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Plug-In Electric Vehicles for Fleets

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The term "plug-in electric vehicle" (PEV) encompasses both plug-in hybrid electric vehicles (PHEVs) and pure electric vehicles (EVs). PHEVs are essentially hybrid vehicles with larger batteries, so that they can run almost exclusively on battery power for a fixed number of miles, after which an internal combustion engine kicks in and the vehicle operates in hybrid mode. As the name implies, EVs run exclusively on electricity stored in an on-board battery. Both types of PEV batteries can be recharged by plugging in to conventional grid power, typically at 110 or 220 volts (V), though higher voltage (and faster) chargers are available.

A plethora of PEVs will be coming to the consumer market over the next few years. Nearly every automobile manufacturer is either in production, gearing up, or in the latter stages of research and development (R&D) with an intent to go into commercial production. Those manufacturers are joined, or in some cases led, by a group of start-ups whose first products will be passenger PEVs.

The marketplace of PEV vans and trucks for commercial fleets is considerably less vibrant than that for passenger vehicles, but there are a number of manufacturers that either already offer vehicles or are preparing to bring them to market. These vehicles span the spectrum from light-duty vans and pickups to heavy-duty class 8 trucks (**Table 1**, page 3).

Primarily due to the cost of the large-capacity lithium ion batteries used, PEVs are an expensive alternative to the vehicles you currently have in your fleet. But a combination of benefits including low operating cost, low maintenance costs, and the potential for federal and state tax incentives and fee reductions could go a long way toward making them financially attractive options. Several manufacturers are working to put together financing to make the monthly cost of owning and operating their vehicles lower than that of conventional vehicles. And then, of course, there's the fact that these vehicles have low tailpipe emissions—none at all in the case of EVs. That attribute can be worth quite a lot for an organization trying to achieve a sustainability goal or to enhance a green image. But beyond image, if legislation is passed that enacts either a carbon tax or a cap-and-trade regime for greenhouse gases, the emission reductions that PEVs offer could have a real, quantifiable dollar value.

Few PEVs for commercial fleets are available today. Those that are on the market come with high price tags and little field experience to point to. Despite their elevated costs and risks, though, some corporate fleet managers are convinced that PEVs have a niche in their fleets that will grow as costs come down. These managers are introducing small numbers of PEVs into their fleets to gain an understanding of the vehicles' benefits and drawbacks, so they'll be ready to deploy PEVs on a wider basis once they can make the business case.

WHY YOU MIGHT WANT TO PAY ATTENTION

"We want to get it to the point where, at the very least, [PEVs are] no more costly than conventionally powered vehicles, and if there's a way to save money by doing it, that's the best, because you're returning some value to shareholders." —Mike Payette, Staples Inc.

PEVs promise substantial benefits for fleets ranging from reduced operating and maintenance costs to reduced emissions of carbon dioxide (CO_2) and the resulting benefits for the green image of the company that incorporates them into its fleet. There's even potential for PEVs to be used as a source of revenue when parked by providing grid-support services. The big question is whether all of these benefits are enough to offset the substantial incremental cost you're likely to face to purchase one. But we'll get to that later. First, the benefits.

TABLE 1: Existing and emerging manufacturers of PEVs for commercial fleets

A handful of manufacturers are adapting existing vehicles to be plug-in electric vehicles (PEVs) or are designing and building them from the ground up.

