1. Name and contact information.

Name: BYD Motors, UPS, FedEx
Contact Information: Andy Swanton, BYD, (213)-458-6918 andy.swanton@byd.com

2. Descriptive (under ten-word) project title.

Title: Zero-Emission Delivery Trucks for UPS and FedEx

3. Location of project (e.g., Interstate-XX, _____ County, post mile _____ to _____ or Port of _____, _____ Road, _____ longitude, _____ latitude).

This project has 2 locations:

- UPS: 1800 N Main St, Los Angeles, CA 90031
- FedEx: TBD – close to BYD's manufacturing facilities in Lancaster, California

4. Concise two paragraph executive summary of project.

Medium duty delivery trucks are arguably the best near-term market for electrification. The duty cycles are inherently short because the national shipping companies deliver large volumes of packages and are therefore able to optimize their routes as short as possible. The customer base is consolidated among large national companies like UPS, FedEx, PepsiCo, Coca-Cola, DHL, and many others. These national companies have engineering resources to evaluate technologies and oversee demonstrations, and many of their corporate missions support sustainability (e.g. UPS, PepsiCo, and Walmart are part of President Obama's American Business Act on Climate Change Pledge). These customers are able to demonstrate significant quantities of trucks and once the business case is proven widespread adoption is possible among just a few customers. Lastly, the market for medium duty delivery trucks is enormous. UPS and FedEx each operate 100,000 trucks, with the majority of trucks in North America, and approximately 9% of all trucks in California.

This project is requesting funding for 20 electric delivery trucks with each of UPS and FedEx in Southern California. The trucks will have at least 100 miles of operating range and thus could replace 80% of the delivery trucks in both UPS's and FedEx's fleets. The UPS trucks will be deployed at 1800 N Main St in Downtown Los Angeles. BYD and FedEx are working to determine the depot for the initial demonstration with FedEx, but would like for it be close to BYD's Lancaster facilities so FedEx has readily available access to BYD' engineering and technical support staff. All trucks will be built at BYD's facilities in Lancaster, California and will be delivered to UPS and FedEx with manufacturer's warranties. The California Air Resources Board and the California Energy Commission will support this project by monitoring and analyzing the performance of the all vehicles via data loggers and real-time telematics. Project outcomes and data will ultimately be utilized to help inform the marketplace and pave the way for widespread commercialization of the tested vehicles.

Comments: We are extremely open to working with ARB should it be determined that modifications to size, scope, and cost of the proposal would be appropriate.

5. Detailed description of how the pilot project idea components will incorporate advanced technologies, alternative fuels, freight and fuel infrastructure, and local economic development; and advance goals of improving freight efficiency, transitioning to zero-emission technologies, and increasing competitiveness of California's freight system.

Technology

The technologies in this project are innovative because for the very first time an original equipment manufacturer will be manufacturing every major electric propulsion component. One of the current hurdles with electric technology is ensuring that each of the electric components communicates seamlessly with the other components. The discharge from the batteries needs to be closely controlled to ensure that power is delivered promptly and reliably to the traction motors. Otherwise, operators will experience irregular propulsion and even scenarios where a truck will not respond to the throttle. These scenarios result in frustration among operators and safety hazards. BYD manufactures each critical component:

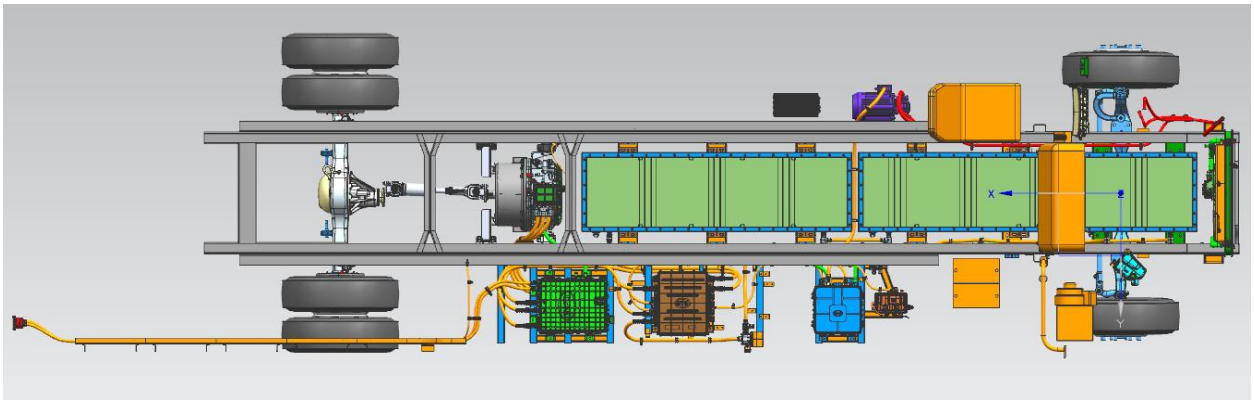
- Batteries: BYD purpose built their iron phosphate battery for vehicle electrification and the technology has three distinct advantages relative to competitive technologies: (1) They are long-lasting and retain 70% charge after 10,000 cycles compared to other lithium ion batteries that rapidly degrade after 2,000 cycles or 5-6 years of regular use; (2) They are extremely safe as the chemical reaction is not exothermic (ie no heat is released) and no oxygen is released; and (3) They are environmentally-friendly as the primary components are iron, which is the most common element on earth by mass, and phosphate, which is naturally occurring.
- BMS System: The batteries will be monitored, diagnosed, and controlled by BYD's proprietary battery management system (BMS), which closely monitors the voltage, temperature, and charge and discharge rates from each individual cell, module, and pack.
- Inverters: BYD also manufactures the inverters responsible for converting AC power from the grid to DC on board the vehicle to charge the batteries and for inverting the DC power from the batteries to AC to power the traction motors. BYD's inverters are bi-directional, which means that vehicle owners can discharge any excess power back to the grid or any other load source whenever they choose. This power can therefore serve as a backup generator to keep critical services running or perform peaking services for utilities.
- Traction Motors: The traction motors used in each vehicle were developed by BYD and are already in use in various vehicle types. These motors are permanent magnet (neodymium) synchronous motors (PMSM) and consist of a stator and rotor assembly.
- Chargers: BYD utilizes 3-phase AC charging because it is a reliable solution that is also cost effective. No transformers are required and the AC power that is delivered to the vehicle is converted to DC power to charge the batteries with the on-board inverter.

All BYD trucks will be equipped with a health activity monitoring system (HAMS) as part of the chassis module control. This device is provided by I/O Controls, who will ensure that the data is available. The HAMS provides the ability to monitor all performance parameters in real-time from a cloud-based server, including fuel efficiency (miles/kWh), strength of charge (SOC), mileage/odometer readings, runtime, idle time, battery temperature, speed, and charging current/voltage. Interagency partners like the California Air Resources Board and the California Energy Commission will have direct access to real-time and historical data for each vehicle throughout their useful life.

Delivery Trucks – UPS

UPS and BYD have been co-developing an electric delivery truck since June, 2015. UPS operates Class 1-8 trucks, but primarily Class 5 and Class 6 delivery trucks, typically with Freightliner MT45/MT55 or Ford F59 chassis and Morgan Olsen or Utilimaster bodies. Globally they have 100,000 vehicles. 3,000

of their vehicles are MY2004-2007 Navistar International trucks that have VT365 diesel engines. Those model year engines have known issues that result in failures. Currently UPS is repowering those 3,000 trucks with new diesel engines; however, they would prefer to repower them with alternative fuel powertrains. BYD and UPS have been working collaboratively on a design whereby BYD would use their iron phosphate cells and powertrain from their 23 foot coach bus to provide a 100% battery electric truck. Currently one of UPS's 218" MY2005 trucks is being converted at BYD's Coach & Bus facility in Lancaster. BYD is configuring the truck with 145 kWh of battery capacity, which is expected to result in 120 mile range. The motor is a 180 kW or 241 hp motor, with 1,106 lb-ft of torque and a maximum speed of 5,000 RPM, which is replacing the 220 hp, 600 lb-ft VT365 motor. BYD's motor does not have a transmission, which increases reliability and decreases downtime, and will be connected to the existing rear axle with a driveshaft and differential. BYD is also manufacturing the VTOG inverter, the two-in-one inverter for the power steering and low voltage system, the high voltage distribution box, a PTC heater, a cooling system for the motor, and all supporting electronics. The general layout is shown below with a picture of the truck.



BYD expects to complete the repower in mid-December, 2015 and deliver to UPS for on road testing in early January, 2016. This project is requesting funding for an additional 20 conversions, all of which would be deployed at UPS's Downtown Los Angeles depot at 1800 N Main St.

