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FIAT CHRYSLER AUTOMOBILES

December 12, 2019

To: **California Air Resources Board**
Clerk's Office
1001 I Street
Sacramento, California 95814

Re: **FCA Comments on The Advanced Clean Trucks (ACT) Regulation Initial Statement of Reasons**

Board Item: act2019

FCA US LLC (FCA) respectfully submits the following comments in response to the California Advanced Clean Trucks Regulation for Model Years 2024-2030 Heavy-duty Trucks Initial Statement of Reasons.[1] The attached comments provide additional supporting analysis and detail.

Introduction

FCA is a North American automaker based in Auburn Hills, Michigan that designs, manufactures, and sells vehicles under the Chrysler, Dodge, Jeep®, Ram, FIAT and Alfa Romeo brands. In 2018, FCA sold over 2 million vehicles in the U.S. In the state of California, FCA has a network of employees, dealers, and suppliers, with a direct economic impact of nearly $5 billion in dealer sales in 2018 alone.

FCA continues to minimize the environmental footprint of both our products and operations. Reducing vehicle greenhouse gas emissions (and improving fuel economy) is important to FCA, our customers, U.S. energy security, and for addressing climate change. While our primary focus remains on improving vehicle technologies, including the electrification of both light and heavy-duty vehicles, we are also working to resolve electrical charging infrastructure challenges through the U.S. Department of Energy's U.S. DRIVE program. We are also engaging in state-level activities such as California's Veloz "Electric for All" campaign, to educate the public on the benefits of electric vehicles and charging availability.

Customers Buy Heavy-Duty Trucks for their Capability

The heavy-duty segment is a large and diverse group of products with hundreds of unique, capability-driven use cases. FCA produces two distinct types of product with many variants of each in this segment: (1) pick-up trucks and (2) commercial vans. Our customers and the heavy-duty market as a whole purchase these products almost entirely based on the ability of the vehicles to do the needed work, and therefore a successful rule must identify those applications that are suitable for electrification and aligned with the capability needs of the market.

We agree with CARB's starting point which focuses the ACT rule on "Fleets that operate in urban centers, have stop and go driving cycles, and are centrally maintained and fueled."[2] These "centralized" use-cases give electrification the best chance for market acceptance by identifying the highest potential for improved efficiency and lowered costs while minimizing the impact of limited charging infrastructure. However, the majority of the heavy-duty pickup truck fleet does not fit this "centralized" profile. Pickup trucks make up over one third of new

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[1] California Advanced Clean Trucks (proposed October 22, 2019) (to be codified at 13 Cal. Code Regs. § 1963 – 1963.5 and 2012 – 2012.3).

[2] California Air Resources Board (2019). *Advanced Clean Trucks*. CA.gov.

heavy-duty sales in California, 90% of which are purchased by small business and retail customers, such as landscapers, contractors, and farmers (Figure 1). These customers are generally "decentralized," needing their vehicles for towing or hauling large loads over variable distances across urban and rural areas where a lack of charging infrastructure introduces barriers to "doing work."

FCA California Heavy-duty Pickup Customer Composition[3]

Small Business and Retail	90%	Construction, Plumbing, Painting, Landscaping, Personal work ...
Commercial	6%	Agriculture, Electrical, Shipping, Landscaping, Drilling, Construction ...
Government	4%	Natural Resources / Parks, Emergency, Fire, Water, Airports, ...

Figure 1: Small Business and Retail sales make up the vast majority of FCA HD pickup truck sales

Heavy-duty pickup truck customers specifically seek out these products for their unique capabilities. Though heavy-duty pickups may look physically similar to their light-duty counterparts, they provide increased capability that can double or even triple the towing and hauling capacity of their light-duty counterparts (Figure 2). This capability increase requires larger drivetrains, heavier and more capable frame and chassis components, and high capacity cooling systems. These upgrades "cost" the customer, either directly via more expensive components, or indirectly by requiring customer to "trade-off" other attributes such as maneuverability, unloaded ride comfort, and fuel economy.

FCA Product Capability Comparison

	Light-Duty RAM 1500 (Class 2a)	**Heavy-Duty RAM 2500 (Class 2b)**	**Heavy-Duty RAM 3500 (Class 3)**
Payload	2,600 lbs	4,050 lbs	7,680 lbs
Towing	12,750 lbs	19,780 lbs	35,100 lbs

Figure 2: FCA heavy-duty pickup capability is significantly greater than light-duty

This capability differentiation extends to the Class 4 and 5 pickup-based vehicles as well. Here, customers purchase vehicles with pickup-based architectures, systems, and powertrains, that provide significantly greater towing and hauling capability than other non-pickup based Class 4 or 5 vocational products (e.g., step vans).

In summary, pickup trucks and their variants form a unique subset of the Class 2b through 5 heavy-duty market, characterized by a decentralized, small business and retail customer base with unique and demanding capability and infrastructure requirements that present challenges to electrification.

BEV Technology Has Cost and Capability Challenges - PHEV Technology Could Be a Bridge

Given the varying use-cases and cost sensitivities in the heavy-duty segment, FCA applauds CARB efforts to analyze total lifetime cost of the different technologies to inform the ACT regulation. While the analysis shows cost-based justifications for certain vehicle applications, it is unfortunate that the analysis did not cover pickup trucks and their variants, which as noted above, account for more than one third of new heavy-duty vehicle sales in California.[4]

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[3] IHS Markit (POLK Registration and Data, 2018).

[4] Derived from CARB 2015 & 2016 California DMV data and based upon Class 2b-3 pick-up based trucks (includes chassis cabs). Data source links: CARB April 2017 ACT Workshop: https://ww2.arb.ca.gov/sites/default/files/2018-

Applying CARB's lifetime cost calculator to the BEV heavy-duty pickup and pickup-based trucks, and their optimistic assumptions (i.e., credit-based purchase incentives, small battery sizes and heavily compromised capability), can still cost customers between $9,500 and $13,000 more than internal combustion engine (ICE) versions over a 12-year period.

When battery sizes are increased to maintain capability equivalent to an ICE vehicle with a 100-mile range, the additional battery weight erodes much of the available payload the customer sought. For example, technology to electrify a RAM 3500 pickup would add ~2,300-pounds, and available payload would be close to a non-electrified RAM 2500 (Figure 3). If the uncertain credit-based purchase incentives were removed from CARB modeling assumptions, costs would be $30,000 to $50,000 more than the ICE model.

RAM 3500 ICE Available Payload	Payload Degradation From Added Battery + BEV Tech[5]	Payload Recovered From Removing ICE	RAM 3500 BEV Payload	RAM 2500 ICE Payload
6,500 lbs	-2,965 lbs	+650 lbs	4,185 lbs	4,000 lbs

Figure 3: A battery-electric RAM 3500's payload capability is reduced to near that of a Ram 2500 with an internal combustion engine

The above example shows how a heavier, more expensive BEV vehicle is required to maintain the payload capability of a lighter, less expensive ICE vehicle and will still cost significantly more and have significantly less range. Limited range vehicles will depend on a readily available charging infrastructure that is not foreseen to be available in this timeframe for a decentralized customer base.

These heavy duty pick-up BEV technology constraints will require time to resolve. For these vehicles, PHEV technology may provide a better path forward in the 2027+ MY allowing continued ICE efficiency improvements while also providing the needed bridge in electrification technology development as we move towards higher penetrations of BEV technology in the heavy-duty segment.

