Perth & Kinross Council

June 2008

Climate Change Implications of the Draft Air Quality Action Plan

PERTH & KINROSS COUNCIL

The Environment Service

Executive Summary

Air quality and climate change issues require national, regional and local governments to take action to curb emissions. Co-ordinated actions are required to be taken at all levels of government in order for the UK to achieve national and international air quality standards and emissions reduction targets to reduce local and global impacts.

Perth & Kinross Council have assessed air pollution levels in the Council area in the context of the Review and Assessment process and found the need to declare an AQMA and develop an Air Quality Action Plan including an assessment of the likely actions to be taken to reduce air pollution levels in terms of air quality. One of the concerns of Perth & Kinross Council is the effect of the proposed Air Quality Action Plan on greenhouse gas emissions. As a result, AEA Energy & Environment was commissioned to undertake a study in terms of the effect of the Air Quality Action Plan on greenhouse gas emissions (GHG) for the whole of the Perth & Kinross Council area, rather than just the AQMA area and to also consider other forms of mitigation, for the Perth and Kinross area as a whole.

This document is derived from a wider greenhouse gas study for Perth and Kinross carried out by AEA Energy and Environment[1]. The subject matter most pertinent to the Draft AQAP is presented below. Where necessary, and in the interests of conciseness, reference will be made to the main report throughout.

[1] *Perth and Kinross Greenhouse Gas Emissions Study (2007), AEA Energy and Environment*


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1 Introduction

1.1 Climate Change and Air Quality

Climate change is a global problem and the IPCC (Intergovernmental Panel on Climate Change, 2001) predicts an average global rise in temperature of 1.4°C to 5.8°C between 1990 and 2100. Increased emissions of methane (CH_4), nitrogen oxides (NO_x), sulphates, halocarbons (CFC's) and aerosol particles all contribute to climate change, but levels of CO_2 has by far the greatest effect. The atmospheric levels of CO_2 have increased by an unprecedented 31% since 1750, and current levels are higher than those recorded in the last 20 million years (IPCC, 2001).

To address climate change the UNFCC (United Nations Framework on Climate Change) developed the Kyoto Protocol and 156 countries pledged to reduce their global greenhouse gas emissions by 5% (compared to 1990 levels) by 2010. Under this protocol greenhouse gas emissions will be cut by 8% in the EU and by 12.5% in the UK by 2012. The UK has signed and ratified the Kyoto Protocol, which commits the UK to a reduction in annual emissions of the 6 main greenhouse gases of 12.5% from 1990 levels by 2008-2012. The UK also has a domestic target for CO_2 of 20% reduction from 1990 levels by 2010. All local and regional governmental bodies are being encouraged to act to help achieve these targets.

Part IV of the Environment Act 1995 introduced new responsibilities for Local Authorities relating to Local Air Quality Management (LAQM). The Act also laid the foundations for a policy that eventually led to the publication of the National Air Quality Strategy in March 1997. The newly elected Government later that year endorsed the Strategy, but committed to review it at the earliest opportunity. The second edition, The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, was published in January 2000 (DETR, 2000a), which accounted for the devolved administration in a joint approach with common objectives but allowing for different policies of implementation. An Addendum to the Strategy was published in February 2003, which tightened the Objectives for particles, introduced variations in Objectives for carbon monoxide and benzene, and initiated an Objective for polycyclic aromatic hydrocarbons ('PAH') in line with EU Daughter Directives (DEFRA, 2003a). Under the Strategy all Local Authorities have to undertake a formal Review and Assessment of air quality within their areas of jurisdiction to determine the likelihood of compliance with health-based Objectives by the end of the relevant target year. If any pollutant concentrations were predicted to exceed the relevant Objective, this should lead to the designation of an Air Quality Management Area (AQMA), and an Air Quality Action Plan to address the elevated pollutant levels has to be prepared.

As such, Climate Change and Air Quality issues are putting increasing pressure on national, regional and local governments. Action to curb emissions of all pollutants has to be taken at all levels of government in order for the UK to achieve national and international targets and to reduce local and global impacts.

Perth & Kinross Council have assessed air pollution levels in the Council area in the context of the Review and Assessment process and found the need to declare an AQMA and develop an Air Quality Action Plan including an assessment of the likely actions to be taken to reduce air pollution levels in terms of air quality. One of the concerns of Perth & Kinross Council is the effect of the proposed Air Quality Action Plan on greenhouse gas emissions. As a result, AEA Energy & Environment was commissioned to undertake a study in terms of the effect of the Air Quality

Action Plan on greenhouse gas emissions (GHG) and to also consider other forms of mitigation, for the Perth and Kinross area as a whole, rather than just the AQMA which covers Perth.

2 Scotland's Climate Change Policy

In 2006, the Scottish Executive set out its climate change strategy, entitled *Changing Our Ways: Scotland's Climate Change Programme*. The total annual greenhouse gas emissions for Scotland are 17.6 Mt C (mega tonnes of carbon) which equates to 64.5 Mt CO_2 (mega tonnes of carbon dioxide). The Scottish Executive has calculated 'the Scottish Share', the amount of carbon savings that Scotland has to deliver through its devolved policies to match savings from all devolved policies in the UK Climate Change Programme, on a per capita basis. The Scottish share is a saving of 1.7 Mt C or 6.2 Mt CO_2 on annual emissions in 1990.

The Scottish target is to exceed the Scottish share by 1 Mt C or 3.7 Mt CO_2 by 2010; in other words, a saving of 2.7 Mt C or 9.9 Mt CO_2. Unlike the UK Kyoto target, this is not a legal target, but it provides a means of benchmarking the effectiveness of the Executive policies against devolved policies across the UK. A breakdown of emissions by sector for Scotland is shown in Table 2.1.

Table 2.1: ***Breakdown of Scottish Emissions by Sector in 2003 and Change Since 1990 Source: Scottish Executive (2006); data from Netcen (AEA Technology)***

Sector	2003 Emissions and Removals (MtC)	1990 Emissions and Removals (MtC)	1990-2003 Change in Emissions and Removals (MtC)	1990-2003 % Change
Energy	6.53	6.33	0.2	3%
Transport	2.99	2.82	0.18	6%
Business *(includes industrial processes)*	2.18	3.7	-1.52	-41%
Agriculture	2.07	2.44	-0.37	-15%
Residential	1.99	1.94	0.05	2%
LUCF Emissions	1.41	1.45	-0.04	-3%
Public	0.27	0.52	-0.25	-48%
Waste	0.2	0.4	-0.2	51%
Total *(excluding removals)*	**17.64**	**19.59**	**-1.95**	**-10%**
LUCF Removals	-2.75	-2.28	-0.46	20%
Total Net Emissions	**14.89**	**17.31**	**-2.41**	**-14%**

Scotland's Climate Change Programme makes clear that efforts to respond to climate change, whether they relate to mitigation (reduction in greenhouse gas emissions) or adaptation (management of the impacts of climate change) require the involvement and participation of all sectors.

However, for many sectors, particularly energy, built environment, transport and waste, policies have been put in place to mitigate the effects of climate for some time. *Scotland's Climate Change*

Programme is, therefore, a collation and synthesis of existing climate change related policies across a range of sectors. In the next section, we look at the implications of the key emission reduction policies by sector for Local Authorities, referencing sector strategies where appropriate.

Many national plans, policies and programmes now consider climate change and offer options for sectoral mitigation and adaptation; these are discussed in the main report.

Local Authorities have been setting their own climate change policy over recent years. A number have been working with the Carbon Trust to develop Local Authority carbon management strategies. These tend to focus on a Local Authority's own greenhouse gas emissions, rather than the emissions of the community it serves. Some of the more developed strategies contain greenhouse gas emission reduction targets and associated indicators. However, until now there has been no co-ordinated effort across Scotland.

That situation has recently changed. At the end of 2006, the Scottish Declaration was launched. The Scottish Declaration is a voluntary declaration made by Local Authorities to take action on climate change.

The Declaration represents a substantially larger commitment to address the climate change issue by Local Authorities than required by national climate change policy. Incorporating climate change into decision-making requires access to a wide range of high quality data and an understanding of climate change issues across many service areas. This represents a major challenge for many Local Authorities, and (we suspect) one that many Local Authorities have not yet understood themselves.

2.1 Strategic Response of Perth and Kinross to Policy Developments

To date, climate change has received relatively little attention in key Council plans and strategies.

The Corporate Plan 2007/10: Securing the Future sets out an objective that could be relevant to climate change, namely to develop *"a prosperous, sustainable and inclusive economy"*. However, there is no mention of climate change here or in any other part of the plan.

The environment is one of the five strategic priorities under the Community Plan. Here, climate change is addressed directly. The Council has committed to work towards reducing energy consumption and CO_2 emissions by 10%.

The Structure Plan provides a spatial framework for transport, air and water quality, energy and waste management strategies: *"While it concentrates on land use matters, the Plan recognises that policies for physical development have an important bearing on other matters. The Plan influences the location, form and extent of development, which generates demand for and responds to transport infrastructure. These in turn have major influences on resources management, energy use and emissions of greenhouse gases."*

The strategic objectives in the Structure Plan that relate to climate change mitigation cut across various corporate policies that support and manage population growth whilst enhancing the quality of life; that promote social inclusion; and that protect and enhance the environment.

The Joint Environment Strategy and Action Plan mentions energy as one of its four key priorities for action, although objectives relate to the partners to the Community Plan and not to the wider community. The Action Plan indicates that resources available to tackle greenhouse gas emissions are limited.

Climate change is an issue that is clearly on the agenda at Perth & Kinross Council. We recognise the significant progress the Council has made in addressing its own GHG emissions, through a comprehensive inventory of organisational emissions and its commitment to carbon management. However, there is little evidence of joined up action to tackle climate change. Now that the Council has signed up to the Scottish Declaration, there is a clear incentive to develop a strategic approach to climate change mitigation across the area. One key way to focus joined up action to tackle climate change is to produce a detailed emissions inventory covering all source sectors.

3 Background to the Inventory

A greenhouse gas inventory for the Perth and Kinross Local Authority area has been prepared. Such an inventory is invaluable as a basis to evaluate emission reduction options and set realistic targets for both climate change and air quality. Furthermore such inventories can be used as an important tool to engage with stakeholders and to identify emission reduction goals and to publicise emissions and achievable reductions. Full discussion of the methodology employed in producing the inventory is provided in the main report. However, It is useful to identify what is meant by a GHG inventory, the pollutants of interest and sources of data that could be used to produce an inventory.

3.1 Greenhouse Gases

Greenhouse gases (GHGs) are components of the atmosphere that contribute to the greenhouse effect. Some GHGs occur naturally in the atmosphere, while others results from human activities. The key Kyoto GHGs are:

- *Carbon Dioxide (CO_2);*
- *Methane (CH_4);*
- *Nitrous Oxide (N_2O);*
- *Hydrofluorocarbons (HFCs);*
- *Perfluorocarbons (PFCs); and*
- *Sulphur Hexafluoride (SF_6).*

Of the above greenhouse gases, CO_2, CH_4 and N_2O are naturally occurring in the atmosphere although industry has dramatically increased their atmospheric concentrations over the last 100 years. In contrast, HFCs, PFCs and SF_6 gases are exclusively man made and appear in lesser concentrations in the atmosphere. The ability of each of the 6 greenhouse gases listed above to cause global warming can be quantified using their Global Warming Potential (GWP). This is a relative scale that compares the global warming effect of the chosen gas to the global warming effect the same mass of carbon dioxide would have over a certain period of time. By definition, the global warming potential of carbon dioxide is one, and Table 3.1 shows the global warming potential of the other GHG included in this report. Analysis of the GWP of the 6 gases shows the man made pollutants to have a far greater global warming potential. However in reality CO_2, CH_4 and N_2O pose the far greatest threat to the climate as these occur in greater concentrations in the atmosphere.

