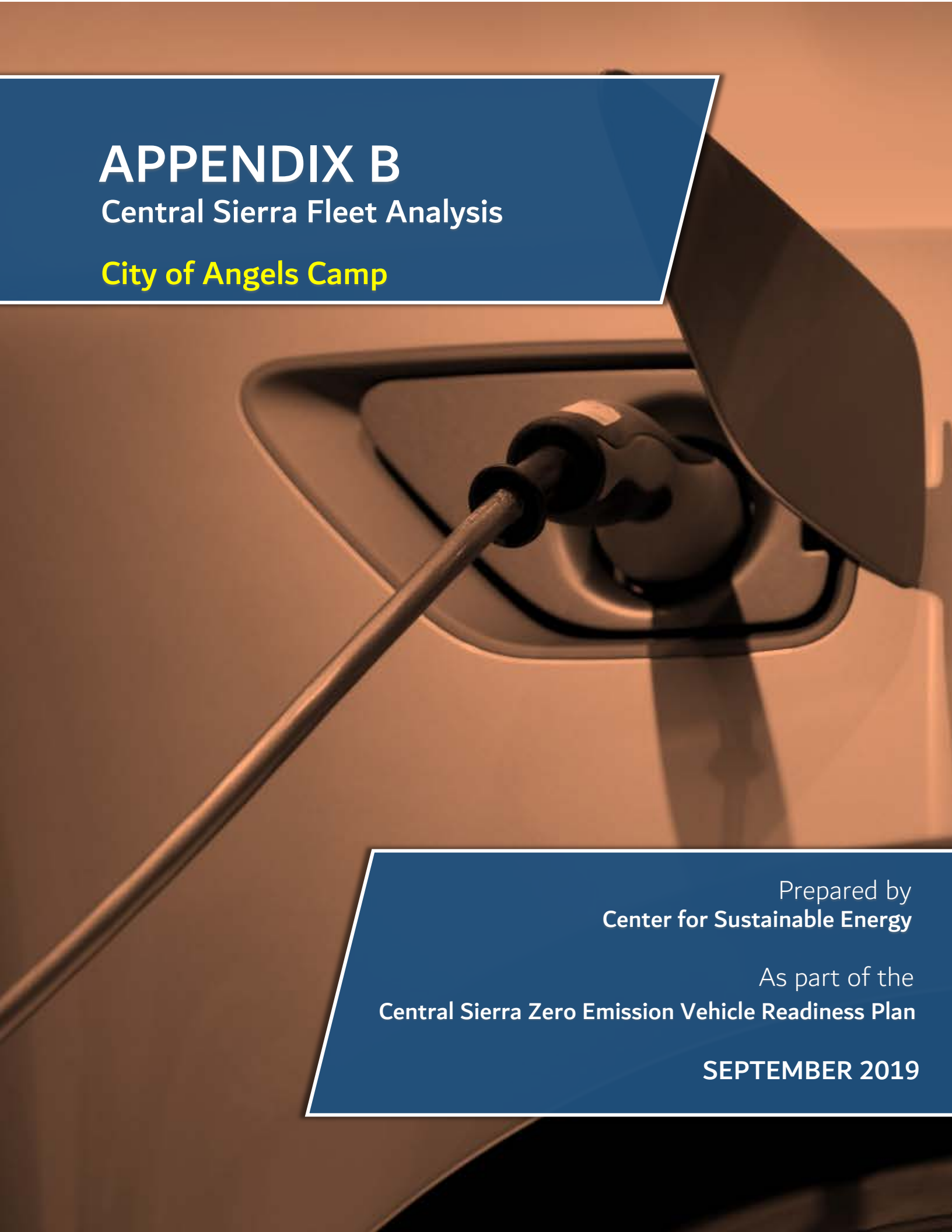

APPENDIX B

Central Sierra Fleet Analysis

City of Angels Camp

Prepared by

Center for Sustainable Energy

As part of the

Central Sierra Zero Emission Vehicle Readiness Plan

SEPTEMBER 2019

I. Introduction

Governor Edmund G. Brown Jr.'s Executive Order B-48-18 committed to a target of 5 million zero-emission vehicles (ZEVs) registered and operating on California roads by 2030. As part of the Central Sierra region's (Region) efforts to comply with the mandates of the Executive Order, the Tuolumne County Transportation Council (TCTC) engaged the Center for Sustainable Energy (CSE) to develop a ZEV Readiness Plan (the Plan) for the four-county Central Sierra region, consisting of the counties of Alpine, Amador, Calaveras, and Tuolumne.The goal of the Plan is to improve opportunities for ZEV Readiness in the Region and resolve barriers to the widespread deployment of private and public ZEV infrastructure. In pursuit of this goal, the City of Angels Camp's fleet was analyzed to identify opportunities for electrification. The analysis focused on the following:

- Analyzing the current fleet and identifying inventorythat can be replaced with electric or plug-in hybrid alternatives.
- Estimate the capital cost to replace current/future vehicles with electric or plug-in hybrid alternatives. Identify incentives and other cost savings associated with fleet transition.
- Discuss benefits of replacing internal combustion vehicles with ZEVs.

Findings

- The estimated total cost of replacing 13 vehicles with similar, 2019 model-year internal combustion vehicles is approximately $440,000. Of these 13 vehicles, all have appropriate BEV replacements and 12 have appropriate PHEV replacements.
- The following two replacement scenarios (a full-BEV scenario and a PHEV-BEV mix) were identified to provide options for TCT fleet transition:
    - **BEV-Only Scenario**: Replace all eligible vehicles with fully electric alternatives. This will cost approximately $1.31 million (an incremental cost of $866,000), save up to $86,000 in fuel costs and abate 2,008 tonnes of GHGs over the vehicles' assumed lifetime of ten years.
