
# Zero Emission Vehicle Transition Plan

2025

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# 1 INTRODUCTION

The transit industry is shifting from traditional diesel vehicles to various alternative fuel technologies due to a combination of increasing environmental awareness, availability and advancement of alternative fuel technologies, fleet diversification and flexibility, efficiency, and federal incentives (i.e., grant funding). Collier Area Transit, operating as CAT, is exploring options related to incorporating alternative fuel vehicles in its fleet. CAT provides fixed route services over 16 routes and paratransit demand response services through CATConnect for eligible individuals. CAT manages a fleet of 30 fixed route buses, 33 paratransit vehicles, and 6 support vehicles, a total of 69 vehicles.

In 2021, the Federal Transit Administration (FTA) announced that no-emission projects seeking funding under the Grants for Buses and Bus Facilities Competitive Program (49 U.S.C. § 5339(b)) and the Low- or No-Emission Program (49 U.S.C. § 5339(c)) must have a Zero-Emission Transition Plan (ZETP). This report substantially meets this requirement in support of future FTA grant funding requests made by Collier County.

A ZETP must meet the following six requirements:

- Element 1 | Demonstrate a long-term fleet management plan with a strategy for how the applicant intends to use the current request for resources and future acquisitions.
- Element 2 | Address the availability of current and future resources to meet costs for the transition and implementation.
- Element 3 | Consider policy and legislation impacting relevant technologies.
- Element 4 | Include an evaluation of existing and future facilities and their relationship to the technology transition.
- Element 5 | Describe the partnership of the applicant with the utility or alternative fuel provider.
- Element 6 | Examine the impact of the transition on the applicant's current workforce by identifying skill gaps, training needs, and retraining needs of the existing workers of the applicant to operate and maintain zero-emission vehicles and related infrastructure and avoid displacement of the existing workforce.

The purpose of this report is to develop a ZETP based on a selection of alternative fuel technologies identified in the following chapters and to meet the requirements of the FTA for competitive grants through the Low- or No-Emission Grant program. While the study evaluates the transition of the fleet, it is imperative to consider the value of diversifying the fleet. The community is dependent on public transit to support transportation needs during natural disasters, for this reason CAT has suggested that a balanced mix of technologies will be the goal of its transition plan, the details of which are documented in this ZETP. This balanced approach takes the transition to low-emission or zero-emission vehicles with thoughtfulness, remaining mindful of local climate challenges. The agency finds it appropriate that a portion of its fleet remains composed of diesel vehicles, as these vehicles would be critical to support mobility during power outages, especially after natural disasters such as hurricanes, which are common in the region.

Development of the ZETP included a review of current transit fleet and analysis of recommended scenarios for determining the feasibility of a fleet transition. To ensure the decisions made during this process consider multiple aspects of the implementation, a Steering Committee was formed from representatives of multiple County agencies and departments. The feedback, guidance and input from the Steering Committee aided in developing the implementation plan for including lower emission fuel considerations for CAT. Brief summaries of the meetings held with the Steering Committee are included as **Appendix A**.

The remainder of this report is divided into seven sections intended to meet the six ZETP elements listed previously:

**Section 2: State of Zero Emission Vehicles:** A review of recent trends and adoption of fuel sources by transit agencies nationwide was conducted. A comparison and evaluation of multiple fuel sources along an Assessment of potential environmental and fiscal impacts is also included.

**Section 3: Peer Experience:** Interviews were held with three transit agencies in Florida to better understand their experiences with alternative fuel sources and potential takeaways that can guide CAT's Transition Plan. A review of national case study examples is also included to provide a broader context of transit agency experiences.

**Section 4: Local, Regional, and State Initiatives:** A summary of key national policy guidance for funding and implementation of low/no emission fuels is included along with key takeaways from Florida DOT studies and action plans for addressing vehicle emissions. Finally, guiding principles and policy guidance included in local planning documents are included.

**Section 5 Utility Provider Coordination:** Contacts were made with Florida Power and Light and Lee County Electric Cooperative were made to identify potential opportunities for fleet conversion to electric was conducted. A brief summary of potential programs and future coordination actions associated with the Transition Plan are brought forward.

**Section 6 Alternative Feasibility Analysis:** A review of the current vehicle fleet, including fixed-route, demand response and support vehicles was conducted. Several scenarios were developed and summarized to identify the potential capital and operating costs, and emissions profiles for each scenario was prepared.

**Section 7 Financial Analysis:** High-level capital cost estimates for the recommended fleet conversion, recommended charging infrastructure, and maintenance/storage facility modifications were completed. In addition, this section provides a review of state and federal funding sources, including FTA's Low or No Emission Grants and the Environmental Protection Agency's (EPA) Community Change Grant Program. Impacts to certain funding sources remain uncertain based on recent federal actions. Availability of funding opportunities should be continually monitored by Collier County.

**Section 8: Implementation Plan:** A 10-year capital plan was developed to support the recommended strategy for transitioning to a lower emission fleet. The implementation plan balances operational feasibility, financial sustainability, and environmental impact. This section outlines the key steps, timelines, and strategies for fleet conversion, infrastructure development, workforce training, and future decision points for monitoring and adjusting the transition plan based on changes in the state of practice and alternative fuel sources.

# 2 STATE OF ZERO EMISSION VEHICLES

The State of Zero Emission Vehicles (ZEVs) chapter explores various technology options to determine which technology or technologies are most appropriate for the agency to consider moving forward. This chapter documents the benefits and drawbacks of popular alternative fuel technologies and how they compare to diesel vehicles.

## 2.1 Recent Trends in Alternative Fuel Technologies

There are two broad categories of alternative fuel technologies: low-emission and zero-emission. Low-emission technologies refer to any alternative technology or alternative fuel that emit lower amounts of harmful tailpipe emissions than diesel. Zero-emission (also known as no-emission) technologies do not rely on fossil fuels for operation and have zero (or nearly zero) harmful tailpipe emissions. Generally, these designations only account for the emissions produced during the usable lifecycle of vehicles and not the emissions produced during the production, disposal of the vehicles, or the production of the fuel source. **Table 2-1** lists the selection of alternative fuel technologies discussed in this report by their respective emission category.

TABLE 2-1 CATEGORIZATION OF MAJOR ALTERNATIVE FUEL TECHNOLOGIES

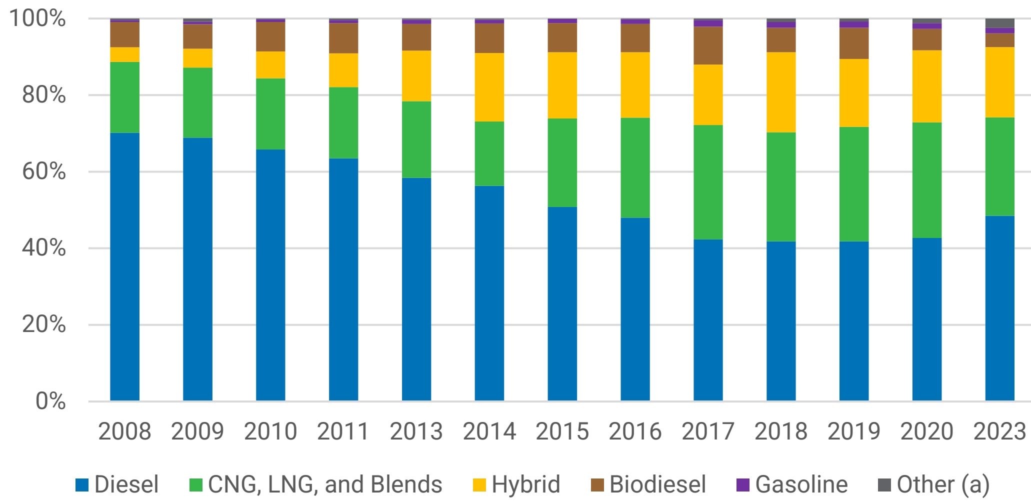
| Low-Emission Technologies | Zero-Emission Technologies |
|---|---|
| • Biodiesel<br>• Compressed natural gas (CNG)<br>• Diesel and battery electric (hybrid)<br>• Gasoline<br>• Liquified natural gas (LNG)<br>• Propane | • Battery electric<br>• Hydrogen fuel cell electric (FCE) |

*Note: While the term "hybrid technology" can refer to a myriad of combinations of fuels, for the purposes of this report, hybrid refers solely to a combination of diesel and battery electric technologies.*

There are multiple fuel alternatives to diesel, and each has evolved at a different pace. The American Public Transportation Association (APTA) maintains a database of more than 450 transit agencies across the United States. The database has helped track various trends in public transportation including fleet fuel mix. **Figure 2-1** shows the changes in fuel mix for buses (excluding commuter bus) between 2008 and 2023. It should be noted that transit agencies voluntarily provide data to APTA and may not update it every year; therefore, data is only as accurate as the agencies reporting.

On average, diesel buses dropped by 1.5 percent annually between 2008 and 2023, beginning with a market share of 70 percent to a current share of 49 percent. The largest diesel decrease occurred between 2011 and 2018. Biodiesel adoption has wavered, with popularity in the past decade peaking at 9.9 percent in 2017 compared to the most recent figure of 3.6 percent.

**FIGURE 2-1: BUS VEHICLE POWER SOURCES**




*Source: APTA Public Transportation Vehicle Database Appendix A (2023)*
*(a) Includes battery-electric, hydrogen, and propane powered buses*
*Note: Data for 2012 is not available.*

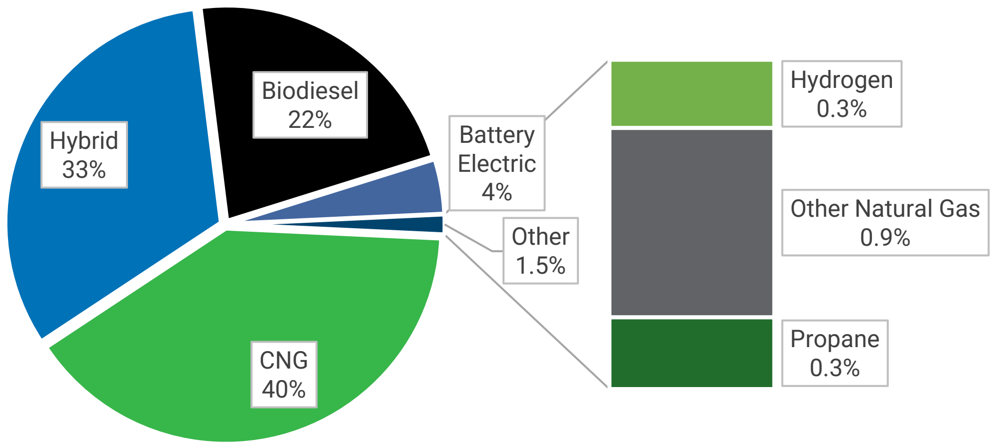
The first alternative fuel technology to gain prominence among transit fleets was compressed natural gas, which increased from 3 percent of transit vehicles to 13 percent between 1996 and 2005. A greater increase in CNG vehicles can be observed between 2015 and 2019, growing about 7 percent annually to an overall 30 percent share in fuel mix, making it the most employed alternative fuel on the market.

Hybrid vehicles (i.e., diesel and battery electric) have had a slow market penetration, with the first models introduced in the late 1990s. However, hybrid vehicles quickly gained traction between 2008 and 2014, growing from an overall fuel mix share of 3.8 percent to 17.9 percent. In 2023, the overall fuel mix share of hybrid vehicles was 18.3 percent.

Other alternative fuel technologies have made marginal market penetration, only recently surpassing 2% of overall fuel mix in 2023. The other alternatives category includes battery-electric, hydrogen, and propane. Propane as a fuel alternative is often used for smaller buses while gasoline is relatively unpopular due to its fuel compression properties and its lack of emission benefits over diesel. The adoption rates of these and other fuel alternative technologies have been impacted either by their level of maturity, cost, or reliability.

**Figure 2-2** shows the current share that each alternative fuel technology has achieved among bus fleets in the U.S. in 2024. The most popular alternative fuel technology is CNG. Approximately 40 percent of the alternative fuel fleet is composed of CNG buses, followed by hybrid buses at 33 percent. Zero-emission buses make up close to 4 percent of all bus fleets, with 3 percent battery electric buses and less than 1 percent being hydrogen buses. Around 22 percent of buses use biodiesel and a combined 1.5 percent use some other fuel alternative such as propane, hydrogen, or another natural gas combination.

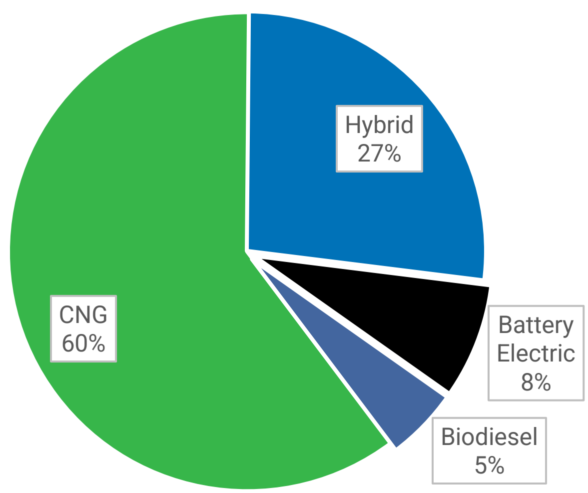
**FIGURE 2-2: MIX OF ALTERNATIVE FUELS FOR US BUSES (2024)**




*Source: APTA Public Transportation Vehicle Database (2024)*
*Other Natural Gas includes compressed natural gas & diesel, compressed natural gas & gasoline, liquified natural gas propane & diesel, propane & gasoline, propane & compressed natural gas, liquified natural gas & diesel*

Similar to the national trend, transit agencies in Florida are increasing their adoption of alternative fuel technologies. **Figure 2-3** shows the alternative fuel mix across buses in Florida in 2024. Among the various fuel alternative fuel technologies, CNG buses are the most common, followed by hybrid buses and battery electric buses.

**FIGURE 2-3: MIX OF ALTERNATIVE FUELS FOR FLORIDA BUSES (2024)**




*Source: APTA Public Transportation Vehicle Database (2024)*

The continued transition away from diesel fuel is expected to accelerate in the coming decade due to state and federal initiatives incentivizing conversion. Nonetheless, an uptick in diesel bus fleet share is observed between 2017 and 2023. The reversal of this trend away from diesel in recent years is due to a combination of factors, including agencies not renewing certain alternative fuel vehicles after pilot programs, and supply chain and manufacturing delays experienced during the COVID-19 pandemic, which may have required extended diesel vehicle usage until this issue was corrected. This all indicates that zero-emission fuels remain challenging to adopt, although their current fuel mix share continues to grow slowly. It is expected that these technologies will gain greater traction in the coming decades as their respective technologies mature.

Due to their low adoption rates, lack of readily available data and/or relatively small reductions in emissions, gasoline, propane, and LNG will not be explored further in this report. **Section 2.2** provides greater detail on five alternative fuel technologies: hybrid diesel-electric, CNG, biodiesel, battery electric and hydrogen FCE. Hybrid, CNG and biodiesel fuel technologies are widely used by transit agencies in Florida. Battery electric and hydrogen FCE vehicles have not been adopted very broadly; however, they are projected to become more popular and are becoming more affordable.

## 2.2 Alternative Fuel Technology Profiles

This section provides detailed profiles for each fuel type. Profiles include data related to the current state of the technology, a basic understanding of the fuel type, performance and reliability, and an evaluation of their impact on infrastructure and operations. Diesel is included below for comparison purposes. The various fuel alternative technologies are presented by category, starting with the low-emission category, and ending with the zero-emission category.

### 2.2.1 Technology Profiles

#### 2.2.1.1 Diesel

Diesel engines have been used for propulsion since the early 20th century. The maturity and reliability of this fuel has made it the primary choice for bus fleet propulsion over the last century. Fuel consumption increased in the later 20th century as modern features were introduced in bus models such as air conditioning, heating, wheelchair lifts and other features that required more engine horsepower. In recent decades, federal regulations and technological advancements have reduced the impact of the fuel's emissions. Current improvements in diesel technology are focused on increased fuel efficiency and a reduction in emissions.

The latest changes in U.S. diesel engine standards occurred between 2007 and 2010, when the Environmental Protection Agency (EPA) aimed for the reduction of diesel emissions in a twofold approach. First, it required the reduction of sulfur content in diesel fuel by 97 percent. Second, it required vehicle exhaust emission controls like particulate filters and exhaust recirculation that reduce nitrogen oxide (NOx) and particulate matter (PM) emissions. The latter approach required improvements in engine design, leading to higher vehicle costs, and added parts for bus repair.

*Breeze Diesel Fueling Station*
*Source: Benesch*

In March 2022, the EPA proposed rules to further reduce air pollution by lowering the emissions of NOx and PM from diesel engines to be introduced in diesel vehicles by model year 2027. Finally, the EPA suggests that for diesel vehicles in 2027, useful life periods and mileages be extended to reflect real-world usage, to extend the emissions durability requirement for heavy-duty engines and to ensure certified emission performance is maintained throughout more of an engine's operational life. These measures will likely impact bus operators by lengthening vehicle life spans, challenging current replacement schedules, increasing maintenance periods, and raising costs due to additional parts for emission control maintenance. Moreover, there is a notable drop in production of diesel vehicles, namely cutaways, meaning that such vehicles will be more challenging to find or replace in the future.

#### 2.2.1.2 Biodiesel

Biodiesel, not to be confused with renewable or green diesel, is a low-emission diesel alternative produced through transesterification, where biodegradable elements such as feedstock or restaurant grease react to alcohol in the presence of a catalyst such as lye. The resulting biodiesel is referred to as B100, an acronym that indicates the percentage of biodiesel present. Pure B100 usage is uncommon; usually, biodiesel is blended with regular diesel to reduce the diesel content in favor of a more biodegradable alternative. Popular biodiesel blends currently available include five percent, 10 percent, and 20 percent forms known as B05, B10, and B20.

*Source: National Renewable Energy Laboratory. www.nrel.gov*

B20 is the more broadly available and used blend today; higher grades are expected to become more common. Biodiesel functions similarly to diesel in compression-ignition engines. While current diesel buses can use certain biodiesel blends, higher blends may require engine upgrades, as pure biodiesel can degrade rubber parts, affecting hoses and gaskets, and causing potential leaks. Biodiesel's lower oxidative stability can also lead to degradation with metals like copper, lead, tin, or zinc, creating sediment that may clog filters.

A cetane number (CN) is assigned to diesel and biodiesel fuels as a measure for identifying fuel ignition delay and related engine performance. Biodiesel fuels generally have a higher CN value than diesel and are considered a lower performing alternative which produces less energy. Biodiesel contains about 8 percent less energy per gallon than diesel. Nonetheless, fuel emissions are notably lower when using biodiesel blends and engines using them are notably cleaner because of a reduced amount of particulate matter compared to diesel.

In freezing temperatures, biodiesel may congeal due to grease-based components, however this is not a concern in Florida's subtropical climate.

Biodiesel blends below B20 are widely available and distributed and require no new infrastructure. The main considerations for any biodiesel fuel blend include specifying which biodiesel feedstock to use given the identified performance and maintenance concerns.

#### 2.2.1.3 Compressed Natural Gas

CNG buses use natural gas as a low-emission fuel for internal combustion, similar to diesel buses but with key differences in fuel type. First, because natural gas is in a gaseous state, it must be compressed for optimal use. CNG is considered one the most mature and well-established fuels available to transit agencies, but its gaseous state has limitations.

CNG contains less energy than diesel, and its high-pressure cylinders connect to the engine via a fuel line with multiple valves and regulators. CNG engines require different mechanical parts than diesel, expanding the parts inventory and requiring specialized staff training.

CNG is considered a low-emission fuel alternative as its main emission is limited to NOx. This fuel alternative is flammable and, because it is an odorless and colorless gas, an additive provides a distinct odor to help detect leaks. Garages supporting CNG vehicles require an extensive evaluation to adhere to guidance from the National Fire Protection Association (NFPA). Additionally, maintenance facilities where CNG is stored or CNG vehicles are repaired require increased ventilation and gas detection systems that can detect and control gas leaks. While CNG may require additional safety infrastructure, issues related to gas leaks are rare.

CNG fueling can occur off site or on site. CNG fueling is a time-consuming process. If a fleet is larger, CNG is ideally produced or pumped on site as it increases operational efficiency. The availability of CNG is contingent upon the local natural gas utility provider. Currently, Collier County may find it challenging to find private CNG fueling but may coordinate with the Florida Power and Light (FPL) subsidiary, FPL Energy Services (FPLES), to assess the availability of natural gas services. Alternatively, private companies such as Trillium or NoPetro are known to create public private partnerships through which transit agencies could benefit from their CNG stations. On-site CNG infrastructure involves substantial investment, including a gas dryer, compressor, and storage system, with costs ranging from $500,000 for a smaller CNG station to $2 million for a larger CNG station[1].

#### 2.2.1.4 Hybrid

Hybrid, specifically diesel-electric hybrid, buses are low-emission vehicles that combine an electric motor with an internal combustion engine. While hybrid buses have an electric component, they operate more like diesel buses than battery-electric buses and don't require external charging, instead using a rechargeable battery alongside traditional mechanical parts.


There are two types of propulsion system configurations in a hybrid bus:

- **Parallel hybrid:** Uses both the electric motor and internal combustion engine, switching between them based on driving conditions. Mostly, the electric motor is used in stop-and-go traffic, while the combustion engine powers the bus at higher speeds, such as on highways.
- **Series hybrid:** Relies solely on the electric motor for propulsion, with power supplied by a battery or a generator driven by an internal combustion engine. This configuration is better suited for stop-and-go conditions.

Concerns have been raised about the impacts related to the mining of lithium, a component required in vehicle batteries. There are two primary concerns: (1) environmental destruction from drilling and mining and (2) water contamination from the refining process. Some environmental advocates contend

[1] Costs Associated With Compressed Natural Gas Vehicle Fueling Infrastructure, US Department of Energy, https://afdc.energy.gov/files/u/publication/cng_infrastructure_costs.pdf

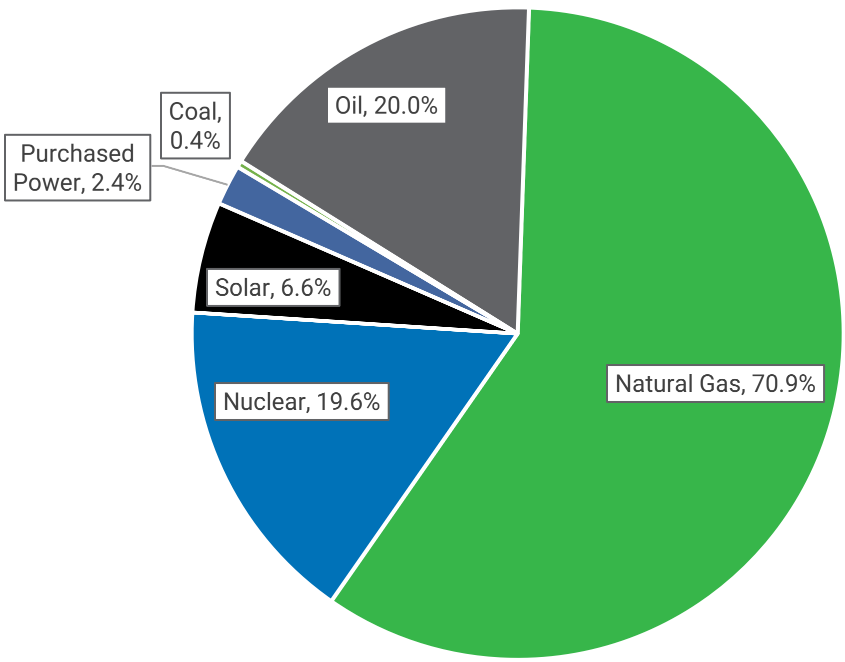
that the negative impacts created by the mining process may outweigh the environmental benefits achieved by battery powered vehicles.

In general, hybrid buses are known for their compromise in emissions and reliability between a diesel and a battery electric bus. Route characteristics and bus configuration may affect the performance of a hybrid bus, which often leads to lower reliability of the vehicle than their diesel and CNG counterparts. Nonetheless, most data shows that hybrids are much more fuel efficient than their diesel counterparts.

#### 2.2.1.5 Battery Electric

Battery electric buses are a zero-emission technology powered by electricity from rechargeable batteries, which draw energy from the local electric grid. The environmental impact of battery electric buses depends on the fuel mix used by the local utility provider, in this case, primarily FPL. **Figure 2-4** shows the most recent fuel mix reported by FPL, CAT's primary local electric utility provider.

**FIGURE 2-4: FPL ELECTRIC GENERATION FUEL MIX SOURCES (2024)**




*Source: Florida Power and Light, Energy News (2024)*

Battery electric buses are evolving rapidly with every year bringing new, more efficient models, but the technology is still not mature. Battery electric buses draw concern due to multiple factors:

- Limited mileage range per charge
- Battery production and life cycle
- Lengthy charging times
- Variability in electric consumption affected by factors such as load, terrain, and climate

Buses carry large batteries that can be recharged and switched out as needed. These batteries require investments in charging infrastructure, with three main charging systems available

1. **Stand-alone Chargers:** This is the most widely used charging system. Chargers can be placed either at the depot or on the right of way, where buses can park next to the chargers and plug into the adapter.
2. **Pantograph Chargers:** These chargers require overhead wiring and a pantograph, an extension that transfers electricity from the overhead wiring into the electrical unit on the bus.
3. I**nduction Chargers:** These chargers provide electricity to buses via electromagnetic induction where buses park over coils that are placed in the street surface to transfer electricity on board.

Most fleets start with stand-alone chargers, typically charging buses overnight at depots. Pantograph and induction chargers offer in-service boosts at stations with longer dwell times. These chargers may require facilities in the right of way and are more useful for larger battery electric fleets with high frequencies.

*Source: APTA*

Two forms of charging exist for buses: long-range charging or fast charging. Long-range charging is typically used overnight to charge vehicles for the following day. A full charge may require up to six hours, and the range may still be inadequate for some operational blocks. Overnight charging provides the cost benefit of lower electric rates, thereby keeping fuel costs down.

Fast charging is generally used in-route to provide a quick recharge of batteries to extend range. To implement fast-charging, in-route facilities require careful coordination to provide enough time to recharge and an understanding that the boost may be minimal compared with energy output. Scheduling for the charging facility is needed to avoid overlap, which can be difficult for low frequency systems using a pulse schedule. Additionally, since fast charging facilities are used in-route, they draw energy during daytime hours when the cost of electricity is typically higher than overnight. Fast charging may also need grid upgrades, as battery electric buses require 480 volts in three phases, while typical commercial supply is 240 volts.

Transitioning to battery electric buses involves considerations for maintenance and repair, with mechanics requiring specialized training. While battery electric buses theoretically need less maintenance due to fewer mechanical parts, practical experience may vary, and agencies often need to expand parts inventory. Moreover, complex repairs that cannot be addressed by local mechanical crews may require that a bus be taken out of service to be repaired by the manufacturer.

As noted under the hybrid section, concerns have been raised about lithium mining needed to produce these batteries.

#### 2.2.1.6 Hydrogen Fuel Cell Electric

Hydrogen FCE buses are zero-emission vehicles that use hydrogen to generate electricity, emitting only water vapor. Despite being the cleanest mobility technology, FCE buses have low market penetration due to high costs and the need for new parts.

Hydrogen FCE buses expose hydrogen to oxygen to create electrical energy that powers the electric motor to propel the bus. While hydrogen is an abundant and renewable natural element, the gas is highly volatile and requires pressurization to be used as a fuel.

Hydrogen propulsion systems are similar to a battery electric bus, while its gas injection and maintenance is very similar to CNG buses. Hydrogen FCEs are in a stage of near maturity, but they remain expensive relative to other technologies.

Fueling options include on-site or off-site hydrogen production, though off-site sources are rare. Moreover, on-site fueling requires a substantial investment in infrastructure to deliver hydrogen. Hydrogen, like CNG, may be provided through trailered cylinders acquired locally. Hydrogen may also be stored in a liquid state. Finally, and more commonly, hydrogen may be created on site, using components similar to CNG such as a compressor, storage units, coolers and dispensers. The increased level of volatility requires more expensive materials, driving up costs significantly.

*Source: https://www.act-news.com/*

Due to complexity and the low levels of both demand and supply, training for such a fuel alternative is more challenging than with other fuel alternatives. Moreover, manufacturers of hydrogen equipment possess a stronghold over maintenance and repairs, meaning that specialized crews provided by manufacturers are required to perform maintenance, leading to increased lifespan costs and operational inefficiencies. Still, hydrogen FCE buses have fewer mechanical parts than diesel engines and offer a longer range than battery-electric buses, making them an appealing alternative.

Overall, nearly $3 to $5 million are required to build or modify facility conditions to adequately allow the use of hydrogen, while also requiring nearly 4,500 square feet of space. The cost of hydrogen equipment continues to drop over time, making it more affordable. The initial investment in hydrogen as an alternative may be expensive, but larger hydrogen fleets reduce the investment per vehicle costs.

### 2.2.2 Technology Comparison

The following section summarizes the data side-by-side to make comparing fuel technologies easier. **Table 2-2** compares key considerations for the various alternative fuel technologies. Several factors are assessed and correspond to five broad categories of impact:

- **State of Technology:** Evaluates the current state of each alternative fuel technology such as the level of technology maturity, current industry adoption rate, the coordination required with various parties to deliver services using the technology for each bus, etc.
- **Financial Impact:** Considers the impact that each technology may have on agency finances, such as lifecycle costs, vehicle costs, and potential grant funding for each technology.
- **Impact to Facility Spaces:** Assesses the impact that the adoption of each fuel alternative technology may have on existing facility spaces, like whether using the fuel alternative requires facility upgrades or if additional space may be needed for new facilities.
- **Operations and Maintenance Impact:** Considers daily impacts of adoption such as the operational burden on the route network, reliability, and the number of unknown factors that may present themselves over time.

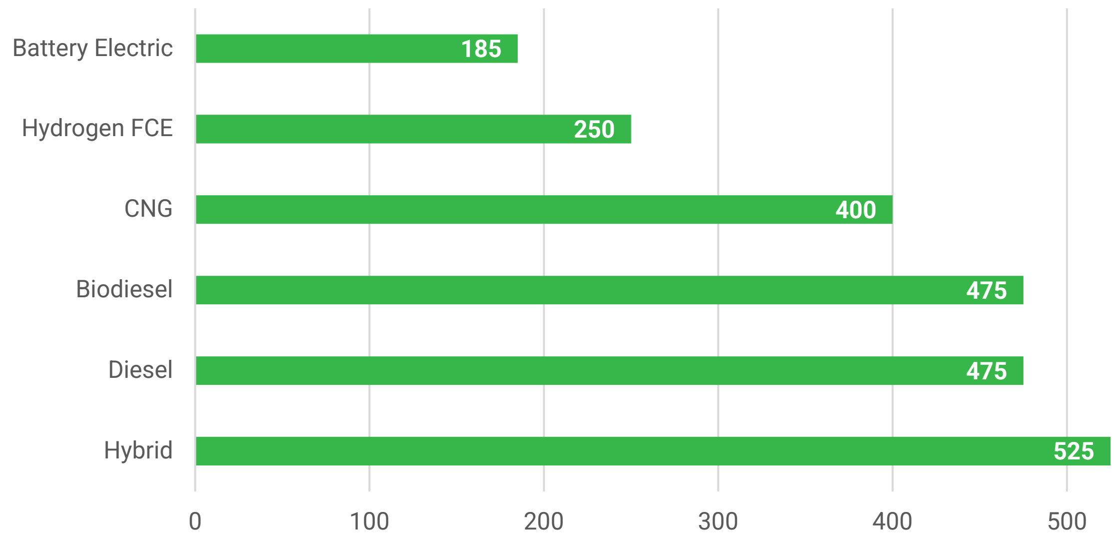
- **Regional Impact:** Considers a technology based on regional factors, such as the successful adoption of a technology in the region or climate and terrain factors.

