

# Technology and Market Trends for Battery Electric

Presented by:

Steve Clermont, CTE Director of Planning and Deployment

# Agenda



- CTE Introduction
- Why ZEVs?
- Commercial Vehicle Availability
  - Light Duty Vehicles
  - Medium Duty Vehicles
  - Heavy Duty Vehicles
- Charging options
- What's next?

# About CTE



## Who We Are

501(c)(3) non-profit engineering and planning firm



## Portfolio

\$1B+

- Research, Demonstration, Deployment
- 100+ active projects totaling \$365m+



## Our Mission

Improve the health of our climate and communities by bringing people together to develop and commercialize clean, efficient, and sustainable transportation technologies



## Our Focus

Zero-Emission Transportation Technologies



## National Presence

Atlanta, Berkeley, Los Angeles, St. Paul



# What We Do



## Technology Development

We support technology providers' cutting edge pilots.



## Smart Deployment

We support early adopters with technical solutions.



## Transition Planning

We help fleet operators develop strategic plans for full-fleet electrification.

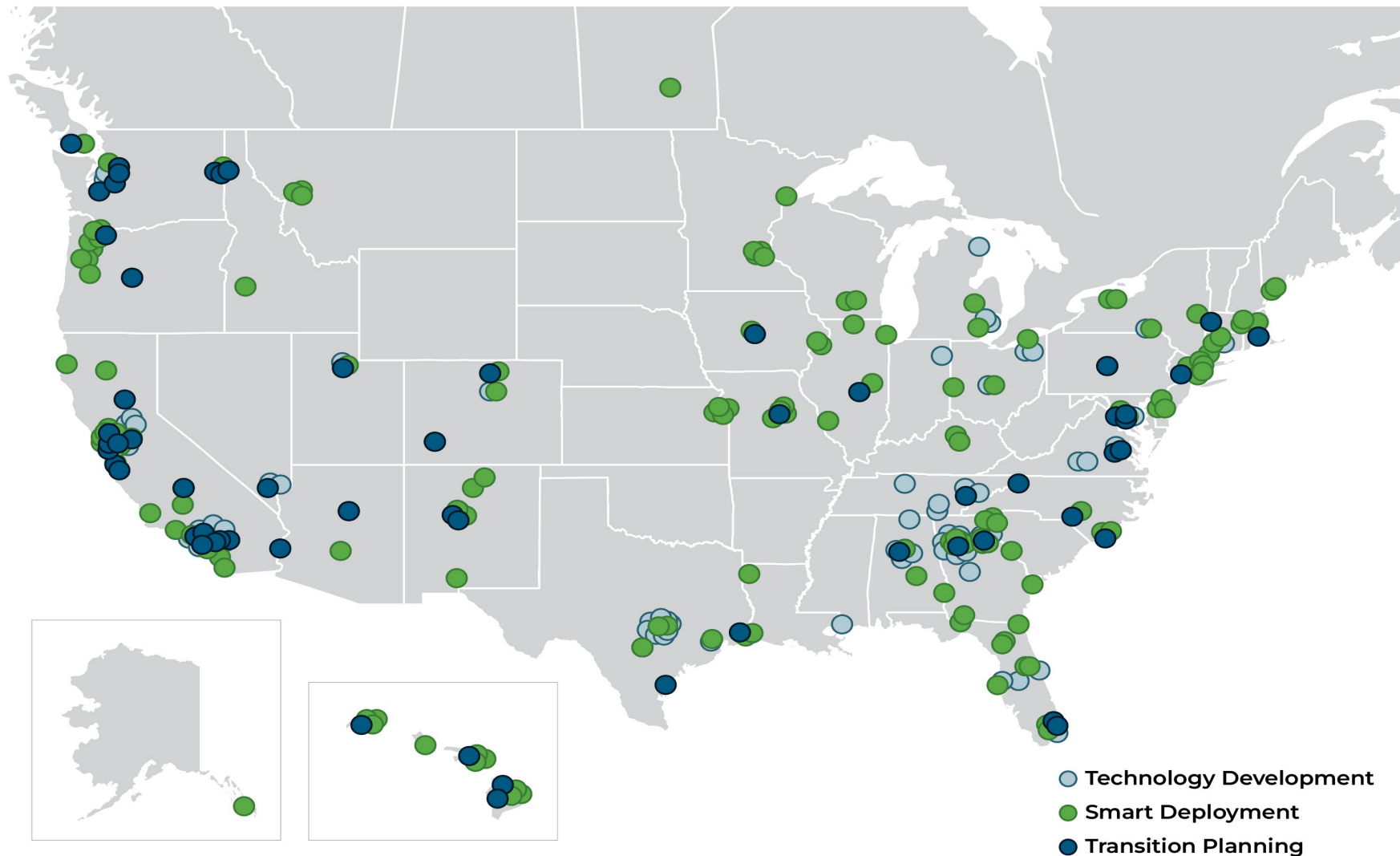


## Advocacy

We help amplify the zero-emission industry's collective voice.

# Impact

 30 years.  
100+ active projects.  
  
