

Rio Tinto

# Battery Electric Vehicle trial at an underground Copper project

September 2023



# Reservation of Rights and the Status of Information in this Presentation

Without limitation, Rio Tinto reserves all its rights in relation to this presentation, including copyright.

This presentation has been prepared for informational and/or educational purposes. Neither Rio Tinto nor the presenter make any representation or warranty with respect to the accuracy or completeness of this presentation.

This presentation may contain forward-looking statements (within the meaning of the US Private Securities Litigation Reform Act of 1995). Forward-looking statements are statements of future expectations in relation to Rio Tinto, including Rio Tinto's financial condition, operations and/or businesses.

Forward-looking statements are not guarantees or predictions of future performance. Forward-looking statements involve known and unknown risks, uncertainties and other factors, many of which are beyond the control of Rio Tinto, and which may cause actual results to differ materially from those expressed in this presentation. Do not place undue reliance on any forward-looking statements in this presentation, including with respect to future investment decisions.

Neither Rio Tinto nor the presenter undertake to update, or revise, any information in this presentation, including any forward-looking statements, because of new information, future events or other information.

# BEV Trial - Emerging Technology

All major manufacturers are responding to the “pull” for BEV from the mining industry, available options on the market are increasing rapidly.

Manufacturers are now progressing 3<sup>rd</sup> generation (built from ground up) machines

Our selected OEM has approximately 400,000 BEV operating hours



<https://www.rocktechnology.sandvik/en/products/equipment/loaders/lh518b-battery-electric-loader/>

# Background

- In 2022 Rio Tinto initiated the trial of two Battery Electric Vehicles (BEV) at an underground development project in the USA in partnership with multiple internal departments, our contracting partners and Sandvik.
- The Sandvik LH518B (18 tonne Battery UG Loader) and Artisan Z50 (50 tonne Battery UG Truck) were commissioned and compared against their diesel powered equivalents.



Site photograph



# Background

- The trial commenced in July of 2022 with the intent to capture specific and quantifiable data on the performance of the vehicles.
- The BEV Trial was conducted in collaboration with the Underground Operations and Maintenance team the Underground Characterisation development team and our contracting partners.



