

CLEAN TRUCK TECHNOLOGY COMPARATIVE REPORT 7 End User Perspectives on Battery Electric Trucks

METRO GOODS MOVEMENT PLANNING



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1 Introduction

This report will discuss information found in current literature regarding the end user perspectives on battery electric trucks (BET). While the project team searched for information on both types of zero emission trucks, battery electric and hydrogen, little information on hydrogen fuel cell electric trucks (FCET) was found. This is likely due to the nascence of this technology in the market. Nevertheless, the perspective and experience of end users when owning and operating battery electric trucks is an important component that can impact the rate of zero emission truck deployment by operators. Increasingly, there is a recognition that landowners and industrial real estate developers are also key players in the scaled deployment of zero emission trucks as many logistics operators lease land and facilities for their operations. Such feedback is also important to understand the impact of current programs, policies, and industry approaches, which can be instructive for improving approaches to battery electric truck deployment. The project team for this effort reviewed publicly accessible materials to evaluate the perspectives of truck and fleet owners and operators; our team reviewed published articles, video interviews, and public reports. From these materials, we found that, generally, fleets are planning to adopt battery electric vehicles but have several concerns, especially as it relates to cost and range. The following sections include summaries of end user perspectives available in the literature across several key areas, including vehicle performance, maintenance, fueling and infrastructure, costs, impact of incentives, environmental impact, and other perspectives. Perspectives were gathered from the following sources: the North American Council for Freight Efficiency's (NACFE),¹ the UCLA Luskin Center for Innovation,² the Center for Climate and Energy Solutions,³ University of Southern California/California State University Long Beach/University of California at Davis,⁴ the Volvo Low Impact Green Heavy Transport Solutions (LIGHTS) Project,⁵ CALSTART,^{6,7,8} and Rocky Mountain Institute (RMI).⁹

The project team also reached out to several trucking associations and requested any available information that they may have regarding the perspectives of truck and fleet operators within their constituencies. This included outreach to the following: California Trucking Association (CTA), Harbor Trucking Association (HTA), American Trucking Association (ATA), and the NACFE. Both the ATA and

¹ North American Council for Freight Efficiency. (n.d.). Videos. In Run on Less. Retrieved from <https://runonless.com/videos/>

² Di Filippo, J., Callahan, C., Golestani, N. (2019). *Zero-Emission Drayage Trucks: Challenges and Opportunities for the San Pedro Bay Ports*. UCLA Luskin Center for Innovation. https://innovation.luskin.ucla.edu/wp-content/uploads/2019/10/Zero_Emission_Drayage_Trucks.pdf

³ Leung, J., Peace, J. (2020). *Insights on Electric Trucks for Retailers and Trucking Companies*. Center for Climate and Energy Solutions. <https://www.c2es.org/wp-content/uploads/2020/02/Insights-On-Electric-Trucks-For-Retailers-And-Trucking-Companies.pdf>

⁴ Giuliano, G., et al. (2020). *Developing Markets for Zero Emission Vehicles in Short Haul Goods Movement*. National Center for Sustainable Transportation. <https://doi.org/10.7922/G2DN43BT>

⁵ Volvo Group North America. (n.d.). *Volvo Lights: Bringing Battery-Electric Freight Trucks to Market...Guidebook*. Volvo Group North America. <https://cdn.lightsproject.com/collateral/volvo-lights-lessons-learned-guidebook.pdf>

⁶ MacDonnell, O., Facanha, C. (2021). *How Zero-Emission Heavy-Duty Trucks Can Be Part of the Climate Solution*. Global Commercial Vehicle Drive to Zero. <https://calstart.org/wp-content/uploads/2021/05/How-Zero-Emission-Heavy-Duty-Trucks-Can-Be-Part-of-the-Climate-Solution.pdf>

⁷ Gurman, R. (2021). *Taking Commercial Fleet Electrification to Scale: Financing Barriers and Solutions*. Global Commercial Vehicle Drive to Zero. <https://calstart.org/wp-content/uploads/2021/03/Taking-Commercial-Fleet-Electrification-to-Scale-White-Paper.pdf>

⁸ Welch, D., Facanha, C. (2020). *Moving Zero-Emission Freight Toward Commercialization*. Global Commercial Vehicle Drive to Zero. <https://globaldrivetozero.org/site/wp-content/uploads/2020/12/Moving-Zero-Emission-Freight-Toward-Commercialization.pdf>

⁹ Daniels, L., Nelder, C. (2021). *Steep Climb Ahead: How Fleet Managers Can Prepare for the Coming Wave of Electrified Vehicles*. Rocky Mountain Institute. https://rmi.org/wp-content/uploads/dlm_uploads/2021/01/steep_climb_ahead_fleets_survey_2021.pdf

NACFE responded to the project team’s request and directed our attention to several of the resources listed above.

