CORVALLIS AREA
Metropolitan Planning Organization

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TECHNICAL ADVISORY COMMITTEE

Thursday, February 28, 2019
9:00 - 11:00 am
CAMPO Office, 777 NW 9th Street, Suite 204C
Corvallis, OR 97330

AGENDA

I.	**Call to Order**	Chair, Greg Gescher
II.	**Agenda Review**	Chair
III.	**Public Comments**	Chair
IV.	**Minutes of November 2, 2018** (Attachment A) **ACTION: Decision**	Chair
V.	**ADA Design Training** (Attachment B) *Review of upcoming training and discussion on attendance* **ACTION: Decision**	Meltzer
VI.	**Electric Bus Study** (Attachment C) *Review draft report* **ACTION: Discussion**	Nappa
VII.	**Regional Performance Measures** *Discuss outcome of RTSP discussion from Policy Board meeting and begin conversation on performance measures*	Meltzer
VIII.	**Updates** *CAMPO Staff Report* *Jurisdictional Reports*	Chair
IX.	**Adjourn**	Chair

Meeting facilities are accessible to persons with disabilities. If you will need any special accommodations, please contact Emma Chavez at least 72 hours prior to the meeting.
Emma can be reached at 541-924-84051. TTY/TTD 711

CORVALLIS AREA METROPOLITAN PLANNING ORGANIZATION
TECHNICAL ADVISORY COMMITTEE
Friday, November 2, 2018
CAMPO Office, Corvallis

DRAFT MINUTES

Members Attending: Greg Gescher, Gary Stockhoff, James Feldmann, and Rebecca Houghtaling
Members Absent: Barry Hoffman, Pat Hare, and Chris Workman
Staff: Phil Warnock, Nick Meltzer, and Emma Chavez

TOPIC	DISCUSSION	DECISION / CONCLUSION
I. Call to Order	The Chair, Greg Gescher called the meeting to order at 10:08 am.	
II. Agenda Review		**There were no changes to the agenda.**
III. Minutes of: September 28, 2018	Gescher provided handwritten clarification on minutes. The spelling of James Feldmann's last name needs to be corrected.	**Consensus by the TAC to approve the September 28, 2018 meeting minutes with corrections.**
IV. Policy on TIP Amendment	Staff Nick Meltzer advised that the Policy on TIP Amendment was discussed at the last TAC meeting. Comments that were provided at the meeting have been incorporated. Members fell into discussion and made the decision to move Number 9. Scope changes including extension or shortening of a project to an Administrative Amendment. Rebecca Houghtaling moved to approve the Policy on TIP Amendment with update to number 9. Seconded by Greg Gescher. Consensus by the TAC.	**Consensus by the TAC to recommend the Policy on TIP Amendment to the Policy Board.**
V. NACTO/Oregon APA/OMUG Debrief	Meltzer summarized the lessons learned from attending the National Association of Transportation Officials (NACTO) conference, as well as the Oregon American Planning Association (OAPA) conference. Meltzer stated that when he attended the NACTO conference he focused on attending the segments that were more non-design	

	oriented, in order to hear more viewpoints about why transportation matters. Major Takeaways: • The scale of what's happening in Los Angeles is much bigger than our region, but there are still lessons to be learned. They've had to become more efficient, nimble and proactive due to necessity, and we have the opportunity to do that as well. • New technologies are coming whether we're ready or not, and it's better to be ahead of the issue rather than reactive. • Cities are building projects more quickly and cheaply, while also evaluating their long term use • How can CAMPO build capacity internally and externally to set up our communities for success? Trainings, policy guidance and data collection Additionally, he noted that there is interest from COG staff on whether the COG could become a NACTO member. Phil Warnock added that the ACT has never been asked to do something on a Regional level that would benefit both AAMPO and CAMPO. There may be a lot of leverage that can be brought in Regionally with a membership through NACTO and Regional requests to the ACT. Meltzer will explore the issue. Meltzer questioned if the City of Corvallis would be interested in a bikeway training if CAMPO sponsored it. Gescher stated that, they would. Meltzer also advised that when he attended the Oregon APA Conference, the City of Bend advised that they implemented a count system. Staff would like CAMPO to work on a count system there is interest. Meltzer went on to provide information on the different types of count mechanisms. Gescher stated that the city has discussed this	

