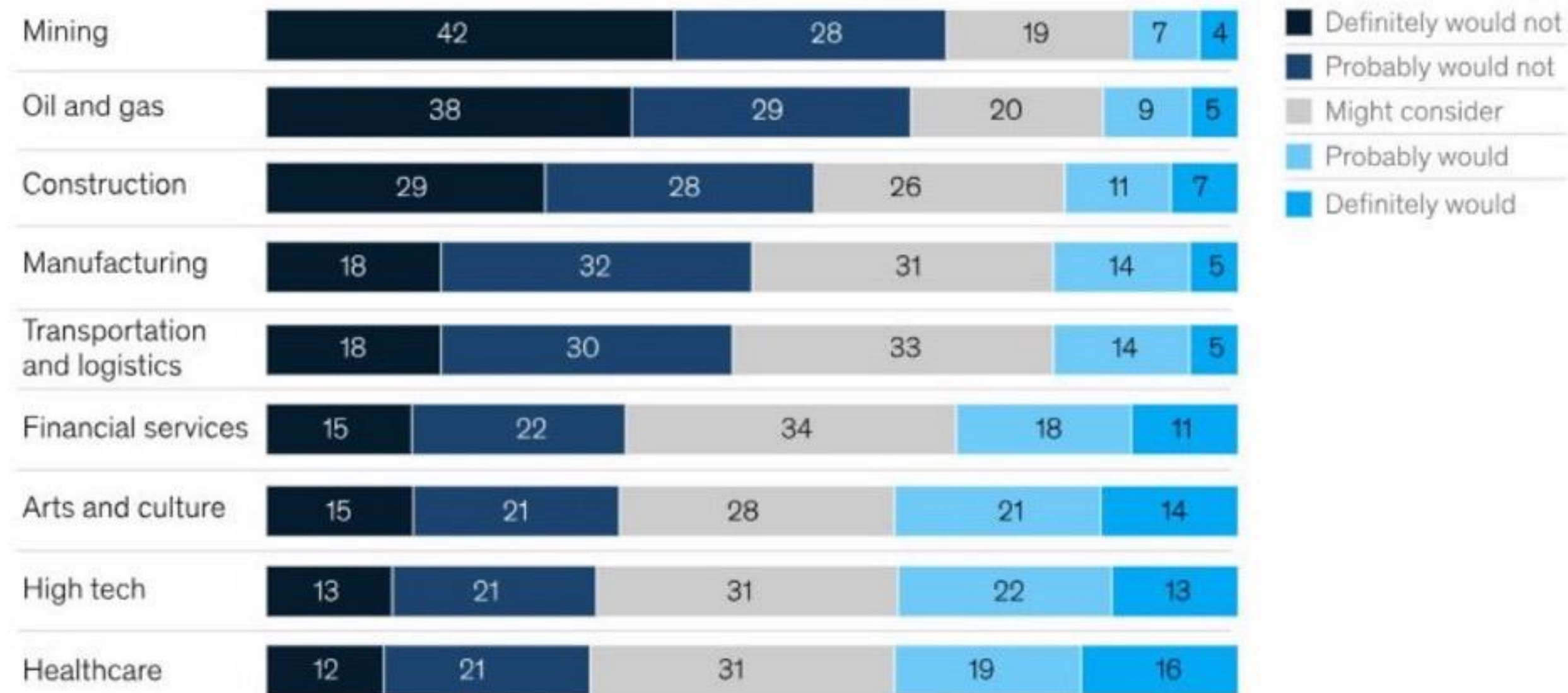


Plugged In and Prepared: Understanding Training Needs for Electric Mobile Mining Equipment

Several Canadian underground mines are global leaders in the roll-out of battery electric vehicles (BEVs) for drilling, loading, and hauling operations. However, the adoption of new low-carbon technology has not been without challenges, and ensuring the supply of a highly trained workforce will help accelerate the uptake of heavy-duty BEVs in Canada and abroad. This presentation will identify new training opportunities and industry initiatives underway to address the gaps.

Mining is not attractive to young talent.

Share of respondents, ages 15 to 30, who would consider working in the following sectors, %



Note: Totals may not sum to 100, because of rounding.

