June 2023

ShastaConnect Zero-Emission Fleet Transition Rollout Plan

SUBMITTED BY

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Contents

Table of Figures

Table of Tables

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Glossary of Terms and Acronyms

BEV - Battery Electric Vehicle

CARB- California Air Resources Board

CALeVIP - California Electric Vehicle Infrastructure Project incentive program

CTSA - Consolidated Transportation Services Agency

DHCL - Dignity Health Connected Living

FCEV - Hydrogen Fuel Cell Vehicle

H2 - Hydrogen

ICE - Internal Combustion Engine

ICT - Innovative Clean Transit

GVWR - Gross vehicle weight rating

RABA - Redding Area Bus Authority

REU - Redding Electric Utility

SRTA - Shasta Regional Transportation Agency

TNC - Transportation Network Companies

VMT - vehicle-miles traveled

Executive Summary

The California Air Resource Board's (CARB) Innovative Clean Transit (ICT) regulation has mandated that all transit agencies in California transition from internal combustion engine buses (ICEBs) to zero-emission buses (ZEBs) by 2040. For small operators, such as the Shasta Regional Transportation Agency's (SRTA) ShastaConnect service, this transition starts with a requirement that 25% of new bus purchases be ZEB starting in 2026, scaling to 100% of purchases in 2029. Limited exemptions are available if the vehicles with needed capability are not available or if the agency declares financial hardship (See section B).

SRTA (www.srta.ca.gov) is the federally designated metropolitan planning organization (MPO) and state designated regional transportation planning agency (RTPA) for the entire Shasta County region. SRTA's primary purpose is to study and plan for the region's transportation needs, pursue all potential funding sources, and determine what improvements are necessary in partnership with federal, state, regional, local partners and community members. However, for over 20 years the agency has also been tasked with overseeing and contracting out specialized public transportation services, primarily in the Shasta Region's rural areas. While historically represented by different names, today those services are known as ShastaConnect (www.shastaconnect.org).

Currently, the ShastaConnect services are operated by a local non-profit, Dignity Health Connected Living (DHCL), under contract to SRTA. ShastaConnect includes demand responsive service (Dial-a-Ride) to qualified senior and disabled riders throughout the Shasta Region (also known as Consolidated Transportation Services Agency (CTSA) services), outside of the area covered by the Redding Area Bus Authority (RABA), and offers Sunday on-demand service within RABA's service area since RABA does not currently provide public transit on Sundays. DHCL operates 10 vehicles in ShastaConnect Services, all powered by gasoline. These vehicles include cutaways of varying lengths, full-size vans, and one minivan. According to CARB's ICT regulation, as well as the Advanced Clean Fleets (ACF) regulation, all vehicles with a gross vehicle weight rating (GVWR) of over 8,500 pounds will need to be converted to zero emissions.

This plan looks at the requirements for SRTA to transition ShastaConnect to zero emission operations using battery electric vehicles (BEVs), Hydrogen Fuel Cell Electric Vehicles (FCEVs), or some combination of both. Each technology has different operating characteristics, with BEVs generally offering lower cost fueling but more limited range than FCEVs. The plan can be updated every few years to reflect current conditions in the rapidly changing ZEB market.

Figure ES-1 shows that only 29% of current daily trips on ShastaConnect could be comfortably covered by a vehicle with a rated 140 miles of range, and nearly 50% of trips would require a mid-shift charge or vehicle swap.

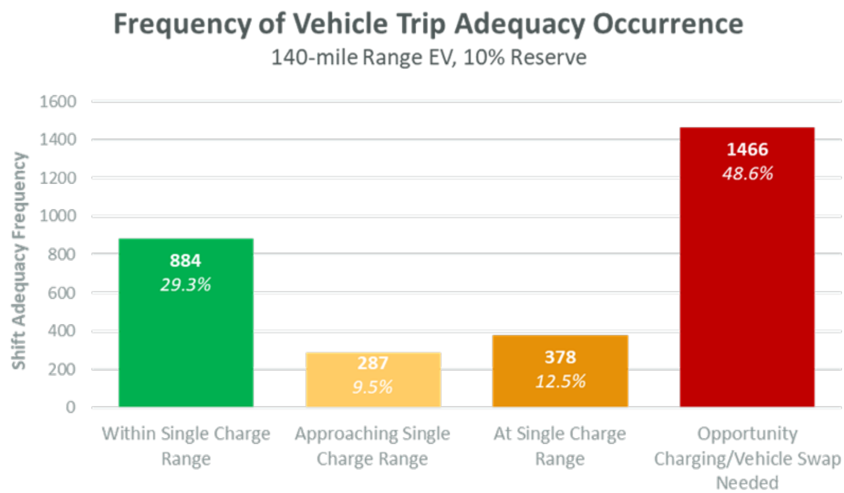

Figure ES- 1: Frequency of daily vehicle shift adequacies - the ability of the vehicle's battery to serve the distance traveled each day

BEVs with longer ranges are expected in the future, although the size and weight of batteries may place practical limits on range. Many BEV cutaway buses are in operation today, but often in local shuttle operations that require less than 100 miles between charging opportunities: for instance, the City of Porterville and City of Auburn operate battery-electric shuttles in interior California. FCEVs are expected to offer 250-300 miles of range before refueling, however these vehicles have not yet been commercially deployed in California in the cutaway bus and van categories. Hydrogen fueling is currently more expensive than gasoline or electricity and would require a reliable local station. However, it's possible that hydrogen fuel costs may reduce to the point they are comparable to gasoline/diesel costs over the next 10-15 years, if the goals of the US Department of Energy's National Clean Hydrogen Strategy and Roadmap efforts are realized. This effort is aimed at encouraging various improvements in hydrogen fuel production and distribution which might result in hydrogen fuel costing $1 per kilogram produced and under $5 per kilogram dispensed within a decade.

Given the relatively small size of the ShastaConnect fleet, regular replacements may not trigger a ZEB purchase requirement until 2030. However, SRTA and DHCL may want to pilot at least one ZEB prior to 2030 to provide more experience and lessons learned to support a full-scale rollout and to make adjustments based on the real-world application of ZEBs in the Shasta Region, including factoring in the region's varying terrain, temperatures, and service operation needs.

Infrastructure is needed to support any ZEB transition. The current DHCL site has existing electrical capacity that could support charging 1-2 BEBs for a pilot deployment. If more ZEBs are deployed for ShastaConnect use, new electrical service from Redding Electric Utility (REU) will need to be added to support charging for the entire fleet. This upgrade is anticipated to cost between $100,000 and $525,000, depending on the number and power levels of charging stations determined to be required. Access to additional public stations throughout the region may also be needed to support mid-day charging.

The Shasta region is already planning for a hydrogen station to support the North State Intercity Bus project. This station may also support hydrogen fueling for RABA and ShastaConnect vehicles. The availability of this station and the potential to collaborate with other regional operators and fuel producers makes hydrogen a compelling choice. Building a hydrogen station for the ShastaConnect fleet alone would be uneconomic, since there is uncertainty about the price and availability of hydrogen fuel, which could be more expensive than gasoline. The potential to produce hydrogen fuel from local biomass would bring more environmental and economic benefits to the region.

SRTA and DHCL staff should continue to monitor trends in vehicle and fuel technology as they seek to transition to a zero-emission fleet. The ShastaConnect operator should continue to work with RABA, other operators, and local government agencies to look at opportunities to collaborate on providing any required training for vehicles, operators, and maintenance staff in the region. Shasta College's Automotive Technology program can serve as a resource to fulfill regional needs for qualified maintenance personnel.

The transition to zero-emissions vehicles will require significant additional capital funding for vehicles and fueling infrastructure, as well as potential increased operating costs for fuel or staff time for managing charging, which far exceeds available formula funding for the region for CTSA and other rural transit needs. SRTA will continue to explore all available funding sources to cover these costs, including competitive grants.

Figure ES-2, below, shows estimated vehicle purchase costs, annual fueling costs, and a 10-year total cost of ownership for gasoline (ICE,) battery electric (EV), and hydrogen FCEVs (H2).

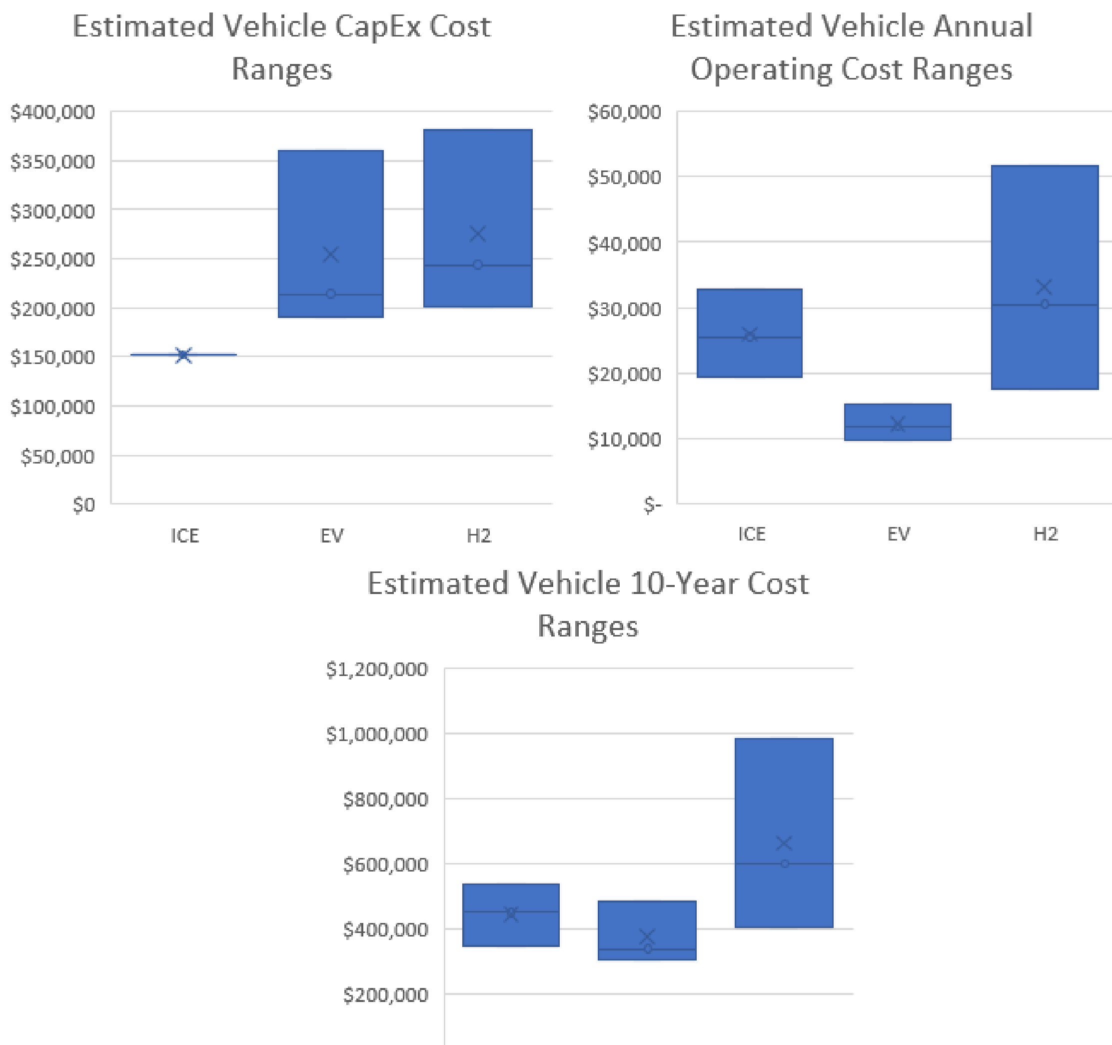

Figure ES- 2: Modeled cost ranges for vehicle capital expenses; annual operating cost ranges; and total 10-year cost ranges.

