Electric Vehicle Cost-Benefit Analysis

Plug-in Electric Vehicle Cost-Benefit Analysis: Colorado

Executive Summary

M.J. Bradley & Associates (MJB&A) estimated the costs and benefits of increased penetration of plug-in electric vehicles (PEV) in the state of Colorado, for two different penetration levels between 2030 and 2050.[1] The "Moderate PEV" scenario is based upon near-term (2025) Zero Emission Vehicle goals adopted by states that together comprise about a third of the automotive market.[2] The "High PEV" scenarios is based on the PEV penetration that would be required to achieve long-term goals for economy wide greenhouse gas (GHG) reduction of 80 percent from 2005 levels by 2050.

This study focused on passenger vehicles and trucks; there are opportunities from electrification of non-road equipment 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 Colorado 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 Colorado drivers plug in and start to charge their vehicles as soon as they arrive at home or work.

The study also evaluated the additional benefits that could be achieved by providing Colorado drivers with price signals or incentives to delay the start of PEV charging until after the daily peak in electricity demand (off-peak charging). Increased peak hour load increases a utility's cost of providing electricity, and may result in the need to upgrade distribution infrastructure. As such, 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 low.

See Figure 1 for a summary of how the projected utility net revenue from PEV charging might affect average residential electricity bills for all Colorado electric utility customers.[3] As shown in the figure, under the High PEV scenario the average Colorado household could realize nearly $80 in annual utility bill savings in 2050.

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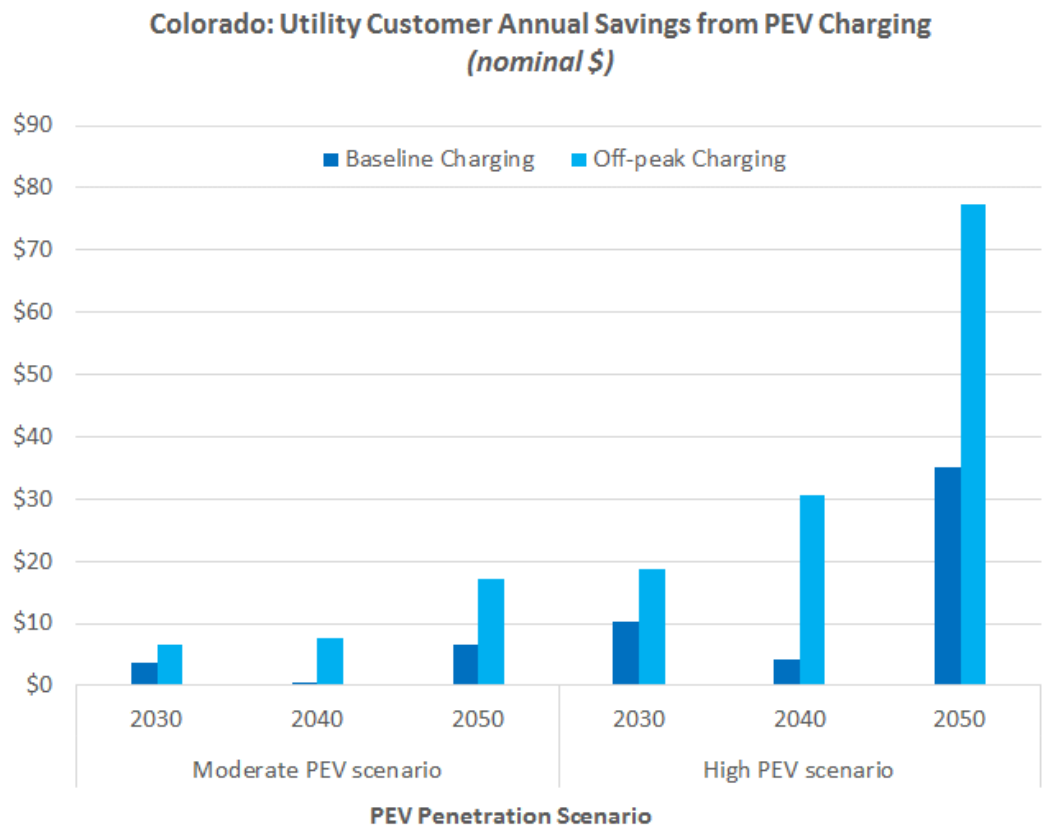
1 PEVs include battery-electric vehicles (BEV) and plug-in hybrid vehicles (PHEV).

2 In 2013, six Northeast/Mid-Atlantic states (MD, MA, NY, CT, RI, VT) and two Pacific coast states (CA, OR) joined in a Zero Emission Vehicle Memorandum of Understanding to enact policies that will ensure the deployment of 3.3 million ZEVs by 2025. Colorado is not a signatory of the MOU but has enacted policies found in the other states, such as vehicle purchase incentives, designed to accelerate EV sales.

