ESKOM

APPLICATION FOR SUSPENSION OF EMISSION LIMITS IN TERMS OF THE MINIMUM EMISSIONS STANDARDS FOR THE GROOTVLEI POWER STATION

DATE: November 2019

Report reference: Eskom ENV19-R236
Version 1

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

AIR	Atmospheric Impact Report
AEL	Atmospheric Emission License
APPA	Atmospheric Pollution Prevention Act, 1965 (Act No. 45 of 1965)
AQMP	Air Quality Management Plan
DEA	Department of Environmental Affairs
DEFF	Department of Environment, Forestry and Fisheries
DOE	Department of Energy
EIA	Environmental Impact Assessment
ERP	Emission Reduction Plan
ESP	Electrostatic Precipitator
FGC	Flue Gas Conditioning
FGD	Flue Gas desulphurisation
GNR	Government Notice No.
HFPS	High Frequency Power Supply
FGD	Flue gas desulphurisation
GNR	Government Notice No.
IRP	Integrated Recourse Plan
IRR	Issues and Response Report
LNB	Low NO_x Burner
LPG	Liquid Petroleum Gas
NAAQS	National Ambient Air Quality Standards
NAQO	National Air Quality Officer
NEMAQA	National Environment Management: Air Quality Act, 2004 (Act No. 39 of 2004)
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NERSA	National Electricity Regulator of South Africa
NO	Nitrogen oxide
NO_2	Nitrogen dioxide
NO_X	Oxides of nitrogen ($NO_X = NO + NO_2$)
PM	Particulate Matter
PM_{10}	Particulate Matter with a diameter of less than 10 µm
$PM_{2.5}$	Particulate Matter with a diameter of less than 2.5 µm
RTS	Return to Service
SO_2	Sulphur dioxide
TSP	Total Suspended Particulates
µm	1 µm = 10^{-6} m
WHO	World Health Organisation

LIST OF ANNEXURES (ANNEXURES 1-4 AVAILABLE SEPERATELY)

Annexure A	Atmospheric Impact Report (2014) – Grootvlei
Annexure 1	A Health impact focused cost benefit Analysis (Highveld MES applications 2019)
Annexure 2	Eskom's summary Atmospheric Impact Report (Highveld MES applications 2019)
Annexure 3	Summary report of Eskom's MES Applications in March 2019
Annexure 4.1	Public Participation report as at Feb 2019 (Highveld MES applications 2019)
Annexure 4.2	Final Issues and Response report as at Feb 2019 (Highveld MES applications 2019)

1 INTRODUCTION

Eskom, as South Africa's public electricity utility, generates, transmits and distributes electricity throughout South Africa. The utility also supplies electricity to neighbouring countries including Namibia, Botswana, Zambia, Zimbabwe and Mozambique. Eskom's principal generation technology is pulverised coal with approximately 90% of its current generating capacity is from coal-fired power stations. One of the 15 power stations is the Grootvlei Power Station (hereafter referred to as "Grootvlei"), which lies in the Gert Sibandae District of the Mpumalanga Province, close to the town of Balfour. The area surrounding the power station is primarily agricultural.

In terms of the Integrated Resource Plan and the Eskom Consistent Data Set, coal power stations will generally be decommissioned at 50 years. The exact date of decommissioning is determined by current and future demand, the performance of other electricity generating plants and the cost of generation and guided by the Integrated Resource Plan (IRP). The last of Grootvlei's generating units was commissioned in the early 1970's and it is intended to decommission the station by 2028 (and no later than 2030). Three of the six units at Grootvlei have already been placed into extended storage and a total of twelve (12) units between Grootvlei, Hendrina and Komati have been shut down prior to the 50 year life and put into extended storage and two into extended inoperability.

In terms of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) (NEMAQA), all of Eskom's coal and liquid fuel-fired power stations are required to meet the Minimum Emission Standards (MES) contained in GNR 893 (amended by GNR 1207 published on 31 October 2018) which was promulgated in terms of Section 21 of the NEMAQA[1]. GNR 1207 provides arrangements in respect of inter alia: a once off postponement with the compliance of minimum emissions for new plant for five years from the date of issue, no once off postponement will be valid beyond 31 March 2025; a once off suspension for plants being decommissioned by 31 March 2030; and that the National Air Quality Officer may grant an alternate emission limit or emission load if certain conditions are met. The application for any of these requests must be submitted by 31 March 2019. A postponement application was issued to Grootvlei in 2015 which is reflected in the stations current AEL, however with the amendment of the MES regulations in October 2018 it is necessary to submit this originally unplanned application for suspension of the NOx and SO_2 limits. Eskom has applied and received a condonation for the late submission of an application for Grootvlei until November 2019.
Grootvlei already achieves the 50 mg/Nm^3 Particulate Matter (PM_{10}) for 'new' MES limits. Grootvlei complies with the existing plant limit of 1100 mg/Nm^3 for nitrogen oxide (NO_X) and the existing plant limit of 3500 mg/Nm^{3}for sulphur dioxide (SO_2). However, Eskom's Grootvlei Power Station will not be able to comply with the 500 mg/Nm^3 'new plant' MES limit for sulphur dioxide (SO_2) and 750 mg/Nm^3 'new plant' MES limit for nitrogen oxides (NO_x). As Grootvlei will be decommissioned before 31 March 2030, Eskom is applying to the National Air Quality Officer for a once-off suspension of compliance timeframes with minimum emission standards for new plant limits for NOx and SO_2. Eskom proposes that Grootvlei should be required to comply with the minimum emission standards for new plant for PM and existing plant standards for SO_2 and NOx up until decommissioning (anticipated to be by 2028, and no later than 2030).

The purpose of this document is to present an application for the suspension of the requirement to meet the new plant compliance date and propose an alternative limit for Grootvlei as required in terms of GNR 1207. The document has been structured to present Eskom's atmospheric emissions reduction plan including the current decommissioning of units, the decommissioning plan and its influence on Eskom's emissions. Based on this application for suspension, emission limits to which Grootvlei could be held and which could then be included in the Atmospheric Emission Licence (AEL) are proposed. The legal basis for the suspension is then

[1] GNR 893 amended the "original: MES regulations GNR 893 which were promulgated on 22 November 2013 in terms of Section 21 of the NEMAQA

presented, including the requirements that must be met in making such an application. Finally, the reasons for the application for suspension are presented.

