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2015 E-Truck Task Force: Key Barriers Affecting E-Truck Adoption, Industry and Policy Implications, and Recommendations to Move the Market Forward

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Summary

CALSTART's E-Truck Task Force (ETTF) produced a report outlining the markets for *electric drive trucks* (E-Trucks), the prime barriers facing their success and provided key findings and recommendations to support expanding E-Truck adoption. Four key findings have been identified by the E-Truck Task Force as barriers currently affecting the growth and viability of E-Truck sales; 1) high incremental *cost*, 2) poor vehicle quality and support from supplier(s), 3) unexpected costs and energy planning with *infrastructure*, and 4) reduced operation in extreme climates. The E-Truck Task Force developed a set of action-oriented recommendations for overcoming each barrier.

1. E-Truck Task Force Background

1.1 Key Findings from 2012 E-TTF Report

CALSTART's E-Truck Task Force (E-TTF) was originally created in 2011 to help understand, support and expand the production and successful deployment and use of plug-in electric trucks and buses. CALSTART published *E-Truck Task Force Findings and Recommendations* in 2012 based on a year-long research and industry engagement process. In that report CALSTART outlined the best use profiles for successful E-Truck deployment, provided a business case calculator for fleets, highlighted early adopter user experience, developed an infrastructure planning guide, and then established industry recommendations of actions required to speed market success. The figure below provides a summary of the 2012 E-Truck Task Force Findings.

Indeed, had E-Truck markets continued to grow, the Task Force's participants believed the cost of E-Trucks could have dropped 11-20 percent by 2017 due to manufacturing improvements and energy storage price reductions, targeted incentive programs and full life cycle purchase evaluations.

2012 E-TTF Key Findings

Cost:

Incremental cost is the biggest barrier to E-Truck purchase/production, but costs do show decline over time; incentive funding is needed in the transition period to cover at least 50% or more of incremental cost.

Quality and Support:

Vehicle quality, warranty, and support are barriers to faster adoption and need to be improved.

Performance Validation and Business Case:

Fleets need better performance data on E-Trucks in real-world usage to validate the reliability and business case of the vehicles, including guidance on best use profiles for their operation and payback.

Infrastructure Needs:

Infrastructure cost and planning complications are a surprise to fleets and are important next tier issues needing resolution.

Figure 1. 2012 E-Truck Task Force Key Findings

1.2 Task Force Process for 2015 Update

In September 2014, CALSTART started the process of updating the 2012 report by reinitiating the E-Truck Task Force at the High-Efficiency Truck Users Forum (HTUF) National Meeting at the Argonne National Laboratory in Illinois. CALSTART facilitated a two-hour E-Truck Task Force Workshop focused on identifying progress against the 2012 report, changes in the industry and current industry barriers. To effectively capture feedback on all aspects of E-Truck commercialization, CALSTART organized a leadership panel comprised of different E-Truck perspectives including a fleet end-user, E-Truck manufacturer, electric utility, and a state government agency responsible for E-Truck incentives to help engage a meaningful discussion with Task Force members on issues that are unique to each perspective. During this session, CALSTART outlined the key barriers presented in the 2012 report and worked with the Task Force to evaluate where changes have been made and where barriers continue to be problem for market development.

Since the 2014 meeting, CALSTART continued to engage with Task Force members through a series of smaller meetings and one-on-one interviews with E-Truck suppliers and fleet end-users. To report on the outcome of these meetings, CALSTART prepared a draft summary of key barriers and recommendations and presented it to an E-Truck Task Force Workshop in parallel with the Alternative Clean Transportation EXPO in Dallas, TX in May 2015. This meeting provided an opportunity for CALSTART to confirm consensus on key barriers and the actions needed to move the industry forward.

In general, many of the same barriers facing E-Truck adoption in 2011 are still present but have been in many ways exacerbated by other conditions in the intervening years. Solutions previously envisioned to overcome the initial barriers identified in prior E-Truck Task Force activities have either not yet materialized or have required major adjustments by stalled market conditions. Based on the results of the 2014-2015 E-Truck Task Force findings, this report serves to summarize the decline in E-Truck production, outlines key challenges facing E-Truck manufacturers and suppliers, and identifies four key barriers that are critical to the E-Truck market and recommendations for corrective actions, all described in this update. Additionally, CALSTART reviews important changes that have been made to existing incentive markets that are key to helping the industry move forward.

