ZEV Strategy and Final Report

Imperial County Transportation Commission
ZEV Rollout and Implementation Plan

Final Report

May 2024

Stantec

Stantec

ZEV Strategy and Final Report

ZEV Rollout Plan and Analysis Services

May 15, 2024

Prepared for:

Imperial County Transportation Commission

Prepared by:

Stantec Consulting Services Inc.

ZEV STRATEGY AND FINAL REPORT

Release Version

Rev.	Description	Date
0	Draft Report Issued to ICTC	12/27/2023
	Comments received	05/08/2024
1	Final Report Issued to ICTC	05/15/2024

Project Team

Stantec Consulting Services Inc.

801 South Figueroa Street Suite 300

Los Angeles CA 90017-3007

Table of Contents

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

Imperial County Transportation Commission (ICTC) provides management, administration, and oversight to local and regional transportation programs including Imperial Valley Transit (IVT), IVT ACCESS, IVT RIDE, IVT MedTrans, and Calexico On-Demand. IVT provides transportation services to Imperial County residents and surrounding areas. In 2021, ICTC provided 262,040 unlinked passenger trips with a fleet comprised of buses, cutaways, and minivans.[1]

This document serves to guide ICTC through its zero-emission vehicle (ZEV) transition to achieve a 100% zero-emission (ZE) fleet by 2040 as required by the California Air Resources Board (CARB) Innovative Clean Transit (ICT) mandate. It provides a detailed plan of the technology, needs, and strategies that will help ICTC transition to a ZEV fleet. The previous phases of this project laid the foundation for this plan by assessing ICTC's existing conditions and modeling the power and energy requirements needed to meet ICTC's service through a ZEV fleet. With this information, the initial ZEV fleet was refined through a collaborative optimization process that led to selecting the preferred fleet composition of hydrogen fuel cell electric (FCE) vehicles.

With the preferred fleet composition established, the next steps included determining the facility upgrades and modifications required to support ZEV operations at ICTC's transit facility. In addition, a financial model was developed to compare a base case (or business-as-usual with fossil fuel vehicles) and a case with a 100% FCE fleet. A phasing and implementation plan was also developed.

Overall, implementing the preferred FCE fleet will cost $80.8 million (cumulative capital and operating costs) compared to $64.2 million for business-as-usual (fossil fuel technology) within a 17-year timeframe (through 2040). Stated otherwise, the transition to ZEVs under the preferred fleet concept adds incremental capital and operating costs of $16.6 million over the 17-year period. While the higher increase comes due to capital cost of fleet acquisition and infrastructure, over a 17-year timeframe the electric fleet is expected to save close to $4.3 million in operational expenses (fuel and maintenance).

Based on ICTC's existing fleet transition schedule, this plan recommends that the ZEV procurement begins in 2028 and gradually continues through 2035 as fossil fuel vehicles reach the end of their useful lives and are retired. The full phasing and implementation plan is outlined in Table 0-1.

This plan is a living document that is intended to provide a practical framework for ICTC to deploy and transition to ZEVs in response to CARB's mandate. Like any other strategic plan, this implementation and transition plan should be revisited and adjusted in response to funding realities, changes in service delivery, and the needs of ICTC and its ridership, particularly given the long-term outlook. Taken together, this plan provides a prudent and feasible approach for ICTC to implement ZEVs that allows the agency to provide high-quality and cost-effective services that exceed customer expectations.

[1] NTD 2021 Annual Agency Profile: https://www.transit.dot.gov/sites/fta.dot.gov/files/transit_agency_profile_doc/2021/90226.pdf

Table 0-1: ZEV Implementation Phasing Plan 2023-2040

Year	Facility Modifications	ZEV Fleet Procurements	Training	Capital Expenses	Operating Expenses	Total Expenses
2023		N/A	• OEM training	$0	$2.9M	$2.9M
2024		N/A	• OEM training for technicians • OEM training for staff	$2.2M	$2.7M	$4.8M
2025		N/A	• Annual refreshers • Local fire and emergency response department introduction to new technology	$5.3M	$2.5M	$7.8M
2026	$4.6 M	N/A	• OEM training	$4.6M	$2.4M	$7.1M
2027	$4.4 M	N/A	• Annual refreshers • Local fire and emergency response department introduction to new technology	$4.5M	$2.3M	$6.8M
2028		1 cutaway, 4 vans	• OEM training	$586,000	$1.9M	$2.5M
2029		4 cutaways, 6 vans	• Annual refreshers • Local fire and emergency response department introduction	$2.4M	$1.9M	$4.2M

Year	Facility Modifications	ZEV Fleet Procurements	Training	Capital Expenses	Operating Expenses	Total Expenses
			to new technology			
2030		7 cutaways, 4 vans	• Annual refreshers	$2.8M	$1.8M	$4.5M
2031		6 cutaways	• OEM training • Local fire and emergency response department introduction to new technology	$1.7M	$1.7M	$3.4M
2032		6 buses, 5 cutaways	• OEM training for technicians • OEM training for staff	$6.9M	$1.7M	$8.6M
2033		4 buses, 8 cutaways	• Annual refreshers • Local fire and emergency response department introduction to new technology	$5.8M	$1.5M	$7.2M
2034		3 buses, 2 cutaways	• OEM training	$3.2M	$1.4M	$4.6M
2035		3 buses, 1 cutaway, 4 vans	• Annual refreshers • Local fire and emergency response department introduction to new technology	$2.9M	$1.4M	$4.2M
2036		4 cutaways, 6 vans	• OEM training for technicians • OEM training for staff	$2.0M	$1.3M	$3.4M

Year	Facility Modifications	ZEV Fleet Procurements	Training	Capital Expenses	Operating Expenses	Total Expenses
2037		4 cutaways, 4 vans	• Annual refreshers • Local fire and emergency response department introduction to new technology	$1.7M	$1.3M	$3.0M
2038		N/A	• OEM training	$0	$1.2M	$1.2M
2039		3 cutaways	• Annual refreshers • Local fire and emergency response department introduction to new technology	$719,000	$1.2M	$1.9M
2040		6 cutaways	• OEM training for technicians • OEM training for staff	$1.4M	1.2M	$2.6M
			Total	**$48.4M**	**$32.4M**	**$80.8M**

Abbreviations

ADA	Americans with Disabilities Act
AHJ	Authorities Having Jurisdiction
AHSC	Affordable Housing and Sustainable Communities Program
APCD	Air Pollution Control District
AQMD	Air Quality Management District
ATS	Automatic transfer switch
AVTA	Antelope Valley Transit Authority
BEB	Battery electric bus
BESS	Battery electric storage system
BTM	Behind the meter
CARB	California Air Resources Board
CMAQ	Congestion Mitigation and Air Quality Improvement Program
CMO	Clean Mobility Options
CMS	Charge management system
CO_2	Carbon dioxide
CPCFA	California Pollution Control Financing Authority
CRRSSA	Coronavirus Response and Relief Supplemental Appropriations Act
CTC	California Transportation Commission
DAR	Dial-A-Ride, demand response
DER	Distributed energy resource
EIA	Energy Information Agency
EPA	Environmental Protection Agency

ESS	Energy Storage System
EV	Electric vehicle
FCE	Hydrogen fuel cell electric
FCEB	Hydrogen fuel cell electric bus
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
GHG	Greenhouse gas
GVWR	Gross vehicle weight rating
H_2	Hydrogen
HVAC	Heating, ventilation, and air conditioning
HVIP	Hybrid and Zero-Emission Truck and Bus Voucher Incentive Program
IC	Internal combustion
ICT	Innovative Clean Transit
ICTC	Imperial County Transportation Commission
IID	Imperial Irrigation District
IVT	Imperial Valley Transit
JPA	Joint powers authority
KPI	Key performance indicators
LCFS	Low Carbon Fuel Standard
LCTOP	Low Carbon Transit Operations Program
LPP	Local Partnership Program
LTF	Local Transportation Fund
MHD	Medium-Heavy-Duty
MTA	Hawai’i Mass Transit Agency
NFPA	National Fire Protection Association

NREL	National Renewable Energy Laboratory
OCPP	Open Charge Point Protocol
OEHHA	Office of Environmental Health Hazard Assessment
OEM	Original equipment manufacturer
O&M	Operations and maintenance
PHEV	Plug-in hybrid electric vehicles
PPE	Personal Protective Equipment
PSPS	Public Safety Power Shutoff
PV	Photovoltaics
RAISE	Local and Regional Project Assistance Program
RFP	Request for proposal
RTPA	Regional Transportation Planning Agency
SCAG	Southern California Association of Governments
SCCP	Solutions for Congested Corridors Program
SGR	State of Good Repair
SOC	State of charge
STA	State Transit Assistance
STEP	Sustainable Transportation Equity Project
STIP	State Transportation Improvement Program
TDA	Transportation Development Act
TIRCP	Transit and Intercity Rail Capital Program
TOU	Time-of-use
TTC	Toronto Transit Commission
ULB	Useful life benchmark
USDOT	United States Department of Transportation

YCIPTA	Yuma County Intergovernmental Public Transportation Authority
ZE	Zero-emission
ZEB	Zero-emission bus
ZEV	Zero-emission vehicle

1.0 INTRODUCTION

ICTC provides management, administration, and oversight to local and regional transportation programs largely within Imperial County, with some service operating between Imperial Valley and San Diego County. All services are operated by Transdev except for Calexico On Demand, which is operated by Via. Transportation programs including Imperial Valley Transit (IVT), IVT ACCESS, IVT RIDE, IVT MedTrans, and Calexico On Demand, and are outlined in more detail below.

- **IVT fixed route**: IVT's fixed route service is comprised of standard fixed route, deviated fixed route, and remote zone route service. Together there are 23 routes, which vary in the time of day and days of the week they are offered.
    - Fixed route service operates over a set pattern of travel with a published schedule.
    - Deviated fixed route service operates so persons with disabilities and limited mobility are able to travel on the bus. For this service, passengers must call and request the day before service is desired.
    - Remote zone routes operate once per week and provide connections to the more distant communities in Imperial County.
- **IVT ACCESS**: IVT ACCESS is a curb-to-curb ADA paratransit service offered to individuals who have physical or cognitive disabilities that cannot use the regular fixed route bus system. Eligibility is determined based on an individual's ability to get to/from fixed route bus stops, board and exit the bus, and navigate the fixed route system. Reservations must be scheduled in advance.
- **IVT RIDE**: IVT RIDE provides curb-to-curb service to seniors age 55 years and over, and persons with disabilities in Brawley, Calexico, El Centro, Imperial, Heber, and West Shores.
- **IVT MedTrans**: IVT MedTrans offers non-emergency transportation service between Imperial Valley and San Diego County medical facilities, clinics, and doctor offices. This service is available to transit dependent persons requiring essential or lifeline medical services and is offered four days per week.
- **Calexico On Demand**: Calexico On Demand is an on-demand service that can be scheduled using the Calexico On Demand app. Pickups and drop-offs can occur anywhere within Calexico. This service is offered Monday through Friday from 6:00 AM to 6:00 PM and costs $2 per ride.

In addition to these services, ICTC partners with Yuma County Intergovernmental Public Transportation Authority (YCIPTA) to provide service between El Centro and Winterhaven. This route operates on Mondays, Wednesdays, and Fridays only. [2]

ICTC currently operates a fleet of 63 revenue vehicles to provide these services: 16 buses, 40 cutaways, and seven minivans. Of the seven minivans, four are plug-in hybrid electric vehicles (PHEV) used for the Calexico On Demand service and are owned by the operating company Via. In addition to the revenue vehicle fleet, there are four non-revenue minivans that are owned by Transdev. The non-revenue vehicles are not included in subsequent analysis and fleet phasing plans.

All vehicles are stored at the maintenance facility located at 792 Ross Ave, El Centro, CA which is leased from Transdev, and is privately owned. ICTC is part of the Imperial County Air Pollution Control District (APCD), the Salton Sea Air Basin, and the Imperial Irrigation District (IID) utility territory.

With a service area population of 179,851[3] and a fleet of 63 revenue vehicles, ICTC is classified as a small transit agency under the Innovative Clean Transit (ICT) mandate and was required to submit a zero-emission (ZE) rollout plan to the California Air Resources Board (CARB) by July 1, 2023[4].

This document serves as the source for ICTC's rollout plan submission to CARB and provides a detailed plan of the technology, needs, and strategies that will help ICTC transition to a ZEV fleet. To develop this rollout plan, the following steps were taken to determine the optimal ZEV strategy for ICTC.

- A review of existing conditions to understand characteristics and constraints for ICTC's operations and service area. This included a primer on different ZEV technologies to provide a scan of the market and technologies, including battery-electric buses (BEBs) and hydrogen fuel cell electric buses (FCEBs).
- Energy and power modeling to understand performance under different ZE technology alternatives, their viability, and suitability for ICTC's needs. A quantitative and qualitative assessment of modeling results was used to determine the preferred ZE fleet composition for ICTC.

This report is intended to act as a roadmap to guide ICTC through the ZEV transition to 100% ZEV deployment and implementation by 2040, as well as to fulfill the CARB guidelines as outlined in the ICT mandate. As CARB has reminded transit agencies, the ICT-regulated rollout plan is intended to be a living document that can and should be regularly revisited and updated over time as ZE technologies continue to evolve and service delivery approaches change with time.

[2] https://www.ycipta.org/routes/10
[3] https://www.census.gov/quickfacts/fact/table/imperialcountycalifornia/PST045222#PST045222
[4] CARB ICT defined large transit agencies as operating in "an urbanized area with a population of at least 200,000 as last published by the Bureau of Census before December 31, 2017 *and* has at least 100 buses in annual maximum service." Agencies that do not meet this definition are categorized as small transit agencies.

2.0 REGULATORY CONTEXT

This section provides a review of the ICT regulation to provide a basis for why the zero-emission vehicle (ZEV) transition is taking place and to provide ICTC staff and Council members with information on how ICT and ZEV implementation fits within and impacts ICTC operations and future plans.

2.1 INNOVATIVE CLEAN TRANSIT

CARB adopted the ICT regulation in December 2018, which requires all public bus transit agencies in the state to gradually transition to a completely ZEV fleet by 2040. This regulation is in accordance with preceding state legislation SB 375 and SB 350. SB 375, the Sustainable Communities and Climate Protection Program, creates initiatives for increased development of transit-oriented communities, better-connected transportation, and active transportation. Relatedly, SB 350 supports widespread transportation electrification through collaboration between CARB and the California Public Utilities Commission (CPUC).

ICT also states that transit agencies are required to produce a ZEV rollout plan that describes how the agency is planning to achieve a full transition to a ZE fleet by 2040 as well as outlining reporting and record-keeping requirements. Specific elements required in the rollout plan include:

- A full explanation of how the agency will transition to ZEVs by 2040 without early retirement of conventional internal combustion engine buses;
- Identification of the ZEV technology the agency intends to deploy;
- How the agency will deploy ZEVs in disadvantaged communities;
- Identification of potential funding sources;
- A training plan and schedule for ZEV operators and maintenance staff;
- Schedules for bus purchase and lease options (including fuel type, number of buses, and bus type); and
- Information on the construction of associated facilities and infrastructure (including location, type of infrastructure, and timeline).

Small California transit agencies, such as ICTC, were mandated to submit ZEV rollout plans to CARB by June 30, 2023. ICT also requires the ZEV purchase schedules for both large and small agencies. Beginning in 2021 and continuing annually through 2050, each transit agency is also required to provide a compliance report[5]. The initial report outlines the number of and information on active buses in the agency's fleet as of December 31, 2017. Subsequent reports must include transit agency information, details on each bus purchased, owned, operated, leased, or rented (including make, model, curb weight,

[5] https://ww2.arb.ca.gov/sites/default/files/2019-10/ictfro-Clean-Final_0.pdf

engine and propulsion system, bus purchases, and any information on converted buses), ZE mobility option information (if applicable), and information on renewable fuel usage (including date purchased, fuel contract number, and effective date, as applicable).

Table 2-1 below outlines the ZEV purchase schedule requirement for small transit agencies for heavy-duty transit vehicles. Specific vehicle types, such as motor coaches, cutaways, double decker, and 60-ft. vehicles, are exempt from this purchase schedule until 2026 or later (dependent on Altoona testing being completed). Whereas large agencies are required to start purchasing ZEVs in 2023, small agencies are exempt until 2026, in that year a minimum of 25% of new bus purchases must be ZE.

Table 2-1: CARB Standard Bus ZEV Purchase Schedule (As a Percentage of Total New Bus Purchases for Small Transit Agencies)[6]

Year	Percentage
2023	-
2024	-
2025	-
2026	25%
2027	25%
2028	25%
2029 and after	100%

Specifically, the ZEV rollout plan required to be submitted to CARB by mid-2023 must include the following components, broken down into nine sections:

- Section A: Transit agency information
- Section B: Rollout plan general information
- Section C: Technology portfolio
- Section D: Current bus fleet composition and future bus purchases
- Section E: Facilities and infrastructure modifications
- Section F: Providing service in disadvantaged communities
- Section G: Workforce training
- Section H: Potential funding sources
- Section I: Start-up and scale-up challenges

[6] In this report, standard buses refer to 35-ft. or 40-ft. unless otherwise stated

To account for circumstances beyond a transit agency's control that may impact their ability to comply with ICT regulations, the mandate laid out specific provisions for exemptions. Exemptions will be permitted for the following circumstances:

- If the required ZEV type is unavailable;
- If daily mileage needs cannot be met;
- If gradeability needs cannot be met;
- If there are delays in infrastructure construction;
- If a financial emergency is declared by the transit agency; and
- In circumstances where incremental capital or electricity costs for charging cannot be offset after applying for all available funding and incentive opportunities.

Finally, CARB acknowledges the continuous evolution of ZEV technologies as well as the service design and delivery of transit services. And as such, CARB encourages transit agencies to treat ZEV rollout plans as living documents that should be adjusted over the course if its life as agencies deploy ZEVs.

ICT Exemptions

As discussed above, the ICT regulation has specific provisions for exemptions if at least one of the following criteria are met. If the exemption is granted, transit agencies may purchase conventional ICE vehicle (s) instead of ZEV(s).[7]

1. Delay in bus delivery is caused by ZEV infrastructure construction setbacks beyond the transit agency's control. ZEV infrastructure includes charging stations, hydrogen stations, and maintenance facilities. The following circumstances would qualify a transit agency for exemption:

    a. Change of a general contractor
    b. Delays obtaining power from a utility
    c. Delays obtaining construction permits
    d. Discovery of archeological, historical, or tribal cultural resources
    e. Natural disaster

    A transit agency may also request an exemption if they can provide documentation that demonstrates the needed infrastructure cannot be completed within the two-year extension period or in time to operate the purchased buses after delivery, whichever is later.

2. When available ZEVs cannot meet a transit agency's daily mileage needs (due to operating conditions and the operating range of a ZEV).

[7] https://ww2.arb.ca.gov/sites/default/files/2019-10/ictfro-Clean-Final_0.pdf

3. If available ZEVs do not have adequate gradeability performance to meet the transit agency's daily needs for any bus in its fleet.

4. When a required ZEV type for the applicable weight class based on gross vehicle weight rating (GVWR) is unavailable for purchase. A ZEV bus type is considered unavailable for purchase for any of the following reasons:

   a. The ZEV has not passed the complete Bus Testing and not obtained a Bus Testing Report
   b. The ZEV cannot be configured to meet applicable requirements of the Americans with Disabilities Act
   c. The physical characteristics of the ZEV would result in a transit agency violating any federal, state, or local laws, regulations, or ordinances

5. When a ZEV cannot be purchased by a transit agency due to financial hardship. Financial hardship would be granted for the following reasons:

   a. If a fiscal emergency is declared under a resolution by a transit agency's governing body following a public hearing
   b. A transit agency can demonstrate that it cannot offset the incremental cost of purchasing all available ZEVs compared to the cost of the same type of conventional bus
   c. A transit agency can demonstrate that it cannot offset the managed, net electricity cost for depot charging BEBs when compared to the fuel cost of the same type of conventional ICE buses

If a transit agency wishes to request an exemption, they must provide documentation demonstrating the criteria are met. Required documentation for each exemption is summarized in Table 2-2. In addition, a request for exemption for a particular calendar year's compliance obligation must be submitted by November 30th of that year.[8]

Table 2-2: Required Documentation for ZEV Purchase Exemptions

Criteria	Required Documentation
1. Delay in bus delivery and infrastructure construction	• A letter from the agency's governing body • A letter from the contractor, utility, building department, or other involved organizations explaining the reasons for delay and estimating the project completion date

[8] https://ww2.arb.ca.gov/sites/default/files/2019-10/ictfro-Clean-Final_0.pdf

Criteria	Required Documentation
2. Available ZEVs cannot meet transit agency's daily mileage needs	• An explanation of why the exemption is needed • A current monthly mileage report for each bus type • A copy of the ZEV RFP and resulting bids showing rated battery capacity • If available, measured energy use data from ZEVs operated on daily assignments in the transit agency's service
3. Available ZEVs do not have adequate gradeability performance to meet the transit agency's daily needs	• Documentation showing no other buses in the fleet can meet the gradeability requirements and the ZEVs of that bus type cannot be placed into service anywhere else in the fleet • Topography information including measurement of the grade(s) where the ZEVs would be placed in service • A description of the bus types that currently serve the route(s) • An explanation of why the gradeability of all available ZEVs are insufficient to meet the transit agency's service needs • A copy of the ZEV RFP, specifying the transit agency's required gradeability and the resulting bids • If available, empirical data including grades, passenger loading, and speed data from available ZEVs operated on the same grade
4. When a required ZEV for the applicable weight class based on GVWR is unavailable for purchase	• A summary of all bus body-types, vehicle weight classes being purchased, chassis, reasons why ZEVs are unavailable for purchase • Current fleet information showing how many ZEVs of that bus type are already in service and how many are on order • If applicable, documentation showing that ADA requirements cannot be met

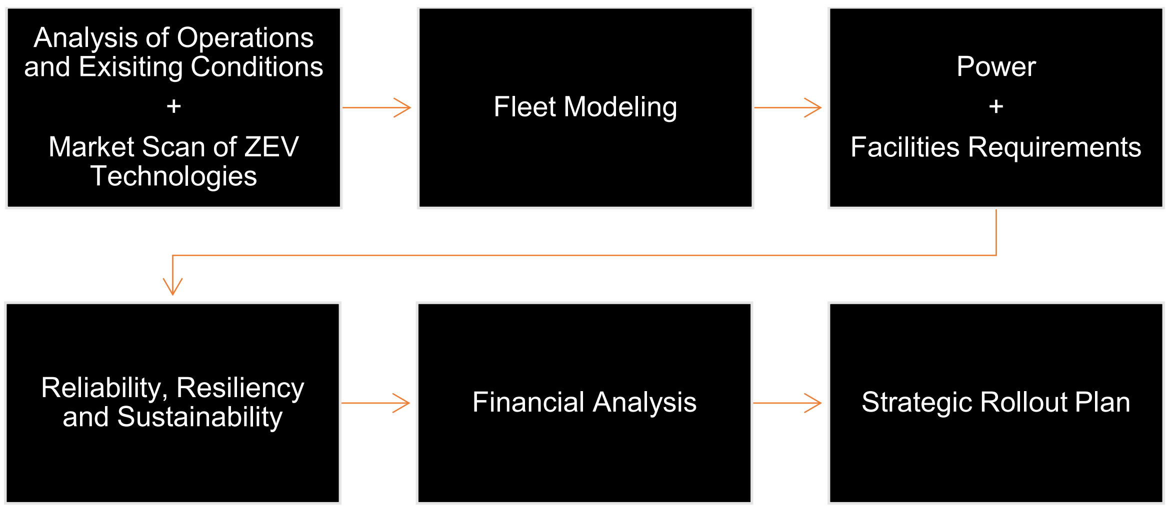
Criteria	Required Documentation
	• If applicable, a letter from its governing body that details how the physical characteristics of the ZEV would violate federal, state, or local law
5. When a ZEV cannot be purchased by a transit agency due to financial hardship	• A resolution by the transit agency's governing body declaring a fiscal emergency • Documentation showing the transit agency cannot offset the initial capital cost of purchasing ZEVs

Taken together, CARB recognizes the challenges that transit agencies will face when adopting ZEVs and wants to avoid hardships around finances and service delivery. As such, if ICTC faces certain challenges for a particular year, for example, if it does not have sufficient capital funds available to purchase a planned ZEV procurement, then ICTC can apply for an exemption to CARB by documenting that ICTC cannot offset the incremental cost of a ZEV compared to a conventional fossil fuel vehicle. Nonetheless, the ZEV rollout and transition plan in this document is built upon assumptions that ICTC will have sufficient funding to carry out the transition. As such, the CARB ICT plan is a living document that is flexible and can be amended to account for circumstances that require exemptions or shifting of ZEV procurement or other implementation steps.

3.0 APPROACH TO ZEV PLANNING

The graphic in Figure 3-1 provides a high-level schematic of the major steps in this project to derive a recommended fleet concept and develop an implementation plan.

Figure 3-1: ZEV Planning Process



The first step involved a review of existing conditions of ICTC's fleet, facilities, and service delivery to provide a foundation and understanding of ICTC's operations and business processes that would be impacted by a transition to a ZEV fleet. A summary of these key findings is provided in Section 4.0. An assessment of the facility provided insights into the constraints and opportunities for implementing ZEVs, as well as the condition of the facilities, buildings, and existing service cycle. A market scan was also conducted to analyze the current ZEV technologies, their limitations, and in-development technologies that can help shape ICTC's future ZEV fleet.

Next, we used computer modeling to simulate the performance of BEBs and FCEBs on ICTC's service blocks and vehicle assignments. The modeling provided predicted performance, including fuel economy, operating ranges, and feasibility of the different ZEV technologies. The analysis revealed that a fleet of FCE vehicles would minimize operational changes, and largely could replace fossil fuel vehicles on a 1:1 basis. The modeling process and ZE fleet concepts are summarized in Section 5.0.

Subsequently, working with ICTC staff, we developed a fleet transition/implementation plan that transitions the fossil fuel fleet to FCE vehicles, along with a phasing strategy for facility modifications. Section 6.0 describes the fleet and facility phasing strategy, Section 7.0 describes the hydrogen fuel demand, and Section 8.0 describes the modifications required at the operations and maintenance facility.

With the site plans and identification of required facility modifications and impacts on capital and operating costs, Stantec developed a financial analysis for the ZEV rollout through 2040 (Section 10.0). Operating and planning considerations (Section 11.0), applicable technology (Section 12.0), workforce training (Section 13.0), potential funding sources (Section 14.0), service in disadvantaged communities (Section 15.0), and greenhouse gas (GHG) impacts (Section 16.0) are also reviewed and discussed.

All steps described here, along with others found in this document, provide ICTC with a comprehensive ZEV rollout plan and strategy.

4.0 SUMMARY OF KEY EXISTING CONDITIONS

The Existing Conditions Report provided a comprehensive review of ICTC's existing conditions, encompassing operations, facilities, and finances to lay the groundwork for the route modeling and to understand current operating conditions.

Overall, the Existing Conditions Report revealed that ICTC's fleet, service area, operating characteristics, and facility provide some challenges for a ZEV transition. First, ICTC's fleet has many cutaway vehicles which have few FCE options that enable long daily distances. Second, ICTC has a large service area and vehicles are kept in service throughout the day, presenting potential challenges for ZEV range and fueling needs. Lastly, ICTC does not own its maintenance facility which poses risks to implementing facility upgrades and changes needed for a successful transition to FCE vehicles. These challenges, as well as the key findings from the Existing Conditions Report are summarized in the subsequent sections.

4.1 FLEET

ICTC currently operates a fleet of 63 revenue vehicles to provide fixed-route (Figure 4-1), demand-response DAR (Figure 4-2), and microtransit services. Four minivans are used for the Calexico On Demand service and are owned by Via. In addition to the revenue vehicle fleet, there are four non-revenue minivans that are owned by Transdev. The non-revenue vehicles are not considered to be a part of ICTC's fleet in this report and are not considered in part of ICTC's ZEV transition.

Table 4-1 shows a breakdown of the fleet roster. Fuel types are a combination of diesel and gasoline for fixed-route service, and gasoline for DAR and microtransit services. Most vehicles are within their useful life benchmarks as outlined by ICTC.

Figure 4-1: ICTC Fixed Route Bus

Figure 4-2: ICTC Dial-A-Ride Cutaway

Table 4-1: ICTC Current Revenue Service Fleet

In-Service Year	Qty.	Make	Fuel type	ICTC minimum useful life	Current age[9]	Service type
2012	10	Gillig 40-ft. bus	Diesel	10 years	11[10]	Fixed route
2015	6	Gillig 40-ft. bus	Diesel	10 years	8	Fixed route
2015	9	Ford E-450	Gasoline	5 years	8	DAR
2016	7	Ford E-450	Gasoline	5 years	7	Fixed route
2016	20	Ford E-450	Gasoline	5 years	7	DAR
2017	1	Ford E-450	Gasoline	5 years	6	Fixed route
2017	1	Dodge Caravan	Gasoline	5 years	6	DAR
2018	1	Ford E-450	Gasoline	5 years	5	Fixed route
2018	2	Ford Transit van	Gasoline	5 years	5	DAR
2019	1	Ford E-450	Gasoline	5 years	4	Fixed route
2020	1	Ford E-450	Gasoline	5 years	3	Fixed route
2023	4	Minivan[11]	PHEV	5 years	1	Microtransit

4.2 VEHICLE OPERATING CHARACTERISTICS

It is important to understand how ICTC's vehicles are used throughout the day, and specifically when these vehicles are in and out of service. This helps identify constraints and opportunities and informs preliminary fleet mix and energy requirements.

