

# **ANGLO AMERICAN SITE VISIT**

## **PROCESSING & POLOKWANE SMELTER - PLATINUM**

**24 NOVEMBER 2016**



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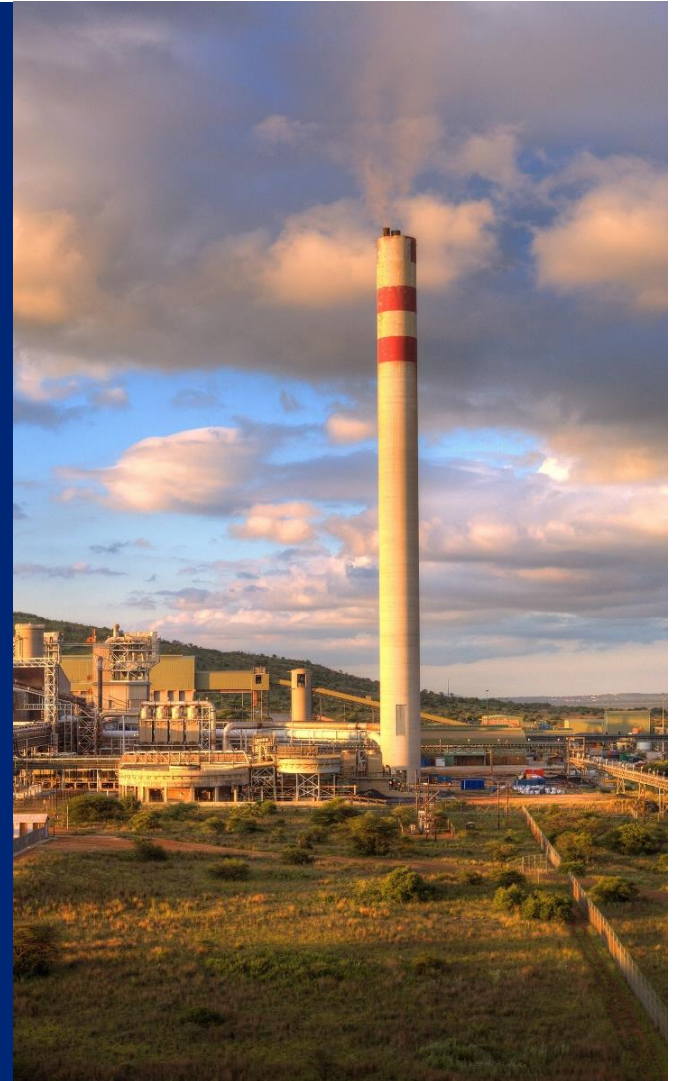
