VOLVO

Decarbonization of Off-road Construction Sites

Midwest Rural Energy Council

Social sustainability

To care for people’s health and wellbeing in all parts of the value chain and to contribute to a sustainable development of the society.

Environmental sustainability

To limit emissions and wise use of natural resources in all phases of the product lifecycle.

Economic sustainability

To offer competitive and financially healthy products and services, enabling investments for the future.

Steps to Site Decarbonization

1. Machine technology (battery electric, grid, H_2)
2. System (how do we charge/refuel)
3. Site (running energy efficient sites)

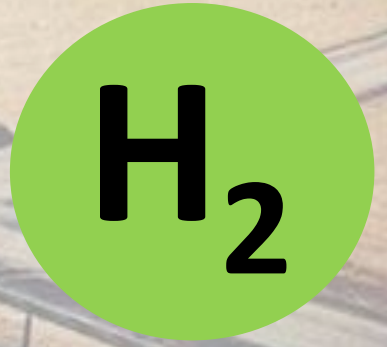
VOLVO

Battery Electric

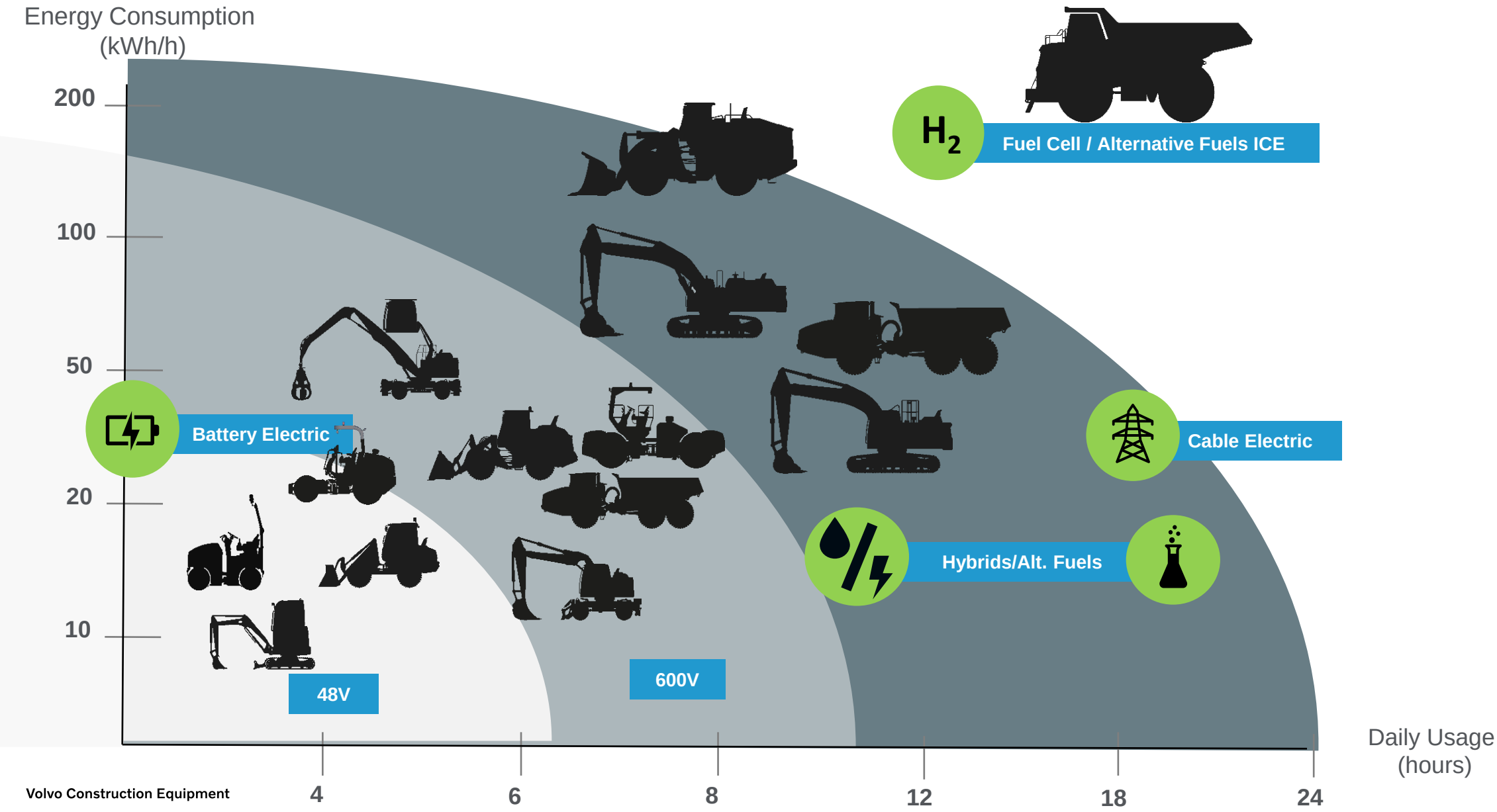
Grid Connected

Hybrid

Alternate Fuels

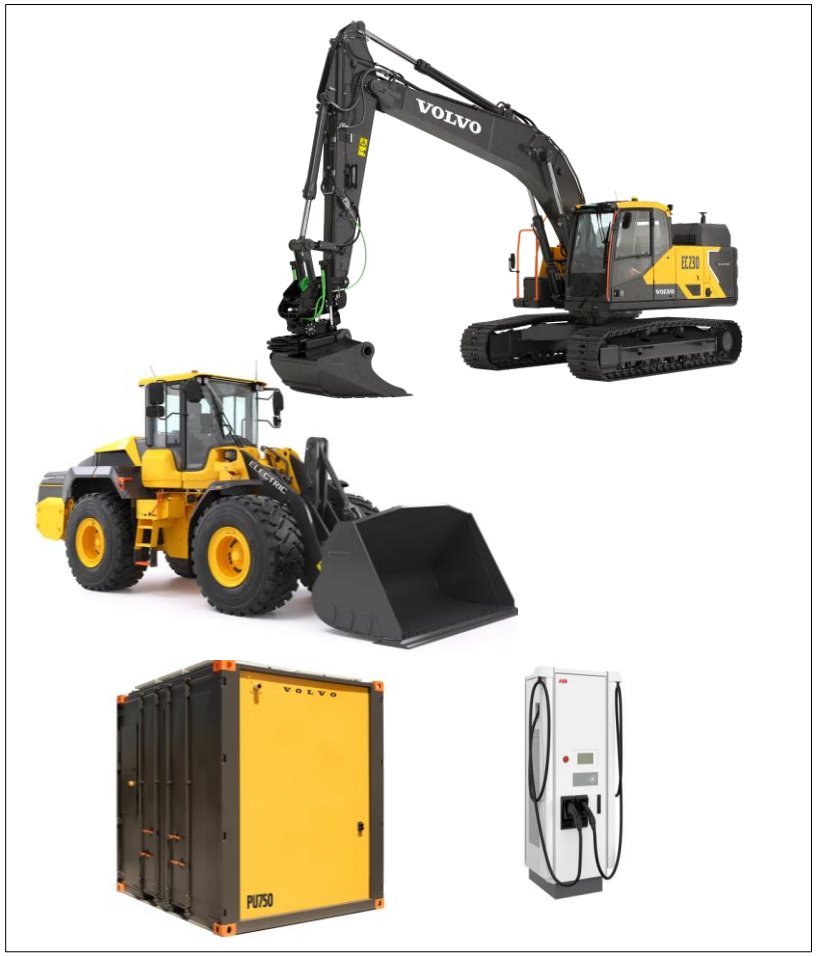


Hydrogen


Energy Consumption
(kWh/h)
200
100
50
20
10
Battery Electric
48V
600V
H_2
Fuel Cell / Alternative Fuels ICE
Cable Electric
Hybrids/Alt. Fuels
4
6
8
12
18
24
Daily Usage
(hours)

Volvo’s Sustainable Power Journey

48 V BEV



600+ V BEV

- Alt fuels
- Hybrid
- Grid
- Hydrogen
- Productivity Services
- Energy Mgmt & circularity