Fixed Route

ICTC inherently has challenges to a ZEV transition because vehicles are kept in operation all day, creating long block lengths. These may be difficult for ZEVs to operate due to potential range limitations, and a lack of time for midday charging or refueling.

[9] Current age determined from model year not in-service year.
[10] Replacements for these vehicles have been ordered and will be delivered late 2023.
[11] These vehicles are owned by the operating company Via.

Figure 4-3: Fixed Route Hourly Weekday Vehicle Requirements

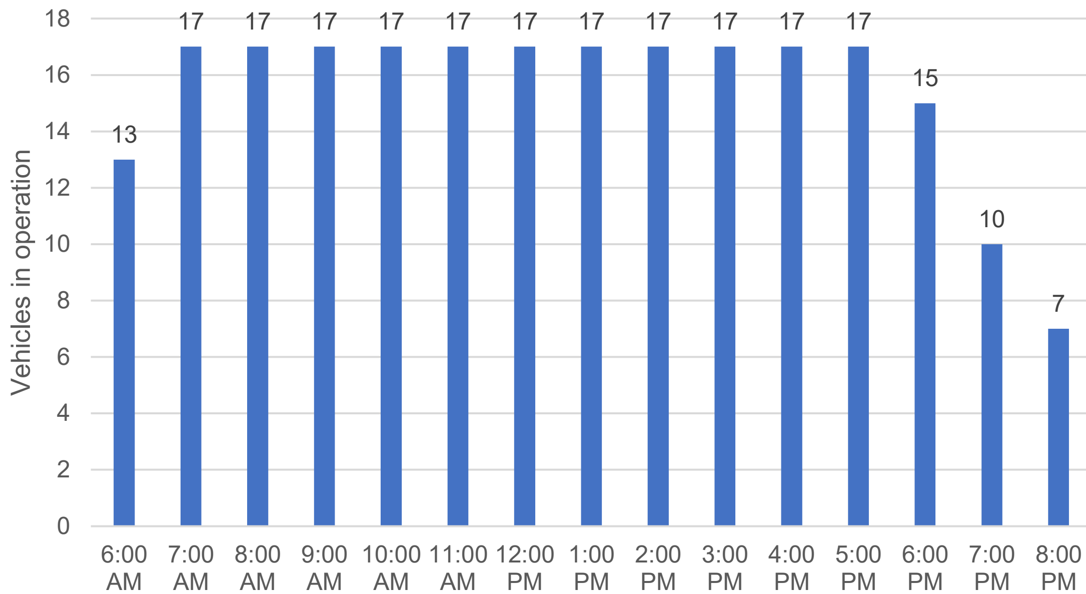
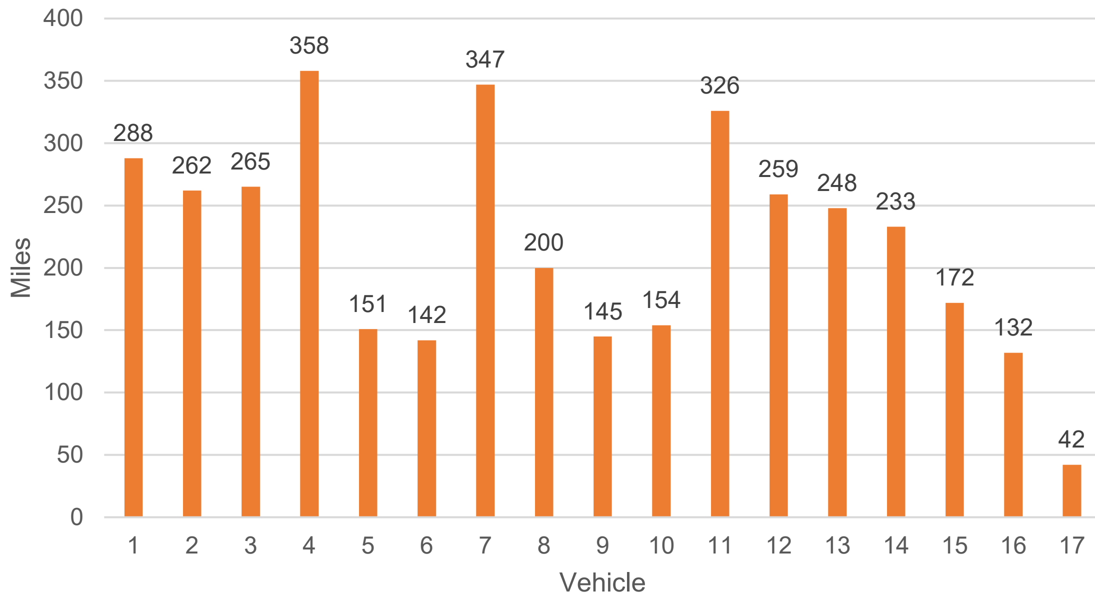


Figure 4-3 shows that ICTC's vehicles are in operation for the majority of the service day (6:00 AM- 6:00 PM), with fewer vehicles being used past 7:00 PM. This could present a challenge for ZEV implementation because vehicles might not have time for midday charging or refueling.

Figure 4-4 shows that vehicles also travel long distances to provide service to ICTC customers throughout the day. This figure shows the distance each vehicle travels on a typical weekday. For example, vehicle 1 travels 288 miles daily, vehicle 2 travels 262 miles daily, and so on. ICTC vehicles are traveling 219 miles on an average weekday with vehicle mileages ranging from a minimum of 42 miles to 358 miles.

Figure 4-4: Fixed Route Daily Vehicle Mileage



Demand Response

ICTC provides DAR and microtransit service using a mix of cutaways and vans. DAR vehicle mileage varies widely as there is no fixed schedule and service is based on demand. Data was analyzed to gain an understanding of the variation of how far the vehicles travel within a day and to ultimately provide a range of expected fuel efficiencies for DAR transitions to ZEVs. Starting and ending odometer readings from 2–3-day periods in April 2023 were provided for IVT ACCESS, IVT MedTrans, and IVT RIDE. Total mileage from January through March 2023 was provided for the Calexico On Demand service.

The average daily vehicle mileages for IVT ACCESS, IVT MedTrans, IVT RIDE, and Calexico On Demand are shown in the graphs below (Figure 4-5, Figure 4-6, Figure 4-7, Figure 4-8). IVT ACCESS shows a minimum average of 100 miles per day, with a maximum of 176 daily miles traveled. IVT MedTrans vehicles traveled further in comparison, with each vehicle traveling approximately 300 miles daily. IVT RIDE vehicles travel about 140 miles per day, and Calexico On Demand vehicles travel between 50 and 150 miles per day. Some vehicles traveled more than the average current operational range of ZEVs, presenting potential range-related issues with ZEV implementation for DAR service.

Figure 4-5: IVT ACCESS Average Daily Vehicle Mileage

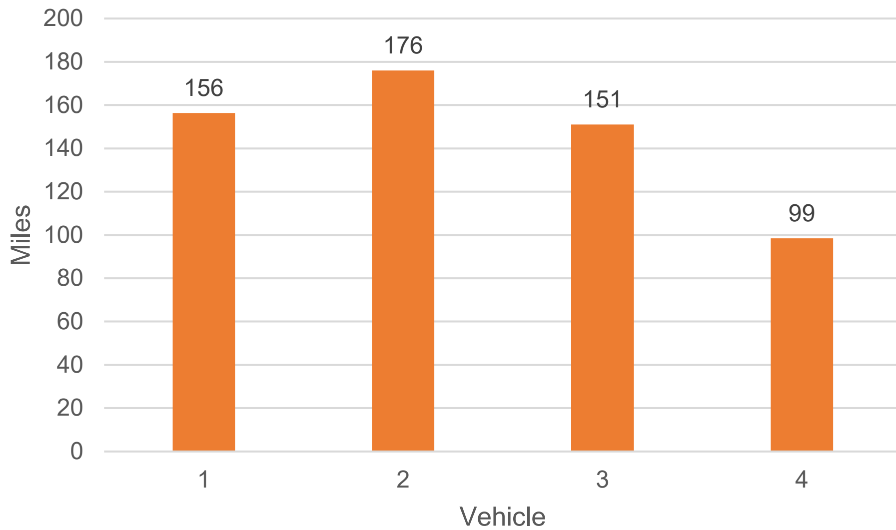


Figure 4-6: IVT MedTrans Average Daily Vehicle Mileage

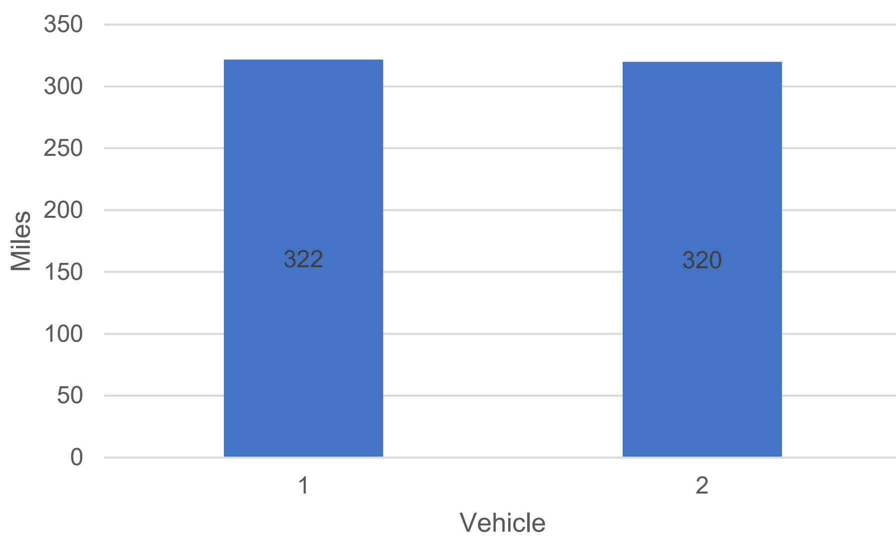


Figure 4-7: IVT RIDE Average Daily Vehicle Mileage

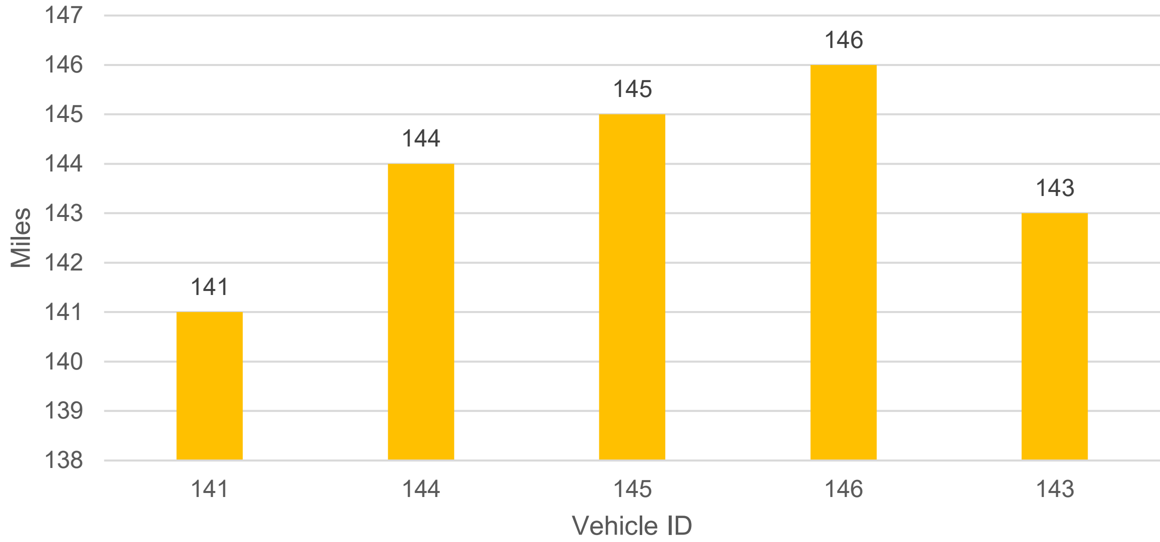
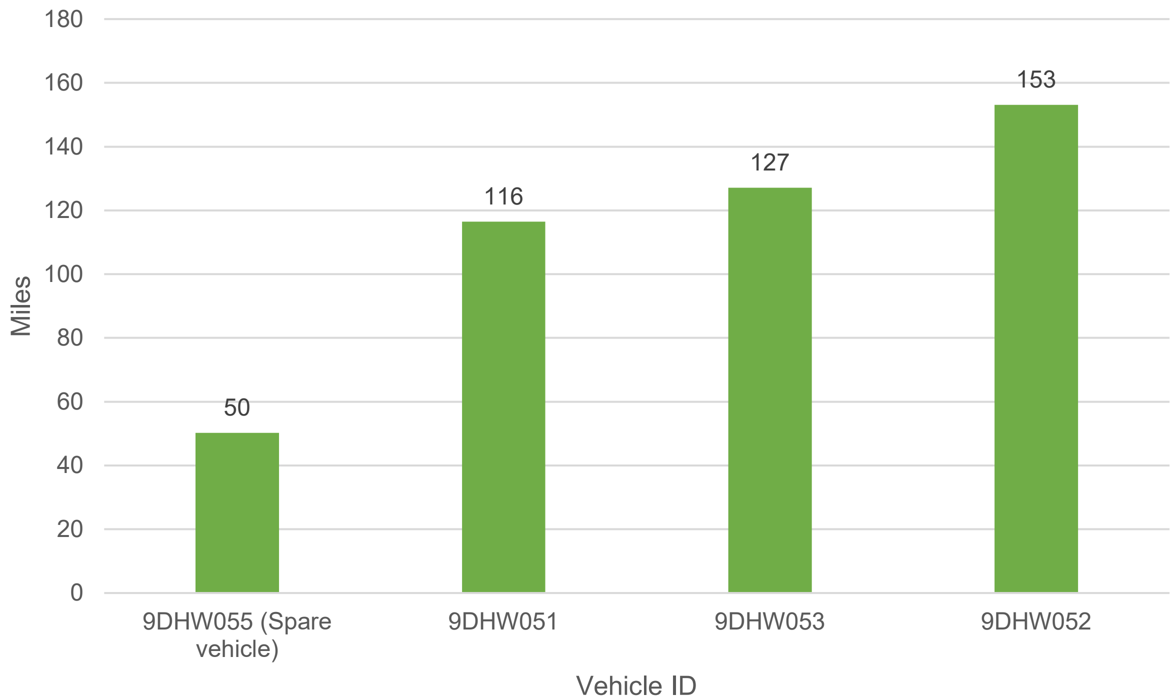


Figure 4-8: Calexico On Demand Average Daily Vehicle Mileage



4.3 FACILITY

ICTC does not own a maintenance facility, but their fleet is maintained in a contracted facility located at 792 Ross Ave, El Centro, CA 92243 (Figure 4-9). This facility occupies a property of the approximately 2.53-acres (110,400 sq. ft.), which houses vehicle service, fleet parking, employee parking, maintenance, and operations. The facility consists of one 40-feet by 100-feet (4,000 sq. ft.) pre-engineered metal building that houses all maintenance and operation functions. The property is partially unpaved on the northern portion of the site with gravel parking and the south side is asphalt pavement. The facility is accessed from one driveway onto Ross Avenue to the south and land-locked on the other three sides.

Figure 4-9: Aerial image of facility (Source: Google Maps)

The physical building is in good to fair condition, but it is very small for the size of ICTC's operations and fleet of vehicles. The maintenance building (Figure 4-10) has three bays used for vehicle maintenance with mobile lifts. An exterior area partially covered with a shade sail on the east side of the building is used for vehicle washing. The shop space is very small with no built-in equipment since the facility is leased and therefore was not purpose-built as a transit vehicle maintenance facility.

Figure 4-10: Exterior wash area with enclosed maintenance bays beyond

There are several significant considerations for implementing FCE vehicles at the current facility:

- **Space**: there is a lack of space for operations and maintenance activities. The site appears to be large enough, but the building is undersized.
- **Gas detection system**: new catalytic-bead sensors and a full gas detection system to detect hydrogen-gas leaks would be required throughout the maintenance portion of the building. This system will require alarm lights, as required by National Fire Protection Association (NFPA) 72 (fire-alarm code), to be installed on both the interior and exterior of the buildings.
- **Hydrogen fueling**: no changes to the current service cycle would be required if a hydrogen fueling station were similarly located offsite, comparable to the unleaded fueling scheme currently in use. An area of roughly 2,500-3,500 sq. ft. should be considered for a hydrogen fueling facility, assuming trucked-in hydrogen is used.
- **Electrical service**: if a hydrogen fueling system was installed onsite, this may also require a new electrical service from the utility to provide 480 V power to the hydrogen compressors and filling equipment.
- **Fire protection**: the NFPA Hydrogen Technologies Code should be applied to any implementation of FCEBs. In addition, early coordination with the local authority having jurisdiction (AHJ) is recommended since more jurisdictions are unfamiliar with hydrogen facilities.
- **Fall protection system**: proper fall protection systems would be required for proper access to the roof of the larger vehicles. ICTC may consider future needs to install ceiling mounted systems in the maintenance bays or rolling access platforms depending on the agency’s preferences.

Importantly, any modifications to this facility would be a financial risk since the property is not owned by ICTC and the investment could be lost if the current maintenance contract ends or changes. Because of this, it is recommended that ICTC purchase its own maintenance facility to mitigate financial risk.

5.0 PREFERRED/RECOMMENDED FLEET COMPOSITION

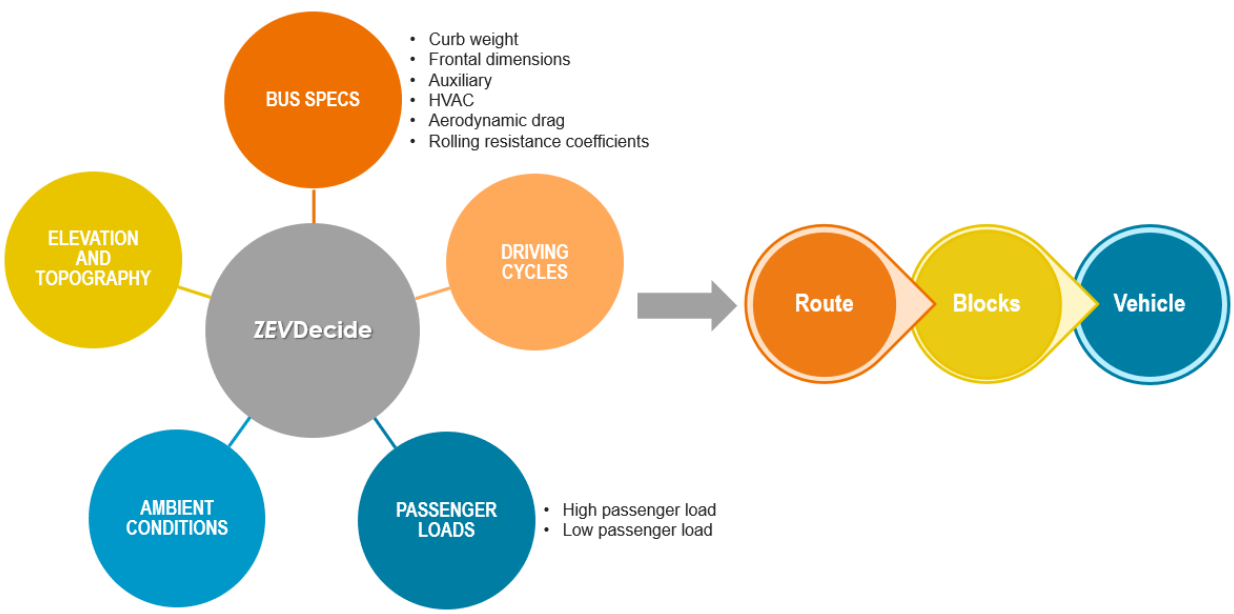
This section describes the modeling and analysis that was used to develop viable fleet concepts and specify a preferred ZEV fleet for rollout planning purposes.

5.1 FLEET AND POWER MODELING OVERVIEW

Energy modeling uses a two-pronged approach to understanding ZEV feasibility using Stantec's modeling tool, ZEVDecide. The two-pronged approach first examines route-level operations, and secondly, examines fuel economy by aggregating route-level outputs to provide block/vehicle level fuel/energy requirements. In this way, Stantec and ICTC will understand how ZEVs perform under ICTC's operating conditions, providing a more realistic estimate of operating range and energy consumption, ultimately informing technology selection.

Figure 5-1 provides a schematic overview of the modeling process. The predictive ZEV performance modeling depends on several inputs, such as actual passenger loads, driving dynamics, topography, vehicle specifications, and ambient conditions subject to the environment in which the agency operates.

Figure 5-1: Modeling Overview

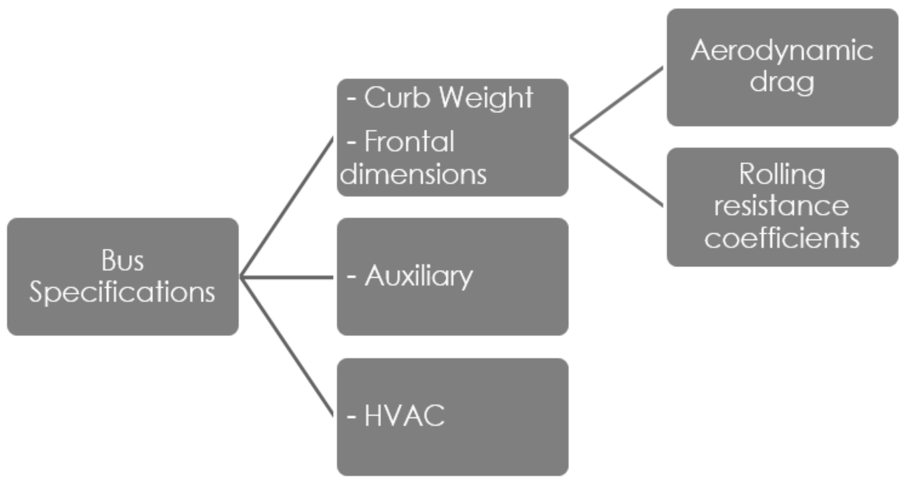


The process for modeling fixed-route services is described first, followed by the modeling process for DAR services.

Fixed Route Modeling Inputs

ZEVDecide's modeling process predicts ZEV drivetrain power requirements specific to given acceleration profiles. One key component to the modeling is the bus design or bus specifications that include curb weight and frontal dimensions (factors needed to account for aerodynamic drag and rolling resistance coefficients), auxiliary, and HVAC (Figure 5-2).

Figure 5-2: Schematic of the Inputs for Bus Specifications



The following inputs are included in the model to determine the feasibility of different ZEV technologies under ICTC's operating conditions.

Bus/vehicle specifications: the key bus specifications used in the modeling process for BE vehicles and FCE vehicles are detailed in Table 5-1 and Table 5-2 respectively. For fixed-route service, buses and cutaways were modeled. It is important to note that on the market today, there are more BE equivalents than FCE equivalents and models and vehicle ranges are limited compared to fossil fuel models.

Table 5-1: BE Vehicle Specifications for Fixed-Route Modeling

	40 ft bus	Cutaway
Photo		
Battery (kWh)	525	127
Curb Weight (lbs.)	45,000	14,500
Service type	Fixed routes: 1N, 1S, 2N, 2S, 21N, 21S, 31D, 32D, 45E, 45W	Fixed routes: 3E, 3W, 4E, 4W, 51N, 51S

Table 5-2: FCE Vehicle Specifications for Fixed-Route Modeling

	40 ft bus	Cutaway[12]
Photo		
Tank (kg)	37.5	13.5

[12] Hydrogen cutaways are not currently commercially available.

Curb Weight (lbs.)	45,000	16,500
Service type	Fixed routes: 1N, 1S, 2N, 2S, 21N, 21S, 31D, 32D, 45E, 45W	Fixed routes: 3E, 3W, 4E, 4W, 51N, 51S

Representative driving cycles: Assigning representative driving cycles, also called acceleration profiles or duty cycles, is the other major step in the energy modeling. A driving cycle is a speed versus time profile that is used to simulate the vehicle performance, and consequently, the energy use. Representative driving cycles were assigned to all routes based on ICTC's operations and observed driving conditions. The driving cycles were created from data collection of real-world operations or from chassis dynamometer tests and have been convened by the National Renewable Energy Laboratory (NREL) in a drive cycle database called DriveCAT. [13]

Passenger loads: As the total weight of a ZEV impacts its performance, it is important to understand and capture passenger loads in the modeling process. To examine the impacts of passenger loads and its associated weight[14], all fixed route blocks were modeled with a high (75% of seated capacity full) and low (25% of seated capacity full) passenger load. This allows for comparison of efficiency and performance between when the vehicle is almost full vs. when the vehicle is almost empty.

Ambient temperature: The ambient temperature has a significant impact on the fuel economy of ZEVs since it is directly related to the power output from the batteries or fuel cells required for the heating, ventilation, and air conditioning (HVAC) system.

Stantec developed a correlation matrix between ambient temperature and power requirements from the HVAC system. For example, moderate daily temperatures (between 55°F and 65°F) can have a nominal power demand on the HVAC system of up to 4 kW. Colder temperatures (below 45°F) or hotter temperatures (above 70°F) can represent more strenuous loads of up to 12 kW.[15]

Topography and elevation: ICTC's service area is influenced by elevation and topography. Therefore, it is important to account for the impacts of terrain and elevation on ZEV energy efficiency and performance.

The first step in the route elevation analysis is to determine the elevation gains and losses seen across ICTC's routes. Furthermore, the total elevation gains will inform the maximum and average grades across each route. From there, an analysis of elevation based on route alignments was undertaken for each route (Table 5-3).

[13] NREL DriveCAT - Chassis Dynamometer Drive Cycles. (2019). National Renewable Energy Laboratory. www.nrel.gov/transportation/drive-cycle-tool
[14] Estimated average passenger weight—170 lbs.
[15] US Climate Data https://www.usclimatedata.com/climate/thousand-oaks/california/united-states/usca1549

Table 5-3: Elevation Analysis

Route	Average slope	Max slope	Weighted average slope
1N	0.3%	2.7%	0.8%
1S	0.3%	2.7%	0.8%
2N	0.2%	3.2%	0.8%
2S	0.2%	3.2%	0.8%
3E	0.3%	3.5%	0.9%
3W	0.3%	3.5%	0.9%
4E	0.3%	1.7%	0.6%
4W	0.3%	1.7%	0.6%
21	0.3%	2.5%	0.9%
22	0.2%	3.8%	0.8%
31	0.3%	2.2%	0.4%
32	0.3%	1.9%	0.4%
41	0.4%	2.1%	0.7%
45	0.5%	2.9%	0.9%
51S	0.6%	4.0%	1.6%
51N	0.6%	4.0%	1.6%
Blue	0.4%	3.4%	0.6%
Gold	0.4%	2.0%	0.7%
Green	0.4%	1.9%	0.4%

Each route shapefile (derived from GTFS data) was uploaded into Google Earth to create an elevation profile to understand the total elevation gains/losses seen for each route in the system. As an example, the elevation profile for Route 15 is shown in Figure 5-3. Additionally, the average and maximum grades for each route were similarly determined using these elevation profiles, which were used as the inputs for the topography analysis.

Figure 5-3: Elevation Profile Example (Route 15)

Source: Google Earth

Fixed Route Modeling Process

Using the inputs above, the first step in modeling is obtaining route-level fuel economy and energy use for the ZEVs using the driving cycles assigned to each route/service type. Then, to account for the impacts of interlining, deadheading, etc., the modeling aggregates route-level results to produce a vehicle-level fuel economy and energy use metric. The process of going from a route to vehicle assignment is outlined in Figure 5-4 and Figure 5-5.

