

# Business Case for the All-Electric Haul Truck

2019 Haulage & Loading Exhibition / Conference  
Tucson, Arizona USA

# Introduction



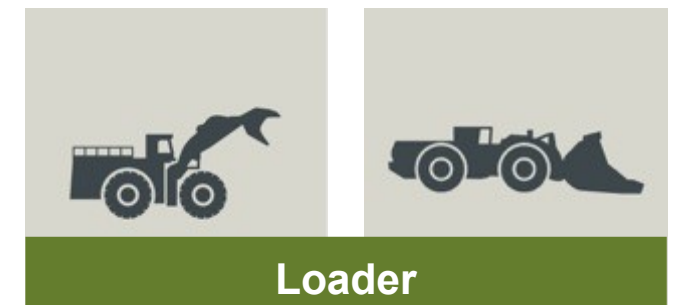
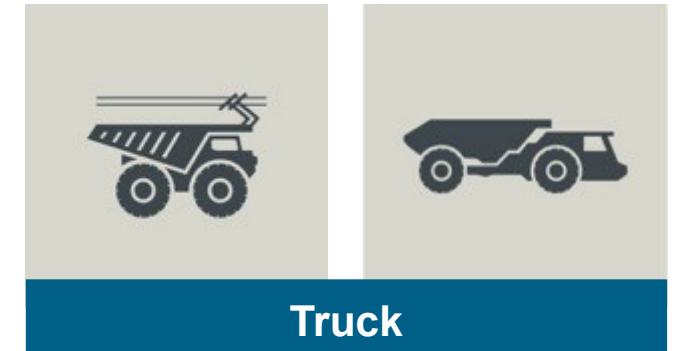
Siemens introduced the concept for the All-Electric Haul truck in our presentation on Electromobility Solutions for Modern Haul Trucks at the 2017 Haulage & Loading Conference.

Since then, we have

- Performed detailed simulations from real world mine profiles
- Proven the readiness of the LTO battery for mining applications
- Investigated various All-Electric drives across several mobile mining product platforms

Today we present ...

## The Business Case for the All-Electric Haul Truck



# Electric Vehicle (EV) w/ On-board Diesel Engine

Electrical Drivetrain powered by On-board diesel engine

Benefits:

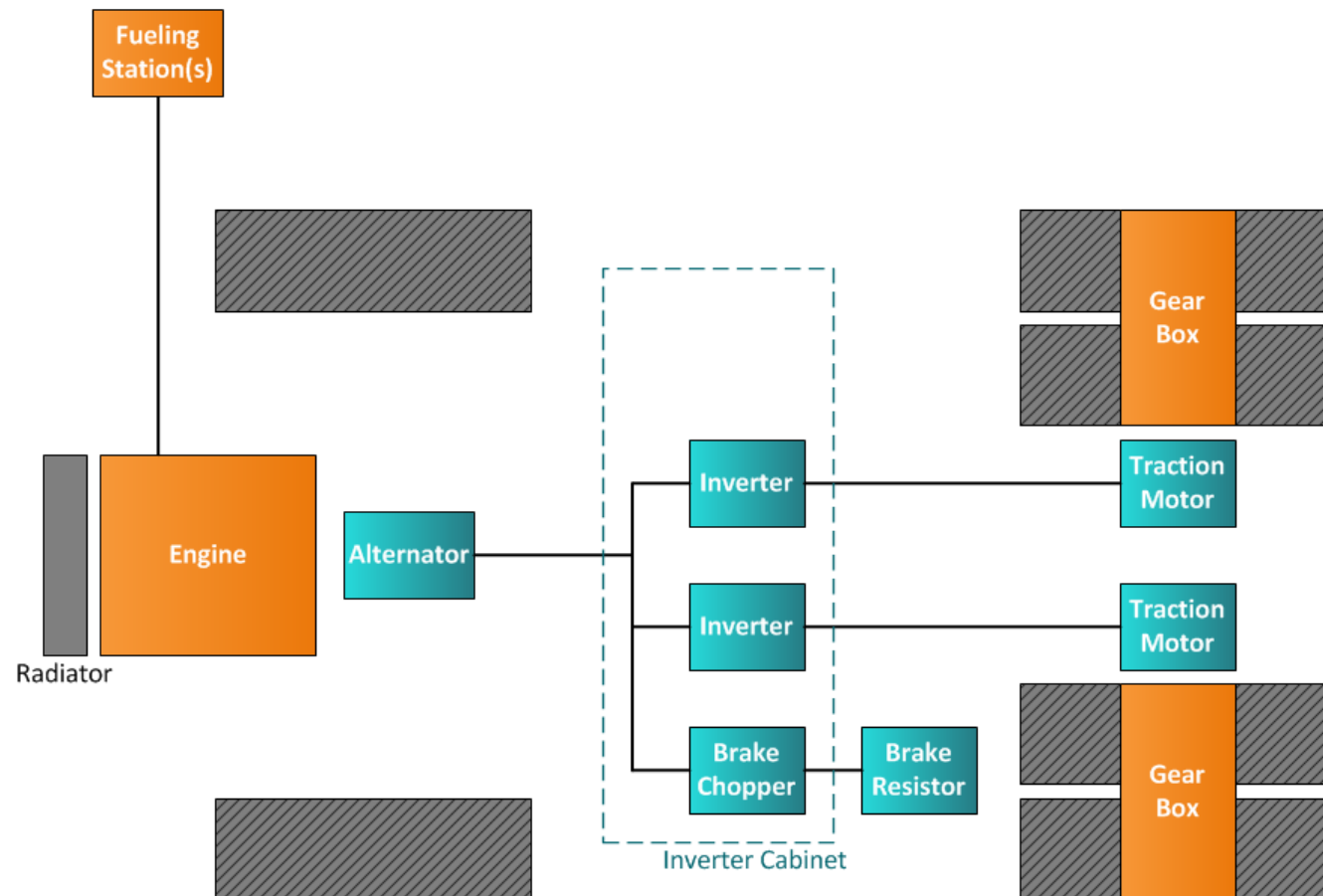
- Baseline

Challenges:

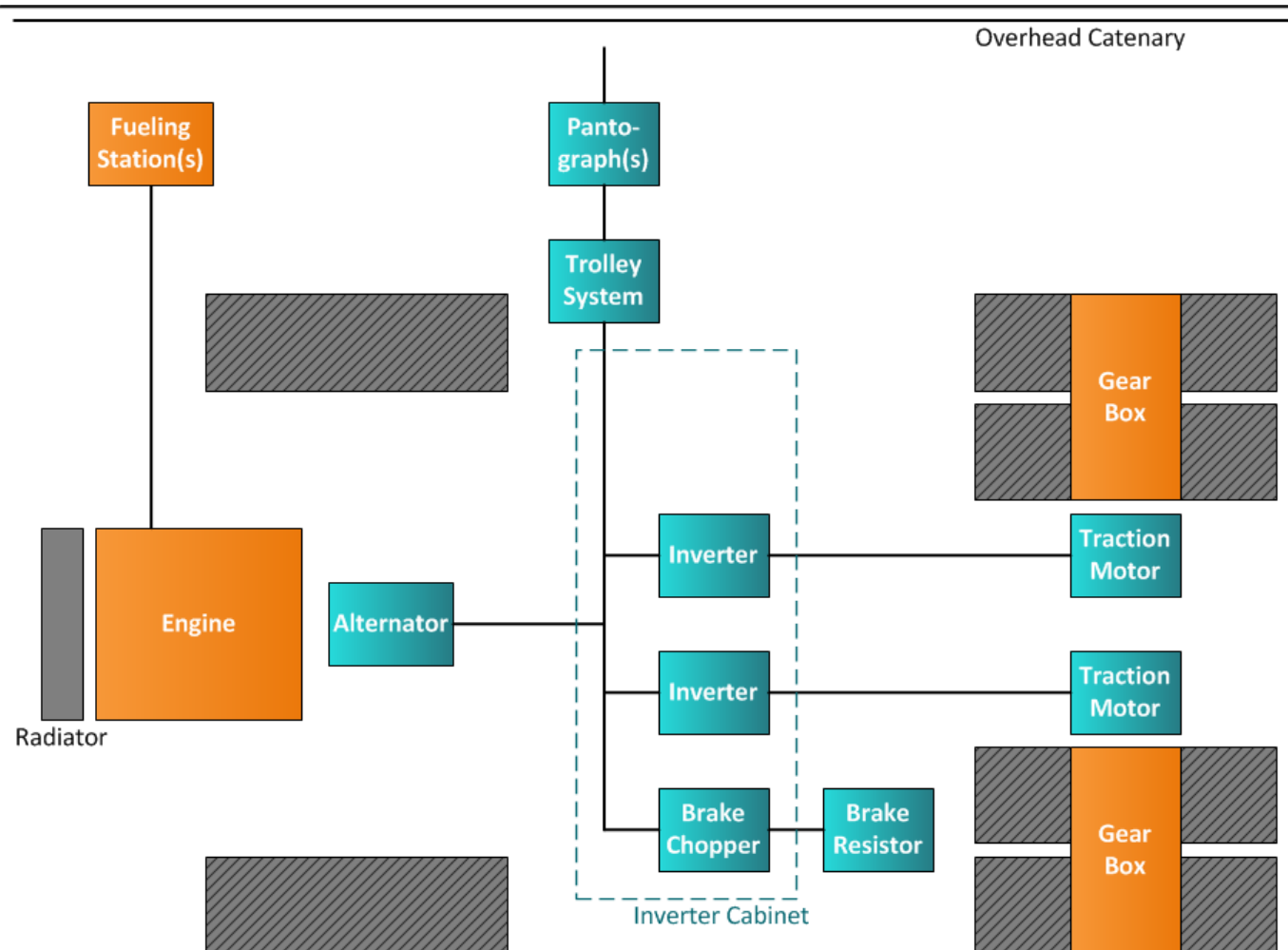
- Baseline.