**TABLE 2-2: ALTERNATIVE FUEL TECHNOLOGIES COMPARISON**

| | Diesel | Biodiesel | CNG | Hybrid | Battery Electric | Hydrogen FCE |
|---|---|---|---|---|---|---|
| **State of Technology** | | | | | | |
| Current Adoption Rate | Phasing Out | Stagnant | Steady | Steady | Growing | Growing |
| Maturity | Mature | Mature | Mature | Evolving | Evolving | Almost Mature |
| Emission Reduction | None | Low | Low | Low | High | High |
| Coordination Level | Few | Few | Some | Some | Many | Many |
| Ease of Adoption | Easy | Easy | Challenging | Easy | Challenging | Challenging |
| **Financial Impact** | | | | | | |
| Lifecycle Cost | Medium | Medium | Low | Medium | Low | High |
| Vehicle Cost | Low | Medium | Medium | Medium | High | High |
| Infrastructure Cost | Low | Low | High | Low | Medium | High |
| Grant Security | None | Low | High | High | High | Medium |
| **Impact to Facility Spaces** | | | | | | |
| Added Footprint | None | Low | High | Low | Medium | High |
| Facility Upgrades | None | Some | Many | None | Many | None |
| **Operations and Maintenance Impact** | | | | | | |
| O&M Cost | High | High | High | Medium | Low | High |
| Vehicle Range | Standard | Standard | Standard | High | Low | Standard |
| Additional Training | None | Low | High | Medium | High | High |
| Added Inventory | None | Minimal | High | Medium | Medium | High |
| Reliability | High | Medium | High | Low | Low | Medium |
| Refueling Time | 5 mins | 5 mins | 5-15 mins | 5 mins | 4 to 6 hours | 7-20 mins |
| Unknown Factors | None | Few | Few | Some | Many | Many |
| **Regional Impact (Florida)** | | | | | | |
| Regional Climate and Terrain Impact | None | Low | Low | Low | Medium | Low |
| Regional Agencies with Technology | Broad | Some | Broad | Broad | Minimal | None |

Because vehicle range is so important to technology adoption, **Figure 2-5** provides greater detail on the range of each technology. On a full tank, hybrid buses provided the greatest vehicle range, even an improvement over the vehicle range for diesel buses. CNG buses, offering a 400-mile range, perform similarly to diesel. Battery electric buses have a relatively low range, which can present a challenge for systems that operate on longer blocks and routes. Hydrogen FCE has a relatively short range as well. It should be noted that vehicle range is affected by many factors including load, use of auxiliary systems such as heating and cooling, terrain, weather, etc.

**FIGURE 2-5 AVERAGE VEHICLE RANGE (MILES)**




*Sources: HART presentation, "Adopting new Fuel Technologies" (2017); Fairfax County DOT presentation, "Electric Buses Overview" (2020); and Academies of Sciences, Engineering, and Medicine, Guidebook for Deploying Zero-Emission Transit Buses (2020)*

# 3 PEER EXPERIENCE

The following section will review the profiles of Collier County's selected peers to understand the implementation of alternative fuels in their respective fleets.

## 3.1 Peer Review

The selection of Pinellas Suncoast Transit Authority (PSTA), Lee County Transit (LeeTran), and Jacksonville Transportation Authority (JTA) as peers was informed by the ongoing CAT Transit Development Plan (TDP) as well as market research of Florida transit agencies with a history of alternative fuel adoption. PSTA, LeeTran, and JTA have already adopted or have plans to adopt alternative fuel technologies, making them relevant benchmarks for CAT's Zero-Emission Transition Plan. While PSTA and JTA were considered for their vast implementation of alternative fuel vehicles, LeeTran scored highly in the TDP's peer comparison criteria, which considered factors such as service characteristics, operational efficiency, and demographic similarities. Their experiences offer valuable insights into the challenges and opportunities associated with transitioning to alternative fuels. **Table 3-1** presents a summary of the peer agencies.

TABLE 3-1: SELECTION OF PEERS FOR REVIEW

| Agency | Location | VOMS* | Fuel Types |
|---|---|---|---|
| **PSTA** | Pinellas County, FL | 273 | Diesel, Electric Hybrid, Electric, and Autonomous Vehicle Advantage (AVA) |
| **LeeTran** | Lee County, FL | 91 | Diesel, Electric Hybrid, Propane |
| **JTA** | Duval County, FL | 225 | Compressed Natural gas (CNG), Diesel, Renewable Natural Gas (Planned), Autonomous Electric Shuttles (Planned), Hydrogen (Exploratory) |

**Vehicles on Maximum Service*

### 3.1.1 PSTA

PSTA serves Pinellas County, Florida, a region with approximately 960,000 residents. PSTA operates 38 fixed routes, including local and regional express bus services, along with popular trolley services like the SunRunner Bus Rapid Transit (BRT), Central Avenue Trolley, and Jolley Trolley routes. These transit options connect major destinations, including downtown St. Petersburg, Clearwater Beach, and Tampa, ensuring comprehensive coverage for residents and visitors. The agency also provides paratransit services for riders with disabilities.

PSTA has been a leader in sustainability efforts, transitioning its fleet to more environmentally friendly technologies. While diesel buses remain the predominant fuel type, the agency has made significant strides in incorporating electric buses, supported by grants through programs like the Low- or No-Emission Vehicle Program. In addition, PSTA has experimented with autonomous vehicle technology, including the Autonomous Vehicle Advantage (AVA) pilot project, as part of its ongoing innovations in transit solutions reflecting its critical role in regional mobility and its commitment to sustainable and efficient public transportation.

### 3.1.2 LeeTran

LeeTran serves Lee County, Florida, providing public transportation across an 820-square-mile area with a population of about 802,178. The system operates 24 fixed bus routes, seasonal trolleys, and paratransit services for individuals with disabilities.

In 2022, LeeTran provided approximately 2.2 million trips and covered nearly 4.8 million revenue miles. Its transit offerings focus on connecting urban centers like Cape Coral, Fort Myers, and Bonita Springs. LeeTran's fleet includes 141 vehicles, primarily diesel-powered, with some hybrid-electric buses as part of efforts to improve sustainability.

### 3.1.3 JTA

The Jacksonville Transportation Authority (JTA) serves Duval County and parts of Clay and Nassau Counties, providing public transportation to a population of approximately 1.6 million residents. JTA operates a diverse transit network that includes fixed-route buses, paratransit services, and the First Coast Flyer BRT system, which offers express service along key corridors.

JTA has been a leader in alternative fuel adoption, prioritizing Compressed Natural Gas (CNG) as its primary fuel source. As of 2023, JTA operates 225 vehicles in maximum service, with a fleet mix of CNG and diesel buses, ensuring operational flexibility and cost efficiency. As part of a plan to modernize Jacksonville's downtown transit infrastructure, the agency has also been at the forefront of autonomous vehicle technology as it is set to introduce 14 autonomous electric shuttles.

Additionally, JTA is exploring Renewable Natural Gas (RNG) and Hydrogen technologies as part of its long-term sustainability strategy. By leveraging a combination of alternative fuels and cutting-edge transit solutions, JTA remains committed to enhancing service reliability, reducing emissions, and preparing for the future of urban transportation in Northeast Florida.

## 3.2 Summary of Peer Interviews

Interviews were conducted to determine the peer agencies' experience with alternative fuel vehicles. The detailed interview notes are included in **Appendix B**.

### 3.2.1 PSTA

The interview with PSTA representatives provided insights into the agency's transition to alternative fuel technologies. PSTA has been incorporating hybrid-electric buses since 2009–2010 and electric buses since 2016–2017, with a strategy aimed at reducing emissions, securing grant funding, and lowering maintenance costs. While most of their fleet consists of hybrid-electric buses, they are gradually expanding the electric fleet, though diesel trolleys continue to be part of the mix. They reported success with hybrids, minimal issues with electric buses, and a 270-mile range on some electric models, though challenges remain, such as charging infrastructure and limited deployment on express routes. PSTA secured initial funding through a BP oil spill settlement and demonstrated the viability of alternative fuel buses before seeking additional funding. Key points learned include avoiding inductive charging due to impracticality, ensuring leadership support for fleet transitions, and recognizing that hybrid vehicles serve as a good starting point before a full conversion to electrification. While some cost savings have been achieved through reduced maintenance, range limitations and infrastructure improvements remain ongoing challenges.

### 3.2.2 LeeTran

The interview with LeeTran representatives revealed their experience with a diverse fleet mix, including aging hybrid buses (in service since 2013), propane vehicles (since 2015), and two electric buses expected in 2026. Their technology choices were driven by grant availability and fuel cost savings, although the hybrids did not meet expected fuel efficiency gains. Propane buses were initially attractive due to rebates but presented operational challenges, such as limited range, mid-day refueling needs, and maintenance delays, including frequent fuel pump replacements and long wait times for parts. Electric buses were selected to align with clean energy goals, particularly in downtown areas. Training needs varied, with propane fueling requiring only basic instruction while hybrid maintenance needs required certified technicians. The agency emphasized the importance of having backup plans due to potential breakdowns and high towing costs, noting that the overall costs of implementing and maintaining alternative fuel buses have been significant.

### 3.2.3 JTA

The Jacksonville Transportation Authority (JTA) interview highlighted a predominantly compressed natural gas (CNG) fleet, making up 70% of their 197 fixed-route vehicles, with CNG adoption starting in 2013–2014 to support their BRT system. Their decision to use CNG stemmed from stable fuel costs and a successful public-private partnership for fueling infrastructure. While early adoption of battery-electric buses through a 2017 grant faced range limitations and charging infrastructure issues, JTA maintains a diesel fleet for operational resiliency. They plan to introduce 14 autonomous electric shuttles in June and are exploring renewable natural gas (RNG) and hydrogen options. Challenges include underperforming electric vehicle ranges and facility space constraints for chargers. JTA values a mixed-fuel approach for safety and operational flexibility, treating its zero-emission bus plan as an evolving document to meet vehicle retirement schedules while leveraging various funding sources.

## 3.3 National Case Studies

As markets across the U.S. continue to transition from gasoline/diesel to various types of alternative sources of fuel energy, it is important to understand how transit agencies have utilized new technologies to enable themselves to do so. To give a broader perspective on alternative fuel implementation at the national level, three case studies from other U.S. based transit agencies were reviewed. Each case study will provide details about the agency and its service, explain their efforts in transitioning to alternate fuel sources, and provide outcomes and lessons regarding the shift. The three transit agencies explored include:

- Reno, NV: Regional Transportation Commission of Washoe County (RTC Washoe).
- Albuquerque, NM: Albuquerque Rapid Transit (ART)
- Lexington, KY: Lexington Transit Authority (Lextran)

### 3.3.1 Reno, NV: Regional Transportation Commission of Washoe County (RTC Washoe)

RTC Washoe serves Reno, Sparks, and other parts of Washoe County, Nevada, providing public transit to a population of approximately 450,000. The agency operates fixed-route buses, paratransit services, and BRT. RTC has been a leader in alternative fuel adoption, with 80% of its fleet already hybrid or electric.

However, the agency faced challenges with electric buses, including limited range (80-120 miles) and decreased efficiency in cold weather or on hilly routes. To address these issues, RTC recently introduced hydrogen fuel-cell buses, which offer a range of 300 miles, similar to diesel buses, making them suitable for longer routes. The agency is also building a hydrogen fueling station and providing innovative virtual reality training for mechanics to service the new buses.

Lessons learned include the importance of matching fuel technologies to operational needs, scalability of infrastructure, and proactive workforce training. RTC's approach demonstrates how agencies can balance diverse technologies to enhance sustainability and reliability.

### 3.3.2 Albuquerque, NM: Albuquerque Rapid Transit (ART)

Albuquerque Rapid Transit (ART), part of the ABQ RIDE system, serves Albuquerque, New Mexico, providing an essential transit backbone for the metropolitan area. ART is a BRT system that enhances connectivity along the Central Avenue corridor with high-capacity, efficient buses. ABQ RIDE overall provides over 13 million passenger trips annually, traveling approximately 160,000 miles daily.

ART's fleet initially used clean diesel buses, but the city has explored alternative fuel solutions as part of its broader sustainability goals. Recent developments include deploying electric buses, although early efforts faced challenges, such as operational issues and infrastructure gaps. These experiences highlighted the need for thorough pre-deployment testing and comprehensive charging infrastructure.

Lessons from ART include the importance of aligning technological upgrades with robust training for operators and maintenance staff. Albuquerque also demonstrated how transit projects like ART can serve as economic catalysts, fostering development along transit corridors.

### 3.3.3 Lexington, KY: Lexington Transit Authority (Lextran)

Lextran, the public transit agency serving Lexington, Kentucky, operates with a strong focus on sustainability and modernization. Its service area includes the Lexington-Fayette region, which has a population of over 320,000. Lextran offers a range of services, including fixed-route buses, paratransit, and campus shuttles.

In recent years, Lextran has made significant strides toward adopting alternative fuels. The agency has integrated CNG buses into its fleet, replacing aging diesel vehicles, and has introduced hybrid-electric paratransit vehicles. These initiatives were funded by federal programs like the Congestion Mitigation and Air Quality Improvement (CMAQ) program and the Low- or No-Emission Bus Grant Program. These upgrades not only reduced mobile-source emissions but also lower operational costs and improve service reliability for riders. For example, in 2024, Lextran received over $4 million in federal funding to acquire six additional low-emission CNG buses, furthering its commitment to sustainability.

Lextran's transition to alternative fuel has provided valuable lessons. Leveraging federal grants has been key to modernizing its fleet without placing undue financial strain on the agency. Moreover, the focus on lower-emission vehicles aligns with broader environmental goals while enhancing community air quality and service dependability.

### 3.3.4 Summary of National Case Studies

The three case studies—RTC Washoe, Albuquerque Rapid Transit (ART), and Lextran—demonstrate the diverse approaches used by transit agencies in adopting alternative fuel technologies. RTC Washoe in Reno has strategically incorporated hydrogen fuel-cell buses to overcome range and terrain limitations, showcasing the importance of tailoring fuel solutions to specific regional needs. ART in Albuquerque initially faced reliability challenges with its electric bus fleet, highlighting the necessity of rigorous pre-deployment testing and robust infrastructure planning.

Meanwhile, Lextran in Lexington has successfully utilized federal grants to integrate CNG buses and hybrid-electric paratransit vehicles, emphasizing the role of funding in facilitating a sustainable transition. Across these agencies, alternative fuel adoption requires a thorough understanding of regional characteristics, proactive investment in infrastructure and workforce training, and strategic use of federal resources. By learning from these examples, other transit agencies can better navigate their own transitions to alternative fuels, balancing environmental goals with operational efficiency and reliability.

## 3.4 Key Takeaways for CAT

The lessons learned from these agencies are important for Collier County and CAT as the possibility of transitioning to different fuel types continues to be explored. Some key takeaways include:

- It is important to understand the range of EVs as buses may need to cover long distances daily. Use of EVs may need to be supplemented by other fuel and battery technologies to extend ranges.
- Any new infrastructure or modifications to existing infrastructure supporting alternative fuel strategies, including its maintenance, should be planned in advance to ensure a smooth transition.
- There are several alternate fuel types that may be explored using different vehicle types and fueling/EV infrastructure. Depending on the scale of changes, multiple fuel types may fit for different uses or route types.
- Funding sources for EV or Low/No-Emission vehicles have been available in the past. Exploring current available funding may provide opportunities for CAT to begin the process of transitioning fuel types.
- Other transit agencies are exploring alternate fuel types and the infrastructure that goes along with it. Even though there are issues that arise when doing so, these are efforts that agencies are utilizing to lower mobile-source emissions and to match community and infrastructure changes.

# 4 LOCAL, REGIONAL, AND STATE INITIATIVES

Understanding the broader landscape of initiatives that support alternative fuel vehicles or zero-emission vehicles (ZEV) implementation is critical to shaping CAT's decision-making and operational planning. This section provides a review of several local, regional, and state initiatives to provide valuable insights into best practices, infrastructure development, and strategic alignment for adopting electric and alternative fuel vehicles. The goal is to highlight key insights and opportunities that CAT can leverage as it transitions its fleet to alternative fuel types. The initiatives reviewed include:

- Federal Transit Administration Low or No Emission Grant Program
- Florida's Energy & Climate Action Plan (2008)
- Florida Electric Vehicle Roadmap Executive Report (2020)
- FDOT EV Infrastructure Master Plan (2021)
- CAT Transit Development Plan Major Update (2020) and Annual Progress Report (2024)
- Collier County Comprehensive Plan (2023)
- City of Naples Critical Assets and Facilities Adaptation Plan (2024)
- LeeTran FTA Bus Low- and No-Emission Grant Award (2022)

To enhance collaboration and leverage existing resources, CAT is encouraged to engage with other County departments managing large fleets—such as fire, police, solid waste, and education—to explore their experiences with ZEVs and alternative fuel technologies. These cross-departmental discussions are essential for addressing potential challenges, such as shared infrastructure and redundancy planning, and will inform CAT's approach to sustainable transit solutions.

## 4.1 Federal Transit Administration Low or No Emission Grant Program

The FTA's Low-No Program provides funding to help transit agencies purchase low- and zero-emission buses, such as electric or hydrogen-powered vehicles, and build facilities like charging stations to support these technologies. It also includes resources for workforce training to prepare transit workers to maintain and operate the advanced vehicles and infrastructure. The program aims to reduce air pollution, improve energy efficiency, and support climate goals while also promoting economic benefits like job creation and local manufacturing. By modernizing fleets, the program helps communities transition to cleaner, more sustainable public transportation systems, benefiting both the environment and public health.

**Key Takeaways**

- Provides critical funding to help transit agencies transition to low/no-emission technology.
- Includes electric/hydrogen buses and their associated infrastructure.
- Used to replace older, high-emission vehicles.
- Reduces greenhouse gas emissions, improves air quality, and aligns public transit with climate and sustainability goals.
- Includes training in the maintenance and operation of low/no emission vehicles and their associated facilities.
- Promotes job creation and supports local manufacturing.

## 4.2 Florida's Energy & Climate Change Action Plan (2008)

The Governor's Action Team on Energy and Climate Change developed a plan that will secure Florida's energy future, reduce greenhouse gas emissions, and heavily support and sustain strategic economic development in the emerging "green tech" sector. The plan concluded that Florida will be significantly impacted if: the current trajectory of greenhouse gas emissions is not reversed; addressing climate change can present significant energy benefits; energy management can reduce energy costs; investments in sustainable energy can stimulate Florida's economy; and that market-oriented regulations can guide a low-carbon economy.

**Key Takeaways**

- Transportation is the second-largest contributor to greenhouse gas emissions.
- Greenhouse gas emissions can be reduced through improving vehicle efficiency, shifting to more efficient fuel types, and reducing vehicle miles traveled.
- Transportation planning efforts should consider reductions in greenhouse gas emissions.
- Implementation of policies/strategies to include funding for non-SOV (single occupant vehicles) modes of travel.

## 4.3 Florida Electric Vehicle Roadmap Executive Report (2020)

Examines the current state and future needs of electric vehicle (EV) charging infrastructure across Florida. The report highlights the critical role of EVs in reducing greenhouse gas emissions and improving public health, outlines gaps in charging infrastructure, and provides recommendations for site selection, planning, and regulatory improvements. It also addresses specific challenges, such as rural and underserved community access, emergency evacuation needs, and aging infrastructure. The roadmap emphasizes the importance of collaboration among public, private, and state entities to support the transition to electric transportation.

**Key Takeaways**

- Identifies the need to address gaps in charging infrastructure and to upgrade existing chargers.
- Recommends temporary charging solutions for emergencies.
- Education and incentives are necessary to increase support for EV implementation.
- Collaboration among governments, businesses, and utility providers is important for successful implementation of EV infrastructure.

## 4.4 FDOT EV Infrastructure Master Plan (2021)

The Master Plan details a comprehensive course of action to efficiently and effectively provide EV charging infrastructure, supporting the goals of F.S. 339.287. This document serves as a starting point for both public and private entities to become familiar with the challenges and opportunities associated with EV charging infrastructure. It also serves as a guide for future legislative, agency-level and public engagement efforts. By advancing the use of EVs to improve air quality and foster economic development by encouraging the expansion of the labor force to support EV infrastructure, this Master Plan also supports the Florida Transportation Plan (FTP). The EVMP supports opportunities to lower the total cost of vehicle ownership per household and enhances transportation equity. The primary objectives of the EVMP include: support short-range and long-range EV travel as well as emergency evacuation in the state; adapt state highway infrastructure consistent with market demand; ensure availability of adequate and reliable EV charging stations.

**Key Takeaways**

- Charging a transit bus will require an electric grid with an output between 150kW – 350kW
- About 5 megawatts (MW) of power will be required to support 30-35 150kW chargers, which would support a 100-bus depot on a daily basis.
- The most common method of vehicle charging comes from on-site chargers; enroute charging is also used to extend bus range and improve operations where beneficial.
- Multiple buses may be necessary to run routes traditionally run by diesel, depending on battery size and charging strategy.

## 4.5 CAT Transit Development Plan Major Update (2020) and Annual Progress Report (2024)

The Transit Development Plan (TDP) is a 10-year plan for transit and mobility needs, cost and revenue projections, and community transit goals, objectives, and policies. The TDP major update occurs every five years with annual updates outlining progress the transit agency has made over the past year in achieving the goals and objectives identified in the last major update. CAT is currently updating the TDP for adoption later in 2025.

**Key Takeaways**

- Supports CAT transition to cleaner, alt-fuel vehicles.
- Establishes need for EV charging infrastructure to be used as vehicle chargers as well as public emergency generators during disasters.
- Explores solar energy as source for EV and operations of transit facility.
- Identifies previous and ongoing CAT grant funding for EV acquisition as well as assumptions on future funding availability.

## 4.6 Collier County Comprehensive Plan (2023)

The Collier County Comprehensive Plan emphasizes creating a safe, efficient, and sustainable multimodal transportation system while protecting natural and coastal resources. The Transportation Element focuses on reducing greenhouse gas emissions through improved traffic circulation, mixed land-use zoning, and enhanced pedestrian, bicycle, and public transit options. The Conservation and Coastal Management Element prioritizes climate adaptation and resiliency, with strategies to address flooding, storm surge, and sea-level rise while conserving water, energy, and biodiversity. Both elements encourage sustainable development and infrastructure improvements to support long-term environmental and community health.

**Key Takeaways**

- Transportation strategies include reducing vehicular trips, supporting transit/active transportation, and compliance with statewide goals and objectives.
- Calls for integration between local efforts and regional planning agencies.

- Long term climate resilience through monitoring sea-level rise, low-emission travel infrastructure, and sustainable land use.
- Emphasizes a balanced approach to development and environmental stewardship for enhanced community resilience and sustainability.

## 4.7 City of Naples Critical Assets and Facilities Adaptation Plan (2024)

Outlines strategies to mitigate the impacts of climate hazards, particularly flooding and extreme heat. The plan builds upon prior vulnerability assessments and identifies critical infrastructure, community facilities, and natural and cultural resources that require adaptation. Strategies are categorized into tiers based on priority, with actions ranging from policy updates to infrastructure projects. The plan emphasizes community and stakeholder engagement, as well as regional partnerships, to ensure effective implementation and resiliency enhancement.

**Key Takeaways**

- Ranks 47 strategies into high, medium, and low priority for addressing climate risks.
- Focuses on urgent needs to reduce the negative effects of weather events, such as flooding and extreme heat.
- Combines physical infrastructure upgrades with policy updates.
- Community input identified flooding as the greatest concern.
- Aims to secure funding, protect health, and enhance the city's resiliency and livability aspects.

## 4.8 LeeTran FTA Bus Low- and No-Emission Grant Award (2022)

In 2022, FTA announced $1.66 billion in grants to transit agencies, territories and states across the U.S. to invest in bus fleets and facilities. Majority of funded projects use zero-emissions technology, which reduces air pollution.

LeeTran, as one of the recipients of this grant, received nearly $3.9 million in funding for new battery electric buses, replacing diesel hybrid vehicles at the end of their useful life.

**Key Takeaways**

- Awarded $3.9 million for LeeTran to purchase battery electric buses.
- Includes additional charging infrastructure.

# 5 UTILITY PROVIDER COORDINATION

The transition to electric vehicles within CAT's fleet requires the development of electric charging infrastructure as well as an overall greater use of the local power grid. To better understand the amount of electricity and its associated infrastructure needed when working towards the electrification of the CAT fleet, communication with Florida Power & Light (FPL) and the Lee County Electric Cooperative (LCEC) was established. The goal of communicating with these electricity providers is vital in gathering information regarding necessary infrastructure upgrades, in-route charging options, planning level-cost estimates, and future maintenance requests.

FPL's Power Distribution Group focuses on larger, commercial industry projects within the Collier County area. This group may work with CAT in developing their site for possible projects that would develop the capacity for on-site EV charging. Currently, the FPL Distribution Group is conducting an internal site review of the Collier Area Transit Administration Office at 8300 Radio Road, Naples, Florida 34104 to determine their local grid's capacity and availability to grow. Continued communication with FPL will provide CAT options for the establishment of EV charging on-site through the local power grid. Future expansion of charging needs at the administration office will require a larger transformer to ensure sufficient power to meet the needs. The current site review is intended to provide direction regarding the timing of this need, in terms of number of chargers, and the maximum need for converting the entire fleet to battery electric buses. The agency will report any determinations from further evaluations beyond the scope of this plan as these take place.

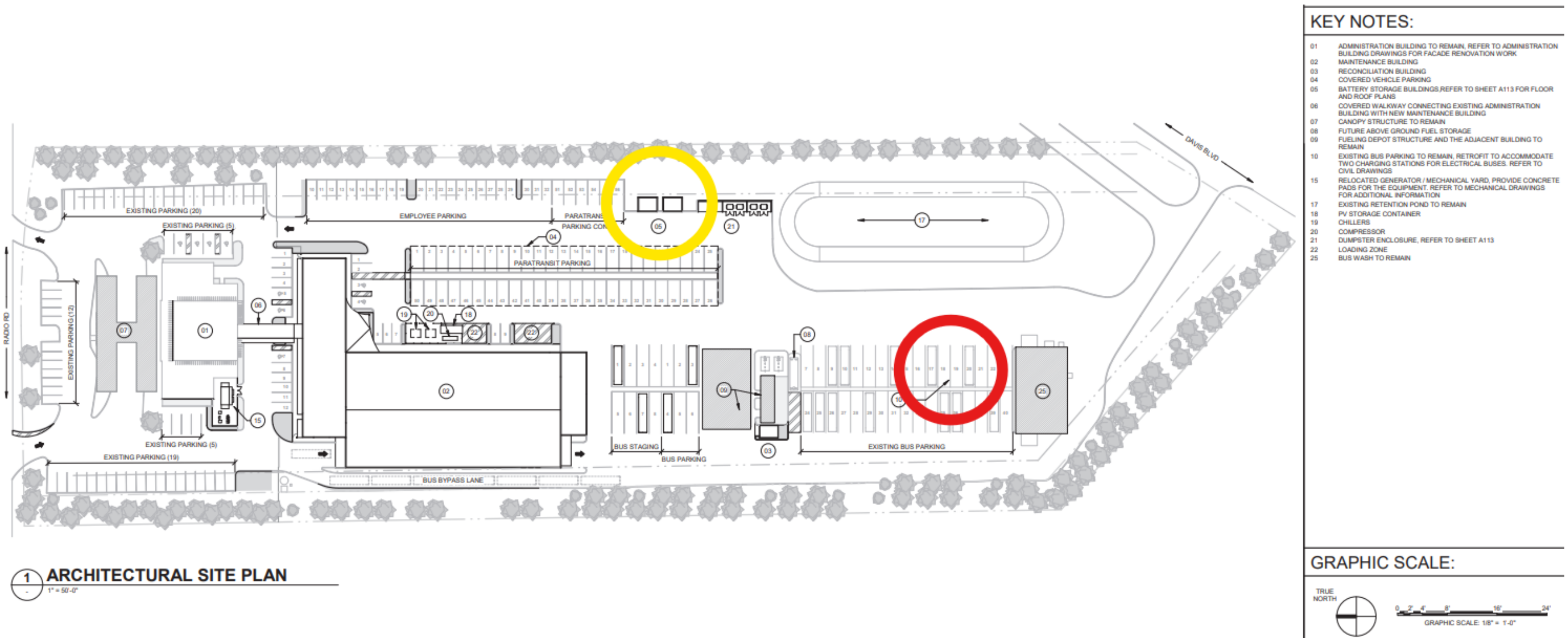
## 5.1 FPL EVolution

FPL's Evolution program provides comprehensive EV charging at residential and commercial levels. While the program is designed primarily for personal vehicles, fast charging and level 2 charging infrastructure can be provided, which may be used in the overnight charging of an EV bus or support vehicles. The EVolution Fleet program was created for commercial businesses to electrify their fleets. The program provides public fast charging stations at no cost, charging the driver of the EV based on the amount of electricity used for charging.

## 5.2 Facility Analysis

CAT has developed a site plan to include EV charging infrastructure at their administrative office. **Figure 5-1** highlights where the infrastructure will be located on the site. According to the plan, two new battery storage units will be installed on the west side of the site and are highlighted in a yellow circle. CAT also plans on retrofitting two of its current bus parking spaces to include EV charging stations, which may be used during buses' downtime to refuel the vehicle. The location of these spaces on the site is highlighted in a red circle. Overall, these electric infrastructure upgrades do not hinder the ability of the site, as the batteries are out of the way of vehicular traffic and CAT currently provides its vehicles with ample parking. In addition to the administrative office, CAT also has transfer facilities located in Immokalee and at the Government Center. Assessment of these facilities was not included at this time. Scenarios developed for the transition plan contemplated in-route charging at these transfer facilities, but were not included in the recommendation. Future decisions regarding in-route charging would require review of each location and the opportunities for adding charging infrastructure for battery electric buses.

**FIGURE 5-1: SITE PLAN FOR CAT OPERATIONS FACLITY**



# 6 ALTERNATIVE FUEL FEASIBILITY

This section presents the findings of a comprehensive feasibility analysis conducted to evaluate the potential implementation of ZEVs and other alternative fuel vehicles within CAT's current transit network. The analysis includes a detailed assessment of fixed-route bus operations, demand-response paratransit operations, and equipment or support vehicle services. By modeling weekday, Saturday, and Sunday service levels, the analysis explores the operational feasibility of battery electric, hydrogen, hybrid electric, and compressed natural gas vehicles. Specific emphasis has been placed on evaluating battery electric vehicles under nominal and strenuous energy demand scenarios, while also considering factors such as battery degradation over the lifecycle of the vehicle.

This analysis aims to provide actionable insights into how fuel alternatives may align with CAT's operational needs and network requirements. Key considerations include the feasibility of vehicle block schedules, the potential addition of mid-route or off-site charging infrastructure, and the number of vehicles required to maintain efficient operations. The findings will support decision-making regarding the transition to a ZEV fleet, with the ultimate goal of achieving sustainable and efficient transit solutions.

## 6.1 Baseline Data

CAT provides service throughout Collier County through a total of 16 bus routes: 12 fixed routes, three circulators, and one express route. Fixed route service is provided seven days a week by CAT along with paratransit services through CATConnect for ADA clients and Transportation Disadvantaged clients. The following information was provided by CAT Staff to understand service provision, fleet size and other data that will help generate an understanding of the feasibility of introducing alternative fuel vehicles.

### 6.1.1 Fleet

CAT owns a fleet of 69 vehicles composed of revenue (rolling stock) and non-revenue (equipment) vehicles. **Table 6-1** summarizes CAT's current fleet composition by asset class and number of vehicles.

TABLE 6-1: CAT FLEET SUMMARY

| Asset Class | Number of Vehicles |
|---|---|
| ***Fixed Route*** | *30* |
| ***Demand Response*** | *33* |
| **Rolling Stock Total** | 63 |
| **Support (Equipment) Total** | 6 |
| **TOTAL FLEET SIZE** | **69** |

The following section describes the fleet by asset class with considerations regarding vehicle lengths, fuel types, and purchase years, as well as replacement period policies.

#### 6.1.1.1 Fixed Route

At the time of this study, CAT's fixed route consisted of the following vehicles which are split into vehicle lengths and fuel types. The fixed route fleet is composed of 30-foot, 35-foot, and 40-foot buses. In total, CAT has 30 buses for fixed route service, with five additional buses currently in procurement. CAT's current fixed route fleet is largely made up of diesel buses, although CAT has experience with one hybrid diesel-electric bus and a new battery electric bus. **Table 6-2** presents the fixed route fleet by fuel type as well as vehicle lengths. **Table 6-3** presents the purchase year of the various buses in CAT's fleet. The largest purchases were made in 2022 and 2012, with six and five vehicles in each year respectively.