2. Key Findings

2.1 Decline in E-Truck Production

The E-Truck market has fallen significantly off the growth path it enjoyed as recently as 2013. The larger suppliers have left the market. This section summarizes some of the critical issues suppliers are facing that has resulted in selling fewer E-Trucks or discontinuing production. As seen in Figure 2 below, while vehicle deliveries remained high into 2013, this was also a lagging indicator and added confusion into the market that supply and demand were up while suppliers started facing challenges with lack of available parts, production delays and unexpected costs. However, vehicle orders, a more meaningful indicator of market direction, had already started a sharp drop off in 2011.

The first large-scale incentive program for E-Trucks, the California Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP), introduced incentives for E-Trucks in 2011. In California HVIP, E-Truck orders peaked in 2011 at 227, and deliveries for those orders peaked at 171 in 2013. Deliveries typically trail orders by 12-20 months for large orders.

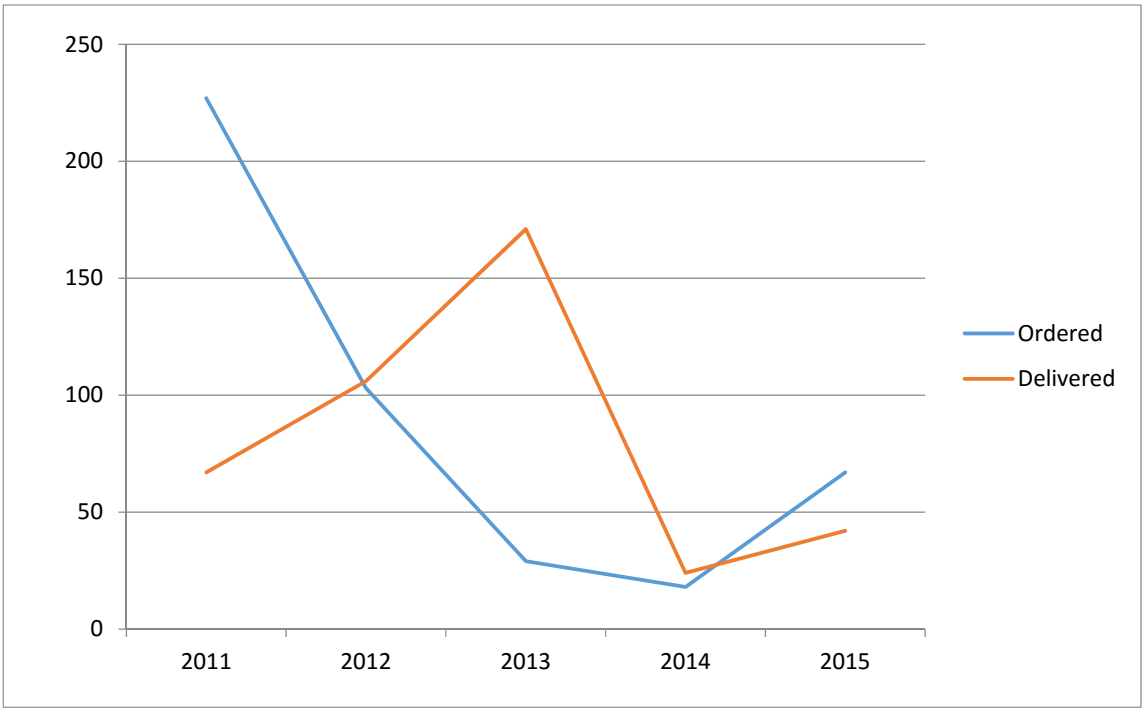

Figure 2: E-Truck Sales through California HVIP from 2011 - 2015

There are emerging signs of growth from some new suppliers, some of whom show strong promise to address issues identified in the 2012 findings that hope to restore E-Trucks to a growing market. But that growth will not likely be able to hit 2011 scale until 2016-2017.

