



Zero-Emission Bus Rollout Plan

April 2022



Foothill Transit

Contents

- 1. Agency Overview..... 2**
- 2. Rollout Plan General Information 3**
 - Rollout Plan Development and Approval..... 4
- 3. Technology Portfolio..... 6**
 - Foothill Transit Energy Requirements..... 6
 - Foothill Transit Renewable Power Supply Plan 8
 - SCE Renewable Energy Supply Plan 10
 - Arcadia On-Site Renewable Energy Plan 11
 - Pomona On-Site Renewable Energy Plan 14
 - Off-Site Renewable Energy Plan 17
- 4. Facilities and Infrastructure Modifications..... 19**
 - Depot Infrastructure Phasing and Development..... 19
 - Depot Infrastructure Costs 20
- 5. Providing Service in Disadvantaged Communities..... 22**
- 6. Workforce Training..... 22**
- 7. Potential Funding Sources 23**
- 8. Start-Up and Scale-Up Challenges 24**
- Appendix 25**
- Resolution No. 2020-03 A Resolution of the Executive Board of Foothill Transit Adopting the Zero-Emission Bus (ZEB) Rollout Plan 25**

1. Agency Overview

1. Transit Agency's Name	Foothill Transit
2. Mailing Address	100 S Vincent Ave., Suite 200 West Covina, CA 91790
3. Name of Transit Agency's Air Districts	South Coast Air Quality Management District
4. Name of Transit Agency's Air Basin	South Coast Air Basin
5. Total Number of Buses in Annual Maximum Service	359
6. Population of Urbanized Area Transit Agency Services (<i>Last Published by the Census Bureau as of 2019</i>)	520,344
7. Contact Information	Roland Cordero Director of Maintenance Vehicle & Technology (626) 931-7246 rcordero@foothilltransit.org Sharlane Bailey Director of Capital Projects & Facilities (626) 931-7253 sbailey@foothilltransit.org
8. Is your agency part of a Joint Group (13 CCR§2023.1 (d) (3))?	Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>

2. Rollout Plan General Information

Foothill Transit is leading the charge among transit agencies as it embarks on a journey to transition its entire bus fleet to zero emission by the year 2040. In this section, the background of Foothill’s plan to deploy zero emission buses will be briefly described. This Rollout Plan is a living document and is subject to change based on experience and improvements in battery and fuel cell technology.

Foothill Transit operates its bus fleet out of two depots. The Arcadia depot, located in Arcadia, CA operates 210 buses with 9% zero-emissions. The fleet consists of 165 40 ft. CNG buses, 24 60ft. Articulated CNG buses, 2 35ft. CNG buses, 14 40ft. Extended Range Battery electric buses, 3 35 ft. Extended Range Battery Electric buses, and 2 Double Deck Battery Electric buses.

The Pomona depot, located in Pomona, CA operates 149 buses with 9% zero-emissions. The fleet consists of 136 40ft. CNG buses and 13 35 ft. Short-Range Battery Electric buses.

The following tables developed by Burns & McDonnell in 2019 outline the bus replacement schedules for single and double deck buses at Arcadia and single deck buses at Pomona.

	MFG Year	Fleet	Planned Retirement	Year														
				2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030			
Current Inventory	2004	1400-1474	2018	22														
	2006	1500-1509	2018	10	10													
	2009	1700-1729	2023	30	30	30	30	30										
	2013	2100-2163	2027	22	22	22	22	22	22	8	6	8						
	2016	2016-2017	2030	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	2016	2400-2429	2029	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
	2017	2500-2529	2030	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
	2017	2600-2613	2032	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	2018	1400s Replacement	2030	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28
	2019	2800 - 2802		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Planned Inventory	2020																	
	2021																	
	2022																	
	2023	1700-1800s & 2001-2003 Replacement	2037					30	30									
	2025	2004-15 & 2100s Replacement	2039							30	30	30	30	30	30	30	30	30
	2026	1900s & 2100s Replacement	2040									6	6	6	6	6	6	6
	2027	2100s Replacement	2041										8	8	8	8	8	8
	2029	2300 & 2400s Replacement	2043														30	30
	2030	2500s & CNG Replacement	2044															56
	2031	2016-2017 Replacement	2045															
	2032	2600s Replacement	2046															
	Year				2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030		
# CNG buses (single decks only)				150	140	140	140	110	110	102	96	88	88	58	28			
# e-buses (single decks only)				17	17	17	17	47	47	55	61	69	69	99	155			
Sum Single Deck buses at this yard				167	157	157	157	157	157	157	157	157	157	157	183			
Sum Single Deck buses at this yard excluding Operating Spare Ratio (20%)				139	131	131	131	131	131	131	131	131	131	131	153			

Figure 1: Arcadia Single Deck Bus Transition

	MFG Year	Fleet	Planned Retirement	Year															
				2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030				
Current Inventory	2006	1600-1629	2022	30	30	10	20												
	Planned Inventory	2019	Double Decks	2033	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
		2021	1600s Replacement	2035			10	10	10	10	10	10	10	10	10	10	10	10	10
2022		1600s Replacement	2036			20	20	20	20	20	20	20	20	20	20	20	20	20	
Legend																			
CNG Buses																			
Electric Buses - Single Deck																			
Electric Buses - Double Deck																			
Articulated Buses																			
Retirement Date																			
Purchased Buses																			
Year				2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030				
# CNG buses (double decks only)				30	30	20													
# e-buses (double decks only)				2	2	12	32	32	32	32	32	32	32	32	32	32	32	32	
Sum Large Capacity buses at this yard				32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	
Sum Double Deck buses at this yard excluding Operating Spare Ratio (20%)				27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	

Figure 2: Arcadia Double Deck Bus Transition

	MFG Year	Fleet	Planned Retirement	Year															
				2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030				
Current Inventory	2004	1400-1474	2018	9															
	2009	1800-1811	2023	12	12	12	12	12											
	2009	2001-2003	2023	2	2	2	2	2											
	2012	1900-1913	2026	14	14	14	14	14	14	14	14	14							
	2013	2004-2015	2027	12	12	12	12	12	12	12	12	12							
	2013	2100-2163	2027	42	42	42	42	42	42	42	42	42	42						
	2014	2200-2229	2028	30	30	30	30	30	30	30	30	30	30	30					
	2015	2300-2329	2029	30	30	30	30	30	30	30	30	30	30	30	30				
	2017	2600-2613	2032	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
	2018	1400s Replacement	2030	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	
	2023	1700-1800s & 2001-2003 Replacement	2037					14	14	14	14	14	14	14	14	14	14	14	
2025	2004-15 & 2100s Replacement	2039								12	12	12	12	12	12	12	12		
2026	1900s & 2100s Replacement	2040									14	14	14	14	14	14	14		
2027	2100s Replacement	2041										42	42	42	42	42	42		
2028	2200s Replacement	2042											30	30	30	30	30		
2029	2300 & 2400s Replacement	2043												30	30	30	30		
2030	2500s & CNG Replacement	2044															8		
2032	2600s Replacement	2046																	
Year				2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030				
# CNG buses (single decks only)				134	134	134	134	122	122	122	108	66	36	6	6				
# e-buses (single decks only)				16	16	16	16	28	28	28	42	84	114	144	152				
Sum Single Deck buses at this yard				150	150	150	150	150	150	150	150	150	150	150	150	158			
Sum buses at this yard excluding Operating Spare Ratio (20%)				125	125	125	125	125	125	125	125	125	125	125	125	132			

Figure 3: Pomona Single Deck Bus Transition

Rollout Plan Development and Approval

Last October 2019 the California Air Resources Board issued their Innovative Clean Transit Regulation (ICT) requiring transit agencies to gradually transition to a 100% zero-emission fleet by 2040. The zero-emission bus (ZEB) purchase requirement begins in 2023 for large transit agencies and 2026 for small transit agencies. For large transit agencies, the ZEB purchase schedule begins in 2023 where 25% of bus purchase must be ZEB. For small transit agencies the purchase requirements begins in 2027 where 25% of bus purchases must be ZEB. All bus purchases in 2029 must be 100% ZEB.

