Colorado Springs Electric Vehicle Readiness Plan

December 2021

Submitted to:
City of Colorado Springs and
Colorado Springs Utilities

Submitted by:
ICF Incorporated, L.L.C.
14123 Denver West Parkway
Suite 100
Golden, CO 80401

Contact: Scott Walsh
Scott.Walsh@icf.com
858-444-3923

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1. Executive Summary

The Colorado Springs Electric Vehicle Readiness Plan (EVRP) outlines strategies that the City of Colorado Springs, Colorado Springs Utilities, and other stakeholders can pursue to prepare for and support the increased adoption of electric vehicles (EVs).[1] Increasing the adoption of EVs in Colorado Springs will help to improve the air quality in Colorado Springs by reducing vehicle emissions. EVs will also provide economic benefits because of lower fuel and maintenance costs. The additional power demand from EV charging may also support lower electricity rates by better utilizing Colorado Springs Utilities' generating assets.

The City of Colorado Springs and Colorado Springs Utilities, working a range of stakeholders and with support from ICF, developed this EVRP to address the following elements:

- Growth scenarios showing potential EV adoption over the next thirty years
- Charging demand projections of the number of public chargers needed to support projected EV growth
- A review of current and recommended policies to support EVs
- Outreach and education recommendations
- Recommendations for the City and Colorado Springs Utilities to electrify their fleets
- Projected pollution reductions from EV adoption projections
- Potential impacts to the city's electricity distribution grid
- Additional energy requirements from EV charging
- Metrics to track the implementation of this plan

Colorado Springs expects a significant increase in the number of EVs over the next 30 years driven by a number of factors, including supportive policies and incentives from the state and federal government and an increasing push by auto manufacturers to offer EVs. While there were about 2,300 EVs in El Paso County as of September 2020, the city can expect between 400,000 and 850,000 EVs on its roads by 2050.

Table E1. Colorado Springs EV Growth Scenarios (number of vehicles)[2]

Scenario	2020	2025	2030	2050
CO Springs Low EV Growth Scenario	2,308	31,799	92,174	408,166
CO Springs Medium EV Growth Scenario	2,308	37,599	107,588	572,185
CO Springs High EV Growth Scenario	2,308	46,320	133,056	848,452

[1] For purposes of this plan, electric vehicles refer specifically to on-road cars and trucks only. This plan does not address other types of electric vehicles such as motorcycles, scooters or bikes.

[2] 2020 figures are reported vehicles for El Paso County. All other years are projections.

This projected growth in the adoption of EVs will require a corresponding growth in the charging infrastructure to support EVs. Although most EV drivers today can charge their vehicles at home, there will be greater demand for public charging as the market expands to include drivers without access to home charging. The US Department of Energy's National Renewable Energy Laboratory's projection tool recommends that to support the projected growth of EVs in Colorado Springs, the city will require between 30,000 and 66,000 charging stations at workplaces and in public locations.

Table E2. Recommended Charging Plugs for Colorado Springs EV Growth Scenarios[3]

Scenario	EVSE	2020	2025	2030	2050
CO Springs Low EV Growth Scenario	Workplace Level 2	110	1,443	4,273	18,921
	Public Level 2	88	885	2,350	10,407
	Public DC Fast	23	243	544	2,410
	Total	**221**	**2,571**	**7,167**	**31,738**
CO Springs Medium EV Growth Scenario	Workplace Level 2	110	1,704	4,994	26,558
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CO Springs CO High EV Growth Scenario	Workplace Level 2	110	2,096	6,182	39,423
	Public Level 2	88	1,282	3,391	21,625
	Public DC Fast	23	289	821	5,235
	Total	**221**	**3,667**	**10,395**	**66,282**

While there are already approximately 100 charging plugs publicly available in Colorado Springs, these projections represent significant growth over the coming years. As the City, Colorado Springs Utilities and other stakeholders look to install charging stations throughout the city, they should concentrate on locations where there is likely to be high demand for charging. Using demographic information and travel demand data, ICF developed maps projecting high demand locations for workplace and destination charging throughout Colorado Springs. These maps can be used by the City, Colorado Springs Utilities, and other stakeholders to guide priorities for new charging stations in the coming years.

There are also a number of policy actions that City and Colorado Springs Utilities can take to support and accelerate adoption of EVs, encourage the deployment of public charging stations, and manage the additional electric load from EV charging. By (1) strengthening EV-ready building codes, (2) developing supportive parking and zoning bylaws, (3) streamlining permitting of EV charging equipment, (4) establishing municipal fleet procurement goals, (5) developing EV charger incentives, and (6) incorporating EV load management strategies (particularly time of use rates), Colorado Springs can complement supportive State policies to accelerate the transition toward electric transportation.

In addition to these policy actions, the City, Colorado Springs Utilities, and their partners can support increased EV adoption through education and outreach. Several surveys[4] have indicated there is

[3] 2020 recommendations are based on reported 2020 EV numbers. All other years are based on projected EVs.

[4] These surveys were conducted by the Colorado Energy Office, Colorado Springs Utilities, and the EVRP project team.

substantial interest in EVs but cost and charging availability stand as significant barriers to wider uptake. The City and its partners should work to educate the public about the total cost benefits of EVs compared to internal combustion vehicles and spread awareness of the availability of public charging stations (especially as more are deployed). In particular, the City and Colorado Springs Utilities should work with the Colorado Energy Office as it develops its multi-year education and awareness campaign for EVs.

The City and Colorado Springs Utilities can also support the transition to EVs by providing examples with their own fleets. This plan includes an analysis of the City and Springs Utilities fleets with recommendations for shifting fleet vehicles to electric vehicles where it makes operational and financial sense. The plan calls for the gradual electrification of roughly 61% the City's fleet and 8% of Colorado Springs Utilities' fleet. These changes are projected to reduce greenhouse gas emissions by more than 100,000 metric tons, save the City approximately $26M over the life of the electric vehicles, and save Colorado Springs Utilities more than $4M over the lives of their electric vehicles.

There are significant potential benefits if Colorado Springs achieves the levels of EV adoption predicted by this plan. If the plan's high projections for EV adoption are achieved, the resulting emissions reductions could include 5 million metric tons of greenhouse gases per year, 10,000 kg per year of fine particulate matter (soot), 500,000 kg per year of nitrogen oxides and nearly 100,000 kg/year of volatile organic compounds (some of the key causes of ozone pollution, or smog). Colorado Springs is danger of violating the Clean Air Act standard for ozone. If Colorado Springs is designated as a nonattainment area for ozone, the city may have to require mitigation measures such as vehicle emissions testing[5] and business permitting requirements. Increasing adoption of electric vehicles, which emit no pollutants, is one step that will help Colorado Springs maintain healthy air quality, avoid nonattainment requirements and preserve Colorado Springs' reputation for healthy outdoor tourism.

Colorado Springs Utilities should be well prepared for the increase in electricity demand from an increase in EVs. Springs Utilities is already projecting to increase its generating capacity in the coming years, and the additional energy charging requirement of EVs form a relatively small portion of Springs Utilities projected energy mix. With time of use rate plans and demand-response programs, Springs Utilities may be able to shift charging demand to times when power is most abundant and generated from the cleanest sources.

Although Colorado Spring Utilities is expected to have enough generating capacity to support EV charging, the expected increase in electric vehicle charging will likely require some upgrades to the city's distribution grid for electric power. The development of the EVRP included a grid impacts analysis, provided separately and confidentially to Colorado Springs Utilities and the City's Office of Innovation. This analysis to identified feeders within the distribution grid that, in theoretical "worst case" scenarios, may experience peak loads greater than their design loading. These feeders should be evaluated further for potential upgrades to handle greater loads. In addition, Springs Utilities should encourage customers

[5] https://gazette.com/news/colorado-springs-area-risks-violating-federal-ozone-standards/article_da2a7a54-0fb4-11e9-8beb-d34db44a8fa1.html

to adopt managed charging practices through time of use rates and other incentives to spread the charging load more evenly.

As the City, Colorado Spring Utilities and their partners and stakeholders move forward to implement this plan, they should also track their progress in achieving their goals. Using relatively simple metrics, they can track adoption of EVs and deployment of charging stations, calculate emissions reductions, monitor the community's knowledge of EVs, and track the amount of external funding secured for EVs and charging stations.

The market for electric vehicles is evolving rapidly and offers great promise for Colorado Springs. This Electric Vehicle Readiness Plan will help to guide the City, Colorado Spring Utilities and their partners and stakeholders as they seek to take full advantage of that promise.

2. Introduction

As a community known for its topographical beauty, outdoor recreation options, and active lifestyle, the City of Colorado Springs prioritizes the preservation of air quality for the health of current and future generations. Colorado Springs is home to nearly half a million residents and is projected to nearly double its population by 2050. With nearly 6,000 lane miles of paved roads and a widespread geography, the community is heavily dependent on individual automobile use. Yet the emissions from these vehicles threaten the air quality of the community and could force the city to adopt requirements for vehicles and industry to maintain compliance with national air quality standards. In order to maintain and improve the community's air quality, the City, along with Colorado Springs Utilities and other partners and stakeholders, have developed an Electric Vehicle Readiness Plan (EVRP) to promote, support and prepare for the increased adoption of electric vehicles (EVs).

EVs have a number of advantages over internal combustion engine vehicles. EVs are partially or entirely powered by an electric motor and a rechargeable battery. Because they run on electricity, EVs have fewer emissions than vehicles with internal combustion engines. Powering a vehicle with electricity is also cheaper than running it on gasoline or diesel, saving about $1,000 per year in fuel costs. With fewer moving parts, EVs have less need for maintenance and can save up to $4,600 in maintenance costs over the life of a vehicle.[6] Though most EVs cost more up front than comparable internal combustion engine vehicles, these cost savings often result in EVs having a lower total cost of ownership over the lifetime of the vehicle. As battery production costs continue to drop, EV up-front prices are expected reach parity with internal combustion engine vehicles by 2025.[7]

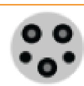
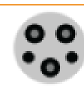
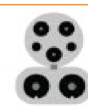
There are two main types of EVs, Plug-in Hybrid Electric Vehicles (PHEVs) and Battery Electric Vehicles (BEVs). PHEVs have both an electric motor and an internal combustion engine, which they use when their battery runs low on charge. They can typically drive 20 to 40 miles on their electric battery before needing a recharge or to switch to the combustion engine. The Toyota Prius Prime is an example of a PHEV. BEVs are powered entirely by their rechargeable battery and have no internal combustion engine. They have typical ranges of 150 to 300 miles. Teslas are the most popular make of BEVs.

There are several types of chargers that EVs use. As shown in the chart below, they differ based on the rate at which they dispense power and are typically used in different settings.

[6] Consumer Reports, 2020. Electric Vehicle Ownership Cost. https://advocacy.consumerreports.org/wp-content/uploads/2020/10/EV-Ownership-Cost-Final-Report-1.pdf

[7] Bloomberg NEF, 2020. Electric Vehicle Outlook Report. Available at https://about.bnef.com/electric-vehicle-outlook/

Table 1. Electric vehicle charging equipment, classified by the maximum amount of power that can be delivered and the rate at which the batteries are charged. V=voltage; A=amperage.

	Level 1	Level 2	DC Fast Charging
Description	120 volt (V) alternating current (AC) plug, single phase service 15-20 amp (A)	208/240V AC plug, split phase service 20-50A	208/480V AC circuit, three-phase service connection 50-200A
Connector Type(s)	 J1772 charge port	 J1772 charge port	   J1772 Combo (CCS); CHAdeMO; Tesla combo
Typical Use Cases	Light-duty EVs; residential, workplace	Light and medium-duty EVs; residential, workplace, public charging, fleets	Light, medium and heavy-duty EVs; public charging, fleets
Charge Time (for light-duty EVs, depending on battery size)	2-5-miles/1 hour of charging PHEVs can be fully charged in 2-7 hours; BEVs in 14-20+ hours.	10-20 miles/1 hour of charging PHEVs can be fully charged in 1-3 hours; BEVs in 4-8 hours.	60-80-miles/20 min of charging BEVs can be fully charged in 30-60 minutes.

Although EVs currently represent about 3 percent of the US vehicle market their share is rapidly growing, across nearly every type of vehicle from light duty to heavy duty. There were more than 40 models of passenger EVs available in the US as of January 2021, and most auto manufacturers and some rental car agencies have announced plans to offer significantly more EV options, or in some cases, shift their entire range of offerings to EVs. The Colorado state government has adopted goals to significantly increase the number of EVs in Colorado. Both the state and federal governments offer a variety of incentives to promote EVs.

This expected growth in EVs requires both support and preparation. EV sales are increasing in Colorado Springs. Sales of EVs in El Paso County more than tripled from less than 500 in 2018 to more than 1,500 in 2019. However, that is just a small fraction of the more than half million vehicles on the road in Colorado Springs. And although the growth rate of EV sales is impressive, in order for EV adoption to make a significant impact on air quality and greenhouse gas reduction, a much faster adoption rate is needed. The Colorado Springs Electric Vehicle Readiness Plan strategies support the continued growth in EV adoption, while identifying necessary preparations to meet the new demands that will come with that growth.

3. Electric Vehicle Market Growth Scenarios

To estimate the potential growth of the electric vehicle market in Colorado Springs, ICF projected four scenarios: U.S Energy Information Agency (EIA) Regional Growth, Low Growth, Medium Growth, and High Growth. ICF relied on existing vehicle projections for Colorado, population forecasts, and the assumption that ratios of vehicles to population would remain stable from 2020 to 2050.

Data Collection and Preparation

Population. ICF acquired population forecasts for Colorado from 2019 through 2050 from the U.S. Census Bureau and isolated projections for both the State and Colorado Springs. ICF then calculated the percentage of Colorado's population in Colorado Springs for each year from 2020 to 2050. ICF then used this percentage to translate state-level EV market forecasts into city-level forecasts.

2020 EV Scenario Values. ICF used 2020 EV registration data (2,308 for El Paso County; 30,256 for Colorado) collected from Atlas EV Hub[8] on September 1, 2020. These figures represent the most recent registration data available and serve as the base market value for all scenarios in this analysis.

EIA Regional Growth. ICF collected the U.S. Energy Information Agency's projections of light-duty EV sales in the Mountain Region from 2020 through 2050.[9] The EIA data represents the average sales projections for the area and offers a conservative projection for the regional EV market. The Mountain Region consists of Arizona, Colorado, Idaho, Montana, New Mexico, Nevada, Utah and Wyoming. This region as a whole has an extremely low adoption rate for EVs that is much lower than that of Colorado or Colorado Springs. This creates an artificially low EV sales projection for both Colorado and Colorado Springs. ICF recommends acknowledging this regional growth, but not relying on this as the Colorado Springs baseline, as local EV deployment growth is already surpassing this projection completed in 2019.

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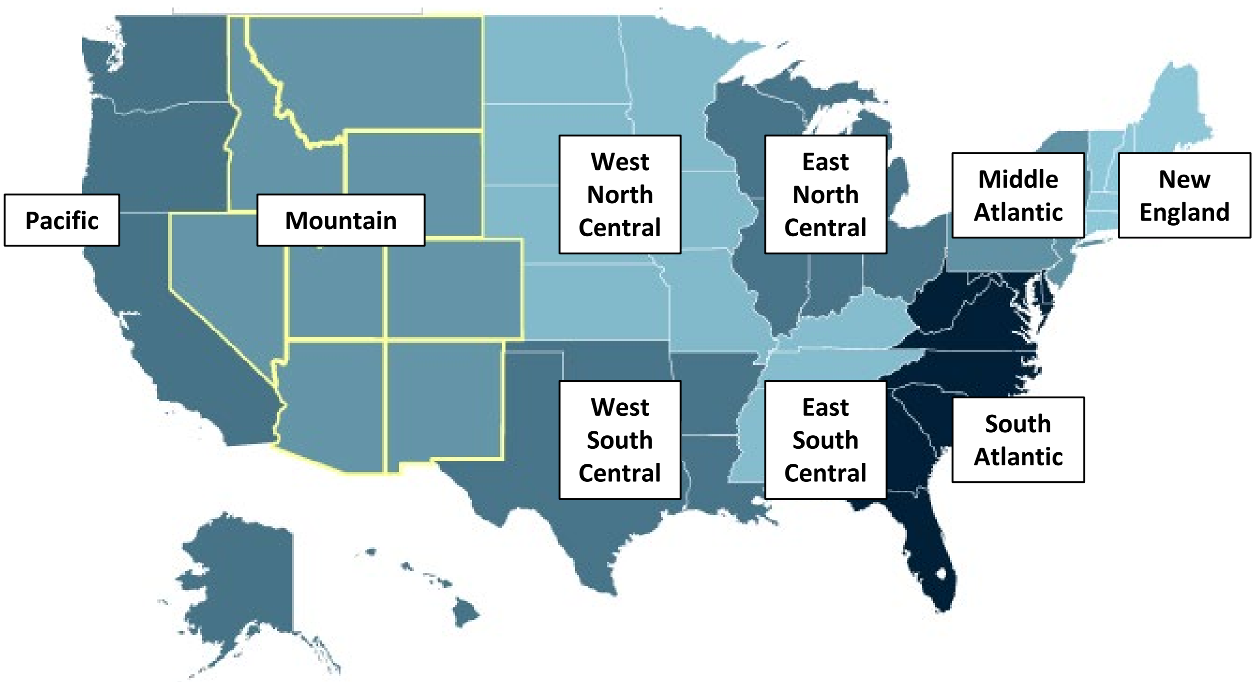
[8] https://www.atlasevhub.com/materials/state-ev-registration-data/

[9] https://www.eia.gov/outlooks/aeo/data/browser/#/?id=48-AEO2020&region=1-8&cases=ref2020&start=2018&end=2050&f=A&linechart=ref2020-d112119a.4-48-AEO2020.1-8&map=ref2020-d112119a.5-48-AEO2020.1-8&sourcekey=0

Figure 1. EIA Regions for Annual Energy Outlook[10]



Assumptions

- ICF used the EV market growth forecast in the Colorado Electric Vehicle Plan 2020[11] to build equations for the low, medium, and high EV growth scenarios. This is only applicable to projections from 2020 through 2030.
- ICF assumes that the EV adoption in Colorado Springs mirrors Colorado EV adoption in each growth scenario based on population proportion.
- The high-level scenario model assumes Colorado will reach the state's long-term goal of 100% light-duty vehicle electrification by 2050.
- The model assumes that 80% of the population will own vehicles, consistent with current ownership levels.

[10] U.S Energy Information Administration. Annual Energy Outlook 2020. Table: Table 38. Light-Duty Vehicle Sales by Technology Type. https://www.eia.gov/outlooks/aeo/data/browser/#/?id=48-AEO2020&region=1-0&cases=ref2020&start=2018&end=2050&f=Q&linechart=ref2020-d112119a.4-48-AEO2020.1-0&map=ref2020-d112119a.5-48-AEO2020.1-0&ctype=map&sourcekey=0

[11] https://energyoffice.colorado.gov/zero-emission-vehicles/colorado-ev-plan-2020

Scenario Methodology

EIA Regional Growth Scenario

Using EIA data, ICF calculated the regional growth rates of EV sales projected by EIA through 2050, using 2019 as the baseline. ICF then applied these regional growth rates to projected EV sales in Colorado Springs, adding the new sales of EVs in a given year to the total number of EVs from the previous year. ICF repeated this calculation from 2020 through 2050. The following equation was applied:

$$EVs(year_{n+1}) = [EVs(year_n) * Growth] + EVs(year_{n-1})$$

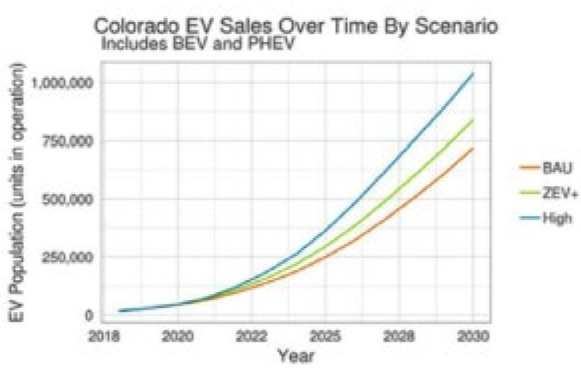
As noted, using the projected adoption rates for the larger region makes this Regional Growth scenario artificially low for Colorado Springs.

Low- Medium-, and High-EV Growth Scenarios

Each scenario begins its projection with 30,256 EVs; the total number of EV registrations in Colorado as of September 1, 2020. ICF then built an equation for each growth scenario using the values within the Colorado EV Plan 2020. The following values are from the Colorado EV Plan 2020 and were used to forecast EV market growth from 2020 to 2030. The Colorado EV Plan 2020 considered three scenarios: (BAU – business as usual; ZEV+ – a middle scenario given more model availability and additional marketing; and High – added infrastructure and incentives and requires policy support and investments).

Figure 2. Colorado State EV Growth Scenarios[12]

Increasing policy support leads to the PEV population for 2030 increasing from ~719,000 vehicles (BAU) to ~1,038,000 vehicles (High) in operation.



PEV Population – Units in Operation
Percentage of Total Population

Scenario	2020	2025	2030
BAU	43,346	249,683	718,787
	0.8%	*4.1%*	*10.2%*
ZEV+	45,701	295,223	838,997
	0.8%	*4.8%*	*11.9%*
High	45,701	363,692	1,037,586
	0.8%	*5.9%*	*14.8%*

Source: Navigant, *CEO EV Growth Analysis*, June 2019.

[12] Colorado Energy Office. Colorado Electric Vehicle Plan 2020. April 2020. https://energyoffice.colorado.gov/sites/energyoffice/files/2020-07/colorado_ev_plan_2020_-_final.pdf

To build the equation, a fit curve was applied to the Colorado EV Plan 2020 projected EV values for all scenarios. The following equations were produced and used to interpolate values between 2020, 2025, and 2030:

2020 to 2030 EV Projection Equations - Colorado

Low EV Growth	$y = 5255.3x^2 + 4480x + 33611$
Medium EV Growth	$y = 5576.1x^2 + 13960x + 10719$
High EV Growth	$y = 6809.2x^2 + 19023x + 4423.8$

In these equations, y equals the number of EVs and x equals the number of years, using 2020 as year 1, 2021 as year 2, and so on.

The above equations were designed based on state-level EV projections and, as a result, forecast state-level EV market growth scenarios. To make these projections applicable to Colorado Springs, the values projected by the state-level EV growth equations were multiplied by the percentage of Colorado's projected population that are projected to reside in Colorado Springs.

2020 to 2030 EV Projection Equations – Colorado Springs

Low EV Growth	$y = (5255.3x^2 + 4480x + 33611) * (a/b)$
Medium EV Growth	$y = 5576.1x^2 + 13960x + 10719) * (a/b)$
High EV Growth	$y = 6809.2x^2 + 19023x + 4423.8 * (a/b)$

As in the state-level equations, y equals the number of EVs and x equals the number of years, using 2020 as year 1, 2021 as year 2, and so on. In the Colorado Springs equations, a equals each year's projected population of El Paso County, and b equals each year's projected population of Colorado.[13]

[13] In addition, the Colorado Springs projections were divided by 2 and 1.5 for the years 2021 and 2022, respectively, to account for a lower growth rate in Colorado Springs than statewide for the first two years of projections.

The State of Colorado has set a long-term goal for all light-duty vehicles to shift to electric but does not have annual benchmark values beyond 2030. To calculate projections from 2030 to 2050, ICF estimated benchmark values for the low, medium, and high scenarios based on the high assumption of 100% light-duty vehicle electrification by 2050. Assuming vehicle ownership will remain a function of population, with 80% of the projected population owning a vehicle, the projected state-level values for 2050 are:

Total EVs in 2050 Assuming 80% Market Saturation - Colorado

Low EV Growth	3,049,848
Medium EV Growth	4,275,410
High EV Growth	6,339,692

To make these values applicable to Colorado Springs, ICF multiplied them by the percentage of Colorado's population that is projected to reside in Colorado Springs. The projected number of EVs in Colorado Springs by 2050 is:

Total EVs in 2050 Assuming 80% Market Saturation – Colorado Springs

Low EV Growth	408,166
Medium EV Growth	572,185
High EV Growth	848,452

ICF then interpolated the number of EV registrations per year from 2030 to 2050 by building formulas for each EV market scenario. The equation was calculated by creating a fit curve between the 2030 and 2050 values in each scenario. The following equations were used to interpolate projected EV market values between 2030 and 2050 at the state-level:

2030 to 2050 EV Projection Equations - Colorado

Low EV Growth	$y = 668672e^{0.0723x}$
Medium EV Growth	$y = 773382e^{0.0814x}$
High EV Growth	$y = 947815e^{0.0905x}$

In these equations, x equals the number of years starting in 2030, with 2030 counting as 1, 2031 counting as 2, and so on.

Using the above equations, ICF interpolated values for each year between 2030 and 2050 for each scenario. ICF assumed a brief slowdown in the EV market after 2030, assuming the state achieves its EV adoption targets and there is a shift from one set of incentives to another. To make the values applicable to Colorado Springs, ICF multiplied them by the percentage of Colorado's population projected to reside in Colorado Springs.

2030 to 2050 EV Projection Equations – Colorado Springs

Low EV Growth	$y = (668672e^{0.0723x}) * (a/b)$
Medium EV Growth	$y = (773382e^{0.0814x}) * (a/b)$
High EV Growth	$y = (947815e^{0.0905x}) * (a/b)$

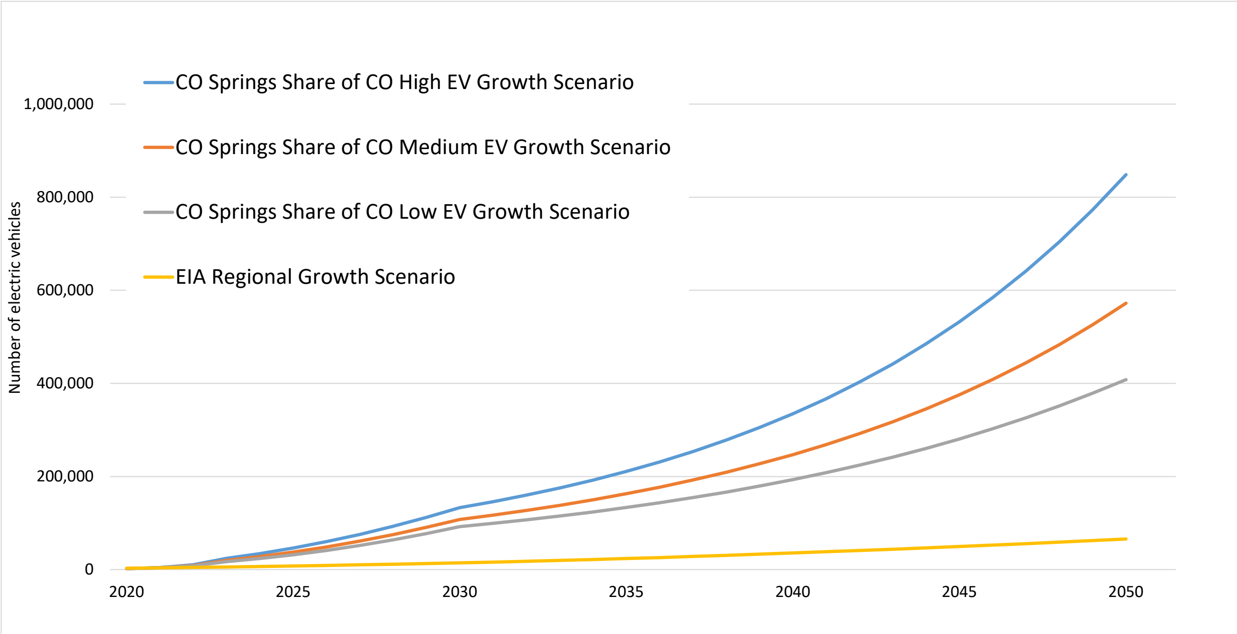
As in the state-level equations, x equals the number of years starting in 2030, with 2030 counting as 1, 2031 counting as 2, and so on. In the Colorado Springs equations, a equals each year's projected population of El Paso County, and b equals each year's projected population of Colorado.

Findings

The following graph shows all four EV market growth scenarios for Colorado Springs, CO. Note that, per discussion above:

- The High growth scenario reflects achieving the State electrification goals;
- The Medium growth scenario reflects the forecasted stretch goal for the region;
- The Low growth scenario is the forecasted "business as usual" goal for the region if no extra incentives, outreach, education, or charging support are provided to the community; and
- The EIA Regional Growth scenario is the artificially low growth projection for the region, distorted by the low rate of electrification in Mountain Region states.

Figure 3. Colorado Springs EV Growth Scenarios



4. Public Charging Demand Projection

In order to support the growth of the EV market as projected in the above scenarios, Colorado Springs will require a significant number of public charging stations. One of the key barriers that has so far discouraged greater adoption of electric vehicles is the concern that an electric vehicle will not have sufficient battery range to serve a driver's needs. The deployment of public charging stations is critical to addressing this barrier and supporting the adoption of electric vehicles.

ICF calculated the number of public charging plugs needed to support the projected vehicles from the EV market growth scenarios using the U.S. Department of Energy's Electric Vehicle Infrastructure Projection Tool (EVI-Pro) Lite.[14] The tool projects recommended numbers of workplace, public level 2 and public DC fast charging (DCFC) stations for given numbers of expected EVs.

The tool bases its projections on several assumptions and user inputs[15]:

- The tool bases its projections on data collected from several travel data sets and typical characteristics for electric vehicles and EV chargers.

- The tool assumes that drivers with access to charging at home will do most of their charging at home. (This is consistent with the rule of thumb cited by the US DOE, and others citing the DOE, that EV drivers do 80% of their charging at home.[16]) The tool assumes that drivers will use workplace and public charging to supplement home charging when needed (e.g. on days when their driving exceeds their battery range).

- The model allows users to set the assumed percentage of drivers with access to charging at home. The model runs shown below assumed that 75% of drivers in Colorado Springs will have access to charging at home. This assumption was based on census data indicating 23% of Colorado Springs housing is multi-unit housing, which typically does not provide charging for residents. This assumption may be low currently – that is, the percentage of EV drivers in Colorado Springs with access to home charging may be much closer to 100% now. ICF used a 75% assumption to project the number of charging stations recommended to support broader adoption of EVs among residents without access to home charging.

- The tool projects a number of charging stations sufficient to prevent lines forming at individual stations, therefore modeling low utilization rates for a larger number of chargers.

Based on these assumptions and user inputs, the EVI-Pro Lite tool projects that for the approximately 2,300 EVs registered in Colorado Springs as of fall 2020, there should be a total of 220 public chargers, as shown below in Table 2.

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[14] https://afdc.energy.gov/evi-pro-lite

[15] A full description of the EVI-Pro tool, upon which the EVI-Pro Lite tool is based, is available here: https://afdc.energy.gov/evi-pro-lite/load-profile/assumptions

[16] https://www.energy.gov/eere/electricvehicles/charging-home

Table 2. Recommended Charging Plugs for Colorado Springs EV Growth Scenarios

Table 2A. Vehicle Scenarios

Scenario	2020	2025	2030	2050
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Table 2B. Charger Recommendations

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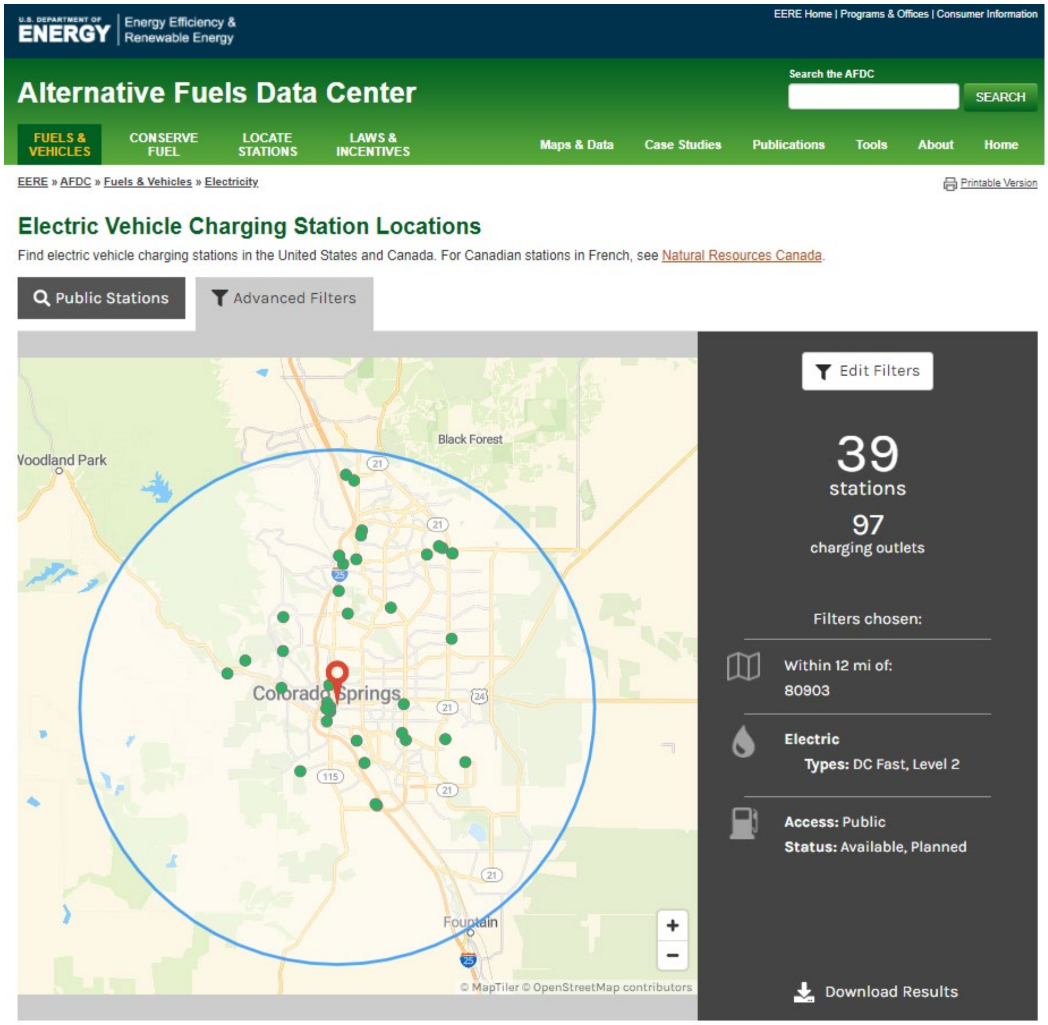
The Alternative Fuels Data Center's EV Charging Station Locator shows that as of December 2020, Colorado Springs had about 100 chargers distributed among 39 charging stations, as shown in the figure below. This is less than half the number of public charging ports recommended by the EVI-Pro tool.

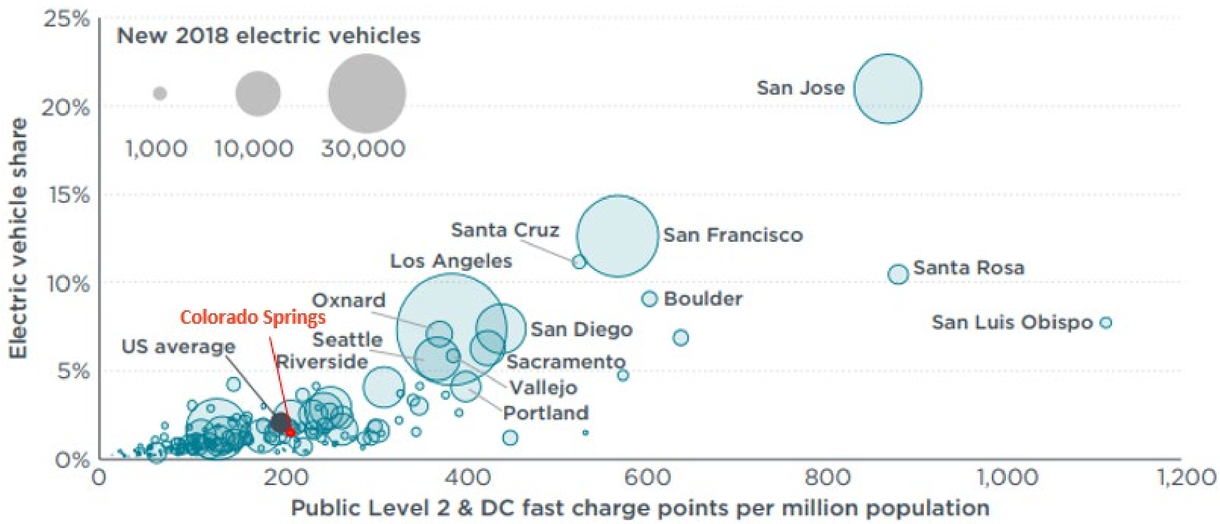
Figure 4. Public Charging Stations in Colorado Springs (as of December 2020)



A study by The International Council on Clean Transportation[17] suggests a strong correlation between the availability of public charging and the uptake of electric vehicles. The figure below shows the share of EV among new vehicle purchases in 2018 compared to the number of public charge points per million population. The chart indicates a high correlation between higher numbers of charge points with higher EV market share. Colorado Springs has approximate 200 charge points per million population (97 plugs for 472,688 residents), while the market share of EVs in Colorado Springs for 2019 was 1.7%. Plotting this on the chart puts Colorado Springs at a similar position to the U.S. average. The study notes that the "five areas with the highest uptake had 2.5 to 6.5 times more chargers than the average. Thirteen of the 15 markets with more than 5% uptake had at least 450 total public chargers per million population or double the national average."

[17] The International Council on Clean Transportation, *Update on electric vehicle adoption across U.S. cities*. August 31, 2020. https://theicct.org/publications/ev-update-us-cities-aug2020

Figure 5. EV share of new vehicles and public charge points per million population[18]



This data suggests that an increase in public charging stations will support an increase in EV market share.[19] This may be especially true for encouraging adoption of EVs among drivers that do not have access to charging at home, such as residents of multi-unit dwellings. Increased availability of public and workplace charging stations gives drivers without access to charging at their homes alternative options to charge, and may therefore encourage broader and more equitable adoption of EVs.

Meeting this demand for additional public charging stations will require significant resources. Purchasing, installing, operating, and maintaining public charging stations is an investment which is much more likely to provide attractive returns if the stations are well used. Research by Idaho National Laboratory[20] demonstrated that charging equipment (deployed in areas with high projected demand for EV charging) experienced nearly 90 percent greater utilization (as measured by charging events per week) compared to charging equipment deployed outside of areas with high projected charging demand.

To help guide charging station deployment to sites more likely to generate high utilization, ICF conducted a demand siting analysis. This siting analysis began by using census data to identify census tracts and traffic analysis zones with demographic characteristics that have been previously shown to indicate likelihood to drive an electric vehicle: current ownership of a hybrid or electric vehicle, higher

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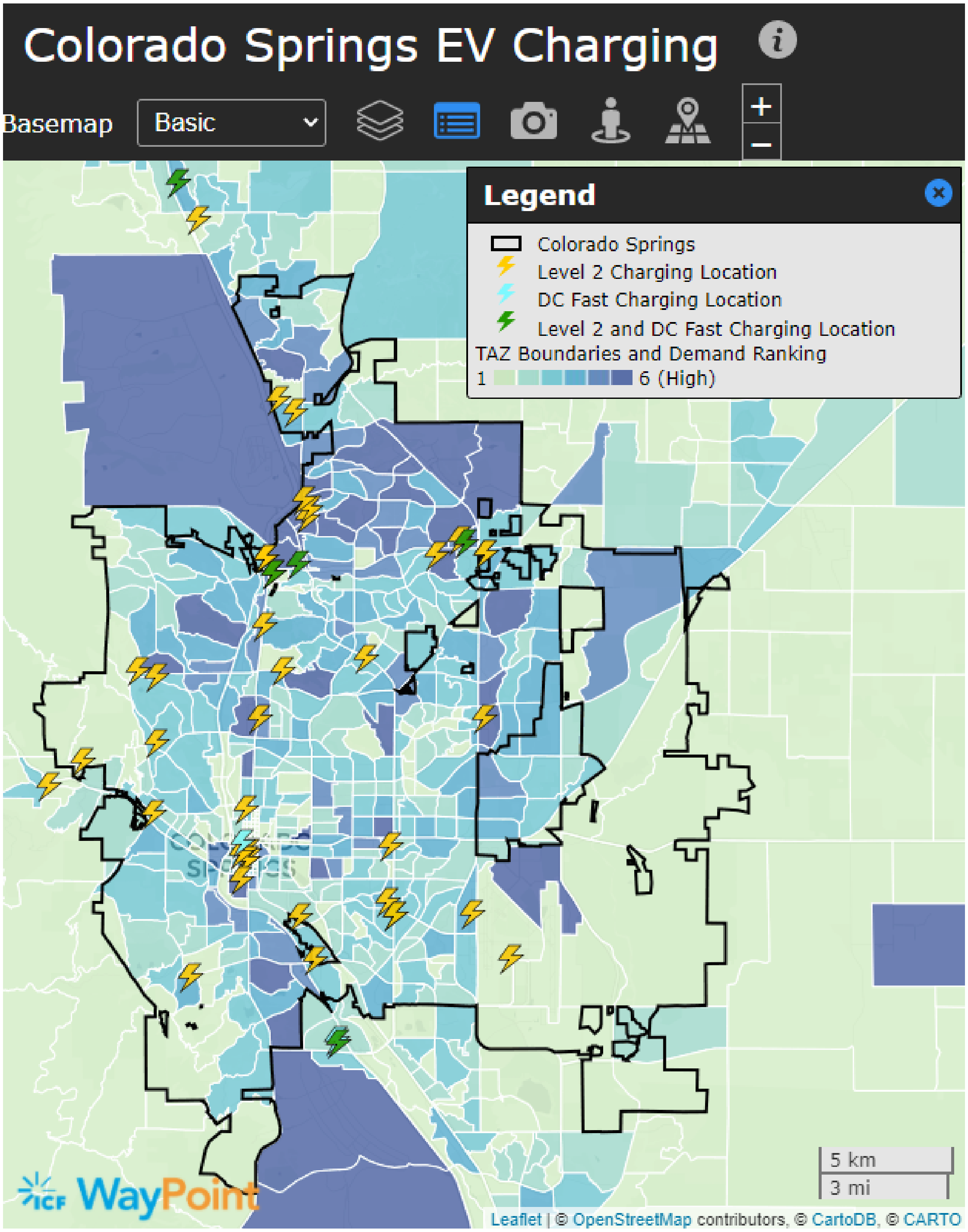
[18] The International Council on Clean Transportation, *Update on electric vehicle adoption across U.S. cities*. August 31, 2020. Colorado Springs data added by ICF.

[19] The study also notes importance of other factors that correlate with high EV adoption rates, such as model availability, policy incentives, and promotion actions. While all of these factors are important in promoting EV uptake, public charger availability seems to have the closest correlation with EV adoption rates (see the comparative graphs in Figure 9 on page 16 of the report). https://theicct.org/publications/ev-update-us-cities-aug2020 Policy actions are addressed later in this document.

[20] Idaho National Laboratory, How Does Utilization of Non-Residential EVSE Compare Between those Installed in Oregon in Planned versus Unplanned Locations?, April 2015. Available online at https://avt.inl.gov/sites/default/files/pdf/EVProj/UtilizationOfNonResEVSEInstallationVsPlan.pdf

income, homeownership and living in a single-family home. ICF then combined this data with origin-destination trip data from the Pikes Peak Area Council of Government's activity-based travel demand model. Using these data, ICF assigned relative probabilistic scores to each traffic analysis zone for likelihood of demand for residential, workplace and destination, or opportunity, charging, as shown in the figure below. ICF created demand projections based on several scenarios – a base scenario prioritizing high income owners of single-family homes, a scenario prioritizing low-income residents, a scenario prioritizing residents of multi-unit dwellings, and a combination scenario showing where demand would be highest from the previous three scenarios. This combination scenario prioritizes those sites that are most likely to serve charging demand from a wide range of demographics. The resulting map showing likely demand for opportunity charging is shown in the figure below.

Figure 6. Map of Likely Opportunity Charging Demand[21]



[21] Map by ICF, 2021.

The models and maps project significant workplace and public charging demand in several areas around the city, including downtown, COS Airport, Peterson Air Force Base, Fort Carson Army Base, the U.S. Air Force Academy, and several areas in the northeast of the city. The map also indicates the locations of existing charging stations. The City, Springs Utilities and other partners can use this map to prioritize investment in new public and workplace charging stations, especially in areas indicating high demand and little existing charging infrastructure.

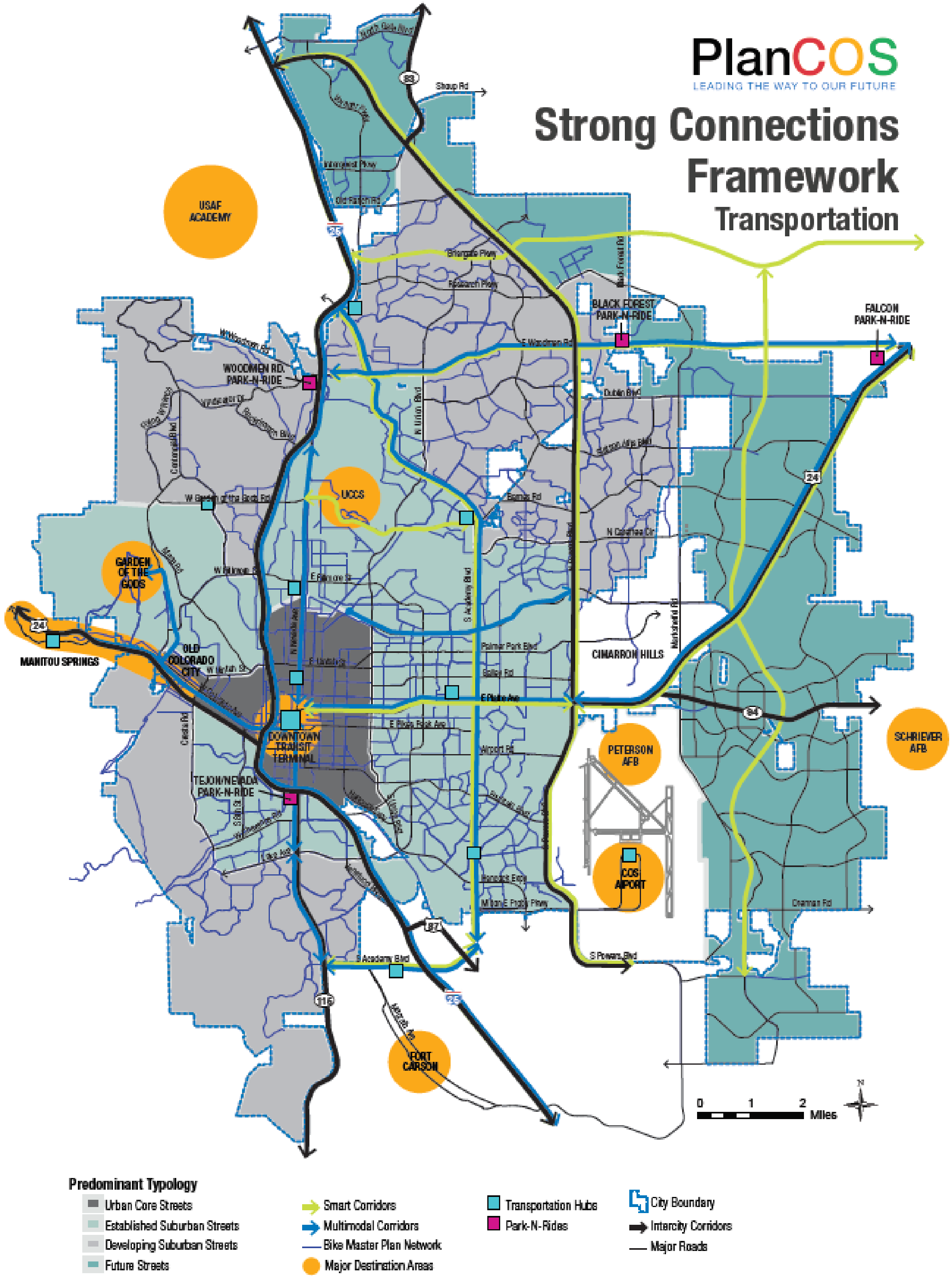
The modeling matches well with the major destinations noted in Colorado Springs PlanCOS Strong Connections Framework[22] (see the figure below). In addition, input from the Colorado Springs planning department can help identify areas that are planned for residential, workplace and retail development, such as at the north and east edges of the city where there is ongoing and potential high density residential and commercial development. In addition to the destination areas noted by ICF's modeling and PlanCOS, PlanCOS also identifies several existing Park-N-Ride locations and transit hubs, as well as planned Smart Corridors and Multimodal Corridors. These locations and corridors should be considered for charging infrastructure.

As the City, Springs Utilities and their partners look to encourage deployment of charging stations throughout the city, they should use the maps and scenarios developed through this plan to prioritize sites most likely to see strong demand for charging. Potential partners could include the Pikes Peak Library District (PPLD), the local school districts, and local businesses. Partner organizations and businesses could survey their employees, patrons and customers to gauge both the amount of demand for charging they could serve and the type of charging that would be most appropriate for their sites. A sample survey is available at the US DOE's Alternative Fuels Data Center.[23] Where survey results suggest a high level of demand, spread across many hours of the day, from EV drivers seeking a high level of charging in a short time (and willing to pay for it), an investment in DC fast chargers may be warranted. Where survey results suggest EV drivers will have their vehicles on site and unused for several hours at a time, level 2 charging stations would be more appropriate and cost effective.

[22] https://coloradosprings.gov/plancos/page/plancos-chapter-five-strong-connections

[23] https://afdc.energy.gov/files/u/publication/WPCC_sample_employee_survey_0816.pdf

Figure 7. PlanCOS Strong Connections Framework



5. Policy Overview and Recommendations

The City of Colorado Springs and Colorado Springs Utilities are well-positioned to help overcome several key transportation electrification barriers by advancing local policies and programs that lay the foundation for future EV growth. By (1) strengthening EV-ready building codes, (2) developing supportive parking and zoning bylaws, (3) streamlining permitting of EV charging equipment, (4) establishing municipal fleet procurement goals, (5) developing EV charger incentives, and (6) incorporating EV load management strategies, Colorado Springs can complement supportive State policies to accelerate the transition toward electric transportation.

The electrification of the transportation sector is a critical strategy for reducing greenhouse gas and criteria pollutant emissions consistent with State and regional goals.[24] Bolstered by a suite of complementary State policies, regulations, and incentives, EVs offer several unique advantages over internal combustion engine vehicles. EVs emit zero tailpipe emissions, have low upstream emissions profiles, can offer significant fuel cost savings relative to gasoline, and can be charged flexibly at homes, workplaces, and other public locations. These emissions benefits are particularly important in disadvantaged communities that have historically faced the brunt of vehicle emissions impacts and other forms of environmental pollution.Also, Colorado Springs is danger of violating the Clean Air Act standard for ozone. If Colorado Springs is designated as a nonattainment area for ozone, the city may have to require mitigation measures such as vehicle emissions testing[25] and business permitting requirements. Increasing adoption of electric vehicles, which emit no pollutants, is one step that will help Colorado Springs maintain healthy air quality, avoid nonattainment requirements and preserve Colorado Springs' reputation for healthy outdoor tourism.

Robust incentives, greater model availability, improved performance, and declining battery prices continue to make EVs a viable and preferable mode of transportation in Colorado Springs. However, several challenges – including the lack of EV charging infrastructure – may hamper EV adoption in Colorado Springs if left unaddressed. Without a reliable source of electric fuel where residents live, work, and play, the region will face hurdles in scaling adoption necessary to reach climate and clean air goals.

While initial efforts by State agencies and EV charging service providers have been vital for establishing EV markets in the region, the City of Colorado Springs and Colorado Springs Utilities have a critical role to play in accelerating transportation electrification: both the City and Colorado Springs Utilities have a suite of policy tools at their disposal to reinforce State EV policies and drive future market growth. This policy framework provides an overview of key local policy areas that address barriers to transportation electrification, identifies applicable State and local EV policies, incorporates examples from other leading jurisdictions – including other Front Range communities – and develops initial policy recommendations for Colorado Springs to advance EV adoption. With careful planning and coordination,

[24] https://energyoffice.colorado.gov/zero-emission-vehicles/colorado-ev-plan-2020

[25] https://gazette.com/news/colorado-springs-area-risks-violating-federal-ozone-standards/article_da2a7a54-0fb4-11e9-8beb-d34db44a8fa1.html

Colorado Springs can establish itself as a regional EV leader and realize the emissions and grid benefits that transportation electrification can provide.

Figure 8. Local EV Policy Areas

Building Codes

Building codes guide building design and prescribe associated electrical infrastructure requirements. Robust building codes that anticipate EV charging needs can significantly reduce the cost of deploying EV charging infrastructure in new buildings and major retrofits.

