CORPUS CHRISTI REGIONAL TRANSPORTATION AUTHORITY

AGENDA MEETING NOTICE

Board of Directors Meeting

DATE: Wednesday, March 1, 2023
TIME: 8:30 a.m.
LOCATION: Staples Street Center – *2ND Floor Boardroom, 602 North Staples St., Corpus Christi, TX*

BOARD OF DIRECTORS OFFICERS
Dan Leyendecker, Chair
Anna Jimenez, Vice Chair
Lynn Allison, Board Secretary (Rural and Small Cities Chair)

BOARD OF DIRECTORS MEMBERS
Gabi Canales (Administration & Finance Chair)
Eloy Salazar (Operations & Capital Projects Chair)
Aaron Muñoz (Legislative Chair)
Beatriz Charo Jeremy Coleman Armando Gonzalez
Erica Maymi Matt Woolbright

	TOPIC	SPEAKER	EST.TIME	REFERENCE
1.	**Pledge of Allegiance**	D. Leyendecker Ram Chavez, Vietnam Veteran	1 min.	-----
2.	**Roll Call**	M. Montiel	2 min.	-----
3.	**Safety Briefing**	J. Esparza	3 min.	-----
4.	**Receipt of Conflict of Interest Affidavits**	D. Leyendecker (L. Allison)	2 min.	-----
5.	**Opportunity for Public Comment** **3 min. limit – no discussion**	D. Leyendecker (L. Allison)	3 min.	-----
	Public Comment may be provided in writing, limited to 1,000 characters, by using the Public Comment Form online at www.ccrta.org/news-opportunities/agenda or by regular mail or hand-delivery to the CCRTA at 602 N. Staples St., Corpus Christi, TX 78401, and MUST be submitted no later than 5 minutes after the start of a meeting in order to be provided for consideration and review at the meeting. All Public Comments submitted shall be placed into the record of the meeting.			

ANNOUNCEMENT:

Under Section 551.074 of the Texas Open Meetings Act, the Board of Directors will be going into CLOSED SESSION in order to discuss – Agenda Item 6; Discussion (in closed session) – On the Selection of a New CEO, and Possible Action thereafter in Open Session

	TOPIC	SPEAKER	EST.TIME	REFERENCE
6.	**Discussion (in Closed Session)** on the Selection of a New CEO, and Possible Action thereafter in Open Session	D. Leyendecker (L. Allison)	20 min.	-----
7.	**Awards and Recognition –**	M. Rendón	5 min.	-----
8.	**Discussion and Possible Action** to Approve Board Minutes of the Board of Directors Meeting of February 1, 2023	D. Leyendecker (L. Allison)	3 min.	**Pages** 1-10

9.	**CONSENT ITEMS:** The following items are routine or administrative in nature and have been discussed previously by the Board or Committees. The Board has been furnished with support documentation on these items. **a)** **Action** to Adopt a Resolution to Support Low or No Emission Grant 5339(c) and Grant for Buses and Bus Facilities 5339(b) Consolidated FY2023 Funding Opportunity **b)** **Action** to Approve A Three-Year Contract for Federal Legislative Consulting Services with Cassidy & Associates, LLC **c)** **Action** to Approve A Three-Year Contract for State Legislative Consulting Services with Longbow Partners, LLP **d)** **Action** to Execute the Federal Transit Administration's Fiscal Year 2023 Certifications and Assurances **e)** **Action** to Approve a Three-Year Agreement for Employment Legal Services with Wood, Boykin & Wolters **f)** **Action** to Exercise Option Year Two (2) and increase in contract price with Enterprise Holdings, dba Commute with Enterprise for Vanpool Services		5 min.	**Pages** 11-25
10.	**Discussion and Possible** Action to Formally Approve the Legislative Program for the 88th Legislature	M. Rendón A. Muñoz/ J. Bell	3 min.	**Page** 26-28 Attachment A
11.	**Discussion and Possible** Action to Authorize the Chief Executive Officer to Execute a Plat of the Port-Ayers Property into a single parcel	S. Montez	3 min.	**Pages** 29-30 Attachment B
12.	**Committee Chair Reports** a) Administration & Finance b) Operations & Capital Projects c) Rural and Small Cities d) Legislative	 G. Canales E. Salazar L. Allison A Muñoz	 3 min. 3 min. 3 min. 3 min.	-----
13.	**Update** on RCAT Committee Activities	S. Montez	5 min.	*PPT*
14.	**Update** on Health Care Consulting/Risk Management Services with Roland Barrera Insurance	M. Rendón/ Roland Barrera	10 min.	*PPT*
15.	**Presentation** on Zero Emission Transition Plan	D. Majchszak/ Steve Clermont, CTE	20 min.	**Pages** 31-166 *PPT*
16.	**Presentations:** **a)** 2022 Annual Report for the Defined Benefit Plan **b)** January 2023 Financial Report **c)** March 2023 Procurement Update **d)** January 2023 Operations Report	R. Saldaña/ Lisa Keckler & Christopher Koeller, Principal Global Advisors R. Saldaña R. Saldaña D. Majchszak	25 min.	*PPT* **Pages** 167-177 *PPT* *PPT* **Pages** 178-187 *PPT*
17.	**Acting CEO Report**	M. Rendón	3 min.	*PPT*
18.	**Board Chair Report**	D. Leyendecker (L. Allison)	10 min.	-----
19.	**Adjournment**	D. Leyendecker (L. Allison)	1 min.	-----

Total Estimated Time: 2 hour 16 mins.

CORPUS CHRISTI REGIONAL TRANSPORTATION AUTHORITY

AGENDA MEETING NOTICE

On **Friday, February 24, 2023** this Notice was posted by **Marisa Montiel** at the CCRTA Staples Street Center, 602 N. Staples Street, Corpus Christi, Texas; and sent to the Nueces County and the San Patricio County Clerks for posting at their locations.

PUBLIC NOTICE is given that the Board may elect to go into executive session at any time during the meeting in order to discuss matters listed on the agenda, when authorized by the provisions of the Open Meetings Act, Chapter 551 of the Texas Government Code. In the event the Board elects to go into executive session regarding an agenda item, the section or sections of the Open Meetings Act authorizing the executive session will be publicly announced by the presiding officer.

In compliance with the Americans with Disabilities Act, individuals with disabilities who plan to attend this meeting and who may need auxiliary aids or services are requested to contact the Assistant Secretary to the Board at (361) 903-3474 at least 48 hours in advance so that appropriate arrangements can be made. Información en Español: Si usted desea esta información en Español o en otro idioma, por favor llame al telèfono(361) 289-2712.

Mission Statement

The Regional Transportation Authority was created by the people to provide quality transportation in a responsible manner consistent with its financial resources and the diverse needs of the people. Secondarily, The RTA will also act responsibly to enhance the regional economy.

Vision Statement

Provide an integrated system of innovative accessible and efficient public transportation services that increase access to opportunities and contribute to a healthy environment for the people in our service area.

CORPUS CHRISTI REGIONAL TRANSPORTATION AUTHORITY

CORPUS CHRISTI REGIONAL TRANSPORTATION AUTHORITY
BOARD OF DIRECTORS' MEETING MINUTES
WEDNESDAY, February 1, 2022

Summary of Actions

1. **Pledge of Allegiance**
2. **Roll Call**
3. **Heard Safety Briefing**
4. **Receipt of Conflict of Interest Affidavits – None Received**
5. **Provided Opportunity for Public Comment**
6. **Presented Awards and Recognition**
   a) **Police Officer of the Year**
   b) **Security Guard of the Year**
7. **Approved Board of Director Meeting Minutes of January 11, 2023**
8. **Approved the Proposed 2022-2023 RTA Legislative Agenda**
9. **Awarded a Five (5) Year Contract to EQUANS-INEO SYSTRANS USA Inc. for a BUS CAD/AVL System**
10. **Adopted a Resolution for the Proposed Changes to the Reserve Policy and Re-Certified the Designations of the Reserves from the Unrestricted Portion of the Fund Balance and the Methodologies to Use in Determining Funding Levels**
11. **Awarded a Three (3) Year Contract to Minnesota Life (Ochs, Inc.) for Life Insurance and Accidental Death and Dismemberment**
12. **Confirmed the Appointment of Ms. Imelda Trevino, as the Chairperson of RTA's Committee on Accessible Transportation (RCAT)**
13. **Heard Update on RCAT Committee Activities**
14. **Heard Committee Chair Reports**
    a) **Administration and Finance**
    b) **Operations and Capital Projects**
    c) **Rural and Small Cities**
    d) **Legislative**
15. **Heard Presentations –**
    a) **December 2022 Financial Report**
    b) **February 2023 Procurement Update**
    c) **December 2022 Operations Report**
    d) **October-December 2022 Safety and Security Report**
16. **Heard Acting CEO Report**
17. **Heard Boar Chair Report**
18. **Adjournment**

The Corpus Christi Regional Transportation Authority Board of Directors met at 8:30 a.m. in the Corpus Christi Regional Transportation Authority Staples Street Center facility located at 602 N. Staples Street, 2nd Floor Board Room, Corpus Christi, Texas.

CORPUS CHRISTI REGIONAL TRANSPORTATION AUTHORITY

Call to Order & Roll Call

Dan Leyendecker, Board Chair, called the meeting to order at 8:33 a.m., and welcomed and gave a brief introduction for Mr. JJ De La Cerda, U.S. Marine Corps Veteran, to lead the Pledge of Allegiance. Ms. Montiel called roll and it was noted that a quorum was present.

Board Members Present

Dan Leyendecker, Lynn Allison, Gabi Canales (virtual), Beatriz Charo, Jeremy Coleman, Armando Gonzalez, Anna Jimenez, Erica Maymi, Aaron Muñoz, Eloy Salazar and Matt Woolbright.

Board Members Absent

None.

Staff Present

David Chapa, Angelina Gaitan, John Esparza, Derrick Majchszak, Sharon Montez, Rita Patrick, Mike Rendón, Robert Saldaña and Marisa Montiel.

Public Present

Robert Lott and Nick Berg with SEC-OPS, Inc., JJ De La Cerda, Nueces County and Imelda Trevino, WFSCB. Isabel Ariaga, Eduardo Canales and Dorothy Pena with For the Greater Good. Mariah Boone and Marigold Boone with Vulnerable Communities Defense League.

Safety Briefing

Mr. John Esparza, Safety and Security Administrator, presented the safety briefing to the Board and audience. He noted that if there is an emergency, the audience would exit the boardroom to his right and proceed down to the first floor where they would exit through the westside door. Once outside, they would continue to the clock tower adjacent to the transfer station. Ms. Montiel will account for all Board Members and he would be the last out to ensure everyone exits safely. He noted to not use the elevator during an emergency, do not return until all clear has been given and if a shelter in place is needed, they would do so in the Westside stairwell.

Receipt of Conflict of Interest Affidavits

There were no Conflict of Interest Affidavits received.

Opportunity for Public Comment

1. Isabel Araiza, For the Greater Good, noted that she would like for the RTA to discontinue hostile architecture that is contaminating the area. She states she has relied on public transportation for three years and it is frustrating and the bars don't do anything in terms of meeting the needs of the people. She says she would rather see RTA use their social, political and economical capital to engage with the City of Corpus Christi to address the issue of house-lessness. She notes that there are more humane ways to serve the public.

2. Eduardo Canales, For the Greater Good, notes that he resides in Corpus Christi, TX. He says he echoes what Ms. Araiza just said. He said he did a survey of the benches from Yorktown to Staples and all of them had the bars. He wanted to note how important it is for the RTA to use their resources and be proactive in regards to house-lessness. He says the bars do not aid the cause. He says it is cruel and does not believe the RTA has done anything to help the issue.
3. Mariah Boone, Vulnerable Communities Defense League, was also there to speak out against the hostile architecture. She notes that the busses do not run late into the night and there are no reasons why individuals should be prohibited to lay down and rest at night. She says that no one would do that unless they were desperate and it is cruel and dangerous to prevent them from doing so. She states that un-housed individual's crime rates are lower than the general public. She says the hostile architecture only adds to the image that un-housed people are dangerous and different. She continues that un-housed people need help, not discrimination and says she does not want her tax dollars or fares to be used towards this hostile architecture. She hopes the RTA will consider removing the bars.
4. Miracle Boone, Vulnerable Communities Defense League, she opens that these bus stops are paid for by the citizens of Corpus Christi and should be accessible to all of them. Ms. Boone says that by placing the hostile architecture, it is making it harder to stop and rest and is discriminatory to the disabled and to the un-housed community. She continues that by targeting the vulnerable community, placing the hostile architecture and preventing them to rest is cruel and should not be paid for by the citizens of the community. She states that the City makes it clear that instead of having empathy for people that are going through a difficult time, it is showing the opposite and says people should just look away. She asks that instead of placing the hostile architecture, they remove it.
5. Dorothy Pena, For the Greater Good, she asked for the RTA to remove the bars from the bus stops. She said in 2015, she was house-less. She said there was nowhere to go, it was cold and she just would look for somewhere to rest. She says the bars at the bus stops just prevent people from resting and it is dehumanizing. She asks that everyone just be better people. She stated it is really discouraging and if she had a voice to say where she would like where her tax payer dollars to actually go, it would not be to this. She asked that the RTA use the funds towards a plan that will actually help the issue.

Awards and Recognitions

Mr. Mike Rendón, Acting CEO opened up by commenting on how exciting this morning was for him being involved in the Safety & Security department.

a) **Police Officer of the Year, Sgt. Michael James –** Mr. Rendón noted Sgt. James has worked as a Police Officer with the CCISD Police Department and has 28 Years of law enforcement experience. He has been on bike patrol, boat patrol, SWAT, active shooter and firearms instructor. Mr. Rendón gave additional family background on Sgt. James and thanked and congratulated him for his service.
b) **Security Guard Officer of the Year, Sandra Lee –** She has worked with SEC-Ops for three years and started off as a Security Officer. Based on her performance, she was

promoted to Sgt. to supervise five security officers working at the Nueces County Courthouse. After that, she promoted to Lieutenant at CCRTA to supervise fourteen security officers working in six different locations. This past year, she has been directly responsible for training and supervising more than thirty different security officers. Mr. Rendón gave background on her family, thanked and congratulated her for her service.

Sgt. James and Lt. Lee both gave a few words of appreciation, the awards were presented and photos were taken with the group.

Discussion and Possible Action to Approve the Board of Directors Meeting Minutes of January 11, 2023

DIRECTOR MATT WOOLBRIGHT MADE A MOTION TO APPROVE THE BOARD OF DIRECTORS MEETING MINUTES OF JANUARY 11, 2023. DIRECTOR JEREMY COLEMAN SECONDED THE MOTION. *ALLISON, CHARO, CANALES, COLEMAN, GONZALEZ, JIMENEZ, LEYENDECKER, MAYMI MUÑOZ, SALAZAR AND WOOLBRIGHT VOTING IN FAVOR. ABSENT NONE.*

Disscussion and Possible Action to Approve the Proposed 2022-2023 RTA Legislative Agenda

Director Muñoz introduced the item going over the general overview and the four main points. He discussed one legislative goal is to allow other political subdivisions to utilize the RTA's natural gas fueling during emergency situations, permitting that taxes are collected and permitted. Next, he discussed the fare approval committee and the need to have a better process and flexibility in getting fares approved under 451.061. Another goal he discussed is to preserve and ensure funding for alternative fuel and clean energy opportunities. Secretary Allison asked for bullet points as a quick reference for the Board when speaking to their constituents. Director Muñoz said he will work with Tris to get those.

SECRETARY ALLISON MADE A MOTION TO APPROVE THE PROPOSED 2022-2023 RTA LEGISLATIVE AGENDA. DIRECTOR AARON *MUÑOZ* SECONDED THE MOTION. *ALLISON, CHARO, CANALES, COLEMAN, GONZALEZ, JIMENEZ, LEYENDECKER, MAYMI MUÑOZ, SALAZAR AND WOOLBRIGHT VOTING IN FAVOR. ABSENT NONE.*

Discussion and Possible Action to Award a Five (5) Year Contract to EQUANS-INEO SYSTRANS USA Inc. for a BUS CAD/AVL System

Mr. Robert Saldaña noted that Mr. Stephan the CEO of EQUANS-INEO was in the audience and noted the Board Priority of Innovation. Next, he provided background on the item stating CCRTA's current Computer-Aided Dispatch (CAD), Automatic Vehicle Location (AVL) Clever Devices DRI, has been CCRTA's primary system since 2009. There are 65 Fixed-Route Buses that use the Clever Devices DRI CAD/AVL System. He noted the system and equipment have reached the end of their useful life. The replacement of the

CAD/AVL system will address five major areas of need, improve on-time performance, improve dispatch reliability/efficiency, improve scheduling/planning, improve data management/reporting and increase ridership. After the five proposals were received, pricing was opened up and scored after each technical scoring. He displayed a table of the top three firms and their scoring. EQUANS-INEO came in with the highest score of 150.35. There is no DBE requirement and funds were identified in the MIS 2021 & 2022 Capital Budget using funding provided by the 5339 Formula Grant Funds with a 80/20 match. The total five-year cost for the Bus CAD/AVL System is $2,036,605.80. At this time, he answered any questions the Board had. Director Woolbright asked for clarification on how many systems are currently being used and if this one is better than the others. Mr. Saldaña stated two systems and the performance is better in their opinion. Director Woolbright asked about the price comparison. Mr. Saldaña said all three proposed systems could do the job but EQUANS is the best value in their opinion. Director Maymi asked if this is the system that started off in testing and if this is in the buses or at Bear Lane. Mr. Saldaña replied yes, it started off as a pilot and yes, they are in both and communicate with each other.

> **DIRECTOR JEREMY COLEMAN MADE A MOTION TO AWARD A FIVE (5) YEAR CONTRACT TO EQUANS-INEO SYSTRANS USA INC. FOR A BUS CAD/AVL SYSTEM. VICE CHAIR ANNA JIMINEZ SECONDED THE MOTION. *ALLISON*, *CHARO*, *CANALES*, *COLEMAN, GONZALEZ, JIMENEZ, LEYENDECKER, MAYMI MUÑOZ, SALAZAR AND WOOLBRIGHT VOTING IN FAVOR. ABSENT NONE.***

Discussion and Possible Action to Review and Recertify the Reserve Policy

Mr. Robert Saldaña opened up with stating the Board Priority is Public Image and Transparency. He noted that the policy is staying intact, they are just adding some language in there to reinforce the policy. The policy was last updated in November 4, 2020 and the reserves recertified were the Operating Reserve, Capital Reserve and the Employee Benefits Reserve. The Calculating Methodology remained unchanged. He discussed the current and proposed methodology for each of those reserves. The recommendation is the retention of the three reserves and calculating a methodology for each. The recommended policy change would be to identify primary risk factor for each reserve to provide clarity to the intended use of each reserve. Operating Reserve – provide contingencies for revenue volatility. Capital Reserve – provide cash reserves to cover local match plus average 3-day float for receiving federal funding reimbursements. Employee Benefits Reserves – shield the Authority from the impacts of economic uncertainties that may affect employee benefit costs. Also, to require the effective dates of implementation, whether the change is temporary or permanent, and current and long-term effects. Also, to limit decreases to the Operating Reserve Account to maintain the minimum balance required by the Texas Transportation Code at not less than an amount equal to two months of actual operating expenses. At this time, he answered any questions the board had. Chair Leyendecker reminded the Board that they are all fiduciaries and reminded them that they are required to stay up to date on their training. Director Woolbright asked what the Employee Benefits

Reserve covers. Mr. Saldaña replied the medical costs and the unfunded portion of the liabilities of the pension plan. Director Woolbright asked what the cost would be for the changes and Mr. Saldaña noted there are no costs, it is just adding verbiage to strengthen the policy.

DIRECTOR MATT WOOLBRIGHT MADE A MOTION TO ADOPT A RESOLUTION FOR THE PROPOSED CHANGES TO THE RESERVE POLICY AND RE-CERTIFYING THE DESIGNATION OF THE RESERVES FROM THE UNRESTRICTED PORTION OF THE FUND BALANCE AND THE METHODOLOGIES TO USE IN DETERMINING FUNDING LEVELS. SECRETARY ALLISON SECONDED THE MOTION. *ALLISON*, *CHARO*, *CANALES*, *COLEMAN, GONZALEZ, JIMENEZ, LEYENDECKER, MAYMI MUÑOZ, SALAZAR AND WOOLBRIGHT VOTING IN FAVOR. ABSENT NONE.*

Discussion and Possible Action to Award a Three (3) Year Contract to Minnesota Life (Ochs, Inc.) for Life Insurance and Accidental Death and Dismemberment

Ms. Angelina Gaitian, Director of Human Resources, opened up with stating the Board Priority is Transparency. She noted CCRTA provides group life and accidental death and dismemberment coverage at no cost to the employee at a maximum amount of $100,000. Employees are able to voluntarily purchase additional coverages for spouse/children as well as supplemental coverage for themselves and the premium is paid by the employee. Minnesota Life currently administers the life insurance products since 2012. Next, she displayed the table of the RFP evaluation breakdown. Minnesota Life (Ochs, Inc.) came in with the highest score of 92.74. The annual basis cost is estimated at approximately $98,342 and is 100% budgeted within individual operating department budgets. The cost is split between CCRTA & Employee Voluntary. At this time, she answered any questions the Board had. Director Salazar thanked the staff for brining in multiple proposals for comparison.

DIRECTOR BEATRIZ CHARO MADE A MOTION TO AWARD A THREE (3) YEAR CONTRACT TO MINNESOTA LIFE (OCHS, INC.) FOR LIFE INSURANCE AND ACCIDENTAL DEATH AND DISMEMBERMENT. DIRECTOR ERICA MAYMI SECONDED THE MOTION. *ALLISON*, *CHARO*, *CANALES*, *COLEMAN, GONZALEZ, JIMENEZ, LEYENDECKER, MAYMI MUÑOZ, SALAZAR AND WOOLBRIGHT VOTING IN FAVOR. ABSENT NONE.*

At this time, Chair Leyendecker had to excuse himself from the meeting and turned the meeting over to Vice-Chair Jimenez.

Discussion and Possible Action to Confirm Appointment of Chairperson of RTA's Committee on Accessible Transportation (RCAT)

Ms. Sharon Montez, opened up by providing the background for the process and selection and confirmation of RCAT members, which is outlined in RCAT Bylaws Article 4, Section Three and reads that the Chairperson for RCAT is appointed by the Chairperson for the

RTA Board of Directors. She provided background information on the recommended appointee, Ms. Imelda Trevino, who is currently an RCAT member. She currently works as a Student Hire Ability Navigator which services as a liaison between Texas Workforce Commission, Vocational Rehabilitation Services and the community. She was recently recognized as one of three mentors for the Student Hire Ability Navigator Program Texas. She also serves on the City of Corpus Christi Committee for Person with Disabilities. She asked the Board if they had any questions and heard none.

DIRECTOR ELOY SALAZAR MADE A MOTION TO CONFIRM THE APPOINTMENT OF MS. IMELDA TREVINO, AS THE CHAIR OF RTA'S COMMITTEE ON ACCESSIBLE TRANSPORATION. DIRECTOR ERICA MAYMI SECONDED THE MOTION. *ALLISON*, *CHARO*, *CANALES*, *COLEMAN, GONZALEZ, JIMENEZ, MAYMI MUÑOZ, SALAZAR AND WOOLBRIGHT VOTING IN FAVOR. ABSENT LEYENDECKER.*

Update on the RCAT Committee Activities

Ms. Sharon Montez, Managing Director of Capital Projects and Customer Services, gave the RCAT Committee Update. She noted their last meeting was held on January 19th and she gave the committee updates that were presented at the November and December CEO's Report Information, Update on Final Plan of Long-Range System Plan, Update on November 2022 Operations Report and November 2022 B-Line Operations Metric Report. She displayed the B-Line Service Performance Report and noted no issues. The next RCAT Committee meeting will be held on February 16th.

Committee Chair Reports

Director Canales had nothing new to report for the Administration and Finance Committee. Director Salazar had nothing new to report for the Operations and Capital Projects Committee but reiterated how important it is to receive multiple proposals for contracts. Secretary Allison reported for the Rural and Small Cities Committee and asked Mr. Majchszak a couple of questions regarding the bus replacements in Port Aransas. Director Muñoz reported for the Legislative Committee and noted that they has been working with State Consultant and Mr. Bell to move forward with the legislative initiatives. Mr. Muñoz noted that he along with Chair Leyendecker, Secretary Allison and Mr. Rendón took a trip to Austin and had productive meetings with Senators and Representatives to help build a stronger presence and advocate for the RTA's initiatives.

Presentations

a) December 2022 Financial Report

Mr. Robert Saldaña presented the December financials and noted that the item aligns with the Board Priority of Public Image & Transparency. He presented the highlights for the month stating Bus Advertising was 155.58% of baseline, Investment Income was 4,943.6% of baseline and Operating Expenses were 105.52% of baseline. He displayed the December 2022 Income Statement Snapshot. Total revenues came in at $4,218,491 and total expenses were

$3,630,912. He displayed the revenue categories. The operating vs. non-operating revenue was displayed and discussed. The total operating revenues were $441,061. Next, he discussed and displayed a pie chart of where the money went. Mr. Saldaña showed the expenses by object for December. Purchased Transportation was 22%, Miscellaneous 2%, Supplies 8%, Salaries and Wages 36%, Benefits 11%, Services 18%, Utilities 2% and Insurance was 1%. The total Departmental Operating expenses were $3,075,434. He presented the YTD for the month of December stating the Bus Advertising was 121.69% of baseline, Investment Income was 2,082.68% of baseline, Sales Tax Revenue 101.55 % of Baseline and Federal, State and Local Grant assistance 99.70% of baseline. He presented the income YTD statement for December stating total revenues were $53,330,316 on a budget of $52,016,776, total expenses were $43,598,336 on a budget of $47,555,362. He displayed the revenue by category year to date. He summarized where the money went year to date and expenses by object year to date. Mr. Saldaña discussed the fare recovery ratio. The current YTD FRC is 2.64%. Mr. Saldaña displayed the sales tax update for November in which $3,078,095 was received. Mr. Saldaña then answered any questions the board had.

b) <u>February Procurement Update</u>

Mr. Robert Saldaña noted this item aligns with the Public Image and Transparency priority. He discussed the current procurements, the purchase, restoration and repurposing of the Kleberg Bank Building for a six-month contract. Occupational Medical Services with The Doctor's Center for a three-year contract for $100,000 and General Architectural and Engineering Services with Hanson Professional Services, Inc. for a Three-Year Contract with Two One-Year Options for $150,000. The total of current procurements is $250,000. The three-month outlook under the CEO signature authority was displayed next. All of these items are $50,000 or less. HVAC services for $42,500, Towing Services with Morgan Towing for $26,734, Memorandum of Agreement – Paisano Transit Demand Response Services for $16,727, Generator Services with Cummins Inc. for $21,917, Memorandum of Agreement – REAL Demand Response Services for $34,603, On-Board APC System Warranty & Software Licensing for $17,486 and Commercial Custodial Services for $33,685. These total $193,652. Mr. Saldaña closed with stating the Marina Space with the City of Corpus Christi is about $6,840.

d) <u>December 2022 Operations Report</u>

Mr. Derrick Majchszak noted the board image for this item is Public Image and Transparency. He provided the highlights for the month of December 2022 vs. December 2021. The Passenger Trips were up 12.4%, the Revenue Service Hours were up 3.8% and the Revenue Service Miles were up 7.7%. He displayed the RTA System Monthly Ridership Trends and the System-Wide Monthly Ridership by Mode. He noted the system overall was up 12.4% but down -41.2% vs. pre-covid. For YTD System Wide Ridership by mode, the system is overall up by 18.2% but down -46.4% vs pre-covid. The Fixed-Route Bus Service was up 17.6% but down -48.5% vs pre-covid. Next, he displayed the 2022 4th Quarter Cost per Passenger by Service Mode. He displayed the system-wide YTD Ridership by Mode chart. Next, he discussed the fixed route bus on-time performance and reported no issues. He displayed a list of the upcoming impacts and pointed out the total number of bus stops currently impacted or remain closed is 44 and 57 additional bus stops to be impacted or possibly closed due to these impacts. The B-Line service passengers per hour did not meet the performance standard and reported no issues. The recent cold period had a lot of same day cancellations. There were seven customer assistance forms for the month, with no issues reported. The miles between road calls and the large bus fleet exceeded the standards as well with no issues. At this time, Mr. Majchszak answered any questions the Board had. Director Coleman asked for an update on the intersection at Lipan and Comanche that they recently discussed discussed and Mr. Majchszak noted an assessment has been done and Ms. Montez is looking at the right-of-way to see if the bus stop can be pushed further away from the intersection and is underway.

e) **<u>October-December 2022 Safety and Security Report</u>**

Mr. Rendón opened up with stating this report starts from the Trainers, to the administrators, to Operations, then to Marketing and it is a team effort. The collision rate for October was 2.30, November was 0.98 and December it was 1.44. The Operators drove a total 630,000 miles. The Year-to-Date collision rate is 1.39 and 2021 was 1.38. Mr. Rendón displayed the Security Contacts with individuals' chart and totaled 1,014 contacts. Next, he provided security updates for the Staples Street Center, Robstown Police Department- K-9 Unit and the Rover.

<u>CEO Report</u>

Mr. Mike Rendón opened up with proving the CEO update by providing the Legislative Update. The CCRTA Board and Leadership met with key political stakeholders from January 23rd-26th. They were productive meetings with Senator Hinojosa, Senator LaMantia, Representative Hunter and Representative Lozano. He noted that Representative Hunter said that they need to be present in Austin at least two times a month to make good headway. Mr. Rendón provided a re-cap of the Small Cities Committee Lunch presentation that was held on January 12th and noted there was great attendance from the Small Cities. Next, he announced the CCRTA Transforming CCRTA Wellness Campaign and noted all the opportunities and resources available to help employees work toward a physically and mentally healthier lifestyle. He also discussed the Mental Wellness "Maintaining a Respectful Workplace" campaign to promote a healthy workplace. Mr. Rendón displayed and discussed all of the community event involvement, transportation initiatives and engagement assisting the community CCRTA has been involved in recently. Next, he was happy to announce that through combined efforts of CCRTA's Board of Directors, Acting CEO, and community partners, CCRTA was able to adjust route 28 service and is able to provide service to Metro Ministries, despite continued heavy construction in the area. Lastly, he provided operation and project highlights providing updates on the shelter expansion program, Del Mar College and Port Ayers Transfer Station Construction updates. He displayed an upcoming events calendar.

CORPUS CHRISTI REGIONAL TRANSPORTATION AUTHORITY

Board Chair Report

Vice Chair Jimenez Leyendecker opened up the floor to the Board Members and they all went down the line to speak. Many of the Directors said good job to the staff and thanked them for the community involvement. Director Salazar said good job on the contracts. Director Coleman thanked the staff for sending representatives to the Habitat for Humanity Presentation. Director Muñoz acknowledged the Safety Staff and noted that Senator Lamantia recognized the work of the RTA and it was a proud moment for him.

Adjournment

There being no further review of items, the meeting adjourned at 10:13 a.m.

____

Lynn Allison, Board Secretary

Submitted by: Marisa Montiel

CORPUS CHRISTI REGIONAL TRANSPORTATION AUTHORITY

Board of Directors Meeting Memo March 1, 2023

Subject: Adopt a Resolution to Support Low or No Emission Grant 5339(c) and Grant for Buses and Bus Facilities 5339(b) Consolidated FY2023 Funding Opportunity

Background

The Federal Transit Administration released a Notice of Funding Opportunity on January 27, 2023, announcing the opportunity to apply for $1.7 billion in FY 2023 funds to support state and local efforts to modernize aging transit fleets with low- or no- emission buses, renovate and construct bus facilities, and support workforce development.

FTA's Low or No Emission (Low-No) Program – 5339(c) and Buses and Bus Facilities Competitive Program 49 U.S.C. 5339 (b), helps transit agencies buy or lease U.S.-built zero-emission and low-emission transit buses along with charging equipment and supporting facilities. Both programs support buses that reduce air pollution and help meet current federal goals of net-zero emissions by 2050.

FTA's Grants for Buses and Bus Facilities Program – 5339(b), supports transit agencies in buying and rehabilitating buses, vans, and related equipment and building bus facilities. The Bipartisan Infrastructure Law provides nearly $2 billion over five years for the program. For Fiscal Year 2023, approximately $469 million for grants will be available.

Funds remain available for obligation for both funding opportunities for four fiscal years. This includes the fiscal year in which the amount is made available or appropriated plus three additional years.

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

The grant applications will need to be submitted by 11:59PM EST on April 13, 2023.

Identified Need

FTA has structured the funding opportunity to advance key national priorities such as replacing old buses, providing good-paying jobs, improving transit affordability and reliability, advancing community health and environmental justice, and contributing to the President's goal of net-zero emissions by 2050.

The grant funds would be used for the transition of CCRTA's fleet to the lowest polluting and most energy-efficient transit vehicles, supporting infrastructure, and a rural transfer station with park and ride capabilities. Grant application will be prepared with assistance and information garnered from the Center for Transportation and the Environment's (CTE) transition feasibility study.

The FTA is striving to speed up the deployment process for electric buses and is allowing for agencies to pre-select their teams before the grant submittal process, in an effort to move things along more quickly.

Under the State of Texas, Chapter 451 regulations, the CCRTA must issue a Request for Proposals for the procurement of zero-emission electric transit buses, even though the FTA has waived the competitive procurement process. However, a contract will not be awarded unless a grant is received. The same holds true for a contract with the Center for Transportation and the Environment.

The CCRTA will post a notice in accordance with the state statute for the Request for Proposals for the potential procurement of electric buses and for the potential contract for professional services with the Center for Transportation and the Environment, due to the deadline for the grant submittal. The CEO requested and obtained authorization from the Chairman to move forward with the aforementioned items.

Participants for 5339(c)
Currently, the anticipated participants in the Low or No Emission Vehicle Program 5339(c) include the Center for Transportation and the Environment (CTE).

Analysis
CCRTA is working with CTE to identify all the items to ensure compliance with state and federal guidelines. In addition, CCRTA is currently working on identifying the most suited routes for electric buses and charging station locations.

Financial Impact
The estimated amount is not to exceed $22 million.

Recommendation
Staff requests the Board of Directors adopt a Resolution to Support Low or No Emission Grant and Grant for Buses and Bus Facilities Consolidated FY2023 Funding Opportunity by authorizing the Chief Executive Officer or designee to execute and submit applications for:

- The Low or No Emission Vehicle Program 5339(c) and
- Buses and Bus Facilities Competitive Program 49 U.S.C. 5339(b)

Respectfully Submitted,

Submitted by: Derrick Majchszak
Managing Director of Operations

Final Approval by: Rita Patrick for____
Miguel Rendón
Acting Chief Executive Officer

Corpus Christi
Regional Transportation Authority

Resolution

IN SUPPORT OF LOW OR NO EMISSION BUSES & FACILITIES AND A RURAL TRANSFER STATION

WHEREAS, the Corpus Christi Regional Transportation Authority has a long-term goal of identifying and implementing alternative forms of transportation in order to address lower emissions, reduce operating costs, enhance safety, and attain quieter transportation.

WHEREAS, the Corpus Christi Regional Transportation Authority is pursuing the construction of a rural transfer station in Robstown, Texas in order to improve transportation accessibility for the region's workforce in order to enhance the regional economy and create greater economic sustainability.

NOW THEREFORE, BE IT RESOLVED BY THE CORPUS CHRISTI REGIONAL TRANSPORTATION AUTHORITY BOARD OF DIRECTORS THAT:

Section 1. The Board hereby declares its support for low or no emission buses and infrastructure in order to address alternative forms of transportation, lower collective emissions, reduce operating costs, enhance safety, and attain quieter transportation.

Section 2. The Board also hereby declares its support for the development of a rural transfer station in Robstown, Texas in order to improve transportation accessibility for the region's workforce in order to enhance the regional economy and create greater economic sustainability.

Section 3. The Board further declares its intention to support the exploration of grant opportunities for the electric vehicle program and rural transportation facilities that would reduce carbon emissions, improve transportation accessibility for the service area's workforce, reduce operating costs, and enhance transit safety and reliability for our transit system.

DULY PASSED AND ADOPTED this ____ day of March, 2023.

ATTEST:

CORPUS CHRISTI REGIONAL TRANSPORTATION AUTHORITY

____
Miguel E. Rendón
Acting Chief Executive Officer

____
Dan Leyendecker
Chairman of the Board

CORPUS CHRISTI REGIONAL
TRANSPORTATION AUTHORITY

Board of Directors Meeting Memo March 1, 2023

Subject: Approve A Three-Year Contract for Federal Legislative Consulting Services with Cassidy & Associates, LLC

Background

CCRTA contracts for federal consulting services to assist with legislative action, Federal Transit Administration (FTA) requests, grant applications, and other congressional-related items. CCRTA currently contracts with Cassidy & Associates, LLC (Cassidy & Associates) to provide specialized grant work and follow-up legislative actions. Cassidy & Associates assisted the CCRTA in earning competitive federal grant awards in 2019.

Identified Need

Cassidy & Associates would assist with any future competitive grant applications. The consulting services provided by Cassidy & Associates have been exceptional. Leadership would like to continue this partnership going forward

The current contract is scheduled to expire on March 31, 2023.

Disadvantaged Business Enterprise

While federal funds would not be used, staff will encourage Cassidy & Associates to outreach to minority, women-owned, and disadvantaged businesses.

Financial Impact

The three-year agreement costs are as follows:

- Federal Legislative Consulting Services
  - Annually $126,000 per year to be apportioned in monthly payments of $10,500
    - Total amount of the contract for 3 years would be $378,000
  - Cassidy & Associates would have the option to expense the CCRTA for pre-approved business expenses and travel

Board Priority

The Board Priority aligns with Transparency.

Recommendation

Staff requests the Board of Directors authorize the Acting Chief Executive Officer (CEO) or designee to approve a contract for Federal Legislative Consulting Services to Cassidy & Associates, LLC, for a Three-Year Period Effective April 1, 2023.

Respectfully Submitted,

Final Approval by: ____Rita Patrick__for__
Miguel Rendón
Acting Chief Executive Officer

Board of Directors Meeting Memo March 1, 2023

Subject: Approve A Three-Year Contract for State Legislative Consulting Services with Longbow Partners, LLP

Background
CCRTA contracts for State consulting services to assist with state legislative initiatives, the legislative process, access, and identification of discretionary funding opportunities. CCRTA currently contracts with Longbow Partners, LLP, (Longbow Partners) to provide state legislative consulting services.

Identified Need
Longbow Partners are currently working to help legislation amend and create transportation laws that would benefit the CCRTA. The state legislative services provided by Longbow Partners have been excellent and management would recommend we continue with these services.

The state legislative consulting services contract is scheduled to expire on June 5, 2023. CCRTA would like to begin a new agreement that would replace the current contract. The new agreement would align with the federal legislative consultant contract's dates.

Disadvantaged Business Enterprise
While federal funds would not be used, staff will encourage Longbow Partners to outreach to minority, women-owned, and disadvantaged businesses.

Financial Impact
The three-year agreement costs are as follows:

- State Legislative Consulting Services
  - Annually $75,000 per year to be apportioned in monthly payments of $6,250
    - Total amount of the contract for 3 years would be $225,000
  - Longbow Partners would have the option to expense the CCRTA for pre-approved business expenses and travel

Board Priority
The Board Priority aligns with Transparency.

Recommendation
Staff requests the Board of Directors authorize the Acting Chief Executive Officer (CEO) or designee to approve a contract for State Legislative Consulting Services to Longbow Partners, LLP, for a Three-Year Period Effective April 1, 2023.

Respectfully Submitted,

Final Approval by: _Rita Patrick_for___
Miguel Rendón
Acting Chief Executive Officer

CORPUS CHRISTI REGIONAL
TRANSPORTATION AUTHORITY

Board of Directors Meeting Memo March 1, 2023

Subject: Authorize to Execute and Submit the Federal Transit Administration (FTA) 2023 Certifications and Assurances

Background

Since 1995, the FTA has been consolidating the various Certifications and Assurances that may be required of its grant applicants and their projects into a single document for publication in the Federal Register. FTA also requires a current compliance with the obligations imposed by the Certifications and Assurances that are selected (*see attached "FTA FISCAL YEAR 2023 CERTIFICATIONS AND ASSURANCES"*).

The annual Certifications and Assurances for federal fiscal year 2023 (October 2022 through September 2023) covers all projects for which the CCRTA seeks funding for in 2023. All applicants for FTA formula program, capital investment program assistance, and current FTA grantees with an active project financed with FTA formula program or capital investment program assistance, are expected to provide the 2023 Certifications and Assurances within 90 days from the date of the Federal Register publication. The 2023 Certifications and Assurances were published in the Federal Register on January 27, 2023.

There are 21 categories within the annual Certifications and Assurances that the CCRTA must agree to comply with before federal funding can be received from the FTA. These are noted below:

01. Certifications and Assurance Required of Every Applicant
02. Public Transportation Agency Safety Plan
03. Tax Liability and Felony Convictions
04. Lobbying
05. Private Sector Protections
06. Transit Asset Management Plan
07. Rolling Stock Buy America Reviews and Bus Testing
08. Urbanized Area Formula Grants Program
09. Formula Grants for Rural Areas
10. Fixed Guideway Capital Investment Grants and the Expedited Project Delivery for Capital Investment Grants Pilot Program
11. Grants for Buses and Bus Facilities and Low or No Emission Vehicle Deployment Grant Programs
12. Enhanced Mobility of Seniors and Individuals with Disabilities Programs
13. State of Good Repair Grants

14. Infrastructure Finance Programs
15. Alcohol and Controlled Substances Testing
16. Rail Safety Training and Oversight
17. Demand Responsive Service
18. Interest and Financing Costs
19. Cybersecurity Certification for Rail Rolling Stock and Operations
20. Tribal Transit Program
21. Emergency Relief Program

By signing the annual Certifications and Assurances, the CCRTA understands and agrees that every provision in these Certifications and Assurances may not apply to it or to every project for which FTA provides federal financial assistance through a grant agreement. The type of project and the section of the statute authorizing federal financial assistance for the project will determine which requirements apply.

Identified Need
Before FTA may award a federal grant to the CCRTA, the CCRTA must submit all Certifications and Assurances pertaining to itself and its projects as required by federal laws and regulations. FTA requires the CCRTA to obtain a current affirmation signed by the agency's attorney affirming CCRTA's legal authority to certify its compliance with the FTA Certifications and Assurances that CCRTA has selected.

Financial Impact
No direct financial impact. By not complying with the Certifications and Assurances, the FTA will not appropriate formula or competitive grant funds.

Board Priority
This item aligns with Board Priority – Public Image & Transparency.

Recommendation
Staff recommends the Board of Directors Authorize the Chief Executive Officer (CEO) or his designee and the CCRTA Legal Counsel, Mr. John Bell, to execute the Federal Transit Administration's Fiscal Year 2023 Certifications and Assurances.

Respectfully Submitted,

Submitted by: Robert M. Saldaña, Managing Director of Administration

Final Approval by: _Rita Patrick_for ______
Miguel Rendón, Acting Chief Executive Officer

FEDERAL FISCAL YEAR 2023 CERTIFICATIONS AND ASSURANCES FOR FTA ASSISTANCE PROGRAMS

(Signature pages alternate to providing Certifications and Assurances in TrAMS.)

Name of Applicant: ____

The Applicant certifies to the applicable provisions of categories 01–21. ________________

Or,

The Applicant certifies to the applicable provisions of the categories it has selected:

No.	Category	Certification
01.	Certifications and Assurances Required of Every Applicant	____________
02.	Public Transportation Agency Safety Plans	____________
03.	Tax Liability and Felony Convictions	____________
04.	Lobbying	____________
05.	Private Sector Protections	____________
06.	Transit Asset Management Plan	____________
07.	Rolling Stock Buy America Reviews and Bus Testing	____________
08.	Urbanized Area Formula Grants Program	____________
09.	Formula Grants for Rural Areas	____________
10.	Fixed Guideway Capital Investment Grants and the Expedited Project Delivery for Capital Investment Grants Pilot Program	____________
11.	Grants for Buses and Bus Facilities and Low or No Emission Vehicle Deployment Grant Programs	____________
12.	Enhanced Mobility of Seniors and Individuals with Disabilities Programs	____________
13.	State of Good Repair Grants	____________
14.	Infrastructure Finance Programs	____________
15.	Alcohol and Controlled Substances Testing	____________
16.	Rail Safety Training and Oversight	____________
17.	Demand Responsive Service	____________
18.	Interest and Financing Costs	____________
19.	Cybersecurity Certification for Rail Rolling Stock and Operations	____________
20.	Tribal Transit Programs	____________
21.	Emergency Relief Program	____________

FEDERAL FISCAL YEAR 2023 FTA CERTIFICATIONS AND ASSURANCES SIGNATURE PAGE

(Required of all Applicants for Federal Assistance to be awarded by FTA in FY 2023)

AFFIRMATION OF APPLICANT

Name of the Applicant: ____

BY SIGNING BELOW, on behalf of the Applicant, I declare that it has duly authorized me to make these Certifications and Assurances and bind its compliance. Thus, it agrees to comply with all federal laws, regulations, and requirements, follow applicable federal guidance, and comply with the Certifications and Assurances as indicated on the foregoing page applicable to each application its Authorized Representative makes to the Federal Transit Administration (FTA) in federal fiscal year, irrespective of whether the individual that acted on his or her Applicant's behalf continues to represent it.

The Certifications and Assurances the Applicant selects apply to each Award for which it now seeks, or may later seek federal assistance to be awarded by FTA during federal fiscal year.

The Applicant affirms the truthfulness and accuracy of the Certifications and Assurances it has selected in the statements submitted with this document and any other submission made to FTA, and acknowledges that the Program Fraud Civil Remedies Act of 1986, 31 U.S.C. § 3801 et seq., and implementing U.S. DOT regulations, "Program Fraud Civil Remedies," 49 CFR part 31, apply to any certification, assurance or submission made to FTA. The criminal provisions of 18 U.S.C. § 1001 apply to any certification, assurance, or submission made in connection with a federal public transportation program authorized by 49 U.S.C. chapter 53 or any other statute Certifications and Assurances Fiscal Year 2023.

In signing this document, I declare under penalties of perjury that the foregoing Certifications and Assurances, and any other statements made by me on behalf of the Applicant are true and accurate.

Signature: ________________________________ Date: ________________

Name: ________________________________
Authorized Representative of Applicant

AFFIRMATION OF APPLICANT'S ATTORNEY

For (Name of the Applicant): ____

As the undersigned Attorney for the above-named Applicant, I hereby affirm to the Applicant that it has authority under state, local, or tribal government law, as applicable, to make and comply with the Certifications and Assurances as indicated on the foregoing pages. I further affirm that, in my opinion, the Certifications and Assurances have been legally made and constitute legal and binding obligations on it.

I further affirm that, to the best of my knowledge, there is no legislation or litigation pending or imminent that might adversely affect the validity of these Certifications and Assurances, or of the performance of its FTA assisted Award.

Signature: ________________________________ Date: ______________

Name: ________________________________
Attorney for Applicant

Each Applicant for federal assistance to be awarded by FTA must provide an Affirmation of Applicant's Attorney pertaining to the Applicant's legal capacity. The Applicant may enter its electronic signature in lieu of the Attorney's signature within TrAMS, provided the Applicant has on file and uploaded to TrAMS this hard-copy Affirmation, signed by the attorney and dated this federal fiscal year.

CORPUS CHRISTI REGIONAL
TRANSPORTATION AUTHORITY

Board of Directors Meeting Memo March 1, 2023

Subject: Approve a Three-Year Agreement for Employment Legal Services with Wood, Boykin & Wolters

Background
CCRTA is in need of the expertise for legal services to assist with employment legal matters that affect the agency and our employees. The Human Resources department utilizes the legal team of Wood, Boykin & Wolters to assist with employment matters such as terminations, EEOC complaints, policy updates and other specialized compliance items. The current contract is set to expire on March 31, 2023.

Identified Need
The authority has identified the need for our Human Resource department to have these services available to them when unexpected incidents occur. The authority has been pleased with the services that Wood, Boykin & Wolters has offered to our Human Resources department.

Disadvantaged Business Enterprise
This item is not funded with federal funds.

Financial Impact
Wood, Boykin & Wolters agreement is for $50,000 annually and is based on the hours worked by the legal team and will vary on a monthly basis. The total for the three-year agreement is $150,000. These monies are 100% budgeted within individual operating department budgets.

Board Priority
The Board Priority is Transparency.

Recommendation
Staff requests the Board of Directors authorize the Chief Executive Officer (CEO) or designee to authorize awarding a (3) three-year agreement with Wood, Boykin & Wolters for Employment Legal Services.

Respectfully Submitted,

Submitted by: Angelina Gaitan
Director of Human Resources

Final Approval by: ___Rita Patrick for
Miguel Rendón
Acting Chief Executive Officer

CORPUS CHRISTI REGIONAL
TRANSPORTATION AUTHORITY

Board of Directors Meeting Memo March 1, 2023

Subject: Exercise Option Year Two (2) and Increase in Contract Price with Enterprise Holdings, dba Commute with Enterprise for Vanpool Services

Background

The Corpus Christi Regional Transportation Authority (CCRTA) vanpool program is a resource for businesses and community groups to access carpooling services through the CCRTA and is a cost-effective public transit option. Commuters travel together in high capacity vehicles between their homes or a designated location to a common work destination. The goal of the vanpool program is to reduce traffic congestion, improve air quality, and provide a cost-effective travel alternative for commuters.

Vanpool participants lease vehicles from Enterprise Holdings, dba as Commute with Enterprise and Enterprise Rent-A-Car, Inc. (Commute with Enterprise). The CCRTA subsidizes a participants' lease by paying a flat rate subsidy directly to the contractor based upon van size and mileage. Currently, the vanpool program is comprised of 31 vans providing transportation to the following employers:

- Federal Correctional Institution (FCI) Three Rivers (8 vans)
- Naval Air Station (NAS) Kingsville (4 vans)
- Border Patrol Station Falfurrias (7 vans)
- Border Patrol Station Freer (4 vans)
- Border Patrol Station Kingsville (6 vans)
- Chevron Plant Ingleside (2 vans)

Ridership levels within the vanpool program have increased 65 percent between April 2019 and December 2022.

Identified Need

The contract with Commute with Enterprise was awarded on April 1, 2019, as a Three (3) Year base contract through March 31, 2022 with Two (2) One-Year options. The current Option Year One (1) contract began on April 1, 2022 and will expire on March 31, 2023. In order to continue the vanpool program beyond Option Year One (1), exercising Option Year Two (2) is required. While Option Year Two (2) will begin on April 1, 2023 and expire on March 31, 2024, Commute with Enterprise is requesting an increase in contract price due to increased vehicle and operational costs.

In January 2023, Commute with Enterprise expressed the desire to increase monthly lease rates. In addition, Commute with Enterprise requested that the CCRTA review current subsidies to determine if an increase is possible. Revised monthly lease rate and subsidy increases would become effective within the Option Year Two (2) contract.

In February 2023, as a result of negotiations with the CCRTA, Commute with Enterprise submitted a proposed price schedule containing rate increases for vanpool program participant monthly leases to be included in Option Year Two (2). The price schedule contains an average 20% rate increase among the 31 vans. The price schedule is included in Attachment A. In addition, Commute with Enterprise requested that the CCRTA evaluate monthly subsidies to offset the increased monthly lease rates.

Based on peer reviews with Texas transit agencies, the CCRTA revised the subsidies, which are based on a flat rate by van size, and not mileage ranges as were included in the current subsidy structure. Under the revised subsidies, the CCRTA agreed to an average increase of 33% among the 31 vans. The revised subsidies will offset an average 20% monthly rate increase as compared to a 36% average rate increase if the current subsidies remained unchanged.

Current CCRTA subsidy table:

One-Way Miles	7-8 Passenger Van	9-10 Passenger Van	11-15 Passenger Van
5-14	$225	$275	$325
15-24	$250	$300	$350
25-34	$275	$325	$375
35-44	$300	$350	$400
45+	$350	$400	$450

Revised CCRTA subsidy table:

One-Way Miles	7-8 Passenger Van	9-10 Passenger Van	11-15 Passenger Van
Varies	$450	$475	$500

Disadvantaged Business Enterprise
Not applicable.

Financial Impact
Under the revised subsidies with 31 vans, the estimated monthly cost increase is $3,725. In anticipation of projected growth, the estimated cost of Option Year Two (2) is $187,050. To fund the first nine months between April and December in Fiscal Year (FY) 2023, funds are allocated up to $122,708 in the FY2023 approved annual operating budget. For FY2023, the total increase in costs for remainder of FY2023 is estimated to be $35,617. An additional amount may be required pending future growth. In FY2024, the appropriate budget amount will be included to support the program through the first quarter of FY2024.

Year	Estimated Number of Vanpools	Estimated Cost
2023 (Apr-Dec)	35*	$143,325
2024 (Jan-Mar)	36*	$43,725
Total		**$187,050**

*Projected 10% increase in FY2023 and 3% increase in first quarter of FY2024 with 7-8 passenger vans.

