



California Energy Commission Clean Transportation Program

**FINAL PROJECT REPORT** 

# ZeroTruck Battery Electric Medium-Duty Truck Demonstration

Prepared for: California Energy Commission Prepared by: Electricore



Gavin Newsom, Governor July 2019 | CEC-600-2019-023

### **California Energy Commission**

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### PREFACE

Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007) created the Clean Transportation Program, formerly known as the Alternative and Renewable Fuel and Vehicle Technology Program. The statute authorizes the California Energy Commission (CEC) to develop and deploy alternative and renewable fuels and advanced transportation technologies to help attain the state's climate change policies. Assembly Bill 8 (Perea, Chapter 401, Statutes of 2013) reauthorizes the Clean Transportation Program through January 1, 2024, and specifies that the CEC allocate up to \$20 million per year (or up to 20 percent of each fiscal year's funds) in funding for hydrogen station development until at least 100 stations are operational.

The Clean Transportation Program has an annual budget of about \$100 million and provides financial support for projects that:

- Reduce California's use and dependence on petroleum transportation fuels and increase the use of alternative and renewable fuels and advanced vehicle technologies.
- Produce sustainable alternative and renewable low-carbon fuels in California.
- Expand alternative fueling infrastructure and fueling stations.
- Improve the efficiency, performance and market viability of alternative light-, medium-, and heavy-duty vehicle technologies.
- Retrofit medium- and heavy-duty on-road and nonroad vehicle fleets to alternative technologies or fuel use.
- Expand the alternative fueling infrastructure available to existing fleets, public transit, and transportation corridors.
- Establish workforce-training programs and conduct public outreach on the benefits of alternative transportation fuels and vehicle technologies.

To be eligible for funding under the Clean Transportation Program, a project must be consistent with the CEC's annual Clean Transportation Program Investment Plan Update. The CEC issued PON-10-063 to provide funding opportunities under the CTP for projects to demonstrate and enhance market viability acceptance of near-term commercial applications of alternative technologies and alternative fueled for use in California's commercial goods movement, transit, and other sectors. In response to PON-10-063, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards March 8, 2012 and the agreement was executed as ARV-11-012 on September 11, 2012.

### ABSTRACT

This ZeroTruck Battery Electric Medium-Duty Truck Demonstration final project report describes the planning, business development and technology development work to introduce new zero-emissions technologies to the marketplace, gather operational data to understand the value proposition, and demonstrate vehicles to gain consumer acceptance and accelerate acquisitions of new zero-emission vehicles.

The goals of the agreement were to demonstrate: 1) The ability of battery electric mediumduty trucks to match or surpass the performance of conventional diesel and natural gas vehicles (under similar defined duty cycles); 2) The ability to charge the vehicle batteries without interruption of the vehicle's use requirements; and 3) Develop quantifiable environmental and economic benefits, based on actual in-use data.

A series of barriers (technical and safety) suffered by vehicle manufacturer, ZeroTruck, resulted in damage to vehicles under construction. The extreme setback coupled with a lack of ZeroTruck internal controls and misreporting lead to a cascading failure of vehicle build and delivery preventing project completion and data collection.

Keywords: electric drive truck, medium duty truck, battery electric, battery pack.

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### **EXECUTIVE SUMMARY**

Electricore is a 501(c)(3) not-for-profit technology development consortium organized under the Defense Advanced Research Project Agency (DARPA) to develop and demonstrate next generation transportation technologies. Electricore teamed with ZeroTruck to build and demonstrate medium-duty electric drive trucks based on Isuzu's Class N medium-duty truck platform. The Isuzu gliders were to be upfitted with the ZeroTruck electric drive train and have a functional urban range of 60 to 100 miles. Funding from the CEC grant was to allow for the development of 12 trucks that were to be field tested with demonstration partners that included the City of Santa Monica, Safeway and Google.

The ZeroTruck Battery Electric Medium-Duty Truck Demonstration final project report describes the project team's efforts to introduce new zero-emissions technologies to the marketplace, gather operational data to understand the value proposition and demonstrate vehicles to educate the consumer, gain consumer acceptance and accelerate acquisitions of new zero-emission vehicles.

The goals of the agreement over a 24-month project period were to demonstrate:

- The ability of battery electric medium duty trucks to match or surpass the performance of conventional diesel and natural gas vehicles (under similar defined duty cycles).
- The ability to charge the vehicle batteries without interruption of the vehicle's use requirements.
- Utilization of commercial, volume motor drives and other electric traction drive system components.
- Zero emission operation and high energy efficiency.
- Quantifiable environmental and economic benefits, based on actual in-use data.

The objectives of this project were:

- 1. **Support:** Assisting fleet operators with 50 percent funding assistance to purchase zero emission electric trucks will "jump-start" the electric truck market.
- 2. **Commercialization**: Partnering with an established original equipment manufacturer (OEM) supply partner and using existing infrastructure commercialization will drive costs of electric drive components down resulting in increased market demand.
- 3. **Job Creation:** Manufacturing has the potential to create hundreds of jobs in the green sector at dealerships, factories, and parts suppliers.

A series of barriers (technical and safety) suffered by vehicle manufacturer, ZeroTruck, including a fire at their manufacturing site, resulted in damage to vehicles under construction and destruction of their inventory of electric battery cells. The extreme setback coupled with a lack of ZeroTruck's internal controls and misreporting lead to a cascading failure of vehicle build and delivery preventing project demonstration and data collection.

A CEC audit found numerous discrepancies between invoicing claims, ZeroTruck's financial records, and the physical evidence found at the ZeroTruck site. The CEC could not confirm a total of \$1.7 million in project costs and sought reimbursement from both ZeroTruck and Electricore. Seven of 12 truck chassis purchased with grant funding could not be located. The CEC canceled the project in March, 2016.

Electricore is a California-based 501(c)(3) not-for-profit technology development consortium organized in 1993 by the U.S. Department of Defense under DARPA to develop and demonstrate next generation transportation technologies. Electricore teamed with ZeroTruck to build and demonstrate 12 medium-duty electric drive trucks based on Isuzu's Class N medium duty truck platform. ZeroTruck is a green transportation technology developer with an initial focus on the medium-duty (Class 4 to 6) urban electric truck market. ZeroTruck shifted its technology development and manufacturing operations from Allentown, Pennsylvania to San Pedro, California for this project.

#### Project Approach Technology Platform

ZeroTruck proposed to build and demonstrate 12 medium-duty electric-drive trucks using the Isuzu N-Class truck chassis and the Dodge Sprinter Van. The Isuzu N-Class chassis can be configured with multiple body styles to fit a variety of urban use applications, including package delivery, municipal services, refuse hauler, street sweeper, flatbed utility and a number airport ground operations vehicles. The Dodge Sprinter Van is a medium sized 15-person passenger van.