Policy Significance

To ensure the safe, reliable operation of an EV charger, the appropriate electrical infrastructure must be installed upstream of the charger itself. This infrastructure, commonly known as "make-ready" infrastructure, refers to any conduit, circuits, trenching, panel upgrades, metering, or other electrical equipment needed to support the electricity demands of EV chargers. In many cases, homes, workplaces, and other commercial buildings are built without considering the electrical infrastructure needs of EV chargers. Retrofitting buildings to accommodate EV chargers can be relatively costly: several studies show that necessary retrofits can be 2-8 times more expensive than if the infrastructure was included during building construction.[26, 27, 28] Costs may vary significantly depending on the site's existing electrical capacity but can ultimately deter potential site hosts and EV charging service providers from

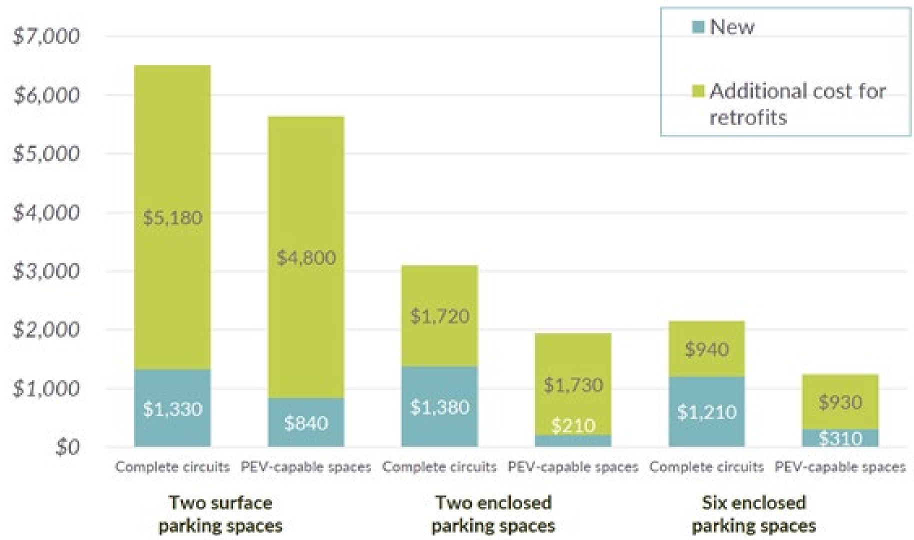
[26]California Air Resources Board, Electric Vehicle Charging Infrastructure: Green Building Standards (CALGreen) Code Suggested Code Changes for Nonresidential Buildings Technical and Cost Analysis, 2015. https://ww3.arb.ca.gov/cc/greenbuildings/pdf/tcac2015.pdf

[27] California Air Resources Board, Electric Vehicle (EV) Charging Infrastructure: Multifamily Building Standards, 2018. https://ww3.arb.ca.gov/cc/greenbuildings/pdf/tcac2018.pdf

[28] Energy Solutions, Plug-In Electric Vehicle Infrastructure Cost Analysis Report for CALGreen Nonresidential Update, 2019. https://caletc.com/wp-content/uploads/2019/10/CALGreen-2019-Supplement-Cost-Analysis-Final-1.pdf

installing EV chargers. The graph below compares the costs of providing EV make-ready infrastructure during building construction versus During retrofits in the City of Oakland,California.[29]

Figure 9. Cost Comparison of Make-Ready Infrastructure: City of Oakland[30]



In short, there is an upfront cost associated with providing the electrical infrastructure necessary to support EV chargers at the time of construction. However, that cost is often significantly lower than the expense associated with retrofitting buildings to accommodate EV charging loads. Supportive local building codes may not only reduce the overall costs of installing EV charging infrastructure but also increase the speed at which future EV chargers can be deployed – further accelerating regional EV adoption.

Current State and City Policy

In April 2020, the Colorado Energy Office (CEO) released the Colorado Electric Vehicle Plan 2020 (the Plan) to outline strategic actions the State will take to increase EV adoption.[31] In the Plan, CEO states it will "support the development of building codes and regulations that encourage the installation of EV charging equipment to meet the vision and goals in the EV Plan."[32] Acknowledging that building codes are adopted at the local level, CEO committed to developing an Advanced Building Code Adoption toolkit to assist local jurisdictions with EV-ready code development.

[29] City of Oakland, City of Oakland Plug-in Electric Vehicle Readiness Grant, January 2020. https://ww2.energy.ca.gov/2020publications/CEC-600-2020-FTD/CEC-600-2020-116.pdf

[30] Source: California Energy Commission

[31] https://energyoffice.colorado.gov/zero-emission-vehicles/colorado-ev-plan-2020

[32] *Id.*

Colorado has not adopted a statewide building code.[33] However, the International Code Council's International Energy Conservation Code (IECC) is widely recognized as the model energy code in the United States and has been adopted by local jurisdictions in all 50 states.[34] To encourage the provision of electrical infrastructure necessary to support EV chargers in new buildings, the IECC has established three terms pertaining to EV-ready building codes: "Electric Vehicle Supply Equipment", "EV capable space", and "EV ready space."[35] The table below explains these terms in greater detail.[36]

Table 3. IECC EV Terms and Definitions

Term	Definition
Electric Vehicle Supply Equipment (EVSE)	The conductors, including the undergrounded, grounded, and equipment grounding conductors, and the Electric Vehicle connectors, attachment plugs, and all other fittings, devices, power outlets, or apparatus installed specifically for the purpose of transferring energy between the premises wiring and the Electric Vehicle.
EV Capable Space	Electrical panel capacity and space to support a minimum 40-ampere, 208/240-volt branch circuit for each EV parking space, and the installation of raceways, both underground and surface mounted, to support the EVSE.
EV Ready Space	A designated parking space which is provided with one 40-ampere, 208/240-volt dedicated branch circuit for each EV parking space, and the installation of raceways, both underground and surface mounted, to support the EVSE.

As noted in the Southwest Energy Efficiency Project's EV Infrastructure Building Codes and Adoption Toolkit, the proposed 2021 IECC contained new provisions to support EV charging in new buildings, though these were ultimately left out of the updated code.Under the proposal, in single- or two-family homes, at least one EV ready space must be made available where parking is provided. In multifamily dwellings (three or more units), two EV ready spaces must be made available, and 20 percent of spaces must be EV capable. Similarly, new commercial buildings with at least 26 parking spaces must have two EV ready spaces and make at least 20 percent of parking spaces EV capable.[37]

[33] https://www.energycodes.gov/status-state-energy-code-adoption

[34] https://energyefficientcodes.org/iecc/#:~:text=The%20IECC%20is%20referred%20to,no%20national%20building%20energy%20code.&text=The%20IECC%20serves%20as%20the,all%2050%20states%20and%20beyond.

[35] https://drive.google.com/file/d/1SasJzGuayKDHKiyqP8SmyEND02MiyeHW/view

[36] For more information on the basics of EV charging technologies, visit https://calevip.org/electric-vehicle-charging-101

[37] https://www.naiopmd.org/2021-energy-code-will-require-ev-infrastructure-in-new-developments/

The Pikes Peak Regional Building Department is responsible for developing the Pikes Peak Regional Building Code – the code that the City adopts. The most recent version of the code was adopted in 2017 and does not include provisions related to EV charging or EV make-ready infrastructure.[38] The next version of the Pikes Peak Regional Building Code is expected to be developed in 2023.

Other Leading Jurisdictions

Several other Front Range communities such as Boulder, Denver, and Fort Collins have already adopted EV-ready provisions in their local building codes. These cities have addressed EV readiness across three key EV charging segments: single-family dwellings, multi-family dwellings, and commercial developments. The table below provides a summary of the cities' EV infrastructure building codes.

Table 4. Front Range EV Infrastructure Building Codes[39]

City	Year Adopted	Building Type		
		Single-family	Multi-family	Commercial
Boulder[40]	2020	1 EV-Ready Space per Unit	5% EVSE Installed, 15% EV Ready, 40% EV Capable (>25 spaces)	5% EVSE Installed, 10% EV Ready, 10% EV Capable
Denver[41]	2020	1 EV-Ready Space per Unit	5% EVSE Installed, 15% EV Ready, 80% EV Capable	5% EV Installed, 10% EV Ready, 10% EV Capable
Fort Collins[42]	2019	1 EV-Ready Space per Unit	10% EV Capable	-

California's green building code, CALGreen, sets requirements for the construction of new buildings in the state and in 2019 it was updated with new minimum requirements for the installation of electrical infrastructure that supports EV charger installations. Effective January 1 2020, the codes require new single-family dwellings to have installed conduit and electrical panel capacity to support the future installation of Level 2 chargers, new multi-family dwellings must have installed conduit and panel capacity to support future installation of Level 2 chargers at a minimum of 10 percent of parking spaces, and non-residential buildings must have installed conduit and panel capacity to support Level 2 chargers

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[38] https://www.pprbd.org/File/Resources/Downloads/Codes/2017%20PPRBC%20V1.0%202nd%20PrintingFINAL3protected.pdf

[39] Note that these codes do not specify whether chargers need to be Level 2 or DCFC. Denver's code allows fewer spaces if at least one is a DCFC.

[40] https://www.swenergy.org/transportatoin/electric-vehicles/building-codes

[41] https://drive.google.com/file/d/1mcJSpvXRuS0V-5pry2FWaZoas67S244X/view

[42] https://www.fcgov.com/building/files/2019-irc-ammendment-supplement-update.pdf?1567101612

at 4-10 percent of parking spaces depending on the total number of spaces available.[43] CALGreen has also established voluntary reach codes that allow cities to further demonstrate their commitment to EVs by exceeding the minimum requirements established in the State's building code. Over 20 California jurisdictions have chosen to adopt these reach codes.[44] The Southwest Energy Efficiency Project has also compiled a table of other leading jurisdictions across the country that have adopted EV infrastructure building codes.[45]

Policy Recommendation

Supportive building codes are a valuable tool for reducing costs and timelines associated with the deployment of EV charging infrastructure. Colorado Springs is expected to experience significant development and population growth over the next several decades – augmenting the importance of establishing strong codes that encourage EV readiness during building construction. In the near term, ICF recommends that the City support EV building code modifications that are at least as ambitious as the City of Boulder's. As the EV market evolves and new information regarding the deployment becomes available, the City may consider supporting new EV infrastructure provisions in future building code cycles.

Parking and Zoning Bylaws

Parking and zoning bylaws influence vehicle parking and EV charging requirements across property types. EV-ready bylaws can provide a flexible approach to increasing EV charging station deployment while reducing costs for the City as development continues to expand.

Policy Significance

City parking regulations and requirements can also encourage EV charging infrastructure installations. Many cities and municipalities have minimum parking requirements that govern the number of spaces that real estate developers need to provide for certain building types. Developers and businesses may be hesitant to deploy charging in new and existing buildings if parking spaces equipped with charging infrastructure are not counted toward minimum parking requirements. Updated parking ordinances that recognize EV charging equipped spaces as parking spaces (and not traditional fueling stations) will create certainty for project developers looking to deploy charging stations at commercial properties. Cities can go further to incentivize EV charging stations in new buildings by allowing EV charging equipped spaces to count as two parking spaces for the purposes of meeting local minimum parking requirements – potentially reducing developer costs associated with zoning compliance. Cities can also potentially use zoning bylaws to establish EV readiness provisions for new developments at a more granular level than the local building code and establish more specific requirements surrounding the provision of EV charging in a given jurisdiction. Cities can also increase access to EV charging by allowing charging stations to be installed in right-of-way locations (e.g., curbside). The majority of EV drivers at this time

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[43] https://businessportal.ca.gov/wp-content/uploads/2019/07/GoBIZ-EVCharging-Guidebook.pdf

[44] *Ibid.*

[45] https://www.swenergy.org/transportatoin/electric-vehicles/building-codes

can charge their vehicles at home, however as the adoption of EVs increases, drivers that do not have access to residential chargers will need access to charging infrastructure.

Current State and City Policy

Parking and zoning bylaws are typically developed and promulgated at the local level. Colorado Springs Department of Planning and Development is responsible for the Comprehensive Plan and Zoning Code that guide the physical development of the city.[46] The City has established a range of minimum required off street parking requirements that vary by building type and square footage. The availability of on-street parking, proximity to transit stations, and proximity to downtown cores can all potentially reduce parking requirements at a given development. EVs and EV charging stations are not specifically referenced in the City's zoning code at this time.[47]

Other Leading Jurisdictions

Front Range communities include varying levels of supportive EV provisions in their parking and zoning codes. The City of Denver, for example, clarifies that EV charging is exempt from the prohibition of fuel sales in various zone districts across the city.[48] The City of Fort Collins permits charging station owners to install designated EV charging signs near chargers, prevents non-EVs from parking in spaces equipped with EV chargers and provides enforcement, and establishes a schedule of fees for use of public charging stations furnished by the local utility.[49] The City of Boulder also establishes similar limitations on the use of spaces equipped with EV chargers.[50]

To ensure that barriers to installation of EV charging are minimized, some cities have clarified that EV chargers are permitted in parking spaces and count toward minimum parking requirements. For example, the City of Pleasanton, California, stipulates that "all of the alternative vehicle parking spaces required…including electric vehicle charging stations, shall be counted toward the off-street parking required by…this chapter" and requires all stations to be marked with signage as well as pavement stencils.[51] Cities can go further to incentivize EV charging stations in new buildings by allowing EV charging equipped spaces to count as *two* parking spaces for the purposes of meeting local minimum parking requirements – potentially reducing developer costs associated with satisfying zoning requirements. For example, the City of Stockton, California, allows parking spaces equipped with EV charging stations to count as two parking spaces for up to 10 percent of total parking required by the local zoning ordinance.[52] Cities can also encourage EV car sharing by modifying parking ordinances to reduce parking requirements when EV car sharing is used on site: for every space designated for car

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[46] https://coloradosprings.gov/planning-and-development/page/planning-development-publications-manuals

[47] https://www.sterlingcodifiers.com/codebook/index.php?book_id=855

[48] https://www.denvergov.org/content/dam/denvergov/Portals/646/documents/Zoning/DZC/Complete_Denver_Zoning_Code.pdf

[49] https://library.municode.com/co/fort_collins

[50] https://library.municode.com/co/boulder

[51] http://qcode.us/codes/pleasanton/view.php?version=beta&view=mobile&topic=18-18_88-18_88_035

[52] https://qcode.us/codes/stockton/view.php?topic=16-3-16_64-16_64_030&frames=off

sharing, the City of Santa Monica allows building developers to reduce their parking requirement by two spaces.[53]

To address concerns of EV charging access in expanding cities, municipalities have begun developing pilot programs for installing charging stations in the right-of-way. For example, the City of Seattle, Washington, recently completed its *Electric Vehicle Charging on the Right-of-Way (EVCROW) Permit Pilot*. This program, designed to provide diverse charging options to meet the needs of an expanding number of EV drivers, was responsible for the installation of two DC Fast Chargers in the right-of-way, while other applications are still being processed.[54] Pilot programs like these are being used to observe challenges and barriers to right-of-way charging installations before developing guidance and policy.[55] For example, the City of Sacramento, California, has found right-of-way construction costs to be high, a major barrier to successful installation.[56] In order to cut costs, cities can also explore innovative right-of-way charging solutions, such as light-pole charging. For example, the City of Los Angeles, California, has already installed EV chargers on over 430 streetlight poles.[57]

Policy Recommendations

Local jurisdictions have considerable discretion to develop supportive bylaws that reduce legal uncertainty and increase efficiency of deploying EV charging stations. Because Colorado Springs is expected to grow rapidly in the coming decades, establishing beneficial codes can ensure that future development accommodates the needs of EV charging service providers, site hosts, and EV drivers. ICF recommends that the City amend their Zoning Code in a manner that:

- Clarifies EV charging stations and the sale of electricity as transportation fuel are exempt from requirements placed on the sale of conventional fuels;
- Clarifies that spaces equipped with EV chargers count toward minimum off-street parking requirements established by the Zoning Code;
- Allows spaces equipped with EV chargers to count as two parking spaces as a mechanism to encourage further EV charging station deployment;
- Reduces off-street parking requirements for residential or mixed use developments with spaces designated for electric shared mobility services;
- Require publicly accessible EV chargers to be designated with signage and appropriate pavement markings;
- Allows the installation of EV chargers in the right-of-way of specific locations, such as urban and commercial centers and parks, in order to serve drivers that do not have access to residential charging; and
- Explores the solicitation and installation of EV chargers in the right-of-way by other partners.

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[53] http://www.qcode.us/codes/santamonica/view.php?topic=9-3-9_28-9_28_180

[54] https://www.seattle.gov/Documents/Departments/SDOT/NewMobilityProgram/EVCROW_Evaluation_Report.pdf

[55] Note this may require coordination with or approval from the Colorado Department of Transportation, depending on who owns the land and/or maintains the road for a proposed charging site.

[56] https://www.cityofsacramento.org/Public-Works/El ectric-Vehicle-Initiatives/Curbside-Charging

[57] http://bsl.lacity.org/smartcity-ev-charging.html

Permitting

Permitting ensures the safe, efficient, and lawful installation of EV charging equipment. Streamlined City permitting processes can markedly reduce implementation timelines and costs as interest in EV charging infrastructure increases across key market segments.

Policy Significance

In virtually all cases, local authorities must issue permits before EV chargers can be installed. Station developers, site hosts, or contractors typically submit permit applications that are reviewed for compliance with building, electric, and fire codes.[58] Public safety and engineering reviews may also be required depending on the jurisdiction. If a permit application complies with all relevant codes and standards, the permit would be approved, and installation can begin. However, if the application is out of compliance, the local authority may ask the applicant to revise their proposed design and documentation prior to approval.

Although permits are important for ensuring that EV chargers are deployed safely and reliable, protracted permitting processes can discourage the installation of EV charging infrastructure and act as a barrier to achieving broader EV adoption goals.[59] These issues are acute for Direct Current Fast Charging projects, which are often more complex and have greater infrastructure requirements than other EV chargers. Streamlined permitting processes can reduce time and financial costs associated with installation, and these processes will only become more critical as more entities seek approval for EV charger deployments as EV adoption in Colorado Springs grows.

Current State and City Policy

Permitting of electrical equipment is typically overseen by local authorities. In the case of Colorado Springs, the Pikes Peak Regional Building Department is responsible for reviewing and approving these permits. Permitting fees are levied based on the value of the project.[60] In some cases, permit applications can be submitted online. However, EV chargers do not appear as an available project type. EV chargers also do not appear on the list of project types that do not require a plan review.[61]

Other Leading Jurisdictions

In single-family and duplex structures, the City of Denver allows appliances and new services rated 200 amps or less to qualify for "quick permits," which can be submitted electronically and do not require plan review. EV charger installations may qualify for this expedited permit.[62] Denver's EV Action Plan[63]

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[58] For more information on CSU's line extension policy and its relation to electric codes, please visit: https://www.csu.org/extrx/util_dev_svcs/svc_standards/electric/chapter/elc_standard_book.pdf

[59] Electrify America, California Cycle 2 ZEV Investments and AB 1236 Permitting Issues, August 28, 2019, presentation. https://efiling.energy.ca.gov/GetDocument.aspx?tn=229618&DocumentContentId=61037

[60] https://www.pprbd.org/Information/FeeSchedule

[61] https://www.pprbd.org/Project

[62] https://www.denvergov.org/content/denvergov/en/denver-development-services/home-projects/quick-permits-exempt-work.html

[63] https://www.denvergov.org/files/assets/public/climate-action/denvervehicleelectrificationactionplan.pdf

identifies an EV Charger Permitting Guide as a potential future action item to streamline the permitting process for entities interested in installing EV charging infrastructure.[64] Boulder County provides a list of all required documentation necessary to submit a complete building permit.[65] Fort Collins outlines a step-by-step process for submitting building permits and has an online "over-the-counter" permitting option that allows for review of residential projects within 72 hours.[66]

Despite deploying more charging stations than any other state, California continues to struggle with streamlining permitting processes at the municipal level. To address permitting issues related to EV charging station installations, California passed Assembly Bill 1236 (AB 1236, 2015), which requires all cities and counties to develop expedited permitting processes for all EVSE "to achieve the timely and cost-effective installation of electric vehicle charging stations."[67] At a fundamental level, cities must issue ordinances that streamline the permitting processes for developers and establish a transparent, online checklist of all requirements needed for a successful permit application. The table below illustrates the core requirements of the legislation.

[64] https://www.denvergov.org/content/dam/denvergov/Portals/779/documents/transportation/DenverVehicleElectrificationActionPlan.pdf

[65] https://www.bouldercounty.org/property-and-land/land-use/building/building-permits/

[66] https://www.fcgov.com/building/res-requirements.php

[67] http://businessportal.ca.gov/wp-content/uploads/2019/07/GoBIZ-EVCharging-Guidebook.pdf

Table 5. AB 1236 Requirements[68]

AB 1236 Compliant	Not AB 1236 Compliant (Challenging to Deploy Charging)
Ordinance creating an expedited, streamlined permitting process for electric vehicle charging stations (EVCS) including Level 2 and direct current fast chargers (DCFC) has been adopted	No permit streamlining ordinance; and/or ordinances that create unreasonable barriers to EVCS installation
Checklist of all requirements needed for expedited review posted on Authority Having Jurisdiction (usually a city or county) website	No checklist for EVCS permitting requirements
EVCS projects that meet expedited checklist are administratively approved through building or similar non-discretionary permit	Permitting process centered around getting a discretionary use permit first
EVCS projects reviewed with the focus on health and safety	EVCS projects reviewed for aesthetic considerations in addition to building and electrical review
Authority having jurisdiction (AHJ) accepts electronic signatures on permit applications	Wet signatures required on one or more application forms
EVCS permit approval not subject to approval of an association (as defined in Section 4080 of the Civil Code)	EVCS approval can be conditioned on the approval of a common interest association
AHJ commits to issuing one complete written correction notice detailing all deficiencies in an incomplete application and any additional information needed to be eligible for expedited permit issuance	New issue areas introduced by AHJ after initial comments are sent to the station developer

To help cities comply with the law, the California Governor's Office of Business and Economic Development (GO-Biz) developed several key resources on charging infrastructure permitting and installation, including a Permitting Electric Vehicle Charging Station Scorecard, which allows users to assess in detail how well different jurisdictions are complying with the law and where cities may be out of compliance.[69] GO-Biz also highlighted examples from leading cities such as Fresno and San Luis Obispo that have fully complied with AB 1236.[70] Additionally, the California Building Officials has also developed toolkits and sample EV charging station permitting ordinances that can assist local jurisdictions in compliance with AB 1236.[71]

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[68] Source: California Governor's Office of Business and Economic Development

[69] https://business.ca.gov/industries/zero-emission-vehicles/plug-in-readiness/

[70] https://business.ca.gov/industries/zero-emission-vehicles/plug-in-readiness/permitting-electric-vehicle-charging-stations-best-practices/

[71] https://www.calbo.org/post/electric-vehicle-charging; click on "documents"

Although AB 1236 does not specify how long permit review should take, GO-Biz has developed a series of best practice timelines based on stakeholder feedback.[72] For single-family residential Level 2 charger projects, one business day for application review and approval is ideal. For example, the City of Los Angeles allows all residential EV charger installations that require less than 400 amps of service to use the City's Express Permit, which allows applicants to receive permits automatically online.[73] For all other Level 2 charger projects and Direct Current Fast Charging projects, five days is identified as best practice.

Policy Recommendation

Given the importance of streamlined permitting processes for the safe and efficient deployment of EV charging infrastructure, ICF recommends that the Pikes Peak Regional Building Department update their permitting practices in line with other leading Front Range jurisdictions and California's AB 1236. Specifically, the City could explore:

- Passing an ordinance that requires streamlined review of EV charger permit applications and requires an online, transparent checklist of all necessary requirements for such applications;
- Clarifying that all EV charger permit applications be submitted electronically;
- Waiving permit requirements or fees for simple projects such as residential Level 2 charger installations;
- Limiting departmental review of EV charger permit applications to solely focus on health and safety criteria, not aesthetics or other discretionary criteria;
- Establishing a permit review goal of less than five business days for all EV charger applications; and
- Offering pre-application meetings with contractors and developers overseeing complex projects to ensure that the permit application is successful.

City Fleet Procurement

If the City seeks to accelerate the use of EVs in the region, it is important that the City lead by example. Although government fleets contain a small fraction of the total vehicle population operating in a given region, they have historically been leaders in the adoption of low-emission vehicles and fuels.

Policy Significance

With direct control over municipal fleets, the City can help reduce emissions, increase adoption of EV technologies, and demonstrate its environmental stewardship to the private sector and the communities they serve. EVs have demonstrated significant potential to reduce emissions from the transportation sector, and the City can accelerate the adoption of EVs through procurements for its own fleet. Establishment of formal procurement targets is directly within local governments' control, providing municipal fleets with firsthand experience owning and operating EVs, and potentially allows for significant fuel and maintenance cost savings over the life of the vehicles.

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[72] https://businessportal.ca.gov/wp-content/uploads/2019/07/GoBIZ-EVCharging-Guidebook.pdf

[73] https://www.ladbs.org/services/core-services/plan-check-permit/types-of-permit-processes/express-permits

Given the availability and performance of light-duty EVs today, local governments can establish near-term EV goals. To bolster the transition to cleaner vehicles and fuels, cities can update procurement guidance to require additional review and justification for the purchase of internal combustion engine vehicles – particularly if the vehicle is intended to operate in or near disadvantaged communities with poor air quality and/or other considerations of environmental injustices and social determinants of health. Medium and heavy-duty EV options are more limited than light-duty EVs but continue to grow rapidly as manufacturers release new models.[74]

Current State and City Policy

The Colorado Energy Office currently offers tax credits for qualified EVs purchased, leased, or converted before January 1, 2026, but these incentives are not available for municipal fleets.[75] However, the Colorado Department of Local Affairs offers an Energy Impact Assistance Fund Grant that offers funding to cover the incremental cost of alternative fuel vehicles for public fleets.[76] The City does not currently have any formal policy specifying the purchase or use of EVs in the municipal fleet, although the City is currently undergoing a fleet assessment to identify suitable vehicles for electrification. There are over 2,000 on-road vehicles in the City's and Colorado Springs Utilities' fleets.

As of June 29, 2020, The State of Colorado is a signatory to the multi-state memorandum of understanding to support the deployment of medium- and heavy-duty ZEVs. Under the Multi-State Medium- and Heavy-Duty Zero Emission Vehicle MOU, Colorado and fifteen other signatory states will strive to make medium- and heavy-duty vehicles account for at least 30% of new sales by 2030 and 100% of new sales by 2050. The MOU says that signatory states will explore coordinated/aggregated purchasing options for public fleet vehicles and infrastructure. The signatory states plan to develop a multi-state action plan to "identify barriers and propose solutions to support widespread electrification of medium- and heavy-duty vehicles."[77]

Other Leading Jurisdictions

Several Colorado cities have adopted formal EV procurement policies to guide vehicle purchase decisions. As of December 2019, the City and County of Denver requires that municipal vehicle replacements be EVs wherever feasible; the City expects that approximately a quarter of its fleet to be electric by 2029.[78] Earlier this year, Denver also reached its 2017 goal of adding 200 EVs to the city's fleet by 2020.[79] The City of Fort Collins adopted its first EVs in 2012 and as of 2018, had 16 EVs in its fleet. The Fort Collins Electric Vehicle Readiness Roadmap establishes a goal of 100% light-duty EV

[74] https://globaldrivetozero.org/tools/zero-emission-technology-inventory/

[75] https://afdc.energy.gov/laws/11702

[76] https://afdc.energy.gov/laws/12007

[77] https://afdc.energy.gov/laws/12458

[78] https://www.denvergov.org/content/dam/denvergov/Portals/779/documents/transportation/DenverVehicleElectrificationActionPlan.pdf

[79] https://www.denvergov.org/content/denvergov/en/mayors-office/newsroom/2019/denver-leading-the-change-with-electric-vehicle-purchases.html

purchases by 2025.[80] Moreover, Governor Polis's *Executive Order D 2019 016* requires the State fleet to reduce GHG emissions by at least 15% by the end of fiscal year (FY) 2022-2023 from a FY 2014-2015 baseline and prioritize the purchase of light-duty EVs.

Other jurisdictions outside of Colorado have adopted aggressive EV procurement goals. For example, the City of Sacramento has established a comprehensive Fleet Sustainability Policy that required a minimum of 50 percent of light-duty vehicles purchased in 2018 to be zero-emission vehicles and a minimum of 75 percent by 2020.[81] Similar to Colorado, California also established an executive order directing state agencies to make 10 percent of new vehicle purchases electric by 2015 and 25 percent by 2020.[82] More recently, California's GO-Biz established a new goal of 100 percent new EV purchases by 2030 with the exception of certain vehicle types.[83]

Many Colorado cities (including Denver, Boulder, Fort Collins, Breckenridge, Manitou Springs, etc.) have also joined the Climate Mayors Electric Vehicle Purchasing Collaborative, a national initiative designed to leverage city fleet procurements to reduce the price of EVs for municipal governments.[84] Participating jurisdictions have committed to purchase more than 3,500 EVs before 2022. Several Colorado cities have also joined a group of GoEV Cities and Counties, setting goals to electrify municipal and private vehicles.[85]

Policy Recommendation

The City and Colorado Springs Utilities should consider several policy options:

- The City and Colorado Springs Utilities should coordinate with the Colorado Energy Office and other relevant state agencies to provide input on the state's plans to implement the Multi-State Medium- and Heavy-Duty Zero Emission Vehicle MOU, especially with consideration for identifying opportunities to leverage funding and price advantages through coordinated action.
- The City and Colorado Springs Utilities should consider setting specific policies, targets and timelines for EV purchases for their own fleets. (This should be coordinated with the fleet assessment they are currently conducting).
- The City and Colorado Springs Utilities should consider joining the Climate Mayors Electric Vehicle Purchasing Collaborative as a means of leverage to reduce the price of EVs for fleet vehicles.

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[80] https://www.fcgov.com/fcmoves/files/cofc-ev-readiness-roadmap.pdf

[81] 6 City of Sacramento, Fleet Sustainability Policy, December 12, 2017. www.cityofsacramento.org/-/media/Corporate/Files/PublicWorks/Fleet/FleetSustainabilityPolicy-00-Policy-Procedure-Cover.pdf?la=en

[82] Executive Order B-16-2012. www.ca.gov/archive/gov39/2012/03/23/news17472/index.html

[83] Governor's Interagency Working Group on Zero-Emission Vehicles, 2018 ZEV Action Plan: Priorities Update, September 2018. https://static.business.ca.gov/wp-content/uploads/2019/12/2018-ZEV-Action-Plan-Priorities-Update.pdf

[84] https://driveevfleets.org/what-is-the-collaborative/

[85] https://www.goevcity.org/

EV Charger Incentives

EV charging station incentives provide funding to mitigate the costs associated with charging infrastructure deployment. Well-designed EV charging station incentives have stable funding streams, meaningfully reduce financial barriers to charging station installations, and incorporate "smart" charging stations that enable data collection.

Policy Significance

The core objective of EV charger incentive programs is reducing the cost of purchasing and installing charging equipment. Rebates should be set at a level that provides a meaningful incentive for prospective charging station owners while encouraging optimal levels of infrastructure deployment with limited financial resources. Charging infrastructure deployment costs can pose a barrier to the growth of accessible charging networks. Estimated hardware costs for public and workplace charging stations are shown below.[86]

Table 6. Public and Workplace Charger Hardware Costs[87]

Level	Type	Per-charger Cost	Total Cost
Level 1 single-charger	Non-networked[88]	$813	$813
Level 2 single-charger	Networked	$3,127	$3,127
Level 2 dual-charger	Networked	$2,793	$5,586
DCFC 50 kW single-charger	Networked	$28,401	$28,401
DCFC 150 kW single-charger	Networked	$75,000	$75,000

Charging station owners must also take into account the cost of installation and make-ready infrastructure needed to support reliable station operation. These costs include, labor, materials, utility service upgrades, permits, and taxes. The table below illustrates typical per-charger public and workplace charging station installation costs.[89] Note that the figures in the table below may underestimate potential installation costs as they are based on historical data and may not include all costs for a particular site.

[86] Nicholas, Michael, *Estimating electric vehicle charging infrastructure costs across major U.S. metropolitan areas*, August, 2019, available at: https://theicct.org/sites/default/files/publications/ICCT_EV_Charging_Cost_20190813.pdf

[87] Source: ICCT

[88] Non-networked chargers refer to chargers that are not connected to a network and cannot send or receive data to or from external sources. Networked chargers, on the other hand, do have this capability.

[89] Nicholas, Michael, *Estimating electric vehicle charging infrastructure costs across major U.S. metropolitan areas*, August, 2019, available at: https://theicct.org/sites/default/files/publications/ICCT_EV_Charging_Cost_20190813.pdf

Table 7. Installation Costs Per EV Charger[90]

Level	Cost Category	1 charger per site	2 chargers per site	3-5 chargers per site	6+ chargers per site
Level 2	Labor	$1,544	$1,827	$1,647	$1,316
	Materials	$1,112	$1,039	$1,272	$874
	Permit	$82	$62	$59	$38
	Tax	$96	$89	$110	$75
	Total	**$2,836**	**$3,020**	**$3,090**	**$2,305**
DCFC 50 kW	Labor	$19,200	$15,200	$11,200	$7,200
	Materials	$26,000	$20,800	$15,600	$10,400
	Permit	$200	$150	$100	$50
	Tax	$106	$85	$64	$42
	Total	**$45,506**	**$36,235**	**$26,964**	**$17,692**
DCFC 150 kW	Labor	$20,160	$15,960	$11,760	$7,560
	Materials	$27,300	$21,840	$16,380	$10,920
	Permit	$210	$158	$105	$53
	Tax	$111	$89	$67	$45
	Total	**$47,781**	**$38,047**	**$28,312**	**$18,577**

These installation costs can vary widely based on the site-specific electrical infrastructure upgrades necessary to support charging equipment.[91] In many cases, however, installation costs comprise a non-trivial portion of total EV charger deployment costs – particularly in the case of DCFC infrastructure.

Current State and City Policy

Colorado has several complementary policies and programs in place to encourage the deployment of EV chargers. CEO, the Regional Air Quality Council (RAQC), and the Colorado Department of Transportation provide grants for eligible EV charging equipment through the ALT Fuels Colorado program.[92] Notably,

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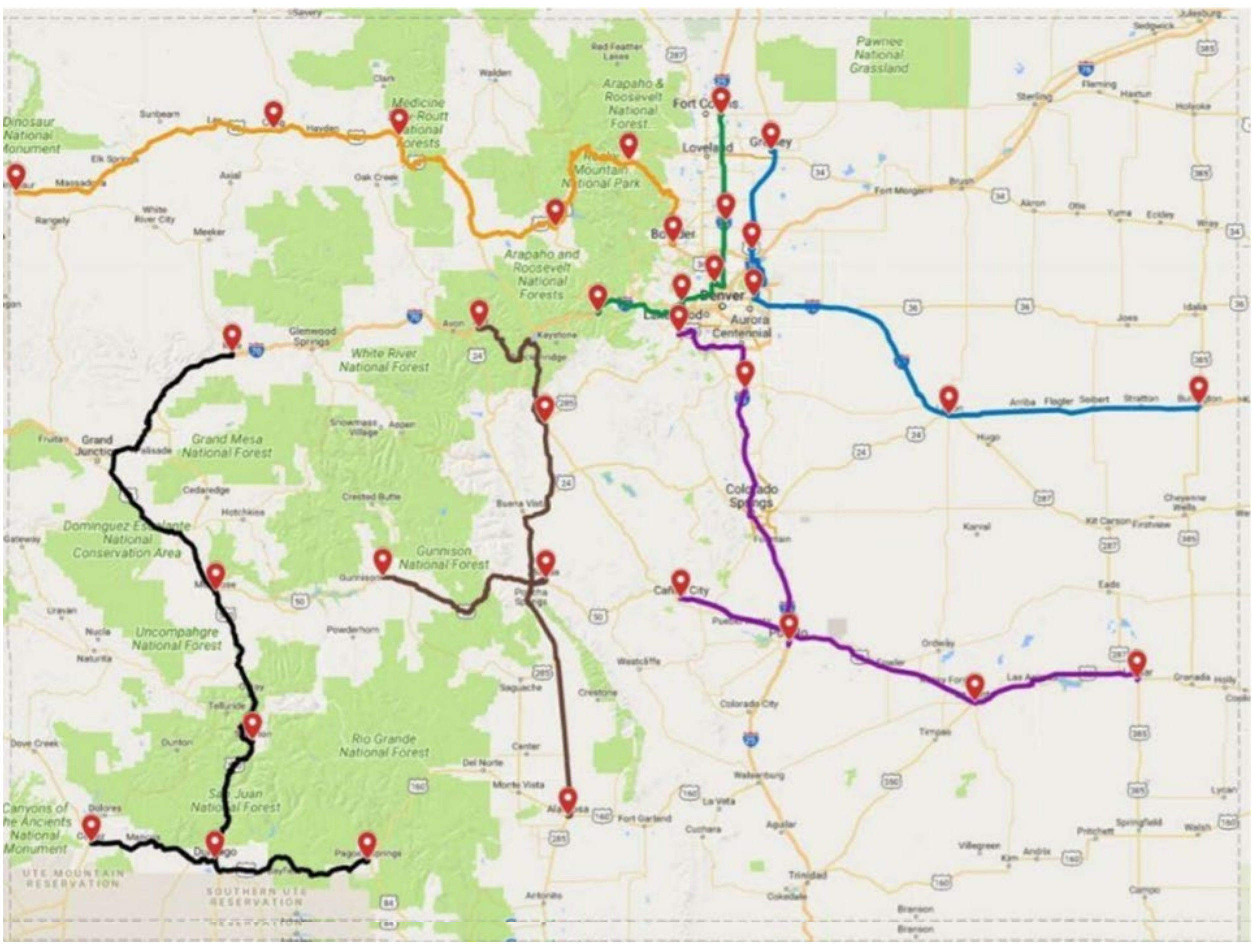
[90] Source: ICCT

[91] Robust EV-ready building codes can help mitigate these costs by requiring the provision of necessary electrical infrastructure during building construction.

[92] https://afdc.energy.gov/laws/11488

the program awarded ChargePoint with a $10.33 million grant to support the deployment of DCFC stations at 33 sites across six key Colorado highway corridors shown in the figure below. CEO and RAQC also jointly administer Charge Ahead Colorado, a grant program that provides funding for community-based Level 2 and DCFC chargers.[93] Established in 2013, the program has supported the development of over 1,000 EV chargers across the state. Colorado's Volkswagen Settlement Beneficiary Mitigation Plan also provides the State with $68.7 million in funds to incentivize use of alternative fuel vehicles and reduce nitrogen oxide pollution from the transportation sector.[94] In response to public comments on the use of the funds as well as the Governor's *Executive Order B 2019 002*, 15 percent of the funds (approximately $10 million), will be allocated toward incentives for light-duty EV charging stations.

Figure 10. ALT Fuels Colorado Planned DCFC Corridor Investments (Source: CEO)



[93] https://energyoffice.colorado.gov/zero-emission-vehicles/charge-ahead-colorado

[94] https://environmentalrecords.colorado.gov/HPRMWebDrawer/Record/1451740/File/document

Colorado Springs has begun to support the deployment of EV charging infrastructure. Colorado Springs Utilities has installed publicly accessible charging stations at four of its facilities.[95] The City and Colorado Springs Utilities have not offered a broader EV charger incentive program to date.

Other Leading Jurisdictions

Utilities, widely viewed as trusted energy advisors, are well-positioned to connect their customers to incentives and information on EV chargers. Many municipal utilities have begun implementing EV charger incentives and similar initiatives to encourage their customers to go electric. As stewards of the grid and providers of electric fuel for EVs, utilities are uniquely positioned to ensure that EV charging infrastructure is deployed in a manner that supports electricity system operations.

Holy Cross Energy (HCE), which serves more than 55,000 customers in Western Colorado, offers free smart EV chargers for residential customers[96] and discounted chargers to commercial workplace customers.[97] In both programs, customers can choose to pay their preferred electrician to install the chargers or have HCE cover the upfront costs that are then recovered on the customer's electricity bill for three years. HCE is also working with CEO on the deployment of DCFC chargers in its service area.

Fort Collins Utilities (FCU) also supported the deployment of public EV chargers around the city, including at municipal parking garages, transit centers, and recreational areas.[98] FCU provides charging services at these stations at a flat rate of $1 per hour.

Gunnison County Electric Association (GCEA) offers their customers several EV charging incentive programs. GCEA offers rebates for 70%, up to $500, for the cost Level 2 home chargers if they sign up for GCEA's time-of-use rate, and will rebate 50%, up to $250 of the installation cost of a Level 2 home charger, regardless of rate plan.[99] They also have a Charge at Home program that offers a free Level 2 home charger and a rebate up to $250 for installation cost in exchange for access to a customer's charging data.[100] GCEA also owns and operates twelve public charging stations in Gunnison and Hinsdale counties, most of which offer free charging. Most of these projects were funded through grants from the Charge Ahead Colorado program and contributions from Towns of Crested Butte and Lake City as well as Hinsdale County, Lake City DIRT, and The Lake City Chamber of Commerce.[101]

Los Angeles Department of Water and Power (DWP), the largest municipal water and power utility in the country, also offers customer EV incentives. DWP's Charge Up LA! Program offers eligible residential customers up to $500 for the purchase of a Level 2 station and $250 for the installation of a dedicated

[95] https://www.csu.org/Pages/ElectricVehicles.aspx

[96] https://www.holycross.com/charge-at-home/

[97] https://www.holycross.com/charge-at-work/

[98] https://www.fcgov.com/utilities/residential/conserve/EVs

[99] https://www.gcea.coop/ev-rebates

[100] https://www.gcea.coop/chargeathome

[101] https://www.gcea.coop/ev-charging

EV meter.[102] Charge Up LA! Also offered up to $5,000 rebates for Level 2 chargers and up to $75,000 rebates for DCFC chargers at commercial sites.[103] The Sacramento Municipal Utility District (SMUD), the nation's sixth largest municipal utility, offers innovative incentives for residential customers purchasing or leasing new EVs: eligible customers can choose between a $599 credit to charge for free at home for two years or a free Level 2 charger.[104] For commercial customers, SMUD offers up to $1,500 per Level 2 charger or $80,000 per DCFC charger.[105] SMUD also has a commercial fleet pilot that provides business incentives for the purchase of EVs as well as an electric forklift incentive for commercial customers.

Beyond California, Austin Energy has established a robust suite of EV programs for customers. The utility offers a rebate of 50 percent of the purchase and installation cost of qualified Level 2 chargers for residential customers up to $1,200.[106] Multifamily customers are also eligible for a 50 percent rebate up to $4,000 for the installation of qualified Level 2 chargers as well as up to $10,000 for the installation of DCFC chargers.[107] Austin Energy's Plug-In Everywhere network also allows customers to purchase a flat monthly subscription for access to over 800 charging ports across the utility's service area.[108] Seattle City Light (SCL) and New York Power Authority (NYPA) have also established similar initiatives to address DCFC charging gaps in their service areas. SCL has installed at least eight utility-owned DCFC chargers across three sites and plans to develop at least four additional sites across the city.[109] NYPA's EvolveNY program is a $250 million initiative to deploy a comprehensive fast charging network across much of New York State.[110] The initial phase seeks to deploy up to 200 DCFC 150 kilowatt chargers at 30 mile intervals along critical interstate corridors along with fast charging hubs at New York City's JFK and LGA airports.

Near-term funding for many municipal utility EV initiatives may come from customer rates. While these programs may lead to marginal increases in customer rates in the near-term, some studies and models predict that additional EV load may put downward pressure on rates for all customers – regardless of whether they drive EVs. By increasing utility revenues and system load factors without commensurate increases in utility costs, off-peak incremental EV load can help mitigate potential electricity rate increases in the long-term by spreading fixed system costs over a greater amount of kilowatt-hour (kWh) sales.[111] While these studies assume that charging occurs in off-peak hours at low power rates, utilities

[102] https://www.ladwp.com/ladwp/faces/wcnav_externalId/r-sm-rp-ev?_adf.ctrl-state=dyghk85pe_4&_afrLoop=183173857111101

[103] https://www.ladwp.com/ladwp/faces/wcnav_externalId/c-sm-rp-commevstation?_adf.ctrl-state=dyghk85pe_4&_afrLoop=183287307434592 Enrollment for Level 2 charging stations is currently closed.

[104] https://www.smud.org/en/Going-Green/Electric-Vehicles/Residential

[105] https://www.smud.org/en/Going-Green/Electric-Vehicles/Business

[106] https://austinenergy.com/ae/green-power/plug-in-austin/home-charging

[107] https://austinenergy.com/ae/green-power/plug-in-austin/multifamily-charging

[108] https://austinenergy.com/ae/green-power/plug-in-austin/charging-station-map

[109] https://www.google.com/maps/d/viewer?mid=1NGNmTvJZaf-RmEFrxNCqmFZvGwSDloGu&ll=47.57130920000003%2C-122.32810150000002&z=10

[110] https://www.nypa.gov/innovation/programs/evolveny

[111] https://www.nrdc.org/sites/default/files/driving-out-pollution-report.pdf

may need to upgrade grid infrastructure to accommodate increased loads if significant EV charging occurs during peak hours at higher rates. The grid impact analysis in this plan projects potential load increases in these scenarios, and the load management recommendations below include incorporation of time of use rates to encourage charging during off-peak hours.

California utilities may also receive funding from the state's Low Carbon Fuel Standard (LCFS), a market-based policy intended to reduce the carbon intensity of California's transportation fuels.[112] EV charging at qualified stations can generate LCFS credits that can then be sold to regulated entities (i.e. refiners), potentially generating revenues for charging station owners. CEO is currently evaluating the feasibility of a similar LCFS program in Colorado.[113]

Policy Recommendations

Municipal utilities in Colorado are beginning to take action to support transportation electrification by encouraging the deployment of charging infrastructure in their respective service territories. To make it easier for Colorado Springs Utilities customers to go electric, Colorado Springs Utilities should establish a comprehensive set of EV programs to accelerate EV adoption, including but not limited to:

- A single-family residential program that provides free or discounted Level 2 chargers to qualified customers;
- A multi-family residential program that provides significant incentives for the purchase of Level 2 chargers for qualified customers;
- A DCFC charger program that supports the deployment of utility-owned L2 and DCFC chargers in publicly-accessible, highly-trafficked areas (e.g. municipal parking garages, recreational areas, grocery stores, shopping cores, etc.); and
- A commercial program that provides significant incentives for the purchase of Level 2 chargers for qualified customers.

EV Load Management

Load management refers to efforts that integrate EV charging onto the grid in a manner that generates benefits for the electricity system and utility customers. Load management policies should be simple for EV drivers to understand, provide adequate incentives to modify customer behavior, and minimize additional equipment costs.

Policy Significance

Left unmanaged, EV charging has the potential to pose challenges to the electricity grid. If EV loads exacerbate local or system peaks, utilities may need to make distribution system upgrades to accommodate new load and procure additional on-peak energy to meet demand. At current levels of adoption, EVs pose little threat to the functioning of the electricity system. However, utilities and grid

[112] https://www.smud.org/en/Going-Green/Electric-Vehicles/Business

[113] http://biomassmagazine.com/articles/16462/colorado-to-evaluate-feasibility-of-an-lcfs-program

operators have already begun to plan how to accommodate additional EV loads and develop strategies to shift EV charging in a manner that responds to grid conditions.

If managed accordingly, EV charging can provide benefits to all utility customers, EV drivers, the grid, and the environment. By charging during off-peak periods when marginal costs to deliver electricity are low, EVs can place additional downward pressure on electricity rates by spreading fixed system costs over a greater number of kWh sales. To encourage this off-peak charging, utilities may offer discounted rates during low-demand periods – magnifying the fuel cost savings EV drivers may experience in comparison to internal combustion engine vehicles. When EV charging occurs during off-peak periods, utilities avoid or defer the need to make distribution system upgrades that can increase rates for customers. Finally, EVs can help integrate renewable energy resources on the grid. For example, wind energy tends to peak during overnight periods when many EVs may be charging at home; moreover, research from the Lawrence Berkeley National Laboratory finds that with the 1.5 million EVs that California expects to have on the road by 2025, the state has the potential to leverage the equivalent of one gigawatt of storage capability to integrate renewable generation and reduce reliance on fossil generation.[114] Colorado has a similar opportunity to take advantage of the energy storage capabilities in EV batteries.

One of the most common strategies to encourage EV load management is the adoption of time of use (TOU) rates, which vary predictably depending on the time of day that electricity is consumed. Rates are typically highest during periods of high demand on the electricity system and conversely lower during off-peak hours when the grid is relatively underutilized. Many utilities offer TOU rates as an option, while a few utilities, including Fort Collins Utilities, use TOU rates as a mandatory default rate for residential customers.[115]

Other examples of rate designs and load management options that encourage off-peak charging include[116]:

- Critical Peak Pricing (CPP) – set a higher rate during pre-identified peak demand events
- Peak Time Rebates (PTR) – reward customers for decreasing their energy usage during similar peak demand events
- Real Time Pricing (RTP) – track the hourly cost of wholesale electricity generation
- Variable Peak Pricing (VPP) – combines elements of TOU and real time pricing

The figure below provides an example of how these options compare to a standard flat electricity rate.

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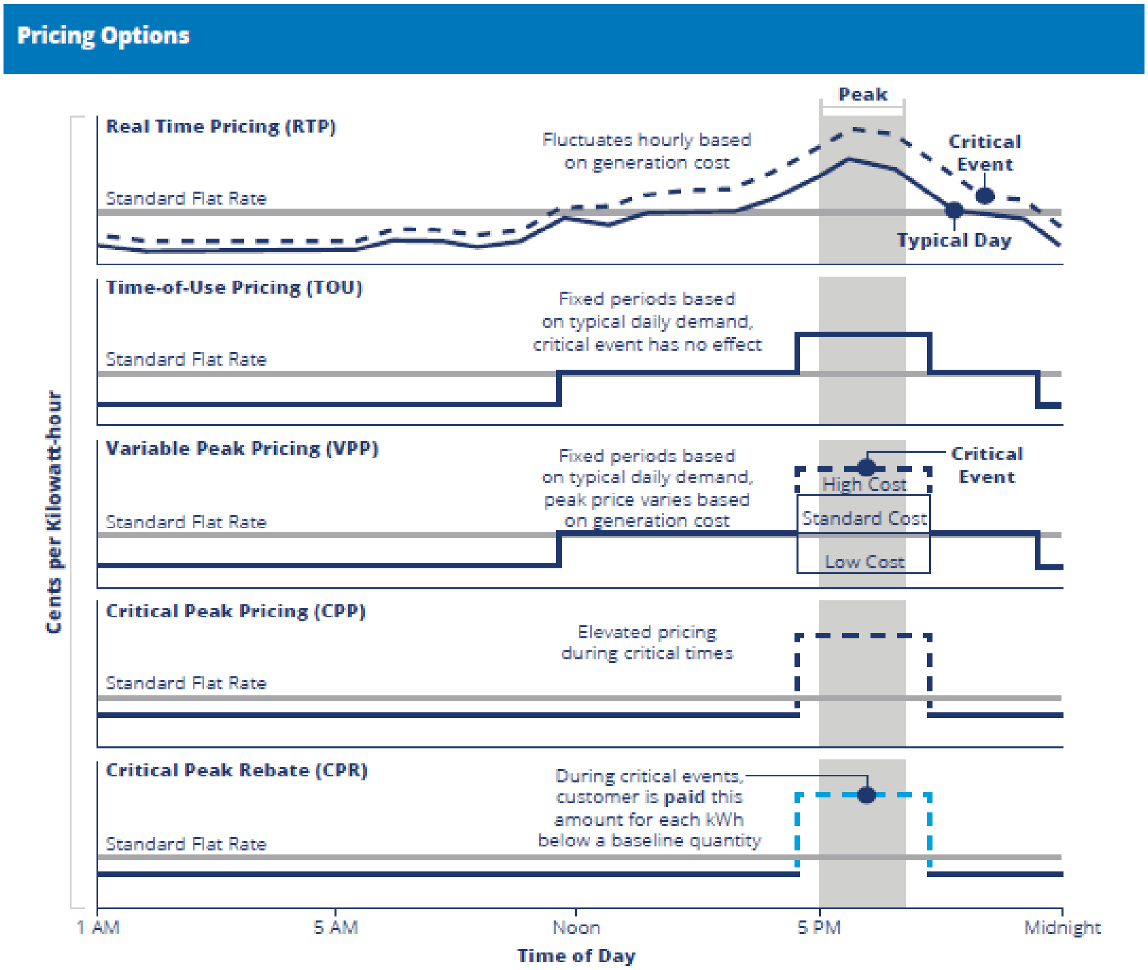
[114] Coignard, Jonathan & Saxena, Samveg & Greenblatt, Jeffery & Wang, Dai. (2018). Clean vehicles as an enabler for a clean electricity grid. Environmental Research Letters. 13. 054031. 10.1088/1748-9326/aabe97.

[115] https://medium.com/getting-it-right-on-electricity-rate-design/tou-takeaways-608d7e5851aa

[116] Smart Electric Power Alliance: https://sepapower.org/resource/residential-electric-vehicle-time-varying-rates-that-work-attributes-that-increase-enrollment/

Figure 11. Illustrative Examples of Time-Varying Rates and Load Management Options[117]



Source: Environmental Defense Fund, 2015 with edits by the Smart Electric Power Alliance.[50]

In addition to these rates, Colorado Springs Utilities may also consider offering a subscription rate, which charges users a monthly fee which covers usage during a defined period and may include additional charges for usage outside of a defined time period. The subscription may include utility control during certain critical events, like critical or dynamic peak pricing.[118]

Current State and City Policy

Load management typically falls on electric utilities, which are regulated either by the PUC or governed by local utility boards in the case of municipal utilities. Colorado Springs Utilities does offer a residential TOU rate (ETR), noting that customers who use more than 750 kWh per month and can shift the

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[117] Source: SEPA

[118] Colorado Springs Utilities should carefully consider the customer experience associated with any rate programs that include utility control of charging. For residential and commercial programs, there should be clear expectations set on how the program will work and how customers can opt-in or opt-out of the program. For public charging stations, signage should indicate that power levels may decrease during critical periods of extreme power demand.

majority of their use to off-peak periods would be ideal candidates for the rate.[119] On-peak periods are 3pm to 7pm in the summer and 4pm to 10pm in the winter. Colorado Springs Utilities also offers time-varying rates for industrial customers and commercial customers.[120] These TOU options cover whole-home and whole-facility loads; they are not specifically targeted for EV applications.

Other Leading Jurisdictions

Many of the municipal utilities that have offered EV charger incentives have also offered accompanying load management options for customers. HCE's Charge at Home program enrolls participating customers in Springs Utilities' Distribution Flexibility Tariff, which allows customers to earn a bill credit based on their participation in HCE's demand response program.[121] DWP also offers residential customers a modest $0.025/kWh incentive to charge EVs during off-peak hours.[122] SMUD EV customers can join the Springs Utilities' Time-of-Day rate, which features off-peak (midnight to noon), mid-peak (noon to 5pm and 8pm to midnight), and peak (5pm to 8pm) periods to encourage drivers to shift their charging.[123] Drivers that register their EVs with SMUD are also eligible to receive an additional $0.015/kWh discount on all EV charging that occurs during off-peak periods. Austin Energy offers an EV360 off-peak charging subscription that allows unlimited charging from 7pm to 2pm on weekdays and anytime on weekends for charging that occurs at home as well as at the Springs Utilities' public Plug-In Everywhere stations.[124] The subscription rate may be as low as $30 per month, and residential electricity usage is measured by a sub-meter at the customer's home.