Table 3.1: ***GWP of Greenhouse Gases on a 100-Year Horizon Used in the UK Greenhouse Gas Inventory***

Gas	GWP
Carbon Dioxide	1
Methane	21
Nitrous Oxide	310

Gas	GWP
Hydrofluorocarbons	140-11,700
Perfluorocarbons	6,500-9200
Sulphur Hexafluoride	23,900

3.2 Emission Sources Covered by the Inventory

The emissions inventory for Perth and Kinross details emissions of the 6 Kyoto greenhouse gases listed above for identifiable sources in the area. The emission sources are presented, via a geographical information system (GIS), in three broad categories:

- *Stationary point sources - for industrial regulated plants;*
- *Mobile line sources - related to road, and;*
- *Area sources - other influential sources, such as combustion, which are often related to population and are not specifically resolved as point or line representations.*

It should be noted that in this 2004 emission inventory that emissions from power stations are mapped by end-user rather than source. This is particularly important for Perth and Kinross as the region is an exporter of energy and assigning emissions of power stations at source would produce uncharacteristically high emissions per head of population.

3.3 Summary of Sources

The Perth and Kinross GHG emissions inventory is based on data from a variety of sources. Perth & Kinross Council provided data for point source emissions and shipping emissions. Road transport emissions were compiled using data from the DfT, SiAS traffic consultants and Perth & Kinross Council. Errol Brickworks provided emissions data and Scone Airport provided information on take-offs and landings. All other emissions were taken the NAEI (2004) database, with some amendments for areas such as fuel split for combustion.

A summary of the data sources for the different pollutant sectors is shown in Table 3.2 below.

Table 3.2: ***Summary of Pollutant Groups and Data Sources***

Source Sectors	Data Source
Point Source Emissions	Perth & Kinross Council, Errol Brickworks
Combustion	NAEI (2004) and Perth & Kinross Council
Road Transport Emissions	DfT (2004), SiAS, Perth & Kinross Council, NAEI (2004)
Other Transport Emissions	NAEI & Perth & Kinross Council, Scone Airport
Agriculture & Nature	NAEI (2004)
Waste Treatment & Disposal	NAEI (2004)

4 Results of the Inventory

Emissions estimates for the 2004 baseline emissions inventory for Perth and Kinross are given below and compared with data from the NAEI where applicable. All emissions are shown in tonnes per annum unless otherwise stated.

4.1 Point Source Emissions

Greenhouse gas emissions of CO_2, CH_4 and N_2O from the 2 relevant industrial processes as estimated for 2004 are shown in Table 4.1. Emissions from the energy sector as distributed by end-user are also presented. It should be noted that Part A landfill processes are included with SNAP code 09 emissions.

Table 4.1: *Greenhouse Gas Emissions From Point Sources and the Energy Sector in 2004 in Tonnes/Year*

Pollutant	Part A	Part B	Electricity Consumption	Total
CO_2 (as C)	1,110.82	0.0026	108,489.53	109,600.35
CH_4	-	-	12.42	12.42
N_2O	-	-	3.40	3.40

There are only 2 industrial processes with significant GHG emissions reflecting the largely rural nature of the Perth and Kinross area. Emissions of CO_2 from Part A and B processes are only a small part of the region's total GHG emissions.

Table 4.2 shows emissions from the energy sector as distributed by source (electricity generation) and by end-user (electricity consumption) in tonnes/year. Although the Perth and Kinross region has 2 power stations these produce relatively few emissions in comparison to emissions when calculated by end-user. This highlights the difference between distributing energy sector emissions by electricity consumption and by electricity generation.

Table 4.2: *Comparison of Emissions From the Energy Sector by Source (Electricity Generation) and by End-User (Electricity Consumption) in 2004 in Tonnes/Year*

Pollutant	Electricity Generation	Electricity Consumption
CO_2 (as C)	13,445.45	108,489.53
CH_4	0.06	12.42
N_2O	0.00	3.40

4.2 Road Transport

Emissions of CO_2, CH_4 and N_2O from road transport during 2004 were calculated by fuel type and vehicle type for this inventory. These are presented in Tables 4.3 (CO_2), 4.4 (CH_4) and 4.5 (N_2O), and summarised in Table 4.6. Emissions for road transport as estimated by the NAEI (2004) are also given in Table 4.6 for comparison and to validate methodologies.

Table 4.3: *Road Transport Emissions of CO_2 (as C) by Fuel Type and Vehicle Type in 2004 in Tonnes/Year*

	Petrol		Diesel				
	Car	LGV	Car	LGV	HGV	Bus	Total
Motorway & A Roads	45,538.67	1,325.41	7,746.42	9,461.91	50,250.97	1,821.08	**116,144.45**
B Roads & C Roads	2,584.05	65.95	429.89	449.23	837.51	89.11	**4,455.75**
AQMA Roads	15,950.21	415.52	2,670.01	2,897.80	5,992.95	2,442.77	**30,369.25**
Minor Roads	18,467.07	494.98	3,158.13	3,496.57	3,755.86	1,480.69	**30,853.30**
Total	**82,540.00**	**2,301.86**	**14,004.45**	**16,305.50**	**60,837.29**	**5,833.66**	**181,822.75**

Table 4.4: *Road Transport Emissions of CH_4 by Fuel Type and Vehicle Type in 2004 in Tonnes/Year*

	Petrol		Diesel				
	Car	LGV	Car	LGV	HGV	Bus	Total
Motorway & A Roads	11.73	0.39	0.77	0.40	9.19	0.35	**22.82**
B Roads & C Roads	0.67	0.02	0.03	0.02	0.12	0.02	**0.89**
AQMA Roads	7.89	0.20	0.21	0.10	1.49	1.07	**10.95**
Minor Roads	11.37	0.28	0.20	0.12	0.83	0.41	**13.22**
Total	**31.67**	**0.89**	**1.21**	**0.64**	**11.63**	**1.84**	**47.89**

Table 4.5: *Road Transport Emissions of N_2O by Fuel Type and Vehicle Type in 2004 in Tonnes/Year*

	Petrol		Diesel				
	Car	LGV	Car	LGV	HGV	Bus	Total
Motorway & A Roads	166.30	4.67	6.75	15.22	121.60	5.21	**319.75**
B Roads & C Roads	9.98	0.25	0.42	0.84	2.13	0.27	**13.89**
AQMA Roads	84.31	2.38	4.24	5.89	21.56	12.11	**130.50**
Minor Roads	105.72	3.06	5.29	7.18	12.64	5.98	**139.88**
Total	**366.31**	**10.37**	**16.71**	**29.13**	**157.93**	**23.57**	**604.02**

Table 4.6: ***Summary of Road Transport Emissions as Calculated by this Inventory, and the NAEI (2004) in Tonnes/Year***

Pollutant	Major Roads*	Minor Roads	Total	NAEI 04 Total
CO_2 (as C)	150,969.45	30,853.30	181,822.75	165,562.56
CH_4	34.67	13.22	47.89	42.99
N_2O	464.14	139.88	604.02	78.78

** Major Roads includes motorways, A, B and C roads, and AQMA roads*

Comparison of the emissions by vehicle type shows petrol cars and HGV's are the 2 greatest sources of CO_2, CH_4 and N_2O. This is probably because petrol cars occur in the greatest quantity on the roads (~70% of fleet split) whereas HGVs although present in lesser quantities (~3% of fleet split) produce more emissions per unit.

It should be noted that the transport emissions tables above relate to the whole of Perth and Kinross, whereas the AQAP relates only to air quality within Perth itself.

4.3 Other Transport Sources

Emissions of CO_2, CH_4 and N_2O from other transport sources were estimated for the Perth and Kinross area. Local data were used to estimate shipping and aviation emissions and other transport including rail and off-road vehicle sources are included in the NAEI totals (2004) for SNAP code 08. These emissions are presented in Table 4.7. It should be noted that emissions from Scone Airport are not currently included in NAEI (2004) estimates for SNAP code 08.

Table 4.7: ***Emissions From Other Transport in 2004, in Tonnes/Year***

Pollutant	Shipping	Scone Airport*	NAEI (2004) Total Other Transport	NAEI (2004) Total and Scone Airport
CO_2 (as C)	10,724.16	29,732.01	49,699.78	79,431.79
CH_4	3.55	74.50	9.19	83.69
N_2O	2.47	3.40	32.60	36.00

* *Not included in the NAEI at the moment*

The shipping sector currently accounts for 14%, 4% and 7% of the total other transport (including Scone Airport) emissions of CO_2, CH_4 and N_2O respectively. In contrast, Scone Airport provides 37%, 89%, 9% of emissions of CO_2, CH_4 and N_2O. Thus by deduction, the rail and off-road source sectors emit the remaining 49%, 7% and 84% of CO_2, CH_4 and N_2O. Rail is likely to account for the majority of these emissions and bottom-up methodology should be used to determine these emissions in any future inventory updates.

4.4 Combustion

Emissions of CO_2, CH_4 and N_2O from combustion were calculated using data on fuel consumption and emissions factors available from the NAEI (2004). Emissions are presented by fuel type and source sector in Table 4.8 (CO_2), Table 4.9 (CH_4), and Table 4.10 (N_2O). Table 4.11 summarises combustion emissions and compares total combustion as calculated by this inventory with that estimated by the NAEI (2004) in SNAP code 02. The NAEI SNAP code 02 total was determined using top-down methodology whereby total UK emissions from combustion have been spatially disaggregated using a relevant statistic. Table 4.12 compares the domestic fuel split as dictated by the NAEI (2004) with data provided by Perth and Kinross.

Table 4.8: ***Emissions of CO_2 (as C) From Combustion by Fuel Type and Source Sector in 2004, in Tonnes/Year***

	Domestic	Public Sector	Light Industry & Commercial	Combustion in Agriculture
LPG	397.77	-	-	-
Oil	10,512.34	637.26	24,236.72	1,583.51
Natural Gas	38,849.98	2550.54	42.09	0.07
Coal	3,890.77	23.06	10.10	12.63
Anthracite	1,346.87	-	-	-
Straw	-	-	-	-
Total	**54,997.73**	**3210.86**	**24,288.91**	**1,596.20**

Table 4.9: ***Emissions of CH_4 From Combustion by Fuel Type and Source Sector in 2004, in Tonnes/Year***

	Domestic	Public Sector	Light Industry & Commercial	Combustion in Agriculture
LPG	0.02	-	-	-
Oil	3.78	0.069	1.17	0.2236
Natural Gas	7.48	0.657	0.0108	-
Coal	87.93	0.0003	0.0002	0.0002
Anthracite	3.29	-	-	-
Straw	-	-	-	0.3471
Total	**102.50**	**0.73**	**1.18**	**0.57**

Table 4.10: *Emissions of N_2O From Combustion by Fuel Type and Source Sector in 2004, in Tonnes/Year*

	Domestic	Public Sector	Light Industry & Commercial	Combustion in Agriculture
LPG	0.0022	-	-	-
Oil	0.32	0.022	0.0129	0.0010
Natural Gas	0.25	248.42	0.1008	0.0046
Coal	0.67	0.023	0.0027	0.0041
Anthracite	0.23	-	-	-
Straw	-	-	-	0.0931
Total	**1.47**	**248.46**	**0.12**	**0.10**

Tables 4.8 to 4.10 show that the domestic and light industry/commercial source sectors produce the greatest emissions for CO_2, CH_4 and N_2O.

Table 4.11: *Summary of Emissions of CO_2, CH_4 and N_2O From Domestic and Other Combustion Processes and the NAEI Total for Combustion in Tonnes/Year*

Pollutant	Domestic Combustion	Other Combustion	2004 Inventory Combustion Total	NAEI Total (2004)
CO_2 (as C)	54,997.73	29,095.98	81,118.90	66,273.75
CH_4	102.50	2.48	104.28	147.63
N_2O	1.47	248.68	1.75	1.94

4.5 Data from NAEI

Emissions of CO_2, CH_4 and N_2O from all other sources including agriculture (SNAP code 10), nature (SNAP code 11) and waste treatment (SNAP code 09) were taken directly from the NAEI database (2004). These are shown in Table 4.12. It should be noted that emissions from landfill (regulated as a Part A process) are included with emissions from waste treatment and disposal.

Table 4.12: *Summary of Emissions Taken Directly From the NAEI*

Pollutant	Agriculture	Nature	Waste Treatment & Disposal
CO_2 (as C)	4,354.00	42,314.02	112.60
CH_4	7,050.10	12.46	863.38
N_2O	975.46	0.00	7.81

Emissions estimates show the agriculture and nature sectors to be a significant source of CO_2. Agriculture is also a significant source of CH_4; the majority of these emissions probably originate from cattle farming. CH_4 is also the greatest GHG by-product from the waste treatment sector as CH_4 is produced at landfill sites during the fermentation of organic matter. Emissions of N_2O are most pertinent from agriculture where N_2O is produced as part of the nitrogen cycle.

