Economic Impacts of Eliminating the Manufacturers’ Cap on the Plug-In Electric Vehicle Tax Credit

Flint Hills Resources

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List of Acronyms

ARRA	American Recovery and Reinvestment Act of 2009
BEV	Battery electric vehicle
BIL	Billion
CBO	Congressional Budget Office
DCFC	Direct current fast charger
DOE	U.S. Department of Energy
EVSE	Electric vehicle supply equipment
FHR	Flint Hills Resources
GW	Gigawatt
HCL1	Home charger Level 1
HCL2	Home charger Level 2
ICEV	Internal combustion engine vehicle
KWH	Kilowatt hour
LDV	Light duty vehicle
LEV	Low emission vehicle
MIL	Million
NREL	National Renewable Energy Laboratory
PHEV	Plug-in hybrid electric vehicle
PEV	Plug-in electric vehicle
PPL2	Public place Level 2 charger
TWH	Terawatt hour
WPL2	Workplace Level 2 charger
ZEV	Zero emission vehicle

Executive Summary

The U.S. electric vehicle market is relatively small. Battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs), collectively referred to as plug-in electric vehicles (PEVs), accounted for less than 1.5% of the new vehicle sales and comprised less than 0.5% of the total on-road vehicles as of 2017.

Federal and State governments have created programs to subsidize PEVs to lower the cost of owning a PEV with the goal of making PEVs cost competitive with internal combustion engine vehicles (ICEVs). The Energy Improvement and Extension Act of 2008 (H.R. 6049) and The American Recovery and Reinvestment Act of 2009 (ARRA) provide Federal income tax credits for new qualified PEVs ranging from $2,500 to $7,500 per vehicle. The current tax credit is manufacturer-specific and begins to phase out for a manufacturer's vehicles when at least 200,000 qualifying vehicles have been sold in the Unites States. As per Internal Revenue Code 30D, "the qualified PEV credit phases out for a manufacturer's vehicles over the one-year period beginning with the second calendar quarter after the calendar quarter in which at least 200,000 qualifying vehicles manufactured by that manufacturer have been sold for use in the United States."[1]

NERA was commissioned by Flint Hills Resources (FHR) to undertake a study to analyze the effects of removing the manufacturers' vehicle cap on PEVs that qualify for the Federal tax credit. The study focuses on impacts of removing the cap or extending the tax credit on PEV sales - without changing consumer preferences or vehicle characteristics, required levels of EV infrastructure deployment, and economic consumer benefit.

Although there are many vehicle market and non-market uncertainties that influence the adoption of electric vehicles, this study is limited to estimating the effects on PEV penetration from removing the manufacturer's cap, i.e., extending the PEV tax credit in perpetuity without changing consumer preferences or vehicle characteristics. This analysis is limited to the economic costs and benefits from higher penetration of PEVs.

For this study, we employed two models: NERA's N_{ew}ERA macroeconomic model and NERA's detailed electricity sector model. The N_{ew}ERA model is linked with the National Renewable Energy Laboratory's (NREL) EVI-Pro Lite model to estimate adoption of PEVs, EV infrastructure requirements, and the net economic impacts of continuing PEV tax credits in perpetuity.

Based on the vehicle market assumptions, PEVs are at cost or below cost parity relative to ICEVs from the mid-2020s onward. Although PEVs incur lower fuel costs than ICEVs over the life of the vehicle, widespread adoption of PEVs has been inhibited by limited driving range of PEVs compared to ICEVs and lack of adequate charging facilities leading to consumer anxiety towards adopting PEVs. The analysis assumes consumer preferences for PEVs do not change in the no cap scenario (i.e., consumer preference and anxiety that is currently holding back adoption continues in the scenario).

Eliminating the manufacturers' cap on the PEV tax credit and hence extending the tax credit in perpetuity induces greater sales of PEVs by reducing the buyer's up-front costs of PEVs. The total stock of PEVs increases by 1.4 million and 10.2 million in 2025 and 2035, respectively, relative to a baseline in which the current cap remains in effect. In 2035, total sales of new PEVs are projected to increase by about 38%

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[1] https://www.irs.gov/businesses/plug-in-electric-vehicle-credit-irc-30-and-irc-30d3

relative to the baseline projected in that year. By 2035, the stock of PEVs is projected to increase from a 10% share of new vehicle sales in the baseline to a 13% share in the scenario.

Electricity demand increases with the adoption of PEVs, as electricity is used to fuel these vehicles in part or in whole. Since some of the increased demand for PEVs comes at the expense of ICEV sales, gasoline demand decreases as ICEVs are displaced. But overall, impacts on energy markets are modest because new vehicle sales are a small portion of the total vehicle stock, resulting in a lengthy period for vehicle stock to turn over. The reticence of many consumers to shift their purchases to new vehicle technologies, especially BEVs that have limited range, results in slow turnover. Electricity demand is projected to increase by 5 TWh in 2025 and 30 TWh in 2035 if the cap is assumed to be eliminated. These increases, however, represent an increase of only 1% above the baseline projection in 2035. Extending the tax credit in perpetuity has a negligible impact on gasoline demand, which falls by about 1% in 2035 (78 thousand barrels a day, or 1.2 billion gallons per year).

Although consumers benefit from lower gasoline bills and EV infrastructure investment stimulus, consumers ultimately pay for the tax credit and investment in EV infrastructure both directly and indirectly. As a result, consumers have less money to spend and reduce their consumption of other goods and services. **In net, the policy's costs more than outweigh the consumers' financial savings**. Our analysis shows that:

- Total personal income of all U.S. households decreases by $7 billion in 2020 and $12 billion in 2035 relative to the baseline projected in that year; which is equivalent to about $50 to $70 per household per year between 2020 and 2035.
- Between 2020 and 2035, the net present value reduction in personal income of all U.S. households would be about $95 billion or about $610 per household.

I. Introduction

Plug-in electric vehicles (PEVs), which include dedicated battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs), comprise a relatively small fraction of the vehicle market presently but continue to gain new vehicle sales market share and therefore, continue to increase their share of the overall vehicle market. U.S. total registration of PEVs in 2011 was around 18,000 while in the past year (June 2017 through June 2018), new PEV registrations reached about 240,000. New PEV registrations have increased by about 29% in the past year (Auto Alliance[2]). Although new vehicle sales maintained a double-digit growth rate, the U.S. electric vehicle market is still relatively small. Plug-in electric vehicles account for less than 1.5% of new vehicle sales and comprise less than 0.5% of the total on-road vehicles in the U.S as of 2017.

Although PEVs incur lower fuel costs than gasoline powered internal combustion engine vehicles (ICEVs) over the life of the vehicle, widespread adoption of PEVs is inhibited by technological limitations, primarily battery technology energy and power densities, and other barriers, which include higher purchase prices and limited driving ranges, as compared to ICEVs, and lack of adequate charging facilities leading to consumer anxiety towards adopting PEVs.

Federal and State governments created programs to subsidize electric vehicles to lower the cost of owning a PEV and improve PEV cost competitiveness relative to ICEVs. The Energy Improvement and Extension Act of 2008 and The American Recovery and Reinvestment Act of 2009 (ARRA) provide federal income tax credits for new qualified PEVs. Based on the gross weight rating and battery capacity, the tax credits range from $2,500 to $7,500 per vehicle. The current tax credit system is manufacturer-specific and is phased out for a manufacturer’s vehicles when at least 200,000 qualifying vehicles have been sold in the Unites States. As per Internal Revenue Code 30D, credits phase out for a manufacturer’s vehicles over the one-year period beginning with the second calendar quarter after the calendar quarter in which at least 200,000 qualifying vehicles are sold for use in the United States.[3] We refer to this phase-out as the subsidy’s “cap limit.” Industry estimates suggest that in the early to mid-2020s, all major manufacturers will hit their respective caps, and PEV tax credits will eventually cease to exist. In addition, however, other Federal incentives (loans and grants) are also available for PEVs (CBO 2012) [4]. There are other commercial and government initiatives to support investment in EV infrastructure. Utilities have also initiated building PEV charging infrastructure in their respective service territories as investment projects with a commercial return. These government tax credit programs along with commercial investment in charging infrastructure are all designed to support and facilitate rapid adoption of PEVs.

This study analyzes adoption of PEVs in a future U.S. outlook that eliminates the vehicle cap limit of 200,000 for the manufacturers, resulting in a perpetual extension of the current tax credit. The U.S. outlook assumes a declining battery costs resulting in PEVs at cost or below cost parity relative to ICEVs from mid 2020s onward. This study compares that adoption to a future U.S. outlook that allows the limit

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[2] https://autoalliance.org/energy-environment/advanced-technology-vehicle-sales-dashboard/

[3] Internal Revenue Code Section 30D provides a credit for qualified PEVs. As per the Code, vehicles acquired after December 31, 2009, the credit is equal to $2,500 plus, for a vehicle which draws propulsion energy from a battery with at least 5 kilowatt hours of capacity, $417, plus an additional $417 for each kilowatt hour of battery capacity in excess of 5 kilowatt hours. The total amount of the credit allowed for a vehicle is limited to $7,500. (https://www.irs.gov/businesses/plug-in-electric-vehicle-credit-irc-30-and-irc-30d3.)

[4] Effects of Federal Tax credits for the Purchase of Electric Vehicles, Congressional Budget Office, September 2012.

to enter into force as provided for under current law. Using a macroeconomic model of the U.S., this study estimates the net economic effects on consumers of the tax credit and the investment in EV infrastructure.

The quantitative results from this study depend in part on assumptions about PEVs. A main component of a PEV is the battery that powers the electric drive. The current battery cost in a typical PEV accounts for more than one-third of its cost. Improvement in battery performance and lower battery costs will significantly affect PEVs' costs. However, the forecasted future cost of battery technology varies significantly (EPRI 2018) [5] and is a major source of uncertainly in projecting the future cost of a PEV and assessing its cost competitiveness compared to a gasoline powered vehicle. Consumer preference, government incentives for PEVs, PEV support infrastructure, and battery costs and performance will have implications for how rapidly PEVs will be adopted in the future.

Although there are many vehicle market and non-market uncertainties that influence the adoption of electric vehicles, this study is limited to estimating the effects on PEV penetration from removing the manufacturers' cap, which amounts to extending the PEV tax credit in perpetuity, and assumes consumer preferences and vehicles characteristics remain the same between the baseline and the scenario, thus limiting these assumptions' ability to change the study's conclusions.

Section II provides a short overview of our methodology. Section III describes the alternate policy scenario and is followed by a detailed discussion of the baseline assumptions in Section IV. Section V highlights the impacts on the vehicle markets and macro-economy.

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[5] US-REGEN Model Documentation, The Electric Power Research Institute (EPRI), April 2018.

II. Study Methodology

The methodology used to compute the penetration of PEVs and their effect on the U.S. economy and state-level electricity charges includes five models. To estimate the macroeconomic and electric sector impacts, we used NERA's N$_{ew}$ERA integrated model, which consists of a top-down, general equilibrium Macro model of the U.S. economy (Block 1 in Figure 1), and a detailed bottom-up model of the North American electricity sector (Block 2 in Figure 1). To compute the penetration of PEVs and their effect on the U.S. economy and state-level electricity charges, we integrated a Vehicle Vintage model (Block 3 in Figure 1), National Renewable Energy Laboratory's (NREL's) Electric Vehicle Infrastructure Projection (EVI-Pro) model (Block 4 in Figure 1), and Electricity Rates and Bills model (Block 5 in Figure 1). Figure 1 illustrates how the models are linked and information flows between the different sub-models and the main N$_{ew}$ERA model.

The N$_{ew}$ERA modeling framework takes into account interactions among all parts of the economy and policy consequences as transmitted throughout the economy as it responds to policies. As a result, NERA's N$_{ew}$ERA model captures macroeconomic impacts of opportunity cost of investment and subsidies.[6]

U.S. General Equilibrium Model (N$_{ew}$ERA Macro Model)

The N$_{ew}$ERA Macro model is a forward-looking dynamic computable general equilibrium model of the U.S. economy. It simulates all economic interactions in the U.S. economy, including those among industries, households, and the government. Industries and households maximize profits and utility, respectively, assuming perfect foresight bout all economic conditions. The theoretical construct behind the model is based on the circular flow of goods, services, and payments in the economy (every economic transaction has a buyer and a seller whereby goods and services go from a seller to a buyer and payment goes from the buyer to the seller). The model includes a representative household, which characterizes the economic behavior of an average consumer, and seven industrial sectors, which represent the production sectors of the economy. The households in the model have the option to choose from three different types of light-duty vehicles (ICEVs, BEVs, and PHEVs). The household's vehicle choice depends upon relative vehicle life-cycle cost differences and consumer's preference for different vehicles.[7] In the model, the government collects revenues from taxes imposed on labor and capital and returns them back to the consumers on a lump-sum basis and so as not to change its overall debt.

Households provide labor and capital to businesses, taxes to the government, and savings to financial markets, while also consuming goods and services and receiving government subsidies. Industries produce goods and services, pay taxes to the government, and use labor and capital. Industries are both consumers and producers of capital for investment in the rest of the economy. Within the circular flow,

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[6] A more detailed description of the N$_{ew}$ERA model can be found at: http://www.nera.com/content/dam/nera/publications/archive2/PUB_Smith_NAM_FinalReport_0213.pdf and http://www.nera.com/content/dam/nera/publications/2017/170316-NERA-ACCF-Full-Report.pdfhttp://www.nera.com/content/dam/nera/publications/2017/170316-NERA-ACCF-Full-Report.pdf.

[7] Consumers choose to buy a certain product over another considering the level of satisfaction they receive from the product. Consumers' choices are based on their preferences which is captured by an elasticity of substitution between vehicle types. A high/low elasticity value allows for high/low degree of substitutability between vehicles types when relative price of vehicles changes.

