MDEC 2025: Cambrian R&D Vale EV Lab

Capabilities and Upcoming Projects

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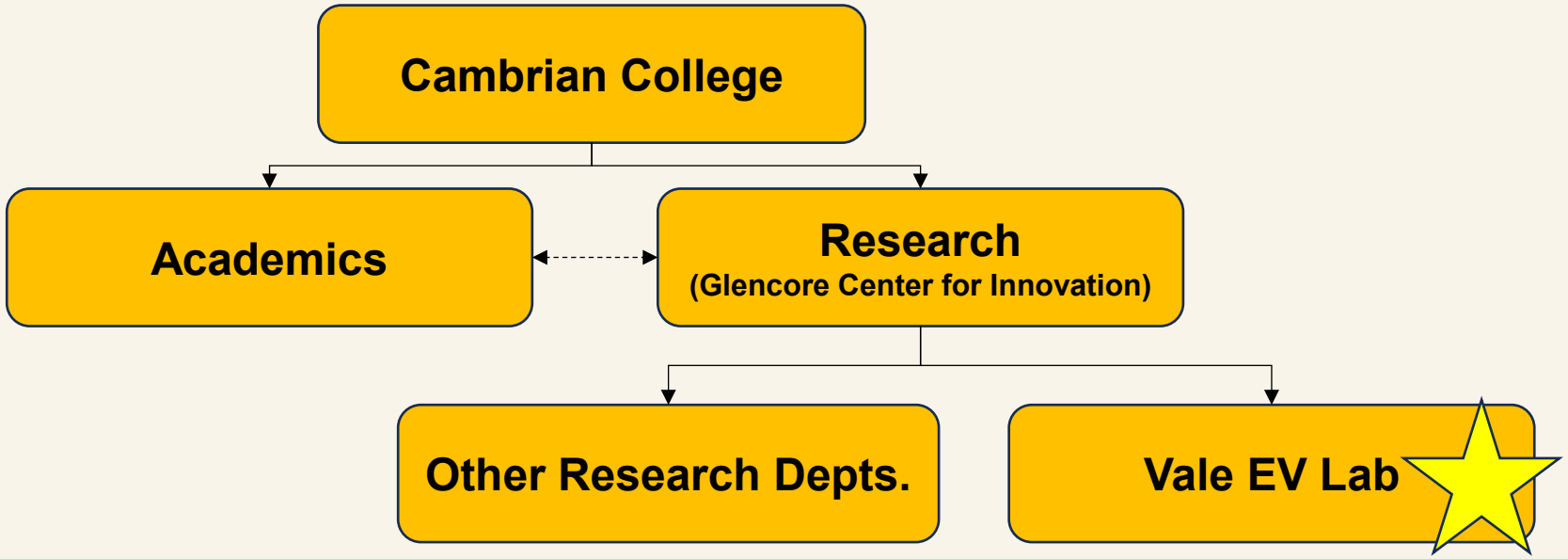
Cambrian College

Mining's Decarbonization Challenge

- Global shift to low / zero emissions fleets
- Unique pressures in underground mining
  - Ventilation
  - Heat
  - Diesel emissions
- Need for new technology and specialized expertise

