Electric Vehicle Cost-Benefit Analyses

Results of plug-in electric vehicle modeling in eight US states

Quick Take

M.J. Bradley & Associates (MJB&A) evaluated the costs and benefits of increased penetration of plug-in electric vehicles (PEV) in eight states: Colorado, Connecticut, Illinois, Maryland, Massachusetts, Michigan, New York, and Pennsylvania. The analyses project the costs and benefits of two[1] different PEV penetration levels between 2030 and 2050, which bracket the states' short- and long-term policy goals for zero emission vehicle (ZEV) adoption (8-state ZEV MOU scenario) and greenhouse gas (GHG) emission reductions (80x50 scenario).[2] Four of these eight states are signatories to the 8-state ZEV MOU, which seeks to put more than three million ZEVs on the road by 2025. Most of these states also have long-term goals to reduce economy-wide GHG emissions 80 percent by 2050.

States Evaluated

Switching to PEVs in the light-duty fleet (cars and light trucks) results in lower operating costs for consumers, reduced GHG emissions, and lower costs for utility customers. These studies estimate the annual financial benefits to PEV owners—from fuel and maintenance cost savings compared to continued gasoline vehicle use. They also estimate the total GHG emission reductions that could be achieved by accelerating the switch to PEVs, and the value of these GHG emission reductions to society. The studies also estimate the benefits that would accrue to all electric utility customers in these states due to increased utility revenue from PEV charging.

