FUTURE BATTERY INDUSTRIES CRC

Electrification of Mining Mobile Fleets and Machinery: The Role of Optimal Systematic Design

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THE UNIVERSITY of ADELAIDE

1. Introduction

Background and Motivations

1. Australian mining industry consumes about 14% of the total energy usage in the country
2. Mining industry is the second largest contributor to carbon emissions in Australia
3. The fastest growing sector in GHG emissions for the past 30 years
4. About 30-50% of diesel fuel used at mine sites is for transportation;
   15-30% of operating cost for material handling, heating, ventilation & processing
5. A report by McKinsey & Company: approximately 56% of emissions from diesel usage in an open-pit iron ore mine in Australia result from hauling.

Background and Motivations

1

Improve Mining Economics

- Reduction in Operating Energy Costs
- Reduction of Operating Maintenance Costs
- Reduction in Capital and Operating Ventilation Costs
- Reduction in Total Operational Expenditure (OPEX)
- Pathways to Mining Vehicle Optimisation and Automation
- Improvements in Lower Grade Ore Extraction Economics

2

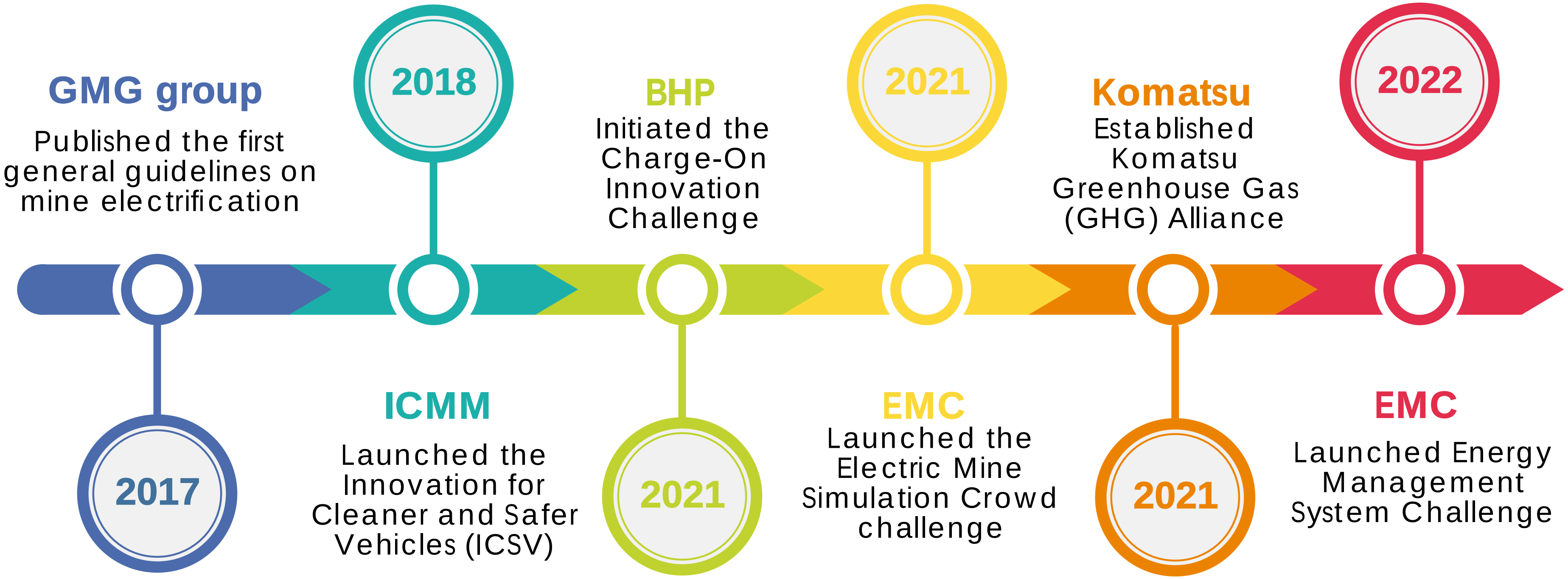
GHG Emissions Reduction from Mining

- Greenhouse Gas Emission Targets
- Stakeholder Interests
- Society

3

Improve Mining Worker Safety

Background and Motivations



The most recent efforts initiated by the mining industry for mining electrification.

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About MOVE project

PROJECT TITLE	Assessment, design and operation of battery-supported electric mining vehicles and machinery
ULTIMATE GOAL	To provide the Australian mining industry with the tools and information needed to help transition their operations to using battery-supported electric vehicles and associated stationary machinery
2 CASE STUDIES	• Leinster Underground Mine, WA (BHP) • Nova Operation, WA (IGO)

BHP igo Allkem Together we go further MULTICOM RESOURCES energetics mriwa SOUTH AUSTRALIA Government of South Australia Department for Energy and Mining Department of Natural Resources, Mines and Energy THE UNIVERSITY OF WESTERN AUSTRALIA

