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Accelerating Investment in Electric Vehicle Charging Infrastructure

Estimated Needs in Selected Utility Service Territories in Seven States

March 2018 Corrected

ACKNOWLEDGEMENTS

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About this Study

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NOTE: This version dated March 2018 contains corrections to estimated GHG emission reductions from transportation electrification in the service territories of Georgia Power, Duke Energy (Ohio), and AEP (Ohio). These corrections also affected the summary of total GHG reductions for all 12 service territories. Estimates of other benefits and costs in these and other utility service territories have not changed from the original November 2017 version.

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EXECUTIVE SUMMARY

This analysis evaluates the total need for electric vehicle charging infrastructure—including private chargers at vehicle owners' homes and publicly accessible chargers—to accommodate plug-in electric vehicles (PEV)[1] in the twelve largest utility service territories in the states of California, Georgia, Maryland, Massachusetts, New York, Ohio, and Pennsylvania. These states were chosen to be fairly representative of needs across the U.S. and to identify regional differences. These twelve utilities serve 60 percent of the residential customers in these seven states—41.8 million customers, with nearly 80 million vehicles.

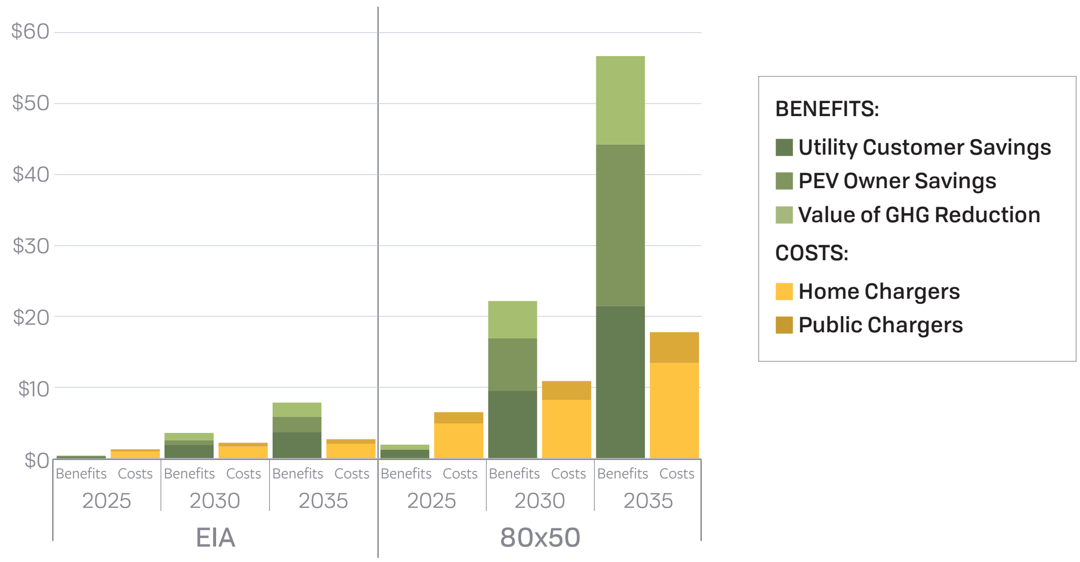
The analysis includes the estimated purchase and installation cost of all chargers required to make PEVs a practical option for most vehicle owners. While there is general agreement that most electric vehicles will be charged primarily at home, publicly accessible chargers will also be required to allow PEV owners to charge at various locations throughout their daily travel. Such "public" chargers will be most useful at locations where PEV owners already park for 15+ minutes on a regular basis as part of their normal routine—most importantly at their workplace, but also potentially at shopping malls, restaurants, movie theatres and other commercial locations. In order to accommodate long-distance travel in battery electric vehicles, a network of higher power chargers—likely located near highway exits—will also be required.

UTILITIES INCLUDED

California	Georgia	Maryland	Massachusetts	New York	Ohio	Pennsylvania
· Pacific Gas & Electric	· Georgia Power	· Baltimore Gas & Electric	· Eversource	· Consolidated Edison	· AEP	· PECO
· Southern California Edison			· National Grid	· National Grid	· Duke Energy	· PPL

1 Including both plug-in hybrid (PHEV) and battery electric vehicles (BEV).

Figure 1: Estimated Charger Costs and Cumulative PEV Benefits (NPV & Billions)—12 Utilities[2]



For each utility service territory, the estimated cost of this charging infrastructure is compared to the estimated economic and societal benefits that the PEVs would provide—including cost savings to vehicle owners from reduced fuel and maintenance expenses, financial benefits to electric utility customers from increased utility revenue for PEV charging, and the value to society of greenhouse gas (GHG) reductions from using PEVs instead of gasoline vehicles. In each state and utility service territory, total PEV charging costs and total PEV benefits were estimated for a relatively low level of PEV penetration, as well as for a much higher level of penetration, between 2025 and 2035.

The low penetration scenario is based on current projections of annual PEV sales from the Energy Information Administration (EIA). The high penetration scenario (80x50) is based on the PEV penetration trajectory that would be required to achieve an 80 percent reduction in GHG emissions from the light-duty vehicle fleet in each state by 2050.[3] For all states, the low (EIA) penetration scenario assumes that PEVs will increase from about one percent of new car sales in 2017 to eight percent in 2025, and then start to fall off after 2025. This will increase the PEV fleet from 2.8 percent of all cars and light trucks on the road in 2025 to 6.1 percent in 2035. The high penetration scenario varies by state, but assumes that PEVs will increase from approximately 15 percent of total light-duty vehicles in 2025, to approximately 43 percent in 2035. To achieve this level of PEV penetration 15 to 30 percent of new car sales would need to be PEV between 2017 and 2035.

The analysis uses a state-specific PEV cost-benefit framework previously developed by MJB&A, estimates of the public charging infrastructure necessary to support high levels of PEV penetration (ports per PEV) drawn from a national analysis conducted by the National Renewable Energy Laboratory (NREL) using their EVI-PRO model, and estimates of the cost of PEV charging infrastructure from various sources.

See **Figure 1** for a summary of the results of this analysis across all twelve utilities studied. For all twelve of these utilities, a total of 2.6 million home chargers and 121,000 public chargers will be required by 2035, under the EIA scenario, to accommodate 2.9 million PEVs. Under the 80x50 scenario 17.5 million home chargers and 754,000 public chargers will be required by 2035 to accommodate 19.1 million PEVs.

The total cost of these chargers is estimated to be $2.7 billion under the EIA scenario and $17.6 billion under the 80x50 scenario. In each case, approximately 75 percent of this estimated charging infrastructure cost is for home chargers and the rest is for publicly accessible chargers.

2 This analysis begins in 2025, so significant annual net benefits have not yet accrued, while necessary investments in infrastructure have already been made. Depending on annual mileage and electricity rates, PEV owners will experience a net reduction in annual costs, compared to gasoline vehicles, between 2025 and 2030; the break-even point varies by state and utility service territory.

3 The starting point for the 80 percent reduction varies by state, from 1990 to 2006. Some of these states have adopted an 80 percent reduction goal for economy-wide GHG emissions in 2050.

Approximately 30 percent of the estimated cost of public charging infrastructure is for direct current fast chargers (DCFC), with the remainder for lower power Level 2 public chargers, including workplace chargers.

As shown in Figure 1, by 2035 cumulative benefits from PEV use in these utility service territories is projected to exceed $7 billion under the EIA scenario and $56 billion under the 80x50 scenario. Approximately 28 percent of these benefits will accrue directly to PEV owners as savings in vehicle operating costs (compared to owning gasoline vehicles), 47 percent will accrue to utility customers as savings on their electric bills, and 25 percent will accrue to society at large from reduced pressure on climate change due to GHG emission reductions.

By 2035, the estimated cost of the required PEV charging infrastructure is about one third of these cumulative PEV benefits under the EIA scenario, and roughly 30 percent of cumulative PEV benefits under the 80x50 scenario. After subtracting the estimated cost of charging infrastructure, the cumulative net benefits of transportation electrification in these twelve utility service territories still exceed $5 billion in 2035 under the EIA scenario and $38 billion under the 80x50 scenario. In future years after 2035 annual net benefits will increase faster than additional charging infrastructure investments, so cumulative net benefits will continue to increase.

Given the substantial net benefits to utility customers, vehicle owners and broader society from transportation electrification, it is incumbent upon utilities, state regulators, policy makers, and other key stakeholders to implement a full suite of policies and programs to support the transformation of the market.

Recommendations

Given the substantial net benefits to utility customers, vehicle owners and broader society from transportation electrification, it is incumbent upon utilities, state regulators, policy makers, and other key stakeholders to implement a full suite of policies and programs to support the transformation of the market. Market transformation to advance transportation electrification will support diverse state and local policy goals at the same time—including energy independence and security, climate change mitigation, air quality improvement, and local economic development. Market transformation will be aided by:

- Developing and approving ambitious, cost-effective and scalable PEV charging infrastructure plans that maximize the combined benefits.
- Identifying key obstacles and barriers to increased PEV deployment, such as equitable access to infrastructure, and lack of consumer awareness, and develop solutions to overcome these barriers.
- Implementing programs that reduce financial risk for private charging station owners, such as by providing direct financial incentives for the development of vehicle charging stations by private companies.
- Designing proper PEV market incentives, such as cash rebates and tax credits, to reduce the cost of PEV purchase in the short term.
- Developing and approving customer rate designs, such as time-of-use (TOU) rates for electric vehicles, that maximize benefits to the electricity system, while also offering cost-effective charging options for vehicle owners.

1 BACKGROUND ON THE STATES STUDIED

1.1 State Policy Goals for Vehicle Electrification and GHG Reduction

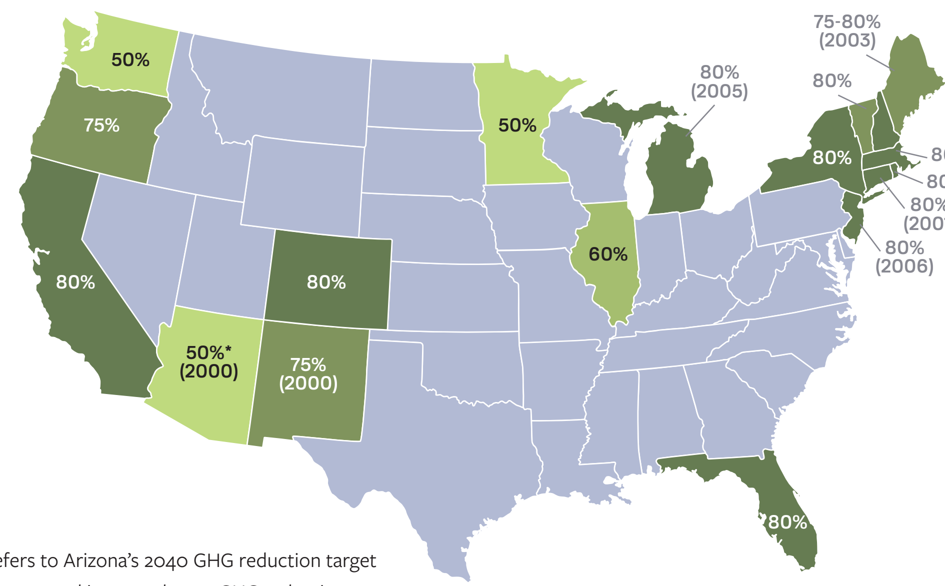
Figure 2 shows the long-term GHG reduction goals which have been adopted by various U.S. states. For the most part these are goals for economy-wide GHG reduction in 2050; the starting point for these reduction goals varies by state, from 1990 to 2006. Many of these states also have interim goals for GHG reductions in 2025, 2030, or 2035.

Of the states included in this analysis, California, Massachusetts, New York, and Maryland have all adopted state level goals for an 80 percent reduction in GHG emissions by 2050. While Ohio, Pennsylvania and Georgia have not adopted long-term state level GHG reduction goals, several major cities in these states have city-level GHG reduction goals and have committed to support the Paris Climate Agreement. The following cities have pledged support of the Accord and have adopted GHG reduction targets:

- Cleveland—80% of 2010 levels by 2050 (Cleveland Climate Action Plan)
- Cincinnati—84% of 2008 levels by 2050 (Green Cincinnati Plan)
- Pittsburgh—20% of 2003 levels by 2023 (Pittsburgh Climate Action Plan)
- Philadelphia—Currently considering options to achieve 80% reductions by 2050 (2012 levels)
- Atlanta—80% of 2009 levels by 2050 (Atlanta Climate Action Plan)

California, Massachusetts, New York, and Maryland have all adopted California vehicle emission standards, which include a zero-emission vehicle (ZEV) mandate that requires auto manufacturers to sell increasing numbers of ZEVs in the participating states each year between 2018 and 2025. These states are also signatories to the 8-state ZEV Memorandum of Understanding (ZEV MOU), which pledges participating states to enact policies that will ensure the deployment of 3.3 million ZEVs and supporting charging infrastructure in participating states by 2025. California's share of the ZEV mandate is 1.5 million ZEVs, New York's share is 850,000 ZEVs, and Maryland and Massachusetts' shares are 300,000 ZEVs each on state roads by 2025.

Figure 2: Long Term (2050) State Goals for Economy-Wide GHG Reduction



* Refers to Arizona's 2040 GHG reduction target

Unless noted in parentheses, GHG reduction targets are below 1990 emission levels

To encourage adoption, California, Massachusetts, New York, and Pennsylvania provide consumers with cash rebates of up to $2,500 for the purchase or lease of a PEV. California, Massachusetts, New York, Pennsylvania, and Maryland also provide financial incentives—ranging from tax credits to grants and rebates—for charging infrastructure installations.

1.2 Current Status of Vehicle Charging Infrastructure Deployment

See **Table 1** for a summary of the existing publicly accessible electric vehicle charging infrastructure in the states of California, Georgia, Maryland, Massachusetts, New York, Ohio, and Pennsylvania [1], including publicly accessible Level 1, Level 2, and direct current fast-charge (DCFC) ports.[4]

Table 1: Current Publicly Accessible Electric Vehicle Charging Infrastructure

STATE	Number of Stations	Number of Ports			
		Level 1	Level 2	DCFC	TOTAL
California	3,876	596	11,173	1,601	13,370
Georgia	606	183	1,352	244	1,779
Maryland	448	77	888	153	1,118
Massachusetts	484	45	1,122	111	1,278
New York	766	70	1,357	168	1,595
Ohio	283	5	443	132	580
Pennsylvania	323	14	539	137	690

Source: U.S. DOE, Alternative Fuels Data Center

Of the stations listed in Table 1, many are fully accessible 24 hours per day, while others are only accessible during normal business hours of the host site. Some stations require a user to call ahead, and others require a card key to access them, which is available to regular users from the host.

California has been at the forefront of EV charging infrastructure policy. Major investor owned utilities (IOUs) have developed programs to help accelerate the deployment of PEV infrastructure. The California Public Utilities Commission (CPUC) has approved programs for San Diego Gas & Electric (SDG&E), Southern California Edison (SCE), and Pacific Gas & Electric (PG&E).[5] In addition, these CA IOUs have also proposed additional charging infrastructure investment programs to the CPUC for medium- and heavy- duty vehicles, as well as for Marine ports.

In Massachusetts, the two largest utilities (National Grid and Eversource), in early 2017 proposed charging infrastructure programs which combined would facilitate the installation of over 5,000 Level 2 ports and approximately 150 DCFC stations over the next 5 years.

In Ohio, AEP proposed a four year $8 million program to install 250 Level 2 Public Smart Chargers, 25 DC Fast Chargers, and 1,000 Residential Chargers.

Georgia Power's $12 million *Get Current Program* has already provided rebates for over 550 Level 2 chargers at commercial and residential locations.

4 Level 1 chargers operate at 120 volts alternating current (AC), and are limited to 1.9 kilwatts (kW) charge rate. Level 2 chargers operate at 240 volts AC and can charge at rates between 4.8 and 9.6 kW. DCFCs operate at voltages above 480 volts direct current (DC), and for light-duty vehicles generally charge at rates between 25 kW and 100 kW.

5 SDG&E's "Power Your Drive Program" is a three-year, $45 million program to install, own, and operate 3,500 Level 2 stations at workplaces and multiple unit dwelling locations. SCE's "Charge Ready Pilot" is a $22 million program to install up to 1,500 Level 1 and 2 stations at workplaces, multiple unit dwellings, destination centers and fleet sites. At the conclusion of the pilot, SCE will seek authority from the CPUC to expand the program to bring the total number of charging stations to about 30,000 for a total estimated cost of $355 million. PG&E's PEV Infrastructure and Education program will deploy 7,500 Level 2 charging stations over a three-year period and provides for rate recovery up to $130 million.

2 STUDY RESULTS—ESTIMATED CHARGING NEEDS

This study estimates that in the twelve utility service territories studied there will be a total of 1.3 million PEVs in 2025 under the EIA penetration scenario, rising to 2.9 million in 2035. Under the 80x50 penetration scenario there will be 6.5 million PEVs in 2025, rising to 19.1 million in 2035. The highest number projected by EIA is for the Pacific Gas & Electric service territory in California (510,000 in 2035) and the lowest is for the Duke Energy service territory in Ohio (79,250 in 2035). The relative number of total PEVs projected in each utility service territory is generally proportional to the number of residential customers served.

In order to accommodate this level of PEV adoption, by 2035 more than 100,000 public charge ports will likely be required in these utility service territories under the EIA scenario and over 750,000 will likely be required under the 80x50 scenario.[6] This is in addition to an estimated 2.6 million home chargers under the EIA scenario and 17.5 million under the 80x50 scenario.

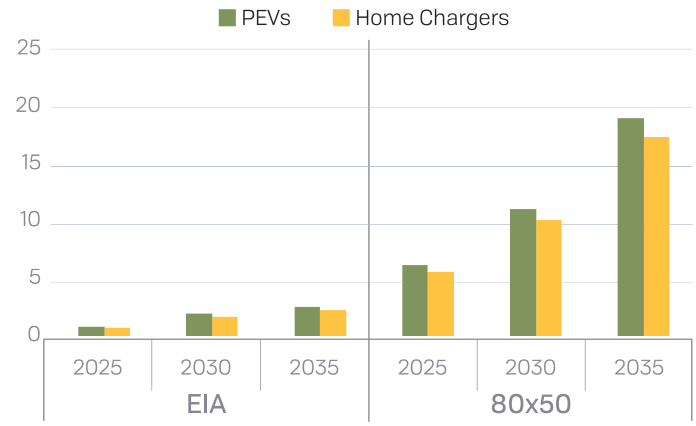
This section briefly discusses the estimated number and type of chargers required in all twelve utility service territories, the estimated cost of these chargers, and the estimated societal benefits of greater PEV use. More detailed results for each utility service territory can be found in Appendix A.

All costs are shown as the net present value of estimated costs, using a three percent discount rate.

2.1 Number of Charge Ports Required

Figure 3 provides a summary of the projected number of PEVs in the twelve utility service territories under each penetration scenario, and the projected number of home chargers required to accommodate them. As discussed further in Section 4.2, the number of home chargers is slightly less than the number of PEVs because not everyone living in a multiple unit dwelling will be able to install a home charger; some of these PEV owners will need to rely on public charging infrastructure. Of the estimated home chargers, 41 percent are projected to be Level 2 chargers and 59 percent are projected to be lower power Level 1 chargers.

Figure 3: Estimated PEVs and Required Home Chargers, 12 Utility Service Territories (Millions)

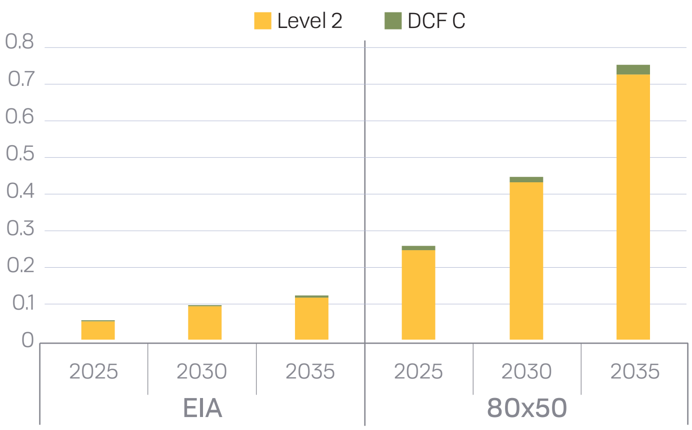


Both the average number of home chargers per PEV, and the percentage that are Level 2 varies by utility service territory—see Appendix A. Average home chargers per PEV is primarily affected by the percentage of housing units in multiple unit dwellings. The percentage of home chargers that are Level 2 is affected by the percentage of housing units in multiple unit dwellings, and the percentage of total PEVs that are hybrid electric or PHEVs—a PHEV owner is much more likely to rely on a Level 1 charger, while a battery electric or BEV owner is much more likely to purchase a higher-power Level 2 charger.

See **Figure 4** for a summary of the estimated number of publicly accessible charge ports that will be required in the twelve utility service territories under each penetration scenario. Under the EIA (low) scenario 121,000 public charge ports are projected to be required by 2035 to support 2.9 million in-use PEVs. Under the 80x50 (high) scenario 754,000 public charge ports are projected to be required by 2035 to support 19.1 million in-use PEVs. Of these estimated public charge ports, approximately 4 percent are DCFC, and 96 percent are Level 2 chargers.

6 This is a central estimate based on expected consumer behavior with respect to the choice of PEV charging time and location. See Section 2.2 and Appendix A for discussion of the potential range of estimated charging infrastructure required, based on varying assumptions about PEV owner charging behavior.

Figure 4: Estimated Required Public Charge Ports, 12 Utility Service Territories (Millions)



2.2 Cost of Charging Infrastructure

The projected cost (NPV) of the required charging infrastructure in the twelve utility service territories under each penetration scenario, including for both home chargers and public chargers, is summarized in Figure 5. In 2035 the total charging infrastructure (for both home and public) required to support 2.9 million PEVs (EIA scenario) is projected to cost $2.7 billion, while the total charging infrastructure required to support 19.1 million PEVS (80x50 scenario) is projected to cost $17.6 billion (NPV). Under both scenarios this equates to approximately $931 per in-use PEV. Of these total charging infrastructure costs approximately 75 percent ($703/PEV) are for required home chargers and 25 percent ($228/PEV) are for required public chargers.

Figure 5: Estimated Cost of Charging Infrastructure, 12 Utility Service Territories (NPV $ Billion)

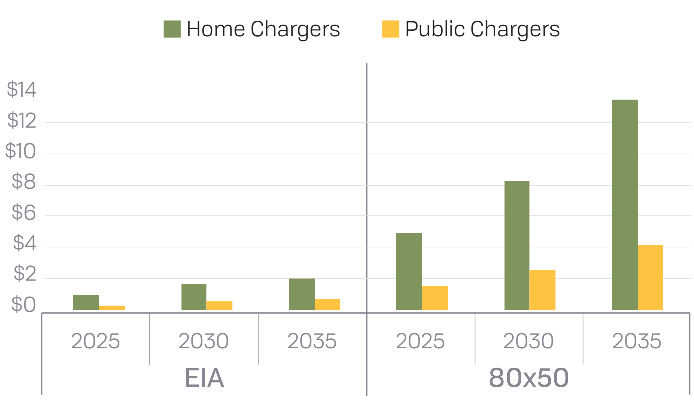
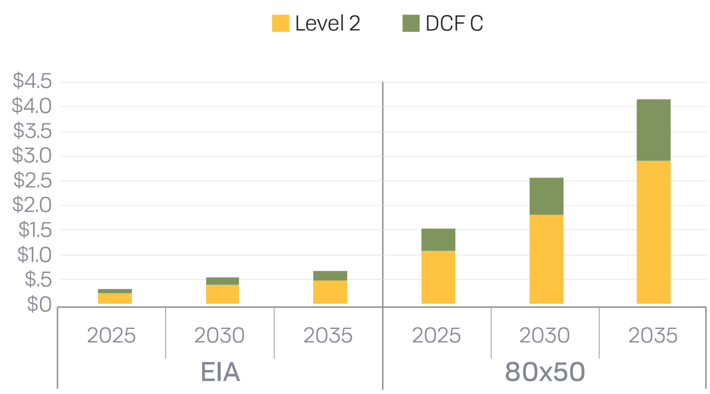


Figure 6 summarizes the estimated cost of public chargers, by type. Approximately 30 percent of the estimated cost of public charging infrastructure is for the required DCFC ($66/PEV) and 70 percent ($162/PEV) is for required Level 2 chargers (at workplaces and other public locations).

Figure 6: Estimated Cost of Public Charging Infrastructure, 12 Utility Service Territories (NPV $ Billion)



As a point of comparison, the major U.S. wireless telecommunication companies[7] spend over $45 billion per year to build out their U.S. networks [2]. Federal, state, and local investments in transportation, drinking water and wastewater infrastructure totaled $416 billion in fiscal year 2014, with the largest share ($165 billion) spent on highways [3].

2.3 Cost of Charging Infrastructure Compared to PEV Benefits

In each of the twelve utility service territories studied, by 2035 PEVs are projected to provide $300 - $500 per PEV in annual benefits under the EIA scenario, and $400 - $800 per PEV in annual benefits under the 80x50 scenario (NPV).[8] Of these annual benefits, $125 - $200/PEV are reductions in annual out-of-pocket operating expenses for PEV owners, due to lower fuel and maintenance costs, which outweigh the increased cost to purchase a PEV compared to a gasoline vehicle. Another $275 - $300/PEV are projected reductions in annual electric bills for all of the utilities' customers, due to net revenue that the utilities will receive from the electricity they sell for PEV charging. This additional net revenue can be used by each utility to maintain the existing electric distribution infrastructure, which will put downward pressure on future rate increases, and will therefore be passed on to consumers in accordance with Public Utility Commission

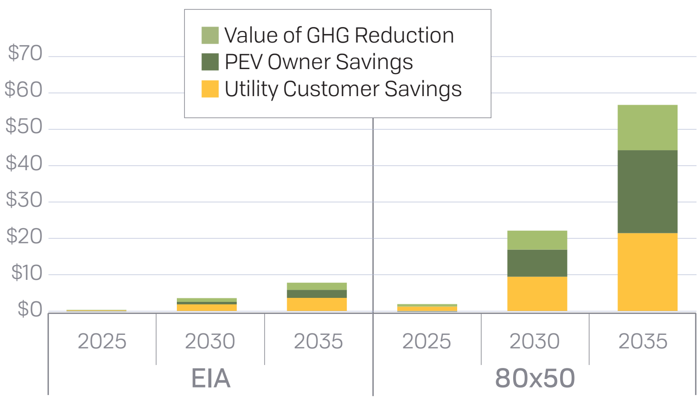
7 AT&T, T-Mobile, Sprint, and Verizon

8 This estimate of benefits does not include the cost of home or public charging infrastructure.

rules in each state. The remainder of the estimated annual benefits is the monetized value of projected GHG reductions from using PEVs instead of gasoline vehicles.

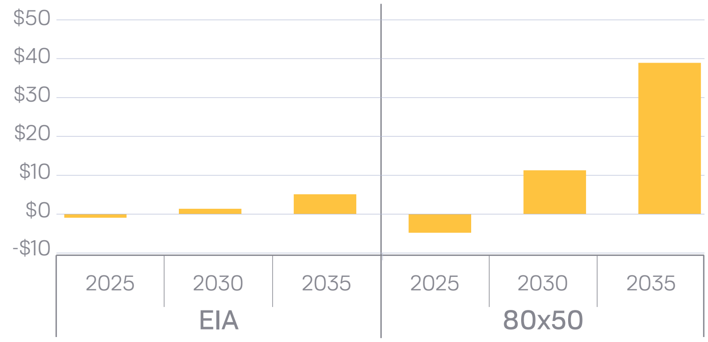
As shown in **Figure 7**, by 2035 cumulative benefits from transportation electrification in the twelve utility service territories studied will exceed $7.8 billion (NPV) under the EIA penetration scenario and $56.7 billion (NPV) under the 80x50 penetration scenario. Of these cumulative benefits 34 percent will accrue directly to PEV owners, 42 percent will accrue to utility customers, and 24 percent will accrue to society at large, from reduced pressure on climate change due to reduced GHG emissions.

Figure 7: Cumulative PEV Benefits, 12 Utility Service Territories (NPV $ Billion)



In the 12 utility service territories studied, a summary of estimated cumulative net benefits of transportation electrification, accounting for the estimated cost of necessary charging infrastructure is shown in **Figure 8**. As shown, in the short-term a small net societal investment will be required for charging infrastructure build-out, but by 2030 projected cumulative net benefits exceed $1.4 billion under the EIA scenario and $11.3 billion under the 80x50 scenario. After 2030, annual PEV benefits exceed annual infrastructure investments, resulting in increasing cumulative net benefits year by year. By 2035 cumulative net benefits of transportation electrification in these twelve utility service territories are projected to exceed $5.1 billion under the EIA scenario and $38.9 billion under the 80x50 scenario.

Figure 8: PEV Cumulative Net Benefits Including Infrastructure Costs, 12 Utility Service Territories (NPV $ Billion)



2.4 Ancillary Air Quality Benefits—NOx and VOC Reduction

In 2015 the Electric Power Research Institute (EPRI), in conjunction with the Natural Resources Defense Council (NRDC), conducted national-level modeling to estimate GHG and air quality benefits from high levels of transportation electrification [4]. This modeling included electrification of light-duty and heavy-duty on-road vehicles, as well as select non-road applications. For light-duty cars and trucks the analysis assumed that by 2030 approximately 17 percent of annual vehicle miles would be powered by grid electricity, using battery electric and plug-in hybrid vehicles. Based on current and projected electric sector trends the analysis also assumed that approximately 46 percent of the incremental power required for transportation electrification in 2030 would be produced using solar and wind, with the remainder produced by combined cycle natural gas plants.

Based on these assumptions EPRI estimates that compared to baseline emissions without electrification, in 2030 annual emissions of nitrogen oxides (NOx) and volatile organic compounds (VOC) from light-duty cars and trucks would be reduced by 7.3 percent and 3.8 percent, respectively, under their electrification scenario.[9] EPRI estimated that fleet-wide NOx would be reduced by 99 tons per day and VOCs would be reduced by 48 tons per day; this equates to a reduction of 11.4 tons NOx and 5.5 tons VOCs for every billion vehicle miles.

9 This reduction is net of additional emissions from electricity production.

Extrapolating from this data, under the low (EIA) penetration scenario analyzed in this project, by 2035 light-duty vehicle electrification could reduce total annual NOx emissions by 24,900 tons per year and reduce total annual VOC emissions by 12,000 tons per year across the twelve utility service territories studied—on average about a two percent reduction in baseline fleet NOx emissions. Under the high (80x50) scenario, total NOx reductions in 2035 could reach nearly 174,000 tons per year, and total VOC reductions could reach almost 84,000 tons per year—on average about a 17 percent reduction in baseline fleet NOx emissions.[10]

According to the EPA, the monetized value of these NOx reductions—due to reductions in negative health effects—would range from $200 to $500 million per year by 2035 under the low penetration scenario, and $1.4 to $3.6 billion per year under the high penetration scenario [5].[11]

According to the EPA, the monetized value of these NOx reductions—due to reductions in negative health effects—would range from $200 to $500 million per year by 2035 under the low penetration scenario, and $1.4 to $3.6 billion per year under the high penetration scenario.

10 Across the twelve utility service territories, estimated annual light-duty vehicle miles traveled (VMT) totals 0.53 trillion miles in 2035. Of these miles approximately 6 percent are powered by grid electricity under the EIA penetration scenario, and 41 percent are powered by grid electricity under the 80x50 penetration scenario

11 EPA estimates that the monetized value of NOx reductions from onroad vehicles in 2030, due to decreased mortality and morbidity, ranges from $8,200 - $21,000 per ton of NOx reduced (2010 dollars).

3 POLICY RECOMMENDATIONS

As the results described above show, transportation electrification has the potential to provide significant economic and environmental benefits in the medium and long-term, and these benefits will be shared widely throughout society. However, the realization of these benefits is not assured; in the short term many obstacles to wide-spread PEV adoption remain. The most critical of these are lack of public awareness of how far the technology has come, high initial cost for vehicle and charger purchase, and uncertainty as to whether sufficient public charging infrastructure will be available to make a PEV the right choice to adequately meet an individual or family's travel needs.

Public policies and programs specifically focused on overcoming these barriers will therefore be critical to accelerating the PEV market. Properly designed PEV market incentives can advance diverse state and local policy goals at the same time—including energy independence and security, climate change mitigation, air quality improvement, and local economic development. State and local policymakers should prioritize these policies and programs in the near-term to aid in the transformation of the transportation sector from one that is dominated by petroleum fuels to one that is increasingly powered by electricity.

3.1 Making PEVs More Affordable

Even though PEV owners can save money on fuel and maintenance costs over the life of the vehicle, high purchase costs remain a significant barrier for many people in the market for a new car. Policies to make PEVs more affordable are therefore critical to accelerate PEV market development in the short term. These policies can come in many forms. The most common is a direct financial incentive for the purchase of an electric vehicle—a cash grant, voucher or rebate, or a tax credit. For example, the *Massachusetts Offers Rebates for Electric Vehicles* (*MOR-EV*) program provides rebates of up to $2,500 to customers purchasing or leasing PEVs. In New York, NYSERDA's Drive Clean Rebate program provides up to $2,000 for the purchase or lease of a PEV.

Other more creative incentives that indirectly reduce the cost of vehicle ownership, and which have been implemented by various states and cities, include exempting EVs from state inspection requirements; discounted tolls for EVs; free or preferential parking for EVs; and EV access to car pool lanes, even when driving with no passengers. Some states also indirectly reduce the cost of PEV purchase by providing sales tax exclusions, or income tax credits, to PEV manufacturers.

A recent study evaluated the link between key electric vehicle support activities and market adoption in several metropolitan areas, and found that incentives that increase awareness and reduce the initial cost barrier drive PEV adoption. Ten of the top 12 major metropolitan areas with the highest electric vehicle adoption all offered consumer purchase incentives typically worth $2,000 to $5,000 per PEV.[6]

Policies to make home EV chargers more affordable are also critical to reduce the upfront costs to consumers. For example, Georgia Power offers a $250 rebate to residential customers who install Level 2 EV chargers, and builders are eligible for a $100 rebate for each dedicated circuit installed in new construction from Jan. 1, 2017, through Dec. 31, 2017.