Figure 5-4: Relationship between routes, blocks, and vehicle assignments

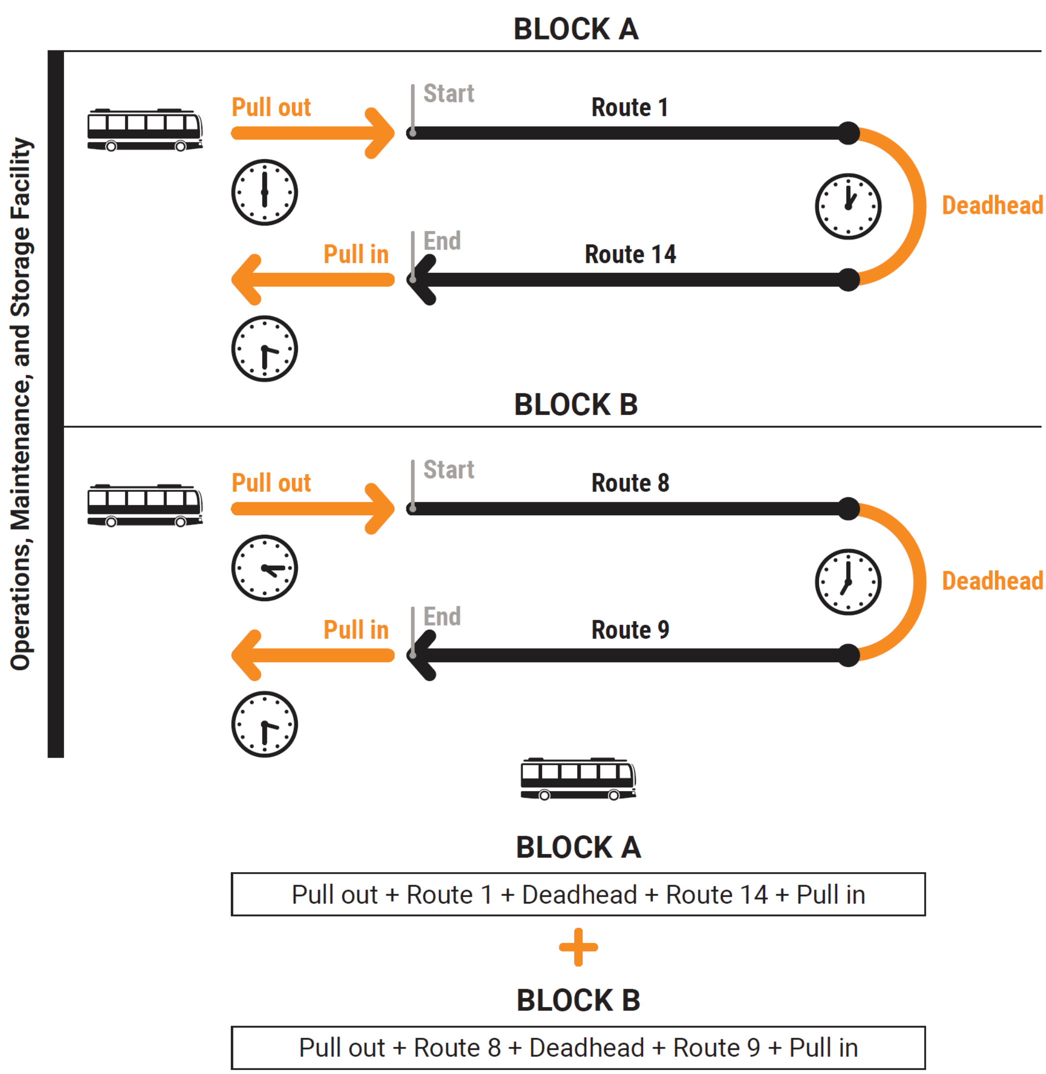
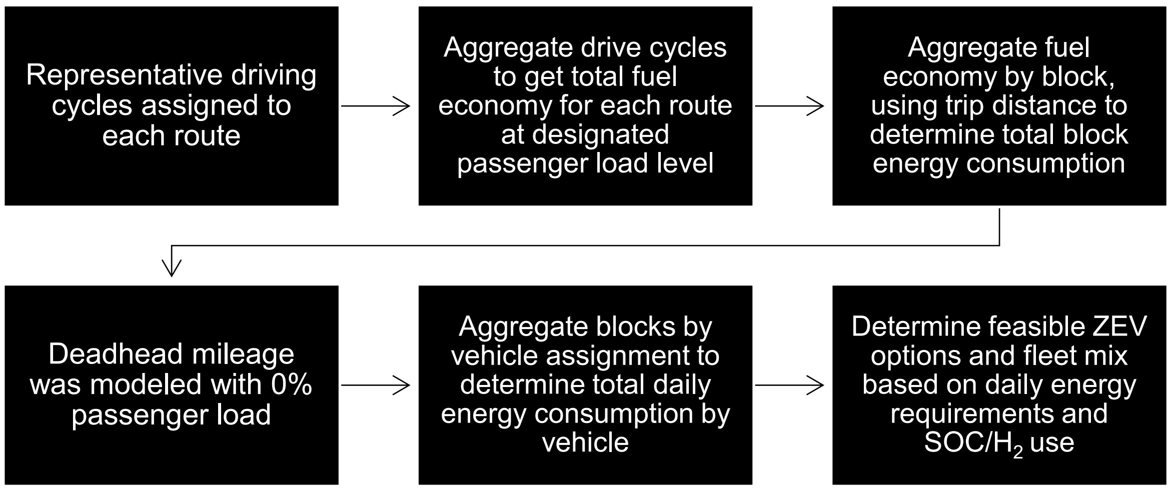


Figure 5-5: ZEVDecide energy modeling process



After the route-level modeling is completed, fuel economies are then aggregated by block using the trip mileage to determine the total energy consumption for each block. Finally, to understand the fuel economy and total daily energy consumption of each vehicle operated on a representative service day, blocks are aggregated at the vehicle level, so that vehicles that are assigned multiple blocks throughout a day are modeled appropriately.

The results of the modeling provide insight into:

- Fuel economy and energy requirements.
- Operating range.
- The feasibility of different ZEV technologies/electrification.
  - For BE vehicles, feasibility is determined through the state of charge (SOC); the vehicle assignment can be successfully completed with a BE vehicle if it can complete its scheduled service with at least 20% battery SOC.
  - For FCE vehicles, if a FCE vehicle consumes less than 95% of its tank capacity, the vehicle assignment is counted as successful.

DAR Modeling Inputs

For ICTC's DAR services, vans and cutaways were modeled in both BE and FCE technologies. The modeled vehicle specifications are outlined in Table 5-4 below. For both classes of vehicles, BE technologies are more common and market ready; in fact, while a FCE passenger van is commercially available, no FCE cutaways are commercially available. The only currently existing FCE cutaway was retrofitted to have its engine removed and outfitted with a hydrogen fuel cell and a small battery, along with a 13-kg hydrogen tank instead of the internal combustion engine as the power train.

Table 5-4: BE Vehicle Specifications for DAR Modeling

	Cutaway	Passenger Van
Photo		
Battery (kWh)	127	118
Curb Weight (lbs.)	14,500	14,330
Service type	IVT RIDE, IVT ACCESS, IVT MedTrans	Calexico On Demand

Table 5-5: FCE Vehicle Specifications for DAR Modeling

	Cutaway[16]	Passenger Van
Photo		
Tank (kg)	13.5	13.5
Curb Weight (lbs.)	16,500	10,360

[16] Hydrogen cutaways are not currently commercially available.

Service type	IVT RIDE, IVT ACCESS, IVT MedTrans	Calexico On Demand

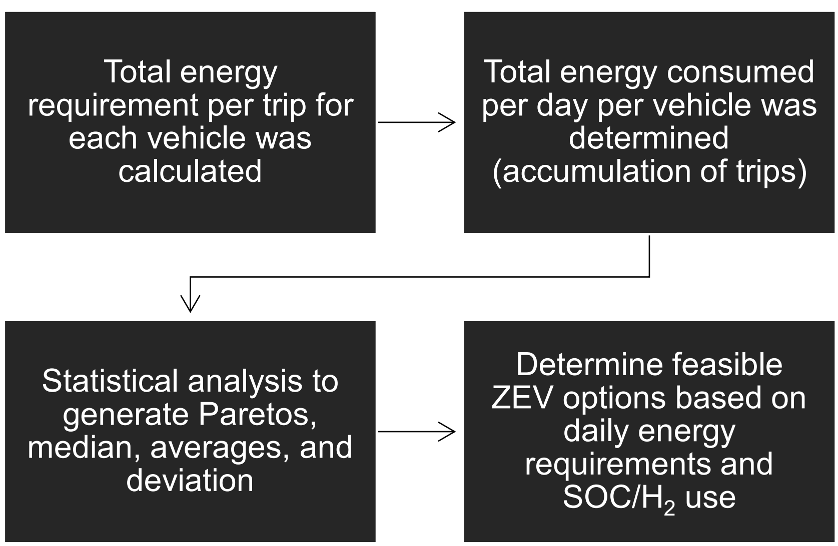
As demand response services do not follow a fixed route and schedule, modeling inputs required adjustment to account for variations in service delivery. Inputs other than the vehicle specifications for the DAR modeling include:

- Passenger load: assumes an average of four passengers onboard.
- Topography and elevation: the methodology does not consider topography directly. Instead, the fuel efficiencies were adjusted according to how topography and elevation impact fixed-route efficiencies.
- Ambient temperatures: consistent with the fixed-route modeling.
- The estimated fuel efficiency is 1.27 kWh/mi for BE vehicles and 13 mi/kg for FCE vehicles.

DAR Modeling Process

The total energy requirement per vehicle was used to calculate the total energy consumed by each vehicle per day. A statistical analysis was conducted on the entire dataset to determine the average fuel efficiency and daily energy use per vehicle to evaluate success levels with the BE or FCE cutaway and van options. Furthermore, the energy requirement of each individual trip was then aggregated at the vehicle level to estimate the total energy consumed by each vehicle per day (Figure 5-6).

Figure 5-6: ZEVDecide Energy Profile Process (DAR services)



The results of the modeling provide insight into:

- Average fuel economy.
- Probability of energy/fuel requirements.
- Probability of operating range.
- The feasibility of different ZEV technologies.
  - For BE vans and cutaways, success is determined through SOC. The vehicle assignment is considered successful when a BE vehicle can complete its scheduled service with at least 20% battery SOC.
  - For hydrogen vans and cutaways, if a vehicle consumes less than 95% of its tank capacity, the vehicle assignment is counted as successful.

5.2 FIXED-ROUTE MODELING RESULTS

Based on the feasibility criteria for the vehicle modeling, 35% of fixed-route services could be electrified when modeled with a 40-ft BEB equipped with a 525-kWh battery pack at both low passenger loads and high passenger loads (Figure 5-7). The main reasons for this low rate of success are due to the long mileages and that vehicles stay out in service most of the day.

Figure 5-7: Fixed Route BE Vehicle Success Rate

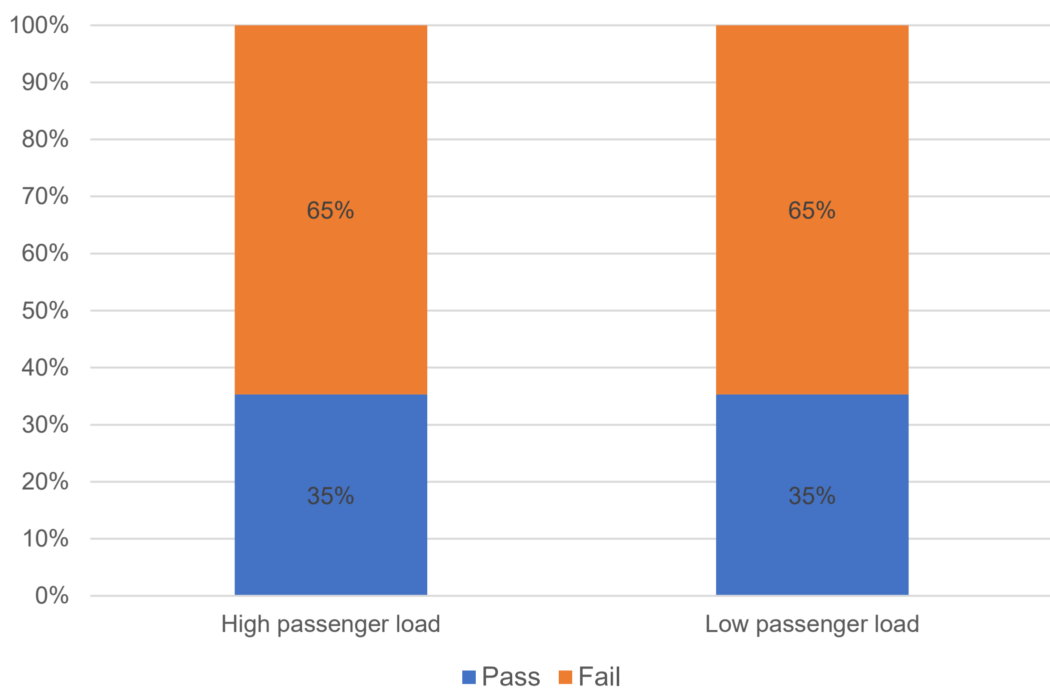


Figure 5-8 demonstrates that FCE vehicles have higher success rates than BE vehicles. With FCE vehicles, 59% of service could be electrified at a high passenger load, and 65% of service could be electrified at a low passenger load. The higher success rates are due to the longer range of FCE vehicles as compared to BE vehicles.

Figure 5-8: Fixed Route FCE Vehicle Success Rate

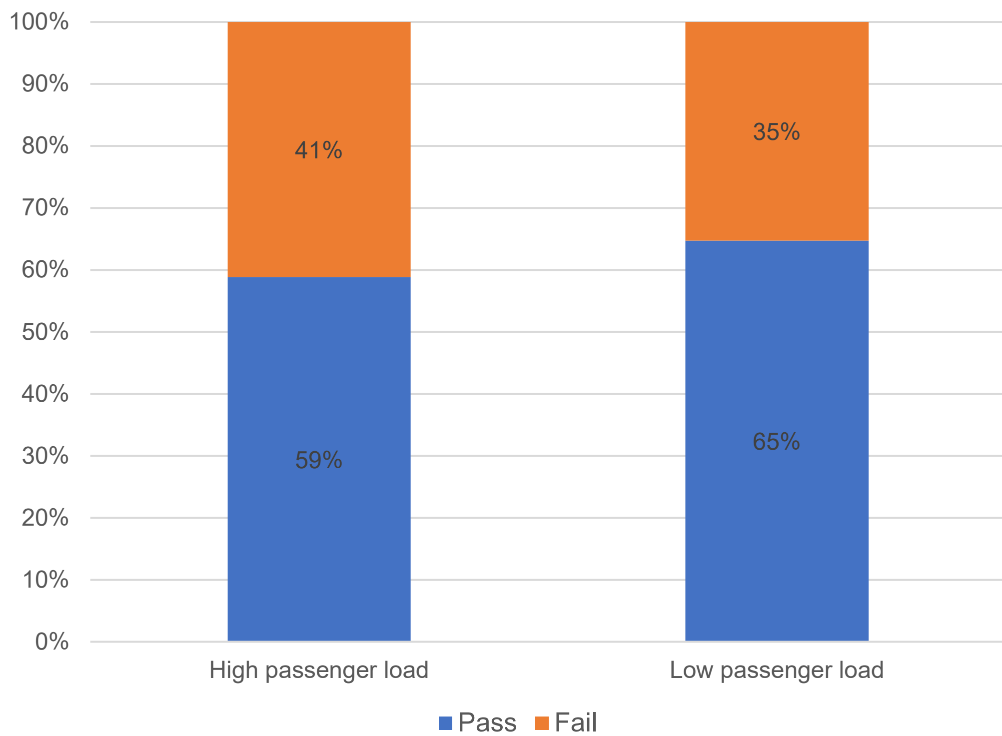


Table 5-6 below summarizes the expected average fuel efficiency and operating ranges for each technology type.

Table 5-6: Average Fuel Efficiency and Expected Ranges for Fixed Route Modeling

Vehicle type	Average fuel efficiency	Est. Maximum Range (mi)
40-ft BEB	2.07 - 2.17 kWh/mi	193 – 203
BE cutaway	1.20 – 1.37 kWh/mi	85 – 97
40-ft FCEB	7.5 – 8.0 mi/kg	254 – 271
FCE cutaway	9.3 – 13.0 mi/kg	120 – 175

While the modeling shows low success rates for BE vehicles and higher success rates for FCE vehicles, elements beyond the modeling need to be considered when deciding which technology to adopt. Further considerations are discussed in Section 5.4.

5.3 DAR MODELING RESULTS

As demand response services do not follow a fixed route and schedule, modeling inputs required adjustment to account for variations in service delivery. Therefore, instead of assigning representative driving cycles or studying a representative day, the model considered the average driving speeds for each individual run. Total daily mileage from 2 – 3-day period odometer readings in April 2023 were modeled for IVT ACCESS, IVT MedTrans, and IVT RIDE. Total daily mileage from January through March 2023 was modeled for the Calexico On Demand service.

Overall, 35% of all DAR services operated could be electrified with BE vehicles at a high or low passenger load. With FCE vehicles, 59% and 65% of service could be electrified at a high passenger load and low passenger load respectively (Figure 5-9).

Figure 5-9: DAR BE and FCE Vehicle Success Rates

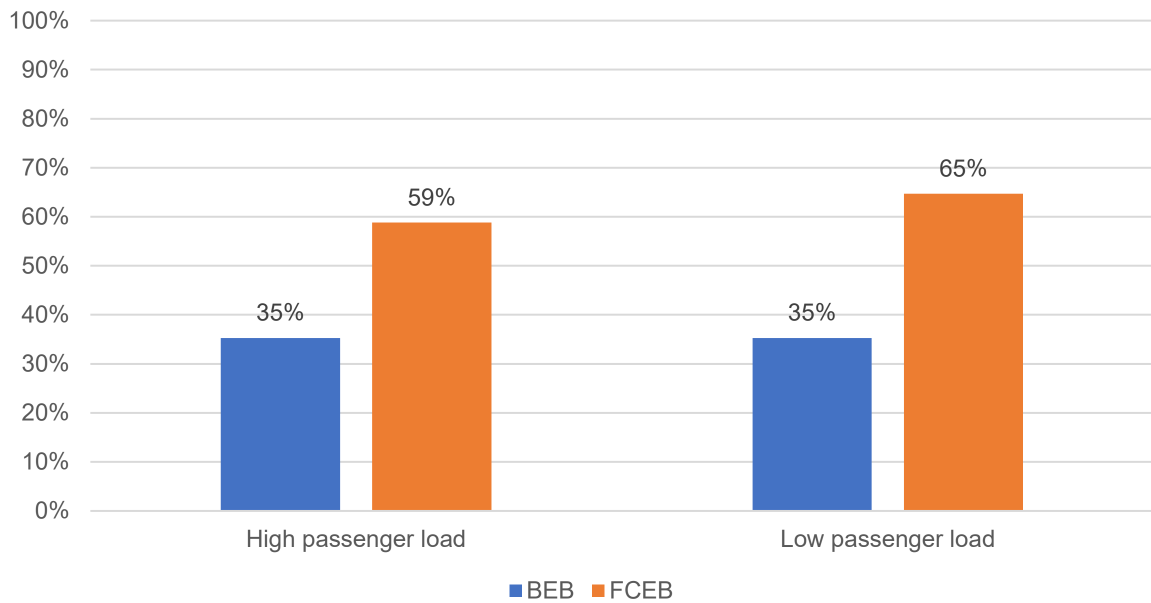
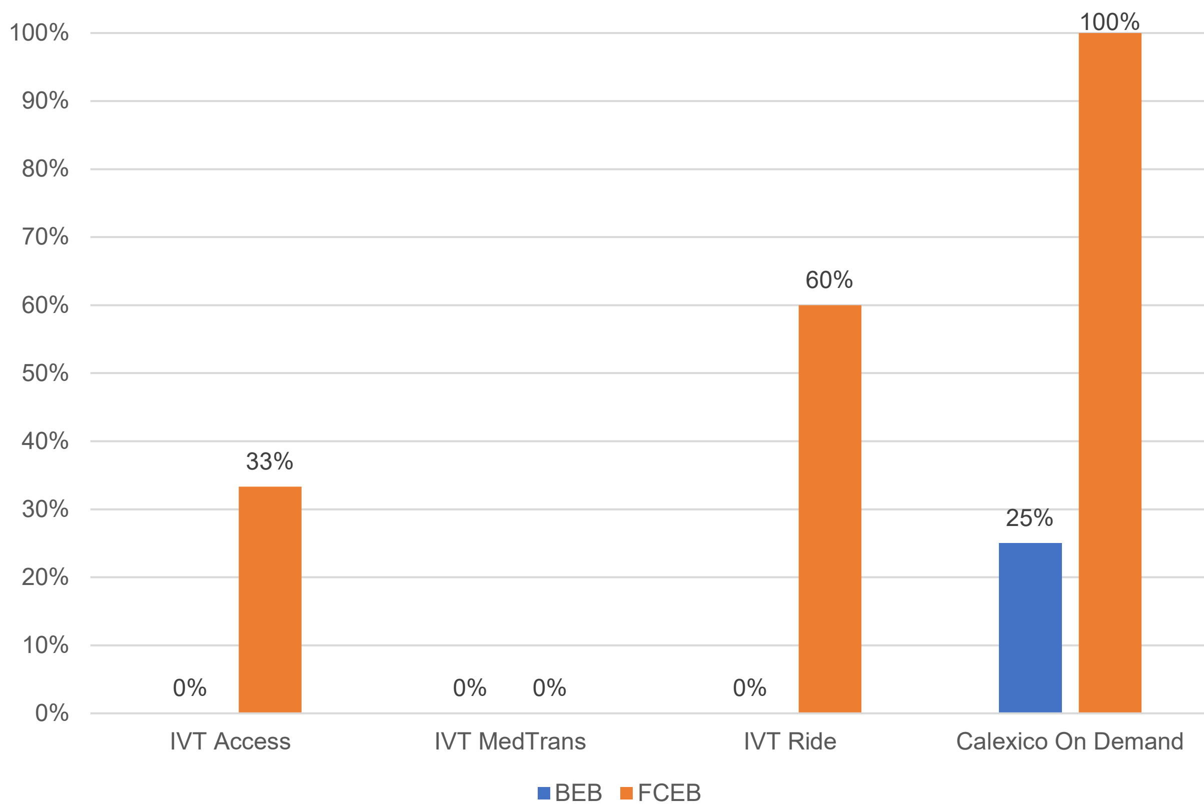


Figure 5-10 shows the success rates of each DAR service with BE and FCE vehicles. Overall, FCE vehicles are more successful than BE vehicles. Thirty-three percent of IVT ACCESS, 60% of IVT RIDE, and 100% of Calexico On Demand service could be successfully electrified with FCE vehicles. Alternatively, 25% of Calexico On Demand service could be successfully electrified, with the remaining services unsuccessful with BE vehicles. IVT MedTrans was not successful with BE nor FCE vehicles.

Figure 5-10: DAR Service Success Rates with BE and FCE Vehicles



5.4 ZE FLEET RECOMMENDATIONS AND IMPLICATIONS

The feasibility of ZEV implementation depends on many factors, including vehicle specifications, elevation, route mileage, climate, and other strategic elements. Based on the modeling results, ICTC has two fleet composition choices to complete the ZEV transition.

BE Vehicle Fleet

One approach is to adopt a full BE vehicle fleet with in-depot overnight and midday charging capabilities. With this approach, ICTC would need to expand its fleet considerably to successfully deliver service given the low success rates of fixed-route and DAR services as modeled with BE vehicles. Table 5-7 shows the requirements needed to successfully deliver service[17]:

[17] Fleet counts only reflect the active fleet, not the total fleet size.

Table 5-7: BE Vehicle Fleet Requirements

Service	Requirements
Fixed Route	• 13 BEBs (includes an additional 3 buses) • 13 BE cutaways (includes an additional 6 cutaways)
DAR	• IVT ACCESS: 17 BE vehicles (includes an additional 8 vehicles) • IVT RIDE: 11 BE vehicles (includes an additional 6 vehicles) • Calexico On Demand: 7 BE vehicles (includes an additional 3 vehicles)
Charging	• In-depot midday and overnight charging

ICTC would need to re-block service and reschedule bus assignments to ensure that BE vehicles are dispatched according to block mileage and duty. Importantly, there would be significant capital costs for the additional vehicles and substantial charging infrastructure.

FCE Vehicle Fleet

The other option is to adopt a fleet of entirely FCE vehicles with midday refueling capabilities. The modeling demonstrated that significantly more of ICTC's fixed route and DAR services could successfully be completed with FCE vehicles. Table 5-8 summarizes the requirements needed to successfully deliver service[18]:

Table 5-8: FCE Vehicle Fleet Requirements

Service	Requirements
Fixed Route	• 10 FCEBs (includes 3 vehicles refueling during the day) • 7 FCE cutaways (5 vehicles refueling during the day)

[18] Ibid.

DAR	• IVT ACCESS: 9 FCE vehicles (6 vehicles refueling during the day) • IVT MedTrans: 4 FCE vehicles (all vehicles refueling during the day) • IVT RIDE: 5 FCE vehicles (2 vehicles refueling during the day) • Calexico On Demand: 4 FCE vehicles
Refueling	• Hydrogen station at a new facility

In this scenario, there would also be significant capital costs due to the greater purchase price for FCE vehicles and the installation of a hydrogen fueling station. Despite the significant capital investment, there are several realities that make a FCE fleet better suited for ICTC's services:

- FCE vehicles would help ICTC meet the needs of its most lengthy and strenuous routes and services due to their longer ranges (as compared to BE vehicles).
- Deploying FCE vehicles for the most challenging routes and services helps to avoid increasing the fleet size and minimizes operational changes like re-blocking.
- Because ICTC plans to move to a different maintenance facility, there is a unique opportunity to find a facility with ample space to install a hydrogen fueling station.
- Hydrogen fueling infrastructure generally has a fixed cost of over $6 million and is better suited to ICTC's large fleet. With a BE vehicle fleet, ICTC would need to install charging infrastructure to account for each vehicle in its expanded fleet, which might outweigh the costs of a hydrogen fueling station.

Therefore, after careful consideration of the modeling results, operational realities, discussions with agency staff and stakeholders, and logistical considerations, Stantec recommends that ICTC transition to a fleet of FCE vehicles.

6.0 FLEET PROCUREMENT PLAN

Based on the preferred fleet concept of an entirely FCE fleet, Stantec developed a procurement plan for transitioning fossil fuel vehicles to ZEVs. Several factors were considered in the development of the procurement plan:

- **CARB requirements**: CARB requires the transition to 100% ZE fleets be completed by 2040. In addition, 100% of new vehicle purchases are required to be ZE starting in 2029. The earliest procurements for a small fleet operator need to take place in 2026 with at least 25% of all purchases being ZEV. However, the transition should avoid the early retirement of any fossil fuel vehicles, so ICTC will begin procuring ZEVs in 2028.

- **Useful life benchmarks (ULB)**: the ULB of ZEVs must be taken into consideration to ensure that vehicles are safe and in good repair. For this analysis, we assumed the following ULBs based on ICTC's fleet replacement practices and preferences (Table 6-1):

Table 6-1: Vehicle ULB Assumptions

Service	Vehicle type	Fuel type	ULB (years)
Fixed route	Heavy duty bus	Fossil fuel	10
Fixed route	Heavy duty bus	ZE	12
Fixed route	Cutaway	Fossil fuel	6
Fixed route	Cutaway	ZE	8
DAR	Cutaway	Fossil fuel	8
DAR	Cutaway	ZE	10
DAR	Van	Fossil fuel	6
DAR	Van	ZE	8
DAR	Van	PHEV	8

- **Service delivery**: It was assumed that approximately 50% of the IVT RIDE cutaways will be replaced with vans to better suit service delivery.

- **Current vehicle procurements**: ICTC is in the process of procuring fossil fuel vehicles to replace current vehicles, with an expected delivery in 2023. The fleet procurement plan assumes the new fossil fuel vehicles as the base fleet and does not consider the older vehicles that are being replaced. This includes:
    - Fixed route
        - 10 diesel heavy duty buses (replacing 2012 Gilligs)
        - 6 gas cutaways (replacing 2016 cutaways)
    - DAR
        - 3 gas cutaways (replacing 2016 cutaways)

- **PHEV classification**: ICTC currently operates four PHEV vans for its Calexico On Demand service. These vehicles were classified as fossil fuel vehicles for the purposes of the fleet procurement plan, as they are not 100% ZE vehicles.

Overall, the total fleet size will remain constant at 63 vehicles across the 2023 – 2040 period, with fossil fuel vehicles gradually being retired and replaced with ZEVs. Consequently, the percentage of the fleet that is made up of ZEVs increases year over year, starting at 8% in 2028 and incrementally increasing to 100% in 2035. ZEV procurements were spread as evenly as possible to avoid purchasing a lot of vehicles in any particular year, while also keeping in mind the ULB of each vehicle type. The overall transition is shown in Figure 6-1.

