

San Francisco office
750 44th Avenue
San Francisco, CA 94121



Silicon Valley office
2 North First Street
San Jose, CA 95113

Plug & Play Electric Drivetrains

Memorandum

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To California Energy Commission Dockets Office
From Fraser Murison Smith, ElectraDrive
Subject Docket No. 09-ALT-1
Date 10/29/09

ElectraDrive submits the attached comments on the 2010–11 Alt-Fuels Investment Plan to support the allocation of funds for the development of electrification solutions to serve the millions of vehicles in California not otherwise served with plug-in options by the automakers. We believe there exists a huge latent opportunity to establish California as a center for innovation in clean vehicles by supporting companies developing novel solutions to upgrade existing vehicle platforms.

ElectraDrive is embarking on a 12–18-month product development process, in conjunction with Bay Area local governments, which would benefit from funds disbursed under AB 118 during 2010–11. Our business is structured so as to stimulate local workforce development for vehicle conversion, bringing green-collar jobs to all parts of California.

Separately we will provide letters of support for our program from participating local governments and California-based electric motor and battery companies who comprise our supply chain.

Sincerely,

Fraser Murison Smith

CEO, ElectraDrive
fdms@electradrive.net
(415) 425-9891

Observations on fund allocations to-date

Although AB 118 was passed “to develop and deploy innovative technologies that transform California’s fuels and vehicle types to help attain the state’s climate change policies”,¹ surprisingly little of the funds approved so far have made their way into the development of technologies and products to accelerate the adoption of plug-in electric vehicles. \$3.5 million has been allocated “to cover the differential cost of vehicles converted to electric drive for public and private fleets or individuals”.² These funds are available for such systems as plug-in retrofits of the Toyota Prius which have received a waiver from CARB.

Separately, the CEC intends to issue a solicitation in November 2009 of around \$9 million, out of the unspent \$100 million previously set aside to match ARRA grants, to support manufacture of batteries, components and whole vehicles.³

Neither of these allocations appears specifically to support product development as distinct from deployment. As such, they would only fulfill one half of the intent of AB 118, which is to “develop and deploy”.

Why vehicle electrification is important

California is the world’s third largest consumer of vehicle fuels after China and the US.⁴ What is the single fastest way to reduce this consumption?

ElectraDrive argues it is by converting vehicles to run electrically. Andy Grove, the former chairman of Intel, has been making the same argument for over a year now.⁵ Giving existing vehicles an electric capability might at first glance appear inefficient compared to putting new plug-in vehicles on the market. However, the economics are favorable for such customers as fleets whose procurement decisions are based on leveled cost. From a policy standpoint, we believe the only way the stated emissions reduction goals are going to be met is through widespread vehicle conversion programs.

- The turnover of new vehicles in the vehicle population is slightly less than 7 percent per year.⁶ This percentage equates to around 1.8 million new vehicles per year in California.
- A number of recent projections put the market penetration of hybrid and electric vehicles by 2020 at around 11 percent.⁷ Roughly ten percent will be various kinds of non-plug-in hybrid. Around one percent will be plug-in hybrid or electric vehicles.
- One percent of California’s vehicles is around 270,000 vehicles. Out of 18 million new vehicles sold over ten years in California, this means only 1.5 percent would be new plug-in hybrids or EVs, according to these figures.

Plug-in vehicles take advantage of the most pervasive, inexpensive and controllable motor fuel available, which is electricity. On a mile-for-mile basis, off-peak grid electricity costs around one-fifth of gasoline at today’s prices. Furthermore, plug-in hybrids can attain aggregate fuel economies 2–3 times better than the most efficient non-pluggable hybrids on the road today. Pure EVs are 2–3 times more efficient again, when converted to gallons of gasoline equivalent (GGE).

The only new plug-in vehicle available today is the Tesla Roadster, and it is produced in small numbers. Several others will come onto the market in the next 2–3 years but their production runs will not make much of a dent in the state’s overall demand for motor fuels in the near term.

¹ AB 118, Legislative Counsel’s Digest.

² 2009 Alt-Fuels Investment Plan, p.15.

³ Comments by Peter Ward at the CEC Alt-Fuels Workshop, CPUC, 12 October 2009.

⁴ *Ibid.*

⁵ See, for example, in the McKinsey Quarterly:
http://www.mckinseyquarterly.com/Automotive/An_electric_plan_for_energy_resilience_2276.

⁶ Based on DOT data from the Bureau of Transportation Statistics.

⁷ A recent Deutsche Bank report projects around 93 million hybrids on the world’s roads by 2020, along with around 9 million plug-in electric vehicles. Out of a projected global vehicle population of around 900 million by 2020, hybrids and electric vehicles will account for 11 percent. This value is consistent with recent comments by Nancy Gioia, head of Ford’s EV program in Wired Magazine (<http://www.wired.com/autopia/2009/10/ford-evs/>).

