AEA Energy & Environment
From the AEA group

Review of the fate of lubricating oils in the UK

Report to Department for Environment, Food and Rural Affairs

Reference: AEAT/ENV/R/2352
Issue Number: Issue One, Version 1.3.1
November 2006

Review of the fate of lubricating oils in the UK

Norris, J
Stewart, R
Passant, N

November 2006

This work forms part of the Climate Energy; Science and Analysis Programme of the Department for Environment, Food and Rural Affairs.

Title	Review of the fate of lubricating oils in the UK
Customer	Department for Environment, Food and Rural Affairs
Customer reference	RMP/2106
Confidentiality, copyright and reproduction	Published by AEA Technology plc.
File reference	N:\naei_general\GHGi Base Year Review 2005\Lubricating_Oil\Review_of_Fate_Of_Lubricating_Oil_2005_NIR_Issue1_v1.3.1_cd4569rs.doc
NAEI contacts database reference	05452/2004/CD4569/RS
Reference number	AEAT/ENV/R/2352
ISBN	n/a
Issue number	Issue One, Version 1.2

AEA Energy and Environment
The Gemini Building
Fermi Avenue
Harwell International Business Centre
Didcot, Oxfordshire, UK
OX11 0QR

Telephone 0870 190 6575
Facsimile

AEA Technology is the trading name of AEA Technology plc

AEA Technology is certified to ISO9001

Report Manager	Name	R Stewart
Approved by	Name	C Dore
	Signature	
	Date	24 November 2006

Units and conversions

Emissions of greenhouse gases presented in this report are given in Million tonnes (Mt) and kilotonnes (kt). To convert between the units of emissions, use the conversion factors given below.

Prefixes and multiplication factors

Multiplication factor	Abbreviation	Prefix	Symbol
1,000,000,000,000,000	10^{15}	peta	P
1,000,000,000,000	10^{12}	tera	T
1,000,000,000	10^{9}	giga	G
1,000,000	10^{6}	mega	M
1,000	10^{3}	kilo	k
100	10^{2}	hecto	h
10	10^{1}	deca	da
0.1	10^{-1}	deci	d
0.01	10^{-2}	centi	c
0.001	10^{-3}	milli	m
0.000,001	10^{-6}	micro	μ

1 kilotonne (kt) = 10^3 tonnes = 1,000 tonnes
1 Million tonne (Mt) = 10^6 tonnes = 1,000,000 tonnes

1 Gigagramme (Gg) = 1 kt
1 Teragramme (Tg) = 1 Mt

Conversion of carbon emitted to carbon dioxide emitted

To covert emissions expressed in weight of carbon, to emissions in weight of carbon dioxide, multiply by 44/12.

Executive Summary

This report set out the results of a work programme to review and update the estimates of emissions from the use of lubricating oil in the United Kingdom Greenhouse Gas inventory. This review involved a literature review of the fate of lubricating oils in the UK, and discussions with trade associations and vehicle servicing agents. This work was part of a wider programme of inventory review and improvement to prepare the UK's greenhouse gas inventory to deliver the UK's Assigned Amount under the Kyoto Protocol.

The data for engine consumption were largely based on an oil industry survey (CONCAWE, 1996) which reviewed potential recovery rates and disposal of waste oil. The CONCAWE data indicated that 65% of oil was potentially recoverable from engines; that is 35% was lost due to combustion or other losses. In the absence of any data to identify the proportion of loss due to combustion, the Inventory had assumed that all losses in an engine are due to combustion.

Netcen considers that lubricant and engine technology have advanced substantially since the CONCAWE report and estimated an automotive engine loss of 25% developed from data collected during this review. Other engines are assigned 35% 'burnt in use' which is a 'worst case' figure consistent with the CONCAWE information. Large marine engines reportedly mix their waste lubricating oil with their fuel oil so a higher allowance is provided for burnt in use. Although no information was obtained specific to aviation and turbine oils these are considered to have had similar development and consequently a 25% loss due to combustion has been assigned for recent years.

All other uses are considered to have no or negligible likelihood of combustion in normal use and will either have good potential recovery or will be effectively lost.

Published data (Oakdene Hollins, 2001) on the sector split of lubricating oil sales for 1999 was then used to calculate a proportion of lubricating oil lost to combustion in use for each year between 2004 (revised losses to combustion) and 1990 (the CONCAWE-based combustion losses).

