Office of the City Manager

CONSENT CALENDAR
July 28, 2020

To: Honorable Mayor and Members of the City Council

From: Dee Williams-Ridley, City Manager

Submitted by: Liam Garland, Director, Department of Public Works

Subject: Referral Response: An Action Plan for Greening the City of Berkeley Fleet of Vehicles

RECOMMENDATION

Receive the City of Berkeley Municipal Fleet Electrification Assessment, a plan to accelerate Berkeley's municipal fleet electrification by 2030, and refer to the City Manager to pursue grant and rebate opportunities through East Bay Community Energy and other entities to support its recommendations for transitioning fleet vehicles away from fossil fuels to electric vehicles, including charging infrastructure and associated distributed energy resource options.

FISCAL IMPACTS OF RECOMMENDATION

This recommendation has no direct fiscal impacts. The City of Berkeley Municipal Fleet Electrification Assessment Plan (Fleet EV Plan), however, estimates that transitioning light-duty fleet vehicles to electric vehicles (EVs) over the next ten years will have significant costs, due primarily to expenses associated with needed charging infrastructure. Light-duty EV fleet replacement is estimated at $9.76 million over the next ten years, compared with $8.34 million for gasoline/hybrid vehicles. The differential is primarily due to the high costs associated with charging infrastructure including procurement, installation at the multiple locations where Berkeley fleet vehicles are domiciled, and electrical upgrades required to support charging. Further, if recommended solar photovoltaic (PV) and battery energy storage systems are included, an additional $1.58 million will be required, totaling an estimated $11.34 million over ten years. Light-duty vehicles are approximately 40% of the total Berkeley Municipal Fleet; costs associated with transitioning medium-duty, heavy-duty, and emergency vehicles to EVs have not been estimated in the Fleet EV Plan because very few options are available. Implementation of an electric fleet will require additional funding through future City Budget adoptions.

CURRENT SITUATION AND ITS EFFECTS

This Fleet EV Plan responds to Item 36, "An Action Plan for Greening the City of Berkeley Fleet of Vehicles," which originally appeared on the agenda of the June 25, 2019 Council meeting and was sponsored by Councilmembers Wengraf, Harrison, Robinson, and Mayor Arreguin. This Council item called for the City Manager and

Department of Public Works to create a plan to aggressively accelerate implementation of the electrification of the City's municipal fleet and phase out fossil fuel use in municipal vehicles by 2030. The Fleet EV Plan complements the drafting of Berkeley's first Electric Mobility Roadmap, by the Planning Department, and embodies the Roadmap goal of Demonstrating City Leadership, specifically the strategy to develop and implement a City fleet electrification plan.

This Fleet EV Plan completes the Strategic Plan Priority project "City Vehicle Fleet Assessment" and supports the Strategic Plan Goals of providing state-of-the-art, well-maintained infrastructure, amenities, and facilities and being a global leader in addressing climate change and protecting the environment.

As directed by Council, the Fleet EV Plan includes an evaluation of the City's current fleet, and an analysis of opportunities for transitioning to a fleet of fossil fuel free vehicles, as soon as the technology can safely and reliably meet operational needs. Based on this analysis, the Fleet EV Plan focuses on light-duty vehicles (approximately 40% of the total fleet) because few medium- and heavy-duty EVs exist, and of those that do, performance is not appropriate for Berkeley's fleet. The Fleet EV Plan addresses 2021-2025 procurement cycles in detail, and 2026-2030 procurement cycles more generally, to ensure fiscally responsible procurement and deployment of EVs. It also proposes associated distributed energy resource (DER) options, including charging infrastructure and onsite solar PV and/or battery energy storage (BES) systems. Specifically, the plan includes an initial screening to identify sites at which solar PV and/or BES may be favorable to offset electricity consumption of the City's EV fleet. BES systems allow for operational flexibility, resilience, and energy demand management. The plan has details on vehicle and DER technology, and financial model recommendations for each fleet facility (domicile). It recommends a scenario to meet fleet electrification requirements with the greatest ease of implementation and integration.

As of February 2020, the City fleet, excluding emergency response vehicles, consisted of 99 passenger sedans and SUVs, 30 parking enforcement scooters, 88 medium-duty pick-up trucks and vans, and 98 heavy-duty vehicles, all domiciled in 15 dispersed locations. It was determined the light-duty fleet could be transitioned to battery electric vehicles (BEVs, such as Chevy Bolts), with some plug-in hybrid electric vehicles (PHEVs, such as Prius Primes) that travel primarily using electricity, but which also have gasoline engines for flexibility and resilience needed for emergency response and disaster preparedness. Emergency vehicles for police patrol and pursuit, firefighting, and emergency medical services are not currently available as BEVs or PHEVs. The plan recommends that medium-duty and heavy-duty gasoline engine/hybrid vehicles continue to be evaluated during the 2020-2030 timeframe via pilot programs, until EVs in these classes are available, cost-effective, and able to meet the same duty cycle of existing vehicles. For example, some of the fleet's 72 medium-duty pickup trucks may be able to be replaced by the all-electric Ford F-150, a light-duty truck currently expected to arrive in the U.S. market by the end of 2021.

Table 1 summarizes Fleet EV Plan recommendations for adding charging stations, solar PV, BES systems, and backup generators to support the transition of the light-duty fleet to an EV fleet. Solar PV and BES recommendations are based on the energy load of the fleet, and some locations are being evaluated through East Bay Community Energy (EBCE)'s separate *Solar + Storage at Critical Municipal Facilities Assessment,* which is expected to completed by the end of 2020. Backup generators are included Fleet EV Plan to provide resilience, but these needs may be met at some locations with solar PV and BES.

Table 1: Summary of Fleet EV Plan Recommendations for Charging Infrastructure and Associated Distributed Energy Resource Options to Support Light-duty Fleet Electrification Transition

Facility Name	Facility Location	Light-Duty EVs	Chargers	Solar PV (kW DC)	BES	Backup Generator
Corp Yard	1326 Allston Way	16	4 dual-head L2 and 1 DCFC	52.7	33 kW / 130 kWh	Yes
Berkeley Transfer Station (prior to rebuild)	1201 Second Street	5	2 dual-head L2 w/ load management			
Berkeley Marina	125/127 University Avenue	33 (includes scooters)	4 dual-head L2	70.5	75 kW / 300 kWh	Yes
Adult Mental Health Clinic	1521 University Avenue	13	3 dual-head L2	--	--	
Mental Health Clinic	1890 Alcatraz Avenue/ 3282 Adeline Street	6	1 dual-head L2	--	--	Yes
Center Street Garage	2025 Center Street	36 (some will relocate to Civic Center)	28 dual-head, 1 single L2 (existing)	168.9	63 kW / 250 kWh	
Central Library Parking Lot	2031 Bancroft Way	1	1 dual-head L2	18.8	--	Yes
Public Safety Building	2100 Martin Luther King Jr Way	2	1 dual-head L2	10.8	--	
Civic Center	2180 Milvia Street	1	2 dual-head L2	--	--	
Mental Health Clinic	2636/2640 Martin Luther King Jr Way	8	2 dual-head L2	60.1		
South Berkeley Senior Center	2939 Ellis Street	2	1 dual-head L2	7.8		Yes
North Berkeley Senior Center	1901 Hearst Avenue	2	1 dual-head L2	29.6		

The City fleet includes three take-home vehicles that are assumed to be charged a staffs' homes.

Table 2 summarizes the estimated annual costs for transitioning the City's light-duty fleet to EVs. Estimates are based on April 2020 data for initial procurement, installation, and annual operation and maintenance costs. Factors that impact these estimates include change in costs of equipment, insurance, sales tax, and utility rates; change in the numbers of vehicles procured each year; implementation of solar PV and/or BES systems, and the availability of incentives and grants.

Table 2: Summary of Estimated Procurement and Operating and Maintenance Costs by Year

	2021	2022	2023	2024	2025	2026-30
Light-duty vehicle procurement	$1,156,200	$678,043	$151,379	$191,797	$151,736	$2,528,658
Charger procurement and installation*	$675,500	$675,500				
Annual charger maintenance fee*	$12,400	$22,300	$22,300	$22,300	$22,300	$111,500
Solar PV procurement and installation*	$534,650	$534,650				
BES procurement and installation	$1,020,000					$1,020,000
Back-up generator procurement	$827,000					
Minimum reserved funds for heavy-duty EV evaluation	$250,000	$250,000	$250,000	$250,000	$250,000	
Total	$4,475,750	$2,160,493	$423,679	$464,097	$424,036	$3,660,158

**Does not include charging stations and solar PV already installed or planned for 2020 or any charging stations that will be incorporated into the new Transfer Station rebuild project*

As shown in Table 2, complete implementation of the EV Fleet Plan requires significant resources, particularly in the first two years of implementation, 2021 and 2022. Costs associated with building adequate charging infrastructure are unavoidable, but the plan attempts to minimize those costs via charger sharing, load management, and potentially providing mobile charging in some locations. EVs require charging stations for refueling, and the City's vehicles are domiciled in dispersed locations (see Table 1), most of which currently have limited electrical capacity, as well as physical constraints related to adding EV charging infrastructure. Although elements such as solar PV and BES are not essential for EV adoption, if incorporated, they will reduce utility costs associated with vehicle charging and provide greater resilience during power losses.

BACKGROUND

As staff sought resources to complete the Action Plan for Greening the City of Berkeley Fleet of Vehicles in July 2019, EBCE offered to perform rapid fleet electrification assessments for member cities to help update EBCE's electricity load growth curve forecast and plan for infrastructure build out. Member cities including Berkeley, Albany, Dublin, and Oakland expressed interest in participating in the assessments, and EBCE issued an RFP for consultant services in September 2019. City of Berkeley staff participated in review of the proposals, and final selection of the consultant team of Frontier Energy, DKS Associates, and Gladstein, Neandross & Associates. The project kicked off in November 2019 with Berkeley in first position for the comprehensive fleet electrification assessment. The consultant team, working closely with EBCE and Berkeley staff, completed the assessment in May 2020.

Transportation is the largest source of greenhouse gas (GHG) emissions in Berkeley, accounting for 60% of the community's total emissions in 2016.[1] In keeping with Berkeley Climate Action Plan goals, and consistent with Council's 2018 Climate Emergency Declaration and resolution to become a Fossil Fuel Free City, staff began incorporating EVs into the municipal fleet in 2016. The fleet currently includes 2 electric scooters (GO-4 EVs) for parking enforcement and 15 Toyota Prius Primes used in multiple departments including Health, Housing & Community Services, Planning, and Public Works.

At the end of 2019, 37 additional charging ports were added to the newly rebuilt Center Street Garage, for a total 57 ports available for public and fleet charging, at this facility which also hosts a 168.9 kW solar PV rooftop canopy. The Center Street Garage rebuild and charging expansion utilized a portion of the $600,000 allocated in the FY2020 budget for EVs and charging infrastructure, with funding also going towards incorporating EV charging stations into current capital projects at the Mental Health Clinic and North Berkeley Senior Center; and charging design work at the Corp Yard and the Berkeley Marina. In addition, staff was recently informed Berkeley's application for the West Oakland Zero Emission Grant Program to fund fleet EVs and charging infrastructure has been recommended for a $100,914 award for approval by the Bay Area Air Quality Management District Board in June 2020.

Further expansion of fleet EVs is dependent on providing appropriate charging infrastructure. This Fleet EV Plan provides the City of Berkeley with a plan and recommendations for the accelerated transition to fleet electrification, including associated DER options. EBCE graciously funded this plan, and will continue to offer assistance for the installation of EV charging infrastructure and DER. EBCE has applied to the California Energy Commission for CALeVIP funding that would provide $14.5 million to our region over 4 years beginning in 2021, for Level 2 and DC Fast Charge stations. This could potentially be combined with other funding opportunities including

[1] Climate Action Plan Update, December 6, 2018, available at https://www.cityofberkeley.info/climate/.

Pacific Gas & Electric's EV Fleet program, but significant City investment will be required for plan implementation.

ENVIRONMENTAL SUSTAINABILITY

Driving an EV instead of a conventional gasoline or diesel-fueled combustion engine vehicle eliminates tailpipe emissions. The associated GHG emissions, when charging is powered by onsite solar PV or by EBCE's 100% carbon-free product (Brilliant 100, which is currently used by municipal accounts), are also completely eliminated. Widespread electric mobility is an essential component of reaching the State's carbon neutrality (zero net carbon) by 2045, and becoming a Fossil Fuel Free City as soon as possible. This Fleet EV Plan estimates the annual lifecycle GHG emissions associated with the light-duty fleet would drop 96% between 2020 and 2030 from 56.6 metric tons to only 2.1 metric tons per year.

RATIONALE FOR RECOMMENDATION

The City of Berkeley Municipal Fleet Electrification Assessment presents an ambitious plan for transitioning fleet vehicles away from fossil fuels to electric vehicles, including developing charging infrastructure and associated distributed energy resource options, such as solar photovoltaics and battery energy storage. The Fleet EV Plan is thorough and was developed in close collaboration with City staff and EBCE to meet Council's referral request and to demonstrate City leadership in addressing climate change and protecting the environment. Given the budgetary impacts of COVID-19 on the City, no specific budget allocation to support Fleet EV Plan implementation is being requested at this time.

ALTERNATIVE ACTIONS CONSIDERED

None.

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Attachments:
1: City of Berkeley Municipal Fleet Electrification Assessment Plan
2: Original Referral Report from June 25, 2019 (Item 36, An Action Plan for Greening the City of Berkeley Fleet of Vehicles)

City of Berkeley Municipal Fleet Electrification Assessment

Prepared for: East Bay Community Energy on behalf of the City of Berkeley

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Contents

Glossary

4WD/4x4	Four-wheel drive
A	Amperes
BAAQMD	Bay Area Air Quality Management District
BES	Battery energy storage
BEV	Battery electric vehicle
CALeVIP	California Electric Vehicle Incentive Program
CapEx	Capital expense
CARB	California Air Resources Board
CORE	California Off-Road Equipment
CVRP	Clean Vehicle Rebate Project
DCFC	DC Fast Charging
DER	Distributed energy resource
EBCE	East Bay Community Energy
EV	Electric vehicle
EVSE	Electric vehicle service equipment
GHG	Greenhouse gas
HVIP	Hybrid Voucher Incentive Program
ICE	Internal combustion engine
kW	Kilowatt
kWh	Kilowatt hour
LCFS	Low Carbon Fuel Standard
Level 2/L2	240-volt charging equipment
O&M/OpEx	Operation and maintenance (expense)
OEM	Original Equipment Manufacturer
PHEV	Plug-in hybrid electric vehicle
PV	Photovoltaic
RA	Resource adequacy
SF	Square feet
SUV	Sport utility vehicle
TCO	Total cost of ownership
V	Volt
W	Watt
ZEV	Zero emission vehicle

City of Berkeley Fleet Transition Plan

Introduction

Fleet electrification offers local governments economic benefits that include lower lifecycle costs and reduced risk of fuel price volatility when compared to internal combustion engine (ICE) vehicles. Deployment of electric vehicles (EV) in municipal fleets also benefits the local population through the use of clean electricity as fuel, which helps reduce criteria air pollutants and greenhouse gas emissions.

To assist local government partners in overcoming perceived barriers to municipal fleet electrification, East Bay Community Energy (EBCE) commissioned a consultant team to develop a plan on behalf of the City of Berkeley (City) that evaluates the short- and long-term cost savings associated with the transition to EVs, determines impacts and benefits to the City, and outlines steps to efficiently integrate EVs and charging infrastructure at municipal facilities in a fiscally responsible manner.

In June 2019 City Council requested the City Manager and Department of Public Works collaborate to create an Action Plan by June 2020 that would outline how the City would accelerate the implementation of municipal fleet electrification by 2030. The purpose of this report is to understand the current municipal fleet composition and make recommendations about transitioning from light-, medium-, and heavy-duty ICE vehicles to EVs by 2030, to the extent feasible. Commitment to fleet electrification will help move the City closer to achieving Council-adopted climate policies while leading by example in the community.

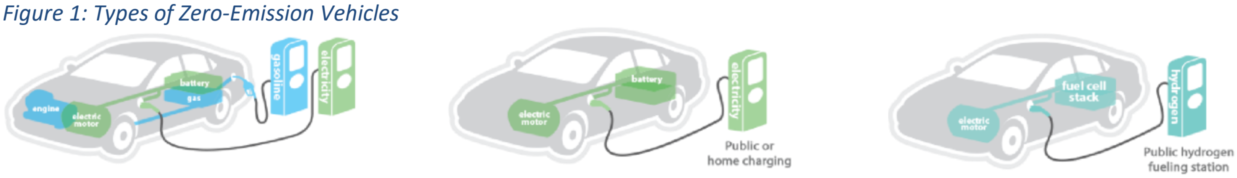
Development of this report was supported by data provided by the City and supplemental information gathered during meetings and interviews.

The purpose of this report is to present a formalized EV deployment plan for the City's municipal fleet in line with the City's commitments and goals. This plan addresses 2021-2025 procurement cycles in detail and 2026-2030 procurement cycles more generally to ensure fiscally responsible procurement and deployment of EVs and proposed associated distributed energy resource (DER) options, including charging infrastructure and onsite solar photovoltaic (PV) and/or battery energy storage (BES) systems. It includes reporting about vehicle and DER technology and financial model recommendations for each fleet facility (domicile), and it ultimately recommends a scenario to meet fleet electrification requirements with the greatest ease of implementation and integration.

Vehicle Technology

Zero-emission vehicles (ZEV) are those that have electric drivetrains to provide all or some of the vehicle's power. California regulations recognize three types of ZEVs as shown in Figure 1.

Figure 1: Types of Zero-Emission Vehicles



Plug-In Hybrid (PHEV)
Uses batteries to power an electric motor, plugs into the electric grid to charge and gasoline power an internal combustion engine.

Battery Electric (EV)
Powered by one or more electric motors, plugs into the electrical grid and stores power in batteries.

Fuel Cell Electric (FCEV)
Powered by one or more electric motors, fills with hydrogen at a fueling station, fuel cells convert hydrogen to energy.

Source: Center for Sustainable Energy

- Plug-in Hybrid Electric Vehicles (PHEV): PHEVs are powered by electric charging and gasoline fueling. Most have an all-electric driving range of 10-50 miles. PHEVs can often be fully charged overnight from a standard electrical socket (Level 1) and accept Level 2 charging. PHEVs are more efficient than hybrids and, if driven on primarily on electric power, can achieve up to 133 miles per gallon gasoline equivalent.[1]
- Battery Electric Vehicles (BEV): BEVs are powered by electric batteries only and have a range of between 70-315 miles. BEVs are very efficient and can achieve up to 120 miles per gallon gasoline equivalent.[1] Most BEVs can be charged at Level 1, which is ideal for vehicles with a long dwell time, and Level 2 and DC Fast Charging. Figure 2 illustrates the difference in time to charge at the three charging levels.
- Fuel Cell Electric Vehicles (FCEV): FCEVs are powered by a fuel cell that converts hydrogen into electric energy within the vehicle. Current FCEV models have a range of 312-380 miles. FCEVs are fueled at public hydrogen stations in about five minutes. One hydrogen station located at 1250 University Avenue in Berkeley is currently in development. FCEVs are efficient in power conversion and can achieve up to 68 miles per gallon gasoline equivalent.[1] Longer term, FCEVs may be considered for medium and heavy-duty fleet applications.

Charging Technology

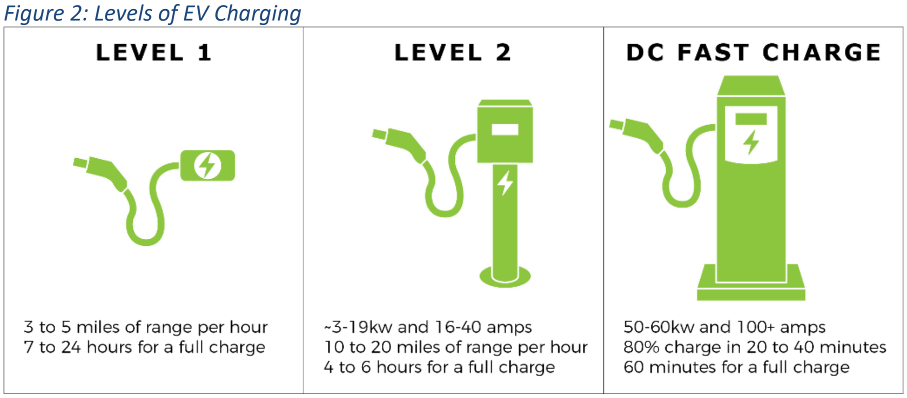
Chargers are identified by their input voltage and are designed and sold by many manufacturers with different prices, applications and functionality. Figure 2 illustrates the difference in charging speeds (miles of range added per hour) from the three charging levels.

- Level 1 charging uses a common wall outlet. Some vehicles can use a standard 120-volt outlet on a dedicated circuit for a "trickle" charge. Most EVs include a cord that can plug into a Level 1 outlet and, therefore, this level of charging does not require installation of charging equipment. Depending on the battery capacity of the EV, Level 1 charging can take 7 to 24 hours for a full charge.

[1] https://fueleconomy.gov

- Level 2 equipment offers charging through a 240V, AC plug and requires electric vehicle service equipment (EVSE) with a dedicated 40-amp circuit. All BEVs and PHEVs can use Level 2 charging by using the cord that is attached to the EVSE and plugging it into the vehicle. Level 2 EVSEs come in many configurations: wall mounted, free standing, curbside, and ceiling mounted, and can be networked (smart) to accept payment and communicate charging status or not networked (dumb). Depending on the battery capacity of the EV vehicle, Level 2 charging generally takes 4 to 6 hours to completely charge a depleted battery, however, charging duration can increase in extreme cold and hot temperatures.
- DC Fast Charging (DCFC) is the fastest way to charge an EV and requires a specialized charger on a dedicated circuit that matches the amperage of the EVSE—between 50 and 150 amps. Most BEVs can utilize a DCFC by using the cord attached to the EVSE. Most DCFCs are networked to charge customers for use and help with power management to avoid peaks in demand. Mobile and portable DCFCs are just entering the market. DCFC charging generally takes fewer than 60 minutes to completely charge a depleted battery, however, charging duration can increase in extreme cold and hot temperatures.

Figure 2: Levels of EV Charging



Source: Frontier Energy

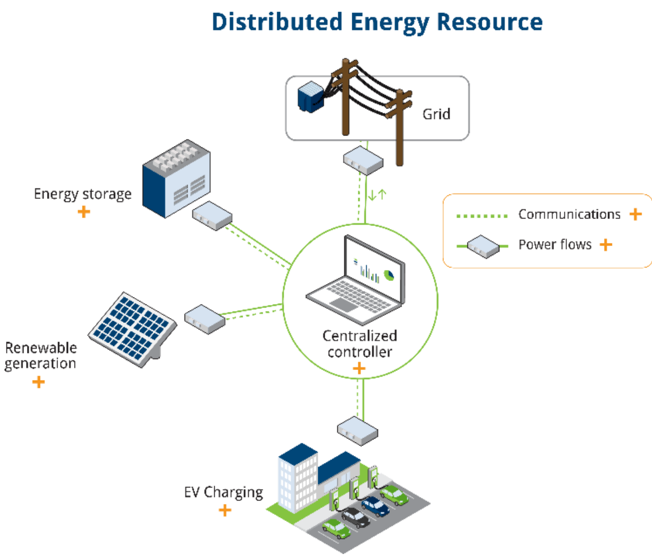
Solar Photovoltaic + Battery Energy Storage Systems

With the threat of a major earthquake predicted to impact the greater San Francisco Bay Area in the next 30 years, cities like Berkeley have extensive experiencing preparing for natural disasters that can interrupt the utility grid. In recent years, however, increased frequency of climate-related wildfires created a new impact on the City's operations and those of its businesses and residents. As a last-resort measure to prevent grid-initiated fires, the investor owned utility PG&E implemented processes to de-energize targeted regions known as Public Safety Power Shutoff (PSPS) events. It is crucial that the City's EV fleet has reliable fueling options when electric service is interrupted due to a natural disaster or PSPS to ensure staff can provide continuity of service to the community.

Onsite solar photovoltaic (PV) arrays paired battery energy storage (BES) systems can provide that resilience. And, on a day-to-day basis, these systems can also reduce costs associated with PG&E demand charges further helping the City's fleet save on operational expenses.

With the help of a central controller, power generated from onsite solar PV is directed to the BES system. If a City facility is not suitable for onsite PV, electricity will be directed from the grid to the BES system by the controller. In either case, the controller monitors onsite electricity production, electricity flowing from the grid to the battery, and consumption by loads like building energy use and EV charging infrastructure. Figure 3 provides a simplified schematic of a solar PV and BES system.

Figure 3: Schematic of a DER system



Source: Frontier Energy

Summarized Recommendations

In late-February 2020, the City fleet, excluding emergency response vehicles, consisted of 99 passenger sedans and SUVs, 30 parking enforcement scooters, 88 medium-duty pick-up trucks and vans, and 98 heavy-duty vehicles. The City's fleet domiciles in 15 locations. With input from City staff, it was determined that the light-duty fleet could be transitioned to EVs and, in fact, that transition had already begun with the acquisition of 15 Prius Prime PHEVs. The detailed recommendations summarized in this report focus on the light-duty fleet. Medium- and heavy-duty vehicles should be evaluated during the 2020-2030 timeframe via pilot programs until EVs in these classes are cost effective and can meet the same duty cycle of the existing vehicles.

Table 1 summarizes the recommendations throughout this report for adding charging stations, solar PV, and BES systems to support the transition of the light-duty fleet to EVs. Solar PV and BES recommendations are based on the energy load of the fleet, and some locations are being evaluated through EBCE's separate *Solar + Storage at Critical Municipal Facilities Assessment*. Backup generators are included to provide resiliency, but these needs may be met at some locations with solar PV and BES.

Table 1: Summary of Light-duty Fleet Electrification Transition

Facility Name	Facility Location	Light-Duty EVs	Chargers	Solar PV (kW DC)	BES	Backup Generator
Corp Yard	1326 Allston Way	16	4 dual-head L2 and 1 DCFC	52.7	33 kW / 130 kWh	Yes
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Facility Name	Facility Location	Light-Duty EVs	Chargers	Solar PV (kW DC)	BES	Backup Generator
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North Berkeley Senior Center	1901 Hearst Avenue	2	1 dual-head L2	29.6		

The City fleet includes three take-home vehicles that are assumed to be charged a staffs' homes.

Summary of Estimated Costs

Table 2 summarizes the estimated annual costs for transitioning the City's light-duty fleet to EVs. Estimates are based on data available in April 2020 for initial procurement, installation, and annual operation and maintenance costs. Factors that impact these estimates include change in cost of equipment, insurance, sales tax, and utility rates; change in the numbers of vehicles procured each year; implementation of solar PV and/or BES systems, and the availability of incentives and grants.

Table 2: Summary of Estimated Procurement and Operating and Maintenance Costs by Year

	2021	2022	2023	2024	2025	2026-30
Light-duty vehicle procurement	$1,156,200	$678,043	$151,379	$191,797	$151,736	$2,528,658
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Solar PV procurement and installation*	$534,650	$534,650				
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Back-up generator procurement	$827,000					
Reserved funds for procurement of heavy-duty EVs for evaluation	$250,000	$250,000	$250,000	$250,000	$250,000	
Total	$4,475,750	$2,160,493	$423,679	$464,097	$424,036	$3,660,158

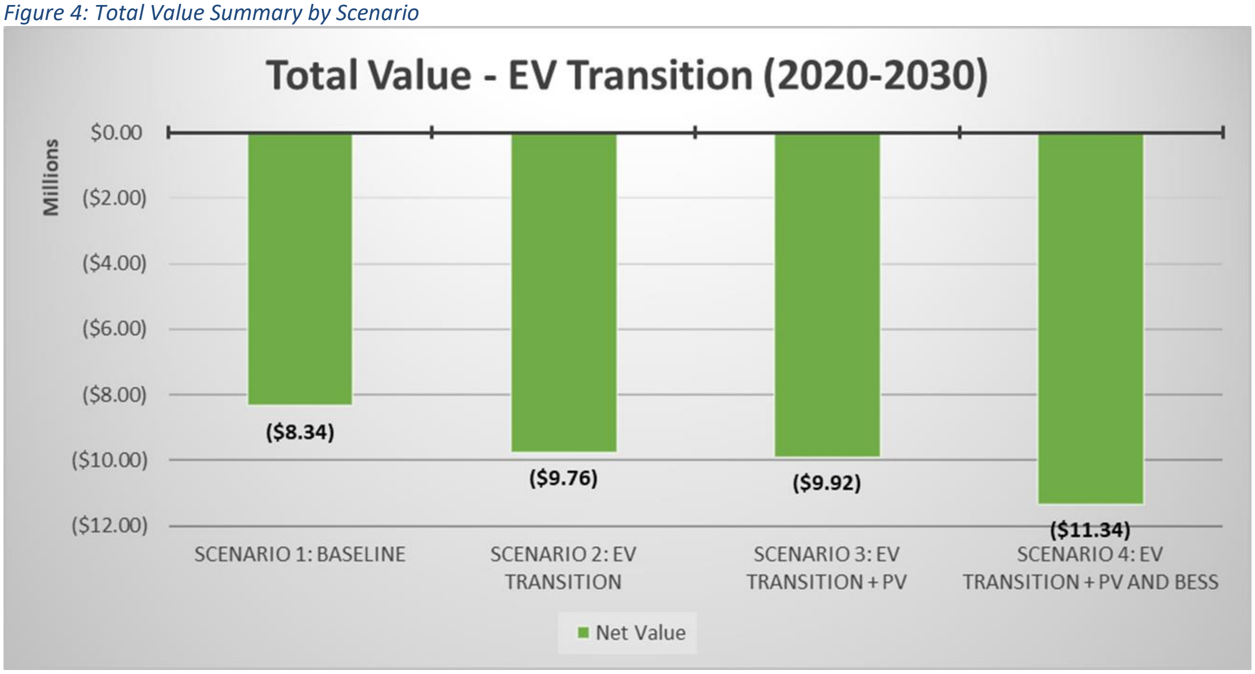
**Does not include charging stations and solar PV already installed or planned for 2020 or any charging stations that will be incorporated into the new Transfer Station rebuild project*

To understand the total cost of ownership, four scenarios were created:

1. Baseline—assume that existing gasoline and hybrid ICE vehicles are replace with similar vehicles
2. EV Transition—assumes that existing gasoline and hybrid ICE vehicles are replace with EVs
3. EV Transition + PV—adds solar to the EV Transition
4. EV Transition + PV and BES—adds battery storage

Due to the high costs associated with charging infrastructure, including procurement, installation, and electrical upgrades, the EV transition scenario is more expensive over 10 years than the Baseline scenario. Adding solar PV is a slight increase further and the addition of both solar PV and BES systems further increases the total cost of ownership, as shown in Figure 4. EBCE plans to aggregate cities' solar PV and BES needs into a competitive solicitation in 2020 to reduce the cost and complexity of deploying these systems in the near term for its local government partners.

Figure 4: Total Value Summary by Scenario



Additional charging may need to be added to support medium-, heavy-duty, and emergency response EVs as they become more readily available and economically feasible. Additionally, grant programs, rebates, and incentives may further offset costs of procuring and operating the proposed supporting DER technologies. It is recommended that the City closely track such funding opportunities and coordinate with partners, such as EBCE, accordingly.