Load management opportunities are not merely limited to Level 2 stations: SCL's fast charger build-out includes charging fees that reflect system conditions. EV charging that occurs during "Daytime" or on-peak hours of 7am to 7pm Monday through Saturday is billed at approximately $0.32/kWh.[125] Charging that occurs during off-peak hours, however, is billed at $0.17/kWh. While some EV charging will inevitably occur during on-peak periods, creating the right price signals for customers can help shift EV loads to periods that are most beneficial for the grid and the environment.

Policy Recommendation

As the energy provider for the City of Colorado Springs, Colorado Springs Utilities has broad authority to establish rates for EV charging that create benefits for customers. To ensure that EV charging loads enhance system flexibility and reliability Colorado Springs Utilities should consider:

- Creating incentives or requirements to shift more (or all) customers to residential TOU rates (including subscription rates with TOU elements);

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[119] https://www.csu.org/pages/electric-tou-r.aspx

[120] https://www.csu.org/Documents/ElectricTariff.pdf?csf=1&e=VqAeSg

[121] https://www.holycross.com/wp-content/uploads/2019/06/Electric-Service-Tariffs-Rules-and-Regulations-amended-14May2019-CLEAN_a.pdf#page=38

[122] https://afdc.energy.gov/laws/6142

[123] https://www.smud.org/en/Rate-Information/Time-of-Day-rates/Time-of-Day-5-8pm-Rate/Rate-details

[124] https://austinenergy.com/ae/green-power/plug-in-austin/home-charging/ev360

[125] https://energysolutions.seattle.gov/wp-content/uploads/Public_EV_Charging_FAQ_Handout.pdf

- Refining existing residential TOU rates to create three time periods, with a super off-peak option that would encourage overnight charging;
- A demand response program that rewards residential customers for responding to demand response signals from Colorado Springs Utilities during peak events;
- Providing a partial demand charge credit for commercial or industrial customers that provide EV charging at their facilities; and
- A schedule of charging fees for Colorado Springs Utilities-owned DCFC chargers that rewards off-peak EV charging.[126]

The City and Colorado Springs Utilities have a range of policy tools at their disposal to reinforce State level EV policies and facilitate the growth of the local EV market. By improving building codes, parking and zoning bylaws, permitting requirements, municipal fleet procurement, EV charger incentives, and EV load management strategies, Colorado Springs can lay the foundation for transportation electrification that supports EV drivers, local organizations, and the EV charging industry.

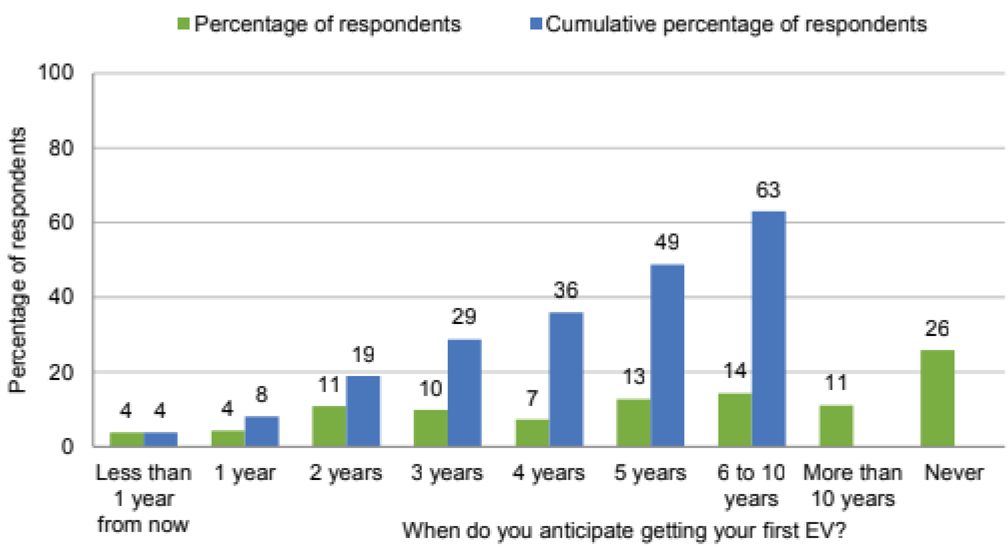
[126] This option is contingent upon the development of utility-owned DCFC chargers.

6. Outreach and Education Recommendations

The City and Colorado Springs Utilities convened a Stakeholder Advisory Committee to provide input and feedback on the development of the Electric Vehicle Readiness Plan. As part of the project team's engagement with this group, ICF conducted a small survey to identify key barriers and drivers to EV adoption in Colorado Springs. Though the sample size was small (12 respondents), the results were similar to a customer survey conducted by Colorado Springs Utilities and a statewide survey conducted by the Colorado Energy Office (CEO).[127]

One key finding from all three surveys is that there is substantial interest in purchasing EVs. In the CEO survey, 29% of the respondents said they expected to purchase an EV in the next one to three years, and another 63% of respondents said they planned to purchase an EV within the next ten years. Only 26% of respondents said they had no plans to purchase an EV. [128]

Figure 12. Survey Results: When Do Respondents Plan to Purchase an EV[129]



Base: Non-EV owners. © E Source (Colorado Energy Office EV Awareness Study)

The EVRP survey found similar results, with half of the respondents expecting to purchase an EV within 3 years.

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[127] Colorado Energy Office: Electric Vehicle Awareness Market Research. Education and Awareness Roadmap Final Deliverable. E Source. June 30, 2020.
https://drive.google.com/file/d/15dmFXJ5RLT2U2Mc3b1Cfqu8xOTrCqAAi/view

[128] Ibid.

[129] Ibid.

Figure 13. Survey Results: Barriers to EV Adoption[130]

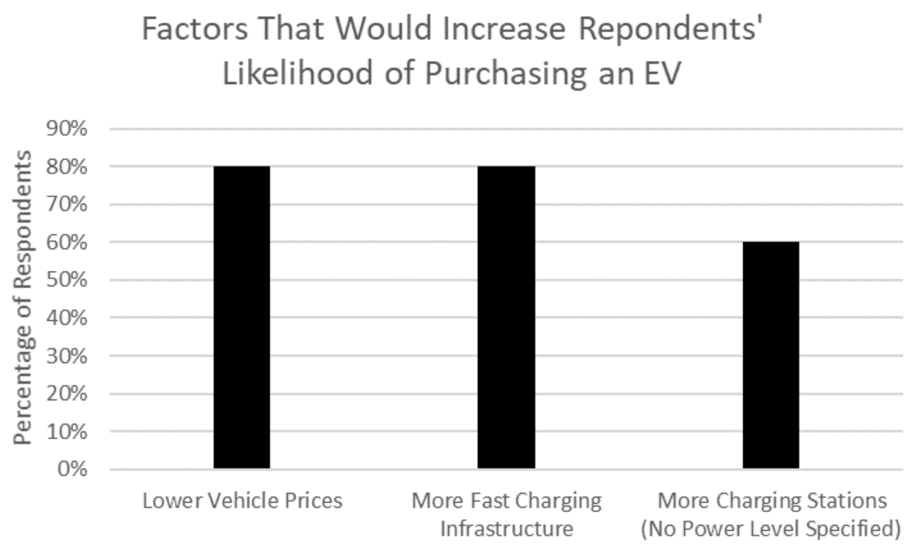
Statement	Percentage of respondents giving a 4 or 5	Percentage of respondents giving a 1 or 2
I'm worried the car will run out of charge before reaching my destination	67	11
The up-front cost of buying an electric vehicle is too high	64	11
I don't know if EVs have the main features I need	48	23
I don't have anywhere to charge an electric vehicle at home	46	27
I won't be able to drive an electric vehicle to (or in) the mountains	42	24
I'm not sure how to charge an electric vehicle	41	29

Base: Non-EV owners. **Question:** On a scale of 1 to 5, where 1 = strongly disagree and 5 = strongly agree, how much do you agree with each of the following statements regarding what's standing in your way of getting an EV the next time you get a car? © E Source (Colorado Energy Office EV Awareness Study)

[130] Colorado Energy Office: Electric Vehicle Awareness Market Research. Education and Awareness Roadmap Final Deliverable. E Source. June 30, 2020. https://drive.google.com/file/d/15dmFXJ5RLT2U2Mc3b1Cfqu8xOTrCqAAi/view

Similarly, the EVRP stakeholder survey found that seven out of ten respondents noted vehicle costs and lack of charging stations as barriers to EV adoption, and five noted vehicle range as an issue. Similarly, eight of ten surveyed for the EVRP noted that lower vehicle prices and more fast charging infrastructure would increase the likelihood of their purchasing an EV. Six of ten noted more charging stations without specifying charging level.

Figure 14. Survey: Factors That Would Increase Respondents' Likelihood of Purchasing an EV



The Colorado Energy Office similarly identified range anxiety (concern the EV will run out of charge before reaching its destination) and vehicle price as the top two barriers to EV purchases. The Colorado Springs Utilities survey similarly had multiple comments from customers noting they would purchase an EV if they could afford one. These similar sets of results suggest that an outreach and education strategy should address vehicle cost and charger availability.

The City and Colorado Springs Utilities and their partners should include messaging to encourage consumers to consider the total cost of ownership when comparing the cost of an electric vehicle to a gasoline or diesel vehicle. Many electric vehicles have lower annual operating costs due to lower electricity costs versus fuel costs and lower maintenance costs. Those lower operating costs may more than offset the initial capital costs of electric vehicles, especially once federal and state tax incentives are factored in. The US Department of Energy's Alternative Fuels Data Center (AFDC) and Edmunds.com both include cost calculators[131] that factor in the total cost of ownership to compare electric vehicles to gasoline or diesel vehicles.

Outreach and education efforts should also highlight the growing network of public chargers in and around Colorado Springs to vehicle drivers. The AFDC's station locator[132] and plugshare.com are both examples of websites that help drivers find location, type, and availability of public charging stations.

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[131] https://afdc.energy.gov/calc/, https://www.edmunds.com/tco.html

[132] https://afdc.energy.gov/stations/#/find/nearest

In particular, the City and Colorado Springs Utilities should partner with the Colorado Energy Office (CEO) as it develops a multi-year EV education and awareness campaign, which will include toolkits for local governments and utilities. The CEO released the Colorado Electric Vehicle Education and Awareness Roadmap on August 4th, 2020, which identifies the types of information consumers require prior to EV purchase. It includes a review of nationwide EV studies regarding consumer awareness and barriers to adoption and a survey of two-thousand Colorado citizens.[133] Key findings of the roadmap include:

- Range anxiety exists, but respondents may have misconceptions about charging equipment and availability;
- Forty-five (45) percent of respondents were aware of federal EV tax credits and only 22 percent were aware of state tax credits;
- As ICF's survey found, most people are open to purchasing an EV;
- A large majority of early market adopters see environmental benefits as an important element of EV purchase;

The following contains general guidance on education and outreach strategies that can be used by the City and Colorado Springs Utilities to educate and promote EV adoption.

[133] Colorado Energy Office. (2020, August 4). Colorado Releases Electric Vehicle Education and Awareness Roadmap. In Colorado Energy Office. Retrieved from https://energyoffice.colorado.gov/press-releases/colorado-releases-electric-vehicle-education-and-awareness-roadmap

Key Messages to Communicate about EVs

- Promote affordability of EVs compared to internal combustion engine (ICE) vehicles fueled by gasoline or diesel. Encourage consumers to consider the total cost of ownership (TCO) when comparing EVs to ICE vehicles, and direct them to TCO calculators such as the ones available on U.S. Department of Energy's Alternative Fuels Data Center and Edmunds.com. [134]
- Identify the locations of public chargers currently available in and around Colorado Springs and highlight that the network of public chargers is expected to grow.
- Develop and provide EV Charging 101 educational materials. Consider different tactics and mediums for developing this material, such as through fact sheets, email campaigns, and videos. Consider developing a series of educational materials about EVs and EV charging.
- Highlight the federal and state tax credits for EVs and explain that the Colorado State EV tax credit is one of the highest in the nation.
- Develop a publicly available list of all EV and EVSE incentives available to Colorado Springs citizens and businesses.
- Focus on the environmental benefits of EVs compared to ICE vehicles, especially in marketing to expected early adopters. For mid-to-late market adopters, include messaging on environmental benefits but focus also on pragmatic items such as vehicle cost, reliability, and performance.
- Inform community members which dealers in Colorado Springs currently offer EV models and which ones are expected to in the near future. Consider partnering with dealers to promote EVs together through events such as ride and drives and educational events.
- Explain what home charging entails, including what equipment is required, what the actual costs are, and what processes homeowners should expect. Promote process simplicity, reliable equipment performance, and expected cost benefits.
- Continually share information on EV model availability as it continues to grow and be mindful of the vehicle needs of different audiences.

Target Audiences to Consider for Education and Outreach Efforts

There are several target audiences to consider when developing and implementing education and outreach efforts. Importantly, key objectives, messages, and tactics will vary as audiences change. Consider the following audiences when pursuing EV education and outreach.

- Vehicle Drivers / Commuters
- Homeowners
- Homeowners Associations
- Multi-Family Housing Tenants

[134] https://afdc.energy.gov/calc/, https://www.edmunds.com/tco.html

- Multi-Family Housing Owners/Managers
- Commercial Building Owners/Managers
- Building Developers
- Business Owners
- Schools, Colleges, and Universities
- Car Dealerships
- Commercial Fleets
- Potential EV Charging Investors, Owners, and Site Hosts
- Other Local and Regional Government Agencies and Offices
- Vulnerable Communities

Channels and Tactics for EV Education and Outreach

There are a number of education, outreach, and marketing channels and tactics available to the City and Colorado Springs Utilities, including the following.

- Websites, including those belonging to the City and Springs Utilities
    - Consider developing and promoting a "one-stop shop" website for EV and EV charging information
- Social media
- Direct training and technical assistance
- Webinars
- Educational or promotional videos
- Education and outreach materials, such as fact sheets, case studies, infographics, checklists, and frequently asked questions (FAQs)
- Direct engagement at existing meetings (e.g., community meetings, board meetings)
- Physical showcases
- Recognition programs
- Consider partnering with dealers to promote EVs, develop key educational materials that cover the concerns which local community members have (such as cost, charging infrastructure, and range anxiety), and to develop a good experience for prospective buyers
- EV "ride-and-drive" events and EVSE demonstrations

Key Considerations for Disadvantaged Community Audiences

Low-moderate income and vulnerable communities typically have less access to EVs and EVSE. Like all other audiences, such communities and their members will have their own set of questions and concerns surrounding EVs. Additional items should be considered when conducting education and outreach efforts with these groups. Consider the following when connecting with vulnerable communities:

- Translate materials into multiple languages as needed
- Engage with vendors to translate sales materials
- Plan outreach at locations where these community members already meet
- Educate the audience on why and how the topic of EVs and EVSE is relevant to them, including benefits such as emissions reduction, improved mobility[135], and lower cost of ownership.
- Describe federal and state incentives for EV adoption and EVSE installation, especially those prioritizing investment and programs in disadvantaged or underserved communities.[136]
- Highlight less costly ways to own, operate, or ride an EV and access EVSE, such as:
    - Purchasing a used EV
    - Participating in an EV carshare or rideshare program where available
    - Utilizing public EVSE
    - Utilizing EVSE available in multi-unit dwellings
    - Taking advantage of EVSE purchase incentives from Springs Utilities and other entities
- Explain Colorado's "Right-to-Charge" laws (Senate Bill 13-126)[137], which protects tenants that wish to install EVSE on leased premises Senate Bill 13-126

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[135] EV carshare and rideshare programs offer an opportunity to enhance low- to no-emission mobility options for underserved communities, such as Denver's Electric Car Share program as an example (https://www.denvergov.org/Government/COVID-19-Information/Public-Health-Orders-Response/News-Updates/2021/Electric-Car-Share). Programs designed as first- and last-mile programs may do so by deploying nodes at or near transit stops to provide more complete transportation networks.

[136] Xcel Energy's $110 million Transportation Electrification Plan devotes a minimum of 15 percent of all funding to low-income customers and underserved communities. (https://www.nrdc.org/experts/miles-muller/colorado-approves-110m-transportation-electrification-plan)

[137] Concerning The Removal of Unreasonable Restrictions on the Ability of the Owner of an Electric Vehicle to Access Charging Facilities, SB 13-126, 69th General Assembly. (2013). https://leg.colorado.gov/sites/default/files/images/olls/2013a_sl_165.pdf

Key Elements of the Colorado Energy Office's EV Awareness and Education Roadmap

The Executive Summary of the CEO's statewide EV Awareness and Education Roadmap includes a list of key elements and goals that entities within State should consider when conducting EV education and outreach. The figure below summarizes those key elements.

Figure 15. Key Elements of the Colorado Energy Office's EV Awareness and Education Roadmap (Adapted from Roadmap)[138]

Awareness — Ambient triggers to consider an EV

- Instill belief that charging is easy and available
- Promote Colorado's EV tax credit as one of the highest in the country
- Promote EVs as a lifestyle that fits Coloradans
- Highlight environmental benefits of EVs and connect them to clean energy
- Push people to the website for detailed information

Consideration — Explore if an EV is worth pursuing

- Demonstrate how to charge at home and on the go
- Show EV models at affordable prices and highlight a variety of models for each lifestyle
- Provide specific advice on how to choose between a battery EV, plug-in hybrid, and ICE vehicle
- Create video case stories that can be shared on social media and at EV demonstrations

Evaluation — Determine which EV is best

- Develop a Colorado-specific advisory website that drives people through to purchase
- Focus on providing intelligent advice for specific needs instead of providing lots of information
- Include calculators for total ownership costs, user stories, and a specific "how to change" video and description

[138] E Source. (2020). *Executive Summary: Electric Vehicle Market Research, Consumer Journey, & Education and Awareness Roadmap*. Colorado Energy Office. https://drive.google.com/file/d/1ol8Hsfw-zdmVc-Sq7f9iiYVn3NEoo6Rv/view

7. Fleet Operational Analysis

Both the City of Colorado Springs Fleet (City) and Colorado Springs Utilities (Springs Utilities) have many vehicles that fit within the operational profiles of an electric vehicle. The purpose of this section is to highlight the opportunities to transition fleet vehicles to EVs across different vehicle segments for both fleets. The results are further refined by City versus Springs Utilities, Using Department, and Vehicle Segment.

Across all vehicle classes we do expect that there are, or will be very soon, commercially available electric vehicles. In all cases, our analysis and recommendations are based on vehicle specifications published by various manufacturers across different vehicle classes where an expected electric drivetrain may be available in the next couple years. However, the near-term ability to purchase or lease these vehicles in the estimated specification is unknown. They are used here as a refence point to gauge potential availability of electric drivetrains in different vehicle segments and classifications. Outside of the sedan class, there is a distinction between recommendations based on commercially available vehicle configurations and an optimal vehicle configuration based on the City's and Springs Utilities' actual driving habits.

Methodology

Telematics trip data from Verizon was analyzed to identify each individual vehicles' fit with an EV. This trip data covered July 1, 2019 through June 30, 2020 and therefore represents a "snapshot" in time. Telematics data was available for 335 out of 2,872 (12%) City fleet vehicles and 611 out of 2145 (28%) Utilities vehicles. The operational needs of City and Springs Utilities are reflected over a 12-month time-period with the hopes that the data would reflect the range of normal and emergency operating conditions across four seasons. This timeframe may not capture the full range of potential driving requirements Colorado Springs Utilities may need to respond to in extreme emergency situations spanning multiple days. As such, Colorado Springs Utilities should develop plans to provide DC fast charging for those vehicles that would require round-the-clock operation during emergencies. In addition, due to the COVID-19 pandemic, 2020 has been anything but normal. Where possible, the initial quarantine timeframe experienced due to COVID-19 is highlighted in the analytics. This topic is covered in more depth in the operational section.

Both fleets are broken down into eleven vehicle segments; each segment has a base electric vehicle that the operational data is compared against. These segments are listed in Table 8. In these comparisons, if the operational needs of a vehicle do not fit with the base model, a recommendation is made to move up into a larger battery size. For example, from the 40 kWh Nissan Leaf to the 62 kWh Leaf. A full list of electric vehicles considered is available in the appendix.

The EV operational analysis is based on a handful of key metrics sourced from the Verizon telematics data which includes the following key data fields: timestamp, speed, vehicle miles traveled (VMT), latitude and longitude. From these base fields we are able to calculate a number of items critical to understanding the potential viability of an EV for both fleets. This includes fields like trip length, trip duration, and estimated fuel/energy use. In the content below, examples of the analytics used are presented for Sedans only to keep this report concise, but the same analytics were completed for all vehicle segments and will be made available to both fleets in an online platform.

Table 8. Vehicle Segments and Base Electric Vehicles

Vehicle Segment	Example Fleet Vehicle	Base Electric Vehicle	Number of City Vehicles With Telematics	Number of Utilities Vehicles With Telematics
Sedan	Ford Focus Toyota Prius	Nissan Leaf 40 kWh	9	2
SUV	Ford Escape Ford Explorer	Hyundai Kona 64 kWh	26	47
Pickups – Light	Ford Ranger Dodge Dakota	Lordstown Endurance 109 kWh[139]	11	8
Pickups – ½ Ton	Ford F-150 Chevrolet 1500	Lordstown Endurance 109 kWh	97	116
Pickups – ¾ Ton	Ford F-250 Chevrolet 2500	Lightning Systems E-450 86 kWh	45	54
Pickups – 1 Ton	Ford F-350 Chevrolet 3500	Lightning Systems F-550 122 kWh	24	131
Pickups – 2 Ton	Ford F-450 Ford F-550 Dodge Ram 5500	Lightning Systems Ford F-59 122 kWh	37	75
Vans	Ford Transit Ford E350 Freightliner MT45	Lightning Systems Ford Transit 43 kWh	19	31
Medium-Duty Trucks	International 7400 Kenworth T300	Lightning Systems Chevrolet 6500XD 122 kWh	18	43
Heavy Duty Trucks	Freightliner 114 International 7600 Mack CV713	Freightliner eCascadia 475 kWh	47	104
Busses	IC Bus CE Series (School Bus)	Bluebird Electric School Bus 155 kWh	2	0
TOTALS			335	611

First is a comparison of vehicle miles traveled (VMT) for each vehicle relative to the expected range of the base electric vehicle. The top plot in Figure 16 shows the distribution of VMT versus hours driven per day for sedans in the City fleet. The colors represent each individual vehicle; hours driven are used on the x-axis to give a sense of the time a vehicle is being driven versus time available for charging. This will be discussed in greater length in the section on charging needs. Both the range calculations and the kWh estimates are broken down into the "sticker" estimates of the vehicles range as well as the estimated

[139] At the time of writing this report, Lordstown Motors had multiple lawsuits filed by investors citing fraud. The Fleet Operational Analysis conducted by ICF was completed prior to learning about these lawsuits.

range of the vehicle on a 20° Fahrenheit day to account for decreased battery capacity and driving range of a vehicle operating in the cold.[140] This is referred to as the "cold threshold" throughout.

Second is a comparison of the estimated kilowatt-hour (kWh) needed to power the vehicle to achieve those miles. kWh estimates are based on each vehicle's actual driving, speed and mileage. As with driving range, kWh estimates are shown relative to the sticker and estimated cold battery capacity of the comparison vehicle. In these comparisons, both are based on the "usable" battery capacity of the vehicle, which across all classes is vehicles is estimated at 95% of sticker battery capacity to account for the fact that even under ideal conditions using 100% percent of the battery is not possible. The bottom plot in Figure 16 shows the distribution of estimated kWh use versus VMT.

It is important to note additional information on vehicle operations that may impact either fleet's decision to acquire and EV but which were not included in the analysis. This analysis does not, for example, include any information relative to a vehicle's particular job function, nor does it factor in the use of auxiliary equipment drawing power from a vehicle. Some data supporting these details may be available and some may be anecdotal, but this level of detail was not within the scope of this effort. Additionally, the analysis does not account for other vehicle functions like carrying passengers, towing, hauling equipment in truck beds, etc. One exception would be vehicle idle time, where the engine is on but the vehicle is not moving. This is accounted for in the estimated kWh usage. These additional factors should be considered in any final decisions on whether any particular vehicle with an EV.

Both comparisons are made on a daily and weekly basis. The logic behind this segmentation is to understand where a vehicle could complete either its daily or weekly driving needs on a single charge and similarly, how often it would then need to charge (daily versus weekly) to meet its operational needs. In many cases, vehicles can complete all of their weekly driving needs on a single charge. The results of this part of the analysis are shown in Figure 16 where weekly VMT per vehicle is on the top plot and weekly estimated kWh use per vehicle is on the bottom. In both plots, cold weather months (Nov – Mar) are shown in grey to illustrate where vehicle use falling into the "cold range" may have an impact on vehicle operations.

[140] A threshold to account for decreased battery capacity and driving range of vehicles on a 20° F day. This is as compared to the sticker threshold of the vehicle, or the battery capacity and range as advertised by the manufacturer and assuming operations at an 'ideal' temperature of 72° F.

Figure 16. Daily Driving in terms of VMT and estimated kWh use for Sedans within the City fleet

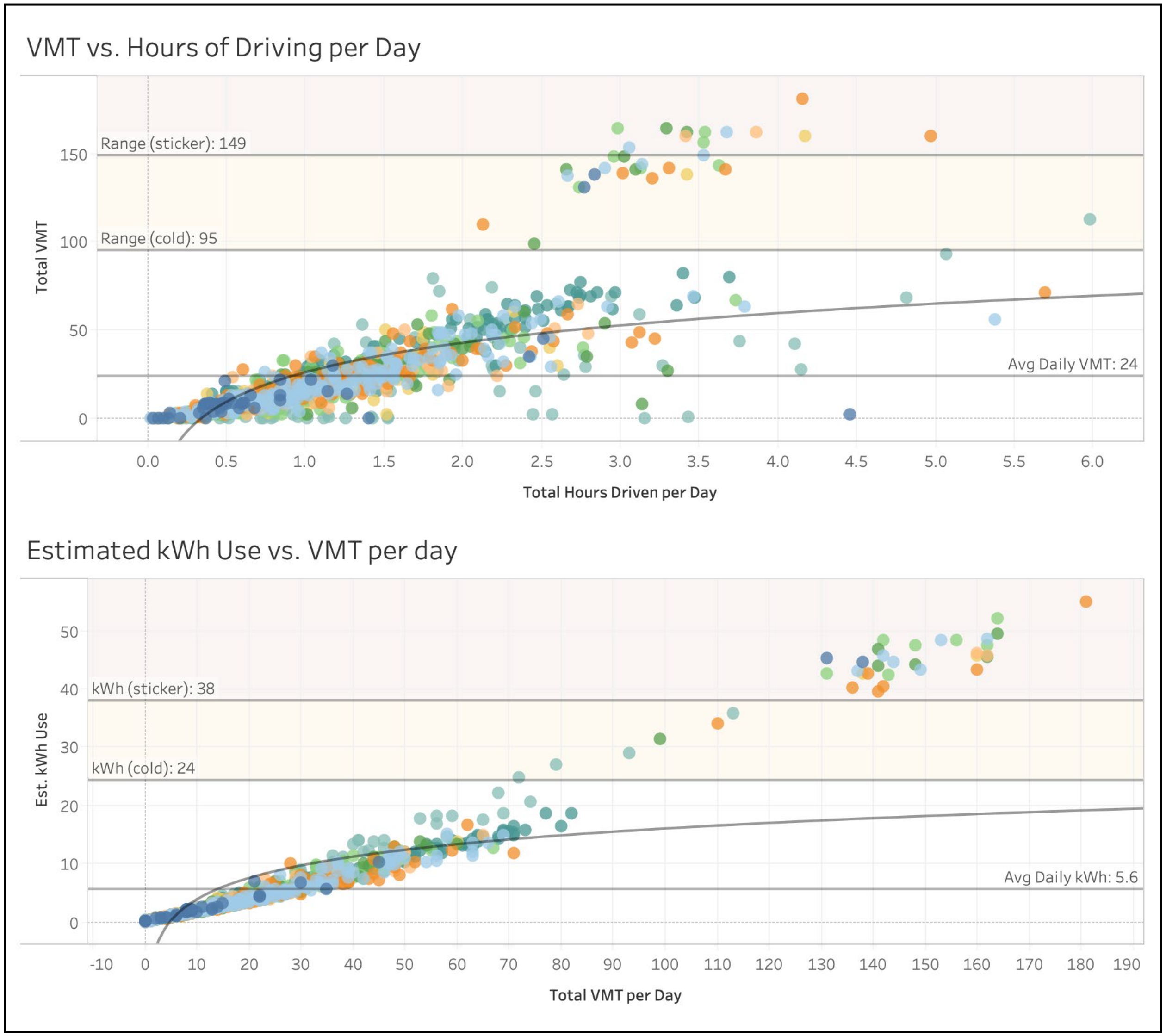
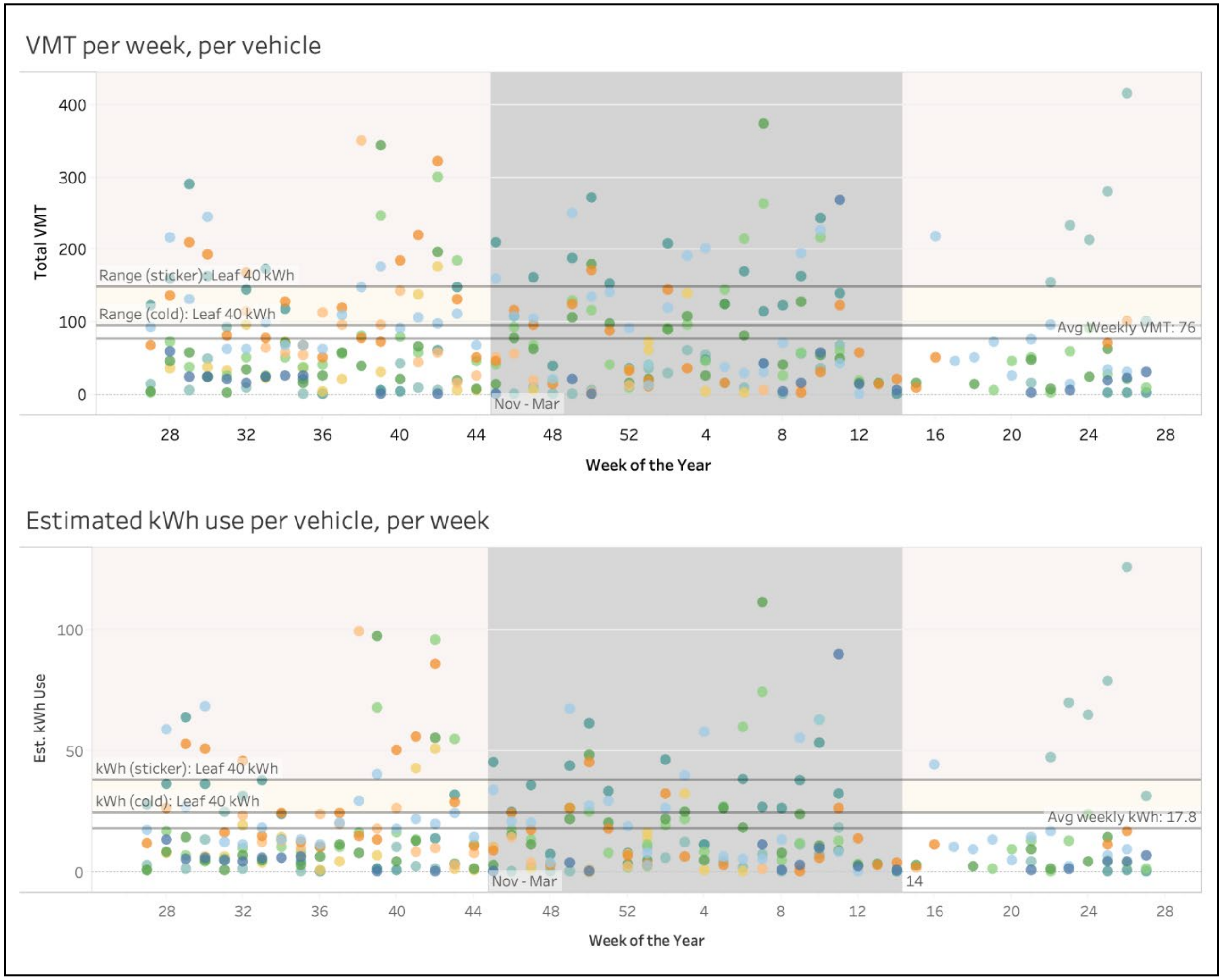


Figure 17. Weekly Driving in terms of VMT and estimated kWh use for Sedans within the City fleet



Sedans

The base vehicle used in this analysis is the Nissan Leaf with an estimated 40 kWh engine and an estimated range of 150 miles and an expected price of $31,600. A summary of the EV operational analysis for Sedans is in Table 9. The City has 9 sedans accounting for 1,012 vehicle-days of observed operation and 317 vehicle-weeks. Springs Utilities has 2 sedans accounting for 133 vehicle-days of observed operation and 60 vehicle-weeks. All 11 vehicles are well suited for replacement with an electric vehicle. 96% of all driving days can be served by a 40 kWh Nissan Leaf, but there are two vehicles that exceeded these parameters with some regularity. The recommendation is that Springs Utilities replace both sedans with 40 kWh Nissan Leaf and the City replace 7 vehicles with a 40 kWh Nissan Leaf and 2 vehicles with a 62 kWh Nissan Leaf. This will ensure that there are some days on which a vehicle with a larger battery capacity is available.

Table 9. EV Suitability Analysis results for Sedans

Daily Metrics	City (9 sedans)	Utility (2 sedans)
Avg. VMT	24	15
Max VMT	181	95
Days over EV Range	12 (1.2%)	0 (0%)
Days in Cold Range	21 (2.1%)	0 (0%)
Avg. Est. kWh	5.6	3.6
Max Est. kWh	55.1	30.7
Days over Battery Capacity	30 (3.0%)	0 (0%)
Days in Cold Battery Capacity	6 (0.6%)	0 (0%)
Weekly Metrics		
Avg. VMT	76	33
Max VMT	416	184
Weeks over EV Range	48 (15.1%)	3 (5.0%)
Weeks in Cold Range[141]	50 (7.9%)	1 (1.7%)
Avg. Est. kWh	17.8	8.0
Max Est. kWh	125.5	59.7
Weeks over Battery Capacity	42 (13.2%)	2 (3.3%)
Weeks in Cold Battery Capacity[142]	22 (6.9%)	1 (0.3%)

[141] Only counts weeks that fall between November and March.

[142] Only counts weeks that fall between November and March.

SUVs

There is currently only one electric vehicle available in a “fleet” type vehicle, though it is not a “typical” fleet vehicle. We do expect that more SUV models will become available in the next model year or so, and they will likely be more readily available to fleets than light pickups, given the proliferation of small electric SUVs in the luxury market. The base vehicle used in this analysis is the Hyundai Kona SUV with an estimated 64 kWh engine and an estimated range of 258 miles and an expected fleet price of $37,390. A summary of the EV operational analysis for SUVs is in Table 10.

Table 10. EV Suitability Analysis results for SUVs

Daily Metrics	City (26 SUVs)	Utility (47 SUVs)
Avg. VMT	31	34
Max VMT	303	378
Days over EV Range	6 (0.2%)	19 (0.7%)
Days in Cold Range	16 (0.6%)	54 (2.0%)
Avg. Est. kWh	6.5	8.4
Max Est. kWh	125.5	114.2
Days over Battery Capacity	9 (0.3%)	31 (1.2%)
Days in Cold Battery Capacity	43 (1.6%)	68 (2.6%)
Weekly Metrics		
Avg. VMT	93	86
Max VMT	672	1,080
Weeks over EV Range	61 (6.9%)	50 (4.7%)
Weeks in Cold Range[143]	32 (3.0%)	44 (4.1%)
Avg. Est. kWh	19.3	20.9
Max Est. kWh	168.6	356.0
Weeks over Battery Capacity	48 (5.4%)	70 (6.6%)
Weeks in Cold Battery Capacity[144]	20 (1.9%)	36 (3.4%)

[143] Only counts weeks that fall between November and March.

[144] Only counts weeks that fall between November and March.

The City has 26 SUVs accounting for 2,658 vehicle-days of observed operation and 889 vehicle-weeks. Based on observed data, 12 of these vehicles are very well suited for replacement with an EV SUV similar to the base vehicle used here, having never exceeded even the cold threshold. There are 14 unique SUVs that exceeded at least the cold threshold on either a VMT or kWh basis at least once, but only 3 vehicles that did so more than 5 times across the full year of data. Across all 26 SUVs, 98% of all driving days can be served by an EV SUV with a 64kWh engine and 258 miles of driving range.

Springs Utilities has 47 SUVs accounting for 2,661 vehicle-days of observed operation and 1,066 vehicle-weeks. Based on observed data, 30 of these vehicles are very well suited for replacement with an EV SUV similar to the base vehicle used here, having never exceeded even the cold threshold. There are 17 unique SUVs that exceeded at least the cold threshold on either a VMT or kWh basis at least once, but only 7 vehicles that did so more than 3 times across the full year of data. Two did so often enough that they should remain as an ICE (67706 and 945063). Across the remaining 45 SUVs, 97% of all driving days can be served by an EV SUV with a 64kWh engine and 258 miles of driving range.

For the City, an electric SUV with 20 kWh would be optimal to support > 95% of daily driving needs, while Springs Utilities would need a vehicle with 22 kWh. On a weekly basis, these numbers increase to 63 kWh for the City and 64 kWh for Springs Utilities. In the weekly scenario, this means that > 95% of each vehicles' weekly driving needs could be met with a single charge on a 63 kWh battery for City and a 64 kWh battery for Springs Utilities.

Vans

The base vehicle used in this part of the analysis is a Lightning Systems Ford Transit Cargo Van with a 43-kWh engine and an estimated range of 60 miles; Lightning Systems also supplies an 86 kWh version with an estimated range of 120 miles. The City has 19 of these trucks in this analysis, while Springs Utilities has 31.

The City has 19 vans accounting for 2,299 vehicle-days of observed operation and 662 vehicle-weeks. Based on observed data, 2 of these vehicles are very well suited for replacement with an EV Van similar to the base vehicle used here, having never exceeded even the cold threshold. There are 17 vans that exceeded at least the cold threshold on either a VMT or kWh basis at least once, if we plot eight of these vehicles against the 86 kWh Transit Van, then 95% of their driving days fit with the capabilities of that vehicle. For the remaining 9 vehicles, there are 7 that could fit more than 96% of their driving day within the capabilities of the 86kWh van, and 2 that should remain ICE (230186 and 228387). The City's van needs could be served by 2 of the 43 kWh Transit, 15 of the 86 kWh Transit, and 2 ICE Vans.

Springs Utilities has 31 vans accounting for 3,986 vehicle-days of observed operation and 1,157 vehicle-weeks. Based on observed data, 3 of these vehicles (U2251, U2532, U2644) are very well suited for replacement with an EV Van similar to the base vehicle used here, having never exceeded even the cold threshold. There are 28 vans that exceeded at least the cold threshold on either a VMT or kWh basis at least once, of these there are 19 that could fit more than 96% of their driving day within the capabilities of the base EV van. The remaining 9 vehicles could fit more than 95% of their driving day within the capabilities of the 86kWh van. Springs Utilities' van needs could be served by 22 of the 43 kWh Transit and 9 of the 86 kWh Transit.

Table 11. EV Suitability Analysis results for Vans

Daily Metrics	City (19 Vans)	Utility (31 Vans)
Avg. VMT	40	23
Max VMT	346	319
Days over EV Range	467 (20.3%)	200 (5.0%)
Days in Cold Range	569 (24.7%)	584 (14.7%)
Avg. Est. kWh	24.9	14.2
Max Est. kWh	288.0	265.7
Days over Battery Capacity	358 (15.6%)	215 (5.4%)
Days in Cold Battery Capacity	444 (19.3%)	399 (10.0%)
Weekly Metrics		
Avg. VMT	140	78
Max VMT	856	488
Weeks over EV Range	423 (63.9%)	567 (49.0%)
Weeks in Cold Range[145]	24 (3.6%)	66 (5.7%)
Avg. Est. kWh	88.3	48.9
Max Est. kWh	540.0	385.2
Weeks over Battery Capacity	411 (62.1%)	509 (44.0%)
Weeks in Cold Battery Capacity[146]	21 (3.2%)	66 (5.7%)

For the City an electric van with 64 kWh would be optimal to support > 95% of daily driving needs, while Springs Utilities would need a vehicle with 43 kWh. On a weekly basis, these numbers increase to 275 kWh for the City and 152 kWh for Springs Utilities. In the weekly scenario, this means that > 95% of each vehicles' weekly driving needs could be met with a single charge on a 275 kWh battery for City and a 152 kWh battery for Springs Utilities.

[145] Only counts weeks that fall between November and March.

[146] Only counts weeks that fall between November and March.

Light Pickups

This is perhaps the most difficult segment to quantify given the lack of vehicle availability with an electric drivetrain, though with the announcement of the Ford F-150 Lightning electric truck estimated to arrive in Spring 2022, this is changing quickly. While we expect that some models will become available in the next model year or so, it is not certain which models will be available and in what quantities for fleets to actually purchase in the near future. The base vehicle used in this analysis is the Lordstown Endurance pickup[147] with an estimated 109 kWh engine and an estimated range of 250 miles and an expected price of $52,500. Specifications for the Ford F-150 Lightning were not available at the time of this analysis but are expected to be equal to or more favorable than the projected specifications for Lordstown Endurance pickup. A Summary of the EV operational analysis for Light Pickups is in Table 12.

City has 108 light pickups accounting for 16,520 vehicle-days of observed operation and 4,665 vehicle-weeks. Based on observed data, 92 of these vehicles are very well suited for replacement with an EV pickup similar to the base vehicle used here, having never exceeded even the cold threshold. There are 16 unique trucks that exceeded at least the cold threshold on either a VMT or kWh basis at least once, none of these vehicles did so more than 4 times across the full year of data. Across all 108 light pickups, more than 99% of all driving days can be served by an EV pickup with a 109 kWh engine and 250 miles of driving range.

Springs Utilities has 124 light pickups accounting for 16,249 vehicle-days of observed operation and 4,337 vehicle-weeks. Based on observed data, 117 of these vehicles are very well suited for replacement with an EV pickup similar to the base vehicle used here, having never exceeded even the cold threshold. There are 7 unique trucks that exceeded at least the cold threshold on either a VMT or kWh basis at least once, but none of these vehicles did so more than 5 times across the full year of data. Across all 124 light pickups, more than 99% of all driving days can be served by an EV pickup with a 109 kWh engine and 250 miles of driving range.

[147] At the time of writing this report, Lordstown Motors had multiple lawsuits filed by investors citing fraud. The Fleet Operational Analysis conducted by ICF was completed prior to learning about these lawsuits.

Table 12. EV Suitability Analysis results for Light Pickups

Daily Metrics	City (108 Light Pickups)	Utility (124 Light Pickups)
Avg. VMT	35	43
Max VMT	391	259
Days over EV Range	4 (0.0%)	1 (0.0%)
Days in Cold Range	23 (0.1%)	18 (0.1%)
Avg. Est. kWh	10.5	13.1
Max Est. kWh	219.6	113.4
Days over Battery Capacity	4 (0.0%)	1 (0.0%)
Days in Cold Battery Capacity	22 (0.1%)	14 (0.1%)
Weekly Metrics		
Avg. VMT	126	162
Max VMT	810	949
Weeks over EV Range	516 (11.9%)	977 (22.5%)
Weeks in Cold Range[148]	325 (7.5%)	454 (10.5%)
Avg. Est. kWh	37.3	49.3
Max Est. kWh	445.9	317.0
Weeks over Battery Capacity	133 (3.0%)	341 (7.8%)
Weeks in Cold Battery Capacity[149]	210 (4.8%)	396 (9.1%)

Since this vehicle segment does not yet have a commercially available vehicle, we have estimated the optimal battery size based on observed driving patterns. To accomplish this, all daily and weekly driving needs are analyzed using a box-whisker plot to segment all driving days and weeks in terms of estimated kWh use into quartiles, each representing 25% of the data points. In Figure 18, this is represented by the two green boxes which represents the middle 50% of data points around the median estimated daily energy use (9.1 kWh). This means that 75% of all driving days are within the first three quartiles, or 14.5 kWh. The upper 25% of driving days helps us understand the optimal battery size by drawing the top

[148] Only counts weeks that fall between November and March.

[149] Only counts weeks that fall between November and March.

"whisker" at the point where values in the upper quartile become 'outliers' from the rest of the 'normal' data. This is the point at which we establish the 'optimal' battery size of the vehicle. Typically, outliers will identify the < 5% of trips that would fall outside the capacity of the optimal battery size. In the case of Light Pickups, 2.5% of trips have estimated kWh use above the optimal battery size of 30 kWh.

For City, an electric pickup with 30 kWh would be optimal to support > 95% of daily driving needs, while Springs Utilities would need a vehicle with 35 kWh. On a weekly basis, these numbers increase to 115 kWh for the City and 155 kWh for Springs Utilities. In the weekly scenario, this means that > 95% of each vehicles' weekly driving needs could be met with a single charge on a 115 kWh battery for City and a 155 kWh battery for Springs Utilities.

Figure 18. Estimation of Optimal Daily Battery Size for City Light Pickups

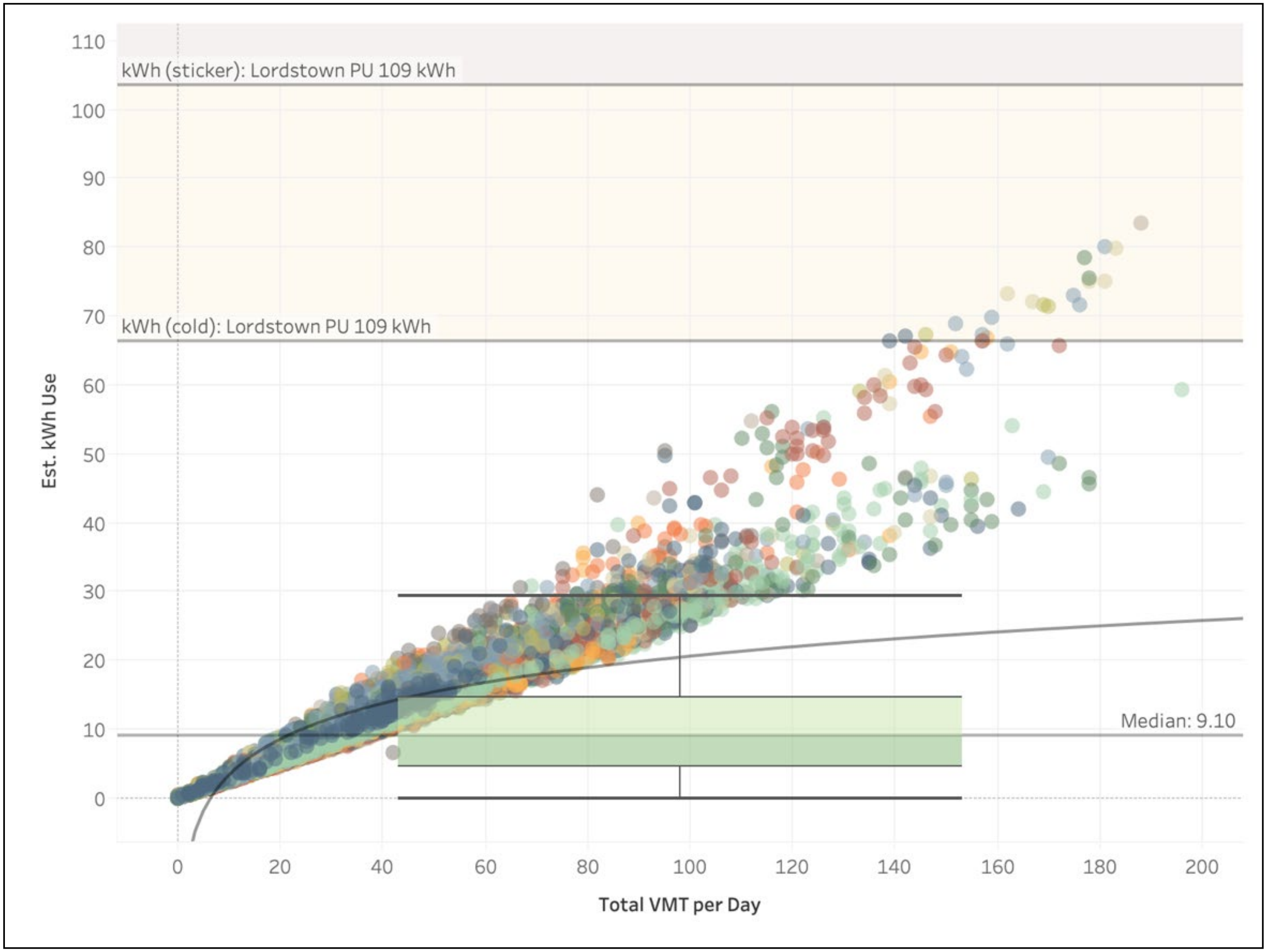
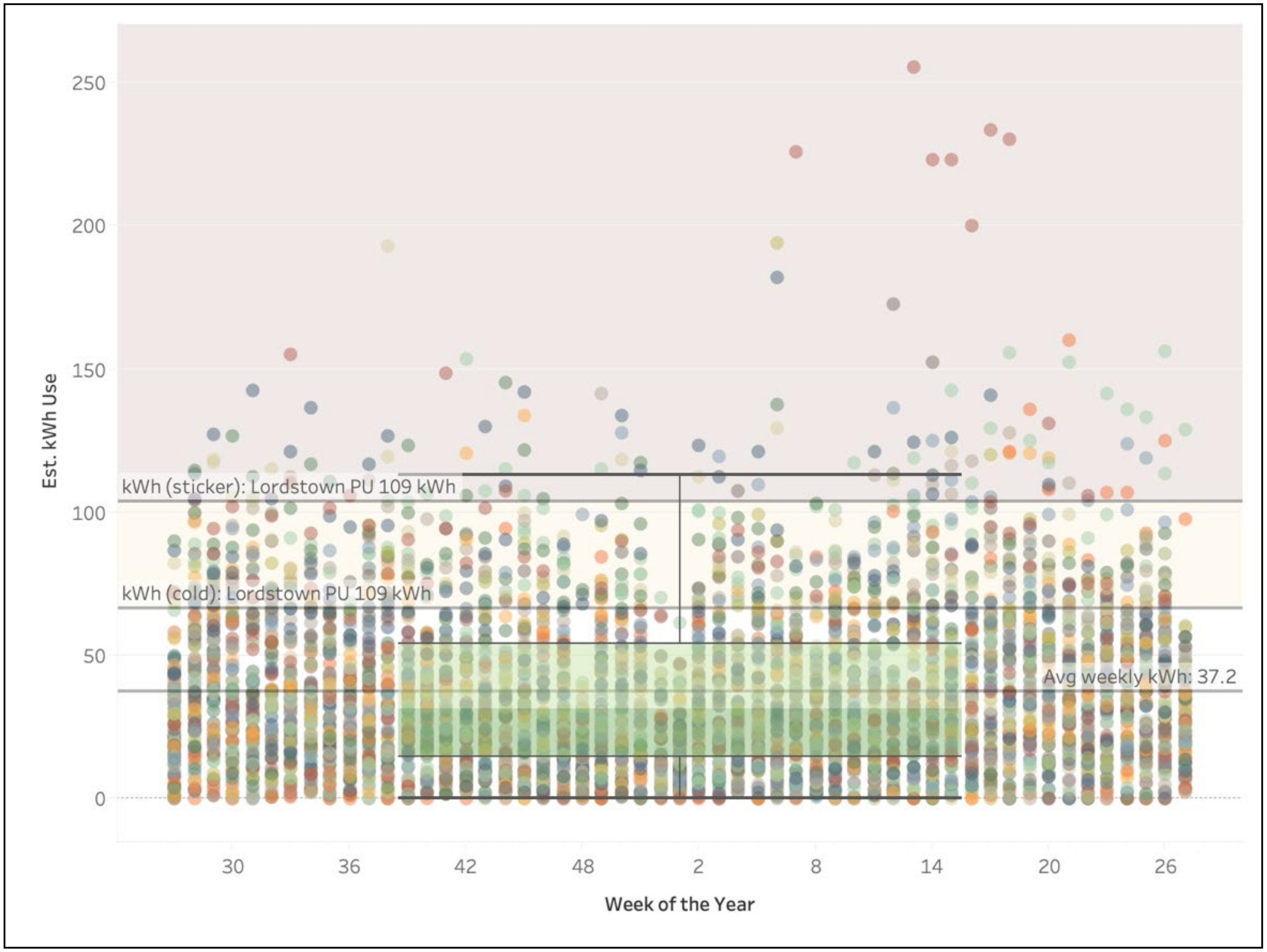


Figure 19. Estimation of Optimal Weekly Battery Size for City Light Pickups



¾ Ton Pickups

The base vehicle used in this part of the analysis is a Lightning Systems E450 truck with an 86-kWh engine and an estimated range of 80 miles. The City has 45 of these trucks in this analysis, while Springs Utilities has 54.

The City has 45 ¾ ton pickups accounting for 7,601 vehicle-days of observed operation and 1,868 vehicle-weeks. Based on observed data, 42 of 45 ¾ ton trucks exceeded at least the cold threshold on either a VMT or kWh basis at least once in the base EV. This number drops to 30 trucks when we plot them against the 129 kWh E450 EV. Of the 17 vehicles that exceeded at least the cold threshold on the 129 kWh E450, two did so often enough that they should remain as an ICE (230488 and 1026814). Among the remaining 43 vehicles, 98% of all driving days can be served by the 129 kWh E450 while 85% of all driving days can be served by the 86 kWh E450. Assuming a relatively even distribution of miles and usage across these vehicles, this would suggest that the City's ¾ ton pickup needs could be served by 28 of the 86 kWh E450's, 15 of the 129 kWh E450's, and 2 ICE pickups.