ZeroTruck developed an electric drivetrain called the Electric Drive Integration System. The key Electric Drive Integration System components include:

- **Battery Pack**: Dow Kokam Lithium Polymer cells with 54 kilowatt hour (kWh) capacity. Multiple options to be made available to suit various duty cycles
- Electric Motor: UQM liquid cooled brushless motor rated at 150 kilowatt (kW) and 425 foot-pounds of torque
- **Transmission:** 3-speed automatic from St. Denis Manufacturing. ZeroTruck working to develop Continuously Variable Transmission with the Automotive Technology Group of Irvine, California
- Charger: On-board 220-volt charger
- **Range:** 60 to 100 miles, depending on battery pack size and duty cycle.

The 12 electric drive trucks specified in the grant agreement would be built on a combination of "gliders" (new chassis without engine or transmission) and the retrofit of existing trucks with internal combustion engines.

#### **Field Demonstration Partners**

Electricore and ZeroTruck identified nine fleet demonstration partners in the commercial, industrial and government services sectors. Each partner agreed to host a 12-month demonstration and data collection trial. The partners and types of trucks are shown in Table 1.

Fleet				Duty Cycle
Customer		Vehicle Type	End Use	(miles per day)
Google	Mountain View	Isuzu Stake Bed Utility	Bicycle Maintenance	40-50
Google	Mountain View	Dodge Sprinter Van	Corporate Campus Shuttle	30-50
Google	Mountain View	Isuzu Freight / Cargo	Campus Food Service	40-50
City of Santa Monica	Santa Monica	Isuzu Stake Bed Utility	Recycling Department	20-30
Port of Los Angeles	San Pedro	Isuzu Stake Bed Utility	Service Dept. Support	20-40
Quixote Studio Equipment	Los Angeles	Isuzu Stake Bed Utility	Movie Operations Support	50-70
Urban Oven	Hawthorne	Isuzu with Mobile Kitchen Body	Mobile Food Sales	50-70
Federal Express	Los Angeles	Isuzu with Package Delivery Van	Package Delivery	30-50
Federal Express	Los Angeles	Isuzu with Package Delivery Van	Package Delivery	30-50
Staples	Los Angeles	Isuzu with Package Delivery Van	Package Delivery	20-40
Toshiba	Irvine	Isuzu w Dry Freight Delivery Body	Local Delivery and Support	50-70
JFE Engineering	Long Beach	Isuzu with Custom Body	Marketing and Display Support	50-100

Table 1: ZeroTruck Fleet Demonstration Partners

Source: Electricore

#### Data Collection Plan

ZeroTruck proposed to collect data with a two-tiered approach.

Tier 1: Basic vehicle reporting using Fleetmatics telemetry and a GPS tracking system.

- A. Daily Drive Time
- B. Idle Time (key on)
- C. Daily Mileage
- D. Vehicle Speeds

Tier 2: Advanced Reporting

- A. State of Charge (battery packs)
- B. Cell Voltage
- C. Cell Temperature
- D. Odometer

Using these telematics, ZeroTruck would be able to generate daily, weekly and monthly reports. Fleetmatics is a global provider of fleet management solutions for small and medium-sized business.

Electricore developed a customer satisfaction survey and will be responsible for administering the survey and collecting and managing the use data (See Appendix A: Demonstration Plan).

### Progress: 2012 to 2014

Between September 2012 when the agreement was executed and the end of 2013, ZeroTruck finalized design and engineering plans for the 12 vehicle builds and began procuring major components, such as chassis, transmissions, electric motors and battery packs. Through the end of 2013, ZeroTruck reported that it was working on five of the trucks, with priority being given to the Santa Monica and Google trucks.

ZeroTruck closed its Allentown, PA plant in January 2014 and moved operations to the new location in Santa Ana, CA. While this move put ZeroTruck's engineers and technicians close to California markets and end-users, it also disrupted operations and scheduling more than anticipated. ZeroTruck reported schedule and quality control challenges with new vendors and supply chains.

ZeroTruck completed the first truck for Google in September 2014, while work on the Santa Monica truck slowed. These trucks are shown in Figure 1. ZeroTruck began falling behind schedule through summer and fall of 2014, citing unanticipated engineering challenges, quality control issues with new vendors, and delays in international shipments from customs issues.



Figure 1: ZeroTrucks for City of Santa Monica and Google

Photo Credits: Electricore

#### 2014 Fire

A fire broke out at ZeroTruck's assembly plant in Santa Ana on October 26, 2014. The initial cause of the fire was reported to be a short in one of the primary high voltage cables used to test battery packs. Subsequent reports from ZeroTruck identified human error to be the cause: "wiring error by a technician." However, a fire investigator for an insurance company indicated that cell failure could be the cause, given the burn patterns on the Google Truck battery pack. See Figures 2 and 3.

The fire damaged or destroyed all the battery modules contained in the assembly plant, including the packs already mounted in the Google Truck. It also damaged the inventory of electric drivetrain components stored at the facility.

Figure 2: Fire Damage to the Google Truck at ZeroTruck Assembly Plant



Photo Credits: ZeroTruck

#### Figure 3: Close Up Photo of Fire Damage to Battery Pack



Photo Credits: ZeroTruck

#### Fire Aftermath

The fire caused numerous delays and changes as ZeroTruck worked to restore the Santa Ana facility, re-order new components and test equipment, and find a new battery module supplier.

ZeroTruck canceled its contract with Xalt Energy of China for battery cells and established a new supply contract with GoodWolfe Energy of the United Kingdom.

ZeroTruck resumed operations at the Santa Ana facility in April of 2015 and continued to work with its demonstration fleet partners to assure them that the electric drive trucks were still planned for completion.

ZeroTruck announced during this same period that they were pursuing additional financing through negotiations with the Vayan Group of the United Kingdom.

However, the fire and its aftermath revealed significant additional issues that had been plaguing the project since its inception.

Despite efforts to continue the project with new suppliers and engineering design improvements, ZeroTruck announced to the CEC in June 2015 that:

# "The engineering, fire and battery issues and lack of finding additional investors to maintain the engineering overhead costs have essentially put ZeroTruck in an insolvent position."<sup>1</sup>

The CEC initiated a project audit in July 2015. The audit revealed substantial inconsistencies between ZeroTruck's reporting and billing practices and information reported to the CEC since the project start in 2012. Other key findings from the audit were:

- Despite claims of substantial damage from the fire, neither Electricore, the CEC Auditor nor the Hartford Insurance Company could confirm the extent of the damage claimed by Electricore.
- Invoices for only three chassis could be confirmed, rather than for all 12 as Electricore had claimed.
- A site visit revealed that only five trucks were found at the ZeroTruck facility, rather than the full 12 as claimed. The status of the other seven trucks could not be confirmed. Of the five trucks at the assembly facility, only two were in the conversion/ upfit process. Two of the trucks had no signs of work, and the third had been shipped to England to the battery supply company.
- The Auditor could not confirm proper accounting for over \$1.7 million in claimed reimbursement expenses and the CEC moved to recover these funds from ZeroTruck and Electricore.

