

Going from Pump to Plug

Adding Up the Savings from Electric Vehicles

HIGHLIGHTS

Electric vehicles (EVs) are significantly cheaper than gasoline-powered vehicles to fuel and operate, according to a Union of Concerned Scientists analysis. Even with today's relatively low gasoline prices, every electricity provider surveyed in the 50 largest US cities offers a rate plan that would save the average EV owner on fuel costs, with median annual savings exceeding \$770. Moreover, EVs are increasingly affordable to purchase, especially after applying federal and state incentives, and they cost less to maintain. Yet even as EVs grow in popularity, policies are essential for improving the charging infrastructure, broadening access to favorable electricity rates, and ensuring that EVs are affordable to more car buyers.

Electric vehicles (EVs) benefit drivers and the environment. Critical for reducing both petroleum use and global warming emissions, this important technology can save drivers money by replacing gasoline with lower-cost electricity and with lower costs for scheduled maintenance. *Going from Pump to Plug* examines the potential cost savings of EVs, including a detailed Union of Concerned Scientists (UCS) analysis of the costs of owning and operating electricity and gasoline vehicles in each of the 50 largest cities in the United States.

EV Charging at Home Costs Less than Gasoline

The UCS analysis shows that all across the country fuel costs for EVs are substantially lower than those for the average-efficiency new gasoline vehicle sold in 2016. The annual savings range from \$443 to \$1,077 per year, depending on the electricity provider, the choice of electricity rate plan, and the local cost of gasoline (Figure ES-1, p. 3–4). Many of the electricity providers associated with greater EV savings offer an option called time-of-use (TOU) rates to lower costs during off-peak periods such as late at night and early in the morning. However, most EV drivers could save money on fuel even when paying standard rates.

The UCS analysis expresses electricity costs as equivalent gasoline prices, using averages for efficiency for EVs and new gasoline vehicles. On standard rate plans, EV refueling ranges from \$0.43 to \$3.34 per gallon gasoline equivalent, with a median of \$0.90. On such plans, 58 of the 60 electricity providers studied have EV charging costs per mile driven lower than the comparable costs for driving a gasoline-powered vehicle.



EVs are significantly cheaper to own than gasoline-powered cars, but stronger policies are needed to effectively transition from pump to plug.

Significant Savings from Cheaper, Off-Peak Electricity

A TOU or EV-specific rate plan can greatly reduce the cost to recharge an EV. These plans offer lower-cost charging during off-peak hours, usually during the late evening and early morning hours when demand for electricity drops. Most cars are parked at home overnight, making TOU plans a good fit for most drivers.

Off-peak, TOU rates vary from \$.03 per kilowatt hour (kWh) to \$0.21 per kWh, resulting in gasoline equivalent costs ranging from \$0.25 per gallon to \$1.78 per gallon. With TOU rates, all electricity providers examined have EV fuel costs at least \$1 per gallon equivalent lower than the current cost of gasoline. Every provider but one offers electricity on a TOU plan at a cost lower than that of gasoline over the last 10 years.

Off-peak charging benefits the service providers by lessening peak electricity demand, but off-peak periods may not align with the availability of low-emission sources of electricity like wind and solar power. In areas with higher amounts of intermittent renewable generation, it may be important to coordinate electric rates for EV charging with the availability of renewables, both to reduce the cost of charging and to minimize emissions from EV recharging.

A time-of-use or EV-specific rate plan can greatly reduce the cost to recharge an EV.



Leviton

Charging an EV at home is almost always cheaper than filling the tank of a gasoline-powered car.

Electricity can be generated from diverse sources, minimizing the impact of a disruption in the supply of any one fuel.

Electricity as a Fuel: Cheaper and Less Volatile Costs

Electricity is not only cheaper than gasoline as a transportation fuel, but also its price is much more stable. In constant dollars, the average price of electricity as a vehicle fuel nationally has remained around \$1 per gallon gasoline equivalent (\$0.88 to \$1.17 per gallon) over the last 15 years. Average US gasoline prices between 2002 and 2017 ranged from less than \$2.00 to more than \$4.50 a gallon.

