City of Elk Grove

Infrastructure Plan for Fleet Electrification

APRIL 2024

LIST OF ACRONYMS AND DEFINITION OF TERMS

ACRONYM OR TERM	DESCRIPTION
ACF	Advanced Clean Fleets
ADA	Americans with Disabilities Act
AFC	Alternative fuel corridor
AFV	Alternative fuel vehicle
BESS	Battery energy storage system
BEV	Battery-electric vehicle
CAN	Controller area network
CARB	California Air Resources Board
CCS	One of the different EV charger connector types. Stands for Combined charging system. In the past, CCS has been the most common connector type for DC fast charging of non-Tesla vehicles. This may change over time as more vehicle and charger manufacturers adopt Tesla's NACS charger type.
CCTV	Closed-circuit television
CEC	California Energy Commission
CHADEMO	A DC fast-charging system and connector used by a few EV manufacturers, such as by Nissan on its Leaf. The CHAdeMO standard has been used by a few OEMs only, with its use expected to further decline.
CHARGING PLUG	A connector of a charging station that can be plugged into an EV. One station may have 1, 2, or more charging plugs
CHARGING STATION	A station designed to dispense electrical energy through its charging cords and plugs to one or more EVs
CVRP	Clean Vehicle Rebate Project
DAC	Disadvantaged community
DC	Direct current
DCFC	Direct current fast charger
DOE	U.S. Department of Energy

ACRONYM OR TERM	DESCRIPTION
DUTY CYCLE	A vehicle’s typical duties, such as its daily mileage or key-on time (hours) per day.
EPA	Environmental Protection Agency
EV	Electric vehicle
EVSE	Electric vehicle supply equipment
FCEV	Fuel cell electric vehicle
GFO	Grant funding opportunity
ICE	Internal Combustion Engine – gas/diesel powered vehicles
IRC	Internal Revenue Code
κVA	Kilovolt-ampere
KW	Kilowatt
LCFS	Low Carbon Fuel Standard
LIC	Low-income community
$MTCO_2e$	Metric tons of carbon dioxide equivalent
NACS	One of the different EV charger connector types. Stands for North American Charging Standard and is equivalent to Tesla’s charging connector. NACS is currently being certified under the SAE J3400 standard for use by manufacturers beyond Tesla.
NEVI	National Electric Vehicle Infrastructure program
OCPP	Open charge point protocol
OEM	Original Equipment Manufacturer
SMAQMD	Sacramento Metropolitan Air Quality Management District
SOC	State-of-charge; refers to the percent of charge present in a vehicle’s battery.
SWCC	Special Waste Collection Center
ZE	Zero-emission
ZEV	Zero-emission vehicle

CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1.

INTRODUCTION

CHAPTER 1: INTRODUCTION

The purpose of the City of Elk Grove's Infrastructure Plan for Fleet Electrification (Plan) is to provide clear, actionable guidance for electrification of City of Elk Grove's (City) municipal fleet, and for infrastructure to support staff and public electric vehicle (EV) charging at City facilities. The intention is to provide near-term guidance that can be enacted over the next five years. Given the pace of technology advances with EVs and electric vehicle supply equipment (EVSE), as well as variability in the number of fleet vehicles in the long-term, planning further out would be unreliable. It is recommended that the Plan be reviewed, re-evaluated, and updated in 2027/2028 to provide a more reliable plan for the next five-year period.

The Plan is based on a two-part analysis. The goal of the first part included evaluating the City's vehicle fleet for electrification and required energy. The goal of the second part of the analysis is to assess each City facility to determine required infrastructure upgrade needs. It also evaluates the feasibility of charging infrastructure installation with recommendations for how to implement the recommendations over time including phasing and cost estimates. Further work will be needed for each facility related to design and cost estimation in preparation for any construction and installation, as this document provides only planning-level information. As noted, the specific details outlined for future project phasing should be re-evaluated closer to the timeframe for implementation of those phases, to update for future technology and needs.

This Plan does not address the increases to the City's fleet from expansion of services or operations that are provided directly (internally) to the City, such as contract operations. It also focuses exclusively on light-duty vehicles. For example, the Plan addresses the conversion of police patrol vehicles under the existing fleet makeup. Increases to the fleet from staffing growth are not addressed. Further, the conversion of contract operations, such as street or drainage maintenance, to in-house operations and the equipment needed to provide this service (e.g., vac truck, dump truck) are not included. Other heavy-duty vehicles (e.g., specialty police equipment) are also not addressed.

The Plan provides a roadmap for supporting the conversion of the City light-duty fleet to zero emissions. Transitioning the City's fleet to EVs will help meet sustainability goals and, potentially, reduce costs over the long run. Fleet electrification will reduce the City's carbon footprint significantly, as the vehicle fleet is one of the largest sources of greenhouse gas (GHG) emissions within City operations. Electric vehicles have a lower maintenance and running cost when compared to either internal combustion engine vehicles or hybrid electric vehicles. Over the coming decade, the City anticipates moving the entire light-duty City fleet to electric, provided suitable electric vehicles are available. At the same time, SMUD is planning to be completely carbon-free in electric generation by 2030, providing the opportunity for the City to be carbon-free for all EVs in the fleet. In order to achieve this goal, sufficient charging infrastructure is critical to maintain the level-of-use needed for City services and operations.

HOW TO USE THIS DOCUMENT

This plan is comprised of three main chapters supplemented by five technical appendices, each of which are explained below.

CHAPTER 1: INTRODUCTION

This chapter introduces the reader to the content and summarizes relevant state and city decarbonization targets.

CHAPTER 2: FLEET VEHICLE ELECTRIFICATION

This chapter provides an in-depth view of Elk Grove's existing vehicle fleet, duty cycle types, distribution across the City's facilities, suitable EVs to replace existing fleet vehicles for energy modeling.

CHAPTER 3: CHARGING & POLICY RECOMMENDATIONS

This chapter includes the main recommendations pertaining to the City's fleet transition towards EVs and the buildout of appropriate charging infrastructure. The chapter documents the recommended strategy for charging of the City's EV fleet, along with a presentation of the recommended charging station quantities by type, location, and installation phase. It also includes a discussion of strategies and technologies to ensure backup-power and resiliency, as well as recommendations related to data collection and best practices.

APPENDIX A: FACILITY-LEVEL ANALYSIS AND RECOMMENDATIONS

This appendix documents in detail the following for each City facility: existing vehicle fleet, existing facility conditions (such as electrical service and parking assignment), charging infrastructure recommendations, a phased implementation strategy, a breakdown of the costs associated with each component including both fleet vehicles and charging infrastructure, and site assessment forms (which summarize the findings and charger installation recommendations for each site, including graphical illustrations of recommended charger installation locations for fleet and public charging by implementation phase).

Some of the assessed City facilities were additionally identified as suitable for installation of public EV chargers, with detailed recommendations included in the respective sections of this appendix.

APPENDIX B: POTENTIAL FUNDING SOURCES

This chapter summarizes multiple funding opportunities for EVs and EV charging infrastructure. Funding sources include federal, state, and local programs as well as private funding.

APPENDIX C: EV CHARGING STRATEGY OPTIONS

This is a summary of four alternative charging strategies explaining operations, benefits, disadvantages and general recommendations for each.

APPENDIX D: BEST PRACTICES RELATED TO EVS AND EVSE

This appendix summarizes best practices for electrification of municipal fleets based on experience with numerous public agency fleet electrification projects.

APPENDIX E: CAPITAL EXPENDITURE ESTIMATES

This consists of spreadsheets estimating fleet electrification capital expenditures.

CARBON REDUCTION & VEHICLE ELECTRIFICATION TARGETS SUMMARY

A key reason the City is electrifying its fleet and adding EV chargers at City-owned facilities for use by City employees and the public is to reduce vehicle emissions. These actions are among the numerous actions being taken to reduce emissions to achieve specific targets consistent with relevant legislation adopted by the state of California and actions addressed in the City's Climate Action Plan summarized below.

The Advanced Clean Fleets (ACF) regulation applies to medium- and heavy-duty vehicles with a gross vehicle weight of 8,500 lbs. or more. This Plan focuses on light-duty vehicles, which are not covered by the ACF rule.

RELEVANT LEGISLATION	GHG REDUCTION TARGET	MILESTONE
ASSEMBLY BILL 1279	GHG emissions 48% below 1990 levels	2030
	GHG emissions 85% below 1990 levels and statewide carbon neutrality	2045
EXECUTIVE ORDER N-79-20 (2020)	All new passenger cars and trucks in CA shall be zero-emissions	2035
	All new medium- and heavy-duty vehicles in CA shall be zero-emissions	2045
ADVANCED CLEAN FLEETS	Commercial and government vehicle fleets must transition to zero emissions	Varies by fleet and vehicle type, latest by 2042, with few exceptions

CITY OF ELK GROVE TARGETS

The City conducted an inventory of GHG emissions in 2023 and found on-road vehicle emissions to comprise the largest emissions sector, resulting in approximately 586,220 metric tons of carbon dioxide equivalent (MTCO2e) and 56% of the City's total emissions. Off-road vehicles resulted in 18,341 MTCO2e and 2% of total emissions. The transportation sector, including on-road and off-road vehicles, resulted in 604,561 MTCO2e, 58% of the City's total emissions.[1]

The City[2] seeks to comply with the state's targets and provide a healthier and more sustainable environment for residents by reducing the City's annual per-capita GHG levels.

The City vision, articulated in the Elk Grove General Plan, includes being proactive in making daily life healthy and sustainable for residents. The General Plan outlines specific goals and policies that align with this vision and support the transition to a zero-emission fleet, particularly GOAL NR-5: *Reduced GHG Emissions that Align with Local, State, and Other Goals*. This highlights the City's commitment related to sustainability and resource protection and provides direction and vision to maintain a healthy, balanced, and more sustainable community.

[1] City of Elk Grove GHG Inventory Memo, 2024

[2] City of Elk Grove Climate Action Plan, 2019 Update

The primary policy vehicle for achievement of these targets is the Elk Grove Climate Action Plan (CAP), particularly policy TACM-9. EV Charging Requirements:

> *Adopt an electric vehicle (EV) charging station ordinance that establishes minimum EV charging standards for all new residential and commercial development. Increase the number of EV charging stations at municipal facilities throughout the City.*

While this provision focuses primarily on residential and workplace charging, it does contain some language relevant to this project including the following:

- *Install a minimum of two EV charging stations at all major municipal facilities.*
- *Installation of EV charging stations at all public facilities and commercial land uses.*
    - *10 EV charging stations installed in public facilities and commercial land uses by 2020.*
    - *100 EV charging stations installed in public facilities and commercial land uses by 2030.*
    - *200 EV charging stations installed in public facilities and commercial land uses by 2050.*

These figures were adopted with the 2019 CAP, which is currently undergoing an update. The growth in electric vehicle sales in California over the past few years, in addition to more ambitious state targets and the ultimate phase-out of light-duty internal combustion engine (ICE) vehicle sales in California, requires additional consideration of EV charging station needs.

STATE OF CALIFORNIA TARGETS

Under the California Air Resources Board 2022 Scoping Plan for Achieving Carbon Neutrality by 2045, California would achieve the following targets:

- Cut greenhouse gas emissions by 85% below 1990 levels
- 71% reduction in smog-forming air pollution
- Reduce fossil fuel consumption (liquid petroleum) to less than one-tenth of what is used today – a 94% reduction in demand.
- Create 4 million new jobs.

- Save Californians $200 billion in health costs due to pollution in 2045

The top strategy for carbon reduction is through transportation electrification. To achieve this, California will ban new gas car sales by 2035 and expects to gradually phase out the sale of gas cars over the next dozen years. To reach its goal of 100% EV sales on new cars by 2035, California will need to reach 35% EV sales by 2026, 51% by 2028, and 68% by 2030, according to the plan. For reference, EVs comprised 25% of all new vehicle sales in California in 2023, a 29% increase over the previous year[3]. To support these future EVs, California's goals for EV infrastructure include installing 250,000 public and private shared light-duty EV chargers by 2025 and 1.2 million chargers by 2030, including 157,000 chargers for medium- and heavy duty EVs.

SUMMARY

As detailed in the chapters that follow, this document provides an overall strategy for moving forward with transitioning the City fleet to zero emissions and to support EV charging for City staff and the public at City facilities. Over the next 12 years, the cost to transition the fleet to EVs and install charging infrastructure at City facilities is estimated to be $27.1 million. This investment represents an additional $2.5 million compared to the estimated cost of maintaining the current ICE fleet over the same period. The transition is expected to reduce carbon emissions by up to 1,200 metric tons of CO_2e per year, supporting the City's climate goals.

A phased approach allows for gradual implementation and assessment of new technologies along the way to ensure the best fit for staff and the community. Charging infrastructure deployment will be tailored to each facility's electrical system requirements, with an estimated total investment of $5.5M for both fleet and public charging, spread across three phases from 2024 to 2035.

Based on an analysis of the fleet's duty cycle data and the need to ensure resiliency, a total of 186 charging ports, both Level 2 and direct-current fast chargers (DCFC), are recommended to support the City fleet vehicles. The phasing of charger installation concurrent with vehicle electrification will accommodate budgeting and funding constraints and allow for adjustments as technology advances and new information becomes available. Table 1 provides an overview of the number and type of chargers recommended, along with the estimated capital expenditures, by facility.

---

[3] https://www.veloz.org/q4-2023-data-shows-a-29-percent-year-over-year-increase/?mc_cid=4fde63c25e&mc_eid=1d72498587

TABLE 1: SUMMARY OF CHARGERS AND ESTIMATED CAPEX BY FACILITY

<table>
<tr><th rowspan="2">FACILITY</th><th rowspan="2">DEPARTMENT</th><th rowspan="2">UNIT</th><th rowspan="2">LIGHT-DUTY FLEET VEHICLES</th><th colspan="3">LEVEL 2 CHARGE PORTS</th><th rowspan="2">DCFC CHARGE PORTS</th><th colspan="2">PUBLIC CHARGE PORTS</th><th rowspan="2">ESTIMATED CAPEX</th></tr>
<tr><th>Low</th><th>Medium</th><th>High</th><th>Low</th><th>Medium</th></tr>
<tr><td>ANIMAL SHELTER</td><td>POLICE</td><td>ANIMAL CARE</td><td>6</td><td>2</td><td>0</td><td>0</td><td>0</td><td>0</td><td>2</td><td>$88,640</td></tr>
<tr><td rowspan="4">CITY HALL</td><td>DEVELOPMENT SERVICES</td><td>CODE ENFORCEMENT</td><td>7</td><td rowspan="4">8</td><td rowspan="4">2</td><td rowspan="4">0</td><td rowspan="4">0</td><td rowspan="4">0</td><td rowspan="4">4</td><td rowspan="4">$234,540</td></tr>
<tr><td>DEVELOPMENT SERVICES</td><td>HOUSING</td><td>2</td></tr>
<tr><td>PUBLIC WORKS</td><td>FACILITIES</td><td>1</td></tr>
<tr><td>CITY MANAGER</td><td>PUBLIC AFFAIRS</td><td>1</td></tr>
<tr><td rowspan="3">CORP YARD</td><td>PUBLIC WORKS</td><td>OPERATIONS AND MAINTENANCE</td><td>2</td><td rowspan="3">24</td><td rowspan="3">0</td><td rowspan="3">0</td><td rowspan="3">0</td><td rowspan="3">0</td><td rowspan="3">0</td><td rowspan="3">$337,400</td></tr>
<tr><td>POLICE</td><td>POLICE</td><td>1</td></tr>
<tr><td>PUBLIC WORKS</td><td>PUBLIC WORKS</td><td>14</td></tr>
<tr><td>FLEET FACILITY</td><td>POLICE</td><td>POLICE</td><td>76</td><td>76</td><td>0</td><td>0</td><td>10</td><td>0</td><td>0</td><td>$2,237,240</td></tr>
<tr><td rowspan="6">LAGUNA PALMS CAMPUS (POLICE)</td><td>PUBLIC WORKS</td><td>FACILITIES</td><td>1</td><td rowspan="6">2</td><td rowspan="6">40</td><td rowspan="6">14</td><td rowspan="6">4</td><td rowspan="6">0</td><td rowspan="6">4</td><td rowspan="6">$1,758,040</td></tr>
<tr><td>POLICE</td><td>POLICE</td><td>76</td></tr>
<tr><td>POLICE</td><td>PROPERTY AND EVIDENCE</td><td>1</td></tr>
<tr><td>POLICE</td><td>MOTOR POOL</td><td>5</td></tr>
<tr><td>POLICE</td><td>TRANSPORT</td><td>1</td></tr>
<tr><td>PUBLIC WORKS</td><td>RECYCLING AND WASTE</td><td>1</td></tr>
<tr><td>SWCC</td><td>PUBLIC WORKS</td><td>RECYCLING AND WASTE</td><td>1</td><td>2</td><td>0</td><td>2</td><td>0</td><td>1</td><td>0</td><td>$64,720</td></tr>
<tr><td>EXISTING ELK GROVE LIBRARY</td><td></td><td></td><td>N/A</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>6</td><td>$141,260</td></tr>
<tr><td>OLD TOWN PLAZA</td><td></td><td></td><td>N/A</td><td>0</td><td>0</td><td>0</td><td>0</td><td>13</td><td>8</td><td>$599,240</td></tr>
<tr><td>DISTRICT 56</td><td>CITY MANAGERS</td><td></td><td>N/A</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>$0</td></tr>
<tr><td>TOTAL</td><td></td><td></td><td>196</td><td>114</td><td>42</td><td>16</td><td>14</td><td>14</td><td>24</td><td>$5,461,080</td></tr>
</table>

CHAPTER 2.

FLEET VEHICLE ELECTRIFICATION

CHAPTER 2: INTRODUCTION

This chapter provides an in-depth view of Elk Grove's existing vehicle fleet, duty cycle types, distribution across the City's facilities, and identifies suitable EVs to replace existing fleet vehicles for energy modeling purposes. It also includes a summary of market-ready and soon to be market-ready EVs to replace existing ICE-powered fleet vehicles, as well as the results of a right-sizing and total cost of ownership (TCO) analysis.

ANALYSIS OF EXISTING FLEET

This section documents which of Elk Grove's existing ICE-powered vehicles can be replaced by battery electric vehicles and evaluates the anticipated electrical energy needs.

FLEET COMPOSITION BY VEHICLE TYPES AND DUTY CYCLE

The fleet transition plan calls for the replacement of 196 light-duty ICE vehicles, including motorcycles, sedans, minivans, pickups, sport utility vehicles and vans, with EVs. This number includes the 22 new light-duty vehicles procured in fiscal year 2023/2024. By replacing these vehicles, the City can reduce its carbon emissions by up to 1.2k MTCO2e per year. Suitable replacement vehicles for each vehicle type or "duty cycle" have been modeled for the purposes of estimating energy demand and capital expenditures. The specific modeled replacement vehicle may not be the one purchased at time of replacement but is used only for estimating energy demand and capital expenditures.

Prior to this Plan being prepared, the City had started the transition to lower emission vehicles with the purchase of 26 gas/electric hybrid vehicles and three battery-electric vehicles. There is also one low-speed electric vehicle domiciled at the District 56 facility for use on the property.

A critical part of this project is to determine charging recommendations which includes projecting electrical loads at each facility where fleet EVs need to charge. Fuel consumption data from existing ICE fleet vehicles provides a starting point for modeling these electrical loads for EV charging, which also includes factors to account for the significantly higher energy efficiency of EVs relative to ICE vehicles, and to address real-world factors affecting range degradation explained below. This analysis estimated a total fleet-wide electrical demand of 1,943.6 kWh at buildout on an average workday.

Based on the City's fleet replacement policies (e.g., expected lifespan) and existing and anticipated commercial EV availability, we assume that Elk Grove will need approximately 12 years to cycle through the existing vehicle fleet, gradually replacing vehicles with a suitable electric model that meets the City's needs for each asset.

EXISTING FLEET VEHICLES

Table 2 on the following page summarizes Elk Grove's existing ICE vehicle fleet, including new vehicles purchased in fiscal year 2023/2024 by duty cycle categories listed in the first column for the purpose of identification of EV equivalents for evaluating energy demands. The second column lists examples of existing ICE vehicles comprising the fleet that will need to be replaced by comparable EVs for each duty cycle category. The "EV range" is the modeled maximum range of these vehicles after accounting for factors that impact driving range such as the use of heating or air conditioning, terrain, parasitic loads like light bars, lifts, on-board computers, cargo weight, battery degradation, etc. Reducing the expected maximum range to account for these real-world conditions will ensure that sufficient charging capacity is planned.

Lastly, it is important to note that the vehicles shown in the "Modeled EV" column have been designated as a model for replacement of a specific duty cycle because these are EVs for which key data, such as battery size, the per-mile energy consumption, and charging acceptance rate (maximum charging speed), were available at the time this study was completed. The intention is not to recommend the City procure these specific models—they are simply being used to model projected energy use.

FIGURE 1: ANIMAL SERVICES

TABLE 2: FLEET REPLACEMENT BY VEHICLE DUTY CYCLE

DUTY CYCLE	EXISTING FLEET VEHICLES	EV RANGE (MILES)	EXISTING VEHICLE QUANTITY	MODEL EV
LIGHT DUTY AUTO	TOYOTA CAMRY FORD FUSION	120	40	TESLA MODEL 3
LIGHT DUTY SUV	FORD EXPLORER FORD CROWN VICTORIA	120	71	CHEVY BLAZER EV
LIGHT DUTY MINI-VAN	CHEVY UPLANDER DODGE CARAVAN	120	5	VW ID BUZZ
LIGHT DUTY PICKUP	FORD F150 FORD RANGER RAM 1500 SILVERADO 1500 DODGE RAM CLASSIC 1500	120	45	FORD F-150 LIGHTNING
LIGHT DUTY PICKUP (2B)	FORD F250	120	8	FORD F-150 LIGHTNING
MOTORCYCLE	BMW R1200RT-P HONDA ST1300PA	176	15	ZERO DSRP
LIGHT DUTY UTILITY-VAN	CHEVY TAHOE 4X4 FORD E-250 RAM PROMASTER 1500	85	12	FORD E-TRANSIT CARGO VAN (LOW ROOF)
TOTAL FLEET VEHICLES			**196**	

Note: The modeled EV is used only for projected energy usage and is not anticipated to represent the actual replacement vehicle. For some vehicle types, the model EV was the only one with key needed data available.

VEHICLE ASSIGNMENT BY DEPARTMENT

As shown below in Table 3, the vast majority of vehicles comprising the City's fleet are part of the Police Department, including the Animal Services, Property and Evidence, Motor Pool and Transport units. The remaining fleet vehicles are assigned to other departments including Public Works and Code Enforcement.

TABLE 3: VEHICLE FLEET ASSIGNMENTS BY DEPARTMENT

DEPARTMENT	UNIT	FLEET VEHICLES TO ELECTRIFY
DEVELOPMENT SERVICES	CODE ENFORCEMENT	7
DEVELOPMENT SERVICES	HOUSING	2
PUBLIC WORKS	FACILITIES	2
PUBLIC WORKS	OPERATIONS AND MAINTENANCE	2
PUBLIC WORKS	RECYCLING AND WASTE	2
POLICE	POLICE	153
POLICE	ANIMAL CARE	6
POLICE	PROPERTY AND EVIDENCE	1
POLICE	MOTOR POOL	5
POLICE	TRANSPORT	1
CITY MANAGER	PUBLIC AFFAIRS	1
PUBLIC WORKS	PUBLIC WORKS	14
TOTAL		**196**

VEHICLE ASSIGNMENT BY FLEET DOMICILE

Elk Grove's fleet is assigned to six City-owned facilities (domiciles) however, the vehicles are disproportionately clustered across these locations. The majority are at two large Police Department facilities—the Fleet Facility and the Laguna Palms campus. The remaining facilities only contain about a quarter of the fleet. Seventeen vehicles are assigned to police officers who take them home each night. These vehicles are included in the table below by the primary location where they are most likely to charge. Electrical demand projections at each facility range from about 997 kWh at the Fleet Facility where the largest number of EVs will be charged, to less than about 2 kWh for the SWCC where only one fleet EV will need to be charged. Vehicle assignment and energy projections by facility are listed in Table 4 below. The sum of about 2,000 kWh per day of electricity demand for charging a fully electrified City fleet is on the order of magnitude of charging the full battery of 30 typical electric cars, such as the Nissan Leaf with a battery size of 62 kWh.

TABLE 4: FLEET VEHICLE DOMICILE LOCATIONS

FLEET DOMICILE	ADDRESS	TOTAL FLEET VEHICLES	DAILY REQUIRED EV ENERGY (KWH)
ANIMAL SHELTER	9150 UNION PARK WAY	6	50.4
CITY HALL	8401 LAGUNA PALMS	11	70.8
CORP YARD	10250 IRON ROCK WAY	17	180.0
FLEET FACILITY	10190 IRON ROCK WAY	76	996.9
LAGUNA PALMS CAMPUS (POLICE)	8380/8400 LAGUNA PALMS/ 9362 STUDIO COURT	85	694.0
SWCC	9255 DISPOSAL LN	1	2.0
TOTAL		**196**	**1,994.0**

As shown in Table 4, the City's fleet vehicles are categorized based on domicile locations, departments, and units, alongside the total number of fleet vehicles that require electrification.

TABLE 5: VEHICLE FLEET ASSIGNMENTS BY DOMICILE LOCATION

FACILITY	DEPARTMENT	UNIT	TOTAL EXISTING FLEET VEHICLES
ANIMAL SHELTER	POLICE	ANIMAL CARE	6
CITY HALL	DEVELOPMENT SERVICES	CODE ENFORCEMENT	7
	DEVELOPMENT SERVICES	HOUSING	2
	PUBLIC WORKS	FACILITIES	1
	CITY MANAGER	PUBLIC AFFAIRS	1
CORP YARD	PUBLIC WORKS	OPERATIONS AND MAINTENANCE	2
	POLICE	POLICE	1
	PUBLIC WORKS	PUBLIC WORKS	14
FLEET FACILITY	POLICE	POLICE	76
LAGUNA PALMS CAMPUS (POLICE)	PUBLIC WORKS	FACILITIES	1
	POLICE	POLICE	76
	POLICE	PROPERTY AND EVIDENCE	1
	POLICE	MOTOR POOL	5
	POLICE	TRANSPORT	1
	PUBLIC WORKS	RECYCLING AND WASTE	1
SWCC	PUBLIC WORKS	RECYCLING AND WASTE	1
TOTAL			**196**

SUMMARY OF MARKET-READY (AND SOON TO BE MARKET-READY) EVS TO REPLACE EXISTING ICE-POWERED FLEET VEHICLES

For many years, one of the main challenges to fleet electrification has been the lack of suitable electric vehicles, especially from Ford, the market leader for fleet vehicles. Until recently, there had been limited selection of all classes of electric vehicles and those that were available were often too expensive for municipal fleets to consider. Most light-duty EV models entering the market have been luxury models by Tesla, Porsche, Audi, and Jaguar. By contrast, Ford's first popular EV was the Mustang Mach-E SUV, primarily targeting individual buyers, and the F-150 Lightning and e-Transit, which were subsequently produced, had limited initial production resulting in severe scarcity and significant price hikes. The availability of medium- and heavy-duty EV models have mainly been limited to semi-custom electrified conversions like Lion and Zenith, while the major producers like Daimler, Volvo, Paccar, and Navistar have only begun to ramp up production in recent months.

As summarized by Table 2 above, a limited selection of EV models were used in this analysis for the purpose of modeling energy demands for developing charging recommendations. However, the availability of a broader range of EV models has significantly increased over the past few years. In 2024 there is expected to be 134 different models of EVs available in the U.S., more than double the number of models available in 2020, when there were only 48.[4] While not all of the new models available will be suitable for Elk Grove's fleet, it shows the expanding range of EV types each year. Table 5 below provides a summary of currently or soon to be available light-duty EV models that could be suitable alternatives for Elk Grove's fleet.

[4] https://www.visualcapitalist.com/the-number-of-ev-models-will-double-by-2024/

TABLE 6: FLEET REPLACEMENT BY VEHICLE DUTY CYCLE

DUTY CYCLE	EXISTING FLEET VEHICLES	MODELED EV (MSRP, IF KNOWN)	OTHER CURRENT EV OPTIONS (MSRP, IF KNOWN)	STATUS
LIGHT-DUTY AUTO	TOYOTA CAMRY FORD FUSION	TESLA MODEL 3 ($40,240)	CHEVROLET BOLT EV ($26,500) NISSAN LEAF ($28,140) HYUNDAI IONIQ 5 ($41,450) HYUNDAI KONA ELECTRIC SE ($33,550) KIA EV6 ($42,600) MINI COOPER HARDTOP SE (2 DOOR) ($30,900)	Readily available, vehicle delivery can be subject to common delays
LIGHT-DUTY SUV	FORD EXPLORER FORD CROWN VICTORIA	CHEVY BLAZER EV	CHEVROLET BOLT EUV ($27,800) KIA NIRO EV ($39,550) FORD MUSTANG MACH-E ($42,995) NISSAN ARIYA ($43,190) VOLKSWAGEN ID.4 ($38,995) AUDI Q4 E-TRON ($52,500) RIVIAN R1S ($78,000)	Readily available, vehicle delivery can be subject to common delays, cargo capacity can be smaller than large ICE SUVs

LIGHT-DUTY MINI-VAN	CHEVY UPLANDER DODGE CARAVAN	VW ID BUZZ	CITROËN Ë-SPACETOURER CANOO LIFESTYLE VEHICLE (7-SEATER)	Not available yet in the US
LIGHT-DUTY PICKUP	FORD F-150 FORD RANGER RAM 1500 SILVERADO 1500 RAM 1500 CLASSIC	FORD F-150 LIGHTNING	FORD F-150 LIGHTNING ($48,817) RIVIAN R1T ($73,000) CHEVROLET SILVERADO EV (EST. $52,000) GMC SIERRA EV DENALI	Readily available
LIGHT-DUTY PICKUP (2B)	FORD F-250	FORD F-150 LIGHTNING	FORD E-TRANSIT T350 CUTAWAY ($41,212)	Needs modification to be used as pickup truck
MOTORCYCLE	BMW R1200RT-P HONDA ST1300PA	ZERO DSRP	–	Modeled EV readily available
LIGHT-DUTY UTILITY-VAN	CHEVY TAHOE 4X4 FORD E-250 RAM PROMASTER 1500	FORD E-TRANSIT CARGO VAN (LOW ROOF) ($46,000)	RIVIAN EDV	Modeled EV readily available

Note: Base retail prices are taken from publicly available manufacturer information or the California State Purchasing Contract (whichever is lower priced) and are as of August 2023.

Note: The modeled EV is used only for projected energy usage and is not anticipated to represent the actual replacement vehicle. For some vehicle types, the model EV was the only one with key needed data available.

LIGHT-DUTY VEHICLES

FIGURE 2: FORD F-150 LIGHTNING

As of mid-2023, there are about 150 battery-electric vehicle (BEV) and plug-in hybrid EV (PHEV) models for sale in California.[5] Some of these available models are relatively or very expensive and thus unsuitable for municipal fleet deployment. However, the market of battery-electric vehicle models that are suitable for municipal fleets steadily expands. Today, there are a number of EV models priced below $45,000 with a range greater than 100, often greater than 200 miles, sold in California. A selection of these models is listed in Table 6.

The most common EV choices for fleets include the Nissan Leaf (and Leaf Plus) or Chevy Bolt. Other reasonably affordable light-duty battery electric vehicles available for purchase are the Hyundai Ioniq 5, Hyundai Kona, and Kia Niro and EV6. The Tesla Model Y and Model 3 are the top selling EVs, but often do not convey the image of practicality and cost effectiveness many municipal fleet managers seek, despite their lower total cost of ownership than most other EVs. The limited number of possible EV models represents a limitation to fleet buyers. However, the range of available light-duty EVs priced below $45,000 is expanding with models like the Chevy Equinox starting around $30K within the next year or two, and the recently expanded federal tax credit offsetting price inflation for eligible models.

In addition to the general market availability, multiple vehicle manufacturers are facing issues related to global supply chain constraints as well as increased demand and limited production capabilities. As an example, the Ford F-150 Lightning, launched in April of 2022, totally sold out in the U.S. until mid-2023. The disruption of the global supply chain is the result of multiple cascading issues. For example, improved battery technology has revealed production capacity limitations which bottlenecks supply for high-performance battery packs.

Lastly, California's Statewide Vehicle Purchasing Contract offers only a limited number of EVs sometimes excluding certain models otherwise available to the general public.[6] However, of the

[5] https://www.veloz.org/ev-market-report/

[6] See here for a list of available vehicle models under the California State Vehicle Purchasing Contract: https://www.dgs.ca.gov/PD/Resources/Page-Content/Procurement-Division-Resources-List-Folder/Statewide-Contract-Fleet-Vehicles

models presented in Table 2, only the Hyundai Ioniq 5, Kia EV6, Kia Niro EV, and MINI Cooper Hardtop SE (2 door) are not available as part of California's Vehicle Purchasing Contract, but may be added in the near future. While the City uses the Vehicle Purchasing Contract, fleet vehicles can also be procured through other avenues, particularly when price expectations and mission needs can be met with a model not listed on the Vehicle Purchasing Contract.

PHEVs can also serve as a low-emissions alternative for fleets. Most PHEV models have sufficient battery-only range to meet the average fleet vehicle's daily duty cycle. If the PHEV's battery is re-charged with a suitable charger between uses, a PHEV could function as a BEV for most, if not all, of its daily usage for typical low-mileage municipal fleet EVs. Some commonly available PHEVs are summarized below in Table 7.

While in some regulation PHEVs are classified as near-zero-emission vehicles, given the increasing range and the fully eliminated tailpipe emissions of all-electric vehicles, only BEVs were considered in the analysis supporting this transition plan and are thus recommended for the City.

TABLE 7: 2023 COMMON PLUG-IN HYBRID VEHICLE MODELS SUITABLE FOR MUNICIPAL FLEETS.

PHEV MODEL	BATTERY RANGE (MI)
CHRYSLER PACIFICA	32
FORD ESCAPE	37
KIA NIRO EX PHEV	33
TOYOTA PRIUS PRIME	44

Fortunately, the majority of legacy automotive original equipment manufacturers (OEMs) are currently developing multiple electric models, with many vehicle models in delivery in 2024 and an expanding line-up in the coming years. In addition, there are many companies entering the EV market from their foundation, like Tesla, Fisker, Polestar, Rivian, Nikola, Lucid, Faraday Future, Byton, Karma, Canoo as well as numerous entries from China and elsewhere. These automakers promise to make EVs competitive on a procurement cost basis compared to fossil fuel vehicles by 2024-2025. Increased production is expected to lower per-unit cost through economies of scale, with some EVs reaching price parity with engine-powered vehicles likely as early as the mid-2020s. For Elk Grove's fleet, this facilitates the purchase of a broader variety of light-duty EV options.

AFFORDABILITY

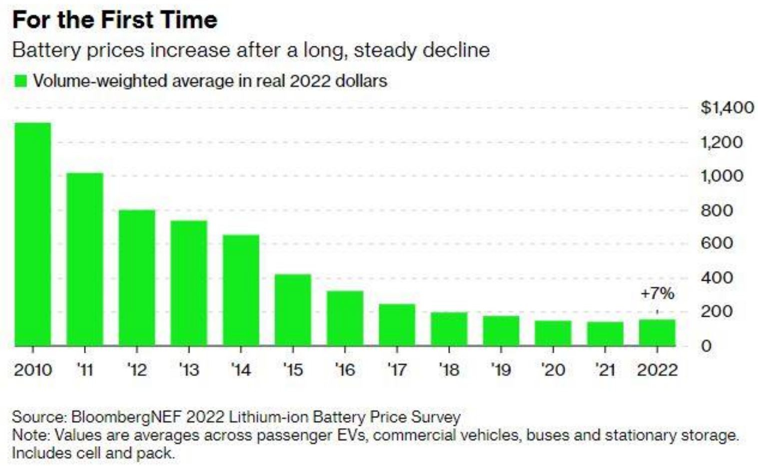


FIGURE 3: ELECTRIC VEHICLE BATTERY PRICES, GLOBAL AVERAGES OVER TIME.
Source: BloombergNEF 2022 Lithium-Ion Price Survey

Impact of battery prices: As seen in Figure 3, battery prices for electric vehicles have become more affordable over the past decade by about a whole order of magnitude (factor of 10), corresponding to an impressive price decrease of more than 90%. This trend is driven by research and development that allows for an increasingly rapid production and deployment of battery capacity around the world. The trend is, to some extent, reinforcing, as through higher battery production, learning rates increase and new battery technology innovation and price decreases can emerge. Falling retail prices of EVs can primarily be attributed to lower battery prices, as the majority of an EV's capital cost is a result of the battery.

Industry reports have noted[7] a small battery price pack increase in 2022 of 7% compared to the previous year, the first one after the decade-long decline. Experts from BloombergNEF projected falling prices again as soon as 2024, given higher raw material supply, an ease of supply chain issues, and new battery technologies and designs reaching product maturity. Indeed, in September 2023, the price of Li-ion battery cells was found to have declined by 30% since March 2022.[8] This could be explained by government subsidies, increased competition, and subsequent improvements to battery technology, as well as potential newly found extractable lithium deposits. These developments will drive a further decrease in overall electric vehicle prices and will make total cost of ownership assessments only more attractive for EVs.

[7] https://about.bnef.com/blog/increase-in-battery-prices-could-affect-ev-progress/

[8] https://www.cnet.com/roadshow/news/evs-set-to-match-gas-guzzlers-in-price-as-battery-costs-plummet/

This is especially relevant in regard to market segments with the highest cost premiums between EVs and combustion-engine vehicles today, particularly medium- and heavy-duty vehicles. The bigger the battery size of a particular EV model, the more battery price declines will help reduce the procurement cost premium of such electric vehicles and off-road equipment.

Total cost of ownership: Many vehicle segments (such as most light-duty vehicle applications with a high daily or annual mileage) have already achieved cost parity on a total cost of ownership basis, which is important for municipal fleets including Elk Grove's. In other segments of the market, electric vehicles already come with little to no cost premium compared to their ICE counterparts, which facilitates EV adoption also among procurement cost-sensitive buyers and fleet managers. Examples for these segments include the compact car market with affordable EV models such as the Nissan Leaf and Chevrolet Bolt EV and EUV available at a price point of well below $30,000. Multiple expert projections[9] as well as academic research findings[10] indicate that purchase price parity for average light-duty electric and gasoline vehicles will be achieved soon, with high expected operational cost savings for private and fleet EV owners. Analysis from the premier regulatory body for emissions regulation on the state level, the California Air Resources Board (CARB), estimates that full light-duty vehicle cost parity to be achieved by 2030, with additional $7,900 in maintenance and operational savings over the first 10 years of ownership of an EV.[11] Beginning with model year 2026, 10-year savings are expected across vehicle models.

THE RISING ROLE OF CHINA IN THE GLOBAL EV MARKET

According to the International Energy Agency's Global EV Outlook from 2023, China's EV sales have risen so fast over the past few years that they now account for 60% of all global EV sales. Chinese automakers, including legacy companies and many innovative electric vehicle start-ups are introducing many new EVs onto the global market, including very affordable models as well as larger vehicle types, such as SUVs. In 2022, there were almost 300 different EV models available for sale in China, as reported in the 2023 Global EV Outlook. This is more than 3 times as many as in the United States. If some of these models will be made available on the U.S. market, these developments could accelerate EV adoption across consumer segments, especially among lower-income groups and individuals demanding larger vehicle sizes. They

---

[9] E.g. https://rmi.org/press-release/evs-to-surpass-two-thirds-of-global-car-sales-by-2030-putting-at-risk-nearly-half-of-oil-demand-new-research-finds/

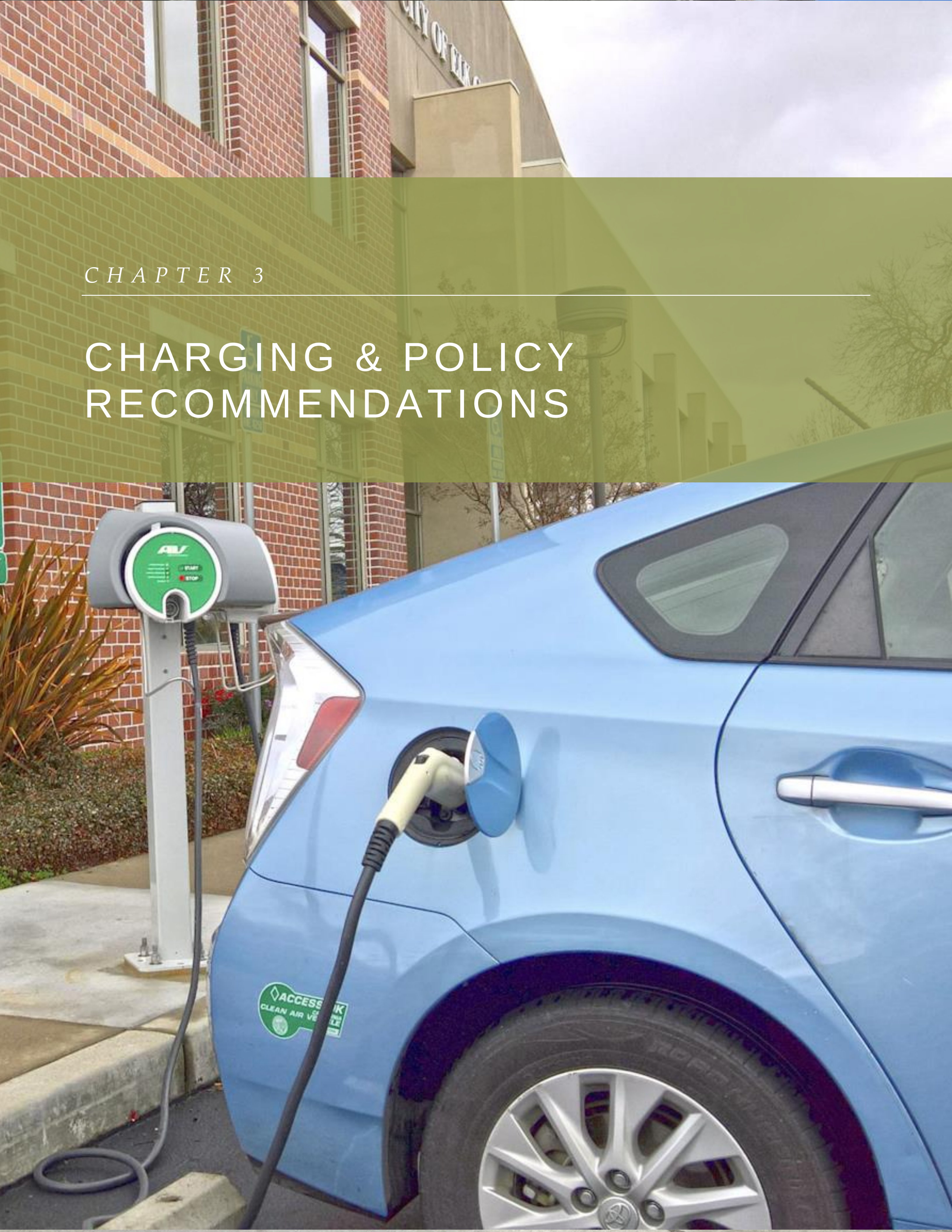
[10] E.g. https://www.sciencedirect.com/science/article/pii/S0301421521004341

[11] https://ww2.arb.ca.gov/news/california-moves-accelerate-100-new-zero-emission-vehicle-sales-2035

will also help municipal fleet electrification by increasing competition between OEMs, covering various vehicle use cases, and improving general affordability further. To what extent public fleets will be able to leverage novel Chinese firms' vehicle offerings, remains unclear, especially considering various "Made in America" provisions for sales and production of EVs and batteries that were set in the 2022 Inflation Reduction Act. Additionally, public vehicle fleets are often bound to legacy and/or American carmakers due to existing sales and maintenance relationships or Buy America regulation. Some municipal fleet mechanics are certified to work on a particular OEM, such as Ford, and it would involve additional training or certification to repair and maintain other automakers' vehicles and equipment.