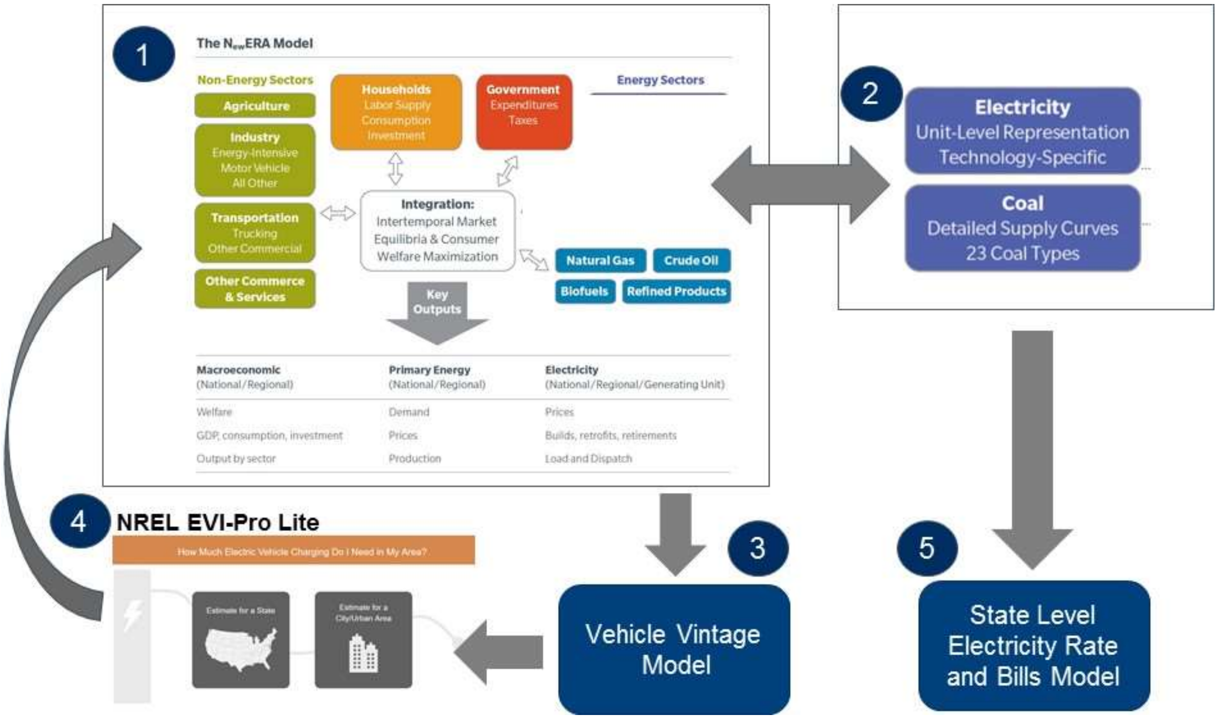
an equilibrium is found whereby demand for goods and services equals their supply, and investments are optimized for the long term. Thus, supply equals demand in all markets for all time periods.

North American Electricity Model (N_{ew}ERA Ele Model)

The bottom-up electricity sector model that is a core component of the N_{ew}ERA integrated model simulates the electricity markets in the U.S. and parts of Canada. The model includes more than 18,000 electric generating units and capacity planning; dispatch decisions are represented simultaneously. The model dispatches electricity to load duration curves. A long-term solution typically includes ten or more years.[8] The model projects investment decisions and unit dispatch decisions by solving a dynamic, non-linear program with an objective function that minimizes the present value of total system costs, while complying with all system constraints, such as meeting demand, reserve margin requirements, emissions limits, transmission limits, and other environmental and electric specific policy mandates.

The integrated nature of the N_{ew}ERA model enables it to provide electricity supply and price responses that are consistent with higher electricity demand from rapid adoption of PEVs.

Figure 1: Modeling Workflow



The bottom-up Vehicle Vintage Model is coupled with the N_{ew}ERA model to estimate new vehicle sales of ICEVs, BEVs, and PHEVs. The vintage model starts with an initial stock of vehicles in the first year. This stock is depreciated assuming a fixed depreciation rate for each vehicle type. In the second year, based on the stock of vehicles and number of first year vintage vehicles, the model computes new vehicle sales in the second year. In the second year, the sale of new vehicles equals the total stock in the second year minus the undepreciated stock of vehicles in the first-year vintage. The model continues forward by estimating each vintage of vehicles and new sales. In summary, the model inputs to the Vehicle Vintage

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[8] The time horizon for this study starts in 2018 and goes out till 2036 in 3-year time steps.

model include annual vehicle stock figures (which are determined endogenously in the N$_{ew}$ERA model), and depreciation rates for BEVs, ICEVs, and PHEVs. Given these inputs, the model outputs new sales for each year over the model horizon by type of vehicle. Using the input data relating to annual vehicle miles traveled per vehicle, the model estimates vehicle miles traveled for each vintage of vehicles.

The PEVs require charging infrastructure. We use the National Renewable Energy Laboratory's Electric Vehicle Infrastructure Projection (NREL EVI-Pro Lite) Tool (Block 4 in Figure 1) to compute the needed amount of infrastructure. The EV infrastructure market which includes EV supply equipment are not determined endogenously nor does it influence PEV adoption decisions.[9] The vintage model transmits its outputs to the NREL EVI-Pro Lite model in the form of the number of new BEV and PHEV sales in each year.

The NREL EVI-Pro tool estimates non-residential charging infrastructure requirements that support consumer adoption of light-duty PEVs (NREL 2017). The model is based on real-world travel data that represents personal vehicle travel patterns, electric vehicle characteristics, and charging station attributes to stimulate demand for PV charging at homes, workplaces, and public places at all 50 states. We use this tool to estimate charging infrastructure requirements and totals costs for each individual state. The expenditures on new charging infrastructure are totaled for the U.S. and passed along to the macro model so that it can correctly account for these costs associated with PEV sales.

We iterate through these four models until convergence is achieved (i.e., where demand and supply are in balance in all markets of the economy). After convergence, the electric sector model feeds the equilibrium solution for the electric sector to the state level Electricity Rates and Bills model to compute state level impacts on electricity rates and bills.

To compute the change in residential electricity rates for each state, we take into account the electricity pricing structure within each state (i.e., share of the market that is competitive and share that is cost of service) and infrastructure cost for PEVs. Both competitive and cost of service rates account for costs associated with O&M, fuel, capacity, compliance with environmental regulations, and transmission and distribution. These costs come from the N$_{ew}$ERA electricity model. To convert infrastructure costs into an effect on the electricity bills, we assume utilities need a 10.25% rate of return on their investment and the investment will last 15 years and require some O&M. We divide the cost of the infrastructure among residential, industrial, and commercial customers.[10]

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[9] We note that the model builds just enough EV infrastructure to support the adoption of PEVs.

[10] Based on EIA 2016 electric utility sales to ultimate customer data.

III. Scenario Design

The goal of this study is to estimate the impacts on PEV sales, PEV infrastructure, and the macro-economy of eliminating the cap on the number of PEVs an auto manufacturer can sell that qualify for the federal tax credit. Future PEV sales will depend in part on how their price compares to that of ICEVs. One of the key drivers of this price differential is the government's policy surrounding PEVs.

Therefore, this study considers a baseline that represents current law and a scenario ("No Cap Limit") that eliminates the manufacturers' cap on PEVs that qualify for tax credit and extending the tax credit in perpetuity. The current federal policy toward PEVs states that purchasers of PEVs can receive a tax credit ranging from $2,500 to $7,500 if the manufacturer's cumulative PEV sales are less than 200,000. The tax credit will phase out for a manufacturer's vehicles over the one-year period beginning with the second calendar quarter after the calendar quarter in which at least 200,000 qualifying vehicles manufactured by that manufacturer have been sold for use in the United States.

In our baseline, we assume that all major auto manufactures will have sold at least 200,000 PEVs by 2025. Under this assumption, no new PEV sales will qualify for the full tax credit after 2025. As previously stated, this view is consistent with industry estimates.

For the No Cap Limit scenario, the tax credit is assumed to permanently remain at $7,500 in 2019 nominal dollars for BEVs. For PHEVs, the tax credit is assumed to permanently remain at $5,300 in 2019 nominal dollars. In real terms, the tax credit for BEV declines from $7,310 in 2020 to $5,209 by 2035. Similarly, the PHEV tax credit in real dollars declines from $5,140 in 2020 to $3,660 by 2035 (see Table 1). Based on the vehicle purchase price, the tax credit for BEV in 2020 is equivalent to 18% of the purchase price and 17% in 2035. For the PHEV, since the tax credit is relatively smaller and the purchase price is relatively higher than BEV, the tax credit as a percent of purchase price of PHEV is about 14% in 2020 and 10% in 2035.[11] To simulate the "No Cap Limit" scenario the model represents the tax credit as an equivalent ad valorem tax credit on the vehicle purchase price.

Table 1: Tax Credit for BEVs and PHEVs in the Scenario (2019$)

	2020	2025	2030	2035
ICEV Purchase Price	$36,415	$36,781	$37,150	$37,523
BEV Purchase Price	$41,196	$36,200	$33,673	$31,455
PHEV Purchase Price	$37,911	$36,893	$36,400	$35,995
Price Ratio (BEV Relative to ICEV)	1.13	0.98	0.91	0.84
Price Ratio (PHEV Relative to ICEV)	1.04	1.00	0.98	0.96
Average Tax Credit Per BEV	$7,309	$6,481	$5,814	$5,209
Average Tax Credit Per PHEV	$5,141	$4,559	$4,090	$3,664
Average Tax Credit Rate for BEV (%)	18%	18%	17%	17%
Average Tax Credit Rate for PHEV (%)	14%	12%	11%	10%

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[11] The vehicle purchase price forecasts are based on baseline vehicle characteristics discussed in the following section (Section IV).

All other assumptions (e.g., fuel price, economic growth forecasts, vehicle properties and costs, consumer preferences, and range anxiety) remain the same between the baseline and the scenario.

IV. Baseline Assumptions

The model's baseline is based on the U.S. Energy Information Administration's (EIA) Annual Energy Outlook 2018 (AEO 2018) Reference Case except for the vehicle characteristics and vehicle market outlook. The model's baseline projections for the vehicle market were taken from third-party sources, compiled by and provided to NERA by FHR.

The model includes three types of representative light duty vehicles: (i) conventional internal combustion engine vehicles (ICEVs) and hybrid vehicles (HEV) that only use liquid fuel; (ii) dedicated battery electric vehicles (BEVs); and plug-in hybrid electric vehicles (PHEVs). ICEVs are the dominant technology and powered by an internal combustion engine using petroleum fuels (gasoline blended with a mix of biofuel-based fuels). BEVs are propelled by an electric motor that is powered by an internal battery. The capacity of the battery determines the range of the vehicle, and currently vehicle ranges vary from 100 to 300 miles with a single full charge. A Nissan Leaf or Tesla Model 3 is an example of a typical BEV. The vehicle battery comes in different capacities and is charged by plugging it into an electric outlet. PHEVs on the other hand use a combination of an electric motor and an internal combustion engine to propel the vehicle. Examples of a typical PHEV are a Chevrolet Volt or Toyota Prius Plug-in Hybrid. Traditional and mild (or micro) hybrids are 100% liquid fueled and counted as ICEVs for this study. How consumers decide among these vehicles depends primarily upon cost and performance characteristics of the vehicles. Below we discuss some of the key vehicle market assumptions and baseline projections.

Vehicle Purchase Prices:

Initial cost of ownership for BEVs and PHEVs is presently more expensive than an ICEV. The current purchase price difference between a typical BEV and PHEV relative to an ICEV is about $7,700 and $2,200, respectively. These purchase price differentials are expected to narrow because of an assumed improvement in battery technology and increased cost of complying with tightening vehicle fuel economy standards. The battery pack costs in the baseline are assumed to decline by almost 60% by 2035 from current costs based on FHR projections. Battery pack costs per kWh are expected to decline from a current cost of $190 to $156 in 2020 to $75 by 2035. According to Bloomberg New Energy Finance's (BNEF) New Energy Outlook 2018, battery pack costs could decline even more rapidly to $96/kWh and $70/kWh by 2025 and 2030, respectively.[12] Based on how the technology will evolve, there are many uncertainties in the rate at which PEV battery pack costs will decline.

The current purchase price of BEV is 20% higher than an ICEV; while the purchase price of PHEV is about 10% higher than an ICEV. Figure 2 below shows the 2018 purchase price of a typical ICEV, BEV and PHEV. However, over time BEVs and PHEVs purchase prices decline; while the ICEV purchase price is expected to stay relatively constant. BEVs are expected to reach initial cost of ownership parity with ICEVs around 2024, and PHEVs are expected to follow a couple years later, see Table 1.

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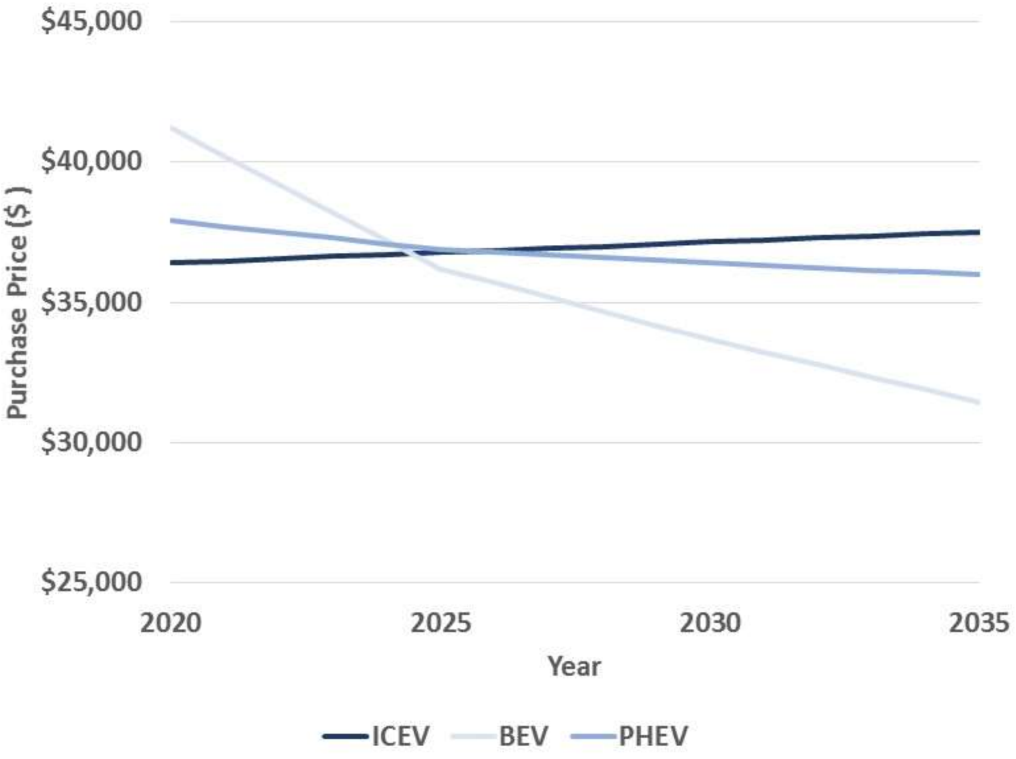
[12] https://bnef.turtl.co/story/neo2018 https://bnef.turtl.co/story/neo2018.

Figure 2: Purchase Price of ICEVs, BEVs, and PHEVs in the Baseline (2019$)



Vehicle Performance

We assume the electric drive in BEVs and PHEVs is powered by similar battery technology, which results in similar performance based on AEO 2018 projection. In the baseline, both BEVs and PHEVs achieve about 2.6 miles per kWh (0.38 kWh per miles) in 2018 and declines to 0.3 kWh per miles by 2035 (EIA AEO 2018). We have assumed that the PHEV fleet will be primarily driven in electric mode: 80 percent in electric mode and 20 percent on gasoline. It is again worth noting that because we have held these assumptions constant across the baseline and scenario, we have inherently limited the potential distortion in our conclusions.