Site photograph

# Benefits and Equipment

## Expected Benefits:



## Equipment:



Site photograph

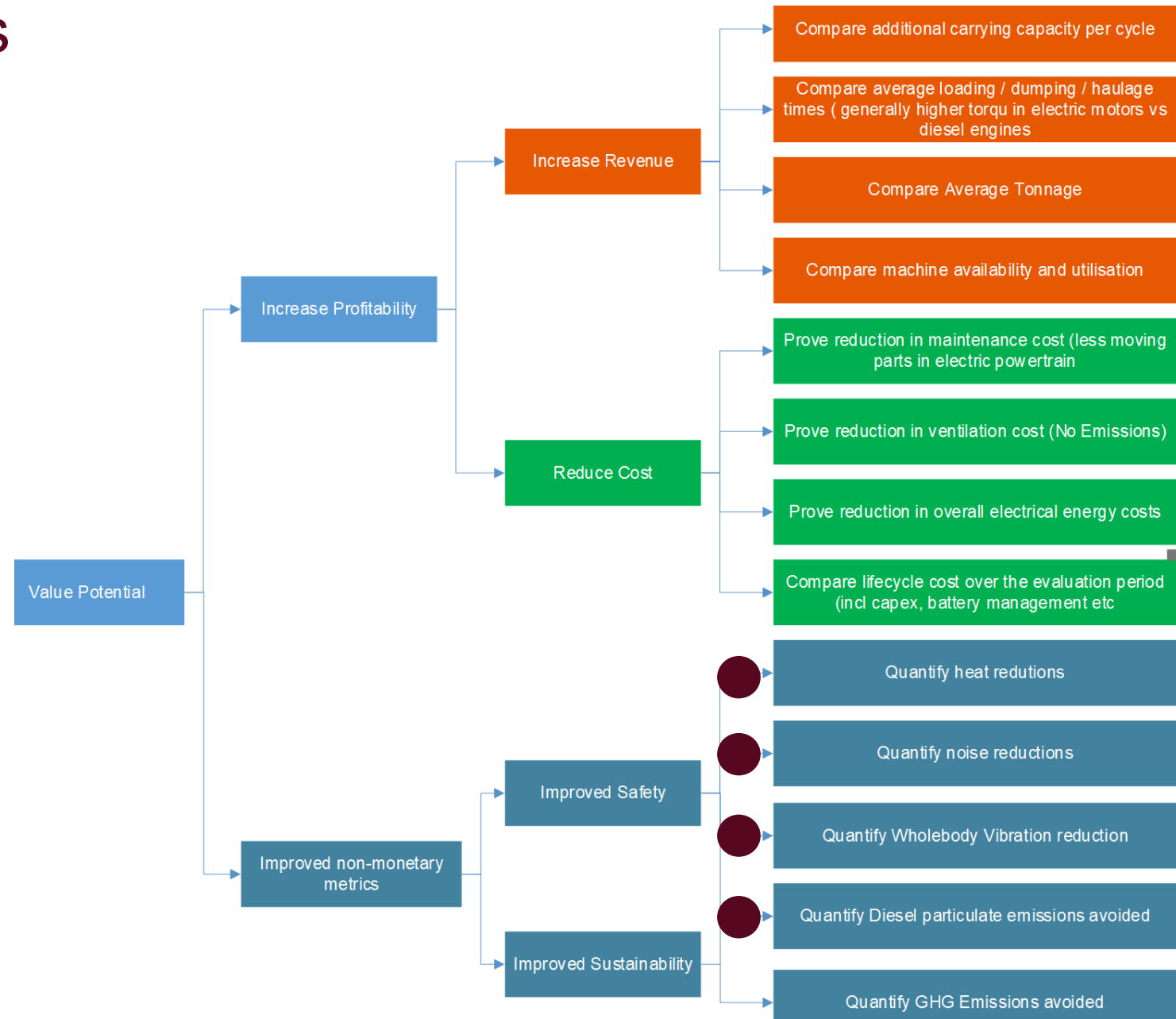
# BEV Trial - Project Summary

- Compare battery electric vehicle (BEV) performance of 18 tonne loader and 50 tonne against their diesel equivalent.
- A four phase trial was developed:
  - Stage 0: Readiness - Preparation
  - Stage 1: Initial Assessment – Controlled Trial
  - Stage 2 – Performance assessment – Integration Trial
  - Stage 3 – Trial Evaluation – Results and recommendation



Site photographs

# BEV Trial - Metrics





# Key Metric - Diesel Particulate Matter (DPM)

## What is DPM?

DPM is a component of diesel exhaust that includes soot particles made up primarily of carbon, ash, metallic abrasion particles, sulfates and silicates.

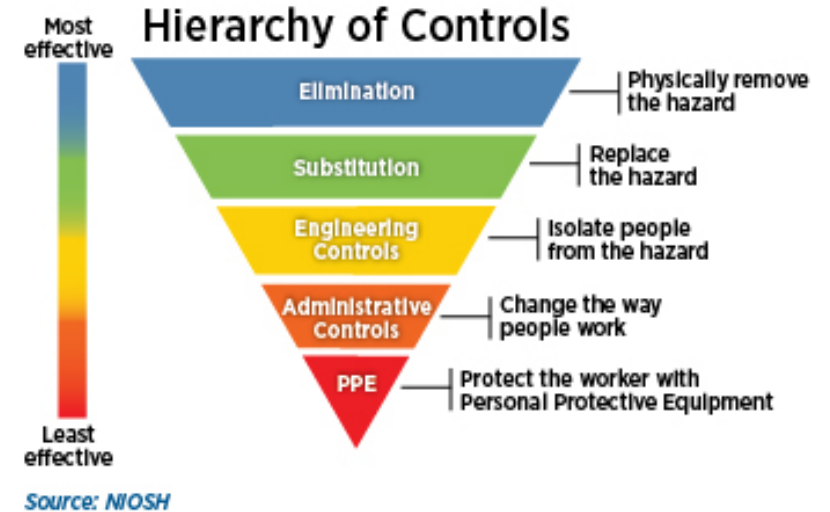
- Diesel soot particles have a solid core consisting of elemental carbon, with other substances attached to the surface, including organic carbon compounds known as aromatic hydrocarbons.