The CEC canceled the grant in March 2016 and pursued repayment of the \$1.7 million in unsubstantiated expenditures.

<sup>&</sup>lt;sup>1</sup> Email received at the CEC from ZeroTruck on June 19, 2015.

The Electricore – ZeroTruck program yielded several important technical and business lessons learned, primarily the extreme difficulty of battery pack integration and susceptibility of business control systems to misreporting. Electricore has taken measures to address the business issues now, such as policy and procedure changes in grant administration tasks of contracting, invoicing and auditing and will incorporate the technical lessons learned in future proposals and programs.

#### New Business and Accounting Controls Needed Accounting System and Internal Controls

Electricore, Inc., a 501 (c)(3) a non-profit maintains a Defense Contract Audit Agency compliant accounting system. The system, procedures and internal controls are compliant with Defense Contract Audit Agency, Generally Accepted Accounting Principles, and Federal Acquisition Regulation requirements. Electricore's systems:

- Segregate direct costs from indirect costs;
- Accumulate cost element by contract, project, task (labor, materials, subcontracts, other direct costs, fringe, overhead);
- Maintain a compliant timekeeping system;
- Maintain compliant labor and accounts payable distribution systems;
- Account for unallowable costs and exclude such costs from billings, claims and proposals;
- Make certain direct costs and indirect costs are controlled by the general ledger;
- Capture pre-contract costs separately;
- Maintain homogeneous indirect cost pools and allocate indirect costs to contracts, projects, tasks or cost objectives based on a beneficial, causal and equitable basis;
- Comply with financial clauses like the Limitations of Costs/Funds and Progress Payments clauses;
- Make interim accumulation of costs in the books of account, at least monthly and;
- Provide reliable historical accounting data for follow-on procurements.

Electricore conducts regular review and audit of financial systems. All expenses are accounted for and reviewed against plan on a monthly basis by Electricore staff. Staff also reviews cumulative revenue and program costs monthly. Twice per year, a private certified public accountant fully reviews Electricore plans, revenue, expenses and procedures and make recommendations to staff and management.

Electricore has established procedures in order to ensure subcontractors adhere to contractual requirements. The procedure has been used successfully on over 200 programs with more than 500 teaming organizations. These controls include contractual flow down of all prime contract (in this case CEC) requirements, weekly or biweekly meetings with the subcontractor, monthly meetings with the sponsor and the subcontractor, periodic site visits, and monthly reporting of progress.

Due to the ZeroTruck issues, Electricore has implemented a new procedure whereby all future subcontractors must either produce evidence of regularly audited internal controls or must submit evidence of spending in additions to certified invoices. Evidence of spending includes receipts, cleared checks, physical inventory or credit card statements. The revised, published process is provided in Figure 4 below.



Figure 4: Electricore's Revised Payment Approval Process

### Technical, Safety and Supply Chain Issues

ZeroTruck reported technical barriers and supply chain issues to Electricore over the course of the program that needed to be overcome prior to initiation of the six-month vehicle demonstrations. Reported barriers were communicated in monthly reports and are summarized below:

- March 2013. ZeroTruck reported issues with the Japanese battery supplier and cited a 2-month delay required to resolve the issues. No technical details were disclosed.
- March 2014. ZeroTruck reported a supplier issue with the shaft on the transmission supplied by Eaton. The issue was described as receiving the "proper data from Eaton" and resolved by the end of March 2014.
- May 2014. ZeroTruck reported a significant issue with battery cell provider, Xalt Energy. A management change resulted in shipment halt and request for a design review. ZeroTruck scheduled a review for June 11, 2014 and Xalt expressed confidence they would resume shipments. ZeroTruck plans called for installing Xalt battery cells in a ZeroTruck-designed module and battery pack. ZeroTruck subsequently reported to Electricore that the integration of the cells into modules and a battery pack was a significant technical barrier. After the ZeroTruck fire incident, a modular procurement was used to abate this issue.
- July 2014. ZeroTruck requested a change in scope of work, reducing the number of vehicles deployed from fourteen to twelve. Justification for the change included "changes to the supply chain, and vehicle types" but no detail of technical issues was disclosed.
- November 2014. Fire at ZeroTruck facility. ZeroTruck reported order of new battery modules from Goodwolfe Energy to replace those destroyed in the fire.

#### Safety Issues

ZeroTruck reported several safety issues to Electricore as suspected causes of the ZeroTruck facility fire.

- Overcharging of the Battery Pack. Immediately after the ZeroTruck fire incident (October 26, 2014), Electricore personnel requested a site visit to document the damage. Four days later, the Orange County Fire Authority allowed access to the site and Electricore personnel visited the facility. Initial phone and email reports from ZeroTruck personnel indicated the suspected cause of the fire was overcharging of the battery pack in test mode. ZeroTruck stated: "After the charge "testing" was accomplished, the system was deactivated and the charge plug was left on by one of the Technicians thinking he deactivated the charge test. That fault in procedure allowed the pack to charge." Later, this cause was ruled out by ZeroTruck personnel.
- **Proximity of Hardware to Battery Terminals**. During the post-fire site visit, ZeroTruck personnel indicated to Electricore personnel that the fire may have actually started because a screw was dangerously close to a connector on the battery modules and may have caused a short.
- **Battery Module Failure.** Also during the post-fire site visit, a fire inspector from the landlord's insurance company visited at the same time as Electricore personnel and stated he did not suspect it was a wiring problem. Instead, he suspected that the

problem stemmed from a faulty battery cell, citing a thermodynamic analysis rather than an electrical one.

• **Incorrect wiring of Battery Modules**. During a status call with CEC staff and Electricore on July 23, 2015, ZeroTruck personnel stated the cause of the fire as a technician wiring error.

### GLOSSARY

ALTERNATIVE AND RENEWABLE FUELS AND VEHICLE TECHNOLOGY PROGRAM (ARFVTP)— Now known as the Clean Transportation Program, created by Assembly Bill 118 (Nunez, Chapter 750, Statutes of 2007), with an annual budget of about \$100 million. Supports projects that develop and improve alternative and renewable low-carbon fuels, improve alternative and renewable fuels for existing and developing engine technologies, and expand transit and transportation infrastructures. Also establishes workforce training programs, conducts public education and promotion, and creates technology centers, among other tasks.

