FAX
FRESNO AREA EXPRESS

Zero Emission Bus
Rollout Plan

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Abbreviations

AHJ	Authority Having Jurisdiction
BEB	Battery Electric Bus
CalSTA	California State Transportation Agency
Caltrans	California Department of Transportation
CARB	California Air Resource Board
CFC	California Fire Code
CNG	Compressed Natural Gas
CO	Carbon Monoxide
DE	Diesel
ESS	Energy Storage System
EV	Electric Vehicle
FAX	Fresno Area Express
FC	Fuel Cell
FCEB	Fuel Cell Electric Bus
FR	Fixed Route
FTA	Federal Transit Administration
GHG	Greenhouse Gas
H_2	Hydrogen
HVIP	Hybrid and Zero-Emission Truck and Bus-Voucher Incentive Project
ICT	Innovative Clean Transit
kg	Kilogram
kV	Kilovolt
kW	Kilowatt
kWh	Kilowatt-hour
mi	Mile
mph	Miles per Hour
MW	Megawatt
NFPA	National Fire Protection Association
NO_X	Nitrogen Oxides
OEM	Original Equipment Manufacturer
PG&E	Pacific Gas and Electric Company
PM	Particulate Matter
PT	Paratransit
V	Volt
VOC	Volatile Organic Compounds
VW	Volkswagen
ZEB	Zero Emission Bus
ZEV	Zero Emission Vehicle

A. Transit Agency Information

Fresno Area Express (FAX) provides public transit services in the City of Fresno and surrounding unincorporated urban areas. FAX's service consists of 17 fixed routes in a modified grid pattern as well as a demand-responsive paratransit service oriented towards elderly and disabled persons who are unable to ride the fixed route system. The fixed route service includes a bus rapid transit line running from North Fresno through Downtown to Clovis Avenue. FAX provides service for approximately 10 million boardings per year and has an annual operating budget of approximately $42 million.

FAX's fixed route fleet operates out of its main facility at 2223 G Street, Fresno, California. This location includes the agency's administrative headquarters, maintenance facility, compressed natural gas (CNG) fueling infrastructure, operations center, and bus parking. Currently, the site can accommodate up to 125 buses.

The Handy Ride paratransit fleet is operated out of a second facility at 4488 N Blackstone Avenue, Fresno, California. This location includes a small administrative building and bus parking. The Handy Ride service has been contracted to Keolis Transit America, who operate and maintain the paratransit fleet on behalf of FAX.

Transit Agency's Name	Fresno Area Express
Mailing Address (number, street, city, county, zip code)	2223 G Street, City of Fresno, Fresno County, California 93706
Name of Transit Agency's Air District(s)	San Joaquin Valley Air Pollution Control District
Name of Transit Agency's Air Basin(s)	San Joaquin Valley Air Basin
Total number of buses in Annual Maximum service	100
Population of the urbanized area a transit agency is serving as last published by the Census Bureau before December 31, 2017	664,000
Contact information of the general manager, chief operating officer, or equivalent: A) Contact Name (Last Name, First Name, MI) B) Title C) Phone Number D) Email	Barfield, Gregory Director, Department of Transportation City of Fresno (550) 621-1520 Gregory.Barfield@fresno.gov

B. Rollout Plan General Information

FAX's zero emission bus (ZEB) rollout plan will enable the agency to fully transition its bus fleet to zero-emission by 2040 in accordance with the Innovative Clean Transit (ICT) regulation. Transitioning to 100% zero-emission will provide significant air quality and health benefits to the local population as well as FAX staff. The agency welcomes the directive from the ICT regulation and is committed to completing this transition.

The final fleet composition will be a mixture of battery electric buses (BEB) and fuel cell electric buses (FCEB). The exact mix was determined to ensure the current level of service will be maintained while minimizing cost. Each new ZEB was designed to join the fleet as a 1:1 replacement for a CNG vehicle. FAX will utilize BEBs on shorter and less demanding routes and assign FCEBs to longer and more difficult routes to take advantage of their greater range and peak power capabilities.

The bus replacement schedule has been designed such that each bus will operate for its entire useful life to avoid any early retirements. It also seeks to limit the number of new bus purchases required in any single year to maintain the annual capital requirement for bus procurements at a relatively consistent level. As the plan is executed, it is likely the exact number of purchases will fluctuate from year to year based on the available funding, but the overall trend will be followed.

In January 2020, FAX executed a contract with its electrical utility, Pacific Gas and Electric Company (PG&E), to enter their Electric Vehicle (EV) Fleet Program. This program provides upstream electrical infrastructure for the charging of battery electric vehicles at a favorable rate. The contract requires FAX to deploy BEBs at a predetermined schedule between 2020-2024. All planned chargers are to be installed at FAX's existing facility. No on-route opportunity chargers will be deployed due to the increased cost. The rollout plan was designed to ensure ZEB deployment satisfies both the ICT Regulation and PG&E contract requirements.

This ZEB Rollout Plan was approved by the Fresno City Council on June 18, 2020 under Resolution ID 20-00712. The board approved resolution is attached in Appendix B.

This Rollout Plan was developed by the LeFlore Group and Zen and the Art of Clean Energy Solutions (Zen) in collaboration with FAX.

For additional information on the Rollout Plan, please contact:

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C. Technology Portfolio

As the fleet transitions to 100% zero-emission, FAX plans to utilize a mixture of BEBs and FCEBs. The fully transitioned fleet composition of 67 fixed route BEBs, 56 fixed route FCEBs, and 65 paratransit BEBs maximizes fleet performance while minimizing rolling stock and infrastructure capital expenditure. Energy and route modelling were conducted to ensure the fleet could satisfy the routes at the current level of service and to ensure infrastructure could be sited without causing issues.

Route Analysis

A route analysis was performed to determine which FAX routes/blocks would be best served by BEBs and which are better suited for FCEBs. A representative sample of routes were analyzed using Zen's proprietary kinetic model which estimates fuel consumption based on a given duty cycle. The model accurately predicts ZEB range by taking into account contributors to power demand throughout the duty cycle, such as speed, elevation change, idling times, and cabin cooling / heating demand. Several commercially available ZEBs were modelled to determine which units could achieve the required range.

Table 1 shows the commercially available BEBs and FCEBs that were analyzed. The model considered vehicle specifications such as battery capacity (power and energy), fuel cell system power output and fuel consumption (where applicable), electric motor size, powertrain efficiency, and vehicle weight.

Table 1: Technical specifications of ZEBs used in route analysis

Bus Specification	New Flyer XCE 40'		Proterra Catalyst 40'		
	FCEB Charge H_2	BEB Charge RC	BEB XR Duo	BEB E2 Duo	BEB E2 Max
Electric Motor Power (kW)	160	160	380	380	380
Energy Storage Power (kW)	160	160	252	380	380
Energy Storage Capacity (kWh)	100	388, 466	220	440	660
FC Engine Power (kW)	85	n/a	n/a	n/a	n/a

Figure 1 shows the duty cycle of one of FAX's operating blocks during peak revenue service. Figure 2 and Figure 3 show the estimated power demand and fuel consumption based on kinetic modelling of the duty cycle shown in Figure 1. In this example, it was determined that none of the BEB models had sufficient range to service this block. The model showed that an FCEB could complete this block, so the plan to maintain service with a 1:1 bus replacement, the CNG bus operating on this block must be replaced with a FCEB.

