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How to Manage Risks of Implementing BEV in an Underground Environment

Presented by: Mayhew Performance

Safety Share

Charging



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Mike Mayhew & Nicole Mayhew
Founders

Vern Cameron
President and CEO



Founded in 2020 by Mike and Nicole
Over 80 years of combined mining experience

Mike Mayhew BEV and Mining Operations

Nicole Mayhew Health Care, Safety & Risk
Management

Vern Cameron President & CEO

Background



- 2012 Kirkland Lake Gold enters the BEV space in production.
- 2015 Mike Mayhew joins Artisan as Director Global Mining.
- 2017 Mike Mayhew, Artisan and CEO Tony Makuch partner to introduce the first 40 TONNE BEV truck; delivered in one year from design to start up.
- 2018 Mike Mayhew joins KLG as Mine SuperIntendent of Underground Mine Operations of Macassa Mine responsible for BEV equipment.
- 2018 Nicole Mayhew joins KLG as the Health Care Nurse for Shaft 4 at the Macassa Mine
- 2019 Mike appointed to Integration Manager (Shaft4 Project).
- 2020 Mayhew Performance commences Consulting with Global Mining Customers focused on BEV related mine design, planning and implementation
- 2021 Vern Cameron CPA/MBA appointed to the President and CEO of Mayhew Performance, bringing with him 30 years of executive leadership roles as VP, President, and CEO of private equity firms and public companies including 18 years in the US