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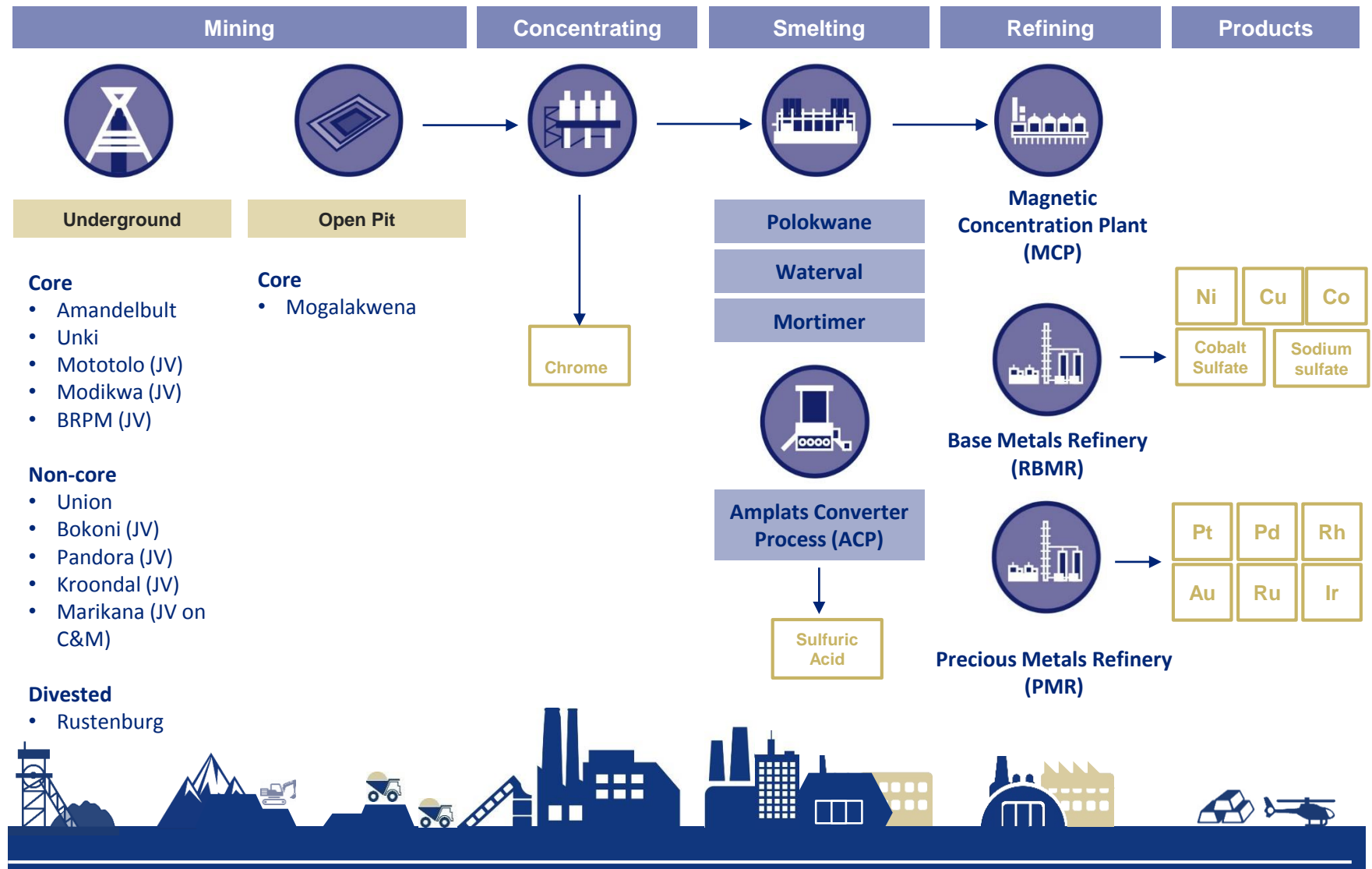
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# OVERVIEW OF PROCESSING OPERATIONS