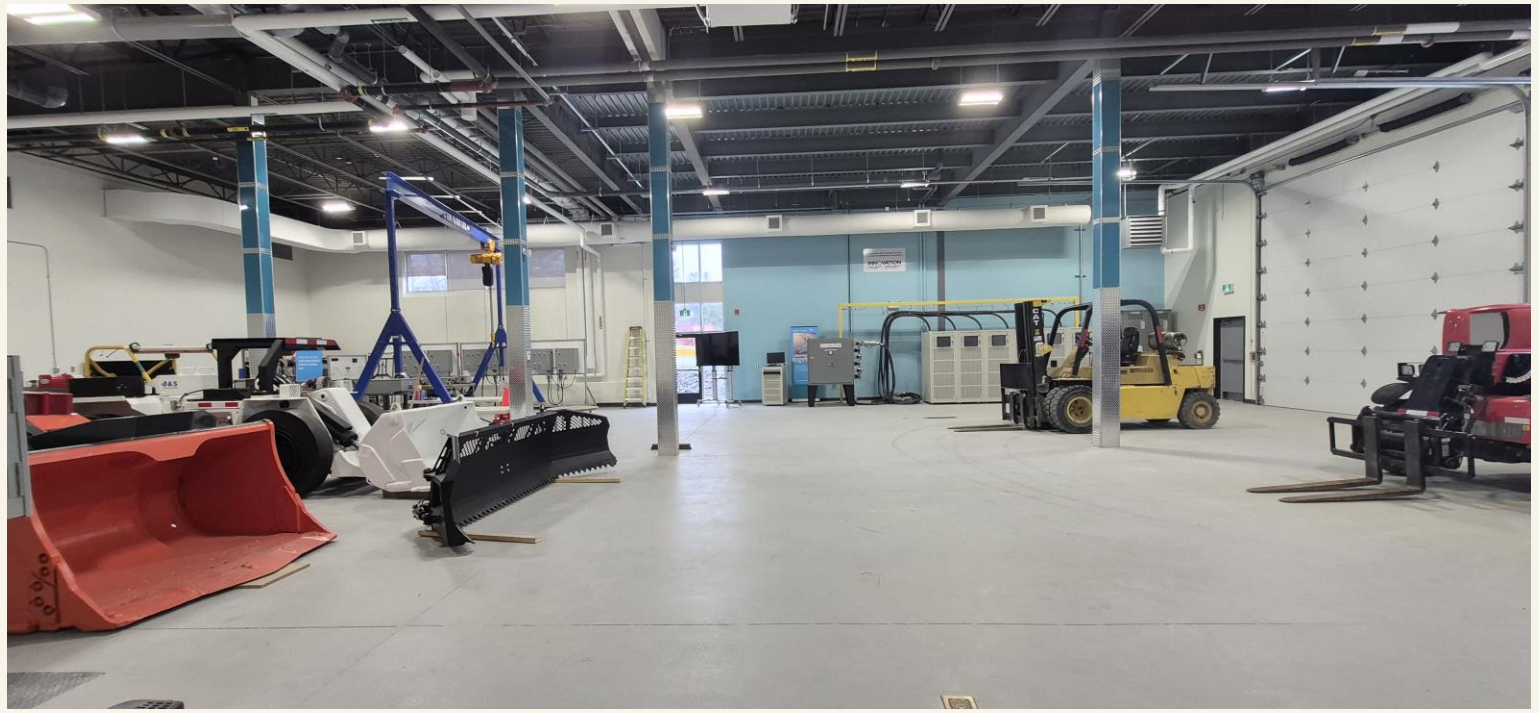
Role of Applied Research

- Industry – Academic – Government partnerships are critical
- Cambrian R&D helps access funding, support, and skilled workers to facilitate research & development to help grow business



Introducing the Vale EV Lab

- Purpose built to advance heavy industry electric vehicles
- Brings together advanced testing infrastructure, applied research expertise, and industry partnerships
- Provides a bridge from concept → prototype → deployment