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About MOVE project

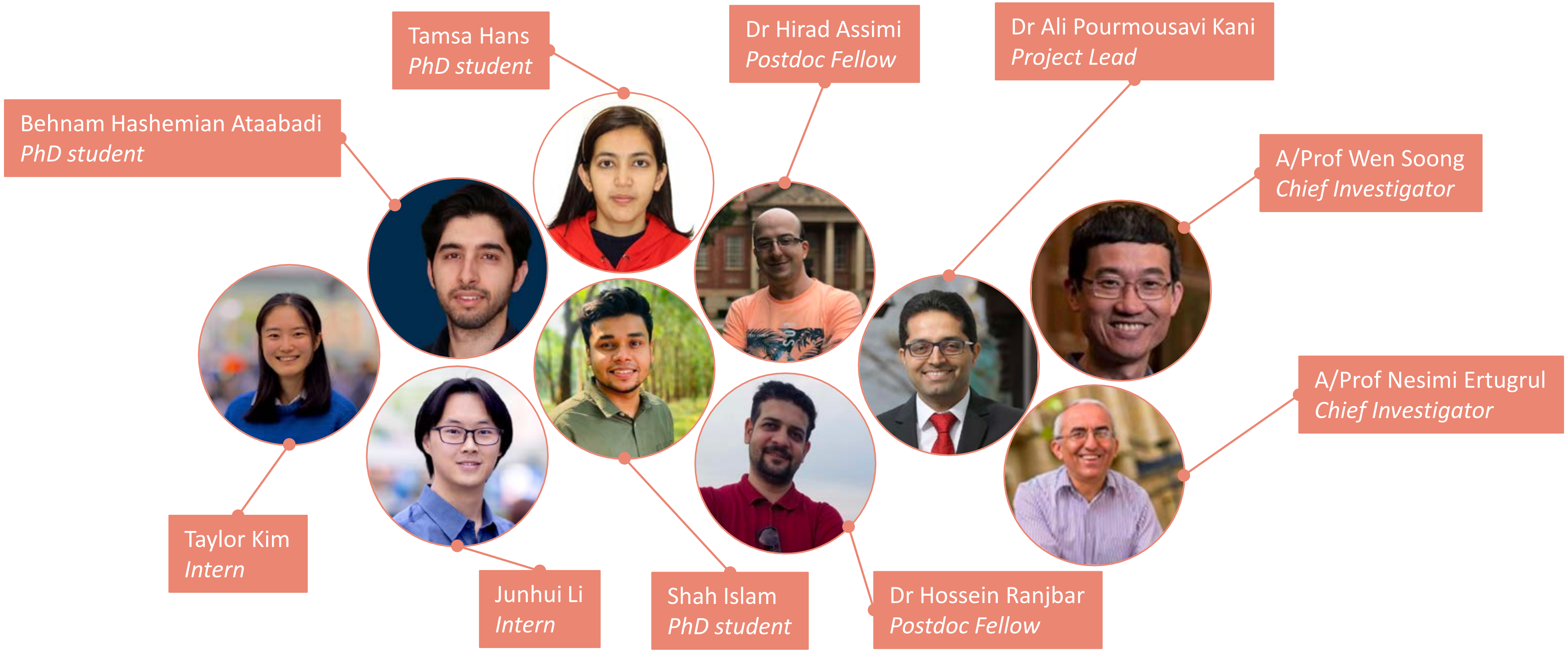
1 ENERGY system study and data collection

2 DEVELOPMENT of tools for EV fleets and associated infrastructure

3 DEVELOPMENT of the toolkit to design backbone energy infrastructure

4 IDENTIFYING Electric mine required skills and producing training materials

Our Team



A team of 3 academic staff members, 2 postdocs, 3 PhD students and 2 undergrad interns

School of Electrical & Mechanical Engineering
The University of Adelaide

2. Underground Mining Truck Electrification

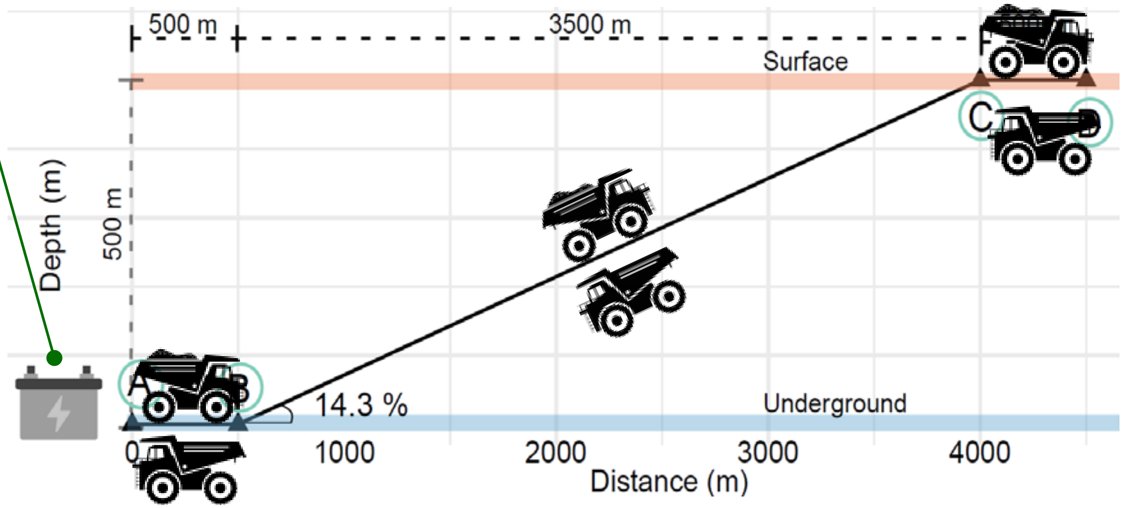
WP2

DEVELOPMENT of software, tools and frameworks for the management of mine site EV fleets and associated infrastructure

Problem Statement

Charging Technology:

- Rated voltage, power, & energy of the charging technologies
- Location of charging, swapping stations or trolly-assist charging



Electric Truck:

