Eskom	**Eskom Air Quality Offset Plans:** **Progress Report March 2019**	**Sustainability Division: Environmental Management**

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1. INTRODUCTION

The Air Emissions Licenses (AEL) for Eskom power stations in the Nkangala District Municipality (Hendrina, Arnot, Komati, Kriel, Matla, Kendal and Duvha), Gert Sibande District Municipality (Majuba, Tutuka, Camden and Grootvlei) and Fezile Dabi (Lethabo) requires that each of the Eskom power stations implement an Emissions Offset Programme to reduce Particulate Matter (PM) in the ambient environment. The AELs' requirements is similar to a condition in the National Air Quality Officer's decision (February 2015) on Eskom's power stations' application for postponement of the compliance timeframes with the National Environmental Management: Air Quality Act (Act No 39 of 2004) section 21 Minimum Emission Standards, which states that each power station is '*to implement an offset programme to reduce PM in the ambient/receiving environment. A definite offset implementation plan is expected from Eskom by 31 March 2016.*'

Air quality offsets address emission sources within vulnerable communities in the vicinity of Eskom's coal-fired power stations in the relevant district municipalities, targeting greater improvement in community experienced air quality than is achievable from other approaches. The Air Quality Offset Implementation Plans covers the period from April 2016 to March 2025.

Eskom's Air Quality Offset Implementation Plans for Nkangala District Municipality, Gert Sibande District Municipality and Lethabo Power Station were submitted to the National Air Quality Officer and the relevant Atmospheric Emission Licensing Authorities on the 28 April 2016 (ENV16_R016, ENV16_R017 and ENV16_R018). Updated plans were submitted to Authorities in April 2019 (ENV19_R058, ENV19_R059 and ENV19_R060). The plans detail the proposed offset interventions per selected settlement. It also details the approach followed in selecting settlements; selecting, designing and implementing interventions; and assessing the effectiveness of the interventions. The plans were approved by the National Air Quality Officer in concurrence with the relevant Atmospheric Emission Licencing Authorities on the 16 September 2016.

As a condition of the approval, Eskom is required to "*implement the air quality offsets according to the approved plans*" and to submit an annual progress report to the "*National Air Quality Officer and the relevant Atmospheric Emission Licensing Authorities for the duration of the implementation*".

The purpose of this report is to provide feedback on progress made in the implementation of the Air Quality Offset Plans in the applicable district municipality during the period: 01 April 2017 to 31 March 2018.

2. PHASED APPROACH

Air quality offsets is an emerging field, and interventions of the type and scale contemplated in this document have not been implemented before. Accordingly, a phased approach is adopted to increase probability of success and to ensure that learnings from early phases are incorporated into the large scale roll-out. The phased approach entails the following:

- *Phase 0: Pilot project*. An intervention is tested on a small scale to discover practically what works.
- *Phase 1:* The intervention is tested on an entire community to see how best to scale up an initiative. The lead implementation is designed to benefit the specific local community, minimize implementation risk, increase practical and scientific knowledge, and develop and refine monitoring, reporting and verification processes.
- *Phase 2: Full implementation* (balance of qualifying households in bigger settlements). Once the intervention has been refined and the learnings of the lead implementation incorporated, the intervention will be rolled out simultaneously at several large communities across the three district municipalities and selected areas in the Vaal.
- Phase 3 *Full implementation* (balance of qualifying households in smaller settlements). Once the intervention has been refined and the learnings of the lead implementation incorporated, the intervention will be rolled out simultaneously at several small communities the three district municipalities and selected areas in the Vaal.

A typical offset implementation (lead or full) in a community will have three phases: baseline establishment; implementation; and monitoring and verification (see figure 1 below).

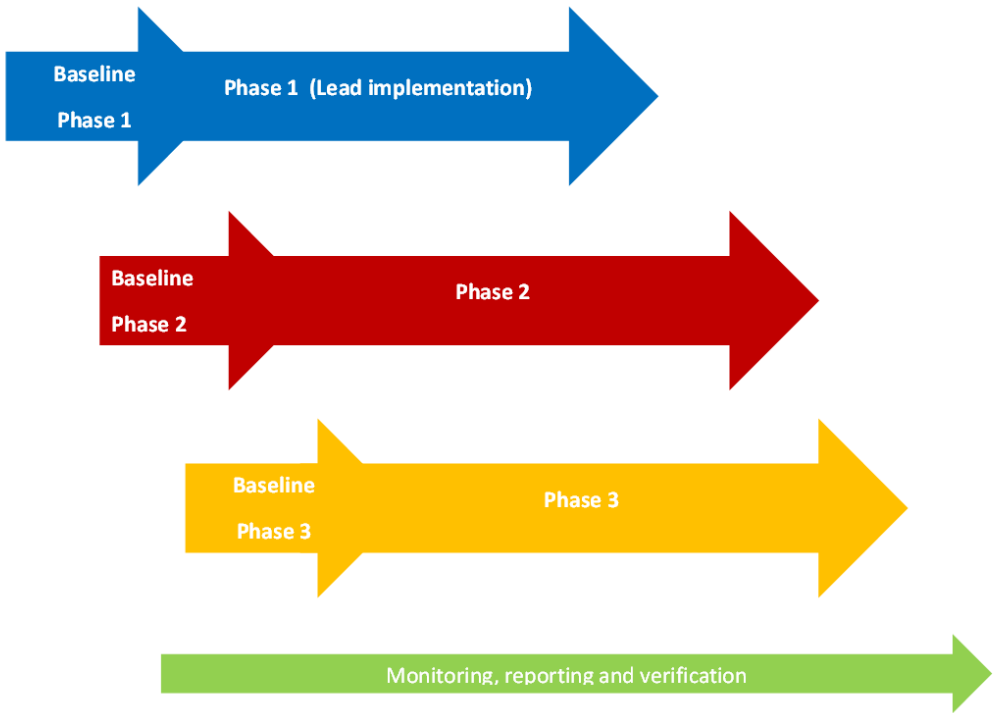

Figure 1: Concept schedule for the implementation of air quality offsets

2.1 PROGRESS FROM APRIL 2018 TO MARCH 2019

The roll-out of interventions in Phase 1 in KwaZamokuhle, Ezamokhule and Sharpeville (lead implementation) was initially planned to start in January 2018. There has been a delay of about 10 months due to amongst other things; finalising the design of the offset interventions, obtaining board approval and procurement of the required services to execute the plan. Phase 1 implementation is now planned to commence in October 2019.

