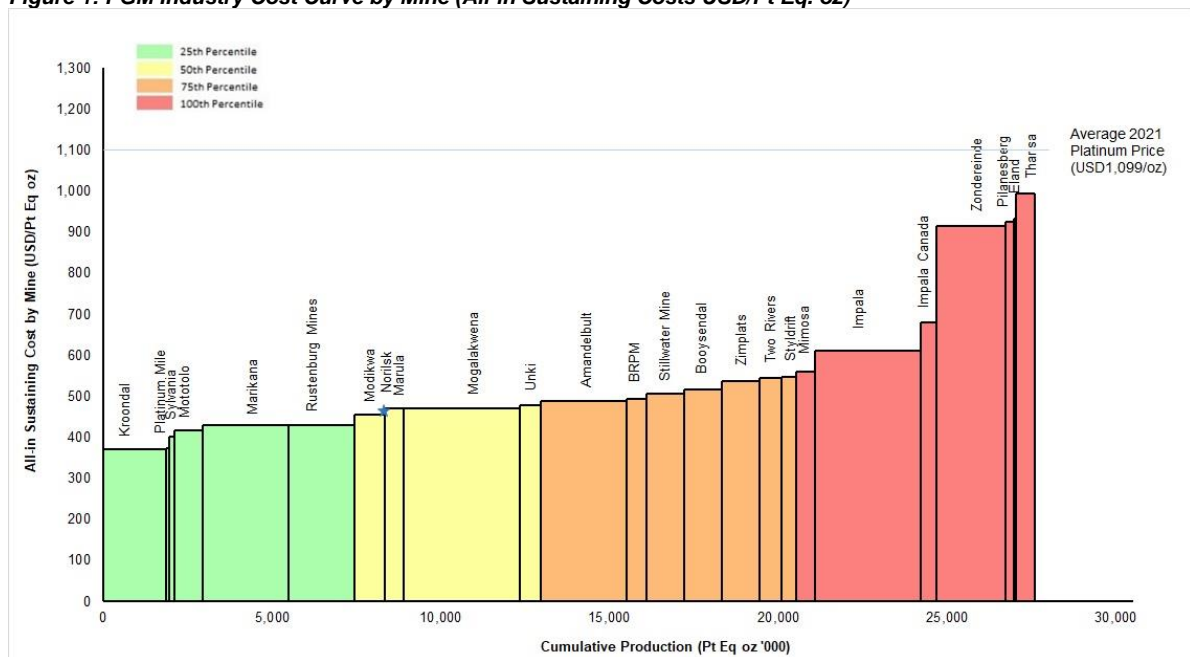


EXPLORATION | CONSULTING | PROJECTS

Platinum Cost Curves

In 2021, the total all-in sustaining costs per Pt eq. oz in ZAR terms decreased by 11.0%. The total all-in sustaining costs per Pt eq. oz in USD terms decreased by 0.9%, year-on-year, as the average Rand strengthened year-on-year. The decrease in equivalent costs is mainly due to an increase in 4E by-product prices (having a positive effect on Pt eq. oz) rather than lower operating costs. The ZAR denominated all-in sustaining costs per milled tonne increased by 24.8% year-on-year. The USD denominated all-in sustaining costs per milled tonne increased by 38.9% year-on-year.

Figure 1: PGM Industry Cost Curve by Mine (All-in Sustaining Costs USD/Pt Eq. oz)



Disclaimer: Information displayed in graphs is based on public information collected from the PGM mining companies' annual reports for the period of January to December 2021. There is no guarantee that the interpreted information is 100% accurate.

NEWSLETTER SPOTLIGHT

- ◇ South African platinum mines accounted for 72% of global platinum production during 2021.
- ◇ No South African platinum mine had an all-in sustaining cost ("AISC") higher than the average 2021 price.
- ◇ USD-denominated AISC per Pt eq. oz decreased by 0.9% year-on-year.
- ◇ USD-denominated AISC per milled tonne increased by 38.9% year-on-year.
- ◇ All areas generally performed well with the Eastern Limb-Central mines performing slightly better to other producing areas on an AISC basis.