As a result of this work, changes were made to the emission estimates in the 2004 United Kingdom Greenhouse Gas inventory (presented in the 2006 National Inventory Report) from the use of lubricating oil. The changes introduced reduced the emissions of carbon from the consumption of lubricating oil.

Table of Contents

Document revision history

Issue	Version	Revision history
Draft		• Reviewed internally. Some commercially confidential data removed.
1.0	**1.2**	• First issue
1.0	**1.3**	• Minor editorial changes made
1.0	**1.3.1**	• AEA front cover added

Abbreviations for Greenhouse Gases and Chemical Compounds

Type of greenhouse gas	Formula or abbreviation	Name
Direct	CH_4	Methane
Direct	CO_2	Carbon dioxide
Direct	N_2O	Nitrous oxide
Direct	HFCs	Hydrofluorocarbons
Direct	PFCs	Perfluorocarbons
Direct	SF_6	Sulphur hexafluoride
Indirect	CO	Carbon monoxide
Indirect	NMVOC	Non-methane volatile organic compound
Indirect	NO_X	Nitrogen oxides (reported as nitrogen dioxide)
Indirect	SO_2	Sulphur oxides (reported as sulphur dioxide)

HFCs, PFCs and SF_6 are collectively known as the ‘F-gases’

Abbreviations, acronyms and definitions

AATSE	Australian Academy of Technological Sciences and Engineering
base year review	A programme of work to review the accuracy and completeness of the emissions in the 2004 UK greenhouse gas inventory
C	Carbon
CRF	Common Reporting Format tables of emissions for submission to the FCCC.
CEF	Carbon Emission Factor
DTI	UK Department of Trade and Industry
DERV	Diesel Engined Road Vehicle fuel used in internal combustion engines that are compression ignition engines
Defra	Department for Environment Food and Rural Affairs
DUKES	Digest of United Kingdom Energy Statistics www.dti.gov.uk/energy/statistics
EA	Environment Agency for England and Wales
EU	European Union
UN	United Nations
FCCC	Framework Convention on Climate Change
GHG	Greenhouse gas
GHGI	Greenhouse gas inventory
HGV	Heavy goods vehicle
HDV	Heavy Duty Vehicle
IPCC	Intergovernmental Panel on Climate Change
kt	kilotonne
LGV	Light goods vehicle
LDV	Light duty vehicles
MOT	vehicle roadworthiness test carried out by garages on behalf of VOSA (the Vehicle Operator and Services Agency)
Mt	Mega tonne
NAEI	National Atmospheric Emissions Inventory www.naei.org.uk
NIR	National Inventory Report
PCB	polychlorinated biphenyl
UK	United Kingdom
UN/ECE	United Nations Economic Commission for Europe
UNFCCC	United Nations Framework Convention on Climate Change
WID	Waste Incineration Directive

1 Introduction

1.1 BACKGROUND TO THIS PROJECT

The United Nations Framework Convention on Climate Change (UNFCCC) was ratified by the United Kingdom in December 1993 and came into force in March 1994. Parties to the Convention are committed to develop, publish and regularly update national emission inventories of greenhouse gases (GHGs). The UK has been compiling and submitting GHG inventories to the FCCC since 1994.

Netcen, on behalf of UK Defra, has prepared the latest (at the time this report was written) greenhouse gas inventory (GHGI) and associated tables of emissions in CRF format according to UNFCCC guidelines contained in FCCC/CP/2002/8 (Baggott *et. al.*, 2005). The estimates within the inventory have been generated by following the methods and procedures set out in the IPCC Revised 1996 Guidelines for National Greenhouse Gas Inventories (IPCC, 1997a, b, c) and Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

The UK GHG inventory is subject to a range of regular external reviews. At the time this report was written, these reviews include reviews by experts from the FCCC during desk, centralised and in-country reviews, and, by invited independent examiners during a process of peer review.

The Intergovernmental Panel on Climate Change (IPCC) Good Practice Guidance (IPCC, 2000) defines expert peer review as follows:

> ‘Expert peer review consists of a review of calculations or assumptions by experts in relevant technical fields. This procedure is generally accomplished by reviewing the documentation associated with the methods and results, but usually does not include rigorous certification of data or references such as might be undertaken in an audit. The objective of the expert peer review is to ensure that the inventory's results, assumptions, and methods are reasonable as judged by those knowledgeable in the specific field.’

The Good Practice Guidance requires that key sources should be subjected to external peer review. Key sources are those source categories with a significant influence on a country’s total inventory of direct greenhouse gases in terms of the absolute level of emissions, the trend in emissions, or both.