CHAPTER 3

CHARGING & POLICY RECOMMENDATIONS



CHAPTER 3: INTRODUCTION

This chapter documents the recommended strategy for charging City fleet EVs and outlines the number and types of required charging stations, for both fleet as well as public chargers. It also includes recommendations for back-up power options and an increased resiliency to ensure EV charging station availability. The chapter concludes with sections that list recommendations to improve fleet data collection and analysis as well as policy-related recommendations.

EV CHARGING STRATEGY

Multiple potential strategies for charging Elk Grove's EV fleet were evaluated to determine recommended quantities of charger by type and charging speed, high-level cost estimates and operational considerations. This analysis determined that due to modeled energy needs relative to available nightly dwell time for charging coupled with large battery capacity, most fleet EVs will be able to share Level 2 chargers. Sharing can be facilitated by rotating EVs through the chargers on a scheduled or as-needed basis depending on each EV's state of charge. Rotations can range from every few nights to once or twice per month. All strategies considered are discussed in detail in Appendix C.

The utilization of shared chargers also simplifies the operational workings of sharing charging infrastructure with employee-owned personal vehicles. A City-wide system to distinguish between fleet EVs and personally-owned vehicles in charging sessions can be deployed and employees are not bound to specific, dedicated charging stations and parking stalls. If fleet chargers were dedicated to specific fleet vehicles, the use of these chargers by personally-owned employee vehicles would not be possible. The recommended numbers of charging stations, as presented in Appendix A, factor in some contingency capacity for employee-owned vehicles to charge during work hours. Most fleet vehicles are out on duty during the day and can be charged overnight in most cases. This allows employee-owned vehicles to charge during the day.

In addition, several high-powered DCFCs located at the City's main fleet depots can supplement overnight level 2 charging to ensure sufficient charging capacity in the event that drivers forget to charge or a charging session failed for some reason. DCFC infrastructure can also help mitigate fleet EV drivers' concerns regarding the driving range of their EV and occasional need to quickly top off the battery state-of-charge.

FACILITIES ASSESSED IN THIS STUDY

Elk Grove's fleet is assigned to six City-owned fleet facilities (or domicile locations). However, the vehicles are disproportionately clustered at two large Police Department facilities—the Fleet Facility and the Laguna Palms campus (see Tables 3 and 4 for a list of the facilities). The remaining facilities only contain about a quarter of the fleet. In addition to City-owned fleet facilities, eleven motorcycles are assigned to police officers who ride them home each night.

The majority of the City's fleet facilities, including the Fleet Facility and Corp Yard, are located along Iron Rock Way and on Laguna Palms Way. The remaining facility, the Special Waste Collection Center (SWCC), has few vehicles and is located elsewhere in the city.

Along with fleet charging, four of the City-owned fleet facilities and another two non-fleet facilities also owned by the City are suitable for installation of public chargers, most of which will be concentrated at the Old Town Plaza. It should be noted that the City-owned District 56 facility has one small fleet EV which can be charged from a standard outlet and has seven pay EV chargers existing for staff and public use.

CITY FLEET FACILITIES

- Animal Shelter, 9150 Union Park Way*
- City Hall, 8401 Laguna Palms Way*
- Corp Yard, 10250 Iron Rock Way
- Fleet Facility, 10190 Iron Rock Way
- Laguna Palms Campus: 8380 Laguna Palms Way, 8400 Laguna Palms Way & 9362 Studio Court*
- Special Waste Collection Center, 9255 Disposal Lane*

* with public charging

NON-FLEET PUBLIC CHARGING FACILITIES

- Existing Elk Grove Library, 8900 Elk Grove Blvd
- Old Town Plaza, 9615 Railroad St
- District 56, 8230 Civic Center Drive

RECOMMENDATIONS ON NUMBER AND TYPE OF CHARGERS

This section documents EV charging infrastructure installation recommendations for Elk Grove's municipal fleet vehicle domicile facilities as well as for public charging at four of these facilities.

It also includes recommendations for installation of EV chargers for the public at other City-owned facilities, all of which are listed below.

While this section only presents summary tables and City-wide numbers, details for each facility are included in Appendix A.

OVERVIEW OF RECOMMENDATIONS

The most important part of this project is to recommend the quantity and type of EV chargers and estimate the cost for their purchase and installation. Based on analysis of the existing fleet's duty cycle data, a total of 85 dual-head Level 2 AC chargers (170 charge ports) are recommended for shared use by the fleet for overnight charging. The specific power levels of these chargers depend on modeled energy requirements of the fleet vehicles. Thus, 57 of these should be dual-head low-output (6.6-7.7 kW) (114 charge ports), 21 should be dual-head medium-output (12 kW) (42 charge ports) and the remaining 7 chargers should be dual-head high-output (19.2 kW) (14 charge ports). To provide operational convenience, flexibility, and redundancy, these should be supplemented by 7 dual-head 150 kW high-speed DCFCs (14 charge ports) to be installed at the City's main fleet domicile locations, including 5 dual-head DCFCs (10 charge ports) at the Fleet Facility on Iron Rock Way and 2 dual-head DCFCs (4 charge ports) at the Police Department at Laguna Palms.

For each fleet domicile location, the quantities of fleet vehicles to electrify as well as proposed Level 2 and DC fast chargers for fleet use and public Level 2 chargers are summarized in Table 8 below, along with planning-level estimated total project capital expenditure (CAPEX). Chargers and supporting electrical service infrastructure need to be installed concurrently with vehicle electrification to ensure that each EV has sufficient charging infrastructure. It is more cost-effective and expedient to plan these in phases as summarized in the same table. The following section contains details on the development of these implementation phases and vehicle and charging infrastructure costs in the different phases.

Facility-level quantities of recommended charging stations by location, type, and phase are presented in Appendix A.

The estimated capital expenditures for each implementation phase and both fleet and public chargers are summarized for each location in Table 9 below.

Multiple implementation phases could be implemented concurrently but are listed separately to facilitate budgeting over time in case of funding constraints.

TABLE 8: SUMMARY OF RECOMMENDED FLEET AND PUBLIC CHARGERS, CAPEX ESTIMATES, AND PHASING

FLEET DOMICILE	VEHICLES TO ELECTRIFY	TOTAL FLEET L2 CHARGERS	TOTAL FLEET DCFC	TOTAL PUBLIC L2 CHARGERS	CAPEX	PHASE 1 CHARGERS INSTALLED	PHASE 2 CHARGERS INSTALLED	PHASE 3 CHARGERS INSTALLED	TOTAL CHARGERS INSTALLED
ANIMAL SHELTER	6	1	-	1	**$88,640**	2	-	-	**2**
CITY HALL	11	5	-	2	**$234,540**	4	-	3	**7**
CORP YARD	17	12	-	-	**$337,400**	6	6	-	**12**
FLEET FACILITY	76	38	5	-	**$2,237,240**	24	12	7	**43**
LAGUNA PALMS CAMPUS	85	28	2	2	**$1,758,040**	22	6	4	**32**
SWCC	1	1	-	1	**$64,720**	2	-	-	**2**
EXISTING ELK GROVE LIBRARY	-	-	-	3	**$141,260**	3	-	-	**3**
OLD TOWN PLAZA	-	-	-	13	**$599,240**	13	-	-	**13**
DISTRICT 56	-	-	-	0	**-**	-	-	-	**-**
TOTAL	**196**	**85**	**7**	**22**	**$5,461,080**	**76**	**24**	**14**	**114**

TABLE 9: ESTIMATED CAPITAL EXPENDITURE BY IMPLEMENTATION PHASE

FLEET DOMICILE	PHASE 1 (2024-2028) CAPEX	PHASE 2 (2029-2033) CAPEX	PHASE 3 (2034-3035) CAPEX	TOTAL CAPEX (FLEET)	TOTAL CAPEX (PUBLIC)	TOTAL CAPEX
ANIMAL SHELTER	$88,640	-	-	$61,260	$27,380	**$88,640**
CITY HALL	$184,560	-	$49,980	$185,800	$48,740	**$234,540**
CORP YARD PUBLIC WORKS/ POLICE	$199,360	$138,040	-	$337,400	-	**$337,400**
FLEET FACILITY	$1,433,800	$319,900	$483,540	$2,237,240	-	**$2,237,240**
LAGUNA PALMS CAMPUS	$1,363,020	$193,060	$201,960	$1,681,300	$76,740	**$1,758,040**
SWCC	$64,720	-	-	$53,280	$11,440	**$64,720**
EXISTING ELK GROVE LIBRARY	$141,260	-	-	-	$141,260	**$141,260**
OLD TOWN PLAZA	$599,240	-	-	-	$599,240	**$599,240**
DISTRICT 56	-	-	-	-	-	**-**
TOTAL	**$4,074,600**	**$651,000**	**$735,480**	**$4,556,280**	**$904,800**	**$5,461,080**

PROJECT IMPLEMENTATION AND PHASING

This section summarizes how and when Elk Grove will replace ICE vehicles with EVs and add charging infrastructure in implementation phases over time for each fleet facility. Existing ICE vehicles will be replaced by EVs as they age out of service following the City's standard fleet replacement schedules. Charging infrastructure must be installed concurrently with vehicle electrification (EV acquisition) at each fleet facility so that fleet EVs will be able to charge as soon as they become part of the fleet. In addition, Elk Grove plans to install a total of twenty-two Level 2 chargers for non-fleet public and employee use at six City-owned facilities open to the public.

OVERVIEW

As previously noted, it will likely take 12 years for Elk Grove to transition the municipal light-duty fleet to EVs. During this period, EVs will gradually replace existing ICE vehicles, and an estimated total replacement cost of about $12.2M.[12] Additionally, electrical system upgrades and EV charging infrastructure will need to be installed, at an estimated cost of about $5.5 million. Because it is more financially manageable to distribute this investment over time, three phases are recommended for project implementation, corresponding to the vehicle replacement schedule and the installation of chargers to support the growing number of EVs in the fleet.

Phase 1, occurring between 2024 and 2028, will incur the largest investments for the City due to the large number of vehicles to replace coupled with the need for electrical service upgrades at multiple facilities. These investments include $6.3M to procure the first 121 electric fleet vehicles and $3.2M for electrical system and fleet charging infrastructure. The total capital cost of Phase 1 is estimated to be $10.4M, representing more than half of the capital cost of the transition to an EV fleet. This phase additionally includes $904k for installation of additional public charging at City facilities, including $141k for public chargers at the Elk Grove Library and $599k for public charging at Old Town Plaza.

Phase 2, occurring between 2029 and 2033, would procure an additional 17 EVs at a cost of $1.2M and install additional charging infrastructure at a cost of $651k. Because relatively few EVs need to be purchased and the electrical system upgrades will have been made during the

[12] It is important to note that the vehicle costs are not new expenditures, but rather replacement expenditures for purchasing ICE vehicles.

previous phase, the total capital cost of this phase is estimated to be $1.9M representing only 11% of the full transition cost.

Phase 3, occurring between 2034 and 2035, will include procurement of the remaining fifty-eight EVs at a cost of $4.7M, along with the final installment of charging infrastructure at an estimated cost of $735k. The total costs of Phase 3 investments are estimated to be $5.4M, representing 31% of the full fleet transition capital cost.

In addition to the capital investments required in each of the three phases, operating expenses (OPEX) will be needed to run (charge) the EVs and operate and maintain chargers. The OPEX related to operating of EVs include the cost of electricity used to charge the EVs and amount to $8.5M during the period until 2035. The OPEX incurred by the fleet chargers total $813k and those of public chargers to $142k. The total contribution of operating expenses to the fleet transition total is about $9.4M.

Once the transition is completed, the City can expect ongoing savings as the annual OPEX of an electrified fleet are estimated to be smaller than those of the existing ICE fleet, given fuel cost savings.

VEHICLE TRANSITION

OVERVIEW

The City will need to invest a total of $27.1M for procurement and operation of EVs and installation and maintenance of charging infrastructure to complete the transition of its fleet to EVs at all City-owned facilities over the next 12 years. This amount is only about $2.5M in additional funding, as the estimated cost of capital and operating expenses for the ICE fleet would be $24.6M over the next 12 years. The recommendation is that the City only procure vehicles meeting the requirements of its duty cycle when they become commercially available. There are expected to be many more choices for light-duty vehicles in 2024 and beyond than are currently available with the possible exception of suitable replacements for pursuit-rated patrol vehicles which may not be available until 2025 or 2026.

Beginning in 2035, all new passenger cars and light-duty trucks sold in California will need to be zero-emission. In addition, CARB has already put in place or is continuing to work on rules for public and private fleets to transition to zero emissions.[13] To ensure the City is able to comply

[13] Most relevantly, this includes the Advanced Clean Fleets (ACF) rule, which was adopted by CARB in mid-2023 and became effective on January 1, 2024. The rule requires an increasing share of new and existing medium- and heavy-duty vehicles in municipal and other fleets to be zero-emission.

with the transition to ZEVs, the 2035 year is a useful planning target to ensure EV charging infrastructure sufficient to support City fleet needs are operational at each City-owned facility. Using a phased approach to the implementation of the fleet transition plan allows for the cost to be spread over the next decade while still ensuring the City will be able to fully meet the State goals with respect to ZEVs. In addition, the phased approach provides an opportunity to assess and implement new technology with the transition.

City of Elk Grove Electrification Assessment Online Data Visualization

To help City staff visualize the transition of its existing fleet to EVs, including the timing and associated costs of this transitions, this project developed an interactive website to host data visualizations. Page 1 of this website summarizes the economics and CO2 reduction relative to a baseline of non-fleet electrification. Page 2 is the Transition Planner allowing users to view and select individual fleet vehicles by replacement year, implementation phase and fleet facility to understand costs. Page 3 lists charger quantities by facility recommended for both fleet and public use as well as their associated capital and operating costs. The remaining pages list each fleet asset by class, quantity, duty cycle, modeled replacement EV and estimated purchase cost. The address and password for the online data visualizations is shown in the text box below.

URL: **https://frontierenergy.com/city-of-elk-grove/**

Password: ***Elk Grove***

PHASES

For planning and budgeting purposes, the fleet transition will take place over three phases, including:

- Phase 1 (2024 – 2028)
- Phase 2 (2029 – 2033)
- Phase 3 (2034 – 2035)

Across these three phases, the City will need to invest a total of $27.1M to procure vehicles and install charging infrastructure to complete the transition.

The quantity of fleet EV purchases by phase for each City fleet facility and department are summarized below in Table 10.

TABLE 10: ELK GROVE FLEET VEHCILE REPLACEMENT SUMMARY

DOMICILE LOCATION	MANAGING DEPARTMENT	PHASE 1: # OF VEHICLES	PHASE 2: # OF VEHICLES	PHASE 3: # OF VEHICLES	TOTAL # OF VEHICLES
ANIMAL SHELTER	Police Animal Care	2	0	4	6
CITY HALL	Code Enforcement	4	1	2	7
	Housing	0	0	2	2
	Facilities	0	1	0	1
	Public Affairs	1	0	0	1
CORP YARD	Public Works	0	7	9	16
	Police Animal Care	0	0	1	1
FLEET FACILITY	Police	53	7	16	76
LAGUNA PALMS CAMPUS – POLICE	Facilities	0	0	1	1
	Police	56	1	19	76
	Police Motor Pool	4	0	1	5
	Police Property Evidence	0	0	1	1
	Police Transport	0	0	1	1
	Recycling and Waste	1	0	0	1
SWCC	Recycling and Waste	1	0	0	1
	Total:	**121**	**17**	**58**	**196**

As described in the next section, the recommendations for a phased installation of the required charging infrastructure is attuned to the timing of the transition of fleet vehicles to EVs.

CHARGING INFRASTRUCTURE INSTALLATION PHASES

Charging infrastructure must be installed in time to charge the fleet EVs assigned to each fleet facility consistent with vehicle replacement timing. Charging infrastructure deployment will be based on the electrical system requirements needed to power the EV chargers. Chargers powered by existing electrical capacity requiring no electrical infrastructure upgrades could be completed in a single phase, typically Phase 1, though the City could delay or phase implementation concurrent with vehicle electrification for budgetary or other reasons. For facilities with relatively few fleet EVs and minimal electric load growth from EV charging such as the Animal Shelter or SWCC, no electrical system upgrades will be needed and therefore charger deployment could be completed in a single phase concurrent with fleet electrification.

The City will need to invest a total of $4.6M to procure and install charging infrastructure to power fleet EVs at all identified City-owned facilities. Additionally, the City will need to invest a total of about $905,000 to procure and install charging infrastructure for the public. The total CAPEX across fleet and public chargers thus amounts to about $5.5M. This should occur in three phases between 2024 and 2035. Appendix A outlines this in detail for each facility, including the number and types of chargers to be installed in each of the three phases.

Figure 4 below graphically illustrates how charger deployment for fleet, staff and public use would be phased, including all studied facilities. Fleet vehicle replacement by EVs is shown in gray while EV chargers are shown in orange.

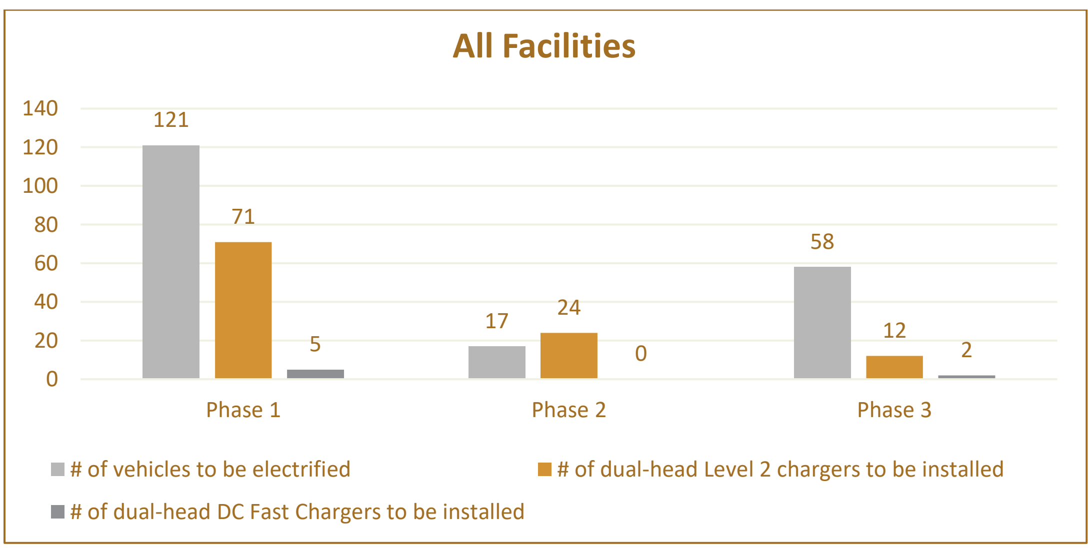


FIGURE 4: FLEET VEHICLE ELECTRIFICATION AND EV CHARGING INFRASTRUCTURE DEPLOYMENT BY IMPLEMENTATION PHASE ACROSS ALL FACILITIES

BACK-UP POWER AND RESILIENCY

Fleets operating mission-critical EVs need to be able to charge independently of the power supply. Most of Elk Grove's mission-critical EVs are domiciled at the Corp Yard, Fleet Facility and at Police Station within the Laguna Palms campus. Therefore, each of these will need to provide backup power summarized below in Table 11 during extended power outages.

TABLE 11: ELECTRICAL DEMANDS OF MISSION CRITICAL FLEET FACILITIES

FLEET FACILITY	DAILY KWH	AVERAGE KW	PEAK LOAD
CORP YARD	240.6	15.0	198
FLEET FACILITY	996.9	62.3	1,565
LAGUNA PALMS CAMPUS (Police & City Hall)	630.2	39.4	1507

The conventional approach would be to install an additional pad-mounted generator, replace an existing generator with a larger unit, or install a plug for quick connection to a portable trailer-mounted generator. Alternative approaches that respect zero-emission targets and mandates include deploying a microgrid to utilize a solar array, preferably with battery energy storage, and/or the use of bidirectional chargers using fleet EVs to charge one another. For example, the Ford F-150 Lightning has integral charging ports that could be used to charge other fleet EVs. Some of the currently available zero-emission resiliency and backup options are explained below.

BACKUP GENERATORS

The conventional approach to energy resiliency is the use of conventional fuel back-up generators, which are available in sizes up to 2,000 kW. These generators can be permanently installed at facilities for dependability and ease of operations or can be mounted on trailers to provide greater flexibility for fleet operators. Elk Grove already has generators at several of its facilities. If they have spare capacity, existing generators could be used to power chargers, however backup generators are typically sized for existing building loads. If additional generation capacity is limited, Elk Grove could install a generator at one or more of its primary fleet facilities where emergency response vehicles are domiciled including the Corp Yard, Fleet Facility and Laguna Palms campus or at least provide quick connect couplings and an adjacent space to park a trailer-mounted portable generator. Portable generators offer flexibility but typically cost up to 30% more to purchase.

FIGURE 5: TRAILER-MOUNTED 625-680 KVA MOBILE GENERATOR

Source: HIPOWER

Backup generators can be powered by diesel fuel or other liquid fuel sources like natural gas or propane. To help achieve the City's carbon reduction goals, renewable diesel—a hydrocarbon diesel fuel produced by hydro-processing of fats, vegetable oils, and waste cooking oils—could be substituted for standard petroleum diesel. According to industry sources like Neste[14], which is available from two distributors in Stockton, such a substitution reduces lifecycle emissions by up to 80% compared to petroleum diesel.

An alternative to traditional internal combustion powered generators are linear generators, which follow a more fuel-agnostic approach. Linear generators can typically run on a range of fuels including natural gas, biogas,

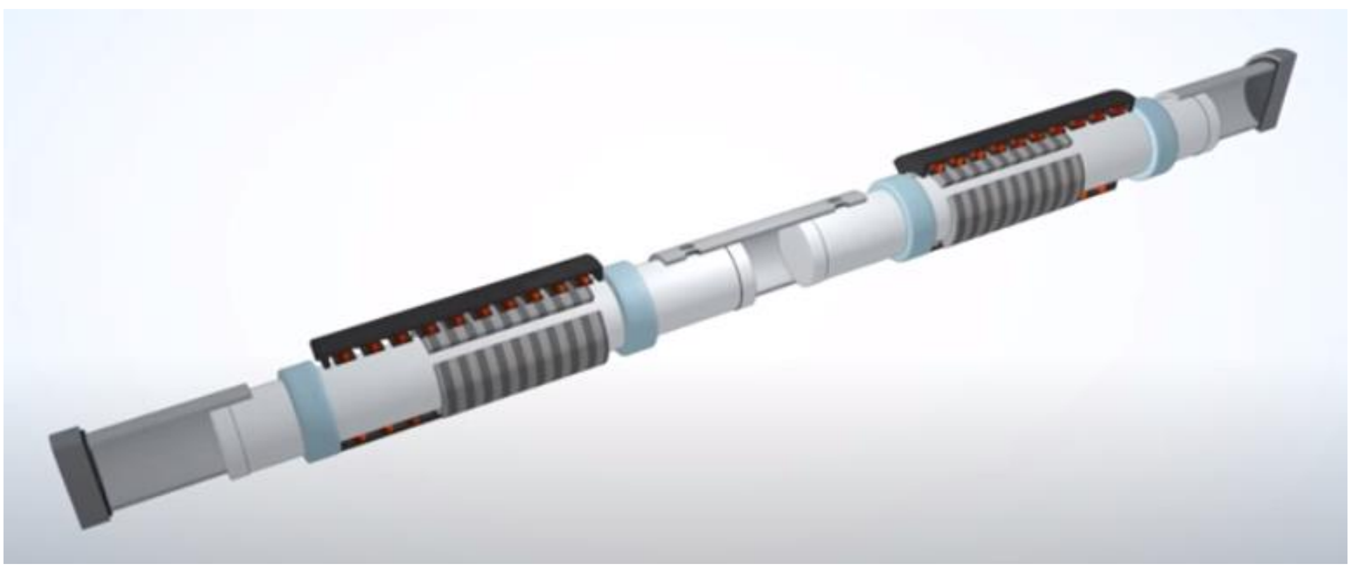


FIGURE 6: MAINSPRING LINEAR GENERATOR

hydrogen, ammonia, and syngas. They are functionally different to conventional generators in that they utilize a flameless compression reaction of the fuel gas in use. The expansion of the

[14]https://www.neste.us/neste-my-renewable-diesel/find-fuel

gas upon reaction drives the generation of electricity in the linear generator. Mainspring[15] offers a scalable product that can provide 480-V output voltage starting at an output power of 230 kW which could easily power a dual-port DC Fast Charger at any of Elk Grove's facilities. In an existing configuration, the linear generator runs on natural gas or biogas with a hydrogen blend of up to 30%, but the system is capable of running 100% on either hydrogen or ammonia. An example of linear generators deployed in California include a new installation to power charging for Prologis's drayage fleet.

HYDROGEN FUEL CELLS

Fuel cells are a rapidly growing form of grid-independent generation that can, depending on the energy feedstock and conversion process, be environmentally sustainable. Fuel cells combine the fuel (typically hydrogen,) with oxygen to shed electrons and generate an electric current. In the case of hydrogen fuel cells, the only byproducts of this process are: electrical current, water (H_2O), and heat. There are several major companies that can provide this type of generation, including Bloom Energy and Kaizen Clean Energy. Their technology is stackable, scalable, and requires only limited physical space.

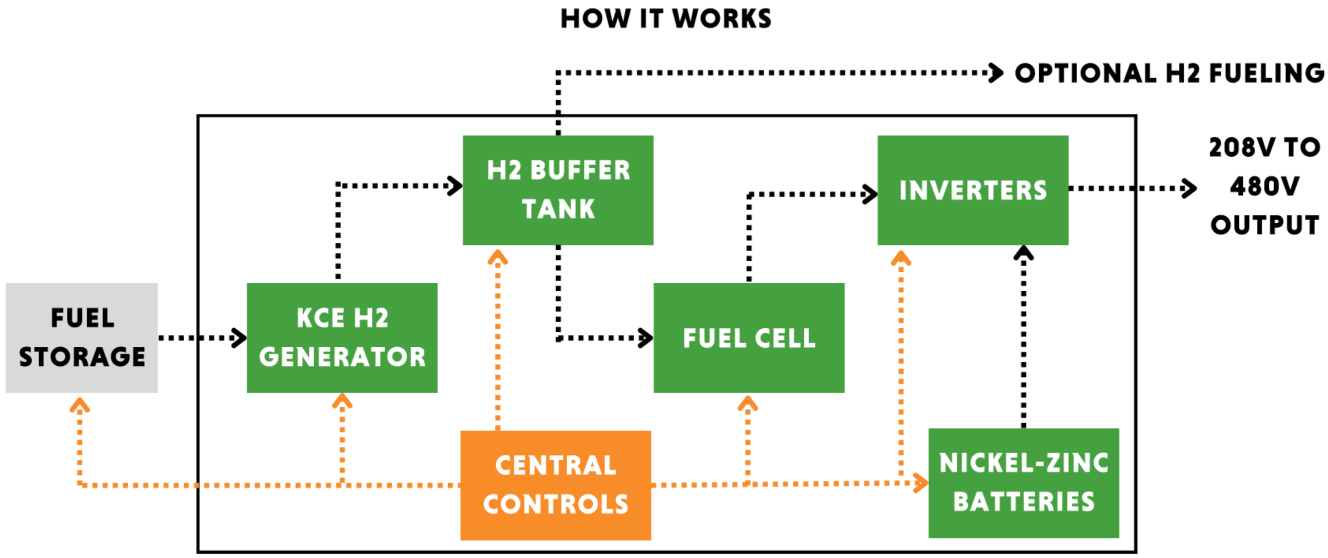


FIGURE 7: SCHEMATIC OF HYDROGEN FUELCELL POWERED CHARGERS (SOURCE: KAIZEN CLEAN ENERGY)

The capital investment required for a fuel cell's initial infrastructure and the cost of hydrogen can be expensive; however, compared to the footprint and efficiency of other forms of power

[15] https://www.mainspringenergy.com/solutions/

generation such as generators, solar PV or wind turbines, they can be a useful alternative or complementary technology.

Since generators and fuel cells are costly and fuel consuming, several alternative approaches to provide resiliency for fleet fueling during power outages are based on the use of distributed energy resources (DER) and battery storage as explained below.

BATTERY ENERGY STORAGE

Battery storage is a technology that enables electrical energy to be stored for later use. A battery energy storage system (BESS) is an electrochemical device that charges (or collects energy) from the grid and then discharges that energy when needed such as during a power outage or to reduce demand on the grid. Like generators, a BESS can be permanently installed or be portable. Examples range from chargers with integrated batteries like Freewire Technology's Boost chargers, to small portable units, like the Dannar Mobile Power Station, to on- and off-site grid-scale storage battery facilities, like Joule's modular battery system.

Improvements in energy storage technology have improved space efficiency too. For example, Joule's battery modules are only 4' wide, 4' high and 8' long and available with up to 300kWh of storage capacity. Therefore a single standard parking stall would provide sufficient space for up to four adjacent modules with 1,200kWh of storage capacity. Since these are stackable, a second row of battery modules would double this capacity to 2,400kWh which would be sufficient to fully charge 40 typical light duty EVs. As battery technologies continue to improve in terms of energy density and lower cost, the use of BESS will become increasingly viable.

FIGURE 8: JOULE'S MODULAR, STACKABLE, CHAINABLE BATTERY SYSTEM (LEFT), DANNAR MOBILE POWER STATION (RIGHT)

One of the main distinctions of types of BESS is whether it is designed to be installed permanently or whether it is a portable or temporary solution. Permanently installed BESS can provide backup power for spontaneous grid outages (blackouts and brownouts, or partial outages) as well as mitigate the daily peak charging demand by replacing all or parts of the power draw from the existing utility service with its own electricity. Mobile or temporary BESS, on the other hand, provide a flexible solution for fleet applications in which less certainty exists around where and when additional or backup power will be needed. Mobile battery systems can be deployed at specific sites on short notice and moved to a different location when needed.

Some third-party charging-as-a-service providers offer large mobile batteries delivered by truck that can power onsite chargers. One startup is StorEdgeAI[16] which will offer a mobile battery-based charging supply solution at less than half the cost of gasoline fueling. StorEdgeAI hopes to deliver bulk electricity daily, independent of the utility grid, directly from large renewable plants to EV charging locations such as fleet depots. StorEdgeAI's technology enables one mobile battery unit (with several MWh onboard on a 30' shipping container) to fulfill the daily energy needs for over 100 light-duty EVs. Mobile battery fleet size scales incrementally with demand (as fleet electrification grows), removing upfront investment risk. Such solutions require no utility grid upgrades or onsite utility distribution infrastructure.

SOLAR

Instead of or in addition to back-up generators or batteries, EV charging operations can be protected from power supply interruptions by on-site renewable generation like photovoltaic solar panels coupled with on-site energy storage batteries.

FIGURE 9: BEAM EV ARC SOLAR-POWERED EV CHARGER WITH BUILT-IN BACKUP ENERGY STORAGE

Source: [BEAM]

Solar power is becoming an increasingly viable source of power for EV charging because of improvements in energy collection and storage technology. Solar technologies provide environmental benefits due to a lack of carbon emissions and resiliency benefits from an ability to operate with independence from the electrical grid during disruptions or emergencies. One example of this is a transportable turnkey vehicle charging station called EV ARC powered by a tracking solar canopy and lithium-ion battery storage developed by Beam, formerly Envision Solar

[16] https://storedge-ai.com/

International, that may be very appropriate for multiple fleet applications. This modular solar charging platform is designed to be operated independently from the grid or it can be grid-buffered. They require no construction nor ground disturbance and therefore can be installed and set up quickly at the charging site without permitting and essentially no operating cost. The company has recently developed an upgraded version of the company's existing standard EV ARC shown in Figure 9, the High Powered EV ARC, which can be equipped with 38-51kWh of battery storage, 40 Amp power supply, and an 8.4-kW Level 2 charger or a 12.5kW DC charger. The charger can split dynamically among as many as six J1772 charging plugs. The high-powered EV ARC is able to be daisy chained or stacked with surface cabling to support 50kW DC fast charging, which is able to produce 1,000 miles of EV driving range per day on average, depending on site location and amount of sunlight.

Another solar powered charger option is Paired Power's Pair Tree, consisting of a 5kW solar canopy with bi-facial modules coupled with a 43kWh storage battery for charging when the sun isn't shining. Each Pair Tree contains dual 5kW Level 2 charging ports, LED lighting and parking bollards, a software app for full charging control including reservations via smartphone.

Solar powered EV chargers such as Beam's EV ARC or Paired Power's Pair Tree can be islanded (no grid connection) to simplify installation. However, they can also be connected to the grid, making them potentially eligible for SMUD's Solar and Storage Rates which allows the utility to purchase excess solar power and credit the City for the power purchased.

MICROWIND

FIGURE 10: 10-KW MICROWIND TURBINES WITH SOLAR AND BUILT-IN BACKUP ENERGY STORAGE

Source: FLOWGEN

Another potential source of distributed renewable energy for powering EV chargers is wind. Due to technological advances, small wind turbines that spin in as little as 5-mph wind can provide up to 10 kW of power, enough to supply a medium output Level 2 charger. Flowgen Technology, a Swiss cleantech company, designs, manufactures, and constructs these turbines as well as “smart microgrids” combined with battery energy storage and smart controls to optimize microgrid performance. These smart microgrids can operate autonomously (in “island mode”), daisy-chained to create to scale (kW-MW) with interoperability control and communication and can also be connected to the larger utility grid, making it more adaptable and resilient and reduces stress on the utility grid.

MOBILE MICROGRIDS

At least one company, CE+T America, has combined multiple distributed energy components (DER) into a stand-alone pre-wired mobile microgrid mounted on an 8'x20' skid that can fit in a single standard parking stall. The Watt2Go mobile microgrid (W2G) power system supports EV charging with an option to mount Level 2 or DCFC stations on a W2G single skid. The system architecture can be configured in a controlled environment using CE+T’s “DEPGreen” design configurator in real-time to meet specific energy requirements. The W2G can operate in grid connected or autonomously in island mode using combinations of conventional and new generation and storage technologies, such as generators, solar PV, MicroWind, LFP batteries and fuel cells. Because they are skid-mounted modular microgrids, they can be deployed in less than a day and be relocated via truck from one fleet facility to another if needed. Like other recommended EV charging technologies, the single skid W2G is modular and scalable up to 240 kW of power and 515 kWh capacity and capable of being stacked to MW size with full interoperability to meet the needs of larger fleets.

BIDIRECTIONAL CHARGING

A promising emerging technology is bidirectional charging. Bidirectional charging refers to being able to charge EVs and draw power back from an EV's battery as a power supply. Bidirectional charging combines the use of a bidirectional charger, a bidirectionally enabled battery-electric vehicle and a software management program. This combination of assets enables EVs to deliver two-way (bidirectional) power flow by drawing power from the grid or a building and discharging energy back into a building or the grid. Each component of bidirectional charging is explained below. Collectively, these technologies are commonly known as "vehicle-to-everything" or simply "V2X". Bidirectional chargers are available in the US by international charging vendors like Borg Warner, Wallbox and Nuvve as well as domestic startups like Fermata Energy.

Vehicle-to-Grid (V2G): Enables surplus EV battery capacity to be exported back to the grid to provide a variety of grid services for grid operators and utilities, including system-wide load management, frequency regulation, renewables integration, power-outage resiliency, etc. Such services are also referred to as vehicle-grid-integration (VGI).

Vehicle-to-Building (V2B): Vehicle-to-Building services, which are behind the meter, non-export-to-grid activities, refer to the dispatch of power from a bidirectional EV to a commercial or residential building. The main application of V2B is demand charge management on facilities with high to moderate demand charges. SMUD currently has demand charges especially during weekdays in the summer, and this could change in the future as electrical demand grows while hydro capacity dips during system-wide summer peaks and the grid becomes increasingly dependent on renewable, intermittent energy sources like wind and solar.

V2B can also provide disaster resiliency/back-up power for buildings through sharing of power between the buildings co-located with the fleet parking facility and the vehicles that charge there, allowing buildings to borrow stored electricity from the EV batteries. This way, EVs could provide emergency dispatchable mobile backup power capacity during power outages.

Vehicle-to-Vehicle (V2V): Allows EVs to transfer power to and from each other's batteries. Since utilization by most fleet vehicles is well within the battery range of currently available EVs, a substantial surplus power is typically available. As battery capacity expands far beyond the daily range needs of most fleets, this surplus capacity will likely expand even more. This power could be shuffled between vehicles via a microgrid or backup generator on an as-needed basis, reducing demands on fleet charging infrastructure as well as on the grid. During power outages, mission critical vehicles, like police cruisers and fire department apparatus, could draw power from non-mission critical vehicles, allowing their batteries to function as backup power storage reducing the need for investments in backup energy storage and emergency generators. A practical application would be to use an EV, e.g., Ford F-150 Lightning with onboard power outlets, to charge other utility vehicles. Other solutions include other EVs capable of bidirectional charging such as a Nissan, Hyundai, or Kia connected to charging stations that are each capable of bidirectional charging. The charging station, or the underlying charge management software, could then request the charging of a specific vehicle using the energy stored in a different vehicles' batteries.

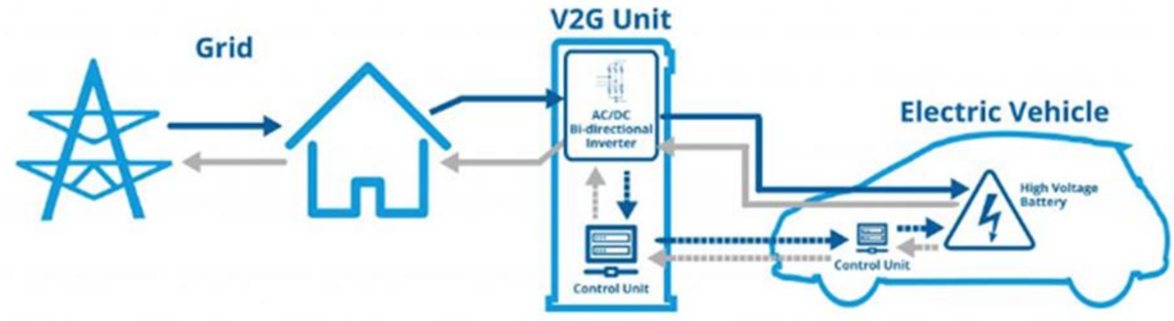


FIGURE 11: BIDIRECTIONAL CHARGING. SOURCE: FLEETCARMA

Benefits: Bidirectional charging will provide a variety of benefits to fleets, facilities, and utilities, including potential revenue from grid services, cost reduction through avoided demand charges and resiliency for buildings and vehicles using EV batteries providing backup energy storage. This technology unlocks the significant energy storage potential of EVs and enables EV batteries to provide valuable energy services to buildings and the electric grid. Most privately-owned EVs are parked 95% of the time (as are privately-owned combustion engine vehicles), and even fleet EVs are typically parked more than 60-70% of the time. This offers abundant sources of mobile, distributed, and dispatchable capacity.

Disadvantages: Unfortunately, universal bidirectional EV chargers are not yet available. Every OEM (like Ford) tends to have proprietary software or communication protocols to allow their EVs to talk to other equipment. Most of it is due to liability concerns so all equipment requires compatibility certification. The current lack of bidirectional charging standards are expected to remain until standards are approved through CharIN by 2025. Bidirectional charging should be considered by fleets to be an emerging technology that will change quickly and should be tracked on an on-going basis as it will likely revolutionize the industry. Another challenge is the lack of current standards for V2G and V2B and open architecture, potentially resulting in compatibility limitations.

Some vehicle OEMs, including Ford, GM, Rivian, and Hyundai, are embracing bidirectional charging technology by aiming to include this capability in their current or future EV model offerings. Additionally, commercially available bidirectional chargers are limited to a few options including the Fermata Energy FE-15 and the Ford Charge Station Pro[17], Wallbox Quasar II and a pair of DCFC from Borg Warner. In addition, more such charging products are under development by many different companies so it is reasonable to assume that bidirectional charging will be part of future EV and charger models and that it will be increasingly deployed given its unique resiliency benefits, potential to mitigate partial or full grid power outages and other benefits.

CONCLUSION

The need for back-up power is growing rapidly as both vehicles and facilities transition from fossil fuels like gasoline, diesel, and natural gas to electricity. This is increasing strain on the electrical grid and the risk of brownouts and public safety power shutoffs events is a critical concern for fleet operators, especially for mission critical EV fleets. Industry has only recently begun to react to this demand with a variety of innovative resiliency solutions, many of which are novel and unproven. For a fleet like Elk Grove's domiciled at multiple locations, each with unique site conditions, different vehicle types and power demands, the City will likely need to deploy a variety of approaches, rather than selecting a specific technology. For example, solar combined with BESS makes sense where space is sufficient and mobile battery powered chargers could be used at multiple sites to supplement and distribute power produced by backup generators. In the future once accepted by more automotive and EV charger OEMs and standardized, V2V will likely be the most cost-effective approach since the City will be acquiring significant battery capacity integral to its growing EV fleet and the incremental cost of bidirectional chargers is negligible. For now, the City should continue to monitor improvements to resiliency technology as it improves and standardizes and make purchases as needed during implementation of this plan.

Table 12 below summarizes the advantages and disadvantages of these backup power alternatives.

[17] https://www.solarpowerworldonline.com/2023/02/what-is-bidirectional-ev-charging/

TABLE 12: COMPARISON OF BACKUP POWER OPTIONS

TECHNOLOGY	ADVANTAGES	DISADVANTAGES
Generators	Flexibility Can be mobile Availability through purchase or lease	Noisy when running Fuel consumption Potential emissions Occupies physical space
Fuel Cells	Zero emissions Silent operations Flexibility	Fuel consumption Occupies physical space
Battery Energy Storage	Zero emissions Silent operations Flexibility Can be mobile Availability through purchase or lease	Needs power supply Occupies physical space
Solar	Zero emissions Silent operations Can be independent of power grid	Daylight only or requires battery energy storage Needs solar access Requires large open area
Microwind	Zero emissions Can be independent of power grid	Wind-dependent and requires battery energy storage
Bidirectional charging (V2X)	Zero emissions Silent operations Flexibility Can be mobile Can be independent of power grid Utilizes existing assets (EV batteries) Requires no additional space	Requires bidirectional EVs and chargers Lack of industry standards (CharIN)

RECOMMENDATIONS FOR IMPROVING DATA COLLECTION/ANALYSIS

VEHICLE DATA

At a minimum, the City's fleet manager will need systems that can collect and analyze data to better understand energy consumption patterns for ICE vehicles to inform electrification planning. Ideally, this would include fuel consumption, engine idling time, trip distance, and use of auxiliary equipment to ascertain total energy consumption. Other data useful for fleet managers includes vehicle health diagnostics, location, and driver performance, such as rapid acceleration and harsh braking that reduces energy (fuel) efficiency. A variety of telematics platforms are capable of collecting this data which can be monitored in real time by fleet managers on online dashboards as well as drivers via mobile devices and subsequently aggregated for analysis and planning purposes. For managing fleet EVs and fleet EV charging, as well as to update this plan, a telematics system should be utilized that monitors vehicle battery state of charge as well as factors affecting battery range such as driving behavior, charging speeds, ambient temperature, topography, and vehicle loads. Some of this data can be collected directly by some vehicles' integral systems while others will require installation of telematics by third-party providers.

Numerous smart technologies are improving the planning and operations of multiple aspects of electromobility from data collection and analytics to distribution and management of electrical loads to specialized charging technologies addressing the unique needs of specific fleet components. The collection and analysis of vehicle data such as miles and routes driven, energy consumption, and driver behavior can be collected using telematics such as Geotab, Samsara, Verizon Connect, Tangerine and dozens of others. The collected information can then be fed into a data analytics platform such as Sawatch Labs for light-duty vehicles or Microgrid Lab's EVOPT for heavy-duty vehicles to perform sophisticated diagnostics to inform decision making on vehicle choice, battery size, and charging requirements.