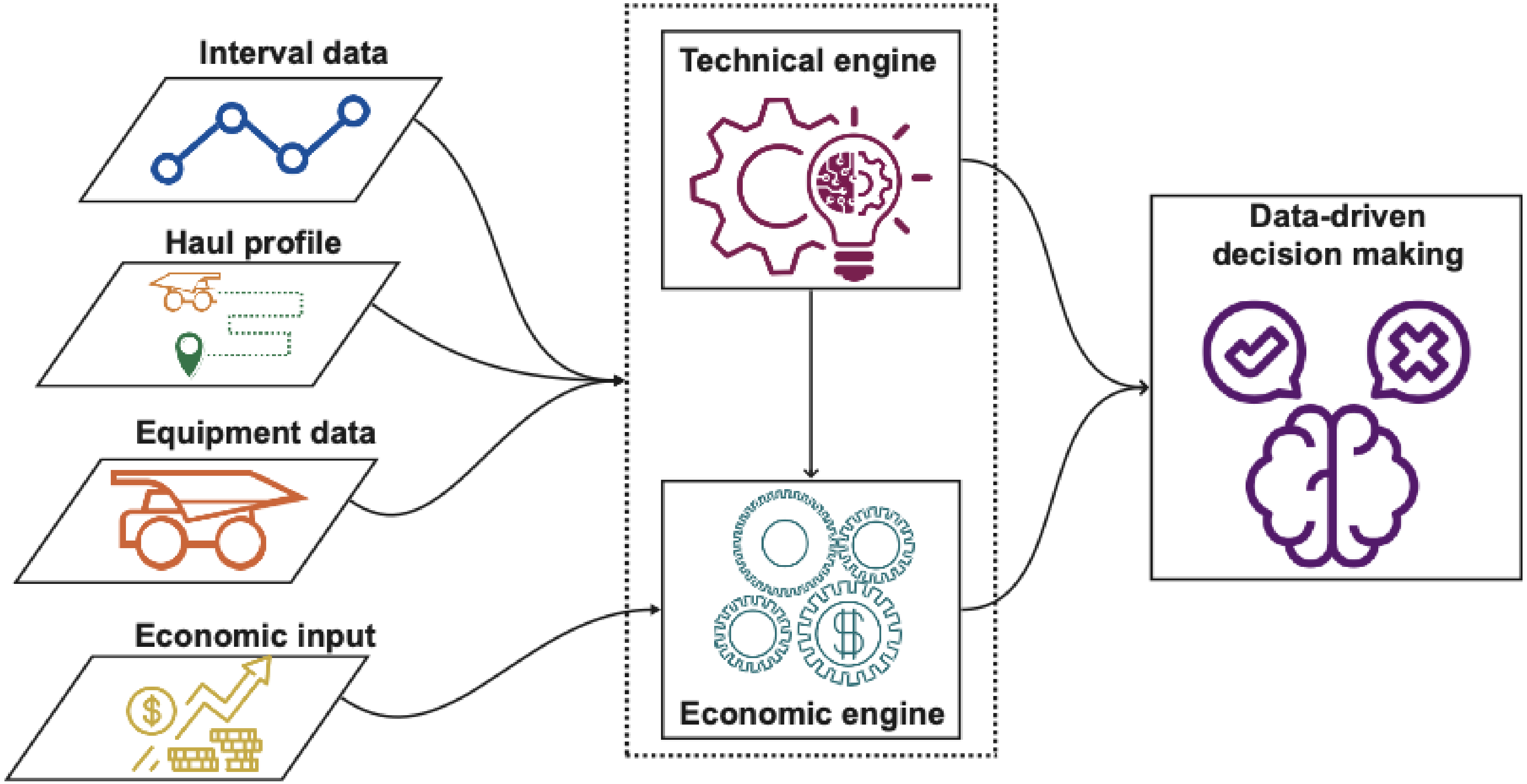
- Power and energy requirements
- Regenerative braking
- Battery onboard the truck

Operational Parameters:

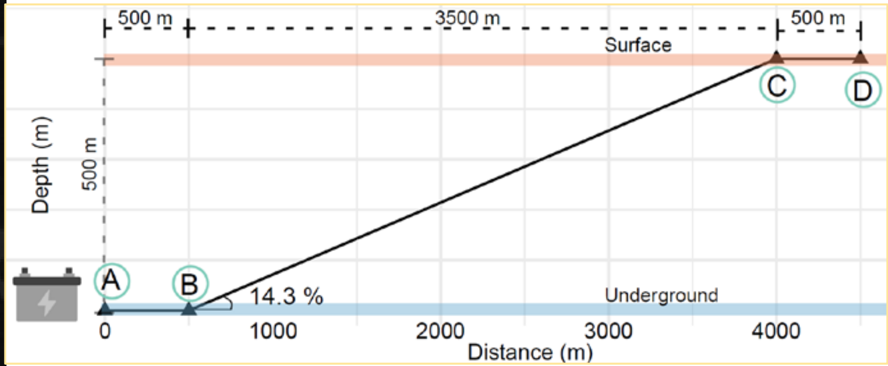
- Battery recharging frequency
- impact of onboard battery size and charging frequency on productivity
- Truck's speed to achieve best cost vs productivity solution
- onboard battery replacement due to degradation

