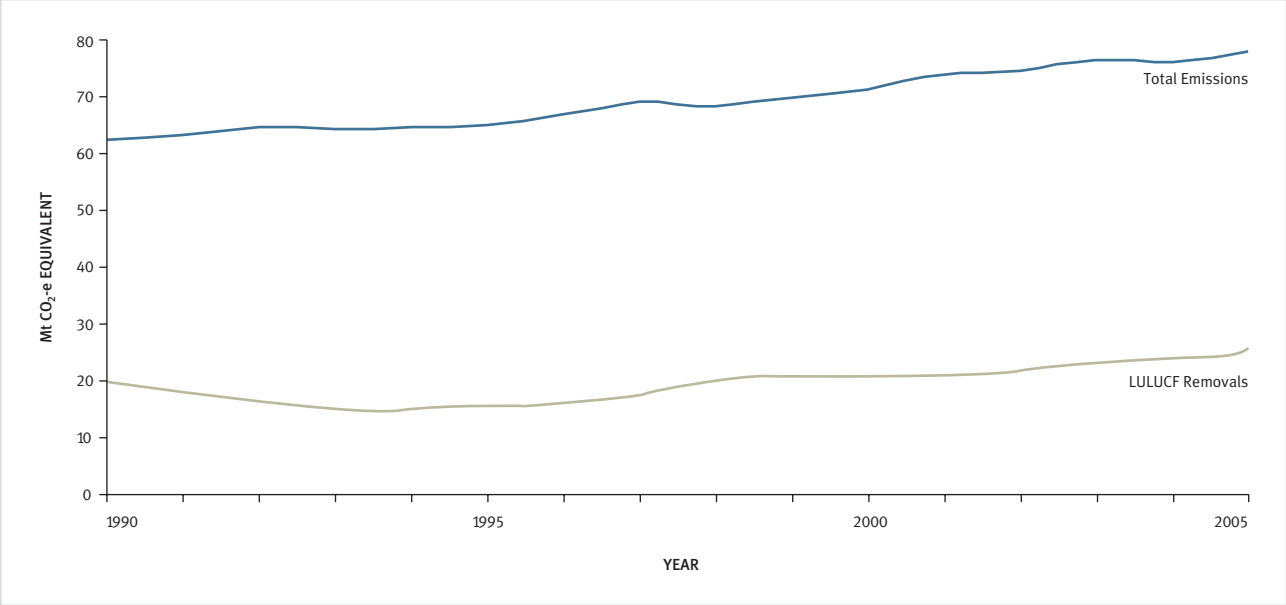
Total emissions and removals

New Zealand's greenhouse gas emissions across all sectors for 2005 totalled 77.2 Mt CO_2-e. Emissions are now 25 per cent higher (15.3 Mt CO_2-e) than the 1990 level of 61.9 Mt CO_2-e (Figure 1).

Removals of greenhouse gases in the Land Use, Land-use Change and Forestry (LULUCF) sector (Figure 1) amounted to 24.5 Mt CO_2-e in 2005. This is an increase of 29 per cent above removals in 1990 (19.0 Mt CO_2-e).

Growth of plantation forests is the major carbon dioxide sink in New Zealand. The inventory reports emissions and removals from all forests, not just "Kyoto forests" (or forests planted since 1990).

Figure 1
New Zealand's total greenhouse gas emissions and removals: 1990–2005



Emissions by gas

Inventory reporting under the UNFCCC covers six direct greenhouse gases – carbon dioxide, methane, nitrous oxide, sulphur hexafluoride, perfluorocarbons and hydrofluorocarbons. Other greenhouse gases are included in inventory reporting but not in national totals.

These indirect gases include carbon monoxide, sulphur dioxide, oxides of nitrogen, and non-methane volatile organic compounds. Figure 2 indicates the contribution of each direct greenhouse gas to total emissions in 2005. Trends in emissions by gas over the period 1990–2005 are shown in Figure 3.

Removal of carbon dioxide from the atmosphere is reported in the LULUCF sector.

