JEFFERSON TRANSIT AUTHORITY
TRANSIT ADVISORY GROUP MEETING
Wednesday, September 1, 2021, 3:30 p.m.

COVID-19 NOTICE:
NO IN-PERSON ATTENDENCE ALLOWED
(Per Governor Inslee's Amended Proclamation 20-28)

To watch the meeting live, register through the link below:
https://attendee.gotowebinar.com/rt/7032561450870328080

For audio only, dial:
1 (213) 929-4212 access code: 496-614-177

AGENDA

Suggested Time

3:30 pm **Call to Order/Welcome**

3:35 pm **Public Comment**

SUBMITTING COMMENTS DURING COVID-19: During social distancing for the COVID-19 pandemic, citizens can submit public comments remotely to Jefferson Transit by email. Emailed comments will be read aloud by staff for up to three minute's during the meeting's public period. **Email comments to speck@jeffersontransit.com, before 2:30 PM on the day of the meeting**

3:40 pm **1. Transpo Group: Electric Vehicle Study Presentation**
- Electric Vehicle Study
- Presentation Slides

4:15 pm **2. Consent Agenda**
- **a.** Approval of July 7, 2021 Minutes

4:20 pm **3. New Agenda Items**

4:21 pm **4. Unfinished Business**
- **a.** Long Range Plan Timeline
- **b.** Route Studies Discussion

4:35 pm **5. New Business**
- **a.** Kingston Service Update
- **b.** Tabling for Transit/Survey Topics

4:45 pm **7. Ridership Report**

4:55 pm **Public Comment**

5:00pm **Adjournment - Next Scheduled Meeting: November 3, 2021**

Individuals requiring reasonable accommodation may request written materials in alternative formats, physical accessibility accommodations or other reasonable accommodation by calling (360) 385-4777 or TDD/TTY users dial 711 to reach a relay operator.

JEFFERSON TRANSIT ELECTRIC BUS FEASIBILITY STUDY

Prepared for:
Jefferson Transit Authority

June 2021

Prepared by:

transpogroup
WHAT TRANSPORTATION CAN BE.

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Table of Contents

Appendix

Figures

Tables

Chapter 1. Introduction

Jefferson Transit Authority (JTA) provides transit service spanning Jefferson County and Clallam County to the north. Jefferson County is unique in that it is a large County spanning the Olympic Peninsula with physical features and potential barriers like the Olympic Mountain Range and inlets of Puget Sound. In Jefferson County, service is primarily focused on the eastern portion of the County between the Haines Park and Ride, Four Corners, Port Ludlow, Paradise Bay, and Poulsbo. However, routes are available that provide service between Port Townsend and Sequim and Port Townsend and Brinnon.

Jefferson Transit currently operates a fleet of 15 buses which run on B5 (containing 5 percent biofuel) biodiesel fuel across 8 fixed routes. As part of an effort to reduce emissions and maintain air quality, JTA is exploring alternative fuels to be utilized by the bus fleet. The motivation to explore alternative fuels comes from the community it services, which believe JTA has an opportunity to be leaders in helping the environment. In August 2019 JTA passed its 6-year transportation development plan which included plans to complete an electric vehicle infrastructure study.

Study Objective

The objective of this report is to evaluate the feasibility of converting the bus fleet from the current biodiesel to battery electric buses (BEBs) and summarizes the proposed utilization of battery electric buses within the Jefferson Transit network. The following chapters summarize the existing network conditions, the existing battery bus technology, an analysis of operating conditions using available electric bus technology, utility department requirements analysis, and an operating costs analysis.

Report Organization

This report is organized in 6 chapters. The remaining chapters discuss: the vehicle fleet and existing transit services provided by Jefferson Transit (Chapter 2), an overview of existing electric bus technologies (Chapter 3), and the operations of existing JTA routes using electric buses (Chapter 4). Chapter 5 discusses the electrical demand requirements, availability, and needs for the Jefferson County Public Utilities District (JPUD). Chapter 6 provides an operating costs analysis.

Chapter 2. Existing Transit Service Conditions

The following sections describe the existing bus fleet and transit services and operating conditions of the JTA. Detailed information about the service area, operating areas, daily runs, length of the runs, elevation gain/loss, and driver route are provided in the following.

Current Fleet

Jefferson County's fixed-route fleet currently includes 15 buses between 29 and 35 feet in length that all run on biodiesel. The fleet ranges in age from 1 to 28 years with 5 buses currently operating past their replacement date. As part of an evaluation of fleet replacement, Jefferson County is evaluating the feasibility of converting the current biodiesel fleet to a battery electric bus (BEB) fleet.

Typically, biodiesel buses have a driving range of up to approximately 690 miles and can easily accomplish the task of traversing Jefferson and Clallam Counties. Battery electric buses have more range and duration related limitations that their diesel counterpart. To understand the feasibility of converting the current biodiesel fleet to BEBs a more detailed understanding of the various routes is required, including route length and duration, dwell time, and elevation gain/loss.

Transit Operations

The following summarizes the transit operations of Jefferson Transit including a summary of the routes serviced during normal operations (before reduced schedule as a result of COVID-19 pandemic), lengths and elevation gain/loss of each route and driver route information in terms of mileage, duration, and elevation gain/loss. Detailed bus schedule information and driver route information was provided by Jefferson Transit. Route length in miles and elevation gain/loss was referenced from Google Earth.

Table 1 summarizes each of Jefferson Transit's routes' service areas, operating hours and runs per day.

Table 1. Existing Transit Routes – Service Areas, Operating Hours, and Runs per Day

Route	Area Served	Approximate Operating Hours	Runs / Day
#1	Port Townsend – Port Hadlock/Irondale – Brinnon	6 a.m. – 7 p.m. (Weekdays) 6:30 a.m. – 6:30 p.m. (Saturdays)	4 (Weekdays) 2 (Saturdays)
#2	Fort Worden - Port Townsend	7 a.m. – 6 p.m. (Weekdays) 9 a.m. – 6 p.m. (Saturdays)	12 (Weekdays) 10 (Saturdays)
#3	Castle Hill – Port Townsend	7:30 a.m. – 6:30 p.m. (Weekdays) 9:30 a.m. – 6:30 p.m. (Saturday)	12 (Weekdays) 10 (Saturdays)
#4	Upper Sims Loop – Port Townsend	8 a.m. – 6 p.m. (Weekdays) 9 a.m. – 6 p.m. (Saturdays)	21 (Weekdays) 19 (Saturdays)
#6	Tri Area Loop – Port Townsend – Port Hadlock/Irondale	7 a.m. – 4 p.m. (Weekdays) 9:25 a.m. – 7:30 p.m. (Saturdays)	5 (Weekdays) 5 (Saturdays)
#7	Poulsbo – Port Hadlock/Irondale -	6 a.m. – 5 p.m. (Weekdays) 9:30 a.m. – 2:30 p.m. (Saturdays)	5 (Weekdays) 2 (Saturdays)
#8	Sequim – Port Townsend	6 a.m. – 6 p.m. (Weekdays) 8 a.m. – 6 p.m. (Saturdays)	5 (Weekdays) 2 (Saturdays)
#11	Shuttle Loop – Port Townsend	7 a.m. – 8 p.m. (Weekdays) 9 a.m. – 8 p.m. (Saturdays)	14 (Weekdays) 11 (Saturdays)

Source: Jefferson Transit Bus Schedule effective May 20, 2019

As shown in Table 1, Jefferson Transit provides a variety of routes that service between Port Townsend, Brinnon, Port Hadlock/Irondale, and Sequim. Overall, operating hours are longer on weekdays than Saturdays with the weekday routes running more frequently as well. Route #4 (Upper Sims Loop) runs the most frequently with 19-21 runs per day while Route #1 (Brinnon) is the least frequent with 2-4 runs per day.

Table 2 summarizes each route serviced by Jefferson Transit in terms of total mileage (one way) and total elevation gain/loss.

Table 2. Existing Transit Routes - Length and Elevation Gain/Loss

Route	Area Served	Approximate Mileage (One Way)	Elevation Gain/Loss in Feet
#1	Port Townsend – Port Hadlock/Irondale – Brinnon	46.9 miles	+3,114 / -3,125
#2	Fort Worden - Port Townsend	7.1 miles	+545 / -545
#3	Castle Hill – Port Townsend	9.9 miles	+664 / -664
#4	Upper Sims Loop – Port Townsend	5.0 miles	+425 / -425
#6	Tri Area Loop – Port Townsend – Port Hadlock/Irondale	20.2 miles	+1,183 / -1,183
#7	Poulsbo – Port Hadlock/Irondale -	34.0 miles	+2,593 / -2,765
#8	Sequim – Port Townsend	30.1 miles	+3,739 / -3,564
#11	Shuttle Loop – Port Townsend	3.9 miles	+241 / -241

Source: Google Earth

As seen in Table 2, Route #1 is the longest in mileage and very high in elevation gain/loss. Route #11 is the shortest in length as well as elevation gain/loss. Route #8 experiences the highest difference in elevation and is relatively long in length at 30.1 miles.

Table 3 summarizes the route information by driver block received from Jefferson Transit. A driver block is the route schedule completed by a driver/bus combination during a single day. As shown, except for driver block S, each driver services multiple routes during a shift. Driver block information also summarizes the mileage, duration, and elevation gain/loss that a bus carries out each day.

Table 3. Existing Transit Routes – Driver Route Information

Driver Block	Routes Driven	Total Route Mileage driven	Duration[1]	Total Elevation Gain/Loss (ft)
A	Uptown, #2, #3, #4, #6, #7	137	7.9 hours	+9,876 / -10,220
B	#1, #2, #4, #6	104	6.9 hours	+6,875 / -6,886
C	#2, #4, #8, #11	132	7.7 hours	+11,199 / -11,368
D	Uptown, #2, #4, #6, #8	72	6.7 hours	+6,742 / -6,567
E	#2, #3, #4, #7, #8	191	10.8 hours	+17,261 / -17,255
F	#1, #4, #8, #11	163	6.7 hours	+14,372 / -14,044
G	#1, #2, #3, #6, #11	88	5.2 hours	+5,747 / -5,728
I	#3, #4, #6, #7, #11	137	9.6 hours	+9,732 / -10,076
J	#3, #4, #6, #7	123	7.3 hours	+9,066 / -9,410
K	#2, #3, #4, #8	89	7.2 hours	+8,512 / -8,346
R	#1, #2, #3, #4, #11	104	9.6 hours	+6,917 / -6,928
S	#11	47	6.6 hours	+2,892 / -2,892

Source: Google Earth and Jefferson Transit
Includes driving hours, lunch time but not unpaid breaks.

As shown in Table 3, the lengths in mile and duration in hours that each driver experiences varies greatly. Driver S experiences the shortest route at 47 total miles for 6.6 hours and approximately 2,900 feet in elevation gain/loss. Meanwhile, Driver E experiences the longest route at 191 miles for 10.8 hours and approximately 17,000 feet in elevation gain/loss. This means that the Driver E bus is in service for 10.8 hours a day with a total route of 191 miles. Any replacement bus must be able to accomplish the task of the routes including duration, range, and elevation changes.

Unlike buses which utilize fuels like diesel or gas that have a range based on the miles per gallon and the size of the fuel tank, the range for BEBs is based on the battery energy density (expressed in terms of kilowatt hours (kWh)) and the energy consumption rate (expressed in terms of kWh per mile). Additional considerations must be made when evaluating BEBs including charging facilities and ambient temperatures. The following chapter provides more detail on the current battery electric technology available.

Chapter 3. Existing Battery Electric Bus Technologies

Battery electric buses use battery packs to store electrical energy that powers a bus motor and drivetrain. As opposed to fuels, electric buses charge at stations. Depot charging, overhead conductive charging, and wireless inductive charging are three types of charging used for BEBs in the United States today. The following section summarizes the available battery electric bus technologies that are available in 2020, the date of this report. These data were compiled from the consultant teams previous experience working with these manufacturers and the Federal Transit Administration (FTA).

BEB Technologies Defined

The following sections provide information regarding the state of charge of a battery as well as bus charging options.

State of Charge

This document addresses both "nominal" and "usable" battery sizes. Rechargeable batteries are consumable components that become less effective with age due to changes in chemical composition that affect storage capacity, power delivery, and the ability to accept a charge. This means that the indicated state of charge (SOC) of a battery does not always indicate the same amount of energy stored. Using batteries with a consistently low SOC can particularly affect the rate at which batteries chemically age; bus manufacturers therefore place limits on battery states at both the high and low ends of the battery's nominal capacity, preventing a bus from charging higher than 95 percent of its nominal value or being discharged below 5 percent of its nominal value.

This range, between the high and low limits is the "usable" battery capacity and is typically 90 percent of the nominal battery size. Manufacturers generally indicate that a battery at the end of its useful life will be able to retain 80 percent of its maximum when-new state of charge. The illustration in Figure 1 is an example of a 100 kWh nominal battery with 90 kWh of usable battery energy when new. At the end of the battery life, this battery will be able to store 72 usable kWh, or 80 percent of the original 90 kWh usable size. Many battery energy meters will show a 100% SOC even at the end-of-life condition when the usable energy is only 80% of the rated capacity.

This discrepancy between SOC and initial usable capacity can cause confusion for operators. Providing an adequate reserve for all passenger operations ensures passenger comfort and safety. The minimum on-route battery SOC selected for this project is 20 percent to account for variations in how SOC may be displayed relative to actual remaining energy available. This value was selected based on information from manufacturers regarding the typical minimum SOC. This minimum SOC is intended to provide for an adequate reserve that accounts for atypical operating scenarios and battery temperature management variations. A recharge from this SOC is also helps prolong the life of the battery and maximize its useful energy by reducing heat buildup during charging and reducing the length of charging cycles.

Figure 1. Nominal vs Usable Battery at Beginning and End of Life

Charging Infrastructure

Depot (plug-in) charging, overhead conductive charging, and wireless inductive charging are the three types of charging used for BEBs in the United States today. Figure 2 depicts the common electric charging options with descriptions of each type in the following sections.

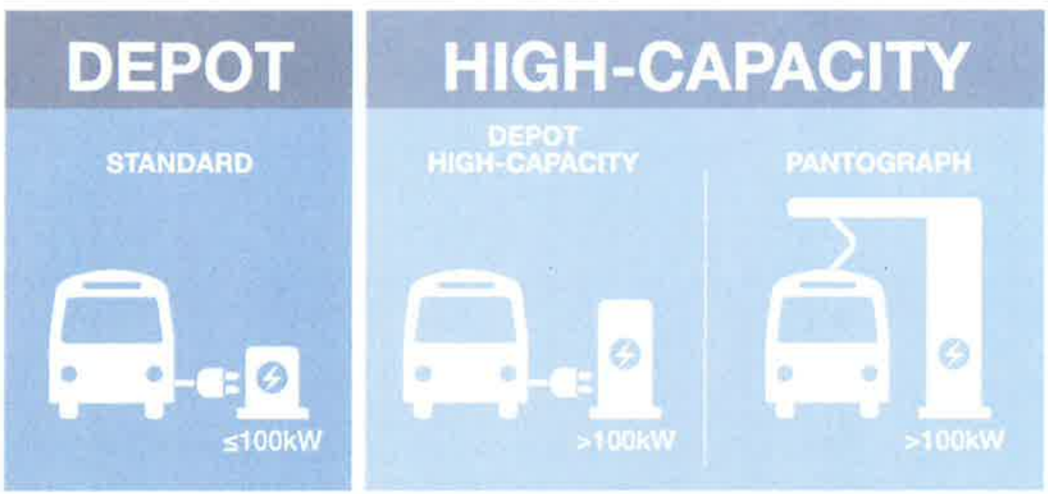

Figure 2. Common Electric Bus Charging Options

Depot Charging

Depot-charging is the most common way to charge a vehicle – plugging in to a power source and letting it charge while not in use (much like how a cell phone or laptop is charged). This charging style can be done at varying levels, using a range of voltages and electric currents to change the speed at which a battery is charged. A charger rated for a higher power output (expressed in kilowatts, or kW, a unit of electrical power) will produce a faster charging time. Electric buses are built to handle different levels of charging, with each manufacturer establishing an upper limit in the number of kW a vehicle's battery can receive. Typical commercial depot charging units provide a greater power output than Level 3 units found in consumer applications, ranging from 20 kW to 200 kW.

High-Capacity Charging

High-capacity charging, for the purposes of this report, is used to describe chargers capable of delivering more than 100 kW. (High-capacity charging is sometimes referred to as "fast charging" but these terms are not uniformly defined for commercial applications at this point). High-capacity chargers can be both depot chargers and charging systems typically intended to be deployed on a route.

Commonly available charging systems are illustrated in Figure 2, include both high-capacity depot chargers or pantograph charging systems require specialized additional hardware on the roof of the bus. The inductive charging option can also require additional hardware on the bus in addition to the depot charging port.

On-Route Charging

On-route charging includes a rapidly developing set of technologies that primarily consist of either inductive (wireless) or pantograph (top down) charging. Inductive charging requires the installation of in-pavement induction coils which emit an electromagnetic field to transfer energy wirelessly to the vehicle's battery. This technology has historically been less efficient than typical plug-in charging, as some of the energy is 'lost' during the wireless transfer, and charging speeds are typically slower than depot charging. However, wireless charging solutions are rapidly developing with a new deployment in Wenatchee, WA capable of charging rates up to 200 kW. As a result, wireless charging options were not considered for the alternatives within this needs analysis.

Pantograph charging is accomplished by connecting the top of the bus to an overhead gantry which supplies power to the bus. This type of charging can supply some of the fastest charging speeds available, up to 500 kW. These chargers typically have the most expensive installation costs and are usually installed at the end of a bus route where a layover may occur, or at an established stop within a bus route where a stop duration exceeds 5-10 minutes.

All current on-route charging options require the bus to be stopped and should not be considered en-route charging operations, those that could charge a moving bus.
For on-route charging, buses would need to be stopped for a minimum of five minutes for a minimum charge cycle. This time includes driver disembarkment, manipulation of the charging equipment, a battery load testing and assessment sequence performed by the charger, and spool-up, run, and cool-down times, charger disengagement, and driver re-board, checks, and bus mobilization. With a 400 kW charger (an average high-capacity charger) and assuming a 3-minute total charge time at the full rate, which is highly optimistic, the bus would take on approximately 20 kWh of energy, enough to drive an additional 5 to 8 miles. Despite the apparent advantage of a high-speed charger in terms of range-boosting, this type of charging produces a large amount of heat in the battery system which has been demonstrated in some applications to reduce battery service life and performance.

On-Route Charging Disadvantages

The high-capacity pantograph chargers require significant investments in additional equipment, including on-bus hardware that increases bus weight and fuel consumption. Additionally, the high-capacity pantograph chargers require large and noisy cooling systems to ensure that heat generated by the charger is adequately controlled; this means it may be unsuitable for certain locations due to customer and driver comfort considerations.
In contract to pantograph charging, inductive charging is a nascent technology that remains costly and is relatively unproven in field operations. There is also limited manufacturer support and a limited number of competing systems. Overall, the non-depot-style high-speed charging options require additional equipment on the bus and introduce complexity in operations.