Solution:

- Alternate power source.



# Electric Vehicle (EV) w/ On-board Diesel Engine and Off-board Trolley Assist



Off-board Trolley Assist adds additional parallel electric power source

## Benefits:

- Increased Productivity (speed boost)
- Increased Efficiency
- Decreased Operating Cost (less fuel)

## Challenges:

- Impractical to implement overhead trolley lines for 100% of haul cycle.

## Solution:

- Onboard energy storage.

# Hybrid Electric Vehicle (HEV) w/ On-board Diesel Engine and On-board Batteries

On-board Batteries provide parallel electric power source, energy storage

## Benefits:

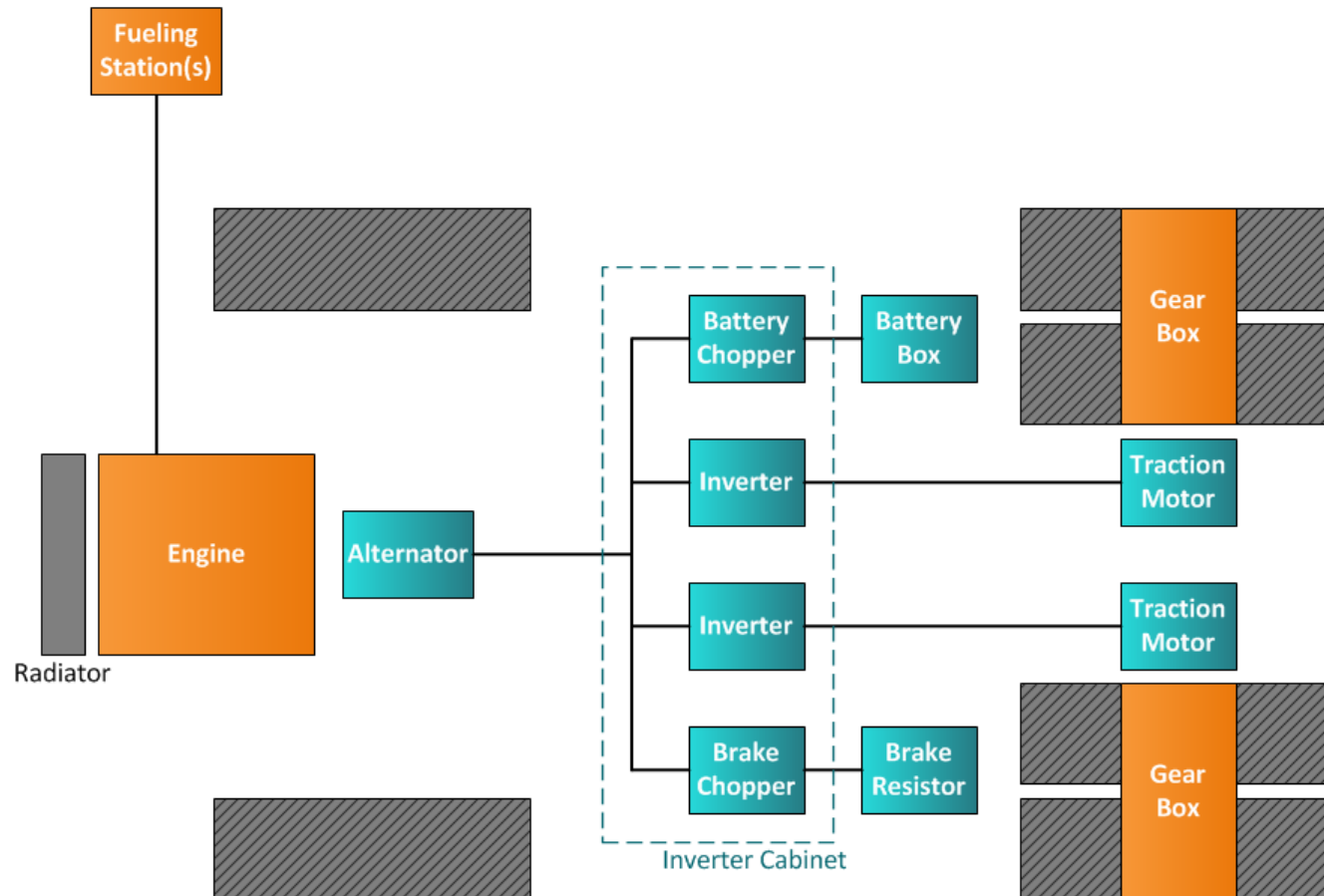
- Increased Productivity (speed boost)
- Increased Efficiency (energy capture)
- No off-board infrastructure required

