MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

ENERGY MODELLING AND SECTOR TRENDS

13

2012 CALENDAR YEAR EDITION

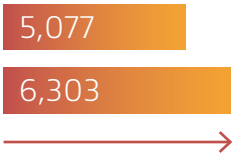
Energy Greenhouse Gas Emissions

Key Messages

Energy Sector Emissions
37% ABOVE
the 1990 level

Road transportation is

of all energy sector emissions



Electricity generation emissions
INCREASE 24%
from 2011

Introduction

This publication presents information on greenhouse gas emissions from the energy sector for the calendar years 1990-2012. Energy sector emissions are responsible for slightly less than half of New Zealand's total gross emissions. Total gross emissions exclude emission reductions from land use change and forestry. The remainder is primarily from agriculture.

Emissions are presented as carbon dioxide equivalent (CO_2-e) of the direct greenhouse gases – carbon dioxide, methane and nitrous oxide – based on their global warming potentials (see Technical Notes on page 11).

This publication updates the annual series and includes revised numbers for 1990-2011 where improved data or methodologies have been applied.

New Zealand is a signatory to both the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol first commitment period. As an 'Annex 1' country under the UNFCCC, New Zealand is committed to produce a national inventory of greenhouse gas sources and sinks.

As a signatory of the Kyoto Protocol New Zealand has accepted, for the period 2008 to 2012 it will take responsibility for all emissions in excess of 1990 levels.

The energy sector emissions data presented in this publication will feed into *New Zealand's Greenhouse Gas Inventory* that will be published by the Ministry for the Environment and submitted to the UNFCCC in April 2014.

In addition to energy sector emissions, *New Zealand's Greenhouse Gas Inventory* includes emissions from agriculture, industrial processes, solvent and other product use, waste and land use change and forestry.

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WANT A CLOSER LOOK? For detailed data, visit:
www.med.govt.nz/sectors-industries/energy/energy-modelling/data

SNAPSHOT 2012

DETAILED DATA TABLES ARE AVAILABLE AT:
http://www.med.govt.nz/sectors-industries/energy/energy-modelling/data

Emissions from transport continue to dominate in 2012, making up 43% of total emissions in the energy sector, although this is down from 45% last year. In fact, transport emissions are greater than electricity, manufacturing and fugitive emissions combined. By fuel type, liquid fuels are responsible for the majority of emissions. Over three quarters of liquid fuel emissions come from the transport sector.

FIGURE 1A: Energy Emissions by Sector 2012 (kt CO_2-e)

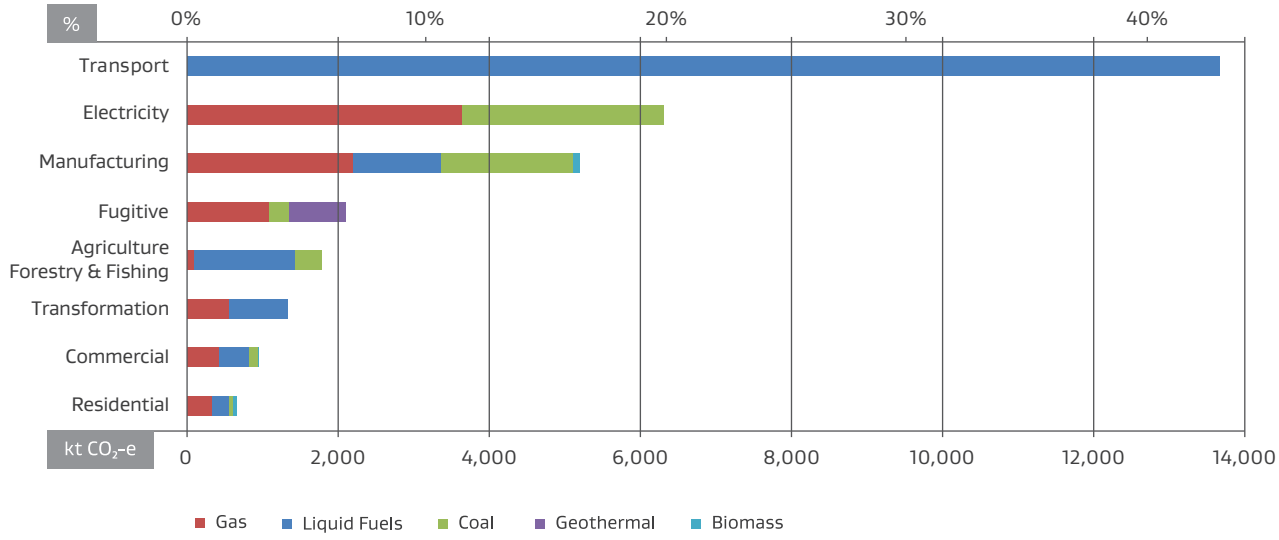
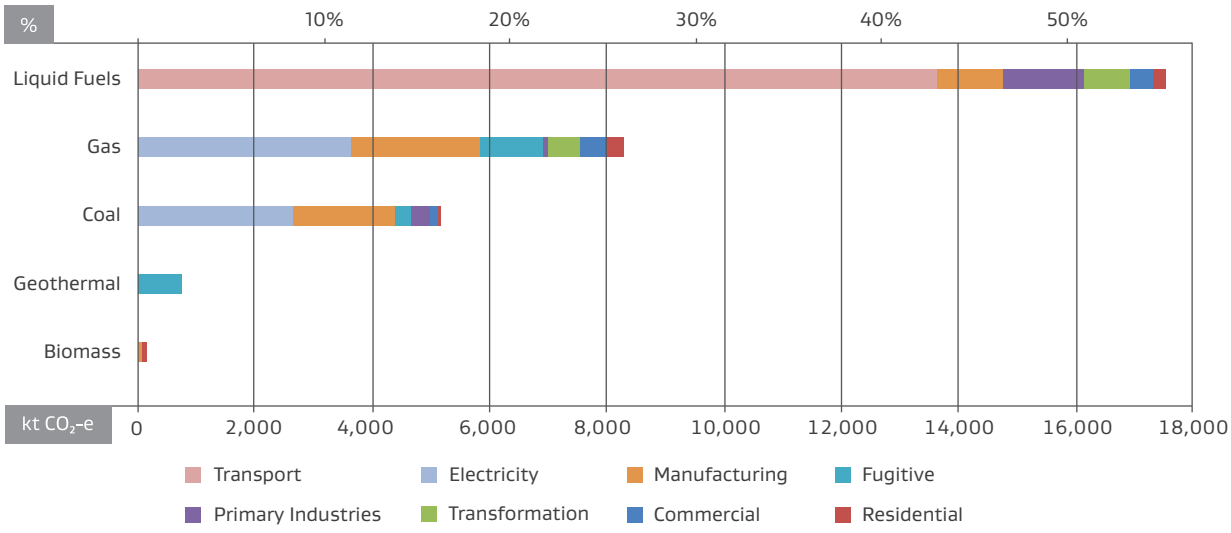


