Reporting of emissions from industrial combustion

Task 55 of the 2010 UK / DA GHG Inventory Improvement Programme

Report for DECC

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Contact:

Joanna MacCarthy
AEA Technology plc
Gemini Building, Harwell, Didcot, OX11 0QR
t: 0870 190 3857
f: 0870 190 6318
e: joanna.maccarthy@aeat.co.uk
AEA is a business name of AEA Technology plc
AEA is certificated to ISO9001 and ISO14001

Author:

Joanna MacCarthy

Approved By:

Glen Thistlethwaite

Date:

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Signed:

Executive summary

This report summarises the findings of *Task 11: Other industrial combustion* under the UK GHG inventory improvement programme. The work has focussed on investigating the availability of data to construct a consistent time series of fuel use for the industrial combustion sub sectors specified for reporting in the Common Reporting Format (CRF) tables.

The main findings of this scoping study can be summarised as follows:

- For coal and gas oil, inconsistencies between the breakdown based on the DUKES data, and the independent estimates within the inventory would require further work to reconcile.
- For the main fuels, a sectoral breakdown is available across the time series from DUKES data.
- For lesser used fuels, no further breakdown is available. Therefore these emissions would remain under either iron and steel, or other industry, consistent with current reporting.
- No significant impacts on emissions totals for either greenhouse gases or other pollutants would result from this work.

A brief overview of recommended work, including the reduction of inconsistencies, the implementation of proposed changes and reporting within the UK GHG inventory is presented below:

Inconsistencies in Coal and Oil estimates:

- At present it is not clear how best to reconcile these estimates. It is therefore recommended that a limited amount of additional work is undertaken to look at uncertainties in the inventory estimates and data from DUKES. It is anticipated that this would involve a review of data available via other reporting mechanisms such as EU ETS and also through consultation with the DECC DUKES team. This should enable the development of a consistent time series for each of the fuels which could be implemented into the UK GHG inventory.

Processing method for implementing the recommended changes needed to the inventory:

- It is recommended that either a pre-processing or post processing approach could be taken. The pre-processing approach is more transparent but is more arduous due to the dependencies between the large number of spreadsheets and a number of Excel databases.

Reporting

- The current reporting systems would need to be modified to allow the more detailed information to be extracted. Changes would be needed to the NAEI database, the database which bridges the NAEI and CRF reporter, and to other outputs such as the final users and DA inventories.

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1 Introduction and background

The UK inventory currently reports all emissions from industrial combustion sources within the categories “1A2a: Iron and Steel” or “1A2f: Other.” The Common Reporting Format (CRF) tables, which are used for reporting greenhouse gas (GHG) inventories contain the following categories:

- 1A2a. Iron and Steel
- 1A2b. Non-Ferrous Metals
- 1A2c. Chemicals
- 1A2d. Pulp, Paper and Print
- 1A2e. Food Processing, Beverages and Tobacco
- 1A2f. Other (as specified in table 1.A(a) sheet 2)

Although the total emissions are reported within the GHG inventory, the sectoral breakdown is currently not available. The reporting of emissions within these additional subcategories has been a recommendation in both UNFCCC expert reviews, and EU internal reviews of the UK inventory.

This scoping study has considered the data availability, consistency with the current inventory reporting and implications for the modification of spreadsheets and databases required to implement the more detailed reporting within the 2012 submission.

1.1 Data considerations

The allocation of industrial emissions to each of these subsectors within the UK GHG inventory is not straightforward. A number of issues have been considered, and are discussed in detail within the results section of this report. The main issues are with time series consistency and consistency with the current inventory reporting (i.e. ensuring that the total fuel use allocation for industrial combustion across the time series is not changed by the inclusion of further data).

The format of the energy balance data in the Digest of UK Energy Statistics (DUKES) changed in the 1998 edition. It is not always straightforward to track the time series of fuel use within sectors between the old and new style tables in DUKES and to maintain a consistent time series. Therefore artificial step changes may be introduced into the time series.

For certain fuels, the fuel use allocation within the GHG inventory at the total 1A2 reporting level differs from the allocation in DUKES. This is where data are supplied directly to the inventory, which are considered to be more accurate (e.g. gas oil use in the rail sector) or where modelled data for off road sources need to be reconciled with the DUKES data. It is important in these cases not to introduce a double count into the emissions data, and to consider carefully how to allocate the fuel use between sectors.

