Comparison of NOx emissions between diesel cars and EfW incinerators
by
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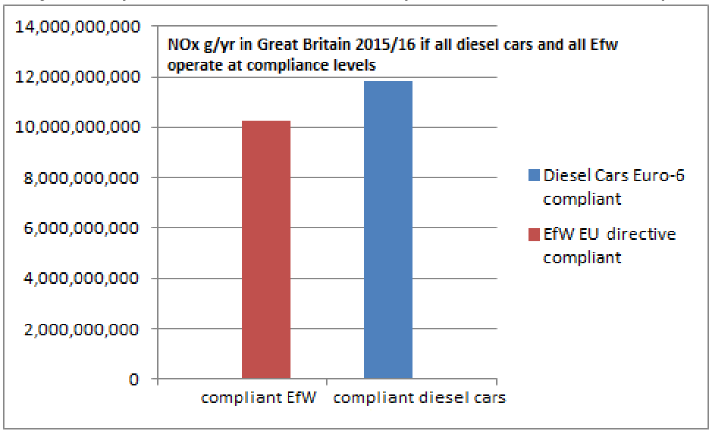
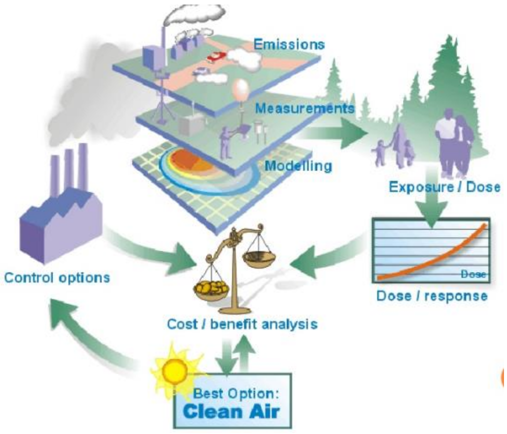
Summary

It is a widely held belief that the majority of NOx pollution levels come from diesel cars and that from EfW incinerators is insignificant by comparison. But is it true?

NOx emissions from all the EfW incinerators in Great Britain match the NOx emissions from all the diesel car journeys in Great Britain if they were all Euro-6 compliant.





DEFRA & COMEAP have started to accept the adverse health impacts of NOx emissions and have published an economic cost per tonne totalling £134m/yr.

	Nox g/yr	NOx tonne/yr	factor	Damage cost/yr
2015/16 GB incinerators	10,223,242,722	10,223	£13,131	£134,241,400

This analysis takes the Greatmoor EfW incinerator as a representative example and computes the amount of NOx emitted by in a year of 8,000 operating hours as 303,964,800 g/year.

To gauge the scale, this is 140 times greater than measured diesel car traffic on the A41 past the incinerator, or put another way there would need to be 407,116 Euro-6 compliant diesel cars per day travelling the 28km between Aylesbury & Bicester to emit the same amount of NOx as the incinerator in the same day.

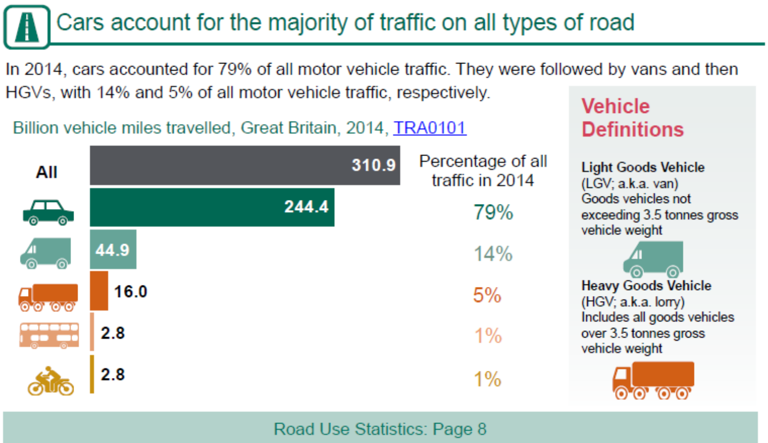
Another widely held belief, is that emissions to the atmosphere from the tall chimney are diluted and disappear in the atmosphere. However NOx are heavier than air so sooner or later fall to the ground somewhere (in the absence of chemical reaction to turn it into Nitric Acid or Ozone Greenhouse gas). Every gram emitted falls to the ground somewhere, that somewhere being controlled by weather conditions.
On cloudless, windless days the emissions will fall to ground near the source and will be equivalent to 407,096 Euro-6 compliant diesel cars per day circling the site.

With wind, the emissions from Greatmoor will fall to ground elsewhere - but emissions from other EfW incinerators in the country will fall to ground around Greatmoor.