Focusing on Small Fleets Could Slow Electrification

As noted earlier, 90% of FCA heavy-duty pickup and pickup-based trucks in California are used by small business and retail customers, who are unlikely to have sufficient capital or large enough fleets to rationalize installing their own fast charge stations. According to CARB's estimates, initial capital costs to install a direct-current fast charger needed to support a BEV vehicle are more than $50,000.[6] Unable to fund their own infrastructure, these customers are forced to turn to public charging with limited availability and uncertain costs. Most public charging is centered in urban areas that are not ideal for heavy-duty pickup truck users like farmers, landscapers, and contractors. Recharging a BEV heavy-duty pickup at a public charger would require valuable time spent away from a work-site and the variable customer pricing for public use could exceed the cost of gasoline or diesel fuel.[7] The risk of increased costs and BEV reliance on an inadequate charging infrastructure places an undue strain on small businesses and retail customers. These customers, who account for close to a third of the trucks in the entire heavy-duty segment, could be forced to keep their ICE vehicles on the road

10/170425workshoppresentation.pdf and CARB August 2017 Workshop: https://ww2.arb.ca.gov/sites/default/files/2018-10/170830arbpresentation.pdf.

[5] Battery sizes from Figure 2-1 were used in conjunction with an estimated battery pack weight of 15lbs/KWh. For comparison, the Chevy Bolt battery pack is ~16lbs/KWh

[6] 10-22-2019 CARB ACT Staff Report ISOR: See Table IX-17 (Charger Power Ratings and Infrastructure Costs).

[7] Visnic, B. (2019). Is DC fast-charging ready for prime time? *SAE International.* Sae.org

longer than they otherwise would without a workable alternative. This presents an opportunity for PHEV technology. PHEVs could lessen the strain on pickup truck customers by lowering cost and mitigating infrastructure concerns while still providing the needed bridge in electrification technology development as we move towards higher penetrations of BEV technology in the heavy-duty segment.

Meanwhile, large-volume, multi-state fleets common in non-pickup, heavy-duty segments can shift vehicle purchases to other states or pull vehicle purchasing ahead of the rule, providing more flexibility to meet requirements. Small businesses and retail pickup truck customers, without multi-state footprints or large capital for near-term investment, cannot pursue these options.

Recommendations

FCA remains committed to ongoing improvements in vehicle fuel efficiency and reductions in GHG, and we believe there is a market-based case for electrifying commercial vans in urban areas, especially for larger fleets. However, the case for BEV heavy-duty pickups and pickup-based chassis cabs needs additional time to mature. Heavy-duty customers purchase these vehicles specifically for their capability that cannot be matched by BEV technology, particularly given cost and reliance on infrastructure that is concentrated in population centers.

FCA offers the following recommendations on the proposed ACT rule (further detailed on the following pages):

- Efforts should be re-focused on identifying practicable electrification use-cases (i.e., mimic existing airport shuttle and transit bus rules by CARB). With this perspective, FCA believes there could be an electrification opportunity for our commercial vans.
- For pickup truck variants, given their important volume contribution and unique challenges described above
  - PHEV technology should be equated to BEV technology for 2024-30MYs as a bridge to full electrification and remain in place until battery technology (including charging) enables BEVs to be viable in the marketplace.
  - CARB should maintain the staff recommended 2027MY start point for Class 2b/3 pickup and; (1) include all pickup-based variants through Class 5, (2) align the initial penetration ramp rate that jumps to 9% in first year to match other segments. If CARB staff cannot implement the needed (and promised) fleet purchase mandates in time, ACT requirements should be reevaluated.
- Execute market-enhancing policies such as incentives, to promote electrification purchase in this segment and invest in the needed infrastructure for the high energy requirements of heavy-duty use cases and ensure availability in both urban and rural areas.
- Incorporate review mechanisms into the regulation that assess both market acceptance of electrified products and infrastructure (lead time and availability), and adjust requirements accordingly.

FCA stands ready to work collaboratively with CARB to support the goals of the ACT rule.

Sincerely,

Mark Chernoby
Head of Vehicle Safety and Regulatory Compliance
FCA US LLC

Table of Contents

1. Customers Prioritize Capability from Heavy-Duty Products

The Heavy-Duty Segment Has Diverse Demands

The heavy-duty segment has a large, diverse group of products totaling roughly 106,000 new vehicles per year and spanning hundreds of unique, capability-driven use cases.[8] Customers in this segment purchase vehicles based on their capability, therefore a successful rule mandating the sale of electric vehicles must consider which applications are best suited for ZEV technology and establish requirements accordingly. CARB's Advanced Clean Trucks (ACT) website acknowledges this point when it states that "Fleets that operate in urban centers, have stop and go driving cycles, and are centrally maintained and fueled are well suited for introducing zero-emission technology."[9]

With this in mind, industry compiled an analysis of heavy-duty market segments and recommended use-cases for electrification based on four main factors: loading, routes, charging, and batteries. Overall 89 use cases were analyzed to identify those suitable for electrification given their light loads, short, fixed routes, centralized vehicle downtime for charging, and ample space for large batteries. Suitable centrally-operated applications, such as parcel delivery vans, school or shuttle buses and others, were identified given that they tend to be part of larger fleets, make short, predictable trips, do not require towing capability, and return to "home base" when not in use.

Heavy-Duty Pickups Provide Unique Capability

FCA is proud to offer capable heavy-duty products, including the RAM ProMaster cargo van, RAM 2500 and 3500 pickup trucks, and RAM 4500 and 5500 chassis cabs, with the vast majority being pickup or pickup-derived products. These products span Class 2b through 5 segments, and almost all are used regularly by our customers for towing and hauling substantial weight.

While use-cases for vehicles like our heavy-duty ProMaster van show promise for targeted electrification, the segment analysis provided to CARB did not identify pickups as suitable for electrification in the near-term. The hauling and towing capability, variable and lengthy routes, decentralized operation and constrained packaging space for battery placement limit the viability of BEV technology in pickup and pickup based chassis cab products.

The Class 2b and 3 pickup truck segment makes up 36%, over one third, of California heavy-duty sales each year,[10] and though these vehicles may look similar to their light-duty counterparts, heavy-duty pickups are specifically designed to deliver capability far exceeding that of a light-duty variant (see Figure 1-1)***Error! Reference source not found.***. While light-duty pickups have payload capacities ranging from 1600 lbs. to 2600 lbs., and can tow up to 12,750lbs, heavy-duty pickup trucks (Class 2b and 3) can tow over 35,000 lbs. and have payload capabilities in the range of 4000 to 8000 lbs.

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[8] EMA Segment Analysis: *Estimated annual new vehicle sales in California, from CARB.*

[9] California Air Resources Board (2019). *Advanced Clean Trucks.* CA.gov.

[10] Derived from CARB 2015 & 2016 California DMV data and based upon Class 2b-3 pick-up based trucks (includes chassis cabs). Data source links: CARB April 2017 ACT Workshop: https://ww2.arb.ca.gov/sites/default/files/2018-10/170425workshoppresentation.pdf and CARB August 2017 Workshop: https://ww2.arb.ca.gov/sites/default/files/2018-10/170830arbpresentation.pdf.

	Light-Duty RAM 1500	Heavy-Duty RAM 2500	Heavy-Duty RAM 3500
Payload	2,600 lbs	4,050 lbs	7,680 lbs
Towing	12,750 lbs	19,780 lbs	35,100 lbs

Figure 1-1: Heavy-duty pickups can carry and tow significantly more than light-duty

Practically speaking, Figure 1-2 shows what this hauling difference could mean to a heavy duty customer, equating to a 3- to 4-fold increase in the quantity of building or landscaping supplies an owner can haul with a RAM 3500 versus its light-duty counterpart. To amplify the point, a heavy-duty RAM 3500 is capable of payloads greater than a light-duty RAM 1500 pickup loaded to its maximum weight.