4.6 F-Gases

F-Gases (HFCs, PFCs and SF_6) do not occur naturally in the environment and unlike CO_2, CH_4 and N_2O are only emitted from anthropogenic processes. As data enabling the estimation of F-Gas emissions are scarce a top-down methodology has been applied to calculate emissions using data held within the NAEI (2004). Table 4.13 provides a summary of the sources of F-Gases in Scotland in 2004. The data shows PFCs and SF_6 are only produced by industry (eg aluminium processing, electronics) the type of which is not present in the Perth and Kinross region. Thus, these F-Gases are not emitted from the study area and the total emissions of PFCs and SF_6 in the study area are zero.

Table 4.13: ***Sources and Emissions of F-Gases in Scotland in 2004 (NAEI, 2004) Emissions are shown in ktonnes of carbon dioxide equivalent***

Source Sector	HFC	PFC	SF_6
Business	500.07	-	-
Industrial Processes	-	75.08	59.22
Residential	219.46	-	-
Total	**719.53**	**75.08**	**59.22**

Concerning HFCs, these are released from business and residential sources. A further break down of these sectors is provided by Table 4.14. Emissions for Scotland were taken from the NAEI database (2004) whereas those for the Perth and Kinross region were estimated using national population (for all source sectors except mobile air conditioning) and vehicle kilometre (for mobile air conditioning) statistics. The data shows mobile air-conditioning units in cars to be the greatest source of HFCs in the study area followed by home and supermarket refrigeration.

Table 4.14: ***Breakdown of Sources of HFCs in Scotland (NAEI, 2004) and Perth and Kinross (as estimated using national statistics)***
Emissions are shown in ktonnes of carbon dioxide equivalent

Source Sector	Scotland	Perth and Kinross
Mobile Air Conditioning	114.03	9.51
Refrigeration	130.96	5.07
Supermarket Refrigeration	175.18	6.78
Foams	43.21	1.67
Fire Fighting	24.73	0.96
Aerosols - Halocarbons	98.07	3.80
Metered Dose Inhalers	121.39	4.70
Precision Cleaning	2.84	0.11
One Component Foams	9.12	0.35
Total	**719.53**	**32.96**

4.7 Emission Totals

The total emissions from all source sectors in Perth and Kinross as calculated in this inventory (2004) are summarised below per source sector in Table 4.15. Detailed 1km squared data is available for each of the source sectors listed below to enable easy scenario testing based on fuel use consumption statistics. Summary 1km area plots are also presented for CO_2 and GWP for Total Emissions, Total Energy Sector Emissions (combustion plus electricity consumption) and Total Road only emissions in Appendix 1. This data has been used as the basis of the future year estimates. In addition the global warming potential (GWP) has also been calculated to allow easy comparisons for the GHG impact of each sector. To qualitatively address the uncertainty involved in calculating these results each emissions total has been rated according to the definitions below:

1. *High quality estimate based on real emissions or activity data at known locations.*
2. *Good quality estimate based on mostly real emissions or activity data at known locations and some modelled emissions.*
3. *Medium quality estimate based on mostly modelled emissions using appropriate surrogate statistics.*
4. *Low quality estimate based on surrogate statistics that may not be fully appropriate for this sector.*

Detailed 1 by 1 km grid square data is also available for each of the source sectors and scenarios listed below. Maps showing CO_2 emissions and GWP resolute to 1km are also presented in Appendix 1 for both total emissions and those pertaining to road transport. This data has been used as the basis of the future year estimates.

Table 4.15: ***Total GHG emissions in tonnes per year for 2004***

Source	CO_2 as C	CO_2 as CO_2	N_2O	CH_4	HFC	GWP	Uncertainty Rating
Shipping & Aviation	40,456	148,339	6	78	0	151,798	3
Electricity Domestic Consumption	53,578	196,454	2	6	0	197,103	2
Electricity Other Consumption	54,911	201,341	2	6	0	202,006	2
Nature	42,314	155,151	0	12	0	155,413	4
Agriculture	4,354	15,965	975	7,050	0	466,409	4
Waste	113	413	8	73	0	4,373	1
Waste Landfill	0	0	0	790	0	16,592	4
Domestic LPG	398	1,458	0	0	0	1,460	3
Domestic Oil	10,512	38,545	0	4	0	38,725	3
Domestic Gas	38,850	142,450	0	7	0	142,684	2
Domestic Coal	3,891	14,266	1	88	0	16,319	3
Domestic Anthracite	1,347	4,939	0	3	0	5,079	3
Industrial Gas	42	154	0	0	0	186	2
Industrial Oil	2,4237	88,868	0	1	0	88,897	2
Industrial Coal	10	37	0	0	0	38	2
Agricultural Coal	13	46	0	0	0	48	4
Agricultural Straw	0	0	0	0	0	36	4
Agricultural Oil	1,584	5,806	0	0	0	5,811	3
Agricultural Gas	0	0	0	0	0	2	2
Public Sector Oil	637	2,337	0	0	0	2,345	3
Public Sector Gas	2,551	9,352	248	1	0	86,375	2
Public Sector Coal	23	85	0	0	0	92	3
Part A and B Industrial Processes	1,111	4,074	0	0	0	4,074	1
Air Conditioning in Vehicles	0	0	0	0	9,515	9,515	4
Other F-Gases	0	0	0	0	23,447	23,447	4
Other Transport Not Listed	38,976	142,911	30	6	0	152,372	4
Minor Roads Petrol Cars	37,001	135,672	200	20	0	198,093	3
Minor Roads Diesel Cars	6,258	22,946	10	0	0	26,043	3

(Continued)

Source	CO_2 as C	CO_2 as CO_2	N_2O	CH_4	HFC	GWP	Uncertainty Rating
Minor Roads Petrol LGV	976	3,580	6	1	0	5,357	3
Minor Roads Diesel LGV	6,844	25,093	14	0	0	29,409	3
Minor Roads HGV	10,586	38,817	36	2	0	50,131	3
Minor Roads Bus	4,013	14,713	18	1	0	20,437	3
Motorway & A Roads Petrol Cars	45,539	166,975	166	12	0	218,776	2
Motorway & A Roads Diesel Cars	7,746	28,404	7	1	0	30,512	2
Motorway & A Roads Petrol LGV	1,325	4,860	5	0	0	6,316	2
Motorway & A Roads Diesel LGV	9,462	34,694	15	0	0	39,420	2
Motorway & A Roads HGV	50,251	184,254	122	9	0	222,141	2
Motorway & A Roads Bus	1,821	6,677	5	0	0	8,299	2
Roads Sub Total	**181,823**	**666,683**	**604**	**48**	**9,515**	**864,450**	-
Total	**501,729**	**1,839,674**	**1,877**	**8,175**	**32,961**	**2,626,132**	-

The above emissions have been calculated using a predominantly bottom-up methodology and are compared with the NAEI database for 2004 in Table 4.16. Emissions of CH_4 and N_2O are given in tonnes whereas emissions of HFCs, PFCs and SF_6 are given in tonnes of carbon dioxide equivalent. It should be noted that emissions from the NAEI (2004) *do not* include those produced by the 2 power stations within the region. These appear to have been included with emissions totals from a neighbouring Local Authority. However, emissions as estimated by this inventory include electricity consumption within the region. Furthermore totals estimated by this inventory used most locally relevant data and are thus believed to be more representative of actual emissions.

Table 4.16: ***Emission Totals of all GHGs in 2004 Emissions of CH_4 and N_2O are in Tonnes, Emissions of CO_2, HFCs, PFCs and SF_6 in Tonnes of Carbon Equivalent***

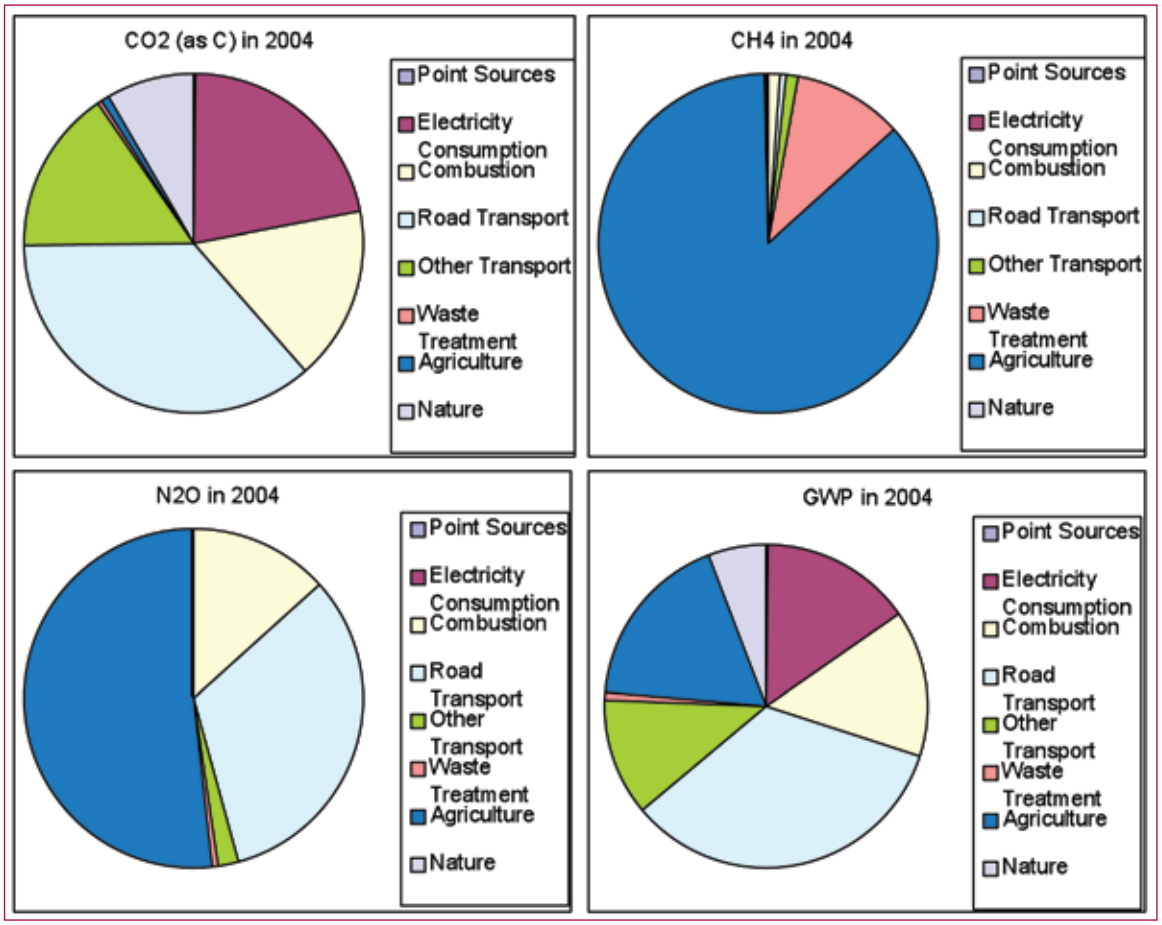
Pollutant	Inventory 2004	NAEI 2004
CO_2 (as C)	501,729	354,381
CO_2 (as CO_2)	1,839,674	1,299,397
CH_4	8,175	7,866
N_2O	1,877	1,182
HFC	32,961	32,961
PFC	-	-
SF_6	-	-

Comparison of estimates made by this 2004 inventory with those made by the NAEI (2004) reveals end totals of CO_2, CH_4 and N_2O of similar magnitude, thus validating the bottom-up methodologies used by this inventory. Estimates of CO_2, CH_4 and N_2O made by the Perth and Kinross Inventory are slightly greater than those generated by the NAEI (2004) reflecting the inclusion of electricity consumption by end-user. Furthermore higher emissions of CO_2 as calculated by this inventory may be attributed to slightly higher emissions from the road transport and combustion sectors (a result of using local data) and also the inclusion of Scone Airport in this inventory (but not within the NAEI). As discussed in Section 4.2, the bottom-up methodology of this inventory estimates far greater emissions of N_2O from road transport and this accounts for the majority of the difference between the 2 totals of N_2O. As HFC was taken directly from the NAEI there is no comparison.

