Comments of Joseph T. Dalum,
Executive Vice President, DUECO, Inc.
and
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at the
California Energy Commission Workshop
San Jose, California

On the draft Investment Plan
For the Alternative and Renewable Fuel and Vehicle Technology Program

California Energy Commission
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Re: Docket No. 08-ALT-1
1516 Ninth Street
Sacramento, CA 95814-5512

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Introduction

Good morning, and thank you for offering DUECO, Inc., the opportunity to share its views on the California Energy Commission's (CEC's) Investment Plan for the Alternative and Renewable Fuel and Vehicle Technology Program.

DUECO commends the CEC staff for developing a sound, comprehensive investment strategy. We strongly encourage the CEC to fully implement proposals to aid in the demonstration and deployment of near-commercial plug-in hybrid electric medium-duty and heavy-duty trucks, defined as trucks that weigh over 14,000 pounds, (*Super-Ultra-Low-Carbon category*), and support the development of retrofit plug-in hybrid electric applications for medium and heavy-duty trucks. Additionally, DUECO urges the CEC to broaden support for research and development efforts in vehicle and engine efficiency. DUECO encourages R&D support to improve both the first generation plug-in hybrid electric medium and heavy-duty trucks as well as longer-term advancements such as hydraulic hybrid technology (*Vehicle and Engine Efficiency category*). The plug-in hybrid technology developed by DUECO will enable California to more effectively achieve its 2020 and 2050 goals. Our proposals offer a logical path to continually reduce medium-duty and heavy-duty vehicle greenhouse gas emissions over time, by enhancing the scalability, scope and technology capabilities of heavy-duty vehicles made by OEMS and latter-stage manufacturers such as DUECO.

I would like to take a few moments to introduce DUECO and Odyne, and then further address our recommendations for the CEC's Investment Plan.

My name is Joe Dalum, and I am Vice President of DUECO. Headquartered in Waukesha, Wisconsin, DUECO is one of the largest final stage manufacturers of utility trucks in the country. DUECO employs over 300 people, and has sold thousands of medium and heavy-duty vehicles over the past 10 years. DUECO is a privately owned business operating for over 50 years, with a 100,000 sq. foot manufacturing facility in Waukesha, Wisconsin, and

additional facilities located in South Dakota, Minnesota, Indiana, Ohio and Pennsylvania. We are a final stage manufacturer of trucks with aerial devices, digger derricks, cranes and other equipment that are sold to electric and gas utilities for the maintenance of their transmission and distribution power lines and underground gas delivery infrastructure, in a 15 state region. In addition to serving the electric utility industry, DUECO provides equipment and services for the telecommunications, contractor, electrical cooperative, municipality, gas utility and tree care markets. In California and other markets outside of our 15 state region, DUECO partners with other companies, such as Terex Utilities, to provide local sales and service support. Our trucks are also used by companies throughout the country through our rental and leasing company, Utility Equipment Leasing Corporation (UELC). UELC has been in business for over 40 years, and has direct facilities in California (both in Sacramento and Ontario), as well as Florida and Texas.

DUECO

Manufacturing facility Waukesha, WI

Odyne, an affiliate of both DUECO and UELC, is a clean technology company that develops and manufactures propulsion systems for advanced Plug-in Hybrid Electric Vehicles for medium and heavy-duty trucks, by integrating our proprietary electric power conversion, electric power control and energy storage systems with a range of off-the-shelf components including electric motors and storage batteries. Our Plug-in Hybrid Electric Vehicle systems are either series or parallel configuration hybrids that are optimized for different applications. Our environmentally friendly and cost-effective Plug-in Hybrid Electric Vehicle system allows vehicles to operate at lower costs and with lower vehicle emissions.

Odyne's Plug-in Hybrid Electric Vehicle solution offers several advantages to stand-alone alternatively fueled vehicles and vehicles powered by conventional internal combustion engines, including lower vehicle emissions and lower operating costs through greater fuel efficiency and lower maintenance costs. Odyne's Plug-in Hybrid Electric Vehicle system integrates off-the-shelf products, advanced control systems and our modular and versatile propulsion system. This combination allows our Plug-in Hybrid Electric Vehicle system to be competitively priced while retaining the flexibility to build to customer specifications and enabling later modifications to extend the life of a vehicle and meet evolving customer needs. The Plug-in Hybrid Electric Vehicle can be recharged overnight by plugging into a high-capacity 220-volt electrical outlet. To protect the value of our Plug-in Hybrid Electric Vehicle system, we have filed patent applications to cover our vehicular battery carriers and cooling systems, vehicle monitoring and control systems, battery management systems, vehicle charging system and overall system architecture.