- Carbon dioxide contributed the largest share of all 2005 emissions at 47 per cent (35.9 CO_2-e). Emissions increased by 41 per cent (from 25.4 Mt CO_2-e) between 1990 and 2005.
- Methane contributed 35 per cent of total emissions (27.3 Mt CO_2-e). Methane emissions have grown by 7 per cent since 1990 (from 25.5 Mt CO_2-e).
- Nitrous oxide contributed 17 per cent of emissions in 2005 (13.3 Mt CO_2-e). Emissions have increased by 27 per cent (10.4 Mt CO_2-e) since 1990.
- PFCs, SF_6 and HFCs contributed the remaining 1 per cent (0.8 Mt CO_2-e). Emissions of PFCs have reduced from 0.5 Mt CO_2-e to 0.1 Mt CO_2-e, or 84 per cent over the period, while emissions of SF_6 have grown from 0.01 Mt CO_2-e to 0.02 Mt CO_2-e, or 77 per cent since 1990. No HFCs were used in New Zealand in 1990. In 2005, 0.7 Mt CO_2-e of HFC emissions were produced.

Figure 2
New Zealand's total greenhouse gas emissions by gas: 2005

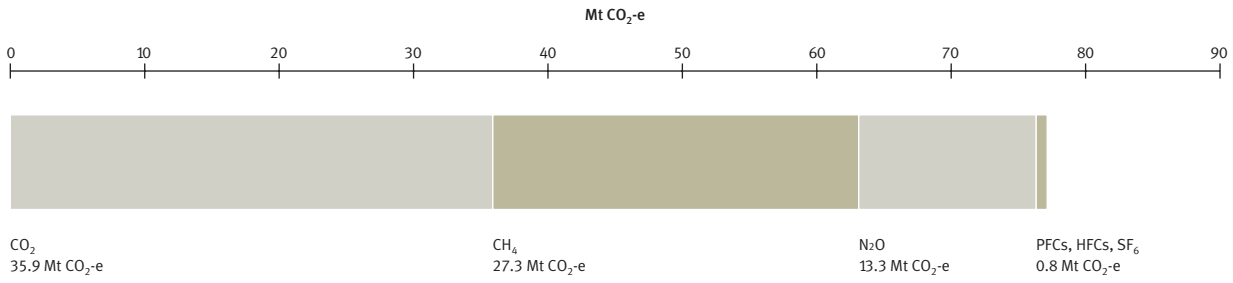
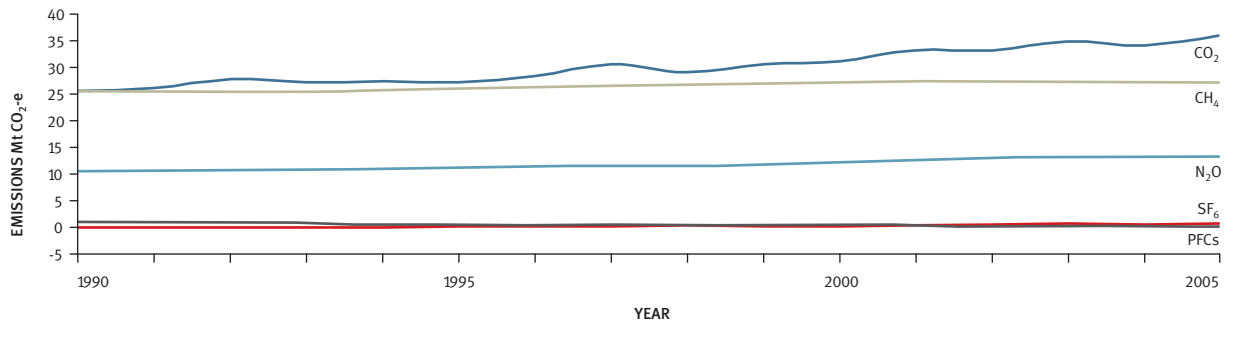


Figure 3
New Zealand's greenhouse gas emissions by gas: 1990–2005



Emissions by sector

The remainder of this document provides detailed emissions from each sector. It also provides removals from the LULUCF sector. Figure 4 indicates the contribution of each sector to total emissions in 2005. Trends in emissions by sector over the period 1990–2005 are shown in Figure 5.