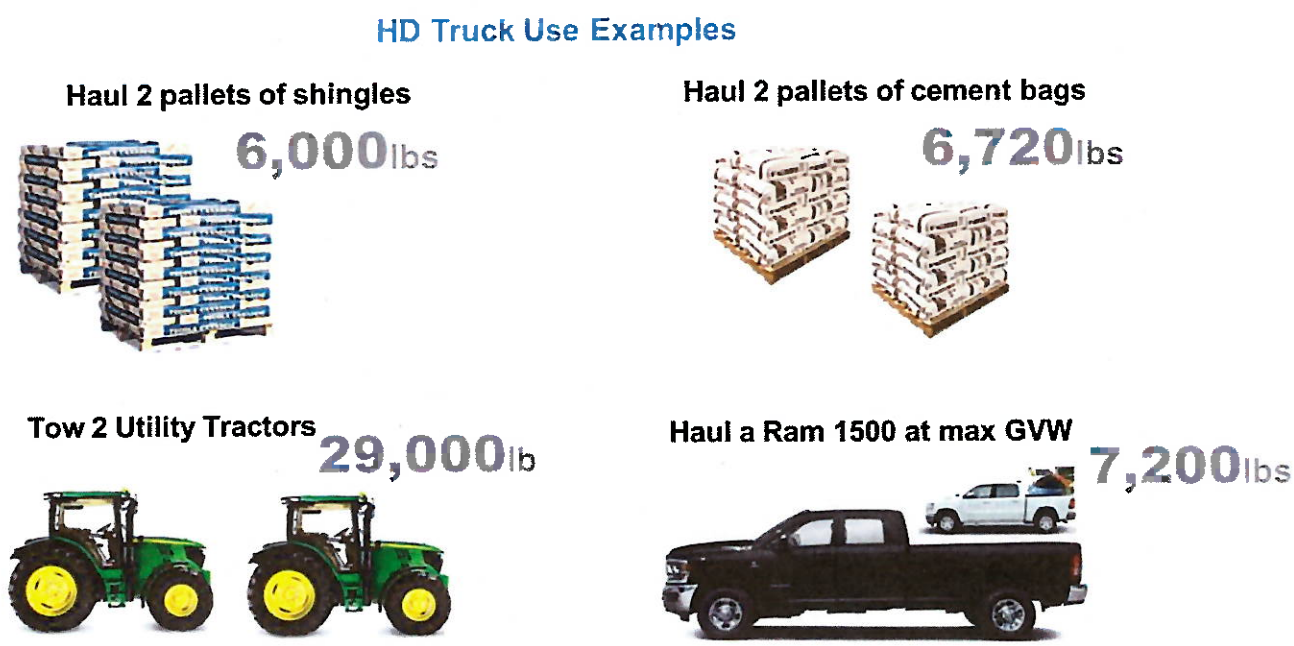

Figure 1-2: Heavy-duty pickups are uniquely able to perform necessary towing and hauling tasks

Customers are Willing to Compromise on other Features for Capability

The capability heavy-duty pickups provide comes with consumer compromises in ease of use and ride-comfort compared to a light-duty pickup. The ability of FCA's heavy-duty pickups to reliably tow and haul as much as they do requires significantly larger and heavier components which cost more and increase fuel consumption.

Several examples of this include:

- The increased size and weight of heavy-duty trucks have higher vehicle demand energy relative to a light-duty truck.

- The rolling chassis of FCA's RAM 3500 weighs twice as much as a RAM 1500 rolling chassis. Similar increases in both cost and weight can be found when comparing the brakes, wheels, driveline, and cooling systems of the industry's light-duty and heavy-duty pickups.
- Cooling a RAM 3500 requires an 80% larger radiator and has significantly greater energy demands from the cooling fan than on a RAM 1500.
- The heavy-duty suspensions required to haul large payloads compromise unloaded ride quality.
- These larger trucks are more challenging to park and maneuver in tight spaces.

These are all examples of trade-offs heavy-duty pickup customers routinely make because there are no other vehicles that fit their towing and payload capability needs. The large majority of heavy-duty pickup buyers only cross shop other heavy-duty pickups, and do not consider vehicles from light-duty segments.

Pickup Trucks and Pickup-Based Class 2b - 5 Chassis Cabs Should Have the Same Requirements

Classes 4 and 5 encompass a wide range of vocational vehicles, united only by similar gross vehicle weight ratings (GVWR[11]). Class 4 and 5 vehicles can range from large delivery vans, small shuttle buses, food trucks, box trucks, to pickup-based work trucks. These vocational vehicles are in a common GVWR range, but have many differing usage profiles – some fitting the "centralized" use profile favorable for electrification. Delivery vehicles, for example, may carry payloads that are large in volume but low in density; the same is true of many box trucks.

Comparatively, pickup-based chassis cabs have much shorter wheelbases, making them unsuitable for use as box trucks or walk-in vans, but do have unique towing capability that cannot be found in any other Class 4 through 5 vocational vehicles. Thus, while they may share similar GVW ratings, pickup-based chassis cabs have much higher gross combined vehicle weight ratings (GCWR[12]) than other Class 4-5 vehicles. Using the "work factor" metric used in both EPA's Heavy-duty Phase 2 GHG rule and California's HD GHG rule – a combination of the maximum payload and towing capacity of a given vehicle to determine vehicle capability – a RAM 4500 has a work factor of nearly 30% higher than a typical Class 4 box truck and 60% higher than a typical Class 4 step van. This significant difference is primarily attributed to the class-unique towing capability Class 4 and 5 pickup-based chassis cabs provide, while other vehicles in the same weight classes may have towing capabilities less than even a light-duty pickup.

Although Class 4 and 5 pickup-based chassis cabs are dissimilar to other Class 4 and 5 vehicles, they share many uses and attributes with Class 2b and 3 pickups. Pickup-based Class 4 and 5 chassis cabs are generally used for pickup-truck-like towing and hauling purposes, but at payloads where even a Class 3 pickup doesn't provide enough capability. These Class 2b – 5 pickup and pickup based vehicles are built on the same or similar architectures, have similar powertrain options, and share many other components. Their towing capability is comparable, while the higher GVWR ratings allow for larger payloads in Classes 4 and 5. While they are sold as chassis cabs, the vast majority of the Class 4 and 5 vehicles are then fitted with a flat, dump, or service bed and used for purposes similar to Class 2b and 3 pickup trucks, just at much higher loads.

Class 4 and 5 pickup trucks also share a decentralized use profile, similar to other heavy-duty pickups, making infrastructure availability and electrification challenging. Many of the common uses, such as utility service, tow trucks, and tree service/landscaping do not have fixed routes or centralized charging points; they also tend to

[11] Gross Vehicle Weight Rating – Maximum weight of vehicle and payload
[12] Gross Combined Weight Rating – Maximum weight of loaded vehicle and trailer combined

have higher daily mileage requirements that make all-day use on a single charge prohibitively difficult given the necessary battery size and associated charging times.

While some Class 4-5 trucks have attributes suitable for electrification, these Class 4-5 pickup based chassis cabs are more like 2b-3 pickups than they are other Class 4-5 vehicles. FCA therefore recommends that these vehicles be subject to the same electrification phase-in schedule as the 2b and 3 pickups. We suggest the following criteria to identify those few Class 4-5 chassis cab pickups that are sufficiently similar to their 2b and 3 counterparts to be included with them. (We suggest that criteria below would not apply to chassis cab Classes 2b/3, since usage in these segments is deemed to be pickup-based and as such all Class 2b/3 complete and incomplete trucks should be categorized as pickups):

- Work Factor Over 10,000 lbs
- Towing Capability over 15,000 lbs
- Manufacturer's attestation that the vehicle is related to and based upon the architecture of a Class 2b or 3 pickup truck.

2. Electrification Erodes Heavy-Duty Product Capability

BEV Pickups with Equivalent ICE Capability Require Larger Batteries

In comparing BEV capability to ICE, assumptions have to be made for appropriate battery size. Unfortunately, the battery sizes CARB assumed in the ACT proposal for Class 2b/3 pickups do not achieve a 100-mile range and do not consider needed towing and hauling capability, thereby failing to produce an "apples-to-apples" BEV vs. ICE comparison.

The original battery sizes assumed for pickup trucks, shown below in Figure 2-1, are too small to maintain sufficient towing capability. A marketable BEV pickup will need to be able to tow an amount similar to an ICE model over at least a 100-mile range. In order to maintain a 100-mile range with towing capacity, the battery sizes on pickup trucks range from over 150 kWh to nearly 300 kWh.[13] This equates to an increase between 94% and 170% percent from CARB's estimates, as shown in Figure 2-1.

