1. Name and contact information.

Name: BYD Motors, BNSF Railway, and Daylight Transport
Contact Information: Andy Swanton, BYD, (213)-458-6918 andy.swanton@byd.com

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

Title: Zero-Emission Truck Development Project for Intermodal and Warehouse Facilities

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

This project has three locations.

- BNSF San Bernardino: 1535 W 4th St., San Bernardino, CA 92411
- BNSF Commerce: 2818 Eastern Ave., Commerce, CA 90040
- Daylight Fontana: 11150 Elm Avenue, Fontana, CA 92337

4. Concise two paragraph executive summary of project.

According to the South Coast Air Quality Management District, Heavy Duty Diesel Trucks are responsible for 49 tons/day or 15% of overall nitrogen oxide emissions in the Southern California region. BYD is currently developing electric Class 8 vehicles for a range of vocational markets, including refuse trucks, drayage trucks, concrete mixers, and yard trucks that will significantly reduce emissions and improve public health. Among those vehicles, yard trucks are arguably the most sensible vehicles to electrify because: (1) they operate within contained facilities and are therefore easier to monitor and service; (2) they are off-road vehicles and thus require fewer registrations; and (3) they are generally in service for 2 or 3 shifts per day, with substantial idling time, and are thus high emitters. There are roughly 5,000 yard trucks in California and 50,000 in North America.

This project would demonstrate 23 yard trucks at three best in class freight facilities. 10 trucks would be deployed at each of two BNSF Railway intermodal facilities: San Bernardino and Commerce. An additional three trucks would be deployed at a new Daylight Transport facility in Fontana. All three of these locations are in the top 10% of disadvantaged communities according to CalEnviroScreen2.0. The technology demonstrators are leaders in the industry and successful demonstration would lead to adoption at BNSF's other facilities in Los Angeles, Oakland, and Stockton, and Daylight's other facilities in Los Angeles, Visalia, and San Francisco. It would also accelerate electric truck adoption at the ports, other intermodal rail yards, and freight support facilities in California and the rest of North America. All trucks will be built at BYD's facilities in Lancaster, California and will be delivered to BNSF and Daylight 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: This proposal is similar to a project submitted by San Bernardino Associated Governments (SANBAG) in response to the California Air Resources Board's 2015 Multi-Source Solicitation. Results from that solicitation have not yet been released. Even if the project is awarded, this proposal provides an opportunity to scale the project at the existing facilities, as well as other BNSF intermodal rail yards and Daylight less-than-truckload facilities. 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.

Yard Trucks

Yard trucks are the focal point of this project. BYD's yard truck model is the T9A and it is currently in the design phase. The T9A will have 175 kWh of battery capacity, allowing it to operate for approximately two consecutive eight-hour shifts between charges. The PMSM traction motor is a 180 kW proprietary BYD product with a maximum torque of 1,106 lb-ft and a maximum speed of 5,000 RPM. The T9A is designed to match or exceed the performance of diesel trucks across each key performance specification. BYD also anticipates meaningful maintenance and fuel savings. BYD testing suggests average maintenance cost per mile for the T9A will be $0.23/mile compared to $0.39/mile for diesel yard trucks. Fuel efficiency for the T9A is 0.39 miles/kWh compared to 3.50 miles/gallon for diesel. Assuming 58 miles/day and 6 operating days per week, the T9A will generate $14,600 in annual savings.

Service Trucks

Each major freight support facility has medium duty off-road service trucks to perform maintenance on yard tractors, rubber tired gantry cranes, forklifts, and other vehicles within the yard. BYD has a zero emission electric truck that is a perfect platform for service trucks called the T5. The T5 is similar to the 16,000 GVWR service trucks that are used at each proposed location. These trucks will be configured with a stake bed (i.e. have flat beds with railings) and will be used for transporting equipment, including air compressors, welders, and tools, as well as spare parts. The T5 is powered by a 145 kWh iron phosphate battery module, which provides a range of 155 miles. The motor is a 150 kW in-line traction motor that is integrated with the rear axle and provides 406 lb-ft of torque. Assuming 100 miles/day and 6 operating days/week, combined maintenance and fuel savings are anticipated to be $10,300 in annual savings.

Emission Reductions

The vehicles in this demonstration will have meaningful impacts on emission reductions.

Metric	**Results**	**Unit**
Metric ton CO2e / year	1,745	metric tons CO2e / year
Ton NOx / year	0.80	tons NOx / year
Ton ROG / year	0.04	tons ROG / year
Ton PM10 / year	0.04	tons PM10/ year
WER / year	1.65	tons criteria pollutants / year

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.

This project is requesting $9,441,800 in total funding to support facility upgrades and EVSE installation, as well as all vehicles and chargers.

