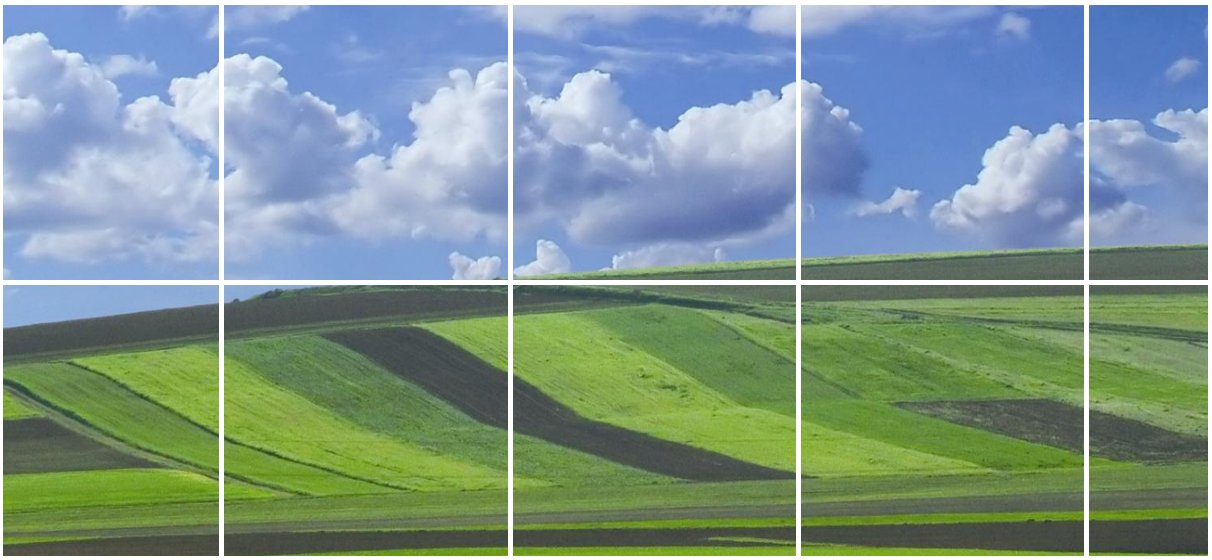
Review of Net Calorific Values for Non-Standard Gaseous Fuels

Task 9 of the 2010 UK / DA GHG Inventory Improvement Programme



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Executive summary

The EU ETS (European Union Energy Trading Scheme) forms a key component of managing the UK's climate change commitments. The use of NCVs (Net Calorific Values) within the EU ETS allows for the accounting of carbon values of different fuels within the EU. For speciality fuel gases within the iron and steel sector (COG (Coke Oven Gas) and BFG (Blast Furnace Gas)) and petroleum sector (OPG (Other Petroleum Gas)) default NCVs are derived based on the data supplied by the largest tier of operators. The current project was required to provide a review of the NCVs in use to assess them for suitability and also to gauge the level of uncertainty within UK data-sets. Recommendations were then made to DECC on based on the findings of the project.

The project methodology included both an internal review of the available UK data for COG, BFG and OPG as well as communication with industry and other reporting nations. The EU-ETS has been running since 2005; however data from earlier years was of variable quality. The internal review of the UK data-sets spanned from 2007 – 2009, and looked at consistency in the values reported across years and comparability between different sites in the same sector.

Alongside the internal review of data the project team contacted the representative trade associations, both within the UK and Europe to discover what additional information might be available regarding the NCVs in use. Additional to these tasks the project team also made contact with expert members of the EU Monitoring Mechanism on Greenhouse Gases: Working Group 1 to request any available information/insight for non UK operators, and further a task was to review the NIRs (National Inventory Reports) from reporting nations globally for representation of NCVs within these sectors.

The results from the study show high levels of consistency in the data surrounding COG and BFG. This includes the internal review of UK data-sets but also cross-comparison of the UK values against similar operators in Europe. The UK three year averages for COG and BFG were 18 MJ/NM3 and 3.59 MJ/NM3 respectively. Comparison to data gathered by Eurofer from European operator's quotes 17.9 and 3.37 MJ/NM3. The recommendations made for COG and BFG was that as a high level of consistency and comparability exists this gives us greater confidence in the default values in use and that no additional action is required to improve upon the 'in-use' numbers.