FIGURE 1B: Energy Emissions by Fuel 2012 (kt CO_2-e)

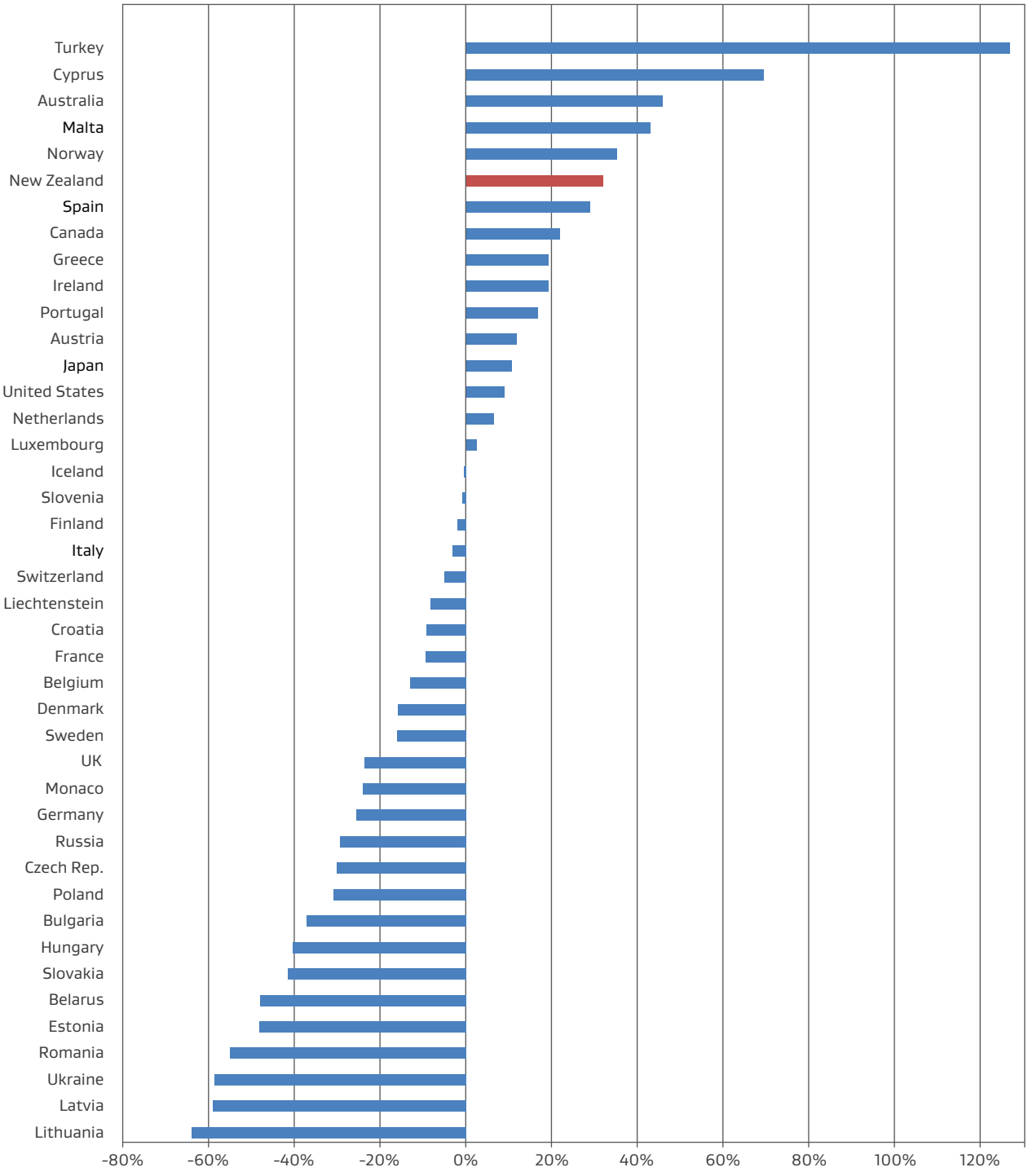


INTERNATIONAL CONTEXT

New Zealand's energy sector emissions grew by 37% from 1990 to 2012. This level of growth is high by international comparison. Figure 1b shows the percentage growth in energy sector emissions for each annex 1 country from their respective base year to 2011. Annex 1 countries are those which are full signatories to the UNFCCC. The base year is 1990 for all countries except Romania (1989), Poland & Bulgaria (1988) and Hungary (average of 1985-1987).

Most of the countries with the largest net reductions in total emissions since 1990 are transition economies. These economies have undergone change from centrally planned economies, towards free market economies. This includes members of the former Soviet Union and communist bloc countries. The economic adjustments required to liberalise these economies (mainly in the early 1990's), led to drops in economic output (GDP) and associated reductions in national emissions.

FIGURE 2: Change Energy Sector Emissions from base year to 2011.



EMISSIONS BY FUEL

DETAILED DATA TABLES ARE AVAILABLE AT:
http://www.med.govt.nz/sectors-industries/energy/energy-modelling/data

New Zealand's energy sector emissions were 32,107 kt CO_2-e in 2012, up 4% from 2011. Since 1990, the base year for Kyoto Protocol obligations, New Zealand's energy sector emissions have increased in total by 37% averaging 1.4% growth per annum. During this period the New Zealand economy grew by over 190%.