Industry cost curves are valuable tools to benchmark the operational cost performance of an existing operation or new proposed mine project against industry. Minxcon calculates a cost per platinum equivalent ounce (Pt eq. oz) so that all companies - those with access to refineries or those selling concentrates - are directly comparable on a cost basis and against the spot platinum price. Pt equivalent ounces were calculated based on the mines' realised revenue divided by the annual average platinum price. A cost per milled tonne is also calculated. The industry cost curve indicates the ability of the existing mines to endure cyclical commodity prices and ensure continuous mining operations over time. This measure of a mine's cash margin per ounce can also be a useful tool for the following:-

- Use as a Comparison tool;
- Use as an Analytical tool:-
 - Shareholders, Management, Industry analysts;
- Use as an Investment decision tool:-
 - Investors, Banks, Equity brokers;
 - Identification of high- and low-cost producing regions, informs company decisions on where to invest;
- Provide a trend in costs as the mine matures; and
- Determine commodity price in times of market oversupply.

The aim should be to remain within the lower 50th percentile of cost producers to ensure profitability even in market downturns. The principle of this logic is based on economic theory that states that the commodity price is a function of the supply-demand balance of the specific commodity. If demand decreases due to weak market conditions and commodity prices subsequently decline, it is likely that the highest cost producers will suspend production first, which reduces supply and ultimately supports higher commodity prices. This has been observed with Twickenham and Bokoni mines which appeared highest on our cost curve in the past and were placed on care and maintenance in 2016 and 2017, respectively, in response to lower prices.

Cost curves can be constructed and analysed at a company or country level to facilitate comparison on a national, regional, or international level. South Africa produced 72% of global platinum during 2021 and is the main constituent of costed mine production.

Minxcon used the cost curves to compare the operating platinum mines' cost curves to the average platinum price for the year. Figure 1 through Figure 3 show the PGM industry AISC curve for calendar year 2021 at a mine level, while the figures below illustrate the historic performance of the industry.

As a whole, the platinum miners had a third consecutive significantly improved year in 2021 in USD-denominated terms with the AISC per Pt equivalent ounce decreasing by 6.3%. The average annual ZAR:USD exchange rate strengthened year-on-year from 16.47 in 2020 to 14.79 in 2021. As a result, the ZAR-denominated AISC decreased by a higher margin of 15.8%.

The prill splits of each mine differ. A mine with higher palladium and rhodium prills will have a higher basket price in the current price environment. Minxcon plotted the AISC per 4E ounce against each mine's basket price. The basket prices were calculated by dividing the 4E revenue by the 4E ounces sold. By-product revenue was credited against the costs. In addition, the AISC per 4E equivalent ounces was also plotted, whereby instead of crediting by-product revenue, all revenue was converted to 4E equivalent ounces using the mine's basket price.

Figure 2 and Figure 3 illustrate the PGM cost curve per 4E oz and per 4E eq. oz, respectively.

Norilsk's cost is plotted without showing its production. This is due to Norilsk's equivalent production skewing the graph due to the size of the operation, rendering it impossible to see the smaller producers on the graph.