Manufacturer	Function	Vehicle class[a]	Electric range (miles)[b]	Available in North America
Plug-in hybrid electric vehicles				
Bright Automotive	Delivery/service van	Light duty	40	2013
Eaton Corp.	Utility bucket truck	Medium duty	NA[c]	Now
DUECO	Utility bucket truck	Medium to heavy duty	NA[c]	Now
Electric vehicles				
Balqon	Port drayage tractor	Heavy duty	30	Now
	Delivery truck	Heavy duty	90	Now
Boulder Electric Vehicles	Cargo van/delivery truck	Light duty	120	2010
	Utility bucket truck	Medium duty	120	2010
DesignLine	Commuter bus	Heavy duty	120	Now
Electric Vehicles International	Delivery truck	Medium to heavy duty	60–115	2010
	Delivery/service van	Medium to heavy duty	60–115	2010
Electrorides	Various	Medium duty	65–75	Now
Ford/Azure Dynamics	Taxi/shuttle service	Light duty	80	2011
Modec	Delivery truck	Medium duty	60–100	Now
Miles Electric Vehicles	Low-speed pickup	Light duty	30	Now
Proterra	Commuter bus	Heavy duty	20–50	Now
Smith Electric Vehicles	Delivery truck	Medium to heavy duty	80–120	Now
ZAP	Low-speed pickup	Light duty	30	Now

Notes: a. Light duty—below 10,000 pounds gross vehicle weight; medium duty—10,001 to 19,500 pounds; heavy duty—above 19,500 pounds.
b. For plug-in hybrid electric vehicles (PHEVs), electric range indicates the approximate range of the vehicle when operating solely on battery power. Once the battery has reached its lowest allowable state of charge, an internal combustion engine powers the vehicle. In practice, many PHEVs will utilize the internal combustion engine to serve peak power needs, such as accelerating onto a highway or climbing steep grades.
c. Vehicles have no all-electric range; they utilize an electric drive system to boost fuel efficiency in transit, but battery capacity is largely reserved for operating the boom and other tools on the job site, avoiding engine idling.

© E Source; data from manufacturers

Fuel Costs

Care to guess the efficiency with which a typical medium-duty truck converts diesel fuel into mechanical motion? If you guessed anywhere between 15 and 25 percent, you're in the right ballpark. OK, same question for an electric motor: What fraction of electrical energy is converted to motion? It's often in excess of 90 percent. There are substantial losses in the supply chain that brings either form of energy to a vehicle, but the difference in conversion efficiency once it's there accounts for a big part of the reason that it's much less expensive to drive a mile in a PEV than it is in a conventional vehicle. How much less? For passenger vehicles, PEV fuel costs are typically about a quarter of those for conventional internal combustion engine vehicles. For commercial vehicles, the range of sizes, types, and applications, and the scarcity of actual field data, make it impossible to provide a clear comparison, but savings of 75 percent are certainly feasible and are advertised by several manufacturers.

Maintenance Costs

Although maintenance savings seem likely for all PEVs, there's an important distinction between EVs and PHEVs. EVs have far fewer moving parts, no engine, no belts, no spark plugs, and no exhaust system. Accordingly, one might expect that these vehicles would have considerably lower maintenance costs, and indeed this does seem to be the case. We found very little documented field experience with the maintenance needs of commercial EVs because very few such vehicles have existed long enough to create a track record. However, there is one fleet in the world that does have significant field experience with electric delivery trucks: the U.S. Postal Service (USPS). In 1996, Han Dinh, the engineering program manager for the USPS, published data on the performance of a set of six standard postal delivery trucks that had been converted to EVs. Dinh's findings were that the average maintenance costs for these vehicles were $0.122 per mile, about 54 percent of the average maintenance costs of the fleet's conventional vehicles.[1]

The story is somewhat different with PHEVs because these vehicles have all the same moving components as conventional vehicles, plus a battery pack, generator/motor, controller, and a clutch to engage/disengage the electric drive system. Many of the PHEV vehicles are designed to operate in "charge depleting" mode, meaning that they operate as electric vehicles until the battery reaches the lower limit of its allowable state-of-charge window, after which the internal combustion engine (ICE) kicks in and the vehicle operates as a hybrid. For these vehicles, the ICE supplies only a fraction of overall vehicle miles, so maintenance intervals should be longer and costs correspondingly lower. However, because these vehicles are only now being developed and deployed, there are no field data to support or refute this assumption.