Springs Utilities has 54 ¾ ton pickups accounting for 7,601 vehicle-days of observed operation and 1,868 vehicle-weeks. The driving and temperature data for these pickups suggest that most of these vehicles can be replaced with electric vehicles, even accounting for range reduction in cold weather. Based on observed data, 46 of 54 ¾ ton trucks exceeded the cold threshold on either a VMT or kWh basis at least once in the base EV; the same number of vehicles exceeded the cold threshold at least once in the 129 kWh E450 EV and there are three that did so often enough that they should remain as an ICE (235698, 855511, and 1033886). Among the remaining 43, there were 8 that crossed the cold threshold less than five times; they are very well suited for the 86 kWh E450. Of the remaining 35 vehicles, 11 crossed the cold threshold more than 5 times and would be better replaced by the 129 kWh E450 EV. This leaves 24 vehicles that are well suited for the base 86 kWh E450 EV. Across all 54 vehicles, 90% of all driving days can be served by the 86 kWh E450. Assuming a relatively even distribution of miles and usage across these vehicles, this would suggest that the Springs Utilities' ¾ ton pickup needs could be served by 40 of the 86 kWh E450's, 11 of the 129 kWh E450's, and 3 ICE pickups.

For City an electric ¾ ton pickup with 70 kWh would be optimal to support > 95% of daily driving needs, while Springs Utilities would need a vehicle with 80 kWh. On a weekly basis, these numbers increase to 266 kWh for the City and 290 kWh for Springs Utilities. In the weekly scenario, this means that > 95% of each vehicles' weekly driving needs could be met with a single charge on a 266 kWh battery for the City and a 290 kWh battery for Springs Utilities.

Table 13. EV Suitability Analysis results for ¾ Ton Pickups

Daily Metrics	City (45 ¾ ton Pickups)	Utility (54 ¾ ton Pickups)
Avg. VMT	35	33
Max VMT	196	407
Days over EV Range	245 (3.3%)	255 (3.9%)
Days in Cold Range	1,171 (15.4%)	838 (12.7%)
Avg. Est. kWh	27.6	31.0
Max Est. kWh	263	503.3
Days over Battery Capacity	120 (1.6%)	231 (3.5%)
Days in Cold Battery Capacity	499 (6.6%)	619 (9.4%)
Weekly Metrics		
Avg. VMT	142	113
Max VMT	536	801
Weeks over EV Range	1,451 (77.7%)	1,133 (59.0%)
Weeks in Cold Range[150]	73 (3.9%)	108 (5.6%)
Avg. Est. kWh	112.2	107.0
Max Est. kWh	495.5	273.5
Weeks over Battery Capacity	1,234 (66.1%)	1,026 (53.5%)
Weeks in Cold Battery Capacity[151]	112 (6.0%)	109 (5.7%)

[150] Only counts weeks that fall between November and March.

[151] Only counts weeks that fall between November and March.

1 Ton Pickups

The base vehicle used in this part of the analysis is a Lightning Systems F550 truck with a 122 kWh engine and an estimated range of 100 miles. The city has 24 of these trucks in this analysis, while Springs Utilities has 131.

The City has 24 1-ton pickups accounting for 3,701 vehicle-days of observed operation and 996 vehicle-weeks. Based on observed data, 9 of these vehicles are very well suited for the 122 kWh F550; the remaining 15 vehicles each exceeded at least the cold threshold on either a VMT or kWh basis at least once in the base EV. One vehicle in particular (1021290) accounted for 83.5% of all travel days that exceed either the VMT or kWh threshold and should remain an ICE. Among the remaining 14 vehicles, 97.2% of all travel days could be served in a 122-kWh EV Pickup. Based on this, the City's 1-ton pickup needs could be served by 22 of the 122 kWh F550 and 2 ICE pickups.

Springs Utilities has 131 1-ton pickups accounting for 17,482 vehicle-days of observed operation and 4,836 vehicle-weeks. Based on observed data, 40 of these vehicles are very well suited for the 122 kWh F550; the remaining 91 vehicles each exceeded at least the cold threshold on either a VMT or kWh basis at least once in the base EV. Three vehicles (403851, 497838, 784922) accounted for about 20% of all travel days that exceed either the VMT or kWh threshold and should remain an ICE. Of the remaining 88 vehicles, 78% of all travel days could be served in a 122-kWh EV Pickup. With only 78% of days being served by the EV Pickup, the recommendation is to keep a higher number of these vehicles as ICEs. Therefore, 17 additional 1-ton pickups (in addition to the three mentioned above, for a total of 20) should remain as ICEs and the Springs Utilities' 1-ton pickup needs could be served by 111 of the 122 kWh F550 and 20 ICE pickups.

For the City an electric 1-ton pickup with 70 kWh of capacity would suffice, while Springs Utilities would need a vehicle with 125 kWh. In either case, upwards of 95% of daily driving needs would be met within the optimal battery size. On a weekly basis, these numbers increase to 260 kWh for the City and 430 kWh for Springs Utilities.

Table 14. EV Suitability Analysis results for 1 Ton Pickups

Daily Metrics	City (24 1-ton Pickups)	Utility (131 1-ton Pickups)
Avg. VMT	27	41
Max VMT	246	587
Days over EV Range	67 (1.8%)	723 (4.1%)
Days in Cold Range	182 (4.9%)	1,681 (15.3%)
Avg. Est. kWh	24.0	42.6
Max Est. kWh	192.4	1,102
Days over Battery Capacity	6 (0.2%)	616 (3.5%)
Days in Cold Battery Capacity	122 (3.3%)	1,777 (10.2%)
Weekly Metrics		
Avg. VMT	101	149
Max VMT	599	1,020
Weeks over EV Range	415 (41.7%)	2,913 (60.2%)
Weeks in Cold Range[152]	81 (8.1%)	228 (4.7%)
Avg. Est. kWh	88.4	154.0
Max Est. kWh	523.3	1,403
Weeks over Battery Capacity	290 (29.1%)	2,655 (54.9%)
Weeks in Cold Battery Capacity[153]	92 (9.2%)	267 (5.5%)

[152] Only counts weeks that fall between November and March.

[153] Only counts weeks that fall between November and March.

2 Ton Pickups

The base vehicle used in this part of the analysis is a Lightning Systems F550 truck with a 122 kWh engine and an estimated range of 100 miles. The City has 37 of these trucks in this analysis, while Springs Utilities has 75.

The City has 37 2-ton pickups accounting for 4,854 vehicle-days of observed operation and 1,422 vehicle-weeks. 6 of these vehicles are very well suited for the 122 kWh F550; the remaining 31 vehicles each exceeded at least the cold threshold on either a VMT or kWh basis at least once in the base EV. Eight vehicles (807307, 942077, 942079, 942082, 942092, 942093, 942096, and 042102) accounted for 74% of all travel days that exceed either the VMT or kWh threshold and should remain an ICE. Of the remaining vehicles, 93% of all travel days could be served in a 122-kWh EV Pickup. Based on this, the City's 2-ton pickup needs could be served by 29 of the 122 kWh F550 and 8 ICE pickups.

Springs Utilities has 75 2-ton pickups accounting for 7,862 vehicle-days of observed operation and 4,836 vehicle-weeks. Based on observed data, 17 of these vehicles are very well suited for the 122 kWh F550; the remaining 58 vehicles each exceeded at least the cold threshold on either a VMT or kWh basis at least once in the base EV. 18 vehicles (230543, 235427, 235524, 235536, 290131, 290520, 293394, 337436, 366014, 624017, 624019, 624020, 910729, 974157, 1021244, 1028402, 1060698, 1061678) in particular accounted for about 80% of all travel days that exceed either the VMT or kWh threshold and should remain an ICE. Of the remaining 40 vehicles, 93% of all travel days could be served in a 122-kWh EV Pickup. Based on this, Springs Utilities' 2-ton pickup needs could be served by 57 of the 122 kWh F550 and 18 ICE pickups.

For the City an electric 2-ton pickup with 100 kWh of capacity would suffice, while Springs Utilities would need a vehicle with 120 kWh. In either case, upwards of 95% of daily driving needs would be met within the optimal battery size. On a weekly basis, these numbers increase to 330 kWh for the City and 485 kWh for Springs Utilities.

Table 15. EV Suitability Analysis results for 2 Ton Pickups

Daily Metrics	City (37 2-ton Pickups)	Utility (75 2-ton Pickups)
Avg. VMT	38	38
Max VMT	330	227
Days over EV Range	358 (7.4%)	317 (4.0%)
Days in Cold Range	419 (8.6%)	1,224 (15.6%)
Avg. Est. kWh	36.2	38.7
Max Est. kWh	319.9	272.1
Days over Battery Capacity	226 (4.7%)	191 (2.4%)
Days in Cold Battery Capacity	293 (6.0%)	865 (11.0%)
Weekly Metrics		
Avg. VMT	132	131
Max VMT	861	730
Weeks over EV Range	709 (0%)	1,111 (48.0%)
Weeks in Cold Range[154]	88 (6.2%)	95 (4.1%)
Avg. Est. kWh	123.7	131.7
Max Est. kWh	812.3	840.7
Weeks over Battery Capacity	576 (40.5%)	994 (43.0%)
Weeks in Cold Battery Capacity[155]	82 (5.8%)	112 (4.8%)

[154] Only counts weeks that fall between November and March.

[155] Only counts weeks that fall between November and March.

Medium-Duty Trucks

The base vehicle used in this part of the analysis is a Lightning Systems Chevrolet 6500XD[156] with a 122 kWh engine and an estimated range of 88 miles. The city has 18 of these trucks in this analysis, while Springs Utilities has 43.

The City has 18 MD trucks accounting for 2,058 vehicle-days of observed operation and 684 vehicle-weeks. 3 of these vehicles are very well suited for the 122 kWh 6500XD; the remaining 15 vehicles each exceeded at least the cold threshold on either a VMT or kWh basis at least once in the base EV. Nine vehicles[157] accounted for 73% of all travel days that exceed either the VMT or kWh threshold and in the base EV; seven of these (218795, 229997, 230344, 235244, 236223, 885828) would be better suited in the 153 kWh 6500XD and two vehicles (228780 and 234538) would be better suited in the 184 kWh 6500XD. Of the remaining vehicles, 85% of all travel days could be served in a 122-kWh EV MD truck. Based on this, the City's MD truck needs could be served by 9 of the 122 kWh 6500XD, 7 of the 153 kWh 6500XD, and 2 of the 184 kWh 6500XD.

Springs Utilities has 43 MD trucks accounting for 3,777 vehicle-days of observed operation and 1,337 vehicle-weeks. Based on observed data, 11 of these vehicles are very well suited for the 122 kWh 6500XD; the remaining 32 vehicles each exceeded at least the cold threshold on either a VMT or kWh basis at least once in the base EV. 1 vehicle in particular (1076680) accounted for about 30% of all travel days that exceed either the VMT or kWh threshold and should remain an ICE. Of the remaining vehicles, 94% of all travel days could be served in a 122-kWh EV MD truck. Based on this, Springs Utilities' MD truck needs could be served by 42 of the 122 kWh 6500XD and 1 of the 153 kWh 6500XD.

For the City an electric medium-duty truck with 135 kWh of capacity would suffice, while Springs Utilities would need a vehicle with 65 kWh. In either case, upwards of 95% of daily driving needs would be met within the optimal battery size. On a weekly basis, these numbers increase to 420 kWh for the City and 215 kWh for Springs Utilities.

[156] This vehicle also comes in a 153 kWh battery with 110 miles range and 184 kWh battery with 130 miles range. There are other Class 6 and 7 EV configurations available, including the Ford F-59 and the Freightliner eM2 106.

[157] 218795, 228780, 229997, 230344, 234538, 235244, 236223, 885828.

Table 16. EV Suitability Analysis results for MD Trucks

Daily Metrics	City (18 MD Trucks)	Utility (43 MD Trucks)
Avg. VMT	38	19
Max VMT	277	217
Days over EV Range	162 (7.9%)	35 (0.9%)
Days in Cold Range	393 (19.1%)	39 (1.0%)
Avg. Est. kWh	41.7	23.5
Max Est. kWh	294.4	328.3
Days over Battery Capacity	111 (5.4%)	39 (1.0%)
Days in Cold Battery Capacity	200 (9.7%)	99 (2.6%)
Weekly Metrics		
Avg. VMT	116	55
Max VMT	734	421
Weeks over EV Range	368 (53.8%)	306 (22.9%)
Weeks in Cold Range[158]	38 (5.6%)	88 (6.6%)
Avg. Est. kWh	126.1	66.3
Max Est. kWh	663.6	682.4
Weeks over Battery Capacity	313 (45.8%)	232 (17.4%)
Weeks in Cold Battery Capacity[159]	45 (6.6%)	73 (5.5%)

[158] Only counts weeks that fall between November and March.

[159] Only counts weeks that fall between November and March.

Heavy-Duty Trucks

The base vehicle used in this part of the analysis is a Freightliner eCascadia with a 550 kWh engine and an estimated range of 250 miles. The City has 47 of these trucks in this analysis, while Springs Utilities has 104.

The City has 47 HD trucks accounting for 5,713 vehicle-days of observed operation and 1,918 vehicle-weeks. 9 of these vehicles are very well suited for the 550 kWh eCascadia; the remaining 38 vehicles each exceeded at least the cold threshold on either a VMT or kWh basis at least once in the base EV. Two vehicles (817488 and 857000) that accounted for 13% of all travel days that exceed either the VMT or kWh threshold should remain an ICE. Of the remaining 36 vehicles, 91% of all travel days could be served in a 550 kWh EV HD truck. Based on this, the City's HD truck needs could be served by 45 of the 550 kWh eCascadias and 2 ICE HD trucks.

Springs Utilities has 104 MD trucks accounting for 13,223 vehicle-days of observed operation and 4,209 vehicle-weeks. Based on observed data, 70 of these vehicles are very well suited for the 550 kWh eCascadia; the remaining 34 vehicles each exceeded at least the cold threshold on either a VMT or kWh basis at least once in the base EV. Six vehicles (446937, 607436, 614950, 702389, 708345, and 720287) accounted for 70% of all travel days that exceed either the VMT or kWh threshold should remain an ICE. Of the remaining 28 vehicles, 96% of all travel days could be served in a 550 kWh EV HD truck. Based on this, Springs Utilities' HD truck needs could be served by 98 of the 550 kWh eCascadias and 6 ICE HD trucks.

For the City an electric heavy-duty truck with 125 kWh of capacity would suffice, while Springs Utilities would need a vehicle with 175 kWh. In either case, upwards of 95% of daily driving needs would be met within the optimal battery size. On a weekly basis, these numbers increase to 830 kWh for the City and 515 kWh for Springs Utilities.

Table 17. EV Suitability Analysis results for HD Trucks

Daily Metrics	City (47 HD Trucks)	Utility (104 HD Trucks)
Avg. VMT	55	33
Max VMT	352	320
Days over EV Range	101 (1.8%)	16 (0.1%)
Days in Cold Range	329 (5.8%)	190 (1.4%)
Avg. Est. kWh	94.1	65.7
Max Est. kWh	737.8	853.7
Days over Battery Capacity	46 (0.8%)	74 (0.6%)
Days in Cold Battery Capacity	255 (4.5%)	344 (2.6%)
Weekly Metrics		
Avg. VMT	164	105
Max VMT	1,011	951
Weeks over EV Range	436 (22.7%)	438 (10.4%)
Weeks in Cold Range[160]	164 (8.6%)	142 (3.4%)
Avg. Est. kWh	280.3	206.3
Max Est. kWh	2,206	2,538
Weeks over Battery Capacity	365 (19.0%)	438 (10.4%)
Weeks in Cold Battery Capacity[161]	156 (8.1%)	157 (3.7%)

[160] Only counts weeks that fall between November and March.

[161] Only counts weeks that fall between November and March.

Busses

The base vehicle used in this part of the analysis is a Bluebird electric School Bus with a 155 kWh engine and an estimated range of 120 miles. The City has 2 of these busses in this analysis, while Springs Utilities has none.

The City has busses accounting for 150 vehicle-days of observed operation and 68 vehicle-weeks. Each of these vehicles exceeded at least the cold threshold on either a VMT or kWh basis eight times in the base EV; approximately 89-90% of all travel days could be served in a 155 kWh EV bus. While these busses are in the range where we'd typically recommend that both be replaced with an EV, the fact that there are only two of them means that it may make sense to replace only one with an EV and reserve longer trips (e.g. > 100 miles) for an ICE bus.

Since this vehicle segment has limited commercially available for an EV, we have estimated the optimal battery size based on observed driving patterns. For the City an electric bus with 30 kWh of capacity would suffice; 87% of daily driving needs would be met within the optimal battery size. On a weekly basis, this number increases to 290 kWh.

Table 18. EV Suitability Analysis results for Busses

Daily Metrics	City (2 Busses)
Avg. VMT	30
Max VMT	237
Days over EV Range	11 (7.3%)
Days in Cold Range	5 (3.3%)
Avg. Est. kWh	44.8
Max Est. kWh	367.0
Days over Battery Capacity	15 (10.0%)
Days in Cold Battery Capacity	2 (1.3%)
Avg. VMT	66
Max VMT	315
Weeks over EV Range	16 (23.5%)
Weeks in Cold Range[162]	0 (0.0%)
Avg. Est. kWh	98.8
Max Est. kWh	595.5
Weeks over Battery Capacity	17 (25.0%)
Weeks in Cold Battery Capacity[163]	0 (0.0%)

[162] Only counts weeks that fall between November and March.

[163] Only counts weeks that fall between November and March.

Opportunities to Consolidate Miles

In order to give both the City and Springs Utilities a sense of where there may be opportunities to consolidate miles onto fewer assets, the Verizon data was analyzed for a number of metrics that can highlight these opportunities at a high level. These include total hours driven per trip and per day, the percentage of trip travel time relative to work hours in the day, as well as the average and maximum number of vehicles in use by week, day, and hour of day. The guiding principle behind these metrics is that if a subset of vehicles rarely, or never, has all vehicles in use on the same day, or at the same time, and if that use is less than 4 hours per day, then there may be opportunities to consolidate miles onto fewer assets.

This is reflected in Table 19 below where each vehicle segment is presented in terms of the maximum number of vehicles in use and the average hours of driving at different intervals, per vehicle. This all culminates in the Low Daily Utilization metric, which represents the percentage of driving days that either (1) consumed less than 4 total hours of driving – regardless of the number of trips – and the sum of trip driving time is less than 50% of the day's total hours of driving, and (2) where a day's driving was completed in just one trip – and therefore equals 100% of the day's total hours of driving – but was less than 4 hours. If a vehicles day meets these criteria, then the vehicle would have been available for another user for the other half of the day. This assumes an 8 hour work day, which may or may not hold true across all vehicle categories. The frequency with which this happened gives us a sense as to how often vehicles could be more heavily utilized. The higher this percentage, the more often a set of vehicles is considered "low utilization". Across all of these summaries, we have included both a summary for each vehicle segment within both the City and Springs Utilities, as well as each department within those two organizations on the assumption that vehicles are not shared across departments. If that is in fact possible, then the summary figures for each vehicle segment at the organization level may be of most value.

In order to achieve a more precise gauge of the likely impact of removing vehicles from a department, it would be appropriate to take the analysis a level deeper to analyze the frequency and extent of vehicle operations based on both timestamps, trip durations, and trip locations. In such an analysis, trips would be classified based on their starting and ending locations to identify when a trip originates or concludes at "home" and therefore whether or not a vehicle would be available for use by another driver when it is not actively driving. In this scenario, if a vehicle is not parked at home then it is considered unavailable for use. This level of depth is outside the scope of this current analysis. In addition, some vehicles that show low utilization may be specialized vehicles, with particular added equipment, that are essential even if not frequently used. Any opportunities for consolidation would need to be reviewed on a more in-depth, case-by-case basis.

Nevertheless, the following tables suggest that there may be some opportunities to consolidate the fleet, and that further analysis may identify and qualify these opportunities. Specifically, it appears there may be opportunities with the following vehicles. First, the seven sedans in the City's Fleet Management Division illustration the impact of the Low Daily Utilization metric. This group of vehicles saw all seven in use, but this only occurred once every other month. More regularly, this group of vehicles would have 5-6 vehicles in regular use. Since the Low Daily Utilization metric is so high (81%) and the vehicles are used for smaller portions of each day when driven – less than 15 minutes per trip and just over 1 hour per day – it is possible that removing one vehicle from this group would have a minimal impact as its usage was spread across the remaining 6 assets.

Table 19. Vehicle Utilization Figures - Sedans

	Avg, Max, and Frequency[164] of Max Vehicles in Use				Avg. Hours Driving		Low Daily Utilization
		Weekly	Daily	Hourly	Trip	Daily	
City Total (9)	**Average** **Maximum** **Frequency**	**5.9** **9** **9.4%**	**4.2** **6** **1.7%**	**1.9** **6** **0.1%**	**0.3**	**1.2**	**81.7%**
Fleet Management (7)	**Average** **Maximum** **Frequency**	4.8 7 13.2%	3.6 6 6.8%	1.8 5 1.5%	0.2	1.1	80.9%
Revenue & Collections (2)	**Average** **Maximum** **Frequency**	1.4 2 28.3%	1.1 2 4.7%	1.0 2 3.5%	0.3	1.6	87.1%
Utility Total (2)	**Average** **Maximum** **Frequency**	**1.6** **2** **41.5%**	**1.1** **2** **6.6%**	**1.0** **2** **4.4%**	**0.3**	**0.7**	**86.5%**
Energy Const, Ops & Maint (1)	**Average** **Maximum** **Frequency**	n/a	n/a	n/a	0.3	1.0	82.2%
IRD Admin Support (1)	**Average** **Maximum** **Frequency**	n/a	n/a	n/a	0.2	0.5	90.7%

Second, the Energy Construction, Operations and Maintenance division within Springs Utilities' fleet has 47 light pickups (Table 20), but the maximum number of these trucks ever used across a single week is 38, and this only occurred on 2% of the weeks observed – 1 week per year. On average, there are less than 30 of these trucks that are operated in a given week. This suggests that this division has roughly 10 – 15 more trucks than necessary. However, the low daily utilization figure of 35% tells us that when these trucks are in use, they are used for longer portions of the day – nearly 40 minutes per trip and 4 hours per day. Which is also to say that if one truck is not available, having some in reserve makes sense. In this scenario, removing vehicles may be more complicated if this division experiences times when a larger number of vehicles – 10 or more – experience concurrent downtime (e.g., for routine maintenance). In this scenario a reserve pool of vehicles would be necessary to meet operational needs and further analysis would be needed to identify opportunities to eliminate vehicles.

[164] The analysis includes 53 weeks, 366 days, and 8,190 hours in during which a trip was initiated across all vehicles. The frequency is reported relative to these specific figures for each vehicle segment.

Table 20. Vehicle Utilization Figures – Light Pickups

		Avg, Max, and Frequency of Max Vehicles in Use			Avg. Hours Driving		Low Daily Utilization
		Weekly	Daily	Hourly	Trip	Daily	
City Total (108)	**Average**	**86.4**	**45.7**	**18.9**			
	Maximum	**97**	**85**	**68**	**0.4**	**2.5**	**54.2%**
	Frequency	**1.9%**	**0.5%**	**0.0%**			
Community Development (26)	**Average**	20.7	14.9	8.6			
	Maximum	25	22	20	0.5	3.1	35.7%
	Frequency	1.9%	0.5%	0.0%			
Fleet Management (2)	**Average**	1.3	1.1	1.1			
	Maximum	2	2	2	0.2	1.0	77.4%
	Frequency	24.5%	5.5%	5.5%			
Miscellaneous (1)	**Average**						
	Maximum	n/a	n/a	n/a	0.8	2.1	47.7%
	Frequency						
Parks (42)	**Average**	34.6	18.6	8.0			
	Maximum	40	34	31	0.3	2.0	71.4%
	Frequency	1.9%	1.9%	0.03%			
Stormwater Enter. (11)	**Average**	7.5	5.2	4.3			
	Maximum	9	8	10	0.4	2.2	42.8%
	Frequency	7.5%	4.1%	0.4%			
Streets (26)	**Average**	21.6	13.5	6.8			
	Maximum	24	24	20	0.5	3.0	47.6%
	Frequency	11.3%	1.9%	0.3%			
Utility Total (124)	**Average**	**80.2**	**44.3**	**18.7**			
	Maximum	**92**	**76**	**75**	**0.5**	**3.8**	**42.4%**
	Frequency	**1.9%**	**0.3%**	**0.02%**			
Energy Const, Ops & Maint (47)	**Average**	28.2	15.9	9.9			
	Maximum	37	34	30	0.6	3.8	34.6%
	Frequency	1.9%	0.3%	0.03%			
Energy Supply (3)	**Average**	2.4	1.7	1.1			
	Maximum	2	3	3	0.3	1.7	89.5%
	Frequency	35.8% [165]	15.1%	1.2%			
Environmental Services (2)	**Average**	1.8	1.3	1.1			
	Maximum	2	2	2	0.7	3.3	16.3%
	Frequency	75.5%	21.1%	10.9%			
Facilities & Security Mgmt (1)	**Average**						
	Maximum	n/a	n/a	n/a	0.3	1.1	90.4%
	Frequency						
Field Service (51)	**Average**	34.2	20.1	12.7			
	Maximum	42	37	35	0.5	4.4	39.9%
	Frequency	1.9%	0.3%	0.02%			

[165] All of this occurred since mid-January 2020 when the 3rd vehicle was added to this department.

Planning & Energy Resource Mgmt[166] (4)	**Average Maximum Frequency**	2.3 3 39.6%	1.6 3 3.8%	1.5 3 7.2%	0.5	2.1	48.8%
Safety & Health (2)	**Average Maximum Frequency**	1.6 2 49.1%	1.2 2 7.9%	1.0 2 4.9%	0.4	1.4	59.5%
Southern Delivery System (1)	**Average Maximum Frequency**	n/a	n/a	n/a	0.4	2.3	59.2%
System Extension (10)	**Average Maximum Frequency**	7.0 9 3.8%	5.5 8 4.7%	4.2 10 0.3%	0.4	3.2	56.4%
Water Systems Operations (2)	**Average Maximum Frequency**	1.4 2 43.3%	1.2 2 9.3%	1.1 2 11.2%	0.5	3.0	51.5%
Water Treatment (1)	**Average Maximum Frequency**	n/a	n/a	n/a	1.5	1.5	0.0%

In a third scenario, it may be instructive to review the assignment of SUVs (Table 21). Both the Council Appointees and the Information Technology fleets have a single SUV. When these vehicles are driven, it is, on average, for short durations – 15-20 minutes per trip, less than an hour per day. In this instance, it would be worthwhile to review whether these organizations need a dedicated vehicle assigned to them. Or, if the assignment of a dedicated vehicle is warranted, could it make more sense to reassign 2 of the 9 SUVs in the Community Development fleet – a subset of vehicles which never experienced more than 7 of the 9 vehicles in operation in any time period.

Of course, these examples present possible scenarios, and we recommend further analysis of vehicle use and input from managers and vehicle operators to more precisely target vehicles that could be eliminated from or reassigned within the fleet.

[166] While there are 4 vehicles in the full data set, one vehicle only appears in 2019 (668881) and another only appears in 2020 (1012913), suggesting that the prior was replaced with the latter. If that is the case, these results only apply to 3 vehicles in total for this department.

Table 21. Vehicle Utilization Figures – SUVs

		Avg, Max, and Frequency of Max Vehicles in Use			Avg. Hours Driving		Low Daily Utilization
		Weekly	Daily	Hourly	Trip	Daily	
City Total (26)	**Average** **Maximum** **Frequency**	**16.5** **22** **3.8%**	**9.2** **19** **0.3%**	**4.1** **15** **0.03%**	**0.3**	**1.7**	**67.7%**
Community Development (9)	**Average** **Maximum** **Frequency**	4.7 7 1.9%	2.9 7 0.3%	2.4 7 0.1%	0.4	1.9	70.4%
Council Appointees (1)	**Average** **Maximum** **Frequency**	n/a	n/a	n/a	0.3	0.7	82.2%
Fleet Management (3)	**Average** **Maximum** **Frequency**	2.5 3 58.5%	2.0 3 20.5%	1.3 3 3.2%	0.3	1.1	69.3%
Human Resources (2)	**Average** **Maximum** **Frequency**	1.5 2 49.1%	1.2 2 5.8%	1.1 2 5.6%	0.3	0.9	53.6%
Information Technology (1)	**Average** **Maximum** **Frequency**	n/a	n/a	n/a	0.2	0.8	89.6%
Parks (3)	**Average** **Maximum** **Frequency**	1.6 3[167] 11.3%	1.3 3 3.0%	1.4 3 0.5%	0.3	1.8	78.3%
Storm Water Enter. (1)	**Average** **Maximum** **Frequency**	n/a	n/a	n/a	0.3	1.4	49.5%
Streets (6)	**Average** **Maximum** **Frequency**	4.0 6 17.0%	2.6 6 0.8%	1.8 6 0.1%	0.4	2.5	54.8%
Utility Total (47)	**Average** **Maximum** **Frequency**	**19.7** **30** **1.9%**	**9.7** **22** **0.3%**	**3.3** **16** **0.04%**	**0.4**	**1.5**	**74.1%**
Energy Aqui, Eng & Plan[168] (4)	**Average** **Maximum** **Frequency**	2.0 3 22.6%	1.3 3 0.5%	1.2 3 1.9%	0.3	0.8	70.1%
Energy Const, Ops & Maint. (16)	**Average** **Maximum** **Frequency**	6.1 13 1.9%	3.3 10 0.5%	1.8 6 0.1%	0.4	1.6	77.2%

[167] All instances of three vehicles operating at any interval occurred on or before 7/31/19, suggesting that one of these vehicles was retired at that point.

[168] Vehicle 668877 only shows two trips across the entire year's worth of data.

Energy Supply (4)	**Average** **Maximum** **Frequency**	1.8 4 1.9%	1.3 3 1.1%	1.3 3 3.5%	0.4	1.2	78.9%
Environmental Services[169] (1)	**Average** **Maximum** **Frequency**	n/a	n/a	n/a	0.1	0.1	100%
Facilities and Security Mgmt[170] (2)	**Average** **Maximum** **Frequency**	1.1 2 3.8%	1.0 2 0.5%	1.0 2 18.0%	0.2	1.1	86.4%
Field Services (1)	**Average** **Maximum** **Frequency**	n/a	n/a	n/a	0.5	1.6	56.5%
IT Service (2)	**Average** **Maximum** **Frequency**	1.7 2 41.5%	1.3 2 8.5%	1.1 2 7.6%	0.5	1.9	71.2%
Plan & Eng Resource Mgmt (5)	**Average** **Maximum** **Frequency**	2.4 5 3.8%	1.6 4 0.8%	1.2 4 0.2%	0.6	3.1	47.3%
Safety & Health (3)	**Average** **Maximum** **Frequency**	1.9 3 5.7%	1.3 3 0.3%	1.2 3 1.4%	0.3	0.9	77.5%
Southern Delivery System (1)	**Average** **Maximum** **Frequency**	n/a	n/a	n/a	0.3	1.3	72.7%
System Extensions (1)	**Average** **Maximum** **Frequency**	n/a	n/a	n/a	0.3	0.6	91.7%
Water System Maintenance (2)	**Average** **Maximum** **Frequency**	1.1 2 7.5%	1.0 2 0.3%	1.0 2 1.3%	0.5	1.6	74.5%
Water System Operations (3)	**Average** **Maximum** **Frequency**	2.2 3 34.0%	1.6 3 4.7%	1.2 3 2.2%	0.3	1.3	85.2%
Water Treatment (2)	**Average** **Maximum** **Frequency**	1.2 2 11.3%	1.1 2 2.7%	1.1 2 6.35%	0.3	0.7	87.7%

[169] Vehicle 939870 only shows one trip across the entire year's worth of data.

[170] Vehicle 966765 only shows two trips across the entire year's worth of data.

Table 22. Vehicle Utilization Figures – ¾ Ton Pickups

		Avg, Max, and Frequency of Max Vehicles in Use			Avg. Hours Driving		Low Daily Utilization
		Weekly	Daily	Hourly	Trip	Daily	
City Total (45)	Average Maximum Frequency	**34.6 39 7.5%**	**20.7 36 0.3%**	**8.7 34 0.02%**	**0.4**	**3.1**	**57.3%**
Fleet Management (4)	Average Maximum Frequency	3.1 4 52.8%	2.7 4 27.4%	1.8 4 5.2%	0.2	2.4	86.5%
Parks (31)	Average Maximum Frequency	22.8 27 7.5%	14.3 24 1.4%	7.0 26 0.02%	0.4	2.9	59.0%
PPRTA (1)	Average Maximum Frequency	n/a	n/a	n/a	2.0	4.9	32.2%
Stormwater Enter. (1)	Average Maximum Frequency	n/a	n/a	n/a	0.4	2.3	61.9%
Streets (8)	Average Maximum Frequency	6.8 8 30.2%	5.0 8 5.2%	2.5 7 0.3%	0.9	2.9	49.5%
Utility Total (54)	Average Maximum Frequency	**35.5 47 1.9%**	**20.2 40 0.3%**	**7.7 27 0.03%**	**0.5**	**2.7**	**63.6%**
Energy Const, Ops & Maint. (38)	Average Maximum Frequency	25.9 33 3.8%	16.2 29 0.3%	6.2 19 0.03%	0.5	2.5	66.2%
Energy Supply[171] (3)	Average Maximum Frequency	2.0 3 7.5%	1.6 3 0.8%	1.5 3 0.4%	0.3	1.3	89.5%
Environmental Services[172] (2)	Average Maximum Frequency	1.1 2 7.5%	1.0 2 1.4%	1.1 2 1.09%	0.7	2.7	46.7%
Field Service (3)	Average Maximum Frequency	1.9 3 39.6%	1.7 3 26.3%	1.7 3 14.1%	0.4	3.0	35.6%
Plan & Eng Resource Mgmt (2)	Average Maximum Frequency	1.7 2 64.2%	1.2 2 10.1%	1.1 2 6.0%	0.4	1.7	76.7%

[171] Vehicle 550151 only shows six trips across the entire year's worth of data.

[172] Vehicle 511808 only shows 16 trips across the entire year's worth of data, all of which show up in a four week period from 5/27/20 – 6/16/20.

Southern Delivery System (1)	**Average Maximum Frequency**	n/a	n/a	n/a	0.3	1.3	100%
Water System Maintenance[173] (4)	**Average Maximum Frequency**	2.1 3 22.6%	1.8 3 5.2%	1.7 3 1.3%	1.1	5.7	26.8%
Water System Operations (1)	**Average Maximum Frequency**	n/a	n/a	n/a	0.6	2.5	53.0%

[173] Vehicle 855510 only shows five trips across the entire year's worth of data.

Table 23. Vehicle Utilization Figures – 1 Ton Pickups

		Avg, Max, and Frequency of Max Vehicles in Use			Avg. Hours Driving		Low Daily Utilization
		Weekly	Daily	Hourly	Trip	Daily	
City Total (24)	Average	**18.4**	**10.5**	**5.4**			
	Maximum	**22**	**18**	**16**	**0.4**	**2.5**	**66.2%**
	Frequency	**1.9%**	**1.4%**	**0.05%**			
Parks (23)	Average	17.5	10.0	5.2			
	Maximum	21	17	15	0.4	2.5	67.6%
	Frequency	1.9%	1.4%	%			
Stormwater Enter. (1)	Average						
	Maximum	n/a	n/a	n/a	0.6	2.8	71.8%
	Frequency						
Utility Total (131)	Average	**89.4**	**47.7**	**15.3**			
	Maximum	**101**	**83**	**66**	**0.6**	**3.4**	**50.7%**
	Frequency	**1.9%**	**0.3%**	**0.02%**			
Energy Const, Ops & Maint. (37)	Average	23.9	14.2	6.0			
	Maximum	28	25	20	0.6	2.8	62.5%
	Frequency	3.8%	0.03%	0.05%			
Energy Supply (3)	Average	2.1	1.7	1.2			
	Maximum	3	3	3	0.4	1.7	86.0%
	Frequency	22.6%	6.0%	1.9%			
Environmental Services[174] (3)	Average	1.9	1.3	1.4			
	Maximum	3	3	3	0.7	2.9	46.6%
	Frequency	34%	1.1%	3.0%			
Facilities and Security Mgmt (8)	Average	5.6	3.9	2.7			
	Maximum	8	7	8	0.3	2.5	80.3%
	Frequency	9.4%	2.7%	0.04%			
Field Service (46)	Average	29.0	15.2	7.7			
	Maximum	35	29	28	0.6	4.3	38.9%
	Frequency	1.9%	0.03%	0.04%			
Plan & Eng Resource Mgmt (3)	Average	2.3	1.8	1.4			
	Maximum	3	3	3	0.9	3.9	36.9%
	Frequency	39.6%	11.5%	5.3%			
Water System Maintenance (9)	Average	7.8	5.4	2.6			
	Maximum	9	9	8	0.6	2.5	62.8%
	Frequency	28.3%	2.7%	0.04%			
Water System Operations (21)	Average	15.9	8.9	3.6			
	Maximum	20	17	16	0.9	3.9	35.7%
	Frequency	1.9%	0.5%	0.03%			
Water Treatment (3)	Average	2.2	1.6	1.2			
	Maximum	3	3	3	0.4	1.9	74.7%
	Frequency	28.3%	3.6%	0.4%			

[174] Vehicle 855510 only shows 38 trips on 8 days across the entire year's worth of data.

Table 24. Vehicle Utilization Figures – 2 Ton Pickups

		Avg, Max, and Frequency of Max Vehicles in Use			Avg. Hours Driving		Low Daily Utilization
		Weekly	Daily	Hourly	Trip	Daily	
City Total (37)	Average Maximum Frequency	**26.3 30 1.9%**	**15.2 27 0.3%**	**6.4 25 0.06%**	**1.1**	**4.3**	**45.0%**
Community Development[175] (1)	Average Maximum Frequency	n/a	n/a	n/a	0.9	1.5	0%
Parks (6)	Average Maximum Frequency	5.1 6 35.8%	3.1 6 1.6%	1.7 6 0.05%	0.4	2.1	68.1%
PPRTA (2)	Average Maximum Frequency	1.3 2 26.4%	1.1 2 5.8%	1.0 2 3.6%	1.1	3.3	31.6%
Stormwater Enter. (1)	Average Maximum Frequency	n/a	n/a	n/a	0.5	2.6	70.8%
Streets (27)	Average Maximum Frequency	19.0 22 5.7%	11.9 21 0.03%	5.5 22 0.07%	1.4	4.9	38.6%
Utility Total (75)	Average Maximum Frequency	**42.8 50 1.9%**	**21.4 38 0.03%**	**8.8 34 0.02%**	**0.7**	**3.5**	**47.3%**
Energy Const, Ops & Maint. (51)	Average Maximum Frequency	31.4 37 1.9%	16.1 28 0.03%	7.0 26 0.02%	0.7	3.6	45.7%
Field Service (4)	Average Maximum Frequency	2.4 4 9.4%	1.5 4 1.1%	1.5 4 5.5%	0.7	3.8	44.4%
Water System Maintenance (14)	Average Maximum Frequency	7.4 10 3.8%	4.8 8 2.5%	3.4 10 0.2%	0.8	3.2	54.2%
Water System Operations (6)	Average Maximum Frequency	1.9 4 7.5%	1.3 4 0.3%	1.6 4 1.2%	0.8	2.6	53.2%

[175] Vehicle 228796 only shows five trips across the entire year's worth of data.

Table 25. Vehicle Utilization Figures – MD Trucks

		Avg, Max, and Frequency of Max Vehicles in Use			Avg. Hours Driving		Low Daily Utilization
		Weekly	Daily	Hourly	Trip	Daily	
City Total (18)	**Average Maximum Frequency**	**12.6 17 5.7%**	**7.6 16 0.3%**	**2.7 13 0.04%**	**1.4**	**4.7**	**38.2%**
Community Development (1)	**Average Maximum Frequency**	n/a	n/a	n/a	1.5	3.8	32.8%
Fleet Management (2)	**Average Maximum Frequency**	1.6 2 58.5%	1.4 2 29.0%	1.4 2 33.5%	1.6	5.4	28.7%
Parks (1)	**Average Maximum Frequency**	n/a	n/a	n/a	0.4	2.7	57.1%
PPRTA (1)	**Average Maximum Frequency**	n/a	n/a	n/a	2.5	6.2	17.4%
Streets (13)	**Average Maximum Frequency**	8.3 12 9.4%	4.6 11 0.3%	2.2 10 0.06%	1.6	4.8	42.1%
Utility Total (43)	**Average Maximum Frequency**	**24.7 32 1.9%**	**11.7 24 0.8%**	**4.4 16 0.03%**	**0.4**	**1.7**	**83.8%**
Energy Const, Ops & Maint. (42)	**Average Maximum Frequency**	24.5 32 1.9%	11.7 24 0.8%	4.4 16 0.03%	0.4	1.7	83.8%
Water System Operations (1)	**Average Maximum Frequency**	n/a	n/a	n/a	0.5	1.3	58.3%

Table 26. Vehicle Utilization Figures – HD Trucks

		Avg, Max, and Frequency of Max Vehicles in Use			Avg. Hours Driving		Low Daily Utilization
		Weekly	Daily	Hourly	Trip	Daily	
City Total (47)	**Average** **Maximum** **Frequency**	**35.5** **46** **3.8%**	**20.5** **40** **0.5%**	**6.1** **29** **0.5%**	**1.6**	**4.9**	**37.3%**
Parks (1)	**Average** **Maximum** **Frequency**	n/a	n/a	n/a	0.5	3.2	41.8%
PPRTA (5)	**Average** **Maximum** **Frequency**	4.1 5 26.4%	2.7 5 2.7%	1.5 5 0.22%	2.8	5.6	28.2%
Stormwater Enter. (5)	**Average** **Maximum** **Frequency**	4.3 5 50.9%	2.9 5 7.7%	1.6 5 0.5%	1.4	4.7	30.7%
Streets (36)	**Average** **Maximum** **Frequency**	26.1 35 9.4%	15.9 32 0.8%	5.1 26 0.04%	1.6	4.9	39.6%
Utility Total (104)	**Average** **Maximum** **Frequency**	**77.9** **86** **3.8%**	**37.2** **71** **0.3%**	**10.5** **47** **0.02%**	**0.9**	**3.1**	**54.0%**
Energy Const, Ops & Maint. (57)	**Average** **Maximum** **Frequency**	42.1 50 1.9%	20.9 40 0.3%	7.1 24 0.03%	0.6	2.2	70.9%
Energy Supply (4)	**Average** **Maximum** **Frequency**	2.7 4 20.8%	1.5 4 0.5%	1.2 3 1.1%	1.8	2.8	67.8%
Field Service (2)	**Average** **Maximum** **Frequency**	2.0 2 98.1%	1.6 2 40.5%	1.2 2 24.2%	1.4	7.3	10.5%
Water System Maintenance (39)	**Average** **Maximum** **Frequency**	30.4 36 3.8%	16.4 31 0.3%	5.5 25 0.03%	1.2	4.0	34.8%
Water System Operations (2)	**Average** **Maximum** **Frequency**	1.3 2 17.0%	1.1 2 1.4%	1.0 2 3.8%	1.4	2.9	56.3

Table 27. Vehicle Utilization Figures – Vans

		Avg, Max, and Frequency of Max Vehicles in Use			Avg. Hours Driving		Low Daily Utilization
		Weekly	Daily	Hourly	Trip	Daily	
City Total (19)	**Average Maximum Frequency**	**12.3 17 1.9%**	**7.3 15 0.5%**	**3.2 11 0.06%**	**0.6**	**3.2**	**50.7%**
Community Development[176] (5)	**Average Maximum Frequency**	3.3 5 30.2%	2.5 5 9.3%	1.8 5 0.5%	1.2	5.2	20.1%
Fleet Management (4)	**Average Maximum Frequency**	3.4 4 62.3%	2.8 4 23.0%	1.7 4 2.4%	0.4	3.0	70.8%
Information Technology (2)	**Average Maximum Frequency**	1.8 2 75.5%	1.4 2 21.4%	1.1 2 9.5%	0.2	0.9	77.9%
Parks (7)	**Average Maximum Frequency**	3.2 7 1.9%	1.8 5 0.8%	1.4 6 0.3%	0.3	0.9	84.7%
Procurement Services (1)	**Average Maximum Frequency**	n/a	n/a	n/a	0.3	3.6	16.7%
Utility Total (31)	**Average Maximum Frequency**	**21.4 26 1.9%**	**12.2 24 0.3%**	**4.4 17 0.03%**	**0.6**	**2.5**	**69.1%**
Energy Const, Ops & Maint. (21)	**Average Maximum Frequency**	16.2 19 9.4%	9.7 16 1.9%	3.8 14 0.03%	0.5	2.2	74.2%
Field Service[177] (3)	**Average Maximum Frequency**	1.8 3 3.8%	1.3 3 0.5%	1.2 3 2.5%	0.2	0.8	86.8%
Water System Maintenance (6)	**Average Maximum Frequency**	3.1 6 1.9%	2.2 6 0.3%	1.4 5 0.32%	2.0	5.2	25.8%
Water System Operations (1)	**Average Maximum Frequency**	n/a	n/a	n/a	0.4	2.3	64.3%

[176] All instances of 5 vehicles occurred in 2019; vehicle 1020803 does not appear with trips in 2020.

[177] Vehicle 981711 only shows three trips across the entire years' worth of data

Table 28. Vehicle Utilization Figures – Busses

		Avg, Max, and Frequency of Max Vehicles in Use			Avg. Hours Driving		Low Daily Utilization
		Weekly	Daily	Hourly	Trip	Daily	
City Total (2)	Average Maximum Frequency	1.5 2 45.3%	1.2 2 6.0%	1.1 2 7.8%	0.5	1.6	36.0%

EVSE Siting Analysis

While the operational profiles of both the City and Springs Utilities fleets are generally well suited for transition to EVs, keeping these vehicles charged and ready for duty presents both a challenge and opportunity for each organization. The purpose of this section is to highlight the charging needs across vehicle segments based on the operational analysis of each vehicle. The results are further refined by facility location for both the City and Springs Utilities.

While vehicle availability lags in some places, the opportunity to prepare for the influx of EVs by planning for and installing the necessary infrastructure to support those vehicles is immediate. The methodology described below estimates the minimum number of chargers needed to support the operation of these vehicles. As with the EV Operational Analysis, estimated energy use per vehicle is used in order to determine how often a vehicle would need to charge at its home location to fulfill the driving observed. Conventional wisdom often assumes that each vehicle requires its own dedicated charger. These results show that much less charging infrastructure is *needed* than a 1-to1 vehicle-to-charger ratio; across all vehicles this ratio is approximately 2.5 vehicles per charger. However, this figure varies from location to location, across vehicle segments, and from Level 2 to DC Fast Charging (DCFC).

The results presented here are intended to facilitate the initial infrastructure planning phase and are based on the 1-year of real-world operational data used for this analysis. To the extent that this data includes anomalies in operation (e.g., a slowdown in vehicle use due to COVID-19, or a boost in vehicle use due to another emergency) versus status quo operations, the data account for these if they occurred in the July 1, 2019 to June 30, 2020 timeframe. Scenario planning outside of these dates is not within the scope of this project.

Methodology

Similar to the approach in the EV Operational Analysis, available telematics data were used to identify each individual vehicles' parking locations and durations to inform needed charging infrastructure, or electric vehicle supply equipment (EVSE). Location based information is combined with the estimated energy consumption for each vehicle to inform the number and power of the chargers (Level 1, Level 2, and DC Fast Charging) needed to support fleet EVs. The results presented are based on the use of either Level 2 or DCFC infrastructure; all estimates are made as if all vehicles were transitioning to their base EV model. The analysis only considers City or Utility facilities for charging since vehicles generally would not require mid-day charging considering (1) the very low frequency of vehicles likely consuming more than a full charge in a single day and (2) that across both organizations 99% of current refueling occurs at bulk fuel centers operated by either the City or Springs Utilities. The potential use of existing, publicly available EVSE is not factored into this analysis.

The EVSE siting analysis relies on the same key data sources as the EV Operational Analysis, particularly the latitude and longitude of parking locations and estimated energy use. First, parking locations were identified at the end of each travel day for each individual vehicle. These were tallied and the location at which a vehicle parked most often at the end of each day's travel is identified as the "home location" for that vehicle. This process identified 24 home parking locations for the City and 15 for Springs Utilities. A deeper dive revealed 123 parking sites at residential locations, City or Utility facilities housing just a single vehicle, and/or which could not be easily identified through online search; this is summarized in Table 34. There were also 6 joint facilities identified – both the City and Springs Utilities have vehicles with home parking locations identified at the facility. The facilities noted only account for home parking location as a function of the *most frequent parking location at the end of each day,* and do not account for vehicles parking at these locations during other trips (during which time they could, theoretically, use EVSE available at that location too).

Table 29. Summary of EVSE Siting Recommendations

	Parking Facilities Included	Total Number of Vehicles	Total Number of Chargers	Vehicle to Charger Ratio	Total Est. Energy Needs
City of Colorado Springs[178]	**24**	**335**	**137**	**2.4 to 1**	**1.37 GWh**
Level 2	24	252	102	2.3 to 1	0.72 GWh
DCFC	7	65	17	3.8 to 1	0.62 GWh
Single Vehicle & Residential	18	18	18	1 to 1	0.03 GWh
Colorado Springs Utilities	**15**	**611**	**238**	**2.6 to 1**	**2.50 GWh**
Level 2	15	350	111	3.2 to 1	0.99 GWh
DCFC	8	145	23	6.3 to 1	0.96 GWh
Single Vehicle & Residential	105	105	105	1 to 1	0.56 GWh

Second, each vehicle was catalogued based on its estimated energy use in the base vehicle listed in Table 8 based their vehicle category. The estimates for charging needs are only based on the single base vehicle and do not account for any recommendations made to move a particular vehicle into an EV with a larger

[178] Level 2 and DCFC charging locations are co-located at city facilities.

battery (e.g., moving from a 40 kWh Nissan Leaf to a 62 kWh Leaf). Similarly, the results do not account for any recommendations to retain an ICE vehicle in place of an EV.

Next, average daily estimated energy use was then calculated for each vehicle – in the base EV for its vehicle segment – and the number of days that it actually drove in the observed dataset. This provides a sense of the energy that would have been needed to power that vehicle when it drove but does not account for the days on which the vehicle did not drive. To account for this, average daily estimated energy use was weighted based on the percentage of days that a vehicle actually drove over the course of the full data set. This figure is then compared to the battery size of the base EVs assigned by vehicle segment to estimate the amount of charge a vehicle would need on a daily basis. These calculations also assume that waiting to charge a vehicle until its battery is fully depleted is not desirable. The results below reflect a scenario in which vehicles are expected to charge at 30% remaining SOC.

For example, sedan 238447 (a 2011 Ford Focus) drove on 192 days (74% of 261 working days in a calendar year) and was active on average 4 days a week during the weeks in which driving was observed. This vehicle averaged 25 miles per day and an estimated daily energy use of 5.6 kWh. In the base 40 kWh Nissan Leaf, this vehicle would only need to charge[179], on average, once every 6-7 days at that level of utilization. Which is to say that the same charger would be available to other vehicles to use the other 6 days. Since the vehicles only operated on 74% of observable days, it would only need approximately 16% of a full charge every day. In this scenario, a single Level 2 charger would be sufficient to support 6 vehicles (each with the same level of driving/utilization averages), each receiving one full charge once per week.

These results are then aggregated by vehicle segment and by home parking locations to establish the number of full charges needed per day, per facility. One full charge needed per day equates to one charger recommended at a particular facility. Facilities housing a single vehicle or vehicles whose charging needs do not sum to one are recommended by default to one charger. All values are rounded up to the nearest whole number of chargers. The results below are further broken down by the need for both Level 2 and DC Fast Charging (DCFC). DCFC is only recommended in this analysis at facilities with either Medium- or Heavy-Duty vehicles given that the base EVs for MD/HD vehicles require DCFC to recharge.

As these recommendations are based on average vehicle use over the course of a year, they necessarily cannot account for a number of real-world operational scenarios that could impact EVSE availability and use. The calculations assume that charging will occur after working hours and overnight at their home parking location. This does not account for nights/days that a vehicle parks at another location, nor does it account for a vehicles ability to charge during working hours when not in use or on days that a vehicle is not active and while other vehicles are in use. The assumptions also do not account for trips ending at another city/utility location that are not the 'home location' and could charge while parking there during work. They also do not account for the fact that utilization and mileage is not evenly distributed across vehicles or days in use. There remains a possibility in which more than one vehicle would experience

[179] Weekend charging is assumed to be possible. One daily charge per charger is allowed on the assumption that vehicles would often be active during working hours, that there is not someone available to swap a charger from one vehicle to another in the middle of the night, and because time to charge differences based on battery technology and size are not accounted for. Theoretically, however, a Level 2 charger could charge 3 fully depleted 40 kWh Nissan Leaf batteries consecutively in a 24-hour period.

unusually high use on the same day and therefore need access to a charger at the same time. These scenarios will need to be managed by both fleets to ensure that vehicles receive enough fuel to remain operational.

EVSE Siting Results

Both the City and Springs Utilities vehicles included in this analysis currently refuel the vast majority of their time at bulk fueling centers owned and/or operated by the City or Springs Utilities. Some of these facilities already include charging infrastructure (noted with an asterisk *) as well. The charging needs at these facilities are shown in Table 30. In some cases, both organizations have vehicles with a home parking location at the other organization's facility.