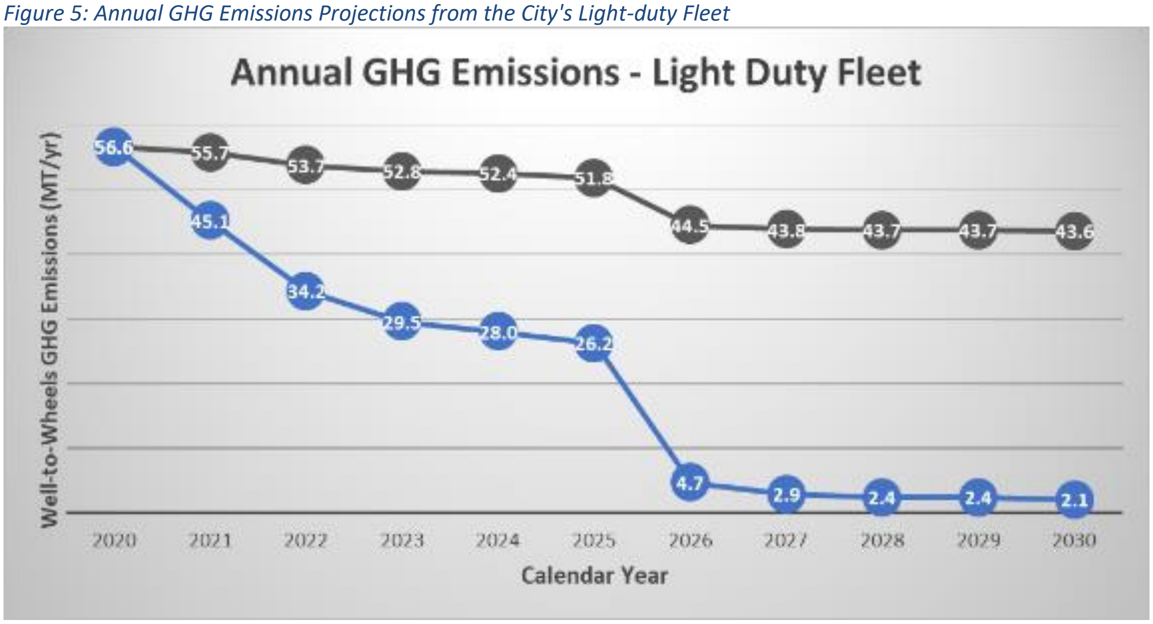
Summary of Emissions Reduction

Transportation contributes 60% of Berkeley's greenhouse gas (GHG) emissions.[2] Transitioning to EVs charged with 100% renewable or carbon-free electricity that EBCE provides dramatically reduces GHGs from the City's fleet. Figure 5 compares GHG emissions under the Baseline scenario and the EV

[2] https://www.cityofberkeley.info/climate/

transition scenario. Precipitous drops in the EV transition scenario in 2021, 2022, and 2025 are associated with the substantial number of vehicles slated for replacement in each of those years.

Figure 5: Annual GHG Emissions Projections from the City's Light-duty Fleet



In 2030, GHGs would be reduced 96% relative to the Baseline scenario. The few remaining GHG emissions are associated with seven PHEV SUVs that have a portion of their daily mileage powered by gasoline. By 2030, it is likely that SUV BEVs that meet the City's duty cycles will be available, effectively allowing the City to achieve a 100% reduction in the GHG emissions for the light-duty fleet considered in this analysis.

Fleet Electrification Transition

Light-duty Vehicles

As of February 2020, the City's light-duty fleet passenger sedans (or cars), SUVs, and parking enforcement scooters (excluding vehicles used for emergency services and response) consisted of 75 passenger sedans, 24 SUVs, and 30 parking enforcement scooters

The City schedules vehicle replacement 7, 10, or 15 years from the purchase date, although some vehicles are kept longer than planned. All the GO-4 scooters are scheduled to be replaced in 2026. Based on the current vehicle replacement schedule, Table 3 summarizes year-by-year transition to EVs.

The consultant team recommends replacing existing passenger sedans with BEVs, transitioning some existing SUVs to BEV sedans and replacing other SUVs with PHEV SUVs. PHEV SUVs will primarily travel on the electricity available from the vehicles' batteries and the gasoline engine provides flexibility and resiliency needed by these vehicles for emergency response and disaster preparedness. By 2026, the BEV parking enforcement scooters will likely meet the City's needs for range and reliability. If BEV scooters are not viable or cost effective by 2026, the City may consider replacing the scooters with BEV sedans.

Table 3: Procurement Schedule for Passenger Sedans and SUVs

Year	Number of BEV Passenger Sedans/Wagons	Number of PHEV SUVs	Number of BEV Scooters
2020*	1	0	
2021**	29	3	
2022	10	8	
2023	3	1	
2024	4	1	
2025	4	0	
2026	11	0	30
2027	6	0	
2028	3	0	
2029	0	0	
2030	1	0	

**Vehicles the City procured in January and February 2020 or are scheduled to be procured in 2031 do not appear in this table.*
***Six vehicles may be replaced with EVs in 2020 (instead of 2021), pending approval of a Bay Area Air Quality Management District (BAAQMD) grant application.*

2020-2025 Budgeting Considerations for Light-Duty EVs

Based on the negotiated contract rates from National Auto Fleet Group, Table 4 lists the estimated price for EVs, including 9.25% sales tax, additional keys, and other fees. The prices are rounded to the nearest dollar, based on the City's stated preference to standardize on the Nissan Leaf Plus and Chevy Bolt. The City doesn't have a stated preference for an SUV replacement and three PHEV options are listed.

Table 4: Average Contract Rates for EVs

Technology Type	Body Type	Make and Model	NAFG Est. Price	EPA Rated All-electric Range	Battery Size (kWh)
BEV	Sedan	Nissan Leaf Plus	$37,934	226	62
BEV	Small Wagon	Chevy Bolt	$37,577	259	60
BEV	Scooter	GO-4 EV	$47,666	100*	20
PHEV	SUV	Kia Niro LX PHEV	$31,505	26	9
PHEV	SUV	Mitsubishi Outlander 4WD	$40,061	22	12
PHEV	Minivan	Chrysler Pacifica	$43,578	32	16

**Manufacturer estimate*

Currently, the City is eligible to claim a Clean Vehicle Rebate Program (CVRP) rebate from the State of California for up to 30 EVs per year.[3] In 2020, BEVs are eligible for a $2,000 per vehicle rebate and some PHEVs are eligible for a $1,000 rebate. The Mitsubishi Outlander, the only four-wheel-drive (4WD) PHEV, is not eligible for the rebate because it does not meet the minimum requirement for all-electric range.[4] The Kia Niro crossover PHEV and the Chrysler Pacifica minivan are eligible for CVRP.

Table 5 estimates the cost for replacement EVs in 2020 through 2025 (from Table 3) for each budget year with the current contracted prices (from Table 4). The estimated budget will vary based on the contract price, vehicle selected, and changes in sales tax rates. Although more EV makes and models will become available, EV costs will likely remain in the same price range through 2025. Because the CVRP rebate program may not be continued beyond the planned end in 2022,[5] the consultant team took a conservative approach and did not include the rebates starting in 2023.

Table 5: Year-by-Year Budget Estimates to Replace Existing ICE Vehicles with EVs

Year	Nissan Leaf Plus @ $37,934	Chevy Bolt @ $37,577	Mitsubishi Outlander PHEV @ $40,061	Potential CVRP Rebate	Total Estimated Vehicle Cost
2020	$37,934 (1)			($2,000)	$35,934
2021*	$455,208 (12)	$638,809 (17)	$120,183 (3)	($58,000)	$1,156,200
2022	$189,670 (5)	$187,855 (5)	$320,488 (8)	($20,000)	$678,043
2023	$113,802 (3)	$37,577 (1)			$151,379
2024	$151,736 (4)		$40,061 (1)		$191,797
2025	$151,736 (4)				$151,736

**The City applied for a grant from Bay Area Air Quality Management District. If awarded, six vehicles scheduled to be replaced in 2021 will be replaced in 2020 and will not need to be included in the 2021 budget.*

[3] https://cleanvehiclerebate.org/eng/fleet. Rebates are on a first-come, first-served basis.
[4] https://cleanvehiclerebate.org/eng/faqs/why-don%E2%80%99t-i-see-my-vehicle-eligibility-list-0
[5] https://ww3.arb.ca.gov/msprog/aqip/fundplan/fy1920fundingplan-appc-rev.pdf

Availability of Medium- and Heavy-Duty EVs

The City fleet includes 72 medium-duty pickup trucks, some of which may be able to be replaced with an upcoming all-electric Ford F-150, which Ford announced will arrive in the U.S. market by the end of 2021. Ford also announced it will have an F-150 PHEV by late-2020; however, the battery is intended to be used for accessories and not motive power.[6] It is unknown if the F-150s will have a utility body application, but companies like Motiv Power Systems produce an EV chassis that can be upfitted with a utility body. Motiv's EV-450 is larger than the F-250 and Rangers the City operates today.

The City also operates 16 cargo vans, primarily Ford E-250/350 and Connect Transit vans, two of which include a genset for camera operation. Electric vans (passenger and cargo) start at about $100,000, but production has not kept pace with orders and supplies are very limited. Some cargo vans may be able to be replaced with PHEV SUVs or pick-ups.

The City operates three Ford E450 20-passenger buses for the South Berkeley Senior Center, two of which are scheduled for replacement in 2020 and 2022. Several manufacturers offer EV shuttle buses that cost $270,000 and up, depending on configuration and accessories (e.g., wheelchair lift).

The fleet inventory list shows 16 refuse and dump trucks that are scheduled to be replaced in 2020 and 2021. Electric models of these vehicles are currently available in limited supply and cost about $320,000 each. Fleet staff have feedback from other agencies that the limited range and long charging time of current BEV refuse trucks is not practical for City operations, which includes multiple 88-mile round trips to the Livermore landfill every day. The City's intention is to electrify refuse vehicles and add charging infrastructure, including solar PV and BES, during the rebuild of the Transfer Station.

From a budgeting perspective, the consultant team recommends allocating up to $250,000 per year to procure medium- and heavy-duty EVs as pilot projects so that City staff can evaluate their suitability to duty cycle and task. As grants and incentives become available, this amount should be reconsidered annually.

Availability of Emergency EVs

Emergency vehicles for police patrol and pursuit, firefighting, and emergency medical services are not currently available in plug-in models. None of the automakers that build police-specific vehicles have announced a plug-in version.[7]

Rosenbauer, an Austrian company, has a concept BEV fire vehicle called the CFT that is smaller than a traditional U.S. firetruck.[8] The City of Los Angeles recently ordered a CFT, which will be the first in North America. Electric "ambulances" are BEV sedans that have been retrofitted to provide aid at an incident;

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[6] Other companies have announced BEV pickups with starting prices in the $70,000 range and are aimed at a luxury market. The consultant team did not consider these trucks for fleet use.

[7] Ford announced a PHEV patrol sedan but released the car as "special services" sedan not rated for patrol or pursuit.

[8] https://innovation.rosenbauer.com/en/concept-fire-truck/

they are not capable of transporting patients as a traditional ambulance does. None of the manufacturers that make firetrucks and ambulances have announced plans to electrify these vehicles.

2026-2030 Budgeting Considerations for Light-Duty EVs

The year-by-year replacement schedule calls for replacing a total of 21 passenger sedans and 30 parking enforcement scooters between 2026 and 2030, with most replacements occurring in 2026.

In its *Annual Energy Outlook*, the Energy Information Agency projects that 300-mile-range BEVs will be upper-tier of the EV market by 2025.[9] Bloomberg New Energy Finance's Electric Vehicle Outlook[10] report published in late-2019 stated, "we expect price parity between EVs and internal combustion engines by the mid-2020s in most segments..."

By 2024, the City will have been acquiring data from the telematics system (scheduled to be installed in 2020) for four years. Data collected on vehicle use patterns and parking behavior will inform and support the City's decision to either procure lower-cost BEVs with 100-to-150-mile range or higher-cost BEVs with 300-miles or more range. Although budgeting the cost of vehicles in future years is imprecise, Table 6 and Table 7 estimate costs for light-duty EVs for both scenarios. Should the City replace the GO-4 scooters with BEV sedans for parking enforcement, upfits to the sedans (e.g., lightbars, license plate readers) will result in approximately the same cost per vehicle as per scooter. Note that the current replacement schedule calls for no vehicles to be replaced in 2029.

Table 6: Higher-cost, Longer-range BEVs

Year	Sedan @ $37,934	Scooter @ $53,906	Total Estimated Vehicle Cost
2026	$796,614 (21)	$1,617,180 (30)	$2,413,794
2027	$227,604 (6)		$227,604
2028	$113,802 (3)		$113,802
2030	$37,934 (1)		$37,934

Table 7: Lower-cost, Shorter-range BEVs

Year	Sedan @ $32,273	Scooter @ $53,906	Total Estimated Vehicle Cost
2026	$677,733 (21)	$1,617,180 (30)	$2,294,913
2027	$193,638 (6)		$193,638
2028	$96,837 (3)		$96,837
2030	$32,273 (1)		$32,273

Medium- and heavy-duty EVs may be competitive in performance, range, and reliability by the latter half of the decade. Additionally, the range of light-duty vehicles may have increased enough that BEVs could be used for some emergency response vehicles (e.g. police patrol and pursuit, some fire applications). It is recommended that the City reevaluate the vehicle budget in early 2025.

[9] https://www.eia.gov/outlooks/aeo/
[10] https://about.bnef.com/electric-vehicle-outlook/#toc-download

Appendix A includes detailed information about fleet replacement analysis, including an itemized list of the passenger sedans and SUVs in the current fleet and recommended replacement types.

Charging Strategy Options

Analysis of the City's existing fleet found that most light-duty vehicles drive between 3 and 63 miles per day with an average usage of 27.1 miles. Considering the relative efficiency difference between gasoline-powered ICE vehicles and BEVs, this translates into approximately 80 kWh of electricity per day on average. In addition, most vehicles are driven during the day and parked overnight at City facilities, which provides ample dwell time for battery charging. The City stated intention to standardize on the Chevy Bolt and Nissan Leaf Plus, which have a 60 and 62 kilowatt/hour (kWh) battery, respectively, and well over 200 miles of range. Due to these minimal power requirements coupled with long dwell times for most vehicles domiciled at the City facilities, light-duty BEVs could share chargers and, at some facilities, share power loads by using a power load management strategy.

Table 8 lists the recommended charging infrastructure for transitioning the light-duty fleet to EVs, including charging stations that are already available to fleet vehicles. Cost estimates include electrical upgrades needed at City facilities (e.g., adding electrical capacity at the panel). To provide back-up power for resiliency, the consultant team included cost estimates for diesel generators at crucial sites, which would be powered by the City's supply of renewable diesel. On-site solar PV and BES may fulfill this requirement. It is assumed that the City will install all charging by 2022 to support rapid transition to electrification and take advantage of anticipated incentive programs.

Table 8: Near-term Recommendations for Charging

Facility Name	Facility Location	Chargers	New Service	Estimated Build-out Costs	Option	Backup Generator
Corp Yard	1326 Allston Way	4 dual-head L2 and 1 DCFC	Yes	$354,000		$487,000
Berkeley Transfer Station	1201 Second Street	2 dual-head L2	No	$87,000		$34,000
Berkeley Marina	125/127 University Avenue	4 dual-head L2	Yes	$290,000		$204,000
Adult Mental Health Clinic	1521 University Avenue	3 dual-head L2	Yes	$135,000		
Mental Health Clinic	1890 Alcatraz Avenue/ 3282 Adeline Street	1 dual-head L2	Yes	$147,000	$45,000 for mobile charger	$34,000

Facility Name	Facility Location	Chargers	New Service	Estimated Build-out Costs	Option	Backup Generator
Center Street Garage	2025 Center St	28 dual-head, 1 single L2	NA	Currently installed/Public access		
Central Library Parking Lot	2031 Bancroft Way	1 dual-head L2	Yes	$149,000		$34,000
Public Safety Building	2100 Martin Luther King Jr Way	1 dual-head L2	No	$42,000		
Civic Center	2180 Milvia Street	2 dual-head L2	No	$65,000		
Mental Health Clinic	2636/2640 Martin Luther King Jr Way	2 dual-head L2	NA	$40,000*		
South Berkeley Senior Center	2939 Ellis Street	1 dual-head L2	Yes	$82,000		$34,000
North Berkeley Senior Center	1901 Hearst Avenue	1 dual-head L2	NA	$45,000 In Progress		

*One L2 charging is being installed; cost is for adding one additional charger

Smart chargers also have an annual fee for networking, which can be negotiated as a multi-year contract. The City currently has a contract with ABM Industries through 2023 for EV network operations and maintenance, plus extended warranty for 57 Level 2 chargers at a cost that equals about $1,100 per charger.[11] DCFC contracts range from $2,500 to $15,000 annually. For purposes of analysis, it was assumed that the Corp Yard DCFC will have a $2,500 annual fee.

The California Electric Vehicle Infrastructure Project (CALeVIP),[12] an incentive program from the California Energy Commission, offers incentives to purchase and install Level 2 and DC fast chargers, available on a first-come, first-served basis. EBCE has applied as a co-funding partner for the 2021 funding round and, if selected, the City of Berkeley may be eligible for up to $4,500 per Level 2 charging connector. Additionally, mobile charging units currently qualify for a 50% rebate under CARB's CORE[13] program.

[11] https://www.cityofberkeley.info/Clerk/City_Council/2018/12_Dec/Documents/2018-12-11_Item_12_Contract_No__9893B_Amendment.aspx
[12] https://calevip.org/about-calevip
[13] http://californiacore.org/

In projecting energy demand for charging, the consultant team took a conservative approach and assumed that all light-duty vehicles will be BEVs, although some will be PHEV SUVs. Estimated costs are for dual-head, pedestal mounted chargers (each charger has two connectors) and include equipment and installation. At some facilities, the estimated cost includes upgrades to the electrical service on the City's side of the meter. For example, charging infrastructure at the Public Safety Building will require new electrical service with a 200 amperes (A) main breaker. Some facilities require one or more new breakers in an existing panel and other locations require a new subpanel.

Estimates do not include upgrades that may be required on the utility side of the meter. For example, the utility may need increase a transformer's capacity to handle the additional load from charging. EBCE will work with the City to identify utility upgrades that may be necessary. To provide back-up power for resiliency, the consultant team included cost estimates for diesel generators at crucial sites, although BES systems may fulfill this need.

Appendix B provides detailed information about how charging needs were determined and considerations for charging strategies to minimize staff time and PG&E demand charges.

Distributed Energy Resources

The consultant team evaluated potential areas for DER—onsite solar PV, BES and EV charging infrastructure—at each of the vehicle domicile locations. The analyses represented an initial screening to identify sites at which solar PV and/or BES may be favorable and reasonably sized to offset electricity consumption of the City's EV fleet.

The current fleet assessment identifies the need to support 1,009 kWh/day of EV charging, indicating that solar PV arrays deployed at some sites could also serve onsite building loads and/or future fleet charging needs.

Five domicile locations are also being evaluated through EBCE's *Solar + Storage at Critical Municipal Facilities Assessment,* which is funded by a Bay Area Air Quality Management District (BAAQMD) grant. The goal of this project is to identify critical facilities designated to serve the community in time of emergency throughout Alameda County and size solar PV and BES systems to meet critical loads at those sites. EBCE plans to aggregate the site portfolio into a competitive solicitation Summer 2020 to reduce the cost and complexity of deploying these systems near term for its local government partners.

Fleet modeling was performed using charging profiles beginning at 6:00 PM each day to provide a conservative baseline for EV charging costs.

As a result of modeling all domicile locations with the upcoming PG&E tariff schedule[22] and assessing the physical space available for solar PV and/or BES systems, the consultant team recommends installing solar PV at eight locations (some of which are already planned or in construction) and augment three of these locations with BES systems for operational flexibility, resilience and demand management. BES at these locations will time-shift excess generation from solar PV or from EBCE-provided electricity during the day to use during the new evening peak period hours.

BES can provide resiliency at these three crucial locations, which could eliminate the need for diesel generators. Load management software for charging stations can effectively avoid PG&E's electricity demand charges more cost effectively than BES.

Table 9 lists the domiciles and the recommendation for solar PV and BES to offset energy use by fleet charging.

Table 9: Recommended Solar PV and BES

Location	Existing and Planned Charging Stations	Total Solar PV Capacity (kW DC)	BES Recommendation	Potential Cost for Solar PV + BES
Corp Yard	4 Dual-head Level 2 and 1 DCFC	52.7*	33 kW / 130 kWh	$423,800
Berkeley Marina	4 Dual-head Level 2	70.5*	75 kW / 300 kWh	$54,000

Location	Existing and Planned Charging Stations	Total Solar PV Capacity (kW DC)	BES Recommendation	Potential Cost for Solar PV + BES
Center Street Garage	28 Dual-head Level 2 and 1 Single-head Level 2	168.9*	63 kW / 250 kWh	$782,100
Central Library Parking Lot	1 Dual-head Level 2	18.8		$75,200
Public Safety Building	1 Dual-head Level 2	10.8		$43,200
Mental Health Clinic	1 Dual-head Level 2	60.1*		$240,400
South Berkeley Senior Center	1 Dual-head Level 2	7.8		$31,200
North Berkeley Senior Center	1 Dual-head Level 2	29.6*		$118,400

**Already installed or considered for development via EBCE's Solar + Storage at Critical Municipal Facilities initiative*

Appendix C provides details about solar PV and/or BES systems at Berkeley facilities and recommendations specific to EV charging needs.

Total Cost of Ownership

To determine the total cost of ownership (TCO) for the transition of the light-duty fleet to EVs, four scenarios were created and modeled over an analysis period from 2020 to 2030:

- Scenario 1. Baseline: This scenario assumes that the City's future fleet purchases maintain their existing light-duty vehicle technology composition, replacing each vehicle with a similar new vehicle at the end of the current vehicle's useful life. Traditional ICE vehicles powered by gasoline are replaced with new ICE vehicles, standard ICE hybrid vehicles powered by gasoline are replaced with new ICE hybrids, PHEVs are replaced with new PHEVs, etc. Under this scenario, no new DER options are deployed at any fleet location.
- Scenario 2. EV Transition: This scenario considers the transition of the light-duty fleet to both BEVs and PHEVs. Infrastructure costs for EV charging are included in this scenario, and electricity costs are based on costs of grid electricity supplied by EBCE.
- Scenario 3. EV Transition with Solar PV: Building on Scenario 2, this scenario includes the deployment of solar PV systems at eight City facilities where fleet vehicles are domiciled. Under this scenario, electricity costs for EV charging are largely eliminated through the onsite solar PV generation.
- Scenario 4. EV Transition with Solar PV and BES: This scenario further extends Scenario 3 to include the deployment of BES systems at two City facilities.

Each scenario also assumed vehicle capital and operational costs which were developed from historical operational and cost data provided by the City for each vehicle in the fleet. Replaced vehicles are assumed to maintain the same activity level of the existing vehicle.

The various electrification scenarios assumed the budgeted amounts for purchase and installation of charging infrastructure (in Table 8) and $1,100 per Level 2 charger and $2,500 for the DCFC in annual costs for network services and maintenance. Costs are based on current City contracts for existing Level 2 chargers at Center Street Garage, though it should be noted that the City is not bound to contracting with this provider for future charger deployment, and maintenance and service costs vary significantly depending on the provider.[14] DCFC maintenance costs are estimated to be 2% of the cost of capital costs per year.

Solar PV and BES costs were estimated using the capital costs in Table 9 plus straight-line depreciation for the solar PV. It is assumed that BES will need to be replaced before 2030, effectively doubling the capital costs.[15]

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[14] Based on Contract 9893B Amendment (Dec 2018) for EVSP services. Average of Y3-Y5 maintenance/network costs. Y1-Y2 include installation costs for new chargers and were therefore excluded.

[15] Studies indicate 5-to-7-year useful life for current lithium battery technologies at 50% or greater depth of discharge. Casals et al, "Second life batteries lifespan: Rest of useful life and environmental analysis", Journal of Environmental Analysis, Vol 232, February 2019, pgs 354-363. Smith et al, "Life Prediction Model for Grid-Connected Li-ion Battery Energy Storage System" National Renewable Energy Laboratory, presented at 2017 American Control Conference, Seattle, WA, May 24-26, 2017.

Fleet EVs can generate revenue credits earned through the California Low Carbon Fuel Standard (LCFS) program.[16] LCFS credit prices vary and the average credit price in 2019 was $196.[17] This analysis took a conservative approach and escalated in future years' credits using the average consumer price index increase of 2.2% per year.

Table 10 shows that transitioning to EVs increases the LCFS credits the City can generate over the baseline of the current fleet. Because all City fleet facilities currently receive 100% zero-carbon electricity from EBCE, adding solar PV and/or BES does not increase the LCFS credits that the City may earn.

Table 10: Value of LCFS Credits 2021-2029

	Scenario 1 Baseline	Scenario 2 EV Transition	Scenario 3 EV Transition + Solar PV	Scenario 4 EV Transition + Solar PV + BES
LCFS Credits	$59,692	$388,924	$388,924	$388,924

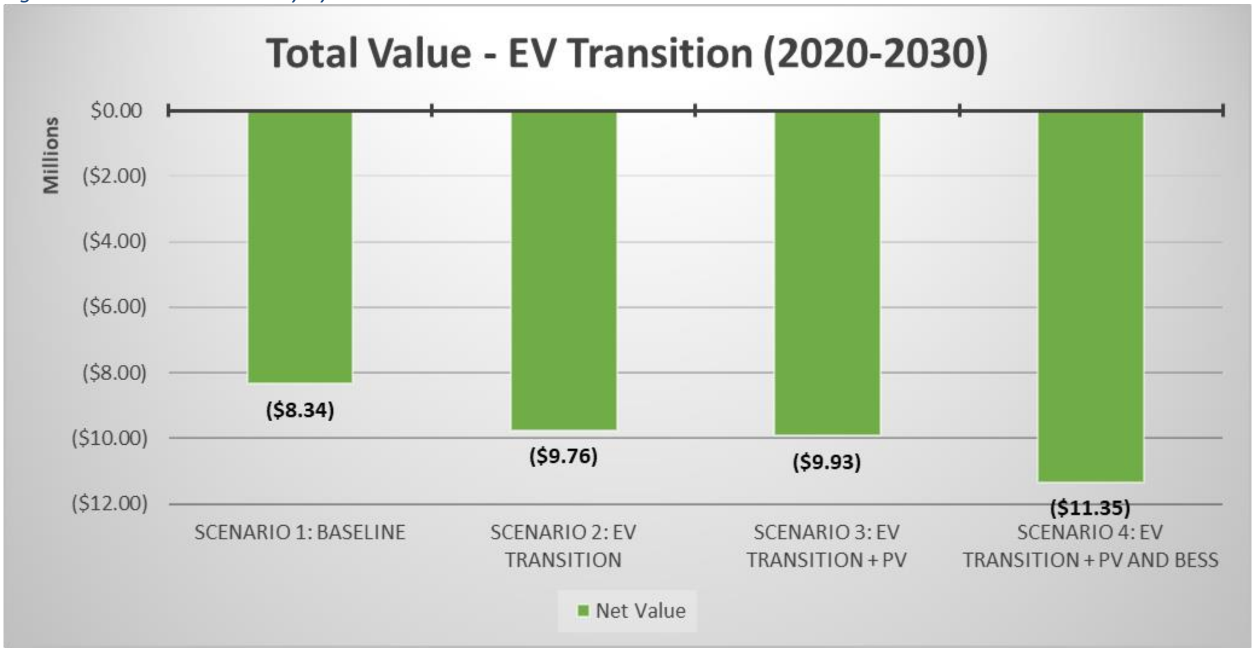
TCO Model Results

The TCO model estimates the cost of the Scenario 1 (Baseline), or business as usual, at $8.34 million over the 2020-2030 analysis period, as shown in Total Value Summary by Scenario. Scenario 2 (EV Transition) cost is estimated at $9.76 million over the same analysis period. The incremental cost of the charging infrastructure (including backup generation) are the primary contributors to the increased cost in this scenario. These costs are partially offset by lower vehicle maintenance costs, incentives, and LCFS program revenues. Additional details are provided in the figures and table below. Scenario 3 adds solar PV systems to Scenario 2 and increases cost by $170,000. This is due to the offset of most of the additional infrastructure expense through reduced grid electricity costs. Scenario 4 adds BES, resulting in a total cost that is approximately $3.0 million greater than Scenario 1 (Baseline). This increased cost assumes BES will need to be replaced before 2030. BES systems do not necessarily reduce operational cost to offset the incremental costs of BES deployment, but may provide resiliency to the City's fleet instead of requiring diesel generators.

[16] https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard

[17] California Air Resources Board, Credit Activity Reports.

Figure 6: Total Value Summary by Scenario



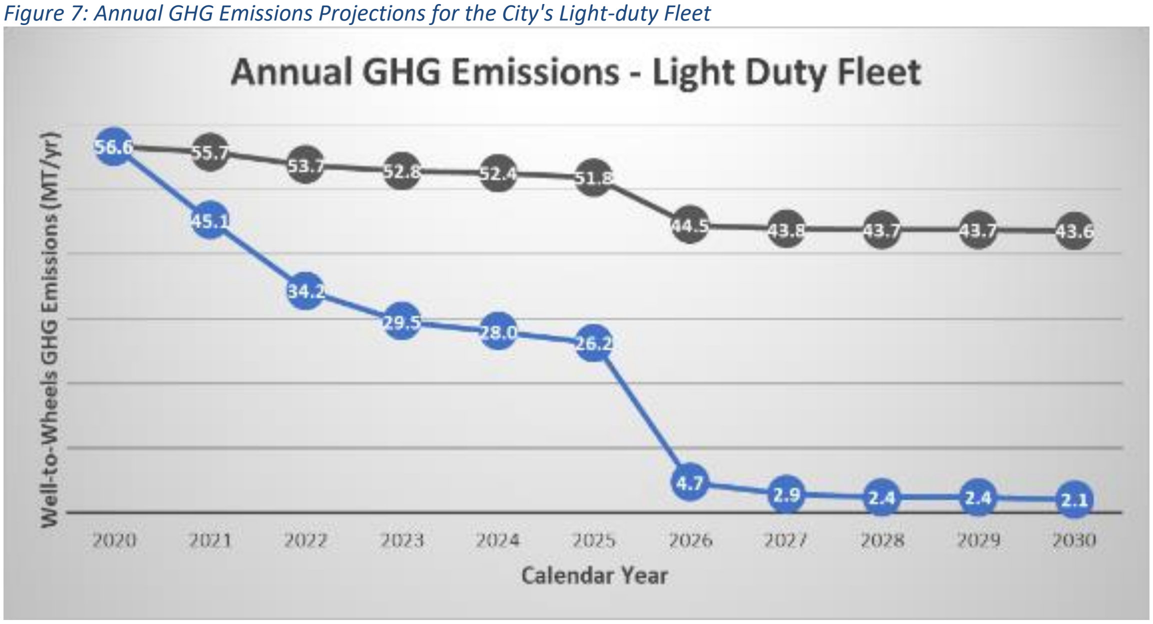
Appendix D provides a detailed analysis of total cost of ownership and the benefits to the City of Berkeley for the transition to EVs and DER.

Greenhouse Gas Emissions Reduction

Annual emissions from each vehicle were estimated using the using emissions factors from the California Air Resources Board's LCFS program "lookup table" and aggregated to estimate annual GHG emissions for the light-duty fleet considered for EV transition. Because the City uses EBCE's carbon-free electricity, GHG emissions from BEVs are estimated as zero.

Figure 7 shows that the emissions under Scenario 1 (Baseline) decline from 56.6 to 43.6 metric tons of CO2 equivalent per year (MT CO2e/year) by 2030. The 23% decrease in emissions largely comes from increasing fuel efficiency of gasoline and hybrid ICE vehicles. Under Scenario 2 (EV transition), emissions decline from 56.6 to 2.1 MT CO2e/year, **or 95% by 2030**. The significant reduction in annual emissions between 2025 and 2026 are associated with a substantial number of vehicles slated for replacement in 2026, including all the parking enforcement scooters. The few remaining GHG emissions are associated with seven PHEV SUVs that have a portion of their daily mileage powered by gasoline. By 2030, it is likely that SUV BEVs that meet the City's duty cycles will be available, effectively allowing the City to achieve a 100% reduction in the GHG emissions for the light-duty fleet considered in this analysis.

Figure 7: Annual GHG Emissions Projections for the City's Light-duty Fleet



Conclusion

This analysis assumes that the City of Berkeley will quickly transition to an all-electric fleet powered by EBCE's 100% carbon free electricity. EBCE, City staff, and the consultant team collaborated on an implementation plan that enables a fast transition to EVs in the light-duty fleet, calls for prudent evaluation of medium- and heavy-duty electrification options, and increases resiliency. The team also took a fiscally conservative approach to capital and operating costs, especially regarding potential incentives and funding sources, given the uncertainties of these programs.

In addition to reduced GHG emissions, residents and businesses benefit from the fleet EV transition via reduced air pollution and noise, particularly in the instance of medium- and heavy-duty vehicle electrification. The City benefits from a more-predictable fuel cost when using electricity, rather than the more volatile price swings of conventional fuels. Additionally, the City will provide an example of how procuring and operating EVs and charging stations at scale can help reduce overall costs, which may encourage private fleet electrification and charging station deployment at workplaces.

Awareness will grow as more EVs perform essential City services in the public eye. Businesses and residents may be encouraged to choose zero-emission transportation options. As the City becomes a leading example in EV and DER deployment, it will encourage additional sustainable operations to be adopted within Berkeley's private sector and may attract even more sustainability-focused businesses to the city.