The following were achieved from April 2018 to March 2019:

- Obtained board approval for implementation of Phase 1 of the Air quality Offsets programme.
- Finalised the scopes work for the various packages for Phase 1
- Initiated the procurement process to acquire services required to implement Phase 1 plans.
- Eskom has been actively engaging its stakeholders on air quality offsets implementation plans (refer to section 6 for more details)
- Engaged with internal Eskom stakeholder at Hendrina, Majuba and Lethabo power stations.
- Conducted rapid assessments at Phola, Emzimnoni, Sivukile, Silobela, Wesselton and Masakhane,
- Monitoring has been installed in KwaZamokuhle, Ezamokuhle, Phola, Thubelihle and Sharpeville (DEA site). Eskom is busy rolling out monitoring sites at Ezimnoni, Silobela, Masakhane and Sivukile,
- Developed proposals for offset interventions in Sharpeville.
- A contract has been put in place with the Medical Research Council (MRC) to determine the health impacts of the air quality offsets in KwaZamokuhle and Emzimnoni.

2.2 PROGRESS SINCE INCEPTION OF AIR QUALITY OFFSET PROGRAMME

Table 1 provides a summary of progress made in implementing Eskom Air Quality Offset Plans in Nkangala District Municipality, Gert Sibande District Municipality and for Lethabo Power Station since the inception of the Air Quality Offset programme. Details are outlined in section 3 to 5.

Table 1: Summary of progress made in implementing Air Quality Offset Plans

Phase	Activities	Nkangala	Gert Sibande	Lethabo
0	Pre-feasibility study	√	√	×
	Pilot project	√	√	×
1	High level plan	√	√	√
	Authority approvals	√	√	√

	Budget approvals	√	√	√
	Baseline monitoring for lead	√	√	√
	Implementation of phase 1 (lead)	×	×	×
	Monitoring and verification	×	×	×
2	High level plan	√	√	√
	Authority approvals	√	√	√
	Budget approvals	×	×	×
	Baseline monitoring for phase 2	×	×	×
	Implementation of phase 2	×	×	×
	Monitoring and verification	×	×	×
3	High level plan	√	√	√
	Authority approvals	√	√	√
	Budget approvals	×	×	×
	Baseline monitoring for phase 3	×	×	×
	Implementation of phase 3	×	×	×
	Monitoring and verification	×	×	×

3. IMPLEMENTATION OF AIR QUALITY OFFSETS PLAN: NKANGALA DISTRICT MUNICIPALITY

Eskom has completed a prefeasibility and pilot studies (phase 0), and have developed a high level plan and obtained approval of the plans from the authorities (Department of Environmental Affairs). The budget for phase 1 (which includes KwaZamokule) has been approved. Baseline monitoring has been established in KwaZamokuhle since April 2016. . The project team finalised the Project Design Document and scopes of work for the various packages. The roll-out of interventions in KwaZamokuhle was initially planned to start in January 2017. This was delayed for a period of 10 months due challenges in obtaining board approval and procurement of the required services to execute the plan.

Baseline monitoring for phase 2 is planned to start in April 2019, with the actual implementation scheduled for July 2019 to August 2023. Baseline monitoring for phase 3 is planned to start in June 2010, with actual implementation scheduled for July 2021 – August 2024. An updated Air Quality Offsets Implementation Plan for power stations in the Nkangala District Municipality will be submitted to DEA in April 2019.

The following sections (3.1 and 3.2) provide a summary of key findings or learnings from activities (mostly undertaken in KwaZamokuhle) that have been completed to date.

3.1 PREFEASIBILITY STUDY

Eskom's exploration of air quality offsets started with a pre-feasibility study conducted by EScience Associates and the Nova Institute in 2013. The objective of this study was to determine the most feasible interventions to offset tall stack emissions from Eskom's power stations by reducing household emissions. Household interventions were selected based on the numerous scientific studies that show that in South Africa the main cause of harmful health effects due to poor air quality is the domestic burning of solid fuels.

An exhaustive list of household interventions was brainstormed, and kick-out criteria were then applied to reduce the list for detailed evaluation. The shortened list of interventions was then evaluated according to the following weighted criteria:

- Reduced human exposure to ambient PM10
- Reduced human exposure to ambient SO_2
- Implementation cost attractiveness of intervention
- Success probability of intervention
- Government and Eskom Board acceptance of intervention
- Sustainability of intervention
- Household acceptance of intervention
- Indirect impact of implementation (long and short term)

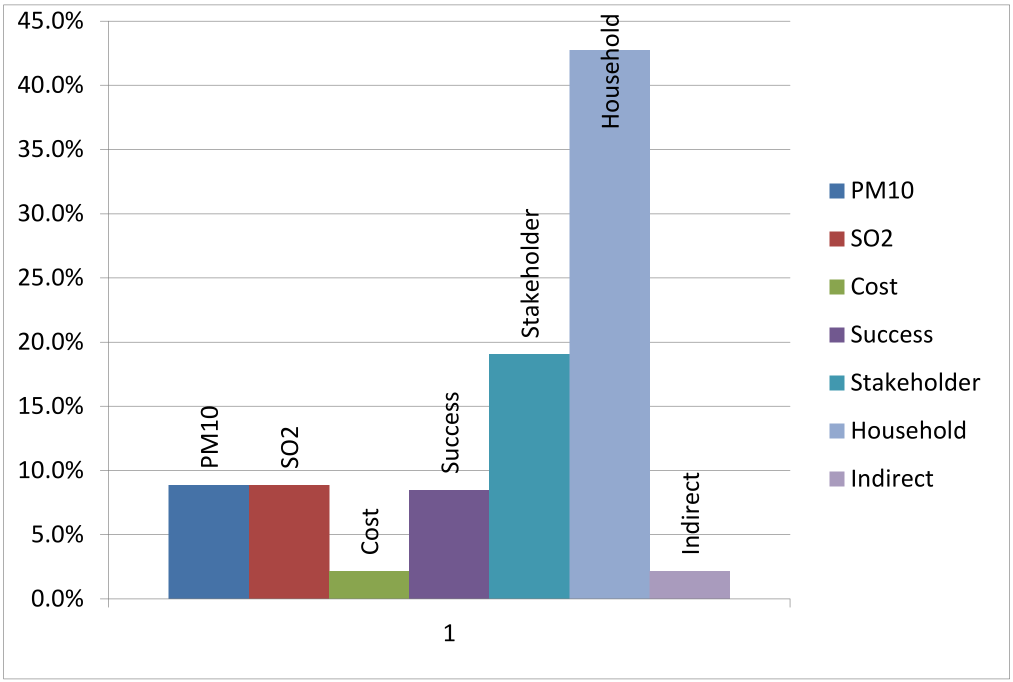

Figure 1: Weighting of the criteria used to evaluate the proposed offset interventions

Households are considered to be the most important stakeholder, and their acceptance was identified as the most important criterion that would determine the success of the offset projects, followed by acceptance by licencing authorities and the Eskom Board.