2.2 Status of E-Truck Suppliers

A major challenge to the success of the E-Truck market over the past several years has been the unique internal issues faced by several of the earlier vehicle suppliers. Common themes among several companies included a lack of adequate financial capitalization, limited customer service and support networks, overextended engineering capability and the challenge to make a business case for users in the absence of sufficient support funding. Collectively this led to the significant downturn in the E-Truck market.

Smith Electric had 2011 plans for an Initial Public Offering (IPO) to raise capital to continue the growth they enjoyed at the time. The IPO failed to go through, and Smith has been operating with severely constrained liquidity ever since. Production was initially constrained, then halted. Smith had been working diligently to support the development of several E-Truck incentive markets as well as through federal-funded programs. However, as the programs came online, Smith had fallen into its liquidity problems, and could not sell into the incentive markets. These E-Truck incentive programs, which were created in large part for the use of Smith E-Trucks, therefore went largely unused. Smith continues to work to raise additional capital and relaunch sales and production. The impact of the most recent investment and creation of a joint venture with FDG Electric Vehicles of China has yet to be seen. Smith also faces challenges to support the existing deployments of E-Trucks around the country. Several fleets have reported operational and reliability problems that a constricted Smith has been unable to address. This specific issue was highlighted vociferously during a fleet panel discussion in 2014 at the HTUF National Meeting.

Electric Vehicle International (EVI) had secured a 100-truck order from UPS in 2011. EVI worked to design, manufacture and deliver the trucks over a two-year period, finally finishing deliveries in June 2013. It was by far the largest order EVI had received, and required considerable focus to design an E-Truck to the demanding duty life-cycle specification of UPS and also to scale up to manufacture such a large, serial order when the company was staffed as a relatively small producer. EVI learned the vehicles were more expensive to build than they had originally forecast. Even with incentives, future sales of the existing design would have resulted in a loss on each vehicle produced. EVI went out of business and EVI's assets were acquired by First Priority Electric Vehicles LLC in 2016.

Boulder Electric Vehicle designed a more-efficient E-Truck that used a lighter-weight chassis and smaller capacity battery pack. Boulder sold a limited number of E-Trucks into its local Colorado market. While the company had established a sales team and a California production facility, it still struggled to secure E-Truck orders, even with incentives available at the time. But the E-Truck market had already collapsed by 2013, and given early difficulties experienced with other product offerings, fleets were increasingly reluctant to place orders with a relatively untested supplier. Boulder decided to cease operation and closed all their facilities in 2014.

Navistar launched the eStar 300 delivery truck in 2010. Navistar had been the leading truck OEM supporting the development of hybrids and E-Trucks at the time. Navistar sold and fielded the eStar in multiple markets across the nation, to a great extent funded by a multi-million-dollar grant from the American Recovery and Reinvestment Act (ARRA) of 2009 program. But by 2012, Navistar was facing significant challenges in its primary product market (conventional diesel trucks and engines). Navistar was the only heavy-duty diesel manufacturer to reject use of selective catalytic reduction (SCR) emission control systems in favor of a proprietary suite of alternative solutions.

As a result of this action, Navistar did not produce the required emission reductions required of the 2010 diesel engine emission regulations. Navistar later adopted an SCR strategy to reduce oxides of Nitrogen from its diesel engines. Unfortunately, however, Navistar faced significant cost, government fines, and substantial lost sales in the interim. The company decided to close down its smaller-market advanced technology initiatives, including its hybrid-electric and all-electric truck platforms to help recover costs. The eStar is among one of the technologies that had been cancelled as a result of the shortcomings with their diesel engine design.

Azure Dynamics was a growing supplier of hybrid-electric and all-electric trucks into the early 2010's. Azure focused on up-fitting new Ford E-series (to hybrid-electric) and Transit Connect (to all-electric) platforms. Azure sold 50 electric Transit Connects into the California market through HVIP, and more across other US markets. But financial challenges led to the bankruptcy of Azure in 2013. While customers were generally happy with the performance of the electric Transit Connect, the company could not overcome liquidity constraints. Azure's assets were liquidated. A number of inventive consultants have grown a cottage industry of providing parts and service to the existing population of Azure trucks in use.

Each of the suppliers outlined in the preceding paragraphs was considered a rising star in 2011. Incentive programs were being crafted to support the projected growth in demand and supply of E-Trucks. Instead, within two years, each of these suppliers had halted production. As a result, several of the incentive programs recently opened found their E-Truck funds went unused.