In 2006, DUECO began to assess alternative hybrid vehicle technologies. Those activities led to a collaborative effort between DUECO and Odyne Corporation. Our efforts resulted in the introduction of the utility industry’s first commercial plug-in hybrid heavy-duty truck in the Fall of 2007. Since 2007, DUECO has produced 17 plug-in hybrid medium and heavy-duty trucks for use by several utilities around the country, including two trucks to Pacific Gas & Electric Company (PG&E) in California, as well as Arizona Public Service (APS), Progress Energy, Florida Power and Light (FP&L), American Electric Power (AEP), We Energies, Dayton Power & Light (DPL), Xcel Energy and others.

Plug-in hybrid medium-duty truck with Odyne system produced for PG&E

In January of this year, DUECO announced the acquisition of most of the assets of Odyne Corporation by an affiliate. Manufacturing and development of plug-in hybrid drive systems has transitioned to the affiliate, further strengthening our commitment to the plug-in hybrid electric medium and heavy-duty truck market.

Plug-in hybrid technology for medium and heavy-duty trucks is in the early stages of testing and deployment. Low production volume and high cost threaten to delay wide-scale adoption. In order to rapidly accelerate the use of plug-in hybrid electric trucks in the next five years, a large increase in resources directed toward research, development, engineering and production will be required. With the aid of government funding and support, DUECO could produce a substantial volume of plug-in hybrid medium and heavy-duty trucks over the next few years. Production could be further expanded to thousands of units through strategic partnerships with other final stage manufacturers and with chassis manufacturers.

Background

According to the U.S. Department of Energy, approximately 80% of all the goods transported in the U.S. are moved by truck. In total, the U.S. consumed about 140 billion gallons of gasoline, and 40 billion gallons of diesel fuel, in 2004 for on-road transportation. Heavy-duty trucks – while fewer in number than passenger vehicles – generate a disproportionately larger share of pollution and greenhouse gas (GHG) emissions. The utility bucket truck segment, served by DUECO, uses diesel fuel, and generates substantial emissions, while idling for several hours at a time at job sites. Plug-in hybrid electric technology offers significant potential to reduce both petroleum fuel consumption and GHG and other emissions in a large number of medium and heavy-duty trucks.

Medium and heavy-duty trucks are typically manufactured and marketed to customers much differently than cars and light-duty trucks. Due to lower volumes of trucks sold (vs. passenger cars) and the high level of specialized applications, the truck manufacturing industry has evolved to enable a high degree of customization. Most medium and heavy-duty trucks are typically built in multiple stages. During the first stage, an original equipment manufacturer builds an incomplete vehicle, commonly known as a chassis. The vehicle is then often completed by a different company, known as a final stage manufacturer. Final stage manufacturers typically evaluate the intended application of the vehicle, perform engineering analysis, and then install an appropriate body, equipment and interface components with chassis systems in a manufacturing operation.

Medium and heavy-duty trucks may also have multiple companies involved in the marketing of the final product. A chassis manufacturer may market directly to an end user, and a final stage manufacturer may also market to the same end user. Because multiple companies are involved in the manufacturing and marketing of medium and heavy-duty trucks, the overall process is more customized than in the car and light-duty truck market.

As a logical extension of our role as a final stage manufacturer, DUECO has begun to offer customers the opportunity to procure medium and heavy-duty trucks that incorporate a

parallel plug-in hybrid electric drive system that DUECO and its business partners design, manufacture and install. Many of DUECO's vehicles utilize a chassis provided by International or GMC, with an Allison transmission. The Allison transmission is built by the OEM with an opening already in place for a connection to a Power Take Off (PTO) unit, which DUECO utilizes for two-way mechanical communications for the plug-in hybrid drive connection.