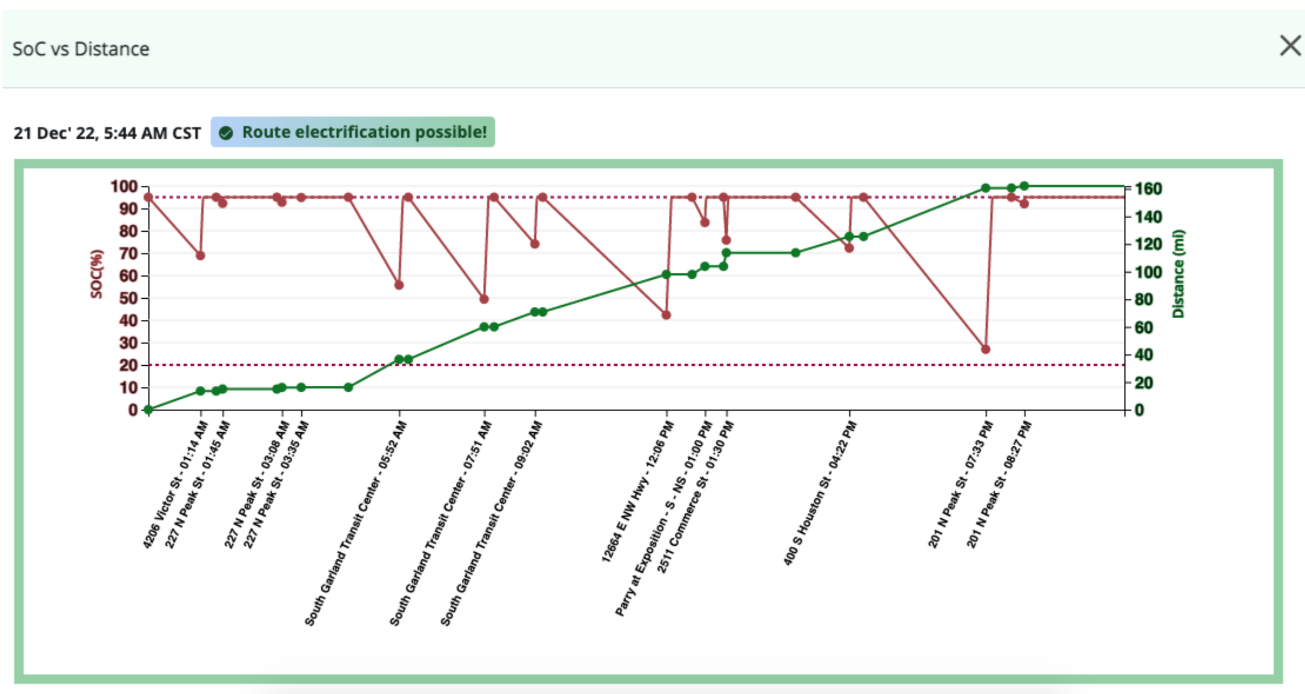


FIGURE 12: DATA DASHBOARD SCREEN CAPTURE

Considerations related to the analysis of EV data include the following:

1. DATA COLLECTION USING AN EDGE COMPUTING DEVICE

Installation of an edge computing device that can collect the following data and push it to the cloud for further analytics would increase the ability to efficiently and effectively manage the City fleet and charging infrastructure.

- Charged energy and discharged energy
- Charger power rating (enroute vs depot/yard)
- The temperature of battery cells (maximum, minimum & average)
- Battery capacity
- Range traveled with current capacity
- Engine start & stop time/locations and GPS
- Energy efficiency/ travel effectiveness
- Ability to configure more parameters

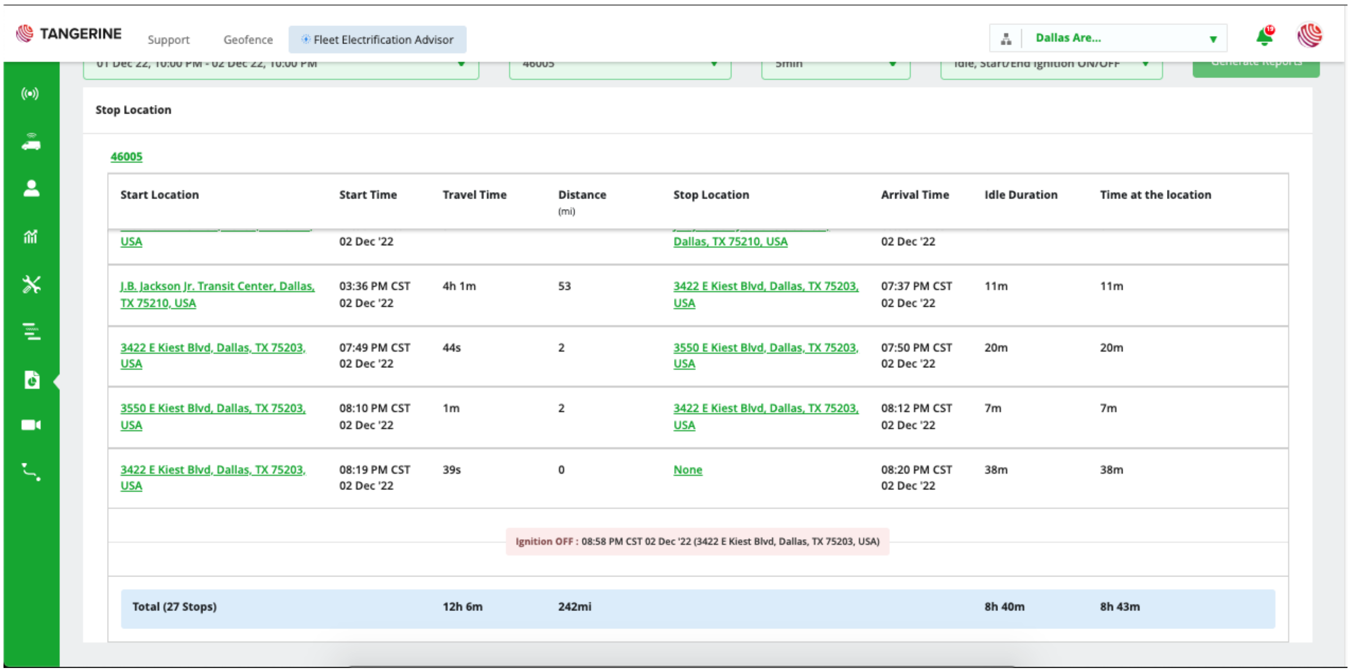


FIGURE 13: DATA DASHBOARD SCREEN CAPTURE

2. BETTER COOPERATION WITH VEHICLE MANUFACTURERS

Whenever the end customer has buyer power over a vehicle OEM, more custom data can be requested for electrification planning. Depending on the use case, this can be requested during planning stages or collected on a continued basis for tracking and monitoring the progress of deployment.

3. ACQUISITION OF QUALITY REAL-WORLD DATA FOR CHARGING/ DISCHARGING RATE

Real-world data on EV charging & discharging rates may vary due to external conditions including weather and vehicle load. For these reasons, real-world data is the most reliable source for analysis and therefore should be used for this purpose rather than simulated data.

4. DATA VISUALIZATION AND GIS OVERLAY

Visualizations and overlaying of the different aspects of the collected information helps in analyzing the data in an intuitive way and makes any issues with data collection or decision-making inputs easier to spot, even those that were previously not apparent from the data collected via traditional methods and means.

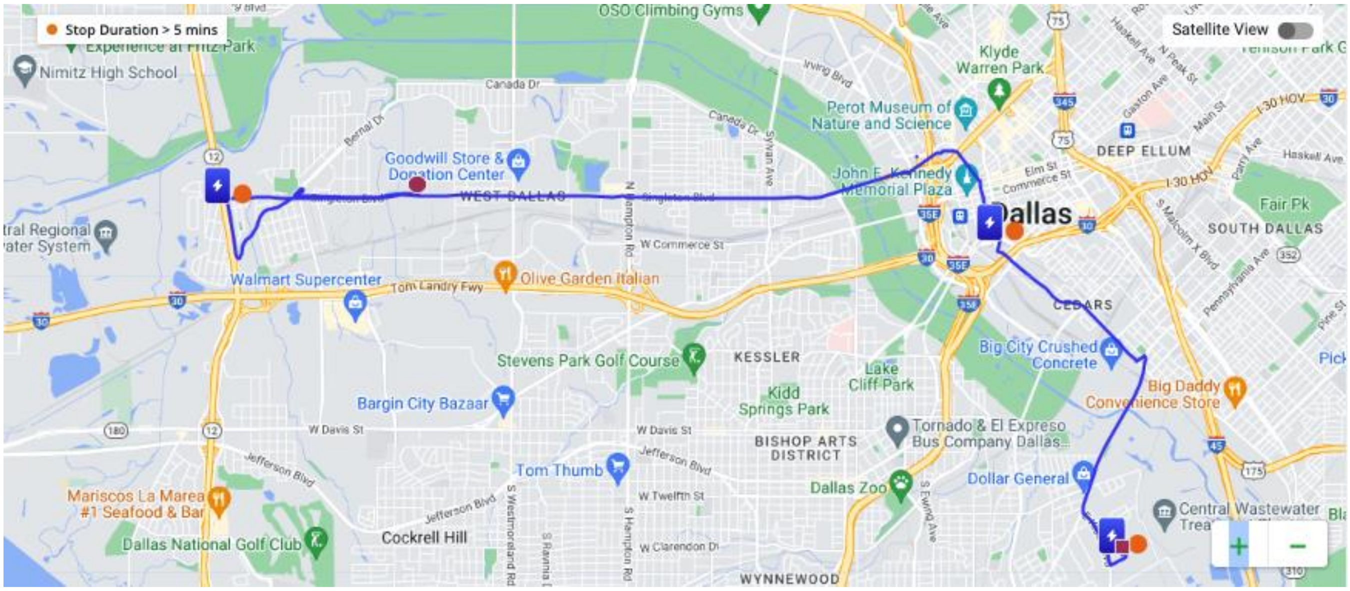


FIGURE 14: DATA DASHBOARD SCREEEN CAPTURE

5. DATA STANDARDIZATION

Standardize the data collected from OEMs or CAN data standardized collection (key-value pair) of data will help the standalone data to make sense.[18] This prevents the need for additional logic for decoding the data.

CHARGER DATA

EV charging data can be collected by EVs themselves as noted above as well as by smart EV chargers that upload data to the cloud or directly to charging facility operator's dashboards. Important data to be collected by smart chargers includes per-charger power dispensation and charging facility electric loads. This data can be used by facility and fleet managers for the purpose of monitoring charger use, tracking service reliability, Low Carbon Fuel Standard (LCFS) revenue collection, and evaluate charger needs for future fleet electrification phases. Smart chargers can also track power use by individual EVs and departments for internal billing (as appropriate), by employees or by members of the public for chargers used by multiple groups for revenue collection and business analytics.

Key considerations to help guide charger selection are listed below. Appendix D describes these attributes in detail and summarizes recommended features and capabilities relevant to them.

- Charge plugs
- Usability
- Ruggedness
- Connectivity
- Payment/data collection
- Efficiency
- Certification
- Interoperability
- Future proofing
- Data collection

[18] CAN data is collected through the controller area network (CAN) standard, which is a common data collection and exchange standard for vehicles.

BEST PRACTICES RELATED TO EVS AND EVSE

This section summarizes recommendations for electrification of municipal fleets based on experience with numerous public agency fleet electrification projects. Appendix D provides more details on the items listed below.

FLEET ELECTRIFICATION

INTERNAL COORDINATION

- **Institute a Facility EV Charging Infrastructure Advisory Committee**: Transitioning the City to an all-electric fleet will require significant capital investments in terms of electrical system upgrades and EV charging infrastructure purchase and installation. This will require close coordination between departmental stakeholders for development of new City policies as well as procedures related to successfully transitioning the fleet to EVs by an advisory committee whose members are (or are committed to becoming) knowledgeable about these issues.
- **Coordination with Fleet/Facilities when planning all new vehicle purchases**: To ensure sufficient charging capacity is available for new fleet EV purchases prior to deployment, close coordination is necessary between the City's fleet and facilities staff regarding the timing of EV purchase and scheduled delivery relative to the purchase and installation of EV chargers at each fleet domicile.

INTERIM ACTIONS

- **Take actions to reduce emissions even before electrification:** Transitioning to an all-electric fleet takes many years. Fleets can take interim actions even before replacing existing ICE vehicles to reduce the emissions of their operations. Examples of such actions include improved driving through driver training and monitoring to reduce rapid acceleration, hard braking and excessive steering, idling reduction, use of telematics and software to improve routing and fuel economy, and shifting to hybrid models prior to fully electric models being available.
- **Fleet rightsizing**: Most fleets have more vehicles than they need. Underutilized vehicle assets should not be replaced with EVs since its emissions savings is unlikely to offset the embedded carbon of the EV's production. Therefore, fleets should evaluate which fleet assets can be declared surplus prior to planning electrification.

FLEET VEHICLE REPLACEMENT

- **Build sufficient contingencies into fleet electrification budgets and schedules:** Elk Grove should develop plans to replace each existing fleet vehicle with suitable EV alternatives by the planned replacement year, but the City should be aware that OEMs have been months or years behind in development of new EV models and delivery of current models, resulting in chronic and severe EV supply shortages. As a result, fleets like Elk Grove's have been unable to comply with planned replacement schedules and EV prices have, at times, escalated above budget estimates. Therefore, the City should expect to be able to adjust plans and budgets to address these constraints.
- **Use surcharges on existing fleet fuel purchases to fund fleet electrification:** One way to fund purchases of charging infrastructure and the incremental cost of EVs relative to ICE vehicles is by adding a modest surcharge to existing fuel sales, a practice the City of Spokane WA has pioneered. Over time, this has generated a sustainable funding stream. Elk Grove's budget office should consult with Spokane regarding that City's experience.
- **Strategically adjust vehicle replacement schedules to accommodate automotive industry delays:** Consider delaying replacement of existing fleet vehicles lacking suitable, available fleet EV models by extending the service life of existing ICE vehicles by an extra year or two, if possible, if doing so would then allow replacement by an EV. If a suitable EV is not available in the near future, fleets may need to delay the replacement opportunity to the next replacement cycle to allow the industry to provide more available products, and use the extra time to plan, permit, purchase and install charging infrastructure.
- **Focus on highest emitters first:** Prioritize replacement of existing fleet vehicles with higher GHG emissions with EVs as soon as suitable EV models exist, to maximize emissions reduction. Since emissions are largely determined by duty cycle, high-use vehicles should be the City's highest priority for electrification, especially for light-duty trucks and vans for which electric models like the Ford F-150 Lighting and e-Transit are now available. Although usage is typically measured in miles, many fleet vehicles are used as mobile offices or run auxiliary equipment like HVAC systems, computers, lights, lifts, blowers, etc. powered by their batteries or hydraulic systems while idling. Thus, engine time and fuel consumption may be a more appropriate metric of vehicle use for measuring emissions and reductions thereof from those vehicles.
- **Only electrify fleet vehicles when environmentally beneficial to do so:** Some vehicles are used so infrequently or are operated so lightly that the emissions reduction benefits of electrification do not offset their lifecycle emissions due to the significant embodied

carbon in current production processes of EVs and their batteries. For such vehicles, it makes more sense – both environmentally and economically – to forgo replacement until regulations mandate the adoption of zero-emission vehicles.

- **Replace vehicles opportunistically:** Because the cost differential between light-duty EV and equivalent ICE models is far lower than for medium- and heavy-duty EVs, fleet managers should generally focus on replacing light-duty vehicles in the near- and mid-terms and medium and heavy-duty vehicles in the medium and long terms when battery technology and economies of scale make these vehicles more cost-competitive. However, there may be opportunities for replacing certain medium and heavy-duty vehicles that fleet managers should consider. Examples include vehicle-specific incentives, grants, and rebates available for certain vehicles. In addition, electric alternatives to certain specialty vehicles offer co-benefits in addition to emissions reduction. For example, electric streetsweepers generate far less noise, allowing them to comply with local noise ordinances, unlike diesel equivalents. Note that Advanced Clean Fleet rule mandates electrification of medium and heavy-duty vehicles, thus the City is required to electrify these regardless of their economics.
- **Plan for special-use vehicles:** While most fleet vehicles have similar uses and duty cycles and can therefore share EV chargers and charging strategies, certain fleet vehicles have unique design and operational characteristics that require special considerations when planning. Examples include fire engines and aid cars which need to operate for extended periods of time in emergency operations with little or no opportunity to recharge their batteries. In addition, the odometer data may not provide an accurate measurement of energy consumption because much of the fuel consumed is used to power special equipment such as pumps, lights, radios, etc. To address the emissions reduction needs of such vehicles, detailed planning is typically required for both vehicle replacement and charging infrastructure installation.
- **Collect and use data to inform planning decisions:** Vehicle replacement plans should be informed by quality data. Therefore as discussed in the previous section, fleet managers should employ GPS and fleet management software to track vehicle usage actively and accurately (e.g., daily VMT, time of day use, O&M costs, etc.) to better understand the usage of the fleet to inform future planning decisions.
- **Purchase EVs to meet realistic range:** The majority of City fleet vehicles drive relatively few miles per day, therefore EV driving range is unlikely to be a concern. For most fleet vehicles, the City should purchase EVs with smaller batteries (if a choice is available for any given model) to reduce expenditure. Of course for mission-critical vehicles (such as

police pursuit vehicles, etc.), where maximum range is essential, the City should consider buying EVs with larger batteries.

STAFF TRAINING

- **Train City fleet EV drivers in EV operations**: City employees authorized to operate City fleet EVs will require training in EV operations. This training needs to address monitoring EV battery state-of-charge and use of Level 2 charging at City fleet parking facilities including rotation of EVs between shared chargers based on schedule or battery state of charge. City fleet EV drivers will also need training on opportunity charging to familiarize them with the use of City-owned and public DCFC stations including payment procedures.
- **Train City fleet technicians in EV maintenance**: City fleet technicians will need training in maintenance of fleet EVs. Due to fewer moving parts and simpler propulsion systems, EVs generally need less maintenance, however since EVs are heavier, wheel bearings, suspension systems, and tires need to be checked and potentially replaced (or tires rotated) more frequently. Technicians will also likely need safety training prior to working on high voltage electrical components as well as on responding to battery fires.
- **Train City electricians on EV charger maintenance**: If Elk Grove opts to maintain its own chargers (rather than outsourcing this to a charging network or other third-party vendor), the City's electricians and IT technicians will need training on monitoring and repair of EV chargers. The most common problems are typically related to data transmission requiring the charger to be rebooted. Another common problem is vandalism and theft of charge cords, so electricians will need to be familiar with system diagnostics replacement of stolen or malfunctioning components.

CHARGING STRATEGY SELECTION

Most municipal fleets are comprised of a mix of light-, medium- and heavy-duty vehicles, the majority of which drive relatively few miles per day and therefore have relatively low energy requirements. In addition, most fleet vehicles are parked every night as well as on weekends at municipal fleet depots (domiciles), providing ample time for EV batteries to be charged even using relatively slow chargers. As a result, the majority of fleet vehicles could be charged using shared chargers as briefly explained below, alongside use of dedicated chargers for comparison. For more detailed discussion on each potential charging strategy, see Appendix A.

- **Use of dedicated chargers**: Dedicated charging is similar to how most EV owners charge their personal EV at home. Dedicated EV chargers are located at parking stalls that are assigned to a specific fleet EV, allowing the EV to be connected to the charger whenever it is not being driven. The use of dedicated chargers is typically the simplest method of charging because every EV gets plugged into its own assigned charger, typically every night. This allows the use of relatively slow chargers, including Level 1 and 2 chargers, and eliminates the need to track EV battery state of charge and ensures a full battery every morning before the vehicle is driven as long as the driver remembers to plug-in the EV after returning the vehicle to its assigned parking stall.

- **Use of shared chargers:** Unlike how EV owners charge their personal EVs, the large scale of fleet operations creates other needs and opportunities for EV charging. Because most EVs, especially newer models, have far greater battery capacity than is needed for a typical day's driving, they don't often need to be charged every night. Therefore, an alternative charging strategy is for multiple fleet EVs to share chargers by rotating them through the chargers on a scheduled or as-needed basis depending on each EV's state of charge which can range from every few nights to once or twice per month. The majority of shared chargers are typically Level 2 chargers at each fleet domicile supplemented by a small number of DCFC installed at main fleet facilities to provide flexibility and redundancy in case EV state of charge is insufficient or a charger is out of service. Due to the reduced number of chargers and electrical infrastructure supporting them, this alternative can be less costly in terms of reduced capital expenditure, depending on the domicile's available electrical capacity and other factors.
- **Use of load management:** Both in addition to or instead of sharing chargers among vehicles, load management can provide additional flexibility and a reduced peak power draw for municipal fleet charging. Modern hardware- and software-side load management platforms have the ability to distribute a given charger's power output among multiple plugged-in vehicles. These charging platforms can be programmed in custom ways allowing prioritization of certain vehicles.

CHARGING INFRASTRUCTURE

With respect to choosing the right charging infrastructure to fit the fleet's needs, there are many important decisions to make by municipal fleet and facilities managers. A few crucial ones are listed here.

- **Select mid to high output chargers when feasible:** The incremental cost differential between charger output is relatively small, so it makes economic sense to select more powerful chargers and supporting electrical infrastructure, as doing so will provide more flexibility in the future for EVs with larger batteries like medium and heavy-duty EVs.
- **Size electrical infrastructure upgrades to meet future charging needs:** Typically, the largest single cost component of charger installation is electrical "make-ready" infrastructure including electrical transformers, switchgear, panels, conduit, trenching, site restoration, etc. Therefore, Elk Grove should size infrastructure to provide extra

electrical capacity to meet the fleet's future needs in anticipation of electrification of heavy-duty vehicles once they become more available and cost-competitive.

PROJECT IMPLEMENTATION

- **Budget sufficient resources for projects:** Fleet electrification typically requires major capital investments. Along with the hard cost of purchasing EVs and chargers, additional investments include purchase of make-ready electrical infrastructure and charger installation consisting of associated materials and equipment for installation along with site restoration when trenching is required. Soft costs such as project design, permitting, utility fees and contingencies must also be budgeted for. Collectively, these costs greatly exceed the purchase price of the chargers themselves.
- **Engage your local utility early:** One of the longest lead items that most fleets have little control over is for the provision of electrical capacity to power chargers. It can take months just to engage a typical utility in the planning process plus many more months to procure critical electrical hardware such as transformers, making utility engagement the critical path on many projects. Elk Grove will benefit by engaging with SMUD as early as possible.
- **Implement project phasing strategically:** Recognizing that replacing the entire fleet with EVs will take over a decade, Elk Grove will need to be strategic in its fleet electrification investments. As previously noted, the most cost-effective fleet components to electrify first are light-duty vehicles for which suitable and cost-effective EV models can be acquired in the short term, especially for high-use vehicles. Implementation of charging infrastructure installation plans should be phased to utilize existing electrical capacity at each facility to power early phase EV purchases while funding and design for future phases is sought.
- **Leverage Low Carbon Fuel Standards as revenue source:** California's LCFS program empowers EV charging infrastructure owners to register credits from delivered electricity which upon monetization produce ongoing revenue through the transportation electrification transformation. The monetization of these environmental credits is through a commodity market for producers of carbon intensive transportation fossil fuels. While carbon pricing will fluctuate depending on the market supply and demand, the revenue from the sale of clean fuel credits can generate revenue for the City that will offset a portion of the costs of fleet electrification including electricity and EVSE operation and maintenance. As a fuel user, the City's fleet is eligible to register as an obligated party to generate and sell clean fuel credits for fuels the City purchases and uses that have a lower carbon intensity than the state standard. This includes electricity dispensed through

both public and fleet EV chargers. The revenue from those credits gets reinvested back into clean fuels and clean fleet vehicles by City departments.

- **Seek third party incentives:** Replacing existing ICE vehicles with EVs and installing charging infrastructure for a fleet as large as Elk Grove's requires major investment. Fortunately, there are currently ample funding opportunities for EVs and EV chargers, and these opportunities continue to grow rapidly. Covered expenses typically include the purchase or lease of EVs, the purchase and installation of charging infrastructure, and expenses for hydrogen fuel cell electric vehicles (FCEVs) and their refueling infrastructure. Funding programs typically have a fixed term and a limited allocation of funds. Incentive information on specific programs can change quickly and have application deadlines or are on a first come, first served basis requiring ongoing monitoring by the City of these opportunities. Incentive funding programs for transportation electrification are documented in detail in Appendix B of this report and summarized in Table 13 below:

TABLE 13: TRANSPORTATION ELECTRIFICATION FUNDING SUMMARY

SOURCE	PROGRAM NAME	RELATED PROGRAMS
FEDERAL PROGRAMS	NATIONAL ELECTRIC VEHICLE INFRASTRUCTURE (NEVI) PROGRAM	National Electric Vehicle Infrastructure Program (State Allocations) National Electric Vehicle Infrastructure Program (DOT Allocation)
	VOLKSWAGEN SETTLEMENT FUNDS	Volkswagen mitigation trust for California
STATE SPECIFIC CALIFORNIA PROGRAMS	LOW CARBON FUEL STANDARD (LCFS) CLEAN VEHICLE REBATE PROJECT (CVRP) HYBRID AND ZERO-EMISSION TRUCK AND BUS VOUCHER INCENTIVE PROJECT (HVIP) CALIFORNIA ELECTRIC VEHICLE INFRASTRUCTURE PROJECT (CALEVIP) CALEVIP 2.0 PROJECT: GOLDEN STATE PRIORITY PROJECT (GSPP) COMMUNITIES IN CHARGE CEC GFO-23-606: CHARGING INFRASTRUCTURE FOR GOVERNMENT FLEETS	
LOCAL AND REGIONAL PROGRAMS	SACRAMENTO METROPOLITAN AIR QUALITY MANAGEMENT DISTRICT (SMAQMD) SACRAMENTO MUNICIPAL UTILITY DISTRICT (SMUD)	SMUD INCENTIVE PROGRAMS –EVSE Rebates -Fleet Rebates

FUTURE PROOFING

- **Keep fleet electrification plans up-to-date:** The electromobility industry is and will likely continue to be in a rapid state of change. Therefore, the implementation actions emerging from Elk Grove's fleet electrification planning should be reviewed and updated every year or two. This will ensure the City stays abreast of rapid developments in the EV market, battery and charging technology changes, and is able to leverage new grants, rebates, and other financial incentive opportunities.

- **Adapt to new technology:** Being open to exploring new ideas and technologies will allow fleets to capitalize on future opportunities that could revolutionize transportation. For example, bidirectional charging will allow fleets to leverage the energy storage capacity of their combined batteries to provide charging resiliency to mission-critical fleet EVs, reduce demand charges, power buildings during power outages, mitigate power demand spikes and generate grid services revenues by selling power back to the grid. Inductive and robotic charging will make charging easier for drivers and eventually power autonomous vehicles. Dynamic inductive charging will eliminate the need for EVs to be parked while charging, allowing EV fleets to maintain state of charge while driving.

While some of such technologies are years out to reach full product maturity and adoption on a larger scale, however they have the potential to significantly change the EVSE landscape and should be followed.

APPENDICES

CONTENTS

APPENDIX A: FACILITY-LEVEL ANALYSES AND RECOMMENDATIONS

APPENDIX A: INTRODUCTION

This appendix details the analysis conducted on the existing fleet assets and facility conditions at each of the studied locations as well as the facility-specific recommendations that include the numbers and types of charging stations, estimated project costs and phasing. It includes each facility's existing access, parking configuration, and electrical service at the six municipal fleet domicile facilities, some of which also include existing public charging or are planned for installation of public EV chargers. It also addresses these conditions at three City non-fleet facilities suitable for installation of public EV charging. These include the following:

FACILITIES ASSESSED IN THIS STUDY

CITY FLEET FACILITIES

- Animal Shelter, 9150 Union Park Way*
- City Hall, 8401 Laguna Palms Way*
- Corp Yard, 10250 Iron Rock Way
- Fleet Facility, 10190 Iron Rock Way
- Laguna Palms Campus: 8380 Laguna Palms Way, 8400 Laguna Palms Way & 9362 Studio Court*
- Special Waste Collection Center, 9255 Disposal Lane*

* with public charging

NON-FLEET PUBLIC CHARGING FACILITIES

- Existing Elk Grove Library, 8900 Elk Grove Blvd
- Old Town Plaza, 9615 Railroad St
- District 56, 8230 Civic Center Drive

EXISTING TRANSFORMER CAPACITY

The existing electrical infrastructure provided by SMUD is presented in the table below, which includes information on transformer size, available capacity, and meter numbers per site:

TABLE 14: EXISTING TRANSFORMER SIZE AND CAPACITY PER SITE

FACILITY NAME	FACILITY ADDRESS	METER NUMBER	EXISTING TRANSFORMER NUMBER	EXISTING TRANSFORMER SIZE (KVA)	AVAILABLE CAPACITY (KVA)	PROPOSED CONNECTED LOAD (KVA)
ANIMAL SHELTER	9150 UNION PARK WAY	2728283	TX-02017910	300	124.81	47
CITY HALL	8401 LAGUNA PALMS WAY	2517905	TX-02000041	500	267.00	129
CORP YARD	10250 IRON ROCK WAY	2515348	TX-01030487	300	218.81	198
FLEET FACILITY	10190 IRON ROCK WAY	2515349	TX-02006531	75	22.77	1,565
LAGUNA PALMS CAMPUS	8380 LAGUNA PALMS WAY	2517902	TX-01030786	300	153.81	1,395
	8400 LAGUNA PALMS WAY	2518506, 2518055	TX-01032877	300	93.68	
	9362 STUDIO CT	2518054	TX-02022754	150	112.41	
SPECIAL WASTE COLLECTION CENTER	9255 DISPOSAL LN	2727313, 2654014	TX-02012476	150	128.69	25
EXISTING ELK GROVE LIBRARY	8900 ELK GROVE BLVD	MULTIPLE	TX-02004686	150	44.49	90
OLD TOWN PLAZA	9615 RAILROAD ST	-	-	-	-	227
DISTRICT 56	8230 CIVIC CENTER DR	2728136, 626988	TX-02017807	500	353.39	0

SUMMARY OF RECOMMENDATIONS

The quantity of recommended *fleet* chargers by location are summarized in Table 15.

TABLE 15: RECOMMENDED FLEET CHARGERS BY FACILITY

FACILITY	# OF DUAL HEAD LOW OUTPUT LEVEL 2 CHARGERS (6.6-7.7 KW)	# OF DUAL HEAD MEDIUM OUTPUT LEVEL 2 CHARGERS (UPTO 12.0 KW)	# OF DUAL HEAD HIGH OUTPUT LEVEL 2 CHARGERS (UPTO 19.2 KW)	# OF SUPPLEMENTAL DUAL HEAD DCFC CHARGERS (150 KW)
ANIMAL SHELTER	1			
CITY HALL	4	1		
CORP YARD	12			
FLEET FACILITY	38			5
LAGUNA PALMS CAMPUS	1	20	7	2
SWCC	1			
TOTAL CHARGERS	**57**	**21**	**7**	**7**
TOTAL CHARGE PORTS	**114**	**42**	**14**	**14**

The quantity of recommended *public* chargers by location is summarized in Table 16. Four fleet facilities accessible to the public, the Animal Shelter, City Hall, Laguna Palms Campus, and the SWCC, are recommended for a total of five dual-head (10 charge ports) and one single-head Level 2 charger of various outputs. In addition, a total of 11 dual-head (22 charge ports) and five single-head Level 2 chargers are recommended to be installed at the existing library and Old Town Plaza. Additionally, a new City library is already in design which will have charging facilities.

TABLE 16: RECOMMENDED PUBLIC CHARGERS BY FACILITY

FACILITY	# OF SINGLE HEAD LOW OUTPUT LEVEL 2 CHARGERS (6.6-7.7 KW)	# OF DUAL HEAD LOW OUTPUT LEVEL 2 CHARGERS (6.6-7.7 KW)	# OF SINGLE HEAD MEDIUM OUTPUT LEVEL 2 CHARGERS (UPTO 12.0 KW)	# OF DUAL HEAD MEDIUM OUTPUT LEVEL 2 CHARGERS (UPTO 12.0 KW)
ANIMAL SHELTER				**1**

CITY HALL		**2**		
LAGUNA PALMS CAMPUS				**2**
SWCC	**1**			
EXISTING ELK GROVE LIBRARY				**3**
OLD TOWN PLAZA	**3**	**5**	**2**	**3**
TOTAL CHARGERS	**4**	**7**	**2**	**9**
TOTAL CHARGE PORTS	**4**	**14**	**2**	**18**

CITY FLEET FACILITIES

Each of Elk Grove's fleet facilities is described below including a summary of the facility's existing access, parking configuration, and electrical service. The analysis also provides the recommendations for fleet EV charging at each facility, documenting required electrical service upgrades, charger quantities and types, implementation phasing, and planning-level cost estimates. For City Hall, SWCC, the Animal Shelter and the Laguna Palms Campus, this information is also provided for proposed public chargers co-located at each facility.

The figure concluding each facility-specific subsection graphically illustrates how charger deployment for fleet, staff and public use should be phased at each City-owned facility. Fleet vehicle replacement by EVs is shown in gray while EV chargers to be installed in each phase are shown in orange.

In addition, a recommendations summary sheet including existing conditions and proposed charging recommendations with conceptual charger locations is included for each fleet facility and public charging site.

ANIMAL SHELTER, 9150 UNION PARK WAY

Description: The Animal Shelter is the home of Animal Services and is a City workplace accessed by citizens during business hours seeking pet-related services.

Municipal Fleet Electrification: A total of six light-duty ICE vehicles need to be replaced by comparable class EVs.

Energy Requirements: The daily required electrical load from fleet EV charging of 50.4 kWh was calculated by comparing the existing vehicle duty cycle with the replacement EV battery range. These vehicles have between 14 and 16 hours of nightly dwell time for charging. The maximum electrical load from the EV chargers is 46.5 kVA.

Existing Parking and Access: The Animal Shelter site has two separate parking lots, one for fleet and the other for staff/public use. The public parking lot is on the west side of the facility, with entry from Union Park Way. The fleet parking area is in a gated area to the southeast of the facility, with entry from Iron Rock Way. A total of six City fleet vehicles park here, all of which are scheduled to be replaced by EVs.

Existing Electrical Service: The electrical room is located on the south side of the building accessed from an exterior entrance door. SMUD's transformer is located in the west side parking area on the south side close to the ADA stalls. It is rated at 150 kVA and has available capacity of 124.81 kVA @ 480V, if the chargers were to be installed directly from the transformer. This transformer as well as panels "LA", "SHA" and "SLC" have more than enough electrical capacity and breaker spaces to power two dual head L2 chargers for fleet and public use in a single installation phase. Two EV-capable spaces are available in the public parking lot.

Existing Infrastructure System: There is an existing spare 1.5-inch conduit that runs from panel "LA" to the existing pull box in the public parking lot on the west side of the facility within the landscaping strip, coinciding with the location of the existing utility transformer. From this existing pull box, two 1.25-inch spare conduits have been stubbed up for the future installation of EV chargers. One of these two stubbed-up 1.25-inch conduits is situated in front of the ADA stalls, behind the sidewalk, while the second 1.25-inch conduit is stubbed up within the adjacent non-ADA stalls. Furthermore, aside from the spare conduits, a 40 Amp 2-pole breaker has been installed in panel "LA" for the purpose of accommodating EV chargers.

Fleet EV Charger Recommendations: A single dual-head (2 charge ports) low-output pedestal-mounted Level 2 charger is needed for fleet use. This should be installed between two parking stalls in the gated parking area southeast of the Animal Shelter building.

Fleet EV Charger Implementation Phasing: Because sufficient power is available, this charger could be installed in Phase 1.

Public EV Charger Recommendations: One dual-head (2 charge ports) medium-output pedestal-mounted Level 2 charger is recommended for public use in the southwest corner of the public parking lot where ADA stalls are located. One charger head would be for an ADA-accessible stall, and one would be for a standard EV charging stall. It is recommended to utilize the existing infrastructure noted in Chapter 3.

Public EV Charger Implementation Phasing: Because sufficient power is available, this charger could be installed in phase one.

Estimated Project Costs: The estimated planning level cost of two new installed dual-head Level 2 chargers for both fleet and public use will be approximately $88,640. Of this total, $61,260 is for fleet charging and the remaining $27,380 is for public charging.

Locations of proposed EV chargers are shown below on Figure 15.

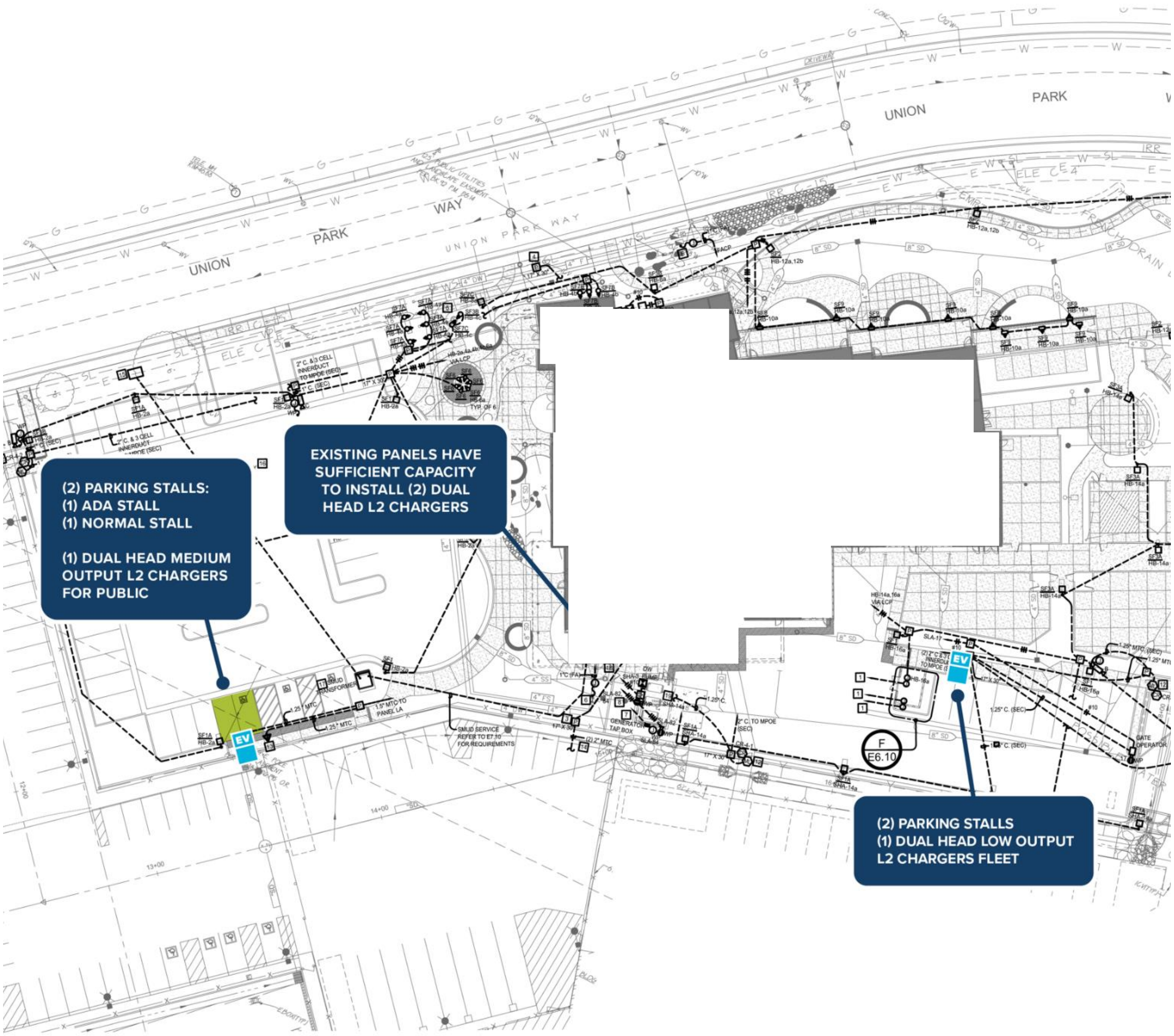


FIGURE 15: CONCEPTUAL CHARGER LAYOUT OF ANIMAL SHELTER ON UNION PARK WAY

Charging Infrastructure Installation Phasing and Costs: One dual-head low-output pedestal-mounted charger is recommended for shared use among six fleet EVs and one dual-head medium-output pedestal-mounted charger is recommended for public use. The total capital costs to purchase and install these chargers are estimated to cost $61,260 for fleet and $27,380 for public, respectively. Existing electrical infrastructure has sufficient capacity to power these so there is no need to phase implementation.

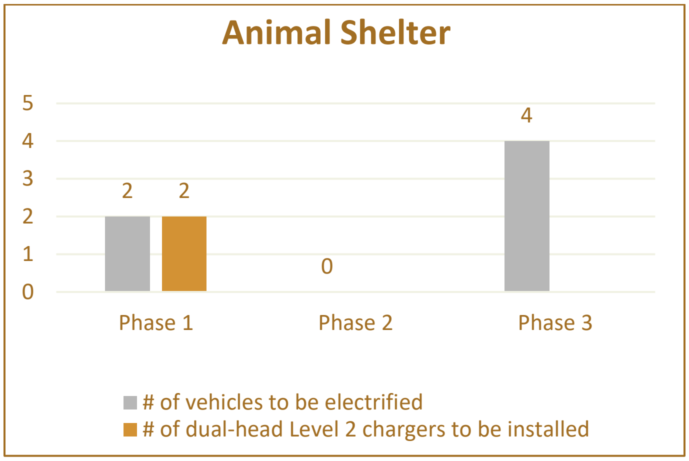


FIGURE 16: FLEET VEHICLE ELECTRIFICATION AND EV CHARGING INFRASTRUCTURE DEPLOYMENT BY IMPLEMENTATION PHASE AT ANIMAL SHELTER

ANIMAL SHELTER

EXISTING CONDITIONS

ADDRESS

9150 Union Park Way, Elk Grove, CA

SITE DESCRIPTION

The site has 2 separate parking areas for fleet and public. The public parking is on the west side of the facility, with entry from Union Park Way. The fleet parking area is in the gated area to the Southeast of the facility, with entry from Iron Rock Way.

ELECTRICAL CAPACITY

The existing transformer that feeds the entire site is in the south side of the public parking area near ADA stalls. According to Sacramento Municipal Utility District (SMUD), the existing transformer has 128.7 kVA of available capacity, and there are multiple electrical panels in the electrical room with available capacity and free breaker spaces to accommodate the proposed electrical loads.

LOCATION OF POWER SUPPLY

The electrical room is located in the Southwest corner of the building.