The percentage gradually increases overtime and by 2040, all bus purchases must be zero-emissions.

The ICT regulation also require large transit agencies to submit a Rollout Plan by July 1, 2020 and must be approved by the agency’s governing body through a Resolution prior to submitting to CARB

The plan must be a living document providing estimated timelines based on best available information on bus purchases, infrastructure upgrades, workforce training, and other information required under the guidance provided by CARB.

Rollout Plan's approval date: May 29, 2020

Resolution number: 2020-03 (See Appendix)

Please provide contact information for CARB to follow up on details of the Rollout Plan, if needed.

Contact name, Title:

Shirin Barfjani

Air Pollution Specialist

Shirin.Barfjani@arb.ca.gov | (916) 914-1031

California Air Resources Board

Zero-Emission Truck and Bus Section

Who assisted in creating the Rollout Plan? Burns & McDonnell

Roland Cordero – Director of Maintenance and Vehicle Technology

Sharlane Bailey – Director of Capital Projects and Facilities

LaShawn King Gillespie – Director of Operations and Customer Service

Joseph Raquel – Director of Planning

3. Technology Portfolio

Foothill Transit’s goal is to meet the California Air Resources Board’s Innovative Clean Transportation Rule of transition to 100 % zero emission bus fleet by 2040. The renewable energy will come from a combination of onsite and offsite sources. Multiple onsite and offsite renewable options were considered when determining the best path for Foothill Transit to implement renewable energy sources and back up generation for its fleet operations. The assessment started by evaluating the energy requirements of Foothill Transit as it transitions its fleet to 100% BEB’s. Once the energy requirements through the different phases of implementation were established, an energy implementation plan was developed to demonstrate how Foothill Transit could successfully source energy from 100% renewable resources. Onsite generation was evaluated and developed by looking at how much solar and storage could be physically located at the Arcadia and Pomona depots. SCE’s long-term renewable percentage mandate was evaluated along with the potential for sourcing renewable energy from purchase power agreements (PPA’s). Lastly, since Foothill Transit’s operations are critical to serving its community, back up generation options such as diesel and natural gas generators were explored and developed to allow Foothill Transit to continue to provide service even when grid power is unavailable.

Foothill Transit Energy Requirements

The forecasted electrical energy requirements presented in Table 1 and Table 2 indicate that the Arcadia and Pomona depots will gradually ramp up to a total electrical energy requirement of 29,222 MWh/year and 16,468 MWh/year with peak demands of 13.9 MW and 7.8 MW by 2030, respectively. The forecasted energy requirements by depot are based on the fleet electrification energy analysis including the number of 325 kW chargers required at each yard to support the electrification of buses for each year until 100% electrification in 2030. The highlighted cells in each table represent when new phases of EV overhead charging infrastructure are installed (i.e. 2021 and 2026 at Arcadia).

Table 1: Arcadia Depot Load and Energy Growth

Year	New Busses	Total Busses	Foothill Bus Power Demand (kW)	Foothill Bus Energy (kWh)
2020	0	0	0	0
2021	19	19	1,398	2,922,200
2022	30	49	3,604	7,536,200
2023	30	79	5,811	12,150,200
2024	0	79	5,811	12,150,200
2025	8	87	6,399	13,380,600
2026	6	93	6,840	14,303,400
2027	8	101	7,429	15,533,800
2028	0	101	7,429	15,533,800
2029	30	131	9,635	20,147,800
2030	56	187	13,754	28,760,600
2031	3	190	13,975	29,222,000

Table 2: Pomona Depot Load and Energy Growth

Year	New Busses	Total Busses	Foothill Bus Power Demand (kW)	Foothill Bus Energy (kWh)
2020	0	0	0	0
2021	0	0	0	0
2022	0	0	0	0
2023	13	13	780	1,752,200
2024	1	14	840	1,886,985
2025	12	26	1,560	3,504,400
2026	14	40	2,400	5,391,385
2027	42	82	4,920	11,052,338
2028	30	112	6,720	15,095,877
2029	5	117	7,020	15,769,800
2030	13	130	7,800	17,522,000
2031	0	130	7,800	17,522,000

Foothill Transit Renewable Power Supply Plan

Based on the estimated load growth and energy requirements from the phased bus electrification plan, Foothill Transit could work towards obtaining renewable power supply from three different sources as outlined below. For each source of renewable energy supply, an implementation plan is also provided. The balance of loads and resources from 2021 to 2045 are presented in Table 3 and Table 4 and Figure 4: Foothill Transit Energy Uses and Sources (kWh). The SCE Non-Renewable Energy values shown in the tables below represent the non-renewable portion of energy purchased at each of the facilities. The basic components of the renewable power supply plan are summarized as follows.

1. SCE Renewable Energy - Purchase SCE grid energy which will increase from 30% renewable (2020) to 100% renewable (2045).
2. On-Site Renewable Energy - Install on-site solar on overhead charging structures as charging infrastructure is completed. This can provide roughly 5% of Foothill's total energy requirement.
3. Off-Site Renewable Energy - Purchase off-site wind energy through a PPA between 2021 and 2041 if economical. This can be used to replace the balance of the SCE non-renewable power.