In 2012, the low rainfall resulted in lower hydro generation and higher thermal generation, with the largest increase coming from coal generation, followed by gas. This resulted in a significant increase in emissions from coal combustion.

Liquid fuel combustion, driven by the transport sector, continues to dominate, at over 55% of total energy sector emissions. An increase of almost 50% between 1990 and 2003 is largely responsible for New Zealand having one of the largest increases amongst Annex 1 countries in energy sector emissions since 1990.

Natural gas combustion emissions increased up to 2001 as the chemicals industry (manufacturing synthetic petrol and methanol) and electricity generators took advantage of the relatively cheap Maui and Kapuni gas contracts.

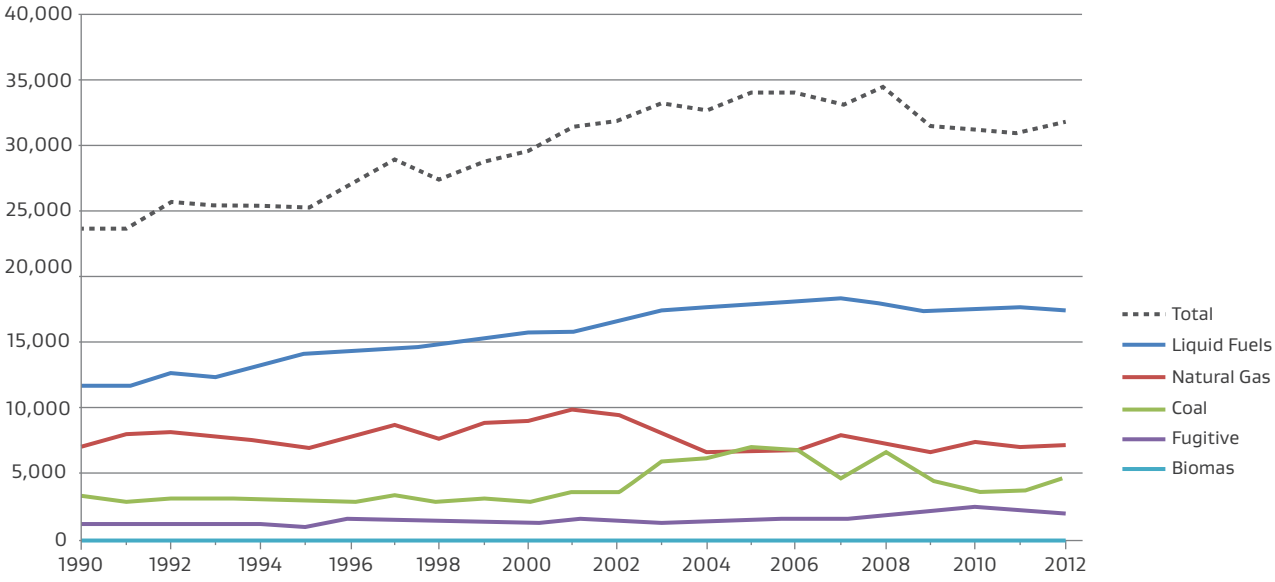
In the late 1990s, synthetic gasoline production stopped in New Zealand and by 2003 rising gas prices led to the closure of Methanex's methanol plant at Motunui followed by the Waitara Valley plant in 2008. As of July 2012, both trains at Motunui have been restarted, while as of October 2013 the Waitara Valley plant was restarted. Emissions from Methanex will increase as production has increased significantly in 2013.

Fugitive emissions, including those associated with geothermal electricity generation, dropped 10% from 2011, driven mainly by reduced coal mining.

TABLE 1: Energy Emissions by Fuel Type (kt CO_2-e)

Calendar Year	Liquid Fuels	Natural Gas	Coal	Biomass	Total Combustion	Fugitive	Total
1990	11,853	7,049	3,201	104	**22,207**	1,277	**23,483**
2000	15,865	9,206	2,845	132	**28,049**	1,609	**29,658**
2008	18,211	7,366	6,545	131	**32,253**	2,130	**34,383**
2009	17,547	6,897	4,612	124	**29,180**	2,347	**31,527**
2010	17,494	7,575	3,574	133	**28,777**	2,555	**31,332**
2011	17,749	7,038	3,702	134	**28,623**	2,331	**30,954**
2012	17,732	7,233	4,904	132	**30,002**	2,106	**32,107**
Δ1990/2012	49.6%	2.6%	53.2%	27.8%	**35.1%**	65.0%	**36.7%**
Δ1990/2012 p.a.	1.8%	0.1%	2.0%	1.1%	**1.4%**	2.3%	**1.4%**
Δ2011/2012	-0.1%	2.8%	32.5%	-0.9%	**4.8%**	-9.7%	**3.7%**
% of total 2012 energy CO2-e emissions	55.2%	22.5%	15.3%	0.4%	**93.4%**	6.6%	**100.0%**

FIGURE 3: Energy Emissions by Fuel Type (kt CO_2-e)



EMISSIONS BY SECTOR

As mentioned in the previous section, most of the increase in emissions seen between 2011 and 2012 was due to increased coal-fired electricity generation. The 24% increase in emissions from electricity generation (excluding geothermal) was mostly due to coal generation increasing from 2,026 GWh in 2011 to 3,317 GWh in 2012.

Note that emissions from geothermal electricity generation are captured in the fugitive sector. For information on electricity generation emissions, go page 7.

Transport accounted for 43% of all energy sector emissions, falling 2.6% since 2011 but is still over 55% higher than in 1990. Transport is broken down by mode on page 6.

'Transformation industries' includes all energy transformation industries other than electricity generation (e.g. oil product refining). The large drop is due to the production of synthetic gasoline ceasing in the late 1990s.