	previously, and would also be interested in moving this forward.	
VI. Updates	CAMPO Staff Report – ODOT performance measures have been a slow roll out based on MAP-21. MPOs are asked to accept ODOT measures or set their own measures. CAMPO accepted ODOTs Safety Measures, and now it needs to consider Pavement, Bridge, and National Highway performance measures. These measures need to be approved by November 16th. If CAMPO decides to adopt its own measures, it would need to collect and report its own data. Houghtaling questioned if ODOT is collecting data on the non-interstate highways. Meltzer noted that it's on the national highway system (NHS). In reference to the local arterial collector, they are all part of the NHS. James Feldman got online to verify that arterial collectors are in fact part of the NHS. Meltzer went on to advise that Tarah Campi the AAMPO lead staff has moved to California and is contracting with the COG. A full time Transportation Planner and an Assistant Planner positions have been posted. The Transportation Planner will be taking Campi's place and the Assistant Planner will assist the MPOs. Benton County – The County now has a Facilities Manager. STIF Committee work continues and will be discussing funding at its meeting on Monday. Is also working on extending its dial a bus contract. A draft of the TSP has been received. It is scheduled to be approved in February of 2019. City of Corvallis – The TSP is in its final draft and will be reviewed this month by both the Planning Commission and planning hearing. The Planning Commission will make a recommendation and the City Council will hold a public hearing. The TDP will be ready when the City begins applying for STIF funds. The City has gone through interviews for the Bike and Ped Coordinator. There is someone the city is interested in. Lastly, there was no strike and on Monday the City Council will ratify the new contract.	

	OSU – Has a new Landuse Planning Manager. He's responsible for the landuse planning coordination regarding and will be working with the City and County. OSU has also wrapped up its Transportation Plan which is not subject to the Transportation Planning Rules. Therefore the document is more of a vision, rather than a plan. A final version is set to be received by end of week. The University is starting a physical development strategy, an 18 month planning project. The Universities Transportation Plan will assist in the development of this strategy. Lastly, Houghtaling reported that there is a Scope of Work (SOW) for Washington Way and they have awarded a contractor to do the design work. The first phase will begin in November. ODOT – Has a consultant on board for the Van Buren project. The Hwy 20 Safety improvement project is also getting a consultant on board soon. Granger and Independence are priority intersections. There was question on the Hwy 20/34 between Corvallis and Philomath and recognizing large truck traffic and giving a priority through movement. Feldmann did not have that information. OCWCOG – Phil Warnock reported that applications have been received for the Planner and Assistant Planner positions. He noted that there are promising candidates to be interviewed. The Electric Bus Study is moving along. Staff has interviewed all the providers in the state that currently use electric busses or are implementing them. There is a break between large and small providers. Smaller providers are seeing electrification as the future and are going ahead with implementation of electric vehicles with a small fleet. Larger providers are taking their time studying electrification. Houghtaling suggested that CAMPO may want to explore testing an electric bus on campus.	
VII. Adjournment	The December meeting falls during the holidays therefore staff will reschedule the meeting via email. Meeting adjourned at 11:45 am.	

The Kiewit Center for Infrastructure & Transportation

ADA Design & Regulation

CONTENT

- Human Factors/Ergonomics of Vulnerable Populations
- Urban Street Design for Bikes and Pedestrians
- Accessible Roadway and Intersection Infrastructure
- New Federal Requirements for Accessible:
  - Rights of Way
  - Intersection Design
- Oregon Specific Design Standards are Regulations

ABOUT

This one-day class is designed for planners, engineers, and technicians who are responsible for planning, design and operations of roadway systems. The class will provide an overview of the design requirements for ADA design elements for all street users. The course will introduce new elements of urban street designs that can increase access and inclusion, but also increase conflicts. The course will quickly summarize and build on information provided in other workshops on Traffic Engineering Fundamentals, MUTCD and Traffic Signal Design.

