Appendix E
Zero Emission Truck Market Assessment

Table of Contents

Table of Figures

This appendix provides a market assessment and discusses the suitability of zero-emission vehicles (ZEVs) in the medium and heavy-duty commercial space.

A. Introduction

The future expansion of the medium and heavy-duty ZEV market is dependent on matching the suitability of zero-emission technologies with fleet operational needs. The California Air Resources Board (CARB) staff worked with various stakeholders during the rulemaking process, including the Truck and Engine Manufacturers Association (EMA), to help identify those truck market segments where the operational nature of ZEVs would be compatible with existing truck uses. EMA developed an initial assessment matrix of the suitability of battery electric applications for Class 2B through 8 commercial vehicles by identifying 87 market segments and 4 suitability factors to rank the compatibility of each market segment for electrification.

In addition to grading the suitability of ZEVs for each market segment, the assessment identified the general vehicle specifications needed by fleets that operate in each segment. The assessment also identified whether vehicles in each segment are built complete by manufacturers, or originally built as an incomplete vehicle (e.g., completed by a bodybuilder). Finally, the assessment includes estimates of the annual sales for each market segment, based on information provided by manufacturers derived from Polk registration data in California. The EMA sales numbers are generally consistent with 2016 and 2017 model year annual registrations in California.

CARB staff updated the suitability analysis to include effects of legislation and other sources of truck operational data and used quantitative method to assign a weighting factor representing the suitability for each vehicle market segment. CARB staff also extended the assessment to include fuel cell electric vehicles (FCEVs). This updated assessment was released by CARB staff as the "Advanced Clean Truck Market Segment Analysis[1]" which includes specific comments addressing all modifications CARB staff made to the original suitability factors developed by EMA. An abridged version of this assessment can be found in section E.

In addition, a more detailed overview of CARB staff's review and assessment of each suitability factor may be found in section B. CARB staff's final assessment and suitability results can be found in section C and section D.

The key findings from the "Advanced Clean Truck Market Segment Analysis" indicates that nearly 40 percent of sales may be suitable for transition into ZEV powertrains. The

[1]California Air Resources Board. ACT Market Analysis. February 22, 2019. https://ww2.arb.ca.gov/index.php/sites/default/files/2019-02/190225actmarketanalysis.xlsx

highest suitability for electrification are uses with predictable routes with daily VMT of under 100 miles, where weight or space is not compromised with the ZEV powertrain, and vehicles are expected to be in centralized operations where they return to base. The assessment identified that just over 70 percent of Class 4-7 vehicle sales are into markets that present a good fit for electrification today while roughly 30 percent of Class 2b-3 and Class 8 vehicles provide a good fit for electrification based on operational characteristics. These percentages are expected to increase as further advances are made in zero-emission technologies.

B. CARB Assessment of ZEV Suitability Factors

CARB staff reviewed the four suitability factors presented in the original EMA assessment and this section provides a detailed analysis of the changes made to each of these four suitability factors; weight, route/range, chagrining/fueling infrastructure, and battery/vehicle space constraints.

1. Weight

Battery-electric and fuel cell electric technology could reduce payload or increase weight compared to conventional vehicles depending on range needs, however AB 2061 allows for higher weights in California. AB 2061 which increases the weight limits by 2,000 lbs. for alternative fueled vehicles including zero emission vehicles[2]. The powertrain of a diesel vehicle includes many components not present in electric powertrains, (drivelines, transmissions and the engine) reducing the impact of a ZE powertrain on weight. In addition for some vehicle classes the owner has the option to use a higher weight class to account for any increased weight of ZEVs if necessary. Additionally, some ground-up BEV designs are lighter than their conventional counterparts through use of lightweight composite materials, as demonstrated by Proterra in their transit buses and by Chanje with their vans. In general, the hydrogen powertrain is less than that of a battery-electric powertrain for meeting higher range needs.

2. Route/Range

While high daily range requirements occur, both the US and California Vehicle In-Use Surveys (VIUS) as well as EMFAC analysis and market studies show that, on average, most trucks travel less than 100 vehicle miles travelled per day (VMT per day). This implies that range limitations may not be the primary concern for a wide range of applications. In addition as larger fleets begin to purchase ZEVs, they will be a small

[2]California Legislature. Assembly Bill No. 2061 Chapter 580. (web link: https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB2061)

percentage of the fleet and can use conventional vehicles to meet longer range needs until ZEV technology advances and infrastructure is built out to meet all of their needs. Staff assumed the range of FCEVs would be equivalent to conventional vehicles but that fueling would still primarily occur at the fleet yard.

3. Charging/Fueling Infrastructure

Centralized deployments, where vehicles return to a depot or similar location a night, is expected to be the primary situation where BEVs are initially used and where charging infrastructure can be installed. Charging at night over extended periods also results in lower cost charging during off-peak hours. Similarly, for FCEVs, staff also assumed hydrogen stations would initially be primarily installed in centralized yards except for vehicles in Class 2B-3 because they would likely be able to fuel at light duty hydrogen stations.

4. Battery/Vehicle Space Constraints

The original EMA assessment of battery and vehicle space constraints was generally accepted by workshop participants and no changes were made to the original assessment regarding suitability for space or weight constraints.

C. Final CARB Market Segment and Suitability Analysis

CARB staff released a final market segment and suitability analysis titled “Advanced Clean Truck Market Segment Analysis” to show the suitability of zero-emission (ZE) powertrains for each of the 87 market segments. The analysis reflects estimated suitability for existing ZEV vehicle technology. This assessment is based on four vehicle operating characteristics including the following:

- Weight,
- Route/range,
- Charging/fueling infrastructure access, and
- Battery/vehicle space constraints.

The characteristics for each market segment was ranked by assigning a number value to the suitability factors as follows:

- Poorly suitable characteristics were assigned a value of 10 (RED)
- Challenging suitability characteristics were assigned a value of 3 (YELLOW)
- Highly suitable characteristics are assigned a value of 1 (GREEN)

These values were then averaged for each market segment to assign each segment a value between 1 and 10, where the lowest values would suggest the highest suitability for electrification. Suitability scores that average above 5 have at least two characteristics identified with poor suitability factors and indicate that electrification with today's technology is not likely to be feasible for most of that market segment. Details of the analysis may be found in Section E of this document.

The market segment analysis does not account for ZEV model availability, costs, site specific issues that could impact infrastructure installations, normal truck replacement rates, fleet size, nor other factors that could impact the number of ZEVs that could be deployed.

D. Suitability Results

The market segment and suitability analysis indicates that nearly 40 percent of the 87 identified truck markets have a ZEV suitability score of 1 or 2, indicating that they are the most suitable segments to transition to ZE powertrains. This suitability assessment has similar results for BEV vs. FCEV, largely because infrastructure was assumed to be at central fleet yards. As expected the results show that a transition to ZEVs is more likely to begin with fleets that have predictable route with daily VMT of under 100 miles, and have a centralized operation where infrastructure investments would likely to be installed.

The suitability distribution for all BEVs and FCEVs are presented below in Figure D-1 and Figure D-2.

Figure D-1 - BEV Suitability Distribution by Score

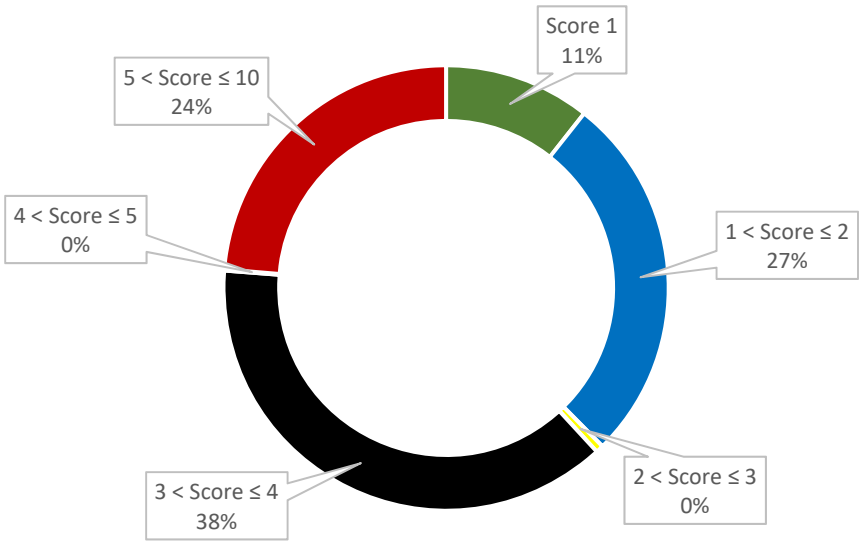
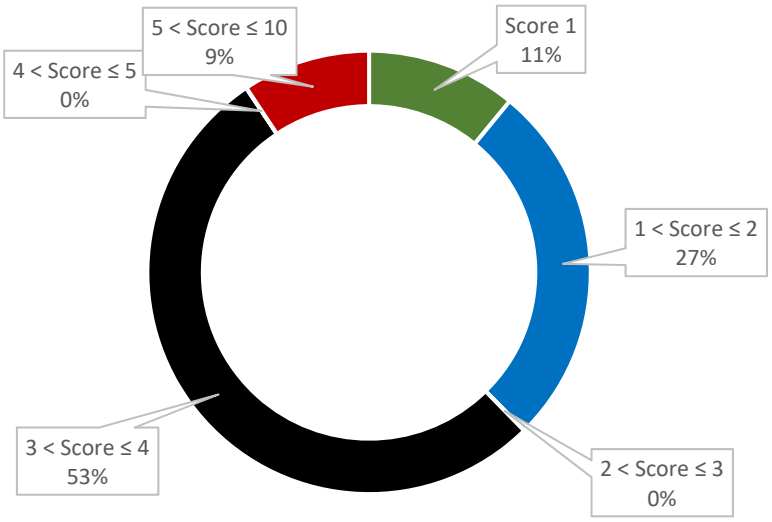


Figure D-2 - FCEV Suitability Distribution by Score



CARB staff also analyzed the suitability factors by weight class, grouping all 87 market segments into three weight categories as determined by the Gross Vehicle Weight Rating (GVWR) of the trucks that operate within each market segment. These categories are Class 2b-3, Class 4-7, and Class 8. The overall results of this assessment show that just over 70 percent of Class 4-7 vehicles received a suitability score of 1 or 2 and are good fits for electrification today while roughly 30 percent of Class 2b-3 and Class 8 vehicles are good fits. CARB staff believe that further advances in ZE technology will increase these percentages. The following is a detailed analysis of the ZE suitability factors for all three weight class categories.

a. Class 2b-3 (GVWR 8,500 to 14,000 lbs.)

