COALTECH 2020

Viability Assessment for a project:

Air Emissions, Air Quality and Energy Efficiency Monitoring for Prioritisation of Pollution Preventions and Public Health in the Region of Mpumalanga Highveld Conurbation

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VIABILITY ASSESSMENT FOR A PROJECT ON: Air Emissions, Air Quality and Energy Efficiency Monitoring for Prioritisation of Pollution Preventions and Public Health in the Region of Mpumalanga Highveld Conurbation

EXECUTIVE SUMMARY

Within the framework of the United Nations (UN), as well as the New Partnership for African Development (NEPAD), a specific and significant role has been identified for the private sector, including multinationals in addressing the Millennium Development Goals (MDG), such as poverty eradication, primary education, reduction of child mortality, as well as ensuring environmental sustainability and enabling a global partnership for development. A focal point of the United Nations Development Programme (UNDP) discussions during the World Summit on Sustainable Development (WSSD) in 2002 was the development of UN Type II Initiatives, involving the establishment of public private partnerships (PPPs).

Participants in such partnerships in southern Africa would include representatives of southern Africa's large private sector concerns and research organisations, in addition to other public and private sector entities working on industry-relevant problems. Multi-lateral agencies and donor organisations would assist with methodological and financial support, as well as with facilitating dialogue and programme development.

On the basis of the analysis set out in this report and its appendices, we have established that atmospheric emissions from numerous sources result in adverse conditions for health. The worst impacts occur in residential areas because of the inefficient use of coal as a heating fuel, and the proximity of residential areas to large industries. Disputes between communities, industries and regulators remain unresolved in the absence of adequate policies and information on atmospheric emissions and air quality. Trans-boundary transports of anthropogenic and natural pollutants have been observed and modelled. However, possible long-term consequences of cumulative loads of acidic and heavy metal species (e.g. Hg, Cr) deposited by dry and wet deposition have not yet been adequately studied.

In South Africa, revised air quality legislation and related standards are in preparation. However, basic air quality management measures, including policy, monitoring, modelling and mitigation, are lacking elsewhere in the southern African region. Within South Africa, important information gaps have been identified that hinder implementation of cost-effective mitigation measures.

The key deliverables of this preparatory phase study included a number of tasks, including collection and presentation of various data sets. These deliverables are presented in the appendices:

- **APPENDIX 1:** Summary of existing air quality data sets and sources, and identified data gaps for Mpumalanga Highveld;
- **APPENDIX 2:** An overview of the legislative framework in South Africa relating to environment, air quality and PPPs; and
- **APPENDIX 3:** Compilation of a skills audit, including a list of individual and organisational stakeholders, with contact details; and
- **APPENDIX 4:** Detailed project outline for an implementable PPP project.

The key deliverable of this preparatory phase study is the preparation of a detailed project outline for a PPP project to address air quality issues in southern Africa. Such an outline for an implementable PPP project is summarised in the text and given in full in Appendix 4. The title of the proposed project is: “Air emissions, air quality and energy efficiency monitoring for prioritisation of pollution prevention and public health in southern Africa”.

The overarching aim of this proposed project is to introduce effective pollution prevention measures for the protection of public health and the environment. Pollution prevention measures are understood in the broadest sense to include understanding of the bio-geophysical environment, policy and technological interventions, and social participation. Initially, two regions will be selected for intensive study: the Mpumalanga Highveld, in South Africa, representing a highly industrialised area; and southern Mozambique, a less developed region, which is down wind of Mpumalanga and has its own emerging industrial base.

This report identifies currently available ambient air quality data, information, monitoring results, and stakeholders for the Mpumalanga Highveld, the area targeted for study. An inventory of the current skills base available to study air quality issues has been compiled.

In South Africa significant changes have occurred in the legislative framework in line with global and constitutional imperatives, such as the right to a clean and healthy environment. These changes act as regulatory drivers for instituting new policies and programmes (Appendix 2). As recognised in the deliberations of the WSSD, public private partnerships (PPP) may provide one of the more effective means to address the lack of skills and shortage of resources that are needed to meet the new expectations and demands of environmental stewardship.

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LIST OF ABBREVIATIONS AND ACRONYMS

ABSA	Amalgamated Banks of South Africa
AEC	Atomic Energy Corporation
AFO	Animal Feedlot Operations
APINA	Air Pollution Information Network for Africa
APOLCOM	Mpumalanga Air Pollution Control Liaison Committee
APPA	Air Pollution Prevention Act
AQMP	Air Quality Management Plan
ARAT	Fokker ARAT, a research aircraft
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
Au	Gold
CAE	Centre for Applied Ethics
CBOs	Communities and Community Based Organisations
CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon Dioxide
Cr	Chromium
CSIR	Council for Scientific and Industrial Research
DEAT	Department of Environmental Affairs and Forestry
DME	Department of Minerals and Energy
EEA	European Environment Agency

EIA	Environmental Impact Assessment
ENPAT	Environmental Potential Atlas
ERI	Energy Research Institute
ESKOM	South African Power Utility Company
ETH	Eastern Transvaal Highveld
EXPRESSO	Experiment for Regional Sources and Sinks of Oxydants
Fe	Iron
FRIDGE	Fund for Research into Industrial Development Growth and Equity
GEAR	Growth, Employment and Redistribution
GIS	Geographic Information System
Goddard SFC	Goddard Space Flight Centre
GWh	G Watt hour
H_2S	Hydrogen Sulphate
H_2SO_4	Sulphuric Acid
HCs	Hydrocarbons
HFO	Heavy Fuel Oil
ICHES	the Integrated Clean Household Energy Strategy
kTpa	kilotonnes per annum
LCVs	Light Commercial Vehicles
LIS	Lightning Imaging Sensor
LNOx	NOx produced during lightning activity
LPATS	Lightning Positioning and Tracking System
LPG	Liquid Petroleum Gas
MAS	Modis Airborne Simulator
MDG	Millennium Development Goals
Mg	Magnesium
MISR	Multi-angle Imaging Spectro-Radiometer
MJ	M Joules
Mn	Manganese
MW	Megawatt
N_2	Nitrogen Molecule
N_2O	Nitrous Oxide
N_2S	Nitrogen Sulphate
NACA	National Association for Clean Air
NAQAC	National Air Quality Advisory Committee
NASA	National Aeronautics and Space Administration
NCAR	National Centre for Atmospheric Research
NCOP	National Council of Provinces
NEDLAC/Nedlac	National Economic Development and Labour Council
NEM	National Environmental Management
NEMA	National Environmental Management Act
NGOs	Non-Governmental Organisations
NMHCs	Non-Methane Hydrocarbons
NMTOC	Non-Methane Total Organic Carbon
NO	Nitric Oxide
NO_2	Nitrogen Dioxide
NOx	Nitrogen Oxides
O_2	Oxygen Molecule
OH	Hydroxyl Radical

PFMA	Public Finance Management Act
PM10	Particulate Matter under 10 micrometers
PM2.5	Particulate Matter under 2.5 micrometers
PPP	Public Private Partnership
R&D	Research and Development
RAPIDC	Regional Air Pollution in Developing Countries
RAU	Rand Afrikaans University
SAC	Satellite Application Centre
SADC-ELMS	Southern African Development Community-Environment and Land Management Sector
SAFARI 1992	South African Fire-Atmosphere Research Initiative
SAFARI 2000	Southern African Regional Science Initiative
SASOL	South African Oil Company
SCOs	Social and Community Organisations
SeaWiFS	Sea-viewing Wide Field-of-view Sensor
SIDA	Swedish International Development Co-operation Agency
SIRDC	Scientific Industrial Research and Development Centre
SO_2	Sulphur Dioxide
THC	Total Hydrocarbon
TOC	Total Organic Carbon
tpa	Tonnes per annum
TPM	Total Particulate Matter
TRMM	Tropical Rainfall Measuring Mission
TSP	Total Suspended Particulates
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organisation
US-EPA	United States – Environmental Protection Agency
V	Vanadium
VOCs	Volatile Organic Compounds
WSSD	World Summit on Sustainable Development, Johannesburg 2002

1. INTRODUCTION

Within the framework of the United Nations (UN), as well as New Partnership for African Development (NEPAD), a specific, significant and much needed role has been identified for the private sector, including multinationals, in addressing the Millennium Development Goals (MDG) such as poverty eradication, primary education, reduction of child mortality, as well as ensuring environmental sustainability and enabling a global partnership for development (UN Secretary General, 2001).

A focal point of United Nations Development Programme (UNDP) discussions during the World Summit on Sustainable Development (WSSD) in 2002 was the development of UN Type II Initiatives, involving the establishment of public private partnerships (PPPs).

Partners in such partnerships in southern Africa would include representatives of the regions large private sector corporations, research organisations, in addition to other public and private sector entities working on industry-relevant problems. The UN agencies would assist with methodological and financial support as well as with dialogue and programme development.

As a follow up to the World Summit on Sustainable Development (WSSD) in 2002 and in line with the Millennium Development Goals (MDG), a strategic private public sector partnership was proposed for the southern African region. Key partners include:

- Coaltech 2020 (South Africa) – a consortium of public and private sector entities working on problems relevant to the coal industry; and
- Scientific Industrial Research and Development Centre (SIRDC) - a government parastatal R&D institute in Zimbabwe.

Discussions between these partners, and with the facilitation of UNIDO and UNESCO resulted in a proposal for the development of specific public private partnerships (PPPs). The current Phase I of the Preparatory Assistance aims at assessing in detail the potential for defining and funding actual projects within southern Africa. The feasibility of one such project, covering the Mpumalanga Highveld and downwind adjacent countries, will be elaborated upon and set out in this report.

The largest concentration of installed electricity generating capacity in Africa is within the Mpumalanga Highveld centred on the city of Witbank / Emalahleni in South Africa. The national electricity generator in South Africa, Eskom and the coal-to-liquid fuel company SASOL, generate in excess of 20,000 MWe of power from large coal-fired power plants, based on an abundant resource of bituminous coal (Figure 1). The ready availability of low-cost electric power has supported the establishment of heavy industry in the region such as base metal smelters.

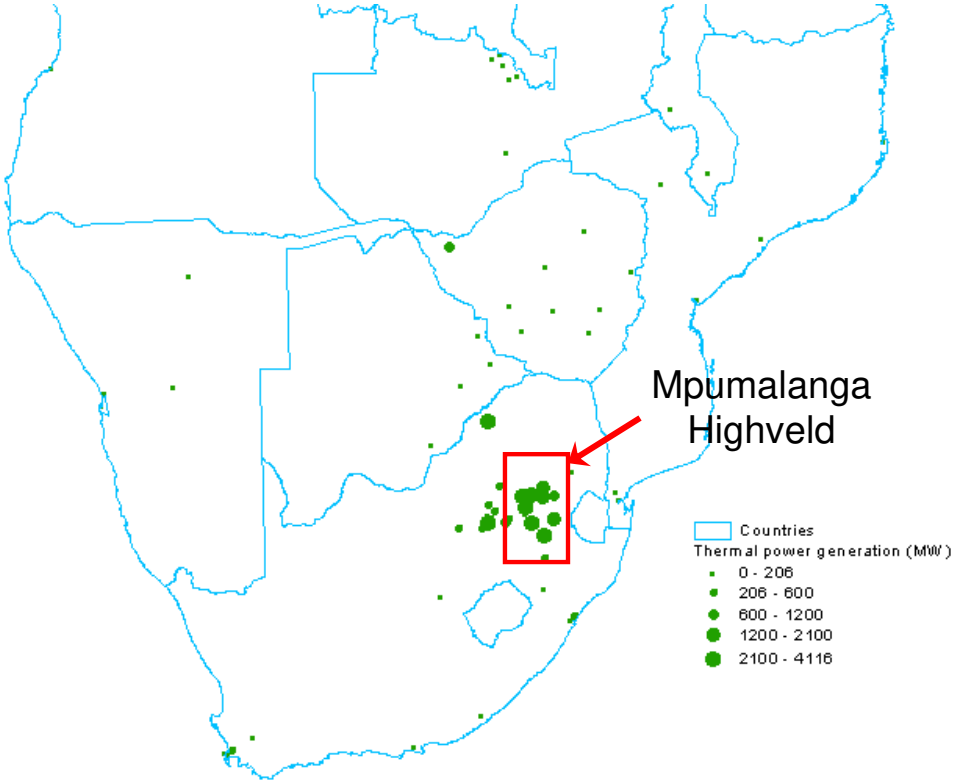

Figure 1. Location of power generation plants and capacities in southern Africa, showing concentration on the Mpumalanga Highveld Source: Gavin Fleming, CSIR

A sociological anomaly occurs in that within the shadow of these giant industries and sophisticated power generation, the poorest sector of the population continues to rely on domestic combustion of poorer quality coal for basic heating and cooking energy. In spite of an overall low population density in Mpumalanga, some of the traditionally disadvantaged groups live in suburbs located close to or downwind from heavy industry. The societal costs of exposure to air pollution from "dirty" fuel combustion have only recently been estimated in South Africa (Scorgie *et al.*, 2004a-c). Results indicate that the poor air quality in the region has significant and serious impacts on health.

Within the context of evolving legislation on air quality and the constitutional right to a clean and healthy environment, it is necessary to engage in comprehensive evaluations of the total exposure to air pollutants, encompassing regional as well as local sources. These include industrial, mining, agricultural, spontaneous combustion, indoor and outdoor domestic sources, together with their fugitive emissions (dust and evaporative losses) and natural emissions.

While the local authorities have begun planning activities in the sphere of air quality as part of their Integrated Development Plans, and in anticipation of promulgation of a new air quality management Act (NEM: Air Quality Bill, B62 - 2003), local councils lack internal skills and resources in the environmental field. In this context, a public private partnership (PPP), involving the authorities (local and provincial), industry (through Coaltech 2020) and multilateral organisations in Mpumalanga, is considered an appropriate way to evolve sustainable environmental management plans including air quality development issues. On the other hand there have been signs of increased collaboration among multi-lateral organisations such as the UN and the large multi-national corporations. Large business has been challenged to join an international initiative, the Global Compact, that would bring companies together with UN agencies, labour and civil society to support UN principles in the areas of human rights, labour and the environment.

Returning to air quality in Mpumalanga, it is important to note that many (but not all) of the major industries in the region have taken action and are currently improving the monitoring and mitigation of their air pollution emissions. These activities address directly issues arising from their own activities and emissions. However, these company-based programmes do not fulfil the need for comprehensive, integrated monitoring and management of air quality in the region and beyond. In fact, many issues remain to be addressed if the implementation of such a regional integrated air-quality management system is to be facilitated and these relate primarily to the need for engagement with and collaboration between stakeholders. The need for air quality inventorying, monitoring and integrative management is recognised and motivations are evident. In order to proceed, partnerships between government, community, and industry, and between neighbouring countries, are considered essential. Such partnerships are globally recognised as the most effective mechanisms for devising and implementing metropolitan and regional air quality management systems. It is only through public private partnerships that the full cycle of generating accurate knowledge of the situation, mobilising funding, and implementing affordable, technically sound and socially acceptable remediation programmes, can be realised.

1.1. AIMS AND OBJECTIVES

The purpose of this report is to identify the need for and the feasibility of fully studying atmospheric emissions, air quality and energy efficiency monitoring for the prioritisation of air pollution prevention and public health protection in the Mpumalanga Highveld conurbation and downwind areas, with a view to identifying practical options for mitigating air quality problems.

In order to meet this aim, the following objectives will be addressed:

- Identify currently available ambient air quality data, information, monitoring results and stakeholders;
- Identify data and monitoring results required to quantify sources of atmospheric emissions;
- Inventory the current skills base available to study air quality issues;
- Estimate the costs involved in addressing these issues;
- Prepare an outline of a feasible programme for presentation to interested and affected parties, and to potential funding organisations. Such a programme would need to:
    - Quantify and identify sources of air pollution (including relative contribution of natural, anthropogenic and distant sources);
    - Identify possible interventions and potential reductions;
    - Establish the cost and cost benefit for each intervention proposed;
    - Support and monitor the implementation of interventions;
    - Support and supplement community education initiatives to empower individuals and other interested and affected parties (I&AP) to reduce their own pollution contributions (e.g. use low-smoke fuels, undertake vehicle and stove maintenance) and to monitor their progress; and
    - Identify and/or supplement monitoring networks and databases.

In summary then, this is a feasibility study, the purpose of which is to define the work required and to devise a plan for achieving the objectives. This report covers an extensive review of the available literature, unpublished data reports, the state of knowledge and needs. An outline of a programme is presented initially for the Mpumalanga Highveld region, and for one adjacent territory, provisionally chosen as southern Mozambique. In later phases of the project it is envisaged that the activity would be expanded internationally with a viable, demonstrated project through existing international structures such as Air Pollution Information Network - Africa (APINA).

1.2. BACKGROUND FRAMEWORK

This report forms part of a process initiated as a follow up to the World Summit on Sustainable Development (WSSD) on the development of a strategic private-public sector partnership for the southern African region. The main aim of this alliance was to identify critical areas for rapid and sustainable industrial development in the southern African region and to map strategies for integrated action plans that currently are not yet effectively being addressed by industry, government or donors. There is an overall need in the southern African region to assure that countries can better compete in competitive global markets, as a precondition for economical growth. In many countries, public-private partnerships have contributed significantly to these objectives. The mutual support for government and industry to deal with key issues of globalisation and sustainability in a comprehensive manner (no single agency or group or donor is doing this at a macro-scale) is a role for input from inter-governmental organizations such as UNIDO and UNESCO.

Key partners for the partnership included the Scientific Industrial Research and Development Centre (SIRDC) a government R&D institute representing public sector views, and Coaltech 2020 a South African consortium of both public and private sector entities working on industry relevant problems. The UN agencies were approached to assist with methodological support and to facilitate dialogue and programme development. In order to identify technical projects as well as institutional arrangements a first working session supported by UNESCO and UNIDO was held in Johannesburg, South Africa from 24-28 March 2003.