"Electric vehicle charging increases utility revenues as we shift from gasoline use to greater reliance on the electric system. Higher revenues support investment and maintenance of the electric system, benefiting all utility customers, regardless of the vehicle they drive." Brian Jones, MJB&A

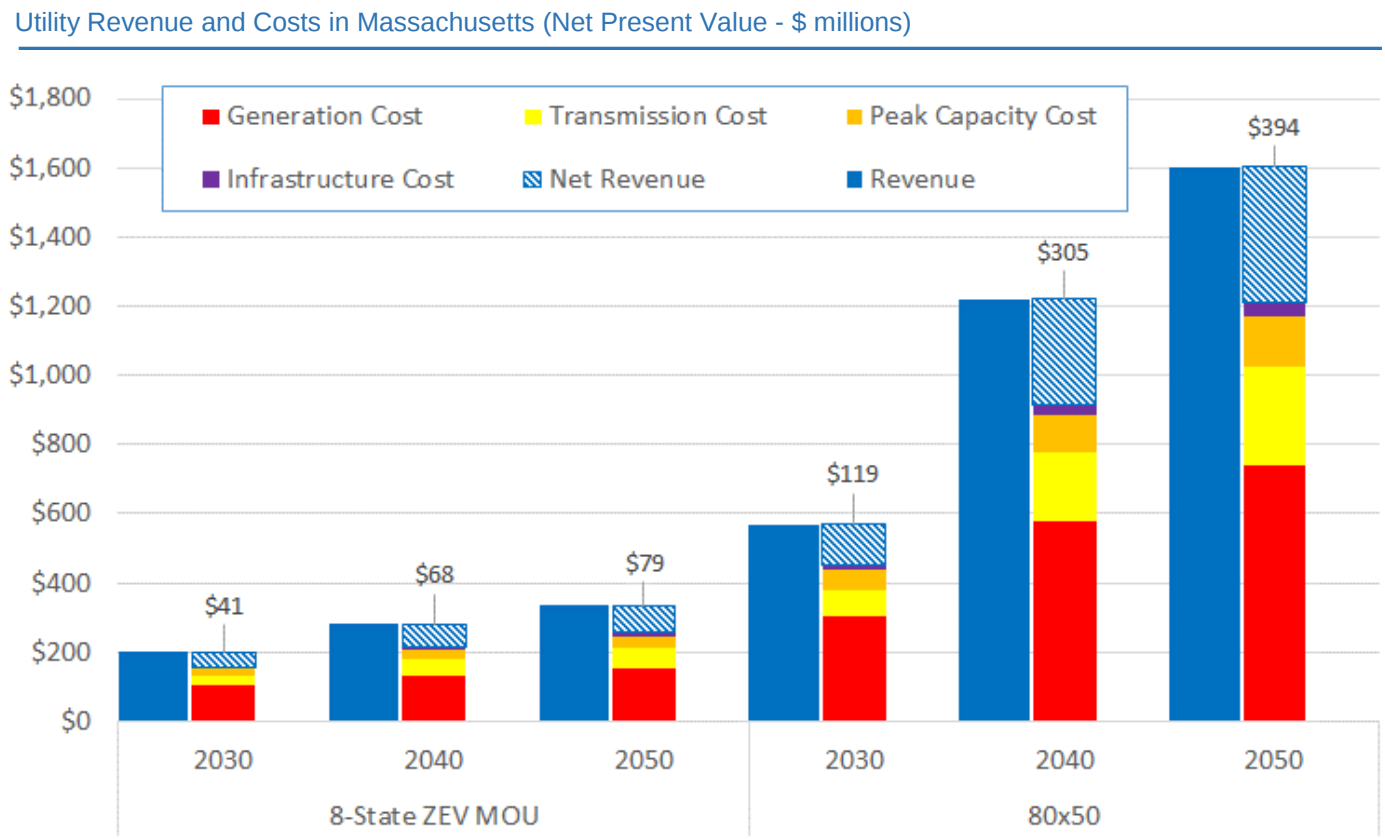
In each of these eight states, the projected load from PEV charging will increase annual revenue for the state's electric distribution utilities, as well as their net revenue (revenue from increased electricity sales, minus costs to provide the electricity). This revenue could be used to support operation and maintenance of the existing distribution infrastructure, thus reducing the need for future electricity rate increases. In general, the costs to maintain distribution infrastructure will increase each year with inflation, and these costs are passed on to ratepayers in accordance with rules established by state Public Utility Commissions (PUC). However, higher net revenue can offset these costs and benefit all utility customers in these states. In effect, this net revenue from PEV charging would put downward pressure on future electricity rates, delaying or reducing future rate increases, thereby reducing energy bills for all customers, not just PEV owners.