The final data consideration is where sectoral information is supplied directly to the inventory, e.g. from the cement industry, which implies an under allocation of fuel within DUKES. For example, the total coal use for cement and lime within the inventory amounts to more than the total 1A2f remainder once the fuel has been allocated to each of the sub sectors.

1.2 Method

The first steps in this study were to consider all of the data available from DUKES. Since the DUKES data can be recalculated for 3-5 years after its initial publication, it is important to ensure that the latest edition of DUKES for each year is used (for example, DUKES 2010 contains recalculated data back to 2007 for most data sets).

A time series of fuel use for each of the fuels in the categories presented in DUKES was put together, and then aggregated to match the reporting categories required in the CRF. Due to changes in the reporting format of the tables in DUKES part way through the time series, this task was not straightforward, and some changes in the categorisation of data are evident.

This data set was then compared with the inventory dataset. Differences are evident for certain fuels, for example coal use for autogeneration of electricity are reported within 1A2f within the GHG inventory, whereas these emissions are outside of the industry category in DUKES.

A time series of sectorally disaggregated fuel use, consistent with the total reported for sector 1A2 in the 2011 GHG inventory has then been developed. Issues that are unique to each to the fuels have been discussed in the relevant sections of this report.

2 Results and discussion

The GHG inventory aims to use the best available data for all emission sources. For fuel combustion, often additional data are used to supplement the DUKES statistics. In some cases, these data can imply that there are sector allocation problems in DUKES. The issues that arise are different for each fuel, and therefore the discussion that follows is presented on a fuel specific basis.

2.1 Fuel specific issues

2.1.1 Coal

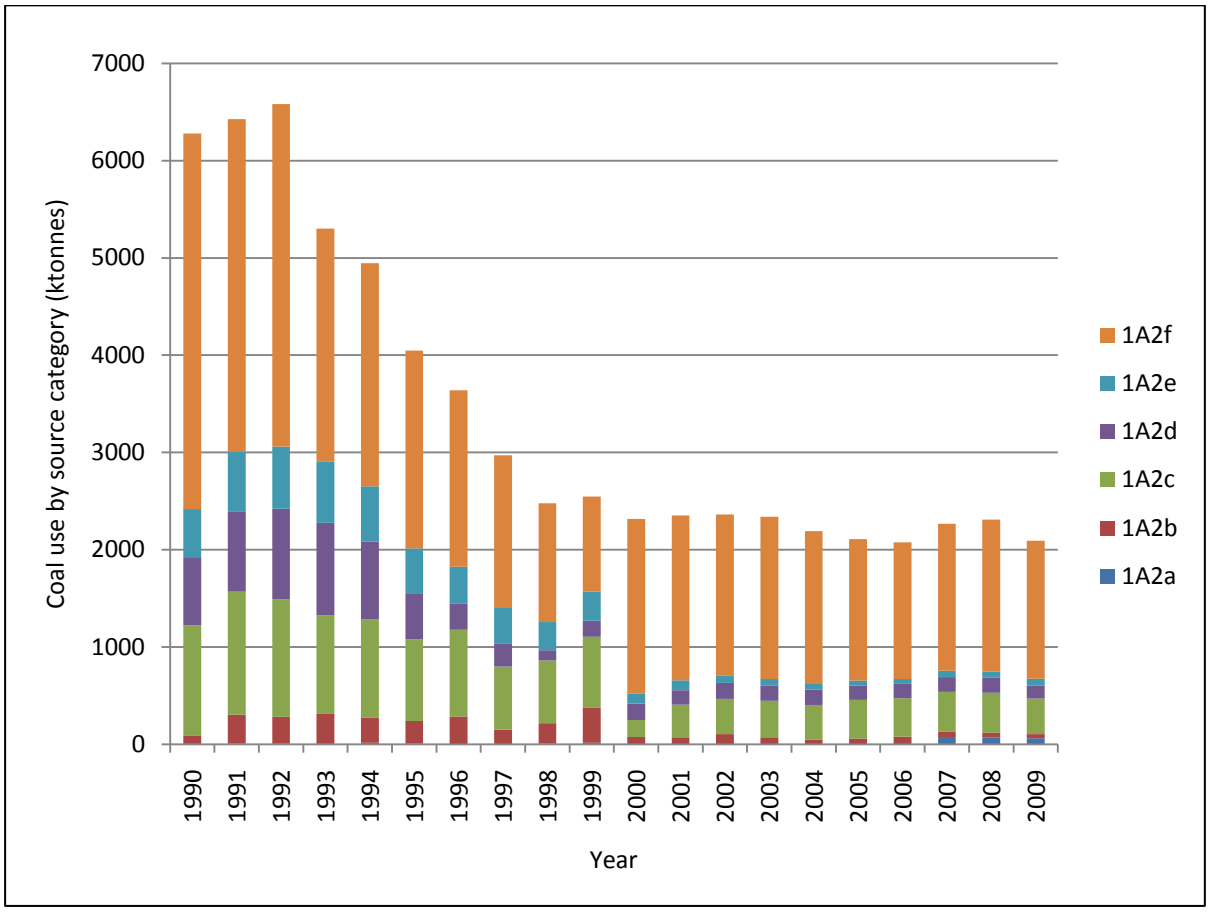
Total industrial coal use within the GHG inventory is consistent with the DUKES total. Coal use has been reported within DUKES in consistent categories across the time series and it has therefore been relatively straight forward to construct the time series based on the DUKES data.