    - **PHEV-BEV Scenario:** Replace two eligible vehicles with PHEVs and replace all others with BEVs. This will cost approximately $779,895 (an incremental cost of $311,095), save up to $78,230 in fuel costs and abate 863 tonnes of greenhouse gases (GHGs) over the vehicles assumed lifetime of ten years.
- Payback periods were universally upwards of 15 years. Light-duty PHEV vehicles tended to display the best payback: the plug-in hybrid F250s driven 9,000 miles annually and the plug-in hybrid F150s are closest to payback. More comprehensive results are illustrated in Tables 3a and 3b.
- BEVs/PHEVs typically have lower maintenance requirements/costs, compared to internal combustion engine vehicles, but specific savings are difficult to predict given the nascent state of the market.
- Benefits of converting to ZEVs include reduced environmental impact, reduced maintenance costs, and achieving/maintaining regulatory compliance.

II. Current Fleet Replacement Analysis

CSE examined the City's current fleet inventory to determine which vehicles may have suitable electric replacement options. This analysis found that there are **13 total vehicles (5 unique models)** that can be replaced with electric vehicles. Table 1, below, shows the vehicles which were identified as having a suitable electric replacement option:

Table 1: Existing fleet vehicles with suitable replacement options (PHEV and/or BEV)

Count of Vehicles	Model Year	Make	Model	Classification	Suitability of Available Replacement (BEV/PHEV)
5	1997-2007	Dodge, Ford	Dakota, Ranger	Light Small Pickup	Moderate/High
2	1997	Ford	F-250	Light Fullsize Pickup	Moderate/High
2	1990-2008	Ford	F-350	Medium Duty Gas Pickup	Moderate/High
3	2010-2013	Chevrolet, Ford	Silverado 2500HD, F-350	Medium Duty Diesel Pickup	Moderate/High
1	2005	International	4200	Heavy Duty Truck	Moderate/None

Please note that the recommendations outlined in section 3 are general recommendations based on vehicle size and weight, and may not be direct replacements due to variations in requirements for duty cycle, passenger capacity, and/or other specific considerations. For more information and additional alternatives, please see the Internal Combustion Vehicle Replacement Guide (enclosed as an attachment to the original email). Please assess your fleet's unique needs as thoroughly as possible through data and use monitoring and carefully considering each vehicle's unique service requirements.

