

# Reduced Consumption of Platinum Group Metals in Automotive Industry: A Threat to South African PGM's Industry? Needs for Proactive Palliative Remediation.

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**Abstract**—Adoption of electric vehicles (EVs) is rising in popularity as the global automotive industry undergoes a significant shift due to environmental concerns and the reduction of greenhouse gas emissions (GHG). The platinum group metal (PGM) business, which has historically been one of the world's top producers of PGM, has been significantly impacted by this change. While there is still debate on the effects of EV adoption on the PGM industry, our survey has revealed a range of opinions. To acquire insight into the viewpoints of individuals from a variety of backgrounds, qualitative questionnaires were administered. While some participants have drawn attention to the challenges posed by economic disparity and the exclusivity of EVs in South Africa, some players have recognized EV adoption as an opportunity to innovate, diversify, and foster economic growth in South Africa's PGM business. Participants have suggested a variety of strategies to seize the potential, including local industrial ownership, investment in research and development infrastructural development, and environmental responsibility. They have also emphasized the value of generating jobs, improving skills, inventing, and spending money on education. The majority of participants were upbeat about the future of the electric vehicle (EV) market, indicating that both EVs and PGM have bright prospects. Even though our analysis provides insightful data, more investigation is required to examine the moral and ethical ramifications of PGM purchases in the age of electric vehicles and to track the industry's practical responses to these changes. An indication on the circularity threat was also made

**Keywords**—Electric vehicles, Platinum group minerals, adoption, threat, palliative remediation..

## I. INTRODUCTION

The Urgent need to address environmental challenges, cut greenhouse gas (GHG) emissions, and switch to sustainable energy sources has resulted in a significant shift of the worldwide automotive sector. Due to their superior efficiency and environmental friendliness over conventional internal combustion engines (ICE), electric vehicles (EV) are a crucial component of this shift. The demand for the materials required for the development and manufacture of electric vehicles (EVs) has increased as the world turns its attention to a low-carbon future, which has had a profound effect on the industries associated to these materials. In recent years, road transportation electrification has moved more quickly. In 2020, according to [1], there were over 10 million fully electric (BEV), hydrogen fuel cell (FCV) and plug-in hybrid electric vehicle (PHEV) vehicles in the world.

The Platinum Group Minerals (PGM) industry in South Africa has a direct connection to catalytic converters, essential components of vehicles with internal combustion engines. The rarest elements on Earth, the platinum group metals (PGMs), constitute a class, and because of their unique physical and chemical properties, they are a key part of many important technologies. PGMs, including platinum, palladium, and rhodium, are employed in catalytic converters to convert dangerous pollutants from exhaust fumes into less hazardous compounds [2]. Its traditional application is in the emission after-treatment systems of vehicles with internal combustion engines.

With a considerable portion of the world's PGM reserves, South Africa has historically been a prominent producer and supplier of these precious metals. The largest producer of PGMs (48%), chromium (44%), and manganese ore (31%), South Africa also makes a substantial contribution to the production of gold, coal, iron ore, diamonds, vanadium, and titanium minerals worldwide [3]. In contrast to the past two centuries, mining in South Africa operates today under very stringent political, social, and economic circumstances [4].

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Due to its tight ties to the automobile industry, the Platinum Group Minerals sector is currently at a turning point. The automobile industry plays a crucial role in catalyzing the decrease of dangerous emissions from car exhaust systems and is a crucial component of the global platinum cycle. The platinum stock used in automotive catalytic converters has reached its maximum level due to tougher laws addressing vehicle emissions since the 1970s [5]. The average yearly demand for automotive platinum catalysts has increased to 85 tons since the late 1990s, accounting for almost 40% of all platinum consumed globally [1]. However, since electric vehicles don't require exhaust catalysts, the growing popularity of electric propulsion systems in the automobile industry could put pressure on the traditional demand for PGMs.

There has been a rapid switch from gasoline-powered cars to electric vehicles (EVs) as a result of ecological concerns and governmental laws. The automobile industry is currently working on electric vehicle (EV) technology, which has the potential to revolutionize the sector and reduce its reliance on fossil fuels. According to [6], it is projected that over time, both the number of electric vehicle operations and their environmental consequences will increase. The largest manufacturers in the world already provide one or more EV models each year, including Tesla. Since electric vehicles are powered by batteries rather than internal combustion engines, they are expected to produce less exhaust pollution than conventional vehicles [7]. As one of the hardest sectors to decarbonize, the use of EVs has the potential to be a game-changer for combating climate change and lowering air pollution.