Diesel car emissions

Great Britain road use:

Department of Transport has just published Road Use Statistics 2016[1] which shows :



of which diesel cars are 37.8% (by vehicle license)[2]

	A	B	C	D	E	F	G	H
1	Department for Transport statistics							
2	Vehicle Licensing Statistics (https://www.gov.uk/government/collections/vehicles-statistics)							
3								
4	Table VEH0203							
5	Cars licensed by propulsion / fuel type, Great Britain, from 1994; also United Kingdom from 2014							
6								
7	Great Britain							Thousands/*Percentages*
8	Year	Petrol	Diesel	Hybrid Electric	Gas[1]	Electric	Other[2]	Total
54	2015	61.2	37.8	0.8	0.1	0.1	-	100.0

244.4 billion car miles ie 244,400,000,000 miles or 391,000,000,000 km per year of which 37.8% are by diesel cars -ie 147,813,120,000 km/yr if using vehicle license as a guide.

Euro 6 vehicle emission limits[3]

Table 1. The light-duty Euro 5 and Euro 6 vehicle emission standards on the New European Driving Cycle (NEDC)

Pollutant	Euro 5 Light-Duty		Euro 6 Light-Duty	
	Gasoline	Diesel	Gasoline	Diesel
CO	1.0	0.5	1.0	0.5
HC	0.1[a]		0.1[a]	
$HC+NO_x$		0.23		0.17
NO_x	0.06	0.18	0.06	0.08
PM	0.005[c]	0.005	0.005[c]	0.005
PN (#/km)		6.0×10^{11}	6.0×10^{11} [d]	6.0×10^{11}

[a] and 0.068 g/km for NMHC; [c] applicable only to DI engines, 0.0045 g/km using the PMP measurement procedure; [d] applicable only to DI engines, 6 x 1012 #/km within the first three years of Euro 6 effective dates.

Diesel cars are currently known to exceed Euro-6 emission limits, but assuming they all manage to conform, then nationally this produces 147,813,120,000 km x 0.08 g/km
ie **11,825,049,600 g of NOx per year**

[1] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/514912/road-use-statistics.pdf
[2] https://www.gov.uk/government/statistical-data-sets/veh02-licensed-cars
[3] http://www.theicct.org/sites/default/files/publications/ICCT_Euro6-VI_briefing_jun2016.pdf

EfW incinerator emission flow rates

Greatmoor

Environmental statement[4] presented as part of the Planning Application for Greatmoor

WRG: Greatmoor EfW 26 411.0197.00783
Technical Appendix 6/A: Atmospheric Dispersion Modelling

Parameter / Source	Value
Stack Height (m)	95
Volume Flow [(a)] (273K, 11%, dry)	52.77 m^3/s / 189978 m^3/hr
Emission Temperature [(a)] (ºK)	403
Oxygen Content [(a)] (% O_2 dry)	8.5
Oxygen Content [(a)] (% O_2 wet)	6.9
Moisture content [(a)] (% H_2O)	18.7
Actual Flow Rate (stack conditions)	76.58 m^3/s / 275675 m^3/hr
Emission velocity (m/s)	15.6

Table Note: (a) Design flow rate provided by manufacturers.

Exhaust volume emitted 189,978 m3/hr or 4,559,472 m^3/day or 1,519,824,000 m^3/(8,000hr)yr

Assuming the incinerator does not breach Waste Incineration Directive (WID) or Environmental Permit[5] daily limits for NOx of 200mg/m3 the incinerator emits 200mg*4,559,472m3 or 911,894g of NOx /day

Plymouth

Table 5-1
Emission Characteristics from Stack

Parameter / Source	Line 1	Line 2
Stack Location NGR (x,y)	259518, 54726	259520.8, 54726.9
Stack Diameter (m)	1.6	1.6
Basal Stack Elevation (m AOD)	60.0	60.0
Stack Exhaust Height (m)	90.0	90.0
Volume Flow [(a)] (m^3/s) (273K, 11%, dry)	26.31	26.31
Emission Temperature [(a)] (ºC)	140.0	140.0
Oxygen Content [(a)] (% O_2 wet gas)	7.82	7.82
Moisture content [(a)] (% H_2O)	16.28	16.28
Actual Flow Rate (Am^3/s)	40.72	40.72
Emission velocity (m/s)	20.25	20.25
(a) Design flow rate provide by manufacturers.		

Normalised exhaust volume for each stream is 26.31 m^3/sec ie 94,716 m^3/hr or 2,273,184 m^3/day each stream totalling 303,091,200 m^3/yr for a 275,000tpa capacity incinerator.