## Challenges:

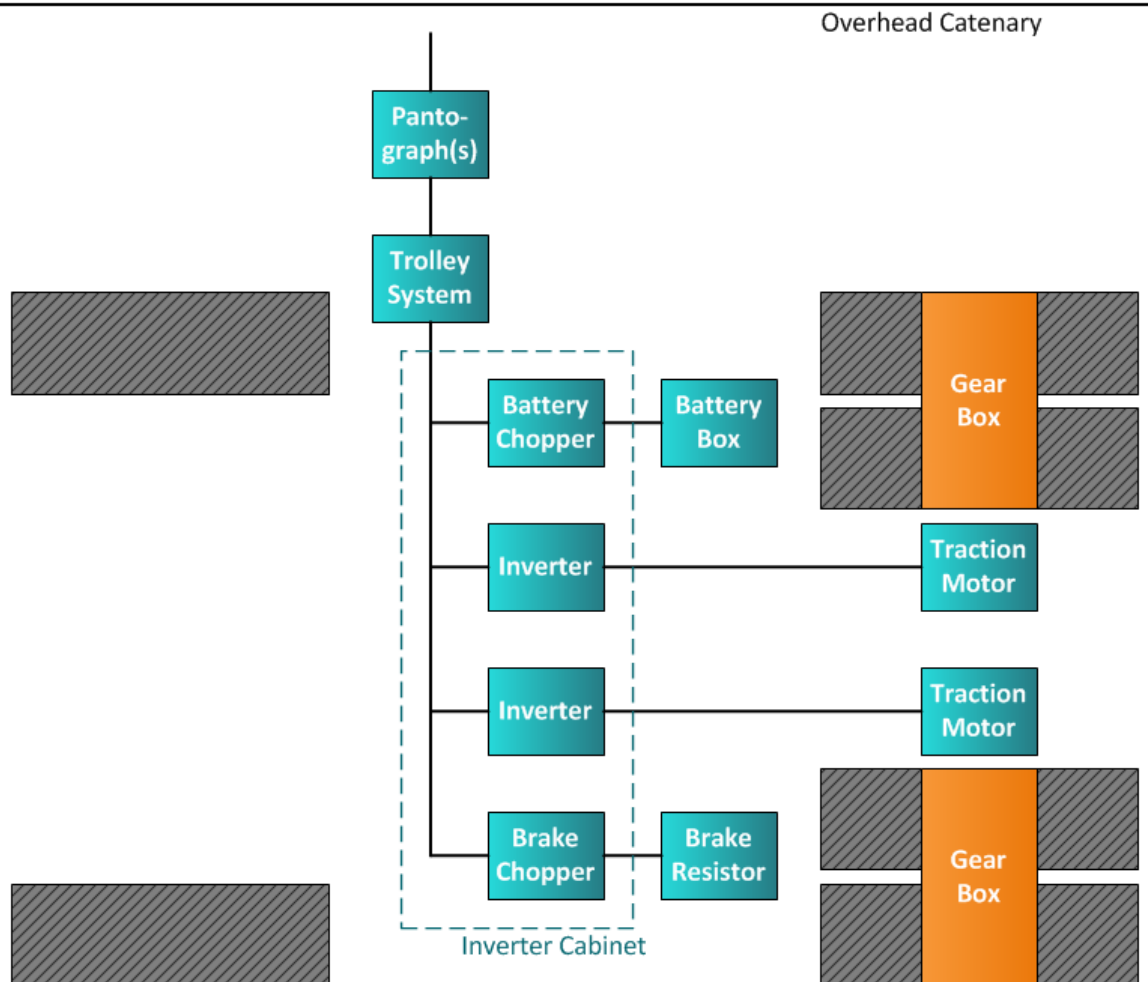
- Limited practical capacity (size).
- Charge/discharge imbalance

## Solution:

- Alternate charging method.



# Battery Electric Vehicle (BEV) w/ On-board Batteries & Off-board Trolley Assist



Optimized On-board Battery storage supported by Off-board Trolley Assist.