# OPERATIONAL FLOW CHART





# PGM PROCESSING

## Own and operate world class processing assets

- PGM processing consists of concentration, smelting and refining – concentrators are always co-located and linked with mining
- Major PGM producers integrated in a resource driven value chain – smelting, base and precious metal refining capacity in SA controlled by the four largest PGM producers
- Excess capacity has generally arisen across the industry due to unachieved growth targets, historical growth aspirations and more recent production rationalisation

### Smelters

- Three smelting complexes (Polokwane, Waterval and Mortimer) with annual capacity of 1.45Mtpa of concentrate
- ACP (converter and acid plant) with annual capacity of 0.25Mtpa furnace matte
- 8% of total cost of production and c.20% of capital employed (incl. WIP inventory)

### Base metal refinery

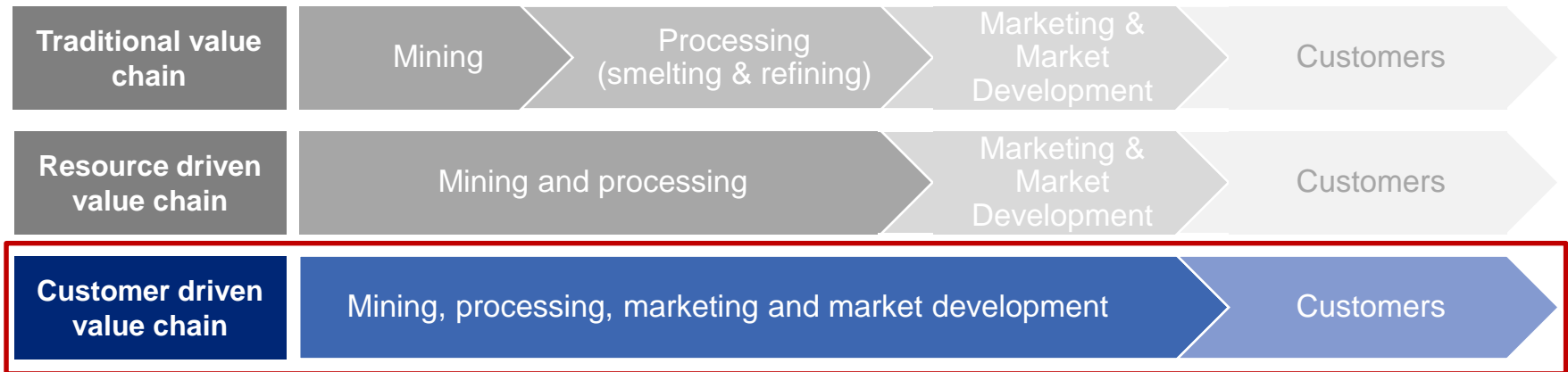
- Refinery complex – annual capacity of 32.4ktpa Nickel
- 2% of total cost of production and c.7% of capital employed

### Precious metal refinery

- Precious metal refinery – annual capacity of 3.5moz refined Platinum
- 1% of total cost of production and c.9% of capital employed

# AN INTEGRATED BUSINESS MINE TO MARKET

Processing integral to extracting greater value



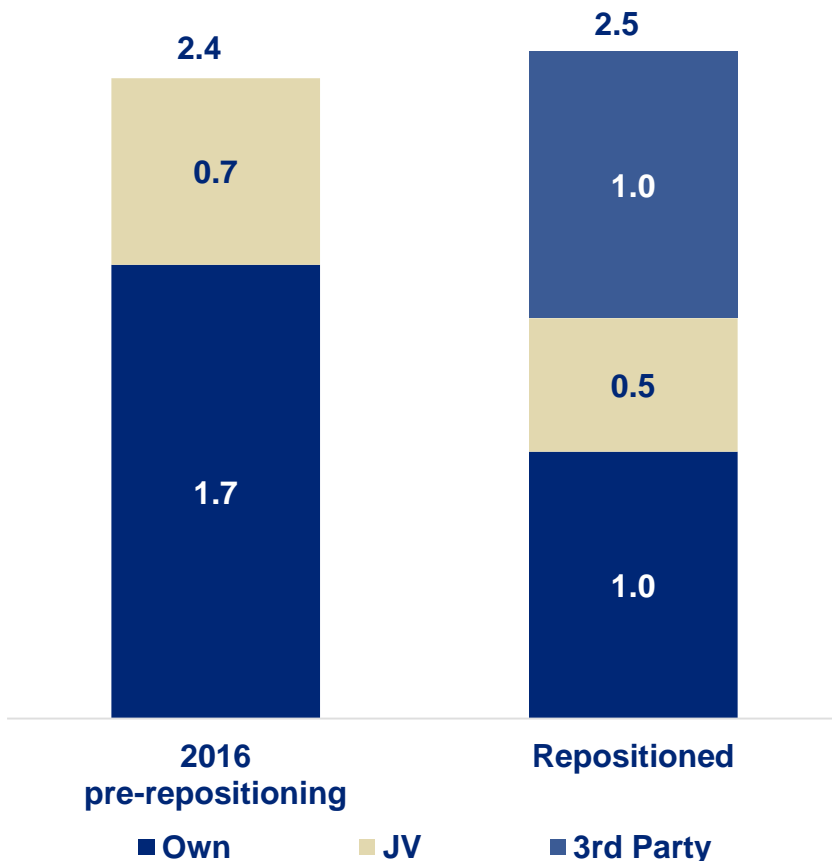
The strategic value is extracted owning PGM processing capacity:

- **Customer driven value chain** – provides access to market participants, allowing the potential for premiums through leveraging our commercial strategy
- **Technological capability** – better equipped to innovate through coordinated participation from mine to market
- **Higher entry barriers** – greater financial and managerial resources required to enter PGM processing (capital investment of c.30 times historical capital employed would be required)
- **AAP growth optionality** – required to unlock profitable mining investment opportunities

# EVOLVING ROLE OF PROCESS ASSETS

The repositioned portfolio increases third party volume processed

Changing profile of refined platinum production (Moz)



- Historically JVs provided access to AAP processing through purchase of concentrate (POC) agreements
  - Agreements structured to contribute to marginal cost of production
- Following the repositioning of the portfolio, c.40% of volume processed will be from third parties
  - New POC and toll agreements to provide ongoing value from non-core assets plus a return on invested capital
  - c.20% of underlying business value to be extracted through processing third party volume
- Processing capacity will be a constraint for future growth

# SMELTING OPERATIONS

Operating assets are underpinned by a sound rebuild and maintenance strategy

- Maintenance strategy developed according to industry best practice with continuous monitoring
- Major furnace rebuilds (including hearth replacements) are planned for all furnaces
- Side and end wall replacements are planned between major rebuilds to ensure operational integrity and reliability of the asset
- Best practice innovation developed in-house including graphite liners for copper coolers and hot furnace rebuilds
- Smelter run-out event at Waterval Furnace on 10 September 2016 –rebuild complete by 27 October and heating of furnace in progress
- Concentrate stocks ahead of the furnaces have increased, and will return to normal levels by the end of 2017



Inspection walkways, Polokwane Smelter



Slag tapping at Polokwane smelter



# OPERATIONAL EXCELLENCE – BMR

Operating assets are underpinned by a sound rebuild and maintenance strategy

- The Rustenburg Base Metals Refinery brownfield expansion initiated in 2011
  - Added 10.9ktpa nickel capacity
  - Capital cost of c.R 2.7bn (c.\$180m)
  - Allowed expansion in the Northern limb
- Focus on nickel circuit debottlenecking
- Cost of incremental nickel processing and electroplating capacity was c.\$25k/t nickel
- Compares favorably to recent greenfield refinery projects
  - Vale (Long Harbour)
    - \$4.5bn for 50 ktpa Ni
    - c.\$85k /t Ni
  - Ambatovy (Toamasina)
    - \$5.3bn for 60 ktpa Ni
    - c.\$90k /t Ni

## Process Operator at Nickel Tank house



Process Operator conducting manual cathode bag top-up with nickel feed after cell harvesting

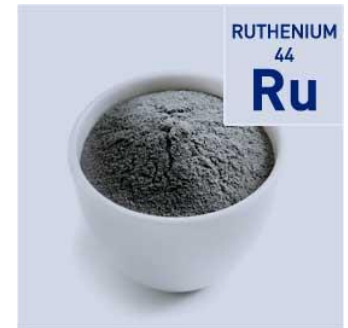
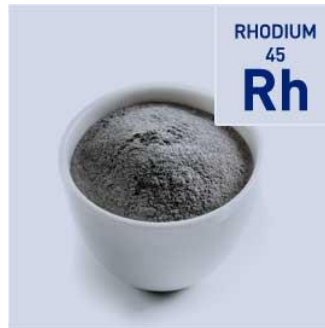
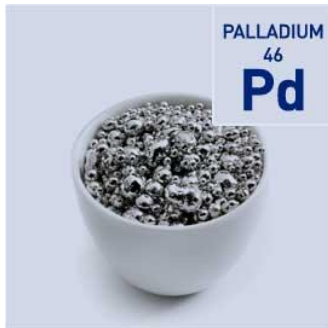
## BMR Ramp Up: Quarterly Nickel Cathode Production