Table 30. EVSE Siting Analysis Needs at Existing Bulk Fueling Locations

	Vehicles	Chargers Needed	Vehicle to Charger Ratio	Total Est. Annual kWh
City – Main Garage	**148**	**43**	**3.4 to 1**	**709,700**
Level 2 – City	43	17	2.5 to 1	195,544
DCFC – City	27	6	4.5 to 1	279,792
Level 2 – Utilities	71	18	3.9 to 1	213,424
DCFC – Utilities	7	2	3.5 to 1	20,939
City – Transit	**2**	**2**	**1 to 1**	**6,701**
Level 2 – City	1	1	1 to 1	2,814
DCFC – City	1	1	1 to 1	3,886
City – Body Shop (Level 2 only)	**23**	**6**	**3.8 to 1**	**54,705**
City – Police West (Level 2 only)	**1**	**1**	**1 to 1**	**1,481**
Utilities – Leon Young*	**186**	**31**	**6 to 1**	**787,745**
Level 2 – Utilities	108	25	4.3 to 1	291,952
DCFC – Utilities	78	9	8.7 to 1	495,793
Utilities – Pinkerton*	**100**	**23**	**4.3 to 1**	**394,022**
Level 2 – Utilities	66	19	3.5 to 1	216,683
DCFC – Utilities	34	4	8.5 to 1	177,339
Utilities – Martin Drake[180]	**9**	**5**	**1.8 to 1**	**34,071**
Level 2 – Utilities	6	4	1.5 to 1	14,788
DCFC – Utilities	3	1	3 to 1	19,283

[180] The Drake facility is in the process of being retired. This analysis was performed before the retirement of the coal plant. Reallocation of chargers at this site should be determined based on relocation of fleet vehicles.

There were an additional four facilities that both City and Springs Utilities vehicles had identified as their home parking location. These are listed in Table 31.

Table 31. EVSE Siting Analysis Needs at Joint Use Facilities

	Vehicles	Chargers Needed	Vehicle to Charger Ratio	Total Est. Annual kWh
City – City Hall	**36**	**9**	**4 to 1**	**35,662**
Level 2 – City	34	7	4.9 to 1	35,229
Level 2 – Utilities	2	2	1 to 1	433
City – Forestry Division	**43**	**15**	**2.9 to 1**	**124,840**
Level 2 – City	40	12	3.3 to 1	111,028
DCFC – City	2	2	1 to 1	8,920
Level 2 – Utilities	1	1	1 to 1	4,892
City – Bear Creek Rd	**11**	**6**	**1.8 to 1**	**101,545**
Level 2 – City	4	3	1.3 to 1	10,345
DCFC – City	6	2	3 to 1	86,305
Level 2 – Utilities	1	1	1 to 1	4,896
City – Parks (El Pomar)	**4**	**3**	**1.3 to 1**	**1,481**
Level 2 – City	3	2	1.5 to 1	1,399
DCFC – Utilities	1	1	1 to 1	82
City – Community Garden (Eros Way)	**8**	**4**	**2 to 1**	**33,894**
Level 2 – City	7	3	2.3 to 1	26,188
Level 2 – Utilities	1	1	1 to 1	7,707

The following 17 facilities had at least two City vehicles with this location as their home parking spot.

Table 32. EVSE Siting Analysis Needs at City Facilities

	Vehicles	Chargers Needed	Vehicle to Charger Ratio	Total Est. Annual kWh
Street Department (Briargate)	**18**	**5**	**3.6 to 1**	**111,367**
Level 2	6	3	**2 to 1**	27,818
DCFC	12	2	**6 to 1**	83,549
Street Department (HQ)	**32**	**8**	**4 to 1**	**147,438**
Level 2	23	6	**3.8 to 1**	64,301
DCFC	9	2	**4.5 to 1**	83,137
Street Department (Out W Dr)	**14**	**6**	**2.3 to 1**	**101,852**
Level 2	6	4	**1.5 to 1**	23,665
DCFC	8	2	**4 to 1**	78,187
Horticulture (L2)	**5**	**3**	**1.7 to 1**	**7,386**
Cheyenne Canyon Rd (L2)	**3**	**2**	**1.5 to 1**	**12,626**
Community Garden (Eros Way) (L2)	**7**	**3**	**2.3 to 1**	**26,188**
Garden of the Gods (L2)	**1**	**1**	**1 to 1**	**3,019**
Lakeshore Ct (L2)	**9**	**4**	**2.3 to 1**	**33,416**
M. Rayner Stables (L2)	**2**	**2**	**1 to 1**	**6,160**
Parks (Gossage) (L2)	**6**	**4**	**2.3 to 1**	**16,573**
Parks (Memorial) (L2)	**6**	**3**	**2 to 1**	**3,141**
Pikes Peak (L2)	**2**	**1**	**2 to 1**	**7,765**
Tenderfoot (L2)	**8**	**5**	**1.6 to 1**	**34,087**

Deerfield Community Center (L2)	**2**	**1**	**2 to 1**	**762**
Girl Scouts Hut (L2)	**4**	**4**	**1 to 1**	**16,815**
Pikes Peak Regional Bldg Dept (L2)	**25**	**8**	**3.1 to 1**	**49,750**
Parking Lot (CO Ave & Cimino Dr) (L2)	**11**	**5**	**2.2 to 1**	**24,308**

The following 5 facilities had at least two Springs Utilities vehicles with this location as their home parking spot.

Table 33. EVSE Siting Analysis Needs at Springs Utilities Facilities

	Vehicles	Chargers Needed	Vehicle to Charger Ratio	Total Est. Annual kWh
Nichols Blvd	**41**	**14**	**2.9 to 1**	**94,516**
Level 2	39	13	3 to 1	90,446
DCFC	2	1	2 to 1	4,069
Las Vegas Wastewater	**39**	**11**	**3.5 to 1**	**309,772**
Level 2	20	8	2.5 to 1	74,002
DCFC	19	3	6.3 to 1	235,770
Nixon Power Plant[181]	**10**	**9**	**1.1 to 1**	**12,447**
Level 2	8	7	1.1 to 1	10,442
DCFC	2	2	1 to 1	2,035
Conservation & Environmental Center*	**3**	**2**	**1.5 to 1**	**959**
Gold Field Dr	**2**	**1**	**2 to 1**	**3,125**

[181] The Nixon facility is in the process of being retired. This analysis was performed before the retirement of the coal plant. Reallocation of chargers at this site should be determined based on relocation of fleet vehicles.

Across both organizations there were a number of vehicles whose home parking locations appear to be at residential locations and/or at facilities where only a single vehicle resided there. A summary of these vehicles' charging needs is shown in Table 34.

Table 34. EVSE Siting Analysis Needs at Residential and Single Vehicle Facilities

	Vehicles	Chargers Needed	Vehicle to Charger Ratio	Total Est. Annual kWh
Level 2 – City	18	18	1 to 1	31,676
Level 2 – Utilities	103	103	1 to 1	563,288
DCFC – Utilities	2	2	1 to 1	1,830

8. Colorado Springs City and Utilities Fleet Transition Opportunities and Recommendations

The purpose of this section of the report is to identify vehicles in the City of Colorado Springs' (City) and Colorado Springs Utilities' (Springs Utilities) fleets that would be most cost-effective to convert to electric, and to summarize the associated financial and environmental benefits of converting those vehicles. The analysis assesses the full number of on-road vehicles in both the City's and Springs Utilities' fleets. For both, ICF produced a recommended replacement timeline and estimated the net present value (NPV) total cost of ownership (TCO) under that timeline for two scenarios: EV replacement and business-as-usual vehicle replacement. Site-level charging infrastructure cost estimates are also included in the analysis, as well as estimated emissions benefits from EV transition. While the analysis in Section 7 focused on using telematics data to identify for which vehicles EV replacement is feasible and to determine EVSE infrastructure siting recommendations, this section expands on that by identifying suitable EV replacement makes and models and identifying where replacement is cost-effective.

As a followup to the telematics assessment of the *operational* feasibility of electrifying the fleet vehicles, ICF assessed the *economic* feasibility of electrifying fleet vehicles. While the operational analysis focused on a subset of vehicles outfitted with telematics, the economic analysis assessed 1,584 on-road vehicles in the City's fleet, and 1,052 on-road vehicles in the Springs Utilities' fleet. This analysis included two replacement scenarios: a non-phased replacement schedule scenario and a phased replacement schedule scenario. The non-phased scenario assumes that EV replacement starts in 2023 and all existing vehicles with an age over the assumed vehicle lifespan (10 years) prior to 2023 are to be first replaced with ICE vehicle intermediaries. In this scenario, the ICE vehicle intermediaries would be operated for another cycle of 10 years, and at that time the intermediaries would be replaced with EVs. Given that approximately half of both fleets, the City and Utilities, are older vehicles which will be ready for replacement before 2023, this scenario generates a significant spike of EV replacements in 2031. The phased scenario is designed to level-out that spike and phase-in annual EV replacements more evenly. To do this, ICF first estimated replacement years for existing vehicles by adding 10 years to the vehicle in-service date. For vehicles with an estimated replacement year prior to 2023, ICF used the life-to-date mileage values provided by the client to estimate the number of useful years left in the vehicle based on typical lifetime mileage values. From there, estimated remaining useful life was used on a per-vehicle basis to deviate the assumed vehicle lifespan by some time above or below the nominal assumed lifespan where appropriate. The amount of deviation was determined by the estimated remaining useful life for each vehicle.

For the City fleet, ICF identified that 1,050 vehicles would be cost effective to convert over the replacement timeline under the non-phased scenario, and 970 vehicles under the phased scenario. For the Utilities fleet, 297 vehicles were found to be cost effective for EV replacement under the non-phased scenario, and 81 vehicles were found to be cost effective for EV replacement under the phased replacement scenario. Importantly, ICF's calculations assume a 10% TCO threshold for determining cost-effectiveness. In this case, any EV replacements that cost less than or up to 10% higher than the business-as-usual replacement cost are considered cost-effective. For the City fleet, these replacements are estimated to yield a NPV transition cost savings of $26.3 million and $26.1 million under the non-phased and phased scenarios, respectively. For the Utilities fleet, recommended replacements are estimated to yield a NPV TCO savings of $2.4 million and $4.3 million under the non-phased and phased scenarios, respectively. This only accounts for the savings associated with one cycle of vehicle replacements and operating costs for the life of all replacement vehicles. It does not include any capital or operating expenses after all replacement vehicles have reached the end of their service lives. It also does not include any vehicle or infrastructure incentive funding, which is available but was intentionally left out of the analysis. It includes infrastructure costs for EVSE hardware and installation but does not include costs associated with any electric distribution grid upgrades or site-level make-ready upgrades that may be necessary to accommodate EV chargers. The following sections discuss ICF's methodology and the assessment results.

Methodology

This assessment covers vehicle replacements from 2023 to 2037, accounting for a target average vehicle lifespan of 10 years. However, the TCO analysis extends to 2050 to account for the ongoing fuel and maintenance costs from the vehicles acquired out to 2037. As discussed above, ICF used a 10% TCO threshold when determining whether or not to recommend EV replacement.

The fleet assessment process was completed in three phases. First, to develop the model's inputs, ICF began by requesting existing baseline vehicle and usage data for all vehicles in the City and Utilities fleets. ICF requested basic vehicle information including vehicle type, make, model, year, engine fuel type, ownership status, lifetime-to-date and annual mileage, scheduled vehicle retirement year, and in-service date. The team also requested more detailed operational data including typical mileage per day, annual fuel and maintenance costs, vehicle purpose, shifts per day, time available to charge between shifts, time to charge at night, and information on any significant variability in daily use. ICF relied on current industry data and trends where data was not available or provided, and the key assumptions used to fill in any data gaps are included in a later section.

ICF used the EV model library it maintains to identify suitable EV equivalents available to replace existing vehicles. ICF then estimated a TCO comparison for each vehicle. The TCO analysis included vehicle capital costs and annual fuel and maintenance costs for both EVs and ICE vehicles. For EVs, the analysis also included charging infrastructure hardware and installation costs. The results of these TCO calculations determined ICF's EV replacement recommendations. The modeling tool used recommended the lowest cost EV option for each existing vehicle which is under the 10% TCO threshold described above. The following sections will describe the results of this assessment, starting with a characterization of the City's and Springs Utilities' existing fleets.

Existing Fleets Characterization

The City provided data on 2,872 fleet vehicles, of which 1,288 were sold during the analysis or excluded as non-road vehicles or equipment, leaving 1,584 on-road vehicles to assess. Springs Utilities fleet data contained 2,145 total vehicles, 1,093 of which were non-road vehicles and equipment that were excluded from the analysis. That left 1,052 on-road vehicles in the fleet to be considered. The table below provides a breakdown of the vehicle data provided by each fleet manager and a breakdown of the vehicles with EV equivalents recommended for conversion for both the City and Springs Utilities fleets.

Table 35. Fleet Summary for City and Springs Utilities Fleets

Item	City of Colorado Springs	Colorado Springs Utilities
TCO Threshold for EV Recommendations	10%	10%
Total of Vehicles Provided in City/Utilities Data	2,872	2,145
Vehicles Sold During Analysis	4	N/A
Excluded On-Road Vehicles Without EV Equivalents	57	N/A
Excluded Non-Road Vehicles and Equipment	1,227	1,093
Total Vehicles Considered in Analysis	1,584	1,052
Vehicles Recommended for Conversion without Incentives (10% TCO Threshold)	Non-Phased: 1,050, Phased: 970	Non-Phased: 297, Phased: 81

City Fleet Characterization

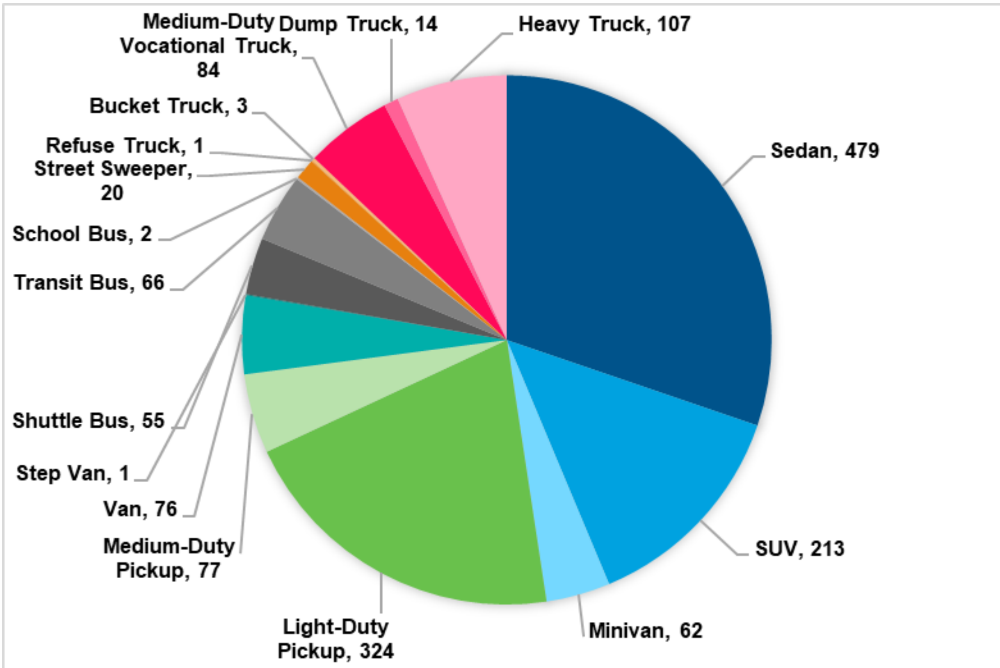
There are 1,584 on-road vehicles in the city's fleet with EV equivalents. Most of these vehicles are gasoline fueled, at 77%, and 23% are diesel fueled. The following table and figures show a breakdown of the city's existing fleet by vehicle type and fuel type.

Table 36. Existing City Fleet Fuel Types

		Existing Fleet - Fuel Types	
Vehicle Types	Total	Gasoline	Diesel
Sedan	479	479	0
SUV	213	213	0
Minivan	62	62	0
Light-Duty Pickup	324	324	0
Medium-Duty Pickup	77	63	14
Van	76	71	5
Step Van	1	0	1
Shuttle Bus	55	0	55
Transit Bus	66	0	66
School Bus	2	0	2
Street Sweeper	20	0	20
Refuse Truck	1	0	1
Bucket Truck	3	0	3
Medium-Duty Vocational Truck	84	0	84
Dump Truck	14	0	14
Heavy Truck	107	0	107
TOTAL	**1584**	**1212**	**372**

Over 70 percent of the fleet is made up of light-duty vehicles which is illustrated in the pie chart below.

Figure 20. Existing Fleet Vehicle Types



The analysis assessed the economic feasibility of replacing the city's on-road vehicles with EV equivalents. The 1,288 active vehicles that were excluded from the analysis included the following vehicle types which are either non-road equipment or are on-road vehicles that do not have any known current or planned electric vehicle options: trailers, chippers, sanders, backhoes, mowers, sign trailers, paint strippers, loader-skids, loaders, snowplows, pavers, snowblowers, compressors, planers, cranes, cement mixers, rollers, forklifts, ATVs, generators, trenchers, concrete saws, motorgraders, welders, overhead cranes, excavators, dozers, screens, water pumps, boats, zambonis, mobile generators, motorcycles, fire trucks, ambulances, motorhomes, trash pumps, and boring machines. Given that this assessment covers a vehicle transition timeline of 15 years, it is possible that some of these vehicle and equipment types could have EV options become available before the end of the transition timeline.

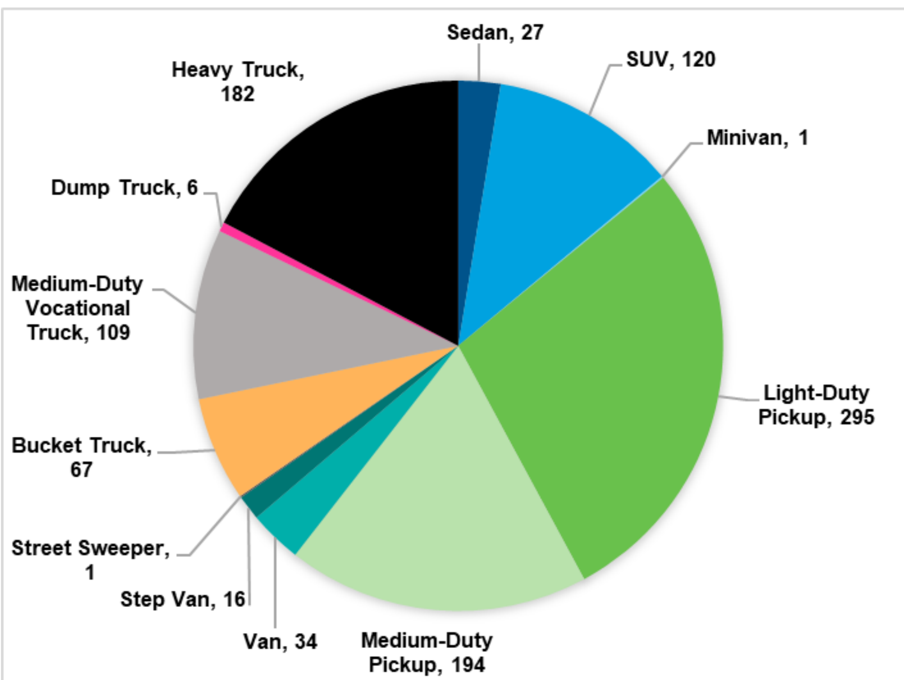
Colorado Springs Utilities Fleet Characterization

There are 1,052 on-road vehicles in the Springs Utilities fleet, most of which are gasoline (60%) and diesel (38%) powered. There are also eight light-duty pickups that are fueled with compressed natural gas, as well as eight sedans with battery electric powertrains. The following table and figures show a breakdown of Springs Utilities' existing fleet by vehicle type and fuel type. Nearly 50% of the fleet is made up of light-duty and medium-duty pickup trucks which is illustrated in the pie chart below. Approximately 58 percent of the Springs Utilities vehicles are medium- or heavy-duty vehicles. This market segment has been slower to mature and there are currently fewer existing EV model equivalents available for these vehicles, however medium- and heavy-duty EV options are expected to expand over time.

Table 17: Existing Springs Utilities Fleet Fuel Types

		Existing Fleet – Fuel Types			
Vehicle Types	Total	Gasoline	Diesel	CNG	BEV
Sedan	27	19	0	0	8
SUV	120	120	0	0	0
Minivan	1	1	0	0	0
Light-Duty Pickup	295	283	4	8	0
Medium-Duty Pickup	194	176	18	0	0
Van	34	27	7	0	0
Step Van	16	0	16	0	0
Street Sweeper	1	0	1	0	0
Bucket Truck	67	0	67	0	0
Medium-Duty Vocational Truck	109	13	96	0	0
Dump Truck	6	0	6	0	0
Heavy Truck	182	0	182	0	0
TOTAL	**1052**	**639**	**397**	**8**	**8**

Figure 21. Existing Fleet Vehicle Types



The 1,093 vehicles that were excluded from the analysis are summarized in the table below. Given that this assessment covers a transition timeline of 15 years, it is possible that EV options become available for some of these vehicle types before the end of the transition timeline. It is also possible that some of these vehicle types may no longer be needed by the end of the timeline; for instance, Coal Pushers may retire as the City retires coal plants over time.

Table 38: Non-Road Vehicles and Equipment Excluded from the Analysis

Vehicle / Equipment Type	Quantity	Vehicle / Equipment Type	Quantity
Aerial Manlift	28	Loader	21
ATV	70	Loader-Skid	20
Backhoe	27	Misc.	38
Boat	5	Motorgrader	4
Boring Machine	6	Mower	12
CAT	2	Mudcat	3
Chipper	1	Roller	8
Coal Pusher	9	Sander	4
Compressor	40	Screen	3
Concrete Saw	1	Sign Trailer	10
Crane CRNR MT	29	Snowcat	4
Crane Overhead	99	Snowplow	31
Derrick	4	Terragator	2
Dozer	6	Trackmobile	2
Excavator	34	Tractor	10
Excavator-SM	3	Trailer	304
Forklift	56	Trencher	1
Generator	128	Utility Machinery (Misc.)	5
Generator-FAC	2	Vacuum	2
Jet Vac	2	Water Pump	28
Light Plant	8	Welder	21
Total Quantity	1,093		

Key Assumptions

Key assumptions and data sources that were used in this analysis include the following. The Electric Vehicle Replacement Recommendations Section below provides additional detail on the financial assumptions used in ICF's modeling.

Assumptions Common to Both Fleets

- **TCO Recommendation Threshold:** This analysis uses a 10% TCO threshold, meaning that on a vehicle-by-vehicle basis, EV replacements are recommended for any vehicle in which the lifetime NPV TCO of the lowest-cost EV is either less than that of the ICE vehicle TCO or no more than 10% higher than the ICE TCO.[182]

- **Vehicle Pricing:** The model uses manufacturer suggested retail prices (MSRPs) for EVs where available, as well as the Colorado State Vehicle Bid List for 2020 model year fleet vehicles where available. When MSRP pricing and Colorado State pricing is unavailable, the model uses average pricing based on vehicle and fuel type based on Argonne National Laboratory's Alternative Fuel Life Cycle Environmental and Economic Transportation (AFLEET) Tool and ICF's Comparison of Medium- and Heavy-Duty Technologies in California report for the California Electric Transportation Coalition." Vehicle pricing was escalated annually using the U.S. Energy Information Administration's (EIA) 2020 Annual Energy Outlook (AEO) and ICF's *Comparison of Medium- and Heavy-Duty Technologies in California* report for the California Electric Transportation Coalition. The model uses the current "leased" or "owned" classification for each vehicle for future replacements.

- **Fuel:** Annual fuel costs were provided by Colorado Springs Utilities on a vehicle-by-vehicle basis, and that data is used in TCO calculations. The modeling completed for the City of Colorado Springs' vehicle fleet does not contain City-provided annual fuel cost data; this data was either not provided or could not be matched based on any unique vehicle identifiers. Where annual fuel cost data was not provided by the client, fleet fuel costs were estimated using the vehicles' annual mileage, AFLEET fuel economy assumptions by vehicle and fuel type, and base fuel prices per gallon. The model assumes unit prices of $2.56 per gallon of diesel and $2.33 per gallon of gasoline, based on the U.S. EIA's Rocky Mountain average pricing for the past 5 years. The model escalates gasoline and diesel pricing annually using projections from the U.S. EIA's 2020 AEO Reference Case for Transportation.

- **Maintenance:** No battery replacement costs are included in the cost modeling for either the City or Springs Utilities fleet. It is assumed that existing warranties will typically cover battery replacement costs during the vehicle lifespans.

- **Electricity Pricing:** The model uses $0.10/kWh base rate, escalated annually using projections from the U.S. EIA's 2020 AEO Reference Case for Transportation: Electricity.

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[182] Note that this financial analysis is separate from the operational analysis in the previous section. The financial analysis assumes that any vehicle that meets the financial criteria can be replaced with an electric vehicle. The implicit assumption is that vehicles that would need more than a single charge a day would get a second charge during the day.

- **Vehicle Replacements:** Based on feedback from Colorado Springs, the ICF team assumed a vehicle lifespan of 10 years for all vehicle types except police or patrol cars, which are assumed to have an 8-year lifespan, to calculate retirement year based on the in-service date.

- **Timeframe:** This analysis focuses on vehicle replacements across a fifteen-year timeline from 2023 through 2037, with TCO calculations extending out across the replacement vehicle lifespans to 2050.

- **Discount Rate**: 5% was used for net present value calculations.

- **Electric Vehicle Supply Equipment (EVSE) Pricing and Incentives:** The EVSE pricing assumptions and incentive program amounts applied in the analysis are detailed further in the Incentives and Funding Source Assumptions Applied section below.

City Fleet Specific Assumptions

- **Maintenance**: The modeling for the City fleet does not incorporate vehicle specific maintenance cost data. Instead, existing fleet maintenance costs were estimated using AFLEET dollar per mile assumptions by vehicle type and by fuel type. Maintenance costs were escalated 2% annually.
- **Annual Mileage:** The city provided lifetime to date (LTD) mileage for nearly 100 percent of vehicles assessed in the study. ICF used the LTD mileage and the vehicle age based on in service date to calculate annual mileage. For vehicles with a calculated annual mileage of less than 800 miles, annual mileage was calculated using AFLEET annual mileage assumptions by vehicle and fuel type.
- **Vehicle Ranges:** The EV mileage ranges per charge were accounted for when recommending vehicle replacements. The analysis used an average temperature range of 22 to 88°F to assess the potential impact temperatures can have on EV ranges; this reduced EV model ranges to 80% of their maximum mileage range. Typical mileage per day per vehicle was not provided by the city. The team assumed a typical mileage of 50 miles per day in use for all vehicles.
- **Leased vs. Owned Vehicles:** Approximately 8% of the city's vehicles were purchased with leased funds. To properly account for these vehicle replacements in the financial analysis, the team used an average of the current annual interest rate for the city's current lease contracts (2.49%). The team assumed a 5-year lease timeframe.
- **Reclassified Vehicle Fuel Types:** The engine fuel type was not available for most, but not all, vehicles in the data provided. Where such data was missing, the team assigned fuel type for all vehicles based on common fuel types for certain vehicle types and gross vehicle weight ratings (GVWR).

Colorado Springs Utilities Fleet Specific Assumptions

- **Maintenance:** Colorado Springs Utilities provided annual maintenance data for approximately 48 percent of entries from July 2019 to June 2020. For vehicles missing annual maintenance data or with annual maintenance costs less than $100, the existing fleet maintenance costs were estimated using AFLEET dollar per mile assumptions by vehicle type and by fuel type. Maintenance costs were escalated 2% annually.
- **Annual Mileage:** Colorado Springs Utilities provided lifetime to date (LTD) mileage for approximately 92 percent of vehicles assessed in the study. For vehicles with LTD mileage greater than 100 miles, the annual mileage was calculated based on the vehicle in service date. For vehicles with no LTD mileage provided, annual mileage was calculated using AFLEET annual mileage assumptions by vehicle and fuel type.
- **Vehicle Ranges:** The EV mileage ranges per charge were accounted for when recommending vehicle replacements. The analysis used an average temperature range of 22 to 88°F to assess the potential impact temperatures can have on EV ranges; this reduced EV model ranges to 80% of their maximum mileage range. Typical mileage per day in use was calculated using the annual mileage divided by 252 workdays annually, approximately 5 out of 7 days per week.
- **Reclassified Vehicle Fuel Types:** The team reclassified 1 existing Bucket Truck in the fleet to fuel type “diesel” instead of gasoline because all similar models in fleet were diesel and it was thought to be entered as an error. There were 2 existing vans, 10 SUVs, 1 sedan, 29 light-duty pickups, and 9 medium-duty pickups in the fleet that use E85 ethanol. These vehicles were reclassified assuming that all of the assumptions that apply to E85 will apply to conventional gasoline. This includes assumptions for fuel economy, maintenance costs, and fuel costs.

Electric Vehicle Equivalents Summary

City Fleet EV Equivalents

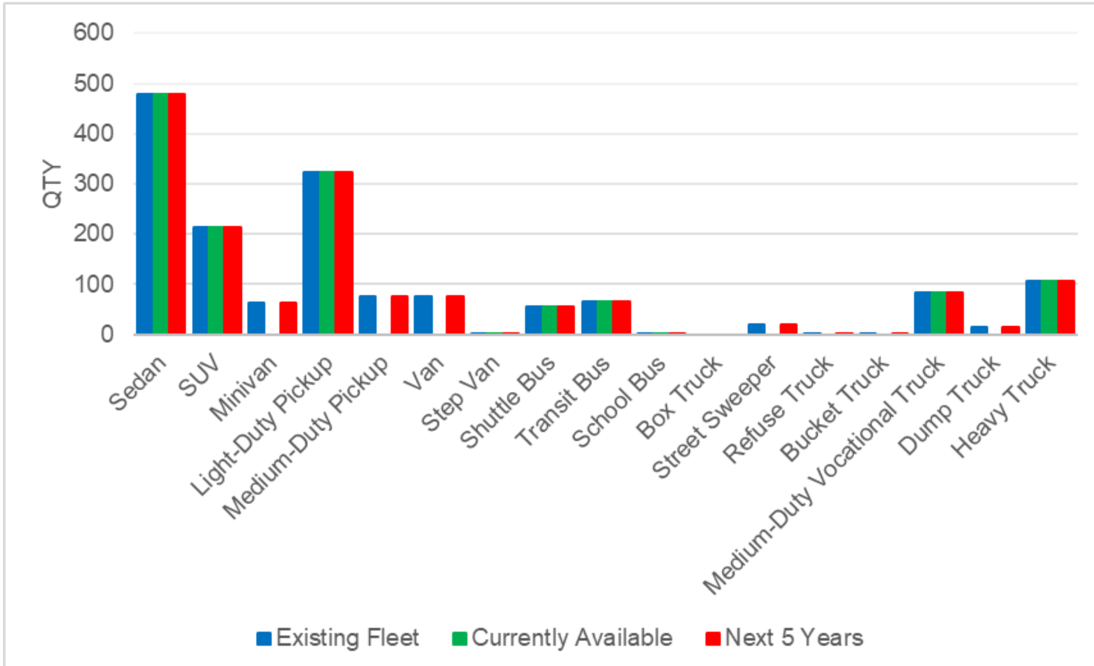
Of the 1,584 existing vehicles in the City's fleet, 84% of them currently have EV equivalents available in the market, and all 1,584 of them are expected to have EV equivalents available within the next five years, including battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs). The following table shows the breakdown of EV equivalent availability; the left-hand side of the table shows how many vehicles in the City fleet have EV equivalents, and the right-hand side of the table shows the number of discrete EV models available over time by vehicle type.

Table 39. Electric Vehicle Equivalents Summary – City and Other Fleet

				Number of EV Models Available Over Time						
		EV Equivalents		PHEV Models		BEV Models		Total EV Models		
Vehicle Types	Existing Fleet	Currently Available	Next 5 Years	Currently Available	New Next 5 Years	Currently Available	New Next 5 Years	Currently Available	New Next 5 Years	Total Currently Available and Planned in 5 Years
Sedan	479	479	479	23	13	29	19	52	32	84
SUV	213	213	213	15	12	6	22	21	34	55
Minivan	62	0	62	1	2	0	0	1	2	3
Light-Duty Pickup	324	324	324	6	0	0	15	6	15	21
Medium-Duty Pickup	77	0	77	3	0	2	0	5	0	5
Van	76	0	76	0	0	3	4	3	4	7
Step Van	1	1	1	0	0	19	1	19	1	20
Shuttle Bus	55	55	55	0	0	22	3	22	3	25
Transit Bus	66	66	66	0	0	38	1	38	1	39
School Bus	2	2	2	0	0	15	7	15	7	22
Street Sweeper	20	0	20	0	0	2	0	2	0	2
Refuse Truck	1	0	1	0	0	3	12	3	12	15
Bucket Truck	3	0	3	0	0	0	5	0	5	5
Medium-Duty Vocational Truck	84	84	84	2	0	16	1	18	1	19
Dump Truck	14	0	14	0	0	0	1	0	1	1
Heavy Truck	107	107	107	0	0	10	45	10	45	55
TOTAL	**1584**	**1331**	**1584**	**50**	**27**	**186**	**142**	**236**	**169**	**405**

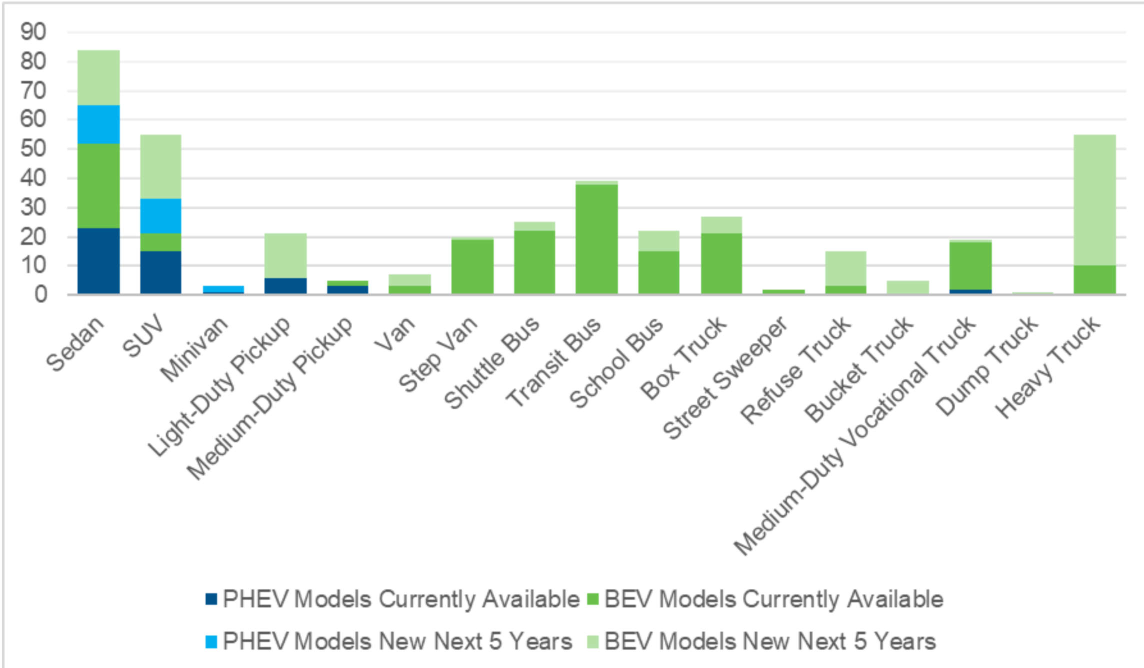
The figure below shows the same information for fleet vehicles with EV equivalents graphically. While all vehicle types are likely to have sufficient EV equivalents in the next five years, current EV availability is limited for minivans, medium-duty-pickups, vans, street sweepers, refuse trucks, bucket trucks, and dump trucks.

Figure 22. EV Equivalents by Vehicle Type



The following figure shows the number of EV models available over time by electric powertrain type and vehicle type. Sedans and SUVs have the largest number of PHEV and BEV model currently available, and notably there are virtually no PHEV models currently available for medium-duty and heavy-duty vehicles.

Figure 23. EV Model Availability by Vehicle Types – Used in the Analysis



Colorado Springs Utilities Fleet EV Equivalents

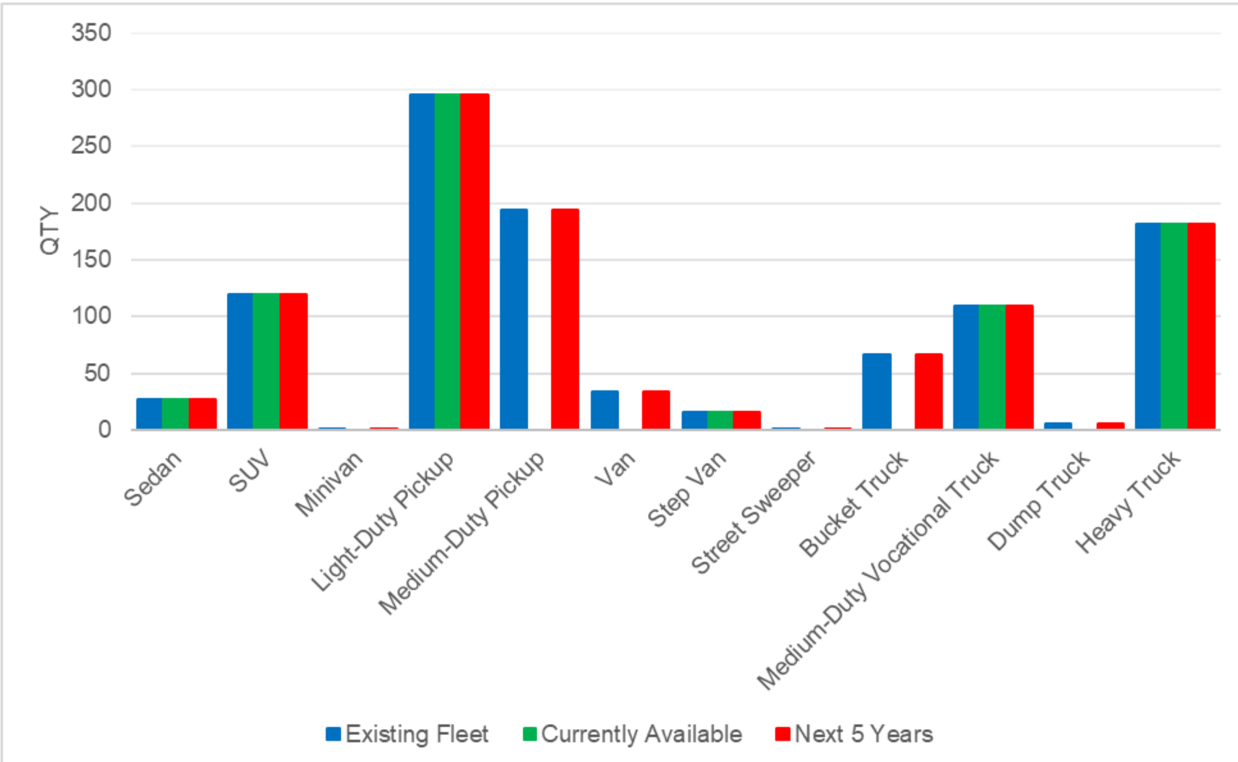
Of the 1,052 existing vehicles in Springs Utilities' fleet, 71% of them currently have an EV equivalent available in the market, and all 1,052 of them are expected to have an EV equivalent available within the next five years. As with the City fleet section above, the following table shows the breakdown of EV equivalent availability; the left-hand side of the table shows how many vehicles in the Springs Utilities fleet have EV equivalents, and the right-hand side of the table shows the number of discrete EV models available over time by vehicle type.

Table 40. Electric Vehicle Equivalents Summary – Springs Utilities Fleet

				Number of EV Models Available Over Time						
		EV Equivalents		PHEV Models		BEV Models		Total EV Models		
Vehicle Types	Existing Fleet	Currently Available	Next 5 Years	Currently Available	New Next 5 Years	Currently Available	New Next 5 Years	Currently Available	New Next 5 Years	Total Currently Available and Planned in 5 Years
Sedan	27	27	27	23	13	29	19	52	32	84
SUV	120	120	120	15	12	6	21	21	33	54
Minivan	1	0	1	1	2	0	0	1	2	3
Light-Duty Pickup	295	295	295	6	0	0	15	6	15	21
Medium-Duty Pickup	194	0	194	3	0	2	0	5	0	5
Van	34	0	34	0	0	3	4	3	4	7
Step Van	16	16	16	0	0	19	1	19	1	20
Street Sweeper	1	0	1	0	0	2	0	2	0	2
Bucket Truck	67	0	67	0	0	0	5	0	5	5
Medium-Duty Vocational Truck	109	109	109	2	0	16	1	18	1	19
Dump Truck	6	0	6	0	0	0	1	0	1	1
Heavy Truck	182	182	182	0	0	10	45	10	45	55
TOTAL	**1052**	**749**	**1052**	**50**	**27**	**186**	**141**	**236**	**168**	**404**

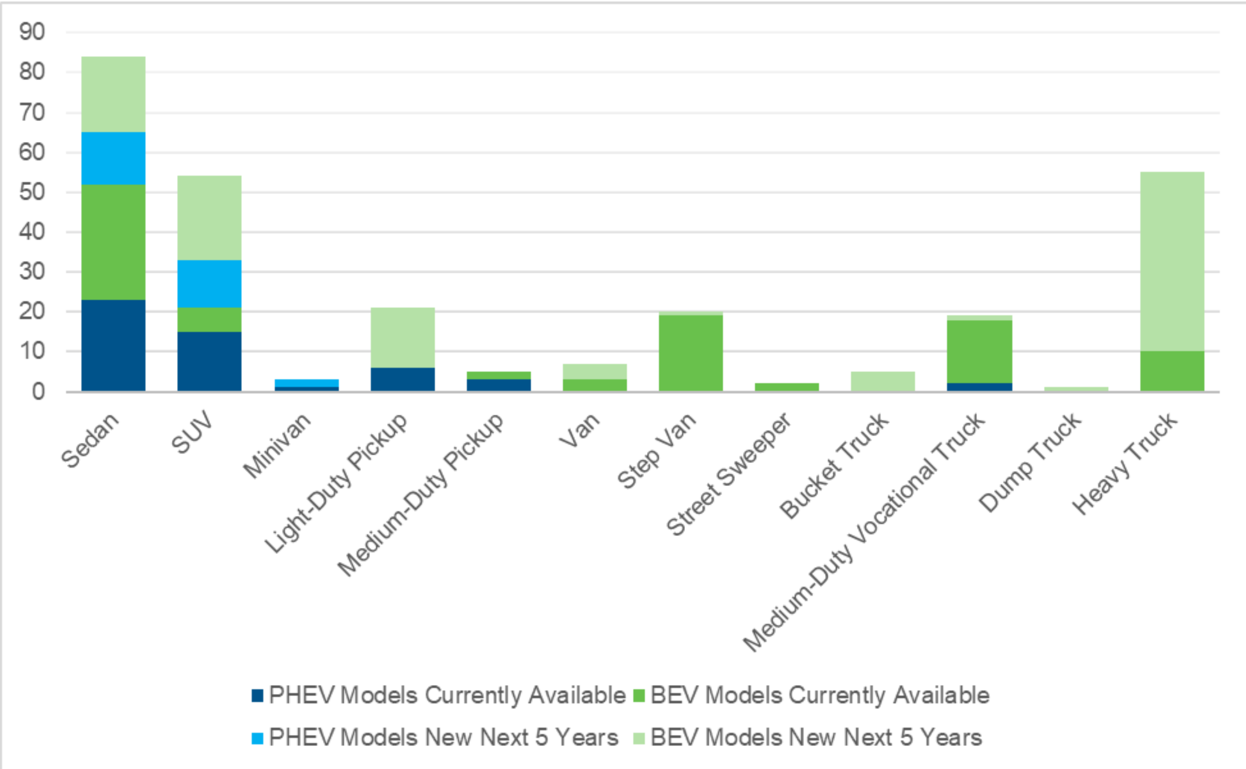
While all vehicle types are likely to have sufficient EV equivalents in the next five years, current EV availability is limited for minivans, medium-duty pickup trucks, vans, street sweepers, bucket trucks, and dump trucks.

Figure 24. EV Equivalents by Vehicle Type



The following figure shows the number of EV models available over time by electric powertrain type and vehicle type. Sedans and SUVs have the largest number of PHEV and BEV model currently available, and notably there are virtually no PHEV models currently available for medium-duty and heavy-duty vehicles.

Figure 25. EV Model Availability by Vehicle Types – Total in Market



Electric Vehicle Replacement Recommendations

At the request of the City and Springs Utilities, ICF analyzed two EV replacement scenarios and their impacts to replacement schedules and replacement costs: a non-phased replacement schedule scenario and a phased replacement schedule scenario. The non-phased scenario assumes that EV replacement starts in 2023 and all existing vehicles with an age over the assumed vehicle lifespan (10 years) prior to 2023 are to be first replaced with ICE vehicle intermediaries. In this scenario, the ICE vehicle intermediaries would be operated for another cycle of 10 years, and at that time the intermediaries would be replaced with EVs. Given that approximately half of both fleets are older vehicles which will be ready for replacement before 2023, this scenario generates a significant spike of EV replacements in 2031. The phased scenario is designed to level-out that spike and phase-in annual EV replacements more evenly. To do this, ICF first estimated replacement years for existing vehicles by adding 10 years to the vehicle in-service date. For vehicles with an estimated replacement year prior to 2023, ICF used the life-to-date mileage values provided by the client to estimate the number of useful years left in the vehicle based on typical lifetime mileage values. From there, estimated remaining useful life was used on a per-vehicle basis to deviate the assumed vehicle lifespan by some time above or below the nominal assumed lifespan where appropriate. The amount of deviation was determined by the estimated remaining useful life for each vehicle. The following section provides information on how the EV replacement timelines vary under each of these scenarios, and the next section will discuss how these scenarios impact fleet transition cost estimates.

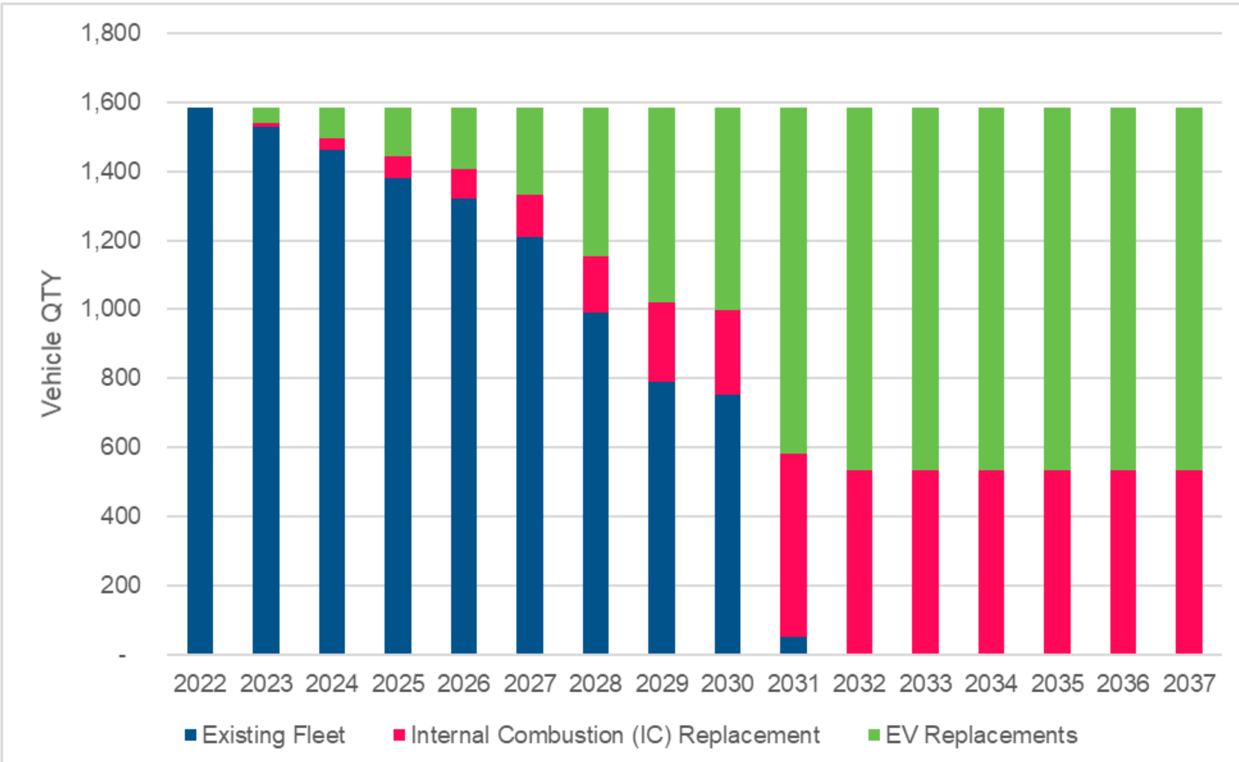
City EV Acquisition Recommendations

Non-Phased Replacement Schedule Scenario

The following section outlines ICF's electrification recommendations for the City fleet. As outlined in the Methodology section, each vehicle within the City's fleet was assessed to identify the lowest cost option available at the time of replacement, while also accounting for potential mileage and charging time restrictions. The team developed a retirement schedule for the City's fleet using vehicle lifespan assumptions shown below in Figure 26 and the in-service date of the City's vehicles. Based on the calculated replacement year for each vehicle, ICF estimated TCO comparisons for suitable ICE, BEV, and PHEV replacement models. EV replacement was recommended for any existing vehicles for which the lowest-cost EV equivalent cost less than or up to 10% higher than the business-as-usual ICE vehicle replacement cost. This TCO analysis included vehicle capital costs and annual fuel and maintenance costs for both EVs and ICE vehicles. For EVs, the analysis also included EVSE hardware and installation costs. While EV or EVSE grants and incentives are available, the analysis did not include any incentive funding at the client's request. The TCO analysis does not include costs to make upgrades to the electric distribution grid or costs for site-level make-ready upgrades.

To calculate the replacement year for each vehicle, ICF used the City's goal of a 10-year lifespan for vehicles. Figure 26 illustrates the recommended vehicle replacement timeline for the City's fleet by fuel type, and it shows the cumulative change in fleet composition over time. This timeline was developed to achieve a gradual transition over the fifteen-year transition term. A gradual replacement approach can offer a few benefits to the City. First, it will give the City more time to adjust to operations and train staff as EVs are phased in over the fifteen-year replacement period. It will also ensure that the City has opportunities to benefit from expected EV and EVSE cost reductions over time as technology costs trend downward. Finally, a gradual transition also gives the City time to demonstrate or pilot newly emerging EV applications, particularly medium- and heavy-duty EVs and specialized vehicles. Under ICF's recommendations, over half of the fleet will have been replaced with cost-effective EV models by 2037.

Figure 26. Recommended EV Replacement Timeline - Fuel Types (Non-Phased)



Importantly, a gradual approach to fleetwide EV adoption is not the only option available to the City. ICF has recommended the replacement approach above assuming that the City prefers to continue owning nearly all of its existing vehicles, as it currently does. One other option available to fleets that wish to transition to EVs is to work with an Infrastructure-as-a-Service (IaaS) company that would cover the upfront capital costs of EV and infrastructure deployment and charge a per unit fee (e.g., per mile) for use of the assets. The upside to this arrangement is that the City would incur little to no upfront capital costs for the transition, and the City may be able to deploy a higher number of EVs and EVSEs due to these removed capital constraints. However, this service is often structured similar to a lease in which the IaaS provider would own the EVs and infrastructure instead of the City itself, and the long-term costs could be higher depending on how the service is structured and depending on any financing fees charged. Further analysis would be needed to assess this option and compare it to the recommended approach above.

The following table shows the EV replacement recommendations in more detail, along with associated information on estimated vehicle lifetimes, estimated financial savings, and emission reductions. Of the 1,584 fleet vehicles considered in the evaluation, 1,050 (66%) were found to have an EV equivalent with a lifetime TCO that is within the 10% threshold. Replacing these vehicles with EVs is estimated to yield roughly $26.3 million in financial savings and over 105,000 MT of lifetime GHG reductions over the analysis period. Importantly, the financial savings and GHG emission reductions in the table represent the difference between replacing the recommended vehicles with EVs compared to business-as-usual ICE vehicle replacements. There are 534 vehicles which have EV equivalents but are not recommended for conversion because they do not fit within the 10% TCO threshold. Over time, these vehicles may become more cost effective to convert due to several reasons, such as reduced technology costs, new EV model options, incentive program availability, and reduced operating costs.