III. Replacement Strategy

Vehicles

Each vehicle identified in Table 1 has a replacement option, however, some are more cost-effective than others. Specifically, recommendations for replacement of light-duty trucks are less cost-effective and offer fewer options than recommendations for replacing sedans. That being said, electric light-duty truck

options are rapidly being released to the market and we expect that there will be more options available within ten years.

Two replacement strategies were developed to provide Angels Camp with an all BEV replacement option and a BEV/PHEV option, which will require less capital investment and increase fleet resiliency. In the first scenario, all the eligible vehicles are replaced with BEVs, which maximizes the potential greenhouse gas reductions but will require the greatest capital investment. This scenario is depicted in Table 2a. Table 2b depicts the second scenario where a mix of BEV and PHEVs is identified. Tables 3a and 3b show the existing vehicles, their associated BEV/PHEV replacement vehicles, the estimated vehicle-life and entire-class fuel cost savings, and abated greenhouse gas emissions resulting from converting the entire vehicle class.

Table 2a: BEV-only fleet replacement scenario (cost)

Count	Class	BEV/ PHEV	Proposed Make and Model	ICE MSRP (unit)	ZEV MSRP (unit)	Incremental Cost (unit)	Cost of ZEV Replacement	Potential Incentives
5	Light Small Gas Pickup	BEV	Lightning Systems Ford Transit 350HD Passenger Van with LightningElectric Drivetrain	$25,000	$139,273	$114,273	$696,365	$50,000 x5 = $250,000
2	Light Fullsize Gas Pickup	BEV	Lightning Systems Ford Transit 350HD Passenger Van with LightningElectric Drivetrain	$25,000	$139,273	$114,273	$278,546	$50,000 x2 = $100,000
2	Medium Gas Pickup	BEV	Motiv Epic 4 Dearborn Pickup Body	$38,000	$188,570	$150,570	$377,140	$80,000 x2 = $160,000
3	Medium Diesel Pickup	BEV	Motiv Epic 4 Dearborn Pickup Body	$38,000	$188,570	$150,570	$565,710	$80,000 x3 = $240,000
1	Heavy Diesel Truck	BEV	Motiv Epic 6 F53 Work Body	$75,000	$228,095	$153,095	$228,095	$90,000 x1 = $90,000
					Subtotal	**$1,705,856**	**$2,145,856**	**$840,000**
						TOTAL INCREMENTAL COST (Incremental Cost – Incentives)		**$865,856**

*Costs are for chassis only. Representative models have not been tested by Altoona.

Table 1b: (2) PHEV – (20) BEV fleet replacement scenario (cost)

Count	Class	BEV/PHEV	Proposed Make and Model	ICE MSRP (unit)	ZEV MSRP (unit)	Incremental Cost (unit)	Cost of ZEV Replacement	Potential Incentives
5	Light Small Gas Pickup	PHEV	XL Hybrids Ford F-150 with XLP Plug-In Hybrid Upfit	$25,000	$50,000	$25,000	$684,285	$2,000 x5 = $10,000
2	Light Fullsize Gas Pickup	PHEV	XL Hybrids Ford F-250 PHEV	$38,400	$63,400	$25,000	$1,140,475	$6,000 x2 = $12,000
2	Medium Gas Pickup	PHEV	XL Hybrids Ford F-250 PHEV	$38,400	$63,400	$25,000	$2,262,840	$6,000 x2 = $12,000
3	Medium Diesel Pickup	PHEV	XL Hybrids Ford F-250 PHEV	$38,400	$63,400	$25,000	$27,400	$6,000 x3 = $18,000
1	Heavy Diesel Truck	BEV	Motiv Epic 6 F53 Work Body	$75,000	$228,095	$153,095	$228,095	$90,000 x1 = $90,000
					Subtotal	**$453,095**	**$921,895**	**$142,000**
						TOTAL INCREMENTAL COST (Incremental Cost – Incentives)		**$311,095**

*Costs are for chassis only. Representative models have not been tested by Altoona.