**TABLE 6-2: FIXED ROUTE FLEET BY FUEL TYPE AND VEHICLE LENGTH**

| Vehicle Length | Diesel | Gasoline | Battery Electric | Total |
|---|---|---|---|---|
| **30'** | 18** | 2 | 0 | **20** |
| **35'** | 10** | 0 | 1* | **11** |
| **40'** | 4 | 0 | 0 | **4** |
| **Total** | **32** | **2** | **1** | **35** |

**In Procurement **Two in Procurement*

**TABLE 6-3: FIXED ROUTE FLEET BY FUEL TYPE AND PURCHASE YEAR**

| Purchase Year | Diesel | Gasoline | Battery Electric | Total |
|---|---|---|---|---|
| **2025** | 4* | 0 | 1* | 5* |
| **2024** | 1 | 0 | 0 | 1 |
| **2023** | 4 | 0 | 0 | 4 |
| **2022** | 6 | 0 | 0 | 6 |
| **2020** | 0 | 2 | 0 | 2 |
| **2019** | 1 | 0 | 0 | 1 |
| **2018** | 1 | 0 | 0 | 1 |
| **2017** | 4 | 0 | 0 | 4 |
| **2016** | 3 | 0 | 0 | 3 |
| **2015** | 1 | 0 | 0 | 1 |
| **2014** | 2 | 0 | 0 | 2 |
| **2012** | 5 | 0 | 0 | 5 |
| **Total** | 32 | 2 | 1 | 35 |

** In Procurement*

CAT follows FTA and FDOT's Minimum Useful Life guidelines for the replacement of its vehicles: CAT replaces its 30-foot buses every 10 years, and its larger 0-foot buses every 12 years. CAT regularly evaluates its rolling stock's maintenance records to determine if a bus needs to be replaced, including if the bus has reached the indicated minimum replacement mileage, which would be 350,000 miles for the 30-foot buses or 500,000 miles for the 35-foot and 40-foot buses. For this analysis, the assumptions are based on the minimum useful years, but this does not preclude CAT from replacing vehicles as needed.

Based on these assumptions, CAT's current fixed route fleet is expected to be replaced as indicated in **Table 6-4**. The information in this table is important in building a replacement schedule that strategically moves CAT towards its vision for a low and zero-emission future.

**TABLE 6-4: ESTIMATED FIXED ROUTE VEHICLE REPLACEMENT SCHEDULE**

| Replacement Yr. | Diesel | Gasoline | Battery Electric | Total |
|---|---|---|---|---|
| **2037** | 2 | 0 | 1 | 3 |
| **2036** | 1 | 0 | 0 | 1 |
| **2035** | 2 | 0 | 0 | 2 |
| **2034** | 1 | 0 | 0 | 1 |
| **2033** | 4 | 0 | 0 | 4 |
| **2032** | 5 | 0 | 0 | 5 |
| **2031** | 0 | 0 | 0 | 0 |
| **2030** | 0 | 2 | 0 | 2 |
| **2029** | 1 | 0 | 0 | 1 |
| **2028** | 3 | 0 | 0 | 3 |
| **2027** | 5 | 0 | 0 | 5 |
| **2026** | 3 | 0 | 0 | 3 |
| **2025** | 0 | 0 | 0 | 0 |
| **2024** | 5 | 0 | 0 | 5 |
| **2023** | 0 | 0 | 0 | 0 |
| **Total** | 32 | 2 | 1 | 35 |

#### 6.1.1.2 Demand Response

At the time of this study, CAT's demand response fleet consists primarily of 23-foot cutaway buses, with a handful of either 24-foot or 17-foot buses. In total, CAT has 33 cutaway buses for demand response service, with four additional vehicles currently in procurement. CAT's current demand response fleet is largely fueled by gasoline, with a number of diesel-fueled cutaways. All six diesel cutaways are 23 feet in length. **Table 6-5** presents information regarding the demand response fleet by fuel type and vehicle lengths. **Table 6-6** presents the purchase year of the various cutaways in CAT's fleet. The largest purchases were made in 2019 and 2020, with eight and seven vehicles each year.

**TABLE 6-5: DEMAND RESPONSE FLEET BY FUEL TYPE AND VEHICLE LENGTH**

| Vehicle Length | Diesel | Gasoline | Total |
|---|---|---|---|
| **17'** | 0 | 3 | **3** |
| **23'** | 6 | 20 | **26** |
| **24'** | 0 | 4 | **4** |
| **TBD** | 0 | 4* | **4*** |
| **Total** | **6** | **31** | **37** |

** In Procurement*

**TABLE 6-6: DEMAND RESPONSE FLEET BY FUEL TYPE AND PURCHASE YEAR**

| | Diesel | Gasoline | Total |
|---|---|---|---|
| **2025** | 0 | 4* | 4* |
| **2024** | 0 | 3 | 3 |
| **2021** | 0 | 6 | 6 |
| **2020** | 0 | 7 | 7 |
| **2019** | 4 | 4 | 8 |
| **2018** | 0 | 4 | 4 |
| **2016** | 2 | 2 | 4 |
| **2012** | 0 | 1 | 1 |
| **Total** | **6** | **31** | **37** |

** In Procurement*

CAT follows FTA and FDOT's Minimum Useful Life guidelines for the replacement of its cutaways from its fleet every 5 years, regardless of vehicle length. CAT regularly evaluates its cutaway's maintenance records to determine if they need to be replaced, including if the cutaway has reached the indicated minimum replacement mileage, which would be 200,000. For this analysis, the assumptions are based on the minimum useful years, but this does not preclude CAT from replacing vehicles as needed

Following CAT's vehicle replacement guidelines, the current demand response fleet is expected to be replaced as indicated in **Table 6-7**. This information is useful in building a replacement schedule that strategically phases out conventional fuel vehicles, such as diesel and gasoline, for alternative fuel vehicles. The table does not reflect all vehicles that will be replaced since some will not be replaced until they have met the minimum replacement mileage. Additionally, some vehicles were not replaced at the desired time due to delays in the supply chain during COVID-19.

**TABLE 6-7: ESTIMATED DEMAND RESPONSE VEHICLE REPLACEMENT SCHEDULE**

| | Diesel | Gasoline | Total |
|---|---|---|---|
| **2029** | 0 | 3 | 3 |
| **2026** | 0 | 6 | 6 |
| **2025** | 0 | 7 | 7 |
| **Total** | **0** | **16** | **16** |

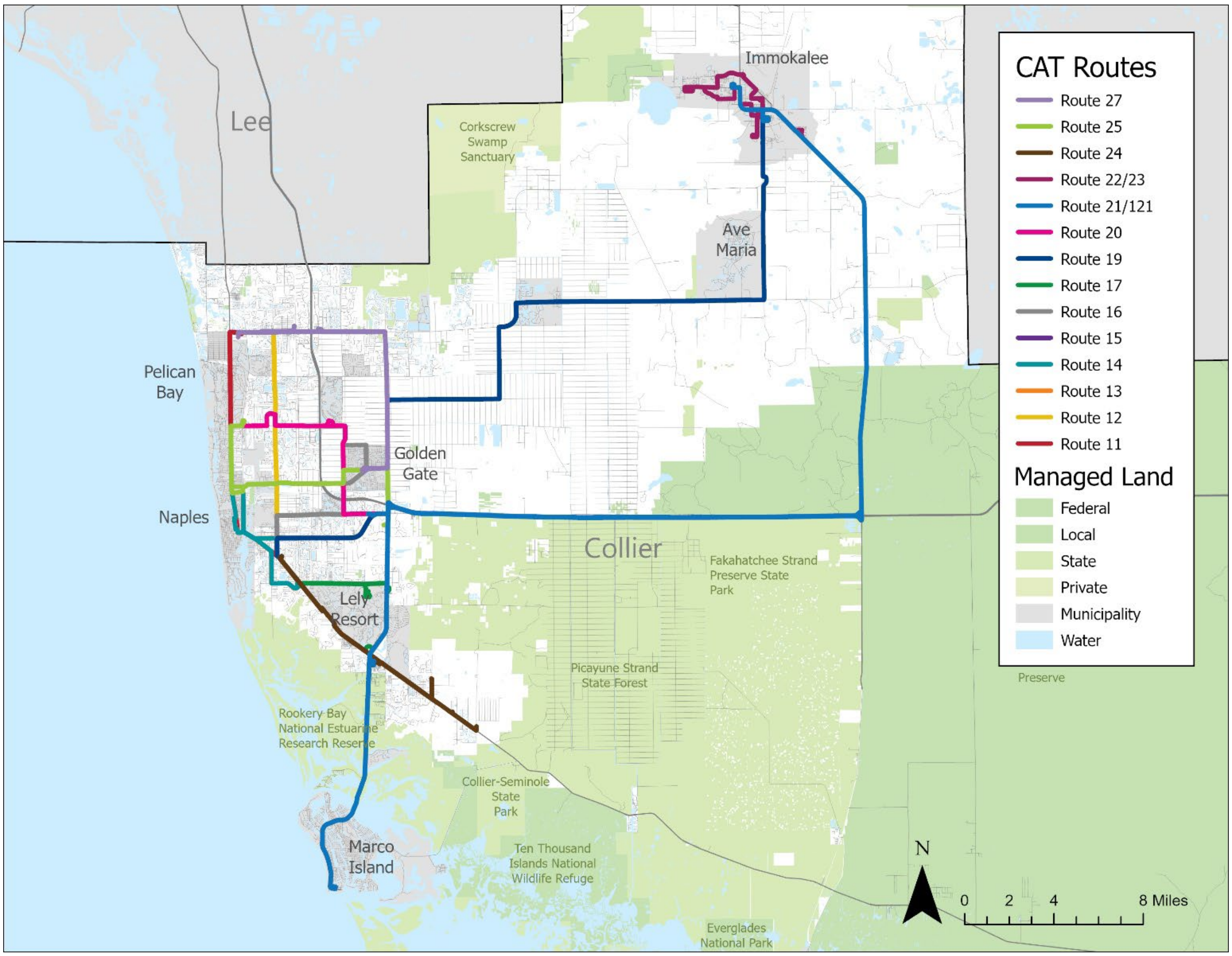
#### 6.1.1.3 Support Vehicles

CAT operates a total of six support vehicles, all of which are gasoline fueled. Support vehicles include one sedan automobile, one sports utility vehicle (SUV), two minivans, and two pickup trucks. Two support vehicles were purchased in 2016, one in 2017 and three in 2018. Following FTA's minimum useful life policy of five years, however, asset management rules are generally less stringent about the useful life of support vehicles since they are not in revenue service. Additionally, it takes support vehicles a longer time to accumulate enough mileage before replacement is needed. CAT will be replacing its two minivans for two electric SUVs in the near future, both of which were purchased in 2018.

### 6.1.2 Fixed Routes and Service Blocks

CAT provides fixed route transit services across Collier County on 16 routes. **Map 6-1** presents the geographical coverage of CAT's fixed route system. Services generally cover the western, urban and suburban sectors of Collier County, including Naples, Marco Island, Pelican Bay, Golden Gate, North Naples, and other communities. Another set of routes and circulators serve Immokalee and Ave Maria which are in the northeastern portions of Collier County. Direct connections to Immokalee are provided by Route 19 to Collier County Government Center in Naples, and by Route 121 to Marco Island.

**MAP 6-1: CAT ROUTES**




*Source: Collier Area Transit*

**Table 6-8** presents a profile of each CAT Route, identified by the numerical route designation along with a description of where these routes operate, service type, and route length.

The table also includes a brief route profile, which subjectively categorizes each route by describing the level of land use intensity as well as traffic along main corridors. Land use categories include urban (mainly serving incorporated areas), suburban (entering, leaving, or straddling incorporated areas), or rural (passes through primarily unincorporated areas between destinations). Traffic categories are determined based on the primary level of vehicular traffic on each route's corridors, which includes low (traveling on roads with Annual Average Daily Traffic (AADT) less than 20,000), medium (primarily on corridors with AADT between 20,000 - 40,000), and high traffic (primarily on corridors with AADT of greater than 40,000). It also establishes routes which travel to destinations outside of the greater Naples urban area long-distance as commuter routes.

**TABLE 6-8: CAT ROUTE PROFILES**

| Route Number | Description | Route Type | Route Length* | Route Profile |
|---|---|---|---|---|
| **11** | US 41 to Creekside Commerce Park | Fixed | 27.6 mi | Suburban/High Traffic |
| **12** | Airport Road to Creekside Commerce Park• | Fixed | 31.4 mi | Suburban/Medium Traffic |
| **13** | NCH & Coastland Center Mall | Fixed | 17.4 mi | Urban/High Traffic |
| **14** | Bayshore Drive to Coastland Mall | Fixed | 15.7 mi | Urban/High Traffic |
| **15** | Golden Gate City (Santa Barbara) | Fixed | 28.3 mi | Urban/Medium Traffic |
| **16** | Golden Gate City (Santa Barbara) | Fixed | 42.2 mi | Urban/Medium Traffic |
| **17** | Rattlesnake to FSW | Fixed | 23.6 mi | Suburban/Medium Traffic |
| **19/19X** | Golden Gate Estates and Immokalee | Fixed | 40.4 mi | Suburban/Low Traffic/Commuter |
| **20** | Pine Ridge Road | Fixed | 29.2 mi | Urban/High Traffic |
| **21** | Marco Island Circulator | Circulator | 37.4 mi | Urban/Low Traffic |
| **22** | Immokalee Circulator | Circulator | 22.2 mi | Urban/Low Traffic |
| **23** | Immokalee Circulator | Circulator | 22.2 mi | Urban/Low Traffic |
| **24** | US 41 to Charlee Estates | Fixed | 30.1 mi**<br>17.6 mi*** | Suburban/Medium Traffic |
| **25** | Golden Gate Pkwy & Goodlette-Frank | Fixed | 30.2 mi | Urban/High Traffic |
| **27** | Immokalee Road | Fixed | 32.1 mi | Suburban/Medium Traffic |
| **121** | Immokalee to Marco Island Express | Express | 134.6 mi | Suburban/Low Traffic/Commuter |

** Represents the total inbound and outbound route lengths*
*** Represents the long route configuration*
**** Represents the short route configuration*

The Zero Emission Vehicle Transition Plan requires evaluating the feasibility of alternative fuel vehicles within existing operations. This assessment must consider not only route profiles but, more importantly, the number of trips a single bus completes on a route or a combination of routes, as determined by the agency's operations unit, referred to as a block.

A **service block**, **vehicle block**, or simply, a **block,** is a group of scheduled trips assigned to a single vehicle. These blocks are subject to the organization of the service provider and may follow a single route or may be split among multiple different routes. Blocks are designed with careful consideration for the number of available vehicles in a fleet, the maximum hours a driver can operate a bus, and miles before refueling, among other things.

To conduct this study, it is essential to determine the number of blocks CAT operates and the total miles a vehicle travels per block, including both revenue miles and deadhead miles.

CAT currently operates weekday service on 16 routes using 21 vehicle blocks. Four of these blocks are paired, with each pair served by a single vehicle. The operating hours for each block vary across weekdays, Saturdays, and Sundays, with some blocks not running on one or both weekend days. On Saturdays, 17 of the 21 blocks are in service, while 13 blocks operate on Sundays.

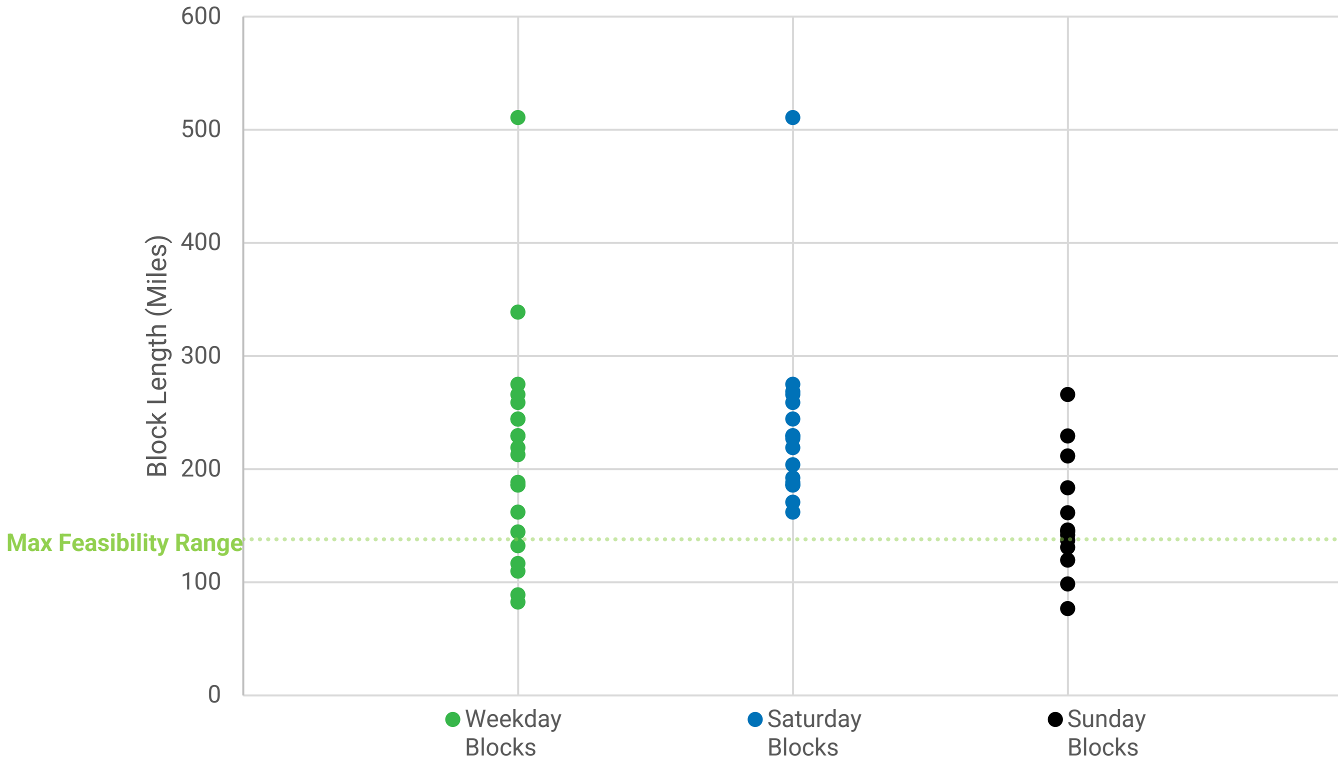
**Table 6-9** presents the number of blocks in service by day and by vehicle length. Vehicle length is a key consideration for battery electric buses, as each length corresponds to a different battery capacity. This variation requires distinct assumptions when analyzing energy needs and operational feasibility.

TABLE 6-9: FIXED ROUTE SERVICE BLOCKS BY DAY OF WEEK AND VEHICLE LENGTH

| Vehicle Length | Weekday | Saturday | Sunday |
|---|---|---|---|
| **30’** | 16 | 12 | 9 |
| **35’** | 4 | 4 | 3 |
| **40’** | 1 | 1 | 1 |
| **Total** | **21** | **17** | **13** |

**Figure 6-1** illustrates the distribution of block lengths in miles for each day of operation. On weekdays, most blocks fall between 100 and 300 miles, with two exceeding this range. Saturday blocks are generally longer, primarily ranging from 150 to 300 miles, with one block extending just over 500 miles. Sunday blocks are the shortest, typically between 100 and 250 miles. A general reference on electric vehicle feasibility range is added at around 125 miles as a quick reference to understand the distribution of blocks that may feasibly be served by battery electric buses.

**FIGURE 6-1: DISTRIBUTION OF BLOCK LENGTHS FOR EACH SERVICE DAY**




CAT service blocks are assigned simple integer identifiers ranging from 1 to 22, excluding Block 14 which is used for route maintenance purposes. Collectively, weekday blocks cover approximately 4,423 miles, including deadhead miles, and covering over 231 hours of total service, which accounts for deadhead and layover time. **Table 2-2** presents a comprehensive overview of service blocks, assigned routes, vehicle lengths, and operational details by day. Highlights of the operating conditions for the block schedule are listed below.

### WEEKDAY SERVICE

Among weekday service blocks, Block 4 (assigned to Route 19) covers the longest distance at approximately 510 miles, followed by Block 10, which serves Routes 24 and 19, at around 339 miles. Route 19 is a long-distance commuter route that is nearly 50-miles long connecting Immokalee to the Collier County Government Center in Naples, contributing to Block 4's high mileage. Route 24 extends south of the government center along Tamiami Trail to Six L's Farm Road.

At the other end of the spectrum, Block 21 (serving Route 20) covers the shortest distance at 82 miles, followed by Block 22 (assigned to Routes 21 and 24) at 89 miles. Route 20 primarily operates along Santa Barbara Boulevard and Pine Ridge Road, while Route 21, the Marco Island Circulator, connects the Super Walmart on Collier Boulevard with Marco Island.

### SATURDAY SERVICE

On Saturdays, service blocks cover a total of 4,015 miles over 209 hours. Block 4 remains the longest, operating the same distance and weekday schedule Route 19. The second-longest block, Block 3, is assigned to Route 19's express service and Route 11, which runs along Tamiami Trail north to Immokalee Road.

The shortest Saturday block is Block 16, serving Route 22, at 162 miles, followed by Block 10. Route 22, known as the Immokalee Circulator, operates as a loop serving various points around Immokalee.

#### SUNDAY SERVICE

Sunday service covers 2,046 miles and operates for 109 hours. The longest block, Block 1, is assigned to Route 13 and covers 266 miles, followed by Block 3, which spans 230 miles.

The shortest block, Block 2, runs Route 25 for 77 miles, followed by Block 5, which serves Route 16 at 98 miles.

### Table 6-10: Fixed Route Service Block Profiles

| Block No. | Vehicle Length | Assigned to Route(s) | Weekday | | Saturday | | Sunday | |
|---|---|---|---|---|---|---|---|---|
| | | | Time (Hours) | Distance (mi.) | Time (Hours) | Distance (mi.) | Time (Hours) | Distance (mi.) |
| **1** | 40’ | 19/12 | 14:39 | 258.79 | 14:39 | 258.79 | 06:24 | 265.89 |
| **2/20** | 30’ | 25/19 Express | 13:58 | 276.59 | 11:17 | 203.8 | 03:15 | 76.62 |
| **3** | 30’ | 19 Express/11 | 14:54 | 274.95 | 14:54 | 274.95 | 12:50 | 229.16 |
| **4** | 35’ | 19 | 17:55 | 510.62 | 17:55 | 510.62 | 10:16 | 146.04 |
| **5** | 35’ | 16 | 13:40 | 218.96 | 13:40 | 218.96 | 03:19 | 98.4 |
| **6** | 30’ | 121 | 06:24 | 265.89 | 06:24 | 265.89 | 12:08 | 211.6 |
| **7** | 30’ | 15 | 14:43 | 244.21 | 14:43 | 244.21 | 09:01 | 144.46 |
| **8** | 30’ | 11 | 12:23 | 185.94 | 12:23 | 185.94 | 10:53 | 161.3 |
| **9** | 30’ | 17 | 11:51 | 188.14 | 11:51 | 188.14 | 08:56 | 137.05 |
| **10** | 30’ | 24/19 | 13:09 | 338.74 | 06:29 | 170.69 | 07:13 | 130.84 |
| **11** | 30’ | 13 | 13:26 | 185.82 | 13:44 | 226.93 | 09:37 | 119.5 |
| **12** | 30’ | 27 | 13:56 | 244.1 | 11:14 | 192.16 | 08:39 | 141.62 |
| **13** | 35’ | 21 | 04:53 | 116.54 | 13:26 | 185.82 | 06:18 | 183.39 |
| **15/21** | 30’ | 20 | 11:14 | 192.17 | 12:50 | 229.16 | | |
| **16** | 30’ | 22 | 12:50 | 229.16 | 11:35 | 161.92 | | |
| **17** | 30’ | 14 | 11:35 | 161.92 | 12:50 | 229.48 | | |
| **18** | 35’ | 23 | 12:50 | 229.48 | 09:18 | 268.37 | | |
| **19** | 30’ | 24 | 12:44 | 212.64 | | | | |
| **22** | 30’ | 21/24 | 04:08 | 88.76 | | | | |
| **Totals** | | | **231:12** | **4423.42** | **209:12** | **4015.83** | **108:49** | **2045.87** |

### 6.1.3 Demand Response Service Details

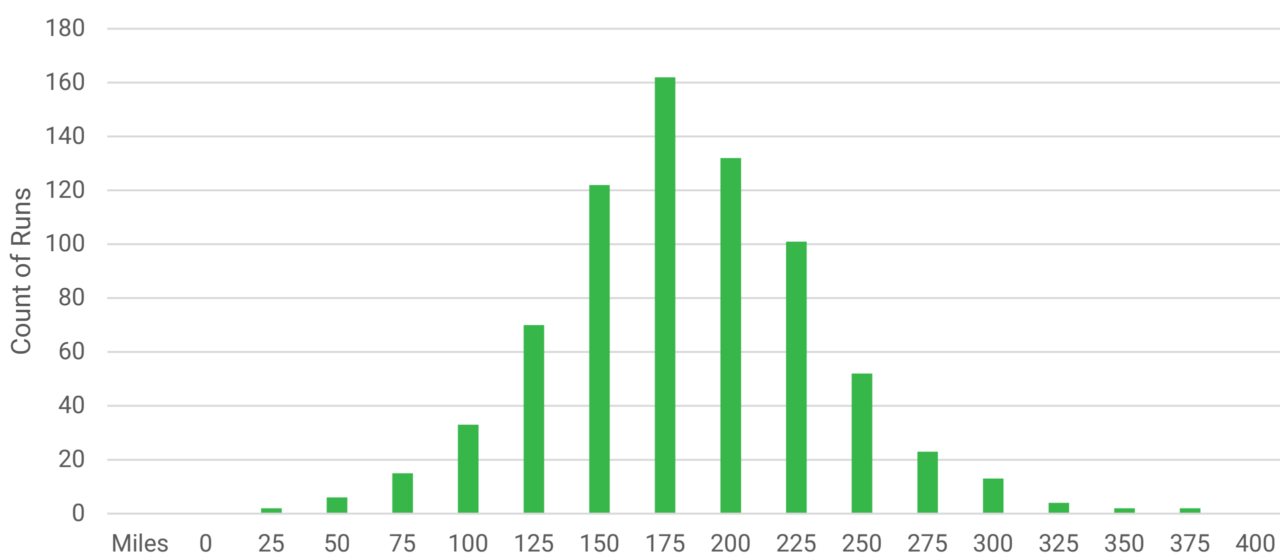
Demand Response operations are not served by routes or blocks, rather they are served by service runs. A service run is the total miles that a vehicle operates for a specific trip on a given day. Because the nature of this type of service is not fixed but based on demand, service details are less predictable. To account for the randomness of trip lengths, a sample of CAT's daily demand response run productivity was analyzed for the month of November 2024. **Table 6-11** provides a few descriptives from this data sample.

**TABLE 6-11: DESCRIPTIVE DATA FROM NOVEMBER 2024 OBSERVED RUNS**

| Values | Miles |
|---|---|
| **Minimum** | 35 |
| **First Quartile** | 166 |
| **Median** | 193 |
| **Average** | 196 |
| **Third Quartile** | 228 |
| **Maximum** | 400 |
| | |
| **Sample Size** | N=739 |

The observed trip lengths range from 35 to 400 miles, with the most frequently occurring trips falling between 166 and 228 miles. The average trip length is 196 miles. **Figure 6-2** illustrates the distribution of trip runs in 25-mile intervals. The assessment compares the feasible service range to the various mileage values presented including average run, quartiles, percentiles, minimums and maximums.

**FIGURE 6-2: DISTRIBUTION OF OBSERVED RUNS BY TRIP LENGTHS**




*N=739*
*Source: Collier Area Transit*

### 6.1.4 Equipment/Support Mileage Details

Support vehicles are operated as needed, with each serving a distinct function, resulting in varying mileages across the support vehicle fleet. Data from the observed FY 24 mileage report for each vehicle is available, however, there is a lack of more detailed information such as daily vehicle usage data, which makes predicting service details for these vehicles challenging.

A set of conservative mileage estimates were developed to assess the feasibility of electric vehicles replacing the current support vehicle fleet. First, an estimated average daily mileage value is needed, which is the observed FY 24 mileage for each vehicle, divided by the number of service days (359), assuming operation of these vehicles occurred every day except for holidays.

Since actual daily mileage is assumed to be random, a value resembling the estimated maximum daily mileage was necessary for a robust feasibility analysis. To determine this, daily mileage values over the year were assumed to follow a normal distribution. The assumption takes that a value approximately one standard deviation from the mean encompasses a significant portion of the observed travel. Given the absence of a calculated standard deviation in the dataset, the empirical rule was applied, which assumes that one standard deviation is roughly 50% of the average value. Given these assumptions, the assumed maximum daily mileage is expressed as follows:

**Estimated Maximum = Average + (1 X (0.5 X Average))** *which is also* **1.5 X Average**

The resulting estimated maximum values used in the feasibility analysis are indicated for each vehicle in **Table 6-12**.

**TABLE 6-12: MILEAGE ASSUMPTIONS USED FOR EACH VEHICLE**

| Vehicle ID | Vehicle Type | Observed FY24 Mileage | Estimated Average Daily Mileage | Assumed Maximum Daily Mileage |
|---|---|---|---|---|
| **CC2-2106** | Minivan | 21,975 | 59.6 | 89.3 |
| **CC2-2107** | Minivan | 20,625 | 55.9 | 83.8 |
| **CC2-2019** | SUV | 5,102 | 13.8 | 20.7 |
| **CC2-1553** | Sedan | 5,972 | 16.2 | 24.3 |
| **CC2-1662** | Pickup Truck | 24,222 | 65.6 | 98.5 |
| **CC2-1402** | Pickup Truck | 20,100 | 54.5 | 81.7 |

### 6.1.5 Facilities and Infrastructure

CAT operates seven key facilities throughout Collier County, serving as important stops or transfer stations. The largest of these include the CAT Operations and Transfer Station, which serves as the bus depot, the Intermodal Transfer Facility at the Collier County Government Center in Naples, and the future CAT Transfer Facility in Immokalee. **Table 6-13** shows the names and location of CAT's various facilities.

When incorporating electric vehicles into a fleet, potential locations for charging infrastructure must be carefully evaluated. Charging site selection should consider service operations across the transit system, prioritizing layover points and locations where multiple routes converge for at least five minutes as strategic recharging hubs. Additionally, a spatial analysis should be conducted to determine optimal placement for charging infrastructure and necessary electrical system expansions. While CAT has identified seven transfer locations for its services, only three of these facilities are owned by Collier County, where the introduction of electric infrastructure could be facilitated. The three county owned facilities include the CAT Operations and Transfer Station, the Intermodal Transfer Facility at the Government Center, and the future CAT Transfer Facility in Immokalee. **Map 6-2** through **Map 6-4** indicate the location of these transfer facilities and the routes that have an established layover of at least five minutes at each location.

