Executive summary

Objective and scope

The primary objective of this study was to provide an assessment of the social and economic impact of the reduction of air pollution from combustible fuels in South Africa over a period of time. This report aims at providing specific guidance and suggestions, where appropriate, on supply side measures to support processes that would have a positive socio-economic benefit.

The study investigated harmful ambient emissions to which South African citizens, residing in selected conurbations, are exposed to as a result of domestic fuel burning, power generation, industrial activity, transportation as well as agricultural activities.

It is important to note that the scope of this study was limited to the quantification of inhalation exposures due to fuel burning related atmospheric emissions i.e. the study specifically examined airborne emissions from the combustion of fuels and did not examine other airborne emissions such as dust and vapour releases. International literature cites numerous quantifiable cases on the harm caused to humans from airborne emissions derived from combustion pollutants.

It must also be considered that although the study investigated emissions and their sources at conurbation level, health impacts were considered at national level in developing the strategy. The purpose of leveraging the study at national level is to inform and assist in the formulation of national policy and strategy to reduce the effects of pollution from fuel combustion and the implementation thereof. However, for the optimisation of initiatives, it is suggested that further focused examinations, supported by air monitoring of local conurbation effects are conducted in the future.

The following conurbations were included in the study:

- Cities of Joburg and Ekurhuleni (greater East Rand), Tshwane, Cape Town and Ethekwini (greater Durban)
- Mpumalanga Highveld
- Vaal Triangle

These regions represent the densest human occupation in South Africa, accounting for some 35% to 40% of the population of South Africa. The harmful impacts from the combustion of fuels on the public are the greatest in these regions. Specific worker exposures were however not examined in the study.

For air pollution prediction, the US-EPA approved Gaussian Puff Air Dispersion Model was used and limited to first order chemical transformation therefore excluding photochemical modelling and ozone generation prediction. This monitoring indicated the major pollutants of concern from fuel combustion, and will assist the development of confirmatory air monitoring programmes in the future. In determining impacts, consideration was given to local versus global scale impacts, inhalation-related human health risks and the risk of paraffin poisoning and burns. Priority was given to suitable interventions on national level; however, specific regional differences were determined which could facilitate further local programme development.

Key findings and conclusions

The strategy devised to reduce air pollution from fuel combustion is the culmination of extensive investigation, which considered international practices, the South African policy and regulatory environment, the current sources and impacts of air pollutions within different conurbations, and the socio-economic impact of various potential interventions identified.

The following are key conclusions from these investigations:

a) Varied implementation options are available for facilitating or forcing intervention, such as regulation, market mechanisms and education as well as a combination of these need to be considered.

b) Ranking of source significance should be based on impact rather than emissions. The following are the percentage health impact levels at national aggregate level contributed from significantly contributing primary fuel burning sources:

- Domestic fuel burning: 69% (but reducing, 64% by 2011)
- Vehicle emissions: 12 % (and growing, 15% by 2011)
- Electricity generation: 6% (similarly 7% in 2011)
- Coal fired boilers: 4% (similarly 4% in 2011)
- Other sources (primarily industrial sources) : 9% (and growing, 11% by 2011)

c) The interventions to be pursued are easily identified from the socio-economic impact analysis. A high level summary of the socio-economic impact assessment of interventions, which allowed the high health impact interventions to be selected, are presented in the table below.

The fuel combustion pollution reduction interventions selected with the highest impact on health, from a benefit-cost, employment viewpoint and financial cost to the

stakeholder were easily established from the socio-economic impact assessment data presented in the table below:

	Int No	Economic B:C Ratio	Total Jobs	Financial Government	Stakeholder Firms	Analysis (Rm) Households
Basa Njengo Magogo - DME ICHES	1	177.0	347.2	413.9	-76.2	173.0
Basa Njengo Magogo - plateau roll out	2	120.1	520.9	573.5	-180.7	315.3
Low smoke fuels	3	0.4	-642.1	1177.5	1317.5	-1236.2
Housing insulation - 5% of plateau fuel burning households	4	6.0	147.9	114.8	-32.6	106.5
Housing insulation - 20% of plateau fuel burning households	5	6.0	591.5	459.0	-130.2	426.2
Housing insulation - 5% of all fuel burning households	6	7.9	220.8	218.3	-32.8	134.1
Housing insulation - 20% of all fuel burning households	7	7.9	883.2	873.0	-131.3	536.5
Electrification	8	1.2	3635.9	2035.3	1825.3	-1586.9
Stove maintenance and repair - 5% households all areas	9	16.5	137.3	114.4	-166.4	167.6
Stove maintenance and repair - 20% households all areas	10	16.5	549.3	457.8	-665.5	670.2
Desulphurisation of all PS emissions	11	0.0	8457.9	1301.0	-3187.9	1908.6
Decommissioning of PTA West PS - gas use by households	12					
RE technology implementation (10 000 GWh block)	13	0.3	2490.7	386.9	-1864.1	661.6
RE technology implementation (37 000 GWh block)	14	0.3	2592.1	483.0	-2261.9	778.1
Coal fired boilers for particulates (>90% control efficiency req.)	15	0.8	951.7	446.7	-140.5	-211.3
Iscor coke oven gas cleaning	16					
Highveld Steel & Vanadium	17					
Desulphurisation of Sasol Secunda PS emissions	18	0.1	936.3	195.3	-501.4	263.6
Reduction of S content of petrol to 500 ppm (0.05%)	19					
Reduction of S content of petrol to 50 ppm (0.005%)	20	0.0	0.2	-44.4	-303.1	-639.0
Reduction of benzene content of petrol to 1%	21	0.0	5.7	-32.9	-612.5	-323.9
Reduction of aromatics content of petrol to 35%	22	0.1	78.3	103.9	-422.4	-810.2
Phasing out of lead in petrol	23	0.0	-4.8	20.8	331.4	-312.0
Reduction of S content of diesel to <500pm (0.05%)	24					
Reduction of S content of diesel to <50ppm (0.005%)	25	0.5	204.3	276.4	-852.4	126.8
New passenger vehicles comply with Euro 2 standards	26	1.0	224.8	410.1	-8.4	73.0
New passenger vehicles comply with Euro 4 standards	27	1.0	184.3	279.6	-5.4	42.2
Taxi recapitalisation programme	28					
All petrol vehicles EURO 2 compliant	29	1.0	462.9	702.4	-13.5	105.5
Conversion of 10% of petrol vehicles to LPG	30	1.0	2148.8	122.6	1702.7	-1312.7
Conversion of 20% of petrol vehicles to LPG	31	1.0	4297.6	245.2	3405.5	-2625.5
Electrification of paraffin burning households	32	1.3	3335.8	1659.4	1325.5	-1215.6

Figure 1 Outputs of the Socio-economic Impact Assessment

The benefit-cost ratio for each intervention is shown in the first column. The net present values (NPV's) for each intervention were also calculated and are reflected in the main report. In the second column the total number of jobs either lost or gained is reflected. This is also further broken down in the report into direct and indirect jobs. Finally an analysis of stakeholder cost is reflected, in terms of *government*, *firms* and *households*. Given these considerations, the selected interventions were chosen for pursuing.

d) From a financial and economic perspective, as can be seen in the summary table above, low (or existing) technology interventions in the domestic (household) sector can yield significant benefit in the short to medium term. These are Basa Njengo Magogo (a stove ignition method), stove maintenance, electrification and housing insulation.

e) Low smoke fuels in the domestic sector are not attractive unless a significantly (20 to 30%) lower cost technology compared to those technologies that are currently possible and being considered, can be developed

f) Proposed interventions (largely derived from the DME draft strategy) related to changes in fuel specifications and vehicle technology standards need to be re-examined from a holistic perspective. Accelerated initiatives that are currently costly to implement, are certain to be phased in over time through the EURO2 and EURO4 standards.