Other

Off-Road Charging

Grid Connected

Portable Power

On-Site Generation

EC230 Electric Excavator Pilot Test

Volvo Construction Equipment

EC230 Demo - GHG & Fuel Savings

I. Fuel economy

a) Diesel twin EC220E: 4.05 gal per hour

III. Energy price

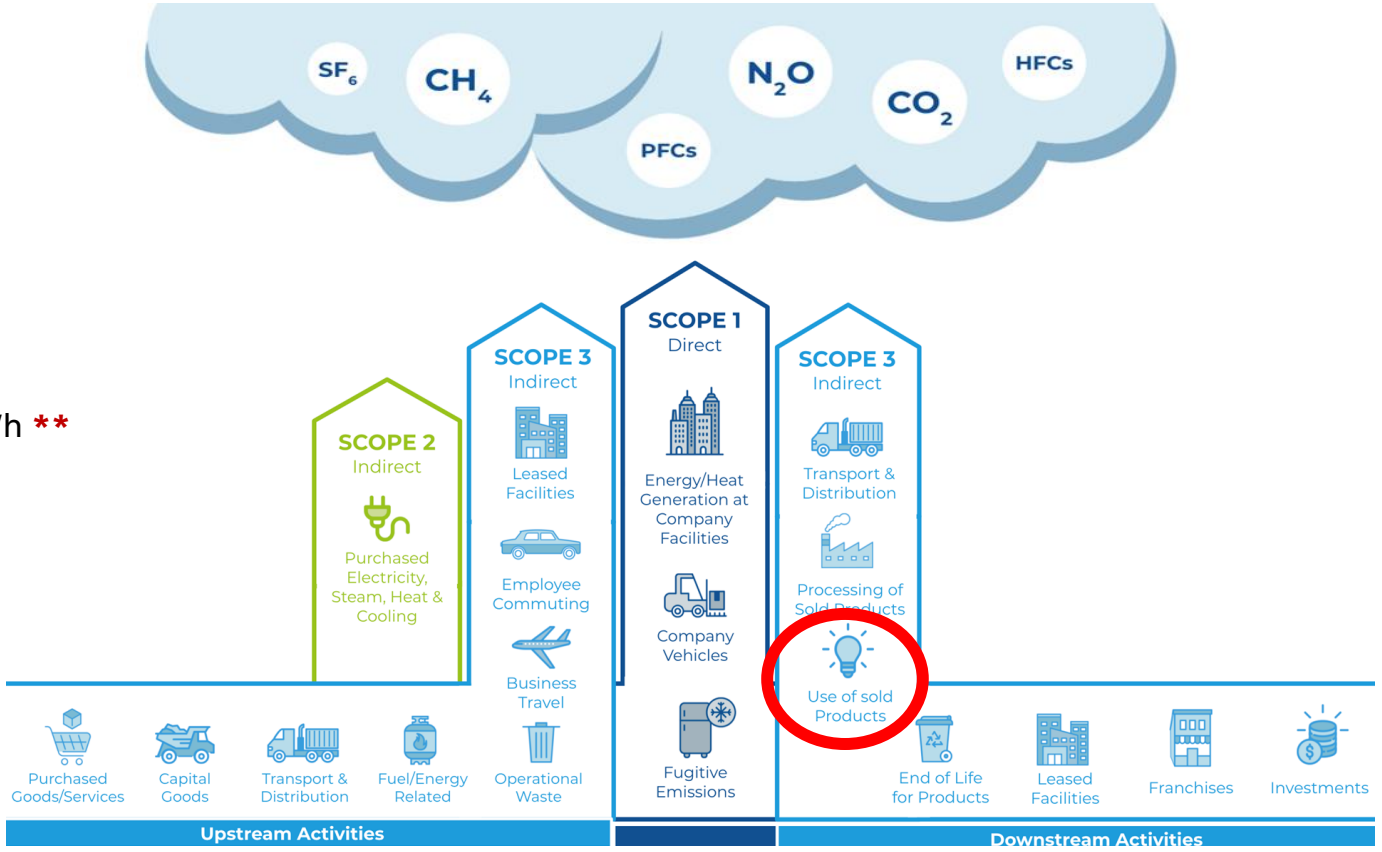
a) Diesel price $5.29 per gal *

b) Industry electricity rate: 10.49¢/kWh

IV. Carbon intensity

a) Electricity: California ISO (CAISO) is 218 gCO_2eq/kWh **

b) Diesel: 10, 180 gCO_2eq/gal

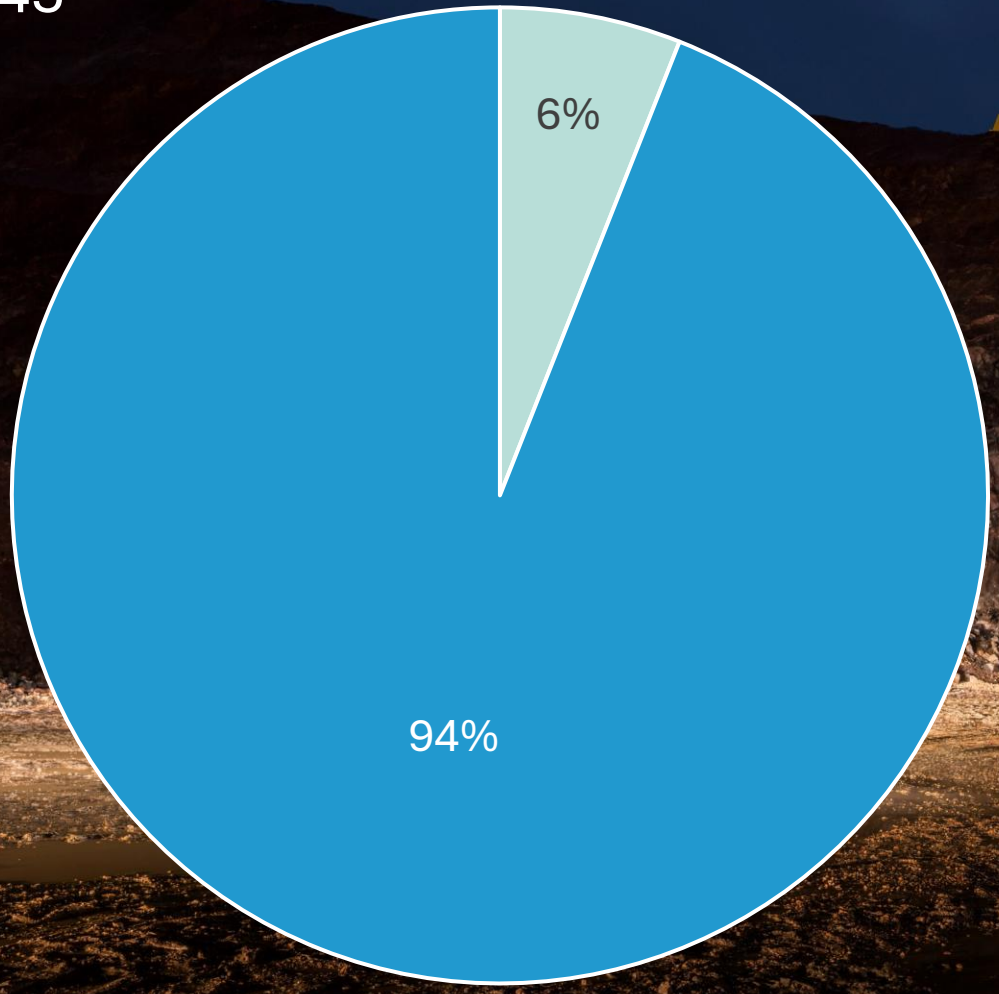


* As of April 15, 2024 per "GasBuddy" Shell

** EIA 2022 State electricity profiles

Cradle to Grave Off-Road Example (CO_2)

