National
Atmospheric
Emissions
Inventory

Report

UK Emission Projections of Air Quality Pollutants to 2030

March 2012

UK Emission Projections of Air Quality Pollutants to 2030

UK Projections Team, AEA:
A Misra, N R Passant, T P Murrells, G Thistlethwaite, Y Pang, J Norris, C Walker, R A Stewart, J MacCarthy, M Pierce

The authors wish to acknowledge contributions to the NAEI projections from:

David Wilson, DECC
Tom Misselbrook, Rothamsted Research
Melanie Hobson, Aether
Ben Grebot, AMEC Environment & Infrastructure UK Limited

March 2012

Title	UK Emission Projections of Air Quality Pollutants to 2030
Customers	Atmosphere and Local Environment Programme (ALE), Defra
Confidentiality, copyright and reproduction	Crown Copyright
NAEI reference	57423001/0/CD7805/YP
Report number	AEA/ENV/R/3337

AEA Group
The Gemini Building
Fermi Avenue
Didcot
Oxfordshire
OX11 0QR

Telephone: +44 (0) 870 190 2963

AEA is a business name of AEA Technology plc
AEA is certified to ISO9001 and ISO14001

Main Authors	Anne Misra	
Approved by	Name	Yvonne Pang
	Signature	
	Date	7 November 2012

Executive Summary

As part of the National Atmospheric Emission Inventory (NAEI), projections of UK emissions of key air quality pollutants are compiled to inform policy development and to enable comparisons to be made with international commitments. This set of projections provides emissions of the pollutants nitrogen oxides (NO_X), sulphur dioxide (SO_2), non-methane volatile organic compounds (NMVOCs), ammonia (NH_3), fine particulate matter ($PM_{2.5}$) and coarse particulate matter (PM_{10}) for 2015, 2020, 2025 and 2030.

These latest emission projections are based on updated activity statistics and emission factors from a number of sources:

- The Department of Energy and Climate Change (DECC) Updated Energy Projections 43 (UEP43) energy forecasts published in October 2011.[1]
- The Department for Transport (DfT) 2011 traffic forecasts, COPERT IV emission factors for NO_X and NH_3 and Transport Research Laboratory (TRL) emission factors for all other pollutants for standards up to Euro 6/VI, diesel car penetration rates kept constant from 2010 to 2016 at 50.5% of new car sales and then falling to 43% sales by 2020. Some measures specific for London are also included such as the London Low Emission Zone combined with specific traffic projections for London provided by Transport for London (TfL).
- Agricultural projections (October 2011) with updated projections of livestock numbers and fertiliser use to 2030 using data derived from the FAPRI agricultural model by Queens University Belfast on behalf of Defra; and
- The 2009 emission estimates for each source sector from the NAEI.

UEP 43 projections include the impacts of climate change policies and measures where funding has been agreed and where decisions on planned policies are sufficiently advanced to enable robust estimates or their impacts. Firm and funded climate change policies include all these reflected in the March 2010 Budget[2] forecast and their associated savings, revised carbon and fossil fuel projections, revised Office for Budget Responsibility growth projections, revised cost estimates for the power sector and updated estimates of the impact of the package of policies set out in the Low Carbon Transition Plan[3] and the Household Energy Management Strategy[4] They do not include policies that are still under consideration, such as policies to meet the 4th Carbon Budget (2023-2027).

These updated projections, based on UEP 43 and the 2009 NAEI pollutant emissions have been termed the UEP43 (2009) projections. To reflect the inherent uncertainties in predicting future emissions activity over a twenty year time horizon, a number of alternative emission projection scenarios have been developed using a range of assumptions. The inputs that were varied were the growth in UK Gross Domestic Product, fossil fuel price determined energy demand and alternative scenarios for agricultural activity. These scenarios reflect a range of realistic emissions scenarios, no one of them will be correct. The results for Scenario 3, a mid-range scenario are used to exemplify

[1] http://www.decc.gov.uk/media/viewfile.ashx?filetype=4&filepath=11/about-us/economics-social-research/3134-updated-energy-and-emissions-projections-october.pdf&minwidth=true
[2] http://www.direct.gov.uk/prod_consum_dg/groups/dg_digitalassets/@dg/@en/documents/digitalasset/dg_186437.pdf
[3] http://www.decc.gov.uk/publications/basket.aspx?FilePath=White+Papers%2fUK+Low+Carbon+Transition+Plan+WP09%2f1_20090724153238_e_%40%40_lowcarbontransitionplan.pdf&filetype=4#basket
[4] http://www.energyandutilities.org.uk/industry_news/content/766/decc_sets_out_its_household_energy_management_strategy

the projected emission trends by source sector and pollutant out to 2030. Results are presented for the range of emission scenarios for all pollutants for 2025.

The results of these scenarios are detailed below. Scenario 1 represents an optimistic estimate of emission reductions which assumes full delivery of central estimates. Scenario 2 represents a slightly less optimistic set of assumptions with higher fossil fuel prices than Scenario 1 which increases coal use relative to natural gas. Scenario 3 is a realistically ambitious scenario with higher economic growth, fossil fuel prices, and transport activity, and increases in livestock numbers and urea use in substitution for ammonium nitrate than Scenario 1. Scenario 4 is a credible but pessimistic emissions scenario with highest economic growth, high fossil fuel prices, highest transport activity, highest livestock numbers and the greatest use of urea of the scenarios investigated. Scenario 5 is based on Scenario 1 but represents results from the DECC energy model with the impact of climate policies removed where this is possible within the model.

Table 0-1 shows the UEP43 (2009) emission projections for Scenario 3 by pollutant and year. The results show that during the period up to 2025 in which current measures on climate and air quality continue to be implemented then emissions will reduce. Hence emissions in 2020 are considerably below 2005 levels for all pollutants.

However for ammonia, particulate matter (both PM_{10} and $PM_{2.5}$) and non-methane volatile organic compounds the longer term projections are driven by economic growth. Hence as a result of the absence of currently firm and funded further measures, emissions are currently projected to be greater in 2030 than 2020. Emissions of nitrogen oxides and sulphur oxides are predicted to continue to decline as energy efficiency measures reduce energy demand and renewable sources of energy replace coal and natural gas combustion.

Table 0-1 Results from Scenario 3 by pollutant and year (kilotonnes)

Year	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_2	NMVOCs
2005†	307	135	81	1580	706	1088
2010†	284	114	67	1106	406	789
2015	272	111	59	910	371	715
2020	284	106	57	708	287	705
2025	289	105	57	612	250	712
2030	294	108	59	589	242	725

† Historic emission estimate from the 2010 NAEI

Table 0-2 shows the results for 2025 from the range of possible scenarios that were developed to explore the impact of assumptions addressing economic growth, fossil fuel prices, agricultural activity and degree of implementation of the UK's existing climate change measures on emission projections.

It can be seen the greatest relative spread of results are in ammonia emissions which are driven strongly by assumptions on fertiliser use and livestock numbers and in emissions of nitrogen oxides which are dependent on the level of energy demand in the economy and future fuel choices. Hence the policy measures with low ambition on climate measures are least beneficial for air pollutants.

Table 0-2 All scenarios for 2025 by pollutant (kilotonnes)

	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_2	NMVOCs
Scenario 1	273	100	54	587	242	707
Scenario 2	273	103	56	601	247	706
Scenario 3	289	105	57	612	250	712
Scenario 4	305	106	58	622	253	719
Scenario 5	273	106	58	652	254	714

Contents

List of Tables

List of Figures

1 Introduction

This report provides a summary of the air quality projections methodology, information on the key data input sources and the emission projections for six pollutants out to 2030. The pollutants covered are ammonia, nitrogen oxides, two particulate matter size fractions (PM_{10} and $PM_{2.5}$), sulphur dioxide and non-methane volatile organic compounds for the years 2015, 2020, 2025 and 2030. This is the first air quality emissions projection report to cover 2025 and 2030.

1.1 SUMMARY OF AIR QUALITY PROJECTIONS METHODOLOGY AND KEY DATA INPUT SOURCES

The data in this report are the actual 2005 and 2010 emissions from the 2010 National Atmospheric Emissions Inventory (NAEI) database reported to the European Commission in December 2011 under requirements in the National Emission Ceilings Directive and to the UNECE Convention on Long Range Transboundary Air Pollutants in February 2012. Emissions for 2015 onwards are projections compiled using the methodology detailed in Annex A and summarised below.

The NAEI projection methodology broadly follows the methodology outlined in the EMEP / EEA Emission Inventory Guidebook 2009. To produce a projection, each source in the NAEI is linked to an activity driver. Examples of drivers may include forecasts of fuel use, vehicle kilometres, animal numbers or broader indicators such as forecasts of population, or economic indicators such as Gross Domestic Product (GDP). Where relevant, emission factors have been varied to account for the future implementation of more stringent abatement measures resulting for example from legal requirements. The projections do not include the impact of additional policies and measures that are currently subject to review and have not yet been implemented into UK law.

These updated projections are based on energy and economic data from the Updated Energy and Emissions Projections published by the Department of Energy and Climate Change (DECC) in October 2011[5](UEP43). The DECC publication contains carbon dioxide projections to 2030 and energy demand projections. The air quality pollutant projections in this report are based on a coherent set of energy and economic assumptions with the DECC publication. The air quality emission projections are based on the historic NAEI inventory up to the historic 2009 emissions year which was published in 2011. Hence these projections have been termed the UEP43 (2009) projections and the key inputs are:

- DECC October 2011 (UEP43) energy forecasts;
- December 2011 traffic forecasts from DfT;
- Transport Research Laboratory (TRL) emission factors for vehicles except for NO_x and NH_3 which are taken from COPERT 4;
- FAPRI agricultural projections (October 2011);
- The 2011 NAEI Inventory ending in 2009.

UEP 43 projections include the impacts of climate change policies and measures where funding has been agreed and where decisions on planned policies are sufficiently advanced to enable robust estimates or their impacts. Firm and funded climate change policies include all these reflected in the

5 http://www.decc.gov.uk/assets/decc/11/about-us/economics-social-research/3134-updated-energy-and-emissions-projections-october.pdf

March 2010 Budget[6] forecast and their associated savings, revised carbon and fossil fuel projections, revised Office for Budget Responsibility growth projections, revised cost estimates for the power sector and updated estimates of the impact of the package of policies set out in the Low Carbon Transition Plan[7] and the Household Energy Management Strategy[8] They do not include policies that are still under consideration, such as policies to meet the 4th Carbon Budget.