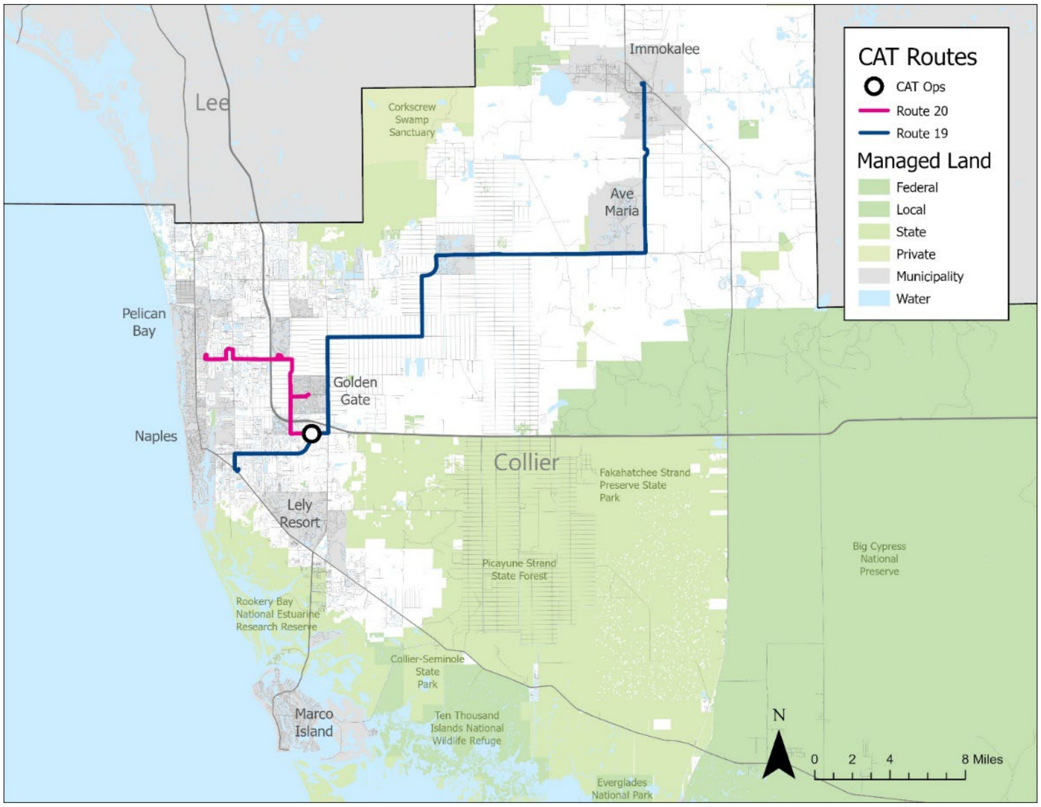
**TABLE 6-13: CAT DEPOT AND TRANSFER FACILITY LOCATIONS**

| Depot / Transfer Station | Stop ID | Address |
|---|---|---|
| CAT Operations and Transfer Station | 161 | 8300 Radio Rd, Naples, FL 34104 |
| Intermodal Transfer Facility (Government Center) | 1 | 3355 Tamiami Trail E, Naples, FL 34112 |
| CAT Transfer Facility - Immokalee | 398 | 155 Immokalee Drive, Immokalee, FL 34142 |
| Creekside (Immokalee Rd.) | 66 | Immokalee Rd / Arthrex Way - North Naples, FL 34108 |
| Walmart Plaza (US41 / CR951) | 235 | 6650 Collier Blvd, Naples, FL 34114 |
| Magnolia Square Plaza (Pine Ridge and Goodlette Frank Rd.) | 471 | 5920 Goodlette-Frank Rd, Naples, FL 34109 |
| Coastland Center | 50 | Fleischmann Blvd, Naples FL 34102 |

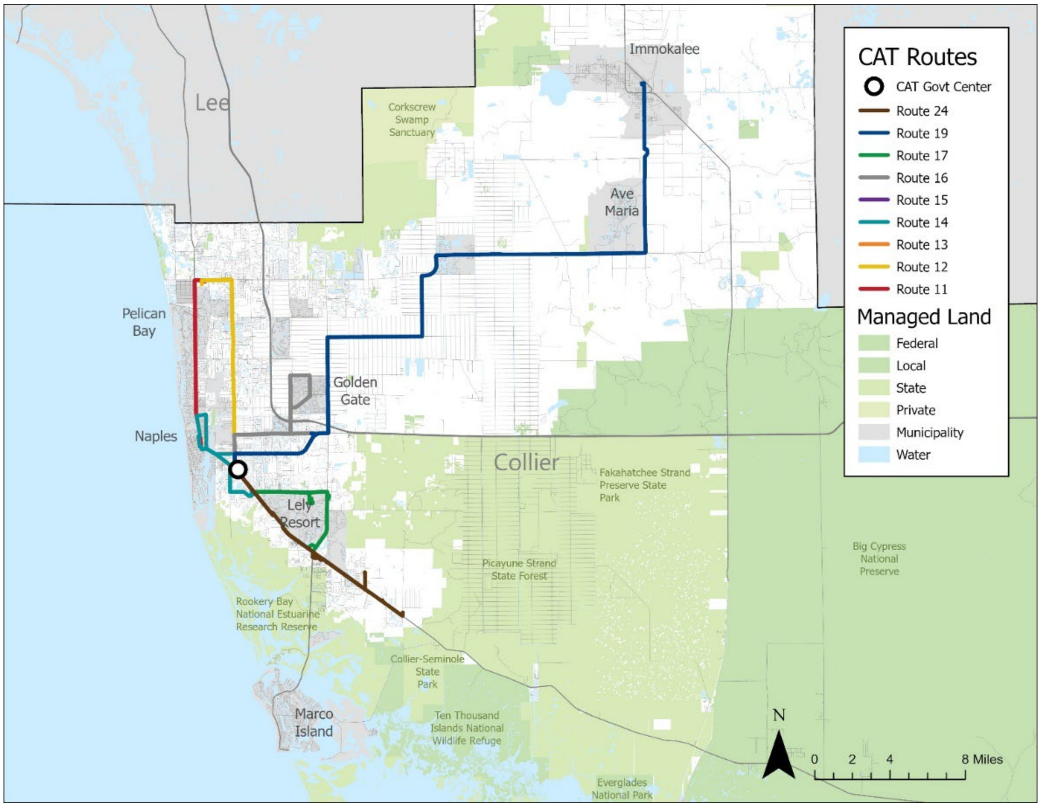
*Source: Collier Area Transit*

Examining these locations can help in strategizing both slow and fast charging approaches for electric vehicles and can provide understanding for which locations would have a higher demand for charging infrastructure.

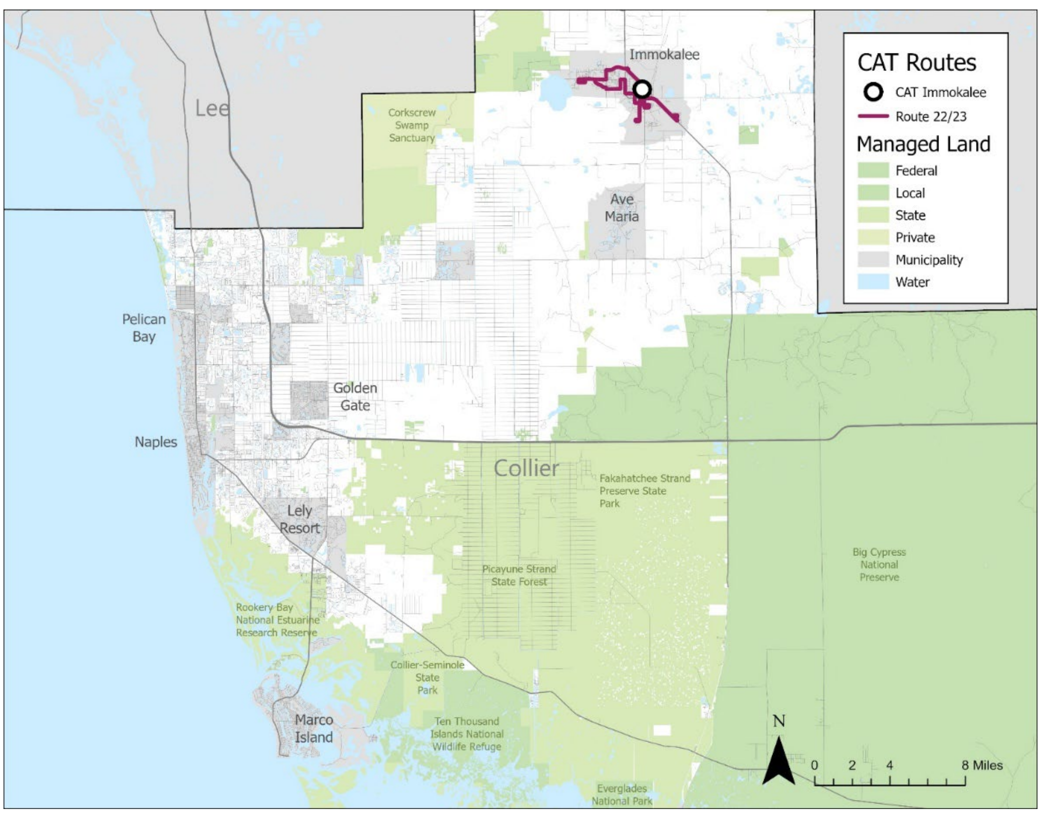
### Map 6-2: Routes with Layovers at CAT's Operations Center



### MAP 6-3: ROUTES WITH LAYOVERS AT THE GOVERNMENT CENTER INTERMODAL TRANSFER FACILITY




### MAP 6-4: ROUTES WITH LAYOVERS AT THE IMMOKALEE TRANSFER FACILITY



## 6.2 Feasibility Analysis Assumptions

The following section outlines the assumptions used in the feasibility analysis, focusing particularly on those related to battery electric buses, which require special consideration. Assumptions for other fuel alternatives are addressed subsequently.

### 6.2.1 Battery Electric Assumptions and Considerations

The battery electric bus analysis evaluates the feasibility of transit operations considering multiple factors at the same time. Battery Electric Vehicles are susceptible to a few challenges in operation due to their low travel range output from a full charge compared to the experience of agencies with vehicles operating on conventional fuels such as gasoline or diesel which provide a longer range. Additionally, strenuous service conditions such as heavy loads, elevated terrains, and hot or cold weather, have adverse impacts over the energy output, limiting the range of operations that are actually able to be served. Moreover, batteries are known to experience degradation over time due to recharging cycles. This additional factor can have impacts over the expectation of service operations of a bus in its later years or may trigger the need to purchase a new battery. These factors are examined further in the following discussion.

#### 6.2.1.1 Nominal and Strenuous Conditions

The battery electric bus analysis evaluates the feasibility of transit operations under two conditions, Nominal and Strenuous. These two conditions reflect the impact that external conditions may have on energy consumption. Energy consumption is measured in kilowatt-hours per mile (kWh/mi, analogous to miles per gallons, mpg) as a way to understand energy efficiency. Additionally, the auxiliary power is also evaluated. While an alternator in diesel buses is responsible for recharging the battery that powers auxiliary systems in those vehicles, there is generally no such system to support the auxiliary power in a battery electric bus. Therefore, auxiliary power is drawn from the same battery that powers the bus for propulsion, adding to the total consumption of energy drawn from the battery.

Assumptions for vehicle energy consumption and auxiliary power are detailed in **Table 6-14** in both nominal and strenuous conditions. Assumptions were developed for the average battery electric bus operating on terrains and climates similar to those in Collier County. These assumptions are used in the model for all vehicle lengths.

Assumptions will specify the vehicle types they apply to. "Fixed Route" (FR) will generally refer to all buses, but when a specific vehicle length is indicated (e.g., "30' FR"), it applies only to buses of that specific length. All cutaways will be designated as "Demand Response" (DR), regardless of length. Assumptions for the support/equipment fleet will be categorized separately by vehicle type, such as minivans, sport utility vehicles (SUVs), or pickup trucks and may be jointly be described as Electric Vehicles (EV).

**TABLE 6-14: NOMINAL AND STRENUOUS ASSUMPTIONS FOR BATTERY ELECTRIC BUSES**

| Variable | Description | Assumption |
|---|---|---|
| **Nominal Energy Consumption** | Energy required to operate the vehicle under nominal conditions | 1.85 kWh/mi for all FR<br>0.9 kWh/mi for all DR |
| **Strenuous Energy Consumption** | Energy required to operate the vehicle under strenuous conditions | 2.14 kWh/mi for all FR<br>1.0 kWh/mi for all DR |
| **Nominal Auxiliary Power** | The amount of power needed to operate auxiliary systems under nominal conditions | 6.5 kW for all FR<br>3.2 kW for all DR |
| **Strenuous Auxiliary Power** | The amount of power needed to operate auxiliary systems under strenuous conditions | 27 kW for all FR<br>13.1 for all DR |

#### 6.2.1.2 Battery Utility and Degradation

The analysis also considers the impact of battery utility and degradation on the operational capabilities of battery electric buses. It has been observed that the nominal energy capacity labeled on a battery does not account for the energy that can be used reliably. A certain amount of energy is reserved for internal battery use, reducing the usable energy to a figure lower than the stipulated total battery energy.

Additionally, the feasibility model considers an additional reserve energy of 20 kWh, which acts as a safety net for buses to travel in cases of emergency or unexpected circumstances. Moreover, battery degradation has also been observed over the years of battery usage. This degradation is responsible for the slow decrease in battery capacity over time. Experience of use suggests that batteries have a 10-year useful life and that within this period, the battery's original energy capacity is reduced by 20%, giving an annual average degradation rate of 2%. Higher rates of degradation can be mitigated by proper battery recharging protocol, which will be discussed in another section.

**Table 6-15** presents the assumptions regarding battery degradation and reserve energy used in the model. Additionally, the table reports the nominal (or total) battery energy for each bus length based on vehicle models available in the market in 2024, as well as the amount of usable energy available, and service energy for each vehicle. These battery capacities are presented in kWh and are also modeled for a new battery scenario in analysis year 2025, and in the end-of-life year 2035 considering the full impact of battery degradation over the years.

**TABLE 6-15: BATTERY LIFE AND DEGRADATION ASSUMPTIONS**

| Variable | Description | Assumption |
|---|---|---|
| **% of Original Capacity** | Percentage of the original battery's capacity that is useable at the end of battery life | 80% |
| **Useful Life of Battery** | The number of years of a battery's useful lifecycle | 10 years |
| **Annual Degradation** | The annual Rate of Battery Degradation | -2% |
| **Reserve Energy (kWh)** | Estimated energy required to travel approximately 10 miles to the depot from an on-route location; a "safety net" to ensure the bus can return to the depot if a bus experiences an issue on-route, causing it to use more energy than expected. | 20 kWh for all FR<br>9 kWh for all DR |

| Variable | Description | Assumption |
|---|---|---|
| **New Battery Scenario (2025)** | | |
| **Total Battery Energy (kWh)** | The total energy contained in the battery upon purchase | 30’ FR: 350 kWh<br>35’ FR: 420 kWh<br>40’ FR: 500 kWh<br>DR: 113 kWh |
| **Useable Energy (kWh)** | The total energy that can be withdrawn from a new battery before needing to stop | 30’: 280 kWh<br>35’: 336 kWh<br>40’: 400 kWh<br>DR: 90 kWh |
| **Service Energy (kWh)** | Maximum energy that should be used in revenue service for buses with new batteries (“Useable Energy” minus “Reserve Energy”) | 30’ FR: 260 kWh<br>35’ FR: 316 kWh<br>40’ FR: 380 kWh<br>DR: 81 kWh |
| **End of Life Battery Scenario (2035)** | | |
| **Total Battery Energy (kWh)** | The total energy contained in the battery at the end of battery life | 30’ FR: 286 kWh<br>35’ FR: 344 kWh<br>40’ FR: 409 kWh<br>DR: 93 kWh |
| **Useable Energy (kWh)** | The total energy that can be withdrawn from the battery before needing to stop | 30’ FR: 229 kWh<br>35’ FR: 275 kWh<br>40’ FR: 327 kWh<br>DR: 74 kWh |
| **Service Energy (kWh)** | Maximum energy that should be used in revenue service (Useable Energy minus Reserve Energy) | 30’ FR: 209 kWh<br>35’ FR: 255 kWh<br>40’ FR: 307 kWh<br>DR: 65 kWh |

#### 6.2.1.3 Battery Improvement

Although battery electric vehicles may currently seem limited in their ability to directly replace conventional fuel vehicles, ongoing research and development aimed at improving battery capacity is making this replacement more achievable each year. Studies show that battery capacity has increased by about 7% annually since 2012, with this rate accelerating as new technologies emerge. For this analysis, a 3.5% annual improvement in battery capacity was used to project which service blocks might become feasible over the next 10 years. Total, usable, and service energy data for each vehicle length are provided in **Table 6-16** for the model years 2030 and 2035.

CAT has procured an electric Gillig bus which at the time of this writing is being built. Notably, the bus has a significantly higher capacity than the average electric bus models available in the current market. Additional analysis based on a 686 kWh battery capacity was conducted, and the results are included in **Appendix D**.

**Table 6-16: Battery Capacity Improvement Assumptions**

| Variable | Description | Assumption |
|---|---|---|
| **Annual Battery Capacity Improvement** | The annual rate of battery capacity improvements due to increased research and development in the industry over the current year's energy assumptions | +3.5% |
| **2030 Battery Improvement Scenario** | | |
| **Total Battery Energy (kWh)** | The total energy contained in the battery | 30' FR: 416 kWh<br>35' FR: 499 kWh<br>40' FR: 594 kWh<br>DR: 110 kWh |
| **Useable Energy (kWh)** | The total energy that can be withdrawn from the battery before needing to stop | 30' FR: 326 kWh<br>35' FR: 399 kWh<br>40' FR: 475 kWh<br>DR: 88 kWh |
| **Service Energy (kWh)** | Maximum energy that should be used in revenue service (Useable Energy minus Reserve Energy) | 30' FR: 306 kWh<br>35' FR: 379 kWh<br>40' FR: 455 kWh<br>DR: 79 kWh |
| **2035 Battery Improvement Scenario** | | |
| **Total Battery Energy (kWh)** | The total energy contained in the battery | 30' FR: 495 kWh<br>35' FR: 592 kWh<br>40' FR: 706 kWh<br>DR: 130 kWh |
| **Useable Energy (kWh)** | The total energy that can be withdrawn from the battery before needing to stop | 30' FR: 396 kWh<br>35' FR: 474 kWh<br>40' FR: 565 kWh<br>DR: 104 kWh |
| **Service Energy (kWh)** | Maximum energy that should be used in revenue service (Useable Energy minus Reserve Energy) | 30' FR: 376 kWh<br>35' FR: 454 kWh<br>40' FR: 545 kWh<br>DR: 95 kWh |

### 6.2.2 Other Fuel Alternatives

Assessing the operational capacity of alternative fuel vehicles is generally less challenging than evaluating battery electric vehicles. Unlike battery electric vehicles, the performance of vehicles using other fuel types does not degrade significantly over their lifecycle and is more predictable. While external factors such as load, terrain, application scenarios, and climate do affect these vehicles, their impact is not as pronounced as it is for battery electric vehicles. Furthermore, refueling alternative fuel vehicles is typically a more straightforward and simple process, enabling these vehicles to cover greater distances without significant downtime for recharging or refueling.

#### 6.2.2.1 Hydrogen Fuel Cell Electric Bus (FCEB)

Hydrogen buses operate with very limited impacts to service. Factors that can influence a FCEB include passenger load, terrain, and the efficiency of the fuel cell. A FCEB requires 10 to 20 minutes for refueling, making it easy to introduce into operations. The range of a FCEB is about 250 miles, which will be used as an assumption on vehicle range in the feasibility analysis.

#### 6.2.2.2 Compressed Natural Gas (CNG)

CNG buses operate with limited impacts to service. Factors that impact fuel efficiency include passenger load, terrain, and importantly, driving patterns. Urban stop-and-go routes have a reduced range compared to highway or long drives. CNG buses can be applied more efficiently over suburban routes with less stop-and-go conditions, but not long commuter routes. A CNG bus requires about 10 to 20 minutes for refueling, making it easy to introduce into operations. The range of a CNG bus is about 400 miles.

#### 6.2.2.3 Biodiesel

Biodiesel fuel is very much a direct substitute to diesel experiencing the same impacts to fuel efficiency that diesel buses do. Biodiesel fueled buses experience a slightly lower range due to the reduced energy density of biofuel compared to diesel, but the difference may be negligible. The most important consideration for a biodiesel fueled bus is that it may perform less efficiently in cold climates when no additives are introduced into the biodiesel mix since this fuel tends to coagulate in colder temperatures. The range of a bus running on biodiesel fuel is 475 miles.

#### 6.2.2.4 Hybrid Diesel-Electric

Hybrid Diesel-Electric buses also act as a substitute for diesel with limited impacts to service. The Hybrid bus operates best in urban stop-and-go environments due to regenerative braking maximizing the efficiency of the bus. As such, the longest ranges are experienced in these urban settings, and less in highway settings. The hybrid battery will also play a role in efficiency but may be negligible if well maintained during the vehicle’s useful life cycle. The range of a hybrid diesel electric bus is 525 miles.

**Table 6-17** presents a summary of alternative fuel vehicle range assumptions used for the feasibility study. The assumptions only consider a quarter tank equivalent of reserve fuel for each vehicle in case of any emergency. Additionally, the total vehicle ranges are also considered for each vehicle type, as presented in the previous discussion. Assumptions are made for both fixed route buses and demand response cutaways. If an alternative fuel type configuration is not in the market for demand response vehicles, these are excluded from the analysis as not available or “NA.”

The metric used to assess feasibility is the assumed service range which is simply the difference between the total vehicle range for each vehicle type, and the fuel reserve assumption that is applied to all vehicle types.

**Table 6-18** outlines additional qualitative factors considered during the feasibility assessment. These factors complement the route profile evaluations by offering strategic insights into the most suitable fuel alternative for each service block. While these considerations are particularly important when developing recommendations for Low or Zero-Emission transition strategies or scenarios, they do not preclude the use of alternative fuel vehicles on blocks that may not fully align with these factors.

**TABLE 6-17: SUMMARY OF ALTERNATIVE FUEL VEHICLE RANGE ASSUMPTIONS**

| Variable | Description | Fuel Alternative | Assumption |
|---|---|---|---|
| **Fuel Reserve** | The policy of having a fuel reserve for vehicles as a "safety net" to ensure the bus can return to the depot if a bus experiences an issue on-route requiring added fuel. | All Fuel Types | 25% or ¼ Tank Equivalent |
| **Total Vehicle Range** | Estimated maximum range of travel for all buses on a full tank or equivalent for each respective fuel type | Hydrogen FCEB | 250 miles for FR<br>NA for DR |
| | | CNG | 400 miles for FR<br>275 miles for DR |
| | | Biodiesel | 475 miles for FR<br>350 miles for DR |
| | | Hybrid Diesel-Electric | 525 miles for FR<br>NA for DR |
| **Service Range** | Maximum range of travel achievable for use in revenue service (Total Vehicle Range minus Fuel Reserve) | Hydrogen FCEB | 188 miles for FR<br>NA for DR |
| | | CNG | 300 miles for FR<br>225 miles for DR |
| | | Biodiesel | 357 miles for FR<br>263 miles for DR |
| | | Hybrid Diesel-Electric | 394 miles for FR<br>NA for DR |

**TABLE 6-18: OTHER FEASIBILITY CONSIDERATIONS MADE DURING FEASIBILITY ASSESSMENT**

| Fuel | Other Consideration |
|---|---|
| **Hydrogen FCEB** | Fuel Cell Efficiency may degrade over time |
| **CNG** | Great for Suburban Routes, with mostly go conditions |
| **Biodiesel** | Cold climate impact over fuel |
| **Hybrid Diesel-Electric** | Operates best in urban stop-and go conditions |

### 6.2.3 Assumptions used for Support Vehicle Assessment

Assumptions for support vehicles take into account the various vehicle models currently used by CAT and their electric vehicle equivalents available in today's market. The most common fuel alternatives available today are hybrid gasoline-electric and full-electric vehicles; hybrid models are not available for all vehicle types, so they were not considered in further analysis. Each vehicle's make and model was categorized under a group, and a suitable electric vehicle model was chosen to assess the impact of replacing it with a comparable electric option. **Table 6-19** presents this information.

**TABLE 6-19: SUPPORT VEHICLE CURRENT INVENTORY AND THEIR EV EQUIVALENT**

| Vehicle Group | Current Inventory | Electric Model Equivalent |
|---|---|---|
| **Minivan** | Ford Transit | Ford E-Transit |
| **SUV/Sedan** | Ford Escape / Ford Taurus SEL | Chevrolet Equinox EV |
| **Pickup Truck** | Ford F-150 XL/XLT | F-150 Lightning |

The assessment of electric support vehicles followed a more simplified approach than the analysis conducted for fixed-route buses and cutaways. While usable energy, reserve energy, and strenuous energy consumption were thoroughly detailed for buses and cutaways, this data is not readily available for the selected support vehicle models. To address this, a conservative assumption was applied to estimate a feasible service range. Specifically, 70% of the total available energy for all electric vehicle models was designated as the assumed safe service range. **Table 6-20** presents the nominal ranges for each vehicle model based on the manufacturer's specifications, along with the service range assumption used to evaluate feasibility.

**TABLE 6-20: SERVICE RANGE ASSUMPTIONS USED FOR EACH VEHICLE GROUP**

| Vehicle Group | Nominal Range | Service Range Assumption |
|---|---|---|
| **Minivan** | 159 miles | 111 miles |
| **SUV/Sedan** | 319 miles | 223 miles |
| **Pickup Truck** | 240 miles | 168 miles |

## 6.3 Model Results

The following section presents the results of the block feasibility model. The section first looks at results from the battery electric bus model for fixed route service blocks, followed by results for other fuel alternative vehicle types. The results are then presented in the same order for demand response vehicles, and equipment vehicles.

### 6.3.1 Fixed Route Block Results

The fixed route block feasibility model considers all the assumptions and considerations in the previous sections for fixed route buses. Assumptions for each of the three vehicle lengths are considered and tabulated separately for each service day.

#### 6.3.1.1 Current Electric Bus Feasibility

The first scenario evaluates the potential implementation of battery electric buses in the current year (2025). The model is performed for each vehicle length testing for the various energy capacity assumptions determined, and accounting for battery degradation up to the 10$^{th}$ year of battery usage (2035) as well as nominal and strenuous conditions. Feasibly was determined as follows:

- **Feasible**: bus can feasibly operate the entire length of a block in strenuous conditions without tapping into reserve energy even after the potential amount of battery degradation in that given model year.
- **Maybe**: The bus may be able to operate but could potentially run into occasional issues where the reserve energy may need to be used. This indicator can also suggest the feasibility of a block if in-route or off-route charging were implemented.
- **Unfeasible**: The bus will likely fail to operate the entire length of a block unless major operational changes are made such as splitting a block, adjusting scheduled operations, reducing number of trips, or making the alignment shorter.

**Table 6-21** lists blocks that are or may be feasible in this scenario. Detailed results can be found in **Appendix C** for each block.

TABLE 6-21: CURRENTLY FEASIBLE BLOCKS BY OPERATION DAY

| Block | Vehicle Length | Block Feasibility by Operation Day | | |
|---|---|---|---|---|
| | | Weekday | Saturday | Sunday |
| **2** | 30’ | | | ✓ |
| **4** | 35’ | | | ! |
| **5** | 35’ | | | ✓ |
| **13** | 35’ | ✓ | | |
| **22** | 30’ | ✓ | | |

*✓ = Feasible ! = Maybe Feasible*

#### 6.3.1.2 Future Electric Bus Feasibility

The second scenario evaluates the potential implementation of battery electric buses starting in a future year. Considering that electric battery capacities are improving at a rate of 7% annually, the availability of new blocks that can be feasibly served by battery electric buses can increase. The model looks at the purchase year's battery capacity and accounts for degradation as well as projected improvements until the battery’s tenth year. This tenth year is then analyzed for feasibility. As an example, for a bus purchased in 2025, feasibility is evaluated using the tenth year of its operation, which would be 2035. Therefore, the future scenario model identifies if a block can reliably support a bus throughout the entire ten-year period after it has been purchased. **Table 6-22** summarizes the various blocks will be or may be feasible for vehicles purchased in either 2025 or 2035. This will indicate which blocks flip from previously unfeasible to feasible in the next ten years. Detailed results from this analysis can be found in **Appendix C**.

TABLE 6-22: FUTURE FEASIBLE BLOCKS BY OPERATION DAY FOR PURCHASE YEARS 2025 AND 2035

| Block | Vehicle Length | Block Feasibility by Operation Day | | | | | |
|---|---|---|---|---|---|---|---|
| | | Weekday | | Saturday | | Sunday | |
| | | 2025 | 2035 | 2025 | 2035 | 2025 | 2035 |
| **2** | 30’ | | | | | ✓ | ✓ |
| **4** | 35’ | | | | | ! | ✓ |
| **5** | 35’ | | | | | ✓ | ✓ |
| **7** | 30’ | | | | | | ! |
| **8** | 30’ | | | | | | ! |
| **9** | 30’ | | | | | | ✓ |
| **10** | 30’ | | | | | | ✓ |
| **11** | 30’ | | | | | | ✓ |
| **12** | 30’ | | | | | | ! |
| **13** | 35’ | ✓ | ✓ | | ! | | ! |
| **16** | 30’ | | | | ! | | |
| **17** | 30’ | | ! | | | | |
| **22** | 30’ | ✓ | ✓ | | | | |

*✓ = Feasible ! = Maybe Feasible*

Based on the results of the service modeling, one additional weekday block would become partially feasible by 2035: Block 17. Block 17 is expected to become partially feasible due to improved battery capacity for vehicle model years 2035 and beyond. Additional in route charging support could make this block fully feasible with the increased battery capacity.

#### 6.3.1.3 Electric Re-Charging Scenario

A selection of blocks was further analyzed to understand the ability to support on-route or off-route charging strategies. Charger types were analyzed for their power output and by battery capacities to assess the amount of time required to charge a battery using one of these. Fast charging is best provided by fast chargers with outputs between 150 kW and 350 kW. When looking at the recharge speed based for each charger, a broad assumption that one-minute of vehicle recharging is equivalent to one-mile gained in range was developed to encompass the overall recharging capacity which can range between a .8-mile gain to a 2 mile gain. The results are found in **Table 6-23**

TABLE 6-23: CHARGING OPTIONS AND TIME TO FULL CHARGE

| Charger Type | Power Output (kW) | Time to Full Charge | | | |
|---|---|---|---|---|---|
| | | 350 kWh | 420 kWh | 500 kWh | 686 kWh |
| **DC Fast Charger (50 kW) or Induction Charger (60 kW)** | 50 kW | 7h | 8h 25m | 10h | 13h 45m |
| **DC Fast Charger (150 kW) Induction Charger (180 kW)** | 150 kW | 2h 20m | 2h 50m | 3h 20m | 4h 30m |
| **DC Fast Charger (350 kW)** | 350 kW | 1h | 1h 12m | 1h 30m | 2h |
| **Overhead Pantograph (450 kW)** | 450 kW | 45m | 55m | 1h 5m | 1h 30m |
| **Overhead Pantograph (600 kW)** | 600 kW | 35m | 40m | 50m | 1h 10m |

Additional assumptions for the on-route charging scenarios include the implementation of fast DC chargers, with the only constraint being that the layover facility must be a county-owned property. Three main locations were identified: CAT Operations Center, Government Center, and Immokalee Transfer Facility. Blocks analyzed needed to have a layover at one of these locations. Vehicles traveling off-route to access a layover location needed to have more than 15 minutes, including deadhead to the off-route location to be considered a feasible off-route recharge location. The following briefly describes the selected routes and the assessment.

- **Block 2/20** Neither in the current scenario nor in the future scenario does Block 2/20 confidently complete a trip in the most strenuous circumstance. This would lead to failure in a worst-case scenario.
- **Block 15/21** would comfortably benefit from on-route charging at the CAT Operations Center through the 10th year in the current scenario. This block would be an excellent candidate for the on-route charging.
- **Block 17** would comfortably benefit from on-route charging at the Government Center through the 10th year in the current scenario. Considerations include the addition of chargers at the transfer station.
- **Block 11** in the current scenario would not benefit from recharging at the Government Center after the fifth year of purchase, when battery degradation will have impacted recharging

capacity significantly. However, Block 11 is expected to benefit from recharging starting in a future scenario.

- **Block 5** Neither in the current scenario nor in the future scenario does Block 5 confidently complete a trip in the most strenuous circumstance. This would lead to failure in a worst-case scenario.
- **Block 16** may be able to complete most of its trips after recharging at the Immokalee transfer station but could fail during its final deadhead trip back to the CAT Ops Center in the current scenario. Adding between 15 and 45 minutes of layover time in the schedule could make this possible. It is, however, possible that battery improvements make on-route charging feasible for Block 16 in a future scenario.
- **Block 18** may be able to complete most of its trips after recharging at the Immokalee transfer station but could fail during its final deadhead trip back to the CAT Ops Center in the current scenario. Adding between 15 and 45 minutes of layover time in the schedule could make this possible. It is, however, possible that battery improvements make on-route charging feasible for Block 18 in a future scenario.
- **Block 7** Neither in the current scenario nor in the future scenario does Block 7 confidently complete a trip in the most strenuous circumstance. This would lead to failure in a worst-case scenario.

It is expected that the on-route charging approach will allow 2 blocks (15/21 and 17) to operate comfortably with Battery Electric Buses. Three additional blocks (11, 16, and 18) will become feasible through on-route charging in a future scenario.