4.8 Source Contributions

Figure 4.1 shows the estimated relative contribution made by each source sector to total emissions. The emission sources have been grouped into 7 categories based on the SNAP codes used by the NAEI.

Figure 4.1: ***Relative Contributions Made by Each Source Sector for CO_2, CH_4, N_2O and GWP in 2004***



Analysis of source contribution reveals that electricity consumption, road transport, other transport and combustion sectors account for 80% of CO_2 emissions. Transport produces over half of CO_2 emissions. In contrast, emissions of CH_4 originate predominantly from agriculture, probably

cattle farming although there is a significant contribution from waste treatment and disposal. CH_4 is produced at landfill sites during the fermentation of organic matter. Emissions of N_2O are dominated by the road transport and agriculture sectors. N_2O is emitted from vehicle exhausts and also produced within the nitrogen cycle. In terms of the GWP the majority is similar to CO_2 in that 33% comes from road transport, followed by a combined 30% energy usage from combustion and electricity consumption.

5 Measures to Reduce Emissions

For the purposes of this report, we consider current and potential initiatives in the Perth and Kinross area which directly relate to the AQAP. The AQAP represents PKC's response to the declaration of an AQMA in Perth and presents a set of options for improving air quality in the city. The plan primarily relates to reduction of emissions from road traffic therefore transportation options that are common to both climate change and air pollution mitigation are presented below.

Full discussion of wider climate change mitigation options for Perth and Kinross, and the process by which they were selected is provided in the full report.

5.1 Method for Assessing Initiatives in Perth and Kinross

The emission reduction initiatives on which we focus have two attributes:

- *they are initiatives over which the Council has some degree of influence, and;*
- *they relate to the whole of the Perth and Kinross area.*

Note that we have ignored in-house actions as these fall within the remit of the Council's carbon management activities. However, there may be some overlap between the initiatives mentioned and carbon management.

The results of the analysis are presented in tabular form (see Tables 5.1 and 5.2). The headings used in the tables are explained in more detail below. Where possible, we have used a similar scoring method to that which was used in the options analysis for the air quality study.

5.1.1 Status

Various initiatives were discussed, including those that are still 'just an idea'. The latter are described as 'possible'. Initiatives that are 'planned' are those to which the Council has committed, or is in the process of putting in place. 'Ongoing' initiatives include those that are current or already completed.

5.1.2 Influence of Council Over Initiative

The scores here (high/medium/low) are based on our assessment of the influence the Council has in the process of delivering the initiative.

Cost of Initiative to Perth & Kinross Council

The scoring system is explained below:

Symbol	Cost/Year Range
£	£0-30,000 (eg for small surveys or campaigns, changes in procedures, policies or systems, or other options)
££	£30,000-60,000 (eg for bigger campaigns, or for a full time officer)

Symbol	Cost/Year Range
£££	£60,000-200,000 (eg for small traffic management schemes)
££££	£200,000+ (eg for new infrastructure)

Annual CO_2 Emission

This is an estimate of the annual emission of greenhouse gases in CO_2 equivalents (the GWP). We have used our own knowledge of emissions from different sources and produced scores based on quick calculations using standard emission factors. Key starting assumptions are described in the 'explanation' columns. Initiatives that affect CO_2 emissions by less than +/- 10 tonnes of CO_2 are not included.

The scoring system is explained below:

Increase	Quantity of CO_2	Decrease
▲	10 to 100 tonnes CO_2/yr	▽
▲▲	100 to 1,000 tonnes CO_2/yr	▽▽
▲▲▲	1,000 to10,000 tonnes CO_2/yr	▽▽▽

Cost Effectiveness

Cost-effectiveness is based on the combination of cost and carbon savings. We have taken the mid-point of the ranges and divided cost by carbon savings to produce a values in £/tonnes CO_2. Where the costs are in the range £0-10/tonnes CO_2, we have assigned a 'high' cost-effectiveness score; costs in the range £10-100/tonnes CO_2 are assigned a 'medium' score; and costs in the £100+/tonnes CO_2 range a 'low' score. We are only interested in the cost-effectiveness of emissions savings, so no score is given for initiatives that increase emissions.

The implications for the scoring are shown in Table 5.1 below:

All ▲	N/R	N/R	N/R	N/R
▽	Low	Low	Low	Low
▽▽	Medium	Medium	Low	Low
▽▽▽	High	High	Medium	Medium
▽▽▽▽	High	High	High	High
	£	**££**	**£££**	**££££**

Risk to Emissions Savings

Emission reduction initiatives are not without risks, and for this reason we have added a column describing events that could undermine the beneficial effects described.

Acceptability

A preliminary judgement is expressed on how acceptable each option might be to the Perth and Kinross community:

- ***Acceptable:*** *costs to and/or opposition from the community likely to be low;*
- ***Neutral:*** *some costs to and/or opposition from the community, but changes in line with Council policy;*
- ***Unacceptable:*** *costs to and/or opposition from the community likely to be high.*

Table 5.2: *Initiatives in Common with the Draft AQAP That Increase Greenhouse Gas Emissions*

Type of Initiative That Could Increase GHG Emissions	Status	Explanation	Influence of Council Over Initiative	Cost of Initiatives to Perth & Kinross Council	Annual CO_2 Emission	Acceptability
Planning						
New housing/ business development out of town	Ongoing	As the number of households and businesses increases, emissions associated with heating, lighting etc will also increase by 4-5 tCO_2/home/year. Developments outside greenbelt will increase average commuting distances to and from work and associated fuel emissions. Assumes a development comprises 25 houses.	High	£	▲▲	Neutral
New housing/ business development in town	Ongoing	As the number of households and businesses increases, emissions associated with heating, lighting etc will also increase by 4-5 tCO_2/home/year. Increasing population density inside green belt will reduce average commuting distances to and from work, but the savings are small in comparison with the increase in emissions from new homes. Assumes a development comprises 25 houses.	High	£	▲▲	Acceptable

Table 5.3: *Initiatives in Common with the Draft AQAP That Reduce Greenhouse Gas Emissions*

Type of Initiative That Could Reduce GHG Emissions	Status	Explanation	Influence of Council Over Initiative	Cost of Initiatives to Perth & Kinross Council	Annual CO_2 Saving	Cost-Effectiveness	Risk to Emission Savings	Acceptability
Transport								
New bridge over River Tay combined with city centre management to minimise car use	Planned	The bridge will divert through traffic around the city and reduce the volume of traffic within the city. A simultaneous increase in development of cycle and pedestrian routes, coupled with restrictions on travel would remove incentives to drive into town. Emissions savings should result from a reduction in number of stationary vehicles.	High	**£££**	▽▽	Low	With ineffective city centre traffic control, the number of vehicles may increase to match road capacity	Neutral
Increased frequency of quicker rail services to Edinburgh	Possible	Potential rail passengers are currently put off by the longer than acceptable commuting times and infrequent service.	Low	**£££**	▽▽▽	Medium	Access to station and parking limits increase in commuting	Acceptable
Multi-transport mode interchange at Perth railway station	Planned	An easy change-over between taxi, bicycle, bus and train will encourage more people to travel longer distances by public transport.	Medium	**£££**	▽▽	Low	The connectivity required for high level of usage may not be commercially viable without subsidy	Acceptable

Table 5.3: *Initiatives in Common with the Draft AQAP That Reduce Greenhouse Gas Emissions (continued)*

Type of Initiative That Could Reduce GHG Emissions	Status	Explanation	Influence of Council Over Initiative	Cost of Initiatives to Perth & Kinross Council	Annual CO_2 Saving	Cost-Effective-ness	Risk to Emission Savings	Acceptability
Transport								
Increased number of bus routes and frequency of services	Ongoing	Many rural destinations are poorly served by buses. An increased frequency of service may encourage some onto the buses.	Medium	££	▽▽	Medium	Empty buses may cause more pollution than cars	Neutral
Provide new long distance links between towns/ cities	Ongoing	Perth-Oban and Aberfeldy-Killin links provide new opportunities for long distance travel on public transport and will encourage car-free tourism.	Medium	££	▽	Low	Empty buses may cause more pollution than cars	Acceptable
Higher fuel efficiency specifications for buses on non-commercial routes	Possible	Some of the private buses in service are old and not the most fuel-efficient models.	High	£	▽	Low	Costs of replacement with newer models could be passed on to the Council	Acceptable

Table 5.3: *Initiatives in Common with the Draft AQAP That Reduce Greenhouse Gas Emissions (continued)*

Type of Initiative That Could Reduce GHG Emissions	Status	Explanation	Influence of Council Over Initiative	Cost of Initiatives to Perth & Kinross Council	Annual CO_2 Saving	Cost-Effective-ness	Risk to Emission Savings	Acceptability
Transport								
Increased information on public transport options and promotion of incentives for tourists	Planned	Visitors to the area are unfamiliar with transport options. The more information and clear signage there is, the more likely visitors are to use public transport.	Medium	**££**	▽▽	Medium	Increasing use of public transport is as much about changing mindsets of tourists	Acceptable
A new Park + Ride scheme into town centre	Possible	A reduction in the number of vehicles travelling into town will reduce both emissions from travel and emission from stationary traffic.	High	**£££**	▽	Low	More drivers take to the roads to take advantage of reduced traffic	Neutral

5.2 Initiatives That Increase GHG Emissions

We were keen to consider initiatives that increase GHG emissions as well as initiatives that reduce GHG emissions. Initiatives that increase GHG emissions are often ignored in climate change strategies because they relate to service areas that are not, traditionally, involved with environmental issues; or because the initiatives are considered as essential to the development of the local economy, and recognition of their greenhouse gas impacts could be seen as a threat to their implementation.

The Council has considerable influence over the outcome of planning decisions, which determine the outcome of the initiatives in Table 5.2. The costs to the Council of approving a development are low but the GHG impacts are medium to high. If the Council is looking to limit emissions, a more thorough consideration of GHG impacts during the planning approval process would be a sensible place to start.

A rationale for balancing economic benefits against the environmental costs of GHG release may help in the decision-making process. One, simple approach would be to value the emissions at market (EU Emissions Trading Scheme) prices. Alternatively, values for carbon that factor in the social and environmental costs have also been developed in a number of studies commissioned by Defra. The adopted approach need not be complex - its purpose would be to give planners a reasonable justification for the decision taken.

Measures that might be typical of Option package 1 in the Draft AQAP - move receptors so that there is no relevant exposure - have been assessed here as having potential to increase GHG emissions in Perth and Kinross. The two initiatives in Table 5.2 are representative of the ways receptors could be moved ie development within Perth, or development outwith. Both are considered to have potential to increase emissions by increasing road use and therefore fuel emissions, and emissions associated with construction/use of the new buildings.

5.3 Initiatives That Reduce GHG Emissions

Table 5.3 gives some indication of the range of activities (closely aligned to the AQAP) that could be utilised to mitigate greenhouse gas emissions.

The construction of a third river crossing and operation of the CCTMR are considered to have potential GHG emissions reductions by reducing congestion in the city, and by removing incentives to drive into the city centre.

As indicated in Table 5.3, the Council is well placed to influence planning, housing and waste initiatives. The Council's influence over high impact initiatives in transport, economic development and tourism is due principally to its control over the planning process. Planning, housing and waste should, in our view, be the focus of an area wide strategy to reduce greenhouse gas emissions.

The main opportunity for improvement appears to lie with the planners. There is currently a real risk that greenhouse gas considerations will be left out of planning decisions. We believe there are three reasons for this:

- *Existing processes may allow some high impact initiatives through without an adequate (or in some cases, without any) assessment of GHG impacts;*

- *The information required to assess GHG impacts is not available or difficult to acquire, and the analysis is not straight forward, and;*
- *Time (and therefore resources) is required to tackle the issues, a luxury that most staff in the Council, including planners, do not have.*

In the next section we focus on specifically on planning, because we believe that improved planning decision-making could result in a significant reduction in greenhouse gas emissions.

5.4 Greenhouse Gas Mitigation Through Planning

The UK Government has become increasingly aware of the importance of planners in the national response to climate change mitigation. In 2004 the Office of the Deputy Prime Minister (ODPM) published a report entitled: *The Planning Response to Climate Change: advice on better practice*. The report, produced by CAG Consultants is aimed at planning professionals, and sets out guidance sector by sector on ways to reduce local greenhouse gas emissions.