3 Based on 2015 average electricity use of 7,728 kWh per housing unit in Colorado.

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



In addition, the study estimated the annual financial benefits to Colorado drivers – from fuel and maintenance cost savings compared to owning gasoline vehicles, and societal benefits resulting from reduced GHG emissions.

As shown in Figure 2 (Moderate PEV scenario), if Colorado meets short term (2025) goals for PEV penetration, and the increase in percent PEV penetration then continues at the same annual rate in later years, the net present value of **cumulative net benefits from greater PEV use in Colorado will exceed $7.6 billion state-wide by 2050**.[4] Of these total net benefits:

- $300 million will accrue to electric utility customers in the form of reduced electric bills,
- $6.3 billion will accrue directly to Colorado drivers in the form of reduced annual vehicle operating costs, and
- $1.1 billion will accrue to society at large, as the value of reduced GHG emissions.

As shown in Figure 3 (High PEV scenario), if the state meets long-term goals to reduce light-duty fleet GHG emissions by 80 percent from 2005 levels by 2050, which requires even greater PEV penetration, the net present value of **cumulative net benefits from greater PEV use in Colorado could exceed $43 billion state-wide by 2050**. Of these total net benefits:

- $4.1 billion will accrue to electric utility customers in the form of reduced electric bills
- $29.1 billion will accrue directly to Colorado drivers in the form of reduced annual vehicle operating costs, and
- $9.7 billion will accrue to society at large, as the value of reduced GHG emissions.

[4] Using a 3% discount rate

Figure 2 NPV Cumulative Societal Net Benefits from CO PEVs – Moderate PEV Scenario

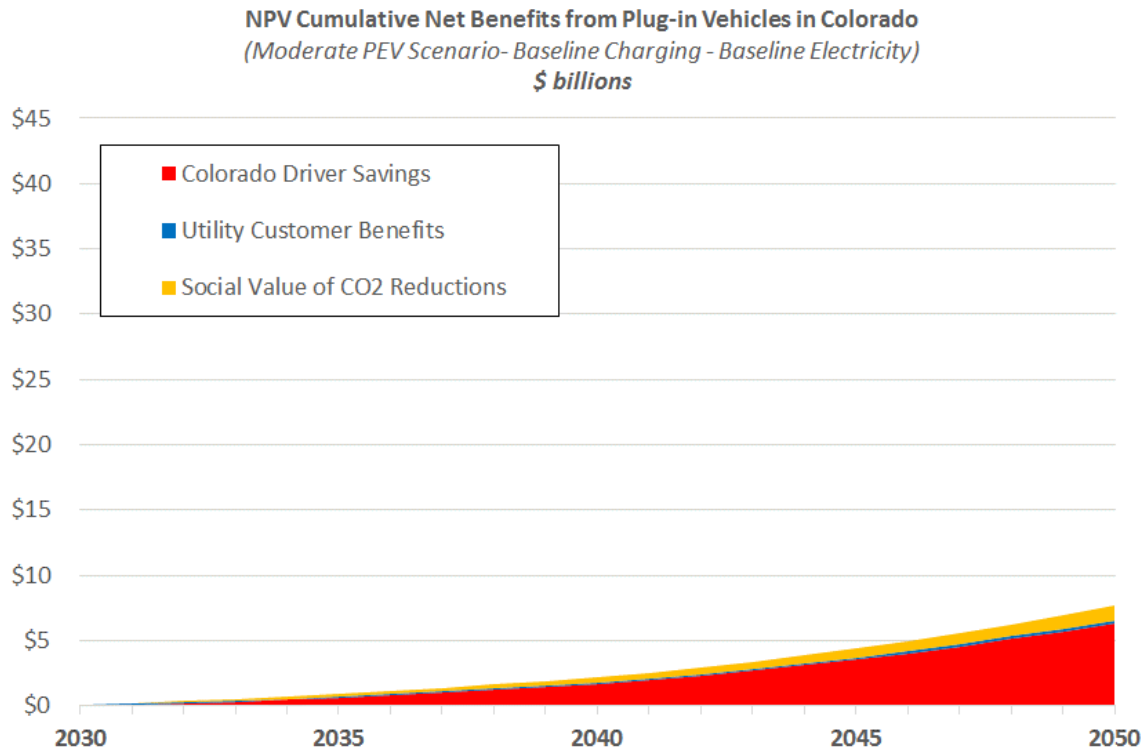
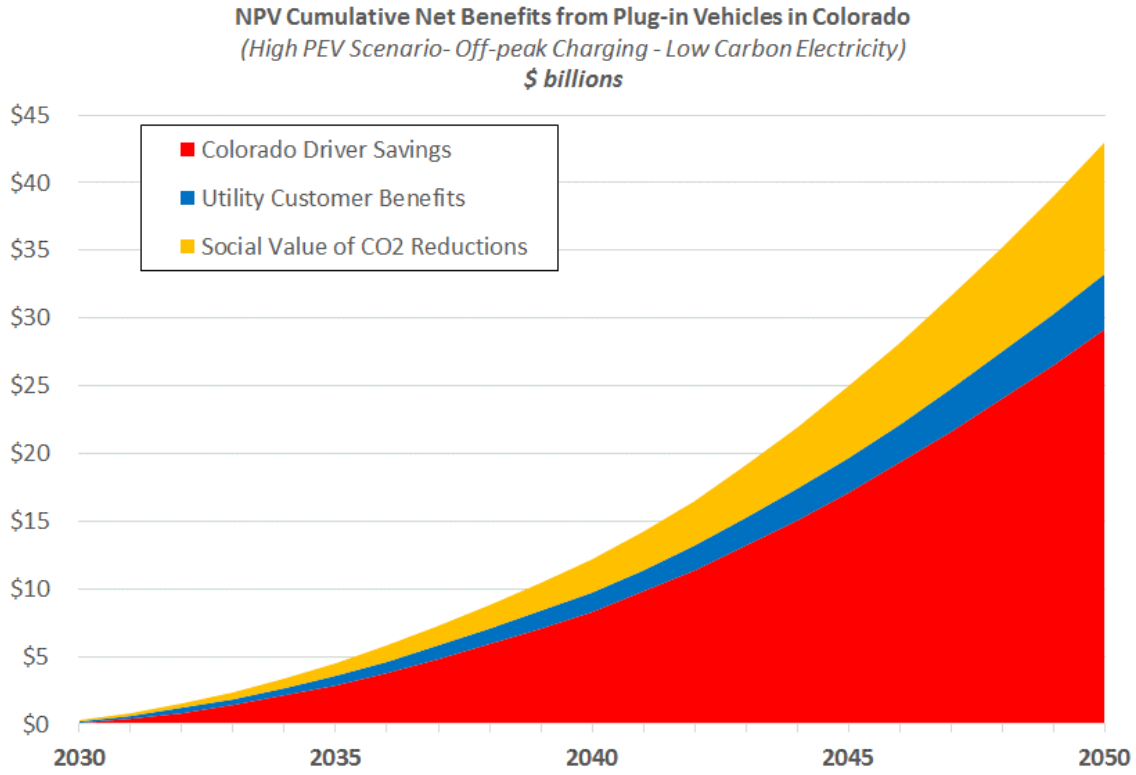