The results for the OPG part of the study show a more variable picture, both in terms of consistency between reported values from operators, but also in the nature of the reporting with multiple unit types used to report (GJ/t – MJ/NM3). Further discussion with the members of the WG1 group and review of the NIRs also shows a disparity with terminology, the UK and Belgium make use of the term 'OPG', while a number of references are used by other member states, including "Refinery Fuel Gas", "Refinery Gas", "Refinery Off-Gas". Further discussion with the Netherlands reporting officer has high-lighted that 'OPG' refers to a family of fuels with varying composition and use. This also affects the nature of the processes and energy efficiency where OPG is used as a fuel and therefore it's NCV as a result. While it is possible to carry-out further disaggregation of the fuel types and NCVs it is unclear how beneficial such an act would prove, with typical NCV values varying between individual plants within the same sub-sectors. The recommendation has therefore been to retain the current NCV values with an improved understanding of the uncertainties attached. Further recommendations would be to look to standardise reporting units and terminology to improve greater review and comparison between data-sets.

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1 Background

1.1.1 Introduction

This study was commissioned by DECC under the UK GHG Inventory Improvement Programme 2010-11, as part of the programme to address high priority inventory improvement items agreed by the National Inventory Steering Committee during 2010.

The EU ETS (European Union Energy Trading Scheme) makes use of NCV (Net Calorific Value) data to provide information on the nature of different fuels in order to allow carbon accounting. For primary fuels such as coal the available data is sufficient to develop default factors that maintain a high level of confidence. For the UK these values are reported within national statistics such as DUKES (Digest of UK Energy Statistics).

Typically secondary fuels are more difficult to characterise due to the nature in which they are formed and used within their respective industries. Since the creation of the EU ETS in 2005 the available data surrounding secondary gases from the iron and steel sector (COG (Coke Oven Gas) and BFG (Blast Furnace Gas) and also secondary gases from petroleum refineries (OPG (Other Petroleum Gases)) has been more scarce and variable in its content. This means that there is a question mark regarding the level of uncertainty surrounding the default values in use.

The current project therefore addresses a need to better understand the available data surrounding the NCVs from COG, BFG and OPG. This includes consideration of the current default NCVs in use and what would be the most suitable default values for use in the EU ETS based on the reliability/suitability of data derived from existing data-sets.

1.1.2 Scope

The national greenhouse gas inventory is used as the source for default UK factors for Net Calorific Values of fuels for use by operators within the EU Emissions Trading Scheme (EUETS), when those operators are required by the EUETS regulators to report to EUETS using a Tier 2 (national default emission factor) method. Based on the data supplied to the greenhouse gas inventory the AEA inventory team conducted a short literature review and industry consultation to collate data on the NCVs of:

- Coke oven gas (COG);
- Blast furnace gas (BFG); and
- Other Petroleum Gas (OPG), also known as Refinery Fuel Gas (RFG).

These gases all tend to be somewhat variable in content and calorific value, as they are secondary fuels derived from process sources and as such are dependent on a range of plant-specific factors as well as upon the composition of the primary fuel or feedstock.

Coke oven gas and blast furnace gas are only generated and used within coke ovens and iron and steel installations, whilst OPG is generated at refineries and is typically then used as a fuel to raise steam and heat for the refinery itself and for co-located petrochemical and chemical manufacturing facilities.

The NCVs used for the EUETS defaults may be cited in mass or volume terms, and are used by operators to convert fuel use into energy (TJ), as part of the calculations to estimate the installation emissions of carbon dioxide (i.e. where the carbon dioxide emission factor is available in energy terms).

The most energy intensive sites within the EUETS are required by the regulators to conduct their own fuel analysis to generate source-specific NCVs and fuel carbon content data, in order to estimate the installation carbon dioxide emissions accurately; these data are then independently verified prior to being submitted to the Environment Agency EUETS team, and are regarded to be good quality data. These higher-tier (“EUETS Tier 3”) installations

provide a useful data source for the inventory to draw upon, where the use of COG, BFG and OPG may be reported.