[4] http://www.fccenvironment.co.uk/assets/files/pdf/Greatmoor/environmental-statement/chapter6/appendix-6-a.pdf
[5] http://www.fccenvironment.co.uk/assets/files/pdf/Greatmoor/permit-2013.pdf

Worcestershire - Hartlebury

The Planning Application for a 200,000tpa incinerator at Hartlebury

Table 13.4 Source and Emissions Data

Item	Unit	Quantity
Stack Height (from ground level)	m	75
Effective Internal Stack Diameter	m	2.1
Stack Position (E,N)	m, m	385974, 269904
Stack Flue Gas Exit Velocity	m/s	15.37
Flue Gas Conditions		
Temperature	°C	150
Oxygen	% v/v, dry	8.0
Moisture Content	% v/v	18.02
Vol at reference conditions	Nm^3/s	36.5
	Nm^3/h	131,371
Vol at discharge conditions	Am^3/s	53.05
	Am^3/h	190,992
Emissions	**Conc. (mg/m^3)**	**Rate (g/s)**
Nitrogen Oxides (as NO_2)	200	7.298
Sulphur Dioxide	50	1.825
Carbon Monoxide	50	1.825
Particulates (PM_{10})	10	0.365
Particulates ($PM_{2.5}$)	3.33	0.122
Hydrogen Chloride	10	0.365
Hydrogen Fluoride	1	0.036
VOCs	10	0.365
Mercury	0.05	0.365
Cadmium and Thallium	0.05	1.825 mg/s
Other Metals	0.5	1.825 mg/s
PAHs	0.002	18.25 mg/s
Dioxins and Furans	0.1 ng/m^3	73.0 µg/s
The emission concentrations are expressed at the reference		

Normalised exhaust volume is 36.5 m^3/sec ie 131,371 m^3/hr or 3,152,904 m^3/day for a 200,000tpa capacity incinerator.

Cardiff - Trident park

Viridor: Trident Park 36 402.0036.00306B
Air Quality: Technical Appendix 19-1 January 2010

Table 5-1
Emission Characteristics from Stack

Parameter / Source	Line 1	Line 2
Stack Diameter (m)	1.78	1.78
Stack Height (m)	90.0	90.0
Volume Flow [(a)] (m^3/s) (273K, 11%, dry)	31.6	31.6
Emission Temperature [(a)] (°C)	140	
Oxygen Content [(a)] (% O_2)	9.57 (in dry gas)	
Moisture content [(a)] (% H_2O)	16.42	
Actual Flow Rate (Am^3/s)	50.0	
Emission velocity (m/s)	20.1	

(a) Design flow rate provided by manufacturers.

Normalised exhaust volume for each stream is 31.6 m^3/sec ie 113,760 m^3/hr or 2,730,240 m^3/day each stream totalling 364,032,000 m^3/yr for a 275,000tpa capacity incinerator.

EfW Incinerator NOx emissions

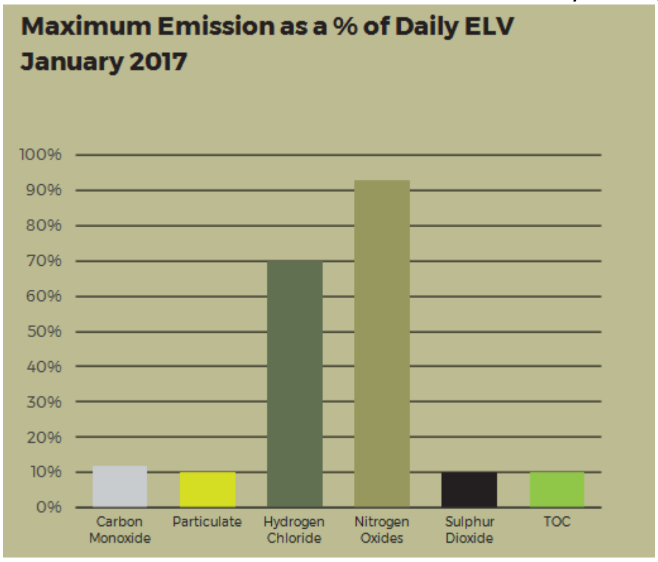
WID/ Industrial Emissions Directive

Table 2-3
WID Emission Limit Values

Pollutant	Emission Limits (mg/Nm^3) [a] Daily average values	Half hourly averages 100th Percentile	97th Percentile
Particles	10	30	10
TOC	10	20	10
HCl	10	60	10
HF	1	4	2
SO_2	50	200	50
NOx	200	400	200
CO [b]	50	150	100
	Spot sample measurements		
Group 1 metals [c]	0.05		
Group 2 metals [d]	0.05		
Group 3 metals [e]	0.5		
Dioxins and furans [f]	0.0000001		

Notes:
(a) Concentrations referenced to temperature 273 K, pressure 101.3 kPa, 11% oxygen, dry gas.
(b) 150 mg/Nm^3 of combustion gas for at least 95% of all measurements determined as 10 minute averages or 100 mg/Nm^3 of combustion gas of all measurements determined as half-hourly average values taken in any 24 hour period.
(c) Cadmium (Cd) and thallium (Tl)
(d) Mercury (Hg)
(e) Antimony (Sb), arsenic (As), lead (Pb), chromium (Cr), cobalt (Co), copper (Cu), manganese (Mn),