Figure 2: PGM Industry Cost Curve by Mine on a 4E Basis

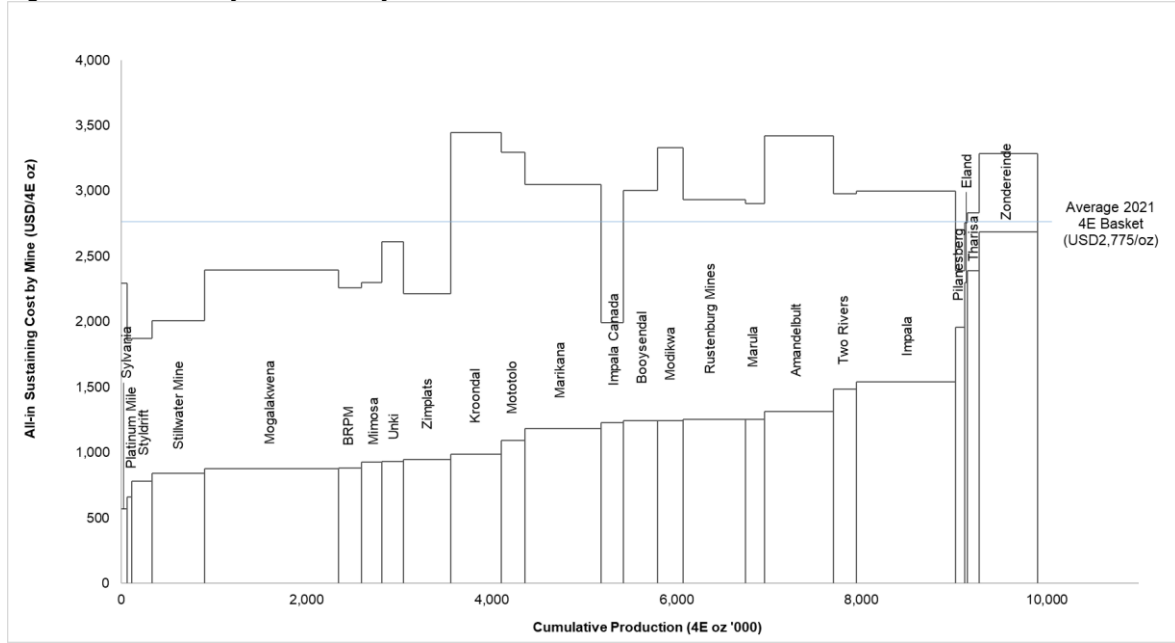
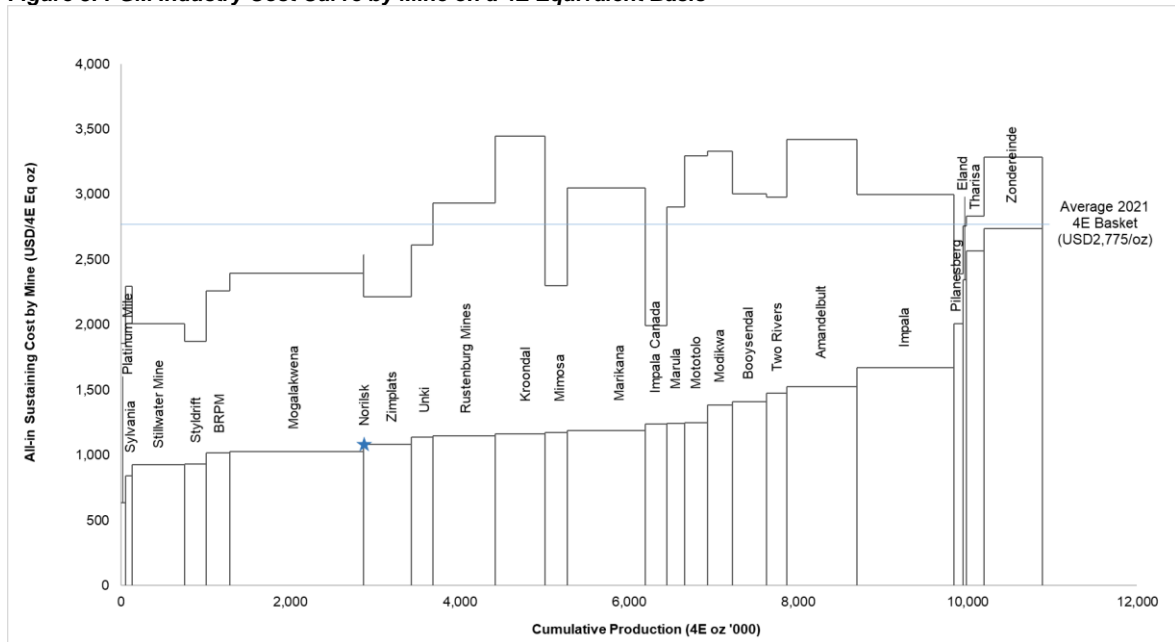


Figure 3: PGM Industry Cost Curve by Mine on a 4E Equivalent Basis



The AISC per milled tonne has increased by a significant 24.8% year-on-year in ZAR terms and 38.9% in USD terms, indicating that the overall mine performance has deteriorated rather than improved.

The 2021 year marked improvement in apparent cost reduction is less as a result of cost savings and more due to the significant increase in palladium, rhodium and gold prices. These rising prices have contributed to an increase in Pt eq. oz. (denominator) and therefore a reduced cost per Pt eq. oz.

High costs can, inter alia, be attributed to the fact that a large percentage of the mines have been operating for decades, thus increasing maintenance costs on the shafts and machinery, as well as the fact that the depth of some of the platinum mines in South Africa are the deepest in the world.