### Benefits:

- Increased Productivity (speed boost)
- Increased Efficiency (energy capture)
- Decreased Operating Costs (no fuel)

### Challenges:

- Trolley line infrastructure and maintenance

### Question:

- Is there a compelling business case for the All-Electric Drive?

# Scenario

## Haul Profile

- Section 1: 2.8km @ 0.0% grade
- Section 2: 1.4km @ 9.0% grade
- Section 3: 0.3km @ 2.4% grade

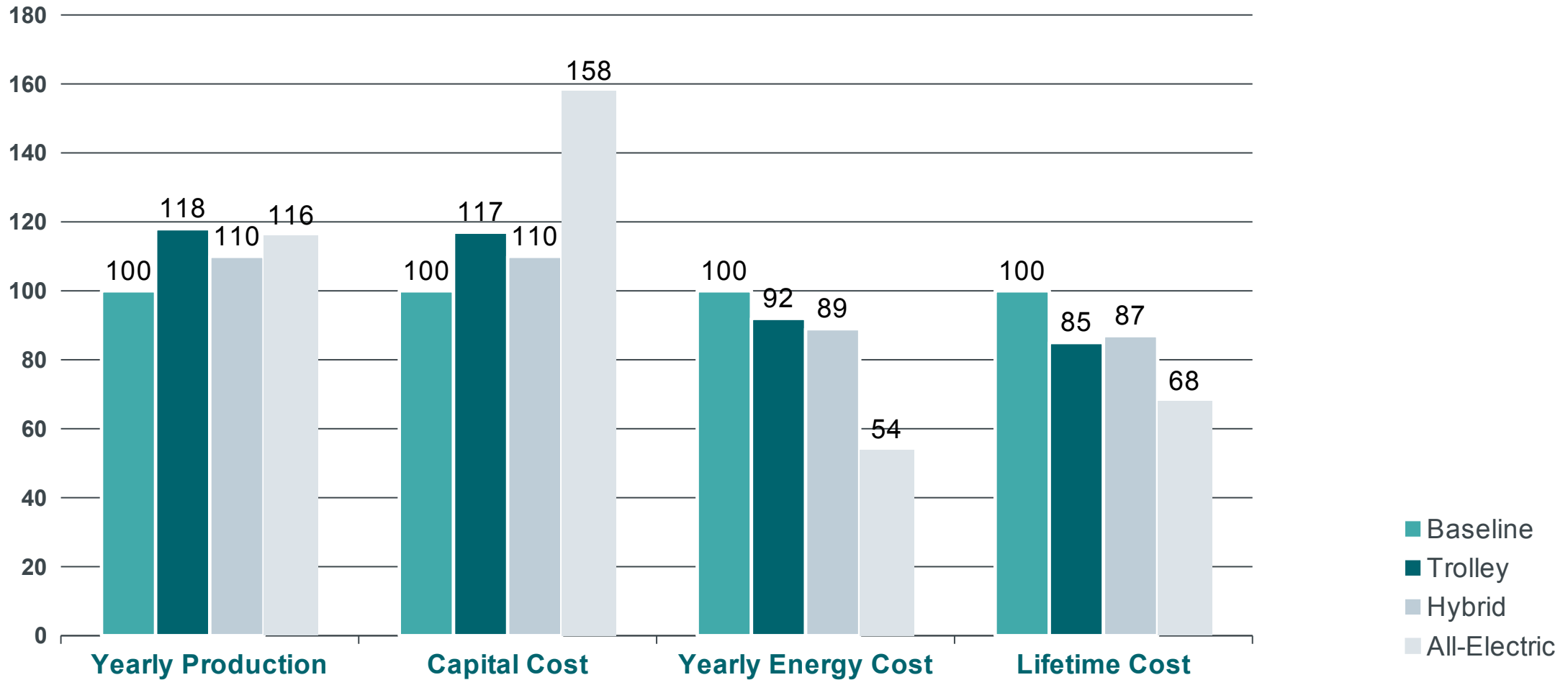
New Fleet ROI and Life Time Savings						
		baseline	trolley	hybrid	all-electric	
Parameter	Scheduled hours per year	[Hrs]	8760	8760	8760	8760
	Truck Mechanical Availability	[%]	90	90	90	95
	Mine site efficiency	[%]	85	85	85	85
	Trolley efficiency	[%]		90		90
	Job efficiency	[%]	85	85	85	85
	Operation hours per year	[Hrs]	6,701	6,031	6,701	6,366
	Diesel cost per gallon	[\$/gal]	\$ 3.00	\$ 3.00	\$ 3.00	\$ 3.00
	Electricity cost per kWh	[\$/kWh]	\$ 0.12	\$ 0.12	\$ 0.12	\$ 0.12
	Empty vehicle weight	[%]	100%	102%	103%	98%
	Gross vehicle weight	[%]	100%	103%	103%	103%
	Payload	[%]	100%	100%	100%	107%
	Production target	[million t]	50	50	50	50
	Truck life	[years]	12	12	12	12
	Production in truck life time	[million t]	600	600	600	600