The current conversion is for UPS's largest residential delivery truck, which has a 218" wheelbase. The same design could be used for their Class 5 178" trucks, with either the same battery capacity or less to reduce costs. These two truck models are the standard trucks for UPS's delivery in

California and North America. Furthermore, BYD has contacted Freightliner, Ford, Morgan Olsen, and Utilimaster regarding sourcing the chassis and bodies for new trucks.

BYD anticipates meaningful maintenance and fuel savings. Analysis and benchmarking suggests average maintenance cost per mile for the electric delivery truck will be $0.13/mile compared to $0.22/mile for diesel equivalents. Fuel efficiency for the truck is 0.83 miles/kWh compared to 9.00 miles/gallon for diesel. Assuming 80 miles/day and 6 operating days per week, the electric conversion will generate $8,100 in annual savings.

Delivery Trucks – FedEx

FedEx's standard delivery truck is a Class 3 with 11,000-12,000 lbs GVWR, 138" or 156" wheelbase, and 600-700 cubic feet of cargo space (pic below). BYD hasn't started design on a conversion or new model, but engineers from the two companies have started discussing possible options. The basic design will be very similar to the UPS conversion, with battery packs between the frame rails of the chassis and electronics outside the frame rails. The motor will either be connected to the rear axle with a driveshaft or BYD will use an integrated, longitudinally mounted motor. Maintenance and fuel savings will be roughly similar to the estimates provided above.

Economic Benefits

BYD is committed to supporting all product development and manufacturing for the North American market from their offices in California. They are currently building local engineering and product development support for their North American product lines, which will be located in Downtown Los Angeles along with the Sales, Finance, and Human Resources teams. All manufacturing will be completed at one of BYD's existing facilities in Lancaster, or in one of the many facilities that BYD intends to build in Lancaster. Therefore, the trucks in this demonstration project, as well as those that stem from this project, will provide direct economic benefits to California in the form of job creation and economic growth.

6. Estimated cost for implementation and existing funding commitments (include any funding limitations or constraints) by stakeholder and amount.

Each UPS truck conversion is $150,000 and UPS is requesting 20 trucks. BYD is able to offer new UPS trucks with the same chassis and bodies as existing trucks for $175,000, but the proposed project will not include new trucks for UPS. A FedEx conversion will be cheaper as the vehicle is smaller and thus requires fewer batteries and less expensive motors. FedEx conversions will be $125,000 and $150,000. For this project FedEx is requesting 20 new trucks.

Each truck will be configured for BYD's 40 kW charger, which utilizes 3-phase AC power and 48 amps and a 75 amp circuit breaker. Each 40 kW charger costs $2,500. There are two infrastructure costs associated with upgrading power supply: costs to the utility provider to upgrade service; and costs incurred by the fleets to upgrade their facilities. The first step is sending the utilities scaled plans of the facilities with the proposed charger site, a peak demand chart, and a charging profile. The utilities will then perform a site evaluation and a $10,000 engineering evaluation to determine if any upgrades are required, including transformer upgrades, trenching, or line extensions. If upgrades are necessary the costs are paid for by the utilities under tariff allowance programs, Rule 15 and Rule 16, provided the fleets uses the increased power from the upgrades. If the fleets do not use the power, then the chargers will be billed to the fleets in future billing periods. Once the power supply to the meter has been upgraded the facility may incur costs to upgrade panels, breakers, and switchgear, install underground wiring conduits, and install the chargers. A general rule of thumb is $70 per amp for these costs or approximately $5,000 for each 40 kW charger.

This project is requesting $6,300,000 in total funding to support facility upgrades and EVSE installation, as well as all vehicles and chargers. The fleets will contribute project match in the form of fuel costs, driver salaries, maintenance, and registration fees, in addition to the engineering evaluations by the utility providers.

