



Pierce Transit Phase I Battery Electric Bus Fleet Transition Plan

**A PATH TOWARDS ACHIEVING A COMPREHENSIVE AND EQUITABLE ROLLOUT OF A CLEAN
TRANSIT FLEET AND INFRASTRUCTURE**



TABLE OF CONTENTS

SECTION A:	OVERVIEW OF PIERCE TRANSIT.....	1
SECTION B:	CURRENT CLEAN ENERGY INITIATIVES.....	4
SECTION C:	LONG-TERM FLEET MANAGEMENT PLAN & STRATEGIES	6
SECTION D:	FLEET TRANSITION AND IMPLEMENTATION RESOURCE PLAN	6
SECTION E:	POLICY AND LEGISLATION IMPACTS BATTERY ELECTRIC BUS FLEET	9
SECTION F:	MOBI SITE EVALUATION FACILITIES TRANSITION.....	12
SECTION G:	EXISTING UTILITY PARTNERSHIPS	15
SECTION H:	STAFFING TRANSITION PLAN	16
SECTION I:	EQUITABLE ROLLOUT PLAN	21
SECTION J:	BATTERY ELECTRIC BUS IMPLEMENTATION CHALLENGES	23
SECTION K:	APPENDIX	24

EXECUTIVE SUMMARY

Pierce Transit has been an early adopter of clean fuel technology when we began to convert our fleet to compressed natural gas from other internal combustion engines types in 1986. We remain committed to that cause and began a new transition to even cleaner buses and fleet types that begin to provide zero emission trips for our patrons in 2018. With Executive Order #1, the agency identified a goal to transition 20% of our fleet to zero emission buses by 2030. Achieving this goal will be challenging with a financial tension from multiple significant capital needs including the Maintenance and Operations Base Improvements (MOBI) project and Pierce Transit's first Stream Bus Rapid Transit Pacific Avenue Corridor project. Both projects are currently estimated to cost more than \$500 million combined and will require significant local funding. The BRT line is not projected to be operational until 2027 while the MOBI project is divided into phases and will likely stretch into 2030. Identifying additional funding through grants and/or partner contributions for these projects will be a priority for the agency in the coming years.

This Phase I Battery Electric Bus Fleet Transition Plan addresses our BEB transition goal and illustrates a future with BRT Stream corridors operated with BEB vehicles through the 2042 horizon. As we transition to zero emission trips and a growing fleet of battery electric buses, we recognize a potential funding gap of \$210M to convert from CNG to BEB which is a 43% increase per bus over time. We also recognize the need to house and charge these buses at our base facilities and will seek opportunities for other charging solution and technologies. To solidify and further expand the agency's planning efforts for transitioning the fleet to zero emissions, the agency has entered into a contract with HDR Engineering Inc. Their analysis on how to proceed is expected by the end of 2022. HDR will consider all forms of zero emission vehicles, including battery electric and hydrogen fuel cell electric. No matter which path is ultimately recommended, there will be financial and logistical considerations that must be overcome to move towards our 20% goal and beyond.

As our electrification needs increase, we will work with our utility partners to ensure energy demands are met and appropriate and timely investments are made to our base facilities to ensure reliable and efficient charging and deployment of our BEB fleet. We are committed to Pierce Transit maintenance employees and to their transition from internal combustion engines to battery electric bus technologies through workforce development and retraining. We will provide the training, recruiting and partnerships to ensure our new propulsion systems are reliable and visible to the public. We are committed to Justice40 and equity as we deploy our BEB fleet across 19 routes in our service area. We are committed to provide quality and reliable zero emission trips to disadvantaged communities.

ACRONYMS

AC	ALTERNATING CURRENT
ADS	AUTOMATED DRIVING SYSTEM
AFV	ALTERNATIVE FUEL VEHICLE
API	APPLICATIONS PROGRAM INTERFACE
APTA	AMERICAN PUBLIC TRANSPORTATION ASSOCIATION
BEB	BATTERY ELECTRIC BUS
BEB FCEB	MIXED FLEET
BTW	BEHIND THE WHEEL
CARB	CALIFORNIA AIR RESOURCE BOARD
CO ₂	CARBON DIOXIDE
CO	CARBON MONOXIDE
CNRSG	CARBON NEUTRAL RESPONSIBLY SOURCED GAS
CNG	COMPRESSED NATURAL GAS
CTE	CENTER FOR TRANSPORTATION & THE ENVIRONMENT
DC	DIRECT CURRENT
DGE	DIESEL GALLONS EQUIVALENT
DOE	DEPARTMENT OF ENERGY
ESS	ENERGY STORAGE SYSTEM
FCEB	FUEL CELL ELECTRIC BUS
FTA	FEDERAL TRANSIT ADMINISTRATION
GH ₂	GASEOUS HYDROGEN
HVIP	HYBRID & ZERO EMISSIONS TRUCK & BUS VOUCHER INCENTIVE PROJECT
ICT	INNOVATIVE CLEAN TRANSIT
KG	KILOGRAM
KPI	KEY PERFORMANCE INDICATOR
kVA	KILOVOLT-AMPERES

kW	KILOWATT
kWh	KILOWATT-HOUR
LH2	LIQUID HYDROGEN
Low-No	LOW OR NO (LOW-NO) EMISSION VEHICLE PROGRAM
M&O	MAINTENANCE AND OPERATIONS
MOBI	MAINTENANCE AND OPERATIONS BASE IMPROVEMENTS
MW+	MEGAWATT PLUS [CHARGING]
MWh	MEGAWATT-HOUR
NEPA	NATIONAL ENVIRONMENTAL POLICY ACT
NOx	NITROUS OXIDE
OEMs	ORIGINAL EQUIPMENT MANUFACTURES
PSRC	PUGET SOUND REGIONAL COUNCIL
PT	PIERCE TRANSIT
PTBA	PIERCE TRANSIT BENEFIT AREA
RSG	RESPONSIBLY SOURCED GAS
TAMP	TRANSIT ASSET MANAGEMENT PLAN
TCP	TRANSIT CAPITAL PRIORITIES
TEC	TRAINING AND EDUCATION CENTER
ZEB	ZERO EMISSIONS BUS
ZEBRA	ZERO-EMISSION BUS RESOURCE ALLIANCE

SECTION A: OVERVIEW OF PIERCE TRANSIT

Founded in 1979, Pierce County Public Transportation Benefit Area Corporation (Pierce Transit) is a nationally recognized leader in the public transportation industry. Pierce Transit covers 292 square miles of Pierce County with roughly 70% of the county population. Serving Washington's second largest county, Pierce Transit provides three types of service, Fixed Route, SHUTTLE paratransit and Vanpools that help get passengers to jobs, schools and appointments.

The combined services of Pierce Transit connect riders to two million jobs across three counties including essential regional generators such as Sea-Tac International Airport, the University of Washington, numerous public and private schools and health and commercial enterprises of the Puyallup Tribe of Indians. The agency also provides riders with multimodal connectivity at major transportation hubs throughout the region via the airport, Sound Transit Link Light Rail, Sounder Commuter Rail, and Washington State Ferries.

Pierce Transit directly operates 31 local fixed routes with 195 coaches and provides regional express bus service under contract to Sound Transit, the regional bus and rail transit provider. New Stream Bus Rapid Transit (BRT) routes will begin operation in 2027. PT both operates and contracts with First Transit for complementary paratransit services using 90 ADA-compliant SHUTTLE coaches. PT also offers an extensive vanpool (Commute Trip Reduction) program using 360 vans. PT is also in the early stages of providing on-demand service in select zones, branded as "Runner," to riders in areas where a traditional fixed-route bus is not an effective mode of public transportation.

OUR CORE VALUES

Pierce Transit improves people's quality of life by providing safe, reliable, innovative and useful transportation services that are locally based and regionally connected.

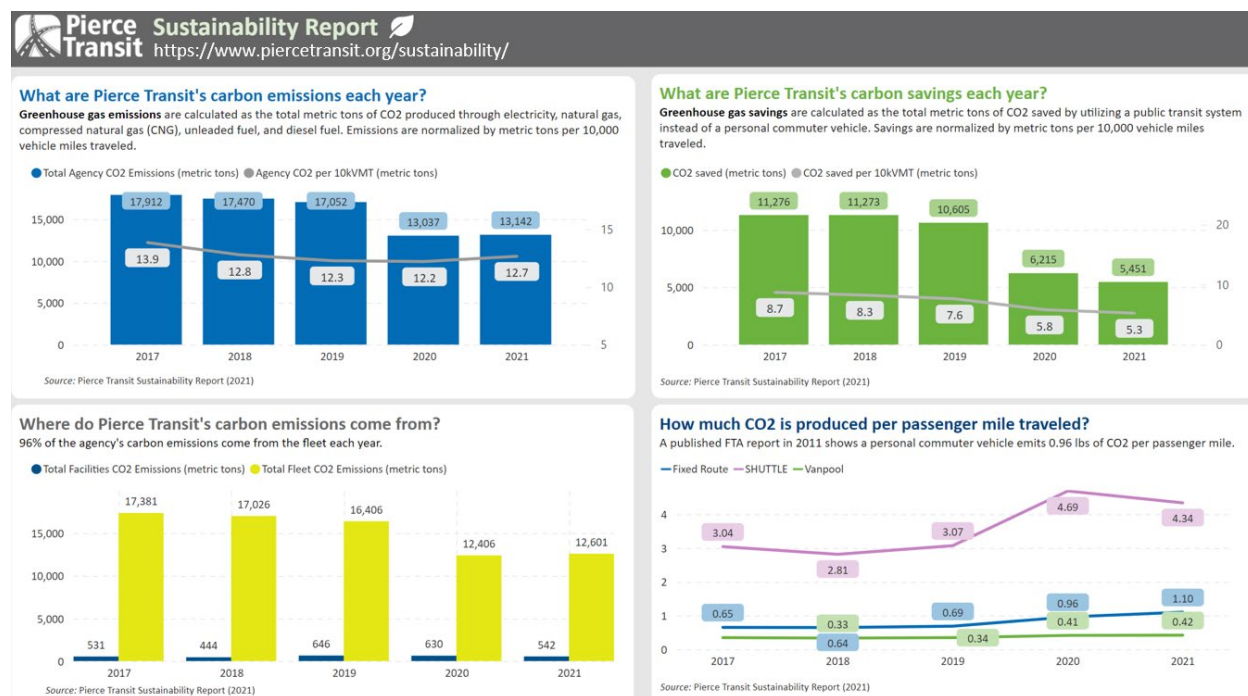
OUR COMMITMENT TO THE ENVIRONMENT

Pierce Transit was an early leader in adopting a low emissions revenue services fleet; the agency converted two GM New Look buses to run on a combination of Compressed Natural Gas (CNG) and diesel in 1986. Its fleet focuses historically on CNG with a more recent conversion to diesel-electric hybrid and battery electric powered coaches. Three battery electric buses (BEBs) were introduced to the fixed route fleet in 2018 and six were added in 2021. Today, the PT fleet operates 80% CNG, 13% hybrid-electric, 5% BEBs, and just 2% still use diesel. Pierce Transit has been recognized by the USDOE's Clean Cities program for commitment to the use of cleaner, alternative fuels.

Pierce Transit is changing the way people live, work, and play in Pierce County by building a zero-emissions, five-route BRT network named Stream. The addition of BRT to the transit network brings transformative value by reducing travel times for riders, increasing affordable housing development, and attracting major employers seeking to locate close to state-of-the-art public transportation corridors. Building Stream BRT will cost an estimated \$558 million and will create 27,580 jobs in Pierce County. Before the inaugural 14.4-mile BRT route from downtown Tacoma to Spanaway opens in 2027, there are key infrastructure investments that PT must make to ensure the agency is able to fully operationalize BRT 1 and support the development of future Stream BRT corridors with zero-emissions propulsion vehicles and modern facilities well into the future.

Pierce Transit has pledged to adopt sustainable business practices and strategies. We track, measure and report progress. We administer these practices on an ongoing basis to continually improve them over time. As a signatory to the American Public Transit Association (APTA) Sustainability Commitment, Pierce Transit actively supports and responsibly serves our community.

