Activity 2

Activity 2.1: Fuel Merchant Survey for Year 1 at Phola

Document by:

ARM
AIR RESOURCE MANAGEMENT

Final Report

27th October 2025

Document Title

Client		Eskom
Title		Activity 2.1: Fuel Merchant Survey for Year 1 at Phola
Our Reference		PMV-Phola-A21-FM-YR1
Issued to Client		27/10/25
Classification		Company Confidential

Document Change Record

Revision No.	Date	Description of Revision
00A	22nd August 2025	Creation of Document
00B	5th September 2025	Peer Review of Document
00C	12th September 2025	Draft Document submitted to Eskom
00D	22nd October 2025	Revised Draft Document submitted to Eskom
01	27th October 2025	Final Document submitted to Eskom

Document Approval

Document	Name	Date
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EXECUTIVE SUMMARY

The Phola community fuel source survey was conducted during August 2025. A questionnaire was used to interview eight fuel merchants identified by the ARM fieldworker team. In addition, samples were taken of the coal supplied by the merchants and were analysed to compare coal quality and potential air quality impacts.

Results indicated that all sources of fuel originated from outside Phola, before distribution by merchants into the community. LPG prices varied between R300 to R330 per 9 kg bottle for refills and R280 for bottle exchanges, with the vendors offering a wide variety of LPG refills from 1kg to 19kg. Availability and fuel prices from this retailer are constant through summer and winter and all sales are done on a cash-only or debit/credit basis for residents.

However, most coal and wood are provided by four other fuel merchants situated inside Phola. Interviews with these fuel merchants provided a different perspective - coal and wood are sold in small quantities of one or two bags, and rarely on credit, with merchants preferring cash only. Merchants paid cash for their fuel and imported it from Delmas. The merchants noted that they were not worried about the reliability of their suppliers providing the fuel.

Competitive prices were charged by merchants for coal and wood, ranging from R110 to R120 per 50kg bag of coal, and R25 to R30 per bag of wood. Analysis of the coal revealed that most coal sold in Phola is of Grade C or Grade D with low energy, low sulfur, high ash, and high volatile content, making for poor air quality on combustion. Monthly consumption of coal was at least 16 tons of wood in winter with data obtained just from four of the merchants. Consumption peaked on very cold days. Summer consumption was about 40% less due to reduced need for space heating, but the need for cooking continued.

According to fuel merchants, coal and wood are mainly used for cooking and space heating, and to a lesser extent for water heating. Electricity is only used for lighting, and LPG is consumed mostly in areas where electricity is not available. Paraffin was reported as a fuel option but mostly sold in small quantities. These perspectives from suppliers will be tested in household surveys with the community directly in due course.

Preliminary opportunities were identified to improve air quality in the PMV project for the Phola area. Alternative fuels other than coal and wood (such as gas and electricity) are perceived to be very costly, but as there are areas within Phola that depend highly on alternative fuels due to the lack of electricity, this provides fertile ground for change towards implementing alternative fuels. To achieve

change, careful consideration is required to develop suitable financing models (such as credit for LPG) for fuel supply and to communicate the benefits of insulation and cleaner fuels to the community, starting with the local schools.

1. BACKGROUND

1.1 Air Quality Offsets Guideline

The Department of Forestry, Fisheries and the Environment (DFFE) published in 2013 the regulations regarding Listed Activities and Minimum Emission Standards (MES) in terms of section 21 of the Air Quality Act (AQA) (GN 893 of 2013). These regulations list activities that result in atmospheric emissions which may have a detrimental impact on the environment. The said regulations also prescribe emission limits that these listed activities must not exceed. Listed activities must comply with prescribed limits at different timeframes, i.e. existing/old plants (operational before 2010) must comply with old plant standards by 2015 and comply with new/stricter plant standards by 2020. The same regulations (GN 893 of 2013) stipulated (before recent amendments) that an existing plant can apply for postponement of compliance timeframes, meaning delaying the timeframe of compliance by sending an application to the National Air Quality Officer. Eskom embarked on a process to apply for postponements of the 1st April 2015 compliance timeframe for some of Eskom's MES-listed activities. The National Air Quality Officer (NAQO) in concurrence with the Nkangala District Municipality licensing authority, granted postponements to Eskom and stipulated conditions to be upheld for the period of postponement. A postponement of timeframes to comply with the limits set in the regulation was granted to Eskom in 2015 to allow time for Eskom to invest in technological and other measures to reduce emissions towards meeting the set limits.

One of the conditions of the granted postponements included the requirement to submit and implement an air emission offset plan to reduce particulate matter pollution in the receiving environment. The condition specifically required that Eskom identify and implement offset projects that will reduce Particulate Matter (PM) in the ambient/receiving environment.

An environmental offset is an action(s), designed to compensate for a negative environmental impact of resource use, a discharge, or emission from an activity. In other words, environmental offsets are alternative actions (investments or initiatives) implemented to mitigate the residual negative environmental impacts of an industrial activity. In relation to air quality, the Department of Environmental Affairs (DEA) Air Quality Offsets Guideline (Notice 333 of 2016) defines air quality offsets as an intervention, or interventions, specifically implemented to counterbalance the adverse and residual environmental impact of atmospheric emissions o deliver a net ambient air quality benefit within, but not limited to, the affected airshed where ambient air quality standards are being or have the potential to be exceeded and whereby opportunities and need for offsetting exist.

1.2 ESKOM'S APPROACH TO AIR QUALITY OFFSETS

DEFF's Air Quality Offset Guideline has shaped and informed Eskom's Air Quality Offsets Implementation Plan. This Plan has been based on a scientific process of feasibility studies, testing and demonstration, and on consultation with key stakeholders. Figure 1 illustrates the concept schedule for the phased implementation of Eskom's air quality offsets.

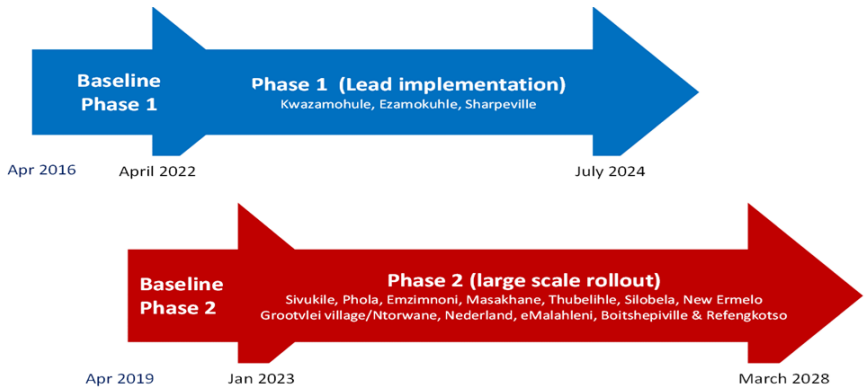

Figure 1: Concept Schedule for the implementation of Eskom's air quality offsets (Matimolane, 2023)

Eskom has adopted the phased approach (Figure 2) herein to increase the probability of success and to ensure that learnings from early phases are incorporated into the large-scale roll-out. (Matimolane, 2023).