Moreover, many US electricity markets are regulated, reducing short-term price fluctuations. And unlike gasoline, electricity can be generated from diverse sources, minimizing the impact of a disruption in the supply of any one fuel. As more generation moves to renewable sources like wind and solar, price volatility may decline even further.

Variable Recharging Costs from Public Charging Stations: Small Impact on Savings

EVs can be recharged using public charging stations that have variable costs, ranging from free (or included with the vehicle purchase) to more expensive than gasoline. In general, the most expensive public charging stations are high-power, fast-charging stations that take 30 minutes to recharge for driving 50 to 90 miles. However, the preponderance of EV charging takes place at drivers' homes (estimates range from 70 to 80 percent), so for most EV drivers the cost of public charging has little effect on total fuel savings from driving EVs. For example, using EVgo's fee-based, fast-charging station for 20 percent of charging in San Francisco would increase the effective cost to charge from \$0.78 per gallon equivalent to \$1.38 per gallon, still well below the cost of gasoline. For EV owners with access to home charging, the potentially higher cost of fast charging has little impact on overall fuel cost savings, but the stations enable EV owners to take longer trips. While relying on paid public fast charging could diminish EV fuel cost savings, most EV buyers can choose lower-cost options.

FIGURE ES-1. Annual Fuel Cost Savings from Driving an Electric Vehicle

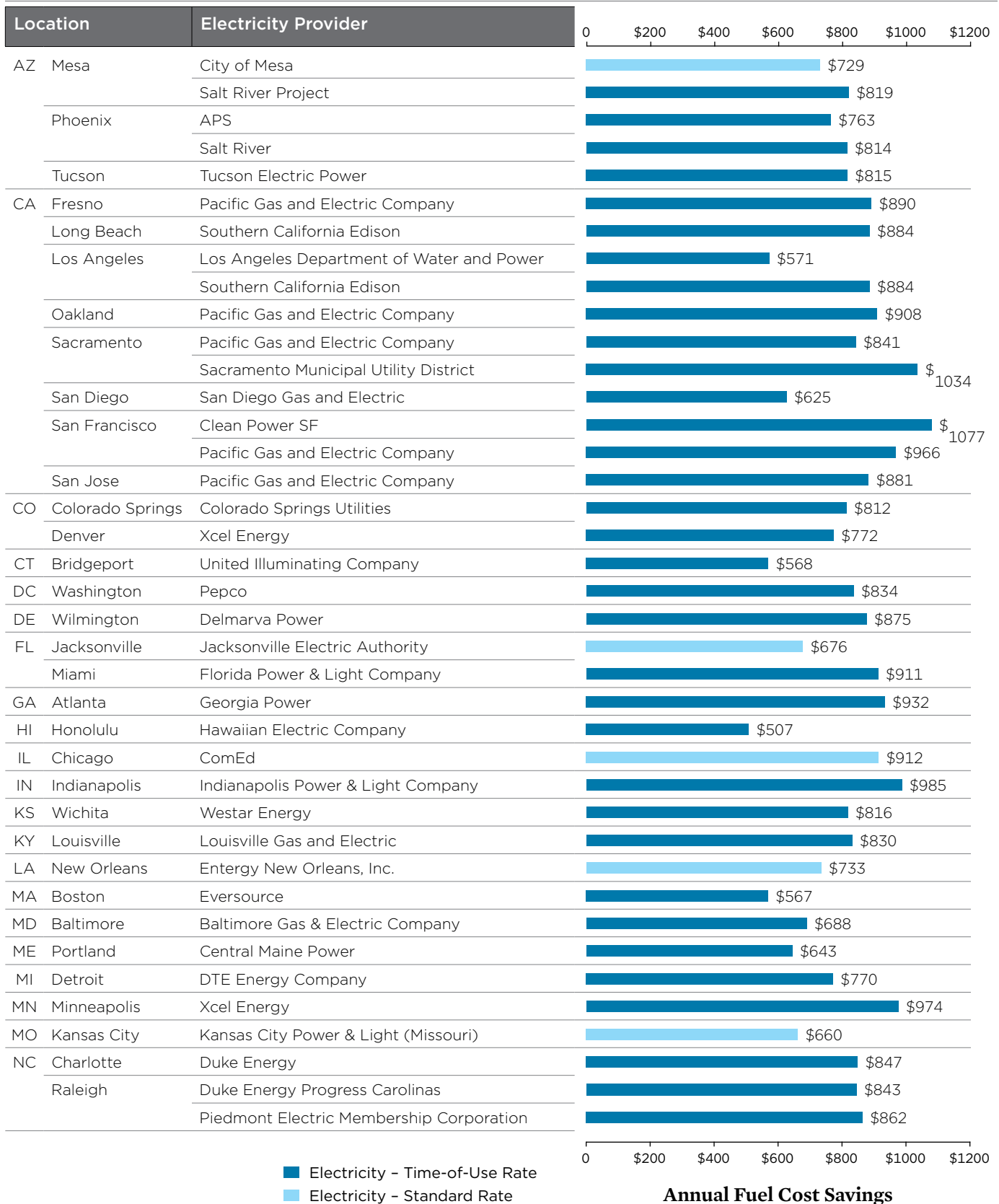
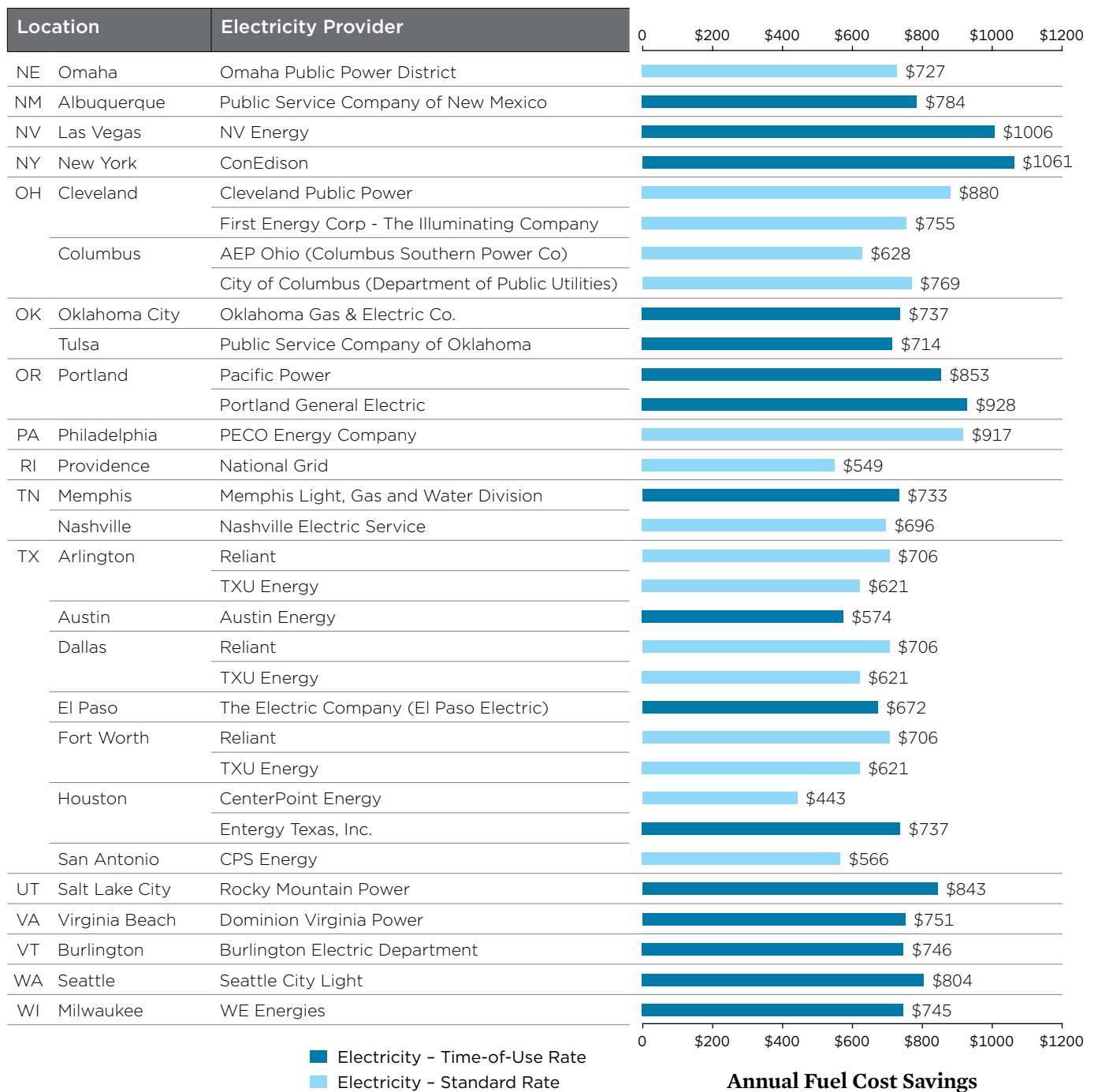


