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A Guide to Adopting Plug-in Electric Vehicles to Your Fleet

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The End-Use Energy Efficiency work group, part of NRECA's Business and Technology Strategies team, is focused on identifying the opportunities and challenges associated with electricity end-use and demand-side management strategies. TechSurveillance research relevant to this work group looks at the various aspects of energy efficiency technology, including market status, related policies and regulations, and business models. This article, the second part of a two-part series, examines the use of electric vehicles for commercial fleets, and provides guidance on how to determine if this technology is right for your cooperative. For more information on electric vehicles, please visit our research topic area website on cooperative.com.

INTRODUCTION

Plug-in electric vehicle (PEV) adoption is growing at both the consumer and commercial levels. This growth could significantly impact the electric sector. Many co-ops are investing time and capital into learning about the opportunities and drawbacks of PEV adoption. Purchasing PEVs—and putting the vehicles to the test in a variety of work applications—is one of the best ways for co-ops to learn about PEVs. This article completes a two-volume guide focused on PEVs for commercial fleets, and provides more in-depth information for co-ops exploring PEVs for their fleet. It covers the key criteria to consider when determining whether PEVs are a good fit for your co-op, the spectrum of commercial PEV models applicable to co-ops, a brief overview of charging infrastructure installation, best practices for reducing the payback periods on PEVs, and ways that various co-ops are approaching PEVs. The first article in this series, **Fleet Electrification 101**, examines more generally the evolving market for electric vehicles and application of this technology to utility fleets.

DECIDING TO ELECTRIFY: ARE PEVS RIGHT FOR YOUR CO-OP?

Adding PEVs to your co-op's fleet can be a great way to gain first-hand experience with the vehicles and better understand what impact they will have on your co-op. Many co-ops

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around the country are taking this step, positioning themselves as experts in the community on PEVs and studying how the vehicles perform in the context of a co-op fleet. As co-ops grow more familiar with PEVs, they may move away from viewing them as novelties and look into using PEVs for more work and transportation purposes.

PEVs may not be feasible for every co-op. However, there are certain applications in which PEVs can perform well and cut operational costs. In determining whether PEVs are a good fit for your fleet, co-ops should carefully consider the functional requirements of their fleet, and take a holistic look at the cost-effectiveness of implementing PEVs.

Fleet Review

In order to determine whether it makes sense to adopt PEVs, co-ops should first take a comprehensive look at the functional requirements of their cars on a per vehicle basis. Co-ops can use Table 1 as a starting point to decide if and where PEVs could fit into fleets. The first two columns define several key criteria co-ops should consider in analyzing their vehicles. The third column lists PEV strengths and limitations relevant to each criterion.

TABLE 1: Fleet Review Criteria

Criteria	Explanation	PEV Characteristics
Range needs	To minimize "range anxiety"–the fear that PEVs will run out of power before reaching a charging station–determine the range necessary for vehicles to complete routine tasks. Co-ops with low-density service areas may have range needs that exceed PEV capability.	The majority of PEVs have a range between 60-100 miles (TCG, 2012). Determining range requirements can help you decide between a plug-in hybrid electric vehicle (PHEV) versus all-electric vehicle.
Vehicle routes	Examine the routes vehicles travel on a daily basis, taking into account the percentage of highway driving, urban versus rural driving, road surface and topography, speed requirements, acceleration, and the number and frequency of vehicle starts and stops.	PEVs perform best on relatively flat, predictable routes with a lot of stops (maximizing the advantage of PEVs regenerative braking feature, used to recoup energy usually lost while stopping), and routes with little to no highway driving (minimizing aerodynamic drag).
Utilization rates	How often are your vehicles used on an hourly, daily, weekly, and yearly basis? How long are vehicles parked between tasks and/or overnight? Are vehicles typically used for ad hoc service calls or more routine maintenance?	Adequate charging time is critical to maximizing the electric miles of PEVs, particularly PHEVs. Consider how long and how often your vehicles will be able to charge in between use, given available charging equipment.
Auxiliary power loads	Determine how often your vehicles use electrical equipment (e.g. aerial devices). In particular, how often are vehicle engines idling? Texas-based Pedernales Electric Cooperative found that on average, running aerial devices (such as the lift on a bucket truck) required 3,000 to 5,000 hours of idling over the lifecycle of the trucks (UFP, 2011).	Vehicles that spend a significant time idling are good candidates for PEV replacement. Climate is also significant; PEVs may not be as effective in extreme outside temperatures or inclement weather. Cold batteries provide less power than warm batteries and the use of climate control systems reduces range.
Cargo needs	What are the payload and towing requirements of your vehicles? How many people do your passenger vehicles typically need to carry?	Towing and hauling heavy loads requires more energy and reduces PEV range. Space is also an issue; Central Electric in South Carolina found that the space limitations of the Nissan Leaf and Chevy Volt are such that they are not often used as pool vehicles.

