Fleet ZEV Transition Planning

Vehicles, Chargers, Corporation Yards, Driving Routes, Technicians, and Drivers… Everything Will Change

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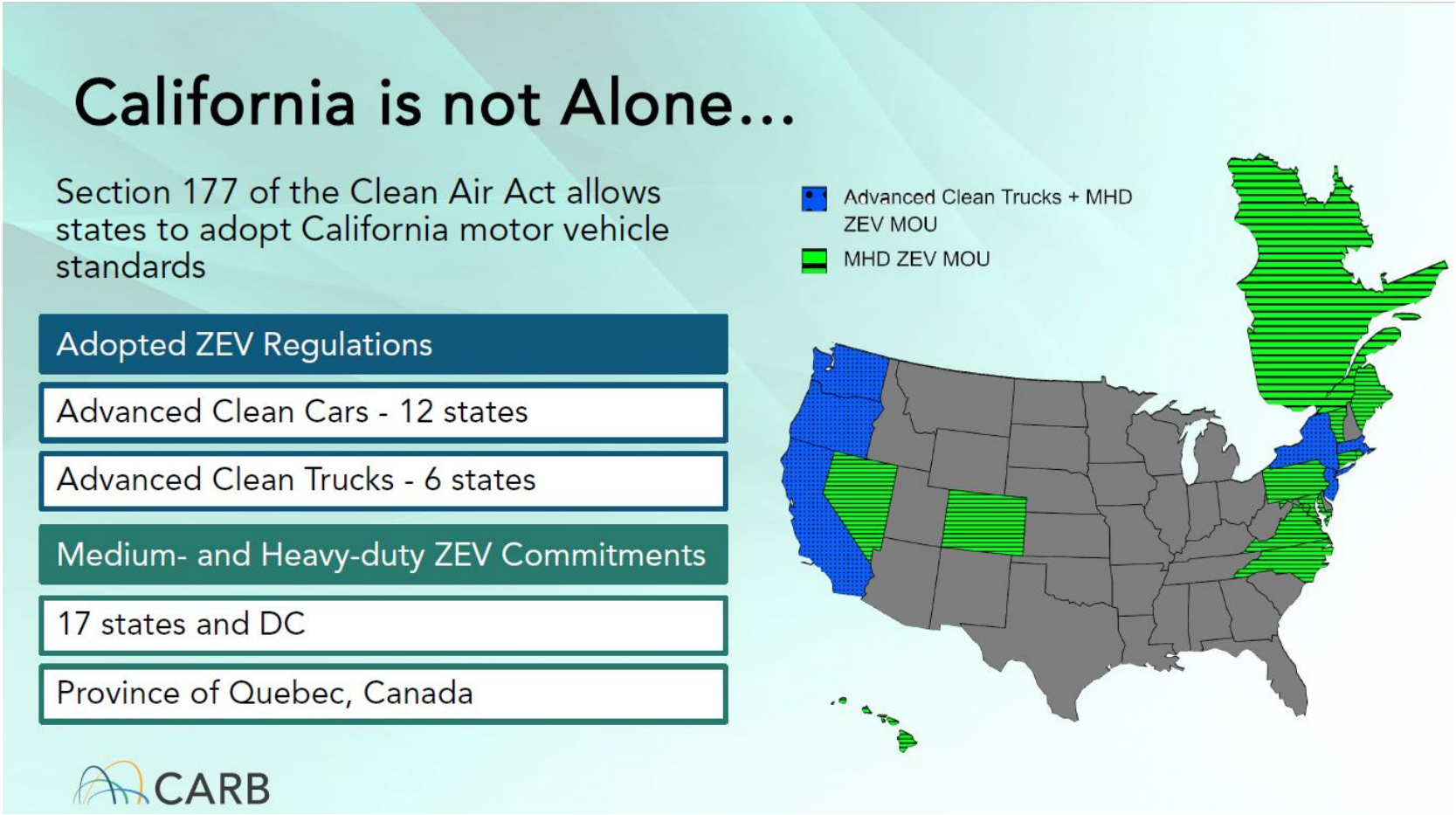
Topics

- We Are Not Alone
- Electric Vehicle Charging Equipment
- Data Collection and Needs Assessment
- Infrastructure Planning
- Cost Recovery
- Challenges
- Accident Damage
- EV Fires
- Necessary Collaboration
- CARB ACF Regulation
- Parting Thoughts
- Questions & Answers

Introduction – We Are Not Alone



https://ww2.arb.ca.gov/sites/default/files/barcu/board/books/2022/102722/22-14-1pres.pdf

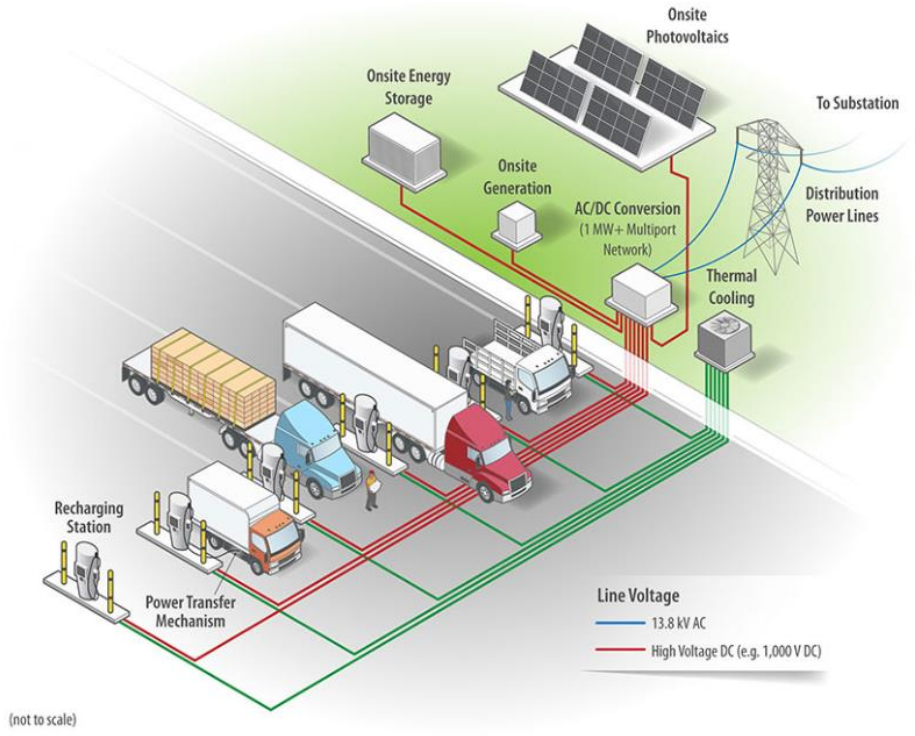
Electric Vehicle Charging Equipment

The higher kWh chargers result in shorter charge times but are larger in the overall design and size. Some charging stations require liquid cooled cords to support high voltage and amperage designs.