The total vehicle acquisition costs may increase by between $50,000 - $200,000 per vehicle, depending on fuel technology and other options. While electric fuel tends to be lower cost than gasoline, hydrogen is likely to be more expensive than gasoline under most scenarios. For a fleet of 10 vehicles, the cost of acquiring and operating gasoline (ICE) vehicles is expected to be between $3.5M-$5.4M, over their lifetime. The cost of battery electric vehicles would be $3.1-$4.9M, over their lifetime offsetting their high purchase cost. Electric vehicles would require $100,000 - $525,000 or more for charging infrastructure for the full. Finally hydrogen FCEVs may have a total cost of ownership of between $4.1M-$9.9M, taking into account that a regional hydrogen station may be available.

The Shasta region's varied topography and climate, uncertainty about certain fuel costs and availability of vehicles, along with the unpredictable daily-mileage of vehicles operating on-demand transit services offers challenges. To transition to a zero-emission fleet will require active collaboration between SRTA, DHCL and other region partners over the coming years.

Recommendations

As a result of the analysis presented in the remaining pages of this plan, the following recommendations are provided:

1. Prepare for a full zero emission fleet transition by year 2039 or possibly later, depending on funding, vehicle, and/or other constraints. SRTA should consider a mixed fleet starting with battery electric vehicles and then add hydrogen fuel cell vehicles in later years once hydrogen cutaway buses or vans are commercially available.
2. Pursue competitive funds to implement a pilot zero emission project between 2025 and 2028 that includes a battery electric bus and supporting infrastructure at DHCL's property.
3. Continue efforts to work with RABA and regional partners to build a hydrogen station to support early transit and other local government medium/heavy-duty zero emission vehicle needs.
4. Track funding opportunities and pursue competitive zero emission grants for vehicles, infrastructure, operations, and training to leverage the region's limited formula funds for zero emission efforts.
5. SRTA should work with DHCL, or any future ShastaConnect operator, to ensure they are eligible for FTA grants besides the FTA 5310 program.
6. Engage in discussions with RABA, local government partners, North State transit agencies, and potential education partners to address workforce training needs, challenges, and opportunities. Pursue partnerships where feasible.
7. SRTA should update its zero-emission transition plan every 2-3 years to reflect advancements in the ZEV markets, changes in operational practices, and funding availability, to make sure that planned ZEV procurements include the technology mix that can best meet regional needs.

Section A: Transit Agency Information

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SRTA is part of the Shasta County Air Quality Management District (AQMD) and is located within the Sacramento Valley Air Basin.

Peak Vehicles: 10 (2021)

Population: 182,155 (Shasta County, 2020 Census)

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Shasta Regional Transportation Agency is not part of a Joint Group/Joint Zero-Emission Bus Group.

Section B: Rollout Plan General Information

The Shasta Regional Transportation Agency (SRTA) is the metropolitan planning organization and regional transportation planning agency for the Shasta County region. SRTA contracts with Dignity Health Connected Living (DHCL) for specialized on-demand public transit services (established as the ShastaConnect brand) and is currently exploring its options for transitioning the ShastaConnect fleet to zero-emission technologies by 2040, in compliance with federal and state regulations for public transit services. Under this arrangement, DHCL operates 6 DHCL-owned vehicles and 3 SRTA-owned vehicles under the ShastaConnect banner, providing paratransit and non-paratransit services outside of RABA jurisdiction during weekdays, and both outside and within RABA jurisdiction during Sunday service.

SRTA will avoid early retirement of conventional cutaway transit buses in order to maintain or exceed its current levels of service. Under this transition plan, the last anticipated conventional vehicle purchase (a cutaway bus) would occur in 2028. With an 11-year useful life benchmark, this vehicle would be turned over to a zero-emission equivalent in 2039, achieving full fleet decarbonization.

This report outlines some potential challenges to the ZEB transition including the availability of vehicles with adequate range, the provision of infrastructure, and the cost of this transition. The ICT regulation § 2023.4. provides the following opportunities for exemptions:

1. Delay in bus delivery is caused by ZEB infrastructure construction setbacks beyond the transit agency's control.
2. When available ZEBs cannot meet a transit agency's daily mileage needs (due to operating conditions and the operating range of a ZEB).
3. If available ZEBs do not have adequate gradeability performance to meet the transit agency's daily needs for any bus in its fleet.
4. When a required ZEB type for the applicable weight class based on gross vehicle weight rating (GVWR) is unavailable for purchase.
5. When a ZEB cannot be purchased by a transit agency due to financial hardship.

SRTA would need to provide detailed information requesting any exemptions information to the CARB Executive Officer by November 30 for a given compliance year.

SRTA's Rollout Plan was developed by Energetics, Inc. with assistance from Transportation Management and Design (TMD). The total cost for the creation of the Rollout Plan was approximately $110,000, including extensive outreach and the creation of the ICT and federal ZEB transition plan. A total of 1,050 person-hours were contributed to the development and finalization of the Plan.

SRTA plans to approve the Rollout Plan on June 22, 2023, as resolution 23-07. A copy of the board-approved resolution is attached to this document as appendix A.

Given the rapid development and evolution of the zero-emission vehicle landscape, the plan is anticipated to be updated, at a minimum, every 2-3 years in order to incorporate lessons learned and to adapt to the newest market technologies as they are made available.

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Section C: Technology Portfolio

Shasta Regional Transportation Agency (SRTA) is examining the most beneficial avenues for fleet electrification, and will work with external agencies to deploy infrastructure based on the operational needs of the fleet as vehicles are purchased. There are three primary paths for electrification that can be explored.

1. **Full battery-electrification:** Vehicles will require the roll-out of multiple EV charging stations at strategic locations within SRTA service territory. Electricity is generally expected to be inexpensive compared to conventional fuels and has high potential for local production, but grid power costs may vary significantly between utilities. Additionally, substantial vehicle technology development may be required to support 100% of ShastaConnect vehicle duty cycles. Due to the lower operating cost of battery-electric vehicles, an earlier adoption of EV transit vehicles will result in greater realized fuel cost savings.

2. **Full hydrogen-fuel-cell electrification:** Vehicles will be able to leverage a planned hydrogen fueling station within the Shasta Region. The technology lends itself better to SRTA's current duty cycle length, but fuel-cell vehicles are not currently available in the cutaway bus, van, and light-duty van segments. Additionally, no hydrogen fuel generation is located within 150 miles of the ShastaConnect service region, which may make certain costs prohibitive without a closer fuel provider and/or a competitive hydrogen fuel price contract. Hydrogen is not expected to be competitive with battery-electric vehicles on a cost basis for quite some time - at the time of writing, hydrogen prices at commercial stations in California were commonly above $25/kg for private sector fueling and averaged between $9 - $14 per kilogram for transit agencies (price varies based on fuel contract price agreements). For cost parity, hydrogen would need to be in the $2-$3/kg region. However, if a ZEV solution that can easily meet all operational demands is desired in the near term, hydrogen represents an easy, internal-combustion-like fueling experience and a long range.

3. **Combination battery- and hydrogen-fuel-cell electrification:** This scenario allows for the most flexibility in terms of operational mileage needs, as hydrogen-fuel-cell vehicles are anticipated to have longer ranges than battery-electric vehicles and thus will be able to serve longer days or as flexible, quick-refueling vehicles at the expense of higher operating costs. However, this will require installing both charging stations and hydrogen stations, providing better coverage of vehicle ranges with significantly increased costs. The combination scenario also has the advantage of being easily adaptable to changes in the technology landscape and for addressing incremental improvements across the technology landscape; planning for a mixed scenario would allow SRTA and its contractor to easily adjust fuel-cell vehicle and battery-electric vehicle ratios within its fleet. Similarly, changes in incentive programs and funding pathways may make one powertrain type more economically feasible than another.

In evaluating these paths, an analysis of both operating requirements and costs was undertaken. The team conducted a vehicle miles traveled (VMT) analysis of ShastaConnect vehicle trips that occurred between October 26, 2020, and January 31, 2023. An average 140-mile range electric van, commonly available on the market today, was examined as a comparison vehicle. The team assumed that vehicles would generally use as much battery as they could, returning to their garage with approximately 10% of their battery remaining - the approximate point where the vehicle's safety failsafes activate (ex. "limp" mode). Figure 1 shows the count and percentage of daily vehicle shift distances that…

- …are within the safety margin of a battery electric van or cutaway ("Within Single Charge Range" - less than 70% of total vehicle battery capacity)
- …approach the safety margin of a battery electric van or cutaway's range ("Approaching Single Charge Range" - 70-80% of total battery capacity)
- …may put the vehicle into limp mode ("At Single Charge Range" - 80-90% of total battery capacity)
- …exceed the total battery capacity of a battery-electric van or cutaway ("Opportunity Charging/Vehicle Swap needed" >90% of battery capacity)

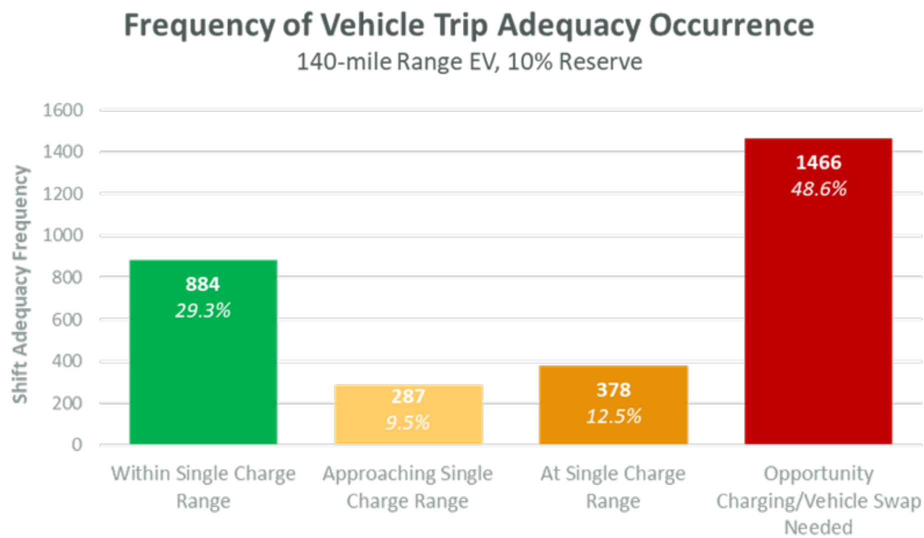

Figure 1: Frequency of daily vehicle shift adequacies - the ability of the vehicle's battery to serve the distance traveled each day.

Under one-third of trips fall into the "Within Single Charge Range" category, while nearly half of daily trips could not be completed on the single charge range of today's battery electric vehicles. To mitigate these trips, two options are available: midday opportunity charging, or swapping vehicles. Although midday charging is a possibility, this would require a change in how operations are handled including in how trips are scheduled, resulting in increased labor and capital costs, or possibly a reduction in trips that could be performed in a day. Having additional vehicles charged or fueled and "on-hand" would mitigate or eliminate the need for significant vehicle charging downtime, but would increase upfront costs and the number of vehicles operating.

Hydrogen vehicles are anticipated to have mileage ranges approaching their gasoline counterparts, and are expected to fulfill all trips due to their quick refueling and longer ranges. However, based on a cost perspective and the anticipated further evolution of technology, this report recommends that SRTA heavily examine battery-electric vehicles, as ZEBs generally offer lower operating costs, can leverage locally-generated power, and offer ancillary benefits that may prove useful as nascent technologies become commercially mature (e.g. vehicle-to-load).