LEARNING OUTCOMES

At the completion of the course, participants will have an increased understanding of:

- design for vulnerable populations
- the regulations and guidance for the design and operation of accessible pedestrian facilities
- conflicts between motorized and non-motorized modes of transportation
- resources available to assist transportation professionals in design and operation of inclusive transportation facilities

SCHEDULE

Registration, with continental breakfast, is from 8:00 to 8:30 am. The class adjourns by 5 pm.

COURSE LOCATION

The LaSells Stewart Center is located on the Oregon State University campus in Corvallis, at the corner of Western Blvd and 26th Street. Visitor parking is available in the OSU parking structure.

INSTRUCTIONAL STAFF

Sheila Lyons , PE
Former ODOT Bicycle & Pedestrian Program Manager

Kate Hunter-Zaworski , PhD, PE
OSU, Associate Professor

ENROLLMENT

Return the attached application form and fee to The Kiewit Center at least one week prior to the class. Registration is limited to the first 35 applicants. If a registration must be canceled, a full refund can be made only if a notice of withdrawal is received at least one week prior to the course starting date. A fee of one-half of the course tuition will be charged for cancellations after that period; substitute attendees are encouraged.

Registration fees cover tuition, course materials, morning coffee and donuts, break refreshments, and lunch.

Tuesday
March 19
Corvallis, OR

$155
6.5 PDH

Register Online
cce.oregonstate.edu/traffic-safety-workshops

Area Lodging
visitcorvallis.com

This publication will be made available in accessible formats upon request. Please call 541-737-4273 for information.

Oregon State University

Attachment B

ADA — March 19 — $155

Name:	Agency
Title: Phone:	Email:
Address:	City, State, Zip:
Dietary Restrictions?	Purchase order _____ Bill me ____ Check Coming _____

One application per person; copy if necessary. Make checks payable to: **The Kiewit Center**
Mail to: The Kiewit Center, OSU, 101 Kearney Hall, Corvallis, OR 97331 *Attn: Traffic Safety Workshops*
email: nancy.brickman@oregonstate.edu

Oregon State University
College of Engineering

The Kiewit Center for Infrastructure & Transportation
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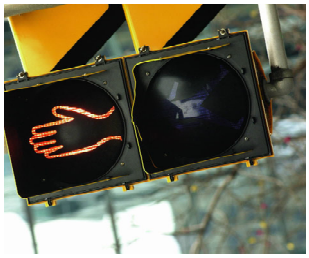
ADA Design and Regulation

March 19, 2019



Sponsored by

The Kiewit Center
for Infrastructure & Transportation
at OSU

and

Oregon Traffic Safety Division
Oregon Department of Transportation

Attachment C

CORVALLIS AREA
Metropolitan Planning Organization

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MEMORANDUM

DATE: February 20, 2019
TO: CAMPO TAC and Policy Board
FROM: Stephanie Nappa and Nick Meltzer
RE: **Battery Electric Bus Feasibility Study**

This memorandum evaluates the feasibility of utilizing battery electric buses in the Corvallis Transit System. It includes potential costs, social benefits, and a summary of technology decisions for Corvallis to consider.

Introduction

Electric Buses are becoming increasingly popular in transit fleets across North America, and the world. Transit providers in Los Angeles, Seattle, and Vancouver, BC have pledged to purchase exclusively zero emission vehicles starting in 2025. Furthermore, electric buses are currently being tested in Washington, DC, Park City, Utah, Chicago, Louisville, KY, Albuquerque, NM, and Portland, Oregon. The technology is evolving exponentially, the market is expanding and a new US manufacturing sector is under development. [1]

But what does this mean for Corvallis? What differences exist between their transit system and those listed above? Does it make sense to invest now in electric buses?