While recognizing Berkeley's reputation as a leader in local climate action and sustainability, EBCE looks forward to collaborating with the City on building and vehicle electrification efforts. The City can leverage EBCE's carbon-free electricity and ability to aggregate procurement of DER to reduce emissions and improve air quality, and to lower the upfront costs associated with these technologies. By acting on the recommendations laid out in this report, the City of Berkeley can further build its already well-recognized status as a city leading the way toward a future with improved quality of life for all its residents, businesses, and visitors.

Appendix A: Municipal Fleet Assessment

The units that can be transitioned to battery electric vehicles (BEV) and plug-in hybrid vehicles (PHEV) were identified by assessing the current fleet composition, identifying applicable electric vehicle models available today and expected to be introduced in the near term, and by using the City Fleet Services' existing vehicle replacement plan. Development of this report was supported by data provided by the City and supplemental information gathered during meetings and interviews. Table 1 summarizes the City's municipal fleet as it existed on February 21, 2020. The fleet includes 346 vehicles (excluding vehicles used for emergency services and response and off-road maintenance), of which only about 25% are capable of electrification today.

Table 11: Summary of the City of Berkeley's Fleet by Vehicle Type and Configuration

Vehicle Type	Fuel	Configuration	Number of Vehicles
Cargo Van	Gasoline	Cargo Van	18
Chassis Cab - Aerial Lift	Diesel	Aerial Lift	4
Chassis Cab - Box Truck	Gasoline	Box Truck	1
Chassis Cab - Pickup	Diesel	Pickup	1
Chassis Cab - Pickup	Gasoline	Pickup	1
Chassis Cab - Specialized Body	CNG	Sweeper	2
Chassis Cab - Specialized Body	Diesel	Chipper	2
Chassis Cab - Specialized Body	Diesel	Crane Truck	1
Chassis Cab - Specialized Body	Diesel	Dump	5
Chassis Cab - Specialized Body	Diesel	Dump/OVHD Loader	1
Chassis Cab - Specialized Body	Diesel	Road Patching Truck	2
Chassis Cab - Specialized Body	Diesel	Sweeper	4
Chassis Cab - Specialized Body	Diesel	Vactor Truck	3
Chassis Cab - Specialized Body	Gasoline	Container Handler	2
Chassis Cab - Specialized Body	Gasoline	Dump	5
Chassis Cab - Specialized Body	Gasoline	Sign Truck	1
Chassis Cab - Stake bed	Diesel	Stake bed	2
Chassis Cab - Utility Truck	Diesel	Utility Truck	3
Chassis Cab - Utility Truck	Gasoline	Utility Truck	22
Cutaway - Box Van	Gasoline	Box Van	1
Cutaway - Pass Van	Gasoline	Passenger Van	1
Cutaway - Shuttle Bus	Gasoline	Shuttle Bus	5
Cutaway - Step Van	Gasoline	Step Van	1
Cutaway - Van	Gasoline	Van	2
Passenger Car	CNG	Passenger Car	1
Passenger Car	Gasoline	Passenger Car	72
Passenger Van	Gasoline	Passenger Van	3
Pickup	Diesel	Pickup	2
Pickup	Gasoline	Pickup	69
Pickup	Gasoline	4x4	1

Vehicle Type	Fuel	Configuration	Number of Vehicles
Scooter	EV	Scooter (Go 4)	2
Scooter	Gasoline	Scooter (Go 4)	28
Semi-tractor	Diesel	Semi-tractor	8
SUV	Gasoline	SUV	26
Refuse Collection Vehicle	CNG	Front Loader	4
Refuse Collection Vehicle	Diesel	Front Loader	6
Refuse Collection Vehicle	CNG	Rear Loader	7
Refuse Collection Vehicle	Diesel	Rear Loader	7
Refuse Collection Vehicle	CNG	Roll-on/Roll-off	2
Refuse Collection Vehicle	CNG	Side Loader	5
Refuse Collection Vehicle	Diesel	Side Loader	6
Van	Gasoline	Van	7

Availability of Electric Vehicles

The City of Berkeley procures vehicles through several negotiated contracts including those from Sourcewell, Climate Mayors EV Fleet Purchasing Collaborative, and Houston-Galveston Area Council (HGAC). Contracts enable public and private fleets across the country to negotiate discounted rates based upon buying large numbers of vehicles. Table 2 lists the base cost (excluding tax, extra keys, and other fees) of light-duty BEVs and PHEVs available from National Fleet Auto Group, the company that manages many individual negotiated contracts.[18]

Table 12: EVs and PHEVs at National Fleet Auto Group

Make/Model	Body Type	Technology Type	EV Range	Total Range	Contract Unit Price
Mitsubishi Outlander	PHEV	SUV	22	310	$31,219
Chrysler Pacifica	PHEV	Minivan	32	520	$39,514
Toyota Prius Prime	PHEV	Mid-size Sedan	25	640	$26,096
Ford Fusion Energi	PHEV	Mid-size Sedan	26	610	$27,968
Kia Niro LX*	PHEV	Small Station Wagon	26	560	$25,706
Kia Optima	PHEV	Mid-size Sedan	29	610	$29,450
Hyundai Ioniq	PHEV	Mid-size Sedan	29	601	$22,950
Honda Clarity	PHEV	Mid-size Sedan	47	293	$34,219
Chevrolet Bolt	BEV	Small Station Wagon	259	259	$33,987[19]
Nissan Leaf Plus	BEV	Mid-size Sedan	226	226	$34,256[3]
Kia Soul	BEV	Small Station Wagon	111	111	$27,762

[18] https://www.nationalautofleetgroup.com/
[19] Provided by Greg Ellington

Make/Model	Body Type	Technology Type	EV Range	Total Range	Contract Unit Price
Hyundai Ioniq	BEV	Mid-size Sedan	124	124	$26,939
VW e-Golf	BEV	Compact Sedan	125	125	$32,285

**The Kia Niro is also available as a BEV but is not listed on the National Auto Fleet Group contract.*

As a point of comparison, the City purchased 15 Toyota Prius Prime PHEVs between October 2019 and January 2020 at a cost of $28,147 each using Climate Mayors EV Fleet Purchasing Collaborative.

Electric medium and heavy-duty trucks for municipal fleet applications, which include pickup trucks and cargo vans, are in earlier stages of commercialization than electric sedans and small wagons. Cities across the U.S. have deployed pilot projects to understand operational requirements of medium and heavy-duty vehicles for fleet use cases that include transit and shuttle buses, cargo vans, refuse trucks, and other types of work trucks, but limited data is yet available on their performance, reliability, and cost of ownership.

Emergency vehicles for police patrol and pursuit, firefighting, and emergency medical services are not available in plug-in models. The Fremont California Police Department is testing a Tesla Model S as a patrol vehicle and reports that it behaved favorably with considerably less downtime than the Ford Explorer Utility Interceptors that are most of the Fremont's patrol vehicle fleet. The Department reports that it typically purchases Explorers (Utility Interceptors) for $48,114 and expects to purchase the $47,960 Ford Hybrid Explorer Hybrid police purpose-built in the future. However, the base price doesn't include upfits that can double the cost of a police vehicle.[20]

Although upcoming EVs like the Ford Mustang Mach E and Tesla Model Y will likely have sufficient interior capacity, battery range, and performance to the Ford police cars currently purchased, these EVs are not pursuit rated and do not have the suspension and security features that are standard on a patrol vehicle, nor are they pre-drilled for mounting lightbars, sirens, and safety equipment. None of the automakers that build police-specific vehicles have announced a plug-in version.[21]

Rosenbauer, an Austrian company, has a concept EV fire vehicle called the CFT that is smaller than a traditional U.S. firetruck.[22] The City of Los Angeles recently ordered a CFT, which will be the first in the U.S. Electric "ambulances" in service and planned are sedans that have been retrofitted to provide aid at an incident; they are not capable of transporting patients in the same way an ambulance transport patients. None of the manufacturers that make firetrucks and ambulances have announced plans to electrify these vehicles.

[20] Upfits include lightbars, sirens, computer equipment, ballistic doors, molded rear seats, and a more than a dozen other police-specific features.
[21] Ford announced a PHEV patrol sedan but released the car as "special services" sedan not rated for patrol or pursuit.
[22] https://innovation.rosenbauer.com/en/concept-fire-truck/

Fleet Electrification Transition

Passenger Sedans and SUVs

As of February 2020, the City's light-duty fleet of passenger sedans (or cars) and SUVs (excluding vehicles used for emergency services and response) consisted of:

- 75 passenger sedans
  - 54 gasoline-powered hybrid internal combustion engine vehicles (ICEs) purchased between 2002 and 2017
  - 15 PHEVs purchased in late-2019 and early-2020
  - 5 gasoline-powered ICEs purchased 1999-2008
  - 1 natural gas-powered car purchased in 2003
- 24 Ford Escape SUVs purchased 2009-2015
  - 7 gasoline-powered hybrid ICEs
  - 17 gasoline-powered ICEs
    - 5 of these have four-wheel drive (4WD)

In February, the City did not use fleet management software or track data about individual vehicle use. The City's Equipment Maintenance Division of the Public Works Department planned to implement GPS tracking (telematics) on some vehicles in mid-2020. With this implementation, real-time service alerts and diagnostic information will be available so that departments can understand each vehicle's daily use, including origin/destination, number of miles traveled, the time parked between uses, and driver behavior that can impact fuel efficiency, including average vehicle speed and amount of idling time.

To identify an EV replacement schedule, the consultant team used data received from the City on the non-emergency passenger sedans and SUVs that shows all except two fleet vehicles have an average daily fuel use of less than one gallon of gasoline, which indicates that vehicles are driven less than 30 miles per day. The two exceptions are Ford Escape SUVs, one from Engineering and one from Meter Repair, that show an average daily fuel use of about 2.5 gallons of gasoline. Of the 97 passenger sedans and SUVs, 75 have a dwell time of 12 hours or longer. Telematics data will help determine if the vehicles are parked overnight or are parked for a few hours between use. In addition, a new Fuel Management System is expected to be installed in all City vehicles beginning in Spring or Summer 2020. It is a passive system that is not dependent on user input and will improve the accuracy of each vehicle's fuel use data.

The City schedules vehicle replacement 7, 10, or 15 years from the purchase date, although some vehicles are kept longer than planned. Based on the current vehicle replacement schedule, the year-by-year summary transition to EVs is listed in Table 4. It is recommended that each passenger sedan be replaced with a BEV and each SUV be replaced with a PHEV SUV. It is assumed that vehicles purchased in 2020 will be replaced in 2031.

Table 13: Procurement Schedule for Passenger Sedans and SUVs

Year	Number of BEV Passenger Sedans/Wagons	Number of PHEV SUVs
2020*	1	0
2021	29	3
2022	10	8
2023	3	1
2024	4	1
2025	4	0
2026	11	0
2027	6	0
2028	3	0
2029	0	0
2030	1	0

**Vehicles the City procured in January and February 2020 or are scheduled to be procured in 2031 do not appear in this table.*

Since November 2019, the City added 12 passenger vehicles to its fleet to accommodate growing service needs. Fleet requested that this report assume that the City will use data from the new telematics platform to help each department determine if vehicles could be shared among staff and/or departments without impacting City services and, therefore, guide vehicle procurement and retirement practices that may not result in one-for-one replacements. The goal is to be able to expand City services without adding more vehicles to the fleet.

Based on the limited data available about vehicle use patterns, the consultant team identified the following potential right-sizing opportunities that the City can validate with telematics data and in consultation with interdepartmental leadership:

- Seven pool vehicles are scheduled to be replaced in 2021. All use less than 0.75 gallons of gasoline daily, on average, and could be replaced with a small BEV wagon like the Chevrolet Bolt, which the U.S. Environmental Protection Agency classifies as a small wagon and can meet the use case of these fleet vehicles. Replacing all seven vehicles with a Bolt would give each vehicle the same cargo capacity.
- The Equipment Maintenance Corp Yard division has two Ford Escape Hybrids scheduled to be replaced in 2021. Both use less than 0.15 gallons of gasoline daily, on average, and are listed as Special Purpose. The City can consider, based on telematics data, whether reducing the number of vehicles to one, or replacing one or both SUVs with a small BEV wagon (Chevrolet Bolt) or BEV sedan (Nissan Leaf) will enable Berkeley to retain the functionality of these vehicle use cases.
- In 2021 and 2022, four of the SUVs scheduled to be replaced use less than 0.25 gallons of gasoline daily, on average. These vehicles are used (one each) by the Office of Transportation, Library Services, Parks Facilities, and Engineering. The City can consider, based on telematics data, if replacing the SUVs with a small BEV wagon (Chevrolet Bolt) or BEV sedan (Nissan Leaf) will enable Berkeley to retain the functionality of these vehicle use cases.
- Five of the Ford Escape SUVs scheduled to be replaced in 2022 are 4WD. The Mitsubishi Outlander is currently the only 4WD PHEV available in the market. If 4WD is not essential for these vehicles, consider replacing with a Chevy Bolt or Nissan Leaf.

- Building and Safety currently operates 10 gasoline-powered hybrid ICE cars that are not dedicated to a special use and each use less than 0.5 gallons of gasoline daily on average. Five of these hybrids are scheduled to be replaced in 2021 and 2022, and the other five between 2024 and 2026. Optimizing vehicle use within the department could allow for the creation of a smaller pool of shared vehicles by 2024, when they are scheduled for replacement.

Table 14 is an itemized list of the passenger sedans and SUVs in the fleet in February 2020 sorted by replacement year and a recommended replacement type. This list does not include the 15 PHEVs already purchased in 2020 and are unlikely to be replaced before 2030. Additionally, six vehicles that are scheduled to be replaced in 2021 (unit numbers 8457, 9103, 9104, 9116, 4110, 9017) will be replaced with Chevy Bolts in 2020, pending approval of a Bay Area Air Quality Management District (BAAQMD) grant application.

Table 14: Itemized Vehicle Replacement List

Chassis	Unit #	Mk	Model	Type	Year	Dedicated Use	Division	Fuel Use	EV Fraction	Replace In	Replace with
Sedan	9102	Hon	Civic	Hybrid	2003	New Employees	Engineering	0.27	100%	2020	BEV sedan
Sedan	478	Frd	Taurus	Wagon	1999	Pool Vehicle	Equip Maint Pool	0.37	100%	2021	BEV small wagon
Sedan	489	Frd	Taurus	Wagon	1999	Pool Vehicle	Equip Maint Pool	0.67	100%	2021	BEV small wagon
Sedan	4011	Toy	Prius	Hybrid	2011	Special Purpose	Bldg & Safety	0.11	100%	2021	BEV sedan
Sedan	4108	Toy	Prius	Hybrid	2009		DHS Admin	0.15	100%	2021	BEV sedan
Sedan	6404	Frd	Fusion		2011		Comm Collection	0.13	100%	2021	BEV sedan
Sedan	6900	Hon	Civic	CNG	2003		Marina Operations	0.60	100%	2021	BEV sedan
Sedan	8192	Hon	Fit		2008	Special Purpose	Portable Meals	0.24	100%	2021	BEV sedan
Sedan	8457	Hon	Civic	Hybrid	2003	Special Purpose	FYC PROGAM	0.11	100%	2021	BEV small wagon
Sedan	8518	Frd	Focus		2001		South Berkeley Senior	0.51	100%	2021	BEV sedan
Sedan	9011	Toy	Prius	Hybrid	2002		Equip Maint Pool	0.52	87%	2021	BEV small wagon
Sedan	9013	Hon	Civic	Hybrid	2003		Equip Maint Pool	0.81	55%	2021	BEV small wagon
Sedan	9103	Hon	Civic	Hybrid	2003	Pool Vehicle	Equip Maint Pool	0.37	100%	2021	BEV small wagon
Sedan	9104	Hon	Civic	Hybrid	2003	Special Purpose	Housing Code Enforcement	0.18	100%	2021	BEV small wagon
Sedan	9106	Toy	Prius	Hybrid	2006	Code Enforcement	Housing Code Enforcement	0.16	100%	2021	BEV sedan
Sedan	9107	Toy	Prius	Hybrid	2006		Comm/ Radio's	0.50	90%	2021	BEV sedan
Sedan	9108	Toy	Prius	Hybrid	2006		Equip Maint Corpyrd	0.30	100%	2021	BEV sedan
Sedan	9109	Toy	Prius	Hybrid	2006		Equip Maint Pool	0.42	100%	2021	BEV small wagon
Sedan	9110	Toy	Prius	Hybrid	2006		Equip Maint Pool	0.26	100%	2021	BEV small wagon
Sedan	9111	Toy	Prius	Hybrid	2006		Parking Enforcement	0.31	100%	2021	BEV sedan
Sedan	9112	Toy	Prius	Hybrid	2006	Inspector	Building & Safety	0.16	100%	2021	BEV sedan
Sedan	9116	Toy	Prius	Hybrid	2010		Neighborhood Svc's	0.20	100%	2021	BEV small wagon
Sedan	9117	Toy	Prius	Hybrid	2011		DHS Admin	0.27	100%	2021	BEV sedan

Chassis	Unit #	Mk	Model	Type	Year	Dedicated Use	Division	Fuel Use	EV Fraction	Replace In	Replace with
SUV	1966	Frd	Escape	Hybrid	2009		Fire Training	0.87	55%	2021	PHEV SUV
SUV	2906	Frd	Escape	Hybrid	2009	Special Purpose	Equip Maint Corpyrd	0.13	100%	2021	BEV small wagon
SUV	4110	Frd	Escape	Hybrid	2008		Equip Maint Pool	0.62	79%	2021	BEV small wagon
SUV	6889	Frd	Escape		2008		Street Light Maint	1.34	72%	2021	PHEV SUV
SUV	6890	Frd	Escape	Hybrid	2009	Special Purpose	Equip Maint Corp Yard	0.06	100%	2021	BEV small wagon
SUV	9017	Frd	Escape		2009		Engineering	2.50	39%	2021	BEV small wagon
SUV	9115	Frd	Escape	Hybrid	2009	Assigned	Engineering	0.21	100%	2021	BEV small wagon
SUV	9604	Frd	Escape		2013		Trans/Disp Svc's	1.02	95%	2021	BEV small wagon
SUV	9605	Frd	Escape		2014	Special Purpose	Office of Trans.	0.16	100%	2021	BEV small wagon
Sedan	4805	Toy	Prius	Hybrid	2012		Comm/ Radio's	0.32	100%	2022	BEV sedan
Sedan	8506	Toy	Prius	Hybrid	2012		Building & Safety	0.32	100%	2022	BEV sedan
Sedan	8507	Toy	Prius	Hybrid	2012		Building & Safety	0.46	99%	2022	BEV sedan
Sedan	8508	Toy	Prius	Hybrid	2012		Building & Safety	0.30	100%	2022	BEV sedan
Sedan	8509	Toy	Prius	Hybrid	2012		Building & Safety	0.54	84%	2022	BEV sedan
SUV	1973	Frd	Escape		2013	Fire	Fire Prev/Insp/ Invest	0.50	100%	2022	PHEV SUV
SUV	1974	Frd	Escape	4WD	2013		Fire Operations	0.59	100%	2022	PHEV SUV
SUV	1975	Frd	Escape		2013		Fire/Supp/Rescue /Haz	1.10	88%	2022	PHEV SUV
SUV	1976	Frd	Escape	4WD	2013		Fire Operations	1.88	51%	2022	PHEV SUV
SUV	1977	Frd	Escape	4WD	2013		Fire Operations	1.69	57%	2022	PHEV SUV
SUV	2909	Frd	Escape		2013		Meter Repair Admin	2.55	38%	2022	PHEV SUV
SUV	8519	Frd	Escape	4WD	2013		Building & Safety	0.71	100%	2022	PHEV SUV
SUV	8520	Frd	Escape	4WD	2013	Inspector	Building & Safety	0.48	100%	2022	PHEV SUV
SUV	9004	Frd	Escape	Hybrid	2012		Corp Yard Mgmt. Office	1.35	36%	2022	BEV small wagon
SUV	9019	Frd	Escape	Hybrid	2012		Parks Facilities	0.27	100%	2022	BEV small wagon

Chassis	Unit #	Mk	Model	Type	Year	Dedicated Use	Division	Fuel Use	EV Fraction	Replace In	Replace with
SUV	9021	Frd	Escape		2013		Library Services	0.34	100%	2022	BEV small wagon
SUV	9119	Frd	Escape		2013		Engineering	0.99	98%	2022	BEV small wagon
SUV	9120	Frd	Escape		2013	New Employees	Engineering	0.41	100%	2022	BEV small wagon
Sedan	8006	Toy	Prius	Hybrid	2008		ASP	0.64	71%	2023	BEV sedan
Sedan	8007	Toy	Prius	Hybrid	2008		ASP/Crisis	0.63	72%	2023	BEV sedan
Sedan	9123	Toy	Prius	Hybrid	2013	Special Purpose	Vector Control II	0.11	100%	2023	BEV sedan
Sedan	2381	Frd	Escape		2014	Special Purpose	Sewer Maint	0.36	100%	2023	BEV small wagon
Sedan	8510	Toy	Prius	Hybrid	2014		Building & Safety	0.43	100%	2024	BEV sedan
Sedan	8511	Toy	Prius	Hybrid	2014		Building & Safety	0.39	100%	2024	BEV sedan
Sedan	9113	Toy	Prius	Hybrid	2009	Special Purpose	IT ADMIN	0.10	100%	2024	BEV sedan
Sedan	9126	Toy	Prius	Hybrid	2015		Meter Repair	0.20	100%	2024	BEV sedan
SUV	4114	Frd	Escape		2015		Bldg Maint	0.66	100%	2024	PHEV SUV
Sedan	1595	Frd	Fusion	Hybrid	2016		Parking Enforcement	0.24	100%	2025	BEV sedan
Sedan	8009	Toy	Prius V	Hybrid	2015		ASP/FSP	0.80	56%	2025	BEV sedan
Sedan	8010	Toy	Prius V	Hybrid	2015		ASP/FSP	0.71	64%	2025	BEV sedan
Sedan	8521	Toy	Prius V	Hybrid	2015		Building & Safety	0.36	100%	2025	BEV sedan
Sedan	8011	Toy	Prius V	Hybrid	2016		ASP	0.59	76%	2026	BEV sedan
Sedan	8012	Toy	Prius	Hybrid	2016		ASP/Crisis	0.32	100%	2026	BEV sedan
Sedan	8013	Toy	Prius V	Hybrid	2016		ASP/FSP	0.70	64%	2026	BEV sedan
Sedan	8014	Toy	Prius V	Hybrid	2016		Mental Health	0.73	62%	2026	BEV sedan
Sedan	8015	Toy	Prius V	Hybrid	2016	Special Purpose	FYC PROGAM	0.19	100%	2026	BEV sedan
Sedan	8016	Toy	Prius	Hybrid	2016		Mental Health	0.40	100%	2026	BEV sedan
Sedan	8232	Toy	Prius	Hybrid	2016		Tuolumne Camp Trk.	0.48	93%	2026	BEV sedan
Sedan	8512	Toy	Prius V	Hybrid	2016		Building & Safety	0.31	100%	2026	BEV sedan
Sedan	8522	Toy	Prius V	Hybrid	2016		Building & Safety	0.51	88%	2026	BEV sedan
Sedan	9024	Toy	Prius V	Hybrid	2016		Building & Safety	0.25	100%	2026	BEV sedan

Chassis	Unit #	Mk	Model	Type	Year	Dedicated Use	Division	Fuel Use	EV Fraction	Replace In	Replace with
Sedan	9025	Toy	Prius	Hybrid	2016	Special Purpose	Neighborhood Services	0.07	100%	2026	BEV sedan
Sedan	6406	Toy	Prius	Hybrid	2016		ZW Admin	0.17	100%	2027	BEV sedan
Sedan	8017	Toy	Prius V	Hybrid	2017		ASP/Crisis	0.66	68%	2027	BEV sedan
Sedan	9026	Toy	Prius V	Hybrid	2017	Special Purpose	Toxics Management	0.13	100%	2027	BEV sedan
Sedan	9118	Toy	Prius	Hybrid	2012	Special Purpose	FYC Program	0.13	100%	2027	BEV sedan
Sedan	9121	Toy	Prius	Hybrid	2012		ASP/Crisis	0.21	100%	2027	BEV sedan
Sedan	9122	Toy	Prius	Hybrid	2012		ASP/FSP	0.78	58%	2027	BEV sedan
Sedan	9022	Toy	Prius V	Hybrid	2014	Inspector	Health Inspections	0.20	100%	2028	BEV sedan
Sedan	9023	Toy	Prius V	Hybrid	2014	Special Purpose	Toxics Management	0.11	100%	2028	BEV sedan
Sedan	9125	Toy	Prius V	Hybrid	2014		Vector Control	0.24	100%	2028	BEV sedan
Sedan	8008	Toy	Prius	Hybrid	2015		ASP/Crisis	0.37	100%	2030	BEV sedan

Budgeting Considerations for Light-Duty Passenger Vehicles

Based on the negotiated contract rates from National Auto Fleet Group, Table 15 lists the estimated price for EVs, including 9.25% sales tax, additional keys, and other fees and rounded to the nearest dollar, based on the City's stated preference to standardize on the Nissan Leaf Plus and Chevy Bolt, and includes three options for a PHEV SUV replacement.

Table 15: Average Contract Rates for EVs

Technology Type	Body Type	Make and Model	NAFG Est. Price	EPA Rated All-electric Range	Battery Size (kWh)
BEV	Sedan	Nissan Leaf Plus	$37,934	226	62
BEV	Small Wagon	Chevy Bolt	$37,577	259	60
PHEV	SUV	Kia Niro LX PHEV	$31,505	26	9
PHEV	SUV	Mitsubishi Outlander 4WD	$40,061	22	12
PHEV	Minivan	Chrysler Pacifica	$43,578	32	16

Currently, the City is eligible to claim a Clean Vehicle Rebate Program (CVRP) rebate from the State of California for up to 30 EVs per year.[23] It is important to note that CVRP rebates are first-come, first-served and the program's rebate funding amount must be reauthorized by the state legislature every year. Historically, legislature has annually authorized funding and the California Air Resources Board (CARB) has allocated money to rebate applications that were waitlisted in the previous fiscal year, which reduces the amount of funding for new applications. It is important to note that in the coming years the legislature may allocate less or no funding for CVRP, or only enough funding for the waitlist.

In 2020, BEVs are eligible for a $2,000 per vehicle rebate and some PHEVs are eligible for a $1,000 rebate. The Mitsubishi Outlander is not eligible for the rebate because it does not meet the minimum requirement for electric range,[24] however the Kia Niro crossover PHEV and the Chrysler Pacifica minivan are eligible for CVPR. The three vehicles are shown in Figure 8.

Figure 8: Kia Niro, Chrysler Pacifica, Mitsubishi Outlander

[23] https://cleanvehiclerebate.org/eng/fleet

[24] https://cleanvehiclerebate.org/eng/faqs/why-don%E2%80%99t-i-see-my-vehicle-eligibility-list-0

Table 16 estimates the cost for replacement vehicles in 2020 through 2025 as recommended in Table 14 for each budget year with the current estimated contracted prices as shown in Table 15. Note that the actual budget will vary based on the contract used, vehicle price, additional options, and changes in sales tax rates.

Between 2023 and 2025 a total of 13 City vehicles are expected to be replaced and it is likely that negotiated contracts will include more EV makes and models at that time. Vehicle costs will continue to be approximately $30,000-$35,000 because OEMs are focused on extending battery range rather than incrementally reducing vehicle cost. The consultant team recommends BEVs to replace existing passenger sedans due to the small price difference between PHEV and BEV sedans.

The consultant team recommends PHEVs to replace most ICE SUVs. Gasoline use indicates that most SUVs drive fewer than 30 miles a day, which will be confirmed by telematics data. SUVs will primarily travel on the electricity available from the PHEVs' batteries, however, the gasoline engine provides flexibility and resiliency needed by these vehicles for emergency response and disaster preparedness.

CARB's most-recent *Three-Year Plan for CVRP*[25] indicates that the existing rebate program may end by 2022 as CARB shifts funding to new, more-targeted equity programs that include Clean Cars 4 All, Financing Assistance for Lower-Income Consumers, and Clean Mobility Voucher Program. Although CVRP rebates may be renewed when CARB updates the *Three-Year Plan for CVRP* in 2021, the consultant team took a conservative approach and did not include the rebates starting in 2023 in Table 7. With that in mind, the City should track the status of CVRP and consider purchasing the four 2023 replacement EVs in 2022, if it appears CVRP rebates will be reduced or concluded in 2022.

As previously noted, the City can currently obtain a maximum of 30 rebates annually through CVRP. The City's vehicle replacement schedule calls for replacing 32 vehicles in 2021, three of which are potentially Mitsubishi Outlander PHEVs that are not eligible for the rebate but are the only currently available 4WD PHEV SUV.

Table 16: Year-by-Year Budget Estimates to Replace Existing ICE vehicles with EVs

Year	Nissan Leaf Plus @ $37,934	Chevy Bolt @ $37,577	Mitsubishi Outlander PHEV @ $40,061	Potential CVRP rebate	Total Estimated Vehicle Cost
2020	$37,934 (1)			($2,000)	$35,934
2021*	$455,208 (12)	$638,809 (17)	$120,183 (3)	($58,000)	$1,156,200
2022	$189,670 (5)	$187,855 (5)	$320,488 (8)	($20,000)	$678,043
2023	$113,802 (3)	$37,577 (1)			$151,379
2024	$151,736 (4)		$40,061 (1)		$191,797
2025	$151,736 (4)				$151,736

**if awarded the BAAQMD grant, six vehicles schedule to be replaced in 2021 will be replaced in 2020 and will not need to be included in the 2021 budget.*

[25] https://ww3.arb.ca.gov/msprog/aqip/fundplan/fy1920fundingplan-appc-rev.pdf

In its *Annual Energy Outlook*, the Energy Information Agency projects that 300-mile-range BEVs will be upper-tier of the EV market by 2025.[26] By 2024, the City will have been acquiring data from the telematics system installed in March 2020 for four years. Data collected on vehicle use patterns and parking behavior will inform and support City and Fleet Services' EV decisions to procure lower-cost BEVs with 100-to-150-mile range for certain use cases or BEVs with 300-miles or more range at a higher price point for other uses cases. Longer-range BEVs may be applicable for municipal sites where deployment of charging infrastructure could be difficult due to space constraints (e.g., BEVs could share charging stations).

Parking Enforcement Scooters

The City operates 30 Westward Industries' gasoline powered GO-4 scooters for parking enforcement activities. During development of this assessment, City staff indicated that the scooters, which have a seven-year lifespan, are easy to maneuver and safely operate. Few companies make vehicles for parking enforcement, and Westward Industries is the only OEM working on an all-electric model. In 2017, the City took delivery of two all-electric GO-4 models. However, after using them in the field, staff found them unsuitable, as reported to City Council on May 14, 2019.[27] Therefore, the City recently purchased and put into service 15 gasoline-powered GO-4 scooters to replace older models that were scheduled for retirement.

The two electric GO-4 scooters were reconditioned by the manufacturer, and the City is testing the scooters to gauge their suitability. Scooters will not need to be replaced until 2026, and by then, it is anticipated the all-electric GO-4 will be further in its market development and other electric scooters may be available for this application.

City staff requested a summary of other local government experiences with all-electric vehicles for parking enforcement and security. Two EVs that cities tested, the FireFly scooter and the Mercedes Smart EV, are no longer available. Polaris offers a public safety package for its GEM neighborhood EV that includes an overhead beacon light and lockable trunk storage on the two and four-seat models. City staff previously researched this option and found it unsuitable for City needs.

Cities are also evaluating BEVs in their police fleets primarily for non-pursuit purposes. The City of Los Angeles uses BMW i3 hatchbacks for sworn officers on routine assignments, the City of Huntsville (MD) has two Chevy Bolts for traffic control officers, and the Cities of Pasadena and San Jose leased Chevy Bolts for civilian and sworn officers to use for safety meetings and injury investigations. None of the cities the consultant team spoke with indicated that they purchased or leased EVs specifically for parking enforcement.

[26] https://www.eia.gov/outlooks/aeo/

[27] https://www.cityofberkeley.info/Clerk/City_Council/2019/05_May/City_Council__05-14-2019_-_Regular_Meeting_Agenda.aspx

Medium-duty Vehicles

The City fleet includes 72 medium-duty pickup trucks, mostly Ford F-150, F-250, and Rangers. Of the 72 trucks, 60 pickups may be able to be replaced with an upcoming all-electric Ford F-150 EV. In mid-March 2020, Ford announced will arrive in the U.S. market late-2021 to early-2022. Ford also announced it will have an F-150 PHEV by late-2020, however, the battery is intended to be used for accessories and not motive power.[28] It's unknown If the F-150s will have a utility body application, but companies like Motiv Power Systems produce an EV chassis that can be upfitted with a utility body. Motiv's EV-450 is larger than the F-250 and Rangers the City operates today.

