

McKinsey
& Company

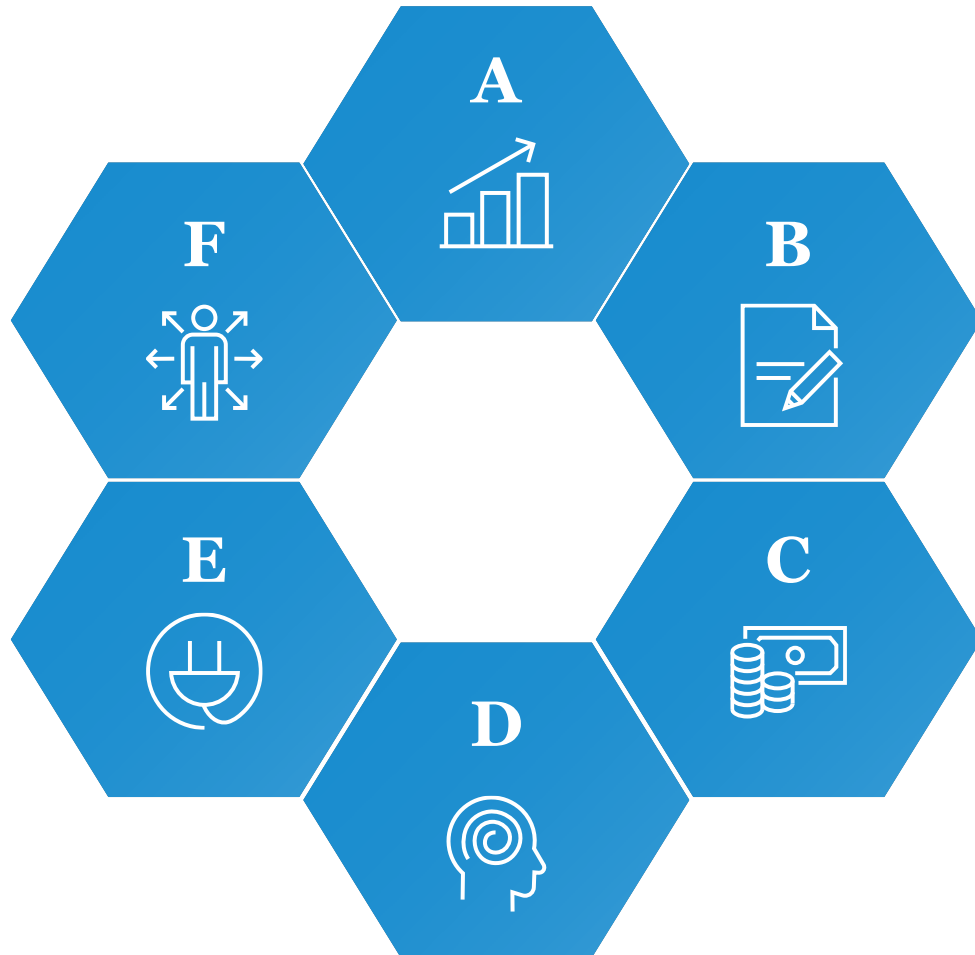
Decarbonization in mining







Mission Innovation Virtual Workshop

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The pressure for mining companies to decarbonize is coming from 6 dimensions