Board Priority
This item aligns with the Board Priority – Public Image and Transparency.

Recommendation
Staff requests the Board authorize the Chief Executive Officer (CEO) or Designee to Exercise Option Year Two (2) and increase in contract price with Enterprise Holdings, dba Commute with Enterprise for Vanpool Services.

Respectfully Submitted,

Submitted by: Gordon Robinson
Director of Planning

Reviewed by: Derrick Majchszak
Managing Director of Operations

Final Approval by: Rita Patrick for__
Miguel E. Rendón
Acting Chief Executive Officer

ATTACHMENT A

CCRTA VANPOOL PROGRAM

Contractor's Annual Not-to-Exceed Price Report (price before program subsidy)

In the table below, enter the van type and monthly lease rate (Use Fee)for each vehicle size at each corresponding mileage interval for each van you operate. On a separate page, provide a description of the major features for each van type.

	Van Type	Van Type	Van Type	Van Type	Van Type	Van Type	Van Type	Van Type	Van Type
Monthly Mileage Allowance	Total Seats 7	Total Seats 8	Total Seats 9	Total Seats 10	Total Seats 11	Total Seats 12	Total Seats 13	Total Seats 14	Total Seats 15
500	$1,075	$1,125	$1,225	$1,225	$1,270	$1,270	$1,380	$1,380	$1,380
750	$1,075	$1,125	$1,225	$1,225	$1,270	$1,270	$1,380	$1,380	$1,380
1000	$1,155	$1,180	$1,230	$1,230	$1,275	$1,275	$1,395	$1,395	$1,395
1250	$1,155	$1,180	$1,230	$1,230	$1,275	$1,275	$1,395	$1,395	$1,395
1500	$1,190	$1,215	$1,245	$1,245	$1,290	$1,290	$1,415	$1,415	$1,415
1750	$1,190	$1,215	$1,245	$1,245	$1,290	$1,290	$1,415	$1,415	$1,415
2000	$1,190	$1,215	$1,245	$1,245	$1,290	$1,290	$1,415	$1,415	$1,415
2250	$1,220	$1,245	$1,265	$1,265	$1,305	$1,305	$1,425	$1,425	$1,425
2500	$1,220	$1,245	$1,265	$1,265	$1,305	$1,305	$1,425	$1,425	$1,425
2750	$1,220	$1,245	$1,265	$1,265	$1,305	$1,305	$1,425	$1,425	$1,425
3000	$1,220	$1,245	$1,265	$1,265	$1,305	$1,305	$1,425	$1,425	$1,425
3250	$1,220	$1,245	$1,265	$1,265	$1,305	$1,305	$1,425	$1,425	$1,425
3500	$1,440	$1,465	$1,480	$1,480	$1,525	$1,525	$1,645	$1,645	$1,645
3750	$1,440	$1,465	$1,480	$1,480	$1,525	$1,525	$1,645	$1,645	$1,645
4000	$1,440	$1,465	$1,480	$1,480	$1,525	$1,525	$1,645	$1,645	$1,645
4250	$1,440	$1,465	$1,480	$1,480	$1,525	$1,525	$1,645	$1,645	$1,645
4500	$1,440	$1,465	$1,480	$1,480	$1,525	$1,525	$1,645	$1,645	$1,645
4750	$1,815	$1,840	$1,855	$1,855	$1,900	$1,900	$2,020	$2,020	$2,020
5000	$1,815	$1,840	$1,855	$1,855	$1,900	$1,900	$2,020	$2,020	$2,020

Monthly Use Fee price is to include everything normally billed to a customer except fuel, car washes, tolls and parking charges, etc.

CORPUS CHRISTI REGIONAL
TRANSPORTATION AUTHORITY

Board of Directors Meeting Memo March 1, 2023

Subject: Approve a Legislative Program Consistent with the Proposed Legislative Agenda Approved by the Board on February 1, 2023.

Background:
Over the past year, the Legislative Committee and staff have been working with the Legislative delegation and our legislative consultants in the development of a legislative agenda for 2022-23. At the February Board meeting, the Board approved the 2022-23 RTA Legislative Agenda outlining four Primary Initiatives, four Secondary Initiatives, three Endorsement Issues and eight Defensive Measures.

The Legislative delegation staff has requested formal adoption of the different measures consistent with the presentations made to the delegation and requests submitted for proposed legislation.

Identified Needs:
The various needs are outlined in the attached Legislative Program.

Analysis:
Each of the items has been previously discussed an analyzed by the Legislative Committee and the Board at various times. Formal approval in this format will serve not only for the current Regular Session of the Legislature but any Special Sessions that might be called in the future.

Relevance to Board Priorities:
The various items of the Legislative Program relate to the Board Priorities of Facilities, Public Image & Transparency, Innovations and Fare Recovery.

Recommendation:
Staff recommends formal approval of the Legislative Program so that a signed document may be furnished to the appropriate parties at the Texas Legislature.

Respectfully Submitted,

Submitted by: Rita Patrick
Director of Marketing

Reviewed by: Robert M. Saldana
Managing Director of Administration

Approval: Rita Patrick for
Miguel Rendón
Acting Chief Executive Officer

CORPUS CHRISTI REGIONAL TRANSPORATION AUTHORITY
LEGISLATIVE PROGRAM
FOR THE 88TH LEGISLATURE

SECTION 01: PRIMARY INITIATIVES

Legislation authorizing an MTA to provide natural gas fueling to municipal, county, and other political subdivisions which are exempt under other provisions of the Texas Tax Code due to emergencies or other exigent circumstances pursuant to interlocal agreements.

1. Protect, preserve, and seek additional appropriations for air quality planning funds (Clean Air Account 151), which benefits Corpus Christi as a near non-attainment community in meeting SIP requirements.

2. Preserve and ensure CCRTA's eligibility for TERP and electric/vehicle infrastructure grant funds.

3. Constructively participate in TxDOT Sunset Review, seeking opportunities to advance positive transit funding & program initiatives.

4. Seek to maximize federal infrastructure and electric vehicle funding for CCRTA and the Coastal Bend.

SECTION 02: SECONDARY INITIATIVES

1. Modifications to the Fare Approval Committee process under 451.061, Transportation Code, in order to follow the procedures established for other transit authorities with principal cities having a population of less than 1,000,000.

2. Increase the criminal penalty for certain offenses committed on the premises of a public transportation system.

3. Exempt from the two-cent local sales tax cap the publicly-imposed transit tax, allowing local communities room for other voter-approved sales taxes to assist in meeting infrastructure or other community needs.

4. Amend the Tax Code to exempt from the gasoline tax, and/or diesel fuel tax, sold to, or delivered into the fuel supply tank of an MTA vehicle for the sole purpose of and engaged exclusively in providing public transportation purposes (similar to school buses), not just in rural areas, and protect against increases in motor fuels tax rates or repeal of alternative fuels exemptions achieved in previous sessions that may adversely impact MTAs.

SECTION 03: ENDORSEMENT ISSUES

1. Provide authority for an urban transit district to expand services as a means to improve services in rural areas served by an MTA.

2. Support efforts to bolster Gulf Coast protection and flood infrastructure capabilities.

3. Support federal infrastructure funding within the Coastal Bend.

SECTION 04: DEFENSIVE MEASURES

1. Preserve the integrity of Chapters 451, 452 of the Transportation Code and general MTA authority.

2. Protect all local and state funding sources for metropolitan and regional public transportation agencies, so that no portion of that funding approved by voters is diverted from public transportation purposes in the area where funding is collected, including:

   - being subject to a road or street maintenance contribution referendum.
   - diversion to the state highway fund or restricting the uses of locally-collected revenue for non-transit purposes.
   - changes to the current sales collection increments.

3. Preserve the MTA appointed governance structure from requiring members to be elected.

4. Preserve the right for political subdivisions, including the MTA's, to utilize their funds for state legislative and regulatory advocacy.

5. Protect against state legislative changes to the governing body of metropolitan rapid transit authorities, including size and make up, unless locally supported.

6. Protect against legislation authorizing the withdrawal by political subdivisions from the territory of a metropolitan rapid transit authority.

7. Preserve the authorization for MTA's to utilize P3, Design-Build and Construction Manager-At Risk to deliver projects, including the use of eminent domain.

8. Preserve an MTA's alternatively fueled vehicles from "road user fee" fairness changes.

The foregoing Legislative Program was duly adopted by the Board of Directors of the Corpus Christi Regional Transportation Authority at its Board meeting on March 1, 2023.

ATTEST:	CORPUS CHRISTI REGIONAL TRANSPORTATION AUTHORITY
By:______________________	By:______________________
Lynn Allison, Board Secretary	Dan Leyendecker, Board Chair

Subject: Authorize the Chief Executive Officer to Execute a Plat of the Port-Ayers Property into a single parcel.

Background:
The CCRTA owns four parcels of land at Port-Ayers and is in the process of redeveloping the property into a new transit center. The City of Corpus Christi is requiring that such properties be re-platted into a single parcel in order to obtain a building permit in connection with the project.

Identified Needs:
The CEO must be authorized by the Board to executed the plat in order to have it recorded with Nueces County.

Analysis:
The Unified Development Code of the City requires certain setbacks and other limitations on the development of property which can hinder the development of multiple parcels as a single development. By replatting the parcels into one lot, the project may proceed in the manner designed. The City requires a Board resolution authorizing the person who signs the plat as being duly authorized by the Board.

Relevance to Board Priorities:
This item is relevant to the Board Priority of Facilities.

Recommendation:
Staff recommends approval of the Resolution authorizing the Chief Executive Officer to execute a plat of the Port-Ayers properties into a single parcel.

Respectfully Submitted,

Submitted by: John D. Bell
General Counsel

Reviewed by: Sharon Montez
Managing Director of Capital Programs and Customer Services

Approval: Rita Patrick for
Miguel Rendón
Acting Chief Executive Officer

Attachment B

Corpus Christi
Regional Transportation Authority

Resolution

Resolution Authorizing Chief Executive Officer to Execute Plat for the Port-Ayers Property into a Single Parcel

WHEREAS, the Corpus Christi Regional Transportation Authority (the "CCRTA") owns four parcels of land at Port-Ayers and is in the process of redeveloping such property into a new transit center; and

WHEREAS, the City of Corpus Christi is requiring that such properties be re-platted into a single parcel in order to obtain a building permit in connection with such project;

NOW THEREFORE, BE IT RESOLVED BY THE CORPUS CHRISTI REGIONAL TRANSPORTATION AUTHORITY BOARD OF DIRECTORS THAT:

Section 1. The CCRTA hereby authorizes Miguel Rendon, Acting Chief Executive Officer, to execute a plat of such property and such other documents as may be required by the City of Corpus Christi or the County of Nueces in connection with such development.

DULY PASSED AND ADOPTED this 1st day of March, 2023.

CORPUS CHRISTI REGIONAL TRANSPORTATION AUTHORITY

____

Dan Leyendecker
Board Chair

Corpus Christi Regional Transportation Authority

Zero-Emission Bus

Fleet Transition Study

Presented by Center for Transportation and the Environment

February 2023

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List of Acronyms

A&E	Architecture and Engineering
BEB	Battery Electric Bus
CARB	California Air Resources Board
CCRTA	Corpus Christi Regional Transportation Authority
CNG	Compressed Natural Gas
CTE	Center for Transportation and the Environment
CI	Carbon Intensity
DOE	Department of Energy
DGE	Diesel Gallons Equivalent
EPA	Environmental Protection Agency
EV	Electric Vehicle
ESS	Energy Storage System
FCEB	Fuel Cell Electric Bus
FCEV	Fuel Cell Electric Vehicles
FTA	Federal Transit Administration
GHG	Greenhouse Gas
GVWR	Gross Vehicle Weight Rating
HVAC	Heating, Ventilation, and Air Conditioning
ICE	Internal Combustion Engine
ICT	Innovative Clean Transit
kW	Kilowatt
kWh	Kilowatt Hour
kWh/mi	Kilowatt-hour/mile
LCFS	Low Carbon Fuel Standard
MW	Megawatt
MWh	Megawatt-hours
OEM	Original Equipment Manufacturer
ROW	Right-of-Way
TOU	Time-of-Use
ZEB	Zero-Emission Bus

Executive Summary

Project Overview

Corpus Christi Regional Transportation Authority (CCRTA) engaged the Center for Transportation and the Environment (CTE) to develop a comprehensive plan to transition CCRTA's full fixed-route system of buses and cutaways to zero-emission buses (ZEBs) with the aim to achieve a 100% zero-emission fleet by 2040. The results of the study will inform CCRTA of the estimated costs, benefits, constraints, and risks of the transition to a zero-emission fleet and will guide future planning and decision-making. CTE is also providing project management services in conjunction with CCRTA's project team. See Methodology Section and **Figure 5** below for details.

Hydrogen Fueling Infrastructure Analysis Background

CCRTA is uniquely located in a region that has already begun developing a complex hydrogen supply chain. Hydrogen is currently being used as a part of the refinery process in operations around the Port of Corpus Christi, and additional industries in the region have released plans to also transition to hydrogen to fuel operations. While the Port of Corpus Christi is not currently involved in any hydrogen projects, it is pursuing becoming a Hydrogen Hub. The Port of Corpus Christi has been encouraged by the United States Department of Energy (DOE) Office of Clean Energy Demonstration to submit a full application for its Horizons Clean Hydrogen Hub (HCH2) through the Regional Clean Hydrogen Hubs Program.[1]

Corpus Christi Regional Transportation Authority Mixed Fleet Analysis

As a result of CCRTA's regional hydrogen presence, CCRTA requested that CTE include both battery electric bus (BEB) and fuel cell electric bus (FCEB) scenarios in the transition plan assessments to best understand the agency's clean energy options. CCRTA can likely take advantage of either technology or some combination of the two. Therefore, CTE incorporated BEB Only, FCEB Only, and Mixed Fleet (BEBs and FCEBs) in the ZEB scenario analysis.

Throughout the transition period (2022 – 2040), CTE lays out key points where CCRTA will need to decide which fueling technology to invest in. As regional hydrogen projects and zero-emission technology grow, CTE recommends CCRTA revisit this plan in late 2023 or

[1] https://www.offshore-energy.biz/doe-backs-port-of-corpus-christis-hydrogen-hub-advancement/

early 2024, pending the outcome of the Port of Corpus Christi's Hydrogen Hubs proposal with the Department of Energy (DOE).

Project Goals

The primary goals of this project were to assess the feasibility of transitioning the entirety of CCRTA's fixed-route fleet to 100% zero-emission technology and to understand technology options, transition timelines, and relevant costs. Within the scope of the plan, CTE estimated capital and operational costs, planned project phases and timelines, and determined infrastructure requirements necessary to adopt ZEB fleet vehicles.

After discussions with CCRTA's project team, CTE used the Innovative Clean Transit (ICT) regulation, enacted by the California Air Resources Board (CARB) as the foundation for CCRTA's transition timeline. On December 14, 2018, CARB enacted the ICT regulation, setting a goal for California public transit agencies to have 100% zero-emission fleets by 2040. The ruling specifies the percentage of new bus procurements that must be zero-emission buses for each year of the transition period. Those annual percentages are outlined in **Table 1** below.

Table 1 - "Baseline" ZEB Procurement Phase-In

Year	Percent ZEB Procurement	CCRTA Procurements	CCRTA ZEB Procurement
2022	0%	0	0
2023	25%	0	0
2024	25%	9	3
2025	25%	8	3
2026	50%	0	0
2027	50%	29	15
2028	50%	0	0
2029	100%	21	21
2030	100%	0	0

This schedule lays out a pathway to reach a 100% zero-emission fleet in 2040 and is based on a 12-year projected lifespan for a transit bus and seven-year projected lifespan for a cutaway.

Zero-Emission Transition Overview

The zero-emission technologies considered in this study include BEBs and FCEBs. These buses have similar electric drive systems that feature a traction motor powered by a battery. The primary differences between BEBs and FCEBs are the respective amount of battery storage and the method by which the batteries are recharged. The electric drive components and energy source for a diesel bus, BEB, and FCEB are illustrated in **Figure 1.**

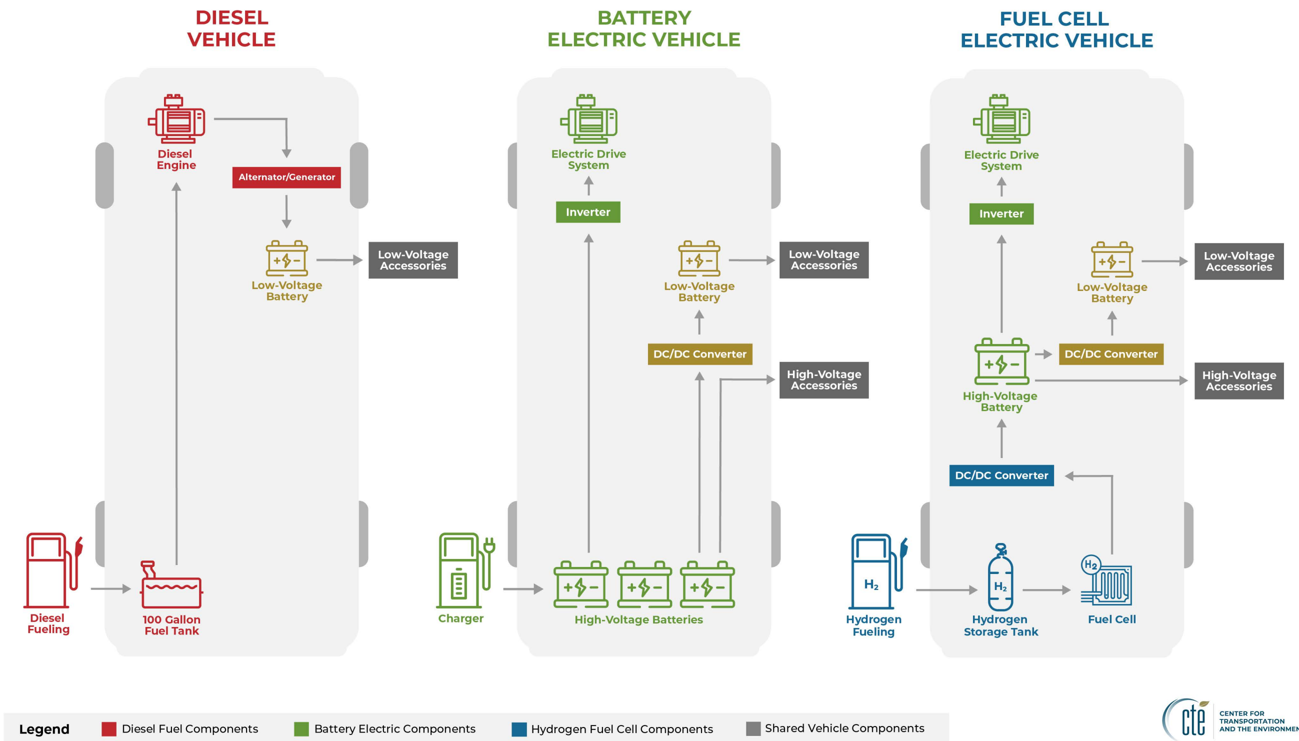

Figure 1 - Battery and Fuel Cell Electric Bus Schematic

CTE worked closely with CCRTA staff throughout the project to develop an approach, define assumptions, and confirm the results. The approach for the study is based on analysis of three ZEB technology scenarios compared to a baseline scenario:

0. Baseline (Current Fleet: Diesel/CNG Buses & Gas Cutaways)
1. BEB Only (Electric Buses & Electric Cutaways)
2. FCEB Only (Fuel Cell Electric Buses & Electric Cutaways)
3. Mixed Fleet – BEB Majority (70% BEB 30% FCEB & Electric Cutaways)

To accurately forecast service feasibility for each of these zero-emission technologies, CTE assessed the block feasibility of CCRTA's current service schedules. A **block** is the series of trips assigned to a single bus from the time of garage pull-out to its return pull-in, including deadhead, in-service hours, and layover. **Block feasibility** is determined by comparing the estimated energy required to operate a BEB on a given block to the usable onboard energy storage capacity of the bus. If the block energy requirement exceeds the usable onboard storage capacity, the block is considered unachievable. If the block energy requirement does not exceed the usable onboard storage capacity, the block is considered achievable. In order to calculate the block feasibility of BEBs, CTE modeled a market representative vehicle, which had specifications that represent the average of the available vehicles in its class. Although not a zero-emission scenario, this study also includes a baseline scenario that is used to compare the cost of a ZEB transition to a “business-as-usual” case.

The **BEB Only Scenario** was developed to model an option with a fleet consisting entirely of battery electric buses that can meet existing service range requirements. Fleets consisting of BEBs that only charge at a depot may not be able to meet the range requirements of present routes and would require additional time to return to the depot to mid-day charge or implement on-route charging. According to CTE’s modeling, 84% (54 feasible vs 10 not feasible) of CCRTA’s blocks are achievable with depot-charged BEBs by 2035 but on-route charging would be necessary in 2030. A shortcoming of a BEB Only fleet is that it may be less resilient than a mixed fuel fleet since interruptions to the power supply could jeopardize the operability of the fleet. This hurdle can be mitigated by installing back-up power supplies and planning contingencies.

The **FCEB Only Scenario** was developed to help identify benefits and mitigate challenges associated with switching the entire fleet to fuel cell technology. A FCEB fleet can replace diesel buses in a 1:1 ratio and avoids the need to install two types of fueling infrastructure that the Mixed Fleet Scenario would require. Additionally, hydrogen fueling infrastructure is less expensive at scale compared to a large-scale fleet transition to BEBs. Though hydrogen is a more expensive fuel than electricity at current market prices, applying a sensitivity analysis to hydrogen costs shows that it will likely become more competitive compared to the cost of electricity by 2040. A FCEB Only fleet lacks the redundancy provided by having alternative technologies and fuel types in a mixed fleet, and current market prices for FCEBs are higher than BEBs.

While the Feasibility Assessment determined that the range of market average BEBs would be sufficient to meet all of CCRTA’s service requirements with the incorporation of on-route charging, a **Mixed Fleet Scenario** was developed that allowed the agency to explore the cost and pragmatism of a Mixed Fleet – BEB Majority (70% BEB, 30% FCEB). A mixed fleet is also more resilient to service interruptions if either fuel is temporarily unavailable. For agencies that operate only one depot, mixed fleets may present space constraints in order to host both infrastructure types in one depot. At present, CCRTA’s facilities are not space constrained and are therefore able to accommodate the two technologies.

The assessment follows CTE's **ZEB Transition Planning Methodology**, a complete set of analyses used to inform agencies planning the conversion of diesel and CNG fleets to zero-emission technologies. The methodology consists of data collection, analysis, and evaluation stages; these stages are sequential and build upon findings in previous steps. In the evaluation stage, CTE assesses energy efficiency and energy use by the buses to calculate the distance that a bus will be able to travel on a single charge or hydrogen fill. CTE collected sample data from multiple CCRTA routes. Then, using market representative ZEB battery capacity specifications for given bus lengths, CTE estimated range and energy consumption on CCRTA routes and blocks under varying environmental and passenger load conditions. Once this information was established, CTE completed the following assessments to develop cost estimates for each of the three scenarios.

The **Service Assessment** phase initiates the technical analysis of the study. The results from the Service Assessment are used to guide ZEB procurements in the Fleet Assessment and to determine energy requirements (depot charging and/or hydrogen) in the Fuel Assessment. CTE met with CCRTA to define assumptions and requirements used throughout the study and to collect operational data. This process was conducted for the fixed service blocks for both buses and cutaways.

The **Fleet Assessment** develops a projected timeline for replacement of current buses with ZEBs that is consistent with the agency's fleet replacement plan. This assessment also includes a projection of fleet capital cost over the transition lifetime and it can be optimized with regard to any city or state mandates or to meet agency goals, such as minimizing cost or maximizing service levels. It should be noted that the assessment assumes buses are replaced with ZEBs of the same length as the diesel and CNG buses and gas cutaways currently in operation.

The **Fuel Assessment** merges the results of the Service Assessment and Fleet Assessment to determine annual fuel requirements and associated costs. The Fuel Assessment calculates energy costs through the full life of the transition, including the agency's current diesel and CNG buses and gas cutaways. As current technologies are phased out in later years of the transition, the Fuel Assessment calculates the increasing energy requirements for ZEBs. The Fuel Assessment also provides a total energy cost over the transition lifetime.

The **Maintenance Assessment** calculates all projected fleet maintenance costs over the life of the project. This includes costs related to existing diesel and CNG buses and gas cutaways remaining in the fleet, as well as new ZEBs.

The **Facilities Assessment** determines the necessary infrastructure to support the projected zero-emission fleet based on results from the Fleet Assessment and Fuel Assessment. The Facilities Assessment is calculated to meet the fleet procurement schedules defined in the Fleet Assessment and the fueling capacity required based on the

Fuel Assessment. The result shows quantities of hydrogen and battery electric infrastructure and calculates associated costs.

The **Redundancy, Resilience, and Emergency Response (3R) Assessment** investigates the new risks to an agency's ability to provide service during power outages or fuel disruptions and to support required emergency response activities, such as community evacuation with a full ZEB fleet. The outcomes of the 3R assessment are a summary of the risk reduction capabilities and cost effectiveness of the recommended alternatives to mitigate the impacts from identified risks specific to an agency's risk tolerances, facility constraints, and budget.

The **Workforce Development Assessment** develops a multi-phase process of training procedures and tools designed to assist the agency with transitioning skilled labor into ZEB proficiency in a manner consistent with the agency's fleet replacement plan. This assessment also includes an inventory of critical skills, training tools, and resources broken down by functional agency department. Furthermore, the report explores case studies and best practices from transit agencies on how to conduct training, what tools are most valuable, and the critical importance of the training relationship, including contractual considerations, with the ZEB OEM.

The **Total Cost of Ownership Assessment** compiles results from the previous assessment stages and provides a comprehensive view of all associated costs, over the transition lifetime. **Table 2** and **Figure 2** below provide a side-by-side comparison of the cumulative transition costs for each scenario.

Table 2 - Total Cost of Ownership, Incremental Cost Compared to Baseline

	Fleet Costs	Maintenance Costs	Fuel Costs	Facilities Costs
Baseline	$ 101.3M	$ 32.5M	$ 27.1M	$ 0.0M
BEB Only	$ 136.9M	$ 29.5M	$ 22.9M	$ 8.9M
FCEB Only [$4/kg H_2]	$ 171.7M	$ 39.5M	$ 29.8M	$ 13.2M
FCEB Only [$8/kg H_2]	$ 171.7M	$ 39.5M	$ 41.3M	$ 13.2M
Mixed Fleet [$4/kg H_2]	$ 165.2M	$ 33.4M	$ 25.8M	$ 16.7M
Mixed Fleet [$8/kg H_2]	$ 165.2M	$ 33.4M	$ 30.6M	$ 16.7M

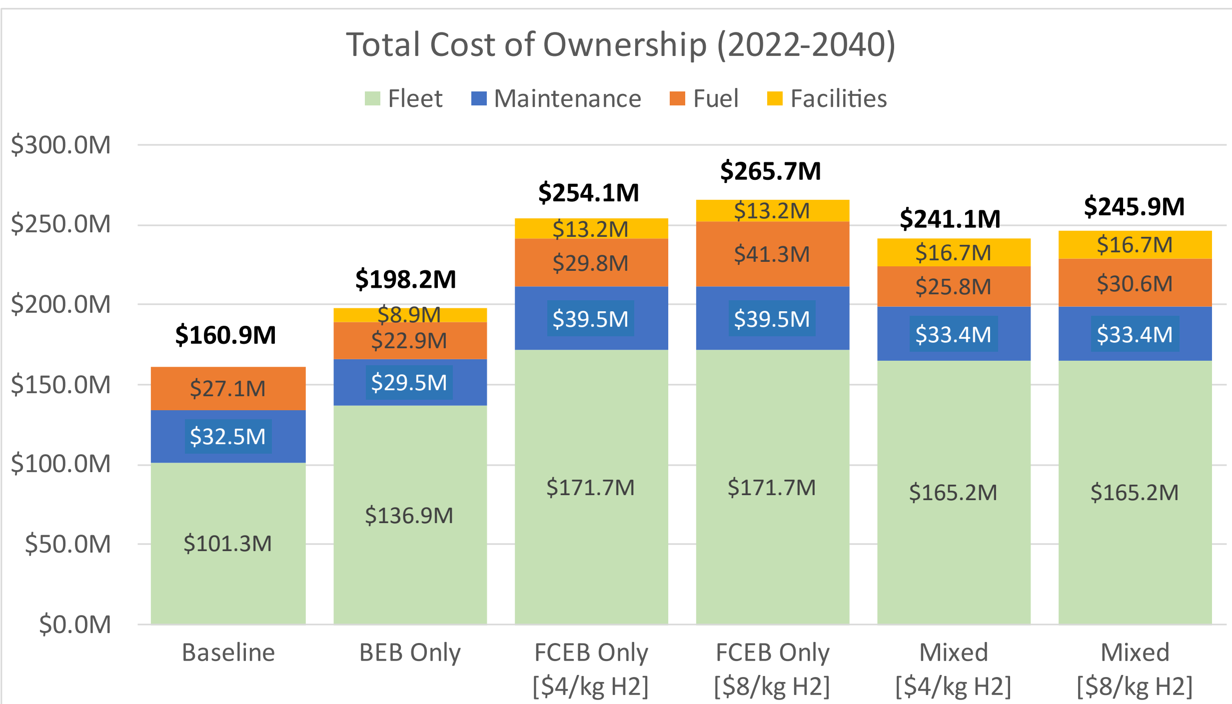

Figure 2 - Total Cost of Ownership, by Scenario (2022-2040)

Baseline Scenario

CCRTA's Baseline fleet consists of diesel, CNG, and gas buses and cutaways. During the transition period, the total cost of ownership for the Baseline scenario is less than the other three scenarios analyzed at $160.9 million. There are significant costs associated with infrastructure procurement for BEB charging and FCEB fueling, but since the infrastructure for the existing fleet is already in place, the Baseline scenario doesn't incur the same infrastructure costs.

Battery Electric Bus (BEB) Only Scenario

For an all-BEB fleet, ZEB transition costs are projected to be $198.2 million where 100% of CCRTA's fleet is replaced with BEBs by 2040 without adding additional buses. This scenario would require CCRTA to incorporate on-route charging in 2030 to continue to meet the service requirements with an all-BEB fleet. The difference in cost between the Baseline and BEB Only scenario is the result of higher capital costs for battery electric buses compared to diesel buses and from the significant infrastructure investment necessary for charging infrastructure. This scenario is also inclusive of battery electric cutaways.

Fuel Cell Electric Bus (FCEB) Only Scenario

In the FCEB Only scenario, ZEB transition costs are estimated at $254.1 million with $4/kg H_2 fuel costs and $265.7 million with $8/kg H_2 to replace 100% of CCRTA's fleet with FCEBs by 2040. It is expected that due to the limited deployment of FCEBs in service in the United States, capital costs for these buses and hydrogen fuel costs will remain high in the near-term due to low market competition. This is expected to decrease in the long-term, although more data is needed to adequately forecast these cost decreases. As such, this study uses current FCEB and infrastructure pricing for the entirety of the ZEB transition period.

For estimates of FCEB maintenance costs, CTE used data reported from Orange County Transit Authority's (OCTA) FCEB fleet of ten New Flyer Xcelsior buses in its first year of operation. Fuel cell technology was new to OCTA and, as a result, the maintenance costs were higher than expected. OCTA does expect reductions in the long run. Given the necessary reliance on this early-adoption maintenance data, FCEB maintenance cost data has a wider margin of error than BEB cost estimates. More concrete data will become available, and costs will likely fall as a larger number of fuel cell electric buses and hydrogen infrastructure are deployed, however, significant investments in hydrogen infrastructure may take years to materialize. This scenario is also inclusive of battery electric cutaways. Fuel cell electric cutaways were not analyzed due to the unavailability of the technology.

Mixed Fleet: BEB Majority

In the BEB Majority Mixed Fleet, 70% of CCRTA's fleet is composed of battery electric buses, with the remaining 30% made up of hydrogen fuel cell buses. The total cost of this scenario is estimated at $241.1 million with $4/kg H_2 fuel costs and $245.9 million with $8/kg H_2. Although all of CCRTA's routes are feasible with BEBs and on-route charging, the addition of fuel cell buses adds redundancy and resilience in potential emergency situations. This scenario is also inclusive of battery electric cutaways.

Project Risks

In addition to the uncertainty of technology improvements, there are other risks to consider in trying to estimate costs over the 18-year transition period. Although current BEB range limitations may be improved over time as a result of advancements in battery energy capacity and more efficient components, battery degradation may re-introduce range limitations, which is a cost and performance risk to a BEB Only fleet over time. In emergency scenarios that require use of BEBs, agencies may face challenges performing emergency response roles expected of them in support of fire and police operations.

Furthermore, fleetwide energy service requirements, power redundancy, and resilience may be difficult to achieve at any given depot in a BEB Only scenario. Although FCEBs may not be subject to these same limitations, higher capital equipment costs and availability of hydrogen may constrain FCEB solutions. The costs and benefits of various alternatives to mitigate the risks of power outages, hydrogen disruptions, and natural disaster impacts were evaluated in the Redundancy, Resilience, and Emergency Response (3R) Assessment.

Project Benefits

Zero-emission buses offer a wide range of benefits not only for the agencies deploying them but also for the communities they impact. There are significant environmental benefits associated with the transition to ZEB technology. For agencies, the total cost of ownership for a ZEB fleet has the potential to be equal to or less than a fleet of Internal Combustion Engine (ICE) vehicles. ZEBs are also significantly quieter than traditional vehicles which can help with noise reduction.

Widespread adoption of zero-emission bus technology has the potential to significantly reduce greenhouse gas (GHG) emissions resulting from the transportation sector. Through the reduction of tailpipe emissions, ZEBs benefit the environment by delivering better air quality and health benefits to the passengers and neighboring areas which tend to be disproportionately low-income and historically disadvantaged communities. CCRTA is committed to implementing environmentally-friendly policies and reducing its carbon footprint.

Recommendations

Given these considerations, the recommendations for CCRTA are as follows:

1) **Select a preferred scenario to refine and remain proactive with ZEB deployment grants:** This Transition Plan was developed to present CCRTA with options for transitioning to a fully zero-emission fleet. The Plan will put forth CCRTA's vision for a ZEB Transition and will act as a living document to help the agency plan out grant funding requirements. As a greater proportion of CCRTA's fleet converts to ZEB technology, auxiliary equipment, hardware, and software will be needed to ensure a successful fleet transition. CCRTA should continue to remain proactive in the purchase and deployment of ZEBs and their associated systems by taking advantage of various grant and incentive programs.
2) **Apply learnings from emergency disaster response:** Evaluate the tradeoffs for various alternatives to reduce the risk from hurricanes, tropical storms, power outages, equipment failure, and fuel disruptions, and allow CCRTA to meet all first responder requirements from the 3R Assessment.
3) **Match the individual bus technology to the individual route and blocks:** CCRTA should consider the strengths of given ZEB technologies and focus those technologies on routes and blocks that take advantage of their efficiencies and minimize the impact of the constraints related to the respective technologies. These technologies cannot follow a one-size-fits-all approach from either a performance or cost perspective. Matching the present technology to the present service levels will be a critical best practice.
4) **Monitor local and regional developments:** In the zero-emission technology sector, developments at the local level can have the ability to catapult the industry forward. When local bus OEMs or fuel providers enter the zero-emission market, it can spark technological innovation and cost reduction. Neighboring transit agencies can also work together through group purchasing agreements and lobbying efforts to bring about reduced purchase costs or more funding opportunities.

The transition to ZEB technologies represents a fundamental paradigm shift in bus procurement, operation, maintenance, and infrastructure. It is only through a continual process of deployment with specific goals for advancement that the industry can achieve the goal of economically sustainable, zero-emission public transit.

Introduction

Corpus Christi Regional Transportation Authority (CCRTA) is conducting a feasibility study which looks at converting its bus fleet to zero-emission buses (ZEB) by 2040. To explore CCRTA's options for meeting this fleet electrification target, this transition study presents three zero-emission fleet transition scenarios and uses CCRTA's current fleet operations as a baseline to measure the effects of each transition scenario. For each scenario, this study assesses bus and cutaway purchase costs, fuel costs, infrastructure investments, and maintenance costs. Additionally, this study also takes into account CCRTA's local needs and conditions, namely considering resilience, redundancy, and emergency response adaptation options. By using real data provided by CCRTA, its partners, and industry-reliable sources in the assessments, CCRTA will be able to draw insights to choose the optimal zero-emission transition scenario.

Transit Agency's Name: Corpus Christi Regional Transportation Authority (CCRTA)

Mailing Address: 5658 Bear Lane, Corpus Christi, Texas 78405

Contact Information

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About CCRTA

History

The Corpus Christi Regional Transportation Authority (CCRTA) was established by referendum on August 10, 1985, as a political subdivision of the State of Texas, to develop, maintain and operate a public mass transportation system, principally within Nueces County, Texas and certain neighboring communities. Operations commenced on January 1, 1986. CCRTA is the primary provider of public transportation services in the Coastal Bend region and provides service in the cities of Corpus Christi, Agua Dulce, Banquete, Bishop, Driscoll, Gregory, Port Aransas, Robstown, San Patricio and the unincorporated areas of Nueces and San Patricio Counties. Under state law, CCRTA is authorized to collect 0.5% sales and use tax on certain transactions for transit purposes, including both capital improvement and operating expenses. The 0.5% sales tax rate is collected from participating cities and communities. According to the 2020 Census, CCRTA's total service area includes 846 square miles and has a population of 350,372.

Service Area and Bus Service

CCRTA provides fixed route service, commuter bus, and van pool services. Additionally, CCRTA offers a paratransit bus service called B-Line and rural on-demand service through third-party contractors. CCRTA currently operates a network of 34 fixed routes and flexible services. CCRTA's complementary paratransit service provides curb-to-curb service during the same days and hours of service as the fixed routes and flexible services.

CCRTA operates a maximum of 70 diesel and CNG buses and 23 diesel, CNG, and gas cutaways on fixed-route service from its maintenance and operations facility. The agency also operates 34 additional diesel, CNG, and gas cutaways in support of paratransit service. Service in 2019 was almost 6.2 million miles and a total of 5.25 million trips, but since the start of the Covid-19 pandemic, CCRTA has seen ridership and service reductions.

Ridership and Workforce

CCRTA serves more than ten communities throughout an area of 846 square miles. The Port Aransas Express route provides seasonal transportation to nearby low-income communities for service-industry workers to high-paying jobs in the island town of Port Aransas, Texas which offers little-to-no affordable housing. CCRTA also implemented a flex service route that serves Texas A&M University Corpus Christi campus, student housing and several nearby apartment complexes. The route flexes out to and from nearby medical clinics, a pharmacy, two grocery stores and other small businesses and restaurants. A map of CCRTA's current system is shown in **Figure 3** and **Appendix A**.

CCRTA's workforce consists of 224 employees, 90 contractors (MV Transportation) and the safety and security department has a combined 50 law enforcement police officers and security guard service personnel. CCRTA is also an active first responder during natural disasters and emergencies.

CCRTA Current System Map

Figure 3 - CCRTA Service Area

Fleet Facilities

Services are oriented around eight transit centers and park and rides throughout the Corpus Christi area: Port Ayers Station, Staples Street Station, Southside Transfer Station, climate-controlled Robstown Station, Flour Bluff Transfer Point, Gregory Park & Ride, Calallen Park & Ride, and Robstown Park & Ride.

CCRTA has 1,387 bus stops and shelters (more than 56 percent are ADA compliant) and four transfer stations. CCRTA's main operations and maintenance facility is located at 5658 Bear Lane, Corpus Christi, TX 78405 as shown in **Figure 4**.

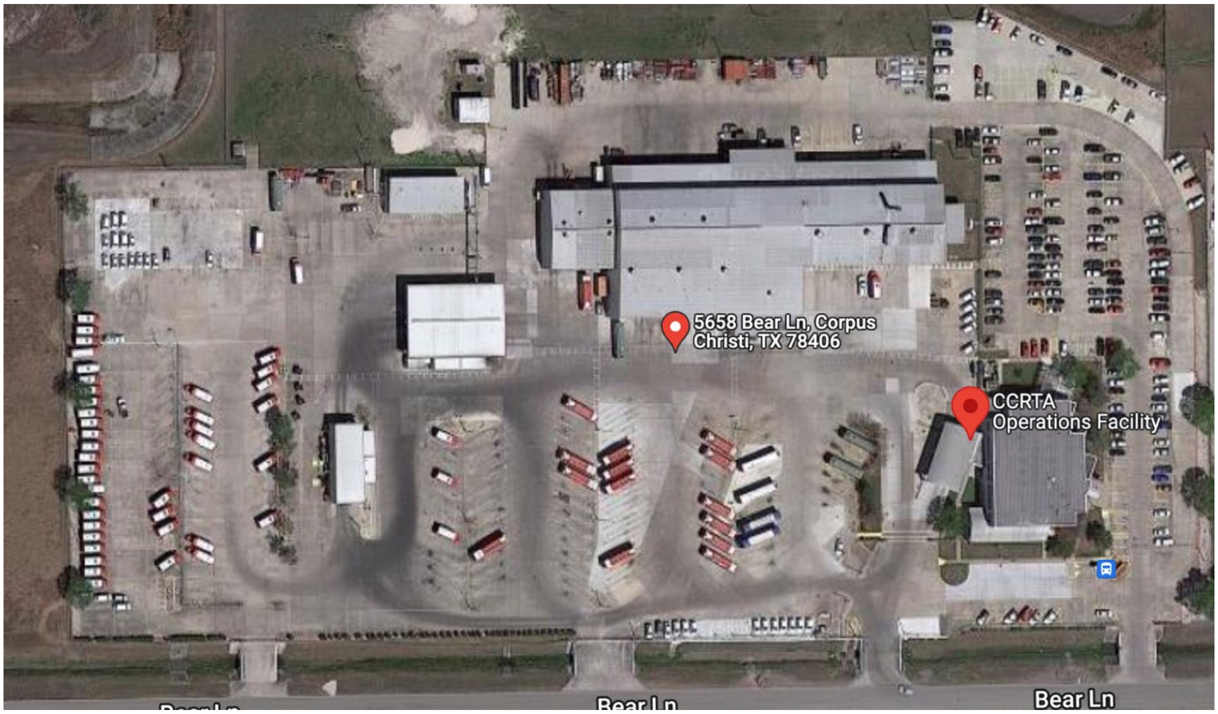


Figure 4 - CCRTA Operations and Maintenance Facility

Emissions Reductions

Greenhouse gases (GHG) are the compounds primarily responsible for atmospheric warming and include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). The effects of greenhouse gases are not localized to the immediate area where the emissions are produced. Regardless of their point of origin, greenhouse gases contribute to overall global warming and climate change.

Criteria pollutants include carbon monoxide (CO), nitrogen oxides (NOx), particulate matter under 10 and 2.5 microns (PM_{10} and $PM_{2.5}$), volatile organic compounds (VOC), and sulfur oxides (SO_X). These pollutants are considered harmful to human health because they are linked to cardiovascular issues, respiratory complications, or other adverse health effects.[2] These compounds are also commonly responsible for acid rain and smog. Criteria

[2] Institute of Medicine. Toward Environmental Justice: Research, Education, and Health Policy Needs. Washington, DC: National Academy Press, 1999; O'Neill MS, et al. Health, wealth, and air pollution: Advancing theory and methods. Environ Health Perspect. 2003; 111: 1861-1870; Finkelstein et al. Relation between income, air pollution and mortality: A cohort study. CMAJ. 2003; 169: 397-402; Zeka A, Zanobetti A, Schwartz J. Short term effects of particulate matter on cause specific mortality: effects of lags and modification by city characteristics. Occup Environ Med. 2006; 62: 718-725.

pollutants cause economic, environmental, and health effects locally where they are emitted.

By transitioning to ZEBs from diesel and CNG buses, CCRTA's zero-emission fleet will produce fewer carbon emissions and fewer harmful pollutants from the vehicle tailpipes. Environmental impacts, both from climate change and from local pollutants, disproportionately affect transit riders. For instance, poor air quality from tailpipe emissions and extreme heat harm riders waiting for buses at roadside stops. The transition to zero-emission technology will benefit the region by reducing fine particulate pollution and improving overall air quality. In turn, the fleet transition will support better public health outcomes for residents in disadvantaged communities served by the selected routes.

Disadvantaged communities are both socioeconomically disadvantaged and environmentally disadvantaged due to local air quality. Lower income neighborhoods are often exposed to greater vehicle pollution levels due to proximity to freeways and the ports, which puts these communities at greater risk of health issues associated with tailpipe emissions.[3] More than half (53 percent) of CCRTA's service area is considered historically disadvantaged. Communities disadvantaged by pollution served by CCRTA's fleet will also directly benefit from the reduced tailpipe emissions of ZEBs compared to ICE buses.[4]

Assessment Assumptions

This transition study uses multiple assumptions to model CCRTA's long-term fleet transition. The overarching assumptions are:

- Heavy-duty large buses have a normal service life of 12 years.[5]
    - This assumption follows the Federal Transit Administration's (FTA's) definition of vehicle useful life of 12 years as its retirement policy for standard bus sizes.
- BEBs are modeled to have a nameplate battery capacity of 440 kWh for 35' BEBs and 580 kWh for 40' BEBs. FCEBs capacity of 40kg (35' and 40').

[3] Reichmuth, David. 2019. Inequitable Exposure to Air Pollution from Vehicles in California. Cambridge, MA: Union of Concerned Scientists. https://www.ucsusa.org/resources/inequitable-exposure-air-pollution-vehicles-california-2019

[4] U.S. DOT 2022 Transportation Disadvantaged Census Tracts (Historically Disadvantaged Communities)

[5] Federal Transit Administration, "Useful Life of Transit Buses and Vans". U.S. Department of Transportation. Retrieved on May 5, 2021, from https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/Useful_Life_of_Buses_Final_Report_4-26-07_rv1.pdf

  - These figures are based on the average of the bus manufacturers' specifications for the model compared with the Altoona Bus Testing and Research Center's bus report at the time of analysis.[6]
- Electric cutaways are modeled to have a nameplate battery capacity of 160 kWh (26'). Fuel cell electric cutaways were not included in the modeling since a commercially available fuel cell electric cutaway is not yet available.
- A five percent (%) improvement in battery capacity occurs every two years, with a cap at 682 kWh for 35' BEBs and 900 kWh for 40' BEBs in 2040.
  - For this study, considering the extended period of a complete fleet transition through 2040, CTE assumes a conservative five percent (%) improvement of battery capacity every two years[7]. If the trend continues, buses will continue to increase the amount of energy they carry on-board without added onboard battery storage or reduction in passenger capacity.
- A five percent (%) improvement in hydrogen tank size occurs every two years.
  - This serves as a proxy for other component improvements such as battery capacity, motor efficiency, and fuel cell efficiency.
- FCEBs can more readily replace ICE buses one-for-one.
  - Alameda-Contra Costa Transit District (AC Transit) and OCTA have reported operational ranges for FCEBs up to 350 miles.

Purpose of Transition Planning

Developing a transition plan helps provide a holistic view of long-term fleet management, the availability of current and future infrastructure requirements, and the agency's workforce development goals. This not only supports identifying funding constraints for procurements over the entire transition period, but it also aids multi-year contracts with vehicle OEMs, fuel providers, and gives utilities the opportunity to plan ahead.

[6] Altoona Bus Research and Testing Center, Bus Tests. Penn State College of Engineering. Retrieved on May 5, 2021, from https://www.altoonabustest.psu.edu/bus-tests/index.aspx

[7] BloombergNEF, "Hitting the EV Inflection Point". Bloomberg Finance L.P.2021. Retrieved on December 5, 2021, from https://www.transportenvironment.org/wp-content/uploads/2021/08/2021_05_05_Electric_vehicle_price_parity_and_adoption_in_Europe_Final.pdf

CTE ZEB Transition Planning Methodology

This study uses CTE's ZEB Transition Planning Methodology. The methodology encompasses ten key phases; these stages are sequential and build upon findings in previous steps. The phases specific to this study are outlined below:

0. Planning & Initiation
1. Requirements & Data Collection
2. Service Assessment
3. Fleet Assessment
4. Fuel Assessment
5. Maintenance Assessment
6. 3R Assessment
7. Facilities Assessment
8. Workforce Development Assessment
9. Total Cost of Ownership Assessment
10. ZEB Transition Plan – Document Creation

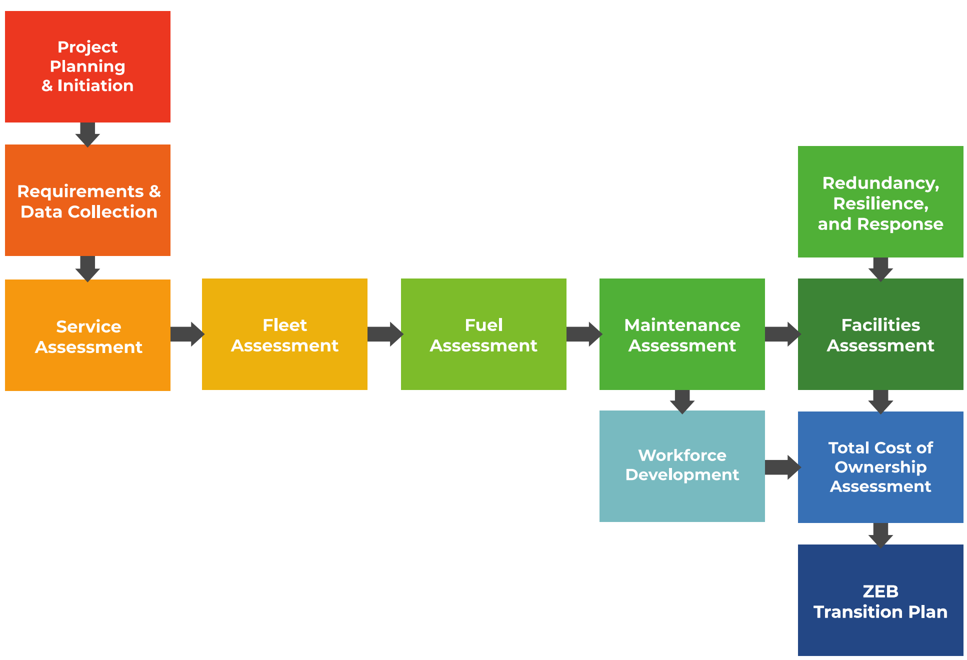


Figure 5 - CTE's ZEB Transition Study Methodology

The **Planning & Initiation** phase builds the administrative framework for the transition study. During this phase, the project team drafts the scope, approach, tasks, assignments and timeline for the project. CTE worked with CCRTA staff to plan the overall project scope and all deliverables throughout the full life of the study.

For the **Requirements & Data Collection**, CTE collects GPS data on selected routes and utilizes software models to estimate ZEB performance. The results from this modeling are used to estimate feasibility of every block in CCRTA's network using BEBs and FCEBs.

The **Service Assessment** phase initiates the technical analysis of the study. The results from the Service Assessment are used to guide ZEB procurements in the Fleet Assessment and to determine energy requirements (depot charging and/or hydrogen) in the Fuel Assessment. CTE met with CCRTA to define assumptions and requirements used throughout the study and to collect operational data. This process was conducted for the fixed service blocks for buses and cutaways.

The **Fleet Assessment** develops a projected timeline for replacement of ICE buses with ZEBs that is consistent with the agency's fleet replacement plan based on results from the Service Assessment. Since CCRTA's blocking was determined to be achievable with BEBs and on-route charging, the mixed fleet scenarios were defined based on composition percentages that would allow for CCRTA to explore the impacts of a majority BEB fleet and an all FCEB fleet on bus capital, fuel, and infrastructure costs. This analysis included an outline of the expected fleet structure and capital costs expected over the transition period for all scenarios explored and how they can be best optimized with regard to any state mandates or to meet agency goals, such as minimizing cost or maximizing service levels.

The **Fuel Assessment** merges the results of the Service Assessment and Fleet Assessment to determine annual fuel requirements and associated costs. The Fuel Assessment calculates energy costs throughout the entire transition timeline for each scenario, including the agency's current diesel and CNG buses. As current technologies are phased out in later years of the transition, the Fuel Assessment calculates the increasing energy requirements for ZEBs. The Fuel Assessment also provides a total energy cost over the transition lifetime.

The **Facilities Assessment** determines the necessary infrastructure to support the projected zero-emission fleet based on results from the Fleet Assessment and Fuel Assessment. The Facilities Assessment is calculated for each scenario used in the Fleet and Fuel Assessments. The assessment determines the required hydrogen and battery electric infrastructure and calculates associated costs.

The **Redundancy, Resilience, and Emergency Response (3R) Assessment** investigates the new risks to an agency's ability to provide service during power outages or fuel disruptions, and to support required emergency response activities, such as community evacuation with a full ZEB fleet. The outcomes of the 3R assessment are a summary of the risk reduction capabilities and cost effectiveness of recommendation of alternatives to mitigate the impacts from identified risks specific to an agency's risk tolerances, facility constraints, and budget.