CALIFORNIA ENERGY COMMISSION (CEC)—The state agency established by the Warren-Alquist State Energy Resources Conservation and Development Act in 1974 (Public Resources Code, Sections 25000 et seq.) responsible for energy policy. The CEC's five major areas of responsibilities are:

- 1. Forecasting future statewide energy needs.
- 2. Licensing power plants sufficient to meet those needs.
- 3. Promoting energy conservation and efficiency measures.
- 4. Developing renewable and alternative energy resources, including providing assistance to develop clean transportation fuels.
- 5. Planning for and directing state response to energy emergencies.

Funding for the CEC's activities comes from the Energy Resources Program Account, Federal Petroleum Violation Escrow Account, and other sources.

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY (DARPA)—An agency of the United States Department of Defense created in 1958 by Dwight D. Eisenhower for the development of emerging technologies for use by the military.

GLOBAL POSITIONING SYSTEM (GPS)—An accurate worldwide navigational and surveying facility based on the reception of signals from an array of orbiting satellites.

KILOWATT (kW)—One thousand watts. A unit of measure of the amount of electricity needed to operate given equipment. On a hot summer afternoon, a typical home—with central air conditioning and other equipment in use—might have a demand of 4 kW each hour.

KILOWATT-HOUR (kWh)—The most commonly used unit of measure telling the amount of electricity consumed over time, means one kilowatt of electricity supplied for one hour. In 1989, a typical California household consumed 534 kWh in an average month.

ORIGINAL EQUIPMENT MANUFACTURER (OEM)—Makes equipment or components that are then marketed by its client, another manufacturer, or a reseller, usually under that reseller's own name.



## **DEMONSTRATION PLAN**

### **"ZeroTruck Battery Electric Medium Duty Truck**

### Demonstration" Contract No: ARV-11-012

### January 2013

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#### 1. Project Background Information

ZeroTruck will demonstrate its pre-commercial variant battery electric medium duty vehicle at multiple sites in California. This demonstration will build upon the successes from the recent prototype delivered to the City of Santa Monica and develop real world data on the operation, maintenance and costs of the ZeroTruck. Variants of an all-electric zero emission medium duty truck based on the Isuzu N series chassis will be delivered to multiple host sites as described in this demonstration plan. The truck has a low cab forward design, a fully automated transmission, up to 100-mile range with full highway capability, advanced lithium batteries, regenerative braking, and powered by a UQM PowerPhase 100 advanced electric motor.

The goal of this demonstration project is to demonstrate over a 24-month project period:

- The ability of battery electric medium duty trucks to match or surpass the performance of conventional diesel and natural gas vehicles (under similar defined duty cycles).
- The ability to charge the vehicle batteries without interruption of the vehicle's use requirements.
- Utilization of commercial, volume motor drives and other electric traction drive system components.
- Zero emission operation and high energy efficiency.
- Quantifiable environmental and economic benefits, based on actual in-use data.

The objectives of this demonstration project and of ZeroTruck Corporation are to replace fossil fueled medium duty trucks with the branded ZeroTruck chassis as a viable and cost effective solution for fleets wanting to replace fossil fueled trucks with the same chassis and body type with all electric versions. This project supports those objectives through three targeted objectives:

- 1. Support assist fleet operators with 50% funding assistance to purchase zero emission electric trucks "jump-starting" the electric truck market
- 2. Commercialization by partnering with an established OEM supply partner and using existing infrastructure commercialization will drive costs of electric drive components down resulting in increased market demand
- 3. Job Creation manufacturing will create hundreds of jobs in the green sector at dealerships, factories, and parts suppliers

#### 2. Description of Advanced Technology to be Demonstrated

ZeroTruck and Electricore have identified the following vehicles for the demonstration plan, because ZeroTruck is the only EV chassis that accommodate these body options, which there are several thousand in use in California. Two main chassis will be used as the basis for conversion to the ZeroTruck Platform. 1) The Isuzu N-Series medium duty truck and 2) the Dodge Sprinter Van medium duty vehicle. The Isuzu N-Series truck specifications can be seen in Table A-1.



Table	A-1:	Isuzu	<b>N-Series</b>	<b>Specification</b>	าร
TUDIC	<b>A</b> I.	JULU		Specification	13

ZeroTruck/Isuzu Chassis Specs					
Base ZeroTruck	Optional Heavy Duty				
Chassis					
Wheelbase 109" 132.5" 150" 176"	202"	213"			
Cab to Axle     86.5" 110" 127.5" 153.5"	н				
Cab to End of Frame 129.6" 153.1" 170.6" 196.6"	н				
Overall Length 200.5" 224" 241.5" 267.5"	"				
• Body Length (ft.) 10-12' 14' 16-18' 20'					
<b>GVWR/GCWR</b> 12,000/18,000 lbs.	14,500/20,500 lbs.				
Body/Payload Allowance (with body) 6,000 lbs.	7,000 lbs.				
GAWR					
• Front 4,700 lbs.	5,360 lbs.				
• Rear 7,950 lbs.	9,880 lbs.				
Front Axle Capacity 6,830 lbs.					
Rear Axle Capacity 11,020 lbs.					
Rear Axle Ratio     4.777	5.125				
Suspension, Front & Rear					
Type Tapered/Multi-Leaf					
Front Suspension Capacity 8,440 lbs.					
Rear Suspension Capacity 9 880 lbs					
Service Prokes					
Service Brakes					
System Vacuum/Hydraulic					
Front Disc					
Rear Drum					
Tires	•225/70R-19	) 5F (12Plv)			
•215/85R-16E (10 Ply)	2207701017				
Steering					
Integral Hydraulic Power Steering Column					
Tilt & Telescopic					
Heat & Air Conditioning (standard)					
Motor					
• UQM liquid cooled PP-150 DC/Brushless 150kW - 425 ft/lbs torque					
Battery Pack					
<ul> <li>Dow Kokam Lithium Polymer base 54kWh - 2,500 cycles</li> </ul>					
Optional Pack & Charger 20kWh & 45kWh - 220v on-board charger					
Range					
Warranty					
<ul> <li>3 year drive-train &amp; battery</li> </ul>					

Source: Electricore

#### Isuzu N-Series Configurations

1. **Urban Refuse** – ZeroTruck chassis outfitted with a Loadmaster (rear loader) and New Way (side loader) models of medium duty refuse trucks with 6-8 yard capacity. This



would be the first medium duty electric refuse truck available to commercial and municipal fleets. The truck can be seen in Figure A-1.