The analysis below includes Class 4/5 chassis cab (RAM 4500 and RAM 5500) not originally included in CARB's baseline assessment used to justify the rule. While the baseline did analyze a 2b/3 pickup and a number of other segments, FCA generated the Class 4/5 data using eMotor assumptions from the Class 2b/3 pickup truck and the battery size from the Class 4/5 box truck. Other than these Class 4/5 exceptions necessary to analyze an important vehicle segment, no other adjustments were made for the "baseline" analysis.

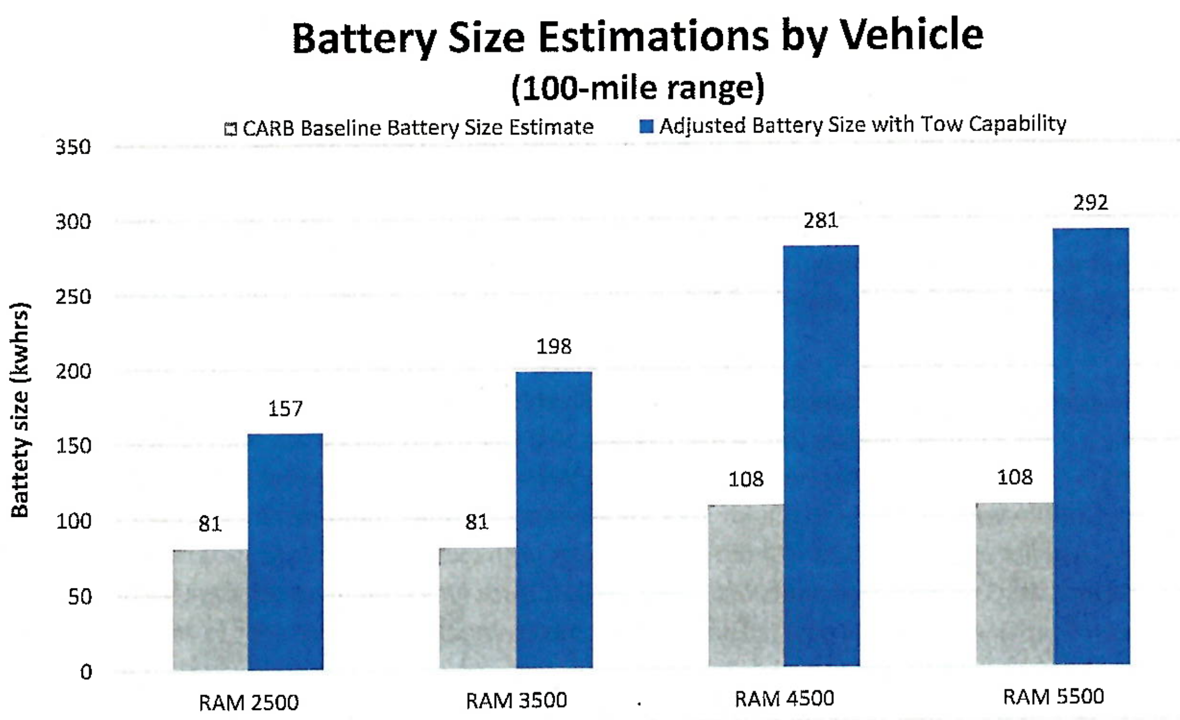

Figure 2-1: CARB did not consider towing needs when estimating battery sizes

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[13] Batteries were sized for the ability to tow an enclosed trailer 100 miles at 80% of GCW. Battery sizes were calculated by scaling up the battery pack of an existing BEV proportional to the increase in vehicle demand energy for the appropriate HD pickup.

Maintaining towing performance over 100 miles, results in lost payload capacity by as much as 50% due to the weight of battery packs, even after accounting for removal of the ICE powertrain. For a given weight class, each pound of additional battery mass that is not offset takes away available payload capacity and reduces towing performance in cases involving high trailer tongue weights. As depicted in Figure 2-2, an electrified RAM 3500 requiring a 198kWh battery adds 2,315lbs of weight after removing IC engine mass. This results in a 46% reduction in payload capability, putting RAM 3500 BEV capability close to that of a RAM 2500. Additionally, though not included in the analysis below, a more robust comparison that includes auxiliary loads such as heater, air-conditioning, power steering, lighting systems, etc., considered in battery sizing for a vehicle to be sold across all ambient conditions, may decrease capability of BEV heavy duty pickup even further.

RAM 3500 ICE Available Payload	**Payload Degradation From Added Battery + BEV Tech[14]**	**Payload Recovered From Removing ICE**	**RAM 3500 BEV Payload**	**RAM 2500 ICE Payload**
6,500 lbs	-2,965 lbs	+650 lbs	4,185 lbs	4,000 lbs

Figure 2-2: A battery-electric RAM 3500's payload capability is reduced to near that of a Ram 2500 with internal combustion engine

This degradation in capability would be unacceptable to consumers who purchase these vehicles specifically for the towing and hauling capabilities they provide. Even in cases where payloads can be reduced and spread over multiple trips, VMT would have to increase to do the same amount of work. This trend of payload erosion applies across the full range of pickups and pickup based vehicles from Class 2b to Class 5.

In response to concerns of payload degradation from electrifying heavy-duty vehicles, the proposed ACT rule references the California AB2061 (2018) provision to increase the gross vehicle weight limits of alternative fueled vehicles by 2,000lbs. This builds upon a portion of the Federal Fixing America's Surface Transportation (FAST) Act which allows a 2,000lb increase in GVWR for heavy-duty trucks powered by natural gas. The natural gas provision in the FAST Act does not address battery electric vehicles, meaning the 2,000lb increase allowed in California would not extend past state lines. While it is important that California has in part recognized the additional weight that comes with large batteries, this clear geographical restriction could complicate their use in large fleets.

Additionally, while increasing the maximum GVWR on a Class 8 vehicle from 80,000lbs to the stated maximum of 82,000lbs is only a 2.5% increase, adding that same 2,000lbs to a Class 2b pickup truck represents a 20% increase in maximum GVWR. Such a substantial increase in GVWR is not possible without significantly reengineering much of the vehicle, either in the form of "up-classing" – using larger, more expensive components from a heavier class of vehicle – or redesigning parts with exotic materials to increase strength and reduce weight. Using Class 3 truck components on a Class 2b BEV truck would drive up the base vehicle weight and cost and detract from any additional payload gained from increasing the allowable vehicle weight. The suggestion to use advanced lightweight materials in order to decrease an electric vehicle's weight, referenced in the ACT proposed rule, would unfortunately also add to the overall vehicle cost, both through higher material costs and increased fixed engineering and tooling costs spread across a much smaller volume of vehicles. In

[14] Battery sizes from Figure 2-1 were used in conjunction with an estimated battery pack weight of 15lbs/KWh. For comparison, the Chevy Bolt battery pack is ~16lbs/KWh

either case, the result is a more expensive vehicle whose capability would not be restored by a 2,000lb allowance, coupled with geographic restrictions on where the vehicle could legally be driven.

The steep challenges BEV technology faces to achieve functional parity in heavy-duty applications emphasize that additional time is needed to allow further maturation of battery technology, especially in the area of energy density. NZEV (PHEV) technology alleviates many of these challenges; as much smaller batteries can be used to provide electric operation on the majority of trips, while also retaining towing and payload capability. The relatively smaller battery requirement of a PHEV results in faster charging times compared to a BEV. Until more advanced battery technology becomes commercially viable, PHEVs provide customers with many of the benefits of a BEV, but fewer of the drawbacks. Thus, PHEVs should remain part of the heavy-duty ZEV program beyond 2030MY.