Table 3: Arcadia Depot Energy Uses and Sources

Year	New Busses	Total Busses	Foothill Bus Power Demand (kW)	Foothill Bus Energy (kWh)	Max On Site Solar Energy (kW)	Max On Site Solar Energy (kWh)	SCE Energy (kWh)	SCE Renewable %	SCE Renewable Energy (kWh)	SCE Non-Renewable Energy (kWh)
2020	0	0	0	0		0	0	30%	0	0
2021	19	19	1,398	2,922,200	467	812,211	2,109,989	33%	696,296	1,413,692
2022	30	49	3,604	7,536,200	467	808,176	6,728,024	36%	2,422,089	4,305,935
2023	30	79	5,811	12,150,200	467	804,156	11,346,044	39%	4,424,957	6,921,087
2024	0	79	5,811	12,150,200	467	800,153	11,350,047	42%	4,767,020	6,583,027
2025	8	87	6,399	13,380,600	467	796,150	12,584,450	45%	5,663,003	6,921,448
2026	6	93	6,840	14,303,400	718	1,228,688	13,074,712	48%	6,275,862	6,798,850
2027	8	101	7,429	15,533,800	718	1,222,516	14,311,284	51%	7,298,755	7,012,529
2028	0	101	7,429	15,533,800	718	1,216,353	14,317,447	54%	7,731,422	6,586,026
2029	30	131	9,635	20,147,800	718	1,210,198	18,937,602	57%	10,794,433	8,143,169
2030	56	187	13,754	28,760,600	718	1,204,043	27,556,557	60%	16,533,934	11,022,623
2031	3	190	13,975	29,222,000	718	1,197,888	28,024,112	63%	17,543,094	10,481,018
2032	0	190	13,975	29,222,000	718	1,191,733	28,030,267	65%	18,275,734	9,754,533
2033	0	190	13,975	29,222,000	718	1,185,578	28,036,422	68%	19,008,694	9,027,728
2034	0	190	13,975	29,222,000	718	1,179,424	28,042,576	70%	19,741,974	8,300,603
2035	0	190	13,975	29,222,000	718	1,173,269	28,048,731	73%	20,475,574	7,573,157
2036	0	190	13,975	29,222,000	718	1,167,114	28,054,886	76%	21,209,494	6,845,392
2037	0	190	13,975	29,222,000	718	1,160,959	28,061,041	78%	21,943,734	6,117,307
2038	0	190	13,975	29,222,000	718	1,154,804	28,067,196	81%	22,678,294	5,388,902
2039	0	190	13,975	29,222,000	718	1,148,649	28,073,351	83%	23,413,174	4,660,176
2040	0	190	13,975	29,222,000	718	1,142,495	28,079,505	86%	24,148,375	3,931,131
2041	0	190	13,975	29,222,000	718	1,136,340	28,085,660	89%	24,883,895	3,201,765
2042	0	190	13,975	29,222,000	718	1,130,185	28,091,815	91%	25,619,735	2,472,080
2043	0	190	13,975	29,222,000	718	1,124,030	28,097,970	94%	26,355,896	1,742,074
2044	0	190	13,975	29,222,000	718	1,117,875	28,104,125	96%	27,092,376	1,011,748
2045	0	190	13,975	29,222,000	718	1,111,720	28,110,280	100%	28,110,280	-

Table 4: Pomona Depot Energy Uses and Sources

Year	New Busses	Total Busses	Foothill Bus Power Demand (kW)	Foothill Bus Energy (kWh)	Max On Site Solar Energy (kW)	Max On Site Solar Energy (kWh)	SCE Energy (kWh)	SCE Renewable %	SCE Renewable Energy (kWh)	SCE Non-Renewable Energy (kWh)
2020	0	0	0	0		0	0	30%	0	0
2021	0	0	0	0		0	0	33%	0	0
2022	0	0	0	0		0	0	36%	0	0
2023	13	13	780	1,752,200	312	542,634	1,209,566	39%	471,731	737,835
2024	1	14	840	1,886,985	312	539,938	1,347,047	42%	565,760	781,287
2025	12	26	1,560	3,504,400	312	537,252	2,967,148	45%	1,335,217	1,631,931
2026	14	40	2,400	5,391,385	312	534,578	4,856,807	48%	2,331,267	2,525,540
2027	42	82	4,920	11,052,338	624	1,074,537	9,977,802	51%	5,088,679	4,889,123
2028	30	112	6,720	15,095,877	624	1,069,166	14,026,710	54%	7,574,424	6,452,287
2029	5	117	7,020	15,769,800	624	1,063,806	14,705,994	57%	8,382,417	6,323,577
2030	13	130	7,800	17,522,000	624	1,058,457	16,463,543	60%	9,878,126	6,585,417
2031	0	130	7,800	17,522,000	624	1,053,108	16,468,892	63%	10,309,526	6,159,366
2032	0	130	7,800	17,522,000	624	1,047,759	16,474,241	65%	10,741,205	5,733,036
2033	0	130	7,800	17,522,000	624	1,042,410	16,479,590	68%	11,173,162	5,306,428
2034	0	130	7,800	17,522,000	624	1,037,061	16,484,939	70%	11,605,397	4,879,542
2035	0	130	7,800	17,522,000	624	1,031,712	16,490,288	73%	12,037,910	4,452,378
2036	0	130	7,800	17,522,000	624	1,026,363	16,495,637	76%	12,470,702	4,024,935
2037	0	130	7,800	17,522,000	624	1,021,014	16,500,986	78%	12,903,771	3,597,215
2038	0	130	7,800	17,522,000	624	1,015,665	16,506,335	81%	13,337,119	3,169,216
2039	0	130	7,800	17,522,000	624	1,010,316	16,511,684	83%	13,770,745	2,740,940
2040	0	130	7,800	17,522,000	624	1,004,967	16,517,033	86%	14,204,649	2,312,385
2041	0	130	7,800	17,522,000	624	999,618	16,522,382	89%	14,638,831	1,883,552
2042	0	130	7,800	17,522,000	624	994,269	16,527,731	91%	15,073,291	1,454,440
2043	0	130	7,800	17,522,000	624	988,919	16,533,081	94%	15,508,030	1,025,051
2044	0	130	7,800	17,522,000	624	983,570	16,538,430	96%	15,943,046	595,383
2045	0	130	7,800	17,522,000	624	978,221	16,543,779	100%	16,543,779	-

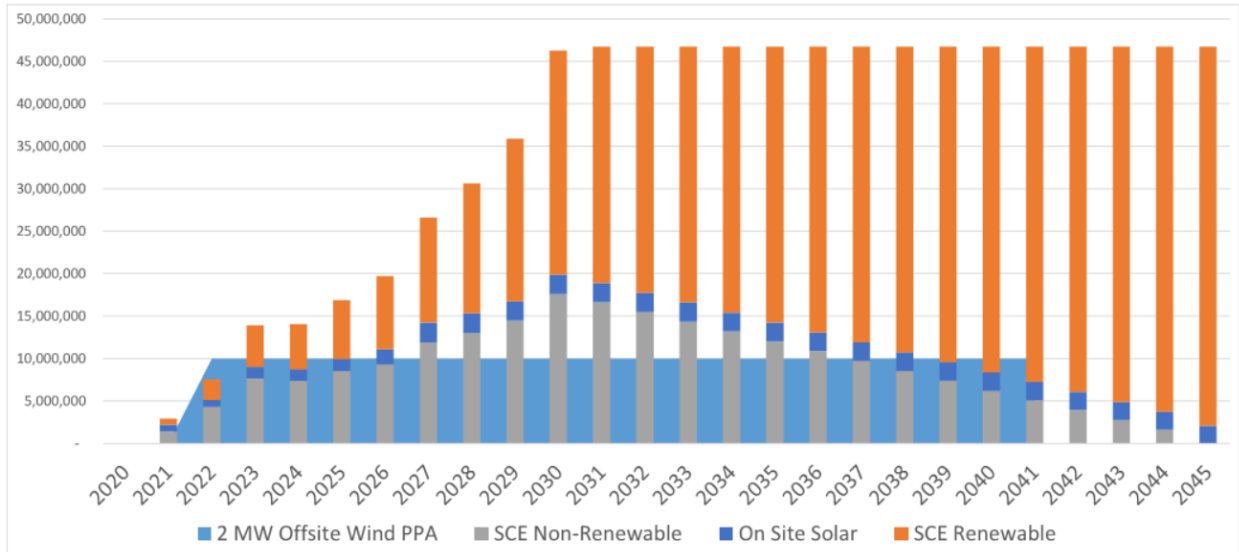


Figure 4: Foothill Transit Energy Uses and Sources (kWh)