Core Testing Infrastructure – NHR9300

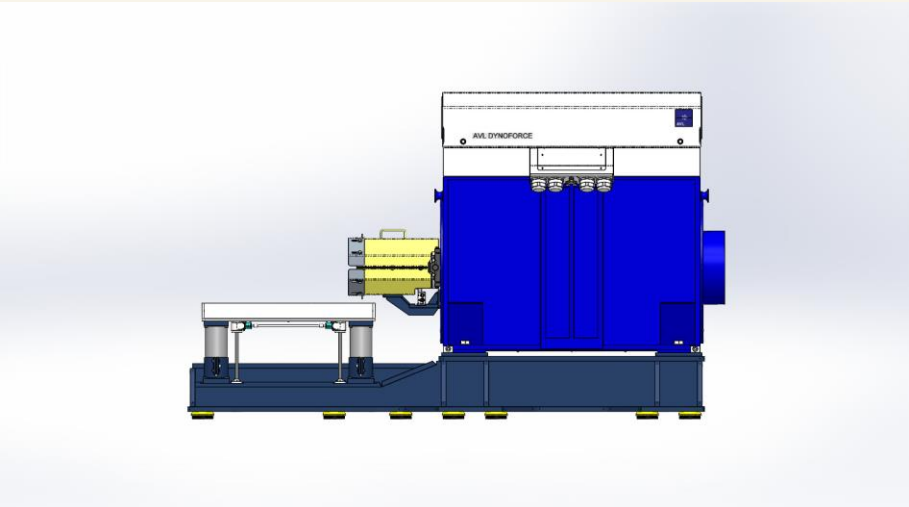
- Modular and scalable high voltage DC battery cycler and emulator
- Wide operating envelope, dual range 600 V, 1200 V
- Regenerative power >90 percent energy efficiency
- Bidirectional DC source and load
- Current, voltage, and mode transitions <2 ms
- Battery emulation mode

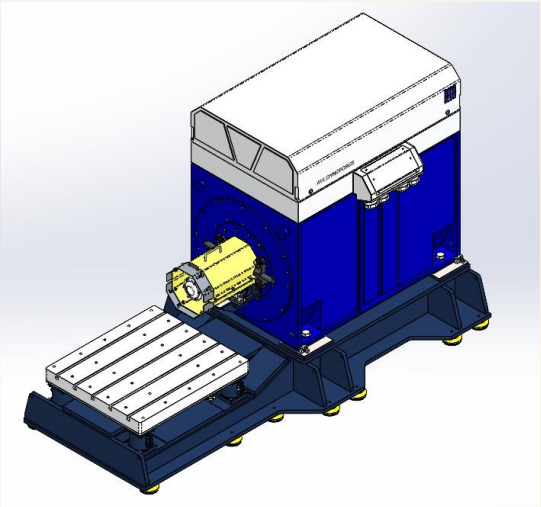
Model	9300-100	9300-200	9300-300	9300-400	9300-500	9300-600	300-1000	93000-1200
DC Output Specifications								
Number of Chassis	1	2	3	4	5	6	0	12
Maximum Power	± 100kW	± 200kW	± 300kW	± 400kW	± 500kW	± 600kW	1.0MW	± 1.2MW
Max Current (1200V)	± 167A	± 334A	± 501A	± 668A	± 835A	± 1002A	1670A	± 2001A
Max Current (600V)	± 333A	± 666A	± 999A	± 1332A	± 1665A	± 1998A	3330A	± 3996A
Programming Capability								
Operating States	Charge (Source), Discharge (Load), Standby (Idle) & Battery (Bi-Directional DC)							
Regulation Modes	Constant-Voltage (CV), Constant-Current (CP), Constant-Power (CP) & Constant Series Resistance (CR)							
Sourcing Envelope	0V to Full Range							
Loading Envelope	Range dependent: 30V to 600V or 60V to 1200V							
Voltage Set Accuracy[1]	0.1% of set + 0.1% of range							
Current Set Accuracy[1]	0.2% of set + 0.2% of range							
Current Slew Rate	Same polarity, 10% to 90%	< 2mS (600V Range)		< 3mS (1200V Range)				
Current Reversal	Opposite polarity, 90% to 90%	< 4mS (600V Range)		< 6mS (1200V Range)				
Parallel	Synchronous control for up to 12 channels (1.2MW)							
Measurement (4Wire)	Range		Accuracy[1]			Resolution		
Voltage (DC)	600V range / 1200V range		0.05% reading + 0.05% range			0.005% range		
Current (DC)	As shown above		0.10% reading + 0.10% range			0.005% range		
Power (DC)	Vrange x Irange		0.12% reading + 0.12% range			0.005% range		
Temperature	0 – 150°C							
Time	1mS to 7 Days							
Facility & Isolation								
Isolation	±1000 VDC UUT- to chassis / facility, ±1500 VDC UUT+ to chassis / facility, ±1000 chassis to facility							
Facility Power	3ϕ, 50/60Hz, 480VAC / 160A (Full Power) or 380-400VAC / 200A (output rating 90kW below 360VAC)							