Figure 4
New Zealand's total greenhouse gas emissions by sector: 2005

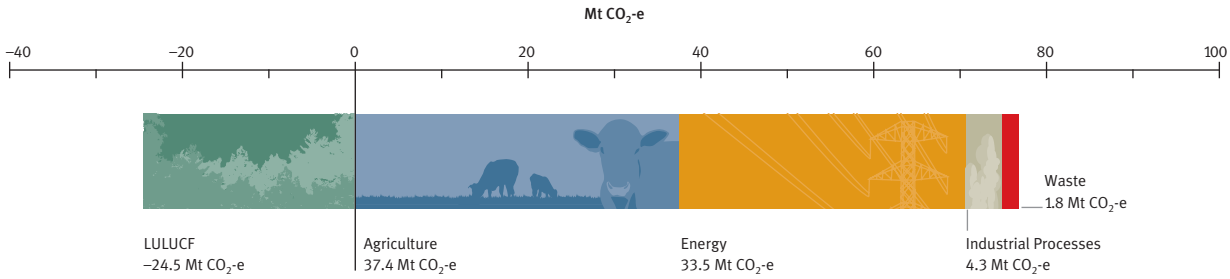
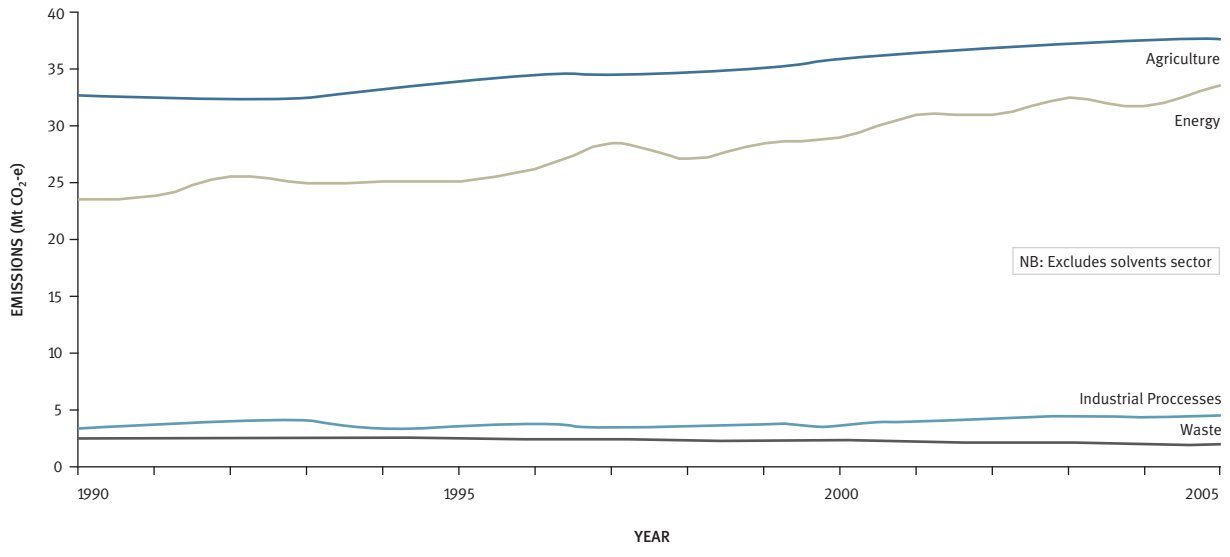