The **WORKFORCE DEVELOPMENT ASSESSMENT** develops a multi-phase process of training procedures and tools designed to assist the agency with transitioning skilled labor into ZEB proficiency in a manner consistent with the agency's fleet replacement plan. This assessment also includes an inventory of critical skills, training tools, and resources broken down by functional agency department. Furthermore, the report explores case studies and best practices from transit agencies on how to conduct training, what tools are most valuable, and the critical importance of the training relationship, including contractual considerations, with the ZEB OEM.

The **MAINTENANCE ASSESSMENT** calculates all projected fleet maintenance costs over the life of the project. These costs include those related to existing ICE buses remaining in the fleet, as well as new cutaways, BEBs, and FCEBs, calculated for each scenario.

The **TOTAL COST OF OWNERSHIP ASSESSMENT** compiles results from the previous assessments and provides a comprehensive view of all associated costs, organized by scenario, over the transition lifetime.

Requirements Analysis

Baseline Data Collection

Understanding the key elements of CCRTA's service is essential to evaluating the costs of a complete transition to a zero-emission fleet. CCRTA staff provided key data on CCRTA's service including:

- Current fleet composition containing vehicle propulsion types and lengths
- Route and block information including distances and trip frequency
- Mileage and fuel consumption
- Maintenance costs and fuel costs

CTE prepared and distributed the CCRTA Agency Data Collection Template to the agency to begin the **Requirements Analysis & Data Collection** stage of the project. As part of this effort, CTE travelled to Corpus Christi, Texas to collect GPS data on a diverse sampling of route. Routes were selected with the assistance of agency staff to ensure each vehicle type, terrain type, range of speeds, and most frequently run routes were represented. CTE and CCRTA also decided that because cutaway vehicles also make up a significant portion of CCRTA's fixed route service, these cutaways should be included as part of the modeling for the ZEB Transition Plan assessment. CCRTA also has cutaways that are used for paratransit service that were not included in the following analyses. Paratransit service is in constant flux, and being unable to predict the service makes it difficult to predict fuel cost and the number of vehicles needed. CTE also met internally to discuss the best approach for conducting the analysis of these service vehicles for the purposes of ZEV transition planning.

Fleet Composition

A summary of CCRTA's 2022 fleet by vehicle size, fuel type, and bus length is shown in **Table 3**. Bus services operate out of a depot at Bear Lane with seasonal services stationed in Port Aransas. Operations, maintenance, and fueling functions are performed at the depot. The fleet currently consists of 70 full size transit buses stationed at the main depot, 19 cutaways used for fixed route service out of the main depot, and 4 cutaways used for seasonal fixed route service out of Port Aransas.

Table 3 - Fleet Summary by Depot, Length, and Fuel Type

Depot	Bus Length	Fuel Type			
		CNG	Diesel	Gasoline	Total
Port Aransas	Cutaway (25’)	-	1	3	4
Bear Lane	Cutaway (26’)	19	-	-	19
Bear Lane	35’	26	20	-	46
	40’	24	-	-	24
	Total	69	21	3	93

Miles and Fuel Consumption

Data on CCRTA’s current fuel consumption is used to estimate energy costs throughout the transition period. Average annual fleet mileage and fuel use are shown in **Table 4** and **Table 5.**

Table 4 - Average Annual Service Miles by Bus Length

Average Annual Miles per Bus			
Fuel Type / Length	**CNG**	**Diesel**	**Gasoline**
Cutaway 26’/27’	41,975	19,032	31,913
35'	53,757	32,253	-
40'	55,753	-	-

Table 5 - Total Average Annual Diesel Consumption by Bus Length

Average Fuel Consumption per Bus			
Fuel Type / Length	**CNG [DGF to Gal]**	**Diesel [gal]**	**Gasoline [gal]**
Cutaway 26’/27’	4,378	2,351	4,632
35'	11,357	5,455	-
40'	30,554	-	-

Service Assessment

The SERVICE ASSESSMENT analyzes the feasibility of maintaining CCRTA's service with battery electric and hydrogen fuel cell electric buses. The key component of the Service Assessment is the **Block Analysis**, which analyzes bus range limitations to determine if ZEBs can meet the service requirements of the blocks within the transition period. The energy needed to complete a block is compared to the available energy for the prospective bus type that is planned for the block. If the prospective bus's available energy exceeds the block's required energy, then that block is considered feasible for that ZEB type. The Service Assessment also yields a timeline for when blocks become achievable for zero-emission buses as technology improves. This information is used to then inform ZEB procurements in the Fleet Assessment.

Bus efficiency and range are primarily driven by bus specifications; however, both metrics can be impacted by a number of variables including the route profile (e.g., distance, dwell time, acceleration, sustained top speed over distance, average speed, traffic conditions, deadhead), topography (e.g., grades), climate (e.g., temperature), driver behavior, and operational conditions (e.g., passenger loads and auxiliary loads). As such, the efficiency and range of a given ZEB model can vary dramatically from one agency to another. Therefore, it is critical to determine efficiency and range estimates that are based on an accurate representation of CCRTA's operating conditions.

Modeling and Analysis Methodology

The first task in the Service Assessment is to develop route and bus models and run operating simulations for typical CCRTA routes. In order to accomplish this, the efficiency values that were obtained through modeling based on the collected GPS data of CCRTA's routes were used to determine the amount of energy required for each of CCRTA's blocks. The Service Assessment determines the percentage of the agency's blocks that will be achievable in a given year considering the energy demand of the blocks and the battery capacity of the buses (for 35' and 40') with an assumed battery capacity improvement factor of five percent every two years. This improvement in battery capacity increases the estimated range of the buses over time, which gradually increases the percentage of blocks that are achievable by 2040. This process was conducted for the fixed service blocks for buses and cutaways.

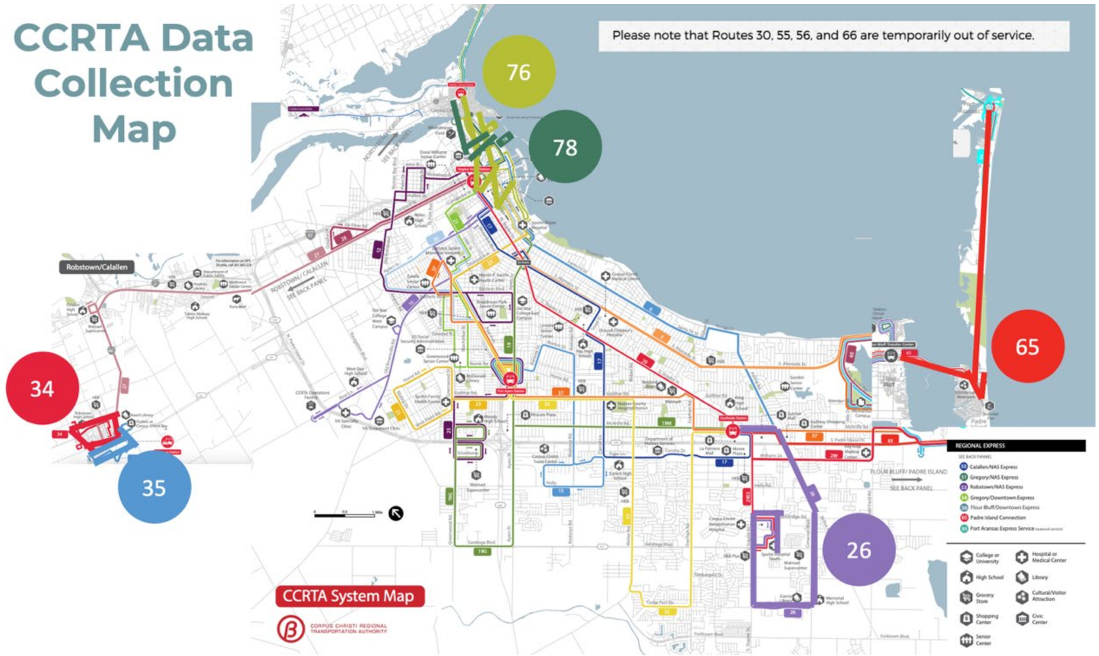


Figure 6 - CCRTA Data Collection Map

CTE obtained this data for routes 26, 34, 35, 65, 76, and 78 as shown in **Table 6** and **Figure 6**. CTE uses a sampling approach for gathering data on an agency's service in which representative sample routes are identified based on topography and average speed characteristics. CTE collected GPS data, which includes time, distance, bus speed, bus acceleration, GPS coordinates, and roadway grade from six CCRTA routes that were identified with the sampling approach, which are included in **Table 6** below. CTE modeled CCRTA's route and the vehicle energy demand to predict which of CCRTA's blocks can feasibly be transitioned to ZEB technology and the timeline of when the transition can occur.

Table 6 - Selected Routes for Modeling

Route ID	Route Description	Route Mileage (Round Trip - miles)	Route Category (Speed, Topography)
26	Airline / Lipes Connector	20.4	Flat/Downhill, Low Speed
34	Robstown North	7.1	Hilly, Low Speed
35	Robstown South	6.9	Flat, Low Speed
65	Padre Island Connection	33.5	Medium Speed
76	Harbor Bridge Shuttle	4.8	Medium Speed
78	North Beach	5.3	Flat, Medium Speed

CTE used component-level specifications for a generic electric bus and the CCRTA sample route data to develop a baseline performance model by simulating the operation of an electric bus on each route in Autonomie. Autonomie is a powertrain simulation software program developed by Argonne National Labs for the heavy-duty trucking and automotive industry. CTE has modified software parameters in Autonomie to assess energy efficiencies, energy consumption, and range projections for ZEBs. The energy requirements of the sample routes were then applied to all routes and blocks that share the same characteristics as the sampled routes.

ROUTE MODELING analyzes varying passenger loads, accessory loads, and battery degradation to estimate real-world bus performance, fuel efficiency, and range. The GPS data from routes and the specifications for each of the bus models are used to simulate operation on each type of route. The models were run under nominal and strenuous load conditions.

NOMINAL LOAD conditions assume average passenger loading and a moderate temperature over the course of the day, which places marginal demands on the motor and the heating, ventilation, and air conditioning (HVAC) system. STRENUOUS LOAD conditions assume high or maximum passenger loading and near-maximum output of the HVAC system. These strenuous loading conditions represent a hypothetical and unlikely worst-case scenario, but one that is necessary to establish an outer bound for the analysis. This nominal/strenuous approach offers a range of operating efficiencies, measured in kilowatt-hour/mile (kWh/mi), to use for estimating average annual energy use (nominal) or planning maximum service demands (strenuous).

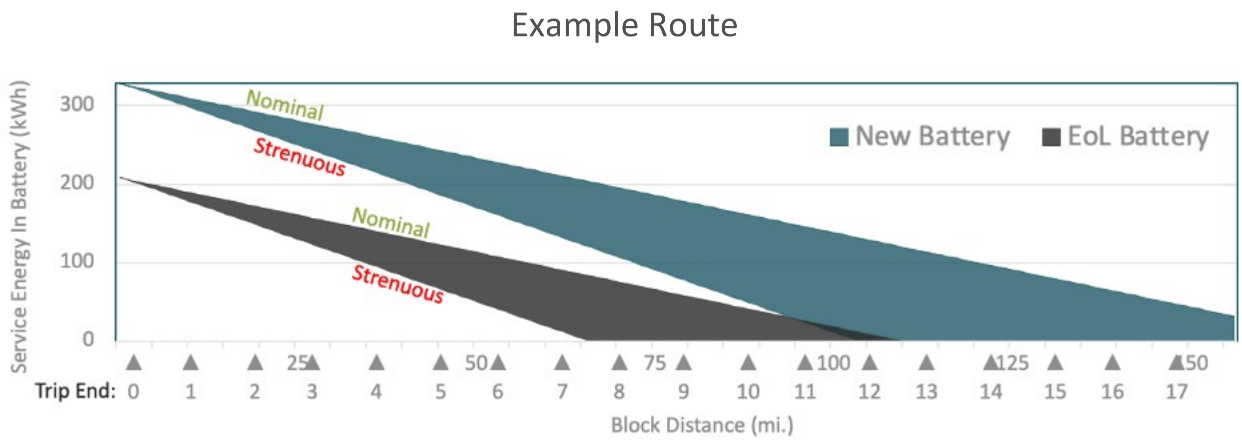


Figure 7 - Example Route Block Analysis

Figure 1 shows the range of remaining BEB battery energy (y-axis) on an example route. The blue and black areas show the range of estimated energy remaining between the nominal and strenuous load conditions for a new and an old battery, respectively. The point at which these areas cross the x-axis is the point at which there is no battery energy remaining. These colored areas shown represent the spectrum of expected operating conditions throughout the bus life to aid in service planning. The triangles under the graph denote trips within a block.

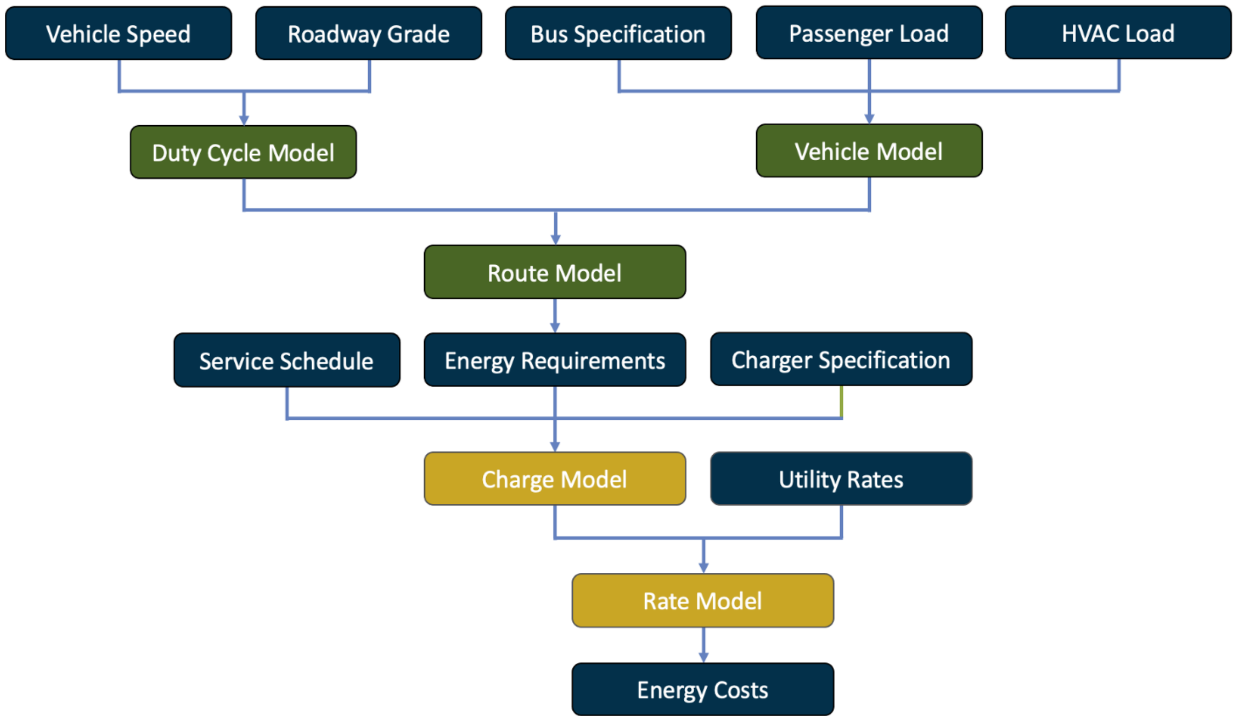


Figure 8 - CTE Modeling Methodology

Assumptions

CTE uses a set of assumptions related to battery capacity to guide the service assessment. The assumptions for the service assessment are as follows:

As of 2022, batteries for battery electric buses have a nameplate capacity of 580 kWh with a usable capacity of 522 kWh. Battery electric cutaways have a nameplate capacity of 160 kWh with a usable capacity of 144 kWh. The usable battery capacity for BEBs is 90% of the nameplate capacity which is the amount advertised by the original equipment manufacturer (OEM). The average service capacity is 90% of the usable capacity and the reserve energy is five percent of the usable battery capacity. Therefore, CTE assumes a service capacity with a reserve of 446 kWh for 40' battery electric buses, 338 kWh for 35' BEBs, and 123 kWh for battery electric cutaways in 2022. A five percent improvement in battery capacity is assumed to expand every two years and is expected to double by the year 2050.

The BEB modeling was completed using strenuous conditions with HVAC loads designated at 40F with buses at 14 kW and cutaways at 9 kW. Modeling was performed with data collected from routes 26, 34, 35, 65, 76, and 78. These routes were selected as a representative sample by the CCRTA team. All of the bus routes modeled had a similar nominal efficiency of ~2.32 kWh/mi. The cutaway routes all had a similar nominal efficiency of ~1.2 kWh/mi. The block list used was comprised of data from CCRTA's 2019 pre-Covid full service.

CCRTA confirmed they will maintain service to similar destinations within the region and therefore the blocks maintain a similar distribution of distance, relative speeds, and elevation changes throughout the transition period. This core assumption affects energy use estimates and block feasibility in each year.

Block Feasibility Results by Bus Type

The **Block Analysis** uses the strenuous energy required to complete each block and compares it to bus energy storage capacities. It considers what length bus is assigned to each block; for blocks that can use either 35' or 40' buses, a 40' bus was used to establish feasibility. Energy storage growth assumed five percent improvement in battery capacity or hydrogen storage capacity every two years which determines the timeline for when routes and blocks become achievable for BEBs and FCEBs. This information is used to inform ZEB procurement projections in the Fleet Assessment. Overall, the block analysis helps to determine when, or if, a full transition to ZEBs may be feasible and when there are requirements for supplemental energy solutions. Results from this analysis are also used to determine the specific energy requirements and develop the estimated costs to operate the ZEBs in the Fuel Assessment. Results from the block analysis for BEBs are included in selected years (2022, 2025, and 2050) in **Table 7** below.

Table 7 - BEB Block Feasibility Percentage by Year

CCRTA: Full Fixed-Route System Service Assessment Results								
Garage	Type	Number of Blocks	2022 BEB Feasible Blocks		2035 BEB Feasible Blocks		2050 BEB Feasible Blocks	
MVT	Cutaway	27	9	33%	11	41%	17	63%
PTA	Cutaway	2	0	0%	0	0%	0	0%
CCRTA	Bus	64	19	30%	39	61%	62	97%
ALL	ALL	93	28	30%	50	54%	79	85%

Another factor affecting block feasibility is battery degradation. BEB range is negatively impacted by battery degradation over time. A BEB placed in service on a given block with beginning-of-life batteries may not be able to complete the entire block at some point during its life before the batteries reach end-of-life. End-of-life is typically defined as when batteries reach 80% of available service energy. Conceptually, older buses can be moved to shorter, less demanding blocks and newer buses can be assigned to longer, more demanding blocks. CCRTA can also rotate the fleet to meet service energy demand, assuming there is a steady procurement of electric buses to match service requirements.

BEB Cutaway Routes

CTE's modeling included an analysis for battery electric cutaway vehicles using CCRTA's fixed route drive cycles. CTE found that the power limitations of the battery electric cutaway motor may reduce feasibility. **Figure 9** shows the BEB feasibility for cutaways in 2022 based on available vehicles on the current 2022 market. Results indicate 33% of CCRTA's fixed route annual service would be considered feasible with nine out of 27 feasible blocks and 18 not feasible.

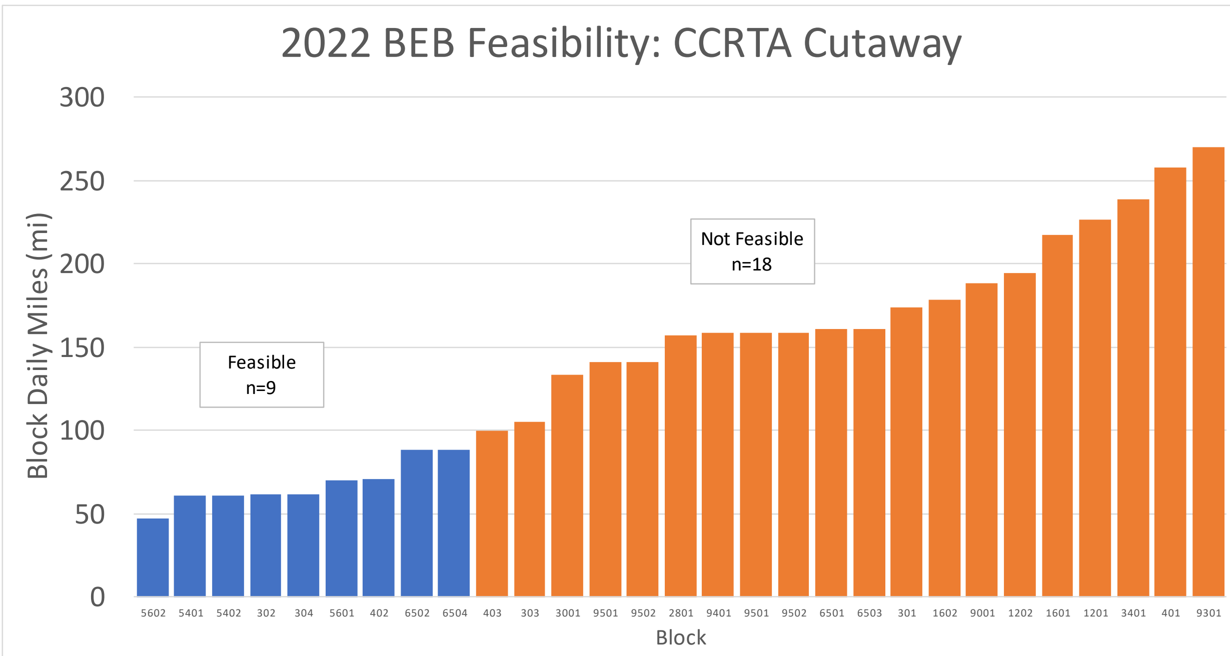


Figure 9 - 2022 BEB Feasibility: CCRTA Cutaway

By 2035, based on the five percent battery capacity bi-annual predicted growth rate, an electric cutaway vehicle is projected to be able to complete 41% of CCRTA's annual service as shown in **Figure 10**. The preliminary results show 11 out of 27 feasible blocks and 16 not feasible. That feasibility jumps to 63% in 2050 with 17 feasible blocks.

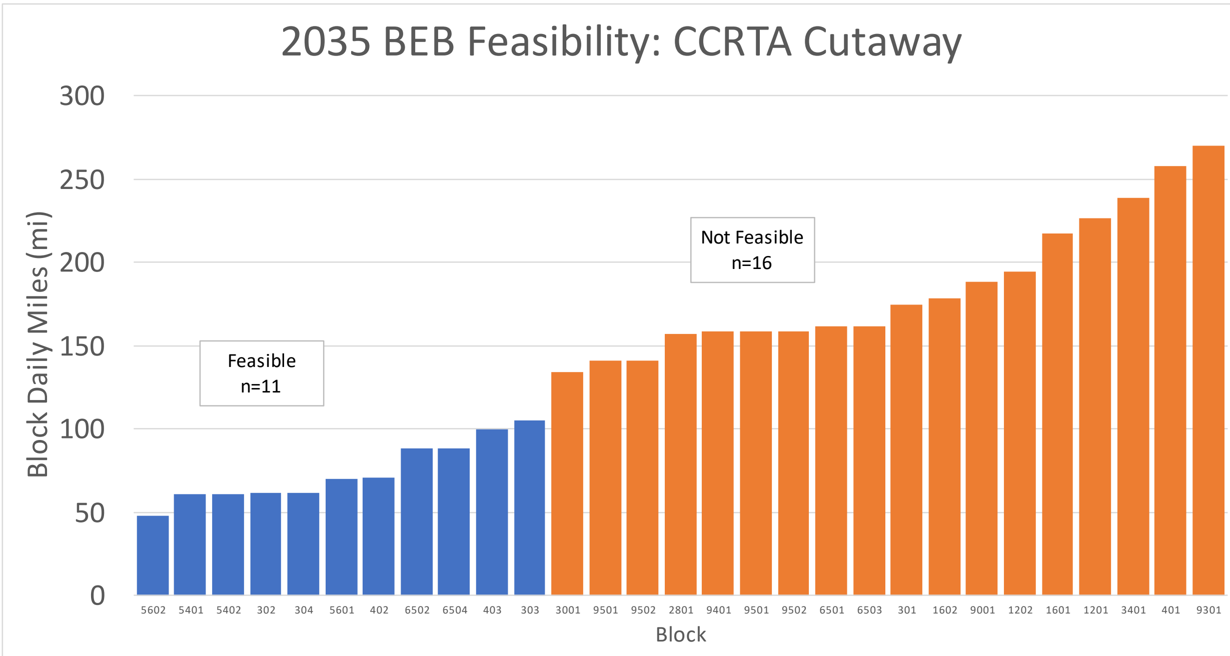


Figure 10 - 2035 BEB Feasibility: CCRTA Cutaway

BEB Bus Routes

Figure 11 shows the BEB feasibility for buses in 2022 based on available vehicles on the current 2022 market. Blocks run with 35' buses are compared to today's 35' BEB energy storage capacities. Blocks that can use either a 35' or 40' use a 40' BEB energy storage capacity for their calculations. The preliminary results show a 34% feasibility rate with 19 out of 64 feasible blocks and 45 not feasible.

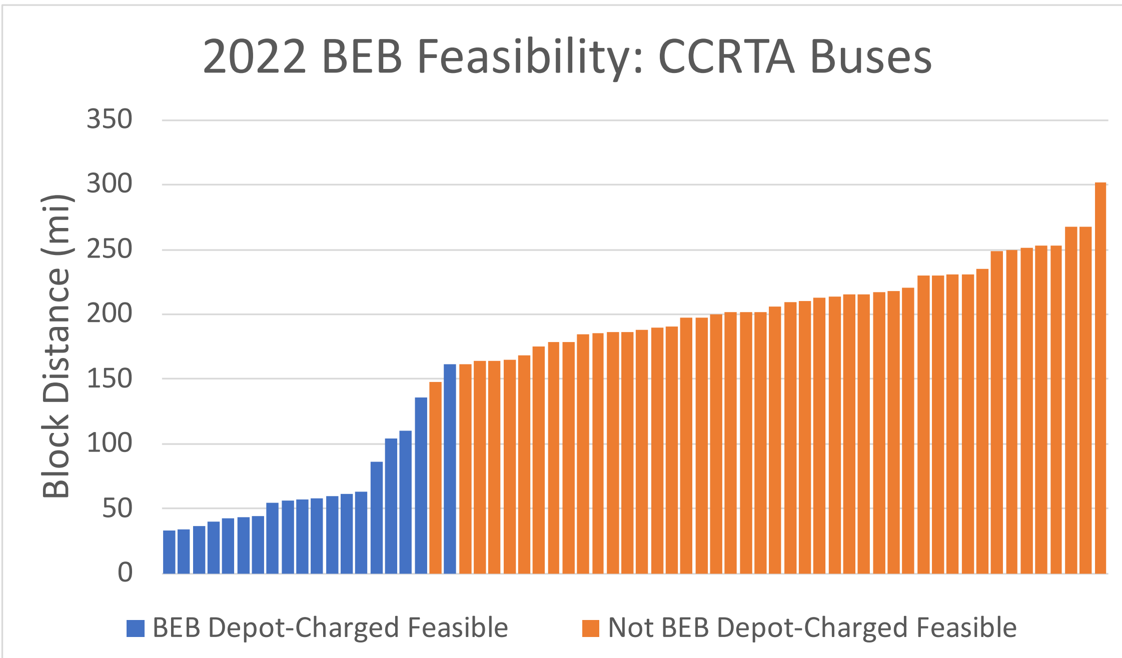


Figure 11 - 2022 BEB Feasibility: CCRTA Buses

Figure 12 shows the BEB feasibility for buses in 2035 based on the five percent predicted battery capacity bi-annual growth rate. The preliminary results show a 61% feasibility with 39 out of 64 blocks feasible. This feasibility increases to 97% in 2050 with 62 out of 64 blocks feasible.

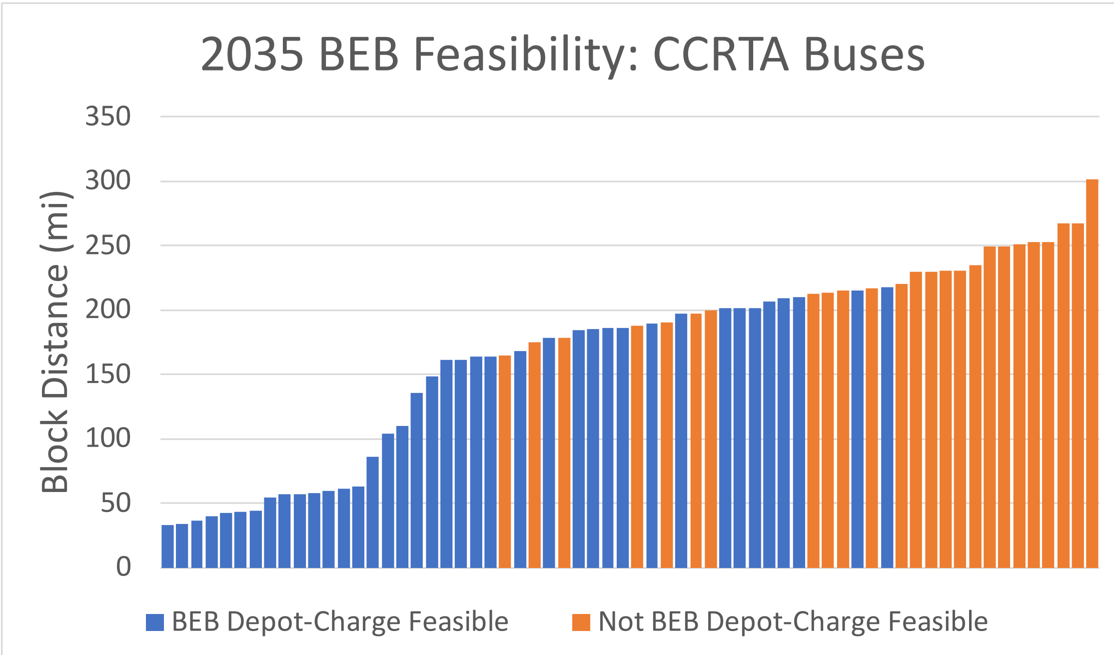


Figure 12 - 2035 BEB Feasibility: CCRTA Buses

FCEB Bus Routes

Figure 13 shows the FCEB feasibility for buses in 2022 based on available vehicles on the current 2022 market. The preliminary results show an 84% feasibility rate with 54 out of 64 blocks feasible. By 2035, only one block is not feasible, increasing the feasibility rate to 98%. By 2050, all blocks are feasible.

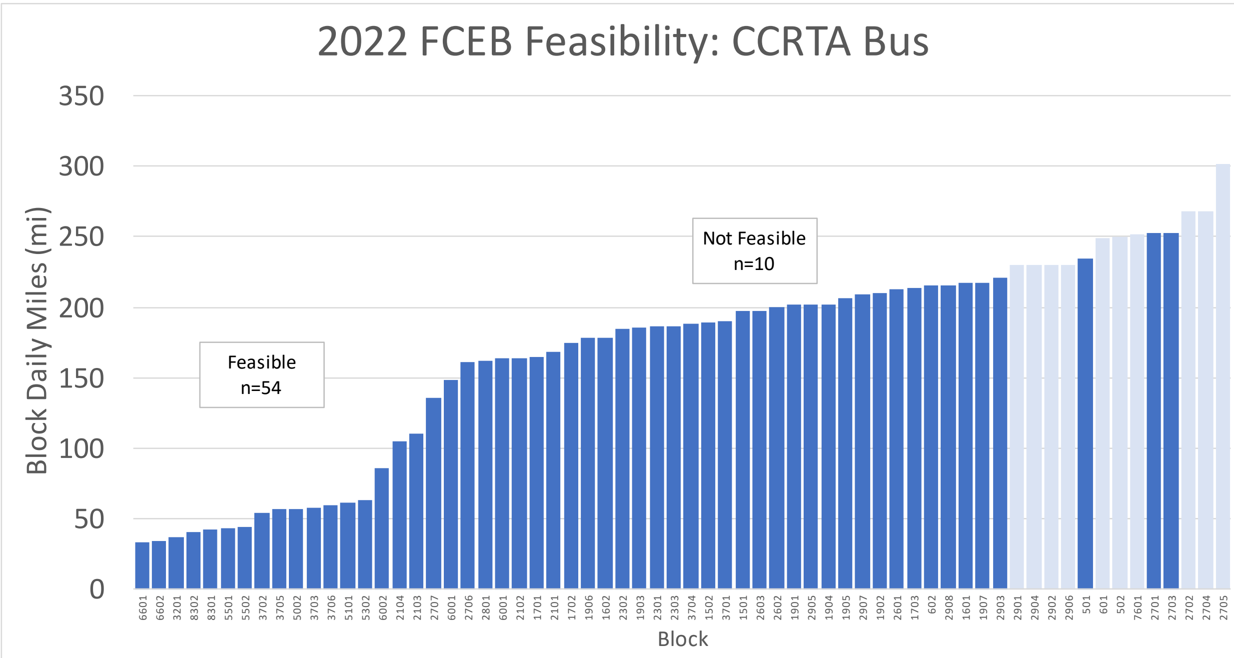


Figure 13 - 2022 FCEB Feasibility: CCRTA Bus

Fleet Assessment

The goal of the **Fleet Assessment** is to determine what type of ZEB technology solutions are required to transition an entire fleet to zero-emission vehicles. Results from the Service Assessment are integrated with CCRTA's current fleet replacement plan and purchase schedule to produce two main outputs:

1) A projected bus and cutaway replacement timeline through the end of the transition period and

2) The total capital costs of those replacements.

Throughout the assessment, the projected bus and cutaway procurement plan is referred to as the transition period.

For this effort, the Service Assessment was used to inform the percentage of buses that could be transitioned to BEBs or FCEBs in a given year during the transition. The mixed fleet scenario was defined based on composition percentages that would allow for CCRTA to explore the impacts of a majority BEB fleet on bus capital, fuel, and infrastructure costs. This analysis included an outline of the expected fleet structure and capital costs expected over the transition period for each scenarios explored as well as prioritized the replacement of diesel vehicles before CNG. All three scenarios also include the procurement of battery electric fixed-route cutaways.

Procurement Timeline

Figure 14 shows the overall procurement phase-in of buses and cutaways during the transition period. This timeline is inclusive of the vehicles that will need to be procured once they reach their end-of-life. The lifespan of a full-sized BEB and FCEB is approximately 12 years whereas the lifespan for a cutaway bus is approximately seven years.

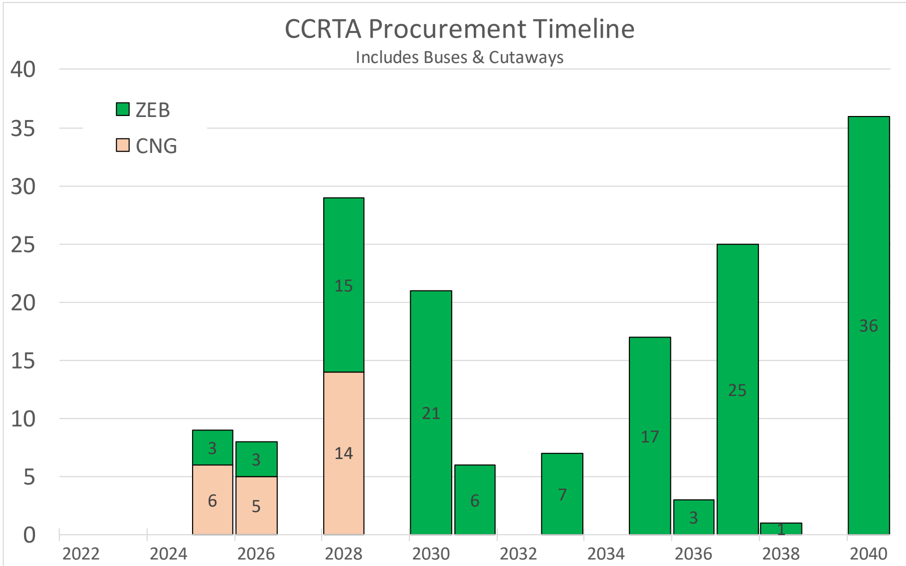


Figure 14 - Procurement Phase-In During Transition Period

Vehicle Composition

Cutaway Buses

Figure 15 shows the composition of cutaway vehicles throughout the transition period. The first electric cutaways are introduced into the fleet in 2026. The transition assumes all CNG and unleaded cutaways are already in the process of replacement with unleaded gasoline cutaways, completed in 2023. Gasoline cutaways are used while phasing in electric cutaways, with a fully electric cutaway fleet reached in 2037. The BEB Only, FCEB Only, and Mixed Fleet scenarios all include the procurement of battery electric fixed-route cutaways.

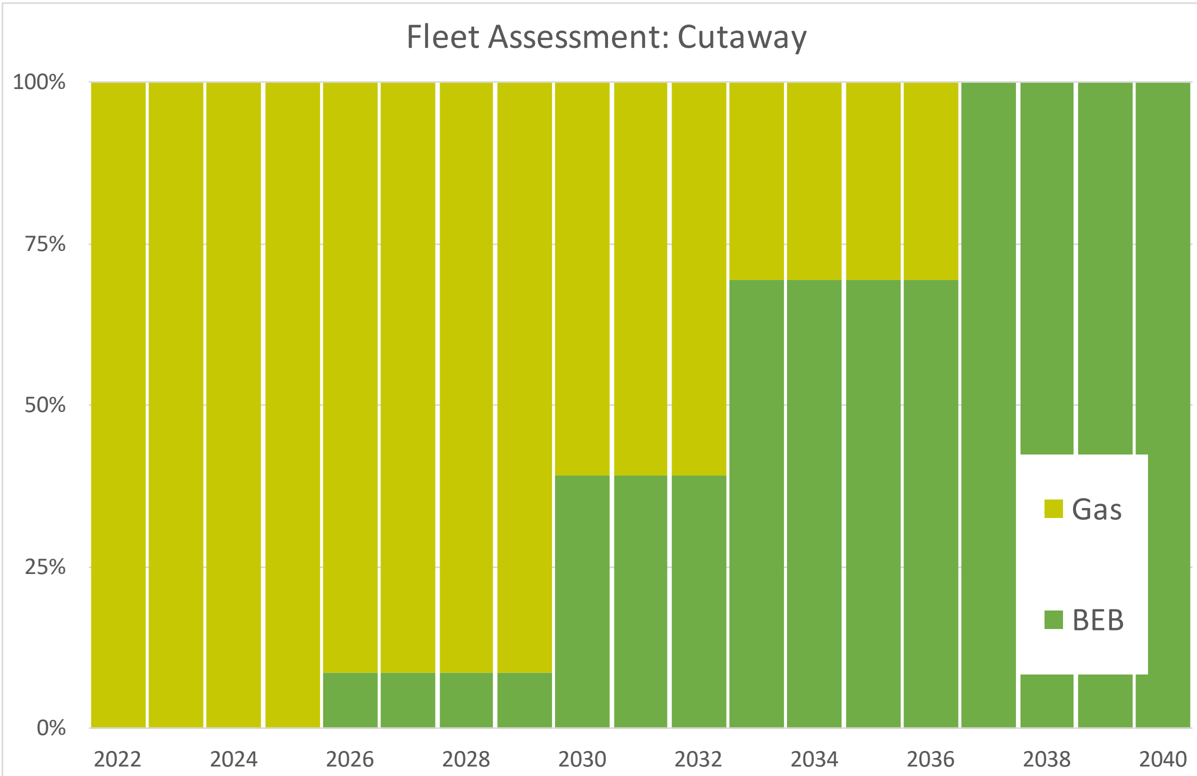


Figure 15 - Cutaway Fleet Composition

BEB Only

Figure 16 shows the vehicle composition of the BEB Only scenario throughout the transition period. The first BEBs are introduced into the fleet in 2025. The transition focuses first on phasing out diesel vehicles followed by CNG. The CCRTA fleet is free of diesel buses by 2028, and the transition to incorporate more ZEBs would continue until the fleet is fully composed of FCEBs and battery electric cutaways in 2040. The BEB Only scenario is the only scenario to incorporate on-route charging.

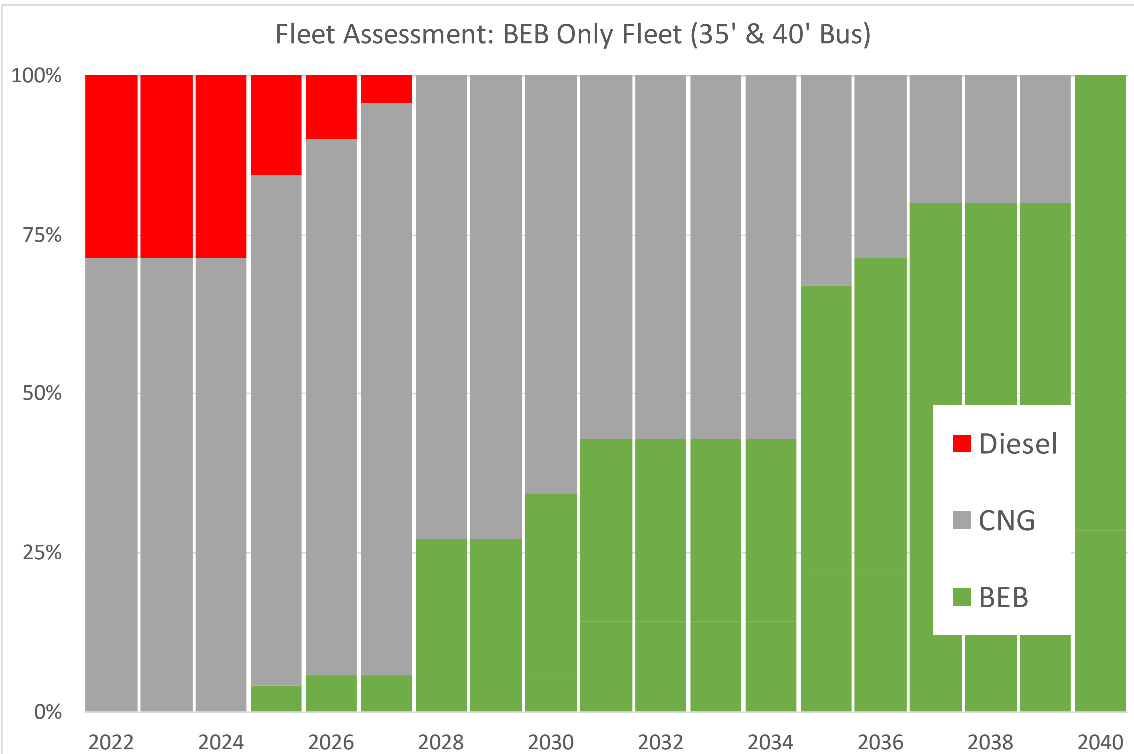


Figure 16 - BEB Only Fleet Composition

FCEB Only

Figure 17 shows the vehicle composition of the FCEB Only scenario throughout the transition period. The first FCEBs are introduced into the fleet in 2025. The transition focuses first on phasing out diesel vehicles followed by CNG. The CCRTA fleet is free of diesel buses by 2028, and the transition to incorporate more ZEBs would continue until the fleet is fully composed of FCEBs and battery electric cutaways in 2040.

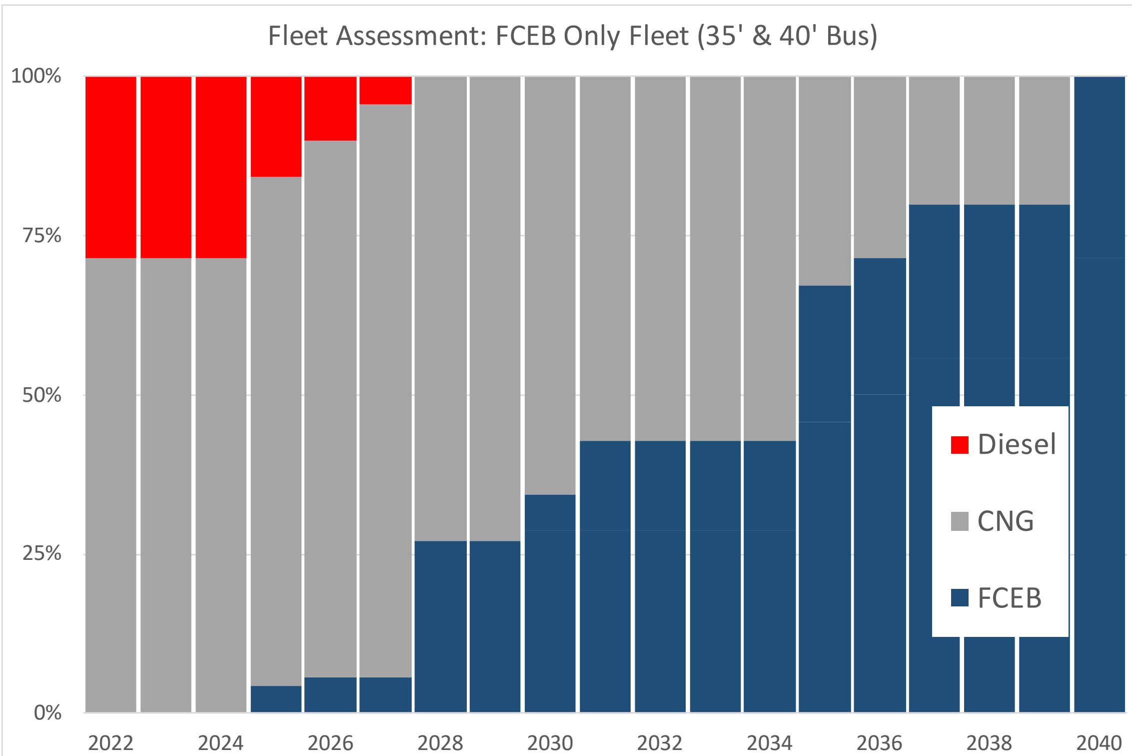


Figure 17 - FCEB Only Fleet Composition

Mixed Fleet – BEB Majority

Figure 18 shows the vehicle composition of the Mixed Fleet scenario throughout the transition period. The first BEBs are introduced into the fleet in 2025 and the first FCEBs are introduced in 2030. The transition focuses first on phasing out diesel vehicles followed by CNG. The CCRTA fleet is free of diesel buses by 2028, and the transition to incorporate more ZEBs would continue until the fleet is fully composed of BEBs and FCEBs and battery electric cutaways in 2040.

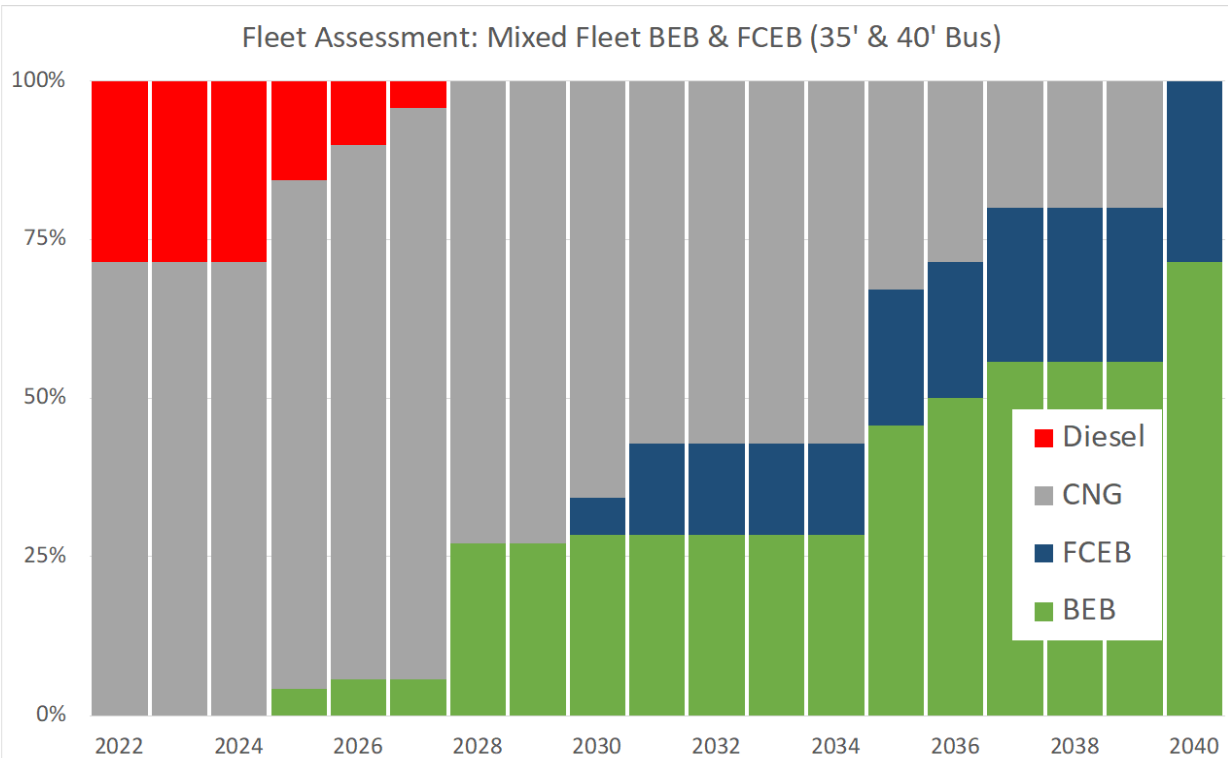


Figure 18 - Mixed Fleet Composition (2022-2040)

Summary

The BEB Only scenario requires on-route charging starting in 2030 in order for the buses to be able to complete all CCRTA blocks. In the Mixed Fleet Scenario, FCEBs are incorporated in 2030 to fill the service requirement limitations of the BEBs. On-route charging is not necessary for the FCEB Only and Mixed Fleet scenarios. Under all scenarios, ICE and CNG vehicles are completely phased out by 2040, when CCRTA would successfully reach the goal of operating a fully ZEB fleet.

Fuel Assessment

The **Fuel Assessment** estimates fuel consumption and costs for each of the technologies: diesel, CNG, electric, and hydrogen studied in the relevant scenario. Using ZEB performance data from the route simulation, CTE analyzed expected bus performance on each block in CCRTA's service catalog to calculate the daily fuel required for that block's completion. CTE completed this analysis for each of the three zero-emission fleet transition scenarios and the baseline scenario. The analysis produced estimates of the fuel costs for each projected fleet composition through the transition period.

Assumptions

Due to the limited range capabilities associated with battery electric vehicles, BEBs will be assigned to low mile blocks and FCEBs will operate on higher mile blocks. For the ICE vehicles, low mile blocks will be assigned to diesel buses until they can be replaced with CNG buses. CTE used CCRTA's holiday schedule to inform this assessment. Fuel cost estimates are based on the assumptions shown in **Table 8** below.

Table 8 - Fuel Cost Assumptions

Fuel	Cost	Source
Hydrogen (liquid)	$4/kg	Based on the expectation that the cost of hydrogen will decline over the course of the transition period.
Hydrogen (liquid)	$7.95/kg	Based on OCTA's 2017 contractual price of liquid hydrogen (trucked in). Cost is inclusive of hydrogen fueling station maintenance by provider.
Electricity	$0.07602/kWh	Based on Average Rate in 2022

Analysis Results

Figure 19 shows the fuel cost per mile by each bus type. The fuel cost for FCEB is the highest at $1.09 per mile whereas the cost for BEB is the lowest at $0.20 per mile. CNG and diesel fuel costs are about even at $0.31 and $0.32 per mile respectively.

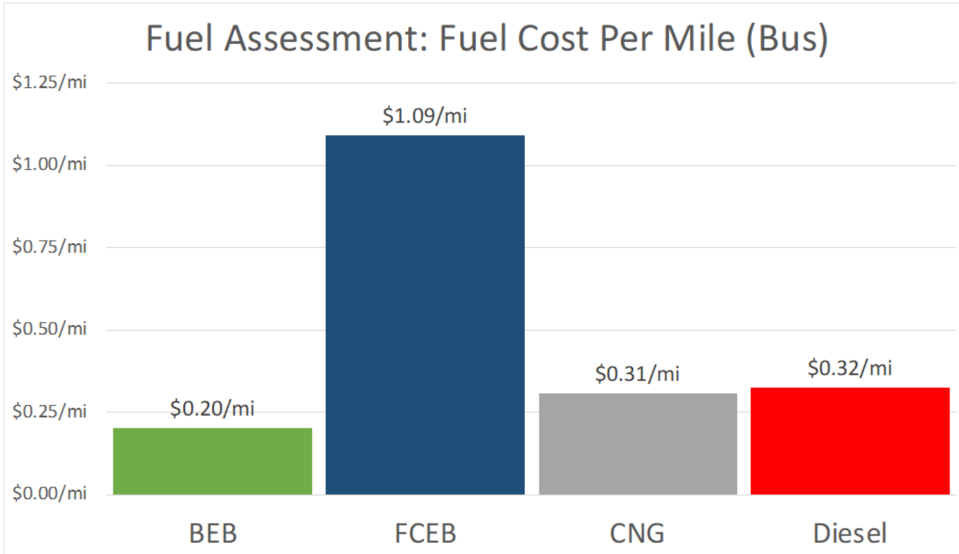


Figure 19 - Fuel Cost per Mile by Bus

Figure 20 shows the annual fuel cost by bus and fleet makeup over the course of the transition period. The Baseline represents the fleet composition in 2022. The BEB Only scenario is comprised of 100% BEBs by 2040 and requires on-route charging after 2030 to reach 100% ZEB. The FCEB scenarios are for 100% FCEB by 2040 with two fuel costs analyzed to include a low and high fuel cost ($4/kg H_2 and $8/kg of H_2). The Mixed Fleet scenario is comprised of 50 BEBs and 20 FCEBs in 2040 and uses $8/kg of H_2 for the fuel cost. The fleet will be entirely zero-emission by 2040.

