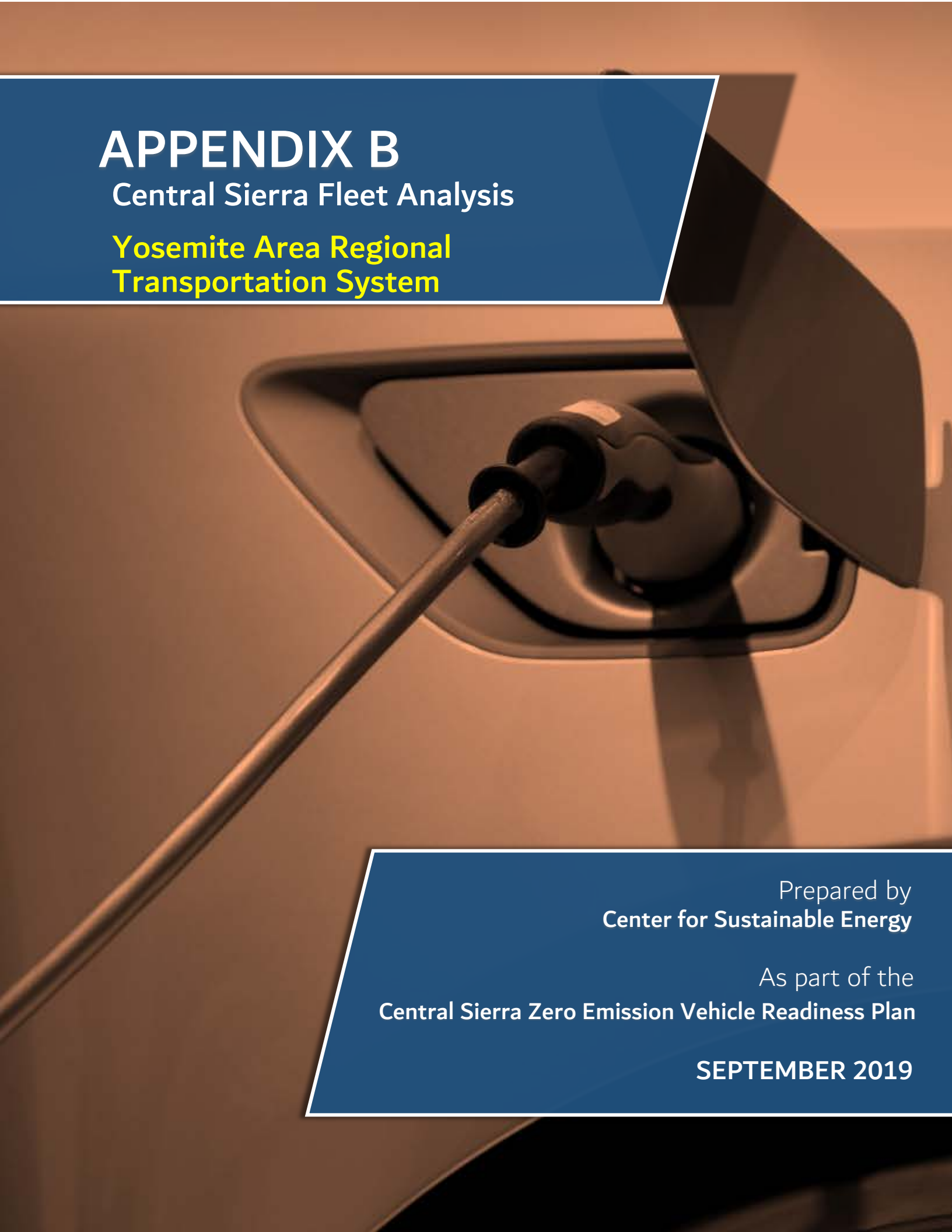

APPENDIX B

Central Sierra Fleet Analysis

Yosemite Area Regional Transportation System

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 Yosemite Community College fleet was analyzed to identify opportunities for electrification. The analysis focused on the following:

- Analyzing the current fleet and identifying inventory that 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 10 vehicles with similar, 2019 model-year internal combustion vehicles is approximately $2.8 million. Of these 10 vehicles, all have appropriate BEV replacements and none have appropriate PHEV replacements.
- The following replacement scenarios (two full-BEV scenarios) were identified to provide options for YARTS fleet transition:
    - **BEV-Only Scenario (40' Bus, direct replacement)**: Replace 10 eligible vehicles with fully electric alternatives. This will cost approximately $6.29 million (an incremental cost of $1.99 million), save up to $473,300 in fuel costs and abate 1,070 tonnes of GHGs over the vehicles' assumed lifetime of ten years.
    - **BEV-Only Scenarios (35' Bus, downsize):** Replace 10 eligible vehicles with BEVs. This will cost approximately $4.75 million (an incremental cost of $1.05 million), save up to $3.35 million in fuel costs and abate 1,584 tonnes of greenhouse gases (GHGs) over the vehicles' assumed lifetime of ten years.
- Payback periods for both buses were well upwards of 15 years. However, transit agencies of YARTS's size are required to ensure that a portion of their new procurements are zero-emission buses beginning in 2026. More comprehensive economic results are illustrated in Table 3.
- 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 Yosemite Area Regional Transportation System's (YARTS) current fleet inventory to determine which vehicles may have suitable electric replacement options. This analysis found that there are **10 total vehicles (all heavy duty motor coaches)** that can be replaced with electric vehicles. Table 1 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	Class	Suitability of Available Replacement (BEV/PHEV)
10	~2010	MCI	D4500	Heavy Duty Diesel Bus	High/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 Options