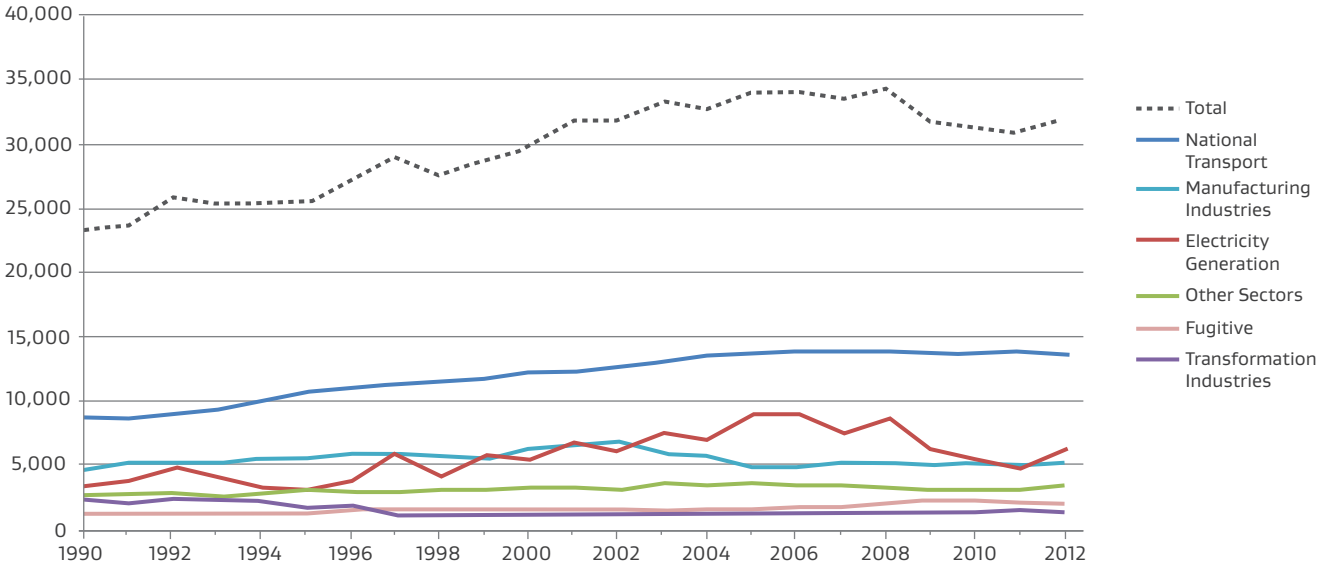
Manufacturing sector emissions increased by nearly 2%, driven primarily by the chemicals subsector. For a sector-by-sector breakdown of manufacturing industries, see page 8.

Definitions of the sectors described on this page can be found on page 11.

TABLE 2: Energy Emissions by Sector (kt CO_2-e)

Calendar Year	National Transport	Electricity Generation	Manufacturing Industries	Transformation Industries	Other Sectors	Subtotal Combustion	Fugitive	Total
1990	8,678	3,472	4,704	2,494	2,859	**22,207**	1,277	**23,483**
2000	12,234	5,318	6,273	1,143	3,081	**28,049**	1,609	**29,658**
2008	13,942	8,578	5,354	1,184	3,194	**32,253**	2,130	**34,383**
2009	13,748	6,301	4,948	1,247	2,936	**29,180**	2,347	**31,527**
2010	13,847	5,445	5,224	1,330	2,931	**28,777**	2,555	**31,332**
2011	14,043	5,077	5,089	1,340	3,074	**28,623**	2,331	**30,954**
2012	13,897	6,303	5,174	1,324	3,305	**30,002**	2,106	**32,107**
Δ1990/2012	60.1%	81.5%	10.0%	-46.9%	15.6%	**35.1%**	65.0%	**36.7%**
Δ1990/2012 p.a.	2.2%	2.7%	0.4%	-2.8%	0.7%	**1.4%**	2.3%	**1.4%**
Δ2011/2012	-1.0%	24.1%	1.7%	-1.2%	7.5%	**4.8%**	-9.7%	**3.7%**
% of total 2012 energy CO2-e emissions	43.3%	19.6%	16.1%	4.1%	10.3%	**93.4%**	6.6%	**100.0%**

FIGURE 4: Energy Emissions by Sector (kt CO_2-e)



TRANSPORT BY MODE

DETAILED DATA TABLES ARE AVAILABLE AT:
http://www.med.govt.nz/sectors-industries/energy/energy-modelling/data

Domestic transport includes all transport where the journey begins and ends in New Zealand. Off-road use is accounted for in the sector in which the activity occurs. For example, emissions from fuel used by a tractor on a farm are included under agriculture energy emissions.

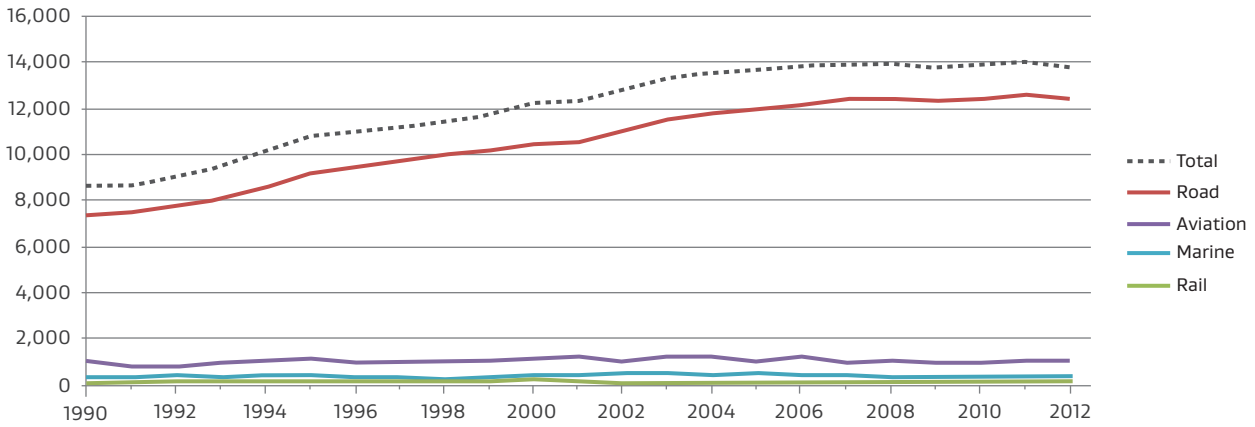
Emissions from fuel combusted by international aviation and sea-going vessels are included here. However, these are reported only as a memo item in *New Zealand's Greenhouse Gas Inventory*, as recommended in the Intergovernmental Panel on Climate Change (IPCC) guidelines.