Figure A-1: Urban Refuse



Source: Electricore

2. **Crew Cab Dump Truck** - ZeroTruck chassis outfitted with crew cab dump body for municipal use. Many municipalities can deploy construction and emergency service crews with one vehicle vs. multiple vehicles for work projects where a dump body is utilized to move construction debris, dirt, gravel, mulch, etc. The truck can be seen in Figure A-2.



#### Figure A-2: Crew Cab Dump Truck

Source: Electricore

3. **Tow Truck** - ZeroTruck chassis outfitted with flatbed or wheel lift bodies for urban utilization. These would be the only medium duty electric trucks that have bodies ready made for the ZeroTruck/Isuzu chassis platform. The truck can be seen in Figure A-3.





4. **Electric Sweeper** - ZeroTruck chassis outfitted with a sweeper body for use by facilities maintenance, airports, campuses, municipalities and construction companies. This is the only zero emission sweeper available. Nighthawk Sweepers has agreed to partner on the project and supply sweeper bodies and engineering support. The truck can be seen in Figure A-4.



#### Figure A-4: Electric Sweeper

Source: Electricore

5. **Airport Lavatory Service -** ZeroTruck chassis outfitted with a Phoenix lavatory service body can reduce diesel idling to zero at airports. Currently there are several dozen conventional, diesel fueled lavatory service trucks on Isuzu platforms operating with airlines at LAX and Long Beach Airport. JetBlue Airways utilizes 2 Isuzu diesel trucks at Long Beach and run them for 4 hours each per day, removing lavatory waste from inbound aircraft. This platform is perfect for reducing diesel emissions. The truck can be seen in Figure A-5.



Figure A-5: Airport Lavatory Service

6. **Airport Fuel Service** - ZeroTruck chassis outfitted with Bosserman Aviation refueling body. This system uses pump pressure from the jet fueling plumbing at major airports and will mitigate emissions of the typical 6 hour per day of idling that diesel versions of this truck operate in daily service. The truck can be seen in Figure A-6.

Source: Electricore



#### Figure A-6: Airport Fuel Service



Source: Electricore

Utility/Facilities Maintenance - ZeroTruck chassis outfitted with a utility body with 7. lift bucket or Autocrane for use in facility maintenance areas. Most municipalities operate a service body in various departments servicing and repairing equipment and facilities. The truck can be seen in Figure A-7.



#### Figure A-7: Utility/Facilities Maintenance

Source: Electricore

#### **Dodge Sprinter Van Specifications:**

Google ZeroVan Sprinter shuttle Mountain View, CA (Figure A-8.)

- Upfit ZeroTruck electric drive system
- Potential to ultimately upfit a total of 14 shuttles SPECIFICATIONS
- 75 mile city all electric range ٠
- Dow Kokam advanced energy storage pack .
- Full regenerative braking system •
- On-board Level II charger
- 13,000 GVWR ٠
- 170" wheelbase
- 38" bi-fold entry doors
- 24'1" length .
- 79.7" width
- 6'3" interior headroom
- 80" door entry height



#### Figure A-8: Dodge Sprinter Van



Source: Electricore

#### Identification and Description of the Demonstration Sites

Table A-2 provides an overview of the 12 sites currently planned for the demonstration. The remaining two sites (for a total of 14 vehicles) remain under negotiation and will be included in a future revision of the demonstration plan.

Site #	Site Name/ Customer	Address/Location	Vehicle Type	Vehicle Description	Estimated Miles/Day	Estimated Hours/Day
1	Google	1600 Amphitheatre Parkway, Mountain View, CA 94043	MEDIUM DUTY BEV TRUCK	2013 ZeroTruck with stake bed body for bike maintenance dept.	40-50	6
2	Google	1600 Amphitheatre Parkway, Mountain View, CA 94043	MEDIUM DUTY BEV SHUTTLE	2008 Sprinter corporate shuttle for transportation dept.	30-50	6
3	City of Santa Monica	2500 Michigan Avenue Santa Monica, CA 90404	MEDIUM DUTY BEV TRUCK	2013 ZeroTruck with stake bed body for recycling dept.	20-30	8
4	Port of Los Angeles	425 South Palos Verdes Street, San Pedro, CA 90731	MEDIUM DUTY BEV TRUCK	2013 ZeroTruck with stake bed for service department	20-40	8
5	Quixote Studio Equipment	1000 North Cahuenga Boulevard, Los Angeles, CA 90038	MEDIUM DUTY BEV TRUCK	2013 ZeroTruck with stake bed for operations department	50-70	12

**Table A-2: Site Overviews** 

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#### Inc.

Site #	Site Name/ Customer	Address/Location	Vehicle Type	Vehicle Description	Estimated Miles/Day	Estimated Hours/Day
6	Google	1600 Amphitheatre Parkway, Mountain View, CA 94043	MEDIUM DUTY BEV TRUCK	2013 ZeroTruck with dry freight for food service department	40-50	8
7	The Urban Oven	14 11 Lemoli Avenue, Hawthorne, CA 90250	MEDIUM DUTY BEV TRUCK	2013 ZeroTruck with mobile kitchen body	50-70	10-12
8	FEDEX	Los Angeles Location TBD	MEDIUM DUTY BEV SHUTTLE	2013 ZeroVan delivery body	30-50	8
9	FEDEX	Los Angeles Location TBD	MEDIUM DUTY BEV TRUCK	2013 ZeroVan delivery body	30-50	8
10	Staples	Los Angeles Location TBD	MEDIUM DUTY BEV TRUCK	2013 ZeroTruck with delivery body	20-40	8
11	Toshiba	Irvine, CA	MEDIUM DUTY BEV TRUCK	2013 ZeroTruck with dryfreight display body	50-70	6
12	JFE ENGINEERING	Long Beach, CA	MEDIUM DUTY BEV TRUCK	2013 ZeroTruck with custom demonstrator body	50-100	6-8

Source: Electricore

#### 3. Facility/Site Description

Tables A-3 through A-14 provide additional detail on the sites selected including a brief description of the general routes to be traveled and the activities/duties to be performed.