# PRECIOUS METALS REFINERY

## World's largest precious metals refinery

- The Precious Metals Refiners is the world's largest refiner of Platinum Group Metals (PGMs), supplying a network of global customers with a range of products
- The PMR is the last stage in the processing chain of PGMs, based in Rustenburg
- Recently had a shut-down due to a section 54 but has fully ramped up to normal production



Good delivery bars, grain and sponge  
typically refined to 99.99%

Recovery of ~98%

Sponge typically refined to 99.95%

Recovery of ~98%

# FOCUS ON POLOKWANE SMELTER



# FOCUS ON POLOKWANE SMELTER

Polokwane is a world class PGM smelter with many innovative design features

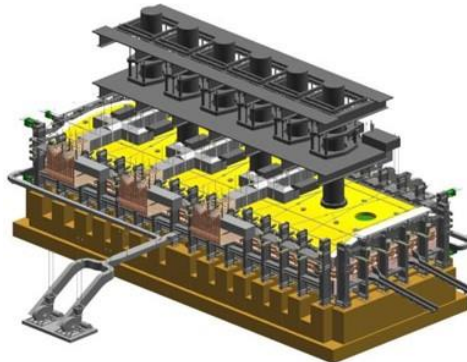
- Polokwane smelter has the biggest platinum furnace in the industry by a factor of two
- It is designed to smelt concentrate from Eastern & Northern limb
- It has a number of key design features including:
- Chrome tolerant for UG2 smelting
- Intense sidewall design to form freeze-lining for self-protection
- Thermally conductive hearth with forced air cooling – hearth is protected against molten matte, and should last longer.

## Flash Dryers



Design	Capacity
Design Capacity	78 tph
Actual achieved	85 tph
Heat source	Coal

## Furnace

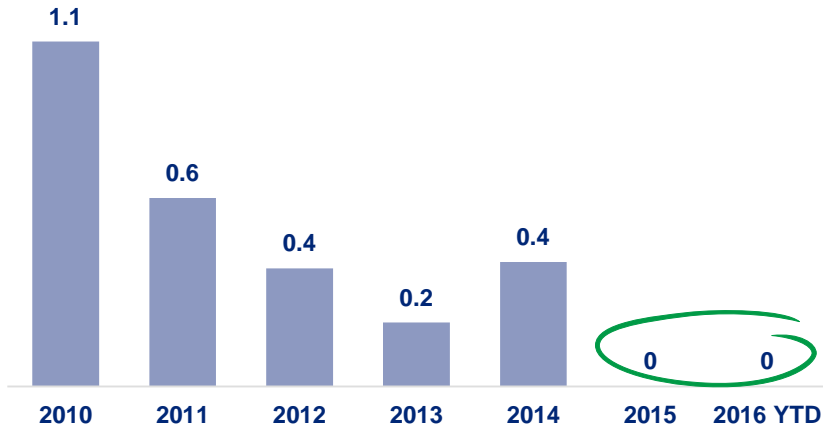


Design	Capacity
Design Capacity	650,000 tpa
Power	68M Megawatts
Power Density	250 kilowatts / m <sup>2</sup>
Matte temperature	1450°C
Slag temperature	1600°C