Source: Mining Industry Human Resources Council 2020 Employer Survey, Mining Industry Human Resources Council, 2021: 15 Canadian mining companies, representing more than 25,000 employees, participated in the survey, which was conducted during Dec 2020 and Jan 2021

McKinsey & Company



Why the Mines of the Future Will be Diesel-Free



David Francis Lyon

Founder and President at Zero Nexus | Innovator in Mining Technology | Critical Minerals

[11 articles](#)

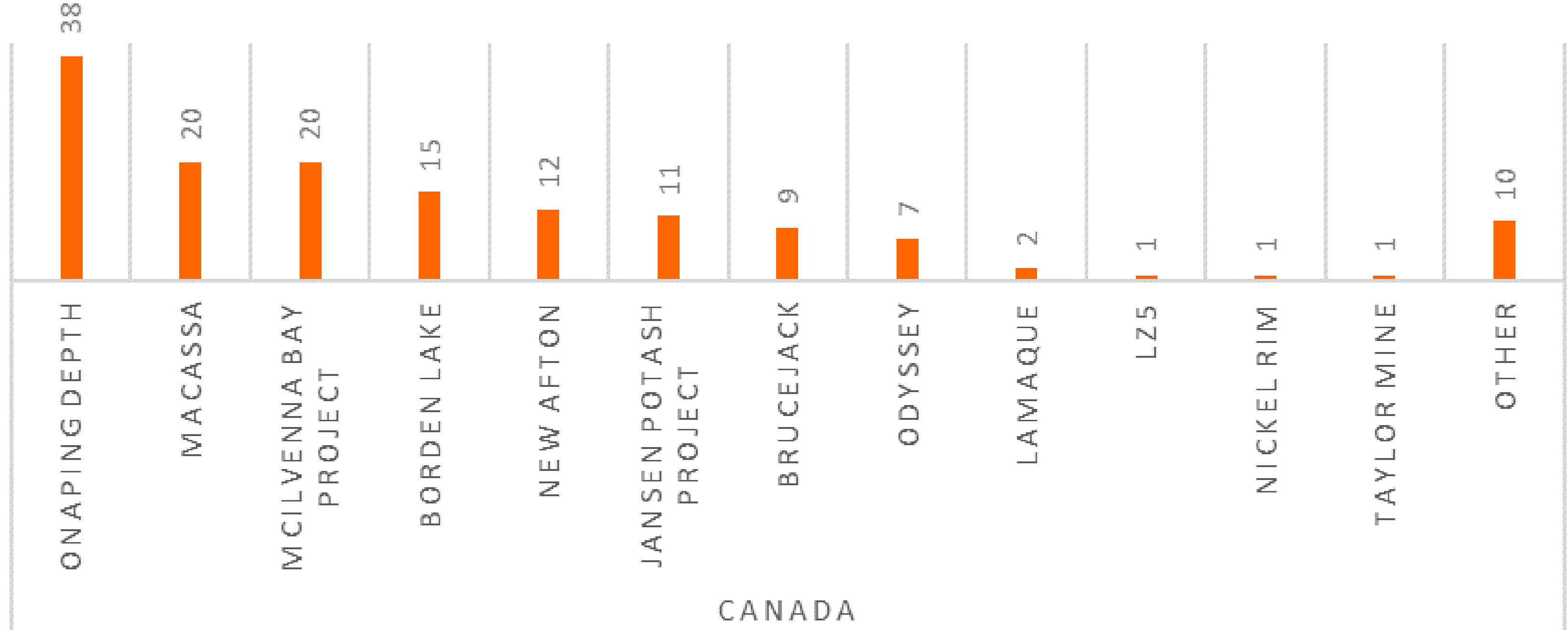
December 20, 2016

"Demand is going to escalate in the mining sector, the next three to five years will be all about battery-powered electrical vehicles."

Goldcorp Inc., a gold producer based in Vancouver, BC, recently announced plans to build the world's first diesel-free hard rock mine near Chapleau, Ontario.

Going diesel-free is an ambitious goal. A typical mine can have dozens of diesel engines across its heavy equipment fleet. Going electric means enormous up front costs, and massive retraining. It means turning away from an entire industry that exists to maintain and replace machines on demand. Most of all, it means embracing the reality that until recently, the technology to create a diesel-free mine was barely a realistic possibility.