Figure 5
New Zealand's greenhouse gas emissions by sector: 1990–2005



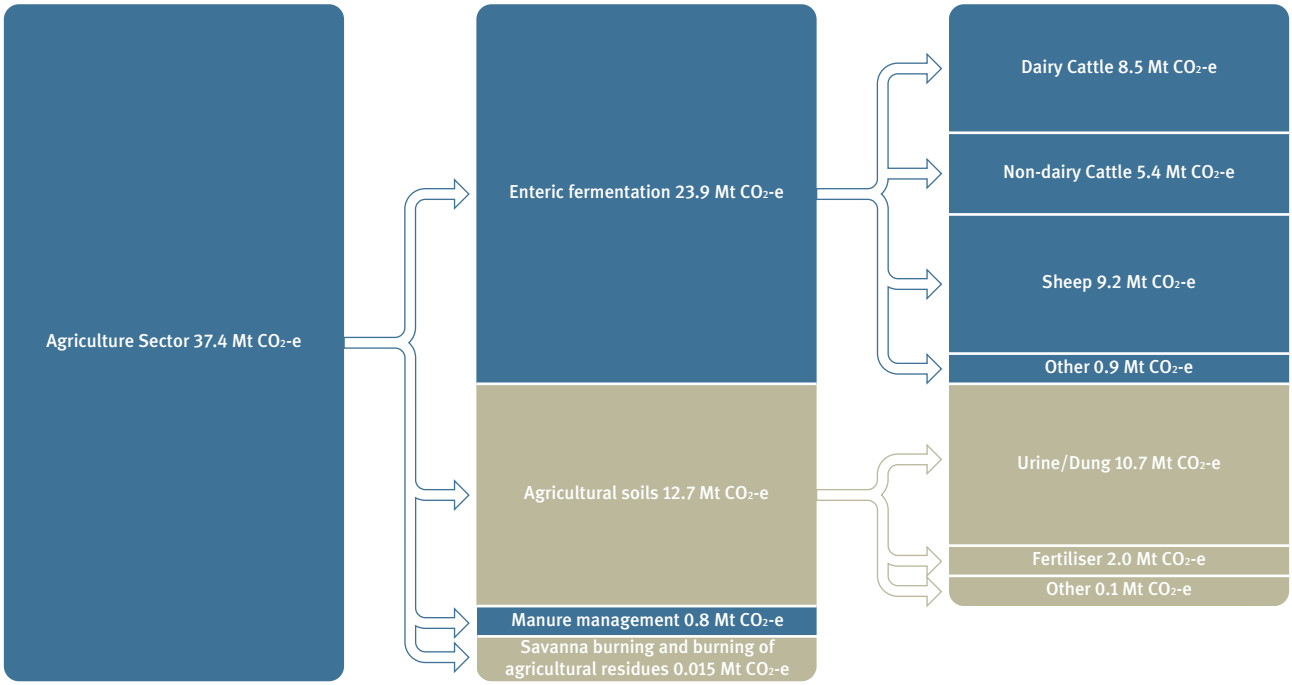
Agriculture sector

New Zealand has a unique emissions profile with 49 per cent (37.4 Mt CO_2-e) of emissions in 2005 produced by the agriculture sector. Typically emissions from agriculture for other developed countries make up around 12 per cent of totals.

Agriculture emissions increased by 15 per cent between 1990 and 2005 (32.5 Mt CO2-e). The sector contributes 96 per cent of New Zealand's total nitrous oxide emissions and 91 per cent of total methane emissions. Figure 6 shows agriculture emissions by category in 2005.

Emissions of methane or nitrous oxide are produced when biomass (organic matter) is consumed, decays or is burnt. Naturally occurring emissions are modified by human activities such as cultivation, addition of nitrogenous fertilisers, farming of livestock, or burning of crop residues.

Figure 6
Emissions from the agriculture sector: 2005



Enteric fermentation

Enteric fermentation is a by-product of digestion by ruminant livestock. This is New Zealand's highest single emissions category, contributing 23.9 Mt CO_2-e, or 31 per cent to total national emissions in 2005, primarily as methane. Enteric fermentation represents 64 per cent of all emissions from agriculture. Emissions from enteric fermentation have increased by 10 per cent from 1990 levels (21.2 Mt CO_2-e).

Ruminant animals are livestock with complex digestive systems consisting of a four-part stomach where microbes break down food. Methane is produced as a by-product of the microbial activity and is mostly released when the animal exhales (enteric fermentation).

Agricultural soils

Emissions of nitrous oxide in this category are associated with the application of nitrogenous fertilisers, crop residues, animal wastes (dung and urine), cultivation of peat soils and the use of nitrogen fixing crops. Emissions can be direct from the soil, and indirect through atmospheric deposition, leaching and run-off. Agricultural soils contributed 34 per cent of all agricultural emissions (12.7 Mt CO_2-e) in 2005. Emissions were 27 per cent (2.7 Mt CO_2-e) higher in 2005 than in 1990.

Manure management

This category produces emissions from decomposition of animal waste held in manure management systems. For example, emissions from animal waste stored in lagoons or ponds. Emissions were 0.8 Mt CO_2-e in 2005, a growth of 28 per cent from 1990 (0.6 Mt CO_2-e).

Savanna burning

Emissions are from the controlled burning of tussock grasslands. The amount of tussock burned has been steadily decreasing since 1959. Emissions from this category comprised 0.001 Mt CO_2-e in 2005, a decrease of 71 per cent from 1990 (0.003 Mt CO_2-e).