In 2019, the City purchased an F-150 for $39,000. It is likely that the F-150 EV will have a higher price point than its gasoline counterpart, but Ford has not announced pricing. Other pickup trucks are also in development and expected to arrive in 2021-2022, but those are aimed at the luxury market and have MSRPs starting at $70,000 or re being developed by start-up companies.

As the F-150 EV becomes available, and if incentives bring the cost of the BEV pickups in line with gasoline-powered ICE trucks, the consultant team recommends that the City evaluate up to three BEV pickups on different duty cycles to determine performance, suitability to task, and total cost of ownership.

The City also operates 16 cargo vans, primarily Ford E-250/350 and Connect Transit vans, two of which include a genset for camera operation. Ford, Mercedes, Nissan, and Volkswagen all introduced electric cargo and passenger vans in Europe in 2020 and intend to launch U.S. versions in 2023. Table 17 shows electric vans (passenger and cargo) that are currently available. Production, however, has not kept pace with orders and supplies are very limited.

Lightening Systems vans start at about $100,000, although incentives can cut the price by half. The Hybrid Voucher Incentive Program (HVIP), [29] which provides incentives for medium- and heavy-duty EVs, has incentives up to $50,000 for zero emission vans, however, the HVIP funds for 2019-2020 have been depleted and new voucher requests are not currently being accepted.[30]

[28] Other companies have announced BEV pickups with starting prices in the $70,000 range and are aimed at a luxury market. The consultant team did not consider these trucks for fleet use.

[29] https://www.californiahvip.org/how-to-participate/#Eligible-Vehicle-Catalog

[30] https://content.govdelivery.com/accounts/CARB/bulletins/2699f43

Table 17: HVIP Incentives for Panel Vans

Model	Make	HVIP Eligible Funds	GVWR	Type	Body Type	Battery Size	Chassis Type
C-Series Logistics	Envirotech	N/A	Class 3 (10,001-14,000 lb)	BEV	Logistics, Standard and Low Roof	106 kWh	Van
Ford Transit LEV60/120 Passenger Van	Lightning Systems	$50,000	Class 3 (10,001-14,000 lb)	BEV	Ford Transit 350HD Passenger Wagon, 148"	43 kWh	Van
Ford Transit LEV60/120 Passenger Van	Lightning Systems	$50,000	Class 3 (10,001-14,000 lb)	BEV	Ford Transit 350HD Passenger Wagon, 148"	86 kWh	Van
Ford Transit LEV Cargo	Lightning Systems	$50,000	Class 3 (10,001-14,000 lb)	BEV	Ford Transit 350HD Cargo Van, 148"	43 kWh	Van
Ford Transit LEV Cargo	Lightning Systems	$50,000	Class 3 (10,001-14,000 lb)	BEV	Ford Transit 350HD Cargo Van, 148"	86 kWh	Van
eSprinter	Mercedes Benz	N/A	Class 2 (6,001-10,000 lb)	BEV	Delivery	35, 55 kWh	Van
Ford Transit	SEA Electric	N/A	Class 3 (10,001-14,000 lb)	BEV	SEA-DRIVE 70a powertrain	88 kWh	Van
Electric Shuttle Van	Zenith Motors	Delisted 1/30/2020	Class 3 (10,001-14,000 lb)	BEV	Passenger van	51.8 kWh	Van
Electric Shuttle Van	Zenith Motors	Delisted 1/30/2020	Class 3 (10,001-14,000 lb)	BEV	Passenger van	62.1 kWh	Van
Electric Shuttle Van	Zenith Motors	Delisted 1/30/2020	Class 3 (10,001-14,000 lb)	BEV	Passenger van	69 kWh	Van

Model	Make	HVIP Eligible Funds	GVWR	Type	Body Type	Battery Size	Chassis Type
Electric Cargo Van	Zenith Motors	Delisted 1/30/2020	Class 3 (10,001-14,000 lb)	BEV	Cargo Van	51.8 kWh	Van
Electric Cargo Van	Zenith Motors	Delisted 1/30/2020	Class 3 (10,001-14,000 lb)	BEV	Cargo Van	62.1 kWh	Van
Electric Cargo Van	Zenith Motors	Delisted 1/30/2020	Class 3 (10,001-14,000 lb)	BEV	Cargo Van	69 kWh	Van

The consultant team recommends that the City use findings from telematics data to identify cargo vans that might be transitioned to PHEV SUVs, and possibly the Ford F-150 PHEV that may be able to provide power for camera operation without requiring a genset. The team also recommends the City consider evaluating the suitability of an electric cargo van when one becomes available at a price (with HVIP or a similar incentive program) that is cost-competitive with a comparable gasoline-powered ICE vehicle.

Heavy-duty Vehicles

The City fleet has 98 heavy-duty vehicles (Class 3 or higher) that range from special-purpose vehicles like street sweepers and refuse trucks to a variety of utility vehicles and flatbed trucks. Fleet is already implementing electrification for vehicles as it is available, including liftgates, dump beds, and electric power take off systems (ePTOs) that use an electric motor and battery to power onboard equipment like aerial lifts and booms.

The City operates three Ford E450 20-passenger buses for the South Berkeley Senior Center. Several OEMs offer EV shuttle buses that are equipped for paratransit and have up to 120 miles of range, although range is dependent upon several factors including accessories (e.g., wheelchair lifts), operating terrain (e.g., up and down hills), and climate (running the heat or air conditioning.) Lion, an electric school bus OEM, also has an "urban midi bus" in development. The fleet inventory list supplied by the City shows that one shuttle will be replaced in 2020 and two in 2026.

Sacramento Regional Transit purchased nine GreenPower shuttles in partnership with Electrify America at a cost of $270,000 to $320,000 each depending on wheelchair lift configuration.[31] The consultant team recommends that the City replace existing ICE shuttles with EVs. As previously noted, the HVIP program[32] provides incentives for medium and heavy-duty EVs. These include up to $90,000 in incentives for zero emission shuttles, as shown in Table 18. HVIP funds for 2019-2020 have been depleted and new voucher requests are not being accepted.[33] Alternatively, the City may consider a

[31] March 1 interview with Will Berry from Electrify America
[32] https://www.californiahvip.org/how-to-participate/#Eligible-Vehicle-Catalog
[33] https://content.govdelivery.com/accounts/CARB/bulletins/2699f43

grant program like the upcoming Clean Mobility Voucher Program with CALSTART and GRID Alternatives.[34]

Table 18: HVIP Incentives for Shuttle Buses

Model	OEM	Vehicle Incentives	Battery	Model Years	GVWR
Gillig 29' ePlus Battery Electric Low Floor Bus	Gillig	$90,000	296 kWh	2018	Bus < 30'
GreenPower EV Star All-Electric Min-eBus	GreenPower Motor Company	$90,000	95 kWh	2018-19	Bus < 30'
Lightning Systems Ford Transit 350HD Passenger Bus - 120 Mile Range	Lightning Systems	$80,000	86 kWh	2018-2019	Bus 20' - 24'
Lightning Systems Ford Transit 350HD Passenger Bus - 60 Mile Range	Lightning Systems	$80,000	43 kWh	2018-2019	Bus 20' - 24'
Micro Bird D-Series Electric Shuttle Bus	Micro Bird	$80,000	88 kWh	2019	< 14,000, Bus < 30'
Phoenix Motor Cars ZEUS 300 Passenger Shuttle	Phoenix	$80,000	105 kWh	2018-2019	14,000 - 26,000, Bus < 30'
Phoenix Motor Cars ZEUS 400 Passenger Shuttle	Phoenix	$80,000	105 kWh	2019	14,000 - 26,000, Bus < 30'
SEA E-450 EV*	SEA Electric	$80,000	100 kWh	2020	14,000 - 26,000
SEA F-450 EV*	SEA Electric	$80,000	136 kWh	2020	14,000 - 26,000
SEA F-550 EV*	SEA Electric	$80,000	136 kWh	2020	14,000 - 26,000
SEA F-650 EV*	SEA Electric	$90,000	160 kWh	2020	14,000 - 26,000

[34] https://ww3.arb.ca.gov/msprog/lct/pdfs/cmo-voucher.pdf

**SEA vehicles can also be configured as a large cargo van or delivery truck.*

The fleet inventory list supplied by the City's Fleet shows 16 refuse and dump trucks that are scheduled to be replaced in 2020 and 2021. Electric models of these vehicles are currently available in limited supply. For an estimate of the cost, the City of Seattle procured two BYD refuse trucks at $320,000 each. Furthermore, Fleet staff have feedback from other agencies that the limited range of and long charging time of current EV refuse trucks will not be practical or acceptable for City operations, which includes multiple 88-mile round trips to the Livermore landfill every day.

Table 19 lists the HVIP incentives available for this category of vehicle. As noted above, HVIP funds for 2019-2020 have been depleted and new voucher requests are not being accepted.[35] The consultant team recommends that the City prepare to evaluate one refuse truck and/or one dump truck when the Transfer Station is complete and when HVIP funding is replenished or a similar incentive is available.

Table 19: HVIP Incentives for Refuse and Dump Trucks

Model	OEM	Vehicle Incentives	Battery	Model Years	GVWR
BYD 8R Class 8 Refuse Truck	BYD Motors	$150,000	295 kWh	2018-2019	> 26,000
Phoenix Motor Cars ZEUS 500 Flat Bed Truck	Phoenix	$80,000	105 kWh	2018-2019	14,000 - 26,000
SEA NPR EV*	SEA Electric	$80,000	136 kWh	2020	14,000 - 26,000
SEA 195 EV*	SEA Electric	$80,000	136 kWh	2020	14,000 - 26,000
SEA ACMD 8 EV*	SEA Electric	$150,000	216 kWh	2020	> 26,000
SEA EXPEDITOR EV*	SEA Electric	$150,000	216 kWh	2020	> 26,000

**Several of the SEA models can be configured for different uses.*

Other HVIP-eligible vehicles include transit and school buses, delivery and drayage trucks, and food trucks that do not match the needs of the City's fleet.

For the City's heavy-duty municipal fleet vehicle use cases, cost-effective EVs are eight-to-ten years in the future, even when accounting for incentives. The consultant team recommends that the City continue to fuel medium- and heavy-duty diesel engine vehicles with renewable diesel. Renewable diesel is produced from plant, animal or other waste products and according to CARB, the full lifecycle emissions of carbon from renewable diesel produced from sustainable sources, which the City is procuring, are more than 60 percent lower than either petroleum diesel or B20 biodiesel. The City's fleet of on and off-road vehicles and equipment consumes about 265,000 gallons of renewable diesel fuel a year, which has enabled the City to reduce its GHG footprint from petroleum diesel by approximately. 74% percent.[36]

[35] https://content.govdelivery.com/accounts/CARB/bulletins/2699f43
[36] Calculated from U.S. EPA Lifecycle GHG Emissions By Feedstock https://www.epa.gov/fuels-registration-reporting-and-compliance-help/lifecycle-greenhouse-gas-results

In addition, the City operates 17 vehicles (15 refuse trucks and two street sweepers) that run on natural gas Clean Energy, a distributor of natural gas and operator of natural gas fueling stations, is distributing its Redeem renewable natural gas (RNG) to cities that include Santa Monica, Santa Clarita, Midway City, Redondo Beach, Sacramento, Ontario and San Jose. RNG is derived from capturing biogenic methane that is produced from the decomposition of organic waste from dairies, landfills, and wastewater treatment plants. Until the refuse trucks can be replaced, the City might consider procuring RNG.

The consultant team also recommends the City continue to procure vehicles with electric power take off systems (ePTOs) that use an electric motor and battery to power onboard equipment like aerial lifts and booms until low and zero-emission vehicle technologies for this segment are more mature and prices are more competitive.

Appendix B: Electrical Needs and Charging Infrastructure Summary

This report documents existing parking and electrical service conditions at 15 facilities at which the City of Berkeley's fleet vehicles are domiciled (parked overnight) and recommends charging equipment and cost estimates to implemented in the near term (two-to-five years). Eventual electrification of medium-duty, heavy-duty, emergency response vehicles, and other specialized equipment is treated in more general terms

Similarly, for facilities that are planned for reconstruction in the medium-to-long-term, such as the Transfer Station, this report provides near-term recommendations for light-duty vehicle charging infrastructure and assumes that medium- and heavy-duty vehicle charging will be accommodated when the facilities are rebuilt or relocated.

For each domicile, the consultant team assessed that parking capacity and layout, the location and capacity of existing electrical service, and any anticipated site-specific constraints to future charging infrastructure installation. Table 20 summarizes near-term recommendations for each site evaluated. To provide back-up power for resiliency, the consultant team included cost estimates for diesel generators at crucial sites, which would be powered by the City's supply of renewable diesel. However, resiliency could be met with on-site solar energy production and storage batteries.

Table 20: Near-term Recommendations for Charging

Facility Name	Facility Location	Energy Needs (kWh/day)	Light-duty Vehicles		Chargers	New Service Req'd	Preliminary Build-Out Costs		
			LDV	C1	L2 (Dual Head)/DCFC		*Option 1* Level 2 Only	*Option 2* Mobile Only*	Backup Generator
Corp Yard	1326 Allston Way	112.74	7	9	4 and 1 DCFC	Yes	$354,000 (includes 1 DCFC)	-	$487,000
Berkeley Transfer Station (prior to rebuild)	1201 Second St	49.64	2	3	2	No	$87,000	-	$34,000
Berkeley Marina	125/127 University Ave	296.07	33		4	Yes	$290,000	-	$204,000
Adult Mental Health Clinic	1521 University Ave	156.74	13		3	Yes	$135,000		-
Mental Health Clinic	1890 Alcatraz Ave/ 3282 Adeline St	33.29	6		1 or 1 Mobile	Yes	$147,000	$45,000	$34,000
Center Street Garage	2025 Center St	247.81	27	9	28 Dual, 1 Single	NA	Currently installed/Public access	-	-

Facility Name	Facility Location	Energy Needs (kWh/day)	Light-duty Vehicles		Chargers	New Service Req'd	Preliminary Build-Out Costs		
			LDV	C1	L2 (Dual Head)/DCFC		*Option 1* Level 2 Only	*Option 2* Mobile Only*	Backup Generator
Central Library Parking Lot	2031 Bancroft Way	3.38	1		1	Yes	$149,000	-	$34,000
Public Safety Building	2100 MLK Jr Way	16.54		2	1	No	$42,000	-	-
Civic Center	2180 Milvia St	7.19	1		2	No	$65,000	-	-
Mental Health Clinic	2636/2640 MLK Jr Way	55.66	8		1	NA	$40,000 1 In Progress/1 Future	-	-
S. Berkeley Senior Center	2939 Ellis St	7.33	2		1	Yes	$82,000	-	$34,000
N. Berkeley Senior Center	1901 Hearst Ave	11.84	2		1	NA	$45,000 In Progress	-	-
Total cost							$1,216,000	$180,000	$827,000

*Note: LDV=Light Duty Vehicle (passenger sedans). Class 1 (C1) includes any vehicle on a truck-style frame with a GVWR of 6,000 lbs or less including SUVs.

Charging Strategy Options

Analysis of the City's existing fleet found that most light-duty vehicles drive between 3 and 63 miles per day with an average usage of 27.1 miles. Considering the relative efficiency difference between gasoline-powered ICE vehicles and BEVs, this translates into approximately 80-kWh of electricity per day on average. In addition, most vehicles are driven during the day and parked overnight at City facilities, which provides ample dwell time for battery charging. The City's stated intention is to standardize its fleet on the Chevy Bolt and Nissan Leaf Plus, which have a 60- and 62-kWh battery, respectively, and well over 200 miles of range. Due to these minimal power requirements coupled with long dwell times for most vehicles domiciled at the City facilities, light-duty BEVs could share chargers or share power loads via a power load management strategy.

Current Charging Options

Currently available charging technologies appropriate to the City of Berkeley's light-duty vehicle fleet needs include the strategies discussed below and summarized in Table 21. The recommended strategies for each site are listed in Table 22.

Dedicated 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 be assigned a parking stall and that each parking stall be equipped with its own charger. Fleets typically use Level 2 chargers to provide greater range and deploy smart chargers to track electrical use by vehicle or department, similar to tracking gasoline consumption. In cases where vehicle use is minimal, BEVs have long-range batteries, and/or long dwell times, Level 1 charging may be an option.

Vehicle operators pick up the vehicle at the assigned stall, manually disconnect the charger before using the vehicle, and later return the vehicle to the assigned stall and reconnect the charging cord. For fleet facilities with on-site staff or an automated parking management system, vehicles could be rotated between stalls because all stalls would be comparably equipped with chargers. For example, the City could potentially implement this approach at the Center Street Garage, which is currently equipped with more chargers than planned fleet EVs; however, the chargers assigned to City vehicles would not be available for public use under this scenario.

Benefits: The primary benefit of this approach is its simplicity and predictability for fleet operators and drivers. It also provides flexibility due to the relative abundance of chargers, allowing for future expansion via implementation of load management systems or other options.

Disadvantages: A ratio of one charger per parking stall or per EV requires numerous charger installations, which is generally inefficient and can potentially be a more-costly approach due to the expense of procuring and installing[37] each charger. In addition to the cost, the parking facility is more heavily impacted during the charging infrastructure construction period.

[37] Installation costs typically include design, permitting, and electrical service upgrades.

With a one-EV-to-one-charger ratio, the capacity to charge other vehicles is wasted for two reasons: 1) the charger sits idle while the dedicated vehicle is in use, and 2) a fully charged EV in the assigned parking space blocks other vehicles from using the charger.

Operational costs of dedicated chargers can be higher as well. Simultaneously charging multiple EVs at fleet facilities, without managed charging or energy storage incorporated into the system, could result in costly demand charges. This expense is included in PG&E's electricity delivery fees component of customer bills. This cost is different from EBCE's electric generation charge, which helps save the City money on its operating costs while maximizing the utilization of renewable energy.

Network and data costs can also add up over time when smart chargers or third-party load management systems are deployed, and ongoing charger maintenance costs are usually proportionate to the quantity of chargers installed.

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

- Locations, such as the Center Street Garage, that are currently equipped with significant quantities of chargers that could be dedicated to a unique parking space/fleet EV. These chargers, however, would not be available to the public when in use by the City's fleet.
- Facilities at which a limited number of EVs are domiciled and ample electrical capacity is available, such as the Central Library parking lot.
- When funds are not constrained.

Dedicated Chargers with Load Management

Load splitting, balancing, or management systems can reduce the maximum power load to avoid or reduce needed electrical service upgrades or utility demand charges. These systems enable fleet operators to control when and how each fleet EV charges.

For example, the company Cyber Switching has a control unit called the EVMC that switches power to multiple chargers in a "round-robin" scenario. A single electrical line can feed multiple chargers and incrementally rotate the current to each charger on a programmable timed basis. The EVMC first polls an individual EV to check its battery status, and if charged, moves on to the next EV in line. Another example, Powerflex, includes sophisticated Adaptive Load Management that incorporates driver inputs and real-time electrical load monitoring to determine which EV will receive a determined amount of electricity and when.

These systems can be paired with Level 2 chargers that are not networked ("dumb" chargers) to upgrade their functionality. Cyber Switching's EVMC spreads the power typically allocated to a single charger to up to four chargers. Powerflex can manage a series of up to 100 chargers while monitoring building loads by reading the power currently in use by all the building's electrical circuits. If additional electric capacity is available, Powerflex will redirect excess electrical capacity to the chargers. Additionally, some charging networks like ChargePoint and Greenlots have dedicated software with customizable algorithms to intelligently share power among networked ("smart") chargers so every EV charges as fast as possible without exceeding the site's rated electrical capacity.

Benefits: The primary benefit of load management is reduction of peak electrical load to reduce or avoid costly electrical service upgrades and PG&E's demand charges.

Disadvantages: Load management requires networked smart chargers, which may have higher capital and/or operating costs and depends 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.

General Recommendations: Adding load management to dedicated chargers generally makes the most sense in parking facilities with limited power supply where large numbers of heavily utilized EVs with long dwell times are domiciled. This does not apply to most of the City's domicile locations; however, as the City adds more EVs to the fleet, the circumstance could change.

Shared Chargers

At facilities with shared chargers, a minimum number of Level 2 chargers are installed to serve all the fleet EVs domiciled by rotating charger use. This is generally feasible for the City because most fleet vehicles travel relatively few miles per day and are parked and available for charging for at least 14 hours. Not needing to charge their batteries every night means the City's fleet EVs could share chargers by taking turns based on a schedule or depending on a vehicle's state of charge. Additionally, a shared DCFC could supplement shared Level 2 chargers at large City facilities with multiple light, medium and heavy-duty vehicles such as the Corp Yard. In cases where dwell times are limited to only four hours, the anticipated duration of charging would still be sufficient to charge the relatively small number of EVs.

Benefits: The primary benefit of sharing EV chargers is cost reduction. The City can purchase and install a minimum number of chargers and avoid the need to increase facility electrical capacity. An additional benefit is reduced construction related disruption at facilities during charger installation.

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. As more EVs are added to the fleet, it is likely that the City will 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 a day and have dwell times longer than eight hours, such as the Corp Yard and Mental Health Clinics.
- Facilities with limited available electrical capacity to avoid the expense of electrical service upgrades.

Shared Chargers with Load Management

This is a variation on shared chargers that incorporates load management to provide flexibility. This could be achieved by networked smart chargers with integral load management or by a third-party add-on system.

Benefits: The primary benefit is to reduce PG&E peak demand charges, potential electric service upgrades costs, and initial investment costs associated with the procurement and installation of chargers generally (e.g., reduced number of individual units required). This approach is also useful to leverage the constrained electrical capacity of certain sites to install more chargers that would share available electrical load.

Disadvantages: It requires active parking/charging management by City staff and poses a potential risk that fleet EVs may not be sufficiently charged if not managed properly.

General Recommendations: Adding load management to shared chargers makes the most sense at locations like the Transfer Station at which a load management system can serve the four chargers needed near term with a relatively small 40-amp electrical capacity.

Mobile Charging

Mobile or semi-mobile charging is an alternative or complement to fixed EV chargers. These consist of energy storage systems that draw power from the grid then dispense the electricity to EVs when needed. Examples are from Freewire Technologies, which has two mobile charging units, Mobi and Boost; and Danner, which has the Mobile Power Station (MPS). The MPS and Mobi units are equipped with wheels and operator controls, while the Boost is stationary and hard-wired but can be easily disconnected for re-location to another facility.

Each Mobi can charge up to eight light-duty EVs per shift and can be equipped with an optional Hydra unit that simultaneously charges seven vehicles (charging is at Level 1 speed). Boost is a larger unit that has 160 kWh of battery capacity and 120 kW output capable of charging 25 light-duty EVs per shift at 100kW.

Dannar's MPS can charge multiple types of batteries and replicate the function of a mobile generator. The DANNAR 4.00 base configuration comes standard with three 42 kWh Li-Ion battery packs (126 kWh total) and can be easily upgraded with up to nine additional packs for a total of 504 kWh of on-board electricity.

Another example, SparkCharge, is an innovative startup that produces a highly portable, modular DCFC. Its battery-powered chargers snap together like Lego blocks, and provide up to 20 miles of range per battery module. Fleets can use SparkCharge modules to augment short-range EVs or rescue EVs that run out of charge, which avoids the need to be towed to a charger.

Benefits: By being able to accept power from the grid at low voltage and/or during times when electrical demand is low or during the day when grid renewables and/or onsite solar (depending on the City facility) generation is high, mobile energy storage platforms can help to avoid PG&E's demand charges. Other benefits include the ability to:

- Charge additional fleet EVs than the facility's existing power capacity may support.
- Provide backup energy to fleet vehicles during power outages.
- Charge multiple EVs at the same site by moving the charger, rather than moving the vehicles.
- Relocate the charger from one facility to another to address changing needs or to provide flexible charging capacity at non-City owned facilities where fleet EVs may be domiciled.

The Danner Mobile Power Stations can also be outfitted with auxiliary equipment such as lifts or loaders, allowing these units to function as fully electric off-road equipment. Both the Danner and Mobi can also perform the function of a generator by powering electrical equipment where no power outlets are available.

Disadvantages: The main disadvantage of this option is the large upfront costs. Using mobile charging units also requires active parking/charging management by City staff who will need to move the charger to individual fleet EVs and manually connect them. Mobile chargers take up space in the parking lot and staff may not be able to get the unit close enough to the EV in a crowded parking facility. Theft and vandalism may also be a concern at facilities lacking site security.

General Recommendations: Using mobile charging units as an option may make sense at:

- Facilities where power upgrades may be significant due to large numbers of EVs and/or has space constraints make installation of multiple individual chargers difficult. (e.g., Berkeley Marina at 125/127 University Ave)
- Facilities that are leased (e.g., Adult Mental Health Clinic at 1521 University Avenue).
- Facilities where fixed charging infrastructure near term is needed but may not be fiscally responsible because of site redevelopment plans in the future (e.g, Transfer Station) or that will be redeveloped.

The Mobi and the Danner units qualify for a 50% rebate under CARB's CORE[38] program.

[38] http://californiacore.org/

Table 21: Charging Strategy Summary

	Dedicated chargers	Dedicated chargers with load management	Shared chargers	Shared chargers with load management	Mobile charging
Strengths:					
Convenience and simplicity	Yes	Yes	No	No	Yes
Capacity for future fleet expansion	Yes	Yes	No	No	Yes
Reduces peak demand and resulting service upgrades	No	Yes	Yes	Yes	Yes
Reduces capital expenditure from fewer chargers purchased and installed.	No	No	Yes	Yes	Depends on facility scale
Challenges:					
Costs for hardware purchase, installation and load upgrades.	Yes	Yes	No	No	More cost effective for larger facilities
Initial cost of system plus data charges	No	Yes	No	Depends on provider	Yes
Requires active parking/charging management by City staff	No	No	Yes	Yes	Yes
Risk of vehicles not being charged	No	No	Yes	Yes	Yes

Table 22: Facility Recommendation Summary

Domicile	Dedicated connectors	Dedicated connectors with load management	Shared connectors	Shared connectors with load management	Mobile charging
Corporation Yard			8 L2 + 1 DCFC		
Berkeley Transfer Station		4 L2			1 Mobile
Berkeley Marina			8 L2		Possible option: 1 Mobile
Adult Mental Health Clinic					3 Mobile
Mental Health Clinic			2 L2		Possible option: 1 Mobile
Center Street Garage	35 L2 (connectors from existing chargers currently assigned to fleet)				
Central Library Parking Lot	2 L2				
Public Safety Building	2 L2				
Civic Center Building	4 L2				
Mental Health Clinic			2 L2		
South Berkeley Senior Center	2 L2				
North Berkeley Senior Center	2 L2				

Future Charging Technologies

The City should monitor emerging charging technologies and plan for pilot programs/evaluation as these become market ready.

- Inductive charging which can wirelessly charge an EV
- Automated charging which pairs with autonomously operated vehicles are paired with robotic or wireless chargers
- Bi-directional charging provides vehicle-to-grid (V2G), vehicle-to-building (V2B), and vehicle-to-vehicle (V2V) electrical flow.

- V2G would enable surplus EV battery capacity to be sold back to the grid in times of peak grid electrical demand, thereby creating a potential source of revenue for fleets.
- V2B would facilitate 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 at times of peak building electrical demand, thereby avoiding PG&E's demand charges.
- V2V would allow EVs to transfer power to and from each other's batteries. Since utilization by most City fleet vehicles is well within the battery range of currently available EVs, a substantial surplus power is typically available. This power could be shuffled between vehicles on an as-needed basis, reducing demands on fleet charging infrastructure as well as on the grid.

As these technologies come to market, the costs will be higher than with traditional charging recommended in this report yet may reduce staff time needed to manage charging and, with bi-directional charging, may help balance utility costs.

Appendix C: Distributed Energy Resources Analysis

The purpose of this report is to summarize the potential areas for distributed energy resources (DER) deployment at each of the City of Berkeley's fleet domiciles. DER is defined as onsite solar photovoltaics (solar PV), battery energy storage (BES) and electric vehicle (EV) charging infrastructure. The analyses represent an initial screening that implies the DER deployments identified are favorable and reasonably sized compared to the proposed EV fleet's needs. Performance and costs are meant to be budgetary level, and firm quotes and scopes of work for each location are encouraged to determine the actual capital needs required.

Summary of Recommendations

Twelve domicile location were examined for solar PV and BES deployment, to balance the electrical load from EV charging. Based on our findings, the consultant team recommends that the City consider deploying solar PV and BES systems at the eight locations listed in Table 23.

Table 23: Recommended Solar PV and BES

Location	Existing and Planned Charging Stations	Total Solar PV Capacity (kW DC)	BES Recommendation	Potential Cost for Solar PV + BES
Corp Yard	4 Dual-head Level 2 and 1 DCFC	52.7*	33 kW / 130 kWh	$423,800
Berkeley Marina	4 Dual-head Level 2	70.5*	75 kW / 300 kWh	$782,100
Center Street Garage	28 Dual-head Level 2 and 1 Single-head Level 2	168.9*	63 kW / 250 kWh	$375,000
Central Library Parking Lot	1 Dual-head Level 2	18.8		$75,200
Public Safety Building	1 Dual-head Level 2	10.8		$43,200
Mental Health Clinic	1 Dual-head Level 2	60.1*		$240,400
S. Berkeley Senior Center	1 Dual-head Level 2	7.8		$31,200
N. Berkeley Senior Center	1 Dual-head Level 2	29.6*		$118.400

**Already installed or being considered for development via EBCE's Solar + Storage at Critical Municipal Facilities initiative (see below)*

Of the recommended locations, five are also being evaluated through EBCE's *Solar + Storage at Critical Municipal Facilities Assessment,* which is funded by a Bay Area Air Quality Management District grant. The goal of this complementary project is to identify critical facilities designated to serve the community in time of emergency throughout Alameda County and size solar PV and BES systems to meet critical loads at those sites. EBCE plans to aggregate the site portfolio into a competitive solicitation Summer 2020 to reduce the cost and complexity of deploying these systems near term for its local government partners.

Three domicile locations, the Adult Mental Health Clinic, Mental Health Clinic, and Civic Center, were excluded from solar PV and BES deployment due to constraints specific to each location discovered during the assessment. The Transfer Station was evaluated to support the LD fleet only, however Solar PV for this size fleet only not recommended. Solar PV and BES should be re-evaluated when the site is rebuilt, and impact of the heavy-duty fleet is assessed at that time.

Solar Potential at City Sites

To offset the electricity consumption of Berkeley's EV fleet, the solar PV potential for each of the primary facilities where vehicles are domiciled was evaluated. Eight of the 12 facilities were found suitable for solar PV for EV fleet charging, while four were found to have site specific constraints precluding solar PV deployment. Solar PV arrays consist of multiple modules, each approximately 17.8 square feet (SF) (5.5-feet x 3.25-feet) and weighing about 40 lbs. The exact size, weight, and electricity output of PV modules will vary by manufacturer however the average electricity output is 300 watts (W) which will produce approximately 16.5 W/SF of area. Panels with more surface area and higher outputs of 350–400 watts (W) are available, but these panels have an equivalent area normalized output of 16.5 W/SF. Roof locations where solar PV are mounted must be able to support the weight of the proposed PV array, which ranges from 650 pounds for a five-kilowatt (kW) array to more than 2,000 pounds for a 15-kW array. Array that use mounting racks must be designed to resist wind-lift, and the underlying roof structure must be more resistant. No structural load analysis was conducted for this project.

At each domicile location, the consultant team analyzed building rooftop and parking carport opportunities.[39] This potential is dictated by the overall unobstructed area available to install the solar PV system and orientation of the system to the sun throughout the day with south, southwestern and west facing facades yielding the greatest electricity production. Surface areas with shading caused by architectural details and mechanical equipment and adjacent trees or buildings are not suitable for solar PV systems.

This methodology resulted in array sizing that matched the existing solar PV design at two projects at the Mental Health Clinic at 2636/2640 MLK Jr Way and the North Berkeley Senior Center, resulting in consistency with work previously performed. Once the geometry constraints of the available roof areas were determined, the configuration was entered in the National Renewable Energy Laboratory's (NREL) PVWatts Calculator.[40] Output from PV Watts was exported as hourly data to combine the performance of the multiple solar PV arrays simulated for each location. The results are summarized in the following sections.