#### 6.3.1.4 Current Alternative Fuel Vehicle Feasibility

The alternative fuel vehicle feasibility model assesses the viability of implementing alternative fuel buses in 2025, using vehicle range assumptions outlined previously in **Table 6-17**. Unlike battery electric buses, this model assumes that fuel type does not significantly impact vehicle range. Additionally, external factors affecting fuel efficiency, such as strenuous operating conditions, are not accounted for, as their impact is considered negligible for modeling purposes.

**Tables 6-24** summarizes the model results based on the day of the week. Feasibility is categorized as follows:

- **Feasible**: The bus can operate the entire length of a block under most conditions without relying on fuel reserves.
- **Maybe**: The bus may complete the block but could occasionally require fuel reserves. This classification also applies to blocks that may be feasible if refueling is possible during layovers.
- **Unfeasible**: The bus is unlikely to complete the block without depleting fuel reserves unless major operational adjustments are made. These could include splitting the block, modifying schedules, reducing trips, or shortening the route.

More detailed information regarding each block and for each analysis year can be found in the **Appendix C**.

### Table 6-24: Feasible Blocks by Fuel Type and Day of Operation

| Block | Vehicle Length | Block Feasibility by Operation Day | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Hydrogen FCE | | | CNG | | | Biodiesel | | | Hybrid | | |
| | | Wkd. | Sat. | Sun. | Wkd. | Sat. | Sun. | Wkd. | Sat. | Sun. | Wkd. | Sat. | Sun. |
| 1 | 40’ | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 2/20 | 30’ | | ! | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 3 | 30’ | | | ! | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 4 | 35’ | | | ✓ | | | ✓ | | | ✓ | ! | ! | ✓ |
| 5 | 35’ | ! | ! | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 6 | 30’ | | | ! | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 7 | 30’ | ! | ! | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 8 | 30’ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 9 | 30’ | ! | ! | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 10 | 30’ | | ✓ | ✓ | ! | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 11 | 30’ | ✓ | ! | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 12 | 30’ | ! | ! | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 13 | 35’ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 15/21 | 30’ | ! | ! | | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | |
| 16 | 30’ | ! | ✓ | | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | |
| 17 | 30’ | ✓ | ! | | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | |
| 18 | 35’ | ! | | | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | |
| 19 | 30’ | ! | | | ✓ | | | ✓ | | | ✓ | | |

*✓ = Feasible   ! = Maybe Feasible*

#### Hydrogen FCE

Based on the results of the service modeling, 5 weekday blocks are feasible (24% of blocks), 9 may be feasible, and 7 are not feasible. Only two blocks, Blocks 8 and 13 are feasible on weekdays, Saturdays, and Sundays.

#### CNG Buses

The results of the service modeling indicate that all weekday blocks are feasible except for Block 10, which may be feasible, and Block 4, which is unfeasible. On Saturday, only Block 4 remains unfeasible, and on Sunday, all blocks are feasible.

#### Biodiesel

Biodiesel fueled buses can feasibly serve all weekday and Saturday blocks except for Block 4, which is unfeasible. All Sunday blocks can be served feasibly.

#### Hybrid Diesel Electric

All weekday blocks can feasibly be served by a hybrid bus on weekdays and Saturday except for Block 4 which may be served under certain conditions. All Sunday blocks can be served feasibly.

### 6.3.2 Demand Response

The following section presents feasibility results for demand response trips. The feasibility model considers all the assumptions and considerations previously presented for demand response cutaways. Assumptions are considered separately for each service day.

#### 6.3.2.1 Current Electric Cutaway Feasibility

The feasibility assessment for electric cutaways differs from that of buses. To evaluate their viability, a month's worth of service runs was analyzed to represent typical trip lengths for demand response services throughout the year. Given that trip lengths vary based on client needs and locations, understanding the distribution of trips by length as a percentage of total trips during the observation period is crucial. This analysis provides insight into how effectively an electric cutaway can accommodate demand response trips as a percentage of accomplishable trips.

In the current scenario, the model results indicate that up to 1% of trips currently served by CATConnect can be feasibly served through 2030. This suggests that the technology is not capable of supporting a reliable amount of services for CAT's demand response unit. This is because most cutaway batteries have low capacities and may be impacted by the use of electric lifts and other additions common in demand response fleets, which in turn drain the battery quicker in addition to the fact that average trip lengths far exceed both nominal and strenuous mileage. Conversely, CATConnect may be serving longer than average demand response trips relative to its peers. This could be a factor due to land use distribution, where origins and destinations may be further apart from each other than in more urban settings.

#### 6.3.2.2 Electric Results Future Scenario

The second scenario evaluates the potential implementation of battery electric cutaways in future years. Considering that electric battery capacities are improving at a rate of 7% annually, the ability for an electric cutaway to serve a larger share of demand response trips feasibly is possible. The model uses the assumptions of the current year's battery capacity (2025) and builds upon the battery's improved capacity over the next ten years (2035).

It is evident that electric cutaways will not be able to reliably assist the demand response fleet in the long-term, as improvements in battery capacity do not seem sufficient to cover even five percent of trips through 2035. Unless drastic operational changes were made to accommodate this challenge, it is strongly recommended that CAT not look into replacing any part of its DR fleet with electric cutaways.

#### 6.3.2.3 Alternative Fuel Results

Unlike buses, alternative fuel cutaways are available in fewer configurations. To reduce operational limitations, this study evaluates CNG and biodiesel models, as these fuel types are also available for use by buses, enabling shared fueling infrastructure across the fleet. The analysis follows the same methodology applied to electric cutaways, assessing the distribution of demand response trips by length to determine the vehicle's effectiveness in meeting service needs. **Table 6-25** presents the results of this assessment.

TABLE 6-25: PERCENTAGE OF DR TRIPS SERVED FEASIBLY BY ALTERNATIVE FUEL CUTAWAYS

| Observed Trips | Miles | CNG Cutaways | Biodiesel (Using Diesel Cutaways) |
|---|---|---|---|
| **First Percentile** | 70 | ✓ | ✓ |
| **Fifth Percentile** | 110 | ✓ | ✓ |
| **Tenth Percentile** | 135 | ✓ | ✓ |
| **25th Percentile** | 165 | ✓ | ✓ |
| **Median** | 193 | ✓ | ✓ |
| **Average** | 195 | ✓ | ✓ |
| **50th Percentile** | 195 | ✓ | ✓ |
| **75th Percentile** | 230 | ! | ✓ |
| **85th Percentile** | 245 | ! | ✓ |
| **All Trips** | 400 | | |

✓ *= Feasible* ! *= Maybe Feasible*

The results indicate that CNG cutaways can reliably serve up to 85% of trips currently provided by the DR fleet, making them a strong replacement option for a significant portion of operations; gasoline or diesel cutaways would still be necessary to accommodate the longest trips. Similarly, biodiesel-fueled cutaways are capable of serving nearly all DR trips, with only a few exceptions for the longest trips. This suggests that biodiesel could effectively replace the entire DR fleet with minimal operational disruptions.

### 6.3.3 Equipment/Support Vehicle

The following section presents feasibility results for CAT's equipment/support vehicles. The feasibility model considers all the assumptions and considerations previously presented for various vehicle models that best represent current vehicle types. Assumptions are considered separately for each vehicle depending on the observed annual mileage for each. The feasibility is only assessed for battery electric vehicles as models in other fuel types are uncommon.

#### 6.3.3.1 Electric Results

Electric vehicle feasibility is assessed using the annual mileage observed for each vehicle. Because daily travel data for each vehicle is unavailable, feasibility is examined through a simple method where the individual vehicles assumed maximum daily mileage is compared with an assumed safe service range. The methodology and assumptions used for this analysis can be found in Sections 6.1.4 and 6.2.3. **Table 6-26** shows the results by vehicle.

TABLE 6-26: FEASIBILITY OF EVS TO SERVE THE MAXIMUM DAILY MILEAGE OF SUPPORT VEHICLES

| Vehicle ID | Vehicle Type | EV Feasibility |
|---|---|---|
| **CC2-2106** | Minivan | ✓ |
| **CC2-2107** | Minivan | ✓ |
| **CC2-2019** | SUV | ✓ |
| **CC2-1553** | SUV | ✓ |
| **CC2-1662** | Pickup Truck | ✓ |
| **CC2-1402** | Pickup Truck | ✓ |

✓ *= Feasible* ! *= Maybe Feasible*

The results indicate that electric vehicles can reliably replace minivans, SUVs, sedans, and pickup trucks in the existing support vehicle fleet, even on days when these vehicles travel long distances. If sufficient downtime is available throughout the day, recharging could maximize the usability of any of these vehicles.

## 6.4 Fuel Mix Recommendations

After reviewing the results of the feasibility model in the previous section, the output was considered for the development of possible fuel mix configurations that CAT can adopt to achieve a low or zero emission objective. The following looks at various approaches that CAT can consider for the replacement of its diesel and gasoline vehicles.

### 6.4.1 Fixed Route

Several possible scenarios can be considered when determining the fuel mix recommendations for the fixed route blocks. The first scenario is the most visionary approach, attempting to replace vehicles in a way that achieves the lowest emissions possible while accounting for reduced capital and operational challenges such as adding vehicles and blocks. The second scenario mimics the first scenario but simplifies the diversification of fleet, compromising for keeping two fuel types with minimal capital investment while maintaining a commitment towards battery electric buses. The third scenario minimizes the impact of capital costs but commits to a soft transition towards a low emission bus fleet. Finally, the fourth scenario also minimizes costs, committing to lowering emissions with the lowest capital cost. **Table 6-27** presents the recommendations under each scenario, proposing a replacement fuel type that best serves the stated objective.

**TABLE 6-27: FIXED ROUTE FUEL MIX RECOMMENDATIONS**

| Block No. | Recommendations | | | |
|---|---|---|---|---|
| | **Scenario 1: Least Harmful Emissions** | **Scenario 2: Optimized Vehicle Function** | **Scenario 3: Balanced Approach** | **Scenario 4: Lowest Capital Cost** |
| **1** | Hybrid | CNG | Biodiesel | Biodiesel |
| **2/20** | Hybrid | Hybrid | Hybrid | Biodiesel |
| **3** | Diesel | Diesel | Diesel | Diesel |
| **4** | Diesel | Diesel | Diesel | Diesel |
| **5** | Hybrid | Hybrid | Hybrid | Biodiesel |
| **6** | Hybrid | CNG | Biodiesel | Biodiesel |
| **7** | Hybrid | Hybrid | Hybrid | Biodiesel |
| **8** | Hybrid | CNG | Biodiesel | Biodiesel |
| **9** | Hybrid | CNG | Biodiesel | Biodiesel |
| **10** | Diesel | Diesel | Diesel | Diesel |
| **11** | Hybrid or BEB with On-Route Charging after 2030 | Hybrid or BEB with On-Route Charging after 2030 | Hybrid or BEB with On-Route Charging after 2030 | Biodiesel |
| **12** | Hybrid | CNG | Biodiesel | Biodiesel |
| **13** | **Battery Electric** | **Battery Electric** | **Battery Electric** | Biodiesel |
| **15/21** | Hybrid or BEB with On-Route Charging | Hybrid or BEB with On-Route Charging | Hybrid or BEB with On-Route Charging | Biodiesel |
| **16** | Hybrid | Hybrid | Hybrid | Biodiesel |
| **17** | Hybrid/BEB 2035+ or BEB with On-Route Charging | Hybrid/BEB 2035+ or BEB with On-Route Charging | Hybrid/BEB 2035+ or BEB with On-Route Charging | Biodiesel |
| **18** | Hybrid or BEB with On-Route Charging after 2035 | Hybrid or BEB with On-Route Charging after 2035 | Hybrid or BEB with On-Route Charging after 2035 | Biodiesel |
| **19** | CNG | CNG | Biodiesel | Biodiesel |
| **22** | **Battery Electric** | **Battery Electric** | **Battery Electric** | Biodiesel |

### 6.4.1.1 Scenario 1: Least Harmful Emissions

This scenario is designed to minimize the impact of harmful emissions in the environment given the operational conditions that CAT can provide within the study period. This maximizes the use of Battery Electric Buses, paired with the least harmful fuel alternative. When modeling the impacts of overall carbon emissions, Hybrid vehicles paired well with battery electric vehicles, due to their balanced profile of carbon emissions, as well as hybrid vehicle's well-to-wheels lifecycle cost on the environment, which is overall slightly lower than CNG buses for example. Additionally, Hybrid vehicles have a reliable range to accommodate CAT's current operations. Finally, a small portion of blocks would remain diesel. **Figure 6-3** demonstrates the expected fuel mix assigned to blocks for Scenario 1A.

A variation of Scenario 1 (1B) was also evaluated, which also aims to minimize the impact of harmful emissions in the environment. This variation maximizes the use of Battery Electric Buses by adopting on-route charging. When modeling the impacts of overall carbon emissions, Hybrid vehicles remained a choice support for battery electric vehicles, due to their balanced profile of carbon emissions. In this scenario, the objective is to flip as many blocks towards Hybrid as possible. A small portion of blocks would remain diesel, representing the longest blocks, as well as the need to retain a portion of the fleet fueled with diesel buses in the case of emergency operations in the absence of electricity. **Figure 6-4** demonstrates the expected fuel mix assigned to blocks for Scenario 1B.

**FIGURE 6-3: SCENARIO 1A (NO ON-ROUTE CHARGING)**

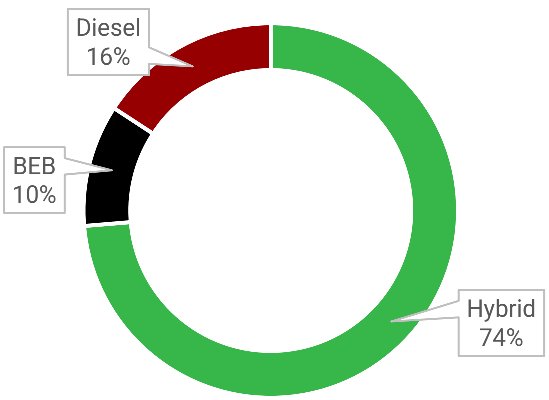
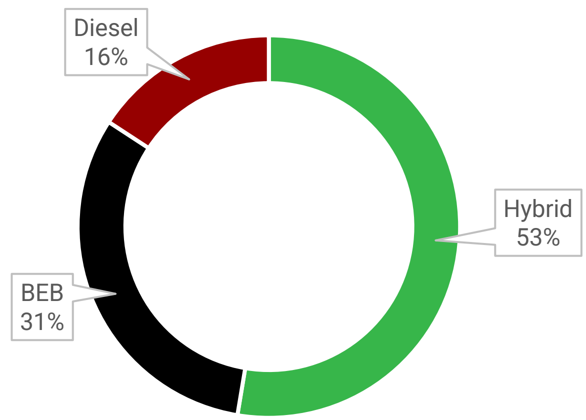



**FIGURE 6-4: SCENARIO 1B (ON ROUTE CHARGING)**




#### 6.4.1.2 Scenario 2: Optimized Vehicle Function

Scenario 2 focuses on optimizing vehicle functions by assigning them to the environments and route profiles where they operate most efficiently. This approach minimizes unnecessary strain on the vehicles, potentially reducing breakdowns and extending fleet longevity. This scenario presents a more experimental approach with a largely diverse fuel mix. This scenario suggests the implementation of CNG as the low-emission fuel of supporting some of CAT's longest blocks with consideration of the suburban nature of parts of the county. This scenario also maximizes the inclusion of battery electric buses without on-route charging. **Figure 6-5** demonstrates the expected fuel mix assigned to blocks for Scenario 2A.

A variation of Scenario 2 (2B) is presented which also aims to maximize the functionality of each vehicle type with regards to operating environment. This variation maximizes the use of Battery Electric Buses by adopting on-route charging. A small portion of blocks would remain diesel, representing the longest blocks, as well as the need to retain a portion of the fleet fueled with diesel buses in the case of emergency operations in the absence of electricity. **Figure 6-6** demonstrates the expected fuel mix assigned to blocks for Scenario 2B.

FIGURE 6-5: SCENARIO 2A
(NO ON-ROUTE CHARGING)

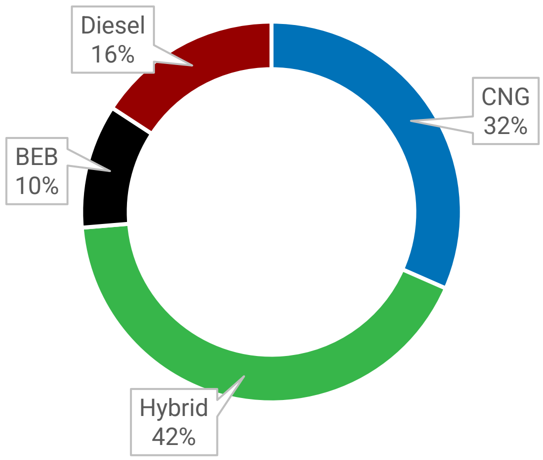
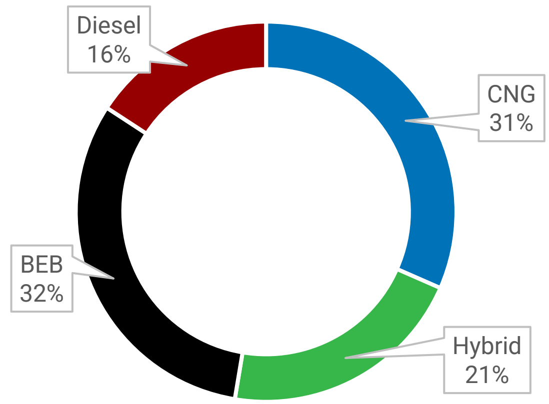



FIGURE 6-6: SCENARIO 2B
(ON-ROUTE CHARGING)




6.4.1.3 Scenario 3: Balanced Approach

Scenario 3 balances capital costs and emissions to achieve the optimal balance between both. This scenario represents a commitment to reduced emissions while also controlling costs. This scenario was best achieved by including biodiesel fuels which reduce capital costs based on the need to only purchase a tank to hold the fuel and its dispensers, which can be added to existing diesel fueling infrastructure. It also retains a larger portion of diesel vehicles in the fleet than other scenarios.

A variation of Scenario 3 (3B) was also evaluated, with the inclusion of battery electric buses. Scenario 3B demonstrates that a continued increase of electric vehicles that are feasible for each block, a decrease in the hybrid fleet is observed. Meanwhile the diesel and biodiesel group is maintained, controlling capital costs.

The fleet fuel mix for Scenario 3A and Scenario 3B are shown in **Figure 6-7** and **Figure 6-8**.

FIGURE 6-7: SCENARIO 3A
(NO ON-ROUTE CHARGING)

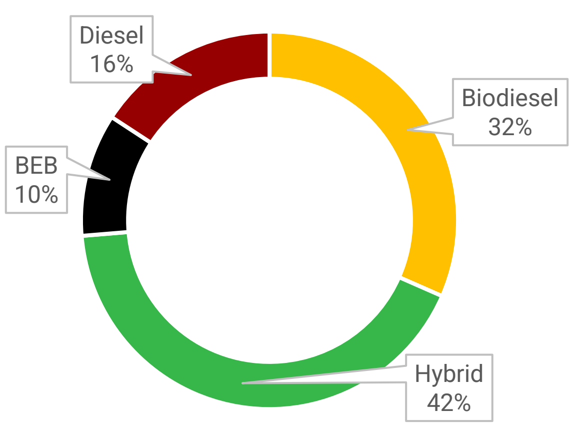
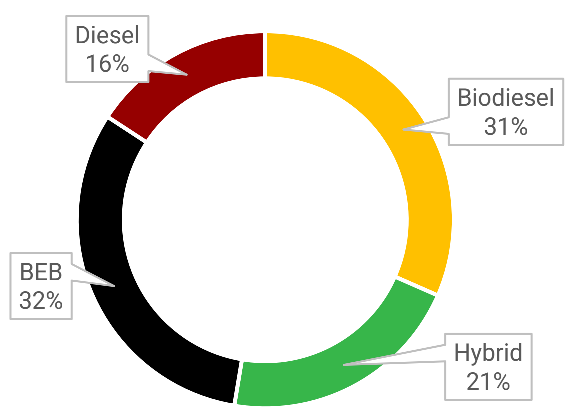


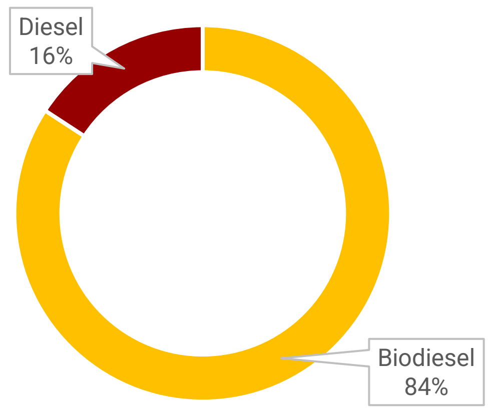

FIGURE 6-8: SCENARIO 3B
(ON-ROUTE CHARGING)



#### 6.4.1.4 Scenario 4: Lowest Capital Cost

Finally, Scenario 4 examines the lowest capital cost approach towards a fleet transition. Without constraints, it is expected that the lowest capital cost is incurred by transitioning to a biodiesel fleet. This scenario minimizes the diversity of the fuel mix and controls the capital cost at the same time. An increase in emissions is expected due to the nature of the organic material related to biodiesel, however, a reduction in lifecycle greenhouse emissions due to fuel production are lower than the current scenario. **Figure 6-9** illustrates the fuel mix.

**FIGURE 6-9: SCENARIO 4**




#### 6.4.1.5 Fixed Route Fuel Mix Scenario Comparison

The following compares estimated financial profiles for each scenario as well as annual emissions outputs, and lifecycle greenhouse gas emissions incurred during the production of the fuel type. These all help to balance considerations and benefits as well as challenges related to each scenario.

The first comparison looks at the total capital cost incurred in the implementation of each vehicle type. Assumptions for these estimates were drawn from the 2023 AFLEET tool, which models capital costs for each vehicle type. The assumptions were made for the generic transit bus assumption built in the tool and considers the vehicle cost (assuming about two vehicles per block) and the cost of additional infrastructure to accommodate the introduction of new fuel types.

Described below are the assumed infrastructure needs for each scenario.

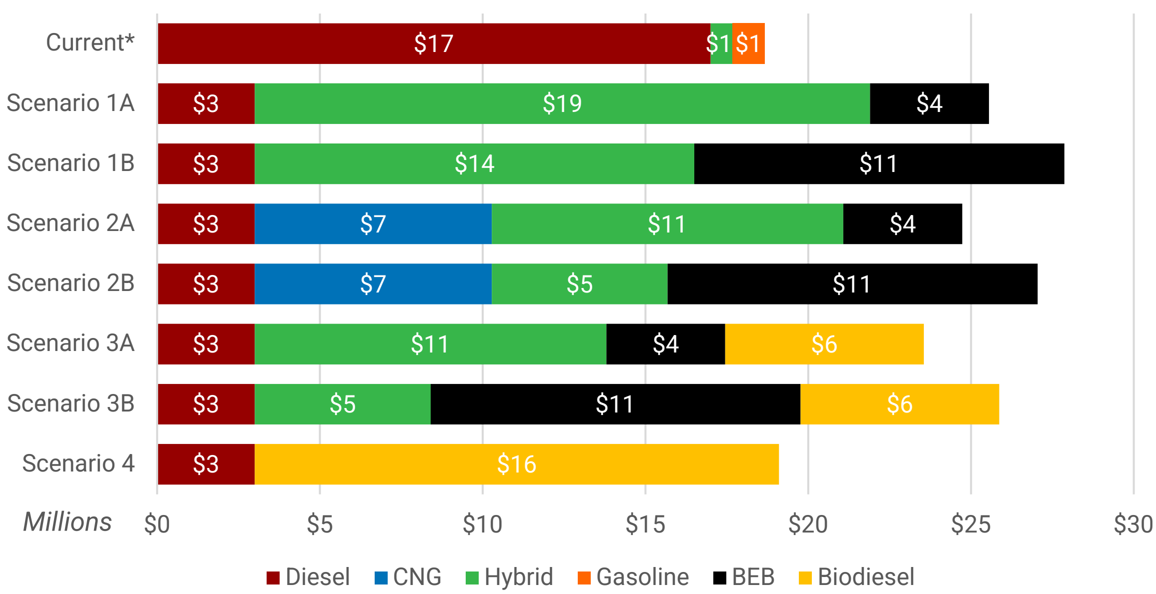
- Scenario 1A: The purchase of four Level 2 Chargers for overnight depot charging as well as the cost of installing these chargers.
- Scenario 1B: The cost of installing 12 Level 2 chargers for overnight depot charging as well as 3 fast chargers to be installed at the CAT Operations Facility, Government Center Transfer Station, and Immokalee Transfer Station, as well as the cost of installation and electrical grid upgrades.
- Scenario 2A: The purchase of four Level 2 Chargers for overnight depot charging as well as the cost of installing these chargers; and the installation of a small to medium slow-fill CNG facility, gas dryers and 12 dispensers at the depot.
- Scenario 2B: The cost of installing 12 Level 2 chargers for overnight depot charging as well as 3 fast chargers to be installed at the CAT Operations Facility, Government Center Transfer Station, and Immokalee Transfer Station, as well as the cost of installation and electrical grid upgrades.

Also, the installation of a small to medium slow-fill CNG facility, gas dryers and 12 dispensers at the depot.

- Scenario 3A: The purchase of four Level 2 Chargers for overnight depot charging as well as the cost of installing these chargers; and the addition of a fuel storage tank for biodiesel and a few added dispensers.
- Scenario 3B: The cost of installing 12 Level 2 chargers for overnight depot charging as well as 3 fast chargers to be installed at the CAT Operations Facility, Government Center Transfer Station, and Immokalee Transfer Station, as well as the cost of installation and electrical grid upgrades. The addition of a fuel storage tank for biodiesel and a few added dispensers.
- Scenario 4: The addition of a fuel storage tank for biodiesel and a few added dispensers.

**Figure 6-10** presents these estimated costs for comparison purposes.

FIGURE 6-10: FIXED ROUTE ESTIMATED CAPITAL COSTS

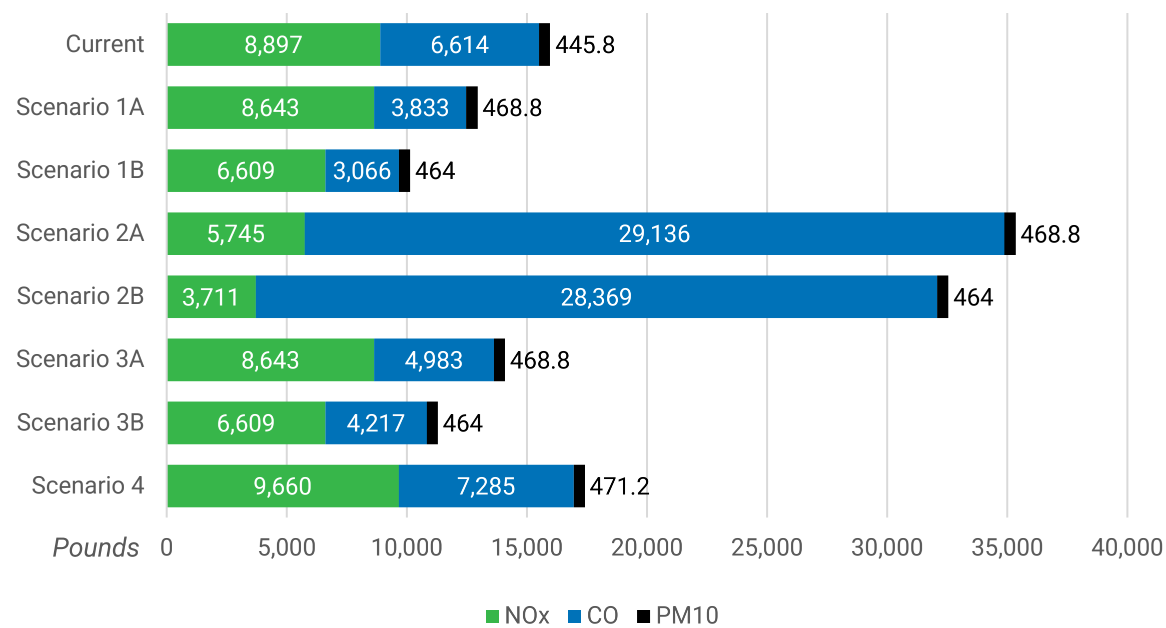



**The current scenario reflects the fleet composition prior to the retirement of the Hybrid Diesel-Electric bus*

Costs range between $18 million and $28 million, with Scenario 1B being the costliest, and Scenario 4 being the least costly, even when compared to the current scenario. Scenario 1A is the median costing approach at just over $25 million.

The estimated annual emissions output was analyzed for each scenario, varying based on the fleet's fuel mix. These figures serve as planning estimates rather than exact values. The emissions evaluated are Carbon Monoxide (CO), Nitrous Oxide (NOx), and Particulate Matter (PM10). Carbon Monoxide is found in natural and organic material in abundance and is released when incomplete fuel burning occurs. Carbon Monoxide is, however, less problematic in open air and is harmful in larger quantities when compared to NOx which can cause acid rain, smog, and ground level ozone. Moreover, NOx can cause respiratory issues and inflammation when inhaled. Finally Particulate Matter is most impactful on human health, which can be introduced into the human tissue and the bloodstream, causing severe problems including a premature death. **Figure 6-11** shows the estimated emissions profile for each scenario and should be interpreted cautiously.

**FIGURE 6-11: ESTIMATED ANNUAL EMISSIONS PROFILE FOR FIXED ROUTE**

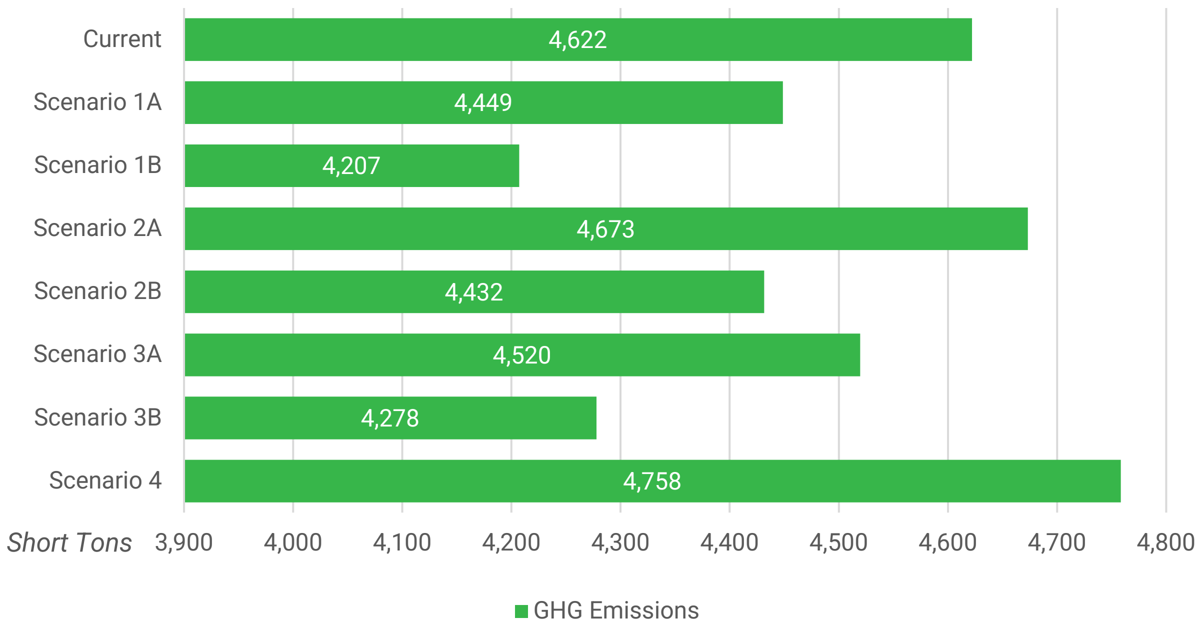



Scenarios 2A and 2B have the highest CO impact due to the release of methane and carbon monoxide from incomplete burning of natural gas in the fleet. While CO may disperse, the figures are significant. On the other hand, these scenarios also show the greatest reduction in NOx due to a large movement away from diesel. Finally, the particulate matter is standard relative to other scenarios. Scenario 1A and 1B present the lowest carbon footprint overall although the NOx profile for 1B is lower than 1A. Scenario 4 has the highest NOx emissions due to maintaining diesel fuel, and the largest particulate matter emission, being more harmful in every respect to the current scenario.