UNITS PURCHASED BY CANADIAN MINES



CANADA

What do you think can help accelerate the adoption of BEV in mining?



From workplace safety north BEV Symposium February 9th, 2023 (n=62)

A worker in an orange safety suit and hard hat stands in a dark tunnel next to a large red mining vehicle. The vehicle has large, treaded tires and a prominent red body. The scene is dimly lit, with the worker's safety gear providing a point of contrast.

There are gaps in the specialized training needed to suitably prepare today's mining workforce for Electrification.

Categories of Training Needs

GENERAL BEV SAFETY:

- Addressing fire hazards, electric shock, arc flash, and battery user interface issues.
- Understanding power and drive systems, battery chemistry, and safety.
- Familiarization with charging systems and machine-specific safety considerations.

CHARGING AND MAINTENANCE SAFETY:

- Handling static discharge, faulty chargers, and over-discharge.
- Addressing contamination from metal particulates, and heat-related battery failures.
- Managing cold temperature charging and inappropriate charging methods.

JOB PLANNING:

- Adapting to the shorter tramming range or working time compared to diesel.
- Adjusting to longer charge or battery swap times.

GENERAL AWARENESS:

- Updating emergency protocols.
- Adapting communication protocols due to the quiet operation of BEVs.
- Effective handling and storage of batteries.

Different roles within mining operations require tailored role-specific training services. These groups include:

- *Operators* – battery user-interface and charging.
- *Mechanics* – mechanical components, such as enclosures and hydraulic packs.
- *Electricians* – BEV-specific high-voltage electric equipment.
- *Remote service/support* – skill sets for remote troubleshooting.
- *Charging* – all workers must be trained in the different methods of charging and/or battery swapping.

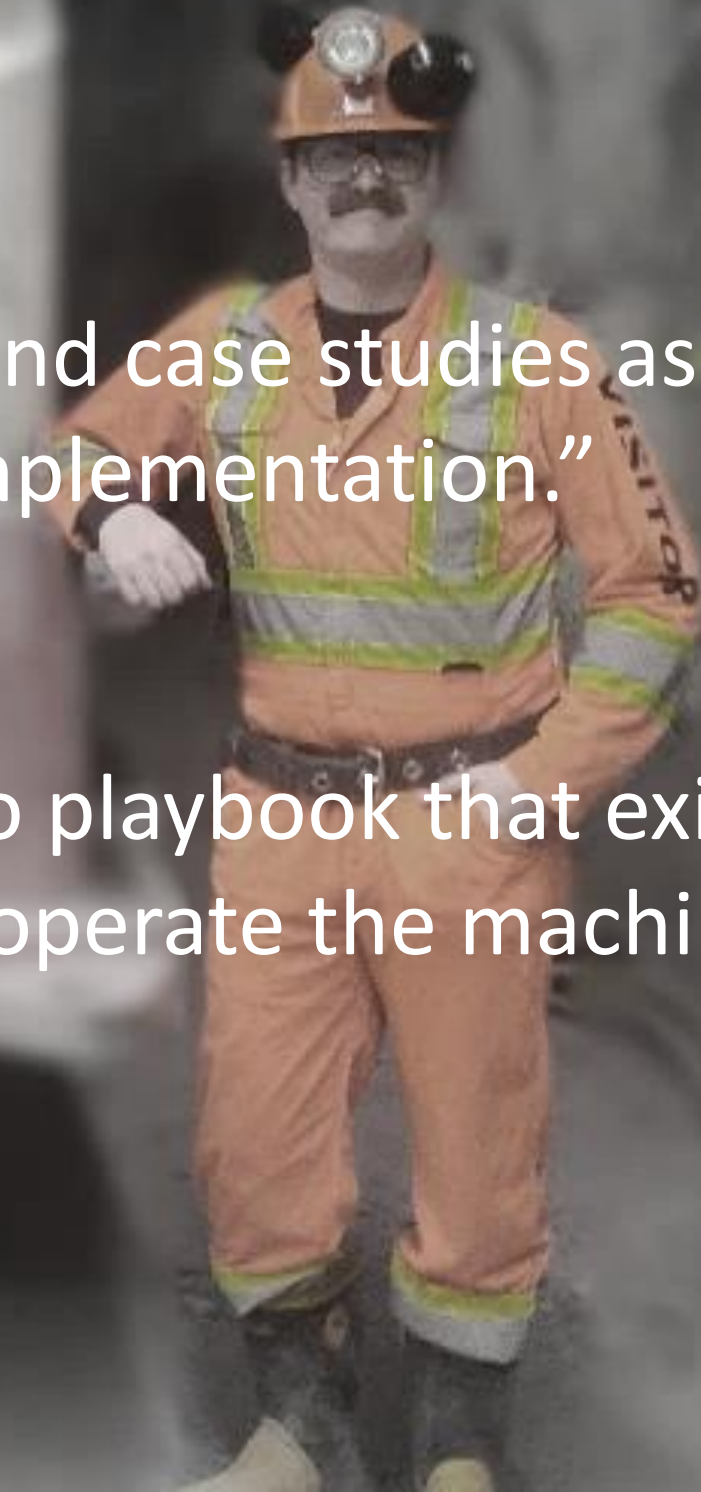
- ✓ Conducted interviews with 100+ industry stakeholders (Virtual and onsite)
- ✓ Conducted two workshops (CIM National & CIM MEMO)



