



OPERATIONAL EXCELLENCE & TECHNOLOGY

Dave Palmer, Head of P101

Bulks Seminar & Site Visit: Brisbane, 12 November 2019



Drone at Kolomela

Real Mining. Real People. Real Difference.

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OPERATIONAL EXCELLENCE & TECHNOLOGY: EMBEDDED IN EVERYTHING WE DO

**Redefining best-in-class
performance**



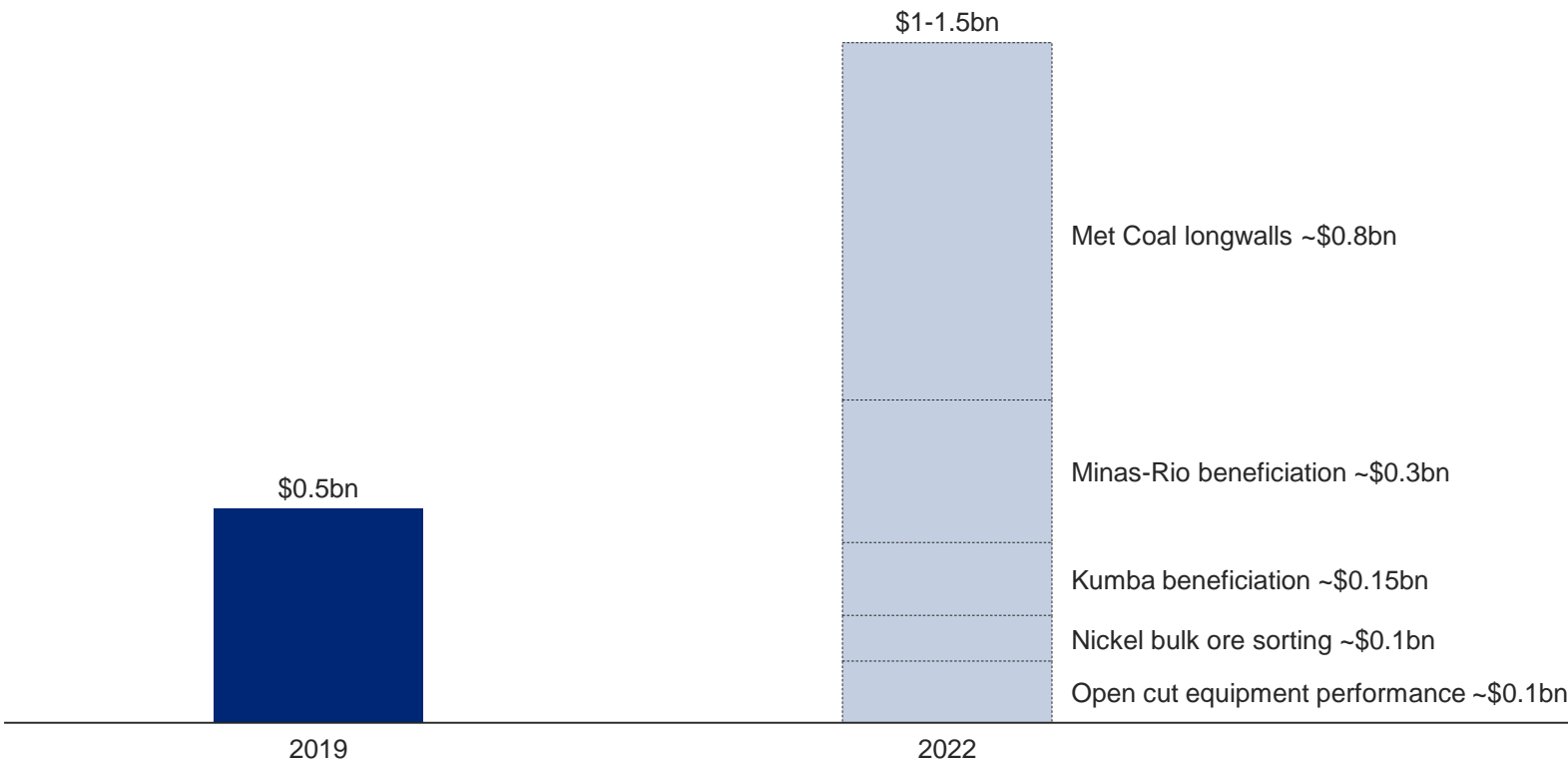
**Innovation, technology &
digitalisation**