Class 2b-3 covers roughly 75,000 California sales on an annual basis and consists of vehicles serving in both private and commercial roles. Figure D-3 and Figure D-4 summarize the suitability scores of Class 2b-3 vehicles from the market segment suitability analysis. The figures show that about 30 percent of trucks in this category received a suitability score of 1 or 2 and have operational characteristics that are suitable for electrification.

Figure D-3 - BEV Suitability, Class 2b-3

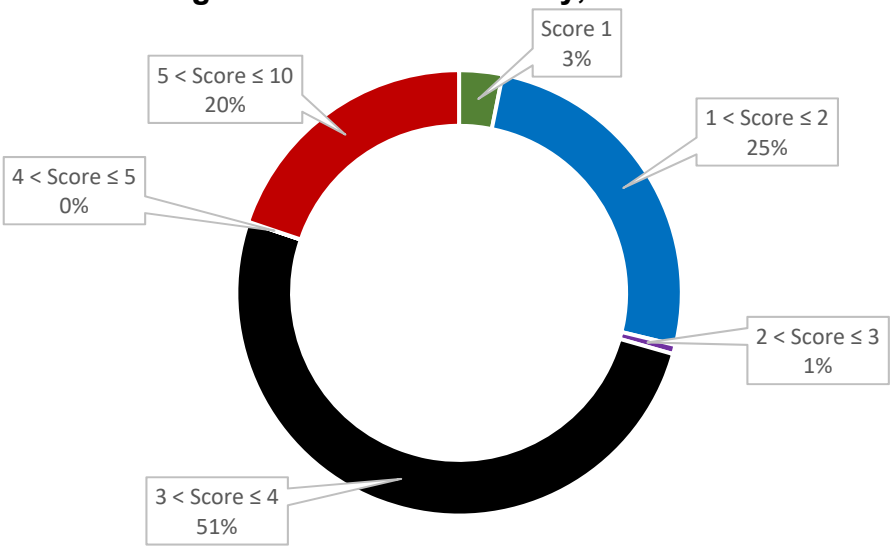
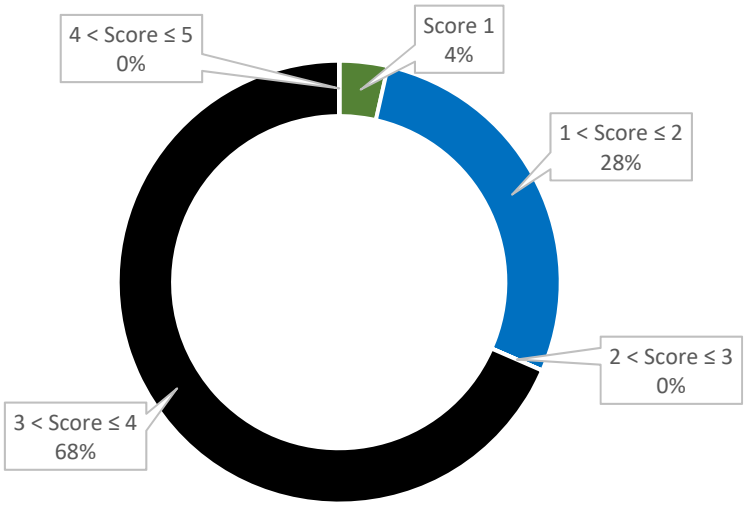


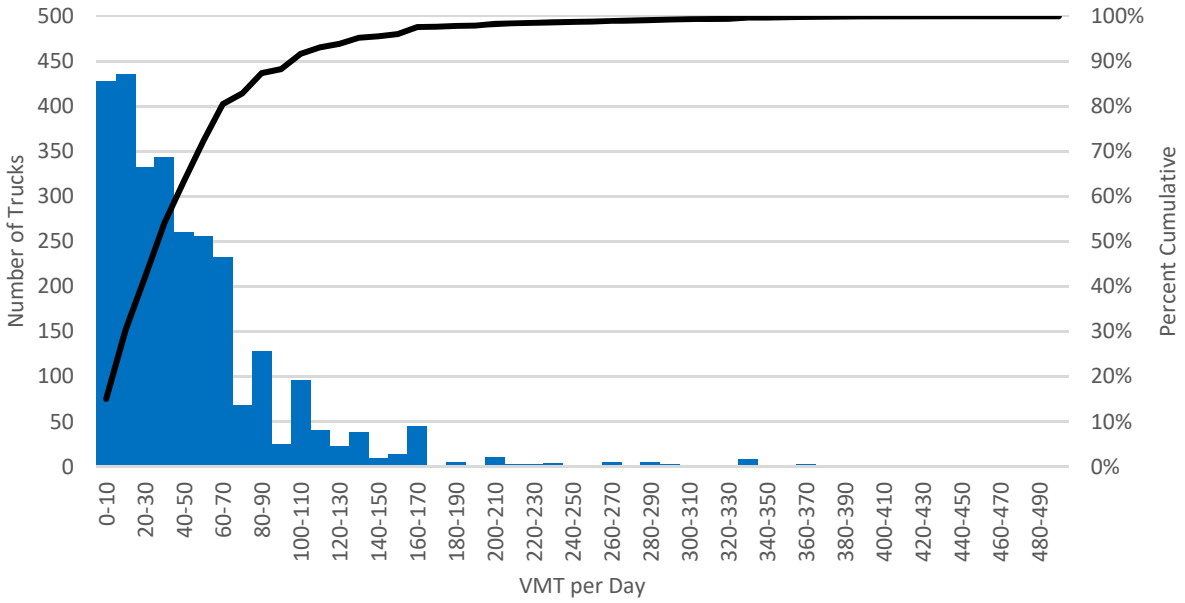
Figure D-4 - FCEV Suitability, Class 2b-3



The 2018 California Vehicle Inventory and Use Survey identifies that almost 90 percent of vehicles within Class 3 accrue less than 100 vehicle miles travelled (VMT) per day. The result of the California VIUS VMT for Class 3 vehicles is shown in Figure D-5. This conclusion is supported by the 2002 US VIUS[3], which identifies around 90 percent of vehicles in Class 3 as having less than 100 daily VMT.

[3]U.S. Census Bureau. 2002 Economic Census Vehicle Inventory and Use Survey Geographic Area Series. (web link: https://www2.census.gov/library/publications/economic-census/2002/vehicle-inventory and-use-survey/ec02tv-us.pdf)

Figure D-5 - Distribution of VMT per Day, Class 3, California VIUS



This population of vehicles is dominated by pickup trucks whose variable towing needs, and lack of space to mount battery systems or hydrogen tanks form the primary obstacles to electrification. Space constraints are not identified as a concern for vans within this segment, which accounts for approximately 30 percent of the Class 2b-3 vehicles, making them well-positioned for transition to zero-emission technologies. Commercial light-duty ZE pickup trucks are planned to be introduced to the market in upcoming years, and it is expected that improvement in battery technology and vehicle designs will make ZE pickup trucks in these higher weight classes more suitable.

b. Class 4-7 (GVWR 14,001 to 33,000 lbs.)

Class 4-7 vehicles account for nearly 19,000 sales annually in California and consist of a wide range of truck body configurations and applications. Figure D-6 and Figure D-7 summarize the suitability score for BEV and FCEV technologies in this vehicle segment. The figures show that about 70 percent of trucks in this category received a suitability score of 1 or 2 and have operational characteristics that are suitable for electrification.