No single PEV solution will fit the needs of every co-op. Co-ops will need to compare the strengths and limitations of various PEV options on a case-by-case basis.

Cost-Effectiveness Analysis

Next, compare your existing vehicles to best-fit PEV replacements on a total cost of ownership (TCO) basis. Your TCO calculations will likely include the following factors:

- **Capital costs:** Compare the upfront costs of conventional vehicles and PEVs, taking financial incentives and financing options into account.
- **Fuel savings:** Consider fuel prices, electricity rates (during peak and off-peak times), and idling time. If evaluating a plug-in hybrid electric vehicle (PHEV), factor in gas miles versus electric miles.
- **Routine maintenance and repair costs:** Though PEVs generally require less maintenance, certain vehicles may require specialized technicians (ARI, 2014).
- **Vehicle service life:** Consider vehicle depreciation and resale value, as well as end of life recycling and replacement costs. PEV batteries need to be replaced once they have dropped to about 80 percent of original capacity (ES, 2010). The residual value of PEVs is clouded by uncertainty around the afterlife value of PEV batteries.
- **Charging costs:** Assess the availability of charging infrastructure in your area. Will it be necessary to install charging stations in addition to those in your vehicle storage facility?

CHOOSING THE MOST COST-EFFECTIVE PEV OPTION

Once your co-op has decided to purchase one or more PEVs, you can use the information you have collected through your fleet review and cost-effectiveness analysis to evaluate the range of PEV options. No single PEV solution will fit the needs of every co-op. Co-ops will need to compare the strengths and limitations of various PEV options on a case-by-case basis. Testing PEVs before purchasing can help your co-op understand the good and the bad, and more accurately determine if the vehicles meet your needs.

Which manufacturer?

While the commercial market is still small and relatively immature, with few established manufacturers offering medium to heavy-duty models, there are a growing number of options for commercial fleets. Co-ops interested in available light-duty models can use the Alternative Fuel Data Center's vehicle search tool available at **www.afdc.energy.gov**.

Table 2 lists currently available commercial PEVs that may fit the work needs of your co-op.

TABLE 2: Commercial PEV Manufacturers

Manufacturer	Function	Vehicle class[1]	Electric range (miles)[2]	PEV Type	Notes
Balqon Corporation	Drayage tractor	Heavy duty	90-150	All-Electric	
	Vocational truck	Heavy duty	102-150	All-Electric	
Bremach	Work truck	Medium duty	75-150	All-Electric	Customizable (comes in three different fuel types)

Continued

TABLE 2: Commercial PEV Manufacturers (cont.)

Manufacturer	Function	Vehicle class[1]	Electric range (miles)[2]	PEV Type	Notes
DUECO/Terex	Bucket truck/ digger derrick	Medium to heavy duty	N/A	N/A	Vehicles use Odyne plug-in hybrid system (see Electrifying Stationary Jobsite Operations section below for more details); 9 kW+ exportable power option.
Electric Vehicles International	Bucket truck	Medium duty	45	PHEV	Exportable power option of up to 75 kW
	Step van	Medium to heavy duty	90	All-Electric	
	Vocational truck	Medium to heavy duty	90	All-Electric	
Electrorides	Vocational truck	Medium duty	60–75	All-Electric	Range of body configurations
Enova Systems	Step van	Medium duty	150	All-Electric	Company primarily manufactures electric drivetrains.
Smith Electric Vehicles	Vocational truck	Medium duty	40–100	All-Electric	Range of body configurations
VIA Motors	Cargo van	Light duty	35	PHEV	14.4 kW exportable power option. 50 kW exportable power option planned for future. Range of body configurations.
	Vocational truck	Light duty	40	PHEV	Same exportable power option as cargo van.

[1] Light duty: below 10,000 lb gross vehicle weight; medium duty: 10,001-19,500 lb; heavy duty: above 19,500 lb
[2] Approximate range of the vehicle when operating solely on battery power.

PHEVs provide the luxury of less range anxiety, but will extend the payback period for the vehicle. All-electric vehicles will limit your range but may have lower upfront costs than PHEVs and a shorter payback.

PEV Type and Vehicle Class

Currently, there are two main PEV types: plug-in hybrid electric vehicles (PHEVs) and all-electric vehicles. PHEVs provide the luxury of less range anxiety, but will extend the payback period for the vehicle. All-electric vehicles will limit your range, but may have lower upfront costs than PHEVs and a shorter payback. Vehicle class is another consideration and will depend on your co-op's goals for the vehicle. Some co-ops may primarily be interested in light-duty passenger PEVs for use as demonstration vehicles or general-purpose office cars. For example, Indiana co-ops Orange County REMC and Hoosier Energy use Chevy Volts for short trips to the post office and bank.