The Corvallis Area MPO previously examined the feasibility of compressed natural gas (CNG) buses for Corvallis Transit System. During the review of the study, the community provided feedback that the life cycle impacts of CNG are not environmentally friendly due to the processing methods for the gas, primarily extraction through fracking. The evolution of this discussion is the starting point for this study. Specifically, the 2018-2019 Unified Planning Work Program, from which the Corvallis Area MPO's work is guided, has the following description:

> ***330 – Feasibility Study of Electric Buses for CTS***
>
> ***Purpose***
> *The purpose of this study is to identify the logistics, the costs and the benefits of an environmental-friendly energy source for CTS buses.*
>
> ***Description***
> *In the past CAMPO studied the feasibility of converting the existing CTS diesel buses to Compressed Natural Gas (CNG), which is a cleaner fuel. The study examined the costs, logistics and the Return on Investment (ROI) for purchasing CNG buses compared to retrofitting the existing fleet. The conclusion of the study pointed to the fact that the current method of extracting*

[1] Roberts, David "Electric buses are coming, and they're going to help fix 4 big urban problems." Vox. April 28, 2018

CNG, known as fracking, is harmful to the environment and due to this extracting practice, CNG is no longer considered an environmental friendly energy source. Therefore, the next phase of this study will be exploring the benefits, the cost and the logistics of using electric buses. The study will be conducted with assistance from the Oregon Department of Energy and in consultation with the City of Corvallis. Activities under this task will include:

- *Data collection on the environmental benefits of electricity as a source of energy and its comparison with diesel and CNG;*
- *Estimation of the costs, identification of grant opportunities for covering the cost;*
- *Identification of needed charging facilities and charging logistics.*
- *Programming fleet renewal and replacement plan, calculation of Return on Investment.*

Product
A report that provides necessary information for making decision on the conversion of the fleet to electric buses.

Glossary

BEB: Battery Electric Bus
NREL: National Renewable Energy Laboratory
CNG: Compressed Natural Gas
DGE: Diesel Gallon Equivalent. A term used to compare the fuel efficiency of electric buses with conventional diesel buses
LONO: Low Or No Emissions, used to describe low emissions transit vehicles as well as a specific Federal Transit Authority Grant for electric bus replacement.
MBRC: Miles Between Road Calls, a term used to describe how often a vehicle is in maintenance
Slow Charge: Bus charging method which uses a plug-in station and typically takes 4-6 hours for a full recharge. Also called depot charge or plug-in charge.
Fast Charge: Bus charging method which uses overhead or wireless charging and typically takes 10-15 minutes for a full recharge. Also called on-route or in-route charge.

Literature Review

To obtain a better understanding of electric buses, their current use in the United States, and existing information on their implementation, staff reviewed current literature on electric buses. Gathered via internet sources, the literature includes articles from general interest news sites as well as peer reviewed papers and articles from research centers across the country.

Eudy, et al. *Foothill Transit Battery Electric Bus Demonstration Results*. National Renewable Energy Laboratory, 2016.
Sponsored by the National Renewable Energy Laboratory (NREL) and in combination with the California Air Resources Board (CARB), this study compared battery electric buses (BEB) with buses operated on compressed natural gas (CNG) for the Foothill Transit District, located in Los Angeles County. The evaluation spanned 14 months and the operating cost, availability, overall usage, fuel economy, and maintenance needs were compared. While the buses were utilized on different routes, the BEBs has lower maintenance costs, much better fuel economy, the same availability, and similar maintenance intervals. One challenge noted on distance between charges involved the length of time idling in traffic as the bus requires a minimum amount of energy to

maintain climate conditions and lighting needs. It should also be noted this study was exclusive to one manufacturer of BEBs.