Bus Manufacturer Battery Options

A number of manufacturers offer a variety of BEBs. Table 4 summarizes the various bus lengths, battery sizes, estimate range, and cost of the electric buses available today.

Table 4. Existing Battery Electric Bus Manufacturers

Manufacturer	Bus Lengths (feet)	Battery Size (kWh)	Estimated Range (miles)	Bus Cost ($)
New Flyer	35'	160-388	75-195	$675,000 - $682,000
	40'	160-480	75-225	$800,000 - $1M
	60'	213-600	55-135	$1.1M - $1.4M
BYD	35'	350	230	$613,885- $698,000
	40'	500	255	$741,000
	60'	652	230	$1,140,000.00
Proterra	35'	94-440	37-276	$613,885-$739,000
	40'	94-650	37-390	$653,885-$847,000
NovaBus	40'	74 - 594	Not available	Not available
Greenpower[1]	30'	210	>175	Not Available
	35'	260	>175	Not Available
	40'	320	>185	Not Available
Gillig Electric Bus[2]	35'	444	Not available	Not Available
	40'	444	150 - 210	Not Available
Eldorado	35'	444	Not available.	Not Available

Price estimates are influenced by several factors including model configurations, customized options (where applicable), and the evolution of technology. Price estimates are an approximate value from recent Transit Authorities contracts and information from Bus Original Equipment Manufacturers.
1. Gillig is a privately owned company and does not share this information
2. Greenpower electric buses are not listed in Altoona testing which is an FTA requirement

As shown in Table 4, BEB buses range in size from 30 feet to 60 feet. The Proterra 40-foot bus offers the longest range at up to 390 miles. As shown in Table 3, the longest route is 191 miles and is associated with driver block E. On the surface, a number of buses shown in Table 4 meet the range requirements of the JTA routes; however, the changes in elevation along the route require additional kWh of energy. An operational analysis was conducted based on available route information to determine the feasibility of utilizing BEBs in the JTA fleet.

Table 5 summarizes the various warranty and battery lease options available for each of the manufacturers. Battery lease options make the purchase of electric buses more feasible.

Table 5. Existing Electric Bus - Battery Technologies

Manufacturer	Base Warranty	Extended Warranty	Additional Battery Warranty	Battery Lease Option?
New Flyer	6 years / 300,000 miles	6 years / 200,000 miles additional	To hold 80% of original capacity after 12 years and ~500,000 miles	Yes
BYD	12 years	N/A	N/A	Yes
Proterra	6 years / 250,000 miles	6 years / 250,000 miles additional	To hold 72% of original capacity for 12 years	Yes
NovaBus	12-year energy storage system warranty only	N/A	To hold 80% of original capacity for service life	N/A
Greenpower	N/A	N/A	N/A	N/A
Gillig Electric Bus	N/A	N/A	N/A	N/A
Eldorado	N/A	N/A	Not official – but expected to market as 'mid-life' battery replacement necessary	No

Price estimates are influenced by several factors including model configurations, customized options (where applicable), and the evolution of technology. Price estimates are an approximate value from recent Transit Authorities contracts and information from Bus Original Equipment Manufacturers.
1. Gillig is a privately owned company and does not share this information
2. Greenpower electric buses are not listed in Altoona testing which is an FTA requirement

Most manufacturers expect a service life of 12 years, some requiring an extended warranty to meet this timeline. The battery warranties also vary but tend to guarantee a certain percentage of original battery life available for the lifespan of the bus. Many buses are offering battery lease options as well, which would lower the initial cost of the bus purchase and add a rental fee for the batteries (similar to purchasing daily fuel for a diesel bus). This is included as a way to reduce the anxiety around battery degradation for vehicle operators.

Chapter 4. Operations Analysis

To understand if current BEB technology can meet the needs of the JTA routes described previously, an operational analysis was conducted to understand how Jefferson Transit's existing routes would operate as electric buses. The following section summarizes the operations analysis completed for each driver block. Both weekday (Monday-Friday) and Saturday time periods are included in the analysis.

Energy Consumption Model Overview

The Zero-Emissions Bus (ZEB) Energy Consumption Model, developed by STV Incorporated, was designed to model the energy consumption of a ZEB as it travels along a specified route under specified loading and weather conditions. Determining the energy demands of a bus, the sizing of an adequate on-board battery, and the sizing of an energy system play a large role in the transitioning of a bus fleet to incorporate ZEB. The ZEB model was developed in Excel's Visual Basic for Applications (VBA) program and possesses a clean and user-friendly interface. The model delivers an approximate kWh / mile value for a bus traveling along a specific route, which can be extrapolated for a multitude of various needs including electrical grid sizing, strategic placement of "on-route" chargers.

The ZEB Energy Consumption model considers three major energy-drawing components of a ZEB. These components include the dynamic / propulsion system, the HVAC system, and the auxiliary loads. By combining the energy demands for all three systems, the ZEB Energy Consumption model delivers an approximate kWh / mile value for a specific bus traveling along a specific route under certain weather conditions. The most intricately modeled system is the dynamic / propulsion system, which relies on a series of assumptions, that are defined below, and variables that aid in the modeling of the bus's velocity, displacement, and the energy consumed at one second intervals as the bus is simulated along its route. The model considers several forces, such as the drag, rolling resistive, and gradient forces, which act on the bus as it performs its route. Inputs for the dynamic / propulsion system include the type of bus used for the simulation, route the bus travels on, what time the bus is running, inclusion of on-route chargers, the acceleration of the bus, the size of the battery, and the efficiency of the bus. The next system that the ZEB Energy Consumption model considers is the HVAC system. The model utilizes a "ground-up" approach to size the HVAC system and then compute its energy demand by calculating the fresh air, internal heat gain, solar, and carbody heat loads. Inputs for the HVAC system include the number of passengers loaded on the bus throughout the route, the temperature outside of the bus, and the desired temperature inside the bus. In determining the energy demands of the energy loads, the model assumes all non-HVAC auxiliary appliances will be drawing power at a constant rate. The model converts the overall power draw from kW to kWh based on how long the route takes to complete, and then divides the total kWh by the mileage traveled to obtained auxiliary energy consumption in the units of kWh / mile. Input for auxiliary load is the rated power of all the auxiliary loads equipped on the modelled bus.

Electrical Energy Assumptions

A review of the existing Jefferson Transit weekday operating schedule was performed to determine the electrical energy requirements needed to operate a 35' battery electric bus. The bus routes from Table 2 were programmed into the STV ZEB Energy Consumption Model analysis tool using the following assumptions:

- Beginning of Life Battery Capacity: 388 kWh
- Degradation over Battery life: -78 kWh
- Degraded Battery Capacity: 310 kWh

- Bus loads at 50% capacity for all routes
- Minimal traffic congestion along each route
- Interior Temperature: 68 degrees (F)
- Ambient Temperature: 60 degrees (F)

The analysis results for each of the routes and driver blocks are summarized in the following sections.

Weekday Driver Blocks

The following section summarizes each driver block's total energy usage for the weekday routes. Figure 3 provides a summary of the total energy requirements for each driver block for the weekday routes as well as the degraded battery capacity. As discussed previously, the capacity of the various batteries degrade over time. In order to determine whether a battery would be sufficient to complete a route the degraded battery number is used to assess if the bus could complete the route toward the end of the life of the bus.

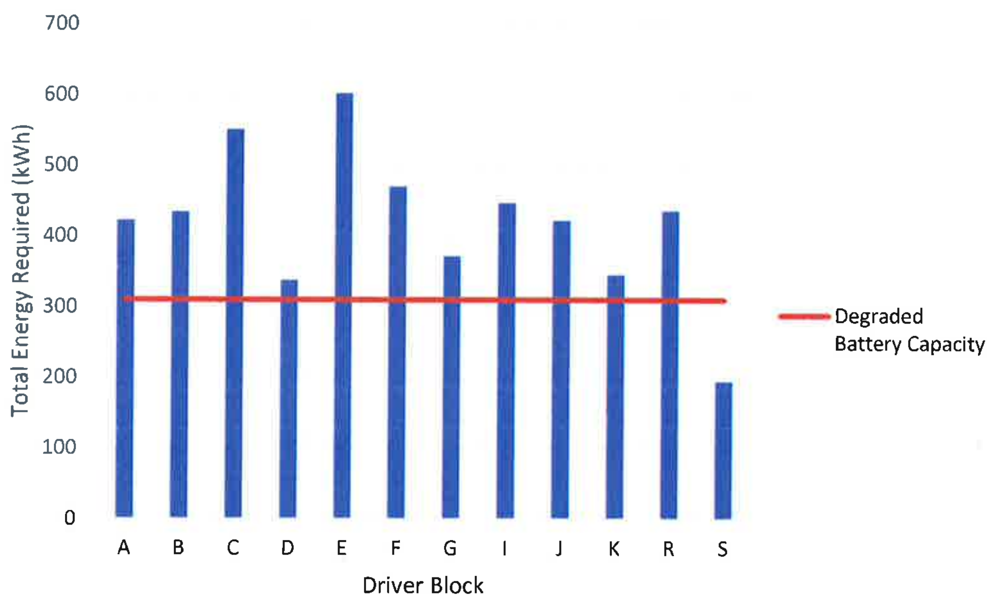

Figure 3. Weekday Total Driver Block Energy Requirements

As shown in Figure 3, only driver block S can be accomplished the route on a single charge for a typical 35-feet bus. The other blocks may require up to 602 kWh per day. While this doesn't mean that BEBs are not an option for JTA it does mean that on-route or mid-route charging considerations need to be made for the majority of the weekday routes. Appendix A provides detailed summaries of energy use by route for the weekday routes.

Saturday Driver Blocks

The following section summarizes each driver block's total energy usage for the Saturday routes. Figure 4 provides a summary of the total energy requirements for each driver block for the weekday routes as well as the degraded battery capacity. As discussed previously, the capacity of the various batteries degrade over time.

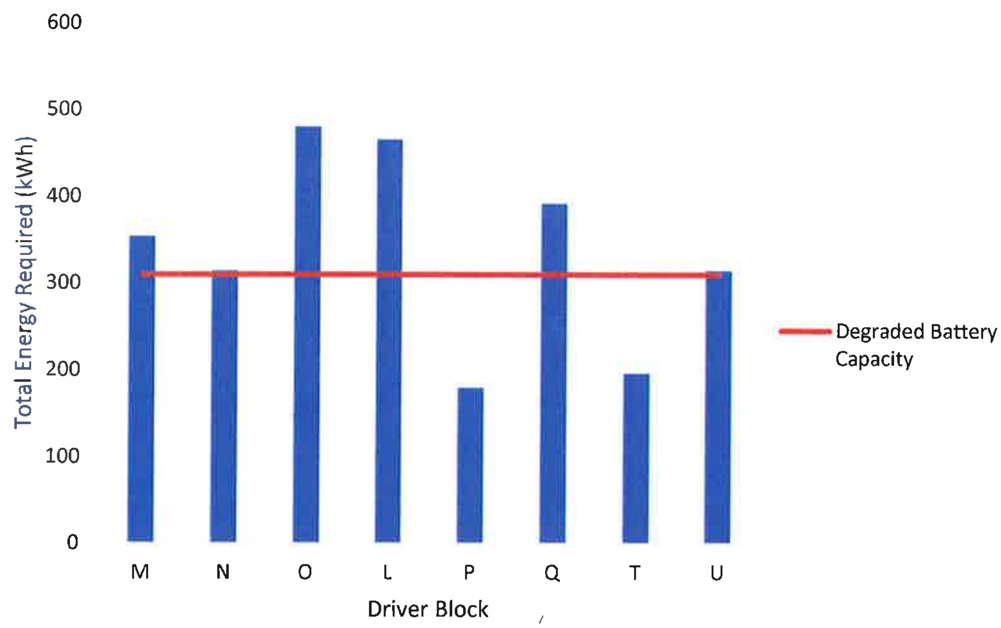

Figure 4. Saturday Total Driver Block Energy Requirements

As shown in Figure 4, only driver block P and T can be accomplished the route on a single charge. The other blocks may require up to 481 kWh per day. Similar to the weekday routes on-route or mid-route charging considerations need to be made for the weekday routes. Appendix A provides detailed summaries of energy use by route for the Saturday routes.

On-Route Charging Feasibility Review

A brief review of the routes was conducted to understand if on-route charging opportunities are available in extended stop or bus layover areas. A majority of the buses layover in areas that are not owned by JTA. As a result, the right-of-way (ROW) would need to be purchased or an agreement would need to be made to provide the required charging infrastructure. While this doesn't explicitly preclude the utilization of BEBs for JTA, it does add an additional cost factor to the conversion process. As discussed in the following chapter the Four Corners Park and Ride was identified as the primary overnight charging location and Haines Place Park and Ride was identified as a possible location for a rapid charging location.

Chapter 5. Electrical Requirements Analysis

Before electric buses can be deployed in Jefferson County, it is important to understand the upstream needs and the ability of the public utility company to meet the expected demand. To better understand the public utility capabilities, the consultant team had discussions with Jefferson County Public Utility District (JPUD), the energy supplier of JTA. The following sections review the energy demand for the existing JTA routes and discuss the electrical infrastructure upgrades needed to meet this demand.

It is not anticipated that currently available BEB technology could complete a majority of the existing JTA driver blocks; however, battery technology is advancing rapidly, and it is possible that BEBs in the future could meet the needs of the existing driver blocks. **For the purposes of this analysis, it is assumed that electric buses could meet the needs of JTA, even though the results of the analysis in Chapter 4 showed that they cannot.**

Electrical Demand Requirements

The Operational Analysis showed that each driver block required levels of electrical energy (expressed in terms of kWh) to meet the needs. Figure 5 provides a summary of the total energy required by driver block as well as the total energy required for a typical weekday.

Figure 5. Total Energy Required (kWh) by Driver Block – Weekday

As shown in Figure 5, the total weekday daily energy required is approximately 5,036 kWh with driver block E requiring the most energy. Figure 6 provides a summary of the energy requirements for the Saturday driver blocks.

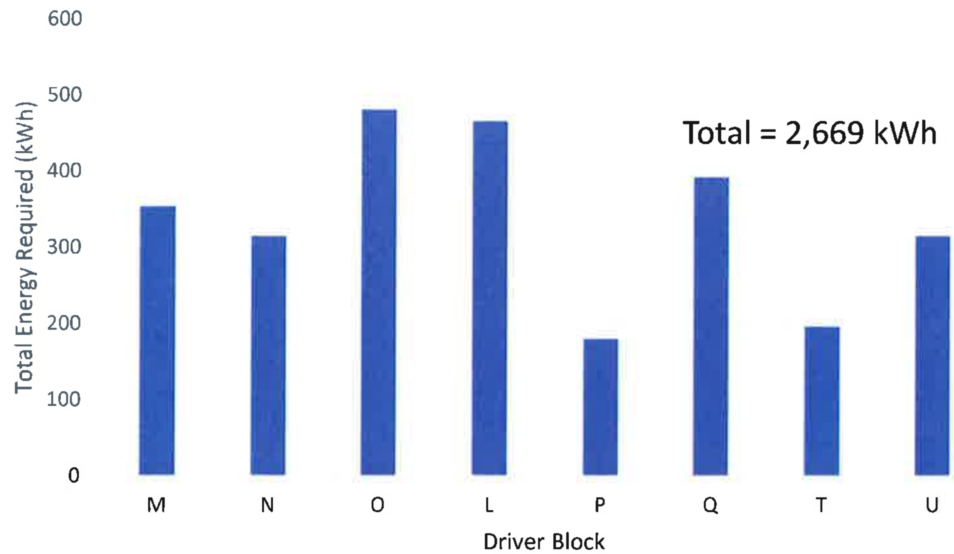

Figure 6. Total Energy Required (kWh) by Driver Block – Saturday

As shown in Figure 6, the total energy required for the Saturday driver blocks is approximately 2,669 kWh with driver block O requiring the most energy.

To understand the feasibility of electrifying the fleet from an energy supply perspective, discussions were had with JPUD as to the availability and needed upgrades to accommodate BEBs. The following section provides a summary of those discussions as well as locations where charging infrastructure could be accommodated.

Potential Charging Infrastructure Locations

Locations were reviewed where charging infrastructure could be constructed to charge buses either overnight or with rapid chargers at layover stations. Chargers would be necessary at Four Corners Transit Base (where buses are stored overnight) and would likely also be required for on-route charging. Based on an overview of route operations and discussions with JPUD the second location selected was Haines Place Park and Ride. JPUD completed some electrical infrastructure upgrades at Haines Place recently in preparation for eventual electric bus chargers.

At the Four Corners transit base it is anticipated that buses would charge overnight with 8 chargers being installed at the same location as the existing bus parking stalls. The preliminary location of the bus chargers is shown in Figure 7. The final location of the chargers would be based on an on-site evaluation of existing electrical infrastructure at a future time.

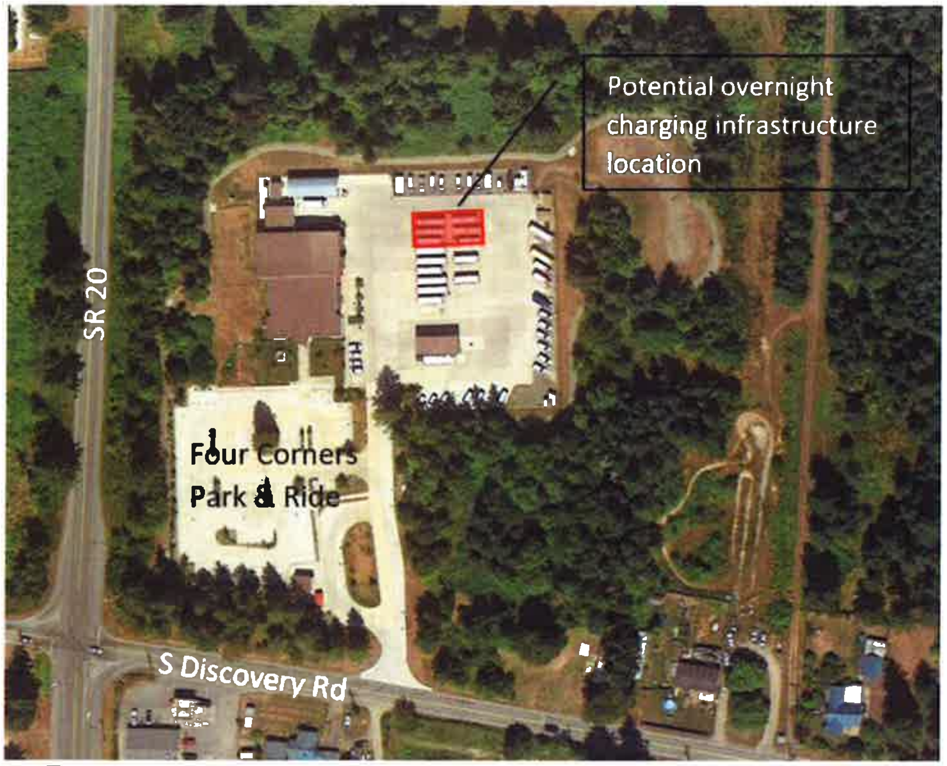

Figure 7. Potential Charging Infrastructure Charging Location – Four Corners Park & Ride

Rapid charging infrastructure may be more appropriate at the Haines Place Park and Ride where buses have shorter layover. The rapid charging infrastructure could be installed in the location as shown in Figure 8. This location was selected as it meets operational needs (where buses currently layer over) and is proximate to the existing electrical vault in the southwest corner of the facility.