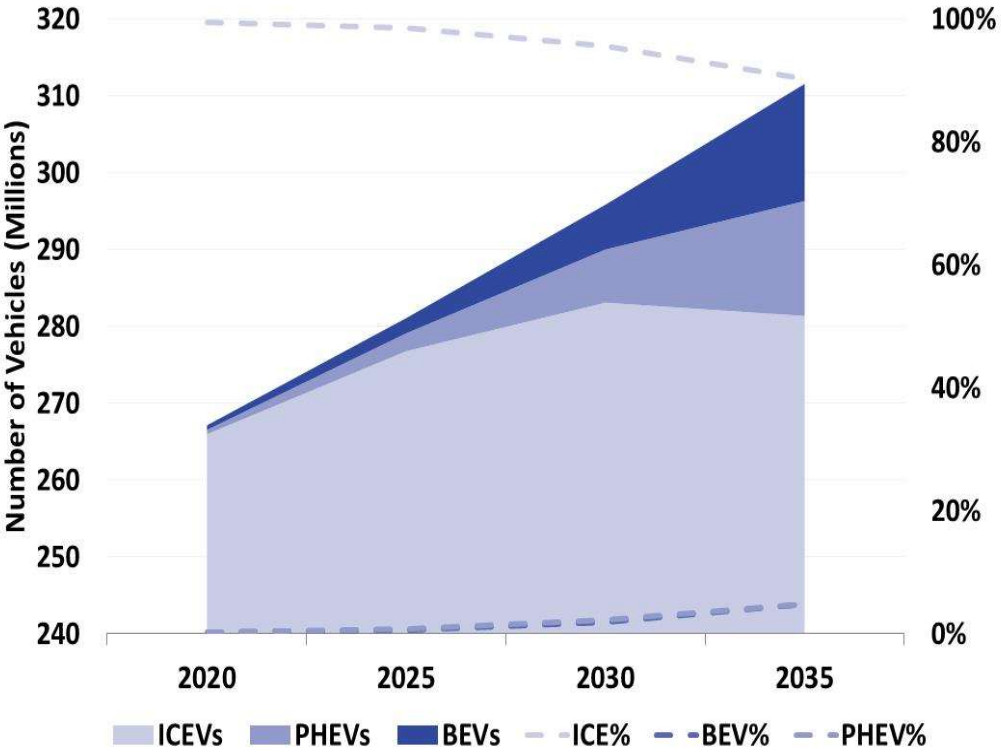
Total Number of Vehicles

In our baseline, the total number of light-duty vehicles rises from 267 million in 2020 to 311 million by 2035. As shown in Figure 3, the baseline vehicle market is dominated by ICEVs, with almost a 100% share of the market in 2020 and dropping to about 90% of the vehicle market by 2035. Although the share of PEVs increases to about 10% (equal share of 5% for BEVs and PHEVs) by 2035, the PEVs are still a small percentage of the stock of vehicles. The total number of PEVs in 2035 is about 35 million in a total vehicle market of 311 million. Even though the purchase price of a PEV is lower than that of an ICEV in the baseline, barriers (limited driving range, long recharging times, and lack of recharging infrastructure) still exist that prevent consumers from rapidly adopting PEVs.

Despite the barriers to adoption assumed in the baseline, the lower purchase price of PEVs relative to ICEVs provides incentive for more new vehicle sales resulting in a higher share of new PEV sales. In 2020, the total number of new vehicle sales for BEVs and PHEVs is about 0.12 million; however, by

2035, new vehicles sales of BEVs increase to 2.45 million while sales of new PHEV increase to 1.75 million. The larger drop in the BEV purchase price leads to higher adoption of new BEVs compared to PHEVs. In terms of market share by 2035, new sales of BEVs and PHEVs account for 13% and 9%, respectively, see Figure 4.

Figure 3: Total Number of Vehicles (Millions) and Shares of Vehicles (%)[13]



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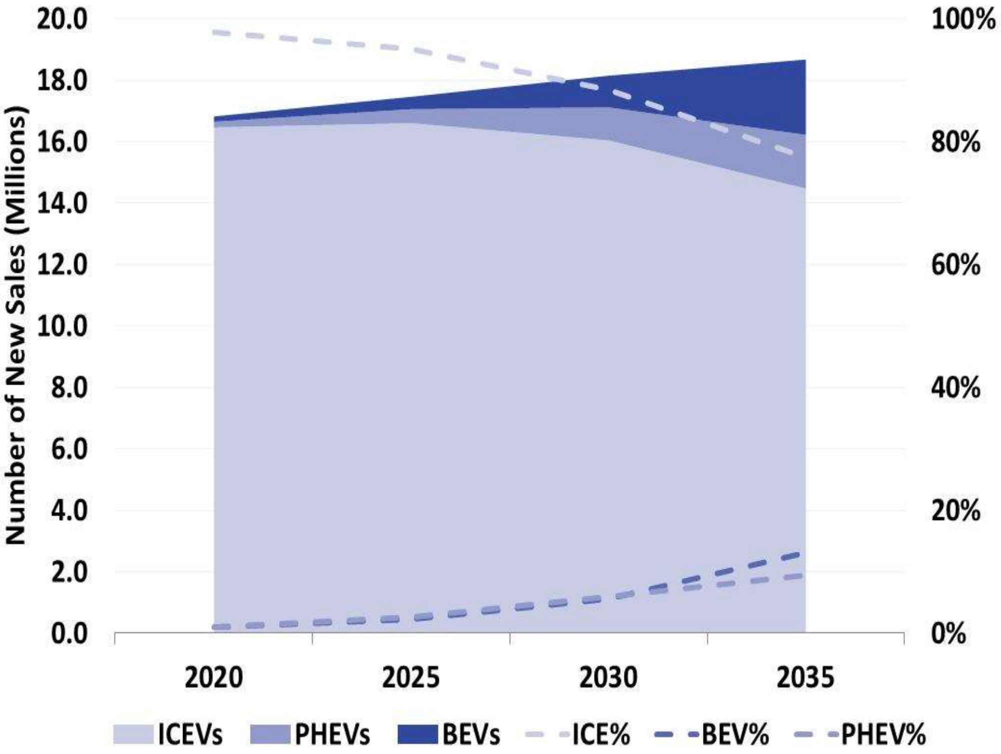
[13] Vehicle share for BEV and PHEV are almost the same, hence it is not distinguishable in the figure.

Figure 4: New Vehicles (Millions) and Share of New Vehicles (%)



Total EV Charging Infrastructure and Costs

As EV adoption continues to increase, additional PEV supply equipment (EVSE) will be needed. The charging infrastructure includes electrical equipment from the electricity power source to the battery pack on the car. There are three types of supply equipment or charging systems: AC Level 1 (L1), AC Level 2 (L2), and DC Fast Charging (DCFC). These charging systems have different battery charging times, which depend on the state of charge of the battery, the power coming from the EVSE, and the rate at which a vehicle can accept power (DOE 2015[14], DOE 2017[15]). The AC Level 1 takes the longest time to fully charge a battery, and DCFC takes the shortest time. Per hour of charging time, an AC Level 1 only provides power to propel a PEV 4 to 6 miles; while charging with an AC Level 2 can propel a typical PEV for about 10 to 60 miles.[16] Level 1 chargers are usually installed at residential or multi-dwelling units and used to supply power at 120V. Level 2 chargers can be installed at residential homes with added voltage adjustment equipment or in public and work places since they use higher voltage of 240V. DCFCs are generally installed in public places and use a much higher power supply source.

In the model, we assume increases in five different types of EVSE: home charger Level 1 (HCL1), home charger Level 2 (HCL2), workplace Level 2 charger (WPL2), public place Level 2 charger (PPL2), and DCFC. We use National Renewable Energy Laboratory's (NREL's) Electric Vehicle Infrastructure

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[14] Costs Associated with Non-Residential Electric Vehicle Supply Equipment, U.S. Department of Energy, November 2015.

[15] National Plug-In Electric Vehicle Infrastructure Analysis, U.S. Department of Energy, September 2017.

[16] The capacity of the battery determines how much miles a PEV can last for a given charging time.

Projection (EVI-Pro) tool to estimate the number of WPL2, PPL2, and DCFC charging plugs installed per PEV sale. The EVI-Pro Lite model is based on real-world travel data that represents personal vehicle travel patterns, electric vehicle characteristics, and charging station attributes to stimulate demand for PEV charging at homes, workplaces, and public places for all 50 states. NREL's EVI-Pro Lite model estimates on average about 2,600 WPL2 and 1,800 PPL2 per 100,000 PHEVs; and 37 WPL2, 87 PPL2, and 173 DCFC per 100,000 BEVs. In addition, we assume 55,000 and 37,000 L1 and L2 home chargers per 100,000 PEVs.[17]

The charger costs per plug (output receptacle) are based on NREL estimates. We assume about $2,200, $5,700, $4,700, and $112,000 per HCL2, WPL2, PPL2, and DCFC, respectively. We do not assume any charger costs for L1 home chargers. Charger costs include charging equipment and installation costs, which include cabling, trenching, transformers, and other grid support costs.[18]

EV Tax Credit Policy

See section III of the report where the tax credit is discussed.

Funding of EV Infrastructure and PEV Tax Credit

We assume that the Federal Government funds PEV tax credits by allowing individuals who purchase a PEV to receive a tax credit on their individual personal income tax. The tax credit has implications for reducing the government's overall tax revenue base to fund government spending. Since we assume that the government must maintain its expenditures on its programs, the shortfall in government tax revenues caused by the requirement to fund the PEV tax credit program is effectively funded by taxing households in the model.

We have assumed that EV infrastructure development costs initiated by utilities would be recovered through an increase in the electricity rates or through a fixed charge. Our modeling is consistent with experience in states that currently and are likely to have high EV adoption rates. They have allowed for recovery of EV investment costs plus a rate of return through higher rates.[19] There are examples where

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[17] Accelerating Investment in Electric Vehicle Charging. Infrastructure Estimated Needs in Selected Utility Service Territories in Seven States, MJB & A Report, March 2018.

[18] DCFC can create a spike in the load demand. DCFCs could face very high demand charges from utilities if used during peak hours. The analysis does not include such DCFC specific demand charges in the cost of the chargers., which could significantly increase charging costs.

[19] In May 2018, the CA PUC approved the state's three largest utilities (PG&E, SDG&E, SoCal Edison) to recover about $740 million in EV infrastructure capex plus a rate of return: https://www.greentechmedia.com/articles/read/california-cpuc-approves-landmark-ev-charging-proposals#gs.aWRRQl4

In June 2018, SoCal Edison filed for CA PUC approval to recover ~$760mm in EV infrastructure capex plus a rate of return: https://www.greentechmedia.com/articles/read/socal-edison-seeks-760m-to-build-48000-new-ev-charging-stations#gs.=VSX3zE

In 2015, the state of WA enacted legislation allowing utilities to recover costs plus a rate of return on EV infrastructure capex: http://lawfilesext.leg.wa.gov/biennium/2015-16/Pdf/Bill%20Reports/House/1853-S%20HBR%20FBR%2015.pdf

In November 2017, the MA Dept. of Public Utilities allowed Eversource, a utility, to recover costs plus a rate of return on $45 million of EV infrastructure capex: https://www.eversource.com/content/docs/default-source/investors/d-p-u-17-05-final-order-(revenue-requirement)-11-30-17.pdf?sfvrsn=5e61c562_1) regulators have been undecided regarding the methods for recovery of EV infrastructure investment costs, and it appears that the decisions may differ among regulatory jurisdictions.[20] It is likely that some may allow recovery through increases in electricity rates. However, there are also cases where only a fixed charge has been allowed. Our analysis assumes that infrastructure costs are recovered through a fixed charge. Regardless of if the recovery is through rate increases or fixed charges, the costs plus rate of return is assumed to be recovered from the customers.[21]

In June 2018, PSEG, NJ's largest utility, proposed including $300 million for EV charging infrastructure as part of its ~$5 billion expansion to its five-year infrastructure plan: https://investor.pseg.com/press-release/featured/pseg-announces-major-infrastructure-investment-program

[20] In 2016, state regulators in Missouri and Kansas turned down KCP&L's request to pass along the costs of their charging network. However, the utility is back before the Missouri Public Service Commission asking for approval as part of a general rate case to recoup costs and earn a return on Missouri's part of its charging network. (E&E News 2018).

[21] This assumption is probably simpler than the patchwork that will actually emerge, but we have determined via sensitivity analyses that our model results would be very similar regardless of the rate structure by which utilities are assumed to recover the EV infrastructure costs.

V. Results

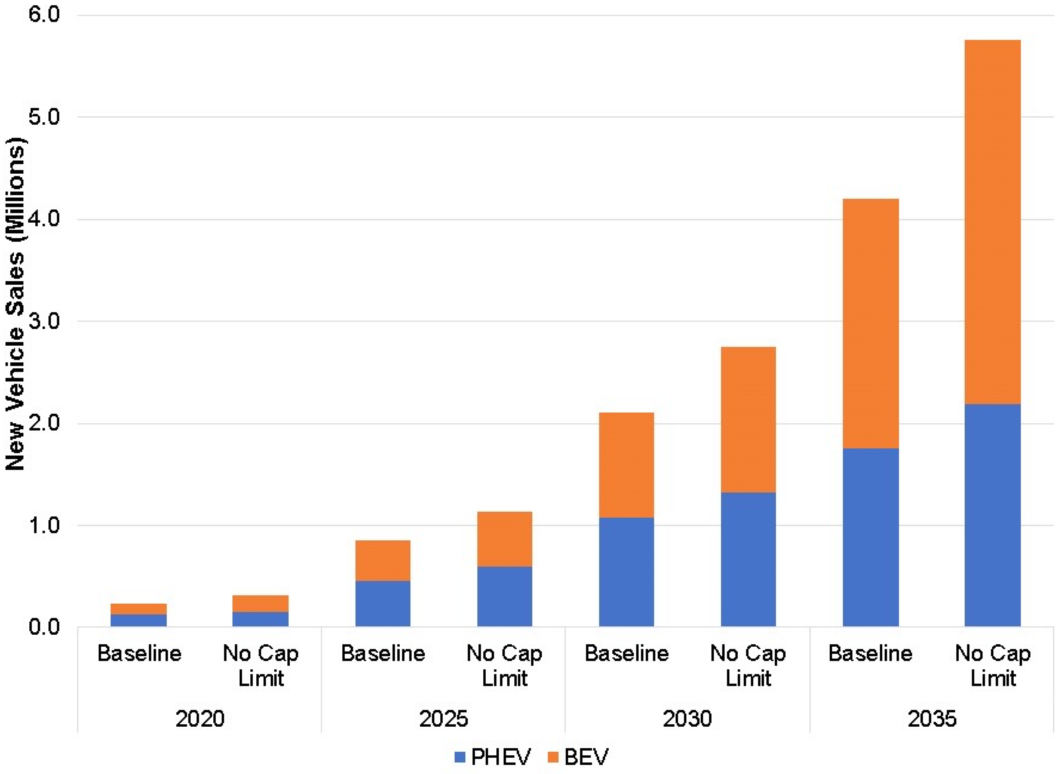
A. Vehicle Market Impacts

1. New Vehicle Sales

Within the PEVs, BEV sales increase more than PHEVs because the tax credit reduces the price of BEVs more than PHEVs. The tax credit on a BEV is $7500 (in nominal dollars), whereas it is about $5,300 (in nominal dollars) on average for PHEVs. These credits remain the same in nominal dollars over the model horizon. Therefore, the persistence of vehicle tax credits benefits BEVs more than PHEVs, thus leading to a greater increase in sales of BEVs than PHEVs (Figure 5).