Infrastructure Planning

How to Determine How Much Power You Need

- Create a fleet vehicle inventory list
- Identify vehicles that can be replaced with EVs
- Determine battery size (kWh) from available sources
  - Manufacturers, EPA Power Search (fueleconomy.gov), industry Sources, etc.
- Determine charge rate AC or DC voltage requirements
  - Level 2 – 208 to 240 VAC – Charge Rates 2.5 kWh - 19.2 kWh
  - DC Chargers (Level 3) – 300 to 600 VDC – Charge Rates 50 kWh to 350+ kWh
- Determine overnight parking locations
- Determine battery degradation during warranty period
- **Do Not** plan on Publicly Available charging infrastructure unless you own it



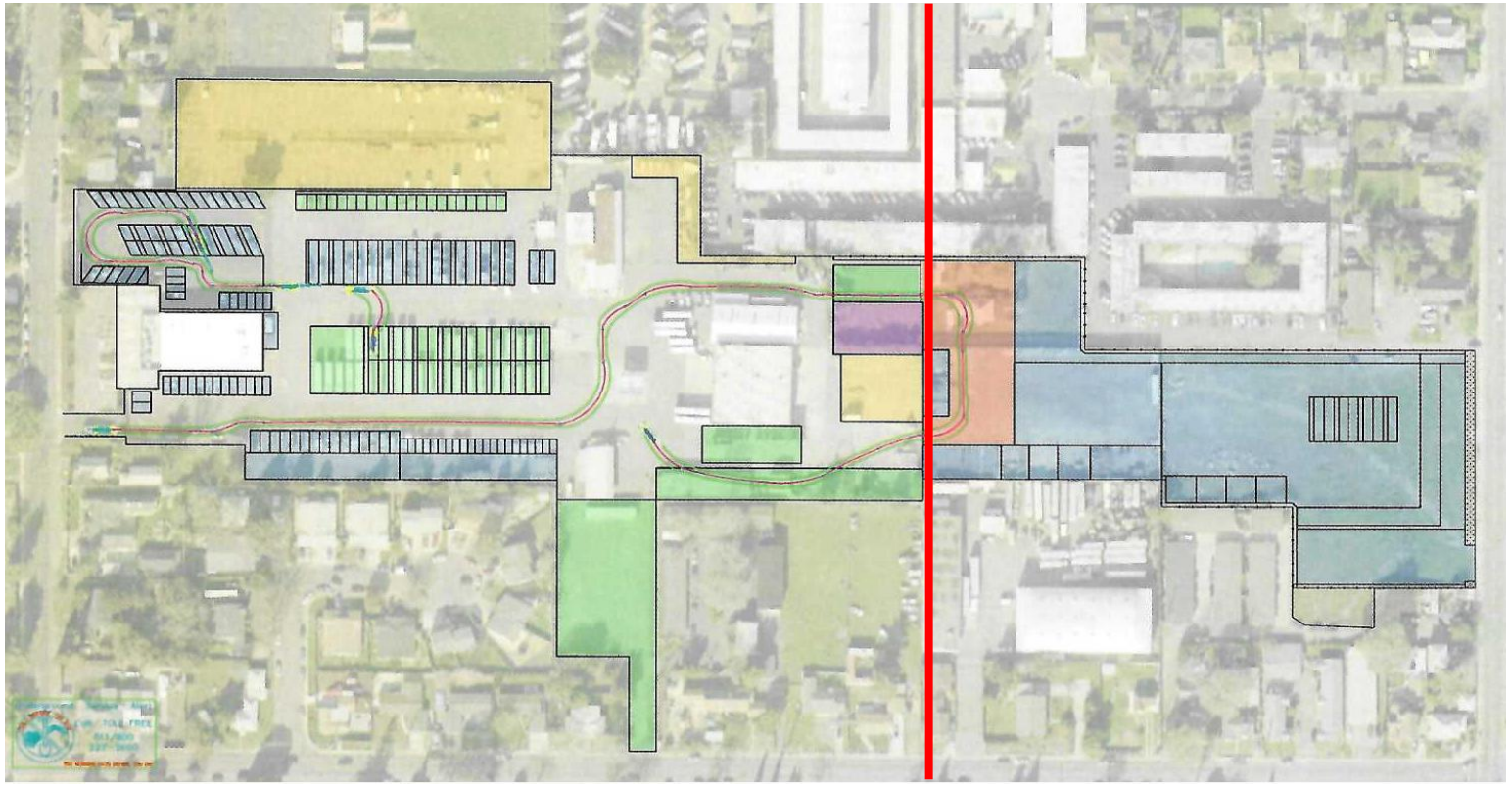
https://www.nrel.gov/transportation/medium-heavy-duty-vehicle-charging.html