Electrifying Stationary Jobsite Operations

Plug-in hybrid power systems are a different approach to PEVs. These systems electrify stationary jobsite operations rather than vehicle propulsion, reducing engine idling and noise. They can interface with a wide variety of truck-mounted equipment and can be retrofitted onto existing vehicles, such as bucket trucks. Quieter operation allows co-op trucks to work

early in the morning or late at night in areas with noise restrictions. Less noise also safeguards against miscommunication between crewmembers. Hybrid power systems may cut operating costs significantly; according to the manufacturer, the Odyne hybrid power system offers $102K in total life cycle savings (Odyne, 2013).

A number of co-ops are currently using trucks outfitted with hybrid power systems: Texas-based Magic Valley Electric Cooperative added a truck equipped with a Terex HyPower hybrid system to its fleet in 2013. The co-op uses the unit while conducting routine troubleshooting tasks and servicing customer power outages. MVEC is pleased with the added productivity the system enables, and crews especially like the quietness of the truck's operation, allowing them to more easily communicate on the jobsite (CEG, 2013).

Charging stations can be a useful resource for co-ops looking to learn more about managing PEV charge loads

Exportable Power Option

Some commercial PEVs offer an exportable power option (see **Table 2 Notes**). Co-ops could potentially use this feature to provide mobile, on-site power to shorten small, unplanned outages and provide backup power for scheduled outages.

Drivetrain Conversion

Adding plug-in capability to new or existing vehicles after market is another option. The process involves replacing the powertrain of an existing conventional or hybrid vehicle with a new all-electric or PHEV powertrain; the rest of the vehicle is retained.

INSTALLING CHARGING INFRASTRUCTURE

Charging a PEV requires plugging in to a charging station—also called electric vehicle supply equipment (EVSE). EVSE for PEVs is classified into three categories (Level I, Level II, and DC Fast Charging) by the rate at which the batteries are recharged. The cost of EVSE varies considerably and depends on the type and number of units installed, required electrical upgrades, and other considerations. Co-ops also may need to upgrade transformers to support charging infrastructure in their fleet facilities. Financial incentives and other electric vehicle promotion programs can reduce EVSE costs. For example, Platte-Clay Electric Cooperative took advantage of the ChargePoint Jumpstart program which offers free public charging stations for employers. (Note: the Jumpstart program ended in 2012.)

In planning for EVSE, co-ops should factor in PEV driving patterns, vehicle charging needs (i.e., expected charging time and number of vehicles being charged), and projected PEV acquisitions, among other factors. Station placement is also important; a station in front of your co-op headquarters can have green marketing value, but may not be practical for public access, as members visiting for a short period may not have time to charge their vehicle (Level II charging stations usually require at least an hour of charging for meaningful range). Charging stations can be a useful resource for co-ops looking to learn more about managing PEV charge loads; South Carolina G&T Central Electric has attached power quality monitoring equipment to its Level II charging station to monitor distribution system impacts. For more information on EV charging stations, visit the Electric Vehicle topic page on **cooperative.com**.

HYBRID POWER SYSTEM MANUFACTURERS:

- **Altec**: Plug-in hybrid system
- **Eaton**: Hybrid system (no plug-in capability)
- **Echo Automotive**: Plug-in hybrid system
- **Odyne Systems**: Plug-in hybrid system
- **Terex**: Plug-in hybrid system

The farther a PHEV travels on electricity, the greater the savings the fleet realizes.

PEV BEST PRACTICES

Co-ops who decide to incorporate PEVs into their fleets will get the most mileage out of plugging-in by following best practices. Here are several ways to promote efficient driving and reduce the payback periods on PEVs:

- **Maximize electric miles:** To reap the fuel and cost savings benefits of PHEVs, it is important to operate the vehicle in electric mode whenever possible. The farther the vehicle travels each day on electricity, the greater the savings the fleet realizes. Continuous monitoring is very important; fleet managers should ensure that drivers avoid running the PHEVs on gasoline.
- **Optimize charging:** Stagger or delay PEV charging until off-peak hours to reduce peak load and charging costs. It is also important to check that drivers plug in PEVs at the end of the day; drivers accustomed to conventional vehicles may forget this step. Opportunity charging, or charging a PEVs battery during lunchtime or any break in the workday, is another way to increase range.
- **Right-size batteries:** For fleet vehicles with highly predictable routes, right-sizing batteries to minimize excess capacity can help reduce the added upfront costs of PEVs.
- **Educate operators:** Invest in training your drivers to ensure that they feel comfortable with the new PEVs, view them as a preferred vehicle, and are operating PHEVs in electric mode whenever possible.