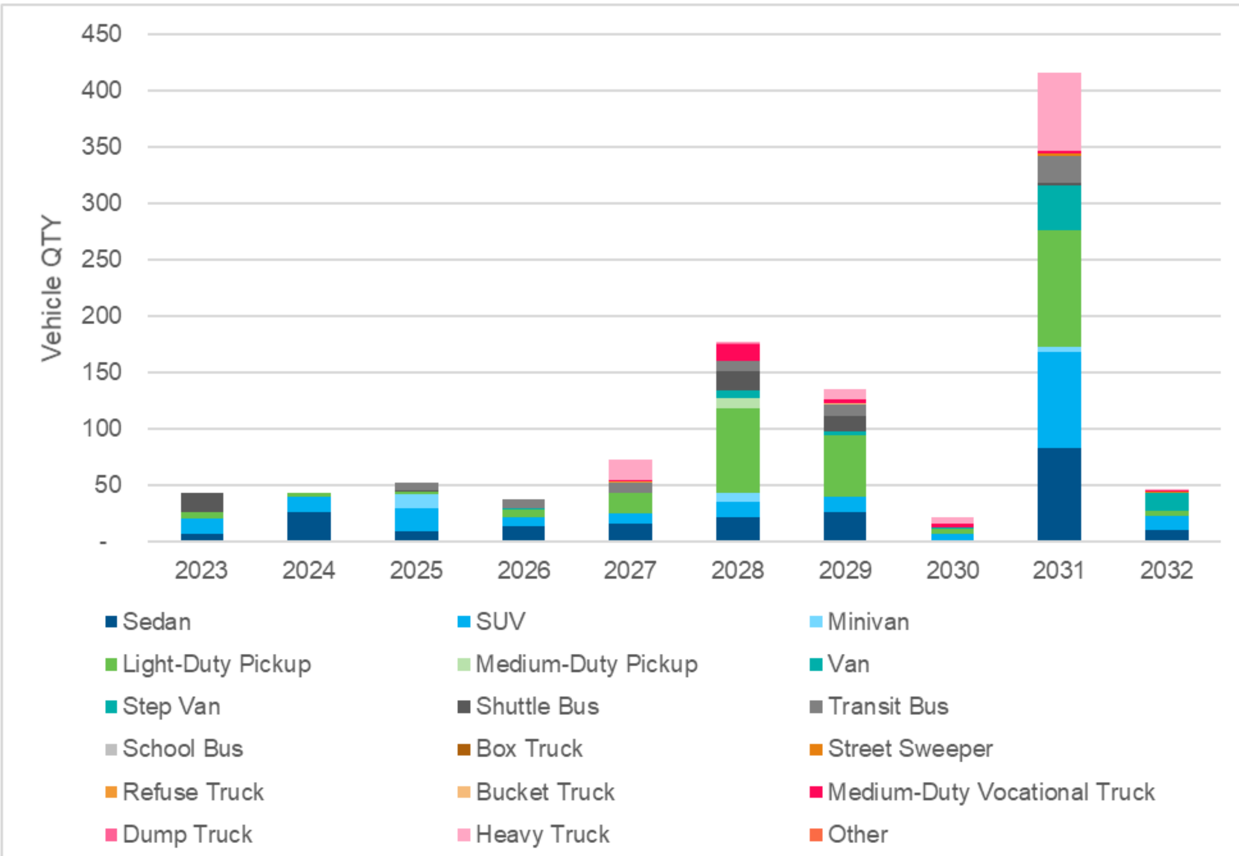
Table 41. City Fleet EV Acquisition Recommendations (Non-Phased)

Vehicle Type and Replacement Make & Model	Total Quantity	Quantity Up for Retirement	Quantity Recommended to Convert to Electric	Assumed Vehicle Lifespan
Bucket Truck	**3**	**3**	**1**	**10**
Lion Electric - Lion8- Tandem - Bucket - 160 kWh	1		1	10
ICE Replacements	2		0	10
Dump Truck	**14**	**14**	**1**	**10**
Neuron EV - MET	1		1	10
ICE Replacements	13		0	10
Heavy Truck	**107**	**107**	**106**	**10**
SEA Electric - SEA Hino 338 EV	106		106	10
ICE Replacements	1		0	10
Light-Duty Pickup	**324**	**324**	**279**	**10**
ICE Replacements	45		0	10
Ford - F-150 Lightning	279		279	10
Medium-Duty Pickup	**77**	**77**	**9**	**10**
Lightning eMotors - Ford F-450	9		9	10
ICE Replacements	68		0	10
Medium-Duty Vocational Truck	**84**	**84**	**25**	**10**
Lightning eMotors - Ford E-450 Cargo Truck (80 mile range) - LEV80E	25		25	10
ICE Replacements	59		0	10
Minivan	**62**	**62**	**24**	**10**
Chrysler - Pacifica Hybrid Touring	24		24	10
ICE Replacements	38		0	10
Refuse Truck	**1**	**1**	**1**	**10**
SEA Electric - SEA EXPEDITOR EV	1		1	10
School Bus	**2**	**2**	**0**	**10**
ICE Replacements	2		0	10
Sedan	**479**	**479**	**214**	**10**
Hyundai - Ioniq Plug-in Hybrid	4		4	10

Vehicle Type and Replacement Make & Model	Total Quantity	Quantity Up for Retirement	Quantity Recommended to Convert to Electric	Assumed Vehicle Lifespan
Chevrolet - Bolt EV LT	208		208	10
Nissan - Leaf S	2	2	2	10
ICE Replacements	265		0	10
Shuttle Bus	**55**	**55**	**53**	**10**
GreenPower Motor Company - EV Star	53		53	10
ICE Replacements	2		0	10
Step Van	**1**	**1**	**0**	**10**
ICE Replacements	1		0	10
Street Sweeper	**20**	**20**	**4**	**10**
Global - M3 SUPERCHARGED	4		4	10
ICE Replacements	16		0	10
SUV	**213**	**213**	**199**	**10**
Ford - Escape SE FWD PHEV	190		190	10
Hyundai - Kona Electric SEL	9		9	10
ICE Replacements	14		0	10
Transit Bus	**66**	**66**	**66**	**10**
BYD - K7M 30' All-Electric Transit Bus	66		66	10
Van	**76**	**76**	**68**	**10**
Chanje - V8100 All-Electric Panel Van	68		68	10
ICE Replacements	8		0	10
Grand Total	**1584**	**1584**	**1050**	

The figure below illustrates the timeline for the recommended EV replacements by vehicles type. As opposed to Figure 26, Figure 27 only shows EV replacements and does not show ICE vehicle replacements. A significant number of EV replacements are scheduled to take place in 2031. This is not because many of the existing vehicles are new with an in-service year of 2021 (assuming a 10 year vehicle lifespan), but rather the opposite. Half of the fleet's existing vehicles are older with in-service years prior to 2013. Given an assumed vehicle lifespan of ten years, vehicles with an in-service year of 2012 or older are set to be replaced by 2022 or sooner; however, the EV replacement timeline starts in 2023, so these vehicles are assumed to be replaced with an ICE vehicle first, and then subsequently replaced with an EV at the end of the ten-year lifespan for the ICE replacement. The subsequent EV replacement is reflected in the figure below without any ICE replacements depicted.

Figure 27. Recommended EV Replacement Timeline - Vehicle Types (Non-Phased)



Phased Replacement Schedule Scenario

As described previously, the phased replacement schedule scenario is designed to level out the spike of EV replacements set to occur in 2031 under the non-phased scenario. Figure 28 shows the vehicle replacement timeline for the phased scenario, which is characterized by a smoother implementation of EV replacements year-by-year compared to the non-phased scenario.

Figure 28. Recommended EV Replacement Timeline - Fuel Types (Phased)

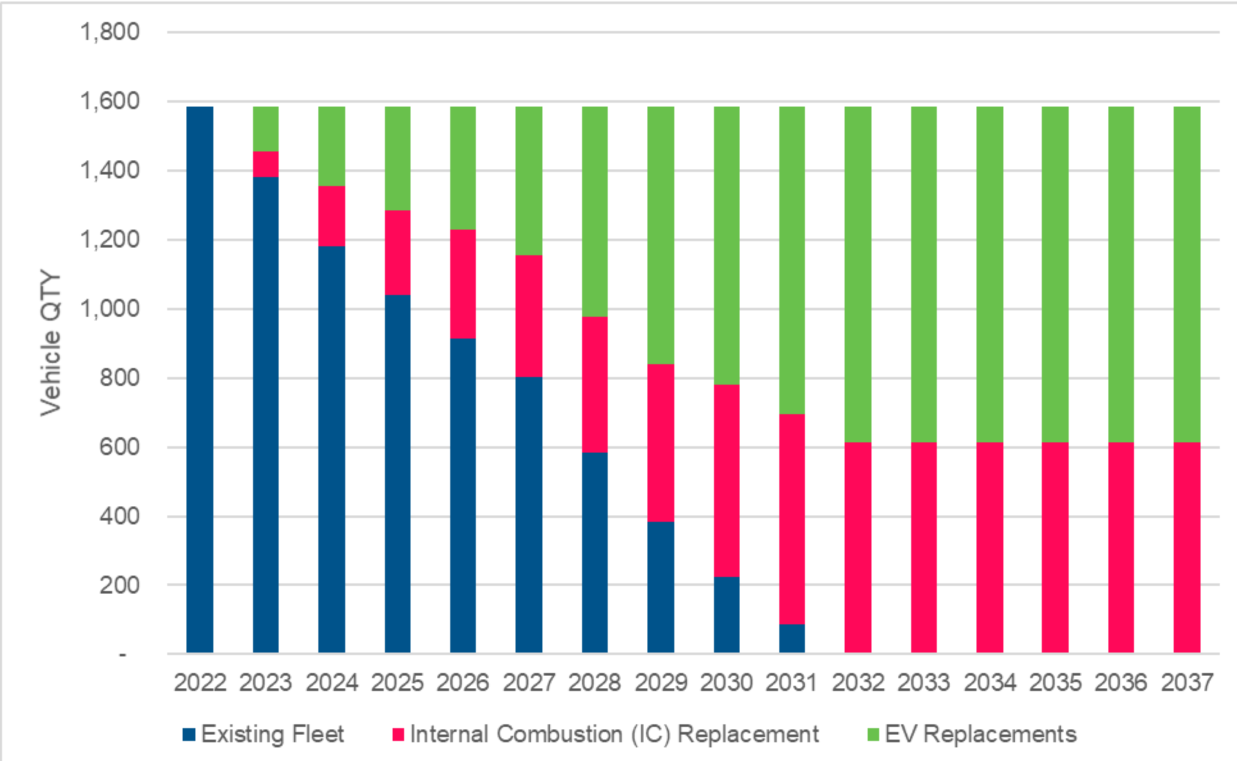


Table 42 shows EV make and model replacement recommendations under the phased scenario, along with the number of EV replacements recommended by make and model, and vehicle type. Compared to the non-phased scenario (Table 41), eighty fewer vehicles are recommended for EV replacement. Fewer EV recommendations are made in the phased scenario for Light-Duty Pickups, Medium-Duty Vocational Trucks, Sedans, Street Sweepers, and SUVs. More EV recommendations are made for Minivans in the phased scenario compared to the non-phased scenario. In general, fewer EV recommendations are made in the phased scenario because cost parity of EVs compared to ICE vehicles is projected to improve as time passes. The non-phased scenario is characterized by a large spike of EV replacements projected to occur later in the transition timeline, whereas the phased scenario shifts replacements to occur sooner when estimated EV costs are expectedly higher than projected future costs.

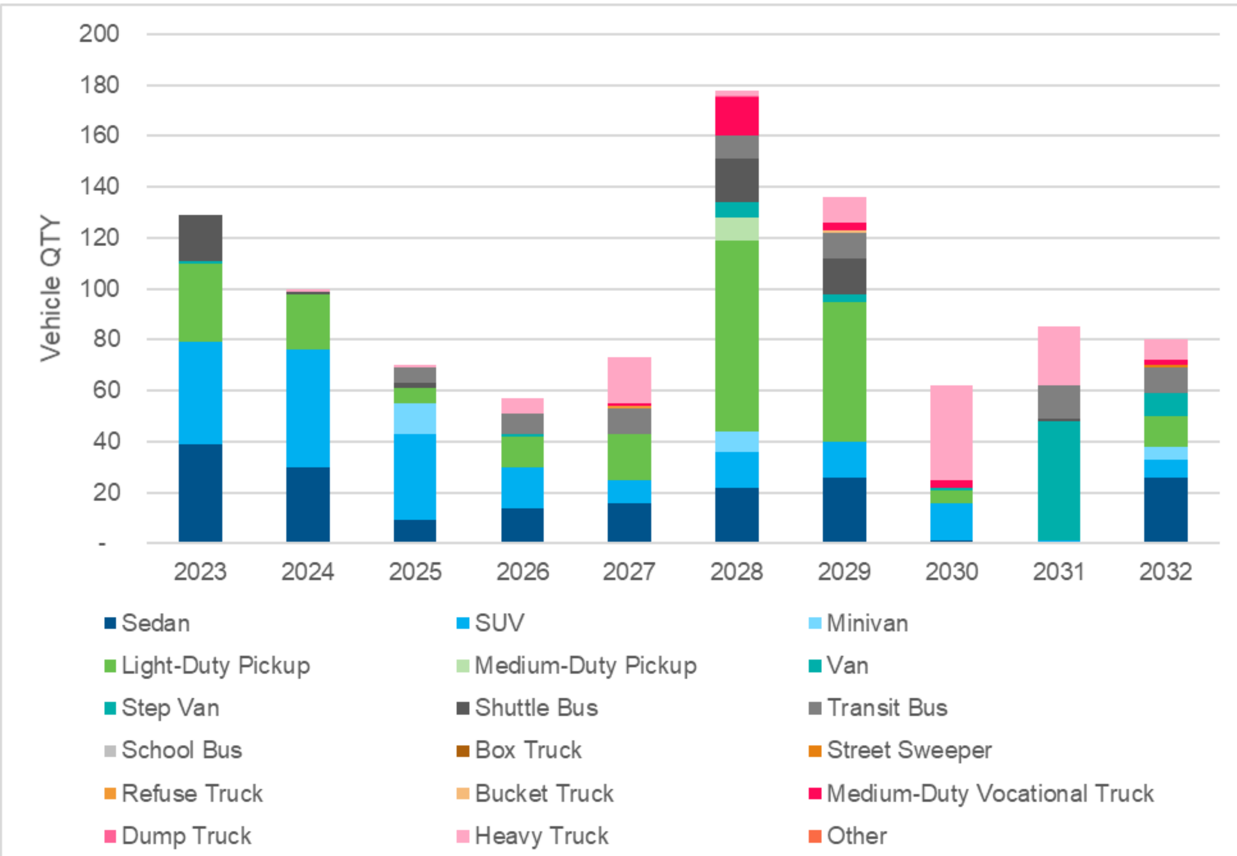
Table 42. City Fleet EV Acquisition Recommendations (Phased)

Vehicle Type and Replacement Make & Model	Total Quantity	Quantity Up for Retirement	Quantity Recommended to Convert to Electric	Assumed Nominal Vehicle Lifespan
Bucket Truck	**3**	**3**	**1**	**10**
Lion Electric - Lion8- Tandem - Bucket - 160 kWh	1	1	1	10
ICE Replacements	2	2	0	10
Dump Truck	**14**	**14**	**1**	**10**
Neuron EV - MET	1	1	1	10
ICE Replacements	13	13	0	10
Heavy Truck	**107**	**107**	**106**	**10**
SEA Electric - SEA Hino 338 EV	106	106	106	10
ICE Replacements	1	1	0	10
Light-Duty Pickup	**324**	**324**	**236**	**10**
ICE Replacements	88	88	0	10
Ford - F-150 Lightning	236	236	236	10
Medium-Duty Pickup	**77**	**77**	**9**	**10**
Lightning eMotors - Ford F-450	9	9	9	10
ICE Replacements	68	68	0	10
Medium-Duty Vocational Truck	**84**	**84**	**24**	**10**
Lightning eMotors - Ford E-450 Cargo Truck (80 mile range) - LEV80E	24	24	24	10
ICE Replacements	60	60	0	10
Minivan	**62**	**62**	**25**	**10**
Chrysler - Pacifica Hybrid Touring	25	25	25	10
ICE Replacements	37	37	0	10
Refuse Truck	**1**	**1**	**1**	**10**
SEA Electric - SEA EXPEDITOR EV	1	1	1	10
School Bus	**2**	**2**	**0**	**10**
ICE Replacements	2	2	0	10

Vehicle Type and Replacement Make & Model	Total Quantity	Quantity Up for Retirement	Quantity Recommended to Convert to Electric	Assumed Nominal Vehicle Lifespan
Sedan	**479**	**479**	**183**	**10**
Hyundai - Ioniq Plug-in Hybrid	4	4	4	10
Chevrolet - Bolt EV LT	177	177	177	10
Nissan - Leaf S	2	2	2	10
ICE Replacements	296	296	0	10
Shuttle Bus	**55**	**55**	**53**	**10**
GreenPower Motor Company - EV Star	53	53	53	10
ICE Replacements	2	2	0	10
Step Van	**1**	**1**	**0**	**10**
ICE Replacements	1	1	0	10
Street Sweeper	**20**	**20**	**1**	**10**
Global - M3 SUPERCHARGED	1	1	1	10
ICE Replacements	19	19	0	10
SUV	**213**	**213**	**196**	**10**
Ford - Escape SE FWD PHEV	187	187	187	10
Hyundai - Kona Electric SEL	9	9	9	10
ICE Replacements	17	17	0	10
Transit Bus	**66**	**66**	**66**	**10**
BYD - K7M 30' All-Electric Transit Bus	66	66	66	10
Van	**76**	**76**	**68**	**10**
Chanje - V8100 All-Electric Panel Van	68	68	68	10
ICE Replacements	8	8	0	10
Grand Total	**1584**	**1584**	**970**	**-**

Figure 29 shows recommended EV replacements by year and vehicle type under the phased scenario, not including ICE vehicle replacements. Compared to the non-phased scenario (Figure 27), the recommended number of annual EV replacements is more consistent year by year. Whereas the non-phased scenario included a spike of over 400 EV replacements in 2031, the phased scenario would limit the maximum annual EV replacements to about 180. To achieve this, it is estimated that some vehicles would need to be replaced some time before or after the assumed nominal vehicle lifespan of ten years. The amount of time before or after the 10-year mark varies based on the estimated remaining lifetime, which is a function the vehicles' current life-to-date mileage compared to typical lifetime mileage by vehicle type. Information on the impact of the phased scenario on estimated fleet transition costs and emissions reduction is provided in the Total Cost of Ownership and Emissions Reduction Estimates sections below.

Figure 29. Recommended EV Replacement Timeline - Vehicle Types (Phased)



Springs Utilities EV Acquisition Recommendations

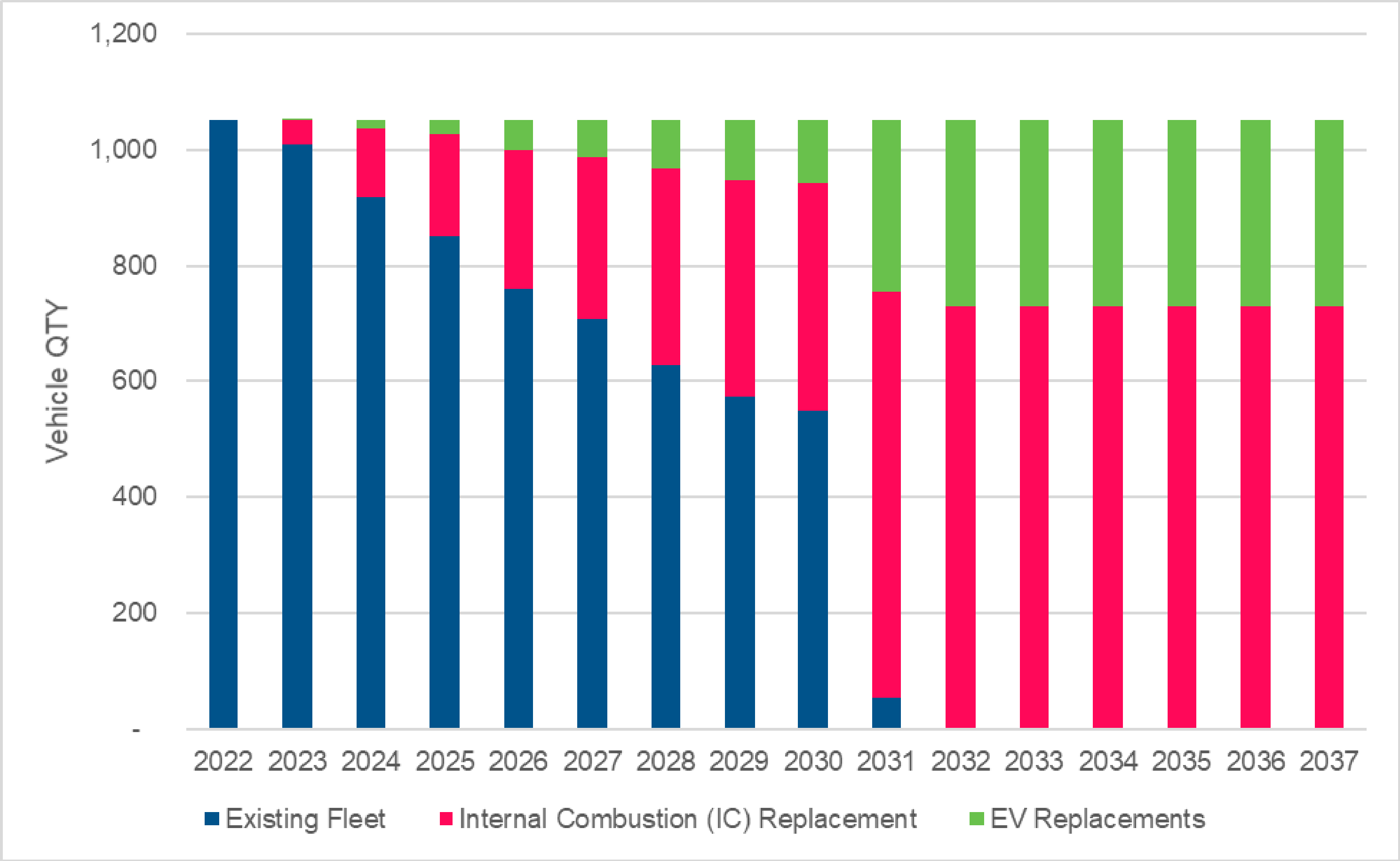
Non-Phased Replacement Schedule Scenario

The following section outlines ICF's electrification recommendations for the Springs Utilities fleet. Like the City fleet, the replacement schedule for the Springs Utilities fleet is developed using an assumed vehicle lifespan of 10 years and the in-service date of the Springs Utilities vehicles. Based on the calculated replacement year for each vehicle, ICF estimated and compared lifetime TCO for suitable ICE, BEV, and PHEV replacement models. EV replacement was recommended for any EV equivalents that were within the 10% threshold. As with the City fleet, ICF's TCO analysis included vehicle capital costs and annual fuel and maintenance costs for both EVs and ICE vehicles. For EVs, the analysis also included EVSE hardware and installation costs. While EV and EVSE grants and incentives are available, the analysis did not include any incentive funding at the client's request. The TCO analysis also did not include the costs associated with electric distribution grid upgrades, nor did it include any site-level make-ready charging infrastructure costs.

The figure below illustrates the recommended vehicle replacements for the Springs Utilities fleet by fuel type, and it shows the cumulative change in fleet composition over time. As with the City fleet, this timeline was developed to achieve a gradual transition over the stated transition term. A gradual replacement approach can offer a few benefits to Springs Utilities. First, it will give the fleet more time to adjust to operations and train staff as EVs are phased in over the fifteen-year replacement period. It will also ensure that the fleet has opportunities to benefit from expected EV and EVSE cost reductions over time as technology costs trend downward. Finally, a gradual transition also gives the fleet time to demonstrate or pilot newly emerging EV applications, particularly medium- and heavy-duty EVs and specialized vehicles that may have more complicated or strenuous operating requirements. As discussed in the City's replacement recommendations, other replacement approaches like Infrastructure-as-a-Service exist, but ICF is recommending this approach due to the potential benefits above and assuming that Springs Utilities' prefers to continue owning its vehicles and infrastructure.

The table that follows shows the EV replacement recommendations in more detail. Of the 1,052 fleet vehicles considered in the evaluation, 297 (28%) were found to have an EV equivalent with a lifetime TCO that is within the 10% threshold. There are 755 vehicles which have EV equivalents but are not recommended for conversion, either due to already being an EV (4 Nissan Leaf & 4 Chevy Bolt), having relatively low EV equivalent availability, or because they do not fit within the 10% threshold. Over time, these vehicles may become more cost effective to convert due to several reasons, such as reduced technology costs, new EV model options, incentive program availability, and reduced operating costs.

Figure 30. Recommended EV Replacement Timeline – Fuel Types (Non-Phased)



Note that because the assumption is that vehicles will have a ten year lifespan, there will be a replacement of many of the vehicles in the current 2021 fleet in the year 2031. Because this scenario models a gradual adoption of EVs, the majority of these replacements are assumed to be internal combustion vehicles.

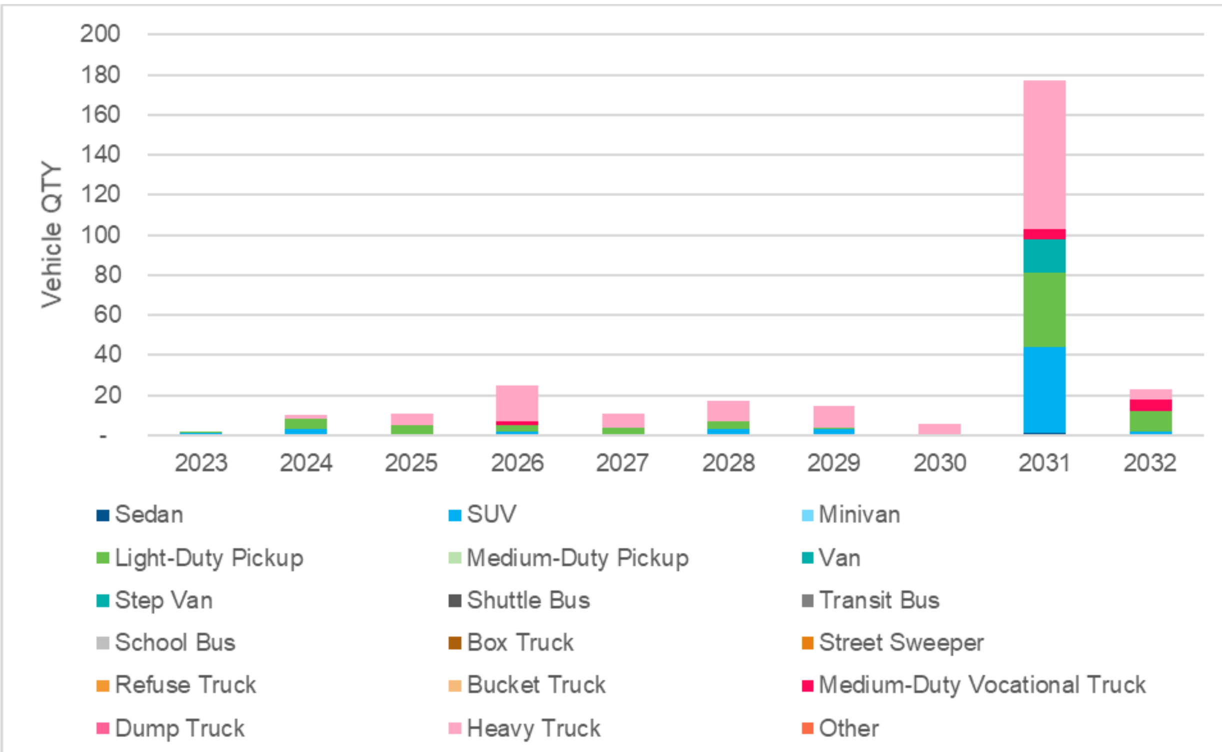
Table 43. EV Acquisition Recommendations (Non-Phased)

Vehicle Type and Replacement Make & Model	Total Quantity	Quantity Up for Retirement	Quantity Recommended to Convert to Electric	Assumed Vehicle Lifespan
Bucket Truck	**67**	**67**	**0**	**10**
ICE Replacements	67		0	10
Dump Truck	**6**	**6**	**0**	**10**
ICE Replacements	6		0	10
Heavy Truck	**182**	**182**	**139**	**10**
SEA Electric – SEA Hino 338 EV	138		138	10
ICE Replacements	43		0	10
Freightliner – eCascadia	1		1	10
Light-Duty Pickup	**295**	**295**	**70**	**10**
Atlis – XT	70		70	10
ICE Replacements	217		0	10
Existing CNG Pickups	8		0	10
Medium-Duty Pickup	**194**	**194**	**0**	**10**
ICE Replacements	194		0	10
Medium-Duty Vocational Truck	**109**	**109**	**13**	**10**
ICE Replacements	96		0	10
Lightning eMotors – Ford E-450 Cargo Truck (80 mile range) – LEV80E	11		11	10
Envirotech Drive Systems Incorporated – Cutaway	2		2	10
Minivan	**1**	**1**	**0**	**10**
ICE Replacements	1		0	10
Sedan	**27**	**27**	**1**	**10**
Hyundai – Ioniq Plug-in Hybrid	1		1	10
ICE Replacements	18		0	10
Existing Electric Vehicles	8		0	10
Step Van	**16**	**16**	**0**	**10**
ICE Replacements	16		0	10

Vehicle Type and Replacement Make & Model	Total Quantity	Quantity Up for Retirement	Quantity Recommended to Convert to Electric	Assumed Vehicle Lifespan
Street Sweeper	**1**	**1**	**0**	**10**
ICE Replacements	1		0	10
SUV	**120**	**120**	**57**	**10**
Ford – Escape SE FWD PHEV	57		57	10
ICE Replacements	63		0	10
Van	**34**	**34**	**17**	**10**
Chanje – V8100 All-Electric Panel Van	17		17	10
ICE Replacements	17		0	10
Grand Total	**1052**	**1052**	**297**	**10**

The figure below illustrates the timeline for the recommended EV replacements by vehicles type. As opposed to Figure 30, Figure 31 only shows EV replacements and does not show ICE vehicle replacements. A significant number of EV replacements are scheduled to take place in 2031. Like the City fleet, just over half of existing vehicles are older with in-service years prior to 2013. Given an assumed vehicle lifespan of ten years, vehicles with an in-service year of 2012 or older are set to be replaced by 2022 or sooner; however, the EV replacement timeline starts in 2023, so these vehicles are assumed to be replaced with an ICE vehicle first, and then subsequently replaced with an EV at the end of the ten-year lifespan for the ICE replacement. The figure below shows the subsequent EV replacements for those vehicles and does not depict any ICE vehicle replacements.

Figure 31. Recommended EV Replacement Timeline – Vehicle Types (Non-Phased)



Phased Replacement Schedule Scenario

As with the City fleet, the phased replacement scenario is designed to level out the spike of EV replacements set to occur in 2031 under the non-phased scenario. Figure 32 shows the vehicle replacement timeline for the phased scenario, which is characterized by a smoother implementation of EV replacements year-by-year compared to the non-phased scenario.

Figure 32. Recommended EV Replacement Timeline – Fuel Types (Phased)

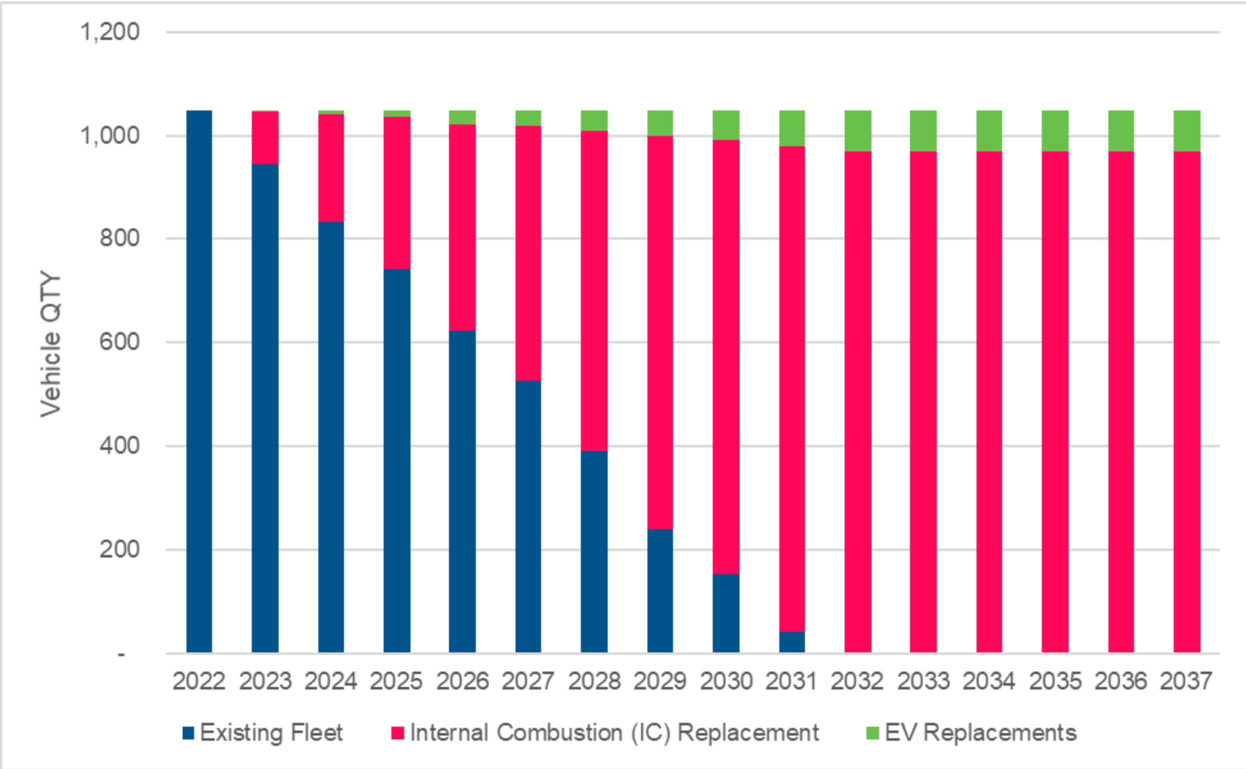


Table 44 shows EV make and model replacement recommendations under the phased scenario, along with the number of EV replacements recommended. Compared to the non-phased scenario (Table 43), 216 fewer vehicles are recommended for EV replacement. There are fewer EV replacement recommendations for Heavy Trucks, Light-Duty Pickups, Medium-Duty Vocational Trucks, Sedans, SUVs, and Vans under the phased scenario, and there is one electric minivan recommendation under the phased scenario compared to zero under the non-phased scenario.

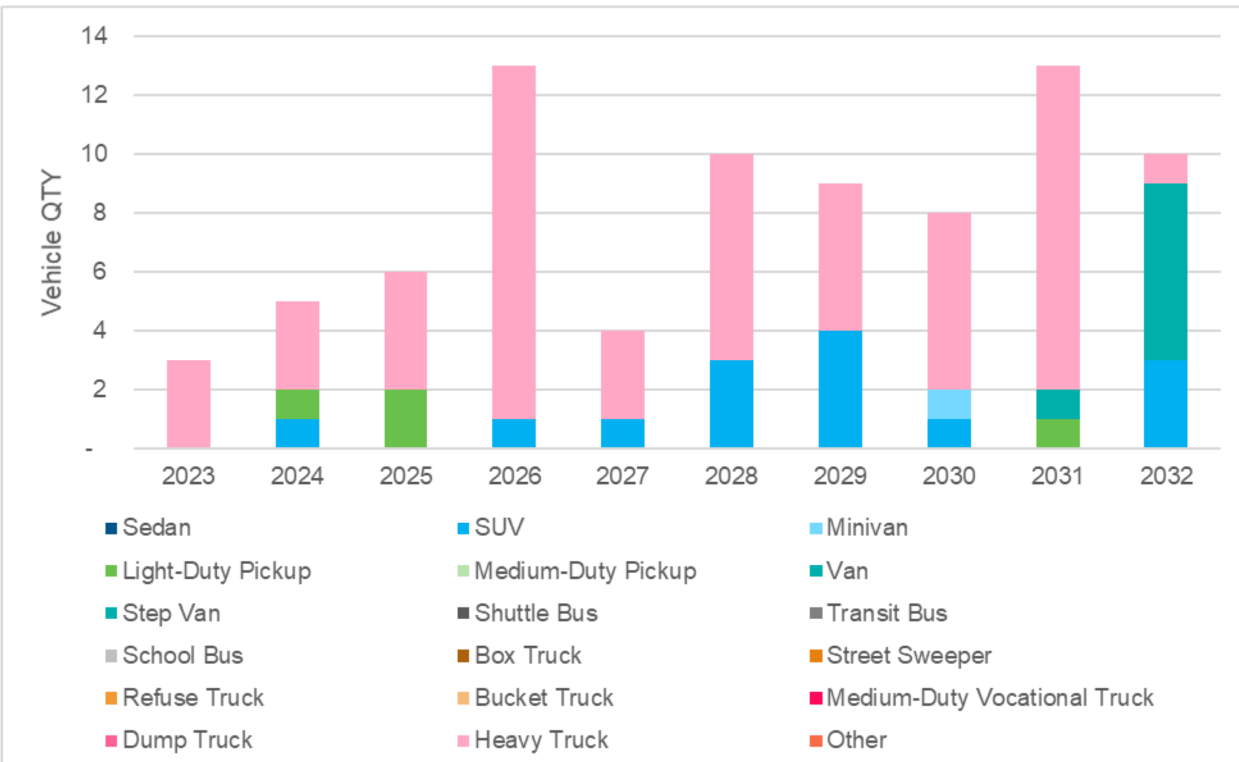
Table 44. EV Acquisition Recommendations (Phased)

Vehicle Type and Replacement Make & Model	Total Quantity	Quantity Up for Retirement	Quantity Recommended to Convert to Electric	Assumed Nominal Vehicle Lifespan
Bucket Truck	**67**	**67**	**0**	**10**
ICE Replacements	67		0	10
Dump Truck	**6**	**6**	**0**	**10**
ICE Replacements	6		0	10
Heavy Truck	**182**	**182**	**55**	**10**
SEA Electric – SEA Hino 338 EV	55		55	10
ICE Replacements	127		0	10
Light-Duty Pickup	**295**	**295**	**4**	**10**
ICE Replacements	283		0	10
Ford – F-150 Lightning	4		4	10
Existing CNG Pickups	8		0	10
Medium-Duty Pickup	**194**	**194**	**0**	**10**
ICE Replacements	194		0	10
Medium-Duty Vocational Truck	**109**	**109**	**0**	**10**
ICE Replacements	109		0	10
Minivan	**1**	**1**	**1**	**10**
Chrysler – Pacifica Hybrid Touring	1		1	10
Sedan	**27**	**27**	**0**	**10**
ICE Replacements	19		0	10
Existing Electric Vehicles	8		0	10
Step Van	**16**	**16**	**0**	**10**
ICE Replacements	16		0	10
Street Sweeper	**1**	**1**	**0**	**10**

Vehicle Type and Replacement Make & Model	Total Quantity	Quantity Up for Retirement	Quantity Recommended to Convert to Electric	Assumed Nominal Vehicle Lifespan
ICE Replacements	1		0	10
SUV	**120**	**120**	**14**	**10**
Ford – Escape SE FWD PHEV	5		5	10
ICE Replacements	106		0	10
Hyundai – Sante Fe	9		9	10
Van	**34**	**34**	**7**	**10**
Chanje – V8100 All-Electric Panel Van	7		7	10
ICE Replacements	27		0	10
Grand Total	**1052**	**1052**	**81**	**-**

Figure 33 shows recommended EV replacements for the phased replacement scenario by year and vehicle type, not including ICE vehicle replacements. Compared to the non-phased scenario (Figure 31), the recommended number of annual EV replacements is more consistent year by year. Whereas the non-phased scenario included a spike of nearly 180 EV replacements in 2031, the phased scenario would limit the maximum annual EV replacements to 13, though this is also due to fewer recommended EV replacements overall. To achieve this, it is estimated that some vehicles would need to be replaced some time before or after the assumed nominal vehicle lifespan of ten years. The amount of time before or after the 10-year mark varies based on the estimated remaining lifetime, which is a function of the vehicles' current life-to-date mileage compared to typical lifetime mileage by vehicle type. Information on the impact of the phased scenario on estimated fleet transition costs and emissions reduction is provided in the Total Cost of Ownership and Emissions Reduction Estimates sections below.

Figure 33. Recommended EV Replacement Timeline – Vehicle Types (Phased)



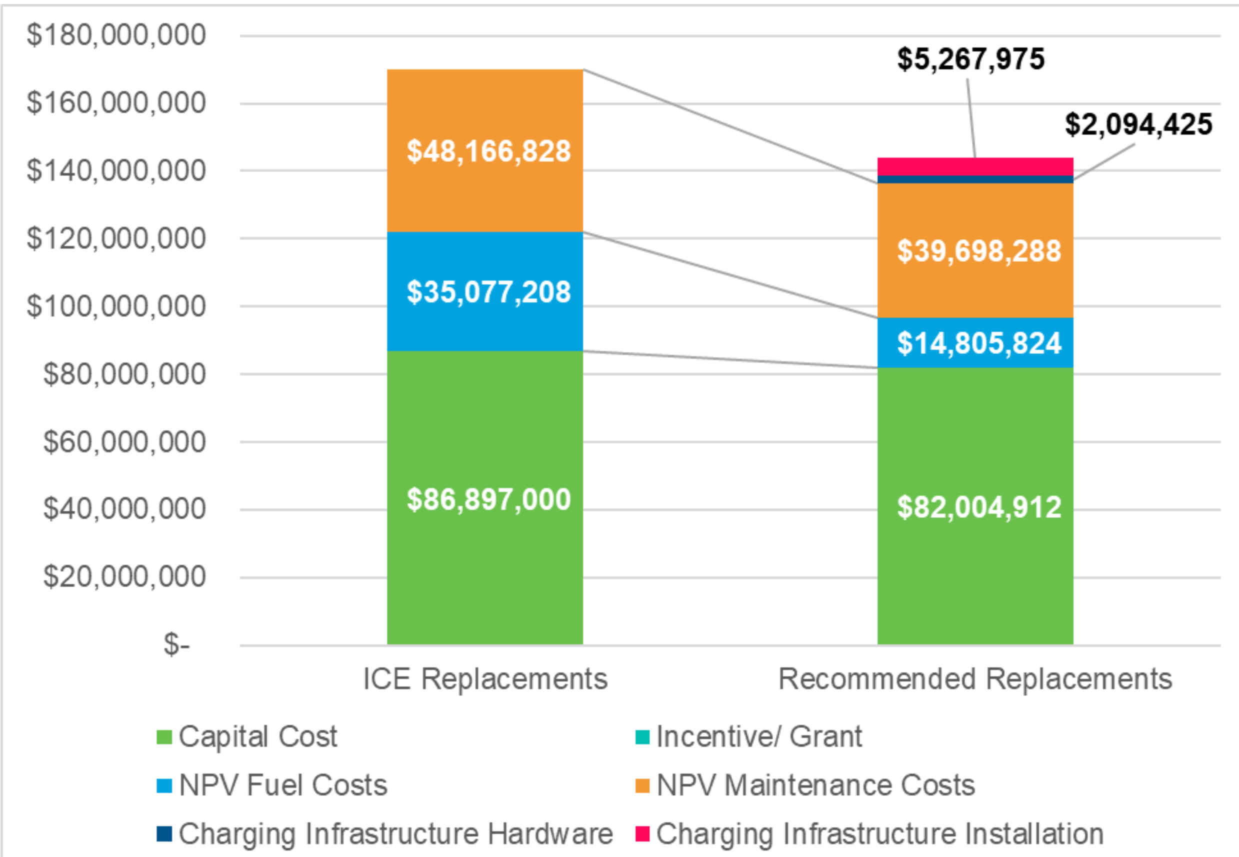
Total Cost of Ownership

City Fleet TCO Comparison

Non-Phased Replacement Schedule Scenario

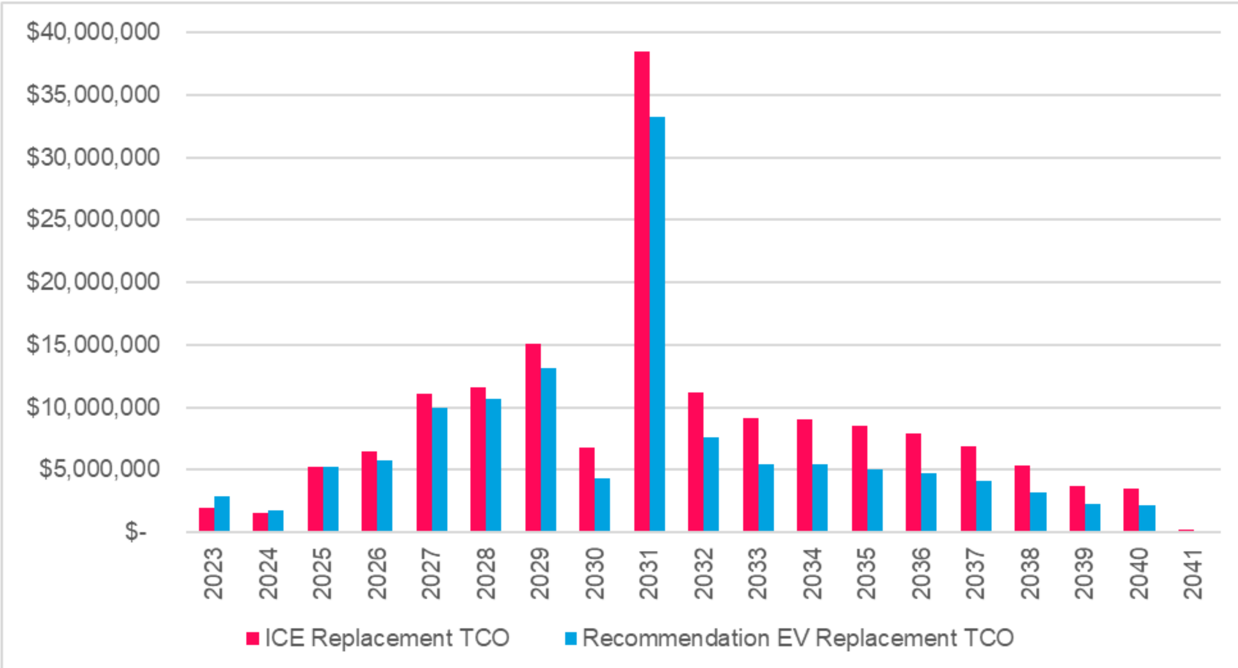
The figure below shows the NPV TCO over the lifespans of all vehicles replaced under two scenarios: a business-as-usual (BAU) scenario in which all vehicles considered in the analysis are replaced with ICE vehicles, and the recommended EV replacement scenario. Overall, the recommended EV replacement scenario is estimated to yield $26.3 million in cost savings compared to BAU, not including the cost of any necessary electric distribution grid or site-level make-ready EV infrastructure costs. This analysis does not include potential revenue from grants.

Figure 34. City Fleet TCO Comparison – NPV Costs Over Vehicle Lifespans (Non-Phased)



There are 1,584 fleet vehicles scheduled for retirement between 2023 and 2037, and ICF estimates that 1,050 of them are cost effective to convert to BEVs or PHEVs. Figure 35 below shows annual TCO for both the BAU replacement approach and the recommended EV replacement approach, based on the timeline described in Figure 26.

Figure 35. Fleet Recommended Replacements TCO Comparison – Annual (Non-Phased)



Based on these estimates, the financial breakeven year is anticipated to be 2027. Figure 36 shows the cumulative cost of vehicle replacements under the two scenarios, including a more visual depiction of when the EV replacement costs break-even with costs under the ICE replacement scenario.

Figure 36. Fleet Recommended Replacements TCO Comparison – Cumulative (Non-Phased)

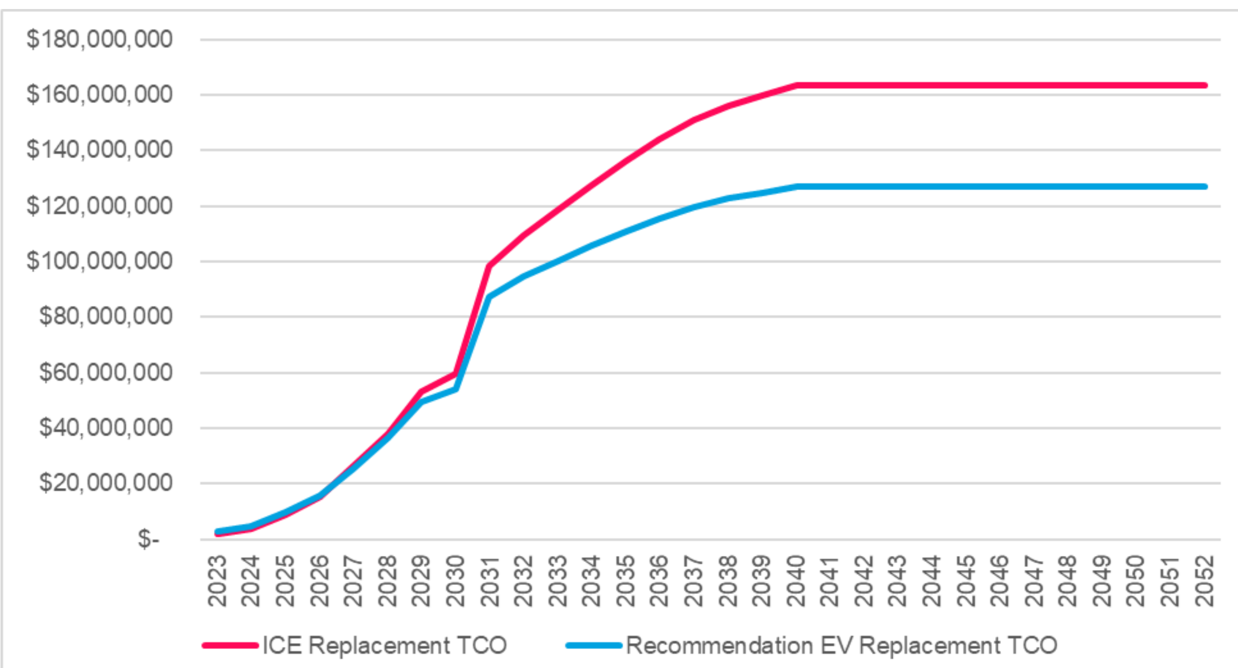


Table 45 shows a detailed breakdown of the costs to implement ICF's EV replacement recommendations, including the number of vehicles up for retirement by 2037, the number recommended to replace with EVs, estimated financial savings, and estimated lifetime GHG emissions reductions from EV replacement, all shown by vehicle type.

Table 45. Financial and GHG Savings for Recommended Vehicle Replacements (Non-Phased)

Vehicle Type and Replacement Make & Model	Quantity Up for Retirement	Quantity Recommended to Convert to Electric	Estimated Financial Savings	Estimated GHG Emissions Reductions (Lifetime MT)
Bucket Truck	**3**	**1**	**$856,676**	**4,281**
Lion Electric – Lion8- Tandem – Bucket – 160 kWh	1	1	$856,676	4,281
ICE Replacements	2	0	$0	-
Dump Truck	**14**	**1**	**$95,936**	**943**
Neuron EV – MET	1	1	$95,936	943
ICE Replacements	13	0	$0	-
Heavy Truck	**107**	**106**	**$3,638,507**	**11,582**
SEA Electric – SEA Hino 338 EV	106	106	$3,638,507	11,582
ICE Replacements	1	0	$0	-
Light-Duty Pickup	**324**	**279**	**$310,793**	**9,964**
ICE Replacements	45	0	$0	-
Ford – F-150 Lightning	279	279	$310,793	9,964
Medium-Duty Pickup	**77**	**9**	**$44,238**	**281**
Lightning eMotors – Ford F-450	9	9	$44,238	281

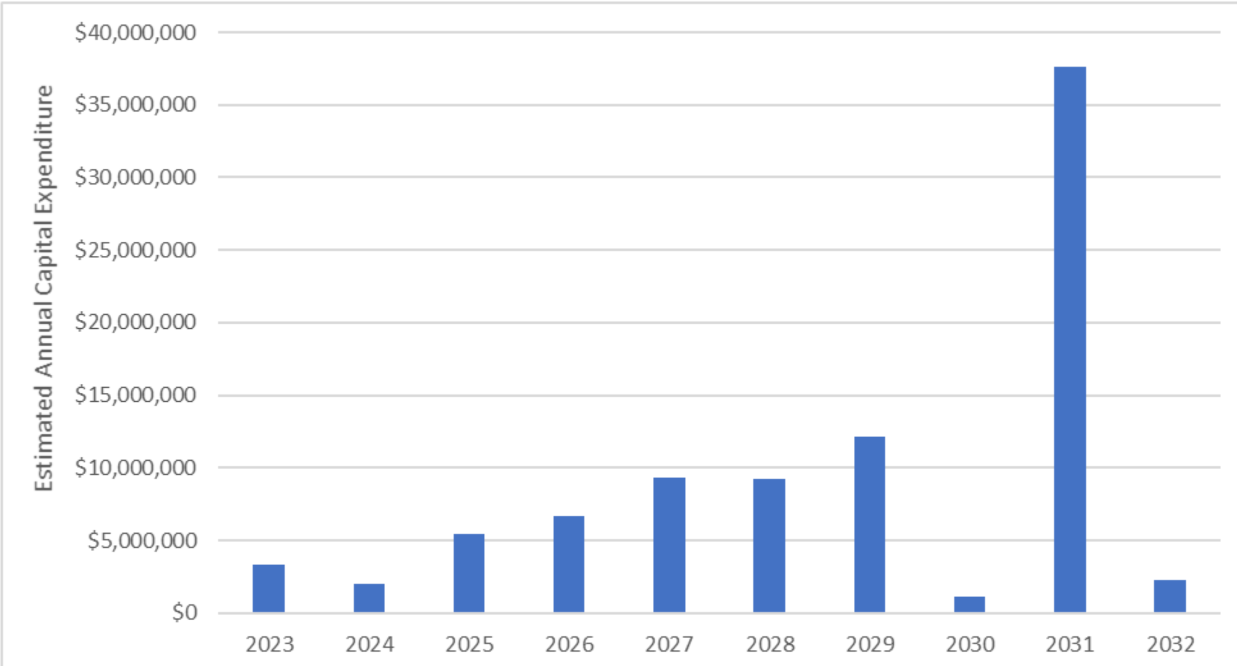
Vehicle Type and Replacement Make & Model	Quantity Up for Retirement	Quantity Recommended to Convert to Electric	Estimated Financial Savings	Estimated GHG Emissions Reductions (Lifetime MT)
ICE Replacements	68	0	$0	-
Medium-Duty Vocational Truck	**84**	**25**	**$335,644**	**1,209**
Lightning eMotors – Ford E-450 Cargo Truck (80 mile range) – LEV80E	25	25	$335,644	1,209
ICE Replacements	59	0	$0	-
Minivan	**62**	**24**	**-$138,718**	**1,222**
Chrysler – Pacifica Hybrid Touring	24	24	-$138,718	1,222
ICE Replacements	38	0	$0	-
Refuse Truck	**1**	**1**	**$29,327**	**131**
SEA Electric – SEA EXPEDITOR EV	1	1	$29,327	131
School Bus	**2**	**0**	**$0**	**-**
ICE Replacements	2	0	$0	-
Sedan	**479**	**214**	**-$209,272**	**7,325**
Hyundai – Ioniq Plug-in Hybrid	4	4	$1,917	157
Chevrolet – Bolt EV LT	208	208	-$223,804	7,026
Nissan – Leaf S	2	2	$12,615	142

Vehicle Type and Replacement Make & Model	Quantity Up for Retirement	Quantity Recommended to Convert to Electric	Estimated Financial Savings	Estimated GHG Emissions Reductions (Lifetime MT)
ICE Replacements	265	0	$0	-
Shuttle Bus	**55**	**53**	**$706,015**	**8,263**
GreenPower Motor Company – EV Star	53	53	$706,015	8,263
ICE Replacements	2	0	$0	-
Step Van	**1**	**0**	**$0**	**-**
ICE Replacements	1	0	$0	-
Street Sweeper	**20**	**4**	**$75,182**	**2,261**
Global – M3 SUPERCHARGED	4	4	$75,182	2,261
ICE Replacements	16	0	$0	-
SUV	**213**	**199**	**$65,612**	**6,272**
Ford – Escape SE FWD PHEV	190	190	-$73,773	5,449
Hyundai – Kona Electric SEL	9	9	$139,385	823
ICE Replacements	14	0	$0	-
Transit Bus	**66**	**66**	**$20,199,109**	**46,949**
BYD – K7M 30’ All-Electric Transit Bus	66	66	$20,199,109	46,949

Vehicle Type and Replacement Make & Model	Quantity Up for Retirement	Quantity Recommended to Convert to Electric	Estimated Financial Savings	Estimated GHG Emissions Reductions (Lifetime MT)
Van	**76**	**68**	**$260,563**	**4,372**
Chanje – V8100 All-Electric Panel Van	68	68	$260,563	4,372
ICE Replacements	8	0	$0	-
Grand Total	**1584**	**1050**	**$26,269,611**	**105,055**

Figure 37 shows the estimated annual capital expenditure from fleet transition for the city under the non-phased scenario. As described previously, this scenario is characterized by a large spike in EV replacements in 2031, along with corresponding annual transition costs.