This study seeks to research the available fuel quality data from UK (and overseas) operators within EUETS, and to conduct a literature search for new data, as well as consulting directly with the iron and steel and refining industries. The main aims are:

- to review current data from UK operators (EUETS Tier 3 data) and from other industry research and expert opinion;
- to assess the current UK range and average values for the NCVs of these fuels from the reported data;
- to benchmark these UK values against equivalent data from other EU Member States; and
- to update the UK GHG inventory NCV data and ensure that the defaults provided for Tier 2 operators are based on the best available data.

1.1.3 Carbon Balance for UK Iron and Steel

Fuel-specific NCVs within the iron and steel sector do not directly impact upon the inventory emission estimates, but are useful as a quality check against the carbon balance approach that is currently used. This review of NCVs may lead to some slight revisions to the detail of the inventory method, through a revision of our understanding of the source-specific inputs and outputs within the inventory carbon balance model.

The UK GHGI takes a mass balance approach for carbon emissions from integrated steelworks which calculates carbon inputs, carbon outputs (including emissions) at each stage of the process (coke ovens, sinter plant, blast furnace and basic oxygen furnace). Activity data required by the mass balance are obtained from the Digest of UK Energy Statistics (DUKES) and statistics published by the Iron & Steel Statistics Bureau (ISSB). The carbon factors are mostly derived externally to the carbon balance e.g. they can be constant for all years, based on literature studies or industry data, or they can be calculated each year based on data such as fuel calorific values published in DUKES. Two carbon factors – those for coke oven coke and basic oxygen furnace gas are calculated within the mass balance, and provide the means to balance the carbon inputs and outputs across the four stages of the steelmaking process.

This study aims to provide a review of the data available within the EUETS data, to assess whether the current model requires any amendment. Currently the carbon factors for blast furnace gas (BFG) and coke oven gas (COG) pre-date the EUETS and are default values provided by the UK operators, Tata Steel. The EUETS data includes very detailed emissions data for these two gases, although there are some limitations in using the data for inventory purposes:

- Data for BFG are given as tonnes of carbon so it is not possible to directly calculate a carbon factor in the units required by the mass balance (kt carbon / Mth gas)
- Some of the data are for mixed gases, probably of BFG and basic oxygen furnace gas (BOFG). The mass balance requires that these gases are treated separately.
- Not all of the data are high quality, with some Tier 1 and Tier 2 factors being used.
- Data for COG is given in two different forms (by different operators) and the different approaches again make it impossible to directly calculate carbon factors in the required inventory format across all UK sites.

Theoretically, one way around these problems would be to use the emissions data directly in the carbon balance, rather than to calculate the emissions from an activity and a carbon factor. However, this is not possible in practice because the EUETS data are not specific enough about where the gases are being used and so it is not possible to fully distinguish between fuels burnt in the steelmaking process, and fuels burnt in the site power plants and furnaces.

EUETS data for other fuels are not always available at Tier 3, and there is limited information within EUETS on the point of use of the fuels within integrated steelworks; these limitations in data detail and scope limit the usefulness of the EUETS data to improve the inventory carbon balance approach.

It might be feasible to use the EUETS data in other ways, for example to use the operator's emissions data directly and to abandon the use of the carbon balance approach, but this would certainly entail some significant need for re-design of UK inventory systems, and might not lead to very significant changes in emissions or inventory quality. The EUETS data are used to provide a quality check on the inventory mass balance results, and previous analysis indicates that the results from the inventory carbon balance and the EUETS are closely consistent, although the allocation of emissions to specific sources within the steelworks may differ.

2 Methodology

The AEA study team has conducted a quantitative review of UK data from the EUETS, other reference sources and EU Member State GHG National Inventory Reports (NIRs) and Common Reporting Format (CRF) tables. The team has also consulted with UK industry, European trade associations and EU working groups. Further details of the review and consultation are given below.