SCE Renewable Energy Supply Plan

SCE is currently required to provide its retail customers power consisting of 30% renewable energy by 2020 and 100% renewable energy by 2045. This will provide a significant contribution towards meeting Foothill Transit’s goal of obtaining renewable power supply. Several considerations that should be discussed as Foothill transitions to renewable energy are provided below:

- a. SCE power purchased under EV TOU rate schedules already provides Foothill with power that is 30% renewable. This will increase over time without any incremental investment by Foothill Transit.
- b. As SCE’s power becomes more renewable (solar), the cost will increase and added TOU rate components will require Foothill Transit to avoid charging during on-peak periods when electricity prices are high.
- c. Currently, it is not necessary for Foothill Transit to commit to procuring on-site solar or off-site renewable energy contracts or projects with terms extending past 2045 due to SCE’s 100% renewable portfolio standard (RPS) requirement.
- d. Foothill Transit can install on-site solar over the next several years to bridge the renewable gap until SCE reaches its 100% renewable goal by 2045. Foothill can procure offsite wind energy through a PPA to meet its goal of economical renewable energy until 2045.

Arcadia On-Site Renewable Energy Plan

On-site solar is economically viable today under the current EV TOU rate structure for the Arcadia depot based on analyses completed in this study. The phased site charging infrastructure plan was considered in the development of on-site solar and it was determined to be feasible to install a 467 kW array in the north portion of the depot (phase 1 - 2021) and a 251 kW array in the east portion of the depot (phase 2 - 2026). The size of the PV area is based on estimated area available within the Arcadia Depot to install a suitable PV array. Stationary battery energy storage, while not economical today, may become a viable option in the future; therefore space has been included in the future Arcadia infrastructure layout. The implementation plan to install this solar in coordination with the other overhead charging infrastructure is outlined below.

1. Phase 1 - Install 467 kW DC solar roof top canopy on top of phase 1 overhead charging structure in 2021.
 - a. The phase 1 overhead charging structure should be designed to support solar racking, modules, and cables.
 - b. Solar power should be fed directly into SCE's future EV switchgear to meet EV phase 1 loads. Switchgear should be designed to accommodate future solar and potential storage systems.
 - c. Once Foothill Transit has completed its phase 1 charging structure design, Foothill should issue an RFP for the solar project. Foothill should request bids for PPA and EPC contracts by 11/2020.
 - d. Preliminary design and performance information should be submitted with proposals to provide a fair evaluation of various module and inverter technologies costs and performance.
 - e. Foothill Transit should evaluate the cost of owning the solar project versus purchasing a PPA contract based on bids provided. The evaluation and selection of the solar provider should be completed within 1 to 2 months with design and installation following over the next 12 months. If a PPA contract is selected, negotiations can take longer and delay the project.
 - f. The Phase 1 solar project should be installed by a competent commercial solar company after the charging infrastructure is installed. The interconnection application to SCE is typically provided by the solar company.
 - g. Target solar completion by 12/2021.

2. Phase 2 - Install 251 kW DC solar roof top canopy on top of phase 2 overhead charging structure in 2026
 - a. The phase 2 overhead charging structure should be designed to support solar racking, modules, and cables.
 - b. Solar power should be fed directly into SCE's future EV switchgear to meet EV phase 2 loads. Switchgear should be designed to accommodate future solar and potentially storage.
 - c. Once Foothill has completed its phase 1 charging structure design, Foothill should issue an RFP for the solar project. Foothill should request bids for PPA and EPC contracts by 11/2025.
 - d. Preliminary design and performance information should be submitted with proposals to provide a fair evaluation of various module and inverter technology, costs, and performance.
 - e. Foothill should evaluate the cost of owning the solar project versus purchasing a PPA contract based on bids provided. The evaluation and selection of the solar provider should be completed within 1 to 2 months with design and installation following over the next 12 months. If a PPA contract is selected, negotiations can take longer and can delay the project.
 - f. The Phase 2 solar project should be installed by a competent regional commercial solar company after the charging infrastructure is installed. Target solar completion by 12/2026.
 - g. Total phase 1 and 2 on-site solar will provide 4% of Arcadia's energy requirement in 2030.

Figure 5 provides a conceptual overview of where the solar system could be installed for phase 1 and phase 2. Figure 6 provides a typical daily generation and load profile curve of the site in year 1.



Figure 5: Arcadia Depot Solar Layout

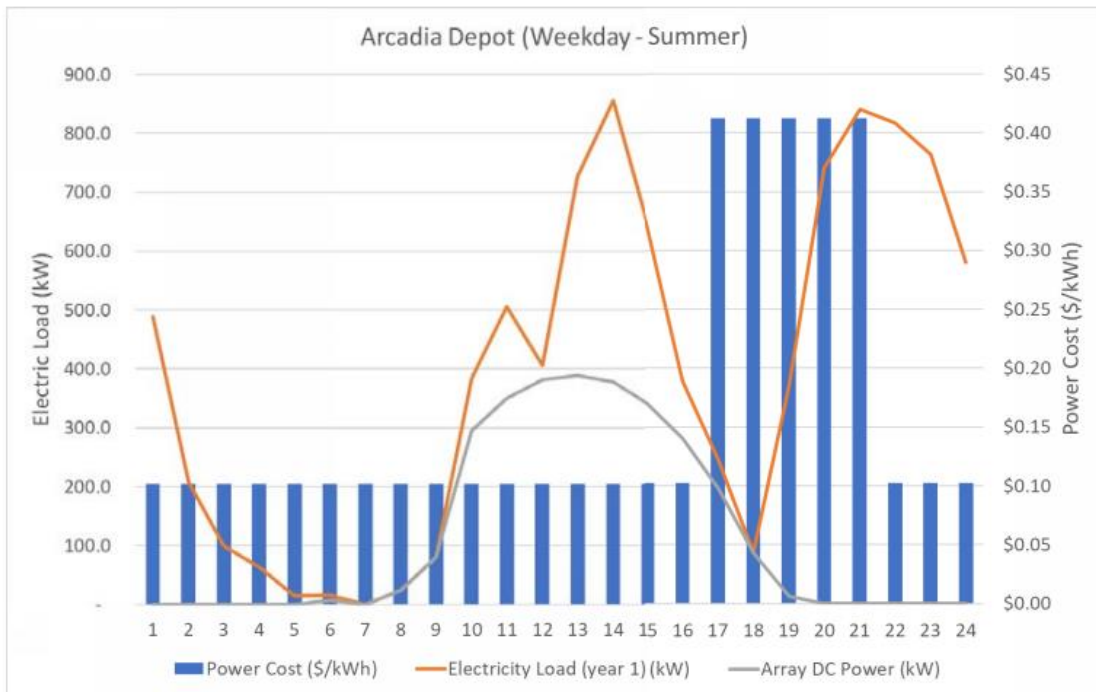


Figure 6: Arcadia Load and Solar Generation versus Time of Use Rates (Phase 1-Year 1)