LAUNCH ALASKA



Celebrating  
**30**  
Years

# Why Zero-Emission Vehicles?

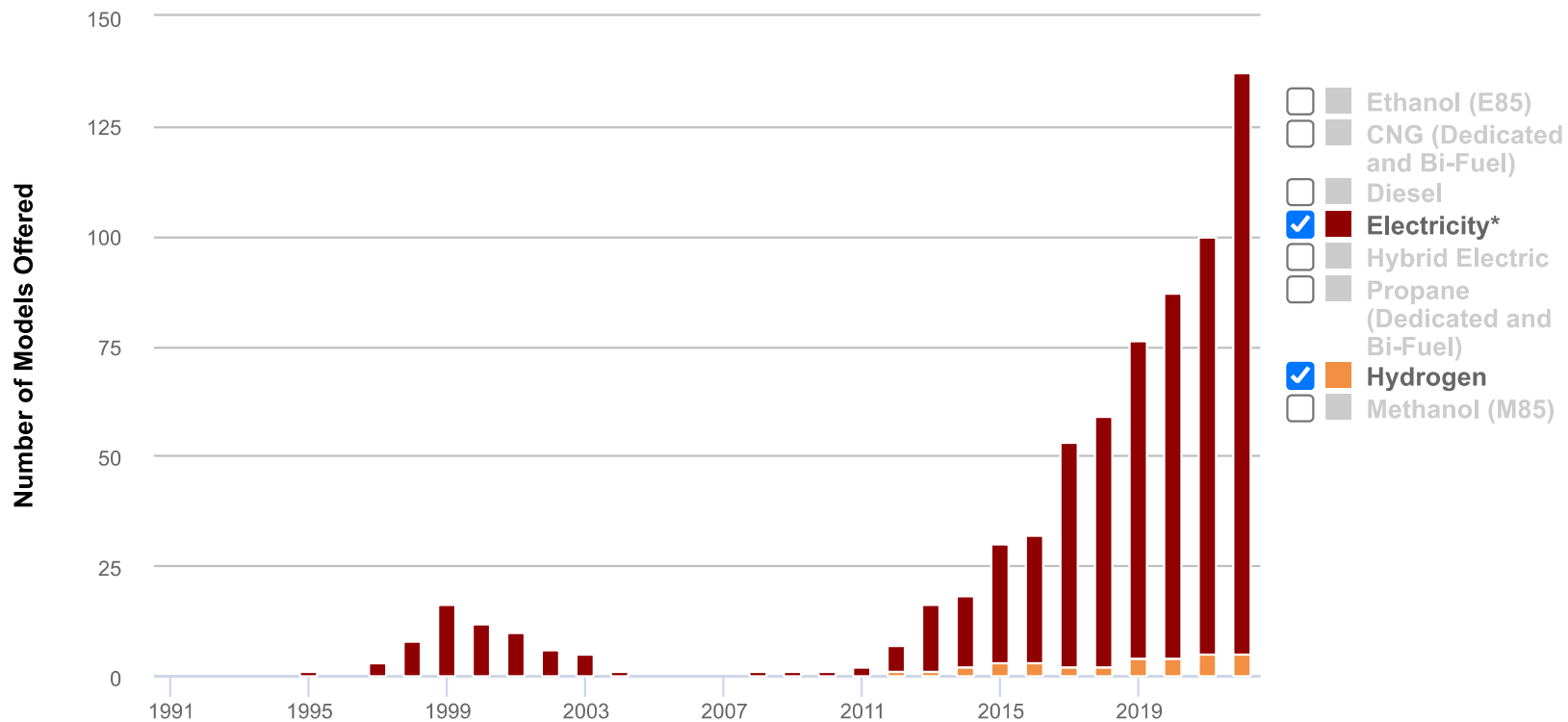


- Cleaner, lowers transportation's contribution to climate change
  - Zero tailpipe emissions
  - Lower source emissions
- More efficient, lower energy consumption
- Quieter, preferred by operators & passengers
- Lower maintenance costs
- Lower fuel cost in some parts of the country
- US-produced fuel source, predictable fuel cost