g) Electricity generation interventions implementing high technology solutions on the supply side (desulphurisation of power stations, renewable energy) are not feasible from a financial and economic perspective. To pursue desulphurisation, considerable cost would be incurred by both Government and households as can be seen in the previous table. Comparatively the costs of electrification are relatively lower, due to the limited costs incurred by households. Renewable energy is however not as costly as desulphurisation but relative to the costs of other interventions, it was not regarded as a feasible option.

h) The benefit, in terms of health impact of specific industrial interventions depends on scale, location and technology factors. Although boiler emission reduction from coal fired boilers is only marginally unfeasible a focused approach to improving the operating technology should be considered.

i) The bulk of savings due to reduced pollution from combustible fuels would go to government, primarily due to reduced spending in the public health care industry.

j) There are a sufficient number of households in the domestic sector to allow for the implementation of multiple interventions without the risk of the deterioration of benefit: cost ratio's of identified interventions.

k) In practice it is not expected that the interventions proposed will result in significant employment loss, in general. Very small losses in indirect jobs (less than 100 jobs) occur across most interventions, and in particular those selected for pursuing further. Indirect jobs are always created, except in the high technology interventions that were deemed not to be feasible as previously stated.

l) The implementation of an appropriate measurement and monitoring system in South Africa is a pre-requisite for implementation of this strategy as already stated in the Air Quality Bill. There are varied implementation options available for facilitating or forcing intervention, such as regulation, market mechanisms, and education.

m) Economic instruments, including taxes, charges show more promise in developing countries than tradable permit systems. Penalties and levies applied in different circumstances were found to be the most appropriate to mitigate air pollution form combustible fuel sources.

Setting a Long Term Goal

The following long-term goal to reduce air pollution from fuel combustion, as suggested by the authors that could be considered is as follows:

> *To reduce the negative health effects associated with air pollution due to fuel-combustion in the short- to medium-term in a cost effective manner, with the purpose of reducing the associated present value health costs assessed at R 4.7 billion per annum by 50% by 2011*.

It is important to note that although there is inherent variance with regards to the determination of the health impacts as a direct result of air pollution from combustible fuels and the associated costs, the numbers can be regarded as comparable per source and intervention, i.e. they are deemed to be sufficient to enable proper prioritisation. Further, a conservative approach was followed throughout the study, so that the benefit-cost quantifications are both realistic and achievable.

The cumulative reduction in the number of cases of morbidity due to the effects of implementing the suggested interventions to reduce air pollution from combustible fuels is estimated to be between 8 to 9 million over the period 2004 to 2011.

The potential number of jobs that are likely to be generated over the aforementioned period is estimated to be between 6 500 to 7 000.

Over-arching themes that guide the strategy

The following suggested five themes are suggested to guide the development of the specific measurable strategic objectives that could be specifically used to monitor the implementation of reducing combustible fuel based air pollution.

a) ***Focus on reducing the effects of air pollution***

   A key theme that emerged from the study is that the aim of all actions to manage air pollution from combustible fuel should be driven by, the *impact on the health of the population* resulting from the emissions and not the emissions themselves.

b) ***Contribution to sustainable development***

   Improvements that could make a *contribution to sustainable development* are the savings on combustible fuel air pollution based health impact costs, calculated to be in the region of R11 200 million over the medium term to 2011. These could be redirected into other areas of potential growth requiring stimulation from expenditure and even other avenues of health care, as well as improvements in productivity which, are included in the above number, are also likely to be realised. Job creation, albeit relatively small, would also make an overall contribution of some 6 500 to 7 000 jobs, across selected interventions, over the medium term.

c) ***Flexible and multiple approaches in defining actions aimed at reducing the negative impacts of air pollution***

A critical point is that a uniform, 'one size fits all' centrally administered regulation, that sets a single acceptable level for any emission, cannot be economically efficient. Numerous approaches ranging from education and awareness, to the implementation of market mechanisms such as taxes and levies, should be considered.

d) ***Close collaboration between national, provincial and local government, as well as the key stakeholders at these levels, in the development and implementation of initiatives and interventions***

Since local and provincial air quality managers will be given responsibility for implementation of air pollution reduction interventions it is imperative that national government work closely with these authorities and stakeholders in devising implementation strategies. The coordination of interdepartmental strategies within national government is also essential.

e) ***Focus on "low hanging fruit" in the short-terms whilst developing appropriate solutions for the longer term***.