Figure 8. Potential Charging Infrastructure Charging Location – Haines Place Park & Ride

Other locations would need to be determined on a case-by-case bases. For example, the Forks Transit Center could be a potential location for charging infrastructure but would need to be negotiated with Clallam County PUD.

Jefferson Public Utility District Electricity Availability & Infrastructure Needs

Jefferson Public Utility District is the local public utility district for residents and businesses in Jefferson County. In 2008 JPUD, with a locally approved ballot measure, bought their electrical infrastructure from Puget Sound Energy and began to operate their own electrical grid[1]. They now buy power from Bonneville Power Administration and their existing electrical mix is 83 percent hydro-powered and 11 percent nuclear, making them one of the lowest polluting electrical grids in Washington State and the United States[2].

Transpo Group engaged in several conversations with staff from JPUD to discuss any issues regarding the increase in electrical demand for JTA, given a full conversion to electric buses. The primary point of contact was Jimmy Scarborough, who provided the following information.

[1] https://www.jeffpud.org/mission-vision/

[2] https://www.jeffpud.org/fuel-mix/

- JPUD does not expect any issue with delivering up to 5 MWh of electricity per day to JTA
- JPUD will require a new contract to determine electricity rates for JTA
- Based on the assumption that there would be up to 8 new electric bus chargers installed at the Four Corners Transit Base, JPUD anticipates a $31,000 cost to upgrade the electric facilities to accommodate the increased demand (this cost does not include the chargers themselves or the cost to install them). This includes excavation work (trench, setting vault), conduit, service equipment and service conducted from the transformer. JTA would be expected to cover this cost.
- JPUD expects up to $26,000 in infrastructure costs would be required to upgrade the electrical equipment at Haines Place Park and Ride to accommodate any chargers at this location (this cost does not include the chargers themselves or the cost to install them). This includes excavation work (trench, setting vault), conduit, service equipment and service conducted from the transformer. JTA would be expected to cover this cost

This information helped inform the charging locations described above, and in the Lifecycle Cost Analysis.

Chapter 6. Lifecycle Costs Analysis

The background information, route analysis, scenario-specific battery consumption analysis, and availability analysis all support the development of lifecycle costs specific to service for JTA operations. The following sections detail the anticipated total cost of ownership (TCO) for a full conversion to BEBs and a full fleet replacement of diesel buses by JTA. The following chapter also reviews the greenhouse gas emissions (GHGs) associated with operating both BEBs and diesel buses.

Total Cost of Ownership

The following sections review the total anticipated capital and operating costs associated with replacement of the existing fleet with either diesel buses or BEBs. The operating costs are considered to include propulsion fuel, charger and fueling system maintenance, bus maintenance and repairs. The electric bus batteries are assumed to last the full lifespan of the vehicle for this analysis.

This analysis does not consider the costs associated with drivers or supervisory and service personnel and does not address personnel changes due to additional maintenance or reduced maintenance workloads. Further, it assumes that site maintenance needs and costs will remain at JTA-planned levels such that no additional snow removal, vegetation management, or other incidental operations will change due to the location and use of electric vehicle charging equipment. Additionally, while the Operations Analysis showed that a one-to-one replacement of diesel buses to BEBs is not currently feasible, this cost analysis assumes the same number of BEBs as diesel buses for a full fleet replacement. Figure 9 summarizes the relationships of each of the components incorporated into the TCO analysis.

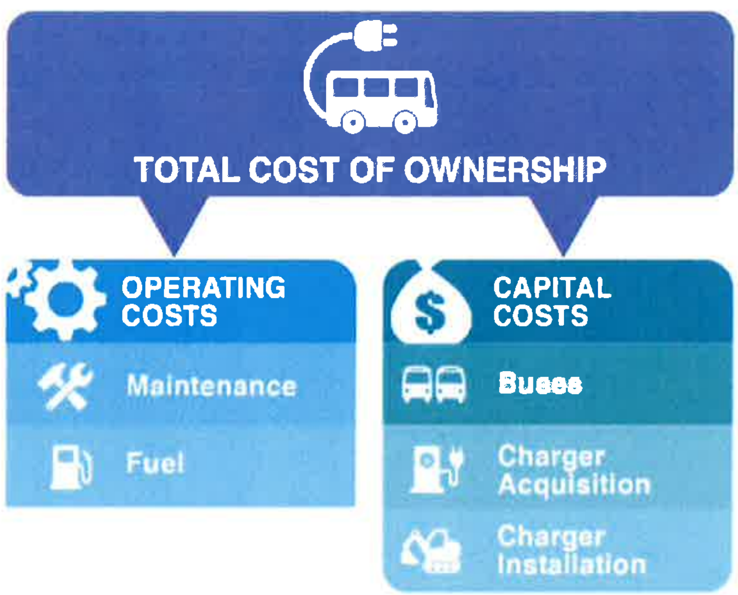

Figure 9. Total Cost of Ownership Flowchart

Capital Costs

Diesel Bus. Given the established nature of diesel as a fuel the primary capital cost associated with owning a diesel fleet is the purchase price of the bus. The current estimated cost to purchase a 40-foot diesel bus is approximately $480,000.[3] Based on an existing fleet of 15 buses to total capital cost to replace all of the buses is approximately $7.2 million dollars.

Battery Electric Bus. As shown in Table 4, the costs of BEBs range between approximately $615,000 and $1.4 million. For purposes of this analysis, to allow for a competitive procurement process, and consistent with the NREL 2020 study[1] a purchase price of $890,000 was assumed, based on industry standard averages. This results in a total cost of approximately $13,350,000 to replace 15 buses.

In addition to procurement of buses, new infrastructure is needed for vehicle charging. Based on the current driver blocks at least 8 buses would need to be charged over night to be ready to use during the day. Additionally, as described in Chapter 5, rapid charging stations could be installed at the Haines Place Park and Ride. This analysis assumes two rapid charging units and eight depot charging units. Table 6 provides a summary of the anticipated costs associated with upgraded infrastructure needs to accommodate BEBs.

Table 6. Capital Cost Estimate for BEB Upgraded Infrastructure Needs

Item	Number of Units	Cost Per Unit	Total Cost
Four Corners Charging Infrastructure	1	$31,000[1]	$31,000
Haines Place Charging Infrastructure	1	$26,000[1]	$26,000
Depot Charging Unit	8	$50,000[2]	$400,000
Fast Charge Unit	2	$496,000[2]	$992,000
Total			**$1,450,000**

1. Estimate provided by the Jefferson County Public Utility District (JPUD)
2. NREL 2020
3. Costs shown in 2021 dollars

As shown in Table 6, costs to upgrade infrastructure to accommodate BEBs are just under $1.5 million dollars. Table 7 provides a summary comparison of the estimated capital cost for replacement of the JTA buses assuming diesel fuel and BEBs.

Table 7. Capital Cost Estimate Comparison

Item	Diesel	BEB	Notes/Assumptions
Base Costs/Quantities			
Life Cycle (years)	12	12	Typical Bus Life Cycle
Number of Buses	15	15	Current Number of Buses and assumes 1 to 1 replacement is feasible
Cost per Bus[1]	$480,000	$890,000	Assumed 40-foot
Estimated Replacement Cost			
Total Bus Cost	$7,200,000	$13,350,000	
Infrastructure Upgrades	$0	$1,450,000	
Total	**$7,200,000**	**$14,800,000**	

1. NREL 2020
2. Costs shown in 2021 dollars

[3] *Financial Analysis of Battery Electric Transit Buses,* Caley Johnson, Erin Nobler, Leslie Eudy, and Matthew Jeffers, National Renewable Energy Laboratory, June 2020 (NREL 2020)

As shown in Table 7, the capital cost associated with BEBs is approximately twice that of diesel. This capital cost is a one-time cost and doesn't account for the reduced operating costs and environmental benefits of BEBs, which are discussed in the following sections.

Operating Costs

The primary difference in operating costs between internal combustion engines (ICE) buses and electric buses is the significant reduction in reciprocating component wear in the engine and the reduced need for fluid replenishment. Electric buses do not require replenishment or service for engine lubrication oil and cooling system fluid.

JTA provided information related to the current operating costs for the fleet. The agency currently operates eight buses with seven buses acting as back-up. The average maintenance cost of the existing fleet currently in operation is approximately $0.80/mile.

The 2020 NREL study published a national average maintenance rate of $0.64/mile for BEBs and $0.88/mile for diesel buses (a 27 percent reduction in maintenance costs for electric buses compared to diesel). To understand the reduced cost of maintaining electric buses, the rate was scaled based on the current maintenance costs provided by JTA. The resulting scaled BEB maintenance cost is estimated to be $0.58/mile (a 27 percent reduction from $0.80).

Diesel. Based on the driver block information in Chapter 2, the buses travel approximately 433,000 miles per year resulting in an estimated annual maintenance cost of $350,000.

Battery Electric Bus. Utilizing the estimated fee of $0.58/mile and the estimated 433,000 miles, the estimated annual maintenance cost of battery electric buses is $255,000.

In addition to maintenance costs, fuel costs are another operating cost to consider when looking at the total cost of ownership. The NREL 2020 study estimated the 2018 cost of diesel fuel at $3.18 per gallon with an average annual increase of 0.7 percent per year. Based on data provided by JTA the buses in service averaged 5.57 miles per gallon (mpg). Table 8 provides an estimate of the annual fuel cost assuming 433,000 miles per year, an average fuel economy of 5.57 mpg, resulting in an annual usage of 77,738 gallons of diesel.

Table 8. Annualized Fuel Cost – Diesel Bus

Year	Date	Diesel Fuel Cost	Diesel Fuel Cost
1	2020	$3.18/gal	$247,000
2	2021	$3.20/gal	$249,000
3	2022	$3.22/gal	$251,000
4	2023	$3.25/gal	$252,000
5	2024	$3.27/gal	$254,000
6	2025	$3.29/gal	$256,000
7	2026	$3.32/gal	$258,000
8	2027	$3.34/gal	$260,000
9	2028	$3.36/gal	$261,000
10	2029	$3.39/gal	$263,000
11	2030	$3.41/gal	$265,000
12	2031	$3.43/gal	$267,000
Total			**$3,083,000**

Source: Transpo 2021 and NREL 2020
Cost shown in 2021 dollars.

As shown in Table 8, the total twelve-year cost of diesel fuel is anticipated to be approximately $3.1 million dollars.

Fuel, or electricity, costs for electric buses are based on rates from JPUD. Based on discussion with JPUD, a new rate would need to be negotiated with JPUD; however, for estimating purposes, current and forecast rates were used based on Rate Schedule 26[4], the Large Demand service category.

The electrical costs are estimated based on the driver block information described in Chapter 4 totaling approximately 5,036.38 kWh on weekdays and 2,699.01 kWh on Saturdays operating 312 days per year. The JPUD electrical service rates include anticipated rate increases through 2024. Rate increases after 2024 were assumed to increase at 1 percent per year. The NREL 2020 analysis notes that electricity rates are anticipated to decrease over time so the 1 percent annual increase should be considered a conservative estimate. The base fee was calculated assuming a peak electrical draw of 560 kW (assuming 8 chargers operating at ~70 kW) which would occur overnight when all bus charging stations are in use. Table 9 provides a cost estimate for the electricity to power the buses.

Table 9. Annualized Fuel Cost – Battery Electric Bus

Year	Date	Annual Rate Changes	Base Charge	Base Fee (Three Phase on all kW)	Base Electric Cost per kWh	Total Electricity Cost Estimate
1	2020	0.00%	$110.00	$9.00/kW	$0.0757/kWh	$171,000
2	2021	3.75%	$114.13	$9.34/kW	$0.0785/kWh	$177,000
3	2022	6.75%	$121.83	$9.97/kW	$0.0838/kWh	$189,000
4	2023	3.25%	$125.79	$10.29/kW	$0.0866/kWh	$195,000
5	2024	3.25%	$129.88	$10.63/kW	$0.0894/kWh	$201,000
6	2025	1.00%	$131.17	$10.73/kW	$0.0903/kWh	$203,000
7	2026	1.00%	$132.49	$10.84/kW	$0.0912/kWh	$205,000
8	2027	1.00%	$133.81	$10.95/kW	$0.0921/kWh	$207,000
9	2028	1.00%	$135.15	$11.06/kW	$0.093/kWh	$209,000
10	2029	1.00%	$136.50	$11.17/kW	$0.0939/kWh	$211,000
11	2030	1.00%	$137.87	$11.28/kW	$0.0949/kWh	$213,000
12	2031	1.00%	$139.24	$11.39/kW	$0.0958/kWh	$216,000
Total						**$2,397,000**

Source: Transpo Group and JPUD, 2021

As shown in Table 9, the total twelve-year cost of electricity is anticipated to be just under $2.4 million dollars.

Life Cycle Costs

Totaling up the capital and ownership costs gives a rough estimate of the total life cycle cost of ownership for both buses. Table 10 provides an annualized summary of the costs for each bus fuel type.

[4] https://www.jeffpud.org/rate-schedule/

Table 10. Estimated Annualized Cost Comparison

		Battery Electric Buses			Diesel Buses		
			Operating Costs			Operating Costs	
Year	Date	Capital	Maintenance	Fuel	Capital	Maintenance	Fuel
1	2020	$14,758,000	$251,000	$171,000	$7,200,000	$346,000	$247,000
2	2021		$251,000	$177,000		$346,000	$249,000
3	2022		$251,000	$189,000		$346,000	$251,000
4	2023		$251,000	$195,000		$346,000	$252,000
5	2024		$251,000	$201,000		$346,000	$254,000
6	2025		$251,000	$203,000		$346,000	$256,000
7	2026		$251,000	$205,000		$346,000	$258,000
8	2027		$251,000	$207,000		$346,000	$260,000
9	2028		$251,000	$209,000		$346,000	$261,000
10	2029		$251,000	$211,000		$346,000	$263,000
11	2030		$251,000	$213,000		$346,000	$265,000
12	2031		$251,000	$216,000		$346,000	$267,000
Total			**$20,209,000**			**$14,435,000**	

Source: Transpo 2021 and NREL 2020

As shown in Table 10 the anticipated twelve-year cost of the battery electric buses is anticipated to be more than the diesel bus. The annualized cost of the fuel and maintenance costs of the BEBs are lower than the diesel bus and eventually a break-even point is reached. The costs also don't account for the decreased GHGs associated with the use of BEBs which are described in the next section.

The costs are based on total cost information available, but do not include discounts from grants and other funding sources that can help offset the initial upfront costs of BEBs. The current preliminary infrastructure bill discussed at the Federal level includes $621 billion for transportation, which includes funds for developing half a million EV stations and modernizing existing transit. The plan also calls for the replacement of 50,000 diesel transit vehicles and electrifying 20 percent of the yellow school bus fleet.

In addition to the federal infrastructure bill, a Clean Transit for America Plan has been introduced that would provide $73 billion for provision of zero-emission buses. The funding would be used to replace up to 70,000 mass transit buses and 85,000 cutaway vehicles and transit vans with clean energy vehicles. As part of the program, funding would be prioritized for areas with the worst air quality.

In Washington State there are several programs geared toward helping agencies transition to zero emissions buses like the Zero Emission Vehicle Infrastructure Partnerships (ZEVIP) that seeks to expand zero emission vehicle infrastructure.

Green House Gas (GHG) Emissions

One of the key advantages of transitioning from diesel buses and toward alternative fuels like electric buses is the decrease in GHGs and other pollutants. Moving away from diesel buses can help improve overall air quality and reduce contributions to climate change. The following sections review the GHGs associated with operating diesel and battery electric buses. The following sections do not include emissions from the construction of vehicles and instead focus on the operating emissions and emissions from extracting, refining, and transporting the materials needed to produce the fuel.

The Union of Concerned Scientists published a report by Jimmy O'Dea, *Electric vs. Diesel vs. Natural Gas: Which Bus is Best for the Climate?,* July, 19, 2018[5] which looked at the emissions from different types of transit buses. Figure 10 shows the summary global emissions from the different transit bus types from the article.

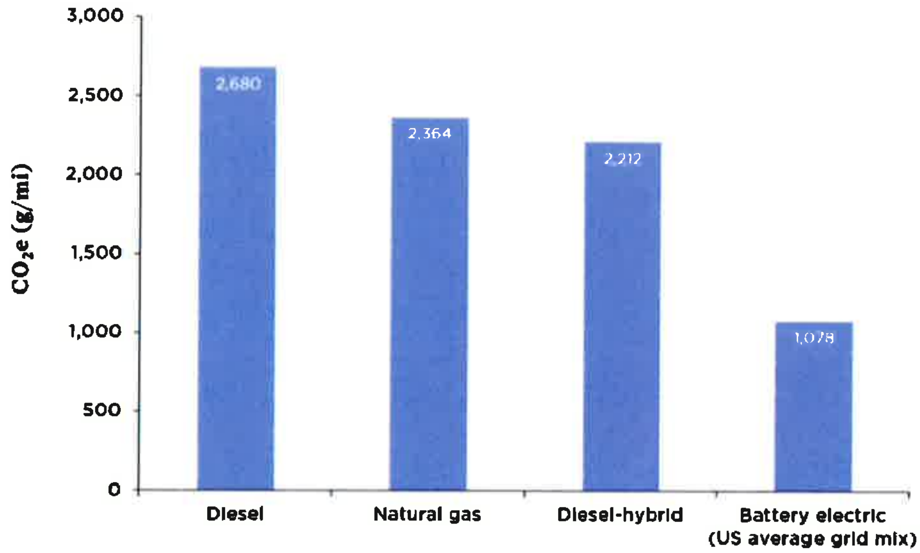

Figure 10. Life Cycle Global Warming Emissions from Different Types of Transit Buses

As shown in Figure 10, and utilized in the following GHG estimations, battery electric buses produce less than half of the CO_2e produced by diesel buses.

Diesel Buses

The report notes that the life cycle global warming emissions from a 40-foot diesel bus is 2,680 grams of CO_2e (carbon dioxide equivalent) per mile (g/mi). Existing JTA operations using diesel buses that travel approximately 433,000 miles per year and burn approximately 77,740 gallons of diesel results in an estimated 1,279 tons of CO_2e emitted each year.

Battery Electric Buses

Based on the same report from the Union of Concerned Scientists, battery electric buses generate approximately 1,078 CO_2e g/mi based on the US average grid mix. Give the same 433,000 annual miles traveled with electric buses, this results in approximately 515 tons of CO_2e emitted by JTA per year or a reduction of almost 765 tons of CO_2e per year over diesel buses. This emissions factor is based on the US average grid mix which includes a mix of renewable/non-carbon-based (wind, hydropower, etc.) and nonrenewable/carbon-based fuels (natural gas, coal, etc.).