While there are electric buses now available from multiple manufacturers, some may be more cost-effective than others. Specifically, vehicles would need to be matched to the range and performance requirements of the given routes, and it is likely longer range, more expensive buses would be required. However, electric options are beginning to drop in price and we expect that there will be many more options available within the next ten years. The vehicles identified as having suitable electrified replacements are listed in Table 2 on the next page.

Table 2: 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
10	Heavy Duty Diesel Bus	BEV	BYD K9 40' All-Electric Transit Bus*	$280,000	$779,000	$349,000	$7,790,000	$150,000 x10 = $1,500,000
					Subtotal	**$3,490,000**	**$7,790,000**	**$1,500,000**

*Underwent Altoona testing in 2013: http://apps.altoonabustest.psu.edu/buses/reports/441.pdf?1423598436

Alternate Vehicles

Count	Class	BEV/ PHEV	Proposed Make and Model	ICE MSRP (unit)	ZEV MSRP (unit)	Incremental Cost (unit)	Cost of ZEV Replacement	Potential Incentives
10	Heavy Duty Diesel Bus	BEV	BYD K9S 35’ All-Electric Transit Bus†	$250,000	$595,000	$225,000	$5,950,000	$120,000 x10 = $1,200,000
					Subtotal	**$2,250,000**	**$5,950,000**	**$1,200,000**

†Alternate. Has not undergone Altoona testing as of August 2019

Table 3: 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)**
Heavy Diesel	MCI D4500	BYD K9 40' All-Electric Transit Bus*	10	$432.26	$4,733.11	>15	$473,311	1071.02
Heavy Diesel	MCI D4500	BYD K9S 35’ All-Electric Transit Bus†	10	$3,056.52	$33,468.06	>15	$3,346,806	1583.95

*Underwent Altoona testing in 2013: http://apps.altoonabustest.psu.edu/buses/reports/441.pdf?1423598436

†Alternate. Has not undergone Altoona testing as of August 2019

Table 3 (above) show 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.

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

Table 4: Assumptions underpinning table 3 (above)

Assumption	Value
Vehicle Service Life*	10 years
Diesel Price ($/gallon)	$2.70
Diesel GHG Intensity (kg CO2e/gallon)	10.21 kg
Electricity Price ($/kWh)	$0.167
Electricity GHG Intensity (kg CO2e/kWh)	0.215 kg
*Vehicles are frequently kept longer than this value, providing further savings on fuel and GHG abatement	

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.

With a fleet consisting entirely of heavy-duty diesel buses, the Yosemite Area Regional Transit System has significant opportunity to reduce operating costs and GHG emissions by pursuing BEV replacements. Newer model years should be lower priority than older vehicles, but do represent similar opportunity for savings.

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.

The procurement of 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.

The Yosemite Area Regional Transit System 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. Innovative Clean Transit Regulations

Transit buses represent an important opportunity to advance clean transportation technologies and fleet sustainability goals, as they are stored and fueled in central locations and benefit from government funding and support. Lessons learned by deploying new technologies in public fleets will aid in their deployment elsewhere in the transportation sector.

The California Air Resources Board Innovative Clean Transit regulation was designed to provide transit agencies with a target and roadmap for meeting the State's air quality, climate, and public health protection targets. With a goal of transitioning to zero-emission technologies by 2040, the rule requires each transit agency to develop a rollout plan detailing how it plans to purchase clean buses, build out necessary infrastructure and train the required workforce. All transit agencies covered in this report qualify as small transit agencies under the rule, allowing for a more gradual transition away from conventionally fueled buses. Each agency is required to submit a ZEB purchase and deployment plan for transit board approval. For small transit agencies, these plans are due on June 30, 2023. Key plan elements include:

- Identification of zero-emission technologies targeted for deployment
- Plan for build out of charging and/or fueling infrastructure
- Planned schedule for bus procurement
- Planned schedule for training of bus operators and technicians
- Identification of potential funding sources

The regulation includes a phased ZEB rollout requirement, illustrated in Table 5:

Table 5: Zero-emission bus purchase requirements

Calendar Year	ZEB Percentage of New Bus Purchases	
	Large Transit Agency	Small Transit Agency
2023*	25%	-
2024*	25%	-
2025	25%	-
2026	50%	25%
2027	50%	25%
2028	50%	25%
2029 and after	100%	100%

* Potential waiver for early compliance

Purchase begins on the date of a Notice to Proceed (NTP) agreement with the bus manufacturer. All buses must be delivered within two years of NTP issuance. Compliance determination is made by December 31 of each year. Recognizing that for many agencies, and for small transit agencies in particular, procurement of ZEBs represents a significant logistical and financial hurdle, CARB has included a number of alternative compliance options and potential circumstantial alterations to the ZEB rollout requirements. Those alternatives that we have identified as potentially useful for Central Sierra Fleets are included in table 6 below. Important potential rule alterations are included.