The first peer review of the GHGI considered CO_2 emissions from fuel combustion (Simmons, 2002). This topic was chosen for peer review since IPCC sector 1A1[1] was identified as a key source because of the magnitude of emissions of carbon dioxide (CO_2) from the combustion of solid, liquid and

[1] Emissions from fuels combusted by the fuel extraction or energy producing industries.

gaseous fuels in that sector. In addition, fossil fuel combustion is the major source of UK emissions of carbon dioxide.

A key recommendation of this Peer Review was that

> "The proportion of lubricating oils considered to be burned in use or after use (in the GHG inventory) is smaller than that estimated in other studies of oil recycling. It is recommended that the proportion be reviewed, taking into consideration the studies (mentioned in the Peer Review) and any later information."

This report set out the results of a work programme to review and update the estimates of emissions from the use of lubricating oil in the GHG inventory. This was part of a wider programme of inventory review and improvement to prepare the greenhouse gas inventory to deliver the UK's Assigned Amount under the Kyoto Protocol.

1.2 GENERAL APPROACH TO THE WORK

This study involved a literature review of the fate of lubricating oils in the UK, and discussions with trade associations and vehicle servicing agents.

1.3 QUOTED ACCURACY OF THE EMISSIONS IN THIS STUDY

In this report, emissions are quoted to 0.01 ktonne (or better) purely for convenience, to avoid the risk of rounding errors, and for convenience when taking ratios. The number of decimal places used should not be taken as indicative of the accuracy of the estimates.

2 Review of the Fate of Lubricating Oils in the UK

2.1 INTRODUCTION

Lubricating oils are used in a variety of applications including engine and process lubrication. UK statistics (DUKES, 2005) include oils and greases. About half the lubricating oil used in the UK is consumed in the lubricated activity or lost, half of the oil used is recovered by the recycling/reuse industry (Oakdene Hollins, 2001).

The NAEI has assumed that all unrecovered lubricating oil is lost by combustion – this is a potentially substantial greenhouse gas (GHG) contribution. This assumption has been reviewed and a revised emission trend developed.

2.2 LOSS IN AUTOMOTIVE ENGINES

This section considers the fate of lubricating oil put into road vehicles.

Possible routes are:

- Combustion;
- Leakage;
- Removed from engine at time of service;
- Other losses (filters, surfaces on end of life components).

The relative proportion of these losses changes for different engine sizes.

Netcen contacted three franchised service centres of HDVs, and received subtly different answers;

For one manufacturer, which only serviced big trucks, with a lot of tractor units, the feeling was that the newer vehicles consumed very low amounts of oil. The estimate provided was that these vehicles lost only around 1 litre of the 40 litres in the sump over a 6 month period between services. This amounts to a 2.5% loss.

For a second manufacturer, which again serviced predominantly the larger engines, the estimate provided was that around 10% of oil loaded into engines is lost by the time it is serviced. The point was made that some vehicles can be poor whilst the majority are excellent.

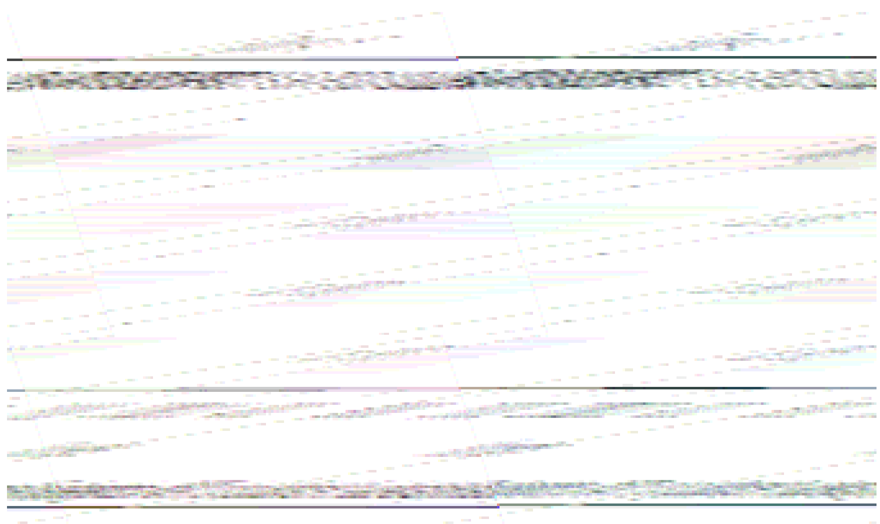
Netcen also spoke to a third manufacturer who deal with a lot of smaller commercial vehicles, "light vans", in addition to the 7.5 tonners and the tractor units. They quoted oil change intervals of:

light vans	every 18,000 miles
7.5 tonne vans	every 30 – 40,000 miles
tractor units	50 – 60,000 km (31-38,000 miles).