The connection between the electric vehicle (EV) and platinum group minerals (PGM) industries is growing more and more significant as the automotive industry undergoes this transition. If the use of traditional internal combustion engines (IC engines) and their catalysts falls as the use of electric vehicles increases, opportunities for the PGM sector may be harmed [8]. The need for PGMs and catalytic converters may change as more nations and customers switch to electric vehicles [9].

This alteration may also prompt PGM producers to consider diversification, especially those who heavily rely on the catalytic converter industry. Supply Chain Diversification, the transition to EVs offers PGM-producing countries like South Africa the ability to diversify their economies and reduce dependency on a single industry [10]. These countries should consider ways to repurpose these minerals for something outside catalytic converters, including hydrogen fuel cells or electric vehicle batteries. Even though electric vehicles (EVs) have a favorable environmental impact, there may still be sustainability concerns. Resource depletion, environmental consequences, and working conditions are all problems associated with the mining and processing of lithium, cobalt, and nickel for EV batteries and components [11].

PGMs are utilized in a variety of other products, including electronics, medical equipment, and fuel cells for hydrogen-

powered cars. As a result, the drop in demand for catalytic converters that the change may bring about may be partially countered by the demand for PGMs in these other applications. Additionally, even though this transformation may have a significant impact on demand overall, other factors including legislative changes, technical improvements, and market dynamics may also have an impact.

## II. MATERIALS AND METHODS

### A. Sampling Strategy

The convenience sampling approach was used to select individuals who fit the criteria based on their accessibility and willingness to participate. People were contacted either in open spaces or online.

A set of inclusion criteria was used to determine who was eligible to participate. Any South African PGM user who is presently residing in South Africa was classified into five categories: lecturer/professor, household consumer, industry professional, government official, and student.

### B. Questionnaire Development

The purpose of the qualitative questionnaire was to get in-depth replies from respondents regarding their comprehension of how EVs will impact the PGM company. It employed open-ended questions that would generate thorough varied responses to gain a deeper knowledge of participants' thoughts, feelings, and views.

### C. Open-Ended Questions:

In your opinion, do electric vehicles pose a threat to the platinum group minerals (PGMs) industry in South Africa?

How do you envision the South African PGM industry capitalizing on these opportunities? Please share your thoughts.

Are you aware of any environmental concerns related to traditional platinum group minerals (PGMs) mining practices in South Africa? Please elaborate.

In your opinion, what steps should the South African PGM industry take to navigate the potential challenges and seize opportunities presented by the rise of electric vehicles?

Is there anything else you would like to share or discuss regarding the impact of electric vehicles on the platinum group minerals (PGMs) industry in South Africa?

### D. Refinement Process

The question development process began with brainstorming sessions using the Delphi technique. A broad list of potential questions was generated to cover different facets of the research study. The initial questions were evaluated for clarity and relevance, then refined to ensure they were concise, easy to understand, and directly related to the study's objectives.

A small group of 5 individuals who were familiar with the research study participated in a pilot test of the questionnaire. The feedback was collected to identify any confusing or ambiguous questions and adjustments were made accordingly.

The refined questionnaire was reviewed by peers not directly involved in its creation, which ensured a fresh perspective and helped in fine-tuning the questions for comprehensibility and neutrality.

Input from external subject matter experts was sought to ensure that the questions adequately covered the key dimensions of the program and were phrased in a way that would encourage thoughtful responses. The questionnaire underwent a final review to ensure that the questions aligned with the aim of the study and would yield the desired insights. The enhanced qualitative questionnaire was created to allow participants to express their genuine experiences and viewpoints, and by allowing participants to assess their survey experience on a scale of 1 to 10, which helped to fully comprehend the impact of the study.

#### E. Data Collection :

The responses were monitored as they came in to track the progress of data collection. Any technical issues or questions from participants promptly were addressed. An online Survey Platform that was used was Google Forms, using various Distribution Channels, the survey link was distributed through email invitation, social media posts on Facebook and WhatsApp. Participants accessed the link by directly clicking on the link and had a duration of 1-2 minutes.