One manufacturer we spoke with is downplaying maintenance savings at this point. Bright Automotive in Anderson, Indiana, is the developer of a lightweight, aerodynamic PHEV delivery van called the IDEA (**Figure 1**, page 5). We asked Michael Brylawski, Bright's executive vice president, about anticipated maintenance savings once the firm's first vehicle hits the market in 2013. Brylawski told us that there should be significantly less wear and tear on the conventional drivetrain, so maintenance costs should be considerably lower. But he also noted that the IDEA is an entirely new vehicle with a new integration of components, and that the company has a lot to learn about its real-world performance. As a result, Brylawski tells prospective customers to anticipate maintenance costs on a par with conventional vehicles.

Carbon Dioxide Emissions

Numerous studies have demonstrated the environmental superiority of PHEV passenger cars.[2] When all fuel-cycle CO_2 emissions for both gasoline and electricity are added to vehicle direct tailpipe emissions, PHEV CO_2 emissions are considerably lower than those of conventional vehicles. Even when the electricity used to charge a PHEV battery is generated by a coal-fired power plant, CO_2 emissions are approximately 30 percent lower than those of a conventional vehicle, and the reduction grows considerably larger when charging electricity comes from less carbon-intensive generation sources (**Figure 2**, page 6).

The diversity of types and uses for commercial fleet vehicles makes it difficult to make broadly applicable statements about their ability to reduce CO_2 emissions. However, Dr. Vincenzo Marano, who conducts research on PEVs at the Center for Automotive Research at Ohio State University, indicated that medium- and heavy-duty vehicles emit about 10.1 kilograms (kg) of CO_2 with each gallon of diesel fuel they consume (vehicles consuming gasoline emit about 8.8 kg CO_2 per gallon). Therefore, each gallon of consumption avoided by a PEV would reduce CO_2 emissions by an equivalent amount. Of course, from a societal perspective, one must also consider the CO_2 emissions of the electricity used to charge PEV batteries. Those emissions will depend on how far a given PEV can travel per kilowatt-hour (kWh) and the fuel type and efficiency of the power plant generating the electricity. In general, though, because the fuel economy of most commercial vehicles is far lower than that of passenger vehicles, the potential CO_2 emission reduction per mile by switching to PEVs is substantially greater for commercial fleet vehicles than for passenger vehicles.

FIGURE 1: Bright Automotive's IDEA delivery van

The IDEA plug-in hybrid delivery van is Bright Automotive's first product. Built from the ground up, the IDEA features aerodynamic design, a lightweight aluminum frame and body panels, and an electric driving range of 40 miles before switching to hybrid mode.