Site Upgrades & EVSE Install	#	$/per	$ Total
BNSF San Bernardino	1	$570,900	$570,900
BNSF Commerce	1	$570,900	$570,900
Daylight Fontana	1	$50,000	$50,000
Equipment			
Yard Trucks	23	$300,000	$6,900,000
Service Trucks	4	$165,000	$660,000
Chargers	23	$30,000	$690,000
Total			**$9,441,800**

The technology demonstrators are contributing annual operating expenses related to electricity costs, driver salaries, and maintenance, which together total $4,316,991 each year.

Items	Request	Match	Total
Equipment and Installation	$9,441,800	$0	$9,441,800
BNSF	$0	$3,624,184	$3,624,184
Daylight	$0	$692,807	$692,807
Total	$9,441,800	$4,316,991	$13,758,791
%	69%	31%	100%

7. Timeline.

BYD is committed to delivering all 27 vehicles 6 months from the date that the project contract is executed. BYD has experience delivering new vehicles within 6 months, most recently fulfilling an order of 20 street sweepers for the City of Beijing within that timeframe. A draft project schedule is included below.

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

Task 2 Product Testing and Registration – acquire EPA and CARB Certifications (BYD)**: Deliverable Due Date: May 1, 2016**

Task 3 Electric Vehicle Supply Equipment (EVSE) Installation (Southern California Edison/BNSF/Daylight): **Deliverable Due Date: July 1, 2016**

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

Task 5 Begin Fleet Demonstration (BNSF/Daylight)**: 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	2 Years or 30,000 miles

The technology demonstrators will incorporate the electric vehicles into their fleet and will operate them in the same conditions and environment as the current diesel 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 the electric yard trucks and service vehicles. All vehicles in this project will operate in real-world conditions and will have to meet the duty cycles of their diesel counterparts, including 24/7 operation at BNSF's San Bernardino facility. And all vehicles in this project will face the daily wear-and-tear inherent to intermodal and LTL environments. 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.

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 yard trucks and service vehicles 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 battery electric yard tractors and service vehicles that can be emulated by other freight operators. Because the utilization of electric vehicles is a new operational model for intermodal rail and LTL end users, 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 yard tractors and service vehicles 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, BNSF, and Daylight.
- 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.

In addition to the state interagency partners, this project team has the support from the following organizations and individuals:

- SANBAG (San Bernardino Associated Governments): a regional leader in the development, demonstration, and advancement of low-emission alternative fuel technologies. SANBAG would assist and facilitate the activities listed above for CARB and CEC.
- CALSTART: a consortium leading the commercialization of advanced transportation technologies. CALSTART will provide commercialization support and market assessment.
- Southern California Edison: utility provider to each of the three proposed locations
- Local politicians who have endorsed the project:
    - R. Carey Davis, Mayor, City of San Bernardino
    - Michael Tahan, Mayor Pro Tem, City of Fontana
    - Connie Leyva, State Senator, 20th District
    - Pete Aguilar, Congressman, 31st District
    - Josie Gonzalez, Supervisor 5th District, San Bernardino County
    - Cheryl R Brown, Assemblymember, 47th Assembly District
    - Terry M Roberts, Managing Director, American Lung Association, California

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

Charger Specs

Model		200 kW
		
ELECTRICS	Rated Input Voltage	AC480V 3-phase
	Operating Voltage Range	AC432V-528V 3-phase
	Input Current	240A
	Input Power	200kW
	Operating Frequency	60Hz
	Output Voltage	AC432V-528V 3-phase
	Output Current	120A per 2 charging connectors
	Output Power	≤100KW per 2 charging connectors
	Output Interface Standard	IEC62196 BYD proprietary
	Number of Charging Connectors	2
	Length of Charging Cable	10 ft.
SAFETY	Protection Function	short circuit protection /over-temperature protection /surge protection
	Certification	DEKRA
	IP Degree for Enclosure	IP54
OTHER	Noise	≤60dB
	Cooling Method	Natural cooling
	Operation Temperature	-25℃～+40℃
	Storage Temperature	-30℃～+60℃
	Environment Humidity	5～95% non-condensing
	LED Indicators	Power, Connect, Charging, Complete, Error
	LCD Screen	SOC, Estimated time to 100%, ID, Charging Volume, Error

BNSF Engineering Estimate for San Bernardino Facility Upgrades and EVSE Installation (same for Commerce Facility)

Kansas City, KS
September 3, 2015

To Nathan Waller

From: Barry Grieser Facilities Engineering

Subject: San Bernardino, CA BNSF Electric Charging Stations Estimate

In line with your recent request, you will find listed below a BUDGETARY ESTIMATE associated with the BNSF electric charging stations, San Bernardino, CA electric charging station project. This estimate is for 1 electrical service to feed the 10 electric charging stations (item1), equipment pads (item 2) directional boring to supply power to the services (item 3) ATS (item 4), and engineering. This estimate is based on 10 electric charging stations that require electrical power.