Federal Transit Administration. *King County Metro Battery Electric Bus Demonstration—Preliminary Project Results*. US DOT, 2017
The National Renewable Energy Laboratory completed a third party evaluation as part of a Federal Transit Administration TIGGER grant in 2010. King County Metro purchased three Proterra 40' Catalyst Battery Electric Buses. Proterra was chosen due to comprehensive test period with a leased bus. King County Metro drove 32,000 miles over 106 days and operated 24 hours a day, covering 325 miles, across an 18.6 mile route. The test also involved rapid charging infrastructure at a Park and Ride, where the bus has a layover.

The analysis compared battery electric buses with diesel and diesel hybrid buses, as well as an electric trolley. FTA uses Miles Between Road Calls (MBRC) as a measure of reliability. With a target of 4,000 MBRC, the battery electric buses at King County Metro had 2,433 MBRC, which is both below the target, and significantly below the hybrid and diesel MBRC, of 10,009 and 14,699, respectively. In terms of energy use, the study converted electricity to miles per diesel gallon equivalent (mpdge). The BEB averaged 16.7 mpdge, compared to 6.4 and 5.4 mpdg for the hybrid and diesel buses respectively. Though the electric buses have better fuel economy, fuel prices were twice as high on a per mile basis due to electricity time of use and demand charges. Maintenance costs over the study period were lower for the electric bus ($0.18/mile), though the study noted this was because the vehicles were under warranty and most of the maintenance was covered by the Proterra technician.

Transit Cooperative Research Program. *Battery Electric Buses – State of the Practice*. Transportation Research Board, 2018.
Sponsored by the Federal Transit Administration and the Transit Development Corporation, this synthesis report provides a comprehensive analysis of BEB deployment considerations including planning, procurement, infrastructure, operations, and maintenance. The report included a literature review, a summary of current BEB deployment in the US, a survey of 18 transit agencies operating BEBs, and five case examples.

Results showed that extensive planning and analysis in partnership with stakeholders was critical to successful BEB deployment. Selecting the appropriate battery size, charging infrastructure type and location, and electricity rate structure are dependent on the needs of each transit agency. Survey respondents recommended including maintenance staff, union representatives, utility providers, local government, and community organizations in the planning process to ensure the bus fleet and charging infrastructure will meet the long term goals of the transit agency.

Capital costs for BEBs are higher than for diesel or CNG buses, primarily due to the cost of the traction battery and the charging infrastructure. Most agencies used external funding to purchase their electric buses. Depending on local utility rate structures, energy costs were also higher for BEBs than for diesel buses for several agencies. However, the study noted that electricity rates are generally more stable than diesel costs which can be useful for budget forecasting. Fuel economy for BEBs is significantly higher than diesel or CNG buses, though driver training is important for achieving consistent fuel economy and ensuring sufficient operating time between charges. Maintenance costs have reportedly been similar to or cheaper than for diesel buses, though lead time for parts is longer. It should also be noted that the relatively young age of BEBs in operation means none of the buses have needed a mid-life overhaul (i.e. a battery replacement), so the

associated costs are yet unknown. The availability and reliability of BEBs is approaching that of conventional buses and the reliability of charging infrastructure has been excellent.

Overall, 12 of 13 agencies were satisfied with their BEB deployment, with 8 agencies stating they felt very positive. 86% of the agencies plan to purchase more BEBs in the future.

Levy, Alon. "The Verdict's Still Out on Battery-Electric Buses." CityLab. https://www.citylab.com/transportation/2019/01/electric-bus-battery-recharge-new-flyer-byd-proterra-beb/577954/ (accessed January 18, 2019).
This article describes the variety of challenges that North American transit agencies have experienced while testing BEBs in their transit fleet. The most common complaints included poor performance when the buses ran on hilly routes, in cold or hot weather, or got stuck in traffic. Most agencies found the battery range did not meet manufacturers' claims. Additionally, charging time posed challenges for route design, and often required the agency to use more buses to provide the same level of service as their diesel fleet. Overall, the agencies interviewed for the article think BEB technology is not ready to meet the demands of providing full day transit service. The article states this is why most European transit agencies have been hesitant to convert their own fleets.