2 ESKOM'S EMISSION REDUCTION PLAN

Eskom considers that it is not practically feasible or beneficial for South Africa (when considering the full implications of compliance and planned decommissioning) to comply fully with the 'new plant' MES by the stipulated timeframes. This is elaborated on in the sections below. As a result, Eskom proposes to adopt a phased and prioritised approach to compliance with the MES. Highest emitting stations will be retrofitted first. Reduction of Particulate Matter (PM) emissions has been prioritised, as PM is considered to be the ambient pollutant of greatest concern in South Africa. In addition, Eskom proposes to reduce NO_x emissions at the three highest emitting stations. Kusile Power Station will be commissioned with abatement technology to achieve the new plant standards. Medupi is commissioned with abatement technology which can meet PM and NOx new plant standards and will be retrofitted with flue-gas desulphurisation (FGD) so that the new plant SO_2 limit will also be achieved over time. There are six power stations which will be decommissioned before 2030, an additional two by 2035 and the remaining existing plants (excluding Majuba, Medupi and Kusile) by 2044.

Emission reduction interventions to achieve compliance with the new plant emission limit are planned for the following stations:

- Particulate Matter emission reduction: Tutuka, Kriel, Matla and Duvha Units 4-6, Kendal and Lethabo;
- NO_x emission reduction: at Matla, Majuba, Tutuka, Camden; and
- SO_2 emission reduction: at Medupi and a pilot study which will confirm the appropriate technology for Matimba and Kendal.

Currently the Integrated Resource Plan 2019 is based on a general 50-year life for all coal fired power stations however the actual shut down and decommissioning dates of power stations are determined based on economic, technical and environmental criteria. For consistency in the Eskom MES applications the decommissioning dates as defined in the in the Eskom Consistent Data set (Eskom 36-623 rev 3) for planning have been used. To date, twelve (12) units between Grootvlei, Hendrina and Komati have been shut down prior to the 50 year life and put into extended storage and two into extended inoperability (at Eskom's most costly and oldest plants). The shutting down of these power plants reduces the cumulative emission load and pollution in Mpumalanga. The emissions load will continuously decrease ensuring that health impacts from Eskom's power stations will not increase.

The retrofits listed above are over and above the emission abatement technology which is already installed at Eskom's power stations, which is:

- Electrostatic Precipitators (ESPs) at Matimba, Kendal, Lethabo, Matla, Kriel, Tutuka, Komati, 3 of the 6 units at Duvha. In addition SO_3 injection plants have also been installed at those stations with ESPs, except Tutuka, to improve the efficacy of the same;
- Fabric Filter Plants (FFPs) at Majuba, Arnot, Hendrina, Camden, Grootvlei, Medupi, Kusile and 3 units at Duvha;
- Boilers with Low NO_x design at Kendal and Matimba;
- Low NO_x Burners (LNBs) at Medupi, Kusile, Ankerlig, Gourikwa, and some units at Camden; and
- Flue gas desulphurisation (FGD) at Kusile.

Eskom applied and was granted a first round of postponements between 2014 and 2015. Since then Eskom has updated its emission reduction plan to include the enhancement of existing particulate matter abatement technology currently installed at Kendal and Lethabo Power Stations.

Implementing the emission reduction plan and installing more efficient emission control technology will reduce Eskom's emissions. The decommissioning of the older stations (including Grootvlei) and an increased use of the newer less emitting Medupi, Kusile and the renewables, will also result in a substantial decrease in Eskom's and South Africa's emissions over time. For example it is projected that compared to a 2020 baseline that by 2035 Eskom's relative PM emissions will reduce by 58%, SO_2 by 66% and NO_x by 46%.

Eskom's proposed atmospheric emission reduction plan is estimated to cost R 67 billion over the next 10 years. The costs have been included in the latest Multi Year Price Determination tariff application and whilst Eskom's full application was not approved by NERSA it remains Eskom's intent to implement the plan described above. Eskom will continue to engage with NERSA through the prescribed processes so that Eskom can recover these costs through the tariff.

The retrofit schedule and projected emission reduction above clearly illustrates Eskom has been and remains committed to implementing emission reduction technologies to improve air quality in South Africa. Though there are delays in the implementation of the retrofit plan Eskom remains committed to ensuring these planned technology installations are completed. A detailed discussion on Eskom's emission reduction plan is provided in the Eskom Summary Document (Annexure 3).

3 GROOTVLEI REQUESTED EMISSION LIMITS

The current limits listed in Table 1 are as in Grootvlei's AEL (ref: Dipaleseng/Eskom H Soc Ltd GPS /0015/2019/F03 25 April 2019). The alternative emission limits that are requested for Grootvlei during normal operating conditions based on a suspension of the new plant limits for NO_x and SO_2 are also shown in Table 1.

Table 1: Current and requested limits for Grootvlei

	Current Limit (from AEL/MES)			Requested Emission Limits***		
	Limit value (mg/Nm^3)	Averaging period	Date to be achieved by	Limit value (mg/Nm^3)	Averaging period	Date to be achieved by
Stack 1 (Unit 1-3) PM	100	Daily	1 April 2018 to 31 March 2020	No Change - 50	Daily	1 April 2020
	50	Daily	1 April 2020 to 31 March 2025			
Stack 1 (Unit 1-3) SO_2	3500	Daily	Immediately	**3500**	**Daily**	**1 April 2020**
	3500	Daily	1 April 2020 to 31 March 2025			
Stack 1 (Unit 1-3) NOx	1100	Daily	Immediately	**1100**	**Daily**	**1 April 2020**
	1100	Daily	1 April 2020 to 31 March 2025			
Stack 2 (Unit 4-6) PM	100	Daily	1 April 2018 to 31 March 2020	No Change - 50	Daily	1 April 2020
	50	Daily	1 April 2020 to 31 March 2025			
Stack 2 (Unit 4-6) SO_2	3500	Daily	Immediately	**3500**	**Daily**	**1 April 2020**
	3500	Daily	1 April 2020 to 31 March 2025			
Stack 2 (Unit 4-6) NOx	1100	Daily	Immediately	**1100**	**Daily**	**1 April 2020**
	1100	Daily	1 April 2020 to 31 March 2025			

****The requested alternate emission limits above are in mg/Nm^3 at 273 K, 101.3 kPa, dry and 10% O_2.*

In summary, the application submitted for Grootvlei is:

(i) Suspension of compliance from the new plant MES NO_x limit (750 mg/Nm^3) and

(ii) Suspension of compliance from the new plant MES SO_2 limit (3500 mg/Nm^3); both until station decommissioning anticipated by 2028, and no later than 2030.