An important consideration for ShastaConnect ZEB operation are reliability and resilience components that will ensure continued operation during power failures, including wildfires, public safety power shutoffs, emergency load reduction events, or climatological events. Installing on-site battery storage represents an additional cost to SRTA and its contracted operator, but would provide two key benefits: demand buffering (allowing for reduced demand charges and potentially cheaper rates on each bill) and backup power in the event of an outage. While these systems are expected to decrease in cost in the coming years, storage systems currently cost around $250 per kWh - a system sized to provide one day of operation (400 kWh) under total power failure would cost around $100,000 to install.

Below, Figure 2 and Table 1 show the results of cost modeling for several factors of the technology adoption process, accounting for variables including maintenance, fuel, purchase price, fuel efficiencies, real-world SRTA vehicle mileages, and infrastructure installation and operation. Figure 3 illustrates the anticipated ranges of costs for capital expenses; operating costs; and total 10-year costs for ICE, battery electric, and hydrogen vehicles. All vehicles are modeled based on FTA minimum service lifetimes (8 years for vans, 11 years for cutaway buses) regardless of powertrain type.

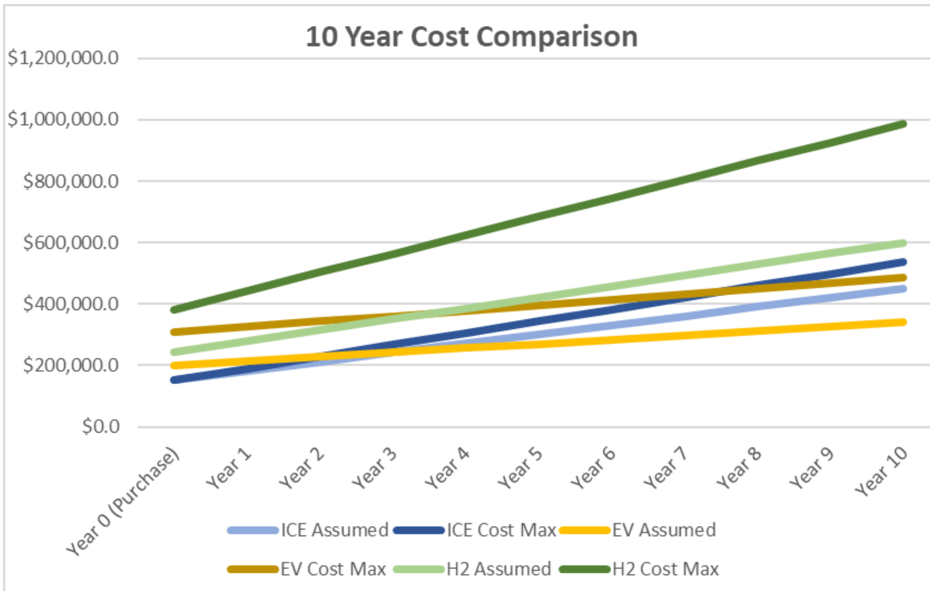

Figure 2: 10-year modeled total-cost-of-ownership comparisons for "baseline" and "maximum" scenarios, for each vehicle type

Table 1: Projected "baseline" and "maximum" acquisition and operation costs for each vehicle type

	ICE			EV			H2		
	Asm.	**Min.**	**Max.**	**Asm.**	**Min.**	**Max.**	**Asm.**	**Min.**	**Max.**
Upfront Vehicle Cost	$52,000	$52,000	$52,000	$101,000	$90,900	$207,750	$143,750	$101,000	$282,000
Upfront Infra. Cost	$0	$0	$0	$13,125	$0	$52,500	$0	$0	$0
Total CapEx Costs	$52,000	$52,000	$52,000	$114,125	$90,900	$260,250	$143,750	$101,000	$282,000
Fuel Cost/Day	$59.67	$36.29	$77.87	$21.88	$15.12	$32.40	$81.65	$40.27	$149.60

Maint. Cost/Day	$22.21	$17.01	$27.41	$16.07	$16.07	$16.07	$16.07	$16.07	$16.07
Total 10-Year Cost per Vehicle	**$450,870**	**$346,554**	**$536,259**	**$339,493**	**$304,735**	**$484,663**	**$600,407**	**$406,640**	**$986,699**

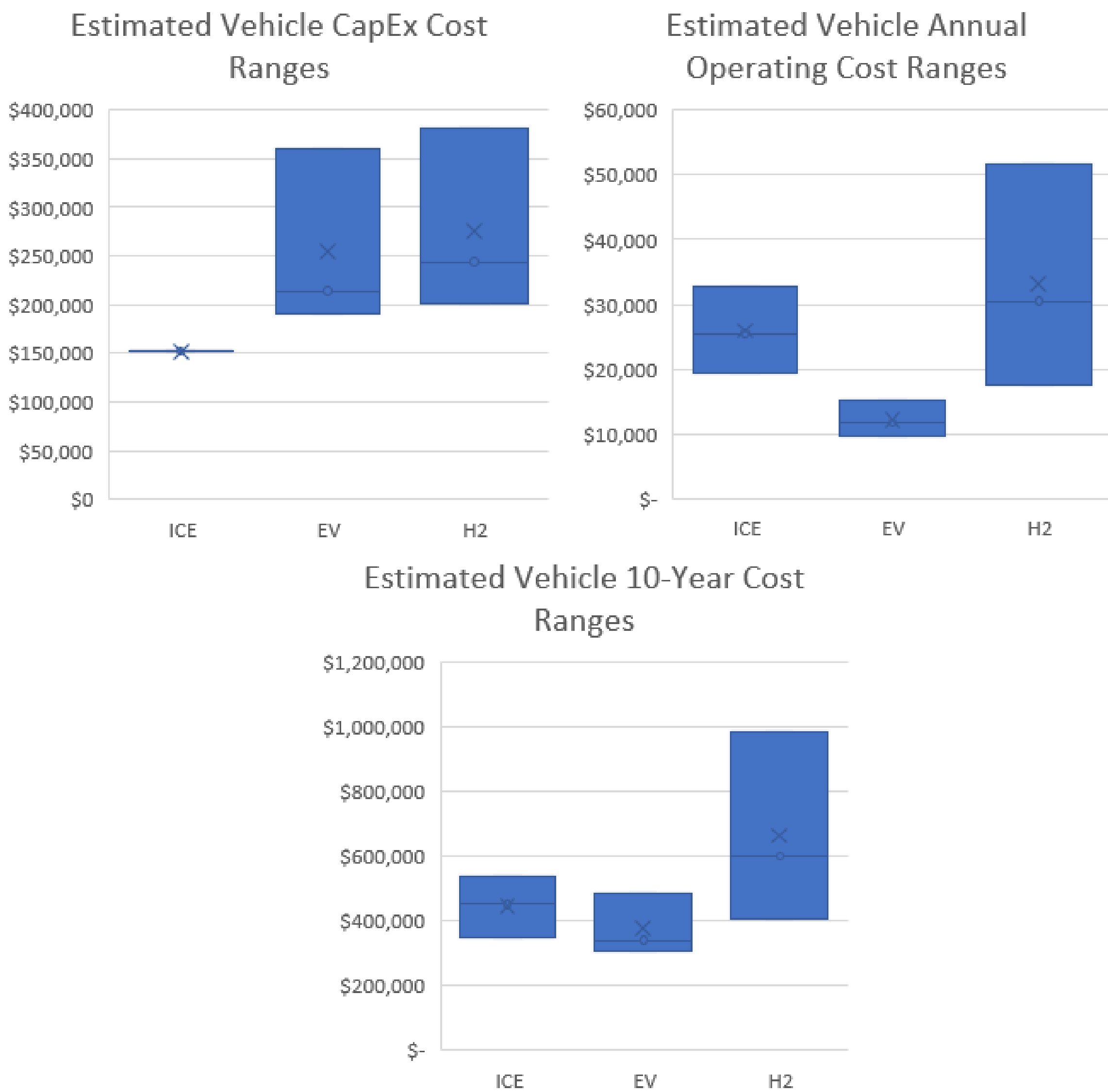

Figure 3: Modeled cost ranges for vehicle capital expenses; annual operating cost ranges; and total 10-year cost ranges

Under the most likely cost trajectories, EVs become more cost-efficient to operate than ICE vehicles starting in the third year of operation. Even in a scenario where EVs follow the "worst-realistic-case" pricing model (a significant increase in vehicle prices, 50% increase in base electricity costs - resulting in the effective prices used in the model escalating from $0.25/kWh to $0.30/kWh - and low sharing of charging infrastructure), battery electric vehicles become more cost-effective than hydrogen's "assumed" price model by year 3, largely due to the cost of hydrogen and the higher upfront cost of the fuel-cell vehicle. Prices for hydrogen fuel cell vehicles and fuel may decrease over time, however, the cost-of-ownership model developed as part of this analysis suggests that hydrogen would need to reach a hypothetical cost of $2.50 per-dispensed-kg of hydrogen to break even with EVs over a 10-year period. Given the operational benefits of hydrogen, a small price premium may be justified; however, significant strides will need to be made in the hydrogen fuel production and distribution process to meet this cost target. Note that all costs are modeled based on the best available information at the time of writing, and are subject to change based on developments in research and commercial availability of relevant technologies.

Table 2, below, highlights the combined upfront and ongoing costs of transitioning the fleet under the "assumed" scenario for each powertrain type, with no fleet expansion (i.e., only the currently existing vehicles in the ShastaConnect fleet are replaced).

Table 2: Estimated total yearly assumed costs under each powertrain scenario. Asterisks and italics indicate hypothetical costs for ICE vehicles after the 2029 cutoff.

Timeline (Year)	Total # of Buses to Purchase	# of ZEB Purchases	# of Conv. Bus Purchases	Estimated Fleet Costs (ICE/BAU)	Estimated Fleet Costs (Electric)	Estimated Fleet Costs (Hydrogen)	Estimated Fleet Costs (Combined, 2035+ H_2)
2024	1	0	1	$480,757	$480,757	$480,757	$480,757
2025	2	0	2	$632,757	$632,757	$632,757	$632,757
2026	1	0	1	$480,757	$480,757	$480,757	$480,757
2027	3	1	2	$784,757	$833,757	$1,017,257	$833,757
2028	1	0	1	$480,757	$464,720	$486,536	$464,720
2029	0	0	0	*$328,757**	$312,720	$334,536	$312,720
2030	1	1	0	*$480,757**	$513,720	$578,286	$513,720
2031	0	0	0	*$328,757**	$296,682	$340,315	$296,682
2032	1	1	0	*$480,757**	$497,682	$584,065	$497,682
2033	0	0	0	*$328,757**	$280,644	$346,093	$280,644
2034	1	1	0	*$480,757**	$481,644	$589,843	$481,644
2035	4	4	0	*$936,757**	$1,068,606	$1,326,872	$1,239,606
2036	2	2	0	*$632,757**	$602,455	$862,487	$775,221
2037	0	0	0	*$328,757**	$168,380	$386,544	$299,278
2038	0	0	0	*$328,757**	$168,380	$386,544	$299,278
2039	1	1	0	*$480,757**	$369,380	$630,294	$543,028
2040	0	0	0	*$328,757**	$152,342	$392,323	$305,057
Total				*$8,324,876*	**$7,805,383**	**$9,856,270**	**$8,737,311**

Section D: Current Bus Fleet Composition and Future Bus Purchases

SRTA currently contracts with DHCL to operate an on-demand fleet of 9 qualifying cutaway buses and vans ranging in size from 8-12 passenger capacity and 21- to 25-foot wheelbases. DHCL also utilizes a minivan that is driven intermittently. These vehicles are summarized, along with their engine and body model years, in Table 3.

