New Afton’s Learnings During the Implementation of Sandvik’s Battery-Electric Mobile Fleet
Outline

1. Overview of New Afton
2. BEV Journey
3. Equipment Usage
4. Change Management
   • Health and Safety
   • Engineering
   • Operation
   • Maintenance
5. Equipment Performance
   • Productivity
   • Health and Safety
   • Maintenance
6. Learnings
New Afton Overview

- West Cave
- East Cave
- B3
- East Cave Recovery (SLC)
- C-Zone

Levels:
- 1150 m
- 760 m
- 600 m
New Afton’s BEV Journey

Timeline

**H1 2020**
- Initial BEV conversations with Sandvik
- MacLean BT3 Boomtruck arrived on-site

**H1 2021**
- 3-month trial of Sandvik LH518B loader
- 2-month trial of DS412E bolter
- 1-month trial of Rokion R100

**H2 2021**
- Started 1-year trial of MacLean EV Sprayer
- On site testing of MEK BEV Toyota Conversion

**H1 2022**
- Arrival of first Artisan (Sandvik) Z50 truck
- Started work on UG BEV Maintenance Bay

**Current**
- Commissioning second Z50 truck
- Evaluating potential for BEV fleet for C-Zone production

*Bold text indicates owned units*
# New Afton BEV Equipment Usage

## Owned

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Acquired on</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MacLean BT3 Boomtruck</td>
<td>July 2020</td>
<td>Tram: 1,261</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Power Pack: 2,411</td>
</tr>
<tr>
<td>Sandvik LH518B Scoop</td>
<td>April 2021</td>
<td>1,623</td>
</tr>
<tr>
<td>Sandvik Z50 Truck</td>
<td>May 2022</td>
<td>302</td>
</tr>
<tr>
<td>Sandvik Z50 Truck</td>
<td>September 2022</td>
<td>-</td>
</tr>
</tbody>
</table>

*Note: 1 Diesel hour = 0.66 BEV due to lack of idling*

## Trialed

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandvik DS412iE Bolter</td>
<td>Site Acceptance Test (2 Months)</td>
</tr>
<tr>
<td>Rokion R100 personnel carrier</td>
<td>1 month trial</td>
</tr>
<tr>
<td>MEK BEV Toyota (surface only)</td>
<td>R&amp;D</td>
</tr>
<tr>
<td>MacLean SS5 Sprayer</td>
<td>1-year trial</td>
</tr>
</tbody>
</table>

1. As of August 31st, 2022
Change Management

Health and Safety

• Project Management Plan

• Risk based approach to charger and maintenance locations and equipment
  • Fresh vs Exhaust air
  • Where to put batteries with faults?
  • Fire protection

• Emergency response readiness
  • Specialized testing equipment
Change Management

Engineering – Charge Bays

• Location and layout highly influence battery swap times

Sandvik’s Provided Design

Location 1

Location 2

Location 3
Change Management

Engineering – Charge Bays

- LH518B - Hydraulic Battery Stands
  - Stand as failsafe
Change Management

Engineering – Charge Bay’s – Cable Management

Current

Next Improvement: Swing Arms
(Photo courtesy of Sandvik)
Change Management

Operations - Battery and Charger
Transport

Boomtruck

Scoop bucket
Change Management

Operations – Workforce Acceptance

- Select high performing, positive, worker champions
- Select an initial operating area with a high probability of success
- High performers value the acceleration and speed of the electric drive
- First users are critical in workforce acceptance through word of mouth
- Re-communicate vision and timeline with workforce routinely
Change Management

Operations – Range Anxiety

Consider Two Scenarios

- Low Risk Tolerance Operator A – 73% battery consumption
- Higher Risk Tolerance Operator B – 92% battery consumption

- 60 kWh difference in battery usage (20%)
- 30 minutes of productivity per day
Change Management

Maintenance

• **Challenges**
  • Shop space
  • Mechanics/Electricians gray area
  • Reliance on Sandvik Technicians and their direct line of contact with factory
  • Transferable skills from Diesel to BEV