Figure D-6 - BEV Suitability, Class 4-7

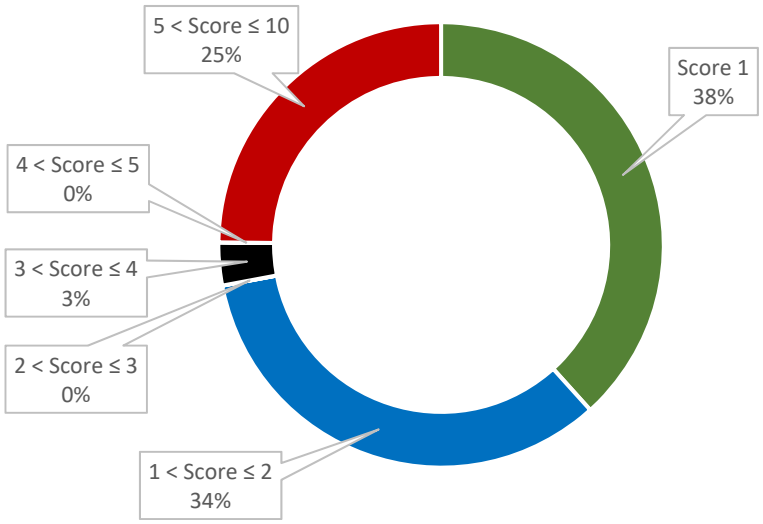
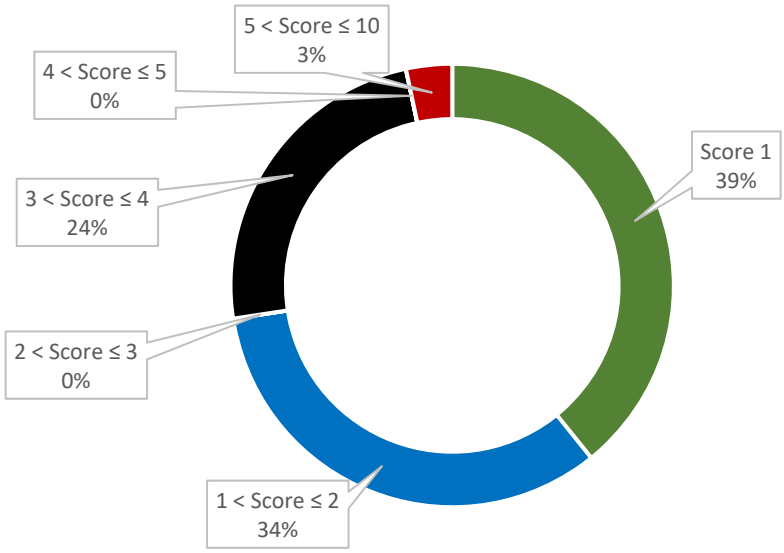
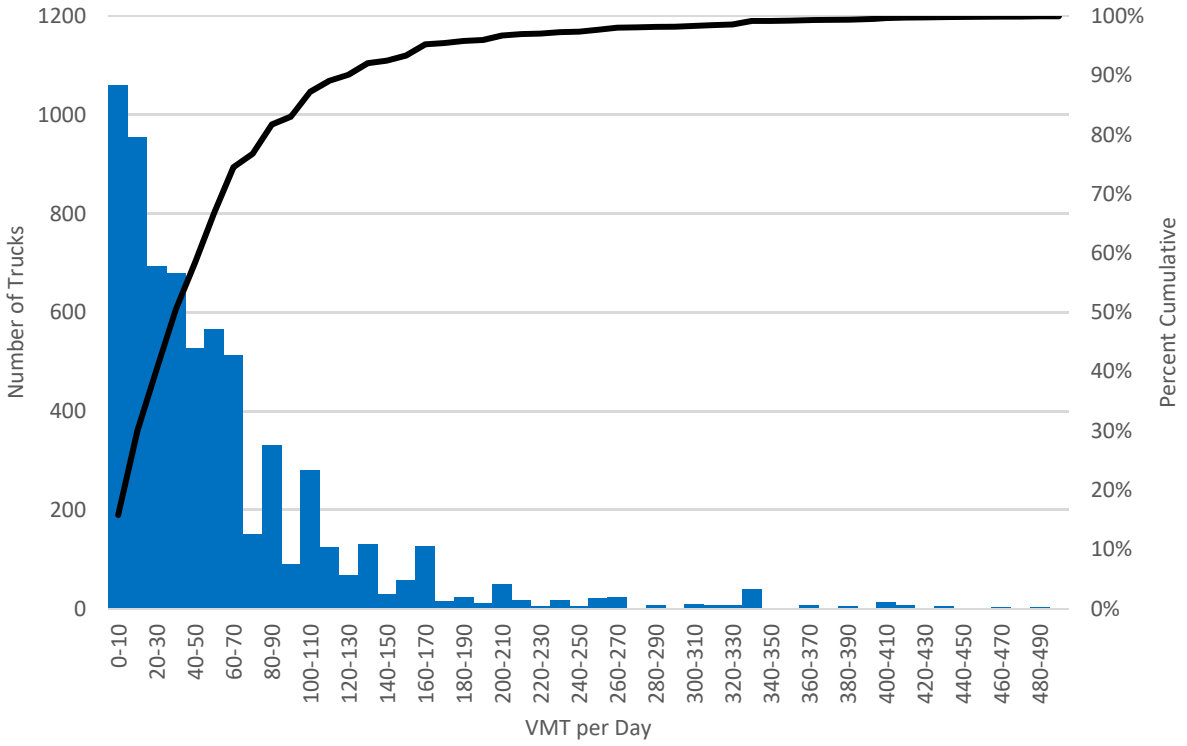


Figure D-7 - FCEV Suitability, Class 4-7



Vehicles in this segment are typically incomplete vehicles (such as cutaway van chassis) used by second stage manufacturers to customize the vehicles' utility to the individual needs of the customer. The California VIUS identifies that more than 80 percent of vehicles in these classes accrue less than 100 daily VMT. The results of the California VIUS is shown in Figure D-8. The US VIUS corroborates this finding and data collected indicates that almost 90 percent of vehicles in these weight categories accrue less than 100 daily VMT.

Figure D-8 - Distribution of VMT per Day, Class 4-7, California VIUS



Class 4-7 represents the segment with highest percentage of vehicles that are suitable for electrification. Centralized deployment, short, predictable routes and the flexibility to accommodate the weight and size of ZE powertrains cause this segment to stand out. These characteristics are reflected in the numerous ZEV options readily available on the market to replace existing conventional vehicles.

c. Class 8 (GVWR >33,000 lbs.)

Class 8 represents nearly 7,600 annual sales in California and consists of large tractors and some vocational vehicles. The results of the market segment analysis are shown in Figure D-9 and Figure D-10. The figures show that about 30 percent of trucks in this category received a suitability score of 1 or 2 and have operational characteristics that are potentially suitable for electrification.

Figure D-9 - BEV Suitability Distribution, Class 8

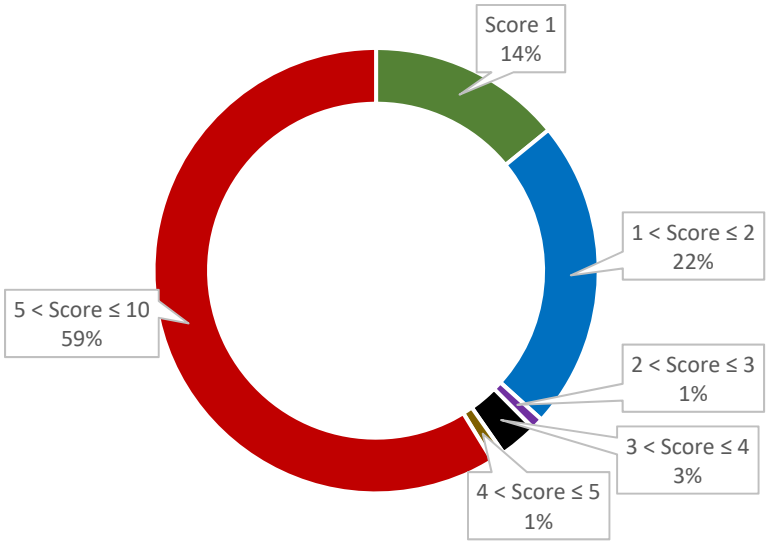
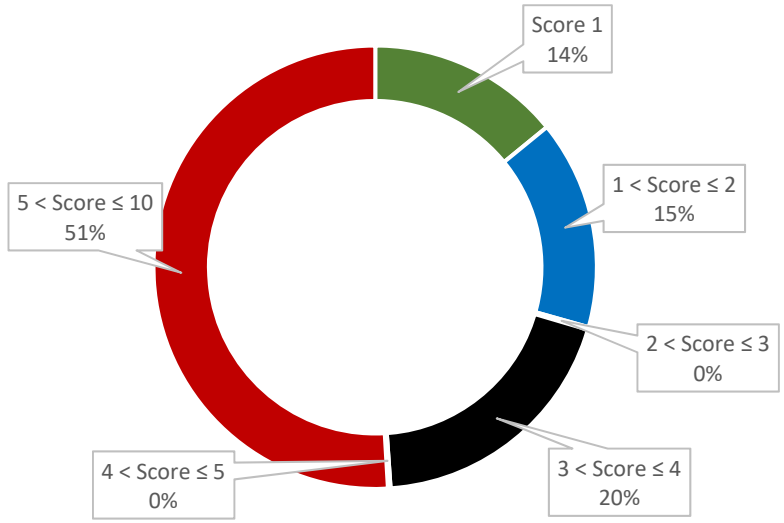
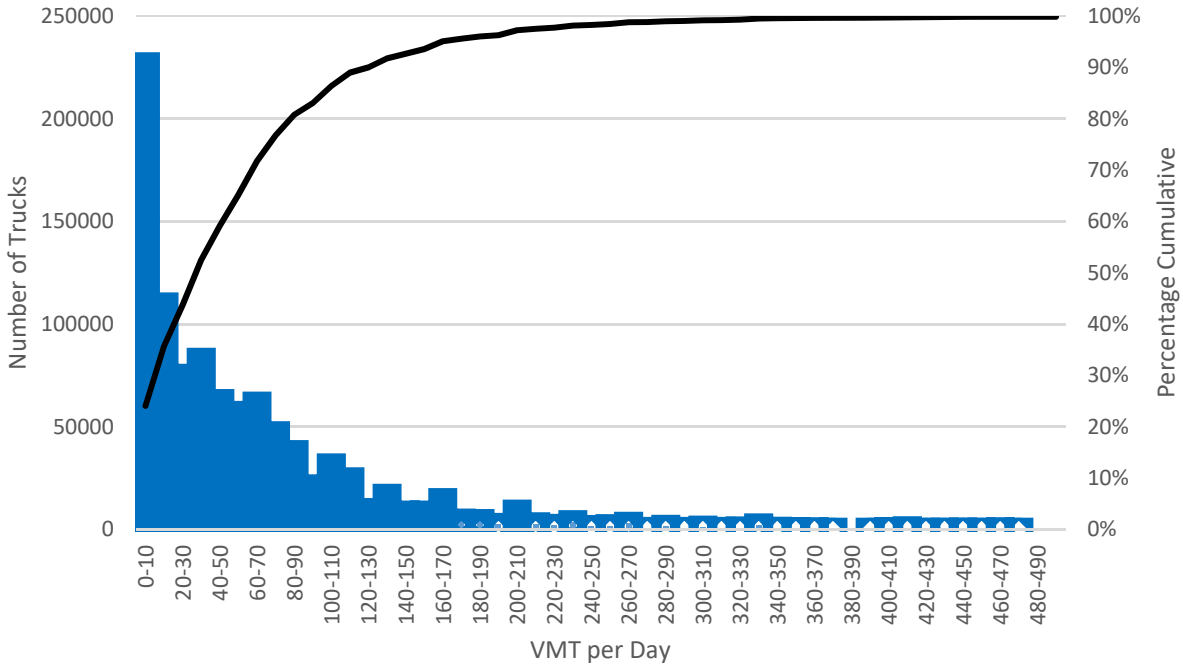