Typically NOx emissions are maintained close to the daily average value of 200mg/m^3



Summary

site	Tonne/yr	Stack m^3/hr	Stack NOx g/day	Stack m^3/yr*	Stack NOx g/yr*		NOx g/yr per Tonne
Greatmoor	300,000	189,978	**911,894**	1,519,824,000	**303,964,800**		1,013
Hartlebury	200,000	131,371	**630,581**	1,050,968,000	**210,193,600**		1,051
Plymouth	275,000	189,432	**909,273**	1,515,456,000	**303,091,200**		1,102
Cardiff	350,000	227,520	**1,092,096**	1,820,160,000	**364,032,000**		1,040

* an incinerator year consists of 8,000 operating hrs (ie 333.33 days)

This confirms that the amount NOx emitted by different incinerators is very similar scaled by nominal tonne per annum (tpa) capacity.

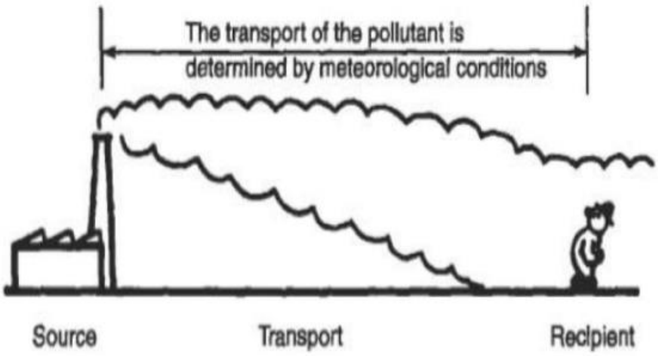
Air dispersion

NOx is a mix of various oxides of Nitrogen. The Specific Gravity (Air = 1.0) of the main components NO , NO_2 and N_2O) are 1.037 , 1.45 and 1.530 respectively so will fall to the ground somewhere depending on wind velocity in concentrations depending on dispersion and mixing with emissions from other sources.

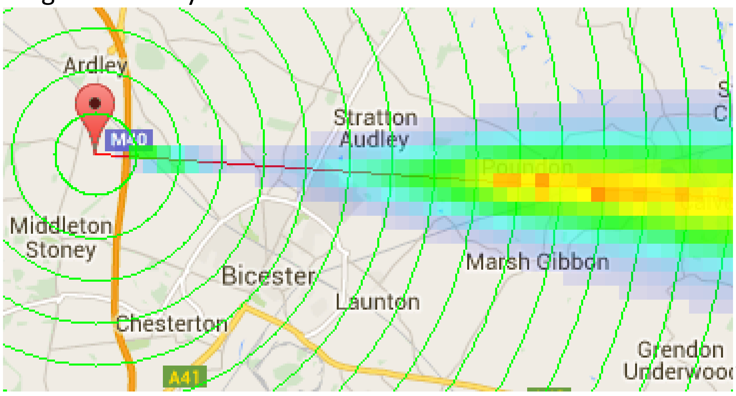
" *Greatest concentrations will be at a distance from the stack (determined by the release conditions and meteorology) after which concentrations will decrease nonlinearly with distance*."[6]

An air pollution problem involves three parts:

- The pollution source
- The movement or dispersion of the pollutant
- The recipient



Planning applications contain ground-level environmental impact assessments based on either of two air dispersion modelling software systems AEROMOD or ADMS



[7]

Immediate problems with such modelling:

(a) The plume is assumed to be homogenous for all constituent gasses and particulates - ie the dispersion pattern for each is assumed to be the same - heavy particulates (ie smoke) is assumed to behave identically to light gasses

(b) The effect of rain is ignored. This therefore ignores the combination of NOx & SO2 to form "acid rain" and which gets precipitated in a totally different way from free gasses in dry conditions.

(c) The effect of inversion layers which occur from time to time in windless conditions is also ignored.

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[6] https://www.hindawi.com/journals/jeph/2013/560342/

[7] http://plumeplotter.com/ardley/

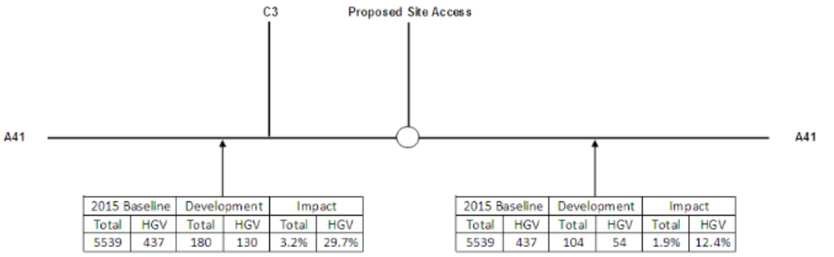
Traffic count reference check

Greatmoor A41

To get an idea of the scale of car journeys, in 2015 the application for the new Greatmoor access road[8] made a baseline count of 5,102 cars during daytime (7am to 7pm) on the A41 between Westcott and Kingswood.

