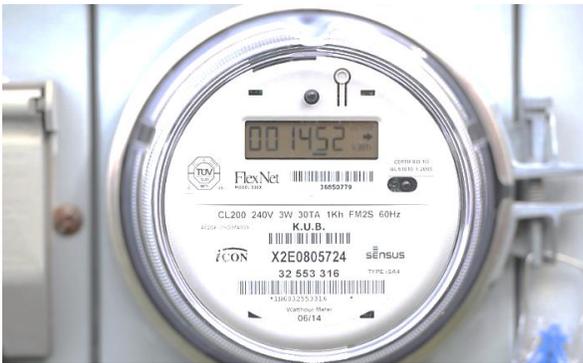


Electric Vehicle Cost-Benefit Analysis

Plug-in Electric Vehicle Cost-Benefit Analysis: Arizona

EXECUTIVE SUMMARY



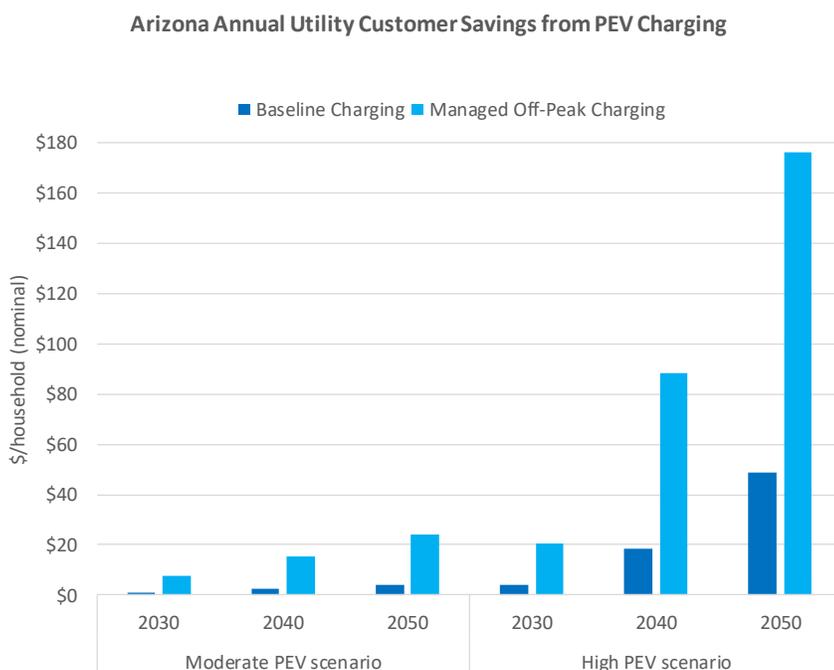
Executive Summary

This study estimated the costs and benefits of increased penetration of plug-in electric vehicles (PEV) in the state of Arizona, for two different penetration scenarios between 2030 and 2050.¹ The “Moderate PEV” scenario is based on the Transportation Electrification Goals in Arizona Corporation Commissioner Andy Tobin’s *2018 Draft Energy Modernization Plan*, which includes a state-wide goal of one million PEVs registered in Arizona by 2050. The “High PEV” scenario includes more aggressive PEV penetration levels that would be required to achieve deep reductions in vehicle air pollution emissions.

This study focused on passenger vehicles (cars and light trucks). There are additional opportunities for electrification of non-road equipment and medium- and heavy-duty trucks and buses, but evaluation of these applications was beyond the scope of this study.

The study estimated the benefits that would accrue to all electric utility customers in Arizona due to increased utility revenues from PEV charging. This revenue could be used to support operation and maintenance of the electrical grid, thus reducing the need for future electricity rate increases. These benefits were estimated for a baseline scenario in which Arizona drivers plug in and start to charge their vehicles as soon as they arrive at home or work (baseline charging). The study also evaluated the additional benefits that could be achieved by providing Arizona drivers with price signals or incentives to delay the start of PEV charging until after the daily peak in electricity demand (managed off-peak charging).