Table 3a: Battery-electric vehicle replacement table

Fully Electric Options								
Car Class	**Representative Model Being Replaced**	**Replacement Vehicle**	**Quantity of Eligible Vehicles in Class**	**Estimated Per-Vehicle Annual Fuel Savings**	**Vehicle Lifetime Savings**	**Estimated Payback Period (Years)**	**Total Class Lifetime Fuel Savings**	**Total Class Lifetime GHG Savings (tonnes)**
Light Small Gas Pickup	Dodge Dakota	Lightning Systems Ford Transit 350HD Passenger Van with LightningElectric Drivetrain	5	$846.89	$9,273.20	>15 years	$46,365.99	243.89
Light Fullsize Gas Pickup	Ford F-250	Lightning Systems Ford Transit 350HD Passenger Van with LightningElectric Drivetrain	2	$486.60	$5,328.17	>15 years	$10,656.33	46.41
Medium Gas Pickup	Ford F-350	Motiv Epic 4 Dearborn Pickup Body	2	$816.60	$8,941.54	>15 years	$17,883.08	131.70
Medium Diesel Pickup	Chevrolet 2500HD	Motiv Epic 4 Dearborn Pickup Body	3	$315.55	$3,455.23	>15 years	$10,365.68	141.37
Heavy Diesel Truck	International 4200	Motiv Epic 6 F53 Work Body	1	$70.08	$767.39	>15 years	$767.39	8.51

Table 2b: Plug-in hybrid vehicle replacement table

Table 3b: PHEV/HEV fleet replacement scenario (benefits)

Plug-in Hybrid Options								
Car Class	**Representative Model Being Replaced**	**Replacement Vehicle**	**Quantity of Eligible Vehicles in Class**	**Estimated Per-Vehicle Annual Fuel Savings**	**Vehicle Lifetime Savings**	**Estimated Payback Period (Years)**	**Total Class Lifetime Fuel Savings**	**Total Class Lifetime GHG Savings (tonnes)**
Light Small Gas Pickup	Dodge Dakota	XL Hybrids Ford F-150 with XLP Plug-In Hybrid Upfit	5	$717.01	$5,736.11	4.18	$5,736.11	106.70
Light Fullsize Gas Pickup	Ford F-250	XL Hybrids Ford F-250 PHEV	2	$233.89	$1,871.14	12.83	$1,871.14	13.92
Medium Gas Pickup	Ford F-350	XL Hybrids Ford F-250 PHEV	2	$654.23	$5,233.85	8.02	$5,233.85	62.35
Medium Diesel Pickup	Chevrolet 2500HD	XL Hybrids Ford F-250 PHEV	3	$270.00	$2,160.00	19.44	$2,160.00	43.50

The City of Angels Camp has access to low-cost, zero-carbon electricity from the New Melones Dam. As such, the Estimated Per-Vehicle Annual Fuel Savings; Vehicle Lifetime Savings; Estimated Payback Period; Total Class Lifetime Fuel Savings; and Total Class Lifetime GHG Savings reflects operating the vehicles using Tuolumne Public Power Agency energy.

The following assumptions (Table 4) were incorporated in the above tables:

Table 4: Assumptions underpinning tables 3a and 3b (above)

Assumption	Value
Vehicle Service Life*	10 years
Gasoline Price ($/gallon)	$2.95
Gasoline GHG Intensity (kg CO2e/gallon)	8.78 kg
Diesel Price ($/gallon)	$2.70
Diesel GHG Intensity (kg CO2e/gallon)	10.21 kg
Electricity Price † ($/kWh)	$0.110
Electricity GHG Intensity † (kg CO2e/kWh)	0 kg
*Vehicles are frequently kept longer than this value, providing further savings on fuel and GHG abatement † Second number reflects electricity from the New Melones Dam, as applicable	

In general, heavy-duty vehicles are relatively well represented within the battery-electric vehicle market, but certain niches are difficult to replace. For example, cutaway bus models are now on the market, but tend to be rare. Specific suitability depends on several variables, including terrain, use intensity, and passenger capacity requirements. Plug-in hybrid heavy-duty vehicles, such as school buses, are even rarer, and thus are typically excluded from the analysis.