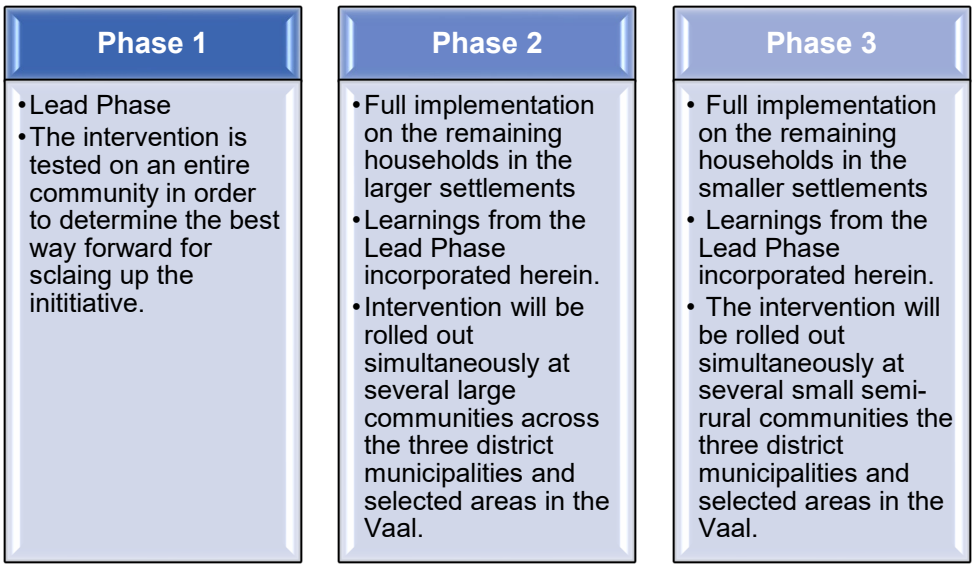

Figure 2: Eskom's Phased approach to the rollout of air quality offset interventions (Matimolane, 2020)

Eskom is pursuing a multi-pronged approach to improving ambient air quality, including reducing emissions at the existing coal-fired fleet, investing in power generation from renewables and nuclear, and implementing air quality offsets. Eskom is implementing air quality offset projects in various communities around Eskom's coal-fired power stations in the district, viz. Hendrina, Arnot, Komati, Kriel, Matla, Kendal, and Duvha Power Stations as shown in Table 1 below:

Table 1: Location of Eskom's Offset Projects

Power station	Areas for offsets	Type of offset
Hendrina	**KwaZamokuhle**	Household (Phase 1)
	Neighbouring farms	Household (Phase 3)
Arnot	**Silobela**	Household (Phase 2)
	Neighbouring farms	Household (Phase 3)
Komati	**Big House informal settlement**	Household (Phase 3)
	Emahlathini informal settlement	Household (Phase 3)
	Goedehoop informal settlement	Household (Phase 3)
	Kamfefe (Driffontein)	Household (Phase 3)
	Vandykdrif	Household (Phase 3)
	Rethabile	Household (Phase 3)
	Neighbouring farms	Household (Phase 3)
Kriel	**Thubelihle**	Household (Phase 2)
	Rietspruit	Household (Phase 3)
	Neighbouring farms	Household (Phase 3)
Matla	**Emzinoni and extensions, Chris Hani, Milan Park Extensions, Kananna Ext 6, Thambo (4300 households only)**	Household (Phase 2) Household (Phase 3)
	Neighbouring farms	
Kendal	**Phola**	Household (Phase 2)
	Eskom Triangle	Household (Phase 3)
	Khayalethu community	Household (Phase 3)
	Olympic community	Household (Phase 3)
	Makhosi community	Household (Phase 3)
	Arbor	Household (Phase 3)
	Neighbouring farms	Household (Phase 3)

Duvha	**Masakhane**	Household (Phase 2)
	Neighbouring farms	Household (Phase 3)

Eskom's air quality offsets are designed to reduce a community's exposure to harmful levels of air pollution by reducing emissions from local sources such as domestic coal burning and waste burning. Examples of air quality offsets implemented by Eskom are:

- switching households from coal to cleaner energy sources,
- improving the thermal comfort of houses to minimise the need for coal-based heating in winter, and
- improving waste collection and recycling.

Such interventions have the potential to counterbalance the effect of emissions from power stations on the air quality in localities near Eskom's power stations.

2. SCOPE OF WORK

2.1 Activity 2 – Fuel Source Survey

As part of phase 2 of Eskom's AQO programme, Phola is proposed to be the main focus of Kendal Power Station's Air Quality Offset Intervention. Phola has an estimated population of 31, 885 (based on the 2011 StatsSA census). The estimated number of households earmarked to receive AQO intervention is 6,700.

Phola meets the site selection criteria for an AQO programme i.e. power station impacts on the area, the area is in non-compliance with the National Ambient Air Quality Standards (NAAQS) and there exists an opportunity for offsets. A reference ambient air quality monitoring station has been in operation in Phola for several years and the results indicate exceedances of the NAAQS for PM_{10}. Eskom appointed Air Resource Management (Pty) Ltd (herein referred to as ARM) to support the Planning, Monitoring and Verification (PMV) services in support of the Phase 2 AQO implementation at Phola. To achieve this, Eskom has included eight targeted work package Activities (Table 2) for the Phola community.

Table 2: Eskom Phola PMV Activity Schedule

Activity no.	Description	Year 1	Year 2	Year 3	Year 4
1.	**Ethical clearance**	Initial report	Update report	Update report	Update report
2.	**Area intelligence**	Inception	Year 2 report (Less in-situ assessment & fuel survey)	Year 3 report (Less in-situ assessment & fuel survey)	Year 4 report
3.	**Household survey (baseline)**	Initial report			Year 4 report
4.	**Ambient Air Quality Monitoring**	Initial report	Year 2 report	Year 3 report	Year 4 report
5.	**Emission inventory**	Initial report	Year 2 report	Year 3 report	Year 4 report
6.	**Air quality modelling**	Initial report	Year 2 report	Year 3 report	Year 4 report

7.	**Project effectiveness review**	Initial report	Year 2 report	Year 3 report	Year 4 report
8.	**Database and Reporting**	Initial report	Year 2 report	Year 3 report	Year 4 report

This report is an output of Activity 2.1: Fuel Merchant Survey for year 1 for Phola. ARM was tasked to collect data to identify sources and suppliers of various fuels (energy sources) supplied and in use in the selected area. ARM is to investigate the business model and supply chain of each fuel and estimate the quantity and cost of fuel to the households. The fuels (energy sources) to be investigated include electricity, coal, dung, wood, LPG, paraffin, or any other fuels used in the community. An emphasis of the study will be to investigate the business model and supply chain of coal merchants in Phola.

2.2 Study Key Tasks

The key tasks for this activity include:

1) to gather information on various fuel sources;
2) interview fuel merchants and other role players in the area; and
3) conduct assessment and report on findings.

3. METHODOLOGY

South Africa has improved household access to electricity from an estimated 36% at the end of 1993 (DME, 2001) to an estimated 84% in 2016, significantly greater than the average for Sub-Saharan Africa (World Bank 2018). Although there has been much progress in the provision of electricity to households, many still rely on traditional sources such as wood and coal (Israel-Akinbo, Snowball & Fraser 2018, 76).

Although the major obstacles preventing people from discontinuing domestic coal combustion are poverty, the ready availability and social acceptability of coal, together with other social customs, cannot be underrated.

In this study, we focus on trying to unravel some of the complex energy-use business models and supply chains of these fuels in the Phola community. The local fuel merchants operating in Phola were surveyed to determine the business model, supply chain, and quantity of fuels being sold to the households. The fuel source survey was conducted during a winter campaign in August 2025.

3.1 Approach To Study

3.1.1 Identification of fuel merchants

In conjunction with local teams in Phola, fuel merchants were identified in Phola. ARM engaged with the fuel merchants as part of the fuel survey and requested permission to conduct the survey.

3.1.2 Ethical framework utilised in fuel merchant engagement

As the fuel merchant's livelihood depends on the fuel business, our approach was framed

considering the following mandatory principles below:

1) Consent is first obtained from the fuel merchants to participate and share their information voluntary with us, in compliance with POPIA (2013). The participants were informed that results will be shared with Eskom.
2) Ensure that ethical research integrity and respect for all participants are upheld throughout the surveys.
3) The surveys were based on multistage stratified area probability cluster sample designs.
4) Due to the small scale of the survey, it was agreed that ARM will conduct the surveys with trained, Zulu-speaking employees as fieldworkers to accommodate the sample population.

5) The results will be anonymised to ensure that the identity of the fuel merchants is protected, and data will be stored securely.