It should be noted that the agencies included in the article have a service area much larger than that of CTS, and many experience weather conditions more extreme than Corvallis' relatively moderate climate. While the caution expressed by these agencies should not be overlooked, it conflicts with the findings from the 2018 Transit Cooperative Research Program report which described overall positive transit agency experience with BEBs. Experiences from Oregon transit providers that have tested BEBs are likely to more accurately predict BEB performance in Corvallis due to similarities in climate, terrain, and service area size.

Interviews

Staff interviewed transit providers across Oregon that are implementing, or planning to implement battery electric buses. This includes Tri-Met, South Metro Area Regional Transit (SMART), Lane Transit District (LTD), and Josephine County Transit (JCT). Summaries of the interviews are below, and full transcripts are available upon request.

The following findings are summarized from the interviews:

- **Investing in Electric Buses is Different for Small Versus Large Transit Agencies.** Larger agencies have more substantial concerns to address when it comes to electrifying their entire fleet. They require buses than can travel longer distances, over longer periods of time, and in turn, more charging infrastructure. In this sense both large agencies are spending more time on "proof of concept" as they think about rolling out electric buses for their entire fleet. On the other hand, the smaller agencies see battery electric buses as a way to save money and reduce maintenance over the long term while diversifying their fleet and preparing for future technology.
- **Good Project Management of the Process is Vital.** If electric buses are to be implemented, one of the biggest recommendations is to insure there is an appropriate amount of staff time, or even an entire staff person, to dedicate towards figuring out all of the moving pieces, and insure the bus manufacturer is meeting approved standards during construction

of the bus. Some agencies outsourced this to a consultant, which was included in their grant application

- **Charging Infrastructure is a Challenge in and of itself.** Determining which routes to run, the type of manufacturer to use, the impacts on maintenance costs and staff are all important considerations for implementing electric buses. However, charging infrastructure adds an additional level of complexity. Some manufacturers have proprietary chargers, there is slow vs. fast charging infrastructure, and significant impacts on electric costs, as well as considerations for how "green" the electricity is. Additionally, no one in the country has had to replace a battery in a bus yet.
- **Battery Electric Buses are New Infrastructure, and Many Unknowns Remain**. Diesel buses have been around for decades, and their technology is both well known, and refined over the years. Compressed Natural Gas technology, while newer than diesel, has also existed for more than a decade. In this sense, buses have gone through a complete life expectancy using either diesel or CNG. However with electric buses and electric bus infrastructure, no public agency has owned or operated one for the entire life expectancy of a bus. Batteries have not been replaced and the longest any agency has been running electric buses is seven years.

Lane Transit District (LTD)
Lane Transit District invested in electric buses for two major reasons: 1) they serve a community where people care about greenhouse gas emissions and want to see investments in cleaner technology, and 2) they have an aging fleet and are looking to replace buses, especially those with a lower maintenance cost. They are experiencing a number of challenges including manufacturer reliability, locating and installing charging infrastructure, and determining route effectiveness.

LTD is currently piloting a 40' electric bus from BYD, with 4 more on order once the first is accepted. Their current fleet consists of 82 vehicles at peak pull out, including multiple engine types and bus lengths. Mainly 40' buses, LTD also runs 60' articulated buses. All of their para transit vehicles are gasoline. LTD has had multiple issues with the quality of the buses they received from the manufacturer. Initially ordered in 2015, it took two years to receive three buses, all of which had quality control issues. Those were sent back and the issues were fixed on the pilot bus they're currently testing.

Josephine County Transit (JCT)
Josephine County Transit decided to invest in electric buses to diversify their fleet and save money on both maintenance and fuel. The original motivation came from a private citizen who arranged for Proterra (a BEB manufacturer) to stop by and give a tour of their buses. This inspired their Transit Program Supervisor to examine the issue in more detail and when presented to the county commissioners, the proposal received broad based support due to the cost savings as well as environmental benefits.