3. Electrified Heavy-Duty Pickups Are Not Cost Effective

BEV Pickups with Equivalent ICE Capability Require Larger Batteries and Have Higher Costs

CARB correctly identified the importance of using total cost of ownership (TCO) to assess the viability of electrification in the heavy-duty arena. In a segment dominated by productivity-driven use cases, ownership cost governs market adoption. However, the baseline assumptions used in the calculator do not recognize the importance of capability and overestimate the impact of incentives. It is important to note that even for small battery sizes that limit capability (see Figure 2-1, baseline), CARB's TCO calculator shows that ICE versions of Class 2b through 5 pickup truck products are cheaper to own and operate than BEV versions.

Using revised battery size estimates described in Section 2, **Error! Reference source not found.** FCA utilized the provided cost calculator to estimate the total cost of ownership for both Class 2b/3 pickup trucks and Class 4/5 pickup based chassis cab trucks. FCA's analysis shows that the battery sizing estimates that reflect equivalent work factor to ICE models increase total cost by $11,789 for battery-electric Class 2b/3 pickup trucks, and $21,859 for battery-electric Class 4/5 chassis cabs, shown in Figure 3-1.

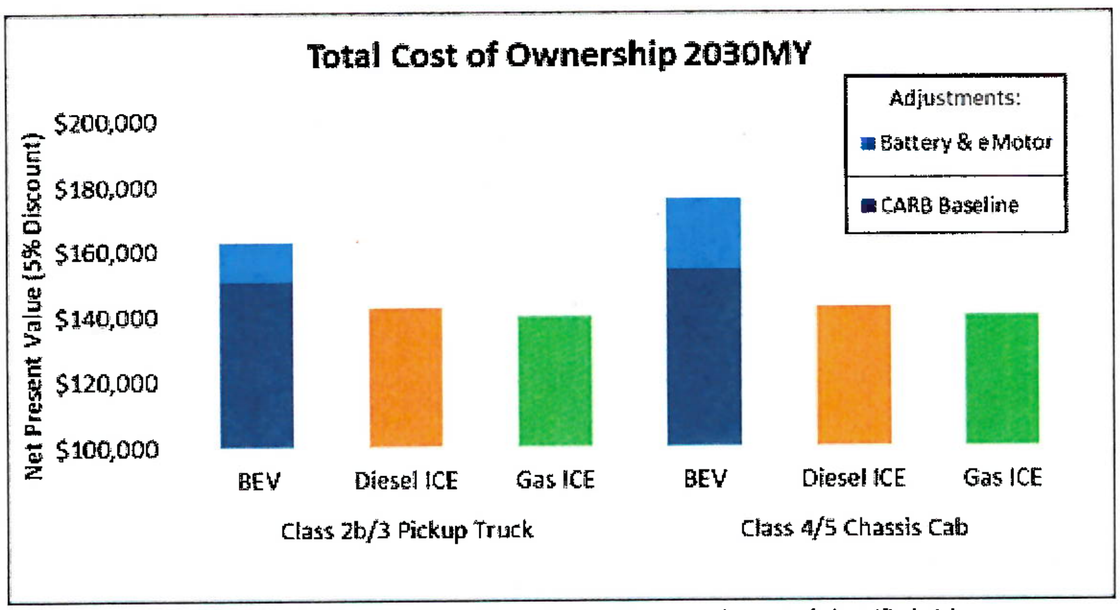

Figure 3-1: Correcting battery size assumptions further increases the cost of electrified pickups

Low Carbon Fuel Standard (LCFS) Cost Offsets Are Uncertain and Not Applicable to Most Buyers

Recognizing the importance of incentives for lowering electric vehicle ownership costs, CARB included in the TCO calculations the revenue generated from non-residential credits in California's LCFS program. Unfortunately, this revenue source should be removed from the analysis for many heavy-duty segments. Per the LCFS regulation, non-residential LCFS credits are awarded to the fuel supply equipment (FSE) owner, which may often be a different person or entity than the owner and operator of the heavy-duty vehicle.

Even if a vehicle owner is able to capture non-residential credits for their vehicle charging, the value of these credits is uncertain. LCFS credits can be sold on the credit clearance market, with an annually determined price, or in private trading, at a variable, agreed upon price. This unstable pricing mechanism causes uncertainty as fleet owners plan their finances in the long-term. Credit pricing can vary greatly depending on a multitude of factors, including the number of entities in the market, new credit-earning pathways, and changing long-term carbon intensity benchmarks. For customers that are accustomed to and prefer certainty, a revenue stream based on variable credit pricing should not be included in the TCO analysis.

Beyond variable pricing, the LCFS program itself is not a certainty. Since its inception in 2009 the LCFS has been amended in 2011, re-adopted in 2015 to address legal challenges, and amended again in 2018 to add new credit generating provisions and adjust the carbon intensity benchmarks. While the addition of an incentive at point of purchase could provide a valuable source of funding and certainty at the time of sale, at present it is difficult for a fleet owner to count on the benefit of uncertain future credits over the assumed 12-year life of a vehicle as the LCFS has already changed several times in the ten-year history of the program.

Figure 3-2 shows the cost of ownership further adjusted to reflect the removal of the LCFS credit, over $11,000 for each class category. When removed, BEV models in each segment are increasingly more expensive than diesel and gasoline counterparts. Compared to the total cost of ICE powertrains, BEV 2b/3 pickups are 23% more expensive and Class 4/5 pickup-based chassis cabs are 32% more, making BEV electrification significantly more expensive than their ICE counterparts for heavy-duty customers over the span of the proposed rule.

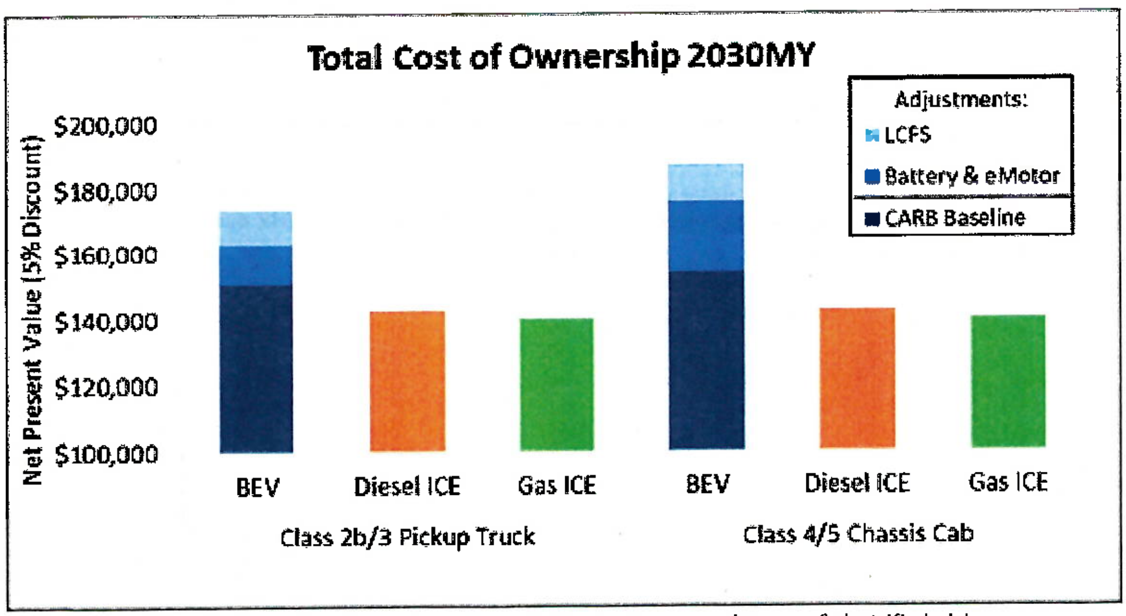

Figure 3-2: Removing uncertain LCFS credits further increases the cost of electrified pickups

After 15 Years of Fuel Savings 2b/3 BEV Pickups Do Not Justify Initial Expense

CARB's total cost analysis recognizes the opportunity to recuperate upfront purchase costs of a more expensive ZEV through lifetime operating cost reductions. Typically, these are derived from electricity charging rates savings when compared to traditional fuel consumption costs. Calculating these savings requires assumptions for the operating life time of a given vehicle. Figure 3-3 shows the total cost of ownership with 5% discount (NPV) for Class 2b/3 pickup trucks, including fuel / energy costs from 2 to 15 years of use, using the CARB-provided calculator and its included assumptions. It shows that gas and diesel pickups have lower lifetime ownership costs than BEVs out to 15 years of operating life. It is understood that most heavy-duty pickup and pickup-based chassis cab operators turn over their fleets significantly more frequently. For fleet operators that turn over their fleets sooner BEVs would have a 60-90% price premium, and cost conscious fleet owners won't spend more to electrify.