#### F. Validity and Reliability

Measures taken to enhance the validity of the research findings, ensuring that they accurately represent the participants' perspectives and experiences. Multiple data sources, methods, or perspectives were employed to cross-verify and validate the findings by comparing the results with existing literature. Findings, analysis process, and interpretations were discussed with colleagues who are familiar with qualitative research. Own potential biases and preconceptions were acknowledged throughout the research process. To enhance the Reliability of the findings, a thorough record of the analysis process, including decisions made, and evolving interpretations were maintained. Another researcher reviewed a portion of the data and categories to identify any discrepancies or areas that needed clarification. Sufficient time was spent engaging with the data to develop a deep understanding of the content.

#### G. Ethical Considerations

Ethical approval was obtained from the Faculty of Engineering and the Built Environment Ethical committee..

### III. FINDINGS AND DISCUSSION

The main objective of this research was to examine whether the growing preference for electric vehicles poses a risk or a possibility for the platinum group metals (PGMs) industry in South Africa. Significant viewpoints from members of various groups, such as students, professors, and household consumers, were gathered by using qualitative questionnaires as research tools. The analysis of the results and the

investigation of their implications for the PGM industry will be done in this section devoted to discussion.

□ A total of 31 individuals did the survey, figure 1 below shows the proportion of each category, with lecturer/Professor, other and industry professionals having the least proportions of 3,2%, 3.2% and 6.5% respectively.

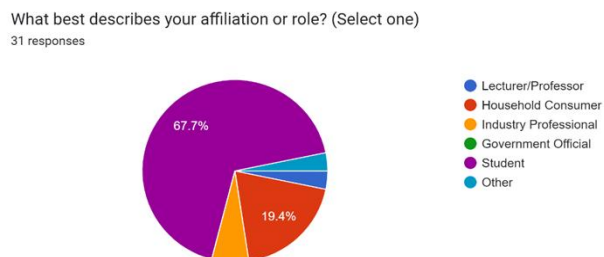


Fig. 1: Affiliation question.

Fig. 1 displays the association of the individuals who took part in the survey, comprising a varied range of respondents including educators and professionals from various industries. This wide range of diversity indicates that there is a variety of different viewpoints regarding the topic.

The respondents were asked about how much are they familiar about the concept of the research study with individuals who were moderately familiar with the concept having the highest %proportion.

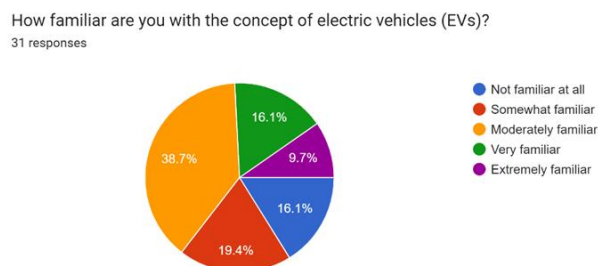


Fig. 2: Familiarity Question.

Fig. 2 shows that a significant number of participants reported having a moderate level of familiarity with the subject matter of our research study. The degree of familiarity displayed here indicates that the members of the sample population have enough knowledge to offer well-informed viewpoints. When checking the awareness of the individuals on the connection between the PGM industry and catalytic converters, with the majority of them about 50% not being aware of the connection.

Are you aware of the platinum group minerals (PGMs) industry's connection to catalytic converters in internal combustion engine (ICE) vehicles?  
31 responses

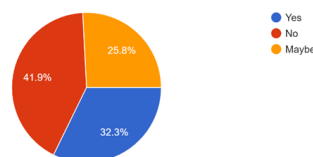


Fig. 3: Awareness Question

A key finding is highlighted in Figure 3: roughly 50% of the respondents were unaware of the connection between the PGM industry and catalytic converters. The lack of information in this area may point to the need for improved educational and public awareness campaigns regarding the significance of PGMs in various industrial applications. The individuals were asked on their opinion, on whether electric vehicles pose a threat to the platinum group minerals (PGMs) industry in South Africa, with 50% of them being neutral, each opinion was supported by a statement.

In your opinion, do electric vehicles pose a threat to the platinum group minerals (PGMs) industry in South Africa?  
30 responses

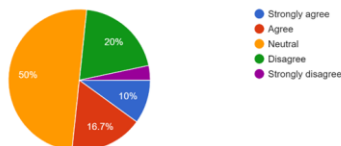


Fig. 4: Opinion Question.