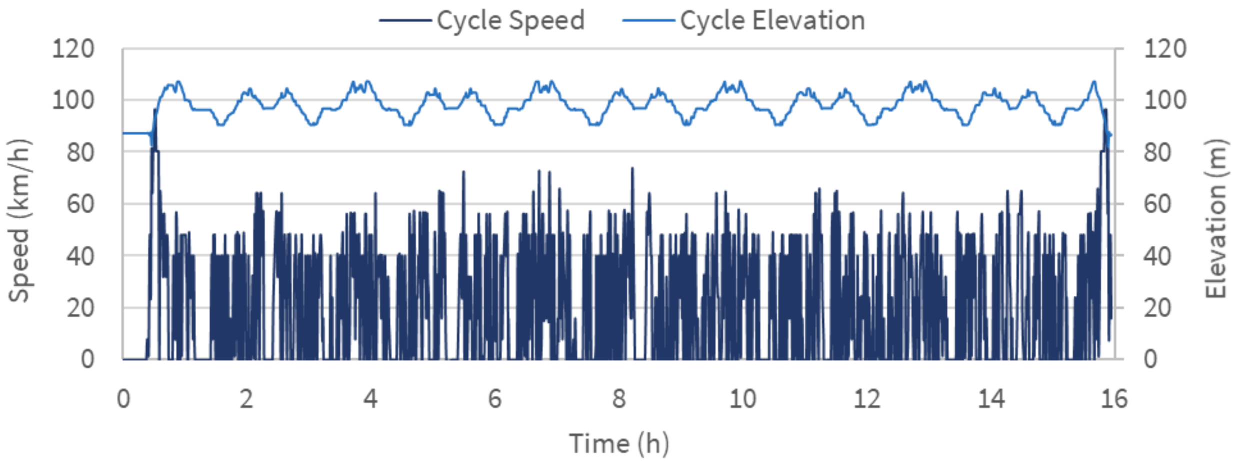


Figure 1: Example duty cycle analysis

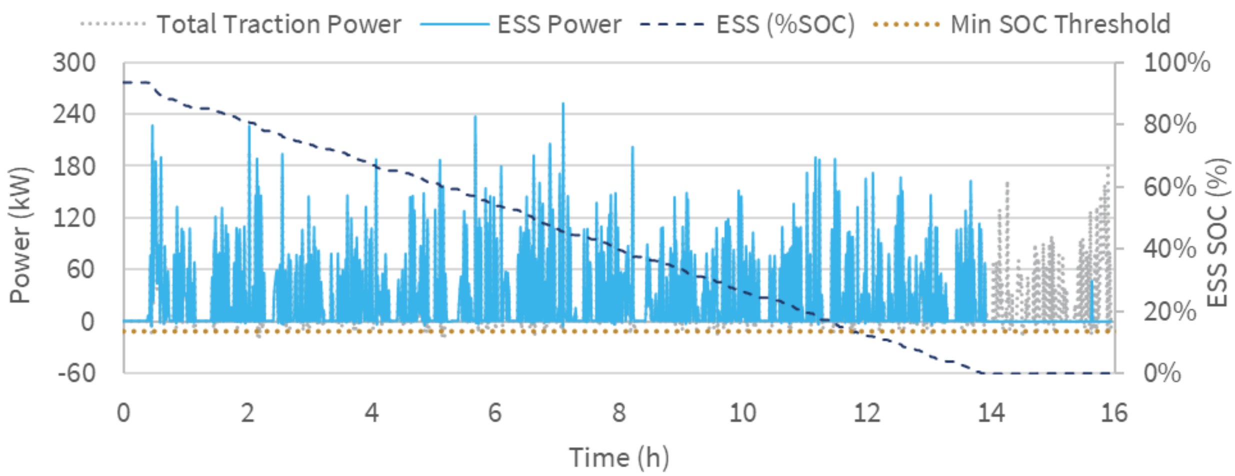


Figure 2: BEB kinetic modelling output

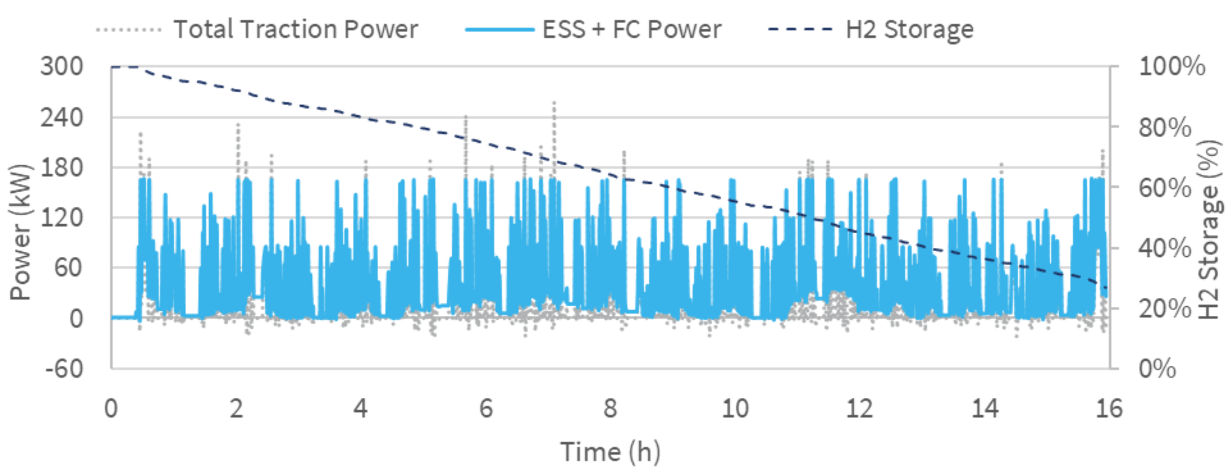


Figure 3: FCEB kinetic modelling output

The model results represent a realistic simulation of BEB and FCEB performance, but actual operational range can only be approximated. The impacts of battery degradation, peak cabin cooling/heating loads, and driver behavior are difficult to accurately predict at this time. The most conservative modelling showed that the BEB fleet size could need to be reduced by as much as 40% depending on performance in the worst-case conditions. Once the first ZEBs have joined the fleet, FAX will carefully monitor performance. It will be essential to validate BEB and FCEB range capabilities in adverse conditions (e.g., hottest and coldest days of the year, near mid-life and end-of-life when battery performance has reduced, etc.) to ensure the vehicles will be able to meet service consistently. Data collected during this process will create a feedback loop to update the transition plan and better inform future purchases.

Infrastructure Constraints

FAX's fixed route and paratransit (Handy Ride) fleets are located on separate properties that each pose unique challenges which impact the anticipated final ZEB fleet composition. Figure 4 shows an overview of FAX's fixed route bus facility.

Figure 4: FAX fixed route depot (2223 G Street)

There are two major factors impacting ZEB infrastructure at the fixed route fleet depot: available electrical capacity and space limitations. FAX's enrollment into PG&E's EV Fleet Program guarantees 3 MW of continuous power dedicated for BEB charging at this facility for the next 10 years. As part of the agreement, PG&E will install supply infrastructure upstream of FAX's meter capable of supplying up to approximately 6 MW. To secure capacity beyond 3 MW, FAX will need to re-engage PG&E and sign a new agreement, since the substation is shared with other users in the area. To limit risk, the transition plan limits the long-term number of BEBs such that a maximum of 5 MW will be required to charge the fleet overnight, using a charging strategy that maximizes the available charging window without impact pull-in and pull-out times. This will utilize the guaranteed 3 MW as well as requiring FAX to secure the additional 2 MW of capacity as its BEB fleet grows. If another customer accesses this power, FAX will need to reassess the plan to either include another electrical service upgrade or deploy more FCEBs and fewer BEBs. Expanding past the existing distribution line capacity may require FAX to purchase and construct a substation, which is estimated to cost in the order of $5 - $10 million which was deemed cost prohibitive.

Siting of hydrogen fueling infrastructure at FAX's facility will be a challenge due to space constraints. There are few locations at the site that conform to NFPA 2 code restrictions, which requires offset distances, for example between hydrogen equipment and buildings electrical power lines, and the property line.

Figure 5 details the most suitable option for hydrogen infrastructure placement. It is close to the current CNG fueling dispensers, which enables buses to flow through the yard similarly to current operations. The hydrogen storage and compression equipment will be surrounded by 10 ft fire walls to reduce NFPA 2 separation distances. The major downside of this option is that it will encroach into the existing employee parking lot, removing approximately 10 spaces and possibly constricting traffic flow. The parking lot is already near capacity, so removing the spots may not be feasible.

Figure 5: Satellite overhead view of hydrogen infrastructure placement

If the hydrogen fueling equipment proves challenging to place on site, it may be beneficial for FAX to purchase a new property for this purpose. In addition to saving the employee parking spots, this option would also enable additional overnight parking for its fixed route fleet, which is also near capacity. FAX is currently in the process of evaluating potential properties.

The Handy Ride facility located at 4488 N Blackstone Avenue is constrained both by available electrical capacity and space. Figure 6 shows an overview of the Handy Ride facility. The cutaway bus parking spots take up most of the lot, which makes safely siting hydrogen fueling infrastructure difficult without losing overnight bus parking capacity. Therefore, FAX plans to transition its paratransit fleet to 100% BEBs.

Figure 6: FAX Handy Ride depot (4488 N Blackstone Ave)

The Handy Ride location is also limited on available electrical capacity and would require upgrades to service BEB charging infrastructure. Current BEB cutaway vehicles on the market use the popular Ford E-450 chassis. The range for BEB cutaway buses is expected to be between 80 – 130 miles, depending on the vehicle's battery capacity. Specifications of these models are described in Table 2. The electrical charging capacity required to service a 65 BEB paratransit fleet will range from approximately 516 kW – 774 kW. Prior to transitioning its paratransit fleet, FAX will seek to engage with PG&E to apply for the EV Fleet Program for this facility.

Table 2: BEB paratransit vehicle specifications

Bus Specification	Motiv Power Systems	Lightning Systems
Bus Platform	Ford E-450	Ford E-450
Battery Capacity (kWh)	106	86, 129
Range (mi)	85	80, 120
Peak Motor Power Rating (kW)	150	180
Max Speed (mph)	65	65
Charging Capability	15kW (J 1772)	Level 2 (6.6 kW) Level 3 (up to 50 kW) with J1772 CCS-1 Combo

D. Current Bus Fleet Composition & Future Bus Purchases

Current Fleet Bus Composition

Fixed Route

FAX's fixed route fleet is composed of 116 standard 40' buses, including 115 CNG buses and 1 gasoline hybrid bus. The average age of FAX's fixed route fleet is 7 years, including 24 buses which are 14 years old or older. FAX's fixed route service requires 100 operated vehicles at maximum service, resulting in a 16% spare ratio. Table 3 displays FAX's current fixed route fleet inventory grouped by purchase year and bus type.

Table 3: Individual Bus Information of Current Fixed Route Bus Fleet

# of Buses	Bus Model Year	Fuel Type	Bus Type
8	2020	CNG	Gillig 40' Low Floor
2	2019	CNG	Gillig 40' Low Floor
1	2018	CNG	Gillig 40' Low Floor
27	2017	CNG	Gillig 40' Low Floor
17	2016	CNG	Gillig 40' Low Floor
8	2014	CNG	Gillig 40' Low Floor
2	2013	CNG	Gillig 40' Low Floor
8	2012	CNG	Gillig 40' Low Floor
3	2012	CNG	Gillig 29' Low Floor
1	2011	CNG	Gillig 40' Low Floor
15	2009	CNG	New Flyer C40LF
1	2009	Gasoline Hybrid	New Flyer GE40LF
14	2006	CNG	New Flyer C40LF
9	2005	CNG	New Flyer C40LF

Handy Ride

FAX's paratransit service, Handy Ride, consists of 51 cutaway buses – 39 gasoline, 3 diesel, and 9 CNG. The average age of their fleet is 6 years. This includes 10 buses that have reached or exceeded their expected lifetime of 8 years and 8 buses over the age of 13. FAX's paratransit fleet is summarized in Table 4.