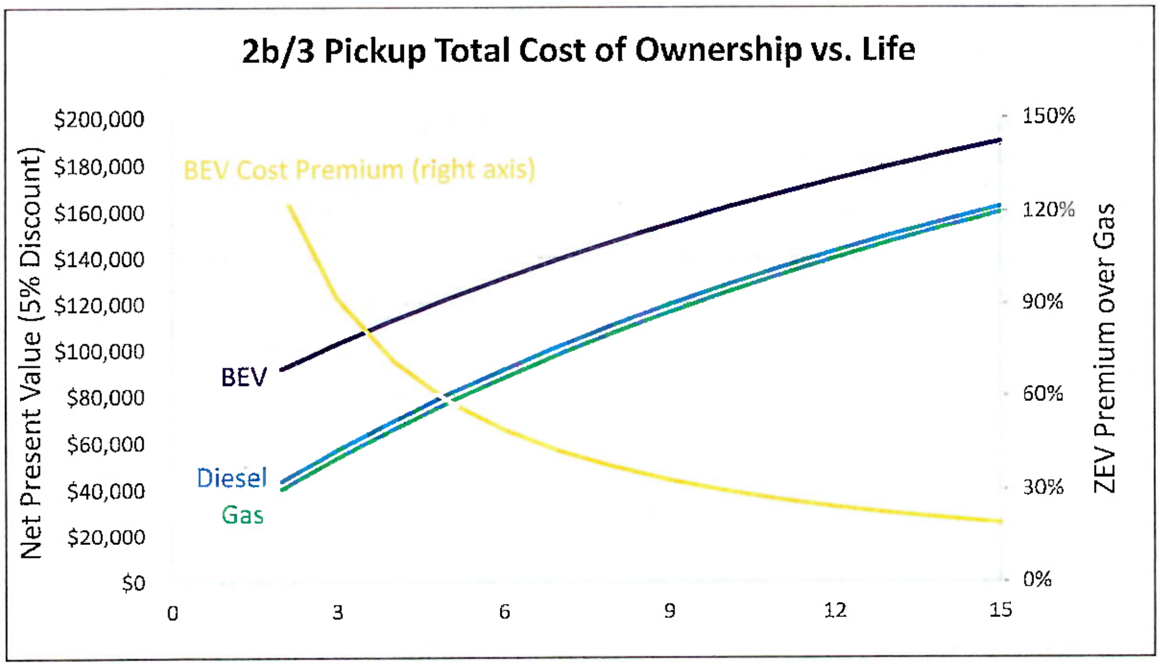

Figure 3-3: Electrified pickups cost more (yellow line above) despite an optimistic ownership length

4. Financial and Logistical Costs Disproportionately Hurt "Small" Customers

Most Pickup and Pickup-based Chassis Cab Customers Are Small Businesses and Retail

As shown in Figure 4-1: Small Business and, FCA heavy-duty customers are broken down into three main types, each of which operates differently. The California-based sales of the Class 2b-5, RAM 2500-5500 pickup and pickup-based trucks consist of 90% small business and retail customers. These small business and retail customers are typically represented by small companies such as landscapers, construction contractors, painters, and handyman services, and compared to the fewer large heavy-duty fleets, would be disproportionately impacted by the financial and logistical costs of operating electrified pickups. In California, this impact is even more pronounced than it would be on the national level, given the larger share of small business and retail customers in the state.

Customer Type[15]	Annual Purchases	Percent of National HD Pickup Fleet[16]	Percent of California HD Pickup Fleet	Example Usage Description
Small Business and Retail	<10	83%	90%	Construction, Plumbing, Painting, Landscaping, Personal Work
Commercial	10+	9%	6%	Agriculture, Electrical, Shipping, Landscaping, Drilling, Construction
Government	varies	3%	4%	Natural Resources / Parks, Emergency, Fire, Water, Airports

Figure 4-1: Small Business and Retail sales make up the vast majority of FCA HD pickup truck sales[17]

Small Business and Retail Customers Are Unlikely to Own Private Charging

In general, charging pick-ups and other electrified product for business use is most easily and efficiently done through privately owned charging infrastructure, which is why CARB correctly identified centralized use-cases as the ideal target of the ACT rule. As referenced in Section 2, required battery sizes for heavy-duty pickup and pickup-based chassis cabs are significant (Figure 2-1). Keeping these battery estimates in mind, **Error! Reference source not found.** shows that the time required to charge the large batteries needed for heavy-duty pickup trucks render Level 2 (LV2) charging impractical in many cases and will require expensive and less common Direct Current Fast Chargers (DCFCs).

Installing new DCFC capability could cost an estimated $52,500, as shown in Figure 4-2 below. Small business and retail operators would have little rationale to select electrification when faced with a choice between an ICE-powered vehicle or a BEV truck + DCFC installation at almost double the cost. Small businesses and retail customers have less flexibility to pay for capital expenses and more difficulty making a case to amortize the cost

[15] Small Business and Retail = Residential/Business address, Commercial=Commercial business address, Small Business=Business address, Government=Government/Municipality owned vehicles: state & local.

[16] An additional 5% of national HD pickup sales are attributed to rental fleets.

[17] "Pickup Fleet" includes class 2b/3 pickups and class 4/5 pickup-based chassis cabs. IHS Markit (POLK Registration and Data, 2018).

over time with fewer vehicles. This is especially true for the many customers who may only have a single vehicle. The CARB TCO analysis underestimated the required battery pack sizing and therefore did not recognize the importance of DCFCs for these particular vehicles (CARB estimated LV2 chargers required for Class 2b through 5 trucks). In reality, very few heavy-duty pickups could be charged in a time-efficient manner using a Level 2 charger, especially the more widespread, commercially available 7kW chargers. Even in cases where a 19kW Level 2 charger is practical, long charging times would push users into paying more expensive peak charging rates, further eroding justification for a BEV heavy-duty truck.

Charger Type	Charger Power (kW)	Charging Time Estimate (hrs)				Charger + Install Cost (CARB Est.)[18]
		150 kWh	200 kWh	250 kWh	300 kWh	
Level 1	1.4	119 hrs	160 hrs	200 hrs	238 hrs	
Level 2	7-19.2	9-24hrs	12-32hrs	15-40hrs	17-48hrs	up to $ 25,000*
DCFC	50	< 5 hrs	< 7 hrs	< 7.5 hrs	< 8 hrs	$ 52,500**

** Level 2 19kW charger cost, **DCFC 40kW charger cost*

Figure 4-2: Large batteries necessitate DCFC charging and increased charger time and cost

Also, it will be small- business and retail consumers who make up the overwhelming majority of pickup and pickup-based chassis cab market that are unable to capture the non-residential charging credits from an LCFS credit program that rewards infrastructure owners. The charging infrastructure owners that can earn credits are more likely to be large fleet operators, utility providers, or charging networks. Even if the small business and retail pickup customers had the ability to earn LCFS non-residential charging credits, they would be burdened with relatively high administrative costs of added staff and IT systems to track, trade, and report credits for compliance purposes. Realistically, it is only a relatively small proportion of large fleet owners that have an opportunity to own charging infrastructure, handle LCFS administrative costs, and capture LCFS credits, leaving out the majority of pickup consumers. As discussed in Section 3, LCFS credits should not be widely assumed or relied upon to justify customer cost savings across all heavy-duty vehicle classes, especially for pickups and pickup-based chassis cabs.