Development problems have been recognized and within the framework of the UN, as well as NEPAD, a specific role has been identified for the private sector in addressing the Millennium Development Goals. A major issue is the evaluation of ways in which companies can address social issues, not only through financing social projects, but also more integrated in the way they conduct their business, and the products and services they deliver.

As large corporations in sub-Saharan Africa are the dominant forces behind the economies and the industrial growth of this region it is imperative to link up with this sector and ascertain areas of co-operation for development programmes. How industry in the SADC region can work together with Governments to produce meaningful policies, and how the UN with its range of specialized agencies can support this process will have to be pioneered since no clear-cut model is available.

Consultations during the first working session held from 24-28 March 2003 in South Africa, identified potential private-sector partners, and prioritised five themes that met Sustainable Industrial Development needs with a regional relevance:

- Air emissions and air quality monitoring and energy efficiency management for the mining, metal industrial sectors and heavy industry, which would be supporting policy issues such as community health, urban planning, and prioritization of pollution prevention interventions.
- Product development and process innovation for improved use of waste products and eco-efficiency to meet international environmental standards.
- Rural energy and related agro-based entrepreneurship development programmes to improve rural livelihoods, and raise incomes to make electrification sustainable and affordable, focusing on agricultural and SME development.
- Social and Environmental impact of operation and closure/rehabilitation of mine sites and related industries; Community development and income diversification programmes with focus on increasing agricultural potential and alternative use of water resources and waste water.
- SME Cluster and value chain development, with specific attention to black entrepreneurship development.

Of these, two themes were selected by UNIDO, Coaltech 2020 and SIRDC in order to initialise the process. The selected themes are 'Air Emissions, Air Quality and Energy Efficiency Monitoring for Prioritisation of Pollution Preventions and Public Health (this report, study led by Coaltech 2020) and 'Product Development and Process Innovation for Improved Use of Waste Products and Eco-efficiency to Meet International Environmental Standards' (study led by SIRDC).

2. SITUATIONAL ANALYSIS

2.1. STATUS OF AIR QUALITY

The air quality in Mpumalanga is widely regarded as poor, and possibly injurious to human and ecological health (Annegarn *et al.*, 2002; Held *et al.*, 1996; Tyson *et al.*, 1996). Factors contributing to this poor air quality include:

- Major contributions from natural sources located within the region;
- Pollutants transported from outside the study region; and
- The large concentration of anthropogenic activities such as mining, heavy industry and power generation.

Only when these factors are studied together can a true picture of the pollution situation in any defined study region be achieved. It is in this context of understanding what is emitted and transported that successful interventions can be planned.

Currently the public knowledge of the air quality situation is sketchy. The Nedlac study, documented in the FRIDGE reports, successfully drew together available data on combustion sources within the Highveld plateau region (Scorgie *et al.*, 2004a-c, Bentley West Management Consultants, 2004). Non-combustion sources were outside the scope of this report. Lessons learnt from FRIDGE include an understanding of the limitations of currently available data.

As participants in this study, we have a comprehensive idea of the workload needed to generate and update source emission inventories (point and non-point sources) in the South African context. Additional information is included as Appendix 1.

Natural sources contributing to poor air quality in the Mpumalanga region include:

- Lightning, which generates significant quantities of NOx;
- Biogenic processes, which release a range of gases, e.g. bacterial processes in soil release NOx; volatile organic emissions from leaves of certain species;
- Biomass burning, including wild fires and rural domestic fuel combustion, which are significant sources of PM2.5 and PM10 particulate matter, CO as well as a range of volatile organic gases.

Natural generation of NOx by lightning has been quantified for southern Africa, on a monthly and annual basis, for the year 2002 (Ojelede, 2004). This study provides an understanding of lightning produced NOx on the overall NOx budget in the Mpumalanga Highveld region, specifically in relation to anthropogenic (power plant) NOx emissions. The source of lightning data is a network of lightning positioning and tracking detectors, which are continuously operated, so that the availability of data over and extended period is assured.

Emission factors from wildfire biomass burning over southern Africa south of 10°S have been quantified in a series of regional field campaigns, namely SAFARI '92 and SAFARI 2000 (www.safari2000.org, Annegarn *et al*., 2002; Swap *et al*., 2003). Satellite monitoring of fires provides information on the positions and extent of larger fires. Using archive satellite imagery (Landsat TM and MODIS) it is possible to derive the annual average of burnt areas and vegetation densities and from these to estimate the regional atmospheric emissions. Recent satellite imagery shows the generation and transport of smoke from fires in central Africa moving southward to cover the southern sub-continent (a major factor in transboundary pollutant transport). The current understanding is that most large area wild fires are started as purposeful agricultural fires.

Within Mpumalanga, fire is not extensively used as an agricultural tool and vegetation densities are low compared with those in northern regions. Hence, long-range transboundary transport of biomass burning emissions is more important than local wild or agricultural fires. In fact within the protected natural park areas fires are actively managed but not prevented, as they are a necessary part of the ecological system. Modelling and transport of the pollutants during the fire season is well understood for the incidents that were studied during the SAFARI campaigns but a generalised modelling has not been attempted.

Biogenic emissions are also affected by farming and the populations of farm animals. They are recognised to be of growing importance to an understanding of the overall pollutant balance in the region. While small studies have identified the emissions and their effects in various locations, there is no regional understanding of this aspect for Mpumalanga.

The major anthropogenic sources in the Mpumalanga region include:

- Household energy, burning wood and low-grade coal in braziers for heating and cooking;
- Transport, tailpipe and evaporative emissions as well as tyre-entrained dust;
- Agriculture, soil and plant material dust, crop spraying with pesticides;

- Mining - coal, Au, V, Mn, Mg, Cr, Fe;
- Power generation - 20,000 MWe from eight large coal fired power plants;
- Coal-to-liquid fuel conversion, petrol from coal emitting significant H_2SO_4;
- Heavy metal processing, iron, steel, vanadium etc; and,
- Other smaller scheduled industries.

The FRIDGE reports (Scorgie *et al*, 2004a-c; Bentley, 2004) inventoried, modelled and quantified the health contributions from the combustion aspects of all of these sources. However, each source has non-combustion contributions as well, which vary in significance, depending on the nature of the activity. Material handling, storage and vehicle-entrained dust during transport are major fugitive contributors. It is not possible to design plans to meet air quality standards without correctly understanding the diversity of sources, including non-traditional areas, fugitive and imported sources.

Mining in the area includes several heavy metals, including vanadium and chrome that are toxic or carcinogenic in certain chemical states. Data on the mining, blasting, storage, handling and transport of these metals is required. Spontaneous combustion of coal in mines, storage piles and slag heaps is another source of pollutants. Current studies of this phenomenon are trying to characterise and quantify spontaneous combustion emissions.

Dust from mining and agricultural activities is significant and needs to be inventoried and modelled. Unpaved roads and the transport of products are significant sources of dust. Currently the relative contributions of these adjacent activities are poorly understood. An on-going dispute between the mining and agricultural groups over who is responsible for what pollution could be quickly resolved with results from a source inventory and modelling study.

Chemicals used to destroy pests on the crops are often toxic to other living systems. Higher doses and longer or more frequent exposures exacerbate their effect. This is a further source of pollutants that needs to be researched.

In many conurbations contributions from general transport are significant. This is less true in Mpumalanga with its low population densities and their minimal access to transport. There are a few routes and nodes where traffic impacts would be more important and some congestion does occur. Of particular interest are routes between product sources and their processing or distribution points

e.g. between coal mines and power plants, and between metal mines and iron and steel processing plants.

The poorer sectors of the population rely on low-grade coal and wood gathered from the environment for heating and cooking. Electricity, where it is available, is reserved for high-grade applications such as lighting, TV and refrigeration. Alternatively paraffin and candles are used to provide light. In densely populated areas in cities, emissions from coal or wood fires in winter is the most serious air quality issue in South Africa's urban areas. In smaller towns and less densely populated areas of Mpumalanga this is not quite as serious. Owing to the proximity of humans to the source, domestic fuel emissions are a significant part of the overall air quality problem. As a result of socio-economic constraints, alternative energy carriers need to be a focus of research, monitoring and education. A baby carried on its mother's back while she cooks over a smoky fire is more at risk from smoke inhalation than from any industrial or mine emission.

Power generation capacity in Mpumalanga of the order of 20,000 MWe represents the largest concentration of electricity generation capacity in Africa. This intensity of power plants complicates environmental risk assessment, as cumulative effects must be taken into account. Eskom (the South African parastatal power company) has extensive monitoring activities, with data records extending over 20 years. However, access to this information is restricted for commercial reasons. Eskom has made significant changes over the past years to reduce particulate emissions from power plants, and to reduce domestic exposure through urban electrification programmes.

Emissions from other industries' scheduled and non-scheduled processes also need to be quantified. Because of their proximity to residential areas, impacts from these sources can be very high at specific locations. Focus on assessing the emissions from stack and boiler ducted emission has led to risks from stored and handled materials being ignored. While the impacts might be local, the problems can be identified and, in most cases, solved with minimal cost and effort.

Major metal processing plants exist in this area; these include basic iron and steel plants as well as other metals such as vanadium and manganese. Again there are varying levels of co-operation, environmental responsibility and transparency between these companies when it comes to air quality issues. Government legislation on emissions from stacks has lead to monitoring and modelling in places. However, there results are not available to the public. Material handling, transport and storage are not considered and although problems have been experienced especially with the more toxic metals.

Coal-to-liquid fuel conversion plants in the area have a reputation for odorous emissions (H_2S). The size and capacity of these plants mean that emissions are significant on a regional scale. Despite extensive monitoring and public awareness of the odours, monitoring results are not accessible to the public. Quality research on source apportionment and its impacts and transparency about the monitoring and data for this source category are urgently needed.

A summary of major source types of air pollution in the Mpumalanga area is set out in Table 1. The state of knowledge about each source is indicated in three categories: emissions inventory; dispersion modelling; and monitoring and impacts.

Table 1. Summary of status of emission inventories, modelling studies, and monitoring for categories of natural and anthropogenic air pollution sources in Mpumalanga

Source Type		Mechnisim	Pollutants	Inventory Data Status	Modelling Status	Monitoring Status
Natural	Lightning	natural	NOx	good	good	good
	Biomass Burning	combustion	SO2, NOx, CO, CO2, PM2.5, PM10, VOC	fair	fair	good
		transported		good	poor	fair
	Biogenic	interaction	NOx, CO, VOC	poor	poor	poor
Anthropogenic	Household Energy	combustion	SO2, NOx, CO, CO2, PM2.5, PM10	fair	poor	very poor
	Transport	combustion entrained by tyres	Pb, Br, NOx, PM10, PM2.5	fair	fair	poor
				poor	poor	poor
	Agriculture	fugitive dust combustion	TSP, PM10, pesticides	poor	poor	poor
				med	poor	poor
	Iron and steel processing Industry	combustion materials handling transportation of material	TSP, PM10, PM2.5, SO2, NOx, heavy metals	good	good	fair
				poor	poor	poor
				poor	poor	poor
	Coal to liquid fuel conversion	combustion materials handling	SO2, H2S, NOx, PM2.5, VOC, benzene	good	fair	good
				fair	poor	poor
	Power generation	combustion materials handling	SO2, NOx, PM2.5	good	fair	good
				fair	fair	fair
	Other industry	combustion materials handling transportation of material	TSP, PM10, PM2.5, SO2, NOx, benzene	good	good	fair
				poor	poor	poor
				poor	poor	poor
	Mining	blasting materials handling transportation of material spontaneous combustion	TSP, PM10, PM2.5, V, Cr, C, Mn, CH4	fair	poor	poor
				poor	fair	fair
				poor	fair	poor
				poor	poor	poor

2.2. LEGISLATION

The South African legislative and regulatory environment has been reviewed in terms of air quality, energy and related policies, as well as recently introduced public private partnership (PPP) legislation. Aspects of the regulatory environment

that create opportunities for PPPs, specifically around air quality and energy issues, have been highlighted (Appendix 2). South African legislation can be located at http://www.acts.co.za.

Amendments to old and introduction of new legislative acts have been made since the adoption of the new constitution in 1996 (Constitution of the Republic of South Africa, Act 108 of 1996). The right to a clean and healthy environment and hence, clean air is enshrined in this law (Act 108 of 1996, 2:24). Since the adoption of the Constitution, a law reform process has been underway to update South African environmental law.

The law reform process with its overarching environmental outcome, National Environmental Management Act (NEMA), Act 107 of 1998, has already influenced the new Air Quality Bill, as well as standards compiled by a technical committee working under the direction of Standards South Africa, STANSA (STANSA, 2004). The final draft Air Quality Bill (NEM: Air Quality Bill, B62 -2003) is due to be promulgated by December 2004. Although the Air Pollution Prevention Act promulgated in Act 45 of 1965 is nominally the ruling act, it has not been reviewed in light of its certain repeal.

The Air Quality Bill together with other relevant government policies in place represents the anticipated benchmark for air quality planning in both public and private domains. Other relevant policy documents assessed and documented in Appendix 2 include:

- Overall energy policy (Dept. Minerals & Energy, DME, 1998);
- Renewable energy policy (DME, 2002);
- Integrated Clean Household Energy Strategy (DME, 2003); and
- Strategy for the control of exhaust emission from road-going vehicles (Dept. Environment Affairs & Tourism, DEAT, and DME, 2003).

Recent PPP laws in South Africa such as the Municipal Finance Management Act 56 of 2003, the Public Finance Management Act 1 of 1999 and the Treasury Regulation 16 (Public Private Partnerships) at local government level regulate public participation in future partnerships with private organisations. The lack of both capacity and financial resources in the public sector presents opportunities for private sector involvement in the delivery of public services. There are already encouraging signs of private sector interest. The Department of Environmental Affairs and Forestry (DEAT), for example, has recently put out a tender for undertaking the responsibility of certifying and monitoring industry stack emissions

currently controlled under the Air Pollution Prevention Act (Act 45 of 1965). DEAT is entering into PPPs in order to fulfil the legal responsibilities of this aspect of air pollution control, making use of technical skills available in the private sector rather than duplicating them in the public sector.

Although there is no specific wording within this legislation relating to international partners, either private or public, there is no obstacle for their involvement under the current legislation. The PPP laws do not exclude any interested and able "external" party from partnerships.

International framework agreements and protocols also directly impact South Africa's international obligations. Each country will put in place legislation to enact the principles outlined in various protocols to which they are signatories. Examples of such protocols and conventions include:

- United Nations Framework Convention on Climate Change, UNFCCC, of 1992;
  - Kyoto Protocol, 1997;
  - Montreal Protocol on the use of ozone depleting compounds;
- Agenda 21, the Rio Declaration on Environment and Development in 1992, further ratified at WSSD in 2002 through the agreements to meet MDGs; and
- South Africa's recently launched National Climate Change Response Strategy to provide a framework for dealing with climate change issues.

2.3. STAKEHOLDERS

Stakeholders and interested and affected parties (Appendix 3) who would participate in air quality issues in Mpumalanga include:

- Mining (Coal mining, other mining);
- Industries using scheduled processes;
- Chambers of Commerce;
- Communities and Community Based Organisations (CBOs);
- Government (national, provincial, local);
- Non-Governmental Organizations (NGOs);
- Consultants; and

- The international community, including bi-national cooperative agreements between South Africa and international donor countries.

Many industries have shown interest in the impacts they have on air quality and collaborated in projects and associations addressing air pollution in the areas of their established operations. Some emitters though, have chosen not to be involved in public projects up to now. Nevertheless, such organisations would need to be included in the proposed regional PPP project on assessing regional air quality and impacts.

Appendix 3 contains a comprehensive list of stakeholders in Mpumalanga and elsewhere in South Africa in each of the categories mentioned above, compiled as one of the sub-tasks of this feasibility assessment.

Several multi-stakeholder groups and organisations have been established in the last ten years to address environmental issues and air quality in South Africa. Valuable lessons have been learnt, some of which will be mentioned here, as they are relevant to the assessment of the proposal under evaluation. However, in Mpumalanga, because of its complexities, including the large number of industries and the fact that the population is mostly dependent on these for subsistence survival, business-backed initiatives have lost impetus without strong support and involvement of government and the wider community. In order to resolve the problems, comprehensive, cumulative and independent data, as well as an analysis of source apportionment, is needed, as the business-based studies of the late 1990s lacked credibility being, as they were, too focused on the interests of supporting industries. A tabulation of air-related co-operation and organisations in South Africa and those international initiatives where South Africa is involved is presented in Table 2. A number of these initiatives have been studied and critical success factors have been identified from these and are discussed below.

Table 2. Inventory of air-related co-operation and organisations in southern Africa

COLLABORATIONS TO ADDRESS SPECIFIC LOCAL PROBLEMS WITH AIR QUALITY • Apolcom - The Mpumalanga Air Pollution Control Liaison Committee • Richards Bay Clean Air Association • Durban South Industrial Basin • Vaal Triangle Strategic Environmental Assessment • Cape Town Brown Haze Project • Coega Industrial Development Zone • Rustenburg Ecoforum
INTERNATIONAL COLLABORATIONS ON AIR ISSUES • SAFARI '92 – South African Fire Atmosphere Research Initiative 1992 • SAFARI 2000 – Southern African Regional Science Initiative 2000 • APINA – Air Pollution Information Network for Africa
OTHER CLEAN AIR ASSOCIATIONS • NACA, National Association for Clean Air (National organisation and local branches) • Earthlife Africa, interested in clean air issues • Trees for Africa, plant trees in disadvantaged areas to improve quality of life, impacts environmental education and clean air

Examples of collaborations to address specific local problems with air quality are discussed below in more detail.