A more productive, more efficient, sustainable business

DELIVERING SIGNIFICANT VALUE THROUGH OPERATIONAL EXCELLENCE & TECHNOLOGY

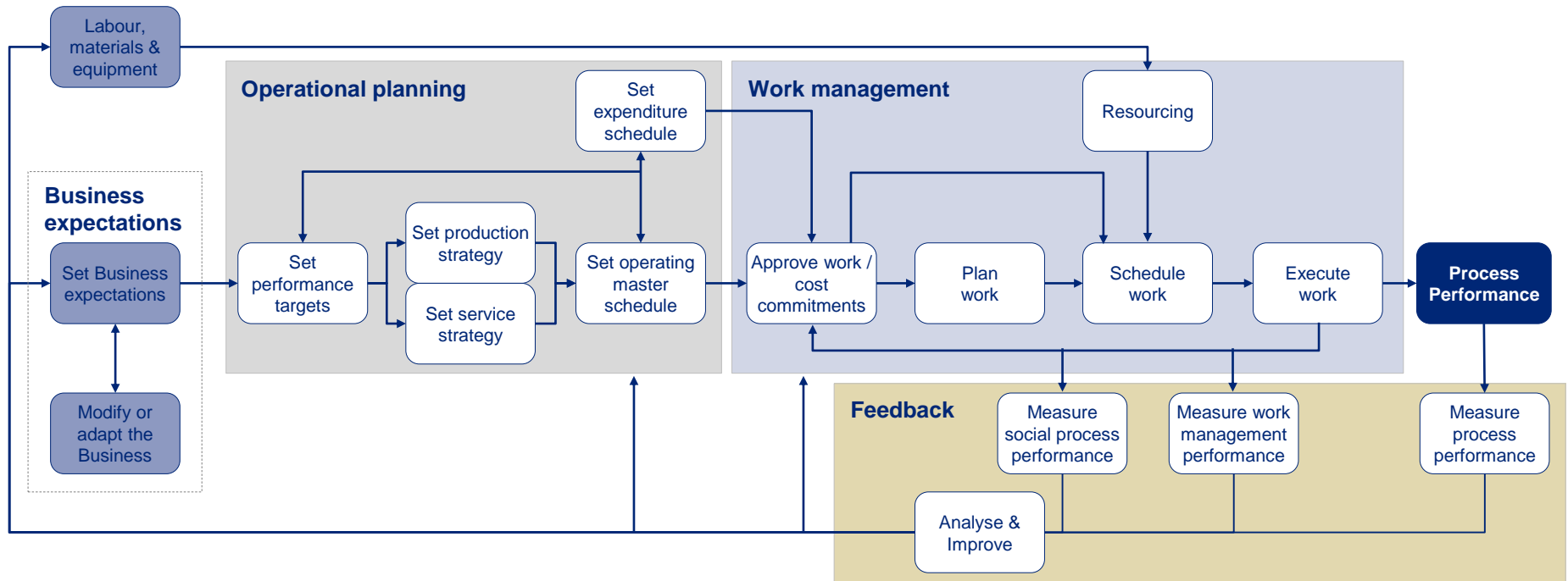
\$0.5bn delivered since 2017 of \$1-1.5bn targeted by 2022