However, there is an apparent step change in the amount of fuel allocated to other industries within DUKES between 1999 and 2000, which can be seen in the chart below. In addition, between 1997 and 1999, the total coal use allocated to 1A2f is less than the independent estimates for cement and lime production used within the inventory.

It is possible that this step change is related to an issue noted a few years ago, when it was found that energy statistics did not fully account for coal being traded by some users. Subsequent revisions to energy statistics resolved this issue, but the revisions may not have extended back to cover all years.

Further investigation would be needed in order to decide how best to reconcile the two estimates and to further investigate the step change in the time series.

Figure 2.1 Coal use by source category



2.1.2 Natural Gas

For natural gas use, the inventory estimates of fuel use are mostly taken directly from DUKES. Only the following modifications are made to the industry total:

- The non-energy use line in DUKES is reconciled with the inventory estimates for feedstock use of natural gas. Discrepancies between these sectors are subtracted from the other industry estimate used for the inventory.
- Natural gas use in blast furnaces is included under 1A2a (this fuel use is included within Energy Industry Use in DUKES).
- Natural gas use in autogenerators is reported under 1A2f in the inventory (reported as transformation in DUKES).

Table 2.1 details the method used to compile the time series of fuel use in this sector.

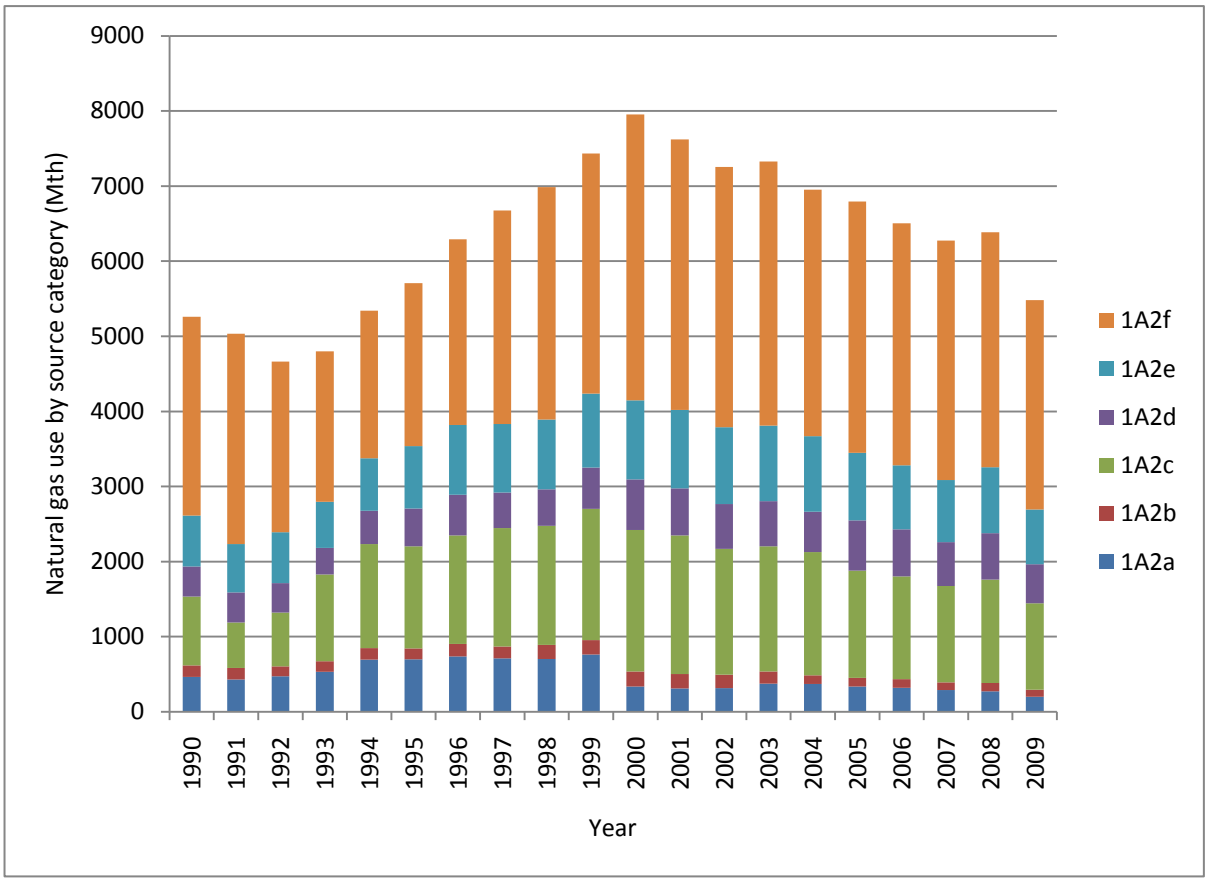
Table 2.1 Methods used to compile the disaggregated time series of natural gas use