The station was retrofitted with Fabric Filter Bags and can comply with the MES new plant standard of 50 mg/Nm^3.

In terms of the existing license Grootvlei has until 1 April 2025 to comply with the new plant NO_x and SO_2 limit. It is therefore understood that the previously granted postponements of limits will remain in place until 2025 and thereafter until decommissioning based on this request for suspension. Practically an alternative daily limit of 1100 mg/Nm^3 for NO_x is requested and a daily limit of 3500 mg/Nm^3 for SO_2 both from 1 April 2000 until decommissioning anticipated by 2028, and no later than 2030.

Based on the remaining life of the Grootvlei power station, the techno-economics and cost benefits assessment any additional measures other than what was committed to above and the alternative emission limits requested are not financially viable.

It is requested that the alternative limits only apply during normal working conditions, and not during start-up or shut-down, upset conditions and maintenance periods.

4 LEGAL BASIS FOR DECISION-MAKING

4.1 Regulatory Requirements

In terms of Section 14(1) of the NEMAQA, the Minister of Environmental Affairs ("Minister") must designate an officer in the Department of Environmental Affairs (DEA) as the National Air Quality Officer. In this regard, Dr Thuli Khumalo has been designated by the Minister as the current National Air Quality Officer. Section 14(4)(b) of the NEMAQA provides that the National Air Quality Officer may delegate a power or assign a duty to an official in the service of his/her administration. It is our understanding that no such delegation has been made for the area of jurisdiction in which the power station is located. Accordingly, Eskom submits this Application to the National Air Quality Officer (NAQO).

In terms of Paragraph (12)(a) – (c) of GNR 893 of 22 November 2013 (the Regulations) as amended by GNR 1207 of October 2018, the application must include:

1. An air pollution impact assessment compiled in accordance with the regulations prescribing the format of an Atmospheric Impact Report (AIR) (as contemplated in Section 30 of the NEMAQA), by a person registered as a professional engineer or as a professional natural scientist in the appropriate category;
2. A detailed justification and reasons for the Application; and
3. A concluded public participation process undertaken as specified in the National Environmental Management Act and the Environmental Impact Assessment (EIA) Regulations made under section 24(5) of the afore mentioned Act.
4.

In respect of these requirements we have attached –

1. As Annexure A, a copy of the AIR prepared in respect of Grootvlei for the 2014 Postponement application. The AIR provides, *inter alia*, an assessment of how ambient air quality is likely to be affected by Grootvlei's requested emission limits by utilising, *inter alia*, atmospheric dispersion modelling. Eskom has appointed properly qualified consultants to prepare an updated AIR and will provide this to the NAQO when completed (anticipated to be May 2020). Eskom has completed a

cumulative air quality impact report for the Highveld which does include updated Grootvlei data and this is also attached (Annexure 1). Eskom believes the status of air quality around the station now is substantively similar to that in 2014 and as such the information presented is appropriate for decision making purposes.

2. Detailed justifications and reasons for the Application (see Section 5 below) and,
3. A comprehensive report on the public participation process followed, and associated documentation (Annexure 4.1 and 4.2). The public participation report deals with the overall Eskom 2019 MES application process but only phase 1 of the public participation process (comments on the Eskom 2018 MES postponement application Background Information Document) for Grootvlei as the public participation process for Grootvlei was halted in September 2018. The issues raised in the overall report will be a reflection of the issues relevant to Grootvlei, however Eskom will initiate a further round of public participation specific to Grootvlei which will be completed based on the updated AIR and a supplementary public participation report will be provided to the NAQA when this is available (anticipated May 2020).

4.2 Changes in Regulatory Framework

In October 2018 the 2017 National Framework for Air Quality Management in the Republic of South Africa and the Amendment to Listed Activities and Associated Minimum Emission Standards Identified in terms of Section 21 of NEMAQA were published. While Eskom and the independent consultants appointed to complete the cumulative AIR have made every effort to provide complete information, Eskom reserves the right to supplement the information if it deems appropriate or if requested to do so by the NAQO.

There was, prior to October 2018, no requirement for Eskom to complete an immediate application for Grootvlei as the station had a valid postponement decision until 2025. Eskom was unable to complete an application by the deadline of March 2019 and as such requested approval for the late submission of an application in March 2019. Approval to submit an application by November 2019 was granted to Eskom in October 2019 by the Minister of Environment, Forestry and Fisheries. Eskom has complied with this request and undertakes to submit an updated AIR and Public Participation report when these are available. It is Eskom's opinion that information submitted with this application does provide sufficient substantive information for the NAQO to make a decision in respect of the application submitted.

4.3 The Need to Amend the Variation Requests

In terms of timing, Eskom is required to submit an AEL variation request parallel to this application. The variation request is prepared based on the assumption that this application is granted by the NAQO. If the NAQO decision is substantially different from that applied for, Eskom reserves its right to amend its variation request. Eskom will complete the variation request for the Grootvlei application during the planned public participation exercise.

5 REASONS FOR APPLYING FOR SUSPENSION

As mentioned above, the application for suspension must be accompanied by reasons. Such reasons are set out below and include the fact that Grootvlei has a short remaining life; emissions from Grootvlei will not result in substantial additional non-compliance with National Ambient Air Quality Standards (NAAQS); together with a suite of undesired environmental consequences of compliance with the MES including associated water demands, transport impacts and increases in waste and carbon dioxide (CO_2) production. These undesired consequences together with the financial costs of compliance (such as an increase in the electricity tariff) must be weighed up against the benefits that will accrue as a result of compliance with the MES. It is Eskom's view that the benefit of compliance does not justify the non-financial and financial costs of compliance and as such the requested suspension and emission limits should be granted (see section 5.5 below for the details of the cost-benefit analysis completed, as well as Annexure 1).