Figure 1 Potential Effect of PEV Charging Net Revenue on Arizona Utility Customer Bills (nominal \$)



Increased peak hour load increases a utility’s cost of providing electricity and may result in the need to upgrade distribution infrastructure. As such, managed off-peak PEV charging can provide net benefits to all utility customers by shifting PEV charging to hours when the grid is underutilized, and the cost of electricity is lower.

¹ PEVs include battery-electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEV).

See Figure 1 for a summary of how the projected utility net revenue from PEV charging might affect average residential electricity bills for all Arizona electric utility customers.² As shown in the figure, under the High PEV scenario with managed off-peak charging, the average Arizona household could realize approximately \$176 in annual utility bill savings in 2050 (nominal dollars) due to vehicle electrification.

In addition, the study estimated the annual financial net benefits to Arizona drivers – from net fuel and maintenance cost savings compared to owning gasoline vehicles. When evaluating costs to PEV owners, this study includes the cost of both home and “public” charging infrastructure required to support the modeled levels of PEV penetration. However, while this charging infrastructure represents a cost to PEV owners, it also represents an opportunity for charging station owners to make money by selling charging services. As such, this study includes as a net societal benefit the annual return on the capital that is invested by public charging station owners.

In addition to direct financial benefits to utility customers, PEV owners, and charging station owners, this study also estimates the societal benefits that would result from reduced nitrogen oxide (NOx) and greenhouse gas (GHG) emissions due to vehicle electrification.

As shown in Figure 2 (Moderate PEV scenario), if Arizona meets the transportation electrification goals included in the *2018 Draft Energy Modernization Plan*, the net present value (NPV) of **cumulative net benefits from greater PEV use in Arizona will exceed \$3.7 billion state-wide by 2050**.³ Of these total net benefits:

- At least \$200 million will accrue to electric utility customers in the form of reduced electric bills⁴,
- \$2.6 billion will accrue directly to Arizona drivers in the form of reduced annual vehicle operating costs,
- \$500 million will accrue to owners of public charging infrastructure in the state,
- \$300 million will accrue to Arizona residents due to reduced costs of complying with future carbon reduction regulations, and
- \$70 million will accrue to society at large, as the value of reduced NOx emissions.

As shown in Figure 3 (High PEV scenario), if PEV penetration were even higher - reaching 90 percent of the vehicle fleet in 2050 - the NPV of **cumulative net benefits from greater PEV use in Arizona could exceed \$31 billion state-wide by 2050**. Of these total net benefits:

- Up to \$9.0 billion will accrue to electric utility customers in the form of reduced electric bills,⁵
- \$15.9 billion will accrue directly to Arizona drivers in the form of reduced annual vehicle operating costs,
- \$3.9 billion will accrue to owners of public charging infrastructure in the state,
- \$2.3 billion will accrue to Arizona residents due to reduced costs of complying with future carbon reduction regulations, and
- \$400 million will accrue to society at large, as the value of reduced NOx emissions

² Based on 2016 average electricity use of 11,075 kWh per housing unit in Arizona.

³ Using a three percent discount rate.

⁴ Figure 2 includes utility customer savings under the baseline charging scenario; savings would be higher under the managed off-peak charging scenario.

⁵ Figure 3 includes utility customer savings under the managed off-peak charging scenario; savings would be lower under the baseline charging scenario.

