NORTH COUNTY TRANSIT DISTRICT

RESOLUTION NO. 20-04

RESOLUTION OF THE BOARD OF DIRECTORS OF THE NORTH COUNTY TRANSIT DISTRICT APPROVING THE ZERO EMISSIONS BUS ROLLOUT PLAN

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

WHEREAS, North County Transit District's (NCTD) Zero Emissions Bus Rollout Plan sets forth the District's plan which meets the following requirements:

- A goal of full transition to zero-emission buses by 2042 with careful planning that avoids early retirement of conventional internal combustion engine buses;
- Identification of the types of zero-emission bus technologies NCTD is planning to deploy;
- A schedule for construction of facilities and infrastructure modifications or upgrades, including charging, fueling, and maintenance facilities, to deploy and maintain zero-emission buses;
- A schedule for zero-emission and conventional internal combustion engine bus purchases and lease options;
- A training plan and schedule for zero-emission bus operators and maintenance and repair staff; and
- Identification of potential funding sources.

NOW, THEREFORE, BE IT RESOLVED that the Board of Directors of the North County Transit District hereby approves the NCTD Zero Emissions Bus Rollout Plan as set forth in full in Exhibit A to this Resolution.

BE IT FURTHER RESOLVED that insofar as the provisions of any Ordinance, Resolution, document or previous action of the Board and/or the Executive Director, prior to the date of this Resolution, are inconsistent with the provisions of this Resolution or any policy adopted by this Resolution, this Resolution and the Board Policies adopted herein shall control.

PASSED, APPROVED AND ADOPTED at the regular meeting of the Board of Directors of the North County Transit District this 18th day of June, 2020.

BOARD CHAIR
North County Transit District

CERTIFICATION

I, Anthony Flores, duly appointed and qualified, Clerk of the Board of the North County Transit District, do hereby certify that the above is a true and correct copy of a resolution passed and approved by the Board of Directors of the North County Transit District adopted at a legally convened meeting of the Board of Directors of the North County Transit District held on the 18th day of June, 2020.

CLERK OF THE BOARD
North County Transit District

RESOLUTION NO. 20-04

RESOLUTION OF THE BOARD OF DIRECTORS OF THE NORTH COUNTY TRANSIT DISTRICT APPROVING THE ZERO EMISSIONS BUS ROLLOUT PLAN

Exhibit A

NCTD Zero Emission Bus Rollout Plan

NORTH COUNTY TRANSIT DISTRICT

INNOVATIVE CLEAN TRANSIT
ZERO-EMISSION BUS ROLLOUT PLAN

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1 ROLLOUT PLAN SUMMARY

1.1 TRANSIT AGENCY INFORMATION

Transit Agency Background	
Transit Agency's Name	North County Transit District (NCTD)
Mailing Address	810 Mission Ave Oceanside, CA 92054
Transit Agency's Air District	San Diego County Air Pollution Control District
Transit Agency's Air Basin	San Diego County Air Basin
Total number of buses in Annual Maximum Service[1]	152 Standard Buses (Breeze Fleet)
Urbanized Area	North San Diego County (including: Oceanside, Escondido, Carlsbad, Vista, San Marcos, and other smaller cities)
Population of Urbanized Area[2]	Approx. 950,000
Contact information of general manager, chief operating officer, or equivalent	Damon Blythe Chief Operations Officer – Transit Planning & Bus Operations760 966-6708dblythe@nctd.org
Is your transit agency part of a Joint Group[3]	**No**
Is your transit agency submitting a separate Rollout Plan specific to your agency, or will one Rollout Plan be submitted for all participating members of the Joint Group?	***N/A***
Please provide a complete list of the transit agencies that are members of the Joint Group (optional)	***N/A***
Contact information of general manager, chief operating officer, or equivalent staff member for each participating transit agency member	***N/A***

1.2 ROLLOUT PLAN GENERAL INFORMATION

Rollout Plan General Information

1 The ICT regulation defines "Annual Maximum Service" (13 CCR § 2023(b)(3)) as the number of buses in revenue service that are operated during the peak season of the year, on the week and day that maximum service is provided but excludes demand response buses. NCTD's public fact sheet notes 152 buses in service, though data directly from their operations notes a total of 152 current fixed route fleet buses (see Table 3-1).

2 Figure calculated based on the cumulative population for the cities that make up North County San Diego – both incorporated and unincorporated, using the data points published by the US Census Bureau for 2010 and 2018, and projected to 2020.

3 The ICT regulation defines a Joint Zero-Emission Bus Group or Joint Group (13 CCR § 2023.2) as two or more transit agencies that choose to form a group to comply collectively with the zero-emission bus requirements of section 2023.1 of the ICT regulation.

Does Rollout Plan have a goal of full transition to Zero Emission technology by 2040 that avoids early retirement of conventional transit buses?	No – Rollout Plan has a goal of full transition to Zero Emission (ZE) technology by **2042**, which avoids early retirement of conventional buses. Modifying this to 2040 would require early retirement of conventional buses.
The ICT regulation requires 100% ZEB purchase in 2029. Conventional transit buses that are purchased in 2028 could be delivered in or after 2029. Please explain how your transit agency plans to avoid potential early retirement of conventional buses in order to meet the 2040 goal. (optional)	While this Rollout Plan has a target of 2042, ZE bus procurement will be in line with ICT's requirements. NCTD's last conventional internal combustion bus will be purchased in 2028, making these buses eligible for retirement in 2042.
Rollout Plan's approval date (optional)	***(06/30/20)***
Resolution No. (optional)	***TBD***
Is copy of Board-approved resolution attached to the Rollout Plan? (required)	Yes ***(Appendix A)***
Contact for Rollout Plan follow-up questions (optional)	Damon Blythe Chief Operations Officer – Transit Planning & Bus Operations760 966-6708dblythe@nctd.org
Who created the Rollout Plan? (optional)	Consultant
Consultant (optional)	STV
Cost of Rollout Plan creation (Optional)	***$20,745***
Person-Hours for Rollout Plan creation (Optional)	***103***

2 INTRODUCTION

In accordance with the California Air Resource Board's Innovative Clean Transportation regulation, the following report serves as North County Transit District's (NCTD) Rollout Plan to transition its bus fleet to 100 percent zero-emission (ZE) by 2042.

2.1 INNOVATIVE CLEAN TRANSPORTATION REGULATION

The California Air Resource Board's (CARB) Innovative Clean Transportation (ICT) regulation became effective October 1, 2019 and requires all public transit agencies in the state to transition from conventional buses (Compressed Natural Gas (CNG), diesel, etc.) to zero-emission buses (battery-electric, fuel cell electric, or trolley). The regulation requires a gradual increase of an agency's percentage of new bus purchases to be zero-emission buses (ZEB). By 2040, CARB expects all bus fleets in the state to be 100 percent ZEBs.

To ensure that each agency has a strategy to comply with the 2040 requirement, the ICT regulation requires each transit agency to submit a ZEB Rollout Plan ("Rollout Plan") before purchase requirements take effect. The Rollout Plan is considered a living document and is meant to guide the implementation of ZEB fleets and help transit agencies work through many of the potential challenges and explore solutions. Each Rollout Plan must include a number of required components (as outlined in the Rollout Plan Guidelines) and must be approved by the transit agency's governing body through the adoption of a resolution, prior to submission to CARB.

NCTD is categorized as a "Large Transit Agency" under the ICT regulation and must comply with the following requirements [4]:

- **July 1, 2020 –** NCTD Board of Directors (Board)-approved Rollout Plan must be submitted to CARB
- **January 2023 –** 25 percent of all new bus purchases must be ZE
- **January 2026 –** 50 percent of all new bus purchases must be ZE
- **January 2029 –** 100 percent of all new bus purchases must be ZE
- **January 2040 –** 100 percent of fleet must be ZE

[4] The ICT defines a "Large Transit Agency" as an agency that operates in the South Coast or the San Joaquin Valley Air Basin and operates more than 65 buses in annual maximum service or it operates outside of these areas, but in an urbanized areas with a population of at least 200,000 and has at least 100 buses in annual maximum service. A "Small Transit Agency" is an agency that doesn't meet the above criteria. Each class of transit agency has its own purchase requirements.

2.2 NCTD'S ZEB EFFORTS

As early as 1991, NCTD adopted policies that commit the agency to using alternative energy buses. Pursuant to this vision, NCTD will have successfully transitioned their bus fleet from all-diesel to CNG in 2021 and has continued to commit to innovative technologies and strategies to further reduce their carbon footprint. The conversion to ZEBs is the next step in NCTD's future and it has the opportunity to further improve the air quality to North San Diego County residents and visitors in the future.

The transition to a ZEB fleet has been a goal of NCTD even before the ICT regulation was adopted. In April 2017, the NCTD Board endorsed staff's Strategic Plan for the transition to ZEBs. The first phase in the Strategic Plan is to evaluate their current fleet, routes, blocks, and facilities; and map out the best strategy and anticipated cost to convert their fleet to ZEB operation. Following this, master planning of their East Division, West Division, and Escondido Transit Center facilities is occurring. Along with this, two Pilot Programs are being implemented, which includes six 40-foot Battery Electric Buses (BEB) intended to operate out of their East Division facility, and eight 40-foot Fuel Cell Electric Buses (FCEB) intended to operate out of their West Division facility.