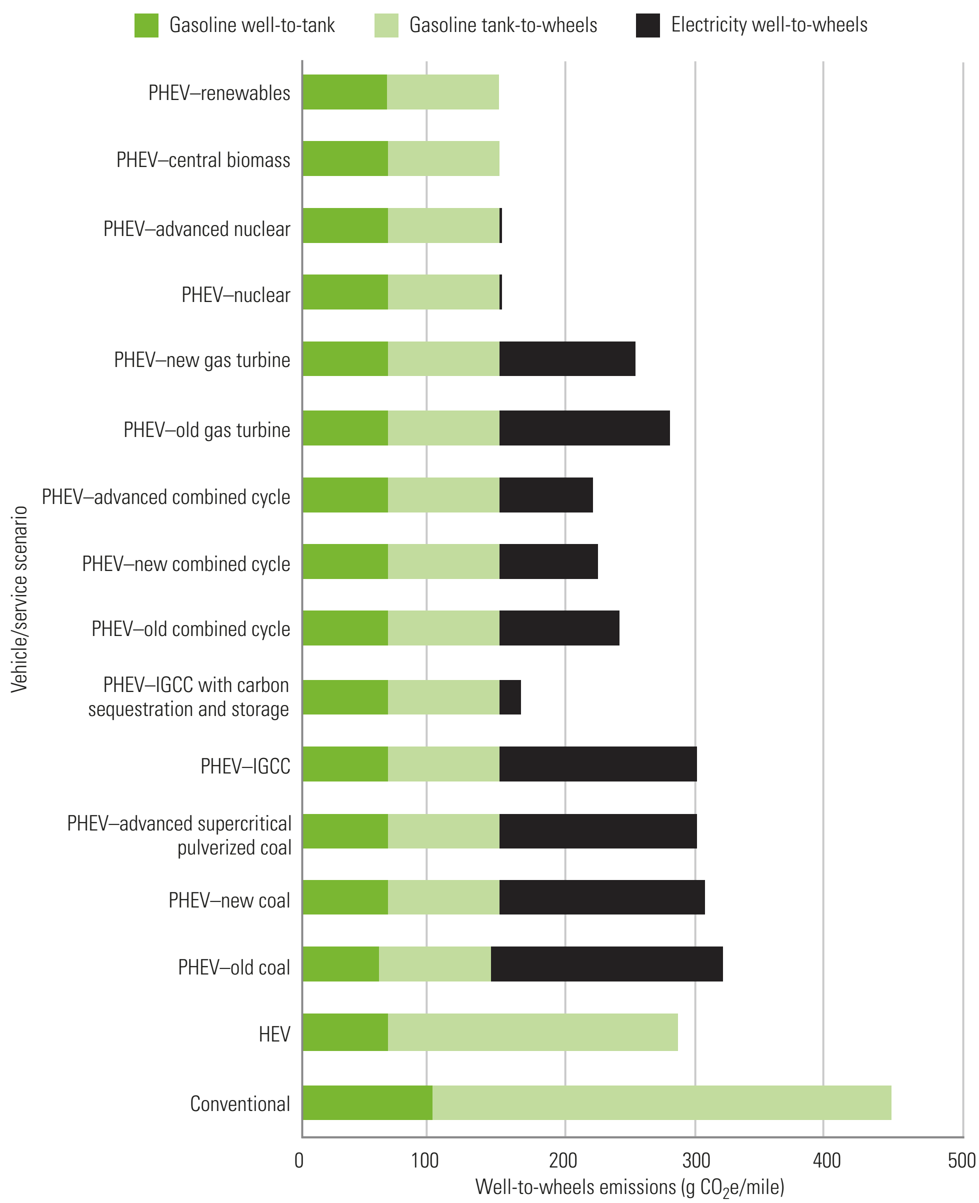
Courtesy: Bright Automotive Inc.

Idling Noise and Emissions

Another benefit that PEVs offer is their ability to tap their batteries to serve a variety of functions while parked, without running the engine. In some applications, that's a huge benefit. Some of the first plug-in vehicles in the commercial sector were PHEV utility bucket trucks. These vehicles bring greater fuel economy and reduced emissions in transit, but one of the biggest benefits for utility crews and residents of the neighborhoods

FIGURE 2: 2010 CO_2 emissions from conventional vehicles, HEVs, and PHEVs charged by a variety of electric generators

Even when the charging electricity comes from a coal-fired power plant, carbon dioxide (CO_2) emissions from plug-in hybrid electric vehicles (PHEVs) are substantially below those of conventional vehicles, albeit higher than the CO_2 emissions from hybrid vehicles. When the electricity comes from gas, nuclear, or renewable generators, PHEV emissions fall below even those of hybrid electric vehicles (HEVs.)



Notes: g CO_2e = grams carbon dioxide equivalent; IGCC = integrated gasification combined cycle.

© E Source; data from Electric Power Research Institute and Natural Resources Defense Council where they operate is the fact that crews can turn off the vehicle's noisy engine when they arrive at the job site. The bucket boom and all other tools used on these trucks run off of the vehicle's battery, rather than the diesel engine. The quiet operation of these trucks is a definite benefit in residential settings, particularly when maintenance or repair must be conducted at night. And of course with the engine shut off, emissions are completely eliminated.