3.1.3 SAFETY AND SECURITY OF THE FIELDWORKERS

A safety file was developed to ensure safe access and execution of the work by field workers. Detailed health and safety procedures were available to explain how to deal with potential Covid-19 incidents, robberies, electrical cords, car accidents, protest action, driving, electrical tools and more. The fieldworkers strictly adhered to Eskom life-saving rules (240-62196227).

3.2 FUEL SURVEY

3.2.1 PROCESS FLOW FOR FUEL SURVEY

Figure 3 highlights the process that ARM adopted to conduct the fuel survey. The fuel surveys were conducted in Zulu by ARM personnel on mobile devices. The data from these devices was securely transferred to the cloud in real-time on JotForm. Provided the fuel merchant provided consent, weighing of coal and wood was done after the interviews.

The fuel survey provided ARM personnel with a detailed, expert, objective perspective on the fuel merchants in the Phola airshed. It also allowed the ARM team to directly build strong face-to-face relationships and networks with the fuel merchants to understand their needs, wants and expectations.

Critically, by ARM personnel conducting the survey, it allowed the ARM project team to gain insight into the fuel merchants operating in the target area to evaluate and correct oversights in the Eskom PMV project plan. Where the fuel merchants provided consent, our team was also able to independently weigh (where applicable) the quantity of fuel being sold.

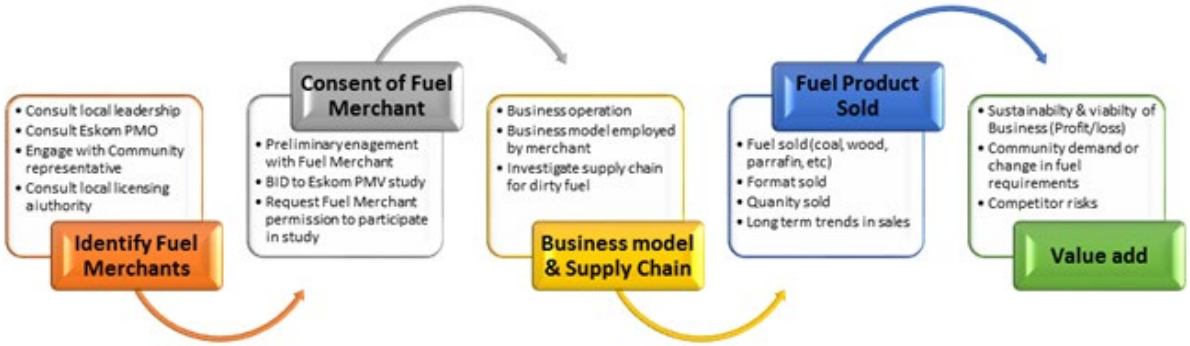

Figure 3: Process flow for fuel survey for Phola

3.2.2 Study Area

For the study, Phola was subdivided into three distinct wards (Figure 4) and fieldworkers interviewed fuel merchants who were operating in these wards.

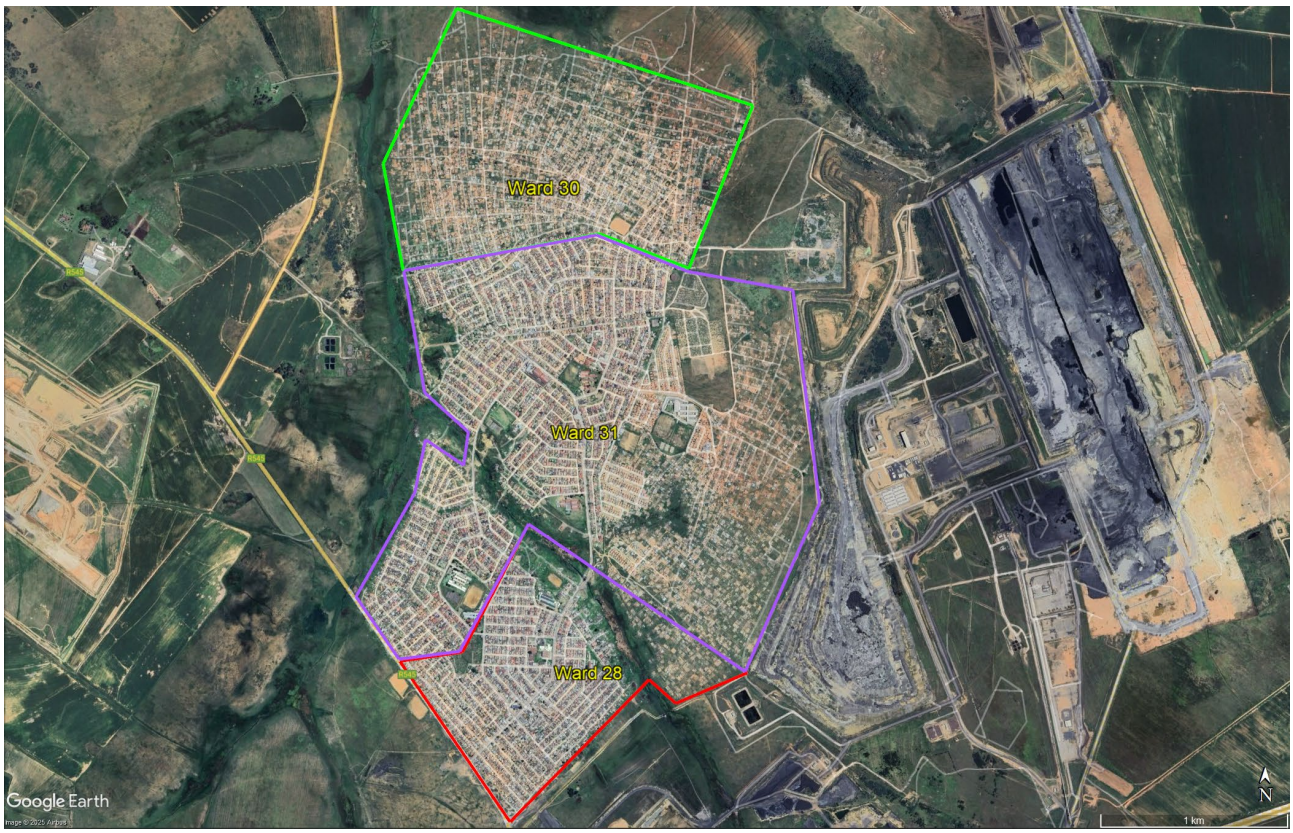

Figure 4: Wards Identified in the Phola Area

3.2.3 FUEL SURVEY QUESTIONNAIRE

A detailed fuel survey questionnaire (**Annexure 1)** was developed to capture the purchased fuel data and the perceptions of the fuel merchants.

4. RESULTS & DISCUSSION

4.1 Fuel Merchants identified in and around Phola

Eight fuel merchants were identified in the study and were approached for interviews. Figure 5 shows the location of each of these fuel merchants within the Phola area. The detailed interview response for each merchant is summarised in Annexure 3, while a summary is provided in the following sections. Detailed recordings are kept for future reference if required. One additional merchant was identified in Phola who sells coal from the back of their truck, but they were unavailable to be interviewed.