DUECO's connection of its parallel plug-in hybrid electric drive system does not alter in any way the OEM-provided transmission, engine or emissions control equipment, but rather complements these systems. Our integration of the parallel plug-in hybrid electric system is a new phase in a continuum of engineering analysis, design and installation of vehicle modifications for our customers. It is a logical expansion of the typical manufacturing and marketing routine for our target customers.

DUECO's Parallel Plug-in Hybrid Electric Trucks

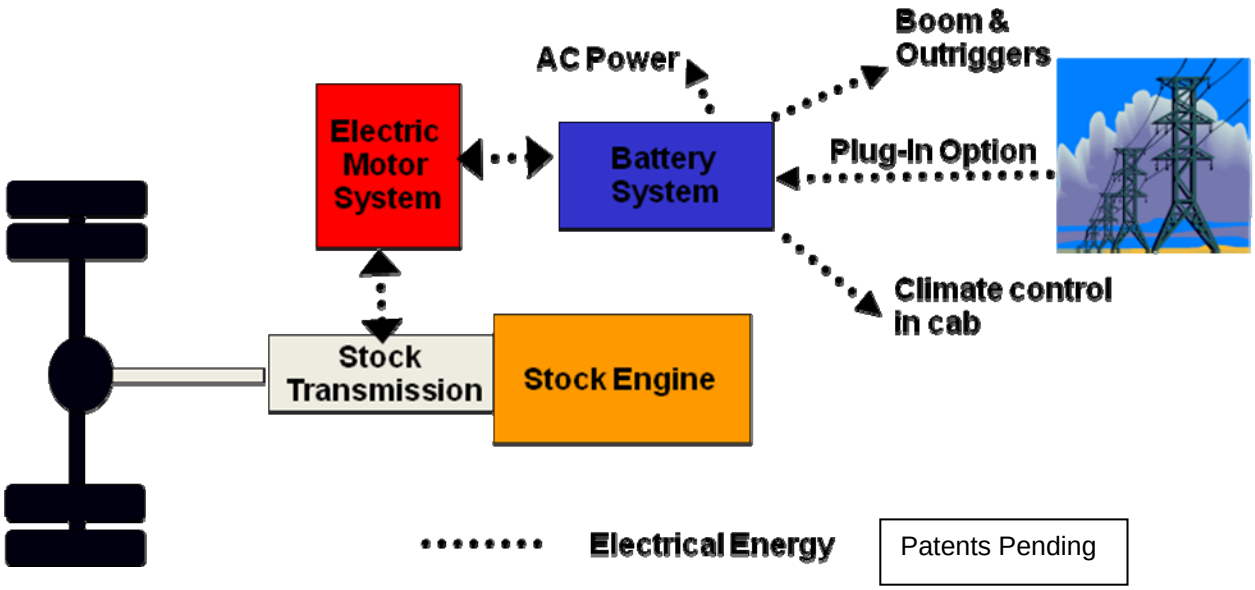
DUECO's parallel plug-in hybrid electric medium and heavy-duty trucks offer unique opportunities to reduce fuel use and lower GHG and other emissions due to the typical mission and duty cycle of our customers. DUECO's customers typically use their medium and heavy-duty trucks-- that is, trucks with aerial lifts, digger derricks, cranes, or other equipment such as air compressors, mounted onto them – while working at a job site. While most of DUECO's trucks have been sold to utilities, the technology developed can be used on a wide variety of medium and heavy duty truck applications and market segments. With a conventional diesel-powered truck, while at the job site, the truck would be idling with the engine on, to power heating or cooling for the cab or to operate truck-mounted equipment such as an aerial lift. By contrast, using DUECO's parallel plug-in hybrid electric trucks, the 35 kWh battery pack powers the climate controls and the hydraulics operating the lift, crane, or air compressor, so the diesel engine can be turned off for hours while operating at a work site. DUECO's plug-in hybrid system reduces diesel fuel consumption and eliminates emissions during idling. In addition, the PHEV system improves diesel fuel economy while driving as well, further reducing emissions.

Here are some examples of DUECO’s parallel plug-in hybrid vehicles in the field.

