COALTECH

Fugitive greenhouse gas emissions from South African coal mines. Executive Summary.

By

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July 2013

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Coaltech Project 6.2. Task 2

EXECUTIVE SUMMARY

FUGITIVE GREENHOUSE GAS EMISSIONS FROM SOUTH AFRICAN COAL MINES. Measured emissions, and emissions using only IPCC approved methodology

AP COOK
July, 2013

CONTRACT REPORT

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SUMMARY

Total GHG emissions for the Coaltech methodology, which can be reported for National Inventory purposes, are 4.34 Mt per year.

Total GHG emissions for the IPCC approved methodology, which can be reported for emissions tax purposes, are 1.93 Mt per year.

Total emissions

Source	Coaltech methodology CO_2e (Mtpa)	IPCC methodology CO_2e (Mtpa)
Underground mines (CH_4)	**2.06**	**1.88**
Underground mines (CO_2)	**0.14**	
Surface mines (fires and spontaneous combustion)	**1.47**	**0**
Surface mines (CO_2 from other sources)	**0.23**	**0**
Surface mines (CH_4 from coal seams)	**0.05**	**0.05**
Abandoned mines	**0.20**	**0**
Discard dump	**0.14**	**0**
Total	**4.34**	**1.93**

ACKNOWLEDGEMENTS

I would like to acknowledge the significant contributions made to this project by the main project team members, namely:

Cor Meyer (Varicon)

Gerhard Strydom (necsa)

Lucky Maseko (UNISA)

Prof Philip Lloyd (IPC)

Dion Marais (Dial)

As well as the contributions from the Coaltech Surface Environment members and other Surface Environment project leaders.

CONTENTS

1 INTRODUCTION

Coaltech initiated research in 2004 to quantify Greenhouse Gas (GHG) emissions from South African coal mines. This initial work, completed in 2007, concentrated on underground mines, and on methane gas. Research began again in 2009, with emphasis on surface mines, and in particular on carbon dioxide emissions and emissions associated with spontaneous combustion and fires.

This review summarises the findings of the research, giving total emissions in tonnes per annum (tpa) from mine sources, but without the detailed descriptions in each of the individual Coaltech reports[1], and evaluates the results in terms of South Africa's National GHG Inventory and possible emissions tax.

2 IPCC OVERVIEW OF FUGITIVE EMISSIONS. AR4[2]

The IPCC generally considers that underground mining sources are amenable to measurements, as they consist mainly of point sources, such as upcast ventilation shafts; but that surface and abandoned mines are very difficult to measure due to their dispersed or inaccessible nature.

Due to this, the measurement methodologies in AR4 do not include emissions due to uncontrolled combustion in surface or abandoned mines.

3 SOUTH AFRICAN NATIONAL INVENTORY AND POSSIBLE EMISSIONS TAX[3]

It is the responsibility of the Department of Environmental Affairs (DEA) to collate all the GHG emissions data and compile the National Inventory. This includes data from all industries and other sources, and including the coal mining emissions. This inventory will also form the basis for possible emissions taxation, and all measured emissions must be included in the National Inventory, including the emissions for coal mining.

However, if the measuring methodology is not approved or accepted by the IPCC as an international standard, no matter how robust and repeatable the methodology is, any emissions so measured, cannot be included by SARS for emissions tax purposes as they cannot be internationally verified.

4 MEASURING AND CALCULATING METHODOLOGY

4.1 IPCC Methodological issues

These subsections describing the IPCC methodology issues have been taken directly from AR4. For coal mining the IPCC AR4 focusses almost entirely on methane (CH_4) emissions as this is considered the most important, but does state that if carbon dioxide ($CO_{2)}$ forms a significant portion of coal seam gas, this should be included on a mine by mine basis where data is available.

4.1.1 Underground mining

AR4 states:

Fugitive emissions from underground mining arise from both ventilation and degasification systems. These emissions are normally emitted at a small number of

[1] See Bibliography.
[2] 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Ch.4. Fugitive emissions.
[3] J. Witi. Personal communication. DEA. Pretoria. 2013

centralised locations and can be considered as point sources. They are amenable to standard measurement methods.

Where there are significant emissions of CO_2 in addition to methane in the seam gas, these should be reported on a mine-specific basis.

4.1.2 Surface mining

AR4 states:
For surface mining the emissions of greenhouse gases are generally dispersed over sections of the mine and are best considered area sources. These emissions may be the result of seam gases emitted through the processes of breakage of the coal and overburden, low temperature oxidation of waste coal or low quality coal in dumps, and uncontrolled combustion.