A45

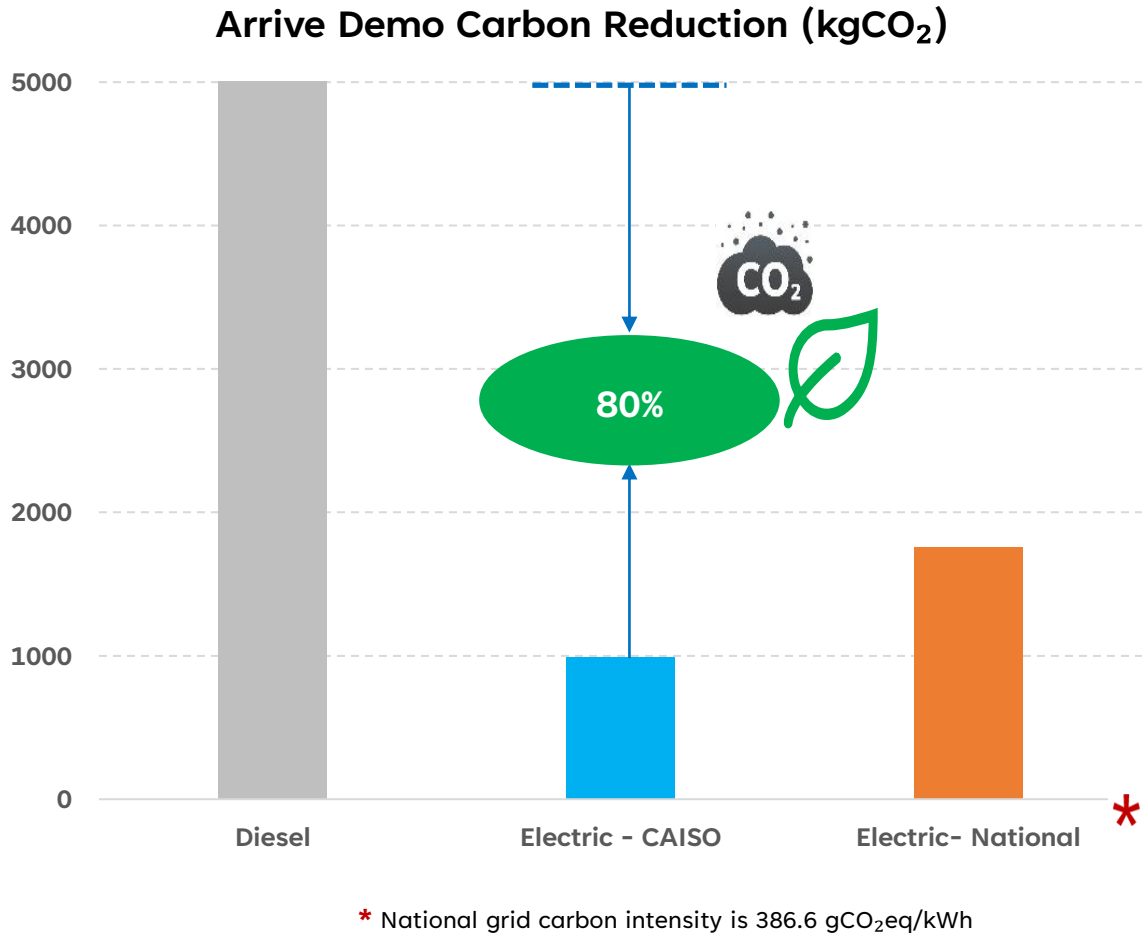


EC230 Demo - GHG Analysis

Carbon intensity for demo

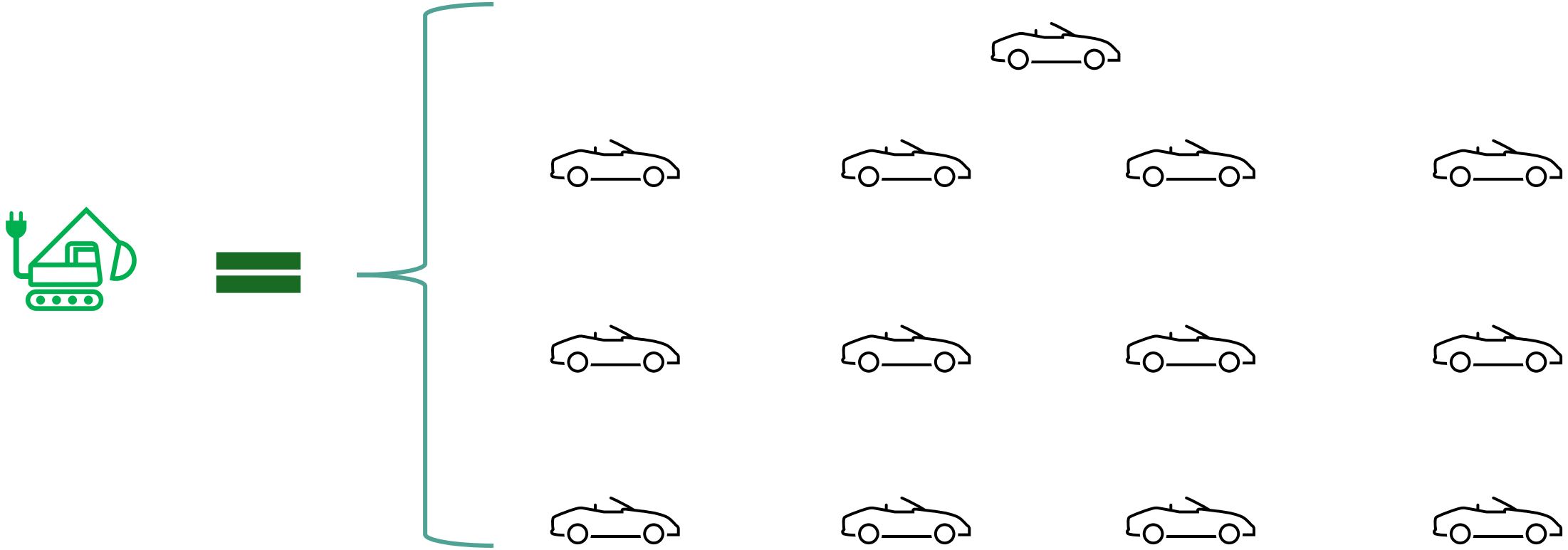
1. Diesel EC220E: 4.05 gal/h * 10,180 gCO_2/gal * 122 hrs. = 5,030 $kgCO_2eq$
2. Electric EC230E: 4,536 kWh * 218 gCO_2/kWh = 989 $kgCO_2eq$