DUECO's HRX55 Plug-In Hybrid Electric Utility Truck

DUECO's TL50M Plug-In Hybrid Electric Utility Truck

A diagram of a plug-in hybrid system is shown below. Electrical energy is used to increase efficiency while driving through hybrid launch assist and regenerative braking. Electrical energy also powers equipment loads at a job site, potentially eliminating the need to run the engine.



Several of DUECO's hybrid heavy-duty trucks are currently being tested with early adopters, including several major electric utilities around the country, like PG&E. Our units are being tested in the field, in regular fleet operations to maintain power lines. Using a 35 kWh battery system and interfacing with an Allison transmission, the plug-in hybrid system provides the opportunity for all-electric operation at a job-site for a typical day; hybrid launch assist; regenerative braking; power for hydraulically operated equipment; electrically powered air conditioning and heating; and 120 VAC exportable power. DUECO currently uses AGM lead-acid batteries made by EnerSys, electric motors supplied by Bosch, and truck-mounted Terex aerial devices and digger derricks.

DUECO's Digger Derrick Plug-In Hybrid Truck

The 35 kWh AGM lead-acid battery system is designed to be charged completely in about 8 hours by plugging into the electric grid, optimally during off-peak periods at night. AGM lead-acid battery system performance is well understood, easily recyclable, and currently much more cost effective. Medium and heavy-duty trucks can be designed to incorporate the battery system on the base vehicle and still meet payload requirements. The battery system is modular; the current battery system can be replaced with advanced battery system technology when newer systems become more readily available and lower in cost.

DUECO's PHEV is built utilizing a versatile, modular design with standard components for trucks ranging from 17,500 – 56,000 lbs. GVWR. It affords enhanced reliability with the use of redundant power for critical operations. Advanced diagnostics and data acquisition are available, as is the ability to monitor the vehicle via satellite. The basic design can be used on a variety of chassis configurations including 2 X 2, 4X4, and tandem axle configurations.

DUECO's PHEV truck sales to-date incorporate aerial lifts, but DUECO is currently testing a PHEV heavy-duty truck with a digger derrick attachment, for deployment in 2009. Digger derricks are used by utilities to drill holes, set poles and lift large loads. The demand for power from the plug-in hybrid system can be very high during certain operations, such as digging in rocky terrain. Other applications, such as the

telecommunications trucks and gas utility trucks, are also on the drawing board or in prototype development.

DUECO's plug-in hybrid electric technology offers numerous benefits in our customer's medium and heavy-duty truck applications. Many of these benefits are well known to the California Energy Commission, and include: reduced diesel fuel consumption; reduced emissions at the job site and during urban stop-and-go driving; reliance on domestically-produced electricity which can offer even greater emissions benefits using a renewable generation mix and lower-cost off-peak charging; lower noise levels during stationary operations; improved vehicle acceleration; standby power capability (9 KW or more exportable power for job site power tools; lighting or temporary restoration of power to facilities); reduced engine maintenance costs (due to fewer daily hours of engine operation); ability to maintain a charge/emergency re-charge via conventional engine; ability to export power from the vehicle for external uses (in the future, it may be possible to export power from the vehicle to the grid to reduce peak loads).

However, the introduction of plug-in hybrid technology faces both technical and commercial challenges. DUECO believes that with the appropriate government-industry partnership, these challenges can be addressed and overcome.

Market acceptance of DUECO's plug-in hybrid electric medium and heavy-duty vehicles is challenged by several factors:

- High acquisition price. Low initial production volume, combined with high start-up costs, contribute to a relatively high acquisition price for current plug-in hybrid systems. The high price deters wide-scale adoption of this technology by commercial customers. The start-up costs include costs for research and development, testing and validation, production floor-space and tooling, low volume manufacturing activities, service and operator training, marketing and other costs associated with launching a new product. Those costs are spread over an initially low production volume, resulting in higher per unit sell prices. Critical

components that are used in the system are also not typically available in high volume, resulting in higher material cost.

- Weak economy and low fuel prices. Commercial truck customers are currently reducing purchases and may have difficulty accessing credit. When purchasing trucks on a limited budget, customers tend to favor low priced products that provide the best short-term return. Low fuel prices and a difficult economy tend to make it more difficult to sell a higher priced product, even if it has substantial benefits over existing products.