According to the US Energy Information Administration (EIA), in 2020 approximately 60 percent of US electricity was generated by fossil fuels with nuclear and renewables each representing approximately 20 percent. In Jefferson County more than 83 percent of the electricity comes from hydroelectric power and just over 11 percent comes from nuclear

5 https://blog.ucsusa.org/jimmy-odea/electric-vs-diesel-vs-natural-gas-which-bus-is-best-for-the-climate

power. This make-up of the carbon-free energy sources helps further reduce the carbon footprint if JTA transitioned to BEBs.

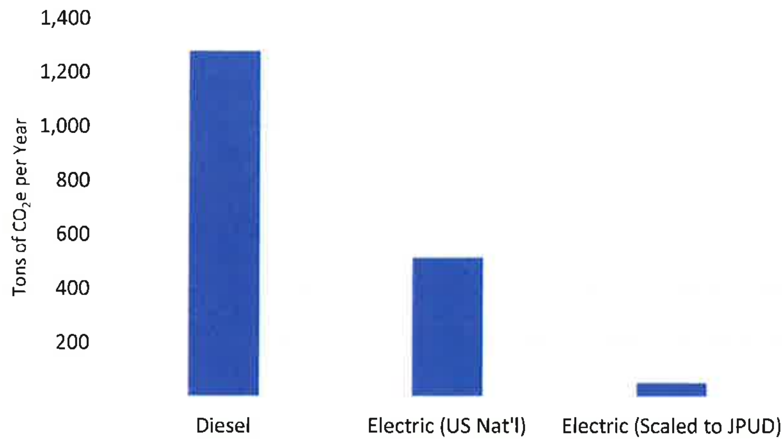

Figure 11. Annual Emissions for JTA Operations by Fuel Type

If the emission rate for vehicles charged using JPUD's electricity mix is based on a linearly scaled ratio of the national electricity mix, then the total CO_2e generated by JTA operating electric buses could be as low as 108 g/mi or 52 tons per year. This equates to a total reduction of approximately 1,228 tons of CO_2e per year when compared to diesel buses, a 96 percent reduction in CO_2e emitted by JTA operations.

Summary

The purpose of this report was to determine whether battery electric buses could meet the needs of Jefferson Transit Authority, how much a full fleet replacement might cost and how much JTA's emissions might decrease given full electrification of their fleet. The results from Chapter 4 noted that battery electric buses cannot meet the existing needs of JTA's routes but given the rapid advance in BEB technology it may be feasible in a few years.

For the purposes of foreward planning, a lifecycle cost estimate was prepared to summarize the total cost of full electrification of JTA's fleet. These total costs are summarized below in Table 11.

Table 11. Lifecycle Cost Summary – Diesel Bus Fleet vs Electric Bus Fleet

Item[1]	Diesel	Battery Electric	Difference
Bus Capital Cost	$7,200,000	$13,350,000	$6,150,000
Infrastructure Cost (chargers, etc.)	$0.00	$1,450,000	$1,450,000
Lifecycle Fuel Cost	$3,083,000	$2,397,000	-$686,000
Lifecycle Maintenance Cost	$4,152,000	$3,012,000	-$1,140,000
***Total*[2]**	**$14,435,000**	**$20,209,000**	**$5,774,000**

Source: Transpo Group and JPUD, 2021
1. Assumes 15 buses for both Diesel and BEB
2. Costs shown in 2021 dollars

Full electrification is expected to save approximately $1.8 million dollars on fuel and maintenance over the lifecycle of BEBs compared to traditional diesel-powered buses. However, the cost of a full fleet of BEBs is expected to be $6.1 million more than diesel buses. The charging infrastructure and associated costs are expected to cost an additional $1.5 million. The total premium for transitioning to BEBs is expected to be $5.77 million.

While transitioning to BEBs is expected to cost 40 percent more, it is also expected to greatly reduce the emissions from JTA's operations. Emissions Rates for electric buses based on the US national average grid fuel mix (~40 percent renewables) and for the local electricity mix provided by JPUD (~94 percent renewable) were both used to show the range of greenhouse gas emissions savings that could be expected by switching from diesel to BEBs. The annual emissions savings are shown in Table 12.

Table 12. Annual Emissions – Diesel Bus Fleet vs Electric Bus Fleet

Fuel Type	Emissions Rate (CO_2e[1] g/mile)	Annual Mileage	Annual Emissions (tons CO_2e)
Diesel	2,680	433,000	1,279
Electricity (US Nat'l Avg)	1,078	433,000	515
Electricity (JPUD)[2]	108	433,000	52

1. Carbon dioxide equivalent
2. Assumes linear relationship between emissions rate from US National Average of 20% renewables to 94% renewables for JPUD

Switching to BEBs from diesel buses could reduce operating emissions up to 96 percent given the high prevalence of renewable energy sources in JPUD's electricity mix. Even given US national grid averages, it is expected that electric buses emit approximately 60 percent fewer greenhouse gases than their diesel counterparts. While these estimates do not take into account the energy required to manufacture both types of vehicles, it is clear that there is a significant reduction in emission when switching to BEBs.

Appendix A:Operations Analysis Detailed Reports

Detailed Weekday Driver Block Energy Requirements

Table 1. Driver Block A – Energy Use Summary

Time Frame	Route	Duration (min)	Energy Rate (kWh/mile)	Total Energy Required (kWh)
5:59 a.m. to 6:59 a.m.	7	60	3.06	123.31
7:26 a.m. to 8:27 a.m.	7	61	2.84	103.3
9:00 a.m. to 9:25 a.m.	2	25	2.69	24.68
9:30 a.m. to 9:55 a.m.	3	25	2.04	18.56
10:00 a.m. to 10:25 a.m.	2	25	2.69	24.68
10:30 a.m. to 10:55 a.m.	3	25	2.04	18.56
11:00 a.m. to 11:18 a.m.	4	18	2.06	10.3
11:30 a.m. to 11:55 a.m.	3	25	2.04	18.56
12:00 p.m. to 12:52 p.m.	6B	52	2.78	77.38
Total				***422.63***

Source: Google Earth and Jefferson Transit
Note: Summary does not include times when energy is not consumed.

Table 2. Driver Block B – Energy Use Summary

Time Frame	Route	Duration (min)	Energy Rate (kWh/mile)	Total Energy Required (kWh)
6:10 a.m. to 7:08 a.m.	1	58	2.46	103.9
7:18 a.m. to 8:22 a.m.	1	64	2.73	132.98
9:00 a.m. to 9:18 a.m.	4	18	2.06	10.3
9:30 a.m. to 9:48 a.m.	4	18	2.06	10.3
10:00 a.m. to 10:52 a.m.	6A	52	2.94	74.8
11:00 a.m. to 11:53 a.m.	6B	53	2.78	77.38
12:00 p.m. to 12:25 p.m.	2	25	2.69	24.68
Total				***434.34***

Source: Google Earth and Jefferson Transit
Note: Summary does not include times when energy is not consumed.

Table 3. Driver Block C – Energy Use Summary

Time Frame	Route	Duration (min)	Energy Rate (kWh/mile)	Total Energy Required (kWh)
6:11 a.m. to 6:47 a.m.	8	36	3.66	110.12
6:52 a.m. to 7:37 a.m.	8	45	2.85	97.46
7:40 a.m. to 8:00 a.m.	11A	20	2.91	15.72
8:30 a.m. to 8:48 a.m.	4	18	2.06	10.3
9:00 a.m. to 9:52 a.m.	6B	52	2.78	77.38
10:00 a.m. to 10:18 a.m.	4	18	2.06	10.3
10:40 a.m. to 11:45 a.m.	7	65	3.06	123.31
12:15 p.m. to 1:16 p.m.	7	61	2.84	106.6
Total				***551.19***

Source: Google Earth and Jefferson Transit
Note: Summary does not include times when energy is not consumed.

Table 4. Driver Block D – Energy Use Summary

Time Frame	Route	Duration (min)	Energy Rate (kWh/mile)	Total Energy Required (kWh)
6:45 a.m. to 7:35 a.m.	6A	50	2.94	74.8
8:00 a.m. to 8:18 a.m.	4	18	2.06	10.3
8:40 a.m. to 9:27 a.m.	8	47	3.66	110.12
9:40 a.m. to 10:24 a.m.	8	44	2.85	97.46
11:00 a.m. to 11:25 a.m.	2	25	2.69	24.68
11:30 a.m. to 11:48 a.m.	4	18	2.06	10.3
12:00 p.m. to 12:18 p.m.	4	18	2.06	10.3
Total				***337.96***

Source: Google Earth and Jefferson Transit
Note: Summary does not include times when energy is not consumed.

Table 5. Driver Block E – Energy Use Summary

Time Frame	Route	Duration (min)	Energy Rate (kWh/mile)	Total Energy Required (kWh)
7:00 a.m. to 7:25 a.m.	2	25	2.69	24.68
7:30 a.m. to 7:55 a.m.	3	25	2.04	18.56
8:00 a.m. to 8:25 a.m.	2	25	2.69	24.68
8:30 a.m. to 8:55 a.m.	3	25	2.04	18.56
9:15 a.m. to 10:18 a.m.	7	63	3.06	123.31
10:53 a.m. to 11:54 a.m.	7	61	2.84	106.6
2:00 p.m. to 2:25 p.m.	2	25	2.69	24.68
2:30 p.m. to 2:55 p.m.	3	25	2.04	18.56
3:15 p.m. to 4:03 p.m.	8	48	3.66	110.12
4:20 p.m. to 5:09 p.m.	8	49	2.85	97.46
5:30 p.m. to 5:48 p.m.	4	18	2.06	10.3
6:00 p.m. to 6:25 p.m.	2	25	2.69	24.68
Total				***602.19***

Source: Google Earth and Jefferson Transit
Note: Summary does not include times when energy is not consumed.

Table 6. Driver Block F – Energy Use Summary

Time Frame	Route	Duration (min)	Energy Rate (kWh/mile)	Total Energy Required (kWh)
7:00 a.m. to 7:20 a.m.	11A	20	2.91	15.72
7:30 a.m. to 8:45 a.m.	1	75	2.46	103.9
9:10 a.m. to 10:26 a.m.	1	76	2.73	132.98
10:30 a.m. to 10:48 a.m.	4	18	2.06	10.3
11:45 a.m. to 12:33 p.m.	8	48	3.66	110.12
12:50 p.m. to 1:40 p.m.	8	50	2.85	97.46
Total				***470.48***

Source: Google Earth and Jefferson Transit
Note: Summary does not include times when energy is not consumed.

Table 7. Driver Block G – Energy Use Summary

Time Frame	Route	Duration (min)	Energy Rate (kWh/mile)	Total Energy Required (kWh)
2:30 p.m. to 2:50 p.m.	11B	20	3.05	16.75
3:00 p.m. to 3:25 p.m.	2	25	2.69	24.68
3:30 p.m. to 3:55 p.m.	3	25	2.04	18.56
4:00 p.m. to 4:52 p.m.	6A	52	2.94	74.8
5:37 p.m. to 6:44 p.m.	1	67	2.46	103.9
6:46 p.m. to 7:44 p.m.	1	58	2.73	132.98
Total				***317.67***

Source: Google Earth and Jefferson Transit
Note: Summary does not include times when energy is not consumed.

Table 8. Driver Block I – Energy Use Summary

Time Frame	Route	Duration (min)	Energy Rate (kWh/mile)	Total Energy Required (kWh)
12:30 p.m. to 12:55 p.m.	3	25	2.04	18.56
1:00 p.m. to 1:52 p.m.	6A	52	2.94	74.8
2:30 p.m. to 2:48 p.m.	4	18	2.06	10.3
3:00 p.m. to 3:52 p.m.	6B	52	2.78	77.38
4:00 p.m. to 4:18 p.m.	4	18	2.06	10.3
4:30 p.m. to 4:48 p.m.	4	18	2.06	10.3
5:08 p.m. to 6:12 p.m.	7	64	3.06	123.31
6:56 p.m. to 7:57 p.m.	7	61	2.84	106.6
8:00 p.m. to 8:20 p.m.	11A	20	2.91	15.72
Total				***447.27***

Source: Google Earth and Jefferson Transit
Note: Summary does not include times when energy is not consumed.

Table 9. Driver Block J – Energy Use Summary

Time Frame	Route	Duration (min)	Energy Rate (kWh/mile)	Total Energy Required (kWh)
1:00 p.m. to 1:18 p.m.	4	18	2.06	10.3
1:30 p.m. to 1:48 p.m.	4	18	2.06	10.3
2:00 p.m. to 2:52 p.m.	6A	52	2.94	74.8
3:12 p.m. to 4:16 p.m.	7	64	3.06	123.31
5:05 p.m. to 6:09 p.m.	7	64	2.84	106.6
6:30 p.m. to 6:55 p.m.	3	25	2.04	18.56
7:05 p.m. to 7:44 p.m.	6B	39	2.78	77.38
Total				***422.25***

Source: Google Earth and Jefferson Transit
Note: Summary does not include times when energy is not consumed.

Table 10. Driver Block K – Energy Use Summary

Time Frame	Route	Duration (min)	Energy Rate (kWh/mile)	Total Energy Required (kWh)
12:30 p.m. to 12:48 p.m.	4	18	2.06	10.3
1:00 p.m. to 1:25 p.m.	2	25	2.69	24.68
1:30 p.m. to 1:55 p.m.	3	25	2.04	18.56
2:00 p.m. to 2:18 p.m.	4	18	2.06	10.3
3:00 p.m. to 3:18 p.m.	4	18	2.06	10.3
3:30 p.m. to 3:48 p.m.	4	18	2.06	10.3
4:00 p.m. to 4:25 p.m.	2	25	2.69	24.68
4:30 p.m. to 4:55 p.m.	3	25	2.04	18.56
5:00 p.m. to 5:18 p.m.	4	18	2.06	10.3
5:50 p.m. to 6:38 p.m.	8	48	3.66	110.12
6:40 p.m. to 7:23 p.m.	8	43	2.85	97.46
Total				***345.56***

Source: Google Earth and Jefferson Transit
Note: Summary does not include times when energy is not consumed.

Table 11. Driver Block R – Energy Use Summary

Time Frame	Route	Duration (min)	Energy Rate (kWh/mile)	Total Energy Required (kWh)
8:00 a.m. to 8:20 a.m.	11A	20	2.91	15.72
8:30 a.m. to 8:50 a.m.	11B	20	3.05	16.75
9:00 a.m. to 9:20 a.m.	11A	20	2.91	15.72
9:30 a.m. to 9:50 a.m.	11B	20	3.05	16.75
10:00 a.m. to 10:20 a.m.	11A	20	2.91	15.72
10:30 a.m. to 10:50 a.m.	11B	20	3.05	16.75
11:00 a.m. to 11:20 a.m.	11A	20	2.91	15.72
11:30 a.m. to 11:50 a.m.	11B	20	3.05	16.75
12:00 p.m. to 12:20 p.m.	11A	20	2.91	15.72
2:00 p.m. to 3:24 p.m.	1	84	2.46	103.9
3:25 p.m. to 4:40 p.m.	1	75	2.73	132.98
5:00 p.m. to 5:25 p.m.	2	25	2.69	24.68
5:30 p.m. to 5:55 p.m.	3	25	2.04	18.56
6:00 p.m. to 6:18 p.m.	4	18	2.06	10.3
Total				***436.02***

Source: Google Earth and Jefferson Transit
Note: Summary does not include times when energy is not consumed.

Table 12. Driver Block S – Energy Use Summary

Time Frame	Route	Duration (min)	Energy Rate (kWh/mile)	Total Energy Required (kWh)
12:30 p.m. to 12:50 p.m.	11B	20	3.05	16.75
1:00 p.m. to 1:20 p.m.	11A	20	2.91	15.72
1:30 p.m. to 1:50 p.m.	11B	20	3.05	16.75
2:00 p.m. to 2:20 p.m.	11A	20	2.91	15.72
3:00 p.m. to 3:20 p.m.	11A	20	2.91	15.72
3:30 p.m. to 3:50 p.m.	11B	20	3.05	16.75
4:00 p.m. to 4:20 p.m.	11A	20	2.91	15.72
4:30 p.m. to 4:50 p.m.	11B	20	3.05	16.75
5:00 p.m. to 5:20 p.m.	11A	20	2.91	15.72
5:30 p.m. to 5:50 p.m.	11B	20	3.05	16.75
6:00 p.m. to 6:20 p.m.	11A	20	2.91	15.72
6:30 p.m. to 6:50 p.m.	11B	20	3.05	16.75
Total				***194.82***

Source: Google Earth and Jefferson Transit
Note: Summary does not include times when energy is not consumed.

Detailed Saturday Driver Block Energy Requirements

Table 13. Driver Block M – Energy Use Summary

Time Frame	Route	Duration (min)	Energy Rate (kWh/mile)	Total Energy Required (kWh)
6:50 a.m. to 8:05 a.m.	1	75	2.46	103.91
8:05 a.m. to 9:20 a.m.	1	75	2.73	132.98
9:30 a.m. to 9:48 a.m.	4	18	2.06	10.3
10:30 a.m. to 11:00 a.m.	3	30	2.04	18.56
11:00 a.m. to 11:18 a.m.	4	18	2.06	10.3
11:30 a.m. to 11:48 a.m.	4	18	2.06	10.3
12:00 p.m. to 12:25 p.m.	2	25	2.69	24.68
1:00 p.m. to 1:18 p.m.	4	18	2.06	10.3
1:30 p.m. to 1:50 p.m.	11B	20	3.05	16.75
2:00 p.m. to 2:20 p.m.	11A	20	2.91	15.72
Total				***353.80***

Source: Google Earth and Jefferson Transit
Note: Summary does not include times when energy is not consumed.

Table 14. Driver Block N – Energy Use Summary

Time Frame	Route	Duration (min)	Energy Rate (kWh/mile)	Total Energy Required (kWh)
7:00 a.m. to 8:03 a.m.	8	63	3.66	110.12
8:10 a.m. to 8:53 a.m.	8	43	2.85	97.46
9:00 a.m. to 9:25 a.m.	2	25	2.69	24.68
9:30 a.m. to 9:55 a.m.	3	25	2.04	18.56
10:00 a.m. to 10:18 a.m.	4	18	2.06	10.3
11:00 a.m. to 11:25 a.m.	2	25	2.69	24.68
11:30 a.m. to 11:55 a.m.	3	25	2.04	18.56
12:00 p.m. to 12:18 p.m.	4	18	2.06	10.3
Total				***314.7***

Source: Google Earth and Jefferson Transit
Note: Summary does not include times when energy is not consumed.