Figure 3 NPV Cumulative Societal Net Benefits from CO PEVs – High PEV Scenario



PEV penetration scenarios and key assumptions

The Moderate PEV and High PEV penetration scenarios were compared to a "business as usual" base case with little PEV penetration. This base case was based on the current light-duty fleet in Colorado, and state projections for future growth in vehicle miles traveled.

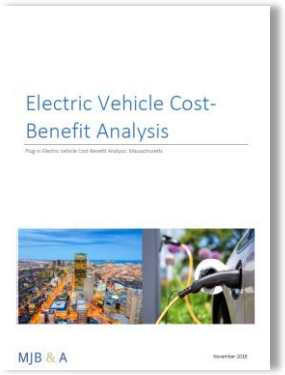
The Moderate PEV penetration trajectory was assumed to result in an increase from approximately 7,600 PEVs today to 349,000 by 2025. Assuming the same annual increase in percent PEV penetration in later years, there would be 544,000 PEVs in Colorado in 2030, 1.02 million in 2040, and 1.6 million in 2050. Under the High PEV penetration scenario, there would be approximately 1.6 million PEVs in Colorado by 2030, rising to 4.2 million in 2040, and 7.8 million in 2050.

Projected future energy costs (gasoline and electricity) were based on regional projections from the Energy Information Administration (EIA).[5]

Assumed propulsion energy use for both gasoline cars and PEVs is consistent with national modeling conducted by the Natural Resources Defense Council and the Electric Power Research Institute (EPRI) in 2015, and reflects the Department of Transportation/Environmental Protection Agency corporate average fuel economy standards (CAFE) through the 2025 model year.[6] For PEVs, additional energy use was assumed to cover cabin heating needs during the winter months in Colorado.

For the Moderate PEV penetration scenario, GHG emissions from PEVs are based on EIA projections of future electricity grid carbon intensity (grams CO_2 per kilowatt-hour of delivered electricity). For the High PEV penetration scenario, PEV GHG emission are based on a "low carbon grid" scenario, in which electricity grid carbon intensity is lowered enough to achieve an 80 percent reduction in emissions by 2050.

MJB&A, founded in 1994, is a strategic consulting firm focused on energy and environmental issues. This study was conducted by MJB&A for the Natural Resources Defense Council, to provide input to state policy discussions about actions required to promote further adoption of electric vehicles.



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The report is available at: www.mjbradley.com

[5] EIA, Annual Energy Outlook 2016.
[6] EPRI, Environmental Assessment of a Full Electric Transportation Portfolio, September 2015.