Figure 6-1: ICTC Fleet Composition & % ZEV

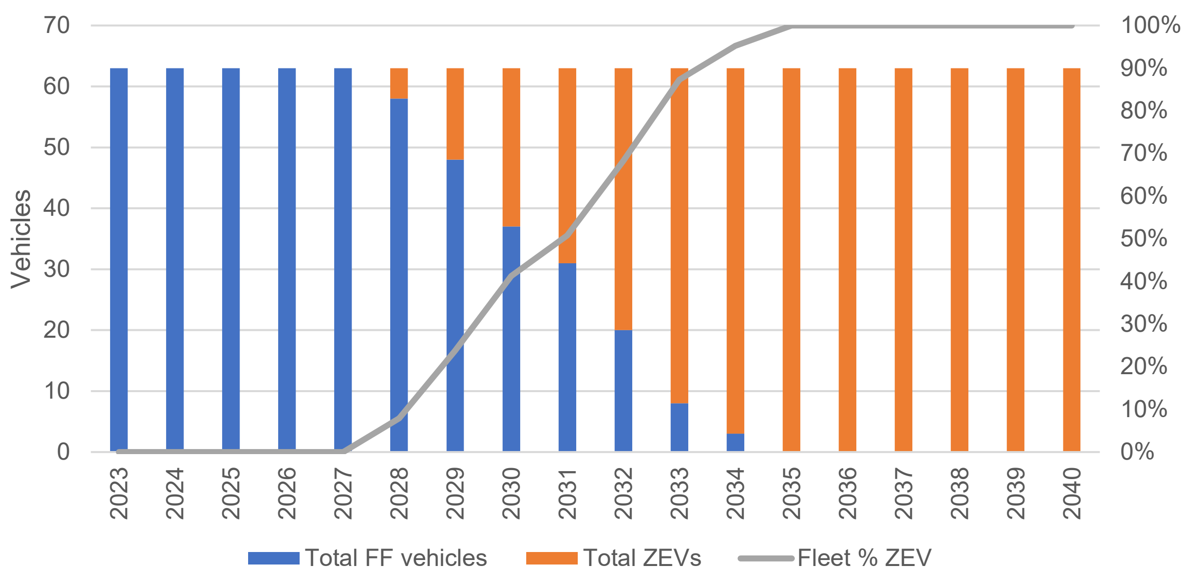


Table 6-2 and Figure 6-2 show the percentage of the fleet that is fossil fuel vehicles vs. FCE vehicles throughout the transition timeline. ICTC's fleet will continue to be 100% fossil fuel vehicles until 2027, and the first ZEV purchases will occur in 2028 with five vehicles. From there, more fossil fuel vehicles will be retired and replaced with ZEVs until 2034. The fleet will achieve a complete transition in 2035.

Table 6-2: ICTC Fleet % ZEV

	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Total vehicles	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63
Total FF vehicles	63	63	63	63	63	58	48	37	31	20	8	3	0	0	0	0	0	0
Total ZEVs	0	0	0	0	0	5	15	26	32	43	55	60	63	63	63	63	63	63
Fleet % FF	100%	100%	100%	100%	100%	92%	76%	59%	49%	32%	13%	5%	0%	0%	0%	0%	0%	0%
Fleet % ZEV	0%	0%	0%	0%	0%	8%	24%	41%	51%	68%	87%	95%	100%	100%	100%	100%	100%	100%

Figure 6-2: ICTC Fleet % ZEV

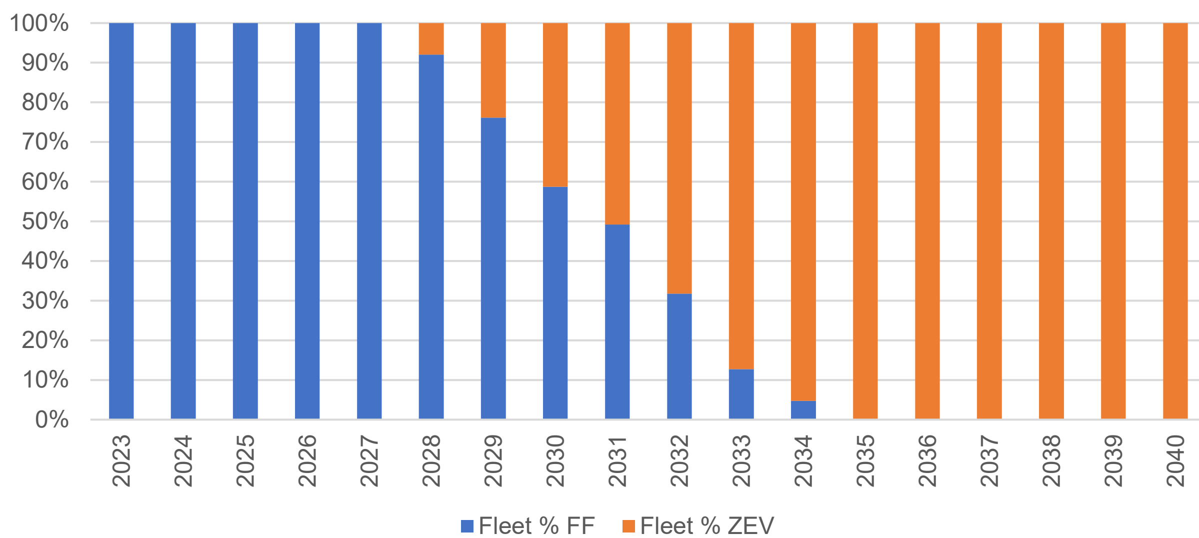


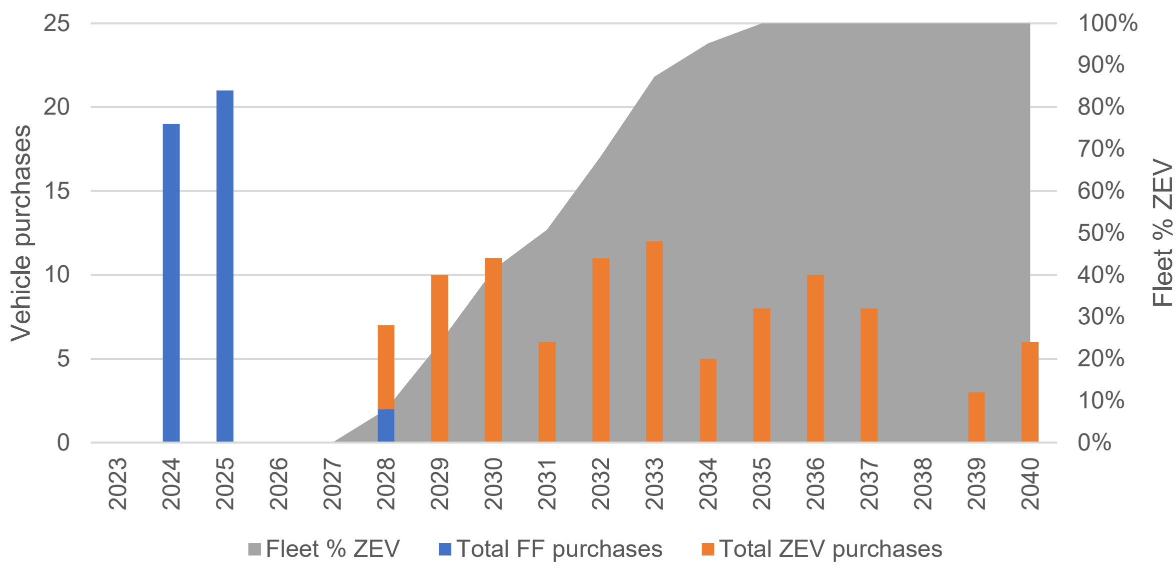
Table 6-3 shows the vehicle purchase schedule for 2023 through 2040. Vehicle purchases will start with fossil fuel vehicles in 2024 and 2025 and the first ZEV purchases will occur in 2028. Starting in 2029, 100% of new vehicle purchases will be ZEVs. This will avoid early retirement of ICTC's fossil fuel vehicles, while also allowing time for the FCE vehicle market to mature and for a wider variety of FCE vehicle types to become available.

Table 6-3: ICTC Vehicle Purchase Schedule

	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Total vehicles	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63
Total purchases	0	19	21	0	0	7	10	11	6	11	12	5	8	10	8	0	3	6
Total retirements	0	-19	-21	0	0	-7	-10	-11	-6	-11	-12	-5	-8	-10	-8	0	-3	-6
Total FF purchases	0	19	21	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Total ZEV purchases	0	0	0	0	0	5	10	11	6	11	12	5	8	10	8	0	3	6
% ZEV Purchases	N/A	0%	0%	N/A	N/A	71%	100%	100%	100%	100%	100%	100%	100%	100%	100%	N/A	100%	100%

To better understand the total vehicle purchases year by year in comparison to the progress of transition, Figure 6-3 shows vehicle purchases with the percentage of the fleet that has transitioned to ZEVs. As shown, 2024 and 2025 will consist of heavier procurements of fossil fuel vehicles. As the transition to ZEVs begins in 2028, vehicle purchases will be distributed more evenly to avoid large procurements in any one year.

Figure 6-3: ICTC Vehicle Purchases vs. Fleet % ZEV

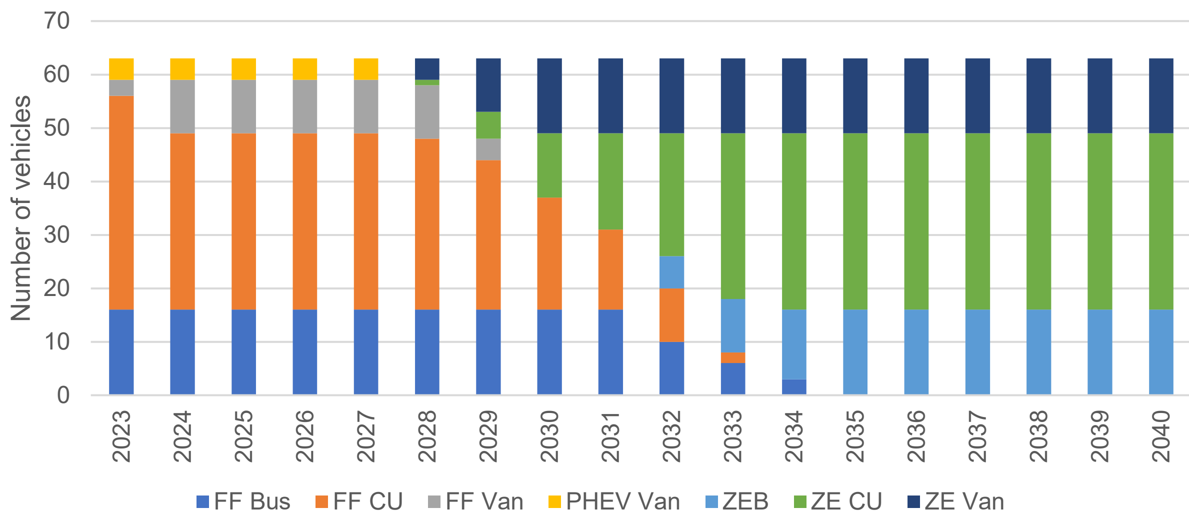


ICTC's fleet composition from 2023 through 2040 is shown in Table 6-4 and displayed graphically in Figure 6-4. The fleet starts as a fossil fuel fleet through 2027 with a mix of heavy-duty buses, cutaways, vans, and PHEV vans. The four PHEV vans along with one fossil fuel cutaway will be retired and replaced with FCE vans and one ZE cutaway in 2028, kicking off the gradual transition to a fleet mix of 100% FCE vehicles composed of heavy-duty buses, cutaways, and vans.

Table 6-4: ICTC Fleet Composition

	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Total vehicles	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63
FF Bus	16	16	16	16	16	16	16	16	16	10	6	3	0	0	0	0	0	0
FF CU	40	33	33	33	33	32	28	21	15	10	2	0	0	0	0	0	0	0
FF Van	3	10	10	10	10	10	4	0	0	0	0	0	0	0	0	0	0	0
PHEV Van	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0
ZEB	0	0	0	0	0	0	0	0	0	6	10	13	16	16	16	16	16	16
ZE CU	0	0	0	0	0	1	5	12	18	23	31	33	33	33	33	33	33	33
ZE Van	0	0	0	0	0	4	10	14	14	14	14	14	14	14	14	14	14	14

Figure 6-4: ICTC Fleet Composition



In addition to vehicle procurement, facility modifications and fueling infrastructure installation was assumed to occur from 2026 to 2027 to prepare for the arrival of the first FCE vehicles in 2028.

The fleet procurement plan shows that ICTC will meet and exceed the CARB-mandated deadlines for ZEV purchases and transitions. Namely:

- ZEV purchases will begin in 2028 to avoid early retirement of fossil fuel vehicles.
- The transition to a 100% ZE fleet will be complete by 2035, well ahead of ICT's deadline of 2040.

It is important to understand that actual procurements will also depend on the ICTC's future competitive funding to finance capital requirements of the transition, as well as supply chain realities related to the delivery of new vehicles.

7.0 HYDROGEN FUEL DEMAND AND SUPPLY

7.1 HYDROGEN DEMAND

After determining a hydrogen-fueled fleet as the best fit for ICTC, the next step was to determine the estimated daily hydrogen demand to fuel the future fleet as well as the best method of supplying hydrogen to the facility. Table 7-1 summarizes estimated hydrogen demand needed at the facility.

Table 7-1: Daily Hydrogen Demand

Item Description	Fixed Route	Demand Response
Daily Active Vehicles	10	7
Average H2 Demand Per Vehicle (kg/day/vehicle)	45.8	25.6
Total H2 Demand for Active Vehicles (kg/day/fleet)	393.1	190.0
Total Estimated H2 Demand (kg/day)	**583.1**	
Monthly Estimated H2 Demand (kg/month)	**17,493.7**	

There are two possible methods for providing hydrogen. Option 1 is to truck in liquified hydrogen to the facility. Option 2 is to produce gaseous hydrogen derived from water electrolysis using onsite solar PV power generation, supplemented by electricity from the grid. Option 1 is the most feasible and least costly. For the near-term implementation of FCE vehicles, it is recommended that ICTC deploy Option 1, similar to most other transit agencies in California.[19] ICTC can explore implementing the hydrolysis concept in Option 2 as a way to generate on-site hydrogen at a later date once the full ZEV transition is complete.

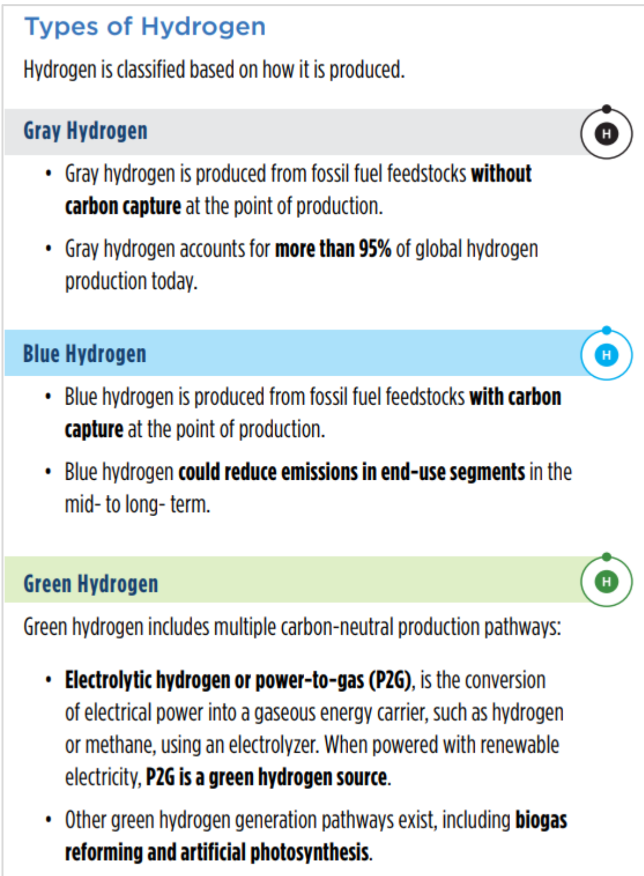
For the purposes of the rollout plan, the remainder of the analysis, recommendations, and strategies are based on the assumption that ICTC will deploy equipment necessary for on-site storage of liquid hydrogen, conversion to gaseous hydrogen, and dispensation of gaseous hydrogen. More information about the equipment required can be found in Section 8.0.

[19] OCTA has recently commissioned hydrogen fueling facility based on trucked-in liquid, and other agencies including Foothill Transit, Santa Clarita Transit and Victor Valley Transit Authority are planning similar systems.

7.2 HYDROGEN SUPPLY

Hydrogen has several pathways to be generated. Figure 7-1 provides an overview of the different hydrogen classifications based on the generation source. Gray, blue, and green hydrogen have different levels of carbon emissions, with green being the ultimate goal because it is carbon neutral.

Figure 7-1: Types of Hydrogen Based on Generation Source[20]



Today, 37% - 44% of hydrogen used in transportation is renewable, but 95% of all hydrogen produced in the United States is made by industrial-scale natural gas reformation (gray hydrogen). This process is called fossil fuel reforming or steam methane reforming (SMR). The process takes natural gas (NG) and steam to generate a product stream of carbon dioxide (CO_2) and hydrogen (H_2). Greenhouse gas emissions can be avoided completely if the CO_2 produced in SMR is captured and stored (blue hydrogen) in a process known as carbon capture and storage (CCS).

As sustainable renewable energy generation advances in the United States, it is anticipated low to zero carbon hydrogen production will become more commonplace. For example, the City of Lancaster,

[20] https://www.energy.ca.gov/sites/default/files/2021-06/CEC_Hydrogen_Fact_Sheet_June_2021_ADA.pdf

California will host and co-own a green hydrogen production facility with SGH2, which will be able to produce up to 11,000 kilograms of green hydrogen per day and 20,000 tons of green hydrogen annually. SGH2 anticipates breaking ground in Q1 2021, start-up and commissioning in Q4 2022, and full operations in 2025.[21][22]

Additionally, Plug Power recently announced it will build the largest green hydrogen production plant on the West Coast. The state-of-the-art production facility in Fresno County in the Central Valley of California will be powered by renewable energy. Once completed, it will produce 30 metric tons of green hydrogen daily and serve customers up and down the West Coast. The facility will use a new 300 MW zero-carbon solar farm to power 120 MW of Plug Power's state-of-the-art PEM electrolyzers. The project includes construction of a new tertiary wastewater treatment plant in the city of Mendota that will provide recycled water for the people of Mendota and supply the full needs of the plant. The plant will break ground in early 2023 and complete commissioning in early 2024.[23]

8.0 MAINTENANCE & FUELING FACILITY REQUIREMENTS

This section outlines the proposed facility requirements for a FCEB implementation. The recommendations below are not specific to the current facility because ICTC plans to construct a new facility.

8.1 PROPOSED FUELING FACILITY

The hydrogen fueling system is designed to support ten 40-ft. FCEBs with each bus averaging a fuel dispensed amount of 25 kg as well as four medium-duty FCE vehicles, adding an average fuel dispensed amount of 13.50 kg per vehicle. The resulting combined daily fuel consumption is 620 kg or approximately 2,720 gallons per day. A 6,000-gallon tank was selected to offer 2.5 days of fuel capacity, reducing the frequency of fuel deliveries needed. While further increasing storage capacity might seem to offer greater resiliency, product loss increases with unused fuel due to "boil-off" or the natural tendency for liquid hydrogen to warm and relieve tank pressure by venting to atmosphere.

The following summarizes the proposed requirements and equipment for the hydrogen fueling system that will serve the ICTC fleet. The conceptual layouts are presented in Figure 8-1, and full site plan details can be found in Appendix A: Site Plans.

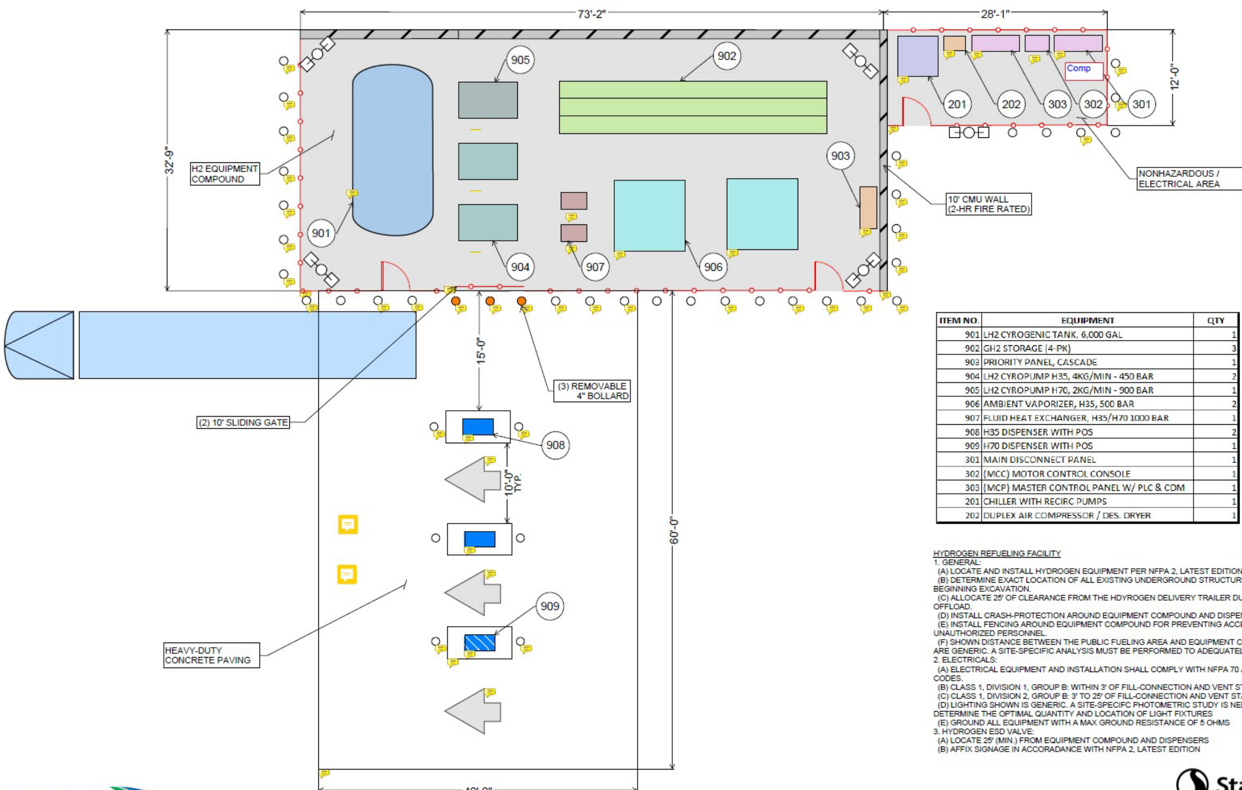
- Hydrogen equipment
    - 6,000 gallon liquified hydrogen cryogenic tank

[21] https://www.sgh2energy.com/worlds-largest-green-hydrogen-project-to-launch-in-california
[22] https://spectrumnews1.com/ca/la-west/environment/2023/01/24/green-hydrogen-plant-in-lancaster-will-be-one-of-ca-s-largest
[23] https://www.globenewswire.com/news-release/2021/09/20/2299650/9619/en/Plug-Power-to-Build-Largest-Green-Hydrogen-Production-Facility-on-the-West-Coast.html

- Reciprocating liquid hydrogen pumps for H35 fueling
- Reciprocating LH2 pump for H70 fueling
- Hydrogen ambient vaporizer (qty: 2)
- Gaseous hydrogen priority valve panel
- High-pressure gaseous hydrogen storage vessels, 500 bar (qty: 8)
- High-pressure gaseous hydrogen storage vessel, 1000 bar (qty: 4)
- Thermal management system; i.e. chiller with recirculating pumps
- Fluid heat-exchanger for H70 fueling
- Hydrogen H35 dispenser, private (qty: 2)
- Hydrogen H70 dispenser, private (qty: 1)
- Duplex air compressor system with dual tower desiccant air dryer
- Main electrical service panelboard
- Motor starter with VFD panelboard for H35 pumps (qty: 3)
- Motor starter with VFD panelboard for H70 pumps (qty: 1)
- Master control panel with PLC, 120VAC power supply, and I/O terminals

- Hydrogen equipment yard site improvements:
  - Perimeter security fencing to separate from other areas. Fencing to include lockable vehicle and pedestrian access gates.
  - Bollards along the vehicle traffic facing sides of the yard.
  - Equipment pads/foundations as required and pavement between all portions of the equipment yard to allow for access and maintenance activities.
  - Site lighting and security cameras in equipment yard as required.
  - Hydrogen gas and flame detection system integrated with site (ESD) emergency shutdown system.
- Electrical system improvements and modifications:
  - A transformer and panelboard to provide adequate power to the new hydrogen equipment.
  - Connection of panelboard to assumed electrical room at the new Fuel Building. Power supply for hydrogen fueling equipment assumed to be backed-up by a generator via electrical connection to switchgear in the Fuel Building.
  - Associated equipment pads, fencing and bollards.
  - CMU fire barrier wall perimeter around new electrical equipment and panels.

Figure 8-1: Conceptual Hydrogen Fueling Equipment Plan



ITEM NO.	EQUIPMENT	QTY
901	LH2 CYROGENIC TANK, 6,000 GAL	1
902	GH2 STORAGE (4-PK)	3
903	PRIORITY PANEL, CASCADE	1
904	LH2 CYROPUMP H35, 4KG/MIN - 450 BAR	2
905	LH2 CYROPUMP H70, 2KG/MIN - 900 BAR	1
906	AMBIENT VAPORIZER, H35, 500 BAR	2
907	FLUID HEAT EXCHANGER, H35/H70 1000 BAR	1
908	H35 DISPENSER WITH POS	2
909	H70 DISPENSER WITH POS	1
301	MAIN DISCONNECT PANEL	1
302	(MCC) MOTOR CONTROL CONSOLE	1
303	(MCP) MASTER CONTROL PANEL W/ PLC & COM	1
201	CHILLER WITH RECIRC PUMPS	1
202	DUPLEX AIR COMPRESSOR / DES. DRYER	1

HYDROGEN REFUELING FACILITY

1. GENERAL:
   (A) LOCATE AND INSTALL HYDROGEN EQUIPMENT PER NFPA 2, LATEST EDITION
   (B) DETERMINE EXACT LOCATION OF ALL EXISTING UNDERGROUND STRUCTURES BEFORE BEGINNING EXCAVATION.
   (C) ALLOCATE 25' OF CLEARANCE FROM THE HDYROGEN DELIVERY TRAILER DURING OFFLOAD.
   (D) INSTALL CRASH-PROTECTION AROUND EQUIPMENT COMPOUND AND DISPENSERS.
   (E) INSTALL FENCING AROUND EQUIPMENT COMPOUND FOR PREVENTING ACCESS FROM UNAUTHORIZED PERSONNEL.
   (F) SHOWN DISTANCE BETWEEN THE PUBLIC FUELING AREA AND EQUIPMENT COMPOUND ARE GENERIC. A SITE-SPECIFIC ANALYSIS MUST BE PERFORMED TO ADEQUATELY SIZE LINES.
2. ELECTRICALS:
   (A) ELECTRICAL EQUIPMENT AND INSTALLATION SHALL COMPLY WITH NFPA 70 AND LOCAL CODES.
   (B) CLASS 1, DIVISION 1, GROUP B: WITHIN 3' OF FILL-CONNECTION AND VENT STACKS.
   (C) CLASS 1, DIVISION 2, GROUP B: 3' TO 25' OF FILL-CONNECTION AND VENT STACKS.
   (D) LIGHTING SHOWN IS GENERIC. A SITE-SPECIFC PHOTOMETRIC STUDY IS NEEDED TO DETERMINE THE OPTIMAL QUANTITY AND LOCATION OF LIGHT FIXTURES
   (E) GROUND ALL EQUIPMENT WITH A MAX GROUND RESISTANCE OF 5 OHMS
3. HYDROGEN ESD VALVE:
   (A) LOCATE 25' (MIN.) FROM EQUIPMENT COMPOUND AND DISPENSERS
   (B) AFFIX SIGNAGE IN ACCORADANCE WITH NFPA 2, LATEST EDITION

Imperial Valley Transit | Conceptual Plan - Hydrogen Fueling Facility | Generic Layout | 04/26/2023

Stantec
801 South Figueroa Street Suite 300
Los Angeles CA 90017

8.2 FIRE PROTECTION CONSIDERATIONS

With the implementation of FCE vehicles, fire protection and life-safety concerns can be significant. The primary code dictating the implementation of hydrogen fueling systems is National Fire Protection Association (NFPA) 2 – Hydrogen Technologies Code. However, since ICTC would be constructing a new facility the requirements for hydrogen-fueled vehicles can easily be included in the design. The impacted building systems, primarily the HVAC and electrical, would also be similarly designed to serve the existing diesel and gasoline vehicles.

The need for enhanced fire protection systems has not been specifically assessed as a part of this study and should be discussed with the local fire marshal and the local building officials to ensure all stakeholders in the approval process understand the proposed systems. Fire truck access to the site and hydrant access at a new facility will be well defined.