Annual Operating Costs	**Number**	**Price**	**Total**	**Cash Match Labor/Capital**
Fuel Cost – annual			$117,636	$117,636
Driver Cost – annual			$2,600,000	$2,600,000
Maintenance Cost – annual			$80,000	$80,000
Total Registration Cost to Fleets - annual			$131,000	$131,000
Direct Costs	**Number**	**Price**	**Total**	**Cash Match Labor/Capital**
Utility Engineering Cost	2	$10,000	$20,000	$20,000
Facility Upgrades - both facilities	40	$5,000	$200,000	
40 kW AC Chargers	40	$2,500	$100,000	
Electric Truck Conversions - UPS	20	$150,000	$3,000,000	
New Electric Trucks - FedEx	20	$150,000	$3,000,000	
Total			$9,248,636	**Split**
Cash Match			$2,948,636	32%
Project Request			$6,300,000	68%

7. Timeline.

BYD is committed to delivering all 40 vehicles 6 months from the date that the project contract is executed. A draft project schedule is included below.

Task 1 Project Kickoff: **Deliverable Due Date: January 8, 2016**

Task 2 Product Testing and Registration:

FedEx: complete FMVSS testing, update DOT NHTSA registration, acquire World Manufacturer Identifier (WMI), EPA and CARB Certifications

UPS: acquire EPA and CARB certifications

(BYD) Deliverable Due Date: May 1, 2016

Task 3 Electric Vehicle Supply Equipment (EVSE) Installation (Utilities/FedEx/UPS): **Deliverable Due Date: July 1, 2016**

Task 4 Delivery of All Trucks (BYD): **Deliverable Due Date: July 1, 2016**

Task 5 Product Registration including Federal Highway Use Tax (HUT) and California DMV and Fleet Integration of Trucks (FedEx/UPS)**: Deliverable Due Date: August 1, 2016**

Each vehicle will be assembled at BYD's facilities in Lancaster, California, and will be warranted by BYD with the following terms.

Category	Warranty Contents	Period (Whichever Comes First)
Ⅰ	High Voltage Battery	8 Years or 250,000 miles
Ⅱ	Low Voltage Battery	3 Years
Ⅲ	Powertrain: Traction Drive Motor, High Voltage Electronics Controller Assembly, BMS Module Assembly	5 Years or 100,000 miles
Other	Bumper to Bumper: Remaining Parts of Complete Vehicle (only relevant for FedEx)	2 Years or 30,000 miles

FedEx and UPS will incorporate the electric vehicles into their fleet and will operate them in the same conditions and environment as conventional vehicles through the end of their useful life, which is anticipated to be 8 years.

8. Means for measuring progress toward meeting goals over time.

Each vehicle in this demonstration will have a data logger for assessing historical and real-time performance. BYD will provide the technology demonstrators, interagency partners, and any other parties with access to the data for analysis and evaluation. The successful conclusion of this project will help move the dial forward for widespread market adoption of the tested vehicles in these targeted markets for several reasons.

First, the project will prove the viability of electric delivery trucks. All vehicles in this project will operate in real-world conditions and will have to meet the duty cycles of their conventional counterparts. And all vehicles in this project will face the daily wear-and-tear inherent to delivery environments. UPS and FedEx are metrics driven organizations that are keenly aware of the performance metrics that alternatively-fueled technologies must meet to adequately replace conventional technologies. A successful outcome of the proposed project will demonstrate that the tested vehicles are in fact viable and capable of meeting the demands placed upon them and will serve as a stamp of approval for the delivery industry.

Second, the project will prove that the long-term economics of the proposed vehicles are sound. Electric vehicles typically have higher upfront costs compared to their diesel counterparts. However, because of the reduced long-term operational costs, electric vehicles can be the more economical option for end users over the life of the vehicle. It is critical to build the business case for electric vehicles by showing that these savings actually materialize after the vehicles have operated under real world conditions. This project will build the business case data point by data point. The final results of the project can then be used to educate the marketplace to view electric delivery trucks as a smart and economical investment—a critically important outcome for achieving widespread market adoption.

Third, the project will establish a real-world utilization model for delivery trucks with both conversions and new vehicles that can be emulated by other delivery companies like DHL, PepsiCo, Walmart, and others. Because the utilization of electric vehicles is a new operational model for delivery fleets, part of what must be done to achieve widespread market adoption is to demonstrate a workable utilization model that can then be copied by potential purchasers in the broader marketplace. This project seeks to do just that. By demonstrating zero emission battery electric delivery trucks on real-world routes, the project will serve as a template for other end users to learn from, mimic, and modify to their individual needs. Long after the project has successfully concluded, this project will serve as an example that helps guide the decision-making of other end users interested in procuring the tested technologies. The end result will be even greater market commercialization.

9. Description of the potential roles each of the interagency partners could provide to support the project's implementation.