The interventions recommended for further study, based on applying the weighted criteria were:

- Retrofit full suite of thermal shell insulation (ceilings and three walls), draft proofing and Trombe wall on all existing subsidy houses [Full retrofit]
- Install ceilings in all formal houses [Ceilings]
- Optimise house size, shell insulation, ventilation, orientation and solar heat absorption for new subsidy houses and social housing [EE RDP]
- Replace coal / wood stove with multi-purpose, high quality, low emission stove [New stove]
- Electricity subsidy
- Gas subsidy with equipment [LPG subsidy & heater]

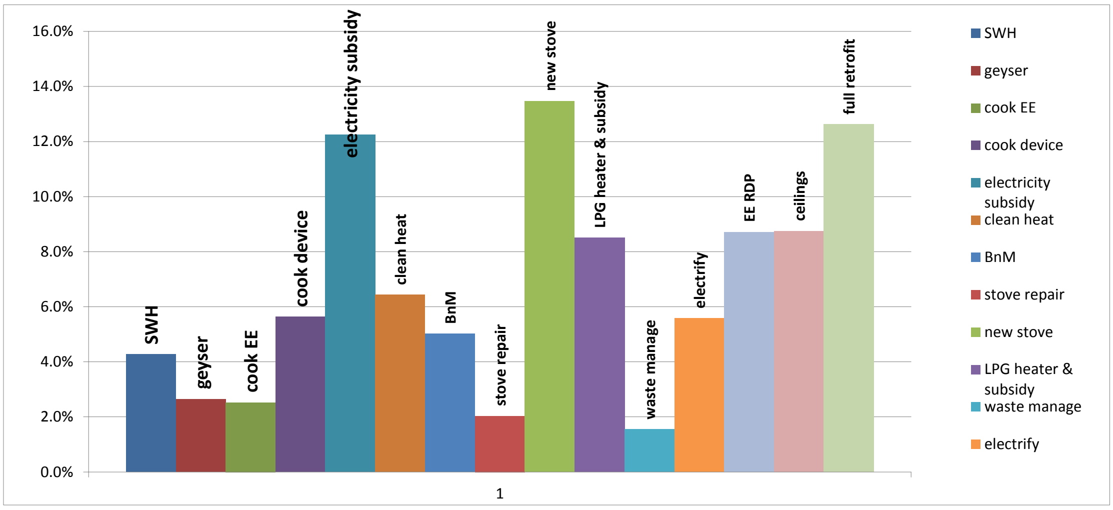

Figure 2: Result of applying the evaluation criteria. (Relative weighing on y-axis)

3.2 AIR QUALITY OFFSETS: 120-HOUSE PILOT STUDY

Following on from the pre-feasibility study, the next step in Eskom's air quality offsets journey was an air quality offsets pilot project, which was conducted in KwaZamokuhle (3 km from Hendrina town, Mpumalanga) from mid-2014 to end 2015. The project team was comprised of experts from the North-West University, the Nova Institute, the Council for Scientific and Industrial Research, EScience Associates and Prime Africa Consulting.

The objective of the pilot study was to evaluate the household-based air pollution offset interventions that have been identified during pre-feasibility study and to make recommendations on the most appropriate intervention combination for scaling. The evaluation included the assessment of associated emission reductions, calculating the expected improvement in air quality, and gauging the acceptability of the interventions to households.

The pilot consisted of discrete activities. Each activity yielded learnings. A selection of learnings per activity is reflected here:

- **Learnings relating to performance of the interventions**

In short, LPG stove and heater with a retrofit effectively eliminate coal use. Full retrofits performed better than basic retrofits in the pilot study, but there is still uncertainty because of the small sample and high variability of measurements. Low emission stoves may be an option in areas where solid fuels are free, especially if they are as effective in real life as in the laboratory test. Electricity subsidies did not work.