7D.17 Figure 7D-2 below considers this increase in terms of percentage impact when set against the 12 hour (0700-1900HRS) 2015 background traffic. The consented IVC facility traffic has been added to the baseline. It should also be noted that this exercise has been based upon 12 hour traffic flows, not 24 hour, reflecting hours of operation.

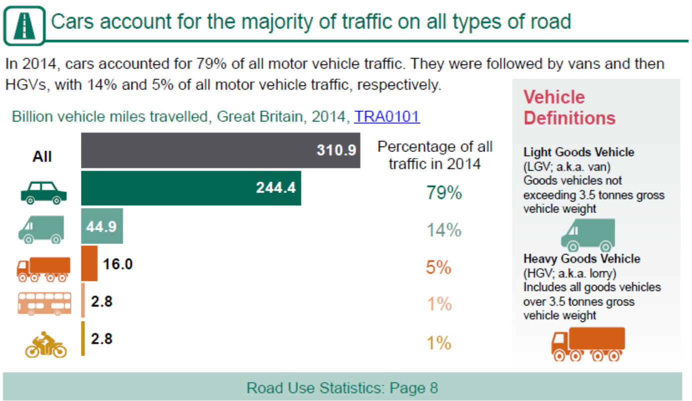
Figure 7D-2
12 Hour Two-Way AAWT Flow Impact



Assuming the night-time number of cars is 1/2 the daytime and applying the 37.8% diesel factor means that **2,893** diesel cars on average per day were travelling on the A41 past the Greatmoor access road.

Heathrow

The average daily traffic of 263,000 vehicles a day recorded[9] in 2014 between junctions 14 and 15 (a distance of 2km) of the M25 near Heathrow flowing past the Lakeside incinerator.



Department for Transport survey found 79% of vehicle traffic are cars so applying this to 263,000 vehicles means 207,770 cars/day
Government statistics[10] show that 37.8% of all license registrations are for diesel cars Applying the same 37.8 % means **78,537** diesel cars per day travelling between J14 & J15 of the M25

It is 2km between the two junctions so 78,537 Euro-6 compliant diesel cars per day emit 78,537 x 2km x 0.08 ie 12,566 g/day NOx or **4,586,564 g of NOx /year**

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[8] http://www.fccenvironment.co.uk/assets/files/pdf/Greatmoor/sup-planning-sub-sept-2011/section7d-highway-traffic/section-7d-highways-traffic.pdf
[9] Department for Transport Road Traffic Estimates: Great Britain 2014
[10] https://www.gov.uk/government/statistical-data-sets/veh02-licensed-cars

Comparison of NOx emission between individual incinerators and diesel cars travelling past

Greatmoor

2,893 Euro-6 compliant diesel cars / day travelling the 28km between Aylesbury & Bicester on the A41 past the incinerator would emit 2,893 x 28km x 0.08 g/km = 6,480 g of NOx /day

The incinerator emissions to are 911,894 g / 6,480 g = 140 times greater than the measured diesel car movements on the A41 travelling the 28km between Aylesbury & Bicester.

Put another way, there would have to be 140 x 2,893 ie 407,116 Euro-6 compliant diesel cars travelling the 28km between Aylesbury & Bicester per day to emit the same amount of NOx as the incinerator in the same 24 hours

Lakeside (beside the M25 opposite Heathrow's Terminal 5 turn-off)

The Lakeside incinerator has a capacity of 400,000tpa so scaling Greatmoor would mean 911,894 x (400,000 / 300,000) ie 1,215,859 g of NOx /day

78,537 Euro-6 compliant diesel cars / day travelling the 2km between J15 & J16 on the M25 past the incinerator would emit 78,537 x 2km x 0.08 g/km = 12,566 g of NOx /day

The incinerator emissions to are 1,215,859 g / 12,566 g = 97 times greater than the measured diesel car movements on the M25 travelling the 2km between J15 & J16.