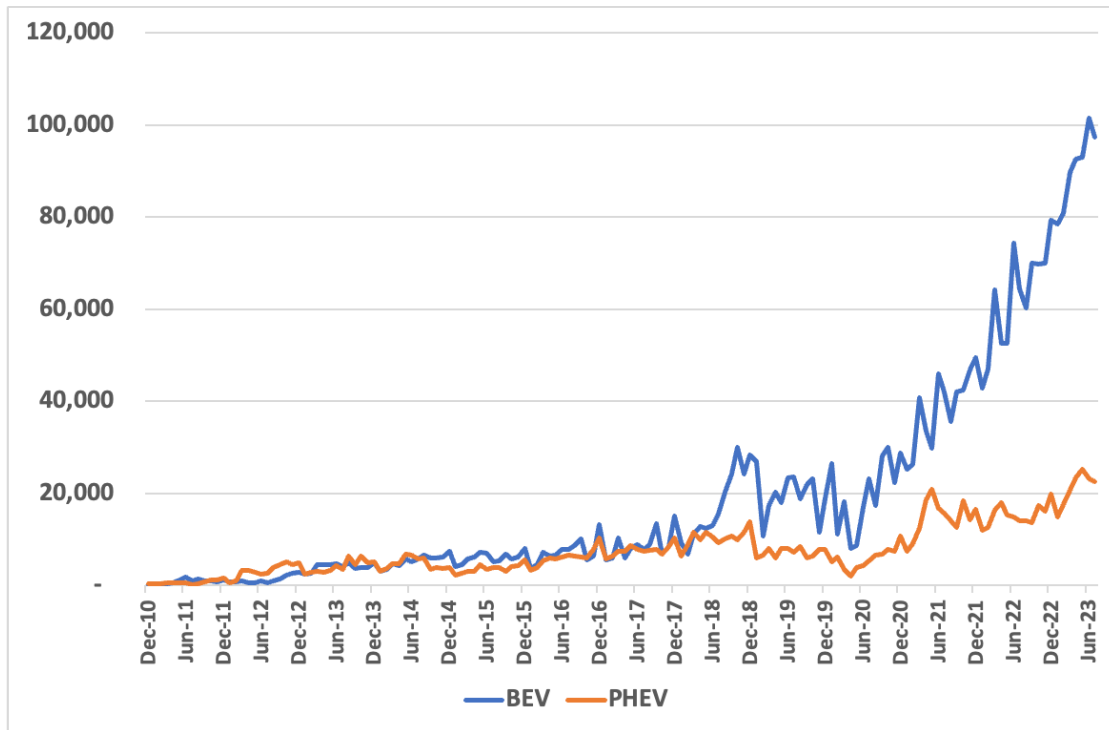
# Light Duty EV Models

## 1995 – 2022 Number of Light Duty BEV, PHEV, and HEV Models



Last updated: January 2023  
Printed on: September 5

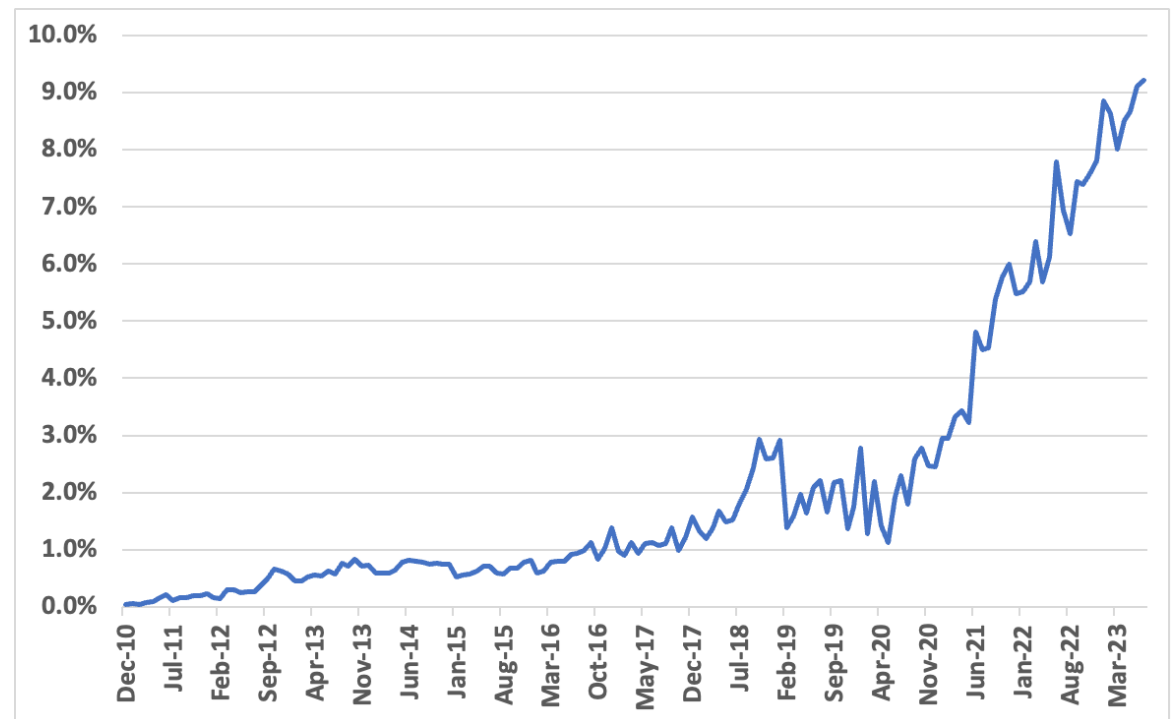
# Light Duty BEV & PHEV Sales in US



US Monthly Sales Light Duty BEV & PHEV

Argonne National Labs

## BEV/PHEV % Share of Total Light Duty Vehicle Sales





# Light Duty BEV and PHEV Models



## BEV Light Duty Sedans, SUVs and Pickups

Manufacturer	Max Energy Storage (kWh)	Est. All Electric Range (miles)	Manufacturer	Max Energy Storage (kWh)	Est. All-Electric Range (miles)
Audi	95	265	Mazda	35	100
BMW	111	324	Mercedes	111	340
Cadillac	119	312	Mini	32	114
Chevrolet	75	259	Nissan	90	304
Fisker	113	360	Polestar	77	270
Ford	165	320	Porsche	109	246
Genesis	87	282	Rivian	144	352
Hyundai	77	361	Subaru	72	228
Jaguar	86	246	Tesla	104	405
Kia	77	310	Toyota	72	252
Lexus	71	220	VinFast	88	207
Lordstown	109	174	Volkswagen	81	275
Lucid	120	516	Volvo	77	226