Transport emissions have been based on the Department for Transport (DfT) 2011 traffic forecasts. COPERT IV emission factors for have been used for NO_X and NH_3. Transport Research Laboratory (TRL) emission factors have been used for all other pollutants for standards up to Euro 6/VI. It has been assumed that, diesel car penetration rates continue at their existing level of ~50% of new car sales until 2016 and then fall to 43% by 2020. Some measures specific for London are also included such as the London Low Emission Zone combined with specific traffic projections for London provided by Transport for London (TfL).
Agricultural projections are based on updated projections of livestock numbers and fertiliser use to 2030 using data derived from the FAPRI agricultural model by Queens University Belfast on behalf of Defra (October 2011).

The projections method presented here assumes in general that:

- All operators comply with new legislation;
- New abatement is applied to sources in order to meet the limits imposed by regulations or in response to the impacts of trading mechanisms, but further emission reductions by voluntary actions over and above those levels are not achieved, unless this occurs anyway through actions in response to non-environmental factors e.g. replacing older, more polluting plant with newer technology on economic grounds.
- New measures such as Euro 6/VI road transport emission standards deliver the expected emission reductions

Regulations that have been taken into account include those to meet the European Union's Climate and Energy Package.

6 http://www.direct.gov.uk/prod_consum_dg/groups/dg_digitalassets/@dg/@en/documents/digitalasset/dg_186437.pdf
7 http://www.decc.gov.uk/publications/basket.aspx?FilePath=White+Papers%2fUK+Low+Carbon+Transition+Plan+WP09%2f1_20090724153238_e_%40%40_lowcarbontransitionplan.pdf&filetype=4#basket
8 http://www.energyandutilities.org.uk/industry_news/content/766/decc_sets_out_its_household_energy_management_strategy

2 Emission Projection Results

The summary results from the emission projections for ammonia (NH3), nitrogen oxides (NOX), Sulphur dioxide (SO2), Non-methane volatile organic compounds (NMVOCs) and particulate matter (PM2.5 and PM10) from Scenario 3, which is based on realistically ambitious assumptions, are shown below in Table 2.1. Further detail of the sectoral breakdown is given in Tables 2.2 to 2.7 and Figures 2.1 to 2.6 which demonstrate the time trend for these pollutants.

Table 2-1 Projected emissions (kilotonnes)

Year	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_2	NMVOCs
2005†	307	135	81	1580	706	1088
2010†	284	114	67	1106	406	789
2015	272	111	59	910	371	715
2020	284	106	57	708	287	705
2025	289	105	57	612	250	712
2030	294	108	59	589	242	725

† Historic emission estimate from the 2010 NAEI

2.1 AMMONIA (NH_3)

The UK emissions of ammonia were 307 kt in 2005 and 284 kt in 2010. UK emissions are projected to decrease in the middle of the next decade and return to 284 kt in 2020 a decline since 2005 of 8%. Emissions are projected to increase thereafter to 294 kt in 2030.

The decline from current amounts to 2015 is a result of a projected continuing decline in animal numbers in the near term. In the longer term three factors lead to a small increase in emissions towards current levels:

- Globally urea is the dominant nitrogen fertiliser used in agriculture. However, in contrast to most European countries, UK fertiliser use is based on ammonium nitrate. The proportion of applied nitrogen released to the air as ammonia when ammonium nitrate is used is much lower than from urea. Hence a change in the market which leads to higher urea use will increase ammonia emissions from agriculture. There is a lower embedded energy content and cost in urea. As a result, if natural gas and carbon prices increase in the long term, the price differential between urea and ammonium nitrate in the UK market may widen. This suggests that urea use in the UK may increase and these projections include a shift of 20% of current ammonium nitrate use to urea from 2020 onwards. The impact of changes in this assumption is explored in the emission reduction scenarios described in Section 3 where higher and lower values are used.
- The increase in world food prices in recent years driven by both global population trends and increased prosperity in developing countries may lead to increased demand for UK agricultural products. This will have two related effects on ammonia emissions:
    - Firstly the size of the UK animal herd may decrease less rapidly than would otherwise be the case based on the UK as an isolated market. Increased animal numbers will lead to proportionately increased ammonia release.
    - Secondly if prices for agricultural products increase, relative to fertiliser prices, the optimum point on the yield curve will increase towards higher fertiliser use and hence the rate of improvement in nitrogen use efficiency will slow.

The combination of these three factors will lead to emissions of ammonia in 2030 being higher than in 2010.

Table 2-2 UK Emissions of Ammonia 2005 to 2030 (kilotonnes)

Sector	2005	2010	2015	2020	2025	2030
Combustion in energy industries	0.70	0.83	0.81	0.82	0.83	0.85
Industrial combustion	0.39	0.36	0.36	0.37	0.37	0.37
Industrial process emissions	5.41	4.02	4.01	4.17	4.40	4.66
Other stationary combustion including domestic heating	1.47	1.92	1.91	1.88	1.92	2.08
Fugitive emissions from fuels	0.16	0.15	0.04	0.04	0.04	0.04
Transport	15.99	10.32	5.61	4.79	5.36	6.07
Solvent and other product use	1.21	1.21	1.26	1.32	1.36	1.40
Agriculture - fertiliser use	64.69	63.38	63.64	68.62	69.21	69.82
Agriculture - Field burning	1.94	0.51	0.51	0.51	0.51	0.51
Agriculture - livestock	204.45	189.07	180.77	187.92	191.37	194.79
Waste	10.72	12.35	12.90	13.10	13.28	13.45
Other	0.31	0.28	0.29	0.29	0.29	0.29
Total	**307.45**	**284.39**	**272.11**	**283.82**	**288.93**	**294.33**

2.2 NITROGEN OXIDES (NO_X)

The UK's emissions of nitrogen oxides were 1580 kt in 2005. Emissions in 2010 were 1106 kt. UK emissions are projected to decrease to 708 kt in 2020 a decline of 55%. Emissions are projected to decline further to 589 kt in 2030.

Table 2-3 UK Emissions of Nitrogen Oxides (NO_X) 2005 to 2030 (kilotonnes)

Sector	2005	2010	2015	2020	2025	2030
Combustion in energy industries	495.62	336.31	305.72	210.13	153.58	129.14
Industrial combustion	261.73	178.18	140.74	126.53	124.12	126.80
Industrial process emissions	11.00	7.18	12.49	12.46	12.59	12.72
Other stationary combustion including domestic heating	128.82	96.61	69.50	68.01	64.96	67.33
Fugitive emissions from fuels	3.14	2.60	1.63	1.41	1.25	1.12
Transport	678.23	483.53	377.89	288.19	253.59	249.90
Waste	1.26	1.13	1.30	1.32	1.35	1.38
Other	0.32	0.27	0.27	0.27	0.27	0.27
Total	**1580.10**	**1105.81**	**909.54**	**708.33**	**611.71**	**588.68**

Projected emission reductions between 2010 and 2030 are driven by emission changes in the following sectors;

- Transport whose emissions are projected to decline by 234 kt despite a projected increase in vehicle usage. The decline arises principally from the penetration through the vehicle fleet of lower emitting vehicle types.
- The power sector where emissions will drop by 176 kt to 2030 as by 2023 under the Industrial Emissions Directive the remaining coal fired power plant and any new coal plant will be operating selective catalytic reduction plant or equivalently effective abatement technology and there is predicted to be significantly less coal burnt for power generation in 2020 than now.

- Industrial Combustion where changes in industrial emission limits and increased penetration of modern burner technology combined with increased energy efficiency are projected to reduce emissions by 51 kt.

2.3 PARTICULATE MATTER (PM_{10})

The UK emissions of PM10 (particles with aerodynamic diameters below 10 µm) are predicted to decline from 135 kt in 2005 and 114 kt in 2010 to 106 kt in 2020 a decline of 22%. Emissions will then increase slightly to 108 kt in 2030.

Projected emission reductions between 2010 and 2030 are driven by the following emission changes:

- A reduction of 12.3 kt in exhaust emissions from vehicles as a result of the implementation of emission control measures over the time to 2030. However, in the absence of further technical measures, vehicle tyre and brake wear and road abrasion are projected to increase by 3.0 kt and 1.5 kt respectively up to 2030.
- Emissions from the power generation sector are projected to decline by 4.4 kt as a result of a reduction in the use of coal and measures to reduce the rate of increase in electricity demand.
- Emissions from the domestic heating sector are projected to decrease very slightly from 2010 to 2015 as domestic coal and solid smokeless fuel use is replaced by biomass or natural gas heating systems. However in 2020, and thereafter, a predicted increase in biomass usage for domestic heating increases emissions of PM10.
- Emissions from a range of other sectors are projected to increase slightly to 2030 as a result of a projected increase in economic activity in the sectors in the absence of specific firm and funded measures which would act to further decrease emissions beyond 2020.

Table 2-4 UK Emissions of PM_{10} 2005 to 2030 (kilotonnes)

Sector	2005	2010	2015	2020	2025	2030
Combustion in energy industries	12.25	8.14	6.88	4.92	4.23	3.81
Industrial combustion	16.66	10.95	8.30	7.44	7.61	7.84
Industrial process emissions	22.63	16.39	18.37	19.71	20.77	21.88
Other stationary combustion including domestic heating	19.46	21.44	23.73	25.13	25.36	27.07
Fugitive emissions from fuels	1.41	1.55	0.80	0.70	0.62	0.55
Transport	35.99	29.15	28.49	23.61	21.57	22.04
Solvent and other product use	5.40	4.01	4.46	4.27	4.29	4.31
Agriculture - livestock	13.34	12.68	10.30	10.30	10.30	10.30
Agriculture - stationary combustion	2.33	5.01	2.32	2.32	2.32	2.32
Waste	2.20	2.19	4.40	4.40	4.40	4.40
Other	3.29	2.65	2.97	3.01	3.04	3.07
Total	**134.95**	**114.15**	**111.02**	**105.80**	**104.50**	**107.60**

2.4 FINE PARTICULATE MATTER ($PM_{2.5}$)

The UK emissions of particles with aerodynamic diameters below 2.5 µm were 81 kt in 2005 and 67 kt in 2010. They are predicted to decline to 57 kt in 2020 a reduction since 2005 of 30%. Emissions are projected to increase slightly thereafter to 59 kt in 2030.

The main reasons for the decline in emissions between 2005 and 2020 are:

- A reduction of 11.5 kt in exhaust emissions from vehicles as a result of the implementation of emission control measures over the time to 2030.
- Emissions from the power generation sector are projected to decline by 2.4 kt as a result of a reduction in the use of coal and measures to reduce the rate of increase in electricity demand.

Over the same time period as a result of increased vehicle use non-exhaust emissions of PM2.5 are projected to increase by 1.7 kt from brake and tyre wear and by 0.8 kt from road abrasion.