Burning of agricultural residues

Emissions are produced from field-burning of crop residues, including those from barley, wheat and oats. Emissions were 0.014 Mt CO_2-e in 2005, a decrease of 44 per cent from 1990 (0.025 Mt CO_2-e).

Energy sector

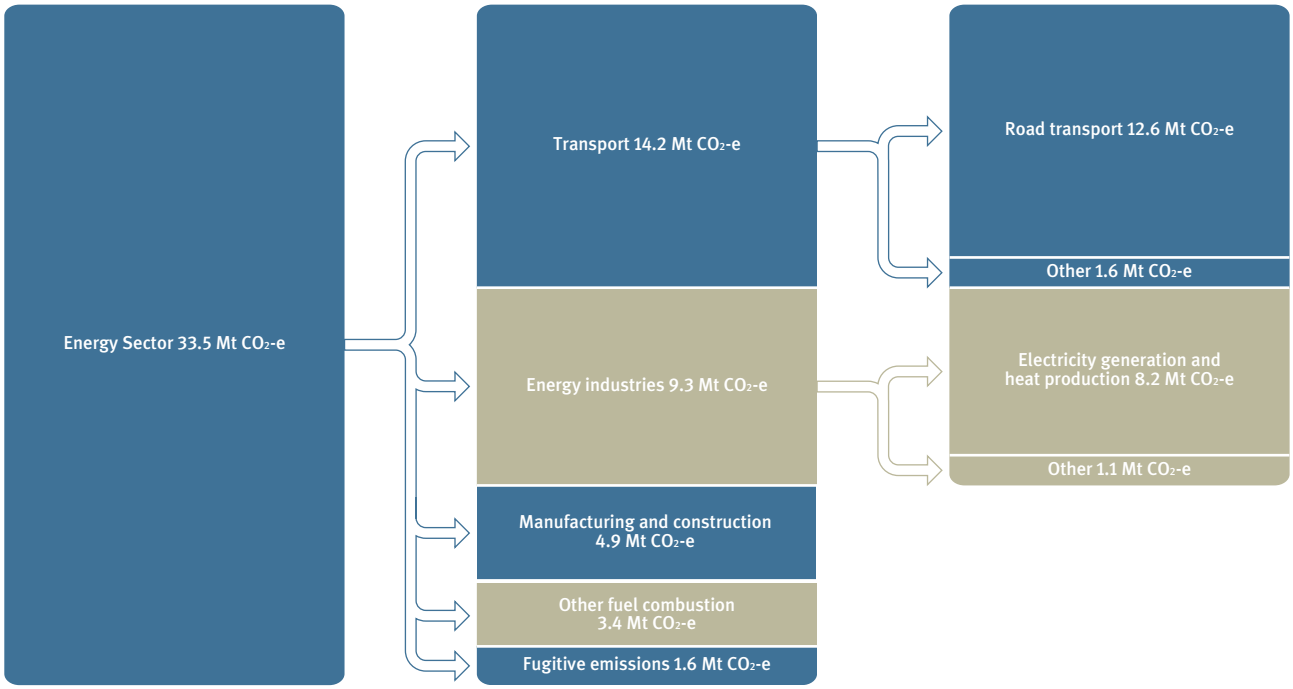
The energy sector reports emissions from fuel combustion (including transport and combustion to produce heat in industry), and fugitive emissions.

The entire energy sector was the source of 33.5 Mt CO_2-e or 43 per cent of all emissions in 2005. The energy sector experienced the highest rate of emissions growth of any sector between 1990 and 2005. Emissions increased by 42 per cent (9.9 Mt CO_2-e) over the period. Figure 7 shows energy emissions by category in 2005.

Fuel combustion is the controlled burning of solid, liquid or gaseous fossil fuels (such as coal, petrol and natural gas) to generate heat or energy.

Fugitive emissions are associated with the production, processing, transport, storage, transmission and distribution of fossil fuels such as coal, oil and natural gas.

Figure 7
Emissions from the energy sector: 2005



Fuel combustion

Transport

Transport emissions include those from road, rail, and domestic air and water transport. International air and water transport are not included in these emissions totals. This separation is required to meet international reporting guidance.

In 2005, transport contributed 14.2 Mt CO_2-e, or 18 per cent of New Zealand's total emissions. Emissions were 62 per cent higher in 2005 than in 1990 (8.8 Mt CO_2-e).