Another way to make PEVs more affordable is to develop PEV-specific pricing mechanisms for the electricity used to charge them. If done correctly, PEV-specific tariffs can reduce the cost of owning a PEV while at the same time benefitting other users of the grid—by providing financial incentive to shift vehicle charging to off-peak hours when generation and distribution infrastructure are underutilized. PEV-specific rates are often structured as "time-of-use" rates that charge a lower price ($/kWh) for electricity consumed during off-peak hours. Recent state-level PEV cost-benefit analyses have demonstrated that off-peak charging can significantly increase an electric utility's net revenue from the energy sold for PEV charging, and can put downward pressure on future electricity rates. [7] Some utilities have begun to experiment with other ways to incentivize PEV owners to charge off-peak. For example, in New York City Consolidated Edison has developed an off-peak charging, incentive program that provides monthly cash payments and energy rebates to PEV owners that charge off-peak. [8] Baltimore Gas and Electric Company (BGE) and Georgia Power offer time-of-use rates for residential PEV customers.

A recent study evaluated the link between key electric vehicle support activities and market adoption in several metropolitan areas, and found that incentives that increase awareness and reduce the initial cost barrier drive PEV adoption.

State policy makers should work with public utility commissions to encourage the development of EV-specific rate or incentive programs that can reduce the cost of PEV ownership, while minimizing grid impacts and ensuring that all electric rate payers share in the significant benefits of transportation electrification.

3.2 Incentivizing Infrastructure Development

Many consumers are hesitant to purchase an EV because they are not confident that they will be able to find publicly accessible chargers where and when they need them. Private companies are hesitant to install public charging infrastructure because they are not confident that there will be enough EVs on the road to provide a solid return on their investment. State and local governments can help to overcome this impasse—policies and programs to support and encourage the deployment of private and public charging infrastructure are critical to foster the development of the electric vehicle market. A recent study of EV adoption in several metropolitan areas found that the availability of public and workplace charging is directly linked with electric vehicle market development [9].

Some automakers are investing in charging infrastructure to support electric vehicle adoption, and to help ensure a positive experience for their customers. For example, Tesla is building out its supercharger network and offered free charging for customers that purchased a vehicle prior to January 2017. The company has committed to install thousands of chargers through the end of 2017. Other automakers, including Nissan and BMW, also offer free charging periods for customers, and have partnered with third party electric vehicle charging providers such as EvGo and Chargepoint to build infrastructure. Finally, Electrify America will invest $2 billion over the next 10 years in charging infrastructure and education programs in the U.S. Over four 30-month cycles, Electrify America will invest $1.2 billion nationwide (in states other than California) and $800 million in California. [10]

Despite these efforts more needs to be done in virtually every state and region. State policy makers can help by implementing programs that reduce financial risk for private charging station owners. To that end, several states and municipalities currently provide direct financial incentives for the development of vehicle charging stations by private companies. These incentives include subsidies or grants, investment tax credits, manufacturer tax credits, low-interest loans, and cash rebates. For example, in New York, a state income tax credit for 50 percent of the cost, up to $5,000, is available to companies that install EVSE. The *Massachusetts Electric Vehicle Incentive Program* (*MassEVIP*) provides grants for 50 percent of the cost of Level 1 or Level 2 workplace EVSE, up to $25,000. Maryland provides rebates that range from $700 to $5,000, for 40 percent of the costs of acquiring and installing qualified EVSE. In Georgia, businesses are eligible for an income tax credit for 10 percent, up to $2,500, of the costs of the EVSE installation.

Many states and municipalities have also adopted zoning and building codes that require developers of new buildings to invest in "make-ready" infrastructure that will make installation of charging stations easier and less costly, as well as revised permitting rules and guidelines that can accelerate electric vehicle charging projects.

In addition to direct government incentives for electric vehicle charging infrastructure, utility infrastructure investment programs have also recently begun, are in the planning stages, or are currently under review by state public utility commissions. Utilities are proposing to make investments in the distribution network to accommodate the increased load associated with electric vehicles; are investing in the make-ready portion of the infrastructure, to reduce the cost of installing electric vehicle charging stations for third party developers; and in several cases are deploying turnkey electric vehicle charging infrastructure to spur the development of the electric vehicle market in their service areas. Regardless of who owns and operates a vehicle charging station, electric utilities will always be involved in the development process because the station must be connected to their distribution systems. As such, electric utilities are critical to establishing the charging network that will spur and support transportation electrification.

Some automakers are investing in charging infrastructure to support electric vehicle adoption, and to help ensure a positive experience for their customers. For example, Tesla is building out its supercharger network and offered free charging for customers that purchased a vehicle prior to January 2017.

In California, the state's three investor-owned utilities (IOUs) all have EV infrastructure investment programs that will deploy at least 12,500 charging stations throughout the state over the next three years. Southern California Edison's approved program deploys a make-ready approach and gives ownership to the host site, San Diego Gas & Electric has adopted a turnkey approach and will own its charging stations, and PG&E will have limited ownership of its EVSE based on market segment, while deploying make-ready infrastructure. In Massachusetts, both Eversource and National Grid submitted proposals in January 2017 to the Massachusetts Department of Public Utilities (DPU) for make-ready infrastructure projects, although the amount of infrastructure each utility plans to provide differs slightly. In addition, AEP Ohio submitted a proposal for a 4-year rebate incentive program to support the deployment of Level 2 and DCFC stations in its service territory.

In addition to their role in infrastructure development, utilities are also in a unique position to help build awareness among their customers, and can significantly reduce the financial risk to charging station developers—especially in the short term as the PEV market develops—by providing special rate structures for commercial charging stations. Commercial electricity customers typically pay demand charges, which can account for 50 percent or more of a monthly electric bill. This is not a problem for most buildings and industrial facilities, for which demand does not fluctuate significantly from day-to-day or month-to-month. However, for commercial charging stations, the structure of traditional demand charges can result in substantial fluctuations in monthly electricity costs, particularly when station utilization is low and highly variable due to small numbers of PEVs on the road. This financial risk can be a significant barrier to private development of charging infrastructure. To alleviate this risk, some utilities are developing special tariffs for commercial charging stations that reduce or eliminate traditional demand charges in the first few years of station operation, and substitute higher power charges during peak periods. For example, Southern California Edison has proposed a rate with no facility demand charges for the first five years; these charges are phased in between years 6 and 11. Even after 11 years, demand chargers are lower than the charges under other applicable commercial tariffs. [11]

State policymakers and public utility commissions should engage with utilities and other stakeholders to enhance and facilitate the positive role that utilities can play in advancing the electric vehicle market—through development of utility infrastructure investments, customer outreach and awareness programs, and rate structures that incentivize off-peak charging and mitigate risk for commercial charging station operators.

3.3 Broader Transportation Policies

In addition to financial incentives for the purchase of electric vehicles and installation of charging infrastructure, some states have implemented or are considering broader policies to reduce GHG emissions from the transportation sector. These policies have the potential to provide both direct financial inventive to use electric vehicles and fund other transportation electrification incentives.

One such policy is a low carbon fuel standard (LCFS), which requires a reduction in the carbon intensity of the fuels supplied to the transportation sector over time. Electricity qualifies as a low carbon fuel under these programs, creating credits that can be traded to regulated parties, thus creating a value stream for using electricity as a transportation fuel. For example, California electric utilities, like PG&E, provide EV owners a $500 Clean Fuel Rebate for their use of electricity as a transportation fuel under the LCFS. Utilities earn credits in the LCFS program when customers use electricity at home to charge their electric vehicles, and return the value of these credits to electric vehicle customers.

Another, similar approach that state policymakers should consider is capping GHG emissions from the transportation sector. So-called "cap and invest" policies would establish declining emission caps over time. Through a market-based program, the revenue from the sale of allowances could fund transportation-related investments, including vehicle and/or charger rebates or incentives. [12]

Another key policy supporting PEV market development is the *Zero-Emission Vehicle (ZEV) Standards*, first implemented by California and then adopted by nine other states under Section 177 of the Clean Air Act. Under this program, large vehicle manufacturers must sell zero-emissions vehicles (which include PEVs as well as plug-in hybrid vehicles and fuel cell vehicles) to meet increasingly stringent ZEV credit requirements. The number of credits earned per vehicle depends primarily on electric range: a 2017 Chevy Bolt earns four credits, and a 2017 Nissan LEAF earns three. [13] The California Air Resources Board estimates that total ZEV sales will need to be approximately 2 million by 2025 to produce enough credits for all participating states' compliance. [14] This mandate would be strengthened if other states adopted the standards, as this would require even more ZEV sales.

In addition, governors from California, Connecticut, Maryland, Massachusetts, New York, Oregon, Rhode Island, and Vermont signed the Zero-Emission Vehicle Memorandum of Understanding (ZEV MOU) in 2013, committing to deploy 3.3 million ZEVs by 2025, along with the necessary charging and fueling infrastructure. The governors established a multi-state ZEV Task Force to coordinate policies and programs to increase the sale of ZEVs, including vehicle purchase incentives, promoting public and workplace charging, and working towards equitable access to charging stations. [15] States are also collaborating to grow regional networks of charging infrastructure, through initiatives such as the West Coast Electric Highway and the Northeast Electric Vehicle Network.

Given the net benefits associated with greater adoption of electric vehicles, state policymakers should look to implement a full suite of policies and programs to support the transformation of the market including:

- **Vehicle purchase incentives.** Cash rebates and tax credits for the purchase of electric vehicles to reduce the upfront costs to the consumer.
- **Electric vehicle charging infrastructure.** Rebates, grants and tax credits to facilitate the purchase and installation of private and public electric vehicle charging infrastructure.
- **Utility electric vehicle programs.** Solicitation and support for electric utility program proposals including consumer outreach and education, electric vehicle charging rate design, and investment in charging infrastructure.

4 STUDY METHODOLOGY

This study used a state-level PEV cost-benefit modeling framework developed by MJB&A to estimate the number of PEVs in each utility service territory, as well as total energy use (kWh) and daily load (kW) for PEV charging, for each penetration scenario. This information was then used to estimate net societal benefits of these PEVs: utility net revenue from PEV charging, PEV owner cost savings, and GHG emission reductions, relative to continued use of gasoline vehicles. State-specific models were used to develop these estimates for the utilities in Massachusetts, New York, Maryland, and Pennsylvania. The results of these analyses were then used to extend the analysis to utilities in the states of California, Ohio, and Georgia.

A literature review was performed to investigate existing studies that informed this analysis' estimate of the number of home and public chargers of different types that would be required to support the estimated number of PEVs in each utility service territory, and the cost of this charging infrastructure. The estimate of required public chargers per PEV is primarily based on work done by NREL, using their EVI-PRO model, but also considers work done by EPRI and PG&E.

4.1 Cost-Benefit Modeling Framework

This section briefly describes the cost-benefit modeling framework used for this study. For more detail about this framework, including a complete discussion of the assumptions used and their sources, see the report: *Mid-Atlantic and Northeast Plug-in Electric Vehicle Cost-Benefit Analysis, Methodology & Assumptions* (October 2016).[12]

This study evaluates the costs and benefits of two different levels of PEV penetration in the target states and utility service territories between 2025 and 2035. Penetration rates in each year will vary from the state average in different utility service territories, based on differences in assumed county-level PEV penetration in each state.

The low penetration scenario is based on EIA's current projections for new PEV sales between 2015 and 2035, as contained in the 2017 Annual Energy Outlook(AEO). Under this scenario, PEVs will increase from 2.8 percent of the in-use light-duty fleet in 2025, to 6.1 percent in 2035, in each of the states analyzed. The differences in PEV penetration for different counties used for this analysis are based on current penetration rates for hybrid-electric vehicles.

The low penetration scenario is also consistent with most independent analysts' current estimates of future PEV sales, including recent estimates by UBS, Navigant, and Edison Electric Institute [16]. The exception is a recent forecast produced by Bloomberg New Energy Finance, which estimates that annual PEV sales will accelerate significantly after 2025, resulting in a penetration rate of almost 20 percent by 2035 [17].

The high penetration scenario is based on an analysis of the level of PEV penetration that would be required in each state by 2050 to achieve an 80 percent reduction in GHG emissions from the light-duty fleet. The starting point for this 80 percent reduction is assumed to be 1990 for California, New York, and Massachusetts, and 2006 for Georgia, Ohio, and Maryland, in accordance with current state policy. Because Pennsylvania currently has no long-term goal for GHG reduction, the starting point for the 80 percent reduction was assumed to be 1990, consistent with adopted goals of surrounding states. To achieve an 80 percent reduction in fleet emissions, 80-97 percent of light-duty vehicles in these states would need to be PEV in 2050. To get onto that trajectory, 15-16 percent of light-duty vehicles would need to be PEV in 2025 and 42-45 percent would need to be PEV in 2035.

Both the low and high penetration scenarios are compared to a baseline scenario with minimal PEV penetration, and continued use of gasoline vehicles. The baseline scenario is based on future annual vehicle miles traveled (VMT) and fleet characteristics (e.g., cars versus light trucks), as projected by each state's Department of Transportation.

Based on assumed future PEV characteristics and usage (e.g., battery size, range), a projection of annual electricity use for PEV charging for each penetration scenario—as well as the average load from PEV charging by time of day—is established. Total revenue that the states' electric distribution utilities would realize from sale of

12 While the over-all modeling framework used for this study is the same as that described in the referenced report, some of the modeling assumptions were updated. In particular, for this study all assumptions taken from the Energy Information Administration were updated to those in the 2017 Annual Energy Outlook. In addition, this study uses a different time frame (2025 - 2035) than the previous studies described (2030 - 2050), and also uses different PEV penetration scenarios.

this electricity, their costs of providing the electricity to their customers, and the potential net revenue (revenue in excess of costs) that could be used to support maintenance of the distribution system are then estimated.

The costs of serving PEV load include electricity generation, transmission, incremental peak generation capacity costs for the additional peak load resulting from PEV charging, and annual infrastructure upgrade costs for increasing the capacity of the secondary distribution system to handle the additional load.

For each PEV penetration scenario, utility revenue, costs, and net revenue for two different PEV charging scenarios are calculated: 1) a baseline scenario in which all PEVs charged at home are plugged in and start to charge as soon as the driver arrives at home each day, and 2) an off-peak charging scenario in which a significant portion of PEV owners that arrive home between noon and 11 PM each day delay the start of charging until after midnight.

Real world experience from the EV Project demonstrates that, without a "nudge", drivers will generally plug in and start charging immediately upon arriving home after work (scenario 1), exacerbating system-wide evening peak demand.[13] However, if given a "nudge"—in the form of a properly designed and marketed financial incentive—many PEV owners will choose to delay the start of charging until off-peak times, thus reducing the effect of PEV charging on evening peak electricity demand (scenario 2) [18].

The total differential annual cost of purchase and operation for all PEVs in the state is estimated as compared to the purchase and operation of comparable gasoline cars and light trucks for each PEV penetration scenario. For both PEVs and gasoline vehicles, annual costs include the amortized cost of purchasing the vehicle, purchase of gasoline and electricity, and maintenance. These variables are used to estimate average annual financial benefits to PEV owners in the state. For this analysis, the amortized cost of home PEV chargers was not included in the estimate of PEV owner costs, because these costs were included in the estimate of total PEV infrastructure costs.

This analysis also considers certain societal benefits (i.e., GHG emission reductions) of PEV adoption. For each scenario, annual GHG emissions from electricity generation for PEV charging are estimated and compared to emissions from operation of gasoline vehicles. For the baseline and PEV penetration scenarios, GHG emissions are expressed as carbon dioxide equivalent emissions (CO_2-e) in metric tons (MT). GHG emissions from gasoline vehicles include direct tailpipe emissions as well as "upstream" emissions from production and transport of gasoline.

For each PEV penetration scenario GHG emissions from PEV charging are calculated based on EIA's projections (AEO 2017) for future average grid emissions (gCO_2e/kWh) in the relevant region [19].

Net annual GHG reductions from the use of PEVs are calculated as baseline GHG emissions (emitted by gasoline vehicles) minus GHG emissions from each PEV penetration scenario. The monetary "social value" of these GHG reductions from PEV use is calculated using the Social Cost of Carbon ($/MT), as calculated by the U.S. Government's Interagency Working Group on Social Cost of Greenhouse Gases [20]. This analysis uses $65/MT in 2025, rising to $95/MT in 2035 (both in nominal dollars).[14]

4.2 Estimate of Charging Needs

Home Chargers

Data collected under the EV Project show that more than 80 percent of all PEV charging took place at the PEV owner's home, for both battery electric (BEV) and plug-in hybrid (PHEV) vehicles [21]. However, many of the participants did not have access to a workplace charger, or to an extensive network of public chargers. The participants in the EV project who did have access to workplace charging generally used it for 30 to 40 percent of their total charging [22]. Data collected by Chargepoint, an owner of commercial charging station networks, also indicate that up to 40 percent of charging done by its customers occurs at public/commercial stations and 60 percent occurs at home [23].

As PEV range increases and workplace, other public, and DCFC charging infrastructure proliferates, it is reasonable to assume that a greater percentage of charging will be done away from the home, but home chargers will likely always be the primary charging location

13 The EV Project is a public/private partnership partially funded by the Department of Energy which has collected and analyzed operating and charging data from more than 8,300 enrolled plug-in electric vehicles and approximately 12,000 public and residential charging stations over a two year period.

14 These are the average values calculated by the Interagency Working Group using a 3 percent discount rate—in 2007 dollars $46/MT in 2025 rising to $55/MT in 2035—and escalated from 2007 dollars to nominal dollars in each year using EIA inflation assumptions.

for most PEV owners—if only because this is where most vehicles spend the majority of their time. For example, NREL analyzed data from the Massachusetts Travel survey and determined that the average vehicle spent 1.4 hours per day driving, 15.5 hours parked at home, 4.1 hours parked at work,[15] and 3 hours parked at public locations [24].

The exception to this general rule is PEV owners who live in multiple unit dwellings and do not have access to a dedicated parking space where a "home" charger could be installed. These PEV owners will of necessity need to rely more heavily on publicly accessible charging infrastructure.

This analysis assumed that PEV owners living in single family homes would buy one home charger for every PEV, but that PEV owners living in multiple unit dwellings would install an average of 0.75 chargers per PEV (i.e., only three of four PEVs would have a dedicated home charger). The required average number of home chargers per PEV therefore varies across different states and utility service territories based on the percentage of housing units in the territory that are located in multiple unit dwellings.[16] [25]

To estimate total costs for home chargers in each utility service territory, it is also important to estimate the type of chargers that will be purchased—relatively low-cost Level 1 chargers or higher power and higher cost Level 2 chargers.[17] Consistent with the results of NREL's modeling for the state of Massachusetts, this analysis assumes that 80 percent of owners of PHEVs—which have a relatively small battery—would choose to install low-cost Level 1 chargers and 20 percent would choose to install higher cost Level 2 chargers [26]. For a PHEV with a battery large enough to provide 30-mile all-electric range, a Level 1 charger could charge a fully depleted battery in less than six hours.

For owners of BEVs, the assumptions for Level 1 and Level 2 charger deployments differ from PHEVs, where 75 percent of owners living in single family homes and 65 percent living in multiple unit dwellings would choose to install a Level 2 charger, with the rest opting for a Level 1. A Level 2 charger (9.6 kW) could add 100 miles range to a BEV in less than four hours. The assumed percentage of Level 2 chargers in multiple unit dwellings is lower than in single family homes due to the greater difficulty associated with installing Level 2 chargers.

Using these assumptions, **Table 2** shows that the ratio of Level 1 to Level 2 home chargers varies across the different utility service territories based on differences in the percentage of total PEVs that are PHEV versus BEV, as well as the percentage of housing units in multiple unit dwellings.

Table 2: Level 1 and Level 2 Home Chargers

Utility	% Level 1	% Level 2
Pacific Gas & Electric	57%	43%
Southern California Edison	57%	43%
Georgia Power	60%	40%
Baltimore Gas & Electric	60%	40%
Eversource	56%	44%
National Grid (MA)	58%	42%
Consolidated Edison	59%	41%
National Grid (NY)	61%	39%
AEP	61%	39%
Duke Energy	61%	39%
PECO	60%	40%
PPL	64%	36%

Workplace and Other Public Chargers

MJB&A conducted a literature review to identify methodologies used by others to estimate requirements for public charging infrastructure to facilitate and support high levels of PEV adoption. Public chargers could include relatively low power chargers (both Level 1 and Level 2), as well as much higher power direct current fast-chargers (DCFC).[18] Public Level 1 and Level 2 chargers are generally considered to be most useful at locations where PEV owners already park for 15+ minutes on a regular basis as part of their normal routine, most importantly at their workplace, where PEVs might routinely spend 4 - 8 hours most weekdays, but also potentially at shopping malls, restaurants, movie theaters, and other commercial locations. Level 1 or Level 2 chargers at these

15 On days when at least one work trip was recorded the average time spent parked at work was 8.4 hours.

16 For this analysis, housing units in structures identified by the Census Bureau as "1-unit detached", "1-unit attached", and "2 units" were included as single family homes. All housing units in structures identified by the Census Bureau as containing three or more units were counted as multiple unit dwellings.

17 Level 1 chargers operate at 120 volts AC and are limited to 1.9 kW. Level 2 chargers operate at 240 volts AC and can charge at rates between 4.8 and 9.6 kW.

18 DCFCs operate at voltages above 480 volts DC, and for light-duty vehicles generally charge at rates between 25 kW and 100 kW.

locations would allow PEV owners to extend their daily PEV range (for both PHEVs and BEVs) without having to spend extra time waiting for their cars to charge. Level 2 public chargers will likely also be required to facilitate high levels of PEV adoption by people who live in multiple unit dwellings—such as apartment buildings—and may therefore not have access to a dedicated parking space where a home charger could be installed.

DCFC are more analogous to traditional gas stations; they are intended to provide a significant range extension (50+ miles) in a relatively short time (<15 minutes). While DCFC might be installed at locations where people already routinely spend time, or to support PEV owners who live in multiple unit dwellings (in lieu of Level 2 chargers), they could also be installed at stand-alone charging locations—particularly along highways—in order to facilitate long-distance travel in BEVs.

Although there have been a number of academic studies published that have estimated public PEV charging needs in specific situations using various modeling frameworks, most of these studies have adopted specific and restrictive criteria to bound the analysis, in particular limitations on the total cost of chargers [27]. The literature review conducted for this effort identified six studies with more general applicability to the scenarios considered. Four studies were conducted by NREL, one was conducted by EPRI, and one was conducted by PG&E.

NREL has developed a modeling framework that they call EVI-PRO, which "uses PEV market projections and real-world travel data from mass-market consumers to estimate future requirements for home, workplace, and public charging" on a regional basis [26]. NREL has used EVI-PRO to model total public PEV charging needs in the State of California [28], the State of Massachusetts [26], and the City of Columbus, Ohio [29]. In September 2017, NREL also released a more comprehensive *National Plug-in Electric Vehicle Infrastructure Analysis*, which estimated the number of public chargers that would be required to support a total of 9 to 21 million PEVs in the U.S. by 2030 [30]. This analysis provides state-level totals for a central scenario of 15 million PEVs in 2030, aa well as a sensitivity analysis to identify the total number of chargers that would be required nationally when varying a number of key analytical parameters, including the total number of PEVs. All of the NREL analyses project the need for workplace and other relatively low power public chargers, as well as the need for high-power DCFC. In earlier state- and city-level analyses, NREL estimated that workplace chargers would include both Level 1 and Level 2 chargers, while in the recent national analysis they estimate that all public chargers (including workplace chargers) will be Level 2 or DCFC.

The EPRI and PG&E studies are focused solely on the number of DCFC required within the area of study; in the case of EPRI it was a national analysis, and in the case of PG&E it was a study of its own service territory in central and northern California. Neither of these studies estimated the number of workplace chargers required, or needs for other public Level 1 or Level 2 chargers. EPRI used its Red Line/Blue Line model to analyze the need for public and workplace DCFC charging. The model uses four main factors to determine necessary EVSE: charger availability, vehicle electric range, location type, and charge power [31]. The PG&E study developed an online, interactive map of PG&E's service territory that predicted the unmet charger demand and identified potential host sites for EVSE. [32]

The NREL, EPRI, and PG&E studies are generally in agreement about the number of DCFC that will be required to support high levels of PEV adoption. EPRI estimated that between 1.7 - 5.2 DCFC charge ports would be required for every 1,000 PEV, while PG&E estimated that 2.2 - 3.7 ports/1000 PEV would be required. The NREL analysis indicates that 0.5 - 6.7 ports/1000 PEV would be required (sensitivity analysis), with a central

DCFC [fast-chargers] are more analogous to traditional gas stations; they are intended to provide a significant range extension (50+ miles) in a relatively short time (<15 minutes).

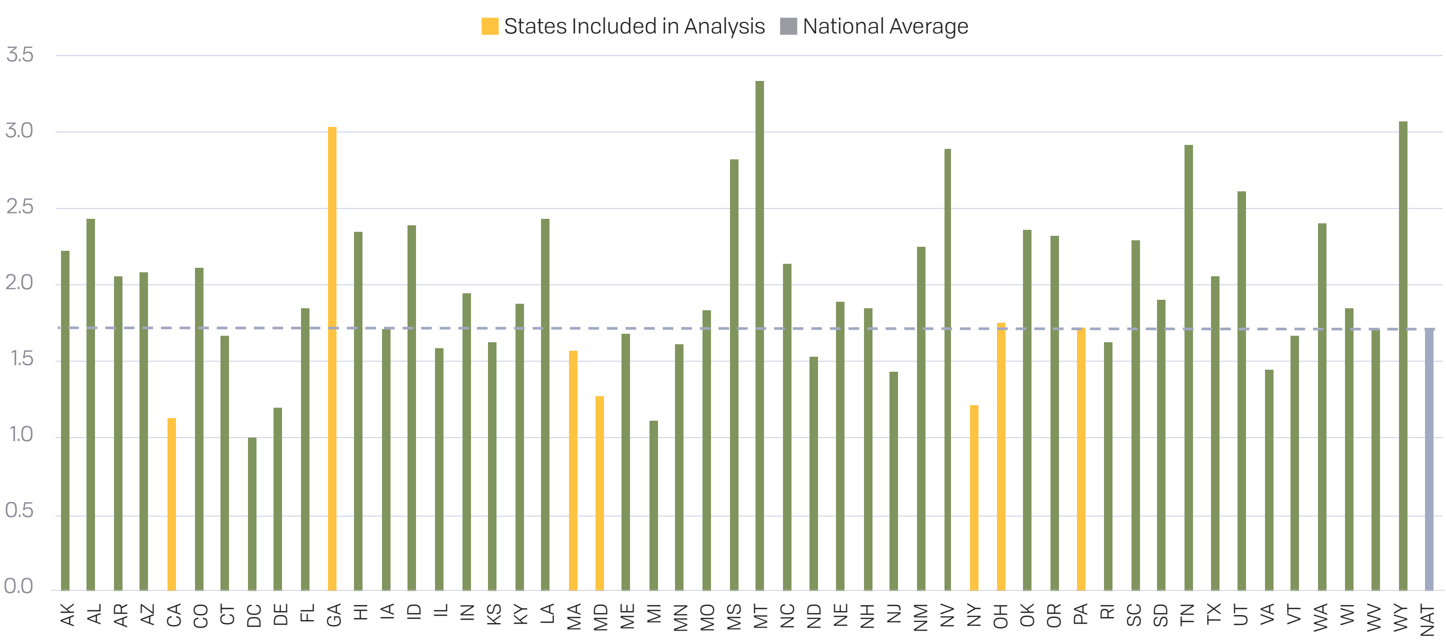
estimate of 1.7 ports/1000 PEV at the national level based on its primary adoption scenario. The central estimate of required DCFC varies by state—from a low of 1.0 to a high of 3.3 ports/1000 PEV. The NREL central estimate for each state is shown in **Figure 9**. In this figure the states included in this analysis are highlighted in yellow, and the national average is shown in grey. These are the values used in this analysis to estimate the total number of DCFC ports required in each utility service territory, based on the PEV adoption scenarios (average values). To estimate the high and low range of infrastructure required in each state, the range of values estimated by NREL at the national level (-70 percent to +390 percent) was applied to the central estimates shown in Figure 9.

Although a comparison of DCFC to gas pumps is an imperfect gauge for a number of reasons,[19] it does give a sense of the scale and coverage of charging infrastructure envisioned by this analysis. As a point of comparison, there are currently approximately 4 gas pumps per 1,000 light-duty vehicles in the U.S. [33].

NREL's central estimates of the number of public Level 2 charge ports—including workplace chargers—required per 1000 PEV in each state are shown in **Figure 10**. In this figure, the states included in this analysis are highlighted in yellow, and the national average is shown in grey. These are the values used in this analysis to estimate the total number of public Level 2 charge ports required in each utility service territory, based on the PEV adoption scenarios (average values). To estimate the high and low range of infrastructure required in each state, the range of values estimated by NREL (-83 percent to +200 percent) was applied to the central estimates at the national level shown in Figure 10.

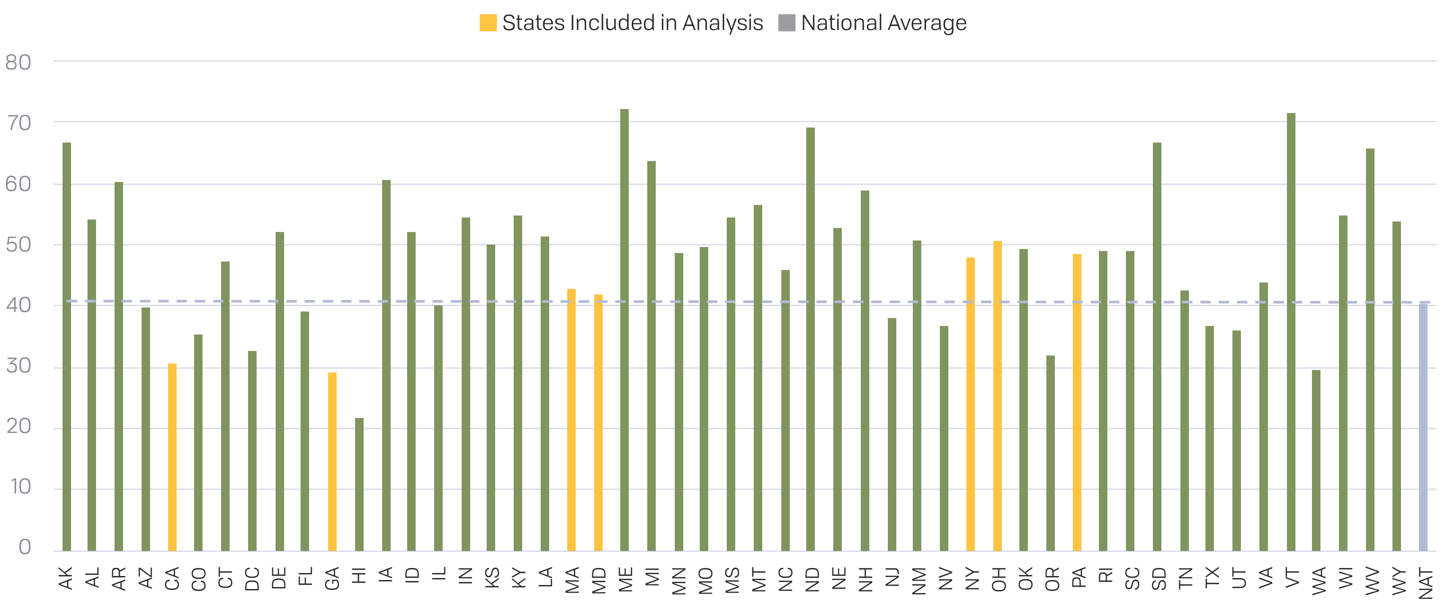
As shown in Figure 10, NREL estimates that an average of 40.3 Level 2 charge ports/1000 PEV will be required nationally (central estimate). The estimated number of Level 2 chargers varies by state, from a low of 21.6 to a high of 72.3 ports/1000 PEV. NREL's sensitivity analysis indicates that at the national level the average number of Level 2 charge ports required could range from 7 to 81 ports/1000 PEV.

Figure 9: NREL National Estimates of Required DCFC Ports per 1,000 PEV



19 On the one hand, it is expected that PEV charging at a DCFC will take significantly longer than it takes to fill up a gasoline car (potentially increasing the number of chargers required relative to gas pumps). On the other hand, as discussed in Section 3.2.1, a significant portion of total PEV charging will be done at home chargers, while virtually all gasoline fill-ups are done at public stations, not at home (potentially decreasing the number of chargers required relative to gas pumps).

Figure 10: NREL Estimates of Required Public Level 1 and Level 2 Charge Ports per 1,000 PEV



4.3 Estimate of Charging Infrastructure Costs

There have been numerous studies published from various organizations that estimate the cost of different types of PEV charging infrastructure, or which summarize costs associated with past installations. **Figures 11 and 12** summarize data taken from five of these studies, which were published by the American Council for an Energy Efficient Economy (ACEEE) [34], the National Academy of Sciences (NAS) [35], the Rocky Mountain Institute (RMI) [36], the EV Project (EVP) [37], and the Transportation Energy Future Series (TEFS) [38].

The values in these figures are in current dollars, and represent projected "national average values" for costs per charge port. Some of these studies evaluated total costs per charge port, including the purchase cost of the electric vehicle supply equipment (EVSE)—i.e., the charger—as well as all installation costs. Others estimated only installation cost. For these studies, installation costs include cabling and/or trenching from the facility service panel/utility meter to the EVSE, the EVSE pad/foundation, upgrade or re-work of the service panel (if required), installation of a sub-panel (if required), purchase and installation of transformers (if required), and design and permitting costs.