Put another way, there would have to be 97 x 78,537 ie 7,618,089 Euro-6 compliant diesel cars travelling the 2km between J15 & J16 per day to emit the same amount of NOx as the incinerator in the same 24 hours

EfW Incinerators in Great Britain (Feb 2017)

County	Location	tpa
Avon	Severnside	400,000
Berkshire	Colnbrook / Lakeside	425,000
Buckinghamshire	Greatmoor	300,000
Cambridgeshire	Peterborough / Fengate	85,000
Cheshire	Ellesmere Port	100,000
Cornwall	St Dennis	240,000
Devon	Exeter / Matford Park	60,000
Cornwall	Devonport / North Yard	265,000
Hampshire	Basingstoke / Chineham	102,000
Hampshire	Marchwood	220,000
Hampshire	Porstmouth	210,000
IoM	Richmond Hill	60,000
Kent	Allington	500,000
Lincolnshire	Grimsby / Stallingborough	56,000
Lincolnshire	Whisby Rd / North Hykeham	154,000
London	Edmonton	620,000
London	Belvedere / Riverside	585,000
London	SELCHP	420,000
Manchester	Bolton / Raikes Lane	130,000
Nottinghamshire	Eastcroft	260,000
Oxfordshire	Ardley	300,000
Scotland	Dundee / Baldovie	120,000
Scotland	Dunbar	300,000
Shropshire	Shrewsbury / Battlefield	90,000
Staffordshire	Cannock / Four Ashes	340,000
Staffordshire	Stoke on Trent	210,000
Suffolk	Ipswich	270,000
Sussex	Newhaven	242,000
Teeside	Tees Valley / Billingham lines 1,2,&3	390,000
Teeside	Tees Valley / Billingham lines 4 & 5	256,000
Teeside	Tees Valley / Billingham line 6	200,000
Wales	Cardiff Bay / Trident Park	350,000
Wales	Swansea / Crymlyn Burrows	166,000
West Midlands	Dudley	105,000
West Midlands	Wolverhampton	118,000
West Midlands	Birmingham / Tyseley	400,000
West Midlands	Coventry / Bar Road	315,000
Yorkshire	Kirklees	136,000
Yorkshire	Sheffield	225,000
Yorkshire	Leeds / Cross Green	214,000
		=========
		9,939,000
In Construction/commissioning		
London	Sutton / Beddington (SLWP)	302,000
Scotland	Edinburgh / Millerhinn	300,000
Worcestershire	Kidderminster / Hartlebury	200,000

Yorkshire	Ferrybridge FM2 (FM1 is RDF only)	570,000
Yorkshire	Knaresborough / Allerton	320,000
Gloucestershire	Quedgeley / Javelin Park	190,000
		=========
		1,882,000
		=========
		11,821,000

WRAP in 2013[11] says 27 incinerators, DEFRA in 2014[12] says 26 operational with a further 4 In-Construction, UKWIn in 2016[13] says 39 incinerators.

Tolvik's report in 2015[14] says 68 lines across 37 facilities with capacity totalling by now 10,090,000 tpa

	# of Facilities		# of Lines		Capacity Mtpa	
	2014	2015	2014	2015	2014	2015
Fully Operational	26	32	51	62	6.77	8.87
In Commissioning	7	5	12	6	1.65	1.21
Total	**33**	**37**	**63**	**68**	**8.42**	**10.09**

[11] http://www.wrap.org.uk/content/list-energy-waste-sites

[12] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/266438/project_list_EIR16Dec.pdf

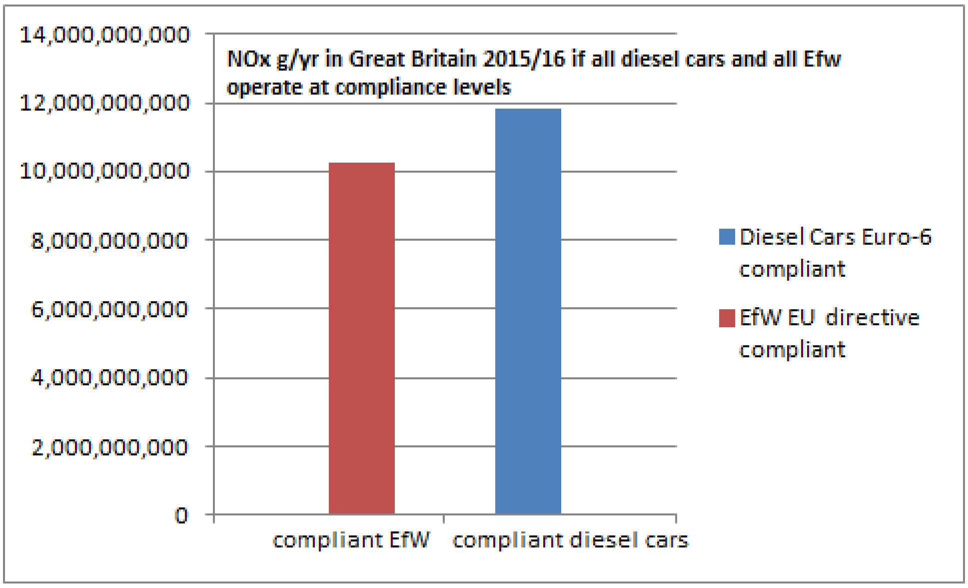
[13] http://ukwin.org.uk/map/

[14] http://www.tolvik.com/wp-content/uploads/UK-EfW-Sector-Report-2015-Final.pdf