Their overall estimate was that sump size for a 9 litre truck is 26 – 32 litres and the difference between is the volume put in, and the volume is lost is around 15%.

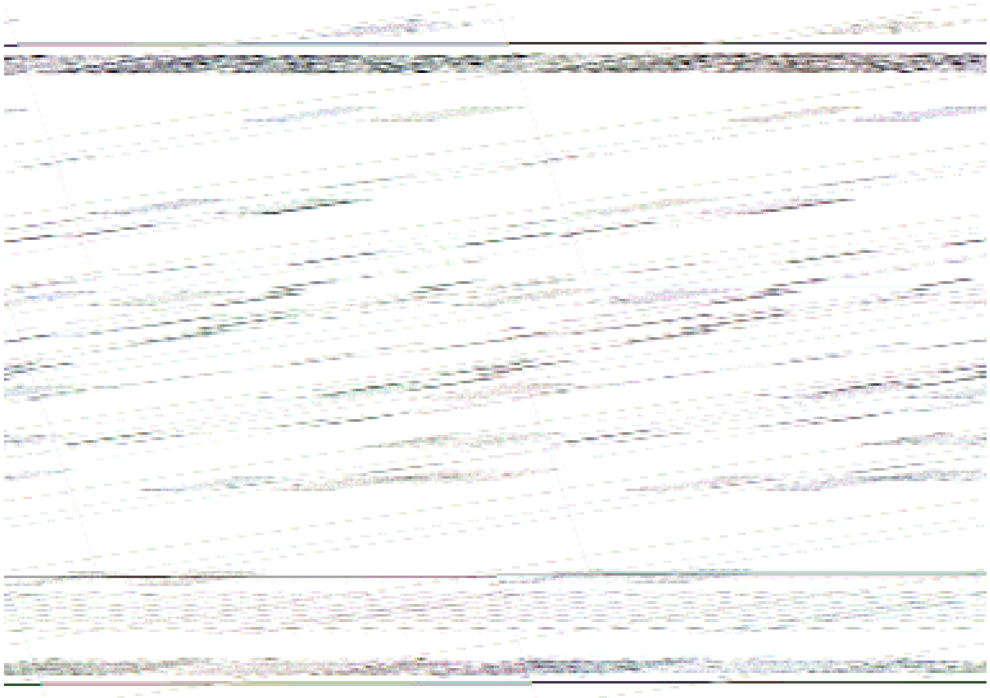
A review of the Australia Stewardship for Oil programme (Allen Consulting, 2004) includes the following data (see **Figure 2.1**) for Volvo heavy truck oil change intervals which references a report by the Australian Academy of Technological Sciences and Engineering (AATSE).

Figure 2.1 Oil drain intervals for Volvo heavy trucks
Australian Academy of Technological Sciences and Engineering (2004)



The same report (see **Figure 2.2**) shows European vehicle numbers and 'base oil' sales – the units are unclear but the trends are clear and over the period 1987-2001 suggest about a 25% fall in 'base oil' sales but a 33% rise in vehicle numbers. Base oil is used in many lubricant formulations and modern engine lubricants have a (increasing) proportion of synthetic and semi-synthetic additives. Hence base oil is not a simple indicator for vehicle lubrication oil but the trends do support the view that modern engines use less lubricating oil.

Figure 2.2 Number of vehicles and engine oil consumption in Europe
Australian Academy of Technological Sciences and Engineering (2004)



For light-duty vehicles, e.g. passenger cars, which make up the majority of the fleet there is the generic problem of knowing how much oil owners put in their vehicles between services. A report on options for recycling waste oil (Oakdene Hollins, 2003) estimated UK passenger car (diesel and petrol) lubricating oil sales for 2001 to be 212 kTonnes of which 60.5 kTonnes (29%) was by direct sales – Netcen considers that this proportion is likely to decrease as engines and lubricants develop and the need for topping up oil decreases. The amount for all vehicles is not quantified, and varies from vehicle to vehicle, and will be much larger than for commercial vehicles.