Figure 11: Estimated Total Cost of Level 1 and Level 2 Chargers, National Average 2015 $Thousands/Port

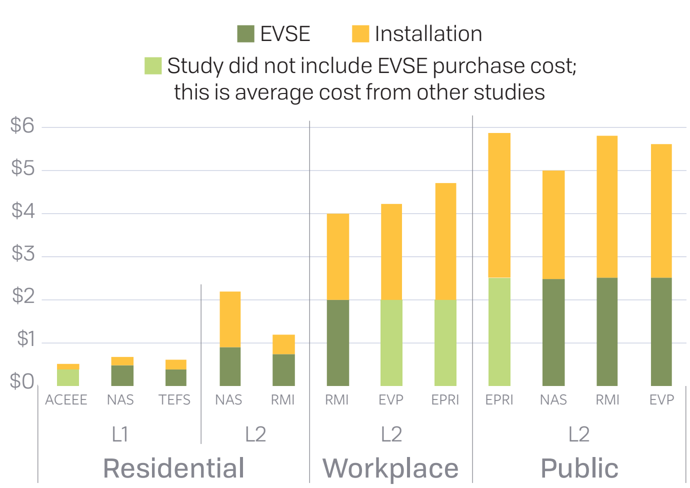
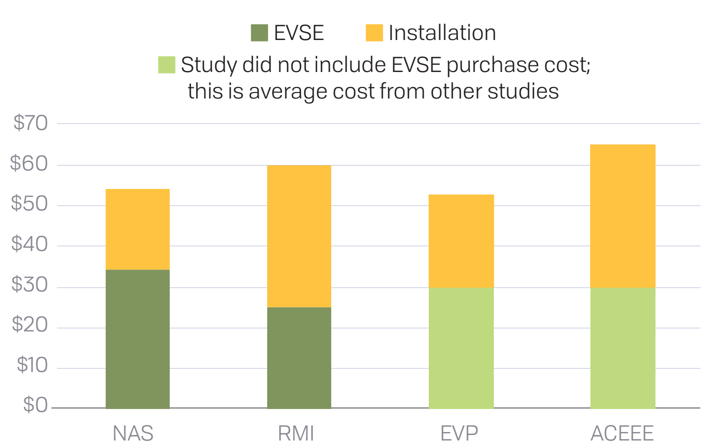


Figure 12: Estimated Total Cost of DCFC, National Average 2015 $Thousands/Port



All of these studies indicate that there will be a significant range of costs for individual installations based on various factors, including:

- prevailing wage rate
- number of ports per location (the greater the number, the lower the cost per port)
- whether a new or upgraded electrical service panel is required to handle the load and whether a sub-panel is required
- whether EVSE is wall- or pedestal-mounted (Level 2)
- distance from electrical panel/utility meter to EVSE
- the need for trenching
- indoor versus outdoor location

In addition, costs will also be higher if the utility is required to upgrade the secondary distribution system (e.g., the local transformer) to handle the increased load.

As shown in Figure 11, these studies consistently estimate that on average the cost of Level 2 home chargers is lower than the cost of Level 2 public chargers. In addition, these studies consistently estimate that on average Level 2 workplace chargers are less expensive than other Level 2 public chargers (i.e. curb side). Researchers for the EV Project indicated that "this difference was attributed to workplaces having more flexibility in choosing the locations of their charging stations and the type of equipment to be installed. However, employers that installed additional charging stations often found the second round of installations to be more expensive because the inexpensive locations had been taken by the initial set of charging stations." [37]

Note that none of these studies estimated the cost of public Level 1 chargers.

The values used in this study for the cost of different types of charging infrastructure are shown in Table 3. The range of values (minimum to maximum) is intended to cover the range of estimated national average values from the literature review, not the range of estimated costs for individual installations. Consistent with data from the literature review, this study assumes that home chargers installed at multiple unit dwellings will be more expensive than the same type of charger installed at single family homes, and that fully public chargers, including workplace chargers, will be even more expensive.

The values in Table 3 are in 2015 dollars. To estimate total costs in each year, these values were escalated using EIA estimates for future inflation[20] [39].

Table 3: PEV Charging Infrastructure Costs Used in this Study, 2015 $/Port

LOCATION	TYPE	COST PER PORT		
		MIN	AVG	MAX
Single Family Home	Level 1	$100	$500	$675
	Level 2	$1,200	$1,400	$2,200
Multiple Unit Dwelling	Level 1	$300	$800	$975
	Level 2	$1,500	$1,700	$2,500
Public & Workplace	Level 1	$500	$1,000	$1,500
	Level 2	$4,000	$5,000	$6,000
	DCFC	$50,000	$55,000	$65,000

20 For estimated total PEV infrastructure costs in 2025 the values in Table 3 were escalated to 2020 dollars, for costs in 2030 they were escalated to 2025 dollars, and for costs in 2035 they were escalated to 2030 dollars.

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APPENDIX A

Results for Individual Utility Service Territories

NATIONAL GRID, MASSACHUSETTS

METRIC		UNIT	2015 ACTUAL
Residential Customers		Million	2.91
Housing Units	Total	Million	1.19
	% in Multiple Unit Dwellings	Percent	30.1%
Highway Miles	Interstate	Thousand	0.184
	State	Thousand	11.509

METRIC		UNIT	EIA			80x50		
			2025	2030	2035	2025	2030	2035
Projected Number of PEVs	BEV	Thousand	24.2	44.0	55.3	131.4	224.1	383.1
	PHEV	Thousand	33.0	60.1	75.6	179.4	306.1	523.3
Annual PEV Charging Electricity	Home	Thousand MWh	161.4	274.0	324.4	850.9	1,462.1	2,459.4
	Non-home	Thousand MWh	45.7	77.5	91.8	240.7	413.6	695.8
Peak Daily Load for PEV Charging	Baseline Charging	MW	57.5	104.6	131.5	312.3	532.9	910.6
	Off-peak Charging	MW	23.7	43.2	54.3	129.0	220.0	376.0
Annual Utility Revenue from PEV Charging		NOM $ Mil	$39.93	$81.36	$110.70	$210.48	$434.10	$839.25
Annual Utility Net Revenue from PEV Charging	Baseline Charging	NOM $ Mil	$14.40	$23.07	$29.04	$75.52	$125.48	$229.54
	Off-peak Charging	NOM $ Mil	$15.81	$28.91	$37.40	$83.17	$155.21	$287.46
Annual GHG Reduction		Thousand MT	158.98	245.61	278.93	820.65	1,344.68	2,303.40
Annual Social Value of GHG Reduction		NOM $ Mil	$10.25	$19.23	$26.54	$52.93	$105.26	$219.15
Annual PEV Owner Savings		NOM $ Mil	-$0.55	$29.59	$40.37	$7.62	$235.60	$410.85

METRIC		UNIT	EIA			80x50		
			2025	2030	2035	2025	2030	2035
ANNUAL NET BENEFITS PER PEV	Utility Net Revenue – BASE	NOM $/PEV	$251.9	$221.5	$221.7	$243.0	$236.6	$253.3
	Utility Net Revenue – OFF PEAK	NOM $/PEV	$276.5	$277.6	$285.7	$267.6	$292.7	$317.2
	Value of GHG Reduction	NOM $/PEV	$179.3	$184.6	$202.7	$170.3	$198.5	$241.8
	PEV Owner Savings	NOM $/PEV	-$9.6	$284.1	$308.3	$24.5	$444.3	$453.3
	Utility Net Revenue – BASE	NPV $/PEV	$198.8	$150.8	$130.3	$191.8	$161.1	$148.8
	Utility Net Revenue – OFF PEAK	NPV $/PEV	$218.3	$189.0	$167.8	$211.3	$199.3	$186.3
	Value of GHG Reduction	NPV $/PEV	$141.6	$125.7	$119.0	$134.5	$135.2	$142.0
	PEV Owner Savings	NPV $/PEV	-$7.6	$193.5	$181.1	$19.3	$302.6	$266.3
CUMULATIVE NET BENEFITS	Utility Net Revenue – BASE	NOM $ Mil	$14.4	$112.4	$245.7	$75.5	$603.0	$1,542.6
	Utility Net Revenue – OFF PEAK	NOM $ Mil	$15.8	$134.2	$304.2	$83.2	$715.1	$1,888.0
	Value of GHG Reduction	NOM $ Mil	$10.3	$88.4	$206.5	$52.9	$474.6	$1,342.6
	PEV Owner Savings	NOM $ Mil	-$0.5	$87.1	$267.4	$7.6	$729.7	$2,433.4
	Utility Net Revenue – BASE	NPV $ Mil	$11.4	$76.6	$144.3	$59.6	$410.6	$906.1
	Utility Net Revenue – OFF PEAK	NPV $ Mil	$12.5	$91.4	$178.7	$65.7	$487.0	$1,109.0
	Value of GHG Reduction	NPV $ Mil	$8.1	$60.2	$121.3	$41.8	$323.2	$788.6
	PEV Owner Savings	NPV $ Mil	-$0.4	$59.3	$157.1	$6.0	$496.9	$1,429.4

NATIONAL GRID, MASSACHUSETTS

PROJECTED NUMBER OF CHARGERS			EIA								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Thousand		22.68			41.29			51.92	
	Single Fam - L2	Thousand		17.28			31.47			39.57	
	MUD - L1	Thousand		7.88			14.35			18.04	
	MUD - L2	Thousand		5.04			9.18			11.55	
	TOTAL HOME CHARGERS/PEV			0.925			0.925			0.925	
	% Home Chargers L2			42%			42%			42%	
PUBLIC AND WORKPLACE CHARGERS	Public L2	x000	0.41	2.45	4.89	0.74	4.46	8.91	0.93	5.60	11.20
	Public DCFC	x000	0.03	0.09	0.24	0.05	0.16	0.44	0.06	0.21	0.55
	DCFC per 100 Highway Miles	Interstate	15.3	48.7	130.3	27.9	88.8	237.4	35.1	111.6	298.5
		State & Inter	0.2	0.8	2.1	0.4	1.4	3.7	0.6	1.8	4.7

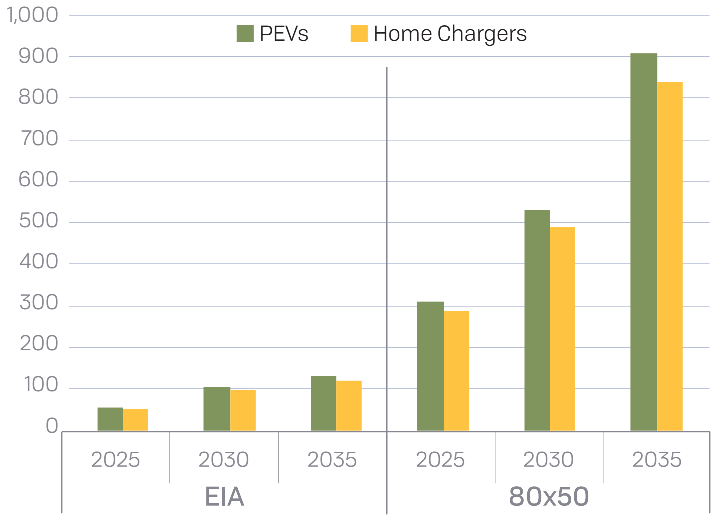
PROJECTED COST OF CHARGERS			EIA								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Nom$ Mil	$2.50	$12.51	$16.88	$5.07	$25.33	$34.20	$7.11	$35.57	$48.02
	Single Fam - L2	Nom$ Mil	$22.87	$26.68	$41.93	$46.33	$54.05	$84.94	$65.05	$75.89	$119.26
	MUD - L1	Nom$ Mil	$2.61	$6.95	$8.47	$5.28	$14.09	$17.17	$7.42	$19.78	$24.10
	MUD - L2	Nom$ Mil	$8.34	$9.45	$13.90	$16.90	$19.15	$28.17	$23.73	$26.89	$39.54
	TOTAL	Nom$ Mil	**$36.32**	**$55.60**	**$81.19**	**$73.58**	**$112.63**	**$164.48**	**$103.30**	**$158.12**	**$230.92**
		NPV $ Mil	**$28.67**	**$43.89**	**$64.09**	**$50.11**	**$76.69**	**$112.00**	**$60.68**	**$92.88**	**$135.64**
		NPV $/PEV	**$501**	**$767**	**$1,121**	**$481**	**$736**	**$1,076**	**$463**	**$709**	**$1,036**
PUBLIC AND WORKPLACE CHARGERS	Public L2	Nom$ Mil	$1.798	$13.493	$32.372	$3.643	$27.334	$65.579	$5.115	$38.375	$92.069
	Public DCFC	Nom$ Mil	$1.560	$5.454	$17.236	$3.160	$11.049	$34.916	$4.436	$15.512	$49.020
	TOTAL	Nom$ Mil	**$3.358**	**$18.947**	**$49.608**	**$6.803**	**$38.382**	**$100.495**	**$9.551**	**$53.887**	**$141.089**
		Nom$ Mil	**$2.651**	**$14.957**	**$39.161**	**$4.633**	**$26.136**	**$68.432**	**$5.610**	**$31.653**	**$82.875**
		NPV $ Mil	**$46,359**	**$261,552**	**$684,811**	**$44,485**	**$250,981**	**$657,134**	**$42,846**	**$241,730**	**$632,912**
	NPV $/PEV	Public L1	$0	$0	$0	$0	$0	$0	$0	$0	$0
		Public L2	$25	$186	$447	$24	$179	$429	$23	$172	$413
		DCFC	$22	$75	$238	$21	$72	$228	$20	$70	$220

PROJECTED NUMBER OF CHARGERS			80x50								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Thousand		123.24			210.26			359.40	
	Single Fam - L2	Thousand		93.91			160.22			273.88	
	MUD - L1	Thousand		42.82			73.06			124.89	
	MUD - L2	Thousand		27.40			46.75			79.92	
	TOTAL HOME CHARGERS/PEV			0.925			0.925			0.925	
	% Home Chargers L2			42%			42%			42%	
PUBLIC AND WORKPLACE CHARGERS	Public L2	x000	2.22	13.30	26.58	3.78	22.69	45.36	6.46	38.78	77.53
	Public DCFC	x000	0.15	0.49	1.31	0.26	0.83	2.23	0.45	1.42	3.81
	DCFC per 100 Highway Miles	Interstate	83.3	264.9	708.4	142.2	452.0	1,208.5	243.0	772.6	2,065.8
		State & Inter	1.3	4.2	11.2	2.2	7.1	19.1	3.8	12.2	32.6

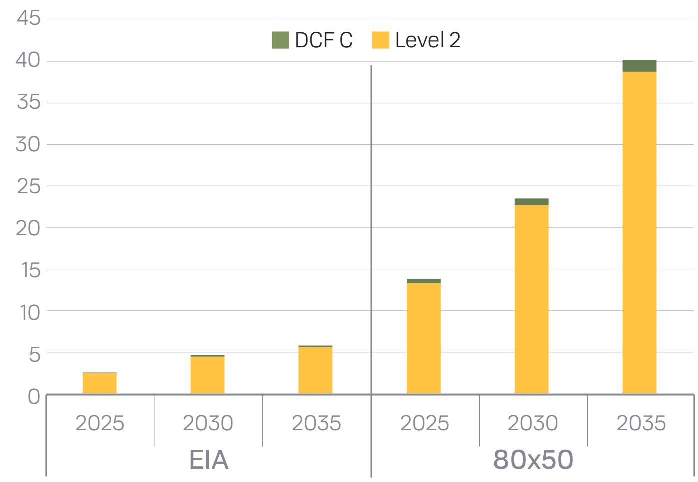
PROJECTED COST OF CHARGERS			80x50								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Nom$ Mil	$13.59	$67.97	$91.75	$25.80	$128.99	$174.14	$49.24	$246.19	$332.36
	Single Fam - L2	Nom$ Mil	$124.30	$145.02	$227.89	$235.91	$275.23	$432.50	$450.26	$525.30	$825.47
	MUD - L1	Nom$ Mil	$14.17	$37.79	$46.05	$26.89	$71.72	$87.41	$51.33	$136.88	$166.82
	MUD - L2	Nom$ Mil	$45.34	$51.38	$75.56	$86.05	$97.52	$143.41	$164.23	$186.13	$273.72
	TOTAL	Nom$ Mil	**$197.40**	**$302.16**	**$441.26**	**$374.65**	**$573.46**	**$837.46**	**$715.05**	**$1,094.50**	**$1,598.37**
		NPV $ Mil	**$155.83**	**$238.53**	**$348.33**	**$255.12**	**$390.50**	**$570.27**	**$420.02**	**$642.90**	**$938.87**
		NPV $/PEV	**$501**	**$767**	**$1,121**	**$481**	**$736**	**$1,076**	**$463**	**$709**	**$1,036**
PUBLIC AND WORKPLACE CHARGERS	Public L2	Nom$ Mil	$9.774	$73.331	$175.935	$18.550	$139.173	$333.904	$35.405	$265.624	$637.285
	Public DCFC	Nom$ Mil	$8.477	$29.642	$93.673	$16.089	$56.256	$177.780	$30.707	$107.370	$339.309
	TOTAL	Nom$ Mil	**$18.251**	**$102.972**	**$269.608**	**$34.639**	**$195.429**	**$511.684**	**$66.111**	**$372.994**	**$976.594**
		Nom$ Mil	**$14.408**	**$81.287**	**$212.831**	**$23.587**	**$133.078**	**$348.432**	**$38.833**	**$219.095**	**$573.646**
		NPV $ Mil	**$46,359**	**$261,552**	**$684,811**	**$44,485**	**$250,981**	**$657,134**	**$42,846**	**$241,730**	**$632,912**
	NPV $/PEV	Public L1	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
		Public L2	**$25**	**$186**	**$447**	**$24**	**$179**	**$429**	**$23**	**$172**	**$413**
		DCFC	**$22**	**$75**	**$238**	**$21**	**$72**	**$228**	**$20**	**$70**	**$220**

NATIONAL GRID, MASSACHUSETTS

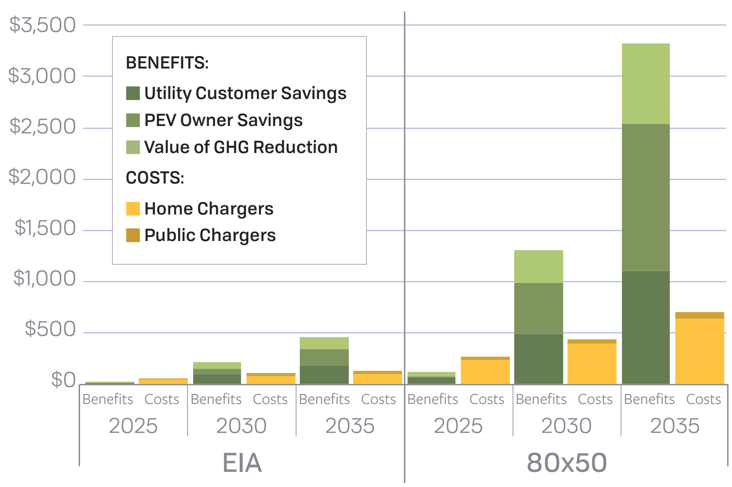
Projected PEVs and Home Chargers (Thousands)



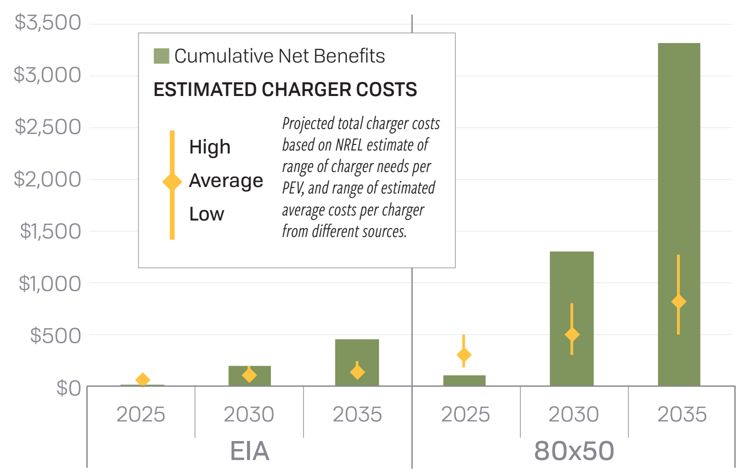
Projected Number of Required Public and DC Fast Chargers (Thousands)



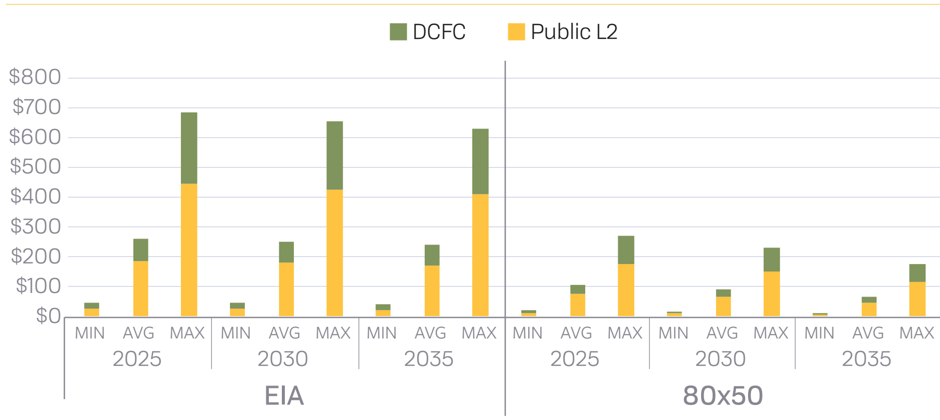
PEV Cumulative Benefits Compared to Charger Costs (NPV $ Millions)



Cumulative PEV Net Benefits Compared to Range of Estimated Charger Costs (NPV $ Millions)



Projected Cost of Public Charging Infrastructure (NPV $/PEV)



EVERSOURCE, MASSACHUSETTS

METRIC		UNIT	2015 ACTUAL
Residential Customers		Million	2.87
Housing Units	Total	Million	1.25
	% in Multiple Unit Dwellings	Percent	35.1%
Highway Miles	Interstate	Thousand	0.189
	State	Thousand	11.817

METRIC		UNIT	EIA			80x50		
			2025	2030	2035	2025	2030	2035
Projected Number of PEVs	BEV	Thousand	29.5	53.7	67.6	160.4	273.6	467.7
	PHEV	Thousand	33.9	61.7	77.6	184.1	314.1	536.9
Annual PEV Charging Electricity	Home	Thousand MWh	165.4	280.9	332.4	871.5	1,496.9	2,520.5
	Non-home	Thousand MWh	52.4	88.9	105.2	275.8	473.7	797.6
Peak Daily Load for PEV Charging	Baseline Charging	MW	60.4	110.0	138.3	328.2	559.9	957.6
	Off-peak Charging	MW	24.9	45.4	57.1	135.5	231.2	395.4
Annual Utility Revenue from PEV Charging		NOM $ Mil	$49.15	$100.16	$136.26	$258.93	$533.82	$1,033.10
Annual Utility Net Revenue from PEV Charging	Baseline Charging	NOM $ Mil	$18.16	$30.18	$38.30	$95.25	$163.37	$300.25
	Off-peak Charging	NOM $ Mil	$19.64	$36.32	$47.10	$103.29	$194.61	$361.16
Annual GHG Reduction		Thousand MT	172.58	267.73	304.66	906.27	1,449.82	2,422.40
Annual Social Value of GHG Reduction		NOM $ Mil	$11.13	$20.96	$28.99	$58.46	$113.50	$230.48
Annual PEV Owner Savings		NOM $ Mil	-$7.89	$17.96	$24.56	-$29.93	$182.01	$302.34

METRIC		UNIT	EIA			80x50		
			2025	2030	2035	2025	2030	2035
ANNUAL NET BENEFITS PER PEV	Utility Net Revenue – BASE	NOM $/PEV	$286.5	$261.5	$263.9	$276.5	$278.0	$298.9
	Utility Net Revenue – OFF PEAK	NOM $/PEV	$309.8	$314.6	$324.5	$299.8	$331.1	$359.5
	Value of GHG Reduction	NOM $/PEV	$175.6	$181.6	$199.7	$169.7	$193.1	$229.4
	PEV Owner Savings	NOM $/PEV	-$124.5	$155.6	$169.2	-$86.9	$309.7	$300.9
	Utility Net Revenue – BASE	NPV $/PEV	$226.2	$178.0	$155.0	$218.3	$189.3	$175.6
	Utility Net Revenue – OFF PEAK	NPV $/PEV	$244.6	$214.3	$190.6	$236.7	$225.5	$211.2
	Value of GHG Reduction	NPV $/PEV	$138.6	$123.6	$117.3	$134.0	$131.5	$134.8
	PEV Owner Savings	NPV $/PEV	-$98.3	$105.9	$99.4	-$68.6	$210.9	$176.8
CUMULATIVE NET BENEFITS	Utility Net Revenue – BASE	NOM $ Mil	$18.2	$145.0	$320.3	$95.2	$775.9	$2,003.4
	Utility Net Revenue – OFF PEAK	NOM $ Mil	$19.6	$167.9	$381.8	$103.3	$893.7	$2,366.4
	Value of GHG Reduction	NOM $ Mil	$11.1	$96.3	$225.1	$58.5	$515.9	$1,434.3
	PEV Owner Savings	NOM $ Mil	-$7.9	$30.2	$139.8	-$29.9	$456.2	$1,727.3
	Utility Net Revenue – BASE	NPV $ Mil	$14.3	$98.7	$188.1	$75.2	$528.3	$1,176.8
	Utility Net Revenue – OFF PEAK	NPV $ Mil	$15.5	$114.3	$224.3	$81.5	$608.6	$1,390.0
	Value of GHG Reduction	NPV $ Mil	$8.8	$65.6	$132.3	$46.1	$351.3	$842.5
	PEV Owner Savings	NPV $ Mil	-$6.2	$20.6	$82.1	-$23.6	$310.7	$1,014.6

EVERSOURCE, MASSACHUSETTS

PROJECTED NUMBER OF CHARGERS			EIA								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Thousand		22.38			40.75			51.24	
	Single Fam - L2	Thousand		18.76			34.17			42.96	
	MUD - L1	Thousand		9.85			17.94			22.56	
	MUD - L2	Thousand		6.83			12.44			15.64	
	TOTAL HOME CHARGERS/PEV			0.912			0.912			0.912	
	% Home Chargers L2			44%			44%			44%	
PUBLIC AND WORKPLACE CHARGERS	Public L2	x000	0.45	2.71	5.42	0.82	4.94	9.87	1.03	6.21	12.42
	Public DCFC	x000	0.03	0.10	0.27	0.06	0.18	0.49	0.07	0.23	0.61
	DCFC per 100	Interstate	16.6	52.6	140.7	30.1	95.8	256.2	37.9	120.5	322.2
	Highway Miles	State & Inter	0.3	0.8	2.2	0.5	1.5	4.0	0.6	1.9	5.1

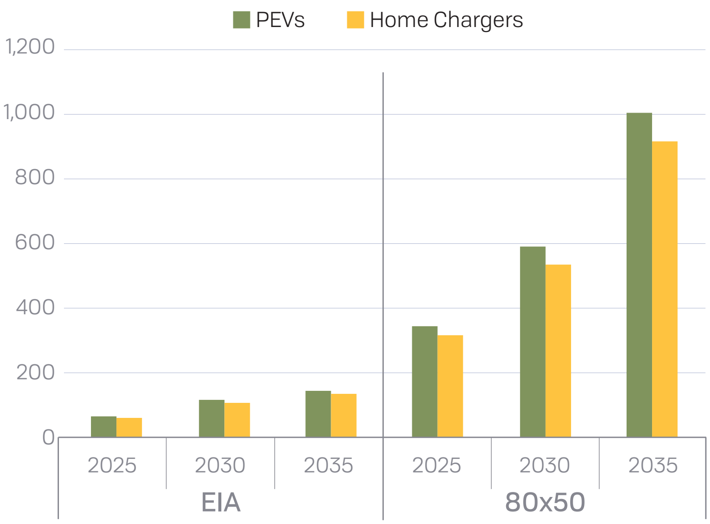
PROJECTED COST OF CHARGERS			EIA								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Nom$ Mil	$2.47	$12.34	$16.66	$5.00	$25.00	$33.75	$7.02	$35.10	$47.38
	Single Fam - L2	Nom$ Mil	$24.83	$28.97	$45.53	$50.30	$58.69	$92.23	$70.63	$82.40	$129.48
	MUD - L1	Nom$ Mil	$3.26	$8.69	$10.60	$6.60	$17.61	$21.47	$9.27	$24.73	$30.14
	MUD - L2	Nom$ Mil	$11.30	$12.81	$18.84	$22.90	$25.95	$38.17	$32.15	$36.44	$53.58
	TOTAL	Nom$ Mil	**$41.87**	**$62.82**	**$91.62**	**$84.81**	**$127.26**	**$185.61**	**$119.07**	**$178.66**	**$260.58**
		NPV $ Mil	**$33.05**	**$49.59**	**$72.33**	**$57.75**	**$86.65**	**$126.39**	**$69.94**	**$104.94**	**$153.07**
		NPV $/PEV	**$521**	**$782**	**$1,141**	**$500**	**$751**	**$1,095**	**$482**	**$723**	**$1,055**
PUBLIC AND WORKPLACE CHARGERS	Public L2	Nom$ Mil	$1.993	$14.956	$35.882	$4.038	$30.298	$72.690	$5.670	$42.536	$102.053
	Public DCFC	Nom$ Mil	$1.729	$6.045	$19.105	$3.502	$12.247	$38.702	$4.917	$17.194	$54.336
	TOTAL	Nom$ Mil	**$3.722**	**$21.001**	**$54.987**	**$7.541**	**$42.544**	**$111.392**	**$10.587**	**$59.730**	**$156.388**
		Nom$ Mil	**$2.939**	**$16.579**	**$43.407**	**$5.135**	**$28.971**	**$75.853**	**$6.219**	**$35.085**	**$91.862**
		NPV $ Mil	**$46,359**	**$261,552**	**$684,811**	**$44,485**	**$250,981**	**$657,134**	**$42,846**	**$241,730**	**$632,912**
	NPV $/PEV	Public L1	$0	$0	$0	$0	$0	$0	$0	$0	$0
		Public L2	$25	$186	$447	$24	$179	$429	$23	$172	$413
		DCFC	$22	$75	$238	$21	$72	$228	$20	$70	$220

PROJECTED NUMBER OF CHARGERS			80x50								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Thousand		121.62			207.49			354.68	
	Single Fam - L2	Thousand		101.96			173.96			297.36	
	MUD - L1	Thousand		53.55			91.36			156.16	
	MUD - L2	Thousand		37.13			63.35			108.29	
	TOTAL HOME CHARGERS/PEV			0.912			0.912			0.912	
	% Home Chargers L2			44%			44%			44%	
PUBLIC AND WORKPLACE CHARGERS	Public L2	x000	2.46	14.74	29.47	4.19	25.15	50.27	7.16	42.98	85.94
	Public DCFC	x000	0.17	0.54	1.45	0.29	0.92	2.47	0.50	1.58	4.22
	DCFC per 100	Interstate	90.0	286.0	764.7	153.5	487.9	1,304.6	262.4	834.0	2,230.1
	Highway Miles	State & Inter	1.4	4.5	12.1	2.4	7.7	20.6	4.1	13.2	35.2

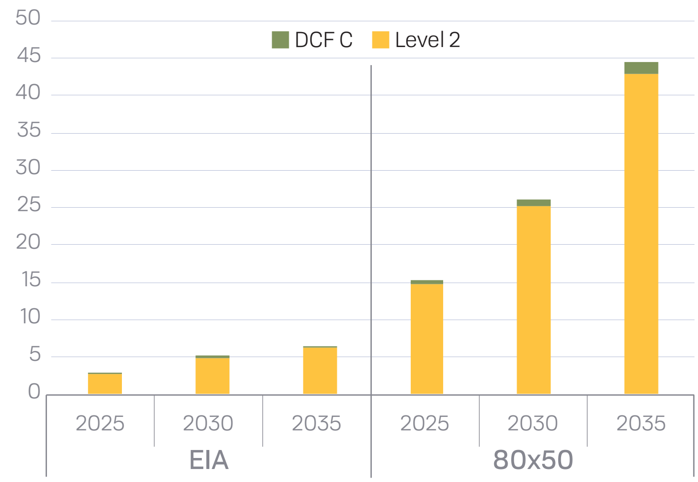
PROJECTED COST OF CHARGERS			80x50								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Nom$ Mil	$13.41	$67.07	$90.55	$25.46	$127.30	$171.85	$48.59	$242.96	$327.99
	Single Fam - L2	Nom$ Mil	$134.96	$157.45	$247.42	$256.13	$298.82	$469.58	$488.85	$570.33	$896.23
	MUD - L1	Nom$ Mil	$17.72	$47.25	$57.59	$33.63	$89.68	$109.29	$64.18	$171.15	$208.59
	MUD - L2	Nom$ Mil	$61.44	$69.63	$102.39	$116.60	$132.15	$194.33	$222.54	$252.21	$370.90
	TOTAL	Nom$ Mil	**$227.53**	**$341.40**	**$497.95**	**$431.82**	**$647.94**	**$945.05**	**$824.17**	**$1,236.65**	**$1,803.72**
		NPV $ Mil	**$179.61**	**$269.51**	**$393.09**	**$294.05**	**$441.22**	**$643.54**	**$484.11**	**$726.40**	**$1,059.49**
		NPV $/PEV	**$521**	**$782**	**$1,141**	**$500**	**$751**	**$1,095**	**$482**	**$723**	**$1,055**
PUBLIC AND WORKPLACE CHARGERS	Public L2	Nom$ Mil	$10.834	$81.282	$195.013	$20.562	$154.265	$370.112	$39.244	$294.428	$706.391
	Public DCFC	Nom$ Mil	$9.396	$32.856	$103.830	$17.833	$62.356	$197.058	$34.036	$119.013	$376.103
	TOTAL	Nom$ Mil	**$20.230**	**$114.138**	**$298.843**	**$38.395**	**$216.621**	**$567.170**	**$73.280**	**$413.440**	**$1,082.493**
		Nom$ Mil	**$15.970**	**$90.102**	**$235.910**	**$26.145**	**$147.508**	**$386.215**	**$43.044**	**$242.853**	**$635.851**
		NPV $ Mil	**$46,359**	**$261,552**	**$684,811**	**$44,485**	**$250,981**	**$657,134**	**$42,846**	**$241,730**	**$632,912**
	NPV $/PEV	Public L1	$0	$0	$0	$0	$0	$0	$0	$0	$0
		Public L2	$25	$186	$447	$24	$179	$429	$23	$172	$413
		DCFC	$22	$75	$238	$21	$72	$228	$20	$70	$220

EVERSOURCE, MASSACHUSETTS

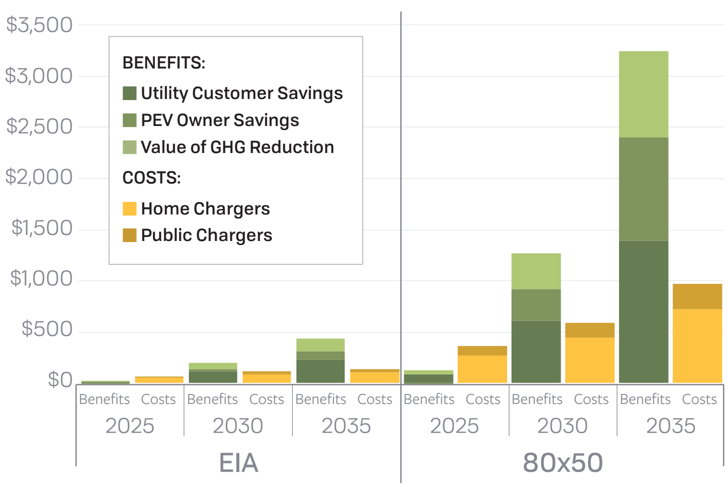
Projected PEVs and Home Chargers (Thousands)