For further consideration, a well-to-wheels lifecycle analysis was also assessed. This analysis looks at the greenhouse gas emissions that are generated during the fuel production and distribution process. In the case of battery electric vehicles, this includes lithium mining for batteries, and petroleum extraction for diesel, biofuel activation for biodiesel, and natural gas extraction for CNG. **Figure 6-12** provides a comparison of the various fuel types in short tons.

The current scenario has the greatest overall impact due to the petroleum extraction process. All other scenarios present a decrease in emissions by comparison. Most notably, Scenario 1B has the lowest emission profile for fuel production, largely due to the lithium batteries, and a reduced overall use of diesel.

**FIGURE 6-12: WELL TO WHEELS LIFECYCLE GREENHOUSE GAS EMISSIONS FIXED ROUTE COMPARISONS**




### 6.4.2 Demand Response

Several possible scenarios can be considered when determining the fuel mix recommendations for the transition of the demand response fleet. None of the scenarios propose the addition of electric cutaways, as these seem to be inadequate for adoption given the current demand response fleet's operations. The first scenario is the most visionary approach, attempting to replace vehicles in a way that achieves the lowest emissions possible while accounting for operational challenges such as long DR trips out of range for certain fuel types. The second scenario mimics the first scenario but simplifies the diversification of fleet by keeping two fuel types with minimal capital investment with a commitment towards low emissions. The third scenario minimizes the impact of capital costs but commits to a soft transition towards a low emission cutaway fleet. **Table 6-28** summarizes the existing fuel mix for Demand Response vehicles and resulting mix for each of the scenarios.

**TABLE 6-28: DEMAND RESPONSE FUEL MIX RECOMMENDATIONS**

| Vehicle Type | Current Scenario | | Recommendations | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Scenario 1: Balanced Emissions and Costs | | Scenario 2: Lowest Capital Cost | | Scenario 3: Strong CNG | |
| Diesel | 25% | 8 | 0% | 0 | 25% | 8 | 0% | 0 |
| Gasoline | 75% | 25 | 75% | 25 | 0 | 0 | 0% | 0 |
| Biodiesel | 0% | 0 | 0% | 0 | 75% | 25 | 25% | 8 |
| CNG | 0% | 0 | 25% | 8 | 0 | 0 | 75% | 25 |

#### 6.4.2.1 Scenario 1

Scenario 1 aims to balance the emissions output and capital costs. This scenario envisions maintaining 25 gasoline vehicles, which is the current composition of the gasoline fleet, and replacing diesel cutaways with CNG cutaways.

#### 6.4.2.2 Scenario 2

Scenario 2 Aims to reduce capital costs while transitioning into a fuel alternative. This scenario maximizes the diesel fleet and applies the use of biodiesel fuel in the fleet.

#### 6.4.2.3 Scenario 3

Scenario 3 aims to take a strong approach or investment into CNG. 75% of the demand response fleet would transition to CNG, with a selection of biodiesel cutaways to serve the longest trips.

#### 6.4.2.4 Scenario Comparisons

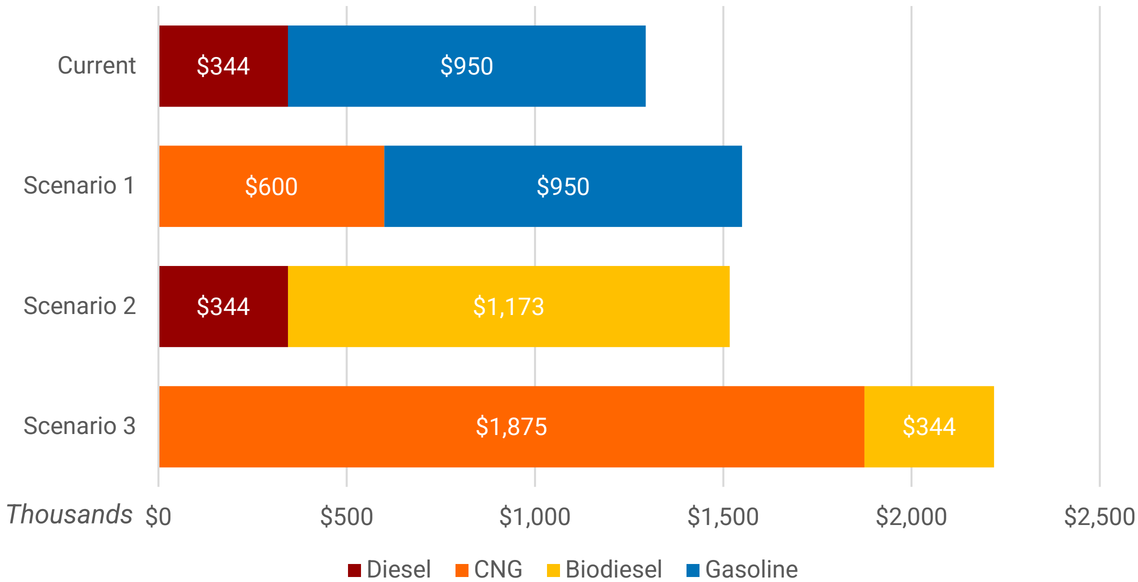
The capital costs range between $1.5 million and $2.2 million, while the current fleet cost is currently about $1.3 million. Scenario 3 is the costliest due to the added infrastructure that would be required in addition to the vehicle purchase. Scenario 2 is the least expensive, only requiring the addition of a biodiesel tank.

Assumptions regarding capital costs include:

- Scenario 1: the installation of a small CNG facility with dispensers
- Scenario 2: The purchase and installation of a biodiesel tank
- Scenario 3: The installation of a small to medium CNG facility with dispensers.

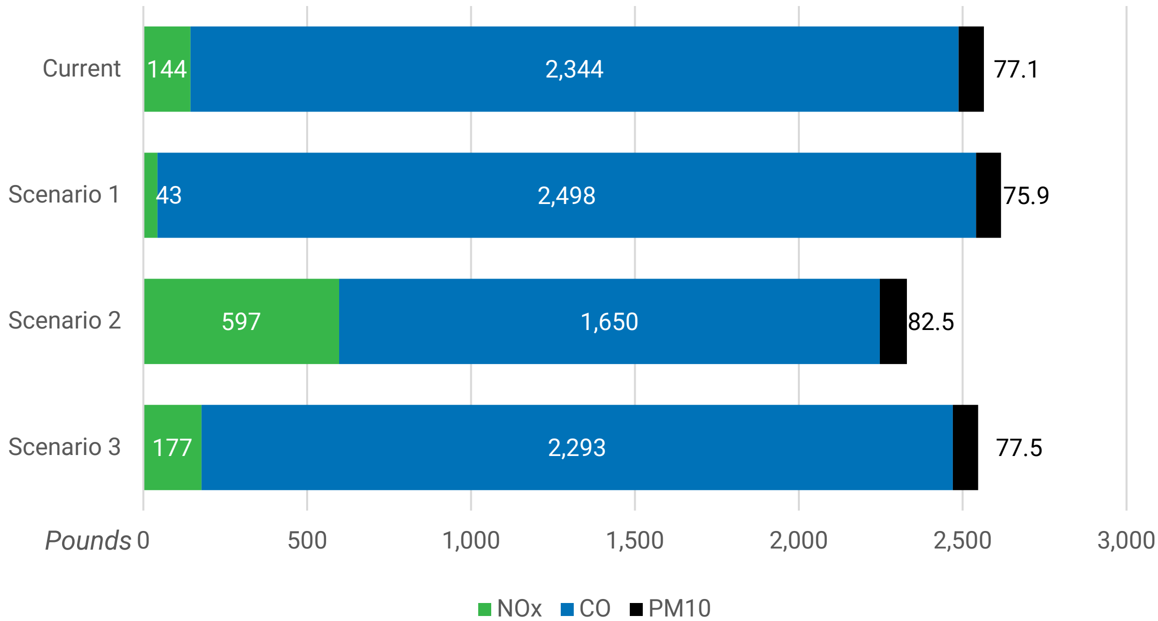
**Figure 6-13** presents the capital costs for the various scenarios proposed compared to the current scenario.

FIGURE 6-13: DEMAND RESPONSE ESTIMATED CAPITAL COSTS



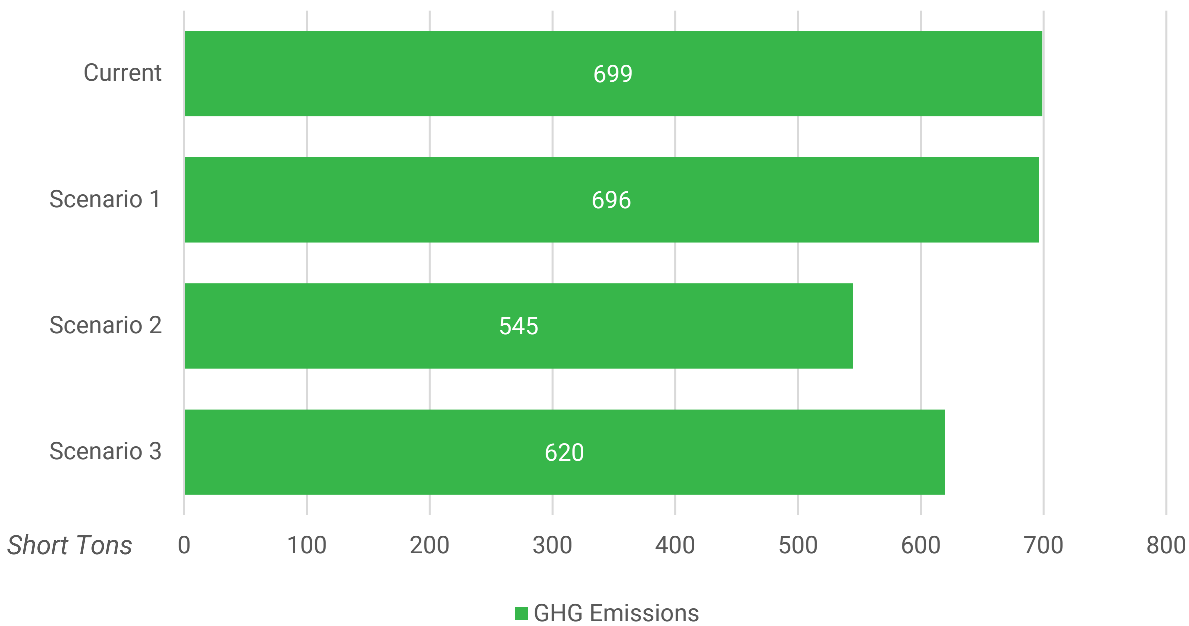

Emissions profiles were also developed for the various demand response scenarios proposed. Variation in emission output is less pronounced compared to fixed route scenarios. The largest observable change is Scenario 2's large increase in NOx and Particulate Matter emissions compared to other scenarios, even though it does achieve a reduction in CO. This could be an alarming counterintuitive approach due to its relatively higher NOx output. **Figure 6-14** presents the comparison.

FIGURE 6-14: ESTIMATED ANNUAL EMISSIONS PROFILE FOR DEMAND RESPONSE




A well to wheels emissions profile was also developed and assessed for the demand response scenarios. Scenario 2 has a clear advantage in its reduction of lifecycle emissions from the well, in this case, the production of biofuel. Meanwhile, the CNG Scenario 3 is also a clear reducer of emissions overall. **Figure 6-15** presents these profiles.

FIGURE 6-15: WELL TO WHEELS LIFECYCLE GREENHOUSE GAS EMISSIONS DEMAND RESPONSE COMPARISONS



### 6.4.3 Equipment/Support Vehicle

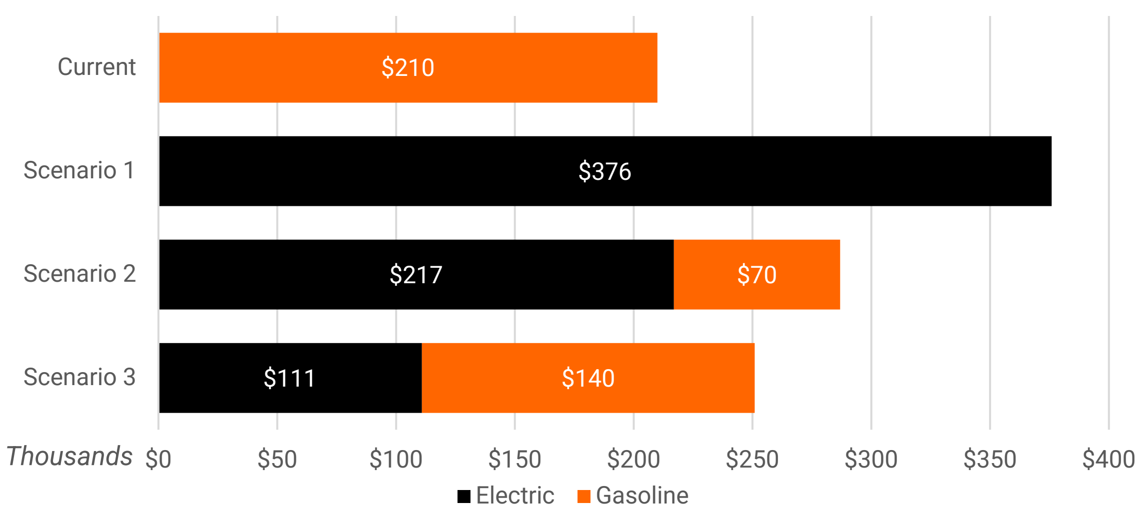
Three recommended scenarios were developed for the Equipment/Support Vehicle fleet. The first scenario commits to the lowest possible emissions, while adding an additional minivan as backup for important operator shift rides in the absence of one vehicle. The second scenario is similar to the first scenario but is cautious about the limitations in operations that can be experienced by minivans. The third scenario attempts to commit to the transition towards zero emissions while limiting the capital cost by reducing the number of EVs, as well as maintaining a cautious approach to emergency backup fleet needs during storms, maintaining enough Gasoline fueled vehicles for this scenario. **Table 6-29** summarizes the recommendations.

**TABLE 6-29: SUPPORT VEHICLES FUEL MIX RECOMMENDATIONS**

| Vehicle Type | Current Scenario | | Recommendations | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Scenario 1: Lowest Emissions (and Lifecycle Cost) | | Scenario 2: Operations Limited | | Scenario 3: Lowest Capital Cost | |
| | Gas | EV | Gas | EV | Gas | EV | Gas | EV |
| Minivan | 2 | 0 | 0 | 3 | 2 | 0 | 2 | 0 |
| SUV | 2 | 0 | 0 | 2 | 0 | 2 | 1 | 1 |
| Pickup Truck | 2 | 0 | 0 | 2 | 0 | 2 | 1 | 1 |

Transitioning from gasoline to electric vehicles has its cost benefits. Going full electric is currently almost $375,000 for CATs DR fleet. However, Scenario 3 presents a balanced approach to the support vehicle fleet that is less than $50,000 more expensive than the current scenario. **Figure 6-16** presents the cost comparisons. Cost assumptions only consider the installation of small commercial chargers for these vehicles, and no additional fuel tanks for any gasoline vehicles.

**FIGURE 6-16: SUPPORT VEHICLES ESTIMATED CAPITAL COSTS**



When evaluating the estimated emissions output for support vehicles, going all electric is nearly feasible and can be the first part of CATs total fleet to have a low impact overall. Adding electric vehicles is a clear step away from emissions as observable in **Figure 6-17**.

Following a similar pattern, the integration of electric vehicles reduces the overall lifecycle greenhouse gas emissions, although these are still present in all electric scenarios, likely due to lithium mining and transferring demand to local energy sources. See **Figure 6-18** for the comparisons.

**FIGURE 6-17: ESTIMATED ANNUAL EMISSIONS PROFILE FOR SUPPORT VEHICLES**

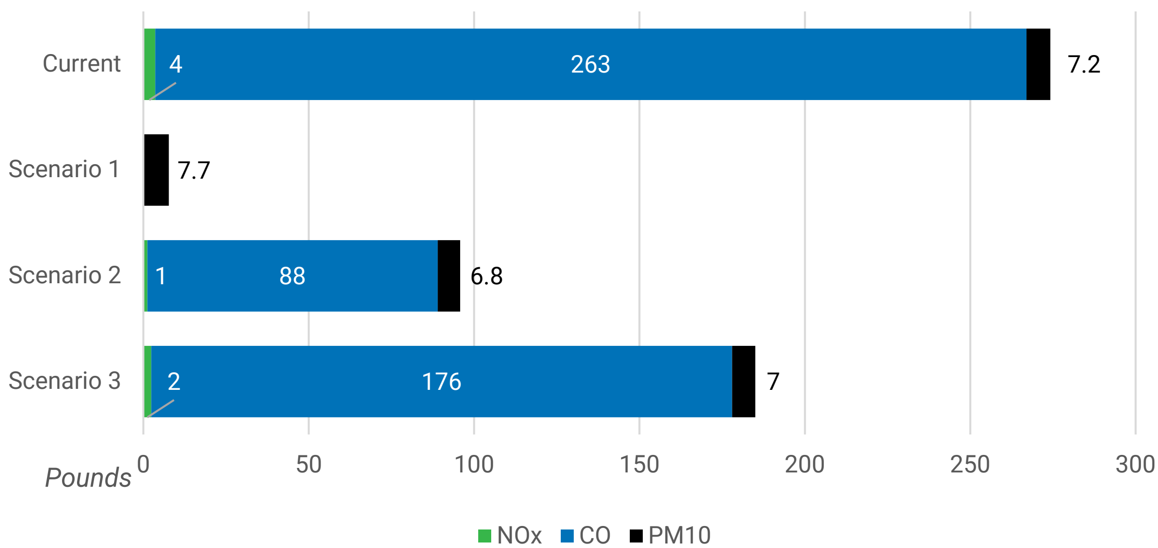
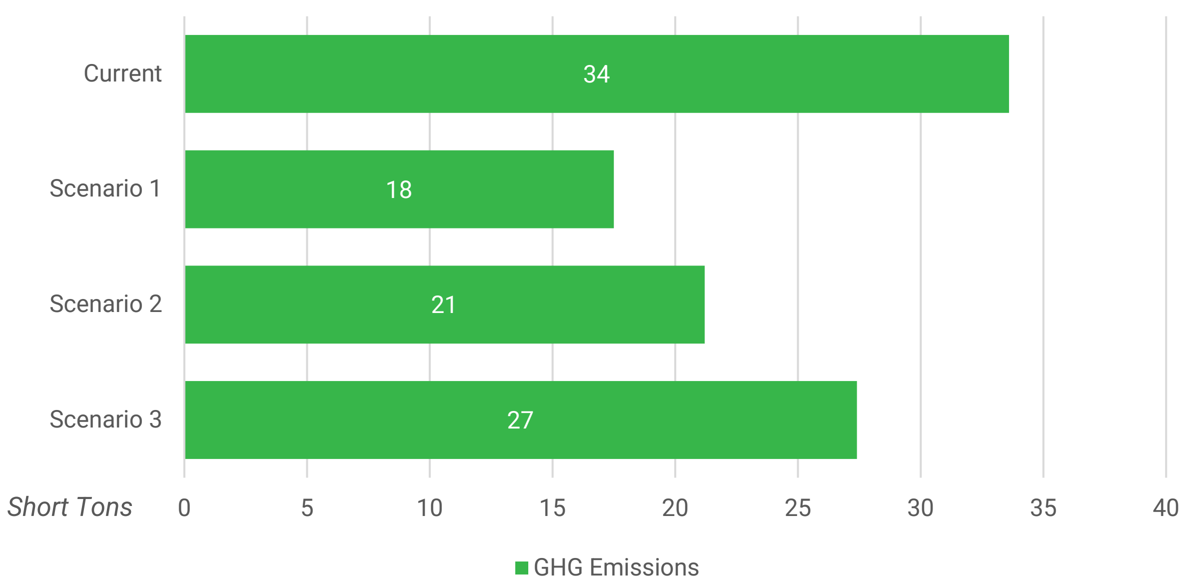



**FIGURE 6-18: WELL TO WHEELS LIFECYCLE GREENHOUSE GAS EMISSIONS SUPPORT VEHICLE COMPARISONS**



# 7 FINANCIAL ANALYSIS

Incorporating the findings from the feasibility analysis, this financial analysis examines the same fuel mix scenarios to assist in the preparation of a vehicle replacement plan for fixed-route, paratransit and support vehicles. These financial estimates, in conjunction with input from the Steering Committee, determined the percentage of vehicles desired to be transitioned to ZEV. The resulting vehicle replacement plan, included in the ZEV transition plan, covers ten years to ensure all current vehicles are replaced with the recommended technology based on the percent replacement desired.

Included in the financial analysis are high-level capital cost estimates for the recommended fleet conversion, recommended charging infrastructure, and maintenance/storage facility modifications. In addition, this section provides a review of state and federal funding sources, including FTA's Low or No Emission Grants and the Environmental Protection Agency's (EPA) Community Change Grant Program.

## 7.1 Financial Plan

Prior to finalizing the vehicle replacement plan and ZEV transition plan, a high-level ten-year financial plan was developed for each scenario by estimating vehicle costs and operating expenses, and assuming all other capital and operating expenses as presented in CAT's FY 2024 Transit Development Plan Annual Progress Report (TDP APR).The Argonne National Laboratory's Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) tool was used to develop capital vehicle cost assumptions for this financial analysis. Additionally, a 2.51% annual inflation rate was assumed to reflect the average annual inflation rate over the past ten years, according to the Bureau of Labor Statistics. Despite these assumptions, this financial analysis does not account for confounding variables such as unforeseen maintenance expenses.

**Figure 7-1** summarizes the estimated ten-year total capital expenses for CAT for each fuel mix scenario. Total capital expenses assume each scenario to differ by fleet fuel mix (and associated infrastructure expenses) while all other expenses remain constant. Scenario 4 and the status quo boast the lowest estimated capital expenses, as a fleet with predominately standard internal combustion engine (ICE) vehicles (fueled by diesel and biodiesel) is less expensive than those comprised of other ZEV's. Each of the other scenarios require an extra $5 to $14 million investment over ten years for costlier capital expenses such as battery electric vehicles and charging infrastructure.

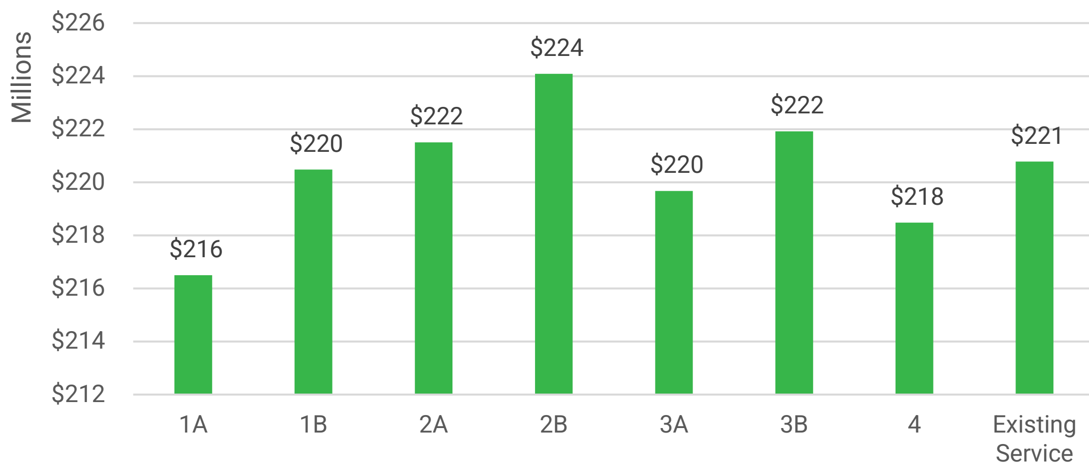
FIGURE 7-1: TOTAL CAPITAL COSTS BY FUEL MIX SCENARIO (2025-2034)


**Figure 7-2** summarizes the estimated ten-year total operating expenses for CAT by fuel mix scenario. Total operating expenses assume each scenario to differ by fleet fuel mix (and associated operating expenses) while all other expenses remain constant. Scenarios 2A and 2B boast the lowest estimated operating expenses, as these propose fleets with the lowest levels of diesel consumption, in contrast to the highest levels of diesel consumption experienced with the existing fuel mix, which is projected to cost an additional $14 million over ten years to operate when compared to Scenario 2A.

FIGURE 7-2: TOTAL OPERATING COSTS BY FUEL MIX SCENARIO (2025-2034)

Considering the sum of capital and operating expenses, **Figure 7-3** visualizes the estimated grand total cost for CAT over ten years, by fuel mix scenario. Scenarios 1A, 1B, 3A, and 4 are likely to be the most affordable overall, as the fuel mix for those fleets are comprised by a limited number of battery electric vehicles, a limited number of vehicles exclusively powered by diesel, and do not require on-route charging. For an extra $6.3 million over ten years, the status quo is the most expensive scenario to operate as the predominantly ICE fleet experiences higher operating costs due to the high consumption of diesel fuel.

**FIGURE 7-3: TOTAL CAPITAL AND OPERATING COSTS BY FUEL MIX SCENARIO (2025-2034)**




### 7.1.1 Cost Savings

Each proposed fuel mix scenario presents a either a slight increase or a slight decrease in cost savings when compared to the status quo, with an estimated net difference between $-3 and $4 million over ten years depending on the scenario, as indicated in **Table 7-1**. Despite potential savings or increased costs of over a million dollars, each fuel mix scenario offers only differs in cost by a rate of no more than two percent when compared to status quo, depending on the scenario.

Scenario 1A presents the greatest potential cost savings because of its relatively low amounts of capital investment and low amounts of operating expenses associated with a fixed-route fleet with many hybrid vehicles and a demand response fleet with many gasoline vehicles. On the other end of the spectrum, Scenario 2B represents the greatest cost increase due to its high amounts of capital investment required for on-route charging, CNG, vehicles, and battery electric vehicles.

**TABLE 7-1: SUMMARY OF COST SAVINGS BY SCENARIO**

| Scenario | Fuel Mix Scenario | Est. Cost Savings | Percent Savings |
|---|---|---|---|
| 1A | Least Harmful Emissions (**No** On-Route Charging) | **$4.3 Million** | 2.0% |
| 1B | Least Harmful Emissions (On-Route Charging) | **$0.3 Million** | 0.1% |
| 2A | Optimized Vehicle Function (**No** On-Route Charging) | **$-0.7 Million** | -0.3% |
| 2B | Optimized Vehicle Function (On-Route Charging) | **$-3.3 Million** | -1.5% |
| 3A | Balanced Approach (**No** On-Route Charging) | **$1.1 Million** | 0.5% |
| 3B | Balanced Approach (On-Route Charging) | **$-1.1 Million** | -0.5% |
| 4 | Lowest Capital Cost | **$2.3 Million** | 1.1% |
| Existing Service | | $0 | 0.0% |

### 7.1.2 Vehicles

Listed below are the vehicle cost assumption made for the financial analysis by fuel type. **Table 7-2** documents the assumed capital costs of vehicles and **Table 7-3** documents the assumed operating costs of vehicles.

**TABLE 7-2: ASSUMED CAPITAL COSTS OF VEHICLES BY FUEL TYPE (AFLEET TOOL, 2023)**

| Service Type | Fuel Type | Vehicle Cost |
|---|---|---|
| Fixed Route | CNG | $704,000 |
| | Battery Electric | $1,058,000 |
| | Biodiesel | $580,000 |
| | Hybrid | $783,000 |
| | Diesel | $580,000 |
| | Gasoline | $580,000 |
| Demand Response | CNG | $316,000 |
| | Battery Electric | $282,000 |
| | Biodiesel | $181,000 |
| | Diesel | $181,000 |
| | Gasoline | $160,000 |
| Equipment/Support Vehicles | Battery Electric | $74,000 |
| | Gasoline | $45,000 |

*Source: AFLEET Tool Per Unit Cost Assumptions (2023)*

**TABLE 7-3: ASSUMED OPERATING COSTS OF VEHICLES BY FUEL TYPE***

| Service Type | Fuel Type | Cost per Mile |
|---|---|---|
| Fixed Route | CNG | $3.18 |
| | Battery Electric | $3.26 |
| | Biodiesel | $3.49 |
| | Hybrid | $2.79 |
| | Diesel | $3.96 |
| | Gasoline | $3.96 |
| Demand Response | CNG | $3.46 |
| | Battery Electric | $2.86 |
| | Biodiesel | $3.91 |
| | Diesel | $3.91 |
| | Gasoline | $3.91 |
| Equipment/Support Van/SUV | Battery Electric | $0.10 |
| | Gasoline | $0.33 |
| Equipment/Support Pickup Truck | Battery Electric | $0.11 |
| | Gasoline | $0.39 |

**Sources for assumptions include the National Transit Database (2023), FTA/King Co. (2017), HART (2017), King Co. (2018), NREL (2019), FTA/HART/NREL, FTA/King Co., Mountain Line ZEB Plan (2020), Transfort ZEB Plan, ICF 2019 Report (Table II-11), DOE, NREL, and the 2023 Federal Fleet Report*

### 7.1.3 Infrastructure/Facility Upgrades

Rolled into the overall capital costs estimates for the purpose of this financial analysis, **Table 7-4** outlines infrastructure cost assumptions associated with the implementation of each fuel type.

**TABLE 7-4: ASSUMED COSTS OF ALTERNATE FUEL INFRASTRUCTURE (AFLEET, 2023)**

| Service Type | Infrastructure Type | Per Vehicle Cost | Flat Cost |
|---|---|---|---|
| Fixed Route | CNG Station and Dispensers (Medium) | $66,660 | |
| | Overnight Chargers (and installation) | $60,000 | |
| | On-Route Chargers (and installation) | | $163,300* |
| | Biodiesel Tank and Dispensers | | $97,935 |
| Demand Response | CNG Station and Dispensers (Small) | $27,700 | |
| | Overnight Chargers (and installation) | $11,900 | |

**per location*
*Source: 2023 AFLEET Tool*

### 7.1.4 Cost Feasible Plan

**Figure 7-4** lists the ten-year operating expenses and revenue sources from CAT's Cost Feasible Plan and **Figure 7-5** lists the ten-year capital expenses and revenue sources from CAT's Cost Feasible Plan. This Cost Feasible Plan, from the CAT's FY2024 TDP APR, was used as the framework for this financial analysis.