OPERATIONAL EXCELLENCE



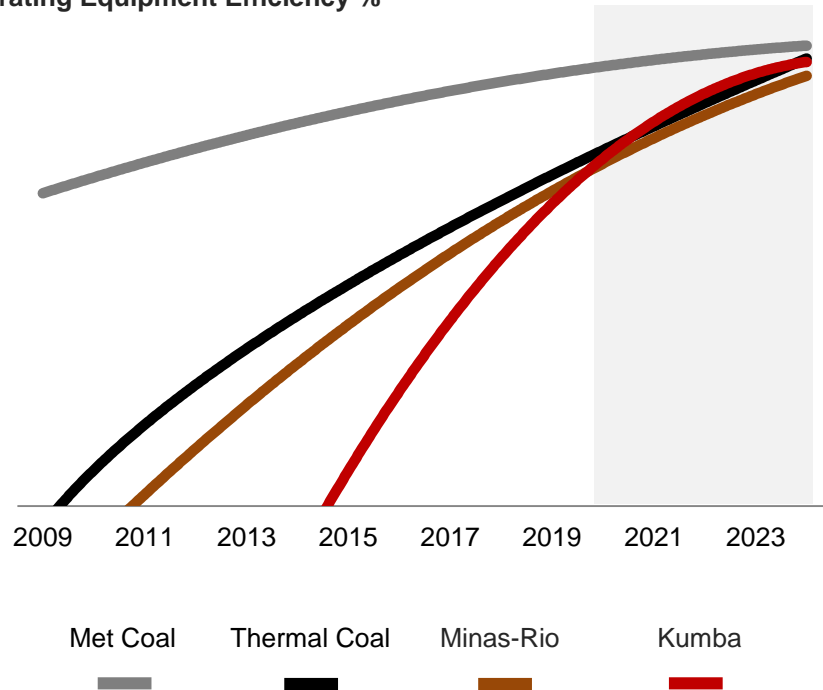
OPERATING MODEL KEY TO TRANSFORMATION JOURNEY



ACHIEVING & REDEFINING BEST-IN-CLASS PERFORMANCE

Open cut equipment performance

Operating Equipment Efficiency %



Clarity of purpose & focus

Aspirational targets

Operating Model

Seeking & sharing best practice

MET COAL: LONGWALL OF THE FUTURE

Establish foundations

Improved performance

Redefine best-in-class



+100% cutting time

+140% cutting time

+200% output

+370% output

50 hrs/wk cutting time
at 1,300 t/hr

100 hrs/wk
2,000 t/hr

120 hrs/wk
2,550 t/hr

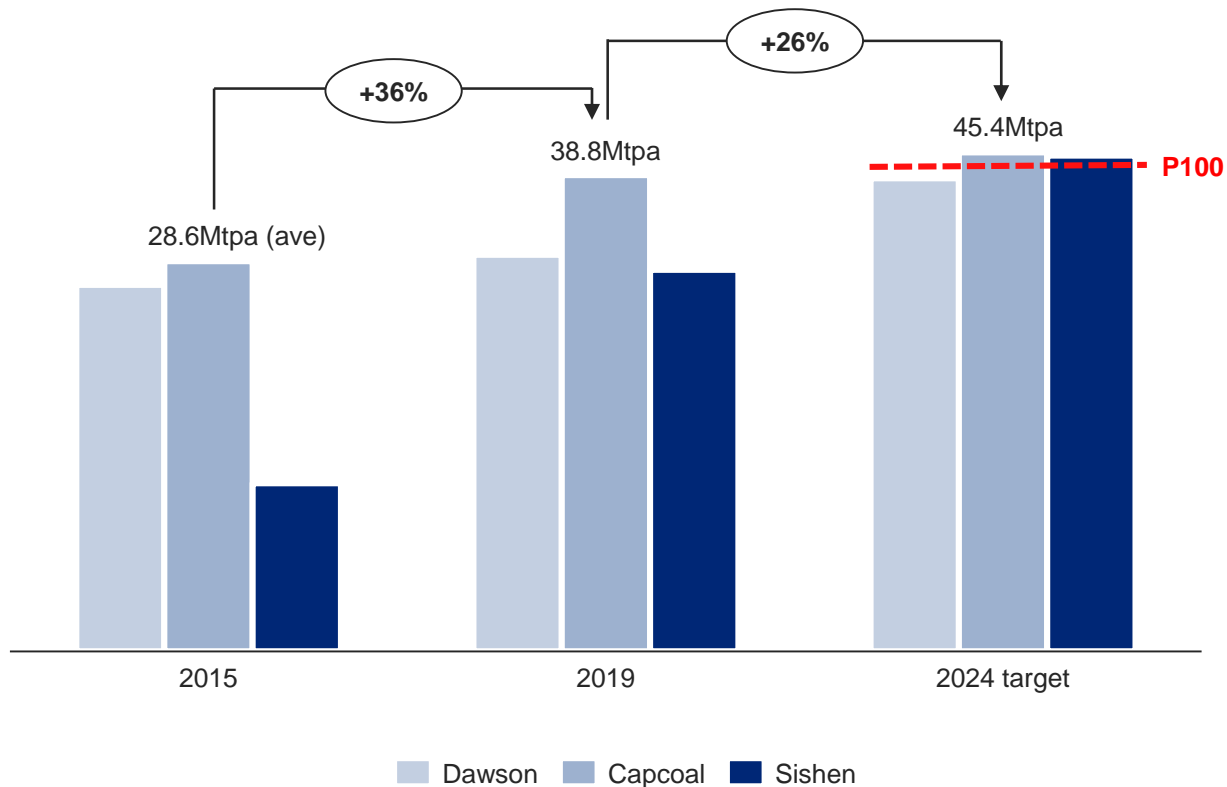


65 kt/wk output

200 kt/wk

306 kt/wk

SIGNIFICANT LARGE ROPE SHOVEL IMPROVEMENT DELIVERED ACROSS BULKS



Mine planning

Utilisation