PIERCE TRANSIT 2021 CARBON EMISSIONS REPORT



BEB ENVIRONMENTAL IMPACTS

As the agency moves to Battery Electric Fleet, new metrics will help us track our carbon footprint and projected energy consumptions into the future. As an example, if we replaced three (3) 2007 model year CNG-fueled buses from service and deployed three (3) zero-emission battery electric buses in their place, combined, we would consume 23,000 less gallons of CNG fuel annually over 81,000 service miles over that same time period.

Deploying battery electric buses in place of fossil fuel vehicles will reduce energy consumption and harmful emissions, including greenhouse gases and particulates. The zero-emission buses that the PT is proposing to put into service consume less energy per mile than buses that use other common propulsion technologies, such as gasoline, diesel, and natural gas engines. Even when considering well-to-wheel energy requirements, battery electric buses are a more efficient transit solution than these other vehicle technologies. Operating one battery electric bus instead of comparable modern fossil fuel buses (model year 2022 CNG bus) will reduce the amount of energy that the PT uses each year by 2,000 gigajoules (GJ). That energy is equivalent to 30 years' worth of gas for the average American car driver, every year.

Deploying the zero-emission buses in place of the existing vehicles will reduce the PT's annual direct carbon (greenhouse gas) emissions by approximately 140 metric tons and prevent the release of harmful emissions, including 2,100 g (grams) of particulate matter under 2.5 micrometers (PM_{2.5}), which has a considerable health impact on the local

community. This reduction of direct carbon and harmful emissions results in a social cost savings of \$66,000 annually, in accordance with Executive Order 13990.

Compared to modern fossil fuel buses (model year 2022), deploying the zero-emission buses will also reduce annual direct carbon emissions by approximately 140 metric tons. In addition, compared to modern fossil fuel buses, zero-emission buses will reduce production of harmful emissions, including particulate matter under 2.5 micrometers (PM2.5) by 240 g annually. This reduction in direct carbon and harmful emissions also results in a social cost savings of \$66,000 annually, in accordance with Executive Order 13990. (Source: CTE Demonstration of Benefits Calculations; see appendix)

SECTION B: CURRENT CLEAN ENERGY INITIATIVES

CARBON NEUTRAL RESPONSIBLE SOURCED GAS

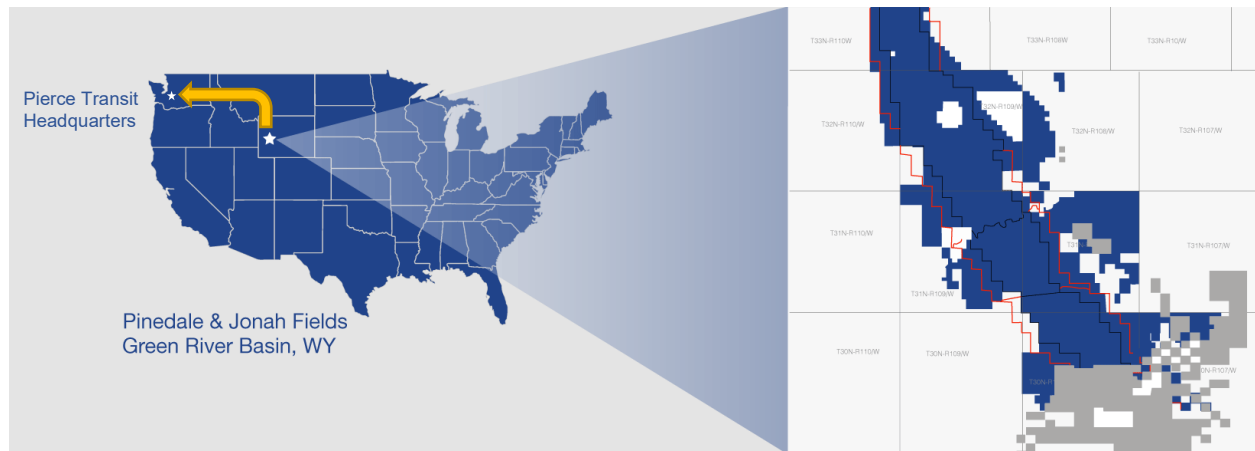
On November 2, 2021, Pierce Transit partnered with United Energy Trading and Pure West Energy, LLC to fuel buses with carbon neutral, Responsibly Sourced Gas (RSG). This will be the first-ever scope 1 and 2 carbon neutral, certified RSG in the country. Scope 1 emissions are direct greenhouse (GHG) emissions that occur from sources that are controlled or owned by an organization (e.g., emissions associated with fuel combustion in boilers, furnaces, vehicles). Scope 2 emissions are indirect GHG emissions associated with the purchase of electricity, steam, heat, or cooling. Although scope 2 emissions physically occur at the facility where they are generated, they are accounted for in an organization's GHG inventory because they are a result of the organization's energy use.

United Energy Trading, LLC, a Green-E Certified company and physical supplier of carbon neutral gas, is proud to partner with Pierce Transit, which has embraced the clean air benefits of compressed natural gas (CNG) for more than 35 years and has been recognized by the Department of Energy's Clean Cities program for its commitment to using cleaner, alternative fuels. Today, 80 percent of Pierce Transit buses operate on CNG, 13 percent are hybrid-electric, 5 percent are battery electric and just 2 percent are diesel. While operating the majority of its buses on CNG offers environmental benefits over traditional fuels, there is still an environmental impact. Transitioning its CNG fleet to this new fuel source means 80 percent of Pierce Transit's buses will be running on certifiably carbon neutral RSG. By using carbon neutral RSG, Pierce Transit's carbon reduction will equal a reduction of 101,370 pounds of coal burned or 230,496 miles driven by an average car each year.



The 3rd quarter of 2021, PureWest received a platinum rating for 90 of its wells on two pads through the independent evaluation company, Project Canary. Through its comprehensive evaluation of PureWest's operations, Project Canary found that PureWest represents their "best-in-class" tier, which comprises the top 10% of peers. PureWest also received the "Low-methane Verified Attribute Rating" on the certified wells and conducts continuous and independent monitoring of methane emissions at the well pads. PureWest's 2020 methane intensity rate was 0.04% based on data reported to EPA, which was reduced from 0.12% as reported in 2019. PureWest, Wyoming's top natural gas producer, plans to certify an additional 779 wells on 38 pads by the end of 2021. Robust and defensible carbon offsets have been procured to cover the remaining scope 1 and 2 emissions.

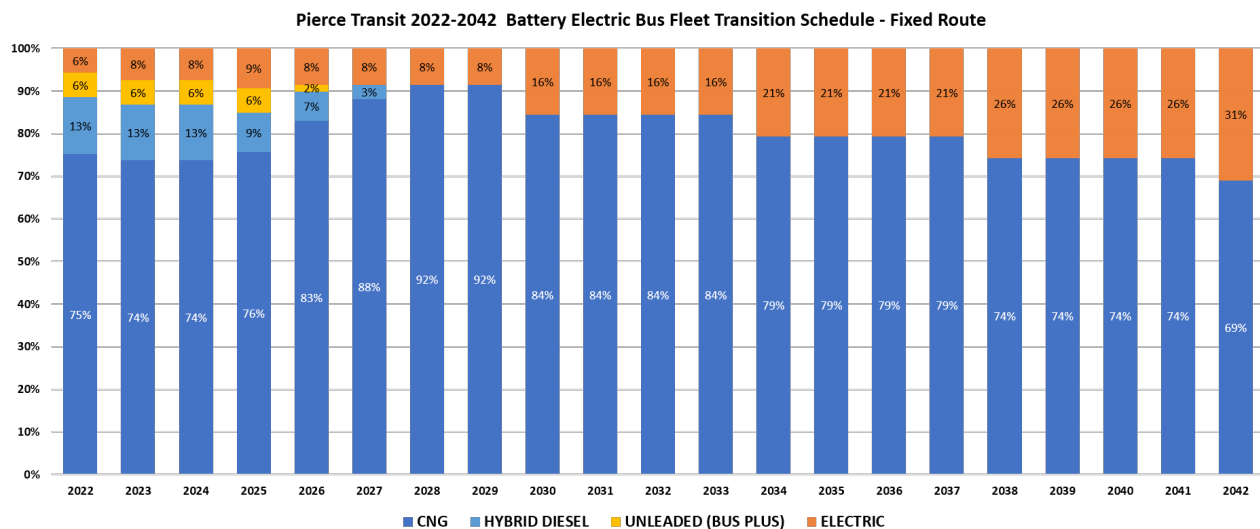
Figure_. PureWest is the largest producer of natural gas in Wyoming, with aggregate net production of approximately 600 MMcf/d (800 MMcf/d gross) as of May 1, 2021, from approximately 3,400 operated wells.



SECTION C: LONG-TERM FLEET MANAGEMENT PLAN & STRATEGIES

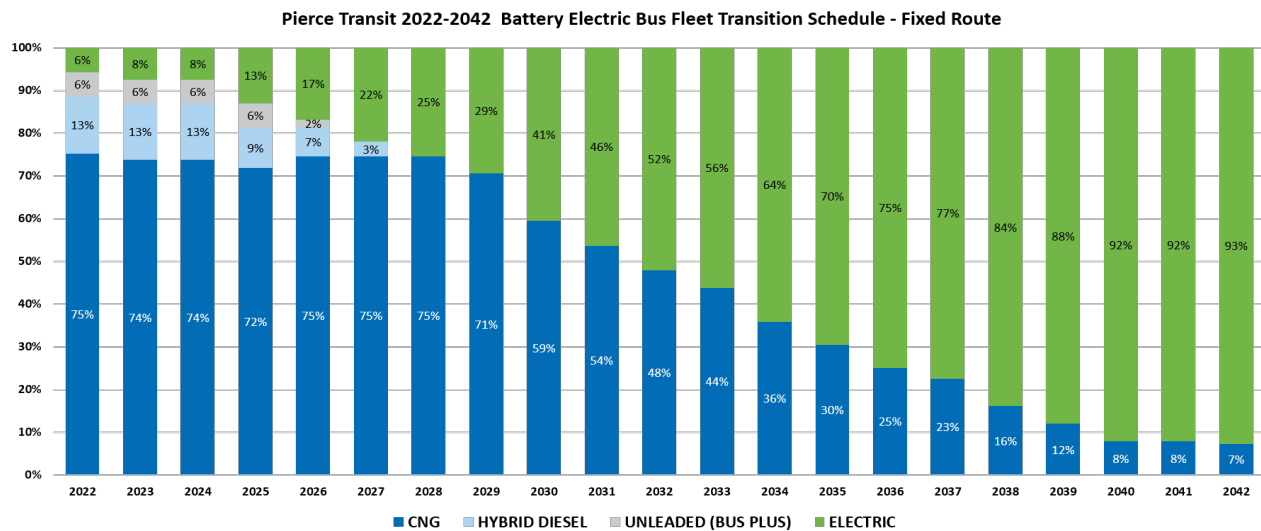
Pierce Transit has established an ambitious goal to convert 20% of its bus revenue fleet to battery electric by 2030. This equates to 33 forty-foot coaches needing to be replaced from 2022-2030. Currently the agency can house and charge nine (9) forty-foot BEBs on its base facility with the potential capacity to house and charge up to 15 BEBs with modest capital investments that may compete well for Federal and State grant funds. In addition, future high-capacity transit plans call for an additional 58 to 60 sixty-foot articulated BEB buses to be used across four future Stream BRT routes. In order to convert 20% of the fleet by 2030 and beyond, the agency developed its initial BEB conversion plan as seen below. Implementing BEB technology in the future will require significant capital investment in both fueling/charging infrastructure at our Lakewood Maintenance and Operations Base as well as the incremental cost increase of BEB equipment over other propulsion systems. Pierce Transit will be limited in our ability to realize this ambitious BEB conversion without Federal and State funding support.

Seventy-five percent (75%) of the existing fleet is CNG, while only 6% is battery electric, however the expected conversion rate to BEB propulsion would allow the agency to accomplish its 20% BEB goal very close to our initial 2030 target. By 2030 the agency hopes to launch its 2nd BRT Route with an entirely BEB fleet and additional zero emission BRT routes in place thereafter every 4 years to 2042. The Bus Fleet Transition Schedule below illustrates a financially constrained BEB conversion rate if the agency procures a total of fifteen (15) 40-foot BEBs with an additional fifteen (15) 60-foot articulated BEBs for the future BRT 2 corridor. Once in service, these thirty (30) total BEBs helps us achieve a 16% conversion rate by 2030.