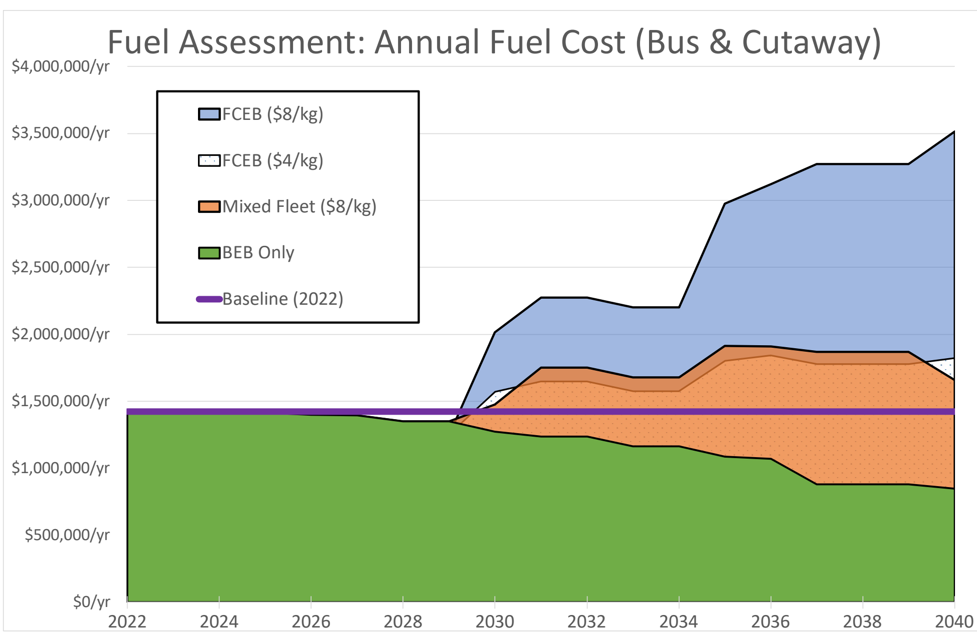


Figure 20 - Annual Fuel Cost by Transition Type

Summary

When comparing vehicle options in terms of fuel cost versus capabilities, there are a few tradeoffs to consider. The fuel cost associated with BEBs is two to four times lower than that of FCEBs. Although FCEBs offer 50% more range capability than BEBs, the cost of hydrogen is still significantly higher than electricity. BEBs will ultimately require more depot infrastructure, and a BEB Only fleet would require on-route charging to reach 100% feasibility. The Mixed Fleet scenario does not require on-route charging since FCEBs would be used to provide coverage for the longer blocks.

Maintenance Assessment

The **MAINTENANCE ASSESSMENT** examines the changes to fleet maintenance costs for each fleet composition scenario over the transition period. Since ICE/CNG and zero-emission vehicles have different maintenance requirements, they generally have different maintenance costs associated with them. For both BEB and FCEB maintenance cost estimates, CTE developed assumptions using real-world data from early adopters of ZEBs and applied them to CCRTA's Maintenance Assessment. Taking on a conservative outlook of vehicle performance, CTE also included the cost impact of midlife overhauls (where technicians look for signs of corrosion and install more durable parts) for components of the fleet.

CTE used CCRTA's reported costs for maintenance and average engine and transmission overhaul for the newest models of the existing fleet (consisting of CNG and diesel-powered buses and gasoline-powered cutaways). CTE also included the price of a midlife overhaul for FCEBs that covers the cost of a complete overhaul of the fuel cell system, which, if required, can be significant and may offset savings from traditional maintenance costs. The cost of a battery replacement for a BEB and the battery portion of FCEB's midlife maintenance costs is traditionally covered under the battery warranty. This is purchased in the procurement year and is therefore considered a capital cost versus an operational/maintenance cost.

Cost Assumptions

CTE's maintenance cost assessment includes labor, materials, and midlife overhaul costs. This assessment applied unit maintenance cost per mile by vehicle type with total costs based on average annual vehicle mileage as reported by CCRTA. Total costs are based on the following assumptions:

- Maintenance costs for diesel and CNG buses and gasoline-powered cutaways are based on data from CCRTA's current fleet.
- Maintenance costs for BEBs are based on a 30% reduction of diesel equivalent bus maintenance costs.
    - It is important to keep in mind that maintenance costs are hard to predict. Compared to conventional diesel and gasoline fueled vehicles, BEBs incur different maintenance needs that vary based on manufacturer and operating environment. In addition, a lot of the equipment for BEBs is covered by warranty, so costs in the first few years for maintenance are significantly lower than in the latter half of their service lives.

- Maintenance costs for FCEBs were based on OCTA's reported labor and maintenance costs.
  - This FCEB maintenance per mile value is based on the costs for the first year of service at OCTA. Therefore, this cost is likely high and will eventually trend downward since this is a first-generation vehicle. Long-term FCEB maintenance costs for US manufactured buses are still to be determined and should be carefully considered as CCRTA implements its transition plan.

Maintenance cost per mile is defined as the total labor costs plus the total material costs divided by the total number of miles. **Table 9** is a summary of the estimated combined costs for scheduled and unscheduled labor and maintenance for each type of bus explored in this study.

Table 9 - Labor and Materials Cost Assumptions

Vehicle Type	Estimate (Per Mile)	Source
40' CNG Bus	$ 0.31	CCRTA maintenance cost
35' Diesel Bus	$ 0.38	CCRTA maintenance cost
Gas Cutaway	$ 0.27	CCRTA maintenance cost
35' Electric Bus	$ 0.21	30% reduction of maintenance cost for a 35'/40' Diesel Bus
40' Electric Bus	$ 0.21	30% reduction of maintenance cost for a 35'/40' Diesel Bus
30'/35'/40' Fuel Cell Bus	$ 0.56	OCTA reported labor and maintenance costs for the first year of service of a first-generation vehicle
26' Electric Bus Cutaway	$ 0.19	30% reduction of maintenance cost

As a reminder, BEB maintenance cost does not include the battery warranty price of $75,000, which is purchased in the year of procurement and covers a single mid-life battery replacement. FCEB maintenance cost does not include the $17,000 extended warranty cost, which is purchased in the year of procurement.

Analysis Results

Baseline

The baseline assessment assumes no change in fleet composition for the duration of the transition period (2022-2040). The costs are not adjusted for inflation to illustrate the flat costs with an unchanged fleet composition; for the scenarios with changing fleet composition each year, this also helps isolate the impacts of vehicle type on maintenance costs.

Figure 21 shows the combined labor, materials, and midlife overhaul costs for the Baseline scenario for each year of the transition.

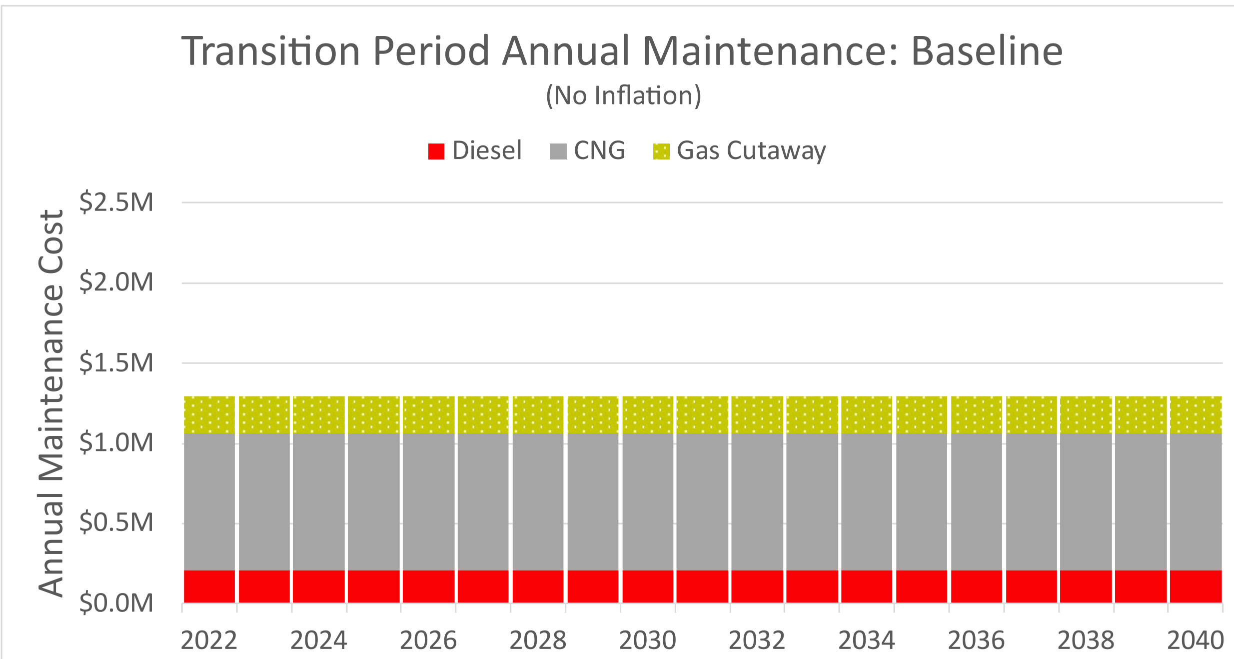


Figure 21 - Annual Fleet Maintenance Costs, Baseline

BEB Only

Figure 22 shows the combined labor and materials for the BEB Only scenario for each year of the transition. For the BEB Only scenario, the cost of the battery warranty is used to reflect the midlife battery replacement. In the assessment, the warranty costs are incurred at the time of the bus purchase and were included in the capital costs seen in the Fleet Assessment. Thus, the warranty costs are not included in the costs shown below. The spikes in expected maintenance costs that would be expected for this scenario are scheduled to occur in the same years that large bus procurements take place. As with the other scenarios, inflation is not applied to isolate the impact on changing fleet composition on maintenance costs.

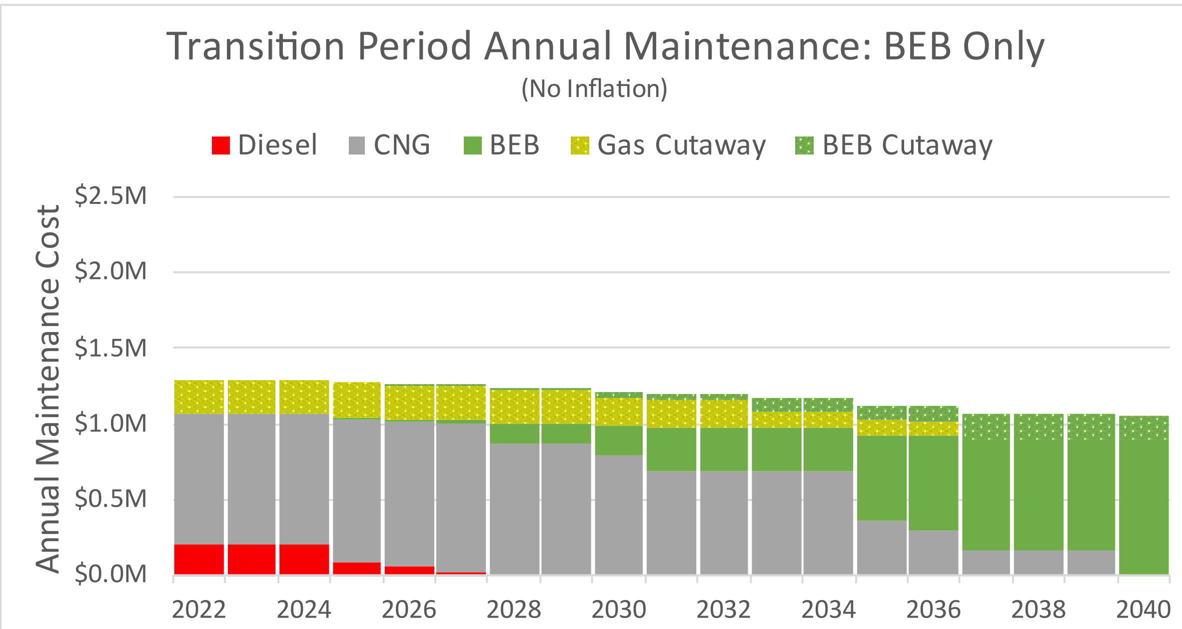


Figure 22 - Annual Fleet Maintenance Costs, BEB Only + Depot Charging

FCEB Only

Figure 23 shows the combined labor, materials and midlife overhaul costs for the FCEB Only scenario for each year of the transition. Maintenance costs for fuel cells were calculated using industry-reported maintenance costs per mile and maintenance costs reported by OCTA. Note that in the FCEB Only scenario, the cutaway fleet continues to use the transition to BEB plan while the full-size transit buses transition to FCEBs. Inflation is not considered in this figure to isolate the trend of vehicle type's impact on maintenance cost during the transition period.

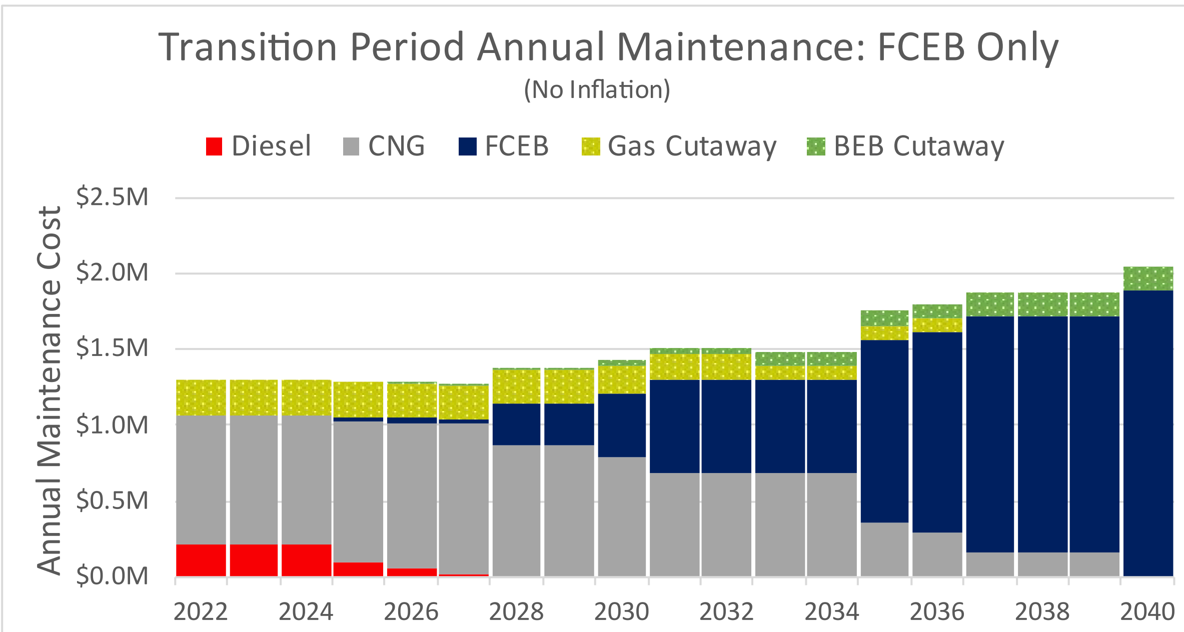


Figure 23 - Annual Maintenance Costs, FCEB Only

Mixed Fleet – BEB Majority

Figure 24 shows the combined labor, materials, and midlife overhaul costs for the Mixed Fleet – BEB Majority scenario for each year of the transition. Similar to the BEB Only scenario, anticipated midlife battery replacements for ZEBs are covered in the extended battery warranty in the year of purchase and can be seen in the Fleet Assessment. Inflation is not applied to isolate the trends seen by changing vehicle fuel type mix.

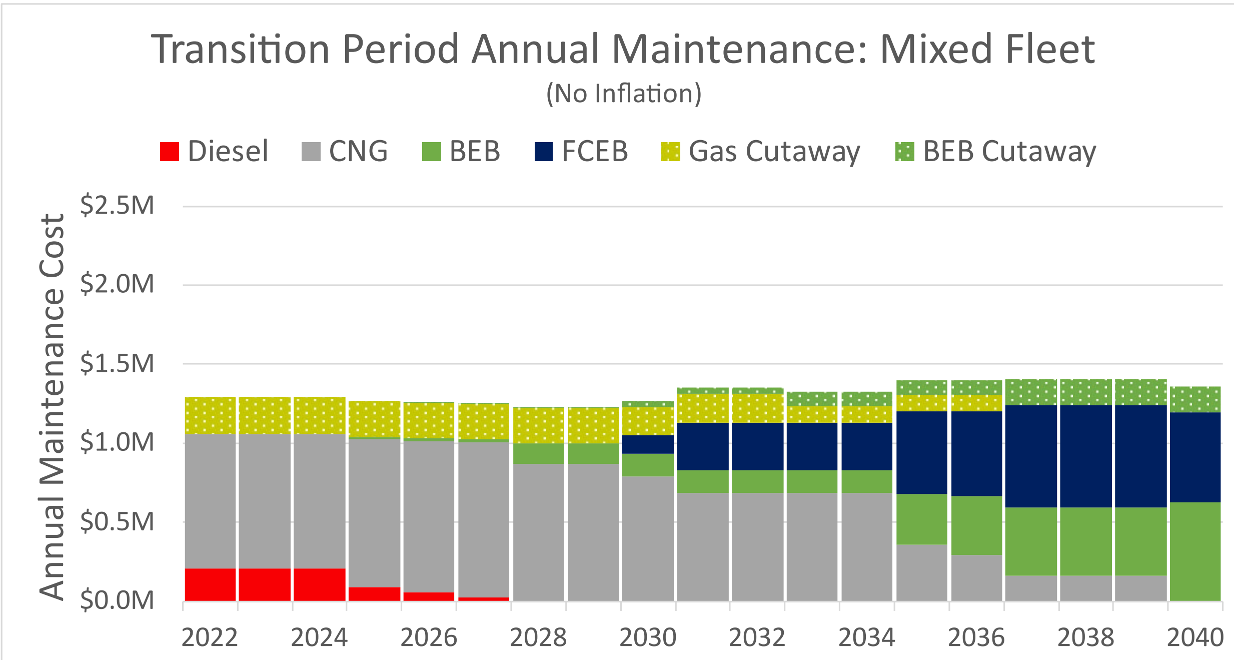


Figure 24 - Annual Fleet Maintenance Costs, Mixed Fleet

Cost Comparison

Figure 25 shows the cumulative maintenance costs for each scenario. CTE's Maintenance Assessment projects that by 2040, the FCEB Only scenario will incur the highest cumulative maintenance cost ($39.5M) while the BEB Only scenario and Mixed Fleet scenario will incur the least amount of maintenance costs ($29.5M and 33.4M, respectively) each over the transition period. These compare to the cumulative maintenance cost of $32.5M for the Baseline scenario. Note that inflation is applied to show the cumulative costs.

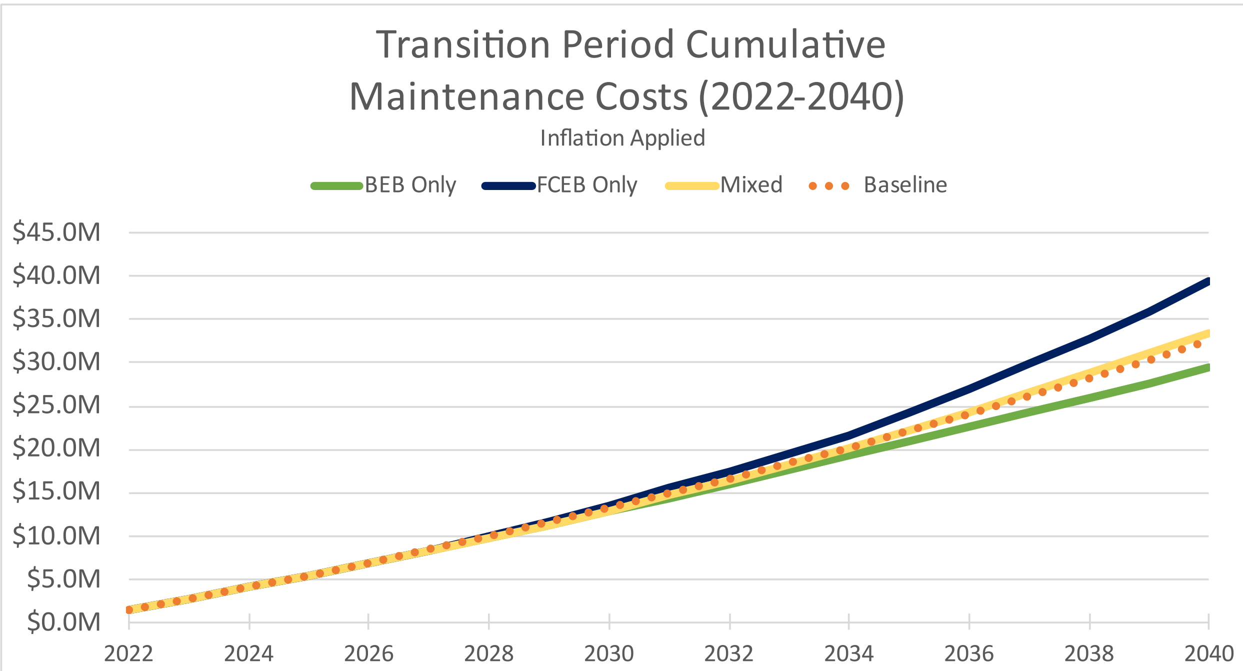


Figure 25 - Cumulative Maintenance Costs

Figure 26 shows the total maintenance costs for each scenario at the end of the transition period in 2040. The total maintenance cost for the FCEB Only scenario is shown to be the most expensive because of higher average costs for fuel cell as well as higher estimated maintenance costs per mile. The BEB Only scenario maintenance costs are the lowest. Note this chart does consider annual inflation when calculating each year's costs.

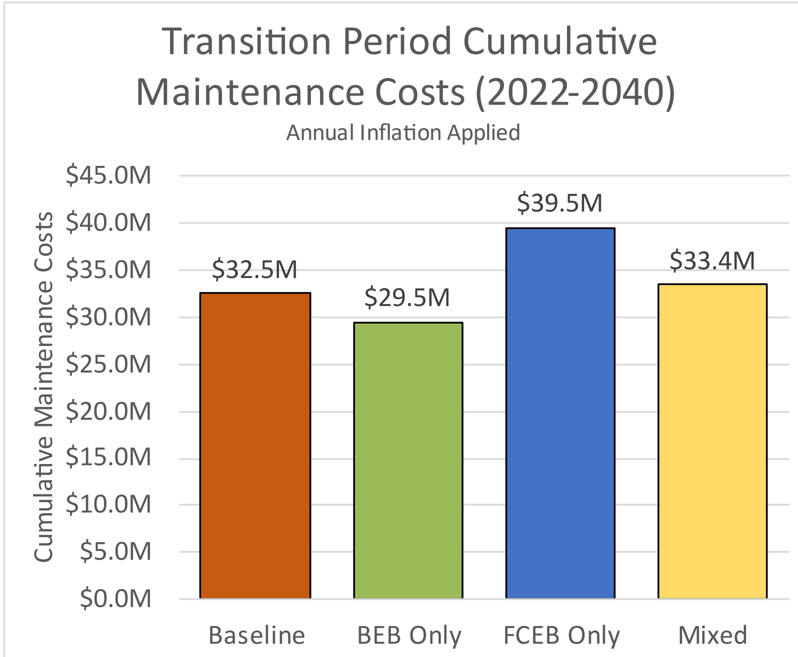


Figure 26 - 2040 Cumulative Maintenance Cost

Figure 27 below shows the average annual maintenance expenditures after the transition is complete. The maintenance costs for the BEB Only scenario and Mixed Fleet scenario are less than the baseline. The FCEB Only scenario maintenance costs drop significantly and are on par with the Baseline scenario.

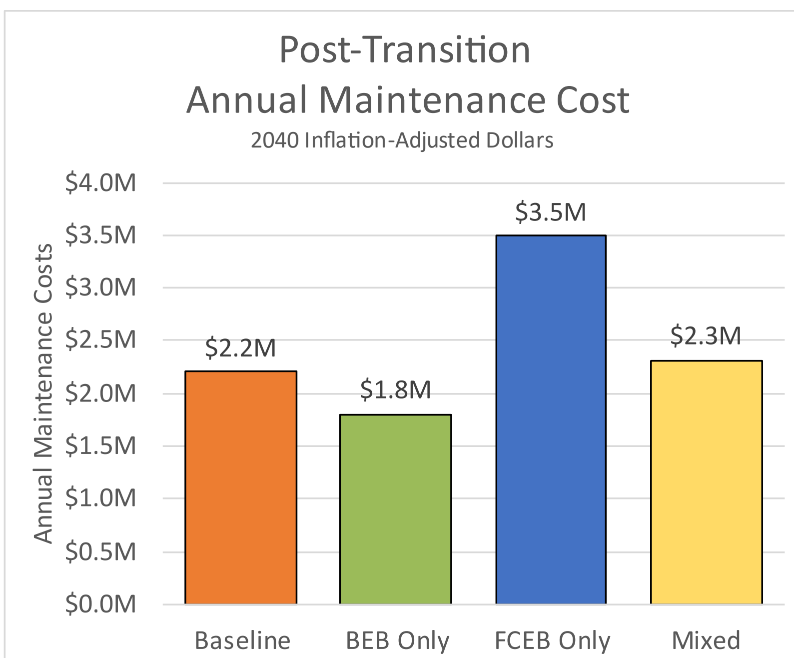


Figure 27 - Post-Transition Average Annual Maintenance Expenditures

Summary

The results of the maintenance cost assessment show the BEB Only scenario as the most cost-effective option. After the transition period is complete, the BEB Only scenario has the lowest cost per mile at 18 percent less than the 2040 Baseline projected cost. The FCEB Only scenario has the highest cost per mile at about 60% more than the baseline and is nearly double the BEB Only scenario. In the Mixed Fleet scenario, the additional costs of the FCEBs are offset by the comparatively lower costs of the BEBs; the Mixed Fleet annual maintenance cost is similar to the current baseline, at $2.3M compared to $2.2M.

Facilities Assessment

The **FACILITIES ASSESSMENT** determines the scale of fueling infrastructure (charging stations for BEBs and hydrogen fueling stations for FCEBs) that is needed to meet the projected energy use for each scenario. It is informed by the Fleet and Fuel Assessments. Facilities costs are estimated based on the assessed infrastructure requirements for the given fleet and the selected fueling technology. The information in this section is organized according to the fueling technology explored in this transition plan: depot-charging, on-route charging, and hydrogen storage and fueling station. Diesel and CNG fueling station build and installation costs are not included in this assessment as CCRTA has already invested in the fueling infrastructure necessary to support the current fleet.

Methodology

For this assessment, CTE divided the ZEB infrastructure purchases into three phases that represent three distinct construction projects. During these phases, the site is prepared for four to six years of vehicle purchases and the installation of a utility capacity for BEBs and a hydrogen fueling capacity for FCEBs. The phased approach allows construction to be grouped with the appropriate site expenditures. Having phases also allows CCRTA the flexibility to adjust the number of BEBs and FCEBs acquired during the transition period as well as accommodate fast evolving ZEB technology.

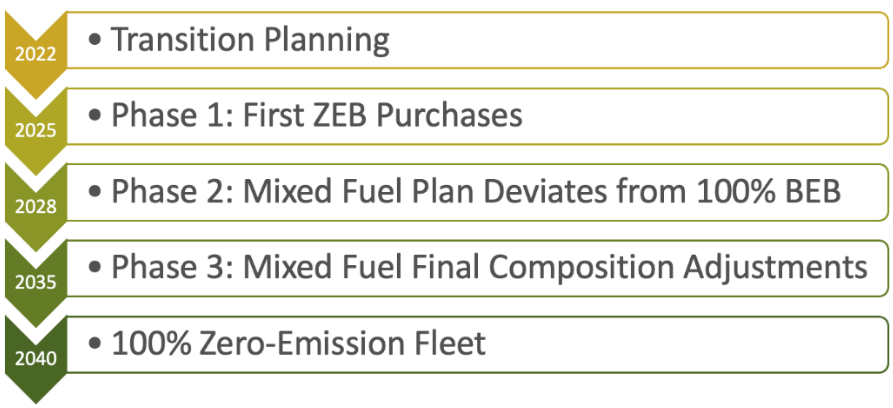


Figure 28 - Methodology Timeline

PHASE 1: The first phase spans from 2025-2027 and prioritizes support of the initial ZEB purchases: four transit buses and two cutaways.

PHASE 2: The second phase occurs between 2028 and 2034 with a focus on supporting the mid-transition initial vehicle purchases: 26 transit buses and 14 cutaways. This brings ZEB totals to 30 transit buses and 16 cutaways. Phase 2 is notable as it encompasses the timeframe during which CCRTA has the ability to shift the transition fuel between BEB and FCEB.

PHASE 3: The final phase includes the initial procurements to support the additional 40 transit buses and seven cutaways that are procured between 2035 and 2040 and similarly allows for flexibility of technology selection. A summary of the methodology timeline is shown in **Figure 28**. At the conclusion of Phase 3, all 70 transit buses and 23 fixed-route cutaways are scheduled to be ZEBs.

Common Terms

The following terms are used when discussing chargers and charging infrastructure:

- **Charging Station:** Self-contained unit that connects to grid, converts electricity from AC to DC, and outputs power to bus through dispenser.
- **Power Cabinet:** Structure to hold large amount of power conversion hardware. Connects to multiple dispensers.
- **Dispenser:** Cord that carries DC power from power conversion hardware to bus's charge inlet.

Assumptions

For BEB charging, a 1.44 MW charging cabinet is used per 16 transit buses (180 kW per two buses). A 1:1 ratio for dispenser to transit bus allows all buses to be plugged in at the end of a shit. Each cutaway uses an associated 60 kW charging station.

For FCEB fueling, CCRTA's current CNG fueling strategy can be carried over to FCEB scheduling. One fueling location is required and it takes approximately 10-15 minutes to fill each bus. The ratio of dispensers is one per ten buses with a two-dispenser minimum for resilience. Costs may vary depending on the region.

The three locations for on-route charging are Staples Street, Southside, and Port Ayers stations. One 350 kW pantograph charger was assumed per four buses.

The assumed facilities cost associated with infrastructure projects is shown in **Table 10**. These costs are based on industry averages.

Table 10 - Facilities Cost Assumptions for Infrastructure Projects

Plug-In Style Infrastructure	Cost	Description/Unit
Electrical Upgrades (Panel/switchgear, trenching/patchwork, etc.)	$300,000	For initial work (first installation)
	$50,000	For additional work (per additional build)
Contingency	20%	On project costs
Design Oversight	7%	On project costs and contingency
Dispenser and Cable Reel	$25,000	Each
Dispenser Installation	$5,000	Each
Infrastructure Planning	15%	Of Electrical Upgrades (BEB) and/or FCEB Fueling station
1.44 MW Power Cabinet	$668,000	Each
150 kW Charger	$100,000	Each
60 kW Charger	$60,000	Each
Charger Installation	$5,000	Each

Analysis Results

Cutaways

In addition to transit buses, CCRTA's transition plan includes the switch from gasoline-powered cutaways to battery electric cutaways. The cutaway phase-in is included within all three scenarios: BEB Only, FCEB Only, and Mixed Fleet-BEB Majority. **Figure 29** shows a breakdown of the procurement schedule for battery electric cutaways and related infrastructure by year within the three-phase plan.

PHASE 1: Between 2025 and 2027, the initial two battery electric cutaways and an accompanying two chargers will be procured. To reduce risk of impacts from an out of service charger, the estimated cost of adding a second charging station is approximately $90,000.

PHASE 2: Between 2028 and 2034, a significant portion of the overall cutaway fleet and charging infrastructure will be acquired. A total of 14 battery electric cutaways and chargers will be incorporated into the fleet making the fleet size and total number of chargers both 16 in 2034. The 14 procurements include the two cutaways at Port Aransas.

PHASE 3: Between 2035 and 2040, an additional seven cutaways and chargers will be added to the fleet for a total of 23 each by the end of the transition period. This cutaway procurement strategy remains the same across all scenarios.

Year	First-time EV Cutaway Purchases	EV Cutaway Fleet Size	EV Cutaway Chargers Purchased	Utility Capacity: Fleet Size Supported	
2022	0	0	0	0	
2023	0	0	0	0	
2024	0	0	0	0	
2025	0	0	0	2	Phase 1 *Initial 2 EV Cutaway Phase-in*
2026	2	2	2	2	
2027	0	2	0	2	
2028	0	2	0	16	Phase 2 *Support Mid-transition* *12 EV Cutaways (Depot)* *2 EV Cutaways (Port Aransas)*
2029	0	2	0	16	
2030	7	9	7	16	
2031	0	9	0	16	
2032	0	9	0	16	
2033	7	16	7	16	
2034	0	16	0	16	
2035	0	16	0	16	Phase 3 *Support Final transition* *7 EV Cutaways*
2036	0	16	0	16	
2037	4	23	4	23	
2038	0	23	0	23	
2039	0	23	0	23	
2040	0	23	0	23	

Figure 29 - Cutaway and Infrastructure Procurement by Phase (2023-2040)

BEB Only

The BEB Only scenario assumes a fleet of battery electric buses and battery electric cutaways and plans a transition to an electric charging infrastructure. **Figure 31** shows the annual infrastructure costs associated with the BEB Only scenario overlayed with the three-phase plan. This scenario is the only setup that requires on-route charging which is reflected in the $8.9 million total infrastructure cost. The proposed locations for the on-route charging infrastructure and site layout for the BEB Only infrastructure can be found in **Appendix B**.

Figure 30 shows a breakdown of the procurement schedule for the buses and related infrastructure by year for the BEB Only scenario within the three-phase plan.

PHASE 1: Between 2025 and 2027, four BEBs and two 150 kW chargers will be procured. To reduce the risks of out of service chargers, an additional two 150kW chargers can be added for an estimated $230,000.

PHASE 2: The second largest procurement period occurs between 2028 and 2034, when an additional 26 first time BEBs and two chargers capable of supporting six buses will be procured. This brings the total BEB fleet size 30 in 2034 with two 150kW chargers and two power cabinets capable of charging 12 vehicles each.

PHASE 3: Between 2035 and 2040, the amount of BEBs for procurement increases to a total of 40 first time BEBs and two additional chargers.

By the end of the transition period in 2040, CCRTA's fleet and infrastructure will be composed of 70 BEBs and six chargers with a utility capacity able to support a maximum of 72 electric buses. A total of 23 electric cutaways would also be procured within the BEB Only scenario.

Year	First-time BEB Purchases	BEB Fleet Size	Power Cabinet Purchases	Utility Capacity: Fleet Size Supported	
2022	0	0	0	0	
2023	0	0	0	0	
2024	0	0	0	0	
2025	3	3	2x 150kW Chargers	6	Phase 1 *Support Initial 4 BEB Phase-in*
2026	1	4	0	6	
2027	0	4	0	6	
2028	15	19	1	24	Phase 2 *Support Mid-transition 26 BEBs* *Flexibility to shift transition fuel focus (BEB vs. FCEB)*
2029	0	19	0	24	
2030	5	24	0	24	
2031	6	30	1	30	
2032	0	30	0	30	
2033	0	30	0	30	
2034	0	30	0	30	
2035	17	47	1	48	Phase 3 *Support Final transition 40 BEBs* *Allow flexibility as technology changes and fuel selection becomes clear*
2036	3	50	0	48	
2037	9	59	1	60	
2038	1	60	0	60	
2039	0	60	0	60	
2040	10	70	0	72	

Figure 30 - BEB and Infrastructure Procurement by Phase (2023-2040)

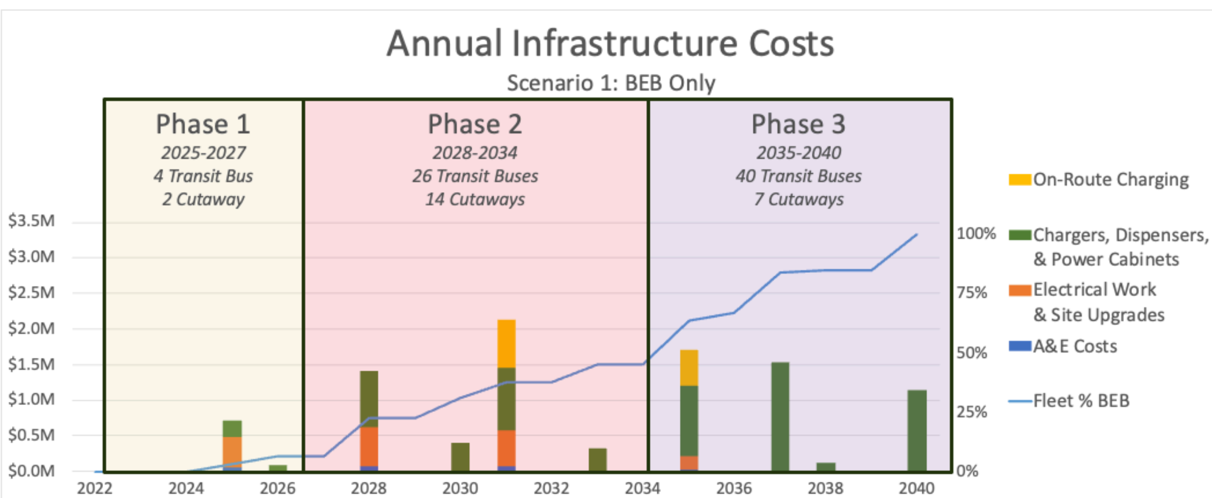


Figure 31 - BEB Only Annual Infrastructure Costs

FCEB Only

The FCEB Only scenario assumes a fleet of fuel cell electric buses and battery electric cutaways. This scenario plans for a full transition to hydrogen fueling. **Figure 33** shows the annual infrastructure costs associated with the FCEB Only scenario overlayed with the three-phase plan. Unlike the BEB Only scenario, this scenario requires significant costs associated with the hydrogen fueling infrastructure in the first phase of the transition. The total infrastructure cost for the FCEB Only scenario is $13.2 million.

Figure 32 shows a breakdown of the procurement schedule for the buses and related infrastructure by year for the FCEB Only scenario within the three-phase plan.

PHASE 1: Between 2025 and 2027, four FCEBs and one fueling station upgrade will be procured.

PHASE 2: The second largest procurement period occurs between 2028 and 2034 where a total of 26 FCEBs and two additional fueling station upgrades will be acquired. This would make the FCEB fleet size 30 in 2034 with a total of three fueling station upgrades.

PHASE 3: Between 2035 and 2040, and additional 40 FCEBs will be procured along with four more fueling station upgrades.

By the end of the transition period in 2040, CCRTA's fleet and infrastructure will be composed of 70 FCEBs and the required seven fueling station upgrades. A total of 23 electric cutaways will also be procured within the FCEB Only scenario.

Year	First-time FCEB Purchases	FCEB Fleet Size	Fueling Station Upgrades	Fueling: Fleet Size Supported	
2022	0	0	0	0	
2023	0	0	0	0	
2024	0	0	0	0	
2025	3	3	1	10	Phase 1 *Support Initial 4 FCEB Phase-in*
2026	1	4	0	10	
2027	0	4	0	10	
2028	15	19	2	30	Phase 2 *Support Mid-transition 26 FCEBs* *Flexibility to shift transition fuel focus (BEB vs. FCEB)*
2029	0	19	0	30	
2030	5	24	0	30	
2031	6	30	0	30	
2032	0	30	0	30	
2033	0	30	0	30	
2034	0	30	0	30	
2035	17	47	4	70	Phase 3 *Support Final transition 40 FCEBs* *Allow flexibility as technology changes and fuel selection becomes clear*
2036	3	50	0	70	
2037	9	59	0	70	
2038	1	60	0	70	
2039	0	60	0	70	
2040	10	70	0	70	

Figure 32 - FCEB and Infrastructure Procurement by Phase (2023-2040)

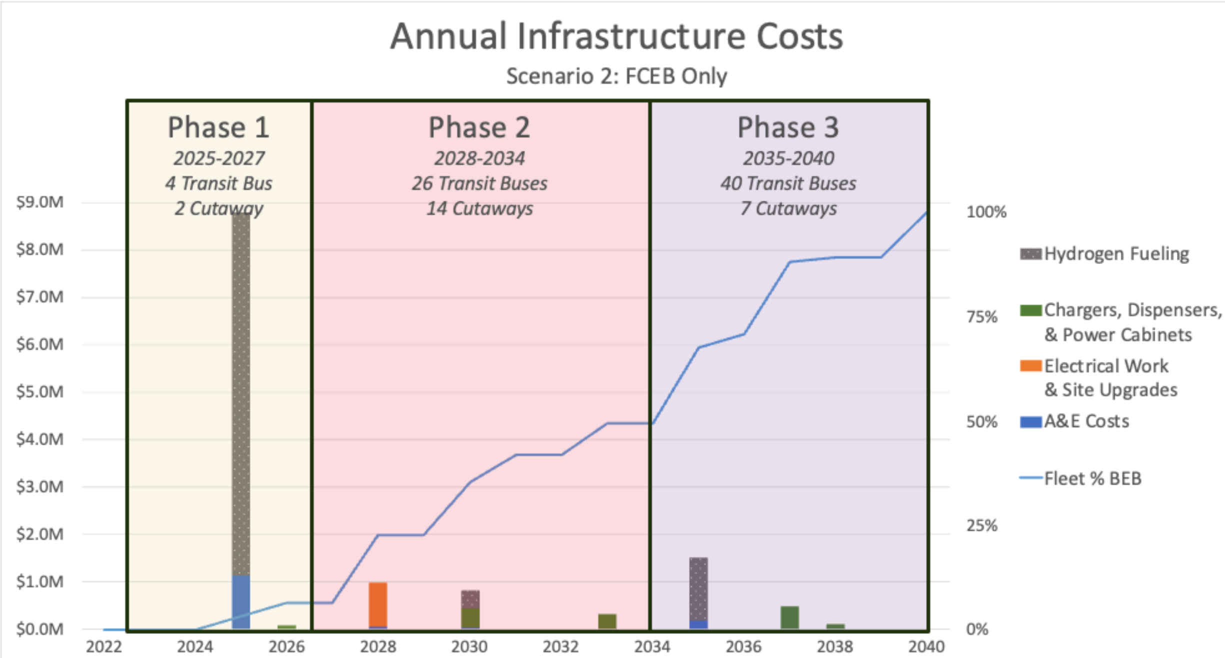


Figure 33 - FCEB Only Annual Infrastructure Costs

Mixed Fleet – BEB Majority

The Mixed Fleet scenario assumes a fleet of battery electric buses, fuel cell electric buses, and battery electric cutaways. This scenario requires both electric charging infrastructure and hydrogen fueling stations. **Figure 35** shows the annual infrastructure costs associated with the Mixed Fleet scenario overlayed with the three-phase plan. As with the FCEB Only scenario, this scenario sees significant costs associated with the hydrogen fueling infrastructure but in the second phase of the transition. The total infrastructure cost for the Mixed Fleet scenario is $16.7 million ($7.8M BEB and $8.9M FCEB). The proposed site layout for the Mixed Fleet infrastructure can be reviewed in **Appendix B**.

Figure 34 shows a breakdown of the procurement schedule for the buses and related infrastructure by year for the Mixed Fleet scenario within the three-phase plan.

PHASE 1: Between 2025 and 2027, four BEBs and two 150 kW chargers will be procured.

PHASE 2: The second largest procurement period occurs between 2028 and 2034 with 16 BEBs, 10 FCEBs, one charger, and one fueling station upgrade acquired. This would equal a total number of 20 BEBs and 10 total FCEBs 10 in 2034 with three supporting chargers and one fueling station upgrade.

PHASE 3: Between 2035 and 2040, an additional 30 BEBs and 10 FCEBs will be procured with four chargers and a second fueling station upgrade.

By the end of the transition period in 2040, CCRTA's fleet and infrastructure will be composed of 50 BEBs, 20 FCEBs, seven chargers with a utility capacity able to support a maximum 70 electric buses, and two fueling station upgrades. A total of 23 electric cutaways would also be procured within the Mixed Fleet scenario.

Year	First Time BEB Purchases	BEB Fleet Size	Power Cabinets Purchased	Utility Capacity: Fleet Size Supported	First Time FCEB Purchases	FCEB Fleet Size	Fueling Station Upgrades	FCEB Fueling Fleet Size Supported	
2022	0	0	0	0	0	0	0	0	
2023	0	0	0	0	0	0	0	0	
2024	0	0	0	0	0	0	0	0	
2025	3	3	2x150kW	6	0	0	0	0	Phase 1 *Support Initial 4 BEB Phase-in*
2026	1	4	0	6	0	0	0	0	
2027	0	4	0	6	0	0	0	0	
2028	15	19	1	24	0	0	0	0	Phase 2 *30 ZEBs Support Mid-transition Initial FCEB purchases*
2029	0	19	0	24	0	0	0	0	
2030	1	20	0	24	4	4	1	10	
2031	0	20	0	24	6	10	0	10	
2032	0	20	0	24	0	10	0	10	
2033	0	20	0	24	0	10	0	10	
2034	0	20	0	24	0	10	0	10	
2035	12	32	1	50	5	15	1	20	Phase 3 *40 ZEBs Support Final transition Allow flexibility as technology changes and fuel selection becomes clear*
2036	3	35	0	50	0	15	0	20	
2037	4	39	1	50	2	17	0	20	
2038	0	39	0	50	0	17	0	20	
2039	0	39	0	50	0	17	0	20	
2040	11	50	2	50	3	20	0	20	

Figure 34 - Mixed Fleet and Infrastructure Procurement by Phase (2023-2040)

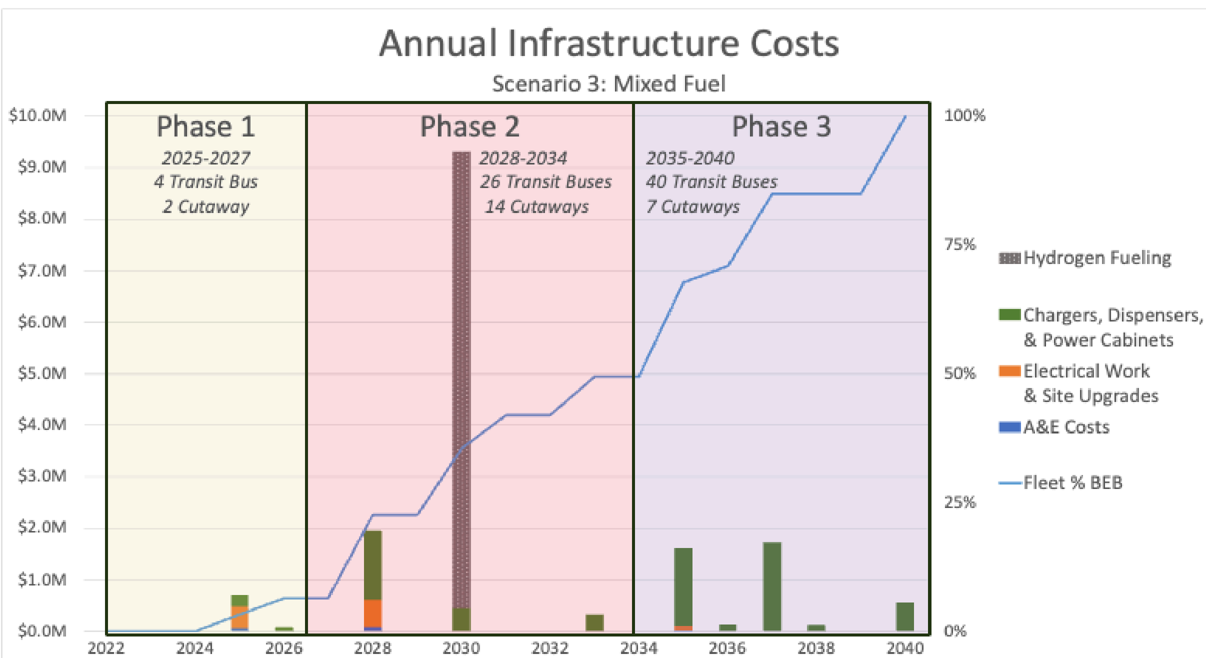


Figure 35 - Mixed Fleet Annual Infrastructure Costs

Summary

The facilities assessment is intended to provide CCRTA with insight regarding infrastructure costs associated with each scenario during the transition to zero-emission. The total infrastructure investment cost during the transition period is shown below in **Figure 36**. For the BEB Only scenario, the cost is $9.6 million which is 27 percent less than the FCEB scenario and 42 percent less than the Mixed Fleet scenario. The infrastructure cost for the FCEB Only scenario is 20 percent less than the Mixed Fleet scenario at $13.2 million, whereas the Mixed Fleet scenario is $16.7 million ($7.8 million BEB and $8.9 million FCEB). Before the BEB purchases scale up, to allow for lower risk of an out of service charger, adding one cutaway and two bus chargers in Phase 1 to have a 1:1 charger to vehicle ratio for that phase only will add an estimated $320,000. This additional cost is not included in the figures.

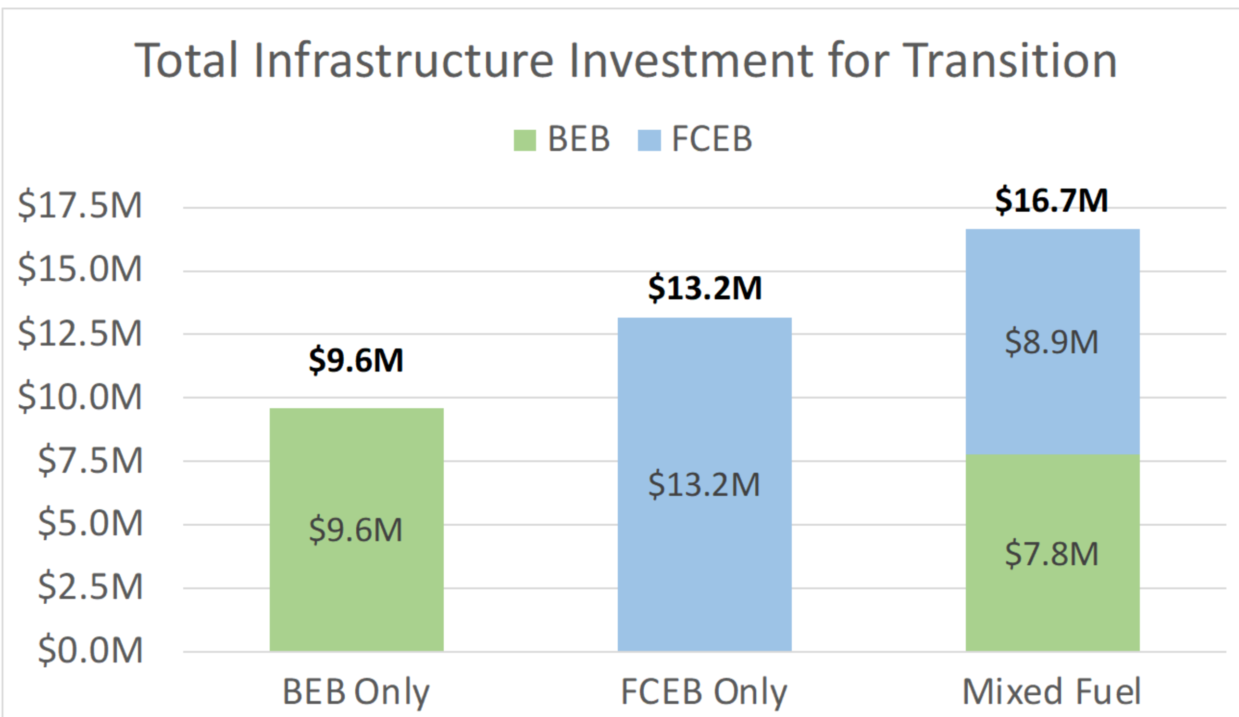


Figure 36 - Infrastructure Capital Costs

Cost estimates for this assessment are constrained by a three percent annual inflation for both infrastructure hardware costs and for A&E construction costs. The final site layout will ultimately determine the construction costs. The analysis assumes CCRTA will maintain the current fleet size, electricity will be readily available at on-route charging sites, and the procurement follows the timeline shown in **Figure 28**. FCEB facility costs vary by region and method of hydrogen delivery.