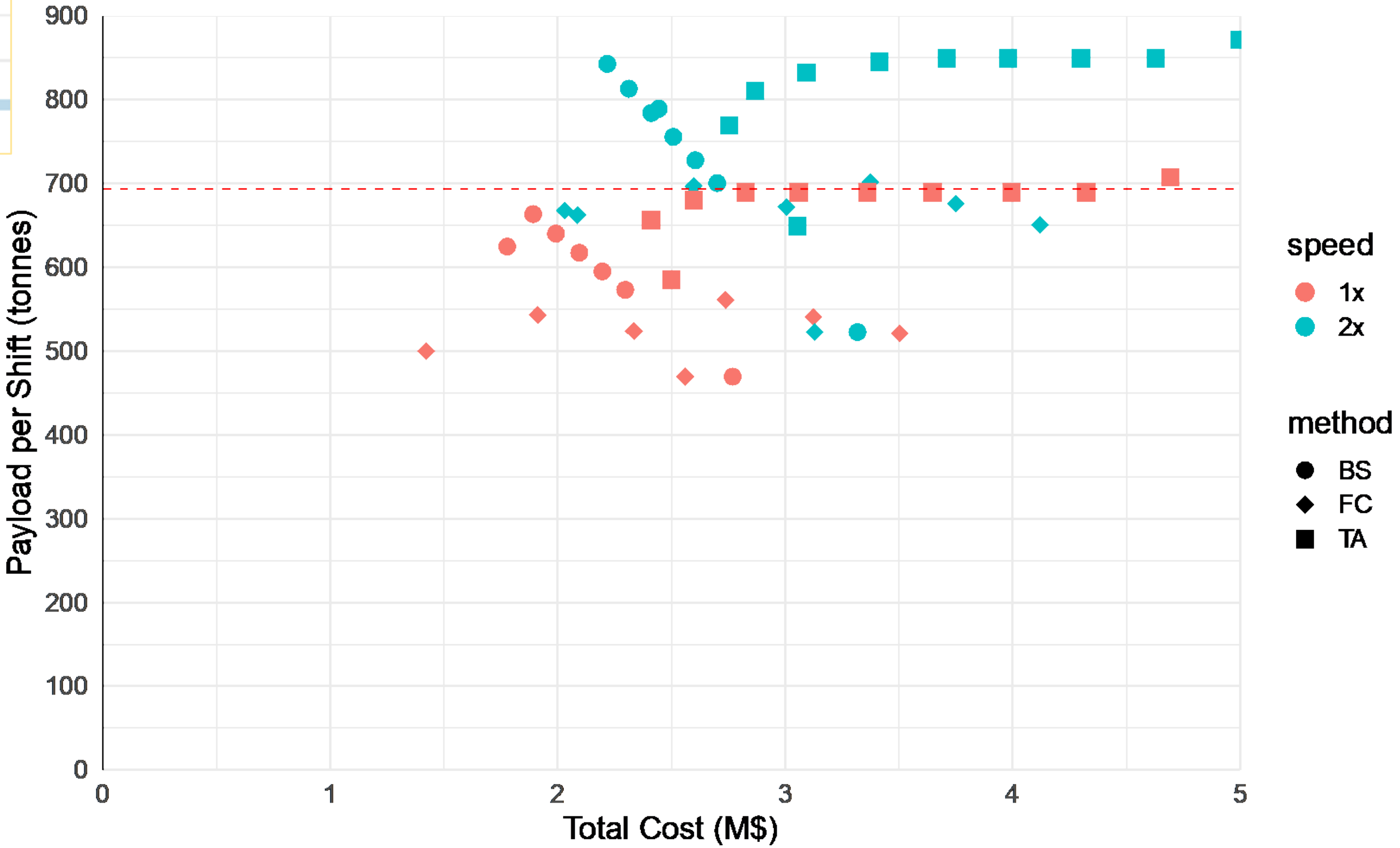
Total CAPEX, OPEX, and salvage value of different electrification solutions

Charging Infrastructure Design Framework



Simulation Results: Cost vs. Productivity Trade-Offs





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3. Backbone Energy Infrastructure Design

WP3

DEVELOPMENT of the toolkit to design the backbone energy infrastructure

Problem Statement

Grid Connectivity:

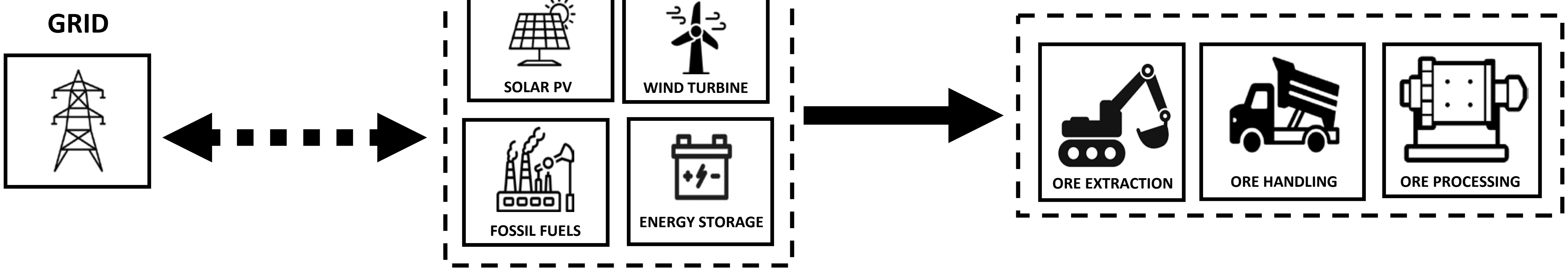
- Grid connection/wholesale electricity market nearby?
- Grid upgrade, network charges

RES Potentials:

- Wind power assessment at the site
- Solar power potential at the site

Mining Electricity Load:

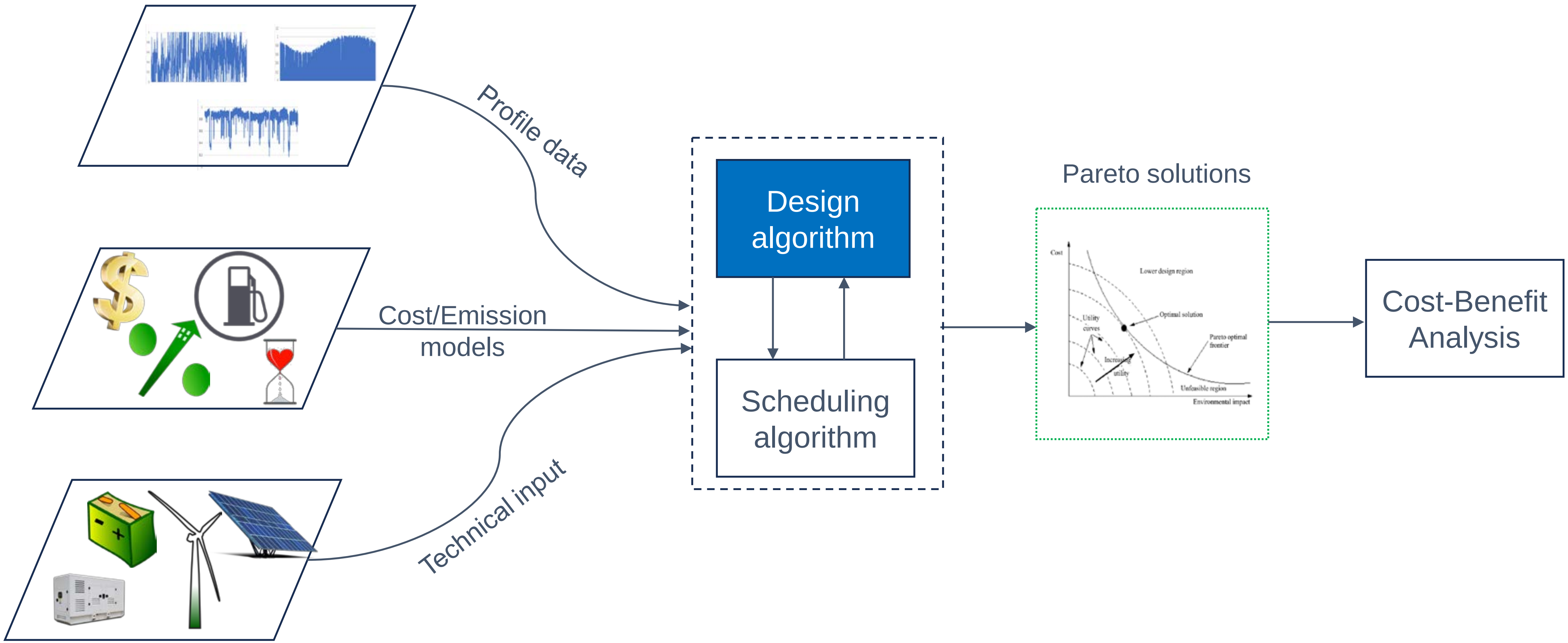
- Load change due to the adoption of electric trucks and machinery?
- Load flexibility and V2G capability?



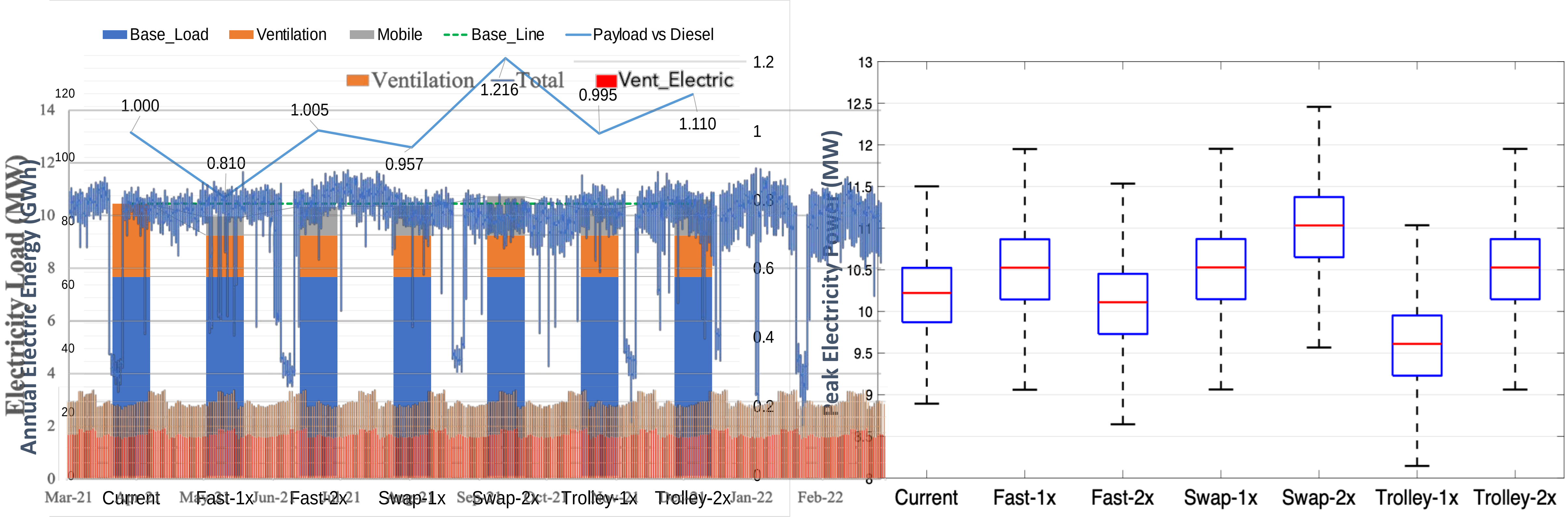
Technology Selection and Sizing:

- Optimum capacity of microgrid components to minimize the cost and emissions?
- Trade-offs between costs and emissions?