The study identified numerous relatively low technology solutions which, if implemented, in the short-to-medium term were calculated to yield significant (up to 40%) reduction in the negative health impacts associated with pollution from fuel combustion. This creates a window of opportunity to develop feasible solutions for the longer term, which should realise the support of the relevant stakeholders, and be implemented in a managed process that advances sustainable development.

Strategy to reduce the health impacts associated with air pollution from fuel combustion

The strategy is defined in terms of strategic objectives that need to be pursued and specific initiatives which, if implemented properly with the necessary monitoring and controls, should realise the objectives.

The strategy also identified three cross cutting issues

It is suggested that these cross-cutting issues need to be addressed by the strategy.

a) ***The need for measurement and monitoring***

This relates not only to the need for a sound system of monitoring emissions levels, but also to the continuous monitoring of progress of the implementation of the recommended interventions.

- Emissions and air quality monitoring systems must be put in place as soon as possible
- Provision must be made for the establishment of monitoring protocols.
- Mechanisms must be established for the rapid sharing of information between local, provincial and national government as well as with stakeholders.
- The proposed Air Quality Bill provides for additional human and financial resources for enforcement and management at provincial and local level. It is of utmost importance that these additional resources be deployed.

b) ***The importance of education and awareness***

Education and awareness is of specific importance for a number of reasons. The first is that the health impact of pollution (and associated costs) is generally not known to stakeholders across a broad spectrum. The following are specific actions that could be considered:

- Mechanisms should be implemented for communicating air quality information (effects, i.e. harm and potential benefits of improvement) to the public on a routine and on-going basis
- The effect of current public disclosure programmes needs to be assessed and used as input to such programmes

c) ***Continued research and development***

Many of the initiatives recommended for implementation are only possible because they were pioneered through research and proper field development. Basa Njengo Magogo can be considered to be a uniquely “African” solution, and it is commonly accepted that Eskom is a world leader in the development of low cost and appropriate solutions for electrification of low-income houses (and informal settlements). It is therefore essential that research and development continue on many fronts right through to successful pilot programmes, with involvement of numerous stakeholders from government, industry and labour. Relevant government supply side measures should be promoted and utilised in this regard.

Proposed strategic objectives – specific suggestions to enable the primary goal to be achieved

The following five strategic objectives, suggested by the authors, need to be considered to enable the proposed strategy to be effectively and timeously implemented.

Strategic objective 1: The implementation of high yield, low technology solutions in the domestic sector in the short- to medium-term (up to 2007) is suggested as the initial drive to significantly reduce combustion based air pollution.

a) *Refine and implement the DME Clean Household strategy***.**

b) *The practical viability of implementing stove maintenance and replacement should be investigated by DME in close consultation with local and provincial authorities, in the short term. If viable, the measures should be implemented in the long term.*

c) *Continue and, wherever possible, accelerate the electrification programme and intensify efforts to reduce incidents of electrocution.*

d) *Ensure that progress is made in reducing air pollution and the related impact on health is monitored at the local and provincial government level and the results are communicated to national government and relevant stakeholders.*

Strategic objective 2: Continue to investigate technologies, such as low smoke fuels and renewable energy, through planning, research and testing, for actual implementation in the long-term (2011 onwards) in both the supply and demand side to further reduce health impact costs

a) Continued development of the low smoke fuels programme

b) Continue government's current policy around renewable energy, with the focus on implementation from 2007 onwards

c) Continuous assessment of the potential for cost savings associated with reduced pollution

