The Minimum Emission Standard (MES) Health Benefit Cost Analysis (BCA) Study at Medupi Power Station

NON-TECHNICAL SUMMARY

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PRIME AFRICA CONSULT

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Disclaimer

The purpose of the non-technical summary is to present the BCA and findings in a non-technical manner. The summary is intended to provide an understanding of the content of the BCA that will be submitted for further decision-making, by non-specialists. Should the BCA in this summary be understood differently to the main report due to simplifying sometimes complex concepts, readers are advised that the meaning presented in the main BCA report is the definitive meaning.

Introduction

Eskom applied for exemption from the SO_2 Minimum Emission Standards (MES) for Medupi Power Station. To motivate the exemption, Eskom compared the cost of complying with the SO_2 standard to the human health costs of not complying. Such a comparison is known as a cost-benefit or benefit-cost analysis (BCA). This document is a non-technical summary of the most recent BCA for submission to the Department of Fisheries, Forestry and Environment (DFFE). Readers requiring more detail than is presented here are encouraged to read the full document available on the Eskom website.

What is meant by air quality?

Human health can be negatively affected by inhaling air pollution. The term 'air quality' is used to describe how much air pollution exists in a certain area, potentially posing a risk to human health. 'Good' air quality implies low risk of negative health affects due to small amounts of air pollution, while 'poor' air quality implies a higher risk of negative health effects due to large amounts of air pollution.

Who manages air quality in South Africa and how?

The DFFE is the custodian of air quality in South Africa. To manage air quality so that it does not pose a risk to human health, DFFE uses National Ambient Air Quality Standards (NAAQS) for the most important air pollutants that occur in South Africa. The NAAQS are expressed as a concentration, which is the mass of the pollutant within a parcel of air - typically in µg (micrograms) per m^3 (cubic meter of air). 1 µg is 1 millionth of a gram which seems like a very small amount, but negative human health effects have been shown to occur even at these very small amounts.

What does ambient mean?

Air pollution is distributed vertically and horizontally in the atmosphere, so the term 'ambient' is used to indicate the pollution at ground level, where people would inhale the air pollution. NAAQS are also defined for different 'averaging periods'. An averaging period refers to the time over which the pollution concentration is averaged. These averaging periods are 10-minutes, 1-hour, 24-hours (daily) and annual. The averaging periods are important because people may inhale large concentrations but only for a short time or smaller concentrations but for a much longer time.

Why are there emission standards?

The NAAQS define a tolerable concentration of air pollution, which is based on the likelihood of negative health effects. The NAAQS are the direct measure of air quality, but to manage and control air quality, the DFFE must control the sources of air pollution. For that control, the DFFE has Minimum Emissions Standards (MES) for different industry types in South Africa. All emitters of air pollution listed in the MES must comply with the emission standards. The MES apply where the industry releases or 'emits' the air pollution into the atmosphere, typically (but not always) through a stack (chimney). As such, the air pollution may be emitted several tens (and even hundreds) of metres above the ground.

How do emissions standards apply to Eskom?

Eskom's coal-fired power stations are also required to comply with the MES. For the Medupi Power Station, which is the subject of this assessment, complying with the MES means installing 'flue-gas desulphurisation (FGD)' to remove sulphur dioxide (SO_2) prior to emitting to atmosphere. With FGD the exhaust gasses are passed through an alkaline water spray. The alkaline water neutralises the acidic SO_2, and converts it to gypsum which is recovered and contained. There are alternative types of FGD. 'Wet' FGD removes the greatest amount of SO_2, followed closely by 'semi-dry' and then 'dry' FGD is less effective, but also less expensive. Eskom's other large coal-fired power station, Kusile has wet FGD. Medupi Power station complies with the MES limits for the other pollutants it emits which are particulate matter and nitrogen oxides.

Why a benefit-cost assessment (BCA)?

The implementation of FGD at Medupi will be expensive and the monies will be recovered through the electricity tariff. The FGD facility requires a large capital (once-off) cost and also large operating (ongoing) costs. Eskom prepared a BCA to compare the costs of FGD with the 'saved' (i.e. prevented) costs of adverse human health effects.

Eskom's exemption application

Eskom applied for additional time to install FGD in the exemption application, but did indicate that investment in the technology may not be appropriate. A BCA (as described above) was

submitted in the exemption application. The Minister of DFFE granted the exemption to Eskom, but in the decision requested that the BCA for FGD at Medupi be expanded to include additional issues and limited to only SO_2.

The expanded BCA

The additional issues included in this BCA are:

1. Is the airshed[1] saturated as a result of other emission sources in addition to Medupi? In other words, has a tolerance for air pollution in the area been reached (or even exceeded)?
2. Exposure Response Functions (the relationship between air pollution and the likely negative health effects) from other countries do not provide for the TB and HIV occurrence in South Africa. TB and HIV impact on respiratory, cardiovascular and immune systems, potentially exacerbating adverse health effects caused by air pollution.
3. Synergistic effects - if multiple pollutants are inhaled simultaneously, will they act together to increase the negative health effects?
4. Morbidity - the previous BCA only considered the cost of premature mortality risk. What of the financial costs of people getting ill (morbidity) as a result of inhaling air pollution?
5. Environmental aspects such as infrastructure and services to provide water and waste management (sorbents) associated with the FGD to be included.
6. Assessment of alternatives to installing FGD at Medupi.