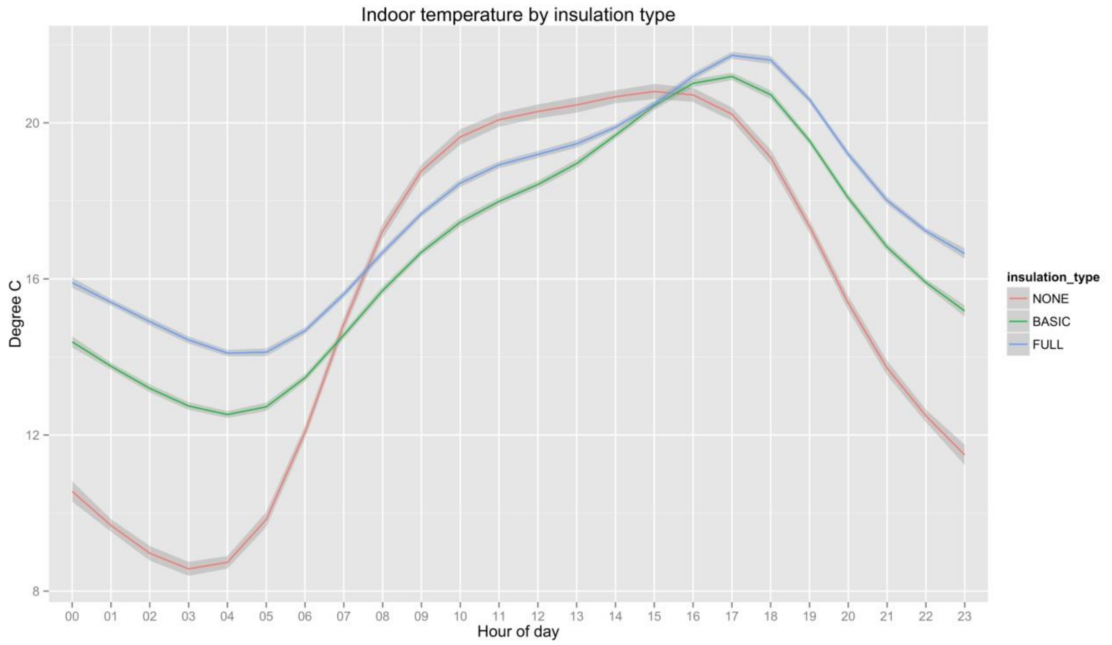

Figure 3: Winter indoor temperatures raised by insulation type

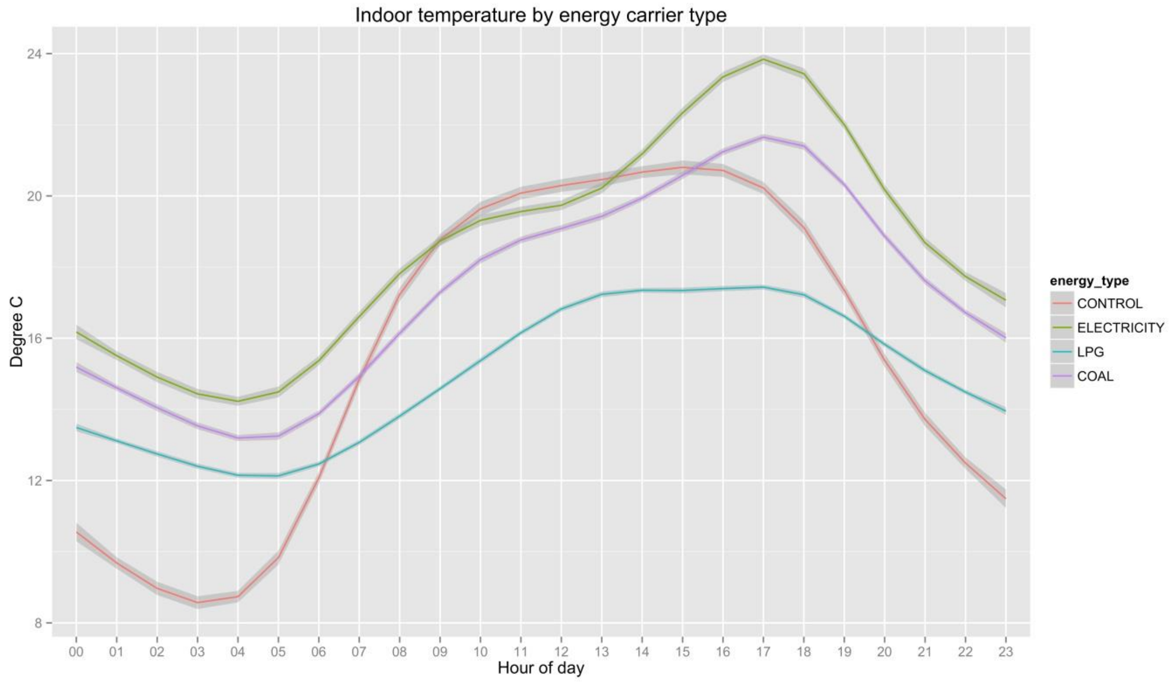

Figure 4: Winter indoor temperatures raised by energy carrier type

As participation is voluntary, it is important that any intervention is well communicated in order for households to make an informed decision whether to participate. Well over 80% of households agreed to participate in the LPG intervention set with full retrofit, as well as in the low emission coal stove plus full retrofit option. The basic retrofit plus LPG stove and heater combination had only a 66% participation rate.

Table 2: Participation rate of coal using households

Intervention	Approached	Qualifying	Participation rate
Ceiling + coal stove	35	29	66%
Full retrofit + coal stove	33	26	88%
Ceiling + LPG	32	24	83%
Full retrofit + LPG	24	23	87%

Generally, households did not want to switch back to their old coal stoves after one winter of use. Households were given an option to swop back to their old polluting stoves, or keep their new LPG or low emission stoves. More than 90%decided to rather keep using the new cleaner technology.

Table 3: Permanent uptake: stove swopping at end of winter:

Intervention	Accept and retain intervention device	Reject intervention device	Permanent device swop
Ceiling + coal stove	39	1	98%
Full retrofit + coal stove	38	2	95%
Ceiling + LPG	40	0	100%
Full retrofit + LPG	39	1	98%

➢ **Learnings from household surveys**

Household surveys were conducted broadly in KwaZamokuhle, in order to understand socio-economic conditions generally (and not just in intervention participating households).

Poverty is a critical driver for ambient and indoor air pollution in KwaZamokuhle. The surveys confirm that KwaZamokuhle is home to many low income households, with most people living below the food poverty line. In the face of energy poverty, low-income households use dirty energy carriers in order to fulfil their need for space heating.

➢ **Learnings from pilot roll-out planning and implementation**

A lot of interaction and consultation with the local community is essential. The interaction should take the form of both a structured local forum and an ongoing local presence that can deal with individual concerns and requests as they arise.

Recruitment and training of local labour was successful.

Figure 5: Member of the newly appointed team being trained on the installation of insulation at the storage facility near KwaZamokuhle.

Pre-existing roof leaks is a challenge and insulated ceilings decrease the amount of moisture than can escape from the roof cavity.

Figure 6: Brown marks on the ceiling as a result of roof leaks.

➢ **Learnings from air quality monitoring**

KwaZamokuhle often has little wind, implying that smoke from coal stoves remain trapped in community air space below the inversion layer, especially during winter. This exacerbates the health risk from household coal use to the local community.

Figure 7: Eskom monitoring site in KwaZamokuhle

Air quality in KwaZamokuhle is poor and the poor air quality is associated with household coal burning – morning and evening concentration peaks are associated with domestic cooking and space heating with solid fuels. Both ambient PM10 and PM2.5 concentrations are high, and PM2.5 (which has a more negative health impact) make up a significant part of the concentration. From end May to middle of August (the cold season), the air quality is worse. Ambient standards are exceeded on most winter days, as well as to a lesser degree during warmer months. Ambient SO_2 and O_3 concentrations are high, but in compliance of the ambient standards during the monitoring campaign. Ambient NO_2 concentrations did not exceed ambient standards.

Table 4: Ambient air quality in KwaZamokuhle between 1 January 2015 and 24 October 2016 compared to South African air quality standards.

Agent	Period	Standard	Exceeds	Average	Confidence Interval	N	N exceeds	Std Dev	Median	25%	75%	99%
PM10 (ug/m3)	24h	75	4	75	71-80	309	132	40	64	44	103	178
PM10 (ug/m3)	Annual	40	0	75		1	1					
PM2.5 (ug/m3)	24h	40	4	40	37-42	278	114	22	33	24	53	99
PM2.5 (ug/m3)	Annual	20	0	40		1	1					
SO2 (ppb)	10min	191	526	27	27-27	15244	29	23	19	14	31	129
SO2 (ppb)	1h	134	88	25	24-26	2665	15	21	19	13	30	107
SO2 (ppb)	24h	48	4	20	18-22	91	0	9	19	12	25	44
SO2 (ppb)	Annual	19	0	20		1	0					
NO2 (ppb)	1h	106	88	17	17-18	2706	1	10	15	11	21	53
NO2 (ppb)	Annual	21	0	17		1	0					
O3 (ppb)	8h	61	11	25	25-25	7521	3	10	24	18	31	51

Household emissions were a more significant source of SO_2 than regional sources with peak concentrations occurring in the evening. Households accounted for about 75% of the peak concentration. Regional industry contributed about 25% of the peak concentrations.

There is no observed morning peak of SO_2 to match the morning peak in PM10. This may be due to reactions that occur in the morning that effectively convert SO_2.

Source apportionment results for the winter samples indicate that domestic cal combustion is an important source in both the coarse (38.7 %) and fine fraction (63.4 %). Dust sources are also important in the coarse fraction (42.5 %). In the fine fraction emissions from automobiles and secondary sulphate and nitrate contributed 13 % and 8.5 % of the aerosol loading respectively.