Annual Solar PV Generation

The following provides a brief summary of the conditions for each location where the City's EV fleet will be domiciled, and the result of the solar PV screening. The total generation potential for all sites based on the resources identified is 419.2 kW of solar PV, with 231.3 kW of new capacity recommended. The

[39] This analysis did not assess whether roof or other structural upgrades would be necessary at City sites, or approximate costs for those potential upgrades.
[40] https://pvwatts.nrel.gov/

solar PV resource generates an average of 1,753 kWh/day. The current fleet electrification assessment identifies the need to support 1,009 kWh/day of EV charging, indicating that solar PV arrays deployed at some sites could also serve onsite building loads and/or future fleet charging needs, as shown in Table 24.

Table 24: Solar PV Sizing Results and Daily Generation

Facility Name	Facility Location	Overall Assessment	Total Solar PV Capacity (kW DC)	Average Daily Generation (kWh/day)	Average Daily EV Charging Need (kWh/day)
Corp Yard	1326 Allston Way	Replacement of the existing 19 kW solar array with a 30.6 kW using higher output panels. Install new 16.1 kW array over the fuel island, and 6.0 kW covered parking array in the yard parking area.	52.7	195.3	112.74
Berkeley Transfer Station	1201 Second St	Defer array design until site redeveloped. Charging need based on near-term light-duty fleet.	0	0	49.64
Berkeley Marina	125/127 University Ave	Suitable for one rooftop array and one parking lot array.	70.5	297.6	298.93
Adult Mental Health Clinic	1521 University Ave	Existing array is not property of the city. No further solar PV can be deployed.	n/a	n/a	156.74
Mental Health Clinic	1890 Alcatraz Ave/ 3282 Adeline St	No solar PV recommended due to insufficient roof area.	0	0	33.29
Center Street Garage	2025 Center St	Existing 168.9 kW rooftop solar PV array installed. No further solar PV recommended.	168.9	732.4	247.81
Central Library Parking Lot	2031 Bancroft Way	Suitable for one rooftop solar PV array.	18.8	71.0	3.38
Public Safety Building	2100 MLK Jr Way	Suitable for one rooftop solar PV array. Parking areas substantially shaded and not recommended.	10.8	40.8	16.5
Civic Center	2180 Milvia St	Roof structurally unsuitable for deployment. No solar PV recommended.	0	0	6.17
Mental Health Clinic	2636/2640 MLK Jr Way	A 60.1 kW solar PV array has already been designed for the facility. No further solar PV recommended.	60.1	258.7	64.94
S. Berkeley Senior Center	2939 Ellis St	Suitable for one rooftop solar PV array.	7.8	33.6	7.33
N. Berkeley Senior Center	1901 Hearst Ave	A 29.6 kW solar PV array has already been designed for the facility. No further solar PV recommended.	29.6	127.8	11.84
Total			**419.2 (231.3 new)**	**1752.7**	**1,009.3**

Changes in Utility Tariffs and Coincidence of DER Loads

Per California Public Utilities Commission (CPUC) Decision 18-08-013,[41] PG&E will phase out legacy tariff series "A" and "E," and replace each tariff with a "B" series that reflects the current costs of transmission. Every account will be migrated to the corresponding "B" series rate by March 2021 (e.g., accounts on the A-1 rate will be migrated to B-1; accounts on E-19 will be migrated to B-19, etc.). All ECBE accounts, including those for the City will be impacted by these changes. Table 25 compares the difference in the peak periods from the tariff revision. The "B" rates shift the peak period from midday to late afternoon and early evening, and the peak period will apply year-round.

Table 25: Changes in Peak Utility Period from Tariff Update

Period	"A" & "E" Rates (Current)	"B" Rate (Future)
Summer Period	May 1 – Oct 31	June 1 – Sep 30
Peak	12:00 PM – 6:00 PM M-F	4:00 PM – 9:00 PM All days
Part-peak	8:30 AM – 12:00 PM M-F 6:00 PM – 9:30 PM M-F	2:00 PM – 4:00 PM All days 9:00 PM – 11:00 PM All days
Off-peak	All other hours	All other hours
Super Off-peak	None	None

Period	"A" & "E" Rates (Current)	"B" Rate (Future)
Winter Period	Nov 1 – Apr 30	Oct 1 – May 31
Peak	None	4:00 PM – 9:00 PM All days
Part-peak	8:30 AM –9:30 PM M-F	None
Off-peak	All other hours	All other hours
Super Off-peak	None	9:00 AM – 2:00 PM All days March – May only

Every rate class has a varying energy charge ($/kWh) for each of the time periods in Table 3, with the energy rate in the peak period being approximately 30% higher than the off-peak period during the summer months and 15% higher during the winter months. **The variation between on-peak and off-peak energy costs in the "B" series tariffs is not substantially different from the current "A" and "E" tariffs in place today, only the time of the on-peak period has changed.**

[41] https://www.pge.com/tariffs/assets/pdf/adviceletter/ELEC_5499-E.pdf

The rate classes of B-10 and B-19 (for larger facilities) have demand charges in addition to the energy charges for each period. Demand is based on the highest rate of energy consumption in a specified 15-minute period and is charged at a cost per kW ($/kW). Best management practices to manage this demand from EV fleet charging can include scheduled charging, smart charging (auto scheduling), and discharge from a battery energy storage system coincident with EV charging. These methods can be successful in lowering, but not eliminating the resulting demand charge, and are most effective when applied against fleet charging that occurs on a regular, controlled schedule. Intermittent charging, and locations that support both fleet charging and public charging can have substantial financial impact from demand charges.

Tariff B-10 has one monthly demand charge assessed for the peak power consumption on any 15-minute interval. Tariff B-19 has up to three demand charges separately assessed monthly and added together: one for the peak period, one for the part-peak period, and one for any 15-minute interval in the month. Tariffs B-1 and B-6 do not have demand charges. Table 26 summarizes the peak for each tariff.

Table 26: Tariffs with Demand Components

Demand Component in Tariff	B-1	B-6	B-10	B-19
Peak	No	No	No	Yes
Part-peak	No	No	No	Yes
Any-hour	No	No	Yes	Yes

The impact of all the above components must be considered when determining the value of the solar PV and BES. For simplicity, assumptions are grouped by rate structure. **Due to the impending rate change, the consultant team evaluated each deployment by using the corresponding new "B" tariff and ECBE supply rates, rather than the current utility rate.** Under the new delivery tariff, ECBE would continue to provide the City with its carbon-free electricity supply product, Brilliant 100. Table 27 summarizes the assumptions used to model rates at each fleet domicile location.

Table 27: Utility Modeling Assumptions

Rate	Buildings	Rate Modeling Assumptions
B-1	Berkeley Marina Adult Mental Health Clinic (1890 Alcatraz) Mental Health Clinic	• No demand component in rate. • Solar PV generation and EV charging impacts energy consumption in the period it occurs. • Addition of EV unlikely to push facility above 75 kW threshold needed to stay on rate B-1.
B-6	S. Berkeley Senior Center	• No demand component in rate. • Solar PV generation and EV charging impacts energy consumption in the period it occurs. • Addition of EV unlikely to push facility above 75 kW threshold needed to stay on rate B-6.
B-10	Corp Yard Berkeley Transfer Station Central Library Parking Lot Mental Health Clinic (2636/2640 MLK) N. Berkeley Senior Center	• Solar PV reduces **any-hour** monthly demand. • EV charging **does not impact** demand.
B-19	Public Safety Building Civic Center	• Solar PV reduces the **any-hour** monthly demand typically occurring mid-day. • EV charging **impacts peak and part-peak** demand. • EV charging **does not impact the any-hour** demand typically occurring mid-day.
B-19	Center Street Garage	• Due to observed load building shape, Solar PV **does not** reduce the **any-hour** monthly demand that occurs at approximately 8:00 PM. • EV charging **impacts peak and part-peak** demand • EV charging impacts the **any-hour** demand due to building load shape.

Figure 9 displays the impacts of these assumptions using actual data for the Corp Yard and the stipulated EV charging profile. The Corp Yard peak power occurs at 7:00 AM and decreases throughout the day as the existing solar PV array provides generation. Under the new B-10 rate, the facility has only a single demand charge, which would be largely unchanged from the addition of EV charging. Part-peak and peak-period energy increases from EV charging would occur, as well as off-peak charging for the balance of the evening. Figure 10 shows that under the new tariff, most of the solar PV generation is during the off-peak hours.

Figure 11 shows the impact of EV charging on the Center Street Garage. This facility already has a sizable solar PV array, and limited additional solar PV can be reasonably accommodated. In the original design, there was space for 20 additional panels to be added totaling 7.5 kW DC (4%) additional capacity, however pursuing this capacity should be secondary to establishing solar PV at the other identified locations. This facility will be adversely impacted by the transition to the B-19 tariff. The facility peak occurs during the new peak period, even before EV charging is added. EV charging contributes to the peak-period demand and the part-peak demand. Additionally, the impact of public charging, which may be highly coincident with the new time-of-use peak period is not considered in this study. The Center Street Garage is adjacent to the Theatre District, and therefore may be subject to substantial evening public charging.

Fleet modeling was performed using charging profiles beginning at 6:00 PM each day, to provide a conservative baseline for EV charging costs. The selected examples illustrate the need for smart charging controls or a load management system to regulate the timing of charging outside of the peak period and demonstrates the opportunity to control costs via a BES system. The City should continue to explore these options, as well as coordinate with ECBE to secure further alternatives for energy supply options and demand mitigation throughout the transition of the tariffs.

Figure 9: Corp Yard Current Electric Load and Impact of EV Charging (Tariff B-10)

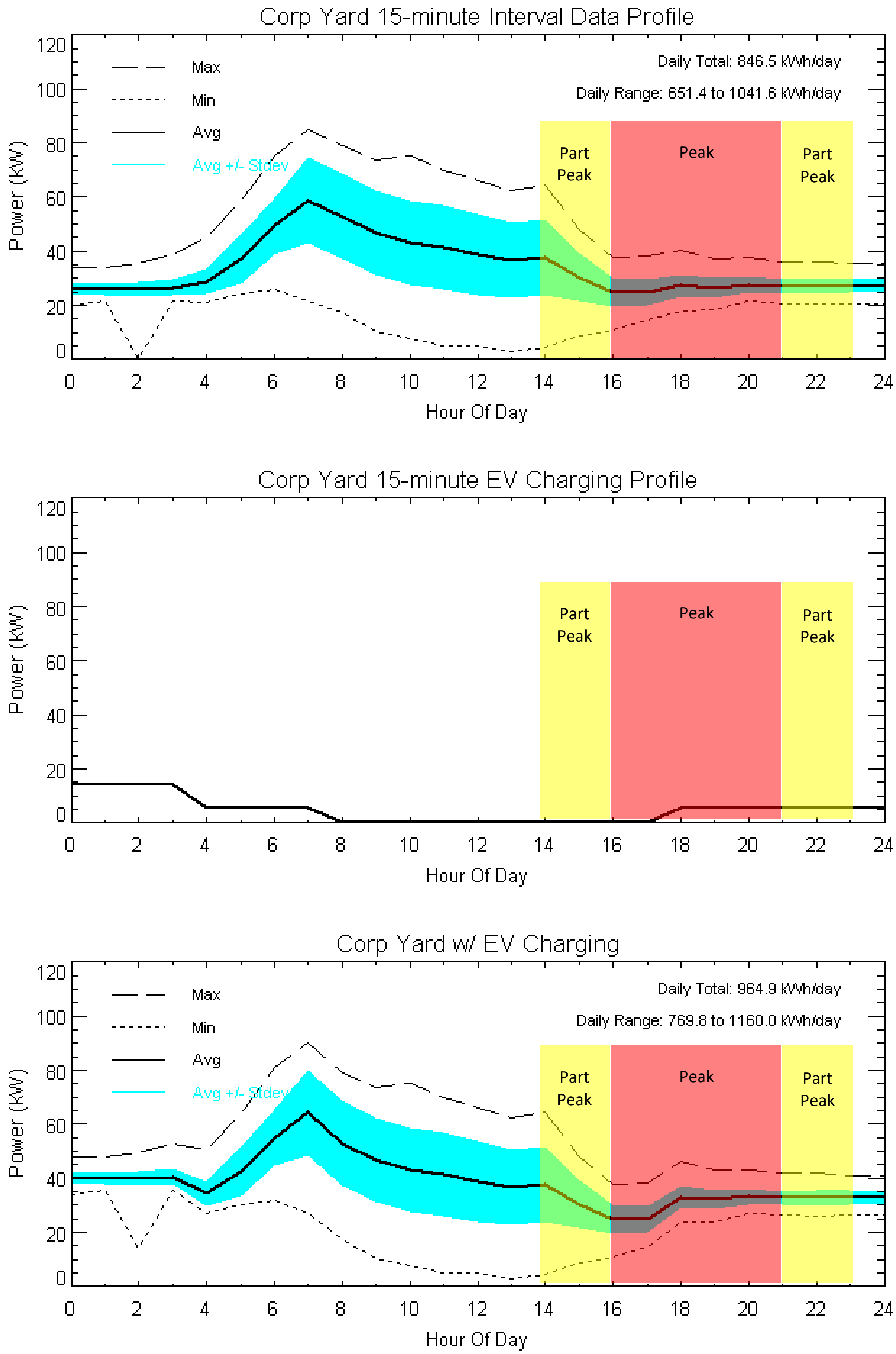


Figure 10: Proposed PV System Performance – Corp Yard (Tariff B-10)

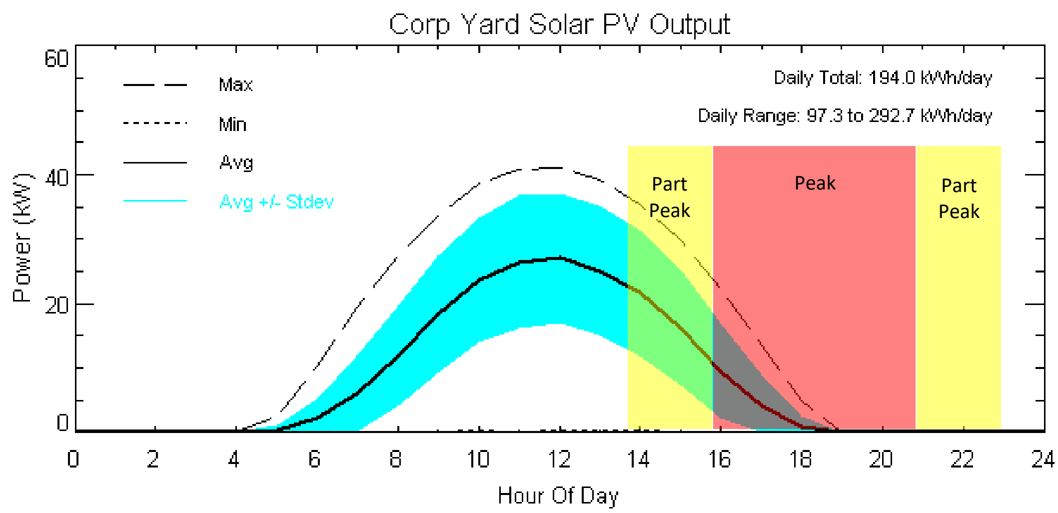
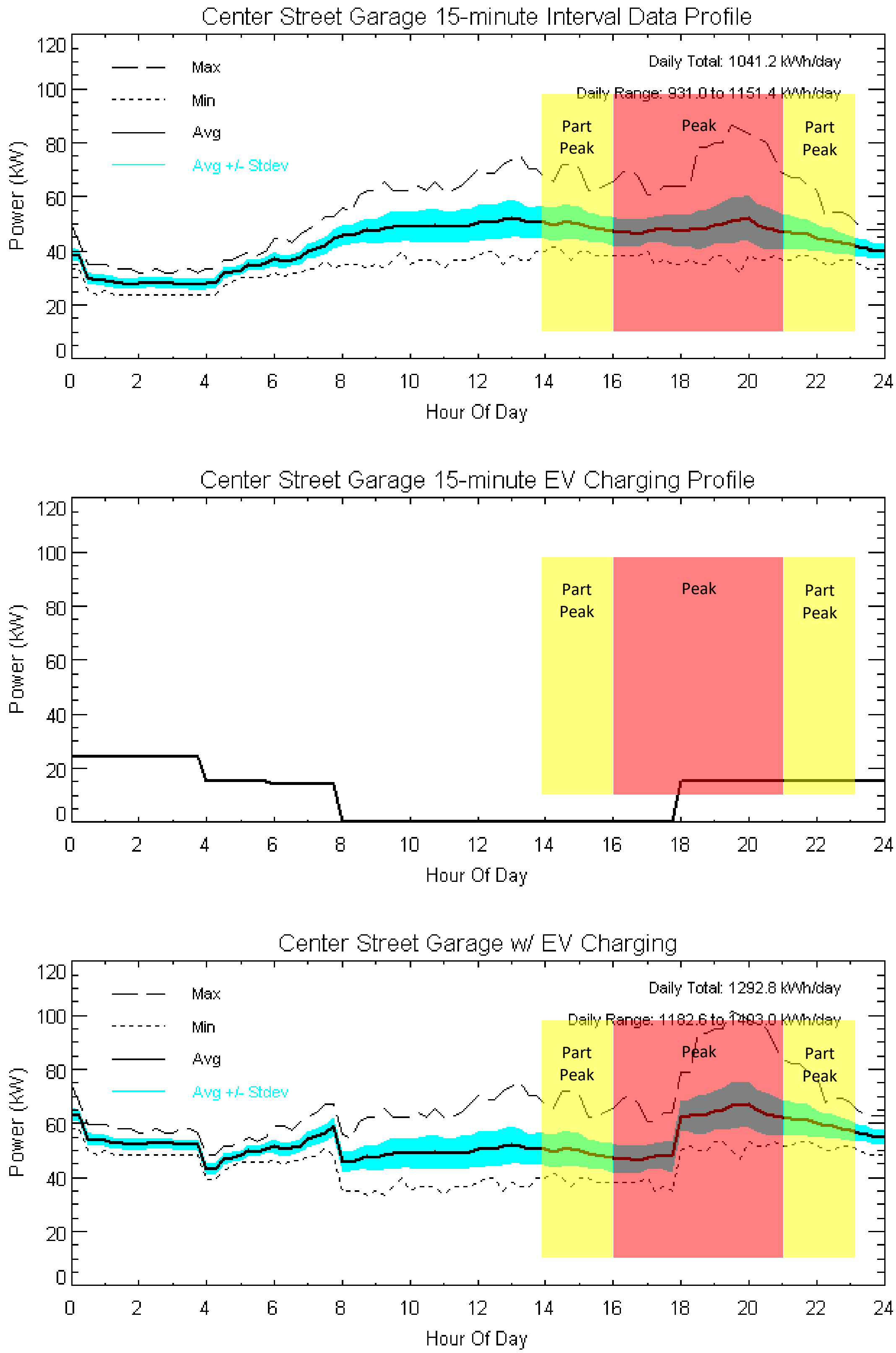


Figure 11: Center Street Garage Current Electric Load and Impact of EV Charging (Tariff B-19) (3/10/2019 – 2/20/2020)



With a large City fleet and public charging potential and substantial deployed solar PV, the rate options for the Center Street Garage should investigated more deeply. Two rate options are available for this building and have dramatic impact on utility charges. Option R is for buildings with less than 15% of annual generation produced by on-site solar; and Option S is for buildings with battery storage sized to 10% or greater of peak demand. These options are only available for facilities on the B-19 rate.

These rate options trade lower demand charges during the peak and part-peak period for higher energy charges in those periods. Option S takes the demand/energy trade-off further by introducing an "as-used-daily-demand" charge. This allows the facility to capitalize on days when BES can limit demand without substantial penalty for missing a day of demand reduction.

Modeling these rate options showed little impact on the cost of charging, however, the influence of the building energy use profile must also be considered. A full load shape study incorporating interval data of the building, and temporary metering data for all EV charging circuits (public or City fleet) should be performed prior to exercising either rate option. The City should continue to engage with ECBE to investigate these rate and load profile studies to ensure the most beneficial rate structures are being utilized.

Value of Solar PV

The value of the solar PV systems modeled was calculated using the applicable ECBE rate for the location and incorporated the impacts of demand and time-of-use costs of energy, where applicable. The time-of-day variation and potential for demand reduction from the prevailing utility rate structure was used to determine the value of the electricity produced from solar PV. This results in the energy generated from solar PV having a much higher value on a $/kWh basis than the comparable average cost of energy of the baseline building evaluated. The underlying energy profile of the host account was not considered in determining the value of the solar PV generation, nor was limiting the solar PV output in the case of grid constraint or curtailment.

Installation costs for the proposed solar PV arrays were based on typical values for small- to medium-sized systems deployed in the Bay Area. A normalized cost of $4.00/watt DC was applied to the rooftop arrays, and $7.00/watt DC was applied to the parking area arrays. Table 28 lists the economic potential from solar PV generation if the electricity is used at the time of generation either as EV charging or as displaced building import energy. Note that all costs are budgetary and need verification from actual scope and industry price quotes prior to proceeding. The City should continue to work with EBCE for all available program dollars and maximize the value of bulk purchase arrangements to reduce this value to the extent possible.

Table 28: Economic Potential from PV Generation

Facility Name	Facility Location	Prevailing Rate	Annual Value of Solar PV Generation	Solar PV System Budget Cost[42]	Calculated Payback (years)
Corp Yard	1326 Allston Way	B-10SX Brilliant 100	$16,833	$228,800	13.6
Berkeley Transfer Station	1201 Second St	B-10SX Brilliant 100	n/a	n/a	n/a
Berkeley Marina	125/127 University Ave	B-1X Brilliant 100	$26,219	$332,100	12.7
Adult Mental Health Clinic	1521 University Ave	B-1X Brilliant 100**	n/a	n/a	n/a
Mental Health Clinic	1890 Alcatraz Ave/ 3282 Adeline St	B-1X Brilliant 100	n/a	n/a	n/a
Center Street Garage	2025 Center St	B-19S Bright Choice	n/a	n/a	n/a
Central Library Parking Lot	2031 Bancroft Way	B-10SX Brilliant 100	$6,120	$75,200	12.3
Public Safety Building	2100 MLK Jr Way	B-19S Bright Choice	$4,269	$43,200	10.1
Civic Center	2180 Milvia St	B-19S Bright Choice	n/a	n/a	n/a
Mental Health Clinic	2636/2640 MLK Jr Way	B-10SX Brilliant 100	$22,445	$240,400	10.7
S. Berkeley Senior Center	2939 Ellis St	B-6 Brilliant 100	$2,814	$31,200	11.1
N. Berkeley Senior Center	1901 Hearst Ave	B-10SX Brilliant 100	$11,043	$118,400	10.7
Total* (new only)			**$89,743**	**$1,069,300**	**11.9**

*Existing systems not included in total
** Account not owned by the City of Berkeley

[42] Add 25% for engineering and 25% for soft costs if a detailed engineering analysis is needed

Fleet Charging Costs

Costs for fleet charging were computed using the applicable utility rate and the stated assumptions for impact on demand charges. Table 29summarizes the cost of charging the EV fleet per domicile location, without the support from beneficial solar PV and BES systems. Total electrification of the light duty fleet by 2030 would have a present-day charging cost of $78,795 at 21.4¢/kWh, calculated from the sum of the EV charging energy (kWh) and the cost of charging ($) under the governing utility rate for each domicile location.

Table 29: Annual Cost of EV Fleet Charging

Facility Name	Facility Location	Annual EV Energy (kWh/year)	Cost of EV Charging ($/year)	Average Cost of Fleet Electricity ($/kWh)
Corp Yard	1326 Allston Way	41,149	$6,272	$0.152
Berkeley Transfer Station (near-term light-duty fleet)	1201 Second St	18,119	$2,906	$0.160
Berkeley Marina	125/127 University Ave	109,109	$26,994	$0.247
Adult Mental Health Clinic	1521 University Ave	57,212	$14,098	$0.246
Mental Health Clinic	1890 Alcatraz Ave/ 3282 Adeline St	12,149	$2,993	$0.246
Center Street Garage	2025 Center St	90,451	$19,449	$0.215
Central Library Parking Lot	2031 Bancroft Way	1,234	$200	$0.162
Public Safety Building	2100 MLK Jr Way	6,036	$690	$0.114
Civic Center	2180 Milvia St	2,626	$396	$0.151
Mental Health Clinic	2636/2640 MLK Jr Way	23,702	$3,516	$0.148
S. Berkeley Senior Center	2939 Ellis St	2,675	$627	$0.235
N. Berkeley Senior Center	1901 Hearst Ave	4,320	$655	$0.152
Total		**368,782**	**$78,795**	**$0.214**

Battery Energy Storage Options

Battery energy storage (BES) systems allow for energy from daytime solar PV generation to be time-shifted for use during the evening and nighttime hours. This allows either on-site generated electricity from solar PV or ECBE's carbon-free electricity to be provided during periods when solar PV is not providing generation. BES systems can also be sized for fleet resilience, providing 100% of the fleet's energy needs over the course of a one-day grid outage. Alternatively, a BES system can be downsized to offset EV charging loads only during the peak and part-peak periods to save the City operational costs.

Additional BES capacity larger than that needed to meet the EV charging requirements can be installed to meet building resiliency loads, or to participate in a utility resource adequacy (RA) program. The City should work with ECBE to investigate these options as programs develop.

BES systems are an evolving technology, and new standards in battery chemistry and technology are emerging each day. Presently the standard for battery technology is centered on the lithium-ion (Li-Ion) technology as a widely available, robust energy storage medium. Current best-in-class Li-ion BES technologies have storage durations of approximately four hours, also known as a four-hour resource. Longer duration storage of six-to-eight hours is under development for utility system support, but not currently available as a behind-the-meter resource. This analysis focuses on the four-hour resource.

BES systems are typically installed as either a packaged containerized system or require a dedicated outdoor shelter. The typical footprint of a BES system is approximately 0.17 sf/kWh. A 25 kW / 100-kWh unit would therefore occupy a 170-sf area, plus applicable clearances around the BES system as required by NFPA and local code enforcement, which generally doubles the area needed.

Fleet charging typically starts at the end of staff shifts and persists across the vehicle dwell time or until the EV is fully charged. The start time of charging will need optimization based on the prevailing utility rate structure. With new utility rates dedicated to EV charging, the City should work with ECBE to choose the optimum rate structure for each location and adapt fleet charging times, when feasible, to ensure the most cost-effective charging configuration.

Based on the daily solar PV generation and EV charging needs, Table 30 provides the required BES system sizing and resulting cost to meet 100% of fleet needs with BES for resilience.

Table 30: BES Sizing and Cost – BES Sized for EV Resiliency Meeting 100% of Daily EV Electricity Need

Facility Name	Facility Location	BES Size Required*	Daily Average EV Need (kWh/day)**	BES Potential Cost
Corp Yard	1326 Allston Way	33 kW / 130 kWh	112.74	$195,000
Berkeley Transfer Station	1201 Second St	To be added during rebuild.	49.65	$0
Berkeley Marina	125/127 University Ave	75 kW / 300 kWh	298.93	$450,000
Adult Mental Health Clinic	1521 University Ave	Insufficient space to site BES.	156.74	$0
Mental Health Clinic	1890 Alcatraz Ave/ 3282 Adeline St	Insufficient space to site BES.	33.29	$0
Center Street Garage	2025 Center St	63 kW / 250 kWh	247.81	$375,000
Central Library Parking Lot	2031 Bancroft Way	2.5 kW / 10 kWh	3.38	$15,000
Public Safety Building	2100 MLK Jr Way	5 kW / 20 kWh (EVs only)	16.5	$30,000
Civic Center	2180 Milvia St	2.5 kW / 10 kWh	6.17	$15,000
Mental Health Clinic	2636/2640 MLK Jr Way	20 kW / 80 kWh	64.94	$120,000
S. Berkeley Senior Center	2939 Ellis St	2.5 kW / 10 kWh	7.33	$15,000
N. Berkeley Senior Center	1901 Hearst Ave	3 kW / 12 kWh	11.84	$18,000
Total		**258 kW / 1032 kWh**		**$1,233,000**

*BES sizing based on 4-hour resource
** Daily Average EV need determined in Fleet Assessment and Charging Infrastructure Analysis

The cost of charging in Table 7 is useful for prioritizing the importance of BES deployment at each location where fleet EVs are domiciled. Domicile locations with substantial annual charging costs and higher average costs of energy should be prioritized for initial BES deployment. These locations will benefit the most from the added operational flexibility and the protection from demand charges that BES provides. The Corp Yard, Berkeley Marina, and Center Street Garage all have substantially more charging load and higher costs of energy than the other domicile locations. Facilities with annual charging costs of less than $3,000 are unlikely to be cost effective for BES deployment, unless the EVs at these locations are critical to providing community services in times of emergency. Table 31 summarizes the locations recommended for BES deployment.

Table 31: BES Sizing and Cost – Recommended Locations

Facility Name	Facility Location	BES Size Recommended	Daily Average EV Need (kWh/day)	BES Potential Cost
Corp Yard	1326 Allston Way	33 kW / 130 kWh	112.74	$195,000
Berkeley Marina	125/127 University Ave	75 kW / 300 kWh	298.93	$450,000
Center Street Garage	2025 Center St	63 kW / 250 kWh	247.81	$375,000
Total		**170 kW / 680 kWh**		**$1,020,000**

Combined Value

The consultant team recommends installing solar PV at the eight locations identified, and augment three of these locations with BES systems for operational flexibility, resilience and demand management. BES at these locations will time-shift excess generation during the day for use during the new evening peak period hours. The Corp Yard and Berkeley Marina, savings from the BES systems assume that all energy from the BES comes from excess on-site solar PV and has a value equal to the grid purchased energy it displaces at the time of use, including applicable demand charge assumption listed in Table 27. Inter-day arbitrage may be possible at the Center Street Garage using the Option S rate rider, however a deeper study into that rate incorporating the impact of the building profile is needed, and the probability of increased savings is uncertain.

Overall, solar PV and BES systems to support EV fleet charging has a total cost of $2,089,300 as shown in Table 32.

Table 32: Recommended Solar PV + BES Summary

Facility Name	Facility Location	Annual Savings	Solar PV Cost	BES Cost	Payback (years)
Corp Yard	1326 Allston Way	$13,390	$228,800	$195,000	31.7
Berkeley Transfer Station	1201 Second St	$4,295	$0	$0	n/a
Berkeley Marina	125/127 University Ave	$26,994	$332,100	$450,000	29.0
Adult Mental Health Clinic	1521 University Ave	$0	$0	$0	n/a
Mental Health Clinic	1890 Alcatraz Ave/ 3282 Adeline St	$0	$0	$0	n/a
Center Street Garage	2025 Center St	$19,449	$0	$375,000	19.3
Central Library Parking Lot	2031 Bancroft Way	$6,120	$75,200	$0	12.3
Public Safety Building	2100 MLK Jr Way	$4,269	$43,200	$0	10.1
Civic Center	2180 Milvia St	$0	$0	$0	n/a
Mental Health Clinic	2636/2640 MLK Jr Way	$22,445	$240,400	$0	10.7
S. Berkeley Senior Center	2939 Ellis St	$2,814	$31,200	$0	11.1
N. Berkeley Senior Center	1901 Hearst Ave	$11,043	$118,400	$0	10.7
Total		**$110,820**	**$1,069,300**	**$1,020,000**	**19.3**

Appendix D: Total Cost of Ownership

This report estimates the total cost of ownership (TCO) and greenhouse gas (GHG) emissions to the City from 2020 to 2030 under four electrification scenarios. Four scenarios form the basis of the TCO analysis presented in this report. All scenarios are modeled over an analysis period from 2020 to 2030 for the light-duty fleet.

- Scenario 1. Baseline: This scenario assumes that the City's future light-fleet purchases maintain their existing light-duty vehicle technology composition, replacing each vehicle with a similar new vehicle at the end of the current vehicle's useful life. Traditional internal combustion engine (ICE) vehicles powered by gasoline are replaced with new (ICE) vehicles, standard ICE hybrid vehicles powered by gasoline are replaced with new ICE hybrids, PHEVs are replaced with new PHEVs, etc. Under this scenario, no new DER options are deployed at any fleet location.
- Scenario 2. EV Transition: This scenario considers the transition of the light-duty fleet to both BEVs and PHEVs. Infrastructure costs for EV charging, or Electric Vehicle Service Equipment (EVSE), are included in this scenario, and electricity costs are based on costs of grid electricity supplied by EBCE.
- Scenario 3. EV Transition with Solar PV: Building on Scenario 2, this scenario includes the deployment of solar PV systems at City facilities where fleet vehicles are domiciled.[43] Under this scenario, demand costs for EV charging are largely eliminated because the solar PV is generating enough power to offset the vehicle energy need. (This assumes that all solar PV power is for the EVs and none for the building.)
- Scenario 4. EV Transition with Solar PV and BES: This scenario further extends Scenario 3 to include the deployment of BES systems at City facilities described in the Task 2.1 report.