The Waterberg Priority Area (WBPA) airshed

Medupi is located in Lephalale, which falls within the WBPA. Analysis of air quality data across the WBPA indicates that the airshed is not saturated. For SO_2 specifically, concentrations are small for most of the time, with larger concentrations occurring infrequently. In the analysis period air quality was materially compliant with the NAAQS implying a low risk of negative health affects in the airshed.

How was the BCA done?

The BCA was conducted using guidelines from the World Health Organisation (WHO) and consisted of the following steps:

1. Atmospheric emission scenarios were quantified for Medupi, namely emissions with no SO_2 reduction (the current situation or 'baseline'), wet FGD, semi-dry FGD and dry FGD. Six alternatives to FGD at Medupi were also assessed.

[1] An airshed refers to a management unit of the atmosphere into which there are multiple emissions from different sources, which then potentially act together to create a given air quality.

2. The ambient air quality caused by these emissions was then modelled for each of the different emission scenarios over an area of 330 km x 330 km. Emissions from Matimba Power Station, which is in the same airshed, were also included in the modelling.
3. The number of people potentially exposed (i.e. who could inhale the air pollution) was then determined based on the latest 2025 population distribution data and the national 2022 census data. Population growth was included in the BCA timeline assessed.
4. Negative health effects associated with inhaling the air pollution were determined. Suitable Exposure Response Functions (ERFs) for South Africa were selected.
5. The financial costs of the negative health effects were determined and multiplied by the number of people estimated to experience the negative health effects.
6. The total financial cost of FGD at Medupi (including all costs as requested) was then compared to the total health cost calculated in steps 1-5 above.

Exposure response functions

Exposure response functions (ERFs) indicate the likely negative health effects associated with inhaling SO_2 (and indeed other pollutants). The term 'response functions' refers to the negative health effects. Synergistic pollutant effects refer to how air pollutants act together in ways that make their combined health impact greater than the sum of their individual effects. In reality, people are exposed to mixtures of pollutants and not just one at a time. ERFs used in this study are derived from studies based on mixtures of pollutants.

An extensive literature review and assessment of several ERFs for both mortality and morbidity was conducted for this BCA study. The selection of ERFs considered vulnerabilities within the area (children, HIV and TB). Given the availability of baseline incidence data and costing information, the following negative health effects were used in the BCA for SO_2 and $PM_{2.5}$:

- Risk of premature mortality
- Risk of morbidity (Childhood respiratory pneumonia, Acute myocardial infarction, asthma resulting in emergency or hospital admissions, cardio-vascular hospital admissions and asthma – all hospital admissions.

Financial costs

Financial values were determined for each of these adverse health effects. In simple terms the adverse health effects costs were determined from the costs of the medical treatment, hospital stay, care-giver costs and cost of workdays lost for each disease type. The financial values were then multiplied by the number of people who would be exposed to the different SO_2 and particulate matter concentrations as indicated by the dispersion modelling. Sensitivity testing (using high and low estimates) was also done to ensure that the health benefits were not undervalued.

Value of Statistical Life (VSL)

The Value of Statistical Life (VSL) indicates the monetary value society is willing to pay to reduce the risk of one premature death. VSL should not be misunderstood to imply the price of a specific person's life, but rather what would be paid to reduce the risk of premature death.

Medupi FGD SO_2 reduction scenarios - results

For all three FGD alternatives the BCA is well less than 1, implying that the monetised health benefit value of the reduction in SO_2 emissions, is substantially less than the capital and operating expenditure for FGD. Unsurprisingly, wet FGD results in the largest health benefit because that alternative removes the largest amount of SO_2. Those health benefit values are, nonetheless, orders of magnitude less than the cost of implementing wet FGD at Medupi. Some R383 billion would be required over the lifetime of the power station for FGD, and that cost would have to be recovered through the electricity price.

Alternative emission reduction scenarios

Eskom is investigating other options for reducing emissions from its coal-fired power station fleet and these options were also assessed using BCA methodology.

1. Air Quality Offset (AQO) Programme (clean cooking and household interventions);
2. Small Modular Reactors (SMR) (nuclear);
3. Long Duration Energy Storage (LDES);
4. Coal beneficiation;
5. High Efficiency Low Emissions (HELE) (an advanced coal-fired generation technology); and
6. Carbon Capture, Utilisation and Storage (CCUS).

BCA results for alternative emissions reduction

1. The AQO programme delivers pronounced health benefits by reducing household air pollution, including fine particulate matter and SO_2 in low income dense settlements where people rely on domestic fuels for cooking and heating. Estimated health benefits significantly exceed implementation costs by more than 30 times. The total AQO project lifetime cost to Eskom is R5.1 billion. The programme is the most cost-effective human health intervention, and pilot study results indicate a high likelihood of success.
2. SMR and LDES are expected to generate significant health benefits, notably SMR because of broader possible implementation. Both interventions have additional power generation benefits that were not assessed in the study.
3. Coal beneficiation, HELE and CCUS generate some health benefits but at costs that exceed the calculated health benefits.