8.3 GAS DETECTION SYSTEMS

The maintenance building will need to be equipped with a modern gas leak-detection system that uses infrared sensors for diesel and gasoline, and catalytic-bead sensors for hydrogen. The sensors would be mounted along the ceiling or underside of the structure in any area open to vehicle service and maintenance activities. Maintenance areas will also be required to have carbon monoxide sensors located at personnel height (carbon monoxide is neutrally buoyant in air) since the facility could still potentially service petroleum- fueled vehicles. The system will have a common control panel, but potentially have separate alarm lights as required by NFPA 72 (fire-alarm code) for the different types of gases detected.

The ventilation system that makes the maintenance garage safe for FCE vehicles will need to provide at least five air-changes per hour and will be equipped with explosion-proof and spark-resistance exhaust fans. Explosion-proof conduits, electrical infrastructure, and lighting will be required in any area such as maintenance pits that don’t allow for fixtures and receptacles to be mounted at least 18-inches away from the underside of the ceiling or roof structure.

8.4 BACKUP PLANNING AND RESILIENCY

Planning for resiliency and redundancy is necessary not only to support operations or evacuations during emergencies or other disruptions, but also to ensure if the bus facility loses power, FCEBs can still be operated. This is particularly important given the propensity of blackouts in California, especially as the adoption of ZEVs increases along with the demand on the electrical grid throughout the state that could affect the power to operate the hydrogen station. The facility should be equipped with a backup diesel or natural gas fueled generator for the hydrogen fueling infrastructure to ensure compression and fueling can continue in case of a power outage.

While the above is most pragmatic and direct solution for redundancy and backup, ICTC could also consider solar photovoltaic (PV) equipment to generate off-the-grid electricity to power the hydrogen fueling equipment in addition to the maintenance facility and reduce reliance on utility derived electricity. Solar canopies can easily be implemented above employee parking or on the rooftop of buildings. Canopies could also be installed over bus parking but at a higher cost due to the increased height and structural spans. Paired with a stationary battery energy storage system (BESS), onsite renewable power could significantly reduce dependence on the utility, reduce peak electrical loads, and reduce the agency's overall operational carbon footprint.

While onsite generators and potential solar and battery systems would be ideal solutions for onsite resiliency, ICTC also needs to consider the resiliency of its hydrogen supply. Different hydrogen suppliers will incorporate into their contract contingency plans if there is a disruption to 1) the generation site or 2) the distribution paths (e.g., the truck cannot make it to its destination). Each disruption would have different mitigation measures such as deploying a new truck to make the delivery on the same day or allowing ICTC to purchase hydrogen from a different supplier at the contracted cost. Each situation would be unique and ICTC would need to incorporate mitigation strategies into their supply contract.

8.5 FUELING FACILITY COST ESTIMATE

Table 8-1 provides a breakdown by cost category for the proposed site modifications to transition to hydrogen as an alternative fuel. Mechanical and electrical equipment account for 77% of the cost, with exterior improvements being the next most expensive at 16% of the total cost. In addition to the construction and equipment costs, soft costs related to market factors, contractor fees, insurance, design contingency, and sales tax bring the total estimated cost of the hydrogen fueling system and associated work to $10.3 million. More details can be found in Appendix B: Cost Estimates.

Table 8-1: Hydrogen Fueling Infrastructure Cost Estimate

Cost Category	Total Estimated Cost ($)	Percent of Estimated Cost
General requirements (equipment rental, testing, shipping/freight, design engineering, etc.)	$330,000	5.5%
Existing conditions (selective demolition, etc.)	$25,700	0.4%
Earthwork (excavation, hauling material, trench excavation/backfill, pipe conduit, etc.)	$52,000	0.9%
Exterior improvements (structural foundation for equipment, concrete paving, fences and gates, concrete trench, canopy, etc.)	$964,590	16.0%
Process gas and liquid handling, purification and storage equipment (mechanical equipment, electrical equipment, etc.)	$4,649,955	77.2%
Subtotal	**$6,022,245**	
General conditions, OH & mobilization	$1,053,893	
Contractor's profit	$636,852	
Bonds and insurance	$192,825	
Design contingency	$1,581,163	

Cost Category	Total Estimated Cost ($)	Percent of Estimated Cost
Local sales tax	$901,263	
Grand total	**$10,388,240**	

9.0 NEW OPERATIONS & MAINTENANCE FACILITY

In 2022, ICTC conducted a space needs study to identify an acceptable, long-term location for fleet operations, fleet maintenance, and administrative functions. The space needs program determined a total of 501,100 square feet (11.50 acres) needed for all operations including operational space, site access, yard storage and parking for buses, staff, and visitors.[24]

However, at the time of this study the technology for the ZEV transition had not been determined and did not include a hydrogen yard for an all-FCE fleet. Stantec determined an additional 3,000 square feet will be needed for the hydrogen fueling area, for a total of 504,100 square feet (11.57 acres). Table 9-1 and Table 9-2 summarize the space needs identified in the previous study as well as the additional space needed for the hydrogen fuel yard.

Table 9-1: Summary of Space Requirements by Functional Area

FUNCTION	%	AREA	
		SQ. FT	ACRES
SITE REQUIREMENTS		57,300	1.32
FLEET PARKING		86,000	1.97
EMPLOYEE PARKING		45,000	1.03
PUBLIC PARKING		13,000	0.30
REVENUE CENTER		900	0.02
ICTC/SCAG FACILITY		10,300	0.24
ADMINISTRATION/OPERATIONS BUILDING		8,800	0.20
MAINTENANCE BUILDING		18,100	0.42
FUEL AREA[25]		10,100	0.23
WASH (AUTOMATED WASHER)		4,600	0.11
SUBTOTAL		251,100	5.76
GENERAL CIRCULATION, SETBACKS, SITE ACCESS, AND EASEMENTS (1)	**50%**	**109,000**	**2.50**
SUBTOTAL		**360,100**	**8.27**
LANDSCAPING PER CITY REQUIREMENTS	**15%**	**54,000**	**1.24**
TOTAL PROGRAMMED REQUIREMENTS		**414,100**	**9.51**
ICTC UNPROGRAMMED FUTURE EXPANSION		**87,000**	**2.00**
TOTAL SITE REQUIREMENTS		**504,100**	**11.57**
RANGE OF SITE SIZES		**10 – 12 acres**	

[24] ICTC Administration Building and Bus Maintenance/Operations Test Fit Site Plan Technical Memorandum.
[25] An additional 3,000 sq. ft (.07 acres) was added to account for the hydrogen fuel yard.

Table 9-2: Detailed Summary of Space Requirements by Functional Area

FUNCTION	%	AREA	
		SQ. FT	ACRES
SITE FEATURES			
Hardscape Patio		1,300	0.03
Storm Water Detention		33,000	0.76
Approach, Weave, and Run Out Areas (Fuel and Wash)		23,000	0.53
Subtotal		**57,300**	**1.32**
PARKING			
Fleet Vehicle Parking		86,000	1.97
Employee Parking		45,000	1.03
Public, Handicapped, and Other Parking		13,000	0.30
Subtotal		**144,000**	**3.31**
ICTC FACILITY			
Reception Area		800	0.02
Offices (See Below for SCAG)		3,800	0.09
Conference Rooms		2,800	0.06
Employee Facilities		800	0.02
Common Areas		800	0.02
Technical Support Spaces		400	0.01
Subtotal		**9,400**	0.22
SCAG FACILITY			
Dedicated Spaces		900	0.02
Subtotal		**900**	0.02
SERVICE PROVIDER ADMIN/OPS			
Administration		1,700	0.04
Road Supervisions (All Modes)		600	0.01
Dispatching (All Modes)		900	0.02
Admin Common Areas		2,000	0.05
Driver Facilities (All Modes)		3,300	0.08
Support Spaces		300	0.01
Subtotal		**8,800**	**0.20**
REVENUE CENTER			
Revenue Center Building		900	0.02
Subtotal		**900**	**0.02**
MAINTENANCE BUILDING			
Office Areas		700	0.02
Employee Facilities		600	0.01
Repair/Inspection Bays		11,400	0.26
Repair Shops		1,800	0.04
Shop Floor Storage Areas		1,700	0.04
Parts Storage		900	0.02
Support Areas		1,000	0.02
Subtotal		**18,100**	**0.42**
FUEL AREA			
Fuel Building Offices		700	0.02
Fuel Lanes[26]		9,400	0.22
Subtotal		**10,100**	**0.23**
WASH AREA			
Bays and Equipment Rooms		4,600	0.11
Subtotal		**4,600**	**0.11**
SUBTOTAL		**251,100**	**5.53**
GENERAL CIRCULATION, SETBACKS, SITE ACCESS, AND EASEMENTS (1)	**50%**	**109,000**	**2.50**

[26] Ibid.

FUNCTION	%	AREA	
		SQ. FT	ACRES
SUBTOTAL		360,100	8.27
LANDSCAPING PER CITY REQUIREMENTS	15%	54,000	1.24
TOTAL PROGRAMMED REQUIREMENTS		414,100	9.51
ICTC UNPROGRAMMED FUTURE EXPANSION		87,000	2.00
TOTAL SITE REQUIREMENTS		504,100	11.57

10.0 FINANCIAL EVALUATION AND IMPACTS

The financial evaluation for ICTC's ZEV transition consisted of the modeling of a Base Case and a ZEV Case. The Base Case is the 'business as usual' scenario and assumes the continued use of the current ICTC fleet, including all scheduled vehicle replacements during the 2040 project horizon. The ZEV Case is the scenario in which the fleet is transitioned to 100% FCE vehicles as described in Section 6.0. The Base Case and ZEV Case are used for illustrative purposes to determine the comparative financial impacts of a transition to a ZEV fleet compared to business as usual. This in turn can provide insight into budget and funding requirements for capital and operating costs.

The financial modeling process is comprised of several steps. First, Stantec worked with ICTC to collect all relevant financial data. The data, coupled with industry research, was used to determine the model inputs. After the model inputs were complete, costs were projected year by year through 2040 using a 3% inflation rate where applicable and a 7% discount rate per USDOT guidance. [27] The financial modeling is expressed in year of expenditure, unless noted otherwise.

It is important to understand the inherent limitations of the financial modeling due to assumptions about costs, service levels, operations, asset life cycles, and other factors that are difficult to predict. Additionally, it is important to note the categories modeled are focused on the impacts of a change in propulsion type. They do not account for service delivery costs (such as driver salaries) as these costs would be largely comparable in both scenarios.

10.1 FINANCIAL MODEL INPUTS

The financial model consists of eight main inputs that can largely be divided into fleet and cost information. The fleet inputs include vehicle lifespan/ULB, vehicle mileage, and fuel efficiency. Cost inputs include vehicle purchase costs, vehicle maintenance, fuel, vehicle midlife refurbishments, and facility infrastructure and charging equipment. All inputs and assumptions are described in more detail below.

[27] Benefit Cost Analysis Guidance 2023 Update.pdf (transportation.gov)

Fleet Inputs

Useful Life Benchmarks (ULB)

Both fossil fuel vehicles and ZEVs were assigned ULBs based on data provided by ICTC as well as ZEV industry information. The assumed life cycle for some FCE vehicles is slightly longer than the current fleet's useful life based on industry knowledge and FTA useful life benchmark guidelines. It is important to note that no agency has operated ZEVs for a full life cycle, so actual ULBs are not currently known. However, given the overlap in components such as chassis, doors, etc. between fossil fuel vehicles and ZEVs, it is not unreasonable to assume that ZEVs can have similar useful lives. The ULBs for each vehicle type are summarized in Table 10-1.

Table 10-1: Vehicle Useful Life Benchmarks (ULB)

Vehicle Type	Useful Life Benchmark (years)
Diesel 40-ft. bus	10
Gasoline cutaway (fixed route)	6
Gasoline cutaway (demand response)	8
Gasoline van	6
PHEV van	6
FCE 40-ft. bus	12
FCE cutaway (fixed route)	8
FCE cutaway (demand response)	10
FCE van	8

Vehicle Mileage

Annual average vehicle mileage was calculated using fleet data provided by ICTC. FCE vehicle types were assumed to have the same annual average vehicle mileage as their fossil fuel equivalents. For example, 40-ft. FCEBs were assumed to have the same mileage as 40-ft. diesel buses. A summary of the annual average vehicle mileage is shown in Table 10-2.

Table 10-2: Annual Average Vehicle Mileage by Vehicle Type

Vehicle Type	Annual Average Vehicle Mileage (miles per vehicle per year)
Diesel 40-ft. bus	41,987
Gasoline cutaway (fixed route)	26,894
Gasoline cutaway (demand response)	11,549
Gasoline van	7,573
PHEV van	34,095
FCE 40-ft. bus	41,987
FCE cutaway (fixed route)	26,894

Vehicle Type	Annual Average Vehicle Mileage (miles per vehicle per year)
FCE cutaway (demand response)	11,549
FCE van	7,573

Fuel Efficiency

Average fuel efficiency was calculated using fleet data provided by ICTC as well as the fleet and power modeling conducted by Stantec (Section 5.0). The fuel efficiencies for each vehicle type are shown in Table 10-3.

Table 10-3: Fuel Efficiency by Vehicle Type

Vehicle Type	Fuel Efficiency
Diesel 40-ft. bus	15.00 mi/gallon
Gasoline cutaway (fixed route)	6.65 mi/gallon
Gasoline cutaway (demand response)	5.86 mi/gallon
Gasoline van	4.33 mi/gallon
PHEV van	23.50 mi/gallon
FCE 40-ft. bus	9.87 mi/kg
FCE cutaway (fixed route)	9.66 mi/kg
FCE cutaway (demand response)	13.43 mi/kg
FCE van	13.43 mi/kg

Cost Inputs

Vehicle Purchase Costs

Vehicle purchase costs were determined using cost information provided by ICTC and FCE market research. The capital costs for each vehicle type are summarized in Table 10-4.

Table 10-4: Vehicle Purchase Costs

Vehicle Type	Vehicle Purchase Costs
Diesel 40-ft. bus	$549,199.00
Gasoline cutaway (fixed route)	$152,496.00
Gasoline cutaway (demand response)	$152,496.00
Gasoline van	$66,000.00
PHEV van	$60,000.00

Vehicle Type	Vehicle Purchase Costs
FCE 40-ft. bus	$1,189,906.00
FCE cutaway (fixed route)	$299,856.00
FCE cutaway (demand response)	$299,856.00
FCE van	$237,981.00

Vehicle Maintenance

Fossil fuel vehicle maintenance costs were estimated using data from ICTC. FCE vehicle maintenance costs were assumed to be 10% less than the fossil fuel vehicle equivalents. ZEVs have fewer moving parts compared to internal combustion engines, translating to fewer breakdowns and reduced maintenance. Maintenance costs are expressed in dollars per mile as shown in Table 10-5.

Table 10-5: Vehicle Maintenance Costs

Vehicle Type	Vehicle Maintenance Costs (dollars per mile)
Diesel 40-ft. bus	$1.44
Gasoline cutaway (fixed route)	$1.44
Gasoline cutaway (demand response)	$1.44
Gasoline van	$1.44
PHEV van	$2.53
FCE 40-ft. bus	$1.30
FCE cutaway (fixed route)	$1.30
FCE cutaway (demand response)	$1.30
FCE van	$1.30

Fuel

Fossil fuel costs were determined using data provided by ICTC and are expressed in dollars per gallon. A rate of $0.13 was used for the electricity cost based on information provided by ICTC, expressed in dollars per kWh. Hydrogen costs were assumed to be $8.00 per kg based on comparable agency prices. All fuel types were also forecasted using the US Energy Information Agency (EIA) trends for the respective energy types. [28] The fuel cost inputs are summarized in Table 10-6.

[28] https://www.eia.gov/outlooks

Table 10-6: Fuel Costs

Fuel	Cost
Diesel	$3.80/gallon
Gasoline	$3.80/gallon
Electricity	$0.13/kWh
Hydrogen	$8.00/kg

Midlife Refurbishments and Battery Replacements

Vehicle midlife refurbishment costs were applied to diesel 40-ft. buses and gasoline cutaways, with a cost of $12,154 and $2,989 per refurbishment respectively. The cost was determined using information provided by ICTC. The cost of a battery replacement for FCEBs was assumed to be included in the vehicle purchase price because FCEB warranties commonly include one battery replacement. However, ICTC should review contract and warranty terms to understand expected battery performance and replacement conditions for specific OEMs and vehicles. Gas cutaways, gas vans, PHEV vans, FCE cutaways, and FCE vans were assumed to not have midlife refurbishment costs or battery replacements due to their short ULBs.

Facility Infrastructure and Charging Equipment

Estimates for the facility infrastructure and charging equipment were developed by EQS Consultants. The facility modifications fueling infrastructure installation was assumed to occur from 2026 to 2027 to prepare for the arrival of the first FCE vehicles in 2028 as described in the fleet phasing schedule in Section 6.0.

In addition to equipment, costs include general requirements, existing conditions, concrete, masonry, metals, wood, plastics, composites, thermal and moisture protection, openings, finishes, specialties, equipment, furnishings, special construction, conveying system, fire protection, plumbing, HVAC, electrical, communications, electronic safety and security, earthwork, exterior improvements, process gas and liquid handling, purification, and storage equipment. Additionally, the cost estimate includes general conditions, contractor's profit, bonds and insurance, design contingency, and local sales tax. Costs per year are summarized in Table 10-7, and more information about itemized costs can be found in Appendix B: Cost Estimates.

Table 10-7: Facility Infrastructure and Charging Equipment Costs by Year[29]

Year	Infrastructure & Equipment Costs	Description
2026	$5,194,120.00	General requirements, existing conditions, concrete, masonry, metals, wood, plastics, composites, thermal and moisture protection, openings, finishes, specialties, equipment, furnishings, special construction, conveying system, fire protection, plumbing, HVAC, electrical, communications, electronic safety and security, earthwork, exterior improvements, process gas and liquid handling, purification, storage equipment
2027	$5,194,120.00	General requirements, existing conditions, concrete, masonry, metals, wood, plastics, composites, thermal and moisture protection, openings, finishes, specialties, equipment, furnishings, special construction, conveying system, fire protection, plumbing, HVAC, electrical, communications, electronic safety and security, earthwork, exterior improvements, process gas and liquid handling, purification, storage equipment
Total	**$10,388,240.00**	

10.2 COMPARISON AND OUTCOMES

The cost comparison between the Base Case and the ZEV Case transition scenario is presented in Table 10-8, incorporating both capital (orange) and operating (blue) expenses. The ZEV Case has a total cumulative cost of $80.8M versus $64.2M for the Base Case, a difference of $16.6M or a 26% increase. While the capital cost for vehicle acquisition and infrastructure is higher than the Base Case, the ZEV fleet is expected to save close to $4M in maintenance expenses over the 17-year timeframe.

The financial assessment does not consider any rebates, grants, credits, or other alternative funding mechanisms. Therefore, there may be several opportunities to offset the difference in the price between the Base Case and ZEV Case. Potential funding sources are discussed in Section 14.0.

[29] Costs are expressed in $2023.

Table 10-8: Base Case and ZEV Case Cost Comparison 2023-2040

	Base Case	ZEV Case	Cost difference (ZEV - Base)[30]
Fleet Acquisition	$27,350,000	$39,322,000	$11,972,000
Fleet Refurbishment/Battery Replacement	$241,000	$-	$(241,000)
Fleet Maintenance	$29,626,000	$25,565,000	$(4,061,000)
Fuel/Electricity	$7,018,000	$6,803,000	$(215,000)
Infrastructure	$-	$9,122,000	$9,122,000
Total	$64,235,000	$80,812,000	$16,577,000

Figure 10-1 shows a breakdown of costs between the Base Case and ZEV Case. The procurement of FCE vehicles is $12M more than the Base Case due to the higher purchase price of FCE vehicles compared to fossil fuel vehicles. Additionally, the hydrogen fueling facility represents an added cost of $10,388,240. Lastly, the use of hydrogen represents an economic benefit of $215,000 over the life of the project when compared to the existing diesel and gasoline refueling. These savings are a direct reflection of the improved efficiency that FCE vehicles have with respect to legacy technologies.

[30] Negative values represent savings.

Figure 10-1: Cost Breakdown of Base Case and ZEV Case Scenarios[31]

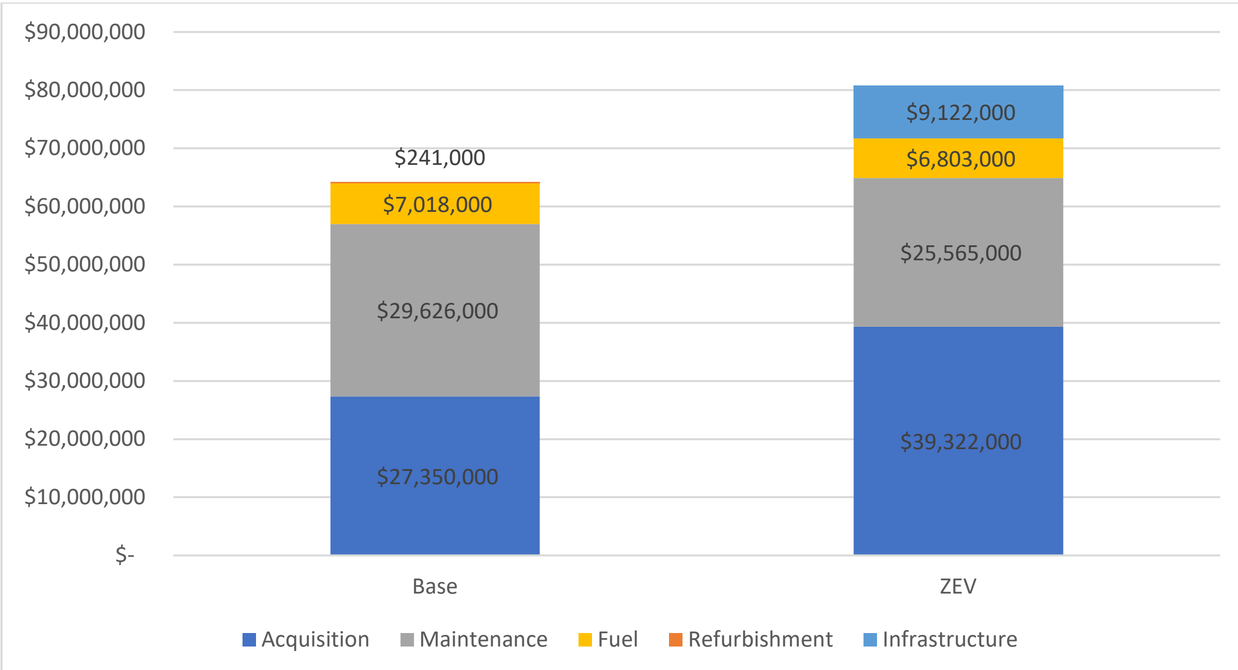
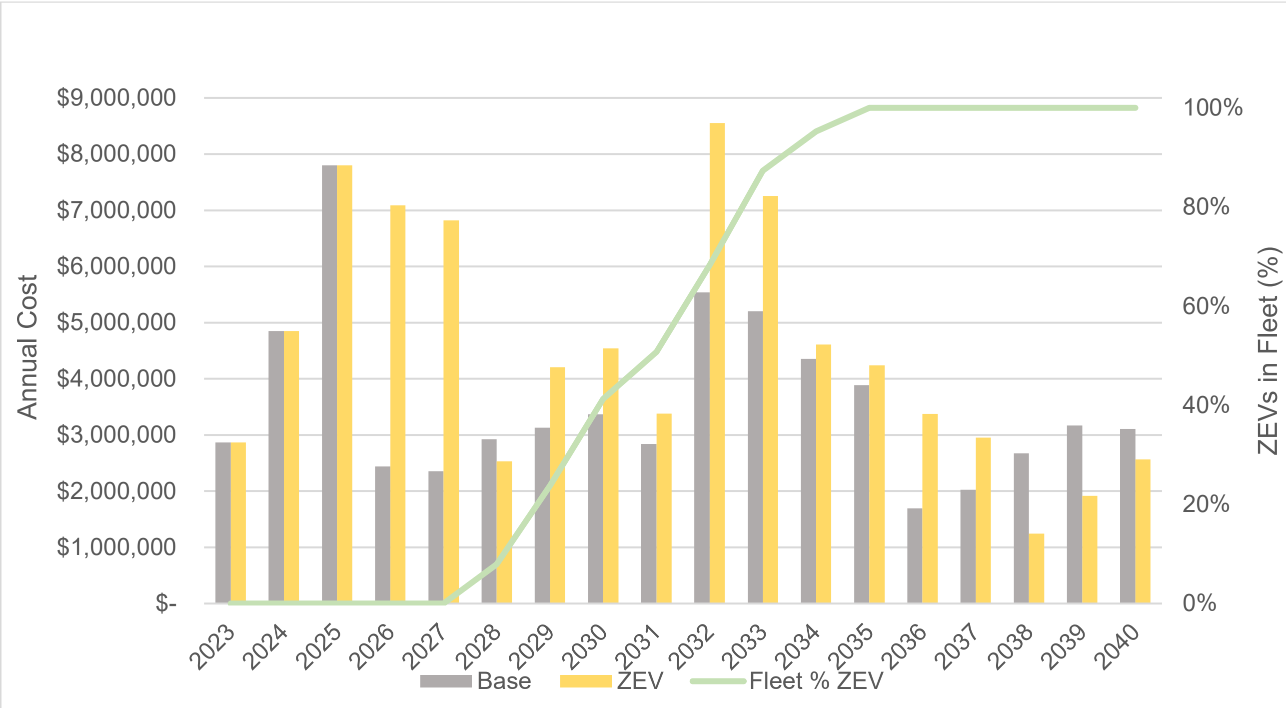


Figure 10-2 shows the year-to-year comparison between the Base Case and the ZEV Case. The higher costs for the ZEV Case occur during the years that facility modifications are conducted and when a greater number of vehicles are purchased.

[31] Includes inflation.

Figure 10-2: Annual Cost Comparison 2023-2040[32]



11.0 OPERATIONAL AND PLANNING CONSIDERATIONS

This section provides guidance and strategies for various operational and planning requirements when implementing FCE vehicles.

11.1 PLANNING, SCHEDULING, AND RUNCUTTING

According to the phasing schedule, the first FCE vehicles will be introduced in 2028, but construction and deployment of a hydrogen fueling station will need to be occur prior to that, preferably at least six months ahead of the acquisition.

FCE vehicles come close to matching the operating ranges of fossil fuel vehicles (200+ miles). ICTC can launch FCE vehicles first on routes/blocks with shorter daily distances to get a feel for range and handling. Next, non-revenue tests should be conducted to establish actual range and fuel economy on longer routes, routes with topography variations, and with simulated passenger loads. This will develop

[32] Ibid.

an understanding of actual driving range and fuel economy, particularly as a function of route operating conditions, ambient temperature, passenger loads, HVAC use, and driver behavior.

Training for the scheduling and planning team will be needed to understand the importance of scheduling FCE vehicles to the correct blocks. Training will also likely be needed in collaboration with ICTC's scheduling software provider to account for hybrid deployments of fossil fuel vehicles and FCE vehicles during the transition period, and finally an entirely-FCE vehicle operation.

It is also important to consider battery capacity degradation. Although battery degradation is not as significant for FCE vehicles as compared to BE vehicles, it should still be factored into planning and deployment because a vehicle may not be able to complete the same planned service at the end of its service life as it was able to upon delivery.[33] Transit agencies can improve battery outcomes through efforts like avoiding extreme temperature exposure and performing regular maintenance on auxiliary systems that consume energy.

Developing specific performance measures, goals, and objectives for FCE vehicle deployment can also help to track FCE vehicle progress and understand if adjustments to the FCE vehicle deployment strategy will be required.

11.2 OPERATOR NEEDS

As FCE vehicles have different components and controls than conventional vehicles, FCE vehicle performance also differs. Operations staff should also be briefed on expected range and limitations of FCE vehicles (such as variability in energy consumption from HVAC under different weather conditions) as well as expected refueling times and procedures. Interaction at the depot should be similar to what is done with the fossil fuel fleet, which is fueled as part of the service line process.

The presence of hydrogen gas and the resulting potential safety issues must be addressed as well as any differences to gauges and instrumentation. A review of technology, unique safety considerations, start-up and shut-down procedures, and procedures for on-route failure should be added to operator training sessions. Finally, ZEVs are much quieter than conventional vehicles. Operators should be aware that pedestrians or people around the vehicle may not be aware of its presence or that it is approaching.

11.3 MAINTENANCE NEEDS

The elimination of the internal combustion engine and powertrain may reduce operating maintenance costs in labor, material, and outsourcing. However, maintenance staff will still need to be trained on safety, scheduled maintenance, diagnostics, and repair of multiple systems that may be new to them. While a smaller high voltage battery installation is present and will require inspection and eventual changeout, the inspection and possible replacement of the hydrogen fuel cell apparatus may be

[33] National Academies of Sciences, Engineering, and Medicine 2020. Guidebook for Deploying Zero-Emission Transit Buses. Washington, DC: The National Academies Press. https://doi.org/10.17226/25842.

necessary. Tanks will have the same ruggedness as fossil fuel products and should fulfill in excess of the heavy-duty bus 12-year service design life cycle.