A new set of suppliers has since entered the E-Truck market.

Workhorse (formerly AMP Electric Vehicles) offers an all-electric walk-in van with a 120-kWh battery pack, and a range-extended electric walk-in van with a 60-kWh battery pack and an on-board gasoline-fueled generator that can only be used when the vehicle is parked to recharge a depleted battery pack.

Zenith Motors provides all-electric drive versions of the Dodge ProMaster. Zenith offers Class 2 and 3 shuttle bus and cargo van configurations. Zenith has had particularly good success selling into the airport and hotel shuttle bus markets.

Phoenix Motorcars uses a Ford E350/E450 platform for all-electric shuttle buses and flatbed trucks.

Motiv Power Systems has multiple truck and bus platforms, including all-electric versions of the Ford E450, Ford F59, school bus, refuse truck, and shuttle bus.

Orange EV performs an all-electric conversion for Class 8 yard trucks.

BYD is entering the US market with a line of electric trucks from Class 2 through Class 8.

2.3 Cost

In 2011, the incremental cost of an E-Truck was identified as the biggest barrier to vehicle purchase. A 2011 CALSTART survey of 200 fleets and industry representatives suggested that 38 percent of the stakeholders surveyed needed incentives to cover at least half or more of the incremental cost to stimulate demand, while 24 percent identified 75 percent of the incremental cost, and 21 percent identified full incremental cost as necessary. Based on recent interviews and the market decisions of customers over the past four years, it seems current opinion requires incentive levels of about 80 to 100 percent of the full incremental cost to incentivize their purchasing decision.

From the 2012 E-Truck Task Force report, a survey of stakeholder expectations projected that E-Truck prices could decrease by 11 to 20 percent from 2012 to 2017 based on increasing volumes. Given the lack of volume increases and the inability to invest in engineering and supply chain savings, this has not happened. Energy storage prices also continue to remain significantly expensive; and though battery prices continue to drop at the cell level, they remain high at the customized, low volume pack level. Customer experience with battery pack sizing in earlier fleet trials has also led customers to ask for larger battery pack sizes to overcome range and cold-weather battery degradation concerns, further increasing the cost of the battery system.

Other cost barriers identified by fleet-users among Task Force members included the difficulty of maintaining an E-Truck fleet with numerous unexpected maintenance costs and the additional costs resulting in a delay of adequate and timely technical support. Fleet users discussed a need for dealerships to provide leasing options with adequate support packages.

Based on fleet response, it appears E-Truck incentive programs today need to target roughly 80 percent of incremental cost to stimulate demand. This means 80 percent of the actual incremental cost, and requires, in many cases, increasing artificially low incremental cost caps. Battery leasing options, which were identified four years ago as a potential solution, have not yet made it to market, although suppliers continue to press to make battery leasing possible. There is hope the upcoming Tesla battery plant may help reduce the overall cost of batteries but its completion is years away. BYD Motors entering the market may assist with battery cost, at least for its own products, as it remains one of the world's leading manufacturers of lithium ion batteries.

E-Truck Task Force Recommendations: Reduce E-Truck Costs

1. Increase voucher incentives to cover 80 to 100 percent of incremental cost while increasing the "cap" amount allowed on the incremental cost to levels more appropriate to real product cost (some caps now reach $150,000) similar to what has been done for the California and Chicago voucher incentive programs.

2. Call on vehicle and battery industry to develop cost effective solutions for batteries such as instituting battery leasing model for E-trucks, extend battery warranties beyond five years, and work with fleet to "right-size" the battery to customer's duty cycle.

3. Encourage dealerships to provide E-Truck leasing options (7- to 10-year period suggested) to fleet users combined with a support package.

4. Funding agencies to evaluate innovative incentive programs to help underwrite risks, develop a loss reserve when high cost issues occur, and to provide support with ongoing maintenance.

Figure 3: E-Truck Task Force Recommendations: Reduce E-Truck Costs

2.4 Quality and Support

Poor vehicle quality and lack of supplier support is impacting consumer confidence in future E-Truck purchases.