Pierce Transit has negotiated a contract with HDR Engineering for additional analysis and implementation support. Our Next Steps: Phase II Zero Emissions Fleet Transition Plan described below provides more detail. It is important to show a vision and desired fleet mix in the future with unconstrained financial and staffing challenges. The image below **could** represent that future, our work with HDR with help the agency refine this vision given the state of the

industry and the state of the agency.



STREAM SYSTEM EXPANSES STUDY (SSES)

What is Stream? The Pierce Transit Board of Commissioners selected Stream as the name for Pierce County's Bus Rapid Transit (BRT) system. Since the name was chosen for an entire BRT system, it will apply to the line planned for Route 1, as well as future Pierce Transit BRT corridors that will replace portions of Routes 2, 3, 4 and 402.

Communities across the country are transforming their key bus corridors by implementing Bus Rapid Transit (BRT). These systems are designed to carry large numbers of riders with greater speed, reliability, and frequency than standard fixed-route buses.

Pierce Transit is completing the planning and design of its first Stream BRT corridor, which will operate on Pacific Avenue/SR 7 from downtown Tacoma to Spanaway. Service is expected to begin in 2027.

Where should we Stream next? Pierce Transit is in the process of identifying the next corridor for investment in BRT. The Stream BRT System Expansion Study is analyzing four potential corridors to determine which one is the best option for our second Stream BRT line. The four corridors under consideration were chosen because they:



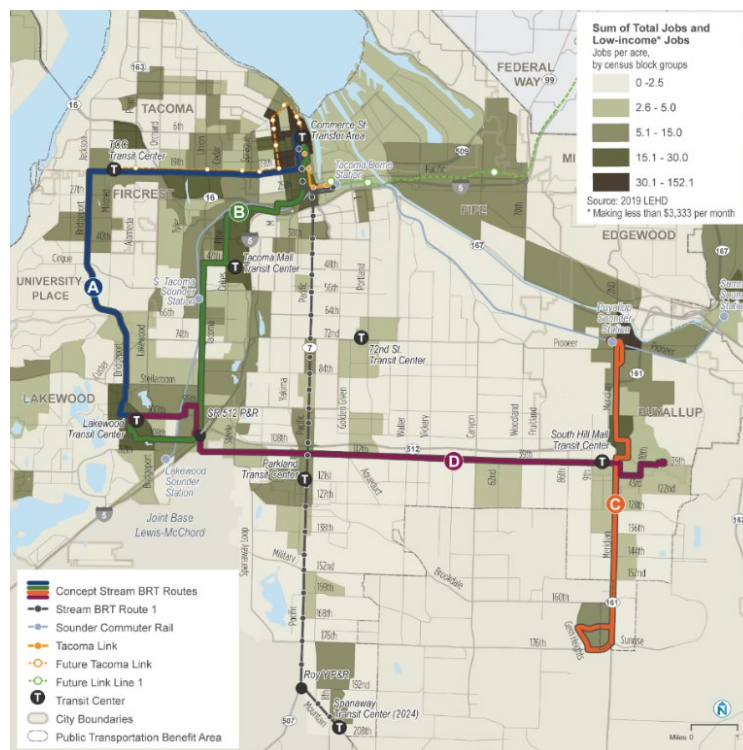
The four corridors are:

Corridor	Current Route Replacement	Battery Electric Buses Required
A	Route 2 (Downtown Tacoma or Tacoma Dome Station to Lakewood Transit Center)	15
B	Route 3 (Commerce Street Station to Lakewood Transit Center)	14
C	Route 402 (176th Street to Downtown Puyallup)	12
D	Route 4 (Lakewood Transit Center to Pierce College Puyallup)	17
Estimated Total 60-foot Articulated Battery Electric Bus Needs		58

Key elements of the project include:

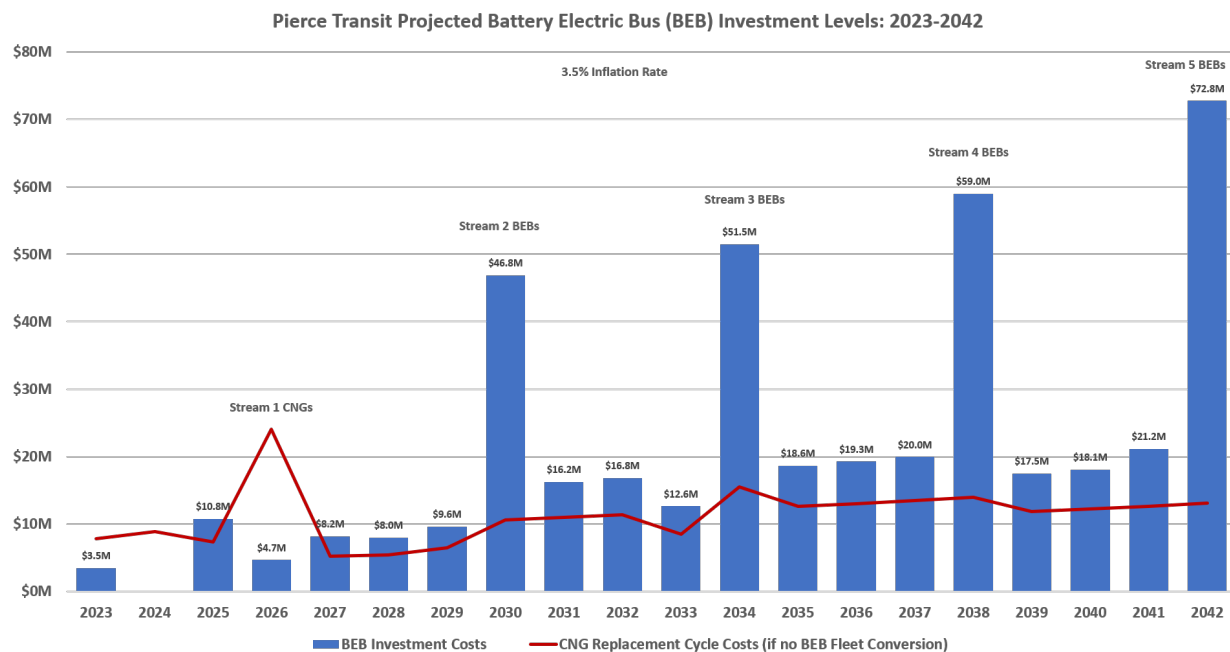
- Assessing each corridor, including ridership patterns, opportunities for transit priority (e.g., bus lanes, bus signals), and future growth potential (e.g., new housing, jobs, or destinations).
- Creating an equity-focused list of evaluation criteria to analyze and compare the corridors.
- Gathering feedback from the public and a Technical Advisory Committee including representatives from the local jurisdictions, major employers, public health agencies, and business associations.

A major component of the SSER is deploying articulated 60-foot ZEB coaches and fleets for corridors A through D. Pierce Transit considered BEB deployment for Stream BRT Route 1, however it was decided to purchase 60-foot articulated buses for that corridor to reduce project risk and manage project budget.



FUTURE STREAM BRT CORRIDOR MAP

SECTION D: FLEET TRANSITION AND IMPLEMENTATION RESOURCE PLAN

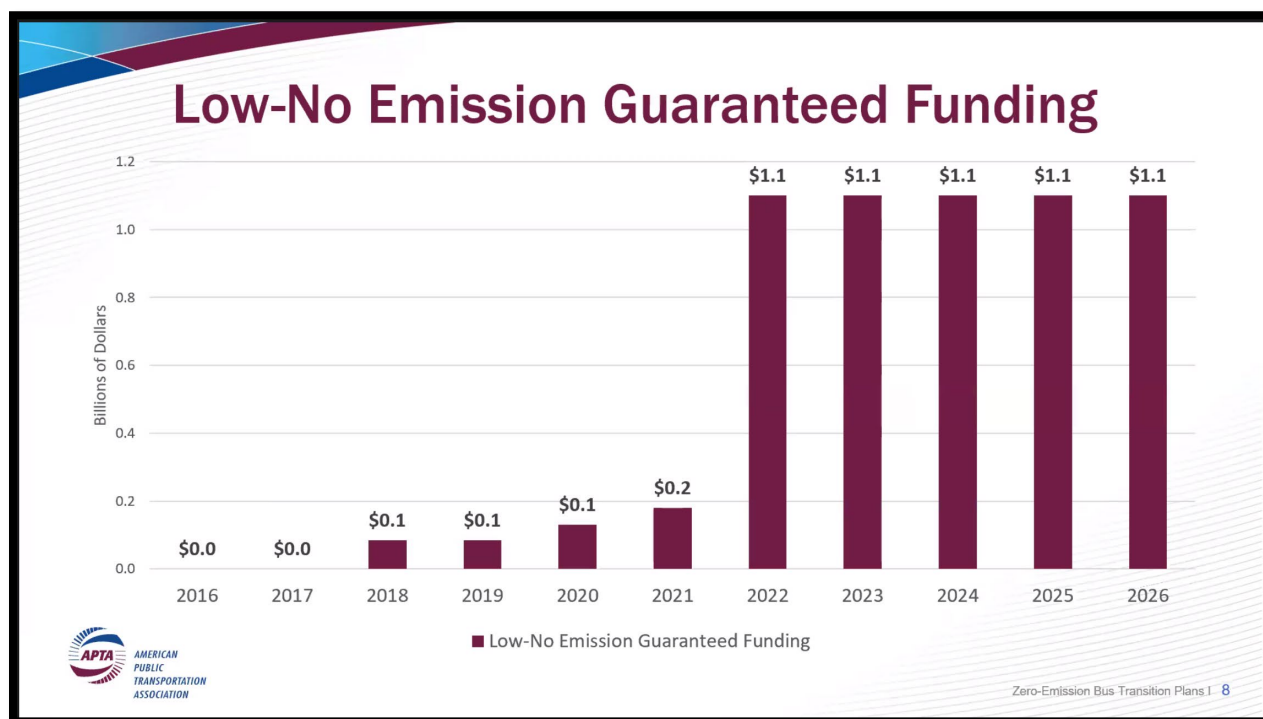


Pierce Transit will need to judiciously invest into its BEB fleet over time. This requires the agency to secure local funds as well as identify grant funding opportunities from year to year. Compressed Natural Gas (CNG) buses have been a reliable propulsion technology for the agency for many years. In the future however, the agency will need to anticipate a 43% cost increase when procuring a new BEB over a CNG or Hybrid vehicle. If the agency were to replace all future buses with a BEB, the agency needs to identify \$210M throughout the next 20 years over and above a CNG replacement cycle as shown above (red line) to meet achieve a full BEB fleet conversion. And that cost does not include the facilities improvements and infrastructure required to support a BEB fleet. As a standard practice, Pierce Transit replaces its buses determined by useful life benchmark every 16 years, or 640,000 miles, whichever comes first. Transitioning to BEB from CNG will be an incremental investment over time but is also the cost of doing business and continued operations. As the agency moves forward with its fleet conversion schedule, it will need to consider the following:

- Cost to replace existing fleet to CNG compared BEB costs over time
- Cost estimates for one for one charging vs overhead pantograph or underground inductive charging solutions
- Maintenance and Operation Base facility upgrades needed for future BEB transition
- Future Stream System expansion bus technologies

As Pierce Transit begins to look for future funding opportunities, the Federal Government has revealed a \$5.5B investment over five years for the Low-No Emission Grants, \$1.1 Billion in 2022. In addition, they have also announced \$2B over five years for the Bus/Bus Facilities \$372M in 2022 through the Infrastructure Investment and Jobs Act (IIJA), commonly referred to as the Bipartisan Infrastructure Bill, was signed into law by President Joe Biden on November 15, 2021. Now is the time for the agency to capitalize on grant funding resources, and to update plans on a regular basis to account for emerging technologies and energy efficiencies. Pierce Transit has an immediate need for the following:

- **Low or No Emission Vehicles - \$4,838,451** (ask of \$2,904,000 for the three BEBs + \$651,560 for the three conductive charging stations + \$315,200 for Workforce Development Training).