Figure 2

NPV Cumulative Societal Net Benefits from AZ PEVs – Moderate PEV scenario

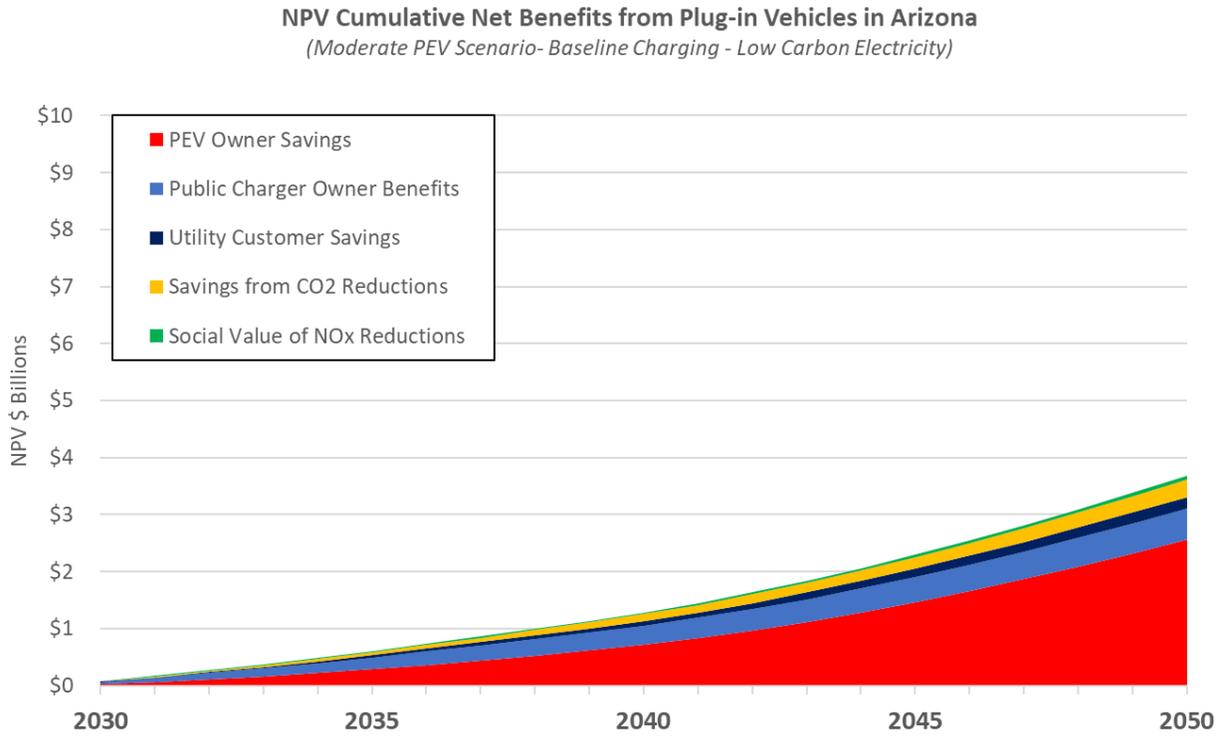
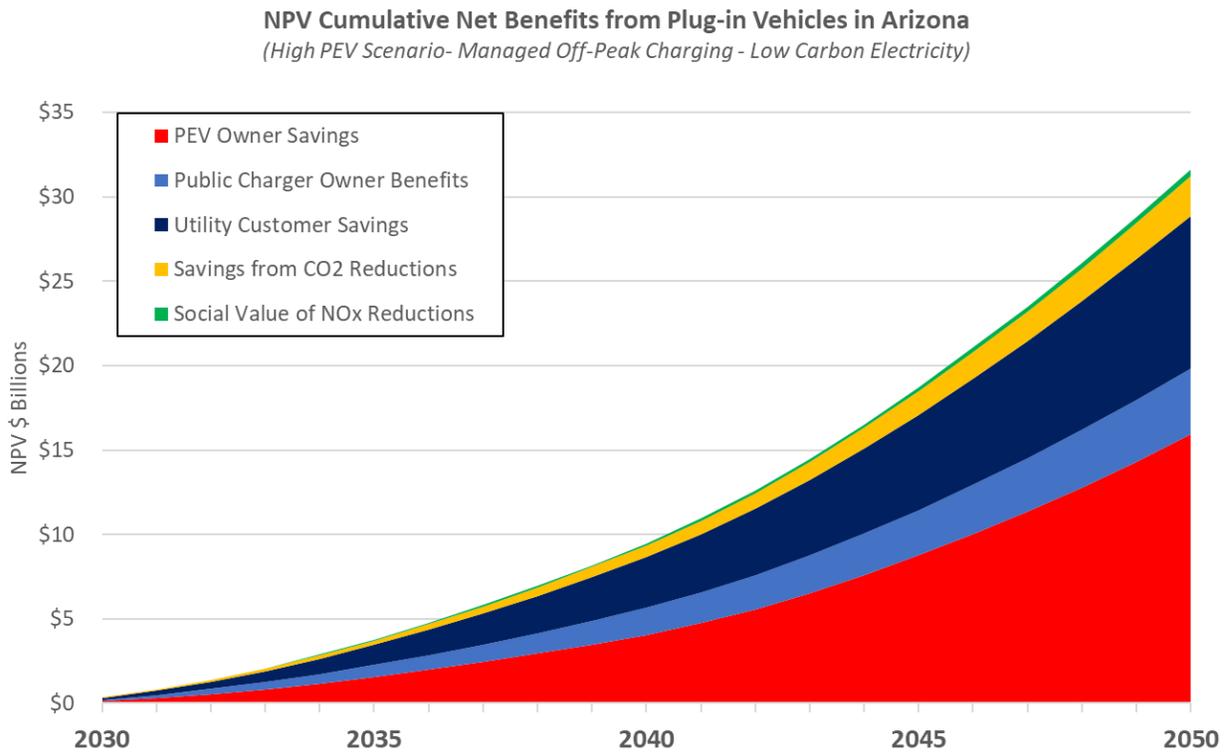