Figure 4: Historic Actual Unit Costs vs Platinum Price

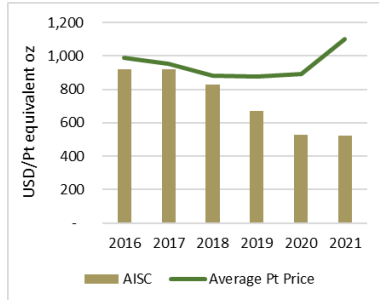


Figure 5: Historic Actual Unit Costs vs Platinum Price – ZAR Basis

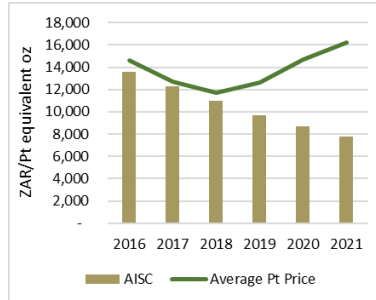
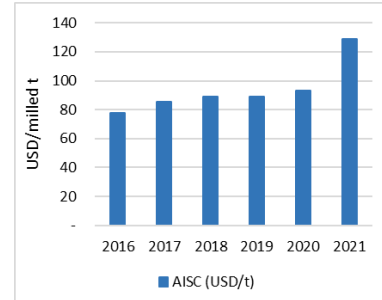


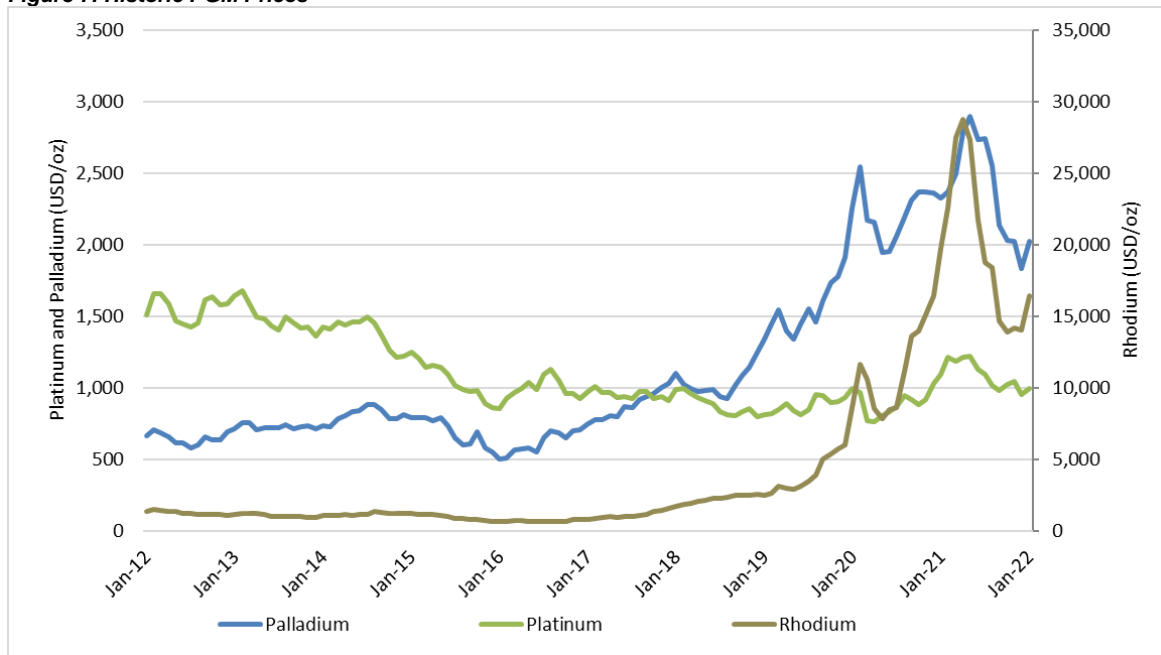
Figure 6: Historic Actual Unit Costs on a Milled Tonne basis



Notes: AISC includes cash cost incurred at each processing stage, from mining through to recoverable metal delivered to market inclusive of royalties and production taxes, sustaining and reserve development capital expenditure, corporate general and administrative costs, reclamation and remediation costs and sustaining exploration and study costs. Platinum producers report costs in a variety of ways. Where platinum producers report costs according to different definitions, Minxcon strives to adjust these costs to conform as close as possible to the above definitions. Pt eq. oz were calculated based on the mines' realised revenue divided by the annual average platinum price. By doing this, all companies - those with refineries or those selling concentrates - are directly comparable on a cost basis and against the spot platinum price.