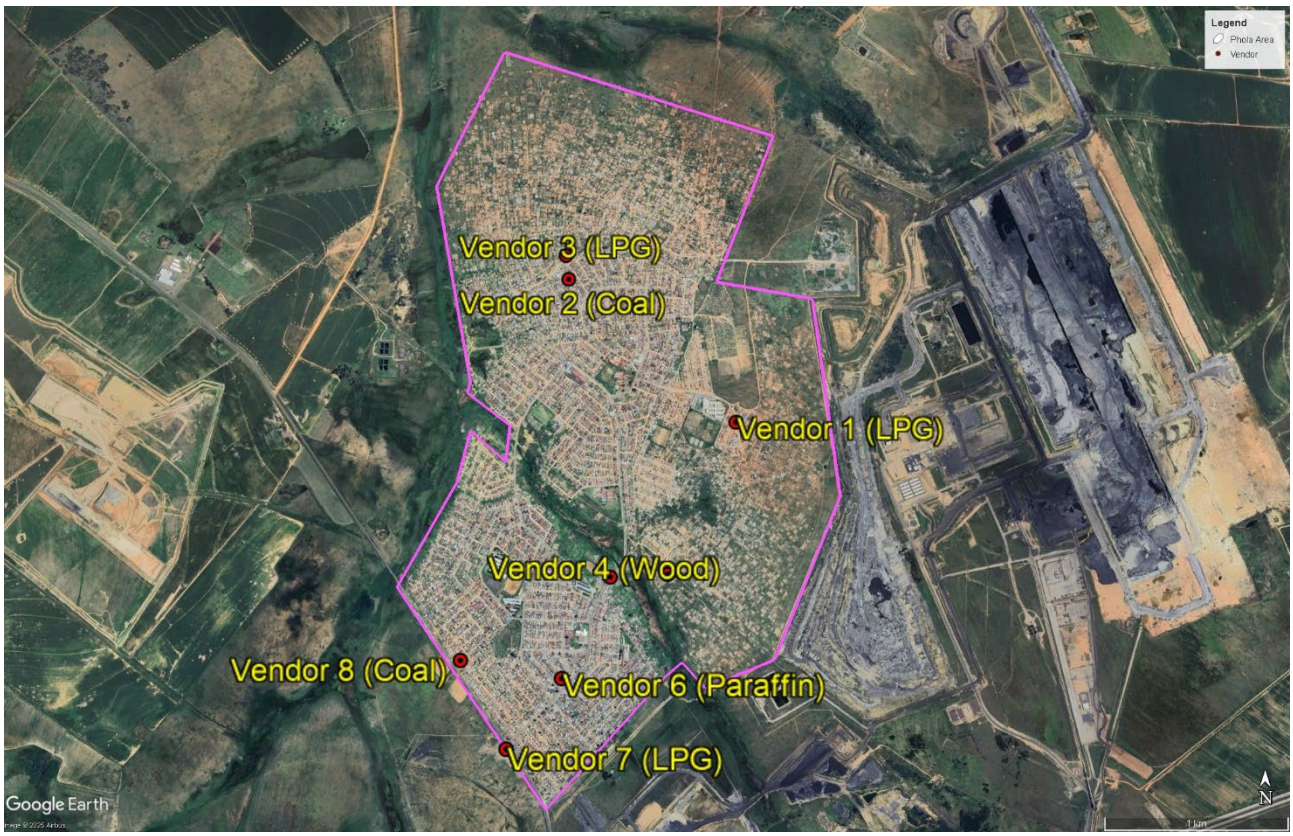

Figure 5: Locality map showing location of fuel merchants (red outline shows perimeter of Phola)

4.2 Fuel Merchants Profile

Table 3 provides a summary profile of the fuel merchants that were identified in the study. It is evident that there is a mix of fuels being sold in Phola. The fuel merchants in Phola are dominated by males. For the fuel merchants in Phola, the fuels business is their primary source of income. These

merchants are established businesses with the majority being in operation for a period of more than 5 years. This is an important point for Eskom to note to ensure that the Eskom air quality offset intervention is not misaligned with their current business operating model. It is key that Eskom proactively engages the fuel merchants to understand the opportunity and willingness of these fuel merchants to diversify their business model. For example, this could include these merchants undergoing supplier development by Eskom for them to be able to resell LPG canisters.

The fuel merchants have stated to ARM that any proposed future business model must be viable and sustainable for them to consider it. This is quite evident in how the fuel merchants were quite knowledgeable about their current business model and very aware of the other merchants in the area. Fuel Merchant C was very apprehensive at the start of the interview and was particular about understanding how Eskom would support the current fuel merchants in Phola. On the other hand, Fuel Merchant A was more approachable and gave greater detail in terms of her business and was well aware of air quality issues presented by the use of coal and wood in Phola and supported the air quality offsets initiative to assist in bringing cleaner air to Phola. The merchant did note it could be a challenge in certain areas in Phola, specifically Ward 30, as a large area of households do not have an electricity connection and therefore depend on alternate fuels such as coal.

When asked if the fuel merchants felt that other merchants were a threat, all merchants viewed no one as a threat, as they viewed it as something that is common in any business to have competition, and customers will go to merchants that are close to them or have better pricing.

The interviewed LPG suppliers all displayed a certificate given to them by the regional office of the Department of Mineral Resources and Energy (DMRE), along with the payment methods accepted (Cash, debit/credit card and EFT), and highlighted that credit is not allowed.

Table 3: Summary profile of Fuel Merchants

Fuel Merchant	Location	Gender	Age	Main Source of Income	Years spent selling fuels on premises	Fuel Sold
Fuel Merchant A	Ward 30	Female	Did not Disclose	Fuel Business	>5 years	LPG
Fuel Merchant B	Ward 31	Male	Did not Disclose	Bottle store	>5 years	Coal
Fuel Merchant C	Ward 31	Male	Did not Disclose	Did not specify	>5 years	LPG

Fuel Merchant D	Ward 28	Male	Did not Disclose	Shop	1-2 years	Wood
Fuel Merchant E	Ward 30	Male	Did not Disclose	Fuel Business	1-2 years	Wood
Fuel Merchant F	Ward 28	Male	31	Fuel Business	1 year	Paraffin
Fuel Merchant G	Ward 30	Male	Did not Disclose	Fuel Business	>5 years	LPG
Fuel Merchant H	Ward 30	Female	48	Fuel Business	20 years	Coal

4.3 Fuel Merchants Supplier Location

Based on the fuel merchants' feedback, it is evident that the different fuels are sourced outside of Phola. The coal originates from suppliers located in Delmas (Figure 6) and is transported to Phola by 3- or 4-ton trucks. Wood is sourced from Kriel, then delivered by van to Phola, where the fuel merchants cut the wood in their yard. The LPG merchants sourced their LPG from eMalahleni or Johannesburg, whilst the paraffin fuel merchant sourced from eMalahleni.

Table 4: Location from which coal and wood are sourced by Fuel Merchants

Fuel Merchant	Location from which Coal is sourced	Location from which Wood is sourced	Location from which LPG is sourced	Location from which Paraffin is sourced	Distance in km (Round trip to Phola)
Fuel Merchant A	N/A	N/A	Did not disclose	N/A	N/A
Fuel Merchant B	Delmas	N/A	N/A	N/A	90.2km
Fuel Merchant C	N/A	N/A	Johannesburg	N/A	222km
Fuel Merchant D	N/A	Kriel	N/A	N/A	93.2km
Fuel Merchant E	N/A	Kriel	N/A	N/A	93.2km
Fuel Merchant F	N/A	N/A	N/A	eMalahleni	58.8km
Fuel Merchant G	N/A	N/A	eMalahleni	N/A	58.8km
Fuel Merchant H	Delmas	N/A	N/A	N/A	90.2km