2.2.1 ZEB PROGRAM MASTER PLAN

In 2019, NCTD awarded STV, an architecture and engineering firm, consisting of multiple industry experts to perform ZEB Infrastructure Planning to transition to all ZEBs by 2042 – an ambitious plan that will guide NCTD in adopting all ZEBs. As part of this plan, STV is responsible for providing the following services:

- Inventory of NTCD Operations
- Assessment of Best Industry Practices
- Evaluation of Compliance with Existing Standards and Codes
- Support Negotiation of Rate Structures with Utilities
- Analyses/System Modeling and Phasing Options
- Development of Technical Specifications for ZEBs and Facilities
- Development of Action-Ready RFPs

STV's efforts are ongoing and many of their findings to date inform the Rollout Plan. The Master Plan's work is iterative and will continue beyond the Rollout Plan submission deadlines. Therefore, some of the information outlined in this report may be superseded based on technological advancements and new information and data; accordingly, the report may be periodically updated.

2.3 ROLLOUT PLAN STRUCTURE

In accordance with the Rollout Plan Guidance, this document provides an overview of a number of key components to NCTD's ZEB transition, including fleet acquisitions, schedule, training, and funding considerations. As previously mentioned, NCTD is currently studying and has a goal of transitioning to all ZEBs by 2042.

It should also be noted that this Rollout Plan is based on 2019 data. This dataset is used because it represents the fleet in typical operations. By the time rollout occurs, there may be a number of factors that may skew the fleet size and division requirements, as exemplified by modified routes/blocks, ridership levels, and street improvements. The Master Plan, however, will make use of the most recent information available for the final version of NCTD's Master Plan.

The Rollout Plan is structured as follows and addresses the 9 sections (A-I) of CARB Rollout Plan Guidance.

1. Rollout Plan Summary *Provides an overview of NCTD and the Rollout Plan. Subsection 1.1 Transit Agency Background addresses Guidance Section A: Transit Agency Information. Subsection 1.2 Rollout Plan General Information addresses Guidance Section B: Rollout Plan General Information.*

2. Introduction *Details the background of the ICT regulation and NCTD's ZEB efforts.*

3. Fleet and Acquisitions *Presents the existing fleet and procurement plan for buses through 2042. Subsections 3.1 & 3.3 address Guidance Section D: Current Fleet Composition and Future Bus Purchases. Subsection 3.2 Existing ZEB Procurements and Projects addresses Guidance Section C: Technology Portfolio.*

4. Facilities and Infrastructure Modifications *An overview of each division and the modifications required and addresses Guidance Section E: Facilities and Infrastructure Modifications.*

5. Disadvantaged Communities (DACs) *Discusses the DACs that will be impacted by the ZEB transition and addresses Guidance Section F: Providing Service in Disadvantaged Communities.*

6. Workforce Training *Provides background on personnel training requirements for ZEB implementation and addresses Guidance Section G: Workforce Training.*

7. Costs and Funding Opportunities *Discusses rough order of magnitude costs and potential funding sources and addresses Guidance Section H: Potential Funding Sources.*

8. Start-Up and Scale-Up Challenges *Provides an understanding of challenges and issues that NCTD will have to mitigate or confront during ZEB adoption and addresses Guidance Section I: Start-up and Scale-up Challenges.*

3 FLEET AND ACQUISITIONS

The following section provides an overview of NCTD's existing fleet, planned purchases, and description of how NCTD will meet the requirements of the ICT regulation.

3.1 EXISTING BUS FLEET

As of December 2019[5], NCTD directly operates 152 standard heavy-duty transit buses on 30 bus routes. NCTD's existing fleet consists of a mixture of 35- and 40-foot buses. NCTD's fleet is a mixture of fleet propulsion types and varying ages of existing buses, resulting in a range of vehicle series and replacement dates. Table 3-1 presents a summary of NCTD's existing bus fleet.

Table 3-1. Summary of Existing Bus Fleet as of December 2019

Manufacturer	Series	Fuel Type	Length	In Service Year	Bus Type	Number of Buses (SBE)
New Flyer	1100	Diesel	40'	2000	Standard	9
	2200	CNG	35'	2003	Standard	10
	2300	CNG	40'	2004	Standard	22
	2400	CNG	40'	2005	Standard	33
	2500	CNG	40'	2007	Standard	12
	2600	CNG	40'	2012	Standard	30
	2700	CNG	40'	2016	Standard	26
	1900	CNG	35'	2019	Standard	10
					Total Buses	**152**

Source: NCTD

[5] Based on Proposed Fleet Replacement Plan after December 2019 fleet purchase.

3.2 EXISTING ZEB PROCUREMENTS AND PROJECTS

While ZEBs are not yet deployed at NCTD's facilities, a series of pilot programs (both BEB and FCEB) are in the planning stages for NCTD's bus bases, and discussions with electric utility provider, SDG&E, have commenced to coordinate make-ready infrastructure. These pilot programs are intended to gather practical data that can be used to inform NCTD's procurement strategy for the full fleet ZEB rollout plan. The procurement strategy is envisioned to be implemented in several steps, based on when existing buses are scheduled to be replaced (in accordance with FTA bus life guidelines).

Information regarding initial analyses and fleet propulsion strategies is detailed below in section 3.3.1.

3.3 PROCUREMENT SCHEDULE

In accordance with the ICT regulation, NCTD will prioritize ZEB purchases and progressively increase the percentage of ZEB purchases over time. Based on initial analysis, the last conventional bus (CNG) is expected to be purchased in 2028 (per CARB mandated cut-off), all new buses will be ZEB starting in 2029.

NCTD's existing fleet consists of 35 and 40-foot buses. NCTD plans to procure all 40-foot ZEBs in the future.

NCTD's current ZEB procurements and specifications consist of 6 BEBs that will be outfitted with charge bars on the roof to make-ready for pantograph charging. These buses also have the ports available for plug-in charging, if necessary. An additional 8 FCEB's will be purchased to round out the Zero Emission Pilot program. The results of this program will determine which type of ZEB is best suited for NCTD's current and future operational requirements.

Table 3-2. Summary of Future Bus Purchases (through 2042)

		Zero-Emission Buses				Conventional (CNG) Buses			
Calendar Year Delivered	Total Buses	No.	Pct.	Bus Type	Fuel Type	No.	Pct.	Bus Type	Fuel Type
2020	**20**	0	-			20	100%	40’	CNG
2021	**43**	6	14%	40’	BEB	37	86%	40’	CNG
2022	**8**	8	100%	40’	FCEB	-	-	-	-
2023	**0**	-	-	-	-	-	-	-	-
2024	**0**	-	-	-	-	-	-	-	-
2025	**10**	-	-	-	-	10	100%	40’	CNG
2026	**10**	-	-	-	-	10	100%	40’	CNG
2027	**10**	-	-	-	-	10	100%	40’	CNG
2028	**10**	10	100%	40’	ZEB*	-	-	-	-
2029	**10**	10	100%	40’	ZEB*	-	-	-	-
2030	**10**	10	100%	40’	ZEB*	-	-	-	-
2031	**11**	11	100%	40’	ZEB*	-	-	-	-
2032	**11**	11	100%	40’	ZEB*	-	-	-	-
2033	**11**	11	100%	40’	ZEB*	-	-	-	-
2034	**11**	11	100%	40’	ZEB*	-	-	-	-
2035	**11**	11	100%	40’	ZEB*	-	-	-	-
2036	**16**	16	100%	40’	ZEB*	-	-	-	-
2037	**11**	11	100%	40’	ZEB*	-	-	-	-
2038	**11**	11	100%	40’	ZEB*	-	-	-	-
2039	**19**	19	100%	40’	ZEB*	-	-	-	-
2040	**11**	11	100%	40’	ZEB*	-	-	-	-

ZEB* denotes determination of ZEB types upon completion of the Pilot Program.

Purchases in 2025, 2026, and 2027 will be all CNG due to offsets provided by the purchase of the BEB and FCEB fleet in 2020 and 2021.

3.3.1 ZEB RANGE REQUIREMENTS AND COSTS

NCTD's ongoing ZEB analysis is evaluating several ZEB technology strategies to meet their 2042 ZEB goals. Initial evaluation looked at NCTD's current routes/blocks – length, average speed, and grade; various loading factors – both weight and mechanical demand; and considered current BEB/FCEB technology.

NCTD and STV worked together to determine a sample of routes for data collection. Routes were categorized based on speed and terrain for service assessment (flat-fast, hills-fast, flat-slow, and hills-slow), and further modified based on loading (weight and mechanical demands). Data points were gathered via real-time measurements while riding the buses, and then processed. The result of this is estimated ranges – for both distance (miles) and duration (hours) – for each block category.