2.1 Review of EUETS Data for UK Installations and Consultation with UK Industry

As part of the reporting obligations under EUETS, UK site operators are required to report full details of their fuel quality (carbon content, NCV), activity data (i.e. amount of fuel used) and other parameters / assumptions (e.g. fuel oxidation factor) that underpin their annually-reported emission estimates. The full detail of these installation-specific calculations is provided annually to the GHG Inventory Agency at AEA, for use within national inventory compilation. The EUETS has been running since 2005, but the data during the first few years was noted to be of variable quality and consistency, and hence in this study we have disregarded any fuel quality analysis from prior to 2007.

Note also that the detailed fuel composition data and other EUETS data are commercially confidential and hence no installation-specific information are presented in this report; the data are presented aggregated at sector level only.

The AEA study team has reviewed the EUETS data to assess the variability of reported fuel quality data within the refining and iron and steel sectors, to identify any outlier data at installation level and ensure that the dataset of Tier 3 information is complete and consistent. Most installations have provided data for 2007, 2008 and 2009 within EUETS, and therefore it is possible to conduct limited time-series consistency checks at the source-specific level. In the case of OPG it should be noted that as the nature of the fuel itself varies greatly from plant to plant that variance will be more significant and that further discussion of the issues seen will be provided in section 3.

The study team has also consulted directly with the key UK industry experts to discuss the fuel quality data from the EUETS, any supplementary industry research on NCVs and to obtain expert insights into the NCV analytical methodology and the reasons behind the observed variable data across different installations. The current project has included discussion with Tata steel for BFG and COG, and also with UK PIA (Petroleum Industries Association) for OPG; the study findings are summarised in the next section.

2.2 Review of Other Reference Sources and Consultation with Overseas Industry Experts

2.2.1 Review of National Inventory Reports and Common Reporting Format Tables

As part of the current project a benchmarking exercise has been carried out to compare the UK estimates for BFG, COG and OPG against non-UK data. The project has undertaken a review of 20 National Inventory Reports (NIRs) and their supporting Common Reporting Format (CRFs) tables submitted by other nations in 2010 to the UNFCCC. The NIRs and CRFs in this case were chosen to represent a good global mixture of nations and also where the team expected to most likely find available NCV data based on AEA's expertise. This has included representation for Europe, North America, Asia and Australasia. The content and approach to completing the CRF tables varies somewhat from country to country, and

therefore in some instances it was necessary to follow up this review with emails to the inventory compilers to request additional information.

2.2.2 Communication with Inventory Agencies for other EU Member States

To improve the range and quality of the fuel NCV data obtained from the NIRs and CRFs, and gain further insight to how national data was derived, the study team emailed a request for further information and links to national inventory industrial data experts to all of the members of the EU Monitoring Mechanism on Greenhouse Gases: Working Group 1 (WG1). This prompted further communication with the sector experts and inventory reporting officers for the Netherlands, Germany and Bulgaria, to help clarify the data sources, scope and range of their national inventory data.

2.2.3 Communication with EU Trade Associations

To supplement the industry-specific data from EUETS Tier 3 installations in the UK, the study team also consulted with EU level trade associations (Eurofer for iron and steel, and CONCAWE for petroleum products) to request any further sector-specific fuel quality research or data that may have been used within EU-wide benchmarking activities, e.g. to underpin development of trading schemes.

2.2.4 Other Reference Materials

Alongside the industry specific data and communication with the relevant stakeholders in the UK and Europe, we have also carried out a review of other existing texts. This principally includes the IPPC BREF notes for ‘Iron and Steel production’, and ‘Mineral Oil and Gas Refineries’, as well as a limited literature review of scientific journals, which was conducted on ‘science-direct’, the hosting engine for Elsevier publishing.

3 Results and Discussion

The results of the review and consultation are presented below on a sector basis for Iron and Steel (BFG/COG) and petroleum refinery sector (OPG).

3.1 Blast Furnace Gas (BFG) and Coke Oven Gas (COG)

3.1.1 Review of EUETS Fuel NCV Data for UK Installations

The EUETS data on NCVs for COG and BFG from UK installations for 2007 – 2009 are summarised in the table below; these data are dominated by data from one major operator of integrated steelworks (Tata Steel), with a handful of other operators running smaller sites / coke ovens around the UK.

Table 3.1 presents the average annual NCV value at UK sites in the EUETS, and the standard deviation of the data from across all sites. Tata steel have also provided the 2010 EUETS reportable data for BFG and COG, which provides comparable values for 2009 NCVs to that reported below, and a 2010 standard deviation of 0.104 for BFG and 0.308 for COG.