These same benefits will apply to other types of PEVs as well. The considerable noise and noxious emissions of trucks with diesel engines have prompted many cities to enact ordinances requiring engines to be shut off when trucks are parked at loading docks. Where this is the case, PEVs, which either have no engine (EVs) or shut the engine down (if it was running) whenever the vehicle comes to a stop (PHEVs), will provide little incremental benefit. But in many cases, the driver's standard practice is to leave the truck running while it's being loaded or unloaded, and here PEVs can provide a deep breath of fresh air. Diesel engines operate inefficiently when idling, consuming as much as 0.9 gallons of fuel per hour.[3] In some facilities where numerous trucks are parked for frequent loading/unloading (think of a parcel delivery service facility), this is far more than purely an aesthetic benefit to employees—it can yield significant health benefits too, as diesel engines emit significant quantities of particulates and smog-causing nitrogen oxides, both of which are detrimental to health.

Demonstrating Corporate Commitment to Sustainability

For a company that operates a large fleet, few aspects of business operation are as public as its vehicles, particularly the vans and trucks that are often covered with the corporate logo. This being the case, there can be a lot of value in using your company's fleet to demonstrate a corporate commitment to sustainability. It may be impossible to quantify the value that a company could derive by painting phrases such as "Emission-free electric vehicle" or "This truck powered by wind energy" on its delivery fleet, but it's certainly a number greater than zero, and it could be a great deal more.

Office supply purveyor Staples Inc. takes its commitment to sustainability seriously. Far from being limited to simply projecting a green image, Staples' national fleet equipment manager Mike Payette told us that his company is piloting alternative-fueled vehicles because "it's the right thing to do," but also because he believes that there will someday be a compelling business case for it, both in terms of reduced vehicle life-cycle costs and in attracting and retaining customers.[4] "When a request for quotation comes in," Payette told us, "customers are starting to ask 'What are you doing to improve the air quality in my city?' I think the customers out there are recognizing that they want to be more environmentally sustainable, so they partner with companies that embrace that same ideology." Along with Coca-Cola Enterprises (CCE), Frito-Lay, and AT&T, Staples is participating in a project that will deploy several electric delivery trucks from Smith Electric Vehicles in the summer of 2010 (**Figure 3**, page 8). Funding for this project from the American Reinvestment and Recovery Act of 2009 is helping to defray some of the cost of the vehicles for project participants.

Coca-Cola is another company with a sustainability commitment; and it's walking the talk—driving it, really. With 336 hybrid electric delivery vehicles, the company has the largest heavy-duty commercial hybrid fleet in North America. The company's self-imposed climate goal is to reduce greenhouse gas emissions in 2020 by 15 percent from 2007 levels, even accounting for considerable sales growth by that time.[5] Company spokesperson Fred Roselli told us that when CCE first began investing in hybrid vehicles (without a plug) a decade ago, they cost twice as much as its conventional delivery trucks. Those costs have declined to the point where the company can now make a business case for them. Roselli said that the two EV delivery trucks CCE will be sending into the field this summer are a substantial investment, but the company is working with Smith Electric Vehicles now to gain an understanding of the benefits and drawbacks of these vehicles so that it will be in a good position to deploy them widely if and when costs decline to the point that they're economically viable. "There's a reputational piece, too," he said. "It helps us a lot when we're working with legislators or community organizations that they know that we're concerned about the environmental impacts of our business and that we're working to reduce them. So our reputation is important, but Coca-Cola won't go forward with EVs unless there's a business case for them."

Smart Charging and Vehicle-to-Grid

Most commercial PEVs are likely to be used in applications where they complete a fairly predictable daily route on a single charge and return to a central depot at the end of the day. Most likely, PEVs in these applications will be plugged in immediately upon return to the depot, but actual charging will be delayed either until a specific time or in response to control signals sent by the local electric utility. Delaying PEV charging until off-peak hours is advantageous because it allows the vehicle owner to fill the vehicle's battery with lower cost off-peak electricity. It's also advantageous to the utility because it prevents

FIGURE 3: Smith Electric Vehicles' Newton delivery truck

Staples is one of six corporations partnering to deploy electric delivery trucks from Smith Electric Vehicles. These medium- and heavy-duty trucks will have ranges of 50 to 100 miles.

Courtesy: Smith Electric

PEVs from adding to congestion on the transmission and distribution systems during peak load hours—something that utilities are getting increasingly nervous about.