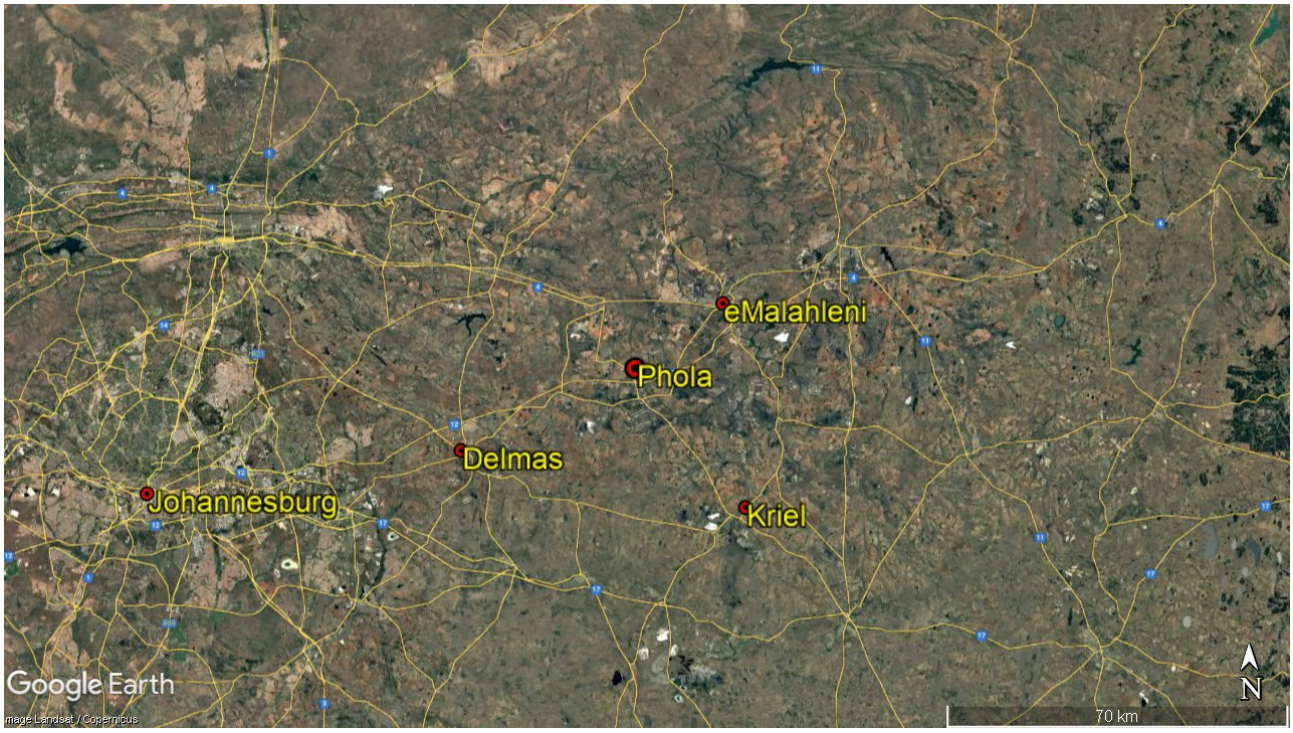

Figure 6: Locality Map shows location of suppliers to Fuel Merchants

4.4 Price, Quantity & Weight of Fuels Sold

4.4.1 Price & Weight of Fuels

An overview of the pricing is shown in Figure 7. The price of coal to the community varies from R110 to R120 per bag. Based on actual ARM measurements, the weight of a bag is variable and varies from 51 kg to 53 kg. Wood is sold for R25 to R30 per bundle and varies in weight due to the varying sizes in wood pieces (Figure 8). Fuel merchant F sells paraffin in 1 litre batches at R25 per bottle. LPG merchants C and G offer a variety of LPG bottle sizes for refills ranging from 1kg to 17kg (Figure 9), with fuel merchant A offering the 9kg bottle as a refill only. Refill pricing varied between the LPG merchants, with Merchant A offering refills at R300, whilst Merchant C and G charge R330. LPG exchange done by Merchant C and G was priced at R280. Merchant A, B and G noted that their fuels remained at the same price between winter and summer. The other merchants noted that their fuel pricing is higher in winter than in summer.

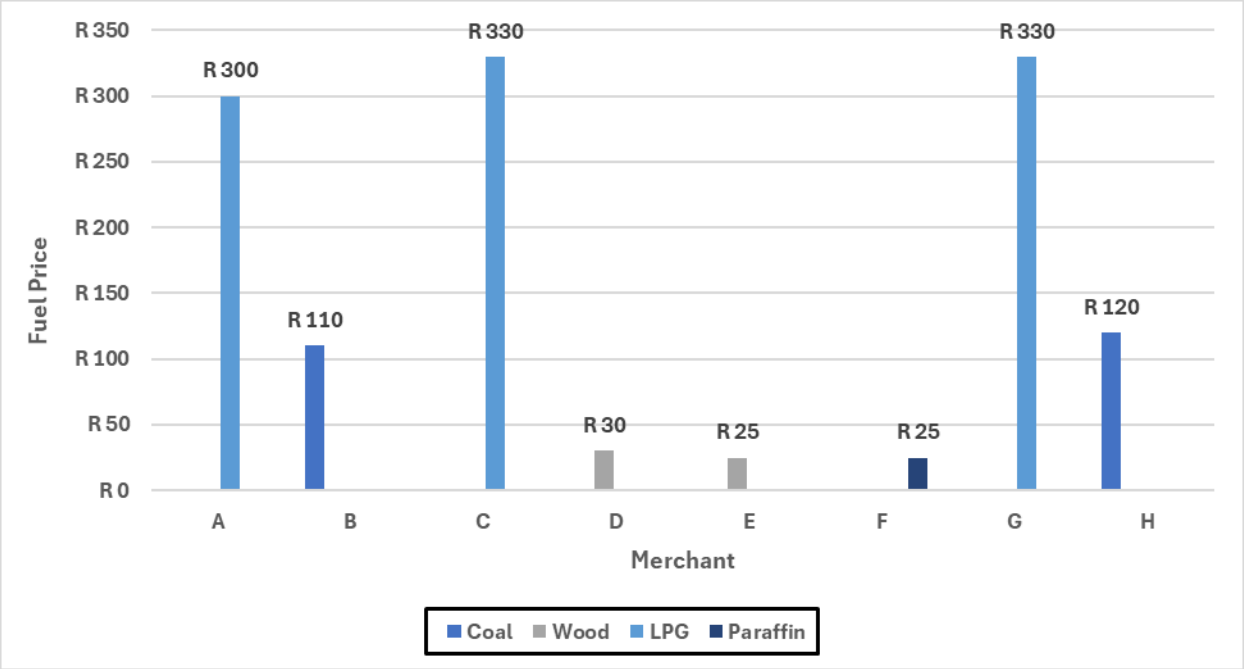

Figure 7: Price of fuels sold by fuel merchants

Figure 8: Wood sold by a Phola Merchant

4.4.2 Quantity of Fuels Sold

All of the fuel merchants provided their coal sales figures (Figure 9). Collectively, the LPG fuel merchants sold about 5 tonnes per month in winter. Coal merchant sales collectively were 16 tonnes per month in the winter period.

The fuel merchants did note that sales do tend to become lower in summer but were not able to give an indication of quantity. During the Census/Energy and Household surveys, more information will be obtained from the community in terms of actual quantities utilised.

In terms of the demand for fuels compared to a year ago, the two wood merchants, coal merchant B and LPG merchant A highlighted that the fuel demand was the same for their respective fuels, with the exception of LPG Merchant C and coal Merchant G, who mentioned that their respective fuel demand is lower. This contradicts the note mentioned by the wood merchants and merchant G that LPG demand is higher in Phola (Figure 10). The paraffin Merchant F noted that paraffin demand is lower in Phola than last year.