Small Business and Retail Customers Will Incur High Charging Costs

In order to operate electrified heavy-duty pickups and pickup-based chassis cabs without private business infrastructure, small business and retail customers need to rely on publicly-available charging stations. Unfortunately, public charging infrastructure is not sufficiently developed nor deployed to the level required for predictable business operations. In November of 2018, it was estimated that an additional 100,000 DCFC ports would be needed by 2030, but only 6,000 were currently in California. This gap is large, and likely did not even

[18] 10-22-2019 CARB ACT Staff Report ISOR: See Table IX-17 (Charger Power Ratings and Infrastructure Costs).

consider the unique requirements of heavy-duty vehicle operations, such as increased battery sizing, longer charge times, and locations suitable for business operations. Without adequate charging infrastructure, small business and retail customers will be burdened with locating and travelling to a reliable off-site charger – if one exists. As chargers are increasingly built in urban areas, this leaves rural operators behind.

Even with adequate charging infrastructure, recharging at a public charger would prove challenging for business operations due to time spent charging off-site and variable consumer pricing for public DCFC use. As shown before in Figure 4-2, charge time for a heavy-duty vehicle is lengthy even using a DCFC (5-8hrs), yet given the size of batteries needed, DCFC may be the only practical charging method for many customers. While the charging downtime in itself is costly to fleet operators, those small-volume operators that don't have private charging infrastructure will face logistical challenges "at the plug." Lengthy, often overnight, charging would require long-term access or parking agreements with charging infrastructure providers, whereas many chargers today have business hours of operation or time limits on each charge session.

While relying on public infrastructure, small fleet owners would also experience uncertainty in electricity pricing in contrast to current gas and diesel fleet operators. Prices for public charging can fluctuate as indicated in a National Renewable Energy Laboratory report published in October 2019 that showed the cost of electricity for DCFC varies dramatically.[19] It can range from less than $0.10 to over $0.50[20] per kWh, depending on the station characteristics and use level. This could cost small business and retail customers up to $75 (150 kWh battery) and $150 (300 kWh battery) for every DCFC recharge event, which does not compare favorably with the cost of fueling an ICE powered vehicle. Charging at a cost of $0.50 per kWh is equivalent to paying more than $15.00 per gallon of gasoline.[21]

Due to the large concentration of small business and retail customers in the heavy-duty pickup and pickup-based chassis cab market, lower-volume consumers will be unfairly burdened with higher financial and logistical costs. Necessary private charging is out of reach on the small scale, and the public charging that small business and retail customers will be forced to turn to is burdensome – lacking in number, spread, and requiring extensive time off-site at unpredictable prices. These costs are further barriers to BEV adoption for FCA pickup and pickup-based chassis cab customers.

[19] Muratori, M., Kontou, E., and Eichman, J. (2019). Electricity rates for electric vehicle direct current fast charging in the United States. *Renewable and Sustainable Energy Reviews*. Volume 113, 2019, 109235.
[20] High end based on Electrify America's mid-tier rate.
[21] https://afdc.energy.gov/fuels/fuel_comparison_chart.pdf

5. Regulatory Framework

2024MY Proposed Implementation Must Align with the Clean Air Act

As a precondition for EPA granting a waiver, the California standards at issue must be consistent with section 202(a) of the Clean Air Act.[22] Section 202(a) of the Clean Air Act requires a minimum of four full years of lead-time before new heavy-duty vehicle emissions standards can take effect.[23] The rule is expected to be promulgated in 2020CY. Therefore, the ACT Rule implementation should be delayed until 2025MY so the lead time requirement is preserved.

This change should not preclude the early phase-in starting in 2021MY. The delay should not accelerate phase-in of the program or start with a greater ZEV sales requirement. In other words, the proposed ZEV requirements for all years should simply be delayed by 1 year (2025-2031MY vs. proposed 2024-2030MY).

[22] 42 USC § 7543(b)(1)
[23] 42 USC § 7521(a)(3)(C), see also EISA § 102(k)(3)

6. Proposed Changes for the Final Rule

Align Phase-in of Pickup and Pickup-Based Products with Cost of Ownership Based on True Heavy Duty Hauling and Towing Capability

As stated above, CARB appropriately identified total cost of ownership as a critical metric for deciding the viability of products within the diverse heavy-duty market. At the numerous workshops, CARB has recognized and highlighted the importance of a favorable total cost on market acceptance of electrified products, in particular shuttle van and return to base delivery applications. However, analysis was missing for the pickup-based portion of the heavy-duty market that span Class 2b – 5 segments and make up more than one-third of California's total heavy-duty sales. This analysis, which FCA completed using the provided TCO calculator, shows that BEV pickup applications are cost negative, even when assuming small battery sizes that limit capability and purchase incentives unlikely to be available to most pickup purchasers. When these assumptions are corrected, the cost penalty for BEV heavy-duty pickups increases and capability is still compromised. FCA asks that the board affirm staff's recommendation that Class 2b/3 pickup sales requirements start in 2027MY. FCA also recommends the Board consider expanding this timing decision to pickup-based Class 4/5 vehicles.

Gradual Electrification Ramp Rates

Development and market acceptance of products utilizing new technology takes time. The typical product development cycle is four years, and consumer awareness and acceptance requires months if not years of sustained effort. Additionally, specific to BEV technology, the necessary charging infrastructure requires time to install across a wide enough footprint to enable BEV consideration. This market hesitation points to the need for gradual sales ramp rates to accommodate market adjustment. The ACT regulation recognizes the gradual transition in some segments, with requirements starting at 3% in 2024MY for Class 2 Vans and Class 8. However, by specifying a 9% starting requirement for Class 2b/3 pickups in 2027MY, the ACT regulation does not address the need for gradual transition in the segment. FCA asks that when electrified pickups are introduced the initial ramp rates follow the phase-in pattern of the other Class 2b/3 and Class 8 vehicles.

Incentives & Fleet Requirements to Promote Market Acceptance of Electrified Products

As recognized by CARB, a market for the electrified product is fundamental to the success of the rule. Like all consumer products, the success of electrified heavy-duty vehicles is determined by the customer. Without a consumer base, heavy-duty electrification would struggle to take off and make it impossible for manufacturers to meet ACT sales requirements. This could stifle future heavy-duty innovation and harm the potential for future deployment of electrified heavy-duty trucks.

The necessity of a market-correcting policy that helps establish a consumer market in the electrified heavy-duty space can be shown through a study of light-duty incentives. While the historical sales of zero-emission light-duty vehicles is small in comparison to predicted adoption percentages, these numbers have proven higher than they would be without the incentives currently offered by various states and countries. Using Georgia as one case study, researchers at UC Davis pointed to drastic downward sales trends following EV rebate confusion and removal (

Figure 6-1).[24] More recently, Ontario, Canada, removed its EV rebate and saw a similar decrease in electric vehicle sales of more than 54% from 2018 to 2019. Meanwhile, Quebec and British Columbia, Canada, continued their rebate programs and saw increases of 56% and 100%, respectively.[25] Under a more obligatory market-correcting mechanism, sales could be even more targeted and predictable.