To develop estimates of oil use, Netcen has assumed that around 1 in 3 motorists add 1 litre to their vehicle once a year. In addition, it is assumed that when serviced, vehicles' sumps only contain 80% of their original charge, i.e. 20% of the oil is lost due to being burnt or leakages.

There is also the question of how often light-duty vehicles are serviced. Most motorists have their vehicles serviced once a year. However, there is a small minority who do not meet this basic standard. Also, there are a number of light-duty vehicles which are serviced more frequently, this includes taxis, reps etc who cover high mileage, and many of the light-commercial vehicles. Overall it is assumed that 1 in 5 vehicles has 2 services a year, whilst the remaining 80% are serviced once.

The above numbers and assumptions have been put into a spreadsheet model together with vehicle stock numbers. All light-duty vehicles have been treated similarly. The overall results are shown in **Table 2.1**.

Table 2.1 Volumes of oil used annual by vehicle type

Type of vehicle	Stock number	Oil quantity added at service	Number of services/year	Volume oil added at services
	(millions)	(litres)		(million litres)
Petrol car	20.608	5	1.2	124
Diesel car	4.751	5	1.2	28.5
Petrol LGVs	0.356	5	1.2	2.1
Diesel LGVs	2.321	5	1.2	13.9
Rigid HGVs	0.305	30	2	18.3
Artic HGVs	0.121	35	2	8.46
Buses	0.100	30	2	5.92

+ 1/3 no of LDVs @ 1 litre added each 9.34 million litres

Total quantity of oil used per year = 210 million litres, or about around 180 ktonnes (assuming about 1.15 litres per kg).

From Table 3C in DTI DUKES (Additional information on inland deliveries for non-energy uses, 2002 to 2004) the mass of “oils and greases” sold for “motors” use was 240 ktonnes in 2002. The agreement is reasonable, especially if one recalls that we are only considering lubricating oils for road vehicles. The data in **Table 2.1** has been extended to calculate losses; see **Table 2.2**.

Table 2.2 Vehicle oil losses

Type of vehicle	Stock number, millions	Volume oil added at services	% oil “lost”	Volume lost
		$*10^6$ litres		$*10^6$ litres
Petrol car	20.608	124	20%	24.73
Diesel car	4.751	28.5	20%	5.70
Petrol LGVs	0.356	2.1	20%	0.43
Diesel LGVs	2.321	13.9	20%	2.78
Rigid HGVs	0.305	18.3	10%	1.83
Artic HGVs	0.121	8.46	5%	0.42
Buses	0.100	5.92	10%	0.59
Additional filling of LDVs		9.34		9.34

This gives total volume lost per year as 45.84 million litres, i.e. around 22% of the total 210 million litres added.

Netcen considers that this weighted average can be reconciled with the separate performance of vehicles from passenger cars to articulated lorries.

In terms of trends, current trends are:

- increase in vehicles registered and switch from petrol fuelled to diesel fuelled;
- modern vehicles have lower oil consumption than older ones, not least this contributes to these vehicles meeting the ever more stringent emission control regulations, which include the emissions staying within the “acceptable” standard after they have travelled 50,000 miles, (type approval durability requirements);
- in-service (MOT) tests will help capture engines with poor smoke emissions;
- the trend is for servicing intervals to be spaced further apart, i.e. vehicles are service now less frequently than was the case 10 and 20 years ago.

Notwithstanding the increase in vehicle numbers, Netcen considers that this would indicate that, lubricating oil put into road vehicles would be predicted to fall slightly (see also base oil trend figure for Europe).

It has been difficult to reconcile the DUKES figures with base oil trends and expert perception of engine oil use. Table 3C on page 75 of the 2005 digest (covering 2004), which gives lubricating oils and greases for motors rising from 240 ktonnes in 2002 to 310 ktonnes in 2004, a rise of 29% in 2 years.

We contacted the DTI to discuss this, and the DTI noted that there was a large increase in the inland deliveries of industrial lubricants, but that the quantities in 2003 looked rather low in relation to the longer term time series. The DTI note that the increase may well be a result of mis-classification, and that there are various minor concerns about the quality and coverage of the lubricating oil data but resolving these does not have a high priority.

2.3 FATE OF RECOVERED OIL RECOVERED FROM ROAD VEHICLES

Netcen telephoned two companies who, under licence from the Environment Agency, take away, process and dispose of waste oil from garages etc.