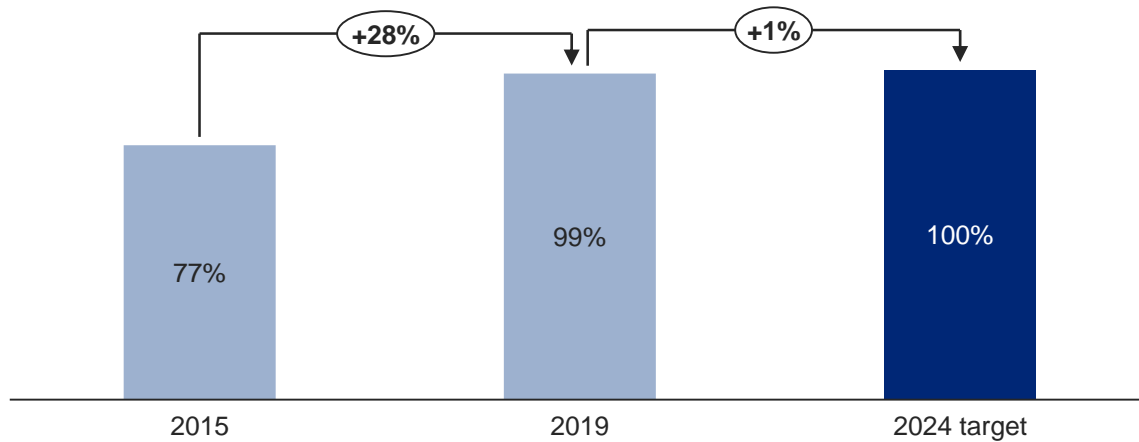
Productivity

Equipment

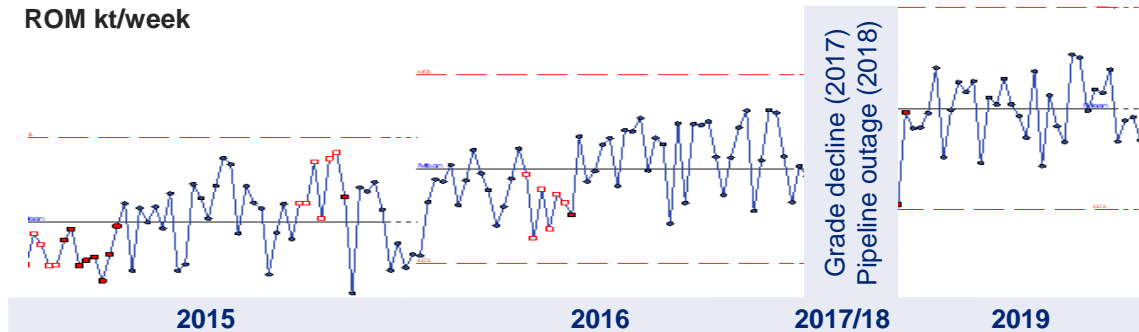
Collaboration

MINAS-RIO: NOW DELIVERING

Plant performance



ROM kt/week



Quality ore

Consistent feed rates and quality

Stabilised process

Plant optimisation



28%

production increase from improved mass recovery

TECHNOLOGY



TECHNOLOGY: KEY TO UNLOCKING FULL POTENTIAL

Identify, adapt & effectively deploy value adding technologies



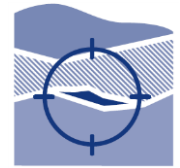
Safety



Sustainability



**Productivity,
efficiencies &
effectiveness**



**Utilisation of
resources**

Identify game changer

Whole value chain approach

Technology as differentiator

Prioritise value

Leverage collaboration

Accelerate adoption