This analysis determined that approximately 45% of NCTD's blocks would not be achievable using current BEB's (depot-only charging). Even with the advancement of BEB technology, it is estimated that 14% of blocks would still not be achievable by 2042.

With this in mind, alternative strategies were considered, including BEB (depot charging plus on-route charging); a mixed fleet of BEB (depot-only charging) plus FCEB; and a homogenous fleet of FCEB. These alternatives enable 100% of blocks to be feasible by 2042, with the on-route charging option being of lesser interest due to complexities related to scheduling on-route charging and the requirement for facilities and infrastructure to perform this charging along the longer blocks. Utility costs, particularly time of use charges, and the inability to bid the energy source are also considerations.

Beyond the various propulsion strategies considered above, NCTD also intends to apply a number of strategies (where applicable/feasible) to supplement onboard battery storage, including midday charging, battery/charging management systems, solar energy production, and battery energy storage systems.

In addition to the physical limitations noted above, other considerations include market forces – BEBs have the advantage in terms of technological advancement, costs, and availability. FCEBs are promising and have many potential benefits (as compared to both CNG and BEB) including lower operational costs and longer ranges, but currently have a higher initial cost and a limited fuel supply chain.

Table 3-3. Estimated Capital Costs by Propulsion System for Bus Procurement

Fuel Type	Per Bus Cost	Total Fleet Cost (152 Buses)
CNG	$500,000 - $600,000	$76.0M - $91.2M
BEB	$750,000 - $900,000	$114.0M - $136.8M
FCEB	$850,000 - $1,100,000	$129.2M - $167.2M

3.3.2 ZEB CONVERSIONS

Conversions are not currently being considered to meet NCTD's ZEB goals.

4 FACILITIES AND INFRASTRUCTURE MODIFICATIONS

The following sections detail the planned charging strategies, infrastructure, detailed division improvements, and program schedule.

4.1 FACILITY MODIFICATIONS

NCTD's transition to ZEB technologies, namely, BEB, will require a number of modifications and changes to existing infrastructure and operations. This would include the eventual decommissioning of CNG equipment, enhancements to and expansions of electrical equipment, additional electrical supply, and the installation of BEB chargers, dispensers, and other components. These modifications will occur at NCTD's East Division and could also occur at select bus layover locations and transit centers that would function as on-route charging stations.

A hydrogen fueling station will be constructed in NCTD's West Division to fuel the 8 FCEB's that will be purchased for the pilot program. The hydrogen fueling station will have the capacity to support 50 FCEB's. This design is modular and can add capacity as required in increments of 50 FCEB's. Both of NCTD's Division's currently operate CNG buses. Each of the fleet maintenance and servicing buildings are equipped with Combustible Gas Detection systems. These systems will require upgrades to be detect hydrogen that will be the fuel source of the FCEB.

Figure 4-1 illustrates the location of NCTD's divisions and Table 4-1 summarizes the modifications and schedules of each bus division.

Figure 4-1. NCTD's Divisions

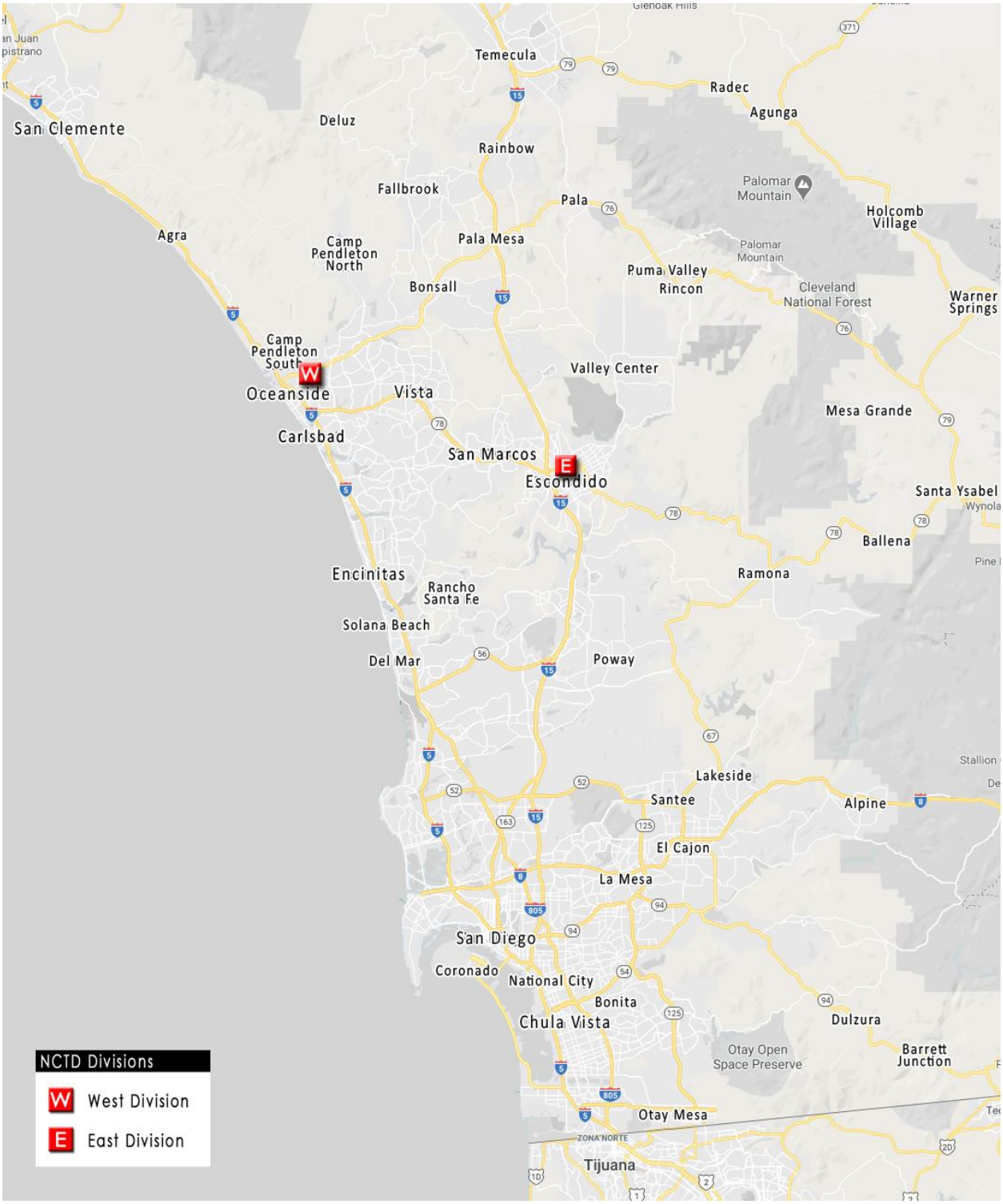


Table 4-1. Bus Divisions Summary

Division /Facility Name	Address	Main Functions	Type(s) of Infrastructure	Service Capacity	Needs Upgrade ? (Yes/No)	Estimated Construction Timeline
East	755 Norlak Avenue, Escondido, CA 92025	O&M	Pantograph Charging, PV Canopy, BESS to support 60 buses by 2042	5.0 MW for full-BEB scenario (Existing MW capacity for Full-FCEB scenario)	Yes	2020-2021 (Pilot) 2030-2032 (Final)
West	303 Via Del Norte, Oceanside, CA 92056	O&M	Pantograph Charging, PV Canopy, BESS to support 98 buses by 2042	8.0 MW for full-BEB scenario (Existing MW capacity for Full-FCEB scenario)	Yes	2021-2022 (Pilot) 2028-2030 (Final)

4.2 DIVISION CHARGING STRATEGIES AND INFRASTRUCTURE

Divisions will support DC pantograph charging if a battery electric ZEB propulsion strategy is chosen. In an effort to maximize space and cost savings (via reduced demand charges), NCTD is currently planning for a 1:2 150-kW charger to dispenser ratio (one charger for two buses), however, individual division strategies are still being analyzed and may vary and change based on unique operating and service conditions. As technology develops, NCTD will also consider other ratios and charging strategies which may impact the layout of each division.

At the divisions, all chargers, conduit, electrical equipment, and associated dispensers will be supported by an overhead frame that will cover the surface of the bus parking tracks (Figure 4-2). This overhead strategy is due to the general constrained space that is available at NCTD's divisions. BEB supporting infrastructure requires a number of charging cabinets, switches, switchgears, and transformers that require a considerable amount of space. This general design will be utilized at each division to maximize space and ensure compatibility with all procured BEBs.

If either full or partial FCEB propulsion scenario is chosen, NCTD intends to utilize liquid delivery hydrogen and charging is not required for the buses. Infrastructure required includes hydrogen storage tanks, compressors, and fuel dispensers. Solar PV would be intended to help offload electrical demand from hydrogen fueling and facility operations and also provide resiliency in power outages.