Table 15. Driver Block O – Energy Use Summary

Time Frame	Route	Duration (min)	Energy Rate (kWh/mile)	Total Energy Required (kWh)
8:45 a.m. to 9:50 a.m.	6A	65	2.94	74.8
10:00 a.m. to 10:25 a.m.	2	25	2.69	24.68
10:30 a.m. to 10:48 a.m.	4	18	2.06	10.3
11:00 a.m. to 11:50 a.m.	6B	50	2.78	77.38
12:30 p.m. to 12:48 p.m.	4	18	2.06	10.3
1:00 p.m. to 1:25 p.m.	2	25	2.69	24.68
1:30 p.m. to 1:55 p.m.	3	25	2.04	18.56
2:00 p.m. to 2:18 p.m.	4	18	2.06	10.3
2:30 p.m. to 3:30 p.m.	7	60	3.06	123.31
4:08 p.m. to 5:08 p.m.	7	60	2.84	100.21
Total				***480.9***

Source: Google Earth and Jefferson Transit
Note: Summary does not include times when energy is not consumed.

Table 16. Driver Block L – Energy Use Summary

Time Frame	Route	Duration (min)	Energy Rate (kWh/mile)	Total Energy Required (kWh)
9:00 a.m. to 9:18 a.m.	4	18	2.06	10.3
9:25 a.m. to 10:25 a.m.	7	60	3.06	123.31
10:43 a.m. to 11:43 a.m.	7	60	2.84	100.21
12:30 p.m. to 12:55 p.m.	3	25	2.04	18.56
1:00 p.m. to 1:50 p.m.	6B	50	2.78	77.38
2:30 p.m. to 2:50 p.m.	11B	20	3.05	16.75
3:00 p.m. to 3:20 p.m.	11A	20	2.91	15.72
3:30 p.m. to 3:50 p.m.	11B	20	3.05	16.75
4:00 p.m. to 4:20 p.m.	11A	20	2.91	15.72
4:30 p.m. to 4:50 p.m.	11B	20	3.05	16.75
5:00 p.m. to 5:20 p.m.	11A	20	2.91	15.72
5:30 p.m. to 5:50 p.m.	11B	20	3.05	16.75
6:00 p.m. to 6:20 p.m.	11A	20	2.91	15.72
Total				***466.03***

Source: Google Earth and Jefferson Transit
Note: Summary does not include times when energy is not consumed.

Table 17. Driver Block P – Energy Use Summary

Time Frame	Route	Duration (min)	Energy Rate (kWh/mile)	Total Energy Required (kWh)
4:30 p.m. to 4:48 p.m.	4	18	2.06	10.3
5:00 p.m. to 5:25 p.m.	2	25	2.69	24.68
5:30 p.m. to 5:48 p.m.	4	18	2.06	10.3
6:00 p.m. to 6:25 p.m.	2	25	2.69	24.68
6:30 p.m. to 6:50 p.m.	11B	20	3.05	16.75
7:05 p.m. to 7:44 p.m.	6B	39	2.78	77.38
8:00 p.m. to 8:20 p.m.	11A	20	2.91	15.72
Total				***179.81***

Source: Google Earth and Jefferson Transit
Note: Summary does not include times when energy is not consumed.

Table 18. Driver Block Q – Energy Use Summary

Time Frame	Route	Duration (min)	Energy Rate (kWh/mile)	Total Energy Required (kWh)
9:00 a.m. to 9:20 a.m.	11A	20	2.91	15.72
9:30 a.m. to 9:50 a.m.	11B	20	3.05	16.75
10:00 a.m. to 10:20 a.m.	11A	20	2.91	15.72
10:30 a.m. to 10:50 a.m.	11B	20	3.05	16.75
11:00 a.m. to 11:20 a.m.	11A	20	2.91	15.72
11:30 a.m. to 11:50 a.m.	11B	20	3.05	16.75
12:00 p.m. to 12:20 p.m.	11A	20	2.91	15.72
12:30 p.m. to 12:50 p.m.	11B	20	3.05	16.75
1:00 p.m. to 1:20 p.m.	11A	20	2.91	15.72
2:30 p.m. to 2:48 p.m.	4	18	2.06	10.3
3:30 p.m. to 3:55 p.m.	3	25	2.04	18.56
4:00 p.m. to 4:18 p.m.	4	18	2.06	10.3
5:00 p.m. to 5:48 p.m.	8	48	3.66	110.12
5:53 p.m. to 6:36 p.m.	8	43	2.85	97.46
Total				***392.34***

Source: Google Earth and Jefferson Transit
Note: Summary does not include times when energy is not consumed.

Table 19. Driver Block T – Energy Use Summary

Time Frame	Route	Duration (min)	Energy Rate (kWh/mile)	Total Energy Required (kWh)
1:30 p.m. to 1:48 p.m.	4	18	2.06	10.3
2:00 p.m. to 2:25 p.m.	2	25	2.69	24.68
2:30 p.m. to 2:55 p.m.	3	25	2.04	18.56
3:00 p.m. to 3:18 p.m.	4	18	2.06	10.3
4:00 p.m. to 4:50 p.m.	6A	50	2.94	74.8
5:00 p.m. to 5:18 p.m.	4	18	2.06	10.3
5:30 p.m. to 5:55 p.m.	3	25	2.04	18.56
6:00 p.m. to 6:18 p.m.	4	18	2.06	10.6
6:30 p.m. to 6:55 p.m.	3	25	2.04	18.56
Total				***196.36***

Source: Google Earth and Jefferson Transit
Note: Summary does not include times when energy is not consumed.

Table 20. Driver Block U – Energy Use Summary

Time Frame	Route	Duration (min)	Energy Rate (kWh/mile)	Total Energy Required (kWh)
3:00 p.m. to 3:25 p.m.	2	25	2.69	24.68
3:30 p.m. to 3:48 p.m.	4	18	2.06	10.3
4:00 p.m. to 4:25 p.m.	2	25	2.69	24.68
4:30 p.m. to 4:55 p.m.	3	25	2.04	18.56
5:25 p.m. to 6:35 p.m.	1	70	2.46	103.9
6:40 p.m. to 7:40 p.m.	1	60	2.73	132.98
Total				***315.10***

Source: Google Earth and Jefferson Transit
Note: Summary does not include times when energy is not consumed.

JEFFERSON TRANSIT ELECTRIC BUS FEASIBILITY

08/17/2021 JTA BOARD PRESENTATION

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WHAT TRANSPORTATION CAN BE

PRESENTATION OUTLINE

1. Review Previous Information (October 2020)
   A. "Existing Conditions"
   B. Summary of Existing Electric Bus Technologies
   C. Route Analysis
2. New Information
   A. Electric Requirements Analysis
   B. Total Cost of Ownership
   C. Greenhouse Gas Estimates
   D. Summary

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'EXISTING' CONDITIONS

INVENTORY EXISTING SYSTEMS

- Understand Existing Routes, distances traveled, layover times, elevation gains, etc.
- Relied upon schedules provided by JTA (pre COVID) and Google Earth.

Route	Area Served	Approximate Mileage (One Way)	Elevation Gain/Loss (Feet)
#1	Port Townsend – Port Hadlock/Irondale – Brinnon	46.9 miles	+3,114 / -3,125
#2	Fort Worden - Port Townsend	7.1 miles	+545 / -545
#3	Castle Hill – Port Townsend	9.9 miles	+664 / -664
#4	Upper Sims Loop – Port Townsend	5.0 miles	+425 / -425
#6	Tri Area Loop – Port Townsend – Port Hadlock/Irondale	20.2 miles	+1,183 / -1,183
#7	Poulsbo – Port Hadlock/Irondale -	34.0 miles	+2,593 / -2,765
#8	Sequim – Port Townsend	30.1 miles	+3,739 / -3,564
#11	Shuttle Loop – Port Townsend	3.9 miles	+241 / -241

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INVENTORY EXISTING SYSTEMS

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ELECTRIC BUS TECHNOLOGY

SUMMARY OF AVAILABLE ELECTRIC BUSES

OEM	Lengths	Propulsion Type	Battery Size (KW)	Range (Miles)	Bus Costs ($)	Base Warranty & Disposal	Extended Warranty	Additional Information on battery warranty	Battery Lease Option
New Flyer	35'	BEB	160-388	75-195	$ 675,606.97- $ 682,606.97	6 yrs/ 300,000 miles	6 yrs/ 200,000 miles $ 40,718.52- $76,861.08	to hold 80% of BOL capacity after 12 years and ~500,000 miles.	Y
	40'		160-480	75-225	$800,000- $1M				
	60'		213-600	55-135	$1.1M-1,4M				
BYD	35'	BEB	350	230	$613,885- $698,000	12 year warranty. Pricing not available		N/A	Y
	40'		500	255	$741,000				
	60'		652	230	$ 1,140,000.00				
Proterra	35'	BEB	94-440	37-276	$613,885- $739,000	6 yrs/ 250,000 miles	6 yrs/ 250,000 miles $ 75,000-$112,000.	72% Energy density of the energy available per battery pack for the 12 years	Y
	40'		94-650	37-390	$653,885- $847,000				
NovaBus	40'	BEB	74 - 594	Not available	Not available	12 year Energy Storage System Warranty		Guaranteed at 80% capacity	Information not yet available
* Greenpower	30'	BEB	210	>175	Not available				
	35'		260	>175					
	40'		320	>185					
** Gillig Electric bus	35'	BEB	444	Not available	Not available to the market				
	40'		444	150- 210					
*** Eldorado	35'	BEB	444	Not available. The Bus is expected to be market ready on 10/2020 according to our source.			Current vendor offers a 1 + 5-year warranty. Eldorado plan to market as "6-years" or "mid-life" replacement		No

Price estimates are influenced by several factors including model configurations, customized options (where applicable), and the evolution of technology.

Price estimates is an approximate value from recent Transit Authorities contracts and information from Bus Original Equipment Manufacturers.

* Greenpower electric buses are not listed in Altoona test which is a FTA requirement.

** Gillig is a private own company and does not share these information

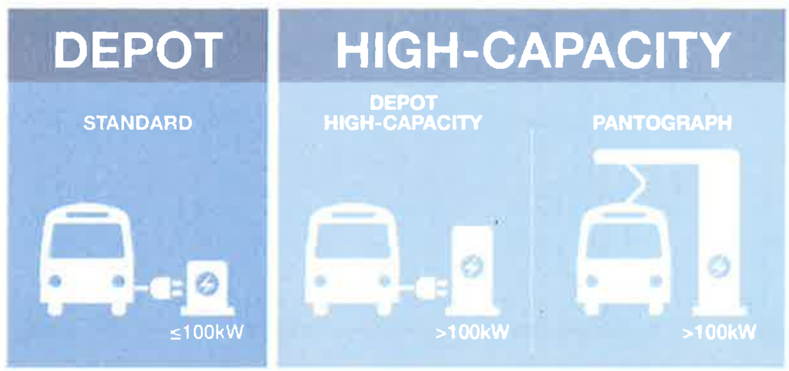
*** Eldorado bus price is estimated to be maximum $900,000 with an estimated price of the battery packs >$200,000 according to our source

transpogroup

ELECTRIC BUS CHARGING TECHNOLOGY

OEM	Lengths	Battery Size (KW)	Range (Miles)	Designation
New Flyer	35'	160-388	75-195	Plug In Depot Overhead Pantograph
	40'	160-480	75-225	
	60'	213-600	55-135	
BYD	35'	350	230	High Power AC charging
	40'	500	255	
	60'	652	230	
Proterra	35'	94-440	37-276	Plug In Depot Overhead Pantograph
	40'	94-650	37-390	
NovaBus	40'	74 - 594	Not available	Plug In Depot Overhead Pantograph
Greenpower	30'	210	>175	Plug In Depot
	35'	280	>175	
	40'	320	>185	
Gillig Electric bus	35'	444	Not available	Not available
	40'	444	150- 210	
Eldorado	35'	444	Not available. The Bus is expected to be market ready on 10/2020 according to our source.	

Charging Types:



OPERATIONS ANALYSIS

ELECTRIC BUS OPERATIONS ANALYSIS (1/2)

- Electrical energy requirements needed to operate a 35' battery electric bus.
- These parameters were programmed into the STV Performance and Evaluation of Electric bus Routes (**PEER**) analysis tool
    - Assumes 50% bus load
    - Minimal traffic congestion
    - Analysis done for 3 temperatures scenarios (34° F, 60° F, 74° F)

SAMPLE ANALYSIS RESULTS

Battery Capacity	388	kWh
Degradation over Battery Life	78	kWh
Degraded Battery Capacity	310	kWh
Interior Temperature	68	Degrees F
Ambient Temperature	34	Degrees F
Route Number	#1	
Route Length (Round Trip)	84.40	miles
Round Trip Time	156	minutes
Calculated kWh / mile	2.71	kWh / mile
Net kWh per route (round trip)	218.95	kWh
Number of Round Trips Able to be Completed	1.134	trips
Total Seconds of Route	8025.00	seconds

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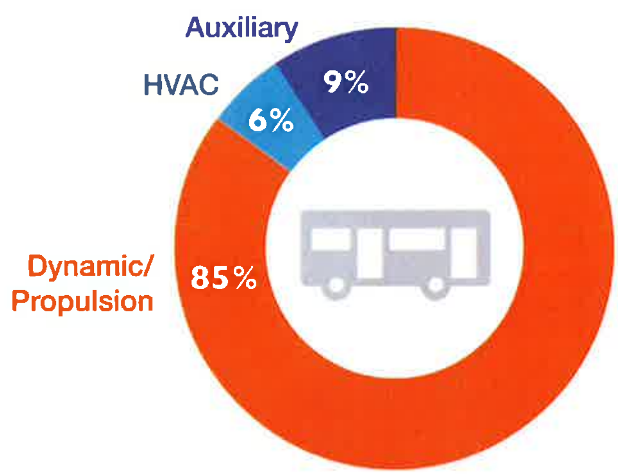
ELECTRIC BUS OPERATIONS ANALYSIS (2/2)

- Electrical energy requirements needed to operate a 35' battery electric bus.
- These parameters were programmed into the STV **P**erformance and **E**valuation of **E**lectric bus **R**outes (**PEER**) analysis tool
  - Assumes 50% bus load
  - Minimal traffic congestion
  - Analysis done for 3 temperatures scenarios (34° F, 60° F, 74° F)

ENERGY CONSUMPTION BY COMPONENT



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ELECTRIC BUS OPERATIONS ANALYSIS (2/2)

- Energy requirements developed for each route.
- Requirements based on:
  - Temperature,
  - Route Elevation Profile,
  - Bus Stop Locations

- Route Profiles combined with Driver Schedules to develop energy requirements per driver block.

ELECTRIC BUS OPERATIONS ANALYSIS (3)

SUMMARY RESULTS

Table 1. Weekday Driver Block Summary

Driver Block	Routes Driven	Time Frame	Total Duration[1]	Total Break Duration (min)[2]	Total Energy Required (kWh)
A	Uptown, #2, #3, #4, #6, #7	5:15 a.m. to 1:07 p.m.	7.9 hours	50	422.63
B	#1, #2, #4, #6	5:50 a.m. to 12:45 p.m.	6.9 hours	28	434.34
C	#2, #4, #8, #11	5:50 a.m. to 1:33 p.m.	7.7 hours	57	551.19
D	Uptown, #2, #4, #6, #8	6:00 a.m. to 12:43 p.m.	6.7 hours	53	337.96
E	#2, #3, #4, #7, #8	6:30 a.m. to 6:40 p.m.	10.8 hours	172	602.19
F	#1, #4, #8, #11	6:30 a.m. to 1:55 p.m.	6.7 hours	75	470.48
G	#1, #2, #3, #6, #11	2:00 p.m. to 7:49 p.m.	5.2 hours	35	371.67
I	#3, #4, #6, #7, #11	12:00 p.m. to 8:35 p.m.	9.6 hours	100	447.27
J	#3, #4, #6, #7	12:30 p.m. to 7:49 p.m.	7.3 hours	71	422.25
K	#2, #3, #4, #8	12:00 p.m. to 7:40 p.m.	7.2 hours	74	345.56
R	#1, #2, #3, #4, #11	7:30 a.m. to 6:35 p.m.	9.6 hours	110	436.02
S	#11	12:00 p.m. to 7:05 p.m.	6.6 hours	30	194.82

Source: Google Earth and Jefferson Transit
1. Includes driving hours, lunch time but not unpaid breaks.
2. Includes paid and unpaid breaks

- 310 'usable' kWh of energy on a 35' BEB at end of life:
- Requires route restructure or on-route charging
- Possibly operate on existing schedule
- Can operate on existing schedule

- Many blocks have long breaks that would allow for charging during breaks if location is good

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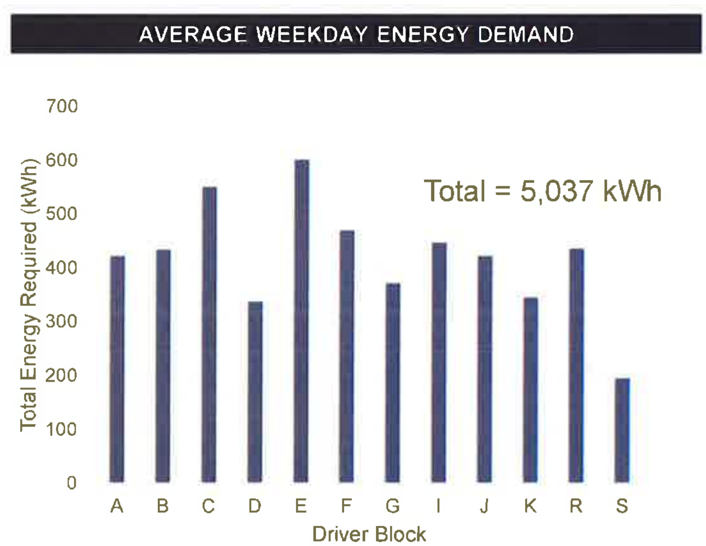
ELECTRICAL ANALYSIS

ELECTRICAL REQUIREMENTS ANALYSIS

- JPUD: No issue providing this quantity of electricity
- At Four Corners Transit Base need excavation work (trench, setting vault) conduit, service equipment – estimated $31,000
- Haines Place P&R - excavation work (trench, setting vault), conduit, service equipment and service conducted from the transformer: estimated $26,000
- **Does not include costs of chargers**



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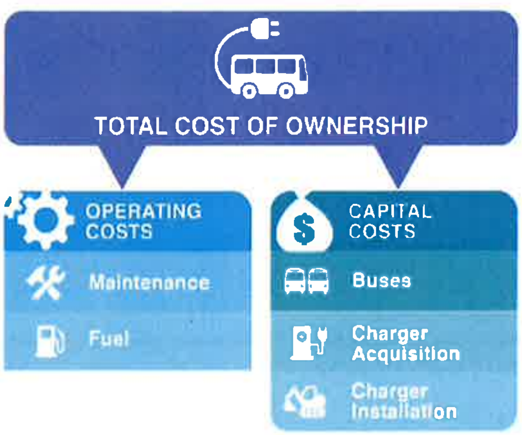
TOTAL COST OF OWNERSHIP