Measurement methods for low temperature oxidation and uncontrolled combustion are still being developed and therefore estimation methods are not included.

4.1.3 Abandoned mines

AR4 states:
Abandoned underground mines present difficulties in estimating emissions, although a methodology for abandoned underground mines is included.

The two key parameters used to estimate abandoned mine emissions for each mine (or group of mines) are the time (in years) elapsed since the mine was abandoned, relative to the year of the emissions inventory, and emission factors that take into account the mine's gassiness.

Methodologies do not yet exist for abandoned or decommissioned surface mines, and therefore they are not included.

4.1.4 Methane recovery and utilisation

AR4 states:
Methane drained from working (or abandoned) underground (or surface) coal mines can be vented directly to the atmosphere, recovered and utilised, or converted to CO_2 through combustion (flaring or catalytic oxidation)without any utilisation. The manner of accounting for drained methane varies, depending on the final use of the methane.

4.2 Coaltech methodology

Details of the methodologies developed for Coaltech are given in the individual reports.[4]

4.2.1 Underground mines

In both the 2004 and 2009 research programmes, six surface fans were monitored for gas emissions. The mines were selected based on their in situ methane seam gas contents intended to cover all seam gas conditions in SA underground coal mines. Ventilation samples were collected over a six week period, with spot samples on each fan at weekly intervals for methane, carbon dioxide and nitrous oxide.

4.2.2 Surface mines

Limited surface mine monitoring was conducted in 2004, and quantified methane emissions from the coal seams. In 2009 six surface mines were each monitored over a minimum of a two day period, on a range of target areas, selected to be practical

[4] See Bibliography

for that mine. Not all mines had measurements on the same target areas and, in terms of the project objectives, some areas were selected particularly for their fire or spontaneous combustion conditions.

A typical surface sampling procedure is shown in Figure 1.

Figure 1 Typical sampling arrangement, showing half barrels and central manifold (topsoiled rehab site)

4.2.3 Abandoned mines

Due to the difficulty in measuring or estimating the emissions from inaccessible abandoned mines over a large area, measurements were taken of relatively small heaps of burning coal to derive emission factors to apply to inaccessible areas.

4.2.4 Methane recovery and utilisation

This was not considered to be significant in South Africa, but should be accounted for on a mine by mine basis if being applied.

4.2.5 Discard dump

Emissions for the Grootegeluk discard dump were extrapolated from six measuring positions on the dump. These positions were selected for depth of sand cladding cover, and also proximity to visible signs of spontaneous combustions.

4.3 Conversion factors for methane

4.3.1 IPCC AR4

The conversion factor for volume to mass for methane is given in AR4 as:

taken at 20°C and 1 atmosphere pressure and has a value of $0.67 \bullet 10^{-6}$ Gg m^{-3}. (670 g/m^3).

4.3.2 Coaltech reports

The conversion factor for volume to mass for methane used in the calculations for the Coaltech reports, and in the subsequent publications was 732 g/m^3.

5 MEASURED GHG EMISSIONS FROM COAL MINES (Coaltech methodology)

All significant gases were measured and quantified for underground, surface and abandoned mines, and for the large discard dump.

This was carried out using the methodology developed for the Coaltech Research project, and calculated using the applied methane volume to mass conversion factor of 732 g/m^3.

5.1 Underground mines

Methane emissions are approximately 80 000 tonnes per year (tpa), and carbon dioxide is approximately 144 000 tpa.

Combining the methane and carbon dioxide gives a total carbon dioxide equivalent (CO_2e) emission of 2 144 000 tpa.

5.2 Surface mines

Carbon dioxide emissions from the mines are approximately 1.27 Mtpa from fires and spontaneous combustion, and 0.23 Mtpa from sources other than fires and spontaneous combustion.

Emissions from methane and nitrous oxide due to fires and spontaneous combustion, contribute approximately 0.19 Mtpa and 1940 tpa respectively, with the further addition of 49 200 tpa of methane emissions from coal seams.

This gives a total CO_2e emission for surface coal mines of approximately 1.75 Mtpa per year, of which 1.47 Mtpa is due to carbon dioxide and methane from spontaneous combustion or other fires.