Name	**APOLCOM, Mpumalanga Air Pollution Control Liaison Committee**	
Type	Voluntary association	
Participants	Industries, mining organizations, transport services, power suppliers, government – local, provincial and national	
Mission	Working towards continuous improvement in air quality of the region where the facts relating to the air pollution can be made known and analysed through constant interaction and mutual support through the sharing of techniques and knowledge	
Start date	1987 (26/02/1987)	Current
Critical Success Factors	Governmental and private sector membership since origination Private sector funding Government chairmanship Development and usage of shared knowledge to benefit of all members and wider environment Establishment and maintenance of air pollution monitoring network	

Name	**Richards Bay Clean Air Association**	
Type	Voluntary association. (non-profit organisation)	
Participants	AECI, Bayside Aluminium, Besboks, Felixton Planters Association, Foskor, Hillside Aluminium, Lafarge, Mondi Kraft, Mondi Kraft Felixton, Richards Bay, Richards Bay Minerals, Ticor, Island View Storage, Department of Environmental Affairs and Tourism, Department of Agriculture, uMhlathuze Municipality, Richards Bay Ratepayers and Residents Association, National Ports Authority, Zululand Environmental Alliance, Bay Hospital, Local community	
Mission	To ensure that ambient concentrations of airborne pollutants are below Department of Environment guideline limits, that information derived is available to all interested and affected parties, that the system will be expanded to include other priority air pollutants, where feasible	
Start date	June 1996	Current
Critical Success Factors	Governmental, private sector and local group membership since origination; Private sector funding Development of a framework for managing complaints and interacting with complainants Development and usage of shared knowledge to benefit all members and wider environment Establishment and maintenance of air pollution monitoring network	

Environmental impact assessments (EIA) in Mpumalanga have to be lodged with district municipalities, the local government authorities. Critical success factors are discussed below on two district municipalities.

Name	**Gert Sibande District Municipality** includes Albert Luthuli (Carolina), Msukaligwa (Ermelo), Mkhondo (Piet Retief), Seme (Volksrust), Lekwa (Standerton), Dipaleseng (Balfour) and Govan Mbeki (Secunda) local municipalities
Type	Environmental impact assessment scoping reports
Participants	Industries, mining organizations, transport services, power suppliers, Government – local, provincial and national, consultancies and specialist scientists/professionals
Role	Preliminary assessment of the environmental impacts before undertaking a particular development project (new/annexure/extension)
Start date	In advance before project start and in dependence of the Record of Decision (RoD) by the relevant district and/or provincial authority
Critical Success Factors	No comprehensive EIA lodged with the district municipality Low capacity to deal with developmental and environmental issues at this level of regional/local government Large number of scoping reports submitted and approved; almost all with air quality/emissions/pollutions sections indicating concern for air quality in planning. Legal procedures followed Stakeholder participation in process noted Lack of concern from the public about impacts of development - no objections recorded (either public participation is weak or public is more concerned with poverty and unemployment)

Name	**Nkangala District Municipality i**ncludes Delmas, Emalahleni (Witbank), Middelburg, Highlands (Belfast), Thembisile (Empumalanga) and Dr. J.S. Moroka (Siyabuswa) local municipalities
Type	Environmental Impact Assessment Scoping and Environmental Impact Reports
Participants	Developers in Industries, Mining organizations, Transport services, Power suppliers; Government authorities – local, provincial and national, consultancies and specialist scientists/professionals
Role	Preliminary assessment of the environmental impacts before undertaking particular development projects (new/annexure/extension)
Start date	In advance before project start and working towards a Record of Decision (RoD) by the relevant district and/or provincial authority
Critical Success Factors	EIA process has been established Stakeholders involved in processes Air quality/emissions increase/pollution issues have been specified and mitigation measures suggested Relative increases in air emissions are compared to higher emissions from older processes; new process is then estimated as insignificant/low/minimal impact and therefore tolerable – not scientifically constrained Reliance on use of improved technologies with energy and resource efficiencies preferred to more mitigation measures Lack of concern from the public about impacts of development - no objections recorded (either public participation is weak or public is more concerned with poverty and unemployment)

2.4. REGIONAL ACTIVITIES AND POTENTIAL FOR EXPANSION

Of particular interest for this feasibility document is the evaluation of the successes and failures of regional initiatives. It is clear that these represent good structures on which to build and/or adapt any new initiative.

Name	**APINA, Air Pollution Information Network – Africa**
Type	Trans-boundary international regional network
Participants	Scientist, policymakers, non-governmental organisations, international donors
Role	Its major role is to transfer knowledge and information from scientific research programmes to create general awareness on air pollution issues in Africa. APINA aims to form strong links among air quality scientific community and policy makers at national and regional levels while involving all stakeholders, and to act as a conduit of knowledge and data derived in scientific programmes to influence policy decisions on matters of air quality. APINA has been tasked to follow up and coordinate the 1998 Harare Resolution on the Prevention and Control of Regional Air Pollution in southern Africa and its likely transboundary effects. The resolution was the result of the Regional Air Pollution in Developing Countries (RAPIDC) Programme a multi-stakeholder dialogue held under the auspices of the Southern African Development Community-Environment and Land Management Sector (SADC-ELMS) in Harare in 1998 Participating countries include Botswana, Malawi, Mozambique, South Africa, Tanzania, Zambia and Zimbabwe

Start date	APINA was formed in 1998 to promote the transfer of information on air pollution issues and impacts to the policymaking process. Since its inception, the network has received the majority of its funding from the Swedish International Development Co-operation Agency (SIDA) as a part of the Agency's Regional Air Pollution in Developing Countries (RAPIDC) Programme
Critical Success Factors	Dissemination of the information that air pollution is a regional issue, influenced by atmospheric movements that know no boundary as all countries in southern Africa are physically connected by air circulation The network is slowly unfolding the air pollution agenda in southern Africa. Its activities have potential to substantially assist in the awareness process on air pollution and contribute to the development of the regional policies on air pollution. However, its success might be limited by financial constraints and lack of political will The role in capacity building at local level is critical to achieve the goals of the network, including the goal of a substantial reduction in air pollution in the region

Name	**SAFARI 2000, Southern African Regional Science Initiative**
Type	A consortium of environmental scientists, research initiative
Participants	Scientists from southern Africa, in collaboration with colleagues from the USA and EU, 20 countries and 250 scientists
Role	Its role was to study the linkages between natural processes and human activities in the southern African region, particularly those processes resulting in the emission of pollutants to the atmosphere, as well as to investigate these pollutants through the atmosphere and their impacts as they are eventually deposited on land or water bodies in the region
Start date	SAFARI 2000 was built upon the results of a former research initiative undertaken in the same region in 1992, the Southern African Fire-Atmosphere Research Initiative (SAFARI-92). The intensive observation periods took place during both the dry (1999 and 2000) and the wet season (2000)
Critical Success Factors	SAFARI 2000 research activities have provided strong evidence that emissions from a host of natural and human-induced processes in southern Africa are transported over long distances across the region and combine to influence the physics and the chemistry of the region's atmosphere Increased concentrations of acid rain and tropospheric ozone precursors and global warming chemicals emitted into atmosphere as a result of natural and man-made emissions have been detected which inhibit the development and /or alter the properties of clouds and have potential to cause acid rain, to increase ground level ozone concentrations and accelerate local and regional climate change. Measurable disturbances in rainfall distribution and solar-terrestrial energy balance have also been detected, which might accelerate regional climate change, with possible adverse consequences The broad implications of these results are that the southern African environment is likely to experience significant stress if political measures to stabilise emissions are not devised and implemented at multiple levels. Immediate action is required at both national and regional levels to control emissions in southern Africa, and to counteract increasing deterioration of the quality of the region's natural environment

2.5. SKILLS AUDIT

Within South Africa there are existing skills in the fields of:

- Environmental management;
  - Air, water and waste monitoring
  - Atmospheric chemistry and physics
  - Modelling and emissions inventory
  - Industrial processes and emissions
  - Mitigation of industrial emissions and cost benefit analysis knowledge
- Climatology and climate change; and
- Public participation.

However, most of these skills are either in the private sector or in academic institutions with a limited number of specialists employed by government. Thus, local government, especially in the smaller municipalities, has to contract expertise from this pool. A list of available expertise is set out in Appendix 3.

Education in environmental issues including air quality is available at both under- and post-graduate level at most of South Africa's tertiary institutions. South African as well as other African students graduate regularly in these fields. Practical experience and mentoring for these students is available through larger consulting companies, parastatal research institutions and through the academic staff involved in research for industry. However, there remains a lack of skilled professionals at local, regional and national government levels in environmental portfolios.

In South Africa there are growing requirements for equity in employments in terms of race and gender. These requirements are proving to be problematic in the specialised fields of air pollution research. There is a shortage of experienced, qualified specialists from previously disadvantaged groups. Skills retention is an issue, as recent graduates readily move from technical into management positions when they are offered improved salary packages and working conditions. PPPs, though, represent an opportunity to overcome the skills shortages in public bodies. The qualitative and quantitative skills pool that exists in academia and the private sector can be engaged, a suitable framework for the mutual benefit of all partners, as well as society. Furthermore, PPPs also facilitate collaboration on the supply of resources with international partners.

3. CONCLUSION AND RECOMMENDATIONS

A public private partnership (PPP) initiative is proposed as a vehicle for a regional programme on air emissions, air quality and energy efficiency monitoring. This PPP will address prioritisation of pollution prevention strategies for public health protection and environmental equity in southern Africa. A full project plan is presented in Appendix 4, and an outline of the plan is presented in this section.

3.1. OUTLINE OF THE PROJECT PLAN

The title of the project will be: "Air emissions, air quality and energy efficiency monitoring for prioritisation of pollution prevention and public health in southern Africa".

On the basis of the analysis set out in this report and appendices, we have established that atmospheric emissions from industrial, domestic, transportation and natural sources have adverse impacts on health in sections of the population. The worst impacts occur in residential areas and are due to the inefficient use of coal as a heating fuel, and the proximity of residential areas to large industries – a consequence of poor town planning in the past. Disputes between communities, industries and regulators remain unresolved in the absence of adequate policies and information on atmospheric emissions and air quality. Trans-boundary transports of anthropogenic and natural pollutants have been observed and modelled. However, possible long-term consequences of cumulative loads of acidic and heavy metal species (e.g. Hg, Cr) deposited by dry and wet deposition are not yet adequately quantified and understood.

In South Africa, revised air quality legislation and related standards are in preparation. However, basic air quality management measures, including policy, monitoring, modelling and mitigation, are lacking elsewhere in the region. Within South Africa, important information gaps have been identified that hinder the implementation of cost-effective mitigation measures.

The overarching aim of this proposed project is to introduce effective pollution prevention measures for the protection of public health and the environment. Pollution prevention measures are understood in the broadest sense to include the understanding of the bio-geophysical environment, policy and technological interventions, and social participation. Initially, two regions will be selected for

intensive study: the Mpumalanga Highveld, South Africa, representing a highly industrialised area; and southern Mozambique, a less-developed region, which is down wind of Mpumalanga and has its own emerging industrial base.

Execution of the project is proposed as four work packages.

- Work package 1: Project initiation
- Work package 2: Project implementation
- Work package 3: Training/technology transfer and cross-cutting activities
- Work package 4: Project management

Readers are referred to Appendix 4 for detailed objectives, work programmes and expected outputs.

As this proposal is conceived around the notion of public private partnerships, it is necessary to identify the likely partners in the initial phase. On the industrial side, Coaltech 2020, a consortium of coal-based industries, is regarded as critical in view of its successful management of the current consortium. Additionally, key partners would include the power industry and representatives from the agricultural sector. Under drafted new legislation, responsibility for air quality management resides at local authority level; hence the public partners will be sought at this level (Witbank / Emalahleni Municipality). Nevertheless, as air quality is a regional and international issue, public sector involvement from multi-lateral organisations, such as United Nations (UN) bodies, will be sought. The nature of the project requires also involvement of other interested and affected parties, including universities and research institutions; other industries and businesses; provincial and national government departments; and civil society. An existing regional policy co-ordinating body in the field of air quality, the Air Pollution Information Network Africa – APINA, would also be an essential partner.

Outputs

The products developed and produced will range from climate data to validated regional air quality models, including:

- Improved air quality through cost-effective interventions;
- Reduced air pollution related health impacts;
- Direct economic benefit and employment opportunities for SMME businesses involved in the generation of air-quality management products; and

- Successful demonstration projects of PPPs involving industry, local and provincial governments, and local communities.

Estimated duration and funding cycles

The overall project, from total inception to full completion, is envisaged as a seven-year cycle, with a rolling three-year cycle of commitment and funding. The proposed operation is as follows. A detailed initial project plan and budget are designed for a three-year period. At the end of year 2, review and evaluation take place. If progress is satisfactory, a further two-year extension is assured (extending the project to year 5). If progress is unsatisfactory, notice may be given to terminate the project at the end of the following year (3rd year of cycle) and the contractors then have 12 months to wind down all activities. At the end of each subsequent year (years 3, 4, and 5) a similar process is followed, with forward financial planning of three years, alternatively one-year notice of termination for unsatisfactory performance, protecting both funding agency and contractor.

Proposed budget for a three-year cycle

Work Package	Description	Year 1	Year 2	Year 3
1	**Project initiation**	**€ 48,000**	**€ 0**	**€ 0**
2	**Project implementation**	**€ 474,000**	**€ 276,000**	**€ 276,000**
3	**Training/technology transfer and cross-cutting activities**	**€ 113,000**	**€ 113,000**	**€ 113,000**
4	**Project management**	**€ 66,000**	**€ 66,000**	**€ 66,000**
Sub-total (excluding VAT)		**€ 701,000**	**€ 455,000**	**€ 455,000**
	VAT 14%	€ 99,000	€ 64,000	€ 64,000
Total (including VAT)		**€ 800,000**	**€ 519,000**	**€ 519,000**

3.2. FUNDING OPPORTUNITIES AND OPTIONS

The goal of sustainable development is a difficult one to begin with and, without the availability of adequate sources of financing, it will remain elusive. It has been stated that there has been an absence of creative thinking on the issue of financing as well as on the challenges of globalisation (WSSD, 2002).

Traditional development work has been funded variously, including through multi-lateral agencies and/or bi-lateral donor agreements channelled via national

government structures. The UN, as well as NEPAD, has now identified a specific role for the private sector, including multinationals, to contribute toward ensuring environmental sustainability and enabling a global partnership for development (UN Secretary General, 2001).

A focal point of UNDP discussions during the WSSD in 2002 was the development of UN Type II Initiatives, involving the establishment of PPPs. The availability of UN funds to initiate and implement such demonstrator programmes, through means such as through the Global Environmental Facility, was indicated. Additional funds could be sourced from international donors through existing and/or new bi-lateral and/or regional agreements.

Government funding could be mobilised through relevant structures. In South Africa, the Innovation Fund, the Department of Trade and Industry and the Department of Environment and Tourism, could be approached to assist.

Contributions from the private sector, including in kind contributions, can be negotiated, particularly if corporate social responsibility benefits are achievable. Further, investment opportunities for new business development for the provision of specialist services can be found in the region; including various banking institutions such as for example, the IDC in Zimbabwe. Other options include small business development and economic empowerment facilitators, such as Zimele (www.zimele.co.za) in South Africa.

The process of incorporating knowledge, establishing linkages, synergies and actual implementation for achieving the objectives listed takes time thus, for a project to have a chance of being sustainable, the required time-frame and commitment must be in place.

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APPENDICES

APPENDIX 1: Air Quality

APPENDIX 2: Legislation

APPENDIX 3: Stakeholders and Contacts

APPENDIX 4: Detailed Project Plan

APPENDIX 1: AIR QUALITY

A comprehensive literature review was undertaken to determine specific pollutants and related sources of concern, nationally and by conurbation.

Air pollutants emitted from combustion processes within industry, services, utilities, agriculture, transport and domestic sectors are generally well documented both locally and internationally (Graham *et al.*, 1999; Wong, 1999; Scholes and Meinrat, 2004).

Sources of emissions that are not widely researched must be accounted for in a larger-scale project. These include **dust emissions, industrial process emissions, and evaporative losses**. The NEDLAC Combustion Fuels Project, in the FRIDGE reports, comprehensively documents combustion sources, modelled and analysed to identify expected health impacts and costs of various combustion-related intervention strategies (Scorgie *et a.l*, 2004 a-c; Bentley, 2004). This process needs to be duplicated to include the non-combustion sources as mentioned above and any improvements to the combustion source data that can be added (for example, spontaneous coal combustion within coal stock piles).

A1.1 AVAILABLE DATA

Various research initiatives over the past 20 years have contributed to an extensive knowledge of some of the pollutant sources in the region. The sources can be divided into: natural sources, not caused by man and that often cannot be reduced or changed; and anthropogenic sources. It is important to understand these thoroughly so that they can be taken into account in the planning and setting of air quality targets. For example, it would be impossible and unwise to try to reduce NOx levels to below that produced by lightning in the region.

NATURAL SOURCES: Pollution is defined as gases and particulates that occur in high concentrations. Natural sources of these gases and particulates include:

- Lightning;
- Natural biomass burning;
- Biogenic interactions;
- Volcanic eruptions (not common in this region); and
- Natural dust storms (not common in this region).

Lightning – inventory of sources: Lightning influences atmospheric chemistry by producing NOx (NO and NO_2), a precursor of ozone. In terms of inventory, lightning is the largest natural source of NOx in the troposphere.

Lightning – pollutant emissions (expected or measured): Atmospheric NOx in the southern hemisphere is caused mostly by lightning, through ionisation and recombination of N_2 and O_2 (Lamarque *et al.*, 1996). Lightning-produced NOx (LNOx) over southern Africa has been quantified by evaluating ground-based and satellite-based lightning frequencies (Ojelede, 2004). Annual lightning density maps show high localisation over the Highveld, with decreasing activity in regions further away.