The companies sell treated used oil, which is filtered, and sold as recovered or alternative fuel oil to places like power stations, roadstone coating plant and cement works. The oil is analysed to ensure level of PCB are within regulatory guidelines.

However, the companies commented that the markets for waste oil are changing. The reclassification of waste streams, combined with the Waste Incineration Directive (WID), means power stations can no longer burn waste oil (without substantial modification) after 2005. Use of waste oil by large coal-fired power plant boilers has been as a substitute for heavy fuel oil - that is to provide start-up energy and stabilise combustion and, combustion of waste fuel under these conditions is unacceptable under WID. There is scope for use as waste oil as a substitute fuel in power station boilers but this is an undeveloped market at present.

The main route for waste oil re-use prior to 2005 in the UK has been combustion primarily in power station boilers, roadstone coating plant and cement kilns. Very little UK waste oil has been re-refined into base oil or other lubricating oil. The demand for such fuel was such that the UK imported about 100 kTonne per year of waste oil. The use of waste oil in power station boilers, roadstone coating plant dryers and some other combustion units will end in 2005 unless plant are upgraded to meet the requirements of WID. It is likely that other processes for example cement kilns and steel works will take more waste oil-derived fuels after 2005.

2.4 GHG INVENTORY REVISIONS TO LUBRICATING OIL EMISSIONS

In the 2003 GHG inventory (prepared in 2004), lubricating oils which were not collected were considered to have been combusted in engines. This is considered unreasonable as much of the lubricating oils used in the UK are not used in combustion processes. The fates of the unrecovered oil has been reviewed across the categories allocated in the Oakdene Hollins 2001 report (Table 3). Some of the unrecovered oil is associated with coating on products, leaks, disposal to landfill and other non-oxidising fates (however note that some of these may simply defer or reduce the rate of oxidation).

Table 2.3 Fate of lubricating oil

Oakdene Hollins 2001			Netcen 1990			Netcen 2004		
End Use	**Sales, kTonnes 1999**	**% potentially recoverable**	**% potentially recoverable**	**% Burnt in use**	**% Lost in use**	**% potentially recoverable**	**% Burnt in use**	**% Lost in use**
Gasoline & Diesel Engines	249 488	65	65	35	0	75	25	0
Agricultural Engines	15 000	65	65	35	0	75	25	0
Other Engines	7 288	0	0	35	65	0	35	65
Marine Engines	37 728	25	10	90	0	10	90	0
Aviation & Turbine Oils	2 214	50	50	50	0	75	25	0
TOTAL ENGINE OILS	**311 718**							
Hydraulic & Transmission	96 352	80	80	0	20	80	0	20
Other Gear Oil	53 815	80	80	0	20	80	0	20
TOTAL GEAR/TRANSMISSION OILS	**150 167**							
Automotive Greases	4 786	10	10	0	90	10	0	90
Industrial Greases	6 981	10	10	0	90	10	0	90
Other Greases	48	0	0	0	100	0	0	100
TOTAL GREASES	**11 815**							
Metalworking Oils - neat /soluble	28 736	20	20	0	80	20	0	80
Other	6 812	20	20	0	80	20	0	80
TOTAL METAL WORKING OILS	**35 548**							
Turbine & Electrical Oils	27 070	95	95	0	5	95	0	5
General Machine Lubricants	15 219	50	50	0	50	50	0	50
Non-Lubricating Industrial Oils	11 792	10	10	0	90	10	0	90
Other Industrial Oils	10 939	20	20	0	80	20	0	80
TOTAL OTHER OILS	**65 020**							
Process Oils	108 230	0	0	0	100	0	0	100
White Oils	21 678	0	0	0	100	0	0	100
TOTAL PROCESSING OILS	**129 908**							
Deliveries to Blenders	86 151	50	50	0	50	50	0	50
TOTAL ALL LUBRICANTS	**790 327**	**49.4**	49	16	35	52	13	35

The data for engine consumption are largely based on an oil industry survey (CONCAWE, 1996) which reviewed potential recovery rates and disposal of waste oil. The CONCAWE data indicated that 65% of oil was potentially recoverable from engines; that is 35% was lost due to combustion or other losses. In the absence of any data to identify the proportion of loss due to combustion, all losses in an engine are assumed to be due to combustion.