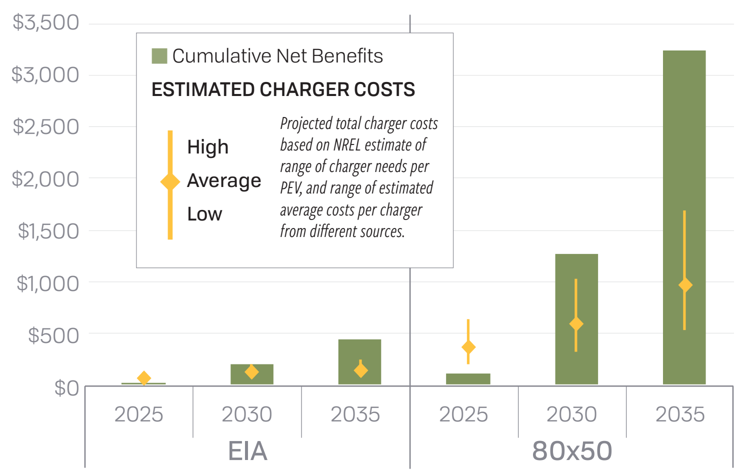
Projected Number of Required Public and DC Fast Chargers (Thousands)



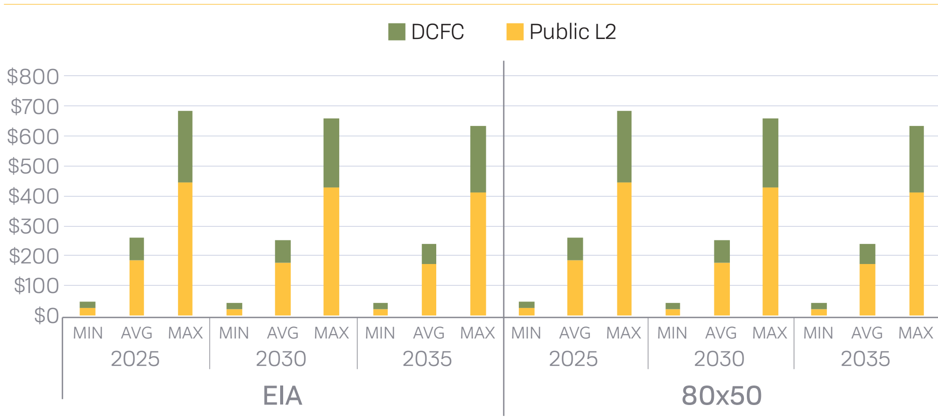
PEV Cumulative Benefits Compared to Charger Costs (NPV $ Millions)



Cumulative PEV Net Benefits Compared to Range of Estimated Charger Costs (NPV $ Millions)



Projected Cost of Public Charging Infrastructure (NPV $/PEV)



ConEd, NEW YORK

METRIC		UNIT	2015 ACTUAL
Residential Customers		Million	8.53
Housing Units	Total	Million	3.31
	% in Multiple Unit Dwellings	Percent	76.7%
Highway Miles	Interstate	Thousand	0.753
	State	Thousand	48.640

METRIC		UNIT	EIA			80x50		
			2025	2030	2035	2025	2030	2035
Projected Number of PEVs	BEV	Thousand	69.7	123.9	154.2	294.9	499.1	824.8
	PHEV	Thousand	91.3	162.4	202.2	386.6	654.3	1,081.3
Annual PEV Charging Electricity	Home	Thousand MWh	278.5	462.5	543.1	1,163.4	1,982.5	3,226.3
	Non-home	Thousand MWh	190.9	317.1	372.3	797.6	1,359.1	2,211.7
Peak Daily Load for PEV Charging	Baseline Charging	MW	133.0	236.5	294.5	562.5	951.3	1,575.0
	Off-peak Charging	MW	24.9	45.4	57.1	135.5	231.2	395.4
Annual Utility Revenue from PEV Charging		NOM $ Mil	$99.33	$193.92	$258.89	$414.90	$831.21	$1,537.93
Annual Utility Net Revenue from PEV Charging	Baseline Charging	NOM $ Mil	$38.75	$76.87	$100.89	$161.55	$335.33	$616.59
	Off-peak Charging	NOM $ Mil	$41.98	$89.22	$117.16	$175.23	$385.03	$703.63
Annual GHG Reduction		Thousand MT	330.54	490.54	531.54	1,394.81	2,124.12	3,225.97
Annual Social Value of GHG Reduction		NOM $ Mil	$24.17	$36.87	$41.17	$101.94	$159.84	$250.15
Annual PEV Owner Savings		NOM $ Mil	-$12.58	$55.03	$75.91	-$29.30	$397.30	$686.63

METRIC		UNIT	EIA			80x50		
			2025	2030	2035	2025	2030	2035
ANNUAL NET BENEFITS PER PEV	Utility Net Revenue – BASE	NOM $/PEV	$240.6	$268.6	$283.1	$237.0	$290.7	$323.5
	Utility Net Revenue – OFF PEAK	NOM $/PEV	$260.7	$311.7	$328.8	$257.1	$333.8	$369.1
	Value of GHG Reduction	NOM $/PEV	$150.1	$128.8	$115.5	$149.6	$138.6	$131.2
	PEV Owner Savings	NOM $/PEV	-$78.1	$192.2	$213.0	-$43.0	$344.4	$360.2
	Utility Net Revenue – BASE	NPV $/PEV	$190.0	$182.9	$166.3	$187.1	$198.0	$190.0
	Utility Net Revenue – OFF PEAK	NPV $/PEV	$205.8	$212.3	$193.1	$202.9	$227.3	$216.8
	Value of GHG Reduction	NPV $/PEV	$118.5	$87.7	$67.9	$118.1	$94.4	$77.1
	PEV Owner Savings	NPV $/PEV	-$61.7	$130.9	$125.1	-$33.9	$234.5	$211.6
CUMULATIVE NET BENEFITS	Utility Net Revenue – BASE	NOM $ Mil	$38.7	$346.8	$803.2	$161.6	$1,490.7	$4,011.1
	Utility Net Revenue – OFF PEAK	NOM $ Mil	$42.0	$393.6	$923.5	$175.2	$1,680.8	$4,561.7
	Value of GHG Reduction	NOM $ Mil	$24.2	$183.1	$380.3	$101.9	$785.3	$1,855.5
	PEV Owner Savings	NOM $ Mil	-$12.6	$127.4	$465.1	-$29.3	$1,104.0	$3,958.5
	Utility Net Revenue – BASE	NPV $ Mil	$30.6	$236.2	$471.8	$127.5	$1,015.1	$2,356.1
	Utility Net Revenue – OFF PEAK	NPV $ Mil	$33.1	$268.0	$542.5	$138.3	$1,144.5	$2,679.5
	Value of GHG Reduction	NPV $ Mil	$19.1	$124.7	$223.4	$80.5	$534.8	$1,089.9
	PEV Owner Savings	NPV $ Mil	-$9.9	$86.7	$273.2	-$23.1	$751.8	$2,325.2

ConEd, NEW YORK

PROJECTED NUMBER OF CHARGERS			EIA								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Thousand		21.10			37.51			46.71	
	Single Fam - L2	Thousand		16.45			29.24			36.40	
	MUD - L1	Thousand		56.05			99.63			124.05	
	MUD - L2	Thousand		36.55			64.98			80.90	
	TOTAL HOME CHARGERS/PEV			0.808			0.808			0.808	
	% Home Chargers L2			41%			41%			41%	
PUBLIC AND WORKPLACE CHARGERS	Public L2	x000	1.29	7.72	15.43	2.29	13.72	27.43	2.85	17.09	34.16
	Public DCFC	x000	0.06	0.20	0.52	0.11	0.35	0.93	0.14	0.43	1.16
	DCFC per 100	Interstate	8.2	26.1	69.7	14.6	46.3	123.9	18.1	57.7	154.3
	Highway Miles	State & Inter	0.1	0.4	1.1	0.2	0.7	1.9	0.3	0.9	2.4

PROJECTED COST OF CHARGERS			EIA								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Nom$ Mil	$2.33	$11.64	$15.71	$4.60	$23.02	$31.07	$6.40	$32.00	$43.20
	Single Fam - L2	Nom$ Mil	$21.76	$25.39	$39.90	$43.05	$50.23	$78.93	$59.85	$69.83	$109.73
	MUD - L1	Nom$ Mil	$18.54	$49.45	$60.26	$36.68	$97.81	$119.21	$50.99	$135.98	$165.72
	MUD - L2	Nom$ Mil	$60.46	$68.52	$100.77	$119.60	$135.55	$199.34	$166.27	$188.44	$277.12
	TOTAL	Nom$ Mil	**$103.10**	**$155.00**	**$216.64**	**$203.94**	**$306.61**	**$428.56**	**$283.51**	**$426.24**	**$595.76**
		NPV $ Mil	**$81.38**	**$122.36**	**$171.02**	**$138.87**	**$208.79**	**$291.83**	**$166.53**	**$250.37**	**$349.95**
		NPV $/PEV	**$505**	**$760**	**$1,062**	**$485**	**$729**	**$1,020**	**$467**	**$703**	**$982**
PUBLIC AND WORKPLACE CHARGERS	Public L2	Nom$ Mil	$5.673	$42.562	$102.115	$11.222	$84.196	$202.002	$15.601	$117.046	$280.816
	Public DCFC	Nom$ Mil	$3.405	$11.906	$37.624	$6.736	$23.552	$74.428	$9.363	$32.741	$103.467
	TOTAL	Nom$ Mil	**$9.078**	**$54.468**	**$139.740**	**$17.958**	**$107.747**	**$276.430**	**$24.964**	**$149.786**	**$384.282**
		Nom$ Mil	**$7.166**	**$42.998**	**$110.312**	**$12.228**	**$73.371**	**$188.236**	**$14.664**	**$87.984**	**$225.725**
		NPV $ Mil	**$44,504**	**$267,023**	**$685,057**	**$42,723**	**$256,335**	**$657,639**	**$41,147**	**$246,881**	**$633,383**
	NPV $/PEV	Public L1	$0	$0	$0	$0	$0	$0	$0	$0	$0
		Public L2	$28	$209	$501	$27	$200	$481	$26	$193	$463
		DCFC	$17	$58	$184	$16	$56	$177	$15	$54	$171

PROJECTED NUMBER OF CHARGERS			80x50								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Thousand		89.33			151.17			249.82	
	Single Fam - L2	Thousand		69.62			117.82			194.70	
	MUD - L1	Thousand		237.25			401.51			663.50	
	MUD - L2	Thousand		154.73			261.84			432.70	
	TOTAL HOME CHARGERS/PEV			0.808			0.808			0.808	
	% Home Chargers L2			41%			41%			41%	
PUBLIC AND WORKPLACE CHARGERS	Public L2	x000	5.44	32.68	65.33	9.21	55.30	110.56	15.23	91.38	182.70
	Public DCFC	x000	0.26	0.83	2.22	0.44	1.41	3.76	0.73	2.32	6.21
	DCFC per 100	Interstate	34.7	110.3	295.0	58.7	186.7	499.3	97.1	308.5	825.1
	Highway Miles	State & Inter	0.5	1.7	4.5	0.9	2.8	7.6	1.5	4.7	12.6

PROJECTED COST OF CHARGERS			80x50								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Nom$ Mil	$9.85	$49.25	$66.49	$18.55	$92.76	$125.22	$34.23	$171.14	$231.04
	Single Fam - L2	Nom$ Mil	$92.12	$107.48	$168.89	$173.50	$202.42	$318.08	$320.12	$373.47	$586.89
	MUD - L1	Nom$ Mil	$78.49	$209.30	$255.08	$147.81	$394.17	$480.40	$272.73	$727.27	$886.36
	MUD - L2	Nom$ Mil	$255.92	$290.05	$426.54	$481.99	$546.25	$803.31	$889.30	$1,007.88	$1,482.17
	TOTAL	Nom$ Mil	**$436.38**	**$656.07**	**$917.00**	**$821.85**	**$1,235.60**	**$1,727.02**	**$1,516.38**	**$2,279.77**	**$3,186.46**
		NPV $ Mil	**$344.49**	**$517.91**	**$723.89**	**$559.64**	**$841.38**	**$1,176.01**	**$890.71**	**$1,339.12**	**$1,871.71**
		NPV $/PEV	**$505**	**$760**	**$1,062**	**$485**	**$729**	**$1,020**	**$467**	**$703**	**$982**
PUBLIC AND WORKPLACE CHARGERS	Public L2	Nom$ Mil	$24.013	$180.158	$432.235	$45.224	$339.296	$814.040	$83.442	$626.025	$1,501.960
	Public DCFC	Nom$ Mil	$14.412	$50.395	$159.257	$27.143	$94.910	$299.933	$50.081	$175.115	$553.397
	TOTAL	Nom$ Mil	**$38.425**	**$230.552**	**$591.491**	**$72.368**	**$434.206**	**$1,113.973**	**$133.523**	**$801.140**	**$2,055.357**
		Nom$ Mil	**$30.333**	**$182.000**	**$466.929**	**$49.279**	**$295.673**	**$758.561**	**$78.431**	**$470.586**	**$1,207.306**
		NPV $ Mil	**$44,504**	**$267,023**	**$685,057**	**$42,723**	**$256,335**	**$657,639**	**$41,147**	**$246,881**	**$633,383**
	NPV $/PEV	Public L1	$0	$0	$0	$0	$0	$0	$0	$0	$0
		Public L2	$28	$209	$501	$27	$200	$481	$26	$193	$463
		DCFC	$17	$58	$184	$16	$56	$177	$15	$54	$171

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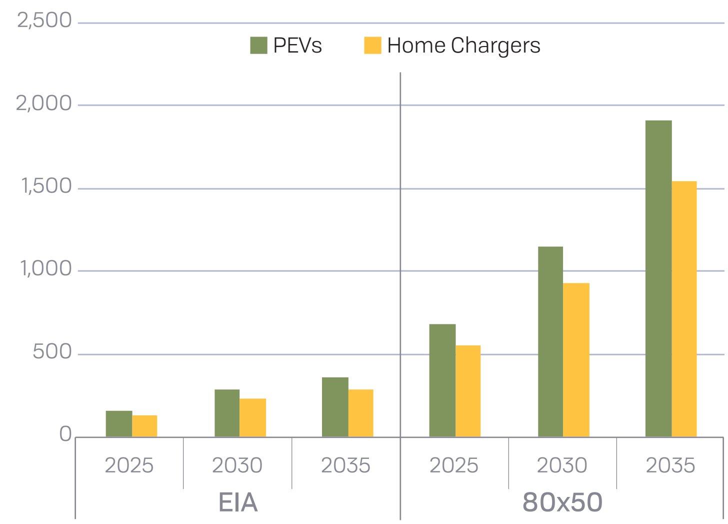
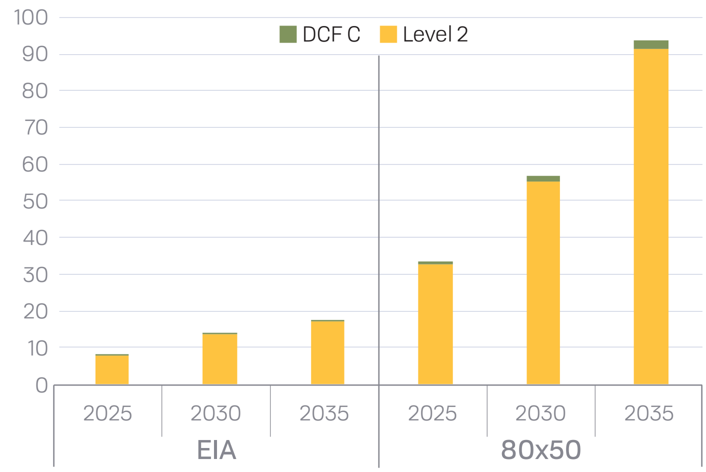
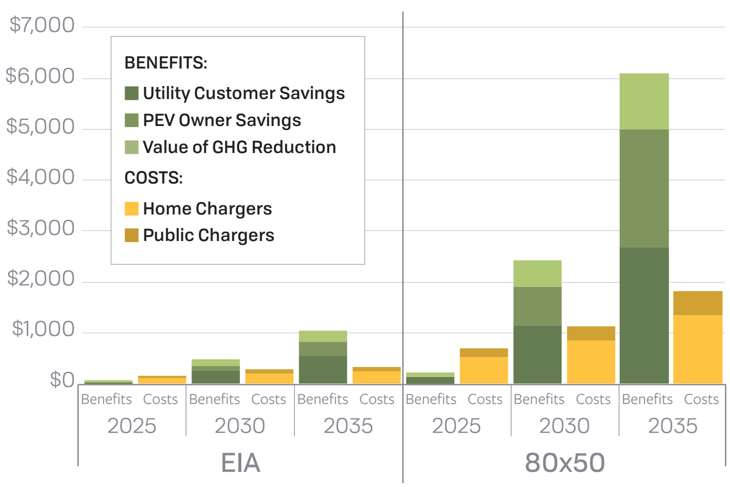
Projected PEVs and Home Chargers (Thousands)



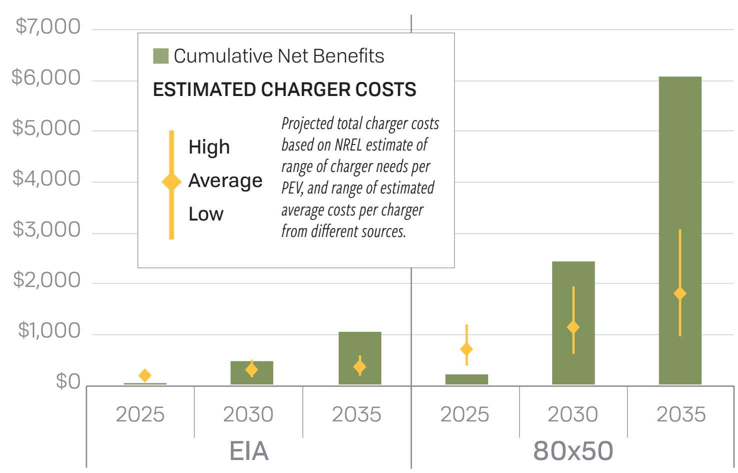
Projected Number of Required Public and DC Fast Chargers (Thousands)



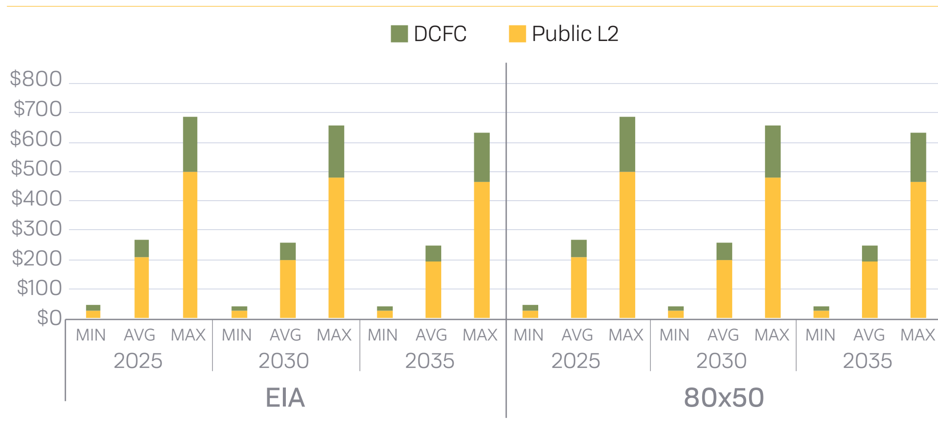
PEV Cumulative Benefits Compared to Charger Costs (NPV $ Millions)



Cumulative PEV Net Benefits Compared to Range of Estimated Charger Costs (NPV $ Millions)



Projected Cost of Public Charging Infrastructure (NPV $/PEV)



NATIONAL GRID, NEW YORK

METRIC		UNIT	2015 ACTUAL
Residential Customers		Million	3.24
Housing Units	Total	Million	1.50
	% in Multiple Unit Dwellings	Percent	28.9%
Highway Miles	Interstate	Thousand	0.286
	State	Thousand	18.479

METRIC		UNIT	EIA			80x50		
			2025	2030	2035	2025	2030	2035
Projected Number of PEVs	BEV	Thousand	26.2	46.5	57.9	110.8	187.4	309.7
	PHEV	Thousand	45.4	80.6	100.4	192.0	325.0	537.0
Annual PEV Charging Electricity	Home	Thousand MWh	219.1	363.8	427.1	916.3	1,562.7	2,537.4
	Non-home	Thousand MWh	60.2	99.9	117.3	251.7	429.2	697.0
Peak Daily Load for PEV Charging	Baseline Charging	MW	79.1	140.7	175.1	335.0	567.1	936.8
	Off-peak Charging	MW	35.0	62.2	77.5	148.2	250.8	414.3
Annual Utility Revenue from PEV Charging		NOM $ Mil	$49.66	$97.12	$127.84	$207.65	$417.21	$759.43
Annual Utility Net Revenue from PEV Charging	Baseline Charging	NOM $ Mil	$31.38	$35.43	$43.80	$131.06	$155.70	$270.45
	Off-peak Charging	NOM $ Mil	$33.31	$42.78	$53.48	$139.20	$185.32	$322.22
Annual GHG Reduction		Thousand MT	164.01	235.44	248.83	653.33	1,116.96	1,905.47
Annual Social Value of GHG Reduction		NOM $ Mil	$10.58	$15.19	$16.05	$42.14	$72.05	$122.91
Annual PEV Owner Savings		NOM $ Mil	$2.99	$41.01	$57.49	$22.86	$247.63	$446.21

METRIC		UNIT	EIA			80x50		
			2025	2030	2035	2025	2030	2035
ANNUAL NET BENEFITS PER PEV	Utility Net Revenue – BASE	NOM $/PEV	$438.7	$278.7	$276.6	$432.8	$303.9	$319.4
	Utility Net Revenue – OFF PEAK	NOM $/PEV	$465.6	$336.4	$337.8	$459.7	$361.7	$380.5
	Value of GHG Reduction	NOM $/PEV	$147.9	$119.4	$101.4	$139.2	$140.6	$145.2
	PEV Owner Savings	NOM $/PEV	$41.8	$322.5	$363.1	$75.5	$483.3	$527.0
	Utility Net Revenue – BASE	NPV $/PEV	$346.3	$189.7	$162.5	$341.7	$206.9	$187.6
	Utility Net Revenue – OFF PEAK	NPV $/PEV	$367.6	$229.1	$198.4	$362.9	$246.3	$223.5
	Value of GHG Reduction	NPV $/PEV	$116.7	$81.3	$59.6	$109.9	$95.7	$85.3
	PEV Owner Savings	NPV $/PEV	$33.0	$219.6	$213.3	$59.6	$329.1	$309.5
CUMULATIVE NET BENEFITS	Utility Net Revenue – BASE	NOM $ Mil	$31.4	$200.4	$402.7	$131.1	$860.3	$1,983.0
	Utility Net Revenue – OFF PEAK	NOM $ Mil	$33.3	$228.3	$474.3	$139.2	$973.6	$2,310.9
	Value of GHG Reduction	NOM $ Mil	$10.6	$77.3	$155.8	$42.1	$342.6	$855.4
	PEV Owner Savings	NOM $ Mil	$3.0	$132.0	$386.5	$22.9	$811.5	$2,645.4
	Utility Net Revenue – BASE	NPV $ Mil	$24.8	$136.5	$236.5	$103.5	$585.8	$1,164.8
	Utility Net Revenue – OFF PEAK	NPV $ Mil	$26.3	$155.4	$278.6	$109.9	$663.0	$1,357.4
	Value of GHG Reduction	NPV $ Mil	$8.4	$52.6	$91.5	$33.3	$233.3	$502.5
	PEV Owner Savings	NPV $ Mil	$2.4	$89.9	$227.0	$18.0	$552.6	$1,553.9

NATIONAL GRID, NEW YORK

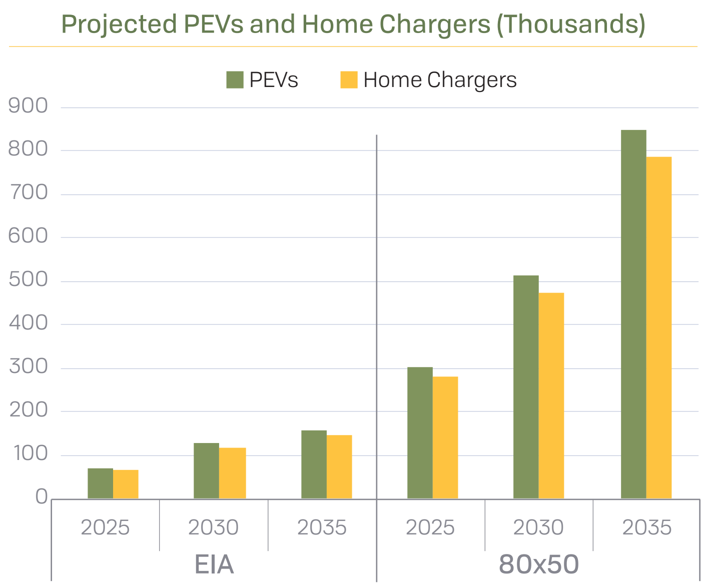
PROJECTED NUMBER OF CHARGERS			EIA								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Thousand		30.47			54.16			67.43	
	Single Fam - L2	Thousand		20.41			36.28			45.18	
	MUD - L1	Thousand		9.84			17.50			21.78	
	MUD - L2	Thousand		5.65			10.04			12.50	
	TOTAL HOME CHARGERS/PEV			0.928			0.928			0.928	
	% Home Chargers L2			39%			39%			39%	
PUBLIC AND WORKPLACE CHARGERS	Public L2	x000	0.57	3.43	6.86	1.02	6.10	12.19	1.26	7.59	15.17
	Public DCFC	x000	0.03	0.09	0.23	0.05	0.16	0.41	0.06	0.19	0.52
	DCFC per 100	Interstate	9.6	30.5	81.5	17.0	54.2	144.9	21.2	67.5	180.4
	Highway Miles	State & Inter	0.1	0.5	1.2	0.3	0.8	2.2	0.3	1.0	2.8

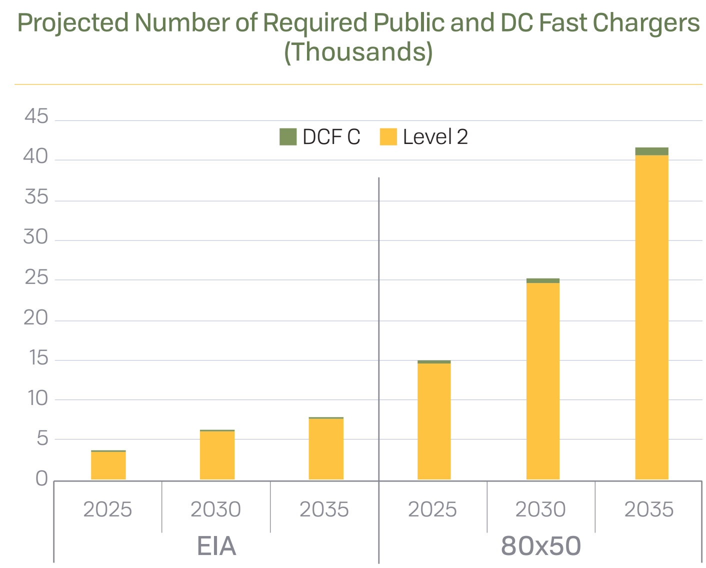
PROJECTED COST OF CHARGERS			EIA								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Nom$ Mil	$3.36	$16.80	$22.68	$6.65	$33.23	$44.86	$9.24	$46.20	$62.36
	Single Fam - L2	Nom$ Mil	$27.01	$31.51	$49.52	$53.43	$62.34	$97.96	$74.28	$86.66	$136.17
	MUD - L1	Nom$ Mil	$3.26	$8.68	$10.58	$6.44	$17.18	$20.93	$8.95	$23.88	$29.10
	MUD - L2	Nom$ Mil	$9.34	$10.59	$15.57	$18.48	$20.94	$30.80	$25.69	$29.11	$42.82
	TOTAL	Nom$ Mil	**$42.97**	**$67.58**	**$98.35**	**$85.00**	**$133.68**	**$194.55**	**$118.16**	**$185.84**	**$270.45**
		NPV $ Mil	**$33.92**	**$53.35**	**$77.64**	**$57.88**	**$91.03**	**$132.48**	**$69.41**	**$109.16**	**$158.86**
		NPV $/PEV	**$474**	**$746**	**$1,085**	**$455**	**$716**	**$1,042**	**$438**	**$690**	**$1,003**
PUBLIC AND WORKPLACE CHARGERS	Public L2	Nom$ Mil	$2.520	$18.908	$45.363	$4.985	$37.403	$89.737	$6.930	$51.996	$124.749
	Public DCFC	Nom$ Mil	$1.513	$5.289	$16.714	$2.992	$10.463	$33.064	$4.160	$14.545	$45.964
	TOTAL	Nom$ Mil	**$4.033**	**$24.197**	**$62.078**	**$7.978**	**$47.865**	**$122.800**	**$11.090**	**$66.540**	**$170.712**
		Nom$ Mil	**$3.184**	**$19.101**	**$49.005**	**$5.432**	**$32.594**	**$83.621**	**$6.514**	**$39.086**	**$100.275**
		NPV $ Mil	**$44,504**	**$267,023**	**$685,057**	**$42,723**	**$256,335**	**$657,639**	**$41,147**	**$246,881**	**$633,383**
	NPV $/PEV	Public L1	$0	$0	$0	$0	$0	$0	$0	$0	$0
		Public L2	$28	$209	$501	$27	$200	$481	$26	$193	$463
		DCFC	$17	$58	$184	$16	$56	$177	$15	$54	$171

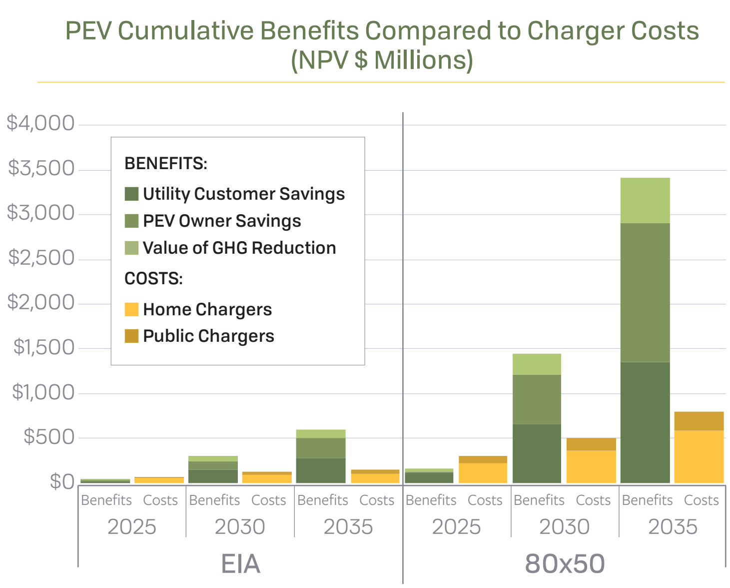
PROJECTED NUMBER OF CHARGERS			80x50								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Thousand		128.96			218.25			360.66	
	Single Fam - L2	Thousand		86.40			146.21			241.62	
	MUD - L1	Thousand		41.66			70.50			116.51	
	MUD - L2	Thousand		23.91			40.46			66.86	
	TOTAL HOME CHARGERS/PEV			0.928			0.928			0.928	
	% Home Chargers L2			39%			39%			39%	
PUBLIC AND WORKPLACE CHARGERS	Public L2	x000	2.42	14.52	29.02	4.09	24.57	49.11	6.76	40.59	81.16
	Public DCFC	x000	0.12	0.37	0.99	0.20	0.62	1.67	0.32	1.03	2.76
	DCFC per 100	Interstate	40.6	129.0	345.0	68.7	218.3	583.8	113.5	360.8	964.7
	Highway Miles	State & Inter	0.6	2.0	5.3	1.0	3.3	8.9	1.7	5.5	14.7

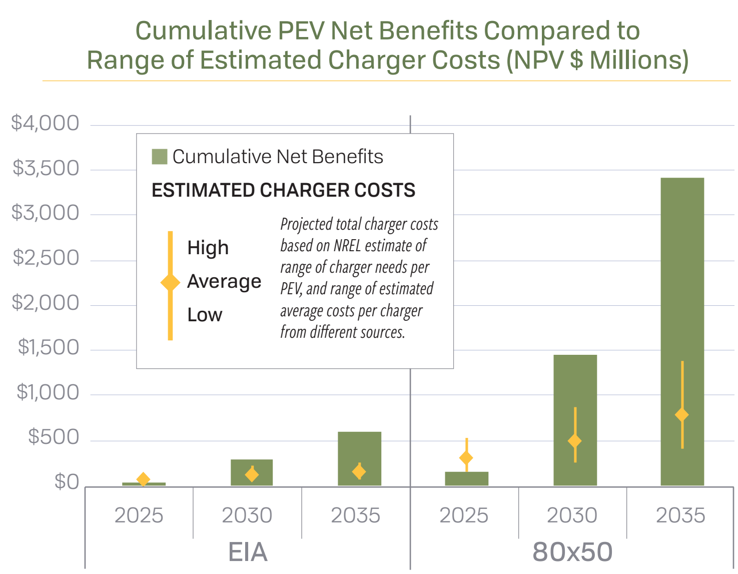
PROJECTED COST OF CHARGERS			80x50								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Nom$ Mil	$14.22	$71.10	$95.99	$26.78	$133.91	$180.78	$49.42	$247.08	$333.55
	Single Fam - L2	Nom$ Mil	$114.33	$133.38	$209.60	$215.32	$251.20	$394.74	$397.27	$463.48	$728.33
	MUD - L1	Nom$ Mil	$13.78	$36.75	$44.79	$25.96	$69.22	$84.36	$47.89	$127.71	$155.64
	MUD - L2	Nom$ Mil	$39.54	$44.81	$65.90	$74.47	$84.40	$124.12	$137.40	$155.72	$229.00
	TOTAL	Nom$ Mil	**$181.87**	**$286.05**	**$416.28**	**$342.52**	**$538.73**	**$784.00**	**$631.98**	**$993.99**	**$1,446.53**
		NPV $ Mil	**$143.57**	**$225.81**	**$328.62**	**$233.24**	**$366.85**	**$533.87**	**$371.22**	**$583.87**	**$849.69**
		NPV $/PEV	**$474**	**$746**	**$1,085**	**$455**	**$716**	**$1,042**	**$438**	**$690**	**$1,003**
PUBLIC AND WORKPLACE CHARGERS	Public L2	Nom$ Mil	$10.667	$80.033	$192.014	$20.090	$150.728	$361.626	$37.068	$278.103	$667.225
	Public DCFC	Nom$ Mil	$6.402	$22.387	$70.748	$12.058	$42.162	$133.241	$22.248	$77.792	$245.839
	TOTAL	Nom$ Mil	**$17.070**	**$102.420**	**$262.762**	**$32.148**	**$192.890**	**$494.867**	**$59.316**	**$355.896**	**$913.064**
		Nom$ Mil	**$13.475**	**$80.851**	**$207.427**	**$21.891**	**$131.349**	**$336.980**	**$34.842**	**$209.051**	**$536.329**
		NPV $ Mil	**$44,504**	**$267,023**	**$685,057**	**$42,723**	**$256,335**	**$657,639**	**$41,147**	**$246,881**	**$633,383**
	NPV $/PEV	Public L1	$0	$0	$0	$0	$0	$0	$0	$0	$0
		Public L2	$28	$209	$501	$27	$200	$481	$26	$193	$463
		DCFC	$17	$58	$184	$16	$56	$177	$15	$54	$171