Furthermore, plug-in vehicle costs are significantly higher than gas-powered comparisons. It should be noted that costs outlined within these tables are incremental costs, i.e. a vehicle with an incremental cost value of $0 means that after incentives are factored in, the cost of procuring that vehicle is not more than simply purchasing a direct replacement vehicle.

The vehicle replacement analysis used average fuel prices as reported by the Tuolumne County Transportation Council, and divided the fleet's vehicles into classes shown above, using a representative vehicle's mileage and fuel consumption to reflect the "typical" vehicle within each class. The representative vehicle was then compared to the replacement plug-in vehicle.

The City of Angel Camp's fleet is composed primarily of light and medium-duty pickup trucks in both diesel- and gas-powered forms. While these pickups represent a significant portion of the vehicle market in the United States, there are few examples of dedicated electric pickup trucks commercially available as of writing. The fully-electric vehicles recommended in this analysis are pickup bodies on multipurpose platforms, and as semi-custom builds, are typically priced significantly higher than a future mass-market EV truck will be.

In general, vehicles with payback periods longer than 15 years may not offer a good economic return, but can still offer fuel savings, reduce greenhouse gas emissions, and position the fleet as a forward-thinking, environmentally conscious entity.

Other Considerations

The procurement of plug-in vehicles should be straightforward, and in many cases does not differ significantly from the procurement process for internal-combustion vehicles. More specialized applications (e.g. custom moderate-to-heavy duty and coach-bodied buses) may require direct communication with a manufacturer or an authorized retailer. Authorized retailers are typically listed on manufacturer websites. Some EVs are available and eligible for reduced cooperative purchase through organizations such as Sourcewell. Incentives outlined below as section 4 offer the ability to lower the upfront cost of procurement but may be subject to additional stipulations and conditions. Due to the size of Tuolumne County's fleet and the high proportion of light-duty vehicles, significant cost savings over direct ownership may be realized if leasing vehicles becomes an option, which would allow for federal incentives to be passed through to the County.

Angel's Camp should carefully evaluate all fuel types and available incentives when vehicle replacement decisions are made. California offers rebates and incentives for alternative fuel vehicles and infrastructure: currently available incentives are outlined later in this chapter.

Accessible charging and fueling infrastructure are crucial for successfully incorporating ZEVs into fleets. It is a best practice to evaluate, site, and construct enough infrastructure prior to adding ZEV vehicles. Ideally, electricity demand evaluations are completed, and the appropriate number of charging/fueling stations are installed before vehicles are ordered. While charging at lower power levels (2kW - 7 kW) is adequate for the small batteries found in passenger cars, vehicles with high gross vehicle weights typically require larger batteries. These large vehicles may require higher-powered charging (30kW – 500kW) in applications that require minimal downtime.

IV. Incentives

a. Low Carbon Transportation Funding

The California Energy Commission (CEC) and ARB offer alternative transportation grants and rebates through under the Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP) and other low carbon transportation funding. Funding is allocated annually and the 2019-2020 budget for the CEC ARFVTP Program (www.energy.ca.gov/altfuels/) is approximately $95.2 million. ARB managed about $400 million in rebates and projects in FY 2017-18 and 2018-19 through the Air Quality Improvement Program/ Low Carbon Transportation funding plan (www.arb.ca.gov/msprog/aqip/aqip.htm).

The calculations that underpin Tables 2a and 2b use the California Hybrid Truck and Bus Voucher Incentive Project (HVIP) program to offset the incremental cost of electrified buses and trucks. Similarly, the federal $7,500 tax credit is combined with incentives from the Clean Vehicle Rebate Program to offset the incremental cost of electrified or PHEV light-duty vehicles.