The economics of installing solar and battery energy storage was analyzed in detail using the National Renewable Energy Laboratory software called System Advisor Model. Detailed hourly loads, electric rates, hourly generation yield, project costs, and economic parameters were developed and used to analyze the economic performance of the solar, storage, and solar/storage options at the Arcadia depot for phase 1. A summary of the financial results from that analysis are provided in Table 5 along with several of the key assumptions from that analysis. Based on the results of the analysis, Foothill should only install solar on the BEB charging canopy structures today as the addition of a battery does not generate enough incremental savings to offset the incremental cost. However, once Foothill Transit begins to be charged demand charges by SCE, the addition of a battery energy storage system should be reconsidered as it may generate additional savings to Foothill.

Category	Unit	Solar	Battery	Solar+Battery
PV Size	[kW]	467.3	---	467.3
Battery Size	[kWh]	---	2,000.0	2,000.0
Capacity Factor	[%]	20.0%	---	18.1%
Energy Yield (year 1)	[kWh/yr]	818,255.0	-110,385.0	741,244.0
Battery Efficiency	[%]	---	82.5%	85.3%
Electricity bill without system (year 1)	[\$]	\$ 414,718.41	\$ 414,718.41	\$ 414,718.41
Electricity bill with system (year 1)	[\$]	\$ 336,182.00	\$ 317,762.41	\$ 249,073.41
Net Savings with system (year 1)	[\$]	\$ 78,536.41	\$ 96,956.00	\$ 165,645.00
Capital Cost	[\$]	\$ 823,913.00	\$ 1,249,725.00	\$ 2,071,662.00
Net Present Value	[\$-NPV]	\$ 492,403.00	\$ (446,973.00)	\$ 25,897.00
Payback period	[yrs]	10.7	21.2	16.1

Notes:

Battery was modelled based on Tesla power pack
 Battery replacement is required at year 15 (\$200/kWh = \$400,000)
 Solar + Battery CF is less due to solar charging battery
 Solar + Battery energy yield is higher than Solar and Battery only due to reduced losses from DC connection
 NPV cash flow is based on a Foothill Transit 5% discount rate
 Analysis prepared using existing 2019 SCE EV rates

Table 5: Arcadia On-Site Solar and Energy Storage Economic Analysis Results

Pomona On-Site Renewable Energy Plan

On-site solar is economically viable today under the current EV TOU rate structure for the Pomona depot based on analyses completed in this study. The phased site charging infrastructure plan was considered in the development of on-site solar and it was determined to be feasible to install a 312 kW array in the north portion of the depot (phase 1 - 2023) and a 312 kW array in the east portion of the depot (phase 2 - 2027). The size of the PV area is based on estimated area available within the Pomona depot to install a suitable PV array. Stationary battery energy storage, while not economical today, may be a viable option in the future and therefore space has been included in the future Pomona infrastructure layout. The implementation plan to installing this solar in coordination with the other overhead charging infrastructure is outlined below:

1. Phase 1 includes installing a 312 kW DC solar roof top canopy on top of the phase 1 overhead charging structure in 2023.

- a. The phase 1 overhead charging structure should be designed to support solar racking, modules, and cables.
 - b. Solar power shall be fed directly into SCE’s future EV switchgear to meet EV phase 1 loads. Switchgear shall be designed to accommodate future solar and potential energy storage.
 - c. Once Foothill Transit has completed its phase 1 charging structure design, Foothill should issue an RFP for the solar project. Foothill Transit should request bids for PPA and EPC contracts by 11/2022.
 - d. Preliminary design and performance information should be submitted with proposals to provide a fair evaluation of various module and inverter technology, costs, and performance.
 - e. Foothill Transit should evaluate the cost of owning the solar project versus purchasing a PPA contract based on bids provided. The evaluation and selection of the solar provider should be completed within 1 to 2 months with design and installation following over the next 12 months. If a PPA contract is selected, negotiations can take longer and can delay the project.
 - f. The Phase 1 solar project should be installed by a competent regional commercial solar company after the charging infrastructure is installed. Target solar completion by 12/2023.
2. Phase 2 includes installing a 312 kW DC solar roof top canopy on top of phase 2 overhead charging structure in 2027.
- a. The phase 2 overhead structure should be designed to support solar racking, modules, and cables.
 - b. Solar power shall be fed directly into SCE’s future EV switchgear to meet EV phase 2 loads. Switchgear shall be designed to accommodate future solar and potentially storage.
 - c. Once Foothill has completed its phase 2 charging structure design, Foothill should issue an RFP for the solar project. Foothill Transit should request bids for PPA and EPC contracts by 11/2026.
 - d. Preliminary design and performance information should be submitted with proposals to provide a fair evaluation of various module and inverter technologies costs and performance.
 - e. Foothill should evaluate the cost of owning the solar project versus purchasing a PPA contract based on bids provided. The evaluation and selection of the solar provider should be completed within 1 to 2 months with design and installation following over the next 12 months. If a PPA contract is selected, negotiations can take longer and can delay the project.

Figure 7 provides a conceptual overview of where the solar system could be installed for phase 1 and

phase 2. Figure 8 provides a typical daily generation and load profile curve of the site in year 2 including phase 1 solar only.



Figure 7: Pomona Depot Solar Layout

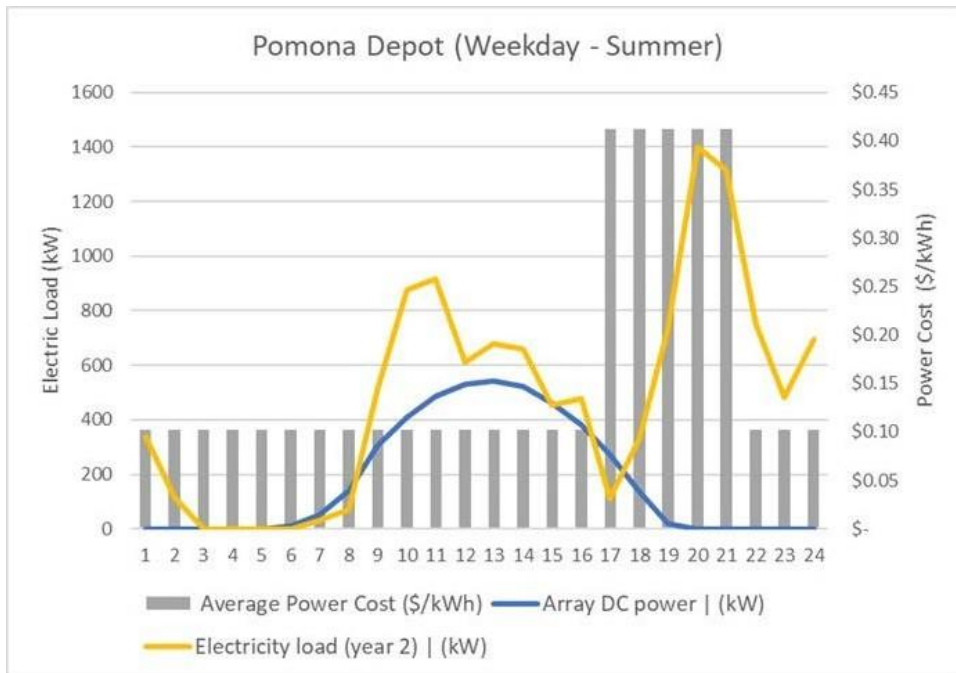


Figure 8: Pomona Load and Solar Generation versus Time of Use Rates (Phase 1-Year 2)