The increase in PHEV and BEV sales accelerates over time. The increase in BEV sales accelerates more rapidly than PHEVs because their costs decline faster than those of PHEVs. Furthermore, after 2025, the purchase price of BEVs are cost competitive with ICEVs in the absence of any tax credit. The ratio of the increase in sales of BEVs relative to PHEVs grows over time as the cost of BEVs continues to fall relative to the cost of PHEVs because the tax credit has a greater impact on BEVs than PHEVs and the pre-credit price of BEVs falls faster than PHEVs. Sales of new ICEVs in the scenario decline relative to the baseline by 0.2 million in 2020 and 1.3 million in 2035. Sales of BEVs roughly increase by 2.5 times every five years in the presence of tax credit in perpetuity.

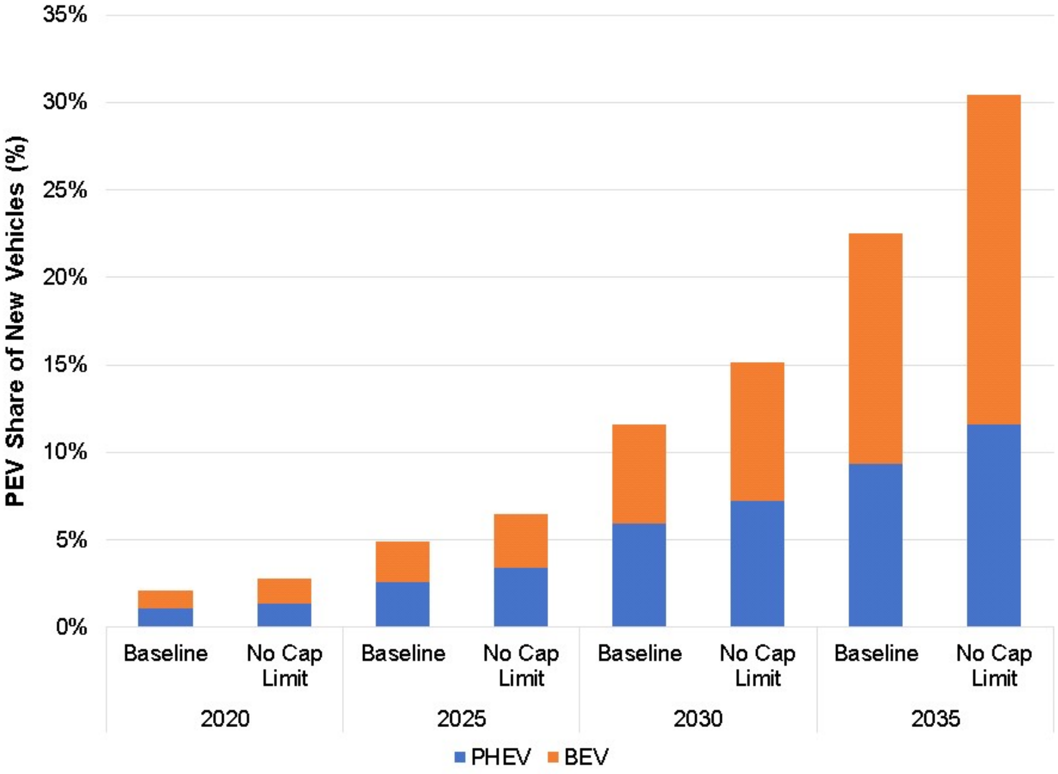
Figure 5: New Vehicle Sales of PHEVs and BEVs (millions)



PEV sales as a share of total light duty vehicle (LDV) sales increase rapidly over time (Figure 6). There is a decrease in new ICEVs share of sale. In the baseline and scenario, PEV's share of new sales is about

2.5% in 2020. By 2035, PEV sales make up more than 30% of new vehicle sales when the tax credit permanently stays in place.

Figure 6: PEV Share of New Vehicle Sales (%)



2. Vehicle Stock

In 2017, approximately 242 million LDVs were in use on the road and more than 99% were ICEVs.[22] Total new vehicles comprise less than 7% of the stock of vehicles. Furthermore, even though there is a large increase in PEV sales, ICEV sales remain dominant throughout the period of study. As a result, ICEVs continue to dominate the light-duty vehicle stock through 2035 in large part because of the slow turnover of the vehicle stock and the continued dominance of ICEVs in new vehicle sales. Through 2030, the change in PEVs' share of the vehicle stock is less than a couple of percentage points. The share increases over time as sales of PEVs increases significantly. PEVs increase their 2035 market share from about 10% in the baseline to about 13% in the scenario (Figure 7).

In 2035, these changes in shares corresponded to an increase of about 10 million PEVs in the No Cap Limit scenario. The total LDV stock in 2035 is 311 million. The increase in new PEV sales in the No Cap Limit scenario is split between BEVs and PHEVs in about a 2 to 1 ratio.

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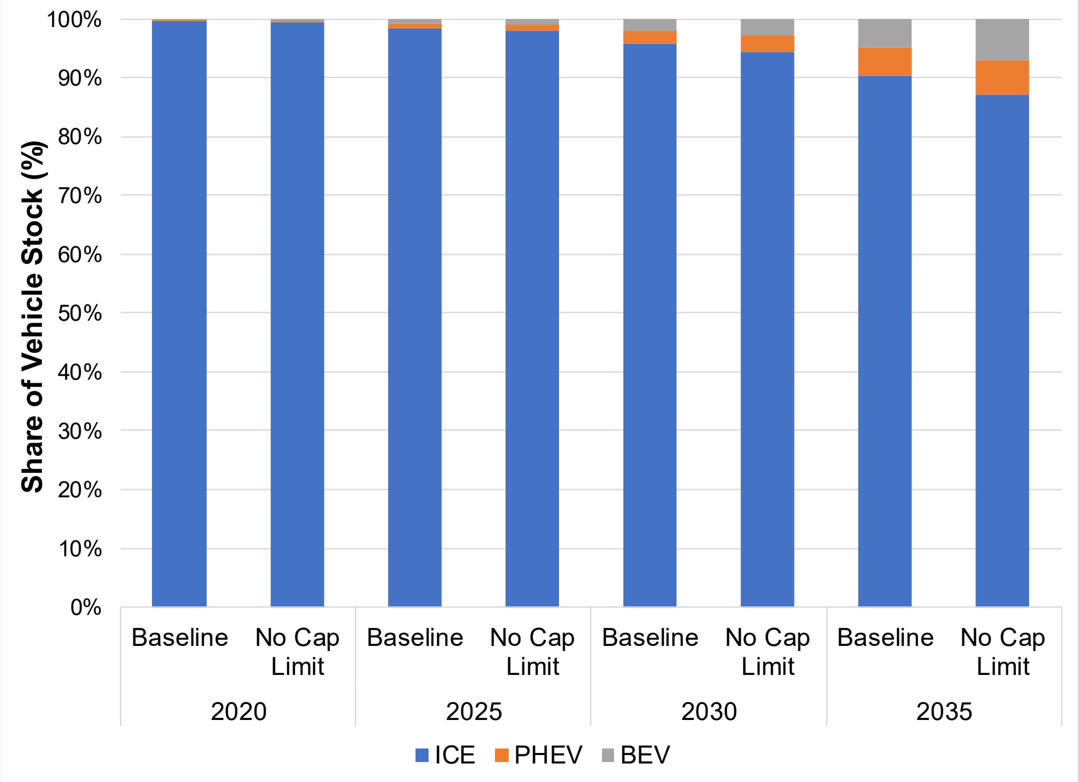
[22] US EIA AEO 2018. The average vehicle age of the current vehicle stock is about 12 years and 75% of the vehicle age ranges from 3 to 19 years (https://www.statista.com/statistics/738667/us-vehicles-projected-age/.). Over time vehicle durability has improved and as a result most new vehicles remain in use for more than ten years. As a result, the average age of vehicles on the road has increased over time. In 2005, the average age of a LDV was 9.8 years, in 2010 it was 10.6 years and it was 11.5 years in 2015 (https://nhts.ornl.gov/vehicles).

Figure 7: Share of Vehicle Stock by Type (%)

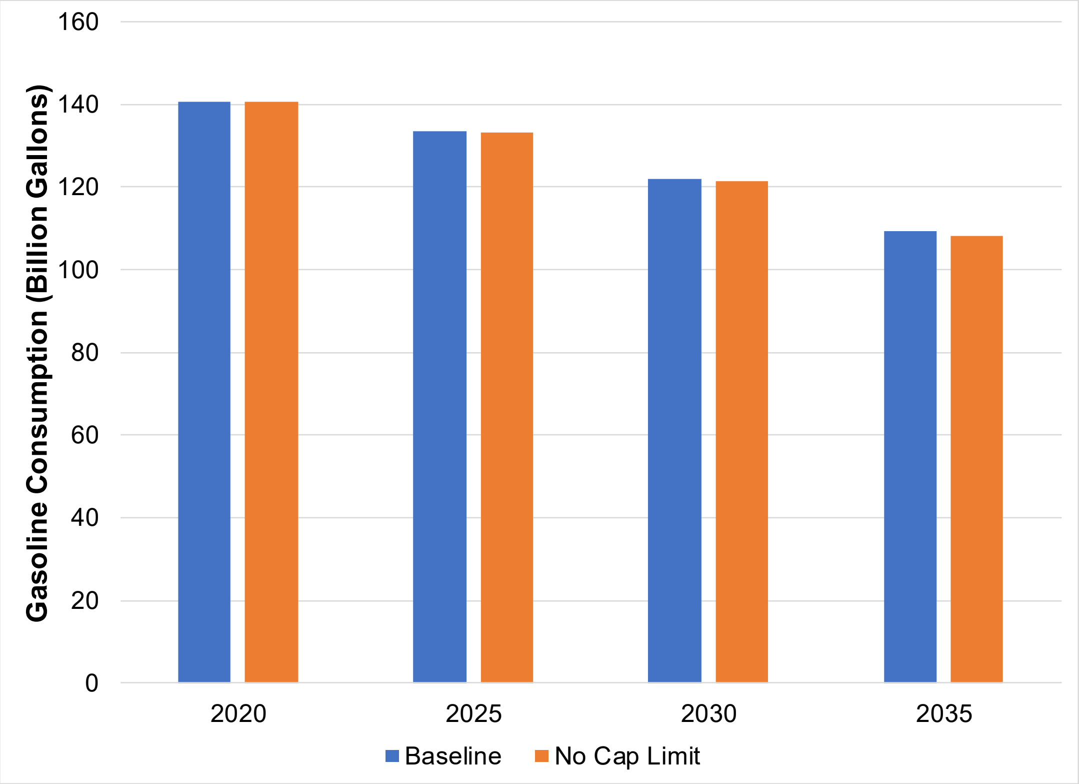


3. Gasoline Consumption

Because the share of ICEVs in the vehicle stock changes by only a few percentage points between the baseline and the scenario, the percentage reduction in gasoline consumption is small. By 2035, the reduction in gasoline consumption from the baseline to the No Cap Limit scenario is 0.8%. This percentage decline corresponds to a reduction of about one billion gallons of gasoline demand per year in 2035 (Figure 8).

The decline in gasoline consumption over time depends much more on increases in the fuel economy of ICEVs than the difference in market penetration of PEVs. As the fuel economy of new ICEVs improves, baseline gasoline consumption declines by about 36 billion gallons between 2020 and 2035, even while the number of ICEVs increases by about 6% during this same time. In moving from the Baseline to the No Cap Limit scenario in 2035, the PEV vehicle stock increases by 10.2 million vehicles (37% increase relative to the baseline), which results in a reduction of only 1.2 billion gallons (78 thousand barrels a day) demand. Therefore, the increase in fuel economy is responsible for about 30 times more of the gasoline reduction from 2020 levels than the increase in PEVs caused by the continuation of the tax credit.

Figure 8: Gasoline Consumption (Billion Gallons)



B. Electricity Market Impacts

In 2035, the increase in PEV sales resulting from the elimination of the cap on the tax credits leads to a 0.7% increase in electricity demand (No Cap Limit scenario). This increase in electricity demand is met by a combination of increased utilization of existing electric generation units and building of new electric generation units. Table 2 shows the increase of new electricity generating capacity additions from 2020 to 2035 in both GW (8.1 GW) and percentage (3%) change relative to the baseline.

Table 2: Incremental increase in new electric generation builds by technology relative to the baseline from 2020 to 2035 (GW and %)

	Gas-CC	Gas-CT	Wind	Biomass	Storage	Solar PV	Total
GW	3.2	3.4	0.3	0.3	0.0	0.9	8.1
%	2%	5%	1%	5%	0%	2%	3%

Before 2030, the annual increase in electricity demand due to the increased number of PEVs resulting from the tax credit is less than 0.3%. In 2035, the electricity demand increases by 0.7% because the PEV stock is building with time from the ever-increasing rate of sales of PEVs (see Table 3). Over time, the share of the increase in electricity generation to meet demand shifts more to new generation sources. Most of this increase in electricity generation comes from gas-fired combined cycle units consistent with the type of new capacity that is built.

Table 3: Electricity Generation and Change in Generation and Utilization

		Baseline	No Cap Limit Change from Baseline	
Type of Generation	**Year**	**Generation (TWh)**	**(TWh)**	**(%)**
Existing	2025	3,330	1.6	0.05%
New	2025	860	3.2	0.40%
Total	2025	4,190	4.8	0.10%
Existing	2030	3,280	4.1	0.10%
New	2030	1,060	10	0.90%
Total	2030	4,340	14	0.30%
Existing	2035	3,140	4.8	0.20%
New	2035	1,360	25	1.90%
Total	2035	4,500	30	0.70%

Table 4 reports the implied electric generation capacity required for charging PEVs. This generation capacity equals the product of the average utilization rate for generation facilities and the electricity demanded by PEVs.

Table 4: Implied Electric Generation Capacity Required for Charging PEVs (GW)

	Baseline	No Cap Limit	Change GW	Change %
2025	4.4	5.8	1.4	32%
2030	12.5	16.8	4.3	34%
2035	25.3	34.8	9.5	38%

C. Macroeconomic Impacts

1. Charging Infrastructure Impacts

PEV charging infrastructure is primarily installed as home chargers since these can be easily installed with relatively small upfront cost (home charger with L2 power level) or with no cost (home charger with L1 power level). To support the baseline level of PEV penetration, the total number of chargers that are installed in 2020 is about 230 thousand. In the baseline, the annual number of chargers required increases significantly to about 4 million in 2035. By 2035, the cumulative number of chargers is about 32.7 million of which about 31 million are installed at home, 820 thousand L2 chargers at workplaces, 560 thousand L2 chargers in public places, and about 22 thousand DC Fast Chargers[23] in public places.

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[23] The number of DCFC are much smaller than other types of chargers because of its high installation and operational costs even though the dwell time for charging with DC Fast Chargers is relatively fast (30 minutes compared to about 2 hours for L2 chargers).

In the No Cap Limit scenario, the size of the PEV charging infrastructure increases by about 33% on average relative to the Baseline between 2020 and 2035. In the scenario, the cumulative number of chargers increases to about 44 million from the baseline number of 33 million chargers. The increase in the number of chargers is singularly driven by the increase in the number of PEVs in the scenario (see Table 5).