Netcen considers that lubricant and engine technology have advanced substantially since the CONCAWE report and proposes a decrease to 25% in the amount of oil burned in petrol and diesel and, agricultural engines. This is consistent with the estimate of automotive engine loss (**Table 2.2**). Other engines are assigned 35% 'burnt in use' which is a 'worst case' figure consistent with the CONCAWE information. Large marine engines reportedly mix their waste lubricating oil with their fuel oil so a higher allowance is provided for burnt in use. Although no information was obtained specific to aviation and turbine oils these are considered to have had similar development and consequently a 25% loss due to combustion has been assigned for recent years.

All other uses are considered to have no or negligible likelihood of combustion in normal use and will either have good potential recovery or will be effectively lost.

The Oakdene Hollins sector split of lubricating oil sales for 1999 was then used to calculate a proportion of lubricating oil lost to combustion in use for 2004 (Netcen expert judgment) and 1990 (the CONCAWE-based combustion losses).

2.5 EFFECT OF CHANGES ON THE 2004 GHG INVENTORY

Revising the assumptions about the quantities of waste oils consumed in the UK as a result of this work reduces the emissions from the GHG inventory (see **Table 2.4**). Emissions of CH_4 and N_2O from this source are trivial.

Table 2.4 Changes in emissions of carbon from the revised assumptions about the consumption of lubricating oil introduced into the UK GHG inventory (ktonnes carbon)

	Sector	Source	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2003 GHG inventory																	
301	Combustion in boilers, gas turbines and stationary	Other industrial combustion	210.44	198.25	209.38	211.87	212.65	243.53	239.09	245.33	214.53	194.66	197.37	208.46	204.27	213.88	
7	Road transport	Road transport - all vehicles lubricants	315.06	291.56	302.61	311.00	307.43	346.87	335.60	339.45	334.02	341.61	346.37	365.83	358.48	375.34	
		Total	**525.50**	**489.81**	**511.99**	**522.87**	**520.09**	**590.40**	**574.68**	**584.78**	**548.55**	**536.27**	**543.74**	**574.29**	**562.75**	**589.22**	
2004 GHG inventory																	
301	Combustion in boilers, gas turbines and stationary	Other industrial combustion	213.52	201.32	212.80	221.88	221.54	252.74	248.55	255.66	223.65	203.20	206.06	218.43	215.71	227.51	239.71
7	Road transport	Road vehicle engines	71.66	64.97	66.04	66.46	64.32	71.04	67.26	66.57	60.85	57.96	57.59	59.59	57.20	58.65	59.61
80402	National sea traffic within EMEP area	Marine engines	29.32	27.25	28.39	29.28	29.03	32.84	31.84	32.25	30.17	29.41	29.89	31.64	31.05	32.55	33.82
80502	International airport traffic (LTO cycles - <1000 m)	Aircraft engines	0.96	0.85	0.85	0.83	0.79	0.85	0.79	0.76	0.68	0.63	0.60	0.61	0.57	0.56	0.55
806	Agriculture	Agricultural engines	4.53	4.11	4.17	4.20	4.06	4.48	4.24	4.19	3.83	3.64	3.62	3.74	3.59	3.68	3.73
808	Industry	Industrial engines	5.94	5.39	5.49	5.53	5.36	5.93	5.62	5.58	5.11	4.87	4.85	5.02	4.83	4.96	5.05
		Total	**325.93**	**303.89**	**317.74**	**328.18**	**325.11**	**367.88**	**358.30**	**365.01**	**324.29**	**299.71**	**302.61**	**319.03**	**312.94**	**327.92**	**342.47**

2.6 ADDITIONAL AREAS FOR WORK IDENTIFIED IN THIS REVIEW

2.6.1 UK Waste Oil Market Changes

During 2005 the market for waste oil has been undergoing major changes because of the impact of Directive 2000/76/EC on the incineration of waste (WID) on the main UK market for waste oil. Burning of waste oil in non-WID facilities is generally prohibited after 28 December 2005 (although the burning of waste oil by garages for small-scale space heating continues to be permitted in the UK). The diversion of waste oil to other markets principally cement kilns and steelworks is underway but is unlikely to soak up all the recoverable oil. There is also a derogation on tax duty/levy on waste oil which is due to be lifted in early 2006.

These factors are likely to reduce or stop imports and may actually lead to export of waste oil. In the longer term the changes could encourage re-refining in the UK but short-term there may be more disposal to incineration (no difference so far as GHG is concerned), landfill or storage – all would involve significant costs to the industry. There is also likely to be an increase of the 'unaccountable' fraction. Development of use of recycled fuels for marine use is another potential market (not believed to be a significant activity in the UK at present).