Equipment ID	Equipment Description	Vehicle Location	Weight Class	Average Daily Milage (mi/day)	Proxy EV Description	Efficiency (kWh/ 100mi)	Average Daily Energy Consumption (kWh/day)
00056	VAN - CARGO - 1 TON	PRUNEYARD	Class 2b-3	17.56	Workhorse, C650 Battery Electric Step Van	74	12.91
00202	TRUCK - 1 TON - FLAT BED DUMP	CORPYARD	Class 2b-3	22.99	Motiv Power Systems, Ford E-450, Flat Bed Dump	133	30.59
00210	TRUCK - 1 TON - FLAT BED DUMP	CORPYARD	Class 2b-3	16.57	Motiv Power Systems, Ford E-450, Flat Bed Dump	133	22.04
00307	TRUCK - GARBAGE	CORPYARD	Class 7-8	18.48	Lion Electric, All Electric Refuse Truck	198	36.52
00312	VAC-CON	CORPYARD	Class 7-8	10.43	**N/A, Figure 1 Estimates**	205	21.39
00315	TRUCK - DUMP - 6 WH	CORPYARD	Class 7-8	13.72	Kenworth, K370E Battery Electric Truck	141	19.35
00325	WATER TANKER TRUCK (WG64)	CORPYARD	Class 7-8	2.05	**N/A, Figure 1 Estimates**	188	3.87
00329	TRUCK - 1-1/4 TON - FLAT BED - W SPRAYER	CORPYARD	Class 4-6	3.22	Kenworth, 270E Battery Electric Truck	141	4.53
00332	TRUCK - DUMP - 10 WH	CORPYARD	Class 7-8	18.11	Kenworth, T680E Battery Electric Truck	264	47.82
00359	TRUCK - DUMP - 6 WH - W EMULS SPRAYER	CORPYARD	Class 7-8	12.23	Kenworth, K370E Battery Electric Truck	141	17.25
03232	VAN - CARGO - 1 TON	CORPYARD	Class 2b-3	52.38	Workhorse, C650 Battery Electric Step Van	74	38.50
07130	PICKUP - 3/4 TON - UTIL BED - LIFT GATE	CORPYARD	Class 2b-3	26.57	Motiv Power Systems, Ford E-450, Work Truck	133	35.34
07231	VAN - CARGO - 1-1/2 TON	CORPYARD	Class 4-6	2.36	Motiv Power Systems, Ford E-450, Box Truck	121	2.85
08098	PICKUP - 3/4 TON - SUPER CAB	RANCHO SOLANO GC	Class 2b-3	12.93	Lordstown Motors, Endurance	45	5.81
08140	PICKUP - 3/4 TON - 4X4	WATERMAN TREATMENT	Class 2b-3	5.09	Lordstown Motors, Endurance	45	2.29
08207	TRUCK - 1 TON -FLAT BED DUMP	CORPYARD	Class 2b-3	19.04	Motiv Power Systems, Ford E-450, Flat Bed Dump	133	25.33
08214	TRUCK - 1-1/4 TON - UTIL BED - SIGN	CORPYARD	Class 4-6	31.17	Kenworth, K270E Battery Electric Truck	141	43.95
08215	TRUCK - 1-1/4 TON - PAINT TRUCK	CORPYARD	Class 4-6	3.36	Kenworth, 270E Battery Electric Truck	141	4.74

Vehicle Type**	Proxy EV Description	Estimated Purchase Price	Usable Battery Capacity (kWh)	Efficiency (kWh/ 100mi)	L2 Max Charging Rate (kW)	DCFC Max Charging Rate (kW)	GVWR (lbs.)
10 WHEEL DUMP	Kenworth, T680E Battery Electric Truck	$259,463	396	264	7.2	120	82,000
6 WHEEL DUMP	Kenworth, K370E Battery Electric Truck	$174,633	282	141	7.2	120	33,000
BOX TRUCK	Motiv Power Systems, Ford E-450, Box Truck	$74,050	127	133	7.2	50	14,500
CARGO VAN	Workhorse, C650 Battery Electric Step Van	$50,399	70	74	7.2	50	12,500
CARGO VAN	Motiv Power Systems, Ford E-450, Box Truck	$96,550	127	121	7.2	50	14,500
FLAT BED	Motiv Power Systems, Ford E-450, Flat Bed	$81,684	127	121	19.2	60	14,500
FLAT BED	Kenworth, 270E Battery Electric Truck	$131,841	141	141	19.2	60	26,000
FLAT BED DUMP	Motiv Power Systems, Ford E-450, Flat Bed Dump	$58,776	127	133	19.2	60	14,500
FLAT BED DUMP	Kenworth, 270E Battery Electric Truck	$104,600	141	148	19.2	60	26,000
PASSENGER VAN	Motiv Power Systems, Ford E-450, Shuttle Bus	$49,050	127	121	6.6	80	14,500
PICKUP	Lordstown Motors, Endurance	64,650	109	45	11.0	60	N/A
REFUSE	Lion Electric, All Electric Refuse Truck	$137,900	336	198	7.2	60	66,000

Equipment ID	Vehicle Description	kWh/day	Daily L2 Charging Time (h:mm:ss)	Daily DCFC Charging Time (h:mm:ss)	Assigned Charger Port*	Charging Strategy
00202	Motiv Power Systems, Ford E-450, Flat Bed Dump	30.59	4:14:55		1a	DEDICATED L2 CHARGING
00210	Motiv Power Systems, Ford E-450, Flat Bed Dump	22.04	3:03:40		1b	SHARED L2 CHARGING
00307	Lion Electric, All Electric Refuse Truck	36.52	5:04:22		2a	DEDICATED L2 CHARGING
00312	**N/A, Figure 1 Estimates**	21.39	2:58:15		2b	SHARED L2 CHARGING
00315	Kenworth, K370E Battery Electric Truck	19.35	2:41:14		3a	SHARED L2 CHARGING
00325	**N/A, Figure 1 Estimates**	3.87	0:32:14			5-DAY CHARGING
00329	Kenworth, 270E Battery Electric Truck	4.53	0:37:47			5-DAY CHARGING
00332	Kenworth, T680E Battery Electric Truck	47.82	6:38:28		3b	DEDICATED L2 CHARGING
00359	Kenworth, K370E Battery Electric Truck	17.25	2:23:44		4a	SHARED L2 CHARGING
03232	Workhorse, C650 Battery Electric Step Van	38.50	5:20:50		4b	DEDICATED L2 CHARGING
07130	Motiv Power Systems, Ford E-450, Work Truck	35.34	**USE A DCFC**	0:41:35	DCFC – 1	DEDICATED DCFC
07231	Motiv Power Systems, Ford E-450, Box Truck	2.85	0:23:46			5-DAY CHARGING
08207	Motiv Power Systems, Ford E-450, Flat Bed Dump	25.33	3:31:03		5a	SHARED L2 CHARGING
08214	Kenworth, K270E Battery Electric Truck	43.95	6:06:15		5b	DEDICATED L2 CHARGING

Infrastructure Planning



Once you know the type, voltage, and amperage requirements of needed charging stations, determine where the infrastructure will be best suited to be installed

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Infrastructure Planning

- Total kWh needs by voltage types (AC vs DC) at overnight parking locations
- Contact your electric utility provider to determine available localized grid capacity
  - Integration Capacity Analysis maps
    - Load hosting capacity
    - Generation hosting capacity
    - Generic Photovoltaic (solar) capacity
    - Where the closest circuit is located
    - Future transformer or grid upgrades
      - Future completion dates
    - Is available capacity distributed on a first come first served basis?