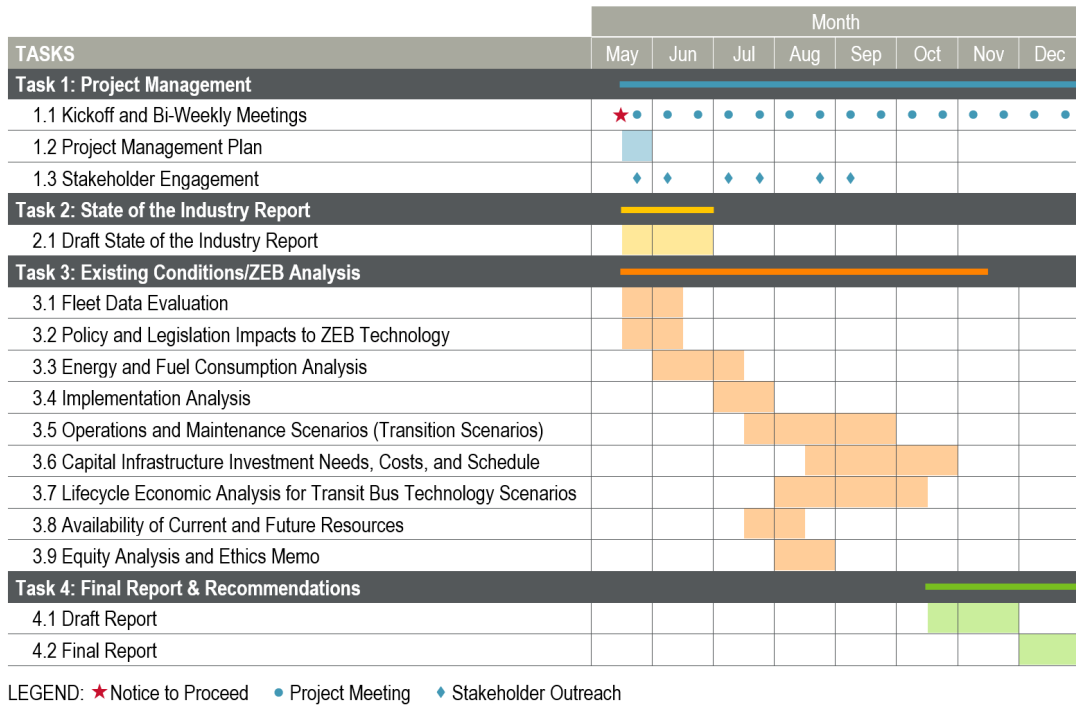
PROJECTED FEDERAL TRANSIT ADMINISTRATION LOW-NO EMISSION GRANT FUNDING OPPORTUNITIES

NEXT STEPS: PHASE II ZERO EMISSIONS FLEET TRANSITION PLAN

Pierce Transit is committed to finding resources and strategic plans to transition and shelter a sustainable bus fleet that meets State of Washington air quality standards and local and regional goals. Emerging technology such as Hydrogen Fuel Cell Electric Buses in combination with Battery Electric Bus drivelines will need to be studied along with the power and energy consumption and spatial constraints/opportunities of our maintenance and operations facilities. In this effort, Pierce Transit has procured the services of an industry leading consultant to produce a state of the industry report, an existing conditions and feasibility analysis, and a final report with recommendations of Pierce Transits transition to these emerging technologies. This study should be completed by December 2022. We anticipate an update to our BEB Transition Plan following this expanded planning effort.

Action steps that the agency will follow in this Phase II effort include:

1. After reviewing the results of the HDR Engineering analysis and consulting with the Executive Team, staff will propose a modified goal year for reaching 20% electrification. Available space and resources should be key considerations in this decision.
2. Using the modified goal year, staff will develop a formal plan to phase in additional electric charging infrastructure and zero emission buses. This plan will require the review and support of Executive Team and approval by the CEO.
3. Completing the MOBI and BRT 1 projects will be the priority for the agency through at least 2027. Our goal to expand zero emissions must be fiscally feasible and take into consideration resources required by these two critical capital projects.



ZEB TRANSITION PLANNING PHASE II TIMELINE

SECTION E: POLICY AND LEGISLATION IMPACTS BATTERY ELECTRIC BUS FLEET

Achieving a zero emissions future is not just a regional goal for Pierce Transit but aligns with Federal statutes. As an example, an update to the agency's base facility (MOBI) project will support the continuation and expansion of public transportation services as outlined in the program goals of the Bus and Bus Facilities Program. This program is authorized under the provisions set forth in the Moving Ahead for Progress in the 21st Century Act (MAP-21), signed into law on July 6, 2012, as codified at 49 U.S.C. 5339 ("Section 5339"). As such, the secretary may make grants under this section to assist eligible recipients in financing capital projects to replace, rehabilitate, and purchase buses and related equipment, and to construct bus-related facilities. Recently the Federal Transit Administration updated grants provisions for the bus and bus facilities competitive program with a stronger lens in equity. **Justice40** is a government-wide initiative with the goal of delivering 40 percent of the overall benefit of relevant federal investments to disadvantaged communities.

These new provisions will help the agency assess how it deploys its battery electric bus fleet throughout the region. Currently 19 routes in the Pierce Transit network receive some

In January 2022, The Washington State Department of Ecology announced the start of rulemaking to adopt new vehicle emission standards that would increase the vehicle sales of passenger cars, light-duty trucks, and medium-duty vehicles to 100 percent starting in 2035. Those vehicles unable to meet these new vehicle standards cannot be registered, licensed, rented or sold in the state even if they meet federal standards.

In addition to these standards for passenger cars and light and medium duty vehicles, the State of Washington **has** adopted the California Advanced Clean Trucks requirements specified in Title 13 of the California Code of Regulations, **requiring manufacturers** to meet California's ZEV production and sales requirements. Beginning with model year 2025, manufacturers will be required to sell zero-emission trucks as an increasing percentage of their annual sales for **Class 2b through Class 8 vehicles in Washington**.

Should this law have enduring effect, manufacturers of Transit Buses such as those highlighted in class 7 would need to offer higher sales of zero-emission fleets starting in 2025. Readyng ourselves for these laws with careful monitoring over time will help Pierce Transit be positioned to procure a cleaner fleet.

TRUCK CLASSIFICATIONS			
CLASS 1 6,000 lbs or less			
CLASS 2 6,001 to 10,000 lbs			
CLASS 3 10,001 to 14,000 lbs			
CLASS 4 14,001 to 16,000 lbs			
CLASS 5 16,001 to 19,500 lbs			
CLASS 6 19,501 to 26,000 lbs			
CLASS 7 26,001 to 33,000 lbs			
CLASS 8 33,001 to REALLY HUGE			

SECTION F: MOBI SITE EVALUATION FACILITIES TRANSITION

MAINTENANCE AND OPERATIONS BASE IMPROVEMENTS (MOBI) HISTORY

Pierce Transit's Headquarters facility opened for service in 1986, initially designed to serve a fleet of **200** revenue vehicles, today it supports a fleet of **300** fixed route buses plus additional revenue and support vehicles. The facility maintains both Pierce Transit and Sound Transit vehicles; **it is overcrowded and no longer meets industry standards.** Buses have gotten wider and fleet styles have changed dramatically in 30 years. In addition, the fleet maintained on the base has changed to include 60-foot articulated buses, the newest technology Battery Electric buses (BEB), and in the future will include double decker commuter buses. This is challenging for our work force, who are doing their best in less-than-optimal conditions.

Since construction of Pierce Transit's only base facility, the agency has purchased adjacent properties to expand the footprint of our campus but had not moved forward with improvements on those parcels. These parcels now provide the room needed to complete the MOBI project, modernizing the base and providing a safer and more efficient working environment. In 2020, the MOBI project evaluated constructing a new maintenance facility compared to modernizing an over 35-year-old structure (New-In-Lieu Comparison, July 2020).

- Due to age and code requirements, modernizing the existing site was estimated to cost \$1.5M more than constructing a new building. Also, updating the existing site was not able to achieve most current industry standards for maintaining a transit fleet.
- A major difference between the "New-In-Lieu Building" and modernization of the current site is flexibility for phasing. The current approach, New-In-Lieu, provides opportunities to phase the construction of the building to better match the funding flow for the project. It also allows ongoing operations while a new facility is constructed.

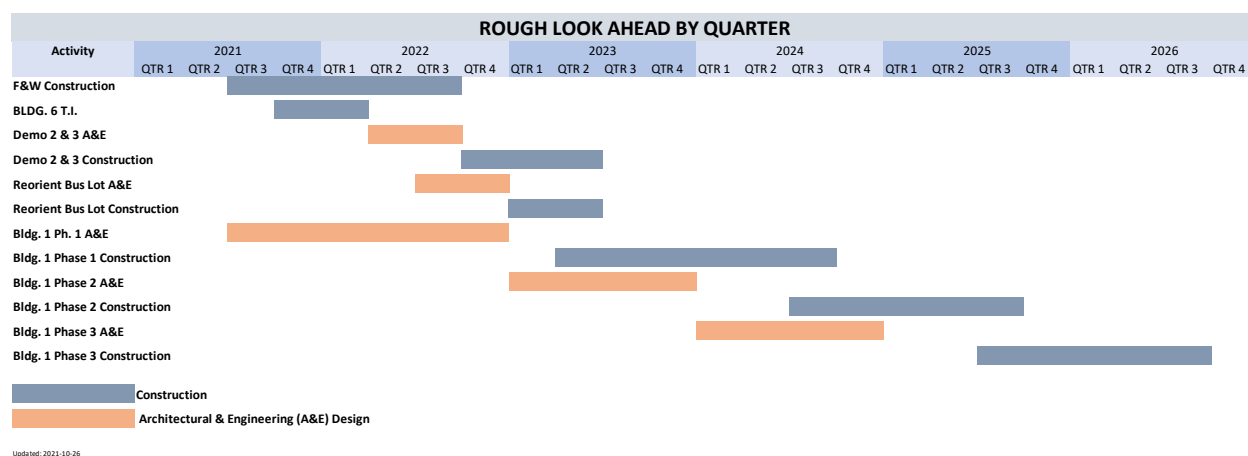
MOBI builds a new maintenance and operations facility at Pierce Transit's current Operations and Maintenance base sized to match the long-range service plans of the agency and addresses the need to maintain articulated coaches, future double-decker buses, and sets the stage to accommodate a Zero Emission Bus (ZEB) fleet. While already operating and testing BEB technology, Pierce Transit is learning from the industry as propulsion technology evolves. As this plan shares, the agency is initiating a Zero Emission Bus Implementation Strategy, Phase 2, effort that includes evaluating both BEB and hydrogen technology to identify the most appropriate propulsion technology for our long term needs and to continue planning for the implementation of our ZEB fleet. The outcome of this additional 2022 planning effort will further guide expansion of ZEB technology on our base and influence our future Low-No applications. Order of magnitude estimates for the ZEB implementation are \$38 million for design and construction of charging infrastructure.

MOBI already provides the infrastructure to accommodate charging capacity for up to 12 BEB vehicles and can be easily expanded to 15 BEB buses; the MOBI program also provides space for future ZEB implementation identified in the agency's 2022 Zero Emission Bus Implementation Strategy, Phase 2, planning efforts underway. Pierce Transit's challenge is fully funding the MOBI project. Today, the agency has committed \$84.5 million in local funds toward the project. But the need is greater, an additional \$207 million is needed to complete the MOBI project by 2030. And additional ZEB projects will need to be developed and added to the agency's portfolio to continue to transition to a ZEB fleet.

MAINTENANCE AND OPERATIONS BASE IMPROVEMENTS (MOBI) FUTURE

Completion of the MOBI project is critical to support Bus Rapid Transit (BRT) projects in the region. Current facilities are not capable of servicing additional articulated, double-decker and electric buses needed for BRT routes that address future transportation infrastructure challenges. MOBI has been submitted for both FTA Bus and Bus Facility Grant and Low-No Grant funding requests but has not been successful obtaining grant awards as of May 2022. Pierce Transit's grants team has sought FTA feedback on those previous applications and is developing new ways to share the story of our need for this project.