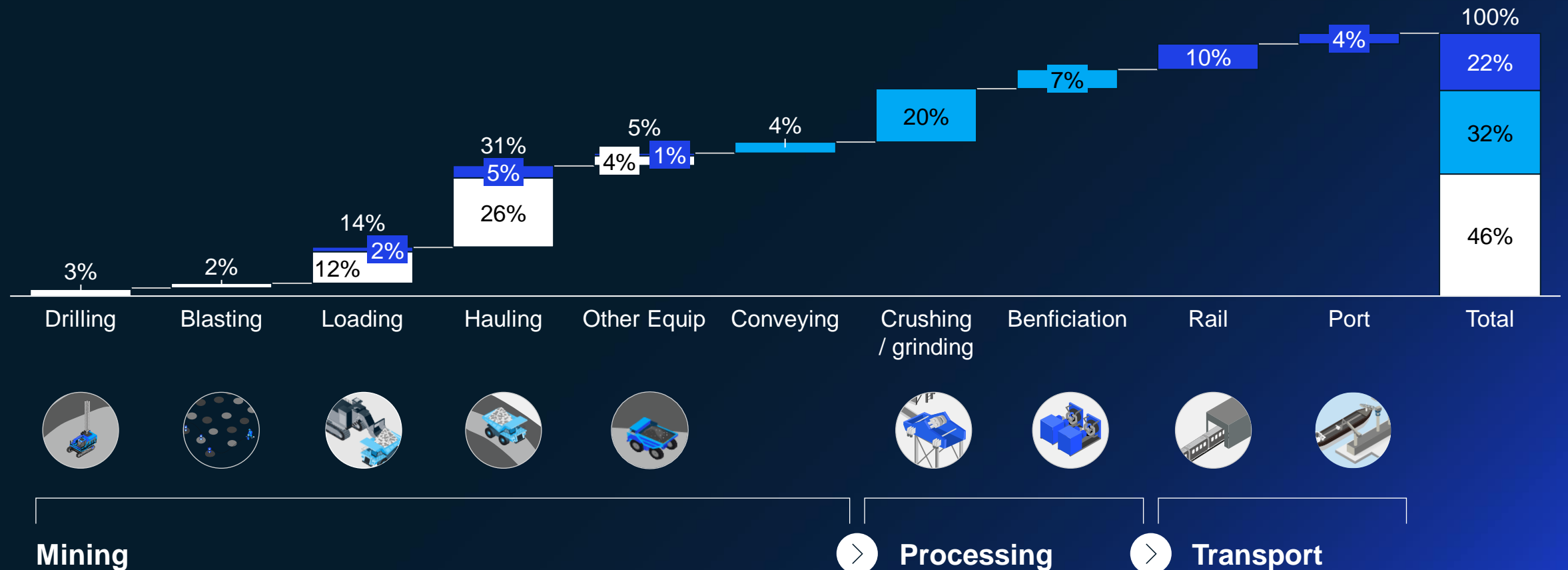
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- A**  **Significant value-at-stake in CO₂ abatement initiatives**
Initiatives to reduce CO₂ emissions such as switching to renewable electricity and BEV/FCEV in haul trucks are becoming NPV positive much faster than expected, with the potential to reduce cost by USD millions per year
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- B**  **Investors are selling out stocks based on climate risk**
Number of investors taking large action to decarbonize their portfolios is growing and so is the amount of funds committed
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- C**  **Environmental performance can lower capital cost**
Lower cost of capital via better bond conditions through green bonds and shifting investors green financing requirement
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- D**  **Customers will demand cleaner products**
Companies are decarbonizing their entire supply chains e.g., Consumer Electronics and Advanced Electronics manufactures, Automotive OEMs, moving up the value chain reaching mining
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- E**  **Increasing regulatory pressure and carbon-tax risk**
Governments are taking actions and increasing pressure on large emitters, with various policies incentivizing emission reduction
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- F**  **Employees are looking for a purpose**
The best talent is increasingly focusing on company purpose, companies with a clear sustainability purpose increase productivity

~35% of mine emissions come from haulage, with a further 30% coming from electricity used in processing

■ Scope 3 (incl. material & fuel transport) ■ Scope 2 (Electricity) ■ Scope 1 (Diesel)



Example: Iron ore; Open Pit; Australia; RoM: 25 Mt p.a.