Figure D-10 - FCEV Suitability Distribution, Class 8



The US VIUS indicates that around 80 percent of the Class 8 population accrue less than 100 VMT. The results of the US VIUS is shown in Figure D-11.

Figure D-11 - Distribution of VMT per Day, Class 8, US VIUS



Vehicles in this market segment are operated in a variety of uses, ranging from a good to poor potential for electrification.

Vehicles in Class 8 are generally characterized by heavy loads, long and unpredictable routes, but many also operate short and predictable routes from centralized locations. Some examples include yard tractors and short-haul on-road tractors used for local delivery and drayage operations. Long-haul ZEVs are not expected to offer one-to-one replacements for conventional vehicles for some time due to limited at present. Class 8

E. Advanced Clean Truck Market Segment Analysis

1. Battery Electric Vehicle Suitability Table

Table E-1 - Battery Electric Vehicle Suitability Table

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
1	3.75	**Beverage Tractor**	8	123	I	Start at max load, diminish throughout day (Value=1)	Fixed, 100 miles per day (Value=3)	Centralized, at night (Value=1)	Constrained (Value=10)
2	1.5	**School Bus - Class C (Longer Rural Routes)**	4-7	87	C or I	Light (Value=1)	125 miles per day (Value=3)	Centralized, at night and during the day (Value=1)	Open (Value=1)
3	1	**School Bus - Class C (Shorter Urban Routes)**	4-7	608	C or I	Light (Value=1)	<75 miles per day (Value=1)	Centralized, at night and during the day (Value=1)	Open (Value=1)
4	1	**School Bus - Class C (Special Needs - ADA)**	4-7	87	C or I	Light (Value=1)	50-150 miles per day (Value=1)	Centralized, at night and during the day (Value=1)	Open (Value=1)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
5	1.5	**School Bus - Class C (Long distance - Field Trip, special Events - just a bus)**	4-7	87	C or I	Light (Value=1)	125 miles per day Multiple uses, fixed and flexible routes (Value=3)	Centralized, at night and during the day (Value=1)	Open (Value=1)
6	1	**School Bus - Class Rear Engine (Transit Style) All**	4-7	226	C or I	Light to medium. Higher capacity. (Value=1)	Varied Occassional use on long routes (Value=1)	Centralized, at night and during the day (Value=1)	Open (Value=1)
7	2	**Refuse, Automatic Side Loader (ASL), Residential Service**	8	400	I	Start light, end day at max load (Value=3)	Fixed, 75 miles per day. Occasional long routes (Value=1)	Centralized, at night (Value=1)	Constrained (Value=3)
8	2	**Refuse, Front Loader, Commercial or High Density Residential Service**	8	65	I	Start light, end day at max load (Value=3)	Fixed, 100 miles per day. Occasional long routes (Value=1)	Centralized, at night (Value=1)	Constrained (Value=3)
9	2	**Refuse, Rear Packer, Residential Service**	8	133	I	Start light, end day at max load (Value=3)	Fixed, 75 miles per day. Occasional long routes (Value=1)	Centralized, at night (Value=1)	Constrained