#### Table A-3: Site #1 Description

Site #1	Site Specific Details		
Site Description	CORPORATE CAMPUS		
Facility Description	MULTI-FACILITY OFFICE CAMPUS ENCOMPASSING 14 BUILDINGS		
Route Description	UNDER 45 MPH, CITY DRIVE CYCLE, LIMITED HIGHWAY USAGE		
Activities/ Duties to be Performed	OPERATING AS A MOBILE BIKE REPAIR SERVICE TRUCK		

Source: Electricore

#### Table A-4: Site #2 Description

Site #2	Site Specific Details		
Site Description	CORPORATE CAMPUS		
Facility Description	MULTI-FACILITY OFFICE CAMPUS ENCOMPASSING 14 BUILDINGS		
Route Description	UNDER 45 MPH, CITY DRIVE CYCLE, LIMITED HIGHWAY USAGE		
Activities / Duties to be Performed	OPERATING AS A CORPORATE SHUTTLE FOR COMPANY EMPLOYEES		

Source: Electricore

#### Table A-5: Site #3 Description **Site Specific Details** Site #3 Site CITY OF SANTA MONICA MUNICIPAL YARD Description Facility CITY FLEET MAINTENANCE YARD Description Route VARIOUS ROUTE WITHIN THE CITY Description Activities/ PICK UP AND DELIVERY OF REFUSE CONTAINERS TO VARIOUS Duties to be CUSTOMERS Performed



#### Table A-6: Site #4 Description

Site #4	Site Specific Details		
Site			
Description	FACILITIES OF THE FORT OF LA		
Facility			
Description	CITE OF EOS ANGEEES SHITTING FORT		
Route	VARIOUS ROUTES THROUGHOUT THE PORT FACILITIES, AND		
Description	ON SURFACE STREETS AND HIGHWAYS		
Activities/	DICKING HD AND DEI IVEDING OF DADTS AND FOUIDMENT TO		
Duties to be			
Performed	WAINTAIN FORT FACILITIES		

Source: Electricore

#### Table A-7: Site #5 Description

Site #5	Site Specific		
Site Description	COMPANY YARD IN N HOLLYWOOD		
Facility Description	OFFICE BUILDING WITH GATED PARKING LOT		
Route	VARIOUS ROUTES AND DESTINATIONS THROUGHOUT LOS ANGELES		
Description	ON SURFACE STREETS AND HIGHWAYS		
Activities/ Duties to be Performed	PICKING UP AND DELIVERING MOVIE STUDIO RENTAL EQUIPMENT		
Source: Electricore			

#### Table A-8: Site #6 Description

Site #6	Site Specific Details			
Site Description	CORPORATE CAMPUS			
Facility Description	MULTI-FACILITY OFFICE CAMPUS ENCOMPASSING 14 BUILDINGS			
Route Description	UNDER 45 MPH, CITY DRIVE CYCLE, LIMITED HIGHWAY USAGE			
Activities/ Duties to be Performed	REPLENISHING FOOD STORES THROUGHOUT 14 OFFICE BUILDINGS			
Courses, Fleetrieere				



#### Table A-9: Site #7 Description

Site #7	Site Specific Details		
Site Description	SURFACE STREETS LOS ANGELES		
Facility Description	YARD LOCATED IN HAWTHORNE, CA		
Route Description	UNDER 45 MPH, SURFACE STREETS ON A CITY DRIVE CYCLE, LIMITED HIGHWAY USAGE		
Activities/ Duties to be Performed	OPERATING AS A MOBILE RESTAURANT		

Source: Electricore

#### Table A-10: Site #8 Description

Site #8	Site Specific Details		
Site Description	SURFACE STREETS LOS ANGELES		
Facility Description	MULTI-FACILITY DISTRIBUTION WAREHOUSE		
Route Description	UNDER 45 MPH, CITY DRIVE CYCLE, LIMITED HIGHWAY USAGE		
Activities/ Duties to be Performed	OPERATING AS A PACKAGE DELIVERY TRUCK		

Source: Electricore

#### Table A-11: Site #9 Description

Site #9	Site Specific Details	
Site Description	SURFACE STREETS LOS ANGELES	
Facility Description	MULTI-FACILITY DISTRIBUTION WAREHOUSE	
Route Description	UNDER 45 MPH, CITY DRIVE CYCLE, LIMITED HIGHWAY USAGE	
Activities/ Duties to be Performed	OPERATING AS A PACKAGE DELIVERY TRUCK	



#### Table A-12: Site #10 Description

Site #10	Site Specific Details			
Site Description	SURFACE STREETS LOS ANGELES			
Facility Description	MULTI-FACILITY WAREHOUSE			
Route Description	UNDER 45 MPH, CITY DRIVE CYCLE, LIMITED HIGHWAY USAGE			
Activities/ Duties to be Performed	DELIVERING OFFICE SUPPLIES			

Source: Electricore

#### Table A-13: Site #11 Description

Site #11	Site Specific Details	
Site Description	SURFACE STREETS LOS ANGELES	
Facility Description	OFFICE FACILITY	
Route Description	UNDER 45 MPH, CITY DRIVE CYCLE	
Activities/ Duties to be Performed	DEMONSTRATING NEW TECHNOLOGY PRODUCTS	

Source: Electricore

#### Table A-14: Site #12 Description

Site #12	Site Specific Details		
Site Description	SURFACE STREETS LOS ANGELES		
Facility Description	OFFICE BUILDING		
Route Description	UNDER 45 MPH, CITY DRIVE CYCLE, LIMITED HIGHWAY USAGE		
Activities/ Duties to be Performed	DEMONSTRATING RAPID CHARGING SYSTEM THROUGHOUT CA		



### 4. The Type of Testing and Monitoring To Be Performed

The monitoring and reporting will be two tiered:

Tier 1. Basic vehicle reporting - Fleetmatics telemetry and GPS tracking for basic reporting, such as:

- a. Daily drive time (minutes)
- b. Idle time (key on)
- c. Daily miles driven
- d. Vehicle speed

Tier 2. Advanced reporting through the ZeroTruck CAN

- a. State of charge (S.O.C)
- b. Cell voltage
- c. Cell temperature
- d. Odometer

With these telematics, ZeroTruck will be able to print daily, weekly, monthly reports in spreadsheet format. Additionally, a monthly service provided by Fleetmatics for the Tier 1 data and the additional parameters including added functionality to monitor the battery cell and pack data is derived by the ZeroTrucks BMS telematics.

Fleetmatics is a leading global provider of fleet management solutions for small and mediumsized businesses delivered as software-as-a-service (SaaS). This solution enables the ZeroTruck customers to meet the challenges associated with managing local fleets, and improve the productivity of their mobile workforces, by extracting actionable business intelligence from real- time and historical vehicle and driver behavioral data.

Fleetmatics' intuitive, cost-effective Web-based solutions provide fleet operators with visibility into vehicle location, fuel usage, speed and mileage, and other insights into their mobile workforce, enabling them to reduce operating and capital costs, as well as increase revenue. Serves more than 17,000 customers, with over 300,000 actively subscribed vehicles worldwide

With the Fleetmatics GPS tracking system, the demonstration partners will have:

- The location of the demonstration vehicles in real time, 24 hours a day from anywhere The historical status of each vehicle, including when it started up and shut down, as well as its idling status, location, speed, and additional parameters associated with the vehicle energy storage
- Preventative maintenance information to recognize potential risks

The Fleetmatics Mobile App (Figure A-9) will also provide key information about the demonstration vehicles anytime, anywhere. Receive alerts, investigate incidents in the field, and, if necessary, send the nearest technician to an urgent job.