Strategic objective 3: Consider the development of an emission licensing system as well as an incentive scheme to reduce the health impacts as a result of air pollution from coal fired boiler operations

a) Develop and manage detailed inventory of coal fired boiler operations

b) Develop regulatory framework at national level for implementation at local level

c) Investigate and develop a support scheme to facilitate investment by industry to reduce emissions from coal fired boilers

d) Launch and awareness and education campaign amongst SMME boiler operators

Strategic objective 4: Continue to develop a holistic and economically efficient strategy to deal with the control of exhaust emissions from road-transportation vehicles

a) The DME and DEAT should revisit the scope of the draft implementation strategy for the control of exhaust emissions from road transportation vehicles

b) *The DME and DEAT could consider revisiting the proposed fuel specifications as specified as part of the strategy for the control of exhaust emissions from road transportation vehicles*.

c) *Fast-track the implementation of provisions in the Air Quality Bill for the regulation of vehicles.*

Strategic objective 5: Consider the development of conurbation and sector specific strategies to reduce aggregate health costs

a) *DEAT should consider facilitating a strategy development process at provincial and local government*
b) *DEAT to implement a measurement system to monitor implementation and effect of provincial and local government plan, including appropriate ambient air monitoring.*

Sector view of strategy

The implementation of the suggested strategy, which might be called the *standard approach*, could also be looked upon from a different viewpoint.

Another view is to take a sectoral perspective of the strategy and assess the possible combination of interventions that need to be managed. Should this alternate approach be considered to implement the strategy, which might be referred to as the 'incremental-benefit' or *triage approach*, consideration would have to be given to assigning responsibilities for its execution. This would need to be done through the different Government Departments as well as at provincial and local Government levels.

The sector view considers each of the targeted sectors, the formulated and suggested strategic objectives, the relevant interventions, the potential impact and potential cost as well as the critical success factors considered for each of the considered strategies.

Suggested Strategies by Sector for the Abatement of Costs due to the Impact of Air Pollution

Sector Targeted	Possible Strategy	Intervention	Potential Impact	Potential Cost (PV)	Critical Success Factors
Domestic	1. Implement high yield, low technology solutions in the domestic sector in the short to medium term	Basa Njengo Mogogo – DME ICHES	R756m PV 350 jobs created 380 000 reduction in health cases by 2011	R76m	Awareness campaign to change behaviour DME to facilitate amongst other departments 4 Year window to achieve reduction in health costs
		Basa Njengo Mogogo – plateau roll-out	R1 123m PV 520 jobs created 522 000 reduction in health cases by 2011	R180m	Awareness campaign to change behaviour
		Stove maintenance and repair in 5% of households	R281m PV 137 jobs created 80 000 reduction in health cases by 2011	R166m	Education and awareness campaign. Replacement parts - consumers may need help: possibly VAT exemption
	2. Investigate technologies such as low smoke fuels and renewable energy, through planning research and testing for implementation in the long-term	Low smoke fuels	R2 494m PV 642 jobs lost 130 000 reduction in health cases by 2011	R1 236m	Focused research within the low-smoke fuels programme As the intervention currently fails B/C tests it is unclear if research can provide a financially and economically feasible low smoke programme by 2007. Financially and economically feasible renewable energy programme by 2007
		Renewable energy technology implementation through financial incentives – 10 000 GWhr block	R1 049m PV 2 490 jobs created 1 660 000 reduction in health cases by 2011	R1 864m	The numbers shown here suggest significantly increasing returns to scale => falling costs per electricity unit. Ongoing but focused research in term of direct benefits created. These can be supply side (renewable electricity generated) or demand side (mains electricity saved by e.g. home solar water heater)
		Renewable energy technology implementation through financial incentives – 37 000 GWhr block	R1 261 PV 2 592 job created 6 000 000 reduction in health cases by 2011	R2 262	

Suggested Strategies by Sector for the Abatement of Costs due to the Impact of Air Pollution continued