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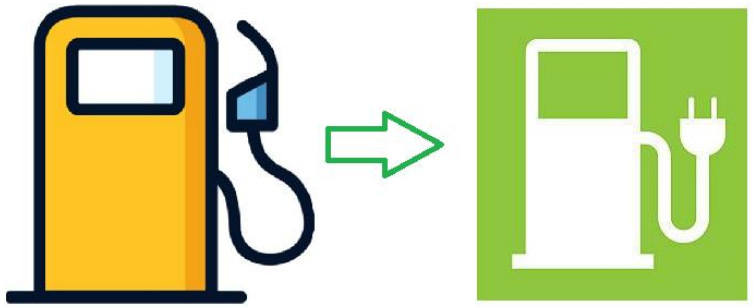
Infrastructure Planning

Facility Name	Address	# of Fleet Vehicles	# of Vehicles to be Replace with EVs	Requested EV Port Needs (Level 2= 19 kW)	Charger Load (kW)	Utility Capacity Check - (kW) Available Now	Future Capacity Increase (kW)	Forecast Date of Completion of Capacity Upgrade
General Admin	101 Main Street San Jose	258	108	54	1037	300	300	2023
Public Works #2	2596 Elm Street San Jose	71	96	48	922	300	0	
Sheriffs Office	222 Santa Clara Ave. Santa Clara	200	2	1	19	0	300	2026
Human Services	3689 Oak Blvd Sunnyvale	141	66	33	634	4000	0	
Health Department	201 Medical Dr Campbell	138	6	3	58	6000	0	
Public Works #1	2022 Windward Way San Martin	49	60	30	576	0	500	2028
Building Operations	4110 Oak Road San Jose	110	0	0	0	4000	0	
Public Works #3	857 Jackson St Milpitas	91	28	14	269	0	2000	2027
Consolidated Services	455 Cabrillo Ave San jose	37	0	0	0	0	0	0
County Park #1	29556 Taper Rd Morgan Hill	18	12	6	115	0	0	0
Airport	101 Executive Parkway San Jose	30	10	5	96	3800	0	
County Park #2	4558 Woodview Rd Los Gatos	36	22	11	211	1300	0	
	TOTAL	**1,179**	**410**	**205**	**205**			

Analyze data to strategize, develop budget forecast, and create implementation plan

Cost Recovery

- Electricity as a fuel
- Connected smart electric vehicle supply equipment
- Fleet Management Information System software integration or charging station software
- CARB Low Carbon Fuel Standard (LCFS) credit generation and sales



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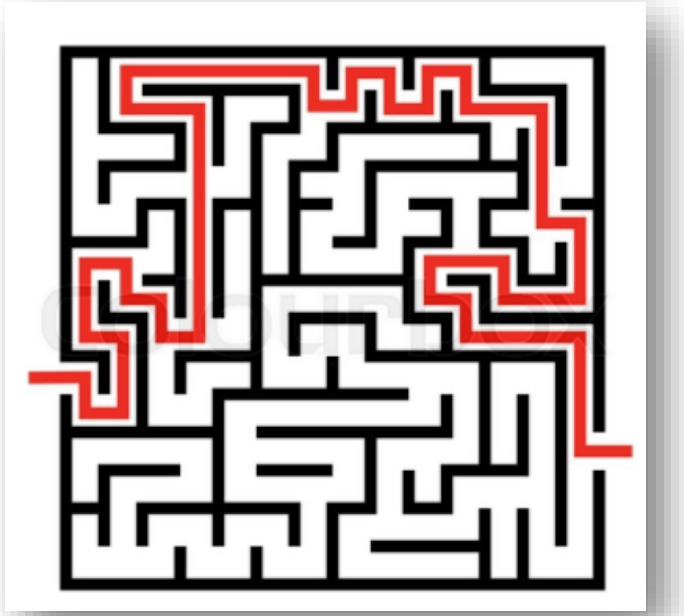
Challenges

Budget/Funding

- No two installations are alike
- Infrastructure costs vary significantly

Vehicle/technology availability

- Manufacturers are decreasing production numbers
  - Increased build/delivery times - from months to years

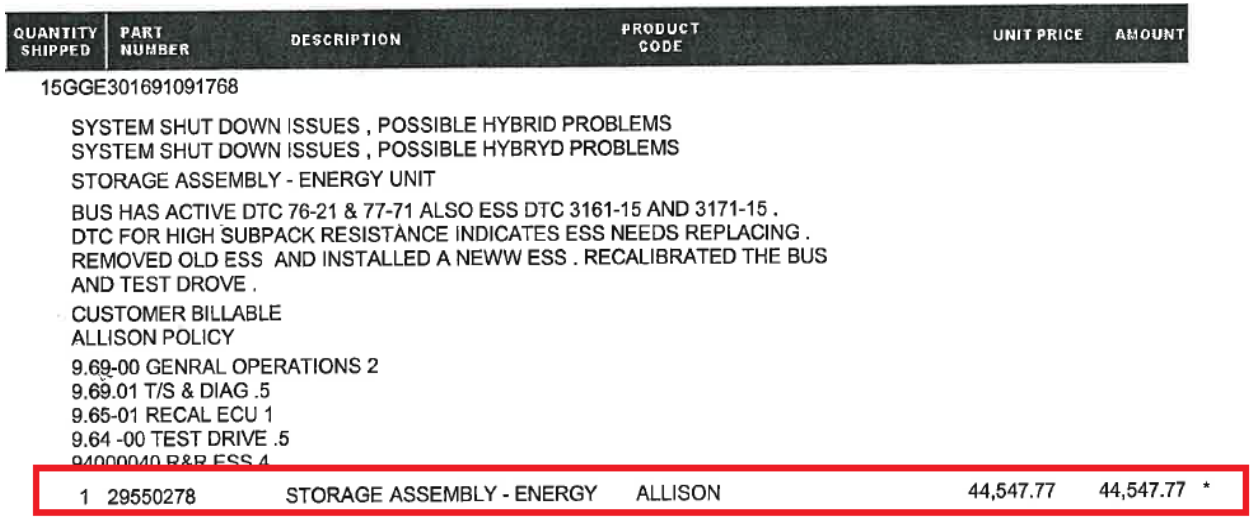


New specifications, research, compatibility

- Battery capacity, powertrain efficiency, charge rates, duty cycles, etc.
- Location of batteries - upfitting body and equipment conflicts