Table 5: Annual Number of Total EV Charging Plugs (in thousands)

		2020	2025	2030	2035	Cumulative
Baseline	Home Chargers (L1)	128.3	462.3	1,135.4	2,262.6	18,303
	Home Chargers (L2)	91.4	329.4	809.0	1,612.2	13,042
	Workplace (L2)	6.3	23.6	55.7	90.9	822
	Publicplace (L2)	4.3	16.1	38.2	62.7	565
	DC Fast Charger	0.1	0.5	1.3	3.0	22
	Total Chargers	230.5	832.0	2,039.7	4,031.4	32,754
No Cap Limit	Home Chargers (L1)	169.5	613.3	1,482.8	3,097.7	24,539
	Home Chargers (L2)	120.8	437.0	1,056.5	2,207.3	17,485
	Workplace (L2)	8.1	30.7	68.3	113.7	1,020
	Publicplace (L2)	5.6	21.0	46.9	78.6	702
	DC Fast Charger	0.2	0.7	1.8	4.4	32
	Total Chargers	304.2	1,102.7	2,656.2	5,501.7	43,778

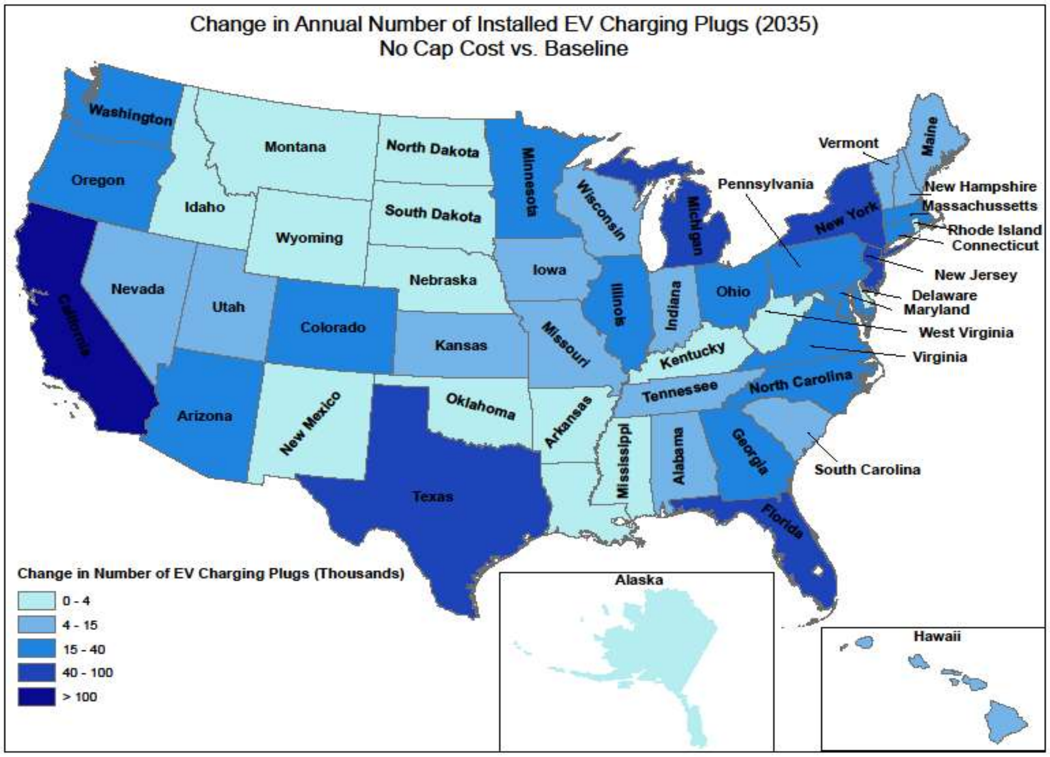
The total requirement for different types of chargers depends upon the increase in the different types of PEVs. Greater numbers of BEVs lead to more DC fast chargers while higher levels of PHEVs lead to more L2 chargers. Over time, the tax credit favors the economics of BEVs; hence over time, the penetration of BEVs is much higher than that of PHEVs. Therefore, the percentage increase in installed DC fast chargers is also much higher than other L2 chargers relative to the Baseline. By 2035, in the scenario, the number of DC fast chargers increases by 45% compared to workplace L2 chargers, whose requirement increases by 25% (see Table 6).

Table 6: Percentage Change in Total PEV Charging Plugs (%)

		2020	2025	2030	2035	Cumulative
No Cap Limit	Home Chargers (L1)	32%	33%	31%	37%	34%
	Home Chargers (L2)	32%	33%	31%	37%	34%
	Workplace (L2)	28%	30%	23%	25%	24%
	Publicplace (L2)	28%	30%	23%	25%	24%
	DC Fast Charger	36%	36%	39%	45%	43%
	Total Chargers	32%	33%	30%	36%	34%

Incremental PEV charging infrastructure requirements for all 50 States in 2035 are shown in Figure 9. Twelve states (California, New York, Florida Michigan, New Jersey, Texas, Washington, Massachusetts, Pennsylvania, Maryland, Illinois, and Oregon) account for about 80% of the nation's charging infrastructure requirements. California leads the nation in PEV sales as well as the number of installed chargers. California alone accounts for about 48% of incremental charging infrastructure in the No Cap Limit scenario. Eight out of the twelve states (California, New York, New Jersey, Massachusetts, Maryland, Oregon, Washington, and Pennsylvania) have adopted either zero emission vehicle (ZEV) or low emission vehicle (LEV) standards. State level infrastructure requirements by types of chargers are provide in Appendix I, Table 10.

Figure 9: Change in Annual Number of Installed PEV Charging Plugs by State and Type in the No Cap Limit Scenario (in Thousands)



Total EV infrastructure costs include the cost of PEV supply equipment as well as installation costs. Table 7 shows the total annual EV infrastructure costs to support the PEVs in the Baseline and scenario. The infrastructure investment costs in 2035 for the Baseline and No Cap Limit scenario amounts to about \$4.8 and \$6.5 billion, respectively.[24] The tax credit program in perpetuity would increase the infrastructure spending by about \$90 million in 2020 to \$1,700 million by 2035, relative to the Baseline.

Table 7: Total EV Infrastructure Cost (2017\$ Millions)

		2020	2025	2030	2035
Infrastructure Costs (\$Million)	Baseline	278	1,008	2,462	4,781
	No Cap Limit	366	1,333	3,187	6,478
Change in Infrastructure Costs (\$Million)	No Cap Limit	88	325	725	1,697
Percentage Change in Infrastructure Costs (%)	No Cap Limit	32%	32%	30%	36%

The EV infrastructure spending at the state level is correlated with the PEV adoption and charger needs. Since California and the other 11 states, discussed above, require the largest number of chargers, these states would also invest the largest amount in their state's EV infrastructure. Figure 10 below shows the state level EV infrastructure investment spending in 2035. Appendix I, Table 12, provides details on state level EV infrastructure spending.

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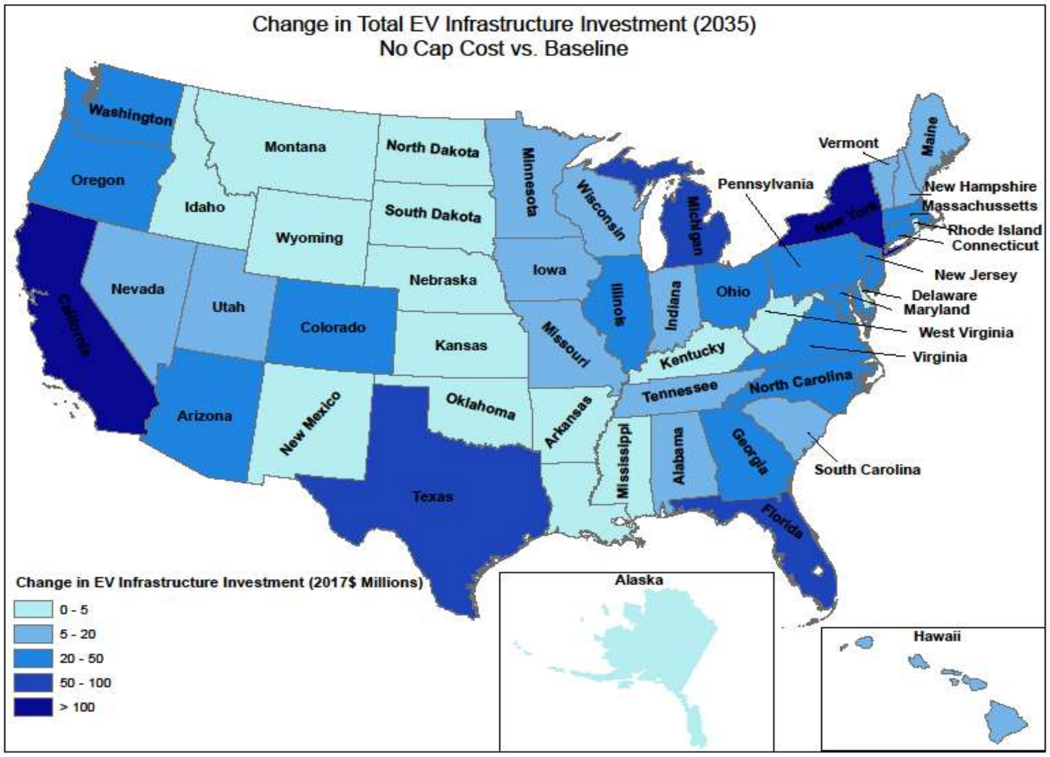
[24] All dollar values are expressed in 2017 dollars unless indicated otherwise.

Figure 10: Total EV Infrastructure Investment by State (2017$ Millions)



3. Infrastructure Costs and Tax Credit Value per New PEV Sales ($ per PEV)

The total tax credit value for the level of adoption of PEVs in the No Cap Limit scenario increases from $5.9 billion in 2025 to about $25 billion in 2035. Since we assume that no PEVs qualify for the tax credit in the baseline from 2025, there is no tax credit beyond 2025. The infrastructure costs along with the tax credit value provide a direct costs metric which burdens the economy. Based on the number of new PEVs, the change in direct cost per new PEV is around $5,200 in 2025 and $4,400 in 2035 (Table 8).

The cost per new PEVs, shown in Table 8, only accounts for the direct cost and does not account for feedback effects within the economy. The total burden on the economy considering the interactions between all sectors of the economy is discussed in the following sections.

Table 8: Infrastructure Costs and Tax Credit Value per New PEV Sales

		Baseline			No Cap Limit			Change		
		2025	2030	2035	2025	2030	2035	2025	2030	2035
New PEVs	Millions	0.86	2.11	4.20	1.14	2.75	5.75	0.28	0.65	1.55
Infrastructure cost	$ Million	$1,008	$2,462	$4,781	$1,333	$3,187	$6,478	$325	$725	$1,697
Tax Credit Value	$ Million				$5,971	$13,137	$25,428	$5,971	$13,137	$25,428
Total Direct Costs	$ Million	$1,008	$2,462	$4,781	$7,304	$16,324	$31,906	$6,296	$13,862	$27,125
Cost per New PEV		$1,174	$1,167	$1,137	$6,411	$5,927	$5,545	$5,237	$4,759	$4,407

4. Household Income

Rapid adoption of PEVs impacts the economy and consumers in several different ways. Some of these effects have positive impacts while others have negative impacts on the overall income level of consumers. In net, considering all the effects, households are worse off in the No Cap Limit scenario than they would be in the baseline scenario where the tax credit effectively expires when the limits are reached.

Higher PEV adoption leads to more demand for electricity and to upward pressure on electricity prices and bills. Consumers also face negative effects for having to fund the Federal Government's tax credit program indirectly. Although there is no clear indication of how EV infrastructure will be funded, we assume that utilities will invest in EV infrastructure and regulators will allow utilities to recover their costs plus a rate of return through a fixed charge on customer's bills. Hence, consumers have less net income to spend on goods and services.

Total personal income of all U.S. households decreases by $7 billion in 2020 to $12 billion in 2035, (Figure 11). This amounts to about a decrease of about $50 to $70 per household per year between 2020 and 2035 (Figure 12). Between 2020 through 2035, the net present value[25] loss in personal income of all U.S. households would be about $95 billion or about $610 per average U.S. household.[26]

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[25] We use discount rate of 5% to compute the net present value.

[26] We have only modeled economic impacts on an average U.S. household and do not estimate economic impacts on households with different income levels (distributional impacts) or at different demographic levels. Others have looked at impacts across income levels, demographics, and regionally. Clean energy tax credits have disproportionately gone to higher-income Americans (http://www.nber.org/papers/w21437.pdf); an increased energy burden would be predominantly felt by Southern and African American households (https://www.eba-net.org/assets/1/6/6-18-265-305-Thompson_-_FINAL_0.pdf).

Figure 11: Change in Total U.S. Household Income (2017$ Billions)