Clean Vehicle Rebate Project (CVRP)

CSE manages ARB's Clean Vehicle Rebate Project (CVRP) (https://cleanvehiclerebate.org/), which provides rebates of up to $2,500 for light duty battery electric and plug-in hybrid vehicle purchases. CSE received $120 million in funding for FY 2018-2019. Table 4, *CVRP Rebate Amounts for Light-Duty Vehicles,* summarizes the rebates available.

Table 5: CVRP rebate amounts for light-duty vehicles

Vehicle Class	Maximum Incentive
Light duty zero emission vehicles (ZEV)	$2,500
Plug-in hybrid electric vehicles (PHEV)	$1,500
Zero emission motorcycles (ZEM)	$ 900
Neighborhood electric vehicles (NEV)	$ 900
Note: Eligible vehicles and associated rebate amounts are subject to change. Visit the CVRP program site for eligible vehicle models and associated rebates.	

Hybrid Truck and Bus Voucher Incentive Project (HVIP)

Rebates for commercial vehicles including trucks and buses are available through ARB's Hybrid Truck and Bus Voucher Incentive Project (HVIP) (www.californiahvip.org). As of May 2019, the HVIP estimated fund balance was over $57 million. A summary of the incentives available is provided in the ARB HVIP Voucher Amounts for Trucks and Buses tables below. Additional incentives are available for transit buses, vehicle conversions, and in disadvantaged communities.

Table 6: HVIP Voucher Amounts for *Zero-Emissions* Trucks & Buses

Gross Vehicle Weight (in pounds)	HVIP Maximum Voucher
5,001 – 8,500 lbs	$20,000
8,501 – 10,000 lbs	$25,000
10,001 – 14,000 lbs	$50,000
14,001 – 19,500 lbs	$80,000
19,501 – 26,000 lbs	$90,000
26,001 – 33,000 lbs	$95,000
> 33,001 lbs	$150,000

Table 7. Maximum HVIP Voucher Amounts for *Hybrid* Trucks & Buses

Gross Vehicle Weight (in pounds)	HVIP Maximum Voucher
6,001 – 8,500 lbs	$2,000
8,500 – 10,000 lbs	$6,000
10,001 – 19,500 lbs	$9,000
19,501 – 26,000 lbs	$12,000
26,001 – 33,000 lbs	$15,000
> 33,000 lbs	$18,000

Note that HVIP additionally provides incentives for electric vehicle charging infrastructure, as outlined in the following Infrastructure section.

Additional Funding Avenues (Vehicles)

Volkswagen Settlement Funding

The Volkswagen Environmental Mitigation trust provides $130 million to the state of California to "replace eligible Class 4-8 school, transit, and shuttle buses with new, commercially available, zero-emission technologies" (Air Resources Board, 2018). A school bus is eligible for a maximum incentive of $400,000; a transit bus is eligible for a maximum incentive of $180,000 (battery electric) or $400,000 (fuel cell); and a shuttle bus is eligible for a maximum incentive of $160,000. All of these awards additionally cover supportive infrastructure. For more information, please visit https://ww2.arb.ca.gov/resources/documents/californias-beneficiary-mitigation-plan

NOTE: VW Mitigation Funds are not stackable with HVIP funds; it is an either/or rebate.

b. Infrastructure

This analysis only covers the costs and fuel savings associated with the ownership and operation of fleet vehicles themselves. Another crucial component of electrification is the presence of reliable onsite charging infrastructure to ensure that vehicles are present and fueled when they are needed. Table 7, below, outlines the range of costs for the first EVCS port (plug) installed at a given site. Table 8 outlines specific installation variables that are incorporated into the "installation" cost element shown in Table 7. Note that many buses use DC Fast Charging as their default charging method.