- Hesitancy to adopt new technology. Commercial truck buyers are typically quite conservative, and are currently more likely to buy trucks that are very similar to others in their fleet. Trucks that are purchased may remain in the field for 20 years or more, so unless there are substantial incentives, the transition to plug-in hybrid trucks will likely occur incrementally. Our experience has been that some customers have adopted a "wait and see" attitude.

- Weight. Plug-in hybrid systems typically require much larger battery systems. The additional weight can create a problem for certain applications. As lightweight, more advanced batteries enter the market, and become affordable, the number of applications where plug-in hybrid technology can be used would increase.

- Stability of supply chain. Current economic challenges and reduced access to credit has negatively affected some suppliers of critical hybrid components. The overall weakness of the automotive supply chain could jeopardize the availability of key components and cause consumers to wait before purchasing technology.

Technical challenges impede deployment of plug-in hybrid electric technology in medium and heavy-duty applications, including:

- Battery system technology. Existing battery technology either tends to offer battery systems that are relatively low cost, but heavy, large and of limited life, or are relatively expensive, but much lighter, smaller and with potentially longer life. While certain applications of trucks may be able to carry low cost, heavier battery systems, it is generally desirable to minimize battery system weight, size and cost. Development of cost-effective larger advanced battery systems, potentially with energy storage in excess of 35 kWh, or even in excess of 100 kWh, would improve the performance and reduce the operating cost of plug-in hybrid electric heavy-duty trucks. Battery systems for commercial trucks must function well under different conditions and duty cycles than those in light-duty automotive applications. Trucks must often locate the larger battery system on the exterior of the truck, exposed to the elements. Trucks may also operate for much longer duty cycles; commercial vehicles may be driven 12 – 16 hours per day, or operate for multiple shifts. Advanced battery systems that cost-effectively meet heavy-duty truck requirements are needed.

- System architecture: Existing hybrid systems for trucks tend to utilize system architectures that are similar in many ways to that of existing truck power trains. In order to improve fuel economy further, different system architectures that are designed for high-volume production – in which the internal combustion engine can be turned off during driving – need to be developed. The development of electrically driven sub-systems such as braking, power steering, HVAC and others need to be brought to high volume production for medium and heavy-duty trucks.

- Utility infrastructure: While studies tend to indicate that there is sufficient capacity in the nation's energy grid at off-peak periods to provide power for charging a large number of plug-in vehicles, there has been little testing on the effects of charging a large number of commercial plug-in hybrid trucks. Assessment and testing of the effects of a large commercial fleet of vehicles, each with a 35 kWh battery pack that needs to be charged overnight, is needed. The use of smart grid technology to

control battery charging and minimize the impact on the grid should also be studied.

- Research into specific medium and heavy duty applications: Plug-in hybrid technology has the potential to reduce fuel consumption and GHG emissions in a wide variety of applications. For example, trucks that use cranes, compressors, welding equipment, or are used in applications such as gas utility maintenance, refrigeration, rescue, refuse and construction may benefit from plug-in hybrid technology. Specific information about the energy required for various mobile and stationary applications is typically not available. In order to optimize plug-in hybrid designs, research data needs to be collected from real-world working fleets, in terms of actual fleet utilization, miles driven, time at idle, power requirements, fuel consumption, and other operational factors.

- Accelerated testing. Plug-in hybrid technology for medium and heavy-duty trucks is relatively new and still under development. Assistance is needed to accelerate testing and reduce the costs of large-scale field tests.

Although current plug-in hybrid technology has the potential to provide significant benefits for many applications, shortcomings in certain areas decrease the value proposition of plug-in hybrid systems for medium and heavy-duty trucks. Wide-scale deployment must be driven by demand. It is necessary to improve the value proposition by providing greater performance and fuel savings for less incremental cost. With appropriate partnerships between government and industry, these challenges can be met in a timely manner.

DUECO's Plug-in Hybrid Electric Trucks Help California Meet Goals

The plug-in hybrid electric technology that DUECO designs and installs in medium and heavy-duty trucks can benefit California in three principal ways: (i) improved fuel economy, reducing the amount of diesel fuel consumed by the medium and heavy-duty truck sector, and (ii) reduced greenhouse gas emissions and lower emissions of criteria pollutants, since an electric battery system will provide the power for truck mounted

equipment and climate control system used during work at a job site (vs. having a diesel on while working at a job site). (iii)Reduced noise in communities and improved work-site productivity and safety.