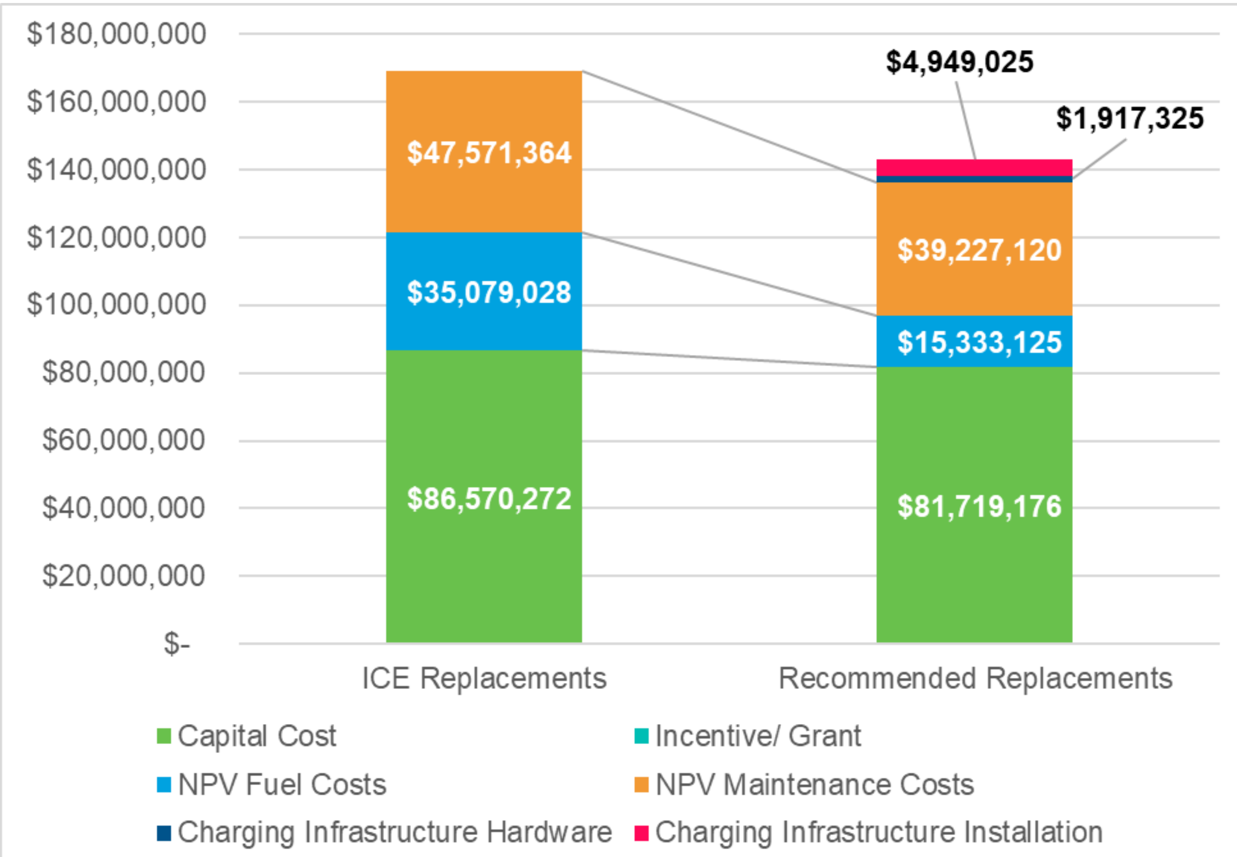
Figure 37. Estimated Annual Capital Spend, City Fleet (Non-Phased)



Phased Replacement Schedule Scenario

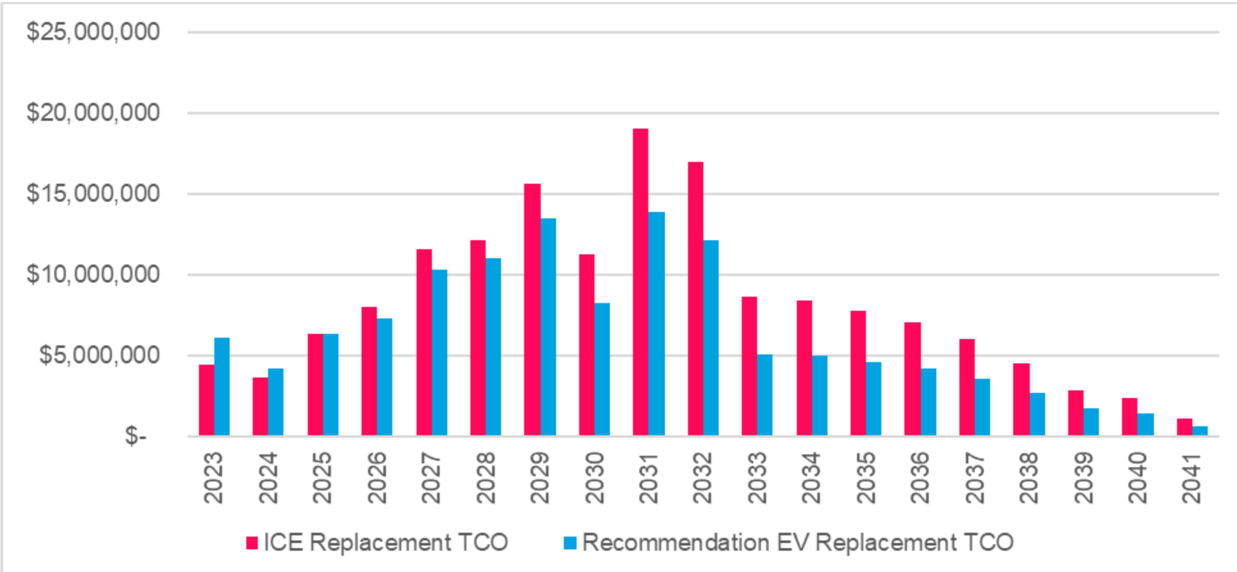
Figure 38 shows a summary of fleet transition costs under the phased scenario if the fleet were replaced with ICE vehicles per business as usual compared to the recommended EV replacements scenario. Compared to the non-phased scenario (Figure 33), the phased scenario is estimated to result in slightly lower vehicle capital costs and vehicle maintenance costs, but slightly higher fuel costs. Overall cost savings from fleet transition are estimated to reduce slightly in the phased scenario, by less than one percent (0.74%). Charging infrastructure costs are also estimated to be slightly lower than the non-phased scenario, due to fewer vehicles recommended for EV replacement.

Figure 38. City Fleet TCO Comparison – NPV Costs Over Vehicle Lifespans (Phased)



As described in previous sections, the phased scenario is designed to level-out the 2031 spike in EV replacements seen in the non-phased replacement scenario. Figure 39 shows the impact of this approach on an annual TCO basis. In the non-phased scenario (Figure 35), an estimated maximum annual EV replacement cost[183] was estimated at nearly $35 million, but in the phased scenario the maximum annual EV replacement cost is estimated to drop to under $15 million.

Figure 39. Fleet Recommended Replacements TCO Comparison – Annual (Phased)



[183] In this case, "estimated maximum annual EV replacement cost" refers to EV costs only, not the incremental cost difference between EV and ICE vehicle replacements.

Figure 40 shows the estimated cumulative replacement TCO for the phased scenario. This is similar to the estimated cumulative TCO for the non-phased scenario, albeit with a more gradual increase and plateau over time and an EV replacement breakeven year of 2028.

Figure 2. Fleet Recommended Replacements TCO Comparison – Cumulative (Phased)

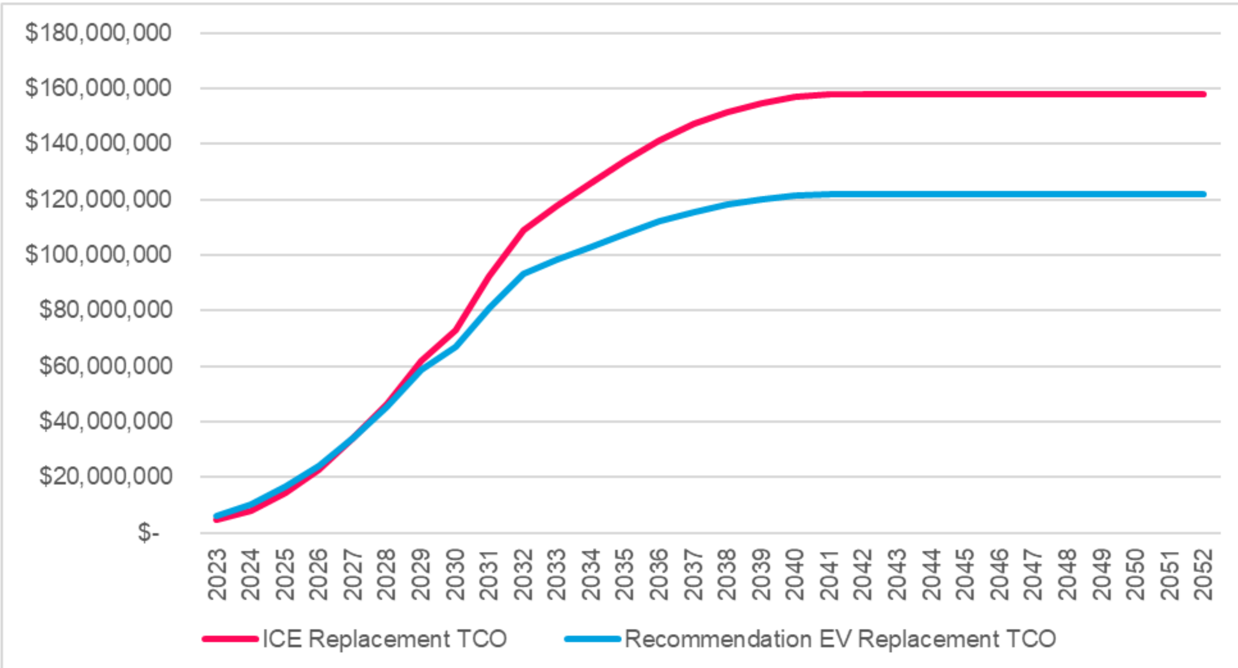


Table 46 shows the estimated financial and GHG emissions savings for the phased scenario from recommended EV replacements compared to a business-as-usual case. As described previously, the estimated financial savings in the phased scenario are expected to reduce by a very small amount compared to the non-phased scenario, by less than one percent (0.74%).

Estimated per-vehicle financial savings for some vehicle types do deviate between the phased and non-phased scenarios, with decreased savings estimated for Heavy Trucks, Minivans, Sedans, Shuttle Buses, SUVs, and Vans under the phased scenario. Per-vehicle financial savings are estimated to increase for Light-Duty Pickups, Medium-Duty Vocational Trucks, Street Sweepers, and Transit Buses under the phased scenario.

Table 46. Financial and GHG Savings for Recommended Vehicle Replacements (Phased)

Vehicle Type and Replacement Make & Model	Quantity Up for Retirement	Quantity Recommended to Convert to Electric	Estimated Financial Savings	Estimated GHG Emissions Reductions (Lifetime MT)
Bucket Truck	**3**	**1**	**$856,676**	**4,281**
Lion Electric – Lion8- Tandem – Bucket – 160 kWh		1	$856,676	4,281
ICE Replacements		0	$0	-
Dump Truck	**14**	**1**	**$95,936**	**943**
Neuron EV – MET		1	$95,936	943
ICE Replacements		0	$0	-
Heavy Truck	**107**	**106**	**$3,289,268**	**11,582**
SEA Electric – SEA Hino 338 EV		106	$3,289,268	11,582
ICE Replacements		0	$0	-
Light-Duty Pickup	**324**	**236**	**$318,304**	**9,063**
ICE Replacements		0	$0	-

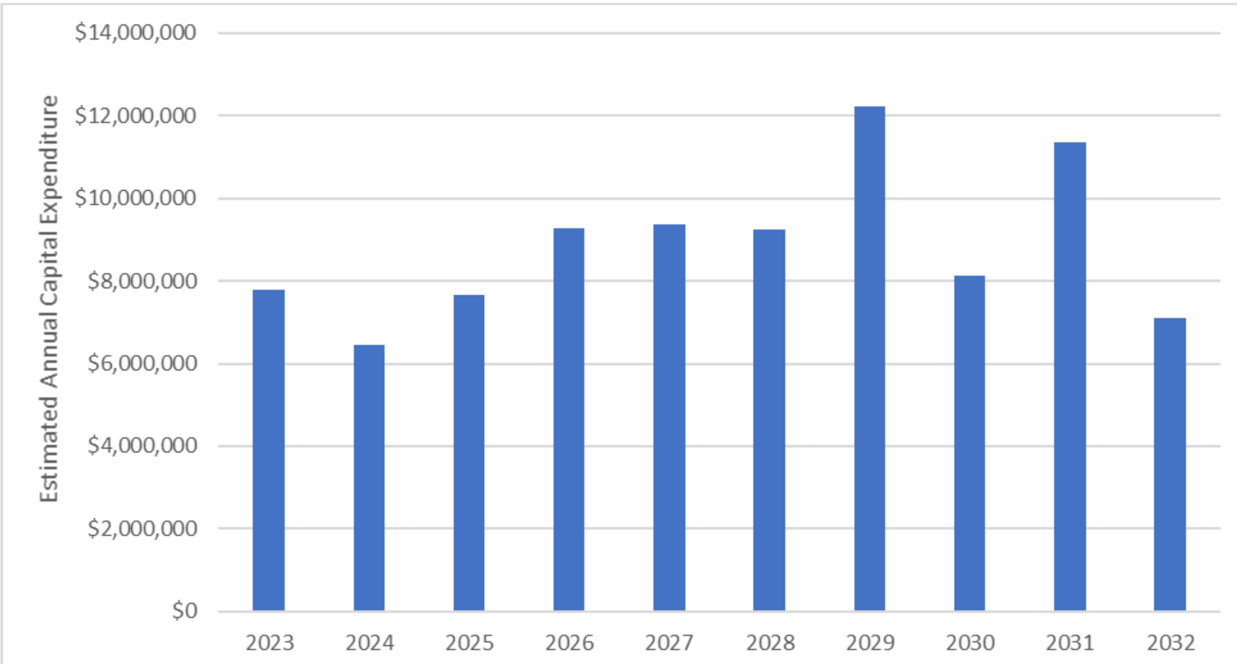
Vehicle Type and Replacement Make & Model	Quantity Up for Retirement	Quantity Recommended to Convert to Electric	Estimated Financial Savings	Estimated GHG Emissions Reductions (Lifetime MT)
Ford – F-150 Lightning		236	$318,304	9,063
Medium-Duty Pickup	**77**	**9**	**$44,238**	**281**
Lightning eMotors – Ford F-450		9	$44,238	281
ICE Replacements		0	$0	-
Medium-Duty Vocational Truck	**84**	**24**	**$347,579**	**1,175**
Lightning eMotors – Ford E-450 Cargo Truck (80 mile range) – LEV80E		24	$347,579	1,175
ICE Replacements		0	$0	-
Minivan	**62**	**25**	**-$145,355**	**1,264**
Chrysler – Pacifica Hybrid Touring		25	-$145,355	1,264
ICE Replacements		0	$0	-
Refuse Truck	**1**	**1**	**$29,327**	**131**
SEA Electric – SEA EXPEDITOR EV		1	$29,327	131
School Bus	**2**	**0**	**$0**	**-**
ICE Replacements		0	$0	-
Sedan	**479**	**183**	**-$180,950**	**6,609**

Vehicle Type and Replacement Make & Model	Quantity Up for Retirement	Quantity Recommended to Convert to Electric	Estimated Financial Savings	Estimated GHG Emissions Reductions (Lifetime MT)
Hyundai – Ioniq Plug-in Hybrid		4	$1,285	157
Chevrolet – Bolt EV LT		177	-$194,850	6,310
Nissan – Leaf S		2	$12,615	142
ICE Replacements		0	$0	-
Shuttle Bus	**55**	**53**	**$658,148**	**8,263**
GreenPower Motor Company – EV Star		53	$658,148	8,263
ICE Replacements		0	$0	-
Step Van	**1**	**0**	**$0**	**-**
ICE Replacements		0	$0	-
Street Sweeper	**20**	**1**	**$129,574**	**1,023**
Global – M3 SUPERCHARGED		1	$129,574	1,023
ICE Replacements		0	$0	-
SUV	**213**	**196**	**$22,622**	**6,238**
Ford – Escape SE FWD PHEV		187	-$116,763	5,415
Hyundai – Kona Electric SEL		9	$139,385	823

Vehicle Type and Replacement Make & Model	Quantity Up for Retirement	Quantity Recommended to Convert to Electric	Estimated Financial Savings	Estimated GHG Emissions Reductions (Lifetime MT)
ICE Replacements		0	$0	-
Transit Bus	**66**	**66**	**$20,398,780**	**46,949**
BYD – K7M 30' All-Electric Transit Bus		66	$20,398,780	46,949
Van	**76**	**68**	**$210,747**	**4,372**
Chanje – V8100 All-Electric Panel Van		68	$210,747	4,372
ICE Replacements		0	$0	-
Grand Total	**1584**	**970**	**$26,074,893**	**102,174**

Figure 41 shows the estimated annual capital expenditure from fleet transition for the city fleet under the phased scenario. Compared to the non-phased scenario (Figure 36), the phased scenario has a much more even distribution of estimated annual capital expenditure. In the non-phased scenario, there is an estimated maximum capital spend over $35 million in 2031, whereas the phased scenario estimates that maximum annual capital spend will be around $12 million.

Figure 3. Estimated Annual Capital Spend, City Fleet (Phased)

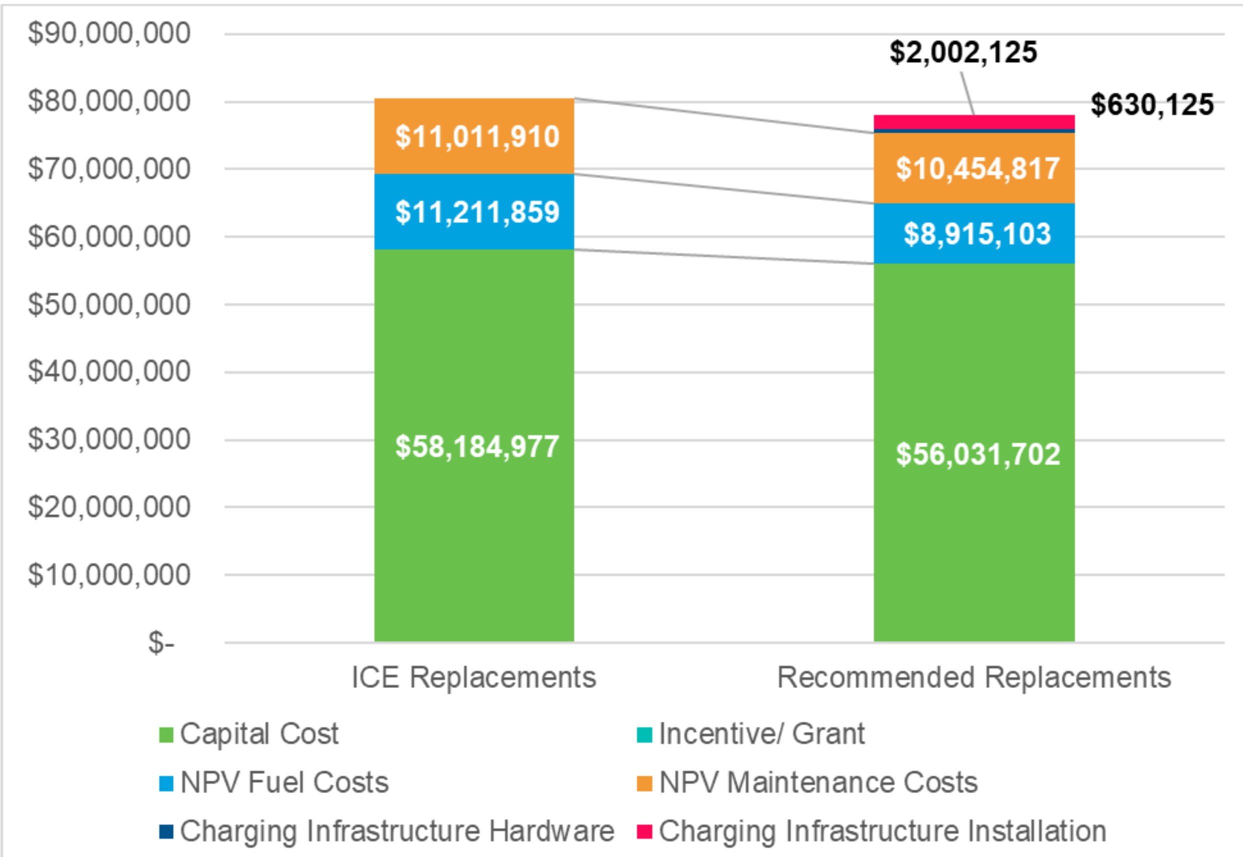


Colorado Springs Utilities Fleet TCO Comparison

Non-Phased Replacement Schedule Scenario

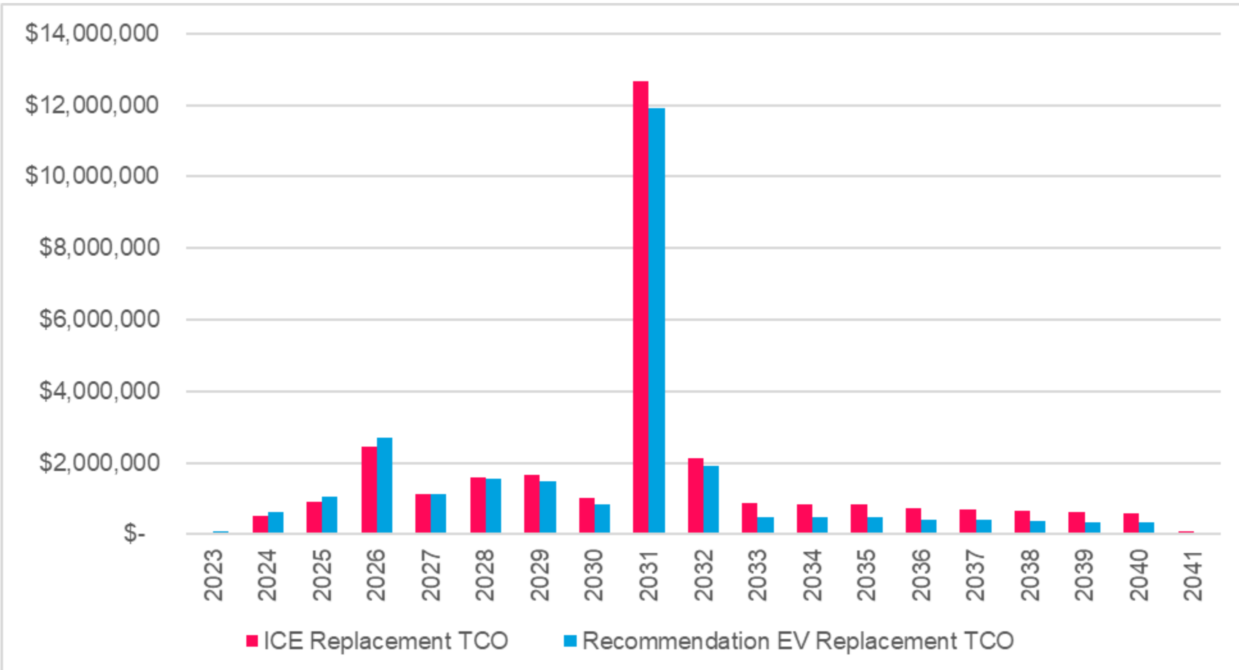
As with the City fleet, the figure below shows estimated NPV transition costs over the lifespans of all vehicles replaced under the business-as-usual ICE replacement and recommended EV scenarios. Overall, the recommended Springs Utilities EV replacement scenario is estimated to yield roughly $2.4 million in cost savings, not including the cost of any necessary electric distribution grid or site-level make-ready EV infrastructure costs.

Figure 4. Springs Utilities Fleet TCO Comparison – NPV Costs Over Vehicle Lifespans (Non-Phased)



There are 1,052 Springs Utilities vehicles scheduled for retirement between 2023 and 2037, and ICF estimates that 297 of them will be cost effective to convert to BEVs or PHEVs. Figure 43 below shows annual TCO for both the business-as-usual replacement approach and the recommended EV replacement approach, based on the timeline described in Figure 30.

Figure 5. Springs Utilities Fleet Recommended Replacements TCO Comparison – Annual (Non-Phased)



Based on these estimates, the financial breakeven year is anticipated to be 2031. Figure 44 shows the cumulative cost of vehicle replacements under the two scenarios.

Figure 6. Springs Utilities Fleet Recommended Replacements TCO Comparison – Cumulative (Non-Phased)

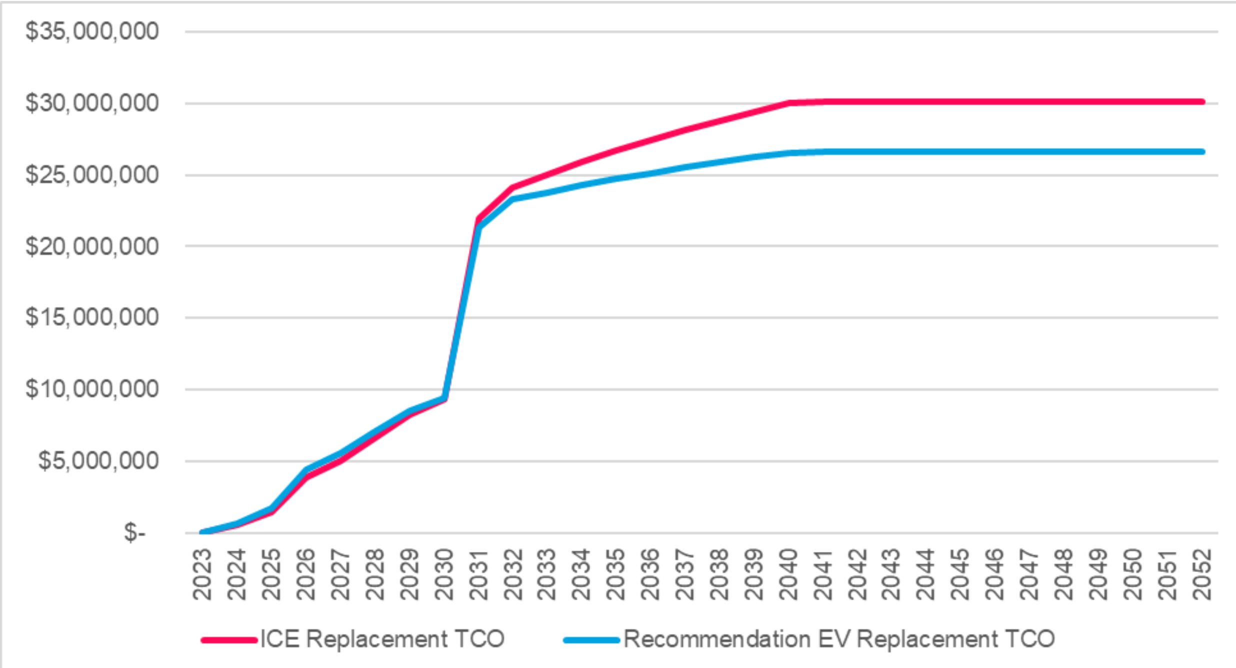


Table 47 shows a detailed breakdown of the costs to implement ICF's EV replacement recommendations. Of the 1,052 fleet vehicles considered in the evaluation, 297 (28%) are found to have an EV equivalent with a lifetime TCO within the 10% threshold, and therefore recommended for EV replacement. This is estimated to yield roughly $2.4 million in financial savings and 11,765 MT of lifetime GHG reductions over the analysis period.

Table 47. Financial and GHG Emissions Savings for Recommended Vehicle Replacements (Non-Phased)

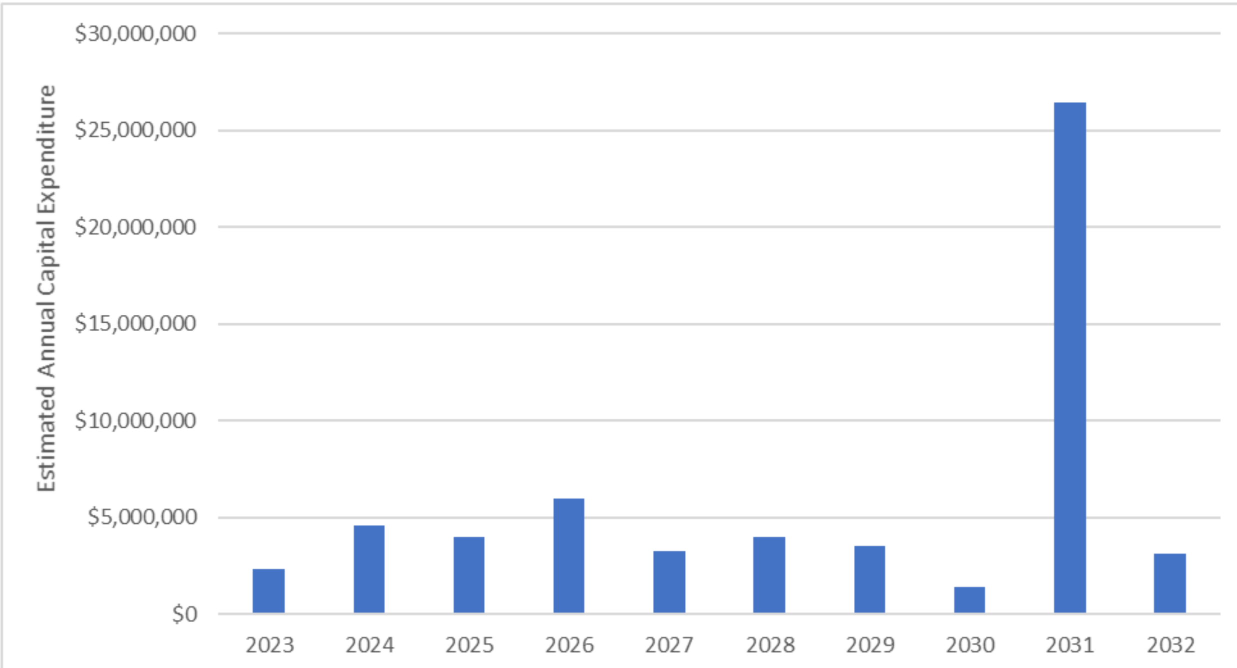
Vehicle Type and Replacement Make & Model	Quantity Up for Retirement	Quantity Recommended to Convert to Electric	Estimated Financial Savings	Estimated GHG Emissions Reductions (Lifetime MT)
Bucket Truck	**67**	**0**	**$0**	**-**
ICE Replacements	67	0	$0	-
Dump Truck	**6**	**0**	**$0**	**-**
ICE Replacements	6	0	$0	-
Heavy Truck	**182**	**139**	**$2,628,966**	**6,419**
SEA Electric - SEA Hino 338 EV	138	138	$2,555,351	6,651
ICE Replacements	43	0	$0	-
Freightliner - eCascadia	1	1	$73,615	(232)
Light-Duty Pickup	**295**	**70**	**-$254,714**	**2,866**
Atlis - XT	70	70	-$254,714	2,866
ICE Replacements	217	0	$0	-
Existing CNG Pickups	8	0	$0	-
Medium-Duty Pickup	**194**	**0**	**$0**	**-**
ICE Replacements	194	0	$0	-

Vehicle Type and Replacement Make & Model	Quantity Up for Retirement	Quantity Recommended to Convert to Electric	Estimated Financial Savings	Estimated GHG Emissions Reductions (Lifetime MT)
Medium-Duty Vocational Truck	**109**	**13**	**$7,373**	**696**
ICE Replacements	96	0	$0	-
Lightning eMotors - Ford E-450 Cargo Truck (80 mile range) - LEV80E	11	11	$14,402	814
Envirotech Drive Systems Incorporated - Cutaway	2	2	-$7,030	(117)
Minivan	**1**	**0**	**$0**	**-**
ICE Replacements	1	0	$0	-
Sedan	**27**	**1**	**-$1,986**	**26**
Hyundai - Ioniq Plug-in Hybrid	1	1	-$1,986	26
ICE Replacements	18	0	$0	-
Existing Electric Vehicles	8	0	$0	-
Step Van	**16**	**0**	**$0**	**-**
ICE Replacements	16	0	$0	-
Street Sweeper	**1**	**0**	**$0**	**-**
ICE Replacements	1	0	$0	-
SUV	**120**	**57**	**-$85,258**	**1,188**

Vehicle Type and Replacement Make & Model	Quantity Up for Retirement	Quantity Recommended to Convert to Electric	Estimated Financial Savings	Estimated GHG Emissions Reductions (Lifetime MT)
Ford - Escape SE FWD PHEV	57	57	-$85,258	1,188
ICE Replacements	63	0	$0	-
Van	**34**	**17**	**$80,493**	**570**
Chanje - V8100 All-Electric Panel Van	17	17	$80,493	570
ICE Replacements	17	0	$0	-
Grand Total	**1052**	**297**	**$2,374,874**	**11,765**

Figure 45 shows the estimated annual capital expenditure from fleet transition for the Springs Utilities fleet under the non-phased scenario. As described previously, and like the City fleet, this scenario is characterized by a large spike in EV replacements in 2031.

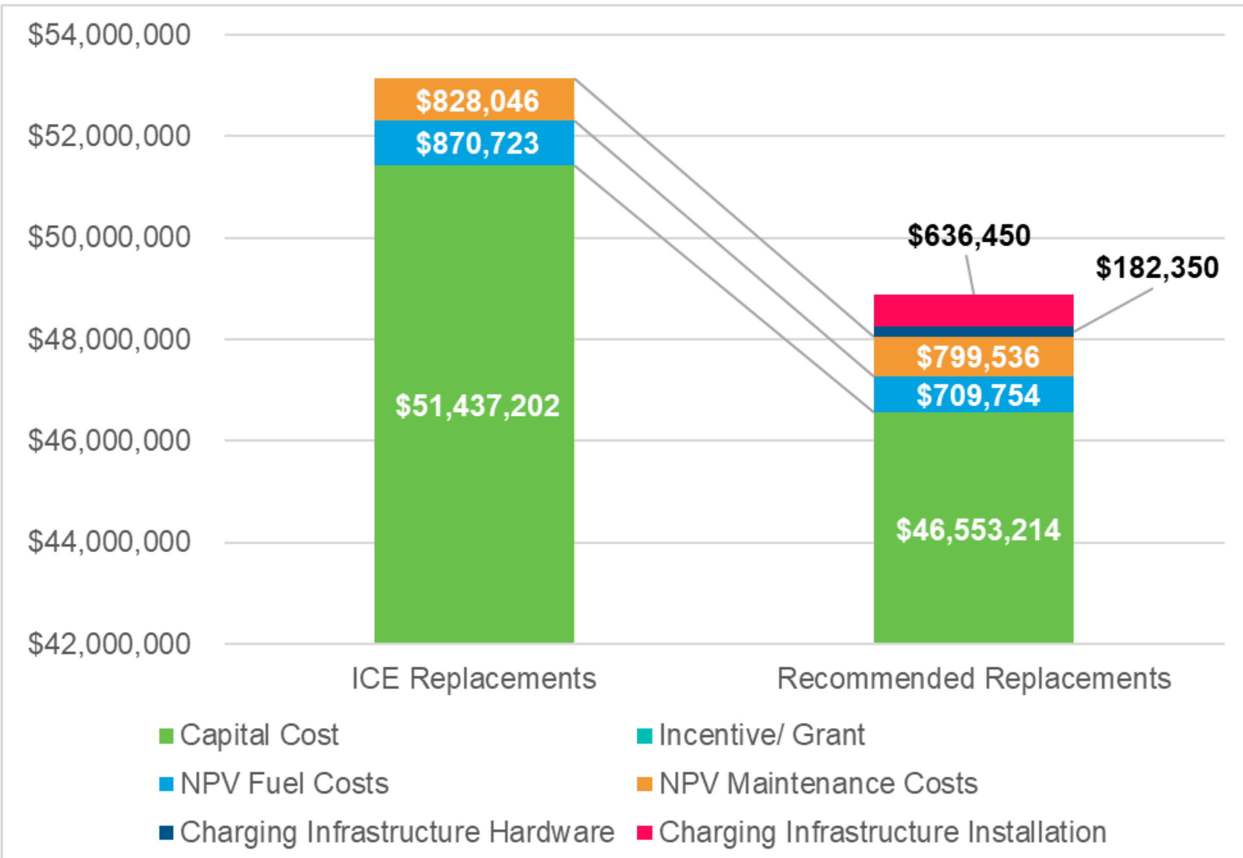
Figure 7. Estimated Annual Capital Spend, Springs Utilities Fleet (Non-Phased)



Phased Replacement Schedule Scenario

Figure 46 shows a summary of fleet transition costs under the phased scenario if the fleet were replaced with ICE vehicles per business as usual compared to the recommended EV replacements scenario. Compared to the non-phased scenario (Figure 42), phased replacement is estimated to result in lower vehicle capital costs and significantly lower fuel, maintenance, and charging infrastructure costs due to a sizeable 73 percent reduction in the number of vehicles recommended for EV replacement. Overall cost savings from fleet transition are estimated to increase by 79% in the phased scenario, and average per-vehicle transition cost savings are estimated to increase by 657% percent compared to the non-phased scenario.

Figure 8. Springs Utilities Fleet TCO Comparison – NPV Costs Over Vehicle Lifespans (Phased)



As described in previous sections, the phased replacement scenario is designed to level-out the 2031 spike in EV replacements included in the non-phased replacement scenario. Figure 47 shows the impact of this approach on an annual TCO basis. In the non-phased scenario (Figure 43), an estimated maximum annual EV replacement cost was estimated at $12 million, but in the phased scenario the maximum cost is estimated to drop to about $1.5 million. Again, in addition to the phasing of vehicle replacement schedules, this is also due to a 73 percent reduction in the number of recommended EV replacements compared to the non-phased scenario.

Figure 9. Springs Utilities Fleet Recommended Replacements TCO Comparison - Annual (Phased)

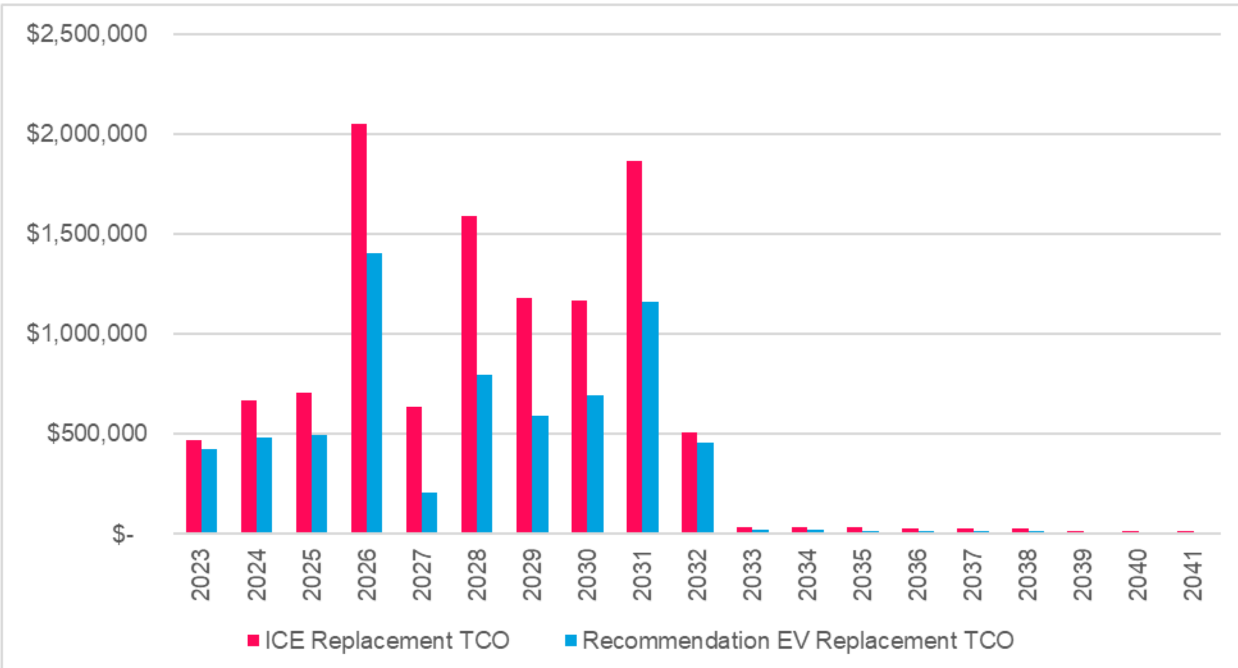


Figure 48 shows the estimated cumulative replacement cost for the phased scenario. While the breakeven year in the non-phased scenario was 2031, the phased scenario estimates a financial breakeven year nearly immediately in 2023.

Figure 10. Springs Utilities Fleet Recommended Replacements TCO Comparison – Cumulative (Phased)

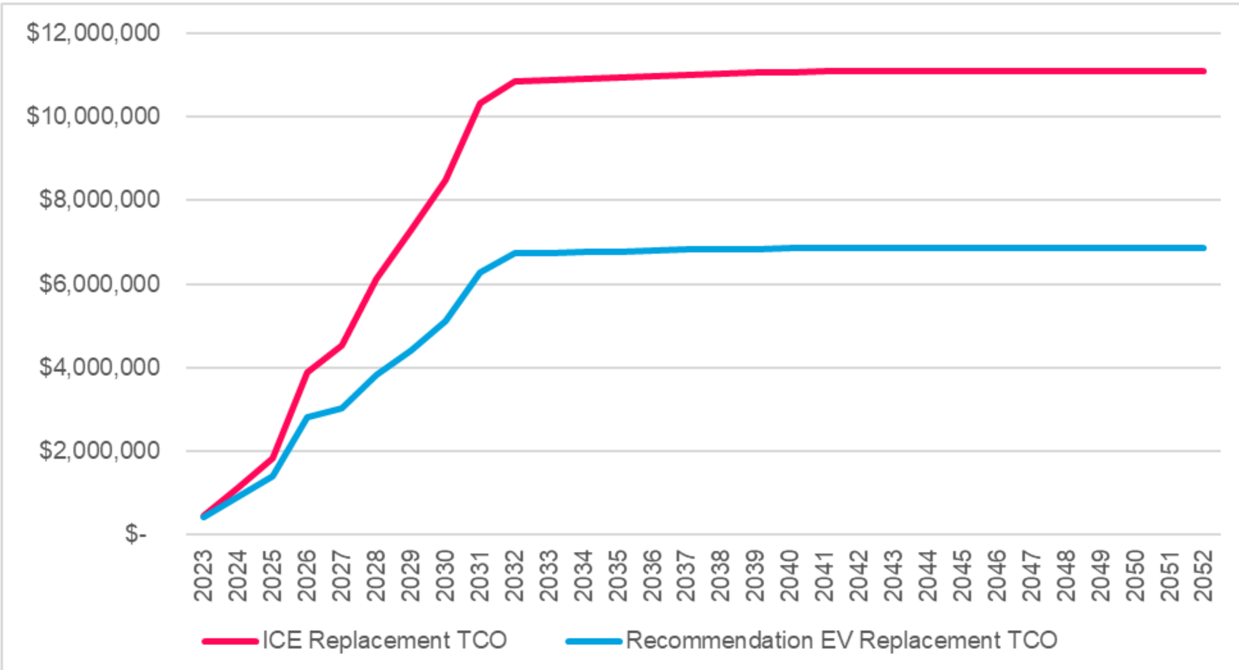


Table 48 shows the estimated financial and GHG emissions savings from recommended EV replacements under the phased scenario compared to the BAU case. As described previously, the estimated total financial savings in the phased scenario are expected to increase by 79 percent, and average per-vehicle transition cost savings are estimated to increase by 657 percent compared to the non-phased scenario.

Estimated per-vehicle financial savings for some vehicle types do deviate between the phased and non-phased scenarios, with decreased savings estimated for Minivans and Vans. Per-vehicle savings are estimated to increase for Heavy Trucks, Light-Duty Pickups, and SUVs under the phased scenario.

Table 48. Financial and GHG Emissions Savings for Recommended Vehicle Replacements (Phased)

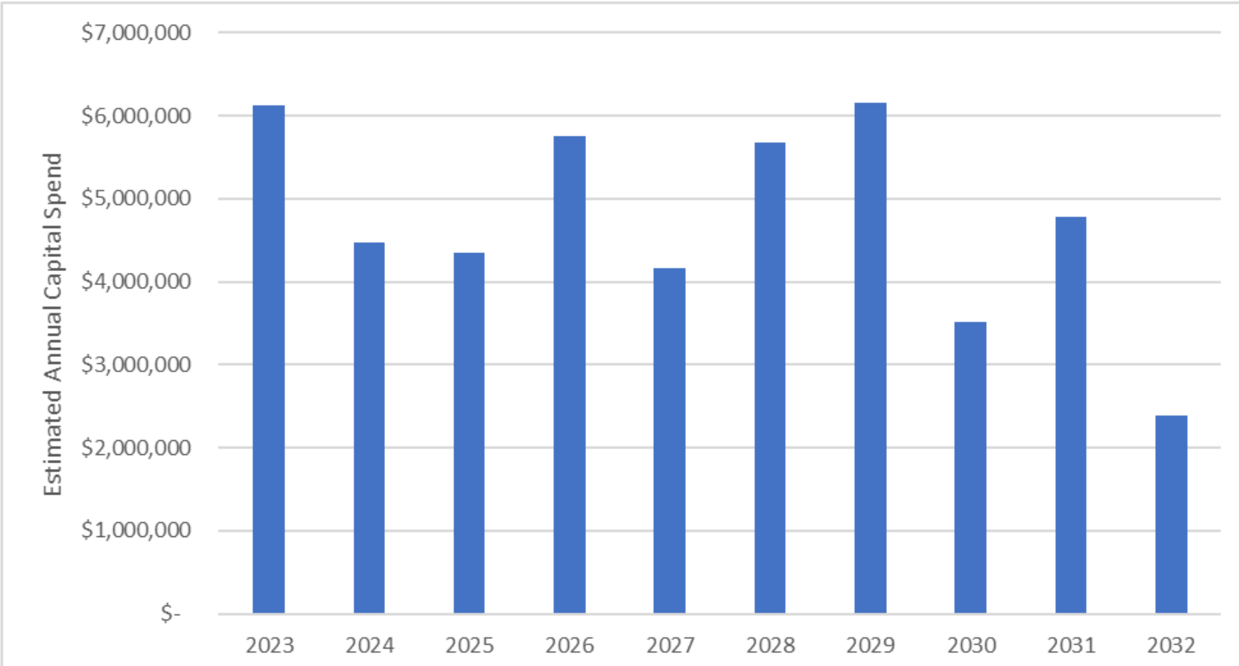
Vehicle Type and Replacement Make & Model	Quantity Up for Retirement	Quantity Recommended to Convert to Electric	Estimated Financial Savings	Estimated GHG Emissions Reduction (Lifetime MT)
Bucket Truck	**67**	**0**	**$0**	**-**
ICE Replacements	67	0	$0	-
Dump Truck	**6**	**0**	**$0**	**-**
ICE Replacements	6	0	$0	-
Heavy Truck	**182**	**55**	**$3,100,646**	**208**
SEA Electric – SEA Hino 338 EV	55	55	$3,100,646	208
ICE Replacements	127	0	$0	-
Light-Duty Pickup	**295**	**4**	**-$5,096**	**7**
ICE Replacements	283	0	$0	-
Ford – F-150 Lightning	4	4	-$5,096	7
Existing CNG Pickups	8	0	$0	-

Vehicle Type and Replacement Make & Model	Quantity Up for Retirement	Quantity Recommended to Convert to Electric	Estimated Financial Savings	Estimated GHG Emissions Reduction (Lifetime MT)
Medium-Duty Pickup	**194**	**0**	**$0**	**-**
ICE Replacements	194	0	$0	-
Medium-Duty Vocational Truck	**109**	**0**	**$0**	**-**
ICE Replacements	109	0	$0	-
Minivan	**1**	**1**	**-$2,259**	**1**
Chrysler – Pacifica Hybrid Touring	1	1	-$2,259	1
Sedan	**27**	**0**	**$0**	**-**
ICE Replacements	19	0	$0	-
Existing Electric Vehicles	8	0	$0	-
Step Van	**16**	**0**	**$0**	**-**
ICE Replacements	16	0	$0	-
Street Sweeper	**1**	**0**	**$0**	**-**
ICE Replacements	1	0	$0	-
SUV	**120**	**14**	**$1,171,893**	**217**
Ford – Escape SE FWD PHEV	5	5	$11,317	209
ICE Replacements	106	0	$0	-

Vehicle Type and Replacement Make & Model	Quantity Up for Retirement	Quantity Recommended to Convert to Electric	Estimated Financial Savings	Estimated GHG Emissions Reduction (Lifetime MT)
Hyundai – Sante Fe	9	9	$1,160,576	8
Van	**34**	**7**	**-$10,516**	**13**
Chanje – V8100 All-Electric Panel Van	7	7	-$10,516	13
ICE Replacements	27	0	$0	-
Grand Total	**1052**	**81**	**$4,254,667**	**446**

Figure 49 shows the estimated annual capital expenditure from fleet transition for the Springs Utilities fleet under the phased scenario. In the non-phased scenario, there is an estimated maximum capital expenditure above $25 million in 2031, whereas the phased scenario is estimated to cap annual capital spend at just over $6 million.

Figure 11. Estimated Annual Capital Spend, Springs Utilities Fleet (Phased)



EV Charging Infrastructure Assumptions

EVs require access to chargers, formally known as electric vehicle supply equipment (EVSE). In most fleet applications, charging is typically done at the fleet facility overnight or between shifts. Depending on the operations of a fleet, facility-based charging may need to be supplemented with periodic charging at workplaces, idle locations, and public destinations as needed. While it is determined on a case-by-case basis, charging at the fleet facility overnight is typically the lowest-cost option because electricity rates are often lowest at that time.

There are three types of EV charger power levels: Level 1, Level 2, and Direct Current (DC) Fast Charging.

- Level 1 chargers provide charging through a 120-volt (V) alternating current (AC) plug. A Level 1 charger plugs directly into a household outlet on one end, and into the vehicle's charge port on the other end. Level 1 chargers are the slowest category of EVSE and typically provide 2 to 5 miles of range per hour of charging a light-duty EV. Exact charging rates will depend upon multiple factors, including the charger power level and the vehicle's maximum power acceptance rate.
- Level 2 chargers provide charging through 240 V or 208 V electrical service. Level 2 charging equipment is common for home, public, and workplace charging. The large majority of public chargers in the United States are Level 2. Level 2 chargers can operate at up to 80 Amperes (Amps) and roughly 20 kilowatts (kW), and they provide faster charging than Level 1 EVSE.

Typically, a Level 2 charger provides 10 to 20 miles of range per hour of charging for a light-duty vehicle, however this rate will depend on the same factors described in the bullet above.

- DC Fast Chargers (DCFC) enable rapid charging through a 208/480 V three-phase input. Installing DCFCs may require site-level and/or utility infrastructure upgrades and these high-powered chargers cost significantly more than a Level 2 charger. DCFCs will typically add 75-150 miles of range for every 30 minutes spent charging a light-duty vehicle. As with the other charger categories, the range of miles added depends on the DCFC's output power and the vehicle's power acceptance rate, which varies by make and model. For example, a DCFC can add about 85 miles to a Chevrolet Bolt in 30 minutes of charging and it can add about 150 miles to a Nissan LEAF PLUS in the same timeframe 30. For comparison, a transit bus will be able to add 60-125 miles for every 30 minutes spent charging, depending on the capacity of the DCFC.

There are also three types of design for EVSEs: plug-in, wireless (inductive), and overhead opportunity charging.

- Plug-in chargers are the most common type of EVSE design. They consist of the EVSE itself, a cable, and a plug which connects to the vehicle's port.
- Wireless, or inductive, chargers are designed to transmit electricity to a vehicle's battery wirelessly. Typically, these chargers consist of a pad which is mounted underground. A vehicle will position itself over the pad and initiate a wireless charging session.
- Overhead opportunity chargers are high power DCFCs that are placed in strategic locations such that a vehicle can stop at the charger while travelling on a standard route and charge the vehicle in a relatively short time period. These chargers often connect to a contact point on the top of the vehicle via a moving overhead pantograph, and they are used frequently for applications with predictable routes, such as electric transit buses.