One respondent said “The rise of electric cars would only serve as a catalyst for efficiency in the industry and push for more sustainable practices. It will also create the need for ingenuity and greater diversification in the space in terms of the uses of the minerals. This would lead to less dependency on a single industry (moto industry) and more opportunities than previously thought in the country”. While another said “Electric vehicles still have a long way to go in replacing traditional combustion engine vehicles and with price of electricity ever increasing, they will remain a luxuries choice for the foreseeable future”. Participants expressed that as much as electric vehicles are being adopted all around the world posing a threat to the PGM industry, South Africa could benefit in terms of having more opportunities to export PGM’s but since South Africa is still a third world country, more people are still struggling, hence electric vehicles is still a thing for the rich hence EV, don’t really pose a threat.

According to the results presented in Figure 4, there is a split in opinions regarding the impact of electric vehicles (EVs) on the precious metal group (PGM) industry. It shows that 50% of the participants remain neutral on this matter. The complexity of the issue was revealed through statements made by participants, thereby confirming these opinions. Respondents expressed various opinions, with some highlighting the opportunities for innovation and expansion within the PGM industry due to the adoption of electric vehicles. Some individuals pointed out the existing economic differences in South Africa and proposed that the relatively expensive nature of electric vehicles may prevent them from posing an immediate concern, as it restricts their availability to a wider population. The participants were asked on whether they believe there are opportunities for the platinum group minerals (PGMs) industry in South Africa due to the rise of electric vehicles, with 45.2% of them agreeing.

Do you believe there are opportunities for the platinum group minerals (PGMs) industry in South Africa due to the rise of electric vehicles?  
31 responses

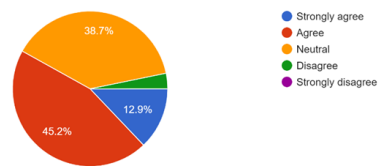


Fig. 5: Believe Question.

According to Fig. 5, nearly half of the participants (45.2%) expressed consensus on the presence of favorable prospects for the PGM industry in South Africa as a result of the increasing popularity of electric vehicles. This discovery indicates that many of the participants recognize possible advantages even though they are aware of potential difficulties. Given different upcoming opportunities with most potential according to literature for the PGM industry in South Africa due to rise of EV’s, with Advanced battery technologies and diversification into other industries being the one with the most votes of 61.3%.

Which specific areas do you think offer the most potential opportunities for the PGM industry in the context of electric vehicles? (Select all that apply)  
31 responses

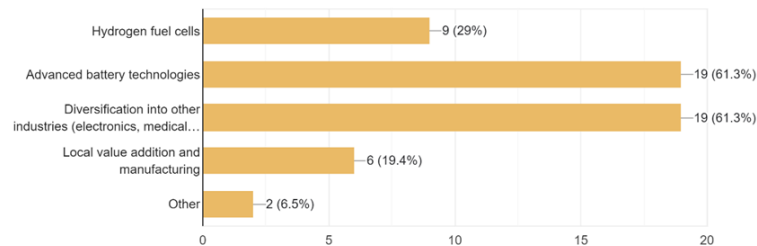


Fig. 6: Opportunities with most potential.

According to Fig. 6, the PGM industry in South Africa views advanced battery technologies and expansion into different sectors as having the greatest potential, mainly because of the increasing popularity of electric vehicles. This is consistent with the literature's indication that these areas have the potential for development and long-term viability. Insights shared by participants regarding seizing opportunities.

Insights shared by participants, through quotes and explanations, offer valuable information on approaches to making the most of opportunities in the PGM industry.

Ownership of manufacturing processes in South Africa was highlighted as crucial by several participants, emphasizing the significance of local control. The objective of this method is to hinder the misuse of resources and foster financial self-sufficiency. Survey participants recommended putting money into research and development-oriented businesses within the PGM industry to enhance progress and ingenuity. This corresponds to the industry's requirement for innovation and adjustment.

Enhancement of Infrastructure: The importance of

infrastructure quality became a crucial aspect. Enhanced infrastructure can contribute to more efficient processes and allocation of resources, thereby boosting the industry's competitiveness.

**Regulatory Measures for the Environment:** The presence of advantageous environmental regulations was recognized as essential for promoting sustainable growth in the industry, while simultaneously ensuring compliance with sustainability criteria. Respondents acknowledged the possibility of job creation and skill enhancement, underlining the socio-economic advantages of maximizing PGM prospects. The importance of technological advancements in enhancing competitiveness and relevance was emphasized as a crucial factor for the industry's ability to innovate and adapt.

When participants were asked to share their thoughts on how they envision the South African PGM industry capitalizing on these opportunities.