None of these reasons should be seen as exclusive (i.e. it is not one reason alone that indicates full compliance to the MES is not appropriate) but rather all in combination. As set out in the Constitution of the Republic of South Africa, there is the need to recognise the interrelationship between the environment and development. There is a need to protect the environment, while simultaneously recognising the need for social and economic development. There is the need therefore to maintain the balance in the attainment of sustainable development.

5.1 Remaining Power Station Life

Grootvlei is currently scheduled to be decommissioned by 2028 and not later than 2030, according to the Integrated Resource Plan and the Eskom Consistent Data Set. Further, the station is shutting down operations between 2017 and 2021. To date three (3) of the six (6) units at the station have been shutdown and placed into extended preservation/storage.

Based on Eskom's experience at Medupi it is estimated that the time required for FGD development and construction would be 12 years (project development 4 years, commercial process 2 years and construction 6 years – one unit per year). Given these project timelines construction of FGD would be taking place simultaneously with the decommissioning of the station (assuming all other issues discussed below could be addressed) – an illogical arrangement. Grootvlei has a postponement from the SO_2 limit until 2025 and therefore will have already commenced with decommissioning prior to being required to retrofit.

5.2 Water Availability

Water is an extremely limited resource in South Africa and it is argued that the implementation of FGD at Grootvlei is not an appropriate decision for a water scarce country. Grootvlei Power Station being a predominantly wet-cooled power station means that it uses large quantities of water.

Both wet and semi-dry FGD are critically dependant on large quantities of water being available at the power stations where FGD is deployed. Recent investigations undertaken for Medupi indicate that the implementation of FGD will increase its water requirement to up to 9 Mm^3/annum. Wet FGD approximately triples the water consumption of a dry-cooled power station; semi-dry FGD more than doubles the water consumption of a dry-cooled power station (A wet cooled power station uses more than 10 times the amount of water of an equivalent dry-cooled power station. Typically 0.12 l/kWh for dry cooled to 2 l/kWh for wet cooled). Retrofitting Grootvlei with FGD would require an additional 3.3 million m^3/annum water for a wet system and an additional 1.4 million m^3/annum water for a semi-dry system.

The water demands of FGD are thus significant across the power stations and will increase Eskom's water demand by some 59 million m^3/annum – a 20% increase in the combined water consumption of Eskom's power stations[2].

The total water demands in the Integrated Vaal River Catchments presently exceed the water availability in the catchment until Phase 2A of the Lesotho Highlands Water Project (LHWP) is implemented. The projected completion date of Phase 2A of the LHWP now being beyond 2026. The water supply deficit is expected to grow with the growing urban demand in the greater Gauteng area. It is unlikely that DWS will license new major demands in this system until then. Thus far all efforts by DWS to reduce demand in the Vaal River system have

[2] **Assuming that wet FGD is installed on the 5 newest stations excluding Kusile, and semi-dry FGD is installed on the rest of the coal-fired fleet, excluding stations which will be decommissioned by 2030. The October amendment of the MES for SO_2 new plant to 1000 mg/Nm^3 will require a revision of technology choices.*

been delayed or ineffective. Rand Water for example are requesting an increase in its water license volume to cater for the additional demand and DWS have refused thus far as there is no water available in the Vaal System.

Eskom has a combined water licence of 360 million m^3/annum from the Vaal River Eastern Subsystem to generate electricity (licensed to Oct. 2025 when it will get reviewed). Some of Eskom's older power stations are expected to be decommissioned within the next 5 to 10 years but that does not significantly contribute to reducing the shortages in the Vaal River System as the declining demand for Eskom's water use is already taken into account in the annual operating analysis. Eskom will not be able to re-allocate its water allocation to FGD as a relinquishing of our licenced volume goes back to DWS to determine whom would be the best user for the water being made available.

Beyond 2026 when LHWP 2 comes into operation it is possible that water is available for retrofits to the current fleet supplied from the Vaal System.

The argument is also not just one of having water available in the catchment, it is also one of determining whether FGD is a judicious use of what is an extremely scarce resource in South Africa in the face of multiple competing demands for that same resource. Especially since more than 95% of South Africa's available water has already been allocated.

5.3 Environmental Implications of FGD

Assuming FGD was required for Grootvlei, which is as said impractical; FGD is not without negative environmental consequences:

- Up to 360 000 tons of sorbent (limestone) per annum is required to operate the FGD at Grootvlei. The main source of sorbent is the Northern Cape, so the sorbent would need to be transported over hundreds of kilometres, preferably by rail or otherwise by road. The transport of the sorbent would result in environmental impacts, notably greenhouse gas emissions, and fugitive dust emissions. An increase in truck traffic would also result in an increase in driver mortalities, as has been observed in association with coal transport in Mpumalanga.
- Up to 420 000 tons of gypsum will be produced per annum as a by-product of the FGD process. If a high quality limestone is used, a high quality gypsum can be produced by wet FGD, and this could be taken up by the market for e.g. wallboard production. Lower grade gypsum can also be used for agricultural purposes. However, if there is not sufficient demand from the market, the gypsum will need to be disposed of in which case it would need to be managed carefully to ensure that there are no impacts on groundwater or air quality (from fugitive dust emissions).
- Grootvlei is expected to produce an additional approximately 115 000 tons of CO_2 per annum, as the wet FGD process directly produces CO_2 as a by-product through the reaction: $SO_2 + CaCO_3 \rightarrow CaSO_4 + CO_2$. In addition, the electricity output of Grootvlei would be reduced by around 1% due to the additional auxiliary power requirements of the FGD, and correspondingly the relative CO_2 emissions would increase by 1%.