➔ Demo CO_2 emission reduction: 4,041 $kgCO_2eq$ (80%)



* National grid carbon intensity is 386.6 gCO_2eq/kWh

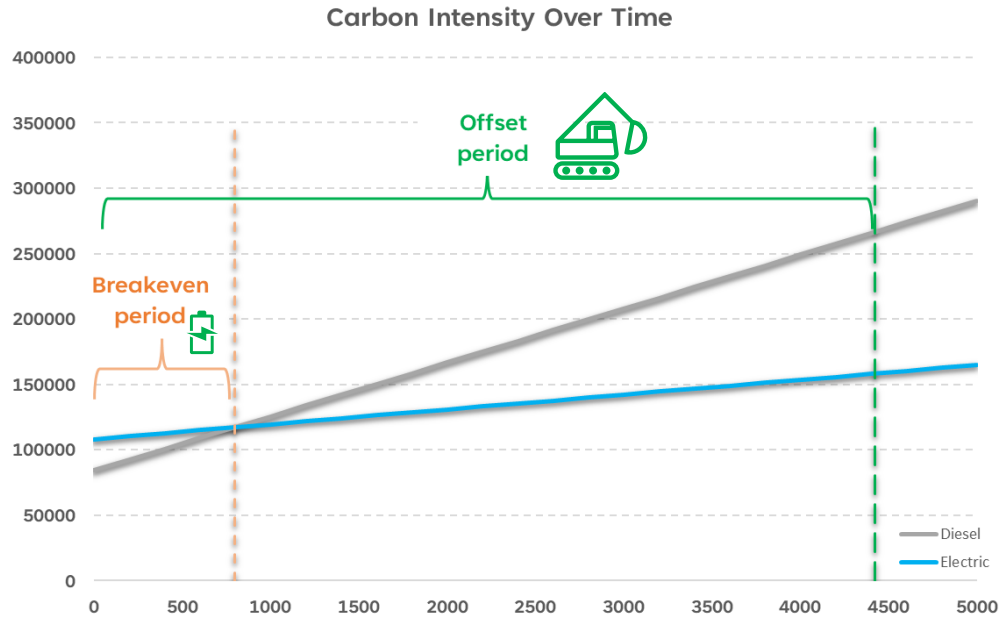
EC230 GHG Savings



One Electric EC230E Offsets the Greenhouse Gas Emissions of 13 Passenger Cars

EC230 - The Economics of Carbon Intensity

Cradle to Gate	Emissions [$kgCO_2eq$ per machine]	
Model	EC220E (Diesel)	EC230E (Electric)
Scope 3 (w/o fuel burn)	82,800	107,700
Scope 1&2	1,460	1,530
Total	**84,260**	**108,230**
Δ = Electric - Diesel	**23,970 (28%)**	



- The EC230E electric has a higher carbon intensity compared to diesel variant (~23,970 kg higher)
- The difference is more than offset by machine operation (est. breakeven period of 800 hours)
- Total carbon intensity is offset after approximately 4,400 hours of operation (< 3 years)