Table 3.1 UK NCV data for BFG and COG from Tier 3 EUETS facilities, 2007 to 2009

	Blast Furnace Gas	**Coke Oven Gas**
2007 – UK average – MJ/Nm^3	3.26	-
2008 – UK average - MJ/Nm^3	3.39	18.01
2009 – UK average - MJ/Nm^3	4.14	18.00
Three year average - MJ/Nm^3	3.59	18.00
Standard Deviation (Three year average)	**0.93**	**0.65**

The UK NCV data for blast furnace gas and coke oven gas shows a high level of consistency and small range year on year. The consistency between plants is good and the annual trends remain largely constant with a slightly increasing trend for NCVs associated with blast furnace gas. This indicates that COG and BFG fuel quality is closely controlled to achieve a consistent composition through time at each of the UK sites.

The fuel quality is assessed using continuous monitoring carried out by the operator (Tata Steel) and is required to meet the high levels of accuracy needed to meet EUETS Tier 3 reporting demands; furthermore the EUETS data are independently verified prior to submission to the EUETS regulator. As a result, the reported NCV data from data are associated with low uncertainty and are the main source of UK-specific data to inform default tier 2 EUETS data, where these are needed for other sources and sites.

The NCV data provided by Tata Steel have been derived '*using standard physical property reference values applied to composition data from continuous gas analysis (CO, CO_2 and H_2)*' (Personal Communication, Bob Lewis, Tata Steel, 2011). The analysis is conducted using online gas sampling equipment which meets the required ISO standards under the reporting requirements of the EUETS.

[Tata Steel have also provided data on Basic Oxygen Furnace Gas (BOFG), which is presented in the section below, for information.]

3.1.2 Review of Non-UK Fuel NCV Data

The European trade association for iron and steel, Eurofer, has provided additional data from across the EU; in 2009, Eurofer carried out a consultation exercise which gathered NCV data for BFG and COG from 20 European plants. These plants provided monitoring data for their facilities which were then aggregated. The aggregated results of the Eurofer survey are provided in table 3.2 below, together with additional data on the carbon dioxide emission factors on an energy basis from the Eurofer consultation.

[During this consultation Eurofer also gathered data on Basic Oxygen Furnace Gas (BOFG), which is included in the table below, together with the data provided by Tata Steel for BOFG. Currently the BOFG values are not used within the EUETS.]

Table 3.2 NCV Data for COG, BFG and BOFG from European Installations, 2009

Best estimated data for 2007/08	NCV as MJ/Nm^3	Emission Factor t CO_2 / TJ
Coke Oven Gas	17.9	43.1
Blast Furnace gas	3.37	265
Basic Oxygen Furnace Gas	8.95	173
Basic Oxygen Furnace Gas UK*	8.56	192

Source: *Eurofer*, 2011
* Data from Tata Steel for the UK

The comparison between Eurofer and UK data provides useful context for range in values and consistency in the data.

As with the UK data, the Eurofer data shows a high level of data consistency across a range of process plant, indicating that the COG and BFG fuels are closely controlled with NCVs that fall within a narrow range of values. This broader scope of coverage of European plant from the Eurofer dataset and good level of consistency with the UK data provides a useful verification of the Tata Steel data.

The communication with Eurofer did also provide one further anecdotal comment regarding Coke Oven Gas:

"*A member operating a significant number of coke oven plants (including stand-alone coke oven plants) points out that the values for coke oven gas should rather be in the range 18.3-19.7/45-46. I would add that deviations are not surprising as the values depend on the quality of the coal used, the process (cooking time, leaks) and the quality of the COG cleaning". David Valenti, Eurofer.*

The results of the Eurofer survey broadly agree with the UK data supplied to AEA by Tata Steel, noting a strong agreement in figures for COG (Eurofer best estimate and UK average). The BFG values are slightly different with the UK three year average 6% higher than the Eurofer best estimate, however again the yearly averages for UK plants between 2007 – 2009, form a range (3.26 – 4.14) which the Eurofer value (3.37) sits within.