[43] As described in the Distributed Energy Resources (DER) Suitability Analysis report.

TCO Methodology and Assumptions

Prior chapter reports are based on an analysis of the City's existing light-duty fleet on a vehicle-by-vehicle basis and projections of the aggregated electrical loads for each fleet facility, considering the specific vehicles domiciled at each facility. The TCO analysis continues this approach, calculating fleet costs on a vehicle-by-vehicle basis and infrastructure costs on a facility basis. Specific cost components included in the TCO analysis and the basis for their estimated values are discussed below.

Vehicle Costs

Vehicle costs have been developed from historical operational and cost data provided by the City for each vehicle in the fleet. Wherever possible, future replacements of existing vehicles are assumed to maintain the same activity level of the existing vehicle. In some cases, recently deployed vehicles do not have any significant historical operational data upon which to develop activity assumptions. For these vehicles, an average of operational data from similar vehicles domiciled at the same facility is used as the baseline activity data.

Capital and Operational Costs

A description of each cost assessed in the vehicle cost model and the basis for projecting future costs is described below.

Capital Costs (CapEx) – The purchase cost of the vehicle (inclusive of taxes), extended warranties, and additional keys are included. The baseline purchase cost is determined by vehicle type and technology. Costs are estimated using recent procurement prices and estimates reported by the City. For gasoline powered ICE vehicles, compressed natural gas (CNG) sedans and gasoline powered ICE SUVs, no recent purchase price data were available from the City as the City has not bought these vehicles in five years or more. Instead, estimates made are based on escalated prices from prior years. Prices for PHEVs and BEVs are consistent with pricing reported in the Fleet Assessment report. Future year prices are estimated using year-over-year percentage changes from the US Energy Information Administration (EIA) Annual Energy Outlook.[44] EIA does not project prices for traffic enforcement scooters. Instead, the year-over-year percentage changes for sedans are used as a surrogate for scooter pricing. This recognizes that the City may transition scooters to sedans or small wagons if suitable BEV versions of scooters do not become available before the current fleet of scooters is due for replacement. Prices for CNG SUVs, CNG scooters, HEV scooters, PHEV scooters, and BEV SUVs are not estimated as none of these vehicles are proposed for deployment.

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[44] US EIA, Annual Energy Outlook 2020, "Table 52. New Light-Duty Vehicle Prices". BEV projections based on "200-mile Electric Vehicle" category. PHEV projections based on "Plug-in 40 Gasoline Hybrid" category. SUV projections are based the "Small Crossover Car" subcategory and Sedans are based on the "Compact Cars" subcategory.

Table 33. 2020 Vehicle Purchase Price Assumptions

Technology	Sedan	Scooter	SUV
Gasoline ICE	$23,000	$46,622	$27,000
CNG	$23,000	N/A	N/A
Gasoline Hybrid ICE	$29,876	N/A	$33,387
PHEV	$28,147	N/A	$36,295
BEV	$34,256	$57,218	N/A

Operating Costs (OpEx) – This category refers primarily to maintenance and repair costs as other operational costs (fuel, insurance, and registration) are identified separately in this report. Maintenance cost data provided by the City does not show a strong dependence on vehicle technology type or annual mileage. This is not unexpected as most of the City's vehicles considered in this analysis have low daily mileages, meaning that maintenance costs are based primarily on calendar time rather than accumulated mileage. Because gasoline powered hybrids and PHEVs have internal combustion engines, preventative maintenance related to engine fluids is not eliminated in the way that such maintenance would be eliminated in a BEV. These results are consistent with other municipal fleets. For example, the City of New York reported reduced maintenance costs associated with their BEVs, whereas reported data showed that maintenance costs for gasoline powered ICE vehicles, including both hybrids and PHEVs, varied substantially with no clear trend in cost reductions for the hybrid platforms. Only BEVs showed clear maintenance cost reductions, albeit over less than a full life cycle thus far.[45] Maintenance reductions reported in the New York data for BEVs ranged from approximately 60% to 90% relative to traditional gasoline powered ICE vehicles. Alameda County cites maintenance cost reductions of 56% for BEVs relative to gasoline ICE vehicles.[46] Additionally, the City of Minneapolis cites a prior Electric Power Research Institute study estimating maintenance cost reductions of approximately 35% for light-duty BEVs.[47]

For the purposes of this analysis, it is assumed that gasoline hybrids and PHEVs have maintenance costs equivalent to traditional gasoline ICE vehicles and that BEVs provide a 56% maintenance cost reduction. Actual maintenance cost reductions may vary, based on factors such as topography, weather, driver behavior, and vehicle.

Fuel Costs – Fuel prices are escalated from current prices using EIA Annual Energy Outlook 2020 projections.48 The average cost of unleaded gasoline (inclusive of taxes) paid by the City in 2019 was $3.45/gallon. CNG pricing is estimated at $2.47/gasoline gallon equivalent (GGE) based on average West Coast CNG pricing.[49] Electricity pricing was estimated based on the facility where the vehicle is domiciled and varies depending on the implementation of DERs at facilities where fleet EVs are domiciled. Table 2 summarizes the estimated cost of electricity for each facility. Without DER infrastructure, costs for fleet charging are computed using the applicable utility rate at each location, as described in the DER

[45] New York City Department of Citywide Administrative Services, NYC Fleet Newsletter, March 8, 2019. Issue 255.
[46] Bay Area Climate Collaborative – Ready, Set, Charge Fleets, May 2015.
[47] City of Minneapolis, Electric Vehicle Study, October 2017
[48] US EIA, Annual Energy Outlook 2020, "Table 3. Energy Prices by Sector and Source - Pacific Region".
[49] US Department of Energy - Alternative Fuels Data Center, Alternative Fuel Price Report, Table 5, January 2020.

Suitability Analysis report. Where DER solutions are implemented, electricity costs are effectively zero because onsite solar PV systems will generate enough power to fully offset fleet energy costs. Additionally, incremental demand charges are not incurred beyond the current site loads due to the use of charging management systems. Note that where BES systems are deployed as recommended the systems provide additional confidence that demand charges can be avoided if charging management systems are unable to consistently avoid incremental demand during peak pricing periods. However, under the assumption that charging management is successfully implemented and avoids incremental demand charges the cost of electricity is the same for sites deploying solar PV only or solar

Table 34. Estimated EV Charging Cost by Facility

Facility Name	Location	Cost of EV Charging ($/year)	Average Cost of Fleet Electricity ($/kWh)
Corporation Yard	1326 Allston Way	$6,272	$0.152
Berkeley Transfer Station	1201 Second Street	$2,906	$0.160
Berkeley Marina	125/127 University Avenue	$26,994	$0.247
Adult Mental Health Clinic	1521 University Avenue	$14,098	$0.246
Mental Health Clinic	1890 Alcatraz Avenue/3282 Adeline Street	$2,993	$0.246
Center Street Garage	2025 Center Street	$19,449	$0.215
Central Library Parking Lot	2031 Bancroft Way	$200	$0.162
Public Safety Building	2100 Martin Luther King Jr. Way	$690	$0.114
Civic Center	2180 Milvia Street	$396	$0.151
Mental Health Clinic	2636 Martin Luther King Jr. Way	$3,516	$0.148
South Berkeley Senior Center	2939 Ellis Street	$627	$0.235
North Berkeley Senior Center	1901 Hearst Avenue	$655	$0.152
N/A	Take Home		$0.240

Fuel economy also impacts total fuel cost. To capture these impacts, EIA projections of fuel economy improvements for light-duty vehicles are applied to the baseline fuel economy of the current fleet vehicle.[50] When the vehicle is replaced, the fuel economy improvement for the replacement vehicle is calculated relative to the baseline vehicle and adjusted to account for any differences in technology.

Insurance Costs – The City participates in an Excess Liability insurance pool rather than purchasing specific automobile insurance coverage. Consequently, it is difficult to assess the effective cost of insurance on a vehicle-by-vehicle basis. As a conservative estimate, it is assumed that annual insurance costs are 1% of the vehicle purchase price.[51]

[50] US EIA, Annual Energy Outlook 2020, "Table 40. Light-Duty Vehicle Miles per Gallon by Technology Type - Pacific Region"

[51] Per City guidance.

Registration Costs – Vehicle registration fees are calculated based on California Department of Motor Vehicle (DMV) guidelines. A portion of vehicle registration fees is based on the DMV's estimate of the current market value of the vehicle. Table 35 summarizes the variable fee schedule based on the age of the vehicle. The calculated cost of the variable portion of the registration fee is the percentage of the purchase price for the age of the vehicle in the registration year. A fixed portion of the fee also applies and is currently $112 for BEVs and $132 for all other light-duty vehicles.

Table 35. California DMV Vehicle Registration Fee Schedule for Variable Portion of Fee (% of original purchase price)

Age (years)	0	1	2	3	4	5	6	7	8	9	10	11	12
Fee	0.65%	0.59%	0.52%	0.46%	0.39%	0.33%	0.26%	0.20%	0.16%	0.13%	0.10%	0.10%	0.10%

Residual Value – The residual value of the vehicle is calculated using straight-line depreciation over five years for all traditional gasoline and CNG ICE vehicles. Depreciation is calculated over seven years for gasoline powered hybrids, PHEVs, and BEVs per City guidance.

Revenue Opportunities

While fleets typically only present costs to the City, PHEVs and BEVs can generate revenue credits earned through the California Low Carbon Fuel Standard (LCFS) program. These revenue sources partially offset the costs of deploying EVs and are calculated in the TCO model.

Purchase incentives are also assumed to be available to the City through 2023 via the Clean Vehicle Rebate Program (CVRP) at a rate of $1,000 per PHEV and $2,000 per BEV. CVRP incentives are calculated in the TCO model as well.

LCFS Credits - The California LCFS program allows fleets to generate credits for the use of low carbon fuels like electricity in transportation applications. One credit is equal to one metric ton of GHG reductions. The number of credits generated by a vehicle depends on the carbon intensity of the electricity supplied, calendar year, and activity of the vehicle. Credit price dependency on calendar year stems from the declining carbon intensity "benchmark" established in the LCFS program. Credit generation is calculated based on the difference between this benchmark and the carbon intensity of the transportation fuel used. Consequently, the number of credits generated per kWh declines approximately ten percent as the benchmark value declines by ten percent between 2020 and 2030. All City fleet facilities currently receive 100% zero-carbon electricity from EBCE. The only leased facility where fleet vehicles are domiciled, the Adult Mental Health Clinic at 1521 University Avenue, is also an EBCE customer.

LCFS credit prices vary and are determined by market demand. The average credit price in 2019 was $196.[52] While there is substantial variation in the market price for LCFS credits, credit prices have trended up over the last several years and now sit near the effective price cap of $219. This price cap is adjusted each year based on the consumer price index using a base price of $200 in 2016. For purposes of this analysis, it is assumed that the LCFS credit price will continue to be near the price cap through

[52] California Air Resources Board, Credit Activity Reports.

2030. Hence, the 2019 average price of $196 is escalated in future years at the average consumer price index increase of 2.2% per year observed between 2016 and 2019.

Infrastructure Costs

Infrastructure costs were developed in the Electrical Needs and Charging Infrastructure and DER Suitability reports. The underlying assumptions and bases for these costs are detailed in the associated reports.

Charging and Associated Infrastructure

EVSE costs include the chargers themselves and the associated facility electrical infrastructure upgrades required to serve the chargers. The cost of BES systems to serve as backup generators in time of grid outages is also included, but detailed separately, as summarized in Table 36. Residual values for both the EVSE and BES systems are calculated based on a 10-year useful life and a construction year of 2021. Residual values use straight line depreciation over the useful life of the equipment. Annual maintenance costs include network services and maintenance by an EVSE service provider. Costs are estimated at $1,100 per dual-head Level 2 charger and are based on current City contracts for existing EVSE at Center Street Garage, though it should be noted that the City is not bound to contracting with this EVSE provider for future EVSE deployment, and maintenance and service costs vary significantly depending on the provider.[53] A single DC fast charger is proposed to be deployed at the Corporation Yard. Maintenance and network costs for DCFCs can vary widely based on site conditions and other factors such as required service response times. Typical maintenance contracts can range from $2,500 to $15,000 per charger per year. Additionally, service providers may use complex pricing models that include per-site costs in addition to per-charger costs. For the purposes of this analysis, the maintenance costs for the DCFC are estimated at $2,500 per charger per year, consistent with a standard maintenance contract that does not include rapid service response times or other special features.

Table 36. EVSE and Related Infrastructure Costs by Facility

Facility Name	Location	Existing EVSE	New EVSE (dual-head L2)	CapEx - EVSE	CapEx- Genset[54]	Residual Value - EVSE	Residual Value - Genset	Annual Maint. Cost
Corporation Yard	1326 Allston Way	0	5[55]	$354,000	$487,000	$35,400	$48,700	$6,900
Berkeley Transfer Station	1201 Second Street	0	2	$87,000	$34,000	$8,700	$3,400	$2,200
Berkeley Marina	125/127 University Avenue 201 University Avenue	0	4	$290,000	$204,000	$29,000	$20,400	$4,400

[53] Based on Contract 9893B Amendment (Dec 2018) for EVSP services. Average of Y3-Y5 maintenance/network costs. Y1-Y2 include installation costs for new chargers and were therefore excluded.
[54] Genset refers to a backup generator used to provide power during grid outages.
[55] 4 Level 2 dual-head chargers and 1 DCFC.

Facility Name	Location	Existing EVSE	New EVSE (dual-head L2)	CapEx - EVSE	CapEx-Genset[54]	Residual Value - EVSE	Residual Value - Genset	Annual Maint. Cost
	841 Folger Avenue							
Adult Mental Health Clinic	1521 University Avenue	0	3	$135,000	$0	$13,500	$0	$3,300
Mental Health Clinic	1890 Alcatraz Avenue 3282 Adeline Street	0	1	$147,000	$34,000	$14,700	$3,400	$1,100
Center Street Garage	2025 Center Street	29	0	$0	$0	$0	$0	$0
Central Library Parking Lot	2031 Bancroft Way	0	1	$149,000	$34,000	$14,900	$3,400	$1,100
Public Safety Building	2100 Martin Luther King Jr. Way	0	1	$42,000	$0	$4,200	$0	$1,100
Civic Center	2180 Milvia Street	0	1	$65,000	$0	$6,500	$0	$1,100
Mental Health Clinic	2636 Martin Luther King Jr. Way	1	0	$0	$0	$0	$0	$0
South Berkeley Senior Center	2939 Ellis Street	0	1	$82,000	$34,000	$8,200	$3,400	$1,100
North Berkeley Senior Center	1901 Hearst Avenue	1	0	$0	$0	$0	$0	$0
Take Home		0	3	$0	$0	$0	$0	$0

Solar Photovoltaic Systems

Solar PV system costs are summarized in Table 5. Residual values for solar PV systems are based on the listed construction year. For all locations except Berkeley Transfer Station, the assumed construction year is 2021. Because the Berkeley Transfer Station is currently planned for redevelopment with construction slated for 2026, the construction year for the solar PV system at this facility is also assumed to be 2026. Residual values use straight-line depreciation over the useful life of the equipment, which is assumed to be 20 years.

Table 37. Solar Photovoltaic System Costs by Facility

Facility Name	Location	Construction Year	CapEx	Residual Value
Corporation Yard	1326 Allston Way	2021	$228,800	$125,840
Berkeley Marina	125/127 University Avenue 201 University Avenue 841 Folger Avenue	2021	$332,100	$182,655

Facility Name	Location	Construction Year	CapEx	Residual Value
Adult Mental Health Clinic	1521 University Avenue	2021	$0	$0
Mental Health Clinic	1890 Alcatraz Avenue 3282 Adeline Street	2021	$0	$0
Center Street Garage	2025 Center Street	2021	$0	$0
Central Library Parking Lot	2031 Bancroft Way	2021	$75,200	$41,360
Public Safety Building	2100 Martin Luther King Jr. Way	2021	$43,200	$23,760
Civic Center	2180 Milvia Street	2021	$0	$0
Mental Health Clinic	2636 Martin Luther King Jr. Way	2021	$240,400	$132,220
South Berkeley Senior Center	2939 Ellis Street	2021	$31,200	$17,160
North Berkeley Senior Center	1901 Hearst Avenue	2021	$118,400	$65,120

Battery Energy Storage Systems

BES system costs are summarized in Table 38. Residual values for BES are based on the listed construction year. For all locations the assumed construction year is 2021. The first generation of BES deployments are assumed to have a five-year useful life, with replacement required five years after the initial construction year.[56] Second generation deployments are assumed to have a ten-year useful life as battery technology improves. Residual values use straight line depreciation over the useful life of the equipment, which is assumed to be five or ten years, as described above.

Table 38. Battery Energy Storage System Costs by Facility

Facility Name	Location	Construction Year	First Replacement	CapEx	First Replacement Cost	Residual Value
Corporation Yard	1326 Allston Way	2021	2026	$195,000	$195,000	$117,000
Berkeley Transfer Station	1201 Second Street	2026	2031	$0	$0	$0
Berkeley Marina	125/127 University Avenue 201 University Avenue 841 Folger Avenue	2021	2026	$450,000	$450,000	$270,000
Adult Mental Health Clinic	1521 University Avenue	2021	2026	$0	$0	$0
Mental Health Clinic	1890 Alcatraz Avenue	2021	2026	$0	$0	$0

[56] Studies indicate 5-to-7-year useful life for current lithium battery technologies at 50% or greater depth of discharge. Casals et al, "Second life batteries lifespan: Rest of useful life and environmental analysis", Journal of Environmental Analysis, Vol 232, February 2019, pgs 354-363. Smith et al, "Life Prediction Model for Grid-Connected Li-ion Battery Energy Storage System" National Renewable Energy Laboratory, presented at 2017 American Control Conference, Seattle, WA, May 24-26, 2017.

Facility Name	Location	Construction Year	First Replacement	CapEx	First Replacement Cost	Residual Value
	3282 Adeline Street					
Center Street Garage	2025 Center Street	2021	2026	$375,000	$375,000	$225,000
Central Library Parking Lot	2031 Bancroft Way	2021	2026	$0	$0	$0
Public Safety Building	2100 Martin Luther King Jr. Way	2021	2026	$0	$0	$0
Civic Center	2180 Milvia St	2021	2026	$0	$0	$0
Mental Health Clinic	2636 Martin Luther King Jr. Way	2021	2026	$0	$0	$0
South Berkeley Senior Center	2939 Ellis Street	2021	2026	$0	$0	$0
North Berkeley Senior Center	1901 Hearst Avenue	2021	2026	$0	$0	$0
Take Home		2021	N/A	$0	$0	$0

TCO Model Results

The TCO model estimates the cost of the Scenario 1 (Baseline), or business as usual, at $8.34 million over the 2020-2030 analysis period, as shown in Figure 12. Scenario 2 (EV Transition) cost is estimated at $9.76 million over the same analysis period. The incremental cost of the charging infrastructure (including backup generation) are the primary contributors to the increased cost in this scenario. These costs are partially offset by lower vehicle maintenance costs, incentives, and LCFS program revenues. Additional details are provided in the figures and table below. Scenario 3 adds solar PV systems to Scenario 2 and increases cost by $170,000. This is due to the offset of most of the additional infrastructure expense through reduced grid electricity costs. Scenario 4 adds BES, resulting in a total cost that is approximately $3.0 million greater than Scenario 1 (Baseline). This increased cost is the byproduct of the assumption made in prior reports that smart charging (e.g., load management) can effectively avoid electricity demand charges and that the grid acts as energy storage. Under those assumptions BES systems do not provide additional operational cost reductions to offset the incremental costs of BES deployment. However, there may be additional value not quantified in this analysis to the BES systems based on their ability to provide a degree of resiliency to the City's fleet to ensure continuity of service to the community in time of grid outage.

Figure 12. Total Value Summary by Scenario

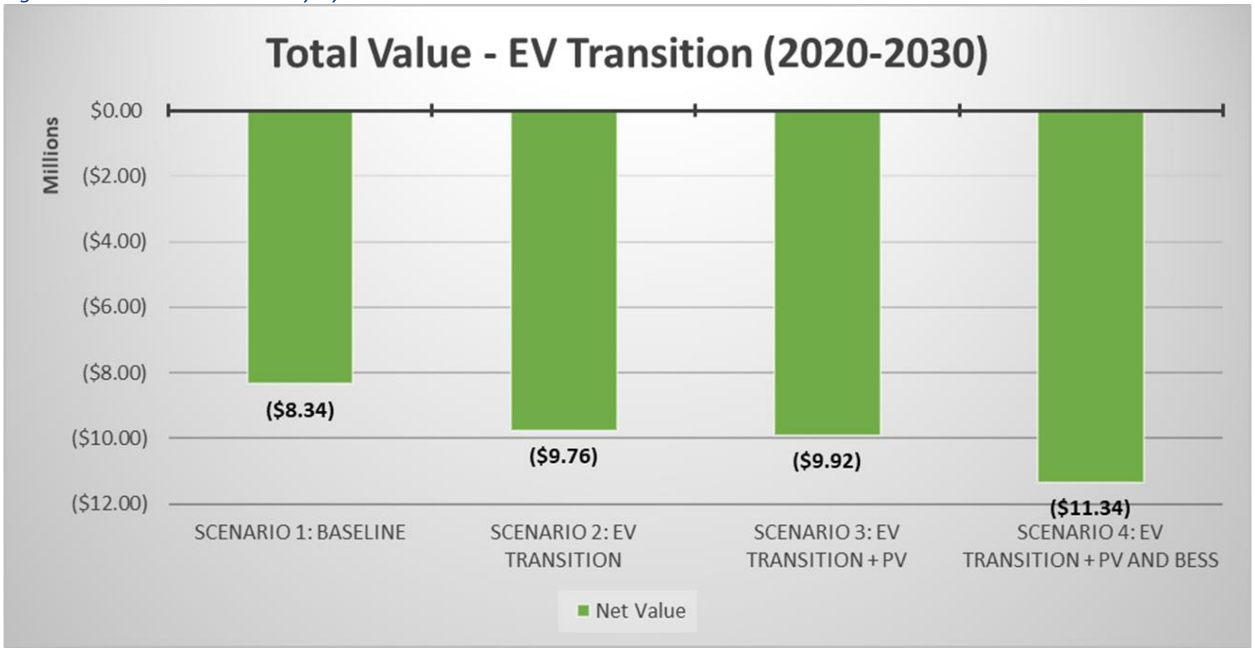


Figure 13 breaks down the major cost components for each scenario. Scenario 1 has the least expenditures, revenue, and residual values. Both Scenario 2 and Scenario 3 have higher upfront expenditures associated with the cost of infrastructure. However, the higher infrastructure costs provide greater residual value, particularly for the solar PV systems that are assumed to have a 20-year useful life. Table 39 further breaks down costs into infrastructure and vehicle categories and the capital and operational cost categories described previously in this report.

Figure 13. Total Value Detail by Scenario

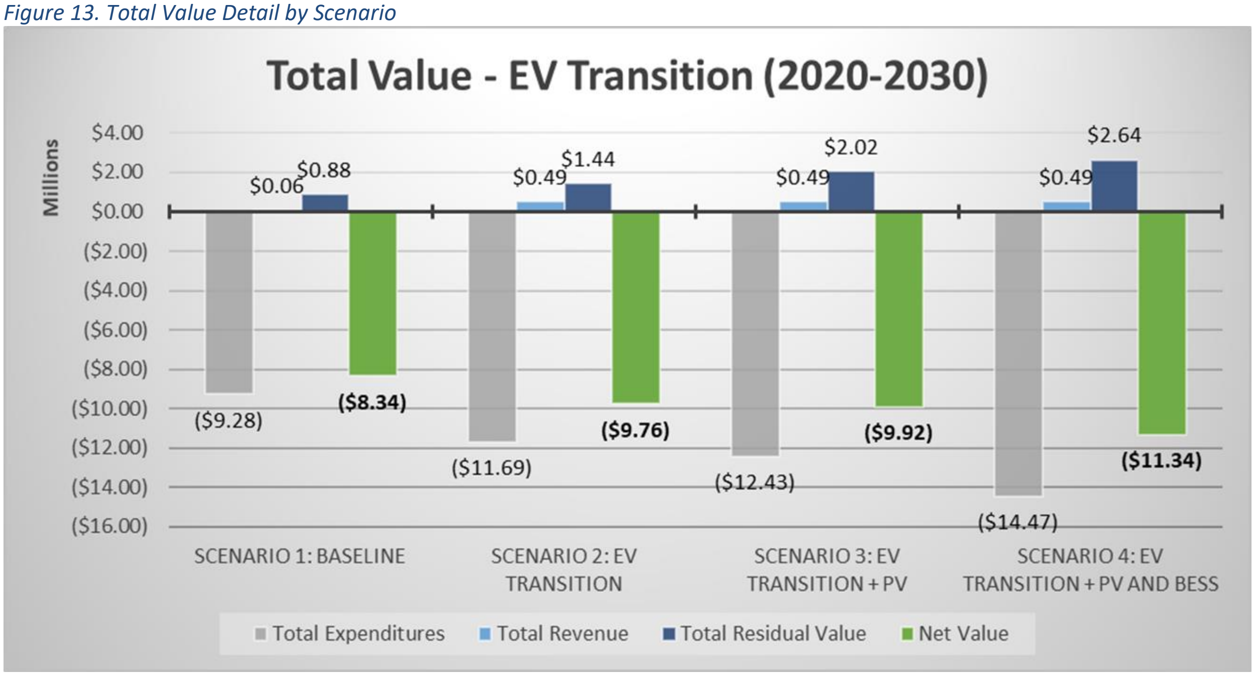


Table 39. TCO Cost Detail

	Scenario	Scenario 1 Baseline	Scenario 2 EV Transition	Scenario 3 EV Transition + Solar PV	Scenario 4 EV Transition + Solar PV + BES
Infrastructure	EVSE CapEx	$0	($1,351,000)	($1,351,000)	($1,351,000)
	EVSE Maintenance	$0	($200,700)	($200,700)	($200,700)
	EVSE Residual	$0	$135,100	$135,100	$135,100
	GenSet CapEx	$0	($827,000)	($827,000)	($827,000)
	GenSet Residual	$0	$82,700	$82,700	$82,700
	Solar PV CapEx	$0	$0	($1,069,300)	($1,069,300)
	Solar PV Residual	$0	$0	$588,115	$588,115
	BES CapEx	$0	$0	$0	($1,020,000)
	BES First Replacement	$0	$0	$0	($1,020,000)
	BES Residual	$0	$0	$0	$612,000
	Infrastructure Subtotal	$0	($2,160,900)	($2,642,085)	($4,070,085)
Vehicles	CapEx	($4,403,279)	($4,737,081)	($4,737,081)	($4,737,081)
	OpEx	($3,278,010)	($2,902,697)	($2,902,697)	($2,902,697)
	Fuel Costs	($653,735)	($665,212)	($337,809)	($337,809)
	Insurance	($478,279)	($532,245)	($532,245)	($532,245)
	Registration	($466,180)	($474,370)	($474,370)	($474,370)
	Specialized Equipment	$0	$0	$0	$0
	Residual Value	$875,159	$1,217,642	$1,217,642	$1,217,642
	Incentives	$0	$104,000	$104,000	$104,000
	LCFS Credits	$59,692	$388,924	$388,924	$388,924
	Vehicles Subtotal	($8,344,632)	($7,601,039)	($7,273,635)	($7,273,635)
	Total	**($8,344,632)**	**($9,761,939)**	**($9,915,720)**	**($11,343,720)**

Greenhouse Gas Emission Projections

GHG emissions and energy consumption metrics for the light-duty fleet are calculated based on projected fuel/electricity use under Scenario 1 and 2 described for the TCO modeling. Metrics are shown for the cumulative 2020-2030 analysis period, as well as the 2030 calendar year. As with the TCO model, activity and emissions are calculated on a vehicle-by-vehicle basis for each calendar year.

GHG Emission Factors

GHG emissions reflect well-to-wheels emissions (emissions associated with the full lifecycle of the fuel including extraction, processing, production, transport, and end use in a vehicle) using emissions factors from the California Air Resources Board's LCFS program. The assumed emission factors are summarized in Table 40. CNG and gasoline values use current LCFS program "lookup table" values for these fuels.[57] Their values are not assumed to decline over the analysis period. Electricity supplied from the grid uses the California grid average carbon intensity for 2020, but declines each year based on California Energy Commission projections.[58] Electricity supplied by onsite solar PV systems and/or through EBCE's Brilliant

[57] https://ww2.arb.ca.gov/resources/documents/lcfs-pathway-certified-carbon-intensities

[58] California Energy Commission, Integrated Energy Policy Report, 2018. Appendix B. Uses emissions reductions based on SB350 through 2029. Future years assume a straight-line decrease from the 2029 value to zero by 2045.

100 electricity service are assumed to have a zero-carbon intensity. Note that all City-owned fleet facilities are served by EBCE. In turn, all City-owned facilities use zero-carbon intensity electricity under Scenario 2, independent of the deployment of additional solar PV and/or BES systems. Additionally, while 1521 University Avenue is a leased facility, it's also an EBCE Brilliant 100 customer. Table 41 summarizes the assumed fraction of electricity supplied as zero-carbon electricity at each facility. Only electricity supplied to take-home vehicles that are charged at staff residences are assumed to use grid-average electricity.

Table 40. Carbon Intensity Factors (gCO2e/MJ)

Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
CNG	79.21	79.21	79.21	79.21	79.21	79.21	79.21	79.21	79.21	79.21	79.21
Gasoline	99.44	99.44	99.44	99.44	99.44	99.44	99.44	99.44	99.44	99.44	99.44
EV (Grid)	82.92	81.63	78.67	74.19	66.88	59.95	55.91	51.28	46.23	40.96	34.02
EV (Zero Carbon)	0	0	0	0	0	0	0	0	0	0	0

Table 41. Assumed Fraction of Electricity for EV Charging Supplied from Zero-carbon Electricity Sources by Facility

Facility Name	Location	% Zero-CI Electricity
Corporation Yard	1326 Allston Way	100%
Berkeley Transfer Station	1201 Second Street	100%
Berkeley Marina	125/127 University Avenue	100%
	201 University Avenue	100%
	841 Folger Avenue	100%
Adult Mental Health Clinic	1521 University Avenue	100%
Mental Health Clinic	1890 Alcatraz Avenue	100%
	3282 Adeline Street	100%
Center Street Garage	2025 Center Street	100%
Central Library Parking Lot	2031 Bancroft Way	100%
Public Safety Building	2100 Martin Luther King Jr. Way	100%
Civic Center	2180 Milvia Street	100%
Mental Health Clinic	2636 Martin Luther King Jr. Way	100%
South Berkeley Senior Center	2939 Ellis Street	100%
North Berkeley Senior Center	1901 Hearst Avenue	100%

Emissions Model Results

Emissions from each vehicle, as detailed in Appendix A, are aggregated to estimate annual GHG emissions for the light-duty fleet considered for EV transition. As shown in Figure 14, emissions under Scenario 1 (Baseline) decline from 56.6 to 43.6 MT CO2e/year by 2030. The 23% decrease in emissions largely comes from increasing fuel efficiency of gasoline and hybrid ICE vehicles. Under Scenario 2 (EV transition), emissions decline from 56.6 to 2.1 MT CO2e/year, **or 95% by 2030**. The significant reduction in annual emissions between 2025 and 2026 are associated with a substantial number of vehicles slated for replacement in 2026 that would transition from gasoline or gasoline hybrid ICE vehicles to BEVs. This includes the parking enforcement scooters.