Per the cost feasible plan, the following funding sources contribute to CAT's revenue stream:

- Capital
  - Federal Grants 5307, 5310, 5339
  - Local Match for 5310
- Operating
  - Federal Grant 5311
  - Local Match for 5307, and 5311
  - Federal Grant 5307
  - FDOT Transit Block Grant
  - Transportation Disadvantaged Funding
  - Collier County CAT Enhancements
  - FDOT Direct Match for 5307 (including toll revenue credits match) and 5310
  - Fare Revenue
  - Other Local Revenues

## Figure 7-4: CAT Operations Cost Feasible Plan (2025-2034)

| Cost/Revenue | | | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 10-Year Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Operating** | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| **Operating Cost** | | | | | | | | | | | | | |
| Maintain Existing Service - Fixed Route | Existing | | $9,015,510 | $9,221,063 | $9,431,304 | $9,646,337 | $9,866,274 | $10,091,225 | $10,321,305 | $10,556,630 | $10,797,322 | $11,043,501 | $99,990,469 |
| Maintain Existing Service - Paratransit | Existing | | $7,131,499 | $7,294,098 | $7,460,403 | $7,630,500 | $7,804,476 | $7,982,418 | $8,164,417 | $8,350,566 | $8,540,958 | $8,735,692 | $79,095,027 |
| Route 22 Realigned - no cost | Route Realignment | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Route 23 Realigned plus freq 60 to 40 | Route Realignment | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $673,469 | $673,469 |
| New Route 25 EW, no change | Route Realignment | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| New Route 25 NS, to Immokalee Rd | Add New Service | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $700,957 | $700,957 |
| New Route 27 EW, Immokalee to Randa | Route Realignment | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| New Route 27 NS, Collier 441 to Immok | Add New Service | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $1,448,282 | $1,448,282 |
| Route 121 - Add one AM and one PM | Increase Frequency | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $288,856 | $288,856 |
| Route 11 from 30 to 20 mins | Increase Frequency | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $1,155,424 | $1,155,424 |
| Route 12 from 90 to 45 mins | Increase Frequency | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $500,684 | $500,684 |
| Route 13 from 40 to 30 min | Increase Frequency | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $165,226 | $165,226 |
| Route 14 from 60 to 30 min | Increase Frequency | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $481,427 | $481,427 |
| Route 15 from 90 to 45 min | Increase Frequency | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $288,856 | $288,856 |
| Route 16 from 90 to 45 min | Increase Frequency | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $308,113 | $308,113 |
| Route 17/18 90 to 45 minutes | Increase Frequency | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $510,312 | $510,312 |
| Route 24 from 85 to 60-min | Increase Frequency | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Route 11 - Extend Hours to 10:00 PM | Increase Hours of Service | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $192,571 | $192,571 |
| Route 13 - Extend Hours to 10:00 PM | Increase Hours of Service | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $130,948 | $130,948 |
| Route 14 - Extend Hours to 10:00 PM | Increase Hours of Service | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $130,948 | $130,948 |
| Route 17/18 - Extend Hours to 10:00 PM | Increase Hours of Service | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $237,247 | $237,247 |
| Route 19/28 - Extend Hours to 10:00 PM | Increase Hours of Service | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $111,691 | $111,691 |
| New Island Trolley | Add New Service | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $1,232,452 | $1,232,452 |
| New Bayshore Shuttle | Add New Service | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $519,941 | $519,941 |
| New Autonomous Circulator | Add New Service | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $392,844 | $392,844 |
| New Naples Pier Electric Shuttle | Add New Service | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $616,226 | $616,226 |
| Mobility on Demand - Golden Gate | Add New Service | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $736,410 | $736,410 |
| Mobility on Demand - North Naples | Add New Service | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $368,205 | $368,205 |
| Mobility on Demand - Naples | Add New Service | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $873,571 | $873,571 |
| Mobility on Demand - Marco Island | Add New Service | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $490,705 | $490,705 |
| **Total Operating Costs** | | | **$16,147,009** | **$16,515,161** | **$16,891,707** | **$17,276,837** | **$17,670,749** | **$18,073,642** | **$18,485,721** | **$18,907,196** | **$19,338,280** | **$32,334,557** | **$191,640,860** |
| **Operating Revenues** | | | | | | | | | | | | | |
| Federal Grant 5311 | Existing | Federal | $800,153 | $818,397 | $837,056 | $856,141 | $875,661 | $895,626 | $916,047 | $936,933 | $958,295 | $980,144 | $8,874,454 |
| Local Match (5311) | Existing | Local | $800,153 | $818,397 | $837,056 | $856,141 | $875,661 | $895,626 | $916,047 | $936,933 | $958,295 | $980,144 | $8,874,454 |
| Federal Grant 5307 Operating Assistand | Existing | Federal | $1,808,252 | $1,849,480 | $1,891,648 | $1,934,777 | $1,978,890 | $2,024,009 | $2,070,157 | $2,117,356 | $2,165,632 | $2,215,008 | $20,055,209 |
| Local Match (5307) | Existing | Local | $1,808,252 | $1,849,480 | $1,891,648 | $1,934,777 | $1,978,890 | $2,024,009 | $2,070,157 | $2,117,356 | $2,165,632 | $2,215,008 | $20,055,209 |
| Federal Grant 5307 ADA and Preventati | Existing | Federal | $965,946 | $987,969 | $1,010,495 | $1,033,534 | $1,057,099 | $1,081,201 | $1,105,852 | $1,131,065 | $1,156,854 | $1,183,230 | $10,713,243 |
| FDOT Transit Block Grant Operating Ass | Existing | State | $1,194,529 | $1,221,764 | $1,249,620 | $1,278,112 | $1,307,253 | $1,337,058 | $1,367,543 | $1,398,723 | $1,430,614 | $1,463,232 | $13,248,447 |
| TD Funding | Existing | State | $737,630 | $754,448 | $771,649 | $789,243 | $807,237 | $825,642 | $844,467 | $863,721 | $883,414 | $903,556 | $8,181,006 |
| Local Match for FDOT Transit Block Grar | Existing | Local | $1,194,529 | $1,221,764 | $1,249,620 | $1,278,112 | $1,307,253 | $1,337,058 | $1,367,543 | $1,398,723 | $1,430,614 | $1,463,232 | $13,248,447 |
| Local TD Funding | Existing | Local | $73,763 | $75,445 | $77,165 | $78,924 | $80,724 | $82,564 | $84,447 | $86,372 | $88,341 | $90,356 | $818,101 |
| Collier County CAT Enhancements | Existing | Local | $4,631,560 | $4,737,160 | $4,845,167 | $4,955,637 | $5,068,626 | $5,184,190 | $5,302,390 | $5,423,284 | $5,546,935 | $5,673,405 | $51,368,356 |
| Federal Grant 5307 -PM | New | Federal | $1,008,555 | $1,031,550 | $1,055,069 | $1,079,125 | $1,103,729 | $1,128,894 | $1,154,633 | $1,180,958 | $1,207,884 | $1,235,424 | $11,185,822 |
| FDOT Match for Federal 5307 and 5310 - | New | State | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Local Match for Federal 5307 and 5310 - | New | Local | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Existing Paratransit Fare Revenue | Existing | Local | $192,157 | $196,538 | $201,019 | $205,603 | $210,290 | $215,085 | $219,989 | $225,005 | $230,135 | $235,382 | $2,131,204 |
| Fare Revenue from New/Improved Ser | New | Fare | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $808,438 | $808,438 |
| Fare Revenue from Existing Services | Existing | Fare | $931,530 | $952,769 | $974,492 | $996,710 | $1,019,435 | $1,042,678 | $1,066,452 | $1,090,767 | $1,115,635 | $1,141,072 | $10,331,540 |
| Other Local Revenues | Existing | Other Local Sources | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Additional Local Revenue Required - N | New | Other Local Sources | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Total Operating Revenue** | | | **$16,147,009** | **$16,515,161** | **$16,891,706** | **$17,276,837** | **$17,670,749** | **$18,073,642** | **$18,485,721** | **$18,907,196** | **$19,338,280** | **$20,587,632** | $171,190,227 |
| **Annual Revenues Minus Costs** | | | **($0)** | **($0)** | **($0)** | **($0)** | **($0)** | **($0)** | **($0)** | **($0)** | **($0)** | **($11,746,925)** | **($11,746,927)** |

### FIGURE 7-5: CAT CAPITAL COST FEASIBLE PLAN (2025-2034)

| Cost/Revenue | | | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 10-Year Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Capital Costs** | | | | | | | | | | | | | |
| **Vehicles** | | | **$2,434,517** | **$1,871,811** | **$4,759,875** | **$2,497,076** | **$1,396,437** | **$977,241** | **$2,879,823** | **$4,030,267** | **$381,881** | **$1,778,313** | **$25,410,250** |
| Replacement Fixed Route Buses - Maintain Existing Service | | | $554,063 | $1,133,390 | $4,057,311 | $1,778,493 | $606,348 | $0 | $0 | $3,243,873 | $1 | $606,348 | $14,954,612 |
| Replacement Vans - Maintain Existing Paratransit Services | | | $1,678,977 | $686,903 | $702,565 | $718,583 | $734,967 | $751,724 | $1,922,158 | $786,393 | $4 | $734,967 | $8,888,891 |
| Replacement of Support Vehicles | | | $201,477 | $51,518 | $0 | $0 | $55,123 | $225,517 | $57,665 | $0 | $1 | $55,123 | $666,746 |
| Preventative Maintenance | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Route 23 Realigned plus freq 60 to 40 | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Increase Frequency on Routes 24 and 121 | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| | | | | | | | | | | $0 | $0 | $0 | $0 |
| New Island Trolley | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| New Bayshore Shuttle | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| New Autonomous Circulator | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| New Naples Pier Electric Shuttle | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| MOD Service Zones (expanded microtransit) | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $381,875 | $381,876 | $0 |
| Spares for New Service and Improved Existing Service | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Spares for MOD Services | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| ADA Service for New Fixed Route Hours | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Other Capital/Infrastructure** | | | **$2,533,377** | **$5,570,538** | **$13,557,976** | **$570,698** | **$583,710** | **$597,019** | **$610,631** | **$624,553** | **$638,793** | **$653,357** | **$28,035,135** |
| Shelter Rehab | | | $40,912 | $41,845 | $42,799 | $43,775 | $44,773 | $45,794 | $46,838 | $47,906 | $48,998 | $50,115 | $429,235 |
| Facility | | | $2,000,000 | $5,000,000 | $13,000,000 | | | | | | | | $22,334,797 |
| Bus Shelters | | | $492,465 | $503,693 | $515,177 | $526,923 | $538,937 | $551,225 | $563,793 | $576,648 | $589,795 | $603,242 | $5,221,103 |
| Security - Driver Protection Barriers | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Technology - Avail Replacement | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Technlogy - APC | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Technology - Annunciators | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Technology - Onboard Information Media | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Technology - Farebox Replacement | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Study Santa Barbara Corridor | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $25,000 |
| Study: Regional Service and Fares | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Study I-75 Managed Lanes Express | | | $0 | $25,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $25,000 |
| Study Everglades City Vanpool | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Total Capital Costs** | | | **$4,967,894** | **$7,442,349** | **$18,317,852** | **$3,067,774** | **$1,980,147** | **$1,574,260** | **$3,490,454** | **$4,654,820** | **$1,020,674** | **$2,431,670** | **$53,445,385** |
| **Capital Revenues** | | | | | | | | | | | | | |
| Federal Grant 5307 Capital Assistance | Existing | Federal | $2,920,334 | $900,000 | $13,920,520 | $920,520 | $941,508 | $962,974 | $984,930 | $1,007,386 | $1,030,355 | $1,053,847 | $27,888,688 |
| Federal Grant 5339 Capital Assistance | Existing | Federal | | $5,000,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $6,000,000 |
| Federal Grant 5339 Capital Assistance | Existing | Federal | $368,583 | $376,986 | $385,582 | $394,373 | $403,364 | $412,561 | $421,968 | $431,588 | $441,429 | $451,493 | $3,907,704 |
| Federal Grant 5310 Capital Assistance | Existing | Federal | $1,511,080 | $618,213 | $632,308 | $646,725 | $661,470 | $676,552 | $1,729,943 | $707,754 | $4 | $661,470 | $8,000,002 |
| Local Match 5310 Capital Assistance | Existing | Federal | $167,898 | $68,690 | $70,256 | $71,858 | $73,497 | $75,172 | $192,216 | $78,639 | $0 | $73,497 | $888,889 |
| **Total Capital Revenues** | | | **$4,967,894** | **$6,963,889** | **$15,008,666** | **$2,033,476** | **$2,079,839** | **$2,127,259** | **$3,329,056** | **$2,225,368** | **$1,471,788** | **$2,240,307** | $46,685,283 |
| **Annual Revenues Minus Costs** | | | **($0)** | **($478,460)** | **($3,309,186)** | **($1,034,299)** | **$99,692** | **$553,000** | **($161,398)** | **($2,429,452)** | **$451,114** | **($191,363)** | **($6,760,102)** |

## 7.2 Potential Additional Funding

This section provides an overview of the grant opportunities available to fund the vehicle and infrastructure needs related to the transition plan. Match requirements vary so CAT will have to work with its governing board to identify funds to match grants received. Grant opportunities are primarily available through FTA, which has allocated greater funding for the Low- or No-Emission Vehicle Program under Section 5339(c). Other federal agencies also provide similar funding opportunities. These funding sources are summarized in **Table 7-5**. A Detailed summary of each funding program is listed in **Appendix E**.

TABLE 7-5: SUMMARY OF POTENTIAL FUNDING SOURCES FOR ZEV'S

| Type | Agency | Funding Program | Funding Available | Funding Eligibility | | |
|---|---|---|---|---|---|---|
| | | | | Facilities | Bus Purchase | Charging Infrastructure |
| Federal | USDOT | Discretionary Grant Program for Charging and Fueling Infrastructure | $2.5 B (FY23) | ✓ | ✓ | ✓ |
| Federal | FHWA | Advanced Transportation and Congestion Management Technologies Deployment Program | $60 M (FY2025) | ✓ | | ✓ |
| Federal | USDOT | Charging and Fueling Infrastructure Discretionary Grant Program | $700 M (FY25) | ✓ | | ✓ |
| Federal | FHWA | Advanced Transportation Technologies and Innovative Mobility Deployment | $60.0 M (FY25) | ✓ | ✓ | ✓ |
| Federal | DOE | Title XVII Renewable Energy and Efficient Energy Projects Solicitation | $4.5 B | ✓ | | ✓ |
| Federal | FTA | Low or No Emission Vehicle Program | $1.22 B (FY24) | | ✓ | ✓ |
| Federal | FTA | Bus and Bus Facilities Formula Funds | $604 M (FY24) | ✓ | ✓ | |
| Federal | FTA | Accelerating Innovative Mobility | N/A | ✓ | ✓ | ✓ |
| Federal | USDOT | Rebuilding American Infrastructure with Sustainability and Equity Grants | $1.5 B (FY24) | ✓ | | ✓ |
| Federal | EPA | Diesel Emissions Reduction Act | $92.0 M (FY24) | | ✓ | |
| Federal | IRS | Alternative Fuel Infrastructure Tax Credit | N/A | | | ✓ |
| Federal | IRS | Alternative Fuel Infrastructure Tax Credit | 30% tax credit, up to $100,000 | | | ✓ |
| Federal | FTA | Accelerating Innovative Mobility | $10 M (FY25) | | | ✓ |
| State | FHWA | National Electric Vehicle Infrastructure Formula Program | $198 M (FY23) | | | ✓ |
| Federal | HUD | Community Development Block Grant (CDBG) | $ 3B (FY25) | ✓ | | |
| State | FDOT | FDOT Transportation Alternatives Program | $80 M (FY25) | ✓ | | ✓ |
| Federal | EDA | EDA Economic Adjustment Assistance Program | $37M (FY25) | ✓ | | |
| State | DEO | Rural Infrastructure Fund | $25M (FY25) | ✓ | | |

# 8 IMPLEMENTATION PLAN

Transitioning the fleet to a low or zero-emission fleet may be a desired outcome, yet after evaluating the feasibility of this ideal, the key to achieving such an outcome is in a structured and phased implementation plan that balances operational feasibility, financial sustainability, and environmental impact. This section outlines the key steps, timelines, and strategies for deploying zero-emission technologies, including fleet conversion, infrastructure development, workforce training, and other considerations. By coordinating efforts with stakeholders, securing funding, and leveraging technological advancements, the implementation plan ensures a smooth and efficient transition while maintaining service reliability and performance standards. This implementation plan considers the first ten years of this transition, allowing CAT to be able to pivot in the best possible direction at the end of this first approach. A detailed vehicle replacement plan schedule for the fixed-route, demand response, and support vehicles has been included in **Appendix F**.

## 8.1 Vehicle Replacement Plan

The ten-year fixed route fleet management plan is based on a partial and gradual transition to a resilient fleet with a diverse fuel mix. This permits CAT to pilot low- and zero-emission vehicles with minimal investment and commitment and allow plenty of time to plan for a complete transition to low- and zero-emission fleet.

The transition commences with a pilot of a battery electric bus followed by a partial transition to multiple low-emission vehicles. At the time of writing, CAT has a total of 30 buses in its fleet of fixed route vehicles, one of which is a battery electric bus. See **Table 8-1** for CAT's fixed-route fleet details.

**TABLE 8-1: CAT EXISTING FIXED ROUTE FLEET**

| Make | Model | Length (ft.) | Quantity |
|---|---|---|---|
| Ford | Villager 7.3L V8 | 30 | 2 |
| Freightliner | Legacy | 30 | 1 |
| Gillig | G27B102N4 | 35 | 3 |
| | G27D102N4 | 40 | 3 |
| | G27E102N2 | 30 | 15 |
| | G27E102N2 | 40 | 1 |
| | (TBD— Diesel) | 30 | 2 |
| | (TBD— Diesel) | 35 | 2 |
| | (TBD— Electric) | 35 | 1 |

**Table 8-2** shows the fixed-route vehicle replacement plan based upon CAT's estimated vehicle retirement dates. CAT follows FTA's Minimum Useful Life guidelines as its policy for vehicle replacement. That means the agency replaces its 30-foot buses every 10 years and its larger 35-foot and 40-foot buses every 12 years.

This replacement plan will gradually guide the transition to a low- and zero-emission fleet.

**TABLE 8-2: CAT FIXED ROUTE VEHICLE REPLACEMENT PLAN**

| Year | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of Vehicle Replacements | 5 | 3 | 5 | 3 | 2 | 2 | 0 | 5 | 4 | 1 |

Within the transition plan timeframe, 30 vehicles will be retired and replaced, maintaining a fixed route fleet size of approximately 31 vehicles. The transition plan incorporates low- and zero-emission vehicles by replacing select diesel vehicles at the end of their useful lives.

## 8.2 Fuel Mix

In order to achieve the desired partial transition to low- and zero-emission fleet with minimal impact on existing infrastructure and operations, a 2034 fuel mix was devised to reflect this. **Figure 8-1** depicts the fuel mix of the current CAT fixed route fleet and **Figure 8-2** depicts the fuel mix of the proposed 2034 CAT fixed route fleet. Two-thirds of the fleet will remain as diesel buses, but the proposed fleet will incorporate approximately six hybrid buses, two battery electric buses, and two gasoline trolley buses.

**FIGURE 8-1: 2025 FUEL MIX**

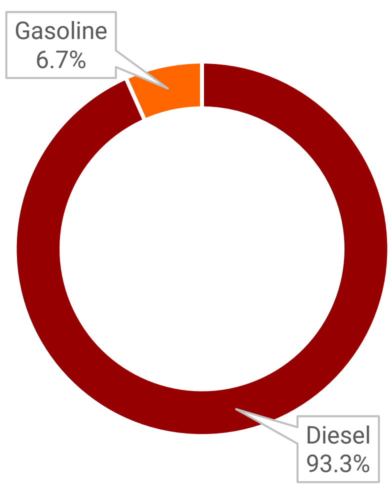
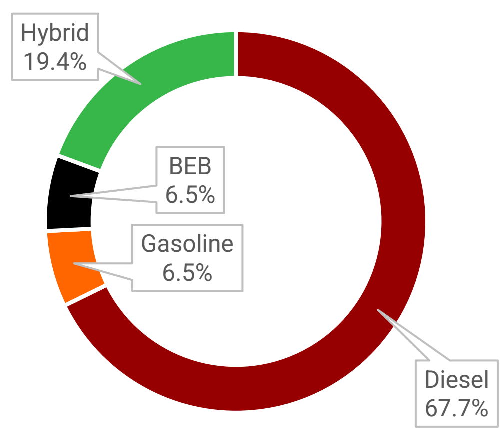



**FIGURE 8-2: 2034 FUEL MIX**



## 8.3 Phasing of Implementation

Based on the vehicle replacement plan and proposed fuel mix presented in this plan, the transition occurs in three phases. It is important to note that internal and external factors may impact the timing and details of this approach. The three main phases of the 2025-2034 transition plan are as follows:

**Phase 1: 2025 – 2029 (BEB Pilot)**

- Purchase and implement one battery electric bus
- Purchase and implement overnight chargers for two battery electric buses
- Evaluate the feasibility of operating and maintaining the battery electric bus
- Address and resolve any issues with the operation and maintenance of the battery electric bus

**Phase 2: 2029 – 2032 (Second BEB)**

- Purchase and implement an additional battery electric bus
- Revisit the ZEV Transition Plan based as part of the 2031 TDP major update vehicle replacement plan

**Phase 3: 2032 – 2034 (Hybrid Pilot)**

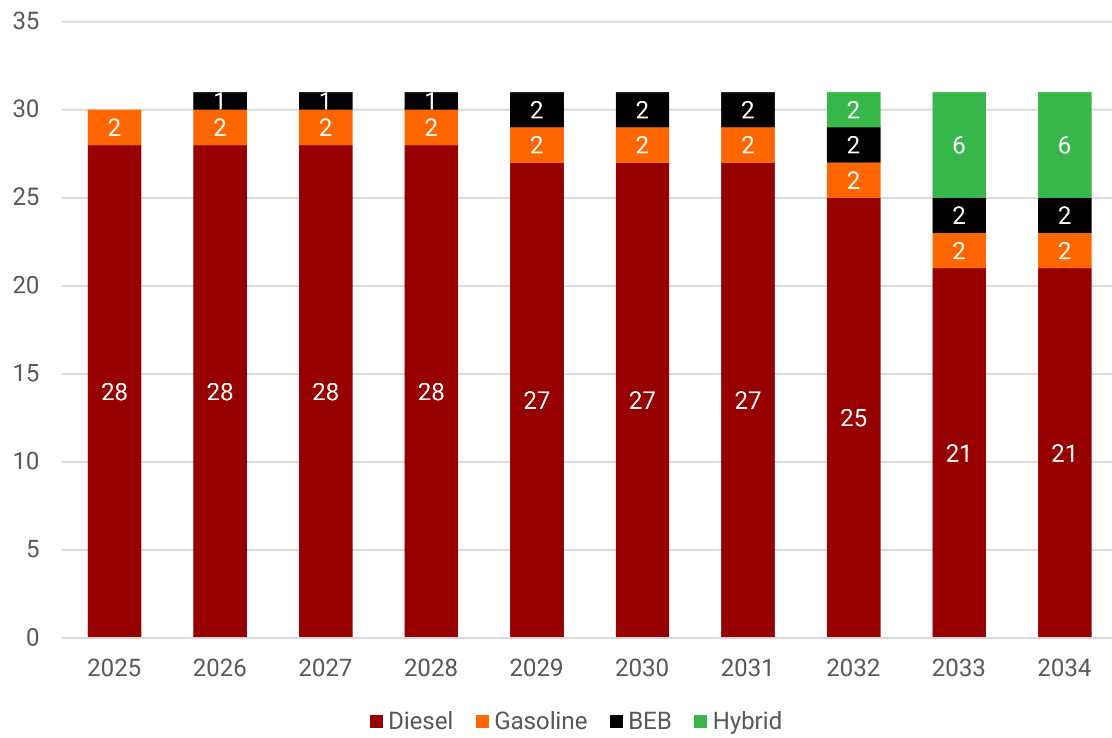
- Purchase and implement six hybrid electric buses
- Evaluate the feasibility of operating and maintaining the hybrid electric buses
- Address and resolve any issues with the operation and maintenance of the hybrid electric buses

Once Phase 3 is complete, CAT will seek to maintain the mixture of vehicle technologies or expand the fleet of low- and zero-emission vehicles. To maintain service quality, no routes will be reconfigured due to the adoption of low- and zero-emission vehicles, but service needs and shifts in transit demand may require changes to route structures.

**Figure 8-3** provides an overview of the transition to low- and zero-emission vehicles in the CAT Fleet. The fleet composition transition is provided for planning purposes and reflects the aforementioned vehicle replacement plan and proposed fuel mix.

The actual replacement schedule may differ based on the availability of replacement vehicles as well as CAT's ability to secure funding. The size of the fleet may also change with the implementation of new or different types of services, therefore affecting the transition.

**FIGURE 8-3: PROPOSED FIXED ROUTE FLEET COMPOSITION**




To achieve the fleet composition mix shown in Figure 8-3, vehicle purchases will occur as provided in **Figure 8-4.** The ten-year plan begins in 2025, which follows the purchase of four new diesel vehicles and one new battery electric bus in 2024.

**Figure 8-5** provides planning level cost projections related to the vehicle purchase plan noted in **Figure 8-4.** This implementation plan incorporates the same cost assumptions used in the financial analysis, which were derived from sources that generated estimates for average costs and may not accurately reflect each individual expense an agency may incur.

**FIGURE 8-4: PROPOSED FIXED ROUTE VEHICLE PURCHASE PLAN**

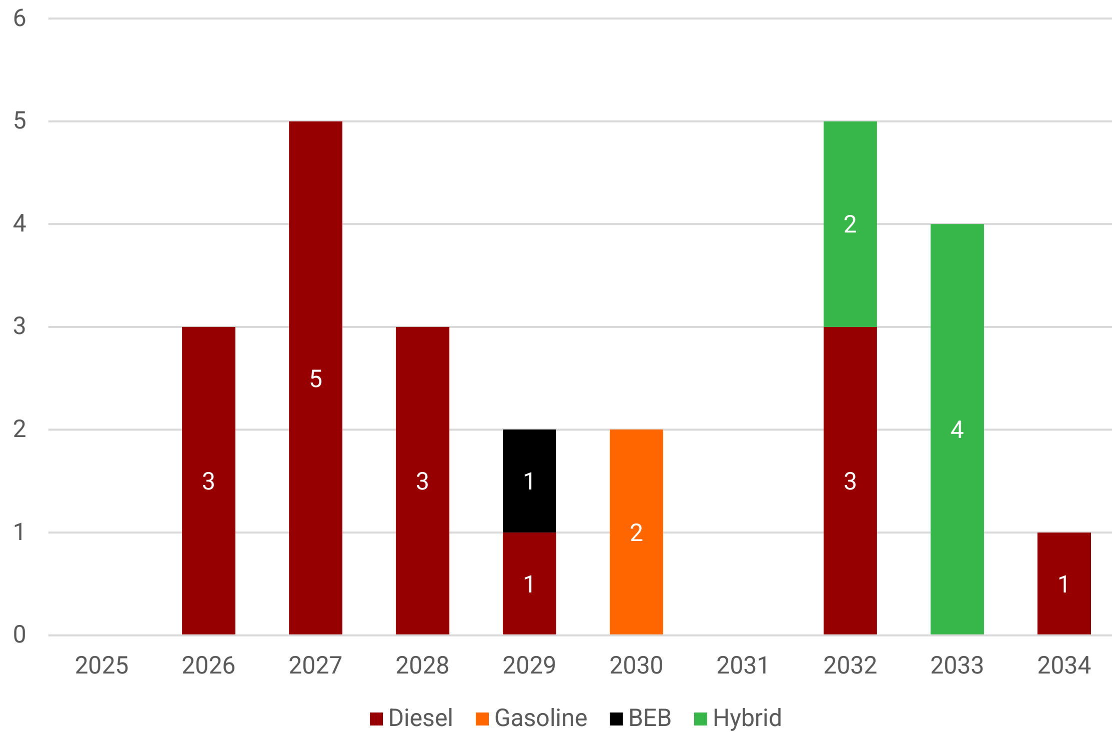
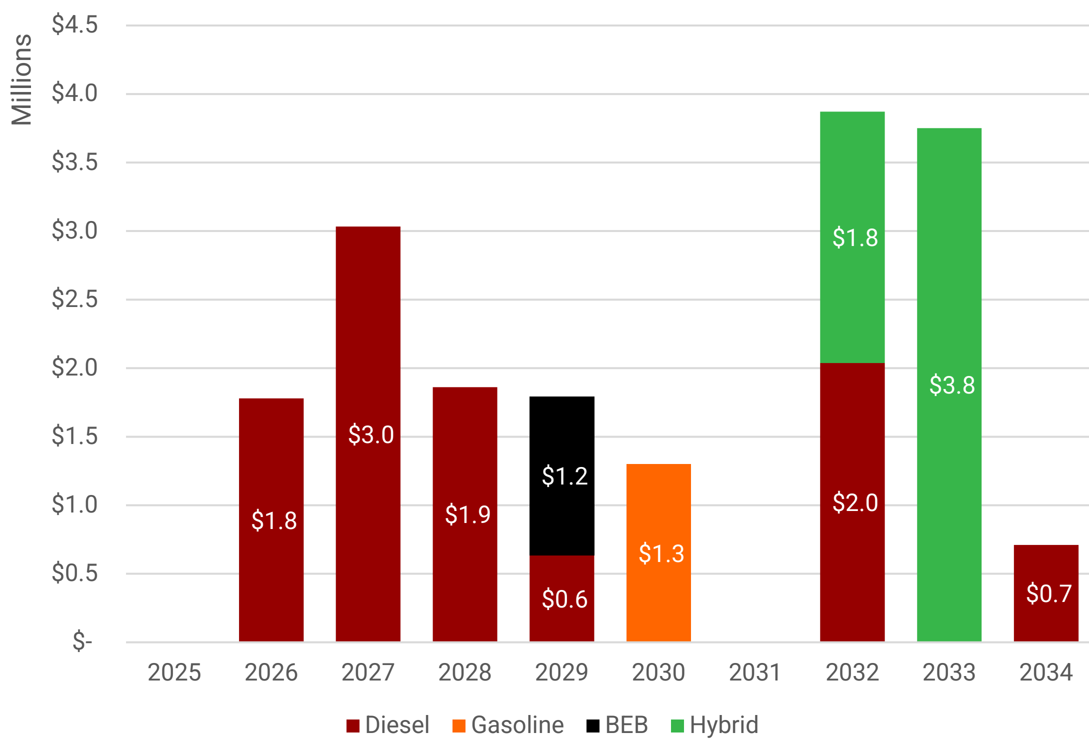



**FIGURE 8-5: PROPOSED FIXED ROUTE VEHICLE EXPENSES**



## 8.4 Paratransit and Support Vehicle Fleet Plan

CAT has not identified a suitable alternative fuel for its demand response paratransit services, which typically use cutaway vehicles. Although CAT purchases and owns its vehicles, any changes made to the technology the vehicles use would need to be negotiated with the operator because CAT's transit services are operated by a third-party vendor. The agency will continue to review options, but there is no intent to transition the paratransit fleet to a low- or zero-emission technology at this time. This transition plan assumes the replacement of demand response vehicles at the end of their useful lives with vehicles of the same fuel type (diesel or gasoline).

For support vehicles, there are low- or zero-emission vehicle options to replace these vehicles. At the time of writing, CAT has six support vehicles. These vehicles include sedans, vans, and pick-up trucks. While this transition plan focuses on the fixed-route fleet transition, CAT will replace two of its retiring support vans with two battery electric sport utility vehicles (SUVs).

## 8.5 Financial Plan

Incorporating the CAT's operating and capital expenses and revenues as presented in **Figure 8-6** and **Figure 8-7**, the financial plan in **Figure 8-8** captures the estimated total expenses and revenue for CAT from 2025 to 2034, reflecting the low and zero-emission vehicle transition.  **Figure 8-9** zeroes in on vehicle capital and operating expenses, which are the only expenses directly affected by this transition plan.