In this section we summarise some of the key guidance for Scottish Local Authorities from the report. We realise that Perth & Kinross Council may already implement many of the measures described. We have not had sufficient time to investigate the Council's planning processes and some of the information provided may be redundant. We hope, however, that the text includes some ideas that are new to the Council. The mitigation of climate change through planning is fully discussed in the main report. Here, we present general options in relation to planning and transportation.

5.4.1 National Planning Policy

The Planning System (2002) states that: *"The Scottish Executive is committed to tackling climate change greenhouse gas emissions from burning fossil fuels, which is the biggest single contributor to global warming. The planning system can play a part in reducing emissions when guiding the location and design of development and the management of land use change. Specific actions include reducing the need to travel and encouraging sustainable forms of transport, and encouraging energy efficient design and appropriate choice of materials. The planning system should take the possible impacts of climate change, for example greater rainfall and increasing risk of flooding into account when taking decisions on the location of new development and other changes in land use."* There is, therefore, clear guidance from government on the issue.

5.4.2 Planning and Transport

Objectives set out in NPPG17 Transport are to integrate planning and transport to:

- *promote more sustainable transport choices for both people and for moving freight;*
- *promote accessibility to jobs, shopping, leisure facilities and services by public transport, walking and cycling, and;*
- *reduce the need to travel, especially by car.*

Although emission reduction is not mentioned explicitly, all of these objectives support and are compatible with objectives to mitigate GHG emissions. The ODPM report suggests the following actions:

- *Require developments that generate many traffic movements to prepare Travel Plans;*
- *Promote the design of planned transport interchanges to encourage the use of sustainable transport modes;*
- *Consider long-term effects on the number or length of journeys, accessibility by non-car modes, air pollution effects and involve transport planners in the appraisal process, for example in SEAs;*
- *Require transport assessments that include accessibility studies and impact assessments for all developments likely to generate significant journeys. Such studies should identify how accessible the development is by different transport modes, and what improvements to access by walking, cycling and public transport are possible. They should provide the basis for determining whether the development is acceptable under NPPG17;*
- *Use Section 75 Agreements to improve facilities for walking, cycling and public transport. The tests for Section 75 agreements in Scotland are contained in Scottish Executive Circular 12/1996 Planning Agreements;*
- *Encourage shared car parking and car clubs;*
- *Prepare a development brief for developers on how to reduce transport movements, use alternative fuels and encourage non-car modes of transport.*

6 Emission Projections to 2010

The UK has a domestic target for CO_2 of 20% reduction from 1990 levels by 2010. All local and regional government are being encouraged to act to help achieve these targets. In order to assess emissions in 2010 it is necessary to first build a business as usual 2010 inventory and ideally a 1990 baseline. In addition a key year for the Air Quality Action Plan is 2010, as this is the year that key EC Daughter Directives come into force in terms of local air pollution. Therefore this section concentrates with first projecting the 2004 baseline inventory to 2010 and secondly assessing the effect of the Air Quality Action Plan on greenhouse gas emissions (GHG) for the whole of the Perth and Kinross area.

Additionally the projected inventory:

- *can provide a basis to evaluate emission reduction options and set realistic targets (such as those outlined in section 5);*
- *can be used as an important tool to engage with stakeholders and to identify emission reduction goals; and*
- *can be used to publicise emission reduction achievements.*

6.1 Methodology Used for Projections

Two scenarios have been envisaged for 2010. The first, the 'Business As Usual' scenario incorporates typical road traffic growth only whereas the second scenario includes the 'City Centre Traffic Management Review' data, as discussed in the Action Plan and Further Assessment (Cooke & Hodgson, 2007).

6.2 Results for 2010

This section presents emissions estimates for 2010 for both the 'Business As Usual' scenario, and the scenario including City Centre Traffic Management. The total emissions from all source sectors in Perth and Kinross as calculated for both 2010 scenarios are summarised below in Tables 6.1 and 6.2. Table 6.1 summarises the results for the 'Business As Usual' Scenario and Table 6.2 for the scenario including City Centre Traffic Management. In addition to individual pollutant emissions, the global warming potential (GWP) has also been calculated to allow the total GHG impact to be easily compared between each sector. Maps showing CO_2 emissions and GWP resolute to 1km are presented in Appendix 1 for both total emissions and those pertaining to road transport.

Comparison of the 2010 'Business As Usual' (BAU) scenario and the data for 2004 shows a decrease of about 5% CO_2 and 13% GWP relative to 2004 for road transport. Overall there is a decrease of about 1% GWP between 2004 and 2010, mainly driven by reductions in N_2O from road transport (45% reduction). These reductions are the result of more efficient engines rather than reduced vehicle kilometres. Comparison of the 2010 BAU and with Traffic Management scenarios results in approximately an additional 6% reduction in both GWP and CO_2 relative to the 2010 BAU, this reduction is related only to road traffic as this scenario only affects road traffic emissions. When the 2010 with scenario is compared to the 2004 base case the overall decrease is about 3% GWP and 18% GWP for road transport relative to 2004.

Figure 6.1 also shows the estimated relative contribution made by each source sector to total emissions for the 2010 BAU scenario. The Traffic Management scenario is not presented as no visual distinction can be made between the two sets of data. As per Section 4 the emission sources have been grouped into 7 categories based on the SNAP codes used by the NAEI. Analysis of source contribution reveals that electricity consumption, road transport, other transport and combustion sectors account for over 90% of CO_2 emissions - the 2004 figure was estimated at 80%. Again transport accounts for approximately half of CO_2 emissions - this is about the same as 2004. Methane emissions are still predominantly from agriculture with a significant contribution from waste treatment and disposal. Similarly, emissions of N_2O are still dominated by agriculture and road transport sectors. In terms of the GWP the road transport contribution has reduced to 30% from 33% in 2004, mainly due to more efficient vehicles rather than lower vehicle kilometers. The combined energy usage is up to 33% from 30% in 2004.

Table 6.1: ***Total GHG Emissions in Tonnes for 'Business As Usual' Scenario in 2010***

Source	CO_2 as C	CO_2 as CO_2	N_2O	CH_4	HFC	GWP	Uncertainty Rating
Shipping & Aviation	46,099	169,029	7	89	0	172,970	4
Electricity Domestic Consumption	55,169	202,287	2	6	0	202,955	3
Electricity Other Consumption	62,570	229,423	2	7	0	230,181	3
Nature	42,314	155,151	0	12	0	155,413	4
Agriculture	4,354	15,965	975	7,050	0	466,409	4
Waste	116	425	8	75	0	4502	2
Waste Landfill	0	0	0	814	0	17,085	4
Domestic LPG	410	1,502	0	0	0	1,503	4
Domestic Oil	10,824	39,690	0	4	0	39,875	4
Domestic Gas	40,003	146,679	0	8	0	146,921	3
Domestic Coal	4,006	14,690	1	91	0	16,804	4
Domestic Anthracite	1,387	5,085	0	3	0	5,230	4
Industrial Gas	48	176	0	0	0	212	3
Industrial Oil	27,617	101,263	0	1	0	101,296	3
Industrial Coal	12	42	0	0	0	43	3
Agricultural Coal	13	46	0	0	0	48	4
Agricultural Straw	0	0	0	0	0	36	4
Agricultural Oil	1,584	5,806	0	0	0	5,811	4
Agricultural Gas	0	0	0	0	0	2	3
Public Sector Oil	656	2,406	0	0	0	2,414	4
Public Sector Gas	2,626	9,630	256	1	0	88,939	3

(continued)

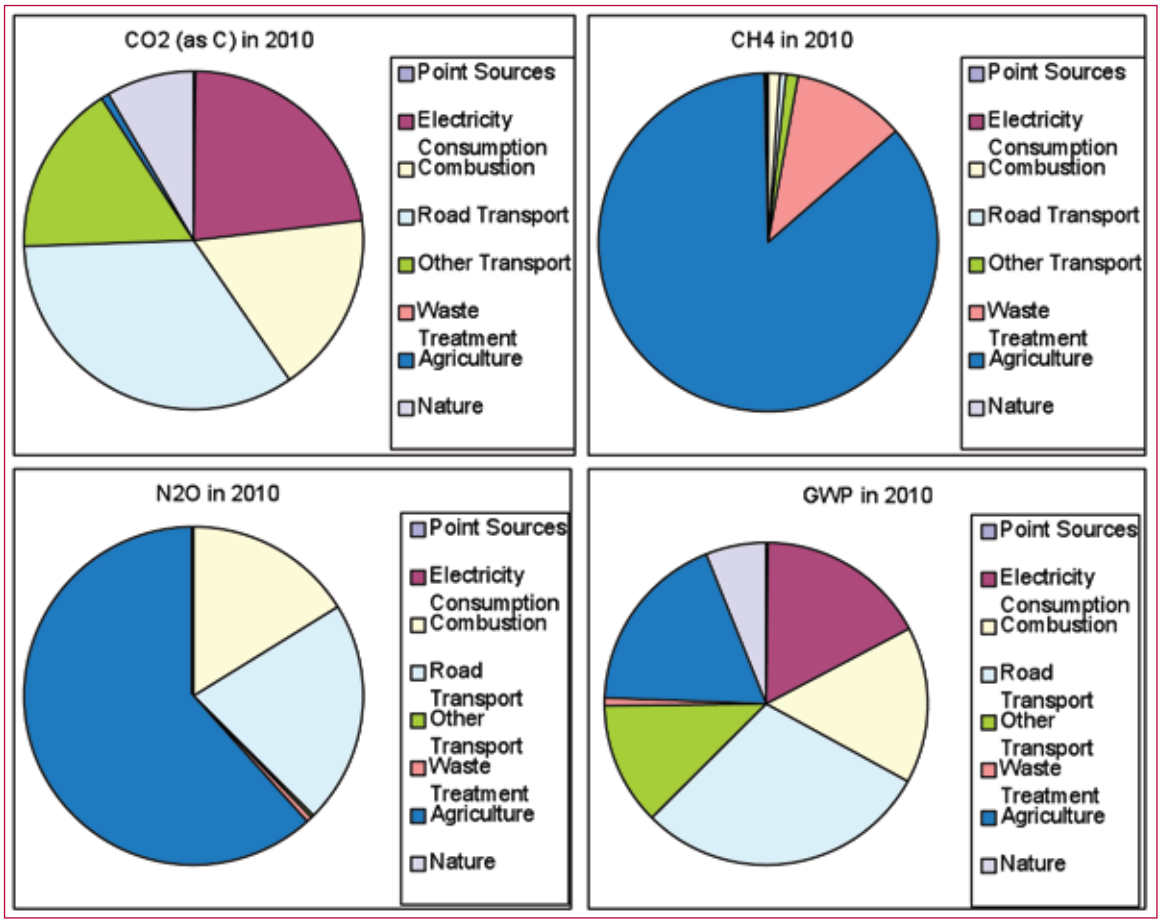
Source	CO_2 as C	CO_2 as CO_2	N_2O	CH_4	HFC	GWP	Uncertainty Rating
Public Sector Coal	24	87	0	0	0	94	4
Part A and B Industrial Processes	1,111	4,074	0	0	0	4,074	2
Air Conditioning in Vehicles	0	0	0	0	10,590	10,590	4
Other F-Gases	0	0	0	0	24,143	24,143	4
Other Transport Not Listed	38,976	142,911	30	6	0	152,372	4
Minor Roads Petrol Cars	35,945	131,800	106	14	0	164,956	4
Minor Roads Diesel Cars	7,370	27,023	9	0	0	29,775	4
Minor Roads Petrol LGV	830	3,044	1	0	0	3,220	4
Minor Roads Diesel LGV	7,331	26,881	9	0	0	29,716	4
Minor Roads HGV	10,609	38,901	23	2	0	46,139	4
Minor Roads Bus	4,144	15,195	10	1	0	18,277	4
Motorway & A Roads Petrol Cars	45,167	165,613	90	8	0	193,830	3
Motorway & A Roads Diesel Cars	9,332	34,217	6	1	0	36,057	3
Motorway & A Roads Petrol LGV	1,111	4,072	1	0	0	4,268	3
Motorway & A Roads Diesel LGV	9,977	36,582	10	0	0	39,770	3
Motorway & A Roads HGV	39,645	145,365	63	4	0	164,994	3
Motorway & A Roads Bus	1,892	6,937	3	0	0	7,907	3
Roads Sub Total	**173,354**	**635,631**	**331**	**30**	**10,590**	**749,500**	-
Total	**513,272**	**1,881,998**	**1,613**	**8,198**	**34,733**	**2,588,832**	-