TOTAL COST OF OWNERSHIP - OVERVIEW



- References data from JTA where available (fuel & maintenance)
- 2020 National Renewable Energy Laboratory (NREL) Study:
    - BEBs reduce maintenance costs by 27%
- Electricity Costs Estimated based on current JPUD rates (Rate Schedule 26) but will need to be negotiated with JPUD
- Assumes 12-year lifecycle for both BEB and Diesel

STV 100 Years transpogroup

TOTAL COST OF OWNERSHIP – CAPITAL COSTS (1/2)

BATTERY ELECTRIC BUS

DEPOT CHARGING

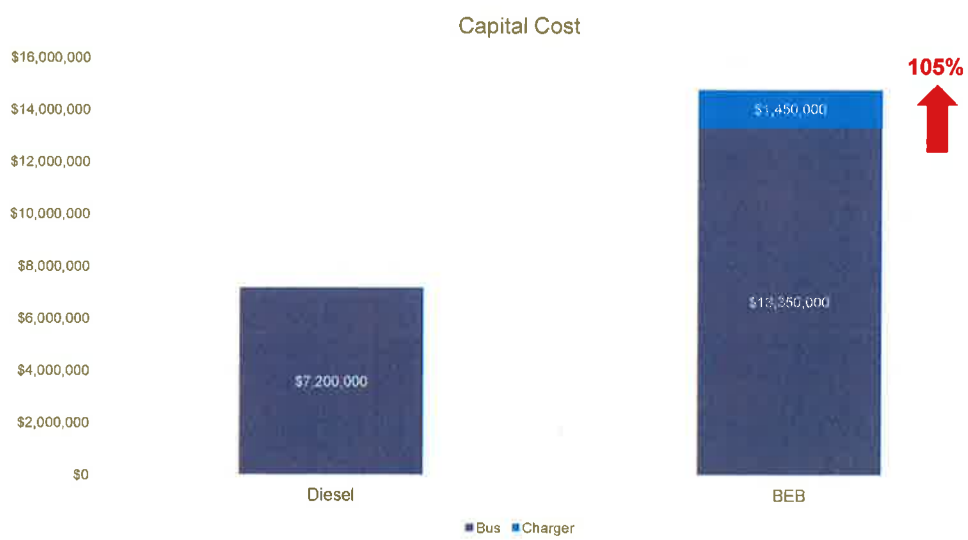
FAST CHARGER

DIESEL BUS

*Electric Bus Cost Range: $615k – $1.4M

STV 100 Years transpogroup

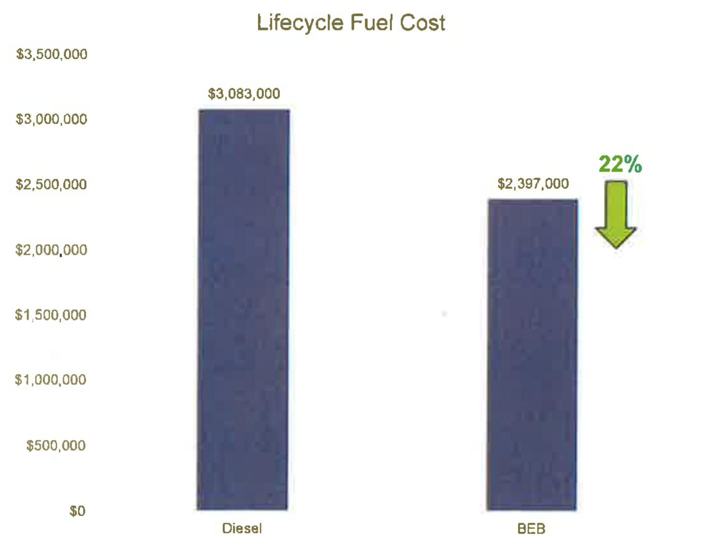
TOTAL COST OF OWNERSHIP – CAPITAL COSTS (2/2)



STV 100 Years transpogroup

TOTAL COST OF OWNERSHIP – FUEL COSTS

- Electrical Rate 26 from JPUD:
  - $110.00 + $0.0757 / kWh
  - Base Fee of $9.00/kW peak load (monthly)
  - Assumes rate increased published through 2024 then 1% increase per year
- Diesel:
  - $3.18 / gallon assumed
  - Increase 0.7% per year
  - Based on 2020 *NREL* study



STV 100 Years transpogroup

TOTAL COST OF OWNERSHIP – MAINTENANCE COSTS (1/2)

Existing Maintenance Costs from JTA

80¢/Mile

$346k annually

Annual Mileage

433000

BEB

58¢/Mile

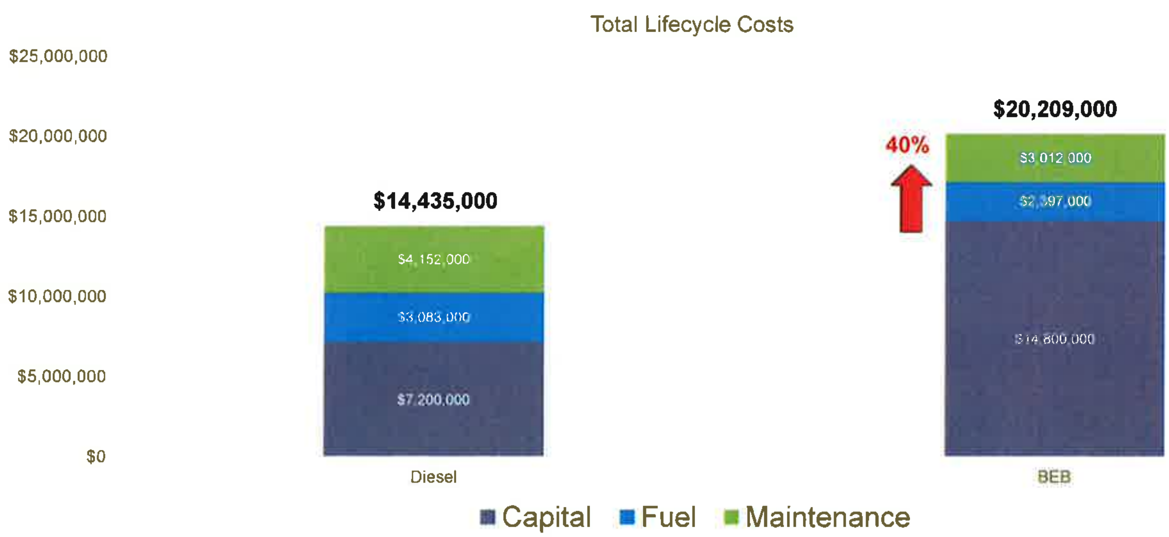
$251k annually

27% reduced annual maintenance costs

STV 100 Years transpogroup

TOTAL COST OF OWNERSHIP – MAINTENANCE COSTS (2/2)

TOTAL COST OF OWNERSHIP – TOTAL

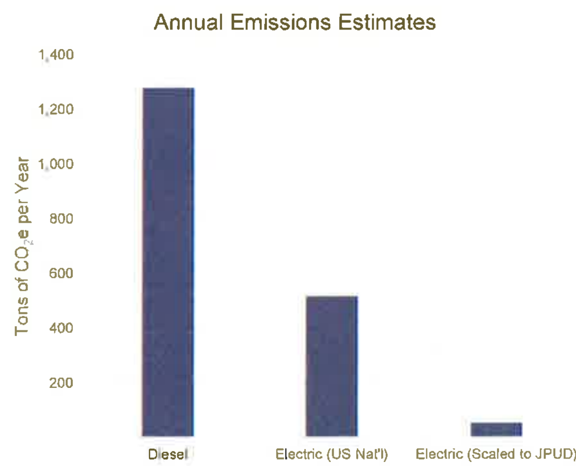


STV 100 Years transpogroup

GREENHOUSE GAS ESTIMATES

GREENHOUSE GAS EMISSIONS FROM OPERATIONS

- Estimated CO_2e g/mi[1]:
  - Diesel: 2,680
  - BEB: 1,078
    - Average US Energy Mix (60% fossil fuel)[2]
- Given JPUD's electricity mix (6% fossil fuel) and assuming linear scaling, could **save approximately 96% of emissions by switching to electric**
- Estimates only include operating emissions. Do not include emission from manufacturing



1. **Union of Concerned Scientists:** https://blog.ucsusa.org/jimmy-odea/electric-vs-diesel-vs-natural-gas-which-bus-is-best-for-the-climate
2. **US Energy Information Administration** https://www.eia.gov/energyexplained/electricity/data-and-statistics.php

SUMMARY

SUMMARY

Existing BEB technology does not allow 1:1 switch from diesel to EV given current schedule.
Would need to swap buses (increase fleet size), add on-route charging, or change schedule.

Switching to BEBs could save up to 96% of operating emissions.

40% increased cost to go electric.
(Likely could be reduced with grant funding)

$7.5B **New infrastructure bill has $7.5B for zero emissions buses and ferries**

Q&A

Paul Sharman
Project Manager
425.896.5262
paul.sharman@transpogroup.com

STV 100 Years   transpogroup

Jefferson Transit Authority
Transit Advisory Group
Remote Meeting Minutes

Wednesday, May 12, 2021, 3:30 pm
63 4 Corners Road, Port Townsend WA

TAG Board Members Present: Debbie Jahnke, Darrell Conder, Anne Metcalfe, John Nowak, Brenda McMillan, and Scott Walker with Brandon Maxwell, Tim Caldwell and Viviann Kuehl absent. A quorum was present.

Authority Board Member Present: None

Staff Present: General Manager Tammi Rubert, Finance Manager Sara Crouch, Fixed Mobility Operations Manager Miranda Nash, Grants and Procurement Jayme Brooke and Executive Assistant/Clerk of the Board SJ Peck

CALL TO ORDER/WELCOME

The meeting was called to order at 3:30 pm by Committee Chair Debbie Jahnke.

PUBLIC COMMENT

There was none.

CONSENT AGENDA ITEMS

Approval of May 12, 2021 Minutes

It was noted that the date for the next meeting be changed from June 7, 2021 to July, 7· 2021.

Motion: Darrell Conder moved to approve the May 12, 2021 Minutes with the change of date. John Nowak seconded. Vote: The motion carried unanimously, 6-0 by voice vote.

NEW AGENDA ITEMS

There were none.

UNFINISHED BUSINESS

Committee Name/Acronym

CAC members discussed the Transit Advisory Group (TAG) as the new committee name/acronym because it wasn't spoken for by other committees. Concern was expressed over using the word "group". It was thought this word is more informal than the word "committee". It was noted that other Advisory committees have used the word "group" in their title.

Motion: John Nowak moved to approve the Committee Name/Acronym to Transit Advisory Group (TAG). Scott Walker seconded. Vote: The motion carried unanimously, 6-0 by voice vote.

NEW BUSINESS

Transit is the Answer (Scott Walker) - Attachment A

Scott Walker presented on the following:

- Opportunities for Emissions Reduction
- Rider Friendly Schedule

There was discussion on the need for a shuttle in the Chimacum area. This is under consideration by JTA and a part of the Long Range Plan (LRP).

There was discussion on parking policies and incentivizing transit use particularly at Jefferson Healthcare. Free bus passes, bike lockers, and monthly drawings for using alternative modes of travel have been utilized at the hospital.

A destination schedule for transit was suggested. Frequency is a major barrier to riding transit. Community members don't want to be stranded. JTA will explore making schedules to major destinations.

A Commuter Perspective of Our Transit, Hadlock-PT

JTA worked with Route Match to implement a system called RouteShout for fixed routes. It did not work. JTA will continue to explore real time bus tracking systems.

A question arose about implementing WIFI on the buses. This uses the same technology as the bus tracking services. Cellular signal is unreliable in Jefferson County due to uneven terrain.

TDP Discussion

A suggestion was made to promote transit using a model from Watcom County. Smart Trips of Watcom provides an incentive to ride transit by partnering with local business and giving incentives to ride. JTA looked at Smart Trips a few years ago. At that time, it was expensive to participate in this program. It was outside of JTA's budget. JTA will revisit the feasibility of this program. JTA is also looking at rideshare, carpool and other multimodal transportation to maximize single use vehicles.

A suggestion was made for JTA to better advertise rideshare and other multi model transportation.

Recommendations were made to look at for alternative methods of dealing with hindering tree roots, JTA wait to research no emission vehicles until it is a proven viable option, and JTA looks into increasing bike capacity. It was also recommended the word commuter be dropped from the Kingston route, create rider friendly schedules, and advocate for transit supportive policies. JTA uses the word "commuter" because it falls under a classification for the Washington State Department of Transportation. The Electric Vehicle study is complete. At this time electric vehicles are only feasible for the Jefferson Transit shuttle route uptown/downtown.

Typos for the TDP will be sent to Jayme Brooks.

Discussion ensued on in-person meetings and the Open Public Meetings Act (OPMA). Jefferson Transit does not have the space to comply with the current OPMA capacity regulations for in-person meetings.

RIDERSHIP REPORT
Attachment B

Miranda Nash reported on the following ridership items:

- Fixed Route Daily Ridership Averages
- JTOC Daily Ridership Averages
- Dial-A-Ride Daily Ridership Averages

A comment was made about the lack of conversation on buses when riders are wearing masks.

PUBLIC COMMENT

Margaret Lee commented on pedestrian safety at the round-a-bout on Kearney Street and Highway 20, buses idling at the park and ride, and in-person meetings.

JTA is involved in roundabout design discussions and advocates for rider and pedestrian safety.

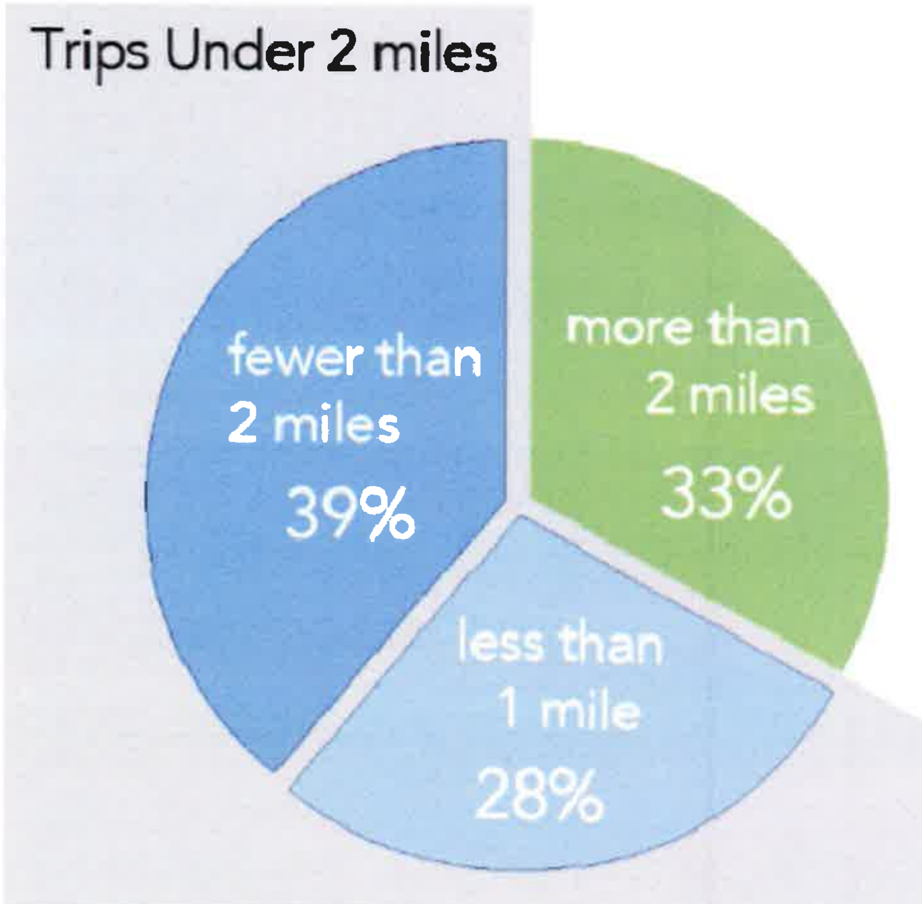
Adjournment

Motion: Scott Walker moved to adjourn. John Nowak seconded. Vote: The motion carried unanimously, 6-0 by voice vote.

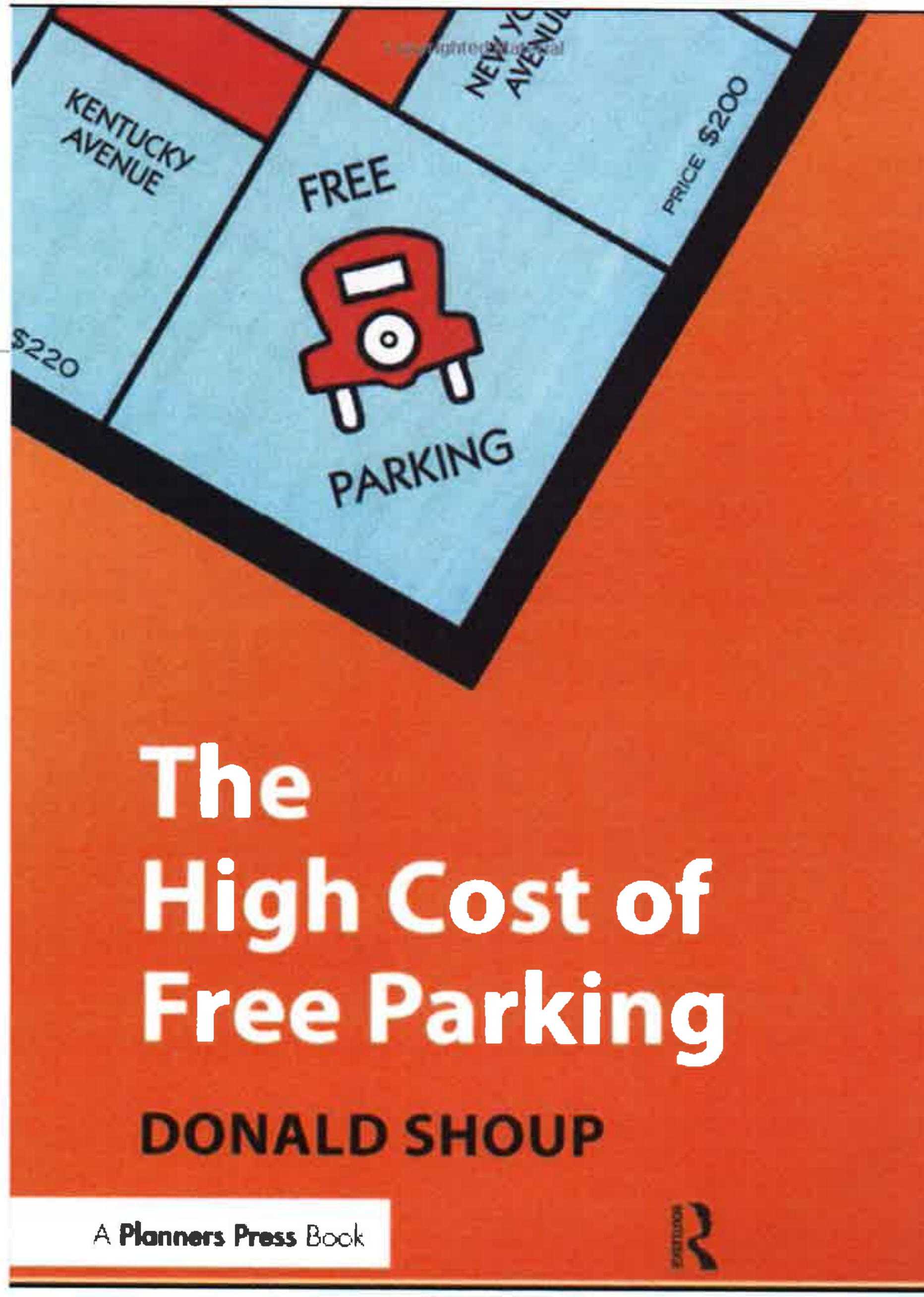
The meeting was adjourned at 5:04 pm. The next regular meeting will be held on September 1, 2021 at 3:30 pm.