STEP-CHANGE BEYOND OPERATIONAL EXCELLENCE

FutureSmart Mining™

Game-changing technology; data analytics;
sustainability



Kumba Ultra High Density Media Separation

Nickel bulk ore sorting

Technology for safety

Longwall of the Future

Advanced Process Control

Technology for sustainability

BULK ORE SORTING AT BARRO ALTO



Nov 2019: First unit installed
2021: Next 2 units

~\$10m

Capex per unit



30%

grade enrichment target



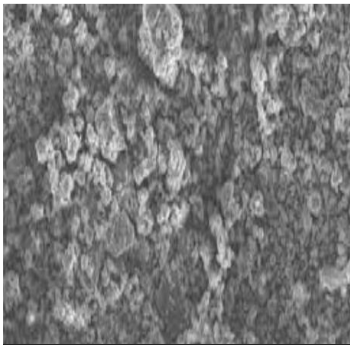
15%

unit costs improvement target

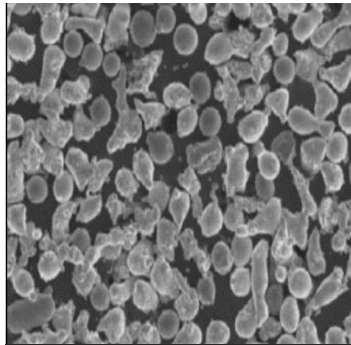
UNLOCKING SISHEN RESOURCE ENDOWMENT

Ultra High Density Media Separation (UHDMS)

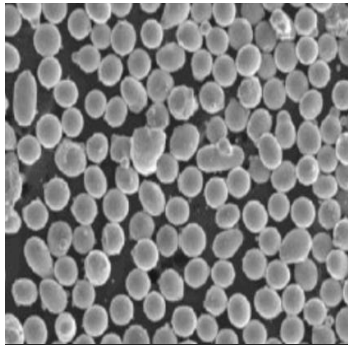
Nitrogen gas atomisation produces a finer, more regular and better distributed separation media