Figure 14: Annual GHG Emissions Projections for the City's Light-duty Fleet

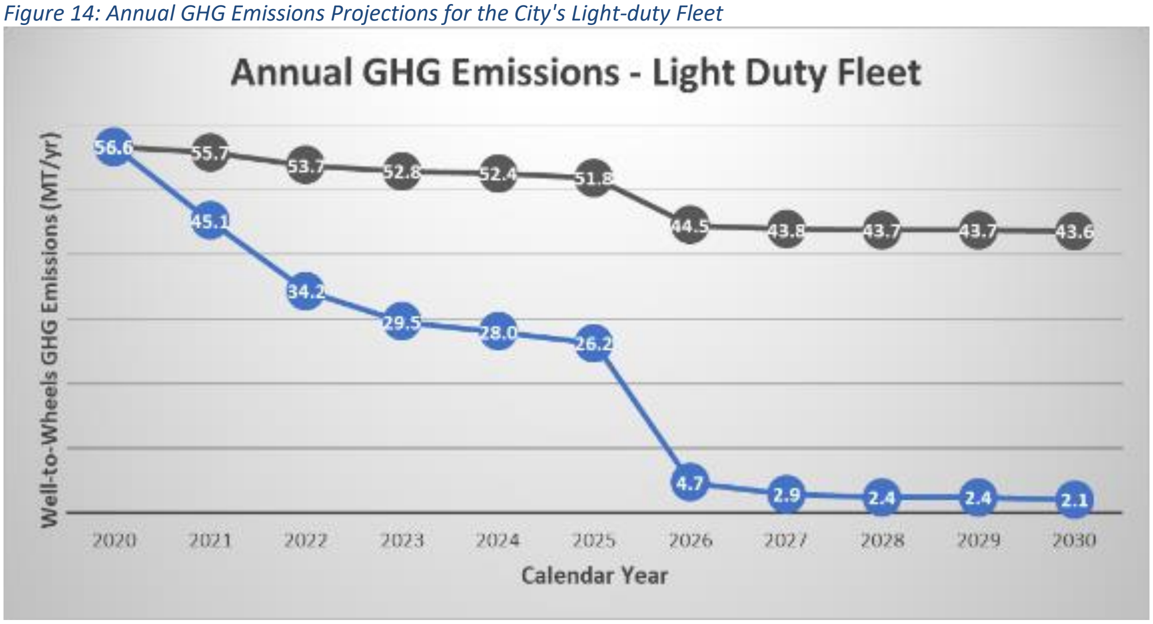


Table 42 and Table 43 summarize mileage, energy consumption, and fleet average emissions for each scenario and the estimated percentage change from Scenario 1 (Baseline) to Scenario 2 (EV Transition). Under Scenario 2 (EV Transition), gasoline and CNG ICE vehicle mileage would decrease by 59% relative to Scenario 1 (Baseline) as it transitions to EV mileage over the 2020-2030 analysis period. In 2030, the annual gasoline and CNG ICE vehicle mileage would be reduced 96% relative to Scenario 1 (Baseline) as most of the miles travelled by these vehicles transition to EV.

Fleet average fuel economy, in miles per gasoline-gallon equivalent (MPGe), increases 38% over the 2020-2030 period and increases by 79% in 2030 relative to the Scenario 1 (Baseline). The few remaining GHG emissions are associated with seven PHEV SUVs that have a portion of their daily mileage powered by gasoline. By 2030, it is likely that SUV BEVs that meet the City's duty cycles will be available, effectively allowing the City to achieve a 100% reduction in the GHG emissions for the light-duty fleet considered in this analysis.

Table 42. Emissions and Energy Consumption Metrics for the City Fleet from 2020 to 2030

Metric	2020-2030		
	Baseline	EV Transition	% Change
Gasoline/CNG ICE Mileage	4,155,346	1,696,465	-59%
EV Mileage	518,992	2,977,873	474%
Gasoline/CNG Consumption (GGE)	160,362	68,529	-57%
Electricity Consumption (GGE)	8,128	53,439	557%
Fleet Avg MPGe	27.7	38.3	38%
Fleet GHG Emissions (MTCO2e)	542.2	234.1	-57%
Fleet GHG Emissions Rate (gCO2e/mi)	116.0	50.1	-57%

Table 43. Emissions and Energy Consumption Metrics for the City Fleet in 2030

Metric	2030		
	Baseline	EV Transition	% Change
Gasoline/CNG ICE Mileage	374,407	22,713	-94%
EV Mileage	50,533	402,227	696%
Gasoline/CNG Consumption (GGE)	12,888	573	-96%
Electricity Consumption (GGE)	676	7,017	939%
Fleet Avg MPGe	31.3	56.0	79%
Fleet GHG Emissions (MTCO2e)	43.6	2.1	-95%
Fleet GHG Emissions Rate (gCO2e/mi)	102.5	4.9	-95%

Appendix E: Recommendations by Domicile: Charging, Solar PV, BES for Light-Duty Fleet EVs

Site #1 Corp Yard

Recommended: Charging stations, solar PV, BES, electrical upgrades

Additional: Structural upgrade to canopy to support solar PV

Site Description

The Corporation Yard (Corp Yard) at 1326 Allston Way is the City of Berkeley's largest fleet parking facility in terms of number of vehicles domiciled. A total of 137 vehicles including light-, medium-, and heavy-duty vehicles are based here, including most of the City's specialty vehicles like sweepers, vactors, and mowers. The facility has a gasoline and diesel fueling station and maintenance garage for all fleet vehicle Figure 15 details the different areas of operations within the Corp Yard. Because the focus of this project is to provide charging for the exclusive use of City-owned fleet vehicles, charging station recommendations exclude the employee/visitor parking lot.

Figure 15: Corp Yard Maintenance Building facility details

The main electrical distribution panel is located on the northwest corner of the yard and the sub-panel is located on the north side of the repair workshop. City staff explained that the sub-panel for the repair shop will be upgraded and will accommodate the load for planned EV chargers.

The Corp Yard site has several constraints for DER (chargers, solar PV, BES) design:

- Temporary/portable buildings not suitable for solar PV due to structural concerns.
- Main Barn is a historic structure and not suitable for solar PV due to structural strength of rafters.

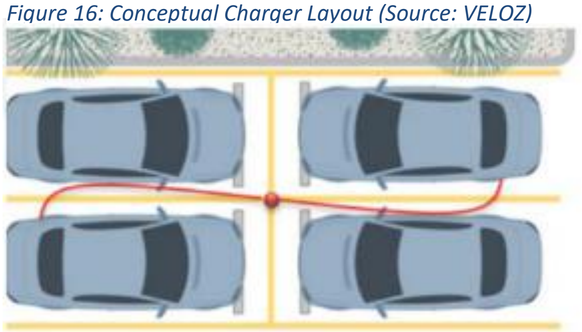
- The parking stalls in the Corp Yard are limited in relation to the number of vehicles domiciled or serviced at this site.
- The vehicle maintenance facility is in the middle of the site, potentially impacting charging infrastructure installation costs.
- Designs for charging, solar PV, and BES need to consider the amount of space that trucks require when navigating the parking lot.
- City staff prefer all conduit to be underground.

Recommendations

The Corp Yard will need multiple types of chargers and charging strategies. To meet the immediate need of replacing all light-duty vehicles with EVs:

- Four dual-head (eight connectors) pedestal-mounted, low-power (7.2 kW) Level 2 chargers in a central location between Buildings A and G, installing the chargers in the center of a block of parking spots as illustrated in Figure 16.
- One DC Fast Charger to accommodate the charging needs for the vehicles that come in for repair and provide flexibility for a broader range of EVs that will be serviced in the future.
- New electrical service will be required to support this charging equipment. The total demand on each circuit is 3,328 V using a 40A breaker that outputs 6,656 VA per charger using a 40A 2-pole breaker. There is also 50 VA added for gateway. The total Level 2 charger load is: 6,656*8 +50 = 53.3 kVA which requires 148A (200 A) of ampacity. DCFCs need 63.5 kVA which requires 156A (200 A breaker). The total DCFC load is 116.8 kVA, which requires 141A. The main breaker should be 300A. A step-down transformer rated 75kVA (480-208/120) will be required for the Level 2 chargers.

Figure 16: Conceptual Charger Layout (Source: VELOZ)



- The Corp Yard is suitable for up seven rooftop solar PV arrays and two parking lot arrays, which would produce 358 kWh/day, which exceeds the estimated energy demand to charge light-duty vehicles. Extra capacity could be available to serve the charging needs of medium- and heavy-duty equipment as they are added to the fleet.
- A 112 kWh BES to provide resiliency for fleet charging and help avoid demand charges.

Figure 17 shows potential locations for solar arrays. The suggested combinations to meet fleet EV needs are Arrays D + E + Yard Parking totaling 52.7 kW. Array D will replace the existing 19 kW system that is approximately 15 years old, which will improve the generation potential of this location.[59]

Array E is the canopy of the existing gasoline and diesel fuel island and a new canopy will need to be constructed to support the weight of the PV array. Cost estimates do not include the fuel island canopy construction, or structural components. Constructing this canopy may present an opportunity to add DC Fast Charging or a charger dedicated to medium- and heavy-duty vehicles to the fueling island.

Figure 17: Potential locations for Solar PV Arrays

Solar PV Siting and Generation Potential - Corp Yard

Solar PV Array Location	Gross Area Identified (SF)	Solar PV Array Area (SF)	Number of PV Modules (-)	DC Power (kW)	Peak AC Output (kW)	Total Generation (kWh)
A	2,252	804	45	13.5	11.2	18,564
B	1,512	465	26	7.8	6.5	8,753
C	2,631	858	48	14.3	11.9	19,727

[59] This replacement scope of work proposed to the City in January 2020 by Sun Light & Power.

East Bay Community Energy Fleet Electrification

Solar PV Array Location	Gross Area Identified (SF)	Solar PV Array Area (SF)	Number of PV Modules (-)	DC Power (kW)	Peak AC Output (kW)	Total Generation (kWh)
D	3,360	1,519	85	30.6	25.4	41,399
E	2,400	965	54	16.1	13.4	21,782
Public Parking	6,480	1,430	80	23.9	19.1	32,334
Yard Parking	1,620	358	20	6.0	5.0	8,117
Total	**20,276**	**5,809**	**325**	**97.2**	**77.8**	**130,768**

Recommended Solar PV Arrays to Meet EV Charging Needs - Corp Yard

Solar PV Array Location	Gross Area Identified (SF)	Solar PV Array Area (SF)	Number of Solar PV Modules (-)	DC Power (kW)	Peak AC Output (kW)	Total Generation (kWh)
D	3,360	1,519	85	30.6	25.4	41,399
E	2,400	965	54	16.1	13.4	21,782
Yard Parking	1,620	358	20	6.0	5.0	8,117
Total	**7,380**	**2,842**	**159**	**52.7**	**43.8**	**71,298**

Value of Solar PV to Battery Energy Storage for EV Charging: B-10SX- Brilliant 100 Rate - Corp Yard

Month	Peak Solar PV Power Generated (kW)	Total Solar PV Generation (kWh)	Value of Demand ($)	Value of Energy ($)	Total Value ($)	Average Value of Solar PV Energy ($/kWh)
1	14.3	1,648	$192	$252	$444	$0.27
2	17.5	2,043	$235	$307	$543	$0.27
3	20.5	3,375	$276	$414	$690	$0.20
4	22.3	4,304	$299	$527	$826	$0.19
5	23.7	5,050	$318	$606	$924	$0.18
6	23.8	5,392	$320	$1,029	$1,348	$0.25
7	23.3	5,062	$313	$967	$1,280	$0.25
8	22.1	4,453	$296	$848	$1,144	$0.26
9	20.5	3,686	$275	$686	$961	$0.26
10	18.2	2,819	$244	$429	$673	$0.24
11	14.9	1,856	$200	$287	$487	$0.26
12	12.5	1,461	$167	$227	$394	$0.27
Total		**41,149**			**$9,715**	**$0.24**

Value of Solar PV to Building: B-10SX- Brilliant 100 Rate - Corp Yard

Month	Peak Solar PV Power Generated (kW)	Total Solar PV Generation (kWh)	Demand Costs Avoided ($)	Energy Costs Avoided ($)	Total Costs Avoided ($)	Average Value of Solar PV Energy ($/kWh)
1	10.5	1,207	$141	$185	$326	$0.27
2	12.8	1,497	$172	$225	$398	$0.27
3	15.1	2,473	$202	$304	$505	$0.20
4	16.3	3,154	$219	$386	$605	$0.19
5	17.4	3,700	$233	$444	$677	$0.18
6	17.5	3,950	$234	$754	$988	$0.25
7	17.1	3,709	$229	$708	$938	$0.25
8	16.2	3,263	$217	$622	$838	$0.26
9	15.0	2,701	$201	$503	$704	$0.26
10	13.3	2,065	$179	$314	$493	$0.24
11	10.9	1,360	$146	$211	$357	$0.26
12	9.1	1,070	$123	$166	$289	$0.27
Total		**30,149**			**$7,118**	**$0.24**

Cost of EV Charging: B-10SX- Brilliant 100 Rate - Corp Yard

Month	EV Charing Demand Impact (kW)	EV Charging Load (kWh)	EV Charging Demand Costs ($)	EV Charging Energy Costs ($)	Total EV Charging Costs ($)	Average Cost of EV Energy ($/kWh)
1	13.9	3,495	$0	$464	$464	$0.13
2	13.9	3,157	$0	$419	$419	$0.13
3	13.9	3,495	$0	$464	$464	$0.13
4	13.9	3,382	$0	$449	$449	$0.13
5	13.9	3,495	$0	$464	$464	$0.13
6	13.9	3,382	$0	$648	$648	$0.19
7	13.9	3,495	$0	$670	$670	$0.19
8	13.9	3,495	$0	$670	$670	$0.19
9	13.9	3,382	$0	$648	$648	$0.19
10	13.9	3,495	$0	$464	$464	$0.13
11	13.9	3,382	$0	$449	$449	$0.13
12	13.9	3,495	$0	$464	$464	$0.13
Total		**41,149**			**$6,272**	**$0.15**

Site #2 Berkeley Transfer Station

Recommended: Charging stations for light-duty fleet; solar PV during 2026 rehabilitation
Additional: Charging for BEV refuse trucks when those trucks are viable for City needs

Site Description

The Berkeley Transfer Station is at 1201 Second St., shown in Figure 18 is being redeveloped with construction is expected to start mid-2026. The Solid Waste & Recycling Transfer Station Feasibility Study concepts[60] for facility replacement included infrastructure to support the electrification of the Zero Waste collection fleet as that technology becomes viable.

In the nearer term, five light-duty vehicles domicile at the Berkley Transfer Station. A sub-panel rated at 100A will be available to EV chargers once the existing trailer on the facility is removed, however 60A of the capacity is reserved for an electric forklift.

Figure 18: Berkeley Transfer Station Facility Details

[60] presented at a November 2019 City Council Work Session

Recommendations

To meet the immediate need of transitioning light-duty vehicles to EVs and consideration that the site will be redeveloped:

- Two dual-head (two connectors) wall- or pedestal-mounted, low-power (7.2 kW) Level 2 chargers
- A third-party load management system to share the 40A of electrical capacity among the four connectors.
- Solar PV during rehabilitation in 2026.

Table 33. Cost of EV Charging on B-10SX-Brilliant 100 Rate - Berkeley Transfer Station

Month	EV Charing Demand Impact (kW)	EV Charging Load (kWh)	EV Charging Demand Costs ($)	EV Charging Energy Costs ($)	Total EV Charging Costs ($)	Average Cost of EV Energy ($/kWh)
1	11.5	1,539	$0	$234	$234	$0.23
2	11.5	1,390	$0	$211	$211	$0.23
3	11.5	1,539	$0	$234	$234	$0.23
4	11.5	1,489	$0	$226	$226	$0.23
5	11.5	1,539	$0	$234	$234	$0.23
6	11.5	1,489	$0	$264	$264	$0.27
7	11.5	1,539	$0	$273	$273	$0.27
8	11.5	1,539	$0	$273	$273	$0.27
9	11.5	1,489	$0	$264	$264	$0.27
10	11.5	1,539	$0	$234	$234	$0.23
11	11.5	1,489	$0	$226	$226	$0.23
12	11.5	1,539	$0	$234	$234	$0.23
Total		**18,119**			**$2,906**	**$0.25**

Site #3 Berkeley Marina (125/127 University Avenue)

Recommended: Charging stations for light-duty fleet and BES
Additional: Solar PV is already planned for this location

Site Description

This facility is being reconfigured into two different zones: one for public parking and one for fleet vehicles with dedicated parking stalls for vehicles used for traffic and parking control, Police Department, and marina maintenance. Figure 19 shows the aerial view of the facility with the fenced/hatched area on the drawing indicating the dedicated fleet parking stalls and areas identified probable for solar PV arrays. An existing dual-head charger for public use is installed on the east end of the 125/127 University building. Combined solar PV generation capacity of 58 kW AC is higher than the building peak demand; however, all the energy is directed to vehicle charging. No energy from the solar PV and BES remains for building use

As a conservative measure, daily energy needs were calculated for BEVs instead of 33 BEV parking scooters. If the City procures BEV scooters, the recommended chargers can charge the scooters and have additional capacity for other fleet vehicles.

Figure 19: Berkeley Marian Ariel View

Recommendations

To meet the near-term needs of light-duty, non-emergency vehicles and parking enforcement vehicles:

- Four dual-head (eight connectors) Level 2 chargers. Most vehicles will likely not need to charge every day, but staff will need to reposition vehicles during charging sessions.
    - A portion of the EVs could be charged using a mobile charger, which would avoid the need to reposition vehicles for charging and eliminate the costs of upgrading the electrical service.
- New electrical service with a 200A main breaker to accommodate the estimated charging loads and capacity for an additional single-head charger. The total demand on each circuit is 3,328 V using a 40A breaker which outputs 6,656 VA for a charger using a 40A two-pole breaker. With 50 VA added for gateway, the total Level 2 charger load is: 6,656*8+50 = 53.3kVA, which requires 148A.
- One 75 kW/300 kWh BES to offset the long-term needs of vehicle charging and maximize the solar PV already planned for this location.

Solar PV Siting and Generation Potential – Berkeley Marina

Solar PV Array Location	Gross Area Identified (SF)	Solar PV Array Area (SF)	Number of Solar PV Modules (-)	DC Power (kW)	Peak AC Output (kW)	Total Generation (kWh)
A	7,200	3,218	180	53.8	44.7	83,172
Parking	4,536	1,001	56	16.7	13.4	25,449
Total	**11,736**	**4,219**	**236**	**70.5**	**58.0**	**108,571**

Value of Solar PV to Battery Electric Storage for EV Charging on B-1X- Brilliant 100 Rate - Berkeley Marina

Month	Peak Solar PV Power Generated (kW)	Total Solar PV Generation (kWh)	Value of Demand ($)	Value of Energy ($)	Total Value ($)	Average Value of Solar PV Energy ($/kWh)
1	47.1	5,532	$0	$1,279	$1,279	$0.23
2	53.0	6,436	$0	$1,489	$1,489	$0.23
3	57.3	9,421	$0	$2,087	$2,087	$0.22
4	58.7	10,811	$0	$2,400	$2,400	$0.22
5	58.2	11,823	$0	$2,632	$2,632	$0.22
6	57.6	12,299	$0	$3,234	$3,234	$0.26
7	56.7	11,786	$0	$3,101	$3,101	$0.26
8	56.6	10,954	$0	$2,882	$2,882	$0.26
9	54.4	9,593	$0	$2,500	$2,500	$0.26
10	52.2	8,760	$0	$2,026	$2,026	$0.23
11	47.5	6,247	$0	$1,443	$1,443	$0.23
12	43.9	4,960	$0	$1,146	$1,146	$0.23
Total		**108,571**			**$26,219**	**$0.24**

Value of Solar PV to Building: B-1X- Brilliant 100 Rate - Berkeley Marina

Month	Peak Solar PV Power Generated (kW)	Total Solar PV Generation (kWh)	Demand Costs Avoided ($)	Energy Costs Avoided ($)	Total Costs Avoided ($)	Average Value of Solar PV Energy ($/kWh)
No additional value to the building						

Cost of EV Charging: B-1X- Brilliant 100 Rate - Berkeley Marina

Month	EV Charing Demand Impact (kW)	EV Charging Load (kWh)	EV Charging Demand Costs ($)	EV Charging Energy Costs ($)	Total EV Charging Costs ($)	Average Cost of EV Energy ($/kWh)
1	25.8	9,267	$0	$2,175	$2,175	$0.23
2	25.8	8,370	$0	$1,964	$1,964	$0.23
3	25.8	9,267	$0	$2,175	$2,175	$0.23
4	25.8	8,968	$0	$2,105	$2,105	$0.23
5	25.8	9,267	$0	$2,175	$2,175	$0.23
6	25.8	8,968	$0	$2,446	$2,446	$0.27
7	25.8	9,267	$0	$2,527	$2,527	$0.27
8	25.8	9,267	$0	$2,527	$2,527	$0.27
9	25.8	8,968	$0	$2,446	$2,446	$0.27
10	25.8	9,267	$0	$2,175	$2,175	$0.23

Month	EV Charing Demand Impact (kW)	EV Charging Load (kWh)	EV Charging Demand Costs ($)	EV Charging Energy Costs ($)	Total EV Charging Costs ($)	Average Cost of EV Energy ($/kWh)
11	25.8	8,968	$0	$2,105	$2,105	$0.23
12	25.8	9,267	$0	$2,175	$2,175	$0.23
Total		**109,109**			**$26,994**	**$0.25**

Site #4 Adult Mental Health Clinic

Recommended: Charging stations or mobile charging for light-duty fleet
Additional: Solar PV is already installed at this leased location

Site Description

The Adult Mental Health Clinic is located at 1521 University Avenue and shown in Figure 20. Currently, 13 light-duty vehicles are domiciled at this location.

Figure 20: Aerial View of the Adult Mental Health Clinic

Recommendations

This site is not owned by the City and requires an upgrade to the electrical service. If the landlord agrees to EV charging at this facility, the recommendation is:

- Three dual-head Level 2 chargers (six connectors) to be shared by all vehicles.
- A new electrical service with a main breaker rated at a minimum of 200A to accommodate the current charging loads and a future single-head charger can be installed, if needed.
  - A back-up option would be to use three mobile chargers.

This site has no future solar PV potential and does not have physical area for a BES system.

Cost of EV Charging on B-1X Rate - Adult Mental Health Clinic

Month	EV Charing Demand Impact (kW)	EV Charging Load (kWh)	EV Charging Demand Costs ($)	EV Charging Energy Costs ($)	Total EV Charging Costs ($)	Average Cost of EV Energy ($/kWh)
1	15.2	4,859	$0	$1,138	$1,138	$0.23
2	15.2	4,389	$0	$1,028	$1,028	$0.23
3	15.2	4,859	$0	$1,138	$1,138	$0.23
4	15.2	4,702	$0	$1,102	$1,102	$0.23
5	15.2	4,859	$0	$1,138	$1,138	$0.23
6	15.2	4,702	$0	$1,272	$1,272	$0.27

Month	EV Charing Demand Impact (kW)	EV Charging Load (kWh)	EV Charging Demand Costs ($)	EV Charging Energy Costs ($)	Total EV Charging Costs ($)	Average Cost of EV Energy ($/kWh)
7	15.2	4,859	$0	$1,315	$1,315	$0.27
8	15.2	4,859	$0	$1,315	$1,315	$0.27
9	15.2	4,702	$0	$1,272	$1,272	$0.27
10	15.2	4,859	$0	$1,138	$1,138	$0.23
11	15.2	4,702	$0	$1,102	$1,102	$0.23
12	15.2	4,859	$0	$1,138	$1,138	$0.23
Total		**57,212**			**$14,098**	**$0.25**

Site #5 Mental Health Clinic

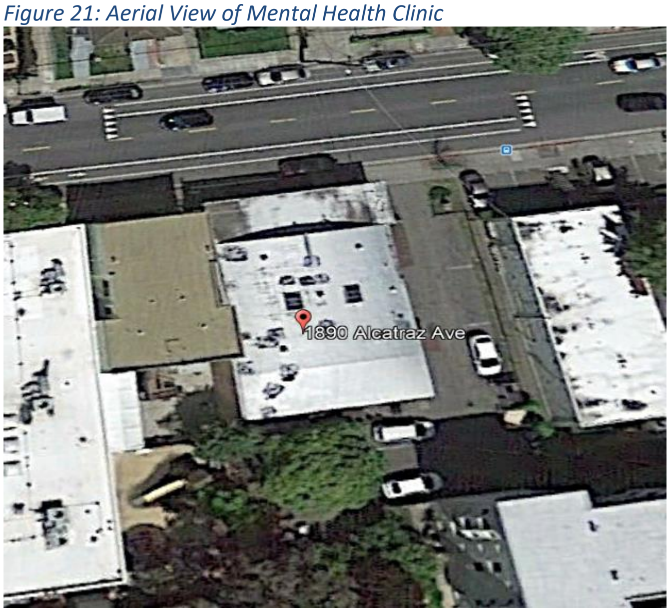
Recommended: Charging stations light-duty fleet

Additional: Relocate vehicles domiciles at Drop-in Center to Mental Health Clinic

Site Description

The mental health clinic is located at 1890 Alcatraz Ave, shown in Figure 21, and a Drop-in Center is located nearby at 3282 Adeline St. Currently, three light-duty vehicles are domiciled at each location, for a total of six vehicles. 3282 Adeline is a leased facility and is not suitable for investment in charging infrastructure. The building has a domed roof that will not accommodate solar PV and does not have enough physical space for a BES system.

Figure 21: Aerial View of Mental Health Clinic



Recommendations

To meet the near-term needs of fleet EVs:

- One dual-head Level 2 charger at 1890 Alcatraz that all six light-duty vehicles share
- New electrical service with a main breaker rated at a minimum of 60A.
    - A new service with 100A main would accommodate the charging loads, and a potential additional dual-head Level 2 charger could be installed in the future, if needed.
    - This site could also be served with a portable charging option, as described for the Adult Mental Health Clinic site.

Cost of EV Charging: B-1X- Brilliant 100 Rate - Adult Mental Health Clinic

Month	EV Charing Demand Impact (kW)	EV Charging Load (kWh)	EV Charging Demand Costs ($)	EV Charging Energy Costs ($)	Total EV Charging Costs ($)	Average Cost of EV Energy ($/kWh)
1	3.0	1,032	$0	$242	$242	$0.23
2	3.0	932	$0	$218	$218	$0.23
3	3.0	1,032	$0	$242	$242	$0.23

Month	EV Charing Demand Impact (kW)	EV Charging Load (kWh)	EV Charging Demand Costs ($)	EV Charging Energy Costs ($)	Total EV Charging Costs ($)	Average Cost of EV Energy ($/kWh)
4	3.0	999	$0	$234	$234	$0.23
5	3.0	1,032	$0	$242	$242	$0.23
6	3.0	999	$0	$270	$270	$0.27
7	3.0	1,032	$0	$279	$279	$0.27
8	3.0	1,032	$0	$279	$279	$0.27
9	3.0	999	$0	$270	$270	$0.27
10	3.0	1,032	$0	$242	$242	$0.23
11	3.0	999	$0	$234	$234	$0.23
12	3.0	1,032	$0	$242	$242	$0.23
Total		**12,149**			**$2,993**	**$0.25**

Site #6 Center Street Garage

Recommended: BES

Additional: Load management system for existing charging stations

Site Description

The Center Street Garage an eight-level public parking garage at 2025 Center St. Thirty-seven light-duty fleet vehicles are domiciled here and it is the main parking facility for City Hall employees and visitors and is used daily by the general public. Currently, 29 EV chargers with a total of 57 connectors are installed and accessible to City employees and the public in addition to fleet vehicles. The main distribution assembly panel for this facility is located on the ground floor. The roof of the garage has an existing solar PV array that is owned by the City. Figure 22 is an aerial view of the Center Street Garage.

Figure 22 Center Street Garage aerial view

Recommendations

The Center Street Garage has existing charger capacity for current and anticipated charging demand. Load management could be used to satisfy future electrical load growth if charging demand exceeds the facility's electrical capacity in the future.

One 63 kW / 250 kWh BES system will increase resiliency and help to avoid peak demand changes from EV charging.

Solar PV Siting and Generation Potential - Center Street Garage

Solar PV Array Location	Gross Area Identified (SF)	Solar PV Array Area (SF)	Number of Solar PV Modules (-)	DC Power (kW)	Peak AC Output (kW)	Total Generation (kWh)
Existing	n/a	n/a	414	113.9	91.1	172,153
Total	**0**	**0**	**414**	**113.9**	**91.1**	**172,153**

Note: Performance calculated assuming 275 W DC/panel, and performance assumptions from other modeling results.

Value of Solar PV to Battery Electric Storage for EV Charging: B-19S-Bright Choice Rate – Center Street Garage

Month	Peak Solar PV Power Generated (kW)	Total Solar PV Generation (kWh)	Value of Demand ($)	Value of Energy ($)	Total Value ($)	Average Value of Solar PV Energy ($/kWh)
1	38.6	4,541	$847	$524	$1,371	$0.30
2	45.1	5,200	$995	$601	$1,596	$0.31
3	47.2	8,045	$1,046	$1,100	$2,146	$0.27
4	47.3	9,037	$1,050	$1,231	$2,280	$0.25
5	47.6	9,706	$1,059	$1,316	$2,375	$0.24
6	47.6	10,260	$1,813	$1,263	$3,076	$0.30
7	45.6	9,918	$1,756	$1,225	$2,981	$0.30
8	46.1	9,383	$1,744	$1,156	$2,899	$0.31
9	46.2	8,007	$1,655	$970	$2,625	$0.33
10	41.3	7,053	$906	$814	$1,720	$0.24
11	38.2	5,340	$828	$614	$1,442	$0.27
12	36.2	3,960	$785	$455	$1,240	$0.31
Total		**90,451**			**$25,752**	**$0.28**

Value of Solar PV to Building: B-19S-Bright Choice Rate – Center Street Garage

Month	Peak Solar PV Power Generated (kW)	Total Solar PV Generation (kWh)	Demand Costs Avoided ($)	Energy Costs Avoided ($)	Total Costs Avoided ($)	Average Value of Solar PV Energy ($/kWh)
1	75.4	8,880	$1,656	$1,024	$2,681	$0.30
2	88.1	10,168	$1,945	$1,176	$3,121	$0.31
3	92.4	15,733	$2,045	$2,151	$4,196	$0.27
4	92.5	17,672	$2,053	$2,407	$4,460	$0.25
5	93.1	18,981	$2,070	$2,574	$4,644	$0.24
6	93.1	20,064	$3,545	$2,471	$6,016	$0.30
7	89.2	19,395	$3,435	$2,396	$5,830	$0.30
8	90.2	18,349	$3,410	$2,260	$5,670	$0.31
9	90.3	15,658	$3,237	$1,897	$5,134	$0.33
10	80.7	13,793	$1,772	$1,591	$3,363	$0.24
11	74.7	10,443	$1,619	$1,200	$2,819	$0.27
12	70.8	7,745	$1,536	$889	$2,425	$0.31
Total		**176,880**			**$50,358**	**$0.28**

Cost of EV Charging: B-19S-Bright Choice Rate – Center Street Garage

Month	EV Charing Demand Impact (kW)	EV Charging Load (kWh)	EV Charging Demand Costs ($)	EV Charging Energy Costs ($)	Total EV Charging Costs ($)	Average Cost of EV Energy ($/kWh)
1	24.5	7,682	$552	$923	$1,475	$0.19
2	24.5	6,939	$552	$834	$1,386	$0.20
3	24.5	7,682	$552	$923	$1,475	$0.19
4	24.5	7,434	$552	$894	$1,445	$0.19
5	24.5	7,682	$552	$923	$1,475	$0.19
6	24.5	7,434	$995	$938	$1,934	$0.26
7	24.5	7,682	$995	$970	$1,965	$0.26
8	24.5	7,682	$995	$970	$1,965	$0.26
9	24.5	7,434	$995	$938	$1,934	$0.26
10	24.5	7,682	$552	$923	$1,475	$0.19
11	24.5	7,434	$552	$894	$1,445	$0.19
12	24.5	7,682	$552	$923	$1,475	$0.19
Total		**90,451**			**$19,449**	**$0.22**

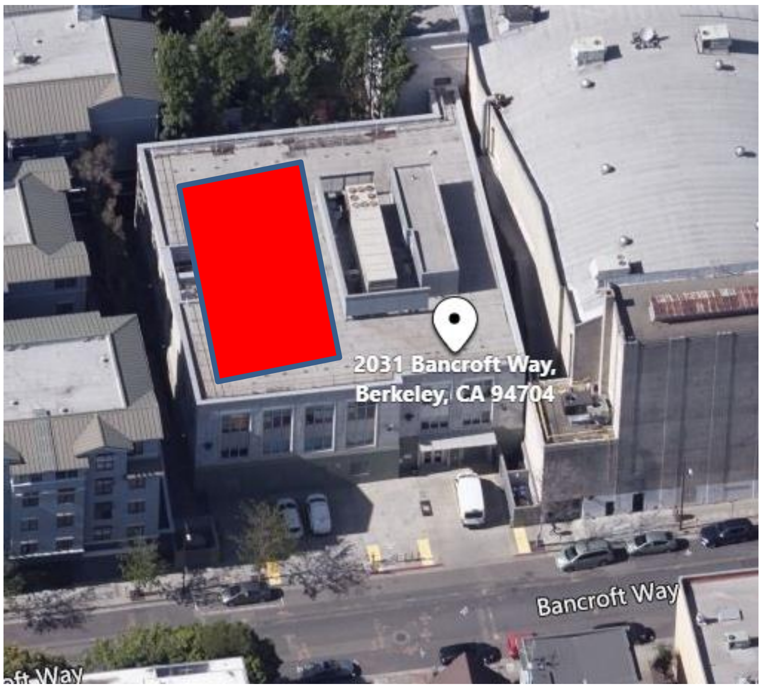
Site #7 Central Library Parking Lot

Recommended: Charging, solar PV
Additional: Potential for assigned vehicles to use other charging stations or plug in to a wall outlet

Site Description

The Central Library is located at 2031 Bancroft Way, as shown in Figure 23. Only one light-duty vehicle is parked at this location. No public EV parking is planned for this site. Available area provides substantially more solar PV potential required to offset EV fleet charging needs. If solar PV is deployed for fleet support only, BES is not recommended due to small system size.