Table 4: Individual Bus Information of Current Paratransit Bus Fleet

# of Buses	Bus Model Year	Fuel Type	Bus Type
11	2017	Gas	ElDorado Aerotech E450
8	2015	Gas	Starcraft Allstar E450
6	2014	CNG	Starcraft Allstar E450
13	2014	Gas	Starcraft Allstar E450
3	2013	Gas	ElDorado Aerotech E450
2	2011	Gas	Goshen Coach GC11 E450
2	2008	Diesel	Chevrolet C5500
3	2008	CNG	Starcraft Allstar E450
1	2007	Gas	Starcraft Allstar E450
1	2005	Diesel	Chevrolet C4500
1	2005	Gas	ElDorado Aerotech E450

Future Bus Purchases

FAX's Fixed Route and Paratransit fleets were analyzed separately when determining the future bus purchases and the agency's overall ZEB transition plan. To comply with FAX's zero-emission vehicle (ZEV) obligations in 2025, ZEB currency from uncredited existing ZEBs in FAX's fleet and bonus credits were applied. As such, the fleet transition schedule is in compliance with the ICT ZEV mandate. The schedule also includes the gradual expansion of the fixed route fleet by 7 vehicles and the paratransit fleet by 14 vehicles. Table 5 displays future purchases based on fuel type, bus type, and procurement year.

Table 5: Future Bus Purchases

Year	Total No. Purchased	ZEB Purchases				Conventional Bus Purchases			
		No.	%	Bus Type	Fuel Type	No.	%	Bus Type	Fuel Type
2020	10	2	20%	Standard	BEB Depot				
2021	21	7	33%	Standard	BEB Depot	6	29%	Standard	CNG
						8	38%	Cutaway	CNG
2022	23	5	28%	Standard	FC	5	28%	Standard	CNG
		1	6%	Standard	BEB Depot	12	39%	Cutaway	CNG
2023	16	2	14%	Standard	BEB Depot	5	36%	Standard	CNG
						9	50%	Cutaway	CNG
2024	14	2	17%	Standard	BEB Depot	5	42%	Standard	CNG
						7	42%	Cutaway	CNG
2025	13					7	64%	Standard	CNG
						6	36%	Cutaway	CNG
2026	16	5	36%	Standard	FC	3	21%	Standard	CNG
		4	21%	Cutaway	BEB Depot	4	21%	Cutaway	CNG
2027	14	5	42%	Standard	BEB Depot	1	8%	Standard	CNG

Year	Total No. Purchased	ZEB Purchases				Conventional Bus Purchases			
		No.	%	Bus Type	Fuel Type	No.	%	Bus Type	Fuel Type
		4	25%	Cutaway	BEB Depot	4	25%	Cutaway	CNG
2028	15	3	23%	Standard	FC	3	15%	Cutaway	CNG
		5	38%	Standard	BEB Depot				
		4	23%	Cutaway	BEB Depot				
2029	19	11	58%	Standard	FC				
		8	42%	Cutaway	BEB Depot				
2030	22	1	6%	Standard	FC				
		9	53%	Standard	BEB Depot				
		12	41%	Cutaway	BEB Depot				
2031	19	10	59%	Standard	BEB Depot				
		9	41%	Cutaway	BEB Depot				
2032	16	9	64%	Standard	BEB Depot				
		7	36%	Cutaway	BEB Depot				
2033	14	3	25%	Standard	FC				
		5	42%	Standard	BEB Depot				
		6	33%	Cutaway	BEB Depot				
2034	16	3	21%	Standard	FC				
		5	36%	Standard	BEB Depot				
		8	43%	Cutaway	BEB Depot				
2035	20	4	22%	Standard	FC				
		8	44%	Standard	BEB Depot				
		8	33%	Cutaway	BEB Depot				
2036	17	9	60%	Standard	FC				
		1	7%	Standard	BEB Depot				
		7	33%	Cutaway	BEB Depot				
2037	18	5	28%	Standard	FC				
		5	28%	Standard	BEB Depot				
		8	44%	Cutaway	BEB Depot				
2038	22	6	35%	Standard	FC				
		4	24%	Standard	BEB Depot				
		12	41%	Cutaway	BEB Depot				
2039	16	6	43%	Standard	FC				
		1	7%	Standard	BEB Depot				
		9	50%	Cutaway	BEB Depot				
2040	12	5	50%	Standard	FC				
		7	50%	Cutaway	BEB Depot				

Table 6 shows the estimated cost per year and required BEB range or on-board hydrogen storage for each future ZEB purchase. The costs were estimated based on recent quotes for new buses and future cost trends projected by the California Air Resources Board (CARB).[1]

Table 6: Range and Estimated Cost of Future ZEB Purchases

Year	# of ZEBs	Bus Type(s)	Required Range [mi]	Estimated Cost of Each Bus
2020	2	Standard: 2	Standard: BE-200	Standard: $1,190,000
2021	7	Standard: 7	Standard: BE-150	Standard: $900,000
2022	6	Standard: 6	Standard: FC-300, BE-200	Standard: $1,070,000, $1,200,000
2023	2	Standard: 2	Standard: BE-200	Standard: $1,200,000
2024	2	Standard: 2	Standard: BE-200	Standard: $1,210,000
2026	9	Standard: 5 Cutaway 4	Standard: FC-300, Cutaway: BE-150	Standard: $1,000,000, Cutaway: $240,000
2027	9	Standard: 5 Cutaway 4	Standard: BE-200 Cutaway: BE-150	Standard: $1,280,000 Cutaway: $240,000
2028	12	Standard: 8 Cutaway 4	Standard: FC-300, BE-200 Cutaway: BE-150	Standard: $1,020,000, $1,290,000 Cutaway: $240,000
2029	19	Standard: 11 Cutaway 8	Standard: FC-300, Cutaway: BE-150	Standard: $1,030,000, Cutaway: $240,000
2030	22	Standard: 10 Cutaway 12	Standard: FC-300, BE-200 Cutaway: BE-150	Standard: $1,040,000, $1,350,000 Cutaway: $240,000
2031	19	Standard: 10 Cutaway 9	Standard: BE-200 Cutaway: BE-150	Standard: $1,370,000 Cutaway: $240,000
2032	16	Standard: 9 Cutaway 7	Standard: BE-200 Cutaway: BE-150	Standard: $1,390,000 Cutaway: $240,000
2033	14	Standard: 8 Cutaway 6	Standard: FC-300, BE-200 Cutaway: BE-150	Standard: $1,100,000, $1,410,000 Cutaway: $240,000
2034	16	Standard: 8 Cutaway 8	Standard: FC-300, BE-200 Cutaway: BE-150	Standard: $1,120,000, $1,440,000 Cutaway: $250,000
2035	20	Standard: 12 Cutaway 8	Standard: FC-300, BE-150, BE-200 Cutaway: BE-150	Standard: $1,130,000, $1,110,000, $1,460,000 Cutaway: $250,000
2036	17	Standard: 10 Cutaway 7	Standard: FC-300, BE-200 Cutaway: BE-150	Standard: $1,150,000, $1,480,000 Cutaway: $250,000
2037	18	Standard: 10 Cutaway 8	Standard: FC-300, BE-200 Cutaway: BE-150	Standard: $1,180,000, $1,510,000 Cutaway: $260,000
2038	22	Standard: 10 Cutaway 12	Standard: FC-300, BE-200 Cutaway: BE-150	Standard: $1,200,000, $1,530,000 Cutaway: $260,000

[1] State of California Air Resources Board. (2018). Staff Report: Initial Statement of Reasons - Public Hearing to Consider the Proposed Innovative Clean Transit Regulation A Replacement of the Fleet Rule for Transit Agencies: Appendix K. Retrieved from https://www.arb.ca.gov/regact/2018/ict2018/appk-statewidecostanalysis.xlsx?_ga=2.48303334.1749999270.1571069223-138148794.1501775822

Year	# of ZEBs	Bus Type(s)	Required Range [mi]	Estimated Cost of Each Bus
2039	16	Standard: 7 Cutaway 9	Standard: FC-300, BE-200 Cutaway: BE-150	Standard: $1,220,000, $1,560,000 Cutaway: $260,000
2040	12	Standard: 5 Cutaway 7	Standard: FC-300, Cutaway: BE-150	Standard: $1,240,000, Cutaway: $270,000

Conventional Bus Conversions

FAX is not considering converting any conventional buses in service to zero-emission buses, but rather the transition plan is based on new purchases of ZEBs only.

Fixed Route

FAX's fixed route fleet transition plan will gradually phase in ZEBs over the next 20 years. The size of the fleet will increase from 116 buses to 123 between 2020 and 2022 The plan maximizes the number of BEBs deployed while ensuring the vehicles will be able to satisfy service requirements with a 1:1 replacement and without exceeding the available electrical capacity. The replacement schedule ensures FAX satisfies its compliance obligations to the ICT Regulation and existing purchase commitments related to the PG&E contract. BEBs and FCEBs are to be deployed earlier than required by the ICT Regulation to build ZEB operational experience and gather data to inform future purchases. Using bonus credits accumulated from ZEB purchases prior to 2023, the fixed route transition plan meets the ICT mandate requirements and results in a 100% ZEB fleet by 2039, with a final fleet composition of 67 BEBs and 56 FCEBs.

It was assumed that each fixed route bus typically lasts for 14 years, but the expected retirement date was sometimes staggard to minimize the fluctuation of bus purchases required between years. All buses not already past their expected useful life were assumed to last between 12 and 15 years.

Figure 7 and Figure 8 represent FAX's fixed route fleet composition and purchases by bus type each year, respectively.