Table 3: Individual Bus Information of Current Bus Fleet (Optional)

Number of Buses	Engine Model Year	Bus Model Year	Fuel Type	Bus Type	Estimated Replacement Year
4	2013	2013	Gasoline	Cutaway	~2024
1	2018	2018	Gasoline	LD minivan	~2026
3	2019	2019	Gasoline	Van	~2027
2	2021	2021	Gasoline	Cutaway	~2032

In compliance with ICT requirements, a proposed fleet replacement schedule through 2040 was developed to identify key checkpoints and time horizons for procuring zero-emission vehicles, as shown in Table 4 below.

Table 4: Future Bus Purchases (Replacement of baseline fleet)

Timeline (Year)	Total # of Buses to Purchase	# of ZEB Purchases	% of Annual ZEB Purchases	ZEB Bus Type(s)	ZEB Fuel Type(s)	# of Conv. Bus Purchases	% of Annual Conv. Bus Purchases	Type(s) of Conv. Buses	Fuel Type(s) of Conv. Buses
2024	1	0	0%	-	-	1	100%	CU	Gasoline
2025	2	0	0%	-	-	2	100%	CU	Gasoline
2026	1	0	0%	-	-	1	100%	LD	Gasoline
2027	2	1	33%	Van	BEB	2	66%	Van	Gasoline
2028	1	0	0%	-	-	1	100%	CU	Gasoline
2029	0	0	0%	-	-	0	0%	-	-
2030	1	1	100%	CU	TBD	0	0%	-	-
2031	0	0	0%	-	TBD	0	0%	-	-
2032	1	1	100%	CU	TBD	0	0%	-	-

2033	0	0	0%	-	TBD	0	0%	-	-
2034	1	1	100%	LD	TBD	0	0%	-	-
2035	4	4	100%	1 CU, 3 Van	TBD	0	0%	-	-
2036	2	2	100%	CU	TBD	0	0%	-	-
2037	0	0	0%	-	TBD	0	0%	-	-
2038	0	0	0%	-	TBD	0	0%	-	-
2039	1	1	100%	CU	TBD	0	0%	-	-
2040	0	0	0%	-	TBD	0	0%	-	-

Based on guidance from the Federal Transit Authority's examination of real-world transit vehicles, ShastaConnect buses were assumed to turn over on an 8-year cycle for passenger vans, and 11 years for cutaway vans. Under ICT rules for small transit fleets, before 2029, 25% of new bus purchases (rounded up) must be zero-emission; based on the lifecycles identified above, SRTA procurements are generally small enough before 2029 that no zero-emission buses are required, with the exception of 2027.

Demand for ShastaConnect services is expected to increase over time. The increase is influenced by changes in residential patterns and a preference for on demand transit services. Table 5 below shows a purchase schedule which includes increasing the fleet by 2 vehicles every 5 years. This would potentially bring the total fleet to 16 vehicles by 2039. This does not factor in other unknown operations, such as a mid-day swap of vehicles, if that operational activity is identified as necessary to meet ridership demand in the future.

Table 5: Future Bus Purchases (Including fleet expansion)

Timeline (Year)	Total Number of Buses to Purchase	Number of ZEB Purchases	% of Annual ZEB Purchases	ZEB Bus Type(s)	ZEB Fuel Type(s)	Number of Conv. Bus Purchases	Percentage of Annual Conv. Bus Purchases	Type(s) of Conv. Buses	Fuel Type(s) of Conv. Buses
2024	1	0	0%	-	-	1	100%	CU	Gasoline
2025	2	0	0%	-	-	2	100%	CU	Gasoline
2026	2	0	0%	-	-	2	100%	LD,Van	Gasoline
2027	2	1	33%	-	BEB	2	66%	Van	Gasoline
2028	2	0	0%	-	-	2	100%	CU	Gasoline
2029	0	0	0%	-	-	0	0%	-	
2030	1	1	100%	CU	TBD	0	0%	-	
2031	1	1	100%	Van	TBD	0	0%	-	

2032	1	1	100%	CU	TBD	0	0%	-	
2033	1	1	100%	-	TBD	0	0%	-	
2034	2	2	100%	LD, Van	TBD	0	0%	-	
2035	4	4	100%	1 CU, 3 Van	TBD	0	0%	-	
2036	3	3	100%	CU	TBD	0	0%	-	
2037	1	1	100%	Van	TBD	0	0%	-	
2038	1	1	100%	CU	TBD	0	0%	-	
2039	3	3	100%	CU	TBD	0	0%	-	
2040	0	0	0%	-	TBD	0	0%	-	

In both potential pathways, it should be noted that the assumed useful life for zero-emissions vehicles is roughly the same as an internal combustion vehicle; however, a lower number of moving parts in zero-emissions vehicles mean they require significantly less maintenance than ICE vehicles and are less likely to suffer late-life powertrain failures in the same manner. While the total-cost-of-ownership model assumed that vehicles would be replaced on the same timescale as ICE vehicles, there is a possibility that the vehicles may be able to operate reliably for even longer. While battery degradation is a heavily discussed issue, battery-electric transit buses are relatively new and lack application-specific measurements of battery degradation - though NREL notes that pack degradation is dependent on battery chemistry, duty cycles, and operating temperatures[1] and places its assumption for bus battery life at 12 years based on modeling, real-world demonstrations, and manufacturer warranties[2]. In light-duty vehicles, battery longevity has been demonstrated to be greater on vehicles equipped with liquid battery cooling and which have sizeable buffers on their usable capacity (i.e., large safety reserves at the “bottom” and “top” of the battery’s state-of-charge)[3], and generally can be expected to last upwards of 150,000 miles. For maximum battery life, primarily charging vehicles overnight, limiting full battery depletion, and seeking vehicles that liquid-cool their batteries may be priorities for SRTA and its contractor.

A pilot vehicle should be deployed to ensure that a specific make and model is able to perform the expected duty cycle and to ensure that operators are satisfied with vehicle performance and capabilities. Early ZEV replacement can frequently be attributed to a mismatch between vehicle performance or reliability and the required operation duty cycles, and ensuring that ZE transit vehicles are thoroughly tested and validated on ShastaConnect service before final vehicle procurement will be crucial in reducing early vehicle replacement rates. Some ZEV manufacturers provide live demonstrations on real routes, or offer modeling based on real usage data to validate range requirements.

[1] https://www.nrel.gov/docs/fy23osti/83232.pdf, p.69
[2] Ibid., p. 56
[3] https://www.geotab.com/blog/ev-battery-health/

Due to the long mileages required by its vehicles' duty cycle requirements, high conversion costs, and prevalence of commercially available zero-emission bus options, no currently owned conventional buses are expected to be converted to zero-emission buses. Table 6, below, reflects the lack of anticipated bus conversion, as required by ICT.

Table 6: Schedule of Converting Conventional Buses to Zero-Emission Buses (required)

Timeline (Year)	Number of Buses	Bus Type(s)	Removed Propulsion System	New Propulsion System
N/A	N/A	N/A	N/A	N/A

Section E: Facilities and Infrastructure Modifications

Table 6, below, illustrates the upcoming or potential facilities construction or modifications that could support ShastaConnect fleet zero-emission transition efforts. Both potential pathways (hydrogen fueling stations and battery electric charging stations) are represented in Table 7 below.

Table 7: Facilities Information and Construction Timeline (Required)

Division/ Facility Name	Address	Main Function(s)	Type(s) of Infrastructure	Service Capacity (bus number)	Needs Upgrade? (Yes/No)	Estimated Construction Timeline
DHCL	200 Mercy Oaks Dr, Redding, CA 96003	Overnight parking of buses	Electric	Existing electrical capacity for 1-2 buses	Yes	2024 - 2030
Burney	37505 Hwy. 299 East Burney, CA 96013	Overnight parking for 1 van	Electric	Existing electrical capacity for 2 light duty vehicles	Yes	2026 - 2030
Anticipated RABA Hydrogen Facilities	2840 Ellis Street, Redding CA 96001	Hydrogen fueling station	Hydrogen	Installed hydrogen capacity for 2-10 buses	No (New Construction)	2025 - 2029

Electric

<u>Electric Vehicle Fueling Options and Cost Considerations</u>

Based on the VMT analysis conducted as part of Section C and the anticipated fuel economy of battery-electric transit vehicles, we estimate that SRTA's ShastaConnect fleet would consume approximately 250-450 kWh of energy per day if its entire fleet was converted to battery-electric. Other transit agencies around the state have demonstrated an ability to support this amount of energy transfer, although upgraded 240V or 480V electrical service at the DHCL-owned facilities would likely be required to support overnight charging for all vehicles at their garage locations. A full build out to support charging 10-15 vehicles could run between $100,000-$525,000.

Three electricity providers serve the region: the City of Redding Electric Utility; the City of Shasta Lake Electric Utility; and Pacific Gas and Electric, as shown in Table 8 below.

Table 8: Comparison of electrical rates and fees across common electrical tariffs within Shasta County, CA.

Utility, Rate	Grid Access Fee (June 2023)	Base Cost per kWh (June 2023)	Demand Charge	Garaged Vehicles

City of Redding Electric Utility *Small Commercial (E2)*	$40/mo	$0.1645	N/A	12 Cutaways & vans
City of Redding Electric Utility *Large Commercial (E7/E8)*	$145/mo	$0.1044	$20/kW	12 Cutaways & Vans
City of Shasta Lake Electric Utility *Commercial Service*	$35/mo	$0.1019	$17/kW	N/A
City of Shasta Lake Electric Utility *Government Service*	$50.50/mo	$0.1556	N/A	N/A
Pacific Gas and Electric *B-1 Rate*	~$10/mo	$0.30 - $0.41	N/A	1 Cutaway or Van

Given the wide range of utilities and tariffs, costs will vary significantly depending on the specific electrical utility and rate schedule vehicles are placed on. However, most vehicles (12 of 13) are expected to be placed on the City of Redding Large Commercial rate, given the ShastaConnect vehicles' garaging location at DHCL facilities in Redding. The remaining vehicle is expected to be placed on Pacific Gas and Electric service in Burney. Due to Burney's more remote location and subjection to Public Safety Power Shutoffs, it may be advisable to consider identifying a location and purchasing property for the purpose of having vehicle storage, charging, and backup power, or identifying an opportunity to share space with another regional partner who could maintain a facility so that vehicle storage, access, and fueling could be made available.

Overall, 36% of 25,530 transit trips examined between October 2020 and April 2023 terminate within a 1-mile radius of an existing electric vehicle charger. Charging infrastructure exists throughout the region, but is concentrated near two ShastaConnect service territory regions observed to have high rates of ShastaConnect drop-offs and pickups: Redding's city core along SR-44, and adjacent to the veteran's clinic and veteran's home in South Redding. This allows for ShastaConnect vehicles to leverage opportunity charging to extend vehicle range between calls, if drivers find it possible based on occupancy and scheduling. Midday charging would most optimally occur during a 30-minute lunch break.

If regular midday charging becomes part of the operating paradigm, more publicly available fast charging would be needed in the region, with certain chargers reserved for ShastaConnect vehicles during regular operating hours. Under the CALeVIP program, the average cost of installing a public DCFC has been around $77,000-$80,000. [4] The vehicle based in Burney currently parks overnight at a grocery store parking lot. This store has provision to add public level 2 charging, which could be used by a ShastaConnect vehicle overnight.