Comments and sentiments documented in this report that reflect on infrastructure investments from industrial real estate developers and landowners are based on Metro staff’s conversations through the 710 Zero Emission Truck Working Group, and comments that were noted at California Air Resources Board (CARB) and California Energy Commission (CEC) workshops which took place during 2021 and 2022 on various clean truck subjects.

2 Literature Review on End User Perspectives for Battery Electric Trucks

2.1 Vehicle Performance

NACFE’s Run on Less is a technology demonstration project coordinated by NACFE and the Rocky Mountain Institute (RMI) with the goal of showcasing innovative solutions for improving efficiency within the freight transportation sector. The Run on Less – Electric (RoL-E) program focuses specifically on electric trucks, and includes a series of short videos from nearly two dozen fleet and manufacturer (OEM) partners, such as NFI Industries and Volvo Trucks, Anheuser-Busch and BYD, Penske and Freightliner, and so on.

The RoL-E program consisted of 13 fleets and represented a wide range of duty cycles, with the demonstration period lasting three weeks. Due to the relatively short duration of the study, maintenance cost data was largely based on existing literature. The vehicles in the study consisted of three terminal tractors, three vans, two medium-duty box trucks, and four heavy-duty regional haul tractors. The four fleet-OEM pairs in the heavy-duty truck (HDT) segment of the study included:

1. Anheuser-Busch with a BYD 8TT tractor
2. Biagi Bros. with a Peterbilt Model 579EV
3. NFI with a Volvo VNR Electric
4. Penske with a Freightliner eCascadia.

In each video, the fleets and OEMs discuss several key components of owning and operating electric trucks and charging infrastructure. When it comes to performance, the majority of fleets interviewed in the video series report being satisfied with vehicle performance. Importantly, Run on Less was designed as a showcase for electric truck technology, and therefore much of the feedback available in its video series is positive. Other related studies and reports have identified more negative and neutral feedback as well. Below is a detailed summary of what these end users shared.¹

Table 1 Summary of End User Perspectives on Battery Electric Truck Performance, Run on Less – Electric

Noise and Vibration Levels
Many fleets mentioned that they are pleased with the low noise and vibration levels of battery electric trucks compared to diesel trucks. Fleets cited multiple benefits of low noise and vibration levels: • Drivers feel more comfortable and less fatigued after long hours of driving • Lower noise levels help drivers to be more aware of their surroundings • Lower noise levels translate to fewer disruptions to people living in areas where the trucks are driving
Truck Exterior and Interior Design
Fleets also shared a couple perspectives on the exterior and interior design of battery electric trucks, including the following: • Drivers are satisfied with more modern designs, and they feel the interior features are comfortable • Battery electric trucks give drivers high visibility of their surroundings because of their design
Handling, Acceleration, and Torque
Fleets shared positive feedback regarding the handling, acceleration, and torque of these trucks. • Generally, drivers mentioned that the driving experience with battery electric trucks is smooth • Fleets shared that the torque and horsepower of current battery electric truck technology make them able to handle heavy loads • Fleets cited the one pedal driving feature as one that helps them have a better driving experience • Battery electric trucks were reported to be very efficient and can climb hills easily • Fleets reported that battery electric trucks accelerate faster than diesel trucks

In addition to the Run on Less video series, two other reports reviewed included information on the perspectives and experiences of end users regarding vehicle performance, including a 2020 report by researchers at the Universities of Southern California, University of California at Davis, and California State University at Long Beach and the 2021 RMI report.^{4,9}