- Road transport represented 89 per cent (12.6 Mt CO_2-e) of domestic transport emissions in 2005. Emissions from road transport increased by 65 per cent (5.0 Mt CO_2-e) between 1990 and 2005.
- Aviation contributed 7 per cent (1.0 Mt CO_2-e) of emissions from domestic transport. Emissions from aviation in 2005 were 31 per cent (0.2 Mt CO_2-e) higher than in 1990.
- Emissions from shipping in 2005 were 3 per cent (0.4 Mt CO_2-e) of domestic transport emissions. Shipping emissions increased by 59 per cent (0.15 Mt CO_2-e) between 1990 and 2005.
- Rail emissions were 1 per cent (0.2 Mt CO_2-e) of all emissions from domestic transport. Emissions from rail increased by 95 per cent (0.07 Mt CO_2-e) between 1990 and 2005.

Energy industries

Electricity generation, petroleum refining, gas processing and solid fuel manufacturing are all reported under energy industries. Emissions from energy industries were 9.3 Mt CO_2-e in 2005 and 12 per cent of national emissions. Energy industries emissions increased by 54 per cent (3.2 Mt CO_2-e) between 1990 and 2005. This increase is primarily due to growth in electricity demand in New Zealand. Increasing demand has required more thermal generation – burning more gas, coal and oil.

Electricity generation and heat production comprised 88 per cent (8.2 Mt CO_2-e) of the energy industries sub-category in 2005. The remaining 12 per cent of emissions are from petroleum refining (9 per cent) and gas processing and solid fuel manufacturing (3 per cent).

Manufacturing industries and construction

This category includes emissions from the manufacture of steel, non-ferrous metals, pulp and paper, and emissions from food processing. Emissions from manufacturing industries and construction contributed 6 per cent (4.9 Mt CO_2-e) to New Zealand's total greenhouse gas emissions in 2005, a 6 per cent increase from the 1990 level (4.6 Mt CO_2-e).

Other fuel combustion

This includes emissions from commercial, institutional and residential sectors. It covers fuel used by agricultural, fishery and forestry equipment and all other fuel combustion emissions. Emissions were 3.4 Mt CO_2-e, or 4 per cent of national greenhouse gas emissions in 2005. This was a 17 per cent increase (0.5 Mt CO_2-e) above emissions reported in 1990 (2.9 Mt CO_2-e).

Fugitive emissions

Fugitive emissions in 2005 were 1.6 Mt CO_2-e, representing 2 per cent of the national total. Emissions increased by 33 per cent (0.4 Mt CO_2-e) from 1990 (1.2 Mt CO_2-e).

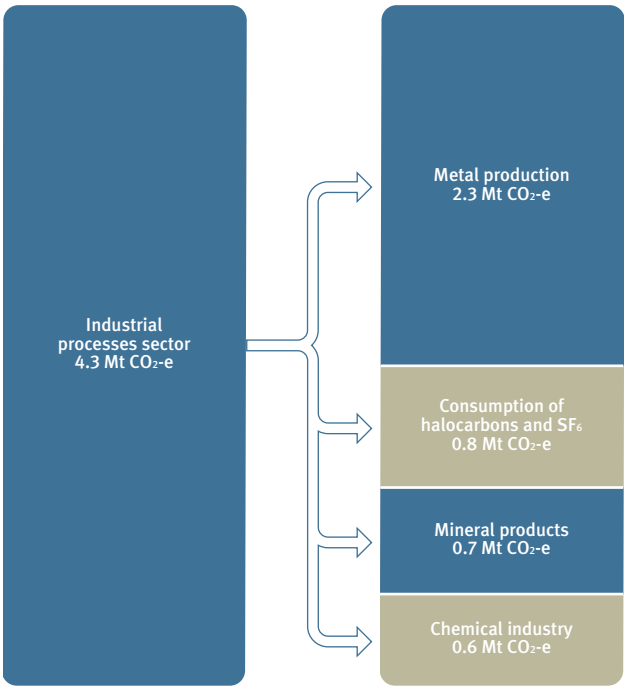
Industrial Processes and Solvents sectors

The industrial processes sector and the solvent and other products sector are covered together in this document. These sectors have similarities and each represents a small proportion of New Zealand's total greenhouse gas emissions.