SRTA has noted that the preferred charging system would minimize driver shift interruption, leading toward a depot-based solution. Supporting a daily energy demand of 400 kWh across 5-6 active buses would require high-powered Level 2 chargers (~11-16kW) or low-power DC (~25kW) chargers to replenish all energy across an 8-hour charging dwell time. This would generate 55 - 150 kW of daily demand at the Redding depot - depending on the number of buses charging simultaneously and the charger power installed. This could add $1,100 - $3,000 per month to the depot's charger electric bills; however, the switch to EVs (from gasoline fuel) could reduce

[4] CALeVIP DC Fast Chargers, Average Rebate, Unit Cost, and Total Project Cost per Charger

fueling costs by $120 - $1,900. Given steady petroleum fuel costs of $4.50/gallon, an estimated 50% increase in base-rate electricity costs (from $0.10 to $0.15/kWh, per REU E7 rates), and 10 kW charging stations charging 5 buses simultaneously, this would result in a net reduction of around $1,130 per month in fueling costs.

A key component to cost-effective charging infrastructure will be finding a balance between a power delivery rate that supports the vehicles' use cases, and the cost of the infrastructure associated with installing the charging stations. Generally, the higher the power delivery rate, the higher the cost of the components of the overall charging station installation. However, as a small municipal utility interested in electrifying their own fleet, the City of Redding Electric Utility may be able to negotiate and approve a specific public EV fleet rate that would better incentivize DC fast charging or encourage EV charging during certain times of the day by lowering or waiving demand charges during workday hours, when the electric grid tends to have an oversupply of clean energy from solar and wind.

The current DHCL facility has access to 480V power, which currently supplies refrigerated containers. A portable lower-power DCFC could be added to this existing service for around $10,000-$14,000, to support a BEV pilot. A conversion of a large portion of the fleet to battery electric vehicles will require new electric service. This service could be 208/240V to primarily support Level 2 charging or 480V to primarily support DCFC.

A level 2 charging installation is likely to be less expensive. Referencing public cost data from the California Electric Vehicle Infrastructure Project (CALeVIP), charging installations cost an average of $8,800 per level 2 port. Assuming 10 ports per project, estimated project costs could be around $88,000. A DCFC project using dual-port equipment that supplies 25kW to each port simultaneously, could cost around $525,000 in total, based on CALeVIP-published costs for 5 charging units. This equipment could generally supply 50KW to a single vehicle if needed for midday charging. Current grants typically cover 50-80% of the capital costs of installation, which would leave up to $212,500 to be covered by SRTA or the operator.

Hydrogen

<u>H_2 Fueling Options and Cost Considerations</u>

Hydrogen is an attractive fuel technology due to the longer range of vehicles and faster fueling times, and the Shasta region is already planning for a hydrogen station to support the North-State Intercity Bus project. This station may support RABA vehicles, ShastaConnect vehicles, and possibly other local government fleets who want to test hydrogen fuel cell vehicles. Assuming a full fleet conversion to hydrogen, the ShastaConnect fleet could account for around 10% of total hydrogen demand if fueled at this station, with the North State Intercity bus fleet and RABA vehicles accounting for the majority of hydrogen use.

Based on the VMT analysis conducted as part of Section C and the expected fuel economy of FCEV buses[5], it is estimated that SRTA would use approximately 60-80 kg/day of hydrogen if its entire fleet was converted to H_2. For this relatively small size, gaseous hydrogen delivered by trailer is the only delivery method that makes economic sense. Onsite electrolyzers are still very capital intensive and are more cost effective at much higher H_2 usage rates. Recent (2020-2021) data from Sunline Transit Agency shows that hydrogen from an electrolyzer can vary from $8/kg to $21/kg, with an average cost of hydrogen of $13.79/kg for a similar sized system (66 kg/day) [6]. Rail delivery would result in parasitic pressure losses when gaseous hydrogen is transferred between

[5] Based on GGE estimates from https://afdc.energy.gov/data/10310

[6] https://www.nrel.gov/docs/fy22osti/83559.pdf

storage vessels. Liquid hydrogen tanks create “boil-off” gas H_2 as the liquid evaporates to gas due to heat transfer losses. This boil off has been estimated to be 15% for small 100 kg/day systems. Given this, liquid hydrogen would need to be delivered weekly, as greater liquid storage may see excessive boil off. Gaseous storage does not experience boil-off, but more physical space for tube storage and greater capital costs would be associated with extended supplies.

With gaseous hydrogen delivered by truck, there are two options:

- A **permanent fueling station with 1 or 2 dispensers and tube trailer storage** requires greater capital cost but can reduce operating costs over time. Hydrogen delivery by this method is expected to be in the range of $9–10.50 per kg[7,8]. In Table 8, a list of recently quoted gaseous hydrogen delivery prices can be found below[9]. Liquid hydrogen is typically $2-3/kg cheaper than gaseous hydrogen, but this reduction is offset by additional station O&M and boil-off losses, which is roughly the same magnitude.

Table 9: Agencies and hydrogen costs associated with the installation of permanent fueling stations and tube-trailer storage.

Agency	Cost/kilogram	Contract type	Source
AC Transit	$9.04	Unknown	Messer
Foothill Transit	$9.12	3-year contract	Clean Energy
Golden Empire Transit	$10.50	No contract	Unknown
OCTA	$9.16	Unknown	Air Products

- A **mobile refueller** can be used in an emergency, but they can also be used for longer periods until hydrogen capacity increases enough to warrant a permanent station. Mobile refuelers can also be relocated or could be maintained as a secondary unit when a primary permanent location is installed. Cost estimates to lease a mobile refueller depend on site specifics. Estimates can range from a monthly fee of $15K - $20K per month[10] to an additional cost adder of $18-20/kg[11]. A table of refueler manufacturers can be found below in Table 10.

Table 10: Agencies and companies associated with manufacture of mobile hydrogen refueling stations.

Company	Fueling specification and pressure	Capacity	Storage (kg)	Availability in California
Nikola Motor[12]	H70/700 bar		960 w/ separate tube trailer	Not aware of any placement yet

[7] Keith Malone (Hydrogen Fuel Cell Partnership) phone conversation, March 30, 2023
[8] https://www.northcoastjournal.com/humboldt/humboldt-moves-to-overhaul-bus-fleet/Content?oid=24448388
[9] Keith Malone (HFCP) email, April 13, 2023
[10] Rick Puri (Air Liquide) phone conversation, April 4, 2023
[11] Kristen Cleven (Air Products) phone conversation, April 24, 2023
[12] Nikola Launches First Hydrogen Fuel Cell Truck Mobile Fueler (nikolamotor.com)

Air Liquide[13],[14]	350 bar & 700 bar			First one at Foothill Transit in Pomona, CA
Air Products[15]	H35/350 bar		150	Yes. Used in fleet operating projects
First Element Fuel[16]	H70/700 bar	125 kg/hr		Yes
Taylor-Wharton[17]	700 bar		172	
Wolf Tank[18]	350 & 700 bar		55	
Bayotech[19]	H35/350 bar		11	
OneH2[20]	500 bar		100 - 300	
PlugPower	350 bar & 700 bar		1700	

The source of hydrogen has an impact on the cost and the carbon footprint. The nearest operational hydrogen production plant is in Sacramento. This produces "gray" hydrogen using natural gas as feedstock. Carbon neutral hydrogen can be found in the below table. However, since almost all truck tractors are fueled by diesel, the longer the delivery route the more carbon associated with delivery. Below in Table 11 is a listing of potential hydrogen sources in the greater Northern California/western Nevada region.

[13] Air Liquide and Foothill Transit pilot advanced hydrogen mobile fueler supplied by North Las Vegas plant | Air Liquide USA
[14] https://hydrogennews.airliquide.com/air-liquide-develops-portable-hydrogen-station-mobility-us
[15] https://www.airproducts.com/services/portable-hydrogen-fueler
[16] FirstElement Fuel partners with Hyundai Motor on hydrogen refueling of class 8 fuel cell electric trucks, driving over 25K miles with zero emissions (prnewswire.com)
[17] https://twcryo.com/products/hydrogen-lng/refueler/
[18] https://wolftankgroup.com/mediapool/2022/10/22.09.2022_Wolftank-Group_Hydrogen-Smart-Continer_EN.pdf
[19] https://bayotech.us/dispensing/

[20] https://oneh2.com/solutions/delivered-hydrogen/

Table 11: Potential hydrogen sources, feedstock sources, and over-the-road distances to expected Shasta County refueler.

Location	Company	Capacity	Date on-line	Production source	Distance to SRTA
North Las Vegas, NV	Air Liquide	30 tonne/day	5/23/22	RNG	636 miles
Richmond, CA[21]	Chevron / Raven SR / Hyzon Motors	6 tonne/day	Q1 2024	Biomass	202 miles
Sacramento, CA	Air Products		Open now	Natural Gas	162 miles
Oroville, CA[22]	Yosemite Clean Energy	24 ton/day	Planning stages	Biomass	94 miles
Red Bluff, CA	Redding Rancheria		Planning stages	Biomass	36 miles

Hydrogen tube trailer capacity varies based on configuration, material, and operating pressure. The typical steel tube trailers transport 380 kg at an operating pressure of 180 bar. While 500 bar composite tube trailers can carry up to 900 kg they also require exemptions from the California Department of Transportation, which normally limits tube trailers to 250 bar.[23] These exemptions have been granted in California in the past. For reference we will assume ~10-15 mi/kg for cutaway type buses for now[24].

One possible future opportunity for a more local source of hydrogen may be provided by the Redding Rancheria Economic Development Corporation (RREDCO). RREDCO received a California Department of Conservation grant[25] to plan for a local facility producing hydrogen from forest biomass. When constructed, this local facility could be a key source of more local hydrogen for the region. Locally produced hydrogen would have reduced transportation costs and could be more reliably delivered.

Outside of the future fueling facility planned with RABA in Redding, there are no known additional definitive plans for MD/HD hydrogen fueling stations in Shasta County. However, the Hydrogen Fuel Cell Partnership has published a report estimating how many stations will be needed to meet 70,000 hydrogen FCEV trucks. They estimated that 2-3 stations will need to be installed in Shasta County by 2025 and an additional 3-17 MD/HD stations will need to be installed in Shasta County by 2030 (5-20 stations total)[26] As of 2023, there are no public

[21] https://ravensr.com/raven-sr-chevron-and-hyzon-motors-collaborate-to-produce-hydrogen-from-green-waste-in-northern-california/
[22] https://www.yosemiteclean.com/_files/ugd/06b2a7_e8e7949b43284e96b9ef5cf92ea317f2.pdf
[23] https://www.energy.gov/eere/fuelcells/hydrogen-tube-trailers
[24] ~15 mi/kg for cutaways per Kevin Gillo at A1 Alt Fuel Systems
[25] Forest Biomass to Carbon-Negative Biofuels Pilot Program - California Grants Portal
[26] https://h2fcp.org/sites/default/files/Truck-Vision-webinar-CaFCP_8-12-2021.pdf

stations funded or planned in the Shasta Region. The April 2023 passage of the Advanced Clean Fleets regulation, which will require many fleets to begin acquiring ZEVs, may encourage more adoption of FCEVs and accompanying infrastructure.

Maintenance facilities require specialized modifications to serve hydrogen fueled buses. A facility would need to include leak detection systems, fire detection systems, electrical classification for hazardous locations, and positive ventilation. These modifications are necessary to insure that any hydrogen gas vented from the vehicles either intentionally or accidentally do not pose any risks of fire or explosion.

Electric and Hydrogen

A combined scenario for fueling a mixture of hydrogen and battery-electric buses would likely be characterized by overnight charging at battery-electric bus garaging locations and a smaller proportion of usage of the regional RABA hydrogen station, as a ShastaConnect fleet composed of both hydrogen and BEBs would have too few fuel-cell buses to warrant its own hydrogen station. Similar issues would be present for both vehicle types (i.e. hydrogen fueling stations would still be subject to boil-off and energy transfer losses, while battery-electric buses would still trigger the need for additional electrical infrastructure at garaging locations).