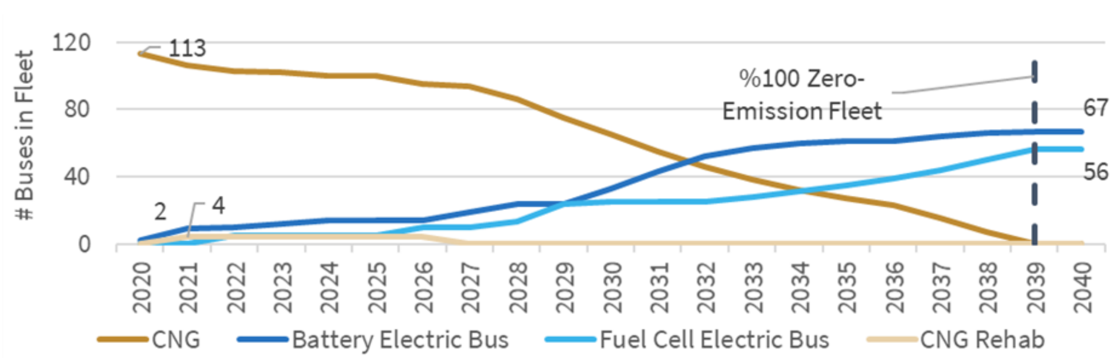


Figure 7: Fixed route fleet composition by fuel type from 2020 – 2040

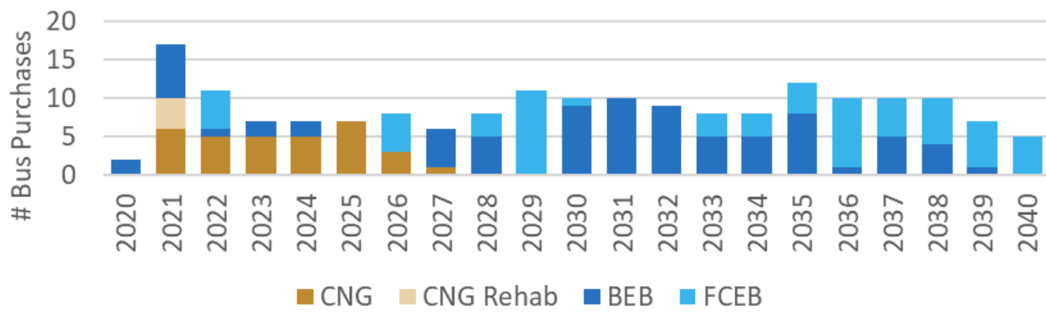


Figure 8: Fixed route future bus procurements by fuel type and year, from 2020 – 2040

The number of ZEB purchases per year prior to 2029 are largely constrained by FAX's existing contract with PG&E, which requires a specific number of BEBs to be deployed each year. The PG&E contract schedule satisfies the ICT regulation and requires 10 BEBs to enter FAX's fleet prior to the start of the mandate in 2023. Based on the sizing of initial hydrogen fueling infrastructure, the first procurements of FCEBs will enter the fleet as a group of 5 buses in 2022. These FCEB purchases will provide FAX experience with FCEB technology and fueling infrastructure, allowing for a more gradual transition of ZEB technology in future years.

A large portion of buses are planned to be replaced in 2021 due to the number of buses that are at or over their expected lifetime and available funding opportunities that year. To reduce the total cost of procurements required in 2021, 4 CNG buses are planned to be rehabbed, extending their current lifetime.

Following the 100% ZEB purchase mandate in 2029, the number and type of ZEBs purchased per year were selected to maximize the lifetime of hydrogen and charging infrastructure and increase the required time between infrastructure upgrades.

Handy Ride

FAX's paratransit replacement plan introduces ZEBs in accordance with the ICT mandate requirements for cutaway vehicles. Other than vehicles currently past their expected useful lives, it was assumed that each paratransit vehicle will last 8 years, which is consistent with current operations at FAX. To avoid a single year with significantly more purchases than usual, the expected retirement age was sometimes staggard to better distribute procurements across years. FAX plans on gradually increasing the size of their paratransit fleet from 51 to 65 vehicles between 2022 and 2029. FAX's paratransit fleet composition and future bus procurements per year are displayed in Figure 9 and Figure 10 respectively.

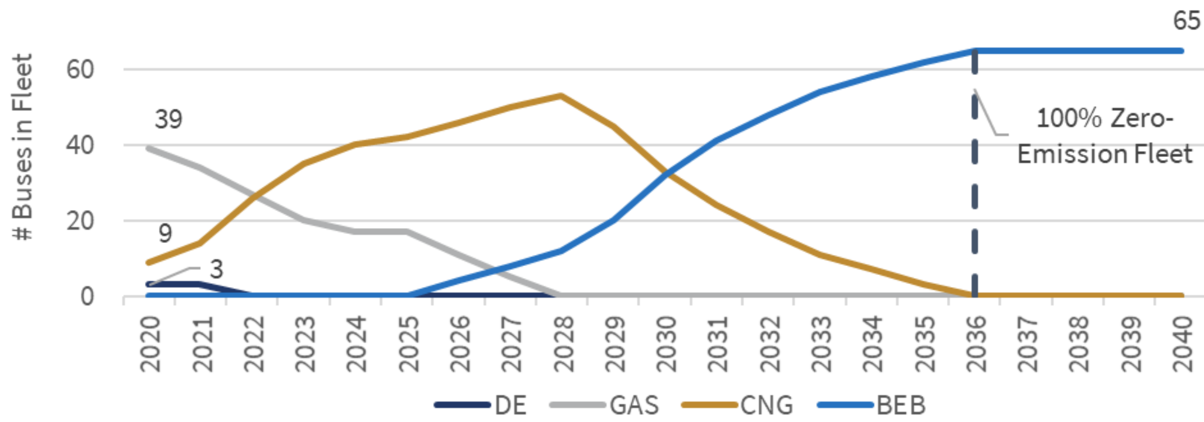


Figure 9: Paratransit fleet composition by fuel type from 2020 – 2040

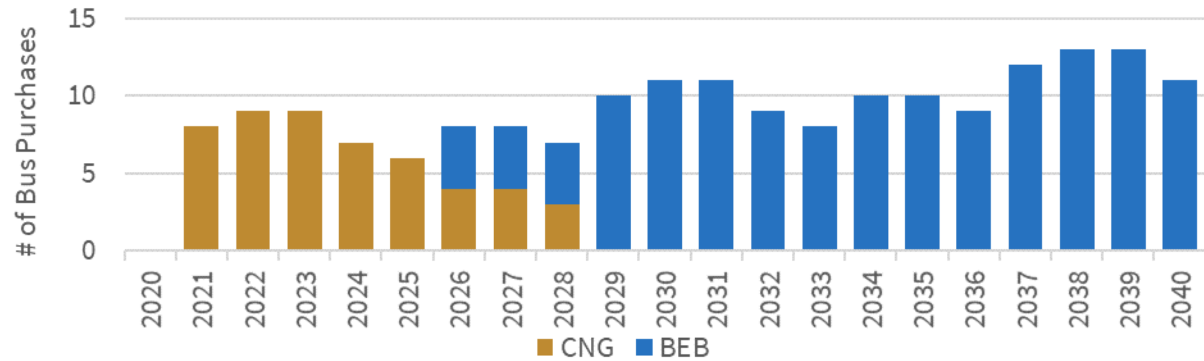
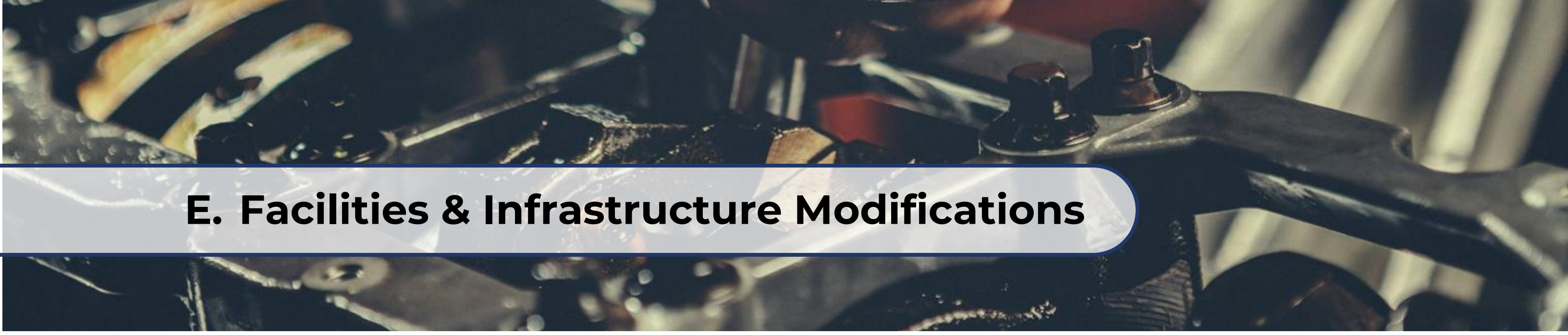


Figure 10: Paratransit future bus procurements by fuel type and year, from 2020 - 2040

All cutaway bus purchases prior to 2026 will be CNG and the last gasoline bus will leave the fleet in 2028. All cutaway ZEBs are planned to be BEBs due to the limited amount of space at Handy Ride's current facility, which restricts the use of hydrogen fueling infrastructure. Following the ICT regulation required replacement schedule, FAX's paratransit fleet will be 100% ZEV by 2036 with a total of 65 BE cutaways. FAX will continue to evaluate the transition plan for paratransit vehicles as new zero emission vehicle options become available.



E. Facilities & Infrastructure Modifications

Fixed Route Depot Infrastructure Upgrades

Electrical Charging Infrastructure

The BEB charging infrastructure will be deployed and scaled to match FAX's BEB purchases. The deployment timeline can be split into two phases: Phase I, 2020-2030 and Phase II, 2030-2040. The engineering and design for Phase I is currently underway and construction is scheduled to begin by Q4 of 2020. As part of FAX's enrollment into PG&E's EV Fleet Program, PG&E will connect a new 12 kV supply line and guarantee 3 MW of continuous power to be available over this 10-year period (2020-2030).

Additional electrical infrastructure will be required on-site in Phase II. However, ten years is beyond the suitable time horizon for FAX to enter into an agreement with PG&E. It is anticipated that FAX's electrical charging capacity will need to expand from 3 MW to 5 MW by 2030. Currently, there is more than enough electrical capacity at PG&E's substation for the 5 MW upgrade, however the substation also services other users, potentially reducing future available power for FAX if other user load grows. FAX will maintain communication with PG&E so that any future power limitations are understood well in advance so that the plan can be revaluated as necessary.