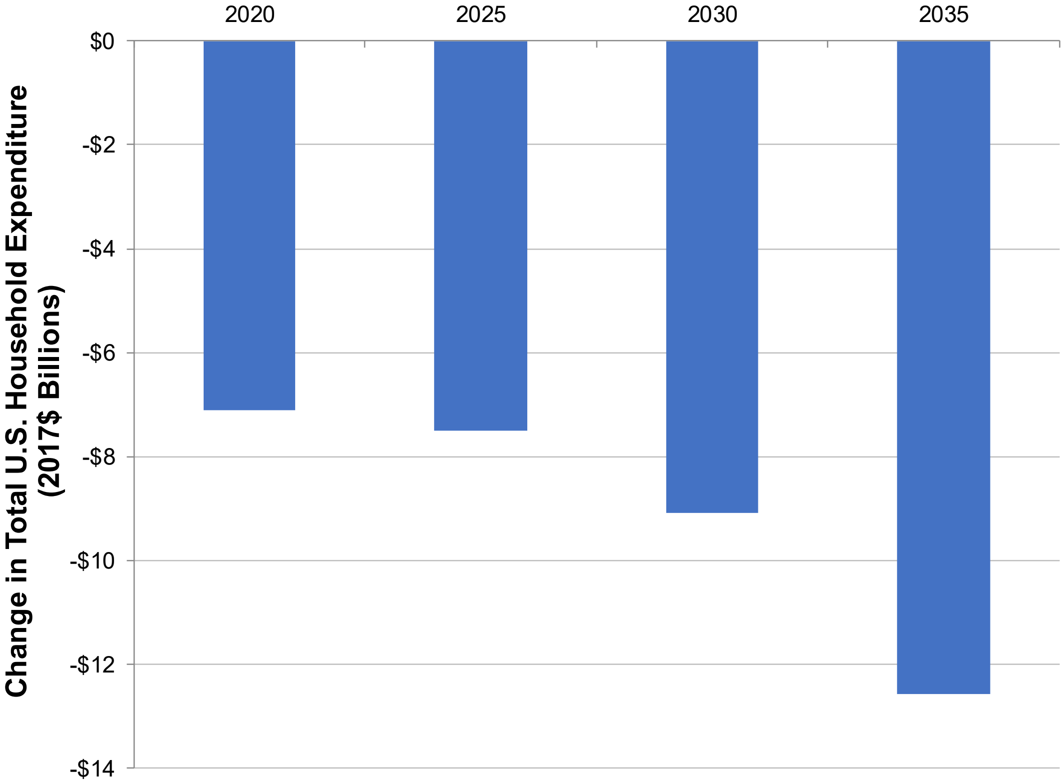
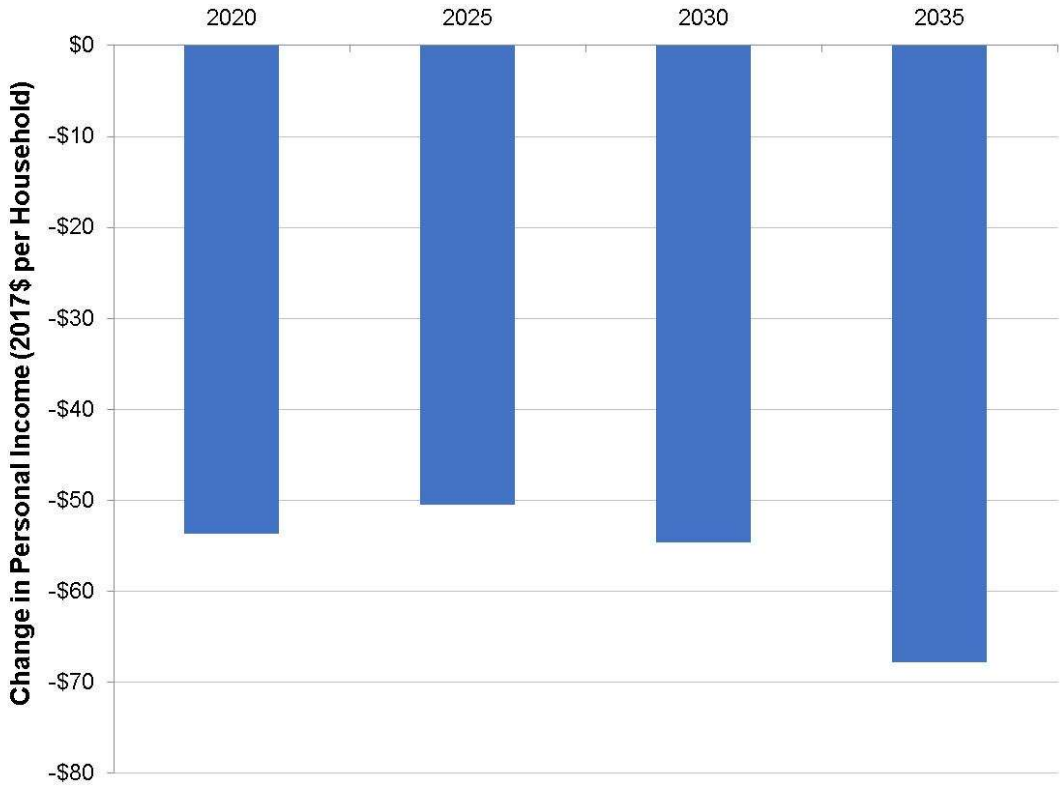


Figure 12: Change in Personal Income Per Average U.S. Household (2017$ per Household)



5. Electricity Bills

Supporting the increase in PEV sales induced by the tax credit requires more electricity production and charging infrastructure. Both effects lead to higher total electricity costs since ratepayers need to pay for the additional generation capacity and charging infrastructure to meet the increased demands from PEVs. These costs are shared by all sectors of the economy and increase over time (Table 9). By 2035, the additional electricity charges are over $3.6 billion, and the average household's electricity bill increases by about $19.

Table 9: Change in U.S. Electricity Bills Impact (2017 $s)

	Baseline				No Cap Limit				Change Between No Cap Limit and Baseline			
	2020	2025	2030	2035	2020	2025	2030	2035	2020	2025	2030	2035
Residential Bills ($ Million)	182,400	189,470	197,950	205,200	182,460	189,820	199,110	207,890	60	350	1,160	2,690
Industrial Bills ($ Million)	69,240	73,420	77,540	80,980	69,240	73,460	77,730	81,550	-	40	190	570
Commercial Bills ($ Million)	147,240	153,670	161,210	165,400	147,250	153,780	161,620	166,600	10	110	410	1,200
All Sectors Bills ($ Million)	398,880	416,560	436,700	451,580	398,950	417,060	438,460	456,040	70	500	1,760	4,460
Residential Bills per Household ($ per household)									-	3	8	19

Figure 13 and Figure 16 show the change in the residential electricity bills by state both in total and per household, respectively. Figure 14 and Figure 15 show the change in the industrial and commercial electricity bills by state. The states with the largest increase in total electricity charges track well with the states that have the greatest additions of new charging infrastructure (Table 13 and Table 14 in Appendix I). The cost per household considers the number of PEVs purchased per household. Therefore, Hawaii has nearly the highest change in electricity bills per household as it lags only California in per capita PEV penetration.

Figure 13: Change in Residential Electricity Bills by State (2017$ Million)

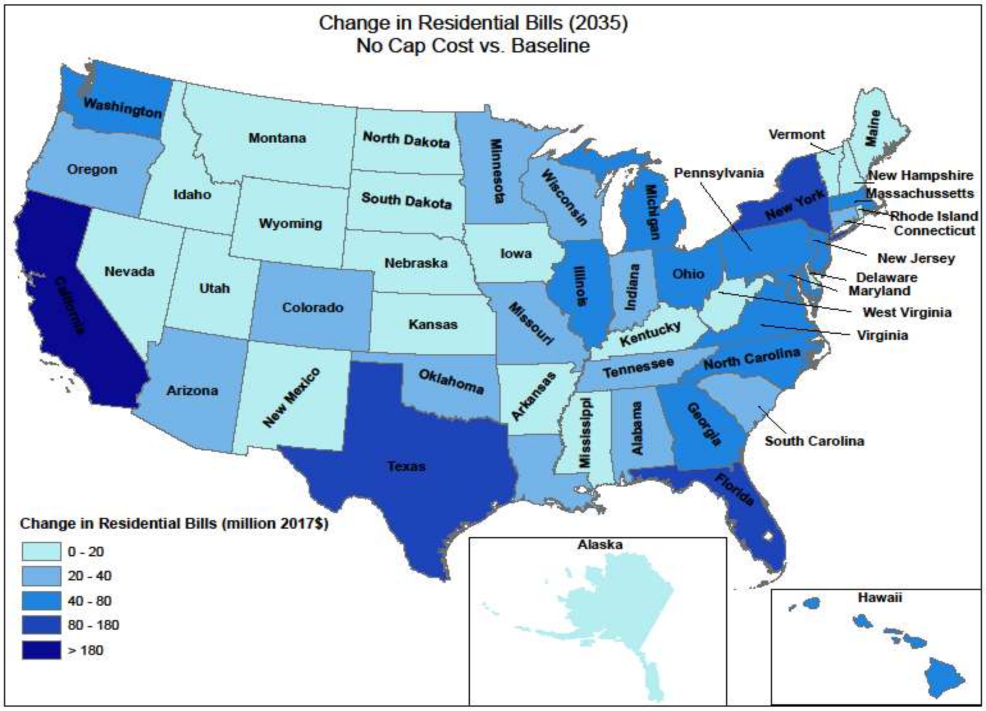


Figure 14: Change in Industrial Electricity Bills by State (2017$ Million)

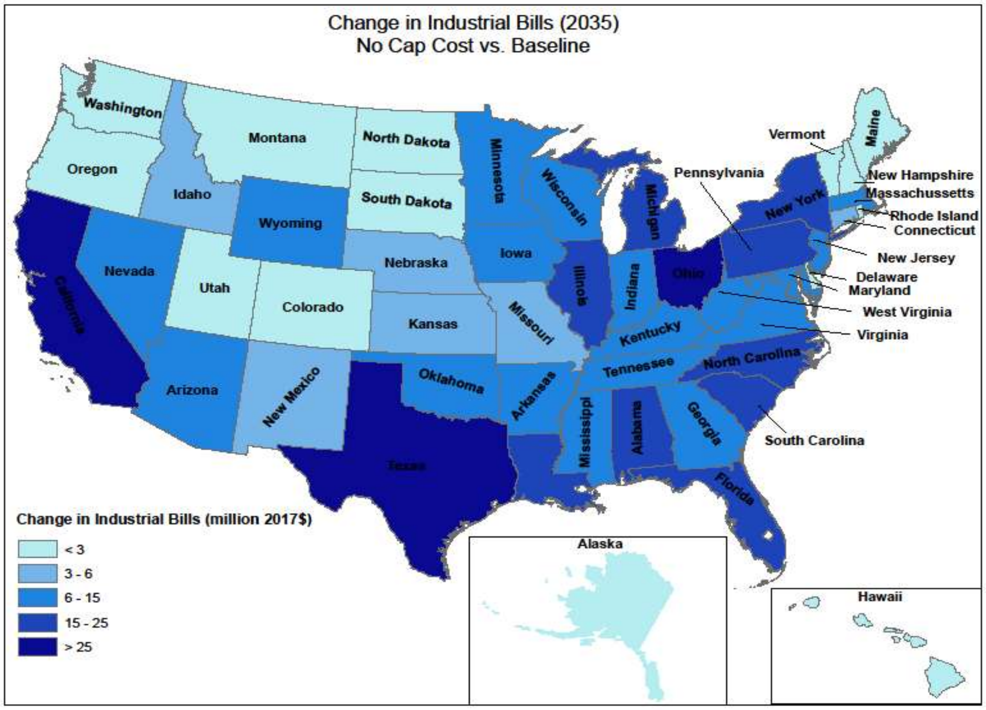


Figure 15: Change in Commercial Electricity Bills by State (2017$ Million)

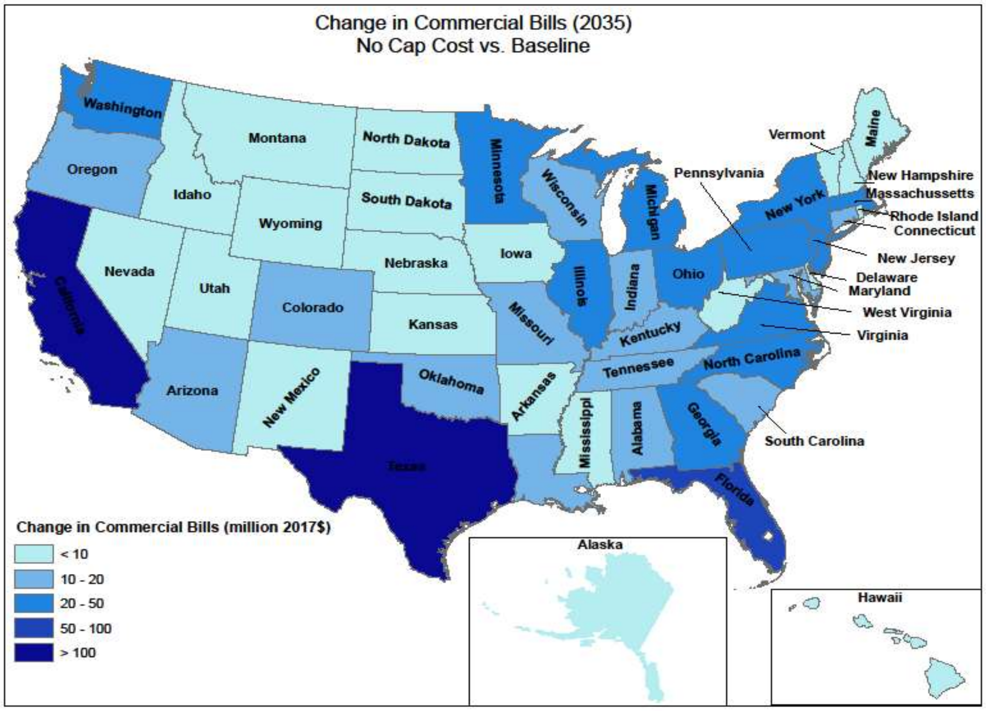
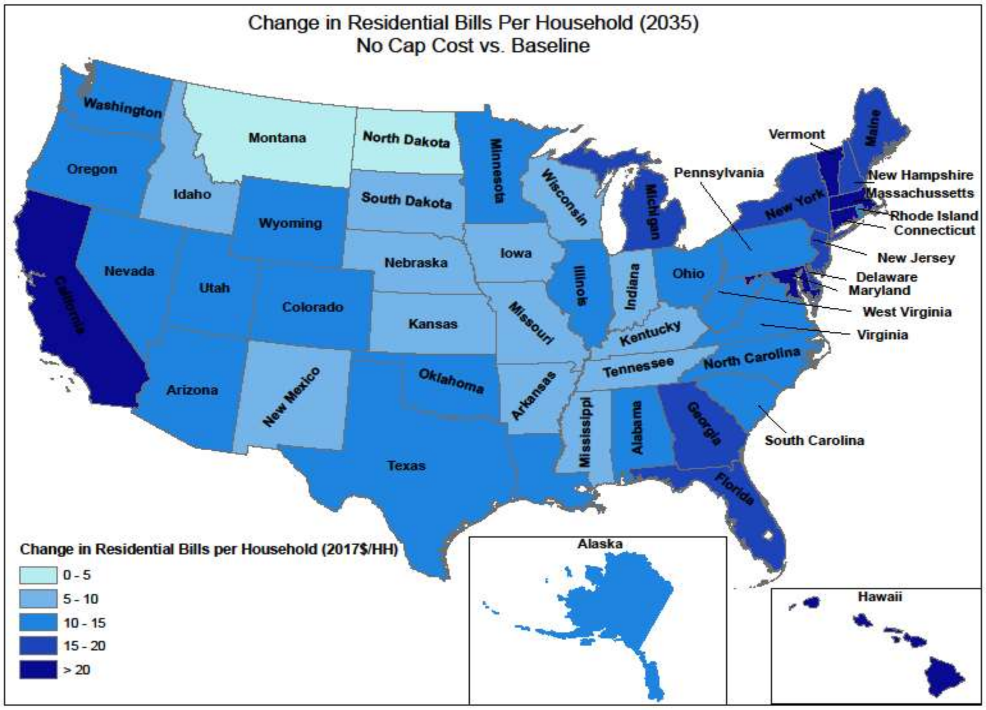


Figure 16: Change in Residential Electricity Bills Per Household ($ per Household)



Appendix I. Detailed State Level Results

Table 10: Change in Home Charger (L1 and L2), Workplace (L2), Public Place (L2), and DC Fast Chargers (Thousands of Plugs) in 2020 and 2025