One participant said “I would like South Africa to capitalize by ensuring that all exported materials are only exported if used in manufacturing in South Africa. Other countries exploit Africa by obtaining these materials cheap and finding cheaper labor elsewhere. There needs to be more ownership of manufacturing processes in Africa.” And another said, “Creation of and further investment into RD focused south African companies in the space would be a great start.” Responses highlight a range of perspectives on how certain factors can contribute to the capitalization of opportunities in South Africa's platinum group metals (PGM) industry:

**Availability of Labor and Skills:** Respondents suggest that having a skilled workforce can play a pivotal role in capitalizing on the opportunity. The availability of skilled labor can enable efficient production and growth within the industry. **Quality of Infrastructure:** The quality of a country's infrastructure is noted as a critical factor. Improved infrastructure can facilitate smoother operations, transportation, and distribution of resources, contributing to capitalization.

**Quality of Geological Database:** The quality of geological data is seen as important. Accurate and comprehensive data can aid in targeted exploration and resource management, potentially leading to optimized capitalization.

**State's Environmental Regulations:** The regulatory environment is identified as influential. Having clear and favorable environmental regulations can encourage responsible growth in the industry while complying with sustainability standards. **Battery Supplies and Electricity Shortage:** A unique suggestion is made to leverage technological batteries for powering the country rather than just vehicles. Addressing electricity shortages through battery solutions could have broader societal and economic benefits. **Shifting Markets to Nickel and Cobalt:** Shifting the focus of the PGM industry to sell nickel and cobalt is proposed. **Diversification into crucial metals** can open up new market opportunities and revenue streams. **Application of Electric Vehicles (EVs):** Respondents point out that advancements in the PGM industry could lead to the increased application of

EVs, aligning with global trends and potentially expanding the industry's scope.

**Job Creation and Skill Development:** A recurring theme is the potential for job creation and skill development. Capitalizing on the opportunity can lead to employment opportunities and enhanced individual skills.

**Innovation and Technology:** Respondents emphasize that innovation and technology are key drivers. The PGM industry's ability to innovate and adapt can enhance its competitiveness and relevance. **Economic Growth and Energy Regeneration:** The PGM industry is seen as contributing to economic growth and energy regeneration through projects that harness its resources.

**Local Manufacturing Ownership:** A participant suggests focusing on local manufacturing ownership to prevent the exploitation of resources. This approach can foster economic independence and value addition. **Research and Development (R&D) Investment:** Investment in R&D-focused South African companies is highlighted to kickstart growth and innovation in the sector. From an environmental perspective, 56.7% participants believe that the adoption of electric vehicles can have positive impacts on the demand for platinum group minerals (PGMs).

From an environmental perspective, do you believe the adoption of electric vehicles can have positive impacts on the demand for platinum group minerals in their applications in EV-related technologies? 30 responses

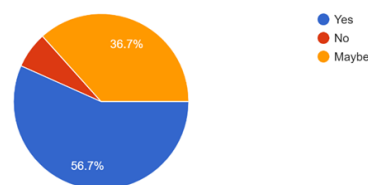


Fig. 7: Perspective Question.

According to Fig. 7, the environmental aspect of adopting electric vehicles is believed to have positive effects on the demand for PGMs by the majority of participants (56.7%). This viewpoint implies a positive outlook regarding the contribution of PGMs in sustainable technologies. Participants were asked to elaborate. If they were aware of any environmental concerns related to traditional platinum group minerals (PGMs) mining practices in South Africa.

The survey responses highlight a range of important environmental concerns associated with platinum extraction and refining. Respondents acknowledge issues such as energy and water consumption, greenhouse gas emissions, waste rock and tailings management, and water pollution as significant considerations in the process. The consensus is that these factors hold significance in the context of platinum mining's impact on the environment. The survey participants showed that they were knowledgeable about the environmental issues associated with conventional platinum group metal mining methods in South Africa. Some of the issues that are worrying include the usage of energy and water, the release of greenhouse gases, the handling of waste, and the

contamination of water. The significance of practicing sustainable mining in the industry is highlighted by this level of awareness. Participants were asked based on their understanding, on whether they believe that the electric vehicle market will continue to grow and dominate the automotive industry in the future, with the majority of 79.3% saying yes.

Based on your understanding, do you believe that the electric vehicle market will continue to grow and dominate the automotive industry in the future?  
29 responses

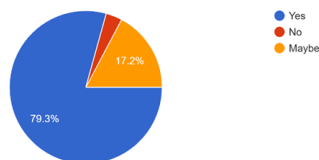


Fig. 8: Question based on the participants understanding.