Quoting directly from Eskom's 2002 annual report, the power plant-generated NOx emissions over South Africa were 2 250 tonnes of N_2O and 702 kt of NO_2 (Eskom, 2002). Comparing this with the calculated lightning-generated NOx budget, it represents 33.0% of the emissions from the coal-fired power plants.

Lightning-produced NOx was 232 kt NO_2 a^{-1} for 2002. The power plant-generated NOx budget for South Africa for 2002 was 702 kt NO_2 a^{-1} (Eskom, 2002). Lightning-produced NOx therefore represents one third of the NO_2 generated by the coal-fired power plants in South Africa (excluding coal-to-oil conversion plants).

Biogenic interactions: Biogenic emissions and their interactions (biosphere, atmosphere, geosphere and hydrosphere) have been recognised as an area of major uncertainty in atmospheric chemistry. Of particular importance is their role as precursors to regional ozone formation.

Biogenic interactions – inventory of sources: Biological activity has the potential to emit large amounts of trace gases and aerosols into the atmosphere. Especially in tropical regions, with their high biological activity, these emissions are expected to be significant. They can take the form of trace gas fluxes from soils and vegetation, where gaseous species are produced and consumed by living organisms, or of smoke emissions from vegetation fires. In the last decade, considerable scientific effort has gone into quantifying these fluxes from the African continent. It has been found that both biogenic and pyrogenic emissions have a powerful impact on regional and global atmospheric chemistry, particularly on photo-oxidation processes and tropospheric ozone. The emissions of gases and aerosols that absorb or reflect radiation from the African continent are likely to have a significant climatic effect, but presently available data is not sufficient for reliable quantitative estimates of this effect.

Biogenic emissions – carbon dioxide: Globally, CO_2 emissions to the atmosphere from soil respiration have been estimated to be 68 ± 4 Pg C a−1. Changes in the biological activity in soils due to biomass burning and other perturbations may influence the atmospheric CO_2 budget, at least on a local scale. Following a fire, CO_2 is released through soil respiration and decomposition of nonliving organic matter produced in the fire. Carbon dioxide is reincorporated into biomass during the post-burn recovery period, thus offsetting its release by soil respiration. During the period in which soil respiration exceeds photosynthetic uptake, however, there is a net emission of CO_2.

Biogenic emissions – carbon monoxide: The concentrations of the OH radical in the atmosphere are strongly influenced by its reaction with CO. Carbon monoxide oxidation can lead either to the production or consumption of tropospheric ozone, depending on the NOx mixing ratio. The photochemical oxidation of methane and other hydrocarbons, and emissions from biomass burning are thought to constitute a large fraction of the global CO source strength. Soils have been proposed as sinks for atmospheric CO on a global basis. However, data is limited and conflicting with regard to both the magnitude and the direction of CO fluxes from tropical savannah soils. The net CO flux results from a kinetic competition between chemical oxidation of soil organic matter to produce CO, which is favoured by dry soil conditions, and biological oxidation of CO by soil micro-organisms. It is inferred that phenolic structures in soil organic matter are the primary source of CO production.

Biogenic emissions – hydrocarbons: Tropical savannahs cover 65% of the land surface of Africa. They have a high potential for biogenic emissions. Guenther *et al.* (1995, 1996) estimate that vegetation is the source of over 90% of all non-methane hydrocarbons (NMHC) in the global atmosphere. Current estimates of NMHC emissions rely on very limited databases. Existing data

demonstrates that there are large variations in emission rates for different plant species and, thus, for various landscapes. NMHC emissions for southern Africa were estimated from five savannah types and compared to the estimates of Guenther *et al*, 1996. Landscape average emission factors were calculated for isoprene and monoterpenes. Tropical and subtropical savannahs have the potential to impact on global NMHC budgets, but the limited data sets available at present do not allow for further extrapolation.

Biogenic emissions – methane: Uncultivated soils that are dry often provide a net sink for atmospheric CH_4. Savannahs, being prone to droughts and long periods of dryness, are usually considered to be net CH_4 sinks or very weak sources. Measurements taken during the SAFARI 2000 campaign and subsequently confirm this view. Otter (2004) measured methane fluxes in southern African savannahs and found clear seasonal patterns of methane production and consumption. Very little data is available for methanogenesis and oxidation in African savannah soils. The net soil methane sink strength in the subcontinent could be ~4000 Gg a−1, offset by up to 20% due to termite emissions. Emissions resulting from enteric fermentation in large herbivores in Africa south of the equator are estimated to be 320 Gg CH_4 a−1.

Biogenic emissions – nitrogen trace gases: Nitric oxide (NO) and nitrous oxide (N_2O) are key species involved in the chemistry of the troposphere and stratosphere and in global climate change. Nitric oxide is an important chemical species involved in the photochemical production of ozone in the troposphere, in the chemical production of nitric acid, the fastest growing component of acidic precipitation, and in the chemistry of the hydroxyl (OH) radical, the major chemical scavenger in the atmosphere. Nitrous oxide leads to the chemical destruction of ozone in the stratosphere and is an important greenhouse gas with a global warming potential more than 200 times that of carbon dioxide on a per molecule basis. It is generally agreed that microbial soil emissions are significant global sources for both N_2O and NO. Recently, several groups reported short-term measurements from west and southern African savannahs, where a wide range of NO emission rates (0.05–100 ng N m^{-2} s^{-1}) were observed. This large variation is due mainly to the very different conditions of disturbance, soil moisture, and soil nutrient (especially nitrogen) content which were encountered during the individual experiments. However, modelling of global soil biogenic NO suggested that tropical and subtropical savannahs are among the most important source areas due to the high temperatures and their large geographic extent.

The role of the world's savannahs and particularly the savannahs of Africa on the global budget of N_2O is uncertain due to the paucity of measurements. Where measurements have been taken in South Africa, Zimbabwe, Namibia and West Africa, it appears that NO is the dominant nitrogen species emitted. The overriding reason for this is the long dry season, followed by periods of rain interspersed with short dry spells, with the water-filled pore space values seldom reaching the thresholds needed for N_2O emissions. During the transition from the dry to the wet season strong "pulsing" effects of the NO flux are observed. NO emissions can increase by up to 60 times the dry season flux. Soil moisture was found to be the dominant factor controlling the NO fluxes.

A recent synthesis of NO flux data for Africa was carried out (Serça *et al*, 1994; 1998). Biogenic soil emissions of NO may be comparable to NO emissions resulting from combustion of biomass. Timing of these emissions is such that they may be an important contributor to the high levels of ozone observed over the South Atlantic from August to mid-September.

Biomass burning: Biomass burning is extensively used as an anthropogenic agricultural tool (sugarcane, crop-residue burning, land clearing) in Africa. Anthropogenic fires, intentional and inadvertent, are believed to be the cause of the bulk of wild fires (Helas *et al*., 1995). Lightning-

induced fires are a secondary factor. Biomass-burning aerosols and trace gases are transported over large distances, and are major factors in regional air quality over sub-equatorial Africa (Figure 1).

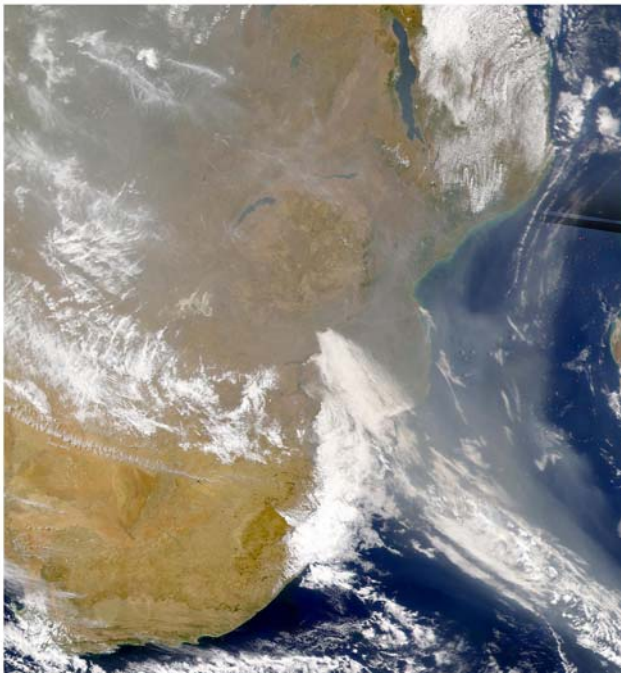

Figure 1: Biomass burning and haze exiting off the east coast on 4 September 2000.
(Source: SeaWiFS Project, NASA/Goddard SFC and ORBIMAGE.)

Biomass burning is an incomplete combustion process with CO, CH_4 and NO_2 being emitted during the process. About 40% of the nitrogen in biomass is emitted as nitrogen, 10% remains in the ashes and it is assumed that 20% of the nitrogen is emitted as higher molecular weight nitrogen compounds. Unlike N species, only small amount of SO_2 and sulphate aerosols are emitted. Biomass burning particle emission factors range, on average, from 20 – 50 g/kg of dry matter burned, with higher emissions occurring during the smouldering phase than during the flaming fire phase (Cachier *et al.*, 1996).

Biomass burning – quantification of sources and impacts: An analysis of the remotely sensed burn scars for five years (1995 – 2000) was performed as part of the NEDLAC dirty fuels combustion project. The extent of large burns during this period is given in Table 1. From the average area burnt per year and the published emission factors the quantities of the pollutant emissions were calculated (Table 2).

Table 1. Extent of area burnt within the Mpumalanga Highveld.

Total area of region	37 300 km^2
Total area burnt over 1995-2000	4 300 km^2
Area burnt during fire season 2000	472 km^2
Average % area burnt in 10 days	0.09%
Peak % area burnt in 10 days	0.16%
Average area burnt in 10 days	33 km^2
Peak area burnt in 10 days	59 km^2
Average area burnt per year	1 218 km^2

Table2: Total annual emissions estimated to occur as a result of biomass burning within Mpumalanga Highveld.

Total Annual Emissions Due to Biomass Burning (tonnes a^{-1})								
CO_2	CO	CH_4	NMHC	NO_X	N_2O	SO_2	TPM	PM2.5
898 701	35 619	1 315	1 699	1 699	82	329	5 480	2 740

This indicates a significant tonnage of gaseous and particulate emissions and this is only from within the Mpumalanga region. Fire frequency per square kilometre within the study region is shown (Figure 2). The absence of repeat fires (>1 burn per five years) indicates the minimal use of fire as an agricultural tool within this region.

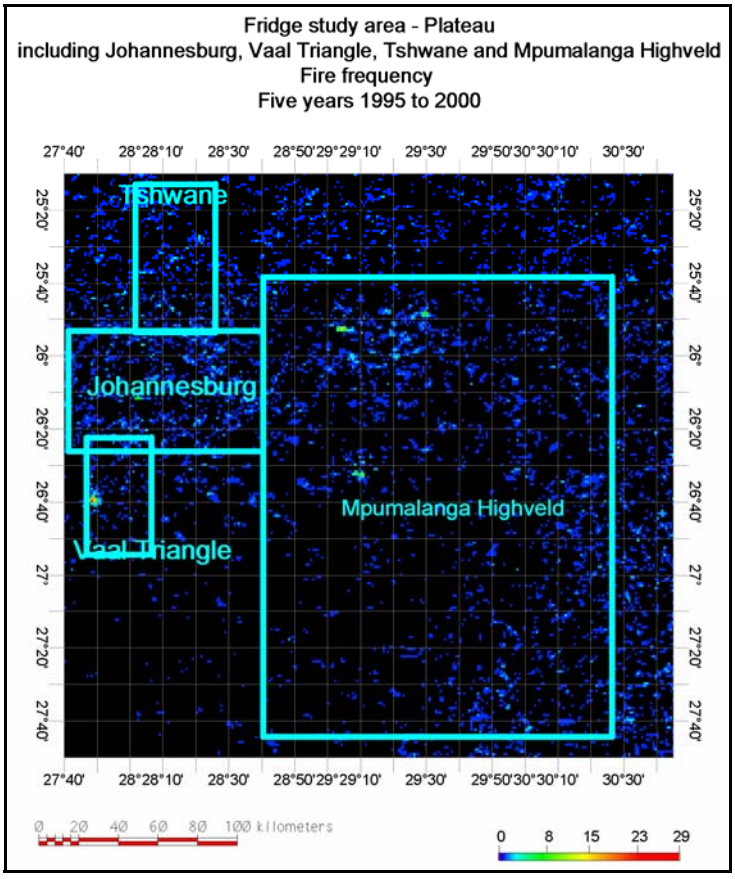

Figure 2: Highveld plateau fire frequency integrated over five years, 1995 to 2000

ANTHROPOGENIC SOURCES:

This category includes industries, power generation, mining, agriculture, domestic burning for household energy and transportation sources.

Household energy use: Owing to the proximity of this pollution source to population concentrations (the receptors), impacts on health from this source are the major and most urgent air pollution health issue.

Household energy use – inventory of sources: Energy use within the residential sector falls into three categories:

- Traditional – wood, dung and bagasse;
- Transitional – coal, paraffin and LPG; and
- Modern – electricity (increasingly includes use of renewable energy).

A universal trend is given as being from traditional through transitional to modern. Currently, 70% of houses in South Africa are electrified (80% in urban areas; 50% in rural areas). During the 2000 to 2002 period a total of 677 000 households were electrified (Eskom, 2002). The Integrated National Electrification Programme administered by the DME aims to ensure that all households have access to electricity by 2010/2011. It is notable that electricity only accounted for 38% of the total energy consumed by the residential sector during 2000 despite the extent of electrification. The remainder of the energy consumed was provided by the combustion of wood (41%), coal (35%), paraffin (13.9%), vegetable wastes (6.9%), LPG (2.9%) and the use of solar energy (0.3%). The estimation of domestic fuel burning emissions is challenging, given that the amount of fuel being consumed is not known with certainty. The average coal usage per household varies depending on:

- Type of house (formal house, planned shack, unplanned shack or backyard shack);
- Whether or not a household is electrified;
- Number of people living in the house;
- Season;
- Availability of fuel types; and
- Price of fuels and the household income.

A synopsis of the emission factors selected for application in the current study is presented in Table 3.

Table 3: Estimated emissions due to household fuel burning within Mpumalanga.
(tpa = tonnes per annum)

POLLUTANT	Coal	Wood	Paraffin	LPG	TOTAL
	tpa	tpa	tpa	tpa	tpa
TSP	2632	452	4.5	0.1	3 089
PM10	735	452	4.5	0.1	1 191
NOx	270	144	34	1.3	448
VOC	895	634	2	0.5	1 531
SO_2	3401	5.2	191	0.01	3 598

POLLUTANT	Coal	Wood	Paraffin	LPG	TOTAL
CO	33 550	3 302	1 011	12	37 873
CO_2	536 632	44 432		1 892	582 956
BENZENE	2.4	26			28
METHANE	644	392			1 036
LEAD	1.8				1.8
BUTADIENE 1.3		3.5			3.5

Household energy use – quantification of sources and impact: In domestic fuel burning a wide array of factors affects the extent of household fuel combustion including: population growth, availability and affordability of electricity, household income, degree of urbanisation, and percentage of informal (unserviced) households (Table 4). These factors will need to be continuously monitored and tracked as targets are pursued to reduce pollution in this sector (Table 5).

Table 4: Estimated total annual household fuel consumption for Mpumalanga Highveld.

Number of Households	Coal	Wood	Paraffin	LPG
	tpa	tpa	tpa	tpa
415 826	179 020	28 811	22 509	909

(C) Extrapolated based on household energy use data from South African Institute for Race Relations (2000) and Wicking-Baird (1997) and typical individual household fuel use figures published by Afrane-Okese (1995).

The following trends in key drivers associated with domestic fuel burning have been noted:

- Population growth rates are projected to increase by 1.6% in the short term 2003 to 2007, but are expected to reduce to a zero growth rate during the first half of 2010 (ABSA, 2002).
- The quantity of coal sold by the merchants to the domestic sector has decreased by a factor of 2.3 over the 1989 to 1999 period.
- The Integrated National Electrification Programme plans that all houses will be electrified by 2010/2011. The affordability of electricity remains in question.

Table 5: Total annual emissions due to household fuel combustion for Mpumalanga Highveld.

TSP	PM10	NO_X	VOC	SO_2	CO	CO_2	Benzene	CH_4
tpa	tpa	tpa	tpa	tpa	Tpa	tpa	tpa	tpa
3 088.5	1 190.9	447.6	1 531.4	3 597.9	37 873	582 956	28.3	1 036

Given these trends it is anticipated that domestic fuel burning will persist in the short-term (2003 to 2007). It is however likely to start to decrease in the medium-term as a result of lower population

growth rates and on-going electrification. This is an important consideration in the development of objectives to reduce air pollution from this source. As an interim measure, alternative lower smoke fuels and improved combustion procedures (Figure 3) are under investigation by the DME and others.

Figure 3: Visible effects of an old and a new way of burning coal in a coal stove. Source: Attie van Niekerk, NOVA Corporation.

Transport sector – inventory of sources: Air pollution from vehicle emissions may be grouped into primary and secondary pollutants. Primary pollutants are those emitted directly into the atmosphere, and secondary are those pollutants formed in the atmosphere as a result of chemical reactions. Primary pollutants emitted by motor vehicle exhausts include CO_2, CO, HC, SO_2, NOx, particulates and Pb. Secondary pollutants formed due to vehicle exhaust emissions include: NO_2, photochemical oxidants (e.g. O_3), HC, sulphuric acid, sulphates, nitric acid and nitrate aerosols. Emission inventories can be conducted for primary vehicle pollutants. Estimation of secondary pollutant concentrations requires complex photochemical dispersion modelling.

Total annual vehicle emissions, including exhaust and evaporative emissions, were estimated for Mpumalanga Highveld region (Table 6). Emissions were spatially allocated on the basis of fuel sales per magisterial district, fleet composition, road densities, projected trip numbers and limited amounts of traffic count data (documented in FRIDGE reports, 2004).