Emissions from the domestic heating sector are projected to increase only slightly from 2010 to 2015 as domestic coal and solid smokeless fuel use is replaced by biomass or natural gas heating systems. However in 2020, and thereafter, a predicted increase in biomass usage for domestic heating increases emissions of PM2.5

Table 2-5 UK Emissions of $PM_{2.5}$ 2005 to 2030 (kilotonnes)

Sector	2005	2010	2015	2020	2025	2030
Combustion in energy industries	6.65	4.82	3.84	2.85	2.62	2.37
Industrial combustion	12.38	8.25	6.20	5.56	5.69	5.87
Industrial process emissions	11.52	7.99	9.17	9.78	10.23	10.71
Other stationary combustion including domestic heating	13.72	15.81	13.91	15.17	15.22	15.85
Fugitive emissions from fuels	1.18	1.18	0.80	0.70	0.62	0.55
Transport	27.97	21.56	16.14	13.61	13.30	13.92
Solvent and other product use	1.89	1.40	1.56	1.49	1.50	1.51
Agriculture - livestock	2.00	1.89	1.85	1.85	1.85	1.85
Agriculture - stationary combustion	0.15	0.15	0.16	0.16	0.16	0.16
Waste	2.20	2.19	4.40	4.40	4.40	4.40
Other	1.65	1.44	1.44	1.44	1.44	1.44
Total	**81.31**	**66.67**	**59.48**	**57.00**	**57.03**	**58.63**

2.5 SULPHUR DIOXIDE (SO_2)

The UK emissions of sulphur dioxide were 706 kt in 2005 and 406 kt in 2010. UK emissions are projected to decrease to 287 kt in 2020 a decline of 59% from 2005. Emissions are projected to decline further to 242 kt in 2030.

The principal reductions are predicted to occur in the power generation sector in which the reduction in coal use combined with the reduction in emission limit values which will be required by the Industrial Emissions Directive, contribute to reduce emissions by 139 kt from 2010 to 2030. The next largest change in a sector is in the emissions from industrial combustion which are projected to reduce by 11 kt.

Table 2-6 UK Emissions of Sulphur Dioxide 2005 to 2030 (kilotonnes)

Sector	2005	2010	2015	2020	2025	2030
Combustion in energy industries	466.74	237.57	206.41	131.68	93.87	77.87
Industrial combustion	110.65	71.40	70.20	63.32	62.28	61.39
Industrial process emissions	40.87	20.41	24.32	24.51	24.76	25.02
Other stationary combustion including domestic heating	55.20	54.62	49.63	47.39	49.01	57.86
Fugitive emissions from fuels	1.26	0.40	0.36	0.31	0.28	0.25
Transport	30.46	21.28	19.09	19.22	19.16	19.34
Waste	0.82	0.75	0.73	0.73	0.73	0.73
Total	**706.01**	**406.43**	**370.74**	**287.17**	**250.08**	**242.46**

2.6 NON METHANE VOLATILE ORGANIC COMPONDS (NMVOC)

The UK emissions of non methane volatile organic compounds (NMVOC) were 1080 kt in 2005. Emissions in 2010 were 789 kt. UK emissions are projected to decrease to 705 kt in 2020 a decline of 35% from 2005. Emissions are projected to increase towards 2030 reaching 725 kt.

The largest declines between 2010 and 2030 are in the transport sector. It is estimated that NMVOC emissions from the evaporation of fuels during distribution, and use will decrease by 61 kt and exhaust emissions from vehicles will decrease by 41 kt.

The increase in emissions after 2020 occurs through the assumptions on economic growth leading to increased activity across a wide range of sectors. Except for transport fuel distribution and use, VOC emissions arise principally from non-energy related use such as solvent production and use, and the activity in these non-energy sectors are driven in the projections by long term economic growth and population growth.

Table 2-7 UK Emissions of Non-methane Volatile Organic Compounds 2005 to 2030 (kilotonnes)

Sector	2005	2010	2015	2020	2025	2030
Combustion in energy industries	6.05	4.86	3.82	3.40	3.33	2.99
Industrial combustion	29.02	22.68	19.97	19.83	20.85	22.00
Industrial process emissions	120.91	103.15	103.36	106.55	109.74	113.25
Other stationary combustion including domestic heating	39.40	37.07	47.66	45.68	46.09	48.53
Fugitive emissions from fuels	232.85	151.25	144.91	129.02	117.88	108.30
Transport	211.92	83.85	52.21	48.25	52.02	57.11
Solvent and other product use	408.27	350.95	326.57	335.94	346.40	356.73
Waste	38.07	33.54	15.37	15.01	14.74	14.55
Other	1.68	1.41	1.41	1.41	1.41	1.41
Total	**1088.18**	**788.77**	**715.29**	**705.09**	**712.46**	**724.88**

Figure 2-1 Projected Trend of Emissions of Ammonia 2005 to 2030

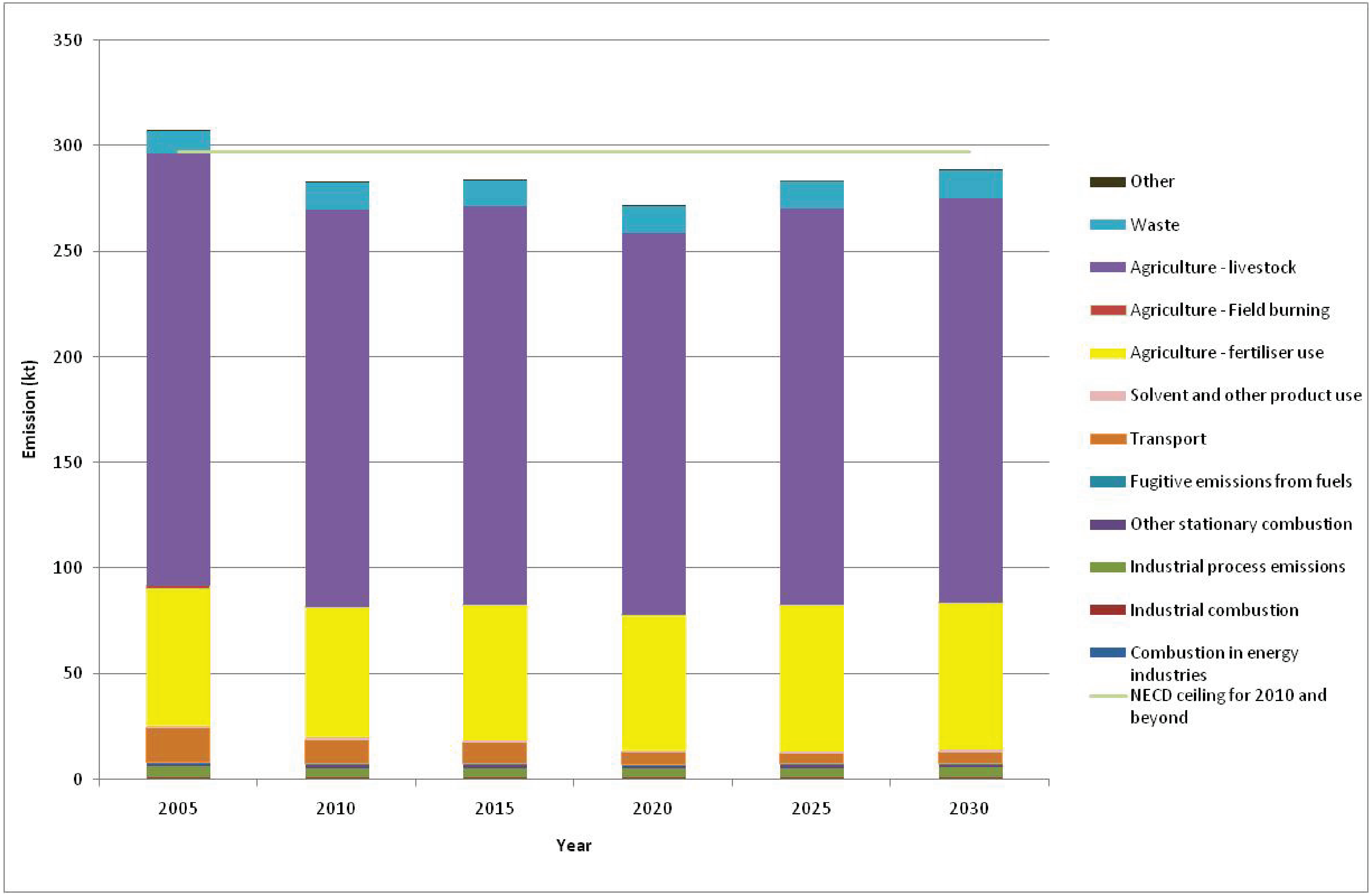


Figure 2-2 Projected Trend of Emissions of Particulate Matter (PM10) 2005 to 2030