Figure 23: Aerial View of the Central Library



Recommendations

To meet the near-term needs of light-duty fleet vehicles:

- One dual-head Level 2 charger is recommended at this facility.
- New electrical service with a main breaker rated minimum of 60A.
    - A 100A main would accommodate a potential future additional charger (one dual-head Level 2), if needed.

Optionally, the single vehicle at this site could charge using the DCFC recommended for the Corp Yard, at available Level 2 chargers at other City facilities or at nearby public charging or charge onsite using an outdoor wall outlet (Level 1 charging), or a combination of these options. Solar PV would not be needed for EV charging but could provide benefit to the building electrical load.

East Bay Community Energy Fleet Electrification

Solar PV Siting and Generation Potential – Central Library Parking

Array Location	Gross Area Identified (SF)	Array Area (SF)	Number of PV Modules (-)	DC Power (kW)	Peak AC Output (kW)	Total Generation (kWh)
A	3,060	1,126	63	18.8	15.0	25,908
Total	**3,060**	**1,126**	**63**	**18.8**	**15.0**	**25,908**

Value of Solar PV to Battery Electric Storage for EV Charging: B-10SX-Brilliant 100 Rate - Central Library Parking Lot

Month	Peak Solar PV Power Generated (kW)	Total Solar PV Generation (kWh)	Value of Demand ($)	Value of Energy ($)	Total Value ($)	Average Value of Solar PV Energy ($/kWh)
1	0.4	49	$6	$7	$13	$0.27
2	0.5	62	$7	$9	$17	$0.27
3	0.6	105	$8	$13	$21	$0.20
4	0.7	126	$9	$15	$24	$0.19
5	0.7	145	$9	$18	$27	$0.18
6	0.7	163	$10	$31	$41	$0.25
7	0.7	156	$9	$30	$39	$0.25
8	0.7	138	$9	$26	$35	$0.25
9	0.6	109	$8	$20	$29	$0.26
10	0.5	83	$7	$13	$20	$0.24
11	0.4	55	$6	$9	$14	$0.26
12	0.4	42	$5	$7	$12	$0.27
Total		**1,234**			**$291**	**$0.24**

Value of Solar PV to Building: A-10SX-Brilliant 100 Rate - Central Library Parking Lot

Month	Peak Solar PV Power Generated (kW)	Total Solar PV Generation (kWh)	Demand Costs Avoided ($)	Energy Costs Avoided ($)	Total Costs Avoided ($)	Average Value of Solar PV Energy ($/kWh)
1	8.4	975	$113	$149	$262	$0.27
2	11.0	1,235	$147	$186	$333	$0.27
3	12.1	2,108	$163	$259	$422	$0.20
4	13.4	2,523	$179	$309	$488	$0.19
5	13.8	2,906	$185	$352	$537	$0.18
6	14.2	3,253	$191	$621	$812	$0.25
7	14.0	3,126	$188	$599	$787	$0.25
8	13.2	2,753	$178	$523	$701	$0.25
9	12.5	2,184	$168	$405	$573	$0.26
10	10.8	1,653	$146	$252	$397	$0.24
11	8.4	1,109	$113	$172	$284	$0.26
12	7.4	848	$100	$132	$231	$0.27
Total		**24,674**			**$5,828**	**$0.24**

Cost of EV Charging: B-10SX-Brilliant 100 Rate - Central Library Parking Lot

Month	EV Charing Demand Impact (kW)	EV Charging Load (kWh)	EV Charging Demand Costs ($)	EV Charging Energy Costs ($)	Total EV Charging Costs ($)	Average Cost of EV Energy ($/kWh)
1	0.8	105	$0	$16	$16	$0.16
2	0.8	95	$0	$15	$15	$0.16
3	0.8	105	$0	$16	$16	$0.16
4	0.8	101	$0	$16	$16	$0.16
5	0.8	105	$0	$16	$16	$0.16
6	0.8	101	$0	$18	$18	$0.17
7	0.8	105	$0	$18	$18	$0.17
8	0.8	105	$0	$18	$18	$0.17
9	0.8	101	$0	$18	$18	$0.17
10	0.8	105	$0	$16	$16	$0.16
11	0.8	101	$0	$16	$16	$0.16
12	0.8	105	$0	$16	$16	$0.16
Total		**1,234**			**$200**	**$0.16**

Site #8 Public Safety Building

Site Description

Recommended: Charging, solar PV

Additional: Additional charging potentially needed as police patrol/pursuit vehicles become available near the end of the decade.

The Public Safety Building is located on 2100 Martin Luther King Jr Way. The main fleet parking is in the center of the facility. The westernmost row is assigned to employee parking. Parking stalls in the middle are assigned to the Police Department and other City fleets for a total of 79 vehicles, many of which are emergency vehicles and are unlikely to transition to EVs before 2030. An additional 12 parking stalls are on the north side of the Communication Tower building. Currently, two non-emergency light-duty vehicles domicile here.

Figure 24 Public Safety Building facility detailsshows the different areas of operations and locations of electrical power infrastructure within the Public Safety Building site. Space for solar PV arrays is limited; location A is still available, but other mechanical equipment has been added to roof since this photo. The parking lot is highly shaded and not effective for solar PV.

Figure 24 Public Safety Building facility details

This facility is equipped with a spare 70-Amp, 3-pole 480Y/277V breaker and in-ground junction boxes for future EV charging. Access to the underground boring, trenching, and repaving could be a concern as other buried conduit essential for public safety operations could be in the vicinity.

Recommendations

To meet the near-term needs of light-duty, non-emergency vehicles:

- One dual-head higher-power Level 2 charger is appropriate to charge the existing vehicles and be prepared for anticipated expansion of the EV fleet.

Solar PV Siting and Generation Potential - Public Safety Building

Solar PV Array Location	Gross Area Identified (SF)	Array Area (SF)	Number of PV Modules (-)	DC Power (kW)	Peak AC Output (kW)	Total Generation (kWh)
A	1,925	644	36	10.8	8.6	14,883
Total	**1,925**	**644**	**36**	**10.8**	**8.6**	**14,883**

Value of Solar PV to Battery Electric Storage for EV Charging on B-19S-Brilliant 100 Rate – Public Safety Building

Month	Peak Solar PV Power Generated (kW)	Total Solar PV Generation (kWh)	Value of Demand ($)	Value of Energy ($)	Total Value ($)	Average Value of Solar PV Energy ($/kWh)
1	2.2	249	$47	$29	$76	$0.30
2	2.8	316	$62	$36	$98	$0.31
3	3.1	539	$69	$74	$142	$0.26
4	3.4	645	$76	$88	$164	$0.25
5	3.5	743	$79	$100	$179	$0.24
6	3.6	831	$145	$103	$248	$0.30
7	3.6	799	$144	$99	$244	$0.31
8	3.4	704	$134	$87	$221	$0.31
9	3.2	558	$116	$68	$184	$0.33
10	2.8	423	$61	$49	$109	$0.26
11	2.1	283	$46	$32	$79	$0.28
12	1.9	217	$41	$25	$66	$0.30
Total		**6,306**			**$1,809**	**$0.29**

Value of Solar PV to Building: B-19S-Brilliant 100 Rate – Public Safety Building

Month	Peak Solar PV Power Generated (kW)	Total Solar PV Generation (kWh)	Demand Costs Avoided ($)	Energy Costs Avoided ($)	Total Costs Avoided ($)	Average Value of Solar PV Energy ($/kWh)
1	2.9	339	$64	$39	$103	$0.30
2	3.8	429	$84	$50	$133	$0.31
3	4.2	733	$94	$100	$194	$0.26
4	4.6	877	$103	$119	$223	$0.25
5	4.8	1,010	$107	$136	$244	$0.24
6	4.9	1,131	$197	$140	$337	$0.30
7	4.9	1,087	$196	$135	$332	$0.31
8	4.6	957	$182	$118	$300	$0.31
9	4.4	759	$158	$92	$250	$0.33
10	3.8	575	$82	$66	$149	$0.26
11	2.9	385	$63	$44	$107	$0.28
12	2.6	295	$56	$34	$89	$0.30
Total		**8,577**			**$2,460**	**$0.29**

Cost of EV Charging on B-19S-Brilliant 100 Rate – Public Safety Building

Month	EV Charing Demand Impact (kW)	EV Charging Load (kWh)	EV Charging Demand Costs ($)	EV Charging Energy Costs ($)	Total EV Charging Costs ($)	Average Cost of EV Energy ($/kWh)
1	4.1	513	$0	$59	$59	$0.11
2	4.1	463	$0	$53	$53	$0.11
3	4.1	513	$0	$59	$59	$0.11
4	4.1	496	$0	$57	$57	$0.11
5	4.1	513	$0	$59	$59	$0.11
6	4.1	496	$0	$57	$57	$0.11
7	4.1	513	$0	$59	$59	$0.11
8	4.1	513	$0	$59	$59	$0.11
9	4.1	496	$0	$57	$57	$0.11
10	4.1	513	$0	$59	$59	$0.11
11	4.1	496	$0	$57	$57	$0.11
12	4.1	513	$0	$59	$59	$0.11
Total		**6,036**			**$690**	**$0.11**

Site #9 Civic Center (City Hall)

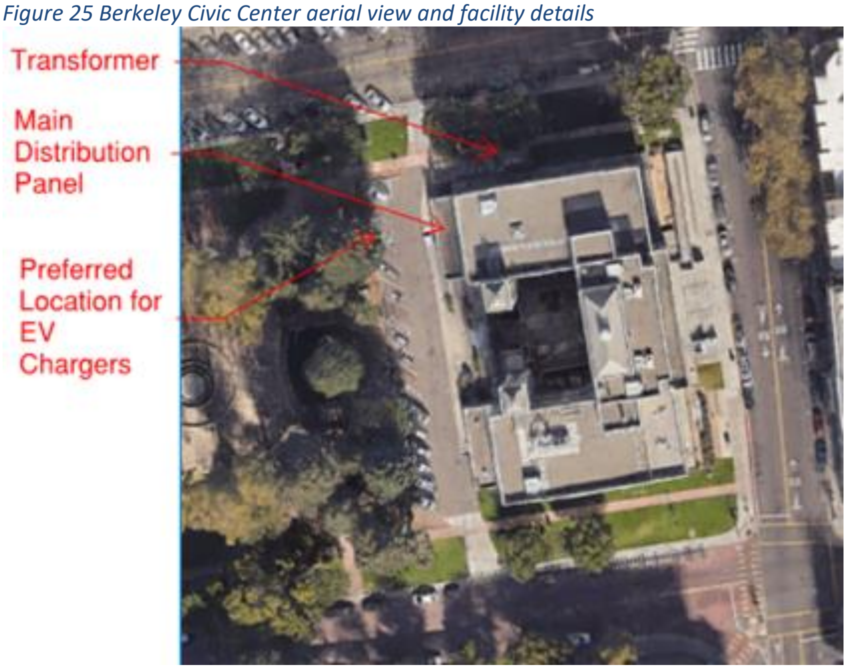
Recommended: Charging

Additional: Additional charging potentially needed as police patrol/pursuit vehicles become available near the end of the decade.

Site Description

The Civic Center is located at 2180 Milvia St. in the heart of downtown Berkeley. Sixteen parking stalls are assigned to City staff with a signpost in the front of each parking stall. A total of 25 light-duty vehicles are assigned to Civic Center Hall, although most park at the City's Center Street Garage (Site #6). Figure 25 shows the aerial view of the Civic Center facility. The building's roof is unsuitable for solar PV based on age and condition.

Figure 25 Berkeley Civic Center aerial view and facility details



The main distribution panel is in the basement of the building across from the parking stalls. The transformer is located on the north side of the building close to the enclosed bicycle parking area. The main distribution panel is about 55 feet from the first parking stall located on the NW corner of Civic Center.

Recommendations

To meet the near-term needs of light-duty vehicles:

- One duel-head Level 2 charger installed at the ends of the angled parking stalls opposite the existing main distribution panel will accommodate the existing vehicles those that are planned to be relocated to this domicile.

Cost of EV Charging: B-19S- Brilliant 100 Rate – Civic Center

Month	EV Charing Demand Impact (kW)	EV Charging Load (kWh)	EV Charging Demand Costs ($)	EV Charging Energy Costs ($)	Total EV Charging Costs ($)	Average Cost of EV Energy ($/kWh)
1	0.5	223	$1	$27	$28	$0.13
2	0.5	201	$1	$24	$25	$0.13
3	0.5	223	$1	$27	$28	$0.13
4	0.5	216	$1	$26	$27	$0.13
5	0.5	223	$1	$27	$28	$0.13
6	0.5	216	$16	$28	$44	$0.20
7	0.5	223	$16	$29	$45	$0.20
8	0.5	223	$16	$29	$45	$0.20
9	0.5	216	$16	$28	$44	$0.20
10	0.5	223	$1	$27	$28	$0.13
11	0.5	216	$1	$26	$27	$0.13
12	0.5	223	$1	$27	$28	$0.13
Total		**2,626**			**$396**	**$0.15**

Site #10 Mental Health Clinic (2636/2640 Martin Luther King Jr Way)

Recommended: Charging, solar PV

Additional: Both are already under construction as part of a building remodel.

Site Description

The City of Berkeley Mental Health and Human Services is located at 2636/2640 Martin Luther King Jr. Way, as shown in Figure 26. A total of eight vehicles assigned to this location share five assigned on-street parking spaces. The main distribution panel is rated as 600 A ampacity according to drawings received from the City.

Figure 26 City of Berkeley Mental Health and Human Services parking facility details

Recommendations

Plans received from the City indicate two dual-head Level 2 chargers are planned at this site as curbside charging. One will be installed in 2020 and the other installed later, if needed. Based on the vehicle inventory and use data, sharing these chargers should accommodate the needs of the eight EVs. A 60.1 kW solar PV array that will cover the entire roof is under construction.

Solar PV Location and Generation Potential - Mental Health Clinic

Solar PV Array Location	Gross Area Identified (SF)	Solar PV Array Area (SF)	Number of Solar PV Modules (-)	DC Power (kW)	Peak AC Output (kW)	Total Generation (kWh)
Planned				60.1	48.1	94,430
Total				**12.6**	**10.1**	**94,430**

Value of Solar PV to Battery Electric Storage for EV Charging: B-10SX-Brillant 100 Rate – Mental Health Clinic

Month	Peak Solar PV Power Generated (kW)	Total Solar PV Generation (kWh)	Value of Demand ($)	Value of Energy ($)	Total Value ($)	Average Value of Solar PV Energy ($/kWh)
1	10.1	1,189	$135	$181	$316	$0.27
2	11.8	1,315	$158	$198	$356	$0.27
3	12.0	2,061	$162	$255	$417	$0.20
4	12.6	2,330	$169	$289	$458	$0.20
5	12.5	2,513	$168	$311	$479	$0.19
6	12.6	2,637	$169	$496	$665	$0.25
7	12.4	2,627	$166	$496	$662	$0.25
8	12.0	2,451	$162	$461	$622	$0.25
9	12.1	2,146	$163	$396	$559	$0.26
10	11.4	1,848	$153	$281	$435	$0.24
11	10.1	1,410	$136	$217	$353	$0.25
12	9.7	1,176	$130	$181	$312	$0.27
Total		**23,702**			**$5,634**	**$0.24**

Value of Solar PV to Building: B-10SX-Brillant 100 Rate – Mental Health Clinic

Month	Peak Solar PV Power Generated (kW)	Total Solar PV Generation (kWh)	Demand Costs Avoided ($)	Energy Costs Avoided ($)	Total Costs Avoided ($)	Average Value of Solar PV Energy ($/kWh)
1	30.1	3,548	$404	$540	$943	$0.27
2	35.2	3,924	$472	$591	$1,063	$0.27
3	35.9	6,149	$482	$762	$1,244	$0.20
4	37.5	6,954	$503	$863	$1,367	$0.20
5	37.3	7,499	$501	$928	$1,429	$0.19
6	37.5	7,870	$503	$1,480	$1,984	$0.25
7	36.9	7,838	$495	$1,480	$1,976	$0.25
8	35.9	7,313	$482	$1,375	$1,857	$0.25
9	36.2	6,403	$486	$1,181	$1,667	$0.26
10	34.1	5,514	$458	$840	$1,297	$0.24
11	30.2	4,207	$405	$649	$1,054	$0.25
12	28.9	3,509	$389	$542	$930	$0.27
Total		**70,728**			**$16,812**	**$0.24**

Cost of EV Charging: B-10SX-Brillant 100 Rate – Mental Health Clinic

Month	EV Charing Demand Impact (kW)	EV Charging Load (kWh)	EV Charging Demand Costs ($)	EV Charging Energy Costs ($)	Total EV Charging Costs ($)	Average Cost of EV Energy ($/kWh)
1	4.6	2,013	$0	$248	$248	$0.12
2	4.6	1,818	$0	$224	$224	$0.12
3	4.6	2,013	$0	$248	$248	$0.12
4	4.6	1,948	$0	$240	$240	$0.12
5	4.6	2,013	$0	$248	$248	$0.12
6	4.6	1,948	$0	$387	$387	$0.20
7	4.6	2,013	$0	$400	$400	$0.20
8	4.6	2,013	$0	$400	$400	$0.20
9	4.6	1,948	$0	$387	$387	$0.20
10	4.6	2,013	$0	$248	$248	$0.12
11	4.6	1,948	$0	$240	$240	$0.12
12	4.6	2,013	$0	$248	$248	$0.12
Total		**23,702**			**$3,516**	**$0.15**

Site #11 South Berkeley Senior Center

Recommended: Charging, solar PV

Additional: Charging should anticipate procurement of BEV passenger vans.

Site Description

The South Berkeley Senior Center is located at 2939 Ellis St., as shown in Figure 27. Two light-duty vehicles and three passenger vans are assigned to this facility. A strip of open ground on the north side of the property between the parking lot and the property line of the facility could be used to run the underground conduit system from the new service enclosure to the parking stalls where EV chargers can be installed. The multifaceted roof makes a solar PV installation difficult at this site; the solar PV array is sized for largest available southern exposure roof area

Figure 27 South Berkeley Senior Center facility aerial view

Recommendations

To meet the near-term needs of light-duty vehicles and potential near-term procurement of EV passenger vans or shuttle:

- A dual-head, high-power Level 2 charger.
- New electrical with a main breaker rated a minimum of 60A.
    - A 100A main will allow for future load of an additional dual-head charger, if needed.

Solar PV Location and Generation Potential – South Berkeley Senior Center

Solar PV Array Location	Gross Area Identified (SF)	Solar PV Array Area (SF)	Number of Solar PV Modules (-)	DC Power (kW)	Peak AC Output (kW)	Total Generation (kWh)
A	1,509	465	26	7.8	6.2	12,265
Total	**1,509**	**465**	**26**	**7.8**	**6.2**	**12,265**

Value of Solar PV to Battery Electric Storage for EV Charging on B-6-Brillant 100 Rate – South Berkeley Senior Center

Month	Peak Solar PV Power Generated (kW)	Total Solar PV Generation (kWh)	Value of Demand ($)	Value of Energy ($)	Total Value ($)	Average Value of Solar PV Energy ($/kWh)
1	1.2	139	$0	$30	$30	$0.22
2	1.4	152	$0	$33	$33	$0.22
3	1.4	234	$0	$51	$51	$0.22
4	1.4	260	$0	$57	$57	$0.22
5	1.4	277	$0	$61	$61	$0.22
6	1.4	289	$0	$71	$71	$0.25
7	1.4	289	$0	$72	$72	$0.25
8	1.3	273	$0	$67	$67	$0.25
9	1.4	242	$0	$59	$59	$0.24
10	1.3	213	$0	$46	$46	$0.22
11	1.2	166	$0	$36	$36	$0.22
12	1.1	139	$0	$30	$30	$0.22
Total		**2,675**			**$614**	**$0.23**

Value of Solar PV to Building on B-6-Brillant 100 Rate – South Berkeley Senior Center

Month	Peak Solar PV Power Generated (kW)	Total Solar PV Generation (kWh)	Demand Costs Avoided ($)	Energy Costs Avoided ($)	Total Costs Avoided ($)	Average Value of Solar PV Energy ($/kWh)
1	4.2	500	$0	$108	$108	$0.22
2	4.8	545	$0	$118	$118	$0.22
3	4.9	839	$0	$183	$183	$0.22
4	5.1	934	$0	$204	$204	$0.22
5	5.0	993	$0	$218	$218	$0.22
6	5.0	1,036	$0	$256	$256	$0.25
7	4.9	1,037	$0	$257	$257	$0.25
8	4.8	979	$0	$241	$241	$0.25
9	4.9	869	$0	$211	$211	$0.24
10	4.7	764	$0	$166	$166	$0.22
11	4.2	594	$0	$128	$128	$0.22
12	4.1	500	$0	$108	$108	$0.22
Total		**9,590**			**$2,201**	**$0.23**

Cost of EV Charging on B-6-Brillant 100 Rate – South Berkeley Senior Center

Month	EV Charing Demand Impact (kW)	EV Charging Load (kWh)	EV Charging Demand Costs ($)	EV Charging Energy Costs ($)	Total EV Charging Costs ($)	Average Cost of EV Energy ($/kWh)
1	1.4	227	$0	$52	$52	$0.23
2	1.4	205	$0	$47	$47	$0.23
3	1.4	227	$0	$52	$52	$0.23
4	1.4	220	$0	$50	$50	$0.23
5	1.4	227	$0	$52	$52	$0.23
6	1.4	220	$0	$54	$54	$0.25
7	1.4	227	$0	$56	$56	$0.25

Month	EV Charing Demand Impact (kW)	EV Charging Load (kWh)	EV Charging Demand Costs ($)	EV Charging Energy Costs ($)	Total EV Charging Costs ($)	Average Cost of EV Energy ($/kWh)
8	1.4	227	$0	$56	$56	$0.25
9	1.4	220	$0	$54	$54	$0.25
10	1.4	227	$0	$52	$52	$0.23
11	1.4	220	$0	$50	$50	$0.23
12	1.4	227	$0	$52	$52	$0.23
Total		**2,675**			**$627**	**$0.23**

Site #12 North Berkeley Senior Center

Recommended: Charging, solar PV

Additional: Both are already under construction as part of a building remodel.

Site Description

The North Berkeley Senior Center is located at 1901 Hearst Ave., as shown in Figure 21. This site was under construction at the time of the site visits. City staff stated that a new load distribution panel, spare breakers, and conduits stubbed-up will be installed as part of the ongoing construction at this facility. Drawings received from the City show a dual-head Level 2 charger to be installed and a solar PV array will be added to the area shown in the figure.

Figure 28 North Berkeley Senior Center aerial view

Recommendations

The planned (or under construction) Level 2 charger and solar PV array will accommodate the charging needs of the two light-duty vehicles domiciled at this location.

Solar PV Siting and Generation Potential – North Berkeley Senior Center

Solar PV Array Location	Gross Area Identified (SF)	Solar PV Array Area (SF)	Number of Solar PV Modules (-)	DC Power (kW)	Peak AC Output (kW)	Total Generation (kWh)
Proposed				29.6	23.7	46,665
Total				**29.6**	**23.7**	**46,665**

Value of Solar PV to Battery Electric Storage for EV Charging on B-10SX-Brillant 100 Rate – North Berkeley Senior Center

Month	Peak Solar PV Power Generated (kW)	Total Solar PV Generation (kWh)	Value of Demand ($)	Value of Energy ($)	Total Value ($)	Average Value of Solar PV Energy ($/kWh)
1	1.8	217	$25	$33	$58	$0.27
2	2.2	240	$29	$36	$65	$0.27
3	2.2	376	$29	$47	$76	$0.20
4	2.3	432	$30	$53	$84	$0.19
5	2.3	477	$31	$59	$89	$0.19
6	2.3	481	$31	$90	$121	$0.25
7	2.2	474	$29	$89	$119	$0.25
8	2.2	445	$30	$84	$113	$0.25
9	2.2	393	$30	$72	$102	$0.26
10	2.0	329	$27	$50	$77	$0.23
11	1.8	257	$25	$40	$64	$0.25
12	1.7	199	$23	$31	$54	$0.27
Total		**4,319**			**$1,022**	**$0.24**

Value of Solar PV to Building: B-10SX-Brillant 100 Rate – North Berkeley Senior Center

Month	Peak Solar PV Power Generated (kW)	Total Solar PV Generation (kWh)	Demand Costs Avoided ($)	Energy Costs Avoided ($)	Total Costs Avoided ($)	Average Value of Solar PV Energy ($/kWh)
1	18.0	2,125	$242	$323	$565	$0.27
2	21.1	2,352	$283	$354	$637	$0.27
3	21.5	3,687	$289	$457	$746	$0.20
4	22.3	4,230	$299	$524	$823	$0.19
5	22.4	4,673	$300	$575	$876	$0.19
6	22.4	4,712	$300	$886	$1,187	$0.25
7	21.4	4,648	$287	$875	$1,162	$0.25
8	21.6	4,358	$290	$819	$1,108	$0.25
9	21.7	3,851	$291	$711	$1,002	$0.26
10	19.5	3,226	$261	$491	$752	$0.23
11	18.1	2,522	$243	$389	$632	$0.25
12	17.1	1,952	$229	$302	$531	$0.27
Total		**42,336**			**$10,021**	**$0.24**

Cost of EV Charging: A-10SX-Brillant 100 Rate – North Berkeley Senior Center

Month	EV Charing Demand Impact (kW)	EV Charging Load (kWh)	EV Charging Demand Costs ($)	EV Charging Energy Costs ($)	Total EV Charging Costs ($)	Average Cost of EV Energy ($/kWh)
1	1.7	367	$0	$48	$48	$0.13
2	1.7	331	$0	$43	$43	$0.13
3	1.7	367	$0	$48	$48	$0.13
4	1.7	355	$0	$46	$46	$0.13
5	1.7	367	$0	$48	$48	$0.13
6	1.7	355	$0	$69	$69	$0.19
7	1.7	367	$0	$71	$71	$0.19

Month	EV Charing Demand Impact (kW)	EV Charging Load (kWh)	EV Charging Demand Costs ($)	EV Charging Energy Costs ($)	Total EV Charging Costs ($)	Average Cost of EV Energy ($/kWh)
8	1.7	367	$0	$71	$71	$0.19
9	1.7	355	$0	$69	$69	$0.19
10	1.7	367	$0	$48	$48	$0.13
11	1.7	355	$0	$46	$46	$0.13
12	1.7	367	$0	$48	$48	$0.13
Total		**4,320**			**$655**	**$0.15**

Kate Harrison
Councilmember District 4
Susan Wengraf
Councilmember District 6

CONSENT CALENDAR
June 25, 2019

To: Honorable Mayor and Members of the City Council

From: Councilmember Harrison, Vice Mayor Wengraf, Councilmember Robinson and Mayor Arreguin

Subject: An Action Plan for Greening the City of Berkeley Fleet of Vehicles

RECOMMENDATION

Request the City Manager and Department of Public Works collaborate to create an Action Plan ("plan"), by June 2020, to aggressively accelerate the implementation of the electrification of the City's municipal fleet and phase out fossil fuel use in municipal vehicles by 2030 with consideration of an earlier transition for light-duty passenger vehicles. The Plan should include an evaluation of the City's current fleet and an analysis of opportunities for transitioning to a fleet of fossil fuel free vehicles, as soon as the technology can safely meet operational needs. An update on our progress should be reported to City Council as an information item every six months.

In the interim, the City Manager is asked to explain criteria used to purchase fossil fuel vehicles in all future staff items related to vehicle purchases with Council.

FINANCIAL IMPLICATIONS

Consultant fees, if deemed desirable by the City Manager, and staff time.

BACKGROUND

The City Council declared a climate emergency on June 12, 2018. In light of this emergency and the City of Berkeley's ongoing commitment to and investment in electric charging technology and facilities, we request that the City develop an action plan to significantly reduce the city's contribution to carbon pollution and to evaluate when electric vehicles can safely and operationally replace the vehicles in the current municipal fleet.[1]
Berkeley has demonstrated its commitment to reducing its vehicle emissions;
The Energy Commission's Recommendations for a Fossil Free Berkeley were articulated in the Fossil Free Berkeley Report (1/23/2019):

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[1] In 2017, San Francisco passed an ordinance mandating that all new light-duty additions to the passenger vehicle fleet, subject to certain exemptions and waivers, be zero-emission. In addition, the ordinance specifies December 31, 2022 as a deadline for transitioning San Francisco's entire light-duty fleet.

- *Requiring all future city government procurements of vehicles to minimize emissions, and establishing a goal and plan for transitioning the city's vehicle fleet to all electric vehicles.*
- *Establishing a goal and plan for transitioning to 100% renewable energy for municipal operations and a community wide goal of 100% reductions by 2030.*
- *Assessing the city's transportation vehicle needs and develop an aggressive timeline for transitioning to all electric. This assessment would include consideration of 1) Switching to lower carbon transport options such as electric cars or bicycles where possible and 2) the timing of technology development and commercialization for car batteries*

Additionally, on September 25, 2018, the City Council approved a contract with Cadmus Group LLC to develop a Berkeley Electric Vehicle Roadmap, a comprehensive action-based EV roadmap to speed the transition from fossil fuels to EV's in the community. The recommendation we are proposing here would focus specifically on the COB fleet of vehicles, complementing the work of Cadmus.

The City is investing in charging stations across Berkeley such as the Center Street Garage and the North Berkeley Senior Center. At the May 14, 2019 City Council meeting, the Director of Public Works confirmed that the City has set aside $600,000 for new electric vehicle charging stations. In addition, East Bay Community Energy is working with City staff to expand charging infrastructure. Thus, we are poised to significantly expand our electric fleet.

The transportation sector accounts for over 60 percent[2] of Berkeley's core greenhouse gas emissions, which are the main driver of climate change. Transitioning our city fleet of vehicles from fossil fuels to clean electricity is an important and vital component of achieving our climate goals that will significantly reduce greenhouse gas emissions and improve air quality, and represent further commitment to the City's decarbonziation obligations. A zero emissions municipal fleet will also help to inspire residents and businesses to transition to zero emissions vehicles.

The following actions are proposed to accelerate Berkeley's transition to a clean and green municipal fleet:

The City Manager in collaboration with the Department of Public Works shall create an Action Plan ("plan") to aggressively accelerate the electrification of the City's municipal fleet and phase out fossil fuel use in municipal vehicles by 2030.

The plan should consider:

- Criteria, safety and operational needs.
- Current available technologies.

[2] Office of Energy & Sustainable Development (OESD) 2016 Community Inventory. Dec 6, 2018 Climate Action Plan Update

- Current fleet right sizing/retirement opportunities.
- A strategy for infrastructure deployment to support the electrification of the municipal fleet. This strategy should take into consideration a long-term funding approach for EV charging infrastructure, including potential partnerships with publicly accessible charging networks and state and regional funding sources.
- Consideration of the possibilities of leasing gas-powered when electric vehicles are not feasible in order to avoid obsolescence.
- A strategy to rapidly electrify the city's fleet and to provide for the use of fossil fuel-free liquid fuels when electric vehicles are not a viable option.
- Plug-in vehicles should be purchased for the municipal fleet when a cost effective, market-ready vehicle is available which matches the planned operations for that vehicle.
- Recognizing the unique needs of emergency management and first response vehicles, the plan should include a strategy to provide emergency management services with electric and fossil fuel-free vehicles wherever possible.
- An assessment of the challenges or opportunities presented by different vehicle fuel types on emergency management and response and allow for exemptions where alternative vehicles are not readily available.

The Action Plan should be completed no later than June, 2020 and presented to City Council in time for the FY 2021 budget process.

ENVIRONMENTAL SUSTAINABILITY

Supports the goals of the COB Climate Action Plan, and Fossil Free Berkeley Report

"Driving an electric car in the Bay Area reduces about 70% of the greenhouse gases produced by a conventional car." *Berkeley Office of Energy & Sustainable Development (OESD)*

CONTACT PERSON

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