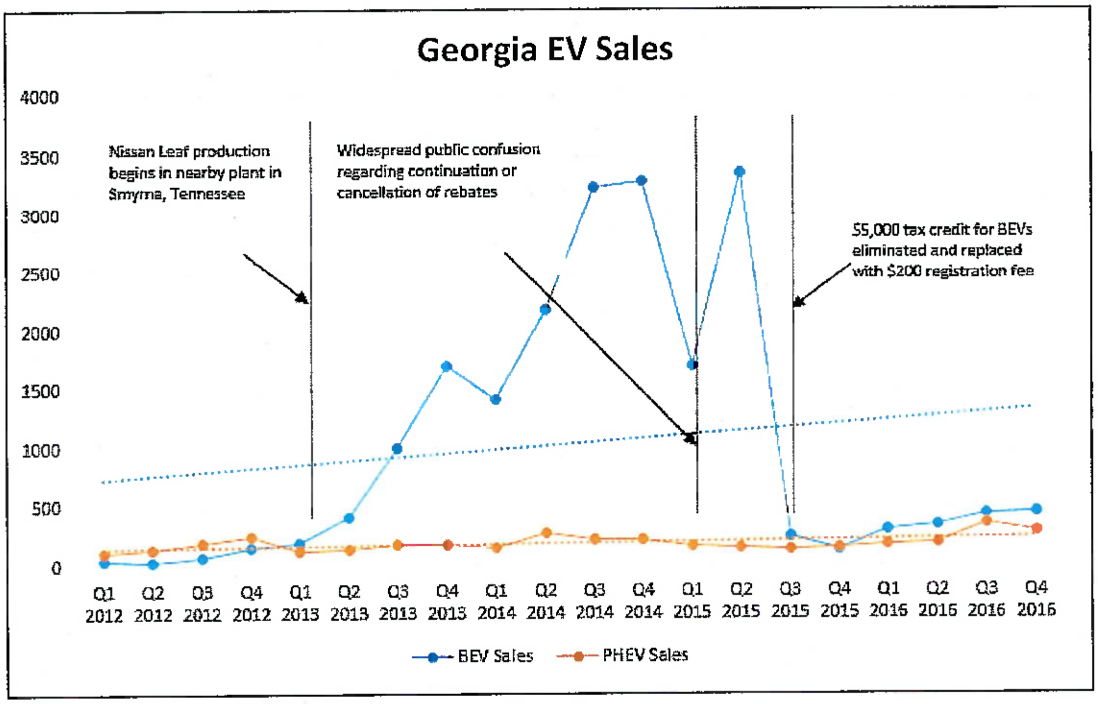

Figure 6-1: Electric vehicle sales rely heavily on purchase incentives

Recognizing the importance of incentives to accelerate technological adoption, CARB has stated its intention for consumer purchase mandates in many ACT public meetings and workshops. FCA supports the implementation of these purchase mandates in order to spur the deployment of electrified heavy-duty trucks and allow manufacturers to meet their zero-emission vehicle sales requirements.

To effectively ensure vehicle sales, CARB's purchase mandate must encompass all segments affected, from Class 2b pickups to Class 8 tractor-trailers, and should be in place no later than the beginning of the rule. CARB has started work implementing targeted fleet purchase incentives through the Zero-emission Airport Shuttle and Innovative Clean Transit rules, but these do not extend to all of the segments impacted by ACT. Class 2b/3 pickups, which will need to carry around one third of the regulatory burden of ACT in 2027MY, do not fall under these categories due to use and weight. A purchase mandate is particularly essential in segments like 2b/3 pickups, where aforementioned capability and cost concerns irrationalize electrification.

The promised market-correcting policy must be implemented in parallel with the ACT regulation, if not before. As seen in the Georgia case study, consumers must be fully aware and sure of a market-correcting mechanism in order for it to have effect. Once product comes, they will then be able to take advantage of it as they did with the Nissan Leaf in 2013 (Figure 6-1). A stable policy implemented alongside the ACT rule that hits all market

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[24] Tal, G. and Brown, A. Credits and Rebates Play a Key Role in Building Consumer Market for Cleaner Electric Vehicles. *University of California-Davis Institute of Transportation Studies: GreenLight Blog.* Ucdavis.edu.
[25] Layson, G. (2019). EV sales continue to plummet in Ontario after provincial rebates end. *Automotive News Canada.* Canada.autonews.com.

segments impacted, especially the pickup segment with its large share, would establish a market for electrified heavy-duty product and a more successful ACT regulation. If CARB staff cannot implement the needed (and promised) fleet purchase mandates in time, ACT requirements should be reevaluated.

Mid-term Evaluation with Defined Metrics for Success

As explained above, electrified heavy-duty pickups will cost significantly more than the conventionally powered versions, their hauling and towing capabilities will be compromised, and owners will have difficulty finding charging stations.

We recognize, however, that battery technology is improving and there will be several more years of advancement before the rule takes effect. There may also be intentions for new rules such as purchase mandates and plans to significantly improve the charging infrastructure.

Should CARB continue to promulgate rules for heavy-duty ZEV pickups on the expectation of future changes, we ask that CARB also consider a regulatory mechanism to adjust the rules should those changes not come to pass. We recommend that CARB consider battery technology (cost, capacity, energy density, specific energy), customer demand, purchase mandates, and the number of charging stations as objective metrics to assess rule success and adjust accordingly. Should these metrics fall short of expectations, we once again would ask that CARB postpone implementation of the heavy-duty ZEV mandate or reduce the number of ZEVs required.

Regulatory Language Clarification

FCA recommends changing the following regulatory language in the ACT rule to avoid ambiguity.

- The NZEV Factor formula changed from a battery capacity based formula (in prior ACT regulatory workshops) to an all-electric range (AER) based formula. FCA requests that CARB clearly indicate the exact AER test procedures to be used for chassis and engine dyno certified NZEV applications.
- FCA suggests rewording section 1963.4 (a) Sales Reporting. Beginning with the 2021 Model Year, a manufacturer must report by March 31 of the calendar year after each model year, the following information to CARB for each type of vehicle certified to California standards and sold in California for each model year.

7. Independent Research Supports FCA Findings

Observations and suggestions made by independent researchers Marshall Miller and Andrew Burke echo FCA's findings regarding the need for alignment and coordination of three critical elements for successful implementation of a new ACT rule: 1) an OEM ZEV sales mandate, 2) a fleet purchase mandate, and 3) available charging Infrastructure including an electricity rate structure that is not burdensome.[26]

Sales and Fleet Mandate Alignment:

This research highlighted the importance of ensuring that ZEV requirements are aligned between OEM offerings and Fleet needs within each segment. Currently, future Fleet requirements are dependent upon the outcome of ACT's fleet reporting provision, an unknown that causes market misalignment concerns. The authors recommend that "ARB should consider eliminating the broad class categories for their mandate and use targeted applications" (like CARB has used with transit buses and airport shuttles) and suggested CARB introduce segments in a staggered timing pattern with highly suitable ZEV segments first. Also highlighted was the concern that OEMs must make product decisions without knowing the distribution of the Fleet purchase mandate. They pointed out that Fleets may avoid ZEV truck purchases with: pre-buys of non-ZEV trucks before a Fleet mandate, ZEV purchase delays (keep their trucks longer), and/or out-of-state non-ZEV purchases (bringing the trucks into California as used vehicles). This could leave OEMs with an inability to sell ZEVs that they have manufactured.

Infrastructure:

The researchers highlighted that charging infrastructure requires significant lead time to install (1-2 years). As such, "... education should be early enough that all fleets have enough time to prepare for decisions related to purchasing and operating ZEVs as well as installing infrastructure."[27] Miller and Burke recommended that "incentives for charging infrastructure be available for fleets during the timeframe for the ZEV mandate."[28]

Total Cost of Ownership:

Miller and Burke additionally mentioned the following TCO concerns: 1) battery sizes must be larger than CARB assumptions due to real world Fleet usage considerations such as hot/cold ambient temperatures, cabin heating/cooling, varied drive cycles/grades, and battery degradation, 2) Fleet operators who do not own chargers will not be able to receive the assumed LCFS credits (including uncertain future LCFS credit value 5-10 years from now), and 3) the CARB total cost calculator uses a 12-year ownership model, but actual ownership models of Fleets are significantly shorter (~5 years), which makes payback periods more challenging for ZEV truck purchasers. Additionally, the authors pointed out that in order to make ZEV purchases competitive with diesel operating costs, ZEV purchase incentives are needed and should remain available for some period of time after the mandate takes effect.

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[26] Personal comments from Miller, M. & Burke, A. researchers at UC-Davis (2019). Issues Concerning the ARB ZEV Truck Mandate Proposal. Sent to CARB and available upon request of authors: mmiller@ucdavis.edu or afburke@ucdavis.edu.

[27] Id p. 11

[28] Id p. 2