FIGURE ES-1. Annual Fuel Cost Savings from Driving an Electric Vehicle CONTINUED



The median EV driver could save more than \$770 per year compared with the cost of driving the average new gasoline vehicle (\$706 on a standard rate plan, and \$818 on a time-of-use plan). Annual savings were calculated using the lowest electric rate plan available for EV charging and October 2017 gasoline prices in each city. Values in dark blue represent cities where a time-of-use rate plan is the lowest cost option and light blue shows cities where a standard (flat) rate plan is the lowest-cost or only option for residents.

FIGURE ES-2. Electricity and Gasoline Prices Compared Using a Standard Rate Plan

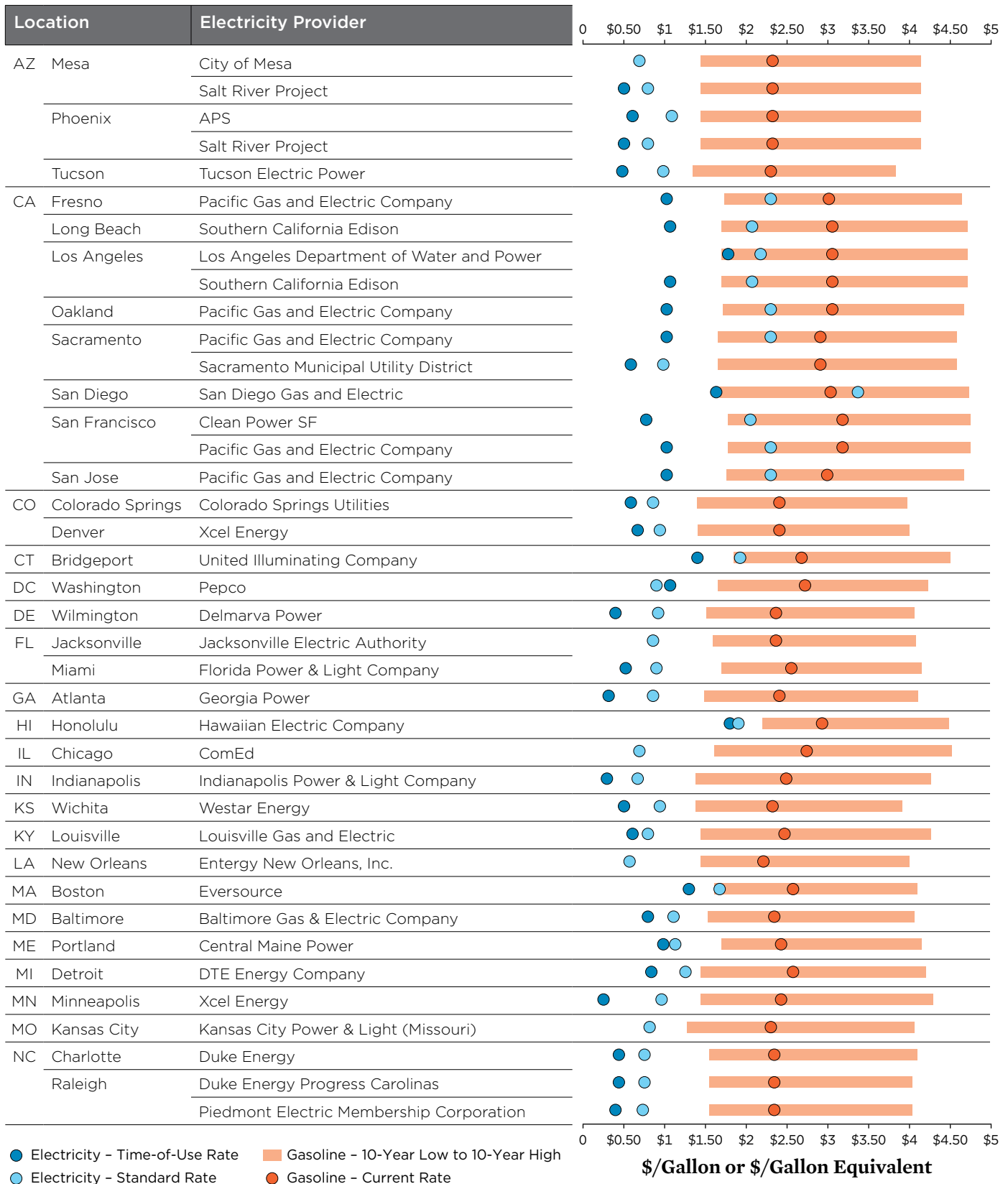
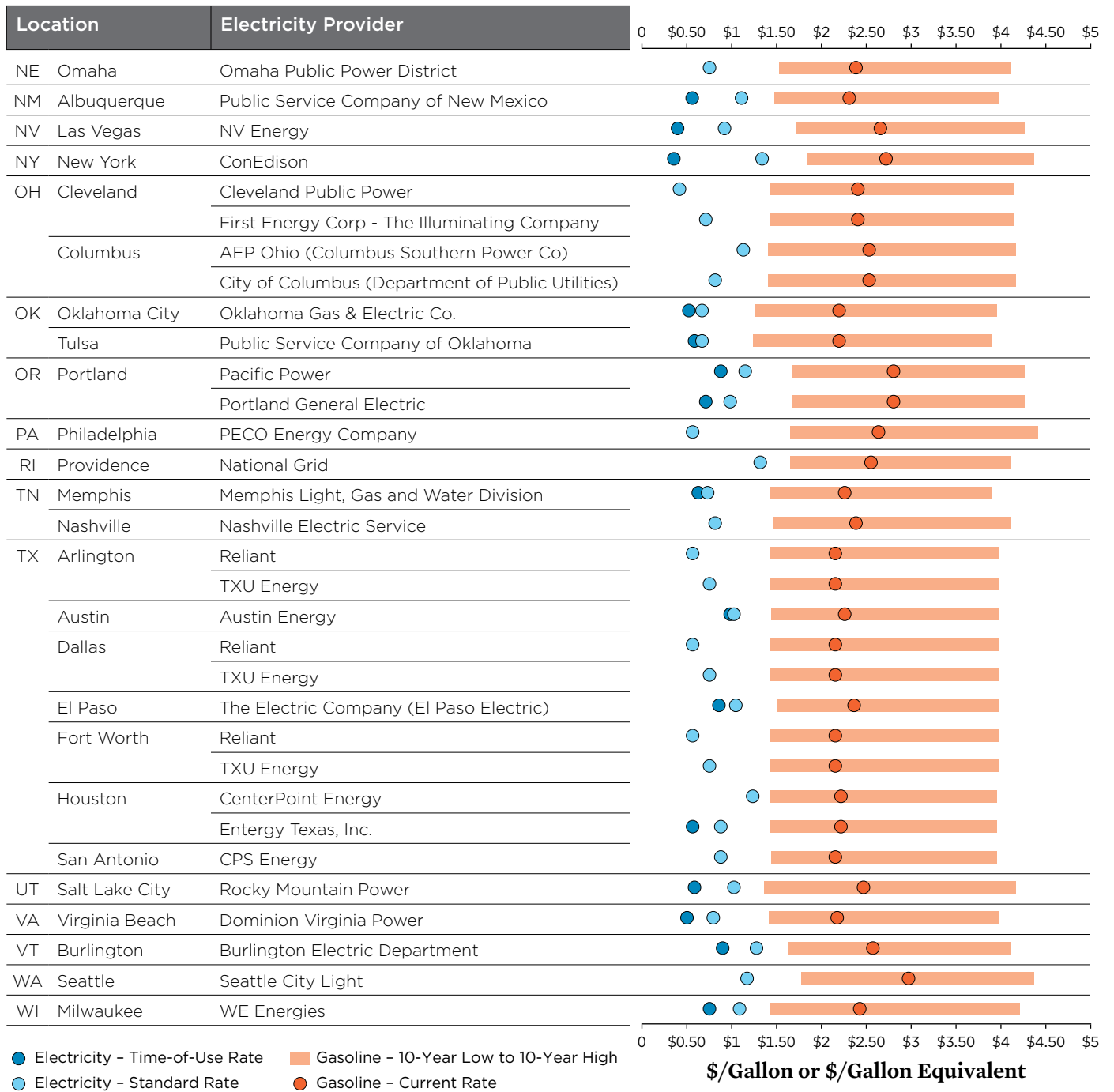