Ultimately, the three-phase approach offers CCRTA a strategic plan for acquiring both vehicles and the necessary infrastructure to support them. The key takeaway from this assessment is CCRTA's ability to adjust between BEB and FCEB technology in the second and third phase. This ultimately allows for flexibility in the fleet composition over time instead of committing to one strategy and may offer future cost savings.

Redundancy, Resilience, and Emergency Response Assessment

The **REDUNDANCY, RESILIENCE, AND EMERGENCY RESPONSE (3R) ASSESSMENT** investigates the new risks to CCRTA's ability to provide service during power outages or fuel disruptions as well as support required during emergency response activities, such as community evacuation with a full ZEB fleet.

CCRTA identified its primary concerns as continuing ZEB fleet operation in the event of a fuel interruption (i.e., power outage or hydrogen fuel delivery disruption) and planning for evacuation support. Historically, CCRTA has been impacted by hurricanes which required community evacuation, and may also put CCRTA at risk from planned power outages. Additionally, the team made an assumption that hurricanes and other natural disasters will become more frequent and extreme in the future due to climate change impacts.

CCRTA is expected to provide community evacuation and re-population support during disaster response. In the event of a hurricane, CCRTA is required to provide up to 80 vehicles to support evacuation efforts for up to 72 hours and during a tropical storm, 73 vehicles may be required for up to 24 hours. During all types of evacuation effort regular service is halted to make all vehicles available for evacuation support.

Each ZEB transition scenarios require different fueling and deployment strategies to meet first responder needs during disaster response. CCRTA will coordinate with other local emergency response agencies to review the fleet's capabilities and plan for supporting community evacuation.

3R Methodology

The project team applied a risk assessment methodology to evaluate various adaptation measures that reduces risks from identified threats under each transition scenario. The effectiveness of adaptation measures is informed by factors including cost, risk reduction capabilities, facility constraints, environmental impacts, and CCRTA's risk tolerances.

Risks are calculated using the following formula:

$$Risk\ Score = Threat\ Likelihood \times Vulnerability \times Consequences$$

Threat likelihood is the probability of a threat occurring in a given year. Threat likelihood is evaluated from Low to Very High, with a maximum value of one. CTE worked with CCRTA to assess the likelihood of each defined threat, utilizing information on past disasters in the agency's service area, climate data trends, and the experiences of other transit agencies deploying ZEBs.

Vulnerability is the probability that a transit agency will experience consequences if a threat occurs, based on internal capabilities to prepare for, respond to, and recover from threats. Vulnerability is evaluated from Low to Very High, with a maximum value of one. CTE collected information on CCRTA's existing internal capabilities, and evaluated potential improvements to those capabilities from the implementation of adaptation options.

Consequences are the level of impacts that a transit agency would experience if a threat occurs. Consequences are evaluated from Low to Very High within different categories, with a maximum value of four. The Consequences Matrix used in this 3R Assessment is shown in **Table 11**. CTE reviewed the matrix with CCRTA and customized the categories, category weightings, and definitions of severity levels to accurately reflect CCRTA's tolerances for different types of impacts or consequences.

Table 11 - 3R Consequences Matrix

Consequences Matrix						
Category	**Category Definition**	**Category Weight**	**Low**	**Medium**	**High**	**Very High**
Regional Economic and Customer Impacts	Impacts to ridership and the regional economy from missed or modified service.	**20%**	< 1 day of impacts to ridership and regional economic impacts	1 day of impacts to ridership and regional economic impacts	1 day < duration of impacts < 1 week to ridership and regional economic impacts	> 1 week of service impacts to ridership and regional economic impacts
Staffing Impacts	Impacts to staff due to stress put on workforce needs to support disaster response.	**20%**	<5% of buses require special fueling logistics or 5% of operators required to alter schedules	5% - 25% of buses require special fueling logistics or 5% - 25% of operators required to alter schedules	25% - 50% of buses require special fueling logistics or 25% - 50% of operators required to alter schedules	> 50% of buses require special fueling logistics or > 50% of operators required to alter schedules
Public Safety Impacts	Impacts to public safety if the ability to fulfill first responder responsibilities are impacted during an emergency response.	**30%**	Able to fulfill all requested emergency response support during incident	Able to fulfill 80% of requested emergency response support during incident	Able to fulfill 50% of requested emergency response support during incident	Able to fulfill <50% of requested emergency response support during incident
Financial and Operating Impacts	The loss of revenue from missed service, as well any operational costs required modify or adapt service based on available resources and response requirements.	**5%**	No delays to service	< 4-hour delay in service	4-24-hour delay in service	> 24-hour delay in service
Equipment Damage	Loss of or damage to transit agency equipment from a hazard.	**25%**	< $3K of equipment damage	$3K-$25K of equipment damage	$25K - $750K of equipment damage	>$750K of equipment damage

The maximum possible risk score is four; a higher risk score indicates a higher level of risk. A matrix showing overall risk level by risk score is shown in **Table 12.** In this matrix, the color indicated by the intersection of the threat likelihood and consequences x vulnerability indicates the relative risk value with green meaning less than 0.19 out of 4, yellow indicating 0.2 to 1.19 out of a possible four points, light orange indicating a high risk of 1.2 to 2.99 and dark orange indicating a very high-risk value of 3 to 4.

Table 12 - Risk Matrix

		Consequences x Vulnerability			
		Low	**Medium**	**High**	**Very High**
Threat Likelihood	**Low**	Low Risk	Low Risk	Low Risk	Medium Risk
	Medium	Medium Risk	Medium Risk	Medium Risk	High Risk
	High	Medium Risk	High Risk	High Risk	Very High Risk
	Very High	Medium Risk	High Risk	Very High Risk	Very High Risk

Low Risk	**< 0.19**
Medium Risk	**0.2 to 1.19**
High Risk	**1.2 to 2.99**
Very High Risk	**3 to 4**

The following parameters are key components of the 3R Assessment methodology:

- **ZEB Transition Scenarios:** Future fleet composition alternatives at a specific year.
- **Threats:** An event that will impact the transit agency's ability to provide service or meet first responder capabilities if it occurs. Threats can be natural disasters, equipment failures, intentional attacks, or accidents.
- **Adaptation Measures:** Any activity, procedure, or equipment that can reduce the likelihood of a threat occurring, reduce the vulnerability from experiencing threats, or reduce the level of consequences experienced if a threat occurs.

Assessments are conducted by assessing the threat likelihood, vulnerability, and consequences for a specific scenario-threat pair with no adaptation options. Then, the threat likelihood, vulnerability, and consequences are re-assessed for the same scenario-threat pair with each adaptation option. This approach is summarized in **Figure 37.**

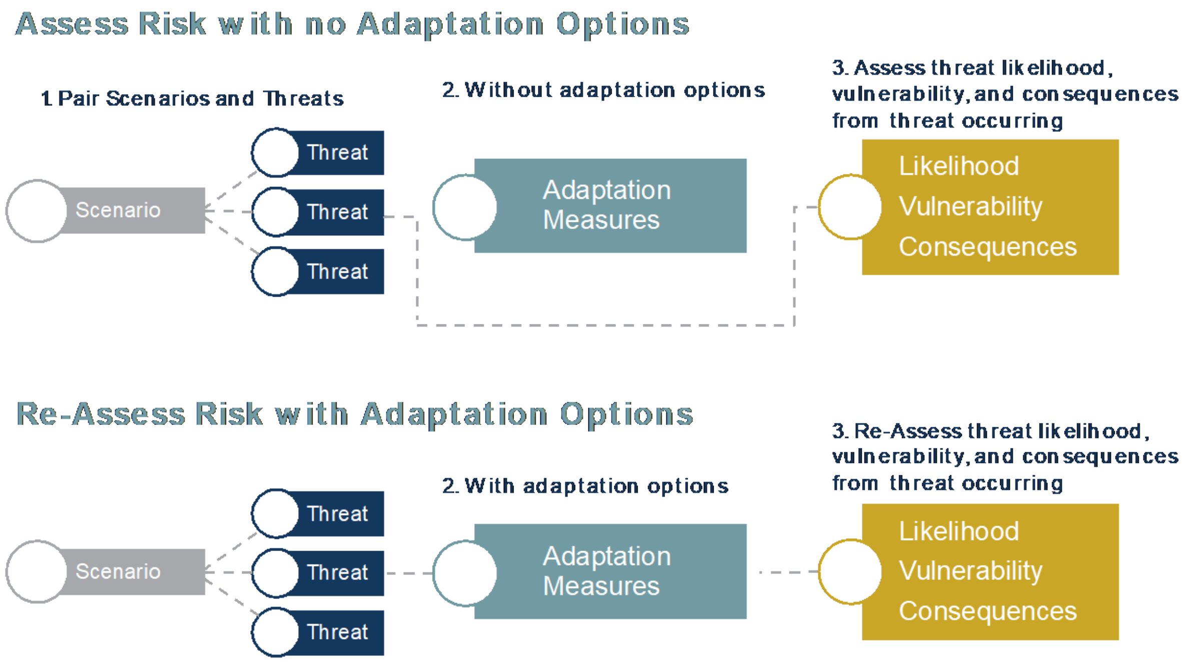


Figure 37 - 3R Risk Assessment Process

The following metrics are used to summarize the results of the 3R Risk Assessment:

- **Risk Score:** Level of risk for an analysis, with or without adaptation measure **(Figure 38)**
    - Risk Score = Likelihood x Vulnerability x Consequences
    - Higher Risk Score = Higher Risk
    - Lower Risk Score = Lower Risk

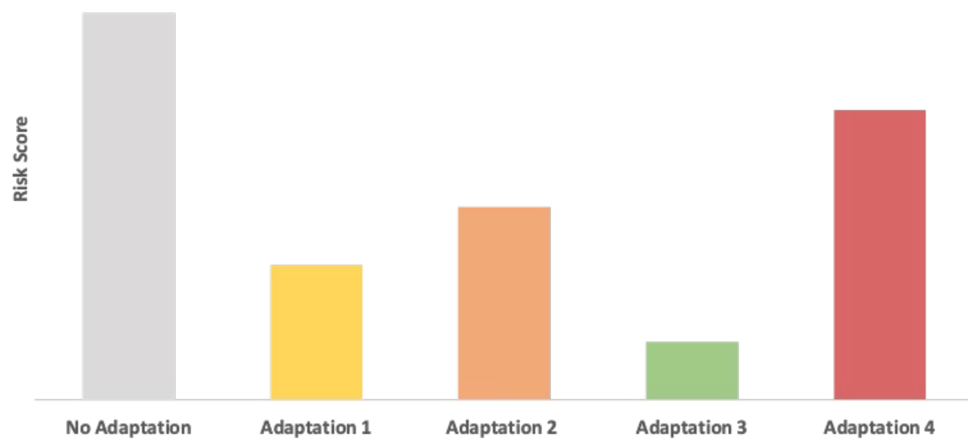


Figure 38 - Illustrative Example of Risk Scores
(Note: This Graph is Provided as an Example and is Not Specific to this Transition Plan)

- **Risk Reduction Units (RRUs):** Effectiveness of an adaptation measure or package at reducing risk **(Figure 39)**
  - RRU = Risk Score without adaptation measures - Risk Score with adaptation measure or package
  - Higher RRU = More Risk Reduction
  - Lower RRU = Less Risk Reduction

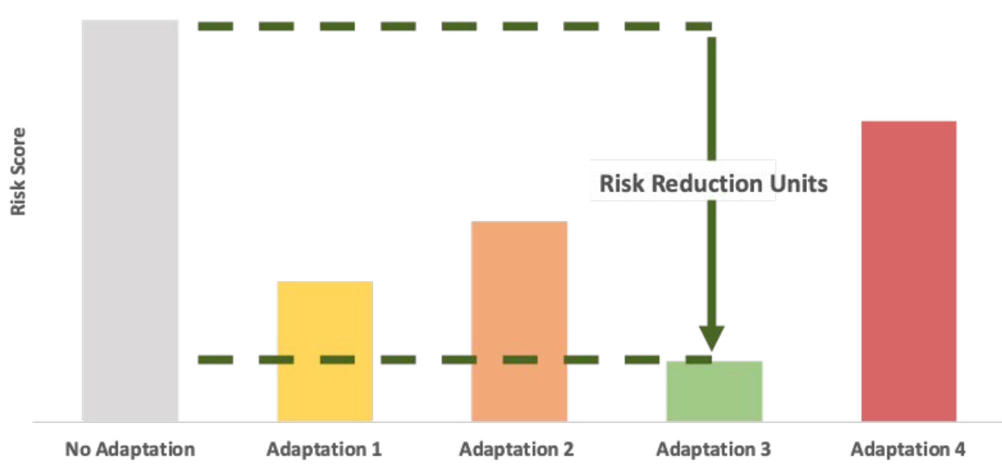


Figure 39 - Illustrative Example of RRUs
(Note: This Graph is Provided as an Example and is Not Specific to this Transition Plan)

- **$/RRU:** Cost effectiveness of adaptation measures or packages **(Figure 40)**
    - $/RRU = Cost of adaptation measure or package / RRUs
    - Higher $/RRU = Less Cost Effective
    - Lower $/RRU = More Cost Effective

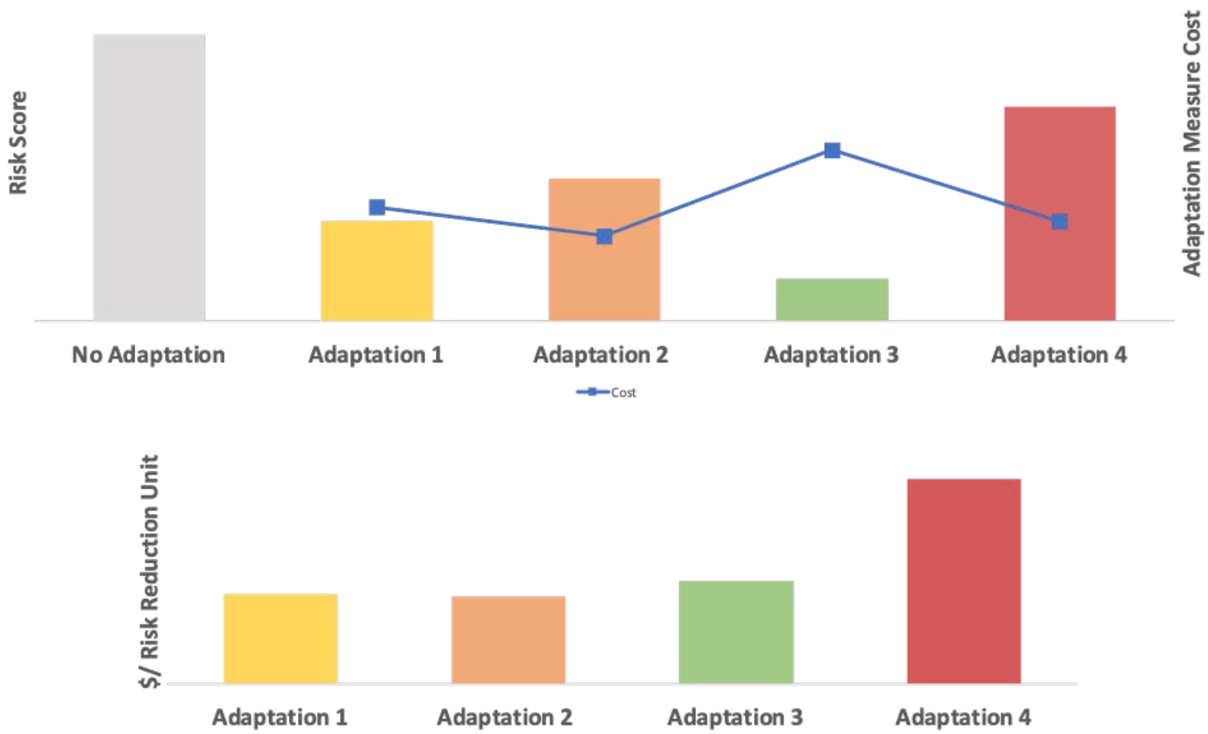


Figure 40 - Illustrative Example of Using Adaptation Measure Costs to Calculate $/RRU (Note: This Graph is Provided as an Example and is Not Specific to this Transition Plan)

Analysis Inputs

Analysis inputs were defined during workshops with CTE and CCRTA. Details on the threats considered in the analysis are shown in **Table 13.**

Table 13 - Threats Included in 3R Assessment

Threat	Definition	Service Expectation	Duration of Impacts	Threat Likelihood
Hurricane	Evacuations requiring at least 80 vehicles on a 24/7 basis	Evacuation support first 72 hours; service at weekend levels 3 days to 1 week after	24 hours, 2-3 weeks	High
Tropical Storm	Evacuations requiring at least 73 vehicles on a 24/7 basis	Evacuation support first 24 hours; full service immediately after	24 hours	High
Power Outage	Power outage without compounding impacts to from natural disaster or to the community.	Regular Service	8 hours	Medium
Hydrogen Fuel Shortage	Hydrogen shortage due to equipment malfunction or force majeure at production facility.	Regular Service	2 days, 2+ weeks	High
BEB Charging Equipment Failure	Equipment failure of on-site charging infrastructure causing prolonged outage; supply chain issues cause delays in parts delivery	Regular service	2 weeks	High
Hydrogen Fueling Equipment Failure	Equipment failure of on-site hydrogen fueling station causing prolonged outage; supply chain issues cause delays in parts delivery	Regular service	2 weeks	High

Based on the fleet composition, not every threat is assessed for every scenario. For example, the hydrogen disruption threat was not assessed for the BEB Only scenario. The threat relevance by scenario is shown in **Table 14.**

Table 14 - Threat Relevance by Scenario

Threat	BEB Only	FCEB Only	Mixed Fleet - BEB Majority
Power Outage Due to Grid Overload / Other Event	√	√	√
Hurricane or Flood with Large Evacuation Effort	√	√	√
Tropical Storm with Moderate Evacuation Effort	√	√	√
Hydrogen Delivery Disruption		√	√
Charging Equipment Failure	√		√
Hydrogen Fueling Equipment Failure		√	√

Adaptation measures can be defined as any activity, procedure, or equipment that reduces the likelihood of a threat occurring, reduces the vulnerability from experiencing threats, or reduces the level of consequences experienced if a threat occurs. The details of the adaptation measures considered in this analysis are listed in **Table 15** shows the adaptation measures considered for the analysis.

Table 15 - Selected Adaptation Measures for 3R Assessment

Adaptation Package Name	Adaptation Measures Included	Estimated Capital Cost
Level 1 Backup Power	**Includes measures: 820 kW Backup Power** Natural Gas Generator OR Microgrid	Generator $ 720,000 - Microgrid $ 1,230,000
Level 2 Backup Power	**Includes measures: 1 4MW, 1 820kW Backup Power** Natural Gas Generator OR Microgrid	Generator $3,520,000 - Microgrid $ 5,630,000
Level 3 Backup Power	**Includes measures: 1 3MW, 1 2.2MW Backup Power** Natural Gas Generator OR Microgrid	Generator $ 2,940,000 - Microgrid $ 5,720,000
Level 4 Backup Power	**Includes measures: 1 4MW, 1 3 MW Backup Power** Natural Gas Generator OR Microgrid	Generator $ 4,200,000 - Microgrid $ 7,700,000
Level 5 Backup Power	**Includes measures: 2 4MW Backup Power** Natural Gas Generator OR Microgrid	Generator $ 5,600,000 - Microgrid $ 8,800,000
ICE Contingency Fleet	ICE Contingency Fleet	$3,600,000
Additional Hydrogen Storage	One week of hydrogen storage	$810,000 - $830,000

The five backup power adaptation levels are included to compare risk reduction capabilities and cost effectiveness. These backup power options support the various scenarios explored in the transition planning analysis and are not all options for every scenario. Only one of these adaptions would be selected for implementation. The ICE Contingency Fleet and Additional Hydrogen Storage could be implemented independently of any of the other adaption level options.

Analysis Results

The risk scores by threat and scenario with no adaptation measures are shown in **Figure 41**. Risk scores without adaptation measures represent the worst-case scenario for each threat.

The risk scores for the **power outage threat** are the same across all scenarios because if this threat occurs and no adaptation measures are implemented, buses will be unable to fuel and will be unavailable for service. Neither chargers nor hydrogen fueling infrastructure can operate during a power outage. The overall risk from this threat is lower than for some of the other threats considered because the likelihood of an 8+ hour power outage occurring separate from a natural disaster is less likely than many of the other threats considered. The outcome of this threat occurring is also less severe than some of the other threats.

The **hurricane with large evacuation effort threat** has the highest risk score overall and is the same for all scenarios. The risk of this threat is very high because there is a high likelihood of the threat occurring and the resulting impacts from it occurring would be severe. Meeting the required evacuation needs will require all buses, therefore no additional service would be provided.

The risk scores for the **tropical storm threat** with moderate evacuation effort are the same across all scenarios, but are lower relative to the hurricane risk since this threat would cause slightly less damage if it were to occur.

Risk scores are higher for the **hydrogen delivery disruption** and **fueling equipment failure** threats. These risks only apply to the scenarios that have FCEBs in the fleet (FCEB Only and Mixed Fleet). The risk scores are higher for the FCEB Only scenarios because the threat would have a greater impact since it would affect all vehicles as opposed to only a portion of the fleet in the Mixed Fleet scenario. The risk scores for these threats are also higher than the scores for an 8+ hour power outage since they are more likely to occur.

Risk scores for the **charging equipment failure threat** are higher for the BEB Only scenario than for the Mixed Fleet scenario since it would only impact the BEBs in the fleet. The risk scores for these threats are also higher than the scores for an 8+ hour power outage since they are more likely to occur.

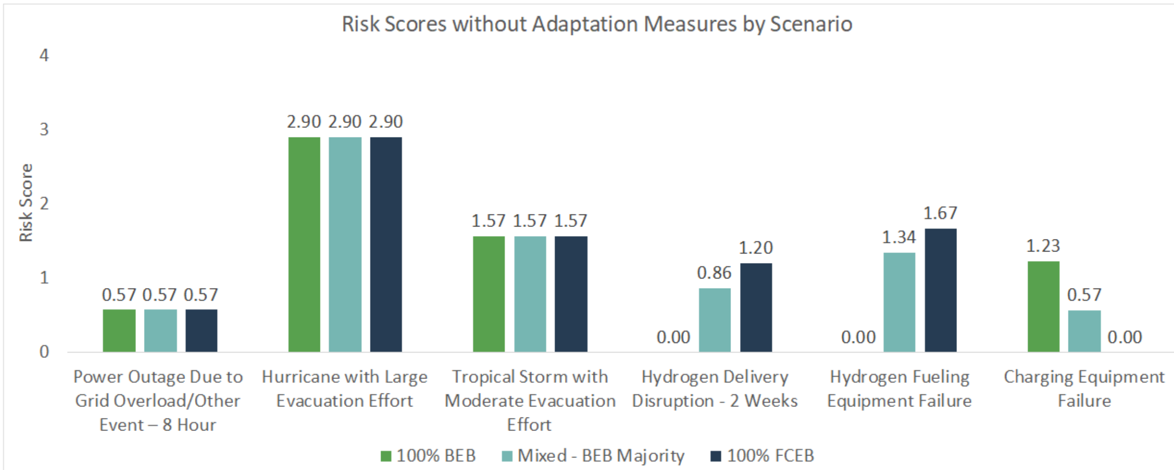


Figure 41 - Risk Scores without Adaptation Measures by Scenario and Threat

Power Outage

The cost effectiveness of the adaptation packages ($/RRU) are shown in **Figure 42**. The costs of natural gas generators and a natural gas microgrid were considered. Either backup power option provides the same amount of risk reduction, but the cost/RRU changes as a result of the cost of the respective equipment. An ICE contingency fleet was also considered as an adaptation strategy for this threat.

The lower the $/RRU, the more cost effective an adaptation package is. The results of the analysis show the CNG Generator as the most cost-effective adaptation package for all scenarios against this threat.

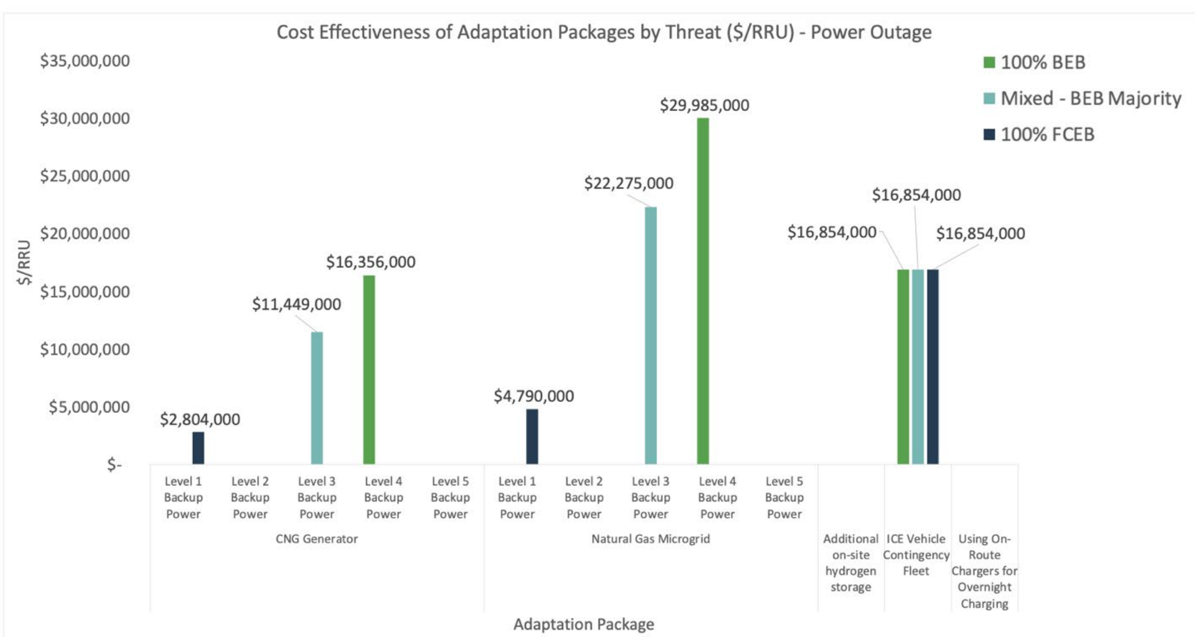


Figure 42 - $/RRU for Adaptation Packages by Threat – Power Outage

Hurricane

The cost effectiveness of the adaptation packages ($/RRU) for a hurricane are shown in **Figure 43.** The costs of natural gas generators and a natural gas microgrid were considered. Either backup power option provides the same amount of risk reduction, but the cost/RRU changes as a result of the cost of the respective equipment. An ICE contingency fleet was also considered as an adaptation strategy for this threat.

The lower the $/RRU, the more cost effective an adaptation package is. The results of the analysis show the ICE contingency fleet as the most cost effective for the Mixed Fleet and the BEB Only scenario, and the natural gas generator is the most cost-effective option for the FCEB Only scenario. The cost/RRU for this threat are all significantly lower than the scores for the previous threat because the RRU score is so much greater, so the cost of the adaptation measure is divided by a larger value.

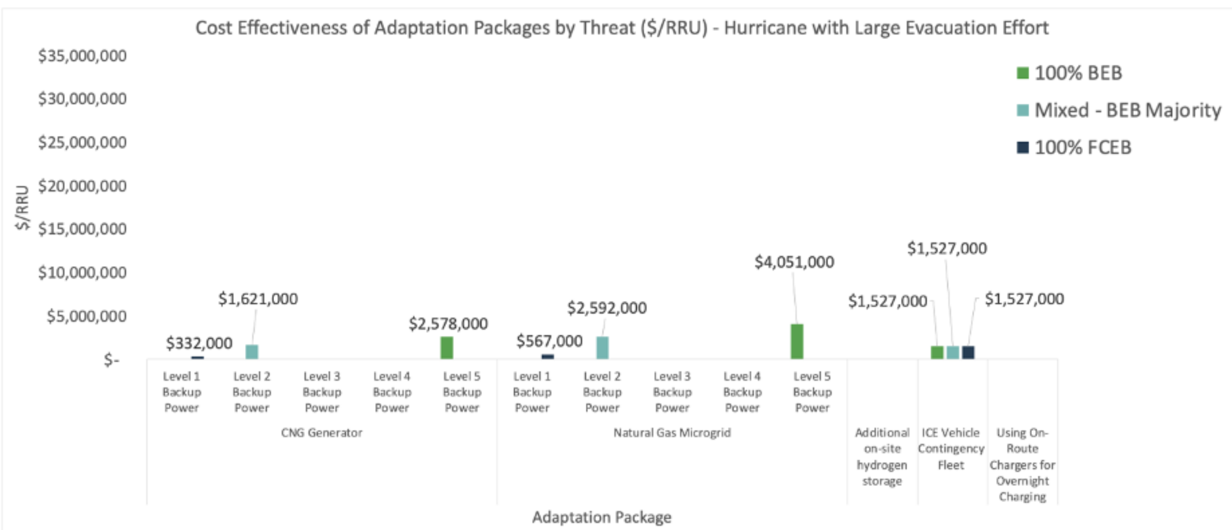


Figure 43 - $/RRU for Adaptation Packages by Threat – Hurricane: Large Evacuation

Tropical Storm

The cost effectiveness of the adaptation packages ($/RRU) for the tropical storm threat are shown in **Figure 44**. The costs of natural gas generators and a natural gas microgrid were considered. Either backup power option provides the same amount of risk reduction, but the cost/RRU changes as a result of the cost of the respective equipment. An ICE contingency fleet was also considered as an adaptation strategy for this threat.

The lower the $/RRU, the more cost effective an adaptation package is. The results of the analysis show the ICE contingency fleet as the most cost effective. The results of the analysis show the ICE contingency fleet as the most cost effective for the Mixed Fleet and the BEB Only scenario, and the natural gas generator is the most cost-effective option for the FCEB Only scenario.

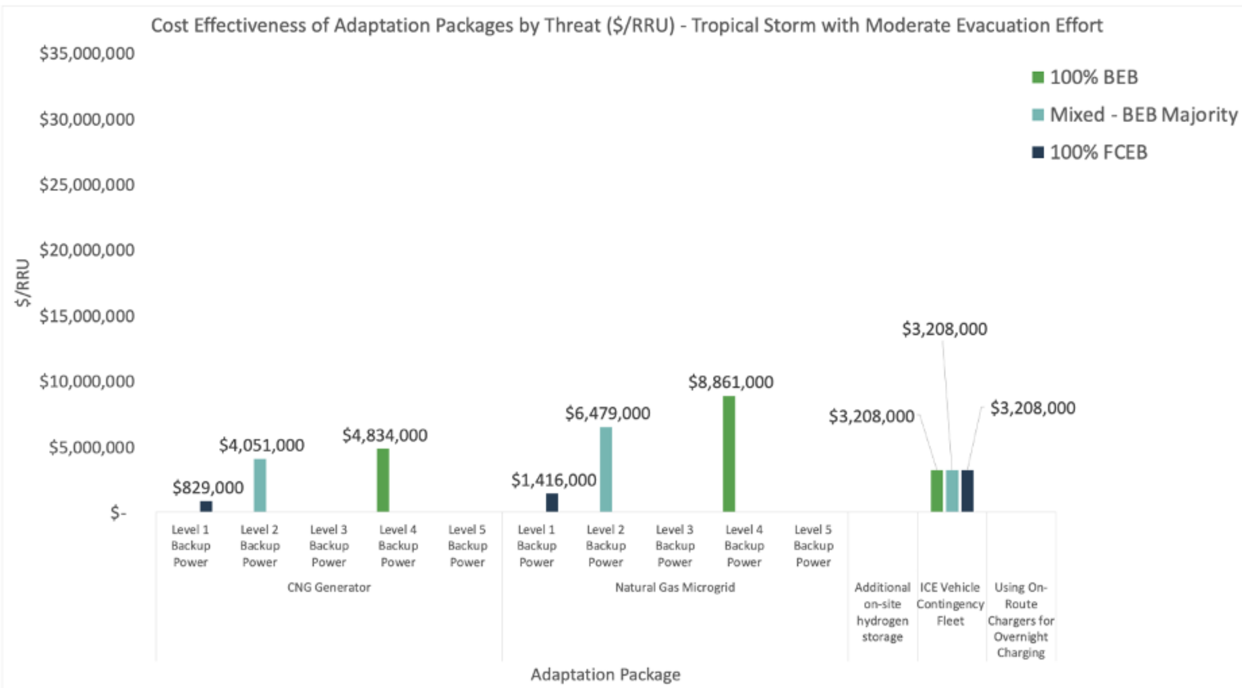


Figure 44 - $/RRU for Adaptation Packages by Threat – Tropical Storm: Moderate Evacuation

H2 Disruption

The cost effectiveness of the adaptation packages ($/RRU) for the H2 disruption threat are shown in **Figure 45**. Additional on-site hydrogen storage and an ICE contingency fleet were adaptation measures considered for this threat.

The lower the $/RRU, the more cost effective an adaptation package is. The results of the analysis show that additional on-site storage is the more cost-effective option for both the Mixed Fleet and the FCEB Only Scenarios. There are no values listed for the BEB Only Scenario as there is no hydrogen involved in charging the vehicles.

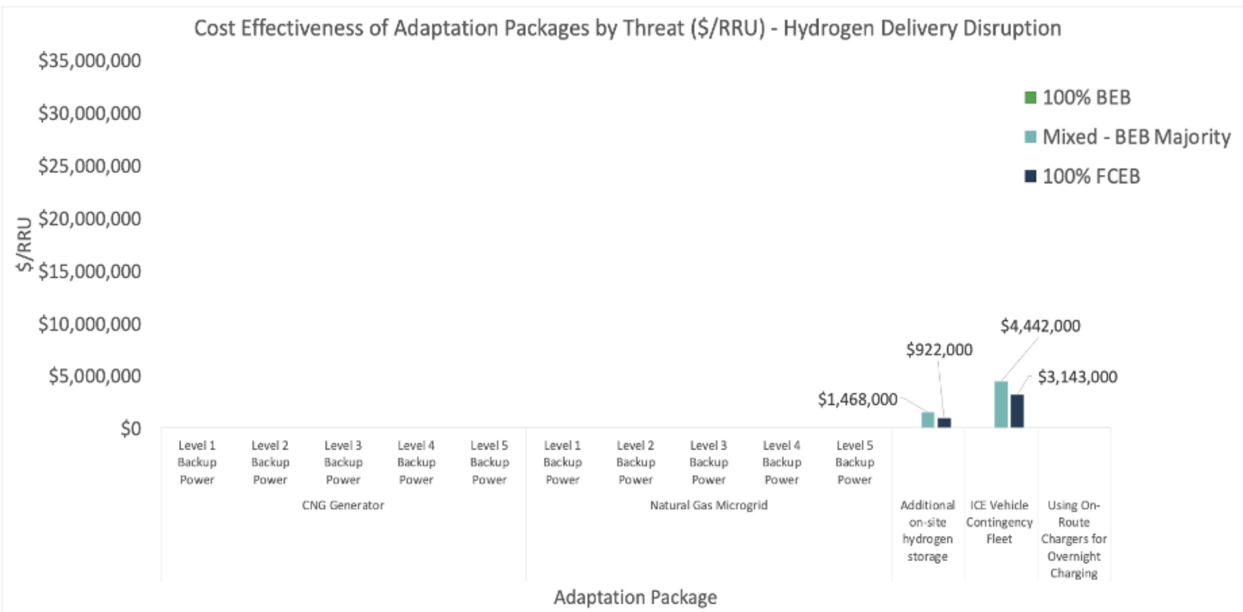


Figure 45 - $/RRU for Adaptation Packages by Threat – H2 Disruption

H2 Fueling Equipment Failure

The cost effectiveness of the adaptation packages ($/RRU) for a H2 fueling equipment failure are shown in **Figure 46**. The only applicable adaptation measure considered that would combat this threat is the ICE contingency fleet.

The lower the $/RRU, the more cost effective an adaptation package is. The results of the analysis show the ICE contingency fleet as the most cost effective. There are no values listed for the BEB Only Scenario as there is no hydrogen involved in charging the vehicles.

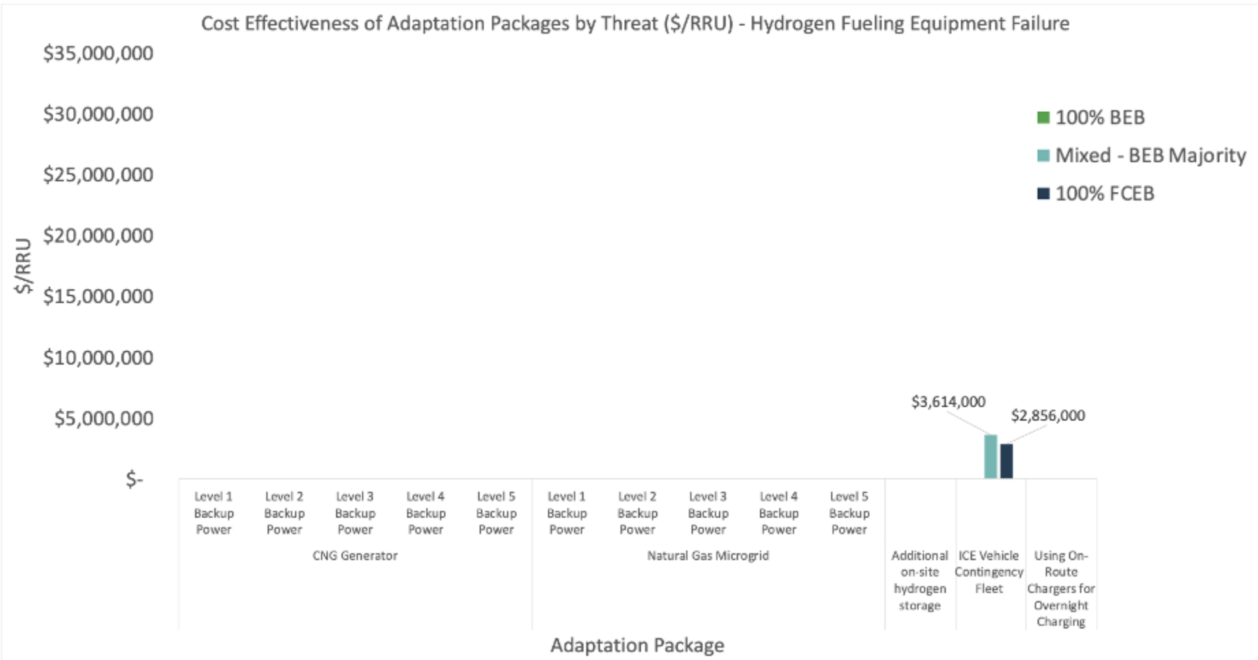


Figure 46 - $/RRU for Adaptation Packages by Threat – H2 Fueling Equipment Failure

Charging Equipment Failure

The cost effectiveness of the adaptation packages ($/RRU) for a charging equipment failure are shown in **Figure 47**. The ICE contingency fleet was the only adaptation measure applicable to the Mixed Fleet Scenario. The BEB Only Scenario considered both an ICE contingency fleet and using the on-route chargers installed to support the agency's longer blocks for overnight charging in the event that the depot chargers failed.

The lower the $/RRU, the more cost effective an adaptation package is. The results of the analysis show the ICE contingency fleet as the most cost effective for the Mixed Fleet Scenario, but using the on-route chargers would be a very cost-effective option for the BEB Only Scenario.

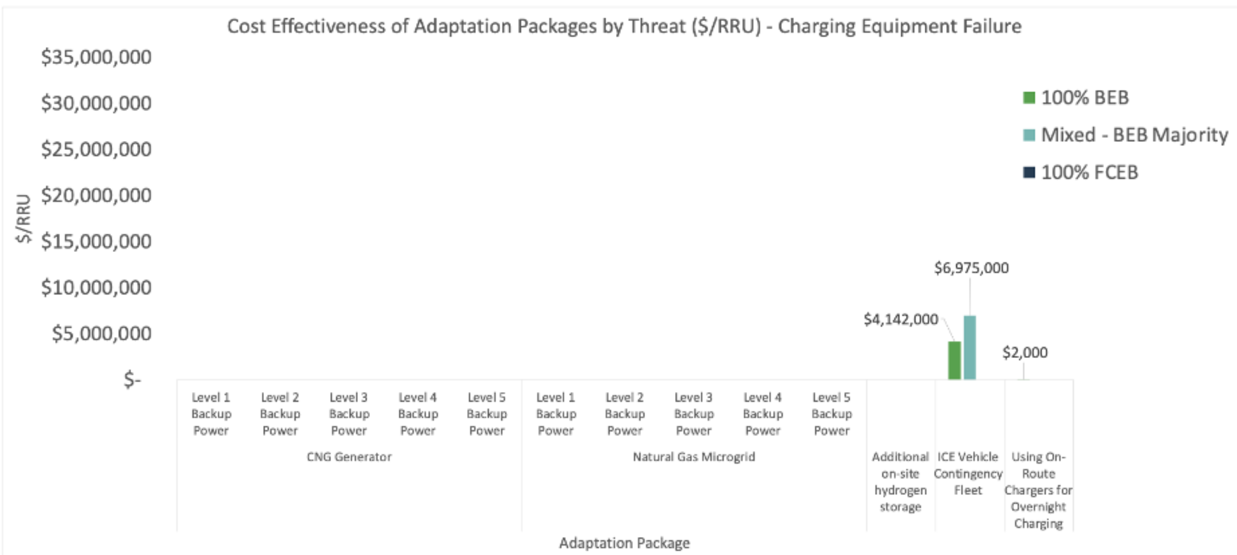


Figure 47 - $/RRU for Adaptation Packages by Threat – Charging Equipment Failure

3R Assessment Summary

Careful consideration is required to prioritize adaptation package(s) to implement once the ZEB transition scenario is selected. Adaptation package selection will be informed by risk reduction capabilities, cost, operational feasibility, and environmental impacts.

Based on CCRTA's transition timeline, no immediate action is required. Adaptation measures should be implemented in advance of when meeting the desired service levels for a threat is at risk, based on the fleet composition.

CCRTA has reviewed assessment results and will use the outcomes to evaluate adaptation measure needs in the future.

Workforce Development Assessment

Background

The **WORKFORCE DEVELOPMENT ASSESSMENT** is comprised of three interrelated concepts:

1. Recruitment of new employees,
2. Retention of existing employees, and
3. Training needs associated with continuously improving employee skills and abilities.

While all are important in a comprehensive workforce plan, in the context of this report, the training element incorporates the bulk of the discussion. The reason for this is straightforward: the training element of the workforce development process is the most directly linked to the zero-emission technology differences.

There are a number of critical training considerations that CCRTA must consider when transitioning from operating a diesel/CNG fleet to zero-emission technology. CTE has identified a series of four distinct phases between the beginning of a ZEB transition and the completed transition where specific training processes are necessary to assure confidence with the new technology. The primary goals of this assessment, accordingly, will be to:

1. Outline the four phases of the transition in the context of the training process,
2. Identify the various process elements of each phase,
3. Identify a library of ZEB specific workforce skills,
4. Map those skills to existing CCRTA department training logs/records and;
5. Provide best practices for transition training via transit agency case study briefings.

Methodology

CTE's workforce development analysis focuses on three major elements:

1. An existing conditions report,
2. A process breakdown through which training takes place (the "how"),
3. The content needed for that programming (the "what").

Each element incorporates a specific methodology designed to directly address CCRTA's needs, allowing a more curated tailoring effort.

To begin the analysis, background research was done on CCRTA's documented planning efforts and stated organizational goals, primarily through review of existing planning documents and agency feedback. The "Transit Plan 20/20 Final Report" published in September 2016 provided a long-term projection of goals for the agency. Embedded in this report are considerations for the long-term workforce development needs of CCRTA, especially as it concerns the speed and reliability of the agency at large.

CCRTA staff provided feedback to a series of questions on staffing and training levels across various departments in the form of both a questionnaire and direct interviews. This information allowed CTE to set a baseline for comparison to other agencies that have undergone or are currently undergoing a ZEB transition. Agency feedback also provided CCRTA's technical baseline and on-the-job training (OJT) skills lists; this information provided the existing conditions for the skills maps later in the report, designed to identify gaps in knowledge.

The phases of the transition align with the phases in the Total Cost of Ownership assessment. The phases can be modified based on the technology adoption, pushing out the timeline in the case of FCEB adoption. The skills library and matrices are based on extensive research by CTE staff into various technical sources, which will be referenced in the resource library provided in this report. In general, they comprise training syllabi from other transit agencies, FTA recommendations, and other transit industry training materials. It is important to note that different OEMs have distinct training and tool elements that are specific to their brands and vary considerably. This element has implications for utilization of certain training materials, especially in the Phase 1: Pre-Deployment.

Special consideration has been given for the three fuel type scenarios in the transition plan. Each fuel option has implications for the Transition Training period that CCRTA should take into consideration when making a selection, as different technologies (FCEB vs BEB) have distinctive types of training requirements. These potential areas of deliberation are discussed in more detail below.

Considerations Beyond Training

One note on the topic of recruitment vs. retention in this section: overwhelmingly, institutional knowledge favors training and retention of skilled labor over attempts to recruit that labor with the skills in place. Given the emerging nature of ZEB technologies and a relatively limited series of training providers the market for skilled labor is exceptionally tight. It is much more cost effective to retain those staff members who have been trained in these specialized skills, making appropriate designation and documentation of these skills even more critical.

Finally, in preparing for training with any of the various partners and resources identified in the appendices, it is important to note that the training itself is not the only element requiring procurement. However, many of the specific items required for the training element are OEM specific, and require direct consultation with the provider for identification.

Those items include, but are not limited to:

- Personal Protective Equipment
- Training simulation materials, including virtual and hands on options.
- OEM machine tools specific to the make and model of vehicle.
- Facilities elements (e.g., chargers, lifts, space requirements, etc.)

Focus Area: Training

In order to provide a comprehensive walkthrough of the Transition Training process phases, a brief definition of terms is necessary.

- **ZEB Champion**: Identified staff that will pioneer the new technology; they will be first to learn new skills, and act as a resource and a technology advocate for the rest of the staff.
- **ZEB Specialist**: Hands on staff that have developed a level of technical competency on ZEB technology to act as an internal resource for troubleshooting, training and other ZEB specific tasks.
- **Hands On Staff**: Staff that interact directly with the ZEBs as a regular part of their job (e.g., maintenance, operators, facilities).
- **ZEB Support Staff**: Staff outside of hands-on departments that will be impacted by the ZEB transition (e.g., IT, finance, planning, etc.).

Existing Conditions

CCRTA's current training programming utilizes a number of valuable tools that can be modified to fit into the ZEB transition phases with content from the skills matrices. Existing OJT and apprenticeship logs provide an existing structure for crucial knowledge transfer from future ZEB Champions and Specialists to those new to the technology. In discussions with other industry leaders, the existence of a developed mentorship program has been defined as crucial for a successful ZEB transition. With additions of the skills needed for ZEB specialization, only limited modification to the general training structure should be necessary.

CCRTA indicated a desire for all staff in maintenance and operator roles to be equally versed across all technology types. Presently, CCRTA's contractual relationship with MV for maintenance and operation of the cutaway fleet presents a potential hurdle to this goal. MV currently uses three different levels of expertise for the maintenance staff, while the flat structure of CCRTA's maintenance staffing may pose a challenge when identifying ZEB Champions and ZEB Specialists within the organization.

For operators, different certification requirements for the two organizations (and the current lack of ZEB certification program) are barriers to cross-org technical familiarity. When planning training programming during the transition, addressing these potential barriers up front will allow for more effective utilization of formal ZEB training in Phases 2 and 3 below.

Process: Training Considerations Per Deployment Phase

CTE recommends pursuing workforce development in four phases: pre-deployment, early deployment, normalized deployment, and refresher/retraining. These phases are determined based on the procurement timeline and the ZEB percentage of the fleet. For each department, the expectation is that the staff will develop introductory skills during the planning phases, then build on those skills, from technical to advanced, through phases two and three; by phase four, ZEBs will have become a normalized part of CCRTA's operation, and all staff should have developed the skills appropriate for their job requirements. The phases and training required is outlined in **Figure 48**.

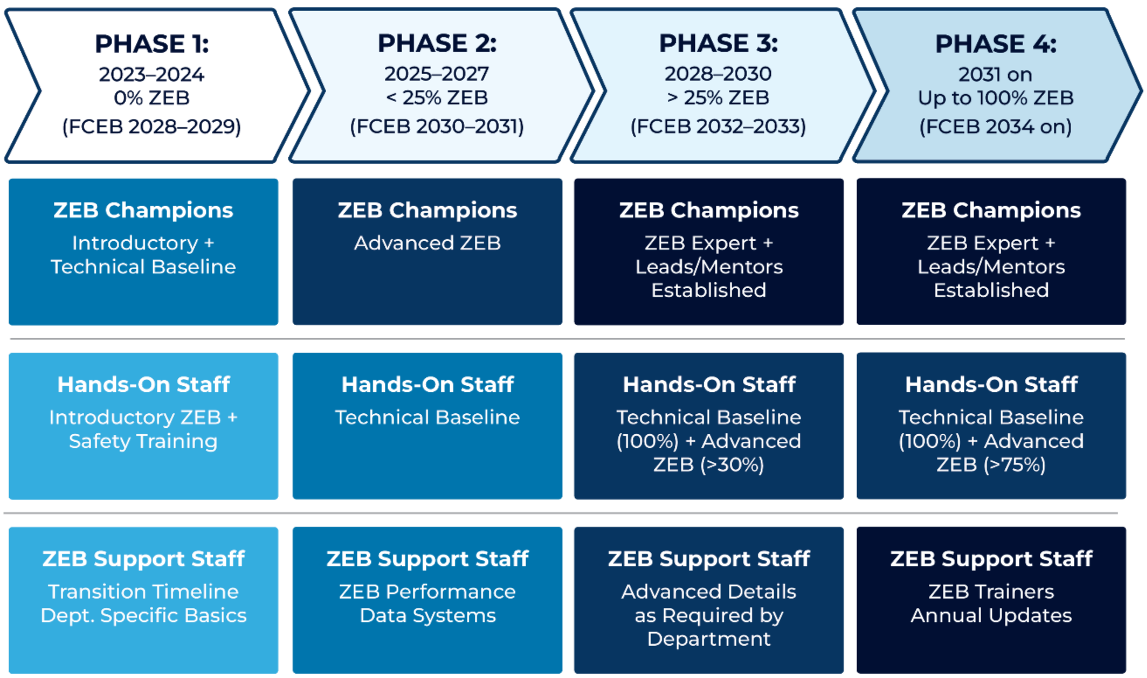


Figure 48 - Workforce Development Training and Phases

Phase 1: Pre-Deployment

The pre-deployment phase is from 2023-2024, before any ZEBs have entered service. The pre-deployment phase carries the heavy lifting on the planning side, including planning for workforce training. During this window, it is a best practice to have champions of zero-emission buses in the departments that will have the most direct contact: fleet, facilities, and operations. These champions can be reservoirs of knowledge while the full staff is learning the new technology. They are also responsible for learning the new material first; this will require substantial knowledge acquisition in phase one before the buses arrive.

In Phase 1, understanding the upcoming relationship with the OEM and the variations in products in the ZEB market is critical. The transit agencies leading the way on workforce development lean heavily on OEM training offered alongside a bus purchase. Those trainings will have the most up-to-date information on the specific buses CCRTA has procured. Many agencies send all staff to these OEM trainings to minimize training costs. Agencies must consider a holistic viewpoint of the vehicles when determining procurement for training tools at this stage, as each OEM has specific mechanical functions across the entire vehicle that can vary substantially. It is crucial to engage with the OEM as soon as possible after selection to ensure that the agency has access to a comprehensive list of tools needed to take full advantage of direct, specialized OEM training in Phase 2. It is recommended to cross reference the skills and tools outlined in the gap analysis of this report with OEM supplied materials to ensure complete coverage.

As is described later in the Case Studies section, peer agencies also recommend prioritizing safety training for hands on staff before the buses arrive; this will help staff feel comfortable with the vehicles once they are on site. A best practice recommended is to explicitly include safety training for the entire agency staff in the initial vehicle procurement contract.

For ZEB support departments, Phase 1 brings the opportunity to start building knowledge on the job components that will change, and start planning for those transitions. For example, the finance team may need to begin to plan for how cost analysis will change with the new technology, and put systems in place to integrate new types of data; IT will need to understand new software, and can begin to plan for that software's arrival; and facilities staff may want to understand the building's existing electrical usage patterns as a baseline to compare against once the buses arrive. Each deployment phase presents unique challenges and opportunities, which are outlined below in **Table 16**.

Table 16 - Phase One Opportunities and Challenges

Phase 1: Pre-Deployment	
Opportunities	Challenges
• Instilling basic technology familiarity across the agency to fully utilize OEM training in Phase 2. • Building ZEB leadership internally across most affected departments. • Flexibility in learning timeline. • Skill development partnerships can be built with other training partners (consultants, technical colleges) external to organization.	• Extremely limited opportunities for hands-on training before buses arrive. • Timeline could be compressed/expedited depending on bus delivery timeline and the availability of training partners. • Tool identification and procurement is OEM-specific. Acquisition of this information should be prioritized during Phase 1 supplier engagement.