SJ Peck, Clerk of the Board	Date

Opportunities for Emissions Reduction



- 87% of all trips are by motor vehicle
- Trips under two miles total 61% of all trips



KENTUCKY AVENUE
$220
FREE
PARKING
PRICE $200
The High Cost of Free Parking
DONALD SHOUP
A Planners Press Book

Two Aspects of Parking as Related to Carbon Emissions

- Fee-based parking management in dense commercial areas
- Parking minimums as part of development


Hill St
Landes Ct
Landes St
14th St
W Sims Way
20
12th St
Haines Pl
© 2021 Google
Google Earth
1985
Imagery Date: 8/15/2020 48°06'34.47" N 122°46'57.71" W elev 10 ft eye alt 822 ft


Google Earth

"What Do Residential Lotteries Show Us About Transportation Choices? Millard-Ball et al."

- Parking availability (or lack thereof) greatly changes decisions around car ownership and driving frequency. With less parking available, fewer people choose to own cars, and fewer people choose to drive to access jobs, goods and services.
- Parking availability (or lack thereof) does not affect employment or job mobility.
- Access to convenient (nearby and frequent) transit reduces frequency of car ownership and driving frequency.

"What Do Residential Lotteries Show Us About Transportation Choices? Millard-Ball et al."

- Greater access to high quality bicycle and pedestrian infrastructure also reduces frequency of car ownership and driving frequency.
- A building's parking ratio not only influences car ownership, vehicle travel, and transit use, but has a stronger effect than transit accessibility. Buildings with at least one parking space per unit (as required by zoning codes in most U.S. cities, and in San Francisco until circa 2010) have more than twice the car ownership rate of buildings that have no parking.

Access to Residential Parking puts More Cars on the Road

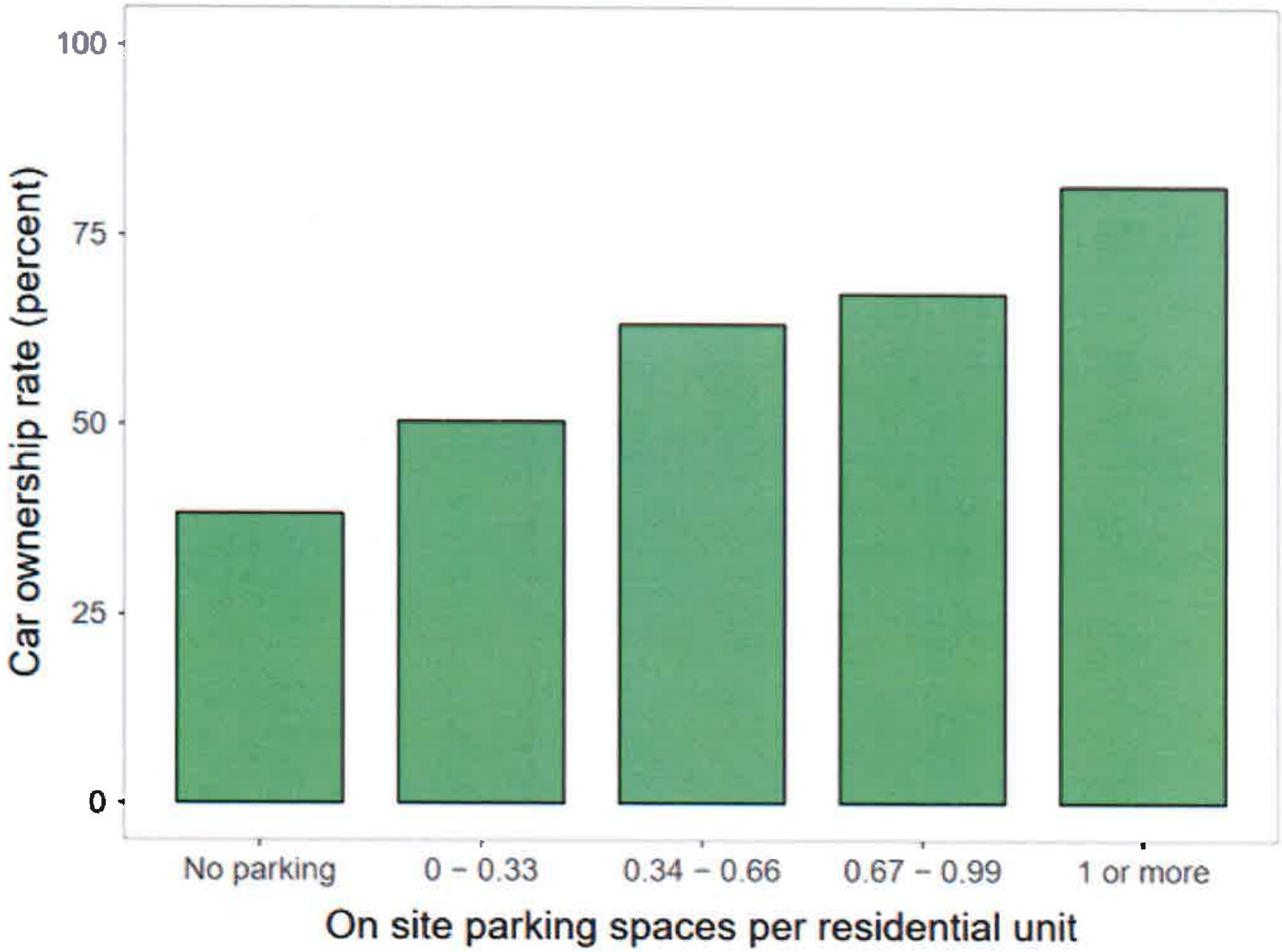


Image: Millard-Ball, West, Rezaei and Desai. Used with permission.

Percent Reduction in VMT as Daily Parking Charges and Transit Subsidies Increase

Daily Parking Charge	$0	$2.60	$5.20
Transit Subsidy of $0.00	0%	13.10%	28.60%
Transit Subsidy of $5.20	31%	52.50%	67.40%

% Reduction in VMT in Green

From: VTPI Trip Reduction Tables; September 6, 2019

Supporting Research

The Economist (2017), “Parkageddon: How Not to Create Traffic Jams, Pollution and Urban Sprawl. Don’t Let People Park for Free” *The Economist*, 8 April (www.economist.com); at https://econ.st/2pdbYaD.

C.J. Gabbe, Gregory Pierce and Gordon Clowers (2020), “Parking Policy: The Effects of Residential Minimum Parking Requirements in Seattle,” *Land Use Policy*, Vol. 91 (https://doi.org/10.1016/j.landusepol.2019.1040530); version at https://bit.ly/2W2v59L.

King County (2011-2018), *Right Size Parking Project and Calculator* (http://metro.kingcounty.gov); at https://bit.ly/2v0vUmZ.

Todd Litman (2007), *Parking Management: Comprehensive Implementation Guide*, VTPI (www.vtpi.org); at www.vtpi.org/park_man_comp.pdf.

More Supporting Research

Todd Litman (2011), "Why and How to Reduce the Amount of Land Paved for Roads and Parking Facilities," *Environmental Practice*, Vol. 13, No. 1, March, pp. 38-46; at http://journals.cambridge.org/action/displayJournal?jid=ENP. Also see, *Pavement Busters Guide*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/pavbust.pdf.

Todd Litman (2018), Parking Planning Paradigm Shift. More efficient parking management can benefit everybody, including motorists, businesses, residents, and any planner who becomes an expert on this subject, as I can report from experience. (https://www.planetizen.com/blogs/99462-parking-planning-paradigm-shift).

Todd Litman (2021), *Housing First; Cars Last. Underutilized parking lots are a costly waste. By managing parking more efficiently, cities can free up land to house people rather than cars*, Planetizen (www.planetizen.com); at www.planetizen.com/blogs/111790.

Christopher McCahill, et al. (2016), "Effects of Parking Provision on Automobile Use in Cities: Inferring Causality," *Transportation Research Record Journal of the Transportation Research Board*, 2543, pp. 159-165 (DOI: 10.3141/2543-19); at https://bit.ly/2XufqiP.

Steven Spears, Marlon G. Boarnet and Susan Handy (2014), *Policy Brief on the Impacts of Parking Pricing Based on a Review of the Empirical Literature*, California Air Resources Board (http://arb.ca.gov/cc/sb375/policies/policies.htm).

Richard Willson (2015), *Parking Management for Smart Growth*, Island Press (http://islandpress.org); at http://islandpress.org/book/parking-management-for-smart-growth.

We can significantly reduce Local GHG emissions from Transportation with Key Policy Changes

1. Rescind parking policies that lead sprawl
2. Rezone to encourage density
3. Implement a fee-based on-street parking management plan for dense commercial zones where demand is high; use revenues to subsidize transit

Transit Authority Board recognize that in their respective city and county government roles, for Transit to be the answer in addressing many problems, including GHG emissions, housing affordability, water pollution, sprawl, and more, that transit will never be what it can be without city and county parking policy changes and zoning changes. I encourage us to make a bold statement in this regard.

What Can the Climate Action Committee Do?

Recommend that the chair works with Scott to develop a draft recommendation to the city and county councils for the CAC to consider that summarizes the tie between parking policy and reduced VMT and GHG emissions, and recommends parking policy changes for GHG reduction, considering both zoning and managed parking.

Climate Action Committee

SCOTT WALKER

JUNE 8, 2021

2019 Ridership Total Including JTOC 258,956				2.8% increase in JT fixed route service, 5.6% decrease in JTOC service									
2019	Jan	Feb	Mar	Apr	May	June	July	August	Sept	Oct	Nov	Dec	Total Riders	Monthly Average
#1 Brinnon	1541	1172	1313	1541	1423	1351	1256	1419	1309	1468	1105	1099	15997	1333
#11 Shuttle	5559	4816	5692	5898	5950	6184	6597	6809	5388	5920	5186	5212	69011	5751
#2 Ft. Worden	1694	1383	1660	1727	1620	1666	2051	2037	1640	1620	1431	1421	20450	1704
#3 Castle Hill	1441	1204	1540	1650	1574	1727	1723	1761	1584	1703	1431	1391	18759	1563
#4 Upper Sims Loop	3590	3100	3571	3798	3584	3334	3343	3735	3120	3437	3350	3456	41397	3450
#6A Tri Area	1264	1122	1341	1466	1473	1328	1284	1405	1263	1616	1260	1208	16078	1340
#6B Tri Area	1163	989	1238	1267	1292	1284	1270	1413	1084	1174	1005	1117	14298	1191
#7 Poulsbo	1823	1605	1998	2016	1843	1839	2057	2302	1926	2016	1746	1634	22804	1909
#8 Sequim	1716	1374	1646	1611	1640	1637	1718	1975	1647	1661	1580	1470	19772	1648
Wooden Boat									4979				4979	
Riders	19791	16565	19998	20993	20679	20548	21297	22886	23940	20815	18124	18007	243643	20304
Average Per Day	761.19	720.22	769.15	807.42	795.35	821.92	819.12	847.63	997.50	770.93	755.17	720.28	798.83	
On Time Performance	94.96	95.39	93.96	90.07	86.84	87.22	87.91	90.21	88.84	89.69	91.47	89.72	87.07	90.52
#Days In Service	26	23	26	26	26	25	26	27	24	27	24	25	305	25.42
Mileage	39041	35624	38319	39037	39056	36660	38990	39859	35765	40597	35050	37376	455374	37948

2019 Notes

Feb 9, 2019 All JTA routes Cancelled due to SNOW

Feb 11, 2019 JTA 11A at 0740 missed due to snow/Closed JTOC service at 10:00, last three JTOC routes of the day Cancelled due to SNOW

2020 Ridership Total Including JTOC 106,716				58.5 % decrease in JT fixed route service, 62.6% decrease in JTOC service									
2020	Jan	Feb	Mar	Apr	May	June	July	August	Sept	Oct	Nov	Dec	Total Riders	Monthly Average
#1 Brinnon	1206	1333	1004	265	230	299	307	307	280	399	449	538	6617	551
#11 Shuttle	5230	5079	3425	1016	854	1169	1348	1478	1414	1548	2015	2356	26932	2244
#2 Ft. Worden	1470	1498	949	302	338	351	483	358	353	388	644	754	7864	655
#3 Castle Hill	1351	1428	867	232	347	452	532	349	372	435	649	810	7844	654
#4 Upper Sims Loop	3372	3416	2322	678	645	923	965	911	889	957	1487	1691	18256	1521
#6A Tri Area	1250	1370	1075	499	479	511	579	505	493	533	526	627	8447	704
#6B Tri Area	1091	1101	851	284	288	324	309	286	259	313	562	615	6293	524
#7 Poulsbo	1601	1860	1156	402	443	476	471	486	478	440	509	708	9030	753
#8 Sequim	1536	1491	1029	516	555	654	665	671	613	613	641	734	9718	810
Wooden Boat									CV19				CV19	
Riders	18107	18576	12698	4194	4179	5159	5679	5359	5151	5604	7462	8833	101001	8417
Average Per Day	696.42	743.04	488.38	190.64	208.95	234.50	246.91	255.19	245.29	254.73	324.43	339.73	364.62	
On Time Performance	89.68	91.3	92.34	91.84	88.69	94.81	94.51	89.17	87.2	93.18	96.4	96.1	92.1	92.20
#Days In Service	26	25	26	22	20	22	23	21	21	22	23	26	277	23
Mileage	38539	36660	36988	15423	13992	15383	16090.8	14692	14692	15391	34160	38991	291001	44769

2020 Notes

Week of January 13th, 2020 snow storm, ridership for the week was down approx 600 riders

1/31/2020 Bridge Closure due to winds, closure approx 7 hours, last two Poulsbo routes unable to go to Viking TC

3/30/20 began reduced service due to COVID-19

11/2/2020- Returned to full/regular Monday-Saturday service.

2021	Jan	Feb	Mar	Apr	May	June	July	August	Sept	Oct	Nov	Dec	Total Riders	Monthly Average
#1 Brinnon	492	638	670	760	725								3283	657
#11 Shuttle	2193	2040	2906	2737	2462								12338	2468
#2 Ft. Worden	753	678	815	961	891								4098	820
#3 Castle Hill	827	786	1043	1039	993								4688	938
#4 Upper Sims Loop	1608	1501	2074	1953	1768								8904	1781
#6A Tri Area	612	642	884	822	824								3784	757
#6B Tri Area	562	656	833	852	778								3678	736
#7 Poulsbo	678	709	1042	932	1001								4362	872
#8 Sequim	632	599	889	847	876								3843	769
Wooden Boat													0	
Riders	8357	8246	11156	10903	10316	0	0	0	0	0	0	0	48978	4082
Average Per Day	348.21	358.52	413.19	419.35	412.64									
On Time Performance	96.1	96.4	96.2	96.8	96.3									96.36
#Days In Service	24	23	27	26	25									25
Mileage	35050	34160	40584	38991	36661									37089

2021 Notes

2/13/21 There was a snowstorm which reduced ridership

Wooden Boat Festival September 7-9 2018 Ridership			
Fri 9/7	Sat 9/8	Sun 9/9	Total
1322	2185	724	4231

Wooden Boat Festival September 6-8 2019 Ridership			
Fri 9/6	Sat 9/7	Sun 9/8	Total
1374	2872	733	4979

Wooden Boat Festival September 2020 canceled/COVID

2019	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total Riders	Monthly Average
JTOC	1268	1096	1183	1455	1502	1201	1202	1511	1355	1179	1183	1178	15313	1276
#Days In Service	26	23	26	26	26	25	26	27	24	27	24	25	305	25
JTOC Mileage	12520	10825	12123	12465	12402	11581	12036	12697	11379	12218	11217	11972	143435	11953

Notes: Feb - two days early closure due to snow

Ridership 2018 compared to 2019, decrease of 5.6%

2020	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total Riders	Monthly Average
JTOC Riders	1058	997	996	284	187	306	314	308	367	357	315	340	5829	486
#Days In Service	26	25	26	22	20	22	23	21	21	22	19	22	269	22
JTOC Mileage	12229	11711	12003	5854	5460	5986	7193	8638	8572	9328	8010	9288	104272	8689

Notes: Snow week of January 13th
CV19- March 30th reduced service
July 22- 7:00am service restored.

Ridership 2019 compared to 2020, decrease of 62.6%

2021	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total Riders	Monthly Average
JTOC Riders	326	372	464	477	558								2197	439
#Days In Service	21	23	27	26	25								122	24
JTOC Mileage	9444	10894	12923	12365	11692								57318	11464

Notes:
January 19, 2021 JTOC returned to full schedule

Vanpool Ridership

2021 Jefferson Transit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Averages
Vanpool Groups in Operation	0	0	0	0	0								
Vans Available	9	9	9	9	9								
Loaner/Spare Vans in Fleet	2	2	2	2	2								
Total Active Vans in Fleet	11	11	11	11	11								
Loaners as % of Vanpool Fleet	18.18%	18.18%	18.18%	18.18%	18.18%	18.18%	18.18%	18.18%	18.18%	18.18%	18.18%	18.18%	
Vanpool Group Starts	0	0	0	0	0								
Vanpool Group Folds	0	0	0	0	0								
Passenger Trips	0	0	0	0	0								0
Average Riders Per Van	0.0	0.0	0.0	0.0	0.0								0
RevenueMiles Traveled	0	0	0	0	0								0
Average Round Trip Miles	0.0	0.0	0.0	0.0	0.0								0
Revenue Hours:	0	0	0	0	0								0

Dial-A-Ride

2020	Jan	Feb	Mar	Apr	May	June	July	August	Sept	Oct	Nov	Dec	Totals	Average
Client Boardings	1166	1245	769	193	263	377	512	513	464	522	437	494	6957	580
PCA Boardings	51	100	50	6	16	26	23	14	9	33	16	50	394	33
Other Boardings	4	7	8	0	0	2	0	0	0	0	0	0	21	2
Riders	1223	1352	827	199	279	405	535	527	473	555	453	544	7372	614
Trips	1113	1138	711	187	247	349	489	499	456	489	421	444	6542	545
Service Hours	653	627	461	173	202	253	319	320	294	314	298	302	4216	351
Service Mileage	5968	5955	4322	1426	1629	2497	3314	3315	2981	3192	2946	2843	40388	3366
Avg Riders per day	47	54	32	9	14	18	23	25	23	25	20	22	26.71	25.99
Trip Productivity	1.10	1.19	1.16	1.06	1.13	1.16	1.09	1.06	1.04	1.13	1.08	1.23	1.13	1.12
On Time Performance	95%	93%	92%	93%	94%	92%	92%	91%	91%	96%	98%	96%		94%
#Days In Service	26	25	26	22	20	22	23	21	21	22	23	25	276	23

*February has a drop in ridership due to inclement weather/ snows day in which many riders cancelled their trips.