# SAFETY PERFORMANCE

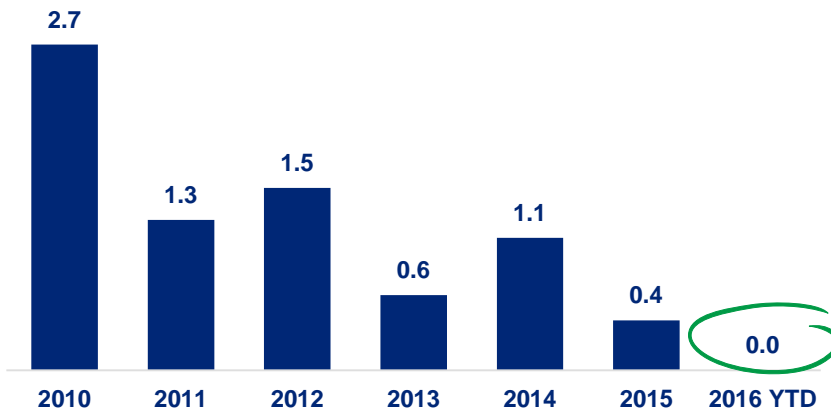
Effective safety strategy has resulted in superior safety performance

Lost time injuries frequency rate (per 200,000 hrs)



- Safety strategy, driven from top-down
  - High performing people
  - Effective processes & systems
  - Plant, equipment and smelting process
- Reduced process safety incidents
- No fatality in history of operation
- Two years without LTI for the complex
- 737 days LTI Free for Smelting operation (first such performance)
- No furnace failure since 2009 – major shift in risk profile, contrary to early years

Total recordable case frequency rate (per 200,000 hrs)



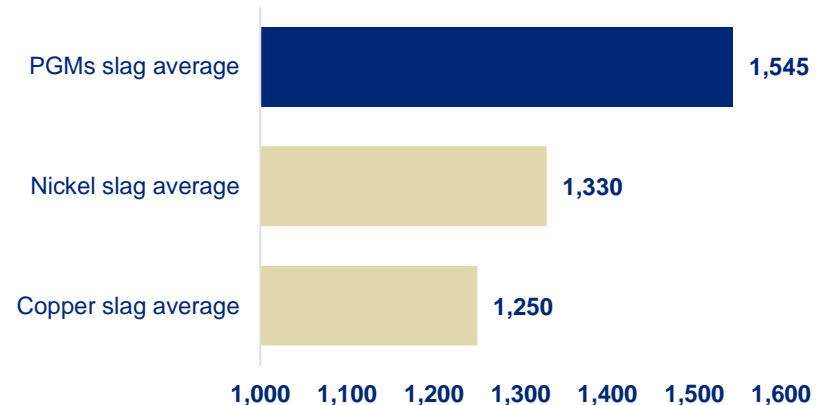


# COMPLEXITY OF PGM PROCESSING

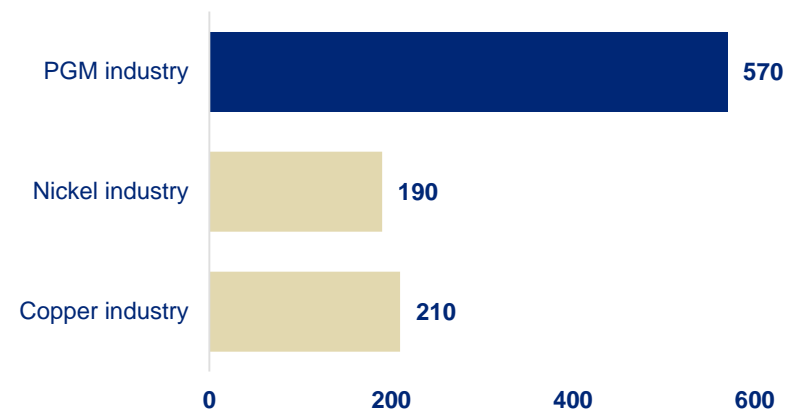
Platinum smelting is unique and complex due to harsh process requirements