Table 6: Total annual vehicular air emissions comparison (catalytic/non-catalytic) estimation for Mpumalanga Highveld (tpa = tonnes per annum).

POLLUTANT	Units	NON-CATALYTIC CONVERTER	CATALYTIC CONVERTER	DIESEL
THC	tpa	6 454	184	1 617
NOX	tpa	5 832	189	18 044
CO	tpa	42 517	820	6 242
CO_2	tpa	542 260	54 681	1 315 342
SO_2	tpa	2 005	1 902	1 874
CH_4	tpa	157	8	127

POLLUTANT	Units	NON-CATALYTIC CONVERTER	CATALYTIC CONVERTER	DIESEL
NMTOC	tpa	4 891	135	1 490
1,3 Butadiene	tpa	71	0	10
Benzene	tpa	76	3.8	3
Formaldehyde	tpa	43	0.8	14
Acetaldehyde	tpa	19	1.2	15
Lead	tpa	38	2.8	
N_2O	tpa	14	1.1	63
Particulates	tpa	not available	not available	1 247

Table 7: Total annual emissions due to vehicle emissions (exhaust and evaporative releases), baseline scenario, 2002. (tpa = tonnes per annum).

POLLUTANT	UNITS	Total annual emissions (tpa) per conurbation
		Mpumalanga
THC	tpa	8255
NO_X	tpa	24065
CO	tpa	49579
CO_2	tpa	1912283
SO_2	tpa	5781
CH_4	tpa	292
NMTOC	tpa	6517
1,3 Butadiene	tpa	81
Benzene	tpa	82
Formaldehyde	tpa	58
Acetaldehyde	tpa	35
Lead	tpa	41
N_2O	tpa	78
Particulates	tpa	1247

Transport sector – quantification of source impact: Table 7 shows the total vehicle emissions for the Mpumalanga Highveld. The distribution of these emissions was modelled at a coarse scale due to the range of data and size of region. Areas of high traffic were identified along national roads and in urban areas. This region is generally rural and does not have heavy traffic congestion.

Agriculture – inventory of sources: Two main categories of source are associated with agriculture:

- Livestock production and related feeding operations (Animal Feedlot Operations, AFO).
- Dust emissions caused by agricultural operations.

These represent substantial but unquantified sources. Accurate measurements are required to calculate the agricultural contribution to overall pollutant emissions within the study region. Generating accurate estimates of air emissions from AFOs is difficult as the operating environment of these farms is complex. The species of animals are varied (e.g. swine, beef and dairy cattle, poultry), and farm practices differ not only between species, but also among farms for each species. Similarly, quantifying the episodic emissions from tilling, harvesting or land clearing is complex, especially as the emission rates depend on wind speed and moisture content of disturbed material.

Agriculture – pollutant emissions: The chemical composition of the gaseous emissions varies depending on animal species, feeding regimes and practices, manure management practices, and the way in which the animals are housed. Air emissions come mainly from the storage and disposal of the manure (the term here is used to mean both urine and faeces, and may also include litter or bedding materials) that is part of every AFO. Emissions come also from dust produced by handling of feed and movement of animals on manure, as well as from the animals themselves.

Agriculture – quantification of sources and impacts: Estimating emissions of gases, particulate matter and other substances from AFOs is technically difficult. Nevertheless, an ongoing dispute makes it necessary to quantify dust emissions from agriculture, in comparison to surface coal-mining emissions. Direct measurements of air emissions at all AFOs are not feasible. Nevertheless, measurements of a statistically representative subset of AFOs are needed

Industrial sector – inventory of sources: Emissions from coal combustion by metallurgical and petrochemical industries represent the greatest contribution to total emissions from the industrial / institutional / commercial fuel use sector within the Mpumalanga Highveld.

Industrial sector – pollutant emissions: The metallurgical group is estimated to be responsible for at least ~50% of particulate emissions from this sector. This group consists of iron and steel, ferro-chrome, ferro-alloy and stainless steel manufacturers.

Petrochemical and chemical industries are primarily situated in Secunda. The use of coal for power generation and coal gasification processes represents significant sources of sulphur dioxide and hydrogen sulphide emissions. (Particulate emissions are controlled through the implementation of stack gas cleaning equipment.)

Other groups include: brick manufacturers, which use coal, wood burning and wood drying by various sawmills, as well as other heavy industries (using coal and to a lesser extent HFO for steam generation). The contribution of fuel combustion (primarily coal) by institutions such as schools and hospitals is relatively small in relation to industrial emissions (Figure 4).

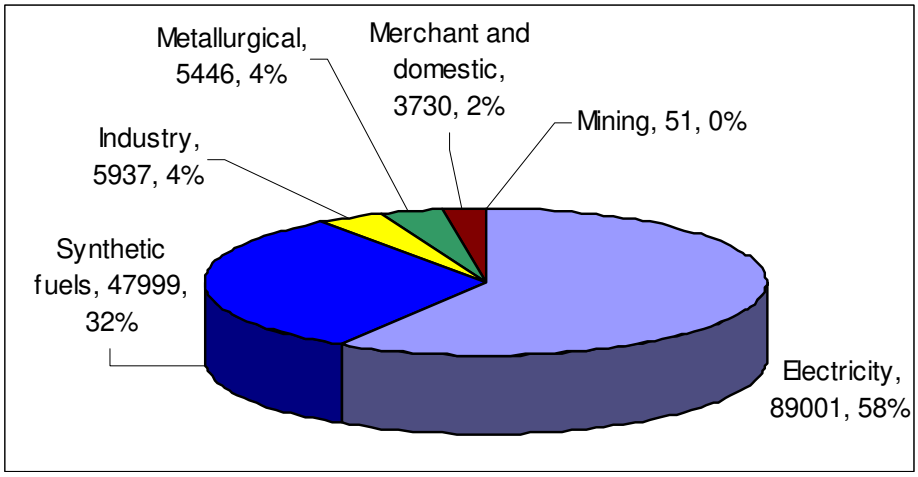

Figure 4: Coal consumption (kilotonne) by sector in 2001. Source: DME.

Table 8: Total annual emissions from industrial, commercial and institutional fuel burning within Mpumalanga Highveld (including emission estimates only for fuel used in Scheduled Processes, and excluding electricity generation for the national grid).

Pollutant	Total annual emissions (tpa)
TSP	19 992
PM10	ND
SO_2	275 665
NO_X	151 021
CO	37 210
CH_4	ND
CO_2	54 463 915
TOC	ND
NMTOC	ND
Benzene	ND
Formaldehyde	ND
Acetaldehyde	ND
Lead	ND
N_2O	ND

ND - no data - emission estimates are not presented since data on fuel use could not be established for a sufficient percentage of industries. The relevance of these sources will therefore need to be ranked in Task 4a, according to their contribution to hospital admissions for respiratory ailments rather than excess cancer cases.

Power generation – inventory of sources: Some coals used in South Africa's power stations are of relatively poor quality (high ash content) since high-grade coal is exported. The average percentage ash and energy content of coals used by Eskom varies, ranging from 21% to 39% ash and 15.2 MJ/kg to 22.5 MJ/kg energy content. South African coals have, however, relatively lower sulphur content (0.6 to 1.4%) than do coals elsewhere. Many of Eskom's power stations use the "run of colliery" unprocessed, high-ash coal. The same coal, beneficiated (washed, to reduce ash content to 5% to 7%) is exported. Most of the coal fired power generation in South Africa occurs in Mpumalanga and this is the major source of South Africa's electricity (Figures 5, 6 and 7).

The main emissions from electricity generation are carbon dioxide (0.85 kg CO_2/kilowatt-hour of electricity), sulphur dioxide (7.95 g SO_2/kilowatt-hour), nitrogen oxides (3.56 g NO_2/kilowatt-hour) and ash (0.35 g/kilowatt-hour).

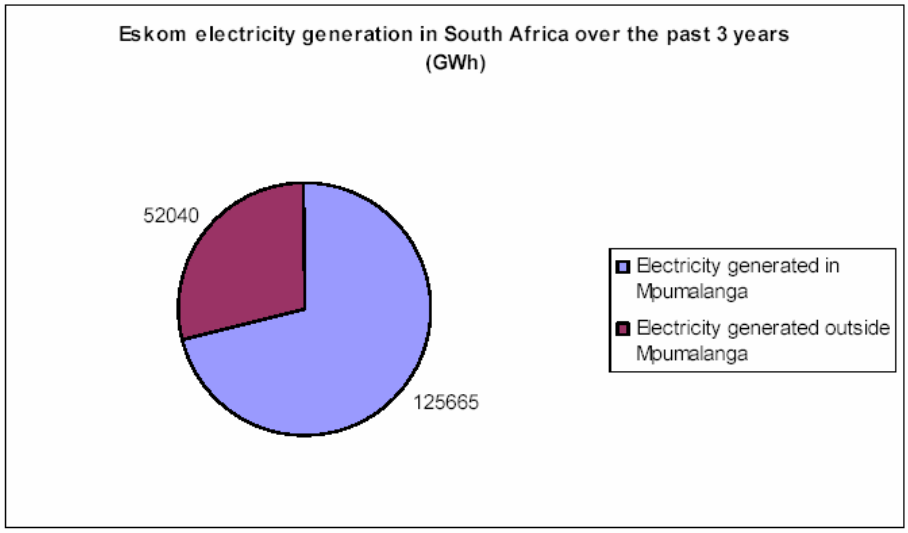

Figure 5: Eskom electricity generation in South Africa, 1999-2001. Source: GWh, Eskom, 2002a.

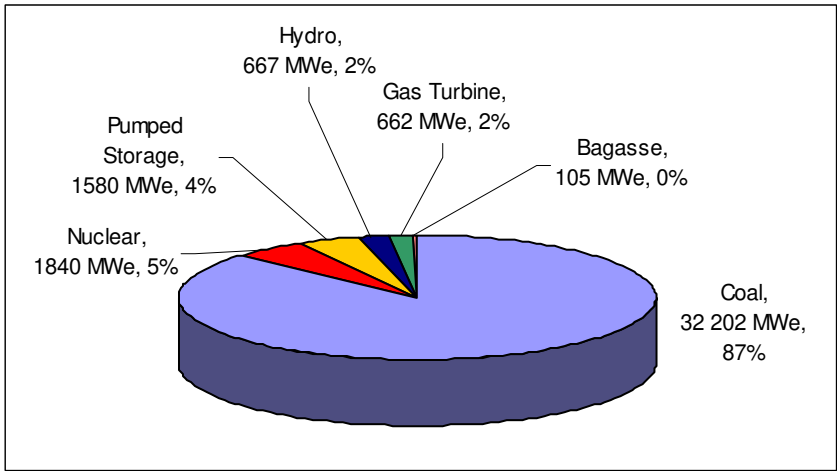

Figure 6: South African electricity generation capacity. Source: DME

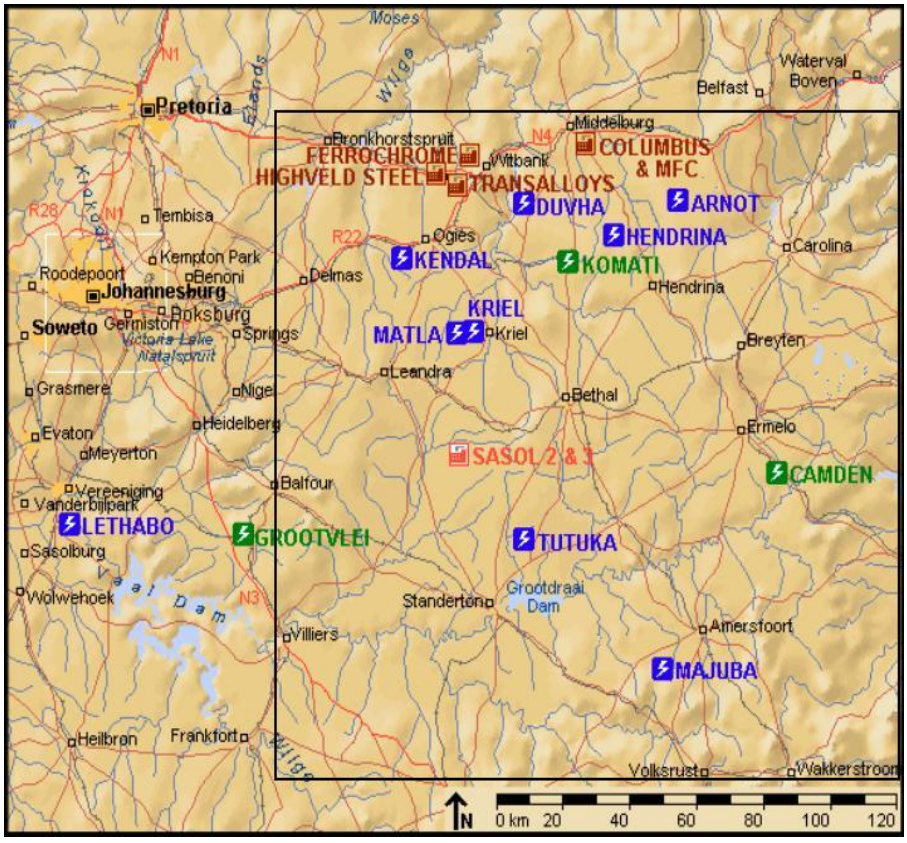

Figure 7: Extent of the Mpumalanga Highveld (inner box) indicating the location of Eskom's coal-fired power stations and various large industries. Source: GEAR Project.

(Active Eskom coal-fired power stations are shown in blue, with mothballed stations, soon to be re-commissioned indicated in green.)

Power generation – pollutant emissions: A comprehensive and up to date emissions inventory is not available for the Mpumalanga Highveld. In order to demonstrate the extent of certain sources, e.g. power station emissions, reference is made to the emissions given for such sources within the National Emissions Inventory database (Table 9).

Table 9: Total annual emissions due to power stations located on the Mpumalanga Highveld (Source: National Emissions Inventory Data Base, last updated 1994).

Power Station	Coal Used (kTpa)	Particulates (kTpa)	SO_2 (kTpa)	NO_X (kTpa)	CO_2 (kTpa)	CO (kTpa)	HC (kTpa)	Stack Height (m)
Arnot	1981	10	40	15	4460	1	0.0	193
Duvha	8325	15	185	58	17600	2	0.0	301
Hendrina	5474	21	103	41	12320	2	0.0	155
Kendal	7324	9	169	51	13800	0	0.0	275
Kriel	7800	22	132	56	15500	1	0.0	213
Majuba	ND	ND	ND	ND	ND	ND	ND	ND
Matla	11040	7	221	77	22600	1	0.3	213
Tutuka	8715	5	173	62	18100	2	0.0	275
TOTAL	**50 659**	**89**	**1 023**	**360**	**104 380**	**9**	**0.3**	

Eskom established and operated an extensive SO_2 monitoring network, comprising 22 stations, for a five-year period from 1984 to 1988. This period is significant in that four major new power stations were commissioned during this period, viz. Duvha, Tutuka, Kendal and Lethabo. Fourteen of the total number of stations were on the Mpumalanga Highveld, six in the Vaal Triangle, and two in Limpopo (then Northern Province).

The plotting of SO_2 isopleths based on the observational data collected during the 1980s was a significant first step towards determining spatial variations in ground level pollutant concentrations occurring through large-scale atmospheric emissions. The determination of SO_2 concentration footprints remains a key focus area, despite the shift from a reliance on extensive ambient air quality monitoring networks towards atmospheric dispersion modelling. The use of measured data at strategically placed monitoring sites remains, however, indispensable in terms of the validation of dispersion simulation results. Ambient sulphur dioxide concentrations are currently measured by Eskom at Elandsfontein, Palmer, Kendal and Verkykkop. Based on long-term trend analysis of ambient air quality in central Mpumalanga, Rorich and Galpin (1999) concluded that SO_2 concentrations have increased since 1991. Daily mean trends indicated significant increases of 8.8% per annum for SO_2.

Mining sector – inventory of sources: The Mpumalanga region is dominated by coal mining with a few gold mines to the east and west (Figure 8). However, of particular concern is the mining of chrome, vanadium and manganese to the north. Relatively few studies on these toxic heavy metal industries have been undertaken. Thus there is potential for health impacts to those living close to these sites.

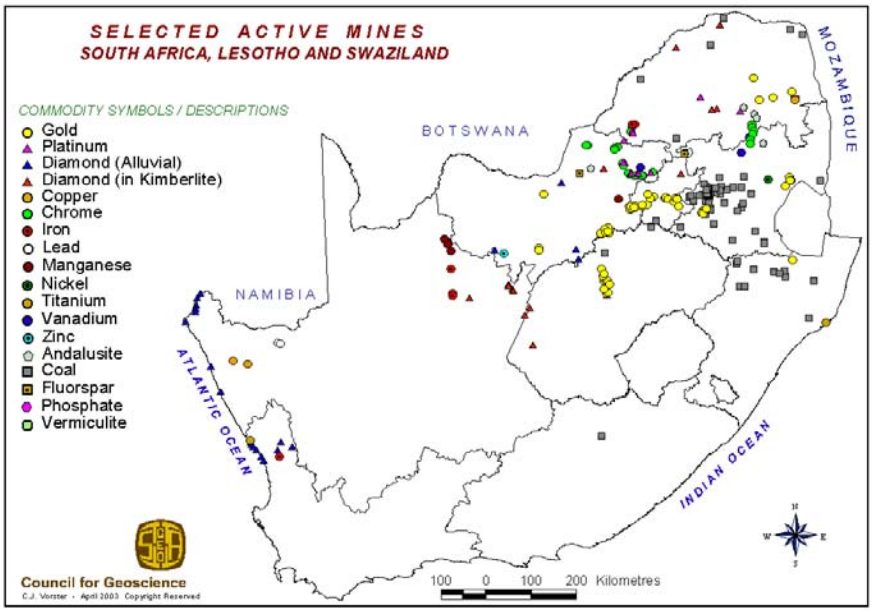

Figure 8: Selected active mines in SA including the coal mines. Source: Council for Geoscience.