Scope 1 emissions from mobile equipment

Example: Iron ore; Open Pit; Australia; RoM: 25 Mtpa

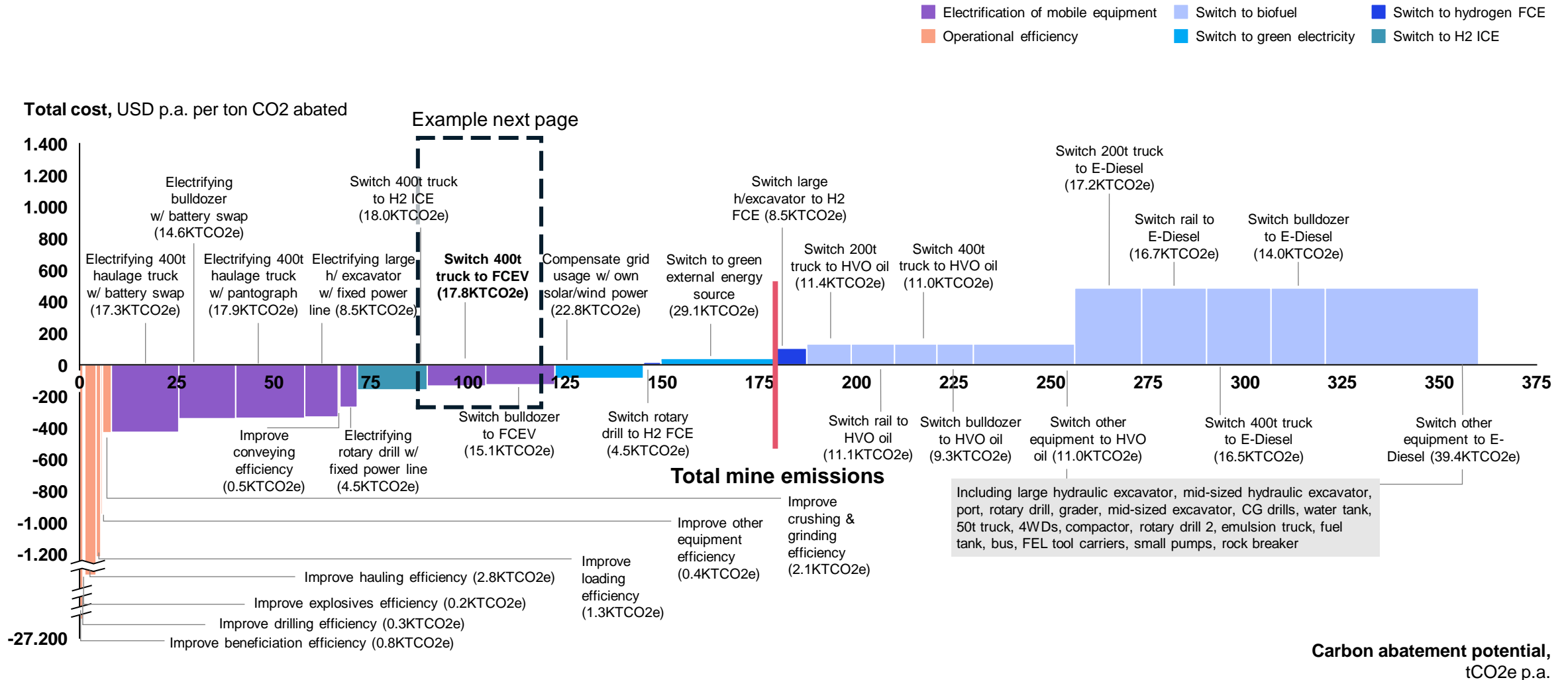


Equipment	Yearly emissions, kton CO ₂ per year	Number of units	Fuel consumption per unit, '000 l/year	Number of operating hours, '000 hours	Operational utilization ¹
220t truck	17.1	12	544	6.0	68%
400t truck	16.4	8	781	6.0	68%
Bulldozer	13.8	15	352	3.9	45%
Large hydraulic excavator	7.9	3	989	6.2	71%
Mid-sized hydraulic excavator	7.2	4	680	6.2	71%
Rotary drill	4.1	3	518	5.5	62%
Grader	3.2	7	176	3.9	45%
Mid-sized excavator	1.9	5	143	2.0	23%
GC Drills	1.5	12	44	3.5	40%
Water Tank	1.4	7	78	3.9	45%
50t truck	1.3	8	61	2.0	23%
Compactor	0.9	3	110	2.0	23%
4wd's	0.8	24	12	2.0	23%
Rotary drill	0.4	1	138	2.1	24%
Emulsion Truck	0.3	3	43	2.1	24%
Fuel Tank	0.3	5	20	1.0	12%
Bus	0.2	5	16	2.0	23%
FEL tool Carriers	0.2	3	27	2.0	23%
Small Pumps	0.2	6	11	3.5	40%
Rock Breaker	0.1	3	18	1.0	12%