Table 6.2: ***Total GHG Emissions in Tonnes for the City Centre Traffic Management Scenario in 2010***

Source	CO_2 as C	CO_2 as CO_2	N_2O	CH_4	HFC	GWP	Uncertainty Rating
Shipping & Aviation	46,099	169,029	7	89	0	172,970	4
Electricity Domestic Consumption	55,169	202,287	2	6	0	202,955	3
Electricity Other Consumption	62,570	229,423	2	7	0	230,181	3
Nature	42,314	155,151	0	12	0	155,413	4
Agriculture	4,354	15,965	975	7,050	0	466,409	4
Waste	116	425	8	75	0	4,502	2
Waste Landfill	0	0	0	814	0	17,085	4
Domestic LPG	410	1,502	0	0	0	1,503	4
Domestic Oil	10,824	39,690	0	4	0	39,875	4
Domestic Gas	40,003	146,679	0	8	0	146,921	3
Domestic Coal	4,006	14,690	1	91	0	16,804	4
Domestic Anthracite	1,387	5,085	0	3	0	5,230	4
Industrial Gas	48	176	0	0	0	212	3
Industrial Oil	27,617	101,263	0	1	0	101,296	3
Industrial Coal	12	42	0	0	0	43	3
Agricultural Coal	13	46	0	0	0	48	4
Agricultural Straw	0	0	0	0	0	36	4
Agricultural Oil	1,584	5,806	0	0	0	5,811	4
Agricultural Gas	0	0	0	0	0	2	3
Public Sector Oil	656	2,406	0	0	0	2,414	4
Public Sector Gas	2,626	9,630	256	1	0	88,939	3
Public Sector Coal	24	87	0	0	0	94	4
Part A and B Industrial Processes	1,111	4,074	0	0	0	4,074	2
Air Conditioning in Vehicles	0	0	0	0	10590	10,590	4
Other F-Gases	0	0	0	0	24143	24,143	4
Other Transport Not Listed	38,976	142,911	30	6	0	152,372	4
Minor Roads Petrol Cars	30,819	113,002	93	12	0	142,196	4
Minor Roads Diesel Cars	6,316	23,160	8	0	0	25,599	4

Source	CO_2 as C	CO_2 as CO_2	N_2O	CH_4	HFC	GWP	Uncertainty Rating
Minor Roads Petrol LGV	716	2,624	0	0	0	2,777	4
Minor Roads Diesel LGV	6,304	23,113	8	0	0	25,574	4
Minor Roads HGV	8,533	31,288	19	1	0	37,228	4
Minor Roads Bus	3,274	12,005	8	1	0	14,505	4
Motorway & A Roads Petrol Cars	45,167	165,613	90	8	0	193,830	3
Motorway & A Roads Diesel Cars	9,332	34,217	6	1	0	36,057	3
Motorway & A Roads Petrol LGV	1,111	4,072	1	0	0	4,268	3
Motorway & A Roads Diesel LGV	9,977	36,582	10	0	0	39,770	3
Motorway & A Roads HGV	39,645	145,365	63	4	0	164,994	3
Motorway & A Roads Bus	1,892	6,937	3	0	0	7,907	3
Roads Sub Total	**163,085**	**597,979**	**310**	**28**	**10,590**	**705,295**	-
Total	**503,003**	**1,844,346**	**1,592**	**8,196**	**34,733**	**2,544,628**	-

Figure 6.1: *Relative Contributions by each source sector for CO_2, CH_4, N_2O and GWP, 2010 BAU*



Appendices

Appendix 1: Emission Maps

Emissions Map 2004: Road Transport Emissions of CO_2

Emissions Map 2004: Global Warming Potential of Road Transport

Emissions Map 2004: Total Emissions of CO_2

Emissions Map 2004: Total Global Warming Potential

Emissions Map 2010 Business As Usual: Road Transport Emissions of CO_2

Emissions Map 2010 Business As Usual: Global Warming Potential of Road Transport

Emissions Map 2010 Business As Usual: Total Emissions of CO_2

Emissions Map 2010 Business As Usual: Total Global Warming Potential

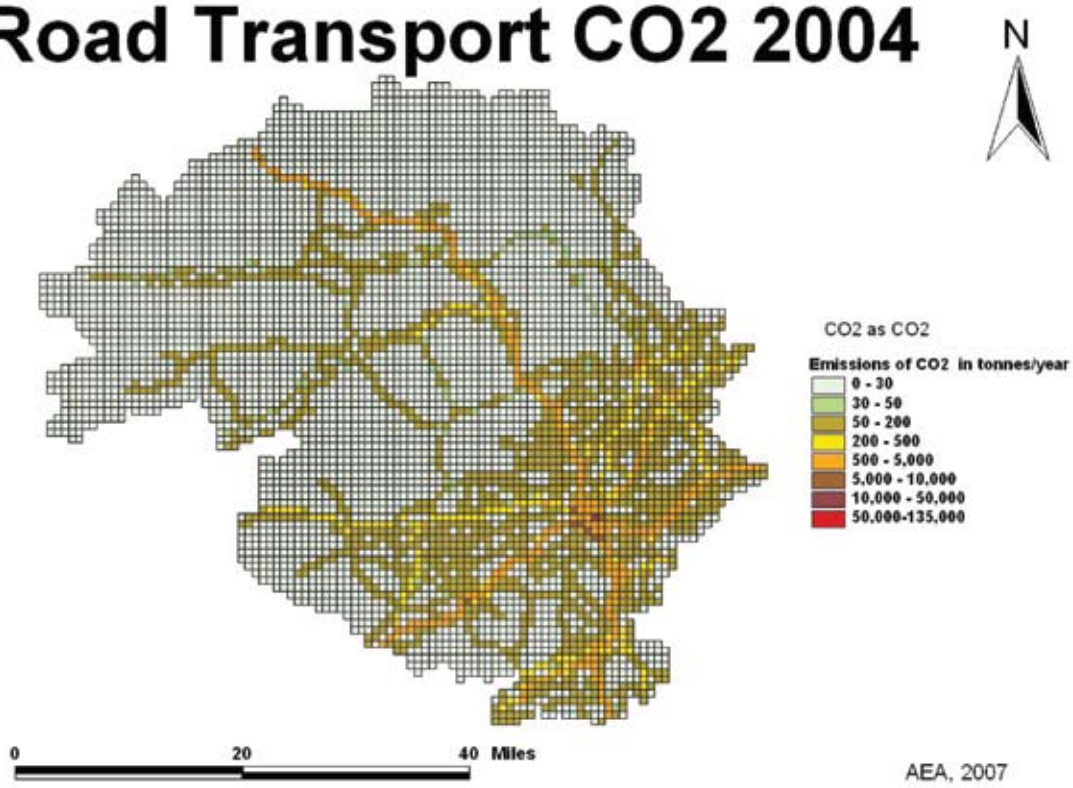
Emissions Map 2010 with City Centre Traffic Management: Road Transport Emissions of CO_2

Emissions Map 2010 with City Centre Traffic Management: Global Warming Potential of Road Transport

Emissions Map with City Centre Traffic Management: Total Emissions of CO_2

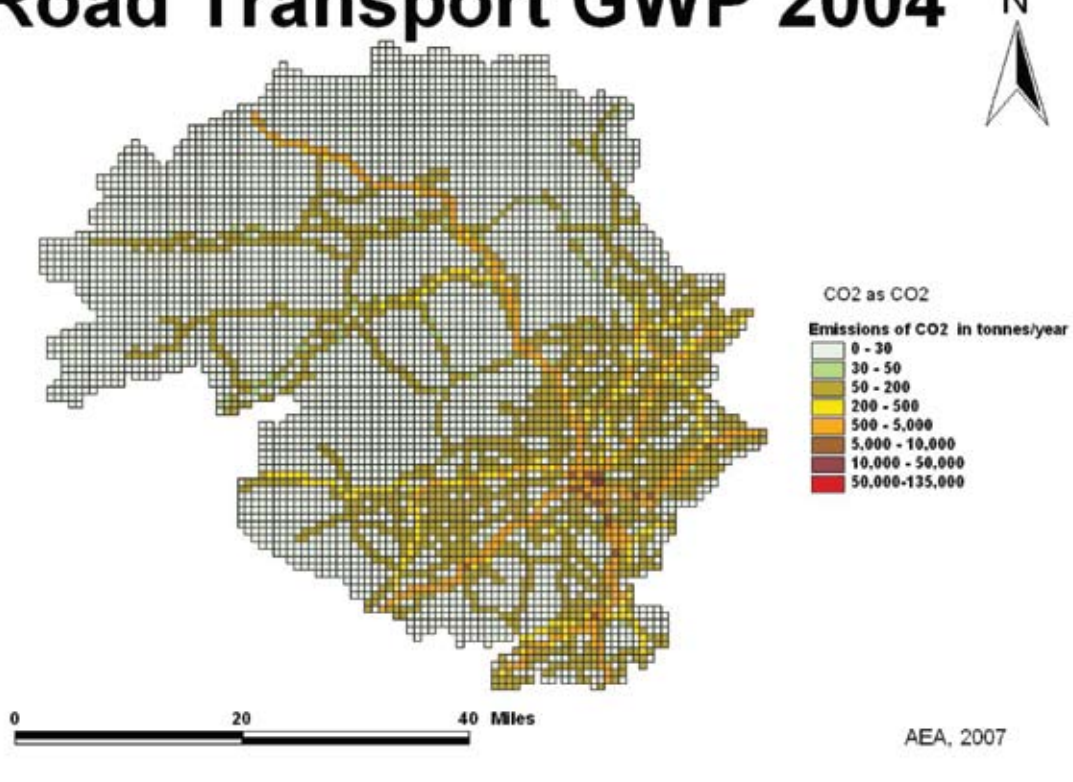
Emissions Map 2010 with City Centre Traffic Management: Total Global Warming Potential