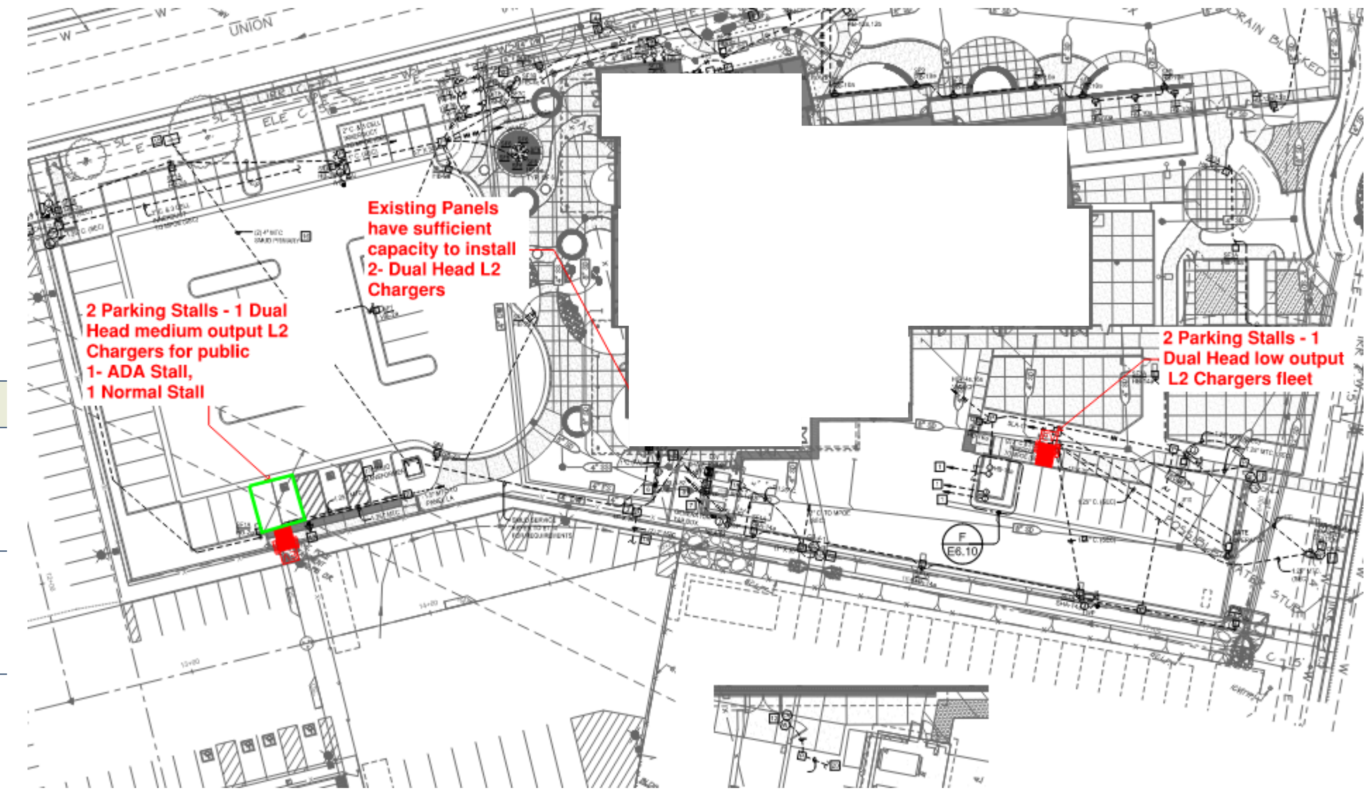
ANALYSIS

A total of 6 light duty ICE vehicles need to be replaced by comparable class EVs. The daily required EV energy was calculated by comparing existing vehicle duty cycle with replacement EV battery range. The vehicles have a minimum of 14 hours and maximum of 16 hours dwell time.

REQUIRED ELECTRICAL LOAD AND COSTS PER CHARGING SCENARIO

CHARGING SCENARIO	ELECTRIC LOAD	COST
SHARED L2 (FLEET) – PHASE 1 CONSTRUCTION	46.5 kVA	$61,260
SHARED L2 (PUBLIC) – PHASE 1 CONSTRUCTION		$27,380

Note: Phase 1 construction timeline is 2023-2028



DESIGN RECOMMENDATIONS

POWER

The proposed chargers can be powered from the existing panels in the electrical room. Panels “LA”, “SHA” and “SLC: have sufficient capacity to install all the proposed chargers. Additionally, panels “LA S2”, “LB S1”, “LB S2”, “SLA S2”, and “HB” can accommodate 1 EV charger each. Conduit and wiring will be trenched from the electrical room to the lot on the West side. There is an existing 1.5” spare conduit that runs from panel “LA” to the existing pull box in the public parking lot. From this pull box, a spare 1.25” conduit stubbed up near the parking stalls can be used for EV Charger installations.

COMMUNICATION

The vehicles park in open parking lot which has good cellular reception. There is no constraint in connecting smart chargers using cellular reception.

CHARGING EQUIPMENT

The following quantities of smart L2 chargers are recommended:

1 x Dual-head medium output pedestal mounted chargers for public use

1 x Dual-head low output pedestal mounted chargers for fleet use

CHARGING STALL LOCATIONS

A total of 4 parking stalls to be equipped with EV chargers.

1 Low output dual head L2 charger for fleet vehicles will be installed at the gated parking area to the SE of the facility.

1 medium output dual head L2 charger for public charging will be installed in the West side parking lot, where ADA stalls are located. One charger head will be for ADA stall and one will be for standard stall.

See site diagram above.

LIGHTING

There are existing light poles that provide sufficient illumination to the parking lot.

SECURITY AND ACCESS

Safety is a concern at this location. Consider installation of a wall mounted CCTV camera for public chargers.

CONDUIT INSTALLATION APPROACH

Wall and ceiling-mounted conduit from electrical room, and trenched conduit installation between electrical service and chargers required.

Core drilling through the walls may be required.

CHALLENGES AND RISKS

CHALLENGES / RISKS	DESCRIPTION
ELECTRICAL	Multiple existing panels with capacity – confirm most suitable panel to draw power for chargers.
CIVIL/ STRUCTURAL	Directional drilling/ expensive trenching (and restoration) required for charger’s location proposed fleet use.
OPERATIONAL	Fleet versus customer parking
OTHERS	See “Security and Access”

CITY HALL, 8401 LAGUNA PALMS

Description: City Hall is the City's main office building, and an important destination for City employees and visitors. The City Hall building is surrounded by surface parking on all four sides with no dedicated parking for fleet, staff, or public vehicles. Currently, there is one dual-head Level 2 chargers (2 charge ports) located on the south side of the building. It is free to charge for anyone between the hours of 7am – 9pm Monday through Friday.

Municipal Fleet Electrification: A total of eleven light-duty ICE vehicles need to be replaced by comparable class EVs.

Energy Requirements: The daily required electrical load from fleet EV charging of 70.8 kWh was calculated by comparing the existing vehicle duty cycle with the replacement EV battery range. These vehicles have between fourteen and sixteen hours of nightly dwell time for charging. The maximum electrical load from the EV chargers is 129.0 kVA.

Existing Parking and Access: The primary access to this parking lot is via Laguna Palms Way. A total of eleven City fleet vehicles park here, all of which are scheduled to be replaced by EVs.

Existing Electrical Service: The electrical room is located inside the building on the northeast side. The main electrical service is 800 Amps @ 480 V, 3 phase power. The existing transformer that feeds the entire site is on the east side of the building. According to SMUD, the existing 500 kVA-rated transformer has 267.0 kVA of available capacity. Additionally, there are multiple electrical panels in the electrical room with available capacity and free breaker spaces to accommodate electrical loads to be generated by the proposed EV chargers for use by public, staff, and City fleet EVs.

Fleet EV Charger Recommendations: To power the eleven fleet EVs, a total of ten parking stalls will need to be equipped with five dual-head EV chargers (10 charge ports) to be installed on the north side of the building. To meet the fleet's projected energy requirements, these will consist of four low-output (6.6 kW) and one medium-output (12 kW) charger.

Fleet EV Charger Implementation Phasing: Sufficient power is available to support the installation of two dual-head low-output Level 2 chargers in Phase 1 and two additional dual-head low-output Level 2 chargers and one dual-head medium-output Level 2 charger in Phase 3 of the project.

Public EV Charger Recommendations: The existing dual-head Level 2 chargers on the south side of the building should be replaced by two dual-head Level 2 chargers (4 charge ports) for staff and public use. The two dual-head Level 2 chargers will serve three non-ADA and one ADA stall. The 2-40A circuit that currently feeds each existing charger could be shared by both proposed dual-head Level 2 chargers and wiring could be installed in the existing conduits from the electrical panel to the outside of the building.

Parking and Access Recommendations: It is recommended that a secured parking area be established around the fleet chargers due to their location at the rear of City Hall, where incidents of vandalism involving fleet vehicles have been reported.

Electrical Service Recommendations: The addition of a solar canopy to the north parking lot as a means to offset a portion of the electrical loads sourced from the grid is recommended.

Public EV Charger Implementation Phasing: Because existing electrical infrastructure is in place, the existing Level 2 charger could be removed and replaced by a pair of dual-head Level 2 chargers in phase one.

Estimated Project Costs: Installing the recommended charging ports for fleet EVs is estimated to cost a total of $185,800. Replacing both existing chargers is estimated to cost $48,740 for public use. The combined planning level estimated cost of fleet and public chargers will total $234,540 for this site.

Locations of proposed EV chargers are shown below on Figure 13.

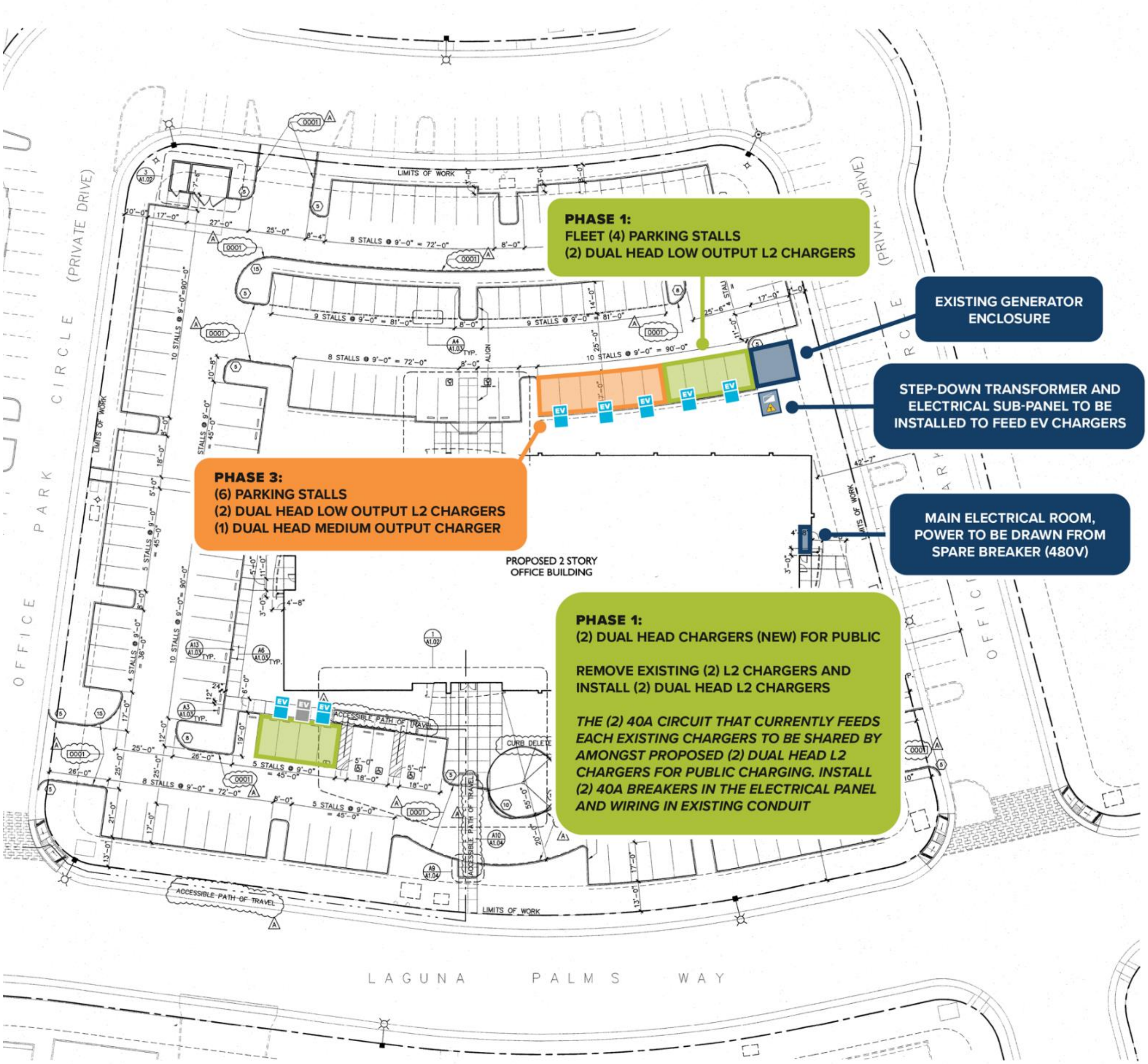


FIGURE 17: CONCEPTUAL LAYOUT OF CITY HALL

Charging Infrastructure Installation Phasing and Costs: A total of four dual-head low-output pedestal mounted chargers and one dual-head medium-output pedestal mounted charger for dedicated use by eleven fleet vehicles is needed along with electrical conduit stub outs for future charger installation at the back side of the City Hall. Additionally, two dual-head low-output pedestal-mounted chargers are proposed for public use. The public chargers should be installed along with two dual-head fleet chargers in Phase 1 at a total cost of $135,820 for fleet and $48,740 for public respectively. The remaining dual-head fleet chargers could be installed in

Phase 3 at an estimated cost of $49,980. The timeline for Phase 1 construction is 2024-2028, and 2034-2035 for Phase 3 construction.

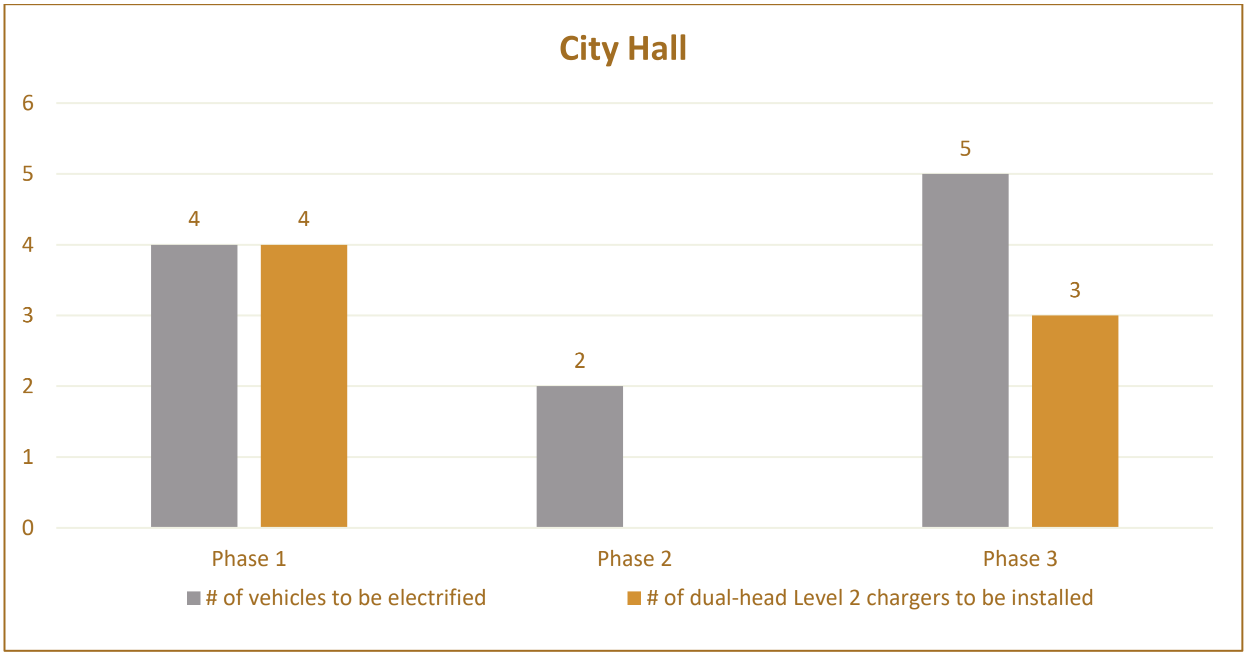


FIGURE 18: FLEET VEHICLE ELECTRIFICATION AND EV CHARGING INFRASTRUCTURE DEPLOYMENT BY IMPLEMENTATION PHASE AT CITY HALL

CITY HALL

EXISTING CONDITIONS

ADDRESS

8401 Laguna Palms, Elk Grove

SITE DESCRIPTION

The site has open parking spaces all four sides of the building with no parking specifically designated for fleet or public use.

ELECTRICAL CAPACITY

The existing 500 kVA transformer that feeds the entire site is on the north side of the building. According to SMUD, it has 267.0 kVA of available capacity, and there are multiple electrical panels in the electrical room with available capacity and free breaker spaces to accommodate the proposed electrical loads.

LOCATION OF POWER SUPPLY

Electrical room is located inside the building on the northeast side.

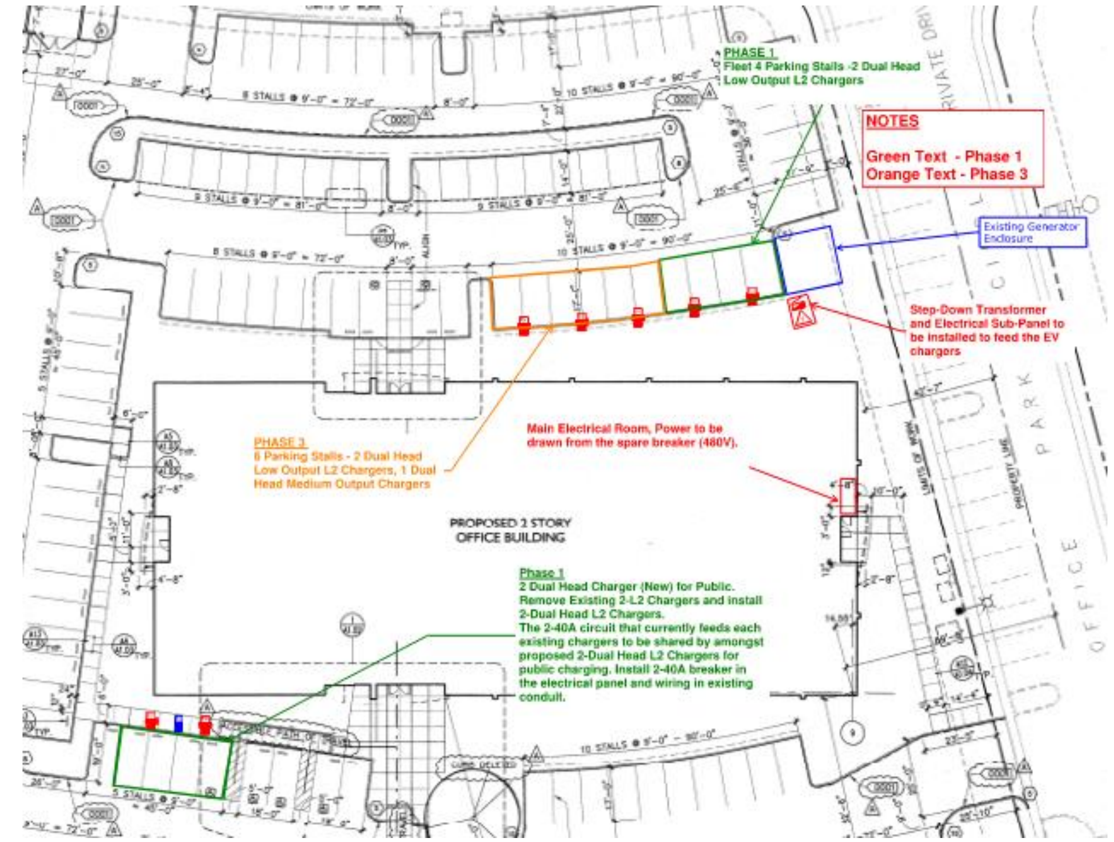
ANALYSIS

A total of 11 light duty ICE vehicles need to be replaced by comparable class EVs. The daily required EV energy was calculated by comparing existing vehicle duty cycle with replacement EV battery range. These vehicles have between 14 and 16 hours of nightly dwell time for charging.

REQUIRED ELECTRICAL LOAD AND COSTS PER CHARGING SCENARIO

CHARGING SCENARIO	ELECTRIC LOAD	COST
SHARED L2 (FLEET) – PHASE 1 CONSTRUCTION	129.0 kVA	$135,820
SHARED L2 (PUBLIC) – PHASE 1 CONSTRUCTION		$48,740
SHARED L2 (FLEET) – PHASE 3 CONSTRUCTION		$49,980

Note: Phase 1 construction timeline is 2023-2028, and Phase 3 construction timeline is 2034-2035



DESIGN RECOMMENDATIONS

POWER

The proposed fleet chargers can be powered from the existing panels in the electrical room. There are 4-100 spares available operating 480V within the electrical room. A new stand-alone step-down transformer and new electrical cabinet needs to be installed outside on the north side of the building to be fed from the spares available in the electrical room. The proposed fleet chargers to be fed from the new electrical cabinet. Conduit and wiring will be trenched from the electrical room to the north side of the building to power the electrical cabinet and from electrical cabinet to the chargers.

The existing two level 2 chargers to be replaced with two dual-head level 2 chargers for public use on the south side of the building. The two dual-head level 2 chargers will serve three non-ADA and one ADA stall. Wiring to be installed in existing conduits from the electrical panel to outside of the building.

The solar canopies are to be evaluated at this site.

COMMUNICATION

CHARGING EQUIPMENT

The following smart L2 chargers are recommended:

4 x Dual-head low output pedestal mounted chargers for fleet use

1 x Dual-head medium output pedestal mounted chargers for fleet use

2 x Dual-head low output pedestal mounted chargers for public use

CHARGING STALL LOCATIONS

A total of 14 parking stalls to be equipped with EV chargers. 4 low output and 1 medium output dual head L2 chargers to be installed in the north side of the building for fleet use.

2 low output dual head L2 chargers to be installed on the south side of the building for public use.

LIGHTING

There are existing light poles that provide sufficient illumination to the parking lot.

SECURITY AND ACCESS

Safety is a concern at this location. Consider installation of a wall mounted CCTV camera and panic button for public chargers.

A secured area is recommended on the north side of the building for fleet and staff use only.

CONDUIT INSTALLATION APPROACH

Wall mounted conduit from electrical room, and trenched conduit installation between electrical room to a new electrical cabinet and from new electrical cabinet to the chargers will be required.

CHALLENGES AND RISKS

CHALLENGES / RISKS	DESCRIPTION
ELECTRICAL	Secure and aesthetically acceptable location for the service cabinet.
CIVIL/ STRUCTURAL	None
OPERATIONAL	Fleet versus customer parking/charging
OTHERS	See “Security and Access”

CORP YARD, 10250 IRON ROCK WAY

Description: This facility comprises a single-story indoor parking area that presently accommodates a number of light-duty fleet vehicles assigned to the Police Department, though these vehicles Are planned to be relocated to the Laguna Palms campus by the end of 2024. Additionally, there is an outdoor parking lot situated on the north and east side of the building, designated for the Public Works Department's fleet vehicles and staff. A small parking lot located on the west side of the building is designated for staff parking purposes. It's important to note that there is no provision for public parking on the premises. Of the current 19 Public Works Department fleet vehicles domiciled at this location, 16 are designated to be replaced by EVs.

Municipal Fleet Electrification: Among the 19 light-duty ICE vehicles housed at this location within the Public Works department, there is a need to replace 16 of them with EVs of similar class. Within the confines of this site, there are a total of 29 vehicles under the jurisdiction of the Police Department, which includes motorcycles. Among these, 18 vehicles must be exchanged for comparable class EVs.

Regarding the 18 Police Department vehicles slated for replacement, 17 of them will be relocated to the Laguna Palms Campus, and one vehicle will remain stationed at this site. In sum, the total count of vehicles to be substituted with comparable class EVs on-site will amount to 17.

Energy Requirements: The daily required electrical load from fleet EV charging of 180.0 kWh was calculated by comparing existing vehicle duty cycle with replacement EV battery range. These vehicles have up to 14 hours of nightly dwell time for charging. The maximum electrical load from the EV chargers is 198.0 kVA.

Existing Parking and Access: Fleet vehicles gain access to this site through gated entrances at both Iron Rock Way and Elmont Way. Presently, Police fleet vehicles are stationed inside the building within the parking stalls situated on the south side. Meanwhile, Public Works fleet vehicles are parked on the eastern side of the building, facing Iron Rock Way.

Existing Electrical Service: The existing transformer is located on the southeast side of the site, outside of the compound. Chargers are to be powered from the transformer directly via a new electrical cabinet.

Electrical Service Recommendations: According to SMUD, the existing transformer has a total available electrical capacity of 218 kVA which could accommodate the proposed added EV charging loads at this facility. A new service connection will be needed from the existing SMUD transformer located on the southeast side of the site, outside of the compound. The EV chargers should be powered from this transformer directly via a new electrical cabinet. A ground pad-mounted electrical cabinet should be installed in the landscaped area near the parking stalls to house the electrical service panel.

Fleet EV Charger Recommendations: A total of 12 dedicated dual-head 6.6 kW smart pedestal-mounted Level 2 chargers are recommended for this fleet (24 charge ports). These 12 should be located at the fleet parking lot on the east side of the building facing Iron Rock Way. As additional non-light-duty and offroad equipment are electrified at this site in the future, the suitable quantity and types of chargers will need to be reevaluated.

There are three options for powering the chargers at this site. The first option would be to replace both existing 240V receptacles with dual-head low-output Level 2 chargers with power shared between them. The second option would be to feed power for new Level 2 chargers from the electrical cabinet that will be installed for the chargers outside for the Public Works fleet. Both options would use the existing 120V wall outlets for charging up to eight EVs using Level 1 charging. The third option would be shared use of the Level 2 chargers that will be installed in the outdoor parking lot on the north and east side of the facility serving the Public Works Department’s fleet vehicles and staff. The existing 120V wall outlets can be used inside the facility for charging up to eight EVs using Level 1 charging.

Fleet EV Charger Implementation Phasing: The EV chargers would be installed in phases one and two and all electrical infrastructure should be installed in phase one. Using the new electrical cabinet which will be fed from the existing SMUD transformer, six dual-head low output Level 2 chargers will be installed in phase one and six dual-head low output Level 2 chargers will be installed in phase two.

Estimated Project Costs: The estimated planning level cost of twelve new installed Level 2 chargers will be approximately $337,400.

Locations of proposed EV chargers are shown below in Figure 19.

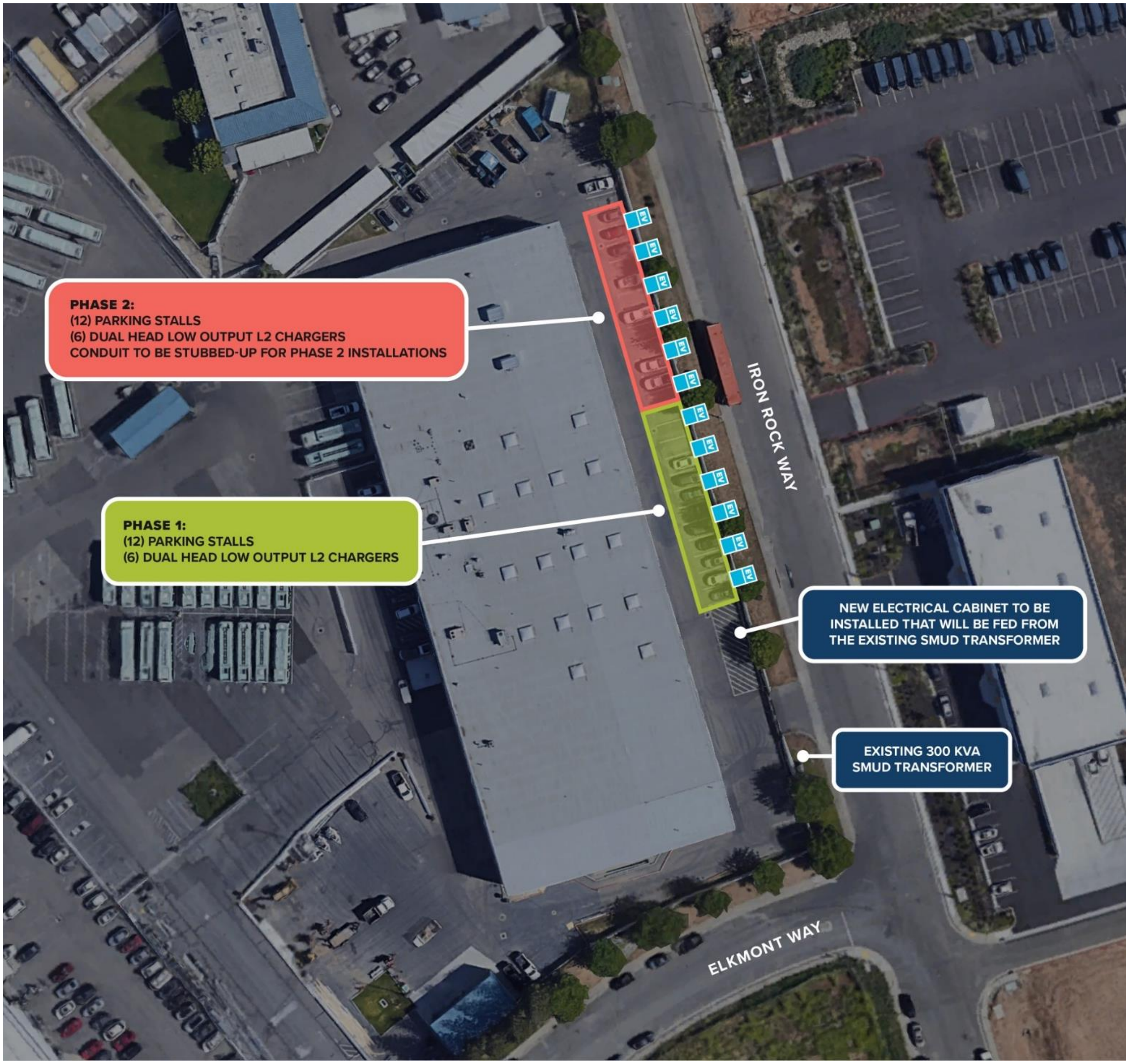


FIGURE 19: CONCEPTUAL CHARGER LAYOUT OF PUBLIC WORKS CORP YARD

Charging Infrastructure Installation Phasing and Costs: Of the 19 Public Works light duty ICE vehicles that domicile at this site, 16 vehicles need to be replaced by comparable class EVs. Of the 29 Police Department vehicles including motorcycles domicile inside at this site, 18 vehicles need to be replaced by comparable class EVs. Regarding the 18 Police Department vehicles slated for replacement, 17 of them will be relocated to the Laguna Palms Campus, and one vehicle will remain stationed at this site. In sum, the total count of vehicles to be substituted with comparable class EVs on-site will amount to 17.

To accommodate the 17 fleet EVs domiciled here, 12 dual-head low-output (6.6 kW) smart Level 2 pedestal mounted chargers will need to be installed in two phases of construction. Phase 1 will consist of all electrical infrastructure upgrades, six dual-head low-output Level 2 chargers, and conduit stub-outs for Phase 2 installations, totaling $199,360 in estimated capital costs. The second phase of construction will install six dual-head low-output Level 2 chargers for a total cost of $138,040.

The Level 1 charging (120V outlets) for Police Department motorcycles available inside at this facility is expected to be sufficient in the near term for this transition.

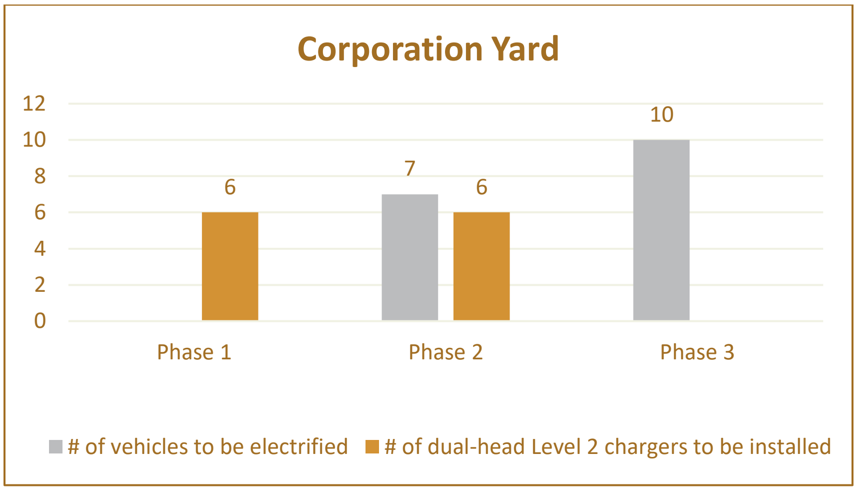


FIGURE 20: FLEET VEHICLE ELECTRIFICATION AND EV CHARGING INFRASTRUCTURE DEPLOYMENT BY IMPLEMENTATION PHASE AT CORP YARD

CORP YARD

EXISTING CONDITIONS

ADDRESS

10250 Iron Rock Way, Elk Grove, WA

SITE DESCRIPTION

Outdoor parking lot serving fleet vehicles for the public works department.

ELECTRICAL CAPACITY

According to SMUD, the existing transformer has total available electrical capacity of 218 kVA which can accommodate the proposed added EV charging loads at this facility.

LOCATION OF POWER SUPPLY

The existing transformer is located to the southeast side of the site, outside of the compound. Chargers are to be powered from the transformer directly via a new electrical cabinet.

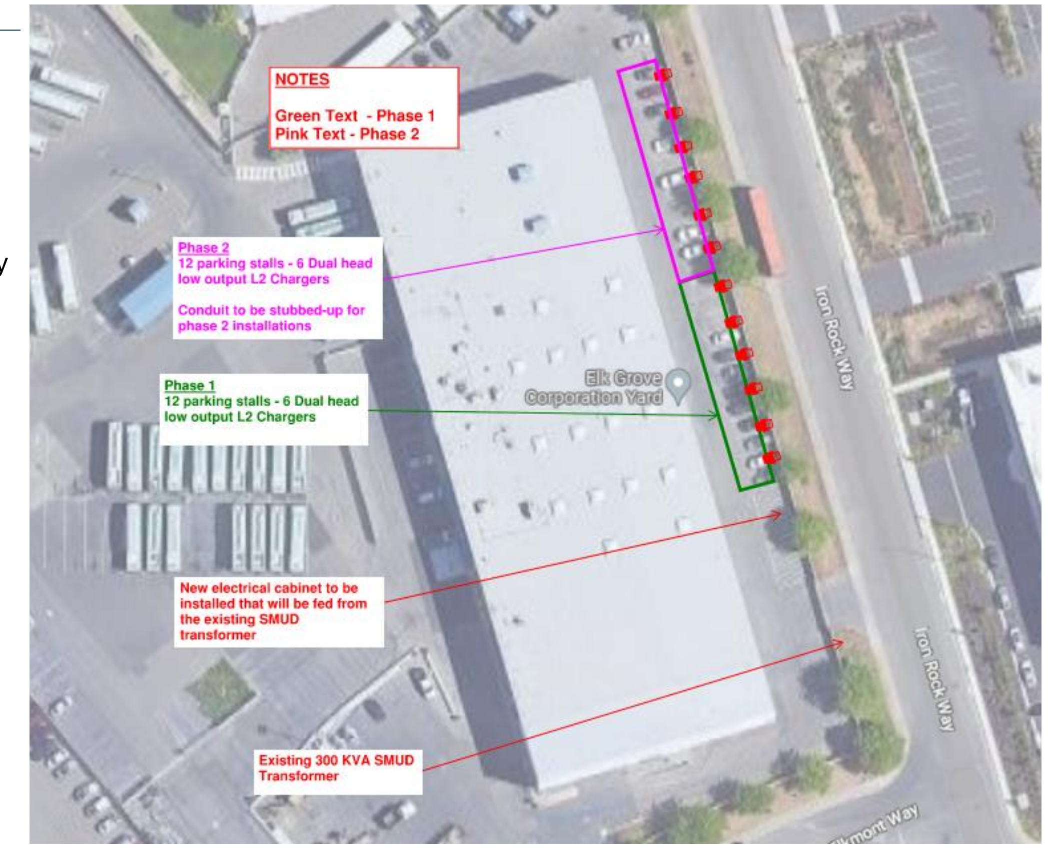
ANALYSIS

Among the 19 light-duty Internal Combustion Engine (ICE) Public Works department vehicles currently stationed at this site, 16 vehicles are slated for replacement with electric vehicles (EVs) of comparable class. The calculation of the daily EV energy requirements was performed by assessing the existing vehicle duty cycle in conjunction with the battery range of the replacement EVs. In addition to the 16 vehicles, 18 out of the 29 existing police vehicles located within the facility are earmarked for electrification, with 17 vehicles to be relocated to the Laguna Palms Campus, and only 1 will remain domiciled at this site. All of these vehicles will utilize the same Level 2 chargers, with a minimum dwell time of 14 hours and a maximum of 24 hours. In the case of the Public Works department, there are no vehicles slated for electrification in Phase 1, but 7 vehicles will undergo electrification in Phase 2, with an additional 9 vehicles slated for electrification in Phase 3 of the project. As for the Police department, 12 vehicles will be electrified in Phase 2, and 6 vehicles will undergo electrification in Phase 3 of the project.

REQUIRED ELECTRICAL LOAD / COSTS PER CHARGING SCENARIO

CHARGING SCENARIO	ELECTRIC LOAD	COST
SHARED L2 (FLEET) - PHASE 1 CONSTRUCTION	198.0 kVA	$199,360
SHARED L2 (FLEET) – PHASE 2 CONSTRUCTION		$138,040

Note: Phase 1 construction timeline is 2024-2028, Phase 2 construction timeline is 2029-2033



DESIGN RECOMMENDATIONS

POWER

Obtain new service connection from the existing SMUD transformer outside the building. A ground mounted electrical cabinet to be installed in landscaped area near the parking stalls to house the electrical service panel. All electrical infrastructure to be installed in Phase 2 of the project construction.

COMMUNICATION

The vehicles park in open parking lot which has good cellular reception. There is no constraint in connecting smart chargers using cellular reception.

CHARGING EQUIPMENT

The following quantities of 6.6 kW smart L2 chargers are recommended:

12 x Dual-head low output pedestal mounted chargers

The chargers will be installed in phases 1 and 2 of construction.

Phase 1: All electrical infrastructure, 6 dual-head low output L2 chargers, and conduit stub-outs for phase 2 installations.

Phase 2: 6 dual-head low output L2 chargers.

CHARGING STALL LOCATIONS

A total of 24 parking stalls to be equipped with EV chargers.

The 24 EV charging stalls will be located at the fleet parking lot on the East side of the building facing Iron Rock Way. See Diagram above.

LIGHTING

There are existing wall mounted fixtures on the cord yard building that may illuminate the parking area.

SECURITY AND ACCESS

Safety and security are not concerns at this site as it is a gated and access-controlled facility.

CONDUIT INSTALLATION APPROACH

Open trenching conduit installation required between existing transformer to new electrical cabinet, and from new electrical cabinet to the EV chargers.

Directional drilling under paved areas may be required.

CHALLENGES AND RISKS

CHALLENGES / RISKS	DESCRIPTION
ELECTRICAL	Not secure location for the new electrical cabinet.
CIVIL/ STRUCTURAL	Directional drilling or expensive trenching (and restoration) may be required for chargers.
OTHERS	Lighting Analysis to be conducted to review the existing light levels in the parking lot

FLEET FACILITY, 10190 IRON ROCK WAY

Description: The fleet facility is Elk Grove's main domicile for the City's Police fleet and will be its main charging location for Police EVs in the future. It consists of a large parking lot with fueling facilities, storage, and an administration building. This is a secure facility with no public access or parking. Parking is available for Police Officers' personal vehicles while they are driving patrol vehicles.

Municipal Fleet Electrification: A total of seventy-six light duty ICE vehicles need to be replaced by comparable class EVs.

Energy Requirements: The daily required electrical load from fleet EV charging of 996.9 kWh was calculated by comparing existing vehicle duty cycle with replacement EV battery range. These vehicles have between 14 and 16 hours of nightly dwell time for charging. The maximum electrical load from the EV chargers is 1,564.5 kVA.

Existing Parking and Access: The fleet vehicles access this site through a gated entrance off Iron Rock Way. Parking stalls are available on all sides of the building, except for a small area to the west. A total of seventy-six City fleet vehicles park here, all of which are scheduled to be replaced by EVs.

Existing Electrical Service: The electrical room is at the north side of the fleet facility building. According to SMUD, the existing transformer has a total available electrical capacity of 75 kVA; which cannot accommodate the proposed EV charger loads. Thus, utility upgrades and a new transformer are required at this facility. The new transformer is recommended to be installed during phase 1 of the project construction.

Additional Considerations: The facility has a 12,000-gallon fuel tank located on the southeast side of the parking lot. This could potentially serve as a significant battery storage area to enhance resiliency or provide backup power, given that the fuel tank will no longer be required once the existing gasoline vehicles are transitioned to EVs.

Electrical Service Recommendations: Utility upgrades and a new transformer are required at this facility. The electrical room is on the north side of the Fleet Facility building. The new transformer should be installed during phase one of the project construction as discussed below. There are two recommended options for the electrical upgrades: 1) upgrade the existing panel/transformer or 2) replace the existing electrical infrastructure and install a new transformer/electrical panel.

Fleet EV Charger Recommendations: 38 dual-head low-output Level 2 chargers (76 charge ports) should be shared between the 76 fleet EVs on a rotating basis. To ensure redundancy and flexibility for quick charging and for medium and heavy-duty EVs in the future, these should be supplemented by up to five dual-head 150 kW DC fast chargers (10 charge ports).

Fleet EV Charger Implementation Phasing: The installation of chargers will be separated into three phases, allowing time to replace existing fleet ICE vehicles with EVs and upgrade electrical system components and install EV chargers:

> **Phase 1**: All electrical infrastructure, 21 dual-head low output Level 2 chargers, conduit stub-outs for Phase 2 and Phase 3 infrastructure installation, and three dual-head DC fast chargers,
>
> **Phase 2**: 12 dual-head low output Level 2 chargers
>
> **Phase 3**: Five dual-head low output L2 chargers and two dual-head DC fast chargers.

Estimated Project Costs: The estimated planning level cost of 38 installed Level 2 and five DC fast chargers would total approximately $2,237,240.

Locations of proposed EV chargers are shown below on Figure 21.

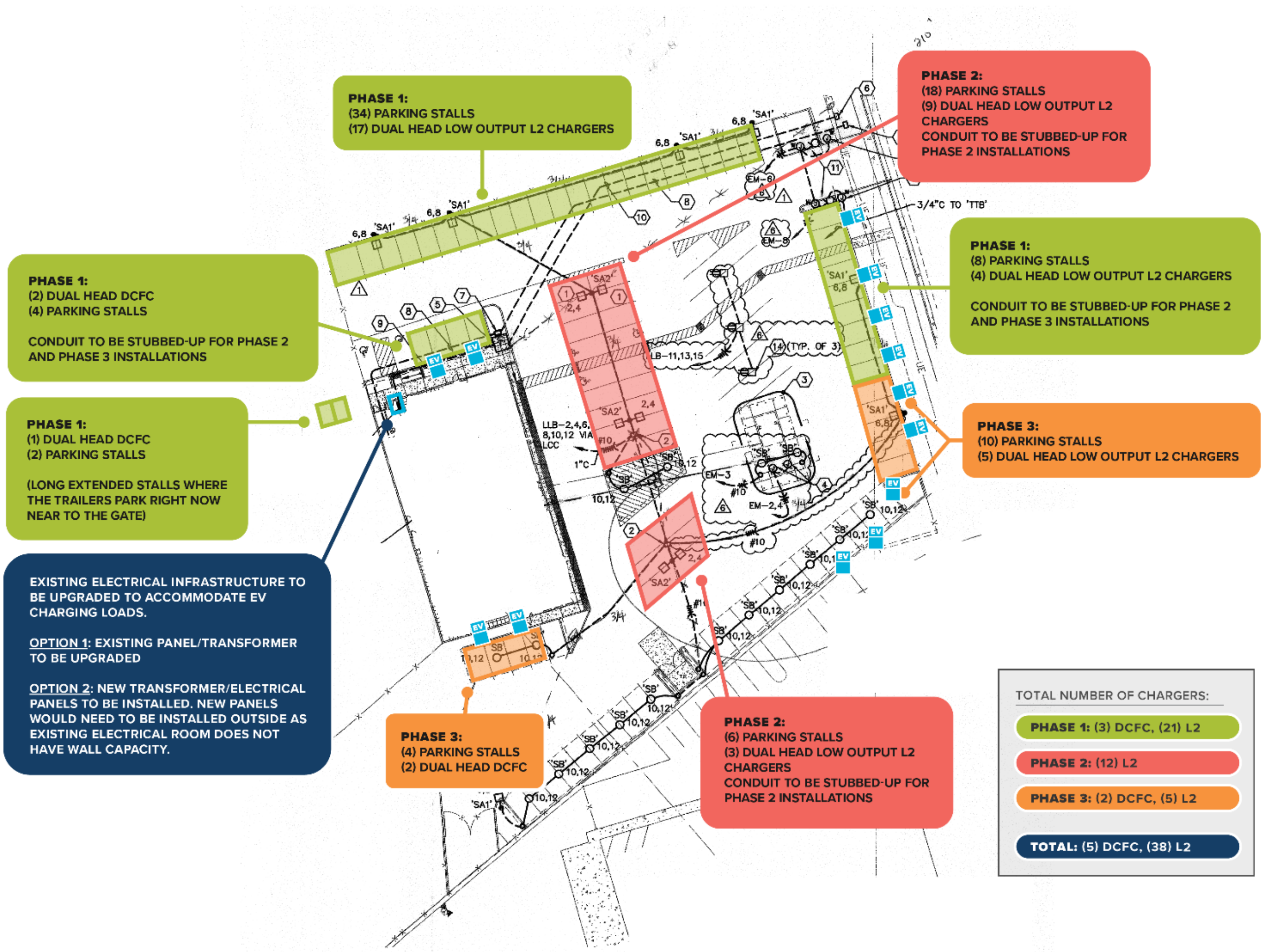


FIGURE 21: CONCEPTUAL CHARGER LAYOUT OF FLEET FACILITY ON IRON ROCK WAY

Charging Infrastructure Installation Phasing and Costs: The Fleet Facility is the City's primary fleet domicile with 76 fleet vehicles to be electrified. A total of 53 of these vehicles are scheduled to be replaced with EVs in Phase 1 followed by another seven vehicles in Phase 2 and 16 vehicles in Phase 3.