*In 2012, the World Health Organization designated diesel exhaust fumes as a Class 1A Carcinogen.*

## Health Impacts

Short term exposure to high concentrations of DPM can cause headache, dizziness, and irritation of the eye, nose and throat severe enough to distract or disable miners and other workers.

Prolonged exposure to DPM can increase the risk of cardiovascular, cardiopulmonary and respiratory disease and lung cancer.



<https://www.cdc.gov/niosh/topics/hierarchy/default.html>

Current controls include ventilation, DPF, PPE, fuel, engine tier, monitoring and training.



# Area and Personal Sampling

A scope of work was developed and executed to collect data on BEV and Diesel equivalents in the same area of the mine while undertaking the same task.

Executing the monitoring ensured that comparative data was collected.

The aim was to determine if a quantifiable improvement could be detected for the BEV over diesel machines.

The four industrial hygiene evaluation areas included:

- Diesel Particulate Matter.
- Noise
- Heat stress
- Whole Body Vibration



# Rationale

- Combustion engines generate more DPM, Heat and Noise than BEV due to the combustion process, hydraulics and exhaust emission.
- Personal and area measurements samples were collected to determine each vehicle type's (Loader and Truck) contribution to area and personal exposure during operations.
- Samples were taken on the person operating the equipment, or in the heading and muck bay area where the equipment was working during each mining cycle.
- Results of the monitoring for each parameter were combined and averaged to give an overall comparable result.



# Health Risk Reduction

Diesel particulate matter



**-35%**  
Personal

**-68%**  
Area

Noise



**-1 to -3 dBA**  
Personal

**-16 dBA**  
Area (under load)

**-2 to -6 dBA**  
Area (idle)

Heat stress



**-2 to -3 degC**  
Area WBGT

Vibration (WBV)



**Low**  
Not conclusive

# Ventilation Comparisons

UG Diesel Equipment	UG BEV
High heatloads – health & productivity impacts	Significantly reduced heatloads
Gas emissions – health impacts (carcinogen)	Zero emissions
Polycyclic aromatic hydrocarbons (PAH) – health impacts (carcinogen)	No PAH
Diesel Particulate (EC) – health impact (carcinogen)	No DPM (EC)
Ventilation dilution rates	Lowered ventilation dilution rates
Large cross-sectional vent shafts & vent drifts	Smaller ventilation shafts & drifts (cost saving) or increase number of BEV vehicles = increase in production
Fire risks – diesel/hydrocarbons, tyres etc	Fire risk – LIB, HF, Tyres & Hydraulic oils
Increased humidity	No humidity increase
Diesel refueling – fire risk and diesel vapours, water contamination risk	Battery charging – thermal runaway, ark flash/fire risk. No diesel vapours reduced water contamination risk
The gas portion of diesel exhaust is mostly carbon dioxide, carbon monoxide, nitric oxide, nitrogen dioxide, sulphur oxides - Challenge to meet future gas OEL's especially for CO (20ppm) & NO <sub>2</sub> (0.5ppm)	Zero gas emissions

# Conclusion

- This small-scale trial involved the introduction of two battery electric vehicles (BEV) into an existing fleet of diesel-powered vehicles within an underground mine.
- The targeted monitoring conducted in this trial has yielded positive outcomes across all measured parameters.
- The transition towards alternative power sources is currently underway, and this trial has provided evidence of the reduction in personal exposure to common contaminants when using BEV compared to traditional diesel-powered vehicles.

# Conclusion

- The data obtained from the trial has revealed that the diesel-powered vehicles operating upstream of the trial area have contributed to the diesel exposure profile of the BEV operators.
- This finding indicates that simply adding BEV to the fleet is not a comprehensive solution; implementing a replacement strategy for the entire fleet is likely to have a more significant impact on reducing personal exposures.

# Limitations

- It is important to note that all industrial hygiene sampling results can be influenced by other external factors (other vehicles)
- Further sampling of longer duration is recommended to make a better assessment of the health benefits.