Road Transport CO2 2004



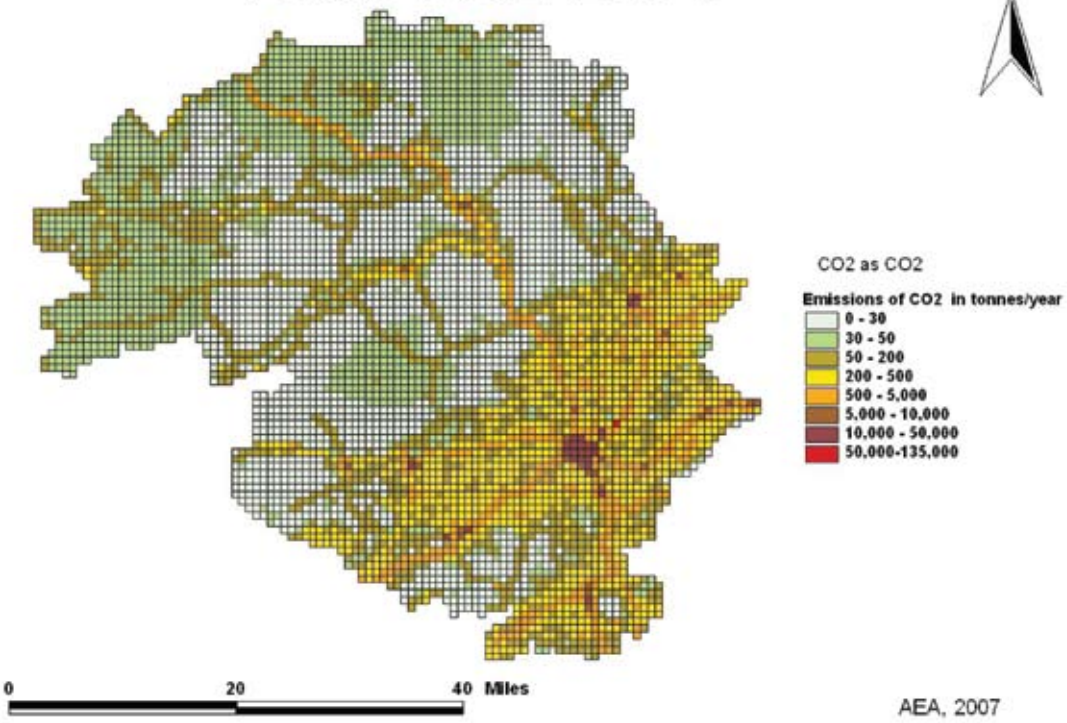
AEA, 2007

Road Transport GWP 2004



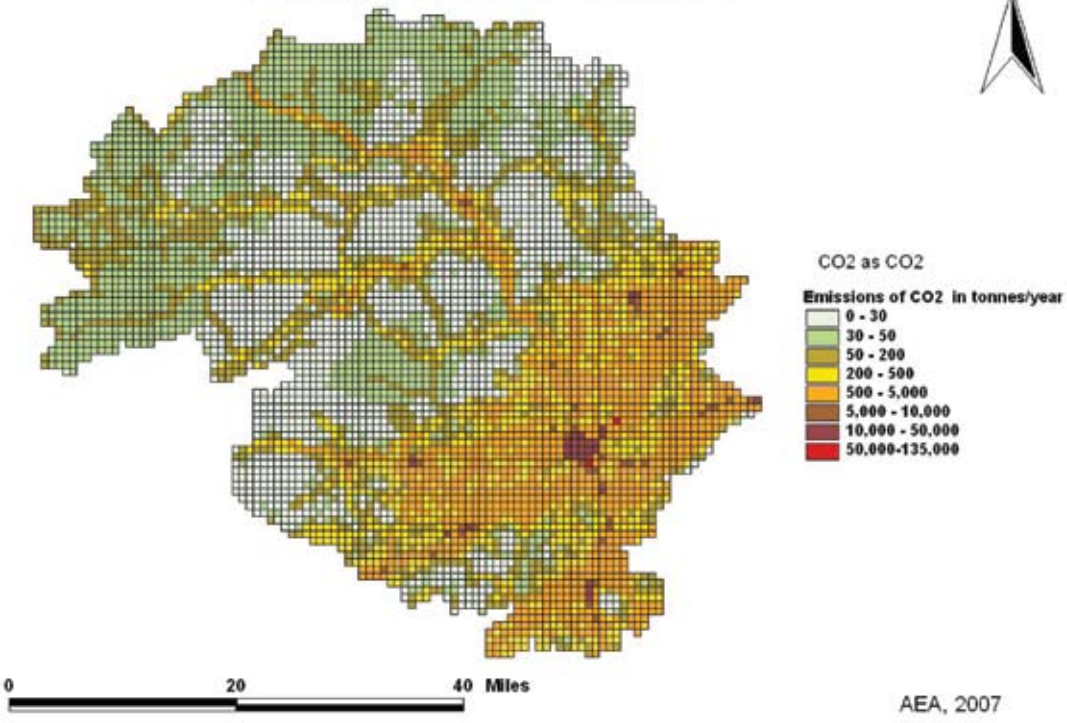
AEA, 2007

Total CO2 2004



AEA, 2007

Total GWP 2004



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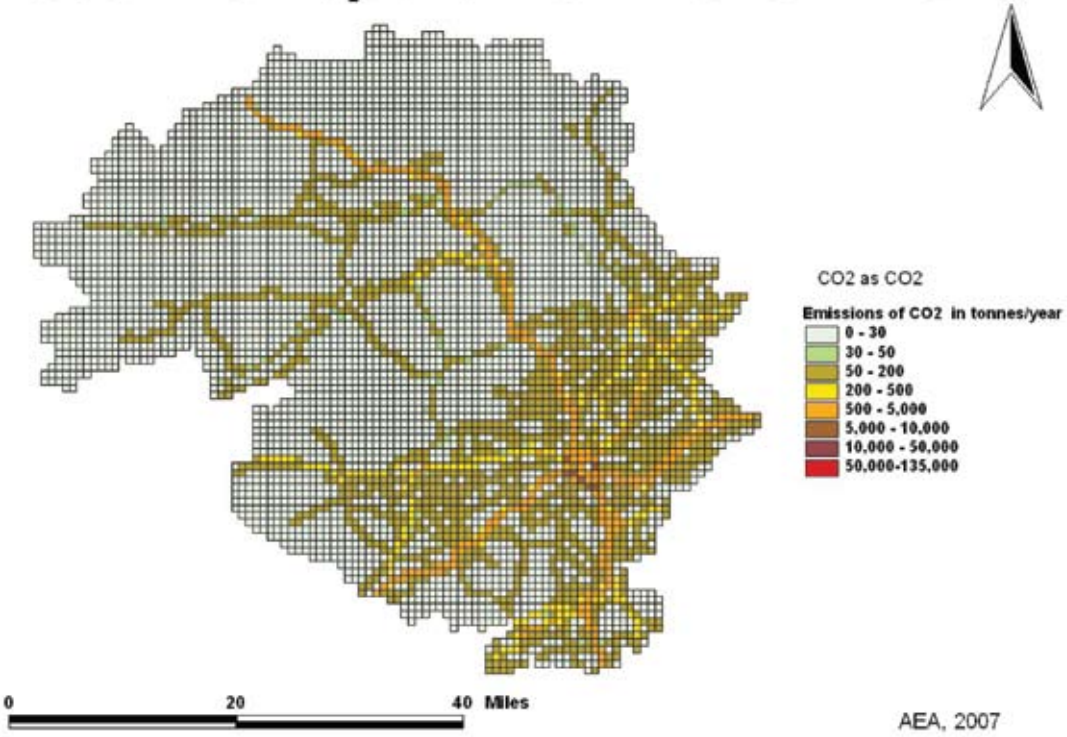
Road Transport CO2 2010 BAU



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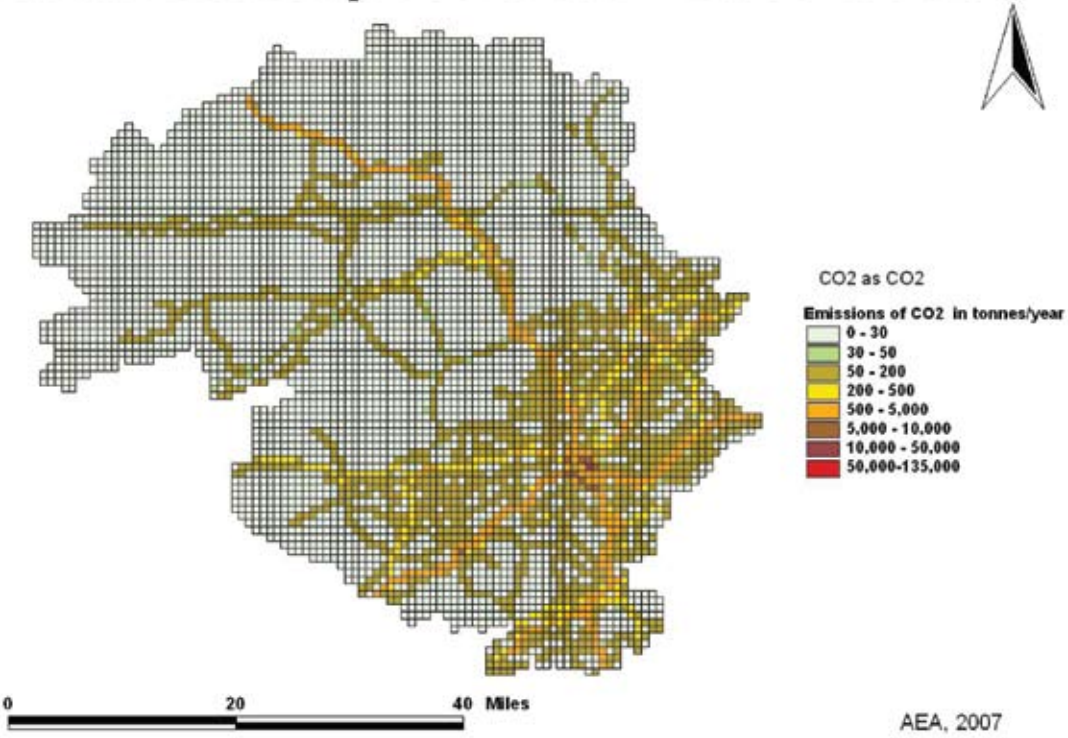
Road Transport GWP 2010 BAU



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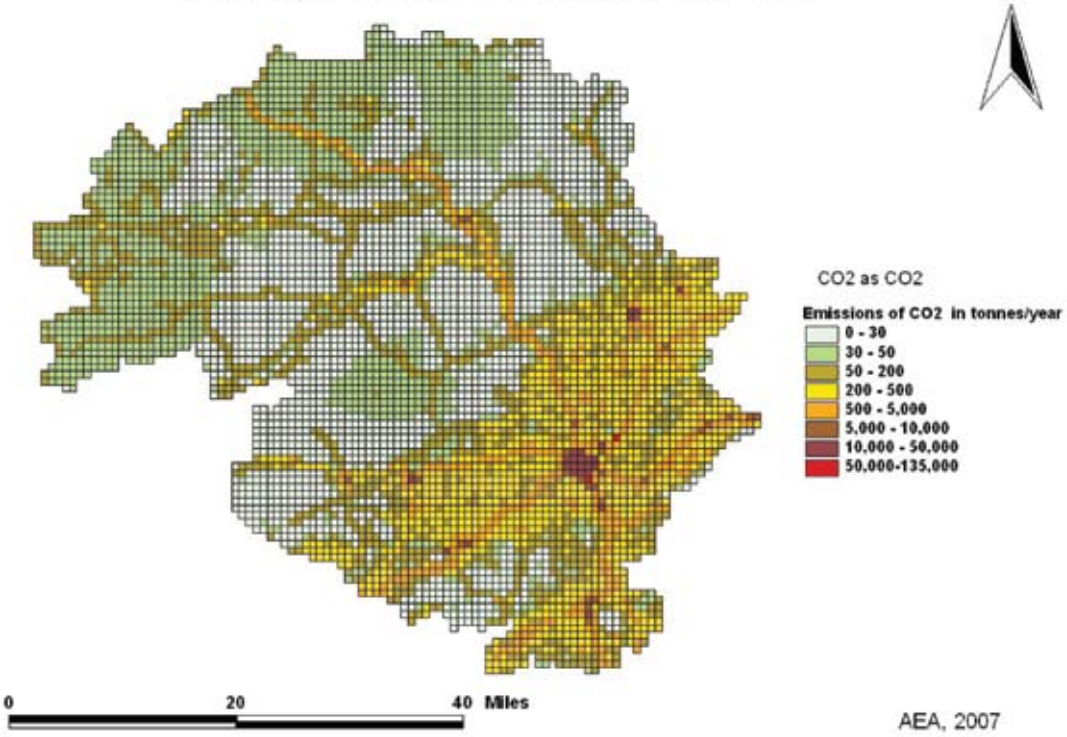
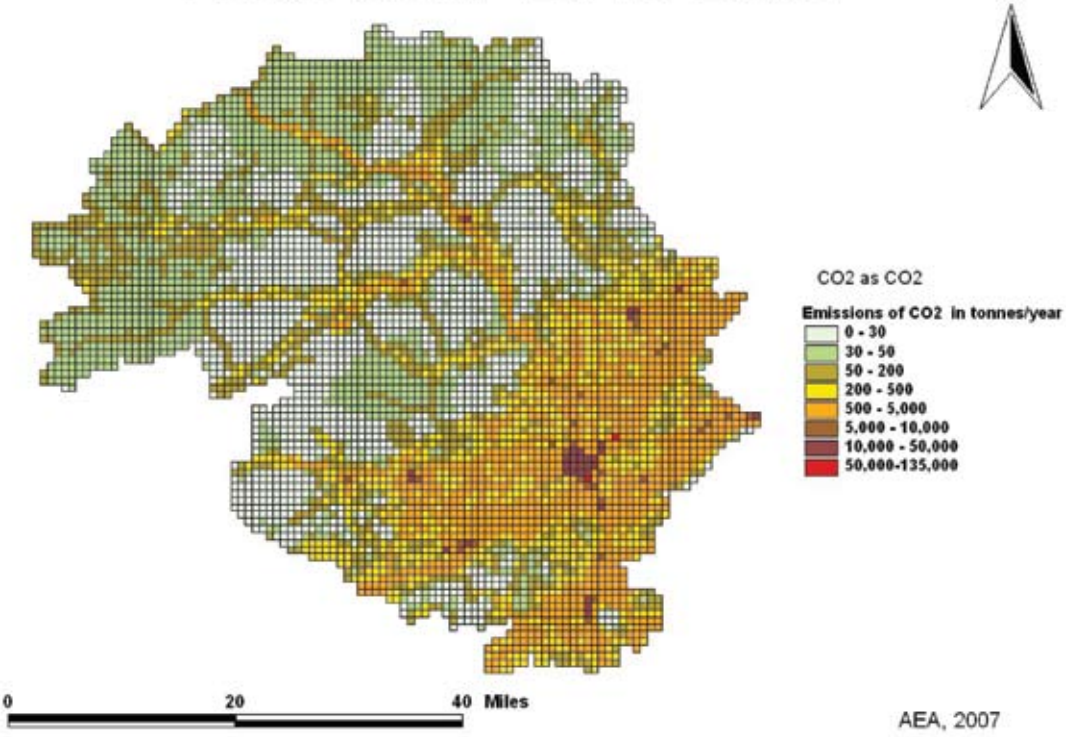
Total CO2 2010 BAU



