State Electric Vehicle Benefits

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Appendix: Methodology and assumptions

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Scope

Here are the datasets and assumptions used to create the following statistics. These statistics apply to battery electric or plug-in hybrid electric vehicles. Fuel cell electric vehicles were not included in this analysis.

EVs cut global warming emissions. Driving an EV in [STATE] produces [X] metric tons of emissions per year compared with [Y] metric tons from the average new gasoline-powered car.

Power plant emissions

The electricity generation-related emissions values used in our analysis come from the U.S. Environmental Protection Agency's (EPA's) Emissions & Generation Resource Integrated Database (eGRID), which is a comprehensive source of emissions data for every power plant in the United States that provides its generation data to the government. We used to the most up-to-date version of eGRID available—eGRID2016—which contains plant emissions and generation data from calendar year 2016.

The subregions are groups of plants organized by the EPA, based on Power Control Areas and North American Reliability regions. These groupings reflect which power plants serve which households, and they reasonably approximate the grid mix of electricity used by those households within a subregion.

The level of disaggregation of the eGRID subregions allows for more precise calculation of plants' emissions intensities than a national average, as regional variations in grid mix are taken into account. For this reason, eGRID was chosen over other data sources that had the same detailed plant information but fewer subregions. The actual grid mix of a household's electricity is specific to the individual utilities serving each household, but specific grid-mix data are not readily available for most utilities and therefore were not used in the study.

eGRID's methodology treats the subregions as closed systems, calculating the emissions intensity of generation for each one based on the emissions intensities of the plants it contains. This methodology ignores imports and exports of electricity between subregions, which harms the accuracy of the regional emissions estimates. Therefore, the 26 subregions are recommended by eGRID's designers as the level of disaggregation best suited for estimating electricity use-related emissions, as they achieve the best balance between the precision gained by disaggregation and the accuracy lost by omitting imports and exports.

Transmission loss factors

The eGRID generation emission rates do not account for transmission and distribution losses between the power plant and the household. To calculate emissions per unit of energy used (rather than energy produced), we increase the emissions rates using grid loss factors as given in eGRID2016**.**

Upstream emissions factors

The eGRID subregion emissions rates include only those emissions produced at the plant generating the electricity, and they exclude upstream emissions resulting from the mining and transport of the power plant feedstock. Therefore, we calculated a feedstock emissions rate for each subregion; this rate depends on which fuel types the corresponding power plants use. Each fuel type has a unique upstream emissions rate, which we obtained from a publicly available life cycle emissions model: GREET (2017 version), developed by the Argonne National Laboratory. The percentage of generation from each fuel type in a subregion was then obtained from eGRID2016.

For each subregion, the fuel-type emissions rates are multiplied by the share of generation they represent in that subregion; the sum of these products is the subregion's feedstock emissions rate. Most fuel types in GREET correspond directly to a fuel type in eGRID, but there were a few exceptions. A very small share of generation in eGRID subregions corresponds to a fuel type labeled "generic fossil"; for this fuel type, the emissions rate from GREET for natural gas was chosen as a conservative guess, given that its upstream emissions value is higher than those of coal and oil (the other two fossil fuels with known feedstock emissions rates in GREET). An even smaller share of generation in eGRID subregions comes from unknown sources; for this category of fuel type, the feedstock emissions rate is the generation-weighted average of the upstream emissions rates for the other fuel types.

Conversion of g/kWh to metric tons CO_2e emissions

We multiplied the estimated emissions intensity values (gCO_2e/kWh) and a sales-weighted EV average efficiency of 0.3385 kWh/mile, resulting in a gCO_2e/mile estimate. Annual emissions rate was estimated using an average annual mileage of 11,440 miles per year. Gasoline vehicle emissions are estimated to be 10958 gCO_2e/gallon based on the GREET carbon intensity of California reformulated and reformulated gasoline, based on a weighted average of 11 percent California gasoline and 89 percent non-California gasoline. This fuel carbon intensity was used with the average 2016 new gasoline vehicle efficiency of 25.6 miles/gallon (EPA 2016) and 11,440 miles/year driving to estimate annual new gasoline vehicle global warming emissions.

Rural EV drivers save the most on fuel. On average, rural [STATE] drivers could save [$X] by switching from gasoline to electricity.

Annual fuel savings were estimated at the county level for an average driver switching from a passenger car to an electric vehicle (EV). The driver is assumed to switch from a gas-powered passenger car with a fuel efficiency of 25.2 miles per gallon (average for new passenger cars in 2017) to a battery-electric vehicle with an efficiency of 0.32 kWh/mile.