Table 6: Alternative compliance options and potential rule changes

Alternative Compliance options		
Alternative compliance option	**Description**	**Stipulations/considerations**
Zero-emissions mobility program credits	Transit agencies may earn ZEB purchase credits for other zero emission mobility programs such as bicycles, van pools, and micro transit.	• Vehicles must have a gross vehicle weight rating (GVWR) of 14,000 lbs or less • Vehicles must be operated directly by or through a contractor with the transit agency • Annual zero-emission passenger miles must be tracked and recorded
Service conditions bonus credits	Bonus compliance may be received for each ZEB placed in revenue service under one of the conditions listed	• 2 bonus credits for each fuel cell electric bus (FCEB) placed in service on or before 12/31/2017 and remaining in service as of Jan 1/1/2018 • 1 bonus credit for each FCEB placed in service between 1/1/2018 and 1/1/2023 • 1 bonus credit for each battery electric bus (BEB) placed in service on or before 12/31/2017 and remaining in service as of 1/1/2018 • Each bonus credit is counted the same as a ZEB in the fleet ○ Credits expire on 12/31/2028, and are not transferable
Joint Zero Emission Bus Groups	Agencies may form Joint Zero Emission Bus Groups to pool resources under one of the conditions listed	• Share the same Metropolitan Planning Organization, or; • Transportation Planning Agency, or; • are located within the same Air Basin • The total annual ZEB purchased collectively must equal the sum of the total annual ZEBs required to purchased by each participating transit agency
Potential rule changes and compliance extension/exemption criteria		
The 2023 ZEB purchase requirement percentage will be waived if California transit agencies have collectively purchased 1,000 or more ZEBs by December 31, 2020. Current ZEB order and deployment information can be found on CARB's Innovative Clean Transit website (https://arb.ca.gov/msprog/bus/faqactoverview_1.pdf)		
Cutaway buses, motor coaches, and articulated buses will be excluded until January 1, 2026 and until the applicable bus type has passed and obtained an Altoona bus testing report.		
A transit agency may request a compliance extension under the following conditions: • Delay in the bus delivery is caused by the bus manufacturer • Delay in bus delivery is caused by setback of infrastructure construction schedule • When an available depot charging BEB cannot meet a transit agency's daily mileage needs		
A transit agency may request a compliance exemption required zero-emission bus type is not available for purchase.		

Yosemite Area Regional Transportation System (YARTS)

Operating 20 total vehicles (10 owned and 10 leased), Yosemite Area Regional Transportation System is classified as a small transit organization, with a rollout plan due by 2023. Starting on January 1, 2026, 25% of new bus purchases must be ZEBs; starting January 1, 2029, all new purchases must be ZEBs (CARB §

2023.1., 2018). If no eligible cutaway buses, motor coaches, or articulated buses have undergone Altoona bus testing and received a report by January 1, 2029, these bus types will be excluded from the mandate until options are available. Note that one of the above recommended models (BYD K9) has undergone the Altoona bus test, while the other (BYD K9S) has not.

V. 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 Table 3 uses 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.

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 September 2019, the HVIP estimated fund balance has been exhausted and a waitlist is in effect, but additional funding is expected in January 2020. 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 7: 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 8. 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.

Federal Transit Administration Low- or No-Emission Program Funding

The Low- or No-Emission Competitive program (Low-No program) is funded by the Fixing America's Surface Transportation (FAST) Act, which provides $55 million in competitive funds per year until fiscal year 2020. The program covers funding for the purchase or lease of low- or zero-emission transit buses, as well as the acquisition, construction, and/or leasing of supporting infrastructure (FTA 2018). Transit agencies will be responsible for at least 15% of transit bus cost, and 10% of project cost for infrastructure and/or facilities. For more information, please visit https://www.transit.dot.gov/funding/grants/lowno.

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 8, below, outlines the range of costs for the first EVCS port (plug) installed at a given site. Table 9 outlines specific installation variables that are incorporated into the "installation" cost element shown in Table 8. Note that many buses use DC Fast Charging as their default charging method.

Table 9: 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 10: 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 and Fast Charge 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. Part of Electrify America's second cycle (2019-2021) of funding will be dedicated to installing charging infrastructure specifically for transit in select communities.

- *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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