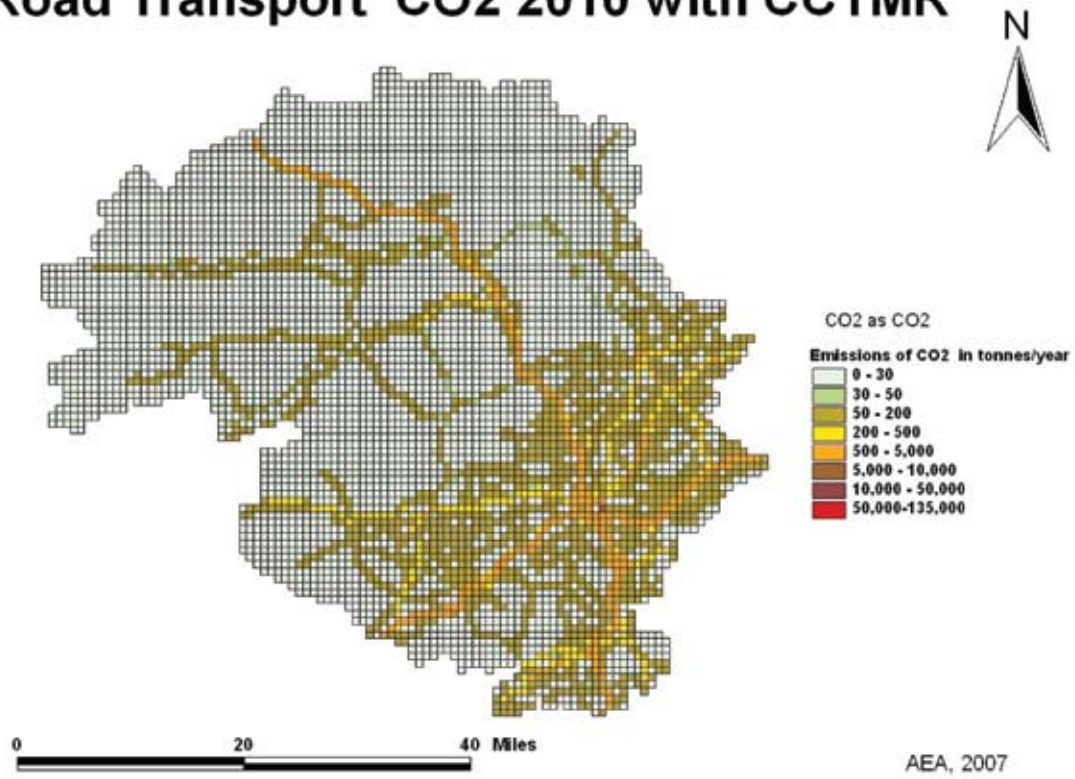
AEA, 2007

Total GWP 2010 BAU



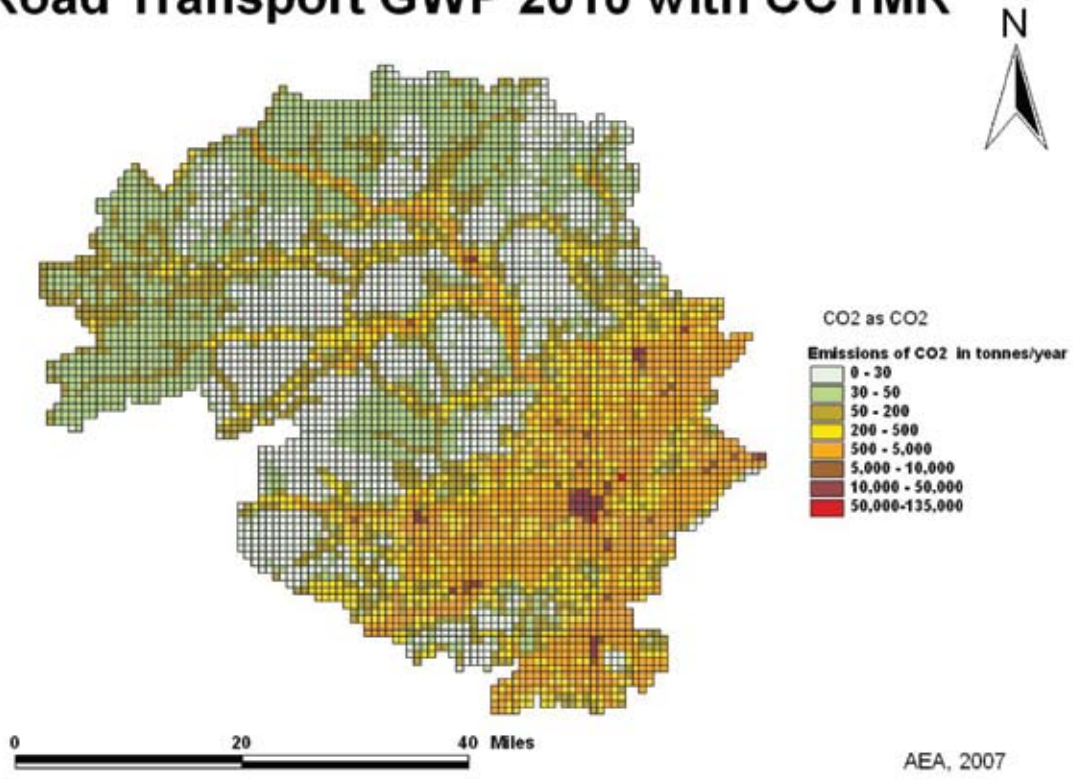
AEA, 2007

Road Transport CO2 2010 with CCTMR



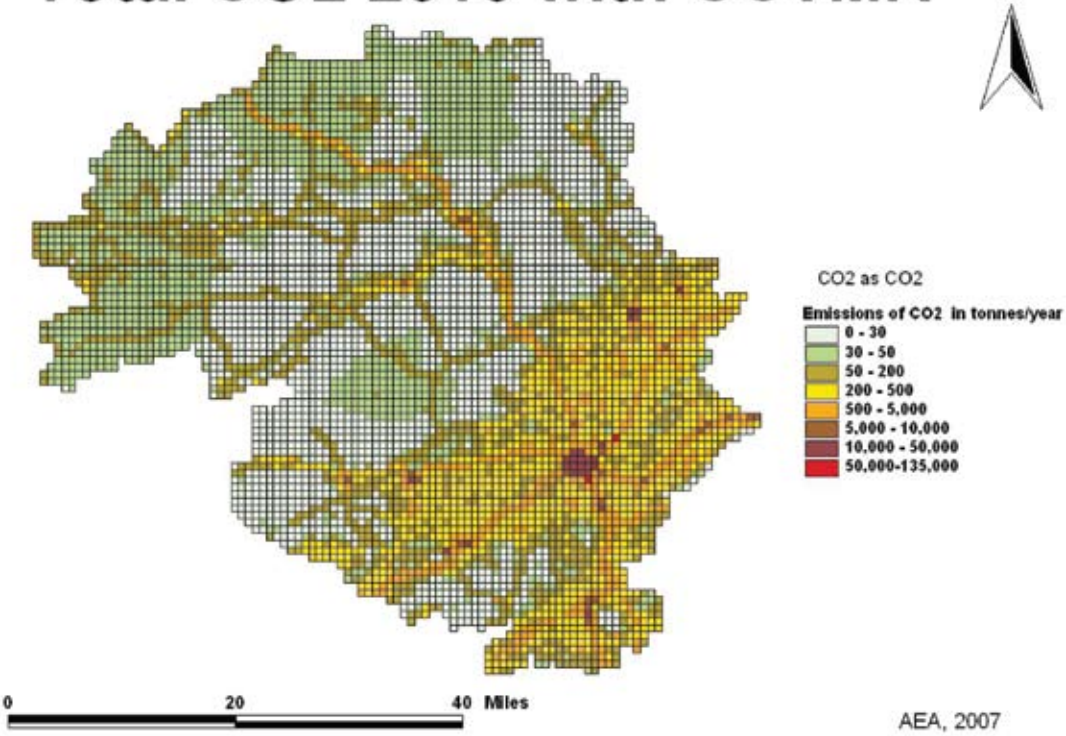
AEA, 2007

Road Transport GWP 2010 with CCTMR



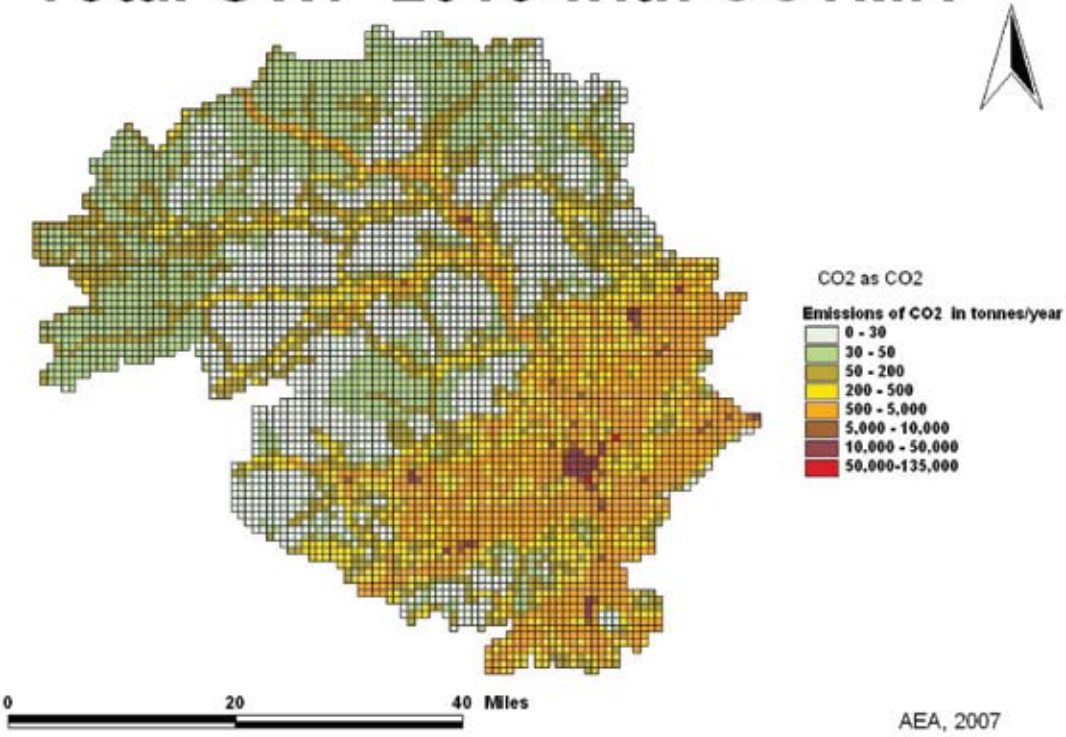
AEA, 2007

Total CO2 2010 with CCTMR



AEA, 2007

Total GWP 2010 with CCTMR



AEA, 2007

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