The average annual palladium price increased by 8.4% from USD2,224/oz in 2020 to USD2,410/oz during 2021. The average palladium price in 2021 was 54% higher than the average platinum price at USD1,099/oz, despite exceeding the platinum price for the first time in two decades in 2018. The average annual rhodium price increased by a 79% to USD20,135/oz over 2021 from USD11,222/oz during 2020.

Figure 7: Historic PGM Prices



South African platinum mines have been buoyed by increased palladium and rhodium prices in recent years as well as a weaker Rand, which assisted to reduce the AISC per Pt eq. oz. This despite falling platinum prices, with the platinum price having fallen for eight consecutive years prior to 2020. The platinum price increased slightly in 2021 to an average price of USD1,099/oz over 2021 from USD891/oz in 2020. Should palladium consolidate below the USD1,500/oz level, all other prices remaining the same, the costs of 16% of PGM mines (excluding Norilsk) will be above the price line on an AISC basis.

Figure 8 and Figure 9 illustrate the revenue achieved per milled tonne by operations according to location. Regionally, there appears to be a distinct price advantage in the Eastern Limb of the Bushveld Complex over the Western Limb, and more specifically, the mines located in the Central Zone of the Eastern Limb have been able to take full advantage of the increased palladium and rhodium price environment. Mines on the Western Limb have also seen improvement in revenue. The Southern Zone of the Eastern Limb have seen less improvement in revenue which means that unless the Eastern Limb's Southern Zone mines reduce costs, they

are the most at risk of becoming unsustainable. Interestingly, the Platreef has seen the most significant improvement in revenue per tonne milled in 2021.

Figure 8: Historic Revenue per Tonne (USD/t) by Locality

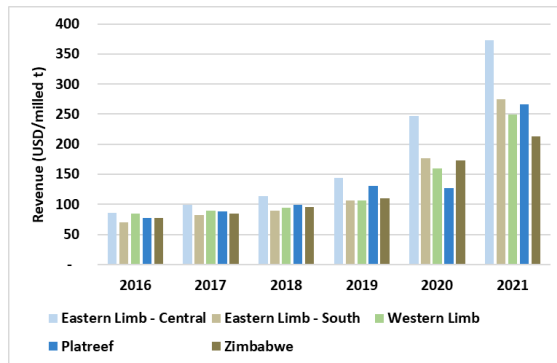


Figure 9: Historic Revenue per Milled Tonne Index by Locality

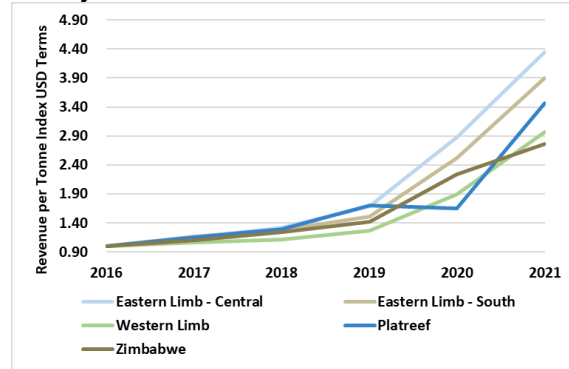


Figure 10 illustrates the revenue achieved per milled tonne against the AISC per milled tonne according to location. Each region is certainly outperforming previous years, however the costs per milled tonne are also climbing steadily. Interesting to note is that both the Eastern and Western Limb mines were largely unprofitable in 2016 and 2017, while the Western Limb continued to be unprofitable in 2018, indicating a return to the prices seen during those years would not be sustainable for the industry. However, both the Eastern and Western limbs were largely profitable in 2020 and 2021, highlighting the positive effects of price increases on revenue.

Figure 10: Historic Revenue per Tonne vs All-in Sustaining Cost (USD/t) by Locality