To charge these EVs, 38 dedicated dual-head low-output Level 2 chargers will be needed, supplemented by five dual-head 150 kW DC fast chargers. The installation of these chargers will be separated into three phases. To meet the expanded electrical loads from EV charging, expanded electrical infrastructure will need to be installed in Phase 1, along with the installation of 21 dual-head low-output Level 2 chargers, three dual-head DC fast chargers, and conduit stub-outs for subsequent installation of chargers in Phases 2 and 3. In Phase 2, twelve dual-head low-output Level 2 chargers will need to be installed. Finally, in Phase 3, five dual-head low-output Level 2 chargers, and two dual-head DC fast chargers will be installed using the previously installed conduit.

Most of these investments and resulting costs will occur in Phase 1, with an estimated total of $1,433,800. Phases 2 and 3 are estimated to cost $319,900 and $483,540, respectively.

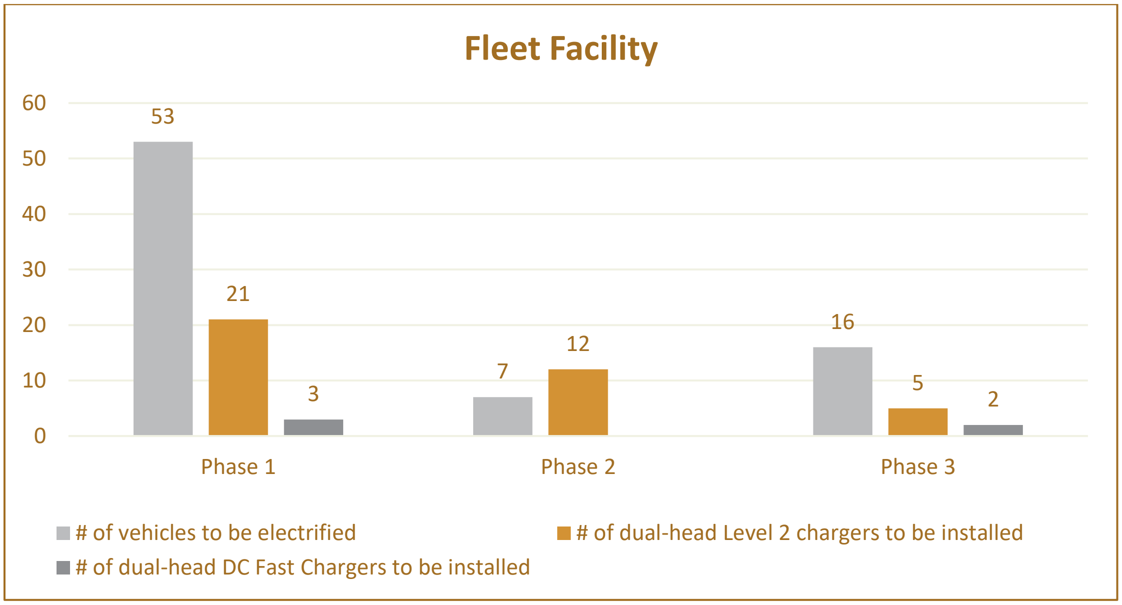


FIGURE 22: FLEET VEHICLE ELECTRIFICATION AND EV CHARGING INFRASTRUCTURE DEPLOYMENT BY IMPLEMENTATION PHASE AT FLEET FACILITY

FLEET FACILITY

EXISTING CONDITIONS

ADDRESS

10190 Iron Rock Way, Elk Grove, CA

SITE DESCRIPTION

Outdoor parking lot serving fleet vehicles.

ELECTRICAL CAPACITY

According to Sacramento Municipal Utility District (SMUD), the existing transformer has a total available electrical capacity of 175 kVA; which cannot accommodate the proposed EV charger loads. Thus, utility upgrades and a new transformer are required at this facility. The new transformer to be installed during Phase 1 of the project construction.

LOCATION OF POWER SUPPLY

The electrical room is at the North side of the fleet facility building.

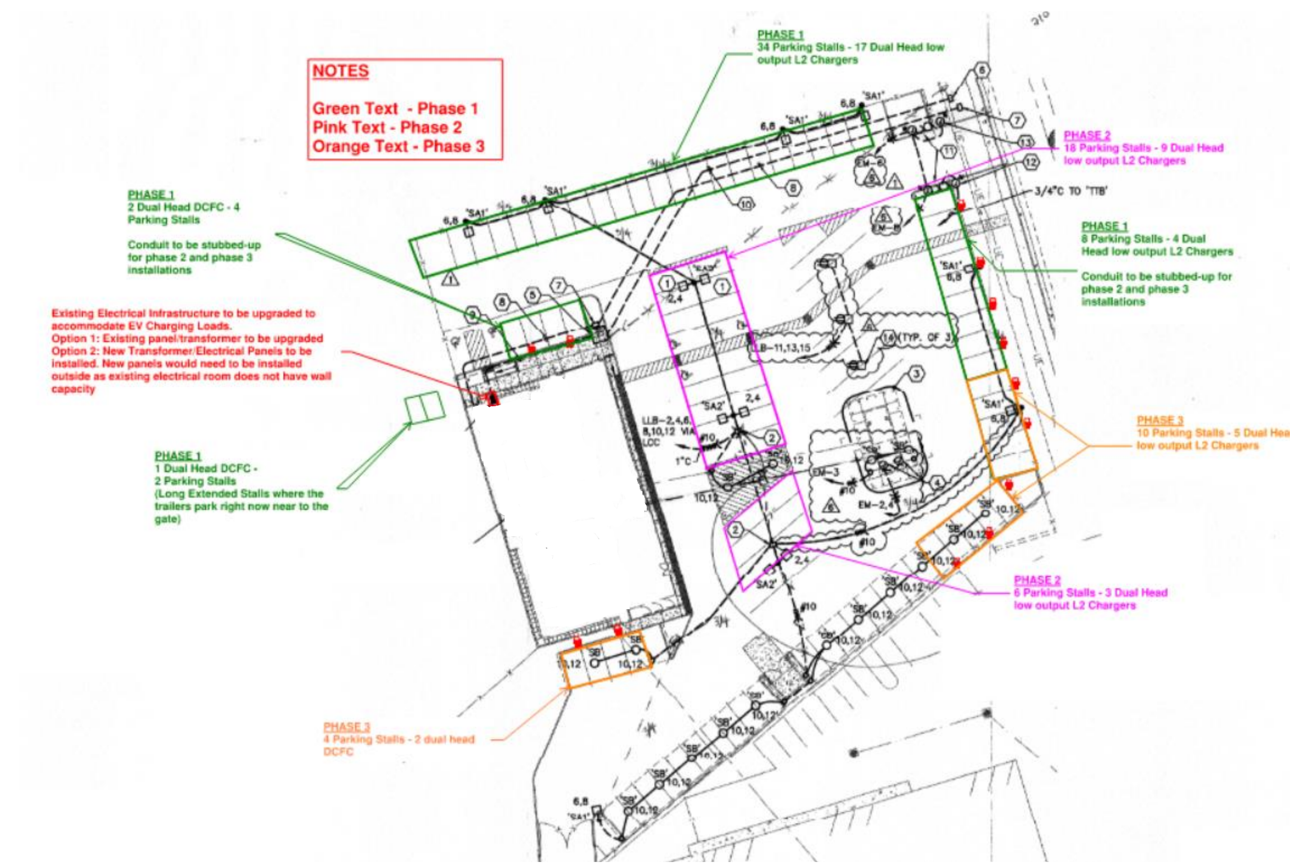
ANALYSIS

A total of 76 light duty ICE vehicles need to be replaced by comparable class EVs. The daily required EV energy was calculated by comparing existing vehicle duty cycle with replacement EV battery range. 42 vehicles to be replaced in phase 1, 15 vehicles in phase 2 and 19 vehicles in phase 3 of the project construction.

REQUIRED ELECTRICAL LOAD AND COSTS PER CHARGING SCENARIO

CHARGING SCENARIO	ELECTRIC LOAD	COST
DEDICATED L2 & SHARED DCFC (FLEET) – PHASE 1 CONSTRUCTION	1,564.5 kVA	$1,433,800
DEDICATED L2 & SHARED DCFC (FLEET) – PHASE 2 CONSTRUCTION		$319,900
DEDICATED L2 (FLEET) – PHASE 3 CONSTRUCTION		$483,540

Note: Phase 1 construction timeline is 2023-2028, Phase 2 construction timeline is 2029-2033, and Phase 3 construction timeline is 2034-2035



DESIGN RECOMMENDATIONS

POWER

Utility and transformer upgrades are required for this site. There are two recommended options to approach the electrical upgrades:

Option 1: Existing panel/transformer to be upgraded.

Option 2: New transformer/electrical panels to be installed.

Chargers are to be installed in 3 phases (see "Charging Equipment"), but all electrical infrastructure upgrades are to be implemented in phase 1.

COMMUNICATION

The vehicles park in open parking lot which has good cellular reception. There is no constraint in connecting smart chargers using cellular reception.

CHARGING EQUIPMENT

The following quantities of smart chargers are recommended:

38 x Dual-head low output L2 chargers

5 x Dual-head 150 kW DC Fast chargers

The installation of chargers will be separated into 3 phases:

Phase 1: All electrical infrastructure, 21 dual-head low output L2 chargers, 3 dual-head DCFC's, and conduit stub-outs for phase 2 installations.

Phase 2: 12 dual-head low output L2 chargers, and conduit stub-outs for phase 3 installations.

Phase 3: 2 dual-head DCFC's, 5 dual-head low output L2 chargers.

CHARGING STALL LOCATIONS

See diagram above for breakdown of charging stall locations and which stalls will have a charger installed for which phase.

LIGHTING

There are existing light poles that provide sufficient illumination to the parking lot.

SECURITY AND ACCESS

As this is a gated and access-controlled facility, security is not a major concern for the site.

CONDUIT INSTALLATION APPROACH

Wall and ceiling-mounted conduit from electrical room, and trenched conduit installation between new transformer and electrical cabinet, and electrical cabinet to the chargers required.

CHALLENGES AND RISKS

CHALLENGES / RISKS	DESCRIPTION
ELECTRICAL	Secure and aesthetically acceptable location for new transformer.
CIVIL/ STRUCTURAL	Directional drilling or expensive trenching (and restoration) required for charger's location proposed in Site alternative 2
OPERATIONAL	Shared DCFC charging stalls: determine schedule to rotate vehicles for charging if needed.
OTHERS	See "Security and Access"

LAGUNA PALMS CAMPUS: 8380 LAGUNA PALMS, 8400 LAGUNA PALMS & 9362 STUDIO COURT

Description: This municipal administrative campus consists of several separate buildings that house the Police Department and City Council Chambers and is comprised of three adjacent sites, each with its own address: 8380 Laguna Palms; 8400 Laguna Palms; and 9362 Studio Court. A total of 65 fleet vehicles are assigned to 8380/8400 Laguna Palms, of which all except one belong to Police Department. An additional 17 Police Department vehicles are planned for relocation from Corp Yard to the Laguna Palms Campus by the end of 2024. The Studio Court building, which houses the Elk Grove's Property & Evidence and CSI, has a four-vehicle fleet, all of which are slated for electrification. Staff are able to park in any of the parking lots.

Municipal Fleet Electrification: A total of sixty-five fleet vehicles are assigned to 8380/8400 Laguna Palms, with all but one planned for electrification. The Police Departments Property & Evidence and CSI building at 9362 Studio Court has a fleet of four vehicles, all of which are slated for electrification. An additional seventeen Police Department vehicles are planned for relocation from Corp Yard to the Laguna Palms Campus by the end of 2024. The total number of vehicles planned for electrification at the Laguna Palms Campus will therefore be eighty-five.

Energy Requirements: The daily required electrical load from fleet EV charging of 668.6 kWh for 8380 and 8400 Laguna Palms and 25.4 kW for 9362 Studio Court was calculated by comparing existing vehicle duty cycle with the replacement EV battery range. These vehicles have between fourteen and twenty-one and a half hours of nightly dwell time for charging. The maximum electrical load from the EV chargers is 1,378 kVA for 8380 and 8400 Laguna Palms and 16.5 kVA for 9362 Studio Court.

Existing Parking and Access: Both 8380 and 8400 Laguna Palms share a common gated parking area for exclusive staff/fleet use that can be accessed from both Laguna Palms Way and Laguna Spring Drive. The parking on the north side of the 8400 Laguna Palms site is public. There is gated parking to the east of the 8400 Laguna Palms building for staff/fleet and accessed from Studio Court or Laguna Palms Way. Studio Court has its own dedicated parking area to the east of the building and accessible from Studio Court, which is not gated.

Existing Electrical Service: According to SMUD, the existing 150 kVA transformer at 9362 Studio Court has a total available electrical capacity of 112.4 kVA, which can accommodate one dual-head low-output charger at this site. This facility received major renovations including a new electrical panel installed on the east side of the building. New electrical service upgrades will be required to power fleet and public EV chargers needed elsewhere at this campus.

Electrical Service Recommendations: Utility and transformer upgrades for 8380 and 8400 Laguna Palms are recommended, which can be installed between the Rain Garden and 8380 Laguna Palms property line to provide power for current planned EV chargers and any future expansion. A new switchgear, electrical cabinets to power DC fast and Level 2 chargers, and step-down transformer will need to be installed in the vicinity of the new transformer.

Fleet EV Charger Recommendations: The following quantities of smart chargers are recommended:

- One dual-head low output pedestal mounted Level 2 chargers for fleet use at 9362 Studio Court (2 charge ports);
- 20 dual-head medium output pedestal mounted Level 2 chargers for fleet use at 8380 and 8400 Laguna Palms (40 charge ports);
- Seven dual-head high output pedestal mounted Level 2 chargers for fleet use at 8380 and 8400 Laguna Palms (14 charge ports);
- Two dual-head 150 kW DC fast chargers for fleet use at 8380 and 8400 Laguna Palms (4 charge ports).

Fleet EV Charger Implementation Phasing: The installation of fleet chargers will be separated into three phases concurrent with replacement of fleet vehicles with EVs:

Phase 1: All electrical infrastructure, sixteen dual-head medium output, two dual-head high output Level 2 chargers, two dual-head DC fast charger, and conduit stub-outs for subsequent charger installations in phase two and phase three.

Phase 2: Two dual-head medium output, and four dual-head high output Level 2 chargers.

Phase 3: One dual-head low output, two dual-head medium output, and one dual-head high output Level 2 chargers.

Public EV Charger Recommendations: Two dual-head medium output pedestal mounted Level 2 chargers for public use at 8400 Laguna Palms (4 charge ports).

Public EV Charger Implementation Phasing: The public chargers should be installed in phase one.

Estimated Project Costs: The estimated planning level cost of thirty newly installed Level 2 and two DC fast chargers will total approximately $1,714,840 plus $43,200 for the Elk Grove Property & Evidence and CSI Building at 9362 Studio Court. The majority of this estimate is for fleet charging with only $76,740 for public charging.

Locations of proposed EV chargers are shown below on Figure 23.

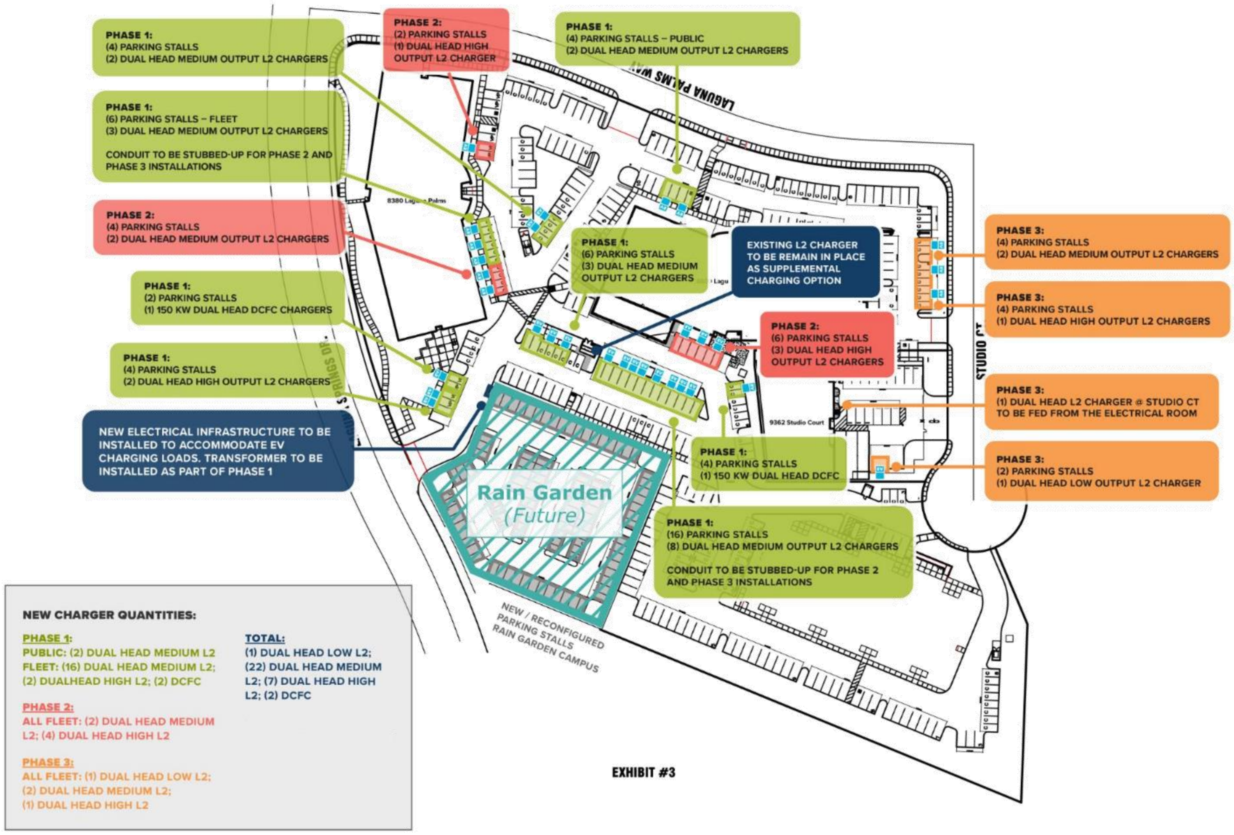


FIGURE 23: CONCEPTUAL CHARGER LAYOUT OF LAGUNA PALMS CAMPUS

Charging Infrastructure Installation Phasing and Costs: A total of 85 light-duty ICE vehicles assigned to the Laguna Palms campus need to be replaced by comparable class EVs, which includes additional 17 Police Department vehicles are planned for relocation from Corp Yard to the Laguna Palms Campus by the end of the next year. Charging this fleet of EVs will require the installation of one dual-head low-output pedestal-mounted Level 2 charger at 9362 Studio Court, 20 dual-head medium-output pedestal-mounted Level 2 chargers as well as seven dual-head high-output pedestal-mounted Level 2 chargers, all supplemented by two dual-head 150 kW DC fast chargers at 8380 and 8400 Laguna Palms. Along with these 30 fleet chargers, two dual-head medium-output pedestal-mounted Level 2 chargers will also be needed for public use at the Laguna Palms campus.

The chargers at the Laguna Palms campus should be installed in three phases. Phase 1 will consist of the installation of all electrical infrastructure, 16 dual-head medium-output, and two dual-head high-output Level 2 chargers, two dual-head DC fast charger, and conduit stub-outs for Phase 2 installations expected to cost $1,286,280. Phase 1 will also include two dual-head medium-output chargers for public use at a cost of $76,740. Phase 2 will consist of the installation of two dual-head medium-output, and four dual-head high-output Level 2 chargers, and conduit stub-outs for Phase 3 installations totaling approximately $193,060. Phase 3 will consist of the installation of one dual-head low-output Level 2 charger at 93362 Studio Court totaling $43,200, two dual-head medium-output, and one dual-head high-output Level 2 charger at 8380 and 8400 Laguna Palms totaling $158,760. The total costs for Phase 3 installation are $201,960.

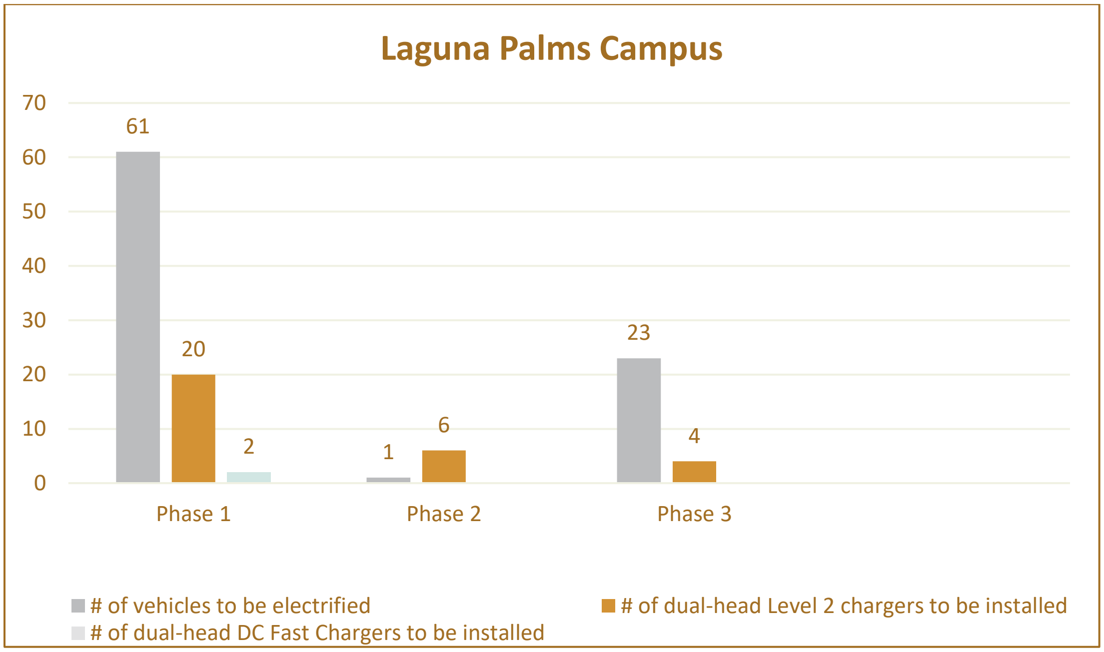


FIGURE 24: FLEET VEHICLE ELECTRIFICATION AND EV CHARGING INFRASTRUCTURE DEPLOYMENT BY IMPLEMENTATION PHASE AT LAGUNA PALMS CAMPUS

LAGUNA PALMS CAMPUS

EXISTING CONDITIONS

ADDRESS

Laguna Palms Campus, Elk Grove

SITE DESCRIPTION

This campus has four addresses; 8380 Laguna Palms, 8400 Laguna Palms, 9362 Studio Court, and a Rain Garden that will be converted into parking stalls.

8380 and 8400 Laguna Palms have a common gated parking area for fleet use. The parking can be accessed from both Laguna Palms Way and Laguna Palms Drive. The public parking is on the north side of the 8400 Laguna Palms site. 9362 Studio Court has its own dedicated parking space which is not gated.

ELECTRICAL CAPACITY

A new transformer to be installed to accommodate the EV charger loads for 8380,8400 Laguna Palms, and future parking stalls at the Rain Garden site.

According to SMUD, the existing 150 kVA transformer at 9362 Studio Court has a total available electrical capacity of 112.4 kVA, which can accommodate 1 dual head low output charger at this site.

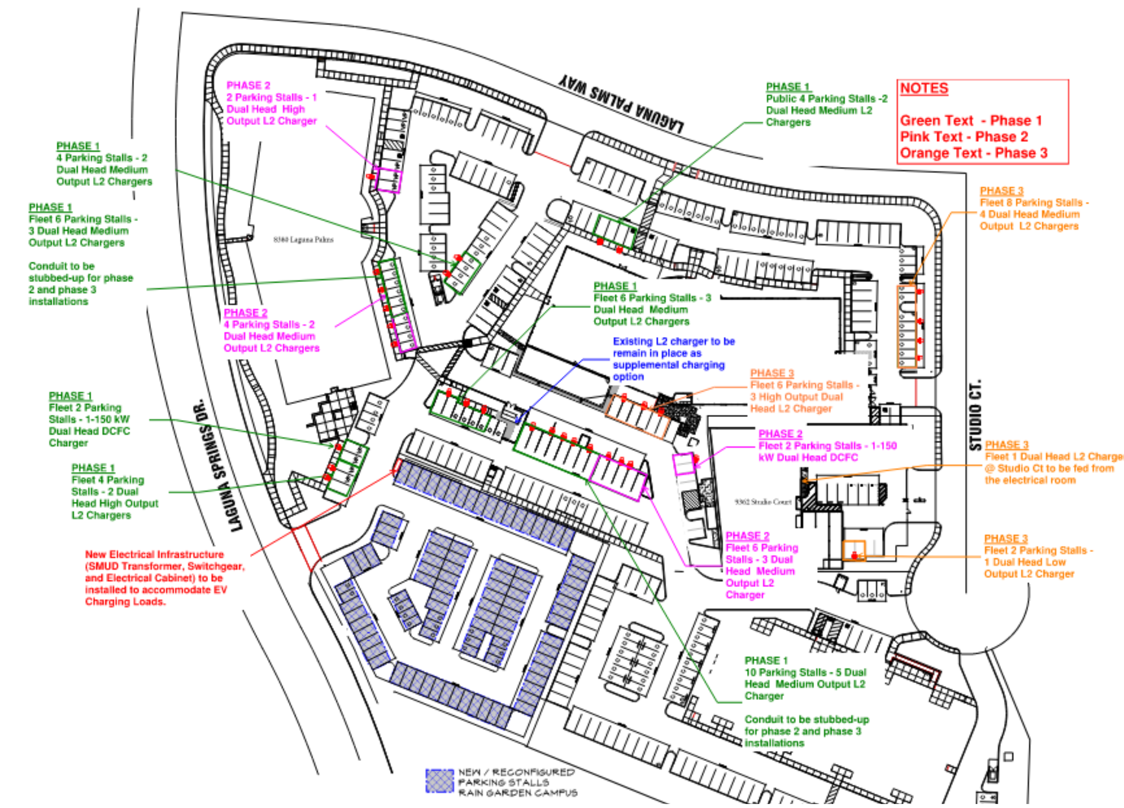
ANALYSIS

A total of 85 out of 86 light duty ICE vehicles need to be replaced by comparable class EVs. Their daily required EV energy was calculated by comparing existing vehicle duty cycle with replacement EV battery range. The vehicles have between 14 and 21.5 hours of nightly dwell time. The chargers at 8380 and 8400 Laguna Palms should be installed in three phases and the chargers at 9362 Studio Court should be installed in phase 3.

REQUIRED ELECTRICAL LOAD AND COSTS PER CHARGING SCENARIO

CHARGING SCENARIO	ELECTRIC LOAD	COST
8380 AND 8400 LAGUNA PALMS (FLEET) - PHASE 1 CONSTRUCTION	1,378 kVA	$1,286,280
8380 AND 8400 LAGUNA PALMS (PUBLIC) - PHASE 1 CONSTRUCTION		$76,740
8380 AND 8400 LAGUNA PALMS (FLEET) - PHASE 2 CONSTRUCTION		$193,060
8380 AND 8400 LAGUNA PALMS (FLEET) - PHASE 3 CONSTRUCTION		$158,760
9362 STUDIO COURT (FLEET) - PHASE 3 CONSTRUCTION	16.5 kVA	$43,200

Note: Phase 1 construction timeline is 2023-2028, Phase 2 construction timeline is 2029-2033, and Phase 3 construction timeline is 2034-2035



DESIGN RECOMMENDATIONS

POWER

Utility and transformer upgrades will be required for 8380, 8400 Laguna Palms and the Rain Garden recommended to be installed between the Rain Garden and 8380 Laguna Palms property line that will serve the power requirements for the EV chargers and future electrical installations at the Rain Garden when converted into parking.

A new switch gear, electrical cabinets to power DC fast and Level 2 chargers, and step-down transformer to be installed in the vicinity of the new transformer.

One dual head low output L2 charger to be fed from the existing electrical panel in the electrical room at 9362 Studio Court.

COMMUNICATION

The vehicles park in open parking lot which has good cellular reception. There is no constraint in connecting smart chargers using cellular reception.

CHARGING EQUIPMENT

The following quantities of smart chargers are recommended:

1 x Dual-head low output pedestal mounted L2 chargers for fleet use at 9362 Studio Court

2 x Dual-head medium output pedestal mounted L2 chargers for public use at 8380 and 8400 Laguna Palms

20 x Dual-head medium output pedestal mounted L2 chargers for fleet use at 8380 and 8400 Laguna Palms

7 x Dual-head high output pedestal mounted L2 chargers for fleet use at 8380 and 8400 Laguna Palms

2 x Dual-head 150 kW DC Fast chargers for fleet use at 8380 and 8400 Laguna Palms

The installation of chargers will be separated into 3 phases:

Phase 1: All electrical infrastructure, 18 dual-head medium output, 2 dual-head high output L2 chargers, 2 dual-head DCFC's, and conduit stub-outs for phase 2 installations. This includes 2 dual-head medium output chargers for public.

Phase 2: 2 dual-head medium output, 4 dual-head high output L2 chargers, and conduit stub-outs for phase 3 installations.

Phase 3: 1 dual-head low output, 2 dual-head medium output, and 1 dual-head high output L2 chargers.

CHARGING STALL LOCATIONS

See site diagram above.

LIGHTING

There are existing light poles that provide sufficient illumination to the parking lot.

SECURITY AND ACCESS

Safety is not a concern at this location as this is a gated site.

CONDUIT INSTALLATION APPROACH

A mixture of directional drilling and trenched conduit installation between new transformer to new electrical cabinet and from new electrical cabinet to the chargers required.

Directional drilling conduit between SMUD vault to new transformer.

CHALLENGES AND RISKS

CHALLENGES / RISKS	DESCRIPTION
ELECTRICAL	None
CIVIL/ STRUCTURAL	None
OPERATIONAL	Fleet versus customer parking/charging
OTHERS	Impacts to existing utilities during installation of conduits

SPECIAL WASTE COLLECTION CENTER, 9255 DISPOSAL LN.

Description: This is the City's household hazardous waste and recycling facility which is open to the public for disposing of waste or collecting re-use materials during operating hours.

Municipal Fleet Electrification: Two ICE fleet vehicles domicile at the SWC, and one of the two vehicles is scheduled to be replaced by a comparable class EV.

Energy Requirements: The daily required electrical load from fleet EV charging of 2.0 kWh was calculated by comparing the existing vehicle duty cycle with the replacement EV battery range. These vehicles have between fourteen and sixteen hours of nightly dwell time for charging. The maximum electrical load from the EV chargers is 24.8 kVA.

Existing Parking and Access: A 12-stall outdoor parking lot serves two fleet vehicles, one of which is already an EV and the other which is planned to be electrified, while the remaining stalls are used for staff and public vehicle parking. There is no public access to this facility after hours.

Existing Electrical Service: The existing 150 kVA-rated transformer is located on the exterior east side of the building. The existing panels are located inside of the building near this transformer. According to SMUD, the total available electrical capacity of the existing transformer is 129 kVA@ 480V, and there are two electrical panels that have breaker capacity for the EV chargers. There are also solar panels installed on the roof of this facility.

Fleet EV Charger Recommendations: One dual-head Level 2 charger (2 charge ports) is recommended for fleet charging in the parking stalls close to the existing pad-mounted transformer where the existing conduits are stubbed up. The chargers should be installed along the east side of the parking lot. The single-head Level 2 charger will be for the ADA-accessible stall. The dual-head Level 2 charger will have one head for the fleet vehicle and one for the standard public EV charging stall.

Fleet EV Charger Implementation Phasing: Because sufficient power is available, this charger could be installed in phase one.

Public EV Charger Recommendations: One single-head Level 2 charger is recommended for public use adjacent to the proposed fleet chargers.

Public EV Charger Implementation Phasing: Because sufficient power is available, this charger could be installed in phase one.

Estimated Project Costs: The estimated planning level cost of two new, Level 2 chargers for both fleet and public use will be approximately $64,720. Of this total, $53,280 is for fleet charging and the remaining $11,440 is for public charging.

Locations of proposed EV chargers are shown in Figure 25.

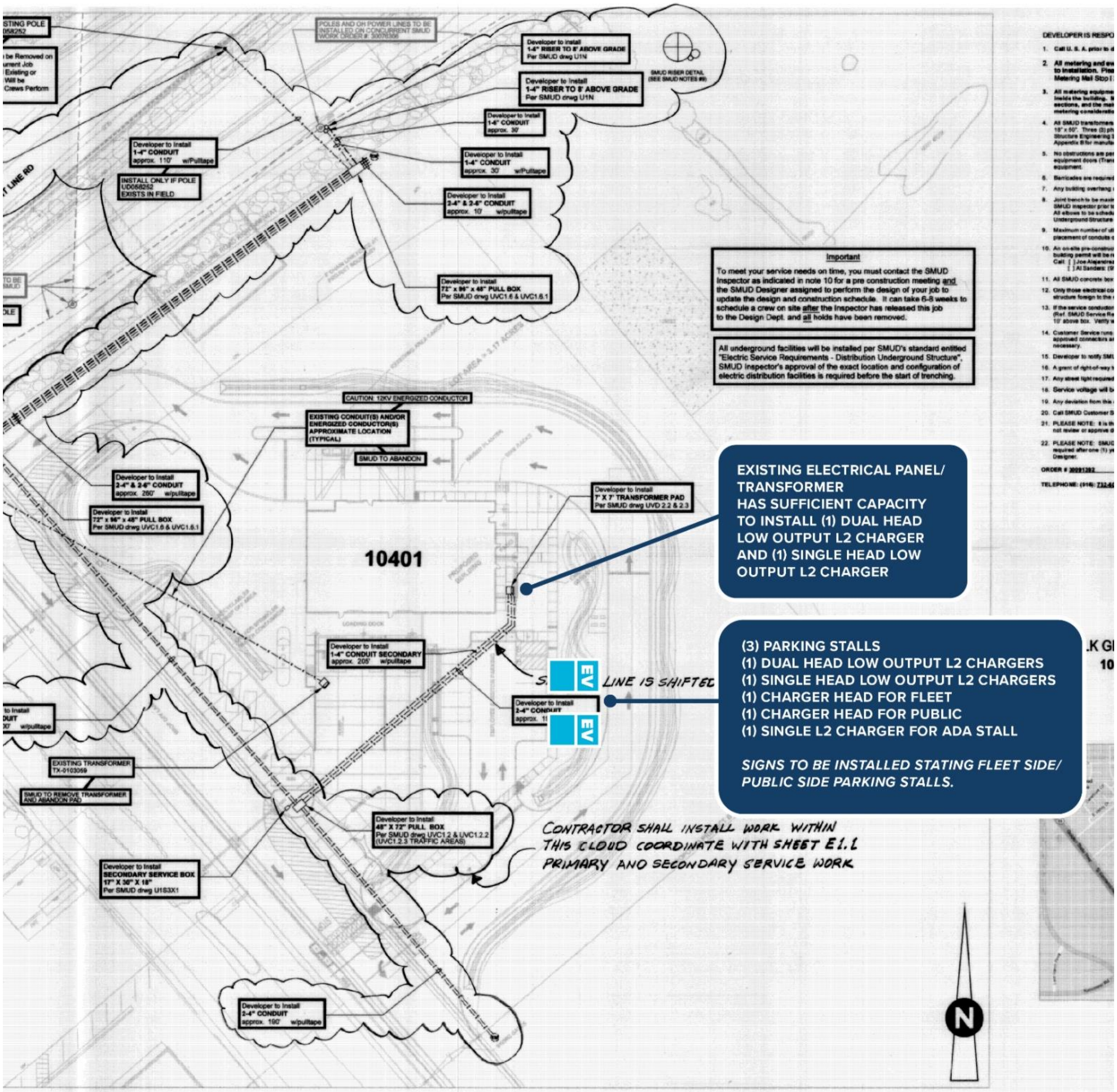


FIGURE 25: CONCEPTUAL CHARGER LAYOUT OF SPECIAL WASTE COLLECTION CENTER

Charging Infrastructure Installation Phasing and Costs: The SWCC has the smallest City-owned fleet with only one fleet vehicle to be electrified. The installation at the SWCC should include one Level 2 dual-head charger plus a single-head Level 2 charger. The single-head charger will be for public use and installed at the ADA stall. The dual-head Level 2 charger will have one head reserved for the fleet vehicle and one head available for the public stall. No electrical system upgrades will be required, allowing this project to be completed in a single phase. The cost of the fleet charger is expected to total $46,840 with the public charger cost an additional $10,520.

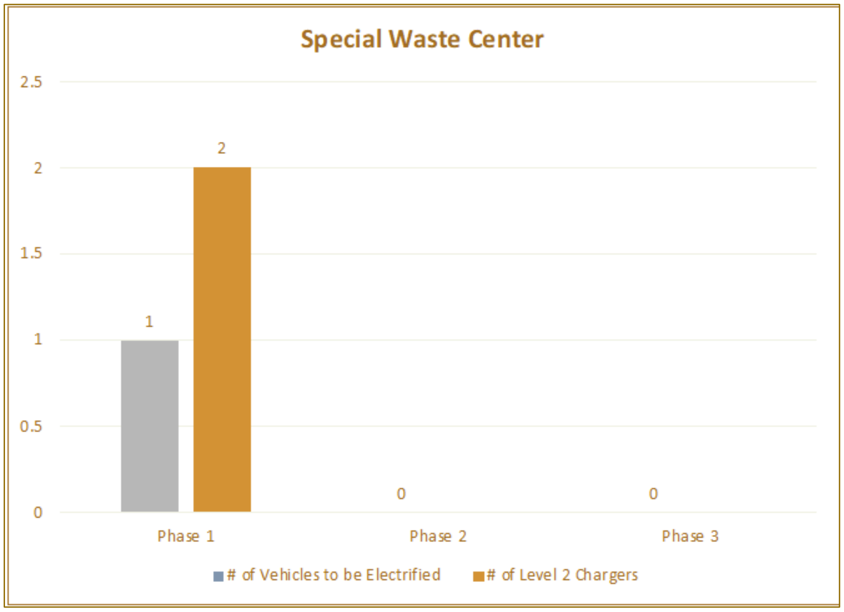


FIGURE 26: FLEET VEHICLE ELECTRIFICATION AND EV CHARGING INFRASTRUCTURE DEPLOYMENT BY IMPLEMENTATION PHASE AT SPECIAL WASTE COLLECTION CENTER

SPECIAL WASTE COLLECTION CENTER

EXISTING CONDITIONS

ADDRESS

9255 Disposal Ln, Elk Grove, CA

SITE DESCRIPTION

Outdoor parking lot serving fleet vehicles and open to public during operating hours.

ELECTRICAL CAPACITY

According to SMUD, the total available electrical capacity of the existing transformer is 129 kVA, and there are 2 electrical panels that have breaker capacity for EV chargers.

LOCATION OF POWER SUPPLY

The existing transformer is located on the exterior east side of the building. The existing panels are located inside of the building near this transformer.

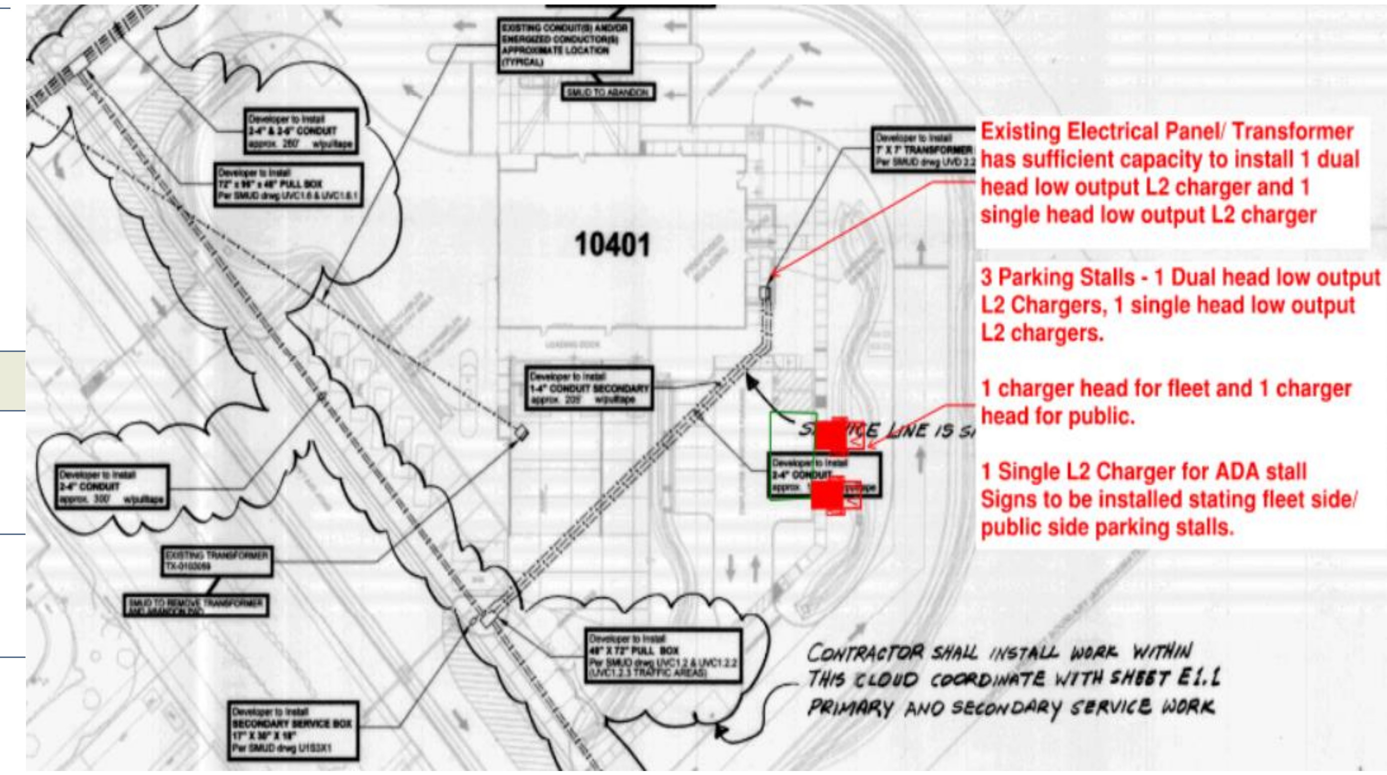
ANALYSIS

2 ICE fleet vehicles domicile at the SWC, and one of the two vehicles is scheduled to be replaced by a comparable class EV. The daily required EV energy was calculated by comparing existing vehicle duty cycle with replacement EV battery range.