Through surveys and interviews with trucking fleets in California, the University researchers identified several concerns and barriers among fleet owners and operators. First, range concerns existed and fleets that had demonstrated electric trucks experienced lower range than what was reported by vehicle manufacturers (OEMs). The fleets explained that actual range may drop when considering the tendency of drayage operations to require frequent stops, starts, and acceleration to highway speeds. Among the fleets surveyed and interviewed, the minimum range desired was about 300 miles. Fleets reported that battery electric truck acceleration was adequate, though one fleet did report some concerns with getting up to highway speeds when fully loaded. Fleets also shared concerns about the

weight of the trucks, namely the increased weight caused by batteries which could lead to potential reductions in payload given legal weight limits on cargo. Finally, the researchers shared that only firms with relatively short trips reported that they could see themselves adopting battery electric truck technology. A summary of the survey results is listed below.

Table 2 Summary of End User Perspectives on Battery Electric Truck Performance, Run on Less – Range, Acceleration, and Payload

Range, Acceleration, Payload
Survey results were generally positive, but with several concerns, including the following: • Lower real-world range compared to OEM specifications • Potential acceleration concerns when trucks are fully loaded • Payload limitations due to increased weight from battery pack

RMI surveyed 91 fleets and interviewed 18 fleets (Class 2 through 8). One of the survey questions posed to fleets was a request to select their biggest concern or barrier to electrification. The top answer was a concern that EV models are not available (tied for first with vehicle cost), and the next most popular answer was a concern that vehicle duty cycles were not suitable for electrification, which may be the case for some vehicle operations, such as those with daily mileage that is higher than an EV's range or mileage that is too low to generate fuel cost savings to offset the high upfront cost of BETs.

2.2 Vehicle Maintenance

Fleet owners and operators interviewed as part of NACFE's Run on Less video series mentioned that the maintenance costs for battery electric trucks differ from diesel trucks; they also shared that wear and tear is significantly less than what is commonly experienced with diesel trucks. Fleets shared the following perspectives with respect to vehicle maintenance:¹

Table 3 Summary of End User Perspectives on Battery Electric Truck Maintenance, Run on Less – Electric

Maintenance and Charging
• Interviewees said that the one pedal driving feature of battery electric trucks can reduce maintenance costs since no-to-minimal wear and tear occurs on the braking system when using this feature • Fleets shared that the truck batteries operate well and they are satisfied with charging rates • Fleets shared that less maintenance is needed for battery electric trucks than for diesel trucks, and maintenance costs are lower • Fleet operators explained that training in-house maintenance staff to resolve technical issues is recommended

None of the other literature reviewed discussed end user perspectives on battery electric truck maintenance directly. However, the Volvo LIGHTS guidebook did explain that Rio Hondo College in Los Angeles County and San Bernardino Valley College in San Bernardino County designed a technician program specific to Volvo heavy-duty electric truck maintenance as part of the project.⁵ Such training programs are imperative for large scale EV truck deployment as maintenance staff must be trained on

battery electric trucks, and to create a pipeline for a new generation of workers who can service heavy-duty electric trucks.

2.3 Charging and Infrastructure

Fleets interviewed in the Run on Less video series reported high levels of satisfaction with their charging experience. These fleets deployed a range of charging infrastructure, including both Level 2 and direct current fast charging (DCFC).¹

The only other piece of literature reviewed which discussed end user perspectives on fueling and charging infrastructure directly was the RMI report. When fleets were asked what their biggest concern or barrier to electrification is, about 19% of respondents said that their unfamiliarity with EV charging and associated operations is their biggest barrier. This response was fifth out of seven options, behind vehicle cost, EV model availability, duty cycle concerns, and insufficient budgets.⁹

Beyond the literature reviewed, it is generally known that charging infrastructure can be a major barrier to electrification for fleets, both the development of private charging infrastructure and the availability of public charging infrastructure. Complexity in the development of charging infrastructure exists in several forms, including the need for upgrades to the electric distribution grid, the timelines associated with such infrastructure development, and the associated capital costs. Further, fleets may be less prepared to deploy electric trucks if a lack of public or shared charging infrastructure facilities exists.

