Letter to the Editor

Response to: "An economic assessment of SO_2 reduction from industrial sources on the highveld of South Africa" by Steyn and Kornelius

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The article, 'An economic assessment of SO_2 reduction from industrial sources on the highveld of South Africa' (Steyn and Kornelius, 2018) is of considerable interest in the context of Eskom's ongoing applications for "rolling postponements" of the Minimum Emissions Standards. (DEA, 2013)

Analysis of the article indicates that certain abatement costs not related to the emission sources are included in the cost-benefit estimates, and benefits related to sulphate exposure and a larger domain are excluded. These factors and other inconsistencies in the article place doubt on the paper's unequivocal conclusion that

"The results of the study indicate that costs of the implementation of the category 1.1 new plant (2020) SO_2 standard exceed the likely quantifiable benefits due to the high capital and operating cost associated with the implementation of FGD."

1. Sources included in the emissions inventory

In 'Methodology', the authors state that "All category 1.1 sources operational at the time of study within the study area expected to have a significant impact on ambient SO_2 concentrations were included in the study." Figure 3 shows the model domain, and the location of the 'major sources', including the Lethabo Stations 1 and 2 and Secunda Stations 1 and 2 (presumably the Sasol-Synfuels plants) respectively. Sasol Stations 1 and 2, and the Kelvin power plant are also shown. Figures 4 and 5 (modelled SO_2 concentrations) do not include the Lethabo or the Sasol-Synfuels plants and the isopleths do not show the concentration imprints of these two plants. The authors state that Sasol Stations 1 and 2 and Kelvin are ***not*** included in the dispersion modelling.

a) Could the authors please clarify why Sasol Stations 1 and 2 and Kelvin are not included in the modelling though they are within the modelling domain?
b) The Sasol-Synfuels plants ('Secunda' Stations 1 and 2) are clearly within the model domain shown in Figure 3. Please clarify if emissions from these plants are included in the dispersion modelling?

2. Are secondary sulphates included in health impact estimates?

Secondary sulphate formation appears to be included in the modelling but sulphate results are not shown, nor are sulphate benefits included in the health benefits.

Several statements infer that sulphates are considered: page 6, "Chemical transformations were modelled using the Mesopuff II chemical transformation model, included in the Calpuff model."; "The changes in ambient concentration of SO_2 and sulfates between the baseline (current operations) and compliance scenario (emissions at 500 mg/Nm^3) were extracted from the dispersion modelling results for short-term (daily average) and long-term (annual average) impacts."; Tables 1 and 2 include mortality and morbidity response values for sulphates; "Discussion" "The methodology for the health impact assessment was as follows: The changes in ambient concentration of SO_2 and sulfates between the baseline (current operations) and compliance scenario (emissions at 500 mg/Nm3) were extracted from the dispersion modelling results for short-term (daily average) and long-term (annual average) impacts."

In contrast, the statement that "The associated health benefit associated with ***SO_2 mortality impacts*** calculated using the base data was R50 billion, compared to the Asian estimate of R26 billion and the South African estimate of R53 billion ***for the SO_2 only impact.***" [emphasis added] unequivocally states that sulphates are not included in the health benefits. Modelled sulphate concentrations are also not reported.

Are sulphates included in the analysis of the impacts and benefits reflected in Table 5 and Figure 3?

3. The influence of a confined domain on the estimation of health benefits

Figures 4 and 5 appear to reflect a significantly smaller domain compared with Figure 3, the "Model Domain". This excludes the populated areas surrounding the Lethabo power station. Confining the model domain effectively assumes a threshold at its boundaries, particularly pertinent for emissions from Lethabo and Sasol Stations 1 and 2 plants. This results in an underestimate of the exposed and impacted population, and the health benefits. A larger domain would account for the known long-range impacts of industrial emissions from tall stacks. Figure 4 reveals that the domain boundaries are curtailing the estimate of impacts and health benefits.

a) Was the larger model domain shown in Figure 3 the basis for estimating ambient concentrations and population health benefits?
b) Which criteria are used for defining domain boundaries?

4. Capital costs of Flue Gas Desulphurisation (FGD)

In 'Capital costs', "The overall calculated direct capital cost was R187 billion (2020 costs) for all the Eskom stations currently in operation within the study area as well as the Sasol facility at Secunda."

Total FGD capital costs include the Sasol-Secunda plants but the estimate of health benefits does not appear to include the Sasol emissions (Question 1b).