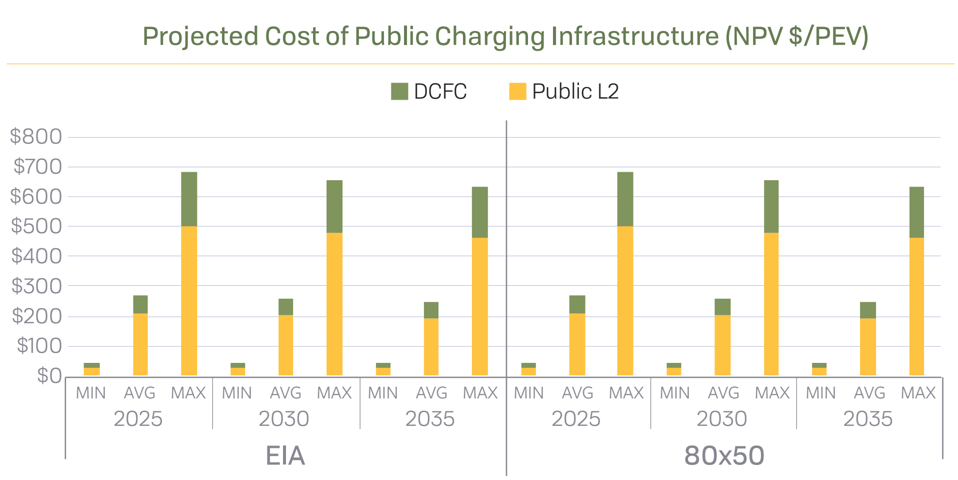
NATIONAL GRID, NEW YORK











BALTIMORE GAS & ELECTRIC, MARYLAND

METRIC		UNIT	2015 ACTUAL
Residential Customers		Million	3.09
Housing Units	Total	Million	1.25
	% in Multiple Unit Dwellings	Percent	25.0%
Highway Miles	Interstate	Thousand	0.227
	State	Thousand	14.951

METRIC		UNIT	EIA			80x50		
			2025	2030	2035	2025	2030	2035
Projected Number of PEVs	BEV	Thousand	16.9	33.0	45.4	135.9	260.5	429.7
	PHEV	Thousand	27.9	54.3	74.9	224.0	429.3	708.1
Annual PEV Charging Electricity	Home	Thousand MWh	115.3	209.1	270.3	892.1	1,722.7	2,793.0
	Non-home	Thousand MWh	29.0	52.7	68.1	224.8	434.0	703.7
Peak Daily Load for PEV Charging	Baseline Charging	MW	43.8	85.3	116.3	351.9	674.3	1,112.5
	Off-peak Charging	MW	17.1	33.3	44.1	137.1	262.8	433.5
Annual Utility Revenue from PEV Charging		NOM $ Mil	$27.15	$55.48	$79.29	$210.07	$457.06	$819.27
Annual Utility Net Revenue from PEV Charging	Baseline Charging	NOM $ Mil	$4.62	$10.21	$11.70	$34.47	$87.32	$131.36
	Off-peak Charging	NOM $ Mil	$7.35	$16.01	$20.15	$56.37	$133.15	$210.79
Annual GHG Reduction		Thousand MT	58.74	102.54	120.01	439.56	866.94	1,346.17
Annual Social Value of GHG Reduction		NOM $ Mil	$3.79	$8.03	$11.42	$28.35	$67.87	$128.08
Annual PEV Owner Savings		NOM $ Mil	-$0.13	$27.20	$43.81	$8.57	$307.76	$567.39

METRIC		UNIT	EIA			80x50		
			2025	2030	2035	2025	2030	2035
ANNUAL NET BENEFITS PER PEV	Utility Net Revenue – BASE	NOM $/PEV	$103.2	$117.0	$97.3	$95.8	$126.6	$115.5
	Utility Net Revenue – OFF PEAK	NOM $/PEV	$164.0	$183.4	$167.5	$156.6	$193.0	$185.3
	Value of GHG Reduction	NOM $/PEV	$84.5	$92.0	$94.9	$78.8	$98.4	$112.6
	PEV Owner Savings	NOM $/PEV	-$2.9	$311.6	$364.2	$23.8	$446.1	$498.7
	Utility Net Revenue – BASE	NPV $/PEV	$81.4	$79.7	$57.1	$75.6	$86.2	$67.8
	Utility Net Revenue – OFF PEAK	NPV $/PEV	$129.5	$124.9	$98.4	$123.6	$131.4	$108.8
	Value of GHG Reduction	NPV $/PEV	$66.7	$62.6	$55.8	$62.2	$67.0	$66.1
	PEV Owner Savings	NPV $/PEV	-$2.3	$212.2	$213.9	$18.8	$303.8	$292.9
CUMULATIVE NET BENEFITS	Utility Net Revenue – BASE	NOM $ Mil	$4.6	$44.5	$100.0	$34.5	$365.4	$934.1
	Utility Net Revenue – OFF PEAK	NOM $ Mil	$7.4	$70.1	$162.6	$56.4	$568.5	$1,467.2
	Value of GHG Reduction	NOM $ Mil	$3.8	$35.4	$85.8	$28.4	$288.7	$808.7
	PEV Owner Savings	NOM $ Mil	-$0.1	$81.2	$267.0	$8.6	$949.0	$3,266.6
	Utility Net Revenue – BASE	NPV $ Mil	$3.7	$30.3	$58.8	$27.2	$248.8	$548.7
	Utility Net Revenue – OFF PEAK	NPV $ Mil	$5.8	$47.7	$95.5	$44.5	$387.2	$861.8
	Value of GHG Reduction	NPV $ Mil	$3.0	$24.1	$50.4	$22.4	$196.6	$475.0
	PEV Owner Savings	NPV $ Mil	-$0.1	$55.3	$156.8	$6.8	$646.2	$1,918.8

BALTIMORE GAS & ELECTRIC, MARYLAND

PROJECTED NUMBER OF CHARGERS			EIA								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Thousand		19.91			38.78			53.43	
	Single Fam - L2	Thousand		13.70			26.69			36.78	
	MUD - L1	Thousand		5.29			10.31			14.21	
	MUD - L2	Thousand		3.11			6.05			8.34	
	TOTAL HOME CHARGERS/PEV			0.938			0.938			0.938	
	% Home Chargers L2			40%			40%			40%	
PUBLIC AND WORKPLACE CHARGERS	Public L2	x000	0.31	1.88	3.75	0.61	3.65	7.30	0.84	5.03	10.06
	Public DCFC	x000	0.02	0.06	0.15	0.04	0.11	0.30	0.05	0.15	0.41
	DCFC per 100 Highway Miles	Interstate	7.9	25.1	67.2	15.4	49.0	130.9	21.2	67.5	180.4
		State & Inter	0.1	0.4	1.0	0.2	0.7	2.0	0.3	1.0	2.7

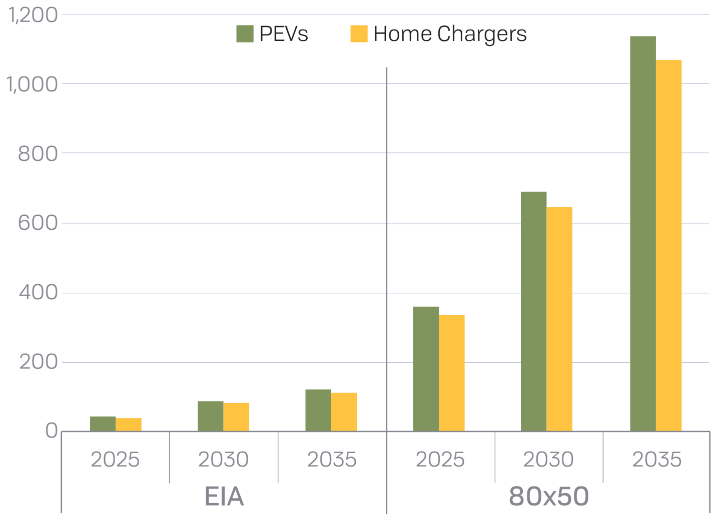
PROJECTED COST OF CHARGERS			EIA								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Nom$ Mil	$2.20	$10.98	$14.82	$4.76	$23.79	$32.12	$7.32	$36.61	$49.42
	Single Fam - L2	Nom$ Mil	$18.13	$21.16	$33.25	$39.30	$45.86	$72.06	$60.47	$70.55	$110.86
	MUD - L1	Nom$ Mil	$1.75	$4.67	$5.69	$3.80	$10.12	$12.34	$5.84	$15.58	$18.98
	MUD - L2	Nom$ Mil	$5.14	$5.83	$8.57	$11.14	$12.63	$18.57	$17.15	$19.43	$28.58
	TOTAL	Nom$ Mil	**$27.22**	**$42.63**	**$62.33**	**$59.00**	**$92.40**	**$135.09**	**$90.78**	**$142.16**	**$207.84**
		NPV $ Mil	**$21.49**	**$33.65**	**$49.20**	**$40.18**	**$62.92**	**$91.99**	**$53.32**	**$83.51**	**$122.08**
		NPV $/PEV	**$479**	**$751**	**$1,098**	**$460**	**$721**	**$1,054**	**$443**	**$694**	**$1,015**
PUBLIC AND WORKPLACE CHARGERS	Public L2	Nom$ Mil	$1.378	$10.339	$24.805	$2.987	$22.409	$53.764	$4.595	$34.477	$82.717
	Public DCFC	Nom$ Mil	$0.992	$3.468	$10.961	$2.150	$7.517	$23.756	$3.308	$11.566	$36.550
	TOTAL	Nom$ Mil	**$2.370**	**$13.807**	**$35.766**	**$5.137**	**$29.927**	**$77.520**	**$7.903**	**$46.043**	**$119.267**
		Nom$ Mil	**$1.871**	**$10.900**	**$28.234**	**$3.498**	**$20.379**	**$52.788**	**$4.642**	**$27.045**	**$70.057**
		NPV $ Mil	**$41,743**	**$243,191**	**$629,952**	**$40,072**	**$233,458**	**$604,739**	**$38,594**	**$224,847**	**$582,435**
	NPV $/PEV	Public L1	$0	$0	$0	$0	$0	$0	$0	$0	$0
		Public L2	$24	$182	$437	$23	$175	$419	$22	$168	$404
		DCFC	$17	$61	$193	$17	$59	$185	$16	$56	$178

PROJECTED NUMBER OF CHARGERS			80x50								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Thousand		159.90			306.44			505.45	
	Single Fam - L2	Thousand		110.06			210.93			347.91	
	MUD - L1	Thousand		42.52			81.50			134.42	
	MUD - L2	Thousand		24.97			47.85			78.92	
	TOTAL HOME CHARGERS/PEV			0.938			0.938			0.938	
	% Home Chargers L2			40%			40%			40%	
PUBLIC AND WORKPLACE CHARGERS	Public L2	x000	2.51	15.06	30.11	4.81	28.86	57.71	7.93	47.61	95.18
	Public DCFC	x000	0.14	0.46	1.23	0.28	0.88	2.35	0.46	1.45	3.88
	DCFC per 100 Highway Miles	Interstate	63.5	201.9	539.9	121.7	387.0	1,034.8	200.8	638.3	1,706.8
		State & Inter	1.0	3.0	8.1	1.8	5.8	15.5	3.0	9.6	25.6

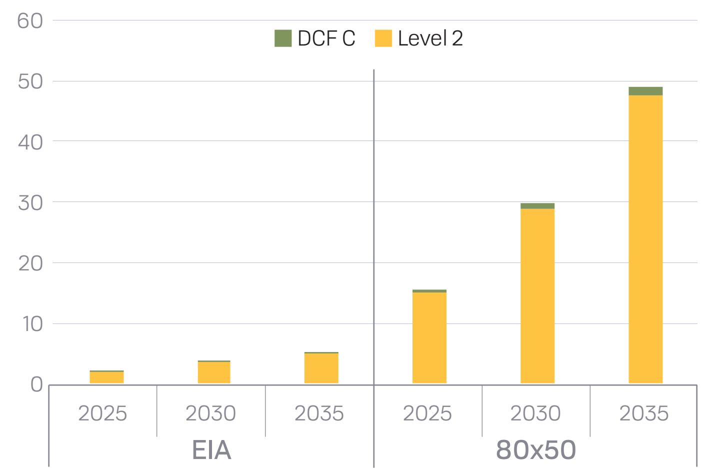
PROJECTED COST OF CHARGERS			80x50								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Nom$ Mil	$17.63	$88.16	$119.02	$37.61	$188.03	$253.84	$69.25	$346.27	$467.47
	Single Fam - L2	Nom$ Mil	$145.63	$169.91	$267.00	$310.61	$362.38	$569.45	$572.02	$667.35	$1,048.70
	MUD - L1	Nom$ Mil	$14.07	$37.51	$45.72	$30.00	$80.01	$97.51	$55.25	$147.34	$179.57
	MUD - L2	Nom$ Mil	$41.30	$46.80	$68.83	$88.08	$99.82	$146.79	$162.20	$183.83	$270.33
	TOTAL	Nom$ Mil	**$218.63**	**$342.38**	**$500.56**	**$466.30**	**$730.23**	**$1,067.59**	**$858.72**	**$1,344.79**	**$1,966.07**
		NPV $ Mil	**$172.59**	**$270.28**	**$395.14**	**$317.52**	**$497.25**	**$726.98**	**$504.41**	**$789.92**	**$1,154.86**
		NPV $/PEV	**$479**	**$751**	**$1,098**	**$460**	**$721**	**$1,054**	**$443**	**$694**	**$1,015**
PUBLIC AND WORKPLACE CHARGERS	Public L2	Nom$ Mil	$11.067	$83.033	$199.213	$23.605	$177.094	$424.883	$43.470	$326.133	$782.459
	Public DCFC	Nom$ Mil	$7.966	$27.854	$88.025	$16.990	$59.408	$187.741	$31.289	$109.405	$345.741
	TOTAL	Nom$ Mil	**$19.033**	**$110.887**	**$287.238**	**$40.595**	**$236.502**	**$612.624**	**$74.759**	**$435.538**	**$1,128.200**
		Nom$ Mil	**$15.025**	**$87.535**	**$226.748**	**$27.643**	**$161.046**	**$417.167**	**$43.913**	**$255.833**	**$662.699**
		NPV $ Mil	**$41,743**	**$243,191**	**$629,952**	**$40,072**	**$233,458**	**$604,739**	**$38,594**	**$224,847**	**$582,435**
	NPV $/PEV	Public L1	$0	$0	$0	$0	$0	$0	$0	$0	$0
		Public L2	$24	$182	$437	$23	$175	$419	$22	$168	$404
		DCFC	$17	$61	$193	$17	$59	$185	$16	$56	$178

BALTIMORE GAS & ELECTRIC, MARYLAND

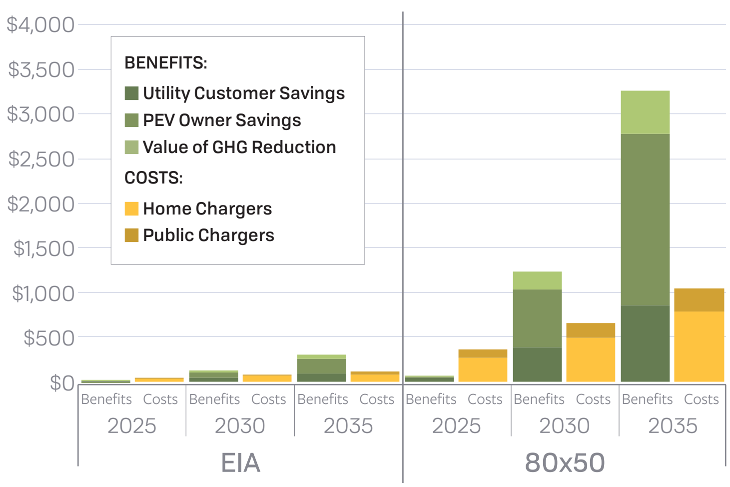
Projected PEVs and Home Chargers (Thousands)



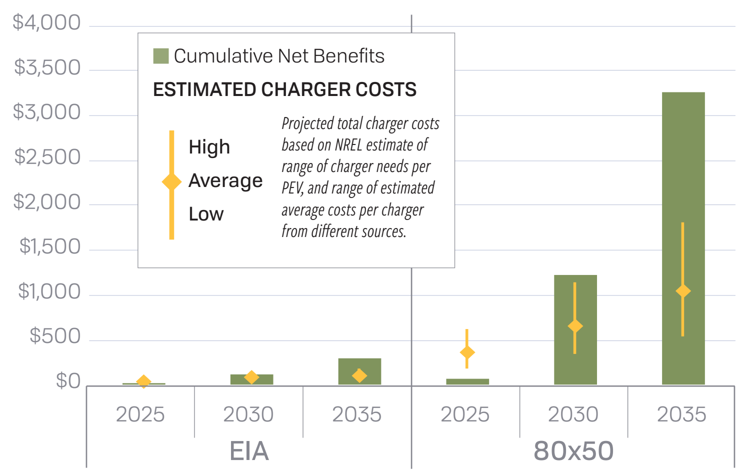
Projected Number of Required Public and DC Fast Chargers (Thousands)



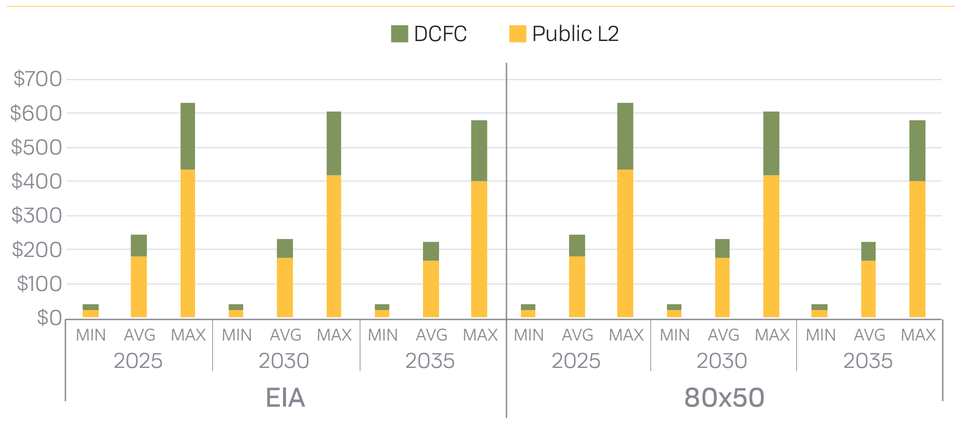
PEV Cumulative Benefits Compared to Charger Costs (NPV $ Millions)



Cumulative PEV Net Benefits Compared to Range of Estimated Charger Costs (NPV $ Millions)



Projected Cost of Public Charging Infrastructure (NPV $/PEV)



PECO, PENNSYLVANIA

METRIC		UNIT	2015 ACTUAL
Residential Customers		Million	3.84
Housing Units	Total	Million	1.57
	% in Multiple Unit Dwellings	Percent	21.8%
Highway Miles	Interstate	Thousand	0.561
	State	Thousand	35.518

METRIC		UNIT	EIA			80x50		
			2025	2030	2035	2025	2030	2035
Projected Number of PEVs	BEV	Thousand	60.6	107.7	134.3	249.1	416.3	709.7
	PHEV	Thousand	98.9	175.8	219.1	406.4	679.3	1,158.1
Annual PEV Charging Electricity	Home	Thousand MWh	255.3	423.9	498.1	1,036.1	1,744.8	2,924.6
	Non-home	Thousand MWh	58.8	97.6	114.7	238.5	401.7	673.3
Peak Daily Load for PEV Charging	Baseline Charging	MW	89.8	138.4	172.5	368.7	615.9	1,051.2
	Off-peak Charging	MW	35.0	56.0	69.8	143.9	240.4	410.3
Annual Utility Revenue from PEV Charging		NOM $ Mil	$78.67	$151.80	$198.31	$319.32	$624.89	$1,164.27
Annual Utility Net Revenue from PEV Charging	Baseline Charging	NOM $ Mil	$19.63	$40.18	$45.20	$79.34	$160.84	$261.34
	Off-peak Charging	NOM $ Mil	$23.72	$48.37	$55.98	$96.16	$198.15	$328.57
Annual GHG Reduction		Thousand MT	199.65	307.80	335.99	822.90	1,267.49	1,977.16
Annual Social Value of GHG Reduction		NOM $ Mil	$12.88	$24.10	$31.97	$53.08	$99.23	$188.12
Annual PEV Owner Savings		NOM $ Mil	-$43.01	-$1.75	$7.57	-$154.81	$129.43	$243.24

METRIC		UNIT	EIA			80x50		
			2025	2030	2035	2025	2030	2035
ANNUAL NET BENEFITS PER PEV	Utility Net Revenue – BASE	NOM $/PEV	$123.1	$141.7	$127.9	$121.0	$146.8	$139.9
	Utility Net Revenue – OFF PEAK	NOM $/PEV	$148.7	$170.6	$158.4	$146.7	$180.9	$175.9
	Value of GHG Reduction	NOM $/PEV	$80.7	$85.0	$90.5	$81.0	$90.6	$100.7
	PEV Owner Savings	NOM $/PEV	-$269.7	-$6.2	$21.4	-$236.2	$118.1	$130.2
	Utility Net Revenue – BASE	NPV $/PEV	$97.1	$96.5	$75.1	$95.6	$100.0	$82.2
	Utility Net Revenue – OFF PEAK	NPV $/PEV	$117.4	$116.2	$93.1	$115.8	$123.2	$103.3
	Value of GHG Reduction	NPV $/PEV	$63.7	$57.9	$53.1	$63.9	$61.7	$59.2
	PEV Owner Savings	NPV $/PEV	-$212.9	-$4.2	$12.6	-$186.4	$80.4	$76.5
CUMULATIVE NET BENEFITS	Utility Net Revenue – BASE	NOM $ Mil	$19.6	$179.4	$395.4	$79.3	$720.6	$1,826.3
	Utility Net Revenue – OFF PEAK	NOM $ Mil	$23.7	$216.3	$481.0	$96.2	$882.9	$2,264.9
	Value of GHG Reduction	NOM $ Mil	$12.9	$110.9	$255.0	$53.1	$456.9	$1,219.7
	PEV Owner Savings	NOM $ Mil	-$43.0	-$134.3	-$115.1	-$154.8	-$76.1	$912.5
	Utility Net Revenue – BASE	NPV $ Mil	$15.5	$122.2	$232.3	$62.6	$490.7	$1,072.7
	Utility Net Revenue – OFF PEAK	NPV $ Mil	$18.7	$147.3	$282.5	$75.9	$601.2	$1,330.4
	Value of GHG Reduction	NPV $ Mil	$10.2	$75.5	$149.8	$41.9	$311.1	$716.5
	PEV Owner Savings	NPV $ Mil	-$34.0	-$91.5	-$67.6	-$122.2	-$51.8	$536.0

PECO, PENNSYLVANIA

PROJECTED NUMBER OF CHARGERS			EIA								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Thousand		73.73			131.07			163.34	
	Single Fam - L2	Thousand		51.02			90.70			113.03	
	MUD - L1	Thousand		16.39			29.14			36.32	
	MUD - L2	Thousand		9.67			17.19			21.42	
	TOTAL HOME CHARGERS/PEV			0.946			0.946			0.946	
	% Home Chargers L2			40%			40%			40%	
PUBLIC AND WORKPLACE CHARGERS	Public L2	x000	1.29	7.74	15.47	2.29	13.75	27.50	2.86	17.14	34.27
	Public DCFC	x000	0.09	0.27	0.74	0.15	0.49	1.31	0.19	0.61	1.63
	DCFC per 100	Interstate	15.4	49.0	131.0	27.4	87.1	232.9	34.1	108.5	290.2
	Highway Miles	State & Inter	0.2	0.8	2.0	0.4	1.4	3.6	0.5	1.7	4.5

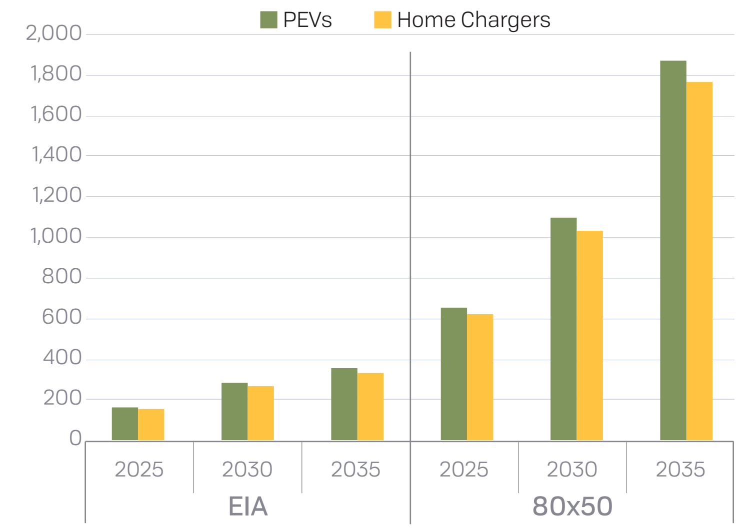
PROJECTED COST OF CHARGERS			EIA								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Nom$ Mil	$8.13	$40.65	$54.88	$16.08	$80.42	$108.57	$22.38	$111.90	$151.06
	Single Fam - L2	Nom$ Mil	$67.51	$78.76	$123.77	$133.56	$155.82	$244.86	$185.83	$216.81	$340.70
	MUD - L1	Nom$ Mil	$5.42	$14.46	$17.63	$10.73	$28.61	$34.87	$14.93	$39.81	$48.52
	MUD - L2	Nom$ Mil	$15.99	$18.12	$26.65	$31.64	$35.86	$52.73	$44.02	$49.89	$73.37
	TOTAL	Nom$ Mil	**$97.06**	**$152.00**	**$222.93**	**$192.01**	**$300.71**	**$441.03**	**$267.16**	**$418.40**	**$613.64**
		NPV $ Mil	**$76.62**	**$119.99**	**$175.98**	**$130.75**	**$204.77**	**$300.32**	**$156.93**	**$245.77**	**$360.45**
		NPV $/PEV	**$480**	**$752**	**$1,103**	**$461**	**$722**	**$1,059**	**$444**	**$696**	**$1,020**
PUBLIC AND WORKPLACE CHARGERS	Public L2	Nom$ Mil	$5.686	$42.661	$102.352	$11.249	$84.397	$202.484	$15.652	$117.429	$281.736
	Public DCFC	Nom$ Mil	$4.768	$16.671	$52.685	$9.432	$32.981	$104.227	$13.124	$45.890	$145.021
	TOTAL	Nom$ Mil	**$10.454**	**$59.332**	**$155.037**	**$20.681**	**$117.378**	**$306.711**	**$28.776**	**$163.319**	**$426.757**
		Nom$ Mil	**$8.253**	**$46.837**	**$122.388**	**$14.083**	**$79.929**	**$208.855**	**$16.903**	**$95.933**	**$250.675**
		NPV $ Mil	**$51,739**	**$293,647**	**$767,307**	**$49,668**	**$281,894**	**$736,597**	**$47,837**	**$271,497**	**$709,429**
	NPV $/PEV	Public L1	$0	$0	$0	$0	$0	$0	$0	$0	$0
		Public L2	$28	$211	$507	$27	$203	$486	$26	$195	$468
		DCFC	$24	$83	$261	$23	$79	$250	$22	$76	$241

PROJECTED NUMBER OF CHARGERS			80x50								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Thousand		303.01			506.46			863.43	
	Single Fam - L2	Thousand		209.67			350.45			597.46	
	MUD - L1	Thousand		67.37			112.61			191.97	
	MUD - L2	Thousand		39.73			66.41			113.22	
	TOTAL HOME CHARGERS/PEV			0.946			0.946			0.946	
	% Home Chargers L2			40%			40%			40%	
PUBLIC AND WORKPLACE CHARGERS	Public L2	x000	5.30	31.80	63.58	8.86	53.15	106.26	15.10	90.61	181.16
	Public DCFC	x000	0.36	1.13	3.02	0.59	1.89	5.05	1.01	3.22	8.61
	DCFC per 100	Interstate	63.3	201.4	538.4	105.9	336.5	899.9	180.5	573.8	1,534.2
	Highway Miles	State & Inter	1.0	3.1	8.4	1.6	5.2	14.0	2.8	8.9	23.9

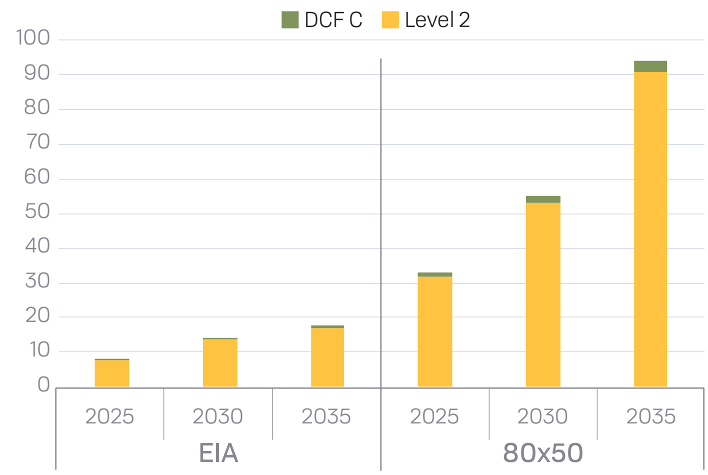
PROJECTED COST OF CHARGERS			80x50								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Nom$ Mil	$33.41	$167.06	$225.54	$62.15	$310.75	$419.52	$118.30	$591.51	$798.54
	Single Fam - L2	Nom$ Mil	$277.45	$323.69	$508.65	$516.07	$602.09	$946.14	$982.33	$1,146.06	$1,800.95
	MUD - L1	Nom$ Mil	$22.29	$59.43	$72.43	$41.46	$110.55	$134.73	$78.91	$210.43	$256.46
	MUD - L2	Nom$ Mil	$65.72	$74.48	$109.53	$122.25	$138.55	$203.74	$232.69	$263.72	$387.82
	TOTAL	Nom$ Mil	**$398.87**	**$624.67**	**$916.16**	**$741.93**	**$1,161.93**	**$1,704.13**	**$1,412.24**	**$2,211.71**	**$3,243.76**
		NPV $ Mil	**$314.87**	**$493.12**	**$723.22**	**$505.22**	**$791.22**	**$1,160.43**	**$829.54**	**$1,299.15**	**$1,905.37**
		NPV $/PEV	**$480**	**$752**	**$1,103**	**$461**	**$722**	**$1,059**	**$444**	**$696**	**$1,020**
PUBLIC AND WORKPLACE CHARGERS	Public L2	Nom$ Mil	$23.368	$175.319	$420.625	$43.466	$326.107	$782.397	$82.737	$620.738	$1,489.274
	Public DCFC	Nom$ Mil	$19.594	$68.513	$216.513	$36.446	$127.439	$402.732	$69.375	$242.578	$766.592
	TOTAL	Nom$ Mil	**$42.962**	**$243.831**	**$637.138**	**$79.913**	**$453.546**	**$1,185.129**	**$152.112**	**$863.315**	**$2,255.865**
		Nom$ Mil	**$33.915**	**$192.483**	**$502.963**	**$54.417**	**$308.843**	**$807.015**	**$89.350**	**$507.107**	**$1,325.083**
		NPV $ Mil	**$51,739**	**$293,647**	**$767,307**	**$49,668**	**$281,894**	**$736,597**	**$47,837**	**$271,497**	**$709,429**
	NPV $/PEV	Public L1	$0	$0	$0	$0	$0	$0	$0	$0	$0
		Public L2	$28	$211	$507	$27	$203	$486	$26	$195	$468
		DCFC	$24	$83	$261	$23	$79	$250	$22	$76	$241

PECO, PENNSYLVANIA

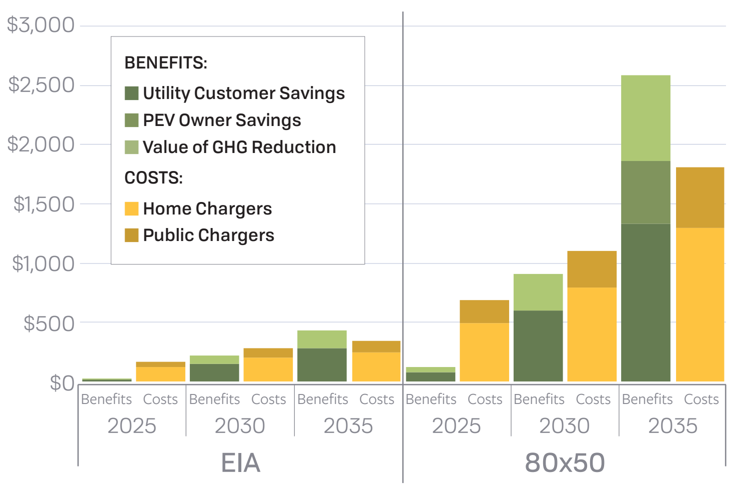
Projected PEVs and Home Chargers (Thousands)