REQUIRED ELECTRICAL LOAD AND COSTS PER CHARGING SCENARIO

CHARGING SCENARIO	ELECTRIC LOAD	COST
DEDICATED L2 (FLEET) - PHASE 1 CONSTRUCTION	24.8 kVA	$52,280
SHARED L2 (PUBLIC) – PHASE 1 CONSTRUCTION		$11,440

Note: Phase 1 construction timeline is 2023-2028



DESIGN RECOMMENDATIONS

POWER

The 2 proposed chargers can be powered by the existing outdoor electrical panels “MSB” or “1LC S2” at the East side of the site. Conduit and wiring can be trenched directly from the panel to the parking stalls at the Southeast side of the lot.

COMMUNICATION

The vehicles park in open parking lot which has good cellular reception. There is no constraint in connecting smart chargers using cellular reception.

CHARGING EQUIPMENT

The following quantities of smart L2 chargers are recommended:

1 x Single-head low output pedestal mounted L2 charger

1 x Dual-head low output pedestal mounted L2 charger

CHARGING STALL LOCATIONS

A total of 3 parking stalls to be equipped with EV chargers.

The chargers will be installed along the East side of the parking lot. The single head L2 charger will be for the ADA stall. The dual head L2 charger will have one head for the fleet vehicle and one for the standard public stall.

Signage will need to be installed to indicate which parking stall is for fleet and which is for public. As this is a gated facility, there will be no access to public chargers after operational hours.

See site diagram above.

LIGHTING

There are existing light poles that provide sufficient illumination to the parking lot.

SECURITY AND ACCESS

As this is a gated facility that is closed to the public after operational hours, so safety and security is not a significant concern.

CONDUIT INSTALLATION APPROACH

Wall-mounted conduit from electrical panels, and trenched conduit installation between electrical service and chargers required.

CHALLENGES AND RISKS

CHALLENGES / RISKS	DESCRIPTION
ELECTRICAL	None
CIVIL/ STRUCTURAL	None
OPERATIONAL	Fleet versus customer parking and charging
OTHERS	N/A

NON-FLEET PUBLIC CHARGING LOCATIONS

Each City-owned, non-fleet site for public charging is described below including a summary of the facility’s existing access, parking, and electrical service.

Unlike City fleet chargers, which are sized based on projected energy loads, public charging recommendations are based on factors such as available on-site power, parking capacity, and/or City recommendations. All three of these could be implemented at any time so no phasing recommendations are included.

FIGURE 27: OLD TOWN PLAZA 2021 (PHOTO CREDIT: BILLY HUSTACE)

EXISTING ELK GROVE LIBRARY, 8900 ELK GROVE BLVD.

Description: The library building is situated at the intersection of Elk Grove Florin Rd. and Elk Grove Blvd., offering access to public library parking from both roadways. The building is owned by the City and currently used by the Sacramento County Library Authority. This location, being a popular public destination with convenient vehicular access and abundant surface parking, presents an optimal site for the installation of public parking infrastructure. It is important to emphasize that no fleet vehicles are allocated to the library; therefore, all charging stations installed here will be exclusively designated for public use. Additionally, it should be noted that the Elk Grove Library is scheduled for relocation to 9260 Elk Grove Blvd as part of an ongoing capital project within the next two to five years. The future utilization of this building by the City remains to be determined.

Existing Parking and Access: There is an unsecured parking lot with access to parking from both Elk Grove Florin Rd. and Elk Grove Blvd.

Existing Electrical Service: Existing panel H is located on the north side of the building close to the entrance from Elk Grove Blvd. This 225A, 208V-rated panel has available electrical capacity to accommodate the proposed EV charging loads at this facility. The maximum electrical load from the EV chargers is 90.0 kVA.

Public EV Charger Recommendations: Installation of three dual-head Level 2 chargers (6 charge ports) is recommended, allowing up to six EVs to charge simultaneously. These chargers should be installed by the parking stalls on the south side of the building. Two parking stalls to the west of the entrance would have one ADA-accessible stall and one standard stall for EV charging. Four parking stalls to be located east of the entrance will have four standard stalls for EV charging.

Estimated Project Costs: The estimated planning level installed cost of these new Level 2 public chargers will be approximately $141,260.

Locations of proposed EV chargers are shown below on Figure 28.

FIGURE 28: CONCEPTUAL CHARGER LAYOUT OF EXISTING ELK GROVE LIBRARY

Charging Infrastructure Installation Phasing and Costs: The facility comprises an outdoor public parking lot exclusively intended for public parking. This building is owned by the City and is currently utilized by the Sacramento County Library Authority. The library is scheduled for relocation to a new site within the next three to five years, and the future utilization of the existing building is under evaluation. It is important to note that no fleet vehicles are designated for the library; hence, all charging stations installed here would be exclusively available for public use. We recommend the installation of three dual-head Level 2 chargers for public use, enabling up to six EVs to charge concurrently. It is worth mentioning that no electrical system upgrades will be necessitated, allowing for the completion of this project in Phase 1 at an estimated cost of $141,260.

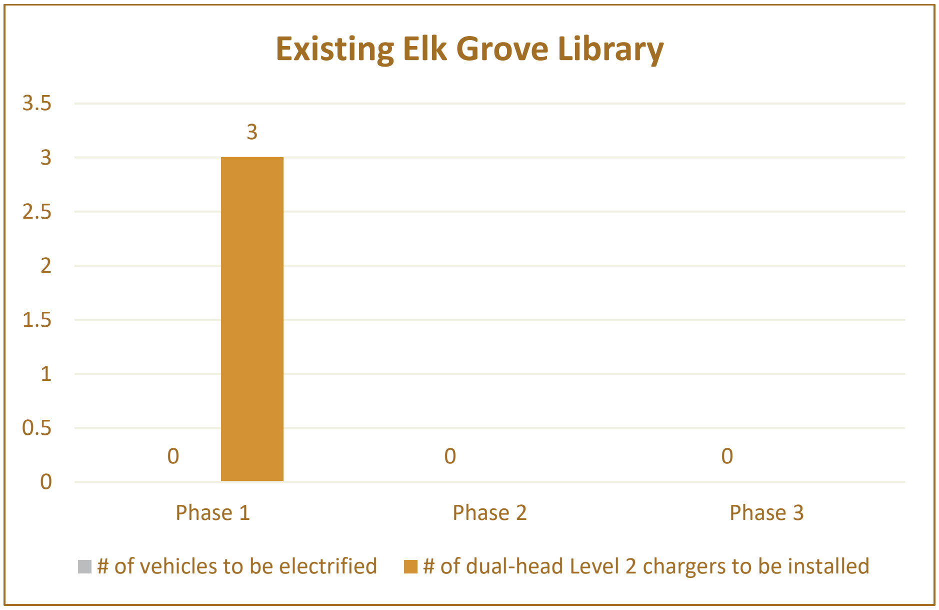


FIGURE 29: EV CHARGING INFRASTRUCTURE DEPLOYMENT BY IMPLEMENTATION PHASE AT EXISTING ELK GROVE LIBRARY

ELK GROVE LIBRARY

EXISTING CONDITIONS

ADDRESS

8900 Elk Grove Blvd, Elk Grove, CA

SITE DESCRIPTION

Outdoor parking lot at library for public, not fleet vehicles.

ELECTRICAL CAPACITY

Existing panel H (225A, 208V) has available electrical capacity to accommodate the proposed added EV charging loads at this facility.

LOCATION OF POWER SUPPLY

Existing Panel H is located on the North side of the building close to the entrance from Elk Grove Blvd.

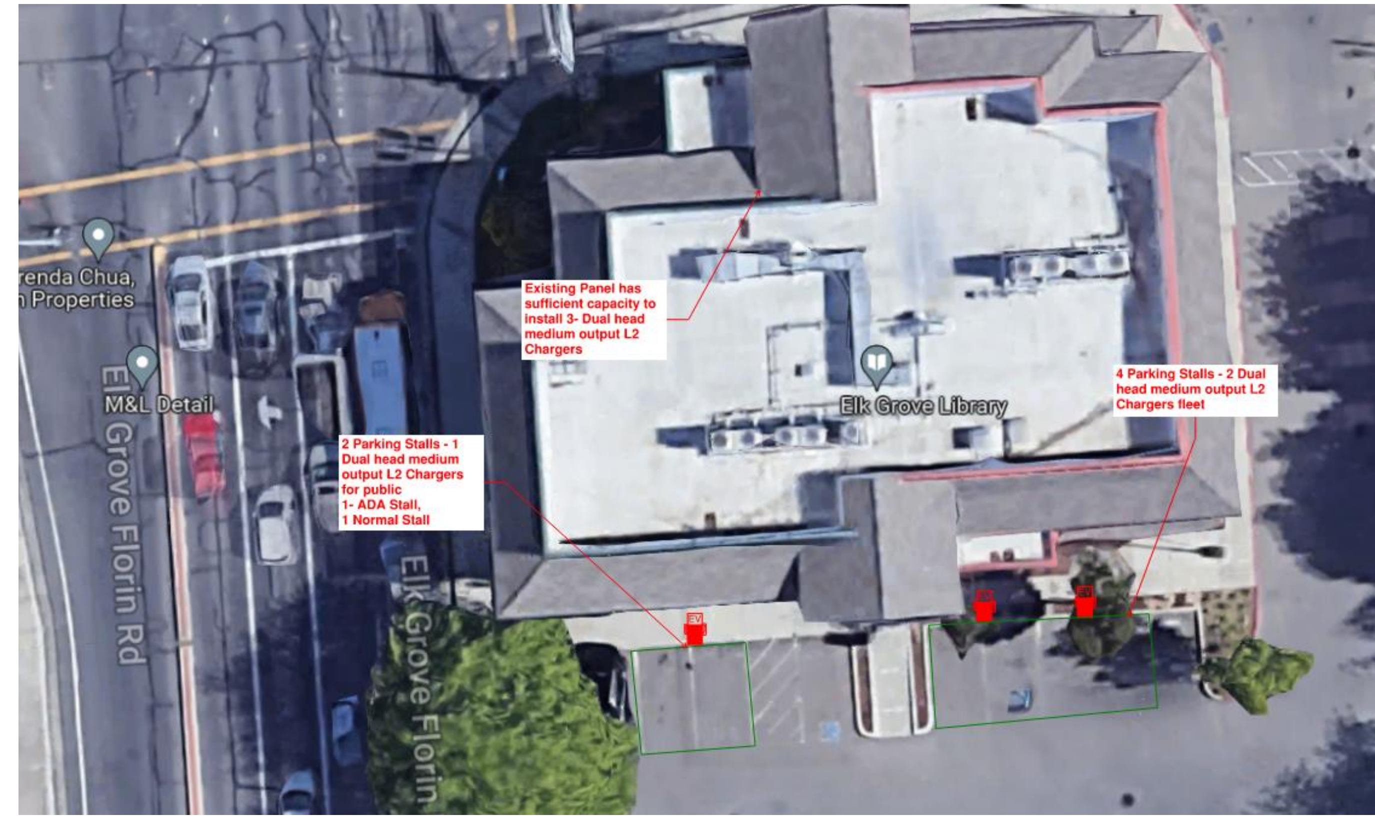
ANALYSIS

All chargers at this location will be for public use, and there are no fleet vehicles that domicile here. Installation of 3 dual head Level 2 chargers is recommended for use by library patrons. 1 charger head will be for an ADA parking stall, and 5 charger heads will be for standard parking stalls, for all total of 3 dual head charging stations allowing 6 EVs to charge simultaneously.

REQUIRED ELECTRICAL LOAD AND COSTS PER CHARGING SCENARIO

CHARGING SCENARIO	ELECTRIC LOAD	COST
SHARED L2 (PUBLIC) – PHASE1 CONSTRUCTION	90 kVA	$141,260

Note: Phase 1 construction timeline is 2023-2028



DESIGN RECOMMENDATIONS

POWER

All the L2 chargers will be powered from existing panel "H" located at the North side of the building. Conduit can be trenched around the outside of the building in the landscaping areas to power the chargers at the south side of the building.

COMMUNICATION

The vehicles park in open parking lot which has good cellular reception. There is no constraint in connecting smart chargers using cellular reception.

CHARGING EQUIPMENT

The following quantities of smart L2 chargers are recommended:

3 x Dual-head medium output pedestal mounted Level 2 chargers

CHARGING STALL LOCATIONS

A total of 6 parking stalls to be equipped with EV chargers.

Chargers to be installed at parking stalls on the South side of the building. 2 parking stalls to the West of the entrance will have 1 ADA stall and 1 standard stall for EV charging. 4 parking stalls to be located East of the entrance will have 4 standard stalls for EV charging.

See site diagram above.

LIGHTING

There are existing decorative-style light poles and fixtures at the parking lot that provide illumination to the site.

SECURITY AND ACCESS

Safety and security can be a concern at this location. Consider installation of a wall mounted CCTV camera and/or panic button for late hours of public usage of the chargers.

CONDUIT INSTALLATION APPROACH

Wall and ceiling-mounted conduit from electrical room to outside, and trenched conduit installation between electrical service and chargers required.

Core drilling through the walls may be required.

CHALLENGES AND RISKS

CHALLENGES / RISKS	DESCRIPTION
ELECTRICAL	None
CIVIL/ STRUCTURAL	Directional drilling/ expensive trenching (and restoration) may be required to run conduit and wiring from existing panel to chargers.
OTHERS	See "Security and Access"

OLD TOWN PLAZA, 9615 RAILROAD STREET

Description: This new City-owned public outdoor event facility includes two public parking lots and street parking. The lots are ideal for Level 2 charging for the public, as there are regular events that occur at the Plaza in addition to multiple businesses in the area. One restaurant is currently open to the south of one parking lot with another restaurant opening soon. The site includes an open-air covered pavilion and a building housing only bathroom facilities. No fleet vehicles are domiciled at this site.

Existing Parking and Access: There are two unsecured, fully public parking lots with easy vehicular access from Grove St. and Railroad St.

Existing Electrical Service: This is a newly constructed parking lot with no available electrical capacity to install EV chargers. All-new electrical infrastructure will need to be installed to power the proposed EV chargers.

Additional Considerations: The eastern parking lot features an unused 4-inch conduit that runs from east to west on the northern side of the lot, connecting existing pull boxes. This conduit also continues westward beyond Railroad Street, leading into the preexisting parking area on the west side of the street. Considering the planned installation site for the SMUD transformer and following EV charger recommendations, it is advisable to leverage the existing 4-inch spare conduit for the implementation of EV charging or power systems, with the aim of cost reduction for the project.

Electrical Service Recommendations: This is a newly constructed parking lot with no available electrical capacity to install EV chargers. All new electrical infrastructure will need to be installed to power the proposed EV chargers. A new transformer will need to be installed and the location of the transformer to be coordinated with SMUD. The new transformer will feed a new service panel for EV Chargers. The location of the new panel will be dependent on the location of the transformer as recommended by SMUD. The maximum electrical load from the EV chargers is 227.3 kVA.

Public EV Charger Recommendations: A total of twenty-one parking stalls could be equipped with EV chargers at fourteen parking stalls along the north side, two parking stalls along East side, and five parking stalls along the south side of the lot. Only one spot at the NE corner will remain non-EV parking. The parking lot features an unused 4-inch conduit that runs from east to west on the northern side of the lot, connecting existing pull boxes. This conduit also continues westward beyond Railroad Street, leading into the preexisting parking area on the west side of the street. Considering the planned installation site for the SMUD transformer and following EV charger recommendations, it is advisable to leverage the existing 4-inch spare conduit for the implementation of EV charging or power systems, with the aim of cost reduction for the project. The following quantities of smart Level 2 chargers are recommended for this parking lot:

- Three single-head low output pedestal mounted Level 2 chargers
- Five dual-head low output pedestal mounted Level 2 chargers (10 charge ports)
- Two single-head medium output pedestal mounted Level 2 chargers
- Three dual-head medium output pedestal mounted Level 2 chargers (6 charge ports)

Estimated Project Costs: The estimated planning level installed cost of these new Level 2 public chargers will be approximately $599,240.

Locations of proposed EV chargers are shown below on Figure 30.

FIGURE 30: CONCEPTUAL CHARGER LAYOUT OF OLD TOWN PLAZA

Charging Infrastructure Installation Phasing and Costs: The Old Town Plaza has no fleet vehicles domicile at this site. The installation at the Old Town Plaza should include three single-head low output, five dual-head low-output, two single-head medium-output, and three dual-head medium-output Level 2 chargers, all for public use. To meet the electrical loads from EV charging, a new electrical infrastructure will need to be installed in Phase 1. The cost of the public chargers is expected to total $599,240.

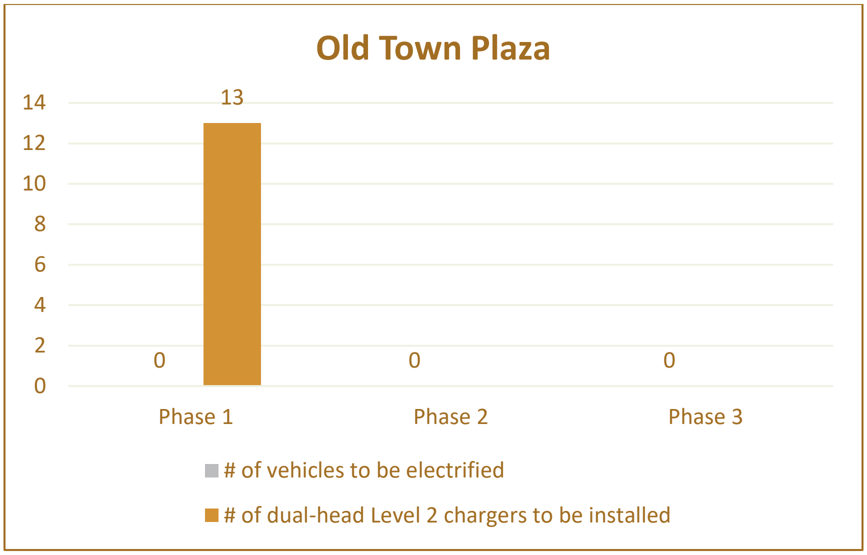


FIGURE 31: EV CHARGING INFRASTRUCTURE DEPLOYMENT BY IMPLEMENTATION PHASE AT OLD TOWN PLAZA

OLD TOWN PLAZA

EXISTING CONDITIONS

ADDRESS

9645 Railroad Street, Elk Grove, CA

SITE DESCRIPTION

Outdoor parking lot for public EV charging.

ELECTRICAL CAPACITY

This is a newly constructed parking lot with no available electrical capacity to install EV chargers. All-new new electrical infrastructure will need to be installed to power the proposed EV chargers.

LOCATION OF POWER SUPPLY

Location of new transformer to be coordinated with SMUD.

ANALYSIS

All chargers at this location will be for public use, and there are no fleet vehicles that domicile here.

The recommendation is to install 13 chargers (mix of dual and single head) for a total of 21 EV charging spaces (parking stalls).

REQUIRED ELECTRICAL LOAD AND COSTS PER CHARGING SCENARIO

CHARGING SCENARIO	ELECTRIC LOAD	COST
SHARED L2 (PUBLIC)	227.3 kVA	$599,240

Note: Construction timeline shall be per City's available funding to install EV chargers at this site.

DESIGN RECOMMENDATIONS

POWER

A new transformer will need to be installed and the location of the transformer to be coordinated with SMUD. The new transformer will feed a new service panel for EV Chargers. The location of the new panel will be dependent on the location of the transformer as recommended by SMUD.

COMMUNICATION

The vehicles park in open parking lot which has good cellular reception. There is no constraint in connecting smart chargers using cellular reception.

CHARGING EQUIPMENT

Installation of 21 level 2 charge ports for public use is proposed for this facility to support EV charging during events hosted in Old Town.

The following quantities of smart L2 chargers are recommended:

3 x Single-head low output pedestal mounted chargers

5 x Dual-head low output pedestal mounted chargers

2 x Single-head medium output pedestal mounted chargers

3 x Dual-head medium output pedestal mounted chargers

CHARGING STALL LOCATIONS

A total of 21 parking stalls to be equipped with EV chargers at 14 parking stalls along the North side, 2 parking stalls along East side, and 5 parking stalls along the South side of the lot. Only one spot at the NE corner will remain non-EV parking.

See site diagram above.

LIGHTING

This area has existing light poles that provide adequate illumination to the site.

SECURITY AND ACCESS

Safety and security may be a concern at this location. Consider installation pole-mounted CCTV cameras and/or panic buttons on the existing light poles.

CONDUIT INSTALLATION APPROACH

As this is a fully outdoor site with no building structures, conduit could be installed by trenching, while directional drilling may be required under paved areas.

There is an existing 4" conduit that runs from East to West on the Northern side of the lot, connecting existing pull boxes. It is recommended to leverage the existing spare conduit for installation of EV chargers.

CHALLENGES AND RISKS

CHALLENGES / RISKS	DESCRIPTION
ELECTRICAL	Secure and aesthetically acceptable location for the transformer and service cabinet.
CIVIL/ STRUCTURAL	Directional drilling or expensive trenching (and restoration) may be required for chargers.
OTHERS	See "Security and Access"

DISTRICT 56, 8230 CIVIC CENTER DRIVE

Facility Description: This City-owned facility includes a Community Center building that also houses the Senior Center and Veteran's Hall, an Aquatic Center that includes a separate building, and a nature preserve. The site has two open public parking lots, one to the east and one to the west of the facility. The facility has high traffic with events and activities happening year-round. There are four existing 125 kW dual-head DCFCs and three dual-head low output Level 2 chargers.

Existing Parking and Access: There are two unsecure, fully public parking lots with easy vehicular access from Civic Center Drive and from Big Horn Blvd.

Existing Electrical Service: The existing 500 kVA transformer has an available capacity of 353.4 kVA to install future EV chargers, if the City decides to expand the charging infrastructure at this site.

Electrical Service Recommendations: The existing 500 KVA transformer has an available capacity of 353.4 kVA to install future EV chargers if the City decides to expand the charging infrastructure at this site.

Public EV Charger Recommendations: No chargers are currently recommended at this facility due to available existing chargers. Additional charging facilities at this site could be considered following an analysis of current EVSE use and increased EV ownership.

Charging Infrastructure Installation Phasing and Costs: This facility is owned by the City and features two open public parking lots. No fleet vehicles are currently domiciled at this facility. There is a high traffic volume due to year-round events and activities. The site currently includes four existing 125 kW dual-head DC fast chargers and three dual-head low-output Level 2 chargers. At present, there is no recommendation for the installation of additional EV chargers at this site. The need for fleet specific charging for maintenance vehicles will be evaluated during the plan update.

APPENDIX B: POTENTIAL FUNDING SOURCES

APPENDIX B: INTRODUCTION

This appendix summarizes numerous funding opportunities for EVs and EV charging infrastructure. As these opportunities continue to change rapidly, this summary is valid as of late 2023.

These funding programs typically cover the costs for purchase or lease of EVs, the purchase and installation of charging infrastructure, and expenses for hydrogen fuel cell electric vehicles (FCEVs) and their refueling infrastructure. Multiple funding opportunities exist federally as well as in California, with eligible applicants ranging from private customers, state and local government agencies, tribal governments, school districts, transit agencies, utilities, fleet owners and operators, ports, and in some cases vehicle dealers and charging infrastructure vendors. Funding programs typically have a fixed term and a limited allocation of funds. However, the range of funding options has vastly expanded over the past couple of years and especially in the past few months. Information on specific programs can change quickly and we encourage the City of Elk Grove to monitor and identify funding sources timely and carefully.

Incentive programs have very specific requirements for applications, including specific requirements for eligible vehicles and charging equipment, data reporting, and special considerations for public fleets. Some programs are very competitive and "sell out" quickly and others take time and persistence.

This memo serves as an overview of the most relevant programs with substantial funding resources. Numerous other funding opportunities related to electric vehicles and their charging infrastructure exist in addition to those mentioned.

The resources listed below include information on funding opportunities which we recommend monitoring:

- Alternative Fuels Data Center Overview of Federal and State Laws and Incentives: https://afdc.energy.gov/laws
- California Governor's Office of Business and Economic Development (GO-Biz) ZEV Funding Resources library: https://business.ca.gov/industries/zero-emission-vehicles/zev-funding-resources/
- PlugStar searchable database by ZIP code: https://plugstar.com/tools/incentives
- DSIRE (database of clean energy programs): https://programs.dsireusa.org/system/program

FEDERAL PROGRAMS

NATIONAL ELECTRIC VEHICLE INFRASTRUCTURE (NEVI) PROGRAM

A funding source only available to states, the National Electric Vehicle Infrastructure (NEVI) Program, allocates funding to all states to deploy EV charging infrastructure along designated alternative fuel corridors (AFCs).[19] The NEVI program is part of the Infrastructure Investment and Jobs Act, a $1 trillion infrastructure bill passed by Congress in November 2021.[20] The bill required states to submit their respective initial NEVI implementation plans to the newly established Joint Office of the Departments of Energy and Transportation[21] by summer 2022 California submitted its NEVI implementation plan in August of 2022[22]. The infrastructure bill provides a total of $7.5 billion in federal funding for EV charging infrastructure. The US DOT has also established an additional discretionary grant fund for states and localities that require additional assistance.

California Formula Funding

California's first NEVI deployment plan was approved in September of 2022.[23] Caltrans and the California Energy Commission will manage funding solicitations or grant funding opportunities (GFO). California's share will be $384 million over five years. Caltrans will open new solicitations for funding approximately every 6 months and accept applications for a defined number of corridor groups each time. Only private entities in good standing and with an experienced charging network provider on the team are eligible to apply for funding.

While this program is not one that the City of Elk Grove would be directly eligible for, the NEVI formula funding program should be monitored. Elk Grove lies along one of the designated

---

[19] US Dept. of Energy-Alternative Fuels Data Center: National Electric Vehicle Infrastructure (NEVI) Formula Program: https://afdc.energy.gov/laws/12744

[20] US Dept. of Transportation-Federal Highway Administration: Bipartisan Infrastructure Law *National Electric Vehicle Infrastructure Formula Program*: https://www.fhwa.dot.gov/bipartisan-infrastructure-law/nevi_formula_program.cfm

[21] Joint Office of Energy and Transportation: https://driveelectric.gov/

[22] California's NEVI implementation plan, as prepared by Caltrans and the California Energy Commission and submitted in August 2022: https://dot.ca.gov/-/media/dot-media/programs/sustainability/documents/nevi/2022-ca-nevi-deployment-plan-a11y.pdf

[23] California's NEVI implementation plan, as prepared by Caltrans and the California Energy Commission and approved in September 2022: https://dot.ca.gov/-/media/dot-media/programs/sustainability/documents/nevi/2022-ca-nevi-deployment-plan-a11y.pdf

electric fuel corridors, State Route 99 between Sacramento and Turlock. Elk Grove could use NEVI-funded DCFCs to supplement its own fleet chargers. In addition, low-income or disadvantaged communities as designated by Justice40 can be found within city limits.

CHARGING AND FUELING INFRASTRUCTURE DISCRETIONARY GRANT PROGRAM

The federal Charging and Fueling Infrastructure (CFI) Discretionary Grant Program[24] is a competitive grant program intended to deploy public chargers and alternative fueling infrastructure in urban and rural activity centers (Community Grants program) in addition to along Alternative Fuel Corridors (Corridor Grants program). Approximately $700 million in funding is available for fiscal years 2022 and 2023. Eligible applicants include state, county, and local governments, among other entities. Grant recipients must comply with the EV Charging Minimum Standards (23 CFR part 680) and projects in disadvantaged or underserved communities will receive priority. The Notice of Funding Opportunity was published in March 2023 and applications for the current round were due on May 30, 2023.

With several public charging locations being recommended, this grant should be considered as a potential funding source for Elk Grove. However, the grant requirements include a minimum of four charging ports at each charging station.

VOLKSWAGEN SETTLEMENT FUNDS

Volkswagen's violation of the Clean Air Act with illegal emissions testing to "defeat" devices in approximately 590,000 model year 2009 to 2016 diesel vehicles has resulted in the Volkswagen Settlement Funds.[25] The settlement has different elements, one of which includes zero-emission vehicle investments, amounting to more than $2.8 billion. California's portion of these funds amounts to $423 million,[26] assigned to different project categories as shown in Table 17. Generally, the funds can be used for projects in the heavy-duty sector (except for one project category that reserves funds for the light-duty sector), including on-road freight trucks, transit and shuttle buses, school buses, forklifts and port cargo handling equipment, commercial marine

[24] https://www.grants.gov/web/grants/view-opportunity.html?oppId=346798

[25] United States Environmental Protection Agency: Volkswagen Clean Air Act Civil Settlement: https://www.epa.gov/enforcement/volkswagen-clean-air-act-civil-settlement

[26] National Association of Clean Air Agencies: https://www.4cleanair.org/volkswagen_settlement_information/

vessels, and freight switcher locomotives.[27] A minimum of 50% of the funds will be directed to low-income or disadvantaged communities.[28] The different project categories have different eligibility criteria and are administered by different Air Quality Management Districts (see section titled Sacramento Metropolitan Air Quality Management District for more information, however SMAQMD does not currently fund light duty vehicles).

TABLE 17: CALIFORNIA VOLKSWAGEN MITIGATION TRUST PROJECT CATEGORIES

PROJECT CATEGORY	APPLICATION TYPE	BENEFITING DISADVANTAGED OR LOW-INCOME COMMUNITIES	TOTAL AMOUNT ALLOCATED
ZERO-EMISSION TRANSIT, SCHOOL, AND SHUTTLE BUSES	First-Come/First-Served	50%	$130 million
ZERO-EMISSION CLASS 8 FREIGHT AND PORT DRAYAGE TRUCKS	First-Come/First-Served	50%	$90 million
ZERO-EMISSION FREIGHT AND MARINE PROJECTS	First-Come/First-Served	75%	$70 million
COMBUSTION FREIGHT AND MARINE PROJECTS	First-Come/First-Served	50%	$60 million
LIGHT-DUTY ZERO-EMISSION VEHICLE INFRASTRUCTURE	Competitive Solicitation	35%	$10 million
RESERVE (INCL. ADMINISTRATIVE COSTS)			$63 million
TOTAL COSTS		> 50%	$423 million

Source: https://ww2.arb.ca.gov/resources/documents/californias-beneficiary-mitigation-plan

[27] California Air Resources Board: Volkswagen Environmental Mitigation Trust for California: https://ww2.arb.ca.gov/our-work/programs/volkswagen-environmental-mitigation-trust-california

[28] California VW Mitigation Trust: https://www.californiavwtrust.org/ev-infrastructure/

COMMERCIAL CLEAN VEHICLE CREDIT

Businesses and tax-exempt organizations that buy a qualified commercial clean vehicle may receive a tax credit from the federal government. The credit consists of the lesser of 15% of the purchaser's basis in the vehicle or the incremental cost of the vehicle. The maximum credit per vehicle is $7,500 for qualified vehicles with gross vehicle weight ratings (GVWRs) of under 14,000 pounds and $40,000 for all other qualified vehicles.

To qualify, vehicles purchased by tax-exempt organizations must be made by a qualified manufacturer as defined in Internal Revenue Code (IRC) 30D(d)(1)(C) and not have been allowed as a credit under IRC sections 30D or 45W. In addition, the vehicle must be a plug-in electric vehicle that draws propulsion with a motor with a battery capacity of at least 7 kWh if the GVWR is under 14,000 pounds and 15 kWh if the GVWR is 14,000 pounds or more. Alternatively, the vehicle may be a fuel cell motor vehicle that satisfies IRC requirements.

SUMMARY OF FEDERAL FUNDING

Table 18 below provides a summary of federal funding opportunities and relevant key information for each.

TABLE 18: SUMMARY OF FEDERAL FUNDING SOURCES

SOURCE	PROGRAM/AWARD NAME	ELIGIBLE APPLICANTS	CATEGORY	APPLICATION TYPE	BENEFITING DISADVANTAGED OR LOW-INCOME COMMUNITIES	FUNDING AMOUNT
THE U.S. DEPARTMENT OF TRANSPORTATION - FEDERAL HIGHWAY ADMINISTRATION	National Electric Vehicle Infrastructure Program (State Allocations)	Private entities	DCFC along highway corridors	Competitive grant in CA	40% as per Justice40	$384 million
THE U.S. DEPARTMENT OF TRANSPORTATION - FEDERAL HIGHWAY ADMINISTRATION	National Electric Vehicle Infrastructure Program (DOT Allocation)	States	EVSE, H2 and Alt. Fuel stations in community locations and along Alternative Fuel Corridors	Competitive Grant	Priority evaluation	Up to 80% $700 million overall
VOLKSWAGEN	Volkswagen mitigation trust for California	Public and private entities that own and operate eligible vehicles	ZEV Class 8 Freight and Port Drayage Trucks	First-Come/First-Served	50%	Up to $200,000 per vehicle

STATE SPECIFIC CALIFORNIA PROGRAMS

The following incentive programs and projects are specific to California, administered and/or funded by state agencies, such as CARB[29] or the California Energy Commission (CEC).[30] Some of the funding available in California-specific programs derives from revenue continually generated in the state's greenhouse gas emissions cap-and-trade program[31] or the Low Carbon Fuel Standard (LCFS).[32]

LOW CARBON FUEL STANDARD

Though not a direct source of rebates, incentives, or other upfront funding, LCFS is a market-based approach to incentivizing clean energy administered by CARB. The LCFS creates a marketplace where air polluters may acquire credits to continue to operate, while clean energy users sell credits to generate revenue.[33]

Owners of EV chargers, utility distributors, and EV owners may be eligible for California LCFS credits, as long as the EV charging is metered, as outlined by Figure 32 below. Since EV charging must be metered to qualify for LCFS credits, Level 1 chargers are usually not eligible unless they are individually metered like a Level 2 or DC fast charger. The owner of a charger can claim LCFS credits if the charger is publicly available.

---

[29] California Air Resources Board: https://ww2.arb.ca.gov/

[30] California Energy Commission: https://www.energy.ca.gov/

[31] California Air Resources Board: Cap-and-Trade Program: https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program

[32] California Air Resources Board: Low Carbon Fuel Standard: https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard

[33] California Air Resources Board: Low Carbon Fuel Standard: https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard

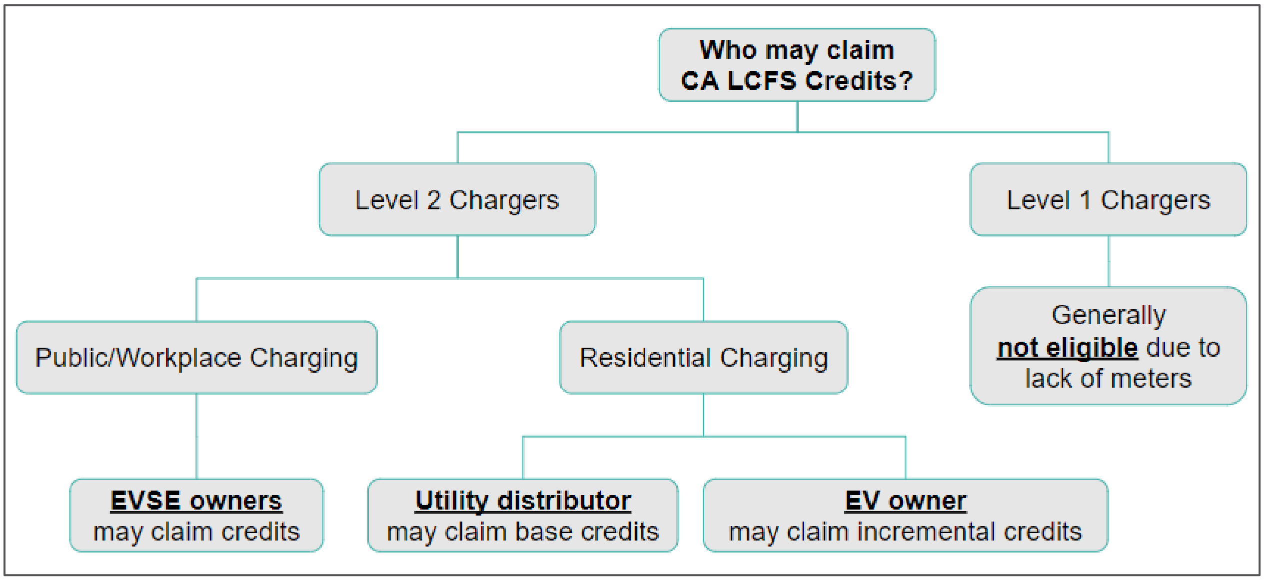


FIGURE 32: WHO MAY CLAIM CALIFORNIA LCFS CREDITS?

Source: California Air Resources Board

LCFS credits have the potential to generate a significant stream of revenue for the charging station owner or the utility. A 7.2 kW Level 2 charger could generate about $1,725 of LCFS credits annually if it is utilized about 7-8 hour per day and 3-5 days per week, at an LCFS credits price of $200 per ton. The LCFS credit value is subject to market fluctuation and has been decreasing since mid-2021 for an average of $69 per ton as of April 2023.[34] The LCFS credits could be a significant revenue stream that could potentially offset operating costs or repay capital expenditures of the chargers.

CLEAN VEHICLE REBATE PROJECT (CVRP)

CARB authorized the Center for Sustainable Energy to administer the California CVRP. The program is two-fold: one part for private EV buyers and one for public fleets (including City-owned vehicles) and rental car and car sharing companies. Eligibility caps apply on vehicle purchase costs ($60,000 for large vehicles such as pickups, SUVs, and minivans and $45,000 for all other light-duty vehicles). Fleets are eligible for a maximum of 20 (rental car and car sharing fleets) and 30 (public fleets) rebates per year. CVRP rebates can be combined with other

[34] California Air Resources Board LCFS Weekly Snapshot: https://ww2.arb.ca.gov/resources/documents/weekly-lcfs-credit-transfer-activity-reports

federal, state, or local agency incentives.[35] As Elk Grove does not contain disadvantaged communities as defined by the CalEnviroScreen tool, the city would be eligible for the standard rebate levels of $2,000 per battery EV, $4,500 per fuel cell EV, $1,000 per plug-in hybrid EV, and $750 per zero-emission motorcycle[36].

HYBRID AND ZERO-EMISSION TRUCK AND BUS VOUCHER INCENTIVE PROJECT (HVIP)

CARB also runs the Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project. The program features two annual funding rounds and provides a point-of-sale rebate for medium- and heavy-duty vehicles, including buses, school buses, refuse trucks, step vans, straight trucks, and tractors. The program web site includes a list of all eligible vehicle models, including most of the market-ready medium- and heavy-duty EVs, and incentive amounts, for example, $120,000 for many Class 7 or 8 trucks.[37] As of this writing, HVIP remains open for all vehicle types. Although the City of Elk Grove is not currently looking to electrify any heavy-duty vehicles, this funding source may be applicable in the future.

CALIFORNIA ELECTRIC VEHICLE INFRASTRUCTURE PROJECT (CALEVIP)

The California Electric Vehicle Infrastructure Project (CALeVIP) was funded by the CEC and implemented by the Center for Sustainable Energy. The CaleVIP 1.0 program is split into different regions across California, including Sacramento County. Both Level 2 and DC fast chargers are funded, and eligible applicants include public agencies, businesses, non-profits, tribal governments, and other site owners.[38]

Funding through the Sacramento County incentive project is fully reserved at this writing and applications are no longer being accepted. While active, this program funded up to $6,500 per Level 2 connector and up to $80,000 per DC fast charger. Interested parties may sign up on the CALeVIP website to receive notices about future funding cycles.

[35] California Clean Vehicle Rebate Project: https://cleanvehiclerebate.org/en

[36] Center for Sustainable Energy: Clean Vehicle Rebate Project Fleet Overview: https://cleanvehiclerebate.org/en/fleet.

[37] California HVIP: https://californiahvip.org/

[38] CALeVIP: https://calevip.org/

CALEVIP 2.0 PROJECT: GOLDEN STATE PRIORITY PROJECT (GSPP)

The Golden State Priority project provides a DC fast charger rebate and currently includes the central and eastern region counties – additional regions may be added as funding availability allows. The application window opened around January 2023 with $10 million allocated to the central region and $20 million to the eastern region. Funding is currently only available for sites located within disadvantaged communities (DACs) or low-income communities (LICs). However, subsequent incentive projects under CALeVIP 2.0 may fund projects outside of DACs and LICs.

Site access requirements no longer require 24/7 access and have been reduced to a minimum of 18 hours per day, 7 days a week, excluding holidays. Only combined charging system (CCS) will be eligible for funding; NACS and CHAdeMO may be installed, but will not be considered for funding. Chargers must also be networked (WiFi, ethernet, or cellular connection) and use open charge point protocol (OCPP). Construction cannot have started prior to the close of the application window.

Four to twenty connecters can be funded and up to 50% of total approved costs covered by the program. Costs incurred starting September 1, 2022, will be eligible. Table 19 outlines the rebate caps per active connector that were available in the central and eastern regions. Again, it is recommended that Elk Grove monitor this program for future funding cycles.

TABLE 19: GOLDEN STATE PRIORITY PROJECT REBATE CAPS

GUARANTEED OUTPUT PER ACTIVE CONNECTOR	REBATE CAPS PER ACTIVE CONNECTOR
150-275 KW	up to $55,000 per active connector
275 KW+	275 kW+: up to $100,000 per active connector
BELOW 150 KW	Below 150 kW: no funding
150-275 KW	up to $55,000 per active connector

Source: https://calevip.org/incentive-project/golden-state-priority-project

COMMUNITIES IN CHARGE

Communities in Charge is a light-duty electric vehicle charging incentive project funded by the CEC's Clean Transportation Program and implemented by CALSTART[39]. Any property owner or authorized lessee may apply for these Level 2 charging incentives. Sites may be for private, public, or mixed use. The base Level 2 EVSE incentive per connector is up to $3,500 or 75% of eligible costs, whichever is less. The proposed charging equipment must be networked and satisfy additional technical criteria. Fifty percent of the current funds are reserved for projects in disadvantaged or low-income communities. A scoring rubric and project readiness scores will be used to award the remaining funds.

[39] Communities in Charge: https://thecommunitiesincharge.org/

SUMMARY OF CALIFORNIA FUNDING

Table 20 below provides a summary of California funding programs related to ZEV infrastructure and vehicles, and relevant key information for each.

TABLE 20: SUMMARY OF CA ZEV INFRASTRUCTURE FUNDING

SOURCE	PROGRAM/AWARD NAME	ELIGIBLE APPLICANTS	CATEGORY	APPLICATION TYPE	BENEFITING DISADVANTAGED OR LOW-INCOME COMMUNITIES	FUNDING AMOUNT
CARB	CLEAN VEHICLE REBATE PROJECT (CVRP Fleets)	Public and commercial fleet owners		Rebate		$2,000 per battery EV
CARB	HYBRID AND ZERO-EMISSION TRUCK AND BUS VOUCHER INCENTIVE PROJECT (HVIP)	All		Rebate		Varies by vehicle type
CEC	CALeVIP [a]	Site owner or their authorized agent	Level 2 & DCFC	Rebate	Additional funds for projects in DACs	Up to $70,000 per DCFC and up to $5,000 per L2 connector
CEC	GSPP [b]	Site owner or their authorized agent	DCFC-150kW-274.99kW	Rebate	100%	Up to 50% of project costs capped at $55,000 per connector

SOURCE	PROGRAM/AWARD NAME	ELIGIBLE APPLICANTS	CATEGORY	APPLICATION TYPE	BENEFITING DISADVANTAGED OR LOW-INCOME COMMUNITIES	FUNDING AMOUNT
CEC	GSPP [b]	Site owner or their authorized agent	DCFC-274kW+	Rebate	100%	Up to 50% of project costs capped at $100,000
CA	LCFS	Electric Utilities, EVSE and EV owners	Clean Energy Credits	LCFS Marketplace	n/a	Market Based
CEC/CALSTART	Communities in Charge	Property owners, lessees, or their representatives	Level 2	Rebate	50%	up to $3,500 per connector

[a] *Sacramento County Incentive Project is currently closed.*

[b] *Golden State Priority Project currently not available in Sacramento County.*

LOCAL AND REGIONAL PROGRAMS

SACRAMENTO METROPOLITAN AIR QUALITY MANAGEMENT DISTRICT

SMAQMD's most recent grant solicitation window opened in Fall 2022. Over $22 million is available in mobile source funding to promote cleaner technology. Note that SMAQMD is not currently funding light duty vehicle incentives. SMAQMD funds EVSE and alternative fueling infrastructure through its Community Air Protection Incentive Program. Funding priority is given to projects operating and/or registered in a disadvantaged community as identified by CalEnviroScreen 4.0 and the designated Community Air Protection Air Monitoring Community. Eligible projects and maximum percentage of costs covered are summarized in Table 21.