- High operating temperatures required
  - Chrome and Magnesium oxides found in PGM concentrate
- Limited choice to use electric arc furnaces due to difficulty in getting to molten state
- Process conditions have changed with evolving mined reef
  - UG2 reef dominating due to depletion of Merensky reef – high chrome content
  - Three-fold increase in Chrome oxide
  - AAP has benefit of low-chrome replacement from Platreef
- Process recoveries critical to profitability
  - AAP has >99% recovery
  - Other commodities smelting recoveries of as low as <85%

Typical operating slag temperatures (°C)



Typical matte super heat (°C)



# DESIGN INNOVATION

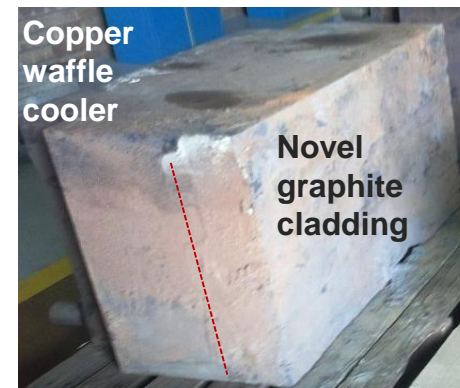
Platinum smelting is unique and complex due to harsh process requirements

- Furnace lining was historically lined with copper
  - Easily corroded
  - Reduced operating time of the furnace
- This led to development of new technology to address the corrosion in conjunction with partner, Novel
  - Developed graphite / cladding and other metal coatings of the copper coolers
  - Extended the length of the furnace to reduce energy needed to improve tapping
- In-house developed water detection leak system to prevent explosion in case of copper failure
- Monitoring of cooler performance remains key
  - Fibre optics installed in critical components
  - Developed event detection on key components

Original copper cooler – waffle design



Copper coolers with graphite lining



# OPERATIONAL EXCELLENCE

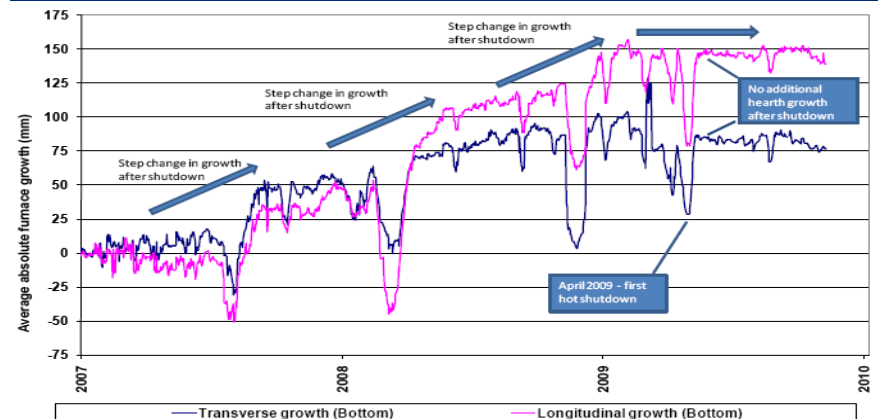
## Design changes complemented by operational practices to further exploit capacity

- Management of shutdowns
  - Hot-shutdowns to reduce furnace growth (ratchetting) – see bottom right
  - Furnace rebuilds times reduced by c.40%
  - Furnace rebuilds easier due to easily replaceable modular sidewall cooling elements
  - Best practice project management and skills
- Process discipline
  - Feed blend active management
  - Process temperature control rules
- Application of Operating Model principles (stability & less variation)
  - Step-change increase in run rate
  - Maintenance practices to reduce downtime