Vehicle durability and supplier support remain significant concerns to fleet customers. The perceived lack of support is also acting as a deployment barrier for vehicle purchases as fleets learn from peers the difficulties of maintaining an E-Truck fleet without reliable support to maintain their successful operation. Fleets are experiencing high failure rates and in turn are waiting long periods of time for technical support and for parts to arrive. As a result, fleets are hindered by non-operational vehicles for unanticipated periods of time resulting in additional costs that may result from rentals or from the cost of fuel by using a conventional counterpart. In addition, fleet users express poor guidance from suppliers on the technology suitability and often too late learn that E-Trucks for certain duty cycles may not be appropriate. Many fleets that made earlier purchases are now waiting to see if reliability and service can be improved before committing to additional orders, which affects market recovery.

Due to financial and supply chain issues, E-Truck suppliers have had challenges responding to warranty claims and providing local service support to E-Truck customers. Suppliers need to build out their service network to provide local and regional support especially, in incentive markets where the potential in growth of E-Truck sales is higher. Alternatively, suppliers could also address these concerns by focusing their sales in regions they could adequately support. E-Truck suppliers should better anticipate customer needs and create a reserve of critical parts to help speed up same day service and repair in addition to training fleet technicians on vehicle repair and maintenance. This along with instituting more timely service calls and ensuring high quality standard checks before a vehicle leaves a manufacturing facility are critical to ensuring a good customer relationship and fleet sustainability.

Lastly, suppliers need to better determine E-Truck suitability for fleet adoption to prevent disappointing results and unnecessary costs. Developing a "Buyer's Best Practices Guide" would help fleets evaluate the business case, be prepared on what to expect, and have better guidance on suitability and planning for E-Truck adoption. Over the last year, there have been new smaller-niched E-Truck suppliers that have entered the market that are not experiencing the barriers described above.

E-Truck Task Force Recommendations: Improve Vehicle Quality and Service Support

1. Suppliers of E-Trucks and batteries to build out local and regional service support in key market areas and to create critical parts reserve to allow for timelier same-day service and support.
2. Suppliers to increase quality control checks before vehicle delivery and to provide regular and timelier service calls to ensure successful vehicle operation.
3. Suppliers to train fleet technicians on technical repair and vehicle maintenance.
4. Develop "Buyer's Best Practices Guide" to help fleet user make smarter purchasing decisions on E-Trucks. Guide to include business case, user experience profiles, case studies, infrastructure needs and other best practices.

Figure 4: E-Truck Task Force Recommendations: Improve Vehicle Quality and Service Support

2.5 Infrastructure Needs

The cost of establishing EV charging infrastructure in fleet facilities continues to be a big surprise to fleets.

The unknown costs that go into EV charging infrastructure for E-Truck fleets continues to remain a big barrier and concern to fleet owners. Fleet users are often unaware of the potential electrical capacity upgrades that might be required at their facility to support charging infrastructure and the costs and time to perform those upgrades. Especially in older buildings that have old wiring systems, making it extremely difficult to manage power loads for EV charging. In addition, there is uncertainty surrounding the potential cost of installing charging infrastructure and the added cost structures such as demand charges. These unknown costs and steps can dissuade fleets from considering E-Truck adoption.

Utilities are working state-by-state to pursue the ability to rate-base the cost of electrical system upgrades (such as increased facility capacity) required for the installation of charging infrastructure. This would shift a potential cost burden from early adopters to those who benefit from the clean air and grid stability that can be provided. However, the timing for such changes is limited by lengthy regulatory review. Regional pilot projects allowing utilities to experiment with support for facility upgrades, "make-ready" programs for EVSE installation and flexibility in demand charges if used for E-Trucks (demand charges are extra fees – often significant – added when a facility uses more energy than its typical demand profile, which is common when E-truck load is added).

As an outcome of the E-Truck Task Force activities performed in 2011, CALSTART developed the E-TTF Infrastructure Planning Guidelines for E-Truck Fleets to provide fleets with important guidance on what to expect when planning for the integration of EV infrastructure to accommodate an E-Truck fleet. These guidelines were developed to address fleet concerns on the unknown costs and planning required for infrastructure needs. With so many variables to consider, it is important that fleets understand the number of EVSE to install based on fleet size, any specific charging needs and upgrades, cost for installation and whether there are incentives available to help buy down infrastructure costs. It is important that CALSTART and the E-Truck Task Force continue to raise awareness and encourage fleets to use this important planning tool.