Table 7 summarizes the major equipment to be installed in each phase.

Table 7: Electrical charging infrastructure details

Phase	Estimated Construction Date	Major equipment to be installed (estimate)
I	2020	• 3 MW transformer (12.47 kV – 480/277V) • Connection from PG&E pull box to transformer • Electrical distribution infrastructure (e.g. switches, cables, meters, panels) • 14 overhead charger power control systems (2 dispensers per) • 30 x 6.7 kW pedestal dual chord chargers
II	2030	• Additional 2 MW transformer (12.47 kV – 480/277V) • Connection from PG&E pull box to new transformer • Additional distribution infrastructure • 14 overhead charger power control systems (2 dispensers per)

Phase I requires FAX to purchase and install a dedicated 3 MW transformer as well as BEB charging infrastructure. The transformer will supply 14 overhead chargers with the option of adding up to 9 more in the future. Each charger will be equipped with two dispensers. The overhead chargers are controlled by a centralized system which optimizes charging schedules and delivery rates at each dispenser. Phase I infrastructure can support forty BEBs, with a planned mix of seven 440 kWh models and thirty-three 660 kWh models.

Phase II involves expanding the charging capacity to 5 MW with the construction of an additional 2 MW transformer.

Figure 11 shows the parking stalls where BEB charging infrastructure will be deployed. The black dashed lines outline the siting for the initial construction and connection of the 3 MW transformer and installation of overhead charging equipment underneath the parking canopy A, as well as light duty chargers in two separate areas. The green boxes show the second phase deployment of overhead charging infrastructure into the rest of canopy A and half of canopy B and an additional 2 MW transformer to be installed in the proximity of the two canopies. The Phase II expansion will support an additional twenty-seven BEBs.

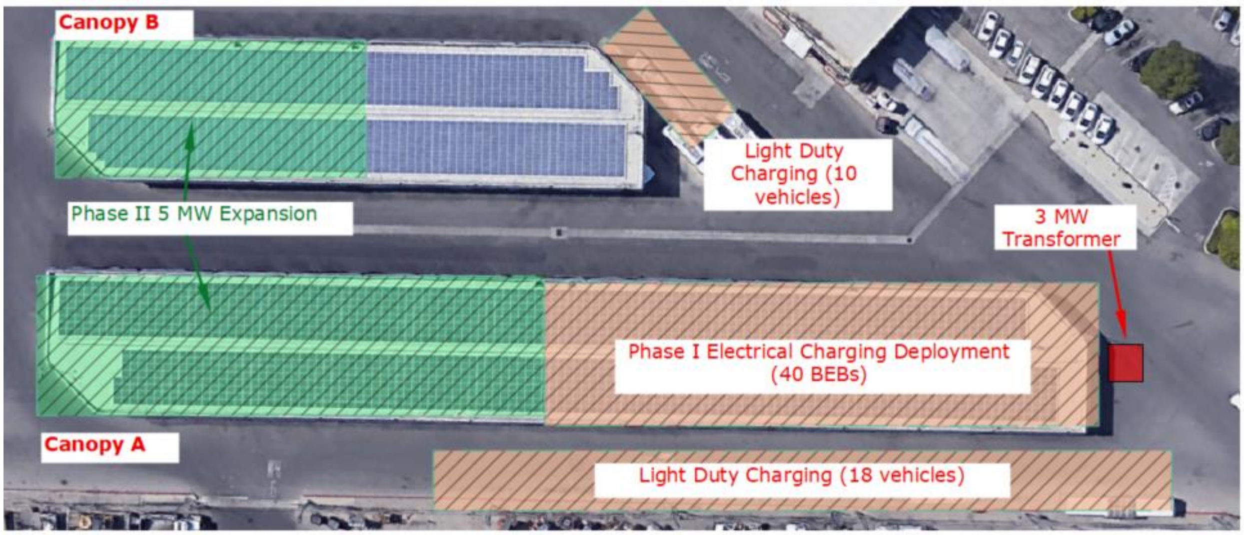


Figure 11: BEB charging infrastructure overview

Hydrogen Fueling Infrastructure

The hydrogen fueling infrastructure will be deployed in three phases, allowing it to scale with the size of the FCEB fleet. As mentioned in Section C, FAX is evaluating whether to site the hydrogen infrastructure at its existing facility or purchase a new parcel of land and install it at the new location. Table 8 details the major equipment for each phase of deployment. As seen in Figure 12, the upgrades will be deployed ahead of the demand curve, ensuring the upgrades are in place and commissioned ahead of time.

Table 8: Hydrogen storage and fueling infrastructure details

Phase	Estimated Construction Date	Major equipment to be Installed (estimate)
I	2022	• Hydrogen liquid storage (leased) • Compressors • 2 x hydrogen pumps • 6 x high pressure gas storage cylinders • Vaporizer • Fueling system • 1 x dispenser
II	2027	• 6 x high pressure storage cylinders • Fuel pre-cooling system • 1 x dispenser

III	2033	• 6 x high pressure storage cylinders • 1 x dispenser

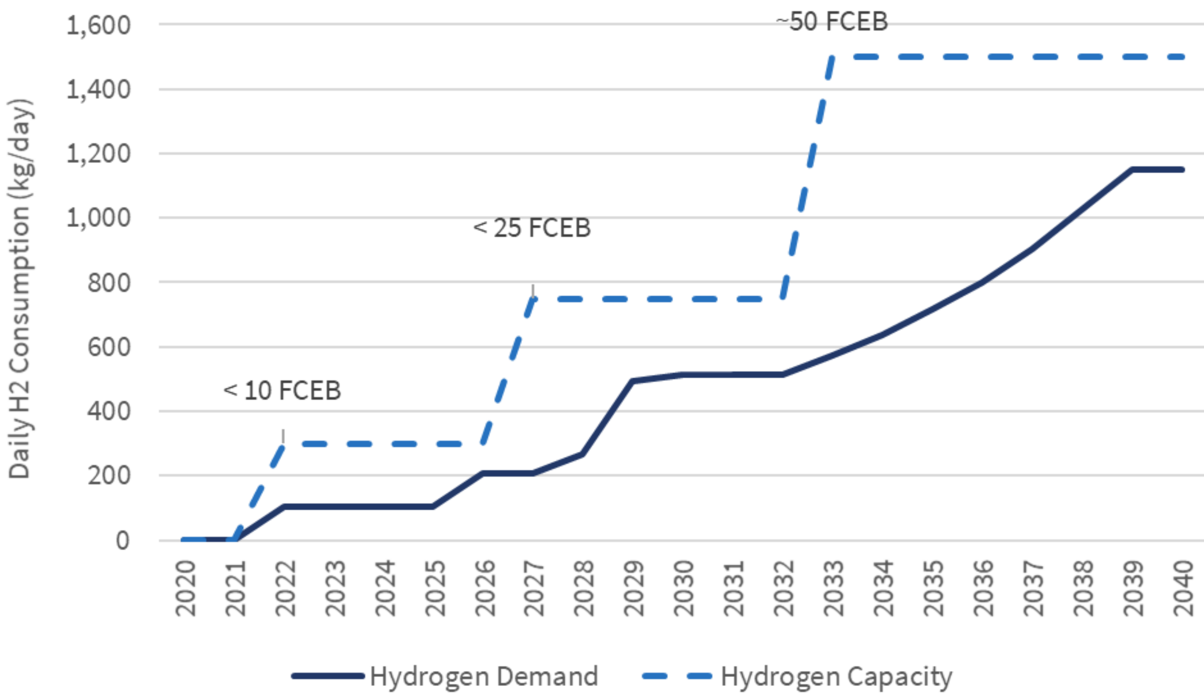


Figure 12: Hydrogen fueling infrastructure capacity vs. demand

The highest capital expenditures will be incurred in 2022 from the initial procurement, engineering, and installation costs for Phase I equipment. The liquid hydrogen tank will be leased from an equipment supplier to decrease initial capital costs and liquid hydrogen may be delivered by truck. The team got directional quotes from two industrial gas suppliers as input to the plan and anticipate a future competitive RFP process to select a partner and finalize costs.

Maintenance Facility

Major repairs on FAX's CNG fixed route buses are currently performed in the maintenance facility, including exterior painting and major engine overhauls. The facility is designed to meet the national and regional code requirements to be designated as a "major repair garage" for CNG buses. The authority having jurisdiction (AHJ) is the City of Fresno Fire Department, which has adopted the California Fire Code (CFC). For guidance relating to hydrogen safety and siting restrictions, the CFC references NFPA 2 guidelines. A gap analysis was performed between the NFPA 2 codes for FCEB "major repair garage" and a CNG bus "major repair garage."

The following code requirements in Table 9 are critical aspects that were identified. As a public transit agency, FAX will undertake a public RFP process to identify contractors to undertake the engineering, modifications, and code compliancy steps.