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
10	2.5	**Refuse Hauler (roll on/roll off)**	8	65	I	50% laden, 50% unladen, highly variable from lightly loaded to grossed out. (Value=3)	Variable, up to 250 miles per day (Value=3)	Centralized, at night (Value=1)	Somewhat constrained (Value=3)
11	1	**Step Van - Parcel Delivery**	4-7	1985	I	Light (Value=1)	Fixed, 50 miles per day (Value=1)	Centralized, at night (Value=1)	Open (Value=1)
12	1	**Step Van - Municipal Fleet**	4-7	298	I	Can be heavy (like electrician or plumber) (Value=1)	Can be highly variable, local some days potentially to many sites around municipality in same day (Value=1)	Centralized, at night Can have a need for emergency service (e.g., storms) that force long drives and long hours away from charging (Value=1)	Open (Value=1)
13	1.5	**H-D Van - Parcel Delivery Class 2B-3)**	2B-3	951	I	Light (Value=1)	50-300 miles per day, Medium route variability (Value=1)	Centralized, at night (Value=1)	Constrained (Value=3)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
14	1.5	**H-D Van - Parcel Delivery (Class 4,5)**	4-7	1985	I	Light (Value=1)	50-300 miles per day, Medium route variability (Value=1)	Centralized, at night (Value=1)	Constrained (Value=3)
15	2	**H-D Van - Contractor**	2B-3	11854	C	Heavy (Value=1)	50-150 miles per day, High route variability (Value=1)	Some central dispatch, many go with driver o/n (Value=3)	Constrained (Value=3)
16	1	**H-D Van - Shuttle**	2B-3	1116	I	Light (Value=1)	50-300 miles per day, Medium route variability (Value=1)	Centralized, but 24/7 operation (Value=1)	Open (Value=1)
17	2	**H-D Van - Refrigerated**	2B-3	70	I	Heavy (Value=1)	200-300 miles per day. Refrigeration reduces range, High route variability (Value=3)	Centralized, at night (Value=1)	Constrained (Value=3)
18	1	**H-D Van - School Bus**	2B-3	70	I	Light (Value=1)	65 miles per day, Low route variability (Value=1)	Centralized, at night (Value=1)	Open (Value=1)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
19	6	**H-D Van - Motor Home**	2B-3	29	I	Heavy (Value=1)	300-450 miles per day, High route variability (Value=10)	Dispersed, or infrastructure dependent (Value=10)	Constrained (Value=3)
20	1	**Box Truck - Pickup & Delivery (Fixed Light <100 Miles per Day)**	4-7	3075	I	Light (Value=1)	Variable <100 miles per day (Value=1)	Centralized (Value=1)	Open (Value=1)
21	2	**Box Truck - Pickup & Delivery (Medium to Heavy Load >100 Miles per Day)**	4-7	1538	I	Medium to heavy (Value=3)	Variable >100 miles per day (Value=3)	Centralized (Value=1)	Open (Value=1)
22	6	**Box Truck - Pickup & Delivery (Medium to Heavy Load >200 Miles per Day)**	4-7	1538	I	Medium to heavy (Value=10)	Variable >200 miles per day (Value=10)	Centralized or remote (Value=3)	Open (Value=1)
23	1.5	**Box Truck - Leasing (Daily Rental)**	4-7	152	I	Light (Value=1)	Variable <100 miles per day (Value=1)	Centralized or remote (Value=3)	Open (Value=1)
24	1	**Box Truck - Leasing (Fixed Customer and Application)**	4-7	228	I	Light to medium (Value=1)	Variable <100 miles per day (Value=1)	Centralized (Value=1)	Open (Value=1)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
25	1	**Box Truck - Leasing (Fixed Customer and Application)**	4-7	228	I	Medium to heavy (Value=1)	Variable <100 miles per day (Value=1)	Centralized (Value=1)	Open (Value=1)
26	2	**Box Truck - Leasing (Fixed Customer and Application)**	4-7	76	I	Medium to heavy (Value=3)	Variable >100 miles per day (Value=3)	Centralized (Value=1)	Open (Value=1)
27	3.75	**Box Truck - Leasing (Fixed Customer and Application)**	4-7	76	I	Medium to heavy GVWR limited (Value=3)	Variable >200 miles per day (Value=10)	Centralized (Value=1)	Open (Value=1)
28	1	**Straight Truck Pickup & Delivery (Heavy Load >100 Miles per Day)**	8	1069	I	Heavy (Value=1)	Variable >100 miles per day (Value=1)	Centralized (Value=1)	Open (Value=1)
29	1.5	**Box Truck - Refrigerated**	4-7	390	I	Medium to heavy load (Value=1)	Variable <100 miles per day (Value=1)	Centralized (Value=1)	Constrained if equipped with diesel TRU (Value=3)
30	1	**Flatbed - Stake/Platform**	4-7	370	I	Variable (Value=1)	Variable (Value=1)	Centralized (Value=1)	Open (Value=1)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
31	1.5	**Regional Tractor - Short Haul**	4-7	400	C	Variable, up to 80K GCW (Value=1)	Variable, <100 miles per day (Value=1)	Centralized, at night. Multiple shift operations impact charging times (Value=1)	Constrained - short wheelbase (Value=3)
32	1.5	**Regional Tractor - Short Haul**	8	400	C	Variable, up to 80K GCW (Value=1)	Variable, <100 miles per day (Value=1)	Centralized, at night. Multiple shift operations impact charging times (Value=1)	Constrained - short wheelbase (Value=3)
33	2	**Regional Tractor - Medium Haul**	4-7	200	C	Variable, up to 80K GCW (Value=1)	Variable, 100-300 miles per day (Value=3)	Centralized, at night. Multiple shift operations impact charging times (Value=1)	Constrained, short wheelbase (Value=3)
34	2	**Regional Tractor - Medium Haul**	8	400	C	Variable, up to 80K GCW (Value=1)	Variable, 100-300 miles per day (Value=3)	Centralized, at night. Multiple shift operations impact charging times (Value=1)	Constrained, short wheelbase (Value=3)
35	8.25	**Regional Tractor - Long Haul**	4-7	100	C	Variable (Value=3)	Variable, >200 miles per day (Value=10)	Future retail charging network? Multiple shift operations impact charging times (Value=10)	Constrained - short wheelbase, fairings (Value=10)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
36	8.25	**Regional Tractor - Long Haul**	8	300	C	Heavy (Value=3)	Variable, 200-500+ miles per day (Value=10)	Future retail charging network? Multiple shift operations impact charging times (Value=10)	Constrained (Value=10)
37	2	**Port Drayage**	8	120	C	Heavy (Value=1)	Variable, 100-500 miles per day (Value=1)	Variable / Centralized, depending on owner. Multiple shift operations impact charging times (Value=3)	Constrained - short wheelbase (Value=3)
38	3	**Pickup Truck - Agriculture**	2B-3	500	C or I	Variable--dependent on type of agriculture. (Value=3)	Assume set routes, <100 miles per day, may have extended idling. Likely extended operation (Value=3)	Centralized (Value=3)	Constrained (Value=3)
39	5.5	**Pickup Truck - Contractor**	2B-3	5000	C or I	Moderate to heavy (Value=1)	Variable (Value=1)	Variable (Value=10)	Constrained (Value=10)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
40	6	**Pickup Truck - Towing**	2B-3	3000	C or I	Heavy (Value=1)	Variable--expect several will have long distance (~500 mile) routes. Towing will significantly shorten available EV range. (Value=3)	Variable (Value=10)	Constrained (Value=10)
41	5.5	**Pickup Truck - 4WD Off Road**	2B-3	5000	C or I	Light to moderate (Value=1)	Variable--expect some will have long distance routes. (Value=1)	Variable--off road usage will likely be away from EV grid. Off-highway usage and extended operation will make charging impossible for extended offroad operation. (Value=10)	Constrained (Value=10)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
42	5.5	**Pickup Truck - PTO Equipped**	2B-3	1500	C or I	Moderate to heavy (Value=1)	Assume set routes, <100 miles per day, may have extended idling. (Value=1)	Variable (Value=10)	Constrained (Value=10)
43	7.75	**Line Haul Tractor**	4-7	500	C	Heavy (Value=10)	Variable; 500+ mile days (Value=10)	Variable (Value=10)	Open (Value=1)
44	7.75	**Line Haul Tractor**	8	3000	C	Heavy (Value=10)	Variable; 500+ mile days (Value=10)	Variable (Value=10)	Open (Value=1)
45	10	**Logging**	8	5	C	Heavy (Value=10)	Variable (Value=10)	Variable, Long off-road travel (Value=10)	Constrained, ground clearance (Value=10)
46	7.75	**Concrete Mixer**	8	70	I	Typically 50% empty, 5-% grossed out (Value=10)	Highly variable (Value=10)	Centralized, at night (Value=1)	Highly constrained due to body equipment and weight (Value=10)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
47	10	**Concrete Pumper**	8	37	I	Due to weight of pumping equipment the vehicle is always heavily loaded (Value=10)	Highly variable (Value=10)	Vehicle may remain at construction site for multiple days (Value=10)	Highly constrained (Value=10)
48	4.25	**Mining Hauler**	8	15	I	Heavy (Value=10)	Fixed (Value=1)	Centralized; Long off-road travel (Value=3)	Constrained (Value=3)
49	4.75	**Mining Service**	8	15	C	Medium – fixed (Value=3)	Variable (Value=10)	Centralized; Long off-road travel (Value=3)	Constrained, due to body (Value=3)
50	7.75	**Heavy Equipment Transport**	8	110	C	Heavy (Value=10)	Variable (Value=10)	Variable (Value=10)	Open (Value=1)
51	1.5	**Utility/Lube Service**	4-7	76	I	Can be heavy (like electrician or plumber) (Value=1)	Can be highly variable, local some days potentially to many sites around municipality in same day (Value=1)	Centralized, at night Can have a need for emergency service (e.g., storms) (Value=3)	Open (Value=1)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