One potentially interesting application under a mixed scenario would be a primarily battery-electric vehicle with an onboard fuel-cell “range extender” that would allow for increased overall vehicle range. Vehicles with this functionality do not currently exist in the commercial market, but are a topic of interest and may become commercially available in the coming years.

Section F: Providing Service in Disadvantaged Communities

Shasta County does not have any census tracts that fall under the Innovative Clean Transit definition of "disadvantaged community" - those sites falling within the top quartile of CalEnviroScreen 4.0 total percentiles. However, the contextual definitions for disadvantaged communities change based on program and region. Native reservations are considered disadvantaged communities under the California EPA - this designation is reflected in the California Climate Investments map. SRTA's planning region encompasses three disadvantaged communities under California Climate Investments - one in Burney at Pit River Native American Trust land, and two on Redding Rancheria land in south Redding, as illustrated below in Figure 4.

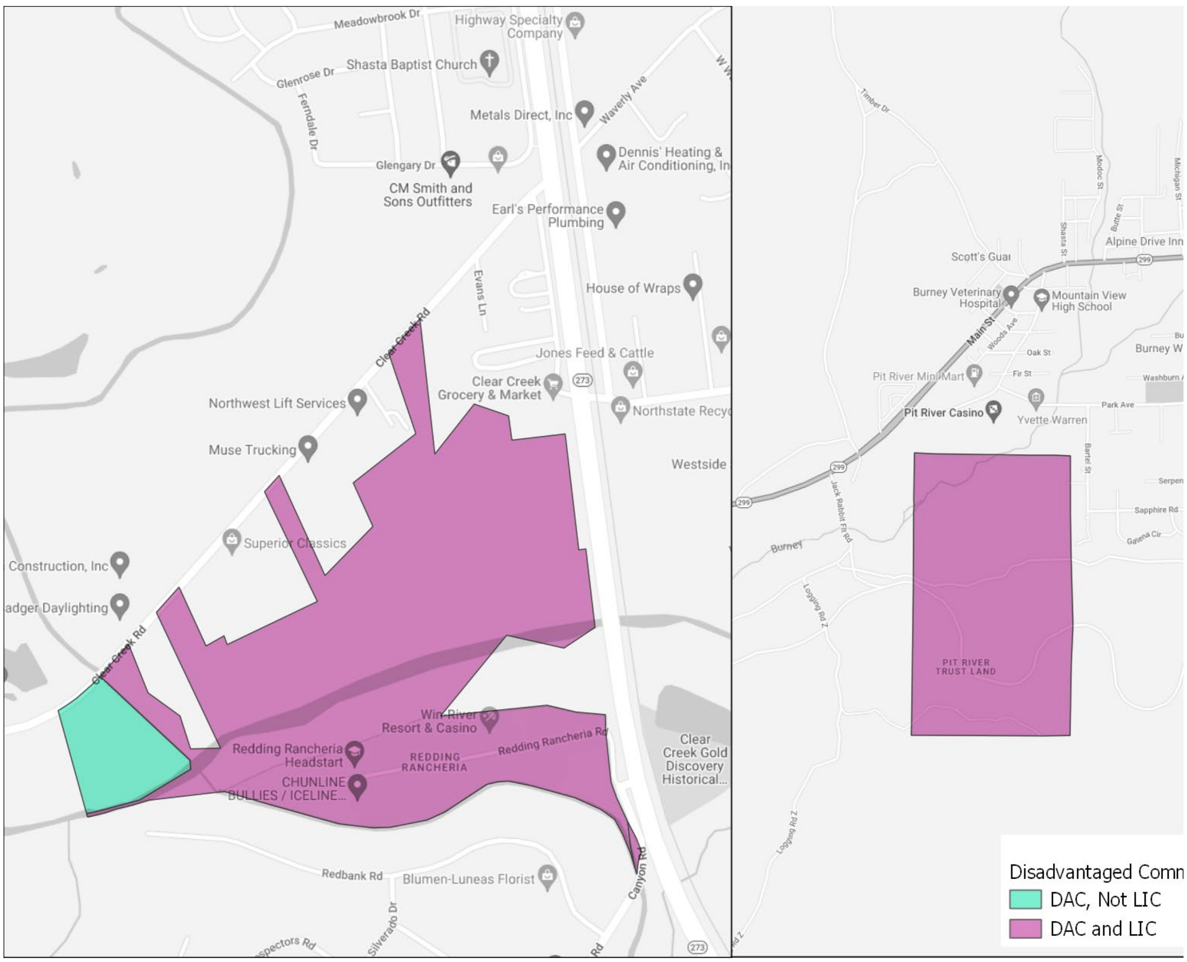

Figure 4: Map of DACs and LICs under the SB 535 definition of DACs. All polygons above are Native American reservation lands.

As SRTA's ShastaConnect service adheres to an on-demand model, it is driven by ride start and endpoints requested by transit riders and there are no specifically designated zero-emission bus routes. Transit drop-off and pick-up points were observed inside of the Redding Rancheria community, indicating that SRTA has previously conducted service to the area. Future rides originating from or terminating in the communities delineated above will be served by a zero-emission bus.

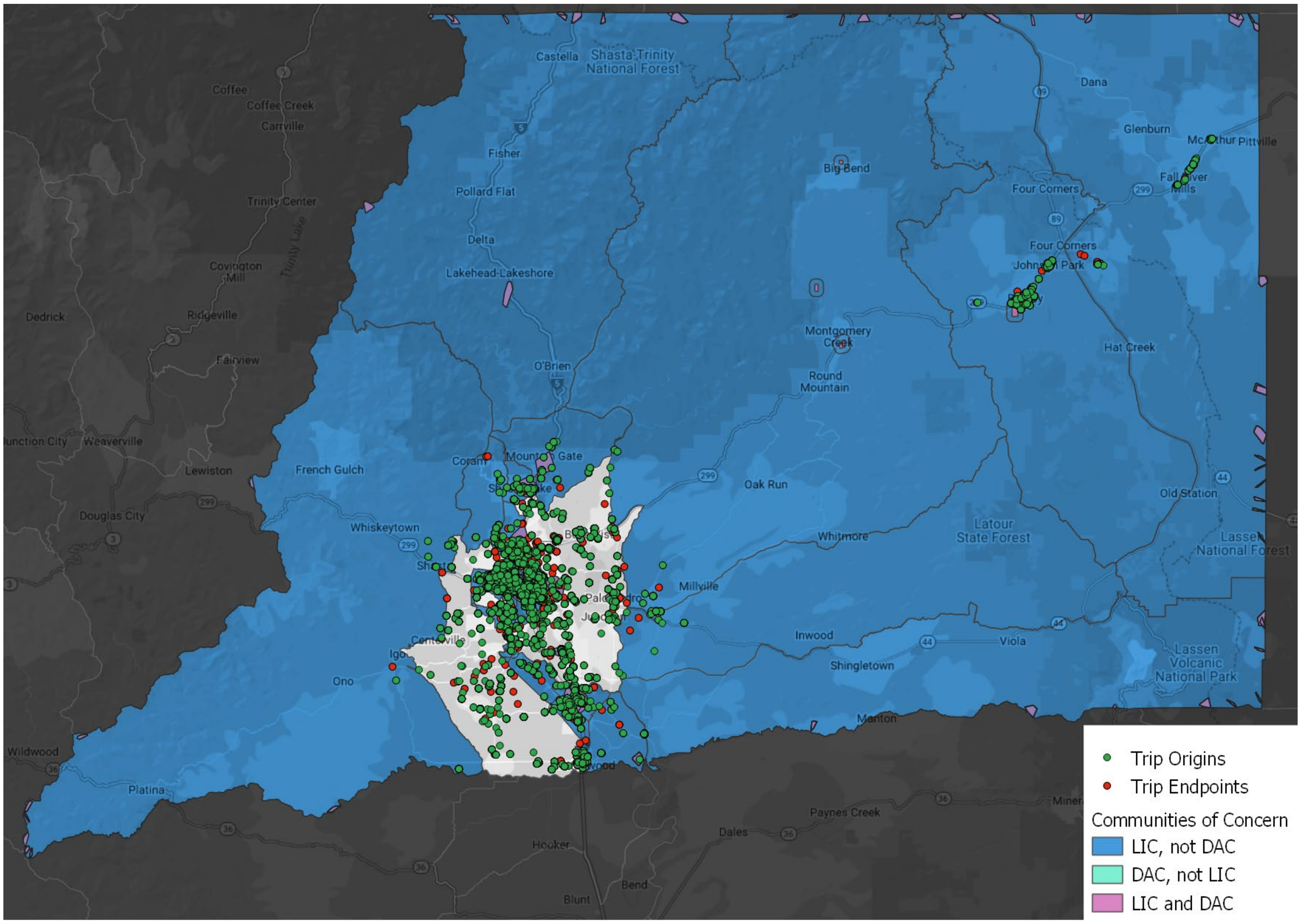

Figure 5: Map of DACs and LICs under the SB 535 definition of DACs/LICs throughout Shasta County

Additionally, despite a lack of CalEnviroScreen 4.0 DACs, SRTA's region includes extensive low-income communities surrounding the Redding area. Figure 5 above illustrates Communities of Concern from the 2022 California Climate Investments Priority Populations 4.0 tool. This merges low-income communities, disadvantaged communities based on CalEnviroScreen 4.0, and Native American reservation and trust lands to provide a comprehensive picture of the regions and communities that would benefit most from the deployment of climate investments, including zero-emission transit. Examining Communities of Concern may provide additional insight and resolution into how zero-emission transit affects regional communities, especially within rural areas with low pollution concentrations combined with low income and reduced access to services.

Section G: Workforce Training

Training for Vehicle Operators

Training for transit operators would be minimal – SRTA's contracted operator may provide drivers with updated information on charging/fueling locations and requirements, but otherwise the driving operation of the vehicles remains generally the same, albeit with some additional considerations. Because of the small capacity vehicles, most drivers do not hold commercial driver's licenses. The drivers are employed by DHCL and are not represented by a trade union.

SRTA's contracted operator may hold a brief hands-on training session for operators to introduce them to the vehicles, the updated charging/fueling process, and the key differences between electric and conventional buses. This training may include:

- An overview of vehicles' range limitations, with special attention paid to how weather conditions and driving patterns can affect the expected mileage;
- An overview of vehicles' control panel to ensure drivers recognize state of charge notifications and low battery warnings;
- A hands-on demonstration of charging/fueling process;
- A general safety training examining what to do in the event of a battery or electrical system malfunction, fire safety procedures, and/or the basics of handling high-voltage systems; and
- A test drive to familiarize drivers with vehicles' acceleration, deceleration, and handling.

Prior to using the vehicles for service, either SRTA or SRTA's contracted operator may consider developing visual materials mapping the location(s) of charging stations for electric vehicles and fueling stations for hydrogen vehicles. These materials should be posted in common areas near where vehicles are domiciled. Some training may be conducted for drivers and dispatchers around scheduled lunch (or other break) opportunity charging .

Training for Vehicle Maintenance

Ensuring proper vehicle maintenance will require more rigorous training than the above training for vehicle operation. SRTA's contracted operator currently works with a private automotive repair shop for all of its maintenance needs; this shop is not prepared nor interested in servicing electric or hydrogen vehicles so DHCL should transition maintenance to another local service shop when electric and hydrogen vehicles begin service. The selected service shop should have a familiarity with high-voltage electric drivetrains, including battery management systems, vital connections and wirings, and charging components.