	2020						2025					
	HCL1	HCL2	WPL2	PL2	DCFC	Total	HCL1	HCL2	WPL2	PL2	DCFC	Total
USA	41.22	29.37	1.79	1.23	0.05	73.66	150.98	107.58	7.07	4.85	0.18	270.66
AK	0.03	0.02	0.00	0.00	0.00	0.05	0.10	0.07	0.00	0.00	0.00	0.18
AL	0.12	0.08	0.01	0.00	0.00	0.22	0.45	0.30	0.02	0.02	0.00	0.79
AR	0.06	0.04	0.00	0.00	0.00	0.11	0.23	0.16	0.01	0.00	0.00	0.40
AZ	0.59	0.40	0.03	0.02	0.00	1.03	2.15	1.46	0.10	0.08	0.00	3.79
CA	19.34	14.59	0.84	0.57	0.01	35.34	70.83	53.44	3.31	2.23	0.05	129.86
CO	0.63	0.43	0.03	0.02	0.00	1.10	2.31	1.57	0.11	0.07	0.00	4.05
CT	0.54	0.37	0.02	0.01	0.00	0.94	1.97	1.34	0.09	0.05	0.00	3.45
DC	0.10	0.07	0.00	0.00	0.00	0.17	0.36	0.24	0.02	0.01	0.00	0.63
DE	0.11	0.07	0.00	0.00	0.00	0.19	0.40	0.27	0.02	0.01	0.00	0.70
FL	1.56	1.06	0.06	0.03	0.00	2.71	5.70	3.87	0.22	0.14	0.01	9.93
GA	0.53	0.35	0.02	0.02	0.00	0.93	1.95	1.30	0.09	0.06	0.00	3.40
HI	0.24	0.16	0.01	0.01	0.00	0.42	0.88	0.59	0.04	0.03	0.00	1.54
IA	0.17	0.11	0.01	0.01	0.00	0.29	0.61	0.41	0.03	0.02	0.00	1.07
ID	0.08	0.05	0.00	0.00	0.00	0.13	0.28	0.19	0.01	0.01	0.00	0.50
IL	0.80	0.54	0.04	0.03	0.00	1.41	2.94	2.00	0.15	0.10	0.00	5.19
IN	0.29	0.19	0.01	0.01	0.00	0.50	1.05	0.71	0.05	0.03	0.00	1.84
KS	0.12	0.08	0.00	0.00	0.00	0.20	0.43	0.29	0.02	0.01	0.00	0.75
KY	0.11	0.08	0.01	0.00	0.00	0.20	0.41	0.28	0.02	0.02	0.00	0.73
LA	0.08	0.06	0.00	0.00	0.00	0.14	0.30	0.20	0.01	0.01	0.00	0.52
MA	0.98	0.74	0.05	0.03	0.00	1.80	3.59	2.71	0.18	0.12	0.01	6.61
MD	0.86	0.57	0.04	0.03	0.00	1.50	3.14	2.10	0.15	0.11	0.00	5.50
ME	0.16	0.11	0.01	0.00	0.00	0.28	0.59	0.40	0.03	0.02	0.00	1.04
MI	1.34	0.91	0.06	0.04	0.00	2.35	4.89	3.32	0.24	0.18	0.01	8.63
MN	0.43	0.29	0.02	0.01	0.00	0.75	1.58	1.07	0.07	0.05	0.00	2.77
MO	0.28	0.19	0.01	0.01	0.00	0.49	1.02	0.69	0.05	0.03	0.00	1.79
MS	0.03	0.02	0.00	0.00	0.00	0.06	0.12	0.08	0.01	0.00	0.00	0.21
MT	0.05	0.04	0.00	0.00	0.00	0.09	0.20	0.13	0.01	0.01	0.00	0.35
NC	0.51	0.35	0.02	0.02	0.00	0.89	1.86	1.26	0.09	0.07	0.00	3.29
ND	0.02	0.01	0.00	0.00	0.00	0.03	0.06	0.04	0.00	0.00	0.00	0.11
NE	0.09	0.06	0.00	0.00	0.00	0.17	0.35	0.24	0.02	0.01	0.00	0.61
NH	0.19	0.13	0.01	0.01	0.00	0.34	0.71	0.48	0.03	0.02	0.00	1.24
NJ	1.25	0.85	0.05	0.04	0.00	2.19	4.59	3.12	0.20	0.14	0.01	8.06
NM	0.10	0.07	0.00	0.00	0.00	0.18	0.38	0.25	0.02	0.01	0.00	0.66
NV	0.22	0.15	0.01	0.01	0.00	0.38	0.80	0.54	0.03	0.02	0.00	1.39
NY	2.43	1.62	0.12	0.08	0.00	4.25	8.89	5.93	0.48	0.33	0.01	15.64
OH	0.63	0.40	0.02	0.02	0.00	1.07	2.30	1.47	0.09	0.07	0.00	3.93
OK	0.11	0.07	0.00	0.00	0.00	0.19	0.39	0.26	0.02	0.01	0.00	0.68
OR	0.75	0.51	0.03	0.02	0.00	1.30	2.74	1.86	0.11	0.07	0.00	4.79
PA	0.98	0.60	0.04	0.03	0.00	1.66	3.61	2.21	0.16	0.12	0.01	6.10
RI	0.11	0.07	0.00	0.00	0.00	0.19	0.40	0.27	0.01	0.01	0.00	0.70
SC	0.17	0.11	0.01	0.00	0.00	0.29	0.61	0.42	0.03	0.02	0.00	1.08
SD	0.02	0.02	0.00	0.00	0.00	0.04	0.09	0.06	0.00	0.00	0.00	0.16
TN	0.21	0.14	0.01	0.01	0.00	0.36	0.76	0.52	0.03	0.02	0.00	1.33
TX	1.20	0.82	0.06	0.04	0.00	2.13	4.41	2.99	0.24	0.17	0.01	7.82
UT	0.22	0.15	0.01	0.01	0.00	0.38	0.80	0.54	0.04	0.02	0.00	1.41
VA	0.69	0.47	0.03	0.02	0.00	1.21	2.52	1.71	0.12	0.08	0.00	4.44
VT	0.21	0.14	0.01	0.01	0.00	0.37	0.77	0.52	0.03	0.02	0.00	1.35
WA	1.10	0.75	0.05	0.04	0.00	1.93	4.03	2.73	0.20	0.14	0.01	7.10
WI	0.34	0.23	0.01	0.01	0.00	0.59	1.23	0.83	0.05	0.04	0.00	2.16
WV	0.05	0.03	0.00	0.00	0.00	0.08	0.17	0.11	0.01	0.01	0.00	0.30
WY	0.01	0.01	0.00	0.00	0.00	0.02	0.05	0.03	0.00	0.00	0.00	0.08

Table 11: Change in Home Charger (L1 and L2), Workplace (L2), Public Place (L2), and DC Fast Chargers (Thousands of Plugs) in 2030 and 2035

	2030						2035					
	HCL1	HCL2	WPL2	PL2	DCFC	Total	HCL1	HCL2	WPL2	PL2	DCFC	Total
USA	347.32	247.48	12.56	8.69	0.50	616.56	835.15	595.08	22.78	15.95	1.38	1,470.33
AK	0.23	0.16	0.01	0.01	0.00	0.40	0.55	0.38	0.01	0.01	0.00	0.96
AL	1.03	0.70	0.04	0.03	0.00	1.80	2.47	1.68	0.07	0.05	0.01	4.29
AR	0.53	0.36	0.01	0.01	0.00	0.91	1.27	0.86	0.03	0.02	0.00	2.18
AZ	4.94	3.35	0.19	0.14	0.01	8.62	11.88	8.06	0.34	0.25	0.03	20.55
CA	162.95	122.92	5.88	3.99	0.14	295.88	391.81	295.57	10.65	7.30	0.39	705.72
CO	5.31	3.60	0.19	0.12	0.01	9.24	12.78	8.66	0.34	0.23	0.03	22.04
CT	4.54	3.08	0.15	0.09	0.01	7.87	10.92	7.40	0.28	0.17	0.02	18.79
DC	0.82	0.56	0.03	0.02	0.00	1.43	1.98	1.34	0.05	0.04	0.00	3.42
DE	0.92	0.62	0.03	0.02	0.00	1.60	2.21	1.50	0.06	0.04	0.00	3.82
FL	13.12	8.90	0.39	0.25	0.03	22.68	31.54	21.39	0.70	0.46	0.08	54.17
GA	4.48	2.99	0.16	0.11	0.01	7.75	10.78	7.19	0.29	0.21	0.03	18.49
HI	2.02	1.37	0.07	0.05	0.00	3.50	4.85	3.29	0.13	0.09	0.01	8.36
IA	1.40	0.95	0.05	0.04	0.00	2.44	3.37	2.29	0.09	0.07	0.01	5.82
ID	0.65	0.44	0.02	0.02	0.00	1.13	1.56	1.06	0.04	0.03	0.00	2.69
IL	6.77	4.59	0.26	0.18	0.01	11.81	16.27	11.04	0.47	0.33	0.03	28.15
IN	2.41	1.63	0.08	0.06	0.01	4.19	5.79	3.92	0.15	0.11	0.02	9.98
KS	0.98	0.67	0.03	0.03	0.00	1.71	2.36	1.60	0.06	0.05	0.00	4.07
KY	0.94	0.64	0.04	0.03	0.00	1.65	2.26	1.54	0.07	0.05	0.01	3.93
LA	0.69	0.47	0.02	0.02	0.00	1.19	1.65	1.12	0.04	0.03	0.00	2.84
MA	8.27	6.24	0.32	0.22	0.01	15.06	19.88	14.99	0.59	0.40	0.04	35.90
MD	7.23	4.82	0.27	0.20	0.01	12.53	17.39	11.59	0.48	0.36	0.03	29.85
ME	1.37	0.93	0.05	0.03	0.00	2.38	3.28	2.23	0.09	0.06	0.01	5.67
MI	11.25	7.63	0.42	0.32	0.03	19.65	27.06	18.35	0.76	0.58	0.07	46.83
MN	3.62	2.46	0.13	0.09	0.01	6.31	8.71	5.91	0.24	0.17	0.02	15.05
MO	2.35	1.59	0.08	0.06	0.00	4.08	5.65	3.83	0.15	0.10	0.01	9.74
MS	0.27	0.19	0.01	0.01	0.00	0.48	0.66	0.45	0.02	0.02	0.00	1.14
MT	0.46	0.31	0.02	0.01	0.00	0.79	1.09	0.74	0.03	0.02	0.00	1.89
NC	4.29	2.91	0.16	0.12	0.01	7.48	10.32	7.00	0.28	0.22	0.03	17.84
ND	0.15	0.10	0.01	0.00	0.00	0.25	0.35	0.24	0.01	0.01	0.00	0.61
NE	0.80	0.54	0.03	0.02	0.00	1.39	1.92	1.30	0.06	0.04	0.00	3.32
NH	1.63	1.10	0.06	0.04	0.00	2.83	3.91	2.65	0.10	0.08	0.01	6.75
NJ	10.57	7.17	0.36	0.25	0.02	18.36	25.41	17.23	0.66	0.46	0.04	43.80
NM	0.86	0.59	0.03	0.02	0.00	1.51	2.08	1.41	0.06	0.04	0.00	3.59
NV	1.83	1.24	0.06	0.04	0.00	3.18	4.40	2.99	0.11	0.07	0.01	7.58
NY	20.45	13.63	0.86	0.59	0.04	35.57	49.17	32.78	1.55	1.08	0.11	84.70
OH	5.28	3.38	0.17	0.12	0.01	8.96	12.70	8.12	0.31	0.22	0.03	21.38
OK	0.89	0.60	0.03	0.02	0.00	1.55	2.14	1.45	0.06	0.04	0.00	3.70
OR	6.30	4.27	0.20	0.13	0.01	10.92	15.16	10.28	0.37	0.24	0.03	26.07
PA	8.30	5.09	0.29	0.21	0.02	13.90	19.95	12.23	0.52	0.38	0.05	33.13
RI	0.93	0.63	0.02	0.02	0.00	1.59	2.23	1.51	0.03	0.03	0.00	3.81
SC	1.41	0.96	0.05	0.03	0.00	2.46	3.40	2.30	0.09	0.06	0.01	5.86
SD	0.21	0.14	0.01	0.01	0.00	0.36	0.50	0.34	0.01	0.01	0.00	0.86
TN	1.75	1.19	0.06	0.04	0.00	3.04	4.21	2.85	0.11	0.08	0.01	7.25
TX	10.13	6.87	0.43	0.31	0.02	17.77	24.37	16.53	0.78	0.57	0.06	42.31
UT	1.85	1.25	0.06	0.04	0.00	3.21	4.44	3.01	0.11	0.08	0.01	7.66
VA	5.80	3.93	0.22	0.15	0.01	10.11	13.94	9.45	0.39	0.28	0.03	24.10
VT	1.77	1.20	0.06	0.04	0.00	3.07	4.25	2.88	0.11	0.08	0.01	7.33
WA	9.26	6.28	0.35	0.25	0.02	16.17	22.28	15.11	0.64	0.46	0.05	38.53
WI	2.83	1.92	0.09	0.07	0.01	4.92	6.80	4.61	0.17	0.13	0.02	11.73
WV	0.39	0.26	0.02	0.01	0.00	0.67	0.93	0.63	0.03	0.02	0.00	1.61
WY	0.11	0.07	0.00	0.00	0.00	0.19	0.26	0.18	0.01	0.01	0.00	0.46

Table 12: Total EV Infrastructure Costs ($ Millions)