Clients & Collaborations

GLENCORE



KIRKLAND LAKE GOLD



RioTinto

Kennecott Utah Copper



COEUR MINING®



GOLDER



COLLÈGE **BORÉAL**
éducation • innovation • recherche

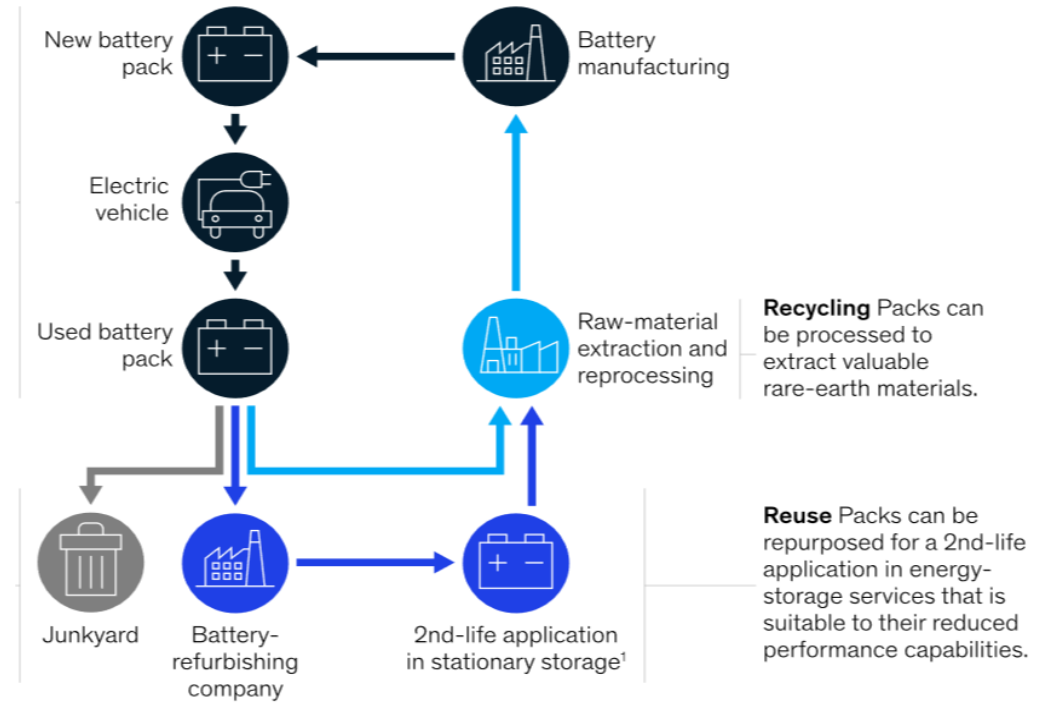
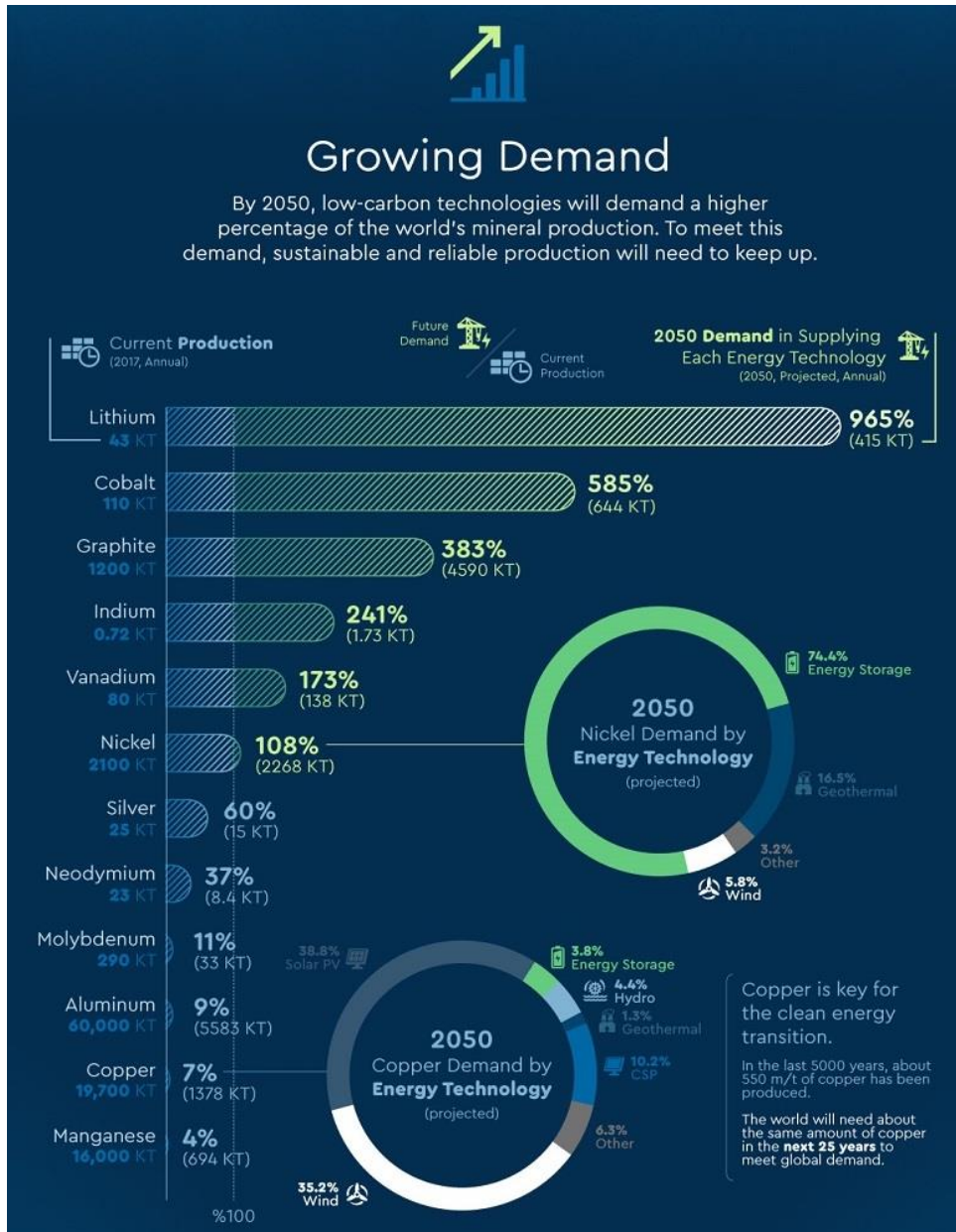


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Why BEV ?