Figure 4-2. General Layout of Division Charging Infrastructure

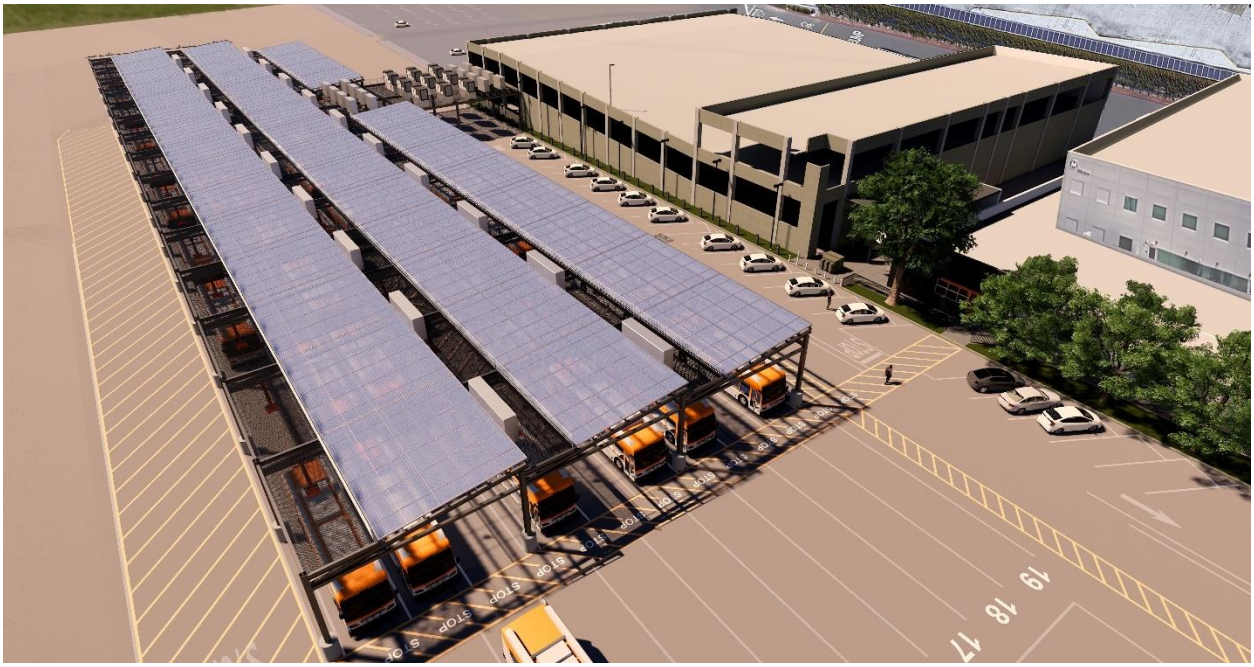
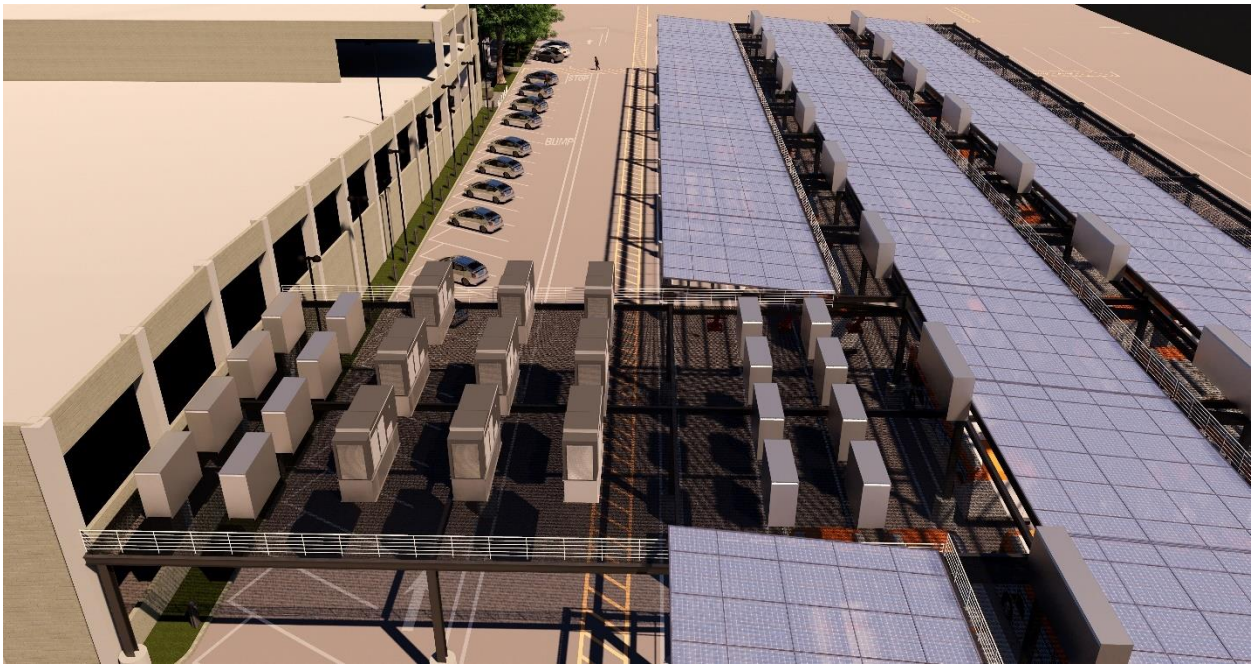


Figure 4-3. Conceptual Division Pantograph-Charging



4.3 ON-ROUTE CHARGING STRATEGIES AND INFRASTRUCTURE

As mentioned, on-route charging is a consideration for NCTD's ZEB transition. On-route charging will assist in extending ranges, reducing peak demand at divisions, and serve as future-ready strategy as it is likely that charging during the day will eventually be more cost-competitive than charging at night (due to increased solar renewable power).

On-route charging facilities will also utilize DC pantograph chargers. All on-route chargers are anticipated to be "high-powered" to ensure that buses can receive more electricity in a small period of time (bus layovers). NCTD is planning for up to 1.0 megawatts (MW) of power per SAE J-3105 (pantograph charging standard) to support multiple chargers at each on-route charging location.

Figure 4-4. North Hollywood Station On-Route Charger

Source: Streetsblog L.A., January 2020

On-route charging is most useful at endpoints (layover locations) of bus blocks. As of December 2018, NCTD has 12 layover locations (see Table 4-2, below). If only two on-route charging stations are to be built, the pair that provides the best opportunity for servicing the most blocks in need of on-route charging is Encinitas Station and Vista Transit Center, which together service 96% of blocks requiring on-route charging in 2042. Vista Transit Center provides charging to the highest number of unique blocks of the options considered, such that if it is paired with the Carlsbad Village Station, Gilman Transit Center, Oceanside Transit Center, or University Towne Center, the on-route charging stations will be able to service 76% of blocks requiring on-route charging.

Table 4-2. Potential Layover Locations

Transit Centers	Number of Routes Serving Each Transit Center	Number of Blocks Requiring On-Route Charging (2042)
Cal State San Marcos	1	1
Carlsbad Village Station	3	18
Del Lago Transit Center	1	0
Encinitas Station	3	27
Escondido Transit Center	13	8
Gilman Transit Center	1	18
Oceanside Transit Center	5	23
Palomar College Transit Center	4	6
Rancho del Oro Station	2	0
San Luis Rey Transit Center	5	15
University Towne Center	1	18
Vista Transit Center	7	20

4.4 PHASING AND CONSTRUCTION STAGING

Adhering to the construction schedule and milestones will be critical because the facility construction must be completed before buses are delivered; otherwise, the buses will not be able to operate.

The transition schedule for NCTD is shown in the table below as three phases, though in execution it may vary from this as necessary to accomplish both NCTD and ICT requirements.