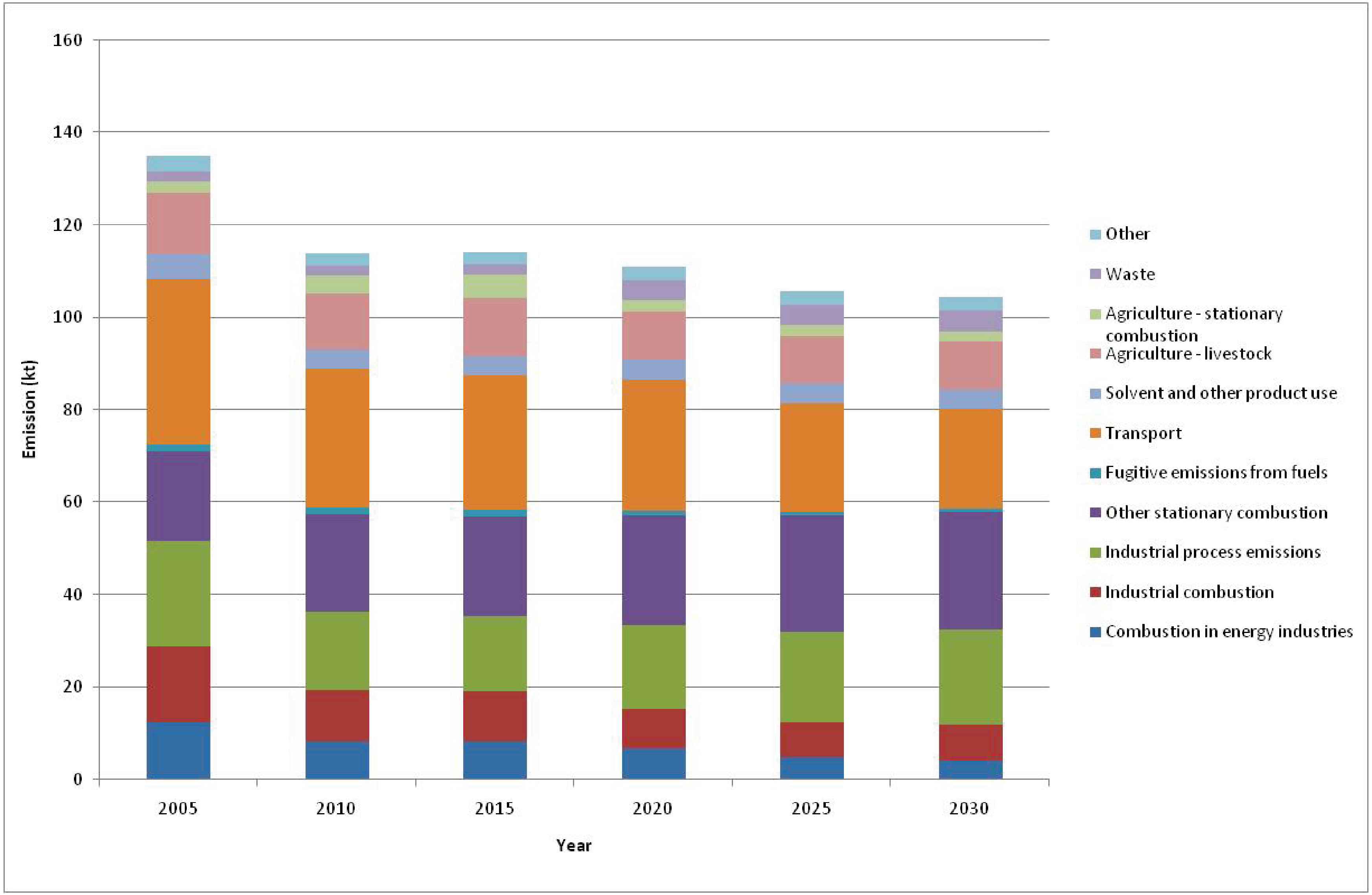


Figure 2-3 Projected Trend of Emissions of Particulate Matter (PM2.5) 2005 to 2030