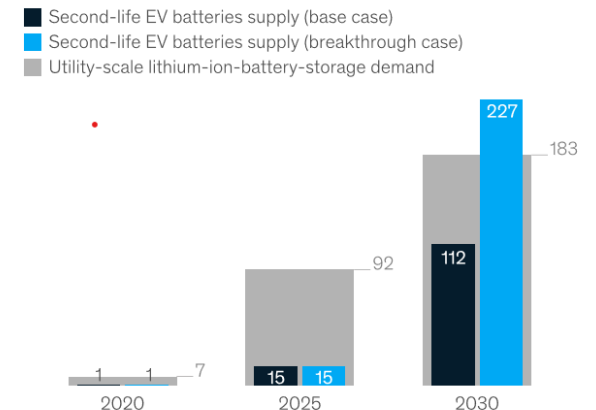
- Battery technology has evolved significantly in recent years. Lead acid batteries are large cumbersome elements and has significant safety risk, instability in its reliability and finally low value for recycling.
- Emerging battery technology such as Lithium Ion and NMC batteries are substantially more reliable and predictable, safer and have multiple options for reuse, repurpose and recycling.
- Battery Electric Vehicles , “BEV” has seen explosive growth across multiple industries, and recently significant momentum in mining
- Reference by McKinsey:
 - <https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/second-life-ev-batteries-the-newest-value-pool-in-energy-storage>
 - https://mineconnect.com/demand-for-battery-metals-to-jump-500-by-2050/?mc_cid=4e665c001e&mc_eid=cf64eefd88

Quoted by McKinsey

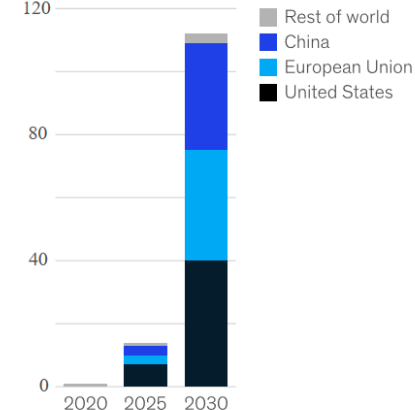


Second-life lithium-ion battery supply could surpass 200 gigawatt-hours per year by 2030.

Utility-scale lithium-ion battery demand and second-life EV¹ battery supply,² gigawatt-hours/year (GWh/y)



Second-life EV battery supply by geography (base case²), GWh/y





“Diesel is a Known Carcinogen”

Why Mining?

- UG mine workers are...
 - exposed to 100 times the diesel exhaust
 - 3 times more likely to get lung cancer
- The road to the healthy use of diesel is onerous, costly...and unlikely

- It is no secret that diesel engine emissions are a significant health risk, and for underground mines takes an enormous amount of fresh air. As mines expand, air costs to “fuel” diesel engines and control heat expands exponentially.
- Kirkland Lake Gold has emerged as the market leader in deploying underground BEV technology at their Macassa Mine. After 9 years of deploying BEV, its mine air is cleaner and safer, batteries are stable, and “air costs” are under control.
- However, BEV is not without its challenges.
 - Educating mine personnel on the nuances of BEV technology is very limited.
 - Managing battery status, location, condition and fleet utilization has proven more difficult for BEV's.
 - Real time data is an absolute requirement.
 - Helping mines manage the increased risk of fire with BEV.





Implementation of BEV

Planning stage

- Why? (why do we need BEV?)
- Where? (Where is it needed?)
- What? (What is required and what type of equipment?)
- When? (When is the implementation?)
- Who? (Who is trained to operate, maintain, service and implement emergency procedures?)



Implementation of BEV

Mining Operations

Existing BEV equipment in underground mines.

- **Production Equipment**
 - LHD, Trucks, Jumbo etc.
- **Utility Support Equipment**
 - Scissor Trucks, Boomtruck, Personal Carriers

Future BEV is fast growing - 3 major OEM's enter this space in 2020.



Risk & Safety Management

BEV Common themes within industry

- Battery chemistry
- Prevention and mitigation vs. root cause failure
 - Arc flash
 - Fire hazards





Battery Chemistry

Each chemistry has its own strengths, weaknesses and unique applications.

LFP (LiFePO₄) Lithium Iron Phosphate batteries is high specific power and is still preferred because of its low energy density.

NMC (LiNiMnCoO₂) Lithium Nickel Manganese Cobalt Oxide batteries are slowly taken over because of their higher energy density.

Understanding BEV Chemical Compound

	LCO	LMO	NMC	LFP	NCA	LTO
Overview						
Strengths	High Specific Energy	Fast Charging	High Specific Energy	Good Safety Rating, Long Lifespan, High Specific Power	High Specific Energy	
Weaknesses	Low Specific Power, Short Lifespan, Poor Safety Rating	Short Lifespan	-	Low Specific Energy	Expensive, Poor Safety Rating	
Applications	Mobile Phones, Laptops, Digital Cameras	Power Tools, Medical Instruments, Electric Vehicles	Power Tools, E-Bikes, Electric Vehicles	Electric Vehicles	Medical Devices, Tesla Vehicles	

Example of LFP VS NMC Safety Test





Arc Flash

Arc Flash

An Arc flash is the light and heat produced as part of an arc fault, a type of electrical explosion or discharge that results from a connection through air to ground or another voltage phase in an electrical system.