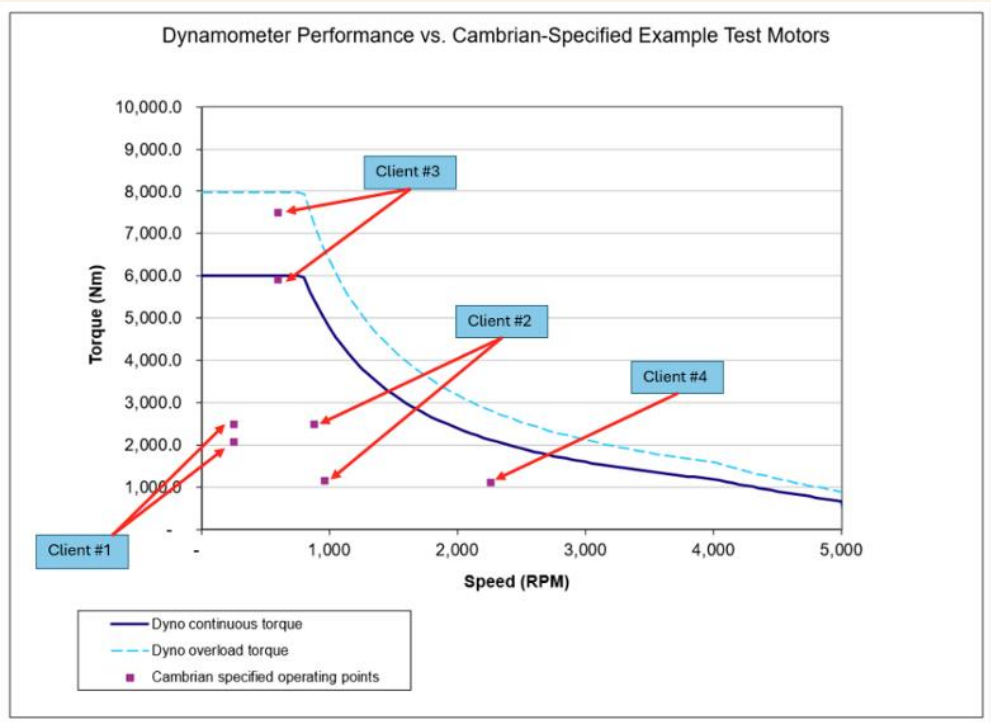
[1] Accuracy apply when the set point & measurement is greater than 10% of range, less than 1000V & after 10 minute warm-up at 25°C

Core Infrastructure – AVL E-Motor Dyno

- Purpose-built system for testing electric drivetrains under controlled load conditions
- Enables safe, repeatable evaluation of motors, inverters, and control strategies
- Provides high-fidelity data without the risks of in-vehicle trials
- Complements battery emulators for full propulsion system testing