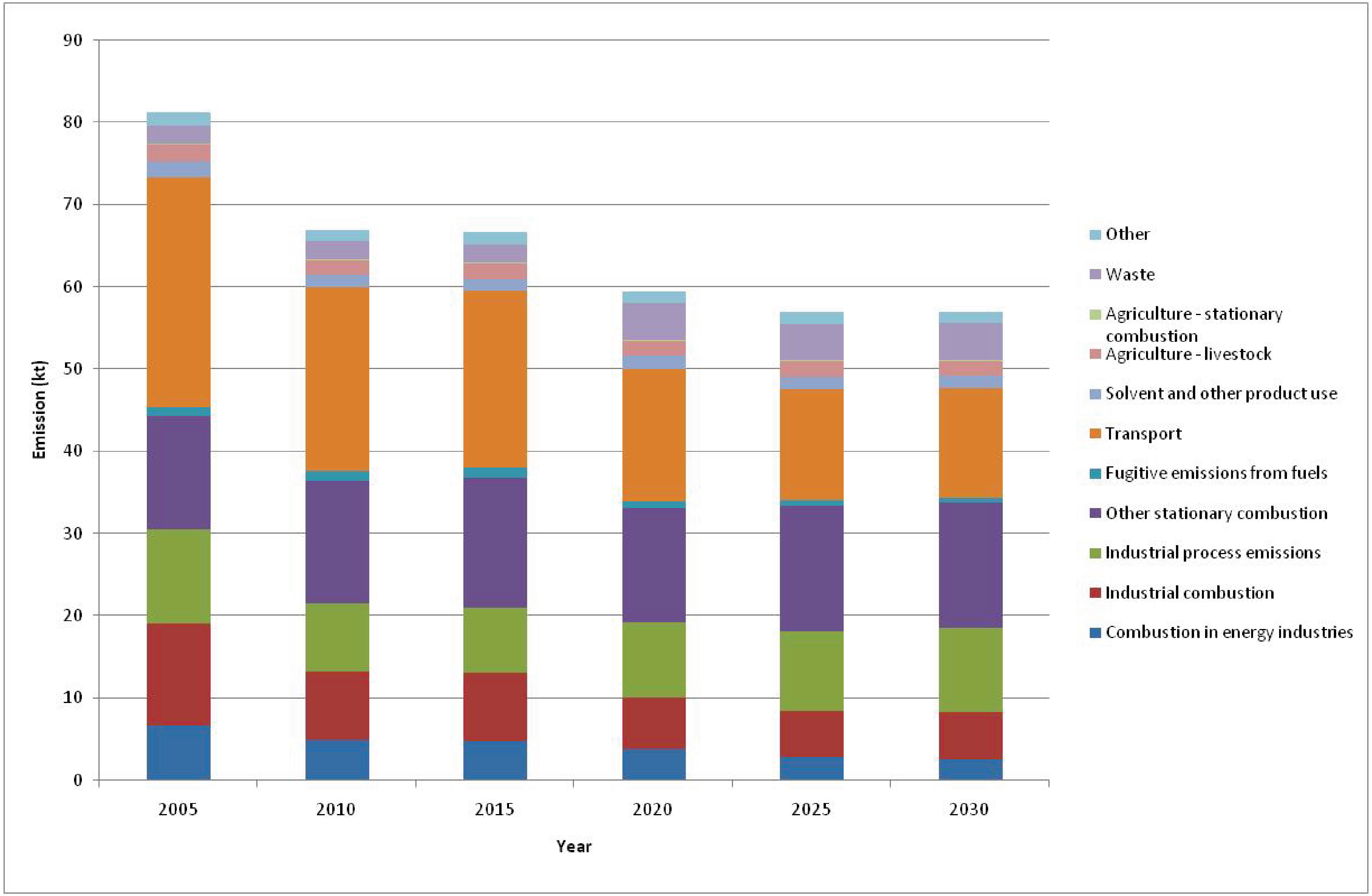


Figure 2-4 Projected Trend of Emissions of Nitrogen Oxides 2005 to 2030

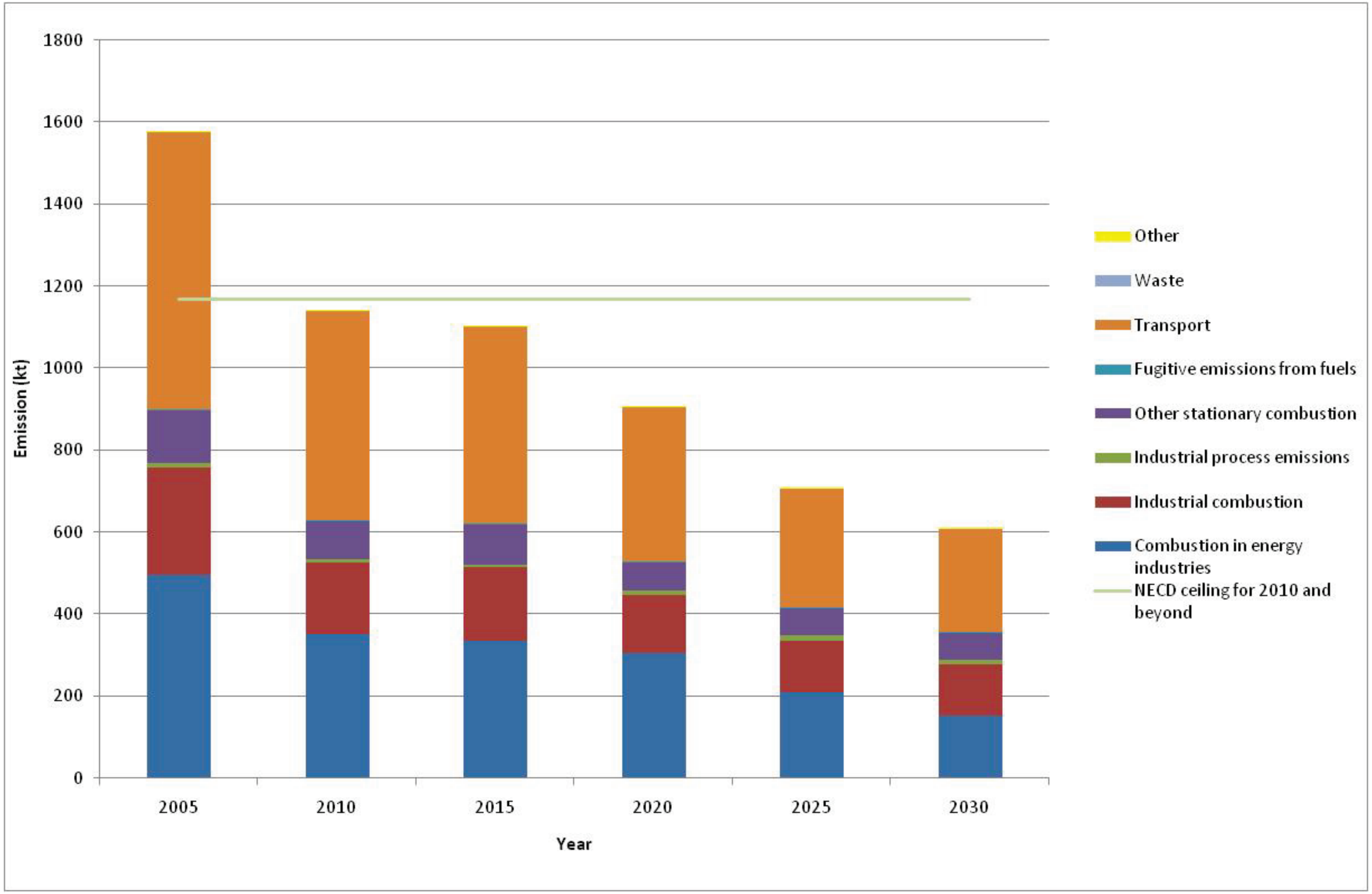


Figure 2-5 Projected Trend of Emissions of Sulphur Dioxide 2005 to 2030

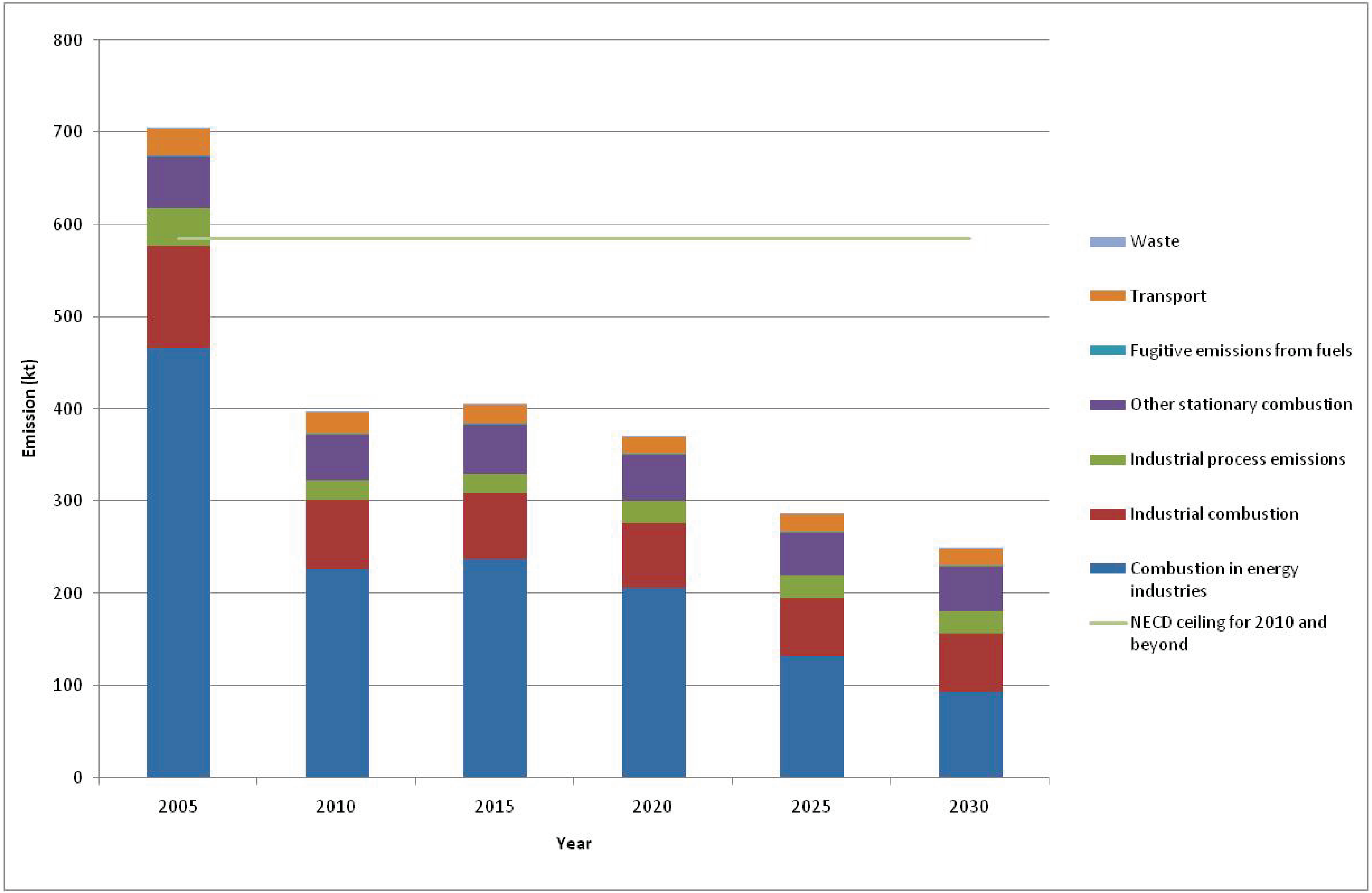
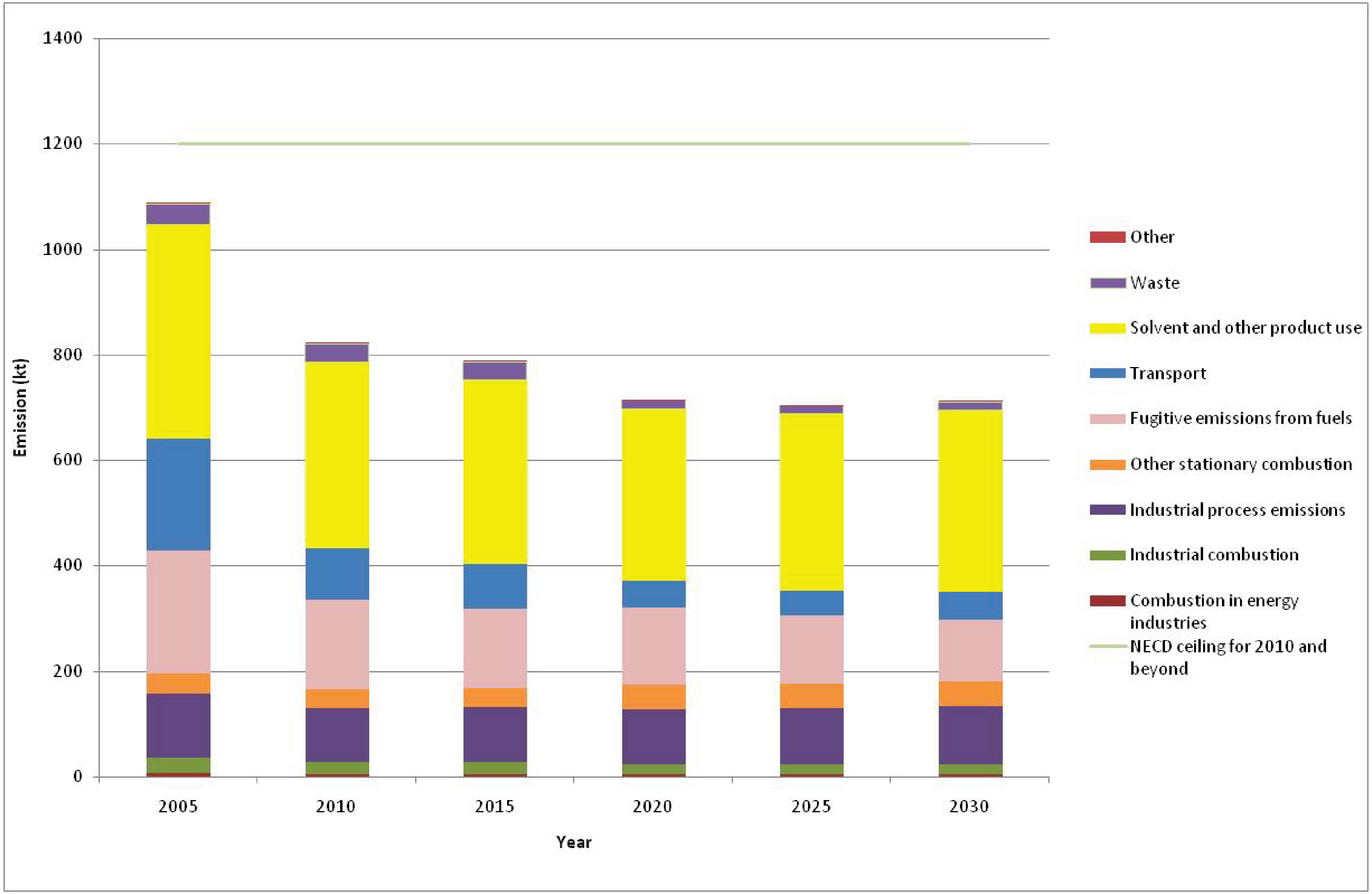


Figure 2-6 Projected Trend of Emissions of Non-Methane Volatile Organic Compounds (NMVOCs) 2005-2030



3 Uncertainty in Emission Projections

The projections whose results are presented in Section 2 of this report are subject to uncertainty from a number of sources. As part of this study a number of plausible future scenarios were explored to provide information on the range of possible future emission projections.

All of the scenarios address uncertainty in the activity statistics and not in the emission factors used. The uncertainty in the base year emissions are given in Table 3.1 which includes an estimate of the uncertainty in the base year emission factors[9]. It can be seen that the uncertainty means that even in the base year the estimates are no more precise than two significant figures. Results have been provided in the tables in Section 2 to two decimal places for clarity of the contribution of some smaller sectors.

Table 3-1 Estimated Uncertainty in 2009 Base Year Emissions[10]

Pollutant	Estimated Uncertainty in 2009 Base Year Emissions
Ammonia	-20% to +20%
Nitrogen Oxides	-10% to +10%
Particulate matter (PM10)	-20% to + 30%
Particulate matter (PM2.5)	-20% to + 30%
Sulphur dioxide	-4% to + 4%
Non methane Volatile Organic Compounds	-10% to +10%

The DECC energy model provided results with central and high fossil fuel prices as published separately to the energy projections by DECC[11]. DECC also provided results based on two economic growth scenarios which were based on the Office for Budget Responsibility forecast from March 2011, one 'central growth' taking the OBR central forecast the other, 'high growth'. A further DECC projection was developed based on removing the impact of policies agreed in the Low Carbon Transition Plan from July 2009 and thereafter to separate the influence of climate change policies from other factors.

Activity in the transport sector was provided from the Department for Transport's National Transport Model runs from December 2011. This was varied to provide a range of emission scenarios from transport.

Agricultural projections were provided from a set of results from FAPRI commissioned by Defra. These were used to generate a number of possible ammonia emission scenarios using the NARSES model provided by Rothamstead Research.

These inputs together with off-model adjustments were used to generate results for five scenarios. The national total emissions from each scenario are given in Table 3.2.

- Scenario 1 represents an optimistic estimate of emissions that assumes full delivery of central estimates of economic growth, fossil fuel prices, transport growth,

[9] http://uk-air.defra.gov.uk/reports/cat07/1103150849_UK_2011_CLRTAP_IIR.pdf
[10] NR Passant, TP Murrells, A Misra, Y Pang, HL Walker, R Whiting, C Walker, NCJ Webb, J MacCarthy UK Informative Inventory Report (1980 to 2010), March 2012,
[11] http://www.decc.gov.uk/en/content/cms/about/ec_social_res/analytic_projs/ff_prices/ff_prices.aspx

agricultural livestock numbers, abatement measures and urea use typical of the last five years.

- Scenario 2 represents a slightly less optimistic set of assumptions using estimates of economic growth, transport growth, agricultural livestock numbers and urea use as in Scenario 1 but addresses the impact of high fossil fuel prices which increases coal use relative to natural gas.

- Scenario 3 is a realistically ambitious scenario which takes account of the possibility of higher economic growth, fossil fuel prices, transport activity, livestock numbers and greater urea use in substitution for ammonium nitrate than Scenario1.

- Scenario 4 is a credible but pessimistic scenario in terms of emissions with highest economic growth, fossil fuel prices, transport activity and livestock numbers and the greatest use of urea of the scenarios investigated

- Scenario 5 is based on Scenario 1 but represents results from the DECC energy model with the impact of climate policies removed where this is possible within the model.

There are several other key sources of uncertainty which are not addressed in these scenarios.