Source category	Notes on method
a. Iron and Steel	Iron and steel (combustion) + blast furnaces taken from the GHGI
b. Non-Ferrous Metals	Direct from DUKES
c. Chemicals	Direct from DUKES, checked to ensure the fuel use is high enough to include known combustion for ammonia production
d. Pulp, Paper and Print	Direct from DUKES

Source category	Notes on method
e. Food Processing, Beverages and Tobacco	Direct from DUKES
f. Other (as specified in table 1.A(a) sheet 2)	Calculated by difference from the inventory other industry total. Includes lime, cement and autogeneration of electricity

Figure 2.2 illustrates the time series of gas use by sector. A consistent time series has been constructed for this fuel, and is comparable with the independent estimate made of natural gas combustion for ammonia production used within the inventory (i.e. the total estimate for 1A2c is higher than the inventory allocation for ammonia).

Figure 2.2 Natural gas use by source category



2.1.3 Fuel oil

For fuel oil, the total fuel use allocated to sector 1A2 is modified slightly from the DUKES total. These modifications are:

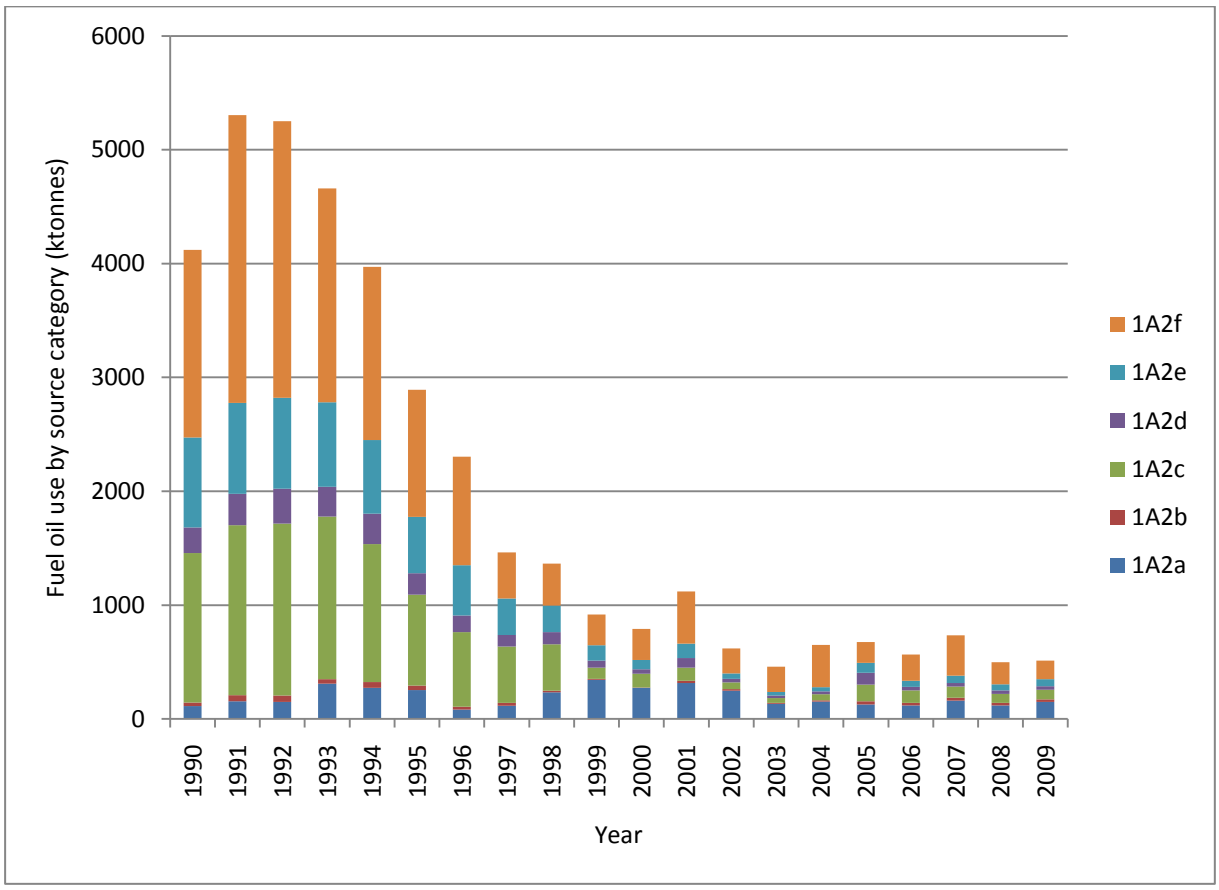
- The inclusion of autogenerators (reported under fuel transformation in DUKES from 1998 onwards, reported under 1A2 in the GHGI)
- Reconciliation of inventory estimates for power station fuel oil use. The fuel oil reported by power station operators amounts to more in most years than the total for this source within DUKES. The total estimate is therefore modified using fuel from the industry line.