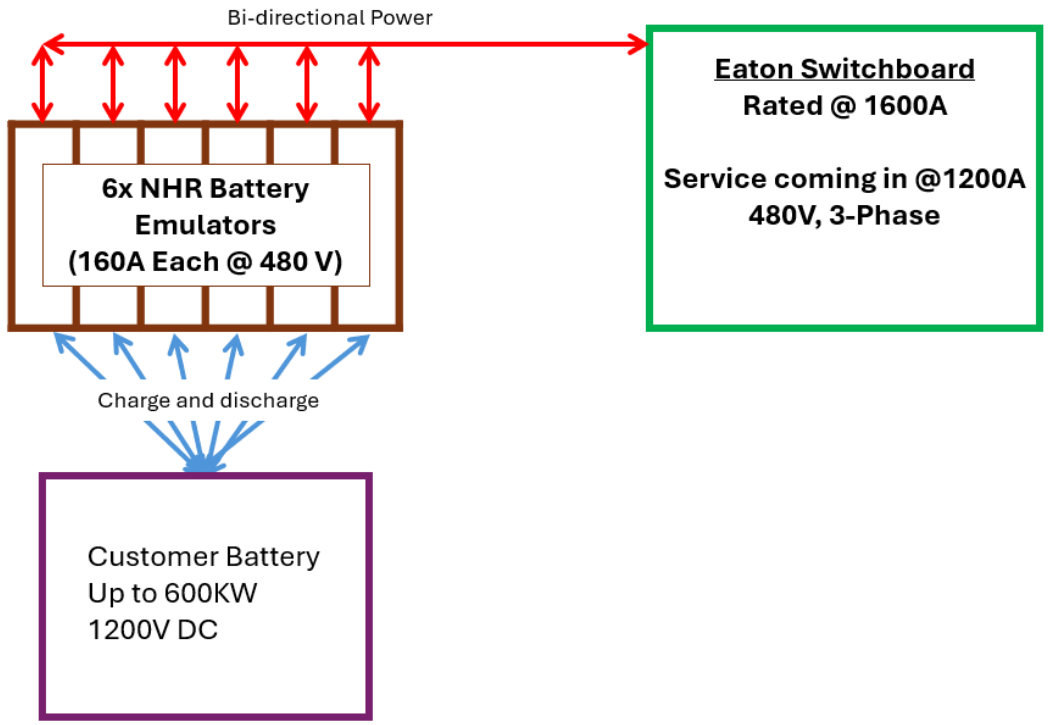




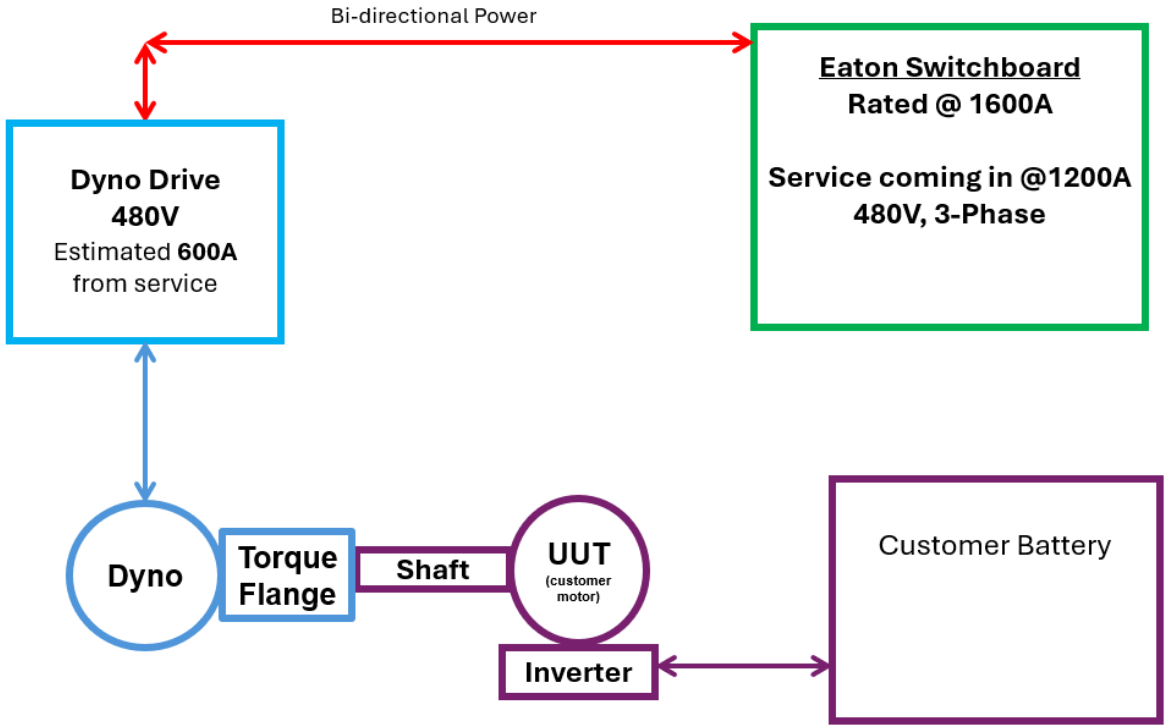


Core Testing Scenarios

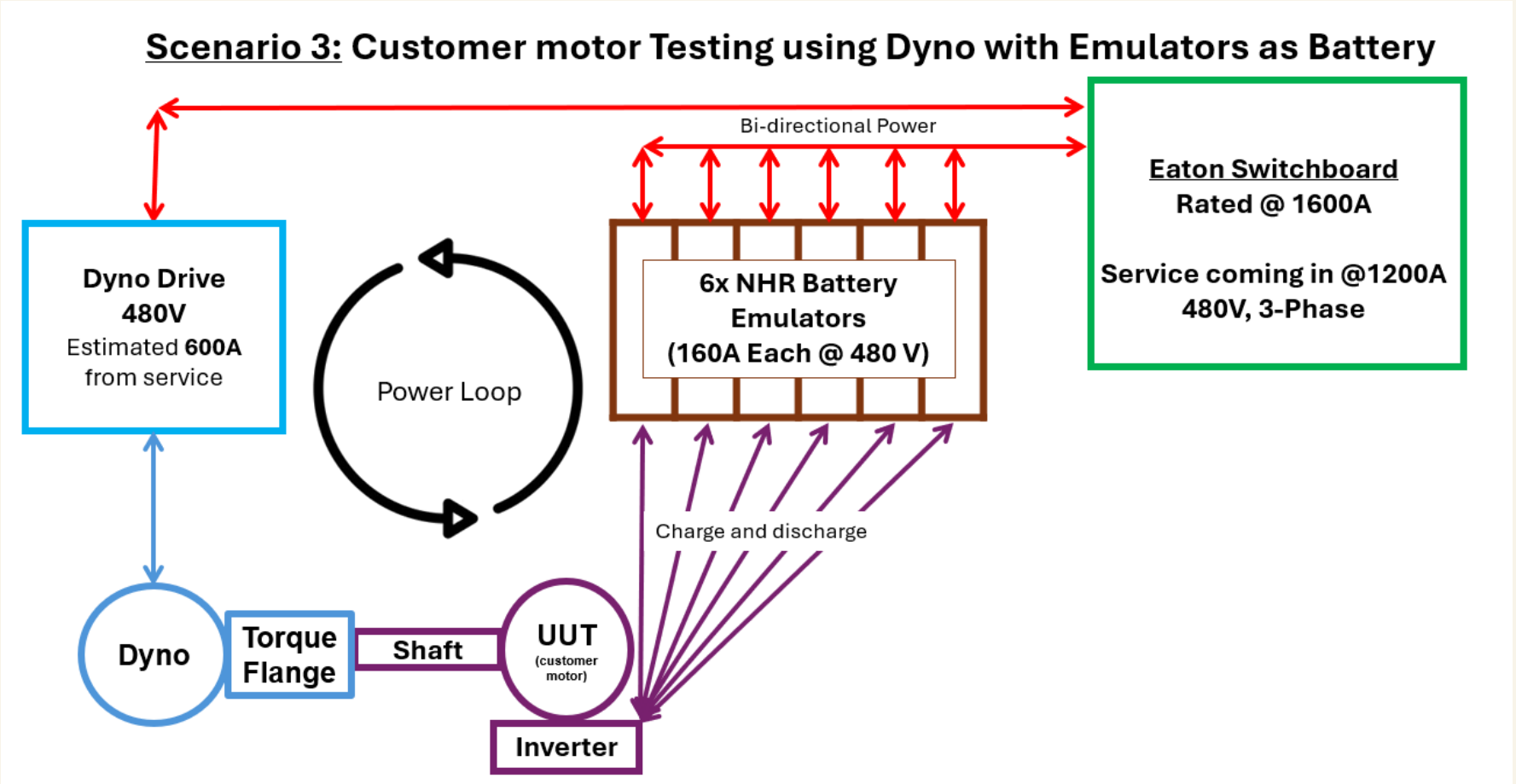
Scenario 1: Battery Testing



Scenario 2: Customer motor Testing using Dyno with Customer Battery



Core Testing Scenarios (cont.)



EV Fleet

Sandvik A4 LHD (215 kWh)

- Donated by Sandvik in 2023

Custom Mini LHD (1.2 kWh)

- Tele-remote upgrade planned