## PHEV Light Duty Sedans, SUVs and Pickups

Manufacturer	Max Energy Storage (kWh)	Est. All-Electric Range (miles)
Bentley	17	21
BMW	29	31
Chrysler	16	32
Hyundai	13	33
Jeep	17	26
Lexus	18	37
Lincoln	12	21
McLaren	10	11
Mini	10	18
Porsche	18	19
Volvo	18	40

# Cargo Vans / Step Vans



Manufacturer	Model	Type
Envirotech	Logistics Van	Van
Ford	E-Transit Cargo Van	Van
GreenPower Motors	EV Star Cargo	Van
Lightning eMotors	ZEV3	Van
BrightDrop	Zevo 600	Step Van
Morgan-Olson	(various models)	Step Van
Utilimaster	(various models)	Step Van
Xos	SV05	Step Van



**Ford e-Transit T-350 Van**



**BrightDrop Zevo 600**



**Workhorse C-1000 Step Van**

# Vocational / Cab Over Chassis: Medium Duty



Manufacturer	Model	GVWR Category
Ford	E-Transit Cutaway/Chassis Cab	2
FUSO	New eCanter	3-4
FUSO	eCanter	4
Envirotech	Cutaway Van	4
Envirotech	Urban Truck	4
GreenPower Motors	EV Star Cargo+	4
GreenPower Motors	EV Star CC	4
Lightning eMotors	ZEV4	4
Optimal-EV	E1 Cutaway Chassis	4
Workhorse	W4 CC	4
Freightliner Custom Chassis	MT-50e	4 -5



Envirotech  
Battery Electric Urban Truck

# Vocational / Cab Over Chassis: Med/Heavy Duty



Peterbilt 579 Battery  
Electric Truck



Lion 8P  
Battery Electric Truck

Manufacturer	Model	GVWR Category
BYD	6F	6
Lion Electric	LION6	6
Peterbilt	220EV - Class 6	6
Freightliner	eM2	6 - 7
International	eMV	6 - 7
Kenworth	K270/K370	6 - 7
Peterbilt	220EV - Class 7	7
Volvo	VNR Electric	7
Xos	MDXT	7
Battle Motors	LOW ENTRY TILT II	6 - 8
Battle Motors	LOW NARROW TILT	6 - 8
Freightliner	Cascadia	8
Lion Electric	LION8 - Class 8	8
Nikola	TRE	8
Peterbilt	579EV	8
Xos	HDXT	8

# Electric Refuse Trucks



Manufacturer	Model
BYD	6R
BYD	8R
Lion Electric	LION8 Refuse ASL and REL
Mack	LR Electric
McNeilus	Volterra ZSL
Peterbilt	520EV - Class 8



Mack LR Electric

# Street Sweepers



Global M3 EV

Manufacturer	Model
Elgin	Pelican Plug-In Hybrid
Elgin	Broom Bear Electric
Global	M3EV - Class 7
Global	M4EV - Class 7
Global	M4ZE/M4HSDZE - Class 7