5.4 Grootvlei Impact on Ambient Air Quality

Ambient air quality monitoring data from Eskom's Grootvlei monitoring station was analyzed for the period 01 January 2016 – 31 December 2018. The results show that both hourly SO_2 and NO_2 concentrations were well within the standards at this monitoring site. However, there was non-compliance with the daily standard for SO_2 in 2017. In addition, daily PM2.5 concentrations were in compliance with the standard in 2016 and 2018. Furthermore, PM10 concentrations were in non-compliance with the daily standard in 2018. However, previous dispersion modelling studies have shown that the contribution of emissions from Grootvlei Power Station to the

SO_2 and PM10 concentrations monitored at Grootvlei monitoring site and the surrounding areas is well below all the standards for both SO_2 and PM10. Analysis of the pollution roses for both SO_2 and PM10 show that there are other low-level and elevated sources contributing significantly to the ambient concentrations of these air pollutants.

5.4.1 Particulate Matter

Daily PM2.5 concentrations frequently exceeded the limit value in 2016 and 2018, while PM10 exceeded a limit in 2018. The diurnal variation in PM10 concentrations clearly show that both low-level and elevated sources contribute to elevated particulate concentrations recorded at the Grootvlei monitoring site, with small peaks in the early morning and evening and a pronounced peak in the afternoon. Although the diurnal variation in PM10 concentrations show that both elevated and low-level sources contribute to elevated concentrations of PM10 measured over the period 01 January 2016 – 31 December 2018, the modelling results have shown that the contribution of Grootvlei Power Station to such concentrations is well below both the daily and annual average limit values.

5.4.2 Sulphur Dioxide

Hourly SO_2 concentrations frequently exceeded the limit value at Grootvlei monitoring station. However, such exceedances were within the permissible number of exceedances. Daily SO_2 concentrations exceeded the limit value frequently. As a consequence, the daily standard for SO_2 was violated in 2017. Diurnal variation in SO_2 concentrations shows a clear peak at midday at the aforementioned monitoring station. This is associated with emissions from elevated sources such as power station tall stacks. However, previous atmospheric dispersion modelling studies have shown that emissions from Grootvlei Power Station do not lead to non-compliance with hourly, daily or annual average standards for SO_2.

5.4.3 Nitrogen Oxides

No exceedances of the hourly standard for NO_2 were recorded at the Grootvlei ambient air quality monitoring site during the period of analysis (i.e. 01 January 2016 – 31 December 2018). Diurnal variations in the NO_2 concentrations clearly show an early-morning and late-evening peaks. This shows that low-level sources such as vehicular emissions are the main contributors to ambient concentrations of NO_2 at the above-mentioned monitoring station. Similar to the SO_2, previous atmospheric dispersion modelling results have shown that emissions from Grootvlei result in ambient NO_2 concentrations that are well below the limit values (i.e. both the hourly and annual average standards).

5.4.4 The Highveld Priority Area

Eskom is aware that Grootvlei is situated within the Highveld Priority Area and is, as such has implemented substantial financial investment into reducing particulate emissions from Grootvlei's operations, through the retrofitting of the station with Fabric Filter Plants (FFP). Grootvlei thus already achieves the new plant emission standard for PM. However due to Grootvlei power station's short remaining life, with some 3 of 6 units already shut down for reserve storage and with final decommissioning anticipated to be by 2028 (and no later than 2030) in terms of the IRP there are no plans to upgrade any additional pollution abatement.

5.4.5 Cumulative Assessment of Requested Emission Limits in the Northern Highveld

In addition to the individual AIR completed for each power station, an air quality report, considering the cumulative impact of the Eskom stations including Grootvlei over the HPA was completed (Annexure 1). The analysis included three scenarios; which considered (1) the actual emissions, (2) emissions if the MES was complied with and (3) emissions if six power stations are decommissioned by 2030. The general conclusions of the analysis indicate that the quality of air will be in compliance with NO_2 National Air Quality Standards (NAAQS), but noncompliance with the daily and annual SO_2 standards in several areas across the Highveld. Daily and annual average PM_{10} and $PM_{2.5}$ concentrations could be in noncompliance and for extended periods

of time. The effect of the above is that PM ambient levels currently result in increased health risk for a large part of the Highveld.

Dispersion modelling results based on individual and combined power station emissions, excluding all other sources; indicate a negligible contribution to PM pollution. In addition the diurnal pattern in PM concentrations based on monitored ambient data clearly indicate a morning and early evening peaks, typical of low level source contributions. However, a combination of SO_2 and NO_x emissions from all the Highveld power stations is predicted to form a significant component of the $PM_{2.5}$ load especially over Emalahleni area, which is in noncompliance with PM standards, is a cause for concern.

In addition, the combined SO_2 emissions from all Eskom power stations are predicted to contribute a significant amount to the pollution in and around the Emalahleni and Middelburg areas and even extending south towards Komati Power Station. However analysis indicates that the non-compliance is not only due to Eskom Power Stations but a function of a multitude of sources in the Highveld.

The dispersion modelling and ambient air quality monitoring data indicate that the elevated pollution levels in the Highveld require a holistic approach, addressing all identified and potential sources. Therefore, a single approach, targeted at only eliminating Eskom power station emissions will not result in acceptable ambient air quality levels that are not harmful to human health and the environment.

5.5 Cost Implications of Compliance with the MES

The financial implications of compliance to the MES, most especially the financial implications of compelling existing plants to comply with 'new plant' standards is presented below.

5.5.1 Direct Financial Costs

Eskom estimates that the CAPEX cost of full compliance with the MES at all Eskom's power stations is greater than R187 billion in 2018 real terms (excluding financing costs), and that annual OPEX costs are at least R5 billion per annum. This includes the costs for emission control for the entire existing fleet and flue gas desulphurisation at Medupi. Medupi's other emission abatement costs and all emission abatement costs for Kusile have been excluded from these totals because they have already been incorporated into the Medupi and Kusile projects. These costs are considered to be accurate to a factor of two.