## Figure 8-6: CAT Operations Cost Feasible Plan (2025-2034)

| Cost/Revenue | | | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 10-Year Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Operating** | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| **Operating Cost** | | | | | | | | | | | | | |
| Maintain Existing Service - Fixed Route | Existing | | $9,015,510 | $9,221,063 | $9,431,304 | $9,646,337 | $9,866,274 | $10,091,225 | $10,321,305 | $10,556,630 | $10,797,322 | $11,043,501 | $99,990,469 |
| Maintain Existing Service - Paratransit | Existing | | $7,131,499 | $7,294,098 | $7,460,403 | $7,630,500 | $7,804,476 | $7,982,418 | $8,164,417 | $8,350,566 | $8,540,958 | $8,735,692 | $79,095,027 |
| Route 22 Realigned - no cost | Route Realignment | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Route 23 Realigned plus freq 60 to 40 | Route Realignment | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $673,469 | $673,469 |
| New Route 25 EW, no change | Route Realignment | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| New Route 25 NS, to Immokalee Rd | Add New Service | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $700,957 | $700,957 |
| New Route 27 EW, Immokalee to Randa | Route Realignment | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| New Route 27 NS, Collier 441 to Immok | Add New Service | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $1,448,282 | $1,448,282 |
| Route 121 - Add one AM and one PM | Increase Frequency | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $288,856 | $288,856 |
| Route 11 from 30 to 20 mins | Increase Frequency | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $1,155,424 | $1,155,424 |
| Route 12 from 90 to 45 mins | Increase Frequency | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $500,684 | $500,684 |
| Route 13 from 40 to 30 min | Increase Frequency | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $165,226 | $165,226 |
| Route 14 from 60 to 30 min | Increase Frequency | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $481,427 | $481,427 |
| Route 15 from 90 to 45 min | Increase Frequency | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $288,856 | $288,856 |
| Route 16 from 90 to 45 min | Increase Frequency | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $308,113 | $308,113 |
| Route 17/18 90 to 45 minutes | Increase Frequency | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $510,312 | $510,312 |
| Route 24 from 85 to 60-min | Increase Frequency | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Route 11 - Extend Hours to 10:00 PM | Increase Hours of Service | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $192,571 | $192,571 |
| Route 13 - Extend Hours to 10:00 PM | Increase Hours of Service | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $130,948 | $130,948 |
| Route 14 - Extend Hours to 10:00 PM | Increase Hours of Service | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $130,948 | $130,948 |
| Route 17/18 - Extend Hours to 10:00 PM | Increase Hours of Service | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $237,247 | $237,247 |
| Route 19/28 - Extend Hours to 10:00 PM | Increase Hours of Service | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $111,691 | $111,691 |
| New Island Trolley | Add New Service | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $1,232,452 | $1,232,452 |
| New Bayshore Shuttle | Add New Service | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $519,941 | $519,941 |
| New Autonomous Circulator | Add New Service | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $392,844 | $392,844 |
| New Naples Pier Electric Shuttle | Add New Service | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $616,226 | $616,226 |
| Mobility on Demand - Golden Gate | Add New Service | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $736,410 | $736,410 |
| Mobility on Demand - North Naples | Add New Service | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $368,205 | $368,205 |
| Mobility on Demand - Naples | Add New Service | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $873,571 | $873,571 |
| Mobility on Demand - Marco Island | Add New Service | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $490,705 | $490,705 |
| **Total Operating Costs** | | | **$16,147,009** | **$16,515,161** | **$16,891,707** | **$17,276,837** | **$17,670,749** | **$18,073,642** | **$18,485,721** | **$18,907,196** | **$19,338,280** | **$32,334,557** | **$191,640,860** |
| **Operating Revenues** | | | | | | | | | | | | | |
| Federal Grant 5311 | Existing | Federal | $800,153 | $818,397 | $837,056 | $856,141 | $875,661 | $895,626 | $916,047 | $936,933 | $958,295 | $980,144 | $8,874,454 |
| Local Match (5311) | Existing | Local | $800,153 | $818,397 | $837,056 | $856,141 | $875,661 | $895,626 | $916,047 | $936,933 | $958,295 | $980,144 | $8,874,454 |
| Federal Grant 5307 Operating Assistanc | Existing | Federal | $1,808,252 | $1,849,480 | $1,891,648 | $1,934,777 | $1,978,890 | $2,024,009 | $2,070,157 | $2,117,356 | $2,165,632 | $2,215,008 | $20,055,209 |
| Local Match (5307) | Existing | Local | $1,808,252 | $1,849,480 | $1,891,648 | $1,934,777 | $1,978,890 | $2,024,009 | $2,070,157 | $2,117,356 | $2,165,632 | $2,215,008 | $20,055,209 |
| Federal Grant 5307 ADA and Preventati | Existing | Federal | $965,946 | $987,969 | $1,010,495 | $1,033,534 | $1,057,099 | $1,081,201 | $1,105,852 | $1,131,065 | $1,156,854 | $1,183,230 | $10,713,243 |
| FDOT Transit Block Grant Operating Ass | Existing | State | $1,194,529 | $1,221,764 | $1,249,620 | $1,278,112 | $1,307,253 | $1,337,058 | $1,367,543 | $1,398,723 | $1,430,614 | $1,463,232 | $13,248,447 |
| TD Funding | Existing | State | $737,630 | $754,448 | $771,649 | $789,243 | $807,237 | $825,642 | $844,467 | $863,721 | $883,414 | $903,556 | $8,181,006 |
| Local Match for FDOT Transit Block Gran | Existing | Local | $1,194,529 | $1,221,764 | $1,249,620 | $1,278,112 | $1,307,253 | $1,337,058 | $1,367,543 | $1,398,723 | $1,430,614 | $1,463,232 | $13,248,447 |
| Local TD Funding | Existing | Local | $73,763 | $75,445 | $77,165 | $78,924 | $80,724 | $82,564 | $84,447 | $86,372 | $88,341 | $90,356 | $818,101 |
| Collier County CAT Enhancements | Existing | Local | $4,631,560 | $4,737,160 | $4,845,167 | $4,955,637 | $5,068,626 | $5,184,190 | $5,302,390 | $5,423,284 | $5,546,935 | $5,673,405 | $51,368,356 |
| Federal Grant 5307 -PM | New | Federal | $1,008,555 | $1,031,550 | $1,055,069 | $1,079,125 | $1,103,729 | $1,128,894 | $1,154,633 | $1,180,958 | $1,207,884 | $1,235,424 | $11,185,822 |
| FDOT Match for Federal 5307 and 5310 - | New | State | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Local Match for Federal 5307 and 5310 - | New | Local | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Existing Paratransit Fare Revenue | Existing | Local | $192,157 | $196,538 | $201,019 | $205,603 | $210,290 | $215,085 | $219,989 | $225,005 | $230,135 | $235,382 | $2,131,204 |
| Fare Revenue from New/Improved Ser | New | Fare | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $808,438 | $808,438 |
| Fare Revenue from Existing Services | Existing | Fare | $931,530 | $952,769 | $974,492 | $996,710 | $1,019,435 | $1,042,678 | $1,066,452 | $1,090,767 | $1,115,635 | $1,141,072 | $10,331,540 |
| Other Local Revenues | Existing | Other Local Sources | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Additional Local Revenue Required - N | New | Other Local Sources | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Total Operating Revenue** | | | **$16,147,009** | **$16,515,161** | **$16,891,706** | **$17,276,837** | **$17,670,749** | **$18,073,642** | **$18,485,721** | **$18,907,196** | **$19,338,280** | **$20,587,632** | $171,190,227 |
| **Annual Revenues Minus Costs** | | | **($0)** | **($0)** | **($0)** | **($0)** | **($0)** | **($0)** | **($0)** | **($0)** | **($0)** | **($11,746,925)** | **($11,746,927)** |

### FIGURE 8-7: CAT CAPITAL COST FEASIBLE PLAN (2025-2034)

| Cost/Revenue | | | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 10-Year Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Capital Costs** | | | | | | | | | | | | | |
| **Vehicles** | | | **$2,434,517** | **$1,871,811** | **$4,759,875** | **$2,497,076** | **$1,396,437** | **$977,241** | **$2,879,823** | **$4,030,267** | **$381,881** | **$1,778,313** | **$25,410,250** |
| Replacement Fixed Route Buses - Maintain Existing Service | | | $554,063 | $1,133,390 | $4,057,311 | $1,778,493 | $606,348 | $0 | $0 | $3,243,873 | $1 | $606,348 | $14,954,612 |
| Replacement Vans - Maintain Existing Paratransit Services | | | $1,678,977 | $686,903 | $702,565 | $718,583 | $734,967 | $751,724 | $1,922,158 | $786,393 | $4 | $734,967 | $8,888,891 |
| Replacement of Support Vehicles | | | $201,477 | $51,518 | $0 | $0 | $55,123 | $225,517 | $57,665 | $0 | $1 | $55,123 | $666,746 |
| Preventative Maintenance | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Route 23 Realigned plus freq 60 to 40 | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Increase Frequency on Routes 24 and 121 | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| | | | | | | | | | | $0 | $0 | $0 | $0 |
| New Island Trolley | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| New Bayshore Shuttle | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| New Autonomous Circulator | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| New Naples Pier Electric Shuttle | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| MOD Service Zones (expanded microtransit) | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $381,875 | $381,876 | $0 |
| Spares for New Service and Improved Existing Service | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Spares for MOD Services | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| ADA Service for New Fixed Route Hours | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Other Capital/Infrastructure** | | | **$2,533,377** | **$5,570,538** | **$13,557,976** | **$570,698** | **$583,710** | **$597,019** | **$610,631** | **$624,553** | **$638,793** | **$653,357** | **$28,035,135** |
| Shelter Rehab | | | $40,912 | $41,845 | $42,799 | $43,775 | $44,773 | $45,794 | $46,838 | $47,906 | $48,998 | $50,115 | $429,235 |
| Facility | | | $2,000,000 | $5,000,000 | $13,000,000 | | | | | | | | $22,334,797 |
| Bus Shelters | | | $492,465 | $503,693 | $515,177 | $526,923 | $538,937 | $551,225 | $563,793 | $576,648 | $589,795 | $603,242 | $5,221,103 |
| Security - Driver Protection Barriers | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Technology - Avail Replacement | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Technlogy - APC | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Technology - Annunciators | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Technology - Onboard Information Media | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Technology - Farebox Replacement | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Study Santa Barbara Corridor | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $25,000 |
| Study: Regional Service and Fares | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Study I-75 Managed Lanes Express | | | $0 | $25,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $25,000 |
| Study Everglades City Vanpool | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Total Capital Costs** | | | **$4,967,894** | **$7,442,349** | **$18,317,852** | **$3,067,774** | **$1,980,147** | **$1,574,260** | **$3,490,454** | **$4,654,820** | **$1,020,674** | **$2,431,670** | **$53,445,385** |
| **Capital Revenues** | | | | | | | | | | | | | |
| Federal Grant 5307 Capital Assistance | Existing | Federal | $2,920,334 | $900,000 | $13,920,520 | $920,520 | $941,508 | $962,974 | $984,930 | $1,007,386 | $1,030,355 | $1,053,847 | $27,888,688 |
| Federal Grant 5339 Capital Assistance | Existing | Federal | | $5,000,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $6,000,000 |
| Federal Grant 5339 Capital Assistance | Existing | Federal | $368,583 | $376,986 | $385,582 | $394,373 | $403,364 | $412,561 | $421,968 | $431,588 | $441,429 | $451,493 | $3,907,704 |
| Federal Grant 5310 Capital Assistance | Existing | Federal | $1,511,080 | $618,213 | $632,308 | $646,725 | $661,470 | $676,552 | $1,729,943 | $707,754 | $4 | $661,470 | $8,000,002 |
| Local Match 5310 Capital Assistance | Existing | Federal | $167,898 | $68,690 | $70,256 | $71,858 | $73,497 | $75,172 | $192,216 | $78,639 | $0 | $73,497 | $888,889 |
| **Total Capital Revenues** | | | **$4,967,894** | **$6,963,889** | **$15,008,666** | **$2,033,476** | **$2,079,839** | **$2,127,259** | **$3,329,056** | **$2,225,368** | **$1,471,788** | **$2,240,307** | $46,685,283 |
| **Annual Revenues Minus Costs** | | | **($0)** | **($478,460)** | **($3,309,186)** | **($1,034,299)** | **$99,692** | **$553,000** | **($161,398)** | **($2,429,452)** | **$451,114** | **($191,363)** | **($6,760,102)** |

**FIGURE 8-8: PROPOSED CAT FINANCIAL PLAN**

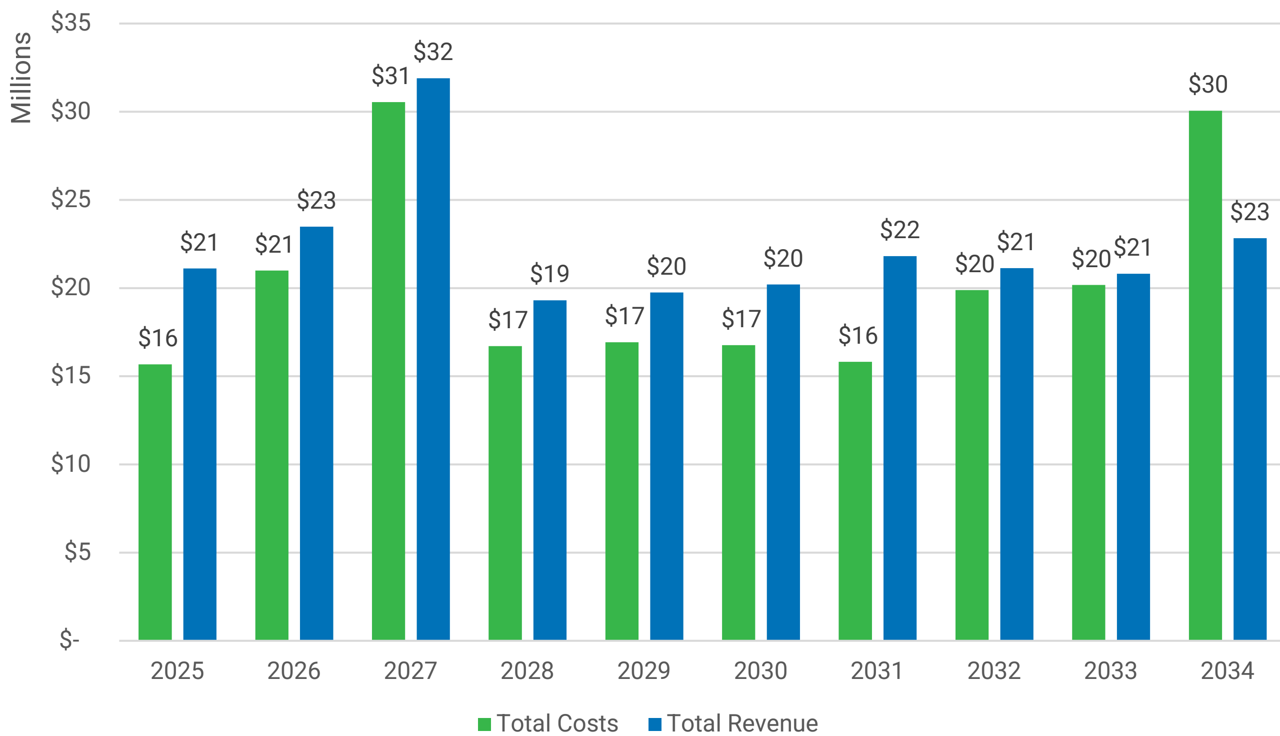
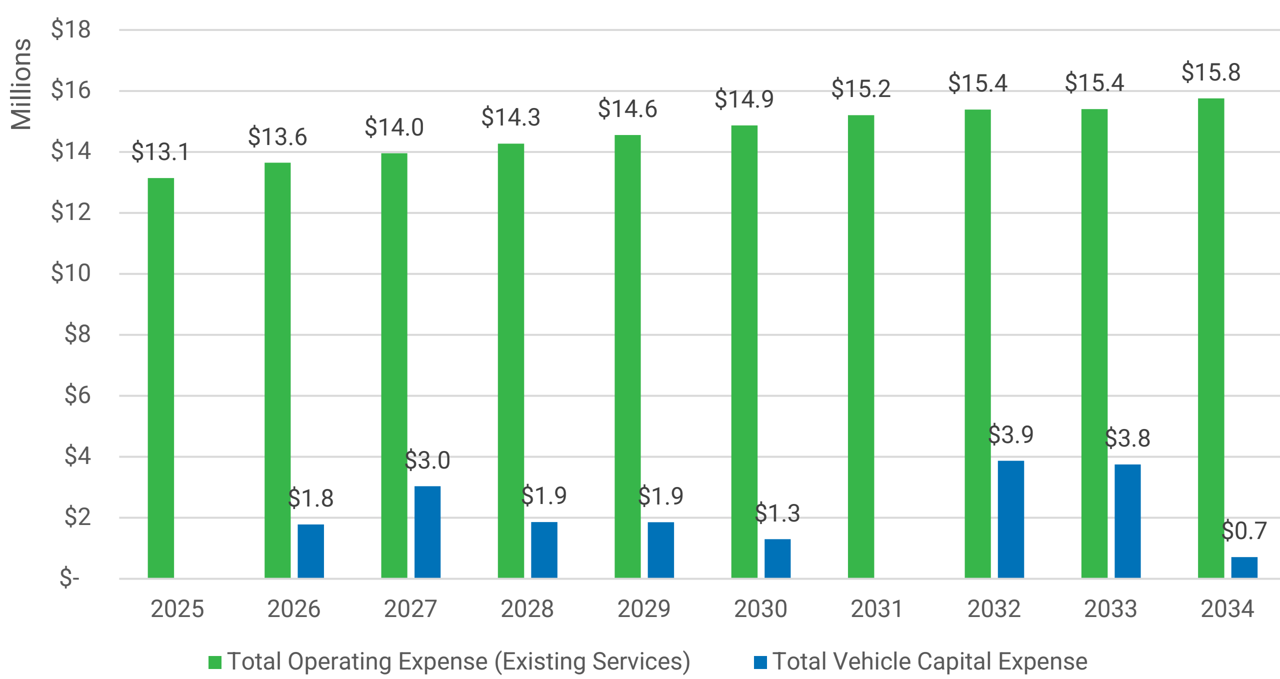


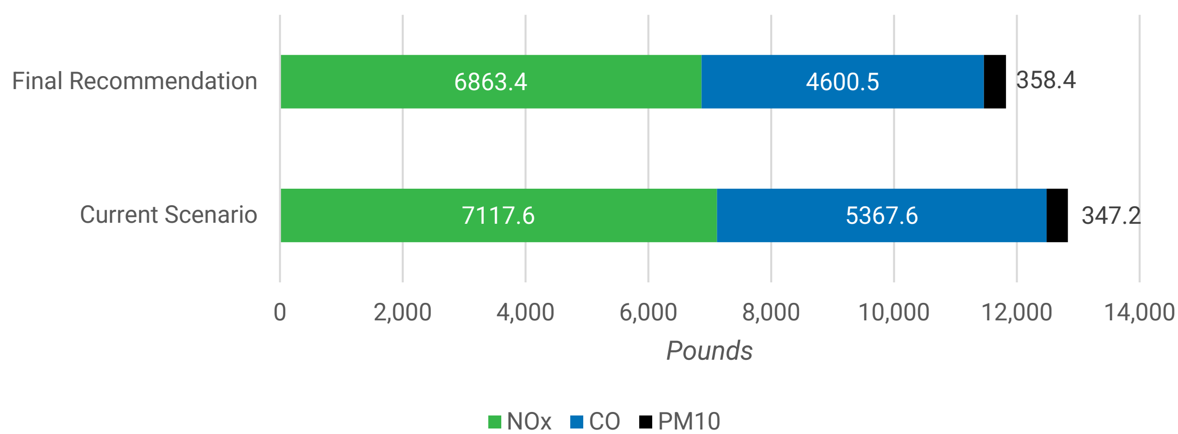

**FIGURE 8-9: CAT ZEV 2025-2034 TRANSITION PLAN TOTAL FIXED ROUTE VEHICLE CAPITAL AND OPERATING EXPENSES**




## 8.6 Emissions Reduction

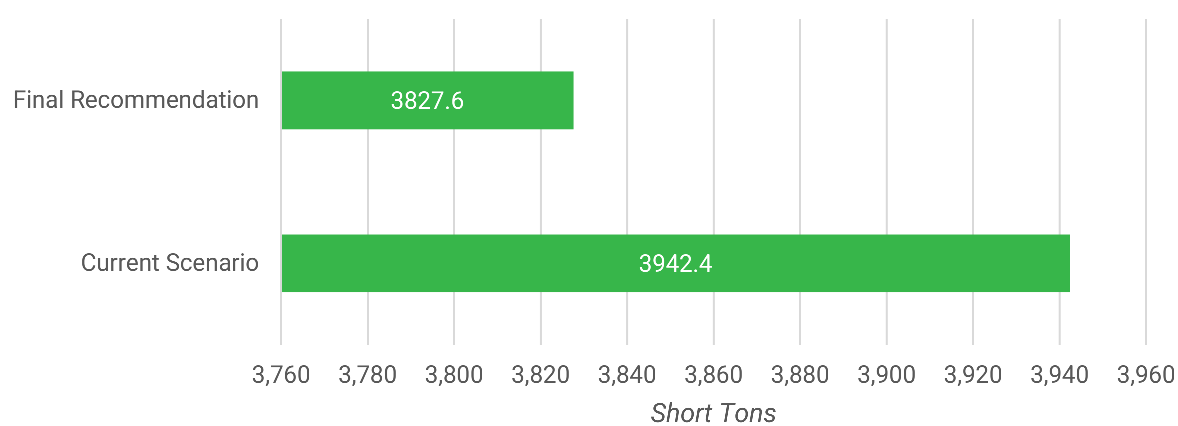
Based on the final transition approach, the following emissions profiles were estimated to understand what the overall emissions would look like compared to the current scenario. Emissions profile is based on previously described emission references found in Section 6.4.1.5 regarding NOx, CO, and PM10. **Figure 8-10** compares the reduction in pounds of annual emissions output for fixed route vehicles in the current scenario and in the transition scenario. **Figure 8-11** compares the reduction in short tons of lifecycle greenhouse gas (GHG) emissions for fixed route vehicles in the current scenario and in the transition scenario.

**FIGURE 8-10: ANNUAL EMISSIONS PROFILE COMPARISON FOR THE FINAL RECOMMENDATION OF FIXED ROUTE VEHICLES**




It is expected that a net annual reduction of about 1,000 pounds of harmful emissions will be experienced as a result of the current transition over the fixed route fleet.

**FIGURE 8-11: WELL TO WHEELS LIFECYCLE GREENHOUS GAS COMPARISON FOR THE FINAL RECOMMENDATION OF FIXED ROUTE VEHICLES**

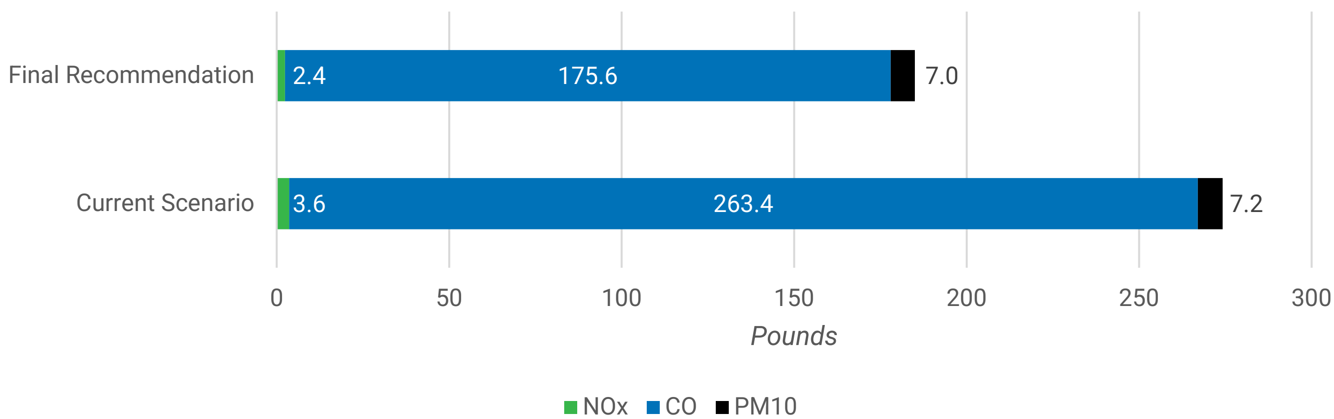



It is expected that a reduction of about 114 short tons of greenhouse gas emissions will be saved over the lifecycle of the fixed route fleet as a result of the current transition.

Since no demand response vehicles are planned for transition in this plan, no comparison in emissions reduction is presented. It is estimated that the output of harmful emissions from the demand response fleet is about 2,560 pounds annually, while the total lifecycle greenhouse gas emissions for this fleet is estimated at almost 700 short tons.

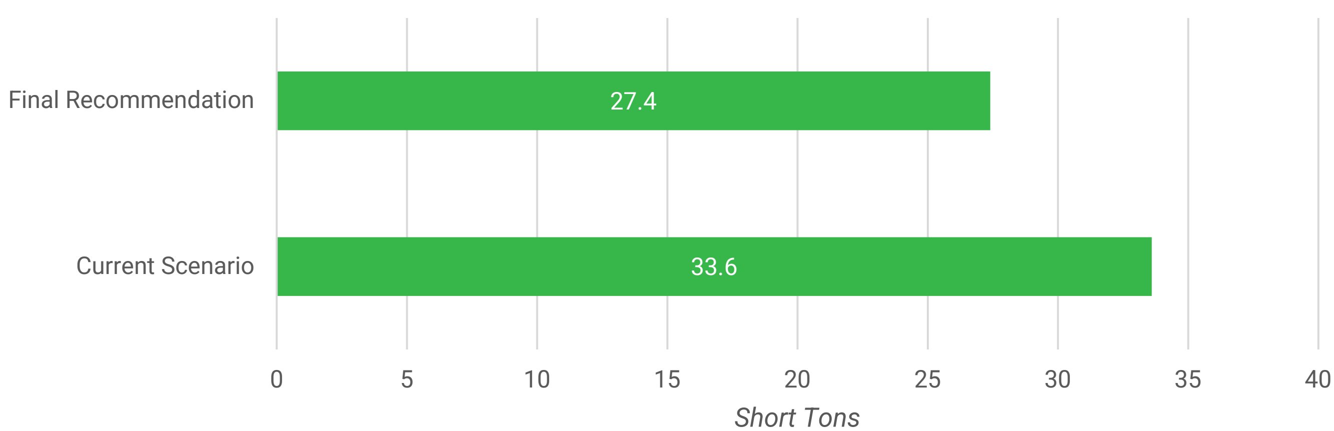
**Figure 8-12** compares the reduction in pounds of annual emissions output for support vehicles in the current scenario and in the transition scenario. **Figure 8-13** compares the reduction in short tons of lifecycle greenhouse gas (GHG) emissions for support vehicles in the current scenario and in the transition scenario.

FIGURE 8-12: ANNUAL EMISSIONS PROFILE COMPARISON FOR THE FINAL RECOMMENDATION OF SUPPORT VEHICLES




It is expected that a net annual reduction of about 90 pounds of harmful emissions will be experienced as a result of the current transition over the support vehicle fleet.

FIGURE 8-13: WELL TO WHEELS LIFECYCLE GREENHOUS GAS COMPARISON FOR THE FINAL RECOMMENDATION OF SUPPORT VEHICLES




It is expected that a reduction of about 6 short tons of greenhouse gas emissions will be saved over the lifecycle of the support vehicle fleet as a result of the current transition.

In total, it is expected that the current transition will amount to a decrease in harmful emissions of about 1,100 pounds annually, and about 120 short tons of greenhouse gas emissions over the lifecycle of CAT's entire fleet.

## 8.7 Facilities Recommendations

A review of CAT's Operations Facility was undertaken to understand what a low- and zero-emission transition would require and how it would be physically implemented at CAT's various facilities.

The Operations Facility, located on Radio Road, will be undergoing a facility reconfiguration in the near future which will replace the maintenance building. At approximately 8 acres, this facility currently houses the full fleet, administration, operations, and maintenance functions. The current facility already includes a fuel depot with existing diesel fuel storage infrastructure and dispensers and will soon be adapted to include unleaded gasoline.

A series of recommendations were developed based on any given scenario, both the recommended, and other potential scenarios to be explored. Only the operations and maintenance facilities are explored since this is the location of bus staging where vehicles will be recharged or refueled. Considerations for the new maintenance facility include:

- **Electric Charging Infrastructure** – The following explores considerations regarding the inclusion of electric charging infrastructure at the Radio Road facility.
    - **Overnight Charging Locations** – It is expected that the reconfiguration will provide for a total of 40 bus parking spots, two of which have been explicitly identified for electric charging capabilities. These spots are located at an adequate distance from the fueling depot. It is recommended that CAT look into the possibility of an additional ten spots beyond these two that could be transformed into electric charging spots if necessary. The facility is otherwise limited to the expansion of additional electric bus charging spots.
    - **Fast Charging Infrastructure** – Fast charging would best be recommended under the canopy structure where buses stop during layovers.
    - **Grid Expansion** – The electric grid will be reconfigured and expanded to handle the new electric output. This system will be placed closer to the administration building and will be able to accommodate the expansion as the electric utility providers deem necessary.
- **CNG Fueling Infrastructure** – If a CNG fueling station were to be considered, this would be challenging under the new configuration and should only be considered if CNG becomes a viable option for this facility. Based on the future configuration of the facility, CNG would best be delivered to the facility for on-site dispensing.
- **Biodiesel Fueling Infrastructure** – The inclusion of biodiesel would require installing an additional fuel storage tank near the fueling depot and reconfiguring the dispensers. This would not be an intensive reconfiguration of the facility area.
- **Hybrid Buses and Vehicles** – There are no substantial requirements over the facility to consider for hybrid vehicles.
- **Additional Spare Parts for any Alternative Fuel Vehicle** – Dedicated space for the inclusion of spare parts for electric vehicles or other alternative fuel vehicles should be considered at the maintenance building.

## 8.8 Workforce Training Considerations

As CAT shifts toward an alternative fuel future, workforce training will be essential to ensure a smooth and timely transition. The training requirements will differ based on each position and current skill level.

By following the prompts from FTA's *Workforce Evaluation Tool*, CAT maintenance and administration staff can strategically assess the impact of the transition to low- and zero-emission technologies on the current workforce. The following information outlines the findings and conclusions derived from using the tool.

First, the training needs for various CAT employee groups were identified.

- **Training Instructors** | CAT will employ a train-the-trainer approach to ensure all technicians and maintenance employees receive the training that they need. Technicians who provide training to other CAT technicians will require training related to all aspects of the new skills required for the individuals that they train.
- **Mechanics and Technicians** | Identified through the agency interviews as the group with the most impact on a low- and zero-emission transition's success, the speed with which these staff members adapt to working with the new technologies is critical. Their transition impacts the speed with which vehicles are returned to revenue service. For these reasons, the most intensive training needs will be related to the mechanic and technician staff.

At present, none of the mechanic and technician staff have been trained in electric vehicle needs. CAT is committed to training current staff as opposed to replacing staff to acquire these skills.

CAT intends to secure training as part of the purchase price of the vehicles. CAT staff should take full advantage of this training and any other training offered by the manufacturer. Most likely, a subset of the current workforce in this department will be trained first and then they will train the other members of the team. Any additional employee training needed beyond the manufacturer training will be acquired and paid for by CAT.

- **Operators** | In order to ensure the best fuel economy, operators will be trained on how to best operate the vehicles. Buses will be purchased with feedback mechanisms on the dashboard. Typically, manufacturers do not offer operator training so training will be conducted internally.
- **Other Staff** | It is not anticipated that any other staff will need to be trained on the new technologies beyond basic safety training.

Second, CAT will operate with the following policies in mind:

- **Displacement Prevention** | If certain technicians or mechanics are not interested in training on the electrical components of the vehicles (e.g., due to impending retirement), they will not be penalized by the agency.
- **Charging Protocols** | A charging protocol will be established for and evaluated when the vehicles are put into operation.

## 8.9 Monitoring and Evaluation Strategy

The following strategy is proposed to CAT as a way to identify key performance indicators that should be tracked and analyzed to evaluate vehicle performance. The goal of a monitoring and evaluation strategy is to compare hybrid, battery electric, and conventional diesel technology vehicle performance.

The National Renewable Energy Laboratory (NREL) tracks the performance of low- and zero-emission buses for several transit agencies across the nation. The proposed strategy below follows the template used by NREL, which tracks progress over time toward meeting the various technical targets set by the Department of Energy (DOE) and the U.S. Department of Transportation (USDOT).

To support data collection, CAT should negotiate with bus manufacturers during the purchase process for manufacturers to share data that is being collected on the vehicle. There is valuable information being collected and can be used to support these monitoring and evaluation efforts.

To ensure that the data generates meaningful analysis the following points should be considered:

- Keep separate data for each technology type: diesel, hybrid, and battery electric vehicles; revenue vehicles separate from support vehicles. This data should include:
    - Miles
    - Revenue hours
    - Miles between road calls for all types of breakdowns and for propulsion-related breakdowns
    - Fuel cost/revenue mile
    - Maintenance cost/revenue mile
    - Bus availability rate (percentage of days the buses are available as a percentage of days that the buses are planned for passenger service)
    - Fuel economy (in diesel gallon equivalents for battery electric buses)
- Generate the following analytics in a biannual report:
    - Data summary
    - Total miles and hours for each technology type
    - Average monthly mileage for each bus within each technology type
    - Availability Analysis
        - Days available
        - Days unavailable
        - Reason for unavailability
    - Fuel Economy and Cost Analysis
        - Miles per diesel gallon equivalent for battery electric buses compared to miles per gallon for hybrid buses
        - Fuel/electricity cost per mile for each technology type
    - Roadcall Analysis
        - Compare total miles between roadcalls for each technology type
        - Compare total miles between propulsion roadcalls for each technology type
    - Maintenance Analysis
        - Compare total cost of parts and hours of labor per mile for each bus under each technology type
        - Compare the maintenance types by technology types
    - Generate a summary of findings and comparisons for each analysis

- Review and report monitoring and evaluation biannually to transit agency leadership