A significant proportion of California's motor fuel consumption comes from vehicles for which the automakers have no plans to provide plug-in electric capabilities until near 2020 at the earliest, namely pickups, vans, SUVs and large sedans.⁸ Given that a large pickup will average about 12 mpg city / 17 mpg highway, the addition of an electric capability to cover its urban miles—63 percent of all vehicle miles, on average—leaving the factory powertrain to pick up the highway miles, will boost its aggregate fuel economy up to around 50 mpg. The same pickup converted to extended-range electric, in which the factory drivetrain is replaced with an electric drivetrain supplemented with a small onboard generator, should attain close to 150 mpg of motor fuel alone, or around 100 mpg when electricity is factored in on a GGE basis.

Vehicle electrification is important not only because of the efficiencies of the vehicle itself but also because of the efficiencies of merchant electrical generation to charge it. Most forms of merchant power generation are 2–3 times more efficient than vehicle combustion engines. Large numbers of plug-in vehicles no doubt will place demands on the electrical infrastructure, particularly at the local level, but it is generally agreed that California and the nation as a whole would only require additional merchant baseload generation once the number of vehicles plugged in at night reaches the tens of millions.

Supporting the development of solutions to electrify large light-duty and certain medium-duty vehicles presently without other electric options, in addition to supporting the introduction of new plug-in vehicles, will significantly accelerate the state's attainment of the greenhouse-gas reduction goals laid out in the California Alternative Fuels plan. Substituting 270,000 electric sedans for 270,000 gasoline sedans of about the same size would yield a benefit of about 1.4 million tons of carbon dioxide abated per year, not counting emissions from merchant power generation. Electrifying the same number of ¾-ton pickups would yield an emissions benefit of 2.3 million tons per year.⁹ The actual benefit would be higher than this assuming some or all of these vehicles were existing ones rather than new ones off the production line. Extending the lives of existing vehicles is a commendable policy goal, one shared by certain substantial segments of the vehicle market.

What the market really wants

Millions of light trucks, vans and SUVs ply California's roads. They are immensely popular because they are immensely useful. Neither the Tesla Roadster nor any of the other plug-in vehicles scheduled for introduction over the next 2–3 years, welcome though they are, will be able to carry lumber like a truck, supplies like a van or the pee-wee soccer team like an SUV.

Public-sector fleets in particular operate a disproportionate number of these vehicles compared to automobiles. Out of 310,000 light trucks owned and operated by public agencies within California, around 260,000 are owned and operated by state and local governments.¹⁰ Many of these entities are tasked by legislation to achieve certain clean-fleet goals within a certain time-frame, usually five years or less. This is impossible if solutions do not exist for their light trucks and similar vehicles. A city or a county can only get so far by replacing all its old Chevy Celebrities with Priuses, or converting those Priuses to plug-in.

Because public fleets are wholly owned and operated for the most part, they benefit from giving existing vehicles a new lease on life while reducing carbon emissions and operating costs, and also deferring the purchase of new vehicles. Many of the trucks, vans and larger sedans in public fleets operate duty cycles extremely amenable to all-electric conversions: 40 miles or less per day, mostly in the urban cycle.

A truck travelling from site to site around a city during the course of a work day has no need for a distributed charging infrastructure, provided it has a hookup when it returns to the yard. The yard typically will already have the kind of electrical service to support multiple charging stations or, in the worst case, an upgrade will necessitate a single tie-in to the distribution feeder, rather than the multiple interconnects necessary to install a distributed charging infrastructure.

Public fleet vehicles requiring range-extension could benefit either from (a) electric drivetrains to supplement the factory powertrain or (b) conversion to extended-range EV.

⁸ Based on ElectraDrive conversations with Bay Area representatives of several global automakers.

⁹ These estimates assume a vehicle travels an average 11,500 miles per year and that burning a gallon of gasoline releases about 20 lb CO₂ into the atmosphere (www.fueleconomy.gov). An average sedan of the kind for which new plug-in vehicles will be an approximate substitute will average around 20–25 mpg in mixed driving. We take the lower number. A ¾-ton truck will typically get around 12 mpg.

¹⁰ Federal Highway Administration data.

Public fleets generally are open to trying new technologies. Early in 2010, ElectraDrive will begin a vehicle electrification project on one of the County of Alameda’s fleet pickups. This kind of project can readily be replicated into a suite of modular products for light trucks, not only for public fleets but also for customers in other sectors, such as truck rentals, commercial fleets and eventually small businesses and consumers. The market in California in each of these segments is substantial.

| Segment | Number of light trucks ¹¹ |
|---|--------------------------------------|
| Light truck rentals | 100,000 |
| Commercial fleets (15 vehicles and up) | 700,000 |
| Small businesses (commercial non-fleets, 5–14 vehicles) | 340,000 |
| Consumers & contractors (1–4 vehicles) | 5 million |

An 11-percent penetration into these markets combined would equate to around 680,000 light trucks. Depending how many of these vehicles were converted to pure EV, as distinct from a plug-in hybrid of some kind, the greenhouse gas savings would run into the several millions of tons of carbon dioxide per year.