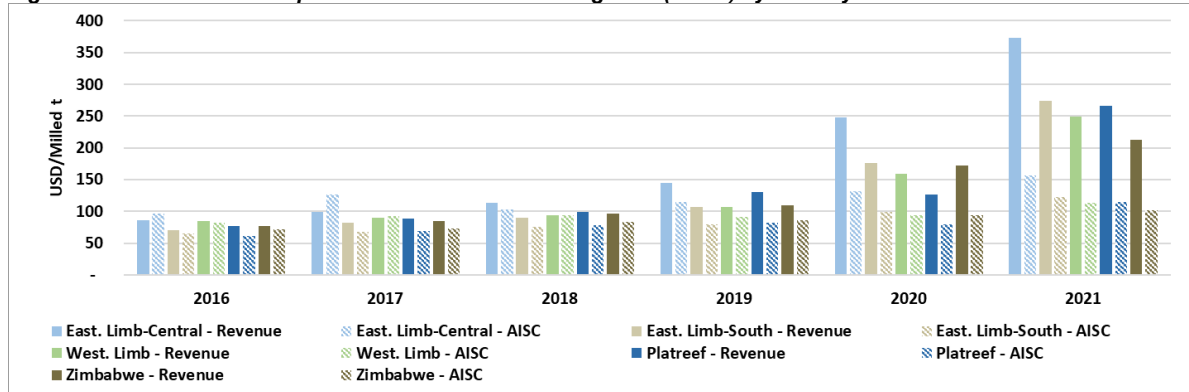


Figure 11 shows the PGM industry AISC curve per milled tonne for calendar year 2021 at a mine level. Worryingly, some of the highest South African cost producers per milled tonne (Zondereinde, Pilanesberg and Tharisa) are also amongst the highest cost producers per Pt eq. oz.

Figure 11: PGM Industry Cost Curve by Mine on a Milled Tonne Basis

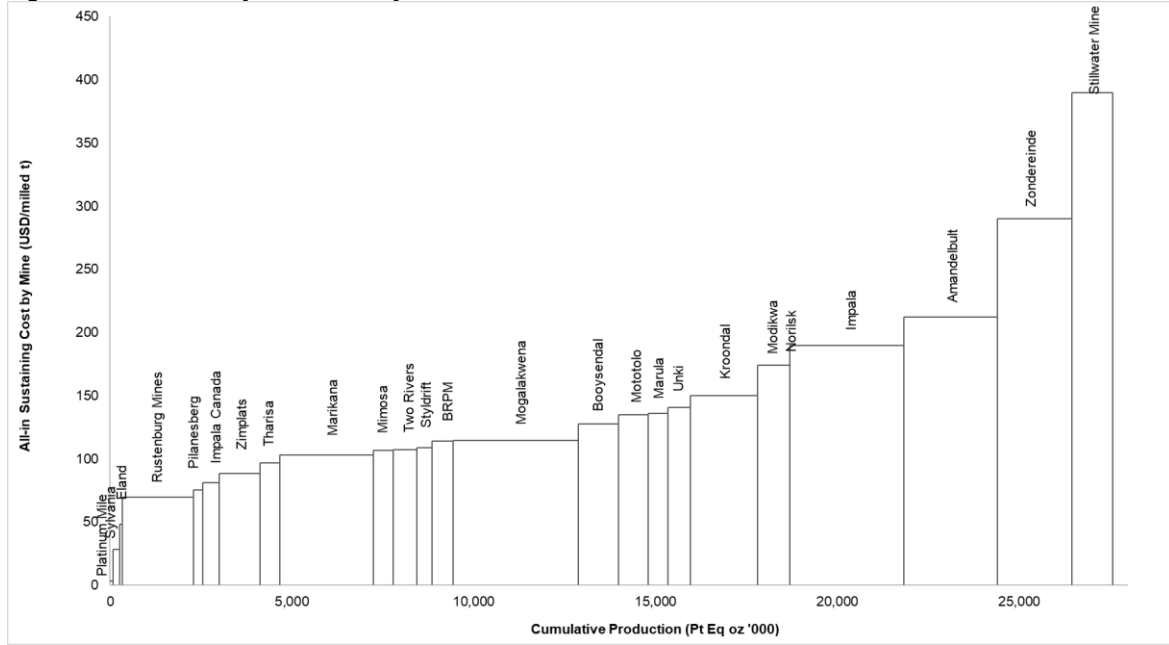


Figure 12 illustrates a year-on-year comparison of the PGM industry AISC per Pt eq. oz at a mine level in dollar terms. Anglo American mines have had decreased apparent costs over the year; however, this appears to be due to more ounces being refined and sold than the ounces mined. In 2020, Anglo American refined significantly less ounces than the mined ounces, most likely due to COVID-19 restrictions, thus it is assumed that the ounces that were not refined in 2020 were stockpiled and refined in 2021. The AISC per Pt eq. oz of other operations increased, with Zondereinde, Eland, Pilanesberg and Tharisa showing the highest increase in cost.