Pierce Transit is committed to financing the construction of its first building identified in our base modernization program, necessary to support BRT and energy conversion plans. Pierce Transit's Destination 2040 Long Range Plan (LRP) directs improved service quality, headway, accessibility to school, work, and regional transit connections. The LRP includes directly serving specific neighborhoods who have borne disproportionate impacts from transportation noise, poor air quality, and community separation from interstate highway construction. The PT service area exceeds Justice40 targets and includes the highest concentrations of environmental justice populations who have been adversely impacted. PT's Stream BRT initiative places premium service within a one-half mile walkshed of the most affected neighborhoods. This Plan can only be realized through the construction of the new Maintenance & Operations (M&O) building, the focus of the first phase of the MOBI base improvements.



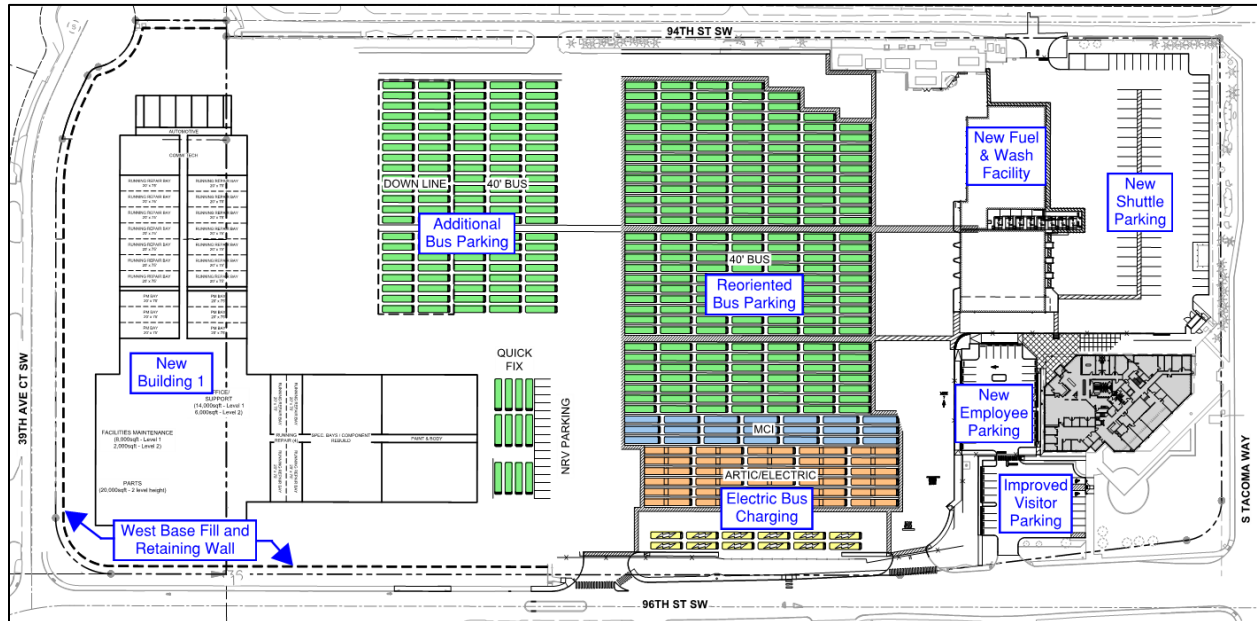
MOBI: MAINTENANCE & OPERATIONS BASE IMPROVEMENT IMPLEMENTATION SCHEDULE (BY PHASES)

The new Building 1 is the primary maintenance location for existing and planned revenue and non-revenue fleets. Building 1 coordinates well with future base modernization plans while offering independent utility from future phases. It provides for maintenance of the planned fleet that will not fit in the existing facility, including new articulated buses to support both the Stream BRT service and Sound Transit regional express as well as potential for double-decker buses already used in the region.

The inaugural Stream BRT corridor, a Small Starts project recommended in the USDOT Fiscal Year 2022 budget, will expand the fleet with seventeen (17) sixty-foot articulated coaches that literally do not fit into existing base facilities (e.g., in the current configuration of the M&O building, a 60-ft. articulated coach will only fit in one preventative maintenance bay currently). An additional 62 zero-emissions, high occupancy articulated coaches will be added as the Stream BRT network expands to five interconnected routes in the future.

This building, the largest on PT's Lakewood headquarters campus, directly impacts the revenue vehicles maintenance capacity of the overall base and includes the following functions: motorbus repair bays, van and support vehicle repair bays, body repair and paint, components rebuild, parts storeroom, chassis wash, tire shop and storage, maintenance

offices, mechanics' amenities (including large training room, wellness center, and restroom/locker/showers), and a chassis dynamometer. The configuration of service bays and warehouse size directly impact the operational efficiency and capacity of the base. As such, improvements within the new M&O Building 1 are required for planned capacity increases, safety, and employee retention. Bringing a 1980s-era M&O building up to current industry standards is a core need for PT in the long-term.

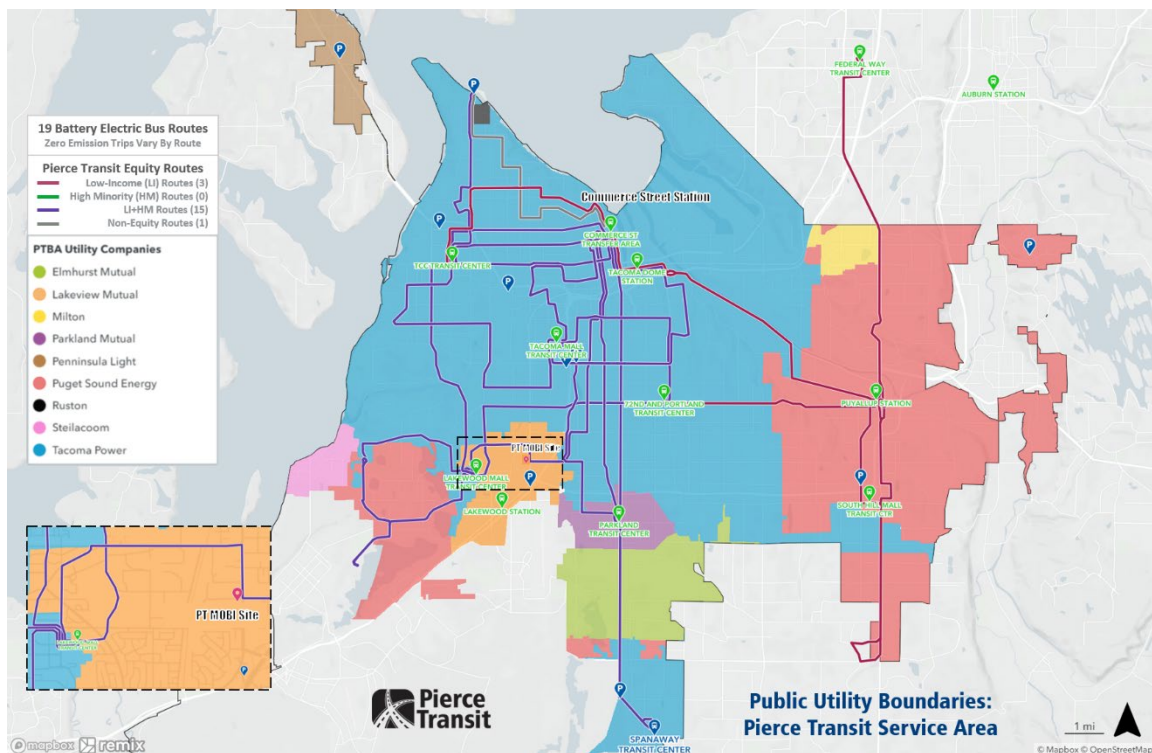


MOBI: MAINTENANCE & OPERATIONS BASE IMPROVEMENT ILLUSTRATION

SECTION G: EXISTING UTILITY PARTNERSHIPS

There are nine (9) public utility companies within the Pierce Transit Benefit Area (PTBA). Currently there are two distinct BEB charging site locations in the PTBA. The first, from north to south, is located at the Commerce Street Station where Pierce Transit is constructing three (3) in-route charging stations, and the second at the Pierce Transit Maintenance and Operations Base facility and current site where we have nine (9) existing charging stations with up to six (6) more planned in the near future. Other locations where Pierce Transit may consider future charging infrastructure would be at the Lakewood Town Center Transit Center, the most popular boarding location in our PTBA and property is owned by Pierce Transit. Based on BEB gap analysis inductive charging, overhead pantograph or plug-in charging solutions may be merited at these and other locations throughout our service area.

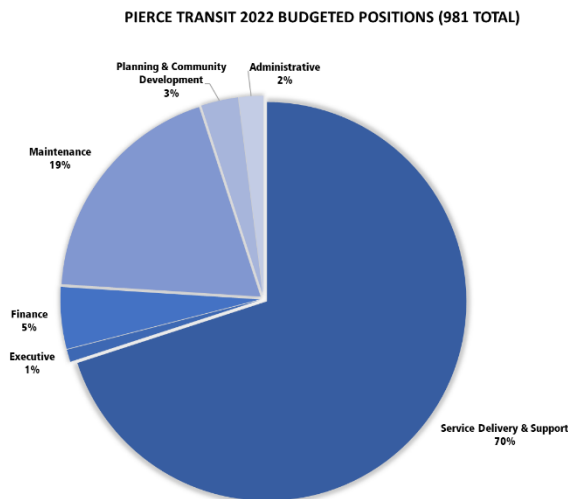
Lakeview Light and Power (LLP) own and operate the Roy Miller Substation located on 96th Street West south of Pierce Transits maintenance and operations facility. To meet Pierce Transit's growing electric demand for charging battery electric buses, LLP installed a new 6-inch electric conduit from the substation switchgear to a newly installed vault located near our bus garage. LLP has developed a schedule to upgrade/replace adjacent substations every two years. In addition, LLP partnered with Pierce Transit with EV program chargers. They remain an interested and engaged partner as we develop more charging infrastructure on our base.



PUBLIC UTILITIES ACROSS THE PIERCE TRANSIT SERVICE AREA

SECTION H: WORKFORCE DEVELOPMENT & TRANSITION PLAN

Pierce Transit dedicates much of its budget on training staff to operate and maintain its bus fleet. For example, in 2022 the agency dedicated 19% of its budget on maintenance while 70% was dedicated to service delivery & support. This means that 89% of Pierce Transit's budget is dedicated to moving and maintaining buses every day.



Pierce Transit will continue to prioritize its budget to maintain the movement of its fleet by hiring and supporting operators and maintenance staff. Currently we have **131** budgeted positions (2022) in our Maintenance Division of which **31** maintain buses.

As the agency transitions to more BEBs, it will require the agency to simultaneously assess how staff intend to maintain and operate new bus technology. The overarching objective is to maintain or add to the current level of Lead and Journey Level Mechanics as our fleet multiplies over time. Currently 31 mechanics are assigned to maintain a fleet of 161 buses, 28 of which are expert with internal combustion engines (ICE) while only three (3) are expert in

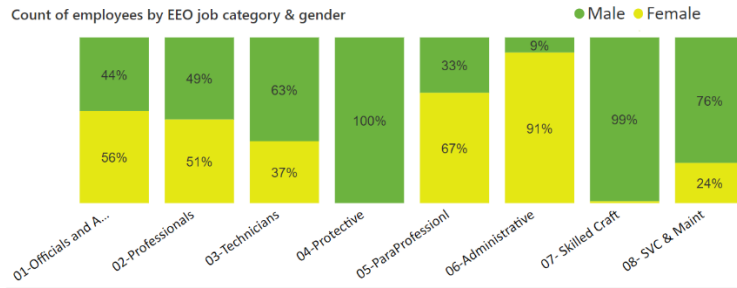
BEB propulsion systems. As the agency prioritizes more battery electric buses, the agency will need to work with the appropriate Original Equipment Manufacturers (OEMs) to ensure training courses directly tie to the operation and maintenance of our changing fleet.

Pierce Transit's staffing composition leans heavy on a male dominant workforce as well as older personnel. Females have a larger presence as officials and administrators, paraprofessional, as well as general administrative roles within the agency, while males are more prominent in service and maintenance, technical and protective positions. There is a general need to recruit more women, more veterans, more minorities, and youthful laborers across all categories to sustain the agencies services into the future.