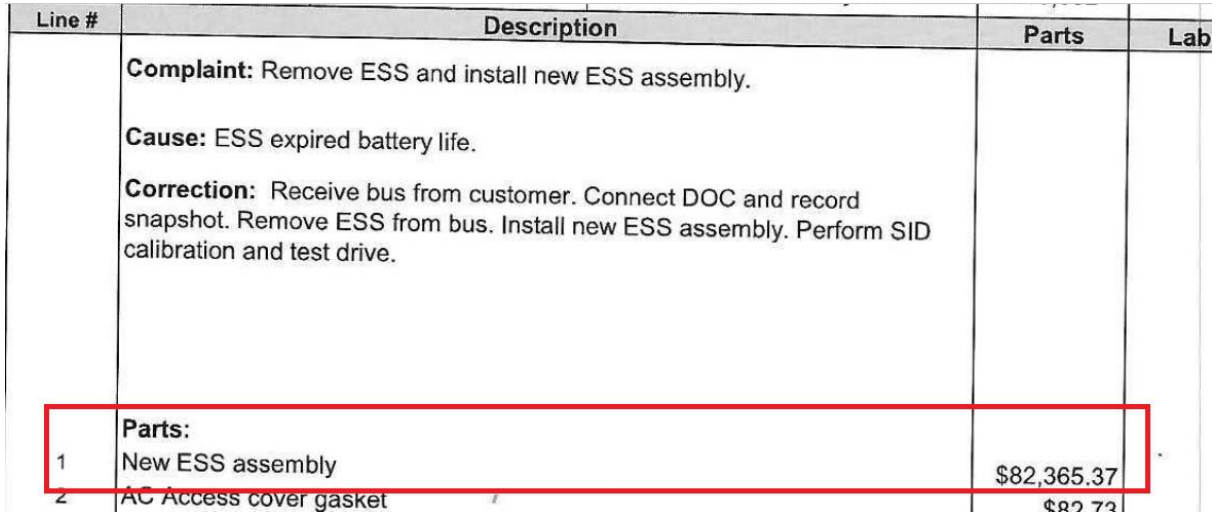
Challenges – Battery Module Replacement

- Will future replacement battery modules be backwards compatible?
- Will vehicles need to be replaced because battery modules and control systems are not backwards compatible or cannot be retrofitted?
- Battery cost per kWh reduction advancements may not decrease older battery module replacement costs



QUANTITY SHIPPED	PART NUMBER	DESCRIPTION	PRODUCT CODE	UNIT PRICE	AMOUNT
15GGE301691091768					
		SYSTEM SHUT DOWN ISSUES , POSSIBLE HYBRID PROBLEMS SYSTEM SHUT DOWN ISSUES , POSSIBLE HYBRYD PROBLEMS STORAGE ASSEMBLY - ENERGY UNIT BUS HAS ACTIVE DTC 76-21 & 77-71 ALSO ESS DTC 3161-15 AND 3171-15 . DTC FOR HIGH SUBPACK RESISTANCE INDICATES ESS NEEDS REPLACING . REMOVED OLD ESS AND INSTALLED A NEWW ESS . RECALIBRATED THE BUS AND TEST DROVE . CUSTOMER BILLABLE ALLISON POLICY 9.69-00 GENRAL OPERATIONS 2 9.69.01 T/S & DIAG .5 9.65-01 RECAL ECU 1 9.64 -00 TEST DRIVE .5 94000040 R&R ESS 4			
1	29550278	STORAGE ASSEMBLY - ENERGY	ALLISON	44,547.77	44,547.77 *

08/2012 – Battery Module Replacement Cost



Line #	Description	Parts	Lab
	Complaint: Remove ESS and install new ESS assembly. **Cause:** ESS expired battery life. **Correction:** Receive bus from customer. Connect DOC and record snapshot. Remove ESS from bus. Install new ESS assembly. Perform SID calibration and test drive.		
	Parts:		
1	New ESS assembly	$82,365.37	
2	AC Access cover gasket	$82.73	

11/2022 – Battery Module Replacement Cost

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Challenges - Staffing

Human Resources

- High Voltage I/II job classification/specifications
- Pay scales
- Bargaining Unit negotiations
- Talent pool availability
  - Industry wide mechanic/technician shortage – now and into the future
- Phase in of positions