According to FCE vehicle OEMs, FCE vehicle technicians should receive training on:

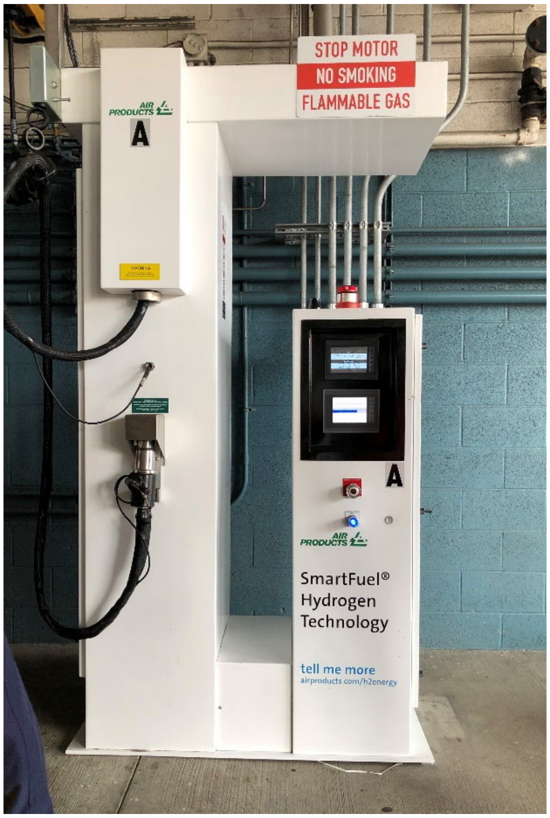
- Hydrogen systems, including fuel cell engine
- Hydrogen fuel system
- Hydrogen detection and fire suppression systems
- Hydrogen cooling system package

Training considerations for operations and maintenance personnel are discussed in greater detail in Section 13.2.

11.4 FUELING NEEDS

Fueling a FCE vehicle is very similar to fueling a traditional fossil fuel bus. Attaching a dispenser nozzle to the vehicle and fueling for approximately 8-12 minutes will yield a full tank. The hydrogen nozzle is completely sealed to the bus while refueling due to the high-pressure delivery method (above 350 bars). The operation of the nozzle and the pump are virtually the same but specific training needs to be provided to staff for safety reasons.

Figure 11-1: Hydrogen Fueling Dispenser at OCTA for Heavy-Duty Transit Buses



Overall, the concept design for the hydrogen fueling station is for two low-pressure dispensers (H35) in the current fueling lanes for 35-ft and 40-ft FCEBs to create a seamless transition to ZEVs by maintaining the current practices around servicing and fueling procedures. Additionally, the design considers one high-pressure dispenser (H70) to refuel FCE vans and cutaways. The pressure difference between H35 and H70 dictates how much hydrogen can be stored in the tanks and is limited by the design specifications of each vehicle. While a van or cutaway could refuel at H35, they would only get half the tank fill capacity. However, a 35-ft or 40-ft bus is unable to fill using a H70 dispenser. Based on the design of the hydrogen infrastructure and the forecasted demand for hydrogen, we estimate that a delivery of hydrogen fuel would be required every 2-3 days to replenish the storage tank.

11.5 O&M CONTRACTOR PROCUREMENT GUIDANCE

Like many transit agencies throughout the country, ICTC's bus operations and vehicle maintenance are handled by a third-party contractor. The operations and maintenance (O&M) contractor provides an all-inclusive billing rate for operations based on scheduled vehicle hours, with a fixed monthly fee for a set contract term, with option rates for additional terms.

Based on this service delivery model, any savings resulting from a ZEV transition (such as reduced vehicle maintenance) would flow to the O&M contractor. Because of this, Stantec recommends that future procurement documents stipulate language for conditions to revisit the contracted rate once a certain portion of the fleet is transitioned to ZEVs. This will ensure that protections are built so that than any cost savings realized by the O&M contractor is passed on to ICTC. Example language from a procurement document drafted by Stantec is shown below:

> *The Contractor acknowledges that, as of the Commencement Date, the County's fleet comprises the Buses listed in Appendix E to the SOP and includes **[XX] Electric Buses**. The Contractor further acknowledges that the City intends to increase the number of Electric Buses available for Service and the Contractor shall cooperate fully with the City in the transition from CNG to Electric Buses, in accordance with the terms of this Contract and the SOP.*
>
> *…*
>
> *The Contractor shall support the City during the transition from a fossil fuel fleet to a zero-emission fleet. If the City transitions greater than **35 percent (35%)** of the fleet to zero-emission buses, the **City may request the Contractor to review the Hourly (or per Mile) Rate to identify reductions associated with zero-emission vehicle maintenance programs and requirements**. Within thirty (30) days of receipt of the request from the City, the Contractor shall submit a proposal setting out the proposed new Hourly (or per Mile) Rate.*

11.6 VEHICLE PROCUREMENT GUIDANCE

Currently, ICTC operates a fleet of heavy-duty transit buses, cutaways, and vans, and this same fleet composition will be carried over through the ZEV transition. Current FCE options for these vehicle types are limited, which also limits procurement options. Example vehicles are summarized in Table 11-1.

For heavy-duty transit bus options, New Flyer manufactures 40-ft. and 60-ft. models with a range of 370 miles. In addition, El Dorado National offers a 40-ft. model in a variety of floorplans.

There are no commercial FCE cutaways currently available. However, US Hybrid has successfully converted two 2014 gasoline El Dorado Aero Elite cutaways for the Hawai'i Mass Transit Agency (MTA). These vehicles use a 40-kW hydrogen fuel cell and a proprietary electric drive system,[34] and have an expected range of approximately 100 miles.[35]

There is one FCE passenger van model from US Hybrid that has a range of approximately 250 miles. Stark Area Regional Transit Authority (SARTA) operates five FCE vans for its paratransit services.[36]

[34] https://www.ushybrid.com/press-release/hawaiis-first-hydrogen-bus/
[35] https://investors.ideanomics.com/2022-04-18-Hawaii-Countys-Hele-On-to-Operate-the-States-First-Hydrogen-Bus
[36] https://www.sartaonline.com/our-fleet-the-environment/hydrogen-fuel-cell/

Table 11-1: Summary of FCE Vehicle Options

Vehicle type	Make and model	Tank size (kg)	Range (miles)	Notes	Example photos
FCEB[37]	New Flyer Xcelsior CHARGE FC (XHE Model)	37.5 kg	370	40-ft. and 60-ft. buses are available.	
FCEB[38]	El Dorado National Axess EVO-FC	Unknown	400		
FCE cutaway[39]	US Hybrid repower of El Dorado Aero Elite cutaway	Unknown	100	Not commercially available and based on a repower of a gasoline-powered cutaway.	
FCE van[40]	US Hybrid by Ideanomics Ford Transit 350 HD	Unknown	250	Supports 350 bar fueling.	

ICTC should develop a competitive tendering process for its fleet procurement and use programs like the CalACT/MBTA Purchasing Cooperative to streamline procurement. ICTC should also leverage APTA's

[37] https://www.newflyer.com/bus/xcelsior-charge-fc/
[38] https://www.eldorado-ca.com/axess-evo-fc#:~:text=The%20Axess%20EVO%2DFC%20is,Systems%C2%AE%20industry%20proven%20powertrain.
[39] https://investors.ideanomics.com/2022-04-18-Hawaii-Countys-Hele-On-to-Operate-the-States-First-Hydrogen-Bus
[40] USH_CaseStudies_SARTAVan_2022_DIGITAL.pdf (ushybrid.com)

Standard Bus Procurement Request for Proposal which contains language about fueling specifications, data logging and telematics, and other information that would be useful to include for vehicle and infrastructure procurements.[41]

11.7 BATTERY/FUEL STACK DEGRADATION

For FCE vehicles, battery degradation is unlikely to be a concern because the battery packs are smaller than BE vehicles. The fuel cell stack for larger heavy-duty buses that have 12+ years of expected life can be refurbished. For smaller vehicles with shorter lifespans, a fuel cell stack replacement is unlikely. ICTC will need to work with vehicle manufacturers to understand warranty terms and potential replacement policies.

12.0 TECHNOLOGY

Technology for ZEVs will help ICTC manage the fleet and its investment into zero-emission propulsion. Fleet tracking software, also known as telematics, will track useful analytics related to the fleet and operations to help ICTC make informed decisions.

12.1 FLEET TRACKING SOFTWARE AND TELEMATICS

Software like Fleetwatch provide agencies with the ability to track vehicle mileage, work orders, fleet maintenance, consumables, and other items. With more complex technologies like ZEVs, it becomes crucial to monitor the status of vehicle batteries and fuel consumption to track performance and understand how to improve fuel efficiency. Many OEMs offer fleet tracking software. Tracking fuel consumption and fuel economy will start to form important key performance metrics for fleet management as well as help inform operations planning.

New Flyer's tool New Flyer Connect 360 is shown in Figure 12-1, and Lightning eMotor's dashboard is shown in Figure 12-2. Other OEMs such as ViriCiti also offer similar tools.

Figure 12-1: New Flyer Connect 360.[42]

[41] https://www.apta.com/research-technical-resources/standards/procurement/apta-bts-bpg-gl-001-13/
[42] https://www.newflyer.com/tools/new-flyer-connect/

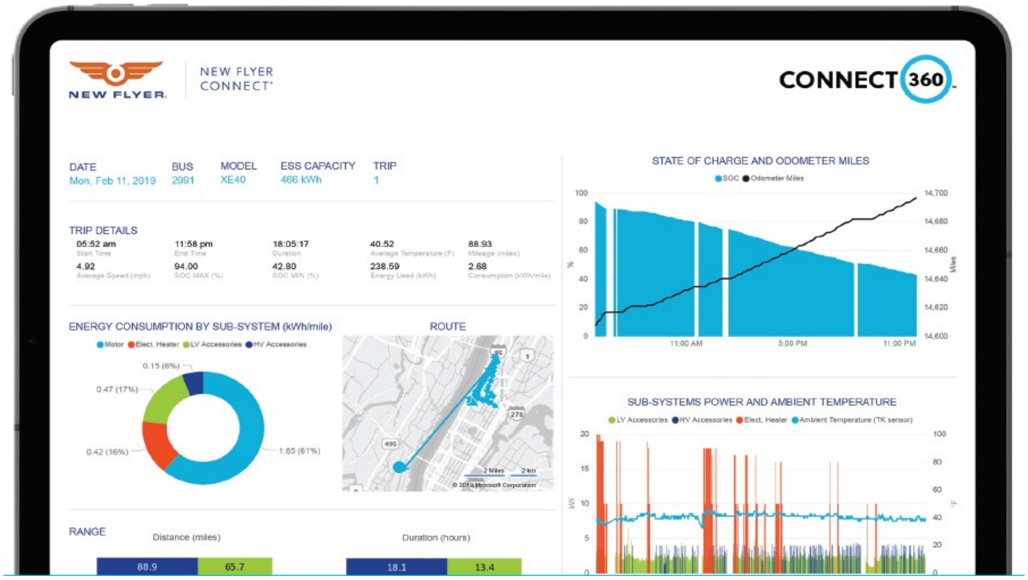
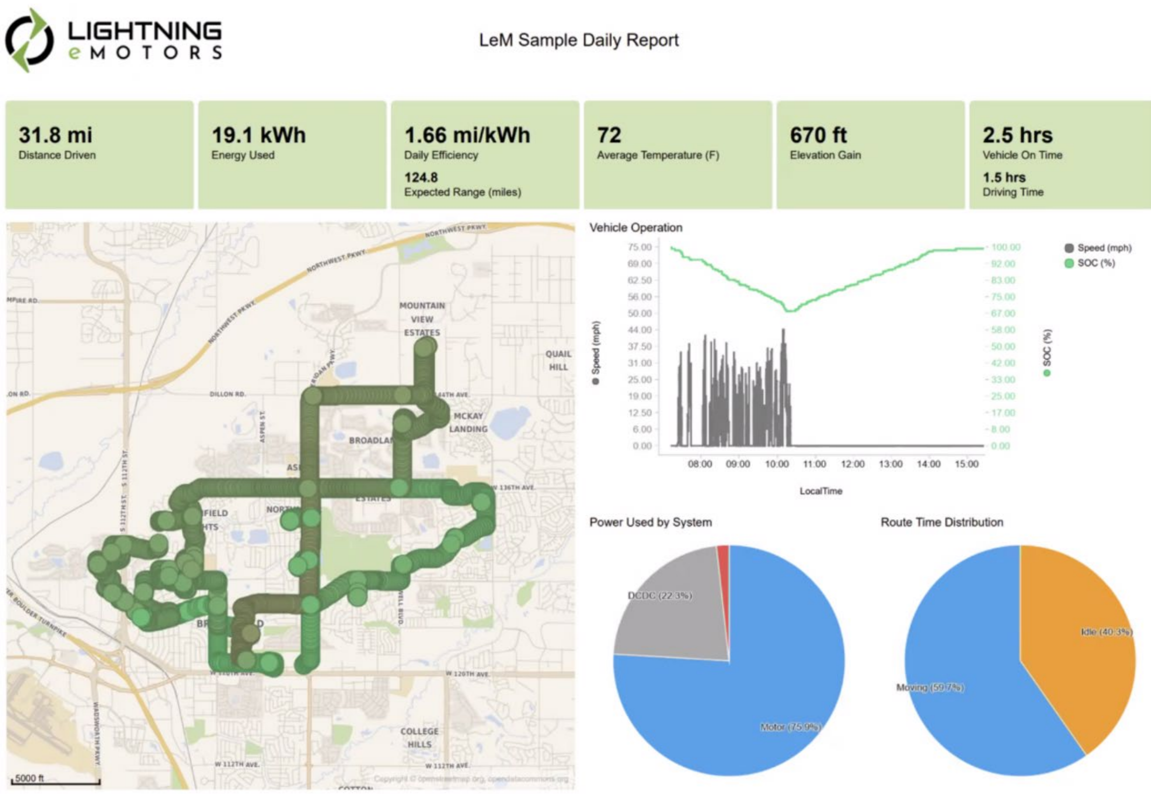

NEW FLYER
NEW FLYER CONNECT
CONNECT 360
DATE
Mon, Feb 11, 2019
BUS
2991
MODEL
XE40
ESS CAPACITY
466 kWh
TRIP
1
TRIP DETAILS
05:52 am
Start Time
11:58 pm
End Time
18:05:17
Duration
40.52
Average Temperature (F)
88.93
Mileage (miles)
4.92
Average Speed (mph)
94.00
SOC MAX (%)
42.80
SOC MIN (%)
238.59
Energy Used (kWh)
2.68
Consumption (kWh/mile)
ENERGY CONSUMPTION BY SUB-SYSTEM (kWh/mile)
Motor
Elect. Heater
LV Accessories
HV Accessories
0.15 (6%)
0.47 (17%)
0.42 (16%)
1.65 (61%)
ROUTE
2 Miles
2 km
© 2019 Microsoft Corporation
RANGE
Distance (miles)
88.9
65.7
Duration (hours)
18.1
13.4
STATE OF CHARGE AND ODOMETER MILES
SOC
Odometer Miles
11:00 AM
5:00 PM
11:00 PM
Miles
SUB-SYSTEMS POWER AND AMBIENT TEMPERATURE
LV Accessories
HV Accessories
Elect. Heater
Ambient Temperature (TK sensor)
kW
°F

Figure 12-2: Example of Lighting eMotors Daily Report Summary



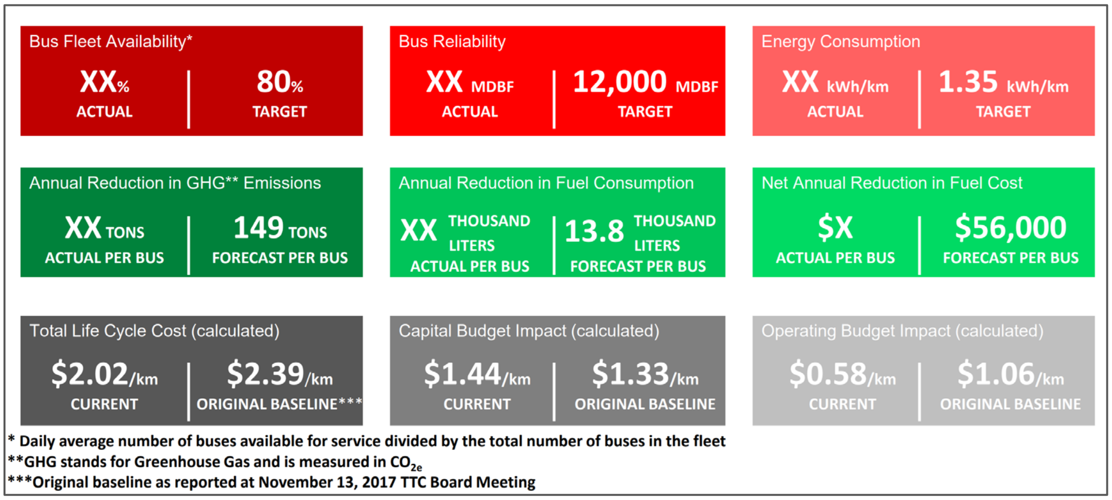
At a minimum, the fleet tracking software should track a vehicle's energy consumption, distance traveled, and hours online. Tracking these key performance indicators (KPIs) can help compare a vehicle's performance on different routes, under different ambient conditions, and even by different operators.

As ICTC transitions from a fossil fuel fleet to ZEV fleet, it will be important to collect and compare data between the fleet types to understand the benefits and costs of the transition. KPIs can include:

- ZEV vs. non-ZEV miles traveled
- ZEV vs. non-ZEV maintenance cost per mile
- ZEV vs. non-ZEV fuel/energy costs by month
- ZEV vs. non-ZEV fuel/energy cost per mile
- Average fuel consumption/fuel economy per month
- Total ZEV vs. non-ZEV fuel and maintenance costs per month
- Mean distance between failures
- ZEV vs. non-ZEV fleet availability

For example, the Toronto Transit Commission (TTC) is currently testing BEBs from three different OEMs and is tracking the following KPIs to compare with its fossil fuel buses (Figure 12-3).

Figure 12-3: TTC eBus KPIs.[43]



All ZEV equipment should be connected to ICTC's current data collection software, networks, and integrated with any existing data collection architecture. All data should be transmitted across secure VPN technology and encrypted.

43 https://www.ttc.ca/About_the_TTC/Commission_reports_and_information/Commission_meetings/2018/June_12/Reports/27_Green_Bus_Technology_Plan_Update.pdf

13.0 WORKFORCE CONSIDERATIONS

The deployment of a new propulsion technology will require new training procedures for operators and maintenance staff. This section describes the implications of the adoption of ZEVs as well as key training considerations.

13.1 ZEV TRANSITION WORKFORCE IMPLICATIONS

Early data suggest that ZEVs may require less maintenance than their fossil fuel counterparts because[44]:

- The battery, motor, and associate electronics require little to no regular maintenance.
- There are fewer fluids, such as engine oil, that require regular maintenance.
- Brake wear is significantly reduced due to regenerative braking.
- There are fewer moving parts relative to a conventional fuel engine.

Because of this, the broader concern throughout the industry is a possible reduction in the number of maintenance staff required for a ZEV fleet. However, a reduction of staff should not be a major concern for agencies and municipalities for two main reasons: 1) high potential for new maintenance needs and requirements that arise from the maturation of ZEV technology, and 2) workforce training, upskilling, and reskilling programs available through the federal government. Currently, there is no comprehensive data to provide detailed insights into long-term maintenance practices for large-scale ZEV deployments in North America.

While fewer maintenance practices may be needed for ZEVs, the technology continues to evolve rapidly, providing avenues for continuous learning and staying updated on the latest advancements in ZEV maintenance and repair. New maintenance protocols and essential knowledge and skillsets have already emerged as the technology continues to mature and become more sophisticated. Examples specialized areas of knowledge include:

- **Overall ZEV technology**: understanding the fundamental principles of ZEV technology, including the battery systems, electric motors, power electronics, regenerative braking, and other key components.
- **Diagnostic tools and software**: knowledge of specialized diagnostic tools and software used to assess and troubleshoot ZEVs.
- **Battery maintenance and management**: understanding of monitoring charge levels, temperature management, and proper storage techniques.

[44] https://afdc.energy.gov/vehicles/electric_maintenance.html

- **Charging and fueling infrastructure**: understanding of charging and fueling methods including fast charging and slow charging, as well as the various charging connectors and their safe usage.
- **Regenerative braking systems**: understanding of how this system works and its impact on vehicle efficiency.

In addition, the FTA Workforce Development Initiative[45] provides resources and support for public transit agencies to recruit, retrain, and train transit workers. The initiative also ensures that agencies can upskill, reskill, and hire an equitable and diverse workforce for current and new jobs emerging through advanced technologies. The goals of the initiative are to:

- Provide a roadmap and strategic support to help transit agencies recruit, retain, and train their workforce.
- Develop resources to ensure equity and diversity in the public transit workforce.
- Help agencies use the half of one percent available from urbanized area formula grants and other funding investments to develop workforce initiatives that address the unique needs of each agency.
- Partner with the Department of Labor to help agencies leverage funding and initiatives across both federal agencies.
- Help support the development of internships, apprenticeships, and/or work-based skills training.
- As needed, develop a transit curriculum for transit operators and engineers/technicians especially in safely working with low or zero-emission buses while ensuring there is no duplication of training activities led by the National Transit Institute (NTI).
- Support academic and technical trade education partnerships, especially with community colleges.
- Assess and develop partnerships with social services programs to ensure workforce development programs also have resources to support worker transitions from other fields or disadvantaged backgrounds.

Elements of the initiative include:

- Cooperative agreements with transit agencies to develop innovative workforce projects.
- Reports and information on the results of those projects.
- Meetings and conferences to gather information about public transit agency workforce issues/concerns.
- A new transit workforce technical assistance program.

It will be important for ICTC to research and utilize any available programs and funding to aid with the transition of their workforce from fossil fuel fleet maintenance practices to ZEV maintenance protocols.

[45] https://www.transit.dot.gov/research-innovation/workforce-development-initiative

13.2 TRAINING

FCEB manufacturers include basic training modules for bus operators and maintenance technicians that are typically included in the purchase price of the vehicle, with additional training modules and programs also available for purchase. It will be important for ICTC leadership to work with its O&M operator and staff to understand how best to approach training for FCE vehicles and determine whether additional training is needed. In general, maintenance technicians and operators will need to know how to perform inspections, conduct routine maintenance and repairs, and understand safety procedures related to the new technology.

For FCE vehicles, the priority training needs will be safety considerations stemming from the presence of hydrogen gas, as well as any differences to gauges and instrumentation. Maintenance staff will need to be trained on safety, scheduled maintenance, diagnostics, and repair of hydrogen fuel cell apparatus. Training might include:

- Hydrogen systems, including fuel cell engine
- Hydrogen fuel system
- Hydrogen detection and fire suppression systems
- Hydrogen cooling system package

In addition, FCE vehicle maintenance will require specific PPE. Examples include:

- Face shields
- Insulated gloves
- Special protective clothing
- Foot protection

In addition to maintenance personnel training, agencywide orientation to familiarize employees with the new technology should also be conducted prior to the first ZE vehicle deployment.

Lastly, it is highly recommended that all local fire and emergency response departments be educated about the layout, componentry, safety devices, and other features of the vehicles. This should reoccur every few years, but the specific frequency can be dependent on agency discretion. Procedures in dealing with emergencies, accidents, and injuries must be established with instructions and warning signs posted. Vehicle manufacturers publish emergency response guides for their vehicles and offer training for emergency responders.[46]

Table 13-1 provides a framework of potential training methods and strategies to bolster ICTC's workforce development and successfully transition to a 100% ZEV fleet.

[46] More information about ZEV emergency response training and resources can be found at the National Fire Protection Association (NFPA) website: http://evsafetytraining.org/

Table 13-1: Potential Training Methods

Plan	Description
Train-the-trainer	Small numbers of staff are trained, and subsequently train colleagues. This maintains institutional knowledge while reducing the need for external training.
Bus vendor training and fueling vendor	OEM training provides critical, equipment-specific operations and maintenance information. Prior to implementing ZEV technology, ICTC staff will work with the OEMs to ensure all employees complete necessary training.
Retraining & refresher training	Entry level, intermediate, and advanced continuous learning opportunities will be offered to all agency staff.
ZEV training from other transit agencies	ICTC should leverage the experience of agencies who were early ZEV adopters, such as the ZEV University program offered by AC Transit. ICTC should also collaborate with partner transit agencies in the county to share lessons learned during ZEV transition.
National Transit Institute (NTI) training	NTI offers zero-emissions courses such as ZEV management and benchmarking and performance.
Local partnerships and collaborations	ICTC could work with local schools to showcase potential careers in bus and facilities management to students.
Professional associations	Associations such as the Zero Emission Bus Resource Alliance offer opportunities for sharing and lessons learned across transit agencies.

14.0 POTENTIAL FUNDING SOURCES

As a clear cost driver for transit agencies, funding the ZEV transition will require external financial aid. ICTC should monitor existing funding and financing opportunities. Additionally, as more transit agencies in the state and country consider ZEV transitions, new funding opportunities may occur. Below are major current programs available for ZEV transition in Table 14-1.

Table 14-1: Grants and Potential Funding Options for ZEV Transition

Type	Agency	Fund/Grant/Program	Description	Additional Notes
Federal	Federal Transit Administration (FTA)	Low or No Emission Program (Low-No Program) (5339(c))[47]	Low-No provides competitive funding for the procurement of low or no emission vehicles, including the leasing or purchasing of vehicles and related supporting infrastructure. This has been an annual program under the FAST Act since FY2016 and is a subprogram of the Section 5339 Grants for Bus and Bus Facilities.	A 20% local match is required.
Federal	Federal Transit Administration (FTA)	Buses and Bus Facilities Program (5339(a) formula[48], 5339(b) competitive[49])	Grants applicable to rehab buses, purchase new buses, and invest and renovate related equipment and facilities for low or no emission vehicles or facilities.	A 20% local match is required.
Federal	Federal Transit Administration (FTA)	Grants for Rural Areas (5311)[50]	5311 grant funding makes federal resources available to rural areas for transit capital, planning and operating assistance. Eligible activities include capital investments in bus and bus-related activities such as replacement, overhaul and rebuilding of buses.	Typically, the MPO or another lead public agency is the direct recipient of these funds and distributes these to local transit agencies based on TIP allocation. Agencies can allocate these funds for the purchase of ZEVs. The federal share is not to exceed 80% for capital projects.

[47] https://www.transit.dot.gov/lowno#:~:text=The%20Low%20or%20No%20Emission,leasing%20of%20required%20supporting%20facilities.
[48] https://www.transit.dot.gov/funding/grants/busprogram
[49] https://www.transit.dot.gov/bus-program
[50] https://www.transit.dot.gov/rural-formula-grants-5311

Type	Agency	Fund/Grant/Program	Description	Additional Notes
Federal	Federal Transit Administration (FTA)	Transportation Infrastructure Finance and Innovation Act (TIFIA)[51]	The TIFIA program provides credit assistance for qualified projects of regional and national significance. Many large-scale, surface transportation projects - highway, transit, railroad, intermodal freight, and port access - are eligible for assistance. Eligible applicants include state and local governments, transit agencies, railroad companies, special authorities, special districts, and private entities.	Credit assistance is limited to 33% of reasonably anticipated eligible project costs unless the sponsor provides a compelling justification for up to 49%. In this case the project must meet certain rural, transit or transit-oriented development eligibility or be part of the Rural/INFRA/Mega grant Extra programs.
Federal	Federal Transit Administration (FTA)	Enhanced Mobility of Seniors & Individuals with Disabilities (5310)[52]	5310 formula funding provides resources to help meet the transportation needs of older adults and people with disabilities. Eligible subrecipients (from the State for rural areas) include public transit operators. Eligible activities include capital investments in buses and vans, wheelchair lifts and harnesses, and other equipment.	For small urban and rural areas, the State is the direct recipient and distributes these funds as it wishes. Agencies can allocate these funds for the purchase of ZEVs.
Federal	Federal Highway Administration (FHWA)	Congestion Mitigation and Air Quality Improvement Program (CMAQ)[53]	The CMAQ Program provides funds to states for transportation projects designed to reduce traffic congestion and improve air quality, particularly in areas of the country that do not attain national air quality standards. This includes projects that reduce criteria air pollutants regulated from transportation-related sources, such as ZEV projects.	
Federal	United States Department of Transportation (USDOT)	Local and Regional Project Assistance Program (RAISE)[54]	Previously known as BUILD and TIGER, RAISE is a discretionary grant program aimed to support investment in infrastructure. RAISE funding supports planning and capital investments in roads, bridges, transit, rail, ports, and intermodal transportation.	A local match is required.