- Includes Dashboard, Live Fleet, Reports, Alerts & more... Find closest vehicles for urgent dispatch
- View animated vehicle journeys in Route Replay Display polygon Points of Interests on map Posted Speed Limit Integration



#### Available for Android and for iPhone

#### Figure A-9: Fleetmatics Mobile App on Apple and Android



Source: Electricore

#### 5. Customer Feedback Mechanisms

Electricore will independently follow up with demonstration partners to survey the performance and acceptance of the ZeroTrucks under this program. Electricore will collect information from both the vehicle operators and the Operations Managers at each site. The preliminary surveys are included below. Additional questions may be added based on specific site requirements and vehicle configurations.

### **User Acceptance Survey – Operators**

As part of the ZeroTruck deployment and testing period we would like to hear your input and evaluation of the all-electric truck. Your input will help us evaluate the performance of the ZeroTruck and identify areas that need improvement. Please take 10 minutes to provide your evaluation of the ZeroTruck by answering the following questions. For each question check the box that best fits your rating.

Please return the completed survey to XXX at fax number XXX or e-mail XXX within 5 days of receiving it.

Fleet Name: \_\_\_\_\_

Survey Name and No:\_\_\_\_\_

Date Prepared: \_\_\_\_\_

First Name:	_Last Name:	Occupation/Position:
Location:	ZeroTruck Unit No:	Telephone:

Today's Date: \_\_\_\_\_



For each question (Questions 1-12), please check the box that best fits your judgment of the performance of the ZeroTruck compared to that of a standard truck. Space is provided in each question for any additional comments you might like to provide on the characteristics of the ZeroTruck.

1a) The standard truck in your fleet used as a comparison unit is:

Make Model Year Engine Tra	nsmission Auto/Manual
----------------------------	-----------------------

1b) Please confirm that you normally use the above truck

Yes No If NO, which truck do you use normally?

For questions 2-12, please describe the performance/behavior of the ZeroTruck under each of the operating conditions:

2) Initial launch from stand-still

Very poor	Poor	Good	Very Good	Excellent	
Comments					
3) Overall br	aking behavio	r			
Very poor	Poor	Good	Very Good	Excellent	
Comments					
4) Slow speed maneuverability					
Very poor	Poor	Good	Very Good	Excellent	
Comments					
5) Acceleration					
Very poor	Poor	Good	Very Good	Excellent	

Comments

#### 6) Deceleration

Very poor	Poor	Good	Very Good	Excellent
Comments				
7) <i>"Grade</i> p	oulling" abili	ty		
Very poor	Poor	Good	Very Good	Excellent
Comments				
8) Shift qua	ality of the t	ransmission		
Very poor	Poor	Good	Very Good	Excellent
Comments				
9) Operatio	n of the boo	om		
Very poor	Poor	Good	Very Good	Excellent
Comments				
10) Operati	on of the to	ool circuit		
Very poor	Poor	Good	Very Good	Excellent
Comments				
11) Noise le	evel inside t	he ZeroTruck		
Very poor	Poor	Good	Very Good	Excellent



Comments

12) The noise level outside the ZeroTruck



Very poor	Poor	Good	Very Good	Excellent Comments		
For Questions 13-14, please rate the overall performance of the ZeroTruck. For each question, please check the box that best fits your rating of the ZeroTruck. 13) In-cab ergonomics (control, switches, etc.)						
Very poor	Poor	Good	Very Good	Excellent		
Comments						
14) Please provide an overall rating of the ZeroTruck.						
Very poor	Poor	Good	Very Good	Excellent		
Comments						

*15) Please provide suggestions or recommendations of performance areas that need improvement in the ZeroTruck.* Comments

*16) Please share any additional comments you have concerning the ZeroTruck.* Comments

### **User Acceptance Survey – Operations Manager**

As part of the ZeroTruck deployment and testing period we would like to hear you input and evaluation of the ZeroTruck. Your input will help us evaluate the performance of the ZeroTruck and identify areas that need improvement. Please take 10 minutes to provide your evaluation of the ZeroTruck by answering the following questions. For each question check the box that best fits your rating.

Please return the completed survey to XXXX at fax number xxx or e-mail XXX within 5 days of receiving it.

Fleet Name: \_\_\_\_\_

Electric Inc.	ore,				ELECTRICORE POWERING THE FUTURE
Survey Name	e and No:				
Date Prepare	ed:				
First Name: _			Last Name:		
Occupation/F	Position:		Location:		
ZeroTruck U	nit No:		Telephone:		
Today's Date	:				
The standard	d truck in your	fleet used as	a comparison unit is	S <i>:</i>	
Make	Model	Year	Engine Trans	smission	Auto/Manual
For Question comparison t comments yo	s 2-4, please of the standard	check the box d truck. Space o provide.	that best fits your e is provided in each	valuation of the question for an	e ZeroTruck in ny additional
1) Reliability	of ZeroTruck				
Very poor	Poor	Good	Very Good	Excellent	
Comments					
2) Availabilii	ty for job assig	nments			
Very poor	Poor	Good	Very Good	Excellent	
Comments					
3) Safety of	ZeroTruck				
Very poor	Poor	Good	Very Good	Excellent	
Comments					
4) In genera	al, the comme	nts from opera	ators were		
Very poor	Poor	Good	Very Good	Excellent	
Comments					

A-20

N



5) Please provide an overall rating of the ZeroTruckVery poorPoorGoodVery Good

Excellent

Comments

Suggestions and Comments

6) Please provide suggestions or recommendations of performance areas that need improvement in the ZeroTruck.

7) Please share any additional comments you have concerning the ZeroTruck.

# 6.The Manner in which the Data will be Validated, Analyzed and Reported

- Electricore will collect both the data from Fleetmatics and the user surveys for each vehicle demonstrated. The results of the demonstration will be provided to the Commission in a comprehensive test report detailing the results. The data will be analyzed to determine if there are any systemic issues with the ZeroTruck that would need to be addressed prior to widespread commercial introduction.
- ZeroTruck will review the data independent of Electricore and provide their interpretation of the vehicles performance and address any problems or issues noted during the demonstration. ZeroTruck will also provide Electricore a response to each of the user feedback comments and suggestions provided in the user surveys.