EV Fleet (cont.)

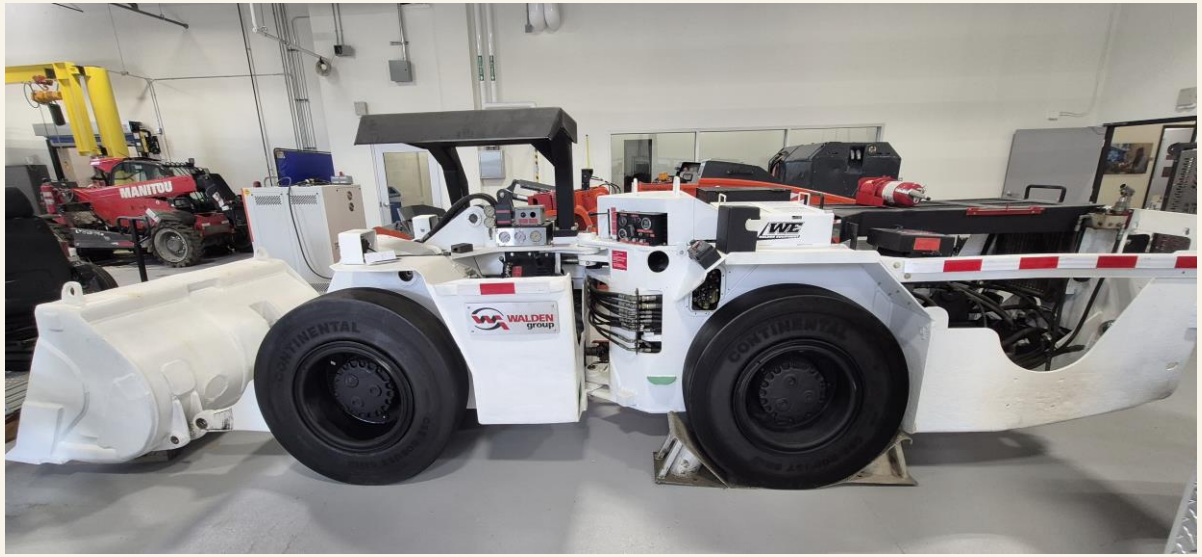
Side by Side (11 kWh)
- LOS remote ready

Telehandler (44 kWh)
- Donated diesel to BEV conversion

Rokion R100 (22 kWh)
- Donated by Vale 2025

Upcoming Projects – Internal

- Dyno construction and commissioning
- LHD Conversion Project
- BEV Telehandler re-build
  - Batteries donated by MEDATech



Upcoming Projects – External

- Second life battery storage testing
- Mobile battery + charger
- On-board charger start-up
- Diesel to BEV miniature train conversion

Broader Research Ecosystem

- Mechanical Engineering & Design
- Welding & Fabrication
- 3D Printing Lab (FDM, Resin, Metal)
- Software & AI
- Mechatronics Engineering
- Chemical and Environmental
- Corporate Training Courses
    - Battery Electric Vehicle Maintenance certificate program