5.3 Abandoned mines

Applying the calculated emission factors to the approximate dimensions of an abandoned mine site estimates emissions of 100 000 tpa of CO_2e from the site. As it was reported that there is a similar site to the observed site, and assuming it is of similar dimensions and properties, the total emissions from burning abandoned mines are calculated as 200 000 tpa.

5.4 Discard dump

Emissions for the single large discard dump gave an estimated emission of 133 800 tpa CO_2e.

5.5 Total emissions

Combining the individual calculated fugitive emissions from all mining sources gives a total of 4.34.Mtpa, as shown in Table 1.

Table 1 Measured GHG emissions from coal mining (Coaltech methodology and factors)

Source	Emissions CO_2e (Mtpa)
Underground mines (CH_4)	**2.06**
Underground mines (CO_2)	**0.14**
Surface mines (fires and spontaneous combustion)	**1.47**
Surface mines (CO_2 from other sources)	**0.23**
Surface mines (CH_4 from coal seams)	**0.05**
Abandoned mines	**0.20**
Discard dump	**0.14**
TOTAL	**4.34**

6 MEASURED GHG EMISSIONS FROM COAL MINES (IPCC approved methodology and factors)

Where no approved methodology is reported in AR4, or where the gases or applications are not significant, the measured emissions are disregarded.

For calculations the AR4 volume to mass conversion value for methane of 670 g/m^3 has been used.

6.1 Underground mines

Carbon dioxide emissions from coal seams are disregarded as not significant.

Methane emissions are reduced by applying the AR4 methane conversion factor to approximately 75 000 tonnes per year (tpa), giving a total carbon dioxide equivalent (CO_2e) emission of 1 875 000 tpa.

6.2 Surface mines

All emissions from fires and spontaneous combustion are disregarded due to the lack of IPCC approved methodology.

Only the 1970 tpa methane emissions from coal seams are reportable, giving a total CO_2e emission for surface coal mines of approximately 0.049 Mtpa per year.

6.3 Abandoned mines

All emission from fires and spontaneous combustion are disregarded due to the lack of IPCC approved methodology.

Methane is not considered to be a significant emission from SA abandoned mines due to the low in seam gas contents of producing coal mines.

6.4 Methane recovery and utilisation

Any emissions from methane recovery or utilisation are disregarded due these being not significant in the South African coal mining industry.

6.5 Discard dump

All emissions for the discard dump are disregarded due to the lack of IPCC approved methodology.

Table 2 Measured GHG emissions from coal mining (IPCC approved methodology and factors)

Source	Emissions CO_2e (Mtpa)
Underground mines (CH_4)	**1.88**
Underground mines (CO_2)	
Surface mines (fires and spontaneous combustion)	**0**
Surface mines (CO_2 from other sources)	**0**
Surface mines (CH_4 from coal seams)	**0.05**
Abandoned mines	**0**
Discard dump	**0**
TOTAL	**1.93**

7 DISCUSSION OF RESULTS

The methodologies developed for Coaltech to measure methane emissions from mined coal for underground and surface mines have been previously approved by the IPCC, and can be used as country specific Tier 2 calculations. This gives considerably reduced and more accurate methane emissions than applying the Tier 1 IPCC methodology.

This already approved underground sampling methodology formed the basis of the sampling methods developed for, and applied to, the emissions from other sources in surface and abandoned mines, particularly for the CO_2 from fires and spontaneous combustion. Although these gave reliable and repeatable results, they are not yet approved by the IPCC, and there are no IPCC approved alternative methods.

As the methodology is not yet approved, this means that the emissions due to uncontrolled fires and spontaneous combustion, and to other sources of CO_2, cannot be internationally verified, and so cannot be included in reportable emissions for any possible tax purposes, but should be included in submissions for the National Inventory.

Table 3 shows the summarised GHG emissions in tonnes per year, comparing the previously calculated totals, using the Coaltech methodology, with the totals using only IPCC approved methodology.

Total emissions for the Coaltech methodology, which can be reported for National Inventory purposes, are 4.34 Mt per year.

Total emissions for the IPCC approved methodology, which can be reported for emissions tax purposes, are 1.93 Mt per year.

Table 3 Measured GHG emissions from coal mining

Source	Coaltech methodology CO_2e (Mtpa)	IPCC methodology CO_2e (Mtpa)
Underground mines (CH_4)	**2.06**	**1.88**
Underground mines (CO_2)	**0.14**	
Surface mines (fires and spontaneous combustion)	**1.47**	**0**
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Total	**4.34**	**1.93**

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