Comparison of NOx emission from all GB incinerators and all diesel cars

We know 300,000 tpa Greatmoor emits 911,894g of NOx per day or 303,961,627 g/yr[15].
Scaling this to Tolvik's GB capacity in 2015/16 of 10,090,000 tpa gives **10,223,242,722 g/yr of NOx**

Compare & contrast this with 2015/16 **11,825,049,600 g/yr of NOx** from Euro-6 compliant diesel cars:



Assumptions:

Diesel cars emit the Euro-6 NOx limit of 0.08g/km
EfW emit the daily average WID NOx limit of 200mg/m^3 for 8,000 operational hours / year
All EfW emit a similar daily m^3 as Greatmoor scaled to tpa capacity
Known 2015/16 EfW incinerator capacity of 10.09Mtpa

N.B. There is a further 1.9Mtpa incinerator capacity in construction planned to come on-stream 2017/18

[15] Assuming 8,000 operating hours per year (ie 333.33 days)

DEFRA has published[16] its position regarding health effects with an update[17] in Sept 2015

....

> Recent developments in the evidence now allow the quantification and valuation of the direct effect of exposure to nitrogen dioxide (NO_2) on mortality. Given the significance of this impact and interim recommendations from the Committee on the Medical Effects of Air Pollution this paper updates Defra guidance.

Section 2.7 begins....

7. Evidence on the health impacts associated with of exposure to NO_2 concentrations has developed significantly over the past few years. Some of the key developments within this area are provided in box 1 below.

Box 1: Recent research publications considering the health impacts of NO_2

1. World Health Organisation (2013). Review of evidence on health aspects of air pollution

In 2013 the World Health Organisation (WHO) released 'Review of evidence on health aspects of air pollution (REVIHAAP)' and Health risks of air pollution in Europe (HRAPIE). These projects made recommendations for concentration–response functions for cost–benefit analysis of particulate matter, ozone and nitrogen dioxide'. The HRAPIE[1] experts recommended applying to adult populations (age 30+ years) a linear Concentration–Response Function for all-cause (natural) mortality, corresponding to a Relative Risk of 1.055 (95% CI = 1.031, 1.08) per 10 $\mu g/m^3$ annual average NO_2.

2. Hoek, G., et al. (2013). Long-term air pollution exposure and cardio- respiratory mortality: a review. Environ Health 12(1): 43.

The Hoek et al. review (2013) brings together the evidence from epidemiological studies on the associations between long-term exposure to air pollutants, including 15 studies on NO_x, and mortality. The papers, on which the review is based, were the latest available in January 2013 and covered a wide geographical area. A significant association was identified between NO_X/NO_2 concentrations and all-cause mortality and a pooled estimate per 10 µg/m3 was calculated to be 1.05 (95% CI 1.03, 1.08).

3. Faustini, A., et al. (2014). Nitrogen dioxide and mortality: review and meta-analysis of long-term studies. Eur Respir J 44(3): 744-753.

Faustini et al. (2014) provides pooled estimates of the long-term effects of NO_x/NO_2 and particulate matter on mortality based on published papers from 2004 to 2013 which covered a wide geographical area and included estimates from studies that analysed particles and NO_2. The pooled effect on mortality, based on 12 studies, was 1.04 (95% CI 1.02–1.06) with an increase of 10 µg/m3 in the annual NO_X/NO_2 concentration. The effect on cardiovascular mortality was 1.13 (95% CI 1.09–1.18) for NO_x/NO_2. The NO_x/NO_2 effect on respiratory mortality was 1.03 (95% CI 1.02–1.03). Four two-pollutant analyses with particulate matter and NO_x/NO_2 in the same models showed minimal changes in the effect estimates of NO_X/NO_2, which suggests that, in the few studies using two-pollutant models, the effects of NO_2 and particles (of different sizes) seemed independent.

[16] https://www.gov.uk/guidance/air-quality-economic-analysis

[17] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/460401/air-quality-econanalysis-nitrogen-interim-guidance.pdf

Section 2.8 states that COMEAP is open to examining new data ...

> The Committee on the Medical Effects of Air Pollutants (COMEAP), funded by the Department of Health, provides independent advice to government on the health impacts of air pollution.[3] On 12 March 2015, in light of the new health evidence, COMEAP published a statement entitled "Nitrogen dioxide: health effects of exposure". The committee concluded:
>
> *From our consideration of authoritative reviews and additional evidence we have reached the following conclusions:*
>
> *i. Evidence of associations of ambient concentrations of NO_2 with a range of effects on health has strengthened in recent years. These associations have been shown to be robust to adjustment for other pollutants including some particle metrics.*
>
> *ii. Although it is possible that, to some extent, NO_2 acts as a marker of the effects of other traffic-related pollutants, the epidemiological and mechanistic evidence now suggests that it would be sensible to regard NO_2 as causing some of the health impact found to be associated with it in epidemiological studies.*
>
> *We have not drawn conclusions on specific health outcomes nor looked in detail at the methodological issues relevant to quantification of effects associated with ambient NO_2 at this stage. We intend to do this and, if appropriate, to consider recommendations for coefficients associating NO_2 with specific health effects, as part of separate work items to be addressed later."*

Section 3.13 states ..

