Clean Energy Extension

FACT SHEET

Hybrid, Hybrid Plug-In, and Battery Electric Vehicles

This is one of a series of fact sheets designed to help rural municipalities reduce fuel usage in their town fleets. For more information, please visit the UMass Clean Energy Extension (CEE) website, https://ag.umass.edu/clean-energy.

Hybrid, hybrid plug-in, and battery electric vehicles are collectively known as electric vehicles. This fact sheet provides an overview of electric vehicle types, performance relative to conventional vehicles, and electric charging infrastructure. For detailed information on purchasing electric vehicles, including state purchasing contracts, funding sources and grants, vehicle models appropriate for municipal departments, and descriptions of how other towns and cities are using electric vehicles, please see our ***Fuel Efficient Vehicle Purchasing Guide for Municipalities***.

Types of Electric Vehicles

Hybrid Electric Vehicles - Hybrid electric vehicles rely primarily on internal combustion engines fueled by gasoline or diesel, but feature an additional small electric motor and battery. The battery is charged through regenerative braking, meaning that every time the driver applies the brakes, rather than wasting the momentum that the car has gained during its acceleration, some of that energy is captured and stored in the battery to be utilized later by the electric motor. The electric motor allows for better fuel economy and reduced emissions, providing the driver with the range and power of a conventional vehicle, while also providing cost savings and environmental benefits.

Battery Electric Vehicles (BEVs) - Battery electric vehicles are powered entirely by electricity, as opposed to conventional fuels such as gasoline or diesel. BEVs are classified by the EPA as "zero-emissions vehicles," although the life-cycle emissions associated with fueling a BEV are dependent on whether the electricity is generated from renewable or fossil fuel sources. BEVs can be charged in normal household outlets (known as *Level 1 Outlets*), or by specialized higher voltage outlets, described in greater detail below. Modern BEVs can travel over 200 miles on a single charge; some luxury brands exceed 300 miles per charge. In additional to the environmental benefits associated with powering a vehicle with electricity rather than conventional fuels, the cost per mile of powering a car with electricity is significantly lower than for gasoline or diesel.

Plug-in Hybrid Electric Vehicles (PHEVs) - Plug-in hybrid electric vehicles combine favorable aspects of both BEVs and hybrid electric vehicles. Plug-in hybrids utilize both gasoline and electricity to power the vehicle, meaning that both an internal combustion engine and an electric motor are contained within the vehicle. PHEVs have a traditional gas tank, but like battery electric vehicles, PHEVs can be charged using normal household outlets or specialized fast charging stations. Many PHEVs are also designed to utilize regenerative braking to re-charge their batteries.

Comparing Electric Vehicles and Conventionally-Fueled Vehicles

Fueling Costs - The U.S. Department of Energy (DOE) has created a metric known as the "eGallon," as a tool to help consumers compare the operation costs of electric and conventional vehicles (calculated using the average fuel economy of current vehicles, and the average cost of electricity in America). As of September 2018, the average national price of one "eGallon" was $1.19, less than half the national average cost of gasoline of $2.84/gallon. Across the board, the fueling costs for electric vehicles are typically far lower than for conventional vehicles.

Maintenance Costs - Although hybrid electric vehicles typically have more complex engines than conventional vehicles, electric vehicles in general have significantly lower maintenance costs. For example, a 2017 study by the American Automobile Association (AAA) found that BEV drivers save around 17%, or just over $200 in maintenance costs annually. Many popular EV brands also offer substantial warranties on electric vehicle components; for example, the Ford Focus, Chevy Volt, and Nissan Leaf all come with a standard 8-year warranty on the EV battery. One potential downside for municipal departments that perform their own vehicle maintenance is that electric vehicles frequently require EV-specific tools, and mechanics may require additional training to work safely on these vehicles. Identifying local mechanics who have experience with electric vehicles may be worthwhile before making an EV purchase.

Initial Purchasing Costs - Currently, many electric vehicle models on the market have higher initial purchasing costs than conventional vehicles. While this fact can deter potential buyers, it is worth considering that the lifetime cost of electric vehicles is often lower than that for conventional vehicles, given the lower cost of operation. In addition, there are a number of state and federal incentives available that significantly reduce the costs of acquiring electric vehicles and EV charging equipment. A 2018 analysis by the Bloomberg New Energy Finance team suggests that current trends in battery pricing indicate many electric vehicles will have lower initial purchasing costs than conventionally fueled vehicles by as early as 2025.