But beyond simply delaying vehicle charging until off-peak hours, so called "smart charging" systems could modulate the rate at which energy is sent to a vehicle's battery in response to signals sent by the local utility. This capability could, for instance, be used to buffer the dynamics of wind power. Wind power is relatively unpredictable and tends to be at its maximum at night when load on the electrical system is far below its peak. Its unpredictable nature limits wind generating capacity on the grid because utilities must be able to ramp other generators up and down quickly enough to react to wind power dynamics and maintain grid stability. If large numbers of PEVs (consumer-owned vehicles as well as those in commercial fleets) were equipped with smart charging capability, their charging power could be ramped up and down in lockstep with the availability of wind power, enabling greater penetration of wind on the grid.

Going one step further, PEV batteries could be tapped to supply power to the grid. Much has been said and written about the value of so-called "vehicle-to-grid" (V2G) capability for passenger PEVs—the concept that the energy stored in large numbers of PEVs could be tapped to help stabilize the power grid. (For more information about V2G, see the University of Delaware's list of **peer-reviewed V2G articles**.) Currently, grid operators send out a signal every four seconds, directing a specific set of generators to ramp up their power output if load on the grid increases or to ramp it down if load declines. This is how grid frequency is maintained at 60 hertz within a very tight tolerance. By equipping PEVs with an inverter (to convert the battery's direct-current power to grid-compatible alternating-current power) as well as communication and control equipment to automate the vehicle's response to grid operator control signals, PEV charging and discharging could provide this frequency-regulation service without significantly impacting battery state of charge or lifetime. PEVs could also provide "spinning reserve" service (essentially emergency power) to help prop up the grid in case a power plant or transmission line goes down. In the utility industry, these functions are collectively called "ancillary services," and utilities (and their customers) pay a lot for them. Ancillary services account for about 10 percent of the cost of electricity, or about $12 billion per year in the U.S.

An analysis that evaluated the potential profit of a fleet of 252 Toyota RAV4 EVs providing frequency-regulation services to the California Independent System Operator found that the annual profit per vehicle ranged from $574 to more than $3,600 (the variation is due to year-to-year variation in market clearing prices for frequency regulation) *after* accounting for the cost of the inverter and communication and control electronics.[6] Note that these values are for passenger vehicles connected to single-phase electrical service, charging and discharging at 6.6 kilowatts (kW). Many commercial fleet vehicles are likely to be connected to 3-phase service at higher voltage and current capacity, enabling higher power levels and the potential for higher revenues. On the other hand, the value of regulation services varies considerably from one region to another, so any assessment of this potential value must consider the local market price (**Table 2**, page 10). For instance, a recent evaluation conducted for the U.S. Postal Service found that EV delivery trucks with 15 kW of charging/discharging capacity could garner about $2,300 per year for regulation services in the PJM Interconnection, which operates the transmission system in 13 states from the Midwest to the East Coast.[7]

ECONOMICS

High first costs but low operating costs? That's a problem the automotive industry has faced since its inception. How did it solve the problem? In a word: financing.

There's no getting around the fact that PEVs come with significant incremental costs compared to the conventional ICE versions of the vehicles they do, or will, compete with. To make matters worse, in many cases the useful life of the vehicle is considerably longer than the design life for its battery, meaning that one or more expensive replacements will be necessary at some point during the vehicle's life. This may make it sound as though PEVs are a nonstarter for your company, and in many cases, that will be true in the short term. But at this point in the development of the PEV industry, it's all about finding the right niches, identifying and assessing the value that PEVs could offer your organization, and considering carefully what role these vehicles might play in the future.

Battery Costs: The Achilles' Wheel?

Although lead-acid batteries have been used for commercial fleet PEVs in the past, all of the PEV manufacturers we're familiar with are focusing on lithium ion batteries for their current or future products. The primary benefits of lithium ion battery technologies are the high energy and power densities they offer (packing a lot of punch per unit volume or weight) and their long cycle lives. Their primary drawback is the cost of the batteries themselves and that of the complex battery management system necessary to operate them in a safe, reliable way.