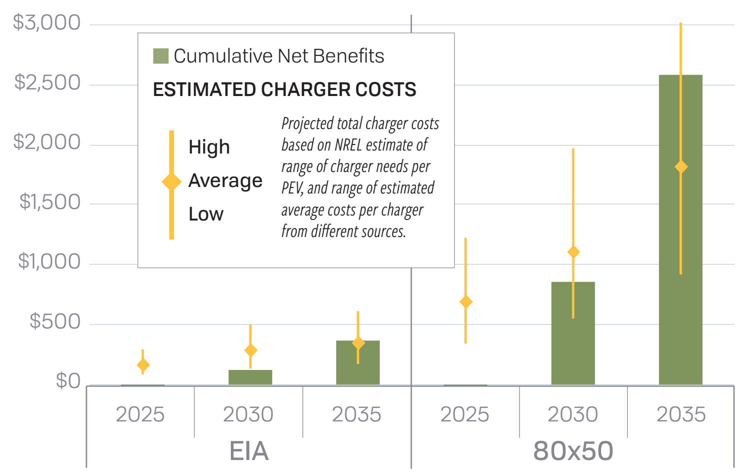
Projected Number of Required Public and DC Fast Chargers (Thousands)



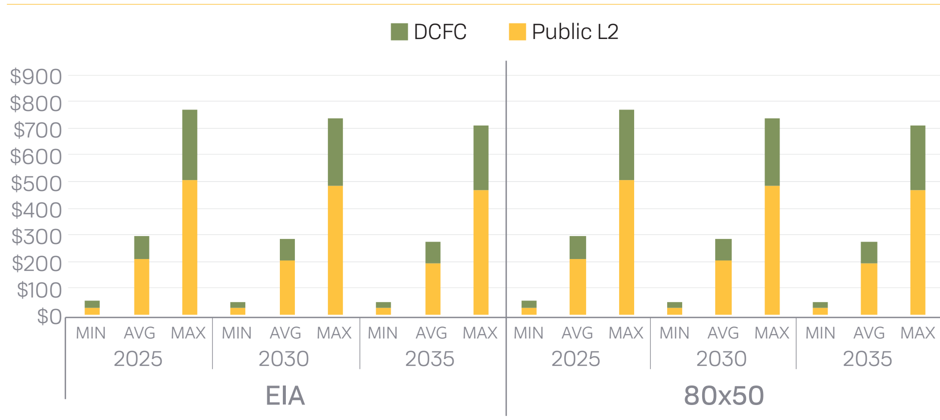
PEV Cumulative Benefits Compared to Charger Costs (NPV $ Millions)



Cumulative PEV Net Benefits Compared to Range of Estimated Charger Costs (NPV $ Millions)



Projected Cost of Public Charging Infrastructure (NPV $/PEV)



PPL, PENNSYLVANIA

METRIC		UNIT	2015 ACTUAL
Residential Customers		Million	2.62
Housing Units	Total	Million	1.14
	% in Multiple Unit Dwellings	Percent	17.9%
Highway Miles	Interstate	Thousand	0.382
	State	Thousand	24.195

METRIC		UNIT	EIA			80x50		
			2025	2030	2035	2025	2030	2035
Projected Number of PEVs	BEV	Thousand	27.0	47.9	59.7	110.8	185.1	315.6
	PHEV	Thousand	63.2	112.4	140.0	259.8	434.2	740.3
Annual PEV Charging Electricity	Home	Thousand MWh	237.8	394.8	464.0	966.5	1,629.2	2,723.9
	Non-home	Thousand MWh	49.2	81.7	96.0	200.0	337.1	563.6
Peak Daily Load for PEV Charging	Baseline Charging	MW	82.0	126.5	157.6	337.4	564.2	960.5
	Off-peak Charging	MW	32.0	51.2	63.8	131.7	220.2	374.9
Annual Utility Revenue from PEV Charging		NOM $ Mil	$69.51	$134.07	$175.14	$282.46	$553.30	$1,028.27
Annual Utility Net Revenue from PEV Charging	Baseline Charging	NOM $ Mil	$17.14	$35.07	$39.37	$69.34	$140.55	$227.45
	Off-peak Charging	NOM $ Mil	$20.88	$42.55	$49.21	$84.74	$174.72	$288.87
Annual GHG Reduction		Thousand MT	162.85	247.57	266.84	650.45	1,073.58	1,788.79
Annual Social Value of GHG Reduction		NOM $ Mil	$10.50	$19.38	$25.39	$41.96	$84.04	$170.20
Annual PEV Owner Savings		NOM $ Mil	-$22.28	$2.93	$9.40	-$79.26	$89.33	$167.58

METRIC		UNIT	EIA			80x50		
			2025	2030	2035	2025	2030	2035
ANNUAL NET BENEFITS PER PEV	Utility Net Revenue – BASE	NOM $/PEV	$190.0	$218.8	$197.1	$187.1	$226.9	$215.4
	Utility Net Revenue – OFF PEAK	NOM $/PEV	$231.6	$265.5	$246.4	$228.7	$282.1	$273.6
	Value of GHG Reduction	NOM $/PEV	$116.5	$120.9	$127.1	$113.2	$135.7	$161.2
	PEV Owner Savings	NOM $/PEV	-$247.1	$18.3	$47.1	-$213.9	$144.2	$158.7
	Utility Net Revenue – BASE	NPV $/PEV	$150.0	$149.0	$115.8	$147.7	$154.5	$126.5
	Utility Net Revenue – OFF PEAK	NPV $/PEV	$182.8	$180.8	$144.7	$180.5	$192.1	$160.7
	Value of GHG Reduction	NPV $/PEV	$92.0	$82.3	$74.7	$89.4	$92.4	$94.7
	PEV Owner Savings	NPV $/PEV	-$195.1	$12.4	$27.7	-$168.9	$98.2	$93.2
CUMULATIVE NET BENEFITS	Utility Net Revenue – BASE	NOM $ Mil	$17.1	$156.6	$344.9	$69.3	$629.7	$1,593.1
	Utility Net Revenue – OFF PEAK	NOM $ Mil	$20.9	$190.3	$423.1	$84.7	$778.4	$1,994.4
	Value of GHG Reduction	NOM $ Mil	$10.5	$89.7	$204.6	$42.0	$378.0	$1,056.7
	PEV Owner Savings	NOM $ Mil	-$22.3	-$58.1	-$24.0	-$79.3	$30.2	$711.6
	Utility Net Revenue – BASE	NPV $ Mil	$13.5	$106.6	$202.6	$54.7	$428.8	$935.8
	Utility Net Revenue – OFF PEAK	NPV $ Mil	$16.5	$129.6	$248.5	$66.9	$530.0	$1,171.5
	Value of GHG Reduction	NPV $ Mil	$8.3	$61.1	$120.2	$33.1	$257.4	$620.7
	PEV Owner Savings	NPV $ Mil	-$17.6	-$39.5	-$14.1	-$62.6	$20.6	$418.0

PPL, PENNSYLVANIA

PROJECTED NUMBER OF CHARGERS			EIA								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Thousand		47.08			83.69			104.29	
	Single Fam - L2	Thousand		26.99			47.98			59.79	
	MUD - L1	Thousand		8.04			14.29			17.81	
	MUD - L2	Thousand		4.04			7.18			8.95	
	TOTAL HOME CHARGERS/PEV			0.955			0.955			0.955	
	% Home Chargers L2			36%			36%			36%	
PUBLIC AND WORKPLACE CHARGERS	Public L2	x000	0.73	4.37	8.75	1.30	7.78	15.55	1.61	9.69	19.37
	Public DCFC	x000	0.05	0.16	0.42	0.09	0.28	0.74	0.11	0.34	0.92
	DCFC per 100	Interstate	12.8	40.7	108.7	22.7	72.3	193.3	28.3	90.1	240.9
	Highway Miles	State & Inter	0.2	0.6	1.7	0.4	1.1	3.0	0.4	1.4	3.7

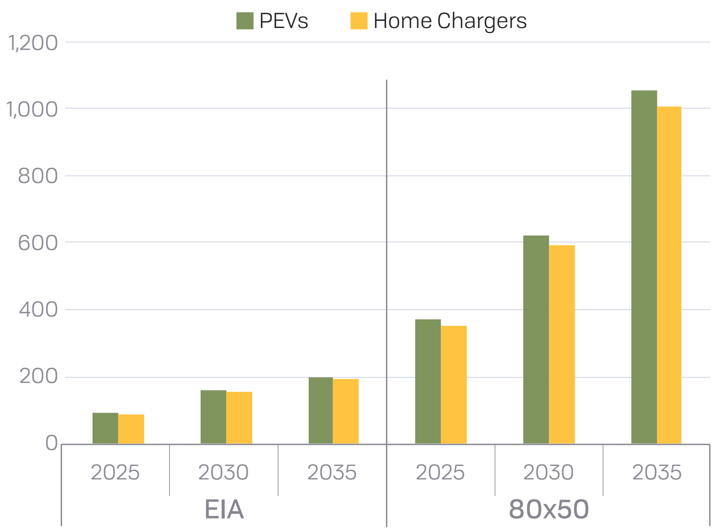
PROJECTED COST OF CHARGERS			EIA								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Nom$ Mil	$5.19	$25.96	$35.04	$10.27	$51.35	$69.32	$14.29	$71.45	$96.45
	Single Fam - L2	Nom$ Mil	$35.71	$41.67	$65.47	$70.65	$82.43	$129.53	$98.30	$114.69	$180.22
	MUD - L1	Nom$ Mil	$2.66	$7.09	$8.64	$5.26	$14.03	$17.10	$7.32	$19.52	$23.79
	MUD - L2	Nom$ Mil	$6.68	$7.57	$11.14	$13.22	$14.98	$22.03	$18.39	$20.85	$30.66
	TOTAL	Nom$ Mil	**$50.25**	**$82.28**	**$120.29**	**$99.40**	**$162.78**	**$237.98**	**$138.31**	**$226.50**	**$331.12**
		NPV $ Mil	**$39.66**	**$64.96**	**$94.96**	**$67.69**	**$110.85**	**$162.05**	**$81.24**	**$133.04**	**$194.50**
		NPV $/PEV	**$440**	**$720**	**$1,053**	**$422**	**$692**	**$1,011**	**$407**	**$666**	**$974**
PUBLIC AND WORKPLACE CHARGERS	Public L2	Nom$ Mil	$3.215	$24.117	$57.861	$6.359	$47.711	$114.467	$8.848	$66.384	$159.269
	Public DCFC	Nom$ Mil	$2.695	$9.425	$29.784	$5.332	$18.645	$58.921	$7.419	$25.942	$81.983
	TOTAL	Nom$ Mil	**$5.910**	**$33.541**	**$87.645**	**$11.692**	**$66.355**	**$173.389**	**$16.268**	**$92.327**	**$241.252**
		Nom$ Mil	**$4.665**	**$26.478**	**$69.188**	**$7.961**	**$45.185**	**$118.069**	**$9.555**	**$54.232**	**$141.710**
		NPV $ Mil	**$51,739**	**$293,647**	**$767,307**	**$49,668**	**$281,894**	**$736,597**	**$47,837**	**$271,497**	**$709,429**
	NPV $/PEV	Public L1	$0	$0	$0	$0	$0	$0	$0	$0	$0
		Public L2	$28	$211	$507	$27	$203	$486	$26	$195	$468
		DCFC	$24	$83	$261	$23	$79	$250	$22	$76	$241

PROJECTED NUMBER OF CHARGERS			80x50								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Thousand		193.47			323.37			551.28	
	Single Fam - L2	Thousand		110.91			185.38			316.05	
	MUD - L1	Thousand		33.03			55.21			94.12	
	MUD - L2	Thousand		16.60			27.75			47.31	
	TOTAL HOME CHARGERS/PEV			0.955			0.955			0.955	
	% Home Chargers L2			36%			36%			36%	
PUBLIC AND WORKPLACE CHARGERS	Public L2	x000	3.00	17.98	35.94	5.01	30.05	60.07	8.53	51.22	102.41
	Public DCFC	x000	0.20	0.64	1.71	0.34	1.07	2.85	0.57	1.82	4.87
	DCFC per 100	Interstate	52.6	167.1	446.8	87.9	279.3	746.9	149.8	476.2	1,273.3
	Highway Miles	State & Inter	0.8	2.6	6.9	1.4	4.3	11.6	2.3	7.4	19.8

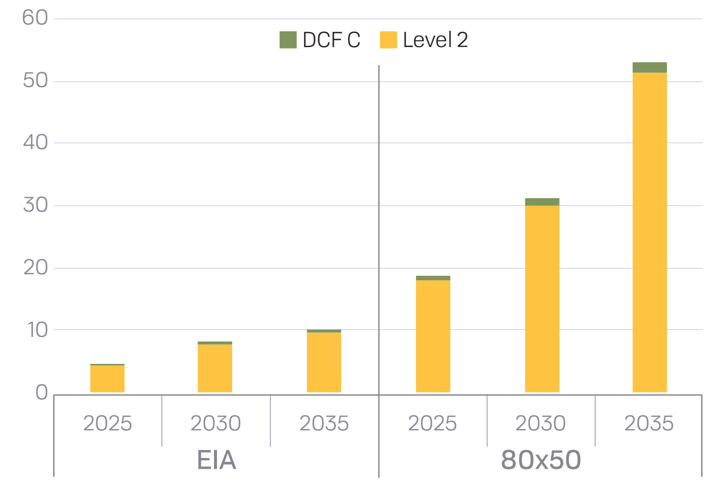
PROJECTED COST OF CHARGERS			80x50								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Nom$ Mil	$21.33	$106.67	$144.00	$39.68	$198.41	$267.85	$75.53	$377.67	$509.85
	Single Fam - L2	Nom$ Mil	$146.77	$171.23	$269.07	$273.00	$318.49	$500.49	$519.64	$606.25	$952.67
	MUD - L1	Nom$ Mil	$10.93	$29.14	$35.51	$20.32	$54.20	$66.06	$38.69	$103.17	$125.73
	MUD - L2	Nom$ Mil	$27.46	$31.12	$45.77	$51.08	$57.89	$85.13	$97.23	$110.19	$162.05
	TOTAL	Nom$ Mil	**$206.49**	**$338.15**	**$494.35**	**$384.08**	**$628.99**	**$919.53**	**$731.09**	**$1,197.28**	**$1,750.31**
		NPV $ Mil	**$163.00**	**$266.94**	**$390.25**	**$261.54**	**$428.31**	**$626.16**	**$429.44**	**$703.27**	**$1,028.12**
		NPV $/PEV	**$440**	**$720**	**$1,053**	**$422**	**$692**	**$1,011**	**$407**	**$666**	**$974**
PUBLIC AND WORKPLACE CHARGERS	Public L2	Nom$ Mil	$13.210	$99.110	$237.786	$24.572	$184.353	$442.301	$46.773	$350.912	$841.909
	Public DCFC	Nom$ Mil	$11.077	$38.731	$122.398	$20.604	$72.043	$227.671	$39.219	$137.133	$433.366
	TOTAL	Nom$ Mil	**$24.287**	**$137.842**	**$360.184**	**$45.176**	**$256.397**	**$669.972**	**$85.991**	**$488.045**	**$1,275.275**
		Nom$ Mil	**$19.172**	**$108.813**	**$284.333**	**$30.763**	**$174.594**	**$456.218**	**$50.511**	**$286.675**	**$749.090**
		NPV $ Mil	**$51,739**	**$293,647**	**$767,307**	**$49,668**	**$281,894**	**$736,597**	**$47,837**	**$271,497**	**$709,429**
	NPV $/PEV	Public L1	$0	$0	$0	$0	$0	$0	$0	$0	$0
		Public L2	$28	$211	$507	$27	$203	$486	$26	$195	$468
		DCFC	$24	$83	$261	$23	$79	$250	$22	$76	$241

PPL, PENNSYLVANIA

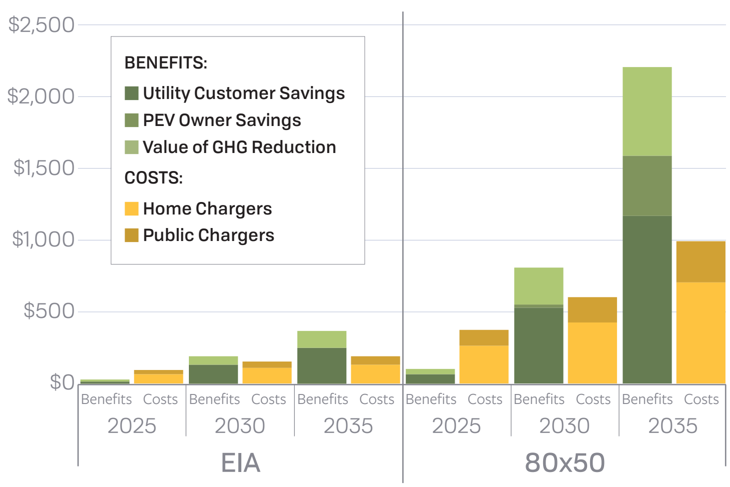
Projected PEVs and Home Chargers (Thousands)



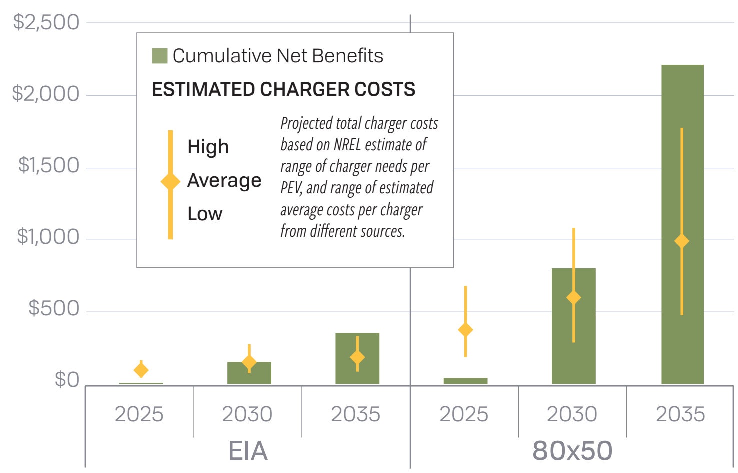
Projected Number of Required Public and DC Fast Chargers (Thousands)



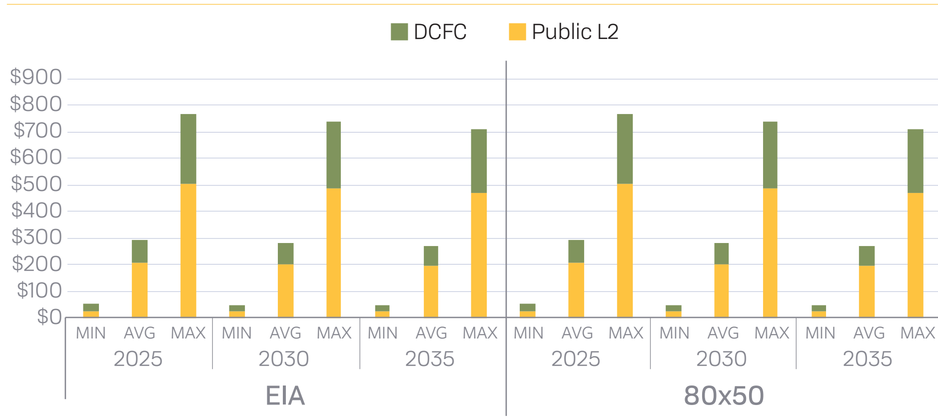
PEV Cumulative Benefits Compared to Charger Costs (NPV $ Millions)



Cumulative PEV Net Benefits Compared to Range of Estimated Charger Costs (NPV $ Millions)



Projected Cost of Public Charging Infrastructure (NPV $/PEV)



PG&E, CALIFORNIA

METRIC		UNIT	2015 ACTUAL
Residential Customers		Million	5.21
Housing Units	Total	Million	4.93
	% in Multiple Unit Dwellings	Percent	31.1%
Highway Miles	Interstate	Thousand	0.858
	State	Thousand	67.684

METRIC		UNIT	EIA			80x50		
			2025	2030	2035	2025	2030	2035
Projected Number of PEVs	BEV	Thousand	98.9	180.2	226.6	537.8	917.5	1,568.3
	PHEV	Thousand	124.1	225.9	284.1	674.2	1,150.2	1,966.2
Annual PEV Charging Electricity	Home	Thousand MWh	606.4	1,029.5	1,218.7	3,195.7	5,490.6	9,239.3
	Non-home	Thousand MWh	180.4	306.2	362.4	950.4	1,632.9	2,747.8
Peak Daily Load for PEV Charging	Baseline Charging	MW	218.9	398.6	501.1	1,189.5	2,029.3	3,468.9
	Off-peak Charging	MW	90.4	164.6	206.9	491.1	837.9	1,432.3
Annual Utility Revenue from PEV Charging		NOM $ Mil	$144.47	$294.36	$400.47	$761.25	$1,569.74	$3,036.20
Annual Utility Net Revenue from PEV Charging	Baseline Charging	NOM $ Mil	$64.91	$105.56	$133.33	$340.35	$573.01	$1,050.34
	Off-peak Charging	NOM $ Mil	$70.81	$130.07	$168.46	$372.46	$697.78	$1,293.50
Annual GHG Reduction		Thousand MT	613.76	949.89	1,079.67	3,191.44	5,176.37	8,774.92
Annual Social Value of GHG Reduction		NOM $ Mil	$39.59	$74.36	$102.72	$205.86	$405.22	$834.88
Annual PEV Owner Savings		NOM $ Mil	-$11.56	$95.86	$130.87	-$20.03	$813.92	$1,399.69

METRIC		UNIT	EIA			80x50		
			2025	2030	2035	2025	2030	2035
ANNUAL NET BENEFITS PER PEV	Utility Net Revenue – BASE	NOM $/PEV	$291.1	$259.9	$261.1	$280.8	$277.1	$297.2
	Utility Net Revenue – OFF PEAK	NOM $/PEV	$317.6	$320.3	$329.9	$307.3	$337.5	$366.0
	Value of GHG Reduction	NOM $/PEV	$177.5	$183.1	$201.2	$169.9	$196.0	$236.2
	PEV Owner Savings	NOM $/PEV	-$51.8	$236.0	$256.3	-$16.5	$393.6	$396.0
	Utility Net Revenue – BASE	NPV $/PEV	$229.8	$177.0	$153.4	$221.7	$188.7	$174.6
	Utility Net Revenue – OFF PEAK	NPV $/PEV	$250.7	$218.1	$193.8	$242.6	$229.8	$215.0
	Value of GHG Reduction	NPV $/PEV	$140.1	$124.7	$118.2	$134.1	$133.4	$138.7
	PEV Owner Savings	NPV $/PEV	-$40.9	$160.7	$150.6	-$13.0	$268.0	$232.6
CUMULATIVE NET BENEFITS	Utility Net Revenue – BASE	NOM $ Mil	$64.9	$511.4	$1,122.5	$340.4	$2,740.1	$7,037.1
	Utility Net Revenue – OFF PEAK	NOM $ Mil	$70.8	$602.7	$1,368.2	$372.5	$3,210.7	$8,486.8
	Value of GHG Reduction	NOM $ Mil	$39.6	$341.8	$798.7	$205.9	$1,833.2	$5,148.3
	PEV Owner Savings	NOM $ Mil	-$11.6	$252.9	$837.2	-$20.0	$2,381.7	$8,208.6
	Utility Net Revenue – BASE	NPV $ Mil	$51.2	$348.2	$659.4	$268.7	$1,865.9	$4,133.6
	Utility Net Revenue – OFF PEAK	NPV $ Mil	$55.9	$410.4	$803.7	$294.0	$2,186.4	$4,985.1
	Value of GHG Reduction	NPV $ Mil	$31.3	$232.8	$469.2	$162.5	$1,248.3	$3,024.1
	PEV Owner Savings	NPV $ Mil	-$9.1	$172.2	$491.8	-$15.8	$1,621.8	$4,821.7

PG&E, CALIFORNIA

PROJECTED NUMBER OF CHARGERS			EIA								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Thousand		85.42			155.56			195.60	
	Single Fam - L2	Thousand		68.23			124.24			156.23	
	MUD - L1	Thousand		31.23			56.86			71.50	
	MUD - L2	Thousand		20.79			37.86			47.60	
	TOTAL HOME CHARGERS/PEV			0.922			0.922			0.922	
	% Home Chargers L2			43%			43%			43%	
PUBLIC AND WORKPLACE CHARGERS	Public L2	x000	1.14	6.83	13.66	2.07	12.44	24.88	2.61	15.65	31.28
	Public DCFC	x000	0.08	0.25	0.68	0.14	0.46	1.23	0.18	0.58	1.55
	DCFC per 100	Interstate	9.3	29.5	78.8	16.9	53.7	143.5	21.2	67.5	180.4
	Highway Miles	State & Inter	0.1	0.4	1.0	0.2	0.7	1.8	0.3	0.8	2.3

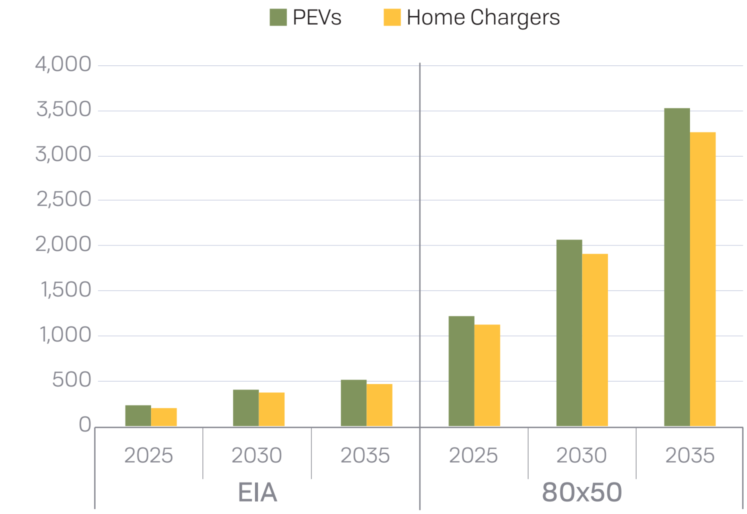
PROJECTED COST OF CHARGERS			EIA								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Nom$ Mil	$9.42	$47.11	$63.60	$19.09	$95.44	$128.84	$26.80	$133.99	$180.88
	Single Fam - L2	Nom$ Mil	$90.30	$105.36	$165.56	$182.94	$213.43	$335.39	$256.83	$299.64	$470.86
	MUD - L1	Nom$ Mil	$10.33	$27.55	$33.58	$20.93	$55.82	$68.03	$29.39	$78.36	$95.51
	MUD - L2	Nom$ Mil	$34.39	$38.98	$57.32	$69.67	$78.96	$116.12	$97.82	$110.86	$163.03
	TOTAL	Nom$ Mil	**$144.45**	**$219.00**	**$320.06**	**$292.63**	**$443.64**	**$648.38**	**$410.84**	**$622.85**	**$910.28**
		NPV $ Mil	**$114.03**	**$172.88**	**$252.66**	**$199.27**	**$302.10**	**$441.51**	**$241.32**	**$365.86**	**$534.70**
		NPV $/PEV	**$511**	**$775**	**$1,133**	**$491**	**$744**	**$1,087**	**$473**	**$716**	**$1,047**
PUBLIC AND WORKPLACE CHARGERS	Public L2	Nom$ Mil	$5.023	$37.685	$90.413	$10.175	$76.341	$183.158	$14.286	$107.179	$257.144
	Public DCFC	Nom$ Mil	$4.386	$15.335	$48.461	$8.884	$31.065	$98.172	$12.473	$43.614	$137.828
	TOTAL	Nom$ Mil	**$9.409**	**$53.020**	**$138.875**	**$19.060**	**$107.406**	**$281.330**	**$26.759**	**$150.793**	**$394.972**
		Nom$ Mil	**$7.427**	**$41.854**	**$109.629**	**$12.979**	**$73.139**	**$191.572**	**$15.718**	**$88.575**	**$232.004**
		NPV $ Mil	**$33,306**	**$187,687**	**$491,608**	**$31,960**	**$180,101**	**$471,739**	**$30,782**	**$173,463**	**$454,351**
	NPV $/PEV	Public L1	$0	$0	$0	$0	$0	$0	$0	$0	$0
		Public L2	$18	$133	$320	$17	$128	$307	$16	$123	$296
		DCFC	$16	$54	$172	$15	$52	$165	$14	$50	$159

PROJECTED NUMBER OF CHARGERS			80x50								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Thousand		464.26			792.06			1,353.93	
	Single Fam - L2	Thousand		370.80			632.61			1,081.36	
	MUD - L1	Thousand		169.70			289.52			494.90	
	MUD - L2	Thousand		112.98			192.75			329.48	
	TOTAL HOME CHARGERS/PEV			0.922			0.922			0.922	
	% Home Chargers L2			43%			43%			43%	
PUBLIC AND WORKPLACE CHARGERS	Public L2	x000	6.19	37.14	74.25	10.56	63.36	126.67	18.04	108.30	216.53
	Public DCFC	x000	0.43	1.37	3.67	0.74	2.34	6.27	1.26	4.01	10.71
	DCFC per 100	Interstate	50.4	160.2	428.3	86.0	273.2	730.6	146.9	467.1	1,248.9
	Highway Miles	State & Inter	0.6	2.0	5.4	1.1	3.4	9.1	1.8	5.8	15.6

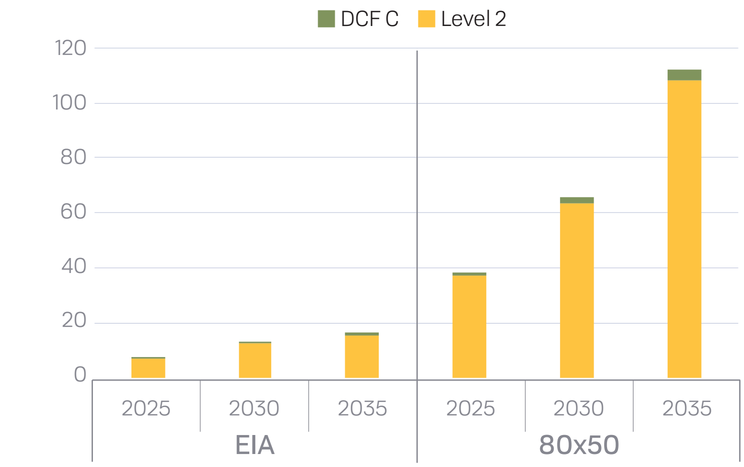
PROJECTED COST OF CHARGERS			80x50								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Nom$ Mil	$51.21	$256.04	$345.65	$97.19	$485.93	$656.01	$185.49	$927.44	$1,252.04
	Single Fam - L2	Nom$ Mil	$490.79	$572.58	$899.78	$931.46	$1,086.70	$1,707.67	$1,777.76	$2,074.06	$3,259.23
	MUD - L1	Nom$ Mil	$56.15	$149.74	$182.50	$106.57	$284.20	$346.37	$203.41	$542.42	$661.07
	MUD - L2	Nom$ Mil	$186.92	$211.84	$311.54	$354.76	$402.06	$591.26	$677.08	$767.36	$1,128.47
	TOTAL	Nom$ Mil	**$785.07**	**$1,190.21**	**$1,739.46**	**$1,489.97**	**$2,258.88**	**$3,301.30**	**$2,843.74**	**$4,311.27**	**$6,300.82**
		NPV $ Mil	**$619.74**	**$939.56**	**$1,373.15**	**$1,014.60**	**$1,538.19**	**$2,248.02**	**$1,670.40**	**$2,532.42**	**$3,701.07**
		NPV $/PEV	**$511**	**$775**	**$1,133**	**$491**	**$744**	**$1,087**	**$473**	**$716**	**$1,047**
PUBLIC AND WORKPLACE CHARGERS	Public L2	Nom$ Mil	$27.299	$204.809	$491.377	$51.810	$388.703	$932.576	$98.883	$741.873	$1,779.903
	Public DCFC	Nom$ Mil	$23.835	$83.342	$263.376	$45.236	$158.173	$499.857	$86.337	$301.887	$954.021
	TOTAL	Nom$ Mil	**$51.134**	**$288.150**	**$754.753**	**$97.046**	**$546.876**	**$1,432.433**	**$185.220**	**$1,043.761**	**$2,733.924**
		Nom$ Mil	**$40.365**	**$227.469**	**$595.809**	**$66.083**	**$372.396**	**$975.417**	**$108.797**	**$613.099**	**$1,605.892**
		NPV $ Mil	**$33,306**	**$187,687**	**$491,608**	**$31,960**	**$180,101**	**$471,739**	**$30,782**	**$173,463**	**$454,351**
	NPV $/PEV	Public L1	$0	$0	$0	$0	$0	$0	$0	$0	$0
		Public L2	$18	$133	$320	$17	$128	$307	$16	$123	$296
		DCFC	$16	$54	$172	$15	$52	$165	$14	$50	$159

PG&E, CALIFORNIA

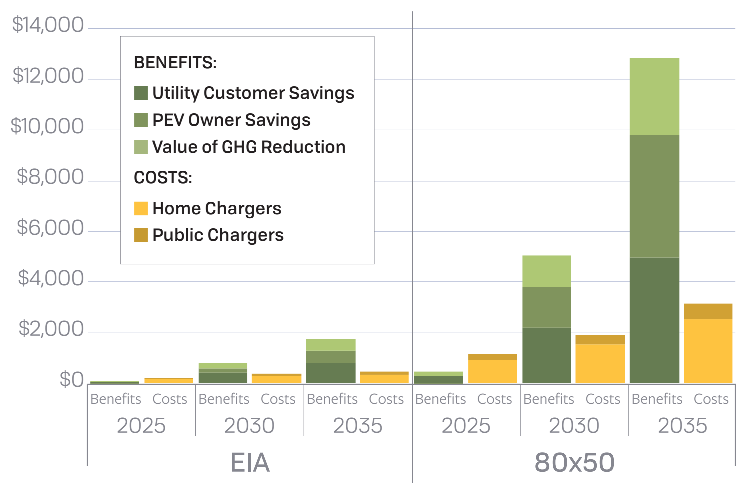
Projected PEVs and Home Chargers (Thousands)



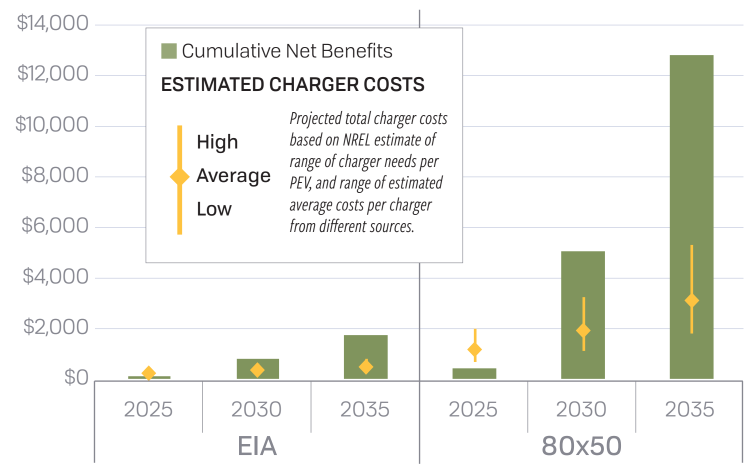
Projected Number of Required Public and DC Fast Chargers (Thousands)