A time series of fuel use consistent with the inventory estimates has been constructed based on the time series of estimates within the commodity balance tables (1998 onwards) and the inland deliveries tables (pre 1998), with autogenerator fuel use allocated to the industrial sub

categories where it is used. 1A2f is calculated from the difference of the inventory total for 1A2 and the sum of the other sub categories. The estimate for 1A2a is consistent with the estimate from the 2011 GHG inventory.

The time series is presented below, and does not contain any notable anomalies.

Figure 2.3 Fuel oil use by source category



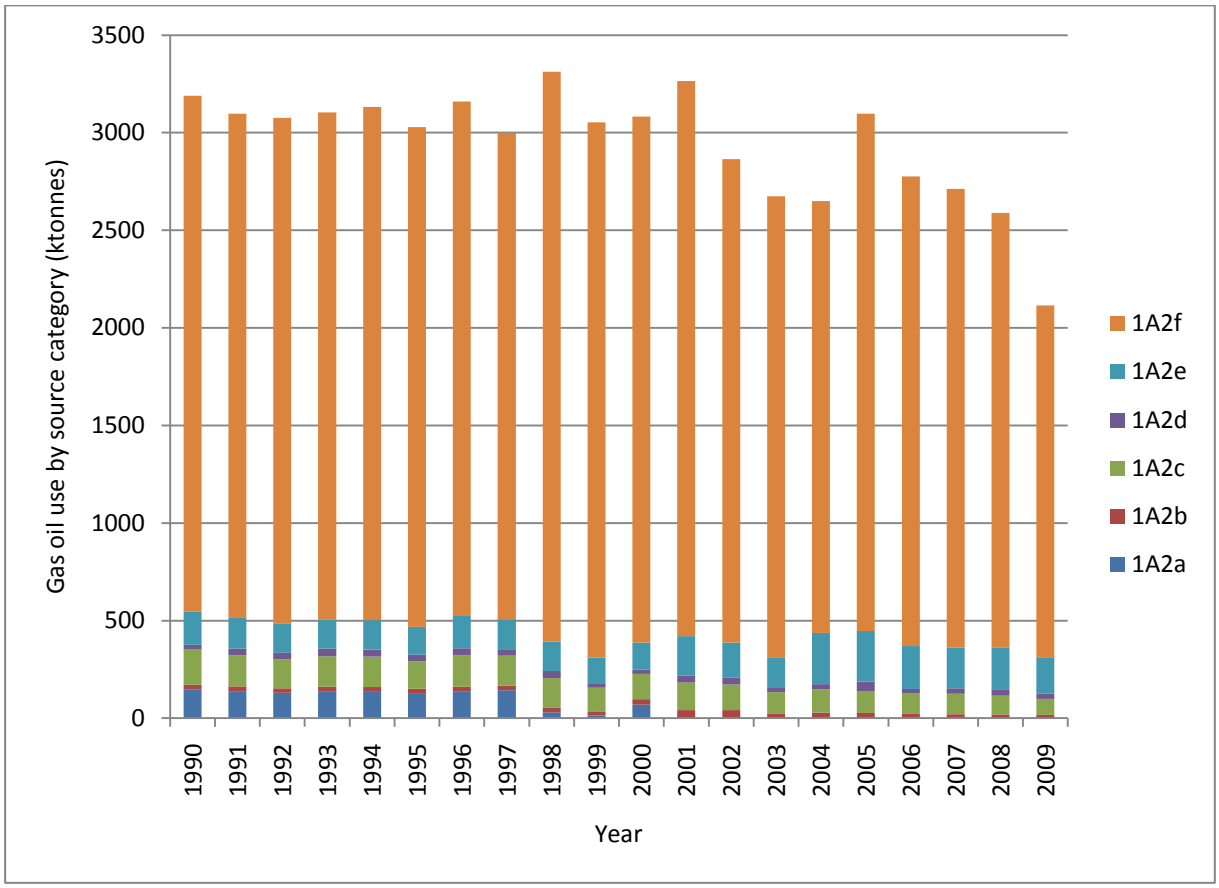
2.1.4 Gas oil

The GHG inventory includes independent estimates of gas oil consumption for a number of sources including cement production, rail and off road machinery. The industry line in DUKES, as well as (for some years) public, commercial and miscellaneous combustion is used as a "float" in order to ensure that enough gas oil is available to allocate to these sources.

In addition, the reporting of oil use within DUKES changed from 1996 onwards, and therefore the inventory method also changed, leading to further problems in reconciling the inventory and sectorally disaggregated DUKES data set.

The time series has been constructed based directly on the DUKES data for all sectors, with 1A2f calculated by difference between the inventory 1A2 total, and the sum of the other sub sectors. However, this does not leave enough fuel allocated to 1A2f to cover the amount allocated to off road machinery. This would need to be further investigated.

Figure 2.4 Gas oil use by source category



2.1.5 Coke

For coke, it has been possible to allocate fuel use to 1A2a and 1A2b, with the remaining fuel still allocated to 1A2f. For years prior to 1995, coke use in DUKES was allocated across other industry categories, but from 1996 onwards this additional split was no longer included.