Arc Flash Risk Assessment (AFRA)

An Arc Flash Risk Assessment is a calculation performed to determine the thermal incident energy at a location which determines the arc flash boundary and what PPE is used.





Prevention and Mitigation

Prevention

- Protection of equipment and installation (Laws & Standards)
- Proper maintenance
- Proper tools (Insulated tools)
- Eliminate excess dust, corrosion, condensation, water or other liquids.

Mitigation

- PPE
- Perform a hazard analysis
- Lock Out Procedure
- Covers and Barriers
- Avoid Live work





BEV Fire

BEV Fire

Battery fires may occur when the battery is damaged, exposed to extreme heat or something penetrates the battery cell or module.

Maintenance and inspection are some of the key steps in BEV fire prevention.





Prevention and Mitigation

Prevention

- Protection of equipment and installation (Laws & Standards)
- Eliminating sources of extreme heat
- Do not open, disassemble or puncture
- Not overcharging

Mitigation

- Safe handling (Using proper tools)
- Storage (away from extreme heat)
- Strategic Charging locations as part of your mine design
- Planning for disposal





Health Care of Batteries

No Side effects using batteries in normal conditions. However, if the outer capsule is damaged, a wide variation of effects may occur.

Here are some side effects that could occur when exposed to a damaged battery;

- Dermatitis
- Chemical burns
- Temperature burns
- Asthma like Symptoms (Cough, Dyspnea)
- With prolonged exposure, Lung Disease
- Smoke/gas inhalation vary from; Carbon Monoxide, Carbon Dioxide, Lithium Oxide and potentially others.
- Safety Data Sheets (SDS) will vary with the type of battery and the capsule the cells are kept together with.



Risk and Safety Management

How to Manage Battery Risk and Safety RASCI CHART

Responsibility	Accountability	Supportive	Consulted	Informed
Who is Responsible? And what are their responsibilities?	Who is Accountable and what are their responsibilities?	Who supports them? What are the supportive actions?	Who can provide valuable advice or consultation for the task?	Who is notified about progress and decisions?
R	A	S	C	I

Responsibility	Accountability	Supportive	Consulted	Informed
Control Group-Upper Management Make all calls as per legislation Initiate response protocol	Control Group Co-ordinate and direct Emergency Response	Mine Rescue MRO's Help co-ordinate emergency response	Mayhew Performance OEM's Head Office	MOL Mine Rescue Office
R	A	S	C	I



Mayhew Performance Hazard Recognition Program

Mayhew Performance Hazard Recognition Program

Hazard Near Miss Spills Positive Behavior

Name: _____

Date & Time: _____ AM/PM

Location: _____

Supervisor: _____

Report to: _____

Crew: _____

Hazard Corrected? Yes No
(Describe actions taken on reserve)

Do you wish to have a follow up? Yes No

For Office Use Only

Date Received: _____

Date Completed: _____

Reviewed By: _____


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Actions Taken:

Follow Up:



Battery Training

Battery training is required in a fast-growing underground market. Currently, OEM's and mining companies continue to struggle to meet industry demands.

As technology continues to evolve, many OEM and mining companies are looking at different training methodologies focusing on:

- Electricians
- Millwrights
- Service Mechanics
- Mechanical/Electrical Specialist

Developing an operator training checklist for the pre-inspection and pre-op procedure in relation to BEV and charging systems.



Outlook-Rapid Growth & Innovation

- Let's go back to the basic
- Mining Equipment will Benefit from the Automotive Industry
- Market Expansion as virtually all OEM's are entering this space
- Operations, Maintenance and Training Departments will need to continually update and validate processes and procedures
- Colleges continue to enter this space to offer additional certified training
- GMG Group strives for BEV standardization





Mining is about People – Let's keep them safe!

*“Diesel equipment has been in operations for years. BEV technology is forever changing and we **MUST** put steps in place for Safety Set up, Operations and Maintenance. Mining companies must go **Back to Basics** to ensure the Worker, the Supervisor and the Management fully understand the new technology that is rapidly taking over the mining industry.”*

– Mike Mayhew



Thank You

www.mayhewperformance.com