Table 6: Pomona On-Site Solar and Energy Storage Economic Analysis Results

Category	Unit	Solar	Battery	Solar+Battery
PV Size	[kW]	625.8	---	625.8
Battery Size	[kWh]	---	2,000.0	2,000.0
Capacity Factor	[%]	20.0%	---	18.7%
Energy Yield (year 1)	[kWh/yr]	1,095,911.0	-89,364.0	1,023,468.0
Battery Efficiency	[%]	---	81.8%	84.4%
Electricity bill without system (year 1)	[\$]	\$ 277,102.00	\$ 277,102.00	\$ 277,102.00
Electricity bill with system (year 1)	[\$]	\$ 172,357.00	\$ 194,677.00	\$ 93,438.00
Net Savings with system (year 1)	[\$]	\$ 104,745.00	\$ 82,425.00	\$ 183,664.00
Capital Cost	[\$]	\$ 1,103,490.00	\$ 1,249,725.00	\$ 2,351,240.00
Net Present Value	[\$-NPV]	\$ 659,467.00	\$ (496,930.00)	\$ 147,502.00
Payback period	[yrs]	10.7	22.6	15.7

Notes:

- Battery was modelled based on Tesla power pack
- Battery replacement is required at year 15 (\$200/kWh = \$400,000)
- Solar + Battery CF is less due to solar charging battery
- Solar + Battery energy yield is higher than Solar and Battery only due to reduced losses from DC connection
- NPV cash flow is based on a Foothill Transit 5% discount rate
- Economic analysis prepared using existing 2019 SCE EV rates

Off-Site Renewable Energy Plan

Foothill Transit cannot achieve a 100% economical renewable power supply through on-site resources and SCE’s power supply mix until 2045. However, Foothill Transit may purchase off-site renewable energy through a PPA. The PPA contract enables Foothill Transit to purchase energy directly from a solar or wind project at a cost and sell that energy into the wholesale energy market for a margin. Based on the power supply RFI bids received in the study, there are financially attractive opportunities available to secure long term economical renewable energy. The implementation plan to securing off-site renewable power is provided below:

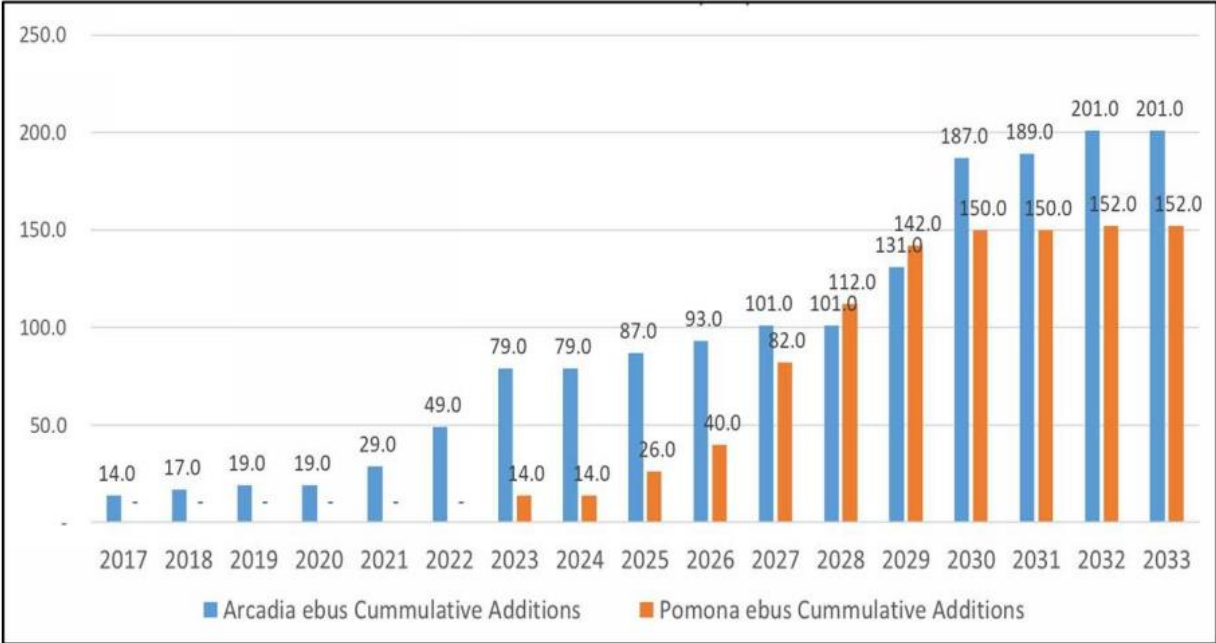
- a. Once the fleet electrification procurement plan is finalized, Foothill Transit should establish the final balance of renewable energy desired. Assuming on-site solar and SCE power is purchased, the renewable energy deficit between 2021 and 2041 is 210,000 MWh or 10,000 MWh per year on average. If the procurement and operation of electric buses is delayed several years, the amount of off-site power should be reduced.
- b. Conduct a renewable power RFP to secure off-site renewable PPA proposals beginning in 2021 or 2022. The RFP should be managed by Foothill Transit’s procurement with bid evaluations done by others. Foothill Transit should release the renewable power supply RFP by 12/2020.

- c. Foothill Transit should provide up to 2 months for bidders to respond to the renewable RFP with 1 month of evaluation and 2 months for contract negotiations. Existing projects energy will be available within a few months while new project PPAs may not be online for 1 to 2 years.
- d. Off-site renewable power supply should be for a term between 10 and 20 years. In no event should Foothill Transit commit to purchasing off-site renewable energy beyond 2045.
- e. Foothill Transit should only secure offsite renewable power PPAs that provide a positive cash flow. The location of the project does not need to be within California but should be located within a relatively stable and well-established U.S. wholesale energy market.
- f. The phase 1 solar project should be installed by a competent regional commercial solar company after the charging infrastructure is installed. Target solar completion by 12/2027.
- g. Total phase 1 and 2 on-site solar will provide 6% of Pomona's energy requirement in 2030

4. Facilities and Infrastructure Modifications

Depot Infrastructure Phasing and Development

Foothill Transit plans to convert the existing CNG bus fleet of Arcadia and Pomona to an all-electric bus fleet over the next 12 years with a target of nearly 100 percent of its routes being fully electrified by 2030 and all CNG buses being removed from the site by 2032. The infrastructure phasing will need to coincide with the procurement of buses as planned in the fleet replacement schedule provided by Foothill Transit otherwise the buses will not be able to meet their routes. The cumulative number of electric buses by depot is presented in Figure 9.