52	10	**Oil Field Rig Mover**	8	14	C	Extremely high (Value=10)	Highly variable (Value=10)	May be enroute/onsite multiple days (Value=10)	
53	10	**Oil Field Well Servicing**	8	110	I	Always loaded at or near GVWR (Value=10)	Highly variable (Value=10)	Mixed locations, could need to charge during peak times Many of these vehicles are for off-road use only. (Value=10)	Constrained (Value=10)
54	1.5	**Tow/Wrecker**	4-7	250	I	Variable (Value=1)	Variable, <100 miles per day (Value=1)	Centralized when not in use (Value=1)	Constrained. Need space for bed/hoist and hydraulic mechanisms between the frame rails where batteries would be installed (Value=3)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
55	1.5	**Farm Service - Truck**	2B-3	119	I	Heavy (almost like a dump truck) May be restricted on weight due to heavy produce and need to operate in ag fields (Value=1)	Fixed, but can be long distance from farm to city (Value=1)	Centralized but in rural area at night (Value=3)	Open (Value=1)
56	6.5	**Farm Service - Tractor**	8	90	C	Heavy (almost like a dump truck) May be restricted on weight due to heavy produce and need to operate in ag fields (Value=10)	Fixed, but can be long distance from farm to city (Value=3)	Centralized but in rural area at night (Value=3)	Constrained (short wheelbase) (Value=10)
57	4.25	**Tanker Truck - Liquids or Gases**	8	44	I	Start at max load, may diminish throughout day (Value=3)	Fixed, but can be long distance from depot to destination (Value=3)	Centralized, at night (Value=1)	Constrained due to effort to maximize payload (Value=10)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
58	8.25	**Car Carrier - Class 8**	8	123	I	High (Value=10)	Variable (Value=10)	Variable (Value=10)	Constrained (Value=3)
59	1.5	**Car Carrier - Class 6/7 (Roll Back)**	4-7	150	I	Variable (Value=1)	Variable, local (Value=1)	Centralized Variable origin and destination pairs (Value=1)	Constrained (Value=3)
60	3.75	**Utility Service - Private (Class 8)**	8	87	I				
61	3.75	**Utility Service - Private (Class 6-7)**	4-7	143	I	High (Value=1)	Variable (Value=1)	Variable + remote Extended operation off road (Value=10)	Constrained (Value=3)
62	3.75	**Utility Service - Private Trouble Truck (Class 4-5)**	4-7	277	I	Medium to heavy (Value=1)	Variable (Value=1)	Variable + remote Extended remote operation (Value=10)	Constrained (Value=3)
63	2	**Utility Service - Public (Class 8)**	8	87	I				
64	2	**Utility Service - Public (Class 6-7)**	4-7	143	I	High (Value=1)	Variable (Value=1)	Variable Extended operation off road (Value=3)	Constrained (Value=3)
65	2	**Utility Service - Public (Class 4-5)**	4-7	277	I	Medium to heavy (Value=1)	Variable (Value=1)	Variable Extended remote operation (Value=3)	Constrained (Value=3)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
66	6	**Recreational Vehicle**	4-7	2500	I	Variable (Value=3)	Expected long distance routes (Value=10)	Non-centralized (Value=10)	Open (Value=1)
67	1	**Airport Service**	2B-3	1167	I	Light (Value=1)	Set routes, <100 miles per day (Value=1)	Centralized, Close proximity to charging infrastructure (Value=1)	Open (Value=1)
68	5.5	**Rail Service**	2B-3	100	I	Light (Value=1)	Expected long distance routes (Value=10)	Centralized (Value=1)	Constrained. Need physical space to mount rail wheels, lift mechanism, and upfitter body. (Value=10)
69	1	**Shuttle Bus**	4-7	331	I	Variable, light (Value=1)	Fixed <100 miles per day (Value=1)	Centralized (Value=1)	Open (Value=1)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
70	1.5	**Armored Car**	4-7	100	I	Variable (depends on drop-off or pick-up work) (Value=1)	Variable, <100 miles per day (Value=1)	Centralized, at night (Value=1)	Constrained. Armor plating and security defenses would take up underbody battery storage opportunities (Value=3)
71	3.25	**Mobile Laboratory**	4-7	81	I	Variable (depends on use requirements) (Value=1)	Variable, <100 miles per day (Value=1)	No central charging available when in use Occasional use on long routes and dependent on deployment needs (Value=10)	Open (Value=1)
72	8.25	**Digger Derrick**	4-7	52	I	High (Value=10)	Variable (Value=10)	Extended operation off road (Value=10)	Constrained (Value=3)
73	6	**Construction Dump**	8	342	I	50% laden (typically to GVWR), 50% unladen (Value=10)	Highly variable, but typically 150-250 miles per day (Value=10)	Centralized, at night (Value=1)	Somewhat constrained (Value=3)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
74	1.5	**Municipal Dump**	4-7	44	I	50% laden, 50% unladen, mixed light to heavy (Value=1)	Variable, 50 miles per day (Value=1)	Centralized, at night (Value=1)	Somewhat constrained (Value=3)
75	1.5	**Yard Tractor - Purpose Built (Warehouse/Rail)**	8	84	C or I	Heavy (65K - 85K lbs). Light-duty cycle. Load on/load off (Value=1)	<100 miles per day, <1 route (Predictable), 8-10 hours per day Accessory loads: high heating and cooling requirements, hydraulics to raise and lower 5th wheel	Centralized, at night and during the day (Value=1)	Constrained, for shorter wheelbase (Value=3)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
76	2	**Yard Tractor - Purpose Built (Port)**	8	21	C or I	Heavy (120K 0 140K lbs.). Load on/Load off (Value=1)	<200 miles per day, 1-2 mile routes (predictable), >10 hours per day Accessory loads: high heating and cooling requirements, hydraulics to raise and lower 5th wheel (Value=1)	Opportunity charging but port dependent. May need to remove from fleet for charging. Constrained for port applications due to hours of operation (Value=3)	Constrained for shorter wheelbase. (Value=3)
77	3.75	**Mobile Command Center**	4-7	27	I	Moderate heavy fixed load (Value=1)	Mostly short, unpredictable (mission dependent) (Value=1)	Generally centralized, may need to be charged while on mission; there may not be enough time for recharge between missions (Value=10)	Somewhat constrained (Value=3)
78	5.5	**H-D Van - Emergency**	2B-3	223	I	Heavy (Value=1)	50-150 miles per day, High route variability (Value=1)	Dispersed, or infrastructure dependent (Value=10)	Constrained (Value=10)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
79	5.5	**Ambulance**	4-7	128	I	Light (Value=1)	Mostly short, unpredictable (mission dependent) (Value=1)	Centralized, opportunity charging when possible; need to be fully charged and ready with no notice (e.g., conventional vehicles have quick disconnect air hoses to keep air brake tanks full, and similar would be required for electrical); there may not be enough time for recharge between missions	Constrained (due to equipment installation) (Value=10)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
80	8.25	**Fire Truck**	8	159	I	Start at high/max load, may diminish slightly throughout day (Value=3)	Mostly short, unpredictable (mission dependent). May be fueled by wet hose when operating continuously at a fire site. (Value=10)	Centralized, opportunity charging when possible; need to be fully charged and ready with no notice (e.g., conventional vehicles have quick disconnect air hoses to keep air brake tanks full, and similar would be required for electrical); there may not be enough time for recharge between missions (Value=10)	Constrained (due to equipment installation) (Value=10)
81	6	**Snow Plow**	8	92	I	Start at max load, diminish throughout day (Value=1)	varied, unpredictable (weather dependent) (Value=3)	Centralized, opportunity charging when possible; there may not be enough time for recharge between missions	Constrained (due to equipment installation) (Value=10)
82	1.5	**Crane**	4-7	100	I	Light (Value=1)	Average <70 miles per day (Value=1)	Centralized (Value=1)	Limited (Value=3)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
83	1.5	**Dump**	4-7	200	I	Variable (depends on use requirements) (Value=1)	Average <70 miles per day (Value=1)	Centralized (Value=1)	Limited (Value=3)
84	1.5	**Refuse/Recycling**	4-7	200	I	Start light, end day at max load (Value=1)	Average <70 miles per day (Value=1)	Centralized (Value=1)	Limited (Value=3)
85	1.5	**Shredder**	4-7	100	I	Start light, end day at max load (Value=1)	Average <70 miles per day (Value=1)	Centralized (Value=1)	Limited (Value=3)
86	3.75	**Pickup Truck - Personal Use**	2B-3	38000	C	Moderate Limited cargo carrying capacity to offset battery pack weights. Most people upgrade to the class 2b-3 pickup over a class 2a pickup for either load carrying or towing needs. (Value=1)	Variable; Towing will significantly shorten available EV range. (Value=3)	Centralized charging at residence/business (Value=1)	Constrained (Value=10)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
87	1.5	**H-D Van - Passenger**	2B-3	6198	C	Light (Value=1)	Variable (Value=1)	Centralized charging at residence/business (Value=1)	Constrained (Value=3)