FIGURE ES-2. Electricity and Gasoline Prices Compared Using a Standard Rate Plan CONTINUED



The cost of electricity to recharge an EV using the standard rate plan is often lower than the equivalent cost of gasoline, and using a TOU rate plan is always lower. In fact, refueling an EV is often cheaper than even the lowest gasoline price of the last 10 years.

Note: Both electricity and gasoline costs include taxes and fees. Gasoline equivalency based on average electric efficiency of 0.325 kWh per mile and average new gasoline vehicle efficiency of 25.6 mpg.

Offsetting Higher Purchase Costs: Lower Fuel and Maintenance Costs and Government Incentives

On average, the manufacturer’s recommended retail price (MSRP) for an EV is higher than that of a non-plug-in vehicle, and the average transaction price for electric vehicles (excluding Tesla’s EVs) is about \$4,000 higher than the overall average for new vehicles (not including taxes, fees, and/or incentives). Some EV owners also need to install home charging equipment, which leads to additional costs.

Offsetting these expenses are significant incentives from federal and state governments. For vehicle purchases, the price for an EV after incentives can be similar to or even lower than that of a comparable gasoline car (see the table). Vehicle lease offers are more variable, but some manufacturers use federal, state, and manufacturer incentives to offer EVs at low rates.

Currently, it is primarily the cost to produce the EV’s battery pack that leads to higher manufacturing costs for EVs compared with those for gasoline vehicles, but falling battery costs and rising EV production are expected to bring the purchase prices of EVs down to approach those of gasoline vehicles, reducing the need for incentives.



Fortune Live Media/Creative Commons (Plicker)

Though EVs may cause initial sticker shock compared to traditional gas vehicles, tax credits, rebates, and lower fuel and maintenance costs end up making EVs the cheaper option for car buyers.

EVs can be cheaper to maintain than comparable gasoline vehicles. Cheaper maintenance is especially the case for battery electric vehicles, like the Chevrolet Bolt EV, which do not require oil changes and other engine services. These battery electric vehicles are mechanically simpler than gasoline vehicles, with no timing belts, accessory belts, emissions control equipment, or much of the conventional transmission system, further reducing maintenance and repair costs.