EC230 Demo - Fuel Savings Economics

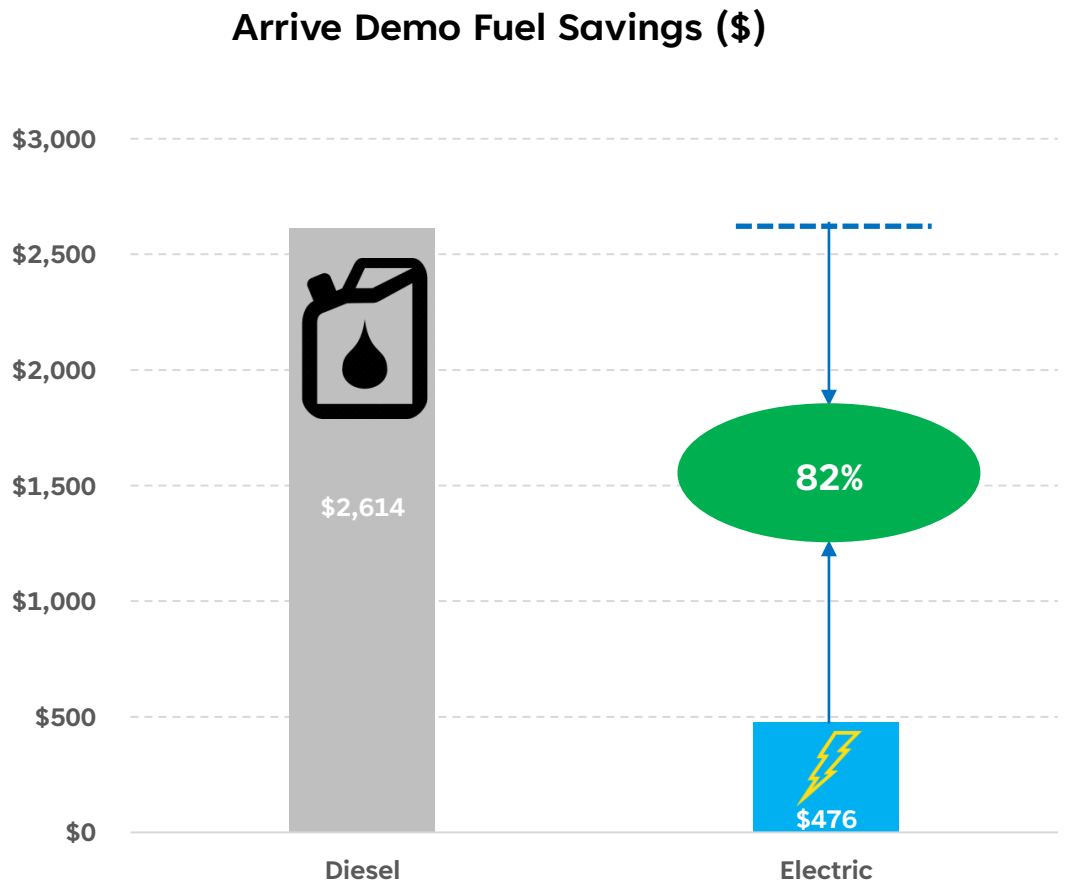
II. Operating fuel savings**:

a) Diesel twin EC220E: 4.05 gal/h * 122 hours * $5.29 = $2,614

b) Electric EC230E: 4,536kWh * 10.49¢/kWh = $476

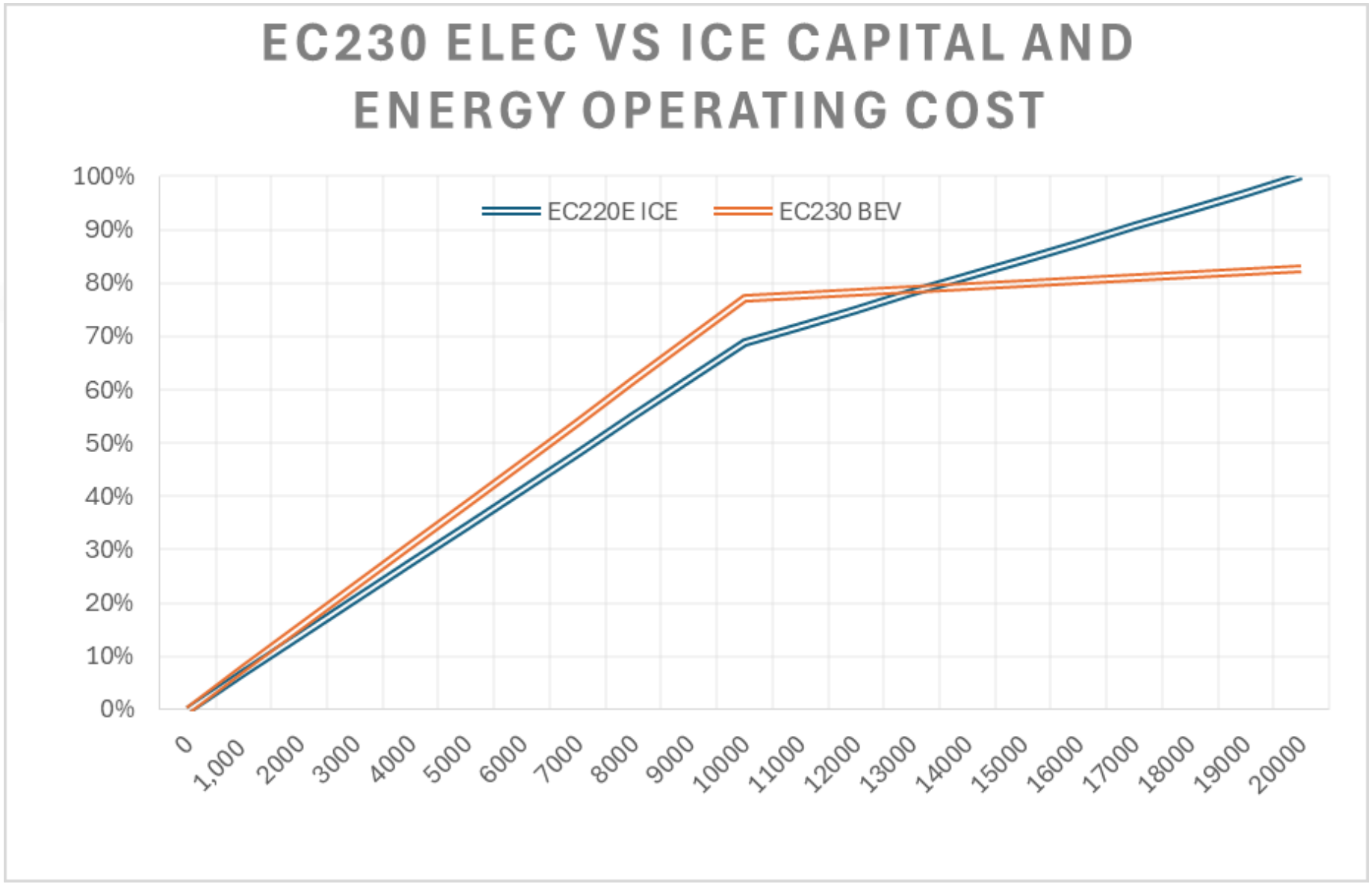
➔ Demo total fuel saving: $2,138 (82%)