# Column chart

New Fleet ROI and Life Time Savings			baseline	trolley	hybrid	all-electric
Truck	Cycle time	[%]	100%	88%	95%	88%
	Total cycles per hour	[%]	100%	112%	106%	102%
	Diesel consumption per hour	[%]	100%	62%	89%	0%
	Electricity consumption per hour	[%]	0.0	100%	0.0	171%
	Productivity per hour	[%]	100%	118%	110%	109%
	Yearly production	[%]	100%	118%	110%	116%
	Yearly Diesel cost	[%]	100%	62%	89%	0%
	Yearly Electricity cost	[%]	0	100%	0	180%
	Yearly total energy cost	[%]	100%	92%	89%	54%
	Battery Cost	[%]	0	0	100%	255%
	Battery control component cost	[%]			100%	173%
	Trolley Interface Equipment Cost	[%]	0	100%	0	100%
	Fleet	Fleet size	[%]	100%	82%	88%
<b>Operation hours to meet production</b>		[%]	100%	102%	103%	104%
Yearly Diesel cost		[%]	100%	52%	81%	0%
Yearly Electricity cost		[%]		100%		185%
Yearly total energy cost		[%]	100%	78%	81%	46%
Total capital cost		[%]	100%	117%	110%	158%
<b>ROI</b>		[years]		<b>2.20</b>	<b>1.47</b>	<b>3.06</b>
<b>Life Time Cost</b>		[million \$]	<b>100%</b>	<b>85%</b>	<b>87%</b>	<b>68%</b>



# Productivity / Cost Analysis



## Conclusion

Separately, the business cases for trolley assist and hybrid assist are strong.

**Together, the business case for the All-Electric Haul Truck is overwhelmingly compelling.**

Benefits:

- 16% Productivity increase
- 46% Energy cost decrease
- 32% Lifetime cost decrease
- Lower Maintenance Costs
- Less Carbon Gas Emissions

**The future of mobility is electric.**

Thank you for your Attention.



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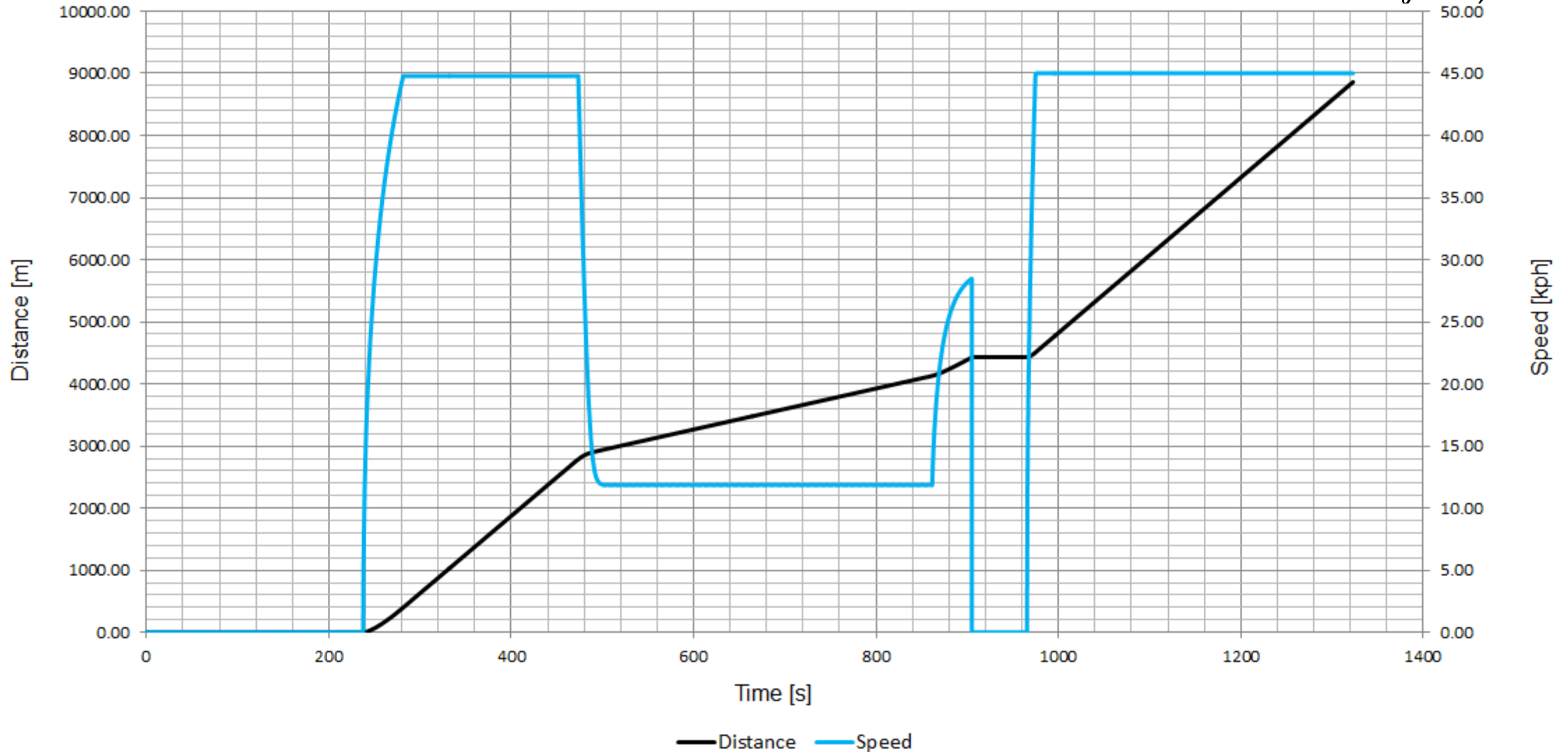
The Technology Provider for the Mining Industry