[1] Foothill fleet replacement plan as of March 2019

Figure 9

As presented in Section 8 of this report, the recommended infrastructure scenario is to use Alternative 2 which includes installing a total of 55 chargers and 110 pantographs at Arcadia and 40 chargers and 80 pantographs at Pomona. The timing of the when the infrastructure is needed is outlined in Table 7 with a description of each infrastructure deployment option following.

Table 7: Electric Bus Charging Infrastructure Requirements

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Arcadia ebus Cummulative Additions	14	17	19	19	29	49	79	79	87	93	101	101	131	187	189	201	201
Pomona ebus Cummulative Additions	-	-	-	-	-	-	14	14	26	40	82	112	142	150	150	152	152
Total ebus Cummulative Additions	14	17	19	19	29	49	93	93	113	133	183	213	273	337	339	353	353
Arcadia New CummulativePantographs	-	-	-	-	-	6	16	32	32	36	38	42	42	42	58	86	110
Pomona New CummulativePantographs	-	-	-	-	-	-	-	8	8	14	20	42	56	72	76	76	80
Total New CummulativePantographs	-	-	-	-	-	6	16	40	40	50	58	84	98	114	134	162	190
Arcadia New CummulativeChargers	-	-	-	-	-	3	8	16	16	18	19	21	21	21	29	43	55
Pomona New CummulativeChargers	-	-	-	-	-	-	-	4	4	7	10	21	28	36	38	38	40
Total New CummulativeChargers	-	-	-	-	-	3	8	20	20	25	29	42	49	57	67	81	95
Arcadia Depot	BUILD PILOT (14 buses)				BUILD PH1					BUILD PH2							
Pomona Depot							BUILD PH1					BUILD PH2					

[1] Based on Foothill fleet replacement plan as of March 2019

Depot Infrastructure Costs

For each depot, the project team prepared a bottom up cost estimate based on the scope and infrastructure required. The scope and costs were determined by year by depot. Additionally, the scope was also segregated between those infrastructure costs that will be directly paid by Foothill Transit, the installed costs of the chargers paid by Foothill Transit that could potentially be partially funded by rebates from SCE, and the cost of the electrical infrastructure that is eligible to be 100 percent paid for by SCE under the Charge Ready Transit Program. The detailed quantities and costs by year by depot (\$2019) are provided as an Appendix to this report with the summary for each depot provided below. The total net cost to Foothill for the Arcadia depot with inflation is \$69.9 million (\$53 million in \$2019). The total net cost to Foothill for the Pomona depot with inflation is \$50.7 million (\$39.9 million in \$2019). The total Foothill cost requirements of \$120.6 million developed within this section serve as an input into Section 13 Fleet Electrification Life Cycle Cost Analysis of this report.

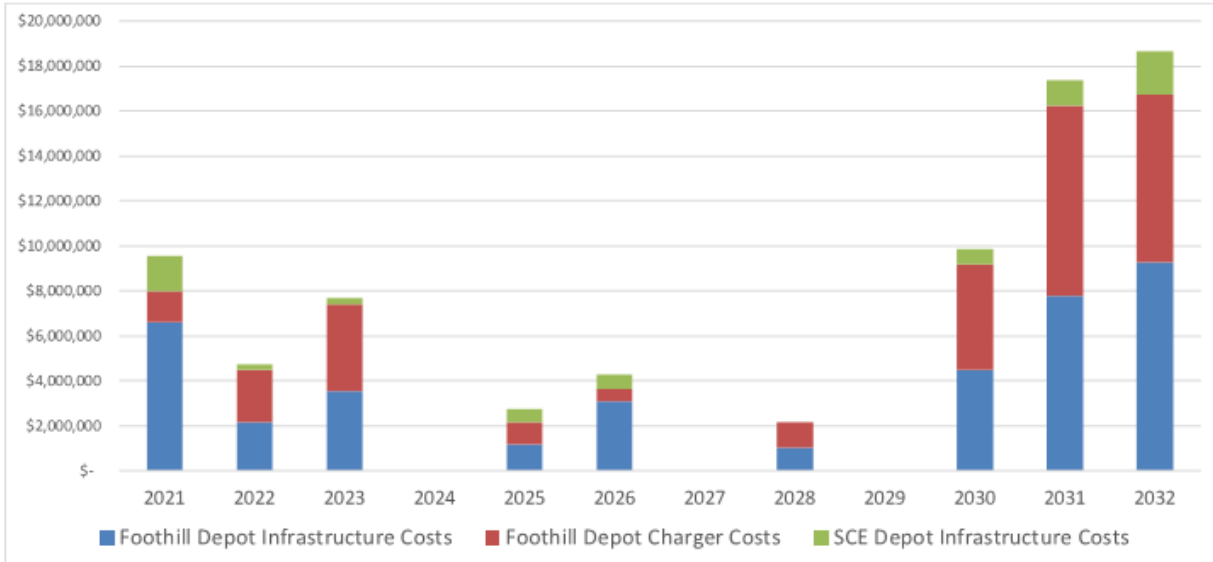


Figure 10: Arcadia Depot Infrastructure Cost (Year by Year Deployment)

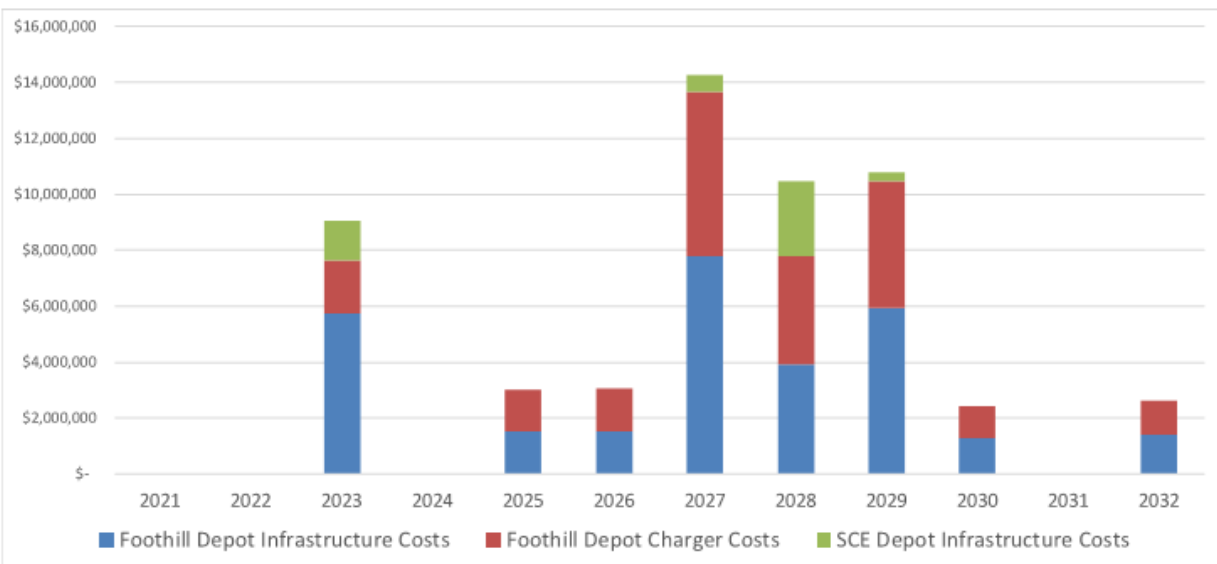


Figure 11: Pomona Depot Infrastructure Cost (Year by Year Deployment)