3.1.3 Review of NIRs and CRFs

AEA has also carried out a review of the NIRs (National Inventory Reports) and CRFs (Common Reporting Formats) of around 20 Annex I countries that report to the UNFCCC, to gather additional information. In the case of the NIRs for BFG and COG, no NCV data was found within the reports. However, most countries do provide emission factors (on an energy basis) for BFG and COG, which is useful for inventory purposes and have been used in this

study to provide an indication of the consistency of data from UK and EU sources with international emission factors for these fuels. Table 3.3 below summarises the carbon dioxide emission factor data from the review of the NIRs.

Table 3.3 Review of emission factor data reported within the NIRs

	t CO2/TJ	
	COG	**BFG**
Netherlands	42.6	239.1
France	57*	
USA	0.0121	0.0708
Japan	40.2	96.94
Belgium	47.4	250 - 265
Sweden	41.6	-
Spain	37.5 - 45.2	267 - 279
Denmark	**-**	**-**
UK	45	242

** All gaseous fuels used in Iron and Steel*
Data from the USA and Japan NIR have been omitted as the units appeared inconsistent with other reporting nations

The UK estimates for COG and BFG sit broadly in the same range as the other reporting nations quoted in table 3.3. On closer review the data notes that the COG values for the UK sits at the upper end of the range, with only Belgium reporting a higher NCV. Conversely the BFG values for UK sit towards the bottom end of the scale, closely consistent with data from the Netherlands but around 10% lower than the NCV cited for Spanish sites.

Further to the review of data within the NIRs, we have also reviewed the NCV data that is presented within the CRF tables for Annex I countries, although only data for COG are typically reported.

Table 3.4 below presents the NCV for COG reported by a range of Annex I countries, as well as the UK data from Tata. The data in table 3.4 shows the quoted UK NCV matches the mean average value for the countries reporting.

Table 3.4 CRF NCV values for COG as TJ / tonne

Nation	Fuel Type	NCV as GJ/t
Austria	Coke Oven Gas	28.2
Bulgaria	Coke Oven Gas	30.0
France	Coke Oven Gas	28.0
Croatia	Coke Oven Gas	29.3
Japan	Coke Oven Gas	27.8
Kazakhstan	Coke Oven Gas	25.1
Slovakia	Coke Oven Gas	24.9
Slovenia	Coke Oven Gas	29.9
Spain	Coke Oven Gas	30.3
Russia	Coke Oven Gas	29.3
United Kingdom	Coke Oven Gas	28.3
Average	Coke Oven Gas	28.3

Alongside the review of NIRs and CRFs we also contacted the EU Monitoring Mechanism on Greenhouse Gases: Working Group 1 (WG1) for comment. This prompted a limited amount of response to our email request for further information. However, in particular feedback from Germany indicated that national statistics on iron and steel fuels are provided at an

aggregated level of mixed gases, i.e. total gas used, of which a percentage is BFG and a percentage is COG. Similar to most other countries, within the CRF Germany only provides data explicitly for COG, whilst BFG data is reported combined with other gases.

3.2 Other Petroleum Gas (OPG)

3.2.1 Review of EUETS Fuel NCV Data for UK Installations

The review of plant-specific fuel quality data from EUETS indicates that OPG is more varied than BFG and COG, with typical OPG composition and calorific value varying considerably between different sites, between different units on the same sites, and in different years.

The UK refinery sector comprises 12 facilities, all of which report under EUETS. For high-emitting sources / process units on site, the refinery operators are required to report to Tier 3, which necessitates fuel compositional analysis to be conducted, whereas for less significant emission points the refiners apply Tier 2 methods, which use the national default factors for fuels (including for OPG).

Table 3.5 below summarises the UK data submitted for OPG across 2007 to 2009, using the Tier 3 level reporting only.

Table 3.5 UK NCV data for OPG from tier 3 EUETS facilities, 2007 to 2009

	NCV as MJ / Nm^3	NCV as GJ / t*
Average value for 2007	-	41.1
Average value for 2008	42.6	46.7
Average value for 2009	42.4	47.3
Three year average value	42.5	45.4
Standard Deviation (three year)	8.0	8.4
Range (over three years)	28.0 – 55.4	11.0 – 72.7

*outliers removed.