Comparing the Purchase Prices of EVs and Comparable Gasoline Vehicles

	Ford Focus EV	Ford Focus Titanium	Toyota Prius Prime Plus	Toyota Prius One	VW e-Golf	VW Golf S	Chevy Bolt LT	Chevy Sonic Hatchback Premier
Powertrain	Plug-in EV	Gasoline	Plug-in EV	Gasoline-only hybrid	Plug-in EV	Gasoline	Plug-in EV	Gasoline
MSRP	\$31,075	\$24,074	\$27,100	\$23,475	\$28,995	\$19,895	\$37,495	\$22,170
Federal Tax Credit	\$7,500	-	\$4,502	-	\$7,500	-	\$7,500	-
Total Before Manufacturer Incentives, Taxes, and Fees	\$23,575	\$24,074	\$22,598	\$23,475	\$21,495	\$19,895	\$29,995	\$22,170
EV Cost Difference	(-\$499)	-	(-\$877)	-	\$1,600	-	\$7,825	-
Additional California State EV Rebate Available	\$2,500	-	\$1,500	-	\$2,500	-	\$2,500	-

EVs are affordable and compare favorably to similar gasoline vehicles when federal incentives are available. Some EVs have list prices below the comparable gasoline cars after applying the federal income tax credit. Some states provide additional incentives that further reduce the cost of an EV; California is shown as an example.

For example, it costs \$1,500 less for the scheduled maintenance of a Chevrolet Bolt EV than for a similarly sized, gasoline-powered Chevrolet Sonic over the first 150,000 miles of driving.

Consumer Recommendations

Evaluating the purchase and charging of an EV can be complex. Prospective EV buyers should consider the following actions:

- Evaluate the ability to get electric power where you intend to park an EV.
- Find out about rate options available for charging an EV, especially whether your electric provider offers TOU rates.
- Research the availability of state, local, and electricity-provider incentives for buying an EV or EV charging equipment.

Policy Recommendations

EVs reduce harmful emissions from transportation and can protect drivers from high and unpredictable fuel prices. Both the number of EV models available and the rate of EV sales are growing, an encouraging indicator of the transition from petroleum to cleaner fuels like electricity. Policymakers, automakers, and electric service providers can help accelerate this transition.

ELECTRICITY POLICIES

- Regulators and electricity providers should ensure that EV customers can access lower-cost electricity rate plans, which are key to making EVs a reliable and affordable alternative to gasoline vehicles.

- Solutions are needed for those who cannot charge at home and must drive long distances. Access is essential to reliable and affordable public charging, especially fast-charging stations.
- Public policies that improve charging options at apartments and multi-unit dwellings will broaden the base of drivers who can choose an EV.
- Electricity providers and regulators should ensure the availability of separate rates for EV and household electricity use so all customers can lower their cost for EV charging.
- Electricity providers and regulators should explore rate plans, pricing mechanisms, and smart-charging technologies that encourage the coordination of EV charging with the availability of renewable electricity sources.

VEHICLE POLICIES

- Policymakers, consumers, and automakers should advocate for federal and state purchase incentives that are vital to making EVs an affordable and competitive option.
- Policymakers should encourage incentive programs that target communities and demographics that could most benefit from lower fuel costs but currently lack the ability to invest in an EV. The initial cost of an EV can be a barrier to adoption, especially for lower-income households.
- Public policies should require manufacturers to produce higher volumes of EVs and encourage a greater diversity of electric-drive models and sizes.

David Reichmuth is a senior engineer in the UCS Clean Vehicles program.

NATIONAL HEADQUARTERS

Two Brattle Square
Cambridge, MA 02138-3780
Phone: (617) 547-5552
Fax: (617) 864-9405

WASHINGTON, DC, OFFICE

1825 K St. NW, Suite 800
Washington, DC 20006-1232
Phone: (202) 223-6133
Fax: (202) 223-6162

WEST COAST OFFICE

500 12th St., Suite 340
Oakland, CA 94607-4087
Phone: (510) 843-1872
Fax: (510) 451-3785

MIDWEST OFFICE

One N. LaSalle St., Suite 1904
Chicago, IL 60602-4064
Phone: (312) 578-1750
Fax: (312) 578-1751