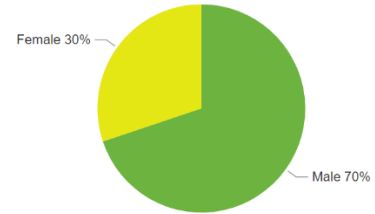
Pierce Transit will require the knowledge and experience of various OEMs to assess the staffing impacts of BEB propulsion systems now that all-electric vehicles offer more maintenance-free motors, eliminating downtime and costs. Pierce Transit has estimated \$8,550 for each bus mechanic to become proficient with the new fleet technologies. Methods and approaches need to include recertification and retraining as new fleets are purchased over time and as technologies advance over time as well. The agency will need to work with local trades and educational institutions to ensure qualified mechanics have a baseline knowledge of how to charge, fuel and maintain powertrains for ZEB FCEB's. Currently, all bus operators at Pierce Transit receive training to operate the agencies BEB fleet.

Gender

Count of employees by EEO job category & gender

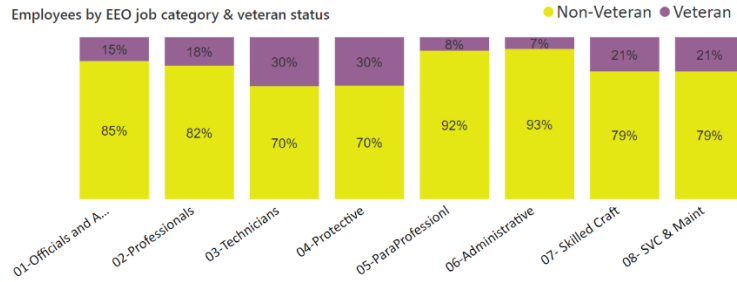


% of agency by Gender

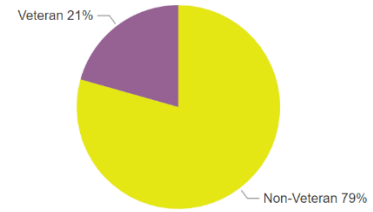


Veteran Status

Employees by EEO job category & veteran status

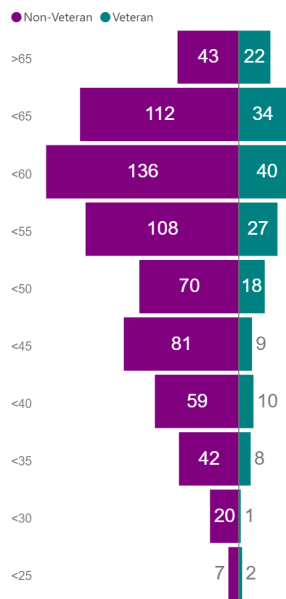


% of agency by Veteran Status

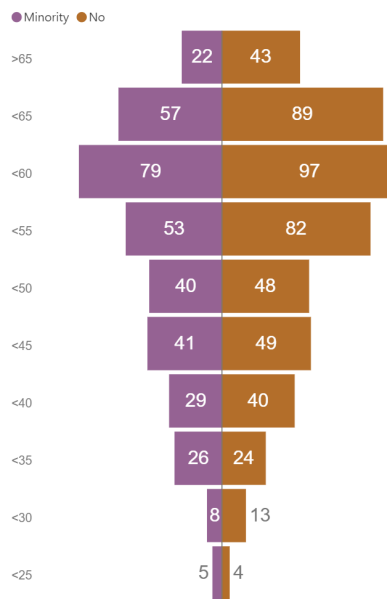


PIERCE TRANSIT 2022 GENDER AND VETERAN POSITION COMPOSITION

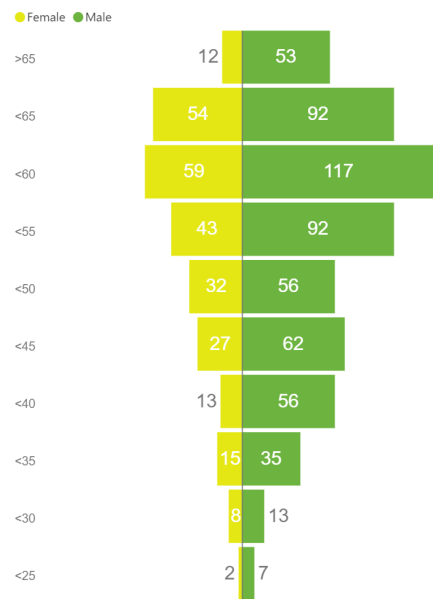
Employees by AgeGroup and Veteran



Employees by AgeGroup and Minority



Employees by AgeGroup and gender



PIERCE TRANSIT 2022 EMPLOYEE POPULATION PYRAMID BY VETERAN, MINORITY AND GENDER STATUS

WORKFORCE DEVELOPMENT TRANSITIONING TO BEB

Maintenance staff receive ongoing, regular training as a course of their regular work. We have identified specific training required for each Journey Level Mechanic that will be needed to develop their skills and retrain the workforce to a BEB fleet. With 46 Journey Level Mechanics on staff, this training is assumed for each individual employee and is valued at \$393,300. Specific retraining that will be programmed includes:

Battery Electric Bus Driveline Training Transition Forecast				
Course	Type	Units	Cost	Notes
Electric Drivelines	Cummins	Per Person	\$4,000	Incl. Per Diem, Hotel
Door Training	Vapor	Class (4-6)	\$3,400	1-day, In-house
BEB JLM Familiarization	GILLIG	Class (4-6)	\$5,000	3-day, In-house (GILLIG)
Multiplex I/O	Dinex G5	Class (4-6)	\$5,000	3-day, In-house (GILLIG)
HVAC	ThermoKing	Class (4-6)	\$4,800	3-day, In-House (ThermoKing)
Charging Stations	ChargePoint	Class (4-6)	FREE	Chargepoint Univ. Installers Course

APPRENTICESHIP PROGRAM

Pierce Transit's Maintenance Department has a strong apprenticeship program that is evolving due to BEB fleet transition. Our agency was recognized in 2022 among the American Transit Training and Apprenticeship Innovators Network (ATTAIN). And staff have presented on ATTAIN panels to talk about successes and challenges faced while developing and maintaining a state-certified apprenticeship program. We currently run a Journey Level Mechanic Apprentice Diesel Mechanic program, that includes a BEB tract, and are actively working on much-needed apprenticeships in the Radio and Body Shop career paths as well. The Apprentice Diesel Mechanic program is an 8,000-hour training program (4 years). This program has been active since the late 1980's. In the past 8 years, 30 employees have earned their state-certified Journeyman's card, including two current (former) apprentices.

The apprenticeship program goal is to help provide a steady revolving income of qualified, internal OJT technicians. Finding skilled technicians from the outside that are "turn-key" capable is extremely difficult for the transit-specific technologies and systems. Having a top-quality, robust training program internally helps Pierce Transit maintain all the new fleets and technologies that show up on our doorstep every year and keeps those fleets mission-capable, safe, and reliable for our customers and community.

DEPARTMENTAL BEB ONBOARDING

As new BEB fleets arrive and the agency prepares to bring them into service, there is training required by each of our departments that work with these vehicles. BEB vehicles have new technologies and inherent training needs around electricity that we will address through our fleet onboarding efforts. A high-level departmental perspective on these activities include:

Maintenance Department: Mechanics, Service Station Attendants, and Custodial teams are trained one-on-one with each BEB fleet to learn the vehicle's unique characteristics to ensure safe operation.

Safety Department: ADA and Safety scoping during design and build of BEB. Safety planning and review as vehicles join our fleet. The Safety Department will also coordinate with local emergency service personnel training first responders on unique BEB equipment as they will need to be ready to respond to an emergency with a BEB vehicle.

Training Department: Instructors will train every transit operator on the fleet before it goes into service. This is generally small group Transit Operator class with a Fixed Route Instructor on the new BEB fleet.

Transit Service Department: Service Supervisors are trained on unique vehicle characteristics and provided tips to support our Transit Operators in the event of a BEB service interruption. These can be issues that happen in the field requiring immediate attention with the intention of quick resolution to keep the BEB in service and service operating smoothly for our riders.

SECTION I: EQUITABLE BATTERY ELECTRIC BUS ROLLOUT PLAN

JUSTICE40 GUIDING PRINCIPLES

JUSTICE DRIVEN



Resource and focus on disadvantaged communities.

COMMUNITY POWERED



Create systems that achieve transformational change from the bottom up.

ACCOUNTABLE CHANGE



Institutionalize equity and justice into government agency practices, policies, and systems.

Pierce Transit will consider the equitable rollout of a BEB fleet to communities in our service area that experience both environmental degradations, but also socio-economic disparities. As a demonstration of the agency’s commitment to equity, we are working to achieve the Justice40 Guiding Principles in addition to APTA’s Racial Equity Commitment Program.

On January 27, 2021, President Biden signed Executive Order 14008, Tackling the Climate Crisis at Home and Abroad, creating the government-wide Justice40 Initiative. This effort aims to deliver 40 percent of the overall benefits of federal investments in climate and clean energy, including sustainable transportation, to disadvantaged communities. Several resources have been provided to communities such as mapping tools that help agencies identify Transportation disadvantaged communities. A disadvantaged community is one that experience four (4) of the following six (6) conditions.

- 1. Transportation access disadvantage identifies communities and places that spend more, and take longer, to get where they need to go.
- 2. Health disadvantage identifies communities based on variables associated with adverse health outcomes, disability, as well as environmental exposures.
- 3. Environmental disadvantage identifies communities with disproportionately high levels of certain air pollutants and high potential presence of lead-based paint in housing units.
- 4. Economic disadvantage identifies areas and populations with high poverty, low wealth, lack of local jobs, low homeownership, low educational attainment, and high inequality.
- 5. Resilience disadvantage identifies communities vulnerable to hazards caused by climate change.
- 6. Social disadvantage identifies communities with a shared history of discrimination, or other forms of disadvantage that warrant consideration along with each/any of the above measures.

Currently, Pierce Transit deploys a fleet of nine (9) BEBs across 19 routes in our service area. BEB trips are allocated based on blocking efficiencies which are primarily determined by existing BEB range, safety protocols and charging limitations in the field. However, 18 of the 19 routes are equity routes as defined by bus routes that pass through or adjacent to high minority and/or low-income block groups when compared to the rest of our service area (Source: 2015-2019 American Community Survey, Geography).

Existing 2022 Battery Electric Bus Routes																			
Route Number	1	2	10	11	16	28	41	45	48	53	54	55	57	202	212	214	400	402	409
Equity Route	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
BEB Trips/Day	9	1	1	1	2	2	4	1	3	1	6	5	7	9	2	1	4	4	2

Ninety Eight percent (98%) of all BEB trips are dedicated to equity routes in some fashion. Route 11 is the only non-equity BEB route in our service area. Routes 400, 402, and 409 are identified as low-income routes exclusively, whereas all other 15 BEB routes are identified as high-equity routes and pass through both high minority and low-income areas.

As a current and long-standing practice, the agency uses Hastus software to organize bus assignments called blocking. In the case of BEBs, buses are assigned a route to maximize efficiency and to capitalize on BEBs ranges using on route algorithms and efficiency. As the agency scales up its charging capacities, it can further dedicate and deploy its BEB fleet to communities that experience the most environmental degradation and/or the least environmental resiliency. Designing future or enhancing existing routes to 100% zero emissions for deserving communities is a goal for the agency. Inter-agency coordination needs to focus on equitable variables that balance the traditional heavy efficiency or optimization approach of past practice.

SECTION J: BATTERY ELECTRIC BUS IMPLEMENTATION CHALLENGES

Pierce Transit is an early leader in adopting a low emissions revenue services fleet with our early conversion to a CNG fleet, Pierce Transit understands the challenges and opportunities of transitioning to a new fleet, like BEB. We recognize there are many unknowns as technologies evolve exponentially. As we have shared in this plan, we will need to be cognizant of the challenges of fleet transitions:

- Deployment of BEB and infrastructure adds significant capital and operating costs.
- Funding challenges due to the uncertainty of funding availability at a state and federal level and due to the very competitive nature of most funding opportunities
- Procurement of BEBs require careful timing to deliver associated infrastructure capital projects when BEBs arrive on property.
- Not all BEB have achieved a one-for-one exchange of a diesel or CNG bus in terms of range and capability.
- BEB and ZEB operations are vulnerable to utility company priorities and limited numbers of fuel suppliers.
- Utility surge pricing often conflicts with BEB charging, this will need to be managed as the BEB fleet is expanded
- IT infrastructure costs/challenges
- Unexpected short-term and long-term impacts due to an emergency such as the COVID-19 pandemic, or a natural disaster
- Unique operational challenges with a fully transitioned BEB fleet in the case of power/fuel supply disruption, lack of propulsion diversification could interrupt service

As the transit industry is learning, BEB and ZEB technologies are becoming readily available. However, there are challenges that Pierce Transit will need to consider as it transitions its fleet and it will need the support and willingness of its policy makers, industry OEMs and energy providers to help address these challenges and risks.