The breakdown of the CAPEX costs is as follows:

- SO_2 emission reduction by FGD is estimated to cost R 140 – 175 billion. The estimated cost assumes R 15 - 26 billion per power station dependent on installed capacity and wet or dry FGD technology. It is taken that wet FGD is implemented on Medupi, Majuba, Matimba, Kendal, and Tutuka, (power stations being decommissioned after 2035) and that semi-dry FGD is implemented on Duvha, Lethabo and Matla (stations decommissioned between 2030 and 2035). For the tariff impact calculation an amount of R150 billion is used.
- NO_x emission reduction by the most appropriate technology is estimated to cost between R10 and R40 billion for all power stations. This includes Low NO_x Burner retrofits at stations which need them, and burner optimisations at others. For the tariff impact calculation an amount of R20 billion is used.
- Particulate Matter emission reduction by FFP retrofits is estimated to cost between R15 and R40 billion. For the tariff impact calculation an amount of R40 billion is used.

Full compliance with the MES at Grootvlei would require a FGD retrofit, which is the only way of supporting compliance to the new plant SO_2 emission limit, in excess of R10 billion and a LNB retrofit estimated to cost in excess of R1 billion Rands.

The CAPEX cost estimates were derived as follows:

- FGD: Costs for existing stations are based on a study done by EON Engineering for all Eskom's power stations in 2006, adding on provisions for balance of plant considerations and owner's development costs, and inflated to 2013 costs. Costs are considered to be accurate to a factor of 2. Costs for Medupi are according to the Concept Design Report, and are considered to be accurate to within 20%.
- Low NO_x Burners and/or Overfired Air: Costs are based on International Energy Agency (2006) costs, escalated for inflation, rate of exchange and Owner Development Costs. Costs are considered to be accurate to a factor of two.
- FFPs: Costs are based on actual tender prices for an enquiry for FFP retrofits at Matla and Duvha in 2011/12. Costs are considered to be accurate to 40% for Tutuka, Matla, Duvha and Grootvlei and to approximately a factor of two for other power stations.

The OPEX costs are only for flue gas desulphurisation, and are also based on costs in the EON Engineering report for the existing fleet, and on costs in the Medupi Concept Report for Medupi. Again, the OPEX costs do not include OPEX for Kusile. The main cost items are the sorbent (limestone), water, gypsum disposal, auxiliary power and maintenance costs. For the tariff impact calculation an amount of R6.3bn per annum is used.

The certainty with which Eskom presents costs depends on the stage of the project. Before concept release approval, costs are based on averages of published international data and benchmarks for similar technologies, and so are considered to be accurate to a factor of two. Once the conceptual designs have been done, costs are generally accurate to within 50%. Once the detailed designs are completed, costs are considered to be accurate to within 20%. Once the contracts have been placed, costs are considered to be accurate to within 10%. Eskom also has to factor in to the costs the national prerogatives of localization, industrialisation, local market maturity & competitiveness, efficiency, financing etc in the determination of the total project costing. There is only complete certainty about the costs once the contract has been completed.

5.5.2 Electricity Tariff Implications

The electricity tariff is the mechanism through which the cost of producing electricity is recovered from the consumers thereof. The cost of compliance with the MES would be part of the inherent cost of production of electricity in future. Eskom has estimated that full compliance with the MES by 2020 would require the electricity tariff to be on average between 7 and 10% higher than what it would be in the absence of the emission abatement retrofits, over a 20-year period. The different between the base tariff and the tariff including the costs of MES compliance would be slightly higher (than the mentioned average) in the earlier years and slightly lower than the mentioned average in the later years. The implications for the tariff are of course dependent on when the emission abatement retrofits are installed, and what assumptions are used for interest and inflation rates and future base electricity tariffs.

This tariff calculation is based on the following assumptions:

- The CAPEX and OPEX costs are the mid-point amounts as provided above.
- The CAPEX costs are incurred in 2020, and fully implemented over a period of up to six years (with a shorter period resulting in the higher %, in the range mentioned above).
- The average remaining power station life is 20 years, thus the CAPEX costs for the retrofits are depreciated over a 20-year period.
- The inflation rate is 6%.
- Nominal pre-tax cost of capital is 14%.
- Cost-reflective electricity tariffs are reached within five years after the Multi Year Pricing Determination 4 (MYPD4) electricity tariff agreement (from 2018-20).

The electricity tariff is applied for by Eskom, but decided on by the National Electricity Regulator of South Africa (NERSA). Eskom has included the CAPEX required to cover the proposed emission reduction plan with an estimated cost of R 67 billion over the next 10 years, it is covered in the MYPD4 application (for costs over the next 3 years). If there is a requirement for additional retrofits based on the DEA response to this application, these costs would need to be provided for through the tariff (i.e. opex recovered annually, capex recovered over the operational life of the assets), failing which Eskom's financial health will further deteriorate and the ability to raise funding for these projects would be limited. The original assumptions however, are still at risk. The Eskom requested electricity price increase of 15% per annum was not approved by NERSA on 7 March 2019, and Eskom will now have to further prioritise its operations which may require amendment to the Emission Reduction Plan. In addition, Eskom has not reached a level where it is recovering its efficient and prudent costs (even at the end of the MYPD 4 period if the 15% increase is approved).

5.5.3 Cost Benefit Analysis

The basis of the assessments of the impact of power stations emissions on human health and the environment is a comparison of the measured and predicted air quality concentrations with the NAAQS. Stakeholders have argued correctly that the NAAQS cannot be interpreted to imply no health risk at all but the counter argument is that the NAAQS express a 'permissible' level of risk. To manage air quality to a point that it is completely free of risk is to invoke such significant financial and non-financial costs that those costs will in themselves result in severe potential economic and social consequences. In these terms it is necessary to present here some perspectives on the cost-benefit of full MES compliance. (Further detail is provided in the Health Impact Focused Cost Benefit Analysis document, Annexure 1).

In the 2017 National Air Quality Framework for Air Quality Management provision is made for suspensions and alternative emission limits due to the potential economic implications of emission standards on existing plant. The provision is provided because a sector specific Cost Benefit Analysis (CBA) was not completed prior to setting standards. Eskom commissioned a health impact focussed CBA to support the decision making process for this application. The aim of the CBA was to determine the health costs associated with current emissions, health benefits associated with compliance to the new MES, and the direct and indirect costs of compliance under the scenarios tested. The CBA followed the approach recommended by the World Health Organisation (WHO) and it used input provided by the South African Medical Research Council (SAMRC).

