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REDUCING MERCURY EMISSIONS FROM COAL COMBUSTION IN THE ENERGY SECTOR IN SOUTH AFRICA

FINAL PROJECT REPORT

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Disclaimer

Based on the agreement between the United Nations Environment Programme (UNEP) and the South African Department of Environmental Affairs (DEA), the UNEP agreed to co-operate with the DEA with respect to the project entitled: "Reducing mercury emissions from coal combustion in the energy sector in South Africa". The information provided in this report is based primarily on published data derived from the participating companies and institutions.

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The electronic version of the report can be found on UNEP website: www.unep.org/

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Summary

This report provides a summary of the mercury emissions from coal-fired power generation facilities in South Africa. The work represents a collaboration between the Department of Environmental Affairs and the United Nations Environment Programme Global Mercury Partnership, who provided technical and financial support to the project.

The emission inventory results presented in this report are a combination of emission factor calculations and actual emission measurements at two of the 18 coal fired power generation facilities in South Africa. This work builds on the initial emission inventory work undertaken by the South African Mercury Assessment (SAMA). Key findings of this report indicate that the mercury emissions from coal-fired power generation are estimated at 39.4 tons/annum for 2009. There is a high degree of uncertainty in this estimate since the bulk of the emissions are estimated using emission factors. Mercury emissions from this sector appear to be increasing due to increased electricity demand and South Africa's dependence on coal-fired power generation. It is estimated that emissions have increased by 45% since 2000 (27.1 tons/annum). Further work is required to fine tune the national mercury emissions inventory to remove the current uncertainty.

The report also highlights the relative lack of trace element analysis of the different coals utilised by the power generation sector in South Africa. Many of the emission factor calculations were based on historical mercury concentrations and where no information was available the national average was applied. This added to the uncertainty of the final emission estimation. The report makes recommendations for further work regarding trace element analysis in South African coals.

Mercury emissions from the coal-fired power generation sector are expected to decrease in South Africa over the next 20 years, based on the Department of Energy's Integrated Resource Plan 2010 (IRP 2010). This reduction will be achieved through a combination of decommissioning of older coal-fired facilities and the construction of new coal-fired facilities with advanced air pollution control units which will reduce mercury emissions. South Africa will also increase the base load provided by renewable energy sources, which will see our dependence of coal-fired generation decrease from 90% to 65%. A number of other smaller projects will also contribute to reduction in mercury emissions (i.e. biomass combustion, retrofitting of fabric filters).

The report acknowledges that further research and investigation is required to understand the extent of mercury emissions from the coal-fired power generation sector.

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List of Abbreviations and Symbols

As	Arsenic
Ba	Barium
Ca	Calcium
Cl	Chlorine
Co	Cobalt
Cr	Chromium
Cu	Copper
DEA	Department of Environmental Affairs
ESP	Electrostatic Precipitator
Ga	Gallium
Ge	Germanium
Hg	Mercury
IPP	Independent Power Producer
IRP	Integrated Resource Plan
kg	Kilogram
Mn	Manganese
MW	Megawatt
Na	Sodium
Ni	Nickel
NOx	Oxides of Nitrogen
O_2	Oxygen
Pb	Lead
PM	Particulate Matter
POG	Process Optimisation Guidance
ppm	Parts per Million
Rb	Rubidium
SARM	South African Reference Material
Se	Selenium
SO_2	Sulphur Dioxide
Sr	Strontium
SSFA	Small Scale Funding Agreement
U	Uranium
UNEP	United Nations Environment Programme
US-EPA	United States Environmental Protection Agency
V	Vanadium
Y	Yttrium
yr	Year
Zn	Zinc
Zr	Zirconium

1. Introduction

1.1 Project Objectives

The Department of Environmental Affairs (DEA) and the United Nations Environment Programme (UNEP) entered into a Small Scale Funding Agreement (SSFA) to co-operate with respect to a project entitled: "Reducing mercury emissions from coal combustion in the energy sector – Part 1" in South Africa. The project objectives to which the SSFA relates is a reduction of mercury emissions, consistent with UNEP Governing Council priorities identified in Decisions 24/3 and 25/5 and is also consistent with the goal of the reduction of mercury emissions from coal under the UNEP Global Mercury Partnership.

The project encompasses the following objectives:

1. Promote approaches to mercury release control and abatement in the coal-fired energy generation sector through optimization and enhancement of pollution abatement techniques and processes in conjunction with energy and resource efficiency improvements;
2. Update and further develop existing inventories of mercury releases in the topical sector through comprehensive analysis of statistical and experimental data;
3. Inform industry, decision-makers and expert community on the problems of mercury releases in the sector and promote emission reductions.

In order to achieve the project objectives the following tasks were undertaken as part of the study:

1. Collection and analysis of available information on coal: amount of coal used by coal type, results of coal analysis (including Hg, As, Se, Cl, Ca, Na content) and information on extent of coal preparation by coal type;
   - Collection of available information (or estimation) of coal consumption (projected coal use) for energy generation for the target years 2020 and 2050, if possible;
   - Chemical analysis of selected samples of coal on Hg, As, Se, Cl, Ca, Na to present a general representative picture of South African coals fired for energy generation;
2. Collection of available information on coal-fired power plants: installed power plant capacity by combustion process, approximate locations of power plants, air pollution control configuration and efficiency by pollutant (PM, SO_2, NO_X, and Hg) and by plant, plant capacity factor, plant heat rate, boiler operating conditions, and ash split; information on any available results of measurements of PM, SO_2, NO_X or Hg emissions in power plants;
3. Development of example Hg emission factors based on data sets from selected power plants which have as complete datasets as possible;
4. Comparison of example emission factors to emissions based on actual measurements, as available;
5. Revision of existing emission factors, as necessary, based on the above collected information;
6. Development of improved emission inventories based on the results from the above tasks (coal use, power plant information, and revised emission factors), and analysis of uncertainties of the data calculated;

7. Distribution of improved emission inventories to the network of experts and stakeholders for comments;
8. Prediction of future mercury emission trends for the status quo and for the Process Optimisation Guidance (POG) mercury control implementation scenario;
9. Hosting of information seminars to gather and disseminate information during the project.

1.2 Background

The African continent contains approximately 5% of the world's proven recoverable reserves of coal (World Energy Council, 2007). Energy consumption in Africa is projected to grow at an annual rate of 2.3% from 2004 until 2030, while the average consumption in the first-world nations is expected to rise at 1.4% annually (US Energy Information Administration, 2007).