Mining sector – pollutant emission: Major coal mining emissions come from heavy vehicle movements, materials handling, blasting and wind blown dust from stockpiles. A secondary source of emissions is the spontaneous combustion of coal stockpiles.

Spontaneous combustion fires typically occur on discard dumps and underground. Emissions from such combustion typically include sulphur dioxide, fine particulates, carbon monoxide, nitrous oxides, hydrocarbons and trace amounts of hydrogen sulphide, ammonia and polycyclic organic matter. Although it is estimated that such fires are locally responsible for burning quantities of coal equivalent to that used by Eskom for power generation, the extent of spontaneous combustion and its resultant emissions have still to be quantified.

Work is needed to quantify the potentially toxic and carcinogenic emissions around Cr, V and Mn mining and smelting operations.

Many of the mines have monitoring programmes to measure quantities of fallout dust in the vicinity of their activities. This data should be accessible as an initial measure of the material handling contributions to the air pollutants. The main pollutant is TSP with fine particulate (PM2.5) and coarse particulate (PM10) components. Collation of this data, monitoring and modelling is still required for the mining sector in general.

A1.2. REQUIRED DATA AND FUTURE WORK

Lightning: Surface-based lightning detection networks are not 100% efficient due to limited area coverage, leading to underestimation of lightning produced NOx. Smallest errors are expected over the Mpumalanga Highveld. Data for only one year (2002) have been analysed. Further analysis is required. Within the next two to three years new satellite data products for LNOx monitoring will become available, enabling remote sensing monitoring of lightning and hence natural NOx production rates.

Biogenic emissions: Quantities and significance of biogenic emissions within this region still have to be assessed. Successful measurement and modelling of biogenic emissions in African savanna regions would be required to apportion these sources. Knowledge of the natural gas and particulate levels is fundamental to setting viable and ecologically sound targets for the assessment of the impacts of anthropogenic emissions.

Biomass Burning: This source must be accurately quantified to allow effective assessment of natural contributions to air pollution. Transboundary transport of these pollutants in significant quantities has been demonstrated. The extent of these fires that are natural or anthropogenic is unknown. Major trans-boundary import of biomass-burning emissions into Mpumalanga occurs from central Africa. The climatology of this phenomenon needs to be established.

Household Energy Use: Domestic fuel use results in the most widespread and serious air pollution exposures to the Highveld (Mpumalanga and Gauteng) populations. The Nedlac study modelled the Mpumalanga region at a scale of 2.7 x 2.7 km receptor grids. Sub-grid modelling needs to be carried out to integrate local and regional scale pollution dispersion.

Transport Sector: Sources of emission that are not accounted for include fugitive dust emissions (e.g. road dust entrainment by vehicles). Modelling constraints require vehicles to be treated as area sources, which do not model traffic loads well. Photochemical modelling was not undertaken because of the complexity of such modelling. It was therefore not possible to predict ozone concentrations arising from transportation combustion emissions. Given the health risks predicted to be due to vehicle emissions it would be beneficial to undertake a more detailed study, comprising photochemical modelling of urban conglomerations to further inform vehicle emission regulations.

Agriculture: Scanning survey methods need to be applied to refine estimates of agricultural emissions from agricultural feed operations and crop farming. Only if found to be significant in relation to other sources should additional efforts be expended on process-specific emission factor determination.

Industrial Sector: Some work was performed by the Nedlac project on the combustion sources associated with the scheduled industries. All material handling, evaporative losses and non-scheduled industries need to be identified, emissions quantified, and modelled. Often the companies concerned hold the information. Effort will be needed to negotiate access and public use of such information.

Power Generation: There is extensive emission and ambient atmospheric data generated by this industry. As a major source class, this information needs to be incorporated in the larger study.

Mining Sector: Material handling and coal waste dumps are significant non-combustion sources that need quantifying and monitoring. The mines of most concern in terms of adverse health impacts, though, are heavy metal operations (Cr, V etc.). Most emissions information on mining currently available is for the coal and gold sectors and not the heavy metals. Thus, research is urgently needed in this area because of higher toxicities.

A1.3. CONSEQUENCES AND VIABILITY OF INTERVENTIONS

Combustion-related emissions for Mpumalanga and other conurbations have been comprehensively analysed and documented in FRIDGE reports (Scorgie *et al.*, 2004a-c; Bentley West Consultants, 2004). Similar compilations of non-combustion sources have not been carried

out for Mpumalanga. These sources need to be identified and incorporated so that a complete assessment of regional air quality can be conducted, a health risk survey carried out and suitable management and intervention strategies developed. Inequalities in access to energy resources, and consequent inequitable exposure to environmental pollution perpetuate and accentuate issues of poverty and poor quality of life. Only through comprehensive assessments of all sources on a regional scale, can cost-effective and socially equitable environmental strategies be devised.

Government departments that have a statutory mandate with respect to air quality include the Departments of Environmental Affairs and Tourism, Trade and Industry, Housing, Transport, Minerals and Energy, and National Treasury. They could use the outcome of this study as valuable input when devising strategies to reduce the health impacts associated with air pollution. A range of interventions has been proposed to reduce health risks, illustrating the need for comprehensive and cross-disciplinary air quality studies (Table 10).

Table 10: Fuel combustion intervention options for significant health risk reduction.

Sector	Intervention	Health Endpoint - most significant risk reduction
Domestic fuel burning	Low smoke fuel implementation	Respiratory hospital admissions, chronic bronchitis, premature mortality
	Electrification of all un-electrified households	
	Large scale housing insulation	
	Large scale top down ignition roll-out	
Vehicles	Requirement of all petrol vehicles to comply with Euro 2 standards	Cancers
	Requirement of new petrol vehicles to comply with Euro 4 (Euro 2) standards	
	Large scale conversion of petrol vehicles to LPG	
	Restriction of benzene content of petrol to 1%	
Power Generation	Desulphurisation of all power station emissions	Respiratory hospital admissions, premature mortality
Industry, commercial & service sector	Restriction of particulate emissions from coal-fired boiler operations	Respiratory hospital admissions, chronic bronchitis, premature mortality

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APPENDIX 2: LEGISLATION

The South African regulatory environment in terms of public private partnerships (PPPs), the environment, and air quality and water policies has been reviewed and promulgated in the last few years. A brief summary of relevant legislation follows.

A2.1. PUBLIC SECTOR

Public private partnerships (PPPs) remain a relatively new phenomenon in South Africa, and they can take many different forms. To help clarify matters Treasury Regulations have adopted a simple definition based on three elements: a contractual arrangement; substantial risk transfer; and outcome-based financial rewards. It is a contractual arrangement between a public and a private sector entity whereby the private sector performs a departmental function in accordance with an output-based specification over a defined period of time in return for a benefit, which is normally in the form of financial remuneration. It furthermore involves a substantial transfer of all forms of project life cycle risk to the private sector. The public sector retains a significant role in the partnership project either as the main purchaser of the services provided or as the main enabler of the project.

Treasury's role in relation to PPPs is to ensure that such projects reflect a prudent use of state resources. The regulations and guidelines enable departments and Treasury to play their respective roles throughout the PPP project cycle. Correctly used, PPPs can be a useful service-delivery option and can have a number of benefits, including:

- *Operational gains:* – ensuring that one delivers better or more services for the same price; or by means of savings that one releases money for investment elsewhere. Operational gains can be achieved by focusing on outputs rather than on processes; by generating economies from integrating design, building, financing and operating phases; through more inventive use of assets, better project identification, and so on.
- *Strategic clarity* – by focussing departmental resources on strategic management and ensuring that key services are delivered effectively.

This viability assessment project aims to identify correct key stakeholders for a full-scale PPP project engagement, and in that sense an understanding of roles, functions and procedures of PPP is critical to its success. Besides the obvious key stakeholders of public partners in national, provincial and local authorities, there are community-based groups, non-governmental organisations, as well as the private sector. This includes corporate organisations of all sizes (local, national and international) as well as interested private citizens.

The legislative framework for public / governmental bodies dealing with PPP (final amended Treasury Regulation 16 (Public Private Partnerships)) is based on National Treasury Public Finance Management Act No. 1 of 1999, as amended in PFMA 29 of 1999 and is applicable to all jurisdiction levels. This regulation defines the PPP and prescribes the procedures and guidelines for referring the decision making to the relevant treasury department in different tiers of the government. The PPP on local government level is specifically legislated by the provision of the Local Government: Municipal Financial management Act No. 56 of 2003. Chapter 11, part 2, and

section 120 from subsection (1) to (7) of the Act deals entirely with local government's requirements in respect to PPP and the involvement of local governments with private partner/s.

Act 56 of 2003 legislates activities of public partners (at local government level) while section 120, subsection (2) strictly stipulates that agreements must comply with any regulatory framework for PPP. Furthermore should PPPs involve provision of municipal services then the provisions of the Chapter 8 of the "Municipal Systems Act" must be complied with (subsection (3)). A very important stipulation (subsection (4)) is a feasibility study that a municipality must conduct whereby the help of provincial and national governments may be requested.

It is important to note here the obligation of the municipal partner to make public details of proposed PPP agreements and associated feasibility studies (subsection (6), (b)(i)) and invite in public participation, local communities and interested and affected parties for their input (point (b) (ii)) as well as obtain the views and recommendations of other government/public relevant bodies (points (c) (i-iv)) before all the relevant documents are presented to a municipal council for decision making in respect of a planned PPP.

All of the above reflect the interests of the public sector to undertake common projects and regular activities for the benefit, financial and otherwise, of all parties in partnership, as well as the society and environment at large. The same benefits the private sector; government provides the framework, but project implementation is a co-operative partnership between stakeholders.

AIR QUALITY POLICY

The air quality policy is currently regulated under the provisions of the Atmospheric Pollution Prevention Act (APPA), 1965 (Act 45 of 1945). This Act is regarded as outdated for a number of reasons. It cannot accommodate the constitutional allocation of air quality control functions in respect of the role of provincial and local government. It has inadequate compliance and enforcement mechanisms for effective implementation and fosters a lack of transparency in decision making. It is largely focused on point source pollution control and does not adequately address the cumulative impacts of air pollution (Government Gazette, 2003). None of this should be surprising, given that the Act is roughly four decades old, and that air pollution problems along with what is now known about dealing with them have advanced significantly.

The recently gazetted Draft National Environmental Management: Air Quality Bill will repeal the Atmospheric Pollution Prevention Act. It will provide the framework for governance of air quality management through the establishment of national norms and standards, a regulatory framework for an air quality management planning, a reporting regime, numerous regulatory instruments for the control of air pollution and a comprehensive approach to compliance and enforcement.

The Air Quality Bill Draft (Government Gazette, 2003), seeks to, among other things:

- Protect, restore and enhance the air quality in the country, having regard to the need to ensure sustainable development;
- Provide increased opportunities for public involvement and participation in the protection of air quality;
- Ensure that the public has access to relevant and meaningful information about air pollution; and
- Reduce risks to human health and prevent the degradation of air quality by the use of mechanisms that promote (1) pollution prevention and cleaner production, (2) the reduction to harmless levels of the discharge of substances likely to impair air quality.

The Draft Bill provides for the identification of substances or mixtures of substances in ambient air that through ambient concentrations, bioaccumulation, and deposition or in any other way, present or are likely to present a threat to health or the environment. In respect of each of these substances the Draft Bill establishes national standards for:

- Ambient air quality, including the permissible amount or concentration of each such substance or mixture of substances in ambient air and
- Emissions from point or non-point sources.

The Draft Bill also allows for the establishment of provincial and municipal standards. If national standards have been established for a particular substance, a provincial MEC responsible for air quality may not alter these standards except by establishing stricter standards for the province or for any area within the province. Similarly, for municipalities wanting to change local pollution standards using by-laws, they can only do so if the by-laws result in stricter standards than provincial and national standards. This allows for an approach that establishes national minimum standards augmented by provincial and local standards to focus on hot-spots.

Further, the Draft Bill permits the devolution of monitoring and implementation responsibilities to provincial and local authorities. In order to ensure adequate national monitoring and information management standards, national standards for the monitoring by municipalities of ambient air quality and point and non-point sources may be established. National standards may also be set for the monitoring by provinces of ambient air quality, as well as the performance of municipalities in implementing the Bill. Monitoring and implementation suggestions by appropriate bodies have been considered in the suggested strategy.

It is envisaged that a National Air Quality Advisory Committee (NAQAC) will be established to advise the Minister of Environmental Affairs and Tourism on the implementation of the Draft Bill. The appointment of a national air quality officer responsible for co-coordinating matters pertaining to air quality management in national government is also envisaged. In addition, the provinces and municipalities must designate their own air quality officers.

The Bill provides that air quality management plans would be required at different levels of government. Each national department or province responsible for preparing an environmental implementation plan or environmental management plan in terms of Chapter 3 of the National Environmental Management Act must include in that plan an air quality management plan. Each municipality must also include in its integrated development plan envisaged in section 25 of the Municipal Systems Act, an air quality management plan. Among other requirements these plans must seek to improve air quality across the country, address the effects of emissions from the use of fossil fuels in residential applications, and give effect to best practice in air quality management.

Four regulatory tools are proposed for the achievement of the goals set out in management plans. These tools, described below, include declaring priority areas, listing potentially harmful activities, setting specific standards for controlled emitters, and requiring emitters to compile atmospheric impact reports.

- National or provincial authorities may declare priority areas where air quality standards are being or are likely to be exceeded and the area requires specific air quality management action to rectify the situation. The basis for this declaration can essentially be derived from the information and analysis provided in this report. This will enable the prioritisation of the interventions to be carried out.
- National and provincial authorities can list activities deemed to pose a threat to achievement of air quality goals. Anyone wanting to commence with a listed activity would then be required to

apply for an emissions licence from the metropolitan and district municipalities charged with implementing the atmospheric emission licensing system. The application process would be exhaustive and the granting of a licence would be accompanied by various conditions aimed at limiting pollution to acceptable levels. An atmospheric emission licence may, with the permission of the licensing authority, be transferred to another emitter. It would have to be reviewed and possibly renewed at appropriate interval to ensure it stays in line with requirements. Note, however, that this transferability cannot be equated to a system of tradable emissions permits. Aside from state air pollution control officers, the state may also require holders of emissions licences to appoint suitably qualified emission control officers depending on the size and nature of the polluting activity.

- *Listed activities* are meant as a category to regulate industry and other large point sources. A further category, that of controlled emitters refers to dispersed activities or appliances, which can be grouped to be regulated with common regulations. Examples of likely controlled emitters are vehicles, domestic fuel burning devices, filling stations, etc.
- Listed activities, in relation to fuel combustion, are easily able to be derived and were considered in the development of the strategy to reduce air pollution with a view to reducing its impact on health. If pollution control officers suspect that any person has contravened or failed to comply with the Act, they will also be allowed to demand that the person produce an atmospheric impact report.

The Draft Bill does not prescribe the exact measures to be used to achieve air quality requirements thus allowing for flexibility. It does, however, explicitly recognise the types of measures that could be used and among these are trading schemes or incentives to encourage change in behaviour towards air pollution. Thus, economic instruments have been recognised as necessary measures.

The Draft Bill recognises that the Atmospheric Pollution Prevention Act effectively marginalised both provincial and local government from the area of air quality management. The Bill seeks to increase the involvement of both these spheres of government, without increasing the burden on national government. Particularly in the case of municipalities, increased personnel and organisational commitments will be needed if requirements are to be fulfilled. In terms of financial implications, it is envisaged that the system of permit fees will cover the added cost of administering the Bill at provincial and local government levels. No increase in the costs associated with air quality control is anticipated at national government level.

The Air Quality Bill was referred to the National Council of Provinces at the end of November 2003. The Bill was approved by the NCOP and with only minor amendments being made by the Select Committee on Land and Environmental Affairs. The Bill had not yet been promulgated as law at the time this report was written.

OTHER RELEVANT POLICIES

Other government policy initiatives to ensure cleaner air are also in place. For example, the National Treasury is working on a study entitled “Market-based Instruments to Support Environmental Fiscal Reform in South Africa”, which is likely to produce recommendations that have an impact on air pollution strategy. Future trends in electricity prices and/or subsides (FBE) should also be monitored, as they will have a direct influence on the demand for electricity and, therefore, the amount of pollution emitted from the coal-based generation process. They would also impact on the willingness and/or ability of consumers to shift from coal stoves for heating and cooking, and paraffin for lighting, to electricity use. Other issues that need to be monitored include industrialisation and urbanisation trends.

Policies that are relevant include overall energy policy and, specifically, renewable energy policy. There is also a need to be aware of other government strategy documents that outline how some of interventions could be implemented. These include the Integrated Clean Household Energy Strategy (covering the top-down ignition, low smoke fuel and housing insulation interventions) and the Strategy for the Control of Exhaust Emission from Road-going Vehicles (covering all the vehicle sector interventions).

Energy Policy: The following five policy objectives as given in the White Paper on Energy Policy form the foundation of South Africa's energy policy (DME, 1998):

- Increasing access to affordable energy services;
- Improving energy governance;
- Stimulating economic development;
- Managing energy-related environmental and health impacts; and
- Securing supply through diversity.

A key feature of the energy White Paper is its focus on demand side as opposed to supply-side interventions. The stress is on making energy use more demand efficient. This will lower the costs borne by households and firms and will also reduce problem emissions.