Table 9: Maintenance facility code considerations

Upgrade or Modification in Areas Servicing FCEBs	NFPA 2 Section	Equipment and Installation Details
Hydrogen detection equipment at locations: inlets to exhaust systems, high points in service bays, inlets to mechanical vent systems	6.13	1. Must activate when hydrogen level exceeds 25% of lower flammability limit. 2. Maintenance, inspection, and calibration shall be conducted annually by trained personnel 3. Connection of hydrogen sensors to existing audible and visual alarms and interlock to deactivate all heating systems and activate mechanical vent system.
Approved hydrogen mechanical exhaust ventilation system OR Designation of areas within 18 inches of ceiling to be Class 1 Div 2, Group B electrical rating.	18.3.5	Hydrogen mechanical ventilation system requirements: 1. Mechanical exhaust or fixed natural ventilation shall be provided at a rate of not less than 1 standard cubic feet per minute per square foot of floor area over the area of use 2. system shall operate continuously unless an alternate design approved by the AHJ 3. When ventilation is provided, a manual shutoff switch shall be provided outside the room in a position adjacent to the principal access door to the room or in an approved location 4. Exhaust ventilation system shall take into account the density of potential gases released 5. For lighter than air gases, exhaust shall be taken from a point within 12 in of the ceiling. The use of supplemental inlets shall be allowed to be installed at points below the 12 in threshold level 6. The inlets to the exhaust systems shall either be designed to prevent blockage or the exhaust system shall detect and react to the blockage 7. Location of both exhaust and inlet air openings shall be designed to provide air movement across all portions of the room or area to prevent the accumulation of hydrogen within the ventilated space 8. Exhaust ventilation shall not be recirculated
Structural sections of repair areas to be sealed with caulk or sealant to minimize air leakage	18.3.1.4	
Purchase and installation of hydrogen de-fueling equipment for vehicle supply containers	18.3.2.2.1	
Relocation of combustible storage and ensuring no combustible construction 3 feet on all sides of repair areas	18.3.1.7	
Ensure all repair areas constructed and separated from surrounding areas by construction assemblies with fire resistance rating > 1 hour	18.3.1.5	

Handy Ride Facility (4488 N Blackstone Avenue) – Infrastructure Upgrades

As explained in Section C, the Handy Ride vehicle fleet will be transitioned to 100% BEBs. Chargers will be installed on-site as cutaway BEBs are added to the fleet starting in 2026. At the time of submission, the number of commercially available paratransit ZEB models is limited, and therefore the specific charging infrastructure design will need to be re-evaluated as additional options come to market. As cutaway buses are trialed and evaluated, more information will also become available on vehicle performance, which may impact the required number of vehicles in the fleet or necessitate the use of FCEBs depending on range limitations.

Facility Parking Modifications

Fixed Route Depot (2223 G Street)

No modifications are required to incorporate ZEBs into FAX's fixed route fleet; however, the G Street facility is space constrained. There are currently 125 dedicated 40' bus parking stalls at the site and the final transitioned fleet is projected to be 123 buses in 2040, not including any contingency. As mentioned in Section C, FAX is currently evaluating purchasing additional land to site its hydrogen fueling infrastructure. This opens the potential to construct additional parking spaces on the new site for the FCEBs.

The overhead BEB charging infrastructure will be designed for FAX's existing overnight parking arrangement. The BEBs will be parked under canopies A and B, and the charging overhead wires and junction boxes that supply the overhead dispensers will be installed on the underside of the canopies. Similarly, FCEBs will be parked in the existing stalls after fueling.

Handy Ride Facility (4488 N Blackstone Avenue)

The Handy Ride facility is currently near its parking capacity and may require additional space to accommodate overnight parking for the planned expansion to FAX's paratransit fleet. Additional properties will need to be investigated as the fleet grows.

Infrastructure Summary

Table 10 identifies the type of buses that will operate out of each of FAX's facilities.

Table 10: NOx-Exempt Area and Electric Utilities' Territories

Division's Name (Same as in Table 5)	Type(s) of Bus Propulsion System	Located in NOx-Exempt Area? (Yes/No)
Fresno Area Express	CNG, fuel cell, battery electric	No
Fresno Handy Ride	CNG, battery electric	No

Table 11 summarizes the major facility improvements that will be required to complete the transition to 100% zero-emission.

Table 11: Facilities Information and Construction Timeline[2]

Facility Name	Address	Main Function(s)	Infrastructure Type(s)	Service Capacity	Needs Upgrade?	Construction Timeline
Fresno Area Express	2223 G Street, Fresno, CA 93706, United States	Overnight electric bus charging	Depot Electric Vehicle Charging Infrastructure	3 MW	New construction	2020
		New supply line and transformer required to service additional electric chargers	Depot Electric Vehicle Charging Infrastructure	5 MW	No	2030
		Fueling of hydrogen fuel cell electric buses	Liquid hydrogen storage and fueling infrastructure	300 kg/day H_2 fueling capacity for 10 FCEBs	New construction	2022
		Upgrade of Hydrogen Fueling infrastructure to increase capacity for growing FCEB fleet	Liquid hydrogen storage and fueling infrastructure	750 kg/day H_2 fueling capacity for 30 FCEBs	Yes	2027
		Upgrade of Hydrogen Fueling infrastructure to increase capacity for growing FCEB fleet	Liquid hydrogen storage and fueling infrastructure	1500 kg/day H_2 fueling capacity for 30 FCEBs	No	2033
		Bus maintenance and repair facility	Bus Maintenance Facility	N/A	Yes	2022
Fresno Handy Ride	4488 N Blackstone Avenue, Fresno, CA 93726, United States	Overnight charging of cutaway buses	Depot Electric Vehicle Charging Infrastructure	65 cutaway electric buses	New construction	2025-2035

[2] Refer to Table 7 and Table 8 for more details on electrical charging and hydrogen refueling equipment to be installed.

F. Providing Service in Disadvantaged Communities

Figure 13 shows the disadvantaged communities in FAX's service territory and the fixed routes that pass through them. This includes a large proportion of communities which fall under the top 5% and top 25% disadvantaged communities as defined by the California Environmental Protection Agency's CalEnviroScreen 3.0.

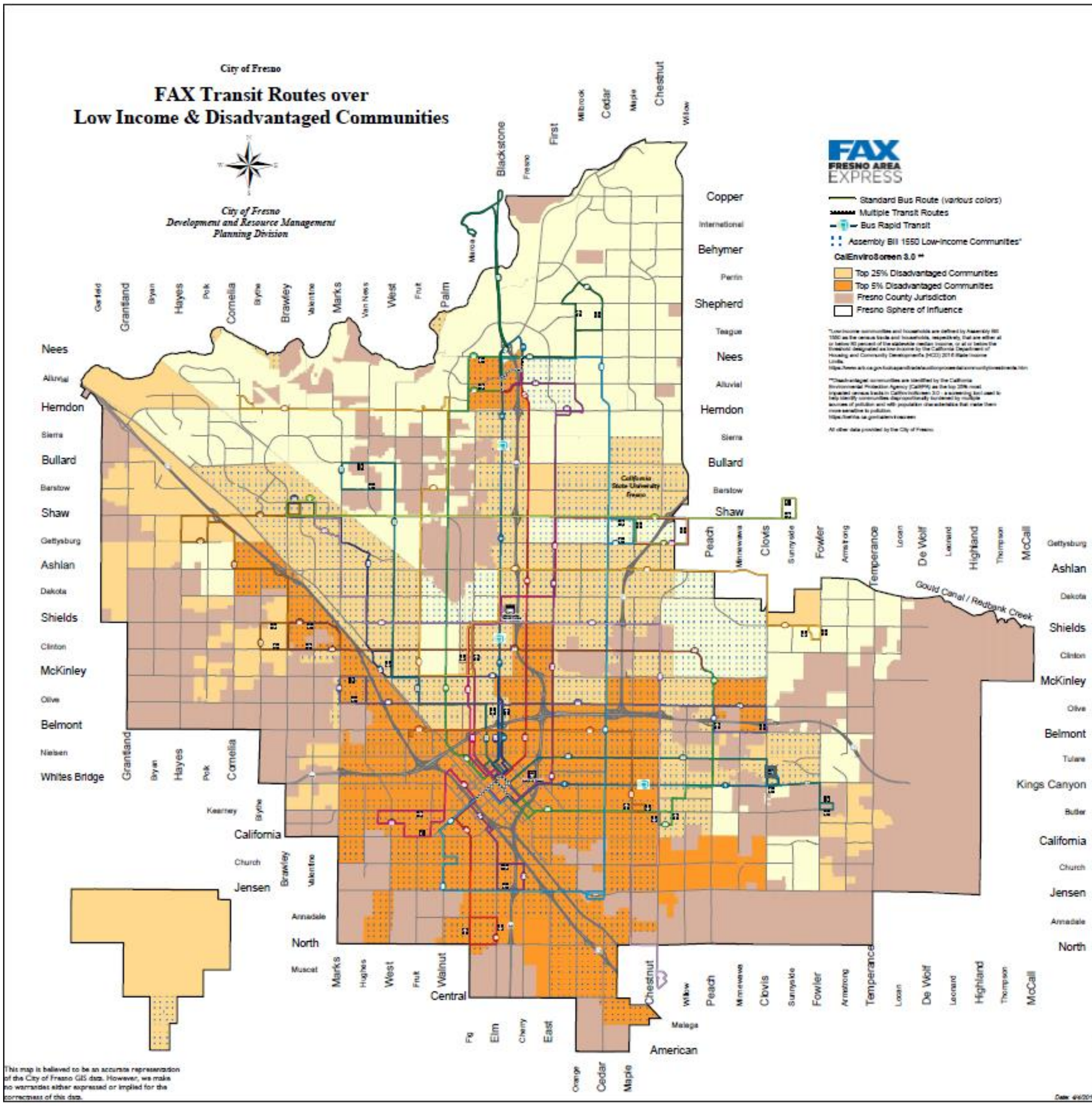


Figure 13: FAX transit routes over low income and disadvantaged communities

Fresno is part of the San Joaquin Valley air basin and does not meet California's air quality standards. It is designated as an ozone, $PM_{2.5}$, and PM_{10} non-attainment area. Ozone is formed from a chemical reaction between nitrogen oxides (NOx), carbon monoxide (CO) and volatile organic compounds (VOCs) in the presence of heat and sunlight. Ozone acts like a corrosive gas, burning lung tissue and damaging the respiratory tract. It causes coughing, shortness of breath, can trigger asthma, lung and heart disease and potentially premature death. Pollutants emitted by fossil fuel combustion vehicles are a key contributor to the formation of ozone.

Disadvantaged communities are disproportionally burdened by multiple sources of pollution and typically have population characteristics that make them more sensitive to pollution than the wider population. As FAX transitions CNG and gasoline vehicles to BEBs and FCEBs, it will improve local air quality by reducing critical emissions of criteria pollutants NOx, VOC, and CO that contribute to the production of ozone. These reductions directly support state and local government efforts to achieve CARB's "attainment" classifications. In addition, zero emission vehicles do not emit particulate matter (PM2.5) and contribute significant reductions in GHG emissions, further contributing to improved local air quality. FAX will prioritize deploying ZEBs on routes servicing disadvantaged communities wherever possible in the early stages of the transition.