Figure 3

NPV Cumulative Societal Net Benefits from AZ PEVs – High PEV scenario



By 2050, PEV owners are projected to save more than \$590 per vehicle (nominal \$) in annual operating costs, compared to owning gasoline vehicles. A large portion of the direct financial benefit to Arizona drivers derives from reduced gasoline use — from purchase of lower cost, regionally produced electricity instead of gasoline imported to the state. Under the Moderate PEV scenario, PEVs will reduce cumulative gasoline use in the state by more than 2.1 billion gallons through 2050 – this cumulative gasoline savings grows to 15.5 billion gallons through 2050 under the High PEV scenario. In 2050, annual average gasoline savings will be approximately 133 gallons per PEV under the Moderate PEV scenario, while projected savings under the High PEV scenario are 179 gallons per PEV.

This projected gasoline savings will help to promote energy security and independence and will keep more of vehicle owners' money in the local economy, thus generating even greater economic impact. Studies in other states have shown that the switch to PEVs can generate up to \$570,000 in additional economic impact for every million dollars of direct savings, resulting in up to 25 additional jobs in the local economy for every 1,000 PEVs in the fleet.

In addition, this reduction in gasoline use will reduce cumulative net greenhouse gas (GHG) emissions by more than 22 million metric tons through 2050 under the Moderate PEV scenario and over 160 million metric tons under the High PEV scenario.⁶ The switch from gasoline vehicles to PEVs is also projected to reduce annual NOx emissions in the state by over 377 tons in 2050 under the Moderate PEV scenario and by over 2,900 tons under the High PEV scenario.

⁶ Net of emissions from electricity generation

Acknowledgements

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This study was conducted by M.J. Bradley & Associates for the Southwest Energy Efficiency Project (SWEET) and Western Resource Advocates (WRA).

SWEET is a public-interest organization promoting greater energy efficiency and clean transportation in Arizona, Colorado, Nevada, New Mexico, Utah, and Wyoming. SWEET collaborates with utilities, state and local governments, environmental groups, national laboratories, businesses, and other energy experts.

Founded in 1989, WRA is dedicated to protecting the West's land, air, and water to ensure that vibrant communities exist in balance with nature. WRA uses law, science, and economics to craft innovative solutions to the most pressing conservation issues in the region.

This study is one of ten state-level analyses of plug-in electric vehicle costs and benefits developed for different U.S. states, including Arizona, Colorado, Connecticut, Illinois, Maryland, Massachusetts, Michigan, Minnesota, New York, and Pennsylvania.

These studies are intended to provide input to state policy discussions about actions required to promote further adoption of electric vehicles.

This report, and the other state reports, are available at www.mjbradley.com.

About M.J. Bradley & Associates

M.J. Bradley & Associates, LLC (MJB&A), founded in 1994, is a strategic consulting firm focused on energy and environmental issues. The firm includes a multi-disciplinary team of experts with backgrounds in economics, law, engineering, and policy. The company works with private companies, public agencies, and non-profit organizations to understand and evaluate environmental regulations and policy, facilitate multi-stakeholder initiatives, shape business strategies, and deploy clean energy technologies.

Our multi-national client base includes electric and natural gas utilities, major transportation fleet operators, clean technology firms, environmental groups and government agencies.

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