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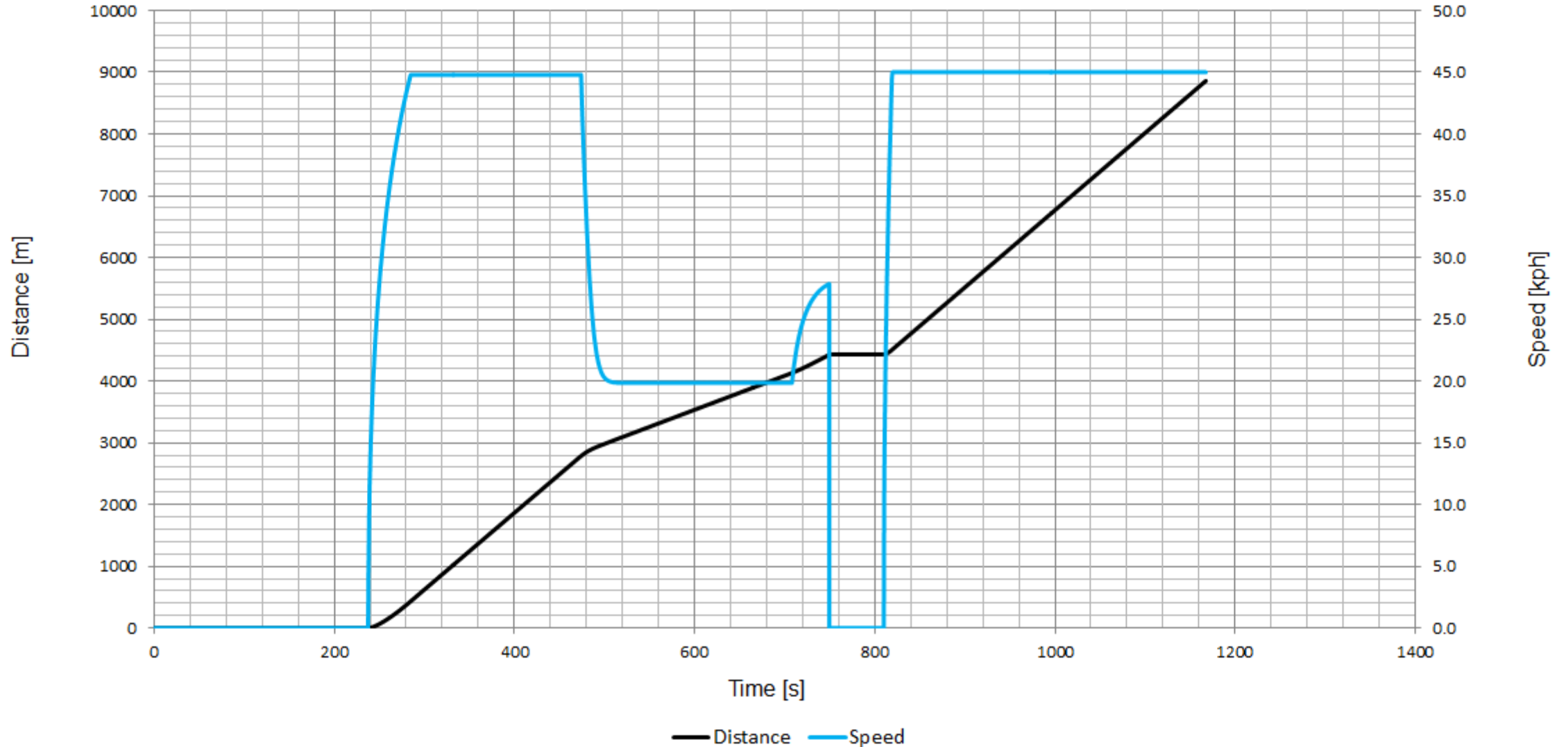