1. Assuming operations 24 hours a day

Within this decade, solutions for the majority of the emissions will become economic

Extraction and processing all levers for open pit iron ore in Australia¹, 2030



1. Mine size - RoM of 25m tons, Baseline emissions ~176kt CO₂ per year

TCO will vary significantly over time, with FCEV costs coming down fastest, and BEV being cost competitive by 2025

Decarbonisation alternatives projected TCO 400t truck, example Australia, MUSD/year

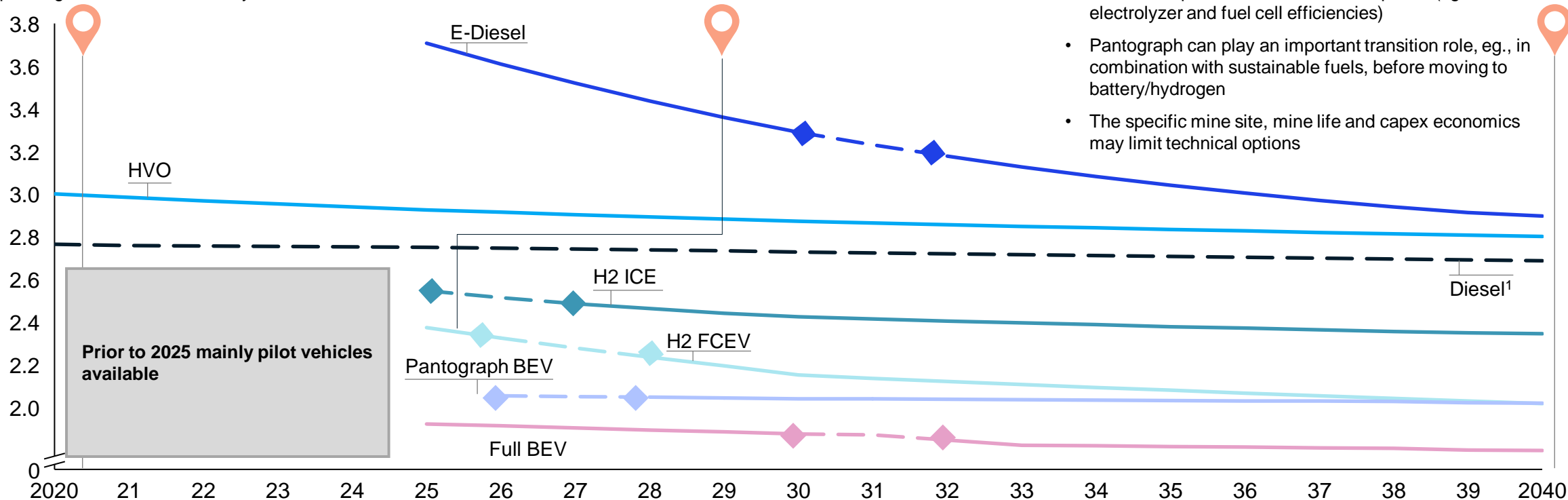
Preliminary ◆ -- ◆ Large scale commercial availability expected — Diesel¹ — HVO — E-Diesel — H2 FCEV — H2 ICE — Pantograph BEV — Battery swap

HVO most cost competitive short term alternative to Diesel (+ ~13%)

Hydrogen solutions will be technically viable before battery electric ones

- Pantograph, battery electric, and hydrogen alternatives are all projected to be more economic than fossil diesel
- Which technology will be most economic in the long-term will depend on technical development (eg., electrolyzer and fuel cell efficiencies)
- Pantograph can play an important transition role, eg., in combination with sustainable fuels, before moving to battery/hydrogen
- The specific mine site, mine life and capex economics may limit technical options

TCO for electric solutions lower than Diesel pending commercial availability



1. Diesel baseline based on increasing fuel prices being outweighed by increasing engine efficiency. Projection does not include potential carbon taxes, which would accelerate cost parity with low carbon alternatives.