• **Maintenance Strategy**
  • New Afton is developing a multi-faceted *Automation* team focused on the management of all BEV equipment
  • Upskilling Electricians and Mechanics as dual-trade personnel
  • Apprenticeships being created in-house
  • BaaS allows job shadowing of Sandvik Techs
Equipment Performance

Productivity - LH518B Material Movement

• Equal time to move same amount of material (~5 hours)

• Increased speed of LH518B compared to diesel equivalent offsets time lost with battery swap (11.4 km/h vs 7 km/h)

• Indicates potential productivity advantages with equal bucket capacity due to higher installed power
  • Potential advantages only realized in demanding applications

Example: Comparison between a CAT R2900 (9.4 m³) and LH518B (6.6 m³) on a 13% grade ramp
Equipment Performance

Productivity - LH518B Battery
Consumption

- ~100kW consumption rate
- ~3 hr. battery life (Max)
- ~460 to 630 tonnes per battery swap¹

¹ Tram distances of 170-235 (1-way) on level ground
Equipment Performance

Productivity - Z50 Battery Consumption

- 4-5 trips per battery swap (180-225 tonnes)
- Usable battery capacity very sensitive to charger location as distance increases

Route A
- 1.5km one-way.
  - About 830m at 16% grade
  - 135m elevation difference
  - 19% net consumption
  - 1 extra trip per battery

Route B
- 1.7km one-way.
  - About 1km at 13% grade
  - 178m elevation difference
  - 23% net consumption
Equipment Performance

Health and Safety – Respirable Dust, Diesel Particulate Matter, and CO₂e

- Study supported by Natural Resources Canada (3rd party)
- All figures are reported as relative increases to the intake baseline

CO₂e

- 254 liters of diesel consumed = 0.66 tonnes of CO₂e\(^1\)
- 432 kWh net energy consumption= 0.004 tonnes of CO₂e\(^2\)
- 100x Less CO₂e

<table>
<thead>
<tr>
<th>Respirable Dust</th>
<th></th>
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<tbody>
<tr>
<td>R2900</td>
<td>82%</td>
</tr>
<tr>
<td>LH518B</td>
<td>18%</td>
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</table>

<table>
<thead>
<tr>
<th>Diesel Particulate Matter</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Station</td>
<td>No Equipment</td>
</tr>
<tr>
<td>Intake</td>
<td>0</td>
</tr>
<tr>
<td>Exhaust</td>
<td>-14%</td>
</tr>
</tbody>
</table>

Note: Both dust and DMP experienced reductions in the heading from intake to exhaust
1. 0.00263 tCO₂e/L for Heavy-duty Diesel (B4) ([2020 B.C Best Practices Methodology for Quantifying Greenhouse Gas Emissions](#))
2. 9.7 tCO₂e/GWh ([B.C. Grid Factors](#))
Equipment Performance

Health and Safety - Heat

- Study supported by Natural Resources Canada (3rd party)
- 3.3 °C increase with Diesel; Negligible for BEV Loader

Note: Airflow @ 42.5kCFM through tests
First 1,500 Operating Hours
- Total downtime: 1,609 hours
- Downtime excluding Parts Not Onsite and No Maintenance Tech Available: 546 hours
Equipment Performance

Maintenance - Major Downtime – Z50

First 300 Operating Hours

- Total downtime: 739 hours (Excluding Commissioning: Ground Fault)
- Downtime excluding No Maintenance Tech Available: 363 hours (Excluding Commissioning)
Learnings

1. BaaS was essential to the success of the project, especially early on. Dedicate resources to job shadowing Sandvik Techs.

2. Proper design and location of charging bays is significant in maximizing productivity

3. Upskill Maintenance personnel in advance (dual-ticket)

4. Select the right operators to become technology advocates to increase workforce acceptance

5. Plan for lower reliability during the first years and bring equipment to site well before productivity is dependent on it.

6. Productivity improvements are not realized in every application

7. Understand the limitations of the technology and software controls and how that fits with your business needs; What are you trying to accomplish?
Vision

2022

• Year 1 Target: 6000 BEV Operating Hours
  • On track to hit 4500-5000

• Year 2 Target: 10,000 Operating Hours
  • Anticipating to reach equivalent of diesel by end of year 2
  • Increased hours driven both by increased demand and availability