Lithium ion battery costs have dropped significantly in recent years as interest in automotive applications has picked up and numerous corporations have invested heavily in R&D as well as battery production facilities. Balwinder Samra, CEO of EV truck manufacturer Balqon Corp., told us that lithium ion battery prices have declined 30 percent in the past two years.[8] Nonetheless, they're still quite high. Emerging technology consultancy Lux Research projects battery prices will drop from about $720 per kWh of capacity today to between $405 and $450 per kWh in 2020 (compared to about $100 per kWh for lead-acid

TABLE 2: Market clearing prices for frequency-regulation services in several markets, 2000–2003

The market value of frequency-regulation services varies considerably from one regional grid operator to another.

		CAISO		ERCOT		
Year	NYISO regulation	Regulation up	Regulation down	Regulation up	Regulation down	PJM regulation[a]
2000	20.9	54.5	15.4	NA[b]	NA[b]	35.9
2001	10.9	62.5	39.7	7.7	7.2	34.3
2002	19.7	12.9	14.0	6.5	5.1	31.7
2003	27.5	19.5	20.3	22.1[c]	7.9[c]	38.2

Notes: CAISO = California Independent System Operator; ERCOT = Electric Reliabiity Council of Texas; NA = not available; NYISO = New York Independent System Operator.
a. The data are for the PJM East market; regulation in PJM West is not yet provided via a competitive market.
b. The ERCOT market started in summer of 2001.
c. Includes data from January to March 2003.

© E Source; data from the *Journal of Power Sources*, v. 168, no. 2 (June 1, 2007) pp. 459–468 batteries).[9] This is roughly corroborated in a study conducted by the Sloan Automotive Laboratory at the Massachusetts Institute of Technology which projects that advances in chemistry and volume production should lead to lithium ion batteries costing about $320 per kWh by 2030.[10]

According to Marianne McInerney, vice president for Sales and Marketing at Smith Electric Vehicles, the Smith Newton delivery truck needs about 40 kWh of battery capacity to provide a 50-mile driving range. At $720 per kWh, this battery currently costs something like $29,000. Even if the above projections prove to be correct and future batteries cost roughly half of what they do today, they'll still represent a significant incremental cost, particularly when one considers that the battery will require replacement at least once during the life of the vehicle. So, do these high costs condemn PEVs to being cost-prohibitive in both the short- and long-run? Perhaps not. Read on.

Financing

What do cell phones, razors, and ink-jet printers have in common? In all three cases, you pay relatively little up front for the hardware but a lot more (in the form of minutes, blades, and ink cartridges, respectively) to use them over time. Given the substantial price increment relative to the conventional vehicles with which they compete, several PEV manufacturers, including Bright Automotive, Balqon, and Smith Electric Vehicles, are working to develop business models analogous to the above products. The price of the PEV will be financed for the owner such that the monthly payment is lower than the monthly cost to fuel a conventional vehicle with gasoline or diesel, giving the owner positive cash flow from the get-go.

That's the concept anyway, but manufacturers face something of a chicken and egg problem. Without substantial on-the-road experience with their vehicles, it's difficult for PEV manufacturers to demonstrate the reliability of their products sufficiently to attract the capital investment necessary to provide financing to customers. But of course without that financing, few customers will be willing to pony up the very high incremental costs that come with these vehicles. In the end, some party will have to take on the performance risk of these vehicles, and in Samra's view it's incumbent on the manufacturer to take that risk away from the customer. He hopes that at some point in the future, third parties will be happy to finance the batteries for the vehicles he sells, but for now, in light of extremely tight credit markets, he's looking for equity investors to provide the capital he needs to offer financing.