- None of the implied emission factors for fuel–activity combinations have been varied between scenarios. Assumptions have not been made that technologies will fail except for the Euro 4/IV 5/V classes of vehicles for which current inventories include assumptions about the on-the-road NO_x emission performance of these vehicles.
- In the power sector the Industrial Emissions Directive provides a number of flexibilities which lead to outcomes which are not easily determinable. The DECC energy model provide predictions of central outcomes for these flexibilities. However there are a range of other outcomes for which the emission outcomes have not been calculated.
- There are a number of industrial sectors for which there is a limited number of operating plant. A decision by an operator to close a single plant will therefore make a significant difference to emissions from that sector. For projections purposes it has been assumed that plant operating in 2009 continue to operate with activity scaled on estimates of economic growth in that sector.

It can be seen that the ammonia emissions are strongly influenced by the assumptions made on animal numbers and the scale of switch in fertiliser use from ammonium nitrate to urea. Non-agricultural sources are a small proportion of emissions and so assumptions on energy use make little difference to the national total. Hence emissions in Scenarios 3 and 4 are higher than those in the other scenarios with less optimistic assumptions about the economic performance of the farming sector. None of the scenarios address any consequences of the current programme of reform of the Current Agricultural Policy.

The emissions of nitrogen oxides are strongly driven by assumptions about economic growth and fuel prices. The higher coal use scenarios represented by high fossil fuel prices and higher economic growth assumptions lead to increased coal use and resulting emissions. The transport NO_x emissions are dependent on the assumptions made about future transport activity. Hence Scenarios 3 and 4 give higher emissions. Scenario 5 which uses central growth and fossil fuel price assumptions but removes any climate policies shows a significant increase in NO_x emissions in 2030 as a result of an increase in natural gas use in power stations in the absence of energy efficiency measures.

Principal differences in the emissions of the PM pollutants are driven by assumptions on fuel use. Those scenarios with high fuel prices also have a larger price differential between coal and natural gas and so encourage a relatively higher coal use. Increased energy demand resulting from the high growth assumptions increases emissions of PM through a range of sources. A further factor is the effect of renewable energy policy on PM emissions in the domestic sector however these do not vary except in the climate policy free Scenario 5 which assumes lower levels of biomass use in 2020 and thereafter.

Sulphur dioxide emission uncertainties are dominated by assumptions about the future emissions from coal combustion in both power generation and industry. Emissions from power generation are dominated by assumptions on the amount of coal burnt, the average sulphur content in coal and the efficiency and operating characteristics of the FGD plant. Emissions from industry have similar uncertainties. The emissions from refinery combustion plant are assumed to meet the requirements of the Industrial Emissions Directive but no more. There is an uncertainty as UK refineries move from using predominately North Sea sourced crudes to a wider range of sources of crude oil as to the level of sulphur which will enter the refineries and the impact if any this may have on future emissions.

Emissions of non-methane volatile organic compounds (NMVOCs) vary between the scenarios principally as a result of the assumed changes in GDP growth which is assumed to drive emissions from the manufacture and use of solvent containing products. Hence the high growth scenarios have the higher VOC emissions.

Table 3-2 Results from Emission Scenarios (kilotonnes of pollutant)

Pollutant	Scenario	2005	2010	2015	2020	2025	2030
Ammonia (NH_3)	1	307	284	272	272	273	274
	2	307	284	272	272	273	274
	3	307	284	272	284	289	294
	4	307	284	272	296	305	315
	5	307	284	272	272	273	274
Nitrogen Oxides (NO_x)	1	1580	1106	916	670	587	561
	2	1580	1106	901	686	586	559
	3	1580	1106	910	708	612	589
	4	1580	1106	915	715	622	603
	5	1580	1106	932	689	642	638
Particulate Matter (PM_{10})	1	135	114	105	100	100	103
	2	135	114	105	100	100	103
	3	135	114	111	106	105	108
	4	135	114	117	109	106	109
	5	135	114	107	105	106	109
Fine Particulate Matter ($PM_{2.5}$)	1	81	67	59	54	54	55
	2	81	67	59	56	56	57
	3	81	67	59	57	57	59
	4	81	67	60	58	58	60
	5	81	67	60	58	58	60
Sulphur Dioxide (SO_2)	1	706	406	384	274	242	237
	2	706	406	370	286	247	240
	3	706	406	371	287	250	242
	4	706	406	372	289	253	245
	5	706	406	401	282	254	245
Non methane Volatile Organic Compounds (NMVOCs)	1	1088	789	714	702	707	717
	2	1088	789	714	701	706	716
	3	1088	789	715	705	712	725
	4	1088	789	717	709	719	734
	5	1088	789	716	708	714	726

Annex A

A.1 EMISSION PROJECTIONS METHODOLOGY

The table and graph below give a summary of the CO emissions in Scotland by broad NFR sector categories. The disaggregation of these categories is available in Appendix A (see Sector Category column). The detailed data are available in Appendix D.

The NAEI projection methodology broadly follows the methodology outlined in the EMEP / EEA Emission Inventory Guidebook 2009. In order to establish consistency between historic and projected emissions, emission inventories and emission projections should be based on the same structure. Therefore a similar method to that used to calculate historic emissions has been used to estimate future emissions. Historical emissions are calculated by combining an emission factor (for example, kilograms of a pollutant per million tonnes of fuel consumed) with an activity statistic (for example, million tonnes of fuel consumed). For more information see Passant et al (2012).

For example:

$$E_{2009} = A_{2009} * EF_{2009}$$

where E = emission, A = activity and EF = emission factor, for the baseline, year 2009.

For projected emissions:

$$E_i = A_i * EF_i$$

Where E = emission, A = activity and EF = emission factor, all for the projected year i from 2010 onwards. When the UEP43 projections were compiled, 2015 onwards were treated as projected years based on the 2009 NAEI inventory. The data for 2005 and 2010 in this report are the historic emissions estimates from the 2010 NAEI to the Commission in December 2011 under the requirements of the National Emission Ceilings Directive and to the CLRTAP in February 2012.

Activity Data Forecasts

To produce a projection, each source in the NAEI is linked to an activity driver. Examples of drivers may include forecasts of fuel use, vehicle kilometres, animal numbers or broader indicators such as forecasts of population, or economic indicators such as Gross Domestic Product (GDP) or Gross Value Added (GVA). The latest activity drivers are derived from a number of sources including the Department of Energy & Climate Change (DECC) latest energy forecasts published in October 2011. This provides projected sectoral energy demand data for the years 2010, 2015, 2020, 2025 and 2030.

The energy projections take into account the projected impacts of government policies that are deemed “firm and funded” at the time the projections are produced. The projections take into account the impact of all policies introduced before July 2009 including the full package of proposals and policies set out in the UK Low Carbon Transition Plan (LCTP)12 in July 2009 and the more recent

[12] http://www.decc.gov.uk/assets/decc/white%20papers/uk%20low%20carbon%20transition%20plan%20wp09/1_20090724153238_e_@@_lowcarbontransitionplan.pdf

Household Energy Management Strategy (March 2010) and so include the implementation of the European Union's Climate and Energy Package as well as UK energy and climate objectives.

Defra funded work to generate activity projections for the agricultural sector. These results from FAPRI were used to generate emissions of ammonia from the sector using the NARSES model provided by Rothampstead Research.

Other sources that are used to derive activity drivers include (but are not limited to) information from the Department for Transport (DfT) for the road transport and aviation sectors and information from trade associations.

Future Emission factors

In addition to changes in activity influencing emissions, improvements in abatement measures will reduce emissions. The implementation of more stringent abatement measures, often the result of established legal requirements, must be considered when estimating future emissions. Therefore the emission factors, where relevant, have been varied to account for this. The projections do not include the impact of additional policies and measures that are currently subject to review and have not yet been implemented into UK law.

In addition to legislation, emissions may be changed through closure of older, generally more polluting plants and/or commissioning of newer, generally less polluting plants. Such changes can affect the overall activity level within a sector as well as emission factors but for technical reasons it is preferable to deal with these in the projections as influencing emission factors only. Since historical emissions data are available up to 2009[13], at least some plant covered by the 2009 NAEI may have closed, been mothballed, or new sites may have started up. Changes in the immediate future can also be taken into account, although a judgement needs to be made about the likelihood of the change actually occurring. In the current economic situation, a number of site closures have been announced or proposed and, where appropriate, the impacts of these closures have been considered in these projections.

General assumptions: the Projections Scenario

The projections method presented here assumes in general that:

- All operators comply with new legislation;
- New abatement is applied to sources in order to meet the emission limits imposed by new regulations or in response to the impacts of trading mechanisms, but further emission reductions by voluntary actions over and above those levels are not achieved, unless this occurs anyway through actions in response to non-environmental factors e.g. replacing older, more polluting plant with newer technology on economic grounds.
- New measures such as Euro 6/VI road transport emission standards deliver the expected emission reductions

Cases where the projections do include reductions that might be considered to go beyond the minimum requirements of legislation include:

[13] The latest available historic year was 2009 when the projections were compiled in October 2011. However by February 2012, final emissions for the calendar year 2010 were also available.

- Projections from coating processes include the impact of product reformulation which in some cases may exceed the requirements of legislation;
- Power station emission projections are based on site- or plant design-specific fuel projection data (from UEP43) and anticipated plant modifications (from consultation with operators) that in some cases may go over and above the minimum legislative requirements;

Similarly for other heavy industry sectors, such as cement and iron & steel, the projections are based on site-specific emissions data and planned plant closures & modifications and improvements.

These exceptions aside, it is considered that the projections scenarios that are presented in this report only models the impacts of “firm and funded” policies. Further reductions may be achieved due to voluntary measures or unexpected / additional impacts of EU and UK policy measures. Future outturns of activity statistics are subject to considerable uncertainty. Section 3 addresses a range of scenarios which express some of these uncertainties.

QA / QC

The projections dataset is based on a database system into which quality assurance and quality control procedures have been built over several years. The projections database links to the main NAEI database, which helps to ensure that time series consistency between the historic and projected emission is maintained. The main NAEI database consists essentially of a table of activity data and a table of emission factors for the NAEI source categories, which are multiplied together to produce emission estimates. The projection database consists of activity drivers for each source-activity combination and a table of future emission factors.

The NAEI is subject to BS EN ISO 9001: 2000 and is audited by Lloyds and AEA Group internal QA auditors to test elements including authorisation of personnel to work on inventories, document control, data tracking and spreadsheet checking and project management.

In summary, the existing QA/QC system incorporates the following checking activities:

- Spreadsheet calculations are checked for internal consistency;
- Calculations and data sources are referenced within spreadsheets;
- Data entry into the database is peer-checked;
- Consistency checks are made to compare future projected emissions against historic estimates. A designated internal auditor identifies sources where large increases or decreases in emissions are expected and inventory staff are required to explain these changes to satisfy the auditor; and
- A final check is made by comparing the emissions generated in the latest dataset against previous projection versions. A designated checker identifies sources where there have been significant changes and inventory sector experts are required to explain these changes.