“I would like to learn more about battery chemistry (un-biased) and the full life cycle analysis of battery electric vehicles for underground mines.”

“(I’m looking for) more applications and case studies as the BEVs grow in popularity and implementation.”

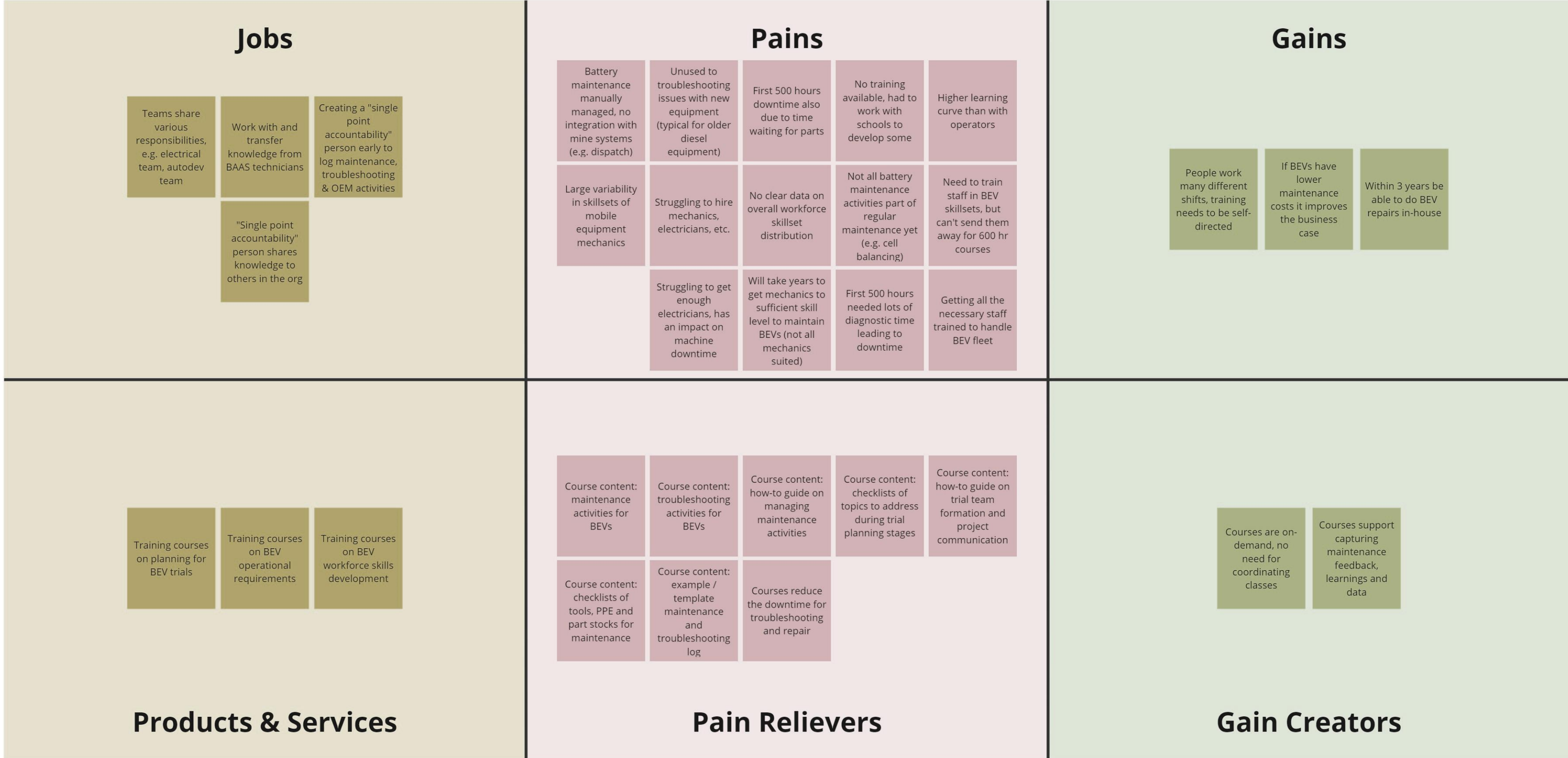
“There’s no rule of thumb, there’s no playbook that exists right now in the industry for [how to operate the machines] as a fleet”