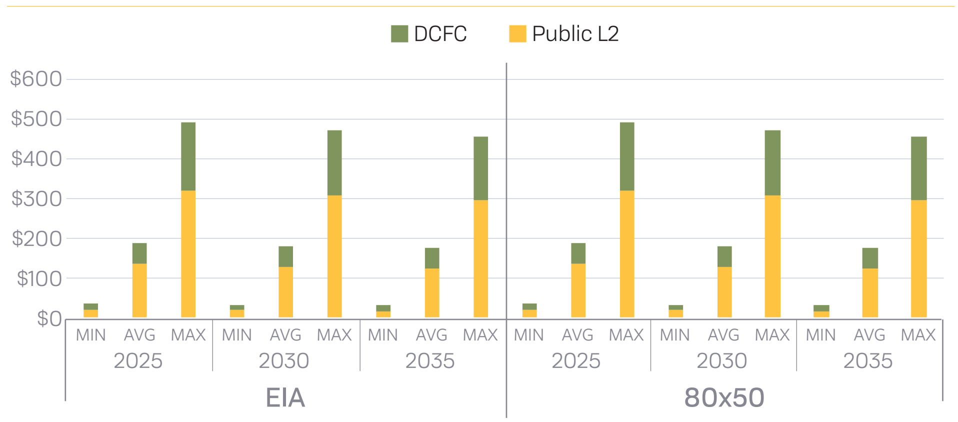
PEV Cumulative Benefits Compared to Charger Costs (NPV $ Millions)



Cumulative PEV Net Benefits Compared to Range of Estimated Charger Costs (NPV $ Millions)



Projected Cost of Public Charging Infrastructure (NPV $/PEV)



SoCalEd, CALIFORNIA

METRIC		UNIT	2015 ACTUAL
Residential Customers		Million	4.89
Housing Units	Total	Million	4.63
	% in Multiple Unit Dwellings	Percent	31.1%
Highway Miles	Interstate	Thousand	0.809
	State	Thousand	63.816

METRIC		UNIT	EIA			80x50		
			2025	2030	2035	2025	2030	2035
Projected Number of PEVs	BEV	Thousand	92.8	169.0	212.5	504.4	860.5	1,470.9
	PHEV	Thousand	116.3	211.9	266.4	632.3	1,078.8	1,844.1
Annual PEV Charging Electricity	Home	Thousand MWh	568.8	965.6	1,143.0	2,997.2	5,149.6	8,665.5
	Non-home	Thousand MWh	169.2	287.2	339.9	891.4	1,531.5	2,577.1
Peak Daily Load for PEV Charging	Baseline Charging	MW	205.3	373.8	470.0	1,115.6	1,903.3	3,253.4
	Off-peak Charging	MW	84.8	154.3	194.1	460.6	785.9	1,343.3
Annual Utility Revenue from PEV Charging		NOM $ Mil	$135.49	$276.07	$375.60	$713.97	$1,472.25	$2,847.63
Annual Utility Net Revenue from PEV Charging	Baseline Charging	NOM $ Mil	$60.88	$99.01	$125.05	$319.22	$537.43	$985.10
	Off-peak Charging	NOM $ Mil	$66.42	$121.99	$158.00	$349.33	$654.45	$1,213.16
Annual GHG Reduction		Thousand MT	575.64	890.89	1,012.62	2,993.23	4,854.88	8,229.94
Annual Social Value of GHG Reduction		NOM $ Mil	$37.13	$69.74	$96.34	$193.08	$380.05	$783.02
Annual PEV Owner Savings		NOM $ Mil	-$10.84	$89.90	$122.75	-$18.79	$763.37	$1,312.76

METRIC		UNIT	EIA			80x50		
			2025	2030	2035	2025	2030	2035
ANNUAL NET BENEFITS PER PEV	Utility Net Revenue – BASE	NOM $/PEV	$291.1	$259.9	$261.1	$280.8	$277.1	$297.2
	Utility Net Revenue – OFF PEAK	NOM $/PEV	$317.6	$320.3	$329.9	$307.3	$337.5	$366.0
	Value of GHG Reduction	NOM $/PEV	$177.5	$183.1	$201.2	$169.9	$196.0	$236.2
	PEV Owner Savings	NOM $/PEV	-$51.8	$236.0	$256.3	-$16.5	$393.6	$396.0
	Utility Net Revenue – BASE	NPV $/PEV	$229.8	$177.0	$153.4	$221.7	$188.7	$174.6
	Utility Net Revenue – OFF PEAK	NPV $/PEV	$250.7	$218.1	$193.8	$242.6	$229.8	$215.0
	Value of GHG Reduction	NPV $/PEV	$140.1	$124.7	$118.2	$134.1	$133.4	$138.7
	PEV Owner Savings	NPV $/PEV	-$40.9	$160.7	$150.6	-$13.0	$268.0	$232.6
CUMULATIVE NET BENEFITS	Utility Net Revenue – BASE	NOM $ Mil	$60.9	$479.6	$1,052.8	$319.2	$2,569.9	$6,600.1
	Utility Net Revenue – OFF PEAK	NOM $ Mil	$66.4	$565.2	$1,283.2	$349.3	$3,011.3	$7,959.7
	Value of GHG Reduction	NOM $ Mil	$37.1	$320.6	$749.1	$193.1	$1,719.4	$4,828.6
	PEV Owner Savings	NOM $ Mil	-$10.8	$237.2	$785.2	-$18.8	$2,233.8	$7,698.8
	Utility Net Revenue – BASE	NPV $ Mil	$48.1	$326.6	$618.4	$252.0	$1,750.0	$3,876.9
	Utility Net Revenue – OFF PEAK	NPV $ Mil	$52.4	$384.9	$753.7	$275.8	$2,050.6	$4,675.5
	Value of GHG Reduction	NPV $ Mil	$29.3	$218.3	$440.0	$152.4	$1,170.8	$2,836.3
	PEV Owner Savings	NPV $ Mil	-$8.6	$161.5	$461.2	-$14.8	$1,521.1	$4,522.2

SoCalEd, CALIFORNIA

PROJECTED NUMBER OF CHARGERS			EIA								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Thousand		80.12			145.90			183.45	
	Single Fam - L2	Thousand		63.99			116.53			146.52	
	MUD - L1	Thousand		29.29			53.33			67.06	
	MUD - L2	Thousand		19.50			35.50			44.64	
	TOTAL HOME CHARGERS/PEV			0.922			0.922			0.922	
	% Home Chargers L2			43%			43%			43%	
PUBLIC AND WORKPLACE CHARGERS	Public L2	x000	1.07	6.41	12.81	1.94	11.67	23.33	2.44	14.67	29.34
	Public DCFC	x000	0.07	0.24	0.63	0.14	0.43	1.15	0.17	0.54	1.45
	DCFC per 100	Interstate	9.2	29.3	78.4	16.8	53.4	142.7	21.1	67.1	179.5
	Highway Miles	State & Inter	0.1	0.4	1.0	0.2	0.7	1.8	0.3	0.8	2.2

PROJECTED COST OF CHARGERS			EIA								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Nom$ Mil	$8.84	$44.19	$59.65	$17.90	$89.51	$120.84	$25.13	$125.67	$169.65
	Single Fam - L2	Nom$ Mil	$84.70	$98.81	$155.28	$171.58	$200.17	$314.56	$240.88	$281.03	$441.62
	MUD - L1	Nom$ Mil	$9.69	$25.84	$31.49	$19.63	$52.35	$63.80	$27.56	$73.50	$89.57
	MUD - L2	Nom$ Mil	$32.26	$36.56	$53.76	$65.35	$74.06	$108.91	$91.74	$103.98	$152.91
	TOTAL	Nom$ Mil	**$135.48**	**$205.40**	**$300.18**	**$274.46**	**$416.09**	**$608.11**	**$385.32**	**$584.17**	**$853.75**
		NPV $ Mil	**$106.95**	**$162.14**	**$236.97**	**$186.89**	**$283.34**	**$414.09**	**$226.34**	**$343.14**	**$501.49**
		NPV $/PEV	**$511**	**$775**	**$1,133**	**$491**	**$744**	**$1,087**	**$473**	**$716**	**$1,047**
PUBLIC AND WORKPLACE CHARGERS	Public L2	Nom$ Mil	$4.711	$35.344	$84.798	$9.543	$71.600	$171.783	$13.399	$100.522	$241.173
	Public DCFC	Nom$ Mil	$4.113	$14.383	$45.451	$8.333	$29.136	$92.075	$11.698	$40.905	$129.268
	TOTAL	Nom$ Mil	**$8.824**	**$49.727**	**$130.250**	**$17.876**	**$100.736**	**$263.857**	**$25.097**	**$141.427**	**$370.441**
		Nom$ Mil	**$6.966**	**$39.255**	**$102.820**	**$12.173**	**$68.596**	**$179.674**	**$14.742**	**$83.074**	**$217.595**
		NPV $ Mil	**$33,306**	**$187,687**	**$491,608**	**$31,960**	**$180,101**	**$471,739**	**$30,782**	**$173,463**	**$454,351**
	NPV $/PEV	Public L1	$0	$0	$0	$0	$0	$0	$0	$0	$0
		Public L2	$18	$133	$320	$17	$128	$307	$16	$123	$296
		DCFC	$16	$54	$172	$15	$52	$165	$14	$50	$159

PROJECTED NUMBER OF CHARGERS			80x50								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Thousand		435.42			742.87			1,269.84	
	Single Fam - L2	Thousand		347.77			593.32			1,014.20	
	MUD - L1	Thousand		159.16			271.54			464.17	
	MUD - L2	Thousand		105.96			180.78			309.02	
	TOTAL HOME CHARGERS/PEV			0.922			0.922			0.922	
	% Home Chargers L2			43%			43%			43%	
PUBLIC AND WORKPLACE CHARGERS	Public L2	x000	5.80	34.83	69.64	9.90	59.42	118.81	16.92	101.58	203.09
	Public DCFC	x000	0.41	1.29	3.45	0.69	2.20	5.88	1.18	3.76	10.05
	DCFC per 100	Interstate	50.1	159.3	426.0	85.5	271.8	726.8	146.2	464.6	1,242.4
	Highway Miles	State & Inter	0.6	2.0	5.3	1.1	3.4	9.1	1.8	5.8	15.5

PROJECTED COST OF CHARGERS			80x50								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Nom$ Mil	$48.03	$240.14	$324.18	$91.15	$455.75	$615.26	$173.97	$869.84	$1,174.28
	Single Fam - L2	Nom$ Mil	$460.31	$537.02	$843.89	$873.61	$1,019.21	$1,601.61	$1,667.35	$1,945.25	$3,056.81
	MUD - L1	Nom$ Mil	$52.67	$140.44	$171.17	$99.96	$266.55	$324.85	$190.77	$508.73	$620.01
	MUD - L2	Nom$ Mil	$175.31	$198.69	$292.19	$332.72	$377.09	$554.54	$635.03	$719.70	$1,058.39
	TOTAL	Nom$ Mil	**$736.31**	**$1,116.29**	**$1,631.43**	**$1,397.43**	**$2,118.59**	**$3,096.27**	**$2,667.13**	**$4,043.52**	**$5,909.50**
		NPV $ Mil	**$581.25**	**$881.21**	**$1,287.87**	**$951.59**	**$1,442.66**	**$2,108.41**	**$1,566.66**	**$2,375.14**	**$3,471.21**
		NPV $/PEV	**$511**	**$775**	**$1,133**	**$491**	**$744**	**$1,087**	**$473**	**$716**	**$1,047**
PUBLIC AND WORKPLACE CHARGERS	Public L2	Nom$ Mil	$25.603	$192.089	$460.859	$48.592	$364.562	$874.657	$92.742	$695.798	$1,669.359
	Public DCFC	Nom$ Mil	$22.355	$78.166	$247.019	$42.427	$148.350	$468.813	$80.975	$283.138	$894.770
	TOTAL	Nom$ Mil	**$47.958**	**$270.254**	**$707.878**	**$91.019**	**$512.911**	**$1,343.470**	**$173.717**	**$978.936**	**$2,564.129**
		Nom$ Mil	**$37.858**	**$213.341**	**$558.805**	**$61.979**	**$349.268**	**$914.838**	**$102.040**	**$575.022**	**$1,506.156**
		NPV $ Mil	**$33,306**	**$187,687**	**$491,608**	**$31,960**	**$180,101**	**$471,739**	**$30,782**	**$173,463**	**$454,351**
	NPV $/PEV	Public L1	$0	$0	$0	$0	$0	$0	$0	$0	$0
		Public L2	$18	$133	$320	$17	$128	$307	$16	$123	$296
		DCFC	$16	$54	$172	$15	$52	$165	$14	$50	$159

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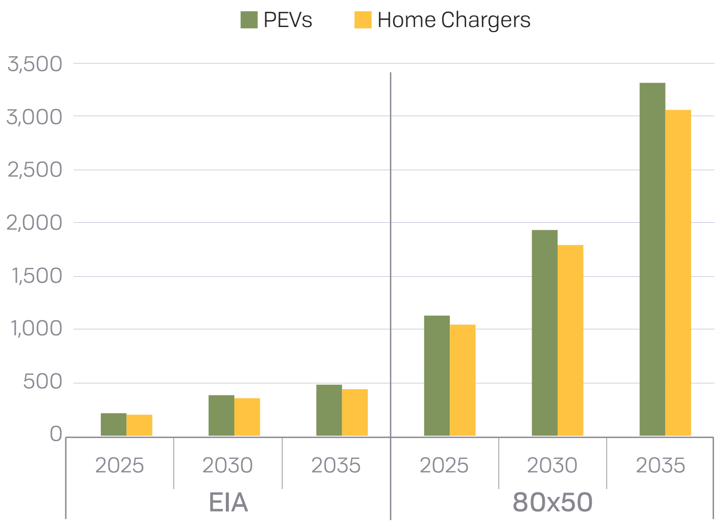
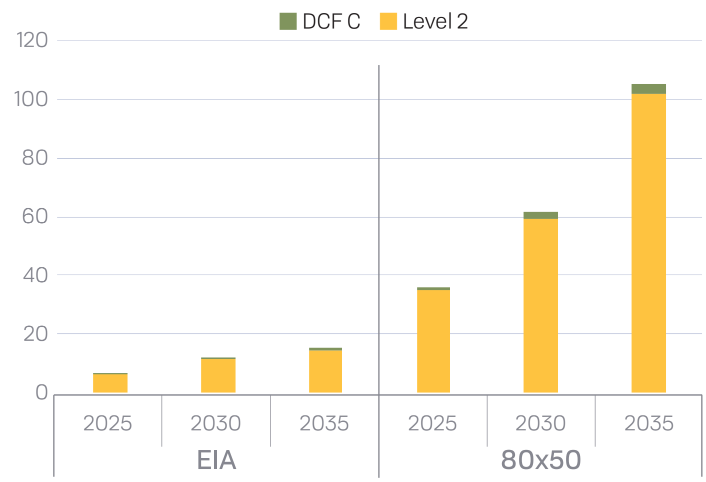
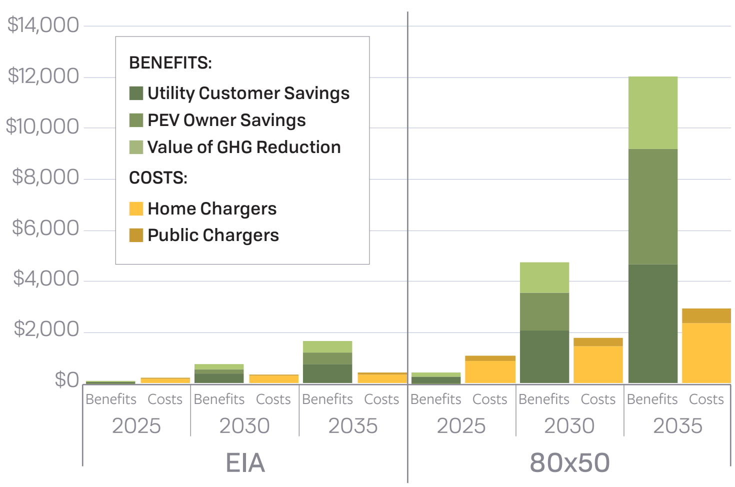
Projected PEVs and Home Chargers (Thousands)



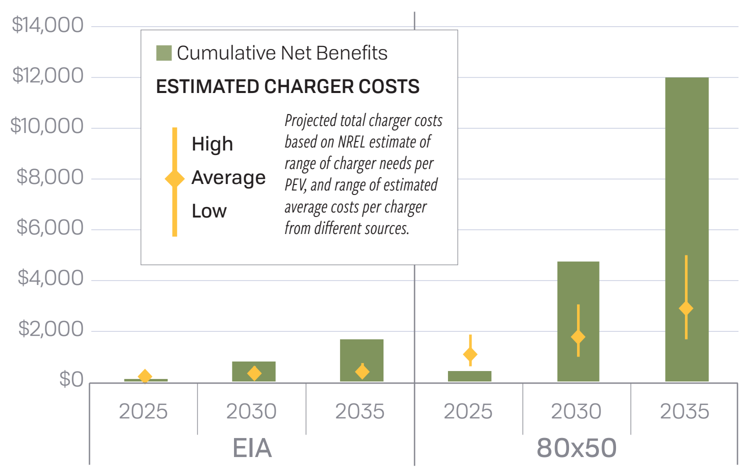
Projected Number of Required Public and DC Fast Chargers (Thousands)



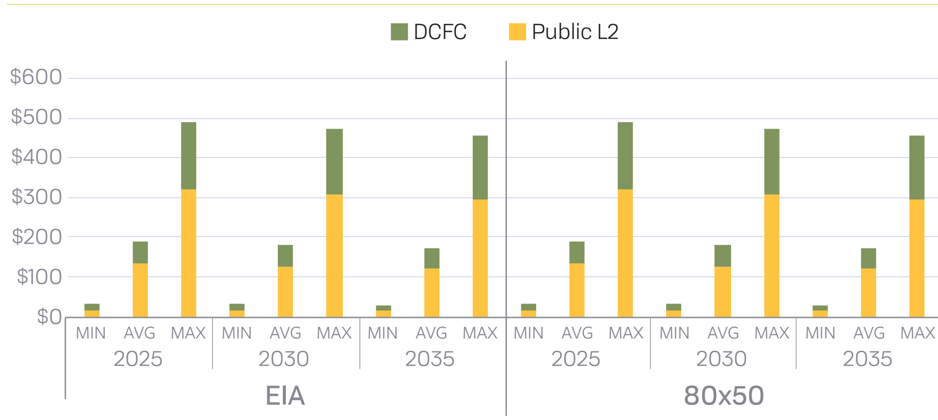
PEV Cumulative Benefits Compared to Charger Costs (NPV $ Millions)



Cumulative PEV Net Benefits Compared to Range of Estimated Charger Costs (NPV $ Millions)



Projected Cost of Public Charging Infrastructure (NPV $/PEV)



GEORGIA POWER, GEORGIA

METRIC		UNIT	2015 ACTUAL
Residential Customers		Million	2.48
Housing Units	Total	Million	2.48
	% in Multiple Unit Dwellings	Percent	20.6%
Highway Miles	Interstate	Thousand	0.736
	State	Thousand	74.863

METRIC		UNIT	EIA			80x50		
			2025	2030	2035	2025	2030	2035
Projected Number of PEVs	BEV	Thousand	26.6	51.8	71.3	213.4	409.0	674.6
	PHEV	Thousand	46.0	89.6	123.4	369.3	707.7	1,167.3
Annual PEV Charging Electricity	Home	Thousand MWh	241.3	437.7	565.8	1,867.6	3,606.9	5,846.5
	Non-home	Thousand MWh	60.7	110.1	142.4	469.9	907.6	1,471.1
Peak Daily Load for PEV Charging	Baseline Charging	MW	71.96	140.14	191.01	577.89	1,107.51	1,826.73
	Off-peak Charging	MW	28.04	54.61	72.42	225.19	431.57	711.83
Annual Utility Revenue from PEV Charging		NOM $ Mil	$54.6	$111.6	$159.5	$422.5	$919.4	$1,647.7
Annual Utility Net Revenue from PEV Charging	Baseline Charging	NOM $ Mil	$6.3	$14.0	$15.9	$47.0	$119.9	$179.3
	Off-peak Charging	NOM $ Mil	$10.4	$22.6	$28.4	$79.5	$188.1	$297.4
Annual GHG Reduction		Thousand MT	$96.2	$167.6	$203.2	$718.6	$1,434.6	$2,401.3
Annual Social Value of GHG Reduction		NOM $ Mil	$6.2	$13.1	$19.3	$46.4	$112.3	$228.5
Annual PEV Owner Savings		NOM $ Mil	$1.6	$39.1	$53.9	$26.8	$433.2	$687.8

METRIC		UNIT	EIA			80x50		
			2025	2030	2035	2025	2030	2035
ANNUAL NET BENEFITS PER PEV	Utility Net Revenue – BASE	NOM $/PEV	$87.1	$98.9	$81.4	$80.6	$107.4	$97.4
	Utility Net Revenue – OFF PEAK	NOM $/PEV	$143.0	$159.9	$145.9	$136.5	$168.4	$161.5
	Value of GHG Reduction	NOM $/PEV	$85.5	$1,136.8	$1,697.4	$79.6	$231.1	$287.7
	PEV Owner Savings	NOM $/PEV	$21.6	$276.9	$276.7	$46.0	$387.9	$373.4
	Utility Net Revenue – BASE	NPV $/PEV	$68.8	$67.4	$47.8	$63.6	$73.1	$57.2
	Utility Net Revenue – OFF PEAK	NPV $/PEV	$112.9	$108.9	$85.7	$107.7	$114.7	$94.8
	Value of GHG Reduction	NPV $/PEV	$67.5	$774.1	$997.1	$62.8	$157.4	$169.0
	PEV Owner Savings	NPV $/PEV	$17.0	$188.6	$162.5	$36.3	$264.2	$219.3
CUMULATIVE NET BENEFITS	Utility Net Revenue – BASE	NOM $ Mil	$6.3	$60.9	$136.4	$47.0	$500.7	$1,278.6
	Utility Net Revenue – OFF PEAK	NOM $ Mil	$10.4	$98.9	$229.3	$79.5	$802.7	$2,071.0
	Value of GHG Reduction	NOM $ Mil	$6.2	$58.0	$142.3	$46.4	$476.0	$1,386.0
	PEV Owner Savings	NOM $ Mil	$1.6	$122.1	$362.0	$26.8	$1,380.1	$4,309.9
	Utility Net Revenue – BASE	NPV $ Mil	$5.0	$41.5	$80.1	$37.1	$340.9	$751.0
	Utility Net Revenue – OFF PEAK	NPV $ Mil	$8.2	$67.4	$134.7	$62.8	$546.6	$1,216.5
	Value of GHG Reduction	NPV $ Mil	$4.9	$39.5	$83.6	$36.6	$324.1	$814.2
	PEV Owner Savings	NPV $ Mil	$1.2	$83.1	$212.6	$21.2	$939.8	$2,531.6

GEORGIA POWER, GEORGIA

PROJECTED NUMBER OF CHARGERS			EIA								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Thousand		34.48			67.15			92.53	
	Single Fam - L2	Thousand		23.12			45.04			62.06	
	MUD - L1	Thousand		7.12			13.87			19.12	
	MUD - L2	Thousand		4.09			7.97			10.98	
	TOTAL HOME CHARGERS/PEV			0.948			0.948			0.948	
	% Home Chargers L2			40%			40%			40%	
PUBLIC AND WORKPLACE CHARGERS	Public L2	x000	0.35	2.12	4.23	0.69	4.12	8.24	0.95	5.68	11.35
	Public DCFC	x000	0.07	0.22	0.59	0.13	0.43	1.15	0.19	0.59	1.58
	DCFC per 100	Interstate	9.4	29.9	80.0	18.3	58.3	155.9	25.3	80.3	214.8
	Highway Miles	State & Inter	0.1	0.3	0.8	0.2	0.6	1.5	0.2	0.8	2.1

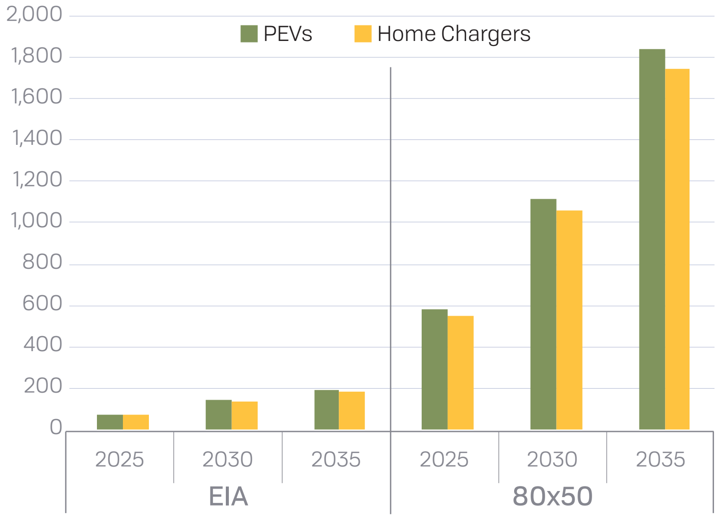
PROJECTED COST OF CHARGERS			EIA								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Nom$ Mil	$3.80	$19.01	$25.67	$8.24	$41.20	$55.61	$12.68	$63.38	$85.57
	Single Fam - L2	Nom$ Mil	$30.61	$35.71	$56.11	$66.31	$77.36	$121.57	$102.02	$119.03	$187.04
	MUD - L1	Nom$ Mil	$2.36	$6.29	$7.66	$5.11	$13.62	$16.60	$7.86	$20.95	$25.53
	MUD - L2	Nom$ Mil	$6.77	$7.67	$11.28	$14.66	$16.62	$24.44	$22.56	$25.57	$37.60
	TOTAL	Nom$ Mil	**$43.53**	**$68.68**	**$100.72**	**$94.32**	**$148.80**	**$218.22**	**$145.12**	**$228.93**	**$335.75**
		NPV $ Mil	**$34.37**	**$54.22**	**$79.51**	**$64.23**	**$101.32**	**$148.60**	**$85.24**	**$134.47**	**$197.22**
		NPV $/PEV	**$474**	**$747**	**$1,096**	**$455**	**$717**	**$1,052**	**$438**	**$691**	**$1,013**
PUBLIC AND WORKPLACE CHARGERS	Public L2	Nom$ Mil	$1.556	$11.670	$28.000	$3.370	$25.285	$60.664	$5.185	$38.902	$93.334
	Public DCFC	Nom$ Mil	$3.821	$13.362	$42.225	$8.279	$28.949	$91.483	$12.738	$44.539	$140.752
	TOTAL	Nom$ Mil	**$5.377**	**$25.032**	**$70.225**	**$11.649**	**$54.234**	**$152.147**	**$17.923**	**$83.441**	**$234.086**
		Nom$ Mil	**$4.245**	**$19.760**	**$55.436**	**$7.933**	**$36.930**	**$103.604**	**$10.528**	**$49.013**	**$137.501**
		NPV $ Mil	**$58,502**	**$272,359**	**$764,075**	**$56,137**	**$261,351**	**$733,194**	**$54,068**	**$251,718**	**$706,169**
	NPV $/PEV	Public L1	$0	$0	$0	$0	$0	$0	$0	$0	$0
		Public L2	$17	$127	$305	$16	$122	$292	$16	$117	$282
		DCFC	$42	$145	$459	$40	$140	$441	$38	$134	$425

PROJECTED NUMBER OF CHARGERS			80x50								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Thousand		276.89			530.66			875.28	
	Single Fam - L2	Thousand		185.71			355.90			587.03	
	MUD - L1	Thousand		57.20			109.63			180.83	
	MUD - L2	Thousand		32.86			62.97			103.86	
	TOTAL HOME CHARGERS/PEV			0.948			0.948			0.948	
	% Home Chargers L2			40%			40%			40%	
PUBLIC AND WORKPLACE CHARGERS	Public L2	x000	2.83	16.99	33.98	5.43	32.57	65.12	8.95	53.72	107.41
	Public DCFC	x000	0.56	1.77	4.73	1.07	3.39	9.06	1.76	5.59	14.95
	DCFC per 100	Interstate	75.6	240.4	642.8	144.9	460.7	1,231.9	239.0	759.9	2,031.9
	Highway Miles	State & Inter	0.7	2.3	6.3	1.4	4.5	12.0	2.3	7.4	19.8

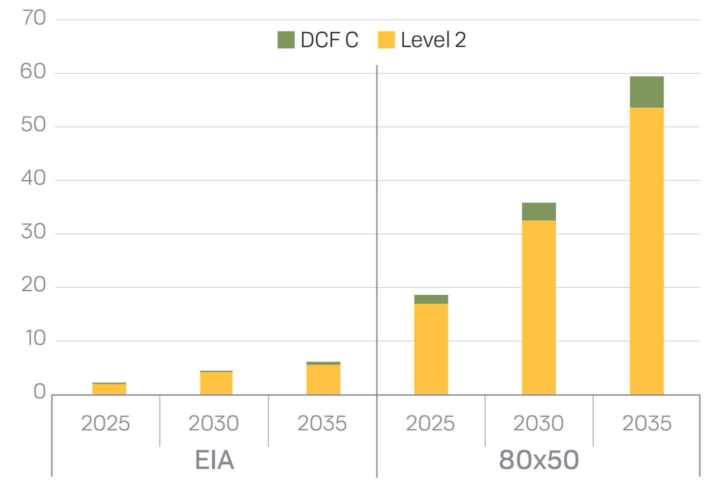
PROJECTED COST OF CHARGERS			80x50								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Nom$ Mil	$30.54	$152.71	$206.15	$65.11	$325.56	$439.51	$119.91	$599.57	$809.42
	Single Fam - L2	Nom$ Mil	$245.80	$286.77	$450.64	$524.03	$611.37	$960.73	$965.08	$1,125.92	$1,769.31
	MUD - L1	Nom$ Mil	$18.93	$50.48	$61.52	$40.36	$107.62	$131.16	$74.32	$198.19	$241.54
	MUD - L2	Nom$ Mil	$54.36	$61.61	$90.60	$115.89	$131.34	$193.15	$213.43	$241.88	$355.71
	TOTAL	Nom$ Mil	**$349.63**	**$551.56**	**$808.91**	**$745.39**	**$1,175.89**	**$1,724.54**	**$1,372.74**	**$2,165.56**	**$3,175.98**
		NPV $ Mil	**$276.00**	**$435.41**	**$638.56**	**$507.58**	**$800.73**	**$1,174.33**	**$806.34**	**$1,272.04**	**$1,865.55**
		NPV $/PEV	**$474**	**$747**	**$1,096**	**$455**	**$717**	**$1,052**	**$438**	**$691**	**$1,013**
PUBLIC AND WORKPLACE CHARGERS	Public L2	Nom$ Mil	$12.493	$93.727	$224.869	$26.634	$199.820	$479.408	$49.050	$367.994	$882.892
	Public DCFC	Nom$ Mil	$30.689	$107.308	$339.112	$65.427	$228.773	$722.967	$120.492	$421.316	$1,331.439
	TOTAL	Nom$ Mil	**$43.182**	**$201.034**	**$563.981**	**$92.061**	**$428.593**	**$1,202.375**	**$169.542**	**$789.311**	**$2,214.331**
		Nom$ Mil	**$34.088**	**$158.698**	**$445.212**	**$62.689**	**$291.851**	**$818.759**	**$99.588**	**$463.637**	**$1,300.686**
		NPV $ Mil	**$58,502**	**$272,359**	**$764,075**	**$56,137**	**$261,351**	**$733,194**	**$54,068**	**$251,718**	**$706,169**
	NPV $/PEV	Public L1	$0	$0	$0	$0	$0	$0	$0	$0	$0
		Public L2	$17	$127	$305	$16	$122	$292	$16	$117	$282
		DCFC	$42	$145	$459	$40	$140	$441	$38	$134	$425

GEORGIA POWER, GEORGIA

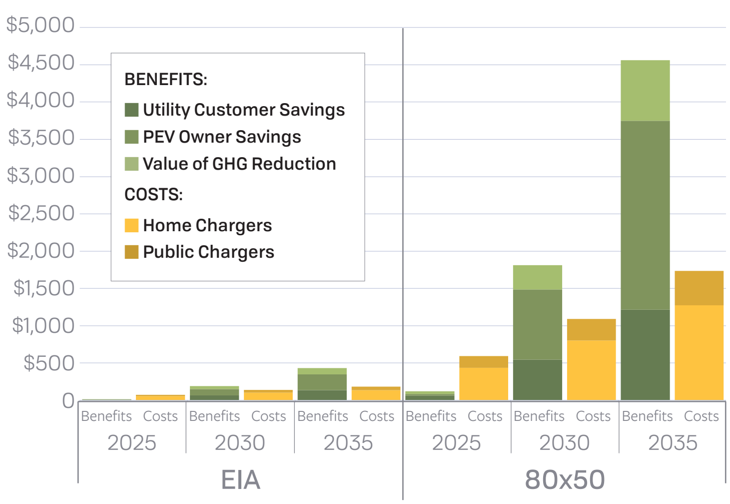
Projected PEVs and Home Chargers (Thousands)



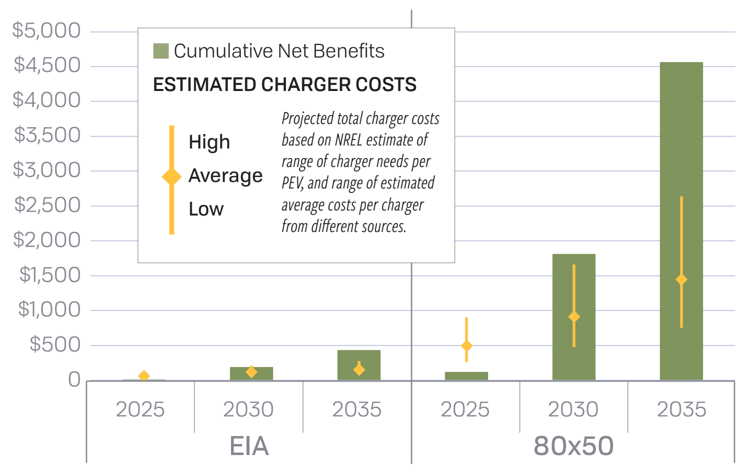
Projected Number of Required Public and DC Fast Chargers (Thousands)