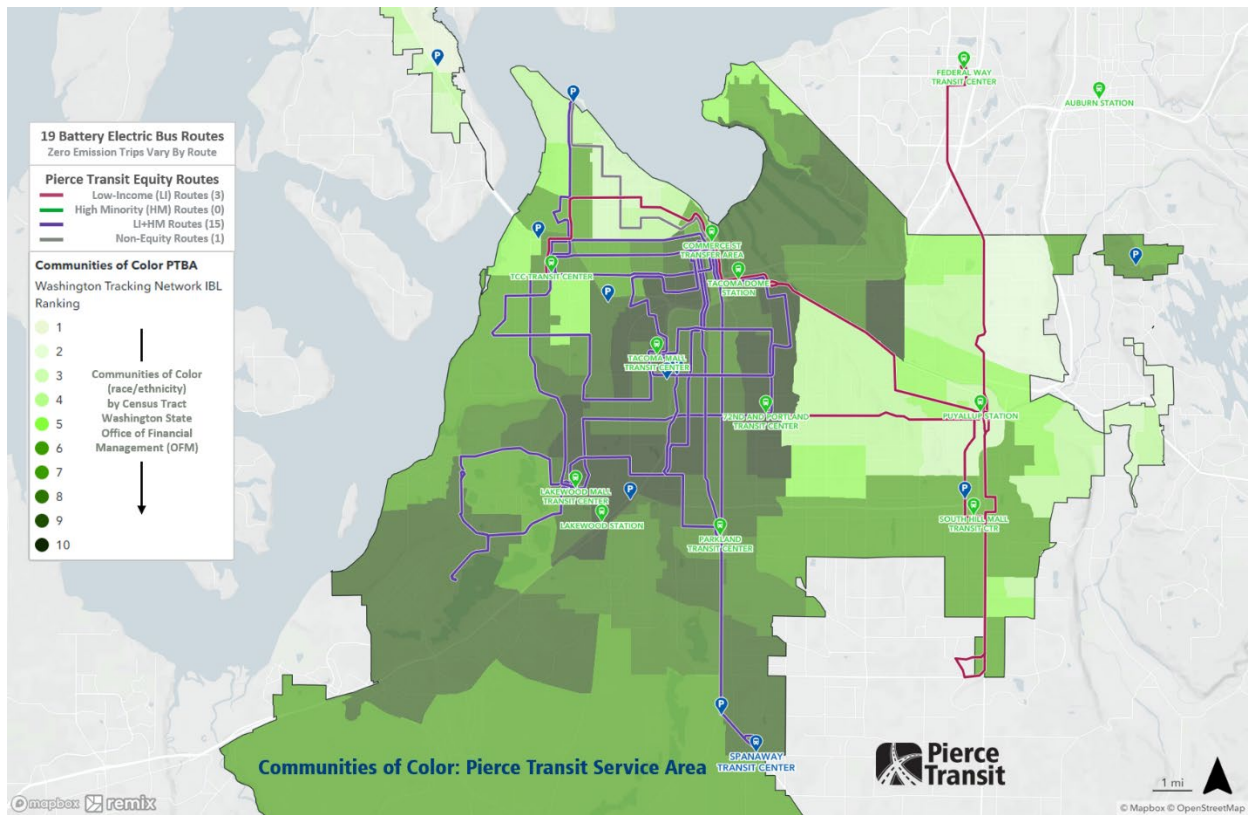
As all planning documents, this BEB Fleet Transition Plan is a living document that will evolve and is meant to guide the implementation of Pierce Transit's BEB fleet. The plan provides a framework centered on Executive Order #1, and the agency's goal to transition 20% of our fleet to zero emission buses by 2030. It also provides an illustrative vision of a complete BEB transition for planning purposes as the agency prepares to further study ZEB technologies with our Phase II Implementation Study. This plan will be further updated pending the outcome of that expanded planning efforts.

SECTION K: APPENDIX

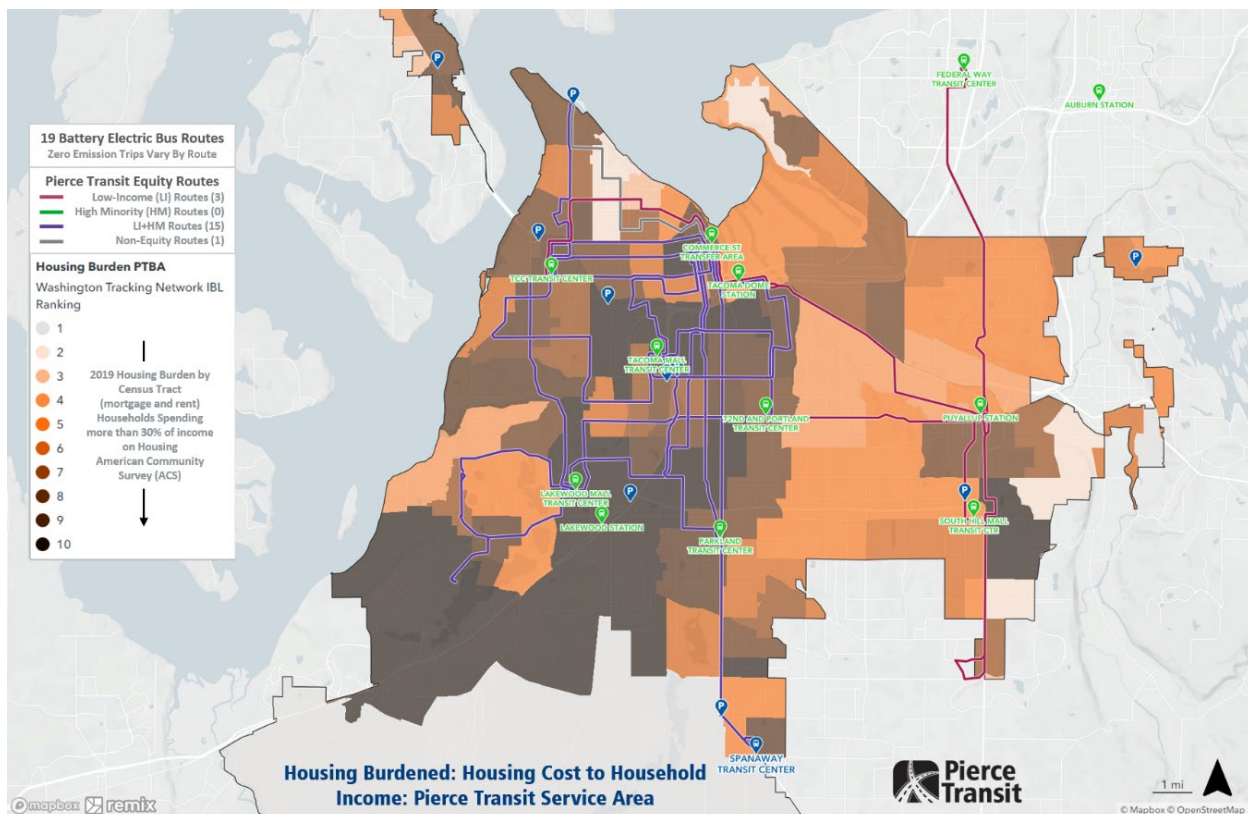
I would like to thank the Pierce Transit Capital Planning Professionals for their thoughtful preparation of the agencies inaugural Phase I Battery Electric Bus Fleet Transition Plan. Pierce Transit is committed to sustainable approaches that improve the way we move people across our region.

A handwritten signature in cursive script that reads "Mike Griffus".