Transportation and logistics industry representatives have weighed in on the challenges that surround EV charging infrastructure through discussions that have been led by Metro's 710 Zero Emission Truck Working Group to-date, a forum which aims to inform Metro in realizing corridor-scale ZE truck deployment along the I-710. These stakeholders have expressed that the developing adequate charging infrastructure, both public and private, will be a significant challenge to achieving the State's large-scale electric truck deployment goals on their target timeline. Developing private charging infrastructure requires significant upfront capital investment, which can take a long time to develop depending on how extensive the project is, and is generally new to fleets. This issue is further complicated by a typical arrangement for some parties involved in the transportation and warehousing industry, facility leases. Warehouse operators, third-party logistics (3PL) companies, and other transportation organizations that operate fleets may lease their facilities from industrial real estate developers, and developing charging infrastructure at the facility requires an agreement between the lessor and lessee. In discussions regarding this project, one such developer which operates in Southern California shared several perspectives on this topic. The developer shared that they are starting to receive inquiries from tenants about upgrading their facilities to meet the demand for EV truck charging. While the developer shared that the number of such inquiries is still relatively small, they recognize the need to forecast the demand for other such requests in the future. The developer shared several concerns about future charging infrastructure development. First, in a built environment like urban areas of Los Angeles County which have low vacancy rates among industrial buildings, designing a site to accommodate electric trucks and on-site charging infrastructure may require demolishing old buildings which have reached the end of their useful lives and building new facilities. For real estate developers and landlords, investing in electric truck charging infrastructure brings uncertainties, such as how long tenants which request such amenities will stay in the facility and whether future tenants will see the value in having charging infrastructure. This highlights a need for more discussions and relationship-building between developers, landlords, and logistics companies to determine a path forward for leased facilities.

2.4 Cost

The upfront cost of buying battery electric trucks and developing associated charging infrastructure is commonly cited as a primary barrier to increased deployment. While, under the right conditions, the lifetime total cost of ownership (TCO) of battery electric trucks may be lower than that of diesel trucks (discussed further in Technical Reports 2 and 6), the capital investment required to deploy the vehicle

and infrastructure can be a difficult obstacle for many fleets. This is a common finding across studies and reports on this technology, including a 2020 report by the Center for Climate and Energy Solutions, in which interviewed fleets expressed similar sentiments.³

In the RMI report, high vehicle cost was the top concern among fleets surveyed about their barriers to electrification; 60% of survey respondents said that their biggest concern was that vehicle cost is too high. Additionally, 38% of respondents said that their biggest concern was insufficient budget to cover upfront costs, 12% said it was uncertainty about charging costs, and 8% said it was uncertainty about the future costs of gasoline or diesel.⁹

The study conducted by researchers at the University of Southern California, University of California at Davis, and California State University at Long Beach also found similar concerns regarding cost. One fleet interviewed stated that a \$300,000 investment for a battery electric truck could not be justified since the cost for their new diesel trucks was about \$98,000 and \$157,000 for natural gas. This interviewee estimated that if they electrified their entire fleet, their drayage rate may double or triple.⁴

2.5 Incentive Programs

While incentive programs are designed to support fleet owners and truck operators by reducing the upfront and ongoing costs of battery electric vehicles, some fleets have reported experiencing trouble with such programs. The only piece of literature that discussed end user perspectives on this topic directly was the previously mentioned study by California university researchers. Researchers of this study found that most fleets had used incentives in the past, including vehicle and infrastructure purchase rebates and subsidies, electric charging rates, and tax credits; however, many participants reported that they experienced difficulties with these programs. To these fleets, incentives were seen as problematic, challenging to use, and not well understood. This aligns with a finding within a 2022 report by the Fuels Institute regarding policies for EV charging infrastructure deployment which found that incentive programs that are less complex and cumbersome are reported to be more effective and attractive to end users.¹⁰

Additionally, in discussions regarding this project, trucking industry representatives anecdotally cited that certain costs can be associated with electric truck deployment while receiving some incentives, including income taxes, vehicle registration fees, and sales taxes. One example of this is the Carl Moyer Program which provides grants for cleaner-than-required engines. Current federal and state laws do not specifically exclude Carl Moyer Program grants from gross income, and therefore they may be subject to federal and state income taxes. Refer to Technical Report 6 for more information on this topic.