[51] https://www.transportation.gov/buildamerica/financing/tifia
[52] https://www.transit.dot.gov/funding/grants/enhanced-mobility-seniors-individuals-disabilities-section-5310
[53] https://www.transportation.gov/sustainability/climate/federal-programs-directory-congestion-mitigation-and-air-quality-cmaq
[54] https://www.transportation.gov/RAISEgrants/about

Type	Agency	Fund/Grant/Program	Description	Additional Notes
State	California Air Resources Board (CARB)	Hybrid and Zero-Emission Truck and Bus Voucher Incentive Program (HVIP)[55]	Voucher program created in 2009 aimed at reducing the purchase cost of zero-emission vehicles. Transit agencies decide on a vehicle, contact the vendor directly, and then the vendor applies for the voucher.	Voucher rebates vary by vehicle type and model.[56]
State	California Air Resources Board (CARB)	Carl Moyer Memorial Air Quality Standards Attainment Program[57]	The Carl Moyer Program provides funding to help procure low-emission vehicles and equipment. It is implemented as a partnership between CARB and local air districts.	Transit buses are eligible for up to $80,000 in funding.
State	California Air Resources Board (CARB)	Volkswagen Environmental Mitigation Trust Funding[58]	VW's settlement provides nearly $130 million for zero-emission transit, school, and shuttle bus replacements.	Transit may be eligible for up to $65 million. Applications are open for transit agencies and are processed on a first come, first serve basis.
State	California Air Resources Board (CARB)	Sustainable Transportation Equity Project (STEP)[59]	STEP was a pilot that took a community-based approach to overcoming barriers to clean transportation. The future of STEP is currently being determined by CARB and stakeholder groups through the FY22-23 Funding Plan and Three-Year Plan for Clean Transportation Incentives. There are two different grant types: Planning and Capacity Building Grants (up to $1.75 million for multiple grantees) and Implementation Grants (up to $17.75 million for between one and three grantees).	Lead applicants must be a CBO, federally-recognized tribe, or local government representing a public transit agency. Award amounts ranged from $184,000 to a maximum of over $7 million.[60]

[55] https://californiahvip.org/
[56] https://californiahvip.org/vehiclecatalog/
[57] https://ww2.arb.ca.gov/our-work/programs/carl-moyer-memorial-air-quality-standards-attainment-program
[58] https://ww2.arb.ca.gov/our-work/programs/volkswagen-environmental-mitigation-trust-california
[59] https://ww2.arb.ca.gov/lcti-step
[60] https://ww2.arb.ca.gov/news/grant-awards-announced-new-195-million-pilot-funding-equitable-clean-transportation-options

Type	Agency	Fund/Grant/Program	Description	Additional Notes
State	California Transportation Commission (CTC)	SB1 Local Partnership Program (LPP) [61]	The Local Partnership Program provides funding to counties, cities, districts and regional transportation agencies to improve aging infrastructure, road conditions, active transportation, transit and rail, and health and safety benefits. Funds are distributed through competitive and formulaic components.	To be eligible, counties, cities, districts, and regional transportation agencies must have approved fees or taxes dedicated solely to transportation improvements.
State	California Transportation Commission (CTC)	Solutions for Congested Corridors Program (SCCP)[62]	The SCCP includes programs with both formula and competitive funds. Funding is available to projects that make specific performance improvements and are a part of a multimodal comprehensive corridor plan designed to reduce congestion in highly traveled corridors by providing more transportation choices for residents, commuters, and visitors.	Improvements to transit facilities are eligible projects. To submit a SCCP application, the applicant needs to know exactly what sources will be funding the project and when the funds will be used, as well as which project phase they will be used for.
State	California Department of Transportation (Caltrans)	SB1 State of Good Repair (SGR)[63]	SGR funds are formula funds eligible for transit maintenance, rehabs, and capital programs. Agencies receive yearly SB1 SGR funding through their MPO, based on population and farebox revenues.	Agencies can decide to devote its portion of SB 1 funds to a ZEV transition.
State	California Department of Transportation (Caltrans)	Low Carbon Transit Operations Program (LCTOP)[64]	The LCTOP provides capital assistance to transit agencies in order to reduce greenhouse gas emissions and improve mobility. 5% and 10% of the annual Cap and Trade auction proceeds fund this program.	Many agencies are already recipients of these funds and can use these funds to purchase ZEVs and related equipment.

61 https://catc.ca.gov/programs/sb1/local-partnership-program
62 https://catc.ca.gov/programs/sb1/solutions-for-congested-corridors-program
63 https://dot.ca.gov/programs/rail-and-mass-transportation/state-transit-assistance-state-of-good-repair#:~:text=Program%20Overview&text=This%20program%20receives%20funding%20of,delivery%20of%20California's%20transportation%20programs.
64 https://dot.ca.gov/programs/rail-and-mass-transportation/low-carbon-transit-operations-program-lctop

Type	Agency	Fund/Grant/Program	Description	Additional Notes
State	California Department of Transportation (Caltrans)	Transit and Intercity Rail Capital Program (TIRCP) [65]	The TIRCP was created to fund capital improvements that reduce emissions of greenhouse gases, vehicle miles traveled, and congestion through modernization of California's intercity, commuter, and rail, bus, and ferry transit systems.	The five cycles of TIRCP funding have awarded $6.6 billion in funding to nearly 100 projects throughout California.
State	California Department of Transportation (Caltrans)	State Transportation Improvement Program (STIP) [66]	The STIP is a five-year plan for future allocations of certain state transportation funds including state highway, active transportation, intercity rail, and transit improvements. The STIP is updated biennially in even-numbered years.	ZEV procurement could compete for STIP funding. Funding is distributed via a formula for a variety of projects.
State	California Department of Transportation (Caltrans)	Transportation Development Act (Mills-Alquist-Deddeh Act (SB 325)) [67]	The TDA law provides funding to improve existing public transportation services and encourage regional transportation coordination. There are two funding sources: the Local Transportation Fund (LTF) and the State Transit Assistance (STA) fund.	Funding opportunities include transportation program activities, pedestrian and bike facilities, community transit services, public transportation, and bus and rail projects.
State	California Energy Commission	Clean Transportation Program (Alternative and Renewable Fuel and Vehicle Technology Program)[68]	The California Energy Commission's Clean Transportation Program provides up to $100 million annually for a variety of renewable and alternative fuel transportation projects throughout the state, including specific projects for heavy-duty public transit buses.	A local match is often required.

[65] https://calsta.ca.gov/subject-areas/transit-intercity-rail-capital-prog
[66] https://catc.ca.gov/programs/state-transportation-improvement-program
[67] https://dot.ca.gov/programs/rail-and-mass-transportation/transportation-development-act
[68] https://www.energy.ca.gov/programs-and-topics/programs/clean-transportation-program#:~:text=The%20California%20Energy%20Commission's%20Clean,advanced%20transportation%20and%20fuel%20technologies

Type	Agency	Fund/Grant/Program	Description	Additional Notes
State	Department of Housing and Community Development	Affordable Housing and Sustainable Communities Program (AHSC)[69]	The AHSC Program funds land use, housing, and transportation projects to support development that reduces GHG emissions. The program provides both grants and loans that reduce GHG emissions and benefit disadvantaged communities through increasing accessibility via low-carbon transportation. Sustainable transportation infrastructure projects, transportation-related amenities, and program costs (including transit ridership) are eligible activities. Agencies can use program funds for assistance in construction or modification of infrastructure for ZEV conversion as well as new vehicle purchases.	The maximum award amount is not to exceed $30 million per project, with a minimum award of at least $1 million.
State	California Climate Investments	Clean Mobility Options (CMO) Voucher Pilot Program[70]	CMO awards up to $1 million vouchers to develop and launch zero-emission mobility projects including the purchase of zero-emission vehicles, infrastructure, planning, outreach, and operations projects in low-income and disadvantaged communities.	
State	California Pollution Control Financing Authority (CPCFA)	Medium-Heavy-Duty (MHD) Zero Emission Vehicle Financing Program[71]	The CPCFA is developing a purchasing assistance program for MHD ZEV fleets. This will provide financial support and technical assistance to fleet managers deploying ZEV fleets. CPCFA will designate high priority fleets based on implications for climate change, pollution, environmental justice, and post-COVID economic recovery.	A minimum of 75% of financing must be directed towards fleets that directly impact or operate in underserved communities.
Local & Regional	Southern California Association of Governments (SCAG)	County Transportation Commission (CTC) Partnership Program REAP 2.0 [72]	The CTC Partnership Program consists of the region's six County Transportation Commissions to fund the development of plans, programs, pilot projects, and certain signature greenhouse gas-/vehicle miles traveled-reducing capital projects with a strong nexus to housing.	Project awards are split across the three eligible projects categories: $35 million invested in projects to increase transit ridership, $36 million invested in projects to realize multimodal communities, and $9 million invested in projects to shift travel behavior.

[69] https://sgc.ca.gov/programs/ahsc/
[70] https://cleanmobilityoptions.org/about/#
[71] https://afdc.energy.gov/laws/12858
[72] https://scag.ca.gov/post/transportation-partnership-programs

Type	Agency	Fund/Grant/Program	Description	Additional Notes
Local & Regional	Imperial County Air Pollution Control District (ICAPCD)	ICAPCD Carl Moyer Program[73]	The ICAPCD has grant funds available under the Carl Moyer Program to assist Imperial County individuals and businesses in reducing pollutants from diesel engines by replacing them with newer, cleaner technologies.	
Local & Regional	Imperial Irrigation District (IID)	Green Grants[74]	IID Green Grants are available to non-profit organizations located in IID's service area, including educational institutions and government agencies. Projects must align with four key funding areas: energy efficiency/management upgrades; income qualified assistance; renewable resources; research, development, and demonstration of emerging energy management technology	Each project may qualify for up to $2,500 per calendar year.
Other	N/A	Low Carbon Fuel Standard (LCFS credits)[75]	LCFS credits are not necessarily funding to be applied for; rather, they are offset credits that are traded (through a broker) to reduce operating costs. Once ZEVs are acquired and operating, agencies can collect LCFS and 'sell' them to reduce operating costs of ZEVs. Both hydrogen and electricity used as fuels are eligible for LCFS credits.	Credit prices vary.
Other	N/A	Transportation Development Credits	Although they are not funds for projects, Transportation Development Credits, also called "Toll Credits", satisfy the federal government requirement to match federal funds.[76]	Toll credits provide a credit toward a project's local share for certain expenditures with toll revenues. FHWA oversees the toll credits within each state.[77]

[73] https://apcd.imperialcounty.org/grants/
[74] https://www.iid.com/customer-service/save-energy-and-money/green-grants
[75] https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard/lcfs-credit-generation-opportunities
[76] https://dot.ca.gov/-/media/dot-media/programs/rail-mass-transportation/documents/f0010121-toll-credit-fact-sheet.pdf
[77] https://dot.ca.gov/-/media/dot-media/programs/rail-mass-transportation/documents/f0009899-2-toll-credits-fact-sheet-a11y.pdf

One chief source of capital funding is the Low-No and Bus and Bus Facility Grant. The FTA releases a Dear Colleague letter annually outlining new requirements for Low-No and Bus and Bus Facility Grant Applications. The letter details the requirement for a Zero-Emission Fleet Transition Plan in response to amendments in the statutory provisions for these programs as part of the Bipartisan Infrastructure Law. The FTA Zero-Emission Fleet Transition plan includes six major elements, presented in Table 14-2. Moving forward, to qualify for these funding opportunities, a transit agency must include a transition plan with these elements. ICTC can use much of the material in the ZEV Rollout Plan to craft the Zero-Emission Fleet Transition Plan to apply for this important source of federal funding.[78] ICTC can contact Gold Coast Transit to learn how it successfully procured over $12 million of FTA Low-No funding.

Table 14-2: FTA Zero-Emission Fleet Transition Plan Requirements

Element	Description
1: Long-Term Fleet Plan and Application Request	Demonstrate a long-term fleet management plan with a strategy for how the applicant intends to use the current application and future acquisitions.
2: Current and Future Resources to Meet Transition	Address the availability of current and future resources to meet costs for the transition and implementation
3: Policy and Legislative Impacts	Consider policy and legislation impacting relevant technologies.
4: Facility Evaluation and Needs for Technology Transition	Include an evaluation of existing and future facilities and their relationship to the technology transition.
5: Utility Partnership	Describe the partnership of the applicant with the utility or alternative fuel provider.
6: Workforce Training and Transition	Examine the impact of the transition on the applicant’s current workforce by identifying skill gaps, training needs, and retraining needs of the exiting workers of the applicant to operate and maintain ZEVs and related infrastructure and avoid displacement of the existing workforce.

[78] To view a list of winners and projects, please see https://www.transit.dot.gov/funding/grants/fy22-fta-bus-and-low-and-no-emission-grant-awards

15.0 SERVICE IN DISADVANTAGED COMMUNITIES

CARB defines Section F of the rollout plan as “Providing Service in Disadvantaged Communities.” Specifically, this section requires agencies to first identify if they provide service to any disadvantaged communities, and if so, to describe how the transit agency is planning to deploy ZEVs in these communities. Section F also provides a table where transit agencies have the option to provide an estimate of the number of buses to be deployed in each disadvantaged community and during what year.

CARB does not provide additional guidance on the level of detail required when denoting the location of the disadvantaged community. However, as CalEnviroScreen defines a disadvantaged community at the census tract-level, it is assumed that listing by census tract is sufficient. An example of this table is provided in Table 15-1 below. This table is optional and not a required component of the rollout plan.

Table 15-1: Service in Disadvantaged Communities (example, optional)

Timeline (Year)	Number of ZEVs	Location of Disadvantaged Community

The ICT utilizes information provided by CalEnviroScreen to identify disadvantaged communities. ICT regulation defines CalEnviroScreen as a mapping tool that is developed by the Office of Environmental Health Hazard Assessment (OEHHA) at the request of the California Environmental Protection Agency (CalEPA) to identify California’s most pollution-burdened and vulnerable communities based on geographic, socioeconomic, public health, and environmental hazard criteria.[79]

CalEnviroScreen evaluates the burden of pollution from multiple sources in communities while accounting for potential vulnerability to the adverse effects of pollution to identify disadvantaged communities from a wide variety of factors to comprehensively assess the overall health of communities, down to the census tract level. Specifically, CalEnviroScreen identifies disadvantaged communities as census tracts which scored in the top 25% based on the factors used by CalEnviroScreen to assess pollution burden and vulnerability.

Figure 15-1 shows the CalEnviroScreen-defined disadvantaged communities in Imperial County according to CalEnviroScreen 4.0. This figure shows that all census tracts colored in orange are in the top 50% for pollution burden and overall vulnerability and are designated as disadvantaged communities according to CalEnviroScreen criteria. ICTC can deploy ZEVs on any route to improve air quality and reduce pollution burden in the Imperial County area.

[79] ICT specifies that the most recent version of CalEnviroScreen should be used, which is currently version 4.0 (found here: https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-40).

Table 15-2 provides a detailed breakdown of census tracts that are considered disadvantaged and the routes that travel through them.

Figure 15-1: Disadvantaged Communities in ICTC Service Area

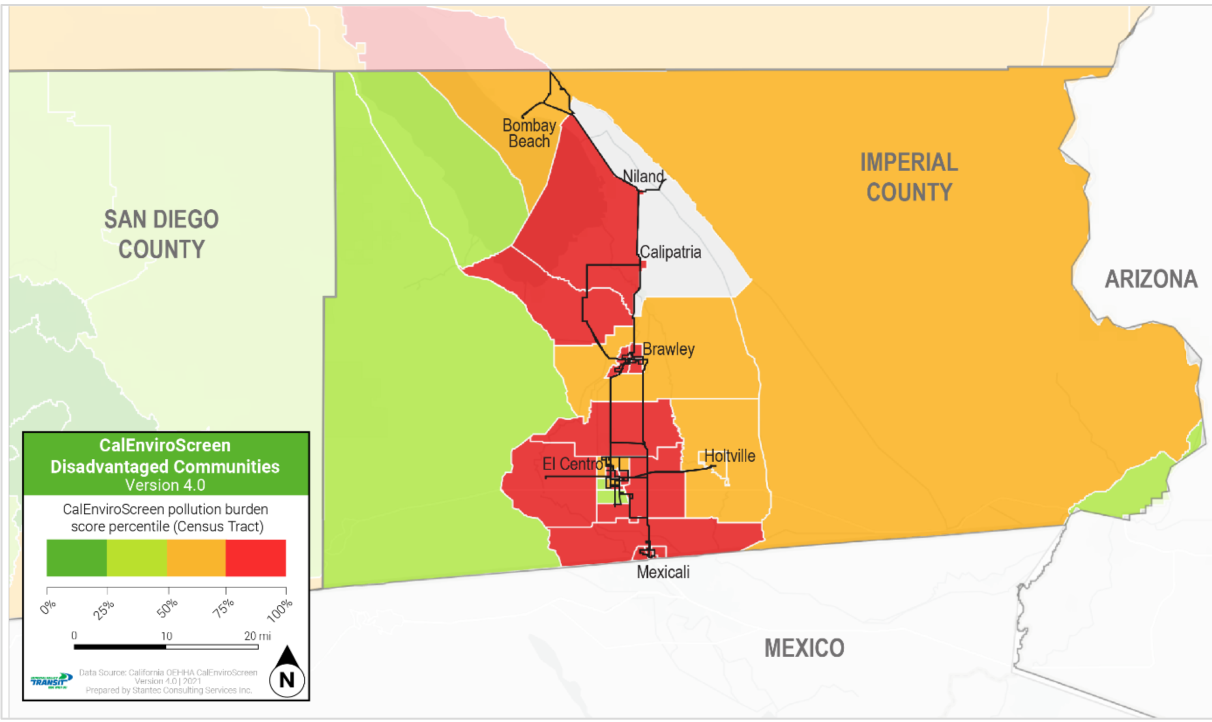


Table 15-2: CalEnviroScreen Disadvantaged Census Tracts in Imperial County with IVT Routes

Census Tract ID	Routes
6025010102	2, 22, 51
6025010200	2, 22, 51
6025010500	2, 22, 32, 51, Gold
6025010400	2, 22, 31, 32, 51, Gold
6025010600	2, 22, 41, 51, Gold
6025010700	2, 22, 31, 32, Gold
6025011100	4
6025011000	2, 3, 4, 21, 22, 31, 32, 41, Green
6025011300	1, 2, 3, 4, 21, 31, 32, 45, Blue
6025011900	1, 21, 31, 32,
6025012200	1
6025012100	1, 21, 31 ,32,

Census Tract ID	Routes
6025012002	1, 21
6025012001	1, 21
6025011202	2, 3, 4, 41, Blue, Green
6025011500	2, 3, 4, 41, 45, Blue, Green
6025011400	1, 3, 4, 45, Blue, Green
6025011700	1, Blue, Green

16.0 GREENHOUSE GAS IMPACTS

One of the chief reasons for transitioning to ZEVs is to reduce pollution by removing the harmful byproducts of fossil fuel combustion from traditional combustion engines. While ZEVs eliminate all tailpipe emissions, there may still be upstream carbon emissions associated with the production of energy sources that power ZEVs. This section assesses the overall impacts of ZEV transition on harmful emissions.

Based on the ZEVDecide modeling of greenhouse gas (GHG) emissions, ICTC's current fleet emits an average of 1,165 tons of GHGs per vehicle in a year.[80] Although FCE vehicles don't have tailpipe emissions, they have upstream emissions resulting from hydrogen production. The FCE fleet would increase ICTC's annual emissions, with an average of 2,652 tons per vehicle emitted annually. Table 16-1 shows the annual emissions of the current fleet and compared to the FCE fleet, and

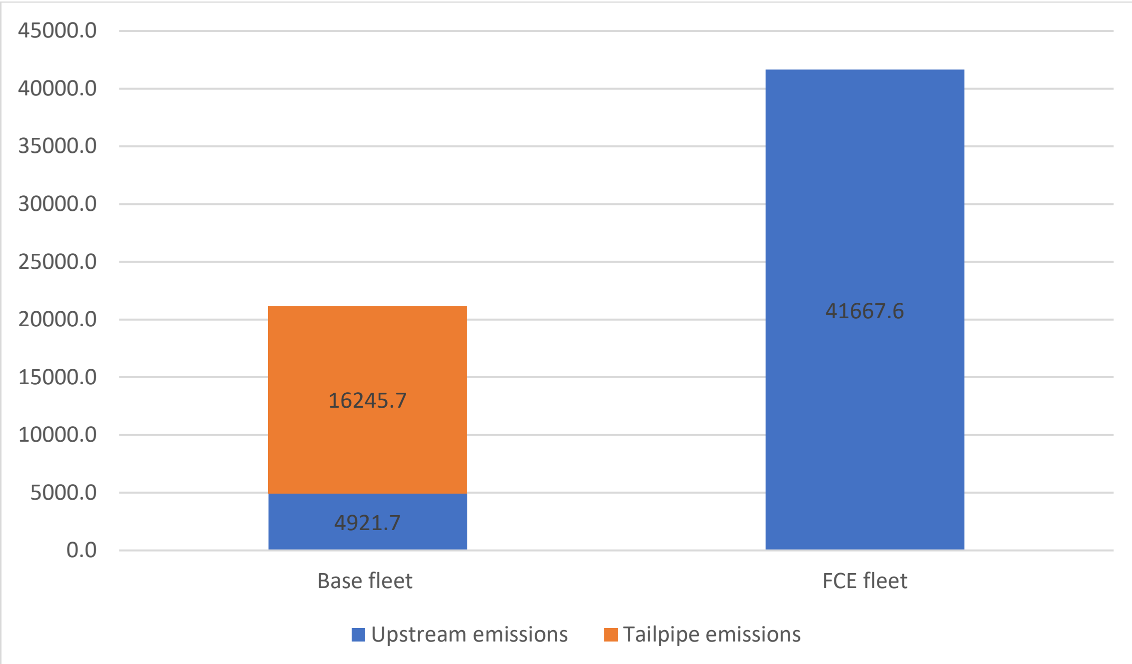
Figure 16-1 represents the annual total emissions by fleet graphically.

Table 16-1: Total Annual CO_2 Emissions (tons)

	Current fleet	**FCE Fleet**
Upstream emissions (ton CO_2/year)	4922	41668
Tailpipe emissions (ton CO_2/year)	16246	0
Total Ton CO_2/year	**21167**	**41668**

[80] All GHG calculations are presented in tons (not metric tons) of CO_2 equivalent, which is calculated using the short-term 20-year global warming potential of CO_2, methane, black carbon, and particulate matter.

Figure 16-1: Total Annual CO_2 Emissions (tons)



The increased GHG emissions are due to the upstream energy-intensive process for producing hydrogen. This process is called fossil fuel reforming or steam methane reforming (SMR), which takes natural gas (NG) and steam to generate a product stream of carbon dioxide (CO_2) and hydrogen (H_2). Currently, 95% of hydrogen produced in the United States uses this method.

However, GHG emissions can be avoided completely if the CO_2 produced in SMR is captured and stored in a process known as carbon capture and storage (CCS). In addition, there are other carbon-neutral hydrogen production pathways such as electrolytic hydrogen, biogas reforming, and artificial photosynthesis that may become more commonplace as sustainable renewable energy generation advances in the United States.

17.0 OTHER TRANSITION ITEMS

According to ICT regulation, transit agencies can pool resources when acquiring ZEV infrastructure if they:

- Share infrastructure
- Share the same MPO, transportation planning agency, or Air District
- Are located within the same Air Basin

The Southern California Association of Governments (SCAG) is the MPO for Imperial County and provides regional transportation funding and planning for Imperial County, Ventura County, Los Angeles County, Orange County, Riverside County, and San Bernardino County. ICTC's service area is located within the Imperial County APCD and the Salton Sea Air Basin.

Table 17-1 lists example SCAG agencies that are implementing FCE vehicles. While ICTC could theoretically partner with any transit agency in the SCAG region, the list was limited to FCE implementations which would be relevant and beneficial to ICTC's transition.

Table 17-1: Other SCAG Transit Agencies Implementing FCE Fleets

Agency	ZEV Technology	Notes
SunLine Transit Agency[81]	FCE and BE	Mix of depot and on-route charging
Ventura County Transportation Commission	FCE and BE	Includes both Valley Express Bus and VCTC Intercity
Gold Coast Transit District[82]	FCE	GCTD will begin construction on the hydrogen fueling facility in 2023/2024 and plans to collaborate with VCTC for hydrogen fueling
Orange County Transportation Authority[83]	FCE and BE	
Foothill Transit[84]	FCE	
Santa Clarita Transit[85]	FCE	
Victor Valley Transit Authority	FCE	
Riverside Transit Agency[86]	FCE	

81 https://ww2.arb.ca.gov/sites/default/files/2020-09/SunLine_ROP_ADA09082020.pdf
82 https://www.gctd.org/wp-content/uploads/2023/03/GCTD-Zero-Emission-Rollout-Plan-1.pdf
83 https://ww2.arb.ca.gov/sites/default/files/2020-09/OCTA%20ZEB%20Rollout%20Plan_ADA08122020.pdf
84 https://ww2.arb.ca.gov/sites/default/files/2020-09/C_Burns_McDonnell_Foothill%20Transit_ROP_ADA08182020.pdf
85 https://ww2.arb.ca.gov/sites/default/files/2021-01/City%20of%20Santa%20Clarita_ZEB_ROPADA11192020.pdf
86 https://ww2.arb.ca.gov/sites/default/files/2021-03/RTA_ZEB_ROP_ADA12212020.pdf

Agency	ZEV Technology	Notes
Long Beach Transit[87]	FCE and BE	
Montebello Bus Lines[88]	FCE	
Norwalk Transit System	FCE and BE	
Pasadena Transit[89]	FCE and BE	

ICTC should remain in communication with other SCAG transit agencies to understand how the agencies can work together to leverage resources and coordinate efforts on a regional level. Specific elements to collaborate on could include:

- Vehicle procurement – developing common specifications and procurements to have efficient pricing
- Charger procurement and installation – procuring similar equipment can help reduce prices and facilitate training and interoperability
- Training and workforce development – for maintenance staff and operators
- Charging software

Finally, a ZEV transition and implementation is an agencywide endeavor that requires multiple stakeholders and partners such as utilities. It would be prudent for ICTC to form a steering committee or task force to guide the transition to ZEVs and this may require additional staff to serve as a program or project manager. Communication will be critical during the transition to ensure customers are made aware of potential disruptions and changes to bus operations. ZEV conversion also offers an excellent marketing opportunity for ICTC to promote its climate and clean air commitments.

[87] https://ww2.arb.ca.gov/sites/default/files/2020-09/LBT_ZEB_Rollout_Plan_ADA08182020_0.pdf
[88] https://ww2.arb.ca.gov/sites/default/files/2021-12/MontebelloRolloutPlanADA.pdf
[89] https://ww2.cityofpasadena.net/2023%20Agendas/Jan_30_23/AR%204%20Attachment%20A_Pasadena%20ICT%20Report_Finalrev.pdf

18.0 PHASING AND IMPLEMENTATION

Table 18-1 provides an overview of the phasing plan for ICTC's ZEV rollout strategy for the ZE fleet. See Section 6.0 for more details regarding the fleet replacement schedule.

This plan is a living document that is intended to provide a practical framework for ICTC to deploy and transition to ZEVs in response to CARB's mandate. Like any other strategic plan, the implementation and transition plan should be revisited and adjusted in response to funding realities, changes in service delivery, and the needs of ICTC and its ridership, particularly given the long-term (~20 years) outlook.