[1] For Illinois and Michigan, two separate penetration scenarios were used that better reflected the current landscape of these states. These two scenarios fell in between the 8-State ZEV MOU and 80x50 penetration rates.

[2] The low (8-state ZEV MOU) and high (80x50) 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 each state and state projections for future growth in vehicle miles traveled. Future PEVs are assumed to be both plug-in hybrid (PHEV) and battery-electric (BEV) cars and light trucks; the assumed ratio of PHEVs to BEVS is based on the current PEV fleet in each state. PEVs are assumed to be mostly cars in 2030, with an increasing percentage of PEV light trucks each year, especially in the 80x50 scenario.

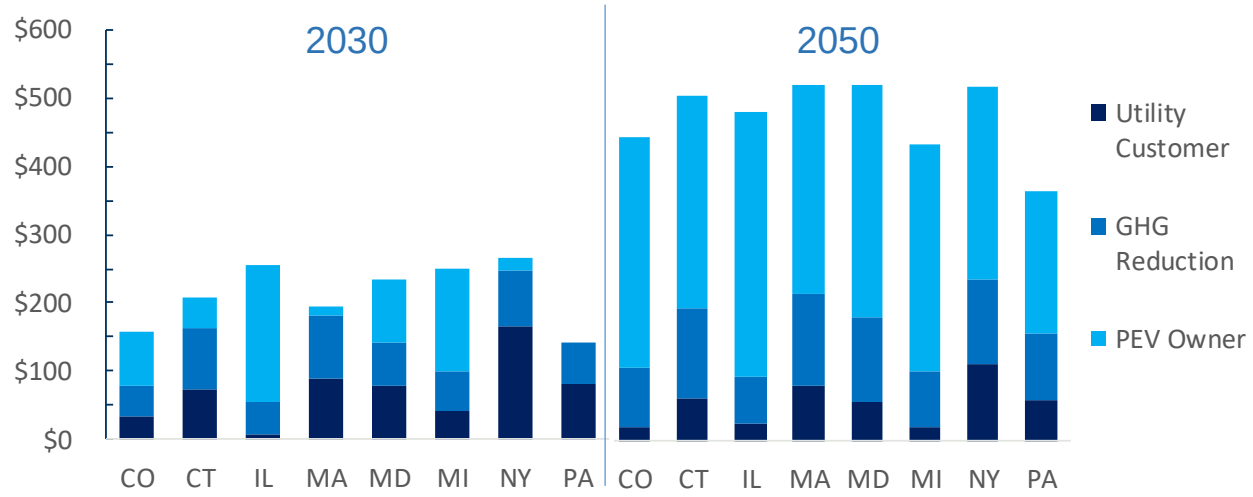
Utility net revenues will be even higher if PEV owners are given price signals, or incentives, to delay the start of PEV charging until off-peak periods, thereby optimizing the utilization of the electric system. Increased peak hour load—i.e., adding demand for electricity during periods when demand is already high—would drive the need to upgrade distribution infrastructure, raising the costs to supply electricity. By contrast, off-peak PEV charging reduces the need for system upgrades, providing additional net benefits to all utility customers by shifting PEV charging to hours when the grid is underutilized and the cost of electricity is low. These eight state analyses indicate that annual utility customer benefits will be 30 to 60 percent greater if PEV owners charge off-peak, compared to PEV owners plugging in and starting to charge as soon as they arrive home.

The estimated benefits to utility customers are significant. Under the high penetration scenario (enough PEVs to achieve 80x50 GHG reduction goals) net revenue from off-peak PEV charging in 2050 could reduce electric rates in these states by 1 to 7 percent, saving the average household between $22 and $144 per year on their electric bills.



The distribution of benefits varies across the states based on the vehicle fleet, the electric grid, and energy costs. Including utility customer benefits, the value of GHG reductions, and PEV owner savings, the net present value (NPV) of total annual societal benefits in 2030 will range from $107 per PEV in Pennsylvania to $265 per PEV in New York.[3]

Projected Annual Net Benefits per PEV (Net Present Value)



By 2050, the NPV of annual benefits will increase to $349 per PEV in Pennsylvania, and to over $500 per PEV in four of the states, primarily due to additional savings for PEV owners, as vehicle costs continue to fall and projected increases in gas prices outstrip projected increases in electricity rates. Total net benefits per PEV are lower in Pennsylvania than in the other states primarily due to lower annual mileage per vehicle. PEV owner benefits are highest in Illinois due to lower electricity rates than in the other states (and thus higher net fuel cost savings for PEVs compared to gasoline vehicles). On the other hand, utility customer benefits are highest in New York due to higher electricity costs than in other states and a lower percentage of utility revenue spent on generation and transmission.

In 2050, state-level net benefits could total over $320 billion for all eight states combined

On a state-wide basis, the net benefits to society are significant under each PEV scenario. In 2030, under the 80x50 scenario, the total estimated state-wide net benefits from greater PEV use ranges from $190 million in Connecticut, to $980 million in New York (NPV). By 2050 the cumulative net benefits could exceed $17.3 billion in Connecticut and could reach almost $76 billion in New York. Across the eight states, cumulative net benefits by 2050 are estimated at nearly $325 billion. The magnitude of state-wide net benefits is generally proportional to state population and the size of the light-duty vehicle fleet. By 2050 the cumulative net benefits could exceed $3,700 per person across these eight states.[4]

Of the projected 2050 net benefits 45 to 54 percent will accrue to PEV owners in these states in the form of vehicle operating cost savings, 13 to 32 percent will accrue to utility customers in the form of reduced electricity bills, and 23 to 28 percent will accrue to society as the value of GHG reductions.[5] Differences among states in the distribution of benefits are based on differences in grid GHG intensity, vehicle usage patterns, and projected future energy costs.