Industrial processes

Emissions are produced from the chemical transformation of one product to another. For example, the reduction of ironsand in steel production releases carbon dioxide. Emissions from energy used to produce heat in the process are reported within the energy sector. Figure 8 shows emissions from the industrial processes sector by category in 2005.

Figure 8
Industrial processes sector emissions: 2005



The main industrial processes producing greenhouse gases in New Zealand are:

- reduction of ironsand in steel production
- oxidisation of anodes in aluminium production
- production of hydrogen
- calcination of limestone for use in cement production
- calcination of limestone for lime
- production of ammonia and urea.

Most greenhouse gas emissions in this sector are carbon dioxide. Small contributions come from hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride.

Emissions from industrial processes were 4.3 Mt CO_2-e in 2005. This represents 6 per cent of total national emissions, and is 1.0 Mt CO_2-e (32 per cent) higher than in 1990 (3.3 Mt CO_2-e). The increase is mainly growth in emissions from metal production and consumption of halocarbons (carbon compounds such as hydrofluorocarbons and perfluorocarbons).

Solvent and other product use

Nitrous oxide is the only direct greenhouse gas reported in this sector. Nitrous oxide is mostly used for anaesthesia with a minor amount used in motor sports and in scientific analysis.

The sector is a minor contributor to New Zealand's total direct greenhouse gas emissions, being responsible for just 0.05 Mt CO_2-e. Emissions have increased by 16 per cent since 1990 (0.04 Mt CO_2-e).

Other emissions in this sector are indirect greenhouse gases, which are not counted in New Zealand's total emissions. Indirect greenhouse gas emissions result from evaporation of volatile chemicals when solvent-based products are exposed to air.

Waste sector

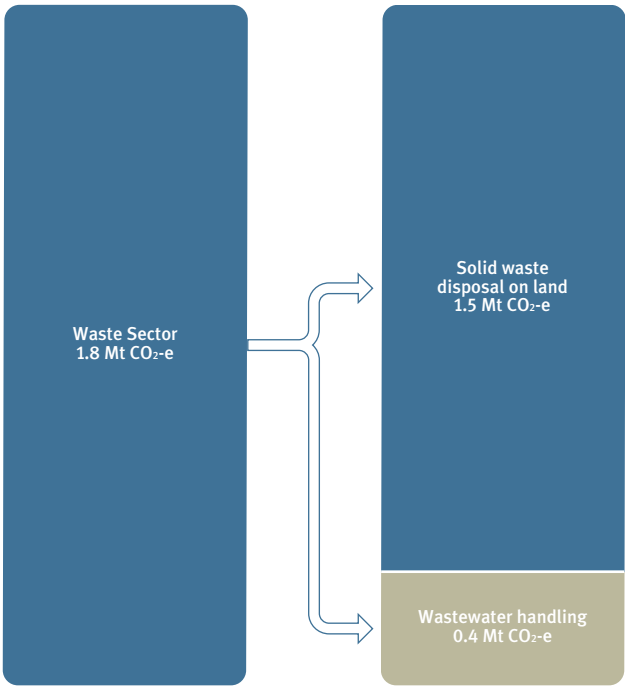
Greenhouse gas emissions from waste are predominantly methane, formed as organic wastes such as food decay. Small amounts of nitrous oxide are also generated from incineration of solvents and decomposition of human waste. Carbon dioxide emissions from the breakdown of organic material are not reported because the carbon dioxide emitted is assumed to be reabsorbed by growth in vegetation and other organic matter in the following year.

Waste emissions were 1.8 Mt CO_2-e in 2005, a decrease of 0.6 Mt CO_2-e (26 per cent) since 1990. This decrease is due to improved processing and the capture of landfill gas from solid waste disposal. The waste sector contributed 2 per cent to New Zealand's total greenhouse gas emissions in 2005.

Solid waste disposal on land represented 79 per cent (1.5 Mt CO_2-e) of waste sector greenhouse gas emissions in 2005. This is a reduction of 29 per cent since 1990 (2.1 Mt CO_2-e).

Wastewater handling makes up the remaining 21 per cent (0.4 Mt CO_2-e) of emissions from the waste sector. Emissions from wastewater are largely driven by changes in human population.