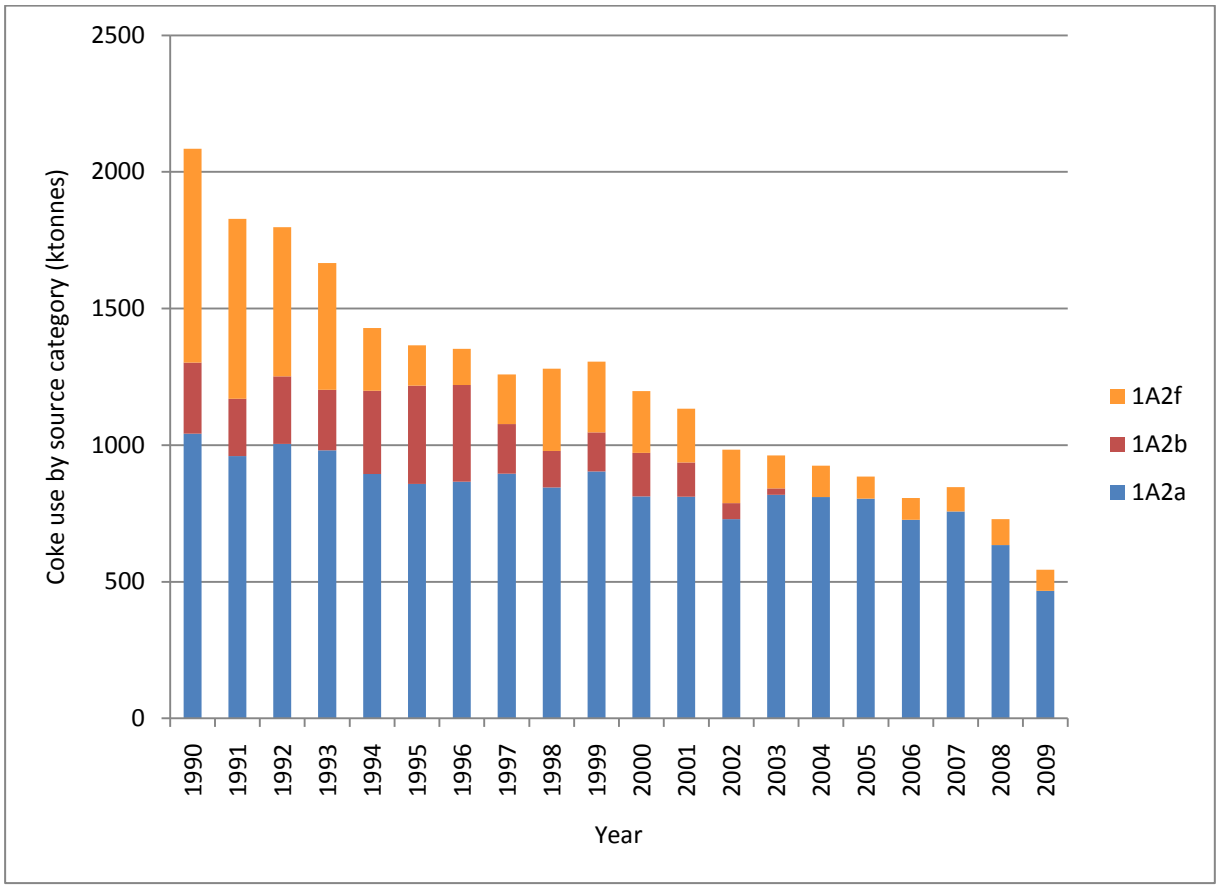
In recent years, coke is known to have been used by industrial sites that would be covered by 1A2a, 1A2b, 1A2c, 1A2e and 1A2f. The coke usage at individual sites is often quite significant, and most, if not all, of these sites will have been in operation since the start of the GHGI time series. A small number of additional sites that are known to have used coke have closed down during the period covered by the inventory, the most significant of these being a few large-scale non-ferrous metal processes.

Many of these sites use the coke in an industrial process, rather than as a fuel in a combustion plant. Emissions from the use of coke could therefore be more correctly reported under CRF sector 2 for industrial processes e.g. subsector 2B for emissions from use of coke in the production of soda ash and titanium dioxide. Other uses of coke could arguably be included in reporting for 2A and 2C. The use of the coke in a process rather than for combustion does have a bearing on emissions of some air pollutants, such as carbon monoxide, which may be emitted at higher levels than if the coke were being burnt for energy. Separating out these process uses of coke would therefore have a small beneficial impact on the quality of these parts of the UK inventory.

Recent inventory development has provided preliminary estimates of coke usage by some of the sites mentioned above, although these only cover part of the time series. Further investigation would be needed to improve these estimates, to extend the estimates to a small number of other sites, and to extend the estimates back to 1990. But such a set of estimates could be used to supplement the data available in DUKES, allowing a full time series of coke use estimates, broken down by CRF sub-sectors in 1A2 and, perhaps 2A-2C. Due to the small number of sites, most of which have been in operation for the full extent of