[In the case of the GJ/t NCV values it has been necessary to remove outliers which were an order of magnitude (1000 times) larger than core body of data.]

The range in NCV values and the standard deviation of the data indicate the variability of fuel quality that the term “Other Petroleum Gases” covers. Under EUETS a wide range of fuel names are used by operators such as “Refinery Fuel Gas”, “Refinery Gas”, “Refinery Off-Gas” and so on. The term OPG covers a wide range of process gases that are not fixed or closely controlled in terms of their chemical composition and may contain quite a variable amounts of gases such as butane, propane and other hydrocarbons that have been driven off within the refinery processes and are then used as a fuel source on-site and on adjacent sites.

The variability of the reported Tier 3 fuel analysis introduces a higher level of uncertainty in deriving and presenting a “default factor” which may then be applied to Tier 2 EUETS calculation methods, as the fuel quality can evidently have a huge range of NCV and carbon content.

As regards the completeness of operator reporting to Tier 3, table 3.6 below shows the reporting rates for OPG within the refinery sector and as a comparison other industrial use of OPG. This reflects an increase in tier 3 level reporting for OPG in the refinery sector since 2007. Within the national inventory, the data on fuel quality for 2007 has been disregarded, whilst in 2008 and 2009 the 80+% Tier 3 reporting rate across all OPG use in the refinery

sector has led to AEA applying the EUETS-derived average factor in compiling the national estimates.

Table 3.6 Reporting rates for NCV tier 3 facilities in the UK 2007 - 2009

	OPG – Refinery sector	OPG – Other industry
Reporting rates 2007	58%	89%
Reporting rates 2008	82%	96%
Reporting rates 2009	81%	94%

3.2.2 Industry Consultation

Consultation with UKPIA has confirmed that the composition of OPG can be highly variable and the 'blend' differs not only from plant to plant, but can change during the course of operation at a given site dependent on fuel quality and operating processes. This will reflect the process design, management and the gearing of the refinery for specific refined fuel outputs. UKPIA also outlined that the typical composition of OPG includes:

- Propane
- Butane
- Hydrogen
- Methane
- Water Vapour

The major proportions of OPG are typically propane and butane, but the facility-specific factors will affect the ratios within the gas and therefore affect its calorific value (Andy Roberts, UK PIA, 2011).

No additional data was provided by UKPIA, who referred the study team back to the EUETS data.

3.2.3 Data from EU Inventory Experts

The current project has included stakeholder input from the WG1 working group. The nomenclature used within other reporting nations does not tend to reflect the UK industry terminology where OPG is more commonly referred to as 'refinery gas', however a number of terms exist, such as 'refinery off gas', and 'refinery waste gases'. The term 'OPG' is also used as the main reference within the Belgian NIR.

Communication from Bulgaria stated that for OPG, which is referred to as 'refinery gas' within the Bulgarian NIR, the NCV is based on the recommended Eurostat data of 50 GJ/tonne. Previous years have used a slightly lower NCV (45.2 GJ/Tonne).

Communication from Germany stated that 14 such refinery plants exist making use of what is termed 'refinery gases'. In this case the data is reported into the ETS by operators, and care is required to maintain confidentiality. The German representatives have begun their own review of NCV values but this is still at an early stage.

Communication with the Netherlands member of the WG1 working group confirmed that the nature and composition of OPG varies from plant to plant and that process type can also affect calorific value. The NCV used within the Netherlands NIR is based on an average NCV from a given plant within the Netherlands over several years of operation.

The Netherlands NIR quotes an NCV value for 'refinery gas', assumed to be equivalent to OPG, of 45.2 GJ/ tonne of fuel. The UK three year average quoted in table 3.5 is 45.43 GJ/ tonne of fuel. While this shows a strong agreement in the factors seen, it is important to recognise the sheer range of values seen in the UK data and the standard deviation. This means that it is extremely difficult to provide a single default average for OPG which suits all purposes, and this was also the view of the Netherlands reporting officer.