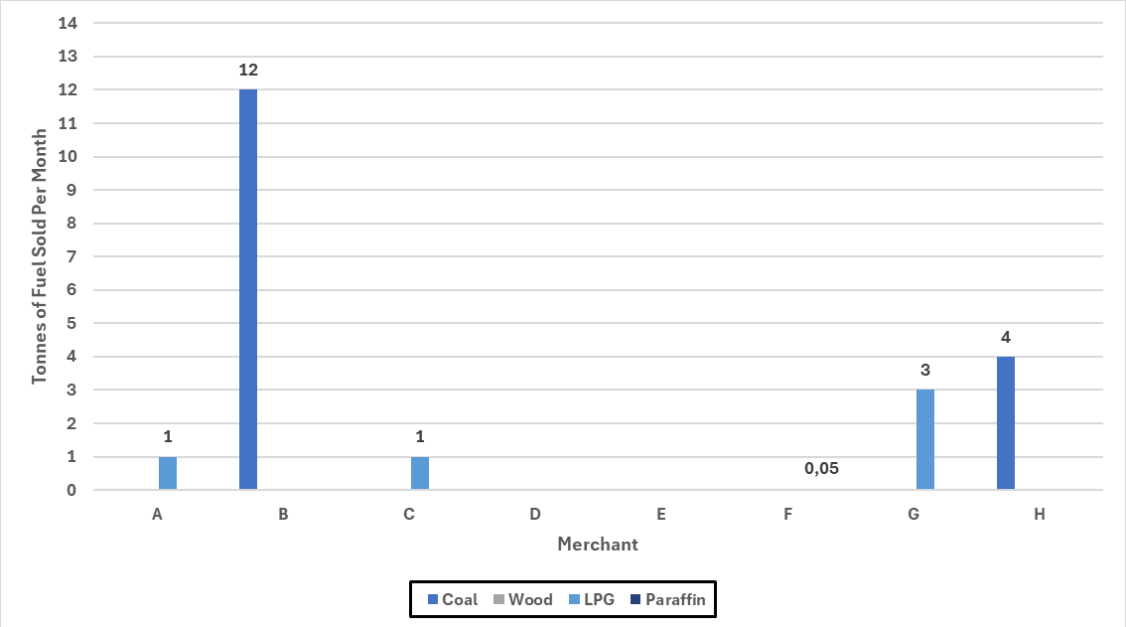

Figure 9: Quantity of fuels sold by Merchant

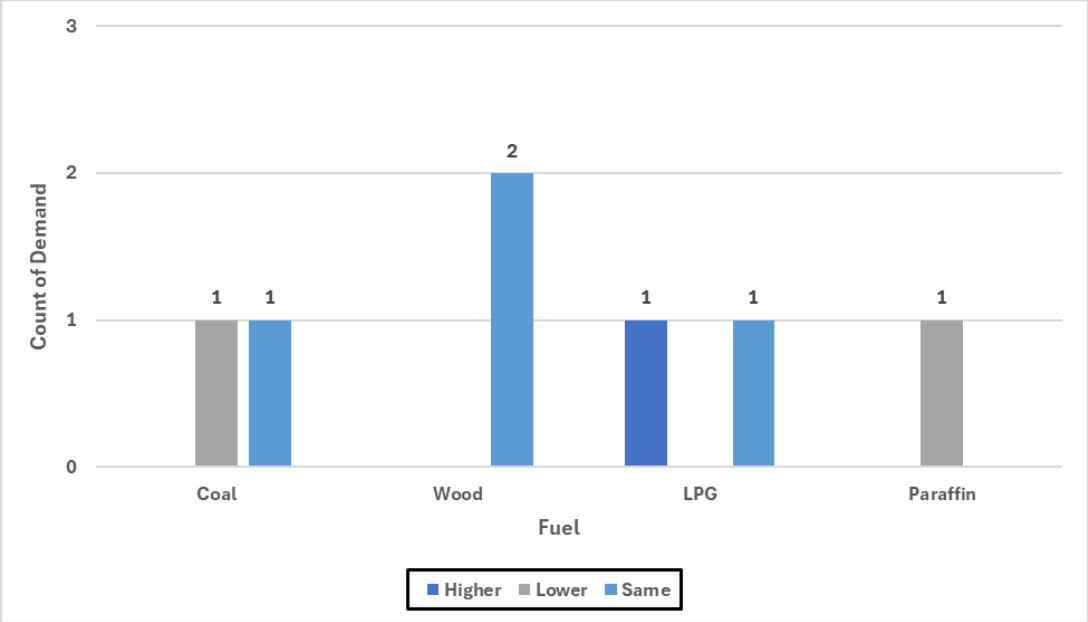

Figure 10: Demand for fuels according to fuel merchants, compared to a year ago

4.5 Fuel Merchants' Perceptions

Almost all the fuel merchants viewed electricity and LPG as being too unaffordable for consumers due to the high cost of buying electricity units and the high price of buying or refilling LPG canisters. Merchants did view paraffin as a fuel that is affordable to purchase in very small quantities, but few households would utilise it as one can only get the most energy benefit with higher amounts of paraffin used, which then gets expensive for the household, compared to buying wood or coal.

The buyers of fuel in the community mostly vary, with whoever is a member of the household coming to purchase the LPG, wood or coal. Responses indicated that electricity is the most commonly used energy source for cooking, lighting, and, to a lesser extent, for space heating and water, depending on affordability. It should be noted that LPG is also a prevalent energy source for cooking and space heating in areas with no electricity source, and in some cases used for water heating. Some of the merchants did indicate that solar is utilised by some households, but only for lighting purposes or utilising smaller solar units to charge their phones. Customers very often bought fuel supplies in cash or using debit/credit cards at the LPG merchants, with only Merchant H allowing for credit purchases for the coal.

4.6 BUSINESS MODEL ANALYSIS

A business model analysis helps determine how a business is able to make profit, and which parts of the value chain are most profitable. As energy markets can be highly regulated and competitive, especially in informal settings, it is important to understand the position of the business within the local market and recognise where inefficiencies are present and where market gaps can be identified. ARM approached the LPG and coal merchants in Phola to better understand their current business models.

It is to be noted that Merchant C and Merchant G did not wish to participate in the business model analysis.

It is also noted that many fuel merchants viewed electricity use a difficult energy source to measure due to the large number of households that are currently using bypassed electricity boxes. Hence, ARM will be able to further explore the view of electricity usage through the household survey exercise.

4.6.1 MERCHANT A

Merchant A has set up a small, corrugated-roof shed in Makause, with hand-painted signage on the side of the building, with a business certificate present on the premises. In terms of safety, the merchant has a fire extinguisher located close to the salesperson, which is serviced regularly. Storage of the LPG is within the building in a 1.5 tonne storage tank.

The business' target market is the residents in Phola as well as the schools, with the business exchanging 9kg cylinders, and offering refills on 3 and 5kg cylinders. The merchant does offer delivery services for exchanges where the customer will place an order via phone or WhatsApp and then schedule the delivery, with the delivery cost being R40. The customer will then provide the empty LPG cylinder to the merchant, who will then provide a filled LPG cylinder. Payment for this service is done either through cash, EFT or debit card.

When it comes to the refill process, the customer enters the secured refill area, and the merchant will then check if the cylinder is safety compliant. The cylinder is then weighed before and after filling to ensure accuracy, and then the customer exits with the filled cylinder. For the LPG exchange, the customer brings their empty cylinder. The cylinder is then inspected for safety and validity and then customer receives a filled cylinder of the same size/brand. Payment is made either through cash, EFT or card before the customer exits with the filled cylinder.

4.6.2 MERCHANT B

Merchant B operates from a well-set-up brick building that mostly serves as a bottle store location. The merchant supplies mostly those that are found in the Phola location area and does not charge for delivery to those that are based locally within Phola. The merchant mostly relies on sales originating from the bottle store business, with the coal merchant business serving as a secondary service.

Customers can arrange delivery or collection beforehand with the merchant via cell phone. This coal seller only sells coal in 50kg bags and utilises a scale to measure the coal bags. After the bag has been prepared for the customer, the customer will pay in cash. This merchant specified that they do not offer a credit option to their customers.

The merchant could not indicate what are their profit margins and would not delve deeper into their arrangements between themselves and their supplier.

4.6.3 MERCHANT H

As noted in the earlier sections, merchant H is the oldest operating fuel merchant in this study. Merchant H operates from her household, with the coal being stored in her yard. Her clients contact her via cell phone to pre-arrange collection of the coal or are able to make their way to her household to order and collect the coal.

Unlike Merchant B, Merchant H uses a wheelbarrow to measure the amount of coal to be sold. Once the coal has been measured, the customer can pay the merchant through cash, although some of the customers that are located nearby are allowed to purchase via credit. Merchant H did note that she does not offer any delivery services for coal.

As the same as Merchant H, she was not able to indicate the business's profit margins, nor was she able to give details in terms of the arrangements between the business and the coal supplier.