the GHGI time-series, it is anticipated that it would be relatively straightforward to develop robust estimates.

Figure 2.5 Coke use by source category



2.1.6 Other fuels

For the remaining fuels that are currently reported in the inventory under 1A2, no further breakdown is available from DUKES. These fuels are:

- Burning oil
- Coke oven gas
- Colliery methane
- LPG
- Lubricants
- OPG
- Petroleum coke
- Petrol
- Scrap tyres
- SSF
- Wood

In the case of lubricants and petroleum coke, GHGI activity data are based on sources other than DUKES and the data are broken down by user-sector. These can be easily assigned to the sub-sectors of 1A2, providing a full time series.

Some of the remaining fuels will be seldom used across industry except by specific sectors or in specific circumstances, and so we believe that it is reasonable to allocate these fuels to certain sub-sectors, for example OPG could be allocated to 1A2c on the grounds that most of

the fuel would be burnt in facilities close to oil & gas refining sites, and these would be likely to be petrochemical facilities. More contentiously perhaps, wood might be expected to be burnt in most cases by those industries with a reliable supply of waste wood e.g. timber processing, chipboard manufacture, furniture, joinery etc. These would all fit within 1A2f. One complication though with wood though is that there is a growing interest in use of wood as a general fuel so that allocation of all wood combustion to 1A2f is likely to be increasingly inaccurate.