Results

User Group: Mine Maintenance

Value Proposition: Improve BEV adoption Success



Customer Profile

Jobs
Describes jobs customers are trying to get done: functional, social, emotional, financial and basic needs

Gains
Describes how the customer measures a job well done, desired benefits, and positive consequences


Pains
Negative outcomes customers want to avoid, challenges, risks, costs, mistakes, etc.

Value Propositions

Products & Services
Describes the products and services that will be delivered to the customer

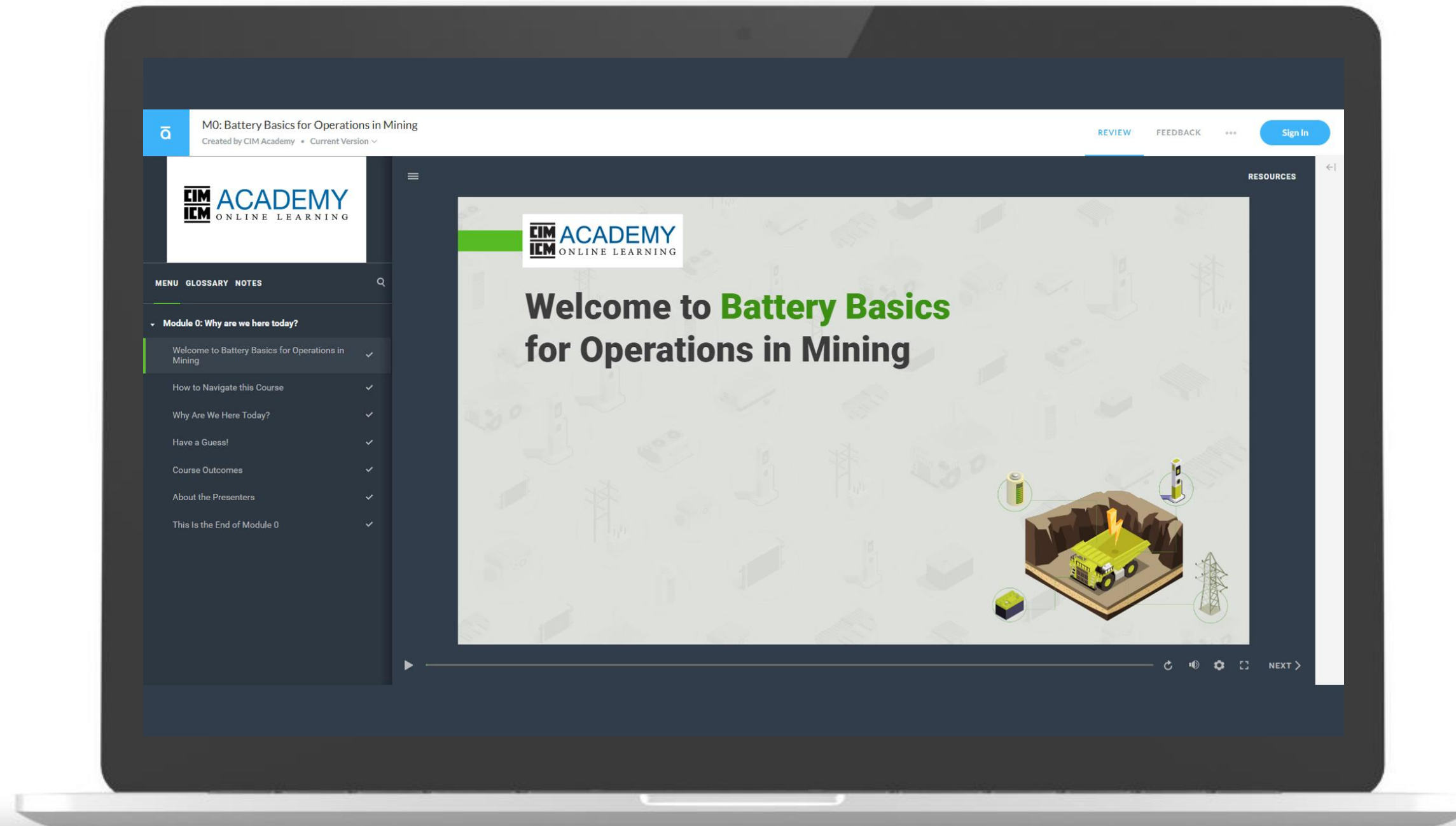
Gain Creators
The benefits the product/service offers and the positive consequences of its use