	Baseline				No Cap Limit				Change Between No Cap Limit and Baseline			
	2020	2025	2030	2035	2020	2025	2030	2035	2020	2025	2030	2035
USA	278.5	1008.1	2462.1	4780.6	366.4	1333.4	3187.3	6478.0	87.9	325.3	725.2	1697.4
AK	0.2	0.7	1.6	3.2	0.2	0.9	2.1	4.4	0.1	0.2	0.5	1.2
AL	0.8	3.1	7.5	14.6	1.1	4.0	9.7	19.8	0.3	1.0	2.2	5.2
AR	0.4	1.4	3.5	7.0	0.5	1.9	4.6	9.5	0.1	0.5	1.1	2.5
AZ	4.0	14.4	35.1	68.4	5.2	19.0	45.5	92.8	1.3	4.6	10.4	24.4
CA	133.0	481.8	1175.6	2273.7	174.9	636.9	1519.9	3076.1	41.9	155.2	344.3	802.4
CO	4.1	14.9	36.5	71.1	5.4	19.8	47.3	96.5	1.3	4.8	10.8	25.4
CT	3.5	12.5	30.6	59.6	4.6	16.5	39.6	80.9	1.1	4.0	9.1	21.3
DC	0.6	2.2	5.5	10.5	0.8	3.0	7.1	14.2	0.2	0.7	1.6	3.7
DE	0.7	2.5	6.2	12.0	0.9	3.3	8.0	16.2	0.2	0.8	1.8	4.2
FL	10.0	36.2	88.7	174.7	13.2	48.0	115.4	238.0	3.2	11.8	26.7	63.3
GA	3.5	12.7	31.2	60.9	4.6	16.9	40.4	82.8	1.1	4.1	9.3	21.9
HI	1.5	5.5	13.4	26.0	2.0	7.3	17.3	35.2	0.5	1.8	3.9	9.2
IA	1.1	4.0	9.9	19.2	1.5	5.3	12.8	26.1	0.4	1.3	2.9	6.9
ID	0.5	1.9	4.6	8.9	0.7	2.5	5.9	12.1	0.2	0.6	1.4	3.2
IL	5.4	19.4	47.5	92.1	7.1	25.7	61.4	124.9	1.7	6.3	14.0	32.7
IN	1.9	6.9	16.9	33.1	2.5	9.2	22.0	45.1	0.6	2.2	5.0	11.9
KS	0.8	2.8	6.8	13.2	1.0	3.7	8.8	17.8	0.2	0.9	2.0	4.7
KY	0.8	2.8	6.8	13.2	1.0	3.7	8.8	17.9	0.2	0.9	2.0	4.7
LA	0.5	1.9	4.7	9.3	0.7	2.6	6.1	12.6	0.2	0.6	1.4	3.3
MA	7.1	25.6	62.7	121.9	9.3	33.9	81.2	165.3	2.2	8.3	18.5	43.4
MD	5.6	20.2	49.3	95.4	7.3	26.7	63.7	129.1	1.8	6.5	14.5	33.7
ME	1.1	3.9	9.6	18.9	1.4	5.2	12.5	25.7	0.3	1.3	2.9	6.8
MI	9.2	33.1	81.0	158.1	12.1	43.8	105.0	214.8	2.9	10.7	24.1	56.6
MN	2.9	10.3	25.2	49.1	3.8	13.7	32.7	66.6	0.9	3.3	7.5	17.5
MO	1.8	6.6	16.2	31.7	2.4	8.8	21.0	43.1	0.6	2.1	4.8	11.4
MS	0.2	0.8	2.0	3.9	0.3	1.1	2.6	5.3	0.1	0.3	0.6	1.4
MT	0.4	1.3	3.2	6.3	0.5	1.7	4.2	8.6	0.1	0.4	1.0	2.3
NC	3.5	12.6	30.7	60.1	4.6	16.6	39.9	81.7	1.1	4.1	9.1	21.6
ND	0.1	0.4	1.0	2.0	0.2	0.6	1.3	2.7	0.0	0.1	0.3	0.7
NE	0.6	2.3	5.6	10.8	0.8	3.0	7.2	14.6	0.2	0.7	1.6	3.8
NH	1.3	4.6	11.3	21.9	1.7	6.1	14.6	29.8	0.4	1.5	3.3	7.8
NJ	8.1	29.4	71.8	139.6	10.7	38.9	92.9	189.3	2.6	9.5	21.2	49.7
NM	0.7	2.5	6.1	11.9	0.9	3.3	7.9	16.1	0.2	0.8	1.8	4.2
NV	1.4	5.0	12.3	24.1	1.8	6.7	16.0	32.7	0.4	1.6	3.7	8.6
NY	16.5	59.7	145.8	282.5	21.7	79.0	188.6	382.6	5.2	19.2	42.8	100.1
OH	3.9	14.3	34.9	68.4	5.2	18.9	45.3	93.1	1.3	4.6	10.4	24.7
OK	0.7	2.6	6.2	12.2	0.9	3.4	8.1	16.5	0.2	0.8	1.8	4.3
OR	4.8	17.3	42.3	82.6	6.3	22.9	54.9	112.2	1.5	5.6	12.6	29.6
PA	6.1	22.1	54.0	105.3	8.0	29.2	70.0	143.0	1.9	7.1	16.0	37.7
RI	0.7	2.4	5.8	11.3	0.9	3.1	7.5	15.4	0.2	0.8	1.7	4.1
SC	1.1	4.1	9.9	19.4	1.5	5.4	12.9	26.4	0.4	1.3	3.0	7.0
SD	0.2	0.6	1.5	2.8	0.2	0.8	1.9	3.9	0.1	0.2	0.4	1.0
TN	1.4	5.0	12.3	24.0	1.8	6.6	15.9	32.7	0.4	1.6	3.7	8.7
TX	8.4	30.5	74.6	144.9	11.1	40.4	96.6	196.4	2.7	9.9	22.0	51.5
UT	1.4	5.2	12.6	24.6	1.9	6.8	16.4	33.4	0.5	1.7	3.7	8.8
VA	4.6	16.6	40.6	78.8	6.0	22.0	52.5	106.8	1.4	5.4	12.0	28.0
VT	1.4	5.1	12.5	24.6	1.9	6.8	16.3	33.5	0.5	1.7	3.8	8.9
WA	7.4	26.8	65.4	127.0	9.7	35.4	84.6	172.2	2.3	8.6	19.3	45.2
WI	2.2	8.1	19.7	38.6	2.9	10.7	25.6	52.5	0.7	2.6	5.9	13.9
WV	0.3	1.1	2.8	5.4	0.4	1.5	3.6	7.3	0.1	0.4	0.8	1.9
WY	0.1	0.3	0.8	1.6	0.1	0.4	1.0	2.1	0.0	0.1	0.2	0.6

Table 13: Change in Annual Residential, Industrial, and Commercial Electricity Bills by State ($ Million)

	No Cap Limit					No Cap Limit					No Cap Limit			
	Residential					Industrial					Commercial			
	2020	2025	2030	2035		2020	2025	2030	2035		2020	2025	2030	2035
USA	62.3	343.8	1160.4	2692.4	USA	2.7	38.2	189.5	574.4	USA	9.5	102.6	412.9	1194.0
AK	0.1	0.4	1.3	3.7	AK	0.0	0.2	0.4	1.5	AK	0.1	0.3	1.0	3.3
AL	1.0	3.8	4.2	24.1	AL	0.9	3.0	1.9	18.9	AL	0.7	2.5	2.3	16.1
AR	1.1	2.1	4.4	12.8	AR	0.9	1.6	3.1	9.5	AR	0.7	1.3	2.8	8.3
AZ	1.9	7.1	18.0	39.5	AZ	0.5	1.3	2.6	6.1	AZ	1.0	3.3	7.3	18.0
CA	5.5	137.6	457.2	918.9	CA	-10.1	8.5	44.4	86.8	CA	-20.8	36.3	156.1	341.5
CO	0.8	4.1	14.5	31.7	CO	0.0	-0.2	1.2	2.6	CO	0.2	0.8	5.0	12.6
CT	2.0	3.7	15.1	35.1	CT	0.4	0.2	1.6	4.3	CT	1.2	0.0	4.0	10.8
DC	0.3	1.1	2.9	8.0	DC	0.0	0.1	0.2	0.7	DC	0.3	0.4	-0.3	3.8
DE	0.2	0.8	3.5	8.0	DE	0.0	0.1	0.7	1.6	DE	0.1	0.1	1.4	3.3
FL	7.2	17.9	54.8	146.5	FL	0.8	1.9	6.1	18.0	FL	4.3	7.9	24.6	75.6
GA	2.7	12.4	22.8	79.5	GA	0.4	1.3	-3.5	8.8	GA	0.8	2.8	-2.4	20.3
HI	1.7	7.9	22.0	49.3	HI	-0.2	-1.7	-6.0	-7.0	HI	-0.1	-1.0	-3.5	-1.7
IA	5.3	6.0	7.0	12.3	IA	8.0	8.0	7.0	9.7	IA	4.5	4.9	5.2	8.8
ID	0.2	0.7	1.8	6.1	ID	0.1	0.3	0.7	3.8	ID	0.1	0.4	1.1	4.2
IL	2.1	8.8	26.4	76.3	IL	0.6	1.1	3.2	21.0	IL	0.9	2.1	6.4	31.4
IN	-4.3	-3.2	3.4	21.1	IN	-6.6	-7.4	-3.9	9.8	IN	-3.3	-3.2	0.2	11.2
KS	0.1	0.5	2.5	8.9	KS	0.0	0.0	1.0	5.0	KS	0.0	0.0	1.4	6.9
KY	-0.2	0.7	3.0	16.1	KY	-0.3	0.0	0.9	12.1	KY	-0.2	0.3	1.5	10.8
LA	0.5	2.3	7.9	22.7	LA	0.5	2.1	7.4	22.1	LA	0.4	1.6	5.7	16.9
MA	3.5	7.5	42.2	66.6	MA	0.8	0.3	7.9	8.5	MA	2.7	0.0	24.0	20.7
MD	2.0	7.7	20.5	59.9	MD	0.2	0.7	1.9	6.7	MD	0.9	1.7	2.3	19.2
ME	0.6	1.0	4.3	10.4	ME	0.2	0.0	0.8	2.3	ME	0.4	0.1	1.6	4.3
MI	3.9	11.2	29.3	75.1	MI	2.3	3.6	6.6	21.9	MI	3.2	6.9	15.9	47.7
MN	1.3	5.8	15.9	34.3	MN	0.8	3.0	7.3	14.3	MN	1.0	4.1	10.7	22.6
MO	3.5	5.6	11.7	22.7	MO	1.3	1.7	3.0	5.4	MO	2.9	4.0	7.6	14.4
MS	0.5	1.6	3.2	11.7	MS	0.4	1.2	2.3	9.1	MS	0.4	1.2	2.3	8.8
MT	0.0	0.4	0.1	0.7	MT	0.0	0.2	-0.4	-0.5	MT	0.0	0.4	-0.1	0.3
NC	1.3	6.8	37.5	57.3	NC	0.3	1.7	12.8	16.0	NC	0.7	3.7	25.1	34.5
ND	-0.1	-0.4	-0.7	0.9	ND	-0.2	-0.7	-1.4	0.5	ND	-0.2	-0.6	-1.1	0.7
NE	0.2	0.7	2.4	7.2	NE	0.1	0.3	1.2	4.4	NE	0.1	0.5	1.6	5.3
NH	0.7	1.3	8.0	11.9	NH	0.2	0.1	2.0	1.9	NH	0.5	0.1	4.5	4.4
NJ	1.7	9.1	34.3	78.0	NJ	0.1	0.5	3.2	8.8	NJ	0.2	-0.7	7.1	20.2
NM	0.2	2.2	4.3	8.6	NM	0.1	1.8	2.7	4.5	NM	0.1	2.2	3.7	6.8
NV	0.6	1.9	6.5	17.0	NV	0.4	0.4	2.0	6.7	NV	0.3	0.8	3.0	9.0
NY	5.5	20.0	49.9	141.7	NY	1.0	2.2	-2.1	19.0	NY	3.7	5.5	-22.9	46.3
OH	-4.0	-1.9	18.6	60.2	OH	-4.7	-6.4	4.1	25.9	OH	-4.4	-5.4	6.1	30.7
OK	0.6	2.2	6.5	20.0	OK	0.3	1.0	2.9	10.8	OK	0.4	1.4	4.0	14.1
OR	0.7	4.5	10.6	24.5	OR	0.1	0.9	0.8	2.4	OR	0.3	2.5	5.1	14.0
PA	1.6	6.5	27.6	68.9	PA	0.2	0.5	8.4	22.7	PA	0.4	1.6	11.3	30.6
RI	0.5	0.7	5.2	7.2	RI	0.1	0.1	0.9	1.0	RI	0.4	0.0	3.6	2.9
SC	0.4	3.0	20.7	25.5	SC	0.2	1.7	15.1	15.3	SC	0.2	1.8	13.8	15.9
SD	0.0	-0.1	0.2	2.1	SD	0.0	-0.1	0.0	0.8	SD	0.0	-0.2	0.1	1.7
TN	1.7	4.2	11.4	30.6	TN	0.8	1.5	3.8	11.1	TN	1.2	2.6	6.8	19.5
TX	5.6	7.8	58.6	173.9	TX	2.7	-3.0	18.3	74.0	TX	3.5	-2.3	26.7	102.2
UT	0.2	2.0	5.0	12.5	UT	-0.1	0.3	-0.1	1.4	UT	-0.1	0.7	1.2	5.0
VA	0.9	5.1	15.9	55.0	VA	0.1	0.6	2.0	11.7	VA	0.3	1.9	6.6	35.4
VT	0.2	0.6	2.9	6.3	VT	0.0	0.3	2.3	2.9	VT	0.1	0.8	4.4	7.2
WA	1.3	8.0	18.0	40.4	WA	0.1	1.7	0.5	1.9	WA	0.5	4.0	7.4	20.2
WI	-0.4	3.4	11.6	28.0	WI	-0.9	1.0	4.3	11.0	WI	-0.8	1.7	6.5	16.7
WV	-0.2	0.9	3.5	9.9	WV	-0.3	0.6	2.6	8.0	WV	-0.2	0.6	2.3	6.7
WY	0.0	0.1	1.6	3.1	WY	0.0	0.2	4.8	8.8	WY	0.0	0.1	1.9	3.6

Table 14: Change in Annual Residential Bill per Household ($ per Household)

	No Cap Limit			
	Residential			
	2020	2025	2030	2035
USA	0.5	2.5	8.2	18.5
AK	0.4	1.6	4.4	12.0
AL	0.5	1.8	1.9	10.6
AR	0.9	1.6	3.3	9.2
AZ	0.7	2.5	6.0	12.8
CA	0.4	9.2	29.7	58.0
CO	0.4	1.7	5.8	12.2
CT	1.3	2.4	9.3	21.1
DC	0.9	3.4	8.6	23.6
DE	0.4	1.9	8.3	18.7
FL	0.9	2.1	6.1	15.8
GA	0.7	2.9	5.2	17.6
HI	3.4	14.8	39.9	86.9
IA	3.8	4.1	4.7	8.0
ID	0.3	0.9	2.5	8.2
IL	0.4	1.6	4.6	12.9
IN	-1.5	-1.1	1.1	6.8
KS	0.1	0.4	1.9	6.5
KY	-0.1	0.4	1.4	7.6
LA	0.3	1.2	3.9	10.7
MA	1.2	2.5	13.8	21.1
MD	0.8	3.0	7.9	22.2
ME	1.0	1.6	6.8	16.1
MI	0.9	2.5	6.3	15.8
MN	0.5	2.3	6.2	13.0
MO	1.3	2.1	4.2	7.8
MS	0.4	1.3	2.5	8.8
MT	0.1	0.9	0.3	1.3
NC	0.3	1.5	8.1	12.1
ND	-0.3	-1.1	-1.7	2.2
NE	0.2	0.8	2.7	7.8
NH	1.2	2.1	13.0	18.7
NJ	0.5	2.5	9.1	19.9
NM	0.2	2.5	4.8	9.2
NV	0.5	1.6	5.1	13.1
NY	0.7	2.4	5.8	16.0
OH	-0.8	-0.4	3.4	10.6
OK	0.4	1.3	3.7	11.1
OR	0.4	2.5	5.7	12.7
PA	0.3	1.1	4.7	11.4
RI	1.0	1.5	10.7	14.4
SC	0.2	1.4	9.3	11.1
SD	-0.1	-0.4	0.6	5.1
TN	0.6	1.4	3.8	9.8
TX	0.5	0.7	5.2	14.9
UT	0.2	1.8	4.5	10.8
VA	0.3	1.4	4.3	14.4
VT	0.6	2.0	9.7	20.4
WA	0.4	2.5	5.5	11.9
WI	-0.1	1.3	4.2	9.8
WV	-0.3	1.1	4.1	11.2
WY	0.0	0.5	6.1	11.4

Qualifications, assumptions and limiting conditions

NERA Economic Consulting was commissioned by Flint Hills Resources to undertake this study to analyze the effects of removing the manufacturers' vehicle cap on plug-in electric vehicles that qualify for the Federal tax credit. There are no third party beneficiaries with respect to this report, and NERA Economic Consulting does not accept any liability to any third party in respect of this report or any actions taken or decisions made as a consequence of the results, advice or recommendations set forth herein.

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