Please clarify if this is the case?

5. Water consumption rates and costs

Water requirements are stated as "The operation of FGD on all the facilities will require an estimated 98 million m^3 of water per annum (Sasol, 2014; Eskom, 2014).". Eskom estimated (Eskom, 2014) that implementing FGD ***on all its plants*** (including Medupi) would increase its water consumption by 70 million m^3 (or 67 million m^3 per annum in Table 4.) per annum. The estimate of a total of 98 million m^3 per annum therefore appears to be high.

a) What is the estimate of water consumption for Eskom's plants that are included in this study?
b) Have water consumption and cost data for Sasol plants been included while their emissions and health benefits were excluded?
c) Are water consumption figures based on wet FGD, wet FGD with inlet cooler or semi-dry FGD or a mix of these technologies? What is the water consumption split, per technology?

6. The sorbent (lime or limestone) consumption and cost estimates

The estimates of sorbent consumption are: "Sasol requires approximately 180 000 tons of lime per annum, while Eskom will require an estimated 5 000 000 tonnes per annum of lime (Sasol, 2014; Eskom, 2014)."

Medupi proposes to use limestone rather than lime in its proposed wet FGD process (Eskom, 2014. Page 32), and limestone appeared to be the sorbent of choice in Eskom's postponement applications. In 2014, Eskom estimated that "Up to almost 5 million tons of sorbent (limestone) per annum is required to operate the FGD ***across the generating fleet***." (Eskom, 2014. Page 14) [emphasis added] The 5 million tonnes per annum of limestone includes sorbent for Medupi and Matimba. The limestone requirements for the Eskom plants within the study area appear to have been overestimated. Could the authors please clarify the basis of their figure?

The total (30-year lifecycle) limestone cost estimates is given as R50 billion in Table 5 and as R63 billion on page 3. The per tonne cost is R300 and the total limestone consumption rate is 5,18 million tonnes/year. For 2020, the annual limestone cost would be 5.18 million x R300 = R1,554 billion. If total limestone consumption rates remain constant over the 30 year period, the cumulative cost would be R46,6 billion. However, the total annual SO_2 emission rates, would decrease as plants are decommissioned. Limestone annual consumption rates, directly related to SO_2 emissions and removal rates, should therefore decline proportionately resulting in a significantly lower 30-year cumulative cost.

Please clarify the calculation of the 30-year total limestone cost, for example, with a year-on-year schedule of consumption (and cost), based on the assumed decommissioning schedule.

7. Clarification of the emissions scenarios used in the modelling

The year-on-year difference in baseline and compliance emissions scenarios is not clear. The assumptions were: ".. all retrofits could be completed by 2020" (page 7); ".. the plants would be decommissioned according to schedule and that their lifetime will not be extended."; "Costs and benefits were only calculated for the remaining life of each facility." The Eskom decommissioning dates in their postponement applications, are: "Camden: 2020-2023; Hendrina: 2020-2026; Arnot: 2021-2029; Komati: 2024-2028; Grootvlei: 2025-2028; Kriel: 2026-2029." (Eskom, 2014. Page 17) Therefore the full cost of retrofitting these plants would be incurred by 2020 but the benefits of reduced SO2 emissions would reduce as these plants are decommissioned. For Camden and Hendrina, retrofitting would be completed in 2020 and decommissioning also begin in 2020. It would clearly be preferable to not retrofit units scheduled for immediate decommissioning, thus saving FGD capital costs. For Camden, Hendrina and Arnot, compliance could be achieved through a combination of accelerated decommissioning of some units and retrofitting of the remainder. This could significantly shift the balance of costs and benefits.

Please clarify year-on-year costs and benefits by providing, for example, the assumed year-on-year baseline and compliance emissions scenarios, and corresponding costs.

Yours sincerely
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8. References

DEA (2013) Department of Environmental Affairs National Environmental Management: Air Quality Act (39/2004): List of Activities which result in atmospheric emissions which have or may have a significant detrimental effect on the environment, including health, social conditions, economic conditions, ecological conditions or cultural heritage. Government Notice 893 of 2013.

Eskom (2014) Applications for postponement of the Minimum Emissions Standards (MES) for Eskom's Coal and Liquid Fuel- Fired Power Stations, February 2014.

Steyn M. and Kornelius G. 2018, 'An economic assessment of SO_2 reduction from industrial sources on the highveld of South Africa'. *Clean Air Journal*. 28:23-33.