Sector Targeted	Possible Strategy	Intervention	Potential Impact	Potential Cost	Critical Success Factors
Industrial	The development of an emission licensing system and related incentive scheme to reduce the health impacts as a result of air pollution from coal-fired boilers	Emission reduction requirements for coal fired boilers for particulates. Standards to vary between high sensitivity and low sensitivity areas.	R 447m PV 951 jobs created A saving of 3-5% of the current health cost base by 2011	R251m PV	Management of a detailed inventory of coal-fired boilers in SA Use of the DOL boiler certification and inspection system / infrastructure to collect and disseminate air quality information (assist with monitoring) Develop regulatory framework at national level for implementation at local level Supply side incentive scheme based on a matching grant system, accelerated depreciation, tax deductions and the SMEDP\ Introduction of a supply side incentive scheme based on a matching grant system, accelerated depreciation and tax deductions and the SMEDP Launch of an awareness and education campaign amongst SMME boiler operations
Transport	Refine and further develop a holistic and economically efficient strategy to control exhaust emissions from road transportation vehicles	DME Strategy - new passenger vehicles comply with EURO 2 standards (assume fuel specs changed)	R483m PV 225 jobs created	R8m PV	Revisit the current proposed strategy on vehicle exhaust emissions and focus execution on EURO 2 and EURO 4 compliance criteria as well as vehicle usage patterns and overt vehicle inspection
		All petrol vehicles EURO 4 compliant (assume fuel spec changes in place)	R322m PV 184 jobs created	R5m PV	Phasing out of lead (Pb) over the medium to long term in favour of effort and cost spent on sulphur, benzene and aromatics in both petrol and diesel First institute lower cost approaches Requires a system of appropriate penalties and buy-in by traffic police and local authorities. Enforce existing regulations => pull over and prosecute when vehicles are blatantly untuned, require regular inspection of older vehicles

This approach involves identifying the most serious cases, and also those with the greatest benefit-cost ratios, and addressing them first, then those with the second best benefit-cost, then the third etc, till the available budget is exhausted.

It is also prudent to recognise that the legal parameters are changing because of the new Air Quality Bill and this would need to be take cognisance of in considering any of the strategy implementation approaches.

The Road Ahead – imperative for Success

In the suggested components of the strategy, their realism is bounded by the accuracy of the data collected and analysed. Notwithstanding this point, the outcomes do provide a clear approach to reducing health costs as a result of combustion based air pollution.

The implementation of the interventions and the concomitant reduction of health costs have impacts on the economy in terms of contribution to growth and employment, which are well quantified in the study. Other related impacts are on productivity due to a decrease in absenteeism.

The challenge is for any Government is to ensure that these benefits are realised so that a contribution made to sustainable development that can to some extent be quantified.

The primary Government Departments that appear to have a vested interest in reducing combustible fuel air pollution are DEAT, DTI, National Treasury and DME. Although other Departments might also play important roles, these are the Departments likely to assume responsibility for execution of the suggested strategy. A suggested central coordinator for the execution of the proposed strategy could for instance be the Parliamentary Standing Committee on Air Pollution.

The *triage approach* and the *standard approach* to strategy has considered those strategies most likely to have a net positive effect on the economy in South Africa and make a contribution to sustainable economic development.

The prioritisation of strategies should be looked upon in terms of the positive impact that they have in both social and economic terms. It is interesting that the study revealed that the most benefit would be derived from low cost and low technology options in the domestic sector of the economy. It is suggested as a final conclusion that Government should draw attention towards taking action utilising relatively inexpensive approaches to make significant inroads towards the reduction in air pollution from combustible fuels up until 2007 as well as an outline of the road ahead from 2007 to 2011.

Success, it is suggested can be achieved by assigning high level responsibility for the coordination and implementation of the “Combustible Fuels Air Pollution Strategy” over the next decade. The “Combustible Fuels Air Pollution Strategy” thereafter would need to encompass a comprehensive solution to address air pollution from all point sources in South Africa using the intended Air Quality Act as the primary legislation, in its final form to achieve the same.