TABLE 21: SMAQMD COMMUNITY AIR PROTECTION INCENTIVE PROGRAM PROJECT ELIGIBILITY

	MAXIMUM ELIGIBLE COST PERCENTAGE
ANY INFRASTRUCTURE PROJECT	60%
ANY INFRASTRUCTURE PROJECT LOCATED AT A SENSITIVE RECEPTOR [a]	100%
PROJECTS WITH SOLAR/WIND POWER SYSTEMS [b]	75%
ADDITIONAL INCENTIVE FOR PROJECTS WITH PUBLIC ACCESS	+10%

[a] Sensitive receptors include schools, hospitals, daycare centers, and other such locations.

[b] Projects that include Solar/Wind Power systems must be capable of supplying at least 50% of the estimated electricity output of the EVSE.

Source: Sacramento Air Quality Management District (airquality.org)

SACRAMENTO MUNICIPAL UTILITY DISTRICT

SMUD provides incentives for commercial charging and fleet vehicles, funded in part by LCFS[40]. Table 22 A amounts for each category. Note that these incentives may be layered onto programs offered by SMAQMD. Presumably, these incentives may be combined with federal clean vehicle tax credits, which are calculated based on the purchaser's basis in the vehicle.

TABLE 22: SMUD INCENTIVE PROGRAMS – FLEET REBATES

CLASSIFICATION	DUTY CLASSIFICATION	WEIGHT LIMIT	INCENTIVE
PASSENGER CAR	Light duty	N/A	$750
CLASS 1	Light duty	0-6,000 pounds	$750
CLASS 2A	Light duty	6,001-8,500 pounds	$750
CLASS 2B	Light/Medium truck	8,501-10,000 pounds	$750

Note: Not shown are available incentives for heavy duty vehicles.

Source: Sacramento Metropolitan Utility District

[40] Sacramento Municipal Utility District Incentive Programs: https://www.smud.org/en/Going-Green/Electric-Vehicles/Business.

TABLE 23: SMUD INCENTIVE PROGRAMS – EVSE REBATES

CHARGING TYPE	REBATE	CRITERIA
LEVEL 1 EVSE	$500/handle	Pilot program opportunity (case-by-case)
LEVEL 2 EVSE	$4,500/handle	All EVSE must be J1772, CCS or CHAdeMO handled or charging port equipped.
PUBLIC DCFC >50KW	$30,000/DCFC unit	DCFC must be available for public use
STUB OUTS	$250/stub out	Pilot program opportunity (case-by-case).
TRANSFORMER UPGRADE SUPPORT	$5,000/project	Only for projects that require transformer upgrade due to new EVSE load. Must be participating in SMUD Commercial EVSE program/installation.
PANEL UPGRADE SUPPORT	$1,000/project	Only for projects that require panel upgrades due to new EVSE load. Must be participating in SMUD Commercial EVSE program/installation.

Note: Not shown are available incentives for school bus DCFC.

Source: Sacramento Metropolitan Utility District

PRIVATE FINANCING

There is an emerging opportunity to obtain the full amount of capital needed to fund electric fleet vehicles and charging infrastructure, charging only a usage fee to the user. Such outside capital will allow the fleet operator and/or EVSE host to avoid the high up-front capital expenditure and still realize the lower total cost of operating for EVs. Although private EVSE operators have existed for a while, it may make more sense from a financial and risk perspective to partner with a company that finances the chargers, the vehicles and all future maintenance, upgrades, and expansions. The outside capital generally would consist of a combination of equity and debt and will be tailored to the project. Private financing groups like 7Gen[41] and investment groups like Sustainability Partners[42] have established some of the most creative and beneficial structures to ensure the highest excellence and efficiency for public sector customers.

[41] https://www.7gen.com/

[42] https://www.sustainability.partners/

APPENDIX C: EV CHARGING STRATEGY OPTIONS

APPENDIX C: INTRODUCTION

The following information is intended to inform the selection of charging options for vehicle fleets at their facilities. This analysis evaluates four primary charging strategies shown below:

- Strategy 1: Dedicated Level 1 and Level 2 chargers
- Strategy 2: Dedicated Level 2 chargers with load management
- Strategy 3: Shared Level 2 chargers with load management
- Strategy 4: Shared DC fast chargers

Conceptually, the simplest way to charge an electric vehicle fleet is with dedicated chargers assigned to each vehicle, so that every vehicle can charge while parked overnight in an assigned parking stall equipped with its own EV charger. This strategy made sense for early EV models with small batteries driven during the day and parked overnight, providing ample parking time (also known as dwell time) for battery charging using low-speed chargers. However, since most public agency fleet vehicles drive relatively few miles per day compared to their existing or anticipated battery capacity, dedicated chargers are not typically necessary and there are more efficient and cost-effective charging strategies.

Currently available light-duty EVs typically used by fleets like the Chevy Bolt and Nissan Leaf Plus have 60 and 62 kWh batteries respectively, providing well over 200 miles of range, and newer EVs have even greater range, typically over 250 miles. Due to the relatively minimal energy requirements of the City's fleet vehicles (see **Chapter 2**), coupled with long overnight dwell times, the City's light-duty fleet EVs could share chargers, or at least share power loads, through a power load management strategy, supplemented with occasionally using the City's planned DC fast charger when needed. As a result, a range of currently available and emerging charging options that could be deployed in the near term at facilities with fleet EVs were considered for Elk Grove's fleet electrification.

For each strategy, the sections below highlight how fleet operations would look under that strategy, which benefits and disadvantages come with it, and general recommendations as when the respective strategy is the most suitable to leverage. Table A1 (in a visual form) and Table A2 (with bullet-point text) below summarize this information.

It should be noted that, for any given fleet, typically, a combination of different strategies with some degree of customization is the most suitable one. As presented in detail in the section on charger recommendations (Chapter 3), the recommended approach for Elk Grove is utilizing shared chargers, both Level 2 and DC fast chargers, distributed at different fleet locations across the city, given decentralized parking, the local topography, and modeled energy needs of an electrified municipal fleet.

DETAILS ON CHARGING STRATEGIES

STRATEGY 1: DEDICATED LEVEL 1 AND LEVEL 2 CHARGERS

The basic way to charge a fleet is with individual chargers dedicated to each vehicle in the fleet. This approach to charging typically requires each fleet vehicle to be assigned a parking stall and that each parking stall be equipped with its own electrical outlet for Level 1 charging or so-called "dumb" Level 2 charger for faster charging. Here, "dumb" refers to chargers that do not feature advanced capabilities such as load management or sharing, demand response, or comprehensive user and data interfaces and connectivity.

This analysis assumes the use of Level 1 charging for fleet vehicles that drive so little each day that they would be able to fully charge their batteries overnight (at a power output typically between 1.3 and 1.8 kW) or have sufficient battery capacity to make up the nightly charging deficit by fully recharging over the weekend when fleet vehicles are not being driven. For vehicles that drive more, this strategy would assign Level 2 chargers due to their ability to provide more vehicle range during the same charging period. This baseline charging scenario assumes the use of low cost "dumb" chargers which are preferred by some fleets as a way to reduce charger purchase costs, avoid monthly data connectivity fees, and address potential reliability issues associated with more sophisticated technologies like networked chargers.

OPERATIONS

Vehicle drivers pick up the vehicle at the assigned stall, manually disconnect the charger before using the vehicle, and later return the vehicle to the same assigned stall and reconnect the charging cord.

BENEFITS

The primary benefit of this approach is its simplicity and predictability for fleet operators and drivers.

- While dedicated Level 1 charging is limited to lightly used light-duty vehicles, dedicated Level 2 chargers can charge vehicles with greater daily mileage and may also be appropriate for charging some medium- and potentially even some heavy-duty vehicles, as long as their daily duty cycle is extremely light.
- Unlike Level 1 chargers, dumb Level 2 chargers are typically available up to 11.5kW, which is a sufficient power output to replenish many batteries overnight.
- Dedicated chargers ensure daily full battery state of charge for all fleet EVs.

Slow charging using Level 1 or 2 chargers is best for EV battery health.

DISADVANTAGES

The main disadvantages of dedicated chargers include resource inefficiency, lack of data tracking for accounting, planning and revenue, potential demand charges by electrical utilities and construction impacts. Each of these issues are discussed below.

A ratio of one charger per parking stall or per EV requires installation of numerous electrical outlets or chargers, which is generally inefficient because each charger would typically be in use for charging only a relatively small fraction of the time. Compared to sharing chargers, this can potentially be a costly approach due to the expense of procuring and installing more chargers. In addition, Chapter 6, section 625 of the National Electrical Code (NEC) requires a dedicated single pole circuit breaker for each 110 V outlet (used by Level 1 chargers) or 220 V dumb Level 2 charger. Depending on the number of EVs to charge, this can easily exceed the capacity of each facility's main electrical panel, requiring installation of subpanels. Therefore, the lower cost of not needing to purchase more expensive smart chargers may be offset by the costs of additional electrical service upgrades. As a result, many medium-sized and most large fleet facilities will typically require costly electrical service upgrades including a new electrical panel or subpanel to comply with this requirement.

Another important disadvantage is that dumb chargers and wall outlets lack the ability to track electrical use by vehicle or department. Not only is this information useful for accounting purposes by the fleet or facility manager, it is very helpful for tracking emissions reductions, and for providing data for planning purposes. Also, this data is typically required for Low Carbon Fuel Standards or clean fuel credit compensation.

Operational costs of dedicated chargers without load management or shared charging (discussed in other charging strategies) can be higher as well. Simultaneously charging multiple EVs at facilities, without managed charging or energy storage incorporated into the system, could result in additional demand charges. It is important to note that many utilities have or are developing electrical rate structures that specifically benefit EV charging, e.g., with time-of-use rates that incentivize off-peak EV charging. In addition to the financial and planning considerations, the installation of electrical conduit to every stall in the parking facility will result in the most displacement and other operational impacts during the charging infrastructure construction period.

GENERAL RECOMMENDATIONS

Dedicated chargers generally make the most sense in the following circumstances:

- Small fleet facilities with few EVs, especially EVs with light duty cycles and at fleet facilities with as many existing electrical outlets as assigned EVs
- Facilities at which a limited number of EVs are domiciled and ample electrical capacity is available
- Locations that are currently equipped with sufficient existing outlets or dumb level 2 chargers dedicated to a unique parking space/fleet EV

STRATEGY 2: DEDICATED LEVEL 2 CHARGERS WITH LOAD MANAGEMENT

As previously addressed, one way to reduce the maximum power load to avoid or reduce needed electrical service upgrades or utility demand charges would be by splitting or balancing the power between chargers (load splitting or balancing), or load management systems. These systems allow fleet operators to control when and how each fleet EV is charged by distributing power between chargers.

With the extra capacity available in buildings, and by utilizing a load management system, certain facilities may be able to avoid the need for electrical service upgrades. Additionally, since load management can integrate with a building's electrical system, facility upgrades that conserve electricity, such as replacing windows, installing air barriers, or upgrading lighting to multi-level LED, can significantly increase capacity for vehicle charging at fleet parking garages that share their electrical systems with buildings.

OPERATIONS

From the driver's perspective, this scenario would function identically to the baseline scenario. For fleet or facility managers, the difference would be the ability to monitor EV charging in real-time, and the ability to prioritize charging of certain vehicles or adjust the power distribution between EV charging and the building.

BENEFITS

Of all the charging strategies considered, dedicated smart chargers with load management provide the most operational simplicity while also providing data and the ability to manage electrical loads. The primary benefits of smart charging with load management include:

- The ability to track data and for chargers to be managed in real-time or be pre-programmed to optimize charging for goals such as reduction of peak electrical load to reduce or avoid costly electrical service upgrades and reduce or avoid utility demand charges.
- Enhanced ability to charge medium- and heavy-duty fleet vehicles with light or variable duty cycles and provides charging flexibility.
- A charger to EV ratio of 1:1 will optimize the benefits of bidirectional charging for fleet vehicles with bidirectional charging capability for providing backup power to facilities, fleet EVs and grid generating grid services revenue through vehicle to grid integration.
- Managed charging using Level 2 chargers is safe for EV battery health.

DISADVANTAGES

As with Strategy 1, dedicated chargers with load management are linked with exactly one vehicle each, resulting in significant infrastructure investments and operational impacts during installation. The addition of load management requires networked smart chargers, which typically results in higher purchase costs as well as higher ongoing monthly data and service costs than dumb chargers, depending on the individual system and quantity of chargers. Third-party load splitting or management systems can operate with non-networked dumb chargers, but the equipment and service require additional capital and data costs. Level 1 chargers are generally incapable of load management, so this scenario only includes Level 2 chargers. Of all the charging strategies considered, dedicated smart chargers with load management can be the costliest strategy due to the higher cost of smart chargers coupled with the need for a high number of chargers and the ongoing cost of data connectivity.

GENERAL RECOMMENDATIONS

Adding load management to dedicated chargers generally makes the most sense in fleet depot facilities with limited power supply where relatively large numbers of heavily-utilized light-duty EVs with long dwell times will be domiciled. Different load management systems are appropriate for fleet facilities of different scales.

STRATEGY 3: SHARED LEVEL 2 CHARGERS WITH LOAD MANAGEMENT

At facilities with shared chargers, a reduced number of Level 2 chargers are installed to serve all the fleet EVs domiciled by rotating vehicles between chargers. Based on relatively low use/mileage (miles/day) and parking durations (12-16 hours), this should be generally feasible for most EV fleets operated by public agencies. This strategy requires careful and systematic monitoring and scheduling of fleet EVs' state-of-charge, charging times, and station power outputs, to optimize the utilization of the installed charging infrastructure.

OPERATIONS

This can be accomplished by rotating parking assignments, or by installing the chargers centrally between parking stalls so that each charger can access multiple vehicles simply by moving the charge cord from vehicle to vehicle. Not needing to charge their batteries every night means fleet EVs could share chargers by taking turns based on a schedule or depending on each vehicle's state of charge. Additionally, a shared DC fast charger (Strategy 4) could potentially supplement shared Level 2 chargers at large fleet facilities with multiple light-, medium-, and heavy-duty vehicles in the future as EV fleets diversify with an increased electrification of heavier vehicle classes. In cases where dwell times are limited to less than eight hours, the anticipated duration of charging may still be sufficient to charge the relatively small number of EVs with low daily mileage.

BENEFITS

The primary benefits of sharing chargers include mitigating potential electric service upgrade costs and reducing initial investment costs associated with the procurement and installation of chargers since a reduced number of individual units are required. This approach is also useful to leverage the constrained electrical capacity of certain sites to install more chargers that would share the limited electrical service by managing (or balancing) the load. Another potential benefit includes reduced peak demand charges by flattening power demand spikes resulting from unmanaged charging.

DISADVANTAGES

Sharing chargers requires careful management of fleet EVs to ensure that all vehicles maintain a sufficient state of charge for their intended daily use. Because the vehicles or the charge cords would need to be moved, this could require behavioral adjustment by fleet vehicle drivers or by dedicated fleet or parking management staff or contractors which increases operation costs. As more EVs are added to the fleet, it is likely that a typical fleet would need to procure and install additional chargers.

GENERAL RECOMMENDATIONS

Sharing chargers makes the most sense under the following circumstances:

- Facilities that serve fleet EVs that typically drive less than 40 miles per day and have dwell times longer than eight hours
- Facilities with limited available electrical capacity to avoid the expense of electrical service upgrades
- Facilities at which there already is or there is potential for dedicated staff to manage fleet EV charging

STRATEGY 4: SHARED DC FAST CHARGERS

Another way to charge EVs is with DC fast chargers. Unlike Level 2 chargers which take multiple hours to charge most EV batteries, a 150 kW DC fast charger can fill a typical light-duty fleet EV's battery to 80% state of charge in approximately 35 minutes. Higher power chargers can charge some EVs in significantly less time, depending on the charger's power and the EV's DC acceptance rate. The opposite is true for less powerful DC fast chargers, so 150 kW is generally recommended. For the same reason, medium and heavy-duty EVs can also charge more quickly using DC fast chargers which is why transit agencies, trucking companies, school bus operators, and other heavy-duty EV fleets primarily rely on DC fast chargers.

DC fast chargers are too fast and expensive to justify dedicated chargers assigned to individual EVs (except in the case of certain heavy-duty vehicles) but sharing DC fast chargers between multiple EVs can make sense for many fleets.

OPERATIONS

There are multiple ways for fleets to use DC fast chargers. For example, drivers could park the EV at the DC fast charger-equipped stall following their trip and connect to the charger where it would remain while charging until the next driver picked it up. Alternatively, a fleet could hire parking management staff or a contractor to rotate EVs through the DC fast charger when they fall below a set minimum state of charge.

Charging speeds are determined by the power rating of the charger as well as the charging acceptance rate of the EV. Until recently, light-duty EVs commonly purchased by fleets such as the Chevy Bolt could only charge at speeds up to 50 kW. However, the Nissan Leaf and newer EVs like the Ford F-150 Lightning and upper-end models such as the Ford Mustang Mach-e have far faster acceptance rates allowing them to charge at speeds up to 150 kW when charged by more powerful DC fast chargers. As battery and related technologies improve, faster charging will likely become more feasible for an increasing number of light-, medium-, and heavy-duty EVs used by fleets. Since more powerful charging takes less time, EV drivers would only need to wait for a little over half an hour to fully charge many EV models using a 150 kW high-power charger and even less time for topping off an only partially discharged battery. Using such a charger, a fleet EV driver could recharge a light-duty EV while he or she waited or while doing a brief errand whenever the vehicle's battery state of charge falls below a specified level, or simply top off the battery after every use. The same charger could also be used for overnight charging of heavy-duty fleet vehicles or potentially as paid public charging during nights and weekends when not in use for fleet charging if installed at locations accessible to the public, however this is not an option at many fleet facilities.

Many DC fast chargers use modular architecture allowing them to be expanded with additional modules. When equipped with multiple charge cords, these chargers can charge multiple vehicles simultaneously, with power flow to each vehicle controlled by charge management software that considers battery state-of-charge and other factors. The charging speed is constrained by the total power output of the charger, so each EV sharing a dual-port charger would charge at approximately half the speed compared to when only a single EV is being charged with the same charger.

BENEFITS

The main benefits of DC fast chargers are faster charging speeds, and flexibility for different types of EVs and possible use by agency employees and the public when not in use for fleet charging.

- Although 50kW to 150 kW DC fast chargers typically cost more than $50K each—several times the cost of a Level 2 charger—far fewer are needed than Level 2 chargers, especially considering the relatively light usage of most fleet vehicles. Since the infrastructure upgrades and installation costs comprise a higher share of the project budget than charger purchase costs, fewer installed chargers could result in substantial capital cost savings. Depending on how the fleet charges its vehicles, the number of chargers needed depends on the charging speed (so the faster the charger, the fewer chargers the fleet will need).

- Faster charging speeds offer the advantage of operational flexibility, being able to recharge an EV relatively quickly, allowing the same vehicle to be quickly re-deployed following a long trip and could also charge medium- and heavy-duty vehicles. If a fleet opted to share charging facilities with vehicles from other institutions, employees, or the public, DC fast chargers would offer more flexibility than Level 2 chargers, and the more powerful the DC fast charger, the more flexibility it would offer the fleet.
- Depending on the accessibility of the DC fast chargers' location, it could potentially be made available for other users including the public when not in use by fleet vehicles, creating a potential source of revenue for the charger owner.

DISADVANTAGES

The main challenges of DC fast chargers are operational and physical.

- DC fast chargers require active management, potentially dedicated staff, to optimize since EVs (or at least the charge cord) would need to be moved after each charge.
- DC fast chargers are large (relative to Level 2 chargers), sometimes including multiple components making charger placement a challenge at physically constrained parking facilities. In addition, their physical footprint may reduce the number of parking spots in a facility, which may impact parking capacity and, in some cases, parking revenue.
- For shared use of charging by users other than fleet EVs such as employees or the public, shared DC fast chargers need to be installed in locations open to multiple users.
- Under some utility tariff structures, the higher wattage of DC fast chargers would incur demand charges which can be significant, potentially resulting in much higher electrical costs than Level 1 or Level 2 chargers for fleet EV charging. In general, the faster the charger, the higher the demand changes.
- DC fast chargers, especially higher power chargers, require significant capital investments. In addition to the costs of chargers, installation of multiple DC fast chargers typically requires significant electrical service upgrades.
- Excessive or regular use of high-speed charging can negatively impact the health of EV batteries when done over the lifetime of a vehicle.

GENERAL RECOMMENDATIONS

Sharing DC fast chargers make the most sense under the following circumstances:

- Facilities that serve larger numbers of fleet EVs, especially EVs with varied duty cycles.
- Facilities serving (or that in the future will serve) medium- and heavy-duty EVs as well as light-duty EVs, since DC fast chargers can charge larger batteries quicker than Level 2 chargers.
- Facilities where charging for multiple users in addition to fleet EVs will be permitted.
- Facilities at which there already is or there is potential for dedicated staff to manage fleet EV charging.

SUMMARY OF CHARGING STRATEGIES

Table C1 compares the different charging strategies with respect to the various criteria discussed above. **Table C2** summarizes the strategies in detail in regard to the operational impacts, benefits, disadvantages, and typical use cases of each strategy.

VISUAL SUMMARY OF THE BENEFITS AND DISADVANTAGES OF ALTERNATIVE CHARGING STRATEGIES.

	STRATEGY 1: DEDICATED L1 & L2 CHARGERS	**STRATEGY 2:** DEDICATED L2 CHARGERS WITH LOAD MANAGEMENT	**STRATEGY 3:** SHARED L2 CHARGERS WITH LOAD MANAGEMENT	**STRATEGY 4:** SHARED DC FAST CHARGERS
CONVENIENCE AND SIMPLICITY	⇈	⇈	⇊	⇊
CAPACITY FOR FUTURE FLEET EXPANSION	–	⇈	–	⇈
REDUCES PEAK DEMAND AND RESULTING SERVICE UPGRADES	⇊	⇈	↑	↓
COSTS FOR HARDWARE PURCHASE, INSTALLATION, AND LOAD UPGRADES	↓	⇊	↑	⇈
PARKING/CHARGING MANAGEMENT	⇈	⇈	⇊	⇊
RISK OF VEHICLES NOT BEING CHARGED	⇈	↑	⇊	⇊
FLEXIBILITY FOR DIFFERENT VEHICLES AND USERS	⇊	↓	⇊	⇈
RISK OF UTILITY DEMAND CHARGES	⇈	⇈	⇈	⇊
UTILITY FOR BIDIRECTIONAL CHARGING	↓	⇈	↑	↓
IMPACT ON EV BATTERY HEALTH	⇈	⇈	↑	⇊

TABLE C2: OVERVIEW OF GENERAL CHARGING STRATEGIES SUITABLE FOR EV FLEETS.

	STRATEGY 1: DEDICATED LEVEL 1 AND LEVEL 2 CHARGERS	**STRATEGY 2:** DEDICATED LEVEL 2 CHARGERS WITH LOAD MANAGEMENT	**STRATEGY 3:** SHARED LEVEL 2 CHARGERS WITH LOAD MANAGEMENT	**STRATEGY 4:** SHARED DC FAST CHARGERS
OPERATIONS	• Drivers manually connect and disconnect the vehicle to and from the charger upon returning to the vehicle and before using it, respectively	• From driver's perspective: same as Strategy 1 • For fleet and facility managers: ability to monitor EV charging in real-time, ability to prioritize certain vehicles or adjust or limit power output	• Rotate parking assignments or install chargers between parking stalls so that they can be accessed by multiple vehicles • Take turns or follow schedule for charging vehicles (not charging every day or night) • A shared DC fast charger could supplement at large facilities that house a diverse vehicle fleet	• Multiple possible approaches: fast charging between trips by different drivers, staff or contractor to rotate EVs through the fast charger(s) • Charging speeds limited by charging acceptance rate which varies by vehicle • Charger(s) could be used by heavy-duty vehicles overnight (if parking stall design allows) • Charger(s) could be opened for paid public use overnight and on weekends (if location accessible to public)
BENEFITS	• Simple and predictable • Potentially suitable for all duty classes of vehicles (light-, medium-, heavy-duty) • Dedicated Level 2 charger can replenish the batteries of all light-duty vehicles overnight • Guaranteed full battery state of charge every day • Slow charging is best for battery health	• Most operational simplicity while providing data and ability to manage loads • Ability to optimize charging e.g. for peak load reduction, avoid electrical service upgrades, or reduce demand charges • Enhanced ability to charge medium- and heavy-duty vehicles • Optimal utilization of capabilities of bidirectional charging • Managed, slow charging good for battery health	• Mitigated potential electric service upgrades • Reduced initial investments costs for procurement and installation of chargers • Leverage constrained electrical service at certain sites • Reduced peak demand charges	• Faster charging speeds • Possible use by public • Potential for capital cost savings due to fewer installed chargers • Added operational flexibility

	STRATEGY 1: DEDICATED LEVEL 1 AND LEVEL 2 CHARGERS	**STRATEGY 2:** DEDICATED LEVEL 2 CHARGERS WITH LOAD MANAGEMENT	**STRATEGY 3:** SHARED LEVEL 2 CHARGERS WITH LOAD MANAGEMENT	**STRATEGY 4:** SHARED DC FAST CHARGERS
DISADVANTAGES	• Resource inefficiency • Large infrastructure investments • Large construction impacts • Potential costly electrical service upgrades • Lack of data tracking or connectivity • Potential demand charges from utility • Non-optimized charging times may result in higher per kWh costs	• Resource inefficiency • Large infrastructure investments • Large construction impacts • Higher charger purchase costs and higher ongoing monthly data and service costs	• Requires careful management of fleet EVs and their state of charge • Requires behavioral adjustment by fleet vehicle drivers (as vehicles and/or charge cords need to be moved) or dedicated fleet staff or contractors which increases operation costs • Requires more planning around when and where which numbers of chargers need to be in place	• Requires careful fleet management to maximize the use of the (costly) charger(s) • Installation sometimes constrained by physical space given that DC fast chargers are larger than Level 2 chargers and sometimes include multiple components • May incur demand charges, depending on the utility rate structure • Potential costly electrical service upgrades • Excessive or regular use of high-speed charging may negatively impact battery health
GENERAL RECOMMEN-DATIONS AND SUITABLE USE CASES	• Small fleet facilities with few EVs, especially EVs with light duty cycles and at fleet facilities with as many existing electrical outlets as assigned EVs • Facilities at which a limited number of EVs are domiciled and ample electrical capacity is available • Locations that are currently equipped with sufficient existing outlets or dumb level 2 chargers dedicated to a unique parking space/fleet EV	• Fleet depot facilities with limited power supply and a relatively large number of heavily-utilized light-duty EVs with long dwell times	• Facilities that serve fleet EVs that typically drive less than 40 miles per day and have dwell times longer than eight hours • Facilities with limited available electrical capacity to avoid the expense of electrical service upgrades • Facilities at which there already is or there is potential for dedicated staff to manage fleet EV charging	• Facilities that serve larger numbers of fleet EVs, especially EVs with varied duty cycles. • Facilities serving medium- and heavy-duty as well as light-duty EVs, since DC fast chargers can charge larger batteries quicker than Level 2 chargers. • Facilities where charging for multiple users in addition to fleet EVs will be permitted. • Facilities at which there already is or there is potential for dedicated staff to manage fleet EV charging

APPENDIX D: BEST PRACTICES RELATED TO EVS AND EVSE

This Appendix summarizes best practices for installation of EV chargers.

CHARGING EQUIPMENT BEST PRACTICES

The following best practices and decision criteria are included to provide guidance in the sizing, selection, and placement of chargers. The issue of addressing resiliency by providing alternative sources of temporary power during utility outages is also included.

CHARGER SIZING

The critical factors in evaluating the “size” (or power, as measured in kW) of EV chargers are the intended vehicle’s battery capacity, charging acceptance rate, energy consumption, dwell time, and the quantity of EVs to be charged.

BATTERY CAPACITY

The capacity of the battery is measured in kilowatt hours (kWh). EVs commonly purchased by fleets and the general public typically have batteries ranging in size from 40-100 kWh. Larger battery sizes can typically require longer charging durations, but greater storage capacity means reduced charging frequency.

CHARGING ACCEPTANCE RATE

Each EV has a maximum acceptance rate for both AC and DC charging. Since this rate is the vehicles’ maximum charging speed, it should be used to calculate the charging duration. While there is no current benefit for fleets and public charging station hosts to purchase higher-speed chargers, future EVs may become available with higher acceptance rates that may require installation of high-power chargers. This may especially become the case with more and more automakers adopting 800-Volt battery architecture, which support higher speeds of charging.

EV QUANTITY

In general, if a site is planned to be used by multiple EVs, charger quantities and speed should be calculated to ensure reasonable charging times, especially if chargers are shared between multiple EVs. Fleet managers should consider the frequency with which they plan to rotate EVs though shared chargers.

ELECTRICAL CAPACITY

The critical factor to determine charger sizing is the available electrical capacity. The electrical panel rating and the available electrical capacity at the charging facility will determine the number of chargers that can be installed and their maximum power ratings. Since many existing facilities were built without anticipating the need to charge EVs, unused capacity to accommodate significant charging infrastructure is typically not available. Here, portable charging stations can be of help to reduce the peak demand imposed on the grid and thus mitigate the need for electrical service upgrades for new charging infrastructure.

ENERGY CONSUMPTION

Vehicle energy consumption consists of its average "daily duty cycle" (average miles traveled). For fleet managers the daily duty cycle for each vehicle type can be useful to calibrate the total charging needs for a particular site.

DWELL TIME

For municipal agencies like Elk Grove, assuming most fleet vehicles will charge overnight while not in use, the duration of "dwell", or stationary charging time, determines the maximum charge duration per night. Longer dwell times mean slower chargers (chargers with smaller kW rating) can be used, which are often less expensive in terms of both purchase costs and electrical service upgrades.

CHARGER SELECTION

Key considerations to help guide charger selection are listed below. Table 24 summarizes recommended features and capabilities relevant to these attributes.

- **Charge plugs:** For most applications, dual-head plugs are more cost-effective and versatile. Level 2 uses J1772 standard plugs while DCFC uses CCS standard plugs. However, these will likely transition to NACS (already in use by Tesla) as NACS is expected to become the national charging standard by 2024/2025.
- **Usability:** The charger should be easy to use by drivers and the charge cord length should reach multiple stalls. The charger face plate should be easy to read in any lighting condition; color-coded lights that indicate charging status increase readability.
- **Ruggedness:** Outdoor charging equipment requires robust hardware as it is exposed to the elements, repeated use, and possibly abuse or vandalism. Chargers installed in garage interiors or with less public use may require less robust and costly hardware. Most

charger vendors include at least a one-year warranty; some vendors include or offer optional extended warranties.

- **Connectivity:** Charging data needs to be conveyed between the chargers, controllers, and management system. Multiple connectivity options are available depending on the charger or site where the chargers are located. These include wired connections using fiber or wireless connections using radio signals such as cellular or WiFi.
- **Payment/data collection:** Collecting payment for charging or tracking energy usage by EVs (or for fleet managers, by departments) can occur through a variety of mechanisms. Not all chargers offer payment functionality. Charging facilities should have a mobile payment device physically located on each charger dispenser or on a kiosk serving the charger dispenser, must support remote start capabilities for, at minimum, payment via a toll-free number. No membership for payment should be required.
- **Efficiency:** Chargers with power load management capability are the most energy efficient; ENERGY STAR-rated chargers use 40% less energy in stand-by mode.
- **Certification:** Commercially available chargers that are certified ensures product integrity, energy efficiency, and chargers that conform with the highest safety standards. Table 24 lists some current certifications available for EV chargers.
- **Interoperability:** Open charge point standards are critical to making EV charging hardware compatible with multiple charging software platforms, providing greater flexibility, accessibility, and affordability for the charging system operator relative to charging hardware using proprietary software. Most chargers are currently OCPP 1.6 compatible, but OCPP 2.0 is becoming increasingly available with superior functionalities explained below.
- **Future proofing:** Charging technology changes rapidly. To maximize the lifespan of charger investments, consider the following adaptable features:
    - OCPP 2.0 compliance expands functionality beyond OCPP 1.6 by improving device management, transaction handling, security features, smart charging functionalities, bidirectional communication, and ISO 15118 support.
    - Modular architecture consists of a singular centralized controller that supports multiple charging heads that can be added over time to provide scalability to meet growing future needs.
    - Demand Response (DR) capability avoids charging during periods of peak power demand and prioritizes charging when the grid has ample electrical capacity.

- ISO 15118 Plug-and-Charge technology-ready simplifies the payment process so that the charger recognizes each fleet vehicle and automatically bills the correct account.
- Bidirectional (V2G) charging based on ISO/IEC 15118 standards and UL 1741-SA and UL 9741 Certification.
- The North American Charging Standard (NACS) is currently being standardized as SAE J3400 and is expected to replace the SAE J1772 by 2025. Originally developed by Tesla in 2012, it was opened up to other EV manufacturers in 2023. During the transition from J1772 to NACS, non-Tesla EV manufacturers will initially provide adaptors to allow EVs equipped with J1772 ports to use Tesla chargers in 2024 and will add NACS plugs to their EV products the following year. Therefore, chargers equipped with NACS plugs or that can be upgraded to NACS and J1772-to-NACS adaptors will need to be included in future charger purchases by fleets.

- **Data collection:** Fleet or facility managers need data from chargers to inform future decision-making and require dependable, accessible, secure, and frequently updated systems.

TABLE 24: RECOMMENDED EV CHARGER ATTRIBUTES

ATTRIBUTE	RECOMMENDED CAPABILITY OR FEATURES
CHARGE PLUGS	• Level 2: Dual-head J1772 (and CHAdeMO for fleets with older Nissan Leafs) or Tesla/NACS/J3400 • DCFC: Dual-head 150 kW (or faster) with CCS and NACS plugs
USABILITY	• Cable management capability with 25-foot cable length • Visible charging status lights
RUGGEDNESS	• NEMA-4 rated to operate outdoors and in extreme weather conditions. • Minimum warranty of three years • Field-swappable modular components
CONNECTIVITY	• Ethernet • 4G/5G wireless communication • Wi-Fi • Bluetooth
PAYMENT/DATA COLLECTION	• Payment collection options to include RFID or QR code, Credit/debit card tap or swipe, Apple Pay, Google Wallet, or with smartphone app • Compliance with electric metering requirements in the CCR 4002.11 Electrical Vehicle Fueling Systems • Provide a mobile payment device physically located on each charger dispenser or on a kiosk serving the charger dispenser. • Support remote start capabilities for, at minimum, payment via a toll-free phone number.

	• Membership for payment not required.
EFFICIENCY	• Load management/power sharing capability • ENERGY STAR[43] rated
CERTIFICATION	• Certified by the UNDERWRITERS' Laboratories, Inc.[44] (UL), to UL 2594*Compliant with Society of Automotive Engineers (SAE) J1772 standard for charging plug connector and operational requirements[45]. • Appropriate IEEE[46] & NEC[47] Ratings
INTEROPERABILITY	• OCPP 1.6 Compliance and Certification
FUTURE PROOFING	• OCPP 2.0 compliance and certification • Modular architecture and scalability • Demand Response capable • ISO 15118 Plug and Charge technology-ready • Bidirectional (V2G) charging[48] based on ISO/IEC 15118 standards and UL 1741-SA and UL 9741 Certification.
DATA COLLECTION	• Capacity to accurately record and produce the number of unique charging events, average duration of each charging event, kilowatt hours delivered by each charger and downtime at each charger by month • Cloud-based dashboard portal

CHARGER PLACEMENT AND INSTALLATION

[43] EPA's ENERGY STAR certified EV chargers provide the same functionality as standard products but use 40% less energy in standby mode: https://www.energystar.gov/productfinder/product/certified-evse/results

[44] UL is an OSHA-accredited Nationally Recognized Testing Laboratory (NRTL) that tests products, including EV charging stations, to applicable UL standards for safety. UL has multiple EV safety standards including: 2202 – Electric Vehicle (EV) Charging System Equipment; 2594 – Electric Vehicle Supply Equipment (EVSE); 2251 – Plugs, Receptacles and Couplers for Electric Vehicles; 62 – Flexible Cords and Cables; 2231-1 & -2 - Personnel Protection for EVSEs and 9741 – Bidirectional EV Charging System Equipment: https://www.ul.com/resources/apps/product-iq

[45] Society of Automotive Engineers (SAE) J1772 and 3400 covers the general physical, electrical, functional and performance requirements to facilitate conductive charging of EV/PHEV vehicles in North America. https://www.sae.org/standards/content/j1772_201710/ and https://www.sae.org/standards/content/j3400/

[46] IEEE 1547: Interconnecting Distributed Resources with Electric Power Systems and IEEE 1547.1: Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems. https://standards.ieee.org/standard/1547-2018.html

[47] Section 625 of The National Electrical Code regulates electrical conductors and equipment supporting EV charging. https://www.ecmweb.com/national-electrical-code/article/20899765/article-625-electric-vehicle-charging-systems

[48] https://www.charinev.org/news/news-detail-2018/news/the-five-levels-of-grid-integration-charin-ev-grid-integration-roadmap-published/

To optimize operational efficiency and reduce installation costs, when planning to place or install EV chargers, consider the four factors below:

1. Electrical service

- Providing power for chargers is typically the most complex and expensive part of EV charger projects, especially for large-scale charger installations like fleet depots that typically lack sufficient existing electrical capacity for deployment of large numbers of chargers and therefore will require electrical service upgrades from the local utility. Depending on the site, providing power to the chargers can be simple or complex. Where appropriate, multiple options for providing power such as from the utility-owned transformer or from the site host facility's electrical room should be considered.
- Evaluate capacity of electrical infrastructure (utility service and electrical panel) to support immediate and long-term vehicle charging needs. Identify costs for necessary electrical service upgrades in collaboration with local utilities and/or a qualified electrician.
- To help minimize costs, choose charging locations that are as close as possible to existing or proposed electrical service infrastructure and other EV charging stalls.
- Plan electrical raceway or conduit runs for electrical wiring and data cables from the electrical panel serving the chargers and consider a layout that minimizes linear conduit distances to all proposed EV charger-equipped parking spaces.
- If possible, install chargers during construction, remodels, or other facility upgrades planned to reduce costs and minimize construction impacts.
- Charger hosts should consider different strategies to separate meters for building and electric vehicle charging uses to manage peak load impact on the grid and minimize demand charges for electric vehicles.

2. Charger location and layout

- Key considerations for siting fleet chargers include proximity to available power, user convenience, and parking facility operations.
- To reduce the cost of conduit and conductor installation and minimize voltage drop, chargers should be located as close to the power source as possible. To maximize convenience, chargers should be placed in accessible locations as close as possible to charger-equipped parking stalls. Chargers should also be clustered together to help fleet managers, especially if chargers are to be shared.
- If possible, surface-mount conduit along wall surfaces to avoid more costly trenching under paved surfaces. If wall or column mounting is not feasible, trench beneath planting

strips to reduce cutting and re-paving costs and to minimize disruptions during construction.

- Identify suitable locations with smooth, plumb surfaces for wall mounted charging stations if possible or suitable floor surfaces for pedestal mount stations. If possible, use wall-mounted chargers to avoid the need for pedestals which are more costly and complex to install.
- To maximize charging capacity, consider installing dual-port pedestal mount stations with long charge cords (up to 25'). Many chargers include optional cord management systems such as retracting reels to minimize trip hazards. Depending on parking configuration, a single charger or dual head charger pair can serve up to eight parking stalls.
- To comply with the Americans with Disabilities Act (ADA), the charging station must not block ramps or pathways, and cables should not extend across ramps or pathways when connected to a vehicle.
- Where feasible, avoid locating chargers under trees where sap, pollen, or leaves would fall on the charging station.
- To better accommodate the varied charge port locations on different EVs, use perpendicular (90 degree) parking stalls that allow a vehicle to enter either front-first or rear-first instead of parallel or diagonal stall parking.
- Check local requirements for accessibility and pathway width, sometimes called "path of travel" to ensure charger placement does not restrict sidewalk use.
- Plan locations for easy and cost-effective future charger installation, typically adjacent to other EV charging stalls.

3. Operational considerations

- Provide adequate lighting activated by motion sensors for safe night-time access and consider weather protection.
- Consider siting chargers in areas with good visibility and securely affixed to the ground or wall.
- Closed-circuit television (CCTV) surveillance is an additional option, especially in low visibility public areas, to prevent theft and vandalism.
- Ensure chargers are easily identified and install signage or wayfinding as needed.
- Provide protective bollards and wheel blocks where appropriate, especially on sloped sites.

4. Data connectivity

- Chargers recommended for public use or fleet vehicles should be smart or at least enhanced with smart charging capability with add-on technology like Cyber Switching, or PowerFlex. This is to provide data on charging and energy use to fleet and facilities managers as well as to provide the benefits of load management. To be smart, chargers must be able to transmit data which requires cellular connectivity, WiFi, or ethernet.
- In general, smart chargers use cellular signals to communicate with the cloud. Stand-alone chargers have their own integral modems while modular chargers communicate to a central control hub using ethernet or WiFi that communicates to the cloud via a cellular modem or through the facility's internet. To ensure dependable coverage, communication systems need to be stand-alone and not be dependent on the building's WiFi system.
- Measure cellular signal levels to ensure adequate coverage where smart chargers will be installed. Underground or enclosed parking structures may require cellular repeaters to ensure adequate signal strength to chargers.

USE OF PUBLIC CHARGING

Fleets generally charge their EVs overnight at fleet domicile facilities. However, fleet EVs can also use public chargers, especially for opportunity charging when driving long distances. Opportunity charging using publicly available high-output DC fast chargers can provide a convenient and cost-effective way for municipal fleets to supplement their own charging infrastructure maintain uninterrupted vehicle availability in times of high usage or as a backup option for emergency response vehicles. Public charging networks like EVgo and Electrify America have deployed charging stations all over Elk Grove and more will be constructed with the help from NEVI funding as previously discussed.

A continually updated map of publicly accessible charging stations in Elk Grove is available though the Alternative Fuels Data Center Station Locator: https://afdc.energy.gov/stations/#/find/nearest?location=elk%20grove.

The largest public charging network as discussed, was developed, and continues to be operated by Tesla for the exclusive use of Tesla EVs. However, in May of 2023, Ford and Tesla announced that Ford would have access to 12,000 chargers in Tesla's Supercharger network. Several weeks later in early June, GM and Rivian followed suit with a similar deal with Tesla and since then, many other OEMs have made similar announcements.

Tesla's charging network has long been the envy of all EV drivers as Tesla Superchargers are strategically sited and more abundant than other high-speed chargers available to the public. They are also generally easier for EV drivers to use thanks to their plug and charge functionality and more reliability than other networks.

By gaining access to the nation's most accessible, reliable, and fastest charging network, fleets and other Ford and GM drivers will be able to avoid capital expenditures by not having to invest in their own supplemental DC fast chargers, or at least may need fewer of them since fast, abundant, and reliable chargers will soon be available at Tesla's charging stations.