5. Providing Service in Disadvantaged Communities

Foothill Transit provides service to disadvantaged communities as listed in the latest version of CaEnviroScreen. We serve the following cities as highlighted in the survey: Azusa, Baldwin Park, Covina, Duarte, El Monte, Hacienda Heights, La Puente, Los Angeles, Monrovia, Montclair, Montebello, Pomona, South El Monte, West Covina, and Whittier. Based on the survey, forty-one percent of Foothill Transit's bus stops are currently located in these communities. Since we do not assign buses to specific routes, these buses will still serve these communities based on our service area and stop distribution.

One specific disadvantaged community is serviced by Foothill Transit's Line 291. This route runs from La Verne to South Pomona and has already been fully electrified for many years. Other communities mentioned above are also served by zero-emission buses based on service areas and bus stop distribution.

6. Workforce Training

Together with original equipment manufacturers (OEMs), Foothill Transit has provided training on zero-emission buses to our bus operators and mechanics since 2010, when we procured our first battery electric buses. For bus operators, it is imperative that they learn how to drive battery-electric buses efficiently. Unlike conventional CNG buses, frequent acceleration and braking can significantly reduce bus ranges because such driving habits consume a significant amount of energy. Therefore, bus operators receive initial trainings, as well as continued training as necessary. Operators who demonstrate a higher need for training are provided additional courses to ensure they perfect their skills.

Mechanics are likewise trained on the nuances of servicing a battery electric bus. While it is true that there are fewer parts to battery electric buses, there are new components that mechanics need to be familiar with in order to safely service buses.

7. Potential Funding Sources

Potential funding sources for zero-emission buses include Federal Transit Administration (FTA) replacement money, as well as \$300,000 per bus from HVIP. OEMs will apply for HVIP funding at the time the buses are purchased, reducing the initial capital cost. CARB's Carl Moyer Program is another potential funding source. This program has a \$80,000 cap per bus, so long as the funding does not exceed 50 percent of the vehicle cost.

As of June 2020, the VW Mitigation Trust has \$130 million in funds available to the transportation industry to replace old vehicles with battery or fuel-cell buses. This program would offer up to \$400,000 per vehicle.

Other funding sources include the Transit and Intercity Rail Capital Program (TIRCP), which has \$291 million available, as well as various funding opportunities from the California Energy Commission and South Coast Air Quality Management District.

8. Start-Up and Scale-Up Challenges

Foothill Transit has been the pioneer in deploying battery electric buses in transit service. With ten years of experience, we have identified several disadvantages in operating battery electric buses versus CNG buses. These include bus range, infrastructure cost, complex utility rates, operational impacts, and unknown battery life.

With the enormous charging infrastructure cost and the higher price of zero emission buses, there is a lack of funding available to meet the capital demands to meet CARB's ICT Regulation. Current funding levels only provide for small-scale pilot deployments. Funding for large-scale deployments of at least 100 buses with different zero-emissions technology (battery electric and fuel cell) is necessary to further learn how zero-emissions buses perform in transit applications.

Appendix

Resolution No. 2020-03 A Resolution of the Executive Board of Foothill Transit Adopting the Zero-Emission Bus (ZEB) Rollout Plan



Foothill Transit
Going Good Places

**A RESOLUTION OF THE EXECUTIVE BOARD OF FOOTHILL TRANSIT
ADOPTING THE ZERO-EMISSION BUS (ZEB) ROLLOUT PLAN
Resolution #2020-03**

The Executive Board of Foothill Transit does resolve as follows:

1. **Findings.** The Executive Board hereby finds and declares the following:
 - a. On October 1, 2019, the California Air Resources Board (CARB) issued the Innovative Clean Transit (ICT) Regulation, which requires public transit agencies to transition to a 100 percent zero-emission bus (ZEB) fleet by 2040.
 - b. The ICT includes the following requirements for bus purchases for large transit such as Foothill Transit:
 - i. 25 percent of all new bus purchases must be zero-emission by January 1, 2023;
 - ii. 50 percent of all new bus purchases must be zero-emission by January 1, 2026;
 - iii. 100 percent of all new bus purchases must be zero-emission by January 1, 2029;
 - iv. 100 percent of fleet must be zero-emission by January 1, 2040; and
 - v. Annual compliance reports must be submitted to CARB by March of every year from 2021 to 2050.
 - c. The ICT Regulation requires each agency to submit a ZEB Rollout Plan (“Rollout Plan”) to CARB by July 1, 2020. The Rollout Plan is a living document intended to guide the agency’s conversion to a ZEB fleet.
 - d. CARB issued guidance to support transit agencies in preparing their Rollout Plans. The Rollout Plan includes the following components:
 - i. Transit agency information, including Foothill Transit’s operations and service area;

100 S. Vincent Ave., Suite 200 • West Covina, CA 91790 **W** foothilltransit.org **P** 626.931.7300 **F** 626.915.1143

MEMBER CITIES Arcadia, Azusa, Baldwin Park, Bradbury, Claremont, Covina, Diamond Bar, Duarte, El Monte, Glendora, Industry, Irwindale, La Puente, La Verne, Monrovia, Pasadena, Pomona, San Dimas, South El Monte, Temple City, Walnut, West Covina and Los Angeles County **A PUBLIC AGENCY**

- ii. Current bus fleet composition and bus procurement plan through 2040;
 - iii. Facilities and Infrastructure Modifications, including a description of each operating and maintenance facility and potential facility modifications needed to support a ZEB fleet;
 - iv. Service provided in disadvantaged communities (DACs) that are affected by existing and future ZEB deployment.
 - v. Workforce training, which provides background on personnel training requirements for ZEB implementation;
 - vi. Costs and funding opportunities, which outlines estimated costs and potential funding sources for ZEB implementation.
- e. The Rollout Plan must be approved by the transit agency's governing body through the adoption of a resolution prior to submission to CARB.

2. **Action.** The Executive Board hereby:

- a. Adopts the CARB Zero-Emission Rollout Plan and approves it for submission to CARB.

3. **Adoption.** PASSED AND ADOPTED at a meeting of the Executive Board held on May 29, 2020, by the following vote:

AYES: 5

NOES: 0

ABSTAIN: 0


CYNTHIA STERNQUIST, CHAIR

APPROVED AS TO FORM:
DAROLD PIEPER, GENERAL COUNSEL

ATTEST:
CHRISTINA LOPEZ, BOARD SECRETARY

By: 

By: 