13. In light of the developments set out in section 2, Defra is updating the recommended guidance on air quality appraisal. This change reflects the new evidence on the impacts of NO_2 on public health.

Table 1: Air quality damage costs per tonne, 2015 prices

		Central (1)	Central sensitivities (2)	
			Low	High
Oxides of nitrogen (NOX)	Transport average	£25,252	£10,101	£40,404
	Industry	£13,131	£5,253	£21,010
	Domestic	£14,646	£5,859	£23,434
Ammonia (NH3)		£2,363	£1,843	£2,685

Applying this formula to the Greatmoor incinerator emissions and indeed to the whole of GB gives:

	Nox g/yr	NOx tonne/yr	factor	Damage cost/tonne/yr
Greatmoor incinerator	303,961,627	304	£13,131	**£3,991,320**
2015/16 GB incinerators	10,223,242,722	10,223	£13,131	**£134,241,400**

DEFRA published an inventory[18] of NOx sources[19]

The 2010 emission ceilings, and new 2020 emission reduction commitments (ERC) for the UK under the Gothenburg Protocol are shown in Table 1.3.

Further information on local air quality legislation and both the Gothenburg Protocol and the NECD can be found by exploring the links at the end of this report.

Table 1.3: UK annual emissions[4] and targets 2010 – 2020 (ktonnes)

	NOx	SO_2	NH_3	NMVOC	$PM_{2.5}$
2014 emissions	949	308	281	819	105
2010 Gothenburg Protocol ceiling	1181	625	297	1200	n/a
2020 Gothenburg Protocol ERC[5]	728	292	282	773	76

UK Government has implemented measures to decrease emissions across the key air quality pollutants. Section 2 of this report reviews trends in these pollutants, highlighting the impact of UK Government policies / actions in meeting the necessary agreements and targets. The new 2020 Gothenburg Protocol emission reduction commitments are placed within the context of the historical emissions so that the scale of emission reductions required can be appreciated.

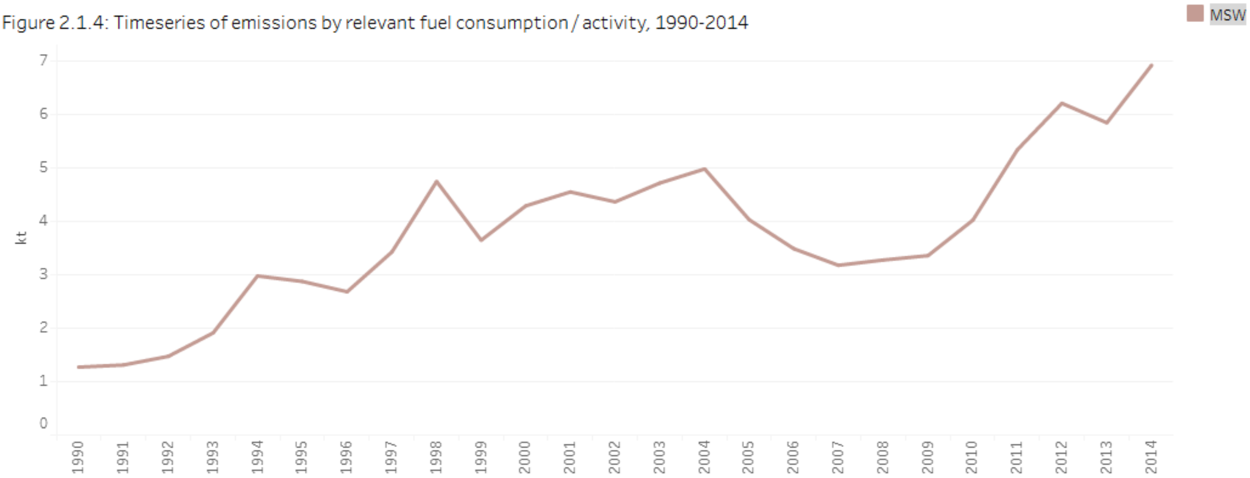


Figure 2.1.4: Timeseries of emissions by relevant fuel consumption / activity, 1990-2014

Analysis in this document shows that by 2016/17 the MSW component of NOx emissions is 10.223 kTonne/annum

18 https://uk-air.defra.gov.uk/assets/documents/reports/cat07/1609130906_NAEI_AQPI_Summary_Report_1990-2014_Issue1.1.pdf

19 http://www.aether-uk.com/Resources/AQPI-Annual-Report/AQPI-Nitrogen-Oxides