Road transport emissions constitute by far the largest share of domestic transport emissions. At 12,437 kt CO_2-e in 2012, these made up nearly 40% of all energy sector emissions. While road transport emissions in 2012 were up 68% over 1990 levels, the trend has been flat since about 2007. This is due to flat trend in transport activity combined with improving efficiency. Emissions from rail transport have generally remained in the region of 160 kt CO_2-e in the last 20 years. The transport of passengers and freight by rail tends to be less carbon intensive than by road.

TABLE 3: Transport Emissions by Mode (kt CO_2-e)

Calendar Year	DOMESTIC					INTERNATIONAL			Total
	Road	Rail	Aviation	Marine	**Total**	Aviation	Marine	**Total**	
1990	7,407	79	939	253	**8,678**	1,320	1,091	**2,411**	**11,088**
2000	10,438	246	1,171	378	**12,234**	1,798	700	**2,498**	**14,732**
2008	12,454	156	1,078	255	**13,942**	2,301	972	**3,273**	**17,215**
2009	12,312	164	977	295	**13,748**	2,193	951	**3,144**	**16,893**
2010	12,443	143	1,004	256	**13,847**	2,315	1,014	**3,329**	**17,176**
2011	12,569	143	1,040	291	**14,043**	2,333	1,033	**3,366**	**17,408**
2012	12,437	150	1,016	293	**13,897**	2,301	1,184	**3,484**	**17,381**
Δ1990/2012	67.9%	90.5%	8.2%	15.8%	**60.1%**	74.3%	8.5%	**44.5%**	**56.7%**
Δ1990/2012 p.a.	2.4%	3.0%	0.4%	0.7%	**2.2%**	2.6%	0.4%	**1.7%**	**2.1%**
Δ2011/2012	-1.0%	5.0%	-2.3%	0.8%	**-1.0%**	-1.4%	14.6%	**3.5%**	**-0.2%**
% of total 2012 energy CO2-e emissions	38.7%	0.5%	3.2%	0.9%	**43.3%**	n.a.	n.a.	**n.a.**	**n.a.**

FIGURE 5: Transport Emissions by Mode (kt CO_2-e)



ELECTRICITY EMISSIONS

Emissions from electricity generation, including geothermal fugitive emissions, were 7,056 kt CO_2-e in 2012. Emissions rose 21% over the year as Huntly's coal and gas units were used heavily after low rainfall lead to lower than normal hydro generation. Huntly coal and gas fired plants produced 1,243 GWh more electricity in 2012 compared to 2011, and this resulted in a 77% rise in coal emissions.

Genesis Energy has decided to put a second Huntly coal and gas unit into long-term storage and to fully decommission the unit they currently have in storage. This has brought forward the planned storage date of the second unit by more than a year, where original plans were to put it into storage at the beginning of 2015. These older and less efficient technologies are being pushed out of the market by cheaper and cleaner technologies such as geothermal and wind, which have lower emissions. Geothermal and wind energy increase baseload electricity generation meaning that less thermal baseload generation is required.

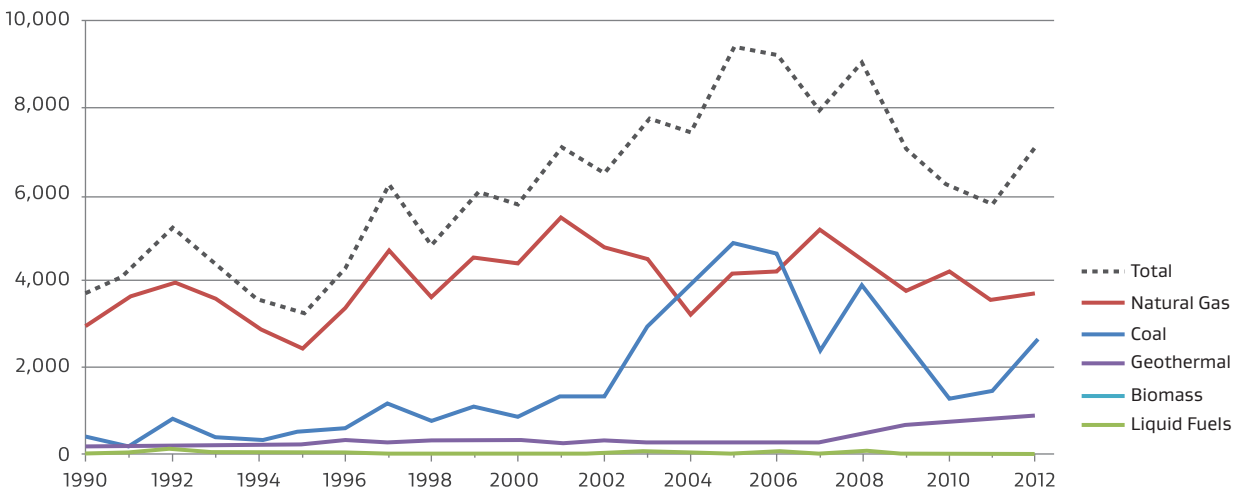
The emissions intensity of New Zealand electricity generation is low by international standards due to the high proportion of demand met by hydro generation. While this provides a strong base in good hydro years, electricity emissions remain sensitive to rainfall in the key catchment areas.

For 2012 the approximate emissions intensities for generation by fuel type were 980 kg CO_2-e/MWh for coal, 430 kg CO_2-e/MWh for gas and 130 kg CO_2-e/MWh for geothermal.