2.6.2 Technical Knowledge

Much of the data on the fate of lubricating oil is dated and refers to a very limited pool of information. There are concerns over:

- the quality and understanding of the DUKES activity data which show fairly high increase in supplies, large changes in imports and data which are generally inconsistent with engine lubrication development and other data;
- the fate of engine and other lubricating oils which are not recovered (is it reasonable to assume that this is all burnt?);
- the quantity of oils recovered – is this real data? (there should be data with regulatory authorities on amounts transferred).

Although 2004 is a key year for the GHG inventory, 2005 will also need detailed review to assess the market changes. The DTI, the Oil Recycling Association, lubricating oil suppliers, the Environment Agency and others will need to be contacted to ensure that a clearer picture of what is happening is developed.

3 References and Bibliography

Allen Consulting, 2004, review of Australia's stewardship for oil project
http://www.oilrecycling.gov.au/pubs/pso-review.pdf

Baggott, SL, Brown, L, Milne, R, Murrells, TP, Passant, N, Thistlethwaite, DG (2005) *UK Greenhouse Gas Inventory, 1990 to 2003*. Annual report for submission under the Framework Convention on Climate Change. ISBN 0-9547136-6-4. AEAT/ENV/R/2037. National Environmental Technology Centre, AEA Technology plc, B551, Harwell, Didcot, Oxfordshire, OX11 OQJ, UK.

CONCAWE, 1996, collection and disposal of used lubricating oil. Report 5/96 available at :
http://www.concawe.be

DTI, Digest of UK Energy Statistics (DUKES), 2005 *TSO*, London 123 Kingsway London, WC2B 6PQ, UK.
http://www.dti.gov.uk/energy/inform/dukes/dukes2005/index.shtml

European Environment Agency (EEA), 2002, Review of selected waste streams:

Institute for Energy and Environmental Research (IFEU), 2005, Ecological and energetic assessment of re-refining used oils to base oils: Substitution of primarily produced base oils including semi-synthetic and synthetic compounds. Prepared for GEIR – European recycling industry association. Available at www.ifeu.de

IPCC, (1997a), IPCC Revised 1996 Guidelines for National Greenhouse Gas Inventories, Volume 1, Greenhouse Gas Inventory Reporting Instructions, IPCC WGI Technical Support Unit, Hadley Centre, Meteorological Office, Bracknell, UK.

IPCC, (1997b), IPCC Revised 1996 Guidelines for National Greenhouse Gas Inventories, Volume 2, Greenhouse Gas Inventory Workbook, IPCC WGI Technical Support Unit, Hadley Centre, Meteorological Office, Bracknell, UK.

IPCC, (1997c), IPCC Revised 1996 Guidelines for National Greenhouse Gas Inventories, Volume 3, Greenhouse Gas Inventory Reference Manual, IPCC WGI Technical Support Unit, Hadley Centre, Meteorological Office, Bracknell, UK.

IPCC, (2000), Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, ed. Penman, J, Kruger, D, Galbally, I, *et al*, IPCC National Greenhouse Gas Inventories Programme, Technical Support Programme Technical Support Unit, Institute for Global Environmental Strategies, Hayama, Kanagawa, Japan.

Oakdene Hollins, reports on waste oil market (2001) and policy options for UK (2003)
http://www.oakdenehollins.co.uk/used-oil-economics.html

Organisation for Economic Co-operation and Development (OECD), 2005, Improving recycling markets – Chapter 2 Improving Markets for Waste Oils. Available at:
http://www.oecd.org/dataoecd/14/9/35438706.pdf

Recycle company index web site
http://www.recycle.mcmail.com/wasman.htm

Sewage sludge, construction and demolition waste, waste oils, waste from coal-fired power plants and biodegradable municipal waste.
Available at:
www.eea.eu.int

Simmons (2002) *Review of the UK Greenhouse Gas Inventory CO_2 from Fuel Combustion 1990-1999*. Avonlog Ltd.

Western Canada Used Oil Management Association program (UOMA) review final report, 2005 prepared by Bearing Point Inc.
http://www.usedoilrecycling.com/index.cfm

4 Acknowledgements

We are grateful for the help of the following people and organisations during the course of this work programme; apologies for any omissions.

- **Young, Martin** (DTI, Downstream Petroleum)
- Onyx Environmental Group
- Oakwood Environmental