Figure 11: A merchant LPG Facility in Phola

4.7 Coal Quality Analysis

After obtaining the consent of two Coal Fuel Merchants (Merchant B and Merchant H), ARM purchased a bag of coal at ~ 25kg from each merchant, which was subsequently sent to an accredited laboratory for analysis. The analysis undertaken included a proximate, sulphur and calorific value (CV) analysis. This was done to gain a better understanding of the coal quality and its impact on pollutant emissions.

4.7.1 Emissions & coal quality

Coal burning results in emission of gaseous (SO_2, NO_x, CO_2) and particulate matter (both PM_{10} and $PM_{2.5}$). These pollutants, especially particulate matter and SO_2 are directly related to the coal composition. Proximate analysis measures the moisture, volatile matter, ash and fixed carbon contents in coal. The volatile matter in the coal is a proxy for the smoke/ particulate matter that is released during coal combustion. The lower the volatile matter, the lower the particulate matter emission. Volatile matter is determined in accordance with the ISO 562 standard method.

Ash content indicates the number of impurities in the coal. Ash is a diluent in the coal and is determined in accordance with the ISO 1171 standard method. Moisture is determined in accordance with SANS 5924 standard method and the results on an air-dry basis are used to express results of other analyses on a dry basis. Moisture is also a diluent to the coal. Fixed carbon content is determined by difference (i.e. 100 - ash + moisture + volatile matter). It is the fixed carbon that gets combusted and produces CO and CO2.

Sulphur (S) in the coal forms part of the ultimate analysis which include Carbon (C), Hydrogen (H), Nitrogen (N) and Oxygen (O) that are present in the organic structure of the coal. Sulphur in coal can occur either as sulphate, organic and/or mineral form. However, irrespective of the form, it will report as SO_2 during coal burning. Sulphur in the coal can be controlled via amongst others, the beneficiation of coal which also reduces the ash content of the coal. Nitrogen in the coal contributes somewhat to NOx emissions although a major part of nitrogen during combustion comes from the air. Nitrogen in coal is hence not controlled for coal utilisation. Carbon, Hydrogen and Nitrogen in the coal are determined in accordance with ASTM D5373 standard method, whilst Sulphur is determined in accordance with ASTM D4239. Oxygen is determined by the difference.

The other property of relevance to this study is the calorific value (CV) of coal. This is the heating value of coal and is measured in megajoules per kilogram (MJ/kg) using the ISO 1928 standard method. The CV of the coal is diluted by ash and moisture which are not combustible. One of the South African classification systems uses CV to decide the grade of coal (Table 5). According to this

system, A-grade coal would have a CV of >27.5 MJ/kg (ad) B-grade >26.5 MJ/kg, C-grade >25.5 MJ/kg and D grade >24.5 MJ/kg. All these grades are supplied to the domestic market through merchants.

Table 5: South African local coal classification system

Parameter	A-grade	B-grade	C-grade	D-grade
CV in MJ/kg (ad)	>27.5	>26.5	>25.5	>24.5

4.7.2 Coal Analyses Results

Results of the coal samples obtained from Phola fuel merchants (Fuel Merchants B & H). Fuel Merchant B sample in Phola originates from very low-grade coal that has a CV of only 19.5 MJ/kg which puts it below the D grade coal on the classification system. This coal should be the cheapest coal in the market. The total sulphur in this coal is relatively low at 0.46%, due to a very high ash content. The volatile matter is however relatively lower which bodes well for particulate matter emissions to atmosphere.

Table 6: Results from coal analysis (air dry basis(ad))

Sample	%Moisture	%Ash	%VolatileMatter	%FixedCarbon	CalorificValue (MJ/kg)	%Total S
Fuel Merchant B	3.3	32.5	17.9	46.3	19.5	0.46
Fuel Merchant H	1.8	20.4	19.4	58.5	26.1	0.74

Fuel Merchant H is supplied with C grade coal with a CV of 26.1, whilst Fuel merchant B is supplied with below Grade D coal with a CV of 19.5. The total sulphur in the coal supplied to Fuel Merchant B is lower (i.e. 0.46% (ad)) when compared to Fuel Merchant H. The total sulphur in the coal supplied to Fuel Merchant H is higher at 0.74% (ad). Fuel merchant B's coal contained a higher ash content than Fuel merchant H at 32.5%.

Merchant B will contribute significantly to the SO_2 localised emissions loading in the area Compared to coal burned from Merchant H), due to the low price and relatively larger volumes, despite the lower sulphur content.

5. CONCLUSION

Currently, coal and wood are provided by the fuel merchants at an affordable price to the Phola community. However, the poor quality of the coal supplied in Phola is of concern from an air quality perspective, but it is understood to be available on the user's doorstep. There is a large energy mix of suppliers within Phola, with a high number of LPG merchants present. The high price of gas (LPG) and electricity was cited by fuel merchants as a limitation to introducing cleaner fuels (as was expected), but LPG remains a favoured alternative fuel source in areas without electricity. However, residents are limited to using cash as the merchants do not allow for credit purchases for coal and wood, except for one interviewed coal merchant (Coal merchant H). LPG is available in small quantities as refills starting from as little as 1kg at R38 to 19kg at R700 and is not available on credit.

The improvement opportunities identified for the PMV project are diverse:

- Coal quality is poor, and cleaner coal will already alleviate the air quality problem to some extent.
- Fuel merchants can provide a valuable resource in terms of established infrastructure, customer base and skills to introduce alternative fuels.
- The safety of the current LPG distribution network should be investigated and improved. One major LPG incident can result in a return to coal burning.
- Alternative funding models for the community should be considered when alternative fuels are introduced, for example, to accommodate credit facilities.
- The spike in coal and wood use during winter (with resultant emissions) can be alleviated by a combination of better insulation and improved fuel types. The improvement benefits need to be communicated to users.
- The next survey activities will explore the options in more detail with the communities directly, as opposed to the fuel merchants' perspectives.

The survey of fuel merchants provided a wealth of information to guide the next activities of the PMV project. The future community surveys will provide more accurate information on fuel source use as experienced by households, compared to the perspective of fuel merchants provided in this report. The questionnaires used in future surveys can now be amended.

6. ACKNOWLEDGEMENTS

Air Resource Management would like to thank the fuel merchants for their assistance in this study.

7. REFERENCES

DFFE. (2020). State of the Air report 2019. Department of Forestry, Fisheries and Environment. *National Association of Clean Air Conference Proceedings. October 2020.*

DME (Department of Minerals and Energy, South Africa) (2001). 'National Electrification Programmes (NEP) 1994-1999: Summary Evaluation Report'. DME, Pretoria

Goede, J. F., & Hofstede, G. J. (2022). A sociotechnical approach to aid household fuel decisions in South African townships. Social Sciences International Research Conference, Mauritius. https://commerce.nwu.ac.za/social-sciences-international-research-conference/ssirc-2022 pp. 1291-1306.

Israel-Akinbo, Sylvia & Snowball, Jeanette & Fraser, Gavin. (2018). An Investigation of Multidimensional Energy Poverty among South African Low-income Households. South African Journal of Economics. 86. 10.1111/saje.12207.

Langerman, K. E., Pauw, C. J., Smith, H. J., & Piketh, S. J. (2018). Moving households to cleaner energy through air quality offsets. 2018 International Conference on the Domestic Use of Energy.

Matimolane, M (2020) *Eskom Air Quality Offset Plans: Progress Report March 2020, ENV20-R47*. Eskom Sustainability Division: Environmental Management.

NEM: Air Quality Offsets Guideline. South Africa. National Environmental Management Act (No. 107 of 1998): Air quality offsets guideline, (2016).

ANNEXURE 1 FUEL MERCHANT RESPONSES

ANNEXURE 2

FINAL FUEL SURVEY QUESTIONNAIRE

Eskom Masibambisane fuel energy services survey August 2025	Air Resource Management (Pty) Ltd and Eskom (Pty) Ltd Tel _____

Introductory note (read to respondent): Hello, my name is …… I am a researcher from Air Resource Management/ Eskom's Masibambisane Project.