Table E-2 - California Sales per Battery Electric Vehicle Suitability Score

Class	Score 1	1 < Score ≤ 2	3 < Score ≤ 4	4 < Score ≤ 5	5 < Score ≤ 10	All
2B-3	2,353	19,192	38,000	0	14,852	74,897
4-7	7,436	6,555	604	0	4,818	19,413
8	1,069	1,710	210	74	4,452	7,580
Total	10,858	27,457	38,814	74	24,122	101,890

2. Fuel Cell Electric Vehicle Suitability Table

Table E-3 - Fuel Cell Electric Vehicle Suitability Table

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Fueling Infrastructure	Vehicle Space Constraints
1	3.25	**Beverage Tractor**	8	123	I	Start at max load, diminish throughout day (Value=1)	Fixed, 100 miles per day (Value=1)	Centralized, at night (Value=1)	Constrained (Value=10)
2	1	**School Bus - Class C (Longer Rural Routes)**	4-7	87	C or I	Light (Value=1)	125 miles per day (Value=1)	Centralized, at night and during the day (Value=1)	Open (Value=1)
3	1	**School Bus - Class C (Shorter Urban Routes)**	4-7	608	C or I	Light (Value=1)	<75 miles per day (Value=1)	Centralized, at night and during the day (Value=1)	Open (Value=1)
4	1	**School Bus - Class C (Special Needs - ADA)**	4-7	87	C or I	Light (Value=1)	50-150 miles per day (Value=1)	Centralized, at night and during the day (Value=1)	Open (Value=1)
5	1	**School Bus - Class C (Long distance - Field Trip, special Events - just a bus)**	4-7	87	C or I	Light (Value=1)	125 miles per day Multiple uses, fixed and flexible routes (Value=1)	Centralized, at night and during the day (Value=1)	Open (Value=1)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
6	1	**School Bus - Class Rear Engine (Transit Style) All**	4-7	226	C or I	Light to medium. Higher capacity. (Value=1)	Varied Occassional use on long routes (Value=1)	Centralized, at night and during the day (Value=1)	Open (Value=1)
7	3.75	**Refuse, Automatic Side Loader (ASL), Residential Service**	8	400	I	Start light, end day at max load (Value=3)	Fixed, 75 miles per day (Value=1)	Centralized, at night (Value=1)	Constrained (Value=10)
8	3.75	**Refuse, Front Loader, Commercial or High Density Residential Service**	8	65	I	Start light, end day at max load (Value=3)	Fixed, 100 miles per day. Occasional long routes (Value=1)	Centralized, at night (Value=1)	Constrained (Value=10)
9	3.75	**Refuse, Rear Packer, Residential Service**	8	133	I	Start light, end day at max load (Value=3)	Fixed, 75 miles per day. Occasional long routes (Value=1)	Centralized, at night (Value=1)	Constrained (Value=10)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
10	2	**Refuse Hauler (roll on/roll off)**	8	65	I	50% laden, 50% unladen, highly variable from lightly loaded to grossed out. (Value=3)	Variable, up to 250 miles per day (Value=1)	Centralized, at night (Value=1)	Somewhat constrained (Value=3)
11	1	**Step Van - Parcel Delivery**	4-7	1985	I	Light (Value=1)	Fixed, 50 miles per day (Value=1)	Centralized, at night (Value=1)	Open (Value=1)
12	1	**Step Van - Municipal Fleet**	4-7	298	I	Can be heavy (like electrician or plumber) (Value=1)	Can be highly variable, local some days potentially to many sites around municipality in same day (Value=1)	Centralized, at night Can have a need for emergency service (e.g., storms) that force long drives and long hours away from charging (Value=1)	Open (Value=1)
13	1.5	**H-D Van - Parcel Delivery Class 2B-3)**	2B-3	951	I	Light (Value=1)	50-300 miles per day (Value=1)	Centralized, at night (Value=1)	Constrained (Value=3)
14	1.5	**H-D Van - Parcel Delivery (Class 4,5)**	4-7	1985	I	Light (Value=1)	50-300 miles per day (Value=1)	Centralized, at night (Value=1)	Constrained (Value=3)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
15	2	**H-D Van - Contractor**	2B-3	11854	C	Heavy (Value=1)	50-150 miles per day (Value=1)	Some central dispatch, many go with driver o/n (Value=3)	Constrained (Value=3)
16	1	**H-D Van - Shuttle**	2B-3	1116	I	Light (Value=1)	50-300 miles per day (Value=1)	Centralized, but 24/7 operation (Value=1)	Open (Value=1)
17	1.5	**H-D Van - Refrigerated**	2B-3	70	I	Heavy (Value=1)	200-300 miles per day. Refrigeration reduces range (Value=1)	Centralized, at night (Value=1)	Constrained (Value=3)
18	1	**H-D Van - School Bus**	2B-3	70	I	Light (Value=1)	65 miles per day (Value=1)	Centralized, at night (Value=1)	Open (Value=1)
19	3.75	**H-D Van - Motor Home**	2B-3	29	I	Heavy (Value=1)	300-450 miles per day (Value=1)	Dispersed, or infrastructure dependent (Value=10)	Constrained (Value=3)
20	1	**Box Truck - Pickup & Delivery (Fixed Light <100 Miles per Day)**	4-7	3075	I	Light (Value=1)	Variable <100 miles per day (Value=1)	Centralized (Value=1)	Open (Value=1)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
21	1.5	**Box Truck - Pickup & Delivery (Medium to Heavy Load >100 Miles per Day)**	4-7	1538	I	Medium to heavy (Value=3)	Variable >100 miles per day (Value=1)	Centralized (Value=1)	Open (Value=1)
22	3.75	**Box Truck - Pickup & Delivery (Medium to Heavy Load >200 Miles per Day)**	4-7	1538	I	Medium to heavy (Value=10)	Variable >200 miles per day (Value=1)	Centralized or remote (Value=3)	Open (Value=1)
23	1.5	**Box Truck - Leasing (Daily Rental)**	4-7	152	I	Light (Value=1)	Variable <100 miles per day (Value=1)	Centralized or remote (Value=3)	Open (Value=1)
24	1	**Box Truck - Leasing (Fixed Customer and Application)**	4-7	228	I	Light to medium (Value=1)	Variable <100 miles per day (Value=1)	Centralized (Value=1)	Open (Value=1)
25	1	**Box Truck - Leasing (Fixed Customer and Application)**	4-7	228	I	Medium to heavy (Value=1)	Variable <100 miles per day (Value=1)	Centralized (Value=1)	Open (Value=1)
26	1.5	**Box Truck - Leasing (Fixed Customer and Application)**	4-7	76	I	Medium to heavy (Value=3)	Variable >100 miles per day (Value=1)	Centralized (Value=1)	Open (Value=1)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
27	1.5	**Box Truck - Leasing (Fixed Customer and Application)**	4-7	76	I	Medium to heavy GVWR limited (Value=3)	Variable >200 miles per day (Value=1)	Centralized (Value=1)	Open (Value=1)
28	1	**Straight Truck Pickup & Delivery (Heavy Load >100 Miles per Day)**	8	1069	I	Heavy (Value=1)	Variable >100 miles per day (Value=1)	Centralized (Value=1)	Open (Value=1)
29	1.5	**Box Truck - Refrigerated**	4-7	390	I	Medium to heavy load (Value=1)	Variable <100 miles per day (Value=1)	Centralized (Value=1)	Constrained if equipped with diesel TRU (Value=3)
30	1	**Flatbed - Stake/Platform**	4-7	370	I	Variable (Value=1)	Variable (Value=1)	Centralized (Value=1)	Open (Value=1)
31	1.5	**Regional Tractor - Short Haul**	4-7	400	C	Variable, up to 80K GCW (Value=1)	Variable, <100 miles per day (Value=1)	Centralized, at night. Multiple shift operations impact charging times (Value=1)	Constrained - short wheelbase (Value=3)
32	1.5	**Regional Tractor - Short Haul**	8	400	C	Variable, up to 80K GCW (Value=1)	Variable, <100 miles per day (Value=1)	Centralized, at night. Multiple shift operations impact charging times (Value=1)	Constrained - short wheelbase (Value=3)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
33	1.5	**Regional Tractor - Medium Haul**	4-7	200	C	Variable, up to 80K GCW (Value=1)	Variable, 100-300 miles per day (Value=1)	Centralized, at night. Multiple shift operations impact charging times (Value=1)	Constrained, short wheelbase (Value=3)
34	1.5	**Regional Tractor - Medium Haul**	8	400	C	Variable, up to 80K GCW (Value=1)	Variable, 100-300 miles per day (Value=1)	Centralized, at night. Multiple shift operations impact charging times (Value=1)	Constrained, short wheelbase (Value=3)
35	6	**Regional Tractor - Long Haul**	4-7	100	C	Variable (Value=3)	Variable, >200 miles per day (Value=1)	Future retail charging network? Multiple shift operations impact charging times (Value=10)	Constrained - short wheelbase, fairings (Value=10)
36	6	**Regional Tractor - Long Haul**	8	300	C	Heavy (Value=3)	Variable, 200-500+ miles per day (Value=1)	Future retail charging network? Multiple shift operations impact charging times (Value=10)	Constrained (Value=10)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
37	2	**Port Drayage**	8	120	C	Heavy (Value=1)	Variable, 100-500 miles per day (Value=1)	Variable / Centralized, depending on owner. Multiple shift operations impact charging times (Value=3)	Constrained - short wheelbase (Value=3)
38	2	**Pickup Truck - Agriculture**	2B-3	500	C or I	Variable-- dependent on type of agriculture. (Value=3)	Assume set routes, <100 miles per day, may have extended idling. Likely extended operation (Value=1)	Centralized (Value=1)	Constrained (Value=3)
39	3.75	**Pickup Truck - Contractor**	2B-3	5000	C or I	Moderate to heavy (Value=1)	Variable (Value=1)	Variable (Value=3)	Constrained (Value=10)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
40	3.75	**Pickup Truck - Towing**	2B-3	3000	C or I	Heavy (Value=1)	Variable--expect several will have long distance (~500 mile) routes. Towing will significantly shorten available EV range. (Value=1)	Variable (Value=3)	Constrained (Value=10)
41	5.5	**Pickup Truck - 4WD Off Road**	2B-3	5000	C or I	Light to moderate (Value=1)	Variable--expect some will have long distance routes. (Value=1)	Variable--off road usage will likely be away from EV grid. Off-highway usage and extended operation will make charging impossible for extended offroad operation. (Value=10)	Constrained (Value=10)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
42	3.75	**Pickup Truck - PTO Equipped**	2B-3	1500	C or I	Moderate to heavy (Value=1)	Assume set routes, <100 miles per day, may have extended idling. (Value=1)	Variable (Value=3)	Constrained (Value=10)
43	5.5	**Line Haul Tractor**	4-7	500	C	Heavy (Value=10)	Variable; 500+ mile days (Value=1)	Variable (Value=10)	Open (Value=1)
44	5.5	**Line Haul Tractor**	8	3000	C	Heavy (Value=10)	Variable; 500+ mile days (Value=1)	Variable (Value=10)	Open (Value=1)
45	7.75	**Logging**	8	5	C	Heavy (Value=10)	Variable (Value=1)	Variable, Long off-road travel (Value=10)	Constrained, ground clearance (Value=10)
46	5.5	**Concrete Mixer**	8	70	I	Typically 50% empty, 5-% grossed out (Value=10)	Highly variable (Value=1)	Centralized, at night (Value=1)	Highly constrained due to body equipment and weight (Value=10)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
47	7.75	**Concrete Pumper**	8	37	I	Due to weight of pumping equipment the vehicle is always heavily loaded (Value=10)	Highly variable (Value=1)	Vehicle may remain at construction site for multiple days (Value=10)	Highly constrained (Value=10)
48	4.25	**Mining Hauler**	8	15	I	Heavy (Value=10)	Fixed (Value=1)	Centralized; Long off-road travel (Value=3)	Constrained (Value=3)
49	2.5	**Mining Service**	8	15	C	Medium – fixed (Value=3)	Variable (Value=1)	Centralized; Long off-road travel (Value=3)	Constrained, due to body (Value=3)
50	5.5	**Heavy Equipment Transport**	8	110	C	Heavy (Value=10)	Variable (Value=1)	Variable (Value=10)	Open (Value=1)
51	1.5	**Utility/Lube Service**	4-7	76	I	Can be heavy (like electrician or plumber) (Value=1)	Can be highly variable, local some days potentially to many sites around municipality in same day (Value=1)	Centralized, at night Can have a need for emergency service (e.g., storms) (Value=3)	Open (Value=1)
52	7	**Oil Field Rig Mover**	8	14	C	Extremely high (Value=10)	Highly variable (Value=1)	May be enroute/onsite multiple days (Value=10)	