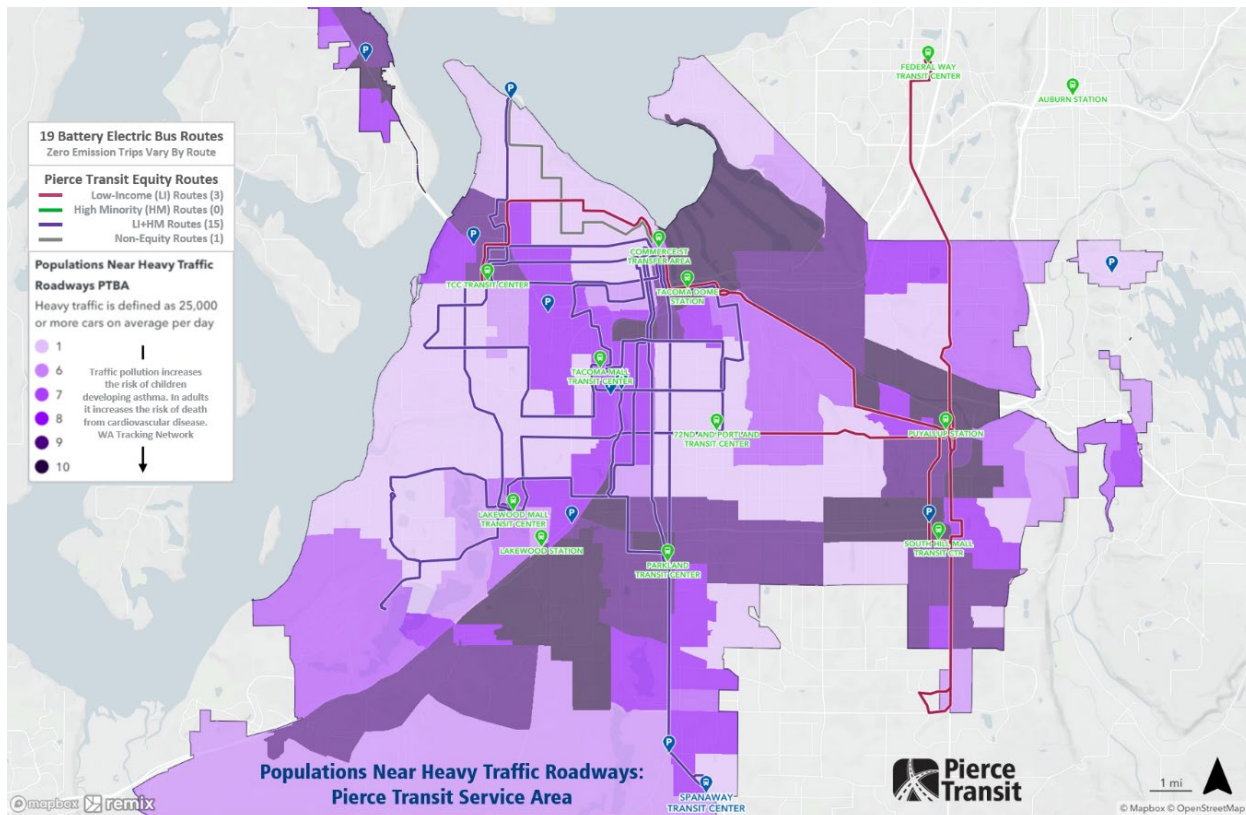
Mike Griffus, Chief Executive Officer



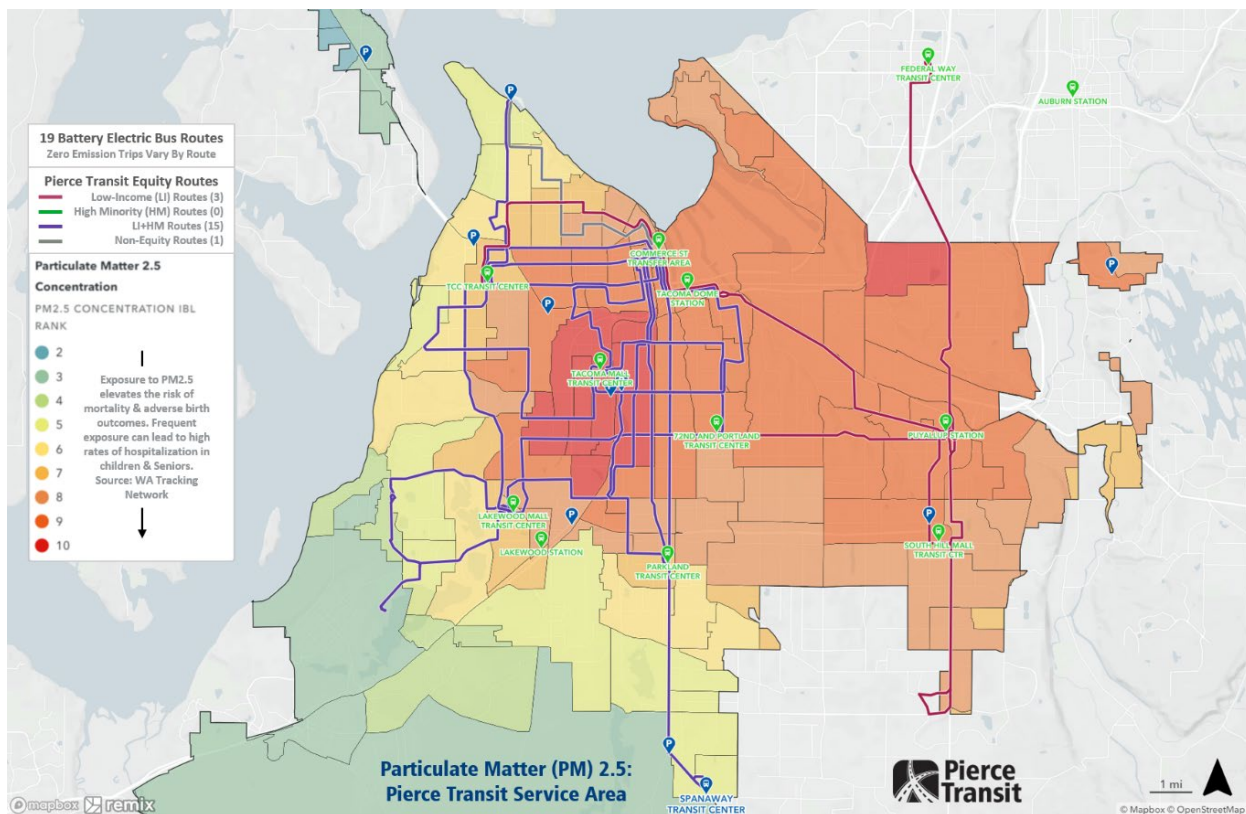
COMMUNITIES OF COLOR CENSUS TRACTS: PIERCE TRANSIT SERVICE AREA



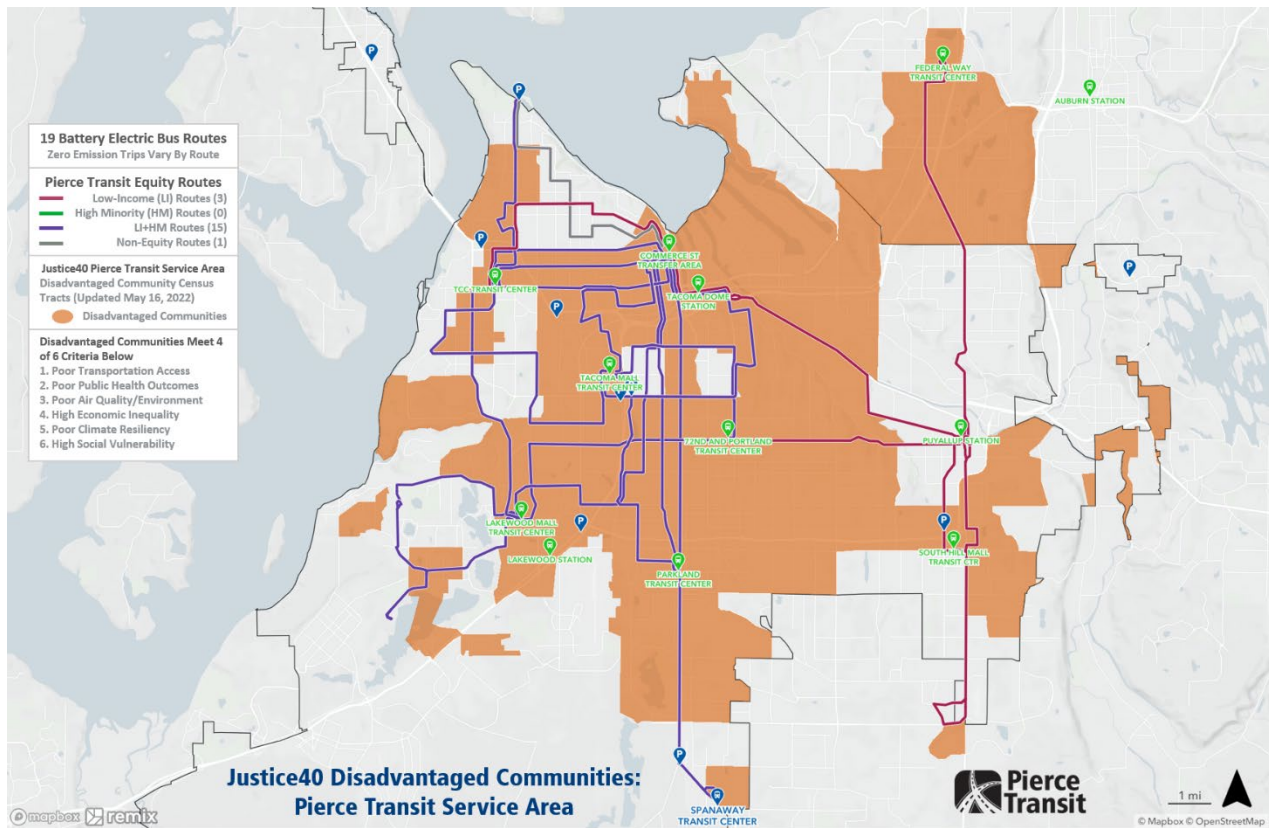
HOUSING BURDENED CENSUS TRACTS: PIERCE TRANSIT SERVICE AREA



POPULATIONS NEAR HEAVY TRAFFIC ROADWAYS BY CENSUS TRACT: PIERCE TRANSIT SERVICE AREA



PARTICULATE MATTER 2.5 CENSUS TRACTS: PIERCE TRANSIT SERVICE AREA



JUSTICE40 DISADVANTAGED COMMUNITY CENSUS TRACTS: ENTIRE PIERCE TRANSIT SERVICE AREA

Demonstration of Benefits Calculation Methodology

This document describes the methods used by the project team to determine the benefits of the proposed project, per Section E.1.b of the FY 2022 Low-No Program Notice of Funding Opportunity (NOFO).

Background

Applicants must demonstrate how the proposed project will support the statutory requirements of the Low-No Program (See 49 U.S.C. 5339(c)(5)(A)). In particular, FTA will consider the quality and extent to which applications demonstrate how the proposed project will: (1) Reduce Energy Consumption; (2) Reduce Harmful Emissions; and (3) Reduce Direct Carbon Emissions.

Approach

- ▶ Estimate the well-to-wheel energy required annually to fuel and operate:
 - the proposed zero-emission buses
 - comparable modern fossil fuel buses
- ▶ Estimate the local harmful particulates emitted annually by fueling and operating:
 - the proposed zero-emission buses
 - comparable modern fossil fuel buses
 - the buses that will be replaced
- ▶ Estimate the well-to-wheel greenhouse gases emitted annually by fueling and operating:
 - the proposed zero-emission buses
 - comparable modern fossil fuel buses
 - the buses that will be replaced

Tools

- ▶ Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) Tool 2020, developed by Argonne National Laboratory

Inputs

- ▶ Agency location (used by AFLEET to estimate emissions generated by local electric utilities and the petroleum fuel pathway)
- ▶ Expected annual vehicle miles traveled (VMT) for proposed service
- ▶ Fuel type of proposed vehicles
- ▶ Expected fuel economy of proposed vehicles
- ▶ Expected fuel economy of comparable modern fossil fuel buses

- ▶ Fuel type of vehicles to be replaced
- ▶ Fuel economy of vehicles to be replaced

Assumptions

- ▶ Well-to-wheel energy estimates include the energy required to produce and deliver fuel (well-to-pump), as well as the energy used by the bus when in service (pump-to-wheel).
- ▶ Well-to-wheel GHG estimates include the GHGs produced during fuel production and delivery (well-to-pump), as well as the GHGs produced by the bus when in service (pump-to-wheel).
- ▶ The proposed vehicles and the comparable modern fossil fuel buses would be used to provide the same service; therefore, their expected VMT is equal.
- ▶ A comparable modern fossil fuel bus is a 2022 model year bus, with the same fuel type as the buses to be replaced.
- ▶ A comparable modern fossil fuel bus would achieve the same fuel economy as the agency's current fleet average. If not available, the average transit bus fuel economy as reported by the DOE Alternative Fuels Data Center (3.7 miles per diesel gallon equivalent) is used. ^[1]
- ▶ Based on CTE's experience in deployment projects and industry research, on average, battery electric vehicles consume the following:
 - For a 35-40' Low-Floor bus: 2.0 kWh per mile driven
 - For a 45' High-Floor bus: 2.5 kWh per mile driven
 - For a 60' Articulated Low-Floor bus: 2.8 kWh per mile driven
 - For a 25-32' Cutaway-style Shuttle bus: 1.0 kWh per mile driven
- ▶ Based on CTE's deployment experience, on average, a fuel cell electric bus achieves the following fuel efficiency:
 - For a 35-40' Low-Floor bus: 7.50 miles per kg H₂
 - For 60' Articulated Low-Floor bus: 4.75 miles per kg H₂
- ▶ The average American car driver uses 474 gasoline gallons per year ^[2]
- ▶ 1 BTU equals 1.0 x 10⁻⁶ gigajoules.^[3]
- ▶ One gallon of gasoline contains 0.126908 gigajoules of energy. ^[3]
- ▶ The following emissions are considered particulate emissions:
 - particulate matter under 10 micrometers (PM₁₀);
 - particulate matter under 2.5 micrometers (PM_{2.5});
- ▶ The following emissions are considered greenhouse gases:
 - carbon dioxide (CO₂);
 - methane (CH₄); and
 - nitrous oxide (N₂O).
- ▶ The reported quantity of greenhouse gas emitted by each deployment scenario is calculated by AFLEET and is adjusted for global warming potential (GWP) per the IPCC Fifth Assessment Report (AR5). The resulting mass of GHGs is a composite of each component multiplied by its warming potential ^[4]
 - CO₂: 1
 - CH₄: 28
 - N₂O: 265

- ▶ Social cost estimates for GHGs (CO₂, CH₄ and N₂O) are derived from President Biden's Executive Order 13990 using a 3% discount rate in 2020 dollars, interpolated for 2022, as follows: ^[5]
 - CO₂: \$53 per ton
 - CH₄: \$1,580 per ton
 - N₂O: \$19,200 per ton
- ▶ Social cost estimates for particulates comes from AFLEET which uses the AP2 2011 Marginal Damages model to estimate social costs relating to particulates. The cost estimate is based on a variety of factors and more details can be found on the model's site in the References section of this paper. ^{[6][7]}

Relevant Output

- ▶ *Reduced Energy Consumption* - the degree to which the proposed technology reduces energy consumption as compared to more common vehicle propulsion technologies (i.e. a comparable modern fossil fuel bus)
- ▶ *Reduced Harmful Emissions* - the rate of particulate emissions generated by the proposed vehicles, compared to the emissions from the vehicles that will be replaced or moved to the spare fleet as a result of the proposed project, as well as comparable modern fossil fuel buses
- ▶ *Reduced Direct Carbon Emissions* - the rate of direct carbon emissions generated by the proposed vehicles, compared to the emissions from the vehicles that will be replaced or moved to the spare fleet as a result of the proposed project, as well as comparable modern fossil fuel buses

References

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7. AP3 (AP2, APEEP Model). Muller, Nick. <<https://public.tepper.cmu.edu/nmuller/APModel.aspx>>