And this is just for pickups. Vans, SUVs and large sedans together comprise about three times as many vehicles again.

What customers in all these markets want is a vehicle offering the functionality they need with the drivetrain they desire—one that emits the least possible junk from the tailpipe. Adoption rates will vary according to customers’ valuation metrics. Public fleet customers, for example, tend to procure based on leveled cost, incorporating capital, operating and retirement costs, whereas consumers today generally look only at sticker price. Public fleets will see the life-cycle value of electrification long before consumers will. On the other hand, the consumer market is where the greatest gains eventually will be possible.

Widespread vehicle electrification in California

Electrification solutions for platforms not served by the automakers are ready for development today, whereas five years ago motor and battery technologies would not have been far enough along. ElectraDrive has designed modular drivetrain products that can be introduced to the market within 18 months of initial funding. We already know how to convert an existing truck to extended-range electric drive, as shown below.

Summary:

- Test prototype developed to understand integration issues in vehicle electrification.
- Gasoline engine replaced with electric motor.
- Battery pack and charger mounted under truck bed.
- Power electronics and onboard generator mounted in engine bay.
- Wheels driven solely by electricity.
- Freeway-capable, with enhanced acceleration.
- Battery pack can be charged from mains using cheap, domestic electricity.
- Battery pack delivers around 30 miles of electric driving between charge-ups.
- Battery pack also can be charged from onboard generator on longer trips, which eliminates range anxiety and caters to the one-third of vehicle miles covered on the highway.
- Overall fuel efficiency improved from around 16 mpg to roughly 100 mpg, combining gasoline and electricity.
- Production systems based on this approach will bring substantial savings on operating costs while reducing



¹¹ Internal ElectraDrive estimate, based on a variety of sources.

dependence on foreign oil and lowering vehicle emissions.

Widespread vehicle electrification in California, whether of existing vehicles, or new vehicles or gliders off the production line, will become possible once prototype systems such as this are developed into modularized, packaged, 'installer-ready' systems, as we call them.



Widespread vehicle electrification also will be dependent upon distributed installation. Some of the thousands of California businesses devoted to vehicle service will secure accreditation to install and service aftermarket modular electric drivetrains. Larger institutional customers, such as public fleets, rental fleets and some commercial fleets may bring installation and service in-house. In either case, there exist substantial workforce development incentives from local governments for the creation of these kinds of jobs. Many local governments are struggling to find placements for green-collar workers who may be eligible for workforce benefits through ARRA block grants in sectors other than the solar PV industry. These are the same local governments looking for ways to clean up their vehicle fleets.

All the pieces are in place for the CEC to stimulate a flowering of innovation and an outpouring of products to serve the latent demand for electric conversions within the state. The demand is real and present, the technologies are ripe, the window of opportunity is substantial, the economics are improving and, speaking for ElectraDrive, the products are designed, the supply chain is being established, the business model is sound, and customers are starting to sign up.

Suggestions for the 2010–11 Alt-Fuels Investment Plan

ElectraDrive proposes that the 2010–11 Investment Plan place a substantial emphasis on stimulating the development of products to support the electrification of vehicles not otherwise served by the automakers with plug-in options. We would suggest an allocation of \$20 million to fund:

1. Basic product development, including regulatory certification, as distinct from, or in addition to, manufacturing or commercialization;
2. Financial incentives for customers purchasing these solutions, in addition to any federal incentives on offer;
3. Subsidies for vehicle service businesses to defray costs associated with becoming set up to perform conversions, such as capital equipment, training and certification.

Our intent here is to follow the example of the solar PV industry, which has been wildly successful in securing incentives and other financial assistance at the federal and state levels for the development and deployment of rooftop solar. Solar power systems today are largely modular and fairly standardized, a state we seek for aftermarket electric drivetrains. Both technologies carry relatively high capital costs and low operating costs. The difference between rooftop solar and electric vehicle conversion is that electric conversion carries a much shorter payback than rooftop solar because it displaces a much more expensive source of energy than grid electricity, namely motor fuel. From a policy standpoint, if rooftop solar is eligible for generous subsidies, without which it would be uneconomic, it stands to reason that vehicle electrification technologies also ought to be eligible for generous subsidies. Vehicle electrification has a reasonable payback even without subsidies (4–8 years, typically). Subsidies will only serve to accelerate market development, just as they have in the California solar market since the inception of the California Solar Initiative.

If the CEC allocates these funds, ElectraDrive will apply for a grant in the 2010–11 cycle to support the introduction of our modular conversion products to the California market. We are excited to be part of one of the largest and most ambitious public funding programs ever to be developed for clean vehicles, and we look forward to a long and fruitful relationship.