This study only provides recommendations for the deployment of plug-in chargers, which are suitable to meet the City's and Springs Utilities' needs. As described in the following section, ICF used information on each existing vehicle's operations and typical daily mileage, as well as assumptions about each replacement EV's battery size and power acceptance rate to determine whether or Level 2 chargers or DCFCs are required. The analysis assumes daily overnight charging for twelve hours and selects Level 2 if such a charger can fill an average-sized EV battery (by vehicle type) for each given EV replacement recommendation in that time, otherwise it selects a DCFC. For this analysis, Level 2 chargers are assumed to be a standard 6.6 kW and DCFCs are assumed to be 50 kW. It is important to note that EV chargers come in many output power level ratings, and power levels between 6.6 kW and 50 kW, and above 50 kW, do exist as well. Higher power chargers will fill an EV battery faster than lower power chargers, but they will also cost more.

EV Charging Infrastructure Assumptions in Both Analyses

The infrastructure analysis completed in this section, assumes a two-to-one vehicle-to-charger ratio and does not account for any existing chargers at the City and Springs Utilities fleet locations. Based on this methodology, under the non-phased scenario the City of Colorado Springs will need 522 Level 2 chargers and 5 DC fast chargers over the next 15 years to support the recommended 1,050 EV replacements.[184] Per ICF's analysis, DCFCs are needed to power EV replacements for street sweepers, refuse trucks, bucket trucks, and dump trucks based on the methodology and assumptions described in the section above. A Level 2 charger is estimated to be suitable for all other vehicle types. Under the phased scenario, the City will need 483 Level 2 chargers and 4 DCFCs. Under a 2:1 vehicle-to-charger ratio and the non-phased scenario, Colorado Spring Utilities will need 149 Level 2 chargers to support the recommended 297 EV replacements; ICF estimates that none of the Springs Utilities vehicles will require DCFCs. Under the phased scenario, Springs Utilities will need 41 Level 2 chargers to support the recommended 81 EV replacements.

Importantly, the EVSE costs in this analysis only account for EVSE hardware and installation costs, based on historical averages that may be lower than current costs. They also do not include the costs of potential utility distribution grid upgrades or site-level make-ready upgrade costs associated with preparing sites with electrical capacity and equipment necessary to enable EV chargers such as trenching, running wires and conduit, or other related activities.

Also, the two-to-one vehicle-to-charger ratio assumption used in this analysis is based off of the EVSE Siting Analysis Section above (within Section 7). That analysis used available telematics data to identify each individual vehicle's parking location and parking duration to inform needed charging infrastructure. Location based information was combined with the estimated energy consumption for each vehicle to inform the quantity and power level of the chargers required to support the recommended EVs. The siting analysis then estimated the number of chargers needed to support EVs in each fleet and identified that a ratio of approximately 2.5 vehicles per charger was required. A simplified 2:1 ratio was then applied in the analysis described in the paragraph above.

[184] DCFCs were found to be required for Bucket Trucks, Dump Trucks, Refuse Trucks, and Street Sweepers. L2 chargers were found to be required for all other vehicle types.

Incentives and Funding Source Assumptions Applied

Federal and State incentives are available for the purchase of EVs and EVSE, and they may contribute to reducing the cost of fleet conversion to EVs. The table below summarizes the incentives that may be available to the City of Colorado Springs and Colorado Springs Utilities, as well as additional information about how to capitalize on these incentives. Per a request from the client, no incentive funding has been included in the cost analysis described in the sections above. These were omitted from the analysis as a conservative measure, because the incentives are competitive and awards are not guaranteed.

In addition to the incentives outlined below, both the City and Springs Utilities fleets would be eligible for the ALT Fuels Colorado incentive funding for the replacement and scrappage of fully electric or renewable gas power Class 8 heavy-duty trucks, Class 4-7 medium-duty local freight trucks, and Class 4-8 school and shuttle buses.[185] Additional funding is also available for associated electric vehicle charging stations used to power this equipment (Level 1 and Level 2). This incentive program was not included in the TCO analysis because the next program opening and application date had not been announced at the time of analysis.

[185] More information available at: https://cleanairfleets.org/programs/alt-fuels-colorado

Table 49. Potential Incentives and Funding Sources

Program	Applicable Vehicle Type				Administrator	Funding Type			Program Offerings	Upcoming Deadlines	TCO Funding Assumptions
	Light-Duty	Medium-Duty	Heavy-Duty	Transit		Vehicle Costs	EVSE Installation	EVSE Hardware			
Charge Ahead Colorado: CEO	✓	✓	✓	✓	Colorado Energy Office			✓	Will fund up to 80% for cost of charging station.	Next application round 1/24/22 – 2/7/22	80% of cost of charging up to max of $6,000 for L2 fleet only, and max of $35,000 for L3 DCFC
Energy/Mineral Impact Assistance Fund Grant (FY22)	✓	✓	✓	✓	Colorado Department of Local Affairs	✓		✓	100% incremental vehicle costs, and 50% of L2 and DCFC costs. $1 million per application	Tier 1 and Tier 2 applications due 2/1/2022-3/4/2022	100% incremental vehicle costs, and 50% of L2 and DCFC costs for applicable vehicles in 2022
Airport ZEV and Infrastructure Pilot Program[186]	✓	✓		✓	Federal Aviation Administration	✓		✓	50% of vehicle costs (BEV only) and 50% of L2 and DCFC hardware costs.	Applications due 11/1/22	Limited to City's airport vehicles and must meet Buy American requirements. Limited to 50/50 match
Diesel Emission Reduction Act (National)		✓	✓	✓	EPA	✓	✓	✓	Up to 45% of EV and EVSE costs, must replace a diesel vehicle with 7,000+ annual miles	TBD[187]	45% of medium-duty, heavy-duty, and transit EV capital costs with 7,000+ annual miles

[186] Only applied to the City Fleet Airport vehicles.

[187] Current program is open until 3/16/2021, but the Consolidated Appropriations Act passed on 12/22/2020 included reauthorization of the DERA Program through 2024.

Emissions Reduction Estimates

Non-Phased Replacement Schedule Scenario

Under the non-phased replacement scenario, the TCO EV replacement recommendations for the City fleet is expected to yield over 105,000 metric tons (MT) of lifetime GHG emission reductions, the equivalent of removing 22,692 typical passenger vehicles from the road or growing 1.7 million tree seedlings for 10 years. It is also estimated to yield 156 MT of lifetime nitrous oxide (NOx) emissions reductions. The EV replacement recommendation for the Springs Utilities fleet is expected to yield 11,765 MT of lifetime GHG emission reductions, the equivalent of removing 2,541 typical passenger vehicles from the road or growing over 194,000 tree seedlings for 10 years. It is also estimated to yield 21 MT of lifetime NOx emissions reductions.

Table 50. Emissions Reduction Estimates (Non-Phased)

Measure	City Fleet	Utilities Fleet
GHG Emission Reductions (MT Lifetime)	105,055	11,765
Nox Emission Reductions (MT Lifetime)	156	21
Equivalent Number of Passenger Vehicles Removed from the Road	22,692	2,541
Equivalent Number of Tree Seedlings Grown for 10 Years	1,733,409	194,128

The following figures show the estimated GHG emissions from the BAU and recommended EV replacement scenarios over time, as well as the estimated average annual GHG emissions by vehicle type and fuel type.

Figure 12. Cumulative City Fleet GHG Emissions (Non-Phased)

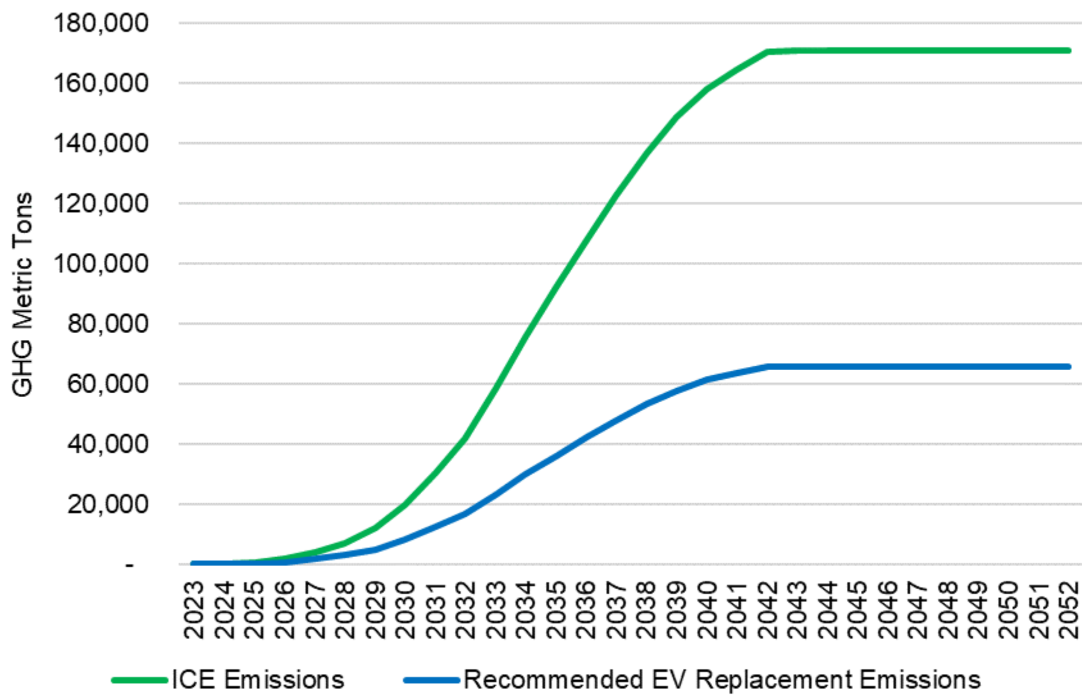
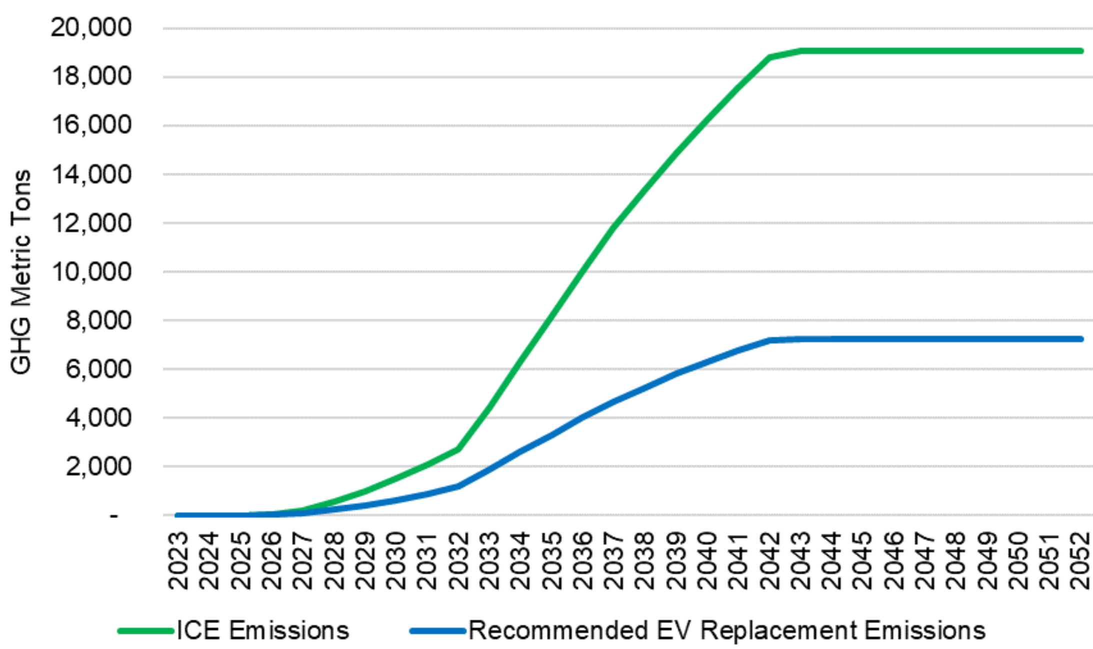


Figure 13. Cumulative Springs Utilities Fleet GHG Emissions (Non-Phased)



Importantly, there are a total of 51 vehicles in the Springs Utilities fleet that run on an E85 ethanol-gasoline blend. As detailed in the Key Assumptions section, the assumptions for gasoline vehicles were applied to these vehicles to carry out the fleet transition modeling. This includes assumptions for fuel economy, maintenance costs, fuel costs and more. The same is true for Springs Utilities fleet emissions reduction estimates, however it is important to note that the lifetime GHG emissions for E85 ethanol vehicles are typically lower than gasoline vehicle because Carbon Dioxide (CO^2) that is emitted when ethanol is burnt in vehicle engines is offset by the CO^2 captured by crops grown to produce the ethanol fuel. As a result, FFVs running on high-level blends of ethanol produce less net CO2 than conventional vehicles per mile traveled.

Phased Replacement Schedule Scenario

Table 51 shows the estimated emissions reduction for both the City and Springs Utilities fleets under the phased scenario. Under this scenario, the city fleet is estimated to see a slight reduction in the total lifetime GHG and NOx emissions reductions compared to the non-phased scenario, about 3 percent for GHG emissions and 0.6 percent for NOx emissions. Under the phased scenario, the Springs Utilities fleet is estimated to see a 96 percent and 98 percent reduction in total GHG and NOx emissions reductions, respectively. This is largely due to the 73 percent reduction in recommended EV replacements in the phased scenario compared to the non-phased scenario.

Table 51. Emissions Reduction Estimates (Phased)

Measure	City Fleet	Utilities Fleet
GHG Emission Reductions (MT Lifetime)	102,174	446
Nox Emission Reductions (MT Lifetime)	155	0.5
Equivalent Number of Passenger Vehicles Removed from the Road	22,070	96
Equivalent Number of Tree Seedlings Grown for 10 Years	1,685,868	7,364

Figure 14. Cumulative City Fleet GHG Emissions (Phased)

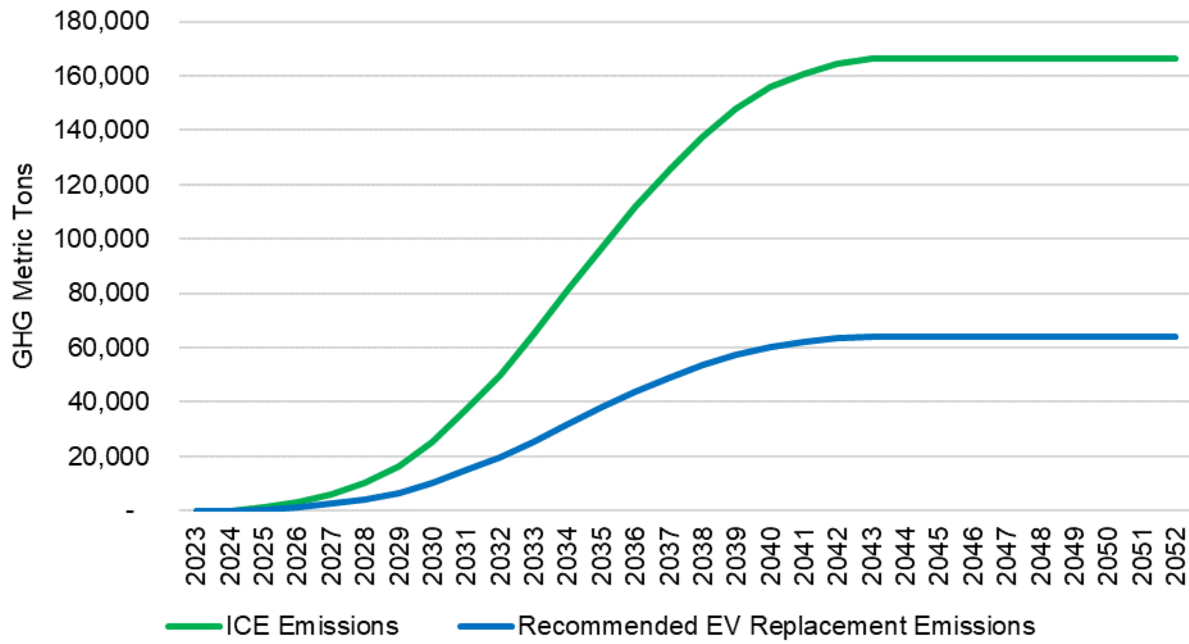
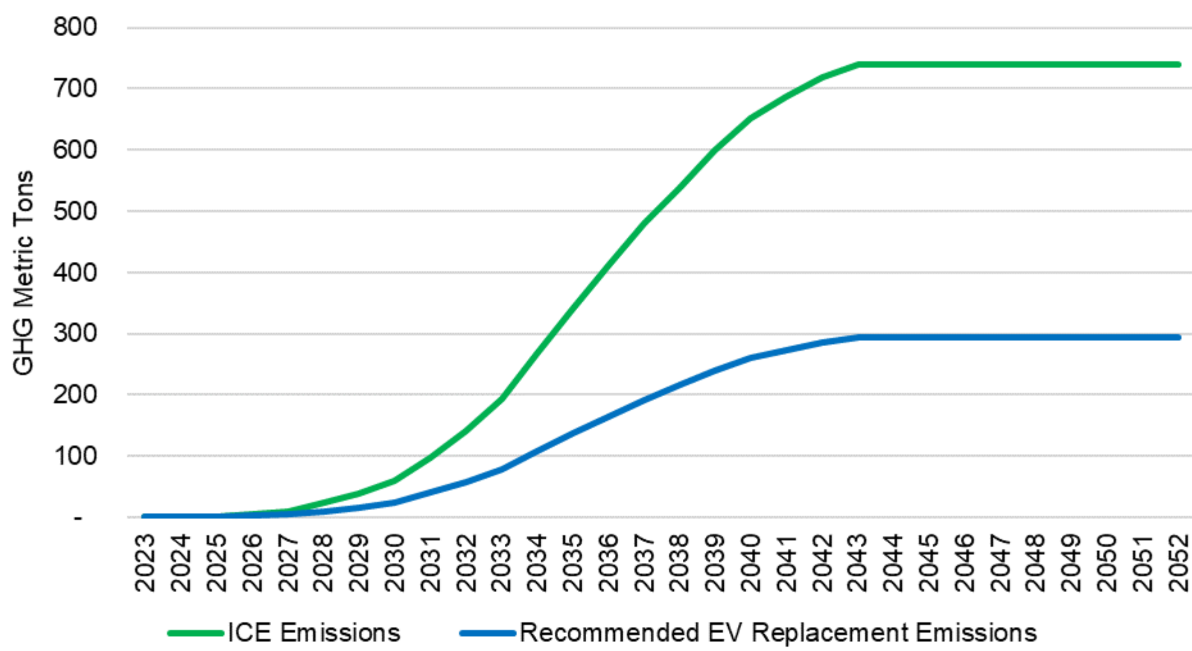


Figure 15. Cumulative Springs Utilities Fleet GHG Emissions (Phased)

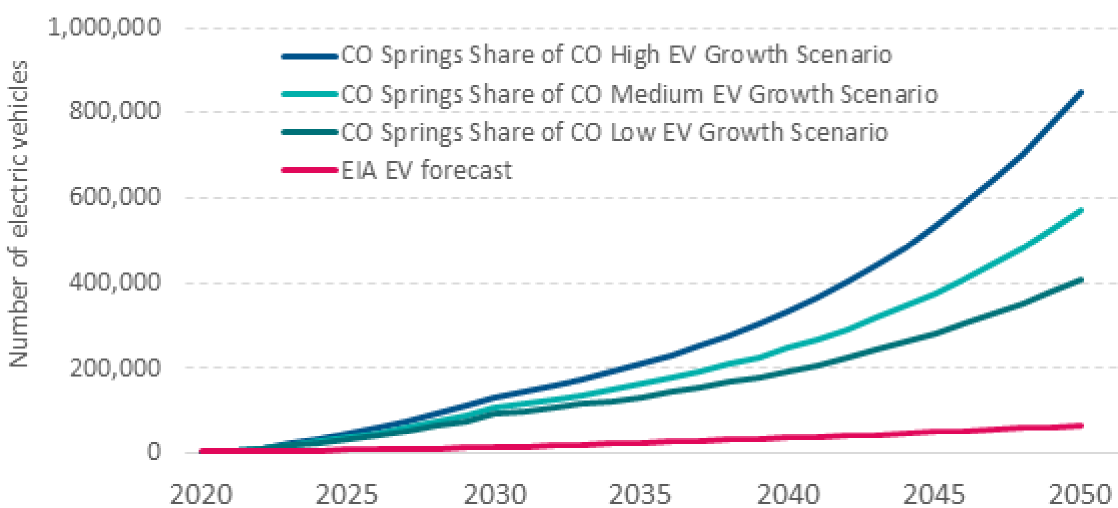


9. Potential Benefits

An analysis was conducted in order to estimate what emissions reductions the city of Colorado Springs could achieve depending on the level of EV adoption from 2020 through 2050.This analysis accounted for both tailpipe and upstream greenhouse gas emissions. For tailpipe emissions ICF calculated emissions of particulate matter 2.5 (PM2.5), ozone precursors nitrogen oxides (NOx), and volatile organic compounds VOCs—collectively termed criteria air pollutants (CAPs). CAPs are a major contributor of ground-level ozone and are an increasing concern to Colorado Springs due to the potential of the region falling into non-attainment with federal air quality standards. Greenhouse gas emissions were calculated based on lifecycle emissions, which account for fuel production and power generation.

For this analysis, an internal combustion engine (ICE) baseline was first developed by calculating the GHG and CAP emissions associated with the number of vehicles in each of the EV growth scenarios by applying ICE emission factors. This first calculation served as the emissions baseline if no EVs were adopted going forward. (See the Electric Vehicle Market Growth Scenarios earlier in this document for a detailed explanation on the EV projection methodology.) EV projections, which outline the number of EVs that replace ICE vehicles each year and served as the ICE baseline, are shown in the figure below.

Figure 54. EV Growth Scenario Projections



After establishing the baseline, the emissions associated with EVs in each of the EV growth scenarios was calculated by applying EV-specific lifecycle GHG and CAP emissions factors to the number of EVs in each analysis year, taking into account annual VMT and fuel economy. In the last step, to calculate the emissions reductions between the ICE baseline and each of the EV growth scenarios, ICF subtracted the EV emissions from the ICE emissions for both GHG and CAP emissions, resulting in the net emissions reductions shown in the figures below. It is important to note that this analysis assumes each EV adopted replaces one ICE vehicle (i.e., 1:1 replacement ratio of EVs and ICE vehicles).

Figure 55. Annual GHG Emissions Reductions from EV Growth Scenarios (MT/year)

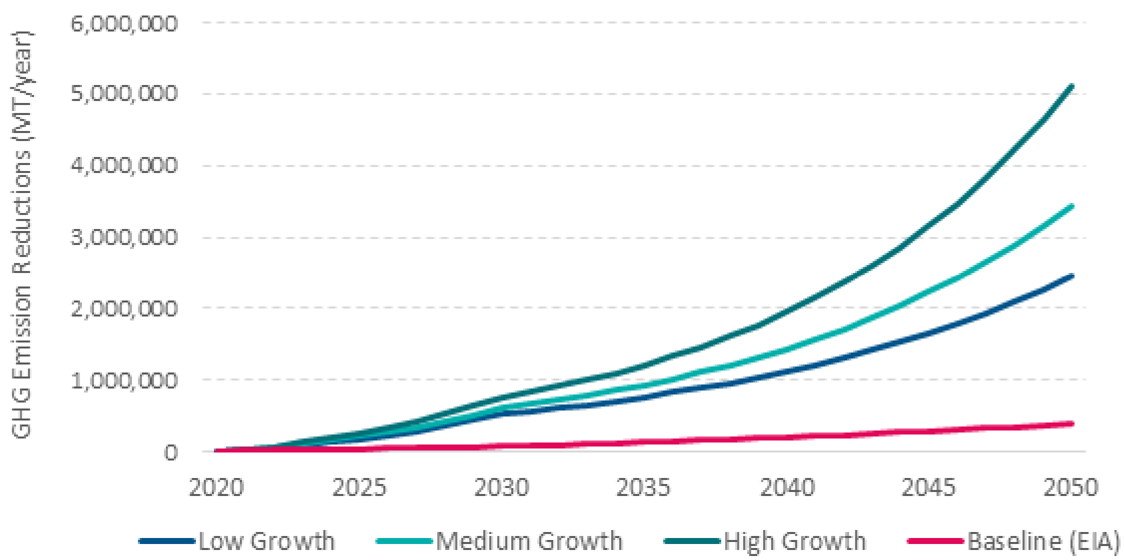


Figure 56. Annual PM2.5 Emissions Reductions from EV Growth Scenarios (kg/year)

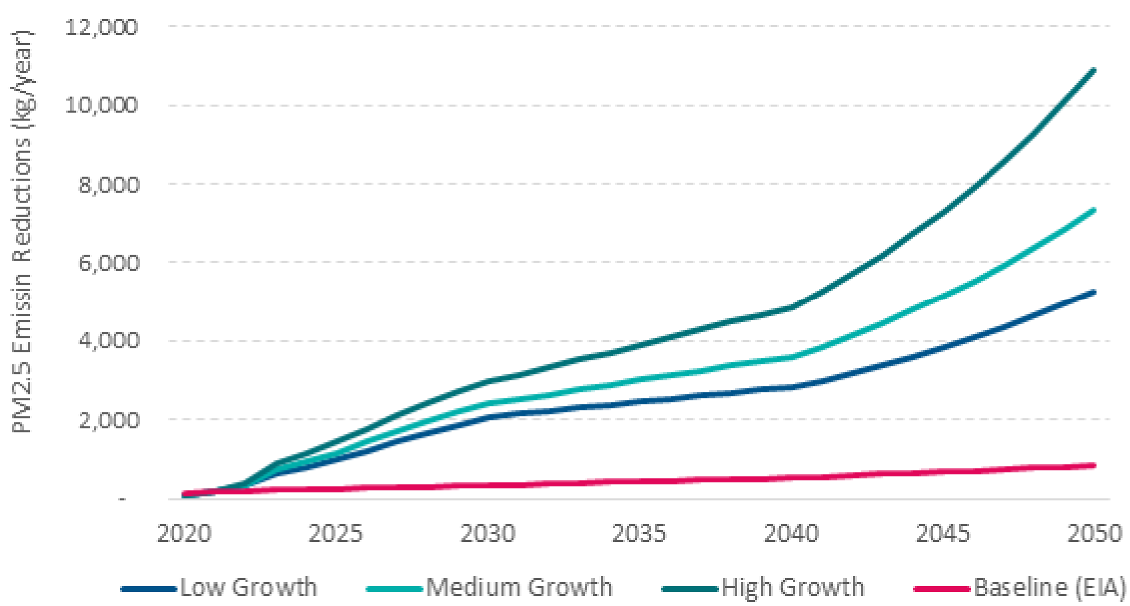


Figure 57. Annual NOx Emissions Reductions from EV Growth Scenarios (kg/year)

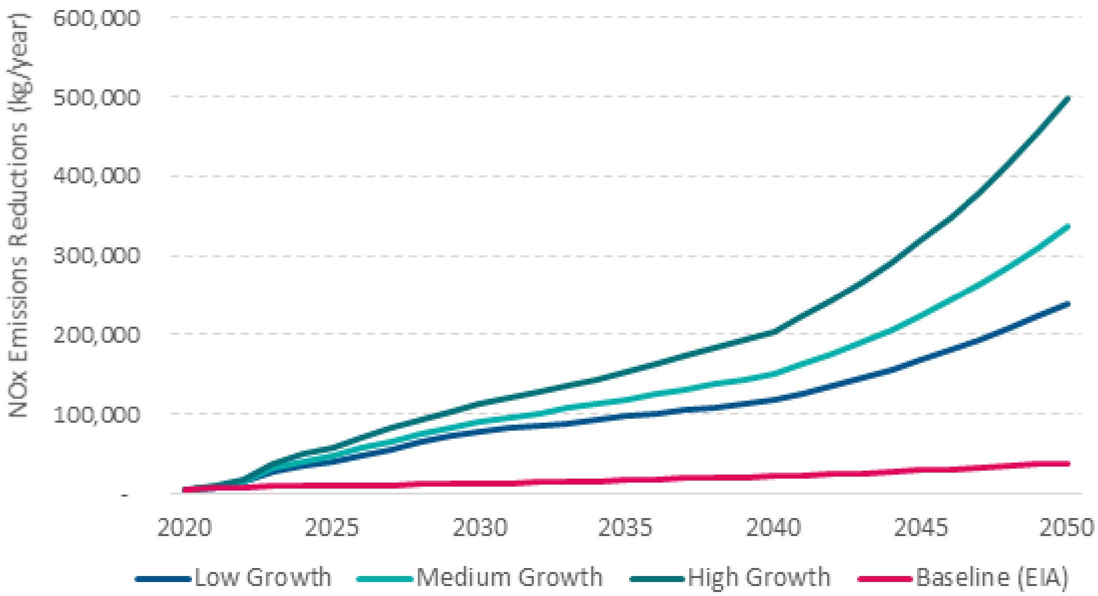
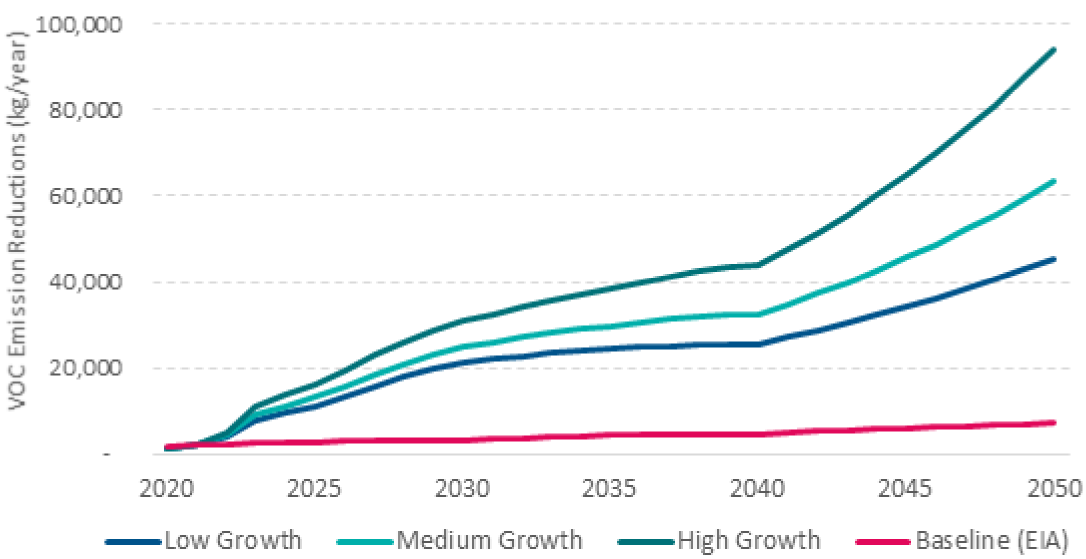


Figure 58. Annual VOC Emissions Reductions from EV Growth Scenarios (kg/year)



Comparing each of the EV growth scenarios show a significant reduction in lifecycle GHG emissions compared to EIA's EV forecast, which assumes a conservatively slow adoption curve of EVs. To illustrate this, in 2030, EIA's forecast assumes approximately 14,000 EVs compared to 92,000 for the low EV Growth scenario. This gap between EIA's conservative projections continues to widen as the analysis approaches 2050, with EIA assuming roughly 65,000 EVs compared to over 400,000 EVs in the low EV growth scenario. Understandably, the emissions reductions between the EV growth scenarios and EIAs EV forecast reflects this difference in EV acceleration curves. In total, cumulative GHG emissions reductions from each of the three EV growth scenarios compared to the EIA scenario shows a roughly 5x emission reduction level from the low EV growth scenario, 7x from the medium growth scenario, and a 10x reduction from the high EV growth scenario. The table below shows the annual GHG emissions reductions by EV growth scenario, with the 'cumulative emissions' representing the total GHG emissions reduced from 2020 through 2050.

Table 52. Annual GHG Emissions Reductions (MT/year)

	Baseline (EIA)	Low Growth	Medium Growth	High Growth
2020	15,732	13,069	13,069	13,069
2021	21,257	21,850	21,988	25,148
2022	26,533	45,248	49,294	58,882
2023	32,182	97,930	112,486	136,814
2024	38,309	135,964	159,562	195,728
2025	**44,811**	**181,558**	**214,674**	**264,467**
2026	51,561	234,831	277,928	343,151
2027	58,672	296,041	349,646	432,176
2028	66,090	364,461	428,956	530,463
2029	74,037	441,020	516,950	639,375
2030	**82,460**	**525,168**	**612,991**	**758,097**
2031	91,674	565,827	666,448	831,766
2032	101,579	609,645	724,623	912,639
2033	112,290	657,509	788,662	1,002,374
2034	123,785	709,447	858,740	1,101,415
2035	136,098	765,994	935,659	1,211,042
2036	149,146	827,167	1,019,623	1,331,786
2037	162,869	893,320	1,111,237	1,464,709
2038	177,220	964,670	1,210,958	1,610,747
2039	192,414	1,042,699	1,320,872	1,773,012
2040	**207,985**	**1,126,126**	**1,439,600**	**1,950,041**
2041	224,052	1,216,508	1,569,356	2,145,243
2042	240,663	1,314,564	1,711,354	2,360,732
2043	257,816	1,420,818	1,866,588	2,598,403
2044	275,528	1,536,086	2,036,466	2,860,804
2045	293,949	1,661,355	2,222,674	3,150,929
2046	312,571	1,795,180	2,423,677	3,467,286
2047	331,924	1,940,853	2,644,298	3,817,486
2048	351,894	2,098,144	2,884,730	4,202,663
2049	372,566	2,268,940	3,148,080	4,628,255
2050	**393,757**	**2,451,713**	**3,436,918**	**5,096,353**
Cumulative Emissions	**5,021,422**	**28,223,707**	**36,778,106**	**50,915,055**

CAP emissions showed a similar pattern of reduction with each of the CAP categories showing similar magnitudes of reduction between the EV growth scenarios and the EIA scenario. In the low EV growth scenario, NOx, PM2.5, and VOC emission reductions were approximately 5x more as compared to EIA, while the medium growth scenario was roughly 7x, and the high growth scenario was around 9x more. Table 52 shows the annual CAP emissions reductions by EV growth scenario, with the ‘cumulative emissions’ representing the total CAP emissions reduced from 2020 through 2050.

10. Incremental Energy Requirements from EV Charging

The growth of EVs within the City will add to Springs Utilities' overall energy requirement. The EV adoption projections show a steep rise in vehicle growth over the next 30 years; Springs Utilities should consider the charging requirements of EVs in its future resource planning assumptions to ensure resource adequacy and system reliability.

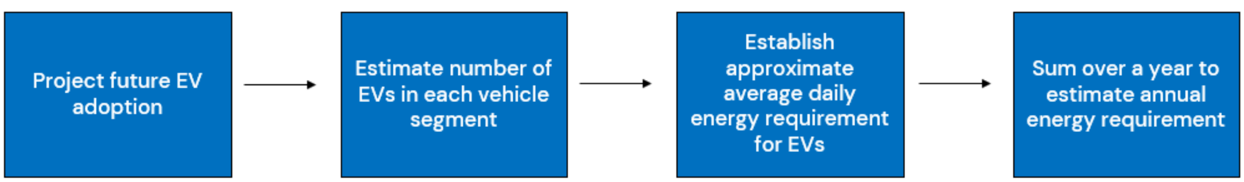
The goal of ICF's energy requirements assessment was to estimate the incremental energy Springs Utilities would need to generate or purchase based on EV adoption projections.

ICF's approach included a simplified method to ascertain the total energy required to charge EVs. The simplified approach is beneficial because it relies on relatively lower amounts of data and is not computationally complex. However, the charging analysis may not fully capture the variations in driving patterns and vehicle miles traveled, as well as the future diversity in the types of EVs. As such, the results of ICF's analysis should be thought of as outputs of a screening exercise, which could serve as a precursor to a detailed energy forecast study conducted by Springs Utilities.

Methodology Overview

Figure 59 below provides a high-level overview of the analytical process used to determine the grid impacts of new EV adoption. As a first step, ICF estimated the total number of EVs in each vehicle segment (sedans, SUVs, etc.) for the key analysis years (2020, 2025, 2030, 2040, 2050).[188] Next, ICF estimated the weekly average energy requirement for each type of vehicle. As a final step, ICF used the average weekly energy requirement in conjunction with the projected vehicles in each segment to establish the total annual energy requirement.

Figure 16. Energy Requirements Analysis Methodology



A description of the methodology is below.

Project Future EV Adoption and Number of Vehicles in Each Segment
The charging energy requirement of an EV is dependent on the type of vehicle and the distance traveled by the vehicle. To account for the diversity in EV types and driving patterns that may materialize in the future, it was necessary to first disaggregate the projections of the total number of EVs into various EV segments. ICF used the EV adoption projections for the City and vehicle registration data from Oak Ridge

[188] ICF used the same EV and charger projections for both the grid impacts and energy requirements analyses.

National Laboratory[189] and the US Department of Transportation's Federal Highway Administration[190] to establish the number of EVs in each segment.

The projected future share of EVs across all segments is shown in Table 53 below.

Table 53. Share of Projected EVs by Vehicle Segment

Vehicle Segment	Share of Vehicle Segment
Sedan	32%
Motorcycles	3%
SUV	36%
Pickups – Light	8%
Pickups – ½ Ton	6%
Pickups – ¾ Ton	2%
Pickups – 1 Ton	2%
Pickups – 2 Ton	2%
Vans	4%
Medium-Duty Trucks	2.5%
Heavy Duty Trucks	2.5%
Buses	0.24%

The values in the 'Share of Vehicle Segment' column yield an estimate of the number of EVs in various segments adopted in Colorado Springs. ICF conducted this disaggregation analysis using the projections of EV adoption for each of the years 2020, 2025, 2030, 2040, and 2050 to obtain the number of EVs in each segment.

[189] Oak Ridge National Lab, Transportation Energy Data Book, Page 80. Available online: https://tedb.ornl.gov/wp-content/uploads/2021/02/TEDB_Ed_39.pdf#page=80

[190] US DOT Federal Highway Administration- Policy and Governmental Affairs – Office of Highway Policy Information. Available online: https://www.fhwa.dot.gov/policyinformation/statistics/2019/mv9.cfm

Estimate Annual Average Energy Requirement

The next step in the analysis involved the estimation of the annual charging energy requirement for each EV segment for the analysis years in consideration – 2020, 2025, 2030, 2040, and 2050. ICF estimated average weekly energy charging requirements for each EV segment by leveraging the fleet analysis described previously in Chapter 7. ICF's assumptions for average weekly charging requirements are in Table 54 below.

Table 54. Average Weekly Charging Requirements by Vehicle Segment

Vehicle Segment	Average weekly charging requirement (kWh)
Cars	12.9
Motorcycles	12.9
SUV	20.1
Pickups – Light	43.3
Pickups – ½ Ton	43.3
Pickups – ¾ Ton	109.6
Pickups – 1 Ton	121.2
Pickups – 2 Ton	127.7
Vans	68.6
Medium-Duty Trucks	96.2
Heavy Duty Trucks	243.3
Busses	98.8

As a final step, ICF used the average weekly charging requirement in conjunction with the disaggregated annual EV projections to determine the annual incremental energy required for charging all EVs.

Key Assumptions

Unchanged Shares of Vehicle in Each Segment: As a simplifying assumption, ICF assumed that the share of EVs in a single segment as a percentage of the total number of EVs would not change over the duration of the analysis period. For example, in effect, the analysis assumes that electric cars will continue to be 32% of all EVs sold in Colorado Springs each year from 2020 – 2050. In reality, the share of each vehicle segment is likely to change in response to market conditions and consumer preferences. However, as future vehicle registrations and purchases are difficult to predict at the segment level, ICF assumed that the share of a certain vehicle segment would remain constant over the analysis period.

Unchanged Average Vehicle Miles Traveled: As a simplifying assumption, for each EV in a vehicle segment, ICF also assumed that EV miles traveled would remain unchanged over the duration of the analysis period, resulting in the same average weekly charging energy requirement. [191] In reality, driving patterns are likely to change over time in response to changing local factors and conditions. However, as it is difficult to predict these local factors and future driving patterns with certainty, ICF assumed that

[191] For example, if a light pickup truck were to travel 50 miles per week in 2020, the analysis assumed that it would continue to travel 50 miles per week for each year until 2050.

the average miles driven by an EV in a particular segment would remain constant for all years in the analysis period.

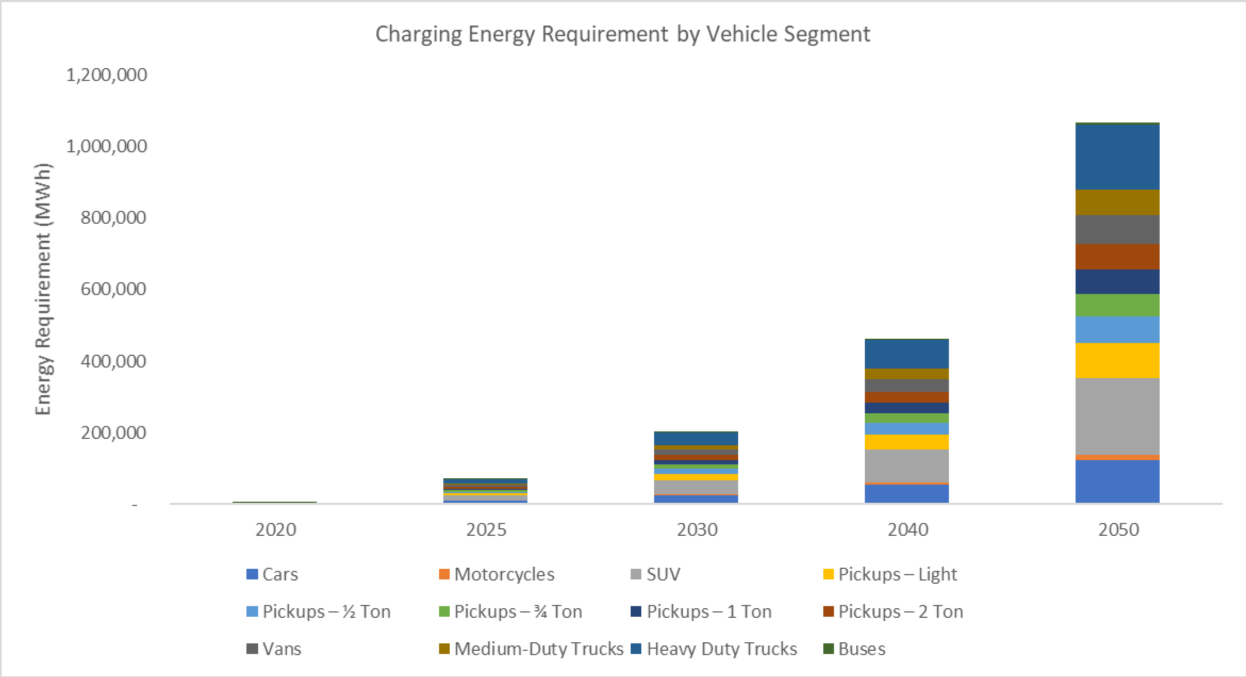
Results

ICF estimated the annual energy charging requirement for EVs in various vehicle segments for the years 2020, 2025, 2030, 2040, and 2050. The results of the analysis are indicated in Table 55 and Figure 60 below. ICF assumed that there were no electric motorcycles in Colorado Springs in 2020.

Table 55. Estimated Annual Charging Energy Requirement by EV Segment – MWh

	2020	2025	2030	2040	2050
Cars	551	8,114	23,217	53,293	123,473
Motorcycles	-	867	2,480	5,694	13,191
SUV	873	14,226	40,708	93,443	216,495
Pickups – Light	396	6,444	18,438	42,325	98,060
Pickups – ½ Ton	297	4,833	13,829	31,743	73,545
Pickups – ¾ Ton	250	4,078	11,668	26,783	62,052
Pickups – 1 Ton	277	4,509	12,903	29,617	68,619
Pickups – 2 Ton	292	4,751	13,594	31,206	72,300
Vans	329	5,365	15,352	35,239	81,644
Medium-Duty Trucks	289	4,702	13,455	30,886	71,557
Heavy Duty Trucks	730	11,892	34,029	78,113	180,976
Busses	28	464	1,328	3,048	7,061
Total (MWh)	**4,312**	**70,244**	**200,999**	**461,390**	**1,068,974**
Total (GWh)	**4.31**	**70.24**	**201.00**	**461.39**	**1,068.97**

Figure 60. Estimated Annual Charging Energy Requirement by EV Segment – MWh

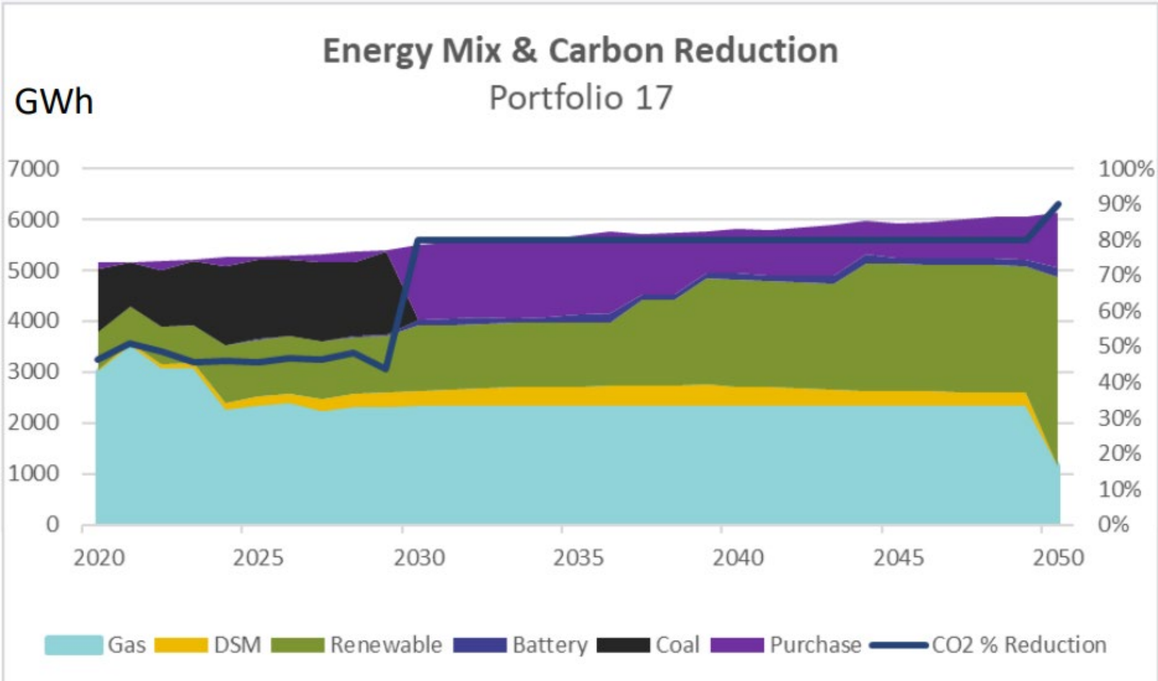


Amongst the various EV segments, SUVs contribute the most to charging energy requirements. On average, of the total incremental annual energy required to charge all EVs, 20% of the energy can be ascribed to SUVs. On average, light pickup trucks and cars contribute 9% and 12% of the total charging requirement, respectively.

The results also indicate a sharp increase in annual energy requirements from EV charging, rising in lockstep with projections of future EV adoption. The estimated total 2050 EV charging requirement of 1068 GWh is a little over 250 times the total EV charging requirement of 4 GWh in 2020.

While the grid impacts analysis demonstrates that feeder load growth might be an issue of concern in localized pockets, ICF notes that Springs Utilities is well placed to absorb the incremental energy requirements for charging EVs. Today, annual electric use in the City is approximately 5000 GWh. The estimated 2020 EV charging demand of approximately 4 GWh constitutes 0.09% of the City's total annual energy demand. Springs Utilities' most recent electric integrated resource plan steadily increases the utilities' energy mix over time, projecting that Springs Utilities will provide just over 6000 GWh of energy by 2050. ICF's projected 2050 EV charging energy requirement of 1068 GWh would constitute 16% of Springs Utilities total 2050 energy mix.

Figure 61. Colorado Springs Utilities – Energy Mix and Carbon Reduction Projections – Electric IRP Portfolio 17[192]



Discussion

ICF estimated the total charging energy requirement for EVs based on EV adoption rates for 2020 and projections for the years 2025, 2030, 2040, and 2050. The results demonstrate that EVs will require approximately 4 GWh of energy annually in the near-term, rising to nearly 1068 GWh of energy annually by 2050. We also note that Springs Utilities most recent electric IRP documents show that Springs Utilities plans to steadily increase its energy generation and purchases, rising from 5000 GWh in the near-term to slightly over 6000 GWh by 2050. The energy charging requirement of EVs forms a growing portion of Springs Utilities projected energy mix.

Springs Utilities should continue to monitor the status of EV adoption in its service territory to shape EV load and inform its planning assumptions and future resource plans. For example, Springs Utilities could capture information on EV charging behavior and track the amount of energy drawn during charging sessions to calibrate its load forecasts and estimates of future energy requirements. As the penetration of variable resources (such as wind and solar) on the system grows, Springs Utilities could incentivize EV drivers to charge at times correlated with high renewable output through special rates or managed charging programs. Such charging behavior would reduce the need to purchase expensive power during peak periods and distribute EV charging throughout the day.

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[192] Colorado Springs Utilities, Electric and Gas Integrated Resource Plans, Utilities Board Special Meeting for Approval, June 26 2020. Available online: https://www.csu.org/Documents/RecommendedIRPs.pdf?csf=1&e=cwh9IB

11. Metrics

Moving forward, the City, Utilities and stakeholders should track the progress of Colorado Springs in achieving the expected benefits from the adoption of electric vehicles by tracking specific metrics noted in the table below.

Table 56. Tracking Metrics

Goal	Measurement	Source
Improve air quality	Project reduction in greenhouse gases and nitrogen oxides	Project emissions reductions based on EV adoption[193]
Increase EV adoption	Track # of EVs	Atlas EV Hub[194]
Increase EV charger deployment	Track # of chargers	AFDC Station Locator[195]
Increase community knowledge of EVs	Track community engagement	Periodically repeat Springs Utilities customer surveys
Identify funding for EVs & charging infrastructure	Track amount of identified funding	City and Springs Utilities staff

[193] Note that there is not a direct correlation between vehicle emissions reductions and air quality improvement, as there are many other factors (e.g., wildfires, industrial emissions, etc.) that affect air quality.

[194] https://www.atlasevhub.com/materials/state-ev-registration-data/

[195] https://afdc.energy.gov/stations/#/find/nearest

12. Conclusion

Electric Vehicles have great potential to help Colorado Springs improve its air quality and local economy, providing benefits to all of Colorado Springs stakeholders. This plan lays out a variety of strategies and actions the City, Colorado Springs Utilities and their partners and stakeholders can pursue to accelerate and smooth the adoption of electric vehicles, including:

- Adopting policies that encourage the adoption of EVs and the deployment of charging stations
- Investing in the deployment of public charging stations
- Adopting EVs in the City's and Springs Utilities' fleets
- Working with partners to provide education and outreach to address barriers to EV adoption
- Preparing the power distribution grid for additional charging demand
- Tracking the implementation and benefits of these strategies and actions

With leadership from the City and Colorado Springs Utilities, these strategies and actions will support the continued growth in EV adoption, while identifying necessary preparations to meet the new demands that will come with that growth.

Appendix: EV Makes and Models Considered in the EV Operational Analysis

Table 57. List of Electric Vehicle Makes and Models[196]

Vehicle Class	Make & Model	Battery Size	Electric Range (miles)	Charging Profile	Base Price[197]
Sedan	Nissan Leaf	40 kWh	149	8 hours @ L2	$28,818*
Sedan	Nissan Leaf	62 kWh	226	11.5 hours @ L2	$31,775*
Sedan	Chevrolet Bolt	66 kWh	259	10 hours @ L2	$27,960*
Sedan	Hyundai Ionic	38 kWh	170	6 hours @ L2	$33,045
SUV	Hyundai Kona	64 kWh	258	9.5 hours @ L2	$37,390
Vans	Lightning Systems[198] Ford Transit Cargo Van	86 kWh 105 kWh	140 170	11 hours @ L2 13.5 hours @ L2	$84,900 $104,900
Light & ½ Ton Pickup	Lordstown Endurance	109 kWh	250	10 hours @ L2	$52,500*
¾ Ton Pickup	Lightning Systems Ford E-450	86 kWh 129 kWh	80 120	5.5 hours @ L2 8.0 hours @ L2	$115,900 $145,900
1 Ton Pickup	Lightning Systems Ford F550	122 kWh	100	15.5 hours @ L2	$126,900
2 Ton Pickup	Lightning Systems Ford F-59	128 kWh 160 kWh 192 kWh	110 140 170	15.5 hours @ L2 20 hours @ L2 24 hours @ L2	$126,900 - $187,900
MD Trucks	Lightning Systems Chevrolet 6500XD	122 kWh 153 kWh 184 kWh	88 110 130	1.5 hours @ DCFC 2 hours @ DCFC 2.3 hours @ DCFC	$147,900 - $207,900
HD Trucks	Frieghtliner eCascadia	550 kWh	250	80% in 1.5 hours @ DCFC	Not Published
Busses	Bluebird Electric School Bus	155 kWh	120	8 hours @ L2	$350,000

[196] Based on information available in December 2020.

[197] Base prices reflect the State of Colorado 2020 vehicle bid prices where available. These prices are identified with an asterisk (*). All other prices are MSRP or stated manufacturer pricing.

[198] Pricing for Lightning Systems vehicles is sourced from the State of Massachusetts VEH102 bid list.