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Challenges – Infrastructure

Long Runs of Trenching = Expensive

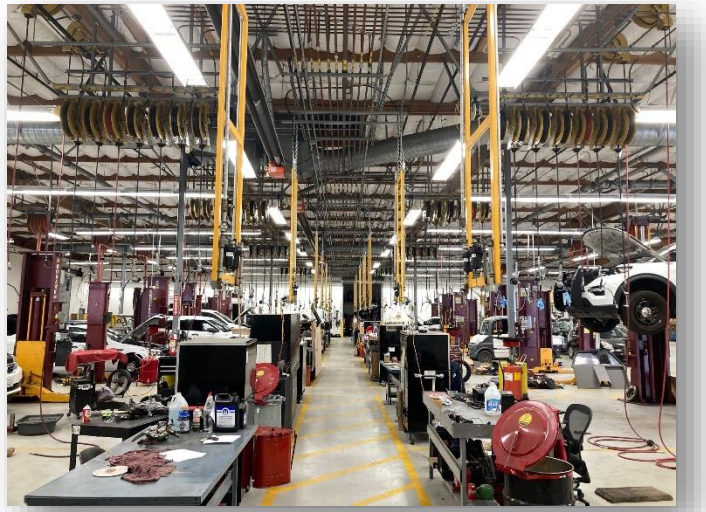
Reduced Parking - During Construction

Reduce Parking – Permanent

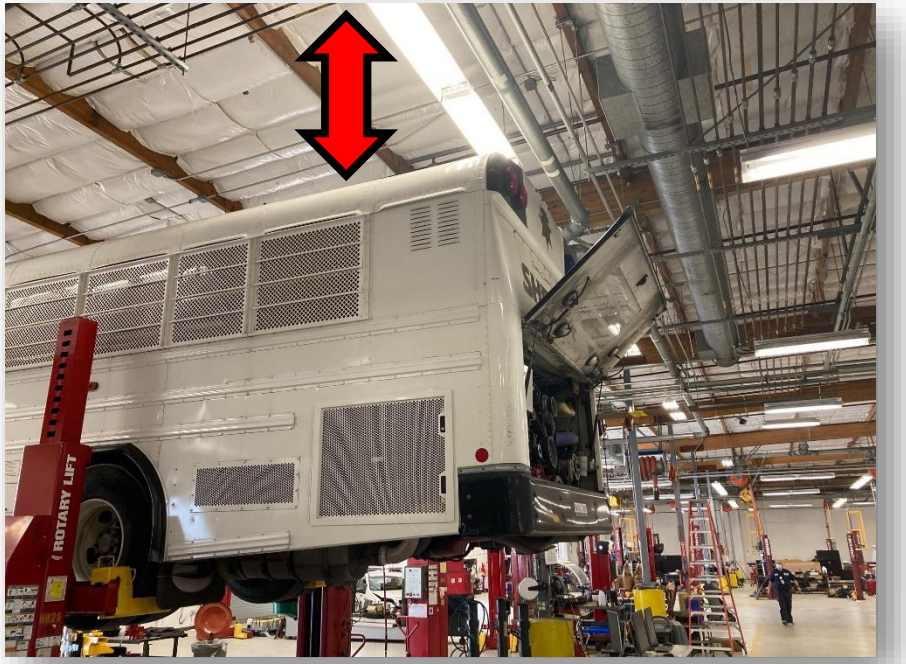
High Voltage/Amperage Underground Vaults = Expensive

Charging Equipment Protection

Challenges - Facilities



Employee Safety - 10’ Clearance Between EV and Closest Metal Object Possible?



Maintenance Facility - Vehicle to Roof Clearance Sufficient?

Employee Safety – Additional 10’ of Clearance Between Insulated Fall Protection Work Platforms and Closest Metal Object

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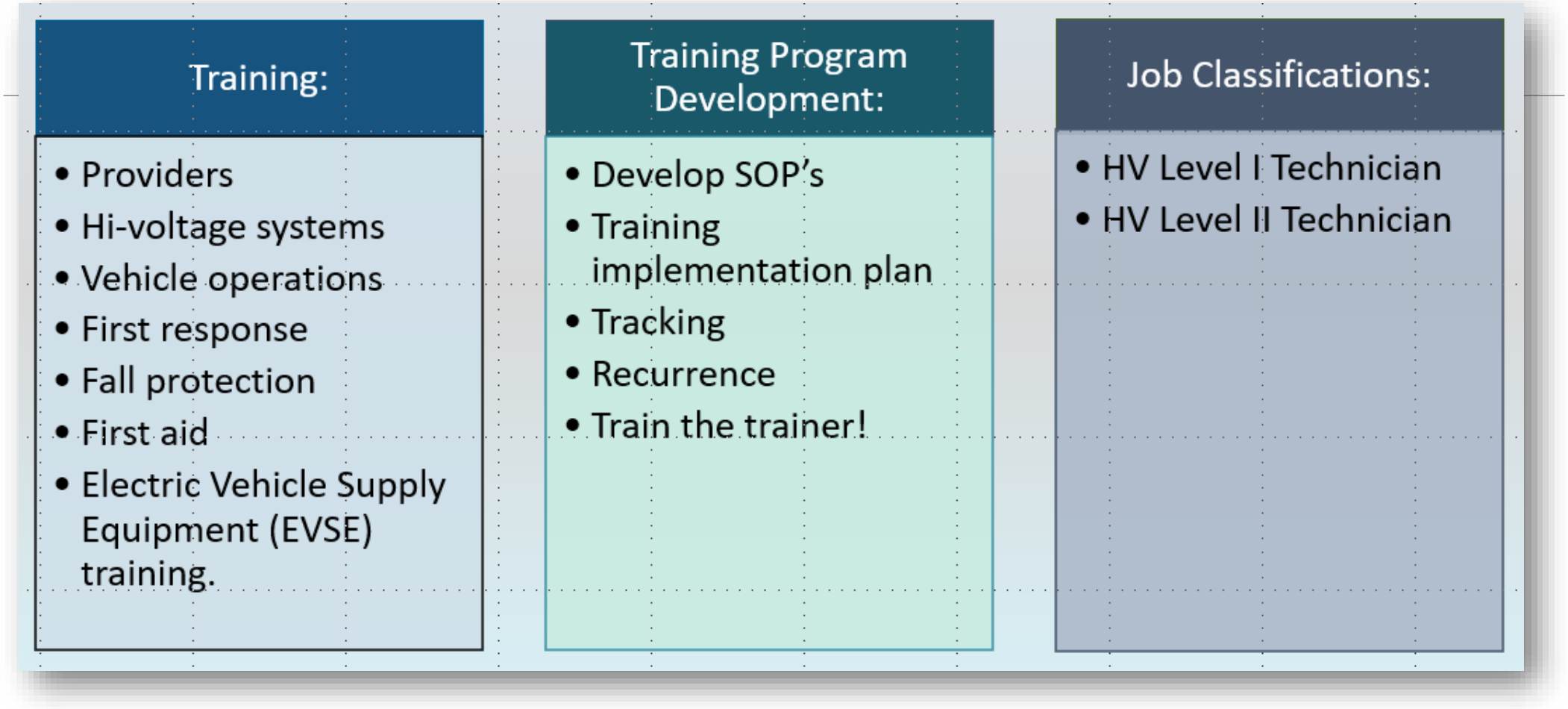
Challenges - Training



Trainings Costs – Onsite, Out of State, Minimum # of Hours, Etc. After Training - Mechanics/Technicians Will Still Need High Voltage Arc Flashing Training

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Challenges - Training

Tow Truck Operator Safety Training

Vehicle Manufacturer (OEM), National Fire Protection Association (NFPA) 70E, OSHA 1910.302-308, and OSHA 1910.269 Training
Regulations & Training
High Voltage Safety Hazards
Work Practices & Responsibilities
Electrically Safe Work Condition
Safety Grounding
Signage Requirements
High Voltage Safety Equipment
Live Line Tools
Personal Protective Equipment
Barricading
Rules & Policies

Job Description Changes
High Voltage - Mechanic, Technician, and Facilities Employee Training and Certifications

High Voltage Safety Training

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Challenges - Operational

Take-Home Trucks

- Commute mileage uses up battery range
- Charging at an employee's residence is not realistic
- Emergency operations can be ongoing for days limiting recharging opportunities

Charging Session Electricity Interruptions

- Is someone notified via an email of interruptions in power?
- Are staff on hand to reset charging stations?
  - Does the charging station or vehicle restart a charge sessions automatically when electrical power is restored?
- Do you have a back-up plan for 3 days of power outages?
  - Do you have alternative locations with unaffected localize electrical grids to charge vehicles?