Table 8: Approximate costs for non-residential, single-port electric vehicle charging stations (EVCS).
Cost data from Dept. of Energy (2015)

Cost Element	Level 1		Level 2		DC Fast Charge	
	Low	High	Low	High	Low	High
Hardware	$300	$1,500	$400	$6,500	$10,000	$40,000
Permitting	$100	$500	$100	$1,000	$500	$1,000
Installation	$0*	$3,000	$600	$12,700	$8,500	$51,000
Total	$400	$5,000	$1,100	$20,200	$19,000	$92,200

Table 9: Installation component cost ranges
Cost data from SANDAG (2016)

Cost Element	Cost
Conduit	$1.50-$2.50/ft
Trenching	$25-$100/ft
Concrete Patch	$14-$15/sq.ft
Asphalt Patch	$10-$11/sq.ft

Several funding programs exist to reduce the overall cost of installing EVCS at sites.

California Hybrid Truck and Bus Voucher Incentive Program (HVIP)

The HVIP program offers a voucher enhancement of up to $30,000 per vehicle voucher received to reduce the cost of installing EV infrastructure intended to support the ordered vehicles. The enhancements require a separate application, are approved on a case-by-case basis, and can be combined with other funding sources to cover up to 100% of the total capital cost of installation.

Pacific Gas and Electric (PG&E)

PG&E administers two currently active funding programs for electric vehicle infrastructure. These programs include the FleetReady Program, Fast Charge Program and EV Charge Network Program.

- **EV Fleet** – Starting in May 2019. PG&E received $236 million in eligible funds from the California Public Utilities Commission (CPUC) for infrastructure supporting fleet vehicle charging. PG&E is working with fleet managers that request funding across Northern and Central California to install EVCS at 700 sites (pge.com/fleetready).

- **Fast Charge Program** – Starting in summer 2019. PG&E will fund and build infrastructure for public DCFCs, including 25% located within DACs. Furthermore, PG&E will offer rebates for customers in disadvantaged communities (DACs) who wish to purchase DCFCs (CPUC Approves New PG&E Projects to Help Accelerate Electric Vehicle Adoption in California, 2018).

California Electric Vehicle Infrastructure Program (CALeVIP)

CALeVIP offers financial incentives for eligible EVCS infrastructure installations, and works with local governments and community partners to develop regional EV charging projects statewide. CSE manages each regional project, distributes rebates, and provides outreach and informational materials to assist property owners and service providers. Though funding is not available in the current 2019-2020 funding cycle for the Central Sierra region, new projects are added periodically and the region may be included in future funding. For more information, please see the CALeVIP website and browse the currently available projects.

Congestion Mitigation and Air Quality Improvement (CMAQ) Program

The FAST Act authorizes funding of $2.3 billion to $2.5 billion to the CMAQ program for apportionment to the states. States, local governments and transit agencies can use these funds to invest in transportation projects that support the Clean Air Act. Projects eligible for the funds include alternative fuel vehicles and infrastructure. A project supported with CMAQ funds must demonstrate that the project reduces emissions, is located in, or benefits an EPA designated nonattainment or maintenance area and is a transportation project (23 U.S.C. 149) (Federal Highway Administration, 2017). Projects located on FAST-designated corridors (including US 395 and SR 120) receive funding priority over those not located on these corridors.

Note: under the current Buy America requirements that apply to projects funded through this avenue, CMAQ funds may prove prohibitively difficult to utilize.

Volkswagen Settlement

- *Electrify America*
  The Electrify America program is a subsidiary of Volkswagen with the goal of investing $800 million into zero-emission vehicle projects between 2017 and 2027. This investment has typically been into Level 2 and DC Fast Charge infrastructure. Communities can suggest locations, but final siting decisions are ultimately up to Volkswagen/Electrify America.
- *California Volkswagen Mitigation*
  The Volkswagen Environmental Mitigation Trust provides approximately $423 million for California to mitigate the additional NOx emissions from diesel Volkswagen vehicles equipped with defeat devices. As part of this, $5 million will be allocated in a competitive solicitation for EV infrastructure buildout. The funding cycle will begin inviting solicitations in Q3/Q4 2019 with the goal of filling physical and funding gaps in installed EVCS.

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