Backbone Energy Infrastructure Design Framework

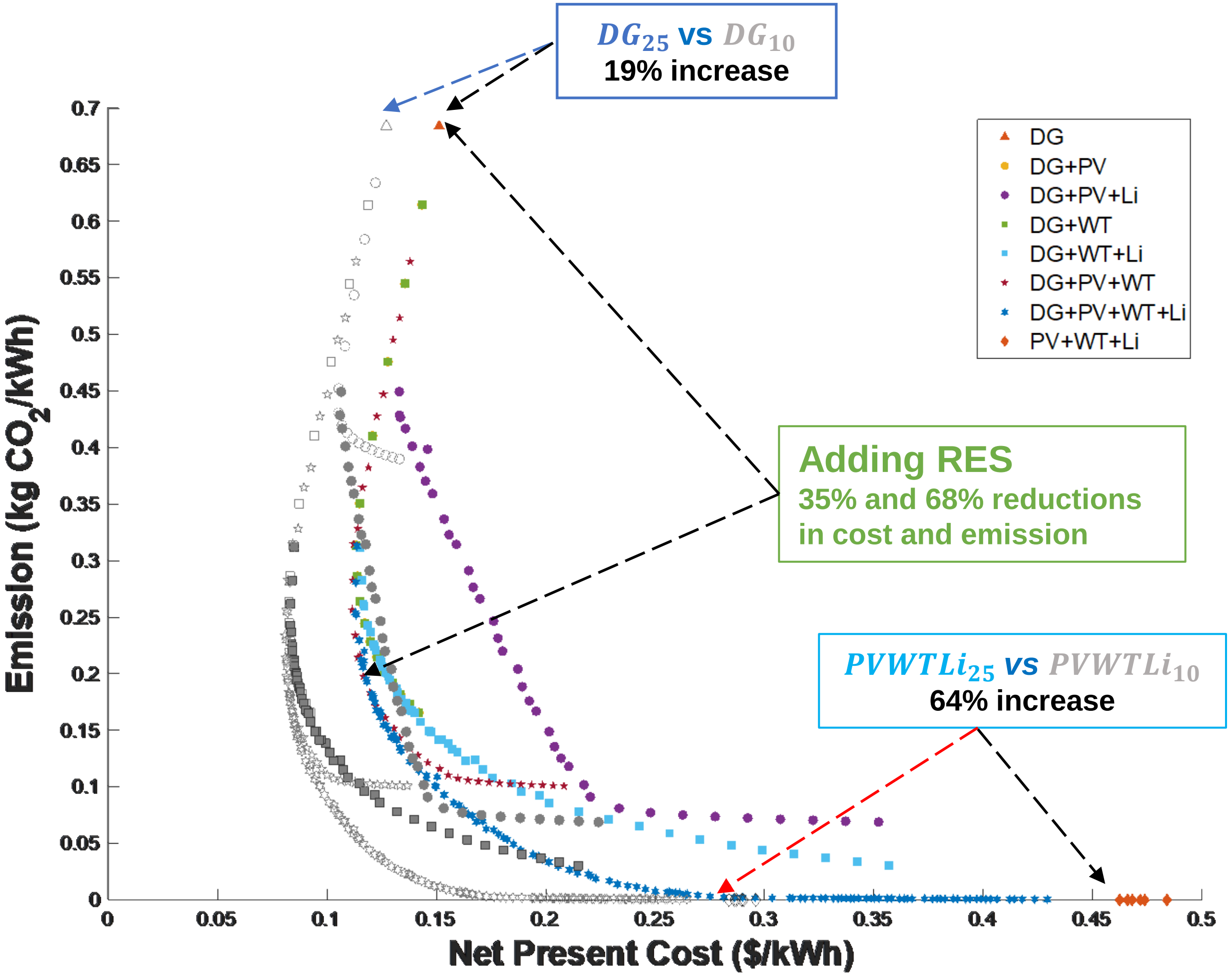


Electricity Demand Analysis

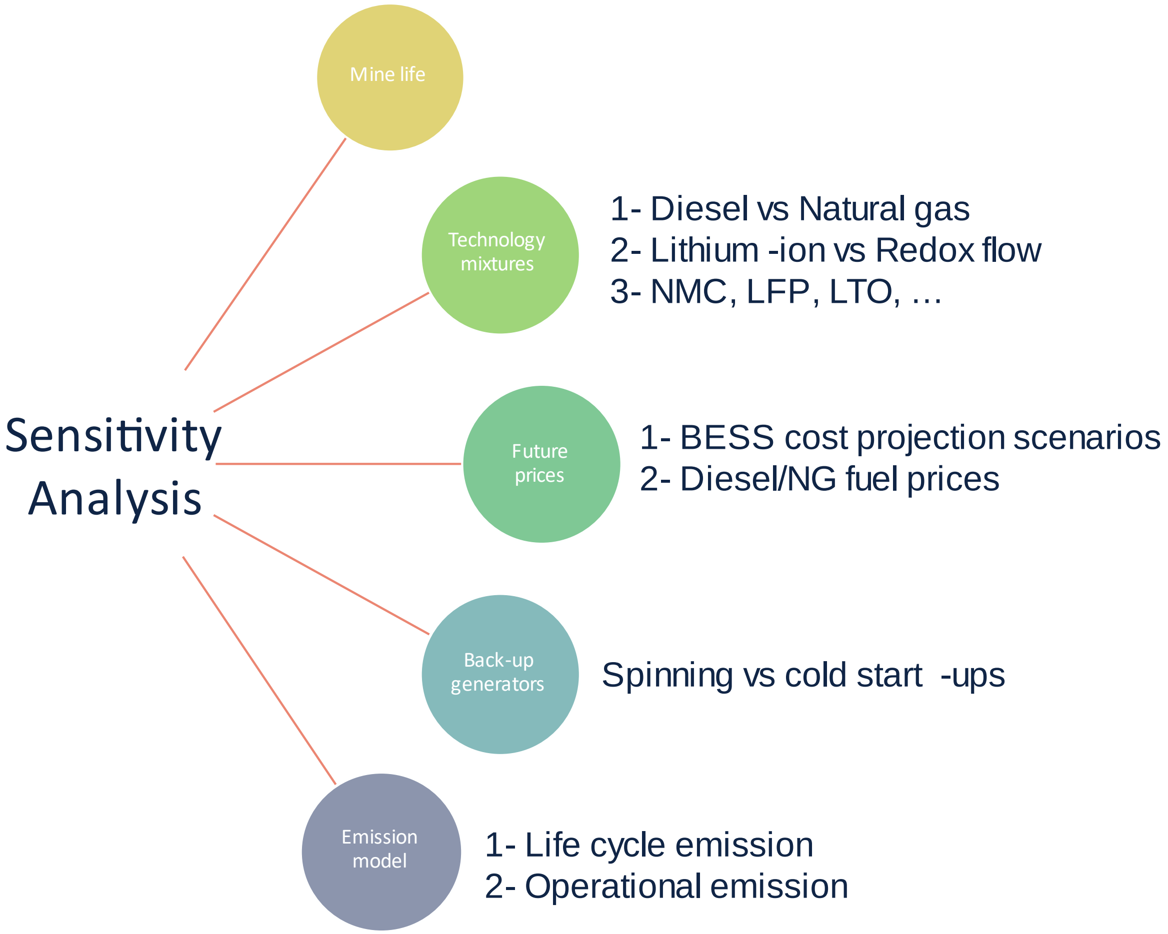


Energy and peak demand for different charging technology of a typical electrified mine

Simulation Results

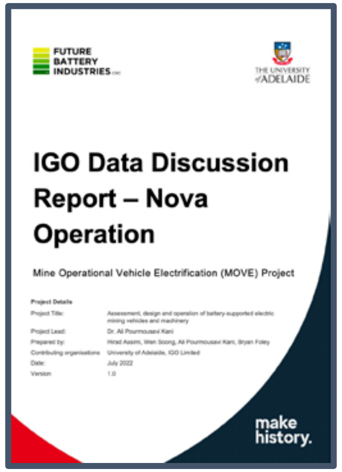


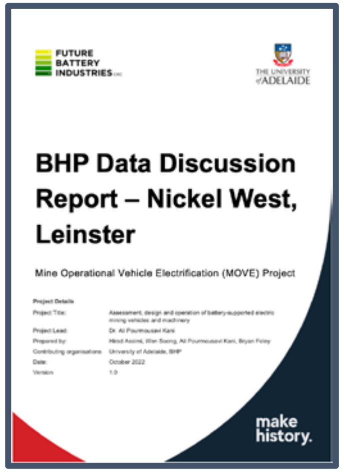
Trade-off between net present cost and emission for different energy technology and mine life (colored points: 10 yrs, grey/white: 25 yrs)