SRTA may require the contracted operator to coordinate with original equipment manufacturers (OEMs) to provide training on new vehicles, using a train-the-trainer approach to disseminate information and skills to others. Many zero-emissions vehicles come with warranties on their chassis, powertrain, or both - vehicles from major manufacturers will come with their standard warranties. Vehicles sourced directly from manufacturers will typically not come with any maintenance coverage included, though if vehicles are leased through a third-party partner, there may be some provisions in service contracts that provide for maintenance on a regular schedule.

One additional avenue to seek out qualified maintenance personnel is through the local community college. Shasta College's Automotive Technology Program[1] offers an Associate of Science Degree, an Automotive Technology Certificate, and a Smog Inspection and Repair Technician Certificate. The Associate of Science Degree develops students' skills in engine, chassis, electrical repair, and powertrain and the courses prepare students to become an ASE-Certified Technician. All three of these require students to take AUTO 11, *Introduction to Hybrid and Electric Vehicle Technology*. The course includes topics on safety, maintenance, driveability, power transfer, and battery technology and prepares students to successfully complete the Light Duty Hybrid/Electric Vehicle Specialist (L3) ASE certification exam.[2] SRTA, SRTA's contracted operator, and any maintenance contractors could consider working with local community colleges to identify recent graduates working locally who expressed particular interest in working on electric vehicles. If other regional stakeholders throughout the region are brought onboard, this could foster a partnership effort with not only DHCL and SRTA, but also RABA and other North State transit agencies.

Other Training

SRTA or SRTA's contracted operator may work with OEMs to provide first responders training on emergency procedures for the electric vehicles, where feasible.

Section H: Potential Funding Sources

The transition to zero-emissions vehicles will require significant additional capital funding for vehicles and fueling infrastructure, as well as potential increased operating costs for fuel or staff time for managing charging, which far exceeds available formula funding for the region for CTSA and other rural transit needs. SRTA will continue to explore all available funding sources to cover these costs, including competitive grants.

Federal Funding Overview

The text that follows provides a high level overview of Federal funding opportunities for SRTA.

SRTA's contracted operator DHCL, through Caltrans, has benefitted from prior Federal Transit Administration (FTA) 5310 funding for the acquisition of vehicles. This section will focus on FTA funding sources that DHCL, nor SRTA, have not been eligible to receive, specifically 5307, 5311, and 5339.

The 5307 and 5311 funds are distributed by a formula based on various metrics in an urbanized area (5307) or non urbanized area (5311). These funds can be used for all capital and some operating expenses. Metrics include population, population density, low income and vehicle revenue miles. A portion of 5339 funds are distributed by formula to RABA, and a larger portion of funds are discretionary. Discretionary funds are awarded based on competitive grants applications. These funds can be used to acquire revenue vehicles and improve facilities used for vehicle maintenance.

In order to receive FTA formula funding, the agency must become a National Transit Database (NTD) Reporter. This requires submitting an annual report to the FTA within four months after the end of the agency's fiscal year. All 5311 funds are distributed directly to states and each agency eligible for 5311 funds must enter into an agreement with the state to be a designated sub recipient. In order to receive both formula and discretionary 5339 funds the agency must complete a Transit Asset Management (TAM) Plan.

NTD

NTD is the Nation's primary repository of public transportation data. The NTD collects the financial data, operating statistics, safety events, and asset conditions from American transit systems. FTA uses NTD data to apportion funding to urbanized and rural areas in the United States, and to inform decision makers at all levels of government. Reporting all public transportation service data to the NTD will result in each state and urbanized area receiving the maximum possible FTA formula funds for public transportation service.

All public transportation services that are provided may be reported to the NTD. This includes services that are directly operated and those that are operated through purchased transportation agreements. This includes agreements with taxi operators and Transportation Network Companies (TNC) to provide public transportation service. Purchased transportation is applicable to SRTA (i.e., the contract with DHCL) - it is service operated through a written contract for someone else to provide the service in your name, in which you specify the terms and conditions by which the service will be provided (e.g., the dates, times, places, and fares for the service).

The main benefit for becoming an NTD reporter is to obtain 5311 funds. While the Redding urbanized area receives 5307 funds, SRTA becoming an NTD reporter will have minimal impact on the amount of 5307 funding available to the Redding urbanized area since reporting Sunday ridership provided in the RABA service area is not likely to be significant. However 5311 funding is available for the non-urbanized area of Shasta County, and Shasta County Department of Public Works has historically been the sole recipient of 5311 funding to the region.

SRTA should consult with Caltrans and FTA Region 9 in San Francisco to get a sense if the additional administrative effort is worth the additional revenue that can be obtained for Shasta County. SRTA would be classified as a "Reduced Reporter' which does reduce the administrative burden, however as Figure 6 below illustrates the following data needs to be reported annually.

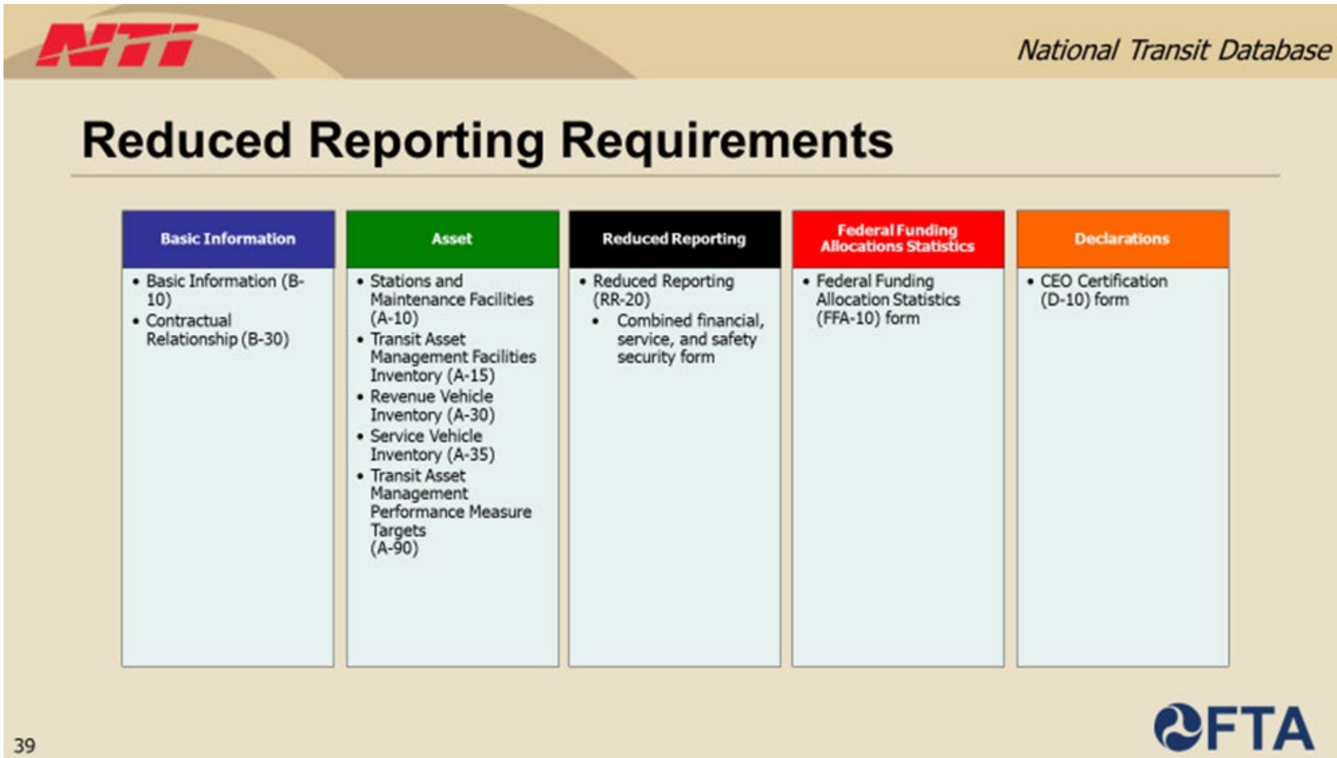

Figure 6: Federal Transit Authority (FTA) reduced-reporting requirements for NTD reporting.

Match for Federal Funding

Generally, the federal share is not to exceed 80 percent of the net project cost for capital expenditures. The federal share may be 90 percent for the cost of vehicle-related equipment attributable to compliance with the Americans with Disabilities Act and the Clean Air Act. This means that the 5339 Low-No Discretionary programs described below only require a 10% non-federal match. The federal share may not exceed 50 percent of the net project cost of operating assistance.

TAM Plan

As noted above in order to be eligible for 5339 funding the SRTA must prepare a TAM plan. A TAM plan, that can be edited by SRTA for subsequent updates, has been prepared in conjunction with this plan.

Grants for Buses and Bus Facilities Program - 5339

Grants for Buses and Bus Facilities has three subsections that could assist with capital funding needs. The Formula Program - 5339(a) provides funding to states and transit agencies through a statutory formula to replace, rehabilitate and purchase buses and related equipment and to construct bus-related facilities. 5339(a) formula funding is apportioned directly to RABA. In addition to the formula allocation, the Grants for Buses and Bus Facilities program (49 U.S.C. 5339) includes two discretionary components: the Bus and Bus Facilities Discretionary Program - 5339(b) and the Low or No Emissions Bus Discretionary Program - 5339(c).

Eligible Recipients

Eligible Recipients include designated recipients that operate fixed route bus service or that allocate funding to fixed route bus operators; and State or local governmental entities that operate fixed route bus service that are eligible to receive direct grants under 5307 and 5311.

Subrecipients: An eligible recipient that receives a grant under the formula or discretionary programs may allocate amounts from the grant to subrecipients that are public agencies or private nonprofit organizations engaged in public transportation. Since SRTA does not operate fixed route service it would be eligible to receive funding as a subrecipient of RABA as the 5307 direct recipient or Caltrans as the 5311 designated recipient.

Eligible Activities

Capital projects to replace, rehabilitate and purchase buses, vans, and related equipment, and to construct bus-related facilities, including technological changes or innovations to modify low or no emission vehicles or facilities.

Low-No Overview

The Low or No Emission competitive program provides funding to state and local governmental authorities for the purchase or lease of zero-emission and low-emission transit buses as well as acquisition, construction, and leasing of required supporting facilities.

Eligible Applicants

Eligible applicants include direct or designated recipients of FTA grants; States; local governmental authorities; and Indian Tribes. Except for projects proposed by Indian Tribes, proposals for funding eligible projects in rural (non-urbanized) areas must be submitted as part of a consolidated state proposal. Since SRTA is primarily serving a rural area this condition would apply. States and other eligible applicants also may submit consolidated proposals for projects in urbanized areas.

Eligible Activities

Eligible projects include:

- purchasing or leasing low- or no-emission buses
- acquiring low- or no-emission buses with a leased power source
- constructing or leasing facilities and related equipment (including intelligent technology and software) for low- or no-emission buses
- constructing new public transportation facilities to accommodate low- or no-emission buses

- rehabilitating or improving existing public transportation facilities to accommodate low- or no-emission buses
- Additionally 0.5% of a request may be for workforce development training and an additional 0.5% may be for training at the National Transit Institute (NTI). Applicants proposing any project related to zero-emission vehicles must also spend 5% of their award on workforce development and training as outlined in their Zero-Emission Transition Plan, unless the applicant certifies that their financial need is less.

Match

All eligible expenses under the Low-No Program are attributable to compliance with the Clean Air Act and/or the Americans with Disabilities Act. Therefore, the Federal share of the cost of leasing or purchasing a transit bus is not to exceed 85 percent of the total transit bus cost. The federal share in the cost of leasing or acquiring low- or no-emission bus-related equipment and facilities is 90 percent of the net project cost. Applicants must identify these specific activities in their application in order to receive this increased federal share.