E-Truck Task Force Recommendations: Address Fleet Concerns with Infrastructure Planning

1. E-Truck Task Force to raise awareness and encourage fleets to use the E-TTF Infrastructure Planning Guidelines for E-Truck Fleets.
2. Improve state-by-state coordination to rate base electrical system upgrades required for the installation of charging infrastructure.
3. Work to create a commercial EV charging rate.
4. Roll out incentives for EV infrastructure and E-Trucks at the same time in a voucher or similar

Figure 5: E-Truck Task Force Recommendations: Address Fleet Concerns with Infrastructure Planning

2.6 Cold Weather Performance

Extreme cold temperatures have negative effects on in-cabin heating and range capacity for E-Trucks.

The unprecedented bitter cold winter of 2013-14 greatly challenged the performance of E-Trucks in the upper Midwest and Northeast. Feedback from E-Truck fleet users not only experienced difficulties keeping in-cabin heating adequate for creature comfort, but observed that electric cabin heating experienced greater parasitic effect as temperatures dropped. Similarly, Lithium-Ion batteries showed notable capacity degradation as temperatures fell below zero. Together, these effects greatly reduced vehicle range by as much as half. The extreme temperatures also proved more difficult to charge Lithium-Ion batteries that had already been exposed to cold weather.

Suppliers have responded with several technical solutions to address range degradation and in-cabin heating. With the use of better insulation and battery pack thermal management systems, fleets can control the level of degradation in extreme climates. The use of fuel-fired cabin heaters eliminates the parasitic load of electric cabin heating and can also maintain warm battery pack temperatures. To address in-cabin heating issues in key incentive markets, CALSTART worked with the Chicago and New York voucher incentive programs to allow for the use of fuel-fired cabin heaters. CALSTART also produced a white paper entitled, E-Truck Performance in Cold Weather, to better understand and quantify the impact of cold weather on E-Truck performance in order to manage fleet expectations, and to explore solutions to maintain E-Truck performance in cold weather.

E-Truck Task Force Recommendations: Mitigating Cold Climate Challenges

1. Suppliers to provide better insulation and battery pack thermal management systems for E-Trucks that operate in extreme climates.
2. Fleets to use fuel-fired cabin heaters to eliminate parasitic load of electric cabin heating.
3. Fleets to review CALSTART white paper *E-Truck Performance in Cold Weather* to understand the impacts of cold weather on E-Truck performance.

Figure 6: E-Truck Task Force Recommendations: Mitigating Cold Climate Challenges

3. The Path Forward

The current E-Truck market is showing signs of ending its several-year stall. While volumes are still low, but increasing, industry watchers have been buoyed by the emergence of newer, smaller and more focused suppliers who have shown success in slowly re-growing demand. Likewise e-bus suppliers have started to see growing success in attracting transit orders for zero-emission buses. Currently, there are at least five bus makers, several of which are major original equipment manufacturers, who are offering all-electric bus options that include; New Flyer, BYD Motors, Proterra, CCW, Nova Bus, and in the shuttle category, Motiv, Phoenix and Zenith. Transit bus technology is often an earlier indicator of technology that can make its way to trucks, as has been the case with natural gas and hybrid systems. Going forward, new suppliers to the US E-Truck market, such as BYD and smaller firms such as Zenith, Motiv, Phoenix, Orange EV, Transpower and Wrightspeed, may add critical production volume and credibility to the market. But these products are months, to possibly years away, and current and projected purchases are still significantly smaller than what was seen in 2011. Even if the E-Truck market would continue to pick up as is expected and hoped, it will likely be 2017 before orders and production levels could get back to 2011-2012 volumes.

Authors

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Jasna Tomic is Research Director at CALSTART. Her work focuses on bringing hybrid and electric vehicles to the marketplace through programs that include field testing and evaluation of advanced vehicle technologies and public policy initiatives improving their business case Her expertise includes research in vehicles-to-grid power (V2G) – innovative use of electric-drive vehicles for transportation and power generation. She holds a Ph.D. in Fuel Science from Pennsylvania State University.