A.2 USE OF THE DECC ENERGY MODEL DATA

Projected fuel consumption for stationary sources in the air quality emissions projection model is predominantly based on the UEP outputs from the DECC energy projections. These outputs affect emissions from combustion in the energy, industry, services and residential sectors. In addition, the economic growth indices presented in the DECC energy projections for various economic sectors are used to project emissions from some of the industrial processes included within the inventory.

DECC's energy projections are based on the DECC Energy Model, a partial-equilibrium model of the whole UK energy market14. The projections are updated regularly and the dataset used in this analysis was published in October 2011 and is referred to as UEP43.

The projections are based on an analysis of historical trends in energy use and their relationship to such factors as economic growth and fuel prices. The projections take into account the impact of the policies including all policies introduced before July 2009 and the full package of proposals and policies set out in the UK Low Carbon Transition Plan (LCTP) in July 2009 and the more recent Household Energy Management Strategy (March 2010).

These policies replace the previous Supplier Obligation, CERT, CESP and Domestic Smart Meters but include some other policies such as an extension of the CERT to 2012. A list of the policies included is given in Table A.2.1.

Assumptions about fossil fuel prices, economic growth and other relevant factors are used in the model to investigate possible scenarios for UK energy demand and supply.

Table A 2.1 Summary of Policies included in UEP43

Residential sector
Building Regulations Part L (2002 & 2005/6)
Warm Front & Fuel Poverty Measures
Supplier Obligation (prior to LCTP)
Supplier Obligation (in LCTP)
Building Regulations 2010 Part
Smart Metering
EU Products policy (Tranche 1, Legislated)
EU Products policy (Tranche 2, Proposed)
Community Energy Saving Programme
Zero Carbon Homes
ECO and Domestic Green Deal
Renewable Heat Incentive
Commercial and Public Services
Carbon Trust Measures
Energy Performance of Buildings Directive
UK Emissions Trading Scheme
Building Regulations Part L (2002 & 2005/6)
Building Regulations Part L (2010)
Business Smart Metering
EU Products policy (Tranche 1, Legislated)
EU Products policy (Tranche 2, Proposed)
Small Business Energy Efficiency Interest-free Loans
Salix, Public Sector Loans, 10% commitment for Central Government
Non-Domestic Green Deal
CRC Energy Efficiency Scheme
Renewable Heat Incentive
Industry
Carbon Trust Measures

[14] http://hmccc.s3.amazonaws.com/pdfs/Final_Report_Dec_2008.pdf

UK Emissions Trading Scheme
Building Regulations Part L (2002 & 2005/6)
Building Regulations Part L (2010)
EU Products policy (Tranche 1, Legislated)
EU Products policy (Tranche 2, Proposed)
Small Business Energy Efficiency Interest-free Loans
Climate Change Agreements (2011-18)
Non-Domestic Green Deal
CRC Energy Efficiency Scheme
Renewable Heat Incentive
Transport
EU new car CO2 mid-term target - 130g/km CO2* in 2015
EU new car CO2 long-term target -95gCO2/km in 2020
Transport biofuel (8% by energy in 2020)
EU new van CO2 regulation – 147gCO2/km in 2020
EU complementary measures for cars
Low rolling resistance tyres for HGVs
Industry led action to improve HGV efficiencies
Local Sustainable Transport Fund
Low carbon buses
Rail electrification
Agriculture & Waste (non-CO_2)
Landfill tax
DEFRA waste policy (non-CO2)
Agriculture Action Plan

Fossil Fuel Price Assumptions

The DECC energy model outputs used in these projections are based on fossil fuel price assumptions which were published in October 2011[15]. Low, Central and High prices are used to explore uncertainty with projecting long term future fossil fuel prices. This analysis is based on a range of values; see Table A2.2 to A2.4. The estimates for UEP38 are given for comparison.

Table A 2.2 Oil Price from UEP43 (Oct 2011) and UEP38 (July 2009)

Oil Prices $/bbl						
	UEP 43 (October 2011) 2011 prices[16]			UEP 38 (July 2009) 2008 prices		
	Low	Central	High	Low	Central	High
2010	82	82	82	50	70	84
2015	101	114	121	58	75	102
2020	92	119	135	60	80	120
2025	83	124	152	Not estimated	Not estimated	Not estimated
2030	75	130	170	Not estimated	Not estimated	Not estimated

Table A 2.3 Table Gas Price from UEP43 (Oct 2011) and UEP38 (July 2009)

Gas Prices p/therm[17]				
	UEP 43 (October 2011) 2011 prices			UEP 38 (July 2009) 2008 prices
	Low	Central	High	Central
2010	44	44	44	58
2015	33	81	85	63
2020	36	70	95	67
2025	41	70	100	Not estimated
2030	45	70	100	Not estimated

Table A 2.4 Coal Price from UEP43 (Oct 2011) and UEP38 (July 2009)

Coal Prices				
	UEP 43 (October 2011) $/tonne 2011 prices[18]			UEP 38 (July 2009) £/tonne 2008 prices
	Low	Central	High	Central
2010	93	93	93	69
2015	106	124	146	50
2020	80	110	152	50
2025	80	110	155	Not estimated
2030	80	110	155	Not estimated

The main changes from the previous energy forecasts, (published in June 2010) include updating the economic growth assumption to reflect the UK economic position in October 2011 and ensure it is consistent with HM Treasury Budget forecasts, revisions to household projections and revised policy appraisals and carbon price assumptions.

[15] http://www.decc.gov.uk/assets/decc/11/about-us/economics-social-research/2933-fossil-fuel-price-projections-summary.pdf
[16] http://www.decc.gov.uk/assets/decc/11/about-us/economics-social-research/2933-fossil-fuel-price-projections-summary.pdf
[17] http://www.decc.gov.uk/assets/decc/11/about-us/economics-social-research/2933-fossil-fuel-price-projections-summary.pdf
[18] http://www.decc.gov.uk/assets/decc/11/about-us/economics-social-research/2933-fossil-fuel-price-projections-summary.pdf

The UEP43 projections have been updated to reflect the revised policy saving estimates, revised DECC fuel and carbon price projections, revised Office for Budget Responsibility growth projections and revised generation cost estimates for the power sector.

Renewable energy

UEP43 outputs provide an estimate of the projected total energy supplied from renewable sources in future years. A further breakdown into the following categories has been provided by DECC:

- Wind
- Large hydro
- Co-firing
- Waste
- Other (excluding co-firing)

We have revised the way in which we use UEP data to calculate future use of renewable fuels. This has been done both to ensure that estimates of future activity were as consistent as possible with the headline UEP data, but also to try to ensure that the NAEI projections were more realistic in identifying those renewable fuels whose use would grow, and those renewable fuels which would not. Development of the methodology is limited to some extent by the structure of the NAEI itself which reflects historical usage of renewable energy rather than future uses. For example, the NAEI does not currently make any distinction between wood that is co-fired with coal in power stations and wood that is burnt in dedicated wood-powered power stations, simply because there are very few dedicated stations at the moment and so, historically speaking, it is a trivial source. Changes may be needed to the structure of the NAEI to allow further development of the projections in this area.

A.3 PROJECTIONS METHODOLOGY BY SOURCE SECTOR

This section provides details of the approach taken to forecasting emissions for the most important sectors where the activity data or emission factors differ from the 2009 baseline.

Power stations (NFR 1A1a)

In the past, the air quality emission projections were based on the use of the absolute values for fuel demand given in the UEP data, but this caused problems in practice due to the different structure of the UEP and NAEI baseline data sets, and in some cases due to different fuel allocations for a source sector in the start-year for projections (i.e. the latest inventory year). Following consultation with the DECC Energy Model team to gain an improved understanding of the applicability of their data, we have reviewed our approach and have moved to using the trends shown in the UEP data and applying the same trends to the NAEI baseline data.

As part of the UEP43 projection compilation the projected emission factors for coal fired power stations for NOx, PM10, SO2 and landfill gas powered power stations for PM10 using data in the Multi-pollutant Measures database were reviewed. The revised projected emission factors were derived on a case by case basis taking into account recently adopted legislations such as the Industrial Emissions Directive (IED) including the implication of new emission limit values (ELVs) as well as technology developments up to 2030 , see Table A3.1.

Table A 3.1 Summary of revised projected EFs for Power Stations.

Source	Activity	Pollutant	Commentary on changes to emission factors
Power stations	Coal	NO_x	Incorporate impact of tightening of emission limit values under the IED (from 500 to 200 mg/Nm3)[†],including progressive uptake based on limited life derogation. Incorporate relative impact of Carbon Capture Storage (CSS) uptake and relative factors for NO_x emissions for different combustion technologies (compared to non-CCS plant).
		PM_{10}	Incorporate impact of tightening of emission limit values under the IED (from 50 to 20 mg/Nm^3), including progressive uptake based on limited life derogation. Incorporate relative impact of CCS uptake and relative factors for PM_{10} emissions for different combustion technologies (compared to non-CCS plant).
		SO_2	Incorporate impact of tightening of emission limit values under the IED (from 400 to 200 mg/Nm^3), including progressive uptake based on limited life derogation. Incorporate impact of changes in biomass co-firing. Incorporate relative impact of CCS uptake and requirement for SO_2 removal, including relative factors for SO_2 emissions for different combustion technologies (compared to non-CCS plant).
		NMVOCs	No change

Source	Activity	Pollutant	Commentary on changes to emission factors
	Landfill gas	NO_x	Change to baseline and all future emission factors based on UK test data from 2002 and applicable ELVs.
		PM_{10}	Change to baseline and all future emission factors based on UK test data from 2002.
		SO_2	N/A
		NMVOCs	No change

Source: AMEC, 2011

† the mg/ Nm3 unit here is short hand for the flue gas concentration normalised to the appropriate conditions of temperature, pressure, oxygen and moisture contents for the source type; it is not introducing a unit of force - the Newton.

Refineries (1a1b)

As part of the UEP43 projection compilation the projected emission factors for refineries burning fuel oil for NOx, PM10, SO2 were reviewed. The revised projected emission factors were derived on a case by case basis taking into account recently adopted legislations such as the IED including the implication of new ELVs, see Table A3.2. For NOx, in order to meet the 2016 IED ELVs a number of large combustion plants (LCPs) at UK refineries will require additional abatement measures, such as switching to natural gas, Selective Catalytic Reduction (SCR) and Selective Non-Catalytic Reduction (SNCR). Fuel switching to natural gas will not impact the emission factor for fuel oil as such, but will impact the activity rate.