Fuel savings and emission reductions are dependent upon the application and duty cycle of the vehicle. Outlined below are two examples of the estimated fuel savings and greenhouse gas emissions that could accrue from the use of a DUECO plug-in hybrid heavy-duty utility bucket truck, over the course of a year.

Example 1:

This example compares a DUECO PHEV truck with a conventional diesel utility heavy-duty bucket truck, in a typical workday where a total of about 4 hours are spent at a job site and hydraulic equipment is utilized for two hours. Baseline miles per gallon data were taken from actual measurements of non-hybrid vehicles, idle fuel consumption and PTO mode measurements were taken with the chassis A/C off. The following data is used to calculate the fueling savings and greenhouse gas reductions.

Vehicle Type	Class 7 Utility bucket truck with aerial lift
Weight	33000 lbs.
Horsepower	255
Driving Fuel Consumption	5.7 mpg
Idling Fuel Consumption	.9 gallons per hour
Power Take Off Mode (use hydraulics while vehicle is stationary)	1.3 gallons per hour
Battery Pack (PHEV)	35 kWh
GHG Emission Reductions	22.2 lbs CO2 per gallon of fuel reduced

The example assumes that the vehicle drives 30 miles to the work site and that the non-hybrid vehicle engine remains on during the time period where work is being done at the job site, under the assumption that the engine is needed to power hydraulic equipment and/or for cab climate control systems. Alternatively, it is assumed that the DUECO PHEV utility truck has the engine turned off during work time at a job site, and the hydraulic equipment and cabin climate controls are powered by the 35 kWh battery pack. A total work time of 4 hours per day is assumed. DUECO's testing has demonstrated about 6.7 miles per gallon in urban driving for a plug-in hybrid truck, representing an 18% improvement in fuel economy. DUECO's testing has also shown a complete elimination of fuel consumption and emissions while stationary at the job site for typical aerial bucket truck applications.

Using the assumptions and data listed above, the Dueco PHEV would generate the following fuel savings and GHG emission reductions.

Activity	Baseline Vehicle (gallons)	Dueco Plug-In Hybrid (gallons)
Drive 30 miles to job site	5.26	4.47
Idle at job site for 1 hour	.9	0
Operate in PTO mode for 2 hours	2.6	0
Idle at job site for 1 hour	.9	0
Drive 15 miles back to garage	5.26	4.47
Total	14.93	8.96

The total estimated fuel reduction is over 40 percent or approximately 6.0 gallons per day. Annually the fuel savings are estimated to be over 1,400 gallons of diesel, based upon 250 work days per year. **This translates to over 30,000 lbs (over 15 tons) of CO2 greenhouse gas reduction each year *per truck.***

Example 2:

This example compares a DUECO PHEV truck with a conventional diesel utility heavy-duty bucket truck, for a typical workday in which idle time is greater and drive distance is shorter than shown in example 1. In this example a total of about 6 hours are spent at a job site and hydraulic equipment is utilized for 5 hours. All of the other parameters except for drive distance remain the same as in example 1. Baseline miles per gallon data were taken from actual measurements of non-hybrid vehicles. The following data is used to calculate the fueling savings and greenhouse gas reductions.

Vehicle Type	Class 7 Utility bucket truck with aerial lift
Weight	33000 lbs.
Horsepower	255
Driving Fuel Consumption	5.7 mpg
Idling Fuel Consumption	.9 gallons per hour
Power Take Off Mode (use hydraulics while vehicle is stationary)	1.3 gallons per hour
Battery Pack (PHEV)	35 kWh
GHG Emission Reductions	22.2 lbs CO2 per gallon of fuel reduced

The example assumes that the vehicle drives 15 miles to the work site and that the non-hybrid vehicle engine remains on during the time period where work is being done at the job site, under the assumption that the engine is needed to power hydraulic equipment and/or for cab climate control systems. Alternatively, it is assumed that the DUECO PHEV utility truck has the engine turned off during work time at a job site, and the hydraulic equipment and cabin climate controls are powered by the 35 kWh battery pack. A total work time of 6 hours per day is assumed. DUECO's testing has demonstrated about 6.7

miles per gallon in urban driving for a plug-in hybrid truck, representing an 18% improvement in fuel economy. DUECO's testing has also shown a complete elimination of fuel consumption and emissions while stationary at the job site for typical aerial bucket truck applications.