Health benefits associated with each scenario were calculated against the baseline that assumed no new abatement technologies would be installed, and all plants would continue to emit air pollution at their current rates until decommissioning. Scenario costs were calculated using Eskom's estimates of abatement technology capital and operational spending requirements.

The scenarios evaluated in the study (against the baseline) included:

1. Full compliance with new plant standards (FC) (Scenario 1 (Sc1))
2. Eskom Emission Reduction Plan (ERP) (Scenario 2 (S2))
3. ERP + FGD at Kendal (Scenario 3 (S3))
4. ERP + Early decommissioning (ED) of Komati, Hendrina and Grootvlei (Scenario 4 (S4))

Scenarios were then compared in a cost-benefit analysis with a cost-benefit ratio, in terms of which a number greater than 1 indicates that the costs outweigh the benefits, and a number less than 1 indicates that the benefits outweigh the costs. The CBA ratios need to be interpreted with care. They are meant only to provide a perspective on and inform the decision-making process underlying the scenarios (See table 2). It is further to be noted that the cost benefit ratios were assessed using different discount rates (8.4%, 1% and -1%) and the order of the scenarios as measured by cost benefit ratio remained the same for all discount rates.

Table 2: Cost and benefits Net Present Value estimates for each scenario and cost:benefit range

	FC (S1)		ERP (S2)		ERP+FGD (S3)		ERP+ED (S4)	
Million Rands	*lower*	*upper*	*lower*	*upper*	*Lower*	*upper*	*lower*	*upper*
NPV of Costs	-43 369	-65 053	-16 923	-25 385	-21 205	-31 808	-16 923	-25 385
NPV of benefits	2 403	21 625	1 962	17 661	2 252	20 264	3 374	30 367
NPV of Benefits minus Costs	-40 966	-43 428	-14 961	-7 724	-18 954	-11 544	-13 549	4 982
Cost:Benefit Ratio *(range)*	18.0	3.0	8.6	1.4	9.4	1.6	5.0	0.8
Cost:Benefit Ratio *(central)*	4.5		2.2		2.4		1.3	

The modelling shows the early decommissioning of the coal-fired power stations assessed in S4 ERP+ED (implementation of the ERP and early decommissioning of Grootvlei, Hendrina and Komati), would have a significantly larger beneficial effect on health costs than abatement technologies alone. This plays a large role in positioning Scenario 4 as the most beneficial scenario, both in terms of largest health cost benefits, lowest cost of abatement, as well as relative cost:benefit ratio.

While S1 FC (full compliance to the MES) would eventually have the most absolute benefits, the uncertainty of the effectiveness of actual emission reduction (even if Eskom complies with the MES ambient concentrations will remain high due the significance of other sources) as well as the long implementation timeframe mean that Net Present Value (NPV) of benefits values are reduced.

Implementation of the Eskom Emission Reduction Plan (S2 – ERP) is shown to be more beneficial from a cost benefit perspective than implementation of the ERP with the addition of FGD at Kendal (S3) and full compliance to the MES (S1).

In addition it should be noted that increased implementation of the PM reduction technology will inflate the cost of electricity, making it more unaffordable to poor communities who are typically exposed to elevated PM10 concentrations thereby curtailing access to one of the most potentially effective means of mitigating the current health risk. In cost-benefit terms the financial cost will result in no real benefit and the financial cost will bring about potentially material negative social consequences in further hindering access to electricity.

In respect of SO_2 emissions the cost-benefit is more difficult to qualify. Although the risk of non-compliance with the NAAQS is generally low, stakeholders have presented that it is 'unacceptable to allow the continued emissions of large quantities of SO_2'. In principle this comment is accepted but again the argument is one of weighing up both the financial and non-financial costs of reducing those emissions. The argument has already been made that the water use implications of SO_2 control are untenable and that the cost benefit ratio does not support FGD as the best option to reduce the impact on health.

No argument is presented anywhere in these applications that reducing atmospheric emissions is not required. The argument is simply one of ensuring that emissions reductions are carefully planned and phased so that the associated cost-benefit is positive. A key consideration is that half of the existing Eskom power stations will be shut down and decommissioned in the next 10 – 15 years significantly reducing the emissions. The planned offset project which will reduce low level emissions in communities in the vicinity of Eskom power station has not been studied long enough to conclusively provide cost benefit. However initial assessment indicates a significant reduction in exposure to indoor air pollution. In cases where solid fuel stoves are removed and replaced with LPG equipment (and in the absence of regression), the particulate matter emissions are avoided completely. Focussing on coal only and taking the annualised coal use of 1206kg per household (control group mean, 2016) – the resulting PM emissions that can be avoided are 14.48kg of PM2.5 per year per household and 15.57kg of PM10 per year per household.

5.6 Project Planning and Delays

Emission retrofit of the type being planned require years of planning, which precede a lengthy installation process, as well as substantial capital funding and power station down-time. The planning process involves Eskom internal processes that allow for technology concept and -design approval after which significant funds need to be allocated to the project. Being a state owned entity, government approval for projects of such a nature is also required which lead to the additional project development time-lines. Contracts to commence the project are only put in place once carefully regulated commercial processes have been completed.

Over and above the aforementioned milestones, the actual commencement of the installation of the abatement technology at a unit needs to be carefully scheduled to fit into a six-month unit outage time, which is usually planned alternatingly for each unit (i.e. one unit per year) as part of an official longer term outage schedule. Once a unit is taken down for maintenance, it is not operational, and thus does not contribute power to the grid. Unit down-time needs to take into account fleet generation capacity and can only take place, if Eskom is sure the country's energy demands can be met. Once the pollutant specific abatement technology has been installed, it takes months for the relevant technology to function optimally (optimisation period), as test-runs and assessments take place to ensure the equipment functions to its design capacity (in this case for NOx and PM to meet 'new plant' emission standards). The optimisation period for FFPs is typically 9 months and the optimisation period for LNBs can typically take up to a year, emphasising that abatement technology installation completion does not automatically signify immediate full compliance.

The process to implement projects such as the emission retrofit projects is complex and there is a continual risk of delays affecting planned project completion dates. Notwithstanding implementing controls to reduce project delays such as high level project oversight and attempts to ensure the commercial processes are completed within reasonable timelines some of the retrofit projects have been subject to delays.