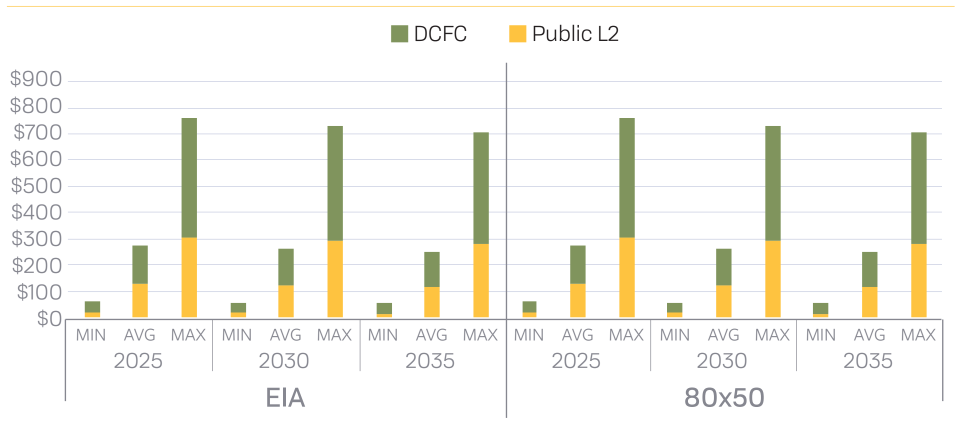
PEV Cumulative Benefits Compared to Charger Costs (NPV $ Millions)



Cumulative PEV Net Benefits Compared to Range of Estimated Charger Costs (NPV $ Millions)



Projected Cost of Public Charging Infrastructure (NPV $/PEV)



AEP, OHIO

METRIC		UNIT	2015 ACTUAL
Residential Customers		Million	1.47
Housing Units	Total	Million	1.47
	% in Multiple Unit Dwellings	Percent	23.1%
Highway Miles	Interstate	Thousand	0.441
	State	Thousand	33.978

METRIC		UNIT	EIA 2025	EIA 2030	EIA 2035	80x50 2025	80x50 2030	80x50 2035
Projected Number of PEVs	BEV	Thousand	23.8	48.3	61.7	129.3	246.1	427.2
	PHEV	Thousand	41.2	83.6	106.8	223.6	425.9	739.2
Annual PEV Charging Electricity	Home	Thousand MWh	160.2	303.3	363.3	839.1	1,610.2	2,746.7
	Non-home	Thousand MWh	40.3	76.3	91.4	211.1	405.2	691.1
Peak Daily Load for PEV Charging	Baseline Charging	MW	64.4	130.9	165.3	350.0	666.5	1,156.8
	Off-peak Charging	MW	25.1	51.0	62.7	136.4	259.7	450.8
Annual Utility Revenue from PEV Charging		NOM $ Mil	$38.3	$81.6	$108.1	$200.5	$433.5	$817.5
Annual Utility Net Revenue from PEV Charging	Baseline Charging	NOM $ Mil	$3.5	$8.1	$8.6	$17.7	$45.0	$70.8
	Off-peak Charging	NOM $ Mil	$5.8	$13.2	$15.3	$30.0	$70.5	$117.4
Annual GHG Reduction		Thousand MT	$86.1	$156.6	$175.9	$435.2	$863.3	$1,520.7
Annual Social Value of GHG Reduction		NOM $ Mil	$5.6	$12.3	$16.7	$28.1	$67.6	$144.7
Annual PEV Owner Savings		NOM $ Mil	$1.0	$27.1	$34.6	$12.1	$193.4	$323.1

METRIC		UNIT	EIA 2025	EIA 2030	EIA 2035	80x50 2025	80x50 2030	80x50 2035
ANNUAL NET BENEFITS PER PEV	Utility Net Revenue – BASE	NOM $/PEV	$54.3	$61.7	$50.7	$50.2	$66.9	$60.7
	Utility Net Revenue – OFF PEAK	NOM $/PEV	$89.1	$99.7	$90.9	$85.1	$105.0	$100.6
	Value of GHG Reduction	NOM $/PEV	$85.5	$92.9	$99.3	$79.6	$100.6	$124.0
	PEV Owner Savings	NOM $/PEV	$16.0	$205.4	$205.3	$34.2	$287.8	$277.0
	Utility Net Revenue – BASE	NPV $/PEV	$42.9	$42.0	$29.8	$39.7	$45.6	$35.7
	Utility Net Revenue – OFF PEAK	NPV $/PEV	$70.3	$67.9	$53.4	$67.1	$71.5	$59.1
	Value of GHG Reduction	NPV $/PEV	$67.5	$63.2	$58.3	$62.8	$68.5	$72.9
	PEV Owner Savings	NPV $/PEV	$12.6	$139.9	$120.6	$27.0	$196.0	$162.7
CUMULATIVE NET BENEFITS	Utility Net Revenue – BASE	NOM $ Mil	$3.5	$35.0	$76.9	$17.7	$188.2	$490.5
	Utility Net Revenue – OFF PEAK	NOM $ Mil	$5.8	$56.8	$129.1	$30.0	$301.7	$795.0
	Value of GHG Reduction	NOM $ Mil	$5.6	$53.4	$128.2	$28.1	$287.0	$856.2
	PEV Owner Savings	NOM $ Mil	$1.0	$84.5	$242.5	$12.1	$616.3	$1,972.5
	Utility Net Revenue – BASE	NPV $ Mil	$2.8	$23.8	$45.2	$14.0	$128.1	$288.1
	Utility Net Revenue – OFF PEAK	NPV $ Mil	$4.6	$38.7	$75.8	$23.7	$205.4	$467.0
	Value of GHG Reduction	NPV $ Mil	$4.4	$36.4	$75.3	$22.2	$195.4	$502.9
	PEV Owner Savings	NPV $ Mil	$0.8	$57.5	$142.4	$9.5	$419.7	$1,158.6

AEP, OHIO

PROJECTED NUMBER OF CHARGERS			EIA								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Thousand		29.89			60.74			77.56	
	Single Fam - L2	Thousand		20.04			40.74			52.02	
	MUD - L1	Thousand		7.15			14.53			18.55	
	MUD - L2	Thousand		4.11			8.34			10.65	
	TOTAL HOME CHARGERS/PEV			0.942			0.942			0.942	
	% Home Chargers L2			39%			39%			39%	
PUBLIC AND WORKPLACE CHARGERS	Public L2	x000	0.55	3.29	6.57	1.11	6.68	13.36	1.42	8.53	17.06
	Public DCFC	x000	0.04	0.11	0.30	0.07	0.23	0.62	0.09	0.30	0.79
	DCFC per 100	Interstate	8.1	25.9	69.2	16.5	52.6	140.6	21.1	67.1	179.5
	Highway Miles	State & Inter	0.1	0.3	0.9	0.2	0.7	1.8	0.3	0.9	2.3

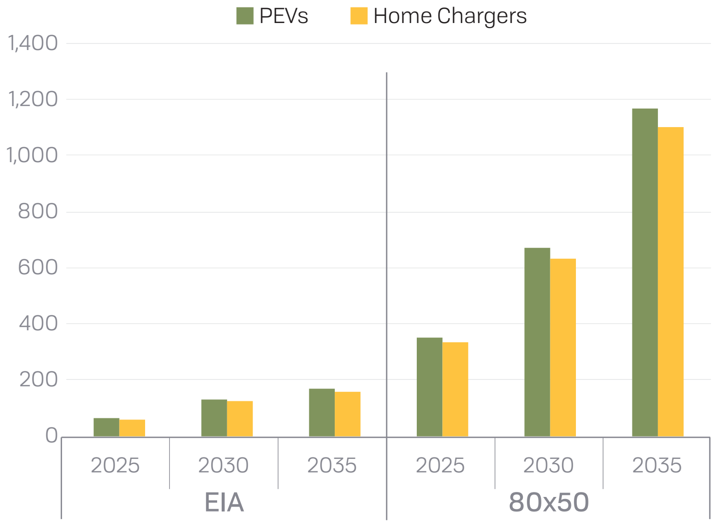
PROJECTED COST OF CHARGERS			EIA								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Nom$ Mil	$3.30	$16.48	$22.25	$7.45	$37.27	$50.31	$10.63	$53.13	$71.72
	Single Fam - L2	Nom$ Mil	$26.53	$30.95	$48.64	$59.98	$69.98	$109.97	$85.52	$99.77	$156.78
	MUD - L1	Nom$ Mil	$2.37	$6.31	$7.69	$5.35	$14.26	$17.38	$7.62	$20.33	$24.78
	MUD - L2	Nom$ Mil	$6.79	$7.70	$11.32	$15.36	$17.41	$25.60	$21.90	$24.82	$36.49
	TOTAL	Nom$ Mil	**$38.98**	**$61.44**	**$89.90**	**$88.14**	**$138.91**	**$203.26**	**$125.66**	**$198.04**	**$289.77**
		NPV $ Mil	**$30.77**	**$48.50**	**$70.96**	**$60.02**	**$94.59**	**$138.41**	**$73.81**	**$116.33**	**$170.21**
		NPV $/PEV	**$474**	**$747**	**$1,093**	**$455**	**$717**	**$1,049**	**$438**	**$690**	**$1,010**
PUBLIC AND WORKPLACE CHARGERS	Public L2	Nom$ Mil	$2.417	$18.133	$43.505	$5.465	$41.000	$98.367	$7.791	$58.451	$140.237
	Public DCFC	Nom$ Mil	$1.978	$6.916	$21.856	$4.472	$15.638	$49.418	$6.376	$22.294	$70.453
	TOTAL	Nom$ Mil	**$4.395**	**$25.049**	**$65.362**	**$9.937**	**$56.637**	**$147.784**	**$14.167**	**$80.745**	**$210.689**
		Nom$ Mil	**$3.469**	**$19.774**	**$51.597**	**$6.767**	**$38.567**	**$100.634**	**$8.321**	**$47.429**	**$123.758**
		NPV $ Mil	**$53,430**	**$304,530**	**$794,613**	**$51,270**	**$292,222**	**$762,498**	**$49,380**	**$281,451**	**$734,393**
	NPV $/PEV	Public L1	$0	$0	$0	$0	$0	$0	$0	$0	$0
		Public L2	$29	$220	$529	$28	$212	$508	$27	$204	$489
		DCFC	$24	$84	$266	$23	$81	$255	$22	$78	$246

PROJECTED NUMBER OF CHARGERS			80x50								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Thousand		162.42			309.28			536.85	
	Single Fam - L2	Thousand		108.93			207.43			360.05	
	MUD - L1	Thousand		38.85			73.98			128.41	
	MUD - L2	Thousand		22.31			42.49			73.75	
	TOTAL HOME CHARGERS/PEV			0.942			0.942			0.942	
	% Home Chargers L2			39%			39%			39%	
PUBLIC AND WORKPLACE CHARGERS	Public L2	x000	2.98	17.87	35.73	5.67	34.03	68.03	9.84	59.06	118.09
	Public DCFC	x000	0.19	0.62	1.66	0.37	1.18	3.15	0.64	2.05	5.48
	DCFC per 100	Interstate	44.2	140.6	375.9	84.2	267.7	715.9	146.2	464.7	1,242.6
	Highway Miles	State & Inter	0.6	1.8	4.8	1.1	3.4	9.2	1.9	6.0	15.9

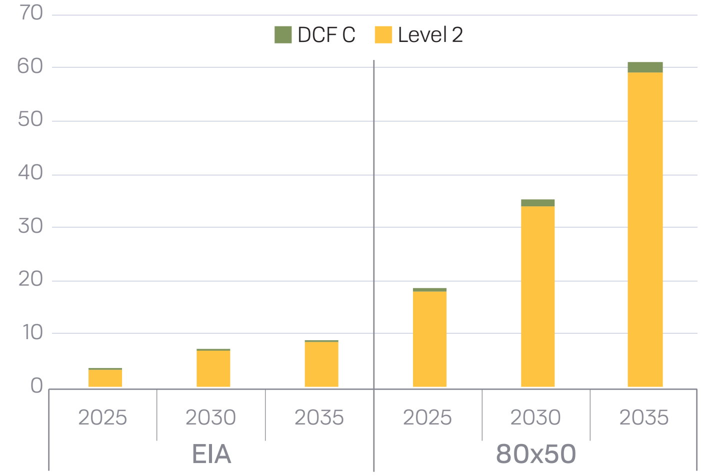
PROJECTED COST OF CHARGERS			80x50								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Nom$ Mil	$17.91	$89.57	$120.93	$37.95	$189.74	$256.15	$73.55	$367.74	$496.45
	Single Fam - L2	Nom$ Mil	$144.18	$168.21	$264.33	$305.41	$356.32	$559.93	$591.92	$690.58	$1,085.19
	MUD - L1	Nom$ Mil	$12.86	$34.28	$41.78	$27.23	$72.62	$88.50	$52.78	$140.74	$171.52
	MUD - L2	Nom$ Mil	$36.92	$41.84	$61.53	$78.20	$88.63	$130.33	$151.56	$171.77	$252.60
	TOTAL	Nom$ Mil	**$211.87**	**$333.90**	**$488.56**	**$448.79**	**$707.30**	**$1,034.91**	**$869.81**	**$1,370.82**	**$2,005.76**
		NPV $ Mil	**$167.25**	**$263.59**	**$385.68**	**$305.61**	**$481.64**	**$704.73**	**$510.92**	**$805.21**	**$1,178.17**
		NPV $/PEV	**$474**	**$747**	**$1,093**	**$455**	**$717**	**$1,049**	**$438**	**$690**	**$1,010**
PUBLIC AND WORKPLACE CHARGERS	Public L2	Nom$ Mil	$13.136	$98.550	$236.442	$27.825	$208.756	$500.848	$53.927	$404.590	$970.693
	Public DCFC	Nom$ Mil	$10.750	$37.588	$118.784	$22.771	$79.621	$251.618	$44.132	$154.314	$487.660
	TOTAL	Nom$ Mil	**$23.885**	**$136.138**	**$355.226**	**$50.596**	**$288.378**	**$752.466**	**$98.060**	**$558.904**	**$1,458.353**
		Nom$ Mil	**$18.855**	**$107.469**	**$280.419**	**$34.453**	**$196.371**	**$512.393**	**$57.600**	**$328.297**	**$856.629**
		NPV $ Mil	**$53,430**	**$304,530**	**$794,613**	**$51,270**	**$292,222**	**$762,498**	**$49,380**	**$281,451**	**$734,393**
	NPV $/PEV	Public L1	$0	$0	$0	$0	$0	$0	$0	$0	$0
		Public L2	$29	$220	$529	$28	$212	$508	$27	$204	$489
		DCFC	$24	$84	$266	$23	$81	$255	$22	$78	$246

AEP, OHIO

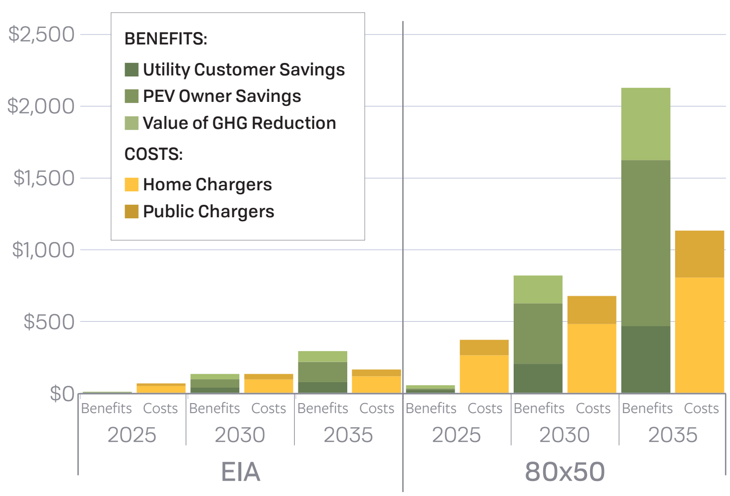
Projected PEVs and Home Chargers (Thousands)



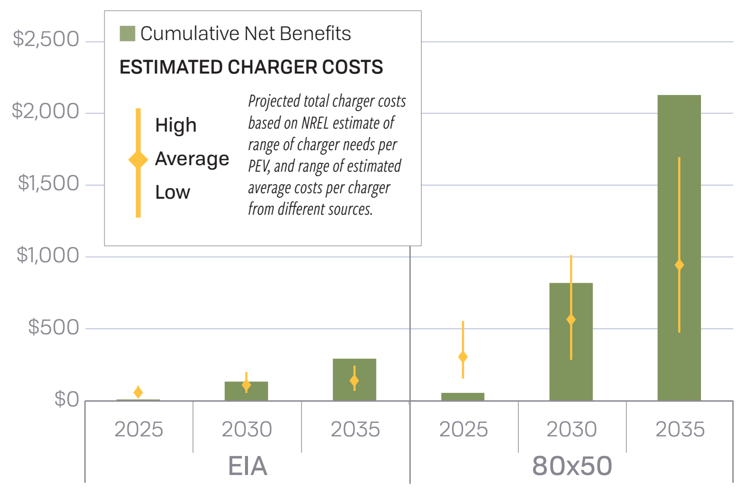
Projected Number of Required Public and DC Fast Chargers (Thousands)



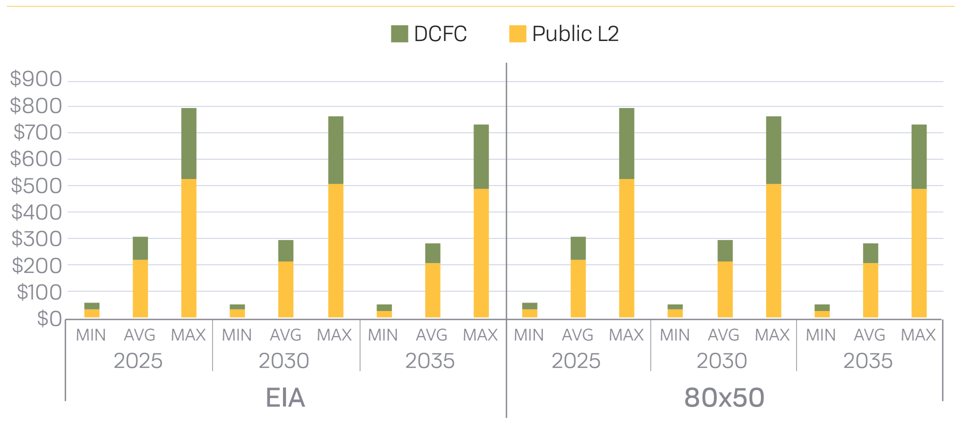
PEV Cumulative Benefits Compared to Charger Costs (NPV $ Millions)



Cumulative PEV Net Benefits Compared to Range of Estimated Charger Costs (NPV $ Millions)



Projected Cost of Public Charging Infrastructure (NPV $/PEV)



DUKE ENERGY, OHIO

METRIC		UNIT	2015 ACTUAL
Residential Customers		Million	0.69
Housing Units	Total	Million	0.69
	% in Multiple Unit Dwellings	Percent	23.1%
Highway Miles	Interstate	Thousand	0.205
	State	Thousand	15.776

METRIC		UNIT	EIA			80x50		
			2025	2030	2035	2025	2030	2035
Projected Number of PEVs	BEV	Thousand	11.2	22.7	29.0	60.8	115.8	200.9
	PHEV	Thousand	19.4	39.3	50.2	105.2	200.3	347.7
Annual PEV Charging Electricity	Home	Thousand MWh	75.4	142.6	170.9	394.7	757.3	1,291.8
	Non-home	Thousand MWh	19.0	35.9	43.0	99.3	190.6	325.1
Peak Daily Load for PEV Charging	Baseline Charging	MW	30.3	61.6	77.8	164.6	313.5	544.1
	Off-peak Charging	MW	11.8	24.0	29.5	64.1	122.1	212.0
Annual Utility Revenue from PEV Charging		NOM $ Mil	$18.0	$38.4	$50.9	$94.3	$203.9	$384.5
Annual Utility Net Revenue from PEV Charging	Baseline Charging	NOM $ Mil	$1.7	$3.8	$4.0	$8.3	$21.2	$33.3
	Off-peak Charging	NOM $ Mil	$2.7	$6.2	$7.2	$14.1	$33.2	$55.2
Annual GHG Reduction		Thousand MT	$40.5	$73.6	$82.7	$204.7	$406.0	$715.2
Annual Social Value of GHG Reduction		NOM $ Mil	$2.6	$5.8	$7.9	$13.2	$31.8	$68.1
Annual PEV Owner Savings		NOM $ Mil	$0.5	$12.8	$16.3	$5.7	$91.0	$152.0

METRIC		UNIT	EIA			80x50		
			2025	2030	2035	2025	2030	2035
ANNUAL NET BENEFITS PER PEV	Utility Net Revenue – BASE	NOM $/PEV	$54.3	$61.7	$50.7	$50.2	$66.9	$60.7
	Utility Net Revenue – OFF PEAK	NOM $/PEV	$89.1	$99.7	$90.9	$85.1	$105.0	$100.6
	Value of GHG Reduction	NOM $/PEV	$85.5	$1,136.8	$1,697.4	$79.6	$231.1	$287.7
	PEV Owner Savings	NOM $/PEV	$16.0	$205.4	$205.3	$34.2	$287.8	$277.0
	Utility Net Revenue – BASE	NPV $/PEV	$42.9	$42.0	$29.8	$39.7	$45.6	$35.7
	Utility Net Revenue – OFF PEAK	NPV $/PEV	$70.3	$67.9	$53.4	$67.1	$71.5	$59.1
	Value of GHG Reduction	NPV $/PEV	$67.5	$774.1	$997.1	$62.8	$157.4	$169.0
	PEV Owner Savings	NPV $/PEV	$12.6	$139.9	$120.6	$27.0	$196.0	$162.7
CUMULATIVE NET BENEFITS	Utility Net Revenue – BASE	NOM $ Mil	$1.7	$16.5	$36.2	$8.3	$88.5	$230.7
	Utility Net Revenue – OFF PEAK	NOM $ Mil	$2.7	$26.7	$60.7	$14.1	$141.9	$373.9
	Value of GHG Reduction	NOM $ Mil	$2.6	$25.1	$60.3	$13.2	$135.0	$402.7
	PEV Owner Savings	NOM $ Mil	$0.5	$39.7	$114.0	$5.7	$289.9	$927.7
	Utility Net Revenue – BASE	NPV $ Mil	$1.3	$11.2	$21.3	$6.6	$60.3	$135.5
	Utility Net Revenue – OFF PEAK	NPV $ Mil	$2.1	$18.2	$35.7	$11.1	$96.6	$219.6
	Value of GHG Reduction	NPV $ Mil	$2.1	$17.1	$35.4	$10.4	$91.9	$236.5
	PEV Owner Savings	NPV $ Mil	$0.4	$27.0	$67.0	$4.5	$197.4	$544.9

DUKE ENERGY, OHIO

PROJECTED NUMBER OF CHARGERS			EIA								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Thousand		14.06			28.57			36.48	
	Single Fam - L2	Thousand		9.43			19.16			24.46	
	MUD - L1	Thousand		3.36			6.83			8.73	
	MUD - L2	Thousand		1.93			3.92			5.01	
	TOTAL HOME CHARGERS/PEV			0.942			0.942			0.942	
	% Home Chargers L2			39%			39%			39%	
PUBLIC AND WORKPLACE CHARGERS	Public L2	x000	0.26	1.55	3.09	0.52	3.14	6.28	0.67	4.01	8.02
	Public DCFC	x000	0.02	0.05	0.14	0.03	0.11	0.29	0.04	0.14	0.37
	DCFC per 100	Interstate	8.2	26.2	70.1	16.8	53.3	142.4	21.4	68.0	181.9
	Highway Miles	State & Inter	0.1	0.3	0.9	0.2	0.7	1.8	0.3	0.9	2.3

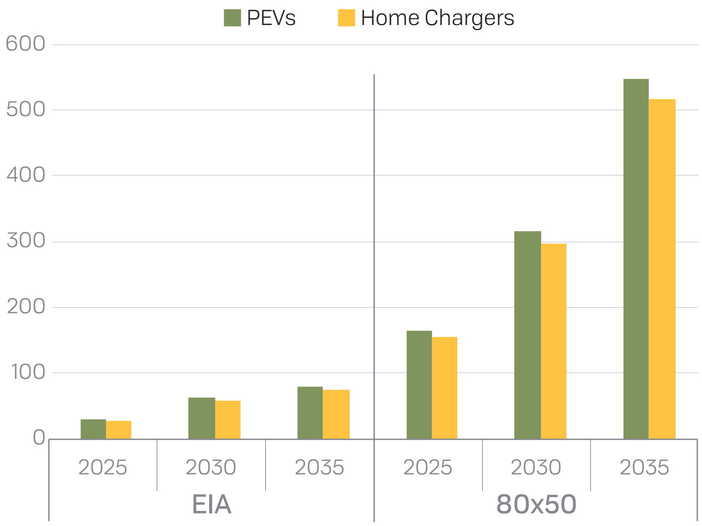
PROJECTED COST OF CHARGERS			EIA								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Nom$ Mil	$1.55	$7.75	$10.46	$3.51	$17.53	$23.66	$5.00	$24.99	$33.73
	Single Fam - L2	Nom$ Mil	$12.48	$14.56	$22.88	$28.21	$32.91	$51.72	$40.22	$46.92	$73.74
	MUD - L1	Nom$ Mil	$1.11	$2.97	$3.62	$2.52	$6.71	$8.17	$3.59	$9.56	$11.65
	MUD - L2	Nom$ Mil	$3.19	$3.62	$5.32	$7.22	$8.19	$12.04	$10.30	$11.67	$17.16
	TOTAL	Nom$ Mil	**$18.33**	**$28.90**	**$42.28**	**$41.46**	**$65.33**	**$95.60**	**$59.10**	**$93.14**	**$136.29**
		NPV $ Mil	**$14.47**	**$22.81**	**$33.38**	**$28.23**	**$44.49**	**$65.10**	**$34.72**	**$54.71**	**$80.05**
		NPV $/PEV	**$474**	**$747**	**$1,093**	**$455**	**$717**	**$1,049**	**$438**	**$690**	**$1,010**
PUBLIC AND WORKPLACE CHARGERS	Public L2	Nom$ Mil	$1.137	$8.529	$20.462	$2.570	$19.283	$46.264	$3.664	$27.491	$65.957
	Public DCFC	Nom$ Mil	$0.930	$3.253	$10.280	$2.103	$7.355	$23.242	$2.999	$10.485	$33.136
	TOTAL	Nom$ Mil	**$2.067**	**$11.781**	**$30.741**	**$4.674**	**$26.638**	**$69.507**	**$6.663**	**$37.976**	**$99.092**
		Nom$ Mil	**$1.632**	**$9.300**	**$24.267**	**$3.183**	**$18.139**	**$47.331**	**$3.914**	**$22.307**	**$58.206**
		NPV $ Mil	**$53,430**	**$304,530**	**$794,613**	**$51,270**	**$292,222**	**$762,498**	**$49,380**	**$281,451**	**$734,393**
	NPV $/PEV	Public L1	$0	$0	$0	$0	$0	$0	$0	$0	$0
		Public L2	$29	$220	$529	$28	$212	$508	$27	$204	$489
		DCFC	$24	$84	$266	$23	$81	$255	$22	$78	$246

PROJECTED NUMBER OF CHARGERS			80x50								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Thousand		76.39			145.46			252.49	
	Single Fam - L2	Thousand		51.23			97.56			169.34	
	MUD - L1	Thousand		18.27			34.79			60.39	
	MUD - L2	Thousand		10.49			19.98			34.69	
	TOTAL HOME CHARGERS/PEV			0.942			0.942			0.942	
	% Home Chargers L2			39%			39%			39%	
PUBLIC AND WORKPLACE CHARGERS	Public L2	x000	1.40	8.40	16.80	2.67	16.00	32.00	4.63	27.78	55.54
	Public DCFC	x000	0.09	0.29	0.78	0.17	0.55	1.48	0.30	0.96	2.58
	DCFC per 100	Interstate	44.8	142.4	380.8	85.3	271.2	725.2	148.1	470.7	1,258.8
	Highway Miles	State & Inter	0.6	1.8	4.9	1.1	3.5	9.3	1.9	6.0	16.1

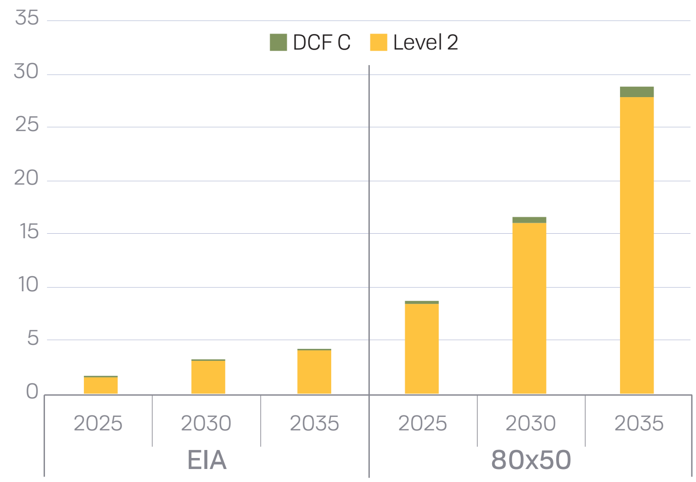
PROJECTED COST OF CHARGERS			80x50								
			2025			2030			2035		
			MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
HOME CHARGERS	Single Fam - L1	Nom$ Mil	$8.43	$42.13	$56.87	$17.85	$89.24	$120.48	$34.59	$172.96	$233.49
	Single Fam - L2	Nom$ Mil	$67.81	$79.11	$124.32	$143.64	$167.58	$263.35	$278.40	$324.80	$510.39
	MUD - L1	Nom$ Mil	$6.05	$16.12	$19.65	$12.81	$34.15	$41.62	$24.82	$66.19	$80.67
	MUD - L2	Nom$ Mil	$17.36	$19.68	$28.94	$36.78	$41.68	$61.30	$71.28	$80.79	$118.80
	TOTAL	Nom$ Mil	$99.65	$157.04	$229.78	$211.08	$332.66	$486.74	$409.09	$644.73	$943.36
		NPV $ Mil	$78.66	$123.97	$181.39	$143.73	$226.53	$331.45	$240.30	$378.71	$554.12
		NPV $/PEV	$474	$747	$1,093	$455	$717	$1,049	$438	$690	$1,010
PUBLIC AND WORKPLACE CHARGERS	Public L2	Nom$ Mil	$6.178	$46.351	$111.204	$13.087	$98.183	$235.561	$25.363	$190.289	$456.541
	Public DCFC	Nom$ Mil	$5.056	$17.678	$55.867	$10.710	$37.448	$118.342	$20.756	$72.577	$229.359
	TOTAL	Nom$ Mil	**$11.234**	**$64.029**	**$167.072**	**$23.796**	**$135.631**	**$353.903**	**$46.120**	**$262.866**	**$685.899**
		Nom$ Mil	**$8.868**	**$50.545**	**$131.888**	**$16.204**	**$92.358**	**$240.991**	**$27.091**	**$154.406**	**$402.894**
		NPV $ Mil	**$53,430**	**$304,530**	**$794,613**	**$51,270**	**$292,222**	**$762,498**	**$49,380**	**$281,451**	**$734,393**
	NPV $/PEV	Public L1	$0	$0	$0	$0	$0	$0	$0	$0	$0
		Public L2	$29	$220	$529	$28	$212	$508	$27	$204	$489
		DCFC	$24	$84	$266	$23	$81	$255	$22	$78	$246

DUKE ENERGY, OHIO

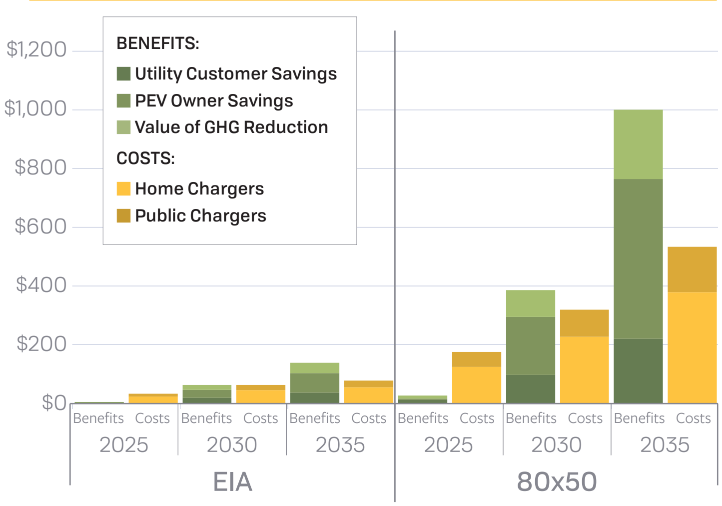
Projected PEVs and Home Chargers (Thousands)



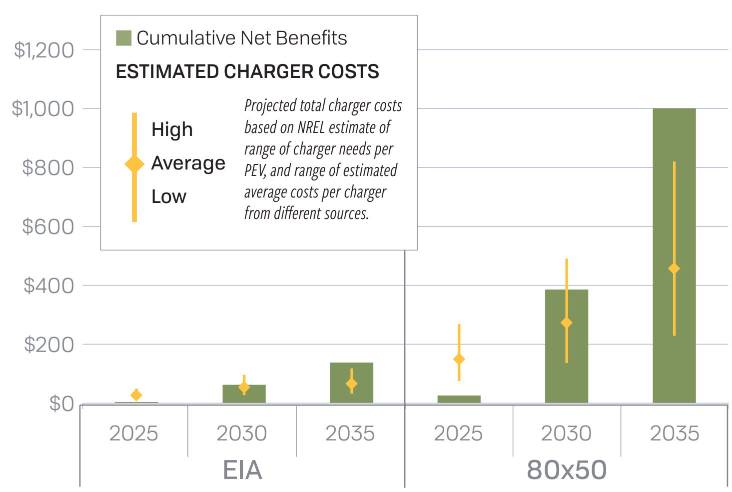
Projected Number of Required Public and DC Fast Chargers (Thousands)



PEV Cumulative Benefits Compared to Charger Costs (NPV $ Millions)



Cumulative PEV Net Benefits Compared to Range of Estimated Charger Costs (NPV $ Millions)



Projected Cost of Public Charging Infrastructure (NPV $/PEV)