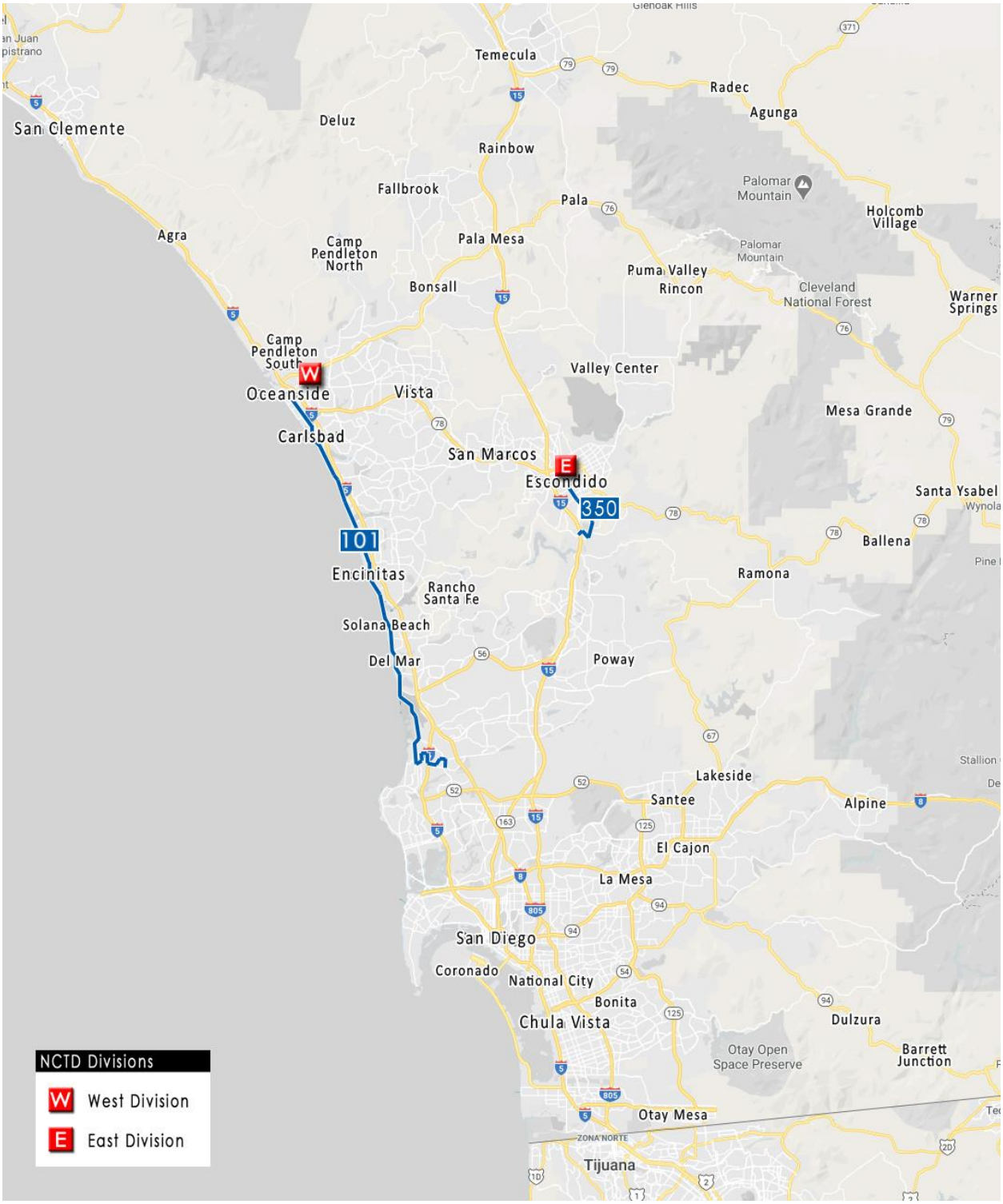
Table 4-3. NCTD Transition and Construction Phases

Phase #	Description	Sites
1	**Pilot Programs:** A six bus BEB program to be located at East Division and includes restriping of parking lots plus the incorporation of an additional property parcel and prep work – to include demo of existing structures, new pavement, and make ready infrastructure to support BEBs. An eight bus FCEB program to be located at West Division and includes restriping of parking lots plus the existing inspection pits and bus washer, and the construction of a new fueling infrastructure to be co-located with the existing CNG fueling infrastructure area.	East Division, West Division
2A	**Initial Fleet Conversion and Supporting Equipment:** The first installment of PV canopies, BESS systems, and BEB charging and/or FCEB fueling infrastructure. The quantity of equipment installed in this phase is aligned with the needs at the midpoint of the transition.	East Division, West Division
2B	**Final Fleet Conversion and Supporting Equipment – Final:** The follow-up installment of PV canopies, BESS systems, and BEB charging and/or FCEB fueling infrastructure. The quantity of equipment installed in this phase is aligned with the ultimate needs at the end of the transition.	East Division, West Division

PILOT PROGRAMS

As noted in the table above and shown in Figure 4-5 (below), NCTD is in the planning process for rolling out two ZEB Pilot Programs.

Figure 4-5. Pilot Programs



Initially, only the BEB Pilot Program was considered, which would deploy six 40’ battery electric buses in 2021 to replace some of the nine remaining diesel vehicles in the fleet. Early discussion

considered placing these BEBs into service on Routes 101 and/or 350 as part of a pilot program since these are high ridership routes and will aid in further ZEB analysis.

One of the early studies for NCTD's ZEB transition calculated potential range (in miles) implied by the efficiency ratios of their typical routes (based on terrain change, bus speed, and loading – mechanical and weight) and the typical service energy of a new 40' BEB available in 2019.

This was applied to the two potential routes for the Pilot Program. It found that the total distance (revenue service plus deadhead miles) for the shortest block on the 101 Route exceeded the capabilities of BEBs (using depot-only charging), and therefore the blocks featuring Route 101 were not advisable for the BEB Pilot Program as they exist today. Alternatively, the study found that the range for BEBs would be sufficient to achieve all of the weekend blocks featuring Route 350 as they are currently scheduled. They would also be able to cover most weekday blocks for most of the year, which exceptions coming on days that require greater heating or cooling than average, or on days that experience more ridership.

For these reasons, Route 350 was chosen to be utilized for the BEB Pilot Program. This route is served by the NCTD's East Division Bus Base, and thus the BEB Pilot Program will be located at this base.

Looking at the larger picture, BEBs using depot-only charging will not be able to achieve nearly half of NCTD's routes initially and, at the current pace of technological advancements, will still fall short in 2042.

Alternative strategies were investigated, including on-route charging for BEBs, and the use of FCEBs. The results of which showed FCEBs having similar ranges as CNG buses and being able to achieve all of NCTD's current routes.

With NCTD strongly considering FCEBs, it was prudent to get real world experience with this propulsion technology as well, and a second Pilot Program consisting of eight FCEBs entered planning and is scheduled to deploy in 2022.

The West Division Bus Base was chosen as the home for the FCEB Pilot Program for a few reasons. Spatial constraints already exist at their bus bases; trying to introduce two new ZEB propulsion technologies, along with their supporting equipment, to a single location would further exacerbate the issue. Additionally, FCEBs capabilities are shown to be well suited for the demands of the 101 Route.

NCTD intends to operate these two Pilot Programs near-concurrently, as a means to increase their knowledge and provide a useful comparison between the technologies, which will help inform their eventual full fleet ZEB transition procurements and program.

PHASING

The anticipated modifications intended to support NCTD's transition to a full ZEB fleet are expected to occur along different schedules for the buses versus the site/facility infrastructure.

The buses are intended to be replaced at intervals and quantities related to the current fleet's service life. FTA guidelines require a minimum of a 12-year service life, and NCTD expands upon this – targeting a 14- to 16-year service life for each bus. As buses age, a percentage of new buses will be purchased with the composition of ZEBs to CNGs following CARB's ICT guidelines.

Procurements are planned such that a small number are replaced every year; instead of a large quantity all at once. For this reason, the phasing of the buses will be more fluid than the infrastructure.

The infrastructure improvements are expected to occur in two to three phases:

- **Pilot Program** – initial six BEBs at East Division or initial eight FCEBs at West Division. This also includes their supporting infrastructure and any modifications necessary to accommodate these Pilot Programs.
- **Full Fleet Infrastructure** – this may occur in one to two phases. If a full build out is not desired, this could be split into a build-out to support the first half of the fleet transition, with a final buildout to occur around the midpoint in the transition, which would provide the remaining infrastructure necessary to support the full fleet.

As a point of consideration, there may be advantages to the phased installation of portions of the supporting infrastructure, including the Solar Photovoltaic (PV) and Battery Energy Storage Systems (BESS), depending on the propulsion system that is ultimately chosen:

- **BEB-Only Scenario** – providing two phases for Solar PV at the facilities will improve cost and efficiency, reducing reliance on grid-based electricity. The first phase would build out to offset 100% of the current site usage and the expected additional load from the pilot programs. A second phase would occur later as the electrical demand from adding BEBs to the fleet increases. The point is to scale PV and BESS to the needs of the fleet to avoid high costs on rapidly advancing technology and obtain full utilization over the entire service life of the individual components.
- **Mixed Fleet (BEB + FCEB) Scenario** – the phasing noted above would also apply here.
- **FCEB-Only Scenario** – Only one phase is anticipated for this option, as FCEBs have similar electrical needs to CNG buses, and adding more to the fleet won't substantially alter the power needs of the facility. Additional hydrogen storage will be required at the midpoint of adoption.

4.5 SCHEDULE AND ADAPTABILITY

While the ICT regulation requires a full fleet conversion by 2040, NCTD is planning to reach 100% ZEB fleet by 2042. NCTD intends to follow ICT's requirements related to 100% percent of new bus procurements to be ZEB by 2029. However, due to the NCTD expected fleet useful life (14-16 years), this pushes past ICT's 2040 goal of 100% ZEB fleet. NCTD continues to provide the most economical service possible and this is especially important when considering the useful life of the buses, which determines how soon newer buses could be procured to provide extended range and further NCTD's ZEB coverage.

The schedule considers the Pilot Programs and Full Fleet Infrastructures at NCTD's two operating and maintenance divisions (East and West). On-route charging will be incorporated in phases if that scenario is chosen. Bus procurements will occur in more granular steps, based on individual NCTD's determination of each bus's useful life.