Phase 2: Early-Deployment

In the early deployment days, with less than 25 percent of the fleet electric, access to vehicles to work on is a challenge. Since the ZEBs will constitute a small percentage of the fleet, the buses rotation through maintenance will be infrequent, and all staff may not have hands-on experience with them on a regular basis. In this training window, it is helpful to have the ZEB champions lead the hands-on work on the buses, and work alongside staff that are still building up their zero-emission experience. Similarly, when possible, it is a best practice to have CCRTA staff work alongside any OEM staff when they come for any work performed while the buses are still under warranty. This on-the-job refresher is invaluable for allowing staff access to experts and seeing best practices at work.

Phase 2 is the most likely period in which direct, hands-on training with the OEM over the details of the ZEBs of choice is to occur. Planning for the most efficient use of this time is crucial. As discussions and scheduling with the OEM occur during Phase 2, the agency should acquire specific training documentation to support foundational training work. By Phase 2, that information should be at hand and the necessary procurement engaged to mitigate potential delays. In the Gap Analysis below, a list of tools has been identified that are pertinent to this procurement effort. CTE suggest cross referencing this list with the OEM's guidelines during Phase 1 for maximum efficiency. In the early deployment, hands-on staff will build on their introductory knowledge base and begin building their technical baseline on the ZEBs. Over the course of this phase, all staff will need to build this technical baseline. Given the small number of buses in service, staff will need to be intentionally scheduled to make sure all staff get the opportunity to re-enforce any classroom learning with hands-on experience. Some peer agencies opt to run ZEBs on training only shifts initially before starting passenger service to allow staff to become accustomed to the new buses.

During the beginning stages of Phase 2 while advanced knowledge is still scarce, it is important to spread the expertise on ZEBs to more than one staff member. CCRTA does not want to end up in a position where the ZEB knowledge holder can't take time off from work without compromising ZEB service. Additional opportunities and challenges are outlined in **Table 17**.

For ZEB support departments, phase two marks the shift from "theoretical" to "actual," and will require departments to incorporate ZEB information into their operations. These departments will now have access to ZEB data as required by their department.

Table 17 - Phase Two Opportunities and Challenges

Phase 2: Early Deployment	
Opportunities	Challenges
• Opportunities for ZEB Champions to build and practice skills, build train-the-trainer program. • OEM field technician contract options allow for on-site training during the first year of deployment, if negotiated in contract.	• Limited ZEB buses in the fleet will limit opportunities for hands-on knowledge internalization. • Intentional scheduling may be required to make sure appropriate skills are available on each shift. • Pressure to meet daily needs may impact availability for staff to work alongside and learn from field-techs.

Phase 3: Normalized Deployment

Once ZEBs constitute over 25 percent of the total fleet, all staff can expect to have hands-on experience with the buses on a regular basis and will need to know how to work on the vehicles. At this point, some hands-on staff will need to move beyond their technical baseline and begin building advanced skills. The ZEB Champions can also begin developing a train-the-trainer program to ensure that knowledge continues to be passed to all staff.

The normalized deployment phase is also well-suited to the development of an apprenticeship program to bring additional staff up to speed or into leadership positions on the new vehicles. CCRTA's ZEB procurement timeline ramps up quickly, and, if training capacity is desired in-house, this window will allow both trainers and trainees immediate access to vehicles to work on. Additional opportunities and challenges are outlined in **Table 18**.

FCEB Introduction:

If CCRTA choose to pursue FCEBs, those buses will arrive once the BEB baseline skills have already been extensively developed. At this point, BEB trained staff can take over leadership of BEB skills, while the ZEB champion role will shift to learning the new FCEB technology. The FCEB process will mimic the BEB process, with the champion initially captaining FCEB learning, then involving more staff at additional levels of leadership as the number of FCEBs increases.

Table 18 - Phase Three Opportunities and Challenges

Phase 3: Normalized Deployment	
Opportunities	Challenges
• Train-the-trainer program will have ample opportunities for practice and can fine-tune the approach. • Larger portion of staff will have growing experience in ZEBs.	• Limited number of buses in service may skill require intentional cycling of staff to keep skills fresh. • All staff will need to come up to speed on ZEBs which may be a challenge for staff that are less interested in new technology.

Phase 4: Ongoing Normalized Deployment

After the staff has spent a few years with a 25% ZEB fleet in phase 3, all staff will have been trained on ZEBs and will have regular hands-on experience with the buses. The goal of the ongoing normalized deployment phase will be similar to the status-quo of diesel and CNG operation: make sure staff stay up-to-date on their skills, allow space for advancements in knowledge, and manage knowledge transfer with any staff transitions (e.g., new staff, retirements, etc.). CTE recommends regular refresher training either through OEM trainings or through an established train-the-trainer program. **Table 19** outlines the remaining opportunities and challenges for ongoing deployment.

Table 19 - Phase Four Opportunities and Challenges

Phase 4: Ongoing	
Opportunities	Challenges
• In house experts available for training • Staff transitions (e.g., hiring, retirement, promotions) will provide opportunities for continued leadership growth in ZEB expertise.	• Aging ZEBs from initial procurements may require new types of maintenance to which the staff haven't yet been exposed to (e.g., battery replacement)

Content: Skills Gap Analysis

CTE has conducted extensive research to identify a comprehensive list of the skills necessary to successfully bridge the gap between having zero ZEB experience and a completed skill transition. The skill analysis covers the development of the ZEB Specialist role, along with a basic level of comprehension across the agency at large. This inventory was then mapped to the existing skills across departments provided during the data gathering phase of the project. Skills maps are can be reviewed in **Appendix C** and identify the gaps in current programming and the concrete skills needed to bridge those gaps. While CTE has differentiated maintenance skills by the aforementioned ZEB progression (ZEB Intro, ZEB Basic, ZEB Advanced, ZEB Expert), the skill matrix is meant to be a fluid, working document and CCRTA may elect to train their staff on certain skills before or after the recommended progression. Below, CTE has provided summaries of those breakdowns.

Maintenance

While ZEBs will present many new and exciting challenges for maintenance staff, there are a number of transferable maintenance skills between ICE vehicles and ZEB vehicles that will ease the transition training burden. The type of fuel selected in the final transition scenario is a noteworthy factor impacting variable levels of skill crossovers available to CCRTA. A brief comparison of bus subsystem changes and their implications on maintenance are summarized below:

Energy Storage System (ESS) and Battery Management

Existing low voltage battery handling skills will be directly applicable to low voltage (LV) battery work in ZEB's; however, ZEB Basic staff will need to have high voltage (HV) awareness training and understand how to safely disable HV systems to work on the LV systems on a ZEB. A critical example of a LV skill that will require HV awareness, but not necessarily HV training, is starting the bus with jumper cables. The component responsible for activating and deactivating HV systems is called a battery contactor, and is actually powered by LV batteries. In the instance that the LV batteries are depleted before the HV system can recharge them, the bus would need to be jumped similar to how a traditional ICE bus would be jumped. BEBs and FCEBs also have larger battery packs requiring specialized high voltage training (most OEM's can provide), and specialized battery handling skills. Staff must be trained on OEM lock-out tag-out procedures before working on primary battery packs. ZEB Advanced staff will dig deeper into the ESS and understand how to diagnose HV system issues on the ZEB.

The most critical non-safety skill for both BEBs and FCEBs, as it pertains to the ESS, will be selecting staff members who will become experts with the OEM ESS fault diagnostic software and interface tool (exact tool varies by OEM). This will allow specialized staff to confirm, diagnose, and apply corrective action to faulty components within the battery packs or the batteries themselves.

Electrical / Multiplexing

Existing basic electrical and multiplexing skills will be crucial for all ZEB service staff, with select staff becoming multiplexing experts. Staff will still need to repair fuses, identify shorts, and effectively use a voltmeter (among other skills). With ZEBs there will be high voltage circuits and risks will be much higher. All staff should be able to be able to identify high voltage components of the bus (batteries, high voltage junction box, DC-DC inverter, traction motor, power steering, HVAC, air compressor, fuel cell, thermal battery management system). In addition, suspension systems, friction-based braking systems, HCAV, power steer, axels, grounding, doors, and ADA will not be different from a tradition ICE bus. The major change is that every component will be powered either by high voltage power directly from the ESS or LV power that has been passed through a DC-DC inverter.

Propulsion, Transmission, Braking

As opposed to diesel and CNG bus technology, ZEBs are propelled forward by an electric motor. Electric motors work by leveraging a fundamental electromagnetic principle: alternating electric power flow induces a magnetic field and correspondingly alternating magnetic fields induce electric power flow. An electric motor generates propulsion from electrical energy by surrounding an electromagnet with a permanent magnet and switching the direction of the current flow such that the electromagnet reverses polarity. ZEB intro staff should be able to describe the power flow from the DC battery to three-phase AC motor. The starter motor is the same as the main motor in ZEBs as electric motors are able to provide powerful, near instantons torque. In addition, ZEBs do not have an alternator nor a static converter. Friction-based brakes will see less wear and tear due to regenerative braking baring some of the braking burden. Regenerative braking works because internal processes within an electric motor are reversible, whereas internal combustion is a chemical process that cannot be reversed. Instead of power flowing from a HV battery through a complicated circuit and switch schematic to create a strong electromagnet, the physical work done by wheels physically moves the permanent magnet such that it creates electric energy to power the battery. Because of this, regenerative braking does not have special maintenance requirements outside of regular requirements of the engine, Controller Area Network (CAN), and (potentially) transmission (ZEBs can also be direct drive).

The most critical non-safety skill for both BEBs and FCEBs, as it pertains to the propulsion system, will be selecting staff members who will become experts with the OEM fault diagnostic software and interface tool (exact tool varies by OEM). This will allow specialized staff to confirm, diagnose, and apply corrective action to faulty components within the motor and its accompanying components.

HVAC

High voltage batteries power the electric HVAC system, as opposed to traditional electric HVAC technology powered by an alternator with a static converter. The electric HVAC system itself is the same across bus types, so service staff will only need to be fully aware of HV safety requirements to understand HVAC maintenance. It is important to note that while the maintenance is similar, the ESS and or fuel cell are more sensitive to temperature than an ICE, so HVAC upkeep will be extraordinarily important to the overall success of a ZEB rollout.

Charging

In a ZEB, LV batteries are charged by originally HV power than has passed through a DC-DC inverter. High voltage batteries are recharged by a fuel cell or from direct plug-in external power. ZEB intro staff must understand the difference between AC and DC fast charging and how charging types impacts the flow of power into the vehicle. The most common bus-side charger malfunction is related to bus-charger communications and the bus CAN. It will be crucial to assign a staff responsible for coordinating software updates between charger OEM and bus OEM, as they might not be the same entity.

Fuel Cell System / CNG System

Fuel cells work by generating electricity through an electrochemical reaction, not combustion. Fuel cells intake hydrogen and then split the hydrogen molecules into electrons and protons (H+) using a highly-specialized catalyst. The protons pass through a porous electrolyte membrane while the electrons are directed towards a nearby circuit. On the other side of the electrolyte membrane, the protons, electrons, and newly added oxygen combine to produce water. The flow of electrons from the positively charged side of the fuel cell (anode) to the negatively charged side of the fuel cell (cathode) generates electricity, which will either directly power the electric motor or recharge battery packs that will power into the electric motor.

Though fuel cells themselves are a new technology, fuel cell systems and CNG systems share a high degree of similarity when it comes to dealing with high pressure gases, for example venting and purging the bus of gaseous fuel and checking gas tubing for pinch points. Fuel cells themselves; however, require unique maintenance with special attention to simple mistakes that can damage the stack. One example of this is exposing the stack to oil or grease, a common substance in and around ICE maintenance shops. Any work on the fuel cell and accompany HV components require HV training. It is important to consider that FCEB training encompasses BEB training in terms of skill sets, but is also more expensive given the extent of the training required. In the past, other transit agencies such as AC Transit have chosen to train all staff on FCEB to ensure every ZEB tech can work on every type of ZEB. Additional fuel cell maintenance tasks are located in the maintenance staff skill matrix (**Appendix C**). Due to the infancy of the hydrogen-fueled transit-bus economy, there is a dearth of information on maintaining FCEBs. The progression of fuel cell skills in the aforementioned skills matrix may vary once buses are deployed and beginning their OEM-specific preventative maintenance programs.

Summary of "Black-Box" ZEB Maintenance Modules

The most complex components of the new technology will likely not be serviced by CCRTA staff. Even a ZEB Expert would not be expected to open an inverter and repair a circuit board, but service staff should understand how each of the following components work to be able to better diagnose faults. A list of modules within a ZEB that technicians will need to rely on the OEM to service can be found below:

- Battery Cells (Battery packs are serviceable)
- Traction Inverter
- Electric Motor (Drive unit may have serviceable parts; the actual motor does not)
- Auxiliary Power Module (HV-LV DC-DC converter)
- Fuel Cell

Operators

Vehicle operations are where some notable skill changes take place between ICE and ZEB vehicles, especially as it relates to the actual experience of driving the bus. Unlike service staff which can have tiers or levels of skills, bus operator training is binary in a sense that a driver is either fully trained to drive a bus or not. It is imperative that a driver is not partially trained and operating a ZEB alone. The following paragraph will summarize a few crucial operator training elements.

Operators	ZEB Education and Safety	•Zero-emission technology overview •Awareness of high voltage systems •High voltage exposure warning emergency response procedure
	Bus Operation	•Regenerative braking and friction-based braking overview •HVAC significance •Remaining operating time •Technological limitations (Fuel Cell output vs. Input) •Turn off 12/24VDC battery disconnect for the bus and apply a multi-lockout device •Fueling a FCEB •Driving feel under various levels of regenerative braking •Optimal driving habits to maximize regenerative braking •Bus docking for on-route charging (BEB only) •Start up / shut down procedures (including inspections) •Decreased noise implications on shut off procedures and pedestrians

Figure 49 - Operator Skill Matrix

Vehicle operators will need to have a heightened understanding of the high voltage exposure warning emergency response procedure. This warning alerts the driver that something is very wrong with the bus (perhaps from an accident) and that they need to follow a series of OEM-specific safety procedures. In addition, operators will need to understand remaining operating time and technological limitations. If they are driving a full fuel cell bus on a hot day at high speeds down the freeway, the power demand might exceed the power output by the fuel cell to charger the on-board battery pack. This is a rare instance, but certainty one to be aware of, especially if CCRTA has city or county emergency response commitments in the event of an evacuation. In most other cases, the battery state of charge of a fuel cell bus should remain relatively high if the bus is fully fueled with hydrogen. Operators will need to know how to charge or fuel the bus, and any pre and post charging/fueling inspection procedures that will accompany the process (OEM specific). Additionally, the extremely quiet nature of the vehicles requires a mental shift in the perceptions of the driver. Noise related lessons learned from other operators have indicated repeated concerns around pedestrian safety and unknowingly leaving the bus on at the end of the shift (see Foothill Transit Demonstration Report in **Appendix C**). Properly training bus operators to turn the bus off can alleviate any risks of leaving the bus on overnight.

Finally, and perhaps most significantly, regenerative braking will significantly change how it feels to drive a ZEB. While the regenerative braking process is described in detail in the above section outlining ZEB skills for service staff, it is crucial for operators to understand what the reversibility of the technology means for them. When an operator approaches a stop, they can choose to apply the friction-based traditional braking system still present with ZEBs, or coast and let the torque created by the regenerative braking system bring them to a halt. The more the operator relies on regenerative braking, the more efficient the bus will use its onboard energy. Additionally, the "strength" of regenerative braking can be adjusted and subsequently change how it feels to drive the bus. Some OEMs automatically increase the regenerative braking strength when the battery state of charge drops below a certain level. Without proper training, this could confuse and concern operators who are not expecting it.

Service Development

Service development staff will need to develop ZEB skills to plan and support hands on staff driving and servicing the vehicles. The necessary skills include, but are not limited to, writing bus procurement and infrastructure development RFP's to specifically include training, planning dispatch so that operators do not run out of fuel under strenuous and nominal conditions, carefully selecting ZEB champions and promoting a ZEB-forward culture from organizational leadership, and completing high voltage awareness training and/or learning hydrogen safety fundamentals. Additional resources including RFP sample language from the International Transportation Learning Center, can be found in the resource library in **Appendix C**.

First Responders

First responders are of paramount importance to keeping staff and the local community safe. The local Fire Department will need to have high voltage training, and in the instance of FCEBs they will need high-pressure gas handling training and to understand the basic chemical properties of hydrogen. While hydrogen dissipates into the atmosphere much quicker than petroleum-based fuels, hydrogen fires are not visible during the day and first responders will need to know when they might be encountering a hydrogen fire. One of the best practices is to explicitly include first responder and safety training into the OEM training contract. Additional resources including first responder training courses from the National Fire Protection Association (NFPA) can be found in the resource library in **Appendix C**.

Tools

Many of the tools integral to the ZEB maintenance process are proprietary designs and highly specified to the make and model of vehicle. Based on the skills identified above, CTE has provided a list of fundamental maintenance and safety tools below. High voltage electricity refers to electrical potential large enough to cause injury or damage. While many of the tools needed to service ZEBs are OEM-Specific; these safety tools will be required regardless of OEM or fleet transition scenario.

- Class 0 High Voltage Rubber Gloves (ASTM D120), inspected biannually to ASTM F1236
- High Voltage Safety Footwear (ASTM F2413-05) or High Voltage Overshoes (ASTM F1117)
- Eyeglasses (no conductive frames)
- CAT III 1000V Digital Multimeter
- CAT III 1000V Test Clips
- CAT III 1000V Test probes
- CAT III two-pole tester (provides voltage reading even with an empty battery)
- Hot Stick (ASTM F-711)
- Insulated tool set
- Insulated torque wrench

- Arc Flash Suit (ATSM 1506) when working on HV batteries, HV disconnect panel, HV switch, etc.
- Gas detector calibrated for hydrogen (FCEB only)
- Defibrillator
- Fire extinguisher (CO2)
- Steering wheel danger sign
- Safety fence
- HV signage
- Man-harness and lanyards
- Safety caged exterior ladders
- Scissor lifts
- Insulated pallets (up to 1000V) for HV batteries
- Insulated cover

Below is a sampling of tools that will be required to work on a ZEB. Please note that the OEM will provide additional information on necessary and required maintenance tooling.

- CAT III 1000V Digital Multimeter – measure voltage, current, and resistance
- Current Clamps – Measure electrical current
- Ohmmeter – Measure electrical resistance
- Refractometer – measure refractive index / coolant conductivity
- Megohmmeter – determine the condition of insulation on wires
- Oscilloscope – Measure voltage waves and display electrical signals
- Hydrogen venting tool (FCEB only)

Case Studies and Best Practices

Utilizing the data provided by CCRTA, two agencies were identified that experienced similar challenges to those discussed above and therefore had valuable, transferrable lessons learned. CTE conducted informational interviews with those agencies to gather lessons learned and best practices for the transition process, specifically as it regards training. Additional best practices from CTE's knowledge database are provided as well.

Case Study 1: Champaign-Urbana Mass Transit District

The Champaign-Urbana Mass Transit District (CUMTD), located in the Illinois college town of the same name, serves an annual ridership of roughly 5.5 million, placing it roughly on par with CCRTA's pre-COVID figures. Their ongoing transition from diesel vehicles to FCEBs accompanied by hybrid buses is still in relatively early stages, giving us direct insight into Phase 1 struggles. Specifically, CUMTD's largest takeaways come in recommendations about the utility of certain training methods.

MTD's leadership emphasized hands-on training was the most effective form, especially when conducted in direct consultation with OEMs. This has implications for the periods both before and after the direct interactions with the OEM trainers. In advance, doing as much fundamental and theory training as possible allows for maximum utilization of specialist's time, Once OEM training is completed, rapidly developing an in-house, formal training system was a strong recommendation on the part of CUMTD. Their creation of a

Fuel Cell Training Center has paid off in dividends, allowing for specialized knowledge to remain among staff.

Case Study 2: Alameda-Contra Costa Transit District

Alameda-Contra Costa Transit District (AC Transit), located in Oakland, California, has been a leader in ZEB adoption in the transit industry for over 20 years. In an effort to meet state standards of a fully zero-emission fleet by 2040, AC Transit has been rapidly replacing its existing diesel fleet with ZEBs, but with over 640 vehicles in service (592 diesel-powered), the transition is still in early stages. AC Transit emphasized that this change represents a total paradigm shift for an agency which, according to AC Transit's leadership, has been and can continue to be improved through the use of "ZEB Champion" roles. Having staff members take ownership of the culture change inherent in the transition is crucial.

AC Transit's additional feedback echoed much of what CUMTD recommended regarding training methodology: hands on training, focus on effective use of OEM time, and building formal in-house knowledge transfer systems. Their largest additional item relates to vertical integration, (i.e., involving as many levels of staff in the process as early as possible). By limiting the cultural shift to only hands-on staff, comfort with the new technologies does not effectively reach all departments, stifling transition.

Total Cost of Ownership Assessment

Methodology

The Total Cost of Ownership Assessment compiles the results from the Fleet, Fuel, Facilities, and Maintenance Assessments to show cumulative and annual costs throughout the transition period for each scenario. The transition period is defined as achieving a 100% ZEB fleet purchasing during the 18-year period between 2022-2040. It includes selected capital and operating costs of each fleet scenario over the transition timeline. Other costs may be incurred such as incremental operator and maintenance training during a fleet transition; however, these four assessment categories are the key drivers in ZEB transition decision-making.

This study assumes no cost escalation or any cost reduction due to economies of scale for ZEB technology because there is no historical basis for these assumptions. Future changes to CCRTA's service level, depot locations, route alignments, block scheduling, or other operations were kept consistent. The analyses below provide best estimates using the information currently available and the assumptions detailed throughout this report.

Assumptions

In order to project costs more accurately, a three percent inflation per year was applied starting in 2023 which was increased from 2022 dollars. This did not include energy costs which were based on Energy Information Administration (EIA) projections. Fleet size and composition were assumed to remain the same.

All of the scenarios have the cutaway fleet transitions to battery electric since fuel cell electric technology is still in development and limited. CTE recommends revisiting this technology option in five years as the FCEB cutaway market is expected to grow rapidly.

It is important to note that on-route charging for the BEB Only scenario or the procurement of FCEBs in place of BEBs in the Mixed Fleet scenario needs to be incorporated in 2030 in order to reach 100% ZEB by 2040.

Analysis Results

The following sections show total costs per scenario, broken down by assessment type.

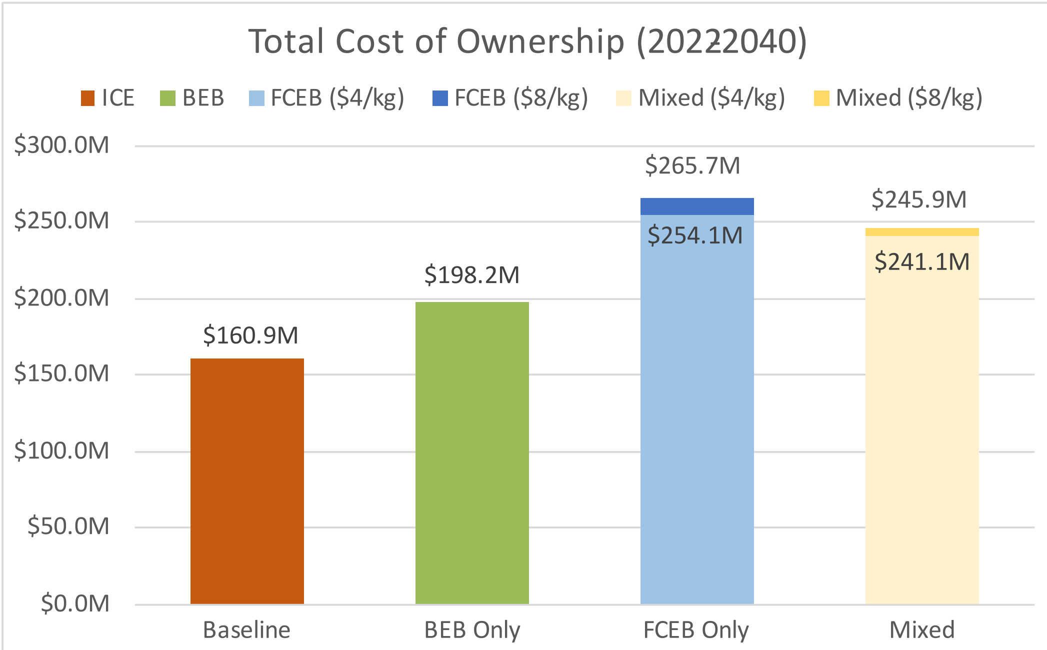


Figure 50 - Total Cost of Ownership

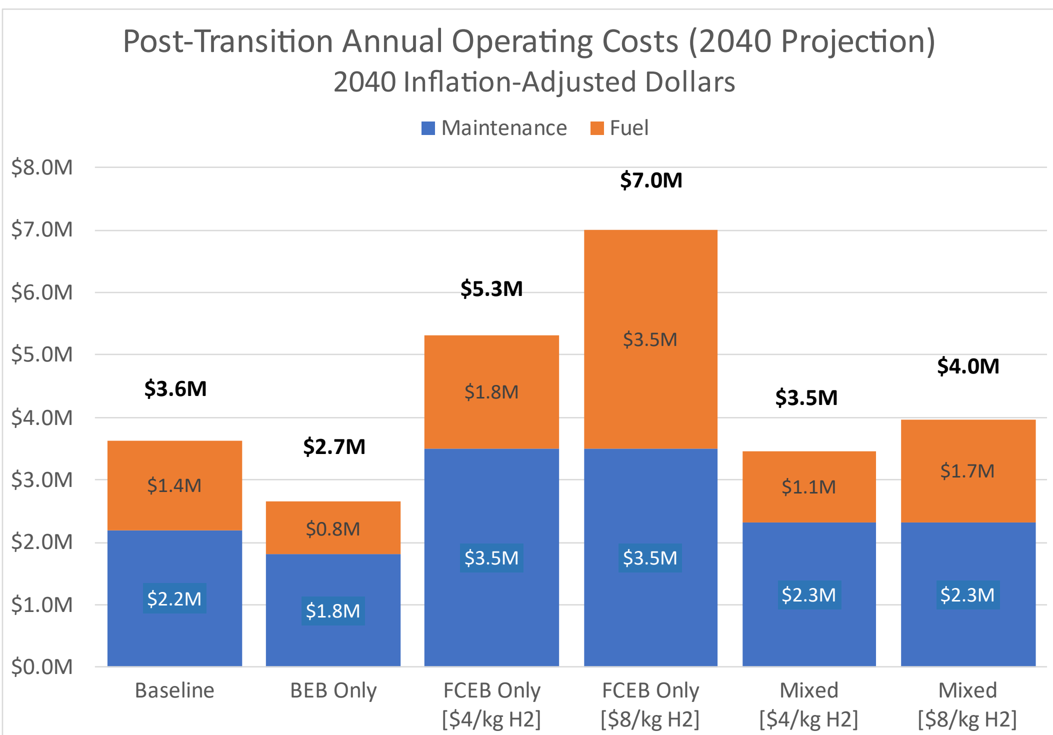


Figure 51 - Post-Transition Annual Operating Costs (2040 Projection)

Baseline

The combined fleet, fuel, facilities, and maintenance costs for the Baseline scenario are shown in **Figure 50**. Since bus capital costs represent the most expensive cost examined, the fleet categories take up the biggest portion of each bar on the graph. Costs peak during years with larger bus procurements. Compared to bus costs, the fluctuations in fueling and maintenance cost are minimal and appear fairly stable. The total combined cost is approximately $160.9 million from 2022 to 2040. This scenario estimates a total of 70 CNG buses and 23 gas cutaways in service in 2040 and demonstrates the capital and operation costs CCRTA could expect to incur over this period.

BEB Only

Figure 50 shows the combined fleet, fuel, facilities, and maintenance costs for the BEB Only scenario in 2022 dollars. The total combined cost is approximately $198.2 million over the length of the transition, from 2022 to 2040. This scenario estimates a total of 70 BEBs and 23 battery electric cutaways in service by 2040. The trends in the total cost fluctuations between years are largely the same as the Baseline scenario, with costs peaking in years with large bus procurements. Bus capital costs are the main component of yearly costs with the largest spike of bus capital costs occurring in 2040 due to the purchase of 29 BEBs and seven battery electric cutaways.

Infrastructure costs are a significant portion of projected annual expenses towards the middle and latter half of the transition period while maintenance and fueling costs remain relatively stable from year to year. The costs of this scenario are significantly lower than the FCEB only or mixed scenarios because of lower vehicle costs and the relatively lower cost of electricity compared to hydrogen at present day pricing. There is significant potential for this relationship to switch in the future, with electricity increasing in price as the cost of hydrogen falls.

Figure 51 shows the total cost of ownership for the BEB Only scenario following completion of the transition period (2040 projection). At $2.7 million total annual operating costs, there are noticeable savings when compared against the $3.6 Baseline and all of the other ZEB-only scenario options ($5.3 to $7.0 million FCEB and $3.5 - $4.0 million Mixed Fleet). This makes the BEB Only scenario the most inexpensive post-transition option.

FCEB Only

Figure 50 shows the combined fleet, fuel, facilities, and maintenance costs related to the FCEB Only scenario in 2022 dollars. The analysis reviewed both $4/kg H_2 and $8/kg H_2 as a low and high fuel price option for hydrogen. The total combined cost is approximately $254.1 million at the $4/kg H_2 cost and $265.7 million at the $8/kg H_2 cost over the length of the transition, from 2022 to 2040. This scenario estimates a total of 70 FCEBs and 23 battery electric cutaways in service by 2040. The general trends of this scenario are similar to the previous ZEB scenarios discussed, with costs peaking in large procurement years. The costs for this scenario are the highest of all the scenario options as fleet, fuel, facilities, and maintenance costs for FCEBs are higher than traditional ICE vehicles and BEBs.

Figure 51 shows the total cost of ownership for the FCEB Only scenario following completion of the transition period. There is only a $0.1 million difference in maintenance costs in post 2040 operations for both $4/kg H_2 and $8/kg H_2 options when compared to the Baseline and Mixed Fleet scenarios. Fuel costs remain high due to the lack of hydrogen availability in the United States. As mentioned above, there is significant future potential for the price of hydrogen to drop and improvements in fuel cell technology and infrastructure to lower costs associated with FCEB adoption.

Mixed Fleet – BEB Majority

Figure 50 shows the combined fleet, fuel, facilities, and maintenance costs for the Mixed Fleet – BEB Majority. The total combined cost is approximately $241.1 million for $4/kg H_2 and $245.9 million for $8/kg H_2 FCEB options over the length of the transition, from 2022 to 2040. This scenario estimates a total of 50 BEBs, 20 FCEBs, and 23 battery electric cutaways in service by 2040. There is a high projected annual expense in 2040 as a result of the procurement schedule for this scenario. In 2040, 26 BEBs and three FCEBs are scheduled for purchase, as well as seven cutaways.

The costs for this scenario are higher than the Baseline and BEB Only scenarios but less than the FCEB Only scenario. Due to the procurement of two different bus types and the need for both battery charging and hydrogen fueling infrastructure, the Mixed Fleet scenario has the highest overall infrastructure costs.

Figure 51 shows the total cost of ownership for the Mixed Fleet scenario following completion of the transition period. At the $4/kg H_2 cost, the Mixed Fleet scenario is similar to the total operating costs of the Baseline scenario and is the second lowest option overall out of all of the ZEB-only scenarios. With $4.kg H_2 cost, operating costs are slightly less than the baseline (about $0.1 million). With $8/kg H_2, costs are higher than the baseline but still over $1 million less per year than the FCEB Only scenarios, even if FCEBs are evaluated at the lower hydrogen cost.

On-Route Charging vs. FCEBs Cost Comparison

Figure 52 shows a comparison of costs between on-route charging required in the BEB only scenario against the procurement of FCEBs. The fleet (vehicle) and facilities (fueling infrastructure) incremental costs below are representative of the 20 CCRTA blocks that depot charged BEBs are not projected to meet the service needs for. Results indicate the utilization of additional FCEBs would incur $7.7 million more than the incorporation of on-route charging. This analysis should be revisited as energy storage technologies progress.

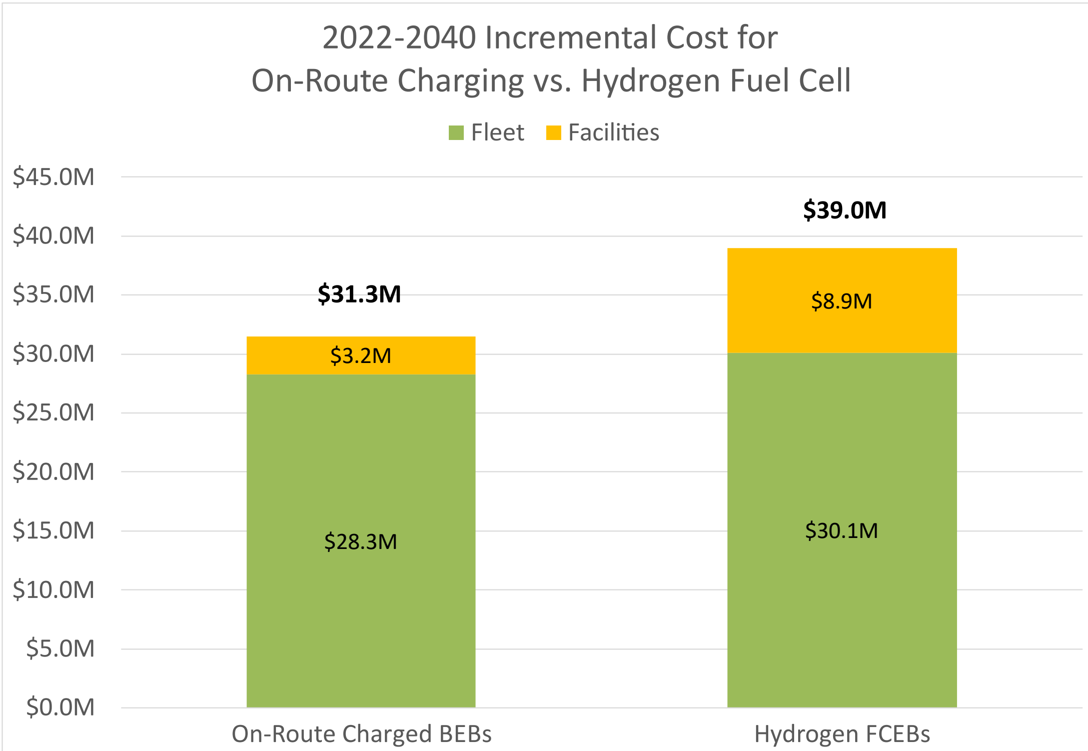


Figure 52 - Incremental Cost for On-Route Charging vs. FCEBs

Charging Infrastructure Replacement Cost

CTE also assessed the potential impacts of replacing CCRTA's charging infrastructure. At CCRTA's request, the cost of replacing 10% of the equipment each year during the transition period was reviewed. A ten percent failure rate is not grounded in field data, but rather gives context to what magnitude of costs for replacement equipment would look like. To calculate the ten percent annual failure rate cost, CTE took the total infrastructure installed in each given year during the transition period and took 1/10th the replacement cost for all equipment. This was summed each year for the transition period and also has inflation applied.

For the BEB Only scenario, the additional cost during the transition period would be $6.5 million which increases the total cost from $198.2 million to $204.7 million. The post-transition annual costs associated with the BEB Only scenario would be $0.9 million in 2040 dollars, which would boost the annual cost from $2.7 million to $3.8 million.

For the Mixed Fleet scenario, the additional cost during the transition period would be $4.5 million which increases the total cost from $254.1 million to $259.6 million ($4/kg H_2) and

\$265.7 million to \$270.2 million (\$8/kg H_2). The post-transition annual costs associated with the Mixed Fleet scenario would be \$0.6 million in 2040 dollars, which would boost the annual cost from \$3.5 million to \$4.1 million (\$4/kg H_2) and \$4.0 million to \$4.6 million (\$8/kg H_2).

Summary

Figure 53 shows the combined total costs from the assessments above, broken down by scenario. The BEB Only scenario is the lowest cost option but requires on-route charging by 2030. Compared to the Baseline scenario, bus and infrastructure costs for the BEB Only scenario are higher while fuel and maintenance costs are lower.

The FCEB Only and Mixed Fleet scenarios are the highest cost options as FCEB vehicles are the most expensive. The cost of hydrogen is likely to decrease over time and CCRTA is well positioned being located near a port. FCEB also functions similarly to CNG, so there are operational advantages outside of cost such as a 1:1 range equivalent and maintenance involving compressed gas as a fuel.

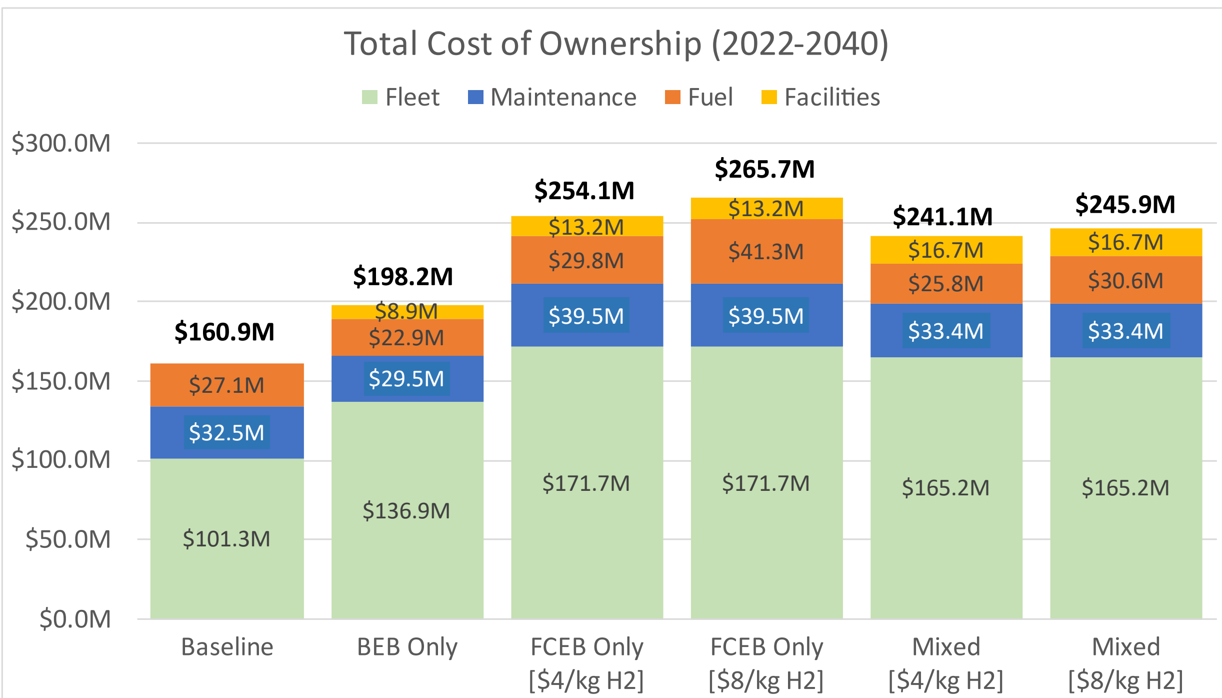


Figure 53 - Total Cost of Ownership, by Scenario

Table 20 shows the incremental costs and how much additional money is spent over the baseline for each scenario. Key savings are identified in the fuel and maintenance costs for the BEB Only scenario and the fuel costs for the Mixed Fleet scenario.

Table 20 - Total Cost of Ownership, Incremental Cost Compared to Baseline

	Incremental Fleet Costs	Incremental Maintenance Costs	Incremental Fuel Costs	Incremental Facilities Costs
Baseline	$ 0.0M	$ 0.0M	$0.0M	$ 0.0M
BEB Only	$ 35.6M	($ 3.0 M)	($ 4.2M)	$ 8.9M
FCEB Only	$ 70.4M	$ 7.0M	$ 14.3M	$ 13.2M
Mixed Fleet	$ 63.9M	$0.9M	$ 3.5M	$ 16.7M

* Mixed Fleet & FCEB Only assumes $8/kg hydrogen

Following completion of the transition period (2040 projection), the annual operating costs for the BEB Only scenario are the lowest when compared against all other options. FCEB remains high due to the cost and limited availability of hydrogen. Totals for each scenario can be seen in **Figure 51**.

As noted throughout the document, this analysis was completed based on the best available fleet data and procurement schedule available as of 2022.

Conclusions and Recommendations

Zero-emission buses offer a wide range of benefits not only for the agencies deploying them but also for the communities they impact. There are significant environmental benefits associated with the transition to ZEB technology. Widespread adoption of zero-emission bus technology has the potential to greatly reduce greenhouse gas (GHG) emissions resulting from the transportation sector. Through the reduction of tailpipe emissions, ZEBs benefit the environment by delivering better air quality and health benefits to the passengers and neighboring areas which tend to be disproportionately low-income and historically disadvantaged communities. Additionally, the total cost of ownership for a ZEB fleet has the potential to be equal to or less than a fleet of ICE vehicles. ZEBs are also significantly quieter than traditional vehicles which can help with noise reduction.

CCRTA is a great example of an agency motivated to move to ZEBs without any mandates or staff well-versed in ZEB technology. To get a better understanding of the obstacles and requirements involved with the switch to zero-emission, CCRTA has proactively worked to develop a ZEB transition plan to act as a blueprint for ZEB long-term fleet and facilities management.

ZEB technologies are in a period of rapid development. While the technologies have been proven in many pilot deployments, they are not yet matured to the point where they can easily replace current ICE technologies on a large scale. BEBs require significant investment in facilities and infrastructure and may require changes to service and operations to manage their range constraints. On the other hand, FCEBs can provide an operational equivalent to CNG buses, but the cost of buses, fueling infrastructure, and fuel remain a significant barrier to mass adoption. Despite the challenges associated with ZEB technology, CCRTA is committed to implementing environmentally-friendly policies and reducing its carbon footprint.

Summary of Scenario Options

The approach for this transition plan is based on the analysis of three ZEB technology scenarios compared to a baseline scenario. The baseline scenario is reflective of CCRTA's current diesel and CNG bus fleet. The three potential transition scenarios include a BEB Only scenario of battery electric buses and cutaways, a FCEB Only scenario of fuel cell electric buses and battery electric cutaways, and a Mixed Fleet scenario comprised of buses and cutaways with 70% BEB and 30% FCEB.

Total transitional costs under the BEB Only scenario are an estimated $198.2 million. The difference in cost between this scenario and the Baseline is largely the result of the price difference between ICE buses and BEBs as well as up-front capital costs for new fueling infrastructure. This scenario is projected to cost approximately $37.3 million more than the baseline over the transition period. The total post-transition costs associated with the BEB Only scenario are $2.7 million which is $0.9 million less than baseline costs.

Total cost for the FCEB Only scenario is estimated at $254.1 million when using the lower $4/kg H_2 cost and $265.7 million when using the $8/kg H_2 cost and results in an entirely fuel cell electric bus fleet by 2040. While only accommodating a single technology, the FCEB Only scenario has a larger total cost due to higher bus capital, maintenance, and fuel cost as compared to CNG or BEBs. A primary assumption for the FCEB analysis is that FCEBs are already available for all bus types and lengths during the transition period. FCEB cutaways were not included as fuel cell electric as the technology is currently unavailable. The earliest expected date CTE anticipates FCEBs will be on the market is in two years from a company called Letenda, but this timeline could be impacted by production delays and parts shortages currently being experienced across bus OEMs. Due to the lack of market diversity of FCEBs and hydrogen availability in the United States, fuel costs and bus capital costs remain high. These costs are largely expected to decrease in the future as more buses are deployed; however, more data is needed to understand how much they may decrease.

Additionally, data for FCEB maintenance costs reflect higher costs than what might be expected as agencies become more familiar with the technology. As such, there are more unknowns associated with costs for the FCEB Only scenario, and costs are more subject to change. This scenario is projected to cost approximately $93.2 million ($4/kg H_2) and $104.8 million ($8/kg H_2) more than the baseline over the transition period.

In the Mixed Fleet – BEB Majority scenario, the total cost is estimated at $241.1 million at the $4/kg H_2 cost and $245.9 million at the $8/kg H_2 cost. Managing a mixed fleet through a transition presents its own complexities, such as installing new BEB charging infrastructure and new FCEB fueling infrastructure in a time frame that does not disrupt service or depot access. A mixed fleet does, however, provide enhanced resilience as it means that portions of the fleet would still be able to operate in the event that fuel delivery of either fuel was disrupted. This scenario also allows the agency to benefit from the lower cost of BEBs compared to FCEBs as much as possible, while still maintaining the benefits that come with a diverse fleet. This scenario is projected to cost approximately $80.2 million ($4/kg H_2) and $85.0 million ($8/kg H_2) more than the baseline over the transition period. The total post-transition costs associated with the Mixed Fleet scenario are $3.5 million ($4/kg H_2) and $4.0 million ($8/kg H_2) which is comparable with baseline costs of $3.6 million annually.

Recommendations

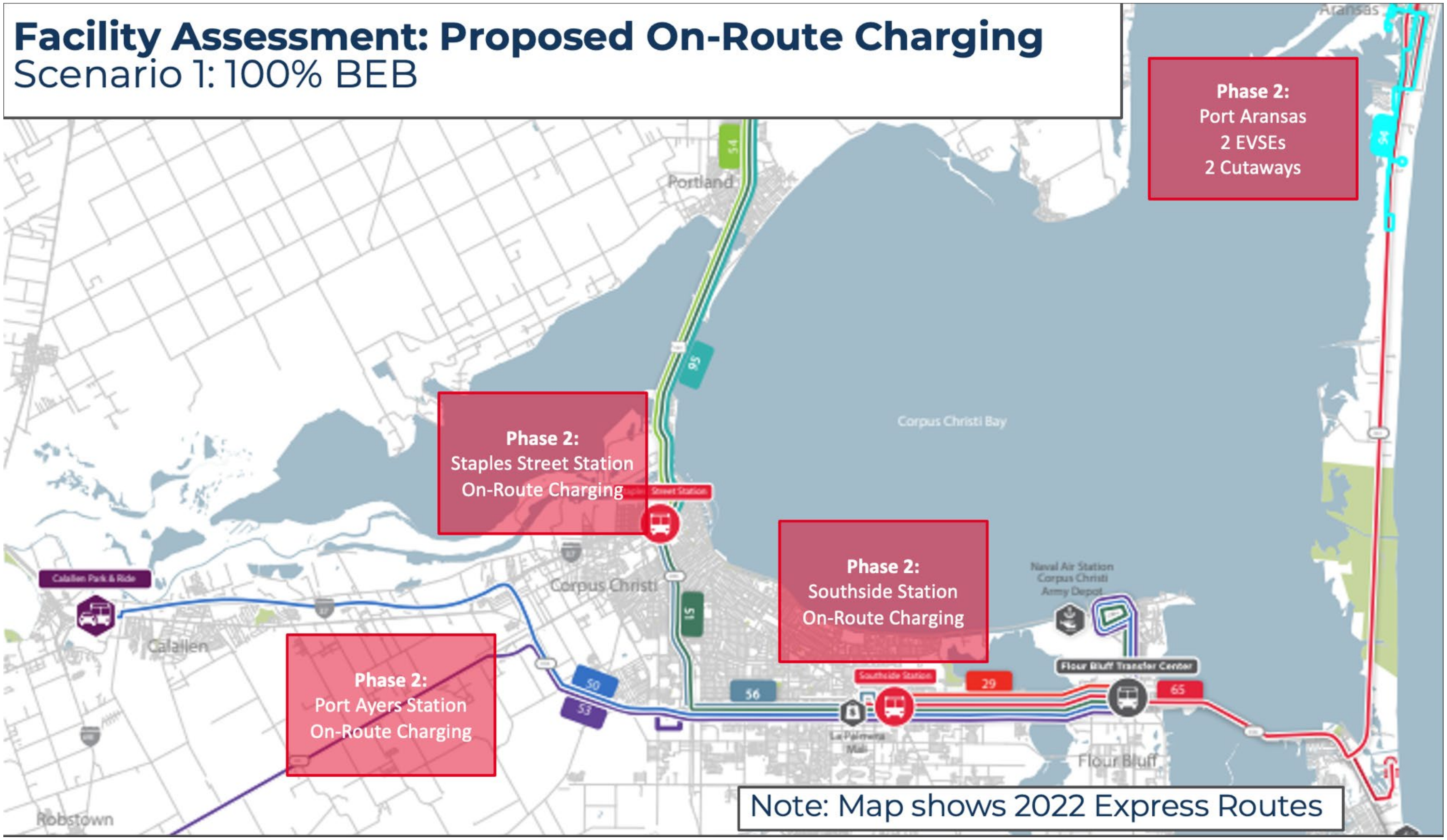
Given these considerations, the recommendations for CCRTA are as follows:

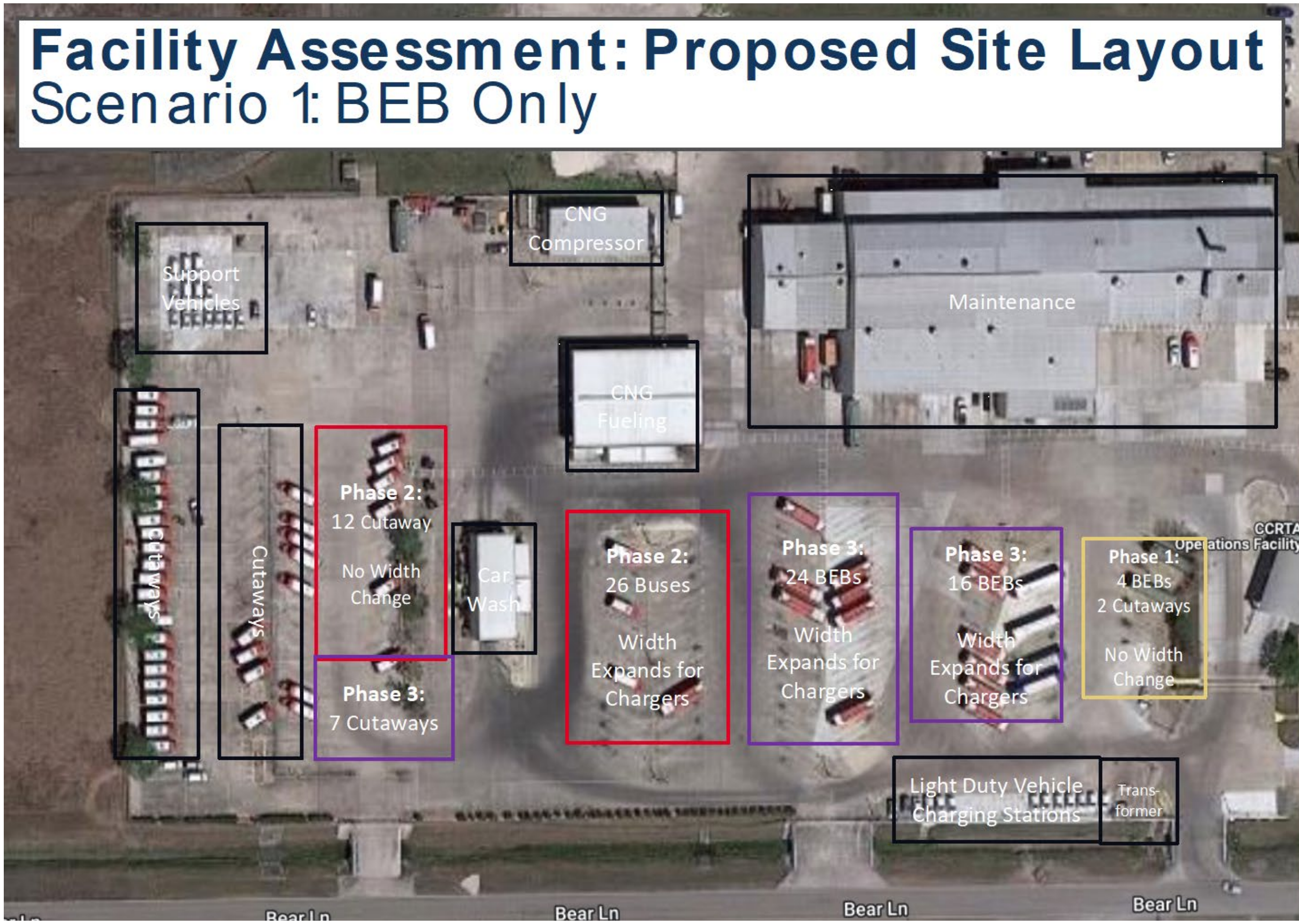
1) **Select a preferred scenario to refine and remain proactive with ZEB deployment grants:** This Transition Plan was developed to present CCRTA with options for transitioning to a fully zero-emission fleet. The Plan will put forth CCRTA's vision for a ZEB Transition and will act as a living document to help the agency plan out grant funding requirements. As a greater proportion of CCRTA's fleet converts to ZEB technology, auxiliary equipment, hardware, and software will be needed to ensure a successful fleet transition. CCRTA should continue to remain proactive in the purchase and deployment of ZEBs and their associated systems by taking advantage of various grant and incentive programs.
2) **Apply learnings from emergency disaster response:** Evaluate the tradeoffs for various alternatives to reduce the risk from hurricanes, tropical storms, power outages, equipment failure, and fuel disruptions, and allow CCRTA to meet all first responder requirements from the 3R Assessment.
3) **Match the individual bus technology to the individual route and blocks:** CCRTA should consider the strengths of given ZEB technologies and focus those technologies on routes and blocks that take advantage of their efficiencies and minimize the impact of the constraints related to the respective technologies. These technologies cannot follow a one-size-fits-all approach from either a performance or cost perspective. Matching the present technology to the present service levels will be a critical best practice.
4) **Monitor local and regional developments:** In the zero-emission technology sector, developments at the local level can have the ability to catapult the industry forward. When local bus OEMs or fuel providers enter the zero-emission market, it can spark technological innovation and cost reduction. Neighboring transit agencies can also work together through group purchasing agreements and lobbying efforts to bring about reduced purchase costs or more funding opportunities.