#### 7. Statement of Anticipated Results from the Demonstration

The results from the demonstration will be used to:

- 1. Demonstrate (qualitatively and quantitatively) to CA fleets that the BEV truck is a viable and efficient alternative to petroleum fueled trucks.
- 2. Identify the ROI between an I.C.E. truck and a BEV truck will be validated across multiple vocation (body type and work usage) categories (vs just delivery as has been the case previously).
- 3. Identify efficiencies in the assembly process.
- 4. Identify component cost reduction synergies.
- 5. Identify owner training protocols.
- 6. Identify owner technical training protocols.
- 7. Expand national awareness of the ZeroTruck brand and product line.
- 8. Enhance the participation of private investment in BEV trucks.
- 9. Identify a realistic specific Job creation plan for assembling BEV trucks.



#### 9. Management and Staffing

### Technical Program Coordinator: Electricore, Inc., Kyle Morris

Electricore, Inc. is a California (CA) based, 501(c)(3), non-profit organization established in 1993 by the United States Department of Defense (DOD), Defense Advanced Research Projects Agency (DARPA) with headquarter offices and personnel in Valencia, CA. Electricore has over 18 years of extensive experience with advanced technology vehicles. The Electricore Team is responsible for the overall objectives and activities, providing administration, management and coordination of subject demonstration projects.

*Program Planning, Tracking & Reporting:* The team approach follows a successful model business and technical management processes conducted by veteran managers and implemented by Electricore for over 18 years in numerous programs. This approach includes: a standard project plan, including a detailed Gantt Chart; a standard Work Breakdown Structure; integrated cost/schedule (Earned Value) planning and systematic risk management. The Electricore Team will provide functional oversight and quality assurance over all ongoing projects using the organization

#### Team Lead: ZeroTruck, Stephen Pagano

The major partners for this project are: ZeroTruck, Isuzu Trucks (OEM Supplier), Dow-Kokam, LA Freightliner, Velocity Vehicle Group, Golden Gate Truck Center, UQM Technologies. These partners and their qualifications can be seen in Table A-15.

ZeroTruck Team members are focused on providing the most advanced technology components into the ZeroTruck and have over 75 years of manufacturing and engineering experience. Partnering with industry leading manufacturers such as Isuzu Trucks for base chassis platforms and UQM's advanced motor technology allows ZeroTruck to offer the most reliable solution to clean fleet needs.

ZeroTruck was created to be a dynamic leader in the commercial application of electric vehicles. The company's founder and management team are passionate about providing solutions for energy independence and cleaner air. Utilizing the latest technology and exclusive partnerships with industry leaders, ZeroTruck now offers the first modern commercial electric truck in the US and serviced through a national dealer network.



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Table A-15: Organization Qualifications				
Organization	Credentials, Qualifications, and Relevant Experience			
ZeroTruck Vehicle Manufacturer and System Integration Lead	ZeroTruck Corporation's management team has over 60 years collective experience in the airline, automotive and electronics industries, including supply chain and maintenance, operations, leasing and manufacturing, and over 20 years of public company management, reporting and investor relations experience.			
Electricore, Inc. Technical Program Coordinator	501(c) (3) non-profit organization with extensive focus and experience on the Green Transportation Sector. Electricore is dedicated to providing more fuel- efficient, high- tech clean transportation systems that reduce emissions, protect the nation's transportation energy future, and create economic opportunities. Electricore partners with public and private organizations, fleets, and government to develop and employ clean, cost-effective transportation solutions.			
South Bay Truck Center, Carson, CA Isuzu OEM supplier	Division of Velocity Vehicle Group of Los Angeles, multiple brand truck sales and service center with 25 years of truck experience. LA Freightliner, the teams worked to secure one of the largest deals to provide alternative fuel trucks to the Ports of Los Angeles and Long Beach, to help reduce emissions and allow truck drivers to purchase discounted vehicles as part of California's Clean Trucks Program. Offering the first complete LNG truck in California, the Sterling LNG, and later along with the Freightliner M2 LNG truck, South Bay Truck Center was a forerunner in bringing a complete alt fuel solution into California. Along with the actual truck sales, South Bay Truck Center is also the closest port of call for all truck service and truck parts in the South Bay / L.A. Basin.			
Dow-Kokam	Dow Kokam is a leader in advanced lithium batteries, which perform well with truck applications. Dow Kokam was established in 2009 to develop and manufacture technologically advanced and economically viable battery solutions for the transportation, defense, industrial and medical industries. The company is owned by The Dow Chemical Company, TK Advanced Battery LLC and Groupe Industriel Marcel Dassault (Dassault).			
UQM Technologies OEM Motor Partner	UQM Technologies has been a leading supplier of high torque, compact DC brushless motors since			

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#### **Project Roles**

Each organization and their roles in the project can be seen in Table A-16.

Table A-16:	Project Roles

ORGANIZATION	ROLE(S) ON PROJECT	ASSOCIATED
Zerotruck Vehicle Manufacturer And System Integration Lead	Prepare and submit demonstration plan, conduct road testing of the vehicles, train operations and maintenance personnel and provide on-site support, collect operating data from the truck and a baseline equivalent conventionally fueled truck, performing a similar duty cycle, and compile and analyze this information, and outreach and commercialization	Assemble completed product, support supplier groups, product training, records, customer service
South bay truck center, Isuzu oem supplier	Oem chassis supplier, demonstrator and distributor for southern California	Oem chassis supplier Fleet demonstrator
Dow-kokam	Us supplier of advanced lithium-ion cells for the zerotruck	Cell supply
Uqm technologies Oem motor partner	Us supplier of electric motors and power components for the zerotruck	Motor supplier

Source: Electricore

#### **Project Key Personnel**

ZeroTruck Corporation's management team has over 60 years collective experience in the airline, automotive and electronics industries, including supply chain and maintenance, operations, leasing and manufacturing, and over 20 years of public company management, reporting and investor relations experience. This can be seen in Table A-17.



Table	A-17:	Kev	Project	Personal
				i el cella

NAME	ORGANIZATION	RELEVANT EXPERIENCE	ROLE ON PROJECT
Kyle Morris	Electricore	Program development and management for a wide variety of transportation, energy and industrial systems.	Program manager – administrative, demonstration logistics, subcontracting
Tedd Abramson	Zerotruck	Founded ZeroTruck corp., cto, designed the ZeroTruck, assembled a highly experienced team of professionals to commercialize ZeroTruck in the US and globally.	Oem project leader – manage supplier groups, maintain assembly deadlines, client training, delivery, post-sale support administration, and records
Steve Pagano	ZeroTruck	Cao, ZeroTruck founding director, investor, leadership team member with 30 years of management experience who will assist in the implementation and success of the project.	Oem project records leader
Mark Kachmarsky	ZeroTruck	Experienced director of project management and chief engineer with mack trucks who has led all phases of new product development and industrialization for mack trucks for the past 32 years	Oem engineering program analyst