The remaining fuels cannot easily be assigned to sub-sectors of 1A2 since there are either in wide, general use (burning oil, LPG), or else used only rarely but in an unpredictable pattern (SSF, coke oven gas, colliery methane, scrap tyres, petrol). For each of these fuels, emissions would either need to continue being reported as other, or for some arbitrary division to be made across all of the sub-sectors of 1A2. These fuels accounted for less than 20% of the carbon emissions within the industrial combustion sector in 2009, almost all of that being from burning oil and LPG.

2.2 Implications on emission levels

It is not anticipated that there would be a significant impact on emissions of carbon dioxide or other direct greenhouse gases directly caused by the disaggregation of fuel use to each of the source categories. Further investigation is needed into the discrepancies in the totals for cement and lime (coal use) and off road machinery (gas oil). If changes are needed for the inventory estimates of fuel use in these sectors, then GHG emissions could be affected, since sector a specific carbon content is used for cement used in coal, and the modelled emissions of indirect greenhouse gas emissions from off road machinery differ from the estimated emissions from stationary fuel combustion.

For other pollutants, emission factors are calculated using a detailed combustion calculator. This uses estimated fuel combustion in each of the sectors, and allocates the fuel within each sector to a sector specific profile of boiler sizes. Emissions are then calculated based on boiler specific emission factors, and combined with the overall fuel use estimates to calculate a sector wide implied emission factor. The estimated sector breakdown of fuel use is based on the DUKES data, and therefore is similar to the breakdown produced for this scoping study.

Therefore, although it will be possible to apply sector specific emission factors to fuel used within the industrial sub-categories, since the emission factors used within the current inventory approach are already calculated at this detailed level, it is not expected that the total emissions will change significantly, although reporting would be more transparent.

3 Next steps

This scoping study has considered the availability of data back to 1990 for the construction of a sectorally disaggregated time series of fuel use for inventory. In order to incorporate these data into the GHG inventory, further work is required. This is outlined in the sections below.

3.1 Further consideration of discrepancies

For coal and gas oil, there are discrepancies between the sectoral allocation of fuel within DUKES, and the independent estimates contained within the inventory. At present it is not clear how best to reconcile these estimates.

It is recommended that further work is carried out to consider the uncertainties in both the inventory estimates, and the DUKES data. This would involve consideration of additional data (e.g. through EU ETS), and consulting with the DECC DUKES team. Once a consistent time series for each of the fuels has been developed, this could then be implemented into the GHG inventory.

3.2 Implementation of changes

Two methods have been identified for implementing the changes needed to the inventory. These are described briefly below:

1. Post processing. The input spreadsheets are compiled as usual, and the emissions and fuel use are disaggregated at reporting stage. This would require entering further information into the database, and writing new queries to extract these data. The advantage of this is that it would require minimal disruption to the existing data compilation mechanisms. The disadvantages are that it would be less transparent, and would also mean that other improvements that could be realised from this work (e.g. the reporting of sector specific emission factors for certain pollutants) would not be possible.

2. Pre processing. The inventory is compiled using around 100 excel spreadsheets and a number of excel databases. There are various dependencies between the spreadsheets and it would therefore not be a straightforward task to modify the spreadsheets for the affected fuels. In addition, each of the spreadsheets containing the emission factors for each pollutant would need to be modified. Whilst this would be more difficult to implement, this approach would be more transparent.

3.3 Reporting

The systems currently in place for reporting GHG emissions are set up to report only under 1A2a or 1A2f. These would need to be modified to allow more disaggregated reporting. This would require changes to the CRF, the database which bridges the NAEI and the CRF, and changes to other outputs, including the End User inventories, DECC statistics and DA inventories.

3.4 Future proofing

The UNFCCC reporting guidelines and CRF tables are currently under review in order to better align the guidelines with the 2006 IPCC guidelines for inventories. At present, the level of disaggregation of the reporting categories under 1A2 is still under discussion, but it is possible that more categories will be included beyond the categories a-f that are currently specified.

This scoping study has identified that more disaggregated data are available (although these data have not been investigated in detail and may lead to further discrepancies between the inventory estimates and available data). It would be a good idea to consider the inclusion of additional categories when implementing the changes so that, should the required level of reporting change, the UK inventory would be ready.

The Gemini Building
Fermi Avenue
Harwell
Didcot
Oxfordshire
OX11 0QR

Tel: 0870 190 1900
Fax: 0870 190 6318

www.aeat.co.uk