Relevant quotations from the White Paper include:

1. Government will promote access to affordable energy services for disadvantaged households, small businesses, small farms and community services.
2. Government policy is to remove distortions and encourage energy prices to be as cost-reflective as possible. To this end prices will increasingly include quantifiable externalities.
3. Energy taxation will continue to remain an option within government's fiscal policy, but will be exercised with more consideration for the economic and behavioural impacts of such policies.
4. Government will promote access to basic energy services for poor households, in order to ameliorate the negative health impacts arising from the use of certain fuels.
5. Government will work towards the establishment and acceptance of broad national targets for the reduction of energy-related emissions that are harmful to the environment and to human health.
6. Given increased opportunities for energy trade, particularly within the southern African region, government will pursue energy security by encouraging a diversity of both supply sources and primary energy carriers.
7. It is estimated that greater energy efficiency could save between 10% and 20% of current consumption.
8. Government needs to facilitate increased energy efficiency.

Energy Policy – Renewable Energy Policy: The Department of Minerals and Energy (DME) released its Draft White Paper on the Promotion of Renewable Energy and Clean Energy Development in 2002 to supplement the White Paper on Energy Policy (DME, 1998) recognising the significant potential of renewable energy in the medium- to long term. It has yet to be approved by parliament; at present only the section on the promotion of renewable energy has been released and not that on clean energy development. In its current form, the Draft White Paper does not list particularly clear objectives. The main focus is on objectives of contributing to the global effort to mitigate greenhouse gas (ghg) emissions and enhancing energy security through diversification into renewable energy. The Draft Paper states that "Government's long-term goal is the establishment of a renewable energy industry producing modern energy carriers that will offer in future years a sustainable, fully non-subsidised alternative to fossil fuels" (DME, 2002).

The target set by DME is that renewable energy will contribute an additional 10 000 GWh to final energy demand by 2012. It is recognised that renewable energy development will require financial incentives the funding for which will have to come from both South African and international sources. The initial thrust of implementation is envisaged to focus more on remote rural areas where the mobile nature of many renewable energy options can provide maximum benefits.

Energy Policy – Integrated Clean Household Energy Strategy: The Integrated Clean Household Energy Strategy (ICHES), which exists as a draft final report (LSS 02 Issue Q dated 24 July 2003) recognises that the continued electrification of residential areas is ongoing and that the full use of electricity for all household energy requirements remains the ultimate long-term solution. It also recognises that electricity is more expensive than coal and that its price is rising. In addition, more expensive appliances are needed to exploit electricity (DME, 2002a). An alternative is offered in the form of the Integrated Clean Household Energy Strategy that was approved by the Minister of Minerals and Energy as a transitional measure between coal and the full use of electricity:

1. Marketing and awareness of low-smoke generating top-down ignition of coal fires ("Basa Njengo Magogo");
2. Manufacturing and distribution of low-smoke fuels; and
3. Implementation of housing insulation and design."

The strategy emphasises that the above are not true alternatives but rather phases in the strategy, as no single solution has the potential to reduce the coal-based air pollution to acceptable levels (DME, 2002a).

Strategy for the Control of Exhaust Emissions from Road-going Vehicles: The final draft of the strategy for the control of exhaust emissions from road-going vehicles, a joint implementation strategy between DME and DEAT, was recently released (DEAT & DME, 2003). The strategy includes a consideration of the issues raised in a report entitled "Investigation into the Optimal Future Octane Grade for South Africa" (CAE, 2003). It sets out a road map for the government, the oil industry; as well as the vehicle manufacturing industry and is aimed at achieving improved air quality through the control of vehicle emissions.

A2.2. MULTI-LATERAL ORGANISATIONS

There have been signs of a rapprochement between multi-lateral organisations such as the United Nations, UN and the large multi-national corporates. In an address to The World Economic Forum in 1999, United Nation Secretary-General Kofi Annan challenged business leaders to join an international initiative, the Global Compact, which would bring companies together with UN agencies, labour and civil society to support its principles in the areas of human rights, labour and the environment. Through collective action, the Global Compact seeks to advance responsible corporate citizenship so that business can be part of the solution to the challenges of globalisation. In this way, the private sector – in partnership with other social actors – can help realise the Secretary-General's vision: a more sustainable and inclusive global economy (http://www.unglobalcompact.org). Initiatives on partnerships have been documented by United Nations Development Programme, UNDP (http://www.undp.org).

The United Nations Industrial Development Organization, UNIDO (www.unido.org) has as a priority, working with the private sector. To this end UNIDO provides a guide for initiating and managing partnerships particularly directed toward the establishment of small, medium and micro enterprises.

A2.3. PRIVATE SECTOR

The corporate private sector, in general, does not have formal PPP policies in place although where such partnerships do occur they are generally under the ambit of Sustainable Development and Corporate Social Responsibility. The sustainable development policies of large private sector entities are documented; for example, on the various homepages on the Internet. This also applies to Coaltech 2020, a member of this current PPP; Coaltech 2020 was launched in 1999 and is a consortium of stakeholders namely, coal industry experts, mining groups, labour unions, government and local authorities, universities and research agencies with expertise and an active network in the public and private sectors (See www.coaltech2020.co.za for the list of consortium members; mining groups such as www.angloamerican.co.uk; www.bhpbilliton.com; www.ingwe.co.za are included).

In a speech at the World Summit on Sustainable Development (WSSD) in 2002, the chairman of the natural resources company, Anglo American plc, Mr. T Trahar stated that

> "…sustainable development is one of those challenges that none of us can leave to anyone else, but nor can we achieve it alone. It will require all of us to work together. … As industry we must also pursue new opportunities in the developing world if we are to achieve the overarching goal of this Summit - poverty eradication and material improvement in the lives of millions. … There are many possibilities for global corporations to work closely with national Governments who, if they develop the will, have the power to implement these sound and pragmatic policies for good business coupled with sustainable development" (www.angloamerican.co.uk).

It must be stressed though, that the business case must be made for the effective implementation of public private partnerships with the large corporate private sector.

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Skills, Consultants	Ecopot Consultants cc		011 726 7933
Skills, Consultants	Ecosun		011 672 0666
Skills, Consultants	Ecotechnik		013 744 9427
Skills, Consultants	Eko-Tekton Environmental Planners		013 764 1592
Skills, Consultants	Envirogreen		018 297 7455
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Skills, Consultants	GAIA Earth Science		015 293 8067
Skills, Consultants	GCS Groundwater services	PO Box 2597Rivonia 2128	017 803 5726
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Skills, Consultants	Geovicon cc		013 243 0542
Skills, Consultants	Globecon Environmental Management		011 347 2051/5
Skills, Consultants	IWR Environmental		012 259 0291
Skills, Consultants	IW Terblanche		015 293 8174
Skills, Consultants	Index		012 346 6447
Skills, Consultants	Jarrod Ball & Associates		011 485 1391
Skills, Consultants	Jasper Muller Associates		013 665 1788
Skills, Consultants	Jones & Wagener		011 803 1455
Skills, Consultants	Kay Environmental Services		011 807 7944
Skills, Consultants	Ken Smith Environmental Services cc		017 826 1427
Skills, Consultants	Landscape Dynamics		012 460 6043
Skills, Consultants	Loxton, Venn & Associates		011 805 2336
Skills, Consultants	Manyaka Greyling Meiring (Pty) Ltd		012 362 0848
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Skills, Consultants	Urban Dynamics (Mpumalanga) Inc.	PO Box 3294 Middleburg 1035	013 243 1219
Skills, Consultants	Van Riet & Louw		012 346 1289
Skills, Consultants	Walmsley Environmental Consultants		011 807 1360/1
Skills, Consultants	Wates, Meiring & Barnard		011 315 0316
Skills, Consultants	Wetland Aspects		012 991 0548
Skills, Consultants	Wiechers Environmental Consultancy		011 886 5709
Skills, Consultants	Wilchem cc		011 462 6052
Skills, Consultants	Witbank Environmental cc		013 697 5021
Skills, Consultants	Social Impact	RAU, Dept Sociology	
Skills, Consultants	Benetech SA Pty Ltd		013 697 4618
Non-Governmental Organisations (NGOs)	Ahiakaneni Environmental Conservation Project	Okkernootboom Farm, Acornhoek, 1360	083 699 6441
Non-Governmental Organisations (NGOs)	Bohlabelo Environmental Forum	BLBSC Bldng Main Rd, Acornhoek, 1360	013 795 5150
Non-Governmental Organisations (NGOs)	Buhle Bemvelo Environmental Group	2534 Willie Ackerman Drive Street Emalahleni, Ackerville, 1039	082 743 8476
Non-Governmental Organisations (NGOs)	CANSA Highveld Region	PO Box 990 Witbank 1035	013 656 5420
Non-Governmental Organisations (NGOs)	CANSA Cosmos Region (Ermelo and Secunda)	PO Box 1077 Ermelo 2350	017 811 5893
Non-Governmental Organisations (NGOs)	Centre for Environment Information & Knowledge in Africa	PO Box 165 Green Point Cape Town 8051	083 306 0030
Non-Governmental Organisations (NGOs)	Eco-Plan Environmental Club	Stand 03ı Mshadza Trust Legogote 1257	

Type	Name	Address	Telephone Number
Non-Governmental Organisations (NGOs)	SACAN (SA Climate Action Network)		011 339 3662
Non-Governmental Organisations (NGOs)	SARCAN (Southern African Regional Climate Action Network)		011 339 3662
Non-Governmental Organisations (NGOs)	Earthlife AFRICA	PO Box 11383 Johannesburg 2000	011 339 3662
Non-Governmental Organisations (NGOs)	Empowerment for African Sustainable Development (EASD)		021 434 6012
Non-Governmental Organisations (NGOs)	Environmental Education	PO Box 17743 Witbank 1035	013 695 3508
Non-Governmental Organisations (NGOs)	Kwa-Guqa Youth Economic Empowerment Forum (KYEEF)		013 699 1443
Non-Governmental Organisations (NGOs)	Mpuma Waste Management Project	237 Church Street, Thushanang Witbank 1036	082 342 1248
Non-Governmental Organisations (NGOs)	Shining Star Youth Group, Witbank		013 690 2645
Non-Governmental Organisations (NGOs)	Sisonke Environmental Club	Stand No 1041, Ward 12, Piet Retief, 2380	083 612 9132
Non-Governmental Organisations (NGOs)	Songimvelo Environmental Care & Conservation Project	Stand No 1356, Section Fı Ekangala North, Ekangala, 1021	082 819 4991
Non-Governmental Organisations (NGOs)	Sustainable Energy & Climate Change Partnership (SECCP)	PO Box 11383 Johannesburg 2000	011 339 3662

Type	Name	Address	Telephone Number
Non-Governmental Organisations (NGOs)	Empowerment for African Sustainable Development (EASD)	PO Box 165 Green Point 8051 Cape Town	021 434 2847
Non-Governmental Organisations (NGOs)	Food & Trees For Africa (FTFA)	PO Box 2035 Gallo Manor 2052	011 803 9750
Non-Governmental Organisations (NGOs)	Endangered Wildlife Trust	The Endangered Wildlife Trust Private Bag X11 Parkview, 2122	011 486 1102
Non-Governmental Organisations (NGOs)	Wildlife and Environment Society of South Africa	1 Karkloof Road, Howick, PO Box 394, Howick, 3290	033 330 3931
Mining	Anglo Coal	PO Box 61587 Marshalltown Johannesburg 2107	011 638 9111
Mining	ANKER COAL and MINERAL HOLDINGS SA (PTY) LTD	PO Box 4929 Middelburg 1050	013 282 6226
Mining	African Rainbow Minerals	PO Box 786136 Sandton 2146	011 883 5606
Mining	Assmang Limited	PO Box 62379 Marshalltown Johannesburg 2107	011 634 9111
Mining	BHP Billiton	6 Hollard Street, Johannesburg 2001	011 376 9111
Mining	EYESIZWE COAL (Pty) LTD	PO Box 61714 Marshalltown 2107	011 376 2815
Mining	DUIKER MINING LTD	PO Box 1146 Johannesburg 2000	011 644 7000
Mining	Ingwe Collieries Ltd	PO Box 61820 Marshalltown 2107	011 376 9111
Mining	ISCOR LTD	PO Box 450 Pretoria 0001	012 307 3000
Mining	KANGRA GROUP (PTY) LTD	PO Box 2465 Johannesburg 2000	011 643 7371
Mining	KUYASA MINING (PTY)LTD	Private Bag X7250 Witbank 1035	013 656 3659
Mining	METOREX LTD	PO Box 2184 Saxonwold 2132	011 880 3155
Mining	WOESTALLEEN COLLIERY (PTY) LTD	PO Box 1639 Middelburg 1050	013 246 6809
Mining	CENTURY CARBON MINING LIMITED	PO Box 4527 Rivonia 2128	011 234-1736
Mining	BLACK WATTLE COLLIERY (PTY) LTD	PO Box 1704 Middelburg 1050	013 243 5840
Mining	EERSTELINGFONTEIN COLLIERY	PO Box 2196 Rivonia 2128	011 8071436
Mining	Samancor Limited	PO Box 8186 Johannesburg 2000	011 3763370

Type	Name	Address	Telephone Number
Mining	SASOL MINING (PTY) LTD	Private Bag X1015 Secunda 2302	017 614 1111
Mining	STUART COAL GROUP	PO Box 14186 Bredell 1623	011 396 1948
Power Generation	Eskom	PO Box 1091 Johannesburg 2000	011 800 8111
Power Generation	Eskom, Witbank		013 693 3260
Industry	Benicon Earthworks & Mining Services, Witbank		013 691 1144
Industry	Black Management Forum - Witbank Branch		013 656 3971
Industry	Chamber of Mines	PO Box 61809 Johannesburg 2000	011 498 7100
Industry	Corobrik	Duvha Power Station Road, Duvha, Naauwpoort, Witbank	013 691 9705
Industry	Mpumalanga Chamber of Commerce & Industry	PO Box 1152 Middelburg 1050	013 243 2253
Industry	Middelburg Chamber of Commerce & Industry	PO Box 1152 Middelburg 1050	013 243 2253/4
Industry	Witbank Chamber of Commerce & Industry	PO Box 2180 Witbank 1035	013 690 2288
Industry	Columbus Stainless Steel	PO Box 1541 Randburg	011 781 0314
Industry	Ferrobank		013 699 9044
Industry	Ferrometals, Witbank		013 693 7274
Industry	Gewi Concrete (Pty) Ltd (Witbank)	PO Box 1239 Witbank 1035	013 596 1153
Industry	Highveld Steel And Vanadium Corporation Ltd	PO Box 111 Witbank 1035	013 690 9911
Industry	Industrial Development Corporation of South Africa	PO Box 784055 Sandton 2146	011 2693000
Industry	Middelwit Stene (Pty) Ltd	PO Box 710, Middelburg 1050	013 229 891
Industry	Rand Carbide		013 656 6626
Industry	Sasol Ltd	P O Box 5486 Johannesburg 2000	011 441 3111
Industry	TOTAL COAL HOLDINGS SA (Pty) Ltd (TESA)	PO Box 31306 Braamfontein 2017	011 727 8400
Industry	XStrata South Africa	Private Bag 82288 Rustenburg 0300	014 590 6163
Commerce			
Government, Local	GERT SIBANDE DISTRICT MUNICIPALITY	PO Box 550 Secunda 2302	017 631 1181
Government, Local	Albert Luthuli Municipality	PO Box 24 Carolina 1185	017 843 1055
Government, Local	Msukaligwa Municipality	PO Box 48 Ermelo 2350	017 819 2892
Government, Local	Mkhondo Municipality	PO Box 23 Piet Retief 2390	017 826 2211

Type	Name	Address	Telephone Number
Government, Local	Seme Municipality	Private Bag X9011 Volksrust 2170	017 734 6100
Government, Local	Lekwa Municipality	PO Box 66 Standerton 2430	017 712 9600
Government, Local	Dipaleseng Municipality	Private Bag X1055 Balfour 2410	017 773 0055
Government, Local	Govan Mbeki Municipality	Private Bag X1017 Secunda 2303	017 620 6000
Government, Local	NKANGALA DISTRICT MUNICIPALITY	PO Box 437 Middelburg 1050	013 243 1441/1457
Government, Local	Delmas Municipality	PO Box 6 Delmas 2210	013 665 6000
Government, Local	Emalahleni Municipality	PO Box 3 Witbank 1035	013 690 6208
Government, Local	Department Environmental Conservation & Recreation, Witbank City Council		013 690 6720
Government, Local	Health Department, Witbank City Council		013 690 6435
Government, Local	Middelburg Municipality	PO Box 14 Middelburg 1050	013 249 7000
Government, Local	Highlands Municipality	PO Box 17 Belfast 1100	013 253 1121
Government, Local	Thembisile Municipality	Private Bag X4041 Empumalanga 0458	013 986 0980/2/3
Government, Local	Dr J S Moroka Municipality	Private Bag X4012 Siyabuswa 0472	013 986 0980/2/3
Government, Provincial	Mpumalanga Provincial Government	Private Bag X11304 Nelspruit 1200, 7 Government Boulevard	013 766 6607
Government, Provincial	Department of Economic Affairs & Gaming, Witbank		013 690 2595
Government, Provincial	Regional/Provincial	Private Bag X11296 Nelspruit 1200, 7 Government Boulevard	013 766 6074
Government, Provincial	Department of Agriculture, Witbank		013 690 1253/69/79
Government, Provincial	Provincial Government Communications Directorate		013 766 2292
Government, National	Department of Local Government and Housing		013 766 6305
Government, National	Department of Local Government, Housing & Land Administration, Witbank		013 656-1066
Government, National	Department of Local Government and Housing		013 766 4491