Using the assumptions and data listed above, the Dueco PHEV would generate the following fuel savings and GHG emission reductions.

Activity	Baseline Vehicle (gallons)	Dueco Plug-In Hybrid (gallons)
Drive 15 miles to job site	2.63	2.24
Idle at job site for .5 hour	.45	0
Operate in PTO mode for 5 hours	6.5	0
Idle at job site for .5 hour	.45	0
Drive 15 miles back to garage	2.63	2.24
Total	12.66	4.48

The total estimated fuel reduction is 65 percent or 8.2 gallons daily. Annually the fuel savings are estimated to be over 2,000 gallons of diesel based upon 250 work days per year. **This translates to over 44,000 lbs (over 22 tons) of CO2 greenhouse gas reduction each year *per truck.***

As stated previously, results will depend upon the drive cycle, specific application and other factors. Vehicles that are used less often have fewer urban miles or idle less may have lower savings than the examples.

Based on the number of heavy-duty utility trucks in California, clearly the potential emissions benefits are substantial. According to the U.S. Department of Transportation, the United States had about 110.5 million trucks, and California had about 13.8 million trucks

in 2007. An estimated 18,700 vehicles were medium- duty or heavy-duty aerial trucks. Not counting retirements, an average of 800 medium and heavy duty aerial trucks are added each year. **If half of those new trucks were PHEVs, the greenhouse gas emissions reduction would be over 6,000 tons per year.** Criteria pollutants such as NOx and PM10 would also be substantially reduced. Other work truck applications could benefit from this technology, potentially increasing total plug-in hybrid medium and heavy duty trucks and further reducing emissions.

The availability of retrofit kits for in-use heavy duty utility aerial lift trucks would also greatly increase potential fueling savings and GHG emission reductions. Installing plug-in hybrid drive systems to 20% of the existing aerial bucket truck market in California would result in an estimated 3700 systems, The same retrofit plug-in hybrid technology can be applied to other medium and heavy duty truck segments, increasing fuel savings and emission reductions much further.

DUECO's Comments on the CEC Proposed Investment Plan

DUECO supports the framework developed by the CEC for setting priorities in its proposed Investment Plan for the Alternative and Renewable Fuel and Vehicle Technology Program established under Assembly Bill (AB) 118. Our comments specifically address two categories of funding recommendations for FY 2008-2009 and 2009-2010: (1) the Super Ultra-Low Carbon category and (2) the Vehicle and Engine Efficiency category.

Super Ultra-Low Carbon Category Comments

(1) Cost differential funding for pre-commercial, demonstration, and deployment of plug-in hybrid electric medium and heavy-duty trucks. DUECO agrees that a partnership with government is needed to accelerate pre-commercial testing and demonstration of plug-in hybrid technology in medium and heavy-duty truck applications. Funding support for pre-commercial testing and demonstrations of medium and heavy-duty plug-in hybrid electric vehicles, followed by funding support for more wide-scale deployment of these trucks, is critically needed to foster this market.

DUECO supports the CEC's proposals to jump-start the market by providing financial assistance to cover the differential cost of plug-in hybrid electric medium and heavy-duty vehicles (that is, the incremental cost above that of a corresponding conventional vehicle). Incentives could be in the form of vouchers, or rebates, for vehicles that the California Air Resources Board (CARB) has deemed appropriate.

(DUECO encourages the California Air Resources Board to consider utilizing the IRS guidelines as a mechanism for qualifying for eligibility, in the near-term. This is because CARB has not yet developed an emissions test protocol for heavy-duty plug-in hybrid electric trucks that adequately reflects the emissions benefits from vehicles that idle much of the day – hence, that do not generate emissions that are present when a conventional counterpart truck is in operation. DUECO welcomes the opportunity to work with CARB to develop appropriate emissions test protocols that include duty cycles with substantial idle time, and calculations of emissions that are "offset".)