Range – Hybrid and hybrid plug-in vehicles can be powered by conventional fuels for trips where the distance travelled exceeds the maximum range possible for the battery on a single charge. Range concerns may make drivers hesitant to adopt fully electric BEVs, although this may be less of an issue for municipal fleets, when vehicles are primarily used within town or city boundaries. Importantly, the average range of BEVs has been steadily increasing; many popular electric vehicle models now have ranges of over 200 miles on a single charge. In addition, Massachusetts is home to more than 1,450 public EV outlets, many of which can be used free of charge, on longer trips. Public EV charging infrastructure is continuing to expand across the state.

Performance – While a plethora of electric passenger car models are available, there is currently a lack of utility capable EVs on the market. For example, there are only a handful of readily available AWD electric vehicles, and the towing capacity of EVs tend to be significantly lower than conventionally fueled trucks or SUVs. For those hoping to achieve improved fuel economy and emissions reductions associated with EVs, while maintaining the utility capabilities of conventionally fueled trucks, numerous hybrid retrofits are available. For example, XL Hybrids has a system to convert conventional vehicles (e.g. Ford F150 or F250) into hybrids, improving the fuel economy by as much as 50%.

Greenhouse Gas Emissions - Electric vehicles produce far fewer harmful tailpipe emissions than conventionally fueled vehicles, but a more valuable comparison to consider is the relative life-cycle emissions associated with conventionally fueled vehicles versus electric vehicles, sometimes referred to as "Well-to-Wheel" emissions. Life-cycle emissions take into account all the emissions associated with resource extraction and electricity generation, and therefore are a more realistic representation of a vehicle's carbon footprint. According to a life-cycle analysis conducted by the DOE's Alternative Fuel Data Center, BEVs, PHEVs, and hybrids in Massachusetts emit 69%, 52%, and 45% less CO_2 respectively per year than gasoline-powered vehicles. It is worth noting that emissions from electric vehicles in Massachusetts are lower than the national average, due to the state sourcing a significant proportion of its electricity from clean or renewable resources.

Charging an Electric Vehicle

EV charging stations fall into three primary categories:

Level 1 - Electric vehicles can be charged directly through the standard 120V outlets found in homes, businesses, and municipal buildings. Level 1 charging is the slowest method of charging an electric vehicle, but can be a practical option for municipal fleets, as vehicles should be able to reach full charge while sitting overnight, and there is no need for investment in additional charging equipment.

Level 2 - The majority of public charging stations are Level 2 chargers, which are able to charge electric vehicles at roughly 4-6 times the rate of Level 1 chargers. This infrastructure is worth considering if the average mileage driven per day is expected to exceed the electric range of the vehicle purchased. It is important to note that these chargers typically only allow for charging of one car at a time, so adopting Level 2 infrastructure for an entire fleet would require purchase of multiple chargers.

DC Fast Chargers - DC Fast Chargers are the quickest method of charging an electric vehicle, and can fully charge most vehicle models within one hour or less. DC Charging Stations are still quite expensive, and are primarily available at commercial roadside fueling stations for a fixed price per kilowatt-hour (kWh). For municipalities considering installation of DC Fast Chargers, it is important to recognize that some older buildings may be unable to support the high electricity wattage demanded by the device. Consult with an electrician before installation.

Locating EV Charging Stations

There are a number of services available that make locating the nearest public EV charging station quick and easy. These include:

AFDC Alternative Fueling Station Locator - An extension of the U.S. Department of Energy, the Alternative Fuel Data Center (AFDC) maintains a website with a wealth of information about electric vehicles, including a fueling station locator, which drivers can use to search by location and/or charger type. https://www.afdc.energy.gov/fuels/electricity_locations.html#/find/nearest?fuel=ELEC

ChargeHub – ChargeHub's map can be searched by street address to find local stations and filter by charging station type and availability. https://chargehub.com/en/charging-stations-map.html

ChargePoint - ChargePoint's database contains over 50,000 public chargers. The Chargepoint app allows you to pay for metered charging, search by station type, and see which charging outlets are available before traveling to the station. https://www.chargepoint.com/

GoogleMaps – In 2011, Google added EV charging stations to its on-line maps, represented by a red GPS marker with a white charging station. Some stations are missing from the map, but for those listed, it can be helpful to use Street View to identify the exact station location. https://www.google.com/maps

Open Charge Map – This non-profit group has a free app where you can search by network operator, charge station type, and availability, as well as offer feedback on map reliability to improve the system. https://openchargemap.org/site

PlugShare - Plugshare.com offers searches by station type and availability, but on an international scale. Additionally, PlugShare has a "trip planning" option, where drivers can plan routes according to charging stations locations along the way. https://www.plugshare.com/