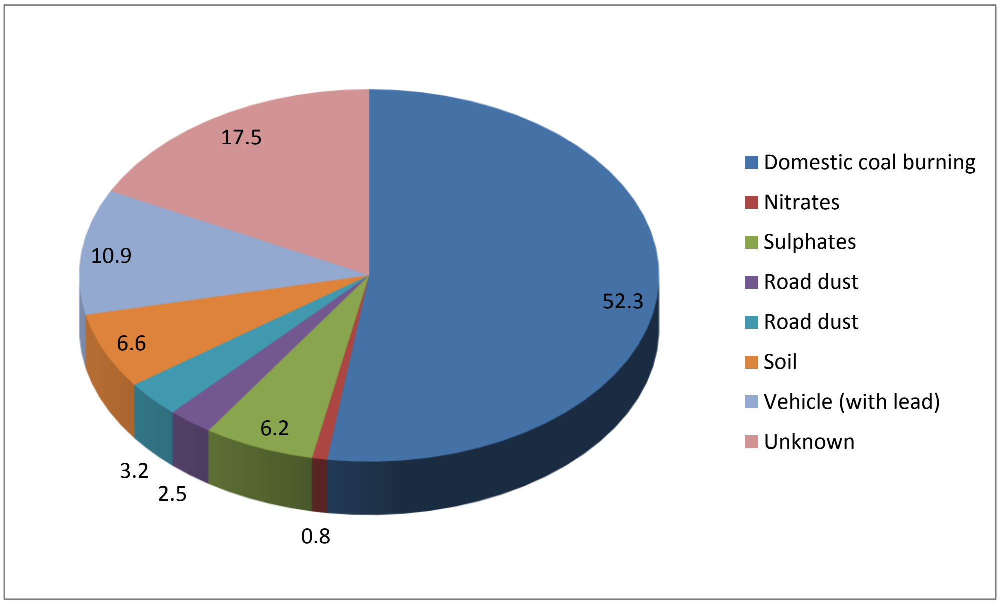

Figure 8: Source apportionment of the fine particulate matter (PM2.5) in KwaZamokuhle in winter 2015

➢ Learnings from dispersion modelling

The emissions inventory in its current form is adequate for modelling potential changes in ambient concentration due to interventions if rolled out at scale.

The inclusion of observed meteorological data significantly improved model performance for PM10 evening peaks by assimilating calm conditions.

➢ Learnings from macroeconomic impact assessment and social cost benefit analysis

Indicative results are that health impacts and costs relating to local air pollution will be greatly reduced due to the reduction in coal consumption through the interventions' efficiency improvements and fuel substitutions. The interventions will make a positive contribution to job creation and GDP. The interventions will reduce greenhouse gas emissions.

The results show that the basic retrofit and LPG intervention has the highest benefits to cost ratio. The benefits of some interventions were less than the costs over a 20 year timeframe, however the assessment excludes the value of continued licensed operation by power stations. Furthermore, we can expect all interventions to improve as more information of intervention performance becomes available.

It should be noted that from a pilot study of this size, no conclusive macro environment findings can be expected – therefore results are indicative.

➢ Learnings from offset methodology development

An overarching framework for accounting for the impact of air pollution has been developed. This Air Pollution Impacts Protocol was successfully used to develop two methodologies and four supporting calculation tools. The methodologies have been tested and are practically applicable.

Figure 9: Images of the installation process, completed thermal installations and stove replacements

3.3 AIR QUALITY OFFSETS: 30-HOUSE ELECTRICITY PILOT STUDY

At the conclusion of the 120-House pilot, the project team was requested by Eskom management to pilot test the feasibility providing household with electrical devices - stove and heater (rather than previous approach which involve provision of an LPG stove and heater). The pilot study was conducted on 30 households during 2017. The main objective of the pilot study was to understand willingness of coal-using households to swap their coal stove for an electric stove, electric heater, energy efficient lighting and a full retrofit (wall and ceiling insulation plus draft proofing).

The results of the pilot study indicated that it was feasible to switch households from coal to electricity, however there were several risks raised, which would limit the success of an electricity-based intervention. To address the risks identified with the electricity based solution, recommended mitigation measures are detailed in the table below:

Table 5: Risks and mitigation measures for the electricity based intervention

Risk	Possible mitigation measures
Electricity interruptions due to faults or outages	This risk will be mitigated by the fact that an LPG backup will be provided. The project team will work with Eskom Distribution and the affected Local Municipality to strengthen supply in the area and limit interruptions.
Social unrest resulting from Eskom debt collection through municipality electricity cut-offs	Eskom customer services stakeholder engagement is assumed to address this issue. LPG back up also mitigates this risk.
Electricity price increases	Insulation of the houses will result in a lower or equal energy cost relative to the post-intervention situation. Electricity and Gas prices are likely to increase the extent of which is dependent on many factors e.g. health the economy and demand for the commodity.

3.4 RECOMMENDED HOUSEHOLD INTERVENSION FOR THE LEAD IMPLEMENTATION

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 entails the following (Figure 10);

- 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

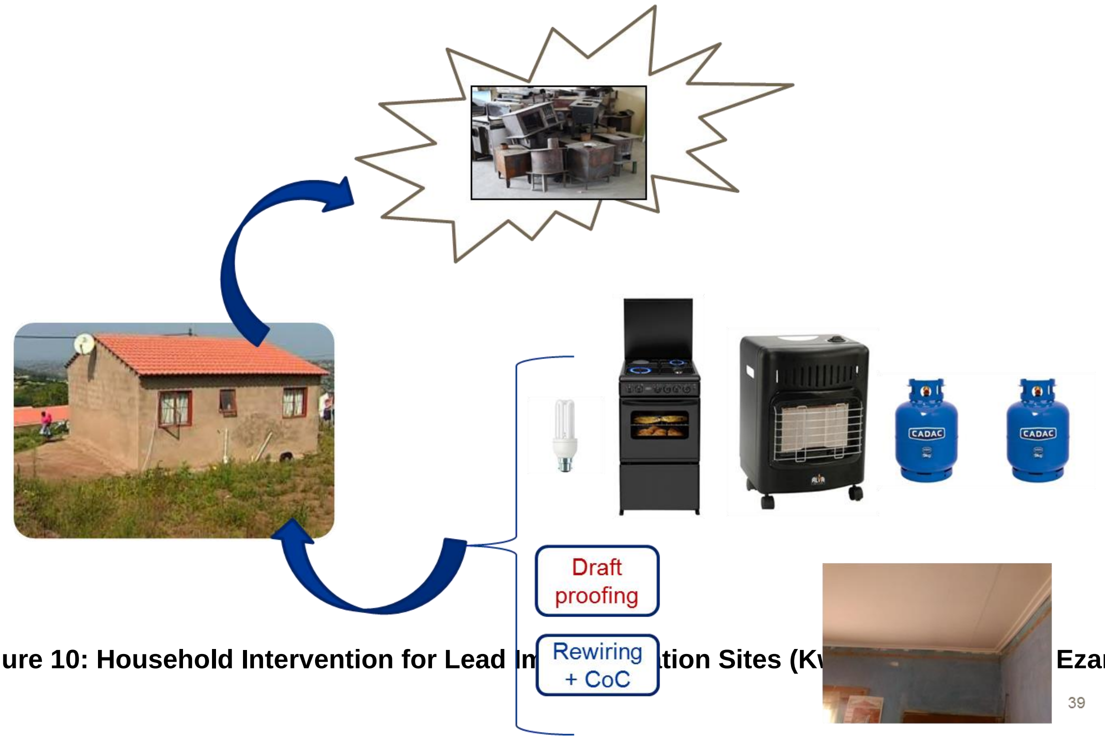

Figure 10: Household Intervention for Lead Im tion Sites (Kw Ezamokuhle)

Electricity is the cleanest source of domestic energy. Rather than providing an LPG stove, heater and cylinder in exchange for the household's coal stove, Eskom is now proposing to provide a hybrid gas electric stove and LPG heater. The proposed changes have impacted the planned schedule for the roll-out of the interventions especially in Nkangala and Gert Sibande.