# Scenario

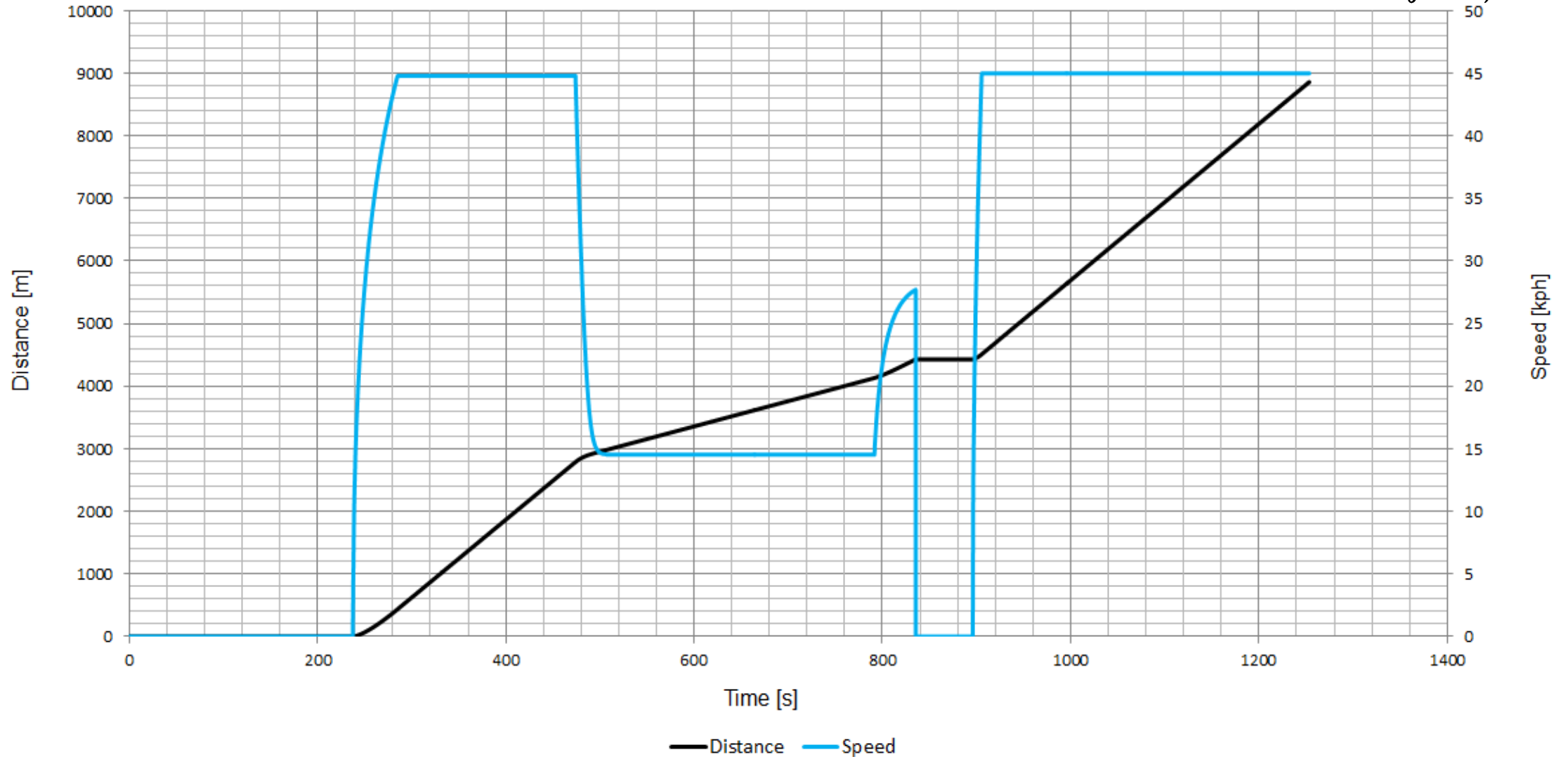
## Baseline - Diesel



# Scenario Trolley



# Scenario Hybrid



# Scenario All-Electric