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Challenges - Upfitting

- Upfitting limitations depending on vehicle trim level package?
- Can additional pieces of equipment be grounded to the frame?
- Are there amperage restrictions on what additional electrical load can be added to truck?
- Are there restrictions on where electrical equipment can be connected to the truck's 12-volt system?
- Can auxiliary 12-volt batteries be added to the truck?
  - Where and how can they be added?
- Where can equipment be mounted?
  - What panels can be drilled through?
- What happens when the 12-volt battery is discharged?
  - Does the powertrain system lock up like a smart phone in a "brick" mode?
  - Does the truck need to be towed on dollies only?

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Challenges - Upfitting

- Self-contained auxiliary power units as an option
  - How do you charge them?
    - Additional charging infrastructure needed?
      - Charge the vehicle first and then charge an auxiliary power unit?
  - Is the design compatible with the truck chassis?
    - Where can it be mounted?
      - Above, between, outside or underneath frame rails?
      - Within a body compartment?

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Accident Damage

- California Vehicle Registrations – 2022 Data
  - 36,229,205 Vehicle Registered
  - 425,300 EVs Registered
    - 1.01% of Vehicles Registered are EVs
- Vehicle Fire Data
  - 1 in 1,500 chance of a vehicle catching fire in the United States
  - 1 in 20,000 chance of a Tesla EV catching fire in Europe
- Current EV fire data is insufficient to determine proper safety protocols for every scenario
- A single EV on fire can need as much as 40,000 gallons of water to extinguish it
- EV fires typically require a Haz Mat response – You may be billed for the costs - $5K to $20K
- It can take several days before a fire begins in a damaged EV
- Dedicated containment systems may be necessary to store damaged EVs as a safety precaution
- Simple accident damage may require battery module/box replacement, effectively “totaling” the vehicle

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Accident Damage – EV Fire Containment

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EV Fires

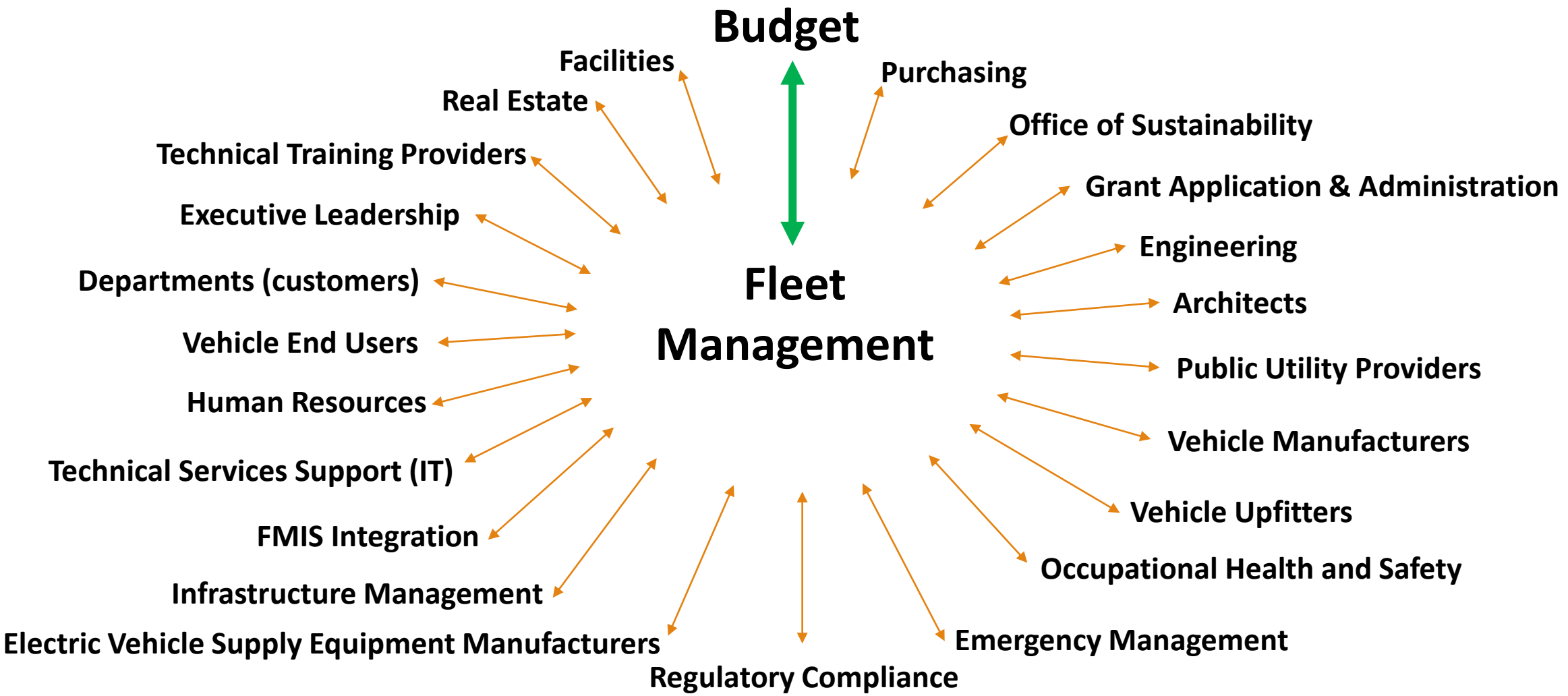
An Electric Scooter Taken On Board the Bus Caught Fire and Spread to the Rest of the Bus. The Bus Hybrid Electric Battery was Intact After the Fire

An EV Bus Caught Fire and It Spread to Adjacent Buses

Firefighters Utilized Dry Chemical Extinguisher and Foam to Put Out this Fire

EV Bus Fire Damages Depot

Internal and External Group Collaboration Required



CARB Advanced Clean Fleets (ACF) Regulation

https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/acf22/appa1.pdf

Scope and Applicability

- State and local government agencies that own, lease, or operate a vehicle with a manufacturer's gross vehicle weight rating (GVWR) greater than 8,500 pounds
  - City, county, public utility, special district, or an agency of the State of California, and any department, division, public corporation
  - Excludes federal agencies