TABLE 4: Electricity Emissions by Fuel (kt CO_2-e)

Calendar Year	Natural Gas	Coal	Liquid Fuels	Biomass	Total Thermal	Geothermal	Total
1990	2,989	472	10	0.2	**3,472**	275	**3,747**
2000	4,440	878	0	0.6	**5,318**	414	**5,732**
2008	4,559	3,919	98	1.0	**8,578**	515	**9,093**
2009	3,770	2,523	7	1.1	**6,301**	723	**7,024**
2010	4,179	1,263	1	1.1	**5,445**	756	**6,200**
2011	3,578	1,497	1	1.3	**5,077**	737	**5,814**
2012	3,641	2,658	3	1.3	**6,303**	753	**7,056**
Δ1990/2012	21.8%	463.3%	-73.6%	519.6%	**81.5%**	174.2%	**88.3%**
Δ1990/2012 p.a.	0.9%	8.2%	-5.9%	8.6%	**2.7%**	4.7%	**2.9%**
Δ2011/2012	1.8%	77.5%	169.4%	3.9%	**24.1%**	2.2%	**21.4%**
% of total 2012 energy CO2-e emissions	11.3%	8.3%	0.0%	0.0%	**19.6%**	2.3%	**22.0%**

FIGURE 6: Electricity Emissions by Fuel (kt CO_2-e)



MANUFACTURING SECTORS

DETAILED DATA TABLES ARE AVAILABLE AT:
http://www.med.govt.nz/sectors-industries/energy/energy-modelling/data

This section includes emissions from fuels combusted in factories, plants or mills, as well as for electricity generation where the primary purpose is to support an onsite manufacturing activity.

This does not include emissions from chemical processes such as hydrogen, steel or cement production as these emissions are considered industrial process emissions according to IPCC guidelines. However, emissions from methanol production are reported under manufacturing in this report and in *New Zealand's Greenhouse Gas Inventory*.

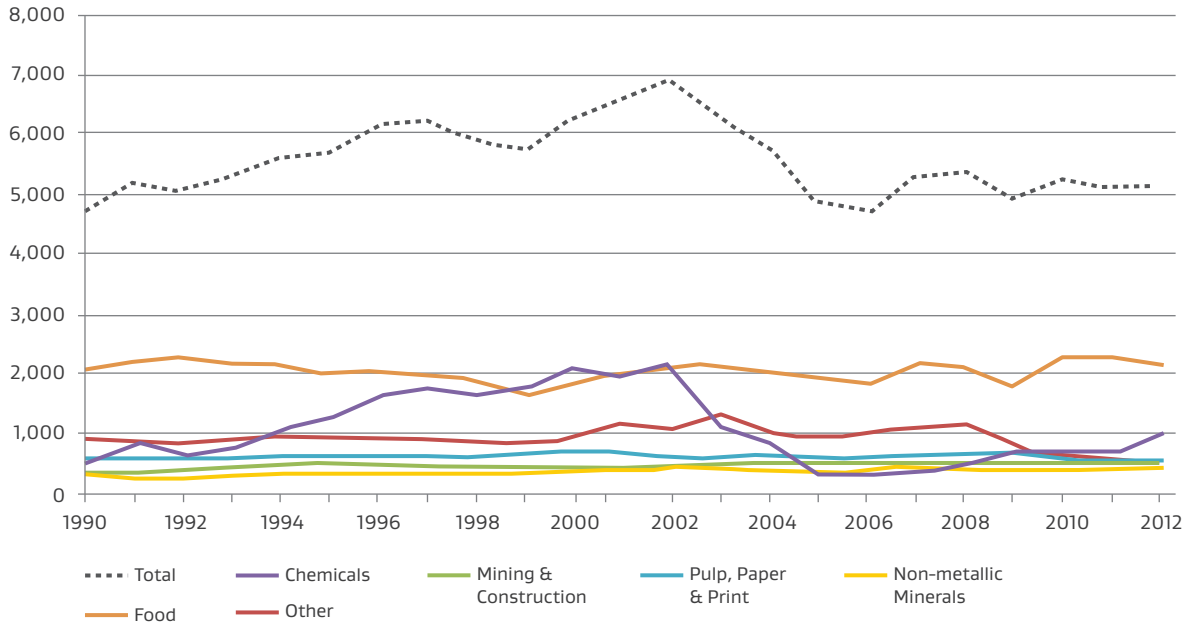
Emissions from the food industries have made up most of New Zealand manufacturing industry emissions since 2003. These emissions are largely the result of coal and gas used to raise heat for dairy processing.

Emissions from the Chemicals sector, which were less than half those of the food sector in 2012, are set to increase as Methanex continues to scale up its methanol production in 2013. Figure 8 shows a distinct drop in emissions from the chemicals sector from 2003, when methanol production fell in the midst of rising gas prices.

TABLE 5: Manufacturing Emissions by Sector (kt CO_2-e)

Calendar Year	Chemicals	Pulp, Paper & Print	Food	Mining & Construction	Non-metallic Minerals	Other	Total
1990	451	544	2,098	363	314	934	**4,704**
2000	2,073	688	1,810	426	384	892	**6,273**
2008	492	541	2,086	615	481	1,139	**5,354**
2009	703	508	1,821	648	458	809	**4,948**
2010	754	508	2,298	544	477	642	**5,224**
2011	765	517	2,306	535	411	553	**5,089**
2012	949	548	2,179	550	432	517	**5,174**
Δ1990/2012	110.2%	0.7%	3.8%	51.4%	37.5%	-44.6%	**10.0%**
Δ1990/2012 p.a.	3.4%	0.0%	0.2%	1.9%	1.5%	-2.7%	**0.4%**
Δ2011/2012	24.0%	5.9%	-5.5%	2.7%	5.0%	-6.6%	**1.7%**
% of total 2012 energy CO2-e emissions	3.0%	1.7%	6.8%	1.7%	1.3%	1.6%	**16.1%**

FIGURE 7: Manufacturing Emissions by Sector (kt CO_2-e)



OTHER SECTOR EMISSIONS

For the purposes of the *National Greenhouse Gas Inventory*, 'Other Sectors' includes the residential, commercial/ institutional sectors and agriculture, forestry and fisheries. This includes fuel combustion for stationary energy, such as space heating in the commercial sector, and off-road mobile combustion, such as on-farm vehicles in the agricultural sector.