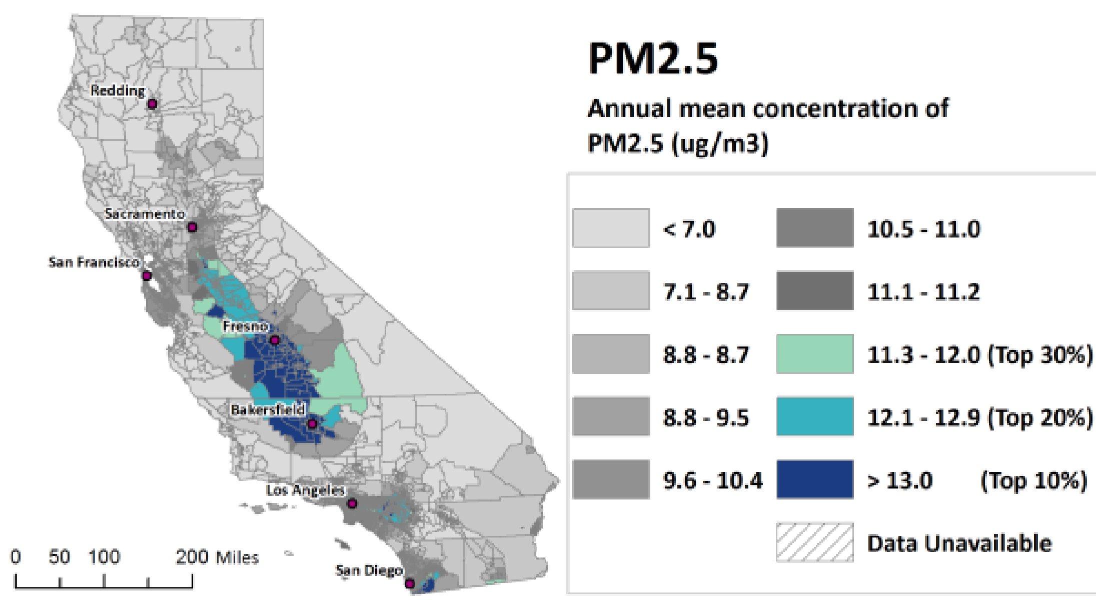


Figure 14: Cal EnviroScreen 3.0 $PM_{2.5}$ concentrations

G. Workforce Training

FAX intends to leverage training offered by vehicle OEMs and infrastructure providers wherever possible. FAX will supplement vendor training with course offered by other transit agencies and outside programs, such as the West Coast Center of Excellence in Zero Emission Technology (CoEZET) hosted by SunLine Transit Agency.

In 2020, Fresno City College, in partnership with FAX, was successful in securing a grant to develop an Advanced Propulsion Training Campus at the College's new west satellite campus. This will be a state-of-the-art training facility serving the San Joaquin Valley to expand the role of alternative fuel and hybrid electric vehicles. Once established, FAX will utilize this program to provide continual training for its workforce.

FAX's first ZEBs will be BEBs provided by Proterra, who will deliver the vendor training for these buses. FAX will evaluate multiple bus original equipment manufacturers (OEM) and equipment vendors as more ZEBs and fueling infrastructure are procured. The outline training plan was based on generalized training information provided by the OEMs and vendors during preliminary discussions.

FAX will design its training program and schedule with a "train the trainer" approach. The goal of this approach is to select key operations and maintenance personnel, such as lead technicians and supervisors, to take part in the OEM and vendor training programs to bring the technical expertise and knowledge in-house. The selected personnel will then train the rest of FAX's operations and maintenance staff on the specific knowledge and skills required for each role.

The key training topics are summarized below, please refer to Table 12 for the detailed training plan.

Battery Electric Bus Training

Training will be provided by the selected OEM (e.g. Proterra, New Flyer, BYD) in the following areas:

1. General bus overview introduction training
2. High voltage safety training
3. Bus maintenance and repair training
4. Bus driver and operations staff training

BEB Charging Infrastructure Training

Training will be provided by the selected equipment vendor (e.g. BYD, Proterra) in the following areas:

1. Charging infrastructure maintenance training
2. Emergency first responder training for Fresno FD representatives as well as FAX onsite first responder staff

Fuel Cell Electric Bus Training:

Training will be provided by the selected OEM (e.g. New Flyer, El Dorado) in the following areas:

1. Bus driver and operations staff training
2. FCEB maintenance and repair training
3. General bus overview introduction training

Additional training will be provided by the fuel cell manufacturer (e.g. Ballard) regarding maintenance and troubleshooting of the fuel cell system.

Hydrogen Fueling Infrastructure Training

Training will be provided by the selected equipment vendor (e.g. Air Liquide, Air Products) in the following areas:

1. General hydrogen safety awareness training for onsite staff
2. Operator specific training on safe fueling procedures, using the gaseous and liquid hydrogen equipment
3. Maintenance and troubleshooting training on equipment
4. Emergency first responder training for Fresno fire department representatives as well as FAX onsite first responder staff

Table 12: Workforce Training Schedule

Year	Training Program/Class	Purpose of Training	Name of Provider	Trainees' Positions	Training Hours	Training Frequency	Estimated Costs/Class
BEB Training Plan							
2021	Operator Training	Operator orientation	BEB OEM	Operator trainers, supervisors, or bus operators	16	One time	$4,000
	Bus Introduction	Overview of the bus	BEB OEM	Maintenance technicians or other yard personnel who need to be aware of bus operation during initial acceptance and launch period	16	One time	TBD
	Structural Composites Training	Hands-on training for structural composites repairs on buses	BEB OEM	Maintenance technicians	24	One time	TBD
	Bus Maintenance Training	Training of bus maintenance technicians on routine servicing	BEB OEM	Bus maintenance technicians	32	One time	$10,000
Electric Charging Infrastructure Training Plan							
2021	Charger Maintenance Training	Training of charger infrastructure maintenance	Electric Charger Vendor	Charger Infrastructure maintenance technicians	16	One time	$5,000
	Emergency First Responder Training	First responder training on electrical buses and infrastructure	Electric Charger Vendor	Fresno first responder representatives	4	One time	TBD
FCEB Training Plan							
2022	FCEB Operator Training	Operator orientation	FCEB OEM	Operator trainers, supervisors, or bus operators	8	One time	TBD
	FCEB specific component training and troubleshooting (ABS, suspension and steering, body and structure) *Optional (FAX will select necessary components to be trained on)	Familiarize operations and maintenance staff with specific systems and structural components of bus. Teach technical details, maintenance, and troubleshooting	FCEB OEM	Maintenance technicians	136	One time	TBD
	FCEB Maintenance Orientation	Routine servicing and maintenance procedures, hands-on demonstrations on topics such as	FCEB OEM	Bus maintenance technicians	8	One time	TBD

Year	Training Program/Class	Purpose of Training	Name of Provider	Trainees' Positions	Training Hours	Training Frequency	Estimated Costs/Class
		emergency procedures and identifying service points					
	FCEB Propulsion & ESS	Familiarization, safety, and troubleshooting of energy storage and propulsion systems	FCEB OEM	Bus maintenance technicians	40	One time	TBD
2022	Fire Suppression/Gas Detection	Familiarization, operation, maintenance of safety systems	FCEB OEM	Bus maintenance technicians	8	One time	TBD
	Fuel Cell Stack Training (Standard)	Standard fuel cell stack maintenance procedures and protocols	Fuel Cell Manufacturer	Bus maintenance technicians	24	One time	TBD
	Fuel Cell Stack Training (Advanced)	Advanced fuel cell stack maintenance procedures and protocols	Fuel Cell Manufacturer	Bus maintenance technicians	16	One time	TBD
Hydrogen Infrastructure Training Plan							
2022	General Personnel Training	Overview training	Hydrogen Fueling Equipment OEM	Maintenance technicians or other yard personnel who need to be trained on material hazards and actions required by emergency response plan	TBD	One time	TBD
	Operations Personnel Training	Training on handling, storing, and using the gaseous H_2 and liquid H_2 equipment (physical and health hazard training, dispensing equipment operation, liquid H_2 and gaseous H_2 storage safety training, safe transportation training	Hydrogen Fueling Equipment OEM	Operators, supervisors, equipment maintenance technicians	TBD	One time	TBD
	Emergency First Responder Training	First responder training on hydrogen fueling infrastructure	Hydrogen Fueling Equipment OEM	Fresno first responder representatives	TBD	One time	TBD

H. Potential Funding Sources

Executing the transition plan will require significant capital expenditure. Figure 15 shows the estimated annual capital expenditure required for the procurement of buses and accompanying ZEB charging/fueling infrastructure.