4. IMPLEMENTATION OF AIR QUALITY OFFSET PLAN: GERT SIBANDE DISTRICT MUNICIPALITY

The prefeasibility and pilot studies (phase 0) conducted for KwaZamokuhle is applicable to the selected communities in Gert Sibande District Municipality. Ezamokuhle is the lead implementation site for power stations in Gert Sibande District Municipality.

Eskom has developed a high level plan for Gert Sibande and obtained approval of the plans from the authorities (Department of Environmental Affairs). The budget for phase 1 (which includes KwaZamokule) has been approved. Baseline monitoring has been established in KwaZamokuhle since

April 2016. The roll-out of interventions in KwaZamokuhle was initially planned to start in January 2017. This was delayed for a period of 10 months due challenges in obtaining board approval and procurement of the required services to execute the plan.

Baseline monitoring for phase 2 is planned to start in April 2019, with the actual implementation scheduled for July 2019 to August 2023. Baseline monitoring for phase 3 is planned to start in June 2010, with actual implementation scheduled for July 2021 – August 2024. An updated Air Quality Offsets Implementation Plan for power stations in the Gert Sibande District Municipality will be submitted to DEA in April 2019.

5. IMPLEMENTATION OF AIR QUALITY OFFSET PLAN: LETHABO POWER STATION

Sharpeville is one of the identified townships that have been selected as a potential site for an offset project implementation. In order to scope the feasibility as well as design a successful offset project, a preliminary baseline assessment of the air pollution and its drivers has been commissioned in Sharpeville. The specific objectives of baseline assessment are:

- Assess the extent to which household air pollution exceeds current guidelines
- Identify key air pollution drivers in Sharpeville
- Understand the current energy usage patterns in Sharpeville
- Quantify the scale of an offset intervention project

The following activities will be undertaken as part of this assessment

- Rapid in situ assessment. This activity has been already been completed.
- Household air pollution assessment
- General household survey
- Detailed household energy survey
- Community source survey

The results of this baseline assessment will inform the design of offset intervention in selected communities which include Sharpeville, Refengkotso, Tshepiso and Boipatong.

An updated Air Quality Offsets Implementation Plan for Lethabo Power Station will be submitted to DEA in April 2019.

5.1 KEY FINDINGS FROM SHARPEVILLE BASELINE STUDY

The conclusions from the study are formulated as answers to a series of interrelated questions. These are summarized below:

- **Are offset interventions in the study areas justified?**

One approach to the question whether offsets are justified is to determine if exceedances of national ambient air quality standards took place. From the results of the indoor air quality monitoring it is clear that indoor guidelines for fine PM are exceeded most of the time.

The same is true for ambient standards for PM2.5 and PM10 where the 24-hour standard is exceeded with alarming frequency. Offsets targeting the local sources will likely have an impact but the exact relationship between foreground and background sources will determine what the magnitude of that impact will be. In the absence of source apportionment results and an extensive dispersion modelling exercise, it is difficult to accurately describe the relationship between foreground and background sources and thus anticipate the potential impact of interventions.

- **Which pollutants should be targeted?**

Both PM10 and PM2.5 exceed air quality standards and should be targeted. PM2.5 is associated more with combustion processes and secondary particle formation and the course fraction of PM10 more with mechanical processes. SO2 concentrations do not exceed any air quality standards.

- **What is the quantum of improvement required?**

The quantum of improvement required can be interpreted in two ways: In the strict interpretation it is the quantum of improvement required to counterbalance the impact of the emissions from Lethabo Power Station in excess of the minimum emission standards.

Another approach to determine the quantum of improvement required is to compare the current state of air with ambient air quality standards. Over the period of a decade between 2007 and 2017, the 24-hour PM10 and PM2.5 standard is exceeded for almost 40% days for which there are measurements. The 99th percentile value for PM10 of 200 µg/m3 is a factor of 2.6 times higher than the standard (75 µg/m3) and the 99th percentile value for PM2.5 of 125 µg/m3 of is a factor of 3.1 higher than the standard, which is 40 µg/m3. In both cases, the mean of the 24-hour values are practically equal to the standard. Seen in this way, the quantum of improvement required is very large and will likely require an extensive effort to address a variety of foreground and regional sources.

- **Which air pollution sources must be addressed?**

The absence of source apportionment results makes it difficult to give a detailed breakdown of source contributions. It is however clear that local combustion sources play an important role. The two household surveys and the community source survey point to three particular source categories that may be addressed namely domestic solid fuel burning, domestic waste burning and dust.

The impact of emissions from domestic solid fuel burning is determined by the fuel type and quality, the efficiency of the fuel-burning device used, and the timing of the emissions. The emissions from waste burning is determined by the waste composition, the way in which the waste is burned (open or in containers / heaped or spread out) and the timing of the emissions.

- **Domestic sold fuel burning**

In Sharpeville the proportion of households who sometimes burn wood is higher than the proportion that sometimes burn coal. This is somewhat surprising given that Sharpeville has had a high proportion of coal users for a long time (see for example the 1996 and 2001 national census). Most households who use solid fuels use a cast iron stove. A minority use welded stoves and a very small fraction use braziers (izimbaula). Although both wood and coal is used for space heating, water heating and cooking, coal is somewhat more likely to be used for space heating (where a long steady fire is an advantage) while wood is somewhat more likely to be used for cooking (where a flame under the plate is an advantage).

Mixed energy carrier use is a reality. In practically all cases, households who use solid fuels have access to electricity, use electricity and prefer to use electricity or gas for cooking and space heating. People are, in other words, not using solid fuels because they like it, but out of necessity. The results suggest that cost savings play at least a part in the transition back from electricity to solid fuels. Interruptions of the electricity supply (either unplanned or through disconnections for non-payment) likely also play a role.

A detailed assessment of fuel quality was outside of the scope of this study. On the surface, coal appear to be similar to that used in other townships on the Vaal Triangle and on the Highveld. Wood from used shipping pallets is an important source of fuelwood.