While new technology is being rolled out, the existing buses and supporting equipment must remain operational to continue utilizing those assets for the remainder of their useful life. Because of this, the schedule and phasing plans are carefully considered to ensure this is feasible. Figure 4.**Error! Reference source not found.**6 below presents the preliminary modification schedule. These activities include electrification (permitting and enhancements), design, and construction.

It should also be noted that as technology develops and new data is revealed, NCTD will make adjustments to maximize utility and cost feasibility. This will have direct impacts on the implementation schedule.

The following sections detail the existing conditions and planned modifications for each of NCTD's two major properties discussed.

4.5.1 EAST DIVISION

EXISTING CONDITIONS

East Division is located at 755 Norlak Avenue, Escondido, CA 92025. Based on preliminary demand modeling, approximately 5.0 MW of power will be needed to be provided by SDG&E to support the current fleet if fully transitioned to BEB.

Currently, 60 CNG-powered buses are stored, maintained, fueled, and serviced at the division. Buses are parked in unassigned stalls. The currently developed portion of the division is constrained with no significant space for future ground-level BEB charging equipment. The adjacent parcel of property (formally a Wonder Bread Distribution Center and referred to as the "Wonder Bread Lot") is planned to be utilized for the incorporation of the BEB Pilot Program.

PLANNED ZEB MODIFICATIONS AND TIMELINE

Initially, East Division is expected to have 6-150-kW chargers to support 6 BEB buses in the Pilot Program. Construction for East Division Pilot Program and its associated BEB equipment and support systems shall be completed in one year.

It is anticipated that ultimately East Division will have infrastructure to support 60 ZEB's in full fleet conversion. East Division and its associated fleet are expected to be full ZEB by 2042.

Additional electrical capacity will be required to meet the service needs of East Division ZEB buses should either full BEB and mixed BEB scenario is chosen. Planning and design for the modification is anticipated for a year, while construction and enhancements to bring the additional capacity is anticipated to take two years.

4.5.2 WEST DIVISION

EXISTING CONDITIONS

West Division is located at 303 Via Del Norte, Oceanside, CA 92056. Based on preliminary demand modeling, approximately 8.0 MW of power will be needed to be provided by SDG&E to support a 100% BEB fleet.

Currently, 98 CNG-powered buses are stored, maintained, fueled, and serviced at the division. Buses are parked in unassigned stalls. The division is constrained with limited space for future ground-level BEB charging equipment.

PLANNED ZEB MODIFICATIONS AND TIMELINE

Initially, West Division is expected to have 8 FCEB's and supporting infrastructure in the Pilot Program. Construction for West Division Pilot Program and its associated FCEB equipment and support systems shall be completed in one year.

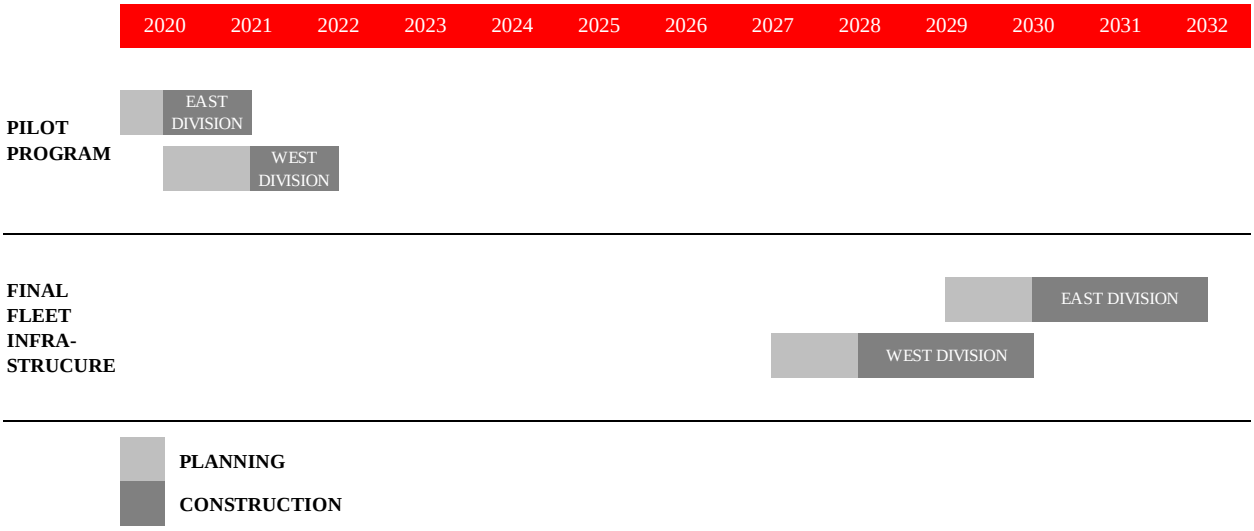
Ultimately, West Division will have infrastructure to support 98 ZEB's upon Full Fleet Conversion. West Division and its associated fleet are expected to be full ZEB by 2042.

Additional electrical capacity will be required from SDG&E to meet the service needs of West Division ZEB buses should either full BEB and mixed BEB/FCEB scenario is chosen. Construction and enhancements to bring this additional capacity is anticipated to take two years.

The choice of propulsion system will be made based upon the findings from the two pilot programs, the state of technology at the time of advanced fleet conversion, and the operating cost and capability of the technology.

Figure 4-6 illustrates timelines for pilot programs and final fleet infrastructures at East and West Divisions.

Figure 4-6. NCTD's Preliminary Modifications Schedule (100% ZEB by 2042)



Source: STV, April 2020

5 DISADVANTAGED COMMUNITIES

The following section provides an overview of disadvantaged communities (DACs) in NCTD's service area and the strategy to prioritize them for ZEB adoption.

5.1 DISADVANTAGED COMMUNITIES SERVED

NCTD does not serve disadvantaged communities, as listed in the latest version of CalEnviroScreen 3.0.

Zero (0) percent of NCTD's divisions are located in communities that are classified as "disadvantaged" according to CalEnviroScreen.

Table 5-1 summarizes whether or not divisions are located in DACs and the number and percentage of DACs that its routes serve. Figure ~~5-1~~ illustrates NCTD divisions and routes in DACs.

Table 5-1. Service in Disadvantaged Communities

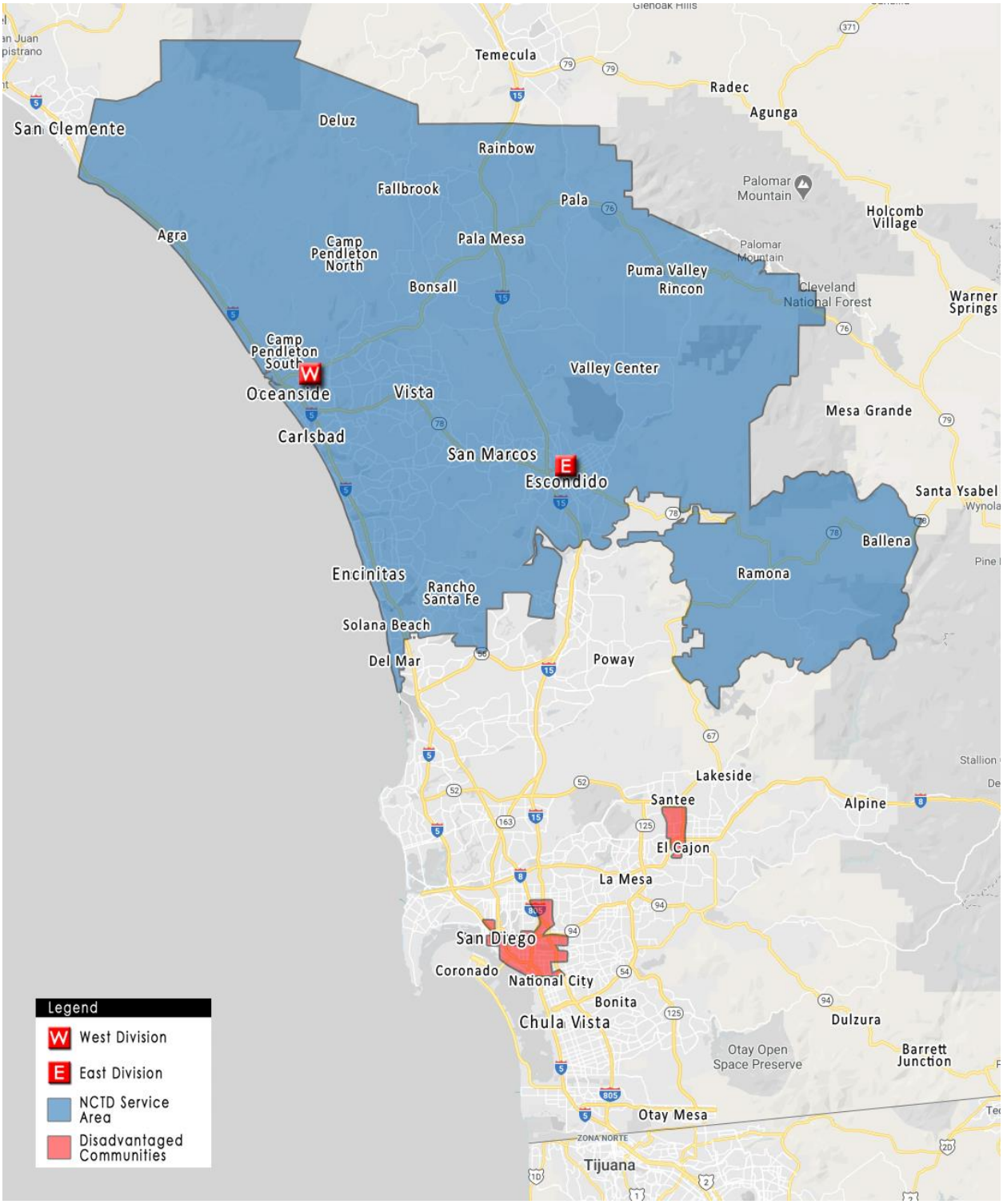
Division	In DAC?	NOx Exempt Area?	DACs Served (#)	DACs Served (%)
East	No	No	0	0%
West	No	No	0	0%