State Funding

SRTA's future procurement of zero-emission buses can take advantage of several state-level funding sources. The Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP) offers grants to reduce the upfront cost of new zero-emission transit buses - the similar CARB Bus Replacement Grant does not cover any of SRTA's vehicles due to their engine years being newer than 2009. SRTA currently receives formula funding through the Caltrans Low-Carbon Transit Operations Program, and California's Transit and Intercity Rail Capital Program offers competitive opportunities to submit for funding within disadvantaged communities and/or communities of concern. Both hydrogen and electric vehicle charging stations can claim Low-Carbon Fuel Credits based on the amount of fuel they dispensed, which can be traded or sold on a spot market to provide a constant source of revenue.

Infrastructure Funding

The California Energy Commission and CALSTART's Energy Infrastructure Incentives for Zero-Emission Commercial Vehicles (EnergIIZE) program can reduce the cost of installing hydrogen and/or electric vehicle charging infrastructure. Additionally, the US Department of Transportation has established a Charging and Fueling Infrastructure Discretionary Grant Program, which will incentivize publicly accessible EV charging along Alternative Fuel Corridors, which includes Interstate 5 through Redding and SR 299 between Redding and Weaverville. Interstate 5 is also a pending Hydrogen Fuel Corridor - upon final designation as such, the Charging and Fueling Infrastructure Grant program will additionally cover hydrogen fueling infrastructure along I-5 within the greater Redding area.

Section I: Start-up and Scale-up Challenges

Availability of Vehicles Meeting Operational Needs

As noted earlier, currently available zero-emission bus models do not meet all of the operational needs of SRTA. More than half of daily routes exceed the safe range of a 140-mile battery electric vehicle. Vehicles exceeding 200 miles of range under all operating conditions would be needed to meet mileage needs, but are not yet available on the market. Hydrogen Fuel Cell Vehicles offer long ranges and fast refueling times, but hydrogen vans and smaller buses have not yet been deployed by any agency in California and are not currently widely commercially available.

The State (CARB, Caltrans, CPUC, and the CEC) should monitor this market and convene operators of vans and shuttles to understand their unique challenges. Additional funding by federal and state agencies to encourage investment in these technologies for smaller vehicles that are needed for many rural and urban services would help transit agencies transition fleets in support of federal and state zero-emission goals.

SRTA and its contracted operator should look for opportunities to learn more about ZEV operations from other transit agencies, prior to any procurement. An earlier demonstration of either a BEB or FCEB (depending vehicle and fueling availability) could be beneficial for the help gain experience and data to support the future transition.

Cost and Funding Availability

The landscape for zero-emissions vehicles continues to develop at an extremely rapid rate, and the incentive programs at all levels of government tend to be highly competitive and subject to evolution and change to better reflect the contemporary ZEV landscape. While many diverse funding programs are available and actively being implemented, funding cycles and high demand mean that broader programs with smaller funds may be exhausted quickly. The high upfront cost of ZEV vehicles and infrastructure may be prohibitive if they cannot be subsidized by these programs. It will be important for SRTA and its contractor to understand the scale and scope of the incentive programs available to them at the time of procurement, which may look substantially different from the programs currently existing at the time of writing.

Infrastructure

EV and hydrogen infrastructure represent a significant departure from traditional fueling architecture. Hydrogen currently relies on smaller-scale production of hydrogen that must be pressurized and stored onsite for dispensing, while EV charging stations tap into the local electrical grid and must be supplied by robust power delivery equipment (transformers, conduit) and safety equipment (switchgear). Hydrogen will require the establishment of a reliable supply of hydrogen from local or regional facilities, which currently are fairly distant from the ShastaConnect service area. Electricity supply to charging stations may be interrupted by public safety power shutoff events, wildfire damage elsewhere in the region, or emergency load reduction events during extreme heat, which may necessitate the installation of local energy storage to improve reliability. This may incur an additional cost of roughly $225-$275/kWh, based on recent reporting from the National Renewable Energy Lab[27].

[27] https://www.nrel.gov/docs/fy21osti/79236.pdf

Power and Service Reliability

As a rural transit agency abutting mountainous wilderness areas, the Redding and Burney service areas are subject to Public Safety Power Shutoffs (PSPS) and wildfires. Consideration must be given to how well vehicles can continue to operate during PSPS events, given the loss of electrical service, as well as the suitability of vehicles to serve as potential emergency evacuation response units in times of need. Battery-electric vehicles may be able to provide benefits during PSPS events, if they are able to charge before events occur and vehicles and infrastructure are equipped with vehicle-to-load functionality. However, both compatible infrastructure and careful sizing and planning will need to occur to ensure uninterrupted, reliable service is maintained.

Weather and Temperature

A recent report[28] by Cleveland State University (CSU) and Center for Transportation and the Environment (CTE) found that cold ambient temperatures had a greater impact on BEBs than FCEBs. The study showed that for temperature drops from 50-60° F to 22-32° F, the efficiency loss for BEBs was 32.1% and the efficiency loss for FCEB's was 28.6%. They noted that diesel buses also have an efficiency loss at cold ambient temperatures, but that was not part of the study. One reason for the improved efficiency of FCEBs over BEBs is the ability to use the waste heat generated by the fuel cell for cabin heating.[29] The CSU/CTE study also found the loss in range was approximately 15% greater for FCEBs than for BEBs (37.8% vs. 23.1%) for the same change in temperature (50-60° F to 22-32° F)

[28] Henning, Mark; Thomas, Andrew R.; and Smyth, Alison, "An Analysis of the Association between Changes in Ambient Temperature, Fuel Economy, and Vehicle Range for Battery Electric and Fuel Cell Electric Buses" (2019). https://engagedscholarship.csuohio.edu/urban_facpub/1630

[29] https://www.ballard.com/docs/default-source/motive-modules-documents/technical-note---bus-cold-weather-operation---final.pdf

Appendix A: Draft Resolution Language

RESOLUTION 23-07

A RESOLUTION OF THE SHASTA REGIONAL TRANSPORTATION AGENCY APPROVING A ZERO-EMISSION FLEET TRANSITION ROLLOUT PLAN FOR SHASTACONNECT SERVICES

WHEREAS, the Innovative Clean Transit Rule (ICT) is a California regulatory policy administered by the California Air Resources Board, which mandates that public transit agencies operating in California must transition their bus fleets to utilize zero-emission buses (ZEB), including electric buses or fuel cell buses; and

WHEREAS, California Code of Regulations Title 13, Division 3, Chapter 1, Article 4.3, Part 2023.1(d) ZEB Rollout Plan Requirements requires that a transit agency's Zero-Emission Bus Rollout Plan must be approved by its governing Board; and

WHEREAS, the ZEB Rollout Plan for contracted public transit services sets forth the Shasta Regional Transportation Agency's (SRTA) plan which meets the following requirements**:**

- A goal of full transition to zero-emission buses by 2040 with careful planning that avoids early retirement of conventional internal combustion engine buses;
- Identification of the types of zero-emission bus technologies Shasta Regional Transportation Agency is planning to deploy;
- An estimated schedule for zero-emission and conventional internal combustion engine bus purchases and lease options;
- An estimated schedule for conversion of conventional internal combustion engine buses to zero-emission technologies, if applicable;
- An estimated schedule for construction of facilities and infrastructure modifications or upgrades, including charging, fueling, and maintenance facilities, to deploy and maintain zero-emission buses;
- Explanation of how Shasta Regional Transportation Agency plans to deploy zero-emission buses in Disadvantaged Communities;
- A training plan and schedule for zero-emission bus operators and maintenance and repair staff;
- Identification of potential funding sources; and

WHEREAS, the Bipartisan Infrastructure Law (BIL), Pub. L. 117-58, signed by the President on November 15, 2021, amended the statutory provisions for the Federal Transit Administration's (FTA) implementation of the Grants for Buses and Bus Facilities Competitive Program (49 U.S.C. § 5339(b)) and the Low or No Emission Program (49 U.S.C. § 5339(c)) to include the requirement that any application for projects related to zero-emission vehicles include a Zero-Emission Transition Plan; and

WHEREAS, to maximize funding opportunities, the Shasta Regional Transportation Agency addressed both state requirements and federal guidelines in one consolidated document, known as the Zero-Emission Fleet Transition Rollout Plan; and

WHEREAS, SRTA has considered all current and relevant information available today, including the state and federal requirements and regulations; availability of vehicles and technologies; and all relevant verbal and written comments which have been submitted in a timely manner; and

WHEREAS, all interested agencies, organizations, and persons have been given the opportunity to be heard with respect to any matters relating to the proposed Zero-Emission Fleet Transition Rollout Plan; and

WHEREAS, the transition to a zero-emission public transit fleet will be a significant investment that may be challenging to meet without federal and state financial support, environmental streamlining, and technological support; and

WHEREAS, the proposed Zero-Emission Fleet Transition Rollout Plan meets or exceeds the requirements of federal and state regulations; and

NOW, THEREFORE, BE IT RESOLVED that the Board of the Directors of the Shasta Regional Transportation Agency approves and adopts the Zero-Emission Fleet Transition Rollout Plan.

NOW, THEREFORE, BE IT FURTHER RESOLVED that the Board of Directors of the Shasta Regional Transportation Agency authorize the executive director to submit the plan to the California Air Resources Board and to make minor administrative amendments to the plan in response to federal and state review and approval processes.

PASSED AND ADOPTED this 22nd day of June 2023, by the Board of Directors of the Shasta Regional Transportation Agency.

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Mark Mezzano, Chair
Shasta Regional Transportation Agency

ATTEST:

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Sean Tiedgen, Executive Director
Shasta Regional Transportation Agency

Appendix B: Federal ZEB Transition Plan

Long term fleet management plan

The Shasta Regional Transportation Agency (SRTA) has proposed a plan for long-term fleet management, consisting of primarily procuring internal-combustion vehicles until after 2029, except for one potential ZEB procurement in 2027. After this, the procurement will shift to entirely zero-emission vehicles, with the fleet's first zero-emission purchase occurring in 2030 under FTA standard replacement timelines. Sections C and D detail the plans for procuring, operating, and replacing the fleet's 9 vehicles on an ongoing basis through 2040.

Policy and legislation impacting relevant technologies

SRTA has identified policies, legislative rulings, and incentive programs that are currently being implemented to guide the development, commercial availability, and adoption of zero-emission vehicles and associated fueling infrastructure on both a broad scale and within disadvantaged communities. For more information, please see sections C, D, F, and H.

Cost and resources to meet the transition

SRTA has conducted an examination of the capital and operating costs associated with transitioning their fleet to either hydrogen or battery-electric vehicles. The analysis encompassed three cost scenarios (high/assumed/low) of the incremental expenses of procuring, fueling, and maintaining battery-electric and hydrogen fuelcell vehicles and their associated infrastructure. This analysis, and associated recommended resources for meeting the transition, can be found in sections C, D, and E.

Evaluation of current and future facilities

SRTA has examined the expected fueling requirements for both battery-electric and hydrogen fuel cell vehicles and identified potential locations, sizes, and service capacities for each proposed fueling depot. For further information, please see Section E.

Partnership with utility or fuel provider

SRTA has identified several potential avenues for partnerships with local utilities (Pacific Gas and Electric, City of Redding Electric Utility) to aid in the installation of electric vehicle charging stations and negotiate rates, as well as several hydrogen providers throughout northern California and western Nevada that may be able to supply hydrogen to proposed filling stations. For more information, please see Section E.

Workforce impacts

SRTA has outlined the expected impacts of vehicle electrification on the regional workforce, and identified next steps to aid in adapting the workforce to the new elements and skills required to support electrified vehicles. This includes on the job training, coordinating with local educational centers for outreach and employment opportunity, and other approaches to engaging and training the local community workforce. For more information, please see Section H.