Solid fuel use has a clear diurnal and seasonal pattern. Solid fuel is used more in winter than in summer. In witer, there are two ignition peaks, a morning peak between 05:00 and 07:00 and an afternoon peak between 16:00 and 18:00. This timing of fire making activity contributes to high ambient concentrations because the ignition phase is the phase where the most particles are emitted and because the time of ignition corresponds to times where dispersion potential is poor.

- **Domestic waste burning**

It is clear from the rapid assessment as well as from the community source survey that waste burning is a common and widespread occurance in Sharpeville. Waste is dumped in public places (no-man’s land) fairly close to houses but seemingly not right in from of someone's stand. People can be seen pushing wheelbarrows with waste to these informal dumpsites. Garden waste such as weeds, grass cutting and pruned branches are also disposed of in this way. Self-employed recyclers appear to move from dumpsite to dumpsite to collect recyclable items.

The results of the household surveys point to the complexity of the problem: Practically all households have access to waste removal services. It is therefore not simply the lack of waste removal services per se that drives domestic waste burning. Respondents to the general household survey reported a very high waste delivery failure rate. There is also anecdotal evidence from the rapid in-situ assessment that households lack waste bins and therefore find it inconvenient to store domestic waste until the next time of collection. The problem around the patches of informal houses is especially acute. Here, however, the lack of access to waste services may play a role.

- **Which air pollution drivers can be addressed?**

➢ **Stove ownership**

An important factor that lends inertia to the use of solid fuels is ownership of a cast iron coal stove. These stoves are durable and can burn coal and wood. The movement to wood shows how having such a stove makes solid fuel use a viable alternative – even when the choice of fuel varies over the years as determined by price and availability. An intervention that swops coal stoves for modern electric and LPG equipment may meet with some enthusiasm since the results of users preference clearly point to electricity and LPG as the preferred energy carriers for cooking and heating.

➢ **The need to cost effective cooking energy**

Wood is other bought and is not necessarily so cost efficient. Where households get wood for free or at low cost, is would obviously be more difficult to change the usage pattern.

Where wood is used as a back-up when the electricity is interrupted, runs out or is cut off, LPG may be is a cost effective alternative for cooking. It appears that LPG use is growing in any event. Given the relatively low household income in the area, the initial cost of the equipment represents a significant barrier for many households who may well use LPG and who aspires to use modern energy carriers.

➢ **Space heating**

Solid fuels, especially coal, burned in cast iron stove remains an effective and cost efficient energy source for space heating. The only feasible solution is to improve the thermal efficiency of existing houses through a retrofit of thermal insulation and draught-proofing.

It is estimated that 1290 of the total of 8975 formal only households in Sharpeville burn coal during winter, but only 224 of these formal houses do not have a ceiling. Thus, there are only a very limited number of households that can be reached with the existing basic plus retrofit and stove and heater swop solution. There might be a chance to reach the approximately 1066 households that already have a ceiling in one or more rooms, with different package, e.g. a stove and heater swop together with a set of garbage bins suited for waste removal and recycling. This should be tested.

- **Adequacy of waste services**

Lack of access to waste removal services may play a role in the informal areas. Informal dump-sites is however also present within areas where there are access to waste services. The frequent service failure may further explain some of the activities. There is anecdotal evidence that lack of waste bins contributes to the problem of informal dumping. We however do not currently have an in-depth qualitative understanding of the waste handling dynamics in Sharpeville. Further in-depth qualitative work is required.

5.2 PROPOSED WASTE INTERVENSIONS FOR SHARPEVILLE

As indicated in section 5.1, the baseline assessment in Sharpeville has been concluded, and confirms waste burning as an important local source of emissions. This was further confirmed by the source apportionment study recently conducted for the Vaal Triangle Priority Area by North West University.

To help address the waste burning problem, the following possible initiatives are being considered for the lead implementation phase in Sharpeville:

Table 6: Waste related initiatives under consideration

Placement of skips in strategic locations	Place skips at strategic sites where dumping occurs and establish weekly collection system.
Clean waste under powerlines	Remove waste from areas under the powerlines (powerline servitude) in Sharpeville.
Vegetable garden under powerlines	Work hand in hand with local NGOs to establish vegetable gardens under the powerlines

The roll-out of interventions in Sharpeville was initially planned to start in January 2018. This was delayed by a period of 10 months due challenges designing an appropriate waste intervention solution and getting buy-in from Emfuleni Local Municipality.

6. STAKEHOLDER ENGAGEMENT

Eskom has been actively engaging its stakeholders on air quality offsets implementation plans. Several municipalities and government departments have been engaged, including housing, electrification and waste management departments

- In the Nkangala District, one local municipality i.e. Steve Tshwete local municipality for KwaZamokuhle in Hendrina

- In Gert Sibande District, Pixley ka Seme local municipality including Ezamokuhle local Councillors
- Emfuleni local municipality in Sedibeng district

Detailed stakeholder engagement is provided in appendix A below.

7. CHALLENGES ENCOUNTERED

Eskom has experienced delays in implementation of the Air Quality Offset Plans for power stations around Nkangala, Gert Sibande and Fezile Dabi District Municipalities. The delays have been mainly due to delays in obtaining internal approval from the Executive Tender Committee (ETC) and changes made to the scope of the proposed interventions. Due to these delays the plans had to be revised and updated.

The implementation timeline is dependent on procurement approvals and on funding being allocated by Eskom. In the previous revisions of this plan Eskom indicated that the implementation time line was dependant on the NERSA tariff approval. In March 2018 NERSA approved a tariff level below that requested by Eskom. As such Eskom will be undertaking a funding re-prioritisation exercise which may unfortunately impact on the implementation of this plan. The authorities will be notified of any significant changes in the plan necessitated by funding reviews

Updated Air Quality Offsets Implementation Plans will be submitted to DEA and the licensing authorities in April 2019.

8. PROGRAMME RISKS

Risks and unintended consequences of an air quality offsets programme and the way in which Eskom proposes to mitigate the risks as follows:

Table 7: Risks of air quality offsets and proposed mitigation

Risk	Risk rating	Mitigation already in place	Planned mitigation
Funding constraints: Funds have been allocated for offsets implementation but they may be cut	Medium	Funding requirements were included in MYPD tariff application but with tariff reduction this provides limited mitigation now	Compliance aspects of offsets will be presented during capital reprioritisation and with specific offset funding requests.
Objections from communities which are not included in the offsets	Medium	An objective process has been used to select communities. Also, offsets will not be implemented in a section	Most communities in the vicinity of power stations will eventually receive an offset implementation