### Hot smelter rebuild at Polokwane smelter



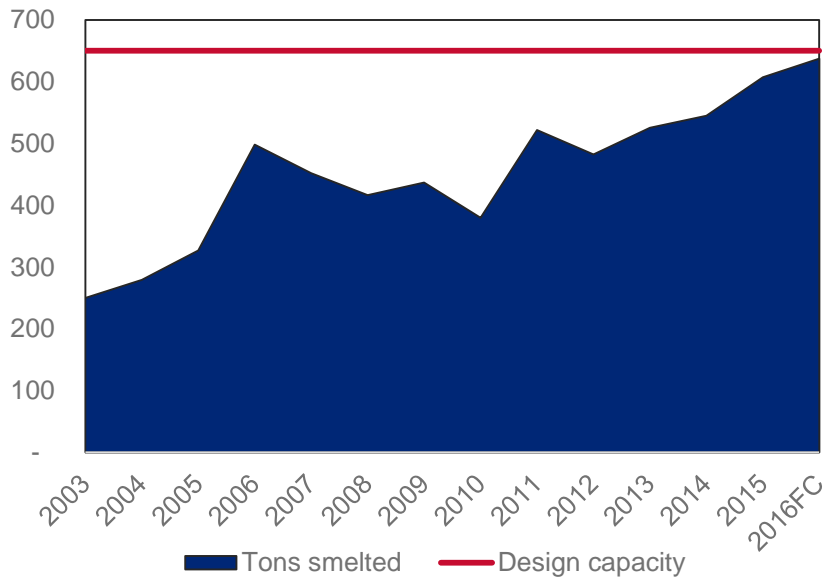
### Reduced rate of furnace ageing from hot shut-down



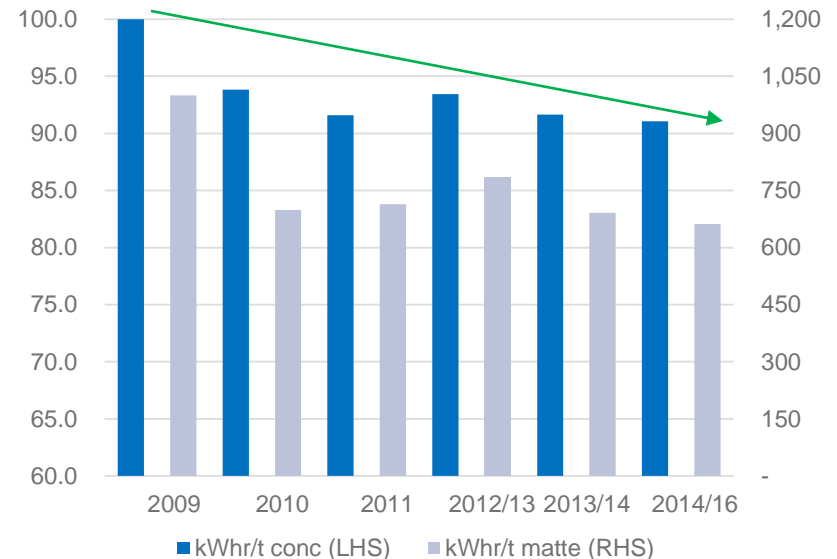
# OPERATIONAL EXCELLENCE - PRODUCTIVITY

## Furnace improvements to meet design capacity of 650kt per annum

Furnace annual throughput (kt)



Indexed Specific Energy Consumption



- Design changes and operation discipline yielding results
- Improved maintenance practices
- Expected to achieve 650ktpa in 2017

- Polokwane has double the energy intensity of other industry furnaces allowing economies of scale and increased performance
- Power is ~60% of cost mix in smelting, with inflation above 10%, hence importance for this efficiency
- As we have run smelters at full temperature for longer, we have seen energy consumption fall

# CONCLUSION

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- Polokwane Smelter is a world class smelting facility
- Custom built operation to execute Northern Limb strategy
- Excellent safety performance with 2016 YTD LTIFR and TRCFR of zero
- Competitive advantage through in-house and partner driven innovations and operational excellence
- Safety, productivity and cost performance have greatly improved
- Lessons from Polokwane smelter are utilised in all AAP smelters



# Q&A