Figure 9
Waste sector emissions: 2005



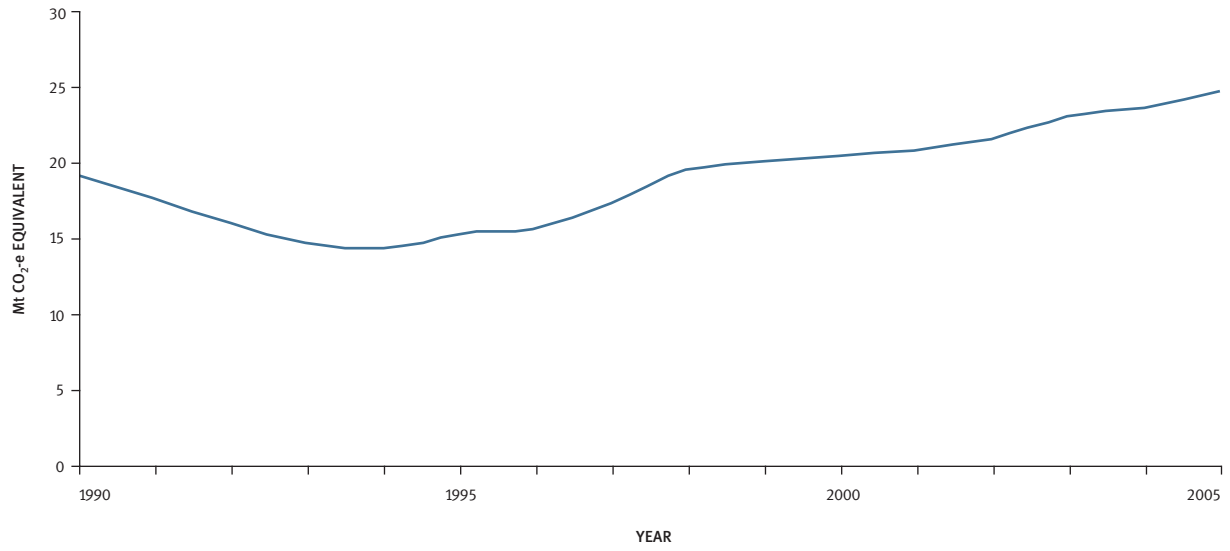
Land Use, Land-use Change and Forestry sector

Changes in the amount of carbon in vegetation and soil as a result of human activity are covered in the Land Use, Land-Use Change and Forestry (LULUCF) sector. The sector also includes emission of nitrous oxide and methane resulting from land-use activity. In New Zealand, the LULUCF sector acts as a carbon sink. Removals in 2005 represent 24.5 Mt CO_2-e or 32 per cent of national emissions. Overall, total LULUCF removals have increased by 29 per cent (19.0 Mt CO_2-e) between 1990 and 2005.

Sinks

Any process, activity or mechanism which removes a greenhouse gas from the atmosphere. Forests and other vegetation may be considered sinks because they remove carbon dioxide through photosynthesis.

Figure 10
LULUCF sector net removals: 1990–2005



Within LULUCF, six land-use categories define all classes of land. These categories are forest land, cropland, grassland, wetlands, settlements, and other land. The categories are defined and required by international inventory guidance.

Transfers of land use from one category to another are associated with emissions or removals. Some categories of land staying in the same land use may be assumed to be in steady-state whereby they are neither gaining nor losing carbon – an example would be grassland. For other categories – such as growing plantation forests – the land use is not changing but forest growth removes carbon dioxide from the atmosphere and stores it as carbon. Emissions can also arise from the burning and decay of biomass and changes in soil carbon.

The trends observed in the LULUCF sector reflect New Zealand's changing land use and forestry activity, particularly during the 1990s. In 2005, removals of greenhouse gases associated with forestry represent the majority of removals in the sector. The inventory reports emissions and removals from all forests not just "Kyoto forests" (or forests planted since 1990).

New Zealand has begun the implementation of a multi-year effort to substantially improve its estimates for the LULUCF sector. Ongoing improvement is a requirement of reporting under the Kyoto Protocol. The Land-Use and Carbon Analysis System (LUCAS) will use satellite and photographic imagery to determine changes in land use from 1990 and over the first commitment period of the Kyoto Protocol (2008–2012). Current LULUCF estimates will be updated when areas of land use and land-use change are confirmed by the LUCAS work.

FURTHER INFORMATION

Refer to the full report
New Zealand's Greenhouse Gas Inventory 1990–2005 available at:
www.mfe.govt.nz/publications/climate/nir-jul07/index.html