# Zero Emission Transit Bus OEMs – Heavy Duty



Battery  
Electric  
Options



Fuel Cell  
Options



# Zero Emission Cutaway OEMs/SVMs



Battery  
Electric  
Options





# Zero Emission Passenger Van OEMs/SVMs



Battery  
Electric  
Options



# Public School Bus

Manufacturer	Model
Blue Bird	All American RE Electric
Blue Bird	Micro Bird G5 Electric
Blue Bird	Vision Electric
BYD	Type A
BYD	Type D
Collins Bus Corp.	DE516
Collins Bus Corp.	DE516WF
Collins Bus Corp.	Ford E-Transit
GreenPower Motor	BEAST
GreenPower Motor	Nano BEAST
IC Bus	Electric CE Series
Lion Electric	LIONA
Lion Electric	LIONC
Lion Electric	LIOND
Starcraft	E-Quest
Starcraft	E-Quest XL
Thomas Built	Saf-T-Liner C2 Jouley



Blue Bird Vision  
Battery Electric School Bus

# Marine



**MS Medstraum, battery electric fast ferry**

*Offshore Energy, July 14, 2022, by Naida Hakirevic Prevljak*



**Greenline 40 electric drive**

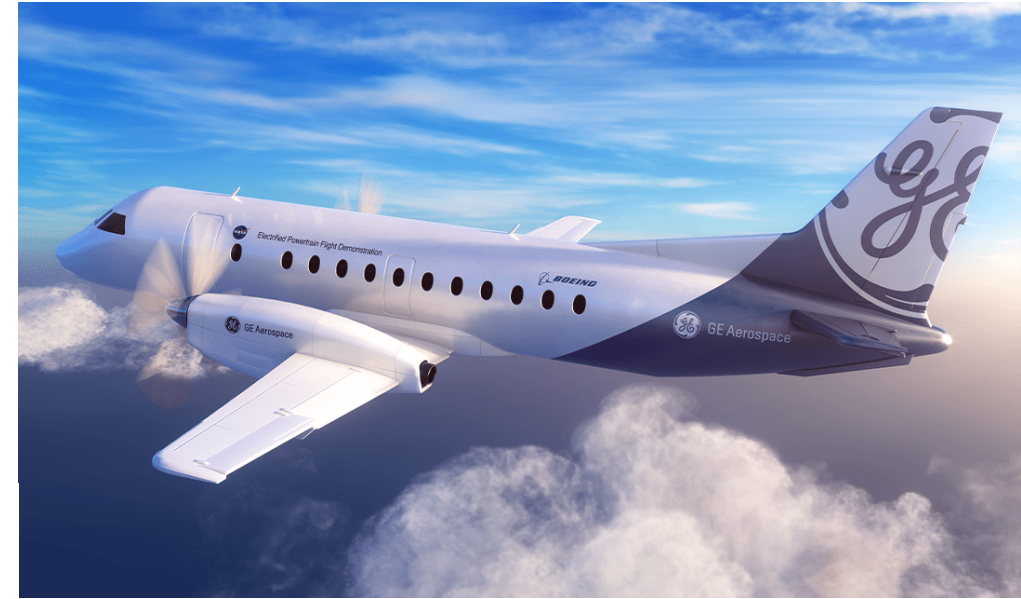


**Flux Marine, rigid inflatable with battery electric outboard motor**

# Aviation



ZeroAvia Successfully Completes Initial Dornier 228 Flight Test Campaign with prototype ZA600 hydrogen-electric engine [Kemble, UK & Hollister, CA: 19th July, 2023] [zeroavia.com](https://www.zeroavia.com)



GE Aerospace aircraft testbed for NASA's Electrified Powertrain Flight Demonstration (EPFD) project, to prove the feasibility of hybrid electric flight for commercial aviation