[3] Net present value based on 3 percent discount rate.

[4] Based on a projected 2050 population in these states of 85.4 million people, up from 77.3 million today. For other than Maryland, Colorado Illinois and Michigan, future population growth in these states is projected to be moderate, and lower than the national average.

[5] Based on the social cost of carbon ($/MT), as calculated by the U.S. government's Interagency Task Force on the Social Cost of Greenhouse Gases.

Projected Cumulative State-Wide Net Benefits Under 80x50 Scenario (NPV $ billion)

State	2030				2050			
	PEV Owner	Utility Customer	GHG Reduction	TOTAL	PEV Owner	Utility Customer	GHG Reduction	TOTAL
CO	$0.14	$0.10	$0.08	**$0.33**	$29.1	$4.1	$9.7	**$42.9**
CT	$0.04	$0.08	$0.07	**$0.19**	$9.4	$3.6	$4.4	**$17.3**
IL	$0.25	$0.05	$0.06	**$0.37**	$35.2	$1.8	$5.6	**$42.6**
MA	$0.03	$0.16	$0.12	**$0.31**	$16.8	$7.8	$8.0	**$32.7**
MD	$0.13	$0.11	$0.08	**$0.32**	$21.6	$4.5	$7.6	**$33.6**
MI	$0.16	$0.07	$0.06	**$0.29**	$23.1	$2.6	$5.7	**$31.4**
NY	$0.06	$0.65	$0.27	**$0.98**	$34.1	$24.3	$17.5	**$75.9**
PA	-$0.09	$0.24	$0.17	**$0.32**	$23.1	$9.6	$12.8	**$45.6**
TOTAL	**$0.72**	**$1.46**	**$0.91**	**$3.11**	**$192.4**	**$58.3**	**$71.3**	**$322.0**

PEV penetration scenarios and key assumptions

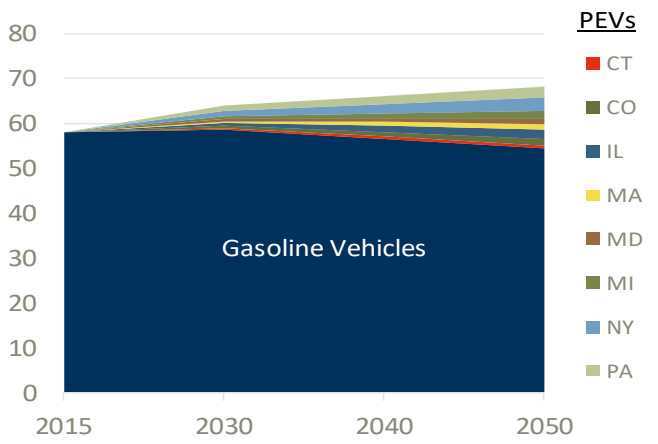
The low (8-state ZEV MOU) and high (80x50) PEV penetration scenarios[6] were compared to a "business as usual" base case with little PEV penetration. This base case was built on the current light-duty fleet in each state and state projections for future growth in vehicle miles traveled.

The PEV penetration trajectory set by the 8-state ZEV MOU goals was assumed to result in 17 to 25 percent PEV penetration in these states by 2050, and a total of 13.8 million PEVs on the road. To achieve a deep level of GHG reductions (80% reduction by 2050), 80 to 97 percent of light-duty vehicles in these states in 2050 would need to be PEVs—a total of 55.5 million plug-in vehicles.