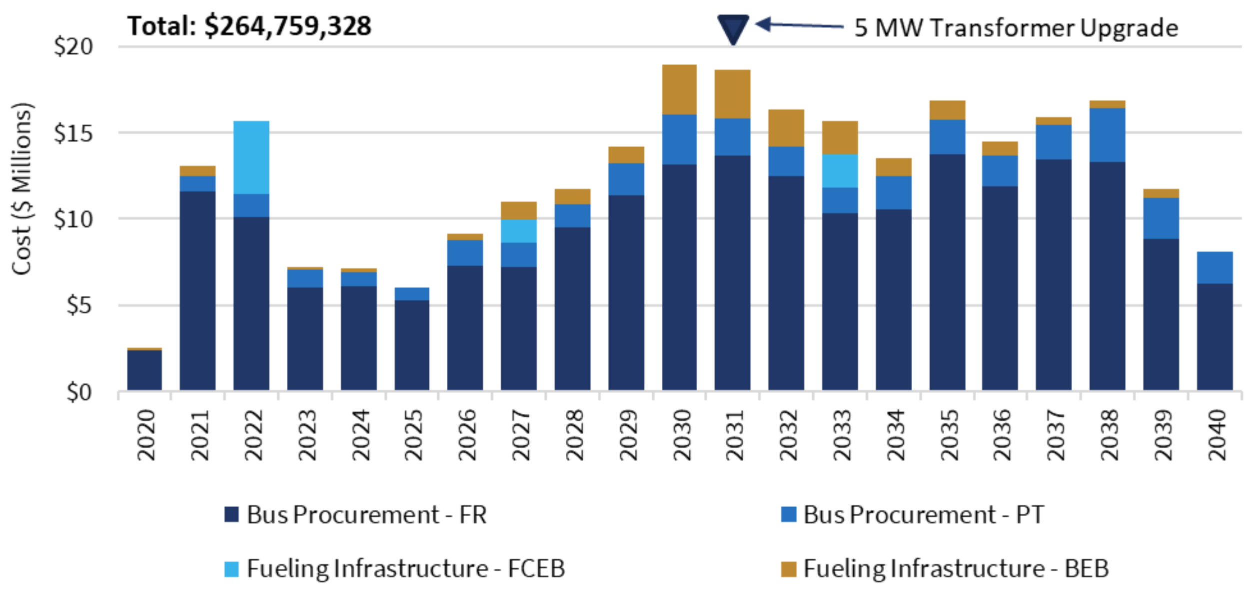


Figure 15. Estimated Capital Expenditure 2020-2040

Between 2020 and 2040 it is estimated that FAX will require $265 million to pay for all new buses and accompanying infrastructure. This includes the purchase of ZEBs as well as replacement and expansion CNG vehicles. To achieve this level of funding, capital must be combined from multiple sources including formula funds and special grant funding.

Formula funds are expected to come primarily from the Federal Transit Administration (FTA). The major sources of funding are Urbanized Area Formula Grants (5307) and, the Bus and Bus Facilities Program (5339), and the Enhanced Mobility of Seniors & Individuals with Disabilities Program (5310).

Future formula funding from these three sources was estimated based on the level of funding previously received and the percent allocation of these funding sources historically to capital purchases. It was assumed that the 5307 and 5339 funding would increase annually at a rate of 1.5% while the 5310 funding remains constant, which is consistent with historical trends.

Table 13. Summary of Estimated Formula Funding

Fund	FY2021 Funding	Total Funding 2020-2040
5307	$2,437,500	$59,646,898
5339	$1,931,000	$47,252,578
5310	$325,000	$6,825,000
Total	**$4,693,500**	**$113,724,476**

In addition to the formula funding, FAX will need to secure approximately $151 million in special grant funding to cover the estimated capital expenditure to achieve this ZEB Rollout Plan. This grant funding will come from a variety of sources – including the California Department of Transportation (Caltrans) and California State Transportation Agency (CalSTA) –but it is difficult to predict what programs will be available in the future. FAX plans to apply for a combination of competitive grants and voucher programs to directly fund procurement of ZEBs and accompanying infrastructure.

Table 14 outlines potential special funding sources

Table 14. Potential Special Funding Sources Summary

Type	Name	Purpose	Offering	Funds Available
Competitive	FTA 5339 (b) Bus & Bus Facilities	Bus procurement and related facilities	80% of capital costs	$457 million (FY2020)
	FTA 5339 (c) Low or No Emission Vehicle	ZEB procurement and fueling / charging infrastructure	85-90% of capital costs	$130 million (FY2020)
	Caltrans Low Carbon Transit Operations Program	Reduce transit agency GHG emissions	Equipment acquisition, fueling, maintenance, and other costs	$146 million (awarded FY2020)
	CalSTA Transit and Intercity Rail Capital Program	Reduce transit agency GHG emissions	Up to 100% of capital costs	$500 million (awarded FY2020)

Type	Name	Purpose	Offering	Funds Available
Voucher	VW Mitigation	ZEB procurement	$400,000/FCEB; $180,000/BEB	$130 million (until exhausted)
	HVIP	ZEB procurement	$300,000/FCEB; $175,000/BEB	$142 million (FY2019 - currently exhausted)

FAX would also benefit from the passing of the INVEST in America proposal currently under discussion by the United States House Committee on Transportation and Infrastructure. This bill would significantly increase available federal funding for zero emission buses and infrastructure to $1.7 billion for fiscal year 2022 through 2025.

I. Start-up and Scale-up Challenges

The most significant challenge facing FAX in the execution of this transition plan is the availability of funding. Procuring and operating ZEBs will be more expensive than conventional CNG buses, which will increase the agency's annual capital and operating budgets. Financial support from the federal, state, and local governments will be necessary to achieve the targets in the ICT regulation.

The incremental cost of replacing CNG buses with ZEBs will increase the financial burden to the agency on a yearly basis. Over the next few years, the price of ZEBs, particularly FCEBs, are expected to drop as technology improves and the scale of manufacturing increases, but the cost of ZEBs is always likely to be greater than CNG vehicles. Funding in the near-term is particularly important because of the high incremental cost.

Per-vehicle cost is also linked to procurement volumes. The overall cost could be reduced through a state-led initiative to purchase ZEBs in bulk on behalf of many agencies. This way, ZEB demand from multiple agencies could be combined to increase the number of vehicles manufactured at one time, reducing the per-vehicle cost.

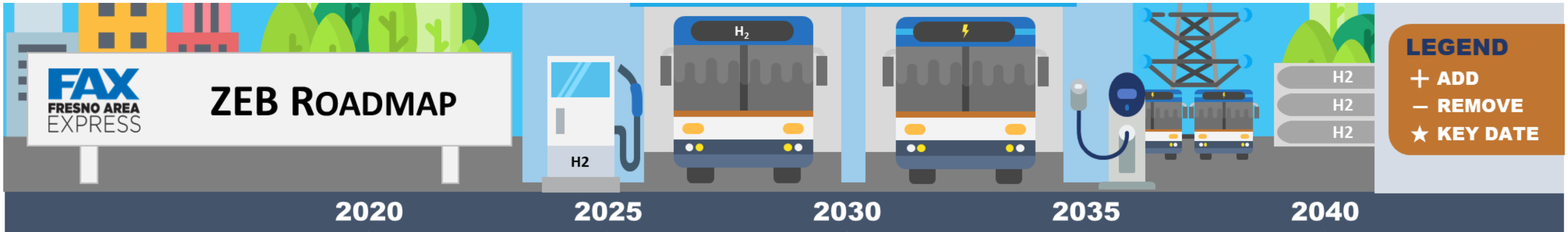
FAX will need support to fund the installation of the required BEB charging and FCEB fueling infrastructure. These costs are likely to be higher for FAX than some other agencies due to the lack of available space for new infrastructure. As described in Section C, both of FAX's facilities are highly space constrained, and will be particularly so during the ZEB transition while both CNG and ZEB fueling/charging equipment will need to be in operation. Installation of hydrogen fueling equipment on-site may not be possible, and if it is, will likely require safety measures such as fire walls to ensure adequate offsets from buildings and additional safety equipment FAX may have to purchase new land to accommodate the fueling infrastructure, which will require capital funding as well as changes to the day to day fueling and operating logistics.

FAX has not deployed ZEBs in the past, so quality workforce training will be essential for ensuring a smooth transition. Classes will be required to train staff on the operations and maintenance of new ZEBs and accompanying infrastructure. In particular, driver behavior can have a large impact on ZEB performance – impacting the range of BEBs as much as 10-20%. In addition to training, it will be important to establish buy-in on the new technologies from all aspects of the labour force through education and outreach activities.

Long-term planning of ZEB deployments is difficult due to many sources of uncertainty. Commercially available ZEBs have not been deployed for very long and the number of deployments is somewhat limited. Continuing access to data showing real-world performance of ZEBs would help determine the ideal fleet mix. It is essential to understand how BEBs and FCEBs perform under a range of conditions including during inclement weather when cabin heating/cooling demand is high and at the end of life when the batteries and other components have degraded. Performance is also likely to change as technology improves in future vehicle generations, so continued evaluation is required. FAX will monitor performance of their own fleet, but it would be useful to share information across agencies to maximize the learning potential and inform purchase decisions.

It is essential the CARB support funding initiatives for transit agencies across the state to transition their fleets to zero-emission vehicles. Funding will be required for all aspects of the plan including vehicles purchases, infrastructure, and workforce training. CARB should also facilitate the sharing of information between agencies to ensure decisions are being made with the best information available. Funding should be made available to study vehicle performance in real-world operation under a wide range of conditions and duty cycles.

APPENDIX A. FAX ZEB Roadmap



	2020–2025	2025–2030	2030–2035	2035–2040	2040
Fixed Route	2% ZEB	15% ZEB	47% ZEB	78% ZEB	100% ZEB
Paratransit	0% ZEB	0% ZEB	50% ZEB	96% ZEB	100% ZEB
H2 Infrastructure	+ Install 300 kg/day delivered LH2 station	— Retire GAS equipment at Handy Ride facility + Upgrade delivered LH2 station to 750 kg/day	+ Upgrade delivered LH2 station to 1500 kg/day	— Retire CNG equipment at Handy Ride facility — Retire CNG equipment at fixed route facility	
BEB Infrastructure	+ Upgrade to 3 MW Electric Transformer		+ Upgrade to 5 MW Electric Transformer		
Buses	+ First BEB enters fixed route fleet + First FCEB enters Fixed Route fleet	+ Last CNG bus purchased in fixed route fleet — Last GAS bus in paratransit fleet retires		— Last CNG bus in paratransit fleet retires — Last CNG bus in fixed route fleet retires	
Milestones	★ First ZEB fixed route bus enters fleet	★ First ZEB paratransit bus purchased	★ 50% ZEB paratransit fleet ★ 50% ZEB fixed route fleet	★ 100% ZEB paratransit fleet ★ 100% ZEB fixed route fleet	

APPENDIX B. Board Resolution