** DEF (Diesel Exhaust Fluid) cost is not included

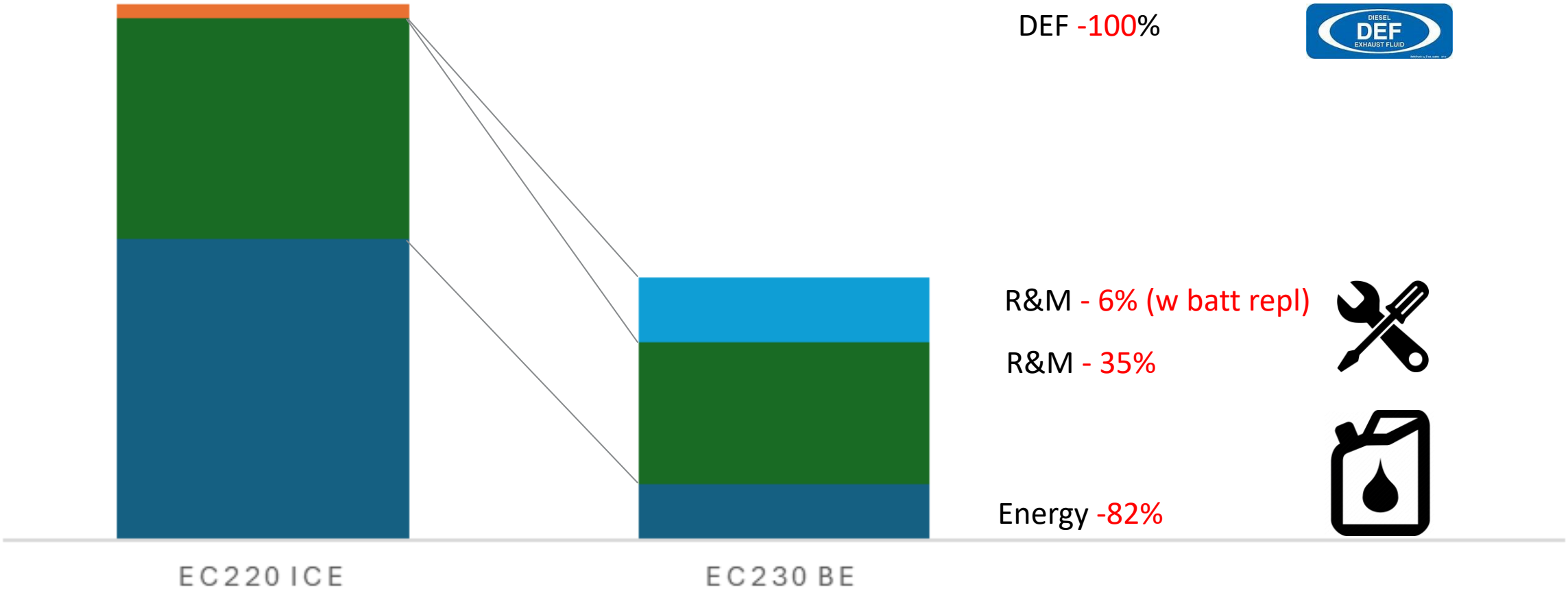


Assumptions:

- Fuel $5.29
- Electric 0.1049/kW
- Interest 8%
- Finance term 60 mths
- Delta Price 1.7
- 2000 hrs/year