Source: CalEnviroScreen 3.0, June 2018

5.2 DAC PRIORITIZATION STRATEGY

This section does not apply as NCTD does not serve the disadvantaged communities, as listed in the latest version of CalEnviroScreen 3.0.

Figure 5-1. DACs in Service Area



Source: STV, CalEnviroScreen 3.0, June 2018

6 WORKFORCE TRAINING

The following section provides an overview of NCTD's plan and schedule to train personnel on the impending transition.

6.1 TRAINING REQUIREMENTS

The transition to ZEBs will significantly alter NCTD's service and operations. Converting to ZEBs from CNG is an arduous endeavor and will impact all ranks of the organization. This will require extensive change for management and training, some of which will be provided by the original equipment manufacturer (OEM), others by NCTD and outside organizations. The following provides a list of personnel and positions that will need to be retrained upon adoption of ZEBs (this list is not exhaustive):

- **Bus Operators**

  Bus operators will need to be familiarized with the ZEB buses, safety, bus operations, and pantograph operations.
- **Facilities Maintenance Staff and Maintenance**

  Facilities staff will need to be familiarized with scheduled and unscheduled repairs, high-voltage systems, and the specific maintenance and repair of equipment.
- **First Responders**

  Local police and fire station staff will need to be familiarized with the new buses and supporting facilities.
- **Tow Truck Service Providers**

  Tow truck providers will need to be familiarized with the new buses and proper procedures for towing ZEBs.
- **Body Repairers**

  Body repairers will need to be familiarized with the safety-related features and other components of ZEBs.
- **Instructors**

  For both Bus Operations Instruction and Maintenance, instructors will need to understand all aspects of ZEBs to train others.
- **Service Attendants**

  Service attendants will become familiarized with proper charging and servicing protocols and procedures that are ZEB-specific.
- **Management Staff**

  All management staff (supervisors, directors, etc.) will be familiarized with ZEB operations and safety procedures.

NCTD plans to use train-the-trainer style training initially. This will be provided by the OEM to the contracted training and safety staff, as well as select NCTD personnel assigned with oversight. Once this training is complete, the contracted training staff and trained NCTD personnel will provide training to the employees assigned to operate, maintain, and dispatch

these vehicles, with the goal of having all employees trained in their respective areas prior to the buses being placed in service. In addition, NCTD and its regional partner Metropolitan Transit Service (MTS) are in the process of upgrading the Regional Transit Management System (RTMS) Computer Aided Dispatching and Vehicle Location System (CAD/AVL) to allow dispatchers real time information on the state of charge of any BEBs in the system. NCTD will also use the time between delivery of buses and the buses being placed into service to offer initial training to first responders thru a series of open house demonstrations at the East and West divisions. First responders will be familiarized with proper procedures surrounding accident response, safe ways to remove power from the vehicle, and issues revolving around fires. This training will also be provided by contracted training and safety staff, as well as select NCTD personnel.

7 COSTS AND FUNDING

The following section identifies potential funding sources that NCTD may pursue in its adoption of ZEBs to implement full CARB requirements.

7.1 PRELIMINARY COSTS

Typically, NCTD allocates $7.2M per year in the capital budget to replace 12 CNG buses. NCTD estimates that full implementation of the CARB requirement will require an average of $11.1M per year beginning in 2021. NCTD does not have a dedicated source of funding to absorb this additional cost and will depend on discretionary grant programs to fund the CARB requirement. Funding comes from formula programs including Federal Transit Administration (FTA) Section 5339 and Section 5307 programs along with Transportation Development Act (TDA) and State Transit Assistance (STA) local funding. Because the Rollout Plan includes ZEB, which are more expensive than CNG buses, there will be a funding shortfall between $52.9M and $83.5M by 2040 depending on the vehicle types purchased. Facilities modification costs are estimated at $55M to support BEB's and $46M for FCEB's[6]. These costs reflect only capital infrastructure. Various operations and maintenance costs are still being analyzed through the work that STV is performing.

Based on preliminary estimates, NCTD's transition is expected to be approximately in the range of $169M - $213M for full BEB implementation, while full FCEB fleet and facilities modifications would range from $174M to $213M. NCTD must seek discretionary program funding to close the shortfall over the term of this plan.

7.2 FUNDING SOURCES

There are a number of potential federal, state, local, and project-specific funding and financing sources at NCTD's disposal. To date, NCTD has applied for and been awarded Federal and State funds for ZEB projects, as indicated in Table 7-1. There are other potential funding sources that NCTD may seek funds under, as indicated in Table 7-2.

Table 7-1. NCTD's Discretionary Program Awards for ZEB Funding

Type	Agency	Funding Mechanism	Year(s)	Status	Award(s)
Federal	FTA	Bus and Bus Facilities 5339 (b)	2018	Awarded	$1.2M
State	Caltrans	Low Carbon Transportation Investments (LCTOP)	2017-2020	Awarded	$5.4M for BEB $1.1M for FCEB

Source: NCTD, April 2020

[6] Facilities improvements estimated costs derived from NCTD Zero Emission Bus Planning Interim Workshop dated November 21, 2019.

Table 7-2. Other Potential Funding Sources

Type	Agency	Funding Mechanism	Annual Funding Available
Federal	FTA	Low- or No-Emission Vehicle Program 5339 (c)	$55M/year
Federal	FTA	Bus and Bus Facilities 5339 (b)	$423.35M
State	Caltrans	Transit and Intercity Rail Capital Program (TIRCP)	$4.3B
Local	APCD	San Diego Air Pollution Control District	Varies
State	CARB	Hybrid & Zero-Emission Truck & Bus Voucher Incentive Program (HVIP)	$150,000/Veh. for 1-100 and $100,000/Veh. for >100 vehicles
State	CARB	Volkswagen Environmental Mitigation Trust for California	Up to $3.2M
State	CARB	Low Carbon Transportation Investments	$2.2M

Source: NCTD, April 2020

NCTD will also continue to leverage funds from its local tax measure(s) and pursue other strategies to meet its ZEB goals, such as public-private partnerships, and other grant opportunities.

8 START-UP AND SCALE-UP CHALLENGES

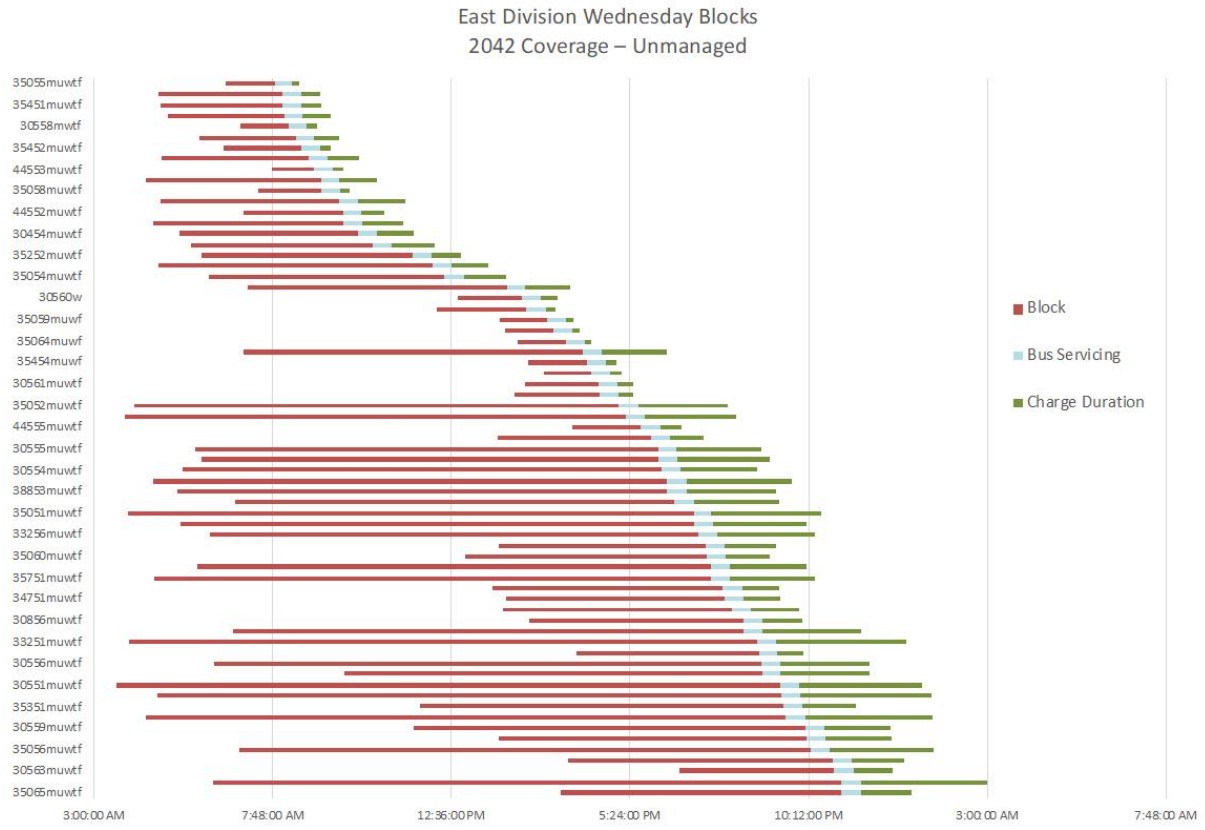
The following briefly described some of the challenges that NCTD faces for its transition:

- **Technological adaptation.** Currently, the BEB technology performance is substandard to meet NCTD's operating requirements. NCTD is modeling and planning for a transition based on current and future service delivery levels and existing ZEB technology. With hard deadlines looming, it is difficult to anticipate future technological enhancements and changes, such as improved batteries and chargers. Slight changes in these technologies could improve bus ranges, in turn, reducing costs. NCTD (and the market) must be stay abreast of these changes, as it would be counterproductive to invest in technologies that will soon be outdated.
- **Operating Costs.** Adoption of ZEBs has many benefits, including potential lifecycle cost savings. If NCTD proceeds with BEB-only scenario, the additional power capacity would require either locking into SDG&E rates (with no backup if there is a black-out, and no protection against future increases) OR producing its own electricity (Solar + Battery or CNG Generator). Neither is desirable nor cost effective. As currently regulated the cost of power from a utility like SDG&E is not subject to a competitive market as is the case with traditional fuels. While the cost of the FCEB vehicle is slightly higher than the BEB or CNG equivalent, the real cost escalation is in the cost of the fuel. Should the State be willing to step in to help lower the cost of fuel and provide subsidies to fuel providers to increase competition and lower costs, FCEB scenario has potential benefits of manageable long-term operational costs.
- **Capital Costs.** The investment required for capital and change management will be very significant. NCTD will have to be creative with funding mechanisms and sources to ensure that the transition to ZEB will not be detrimental to its operations and service. New funding must be provided by the State to support these implementations. FCEB strategy has higher initial capital cost but in consideration of operating costs, will be more promising.
- **Market Production Factors.** The ICT regulation will put a lot of pressure on original equipment manufacturers (OEMs) to produce ZEBs at unprecedented rates. However, it is not only California that is interested in converting to ZEBs. These monumental policy changes will have a great impact on these transitions; however, it will also make it challenging to meet ZEB goals for agencies if the supply of buses cannot meet the demand.
- **Phasing and Transition.** Transitioning to ZEBs without any service interruptions will be very challenging due to the limited space for temporary construction and bus relocation and hard deadlines.
- **Utility Upgrades.** Utility capacity upgrade may be necessary to support larger number of BEB's beyond the Pilot Program. NCTD's divisions are within the SDG&E electric utility service area. SDG&E is in the process of rolling out their Medium/Heavy-Duty (MD/HD) EV Charging Infrastructure Program, related to providing make-ready infrastructure for Pilot Programs. It may be difficult to schedule meetings/site visits with SDG&E initially,

as there will be a large demand on them from other agencies looking to take part in this. Additionally, with any new complex program such as this, a learning curve on their part is expected, and may also push dates out. This challenge would apply more for BEB fleet scenarios. The existing power capacity at the two Divisions is sufficient to support full FCEB fleet.

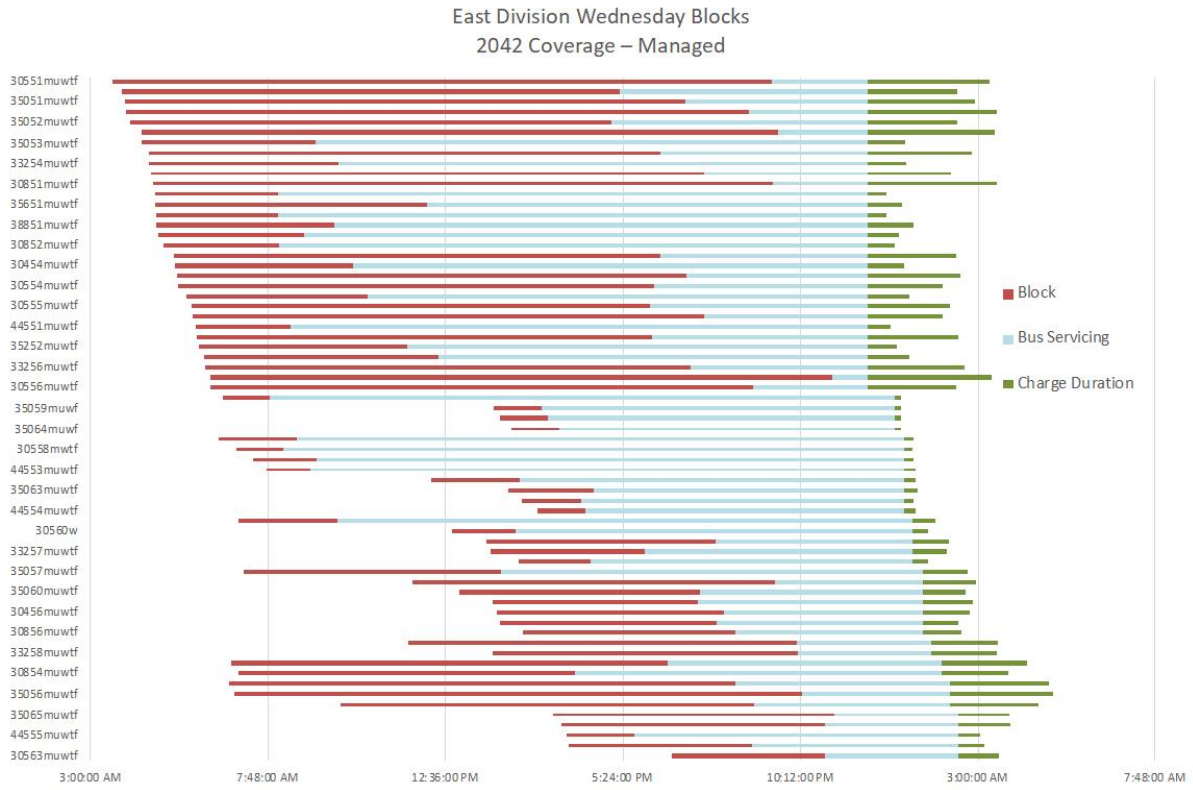
- **Managing Power.** The transition to BEBs will require strategies to ensure that NCTD can utilize power in the most cost-efficient way. This is currently being evaluated via utility negotiations, demand modeling, and managed charging to determine methods to reduce electrical costs. For instance, Figure 8-1 and Figure 8-2 illustrate the difference between unmanaged and managed charging (charging durations for each bus are shown as the green portion of the charts below). The managed charging scenario prioritizes bus charging to occur during super off-peak times, to take advantage of the cheapest electrical rate available. Additional methods for shaving or eliminating electrical needs from the utility company and lowering operating cost focus on PV and BESS. Whether PV is introduced or not, large scale BESS will enable a lower rate of consumption from the utility. In FCEB only scenario, there are no additional power demands and Solar PV will be utilized only for offloading demands from hydrogen fueling and for resilience support.

Figure 8-1. Unmanaged Charging Scenario



Source: STV, November 2019

Figure 8-2. Managed Charging Scenario



Source: STV, November 2019

In conclusion, NCTD is slated to convert their entire fleet to ZEB by 2042 but is still determining the path forward to meeting its transition goals. The low range of BEBs is limiting the feasibility of this system and NCTD is willing to look at options above and beyond ICT regulations. FCEBs are currently the only ZE propulsion system that is proven to match the existing technology on a one bus to one bus basis in terms of range and time to "charge". However, the excessive initial capital costs make the FCEB strategy infeasible unless the State can provide assistance with the hydrogen technology, particularly as regards the availability of clean-source fuel supply and distribution.

NCTD's next steps in this process is to continue refining their pilot programs, analysis, and Master Planning efforts to meet CARB's goal for full ZEB transition.