Figure 12: Year-on-Year Comparison of Cost by Mine on Pt Equivalent Basis

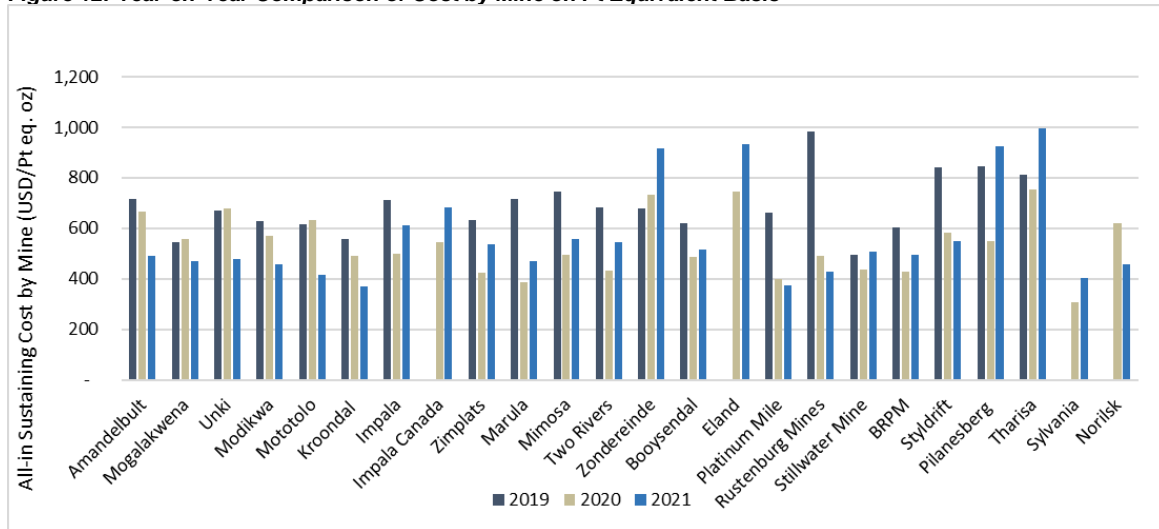
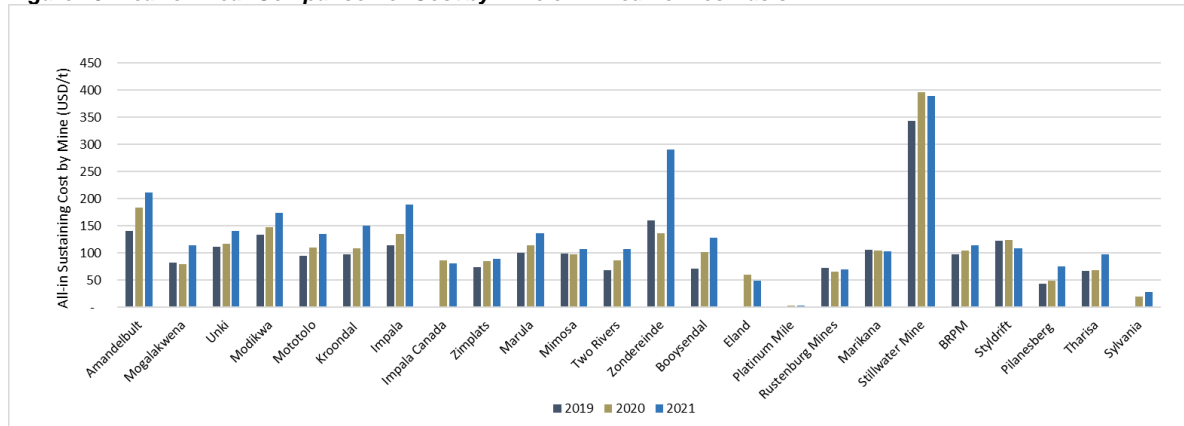


Figure 13 illustrates a year-on-year comparison of the PGM industry AISC per milled tonne at a mine level in dollar terms. Most mines increased their cost per milled tonne year-on-year. The contrast of the two graphs illustrates the impact of the increased price environment.

Figure 13: Year-on-Year Comparison of Cost by Mine on Milled Tonnes Basis



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Minxcon is a multi-faceted South African advisory company offering an integrated team of internationally accredited experts to investigate and develop your mineral project. Our core business is to provide local and international clients with independent solutions to all matters arising in the fields of mining. Our ability to provide services and advice from the project inception stage to the successful execution and management of the operation and closure makes Minxcon exceptionally diversified. New and existing mineral projects benefit from our comprehensive service offering through our one-stop firm.

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