Pain Relievers
The ways which the product/service relieves customer's pain, reducing negative costs, feelings, efforts and risks

- 
- A worker wearing a dark hard hat, safety glasses, and a high-visibility yellow safety vest is working on a piece of yellow machinery in a mine. The worker is seen from the side, focused on the task. The machinery has several warning signs, including a lightning bolt symbol. The background is dimly lit, showing other parts of the mine's interior.
-
- ❑ *There exists a gap in addressing the planning stages for BEV (Battery Electric Vehicle) adoption.*
 - ❑ *For Operators, training may not be as critical, given that hands-on experience tends to address most of their challenges more effectively.*
 - ❑ *The steep learning curve for Mine Maintenance personnel necessitates a more comprehensive training approach.*

Training Program	Provider	Location	Description
<u><i>Industrial BEV Maintenance Certificate Program</i></u>	Cambrian College	Sudbury, ON	Consists of four 2-day courses, covering BEV safety, components, design, maintenance, troubleshooting, and hands-on training in an underground mine.
<u><i>BEV Maintenance Program: Basic Course</i></u>	College Boreal	Sudbury, ON	A completely virtual course, providing fundamental knowledge of mining BEVs from various OEMs, including safety procedures. Hands-on courses are in development.
<u><i>Battery Electric Vehicle Electrical</i></u>	Northern College	Timmins, ON	A two-part self-paced online course, providing an overview of battery safety, design, control, charging, and maintenance, along with larger systems-level BEV training.
<u><i>Battery Electric Mine Equipment</i></u>	Laurentian University	Sudbury, ON	A graduate-level university course, covering BEV design, battery chemistries, traction motors, charging systems, mine layouts, chassis design onboard systems. (e.g., braking, hydraulic power) and cost.

CIM Academy – Battery Basics for Operations in Mining



slido



What would you like to learn if you could spend time at a mine using electric vehicles?

ⓘ Start presenting to display the poll results on this slide.

Next Steps - Fleet Adoption Research



ZERO NEXUS

Invitation to Participate

We would be excited to include you. Let's explore how your organization might contribute to and benefit from these initiatives.

Please feel free to contact me to discuss this opportunity or to ask any questions you may have.

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Thank you to NRC IRAP for Research Sponsorship



Thank you to Epiroc and MacLean Engineering for generously contributing video content showcasing their battery electric vehicles.