Note that there are differing definitions of what constitutes a rural area. In this analysis, rural drivers are defined to be those who live in counties within the two lowest population density groups (one group up to 99 persons per square mile, and the second group from 100 to 499 persons per square mile).

Annual fuel savings were first estimated for each county within the two lowest population density groups. These savings were then averaged over the two groups to obtain an overall annual fuel savings estimate for rural drivers in the state.

Annual vehicle miles driven (VMT) for each county was determined by identifying which population density group the county is located in. The annual VMT was determined by mapping the county into one of the 72 'baskets' for 8 typical population density areas in 9 census divisions (See Table 1).

Gasoline prices are 2018 state averages. EV drivers were assumed to charge their vehicles at home so electricity prices are 2017 residential retail rates in the state. It should be noted that many areas have time-of-use (TOU) rates, which are usually lower than the state average, so the estimates presented here are conservative, and fuel savings could be higher.

Since gasoline and electricity prices were assumed to be state-level averages, and since constant fuel economies and EV efficiencies are assumed, the only factor that determines the difference between fuel savings in different counties is the VMT. Therefore, if all other factors remain constant, annual fuel savings for each driver increases proportionally with annual VMT.

Table 1 – Annual miles driven by an average driver in 8 typical population density areas for each of the 9 census divisions.

Persons per square mile	New England	Middle Atlantic	East North Central	West North Central	South Atlantic	East South Central	West South Central	Mountain	Pacific
0-99	13634	13251	14347	15934	14569	15337	14394	13847	11666
100-499	14491	12816	14224	15324	13189	13389	12574	11498	12144
500-999	11924	11424	12830	15862	13016	13258	12954	11119	10133
1,000-1,999	11506	11385	11362	11741	12168	11764	13373	11358	11223
2,000-3,999	10737	11260	11804	10739	10576	14065	12378	9621	10494
4,000-9,999	10014	10586	10593	11729	11165	10014	11464	10765	10006
10,000-24,999	6735	7840	9203	7978	10103	1735	12615	10905	10273
25,000-999,999	3441	4721	6676	6916	8758	.	13062	24988	8002

City drivers save money too. Charging an EV at home in [CITY] is like paying $[X] per gallon of gasoline.

Rate design and costs were obtained via the U.S. Department of Energy's Utility Rate Database with confirmation using the websites of the electric service providers. The marginal volumetric rate including adjustments (taxes and fees) was determined for each service provider. Fixed charges (meter charges) were not included. Seasonal rates were averaged based on the proportional length of the season, with the assumption that EV electric use occurs at a constant rate throughout the year.

Demand charges were added if they were applied at all hours, assuming 30A, 240V (7.2 kW) charging with 1.6 hours of charging required per day (12,700 miles per year, 0.325 kWh per mile). If demand charges were applied only on peak hours, then no demand charges were added; it is assumed that charging would be avoided during peak periods.

Tiered non-TOU rates assumed that EV charging was above the average EIA household consumption or over 100 percent of baseline (if data were available). EV monthly charging was assumed to require 344 kWh/month (11.3 kWh/day). When both tiered and non-tiered TOU/EV rates were available, the non-tiered rates were used. If multiple TOU/EV rates were available, the rate with the lowest nighttime rate was chosen. Rates that required installation of an additional meter were not considered due to the difficulty in quantifying the expense and charges associated with installation and use of a second meter.

Rates for deregulated markets were estimated by selecting representative rate plans with a 12-month contract period. Because the rate structures in deregulated markets can vary significantly between electricity providers, rates available in these markets may result in lower electricity costs than those presented here.

For each rate where a per kWh charge (and per KW demand charge, if applicable) was known, the $/GGE equivalent was calculated using (electricity cost) x (EV efficiency) x (1/gasoline efficiency), where the EV efficiency was the sales-weighted US EV efficiency (0.325 kWh/mi) and miles per gallon were 25.6, the average new vehicle efficiency for all MY2016 vehicles.

Note that the GGE rate for Newak was based on an average for NJ GGE rates, since data for Newark was unavailable.

Interest in EVs is quickly growing. EV sales grew [X] percent in [STATE] from 2017 to 2018, reaching [Z] sold by the end of 2018.

EV sales and sales growth rates based on new car registration data from IHS Markit (non-pubic dataset).

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