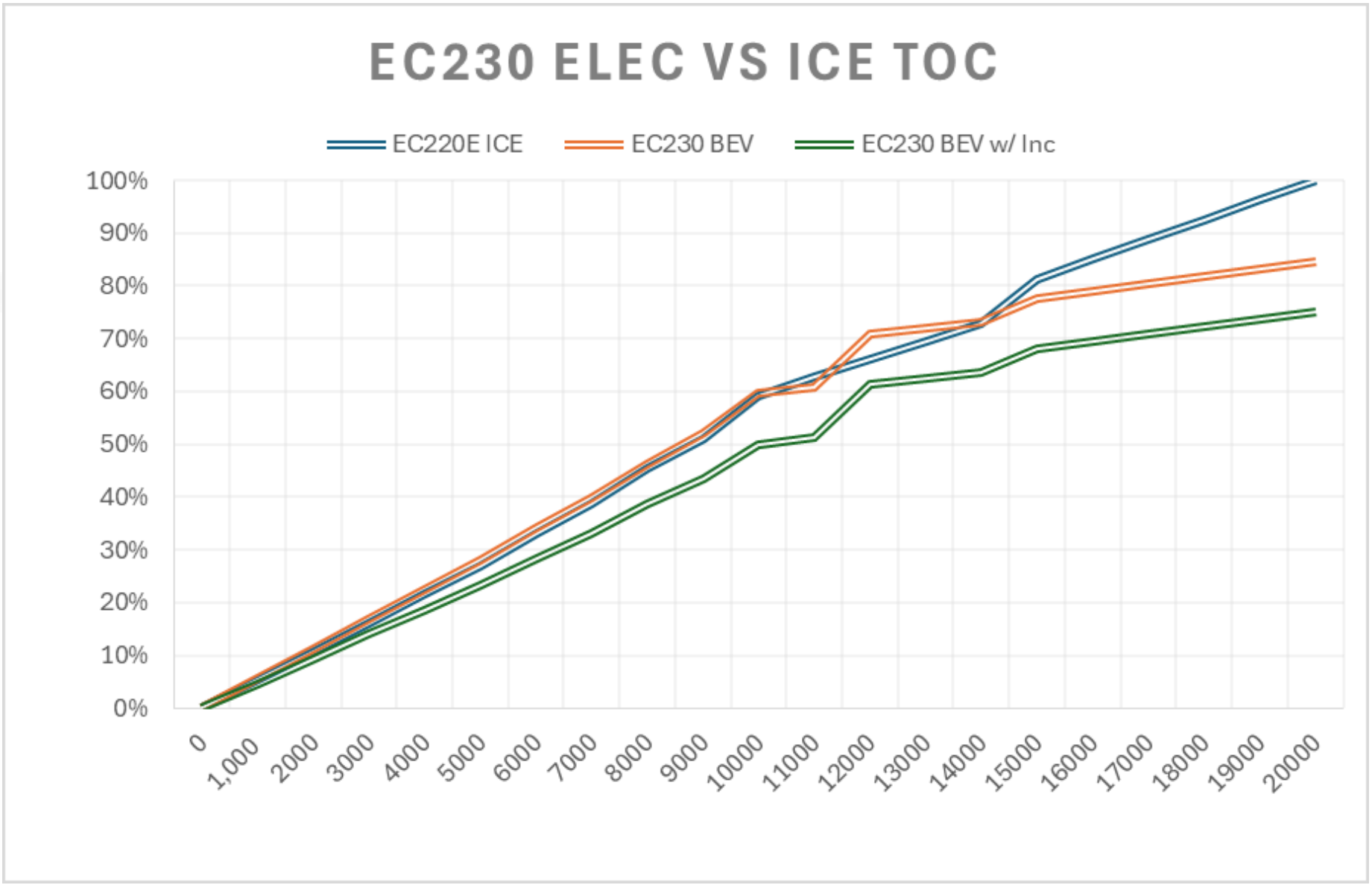


OPERATING COST COMPARISON



Assumptions:

- Fuel $5.29
- Electric 0.1049/kW
- Interest 8%
- Finance term 60 mths
- Delta Price 1.7
- 2000 hrs/year
- With Maint and DEF (ICE)
- Batt pack replacement at 12K hours
- With incentive (20%)



Steps to Site Decarbonization

1. Machine technology (battery electric, grid, H2)
2. System (how do we charge/refuel)
3. Site (running energy efficient sites)

Key to sustainable sites is energy management

THE FUTURE…

SUSTAINABLE POWER

DIGITIZATION / A.I.

AUTOMATION

VOLVO

CO_2 95% ↓

TCO 25% ↓

1 50 T diesel loader
1 70T diesel excavator
1 Mobile diesel crusher
3 x 40 T rigid haulers
6 Units, 6 operators

1 20T hybrid
1 electric conveyor
1 70T grid electric exc
1 Grid powered crusher
8 autonomous haulers
11 units, 3 operators

Equal Production

CO_2 95%

TCO 25%

-98% CO_2

-70% Energy cost
-40% Operator cost

Increased safety

Questions

1. Will Emob machines perform like my ICE unit?
   - Are they reliable?
2. How do I charge?
3. Will the grid in NA be adequate?
4. How much difference does it *really* make to CO2?
   - Critics point out (rightly) that battery production is a very carbon-intensive and highly polluting activity and our grid is not emission-free either
5. Economics of Emob?
   - Who are the buyers and ***why*** would they pay the premium?

“Faith in the future gives us power in the present”

Senator Tim Scott, (R SC)

VOLVO

Dr. Ray Gallant, DBA
Vice President Sustainability and Productivity Services
Region Americas

Volvo Construction Equipment
312 Volvo Way
Shippensburg, PA, USA
17257

Telephone: +1 (717) 300 6021
Mobile/SMS: +1 (717) 385 8023
Telefax: +1 (717) 530 6375
Email: ray.gallant@volvo.com
www.volvoce. com