4 Summary and Recommendations

The UK iron and steel industry is dominated by one major manufacturer and a small number of facilities. The NCV data for BFG and COG is well defined with a high level of consistency and low standard deviation across plants and reporting years. In comparison to other data from across Europe the UK values also show a high level of comparability. The data are also derived using continuous measurements and meet the stringent requirements of EUETS Tier 3 reporting and hence are associated with low uncertainty. Table 4.1 illustrates the range of values seen with recommendations for best estimates based on the UK data-sets. We believe the best estimates quoted within table 4.1 illustrate the true values for UK industry.

The review of BFG and COG NCV data against the mechanics of the mass balance model used within the UK GHGI for integrated steel works has identified a number of compatibility issues. On this basis it would not be prudent to try and directly replace NCV factors in the model for EUETS data. It is worth noting that the EUETS data commences from 2005, while the model is used to present emissions data for the full UK GHG inventory time series back to 1990. It may be possible to adopt EUETS data for more recent years, however a number of issues would need to be addressed first, specifically the issue of tier 1 and 2 data used for specific fuels and disaggregation of values for specific process within the integrated steelworks.

The OPG data submitted to AEA shows a greater level of variance between plants and reporting years, this data is also affected by issues of outliers and data completeness (table 4.1 shows the range in values after removal of outliers). In some respects trying to derive a standard national NCV for OPG is extremely difficult as the composition of OPG varies from plant to plant and process type. There is also an issue of reporting units and nomenclature with other reporting nations using differing terminology for what is accepted as being the same mixture of fuel gases.

The term “OPG” covers a wide range of hydrocarbon-laden gas streams from refineries that are used as a fuel to raise heat and steam on-site and in adjacent installations. It is not recommended to try and further disaggregate the fuel type for OPG; this could be resource intensive and is unlikely to lead to significant data improvements. The best estimate for OPG shown in table 4.1 represents the most suitable option for a national default. However care should be taken to recognise the uncertainty attached to this factor when used across multiple differing processes and operations.

Table 4.1 NCV Range and Recommended UK Default Factors for COG, BFG and OPG, 2009

	UK range of NCVs (2007-2009) tier 3 data as MJ/Nm^3	Other reference source NCVs (MJ/Nm^3)	Best estimate for default factors (MJ/Nm^3)
Blast Furnace Gas	3.26 – 4.14	3.37 (Eurofer)	3.59
Coke Oven Gas	18.00 – 18.01	17.9 (Eurofer)	18.0
Other Petroleum Gas	42.4 – 42.6		42.5
	(GJ/tonne)	(GJ/tonne)	(GJ/tonne)
Other Petroleum Gas as GJ/tonne	41.1 – 47.3	45.2 (Netherlands NIR) 50 (Reported Eurostat value by Bulgaria)	45.4

To summarise the findings and recommendations of the current study:

- COG and BFG data show a high level of consistency. This is based on a single large UK operator; however comparison to other data from the EU shows strong a correlation.
- Recommendation is to retain existing NCV values in use.
- Merging of mass balance model with EU ETS data would be highly problematic and is not recommended at this time without further careful review.
- OPG data is far more variable due to the variance in the nature of the fuel mixture between plants. Further disaggregation of the OPG sector would likely be labour intensive with only minimal benefit.
- Recommendation for OPG NCV is continue to make use of the existing value with an improved understanding of the under lying uncertainty.

Annexes

1) Details of the stakeholder engagement
2) Members of the WG1 working group
3) List of NIRs and CRFs reviewed

1) Details of the stakeholder engagement

Company/Organisation
Tata Steel (formerly Corus)
UK PIA
Eufofer
CONCAWE

2) Members of the WG1 working group

The study team emailed over 60 inventory experts from the European Working Group 1, but responses were only received from the following:

Netherlands
Bulgaria
Germany

3) List of NIRs and CRFs Reviewed (2010 submissions)

Nation	NIR	CRF
Australia		X
Austria		X
Belgium	X	X
Bulgaria		X
Canada		X
Germany	X	X
Spain	X	X
France	X	X
Greece		X
Croatia		X
Hungary		X
Italy		X
Japan	X	X
Kazakhstan		X
Netherlands	X	X
Poland		X
Portugal		X
Romania		X
Russia		X
Slovakia		X
Sweden	X	X
USA	X	X

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