According to Fig. 8, a large majority (79.3%) of participants are of the opinion that the electric vehicle market will persistently expand and take control of the automotive industry in the coming years. This indicates a firm conviction in the sustainable future of electric vehicles. Participants were asked according to their opinion, what steps should the South African PGM industry take to navigate the potential challenges and seize opportunities presented by the rise of electric vehicles. The survey responses highlight a range of perspectives on addressing challenges in the electric vehicle (EV) industry, particularly those related to energy reliability, environmental impact, supply chain issues, technical skills, demand increases, illegal mining activities, infrastructure reliability, worker safety, and operational security. The consensus is that mitigation is crucial, and if issues pose threats to the industry or users, their elimination should be the foremost response. Several respondents emphasize the importance of research and development (R&D) to tackle these problems effectively. They suggest that the industry should focus on producing products that align with the EV sector's needs and capitalize on the growing market. Educating people about electric cars is seen as vital, as is disseminating knowledge to foster understanding of EV technology and its benefits. Some participants expressed uncertainty or lack of knowledge, while others highlighted the significance of leveraging the EV market's demand for platinum group metals (PGMs). Diversification into other industries that consume PGMs is also proposed as a strategy.

Investing in R&D, releasing information on mineral processing for EVs, and increasing the number of electric vehicles were other ideas put forth. Respondents called for innovation and infrastructure development, underscoring the need for proactive and transparent governmental negotiations.

An interesting perspective emerged, suggesting that rather than resisting the rise of the EV market, the industry should embrace the trend and position South Africa favorably by creating an environment conducive to participating in the global electric car market while maintaining a reputable role as a PGM supplier. Exploring environmentally friendly

applications and investing in education were highlighted as pathways for adapting to an EV-centric world. These suggestions underscore the belief that investing in young minds can spur innovation and ideas for addressing the industry's challenges.

#### *Advice from Participants on Overcoming Challenges and Capitalizing on Opportunities.*

Respondents proposed various ideas to effectively address challenges and capitalize on the opportunities arising from the increasing popularity of electric vehicles. These recommendations covered a wide range of areas, spanning from boosting research and development funding to taking advantage of the increasing market demand for PGMs. The individuals who participated in the survey stressed the importance of innovation, the development of infrastructure, and education as essential components in adjusting to a world that is centred around electric vehicles.

#### *Comparison with Existing Literature*

The results are consistent with previous studies on the topic. The growth of electric vehicles (EVs) is likely to have an impact on the PGM industry, according to numerous studies. This is due to the fact that PGM demand will decrease in the traditional PGM industry while PGM demand will increase for battery technology. Although electric vehicles offer great possibilities for increased demand of precious group metals (PGMs), they also bring about challenges concerning sustainability and market fluctuations. In the era of electric mobility, it is extremely important for industry stakeholders and policymakers to strategically tackle these matters, ensuring a sustainable and flourishing future for the PGM industry. Examining the potential challenges linked to supply chain and sustainability issues, however, has received less focus.

#### IV. CONCLUSION

Globally, the automobile sector is going through a significant shift as a result of environmental demands and the requirement to cut greenhouse gas emissions. The demand for materials required to make electric vehicles, especially Platinum Group Metals (PGMs) utilized in traditional combustion engine vehicles' catalytic converters, is being significantly impacted by this shift toward electric vehicles. PGM manufacture in South Africa has historically been very important, but the shift to electric vehicles has caused some uncertainty about the industry's future.

Whether EVs pose a threat or an opportunity for South African Platinum Group Miners (PGMs) cannot be answered in a generalized manner. Some believe that the sector could benefit from EVs because they might encourage innovation and help us diversify into new battery technologies. However, some people view EVs negatively since they can result in economic inequality and elevate EVs to a status of luxury.

The good news is that South Africa has several potential for

the PGM business to thrive, from cutting-edge battery technology to industry diversification. It's crucial to control your production processes, make R&D investments, upgrade your infrastructure, and adhere to environmental rules if you want to take full advantage of these prospects. Additionally, it's crucial to acquire new skills, invest in education, and create jobs. Most people believe that EVs will continue to develop and rule the automobile sector in the future, which is good news for PGMs.

#### *Contribution of authors*

Antoine F. Mulaba - Bafubiandi initiated, conceptualized and supervised the research project. Sinthemba Sithole conducted the research work under the supervisor of Antoine F. Mulaba – Bafubiandi.

#### *Declaration of interest*

The authors have no financial nor personal interest in the content of the work here presented.

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