Battery Residual Value

The high initial cost of PEV batteries may be offset to some degree if their future salvage value is taken into consideration when the vehicle is purchased, or if the battery is leased to the vehicle operator by the PEV manufacturer or a third party. The industry consensus is that PEV batteries will be ready for replacement once their energy storage capacity has dropped to about 80 percent of original value. Vehicle performance after that point may be unacceptable, but the battery will retain considerable energy storage capacity and will likely hold considerable value for less-demanding stationary applications. Such applications might include residential or commercial load leveling, residential or commercial arbitrage (storing energy at night and using or delivering it to the grid during the day), storage for uninterruptible power supplies, buffering the dynamics of solar or wind power or to provide grid-independent power, or any of a number of grid-support functions such as those described previously or relieving peak loads on individual transmission or distribution system components.

No one yet knows precisely what the value of these stationary "second lives" of PEV batteries might be or even whether a market for used PEV batteries will develop. Significant questions regarding the remaining useful cycle and calendar lives of the batteries must be resolved and the costs of reconfiguring PEV batteries to work with specific stationary applications need to be better understood before a thriving market can emerge. Another open question is whether it will be profitable to collect and reconfigure PEV batteries in the future when new batteries will be less costly. It will most likely be possible to offer used batteries well below the cost of new ones, but the price difference will have to be large enough to overcome the buyer's perceived risk of selecting a used battery over a new one.

Although these uncertainties exist, it's quite clear that a PEV battery with 80 percent of its original storage capacity will have considerable residual value for stationary applications, and at least one business is already planning to capture that value. Nissan Motor Co., which will release its LEAF EV (passenger vehicle) in 2010, plans to lease the battery pack to consumers so that monthly operating costs will be less than those of conventional vehicles. In October 2009, Nissan announced a joint venture that will reuse, refabricate, resell, and recycle its batteries, passing some of that value back to the consumer in the form of lower lease payments.[11] Once that path is paved in the passenger vehicle market, the commercial market will likely follow.

EVALUATING PEVS FOR YOUR BUSINESS

"Electric trucks today are in a position similar to electric forklifts two decades ago. After we started deploying the first electric forklifts, it didn't take long for users to learn their benefits. All of a sudden they began to carve these niches in their plants and found the best applications for them. It took about a year for them to find out that electrics have significantly lower maintenance and lower operating costs, and once that happened, the industry took off on its own." —Balwinder Samra, Balqon Corp.

Although there are cost-effective applications for most businesses such as logistical functions at large warehousing and shipping operations and some very short-haul trucking operations, there are few if any niches where PEVs make economic sense today. That's likely to remain the case until some form of financing or government subsidy substantially lowers the first-cost barrier. Until then, PEVs are likely to find application primarily as research projects—such as those being conducted by Staples and Coca-Cola—to provide insight into how and where these vehicles will fit into a fleet once a viable business case can be made for them. With battery prices declining, fuel prices volatile but headed upward in the long term, and corporations looking to shrink their carbon footprint, it may not be long before you are asked to determine where PEVs could fit into your business operations. Where should you start?

Samra recommends that fleet mangers start by evaluating PEVs in the least demanding application they can identify. From our discussions with vendors and fleet managers, the following application characteristics will help you to identify the most likely candidates:

- Vehicles that run relatively short, well-defined daily routes
- Vehicles that return to a specific facility each night
- Vehicles that spend significant time idling
- Routes that follow a relatively flat topography
- Routes with a lot of stops (this tends to make the best use of the vehicles' regenerative braking)
- Routes with little or no highway driving (this minimizes losses from aerodynamic drag)
- Facilities with competent service personnel
- Local management willing to embrace and drive technology change

Once you have identified an application in which you'd like to evaluate a PEV, Samra recommends that you ask the PEV manufacturer to demonstrate a vehicle in that application for a week or two to learn about the its strengths and weaknesses. If the short-term test is promising, acquire a small number of vehicles to evaluate long-term performance under a wider range of operating conditions. Early evaluation of PEVs in these types of applications will prepare you to deploy them quickly on a broader basis if and when you can demonstrate a solid business case.

RESOURCES

Dueco Inc.

Balqon Corp.

Boulder Electric Vehicle

DesignLine

Electrorides Inc.

Modec

Miles Electric Vehicles

Proterra Inc.

Smith Electric Vehicles

ZAP

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