We are conducting a survey for Eskom about fuel energy use in Phola. We are interested in learning more about the energy sources that different households use for lighting, cooking, and heating, as well as the affordability and safety of coal and other energy sources. We ask that you help us by participating in a short interview, which should only take about 30 minutes. The information you give will be kept confidential and you can withdraw at any time.

SECTION I: INTERVIEW INFORMATION

QUESTIONNAIRE NUMBER

I.1 Fieldworker name:			I.5 Area		
I.2 Date of survey			I.6 Household No		
I.3 Respondent age			I.7 Cell phone No		
I.4 Respondent sex	F	M	I.8 Consent has been read and obtained?	Yes	No
I.9 Signature of respondent					

SECTION A: PURCHASED FUEL

A.1 Could you please tell us how long you have been selling fuels at these premises?					
Years	**(1) 0-1 years**	**(2) 1-2 years**	**(3) 2-3 years**	**(4) 3-4 years**	**(5) >5 years**
Number					

A.2 What is your main source of income?				
(1) Fuels Business	**(2) Salary from another Job**	**(3) Grant**	**(4) Pension**	**(5) Other (Specify)**

A.3 What fuels do you sell at your business? (Mark all applicable)				
(1) Electricity	**(2) Coal**	**(3) Wood**	**(4) Paraffin**	**(5) Other (Specify)**

A.4 What is the price, quantity, and availability of the fuels that you sell at your business?				
Fuel	**Unit**	**Price per Unit**	**Quantity**	**Availability**
Electricity	**kwh**			
Coal	**kg**			

Wood	kg. equivalent			
Paraffin	liter			
LPG	cylinder			
Battery (dry cell)	voltage			
Other (Specify)	kg. equivalent			

A.5 What is the total quantity of the fuels you have sold on average per month?

Fuel	Unit	Quantity sold per month	Highest demand in Summer or Winter?
Electricity	kwh		
Coal	kg		
Wood	kg. equivalent		
Paraffin	liter		
LPG	cylinder		
Battery (dry cell)	voltage		
Other (Specify)	kg. equivalent		

A.6 Where do you get the fuels you sell at your business? (Mark all applicable)

Fuel	In the township	Outside of the township (Specify)
Electricity		
Coal		
Wood		
Paraffin		
LPG		

Battery (dry cell)		
Other (Specify)		

A.7 How do you transport the fuels to your business? (Mark all applicable)		
Fuel	**Supply Source (Truck, Car, Motorcycle, Van, Animal, Handcart, Hand-carried, Other)**	**Time required to go to supply source and Return to Business (Specify in Hours and Minutes)**
Electricity		
Coal		
Wood		
Paraffin		
LPG		
Battery (dry cell)		
Other (Specify)		

A.8 How do you pay for the fuels that you buy from your supplier? (Mark all applicable)			
Fuel	**Cash**	**Credit**	**Barter**
Electricity			
Coal			
Wood			
Paraffin			
LPG			
Battery (dry cell)			
Other (Specify)			

A.9 How does your customer pay for the fuels that they buy from you? (Mark all applicable)			
Fuel	**Cash**	**Credit**	**Barter**
Electricity			
Coal			
Wood			
Paraffin			
LPG			
Battery (dry cell)			
Other (Specify)			

A.10 State person(s) with the following responsibilities				
Energy source used	**(a)Who decides to buy and when to buy?** (man/ woman / daughter/ son /….)	**(b) Who comes to fetch/buy?** (man/ woman / daughter/ son /…..)	**(c) Who pays?** (man/ woman / daughter/ son /….)	**(d) How much do they buy/fetch at a time?**
(a) Electricity	(1)	(1)	(1)	(1) R
(b) Paraffin	(2)	(2)	(2)	(2) R
(a) LPG / gas	(3)	(3)	(3)	(3) R
(b) Coal	(4)	(4)	(4)	(4) R
(c) Wood (bought)	(5)	(5)	(5)	(5) R
(d) Dung	(6)	(6)	(6)	(6)

A.11 What is the price of fuels sold now compared to a year ago?			
Fuel	**Lower**	**Higher**	**Same**
Electricity			
Coal			

Wood			
Paraffin			
LPG			
Battery (dry cell)			
Other (Specify)			

A.12 What is the Phola community's demand for fuel now compared to a year ago?

Fuel	Lower	Higher	Same
Electricity			
Coal			
Wood			
Paraffin			
LPG			
Battery (dry cell)			
Other (Specify)			

A.13 What is the price of fuel in Winter compared to Summer?

Fuel	Lower	Higher	Same
Electricity			
Coal			
Wood			
Paraffin			
LPG			

Battery (dry cell)			
Other (Specify)			

A.14 Do you have any difficulties in obtaining the fuels you sell at your business? (Mark all applicable)

Fuel	Availability	Price	Distance	Other
Electricity				
Coal				
Wood				
Paraffin				
LPG				
Battery (dry cell)				
Other (Specify)				

A.15 Are there any competitors selling the following fuels in Phola?

Fuel	Yes	No
Electricity		
Coal		
Wood		
Paraffin		
LPG		
Battery (dry cell)		
Other (Specify)		

A.16 Do you see competitors as a risk to your fuels business in Phola?		
Fuel	**Yes (Specify Reasons)**	**No**
Electricity		
Coal		
Wood		
Paraffin		
LPG		
Battery (dry cell)		
Other (Specify)		

A.17 How much longer do you see yourself continuing your fuel-selling business at Phola?					
Years	**(1) 0-1 years**	**(2) 1-2 years**	**(3) 2-3 years**	**(4) 3-4 years**	**(5) >5 years**
Number					

A.18 Can we get your consent to weigh the fuels been sold here?		
Yes	**No**	**If No, could please provide a reason (Optional).**

A.19 (Only if answer is Yes to Question A.18) Specified weight of fuel sold and actual weight measured				
Fuel	**Specified Weight**	**Measured Weight 1**	**Measured Weight 2**	**Measured Weight**
Coal				
Wood				
Paraffin				
LPG				
Battery (dry cell)				

Other (Specify)				

SECTION B: FUEL MERCHANT PERCEPTIONS

B.1 What types of energy are used for the following household tasks in Phola? Please choose more than one if necessary. Rank them from most frequently to least frequently used (top 5).										
	1. Electricity	**2. LPG Gas**	**3. Paraffin**	**4. Wood**	**5. Coal**	**6. Candles**	**7. Ethanol gel**	**8. Solar**	**9. Dung**	**10. None**
Example – cooking	*1*	*5*	*2*	*3*	4					
Cooking										
Lighting										
Heating of Home in Winter										
Water heating										

B.2 Do you think that the cost of fuel for the customer is affordable?			
Fuel	**Yes**	**No**	**Don't know**
Electricity			
Coal			
Wood			
Paraffin			
LPG			
Battery (dry cell)			
Other (Specify)			
B.3 How much of the household budget do you think is spent on fuel?			
Fuel	**Little**	**A lot**	**Don't know**

Electricity			
Coal			
Wood			
Paraffin			
LPG			
Battery (dry cell)			
Other (Specify)			

B4 What do you think the Phola households did because of the increase in electricity prices in the last 12 months? (Choose one option)	
Continued to use the same level of electricity and paid the extra amount for it	
Reduced the amount of electricity used	
Used other energy sources, such as paraffin, gas, coal, wood, and candles	
Other (specify)	
Don't know	

B.5 Do you think the fuel meets the household's needs?			
Fuel	**Yes**	**No (Why not)**	**Don't know**
Electricity			
Coal			
Wood			
Paraffin			
LPG			
Battery (dry cell)			
Other (Specify)			

B.6 Are there any alternate fuels for Phola?		
Yes (Specify)	No	Don't know

B.7 What are the barriers to using these alternate fuels (Mark all applicable)				
Fuel	Availability	Price	Distance	Other

SECTION C: GENERAL COMMENTS

C.1 Are there any general comments?

THANK YOU FOR YOUR TIME!

ANNEXURE 3

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