Charlatte T137-V3  
Electric Baggage Tractor



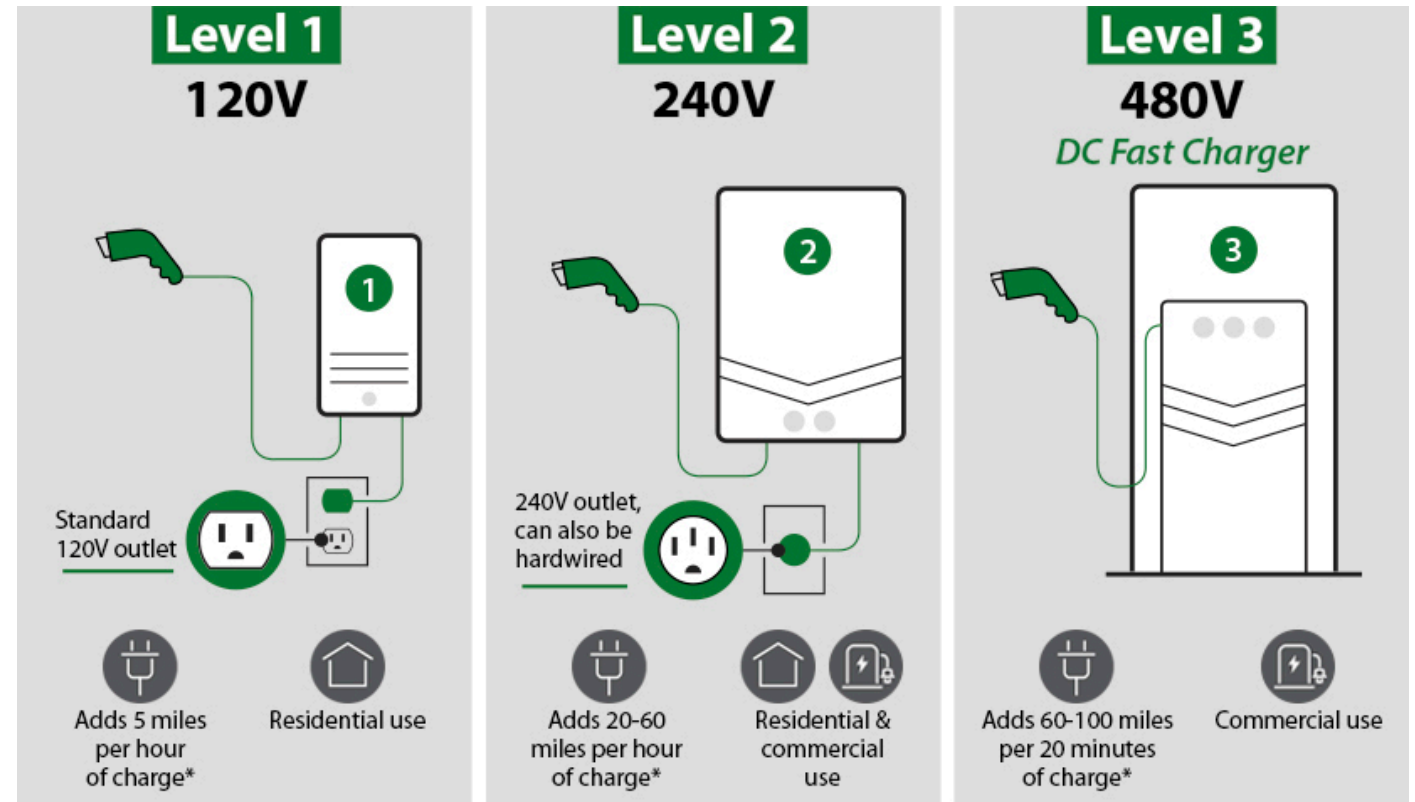
Caterpillar 793 electric mining truck

- Ports
- Construction
- Agriculture

# Chargers

## Charging Levels:

- Level 1
  - 1.4kW AC
- Level 2
  - 19.2kW AC
- DC Fast Charger/Level 3
  - Up to 350kW



\* Estimated. Actual charge times may vary.