Table 18-1: ZEV Implementation Phasing Plan 2023-2040

Year	Facility Modifications	ZEV Fleet Procurements	Training	Capital Expenses (2023$)	Operating Expenses (2023$)	Total Expenses (2023$)
2023		N/A	• OEM training	$0	$2.9M	$2.9M
2024		N/A	• OEM training for technicians • OEM training for staff	$2.2M	$2.7M	$4.8M
2025		N/A	• Annual refreshers • Local fire and emergency response department introduction to new technology	$5.3M	$2.5M	$7.8M
2026	$4.6 M	N/A	• OEM training	$4.6M	$2.4M	$7.1M

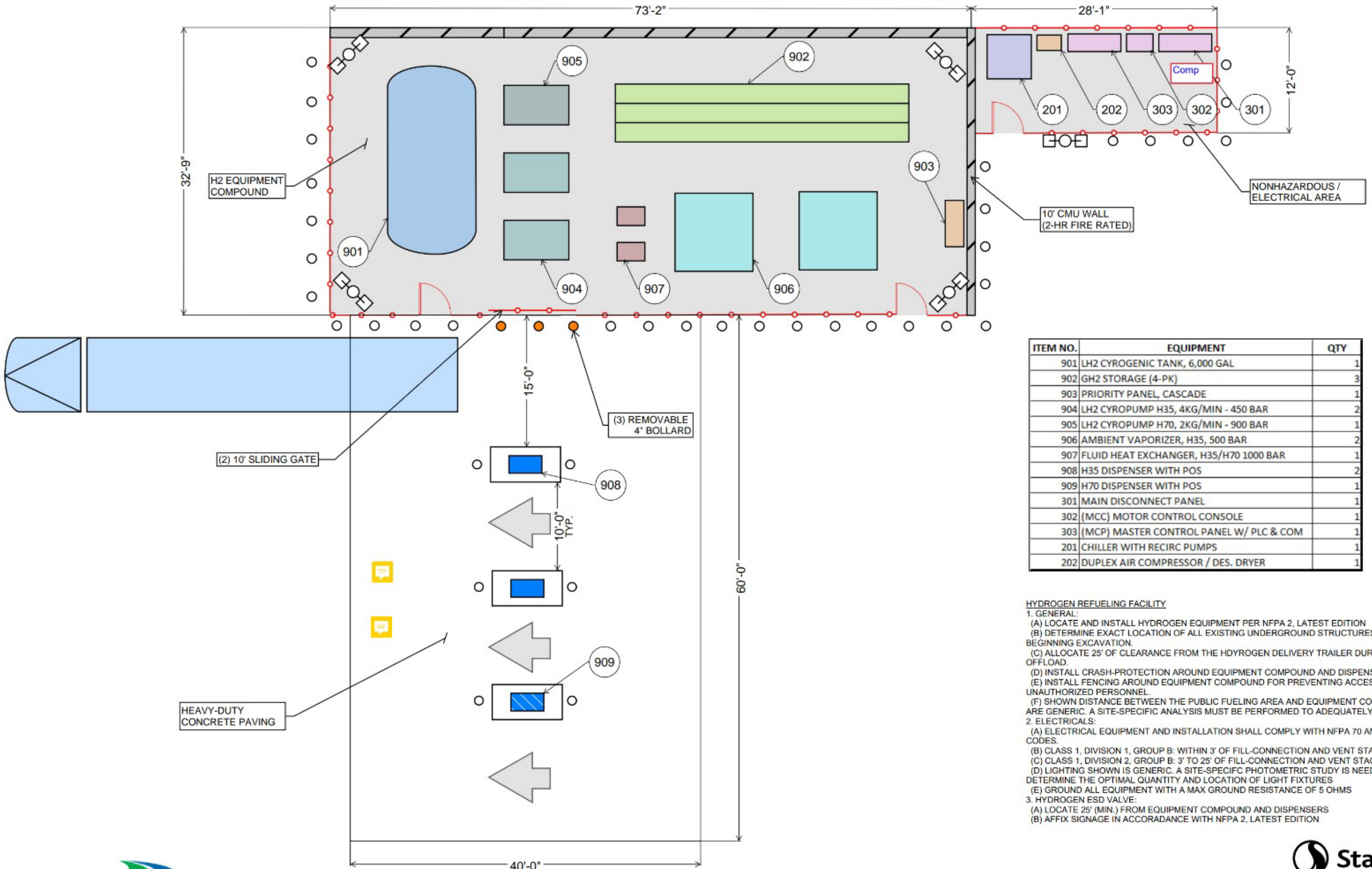
Year	Facility Modifications	ZEV Fleet Procurements	Training	Capital Expenses (2023$)	Operating Expenses (2023$)	Total Expenses (2023$)
2027	$4.4 M	N/A	• Annual refreshers • Local fire and emergency response department introduction to new technology	$4.5M	$2.3M	$6.8M
2028		1 cutaway, 4 vans	• OEM training	$586,000	$1.9M	$2.5M
2029		4 cutaways, 6 vans	• Annual refreshers • Local fire and emergency response department introduction to new technology	$2.4M	$1.9M	$4.2M
2030		7 cutaways, 4 vans	• Annual refreshers	$2.8M	$1.8M	$4.5M
2031		6 cutaways	• OEM training • Local fire and emergency response department introduction to new technology	$1.7M	$1.7M	$3.4M
2032		6 buses, 5 cutaways	• OEM training for technicians • OEM training for staff	$6.9M	$1.7M	$8.6M

Year	Facility Modifications	ZEV Fleet Procurements	Training	Capital Expenses (2023$)	Operating Expenses (2023$)	Total Expenses (2023$)
2033		4 buses, 8 cutaways	• Annual refreshers • Local fire and emergency response department introduction to new technology	$5.8M	$1.5M	$7.2M
2034		3 buses, 2 cutaways	• OEM training	$3.2M	$1.4M	$4.6M
2035		3 buses, 1 cutaway, 4 vans	• Annual refreshers • Local fire and emergency response department introduction to new technology	$2.9M	$1.4M	$4.2M
2036		4 cutaways, 6 vans	• OEM training for technicians • OEM training for staff	$2.0M	$1.3M	$3.4M
2037		4 cutaways, 4 vans	• Annual refreshers • Local fire and emergency response department introduction to new technology	$1.7M	$1.3M	$3.0M
2038		N/A	• OEM training	$0	$1.2M	$1.2M

Year	Facility Modifications	ZEV Fleet Procurements	Training	Capital Expenses (2023$)	Operating Expenses (2023$)	Total Expenses (2023$)
2039		3 cutaways	• Annual refreshers • Local fire and emergency response department introduction to new technology	$719,000	$1.2M	$1.9M
2040		6 cutaways	• OEM training for technicians • OEM training for staff	$1.4M	1.2M	$2.6M
			Total	**$48.4M**	**$32.4M**	**$80.8M**

APPENDICES

APPENDIX A: SITE PLANS



ITEM NO.	EQUIPMENT	QTY
901	LH2 CYROGENIC TANK, 6,000 GAL	1
902	GH2 STORAGE (4-PK)	3
903	PRIORITY PANEL, CASCADE	1
904	LH2 CYROPUMP H35, 4KG/MIN - 450 BAR	2
905	LH2 CYROPUMP H70, 2KG/MIN - 900 BAR	1
906	AMBIENT VAPORIZER, H35, 500 BAR	2
907	FLUID HEAT EXCHANGER, H35/H70 1000 BAR	1
908	H35 DISPENSER WITH POS	2
909	H70 DISPENSER WITH POS	1
301	MAIN DISCONNECT PANEL	1
302	(MCC) MOTOR CONTROL CONSOLE	1
303	(MCP) MASTER CONTROL PANEL W/ PLC & COM	1
201	CHILLER WITH RECIRC PUMPS	1
202	DUPLEX AIR COMPRESSOR / DES. DRYER	1

HYDROGEN REFUELING FACILITY

1. GENERAL:
   (A) LOCATE AND INSTALL HYDROGEN EQUIPMENT PER NFPA 2, LATEST EDITION
   (B) DETERMINE EXACT LOCATION OF ALL EXISTING UNDERGROUND STRUCTURES BEFORE BEGINNING EXCAVATION.
   (C) ALLOCATE 25' OF CLEARANCE FROM THE HDYROGEN DELIVERY TRAILER DURING OFFLOAD.
   (D) INSTALL CRASH-PROTECTION AROUND EQUIPMENT COMPOUND AND DISPENSERS.
   (E) INSTALL FENCING AROUND EQUIPMENT COMPOUND FOR PREVENTING ACCESS FROM UNAUTHORIZED PERSONNEL.
   (F) SHOWN DISTANCE BETWEEN THE PUBLIC FUELING AREA AND EQUIPMENT COMPOUND ARE GENERIC. A SITE-SPECIFIC ANALYSIS MUST BE PERFORMED TO ADEQUATELY SIZE LINES.
2. ELECTRICALS:
   (A) ELECTRICAL EQUIPMENT AND INSTALLATION SHALL COMPLY WITH NFPA 70 AND LOCAL CODES.
   (B) CLASS 1, DIVISION 1, GROUP B: WITHIN 3' OF FILL-CONNECTION AND VENT STACKS.
   (C) CLASS 1, DIVISION 2, GROUP B: 3' TO 25' OF FILL-CONNECTION AND VENT STACKS.
   (D) LIGHTING SHOWN IS GENERIC. A SITE-SPECIFC PHOTOMETRIC STUDY IS NEEDED TO DETERMINE THE OPTIMAL QUANTITY AND LOCATION OF LIGHT FIXTURES
   (E) GROUND ALL EQUIPMENT WITH A MAX GROUND RESISTANCE OF 5 OHMS
3. HYDROGEN ESD VALVE:
   (A) LOCATE 25' (MIN.) FROM EQUIPMENT COMPOUND AND DISPENSERS
   (B) AFFIX SIGNAGE IN ACCORADANCE WITH NFPA 2, LATEST EDITION

Imperial Valley Transit | Conceptual Plan - Hydrogen Fueling Facility | Generic Layout | 04/26/2023

Stantec
801 South Figueroa Street Suite 300
Los Angeles CA 90017

APPENDIX B: COST ESTIMATES

EQS CONSULTANTS construction cost management

IMPERIAL COUNTY TRANSPORTATION COMMISSION
HYDROGEN FUELING FACILITY - GENERIC LAYOUT

Summary - Hydrogen Fueling Yard

ROM Statement of Probable Cost 16-Oct-23

CSI DIV	CSI Category		Total	Cost per SF
1	General Requirements		$330,000	
2	Existing Conditions		$25,700	
3	Concrete			
4	Masonry			
5	Metals			
6	Wood, Plastics & Composites			
7	Thermal & Moisture Protection			
8	Openings			
9	Finishes			
10	Specialties			
11	Equipment			
12	Furnishings			
13	Special Construction			
14	Conveying System			
21	Fire Protection			
22	Plumbing			
23	HVAC			
26	Electrical			
27	Communications			
28	Electronic Safety & Security			
31	Earthwork		$52,000	
32	Exterior Improvements		$964,590	
43	Process Gas & Liquid Handling, Purification & Storage Equipment		$4,649,955	
	Subtotal		$6,022,245	
	General Conditions, OH & Mobilization	17.5%	$1,053,893	
	Contractor's Profit	9.0%	$636,852	
	Bonds & Insurance	2.5%	$192,825	
	Design Contingency	20.0%	$1,581,163	
	Escalation to MOC - EXCLUDED			
	Local Sales Tax	9.5%	$901,263	
	TOTAL CONSTRUCTION COST - HYDROGEN FUELING FACILITY		**$10,388,240**	

EQS CONSULTANTS construction cost management

IMPERIAL COUNTY TRANSPORTATION COMMISSION
HYDROGEN FUELING FACILITY - GENERIC LAYOUT

DETAILS - HYDROGEN FUELING YARD
ROM Statement of Probable Cost

16-Oct-23

No.	Item	Quantity	Unit	Unit Cost	Total Cost
1	General Requirements				$330,000
	General Requirements				
1.01	Equipment rental, allowance	1	ls	$25,000.00	$25,000
1.02	Third-party testing, allowance	100	hrs	$150.00	$15,000
1.03	Shipping/freight, allowance	1	ls	$85,000.00	$85,000
1.04	Testing & Startup, Allowance	1	ls	$50,000.00	$50,000
1.05	Design engineering	1	ls	$155,000.00	$155,000
2	Existing Conditions				$25,700
	Hazmat Abatement				
2.01	Hazmat abatement, EXCLUDED				
	Selective Demolition				
2.02	Sawcut & remove extg pavement (asphalt)	5,140	sf	$5.00	$25,700
31	Earthwork				$52,000
	Earthwork				
31.01	Excavate & recompact w/ imported, pad area, 2' deep	400	cy	$35.00	$14,000
31.02	Haul away excavated material	400	cy	$25.00	$10,000
31.03	Misc excavation, allowance	1	ls	$20,000.00	$20,000
31.03	Trench excavation/backfil, pipe conduit, allowance	200	lf	$40.00	$8,000
32	Exterior Improvements				$964,590
	Structural Foundation for Equipment				
32.01	LH2 Tank	1	ea	$15,000.00	$15,000
32.02	GH2 Storage	1	ea	$8,500.00	$8,500
32.03	Pump skids	3	ea	$7,500.00	$22,500
32.04	Vaporizer	2	ea	$15,000.00	$30,000
32.05	Heat Exchanger	2	ea	$5,000.00	$10,000
32.06	Dispenser island	3	ea	$7,500.00	$22,500
32.07	Chiller	1	ea	$10,000.00	$10,000
32.08	Air compressor	1	ea	$5,000.00	$5,000
32.09	Gen set	1	ea	$12,000.00	$12,000
	Concrete Paving				
32.10	HD concrete paving, 8" thick	2,400	sf	$25.00	$60,000
32.11	Concrete paving, 6" thick	2,740	sf	$22.00	$60,280
32.12	Repair concrete incl dowels, trench	200	lf	$165.00	$33,000

EQS CONSULTANTS construction cost management

IMPERIAL COUNTY TRANSPORTATION COMMISSION
HYDROGEN FUELING FACILITY - GENERIC LAYOUT

DETAILS - HYDROGEN FUELING YARD
ROM Statement of Probable Cost

16-Oct-23

No.	Item	Quantity	Unit	Unit Cost	Total Cost
	Fences & Gates				
32.13	8" CMU wall, 10' high incl foundation	106	lf	$425.00	$45,050
32.14	Chainlink fence, 10' high	174	lf	$90.00	$15,660
32.15	Chainlink sliding gate, 10'x10' high, manual	1	ea	$6,500.00	$6,500
32.16	Chainlink gate, single	3	ea	$3,500.00	$10,500
32.17	4" Bollard	35	ea	$550.00	$19,250
32.18	4" Bollard, removable	3	ea	$700.00	$2,100
	Concrete Trench				
32.19	Concrete trench w/ steel cover, 20"x24" deep	325	lf	$350.00	$113,750
	Canopy				
32.20	Dispenser island canopy, incl columns & footings	2,400	sf	$187.50	$450,000
	Miscellaneous				
32.21	Ground markings, allowance	1	ls	$8,000.00	$8,000
32.22	Safety signage, allowance	1	ls	$5,000.00	$5,000
43	**Process Gas & Liquid Handling, Purification & Storage Equipment**				**$4,649,955**
	Mechanical Equipment				
43.01	LH2 Storage tank, 6,000 gal	1	ea	$682,500.00	$682,500
43.02	GH2 Storage, 4-pk	3	ea	$150,400.00	$451,200
43.03	Priority panel / Valve panel assembly	1	ea	$120,000.00	$120,000
43.04	Valve panel controller	1	ea	$80,000.00	$80,000
43.05	LH2 pump, H35	2	ea	$191,988.50	$383,977
43.06	LH2 pump, H70	1	ea	$340,000.00	$340,000
43.07	Ambient Vaporizer, 500 BAR	2	ea	$101,090.00	$202,180
43.08	Ambient Vaporizer, 800 BAR	1	ea	$130,000.00	$130,000
43.09	Fluid Heat Exchanger, H35/H70, 1000 BAR	1	ea	$91,350.00	$91,350
43.10	H35 Dispenser w/ POS	2	ea	$232,680.00	$465,360
43.11	H70 Dispenser w/POS	1	ea	$322,500.00	$322,500
43.12	Fuel-management terminal	3	ea	$48,000.00	$144,000
43.13	Chiller w/ recirc pumps	1	ea	$55,000.00	$55,000
43.14	Duplex Air Compressor w/ receiver, dryer, & distribution lines	1	ea	$18,750.00	$18,750
43.15	SS Medium pressure piping, 1/4" dia.	200	lf	$81.25	$16,250
43.16	SS Medium pressure piping, 3/8" dia.	200	lf	$100.00	$20,000
43.17	SS Medium pressure piping, 9/16" dia.	200	lf	$137.50	$27,500
43.18	SS pneumatic/instrument air tubing, 1/2" dia.	500	lf	$27.50	$13,750
43.19	Vacuum jacketed piping	50	lf	$625.00	$31,250
43.20	Vacuum jacketed valve	10	ea	$4,375.00	$43,750
43.21	Foam pipe insulation	200	lf	$25.00	$5,000
43.22	Pipe sleeve, 1" ENT	1,000	lf	$5.00	$5,000
43.23	Motor starter assembly	4	ea	$52,500.00	$210,000

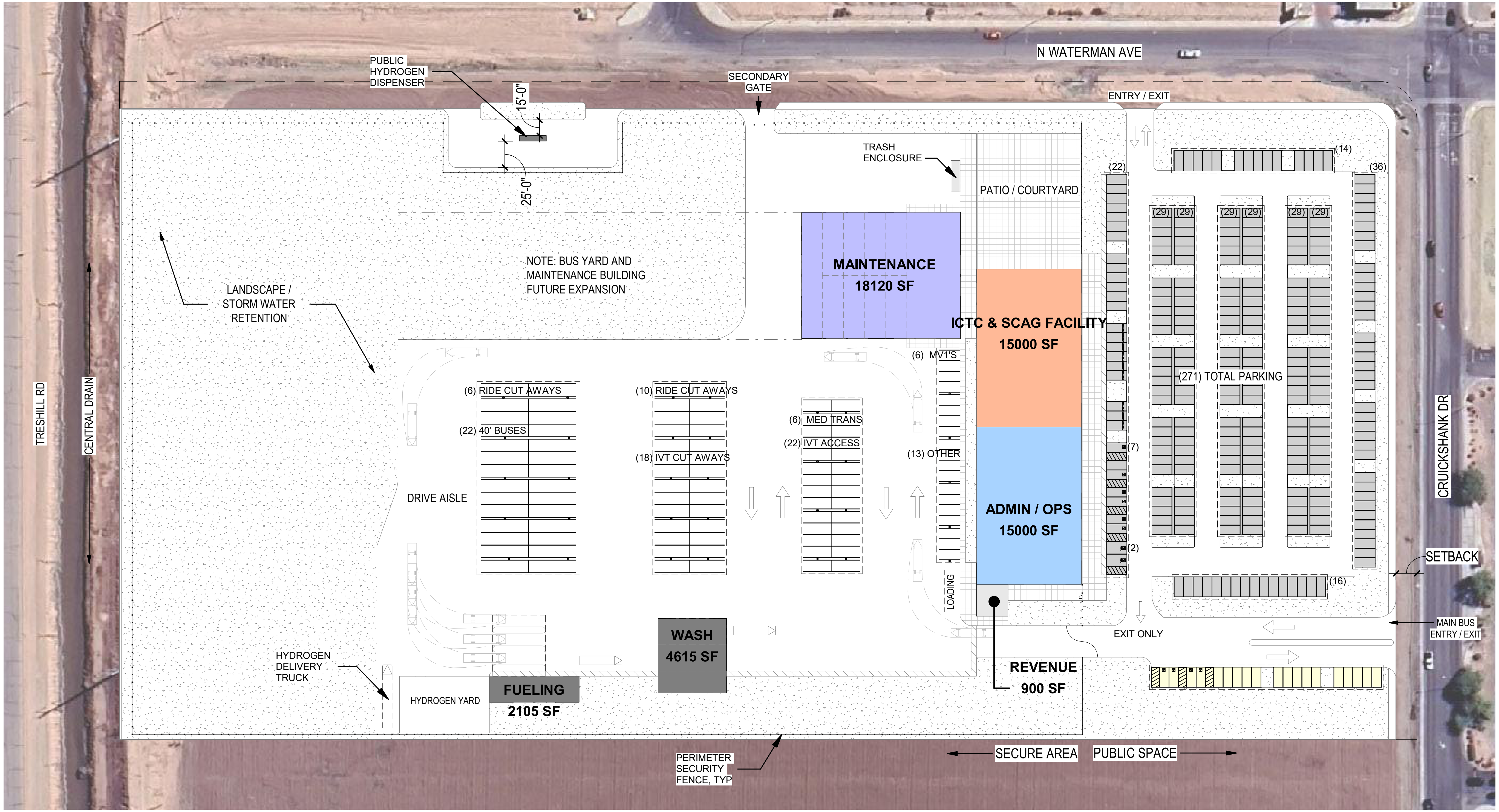
EQS CONSULTANTS construction cost management

IMPERIAL COUNTY TRANSPORTATION COMMISSION
HYDROGEN FUELING FACILITY - GENERIC LAYOUT

DETAILS - HYDROGEN FUELING YARD
ROM Statement of Probable Cost

16-Oct-23

No.	Item	Quantity	Unit	Unit Cost	Total Cost
43.24	Fire Extinguisher & signage	5	ea	$312.50	$1,563
43.25	Supports, piping & conduits	30	ea	$187.50	$5,625
43.26	Installation cost - 12 weeks	1	ls	$330,000.00	$330,000
43.27	Fuel management labor, tie-in & commission	1	ls	$5,500.00	$5,500
	Electrical Equipment				
43.26	Utility xfmr pad & incoming conduit	1	ea	$25,000.00	$25,000
43.27	Pad mtd xfmr, by utility co.				
43.28	Main switchboard, 800A	1	ea	$30,000.00	$30,000
0.01	Motor Control Console (MCC)	1	ea	$15,000.00	$15,000
43.27	Master Control Panel (MCP) w/ PLC & Com	1	ea	$100,000.00	$100,000
43.28	Backup Generator, 300KW and piping	1	ea	$80,000.00	$80,000
43.29	Automatic Transfer Switch	1	ea	$15,000.00	$15,000
43.30	Start up fuel	1,500	gal	$5.50	$8,250
43.31	Compound -area lighting, LED, pole	5	ea	$7,500.00	$37,500
43.32	Canopy lighting, LED	6	ea	$1,200.00	$7,200
43.33	Conduit & wire, lighting	700	lf	$35.00	$24,500
43.34	Conduit & wire, power	700	lf	$35.00	$24,500
43.35	Conduit & wire, sensor & control	700	lf	$25.00	$17,500
43.36	Gas & flame detection, allowance	1	ls	$60,000.00	$60,000
43.37	Grounding, allowance	1	ls	$3,500.00	$3,500
	Subtotal A				$6,022,245
	General Conditions, OH & Mobilization	17.5%			$1,053,893
	Subtotal B				$7,076,137
	Contractor's Profit	9.0%			$636,852
	Subtotal C				$7,712,990
	Bonds & Insurance	2.5%			$192,825
	Subtotal D				$7,905,814
	Design Contingency	20.0%			$1,581,163
	Subtotal E				$9,486,977
	Escalation to MOC - EXCLUDED				
	Subtotal F				$9,486,977
	Local Sales Tax	9.5%			$901,263
	Total Construction Cost - Hydrogen Fueling Yard				**$10,388,240**



Stantec

Stantec Proj No:
2073017500

Imperial County Transportation Commission
ICTC ZEB Plan

PROPOSED SITE PLAN CONCEPT - OPTION 1

PROJECT INFORMATION:

PROJECT ADDRESS:
CRUICKSHANK DR & N WATERMAN AVE
EL CENTRO, CA

LEGAL DESCRIPTION: APN 064-450-076

SITE AREA: 19.66 AC

TOTAL NUMBER OF PARKING SPACES:
REQUIRED EMPLOYEE PARKING: 165

PROVIDED EMPLOYEE PARKING: 271
(9) VISITOR
(7) ACCESSIBLE SPACES REQUIRED
(2) VAN ACCESSIBLE
(55) EV CAPABLE SPACES REQUIRED
W/ (14) EVSC [CALGREEN TABLE 5.106.5.3.1]

REVENUE VEHICLES SPACES:

FLEET VEHICLES	REQUIRED	PROVIDED
IVT 40' BUSES	22	22
IVT CUT AWAYS	18	18
IVT RIDE CUT AWAYS	16	16
IVT ACCESS	12	22
MED-TRANS	6	6
MV1s	6	6
OTHER VEHICLES	13	13
	93 TOTAL	103 TOTAL

SITE PLAN LEGEND

- POTENTIAL SOLAR CANOPY ABOVE
- EMPLOYEE PARKING
- PUBLIC CHARGING STATIONS
- LANDSCAPE
- HARDSCAPE / LANDSCAPE
- ADMIN / OPS
- ICTC & SCAG FACILITY
- MAINTENANCE
- FUELING / WASHING

SITE PLAN - OPTION 1

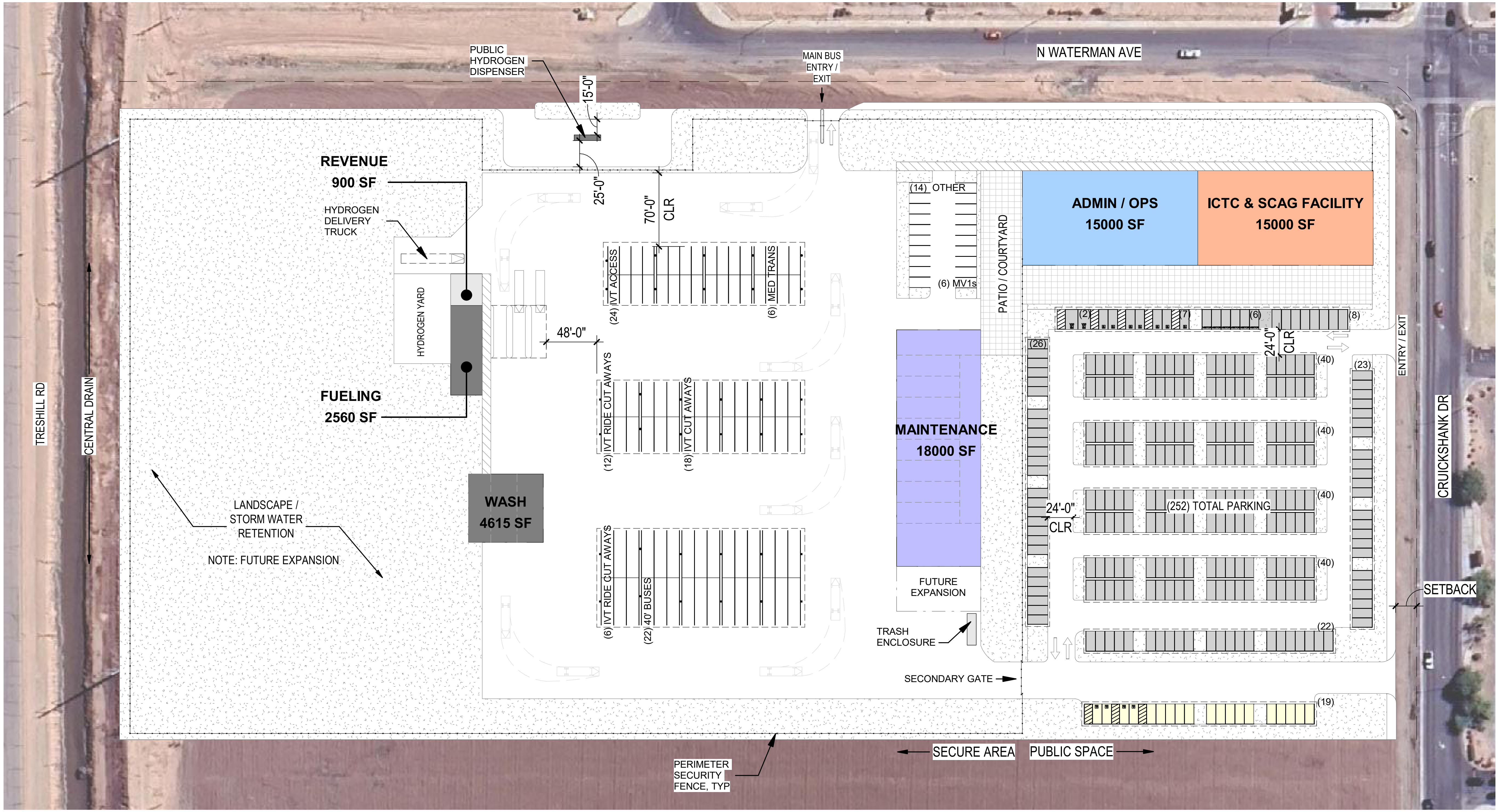
0' 25' 50' 100'

N

DATE:
07/08/24

DWG:

A-01



Stantec

Stantec Proj No: 2073017500

Imperial County Transportation Commission
ICTC ZEB Plan

PROPOSED SITE PLAN CONCEPT - OPTION 2

PROJECT INFORMATION:

PROJECT ADDRESS:
CRUICKSHANK DR & N WATERMAN AVE
EL CENTRO, CA

LEGAL DESCRIPTION: APN 064-450-076

SITE AREA: 19.66 AC

TOTAL NUMBER OF PARKING SPACES:
REQUIRED EMPLOYEE PARKING: 165

PROVIDED EMPLOYEE PARKING: 252
(6) VISITOR
(7) ACCESSIBLE SPACES REQUIRED
(2) VAN ACCESSIBLE
(51) EV CAPABLE SPACES REQUIRED
W/ (13) EVSC [CALGREEN TABLE 5.106.5.3.1]

REVENUE VEHICLES SPACES:

FLEET VEHICLES	REQUIRED	PROVIDED
IVT 40' BUSES	22	22
IVT CUT AWAYS	18	18
IVT RIDE CUT AWAYS	16	18
IVT ACCESS	12	24
MED-TRANS	6	6
MV1s	6	6
OTHER VEHICLES	13	14
	93 TOTAL	108 TOTAL

SITE PLAN LEGEND

- POTENTIAL SOLAR CANOPY ABOVE
- EMPLOYEE PARKING
- PUBLIC CHARGING STATIONS
- LANDSCAPE
- HARDSCAPE / LANDSCAPE
- ADMIN / OPS
- ICTC & SCAG FACILITY
- MAINTENANCE
- FUELING / WASHING

SITE PLAN - OPTION 2

0' 25' 50' 100'

N

DATE:
07/08/24

DWG:

A-02