2) Co-fund niche market demonstrations. Field testing data is limited on the performance, fuel economy, and emissions benefits of the pre-commercial heavy-duty plug-in hybrid electric trucks. DUECO encourages the CEC to co-fund niche-market demonstrations and incorporate acquisition of data on fuel economy savings and emissions benefits as part of the plug-in hybrid heavy-duty truck demonstration programs. For example, DUECO would like to create plug-in hybrid systems that optimize the emissions and fuel economy benefits for specific industry applications and duty cycles. Additionally, pre-commercial and demonstration projects should incorporate data analysis to better refine the design of PHEV systems.

3) Fund development and use of Retrofit kits for Medium and Heavy-duty plug-in hybrid trucks. DUECO and Odyne's parallel plug-in hybrid electric technology can potentially benefit a much larger market than just new medium and heavy-duty truck sales in our target market niche. By focusing R & D on the development of a retrofit application designed to convert appropriate medium and heavy-duty trucks in the field, a much greater

opportunity to reduce greenhouse gas emissions could evolve. Development of such a retrofit kit could extend the reach of parallel plug-in hybrid technology to many more trucks in fleet operation today, potentially reducing greenhouse gas emissions years before truck turnover would present such opportunities. DUECO supports the CEC's proposal to fund, and implement, retrofit kits to convert existing fleet vehicles to plug-in hybrid electric trucks, in the medium and heavy-duty truck market. The production of a retrofit kit could also potentially create significant job opportunities within the state of California. The kits could be installed on fleets locally, reducing transportation costs and bringing jobs to the state.

Using off-the-shelf components, DUECO and Odyne can engineer and design retrofits for numerous in-fleet applications. Certain factors must be considered in a retrofit, such as packaging space for components (batteries, electric motors, electronics), the type of transmission and availability of a PTO opening, drive train communications, and available payload for the additional weight of the PHEV system.

4) Defray costs of chargers and their installation, for both private fleets and public access. DUECO supports the CEC's proposals to provide early adopter incentives to help defray the cost of installing charging infrastructure at private fleet and public access locations. As part of these efforts, the CEC can promote data gathering to inform improvements in charging equipment design, and data acquisition that will benefit the electric utility industry's understanding and management of the emerging electric vehicle load.

Vehicle and Engine Efficiency

1) Expand R&D to include funding for improvements to near-term plug-in hybrid designs for medium and heavy-duty trucks. The CEC proposals in this area focus on long-term research and development efforts, which DUECO supports. However, DUECO encourages the CEC to expand proposed R&D funding to include development of "Gen 2" designs for current plug-in hybrid systems for medium and heavy-duty trucks. R&D would

focus on cost reduction opportunities, and ways to broaden the scope of vehicles served by plug-in hybrid technology. For example, the size and weight of the existing plug-in hybrid system is an issue in some heavy-duty and medium duty applications. For wider application on a larger number of vehicles, it would be very helpful to have funding support to design a smaller, lighter system (broadening plug-in technology's reach). A smaller, lighter system would probably use a different battery technology and the latest automotive grade components which are expected to be available very soon (e.g., a new Bosch inverter may be available this year). These improvements would yield greater GHG emissions reductions, sooner.

2) Fund R&D on Medium and Heavy-duty vehicle engine and component design, system architecture design, and hydraulic hybrids. In order to improve fuel economy further, different system architectures that are designed for high volume production in which the internal combustion engine can remain off during driving need to be developed. The development of electrically driven sub-systems such as braking, power steering, HVAC and others need to be brought to high volume production for medium and heavy duty trucks. Future system architectures could also combine the benefits of plug-in hybrid technology, which require battery systems with high energy densities, with that of hydraulic hybrids that have high power densities. The combined plug-in electric hybrid system with hydraulic hybrid components could offer high horsepower during acceleration and recapture more energy during braking while providing enough energy for sustained operation with the engine off. R&D for advanced Series/Parallel power train concepts should also be considered, along with systems specifically designed for class eight long-haul vehicles. DUECO supports the CEC's proposals to fund research in this area, which offers great potential for emissions reductions and fuel economy.

DUECO and Odyne appreciate the opportunity to share our suggestions for the CEC's proposed Investment Plan. We are looking forward to working in partnership with the CEC to accelerate the introduction of medium and heavy-duty plug-in hybrid electric technology.