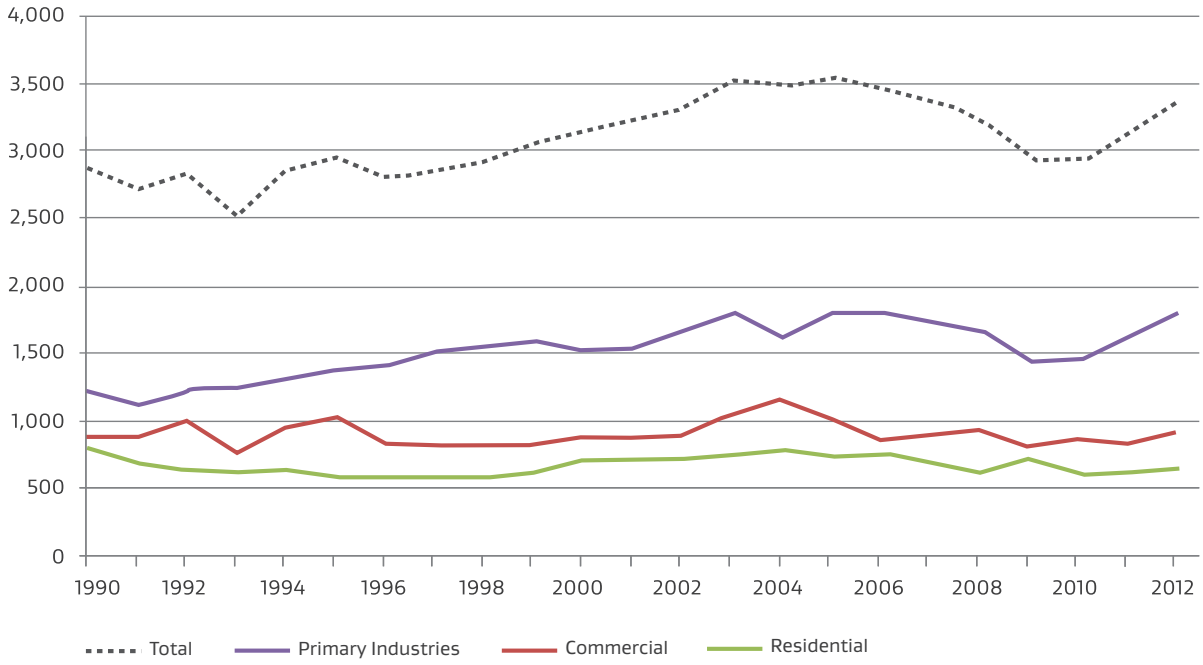
Emissions allocated to the residential sector have decreased 20% since 1990, while commercial sector emissions increased by only 4%, despite increasing household numbers and GDP. This is the result of a shift toward electricity as a primary energy source for both sectors. As electricity generation is itself considered a sector, switching from primary fuels – such as gas or coal – to electricity, causes an apparent decrease in emissions in the sector in which the energy is consumed.

Emissions from the primary industries sector have increased 47% since 1990, in line with increased production. Approximately 30% of 2011 emissions in these sectors come from mobile combustion of liquid fuels, such as off-road vehicles on farms. Note that these are combustion emissions only. Emissions resulting from enteric fermentation and manure management are not energy-related emissions, so are captured elsewhere according to IPCC guidelines.

TABLE 6: Other Sector Emissions (kt CO_2-e)

Calendar Year	Commercial	Residential	Primary Industries	Total
1990	876	771	1,213	**2,859**
2000	858	701	1,521	**3,081**
2008	922	620	1,652	**3,194**
2009	796	698	1,442	**2,936**
2010	877	604	1,450	**2,931**
2011	835	613	1,626	**3,074**
2012	911	616	1,778	**3,305**
Δ1990/2012	4.0%	-20.1%	46.7%	**15.6%**
Δ1990/2012 p.a.	0.2%	-1.0%	1.8%	**0.7%**
Δ2011/2012	9.0%	0.4%	9.4%	**7.5%**
% of total 2012 energy CO2-e emissions	2.8%	1.9%	5.5%	**10.3%**

FIGURE 8: Other Sector Emissions (kt CO_2-e)



FUGITIVE EMISSIONS

DETAILED DATA TABLES ARE AVAILABLE AT:
http://www.med.govt.nz/sectors-industries/energy/energy-modelling/data

Fugitive emissions are those which arise from the production, processing, transmission and storage of fuel, and from non-productive combustion. These emissions have decreased 23% in the last two years, with the largest decline coming from the coal mining subsector.

Emissions from natural gas processing and flaring had increased considerably in previous years. This was partly due to the decline in methanol production from 2003, which resulted in an increase in emissions vented from the Kapuni gas treatment plant. Previously, high-CO_2 gas from the Kapuni low temperature separation plant had been exported for methanol production. During 2012 methanol production increased causing gas processing emissions to decrease.

In addition, flaring of natural gas at offshore oil fields has increased significantly. Offshore oil fields will flare natural gas produced along with oil if it is not economically viable for a dedicated pipeline to be built to transport the gas onshore for sale. Combusting the natural gas results in lower emissions than simply venting it due to the higher global warming potential of methane relative to carbon dioxide.

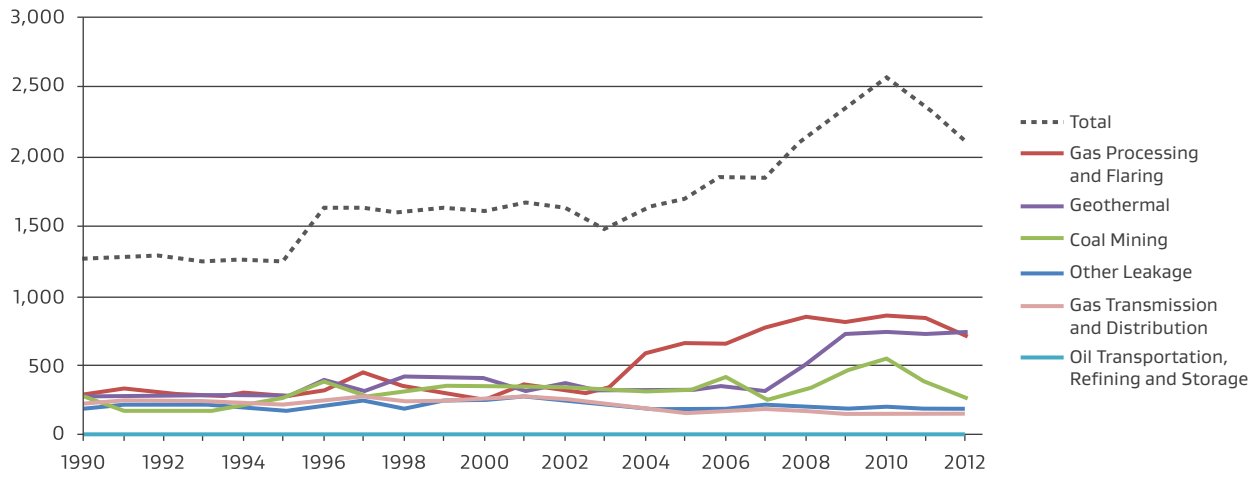
Geothermal electricity generation is another significant and increasing source of fugitive emissions. These emissions are considered fugitive as they are the result of the extraction process rather than combustion.