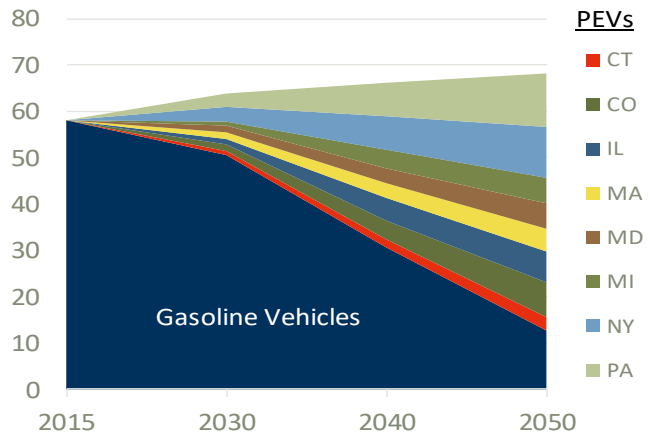
Projected future energy costs in each state (gasoline and electricity) were based on regional projections from the Energy Information Administration (EIA).[7]

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

Low PEV Penetration Scenario (mill LDV)



High PEV Penetration Scenario (mill LDV)



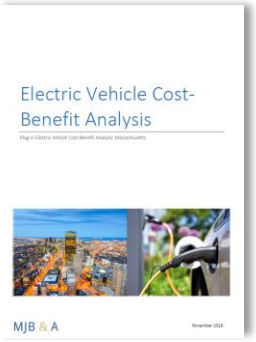
6 MISO and Bloomberg penetration scenarios in Illinois and Michigan
7 EIA, Annual Energy Outlook 2016.

model year.[8] For PEVs, additional energy use was assumed to cover cabin heating needs during the winter months in these Northern states.

For the 8-state ZEV MOU (as well as MISO and Bloomberg) penetration scenarios, GHG emissions from PEVs are based on EIA projections of future electric grid carbon intensity (grams CO_2 per kilowatt-hour of delivered electricity). For the 80x50 penetration scenario, PEV GHG emission are based on a "low carbon grid" scenario, in which grid carbon intensity is lowered enough to achieve an 80 percent reduction in grid emissions by 2050, consistent with state-level economy-wide GHG reduction goals.

These studies were 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.

For questions and comments, please contact:



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About Us

MJB&A provides strategic consulting services to address energy and environmental issues for the private, public, and non-profit sectors. Our approach fuses private sector strategy with public policy in air quality, energy, climate change, environmental markets, energy efficiency, renewable energy, transportation, and advanced technologies. Our international client base includes electric and natural gas utilities, major transportation fleet operators, investors, clean technology firms, environmental groups and government agencies. Our seasoned team brings a multi-sector perspective, informed expertise, and creative solutions to each client, capitalizing on extensive experience in energy markets, environmental policy, law, engineering, economics and business.

Transportation electrification has been a focus of our work since the early 1990's. MJB&A staff manage in-use demonstration and emissions and fuel economy testing projects for hybrid-electric, plug-in hybrid, and electric school buses, transit buses, and trucks; and conduct fleet sustainability and alternative fuel/advanced technology vehicle analyses for transit agencies, municipal, and utility clients. During the past several years, we have executed numerous policy studies and analyses related to transportation electrification. This has included analysis of electricity pricing options for EV charging while minimizing grid impacts, and development of GIS-based tools to prioritize EV charging investments.

In 2016 we launched the Utility EV Initiative, a group of leading electric utilities collaborating to address key market, regulatory and technical factors affecting the growth of the electric vehicle market. The mission of the Utility EV Initiative is to advance the electrification of the transportation segment through consumer engagement and education, making the case for utility programs to help accelerate EV charging infrastructure deployment, and integration of EVs into the electric grid for the benefit of all electric customers. MJB&A provides facilitation, technical, and strategy support to Utility EV Initiative participants. In March 2017 the Utility EV Initiative released the MJB&A-authored white paper Accelerating the Electric Vehicle Market: Potential Roles of Electric Utilities in the Northeast and Mid-Atlantic States.

[8] EPRI, Environmental Assessment of a Full Electric Transportation Portfolio, September 2015.