The transition to ZEB technologies represents a fundamental paradigm shift in bus procurement, operation, maintenance, and infrastructure. It is only through a continual process of deployment with specific goals for advancement that the industry can achieve the goal of economically sustainable, zero-emission public transit.

Appendix A - CCRTA Current System Map

Appendix B - Proposed On-Route Charging & Site Layouts





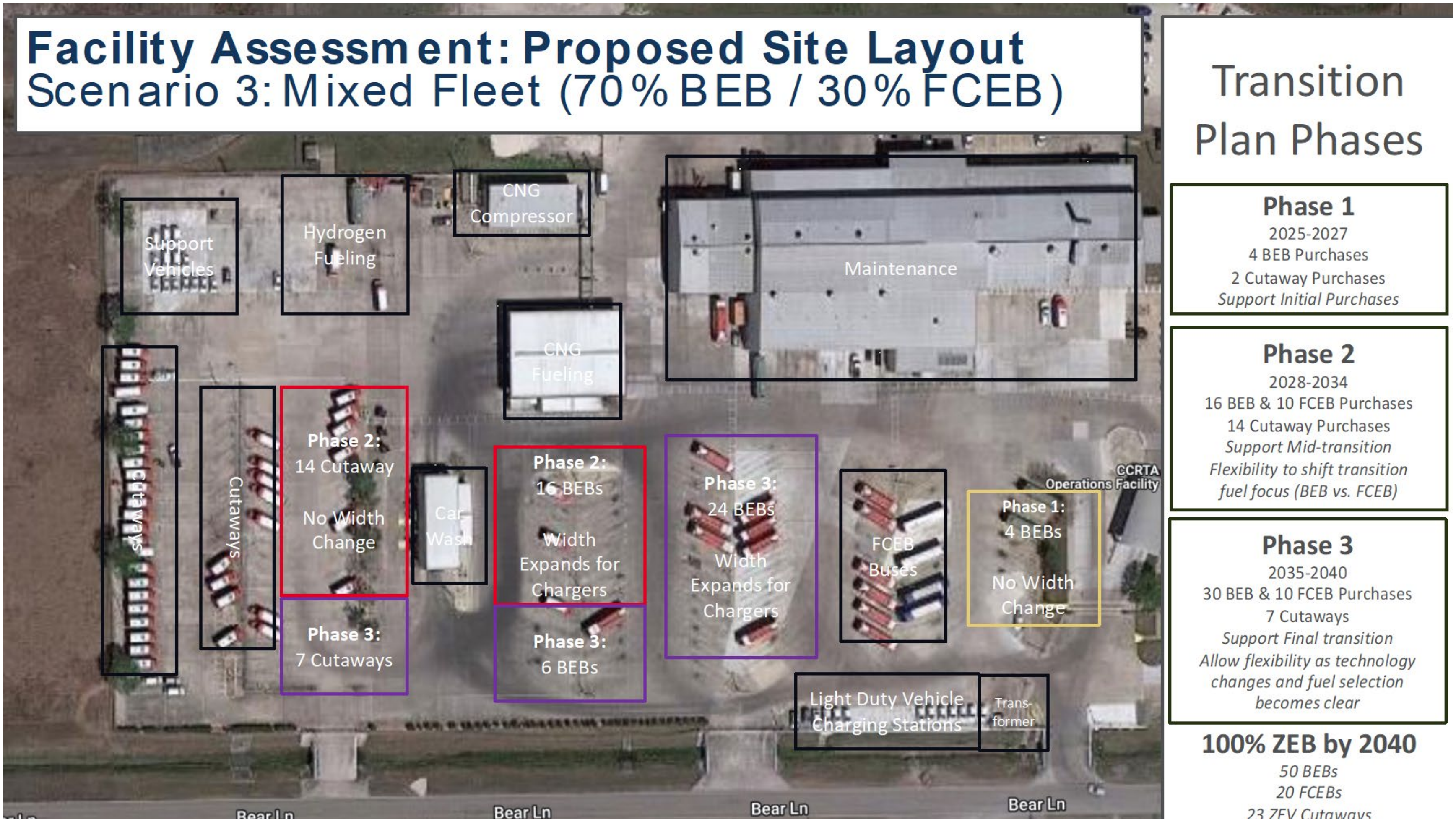
Transition Plan Phases

Phase 1
2025-2027
ZEB Purchases:
4 Transit Buses
2 Cutaways
Support Initial Purchases

Phase 2
2028-2034
ZEB Purchases:
26 Transit Buses
12 Cutaways
2 Cutaways at Port Aransas
Support Mid-transition
Flexibility to shift transition fuel focus (BEB vs. FCEB)

Phase 3
2035-2040
ZEB Purchases:
40 Transit Buses
7 cutaways
Support Final transition
Allow flexibility as technology changes and fuel selection becomes clear

100% ZEB by 2040
70 BEBs & 23 Cutaways


Facility Assessment: Proposed Site Layout
Scenario 3: Mixed Fleet (70% BEB / 30% FCEB)
Support Vehicles
Hydrogen Fueling
CNG Compressor
Maintenance
CNG Fueling
Cutaways
Cutaways
Phase 2: 14 Cutaway
No Width Change
Car Wash
Phase 2: 16 BEBs
Width Expands for Chargers
Phase 3: 24 BEBs
Width Expands for Chargers
FCEB Buses
Phase 1: 4 BEBs
No Width Change
CCRTA Operations Facility
Phase 3: 7 Cutaways
Phase 3: 6 BEBs
Light Duty Vehicle Charging Stations
Trans-former
Bear Ln
Transition Plan Phases
Phase 1
2025-2027
4 BEB Purchases
2 Cutaway Purchases
Support Initial Purchases
Phase 2
2028-2034
16 BEB & 10 FCEB Purchases
14 Cutaway Purchases
Support Mid-transition
Flexibility to shift transition fuel focus (BEB vs. FCEB)
Phase 3
2035-2040
30 BEB & 10 FCEB Purchases
7 Cutaways
Support Final transition
Allow flexibility as technology changes and fuel selection becomes clear
100% ZEB by 2040
50 BEBs
20 FCEBs

Appendix C - Workforce Development Skills Matrix

See Attached Document.

Appendix D - Workforce Development Resource Library

Facility Staff Resources – 1

Format Type	Description	Source
"Fuel Cell Electric Buses: Adapting Maintenance Facilities for Hydrogen"		
PDF Report	*"This paper reviews best practices in hydrogen bus maintenance facilities for transit agencies. It includes safety and infrastructure factors transit managers must consider when transitioning to servicing and maintaining fuel cell electric buses."* This paper also explains key properties of hydrogen as well as how to safely interact with the fuel, accompanying technology, and systems. Information on training and agency experience with hydrogen facility implementation can be found in this document.	(2020). Fuel Cell Electric Buses Adapting Maintenance Facilities for Hydrogen. 14. Ballard Power Systems Europe A/S
"Foothill Transit Battery Electric Bus Demonstration Results"		
PDF Report	This report compares the performance of Foothill Transit's BEBs to conventional vehicles. It tracks bus performance over time and documents the BEBs' ability to successfully complete Foothill Transit services among other factors. A cost analysis and comparison of the buses is also included in this report. *"In October 2010, Foothill Transit began a demonstration of three Proterra battery electric buses (BEBs) in its service area located in the San Gabriel and Pomona Valley region of Los Angeles County, California. The agency had a goal of evaluating the technology to determine if it could meet service requirements and was feasible for selected Foothill routes. The demonstration went well, and Foothill moved forward with an order of 12 next-generation BEBs. In March 2014, Foothill Transit began operating the new fleet in its service area. These BEBs, produced by Proterra, are 35-ft, composite body buses that are capable of being charged quickly on route."*	https://www.nrel.gov/docs/fy16osti/65274.pdf National Renewable Energy Laboratory All NREL hydrogen and fuel cell-related evaluation reports can be downloaded from the following website: www.nrel.gov/hydrogen/proj_fc_bus_eval.html

Facility Staff Resources – 2

Format Type	Description	Source
"How to Adapt Your Bus Depot to Refuel and Service Hydrogen Fuel Cell Buses"		
Online Article/Blog Post	This article explains how to adapt existing bus depots to refuel and service a fleet of hydrogen fuel cell buses, outlining some of the most important steps in the process.	https://blog.ballard.com/adapting-bus-depots-for-hydrogen Ballard Power Systems
"Providing Training for Zero Emission Buses"		
PDF Report	*"This document is intended for use as a starting point for agencies to tailor training procurement to suit specific needs."* *"The intent of the training defined in this document is to make frontline workers, operators, technicians and related personnel, proficient at their jobs"*	https://www.transportcenter.org/images/uploads/publications/ITLC_ZEB_Report_Final_2-11-2022.pdf (2022). Providing Training for Zero Emission Buses. 32. International Transportation Learning Center
"Preparing to Plug in Your Bus Fleet: 10 Things to Consider"		
PDF Report	*"The purpose of this guide is to identify some of the key areas where electric companies and public transit agencies can work together to streamline the bus fleet electrification process."* *"This guide is organized around 10 key things that public transit agencies that are considering plugging in bus fleets should know about electric companies and fleet electrification."*	https://www.apta.com/wp-content/uploads/PreparingToPlugInYourBusFleet_FINAL_2019.pdf Prepared by the Edison Electric Institute in collaboration with the American Public Power Association, the National Rural Electric Cooperative Association, and the American Public Transportation Association

First Responder Resources – 1

Format Type	Description	Source
"Electric vehicle fires are a threat. Be ready to respond safely."		
Online Trainings	This website offers various trainings, videos, and more to the public on electric vehicle (EV) Fire Safety. The National Fire Protection Association (NFPA) created this site to educate first responders in critical skill sets to avoid EV fire incidents, spread awareness of alternative fuel vehicle (AFV) hazards and provide access to content and instruction for professionals.	https://www.nfpa.org/EV National Fire Protection Association
"CHS First Responders Micro Training Learning Plan"		
Online Training	The Center for Hydrogen Safety (CHS) and AIChe created this site to offer hydrogen safety training in the form of four online multimedia courses to educate first responders and to support the safe handling and use of hydrogen in variety of fuel cell applications. *"The 4-part training will cover four key safety topics: (1) FCEV introduction, (2) FCEV fire response & extrication, (3) hydrogen transport, and (4) hydrogen fueling station incident response."*	https://www.aiche.org/academy/courses/elp001/chs-first-responders-micro-training-learning-plan Center for Hydrogen Safety (CHS) and AIChe
"NFPA 70E: Standard for Electrical Safety in the Workplace"		
Reports	This website lists various documents that support the NFPA 70E requirements for safe work practices to protect personnel by decreasing exposure to major electrical hazards. *"…NYPA 70E helps companies and employees avoid workplace injuries and fatalities due to shock, electrocution, arc flash, and arc blast, and assists in complying with OSHA 1910 Subpart S and OSHA 1926 Subpart K."*	https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=70E National Fire Protection Association

First Responder Resources – 2

Format Type	Description	Source
"Introduction to Hydrogen Safety for First Responders"		
Online course	"This introduction to Hydrogen Safety for First Responders is a Web-based course that provides an 'awareness level' overview of hydrogen for fire, law enforcement, and emergency medical personnel. This multimedia tutorial acquaints first responders with hydrogen, its basic properties, and how it compares to other familiar fuels; hydrogen use in fuel cells for transportation and stationary power; potential hazards; initial protective actions should a responder witness an incident; and supplemental resources including videos, supporting documents, and links relevant to hydrogen safety." This course is broken down into six sections: Hydrogen Basics, Transport and Storage, Hydrogen Vehicles, Hydrogen Dispensing, Stationary Facilities, and Emergency Response.	https://www.aiche.org/academy/courses/ela253/introduction-hydrogen-safety-first-responders Center for Hydrogen Safety and AIChe
"Electric and Hybrid Vehicle Quick Reference: Fire Service Edition"		
Guide/ Info-Sheet	This guide provides steps to conduct an initial scene assessment in order to identify hazards on alternative fuel vehicles (AFVs) as well as warnings and cautions to be aware of when getting into an AFV incident.	https://www.nfpa.org/-/media/Files/Training/AFV/EV-Fire-QR-info-card.ashx National Fire Protection Association

Maintenance Staff Resources – 1

Format Type	Description	Source
"Training Syllabus to Instruct/Prepare for the ASE Transit Bus Electrical/Electronics Test"		
PDF Report	*"This* Recommended Practice *provides guidelines for establishing a standardized bus maintenance training related to the ASE certification program syllabus for the electrical/electronics systems used in transit buses and coaches."*	https://www.transitworkforce.org/resource_library/training-syllabus-to-instruct-prepare-for-the-ase-transit-bus-electrical-electronics-test/ 2016. American Public Transportation Association
"Battery Electric Bus Familiarization Webinars"		
Webinar	*"The Transportation Learning Center presents three distance-based courses to help transit bus technicians gain a fundamental understanding of battery electric bus (BEB) technology. These courses are recorded from live online sessions."*	https://www.transitworkforce.org/resource_library/battery-electric-bus-familiarization-webinars-for-transit-technicians/ Topics: BEB Overview; High Voltage Safety Considerations; Battery Charging Approaches International Transportation Learning Center
"Certified Electric Vehicle Technician (CEVT) Training Program"		
In-Person/Online Hybrid Course	*"The CEVT certificate program has been designed to train a new generation of vehicle specialists to work in electric vehicle production, repair and maintenance. The 16-week training program covers comprehensive topics through lectures and hands-on workshops in advanced electric car theory and practice."*	https://www.cleantechinstitute.org/Training/CEVT.html Clean Tech Institute
"EV Transit Bus Safety Awareness and Familiarization SC-BEV-5000_I"		
In-Person Instructor Facilitated Training	*"This course will provide a general understanding of safety dos and don'ts when working around all-electric high voltage (HV) transit vehicles. This course is not intended as a replacement for manufacturer specific training and does not qualify the student to diagnose, repair, and work on HV vehicles."*	https://www.scrttc.com/courses/ev-transit-bus-safety-awareness-and-familiarization California Transit Training Consortium

Maintenance Staff Resources – 2

Format Type	Description	Source
"Introduction to Troubleshooting Zero Emission Propulsion (ZEPS) SC-ZE-4400-1"		
In-Person Instructor Facilitated Training	*"This 16-hour course will orient participants to bus electrical systems and their safe operation. Participants will learn essential aspects of the high-voltage drive system and low-voltage and chassis grounds."*	https://www.scrttc.com/courses/introduction-and-troubleshooting-zero-emission-propulsion-zeps California Transit Training Consortium
"Digital Volt-Ohm Meter (DVOM) for Electric Buses"		
Online Course	*"The Digital Volt-Ohm Meter (DVOM) self-paced online learning course is designed for mechanics seeking a better understanding of DVOM functions and how to apply and use this tool to assist with electrical diagnosis and problem-solving repairs. "*	https://www.scrttc.com/courses/digital-volt-ohm-meter-dvom-for-electric-buses California Transit Training Consortium
"Introduction to HVAC for Transit SC-eHV-3000-DE-I"		
In-Person/Online Hybrid Course	*"This blended course is designed to introduce the technician to the air conditioning system used on transit vehicles."*	https://www.scrttc.com/courses/introduction-to-hvac-for-transit California Transit Training Consortium
"High Voltage Awareness for Transit"		
Online Course	*"This Course examines high voltage hazards and provides information on how to prevent accidents. Participants will learn about the ratings and categories of Personal Protective Equipment (PPE) and gain the information they need to stay safe in a high voltage environment."*	https://www.scrttc.com/product/high-voltage-awareness-for-transit California Transit Training Consortium

Maintenance Staff Resources – 3

Format Type	Description	Source
"Electrified Transportation Pro+ Training and Certification: Levels 1-3 Program Guide"		
In-Person Course	*"The objective of the Electrified Transportation Pro+ program is to ensure that all individuals across all transportation industries are trained in Electrified Vehicle Systems and Technologies consistently to one standard. The training is completed in preparation to perform the practical and written exams for earning the corresponding Level 1, Level 2, and Level 3 Certifications."*	Program Guide 6/02/2021 Electrified Transportation Pro+ Training and Certification Program
OEM Trainings		
Variable	Trainings offered directly by OEMs have been cited by peer agencies as the most valuable training resource. These trainings can come from the bus manufacturer as well as component manufacturers (HVAC, Fuel Cells, etc.).	Original Equipment Manufacturers (OEMs)
Webinar Series		
Webinar	Webinar series, including *Recruiting and Developing Today's Transit Workforce*, *Fundamentals in Mentoring,* and Online Learning and Learning Technologies.	https://www.transitworkforce.org/resource_library/battery-electric-bus-familiarization-webinars-for-transit-technicians/ Transit Workforce Center

Operation Staff Resources

Format Type	Description	Source
Bus Driver Simulation Training		
Simulator Training	Bus driver training simulations use vivid virtual environments alongside physical bus vehicle components to train drivers on safety, driving skills, fuel economy, and overall efficiency.	https://www.faac.com/simulation-training/transportation/bus-driver-training/ FAAC Commercial
"Bus Operator Workforce Management"		
Report	*"The TRB Transit Cooperative Research Program's pre-publication draft of TCRP Research Report 240: Bus Operator Workforce Management: Practitioner's Guide provides recommendations and resources enabling transit agencies to better assess, plan, and implement their operator workforce management programs. "*	https://nap.nationalacademies.org/read/26842/chapter/1 The Eno Center for Transportation & International Training Learning Center
"Drive to Revive: Preparing Operators for ZEB Deployment"		
PDF Slide Deck	*"As transit agencies integrate zero-emission technologies into their fleet, many are experiencing difficulties in preparing their frontline workforce to properly maintain and operate equipment. In this workshop, panelists explored lessons learned, best practices, and available resources to upskill their operator workforce and prepare the future frontline workers to safely and effectively work with ZEB technologies."*	https://www.transitworkforce.org/wp-content/uploads/2022/12/Drive-to-Revive-12.13-Website-Edit.pdf Transit Workforce Center

Facility Staff Resources – 1

Format Type	Description	Source
"Fuel Cell Electric Buses: Adapting Maintenance Facilities for Hydrogen"		
PDF Report	*"This paper reviews best practices in hydrogen bus maintenance facilities for transit agencies. It includes safety and infrastructure factors transit managers must consider when transitioning to servicing and maintaining fuel cell electric buses."* This paper also explains key properties of hydrogen as well as how to safely interact with the fuel, accompanying technology, and systems. Information on training and agency experience with hydrogen facility implementation can be found in this document.	(2020). Fuel Cell Electric Buses Adapting Maintenance Facilities for Hydrogen. 14. Ballard Power Systems Europe A/S
"Foothill Transit Battery Electric Bus Demonstration Results"		
PDF Report	This report compares the performance of Foothill Transit's BEBs to conventional vehicles. It tracks bus performance over time and documents the BEBs' ability to successfully complete Foothill Transit services among other factors. A cost analysis and comparison of the buses is also included in this report. *"In October 2010, Foothill Transit began a demonstration of three Proterra battery electric buses (BEBs) in its service area located in the San Gabriel and Pomona Valley region of Los Angeles County, California. The agency had a goal of evaluating the technology to determine if it could meet service requirements and was feasible for selected Foothill routes. The demonstration went well, and Foothill moved forward with an order of 12 next-generation BEBs. In March 2014, Foothill Transit began operating the new fleet in its service area. These BEBs, produced by Proterra, are 35-ft, composite body buses that are capable of being charged quickly on route."*	https://www.nrel.gov/docs/fy16osti/65274.pdf National Renewable Energy Laboratory All NREL hydrogen and fuel cell-related evaluation reports can be downloaded from the following website: www.nrel.gov/hydrogen/proj_fc_bus_eval.html

Facility Staff Resources – 2

Format Type	Description	Source
“How to Adapt Your Bus Depot to Refuel and Service Hydrogen Fuel Cell Buses”		
Online Article/Blog Post	This article explains how to adapt existing bus depots to refuel and service a fleet of hydrogen fuel cell buses, outlining some of the most important steps in the process.	https://blog.ballard.com/adapting-bus-depots-for-hydrogen Ballard Power Systems
“Providing Training for Zero Emission Buses”		
PDF Report	*“This document is intended for use as a starting point for agencies to tailor training procurement to suit specific needs.”* *“The intent of the training defined in this document is to make frontline workers, operators, technicians and related personnel, proficient at their jobs”*	https://www.transportcenter.org/images/uploads/publications/ITLC_ZEB_Report_Final_2-11-2022.pdf (2022). Providing Training for Zero Emission Buses. 32. International Transportation Learning Center
“Preparing to Plug in Your Bus Fleet: 10 Things to Consider”		
PDF Report	*“The purpose of this guide is to identify some of the key areas where electric companies and public transit agencies can work together to streamline the bus fleet electrification process.”* *“This guide is organized around 10 key things that public transit agencies that are considering plugging in bus fleets should know about electric companies and fleet electrification.”*	https://www.apta.com/wp-content/uploads/PreparingToPlugInYourBusFleet_FINAL_2019.pdf Prepared by the Edison Electric Institute in collaboration with the American Public Power Association, the National Rural Electric Cooperative Association, and the American Public Transportation Association

First Responder Resources – 1

Format Type	Description	Source
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Online Trainings	This website offers various trainings, videos, and more to the public on electric vehicle (EV) Fire Safety. The National Fire Protection Association (NFPA) created this site to educate first responders in critical skill sets to avoid EV fire incidents, spread awareness of alternative fuel vehicle (AFV) hazards and provide access to content and instruction for professionals.	https://www.nfpa.org/EV National Fire Protection Association
"CHS First Responders Micro Training Learning Plan"		
Online Training	The Center for Hydrogen Safety (CHS) and AIChe created this site to offer hydrogen safety training in the form of four online multimedia courses to educate first responders and to support the safe handling and use of hydrogen in variety of fuel cell applications. *"The 4-part training will cover four key safety topics: (1) FCEV introduction, (2) FCEV fire response & extrication, (3) hydrogen transport, and (4) hydrogen fueling station incident response."*	https://www.aiche.org/academy/courses/elp001/chs-first-responders-micro-training-learning-plan Center for Hydrogen Safety (CHS) and AIChe
"NFPA 70E: Standard for Electrical Safety in the Workplace"		
Reports	This website lists various documents that support the NFPA 70E requirements for safe work practices to protect personnel by decreasing exposure to major electrical hazards. *"…NYPA 70E helps companies and employees avoid workplace injuries and fatalities due to shock, electrocution, arc flash, and arc blast, and assists in complying with OSHA 1910 Subpart S and OSHA 1926 Subpart K."*	https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=70E National Fire Protection Association

First Responder Resources – 2

Format Type	Description	Source
"Introduction to Hydrogen Safety for First Responders"		
Online course	"This introduction to Hydrogen Safety for First Responders is a Web-based course that provides an 'awareness level' overview of hydrogen for fire, law enforcement, and emergency medical personnel. This multimedia tutorial acquaints first responders with hydrogen, its basic properties, and how it compares to other familiar fuels; hydrogen use in fuel cells for transportation and stationary power; potential hazards; initial protective actions should a responder witness an incident; and supplemental resources including videos, supporting documents, and links relevant to hydrogen safety." This course is broken down into six sections: Hydrogen Basics, Transport and Storage, Hydrogen Vehicles, Hydrogen Dispensing, Stationary Facilities, and Emergency Response.	https://www.aiche.org/academy/courses/ela253/introduction-hydrogen-safety-first-responders Center for Hydrogen Safety and AIChe
"Electric and Hybrid Vehicle Quick Reference: Fire Service Edition"		
Guide/ Info-Sheet	This guide provides steps to conduct an initial scene assessment in order to identify hazards on alternative fuel vehicles (AFVs) as well as warnings and cautions to be aware of when getting into an AFV incident.	https://www.nfpa.org/-/media/Files/Training/AFV/EV-Fire-QR-info-card.ashx National Fire Protection Association

Maintenance Staff Resources – 1

Format Type	Description	Source
"Training Syllabus to Instruct/Prepare for the ASE Transit Bus Electrical/Electronics Test"		
PDF Report	*"This* Recommended Practice *provides guidelines for establishing a standardized bus maintenance training related to the ASE certification program syllabus for the electrical/electronics systems used in transit buses and coaches."*	https://www.transitworkforce.org/resource_library/training-syllabus-to-instruct-prepare-for-the-ase-transit-bus-electrical-electronics-test/ 2016. American Public Transportation Association
"Battery Electric Bus Familiarization Webinars"		
Webinar	*"The Transportation Learning Center presents three distance-based courses to help transit bus technicians gain a fundamental understanding of battery electric bus (BEB) technology. These courses are recorded from live online sessions."*	https://www.transitworkforce.org/resource_library/battery-electric-bus-familiarization-webinars-for-transit-technicians/ Topics: BEB Overview; High Voltage Safety Considerations; Battery Charging Approaches International Transportation Learning Center
"Certified Electric Vehicle Technician (CEVT) Training Program"		
In-Person/Online Hybrid Course	*"The CEVT certificate program has been designed to train a new generation of vehicle specialists to work in electric vehicle production, repair and maintenance. The 16-week training program covers comprehensive topics through lectures and hands-on workshops in advanced electric car theory and practice."*	https://www.cleantechinstitute.org/Training/CEVT.html Clean Tech Institute
"EV Transit Bus Safety Awareness and Familiarization SC-BEV-5000_I"		
In-Person Instructor Facilitated Training	*"This course will provide a general understanding of safety dos and don'ts when working around all-electric high voltage (HV) transit vehicles. This course is not intended as a replacement for manufacturer specific training and does not qualify the student to diagnose, repair, and work on HV vehicles."*	https://www.scrttc.com/courses/ev-transit-bus-safety-awareness-and-familiarization California Transit Training Consortium

Maintenance Staff Resources – 2

Format Type	Description	Source
"Introduction to Troubleshooting Zero Emission Propulsion (ZEPS) SC-ZE-4400-1"		
In-Person Instructor Facilitated Training	*"This 16-hour course will orient participants to bus electrical systems and their safe operation. Participants will learn essential aspects of the high-voltage drive system and low-voltage and chassis grounds."*	https://www.scrttc.com/courses/introduction-and-troubleshooting-zero-emission-propulsion-zeps California Transit Training Consortium
"Digital Volt-Ohm Meter (DVOM) for Electric Buses"		
Online Course	*"The Digital Volt-Ohm Meter (DVOM) self-paced online learning course is designed for mechanics seeking a better understanding of DVOM functions and how to apply and use this tool to assist with electrical diagnosis and problem-solving repairs. "*	https://www.scrttc.com/courses/digital-volt-ohm-meter-dvom-for-electric-buses California Transit Training Consortium
"Introduction to HVAC for Transit SC-eHV-3000-DE-I"		
In-Person/Online Hybrid Course	*"This blended course is designed to introduce the technician to the air conditioning system used on transit vehicles."*	https://www.scrttc.com/courses/introduction-to-hvac-for-transit California Transit Training Consortium
"High Voltage Awareness for Transit"		
Online Course	*"This Course examines high voltage hazards and provides information on how to prevent accidents. Participants will learn about the ratings and categories of Personal Protective Equipment (PPE) and gain the information they need to stay safe in a high voltage environment."*	https://www.scrttc.com/product/high-voltage-awareness-for-transit California Transit Training Consortium

Maintenance Staff Resources – 3

Format Type	Description	Source
"Electrified Transportation Pro+ Training and Certification: Levels 1-3 Program Guide"		
In-Person Course	*"The objective of the Electrified Transportation Pro+ program is to ensure that all individuals across all transportation industries are trained in Electrified Vehicle Systems and Technologies consistently to one standard. The training is completed in preparation to perform the practical and written exams for earning the corresponding Level 1, Level 2, and Level 3 Certifications."*	Program Guide 6/02/2021 Electrified Transportation Pro+ Training and Certification Program
OEM Trainings		
Variable	Trainings offered directly by OEMs have been cited by peer agencies as the most valuable training resource. These trainings can come from the bus manufacturer as well as component manufacturers (HVAC, Fuel Cells, etc.).	Original Equipment Manufacturers (OEMs)
Webinar Series		
Webinar	Webinar series, including *Recruiting and Developing Today's Transit Workforce*, *Fundamentals in Mentoring,* and Online Learning and Learning Technologies.	https://www.transitworkforce.org/resource_library/battery-electric-bus-familiarization-webinars-for-transit-technicians/ Transit Workforce Center

Operation Staff Resources

Format Type	Description	Source
Bus Driver Simulation Training		
Simulator Training	Bus driver training simulations use vivid virtual environments alongside physical bus vehicle components to train drivers on safety, driving skills, fuel economy, and overall efficiency.	https://www.faac.com/simulation-training/transportation/bus-driver-training/ FAAC Commercial
"Bus Operator Workforce Management"		
Report	*"The TRB Transit Cooperative Research Program's pre-publication draft of TCRP Research Report 240: Bus Operator Workforce Management: Practitioner's Guide provides recommendations and resources enabling transit agencies to better assess, plan, and implement their operator workforce management programs. "*	https://nap.nationalacademies.org/read/26842/chapter/1 The Eno Center for Transportation & International Training Learning Center
"Drive to Revive: Preparing Operators for ZEB Deployment"		
PDF Slide Deck	*"As transit agencies integrate zero-emission technologies into their fleet, many are experiencing difficulties in preparing their frontline workforce to properly maintain and operate equipment. In this workshop, panelists explored lessons learned, best practices, and available resources to upskill their operator workforce and prepare the future frontline workers to safely and effectively work with ZEB technologies."*	https://www.transitworkforce.org/wp-content/uploads/2022/12/Drive-to-Revive-12.13-Website-Edit.pdf Transit Workforce Center

CCRTA Subgroup	ZEB Skill Subcategory	CCRTA Current Skills	ZEB Intro Skills	ZEB Basic Skills	ZEB Advanced Skills	ZEB Expert Skills
Maintenance Staff	Goals	No High Voltage Training Service ICE Buses	High Voltage Awareness Training Trained in basics of ZEB-specific systems & components Service non-HV Systems on ZEBs	High Voltage Training Safely Disable HV Systems Service HV Systems on ZEBs	High Voltage Training Safely Disable HV Systems Service HV Systems on ZEBs Diagnose HV System Issues on ZEBs	High Voltage Safety Trainer Expert in OEM Diagnostics and Software
	Low Voltage (LV) Batteries and Charging	•Perform LV battery state-of -charge determine service •Perform LV battery capacity (load, high-rate discharge) test determine service needed •Maintain or restore electronic memory functions •Inspect, clean LV battery cables, connectors, clamps, and hold -downs, repair as needed •Start vehicle using jumper cables and a battery or auxiliary power supply.	•Understand vehicle battery schematic symbols •Read vehicle battery schematic diagrams •Utilizes shock protection tools and equipment when required	• Inspect, repair, and replace the DC-DC Converter		
	High Voltage (HV) Batteries and Charging		•Understand HV vehicle battery schematic symbols •Read vehicle battery schematic diagrams •HV System Awareness, including labels, color coding, and which ZEB parts are HV •Understand OEM HV lock out tag out procedures • Proper use and knowledge of specific high voltage PPE, including 1,000 volt gloves and fire protective •Identify high voltage systems within FCEBs and BEBs (batteries, high voltage junction box, inverter, traction motor, power steering, HVAC, air compressor, fuel cell, thermal battery management system) •Jump-start bus with jumper cables •Jump-start bus with other power supply	•Basic exposure with OEM Energy Storage System software and interface tool •Perform HV battery load and capacity tests •Check the HV battery box for cracks •Check HV batteries for coolant leak •Check HV battery coolant levels •HV Disconnect training, including Manual Service Disconnect training with live-dead-live checks, required PPE, and safety protocols •Safely disconnect the HV batteries for replacement	• Inspect rooftop/rear HV battery packs •Inspect ESS cooler condenser •Inspect HV battery pack •Inspect insulation monitoring device •Use OEM diagnostic software to confirm, diagnose, and apply corrective action to ESS / battery management faults •Disconnect axel or drive shaft from battery pack when towing •Diagnose and repair Battery Management Controller fuses, relays, and control boards •Remove ESS from vehicle •Diagnose and repair ESS end of life condition	• Become an OEM ESS diagnostic software expert
	Electrical / Multiplexing	•Use wiring diagrams during diagnosis of electrical circuit problems •Check electrical circuits with a volt meter, determine needed repairs •Check voltages and voltage drops in electrical / electronic circuits using a volt meter •Check current flow in electrical /electronic and components using a volt meter •Check electrical circuits using a jumper wires •Find shorts, grounds, open, and high resistance problems in electrical /electronic circuits •Measure and diagnose the cause of abnormal key-off battery drain •Inspect and test fusible links circuits breakers, and fuses, replace as needed •Inspect and test switches, connectors, and wires of electronic / electrical circuits and repair •Diagnose the cause of intermittent, high, low or no gauge readings •Test gauge circuit voltage regulators (limiters) replace as needed •Inspect and test gauges and gauge sending units, replace as needed •Inspect and test connectors, wires, and printed circuits boards of gauge circuits and repair •Diagnose intermittent, high, low or no reading on electronic digital instrument clusters •Test sensors, sending units, connectors and wires of electronic digital instrument circuits	•Understand symbols used in schematic / ladder diagrams •Read single-circuit electrical schematic / ladder diagrams •Identify electrical components on the bus from a wiring diagram •Describe the difference between digital and analog signals •Understand the difference between fluke digital multimeters vs. clamp digital multimeters •Convert between volts and millivolts •Properly use current clamps •Use an Ohmmeter to troubleshoot a CAN, specific to HV systems •Understand factors influencing Ohmmeter readings •Understand the risks associated with high voltage (arc flash, thermal runaway) •Understand the basic principles behind voltage, current, resistance, and Ohm's law •Identify high voltage systems within FCEBs and BEBs (batteries, high voltage junction box, inverter, traction motor, power steering, HVAC, air compressor, fuel cell, thermal battery management system) •OEM high voltage lock out tag out procedures and necessary PPE	•De-energize the high voltage system / Follow OEM voltage shutdown procedures •Disconnect manual service disconnect prior to removing or installing electrical components •Use wiring diagrams to troubleshoot ZEB-specific electrical problems •Use wiring diagrams to assemble ZEB-specific electrical equipment •Use digital multimeters to check ZEB-specific circuit voltage amperage and resistance •Understand factors that influence LV and HV system voltage drops/spikes •Use LEDs to confirm LV system continuity and confirm CAN signals •Understand how to remove somebody from an arc flash situation •OEM high voltage lock out tag out procedures and necessary PPE •Test semiconductor diodes using diode test •Inspect, repair, or replace control rack •Explain the functions of the multiplex controller •Identify symbols used for multiplexing inputs and outputs •Use ladder logic/schematic diagrams to troubleshoot a multiplex system •Use on and off board multiplexing diagnostic tools •Inspect, troubleshoot, and replace remote I/O blocks •Replace gateway module •Understand the types of faults in an electrical power system and their impacts •Inspect low voltage distribution box •Inspect HV AC Compressor •Inspect HV Heater •Inspect, repair, and replace HV connections •Monitor ESS Cooling System	•Diagnose condition of HV fuses, circuit breakers, and switches •Measure and troubleshoot HV circuits •Inspect and troubleshoot the main controller and power management system modules •Know how to use Megohmmeters to determine HV wire insulation condition •Replace HV current limiters •Inspect HV cables (accessory cables included) •Understand how to use an oscilloscope to analyze waveform of electrical •Repair and replace HV cables covers •Inspect auxiliary power distribution box (DC-DC converter) •Inspect HV distribution boxes •Inspect Roof Top Electronics Enclosure •Maintain fire suppression electrical systems •Use OEM diagnostic software to confirm, diagnose, and apply corrective action to HV and LV faults •Accurately follow OEM HV maintenance procedures •Diagnose and repair High Voltage Interlock Loop (HVIL) problems •Diagnose CAN and other applicable network errors and faults •Explain the purpose of a Transient Voltage Suppression (TVS) diode or Y-capacitors •Test a TVS diode	
	Propulsion / Transmission / Braking	•Perform starter current draw and circuit voltage drop test, determine needed repairs •Inspect and test starter relays and solenoids, replace as needed •Remove and replace/ reinstall starter •Perform starter free-running (bench) test, determine needed repairs •Interpret and verify complaint, determine needed repairs •Inspect engine assembly for fuel, oil, coolant, and other leaks, determine repairs •Diagnose the cause of unusual engine noise or vibration problems, determine repairs •Diagnose the cause of unusual exhaust color, odor, and sound, determine action •Perform engine absolute (vacuum/boost) manifold pressure test, determine repairs •Perform cylinder power balance test, determine needed action •Perform cylinder compression test, determine needed action •Perform cylinder leakage test, determine needed action •Diagnose engine mechanical, electrical, electronic, fuel, and ignition problems •Diagnose emissions problems resulting from failure of computerized engine controls •Perform analytic/diagnostic procedures with on-board diagnostic computer systems •Inspect/test engine sensors, controls, actuators components and engine control systems •Obtain and interpret digital multimeter (DMM) readings •Read and interpret technical information •Located and interpret vehicle (VIN, vehicle certification labels and calibration decals) •Inspect and test power and ground circuits and connections, service or replace •Practice recommended precautions when handling static sensitive devices •Inspect, test, service wire harness connectors and wire taps •Diagnose no-starting, hard starting, engine misfire, poor drivability, spark knock, power loss, poor mileage, and emissions problems on vehicles with electronic ignition systems •Inspect and test ignition primary circuit wiring and components, repair or replace as needed •Inspect and test ignition secondary circuit wiring and components, replace as needed •Inspect and test ignition coils, replace as needed •Inspect and test ignition wiring harness and connectors, replace as needed •Inspect and test ignition system pick-up sensors or triggering devices, replace as needed •Inspect and test ignition control module, replace as needed •Diagnose hot or cold no-starting, hard starting, poor idle, flooding, hesitation, surging engine misfire, power loss, stalling, poor mileage, and emissions problems •Inspect and replace fuel tank, fuel cap, fuel lines, fittings, and hoses •Check fuel for contaminants and quality •Inspect and test mechanical and electrical fuel pumps and pump control systems •Replace fuel filters •Inspect/test fuel pressure regulation system and components of injection type fuel systems •Inspect and test fuel injectors, clean or replace as needed •Inspect throttle body mounting, air induction, filtration system, intake manifold, gaskets •Check / adjust idle speed and fuel mixture where applicable •Inspect, and test vacuum and electrical components and connections of fuel system •Inspect exhaust manifold, exhaust pipes, mufflers, resonators, tail pipes, and heat shields •Diagnose cause(s) of emissions problems, from failure of crankcase ventilation system •Inspect and test positive crankcase ventilation (PCV) filter/breather cap, valve, tubes, orifices, and hoses, service or replace as needed •Diagnose cause(s) of emission problems resulting from failure of the spark/timing system •Inspect and test circuits of spark timing control systems, replace as needed •Diagnose cause(s) of emissions problems resulting from failure of the idle and deceleration speed control system •Inspect and test wiring, hoses, and components of idle speed control system, adjust or replace as needed •Adjust valves on engines with mechanical or hydraulic lifters. •Verify correct camshaft timing; determine needed action. •Verify engine operating temperature; determine needed action. •Perform cooling system pressure tests; check coolant condition; inspect and test radiator •Inspect and test thermostat, by-pass, and housing; replace as needed. •Inspect and test mechanical/electrical fans, fan clutch, fan shroud/ducting, and fan control devices; service or replace as needed.	•Describe a relay •Describe a switch •Describe a contactor •Describe a solenoid •Understand the basics of electric propulsion •Understand the relationship between an electric current and a magnetic field •Understand the difference between a temporary magnet and a permanent magnet •Describe the power flow from the DC battery to three-phase AC motor • Understanding how regenerative braking works • Know regenerative braking settings • Understand OEM-specific performance inhibiting factors (cold weather, fuel cell output, low SOCs) • Understand OEM-specific preventative maintenance program • Understand ZEB towing procedure • Understand unique ZEB transmissions	•Regularly lubricate motor bearings •Grease/lubricate traction motor fittings •Inspect coolant lines for leaks •Inspect coolant lines for proper tightness •Perform voltage drop tests on starter circuits using tester unit •Basic exposure with OEM powertrain software and dongle attachment •Identify relays, switches, contactors, and solenoids in the propulsion electronics •Demonstrate use of hot stick and follow safety requirements for two-person jobs •Work safely with HV cables	•Inspect, test, and replace relays •Inspect, test, and replace switches / contactors •Inspect, test, and replace solenoids •Use ammeter to inspect motor •Inspect traction motor inverter •Inspect power steering (hydraulic power is generated electrically) •Use OEM Powertrain diagnostic software to confirm, diagnose, and apply corrective action to powertrain faults •Check torque at power cables to the electric motor •Disconnect axel or drive shaft from battery pack when towing • Correctly follows procedures for washing electric propulsion systems • Use OEM schematics to determine fault in Propulsion system • Diagnoses and repair speed, temperature sensors associated with the motor • Diagnoses and repair stator problems • Inspect, maintain and repair regenerative braking function	•Become an OEM powertrain diagnostic software expert

CCRTA Subgroup	ZEB Skill Subcategory	CCRTA Current Skills	ZEB Intro Skills	ZEB Basic Skills	ZEB Advanced Skills	ZEB Expert Skills
	HVAC		•Understand why properly working HVAC systems are more important for ZEBs • Asses HVAC coolant with a refractometer • Understand heat pump technology •Monitor HVAC cycling	•Inspect HV AC Compressor •Inspect HV Heater •Inspect, repair, and replace HV connections • Monitor cell temperatures •Monitor ESS Cooling System		
	Charging	•Diagnose charging system problems that cause an undercharge, no-charge or an overcharge condition. •Inspect and adjust alternator drive belts, replace as needed •Inspect and test voltage regulator, replace as needed •Disassemble, clean, and test alternator components, replace as needed	•Check and adjust voltage regulator set points •Replace voltage regulators •Inspect electrically operated air equipment • Understand OEM-specific setting for cabin and HVAC preconditioning • Understand DC-fast charge charge curve • Understand the difference between AC and DC charging	•Inspect overall charging system operation •Inspect and repair connectors and wires in charging circuits •Diagnose charging systems using fault tree chart •Inspect and troubleshoot power supply •Diagnose circuit malfunctions (short circuits, grounded circuits and open circuits)	•Differentiate between software and hardware bus-charger malfunctions	
	Fuel Cell System / CNG System	•Interpret and verify complaint; determine needed repairs. •Analyze symptoms and perform diagnostic procedures on vehicles with supplemental on-board diagnostic computer support systems. •Diagnose and repair intermittent or complete failure of electric, electronic or mechanical devices (e.g., hour meters, fuel level indicators, fuel selection devices). •Check all fuel system components to include fuel lock-off, valves, solenoids, manual shutoff, connections, fittings, hoses, and tubing leaks. •Diagnose the cause of abnormal fuel flow through fuel carrying component •Diagnose the cause of fuel odor or fuel loss by inspecting or testing fuel supply system components such as valves, fuel supply container, pressure relief device (PRD), tubing and hoses; repair or replace as needed. •Diagnose the cause of inaccurate fuel level indicator reading; adjust, repair •Diagnose hot or cold no-starting, hard starting, poor drivability, incorrect idle speed, poor idle, flooding, hesitation, surging, engine misfire, power loss, stalling, poor mileage, and lean or rich mixture problems on vehicles with variable or fixed venturi type fuel systems; determine needed repairs. •Inspect and test cold enrichment system components; adjust or replace as needed. •Inspect and test fuel injectors; service or replace as needed. •Inspect and test vacuum and electrical components and connections of fuel system; repair or replace as needed. •Perform diagnostic procedures on vehicles with on-board computer/electronic fuel system support. •Follow manufacturer's maintenance schedule to ensure fluids and lubricants are at proper levels and serviced with recommended products. •Identify the process of recertification or replacement of fuel supply container(s) according to most current regulations (e.g., NGV-2, DOT); complete documentation; remove and replace fuel supply container, if required. •Inspect fuel supply container(s) and brackets as it relates to certification: data plate, working pressures, fuel supply container damage, valves, bolts, torque specifications, and all sealing and venting equipment. •Inspect air filters and fuel filter; service or replace as needed. •Inspect and ensure that all required emission control devices are present and functional. •Inspect, adjust, and test manual shut-off valve, service valve, check-valves, and solenoid valves; repair or replace as needed	•Understand the high-level chemical reaction that takes place within the fuel cell •Never open or tighten high pressure components without venting hydrogen and verifying psig is below 10 •Regularly inspect gas tubing for rubbing and pinch points •Be aware of fuel cell lockout procedures before servicing the bus •Understand what can damage the fuel cell stacks (closing fuel shut off valve during operation damages stacks; oil and grease; temperatures below 41 F) •Understand steps to safely service a fuel cell	•Vent (depressurize) and purge the fuel storage system •Clean the fuel cell stack and other fuel cell components •Monitor/check fuel cell voltage and check connections •Check ground fault monitor and perform ground integrity tests •Replace de-ionizing filter •Check stack vent fans •Inspect water traps •Inspect roof vents •Inspect pressure relief devices and tank isolation valves •Inspect high pressure regulator •Inspect cylinder mountings •inspect lines and fittings •Inspect air system oil detector •Inspect hydrogen diffuser •Inspect burst disk vent cap •Perform leak-down test •Perform fuel delivery circuit leak test •Regularly inspect gas tubing for rubbing and pinch points •Inspect gaseous storage tanks for malformations or cracks •Inspect fuel cell coolant levels and replace fuel cell coolant •Basic exposure with OEM fuel cell diagnostics tool	•Remove fuel cell stack •Use OEM diagnostic software to confirm, diagnose, and apply corrective action to fuel cell system faults •Perform fuel cell leak tests •Perform glycol system integrity test •Perform circuit leak tests •Replace hydrogen particulate filter •Compare fuel pressure transducer readings •Check the motive pressure regulator solenoid valve •Perform cylinder internal and external inspection •Inspect, repair, and replace fuel cell air compressors •Replace pressure regulator diaphragm •Perform fire suppression system tests •Demonstrates the ability to correctly fabricate/bend replacement lines with proper fittings	•Become an OEM fuel cell diagnostic software •Replace fuel cell stack
Operators	ZEB Education and Safety		•Zero-emission technology overview •Awareness of high voltage systems •High voltage exposure warning emergency response procedure			
	Bus Operation		•Regenerative braking and friction-based braking overview •HVAC significance •Remaining operating time •Technological limitations (Fuel Cell output vs. Input) •Turn off 12/24VDC battery disconnect for the bus and apply a multi-lockout device •Fueling a FCEB •Driving feel under various levels of regenerative braking •Optimal driving habits to maximize regenerative braking •Bus docking for on-route charging (BEB only) •Start up / shut down procedures (including inspections) •Decreased noise implications on shut off procedures and pedestrians			

CORPUS CHRISTI REGIONAL
TRANSPORTATION AUTHORITY

Board of Directors Meeting Memo March 1, 2023

Subject: January 2023 Financial Report

Overview: The results from the **operating budget** for the **month** of **January** report **Expenses** in excess of **Revenues** by **$540,566.** Operating revenues totaled **$3,182,037,** representing 100.60% of the budget baseline, while operating expenses finished at **$3,722,603**, or 100.92% of baseline.

The CIP budget for the **month** of January reports grant revenues of $137,226, which includes the 80% federal share from phase II of the bus public Wi-Fi and automatic vehicle location (AVL) project, a Cat forklift for the vehicle maintenance department, and costs associated with phase VII of the bus stop improvements program. In addition to the grant funding, a budgeted transfer-in of $304,129 from fund balance was used to fund the capital program, bringing total capital funding for the month to **$441,355**. Meanwhile, January expenditures totaled **$288,414** and consists of the $137,226 for the grant eligible costs plus the depreciation expense of $151,188 which rendered a positive variance of **$152,941**.

The overall performance for the **month** results in an initial decrease of **$387,625** to the fund balance with a reduction of $540,566 attributable to the operating budget**,** and an increase of $304,129 related to the CIP budget. The increase of **$304,129** represents one-twelfth of the 2023 Budget that allowed a transfer in of **$3,649,552** from reserves. The final decrease in fund balance totaled **$691,754** when you factor in the incoming transfer from fund balance.

This information is presented in greater detail in the financial reports located at the end of this document.

SUMMARY: <u>Results from all Activities Compared to Budget</u>

Total Revenues for the month of **January** closed at **$3,623,392**, of which $3,182,037 is attributable to the **Operating Budget (Table 4 and PPT Slides 3 and 4)** and $441,355 to the capital budget. The performance from the revenue categories from the Operating Budget are discussed as follows.

Operating Revenues, which include only resources generated from transit operations, **totaled $121,261,** or **$1,637** more than forecasted **(Table 4.1) & (PPT Slide 5). Fare Revenues** ended the month at 96.67% of the baseline expectation. Meanwhile, commissions from **Bus and Bench Advertising** ended the month at $16,823, or 138.87**%** of baseline. Note that the revenue earned from **Bus and Bench Advertising** is net of the portion paid to the City of Corpus Christi, which collects one-third (1/3) of the Authority's share of bench advertising commission for the use of City property. **Other Operating Revenues** totaled $15,169, or 100% of baseline, which includes an adjustment to align with the receipt of the federal CNG fuel credit that comprises the majority of this category's budget expectation. **(Table 4.1).**

Non-Operating Revenues, which **includes** sales tax, investment income, lease income from tenants, and federal assistance grants totaled **$3,060,776**, reaching **100.57%** of the **$3,043,429** budget expectation, generating **$17,347** more than forecasted **(Table 4.1)**. Federal operating grant assistance missed the baseline as the annual preventive maintenance grant funding has not yet been received. Meanwhile, investment income continues to perform well against the budget as a result of the higher yields earned due to the Federal Reserve's increases to the federal funds rate. Staples Street Center lease income reached 99.38% of baseline, though future periods may present a shortfall as a tenant moved out in January (Nueces River Authority).

For clarification, please keep in mind that all revenues reported are **actual** revenues received or earned with the exception of the sales tax revenue. The Sales Tax Revenue, has been **estimated** since the amount will not be determined until payment is received on **March 10, 2023**. Out of the seven (7) sources included in this revenue category, 88.66% of total revenue came from the sales tax revenue estimate as indicated in the table on the following page:

January 2023 Revenue Composition – Table 1

Line #	Revenue Source	Actual	%
1	Sales Tax Revenue	2,821,289	88.66%
2	Passenger Service	89,269	2.81%
3	SSC Lease Income	43,550	1.37%
4	Bus Advertising	16,823	0.53%
5	Investment Income	195,937	6.16%
6	Grant Assistance Revenue	-	0.00%
7	Other Revenue	15,169	0.48%
	Total (excluding capital)	**$3,182,036**	**100.00%**

The **Investment Portfolio** closed the month of January 2023 with a market value of **$56,320,715**, a decrease of **$3,435,589** from the balance at the end of December 2022 of **$59,738,304.** The decrease is primarily due to the cash outlay resulting from the annual contribution of $1,330,108 to the RTA Employee Defined Benefit Plan, along with payments made to Tolar for bus shelters totaling $668,400. The payments to Tolar are part of the American Rescue Plan (ARP) grant, and while apportioned, have not yet been allocated but funding is expected sometime in March 2023. The total unreimbursed funds for the Tolar shelters as of January 31, 2023 amount to $2,677,226.

The January market value of **$56,302,715** consists of **$32,187,854** in short-term securities consisting of **$9,770,408** in Commercial Paper, **$19,467,816** in Federal Agency Coupon Securities, and **$2,949,630** in Treasury Discounts, while **$21,774,662** is held in TexPool Prime and **$3,270,506** in bank accounts. For the month of **January**, earned interest income was recorded at **$195,937.**

This investment portfolio does not include any assets from pension plans but only assets from operations.

The **Sales tax** allocation for January 2023 is ***estimated*** at **$2,821,289**. The estimate is necessary since allocations lag two months behind and will not be received until March 10, 2023.