The interagency partners would provide administrative oversight throughout the project, namely the California Air Resources Board (CARB) and the California Energy Commission (CEC). Critical functions include:

- Project Kickoff: reviewing and finalizing project budget, timeline, and emissions reductions with BYD, UPS, and FedEx.
- Monthly Progress Meetings: web conference with project partners during product development, site facility upgrades and EVSE installation, delivery, vehicle deployment, and ongoing operations.
- Data Monitoring and Synthesis: ongoing assessment of performance indicators like odometer readings, fuel economy, and vehicle downtime.
- Report Writing: distilling learnings from the project and publishing results for review by industry stakeholders, operators, and advocates.

Additional information may be attached. Please note that any information provided is considered public.

Charger Specs

Charger	40 kW
Price	$2,500
Charging Mode	AC
Input Voltage	480V 3-phase
Operating Voltage Range	432V-528V 3-phase

Input Current	48A
Input Power	40kW
Frequency	60Hz
Output Voltage	432V-528V 3-phase
Output Current	48A
Output Power	40kW
Charging Coupler Type	IEC62196-2
Length	15.75in
Width	7.87in
Height	27.17in
Number of Coupler(s)	1
Charging Cable Length	118.11in
Mounting Method	Wall-mounted
Short-circuit Protection	✓
Overheat Protection	✓
Lightning Protection	✓
Certification	TUV
Reference Standard	IEC61851/IEC62196
Enclosure Protection	IP55
Operating Temperature	-22 to +122 deg F
Surrounding Humidity	5-95%
LED Indicators	Power, Connect, Charging, Complete, Error
LED Screen	SOC, Est Time to 100% SOC, ID, Charging Volume, Error

Idea summaries and any supporting materials should be provided via email to freight@arb.ca.gov by ***5:00 pm November 30, 2015.*** *All ideas will be reviewed by the State agencies and a list of preliminary pilot projects for consideration will be presented for public comment at regional workshops planned for January 2016.*

Most Reliable

Package Car Powertrain Repower

Long Range

The 100% Battery Electric Powertrain
Affordable, Dependable, and Environmentally Friendly

BYD's package car powertrain rewpower utilizes the first battery that was purpose-built for vehicle electrification. Our proprietary iron phosphate technology is the core of BYD's package car solution, enabling 110 miles of range with gradual battery degradation. This truck is designed to fit seamlessly into your fleet without changing the way you do business.

Our Package Car Powertrain Repower is completed at BYD's Lancaster, CA Facility, and is compliant with FMVSS and CMVSS.

- ☑ Environmentally friendly: no heavy metals or toxic electrolytes
- ☑ Regenerative braking extends battery life and reduces brake component wear
- ☑ High-efficiency, permanent magnet synchronous motors
- ☑ Vehicle-to-Grid system that allows the truck to deliver power back to the grid, to a load, or to another vehicle

Build Your Dreams

WHAT SETS BYD APART

LONG RANGE
Our breakthrough battery technology enables 110 miles of range

FUEL SAVINGS
$9,800 annual savings assuming 100 miles per day and 6 days per week.

LONG-LASTING
Our batteries will still have 70% strength of charge after 10,000 cycles or 27 years if cycled every day.

MAINTENANCE SAVINGS
$3,100 annual savings assuming 100 miles per day and 6 days per week. Lower maintenance on propulsion system, fewer fluids to change, less brake wear, and fewer moving parts.

ECO-FRIENDLY
Zero emission. The battery chemistry is iron-phosphate and contains no heavy metals and the electrolyte is non-toxic.

SAFE
No propensity to combust: no oxygen released, thermal balancing, and no cell swelling. Proprietary Battery Management System (BMS) assists with balancing and charging safety.

VEHICLE		23,500 lbs GVWR
Performance	Top Speed	56 mph
	Gradeability	12%
	Range	110 miles
Powertrain	Motor Type	AC Permanent Magnet Synchronous Motor
	Max Power	241 hp
	Max Torque	1,106 lb-ft
	Battery Type	Iron-Phosphate
	Battery Capacity	145 kWh
	Charger	40 kW
	Charging Voltage	480 V
	Charging Time	3.6 hrs

Note:
1. All information based on the latest data available at the time of printing. Final specs subject to change at production.
2. Initial capacity shown. Numbers may decrease with time and use.
3. Battery age and outside ambient temperature affect charging times.