In terms of the 2014 postponement application, it was intended to install FFP at Grootvlei and this technology was installed, ahead of schedule, by 2017. There were no further emission reduction projects planned for Grootvlei in the past 5 years and as such no delays in implementation of station specific commitments have been experienced there.

A review of the process described above clearly illustrates that given the station is already mostly shutdown and will be decommissioned by no later than 2030, it is practically inappropriate to attempt further retrofits at Grootvlei.

6 PUBLIC PARTICIPATION

The requirement that the public participation process for this application partially follows the process specified in the NEMA Environmental Impact Assessment (EIA) Regulations. Eskom supports and aligns its public participation process with the requirements as stipulated within the NEMA EIA Regulations. The public participation process followed for this application has increased the number of public meetings to include communities in the vicinity of the power stations. In the case of Grootvlei meetings took place in the towns of Balfour and Grootvlei both close to the station. The public participation report (Annexure 4.1 and 4.2) deals with the overall Eskom 2019 application process but only phase 1 of the public participation process (comments on the Eskom 2018 MES postponement application Background Information Document) for Grootvlei as the public participation process for Grootvlei was halted in September 2018. The issues raised in the overall report will be a reflection of the issues relevant to the station however, Eskom will initiate a further round of public participation specific to Grootvlei when the updated AIR is available and a supplementary public participation report will be provided to the NAQA when this is available (anticipated May 2020).

An AEL variation request, which will be submitted, will be subject to a public participation process that meets the requirements of Section 46 of NEMAQA.

7 EMISSION OFFSETS

Eskom is willing to implement emission offsets in areas where power stations impact significantly on ambient air quality, and where there is non-compliance with ambient air quality standards as a condition of an approved postponement. Eskom is of the view that in many cases household emission offsets are a more effective way of reducing human exposure to harmful levels of air pollution, than is retrofitting power stations with emission abatement technology. Emission retrofits at power stations also increase the cost of electricity, which may make electricity unaffordable for more people, resulting in an increase in the domestic use of fuels and a deterioration in air quality in low income areas.

Eskom has undertaken several feasibility and pilot studies (2011 – 2018) in KwaZamokuhle, a township near Hendrina Power Station to identify and test potential offset interventions. Based on the results of the studies conducted to date, it was concluded that ambient air quality in the affected communities could be improved by replacing household's coal stoves with a hybrid gas electricity stoves and a LPG heater together with retrofitting the houses with a ceiling to insulate the houses.

The recommended Air Quality Offset intervention for the lead implementation (in KwaZamokuhle and Ezamokuhle) entails the following (Figure 2);

- **Provision of a basic plus retrofit which consists of:**
    - Insulation entailing installation of a SPF ceiling system and draft proofing
    - Electrical rewiring and issuance of Certificate of Competence (CoC).
- **Stove swap which entails:**
    - Provision of electricity based energy source with LPG backup. This will include a hybrid electric gas stove, LPG heater plus 2x9 kg LPG cylinders and Compact fluorescent lamp (CFL) for energy efficiency lighting.
    - Removal and disposal of the coal stove

Figure 1: Household Intervention for Lead Implementation Sites (KwaZamokuhle and Ezamokuhle)

The lead implementation in KwaZamokuhle and Ezamokuhle is planned to commence in 2019. The large scale rollout of offset intervention is planned for 2020 to 2025.

8 CONCLUSIONS

Eskom is committed to ensuring that it manages and operates its coal-fired power stations in such a manner that risks to the environment and human health are minimised. As set out in the Constitution of the Republic of South Africa, there is the need to recognise the interrelationship between the environment and development. There is a need to protect the environment, while simultaneously recognising the need for social and economic development. There is the need therefore to maintain the balance in the attainment of sustainable development.

Grootvlei will be decommissioned by no later than 2030, with three (3) of six (6) units already shutdown. Given this time frame it is not practically possible to install FGD on the station before decommissioning. In addition compliance with the new plant MES for SO_2 will result in additional environmental impacts in terms of water demand, increases in CO_2 emissions and waste production, and significant financial costs. The financial costs of compliance with the new plant MES will translate into an increase in the electricity tariff. If air quality is to be improved in surrounding residential areas then interventions should be geared towards limiting low-level (surface) emission sources of especially PM.

The Eskom Emission Reduction Plan will lead to a reduction in total emissions from several power stations specifically particulate emissions. Further six power stations (including Grootvlei) will be decommissioned by 2030 reducing the total load of all emissions in each of the three air sheds applicable to this application.

The impact of Grootvlei's emissions on ambient air quality has been comprehensively assessed previously and as part of the Summary air quality assessment and an updated AIR will be provided by May 2020. Ambient air quality monitoring data from Eskom's Grootvlei monitoring station was analyzed for the period 01 January 2016 – 31 December 2018. The results show that both hourly SO_2 and NO_2 concentrations were well within the standards at this monitoring site. However, there was non-compliance with the daily standard for SO_2 in 2017. In addition, daily PM2.5 concentrations were in compliance with the standard in 2016 and 2018. Furthermore, PM10 concentrations were in non-compliance with the daily standard in 2018. However, previous dispersion modelling studies have shown that the contribution of emissions from Grootvlei Power Station to the SO_2 and PM10 concentrations monitored at Grootvlei monitoring site and the surrounding areas is well below all the standards for both SO_2 and PM10. Analysis of the pollution roses for both SO_2 and PM10 show that there are other low-level and elevated sources contributing significantly to the ambient concentrations of these air pollutants.

The Air Quality offset programme initiated by Eskom will continue to be implemented, based on current information Eskom believes this programme will reduce direct exposure to harmful indoor pollution and improve the quality of life.

Eskom has complied with the requirement to submit this application by November 2019 but intends to supplement the application with an updated AIR and public participation report.

Eskom believes given the motivation presented above in terms of Grootvlei already complying with the new plant emission standards for PM, its shutdown and decommissioning plan, Eskom's complete emission reduction plan and its implications and the specific detail in respect of Grootvlei, that the application for the suspension is appropriate and in line with the relevant Constitutional, regulatory and policy requirements and as such the application should be approved by the NAQO.