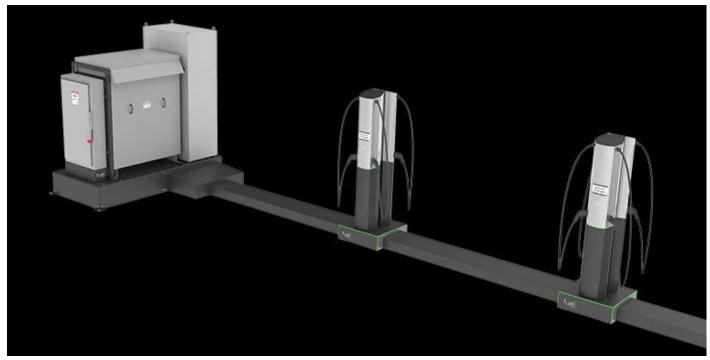
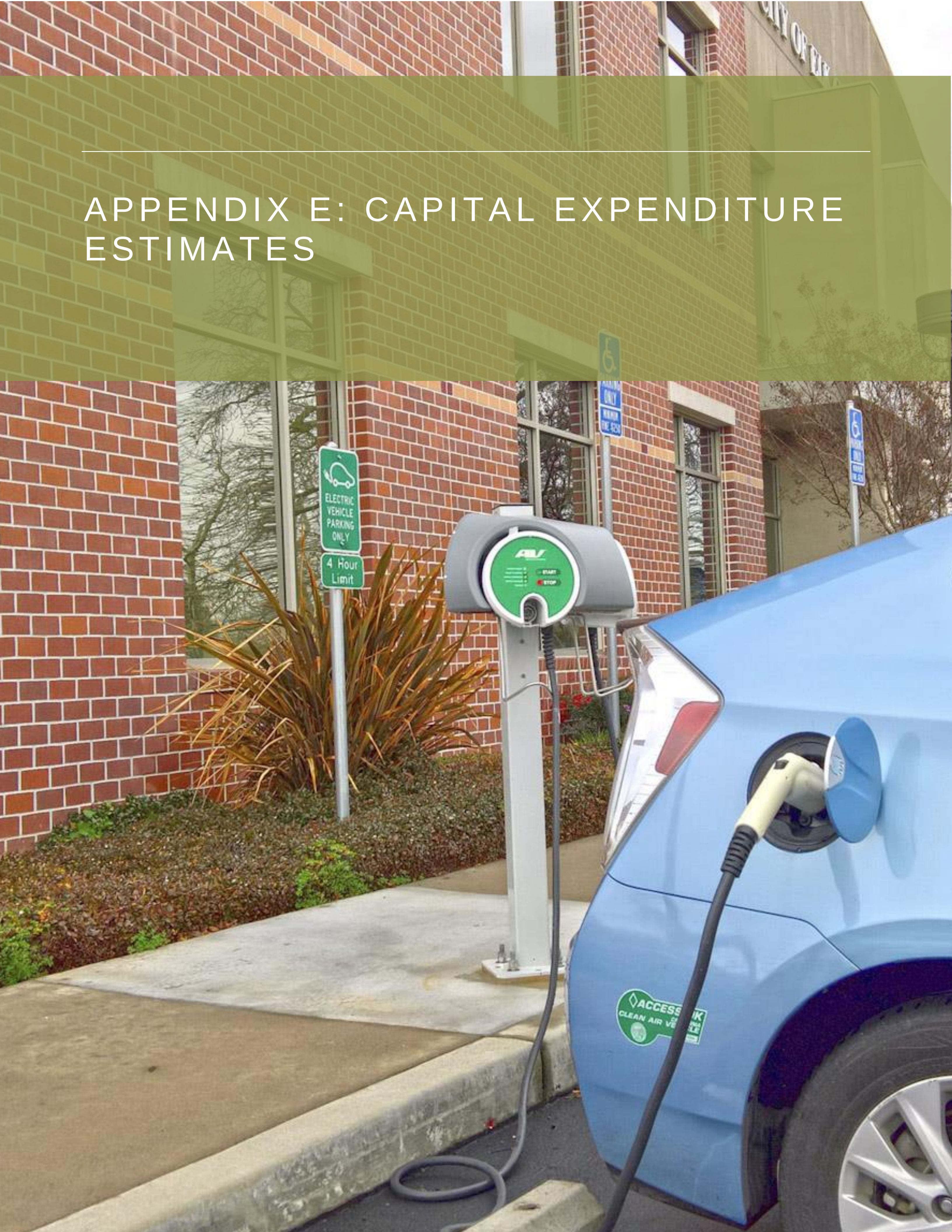


FIGURE 33: SHOALS FUEL EV CHARGING SOLUTION

Source: [Shoals]

The rapid adoption of EVs by the public and the relatively long charging times (by comparison to liquid fuels) presents a business opportunity for a new industry of commercial charging destinations with amenities for drivers while charging their EVs. For example, Electrify America is planning a handful of "showcase stations" with up to 20 DC fast chargers, plus amenities like customer lounges and solar canopies to shield customers from sun and foul weather, vehicle showcases, and security cameras plus additional lighting for increased safety. Mercedes-Benz will also be developing its own EV fast-charging network with more than 400 North American charging sites, with a total of 2,500 350-kw DC fast-charging connectors in place by 2027. Charging sites will be spaced at regular intervals along highways, close to major intersections and metropolitan areas, with an emphasis on sites near shopping or restaurants, as well as Mercedes dealerships. Amenities like restrooms and some form of shelter from weather, as well as video surveillance, will also be included. Startups like Rove are developing 40 publicly accessible DC fast-chargers some of which will offer up to 350 kw, plus a 24/7 indoor lounge, outdoor seating with WiFi, restrooms, car wash, and a Recharge by Gelson's market. There will also be nighttime security guards and a fenced-in pet area.

APPENDIX E: CAPITAL EXPENDITURE ESTIMATES



EVSE MASTER PLAN ESTIMATE – ANIMAL SHELTER FLEET PHASE 1

COST ESTIMATE

ITEM DESCRIPTION	UNIT	UNIT COST	QUANTITIES	Materials	ITEMS COSTS	Charger Costs	ITEMS COSTS	Permits	ITEMS COSTS	Civil/ Landscaping	ITEMS COSTS	Contracting/ Design
JUNCTION BOXES												
Furnish & Install Pull Box #3 1/2	EA	$1,800										
Furnish & Install Pull Box #5	EA	$2,300	**2**	$4,600								
Furnish & Install Pull Box #7 in Ceiling/Wall/Structure	EA	$518										
Furnish & Install Wall-Mounted Junction Box	EA	$115										
CONDUIT												
Furnish & Install 1.5" conduit with backfill and trenching	LF	$46										
Furnish & Install 2" conduit with backfill and trenching	LF	$52	**150**	$7,791								
Furnish & Install 3" conduit surface mounted	LF	$30	**20**	$598								
Furnish & Install 4" conduit surface mounted	LF	$35										
CONDUCTORS/WIRES												
Furnish & Install #8	LF	$1.17	**850**	$997								
Furnish & Install #2 and Higher	LF	$2.70										
ELECTRICAL SERVICE												
ELECTRIC VEHICLE CHARGING EQUIPMENT												
Pedestal	EA	$500	**1**	$500								
Level 2 Charger (up to 12.0 kW) - Dual Head ChargePoint	EA	$6,800	**1**			$6,800						
Footing	EA	$1,300	**1**	$1,300								
SIGNING/STRIPPING												
Signage/Striping	LS	$1,050	**2**	$2,100								
MISCELLANEOUS ITEMS												
Bollard	EA	$575	**2**	$1,150								
Permits	EA	$5,000	**1**					$5,000				
Civil	LS	$30,000	**0.25**							$7,500		
SUBTOTALS				**$19,036**		**$6,800**		**$5,000**		**$7,500**		
CONTINGENCY			**20%**	**$3,807.14**		**$1,360.00**		**$1,000.00**		**$1,500.00**		
TOTALS WITH CONTINGENCY				**$22,900**		**$8,200**		**$6,000**		**$9,000**		**$15,160**
PROJECT COST ANIMAL SHELTER FLEET				**$61,260**								

EVSE MASTER PLAN ESTIMATE – ANIMAL SHELTER PUBLIC PHASE 1

COST ESTIMATE

ITEM DESCRIPTION	UNIT	UNIT COST	QUANTITIES	Materials	ITEMS COSTS	Charger Costs	ITEMS COSTS	Permits	ITEMS COSTS	Civil/ Landscaping	ITEMS COSTS	Contracting/ Design
JUNCTION BOXES												
Furnish & Install Pull Box #3 1/2	EA	$1,800										
Furnish & Install Pull Box #5	EA	$2,300	1	$2,300								
Furnish & Install Pull Box #7 in Ceiling/Wall/Structure	EA	$518										
Furnish & Install Wall-Mounted Junction Box	EA	$115										
CONDUIT	0	$0										
Furnish & Install 1.5" conduit with backfill and trenching	LF	$46										
Furnish & Install 2" conduit with backfill and trenching	LF	$52		$0								
Furnish & Install 3" conduit surface mounted	LF	$30		$0								
Furnish & Install 4" conduit surface mounted	LF	$35		$0								
CONDUCTORS/WIRES	0	$0										
Furnish & Install #8	LF	$1.17	850	$997								
Furnish & Install #2 and Higher	LF	$2.70		$0								
ELECTRICAL SERVICE												
ELECTRIC VEHICLE CHARGING EQUIPMENT	0	$0										
Pedestal	EA	$500	1	$500								
Level 2 Charger (up to 12.0 kW) - Dual Head ChargePoint	EA	$6,800	1			$6,800						
Footing	EA	$1,300	1	$1,300								
SIGNING/STRIPPING												
Signage/Striping	LS	$1,050	2	$2,100								
Bollard	EA	$575	2	$1,150								
Permits	EA	$5,000						$0				
Civil	LS	$30,000	0.10							$3,000		
SUBTOTALS				$8,347		$6,800		$0		$3,000		$0
CONTINGENCY			20%	$1,669.41		$1,360.00		$0.00		$600.00		$0.00
TOTALS WITH CONTINGENCY				$10,100		$8,200		$0		$3,600		$5,480
PROJECT COST ANIMAL SHELTER PUBLIC				$27,380								

EVSE MASTER PLAN ESTIMATE - CITY HALL FLEET PHASE 1

COST ESTIMATE

ITEM DESCRIPTION	UNIT	UNIT COST	Quantity	Materials	ITEMS COSTS	Charger Costs	ITEMS COSTS	Permits	ITEMS COSTS	Civil/ Landscaping	ITEMS COSTS	Contracting/ Design
JUNCTION BOXES												
Furnish & Install Pull Box #3 1/2	EA	$1,800	**4**	$7,200								
Furnish & Install Pull Box #5	EA	$2,300	**2**	$4,600								
CONDUIT												
Furnish & Install 2" conduit with backfill and trenching	LF	$52	**160**	$8,310								
Furnish & Install 6" conduit with backfill and trenching	LF	$92	**100**	$9,200								
CONDUCTORS/WIRES												
Furnish & Install #8	LF	$1.17	**400**	$469								
Furnish & Install #2 and Higher	LF	$2.70	**400**	$1,081								
ELECTRICAL SERVICE												
Step-Down Transformer - 150 kVA	EA	$7,579	**1**	$7,579								
Service Panel	EA	$10,000	**1**	$10,000								
ELECTRIC VEHICLE CHARGING EQUIPMENT												
Pedestal	EA	$500	**2**	$1,000								
Level 2 Charger (up to 12.0 kW) - Dual Head ChargePoint	EA	$6,800	**2**			$13,600						
Footing	EA	$1,300	**2**	$2,600								
SIGNING/STRIPPING												
Signage/Striping	LS	$1,050	**4**	$4,200								
MISCELLANEOUS ITEMS												
Bollard	EA	$575	**4**	$2,300								
Permits	EA	$5,000	**1**					$5,000				
Civil	LS	$30,000	**0.25**							$7,500		
SUBTOTALS				**$58,539**		**$13,600**		**$5,000**		**$7,500**		
CONTINGENCY			**20%**	**$11,707.84**		**$2,720.00**		**$1,000.00**		**$1,500.00**		
TOTALS WITH CONTINGENCY				**$70,300**		**$16,400**		**$6,000**		**$9,000**		**$34,120**
PROJECT COST - PHASE 1				**$135,820**								

EVSE MASTER PLAN ESTIMATE - CITY HALL FLEET PHASE 3

COST ESTIMATE

ITEM DESCRIPTION	UNIT	UNIT COST	QUANTITIES	Materials	ITEMS COSTS	Charger Costs	ITEMS COSTS	Permits	ITEMS COSTS	Civil/ Landscaping	ITEMS COSTS	Contracting/ Design
ELECTRIC VEHICLE CHARGING EQUIPMENT												
Pedestal	EA	$500	**3**	$1,500								
Level 2 Charger (up to 12.0 kW) - Dual Head ChargePoint	EA	$6,800	**3**			$20,400						
Footing	EA	$1,300	**3**	$3,900								
SIGNING/STRIPPING												
Signage/Striping	LS	$1,050	**6**	$6,300								
MISCELLANEOUS ITEMS												
Bollard	EA	$575	**6**	$3,450								
SUBTOTALS				**$15,150**		**$20,400**						
CONTINGENCY			**20%**	**$3,030.00**		**$4,080.00**						
TOTALS WITH CONTINGENCY				**$18,200**		**$24,500**						**$7,280**
PROJECT COST PHASE 3				**$49,980**								

EVSE MASTER PLAN ESTIMATE – CITY HALL PUBLIC PHASE 1

COST ESTIMATE

ITEM DESCRIPTION	UNIT	UNIT COST	QUANTITIES	Materials	ITEMS COSTS	Charger Costs	ITEMS COSTS	Permits	ITEMS COSTS	Civil/ Landscaping	ITEMS COSTS	Contracting/ Design
CONDUIT												
Furnish & Install 2" conduit with directional boring	LF	$127	20	$2,534								
CONDUCTORS/WIRES												
Furnish & Install #8	LF	$1.17	60	$70								
ELECTRICAL SERVICE												
ELECTRIC VEHICLE CHARGING EQUIPMENT												
Pedestal	EA	$500	2	$1,000								
Level 2 Charger (up to 12.0 kW) - Dual Head ChargePoint	EA	$6,800	2			$13,600						
Footing	EA	$1,300	2	$2,600								
SIGNING/STRIPPING												
Signage/Striping	LS	$1,050	4	$4,200								
MISCELLANEOUS ITEMS												
Bollard	EA	$575	4	$2,300								
Removals	LS	$10,000	0.20	$2,000								
Civil	LS	$30,000	0.15							$4,500		
SUBTOTALS				$14,704		$13,600				$4,500		
CONTINGENCY			20%	$2,940.83		$2,720.00				$900.00		
TOTALS WITH CONTINGENCY				$17,700		$16,400				$5,400		$9,240
PROJECT COST CITY HALL PUBLIC				$48,740								

EVSE MASTER PLAN ESTIMATE - CORP YARD PUBLIC WORKS PHASE 1

COST ESTIMATE

ITEM DESCRIPTION	UNIT	UNIT COST	QUANTITIES	Materials	ITEMS COSTS	Charger Costs	ITEMS COSTS	Permits	ITEMS COSTS	Civil/ Landscaping	ITEMS COSTS	Contracting/ Design
JUNCTION BOXES												
Furnish & Install Pull Box #3 1/2	EA	$1,800	**6**	$10,800								
Furnish & Install Pull Box #5	EA	$2,300	**1**	$2,300								
CONDUIT												
Furnish & Install 2" conduit with backfill and trenching	LF	$52	**150**	$7,791								
Furnish & Install 4" conduit with backfill and trenching	LF	$69	**150**	$10,378								
CONDUCTORS/WIRES												
Furnish & Install #8	LF	$1.17	**750**	$880								
Furnish & Install #2 and Higher	LF	$2.70	**450**	$1,216								
ELECTRICAL SERVICE												
Service Panel	EA	$10,000	**1**	$10,000								
ELECTRIC VEHICLE CHARGING EQUIPMENT												
Pedestal	EA	$500	**7**	$3,500								
Level 2 Charger (up to 12.0 kW) - Dual Head ChargePoint	EA	$6,800	**6**			$40,800						
Footing	EA	$1,300	**7**	$9,100								
SIGNING/STRIPPING												
Signage/Striping	LS	$1,050	**12**	$12,600								
MISCELLANEOUS ITEMS												
Bollard	EA	$575	**12**	$6,900								
Permits	EA	$5,000	**1**					$5,000				
Civil	LS	$30,000	**0.30**							$9,000		
SUBTOTALS				**$75,465**		**$40,800**		**$5,000**		**$9,000**		
CONTINGENCY			**20%**	**$15,092.93**		**$8,160.00**		**$1,000.00**		**$1,800.00**		
TOTALS WITH CONTINGENCY				**$90,600**		**$49,000**		**$6,000**		**$10,800**		**$42,960**
PROJECT COST PHASE 1				**$199,360**								

EVSE MASTER PLAN ESTIMATE - CORP YARD PUBLIC WORKS PHASE 2

COST ESTIMATE

ITEM DESCRIPTION	UNIT	UNIT COST	QUANTITIES	Materials	ITEMS COSTS	Charger Costs	ITEMS COSTS	Permits	ITEMS COSTS	Civil/ Landscaping	ITEMS COSTS	Contracting/ Design
JUNCTION BOXES												
Furnish & Install Pull Box #3 1/2	EA	$1,800	6	$10,800								
CONDUIT												
Connect new and existing conduit (CC)	EA	$173	1	$173								
Furnish & Install 2" conduit with backfill and trenching	LF	$52	150	$7,791								
CONDUCTORS/WIRES												
Furnish & Install #8	LF	$1.17	750	$880								
ELECTRIC VEHICLE CHARGING EQUIPMENT												
Pedestal	EA	$500	6	$3,000								
Level 2 Charger (up to 12.0 kW) - Dual Head ChargePoint	EA	$6,800	6			$40,800						
Footing	EA	$1,300	6	$7,800								
SIGNING/STRIPPING												
Signage/Striping	LS	$1,050	12	$12,600								
MISCELLANEOUS ITEMS												
Bollard	EA	$575	12	$6,900								
Civil	LS	$30,000	0.10							$3,000		
SUBTOTALS				$49,943		$40,800				$3,000		
CONTINGENCY			20%	$9,988.61		$8,160.00				$600.00		
TOTALS WITH CONTINGENCY				$60,000		$49,000				$3,600		$25,440
PROJECT COST PHASE 2				$138,040								

EVSE MASTER PLAN ESTIMATE – FLEET FACILITY PHASE 1

COST ESTIMATE

ITEM DESCRIPTION	UNIT	UNIT COST	QUANTITIES	Materials	ITEMS COSTS	Charger Costs	ITEMS COSTS	Permits	ITEMS COSTS	Civil/ Landscaping	ITEMS COSTS	SMUD Power Upgrades	ITEMS COSTS	Contracting/ Design
JUNCTION BOXES														
Furnish & Install Pull Box #3 1/2	EA	$1,800	**21**	$37,800										
Furnish & Install Pull Box #5	EA	$2,300	**4**	$9,200										
CONDUIT														
Furnish & Install 2" conduit with backfill and trenching	LF	$52	**150**	$7,791										
Furnish & Install 4" conduit with backfill and trenching	LF	$69	**900**	$62,269										
Furnish & Install 6" conduit with backfill and trenching	LF	$92	**100**	$9,200										
Furnish & Install 6" conduit with directional boring	LF	$200	**200**	$40,000										
CONDUCTORS/WIRES														
Furnish & Install #8	LF	$1.17	**4750**	$5,572										
Furnish & Install #2 and Higher	LF	$2.70	**2000**	$5,405										
ELECTRICAL SERVICE														
SMUD Upgrades	LS	$60,000	**1**									$60,000		
Step-Down Transformer - 300 kVA	EA	$14,862	**2**	$29,724										
Switchgear	EA	$70,000	**1**	$70,000										
Service Panel	EA	$10,000	**1**	$10,000										
ELECTRIC VEHICLE CHARGING EQUIPMENT														
DC Fast Charger - Dual Head (150 KW)	EA	$115,000	**3**			$345,000								
Pedestal	EA	$500	**25**	$12,500										
Level 2 Charger (up to 12.0 kW) - Dual Head ChargePoint	EA	$6,800	**21**			$142,800								
Footing	EA	$1,300	**25**	$32,500										
SIGNING/STRIPPING														
Signage/Striping	LS	$1,050	**48**	$50,400										
MISCELLANEOUS ITEMS														
Bollard	EA	$575	**48**	$27,600										
Permits	EA	$5,000	**1**					$5,000						
Civil	LS	$30,000	**1**							$30,000				
SUBTOTALS				**$409,960**		**$487,800**		**$5,000**		**$30,000**		**$60,000**		
CONTINGENCY			**20%**	**$81,992.03**		**$97,560.00**		**$1,000.00**		**$6,000.00**		**$12,000.00**		
TOTALS WITH CONTINGENCY				**$492,000**		**$585,400**		**$6,000**		**$36,000**		**$72,000**		**$242,400**
PROJECT COST PHASE 1				**$1,433,800**										

EVSE MASTER PLAN ESTIMATE – FLEET FACILITY PHASE 2

COST ESTIMATE

ITEM DESCRIPTION	UNIT	UNIT COST	QUANTITIES	Materials ITEMS COSTS	Charger Costs ITEMS COSTS	Permits ITEMS COSTS	Civil/ Landscaping ITEMS COSTS	Contracting/ Design
JUNCTION BOXES								
Furnish & Install Pull Box #3 1/2	EA	$1,800	12	$21,600				
Furnish & Install Pull Box #5	EA	$2,300	1	$2,300				
Furnish & Install Wall-Mounted Junction Box	EA	$115						
CONDUIT								
Connect new and existing conduit (CC)	EA	$173	1	$173				
Furnish & Install 2" conduit with backfill and trenching	LF	$52	300	$15,581				
Furnish & Install 4" conduit with backfill and trenching	LF	$69	200	$13,838				
Furnish & Install 3" conduit surface mounted	LF	$30						
CONDUCTORS/WIRES								
Furnish & Install #8	LF	$1.17	2500	$2,933				
Furnish & Install #2 and Higher	LF	$2.70						
ELECTRICAL SERVICE								
ELECTRIC VEHICLE CHARGING EQUIPMENT								
Pedestal	EA	$500	12	$6,000				
Level 2 Charger (up to 12.0 kW) - Dual Head ChargePoint	EA	$6,800	12		$81,600			
Footing	EA	$1,300	12	$15,600				
SIGNING/STRIPPING								
Signage/Striping	LS	$1,050	24	$25,200				
MISCELLANEOUS ITEMS								
Bollard	EA	$575	24	$13,800				
Civil	LS	$30,000	0.5				$15,000	
SUBTOTALS				$117,024	$81,600		$15,000	
CONTINGENCY			20%	$23,404.79	$16,320.00		$3,000.00	
TOTALS WITH CONTINGENCY				$140,500	$98,000		$18,000	$63,400
PROJECT COST PHASE 2				$319,900				

EVSE MASTER PLAN ESTIMATE – FLEET FACILITY PHASE 3

COST ESTIMATE

ITEM DESCRIPTION	UNIT	UNIT COST	QUANTITIES	Materials / ITEMS COSTS	Charger Costs / ITEMS COSTS	Permits / ITEMS COSTS	Civil/ Landscaping / ITEMS COSTS	Contracting/ Design
JUNCTION BOXES								
Furnish & Install Pull Box #3 1/2	EA	$1,800	**3**	$5,400				
Furnish & Install Pull Box #5	EA	$2,300	**2**	$4,600				
Furnish & Install Wall-Mounted Junction Box	EA	$115	**5**	$575				
CONDUIT								
Furnish & Install 2" conduit with backfill and trenching	LF	$52	**100**	$5,194				
Furnish & Install 4" conduit with backfill and trenching	LF	$69	**150**	$10,378				
Furnish & Install 3" conduit with directional boring	LF	$132	**100**	$13,244				
Furnish & Install 4" conduit with directional boring	LF	$138						
Furnish & Install 2" conduit surface mounted	LF	$25	**200**	$5,060				
CONDUCTORS/WIRES								
Furnish & Install #8	LF	$1.17	**2000**	$2,346				
Furnish & Install #2 and Higher	LF	$2.70	**750**	$2,027				
ELECTRIC VEHICLE CHARGING EQUIPMENT								
DC Fast Charger - Dual Head (150 KW)	EA	$115,000	**2**		$230,000			
Pedestal	EA	$500	**7**	$3,500				
Level 2 Charger (up to 12.0 kW) - Dual Head ChargePoint	EA	$6,800	**5**		$34,000			
Footing	EA	$1,300	**7**	$9,100				
SIGNING/STRIPPING								
Signage/Striping	LS	$1,050	**14**	$14,700				
MISCELLANEOUS ITEMS								
Bollard	EA	$575	**14**	$8,050				
Civil	LS	$30,000	**0.5**				$15,000	
SUBTOTALS				**$84,174**	**$264,000**		**$15,000**	
CONTINGENCY			**20%**	**$16,834.70**	**$52,800.00**		**$3,000.00**	
TOTALS WITH CONTINGENCY				**$101,100**	**$316,800**		**$18,000**	**$47,640**
PROJECT COST PHASE 3				**$483,540**				

EVSE MASTER PLAN ESTIMATE - 8380/8400 LAGUNA PALMS WAY FLEET PHASE 1

COST ESTIMATE

ITEM DESCRIPTION	UNIT	UNIT COST	QUANTITIES	Materials	ITEMS COSTS	Charger Costs	ITEMS COSTS	Permits	ITEMS COSTS	Civil/ Landscaping	ITEMS COSTS	SMUD Power Upgrades	ITEMS COSTS	Contracting/ Design
JUNCTION BOXES														
Furnish & Install Pull Box #3 1/2	EA	$1,800	**16**	$28,800										
Furnish & Install Pull Box #5	EA	$2,300	**6**	$13,800										
CONDUIT														
Furnish & Install 2" conduit with backfill and trenching	LF	$52	**250**	$12,984										
Furnish & Install 3" conduit with backfill and trenching	LF	$63	**1300**	$82,469										
Furnish & Install 4" conduit with backfill and trenching	LF	$69	**250**	$17,297										
Furnish & Install 6" conduit with backfill and trenching	LF	$92	**100**	$9,200										
CONDUCTORS/WIRES														
Furnish & Install #8	LF	$1.17												
Furnish & Install #6	LF	$1.73	**8000**	$13,800										
Furnish & Install #4	LF	$2.07	**1000**	$2,070										
Furnish & Install #2 and Higher	LF	$2.70	**1000**	$2,703										
ELECTRICAL SERVICE														
SMUD Upgrades	LS	$85,000	**1**									$85,000		
Step-Down Transformer - 300 kVA	EA	$14,862	**2**	$29,724										
Switchgear	EA	$70,000	**1**	$70,000										
Service Panel	EA	$10,000	**1**	$10,000										
ELECTRIC VEHICLE CHARGING EQUIPMENT														
DC Fast Charger - Dual Head (150 KW)	EA	$115,000	**2**			$230,000								
Pedestal	EA	$500	**20**	$10,000										
Level 2 Charger (up to 19.2 kW) - Dual Head ChargePoint	EA	$6,800	**18**			$122,400								
Footing	EA	$1,300	**20**	$26,000										
SIGNING/STRIPPING														
Signage/Striping	LS	$1,050	**40**	$42,000										
MISCELLANEOUS ITEMS														
Bollard	EA	$575	**40**	$23,000										
Permits	EA	$5,000	**1**					$5,000						
Civil	LS	$30,000	**1**							$30,000				
SUBTOTALS				**$393,847**		**$352,400**		**$5,000**		**$30,000**		**$85,000**		
CONTINGENCY			**20%**	**$78,769.30**		**$70,480.00**		**$1,000.00**		**$6,000.00**		**$17,000.00**		
TOTALS WITH CONTINGENCY				**$472,700**		**$422,900**		**$6,000**		**$36,000**		**$102,000**		**$246,680**
PROJECT COST PHASE 1				**$1,286,280**										

EVSE MASTER PLAN ESTIMATE - 8380/8400 LAGUNA PALMS WAY FLEET PHASE 2

COST ESTIMATE

ITEM DESCRIPTION	UNIT	UNIT COST	QUANTITIES	Materials / ITEMS COSTS	Charger Costs / ITEMS COSTS	Permits / ITEMS COSTS	Civil/ Landscaping / ITEMS COSTS	Contracting/ Design
JUNCTION BOXES								
Furnish & Install Pull Box #3 1/2	EA	$1,800	**6**	$10,800				
Furnish & Install Pull Box #5	EA	$2,300						
CONDUIT								
Furnish & Install 2" conduit with backfill and trenching	LF	$52	**300**	$15,581				
CONDUCTORS/WIRES								
Furnish & Install #8	LF	$1.17	**1200**	$1,408				
Furnish & Install #6	LF	$1.73	**1500**	$2,588				
ELECTRICAL SERVICE								
Service Panel	EA	$10,000	**1**	$10,000				
ELECTRIC VEHICLE CHARGING EQUIPMENT								
DC Fast Charger - Dual Head (150 KW)	EA	$115,000						
Pedestal	EA	$500	**6**	$3,000				
Level 2 Charger (up to 19.2 kW) - Dual Head ChargePoint	EA	$6,800	**6**		$40,800			
Footing	EA	$1,300	**6**	$7,800				
SIGNING/STRIPPING								
Signage/Striping	LS	$1,050	**12**	$12,600				
MISCELLANEOUS ITEMS								
Bollard	EA	$575	**12**	$6,900				
Civil	LS	$30,000	**1**				$15,000	
SUBTOTALS				**$70,676**	**$40,800**		**$15,000**	
CONTINGENCY			**20%**	**$14,135.27**	**$8,160.00**		**$3,000.00**	
TOTALS WITH CONTINGENCY				**$84,900**	**$49,000**		**$18,000**	**$41,160**
PROJECT COST PHASE 2				**$193,060**				

EVSE MASTER PLAN ESTIMATE – 8380/8400 LAGUNA PALMS WAY FLEET PHASE 3

COST ESTIMATE

ITEM DESCRIPTION	UNIT	UNIT COST	QUANTITIES	Materials	ITEMS COSTS	Charger Costs	ITEMS COSTS	Permits	ITEMS COSTS	Civil/ Landscaping	ITEMS COSTS	Contracting/ Design
JUNCTION BOXES												
Furnish & Install Pull Box #3 1/2	EA	$1,800	**3**	$5,400								
Furnish & Install Pull Box #5	EA	$2,300	**1**	$2,300								
CONDUIT												
Furnish & Install 2" conduit with backfill and trenching	LF	$52	**700**	$36,356								
CONDUCTORS/WIRES												
Furnish & Install #6	LF	$1.73	**1500**	$2,588								
Furnish & Install #4	LF	$2.07	**1500**	$3,105								
ELECTRIC VEHICLE CHARGING EQUIPMENT												
Pedestal	EA	$500	**3**	$1,500								
Level 2 Charger (up to 19.2 kW) - Dual Head ChargePoint	EA	$6,800	**3**			$20,400						
Footing	EA	$1,300	**3**	$3,900								
SIGNING/STRIPPING												
Signage/Striping	LS	$1,050	**6**	$6,300								
MISCELLANEOUS ITEMS												
Bollard	EA	$575	**6**	$3,450								
Civil	LS	$30,000	**0.5**							$15,000		
SUBTOTALS				**$64,899**		**$20,400**				**$15,000**		
CONTINGENCY			**20%**	**$12,979.75**		**$4,080.00**				**$3,000.00**		
TOTALS WITH CONTINGENCY				**$77,900**		**$24,500**				**$18,000**		**$38,360**
PROJECT COST PHASE 3				**$158,760**								

EVSE MASTER PLAN ESTIMATE – STUDIO COURT FLEET PHASE 3

COST ESTIMATE

ITEM DESCRIPTION	UNIT	UNIT COST	QUANTITIES	Materials / ITEMS COSTS	Charger Costs / ITEMS COSTS	Permits / ITEMS COSTS	Civil/ Landscaping / ITEMS COSTS	Contracting/ Desing
JUNCTION BOXES								
Furnish & Install Pull Box #3 1/2	EA	$1,800	**1**	$1,800				
Furnish & Install Pull Box #5	EA	$2,300	**1**	$2,300				
Furnish & Install Wall-Mounted Junction Box	EA	$115	**1**	$115				
CONDUIT								
Furnish & Install 2" conduit with backfill and trenching	LF	$52	**100**	$5,194				
Furnish & Install 2" conduit surface mounted	LF	$25	**40**	$1,012				
CONDUCTORS/WIRES								
Furnish & Install #8	LF	$1.17	**700**	$821				
ELECTRIC VEHICLE CHARGING EQUIPMENT								
Pedestal	EA	$500	**1**	$500				
Level 2 Charger (up to 19.2 kW) - Dual Head ChargePoint	EA	$6,800	**1**		$6,800			
Footing	EA	$1,300	**1**	$1,300				
SIGNING/STRIPPING								
Signage/Striping	LS	$1,050	**2**	$2,100				
MISCELLANEOUS ITEMS								
Bollard	EA	$575	**2**	$1,150				
Civil	LS	$30,000	**0.15**				$4,500	
SUBTOTALS				**$16,292**	**$6,800**		**$4,500**	
CONTINGENCY			**20%**	**$3,258.37**	**$1,360.00**		**$900.00**	
TOTALS WITH CONTINGENCY				**$19,600**	**$8,200**		**$5,400**	**$10,000**
PROJECT COST PHASE 3				**$43,200**				

EVSE MASTER PLAN ESTIMATE – LAGUNA PALMS PUBLIC PHASE 1

COST ESTIMATE

ITEM DESCRIPTION	UNIT	UNIT COST	QUANTITIES	Materials	ITEMS COSTS	Charger Costs	ITEMS COSTS	Permits	ITEMS COSTS	Civil/ Landscaping	ITEMS COSTS	Contracting/ Design
JUNCTION BOXES												
Furnish & Install Pull Box #3 1/2	EA	$1,800	**3**	$5,400								
CONDUIT												
Furnish & Install 2" conduit with backfill and trenching	LF	$52	**300**	$15,581								
CONDUCTORS/WIRES												
Furnish & Install #8	LF	$1.17	**1500**	$1,760								
ELECTRIC VEHICLE CHARGING EQUIPMENT												
Pedestal	EA	$500	**2**	$1,000								
Level 2 Charger (up to 19.2 kW) - Dual Head ChargePoint	EA	$6,800	**2**			$13,600						
Footing	EA	$1,300	**2**	$2,600								
SIGNING/STRIPPING												
Signage/Striping	LS	$1,050	**4**	$4,200								
MISCELLANEOUS ITEMS												
Bollard	EA	$575	**4**	$2,300								
Civil	LS	$30,000	**0.10**							$3,000		
SUBTOTALS				**$32,841**		**$13,600**				**$3,000**		
CONTINGENCY			**20%**	**$6,568.15**		**$2,720.00**				**$600.00**		
TOTALS WITH CONTINGENCY				**$39,500**		**$16,400**				**$3,600**		**$17,240**
PROJECT COST PUBLIC				**$76,740**								

EVSE MASTER PLAN ESTIMATE - SWCC FLEET PHASE 1

COST ESTIMATE

ITEM DESCRIPTION	UNIT	UNIT COST	QUANTITIES	Materials	ITEMS COSTS	Charger Costs	ITEMS COSTS	Permits	ITEMS COSTS	Civil/ Landscaping	ITEMS COSTS	Contracting/ Design
JUNCTION BOXES												
Furnish & Install Pull Box #5	EA	$2,300	2	$4,600								
CONDUIT												
Furnish & Install 3" conduit with backfill and trenching	LF	$63	100	$6,344								
Furnish & Install 3" conduit surface mounted	LF	$30	20	$598								
CONDUCTORS/WIRES												
Furnish & Install #8	LF	$1.17	600	$704								
ELECTRICAL SERVICE												
ELECTRIC VEHICLE CHARGING EQUIPMENT												
Pedestal	EA	$500	1	$500								
Level 2 Charger (up to 12.0 kW) - Dual Head ChargePoint	EA	$6,800	1			$6,800						
Footing	EA	$1,300	1	$1,300								
SIGNING/STRIPPING												
Signage/Striping	LS	$1,050	2	$2,100								
MISCELLANEOUS ITEMS												
Bollard	EA	$575	2	$1,150								
Permits	EA	$5,000	1					$5,000				
Civil	LS	$30,000	0.15							$4,500		
SUBTOTALS				$17,296		$6,800		$5,000		$4,500		
CONTINGENCY			20%	$3,459.11		$1,360.00		$1,000.00		$900.00		
TOTALS WITH CONTINGENCY				$20,800		$8,200		$6,000		$5,400		$12,880
PROJECT COST PHASE 1				$53,280								

EVSE MASTER PLAN ESTIMATE - SWCC PUBLIC PHASE 1

COST ESTIMATE

ITEM DESCRIPTION	UNIT	UNIT COST	QUANTITIES	Materials	ITEMS COSTS	Charger Costs	ITEMS COSTS	Permits	ITEMS COSTS	Civil/ Landscaping	ITEMS COSTS	Contracting/ Desing
CONDUIT												
CONDUCTORS/WIRES												
Furnish & Install #8	LF	$1.17	300	$352								
ELECTRIC VEHICLE CHARGING EQUIPMENT												
Level 2 Charger (up to 19.2 kW) - ChargePoint	EA	$4,150	1			$4,150						
Pedestal	EA	$500	1	$500								
Footing	EA	$1,300	1	$1,300								
SIGNING/STRIPPING												
Signage/Striping	LS	$1,050	1	$1,050								
MISCELLANEOUS ITEMS												
Bollard	EA	$575	1	$575								
SUBTOTALS				$3,777		$4,150						
CONTINGENCY			20%	$755.38		$830.00						
TOTALS WITH CONTINGENCY				$4,600		$5,000						$1,840
PROJECT COST - PHASE 1 PUBLIC				$11,440								

EVSE MASTER PLAN ESTIMATE - EXISTING ELK GROVE LIBRARY PHASE 1

COST ESTIMATE

ITEM DESCRIPTION	UNIT	UNIT COST	QUANTITIES	Materials	ITEMS COSTS	Charger Costs	ITEMS COSTS	Permits	ITEMS COSTS	Civil/ Landscaping	ITEMS COSTS	Contracting/ Design
JUNCTION BOXES												
Furnish & Install Pull Box #3 1/2	EA	$1,800	**3**	$5,400								
Furnish & Install Pull Box #5	EA	$2,300	**2**	$4,600								
CONDUIT												
Furnish & Install 2" conduit with backfill and trenching	LF	$52	**50**	$2,597								
Furnish & Install 3" conduit with backfill and trenching	LF	$63	**200**	$12,688								
Furnish & Install 3" conduit surface mounted	LF	$30	**50**	$1,495								
CONDUCTORS/WIRES												
Furnish & Install #8	LF	$1.17	**1500**	$1,760								
ELECTRICAL SERVICE												
Service Panel	EA	$10,000	**1**	$10,000								
ELECTRIC VEHICLE CHARGING EQUIPMENT												
Pedestal	EA	$500	**4**	$2,000								
Level 2 Charger (up to 12.0 kW) - Dual Head ChargePoint	EA	$6,800	**3**			$20,400						
Footing	EA	$1,300	**4**	$5,200								
SIGNING/STRIPPING												
Signage/Striping	LS	$1,050	**6**	$6,300								
MISCELLANEOUS ITEMS												
Bollard	EA	$575	**6**	$3,450								
Permits	EA	$5,000	**1**					$5,000				
Civil	LS	$30,000	**0.30**							$9,000		
SUBTOTALS				**$55,489**		**$20,400**		**$5,000**		**$9,000**		
CONTINGENCY			**20%**	**$11,097.78**		**$4,080.00**		**$1,000.00**		**$1,800.00**		
TOTALS WITH CONTINGENCY				**$66,600**		**$24,500**		**$6,000**		**$10,800**		**$33,360**
PROJECT COST				**$141,260**								

EVSE MASTER PLAN ESTIMATE - OLD TOWN PLAZA PUBLIC PHASE 1

COST ESTIMATE

ITEM DESCRIPTION	UNIT	UNIT COST	QUANTITIES	Materials	ITEMS COSTS	Charger Costs	ITEMS COSTS	Permits	ITEMS COSTS	Civil/ Landscaping	ITEMS COSTS	SMUD Power Upgrades	ITEMS COSTS	Contracting/ Design
JUNCTION BOXES														
Furnish & Install Pull Box #3 1/2	EA	$1,800	13	$23,400										
Furnish & Install Pull Box #5	EA	$2,300	2	$4,600										
CONDUIT														
Furnish & Install 2" conduit with backfill and trenching	LF	$52	100	$5,194										
Furnish & Install 3" conduit with backfill and trenching	LF	$63	300	$19,031										
Furnish & Install 6" conduit with backfill and trenching	LF	$92	100	$9,200										
CONDUCTORS/WIRES														
Furnish & Install #8	LF	$1.17	1000	$1,173										
Furnish & Install #6	LF	$1.73	1000	$1,725										
Furnish & Install #2 and Higher	LF	$2.70	400	$1,081										
ELECTRICAL SERVICE														
SMUD Upgrades	LS	$100,000	1									$100,000		
Switchgear	EA	$50,000	1	$50,000										
Service Panel	EA	$10,000	1	$10,000										
ELECTRIC VEHICLE CHARGING EQUIPMENT														
Level 2 Charger (up to 12.0 kW) - Single Head ChargePoint	EA	$4,150	5			$20,750								
Pedestal	EA	$500	13	$6,500										
Level 2 Charger (up to 12.0 kW) - Dual Head ChargePoint	EA	$6,800	8			$54,400								
Footing	EA	$1,300	13	$16,900										
SIGNING/STRIPPING														
Signage/Striping	LS	$1,050	21	$22,050										
MISCELLANEOUS ITEMS														
Bollard	EA	$575	21	$12,075										
Permits	EA	$5,000	1					$5,000						
Civil	LS	$30,000	0.5							$15,000				
SUBTOTALS				$182,929		$75,150		$5,000		$15,000		$100,000		
CONTINGENCY			20%	$36,585.80		$15,030.00		$1,000.00		$3,000.00		$20,000.00		
TOTALS WITH CONTINGENCY				$219,600		$90,200		$6,000		$18,000		$120,000		$145,440
PROJECT COST				$599,240										

COST ASSUMPTIONS

Each of these categories of project capital costs are explained and listed below.

HARD COSTS

EV CHARGERS

This includes:

- Level 2 EV (ChargePoint) chargers
- Power cords and cable management for Level 2 chargers
- DC fast chargers (Blink/ChargePoint Chargers)
- Gateway Module/ Load Management Devices

Note: this excludes costs for warranties because the standard warranty that vendor offers is part of the cost estimate tool.

MATERIALS/EQUIPMENT

This includes costs of purchasing and installing materials typically required for fleet EV charging projects (other than the EV chargers themselves) including the following items:

- Wiring
- Conduit Systems (underground and/or surface-mounted)
- Trenching and/or directional drilling
- Pull Boxes (installed in the ground and/or surface mounted)
- Aerial wire spans
- Footings for installation of EV charger pedestals and electrical service panels
- Bollards
- Wheel stops
- Stepdown transformers
- Electrical service panels including sub panels
- Circuit breakers
- Signage
- Striping for parking stalls

SITE RESTORATION

Site restoration covers the costs to install civil/landscaping improvements to restore the site following excavation and other construction activities including:

- Minor restoration for civil infrastructure such as roadway and/or sidewalk repaving
- Minor curb and gutter restoration
- Minor surface water (drainage infrastructure) restoration
- Minor landscaping restoration such as replanting

SOFT COSTS

CONTRACTING/DESIGN

An estimated 40% mark-up has been applied to the project costs excluding charger purchase costs to include:

- Engineering design fees
- Contractor profits

PERMITTING

Each local authority with jurisdiction mandates electrical permits for installation of EV chargers:

- Electrical permit fees charged by local jurisdictions, typically $5k per site plus $1k for labor and contingency.

UTILITY FEES

This consists of fees charged by the electrical utility (SMUD) to bring additional power to the fleet charging depot to power the EV chargers, including:

- Electrical upgrade design
- Transformer replacement

To serve EV charging loads, utility upgrades are proposed at the following sites: Fleet Facility, Laguna Palms, and Old Town Plaza.

CONTINGENCIES

A 20% mark-up has been applied to the project costs for each cost category consistent with public agency capital project budgeting.