Risk	Risk rating	Mitigation already in place	Planned mitigation
implementation		of a community only. In-depth community consultation will only occur after authority approval of the plan and allocation of budget.	
Unreliable supply of electricity will leave communities without an energy source at times.	Medium		The proposed intervention include provision of an LPG backup.
Money used by households to buy electricity will be used instead to pay off **municipal debts.**	High	-	Engagements will be held with the local municipalities to see if an agreement can be reached regarding the payment of household debts.
Safety: Electric wiring in many houses is unsafe. Injuries may be caused by electric heaters or stoves.	Medium	-	The project team will ensure the wiring is safe after installation of the gas electric stove and ceiling. An electrical CoC will be issued by a competent electrician. Members of the local community will be trained in safe operations prior to the installations. Health and safety requirements of Eskom's procurement process will be adhered to.
Objections from households which do not use solid fuels	Low	-	An understanding of the objectives of the offsets roll-out and the secondary benefits for non-participating households will need to be conveyed through community consultation and awareness initiatives.
Inability of local authority to support/facilitate waste and household solutions impacting on ability to create sustainable solutions	High	Continued engagement with authorities	Continued engagement with authorities Consider projects which require less authority involvement

9. CONCLUSION

Despite the challenges encountered, Eskom has made some progress in the implementation of the air quality plans in the Nkangala, Gert Sibande and Fezile Dabi District Municipalities. These include;

- Successful completion of the prefeasibility and pilot studies for KwaZamokuhle.
- Establishment of the baseline for KwaZamokhule, Ezamokuhle and Sharperville.
- Budget approval by board, finalisation of scope of work and initiation of the procurement process for phase 1.
- A contract has been put in place with the Medical Research Council (MRC) to determine the health impacts of the air quality offsets in KwaZamokuhle and Emzimnoni.

Updated Air Quality Offsets Implementation Plans will be submitted to DEA before the 31 March 2018 reflecting the new proposed roll-out schedule and changes.

10. REFERENCES

Eskom, 2019: *Air Quality Offsets Implementation Plan for Nkangala District Municipality*, March 2019 update.

Eskom, 2019: *Air Quality Offsets Implementation Plan for Gert Sibande District Municipality*, March 2019 update.

Eskom, 2019: *Air Quality Offsets Implementation Plan for Lethabo Power Station*, March 2019 update.

11. APPENDIX A: DETAILS OF STAKEHOLDER ENGAGEMENT 2018-2019

Stakeholder group	Department	Eskom lead engagers	Date	Key topic discussed	Purpose of engagement	Our response /action promised
Steve Tshwete Local Municipality	• Housing department • Electrical department	• Sibusiso Tshabalala • Motshewa Matimolane	28 February 2018	• Air quality offset project implementation • RDP new development • Electricity supply at KwaZamokuhle	• To inform them about air quality offset project	• Follow up meeting to update about progress
Dr Pixley Ka Seme Local Municipality	• Speaker and Ezamokuhle Councilors	• Sibusiso Tshabalala • Nokwethemba Khumalo	6 March 2018	• Air quality offset project	• This was a follow up meeting extended to Ezamokuhle Councillors • To update the Speaker with progress wrt implementation plans and inform the Councillors about air quality offset project.	• Follow up meeting to update about progress
Emfuleni Local Municipality	• Waste Management	• Thobela Lelibana • Motshewa Matimolane	8 March 2018	• Air quality offset project • Waste management solution in Sharpeville	• To discuss waste management solution for Sharpeville	• Follow up meeting to update about progress
KwaZamokuhle Local Councillors	Council	• Nokwethemba Khumalo • Sibusiso Tshabalala	16 August 2018	• Air quality offset project • Job creation	• To inform them about air quality project that Eskom will be implementing for the community	• Follow up meeting to update about progress
KwaZamokuhle coal merchants	Coal merchants	• Sibusiso Tshabalala • Nokwethemba Khumalo	16 August 2018	• Air quality offset project	• To inform them about air quality offset project and also assess the impact on the coal business	• Follow up meeting to update about progress and discuss other business ideas.
Emfuleni local municipality	Speaker's Office	• Sibusiso Tshabalala • Thobela Lelibana	7 February 2019	• Air quality offset project • Waste dumping and burning • Job creation	• To inform the Speaker about air quality offset project	• Speaker to coordinate meeting with Sharpeville local Councillors
Sharpeville, Tsepiso and Boipatong local Councillors	Speaker's Office	• Motshewa Matimolane • Nthabiseng Letlapa	18 February 2019	• Air quality offset project • Waste dumping and burning • Job creation	• To inform the Councillors about air quality offset project, support and buy-in to the project	• Dump site visit • Follow up meeting to update about progress

12. APPENDIX B: SUMMARY OF EXPENDITURES FOR ESKOM'S AIR QUALITY OFFSETS PROGRAMME

Area/Township	Year		Activity/Action	Status/progress	Cost/budget*
KwaZamokuhle Mpumulanga (next to Hendrina Power Station)	2016	Q1	Offset pilot KwaZamokuhle (150 households)	Project started 2014 ongoing	-
KwaZamokuhle Mpumulanga (next to Hendrina Power Station)		Q2	Offset pilot KwaZamokuhle (150 households)	Ongoing	-
KwaZamokuhle Mpumulanga (next to Hendrina Power Station)		Q3	Offset pilot KwaZamokuhle (150 households)	Ongoing	-
KwaZamokuhle Mpumulanga (next to Hendrina Power Station)		Q4 - Total 2016 expenditure	Offset pilot KwaZamokuhle (150 households)	Ongoing	R 6 957 000
KwaZamokuhle Mpumulanga (next to Hendrina Power Station) - Sharpville	2017	Q1	- Offset pilot KwaZamokuhle (150 households) - Sharpville baseline study	Ongoing	-
KwaZamokuhle Mpumulanga (next to Hendrina Power Station)		Q2	- Offset pilot KwaZamokuhle (150 households) - Sharpville baseline study		-
Sharpville baseline study, Gauteng (next to Lethabo power station)		Q3	- Offset pilot KwaZamokuhle (150 households) - Sharpville baseline study	Ongoing	-
KwaZamokuhle Mpumulanga (next to Hendrina Power Station)		Q4 - Total 2017 expenditure	- Offset pilot KwaZamokuhle (150 households) - Sharpville baseline study - Awareness & Communication	Ongoing	R 11 477 509
KwaZamokuhle Mpumulanga (next to Hendrina Power Station)	2018	Q1	- Offset pilot KwaZamokuhle (150 households) - Sharpville baseline study	Ongoing	-
KwaZamokuhle Mpumulanga (next to Hendrina Power Station)		Q2	- Offset pilot KwaZamokuhle (150 households) - Sharpville baseline study - Awareness & Communication	- KwaZamokuhle Pilot completed - Sharpville baseline completed	-
KwaZamokuhle Mpumulanga (next to Hendrina Power Station)		Q3	- Offset pilot KwaZamokuhle (150 households) - Sharpville baseline study - Awareness & Communication	Ongoing communications	-
KwaZamokuhle Mpumulanga (next to Hendrina Power Station)		Q4 - Total 2018 expenditure	- Offset pilot KwaZamokuhle (150 households) - Sharpville baseline study - Proactive assurance - Promotional material	Ongoing communications	R 3 119 535