CARB Federal fleets addressed with high-priority fleets

State and Local Government Requirements

2024-2026	January 1, 2027
50 percent of additions to the fleet must be ZEV	All additions must be ZEV

- Agencies in designated counties exempt until 2027

CARB

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Excluded From Fleet Requirements

- School buses
- Transit buses
- Military tactical vehicles
- Vehicles awaiting sale
- Emergency vehicles*
- Dedicated snow removal vehicles
- Historical vehicles

- Heavy cranes
- Two-engine trucks and workover rigs
- Vehicles subject to Mobile Cargo Handling Equipment regulation

CARB

*Authorized emergency vehicles as defined in California Vehicle Code Section 165

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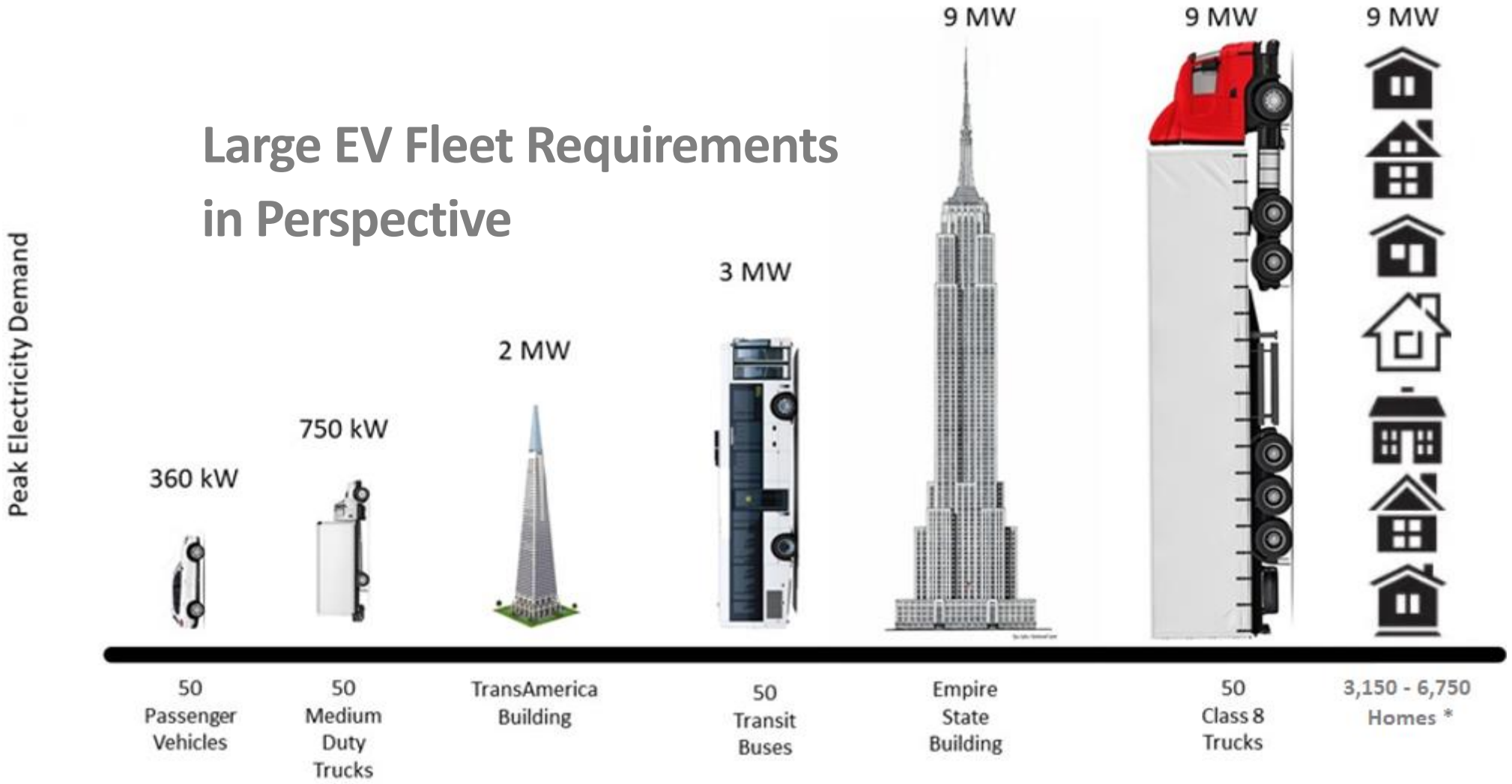
Parting Thoughts - Infrastructure

Large EV Fleet Requirements in Perspective



* Varies Between 350 – 750 Homes per MW Depending on Location in U.S. and Size of Home

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Parting Thoughts - Infrastructure

- Average vehicle miles traveled by EVs in the United States increased from less than 2.9 Billion miles in 2015 to 19.1 Billion miles in 2021
- EVs in 2015 consumed 0.99 Terawatts (990 Gigawatts) of electricity
- EVs in 2021 consumed 6.1 Terawatts of electricity
- San Francisco County consumes approximately 0.005 Terawatts (13.72 Megawatts) of electricity per day
- It would take San Francisco County approximately 3.3 years to consume as much energy as the USA's EVs did in 2021
  - 0.5% of US registered vehicles were EVs in 2021

Data compiled from US Department of Energy's Argonne Laboratory Study on Light-Duty Plug-In Electric Vehicles in the United States

https://publications.anl.gov/anlpubs/2022/11/178584.pdf

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Questions

Thank You to the Clean Cities Coalitions and Fleet Associations that Made this Webinar Possible

East Bay Clean Cities
Membership and Sponsorship
https://www.cleancitieseastbay.org/join.html

Sacramento Clean Cities
Membership and Sponsorship
http://www.cleancitiessacramento.org/sponsors.html

Long Beach Clean Cities
Membership and Sponsorship
https://cleancitieslongbeach.org/contact-us/

MEMA Chapters
Membership
https://memafleet.org/local-chapters/

NAFA
Membership
https://www.nafa.org/membership/

Please Consider Supporting These Coalitions and Fleet Associations