Milled



Steam atomised



Nitrogen gas-atomised

15-20%

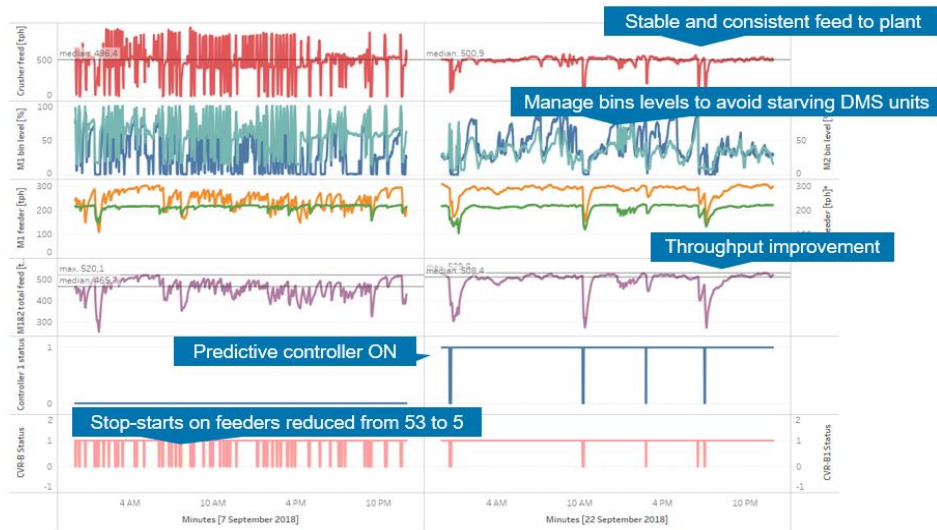
potential reduction in cut-off grade

10-15%

potential lower strip ratio

Enables production of even higher grade product

DIGITAL TRANSFORMATION: ADVANCED PROCESS CONTROL



Greenside, Thermal Coal

Advanced Process Control Technology

- Uses process models
- APC controllers in place rather than manual control
- Honours the process & equipment operating constraints
- Optimises process performance

Kolomela

↑ 36%
productivity & improved stability

Moranbah North

↑ 38%
plant feed stability & 2% throughput benefit

Minas-Rio

↑ 30%
improvement in stability & 5% energy reduction

TECHNOLOGY FOR SAFETY: EXAMPLES

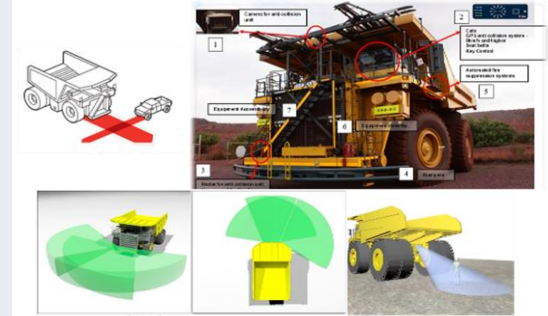
Proximity detection

Incident avoidance underground by preventing people-machine interactions



Collision avoidance

Automatic control & stoppage of trucks to prevent collisions



Fatigue management

Detect & prevent low alertness levels



U/G mobile devices

Tablets used underground to assist & support safe operations



Develop

Pilot

Scale-up

Replicate

TECHNOLOGY FOR SUSTAINABILITY: MET COAL UNDERGROUND GAS EMISSIONS MANAGEMENT

Gas is 97% of Met Coal GHG emissions

Seam degassing required for safety

Waste gas capture

145MW of power generation

63% reduction in GHG emissions



Power generation from waste gas is:

More than

2x

our UG needs

or

Enough to power

146k

households

or

Eq emissions reduction to

1.4m

fewer cars on the road

THE NEXT STEP-CHANGES

FutureSmart Mining™

Continuous innovation to stay 3-5 years ahead of the field



Data analytics

Dry tailings storage

Barro Alto low grade ore leaching

Minas-Rio in-pit crushing & conveyor

Mining low permeability coal

Minas-Rio coarse particle flotation

Sishen low grade beneficiation

Processing high ash coal

DIGITAL TRANSFORMATION: DATA ANALYTICS

Data platform



Ingest data from sites, sensors, SAP & external sources

Enable P101 benchmarking and analysis

Longwall cavity prediction



Predicting cavity formation

2020 value target of \$45m

Processing optimisation



Optimising operations with machine learning

2020 value target of ~\$40m

Asset monitoring, predictive maintenance



Predicting equipment failures before they occur

2020 value target of ~\$12m

COARSE PARTICLE FLOTATION: MINAS-RIO

20% of feed rejected as silica sand

Improved product quality & consistency

Reduced tailings volumes



↑ ~\$500m
potential NPV uplift

↓ 15%
water saving

↓ 20-30%
mill energy reduction

SUMMARY

Leading capabilities actively transforming a world class asset base to drive sustainable, competitive returns

Redefining best-in-class performance



Innovation, technology & digitalisation