Type	Name	Address	Telephone Number
Government, National	Department of Roads and Transport		013 766 6602
Government, National	Department of Health and Social Services		013 766 3253
Government, Provincial	Department of Health, Gender & Welfare, Witbank		013 656 6226 X2027
Government, Provincial	Department of Labour, Witbank		013 690-3617
Government, Provincial	Department of Agriculture and Land Administration		013 766 6006
Government, Provincial	DME - Regional Office	Private Bag X7279 Witbank 1035	013 656 1448
Government, National	Mine Environmental Management Directorate		012 317288
Government, National	Department of Environmental Affairs and Tourism (national)	Private Bag X447 Pretoria 0001	012 310 3458
Minerals	MINERAL RESOURCES MANAGEMENT CHIEF DIRECTORATE		012 317 9029
Minerals	Mineral Development Directorates	Private Bag X7279 Witbank 1035	013 656 1448
Minerals	Minerals Bureau	Private Bag X59 Pretoria 0001	012 317 9498
Minerals	Petroleum Agency SA	PO Box 1174 Parow 7499	021 938-3500
Minerals	Mine Health and Safety Inspectorates	Private bag X727 Witbank 1035	013 656 1448
Funding Agencies	African Development Bank	Rue Joseph Anoma 01 BP 1387 Abidjan 01 Côte d'Ivoire	(225) 20 20 44 44
Funding Agencies	United Nations Economic Commission for Africa (UNECA)	Subregional Development Centre –Southern Africa P.O. Box 30647 Lusaka, Zambia	(260) 1 23 10 62 / 1 22 85 03
Funding Agencies	Canadian International Development Agency (CIDA)	200 Promenade du Portage Gatineau, Quebec K1A 0G4	(819) 997 5006
Funding Agencies	Danish International Development Agency (DANIDA)	PO Box 11439 Hatfield 0028	012 430 9340
Funding Agencies	Development Bank of Southern Africa	PO Box 1234 Halfway House Midrand 1685	011 313 3911

Type	Name	Address	Telephone Number
Funding Agencies	Deutsche Geselschaft fur Technische Zusammenarbeit (GTZ)	Dag-Hammarskjöld-Weg 1-5 65760 Eschborn Germany	(49) (0)6196 790
Funding Agencies	National Research Foundation		
Funding Agencies	Nedlac		
Funding Agencies	Norwegian Institute for Air Research (NILU)	PO Box 100 Kjeller 2027	047 638 9800
Funding Agencies	Japanese International Cooperation Agency (JICA)	JICA South Africa Office PO Box 14068 Hatfield 0028	012 346 4493
Funding Agencies	Norwegian Agency for Development Cooperation (NORAD)	Postboks 8034 Dep 0030 Oslo	(code)22 24 20 30
Funding Agencies	Swedish International Development Cooperation Agency (SIDA)	Sida, 105 25 Stockholm	(46) 86 98 50 00
Funding Agencies	United States Agency for International Development (USAID)	USAID/South Africa Mission PO Box 43 Pretoria 0027	012 452 2000
Funding Agencies	World Bank	South Africa Country Office/PO Box 12629 Hatfield 0028	012 431 3100
International Organizations	United Nations Environment Programme (UNEP)	PO Box 30552 Nairobi 00100 Kenya	(254-20) 62 12 34
International Organizations	United Nations Development Programme (UNDP)	PO Box 6541 Pretoria 0001	012 354 8037
International Organizations	United Nations Industrial Development Organisation (UNIDO)	PO Box 300 A-1400 Vienna Austria	(43) 1 21346 4570
International Organizations	World Health Organisation		
International Organizations	World Meteorological Organisation (WMO)	Case Postale No. 2300 CH-1211 Geneva 2 Switzerland	(41) 22 730 81 11
Local Media	OH Frewin Publishing		
Local Media	Witbank Nuus/News	PO Box 36 Witbank 1035	013 656 2490
Local Partnerships	The Fossil Fuel Foundation of Africa	Chamber of Mines Building, Room 307, 5 Hollard Street, Johannesburg	011 833 7708
Local Partnerships	Mpumalanga Air Pollution Control Liaison Committee (APOLCOM)	Private Bag X1000 Secunda 2302	017 610 3443
Local Partnerships	Air Pollution Liaison Committee (APOLCOM), Eastern Highveld, Mpumalanga	PO Box 111 Witbank 1035	013 690 9248

Type	Name	Address	Telephone Number
Local Partnerships	Richards Bay Clean Air Association	PO Box 10299 Meerensee 3901	035 901 5340
UNIONS Organised Labour	National Union of Metalworkers of SA, Witbank	Witbank	013 656 6732
UNIONS Organised Labour	National Union of Mineworkers, Witbank	Witbank	013 656 2045
UNIONS Organised Labour	Mynwerkersunie, Witbank	Witbank	013 656 3871

APPENDIX 4: DETAILED PROJECT PLAN

This project plan summarises a recommended structure, by no means final, for a regional programme on air emissions, air quality, and energy efficiency monitoring for prioritisation of pollution preventions and public health; in this outline, the following elements are elaborated upon:

i. Title
ii. Rationale and aims
iii. Objectives
iv. Expected outputs
v. Target beneficiaries
vi. Regional relevance
vii. Thematic relevance
viii. Work packages
ix. Partners
x. Estimated duration
xi. Estimated budget

i. Title

"Air emissions, air quality and energy efficiency monitoring for prioritisation of pollution prevention and public health in southern Africa"

ii. Rationale and aims

On the basis of the analysis in this report, we have established that atmospheric emissions from industrial, domestic, transportation and natural sources produce adverse health effects in sections of the population. Worst impacts occur in residential areas, because of the inefficient use of coal as a heating fuel, and the proximity of residential areas to large industries – a consequence of poor town planning in the past. Disputes between communities, industries and regulators remain unresolved in the absence of adequate policies and information on atmospheric emissions and air quality. Trans-boundary transports of anthropogenic and natural pollutants have been observed and modelled. However, possible long-term consequences of cumulative loads of acidic and heavy metal species (e.g. Hg) deposited by dry and wet deposition are not yet adequately quantified and understood. In South Africa, revised air quality legislation and related standards are in preparation. However, basic air quality management measures, including policy, monitoring, modelling and mitigation, are lacking in most other countries in southern Africa. Except in South Africa, information on concentrations of criteria and other air pollutants is lacking. Within South Africa, important information gaps have been identified that hinder the level of understanding required to implement cost-effective mitigation strategies on local, regional and international scales.

The overarching aim of this proposed project is to introduce effective pollution prevention measures for the protection of public health and the environment, developed initially within two selected regions of southern Africa, but applicable ultimately to the entire region. Pollution prevention measures are understood in the broadest sense to include understanding of the bio-geophysical environment, policy and technological interventions, and social participation.

The following subsidiary aims are articulated:

- To introduce local industry, government, communities, and research and development institutions to the principles of effective air quality management, monitoring and planning.
- To identify and promote new and innovative business opportunities for SMMEs (including BEE) by developing an innovative air quality product portfolio (e.g. monitoring, collation and interpretation of atmospheric and meteorological data, and air quality forecast products).
- To develop high-quality and high-value products for new markets and applications.
- To recognise and develop capacity via outreach programmes to schools, communities, local and regional government authorities (e.g. school-based monitoring projects, community environmental forums, local environmental resource centres).
- To develop training and educational capacities in the field of atmospheric sciences and air quality management in regional tertiary institutions.
- To implement knowledge and technology transfer across institutions and agencies within the region.

iii. Objectives:

- Identify two target regions for participation in the project, for the development of effective pollution prevention measures for the protection of public health and the environment.
- Develop materials and presentations on principles of effective air quality management, monitoring and planning, suitable for dissemination to local industry, government, communities, and research and development institutions. Distribute these materials through a programme of seminars, media releases and printed materials.
- Small business innovation: develop case studies and sample packs from elsewhere to demonstrate successful business innovation and service in the air quality field. Disseminate through business schools and local chambers of commerce.
- Implement detailed atmospheric emission inventories for the selected regions.
- Implement an appropriate regional-scale dispersion model, incorporating the developed emission inventory and suitable meteorological input fields to demonstrate worst-case, seasonal and annual average behaviours.
- Identify, adapt or develop an information technology database for storing and serving air quality information on the web.
- From the identified data sources (this project) access and assemble relevant air quality information and place it in the shared database.
- Identify, adapt or develop a GIS-based system populated with population densities, air quality information and health risk factors as a tool for prioritising interventions and mitigation based on human health risks.
- Identify, adapt or develop a GIS-based system populated with land-use, water and biosphere information, dispersion model derived air quality information, and environmental risk factors, as a tool for assessing cumulative depositions and critical load factors.
- Identify, adapt or develop materials for government officials at local and provincial levels. Use these materials for courses in the target areas.

- Initiate a school-based programme of meteorological and atmospheric pollution monitoring, with results linked to the regional open-access air-quality database.
- Recruit and support MSc and PhD students to work on aspects of this project, through bursaries and logistic support. Facilitate pairing with regional or international co-supervisors to promote knowledge and technology transfer to regional tertiary institutions.

iv. Expected outputs:

The products developed and produced will range from climate data to validated air quality models, pre-empting disputes on trans-boundary air pollution transport. Expected outputs are:

- Improved air quality through cost-effective interventions;
- Reduced adverse health impacts due to poor air quality;
- Direct economic benefit and employment opportunities for SME businesses involved in the generation of air quality management products as well as in the mitigation of air pollution;
- Improved conceptual and practical knowledge at the research institutes involved;
- Building of an innovation system related to the value chains involved, including legislation and education issues;
- Successful demonstration projects of PPPs involving industry; local and provincial governments; and local communities;
- Spawning of SMMEs involved in air quality issues;
- Development of framework methods for technology transfer in the southern Africa region; and
- Improved image and proof of corporate social responsibility of industrial and agricultural sectors.

The project outcomes should have a regional southern African focus and, as such, different levels of understanding and research will be encountered. This presents the opportunity to learn from more advanced partners. Experiences from the mining area in Mpumalanga, South Africa can be transferred to other partners in the project, such as Mozambique or Zambia. The demand and capacity for air quality products is expected to grow, leading to a need for a higher-value product assortment and improved business opportunities.

v. Target beneficiaries:

Communities (impoverished townships without electrical power, in the shadow of large power plants; urban communities)

Local and provincial government (required to implement complex legislation, lacking financial and technical resources)

Industry (image problem, commercial vulnerability in international markets)

Neighbouring countries (under-resourced in terms of policy and technical capacity in air quality)

Research and development institutions (real world experience and mentoring for young scientists)

vi. Regional relevance:

An active regional policy co-ordination body has been formed to address issues of trans-boundary air pollution transport within southern Africa (APINA). Through the deliberations and publications of this body, the need for regional co-operation, studies, and policy and joint actions has been articulated. The health of both urban and rural dwellers, and socio-economic issues, are drivers of this international co-operation. The proposed project will be complementary to APINA, and provide the vehicle for implementing some of the needs identified at regional levels.

Through previous regional projects such as APINA and SAFARI 2000, effective co-operation and capacity development have been demonstrated. Despite these successes, the required number of trained individuals remains inadequate. The proposed project can build confidently on such existing partnerships to extend capacity within the region.

Also, the need for capacity and thus higher added-value products, exists across the region. Existing differences in experience and products between the countries will trigger technology transfer within this proposed project.

vii. Thematic relevance:

The issue of air quality is relevant for all countries in the region, as are the opportunities to benefit from an improvement in air quality. This includes addressing the need for capacity as well as value-added products across the region. The differences in experience and product delivery within the countries in the region will also act as a driver or trigger for technology transfer.

viii. Work packages:

Work package 1: Project initiation

The overall management team/steering committee for the project will consist of the current PPP group (administrative management – project management team): Coaltech 2020, participating universities, together with additional industry, government and civil-society partners for each of the two demonstration projects. Detailed terms of reference will be given.

Implementation project teams will be recruited and will incorporate multi-disciplinary skills. These groups will comprise research and technology experts, financial and market experts, and community outreach educators. Two teams will be assembled, one for each of the two proposed study regions, namely: Region 1 – Mpumalanga Highveld, South Africa and Region 2 - Maputo, Mozambique. A separate team will be assembled for work package 3 (Training/technology transfer and cross-cutting activities).

The lead agency for Region 1 will be Coaltech 2020, and for Region 2, Eduardo Mondlane University. Contracts will be entered into with project leaders, and through them, subsidiary contracts will be entered into with project implementing agencies and individuals.

The preconditions for future business development will also be investigated. This will include investigating the possibilities of (micro-) financing and initiator schemes (joint development of business, R&D, product and market innovation).

Work package 2: Project implementation

The two demonstration projects will be implemented by the contracted groups. The projects will cover:

1) Detailed project design and planning;

2) Implementation of technical project, including attendant legal and administrative arrangements;

3) Compiling, calculating, and analysing information as required to produce air quality management deliverables as per project objectives; and

4) Identification of opportunities for SMME and BEE initiatives.

The scope of activities will include but not necessarily be limited to addressing the following issues:

- Further development of higher-value products evolving from current knowledge (upgrading of emission inventories, database capture of historical and current air quality monitoring data);
- Compilation of missing information (area and fugitive sources, refined emission factors);
- Implementing an appropriate regional-scale dispersion model, incorporating the developed emission inventory and suitable meteorological input fields to demonstrate worst-case, seasonal and annual average behaviours.
- Identifying, adapting or developing risk-evaluation models;
- Identify, adapt or develop a GIS-based system populated with population densities, air quality information and health risk factors to map human health risks;
- Identifying, adapting or developing a GIS-based system, populated with environmental and dispersion model derived air quality information, to calculate risk factors and to map cumulative depositions and identify critical load zones; and
- Transfering existing learning experiences to other teams.

Although the regional teams co-operate, they are financed separately and work independently, so delays or financing problems in one group do not directly affect the other.

Work package 3: Training/technology transfer and cross-cutting activities

The implementation team for this work package will carry out the following activities:

Liaise with existing organisations and agencies involved in air quality management and science to ensure complementarity of project activities;

Prepare and present briefs on technology issues;

Prepare and present briefs on policy, in particular, transfer of information with respect to air quality management, standards and practices based on recent EU experiences;

Prepare and present briefs on sustainability, market and economic topics of relevance for all project groups and stakeholders;

Prepare and implement training courses and educational materials for communities, schools, in-service training and (new) SMME;

Facilitate technology transfer activities between the project teams;

Set up and maintain a project and a public website;

Plan the roll-out of similar initiatives in further southern African countries.

Work package 4: Project management

Project management is required both at the level of the overall project (PPP group) as well as within the project teams (team leaders).

Management activities include: internal and external communication, overall scientific, technical and non-technical management of the projects, quality control, progress and process management, time schedule and budget management, preparation of content and financial reports, set-up, maintenance and implementation of an administrative organisation for the project, annual accountancy reports, project steering committee, project archiving, maintenance and update of website, and daily management activities.

The management team will ensure that an organisation is established in the form of a PPP that can continue supporting the newly formed structures.

ix. Partners:

Partners will include:

- Universities and research institutions:
  - Coaltech 2020
  - University of Johannesburg
  - University of the Witwatersrand, Johannesburg
  - Eduardo Mondlane University, Maputo
  - University of Venda for Science and Technology
- Industry and business
  - Coal mining
  - Power generation
  - Coal to liquid fuel conversion
  - Metallurgical
  - Gas cleaning and air quality monitoring equipment suppliers
  - Industry environmental cooperatives
  - Environmental consultants
  - Chambers of Commerce and business development agencies
- Government
  - Provincial environmental departments
  - Local authorities

- National Department of Environment Affairs
- Department of Minerals and Energy
- Provincial education departments

- Civil society
  - Environmental societies
  - Environmental NGOs
  - Community Based Organisations – CBO
  - Schools and school districts

x. Estimated duration:

The overall project, from total inception to full completion, is envisaged as a seven-year cycle, with a rolling three-year cycle of commitment and funding. The proposed operation is as follows:

The initial project plan and funding cycle are designed in detail for a three-year period. At the end of the second year, review and evaluation take place. If progress is satisfactory and the project is on track, a further two-year extension is assured (taking the project out to the end of year 5). If progress is unsatisfactory, or the tasks are nearing completion, notice can be given to terminate the project at the end of the following year (3rd year of cycle). The contractors then have 12 months to wind down and terminate all activities.

At the end of each subsequent year (years 3, 4, and 5) a similar process is followed, with forward financial planning of three years, with an option of one-year notice of termination for unsatisfactory performance, protecting both funding agency and contractor.

At the end of the seven-year cycle, a final comprehensive report needs to be submitted, and the project formally completed. No further extensions will be entertained. Further initiatives along similar lines would need to be the subject of a completely new project proposal.

This arrangement ensures that forward planning can take place on appropriate time horizons. Alternatively, it allows for the orderly winding down of a project, with appropriate notice to employees, if the project is not be extended.

xi. Estimated budget (for a three year cycle):

Work Package No.	Description	Year 1	Year 2	Year 3
1	**Project initiation**	**€ 48,000**	**€ 0**	**€ 0**
2	**Project implementation**[1]	**€ 474,000**	**€ 276,000**	**€ 276,000**
3	**Training/technology transfer and cross-cutting activities**	**€ 113,000**	**€ 113,000**	**€ 113,000**
4	**Project management**	**€ 66,000**	**€ 66,000**	**€ 66,000**
Sub-total (excluding VAT)		**€ 701,000**	**€ 455,000**	**€ 455,000**
	VAT 14%	€ 99,000	€ 64,000	€ 64,000
Total (including VAT)		**€ 800,000**	**€ 519,000**	**€ 519,000**

[1] Including equipment, detail below. Maintenance and software renewal estimated at 10% per year of initial cost.

Equipment detail	Qty	Cost per unit (Euro)	Cost (Euro)
Demonstration mobile monitoring station for training purposes (SO2, NOx, ozone, PM10, CO, met)	1	€ 125,000	€ 125,000
Junior met and sampling kits for schools	30	€ 2,000	€ 60,000
Dispersion modelling software licences	2	€ 9,000	€ 18,000
GIS software licences	2	€ 5,000	€ 10,000
Computer web servers	2	€ 4,000	€ 8,000
Total			**€ 221,000**