The Sales Tax revenue payment of **$3,868,927** for December 2022 was received February 10, 2023 and was **$391,704**, or **11.26%** more than the **$3,477,223** December reported **estimate**. The year to date sales tax revenue recorded through December 2022 is **$34,482,167** and represents an increase of **$1,332,671** over the same period last year or **3.59% growth**. The December payment included the allocation from internet sales of **$41,925**, an increase of $1,585 or 3.93% from the prior month. RTA started receiving internet sales tax revenue in December 2019, and to date have received **$1,064,463**. Retailers started collecting sales tax on internet sales October 1, 2019.

The sales tax revenue over the last five years' averages to 74.92% of total income. In 2022, Sales Tax Revenue represented 69.71% of total revenues. Sales tax typically represents the largest component of CCRTA's total income, however there are several factors that can cause fluctuations from year to year. Although sales tax revenue is related to economic conditions, other factors such as the amount of revenues from other sources and capital improvement plans do come into play. During this reporting period sales tax represented 88.66% of total operating revenues. **Table 2** illustrates the sales tax revenue trend from the beginning of the year.

Transparency Disclosure

The sales tax revenue reported as 2022 Actual is higher than what is reported by the state comptroller's website. The difference represents the $27,374 that is deducted by the state comptroller each month as repayment of $1,177,082 that occurred in December 2019 as a result of an audit. The repayment is over 43 months and as of December have made 26 installments. This amount is added back in order to calculate the growth rate when compared to the same period last year.

Sales Tax Growth – Table 2

Month Revenue was Recognized	2022 Actual	2021 Actual	$ Growth	% Growth
January (actual)	2,700,560	$ 2,497,985	202,575	8.11%
February (actual)	2,726,132	2,333,543	392,589	16.82%
March (actual)	3,504,497	3,774,978	(270,481)	-7.17%
April (actual)	3,074,059	3,006,523	67,536	2.25%
May (actual)	3,067,990	3,041,775	26,215	0.86%
June (actual)	3,483,166	3,445,918	37,248	1.08%
July (actual)	3,326,242	3,012,974	313,268	10.40%
August (actual)	3,220,185	2,928,381	291,804	9.96%
September (actual)	3,341,572	3,343,477	(1,905)	-0.06%
October (actual)	3,090,741	2,857,364	233,377	8.17%
November (actual)	3,078,095	3,110,009	(31,914)	-1.03%
December (estimate)	3,868,927	3,796,568	72,359	1.91%
	$ 38,482,167	**$ 37,149,496**	**$ 1,332,671**	**3.59%**

The detail of all revenue and expense categories are presented in the following tables, along with the fare recovery ratio for January 2023:

Revenue – January 2023 – Revenue Composition (Includes Operating and Capital Funding) – Table 3

Revenue Source	January 2023	%	YTD	%
Passenger Service	$ 89,269	2.69%	$ 89,269	2.69%
Bus Advertising	16,823	0.51%	16,823	0.51%
Other Revenue	15,169	0.46%	15,169	0.46%
Sales Tax Revenue	2,821,289	85.00%	2,821,289	85.00%
Grants - Operating	-	0.00%	-	0.00%
Grants - Capital	137,226	4.13%	137,226	4.13%
Investment Income	195,937	5.90%	195,937	5.90%
SSC Lease Income	43,550	1.31%	43,550	1.31%
Total Revenue	**$ 3,319,262**	**100.00%**	**$ 3,319,262**	**100.00%**

Revenue – January 2023 Operating Revenue and Capital Funding – Table 4

			01/2023		
	2023 Adopted Budget	January 2023 Actual	Baseline into Budget	% Actual to Budget	% Actual to Baseline
Revenues					
Passenger service	$ 1,108,110	$ 89,269	$ 92,343	8.06%	96.67%
Bus advertising	145,371	16,823	12,114	11.57%	138.87%
Other operating revenues	312,337	15,169	15,169	4.86%	100.00%
Sales Tax Revenue	39,793,301	2,821,289	2,821,289	7.09%	100.00%
Federal, state and local grant assistance	1,565,828	-	130,486	0.00%	0.00%
Investment Income	574,000	195,937	47,833	34.14%	409.62%
Staples Street Center leases	525,850	43,550	43,821	8.28%	99.38%
Total Operating & Non-Operating Revenues	**44,024,797**	**3,182,037**	**3,163,055**	**7.23%**	**100.60%**
Capital Grants & Donations	8,864,316	137,226	137,226	1.55%	100.00%
Transfers-In	3,649,552	304,129	304,129	8.33%	100.00%
Total Operating & Non-Operating Revenues and Capital Funding	**$ 56,538,665**	**$ 3,623,392**	**$ 3,604,410**	**6.41%**	**100.53%**

Revenue – January 2023 From Operations – Table 4.1

			01/2023		
	2023 Adopted Budget	January 2023 Actual	Baseline into Budget	% Actual to Budget	% Actual to Baseline
Revenues					
Passenger service	$ 1,108,110	$ 89,269	$ 92,343	8.06%	96.67%
Bus advertising	145,371	16,823	12,114	11.57%	138.87%
Other operating revenues	312,337	15,169	15,169	4.86%	100.00%
Total Operating Revenues	**1,565,818**	**121,261**	**119,625**	**7.74%**	**101.37%**
Sales Tax Revenue	39,793,301	2,821,289	2,821,289	7.09%	100.00%
Federal, state and local grant assistance	1,565,828	-	130,486	0.00%	0.00%
Investment Income	574,000	195,937	47,833	34.14%	409.62%
Staples Street Center leases	525,850	43,550	43,821	8.28%	99.38%
Total Non-Operating Revenues	**42,458,979**	**3,060,776**	**3,043,429**	**7.21%**	**100.57%**
Total Revenues	**$ 44,024,797**	**$ 3,182,037**	**$ 3,163,054**	**7.23%**	**100.60%**

January 2023 Expenses

The results of all expenditure activities, including capital, are presented below. Overall the total operating expenses came in $34,037 over the anticipated baseline of $3,688,566. Departmental expenses came in $97,857 over the anticipated baseline or 2.91%. Debt service payments are fixed by the terms of the bond contract which is the reason for the resulting 0% actual to baseline. Street Improvements is also a fixed amount that represents one-twelve of the annual amount budgeted for all member cities, resulting 100% of baseline.

January 2023 Total Expenses & Capital Expenditures – Table 6

	2023 Adopted Budget	January 2023 Actual	01/2023 Baseline into Budget	% Actual to Budget	% Actual to Baseline
Expenditures					
Departmental Operating Expenses	$ 40,313,484	$ 3,457,314	$ 3,359,458	$ 8.58%	102.91%
Debt Service	1,597,313	-	-	0.00%	0.00%
Street Improvements	3,183,464	265,289	265,289	8.33%	100.00%
Subrecipient Grant Agreements	765,828	-	63,819	0.00%	0.00%
Total Operating & Non-Operating Expenses	**45,860,089**	**3,722,603**	**3,688,566**	**8.12%**	**100.92%**
Grant Eligible Costs	8,864,316	137,226	137,226	1.55%	100.00%
Depreciation Expenses	1,814,260	151,188	151,188	8.33%	100.00%
Total Operating & Non-Operating Expenses and Capital Expenditures	$ **56,538,665**	$ **4,011,017**	$ **3,976,980**	**7.09%**	**100.86%**

EXPENSES – REPORTED BY EXPENSE OBJECT CATEGORY

The **Financial Accounting Standards Board (FASB**) requires expenses to be reported by object category which include expenses that can be traced back to a specific department and or activity. It excludes depreciation expenses, expenses associated with the Street Improvement Program, debt service expenses, and pass through activities (Sub-recipients).

Accordingly, for the month of January 2023, total departmental operating expenses realized favorable variances against the baseline expectation in categories including Services, Utilities, Insurance, Purchased Transportation, and Miscellaneous. Meanwhile, unfavorable variances were identified with the categories of Salaries & Wages, Benefits, and Materials & Supplies.

Salaries & Wages ended the month at 102.29% of baseline, or $28,221 over budget.

Benefits ended the month at 169.08% of baseline, or $313,240 over budget. This significant variance comes as a result of a high-dollar claim against the Authority's healthcare self-insurance plan. The claim in the amount of $297,264 is for a single claim and triggers the plan's stop loss policy, which will reimburse the Authority for costs in **excess of $65,000.** The excess of **$232,264** will offset this expense when received.

Services ended the month at 102.95% of baseline, or $7,878 over budget, primarily due to the timing of invoices for professional services agreements.

January 2023 Departmental Expense Breakdown – Table 7.1

	2023 Adopted Budget	January 2023 Actual	01/2023 Baseline into Budget	% Actual to Budget	% Actual to Baseline
Departmental Operating Expense Object Category					
Salaries & Wages	$ 14,794,668	$ 1,261,111	$ 1,232,889	8.52%	102.29%
Benefits	5,441,013	766,658	453,418	14.09%	169.08%
Services	5,698,190	306,580	474,849	5.38%	64.56%
Materials & Supplies	3,202,967	274,791	266,914	8.58%	102.95%
Utilities	802,906	62,999	66,909	7.85%	94.16%
Insurance	648,227	46,823	54,019	7.22%	86.68%
Purchased Transportation	8,765,945	695,542	730,495	7.93%	95.22%
Miscellaneous	959,568	42,810	79,964	4.46%	53.54%
Total Departmental Operating Expenses	**$ 40,313,484**	**$ 3,457,314**	**$ 3,359,457**	**8.58%**	**102.91%**

2023 Self-Insurance Claims, Medical & Vision and Dental – Table 9

Month	Medical & Vision	Dental	Total
January	$ 523,138	$ 6,669	$ 529,807
	$ 523,138	**$ 6,669**	**$ 529,807**

Fare Recovery Ratio – Table 10

Description	1/31/2023	Year to Date
Fare Revenue or Passenger Revenue	$ 89,269	$ 89,269
Operating Expenses	3,457,314	3,457,314
Fare Recovery Ratio	2.58%	2.58%
*Excluding Depreciation		

Note: Same period last year (January 2022) the FRR was 2.16%

January 2023 – Table 11

For the month of January, total Expenses exceeded Revenues by $587,578. A greater detail of the financial results is explained in the accompanied Power Point presentation.

	2023 Adopted Budget	January 2023 Actual	01/2023 Baseline into Budget	% Actual to Budget	% Actual to Baseline
Operating Revenues	$ 44,024,797	$ 3,182,037	$ 3,163,055	7.23%	100.60%
Operating Expenses	45,860,089	3,722,603	3,688,566	8.12%	100.92%
Revenue over Expenses	**(1,835,292)**	**(540,566)**	**(525,510)**	29.45%	102.86%
Capital Funding	12,513,868	441,355	441,355	3.53%	100.00%
Capital Expenditures	10,678,576	288,414	288,414	2.70%	100.00%
Revenue over Expenses	**1,835,292**	**152,941**	**152,941**	8.33%	100.00%
Revenue over Expenditures	$ **(0)**	$ **(387,625)**	$ **(372,569)**		

NET POSITION

The Total Net Position at the end of the month was **$111,882,388**, a decrease of **$554,527** from December 2022 which closed at **$112,436,915**.

The Total Net Position is made up of three (3) components: Net Investment in Capital Assets, Funds Restricted for the FTA's Interest, and Unrestricted which represents the residual amount of the net position that is available for spending.

Of the Total Net Position of **$111,882,388**, the portion of the fund balance that is not restricted in accordance with GASB Concepts Statement No 4 is **$50,937,908,** but only **$29,059,288** is available for spending as a result of the internal restrictions placed by the Board for specific reserves which total **$21,878,620**. To stabilize the fluctuations of sales tax revenue, CCRTA has established several reserve accounts that serve as a liquidity cushion. As you can see from the fund balance breakdown below, 42.95% of the unrestricted portion is assigned by the Board to fund reserves that are earmarked to meet certain unexpected demands.

FUND BALANCE AS OF JANUARY 31, 2023:

FUND BALANCE	
Net Invested in Capital Assets	$ 60,369,172
Restricted for FTA Interest	575,308
Unrestricted →	50,937,908
TOTAL FUND BALANCE	**111,882,388**
UNRESTRICTED BREAKDOWN	
Designated for Operating Reserve (25% OpEx less EBR)	9,834,375
Designated for Capital Reserve (25% of total CIP)	11,068,263
Designated for Employee Benefits Reserve	975,982
Total Designated Reserves (42.95%)	**$ 21,878,620**
Unrestricted (57.05%)	29,059,288
TOTAL DESIGNATED & UNRESTRICTED →	**$ 50,937,908**

Please refer to the following pages for the detailed financial statements.

Respectfully Submitted,

Submitted by: Marie Sandra Roddel
Director of Finance

Reviewed by: Robert M. Saldaña
Managing Director of Administration

Final Approval by: Rita Patrick for__
Miguel Rendón
Acting Chief Executive Officer

Corpus Christi Regional Transportation Authority
Operating and Capital Budget Report
For the month ended January 2023

OPERATING BUDGET	2023 Adopted Budget	January 2023 Actual	01/2023 Baseline into Budget	% Actual to Budget	% Actual to Baseline
	A	B	C = A / 12	B / A	C vs B
Revenues					
Passenger service	$ 1,108,110	$ 89,269	$ 92,343	8.06%	96.67%
Bus advertising	145,371	16,823	12,114	11.57%	138.87%
Other operating revenues	312,337	15,169	15,169	4.86%	100.00%
Sales Tax Revenue	39,793,301	2,821,289	2,821,289	7.09%	100.00%
Federal, state and local grant assistance	1,565,828	-	130,486	0.00%	0.00%
Investment Income	574,000	195,937	47,833	34.14%	409.62%
Staples Street Center leases	525,850	43,550	43,821	8.28%	99.38%
Total Revenues	**44,024,797**	**3,182,037**	**3,163,055**	**7.23%**	**100.60%**
Expenses					
Transportation	9,677,928	982,275	806,494	10.15%	121.80%
Customer Programs	583,377	92,385	48,615	15.84%	190.03%
Purchased Transportation	8,765,945	695,542	730,495	7.93%	95.22%
Service Development	787,213	74,090	65,601	9.41%	112.94%
MIS	1,658,217	139,317	138,185	8.40%	100.82%
Vehicle Maintenance	6,467,275	579,823	538,940	8.97%	107.59%
Facilities Maintenance	3,073,685	250,610	256,140	8.15%	97.84%
Contracts and Procurements	439,574	39,812	36,631	9.06%	108.68%
CEO's Office	1,196,022	72,036	99,668	6.02%	72.28%
Finance and Accounting	886,912	52,579	73,909	5.93%	71.14%
Materials Management	272,912	28,067	22,743	10.28%	123.41%
Human Resources	986,814	72,315	82,235	7.33%	87.94%
General Administration	528,001	43,920	44,000	8.32%	99.82%
Capital Project Management	395,912	34,724	32,993	8.77%	105.25%
Marketing & Communications	824,912	52,516	68,743	6.37%	76.39%
Safety & Security	2,401,747	158,897	200,146	6.62%	79.39%
Staples Street Center	1,135,037	88,241	94,586	7.77%	93.29%
Port Ayers Cost Center	32,000	165	2,667	0.52%	6.20%
Debt Service	1,597,313	-	-	0.00%	0.00%
Special Projects	200,000	-	16,667	0.00%	0.00%
Subrecipient Grant Agreements	765,828	-	63,819	0.00%	0.00%
Street Improvements Program for CCRTA Regional Entities	3,183,464	265,289	265,289	8.33%	100.00%
Total Expenses	**45,860,089**	**3,722,603**	**3,688,566**	**8.12%**	**100.92%**
Revenues Over Expenses - Operating Budget	**(1,835,292)**	**(540,566)**	**(525,511)**		

CIP BUDGET	2023 Adopted Budget	January 2023 Actual	Baseline into Budget	% Actual to Budget	% Actual to Baseline
	A	B	C = A / 12	B / A	
Funding Sources					
Transfer In	$ 3,649,552	304,129	304,129	8.33%	100.00%
Grant Revenue	8,864,316	137,226	137,226	1.55%	0.00%
Total Funding Sources	**12,513,868**	**441,355**	**441,355**	3.53%	100.00%
Capital Expenditures					
Grant Eligible Costs	8,864,316	137,226	137,226	1.55%	0.00%
Depreciation Expenses	1,814,260	151,188	151,188	8.33%	100.00%
Total Expenditures	**10,678,576**	**288,414**	**288,414**	2.70%	100.00%
Funding Sources Over Expenditures	**1,835,292**	**152,941**	**152,941**	8.33%	100.00%
Revenues Over Expenses - Operating Budget	**(1,835,292)**	**(540,566)**	**(525,511)**		
Revenues Over Expenses - CIP Budget	**1,835,292**	**152,941**	**152,941**		
Revenues Over Expenses (including rounding)	**$ (0)**	**$ (387,625)**	**$ (372,570)**		

CORPUS CHRISTI REGIONAL TRANSPORTATION AUTHORITY
Statement of Net Position
Month ended January 31, 2023, and year ended December 31, 2022

	Unaudited January 31 2023	Unaudited December 31 2022
ASSETS		
Current Assets:		
Cash and Cash Equivalents	$ 23,050,271	$ 25,332,576
Short Term Investments	32,290,936	32,880,161
Receivables:		
Sales and Use Taxes	6,635,468	6,892,274
Federal Government	118,935	85,239
Other	557,303	486,900
Inventories	1,063,212	1,044,258
Prepaid Expenses	1,152,909	614,810
Total Current Assets	**64,869,034**	**67,336,217**
Non-Current Assets:		
Restricted Cash and Cash Equivalents	779,623	779,623
Net Pension Asset	2,360,935	1,090,246
Capital Assets:		
Land	4,882,879	4,882,879
Buildings	52,689,967	52,689,967
Transit Stations, Stops and Pads	25,112,677	25,112,677
Other Improvements	5,525,123	5,525,123
Vehicles and Equipment	67,270,387	67,270,387
Software Subscriptions	172,875	172,875
Construction in Progress	356,089	356,089
Current Year Additions	6,201,440	4,932,100
Total Capital Assets	162,211,437	160,942,097
Less: Accumulated Depreciation	(87,272,986)	(87,121,798)
Net Capital Assets	74,938,451	73,820,299
Total Non-Current Assets	**78,079,009**	**75,690,168**
TOTAL ASSETS	**142,948,043**	**143,026,386**
DEFERRED OUTFLOWS OF RESOURCES		
Deferred outflow related to pensions	1,345,223	1,345,223
Deferred outflow related to OPEB	42,767	42,767
Deferred outflow on extinguishment of debt	3,120,721	3,120,721
Total Deferred Outflows	**4,508,711**	**4,508,711**
TOTAL ASSETS AND DEFERRED OUTFLOWS	**147,456,753**	**147,535,096**
LIABILITIES AND NET POSITION		
Current Liabilities:		
Accounts Payable	1,932,115	1,973,534
Current Portion of Long-Term Liabilities:		
Long-Term Debt	-	-
Compensated Absences	331,157	331,157
Sales Tax Audit Funds Due	301,114	328,488
Distributions to Regional Entities Payable	7,788,503	7,523,215
Other Accrued Liabilities	765,327	485,639
Total Current Liabilities	**11,118,216**	**10,642,032**
Non-Current Liabilities:		
Long-Term Liabilities, Net of Current Portion:		
Long-Term Debt	17,690,000	17,690,000
Compensated Absences	950,274	950,274
Sales Tax Audit Funds Due	164,258	164,258
Net OPEB Obligation	853,090	853,090
Total Non-Current Liabilities	**19,657,622**	**19,657,622**
TOTAL LIABLILITES	**30,775,838**	**30,299,654**
DEFERRED INFLOWS OF RESOURCES		
Deferred inflow related to pensions	4,798,527	4,798,527
Total Deferred Inflows	4,798,527	4,798,527
TOTAL LIABILITIES AND DEFERRED INFLOWS	**35,574,365**	**35,098,181**
Net Position:		
Net Invested in Capital Assets	60,369,172	59,251,020
Restricted for FTA Interest	575,308	779,623
Unrestricted	50,937,908	52,406,272
TOTAL NET POSITION	**$ 111,882,388**	**$ 112,436,915**

Corpus Christi Regional Transportation Authority
Statement of Cash Flows (Unaudited)
For the month ended January 31, 2023

		1/31/2023
Cash Flows From Operating Activities:		
Cash Received from Customers	$	64,425
Cash Received from Bus Advertising and Other Ancillary		79,239
Cash Payments to Suppliers for Goods and Services		(2,385,148)
Cash Payments to Employees for Services		(816,298)
Cash Payments for Employee Benefits		(1,834,921)
Net Cash Used for Operating Activities		**(4,892,703)**
Cash Flows from Non-Capital Financing Activities:		
Sales and Use Taxes Received		3,050,721
Grants and Other Reimbursements		49,047
Distributions to Subrecipient Programs		-
Distributions to Region Entities		-
Net Cash Provided by Non-Capital Financing Activities		**3,099,768**
Cash Flows from Capital and Related Financing Activities:		
Federal and Other Grant Assistance		54,483
Proceeds/Loss from Sale of Capital Assets		-
Proceeds from Bonds		-
Repayment of Long-Term Debt		-
Interest and Fiscal Charges		-
Purchase and Construction of Capital Assets		(1,269,339)
Net Cash Used by Capital and Related Financing Activities		**(1,214,856)**
Cash Flows from Investing Activities:		
Investment Income		87,703
Purchases of Investments		(6,500,000)
Maturities and Redemptions of Investments		7,000,000
Premiums/Discounts on Investments		137,782
Net Cash Provided by Investing Activities		**725,486**
Net decrease in Cash and Cash Equivalents		**(2,282,306)**
Cash and Cash Equivalents (Including Restricted Accounts), January 1, 2023		**26,112,199**
Cash and Cash Equivalents (Including Restricted Accounts), January 31, 2023	$	**23,829,894**

CORPUS CHRISTI REGIONAL
TRANSPORTATION AUTHORITY

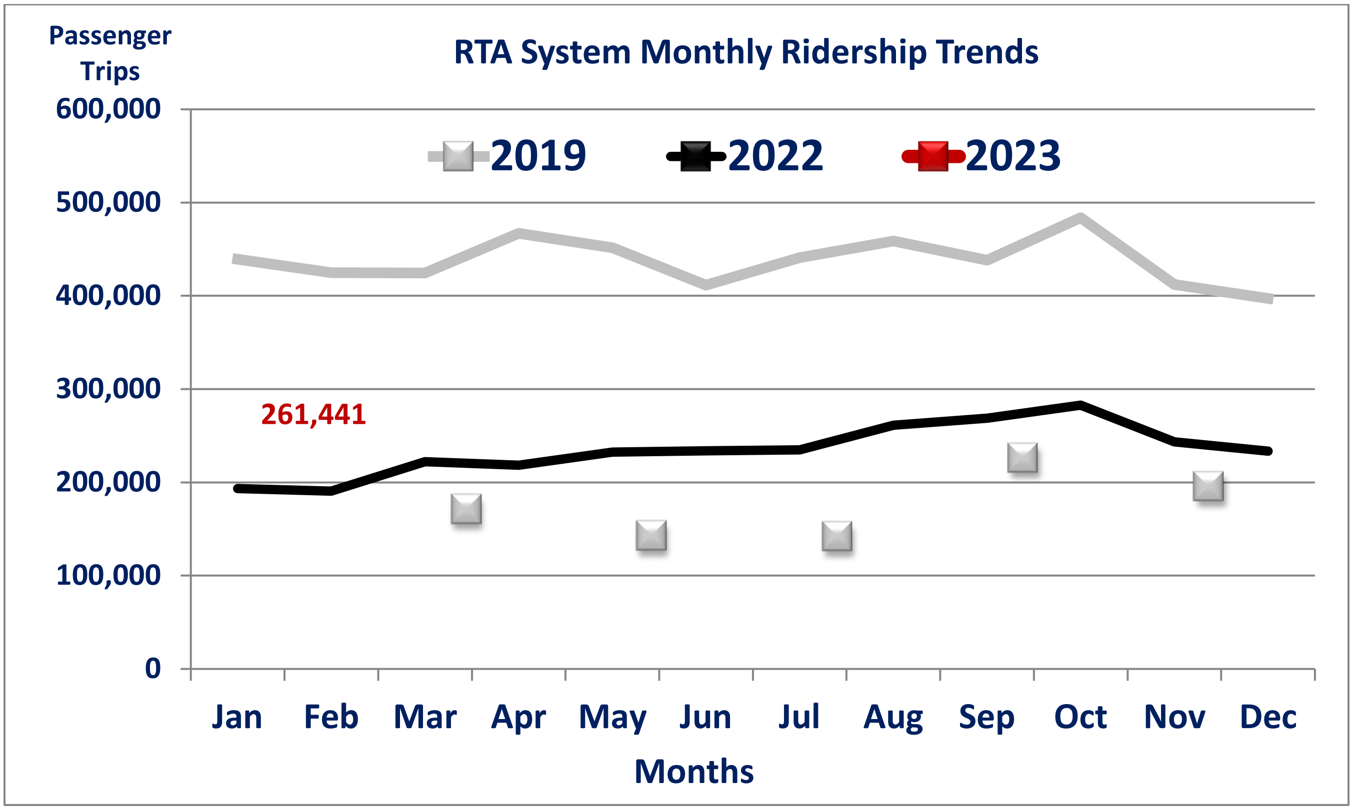
Board of Directors Meeting Memo March 1, 2023

Subject: January 2023 Operations Report

The system-wide monthly operations performance report is included below for your information and review. This report contains monthly and Year-to-Date (YTD) operating statistics and performance measurement summaries containing ridership, performance metrics by service type, miles between road calls and customer service feedback.

System-wide Ridership and Service Performance Results

January 2023 system-wide ridership levels continued to be impacted by the COVID-19 pandemic. Passenger trips totaled 261,441 which represents a 35.3% increase as compared to 193,233 passenger trips in January 2022 with 68,208 more trips provided this month. In comparison to the pre-COVID-19 (Pre-Covid) period in January 2019 with 439,123 passenger trips, the 261,441 passenger trips represent a 40.5% decrease with 177,682 fewer trips.

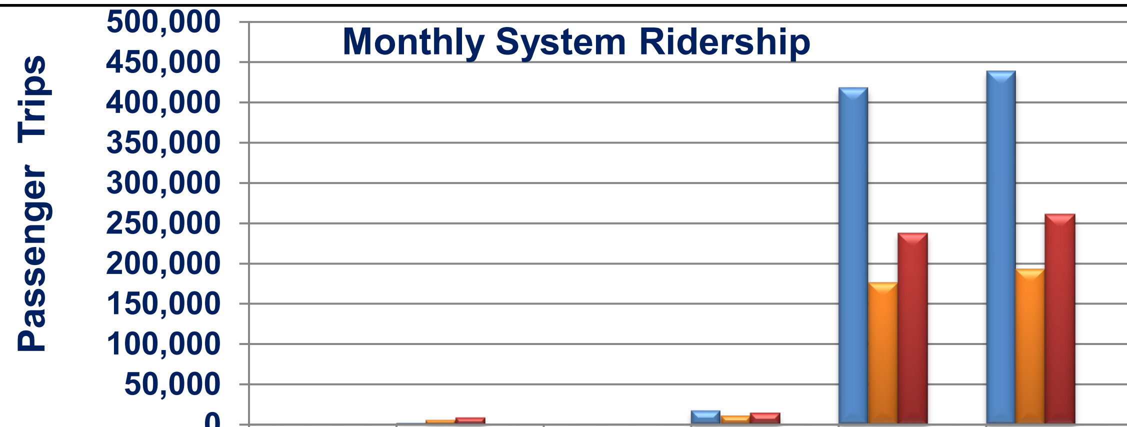


January 2023	January 2022	Variance
22 Weekdays	21 Weekdays	+1
4 Saturdays	5 Saturdays	-1
5 Sundays	5 Sundays	-
Sunday Service Levels on Jan. 1, 2023	Sunday Service Levels on Jan. 1, 2022	-
31 Days	31 Days	-

The average retail price for unleaded gas in Corpus Christi was approximately $2.58 per gallon as compared to $2.96 per gallon in January 2022[1] which represents a 12.8 % decrease in the average cost per gallon. Rainfall was below normal at 0.72 inches as compared to the January 2022 total rainfall of 2.31 inches.[2] Normal average January rainfall is approximately 1.39 inches. The 74.3-degree average temperature was above the average monthly temperature of 67.9 degrees.

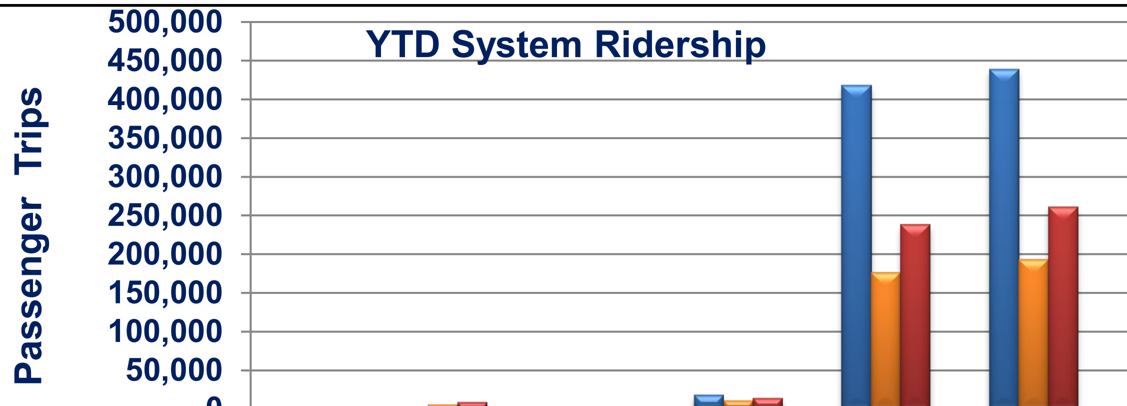
1. GasBuddy.com historical data at http://www.gasbuddy.com.
2. https://etweather.tamu.edu/rainhistory

The chart below shows monthly ridership results for all services. CCRTA recorded 68,208 more passenger trips in January 2023 for a 35.3% increase as compared to January 2022. As compared to January 2019 Pre-Covid, passenger trips decreased 40.5%.



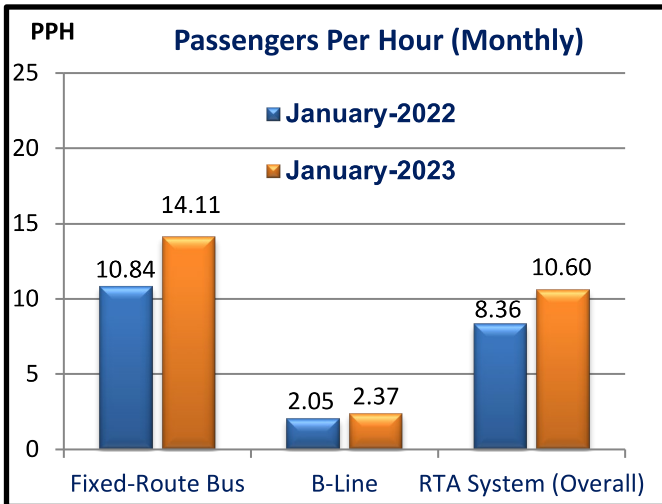
	Rural Services	Vanpool	Flexi-B (Contract Demand)	B-Line	Fixed-Route Bus	System Overall
January-19 Pre-Covid	117	2,385	247	17,870	418,504	439,123
January-22	16	5,740	223	10,911	176,343	193,233
January-23	29	8,914	266	14,026	238,206	261,441
% Change 2023 vs 2022	81.3%	55.3%	19.3%	28.5%	35.1%	35.3%
% Change 2023 vs Pre-Covid	-75.2%	273.8%	7.7%	-21.5%	-43.1%	-40.5%

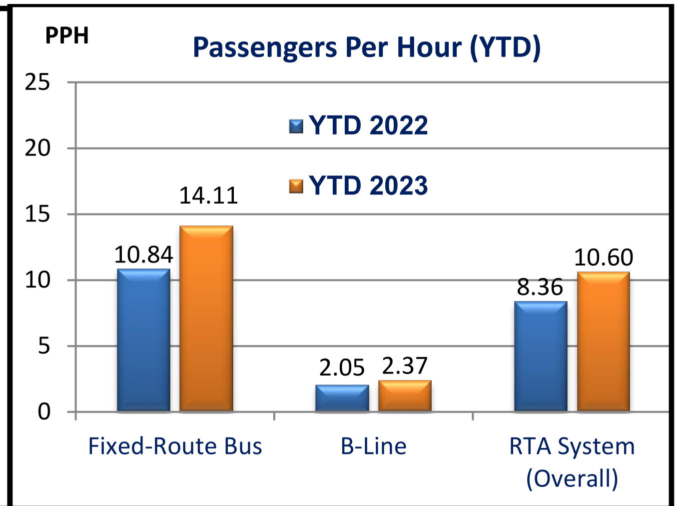
The chart below shows YTD ridership results for all services.

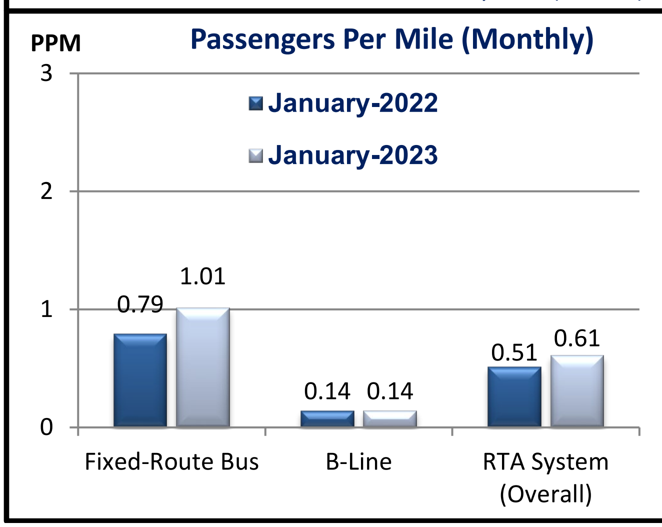


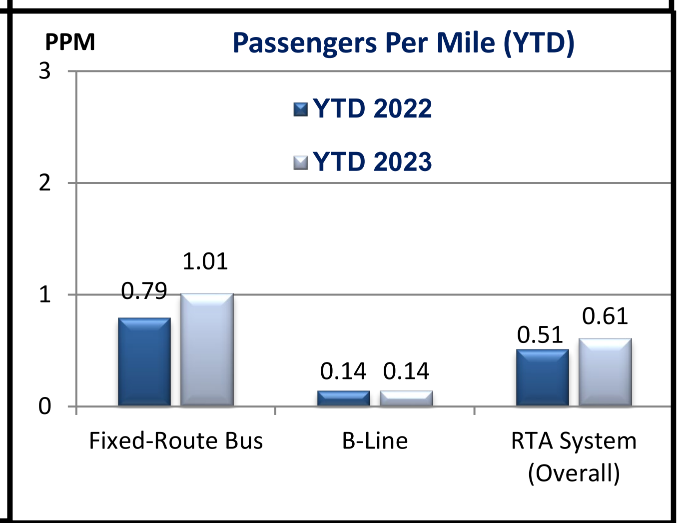
	Rural Services	Vanpool	Flexi-B (Contract Demand)	B-Line	Fixed-Route Bus	System Overall
YTD 2019 Pre-Covid	117	2,385	247	17,870	418,504	439,123
YTD 2022	16	5,740	223	10,911	176,343	193,233
YTD 2023	29	8,914	266	14,026	238,206	261,441
% Change YTD 2023 vs 2022	81.3%	55.3%	19.3%	28.5%	35.1%	35.3%
% Change YTD 2023 vs Pre-Covid	-75.2%	273.8%	7.7%	-21.5%	-43.1%	-40.5%

The following charts report system-wide productivity for the month of January 2023 vs. January 2022 and YTD figures.









The following table shows on-time performance of fixed route services.

Schedule Adherence	Standard	Oct-22	Nov-22	Dec-22	Jan-23	4-Month Average
Early Departure	<1%	0.5%	0.0%	0.0%	0.0%	0.1%
Departures within 0-5 minutes	>85%	88.3%	89.6%	89.3%	93.6%	90.2%
Monthly Wheelchair Boardings	No standard	3,971	2,899	3,732	3,463	3,516
Monthly Bicycle Boardings	No standard	5,637	4,694	4,429	4,444	4,801

On Detour	• **Port Ave.** Utility Replacement Project (6) month project: Began March 2022 with anticipated completion in late March 2023. ➢ Routes 21, 23 & 37 (**2 stops impacted**) • **Leopard St.** (Nueces Bay-Palm) (14) month project: Began April 2021-anticipated completion in late March 2023. ➢ Routes 27 & 28 (**4 stops closed**) • **S. Staples St.** (Kostoryz-Baldwin) (29) month project: Began March 2021. First Phase now complete-traffic switch over to new constructed east section. ➢ Route 29 (**12 Stops closed**) Detour from Staples to Alameda to Texan Trail. • **Park Road 22 water exchange bridge:** Began late 2020. Slight detour only. ➢ Route 65 (No stops impacted) • **New Harbor Bridge (North Beach):** Routes 76 & 78 remain on minor detour under U.S. HWY 181 in the inbound direction. (No stops impacted) • **Winnebago & Lake St.** (Harbor Bridge reconstruction): Began August 2020. ➢ Route 12 (**4 stops impacted**) • **Leopard St.** (Crosstown-Palm) (14) month project began Dec. 5, 2022. This Bond project will extend the current/existing Leopard St. detour. ➢ Routes 27 & 28 (**9 stops impacted**)
Detours Expected	• **McArdle** (Carroll-Kostoryz) To begin mid-2023. ➢ Route 19 (**8 stops may be impacted**) • **Gollihar** (Crosstown-Greenwood) To begin mid-2023. ➢ Routes 23 & 25 (**11 stops may be impacted**) • **Alameda** (Chamberlain-Texan Tr.) To begin late-2023. ➢ Routes 5 & 17 (**8 stops will be impacted**) • **Comanche** (Carancahua-Alameda) To begin late-2023. ➢ Routes 12, 21, 27 & 28 (**4 stops will be impacted**) • **Brownlee Blvd.** (Morgan-Staples) To begin late-2023. ➢ Routes 5x & 17 (**7 stops will be impacted**)
No Detour	• **Wildcat** (Northwest Blvd.-Teague) Began Jan. 10, 2023. (10) month project. ➢ Route 27 (**1 stop closed 3 stops slightly impacted**) • **Everhart Rd. (SPID-S. Staples):** Project could begin late-2023. ➢ Routes 32 & 37 (**7 stops will be impacted**) • **Waldron Rd.** (SPID-Purdue): Began November 28, 2022. Phase 2 complete, Phase 3 about to begin which is anticipated to last six weeks. ➢ Route 4 (**13 stops temporarily impacted**)

For January 2023, there were 11 impacted fixed routes out of 32 fixed route services in operation. This equates to approximately 34% of CCRTA services travelling on the local streets. Detoured bus route services include: 4, 12, 21, 23, 27, 28, 29, 37, 65, 76 & 78.

Total number of bus stops currently impacted or closed is **48**.

<u>Purchased Transportation Department Report: B-Line Service Contract Standards & Ridership Statistics</u>

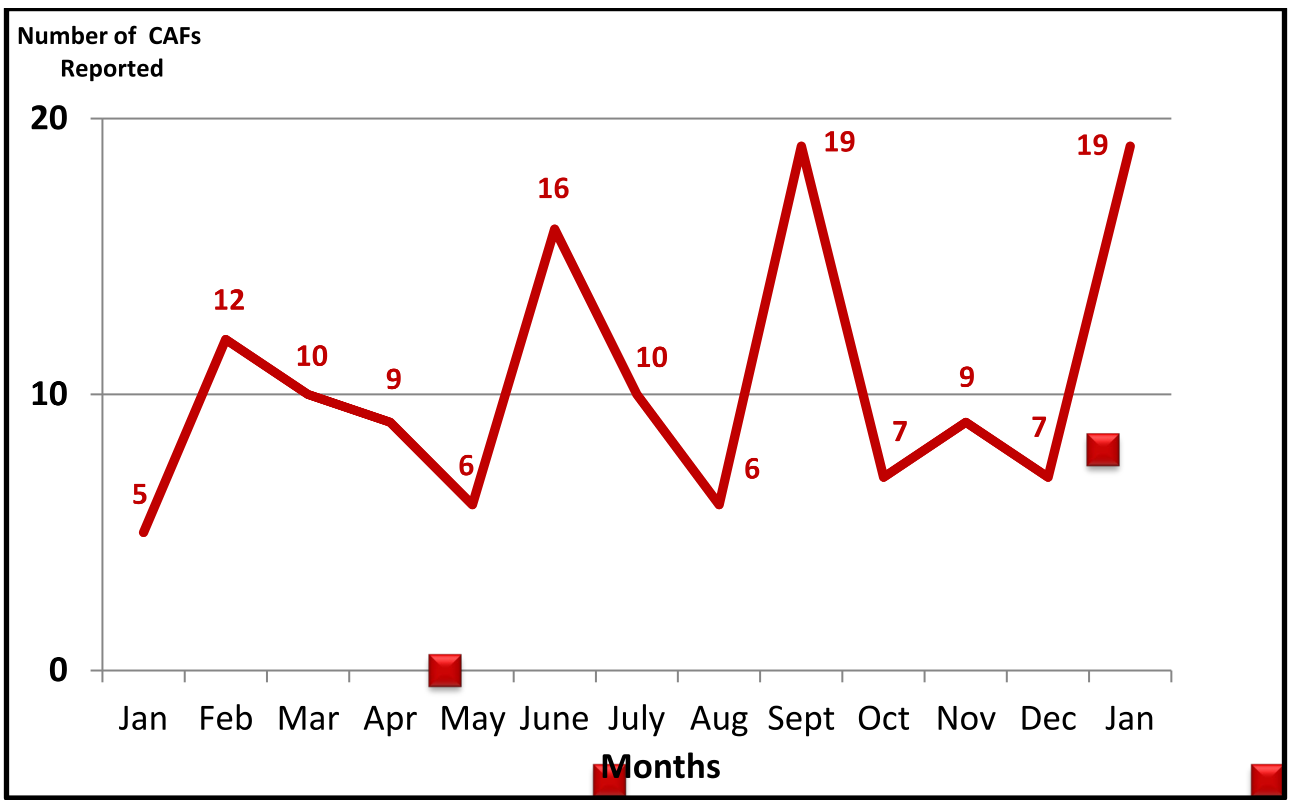
In January 2023, B-Line service metrics remain slightly impacted by RSV, Influenza and the persistent COVID-19 pandemic.

- <u>Productivity</u>: **2.37** Passengers per Hour (PPH) did not meet the contract standard of 2.50 PPH.
- <u>Denials</u>: 0 denials or **0.0%** did meet contract standard of 0.0%.
- <u>Miles between Road Calls (MBRC)</u>: **13,216** did meet the contract standard of 12,250 miles.
- <u>Ridership Statistics</u>: **9,417** ambulatory boardings; **3,680** wheelchair boardings

Metric	Standard	Oct-22	Nov-22	Dec-22	Jan-23	(4) Month-Ave.
Passengers per Hour	2.50	2.55	2.43	2.40	2.37	2.44
Denials	0.00%	0.00%	0.00%	0.00%	0.00%	0.0%
Miles Between Road Calls	12,250	21,852	13,936	15,366	13,216	16,092
Monthly Wheelchair Boardings	No standard	3,917	3,461	3,879	3,680	3,734

<u>Customer Programs Monthly Customer Assistance Form (CAF) Report</u>

For January 2023, Customer Service received and processed 19 Customer Assistance Forms (CAF's). 19 CAF's is 12 more than the previous month and represents a 171% increase.
There was one commendation received from customers.



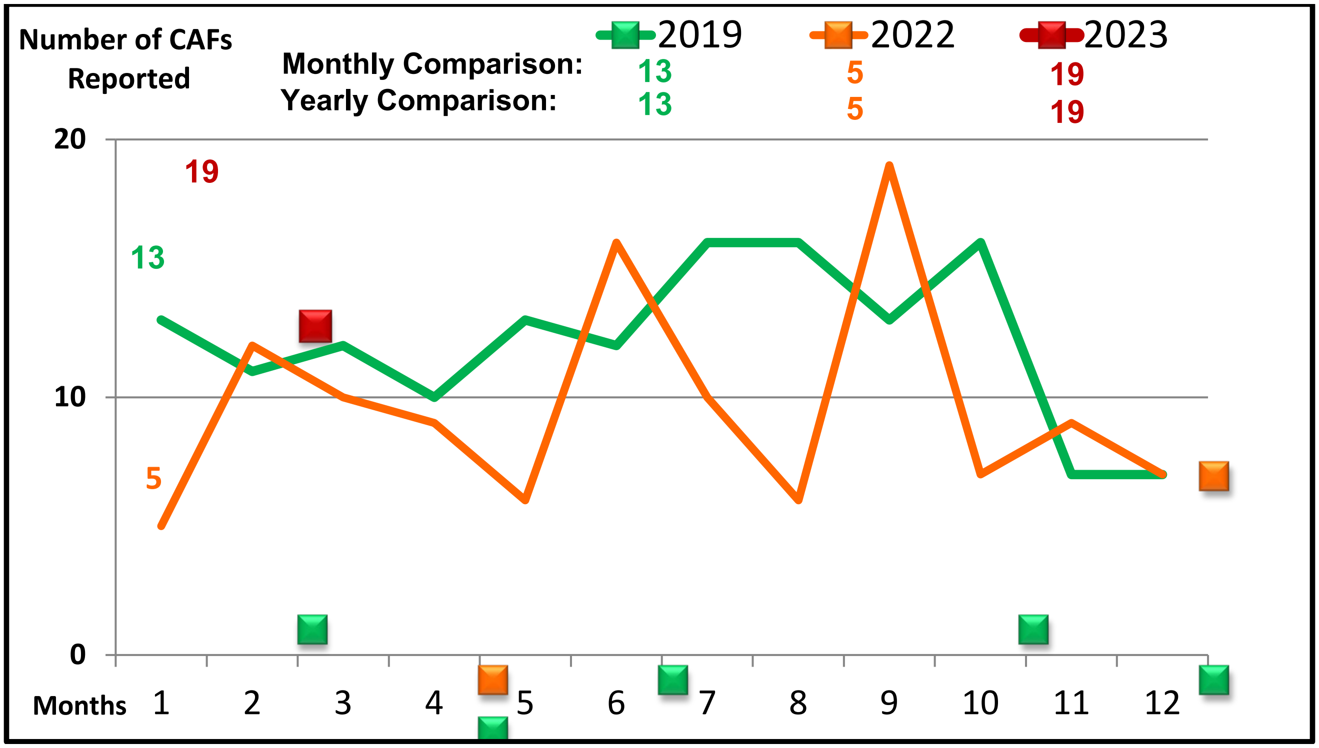
Route Summary Report:

Route	# of CAFs	Route	# of CAFs
#3 NAS Shuttle		#34 Robstown North Circulator	
#4 Flour Bluff	2	#35 Robstown South Circulator	
#5 Alameda		#37 Crosstown/TAMU-CC	1
#5x Alameda Express		#50 Calallen/NAS Ex (P&R)	
#6 Santa Fe/Malls		#51 Gregory/NAS Ex (P&R)	
#12 Hillcrest/Baldwin		#53 Robstown/NAS Ex (P&R)	
#15 Kostoryz/Carroll HS		#54 Gregory/Downtown Express	
#16 Morgan/Port	1	#60 Momentum Shuttle	
#17 Carroll/Southside	1	#65 Padre Island Connection	1
#19 Ayers	2	#76 Harbor Bridge Shuttle	
#19G Greenwood		#78 North Beach Shuttle	
#19M McArdle		#83 Advanced Industries	
#21 Arboleda		#90 Flexi-B Port Aransas	
#23 Molina	2	#93 Flex	
#24 Airline/Yorktown		#94 Port Aransas Shuttle	
#25 Gollihar/Greenwood		#95 Port Aransas Express	
#26 Airline/Lipes		B-Line (Paratransit) Services	3
#27 Leopard	2	Safety, Security & Transportation	2
#27x Leopard (Express)		Facilities Maintenance	
#28 Leopard/Navigation		Customer Service Department	
#29 Staples	1	Service Development	
#29F Staples/Flour Bluff		Facilities/Service Development	
#29SS Staples/Spohn South		Commendations	1
#32 Southside		TOTAL CAF's	19

CAF Breakdown by Service Type:

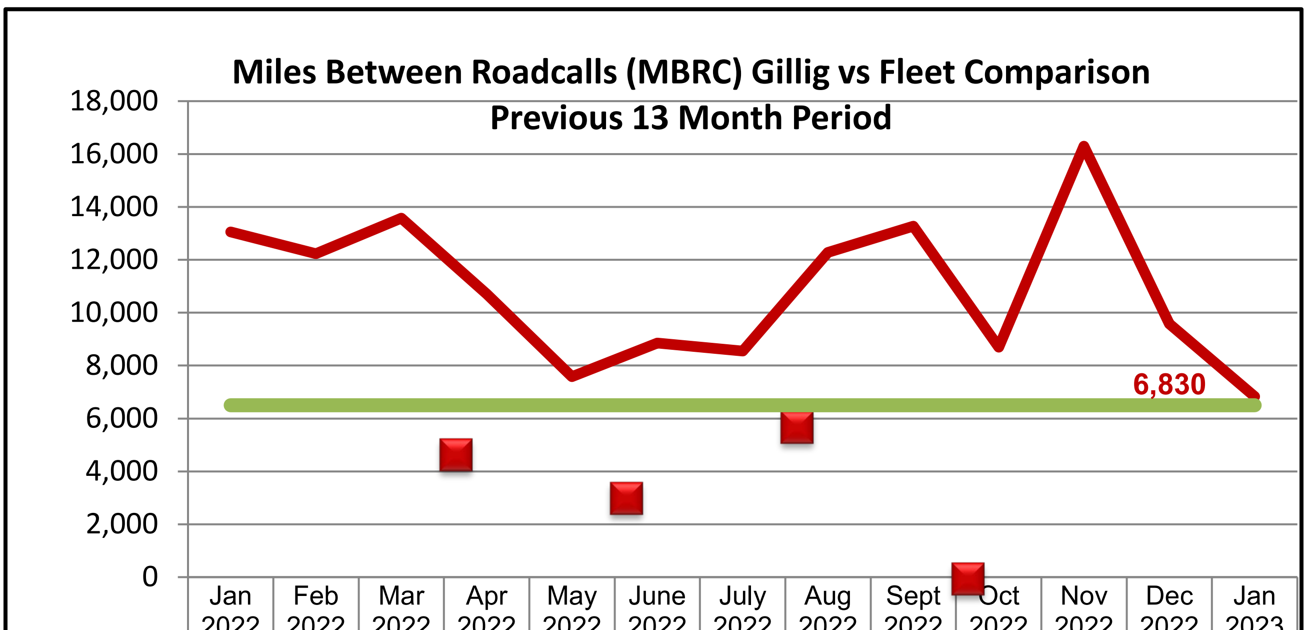
CAF Category	RTA Fixed Route	B-Line ADA Paratransit	MV Fixed Route	Totals
ADA				
Service Stop Issues	1			1
Driving Issues	2	1	2	5
Customer Services				
Late/Early – No Show	1			1
Alleges Injury			1	1
Fare/Transfer Dispute	1			1
Clean Trash Can				
Dispute Drop-off/Pickup		1		1
Add Bench/Stop				
Tie Down Issues		1		1
Inappropriate Behavior				
B-Line Calls				
Incident at Stop				
Incident on Bus	1			1
Incident at Station				
Policy/Standing Orders	1		1	2
Denial of Service	1			1
Safety & Security				
Rude	3			3
Facility Maintenance				
Service Development				
Vehicle Maintenance				
Over Crowded Vehicle				
Cell Phone User				
Safety Transportation				
Commendations		1		1
Total CAFs	11	4	4	19

Number of CAF Reports: Current and Historical Trends



Vehicle Maintenance Department: Miles Between Road Calls Report

In January 2023, there were 6,830 miles between road calls (MBRC) recorded as compared to 13,050 MBRC in January 2022. A standard of 6,500 miles between road calls is used based on the fleet size, age and condition of CCRTA vehicles. The thirteen-month average is 10,886.



	Jan 2022	Feb 2022	Mar 2022	Apr 2022	May 2022	June 2022	July 2022	Aug 2022	Sept 2022	Oct 2022	Nov 2022	Dec 2022	Jan 2023
MBRC	13,050	12,233	13,580	10,711	7,580	8,857	8,550	12,279	13,269	8,697	16,298	9,581	6,830
Goal	6,500	6,500	6,500	6,500	6,500	6,500	6,500	6,500	6,500	6,500	6,500	6,500	6,500

Board Priority

The Board Priority is Public Image and Transparency.

Respectfully Submitted,

Submitted by: Gordon Robinson
Director of Planning

Reviewed by: Derrick Majchszak
Managing Director of Operations

Final Approval by: Rita Patrick for_
Miguel Rendón
Acting Chief Executive Officer