2.6 Environmental Impact

Fleets interviewed as part of NACFE's Run on Less video series were generally positive about the environmental impact of their battery electric truck deployments. Fleet owners and operators shared the following:¹

- One Canadian fleet shared that adopting battery electric trucks helps them with their goal of being the greenest company in Canada
- Several fleets mentioned that they are proud to adopt battery electric trucks and it is important to them that they are contributing to reduced emissions
- Fleets shared that adopting battery electric trucks supports their brand as environmentally friendly companies with more sustainable operations

¹⁰ Fuels Institute & ICF. (2022). *Evaluation of Policies for Electric Vehicle Charging Infrastructure Deployment*. Fuels Institute: <https://www.fuelsinstitute.org/Research/Reports/Evaluation-of-Policies-for-Electric-Vehicle-Chargi>

Other literature reviewed also discussed end users' perspectives regarding the environmental impact of using battery electric trucks, including the 2020 study by California university researchers and the RMI report. The California university researchers found that the drayage truck companies interviewed appreciate the marketing potential of operating battery electric trucks, but other concerns outweigh this consideration (e.g., range, cost). All but one fleet surveyed in this study agreed that using battery electric trucks are a competitive marketing tool. Similarly, fleets responding to the RMI survey and interviews stated that they recognize their responsibility to be good citizens from an environmental perspective.

2.7 Other Perspectives

The literature reviewed included several other informative perspectives from end users regarding battery electric trucks. Below is a summary of those perspectives:

From the 2020 Study by California University Researchers⁴

- Study participants ranked concerns about alternative fuel trucks in the following order
 - Vehicle cost
 - Charging equipment cost
 - Fueling/charging time
 - Performance (e.g., on hills and when carrying heavy cargo)
 - Fueling/charging locations
 - Range
 - Maintenance cost
 - Fuel cost
- Summary of study participants' attitudes about electric trucks
 - 24% said very knowledgeable, 66% said they are somewhat knowledgeable about electric trucks, and 10% said they are not at all knowledgeable
 - Purchase price and range are top concerns among respondents regarding electric trucks, followed by charging locations and operating costs
 - If given a choice of just one government program to incentivize electric trucks, 38% of respondents said they would prefer no government incentive program, 26% would prefer low-interest loans or leases, 23% would prefer purchase price rebates, and 13% would prefer charging equipment rebates

From the 2021 CALSTART Report, *How Zero-Emission Heavy-Duty Trucks Can Be Part of the Climate Solution*⁶

- This report listed the following barriers and concerns for zero-emission vehicle adoption:
 - High cost of batteries
 - Extra weight associated with batteries leading to potential reductions in payload and truck utilization
 - Limited range
 - Charging time and convenience
 - Lack of confidence that technology can fulfill operational requirements

From the 2021 CALSTART Paper, *Taking Commercial Fleet Electrification to Scale: Financing Barriers and Solutions*⁷

- This paper did not discuss end user perspectives directly, but it did explain that fleet operators have cited a lack of commercial EV models available to meet their specific needs as a barrier, as well as an inability to customize EV model options without significant increases in cost.

From the 2020 CALSTART Paper, *Moving Zero-Emission Freight Toward Commercialization*⁸

- This paper did not discuss end user perspectives directly, but it did explain that fleets adopting used trucks in their second life may have concerns over the useful lifetime of used batteries.

3 Summary and Key Takeaways

This report summarized publicly available information on end user perspectives regarding heavy-duty battery electric trucks. User perspectives on hydrogen fuel cell trucks are not documented due to limited adoption of such trucks and a lack of information available at this time. The project team reviewed several reports, papers, and videos on this topic across multiple sources, including NACFE, the UCLA Luskin Center for Innovation, the Center for Climate and Energy Solutions, research by California university researchers, a guidebook from the Volvo LIGHTS project, CALSTART, and the Rocky Mountain Institute. The sources identified a mixed set of perspectives among end users, including both positive and negative views about the technology. Generally, experiences among fleets using heavy-duty battery electric trucks have been positive, but several concerns exist among fleets, and some fleets have also had negative experiences. Key concerns include vehicle and infrastructure cost, the actual range of vehicles, the weight of batteries and subsequent impacts to payload and truck utilization, availability of electric truck models capable of meeting duty cycle requirements, and the availability of public charging infrastructure as well as the processes and cost required to develop private charging infrastructure.