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
53	7.75	**Oil Field Well Servicing**	8	110	I	Always loaded at or near GVWR (Value=10)	Highly variable (Value=1)	Mixed locations, could need to charge during peak times Many of these vehicles are for off-road use only. (Value=10)	Constrained (Value=10)
54	1.5	**Tow/Wrecker**	4-7	250	I	Variable (Value=1)	Variable, <100 miles per day (Value=1)	Centralized when not in use (Value=1)	Constrained. Need space for bed/hoist and hydraulic mechanisms between the frame rails where batteries would be installed (Value=3)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
55	1	**Farm Service - Truck**	2B-3	119	I	Heavy (almost like a dump truck) May be restricted on weight due to heavy produce and need to operate in ag fields (Value=1)	Fixed, but can be long distance from farm to city (Value=1)	Centralized but in rural area at night (Value=1)	Open (Value=1)
56	5.5	**Farm Service - Tractor**	8	90	C	Heavy (almost like a dump truck) May be restricted on weight due to heavy produce and need to operate in ag fields (Value=10)	Fixed, but can be long distance from farm to city (Value=1)	Centralized but in rural area at night (Value=1)	Constrained (short wheelbase) (Value=10)
57	3.75	**Tanker Truck - Liquids or Gases**	8	44	I	Start at max load, may diminish throughout day (Value=3)	Fixed, but can be long distance from depot to destination (Value=1)	Centralized, at night (Value=1)	Constrained due to effort to maximize payload (Value=10)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
58	6	**Car Carrier - Class 8**	8	123	I	High (Value=10)	Variable (Value=1)	Variable (Value=10)	Constrained (Value=3)
59	2	**Car Carrier - Class 6/7 (Roll Back)**	4-7	150	I	Variable (Value=1)	Variable, local (Value=1)	Centralized Variable origin and destination pairs (Value=3)	Constrained (Value=3)
60	3.75	**Utility Service - Private (Class 8)**	8	87	I				
61	3.75	**Utility Service - Private (Class 6-7)**	4-7	143	I	High (Value=1)	Variable (Value=1)	Variable + remote Extended operation off road (Value=10)	Constrained (Value=3)
62	3.75	**Utility Service - Private Trouble Truck (Class 4-5)**	4-7	277	I	Medium to heavy (Value=1)	Variable (Value=1)	Variable + remote Extended remote operation (Value=10)	Constrained (Value=3)
63	2	**Utility Service - Public (Class 8)**	8	87	I				
64	2	**Utility Service - Public (Class 6-7)**	4-7	143	I	High (Value=1)	Variable (Value=1)	Variable Extended operation off road (Value=3)	Constrained (Value=3)
65	2	**Utility Service - Public (Class 4-5)**	4-7	277	I	Medium to heavy (Value=1)	Variable (Value=1)	Variable Extended remote operation (Value=3)	Constrained (Value=3)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
66	3.75	**Recreational Vehicle**	4-7	2500	I	Variable (Value=3)	Expected long distance routes (Value=1)	Non-centralized (Value=10)	Open (Value=1)
67	1	**Airport Service**	2B-3	1167	I	Light (Value=1)	Set routes, <100 miles per day (Value=1)	Centralized, Close proximity to charging infrastructure (Value=1)	Open (Value=1)
68	3.25	**Rail Service**	2B-3	100	I	Light (Value=1)	Expected long distance routes (Value=1)	Centralized (Value=1)	Constrained. Need physical space to mount rail wheels, lift mechanism, and upfitter body. (Value=10)
69	1	**Shuttle Bus**	4-7	331	I	Variable, light (Value=1)	Fixed <100 miles per day (Value=1)	Centralized (Value=1)	Open (Value=1)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
70	1.5	**Armored Car**	4-7	100	I	Variable (depends on drop-off or pick-up work) (Value=1)	Variable, <100 miles per day (Value=1)	Centralized, at night (Value=1)	Constrained. Armor plating and security defenses would take up underbody battery storage opportunities (Value=3)
71	3.25	**Mobile Laboratory**	4-7	81	I	Variable (depends on use requirements) (Value=1)	Variable, <100 miles per day (Value=1)	No central charging available when in use Occasional use on long routes and dependent on deployment needs (Value=10)	Open (Value=1)
72	6	**Digger Derrick**	4-7	52	I	High (Value=10)	Variable (Value=1)	Extended operation off road (Value=10)	Constrained (Value=3)
73	3.75	**Construction Dump**	8	342	I	50% laden (typically to GVWR), 50% unladen (Value=10)	Highly variable, but typically 150-250 miles per day (Value=1)	Centralized, at night (Value=1)	Somewhat constrained (Value=3)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
74	1.5	**Municipal Dump**	4-7	44	I	50% laden, 50% unladen, mixed light to heavy (Value=1)	Variable, 50 miles per day (Value=1)	Centralized, at night (Value=1)	Somewhat constrained (Value=3)
75	1.5	**Yard Tractor - Purpose Built (Warehouse/Rail)**	8	84	C or I	Heavy (65K - 85K lbs). Light-duty cycle. Load on/load off (Value=1)	<100 miles per day, <1 route (Predictable), 8-10 hours per day (Value=1)	Centralized, at night and during the day (Value=1)	Constrained, for shorter wheelbase (Value=3)
76	3.25	**Yard Tractor - Purpose Built (Port)**	8	21	C or I	Heavy (120K 0 140K lbs.). Load on/Load off (Value=1)	<200 miles per day, 1-2 mile routes (predictable), >10 hours per day (Value=1)	Opportunity charging but port dependent. May need to remove from fleet for charging Constrained for port applications due to hours of operation (Value=1)	Constrained for shorter wheelbase. Constrained for port applications due to hours of operation (Value=3)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
77	1.5	**Mobile Command Center**	4-7	27	I	Moderate heavy fixed load (Value=1)	Mostly short, unpredictable (mission dependent) (Value=1)	Generally centralized, may need to be charged while on mission; there may not be enough time for recharge between missions (Value=1)	Somewhat constrained (Value=3)
78	3.75	**H-D Van - Emergency**	2B-3	223	I	Heavy (Value=1)	50-150 miles per day (Value=1)	Dispersed, or infrastructure dependent (Value=3)	Constrained (Value=10)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
79	3.25	**Ambulance**	4-7	128	I	Light (Value=1)	Mostly short, unpredictable (mission dependent) (Value=1)	Centralized, opportunity charging when possible; need to be fully charged and ready with no notice (e.g., conventional vehicles have quick disconnect air hoses to keep air brake tanks full, and similar would be required for electrical); there may not be enough time for recharge between missions (Value=1)	Constrained (due to equipment installation) (Value=10)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
81	3.25	**Snow Plow**	8	92	I	Start at max load, diminish throughout day (Value=1)	varied, unpredictable (weather dependent) (Value=1)	Centralized, opportunity charging when possible; there may not be enough time for recharge between missions (Value=1)	Constrained (due to equipment installation) (Value=10)
82	1.5	**Crane**	4-7	100	I	Light (Value=1)	Average <70 miles per day (Value=1)	Centralized (Value=1)	Limited (Value=3)
83	1.5	**Dump**	4-7	200	I	Variable (depends on use requirements) (Value=1)	Average <70 miles per day (Value=1)	Centralized (Value=1)	Limited (Value=3)
84	1.5	**Refuse/Recycling**	4-7	200	I	Start light, end day at max load (Value=1)	Average <70 miles per day (Value=1)	Centralized (Value=1)	Limited (Value=3)
85	1.5	**Shredder**	4-7	100	I	Start light, end day at max load (Value=1)	Average <70 miles per day (Value=1)	Centralized (Value=1)	Limited (Value=3)

Index	Quantitative Suitability Score	Market Segment	Class	Annual CA Sales	Complete/ Incomplete	Loading	Routes/Range	Infrastructure/ Charging	Battery Space Constraints
86	3.75	**Pickup Truck - Personal Use**	2B-3	38000	C	Moderate Limited cargo carrying capacity to offset battery pack weights. Most people upgrade to the class 2b-3 pickup over a class 2a pickup for either load carrying or towing needs. (Value=1)	Variable; Towing will significantly shorten available EV range. (Value=1)	Centralized charging at residence/business (Value=3)	Constrained (Value=10)
87	1.5	**H-D Van - Passenger**	2B-3	6198	C	Light (Value=1)	Variable (Value=1)	Centralized charging at residence/business (Value=1)	Constrained (Value=3)

Table E-4 - California Sales per Battery Fuel Cell Electric Vehicle Suitability Score

Class	Score 1	1 < Score ≤ 2	3 < Score ≤ 4	4 < Score ≤ 5	5 < Score ≤ 10	All
2B-3	2,472	19,573	47,852	0	5000	74,897
4-7	7,610	6,484	4,667	0	652	19,413
8	1,069	1,156	1,466	15	3859	7,580
Total	11,151	27,213	53,985	15	9,511	101,890

F. Reference List

The following documents are the technical, theoretical, or empirical studies, reports, or similar documents relied upon in proposing these regulatory amendments, identified as required by Government Code, section 11346.2, subdivision (b)(3). Additionally, each appendix references the documents upon which it relies, as required by Government Code, section 11346.2, subdivision (b)(3).

1. California Air Resources Board. ACT Market Analysis. February 22, 2019. https://ww2.arb.ca.gov/index.php/sites/default/files/2019-02/190225actmarketanalysis.xlsx
2. California Legislature. Assembly Bill No. 2061 Chapter 580. (web link: https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB2061)
3. U.S. Census Bureau. 2002 Economic Census Vehicle Inventory and Use Survey Geographic Area Series. (web link: https://www2.census.gov/library/publications/economic-census/2002/vehicle-inventory and-use-survey/ec02tv-us.pdf)