FIGURE 1: Dairyland Power Cooperative's Ford C-Max. *Source: Dairyland Cooperative*

HOW ARE OTHER CO-OPS USING PEVS?

Early adopter co-ops around the country are incorporating PEVs into their operations in a number of ways. As more of your members consider PEVs, they may look to your co-op's experience to inform their decision-making. Implementing PEVs may also help your co-op better understand the impact of PEVs on your co-ops operations; co-ops might gather useful insights on managing charge demand, for example. Here are a few real-world examples of co-ops using PEVs:

Rolling "Green Billboards"

Some co-ops are using PEVs for member education and awareness purposes, allowing any interested parties to test drive the vehicles. In 2012, South Carolina generation and transmission (G&T) Central Electric Cooperative lent their 2011 Nissan LEAF to a Columbia-based civic group considering the car for their fleet. This test drive led to the group purchasing a LEAF to serve as Columbia's first all-electric, free shuttle in 2013. Central Electric and Wisconsin-based Dairyland Power, another G&T co-op, regularly bring their PEVs to annual meetings and other community events (Figure 1). Central Electric has also encouraged its retail co-ops to test drive their PEVs, motivating four of Central's 20 retail cooperatives to purchase their own cars. Co-ops can customize PEVs with

FIGURE 2: Choptank Electric Cooperative's Hybrid Bucket Truck. *Source: Robert Belhke, VP Member Affairs at Choptank Electric Cooperative*

co-op signage and decals such that they become rolling "green billboards," prompting member interest in the vehicles.

Hybrid Bucket Trucks

Other co-ops are testing out diesel bucket trucks outfitted with modular plug-in hybrid systems. Adams Electric Cooperative, headquartered in Gettysburg, Pennsylvania, was the first utility nationwide to add a bucket truck with a first generation Odyne plug-in hybrid power system to its fleet in 2008 (Business Wire, 2008). However, the co-op experienced a number of challenges with the system as it worked with Odyne to collect data and learn as much as possible about how the truck operated under real field conditions. Eventually, the batteries were removed and the truck was converted to diesel (Kanagy, 2014). Maryland co-op Choptank Electric Cooperative has had better luck with the Odyne system, which is currently installed on a DUECO-built truck that was added to the co-op's fleet in 2012 (Figure 2)—the system was partially funded by a grant from the U. S. Department of Energy (Odyne, 2012). Texas-based D&T Pedernales Electric Cooperative (PEC) added a Kenworth bucket truck with an Eaton hybrid power system to its fleet in 2011. The co-op is using the truck to save thousands of dollars on idling costs; PEC expects to pay off the cost difference against a non-hybrid truck in a short period and predicts substantial operational savings over the truck's 8 to 10 year trade cycle.

CONCLUSION

The electrification of transportation could be a significant long-term business opportunity for co-ops. Although the future and impact of PEVs is still uncertain, it is important for co-ops to take a proactive approach to learning about PEVs. Testing PEVs as fleet vehicles can be a good way for co-ops to explore this technology. There is an increasing range of options—from basic commuting vehicles to hybrid bucket trucks. As PEVs have strengths and limitations and will not be suitable for all transportation or work functions, co-ops should carefully consider their needs. In certain applications, PEVs can reduce operating costs. Furthermore, PEVs offer a number of indirect benefits. Co-op-branded PEVs are a powerful and visible way of promoting alternative fuels. Co-ops might use PEVs for education, allowing members to test drive the vehicles, or as conversation-starters, prompting discussion about special PEV charging rates or off-peak charging scenarios. Purchasing a PEV can be an opportunity for co-ops to experiment with a rapidly evolving technology that is becoming more and more relevant to the future of the electricity industry. ■

ADDITIONAL RESOURCES

The Department of Energy maintains a wealth of information and free tools related to PEVs, including cost calculators, databases of currently available PEVs and interactive maps of charging stations: Visit the Alternative Fuels Data Center (**www.afdc.energy.gov**) and FuelEconomy.gov (**www.fueleconomy.gov**) websites for more information. To find currently available PEVs, use the AFDC Vehicle Search tool (**www.afdc.energy.gov/tools**). Co-ops can find up to-date information on federal incentives the following websites: **www.afdc.energy.gov/afdc/laws** and **www.fueleconomy.gov/feg/taxcenter.shtml**. For more information about incentives in your area, contact your local Clean Cities coalition (**www.afdc.energy.gov/cleancities/coalitions/coalition_locations.php**) or state energy office (**http://www.naseo.org/members-states**)

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