'Other leakage' includes natural gas losses at the point of consumption.

TABLE 7: Fugitive emissions (kt CO_2-e)

Calendar Year	Coal Mining and Post-mining Operations	Gas Transmission and Distribution	Gas Processing and Flaring	Oil Transportation, Refining and Storage	Geothermal	Other Leakage	Total
1990	274	237	283	5	275	203	**1,277**
2000	352	305	256	5	414	277	**1,609**
2008	339	200	855	6	515	214	**2,130**
2009	442	164	815	6	723	197	**2,347**
2010	552	158	861	6	756	222	**2,555**
2011	391	157	838	6	737	202	**2,331**
2012	272	160	712	6	753	203	**2,106**
Δ1990/2012	-1.1%	-32.2%	151.5%	24.4%	174.2%	-0.1%	**65.0%**
Δ1990/2012 p.a.	0.0%	-1.8%	4.3%	1.0%	4.7%	0.0%	**2.3%**
Δ2011/2012	-30.5%	2.1%	-15.0%	-2.6%	2.2%	0.3%	**-9.7%**
% of total 2012 energy CO2-e emissions	0.8%	0.5%	2.2%	0.0%	2.3%	0.6%	**6.6%**

FIGURE 9: Fugitive emissions (kt CO_2-e)



Technical Notes

Carbon Dioxide Emission Factors

Carbon dioxide emission factors are used to calculate the amount of CO2 emitted per unit of fuel combusted.

Other emission factors that do not involve combustion or the use of fuel are expressed in terms of emissions per unit of production, or some other kind of activity.

Oxidation factors are used to account for incomplete combustion. Carbon dioxide emission factors, both before and after oxidation, are presented in the detailed data tables at: www.med.govt.nz/sectors-industries/energy/energy-modelling/data

Non-Carbon Dioxide Emissions

Non-carbon dioxide emissions are highly dependent on the conditions of combustion. For example, a litre of diesel used for industrial heating produces a different level of methane emissions than the same amount used in a vehicle. Consequently, methods for calculating non-carbon dioxide emissions differ by sector.

Carbon Dioxide Equivalent Emissions

Carbon dioxide equivalent (CO2-e) emissions are calculated based on the ratio of the radiative forcing of one kilogram of greenhouse gas emitted to the atmosphere to that of one kilogram of carbon dioxide over a given time horizon. This report uses the following global warming potentials:

Methane (CH_4) = 21

Nitrous oxide (N_2O) = 310

Biomass Emissions

Carbon dioxide emissions from the combustion of biomass are not included in this publication, but methane and nitrous oxide emissions from biomass are. This is because any carbon dioxide emissions from woody biomass are captured in the 'Land Use, Land Use Change and Forestry' (LULUCF) category, while carbon dioxide emissions from biogas emissions are accounted for in the 'Waste' category.

Sector Definitions

Domestic Transport: includes emissions from fuels combusted for domestic road, rail, air or waterborne transport. Emissions from off-road vehicle use are included in the sector where the activity takes place.

Electricity Generation: includes emissions from thermal combustion plants whose primary business activity is electricity generation. Plants that generate electricity to support another primary business activity are included in the manufacturing sector.

Manufacturing Industries: includes emissions from fuels combusted in plants, factories or mills, and fuel combusted for electricity generation where the primary purpose is to support the manufacturing activity. Emissions from methanol production are reported in the manufacturing sector in this report and in New Zealand's Greenhouse Gas Inventory.

Transformation Industries: includes emissions from fuels combusted by energy-producing industries during conversion processes, e.g. petroleum refining, synthetic petrol production, and oil and gas extraction and processing.

Other: includes primary industries (agriculture, forestry and fishing), commercial and residential.

Fugitive: includes emissions which arise from the production, processing, transmission and storage of fuels, from non-productive combustion, and from geothermal electricity generation.

Voluntary Corporate Greenhouse Gas Emissions Reporting

Information and emissions factors for individuals and organisations wishing to calculate greenhouse gas emissions from their activities can be found in the Ministry for the Environment's publication Guidance for Voluntary Greenhouse Gas Reporting at: www.mfe.govt.nz/publications/climate/

Industrial Process Emissions

Industrial process emissions are those which arise from chemical reactions in which carbon dioxide is a by-product, rather than the result of fuel combustion. Examples of industrial processes in New Zealand include the production of iron, and steel, aluminium, hydrogen, cement, lime, urea and methanol.

Industrial process emissions are not included in this report, with the exception of emissions resulting from methanol production, which are reported as energy-related emissions in the manufacturing sector.

Data Revisions

New Zealand Energy Greenhouse Gas Emissions 2012 includes many small revisions to time series due to improvements in data collection and emission factors. These improvements are made in order to better align with IPCC guidelines and are often the result of Expert Review Team recommendations.

Revisions may be due to the inclusion of emissions that were not captured in past reports, such as waste oil combustion in the manufacturing sector or gas leakage at the point of consumption.

They may also be the result of more accurate country-specific or site-specific emission factors being developed, as has been the case for many geothermal electricity generation plants. As IPCC default emission factors are generally conservative, establishing a local emission factor normally results in a decrease in calculated emissions.

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