Image Source: Central Hudston

(<https://www.cenhud.com/en/my-energy/electric-vehicles/how-to-charge/>)

# Chargers

## Fueling Technology:

- Plug-in charging
- Overhead conductive charging
- Wireless inductive charging

## Supplier Examples:

- ChargePoint
- Heliox
- ABB
- SemaConnect
- Siemens
- Proterra
- Tesla
- BTC
- Tritium



*Plug-in charging examples (Image Source: Rodrigo Garrido/Reuters)*

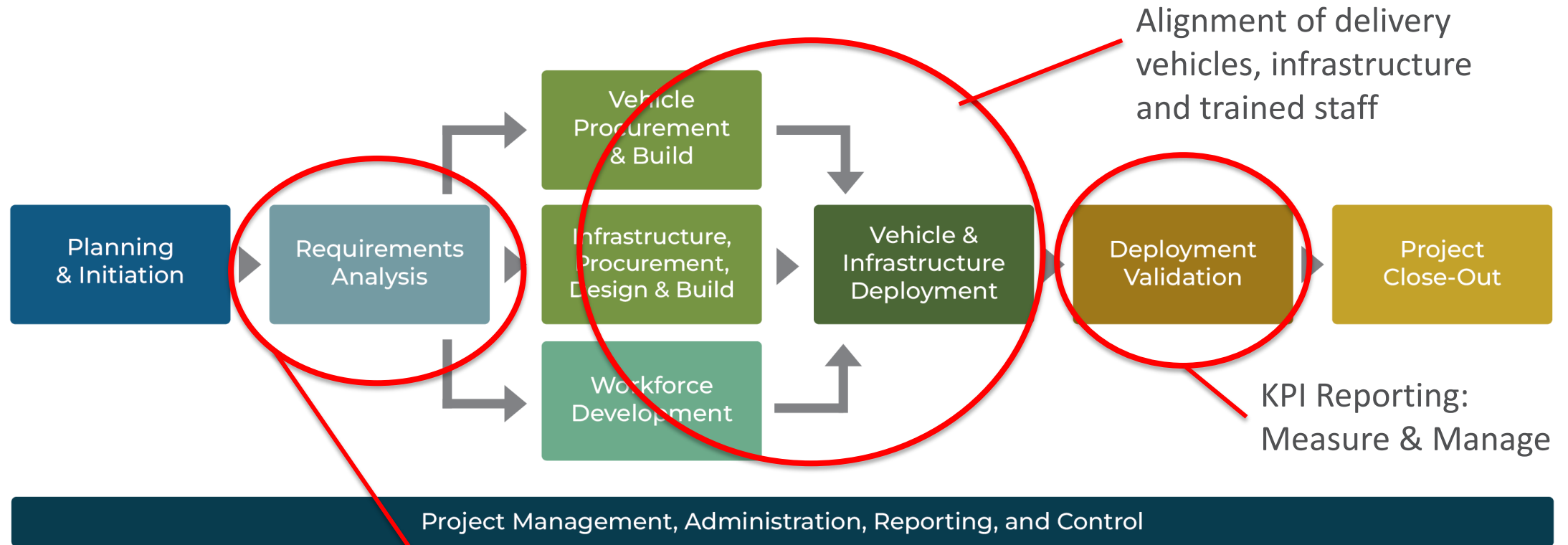


*Overhead charger with pantograph (pantograph down)*



*Example of inductive charging capabilities (Source: CARTA)*

# Best Practices in Deployment



## Engineering Analysis

- Duty Cycle Modeling: Efficiency, Energy Requirements, Range
- Charge Modeling: Charge Rate, Duration, Cost



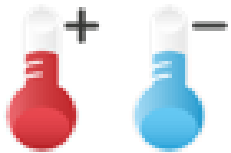
# Factors Affecting BEV Range



- **Route characteristics:** speed, stops, grade



- **Weight:** Cargo/Ridership



- **Climate:** Heating and cooling



- **Battery degradation**



- **Operator**

# What's Next



- Increased range capabilities
- Expanded vehicle type availability
- Advanced Battery Chemistries
  - Higher energy density
  - Faster Charging...more power, less time

# Questions?