*February 9th DAR cancelled due to snow routes

2021	Jan	Feb	Mar	Apr	May	June	July	August	Sept	Oct	Nov	Dec	Totals	Monthly Average
Client Boardings	512	462	730	724	801								3229	646
PCA Boardings	30	23	48	56	51								208	42
Other Boardings	0	1	0	4	4								9	2
Riders	542	486	778	784	856	0	0	0	0	0	0	0	3446	689
Trips	482	438	682	664	746								3012	602
Service Hours	322	310	439	397	427								1895	379
Service Mileage	3166	3063	4240	3899	4366								18734	3747
Avg Riders per day	22.58	21.13	28.81	30.15	34.24								27.57	27.38
Trip Productivity	1.12	1.11	1.14	1.18	1.15								1.14	1.14
On Time Performance	94%	94%	94%	95%	94%									94%
#Days In Service	24	23	27	26	25								125	25

Route Studies Discussion

To Port Townsend: Weekday Service

	Chimacum Chevron	Curtis@ Irondale	Hadlock Post Office	Jefferson County Library	Hwy 19 & WA 116	5th @ Eugene	7th @ Maude	Hwy 19. @ McCrories	HJ Carroll Park	Salmon Business Park	Four Corners & SR 20	Jefferson Healthcare	Park & Ride
#6A Tri Area	7:15	--	--	--	--				7:17	7;19	7:24	7:33	7:35
#1 Brinnon	7:51	7:57		8:00	8:01				--		8:07	8:19	8:22
#7 Poulsbo		8:05		8:08					--		8:14	8:23	8:27
#6B Tri Area	9:19	9:21	9:22	9:25	--	9:29	9:32	9:35	--	--	9:39	9:48	9:52
#1 Brinnon	9:58	10:04		10:07	10:08						10:13	10:24	10:26
#6A Tri Area	10:30								10:32	10:34	10:39	10:48	10:52
#6B Tri Area	11:19	11:21	11:22	11:25		11:29	11:32	11:35	--	--	11:39	11:48	11:53
#7 Poulsbo		11:32		11:36					--		11:41	11:50	11:54
#6B Tri Area	12:19	12:21	12:22	12:25			12:32	12:35			12:39	12:48	12:52
#7 Poulsbo		12:54		12:58					--		1:03	1:12	1:16
#6A Tri Area	1:30								1:32	1:34	1:39	1:50	1:52
#6A Tri Area	2:30								2:32	2:34	2:39	2:48	2:52
#6B Tri Area	3:19	3:21	3:22	3:25			3:32	3:35	--	--	3:39	3:48	3:52
#1 Brinnon	4:12	4:18		4:21	4:23	--	--		--		4:27	4:37	4:40
#6A Tri Area	4:30								4:32	4:34	4:39	4:48	4:52
#7 Poulsbo		5:50		5:54							5:59	6:08	6:12
#6B Tri Area	7:24	7:26	7:27	7:30	--	7:34	7:37	7:40	--	--	7:44	--	--
#7 Poulsbo		7:35		7:39		--	--		--	--	7:44	7:53	7:57
#1 Brinnon	7:30	7:36		7:39	7:41				--		7;44	--	--

courtesy Gerald Braude

To Port Townsend Saturday Service:

#1 Brinnon	8:51	8:57		9:00	9:01				--		9:08	9:18	9:20
#6A Tri Area	9:30								9:32	9:34	9:39	9:48	9:50
#6B Tri Area	11:19	11:21	11:22	11:25		11:29	11:32	11:35	--	--	11:39	11:48	11:53
#7 Poulsbo		11:22		11:26							11:31	11:39	11:43
#6B Tri Area	1:19	1:21	1:22	1:25		1:29	1:32	1:36	--	--	1:39	1:48	1:53
#6A Tri Area	4:30								4:32	4:34	4:39	4:48	4:52
#7 Poulsbo	--	4:47		4:51					--		4:56	5:04	5:08
#1 Brinnon	7:26	7:32		7:35	7:36				--		7:40	--	--
#6B Tri Area	7:24	7:26	7:27	7:30		7:34	7:37	7:40	--	--	7:44	7:53	7:55

courtesy Gerald Braude

To Tri Area: Weekday Service

	Park & Ride	Sims @ Hendricks	Four Corners @ SR 20	Irondale at Sign Station	7th @ Maude	5th @ Eugene	Salmon Business Park	H.J. Carroll Park	Jefferson County Library	Hadlock Post Office	Pt. Hadlock QFC	Chimacum Chevron
#1 Brinnon			6:10					--	6:16		6:18	6:24
#7 Poulsbo	5:59	6:01	6:09						6:15		6:24	
#6A Tri Area	6;45	6:47	6:55	6:58	7:01	7:03			7:08	7:10	7:11	7:15
#1 Brinnon	7:30	7:32	7:40					--	7:45		7:48	7:53
#6B Tri Area	9:00	9:02	9:10				9:12	9:17				9:19
#7 Poulsbo	9:15	9:17	9:28						9:33		9:37	--
#6A Tri Area	10:00	10:02	10:10	10:13	10:16	10:18			10:23	10:25	10:26	10:30
#7 Poulsbo	10:40	10:42	10:50				--	--	10:57		11:01	--
#6B Tri Area	11:00	11:02	11:10				11;12	11:17				11:19
#6B Tri Area	12:00	12:02	12:10	--	--	--	12:12	12:17				12:19
#6A Tri Area	1:00	1:02	1:10	1:13	1:16	1:18			1:23	1:25	1:26	1:30
#1 Brinnon	2:00	2:02	2:12					--	2:20		2:23	2:29
#6A Tri Area	2:00	2:02	2:10	2:13	2:16	2:18			2:23	2:25	2:26	2:30
#6B Tri Area	3:00	3:02	3:10	--	--	--	3:12	3:17				3:19
#7 Poulsbo	3:12	3:14	3:23				--	--	3:31		3:35	--
#6A Tri Area	4:00	4:02	4:10	4:13	4:16	4:18	--	--	4:23	4:25	4:26	4:30
#7 Poulsbo	5:08	5:10	5:19				--	--	5:26		5:31	--
#1 Brinnon	5:37	5:39	5:47					--	5:53		5:55	5:57
#6B Tri Area	7:05	7:07	7:15	--	--	--	7:17	7:22	--	--	--	7:24

courtesy Gerald Braude

To Tri Area: Saturday Service

#1 Brinnon	6:50	6:52	7:00					--	7:04		7:07	7:12
#6A Tri Area	9:00	9:02	9:10	9:13	9:16	9:18			9:23	9:25	9:26	9:30
#7 Poulsbo	9:25	9:27	9:35				--	--	9:40		9:44	--
#6B Tri Area	11:00	11:02	11:10	--	--	--	11:12	11:17				11:19
#6B Tri Area	1:00	1:02	1: 10	--	--	--	1:12	1:17				1:19
#7 Poulsbo	2:30	2:32	2:40						2:45		2:49	
#6A Tri Area	4:00	4:02	4:10	4:13	4:16	4:18			4:23	4:25	4:26	4:30
#1 Brinnon	5:25	5:27	5:35					--	5:39		5:42	5:47
#6B Tri Area	7:05	7:07	7:15	--	--	--	7:17	7:22				7:24

courtesy Gerald Braude

Ridership Report

2019 Ridership Total including JTOC 258,956 — **2.8% increase in JT fixed route service, 5.6% decrease in JTOC service**

2019	Jan	Feb	Mar	Apr	May	June	July	August	Sept	Oct	Nov	Dec	Total Riders	Monthly Average
#1 Brinnon	1541	1172	1313	1541	1423	1351	1256	1419	1308	1468	1105	1099	15997	1333
#11 Shuttle	5559	4616	5692	5898	5950	6184	6597	6809	5388	5920	5186	5212	69011	5751
#2 Ft. Worden	1694	1383	1680	1727	1820	1966	2051	2037	1640	1620	1431	1421	20450	1704
#3 Castle Hill	1441	1204	1540	1650	1574	1727	1723	1791	1584	1703	1431	1391	18759	1563
#4 Upper Sims Loop	3590	3100	3571	3798	3664	3334	3343	3735	3120	3437	3350	3465	41397	3450
#6A Tri Area	1264	1122	1341	1486	1473	1326	1284	1405	1263	1616	1280	1208	16078	1340
#6B Tri Area	1163	989	1238	1267	1292	1284	1270	1413	1084	1174	1005	1117	14296	1191
#7 Poulsbo	1823	1605	1998	2015	1843	1839	2057	2302	1926	2016	1746	1634	22904	1909
#8 Sequim	1716	1374	1645	1611	1640	1537	1716	1975	1647	1661	1580	1470	19772	1648
Wooden Boat									4979				4979	
Riders	**19791**	**16565**	**19998**	**20993**	**20679**	**20548**	**21297**	**22886**	**23940**	**20815**	**18124**	**18007**	**243643**	**20304**
Average Per Day	**761.19**	**720.22**	**769.15**	**807.42**	**795.35**	**821.92**	**819.12**	**847.63**	**997.50**	**770.93**	**755.17**	**720.28**	**798.83**	
On Time Performance	94.96	95.39	93.96	90.07	86.84	87.22	87.91	90.21	88.84	89.69	91.47	89.72	87.07	90.52
#Days In Service	26	23	26	26	26	25	26	27	24	27	24	25	305	25.42
Mileage	39041	35624	38319	39037	39056	36660	38990	39859	35765	40597	35050	37376	455374	37948

2019 Notes

Feb 9, 2019 All JTA routes Cancelled due to SNOW

Feb 11, 2019 JTA 11A at 0740 missed due to snow/Closed JTOC service at 10:00, last three JTOC routes of the day Cancelled due to SNOW

2020 Ridership Total including JTOC 106,716 — **58.5 % decrease in JT fixed route service, 62.6% decrease in JTOC service**

2020	Jan	Feb	Mar	Apr	May	June	July	August	Sept	Oct	Nov	Dec	Total Riders	Monthly Average
#1 Brinnon	1206	1333	1004	265	230	299	307	307	280	399	449	538	6617	551
#11 Shuttle	5230	5078	3425	1016	854	1169	1348	1478	1414	1548	2015	2356	26932	2244
#2 Ft Worden	1470	1498	949	302	338	351	483	356	353	368	844	754	7864	655
#3 Castle Hill	1351	1428	887	232	347	452	532	349	372	435	849	810	7844	654
#4 Upper Sims Loop	3372	3418	2322	678	645	923	985	911	889	957	1487	1691	18256	1521
#6A Tri Area	1250	1370	1075	499	479	511	579	505	493	533	526	627	8447	704
#6B Tri Area	1091	1101	851	284	288	324	309	298	259	313	582	615	6293	524
#7 Poulsbo	1601	1860	1158	402	443	476	471	486	478	440	509	708	9030	753
#8 Sequim	1536	1491	1029	516	555	654	665	671	613	613	841	734	9718	810
Wooden Boat									CV19				CV19	
Riders	**18107**	**18576**	**12698**	**4194**	**4179**	**5159**	**5679**	**5359**	**5151**	**5604**	**7462**	**8833**	**101001**	**8417**
Average Per Day	**696.42**	**743.04**	**488.38**	**190.64**	**208.95**	**234.50**	**246.91**	**255.19**	**245.29**	**254.73**	**324.43**	**339.73**	**364.62**	
On Time Performance	89.68	91.3	92.34	91.84	88.69	94.81	94.51	89.17	87.2	93.18	96.4	96.1	92.1	92.20
#Days In Service	26	25	26	22	20	22	23	21	21	22	23	26	277	23
Mileage	38539	36660	36988	15423	13992	15383	16090.8	14692	14692	15391	34160	38991	291001	44769

2020 Notes

Week of January 13th, 2020 snow storm, ridership for the week was down approx 600 riders

1/31/2020 Bridge Closure due to winds, closure approx 7 hours, last two Poulsbo routes unable to go to Viking TC

3/30/20 began reduced service due to COVID-19

11/2/2020- Returned to full/regular Monday-Saturday service.

2019	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total Riders	Monthly Average
JTOC	1268	1096	1183	1455	1502	1201	1202	1511	1355	1179	1183	1178	15313	1276
#Days In Service	26	23	26	26	26	25	26	27	24	27	24	25	305	25
JTOC Mileage	12520	10825	12123	12465	12402	11581	12036	12697	11379	12218	11217	11972	143435	11953

Notes: Feb - two days early closure due to snow

Ridership 2018 compared to 2019, decrease of 5.6%

2020	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total Riders	Monthly Average
JTOC Riders	1058	997	996	284	187	306	314	308	367	357	315	340	5829	486
#Days In Service	26	25	26	22	20	22	23	21	21	22	19	22	269	22
JTOC Mileage	12229	11711	12003	5854	5460	5986	7193	8638	8572	9328	8010	9288	104272	8689

Notes: Snow week of January 13th
CV19- March 30th reduced service
July 22- 7:00am service restored.

Ridership 2019 compared to 2020, decrease of 62.6%

2021	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total Riders	Monthly Average
JTOC Riders	326	372	464	477	558	484	590						3271	467
#Days In Service	21	23	27	26	25	26	27						175	25
JTOC Mileage	9444	10894	12923	12365	11692	12420	12697						82435	11776

Notes:

January 19, 2021 JTOC returned to full schedule

2021	Jan	Feb	Mar	Apr	May	June	July	August	Sept	Oct	Nov	Dec	Total Riders	Monthly Average
#1 Brinnon	492	636	670	760	725	812	825						4920	703
#11 Shuttle	2193	2040	2906	2737	2462	3013	3481						18832	2690
#2 Ft. Worden	753	678	815	961	891	997	1253						6348	907
#3 Castle Hill	827	786	1043	1039	993	1031	1186						6905	986
#4 Upper Sims Loop	1608	1501	2074	1953	1768	1984	2132						13020	1860
#6A Tri Area	612	642	884	822	824	858	843						5485	784
#6B Tri Area	562	656	833	852	776	866	825						5369	767
#7 Poulsbo	678	709	1042	832	1001	1139	1309						6810	973
#8 Sequim	632	599	889	847	876	976	1115						5934	848
Wooden Boat													0	
Riders	8357	8246	11156	10903	10316	11676	12969	0	0	0	0	0	73623	6135
Average Per Day	348.21	358.52	413.19	419.35	412.64	449.08	480.33	0.00	0.00	0.00	0.00	0.00		
On Time Performance	96.1	96.4	96.2	96.8	96.3	95.47	96.5							96.25
#Days In Service	24	23	27	26	25	26	27	26	25	26	24	26		25
Mileage	35050	34160	40584	38991	36661	38991	39877							37759

2021 Notes

2/13/21 There was a snowstorm which reduced ridership

Wooden Boat Festival September 7-9 2018 Ridership			
Fri 9/7	Sat 9/8	Sun 9/9	Total
1322	2185	724	4231

Wooden Boat Festival September 6-8 2019 Ridership			
Fri 9/6	Sat 9/7	Sun 9/8	Total
1374	2872	733	4979

Wooden Boat Festival
September 2020 cancelled/COVID

Wooden Boat Festival September10-12 2021 Ridership			
Fri 9/10	Sat 9/11	Sun 9/12	Total
0	0	0	0

Vanpool Ridership

2021 Jefferson Transit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Averages
Vanpool Groups in Operation	0	0	0	0	0	0							
Vans Available	9	9	9	9	9	9							
Loaner/Spare Vans in Fleet	2	2	2	2	2	2							
Total Active Vans in Fleet	11	11	11	11	11	11							
Loaners as % of Vanpool Fleet	18.18%	18.18%	18.18%	18.18%	18.18%	18.18%	18.18%	18.18%	18.18%	18.18%	18.18%	18.18%	
Vanpool Group Starts	0	0	0	0	0	0							
Vanpool Group Folds	0	0	0	0	0	0							
Passenger Trips	0	0	0	0	0	0							0
Average Riders Per Van	0.0	0.0	0.0	0.0	0.0	0.0							0
RevenueMiles Traveled	0	0	0	0	0	0							0
Average Round Trip Miles	0.0	0.0	0.0	0.0	0.0	0.0							0
Revenue Hours:	0	0	0	0	0	0							0

Dial-A-Ride

2020	Jan	Feb	Mar	Apr	May	June	July	August	Sept	Oct	Nov	Dec	Totals	Average
Client Boardings	1168	1245	769	193	263	377	512	513	464	522	437	494	6957	580
PCA Boardings	51	100	50	6	16	26	23	14	9	33	16	50	394	33
Other Boardings	4	7	8	0	0	2	0	0	0	0	0	0	21	2
Riders	1223	1352	827	199	279	405	535	527	473	555	453	544	7372	614
Trips	1113	1138	711	187	247	349	489	499	455	489	421	444	6542	545
Service Hours	653	627	461	173	202	253	319	320	294	314	298	302	4216	351
Service Mileage	5968	5955	4322	1426	1629	2497	3314	3315	2981	3192	2946	2843	40388	3366
Avg Riders per day	47	54	32	9	14	18	23	25	23	25	20	22	26.71	25.99
Trip Productivity	1.10	1.19	1.16	1.06	1.13	1.16	1.09	1.06	1.04	1.13	1.08	1.23	1.13	1.12
On Time Performance	95%	93%	92%	93%	94%	92%	92%	91%	91%	96%	98%	96%		94%
#Days In Service	26	25	26	22	20	22	23	21	21	22	23	25	276	23

*February has a drop in ridership due to inclement weather/ snows day in which many riders cancelled their trips.

*February 9th DAR cancelled due to snow routes

2021	Jan	Feb	Mar	Apr	May	June	July	August	Sept	Oct	Nov	Dec	Totals	Monthly Average
Client Boardings	512	462	730	724	801	712	731						4672	667
PCA Boardings	30	23	48	56	51	0	50						258	37
Other Boardings	0	1	0	4	4	41	5						55	8
Riders	542	486	778	784	856	753	786	0	0	0	0	0	4985	712
Trips	482	438	682	664	746	712	731						4455	636
Service Hours	322	310	439	397	427	482	427						2804	401
Service Mileage	3166	3063	4240	3699	4368	4495	4647						27876	3982
Avg Riders per day	22.58	21.13	28.81	30.15	34.24	28.96	29.11						28.01	27.86
Trip Productivity	1.12	1.11	1.14	1.18	1.15	1.06	1.08						1.12	1.12
On Time Performance	94%	94%	94%	95%	94%	94%	93%							94%
#Days In Service	24	23	27	26	25	26	27						178	25