	Material		Labor		Other	Total
	quant	dollars	quant	dollars	dollars	dollars
1 Electrical Service - Power Transformer, Panelboards, Breakers, Switchgear, Conduit, & Conductors.	1 Lots	175,000	1,000 mH	100,000		275,000
2 Equipment Pads & Bollards.	1 Lots	15,000	300 mH	30,000		45,000
3 Directional Boring - Includes HDPE Pipe & Conductors.	1 Lots	50,000	160 mH	16,000		66,000
4 Automatic Transfer Switch ATS	1 Lots	75,000	80 mH	8,000		83,000
5 Engineering/CM					50,000	50,000
subtotal:		315,000	1,540 mH	154,000	50,000	519,000
Contingency		10.0%				51,900
Totals:		**$315,000**		**$154,000**	**$50,000**	**$570,900**

Barry Grieser
Facilities Engineering

Daylight Transport Engineering Estimate for Fontana Facility Upgrades and Installation

Items	Cost
Panel	$20,000
Underground wiring conduit terminals	$15,000
Labor to install the panel and weather resistant cabinet interconnect enclosures	$10,000
Additional materials	$5,000
Total estimated cost	$50,000

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

Battery Electric Yard Truck

Up to 81,000 lbs GCWR, 8+ Hours

T9A

The 100% Battery Electric Yard Truck
Affordable, Dependable, & Environmentally Friendly

BYD's Class 8 truck utilizes the first battery that was purpose-built for vehicle electrification. Our proprietary iron phosphate technology is the core of BYD's delivery truck, enabling 8+ hours of operation between charges and gradual battery degradation. This truck is designed to fit seamlessly into your fleet without changing the way you do business.

Our Yard Truck is manufactured at BYD's Lancaster, CA Facility.

- ☑ 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 DUTY CYCLE
BYD's breakthrough battery technology enables 8+ hours of continuous operation.

FUEL SAVINGS
$12,100 annual savings assuming 60 miles per day and 6 days per week.

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

MAINTENANCE SAVINGS
$3,000 annual savings assuming 60 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. Our iron-phosphate chemistry 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		81,000 lbs GCWR
Dimensions	Length	20.1 ft
	Width	98.4 in
	Height	148.2 in
	Wheelbase	116 in
	Curb Weight	22,046 lbs
	GCWR	81,000 lbs
Performance	Top Speed	56 mph
	Max Gradeability	24%
	Range	8+ hours
	Turning Radius	21.5 ft
	Approach/ Departure Angle	24° / 41°
Chassis	Suspension	Leaf Spring 10L-9R Front, Rigid Suspension Rear
	Brakes	Pneumatic Drum , ABS, Regenerative Braking
	Tires	11R 22.5
Powertrain	Motor Type	AC Permanent Magnet Synchronous Motor
	Max Power	241 hp
	Max Torque	1,106 lb-ft
	Battery Type	Iron-Phosphate
	Battery Capacity	175 kWh
	Charging Capacity	100 kW
	Charging Voltage	480 V
	Charging Time	1.75 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.

MOST RELIABLE

Battery Electric Delivery Truck

16,100 lb GVWR, Long-Range

T5

The 100% Battery Electric Delivery Truck
Affordable, Dependable, & Environmentally Friendly

BYD's delivery truck utilizes the first battery that was purpose-built for vehicle electrification. Our proprietary iron phosphate technology is the core of BYD's delivery truck, enabling 155 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 16,100 lb GVWR Delivery Truck is manufactured 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, longitudinal mounted motors that are integrated with the drive axle
- ☑ 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
BYD's breakthrough battery technology enables 155 miles of range

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

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

FUEL SAVINGS
$7,500 annual savings assuming 100 miles per day and 6 days per week.

MAINTENANCE SAVINGS
$2,800 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.

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		16,138 lbs GVWR
Dimensions	Length	19.7 ft
	Width	80.7 in
	Height	116.1 in
	Wheelbase	132.3 in
	Curb Weight	9,480 lbs
	Gross Weight	16,138 lbs
Performance	Top Speed	62 mph
	Max Gradeability	30%
	Range	155 miles
	Turning Radius	22.3 ft
	Approach/ Departure Angle	21°/ 16°
	Cargo Volume	494 ft 3
Chassis	Suspension	Suspension Leaf Spring
	Brakes	Pneumatic Disc Brakes, ABS, Regenerative Braking
	Tires	215 / 75 R 17.5
Powertrain	Motor Type	AC Permanent Magnet Synchronous Motor
	Max Power	204 hp
	Max Torque	406 lb-ft
	Battery Type	Iron-Phosphate
	Battery Capacity	145 kWh
	Charging Capacity	100 kW
	Charging Voltage	480 V
	Charging Time	1.5 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.