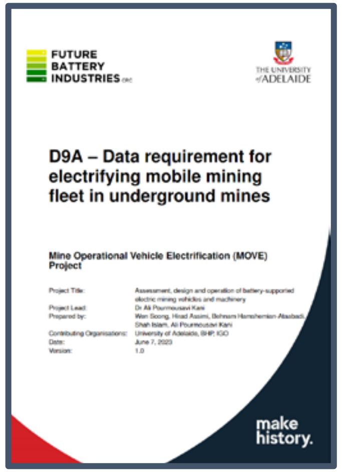


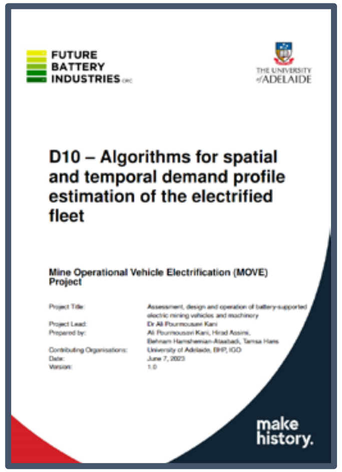
4.
Project Progress

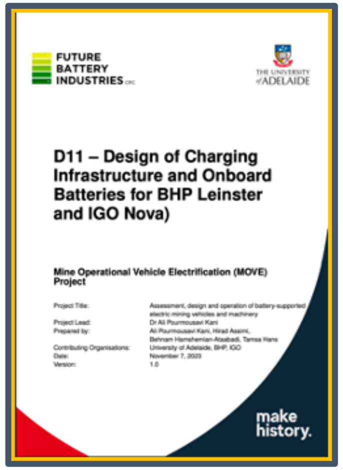
Project Progress







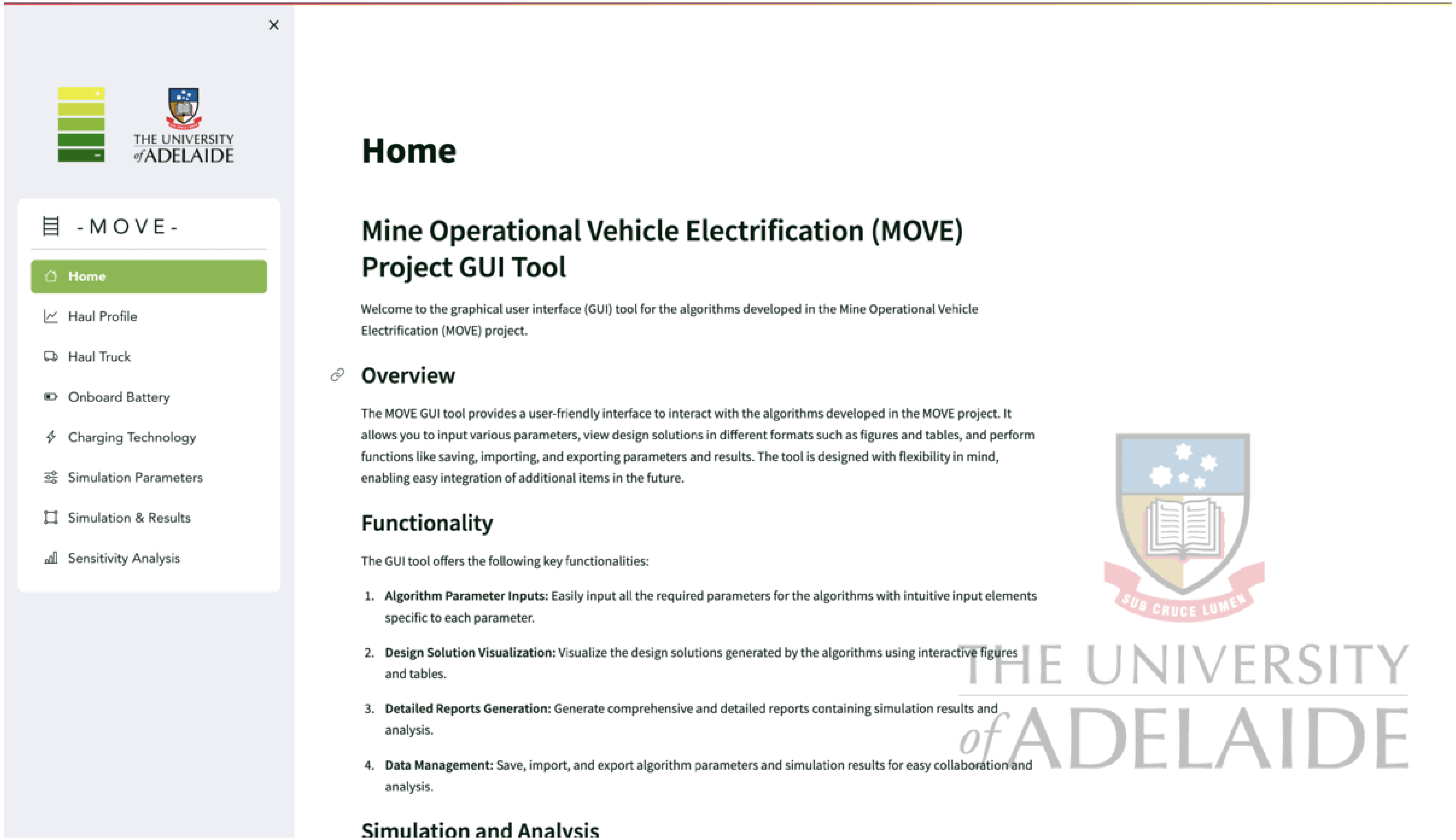




Project Progress

Graphic User Interface

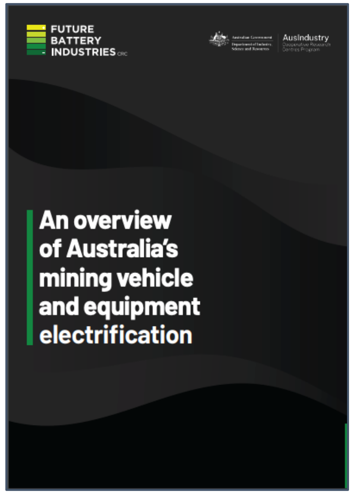
Charging infrastructure design and onboard battery sizing



Project Progress

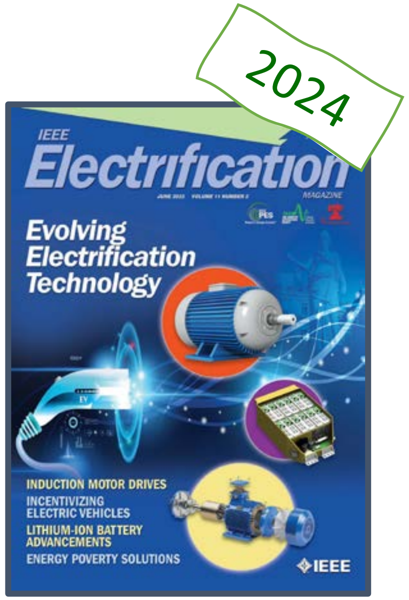
Provisional Patent Application

Charging infrastructure sizing, technology selection and onboard battery sizing for electric haul trucks in underground mining application



Landscape Report

Provides insight into the current status of mine vehicle electrification in Australia.



IEEE Electrification Magazine

Towards Underground Mobile Fleet Electrification
Three Essential Steps to Make a Real Change

Industrial IoT in Mine Electrification:
Necessity or Luxury?

Our Service

We offer four primary services that can assist your site towards the net zero transition:

1 ELECTRIFICATION ASSESSMENT

We will work with you to identify the potential to electrify your specific site using extensive data analysis to deliver your custom roadmap for action.

2 MOBILE FLEET

Armed with this information we can help guide you through the selection of appropriate technology, considering the optimal size of charging mechanism and onboard battery systems to meet your needs.

3 FLEET MANAGEMENT SYSTEM

We can develop and customise software tools to help you manage your site's electric vehicle fleets and associated infrastructure.

4 ENERGY INFRASTRUCTURE DESIGN

We can also design your optimal energy infrastructure to ensure that EV fleet and electric machinery operates efficiently and reliably.

Q&A

“FROM UNDERSTANDING THE EXACT INVENTORY REQUIRED, TO CALCULATING THE COSTS OF IMPLEMENTATION, OUR TOOLS WILL HELP SUPPORT MINING COMPANIES TO MAKE A SUCCESSFUL TRANSITION TO BEVS.” — Dr Ali Pourmousavi Kani

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