Table A3.2 Summary of revised projected EFs for Refineries - combustion

Source	Activity	Pollutant	Commentary on changes to emission factors
Refineries - combustion	Fuel oil	NO_X	Revision to future emission factors based on changes in ELVs under the IED.
		PM_{10}	No change
		SO_2	No change
		NMVOCs	No change

Source: AMEC, 2011

Combustion AT Collleries (1a1c)

The projected NH_3 emission for coal is now kept constant in future years because there is no evidence that NH_3 emission will vary in the future for this sector (Hobson, 2011).

Iron and steel Combustion plant (1A2a)

Previously, future factors for steel-making processes (coke ovens, sintering, blast furnaces, oxygen furnaces) were based on use of 2008 emission estimates from Corus, combined with the assumption that various processes on the Teesside site are no longer in operation from 2010 onwards.

For the UEP43 projections, this approach was modified slightly. Firstly, the future emission factors were based on 2009 emissions data which have been supplied by Corus, now Tata Steel Europe, for use in the 2009 NAEI Inventory. The mothballed Tata Teesside operations were sold in 2010 to SSI

UK, with production aimed to start again in 2012. For 2015 onwards, it is assumed that the Teesside works are operating with emission factors at 2009 levels.

Other industrial combustion (NFR 1A2fi)

As part of the UEP43 projection compilation the projected emission factors were reviewed for Other Industrial combustion burning coal for NOx, PM10, SO2 and NMVOCs. The revised projected emission factors were derived on a case by case basis taking into account recently adopted legislations such as the IED including the implication of new ELVs, see Table A3.3.

Table A 3.3 Summary of revised projected EFs for Other Industrial Combustion, coal.

Source	Activity	Pollutant	Commentary on changes to emission factors
Stationary combustion in manufacturing industries and construction	Coal	NO_x	Revision to future emission factors based on decline in emission factors for the LCP component due to the IED ELVs of Annex V Part I coming into force on 1 Jan 2016 for plants not opting into the Limited Life Derogation (LLD). Emission factors assumed to remain constant for small combustion plants (SCPs) as set out in the process guidance note for 20-50MWth plants (PG 1/3 (95).
		PM_{10}	Revision to future emission factors based on decline in emission factors for the LCP component due to the IED ELVs of Annex V Part I coming into force on 1 Jan 2016 for plants not opting into the Limited Life Derogation (LLD). Emission factors assumed to remain constant for small combustion plants (SCPs) as set out in the process guidance note for 20-50MWth plants (PG 1/3 (95).
		SO_2	Revision to future emission factors based on decline in emission factors for the LCP component due to the IED ELVs of Annex V Part I coming into force on 1 Jan 2016 for plants not opting into the Limited Life Derogation (LLD). Emission factors assumed to remain constant for small combustion plants (SCPs) as set out in the process guidance note for 20-50MWth plants (PG 1/3 (95).
		NMVOCs	No change

Source: AMEC, 2011

Road transport (NRF 1A3b)

This section sets out the key assumptions and main changes to the Road Transport emissions projections (Base 2011). The NAEI baseline remains the same in UEP43 compared to the previous update.

Changes to the activity data include;

- Updated traffic forecasts (RTF11) for GB produced by the ITEA Division of the Department for Transport, except for London, where traffic growth rates from Transport for London (TfL) replaced DfT's forecasts for London.
- For Northern Ireland, traffic is assumed to grow at GB average rates for appropriate area types due to lack of suitable traffic projections data for Northern Ireland.
- For London, a different set of growth factors, as provided by TfL, is used and applied to LAEI 2008 total vehicle kilometres for London (GLA). The growth factors are the latest estimates provided in December 2010, and they are for 2016 and 2031 (relative to 2006).

Changes to the fleet turnover and other assumptions include:

- Updated NOx emission factors and degradation methodology based on COPERT 4 v8.1
- Revised diesel penetration rate in the car fleet using SMMT diesel car sales forecasts for 2011-2013, and keep the SMMT value in 2013 (at 50.5%) until 2016 then fall (linearly) to 43% in 2020 as agreed with DfT. Previous assumptions were sales rise to 43% by 2010 and stay constant thereafter.
- Revised assumption on diesel/petrol car mix by different road types (urban, rural and motorway) based on Automatic Number Plate Recognition (ANPR) data.
- Vehicle sales projections are re-forecasted based on actual level in 2010; in the case for cars & LGVs, the Society of Motor Manufacturers and Traders (SMMT) provide sales projections for 2011-2013.
- Included electric vehicles (central case) information provided by DfT. We assume electric cars have zero emissions at the point of use and the impact happens in urban areas.

Other transport (1A3a/c/d, 1a5b)

Growth in the shipping sector has been taken from UEP43 and it has been assumed that all ships will comply with the Marpol VI agreement requiring marine fuel oil to have a sulphur content no higher than 1.5%. Whilst legally, Marpol only applies to ships in the North Sea as this has been designated a sulphur emissions control area (SECA), it has been assumed that ships in other UK waters will also meet this standard due to no data being available on the split between fuel consumption in the North Sea and other sea areas.

The rail emission projections have been revised following a revision of the emission factors for PM and NOx. Reason for the change has been the engine replacement programme for Type 43 locomotives which replaced Paxman VP185 engines with MTU units that meet Stage IIIA NRMM emissions standards.

As part of the UEP43 projections compilation Aether reviewed the projected NH3 emission factors for off-road mobile machinery (industrial off-road mobile machinery, house and garden machinery, agriculture - mobile machinery and aircraft support vehicles). NH3 emissions from these sources are now kept constant based on the fact that there is unlikely to be any change in NH3 emission per weight of fuel combusted (Hobson 2011). This approach is in line with the EMEP/EEA Guidebook 2009.

Domestic combustion of gas (nfr 1a4b)

Previously, the NAEI and the projections have used a constant emission factor for estimates of NOx from the domestic combustion of gas. We have reviewed this assumption and conducted research into the sector and technologies as part of the NAEI improvement work, and it is evident that NOx emission factors have fallen as domestic boiler technology has improved. Voluntary emission standards within the industry have been developed that indicate that current technology achieves NOx emission levels that are far lower than the emission factor previously applied in the NAEI. The new future emission factors reflect the phased impact of boiler technology and stock renewal.

Cement & Lime Production (NFR 2a1/2)

Future factors for cement works were updated to take account of changes in reported emissions for 2009. A similar approach was adopted for lime works which use coal as a fuel, because reported emissions showed a large drop in 2009, compared with 2008. A future factor, based on the 2009 reported emissions was therefore introduced to avoid projected emissions being based on the much higher emissions reported for 2008.

Sinter production (NFR 2C1)

As part of the UEP43 projection compilation AMEC have reviewed the projected emission factors for other sinter production plants burning coke for NOx, PM10, SO2 and NMVOCs. The revised projected emission factors were derived on a case by case basis taking into account recently adopted legislations such as the IED including the implication of new ELVs, see

Table A 3.4 Summary of revised projected EFs for Sinter production, coke.

Source	Activity	Pollutant	Commentary on changes to emission factors
Sinter production	Coke	NOx	2009 baseline EF left constant rather than changing as the previous projections, based on review of IED requirements.
		PM_{10}	No change
		SO_2	2009 baseline EF left constant rather than changing as the previous projections, based on review of IED requirements.
		NMVOCs	No change

Source: AMEC, 2011

Primary aluminium (NFR 2c3)

In September 2009, one of the UK's two large primary aluminium smelters closed. We have used historical activity data for the remaining large plant and another, much smaller plant to model the impact of the closure on emissions from aluminium production in the UK from 2010 onwards. Emission factors for the sector have been held constant, but a further development in future would be to develop future factors for the sector that took into account any differences in emission rates at the closed and the remaining smelters.

Agriculture (NFR 4)

Projections of livestock and fertilizer use to 2019 were revised using data derived from FAPRI[19]. The projected emissions for livestock and nitrogen fertiliser use were calculated using the NARSES model, see Table A3.5. It was assumed that the current trend to higher urea use replacing ammonium nitrate in Great Britain will continue and that recent improvements in nitrogen use efficiency may begin to reverse as increasing food prices move the position of the economic optimum towards higher yield.

[19] http://archive.defra.gov.uk/evidence/economics/foodfarm/reports/fapri/GHG%20Paper%20(Dec%202010).pdf

Table A 3.5 Summary of revised projected emissions for Agriculture

Source	Pollutant	Commentary on changes to emission
Livestock numbers	NH_3	Previously, livestock number projections were based on projections made in Defra project SFF0601 (Baseline projections for Agriculture), using June 2004 census data as the base year. However, these have now been replaced with projections based on FAPRI data. In addition, trends in N excretion and fertiliser use were included.
Fertiliser use	NH_3	Previously, fertiliser use projections were also taken from Defra project SFF0601, using 2004 data as the base year. These are still used as the basis of the revised projections, but have been revised according to FAPRI projections of crop production.
Farm management practices	NH_3	For the default scenario, therefore, it has been assumed that no changes will take place in management practice in the absence of legislation or incentive schemes. IPPC legislation has a continued impact on the practices of large pig and poultry farms from 2007 onwards.

Source: AMEC, 2011

With regards to non-agriculture sources, the NH3 emission factors for domestic pets and Field Burning of agricultural wastes are now kept constant in the absence of projected data (Hobson, 2011).

Waste treatment and disposal (NFR 6)

As part of the UEP43 projections update the NH3 emissions from Waste treatment and Disposal were reviewed.

Table A 3.6 Summary of revised projected Emission Factors for Landfill.

Source	Activity	Pollutant	Commentary on proposed changes to emission factors
Landfill	Non-fuel combustion	NH_3	The projected emission factors are now kept constant to 2030 in line with the recent CEH study[20].

[20] Ammonia emissions from UK non-agricultural sources in 2009: contribution to the NAEI. Dragosits and Sutton. CEH, April 2011 http://nora.nerc.ac.uk/14264/

References

AMEC (2011), Support on improvements to existing NAEI projections and extension to 2030, AMEC Environment & Infrastructure UK Limited, October 2011

Hobson (2011), Non-agricultural ammonia emission projections, Aether, August 2011

Rothamstead Research (2011), Misselbrook T H, Chadwick D R, Gilhespy S L, Chambers B J, Smith K A, Williams J and Dragosits U, Inventory of Ammonia Emissions from UK Agriculture 2010, DEFRA Contract AC0112, September 2011

NR Passant, A Wagner, TP Murrells, Y Li, S Okamura, G Thistlethwaite, HL Walker, C Walker, R Whiting, S Sneddon, RA Stewart, NCJ Brophy, J MacCarthy, I Tsagatakis, T Bush, UK Informative Inventory Report (1980 to 2009), AEA Group, March 2011