JCT has 14 buses at peak pull out, of which 4 are standard 40' and the remainder are Class C cutaways (short bus). Part of JCT's transition to electric buses is they were in need of new buses and additional capacity. They are purchasing 2 vehicles from Complete Coach Works, which are remanufactured Gillig or New Flyer buses converted to electric. Complete Coach Works was chosen due to an existing state contract in Washington, which allows Oregon municipalities to purchase through their approved vendors. Furthermore, JCT chose Complete Coach Works because they use Gillig or New Flyer buses, which are buses first, and electric vehicles second, as opposed to some of

the new manufacturers that are strictly electric vehicle manufacturers. This was the quickest way to get a new bus.

South Metro Area Regional Transit (Wilsonville)
South Metro Area Regional Transit (SMART) is the provider for the City of Wilsonville, but connects with the larger Portland Metropolitan system, and as such receives some funding from Tri Met. Interest in electric buses has been ongoing over the last couple years, as the city applied for FTA grants twice before receiving it on third try, in 2017. The new transit program manager sees electric buses as the natural progression of compressed natural gas (CNG), of which Wilsonville has been involved with for 10 years. He also is looking to diversify at the start however, and not going full electric.

They have 32 vehicles at peak pull out, which range from 40' conventional buses to 26' cutaways. Two thirds of their service is free, while routes that leave the city charge a fee. They are purchasing two 35' Proterra buses, along with infrastructure for charging. In addition to the buses and infrastructure, Wilsonville included the cost of a consultant in their application, provided preliminary route analysis, as well as provide quality control/assurance during manufacturing. The buses will likely go into service in May or June of 2019. They're using slow charge infrastructure on their lot, which they are currently working through.

TriMet
TriMet, the regional transit provider for the Portland Metro area, is currently testing an electric bus, with the expectation to receive four more once they have approved the first. After winning a LONO grant in 2016, TriMet received their New Flyer electric bus this year. A number of factors contributed to TriMet's desire to test electric buses, including community interest, pressure from advocacy groups, and the desire to explore new technology. More recently, TriMet's adopted long range plan includes a provision to convert their entire fleet to zero emissions, and use HB 2017 to start the transition. A conversion plan was developed in September 2018 which describes the process of converting to BEBs by 2040 which involves a 5-year "trial phase" ending in 2023.[2] In this sense, they are being very methodical about testing and implementing electric buses.

TriMet has 670 buses at peak pull out, and uses exclusively Gillig and New Flyer buses. Nearly all of their buses are diesel, with 9 diesel hybrids. They decided to use New Flyer primarily because of their relationship and history with the manufacturer. In terms of maintenance, TriMet is less concerned then other agencies due to the fact their technicians also work on light rail vehicles, so they are more comfortable with different vehicles. They have faced challenges with implementation, including delays and quality control issues.

TriMet's conversion plan states that slow charge buses are currently the agency's preferred technology, but a pilot project for Line 62 will test fast charge bus performance. This pilot involves a partnership with PGE, the local utility provider, in which PGE is responsible for the design, implementation, and maintenance of the fast-charge infrastructure. This reduced the infrastructure cost for TriMet and allowed them to purchase an additional bus instead.

Corvallis Needs & Challenges

[2] TriMet. *Non-Diesel Bus Plan*. TriMet, 2018.

Corvallis has 15 buses and one trolley, using 10 vehicles at peak pullout. Buses are 35' Gilligs that operate 30,000 revenue hours and 445,000 miles annually.

Several CTS buses are in need of replacement in the near future. This creates an opportunity to begin transitioning the fleet to BEBs if Corvallis chooses to move forward. However, the Corvallis Transit Development Plan (2018) calls for increased bus service frequency on all routes which will require an additional bus within 10 years, and 9 additional buses within 20 years. The TDP assumed a diesel bus fleet and calculated costs accordingly. Switching to BEBs with higher capital costs will likely require additional funding or a change in the proposed improvements to service frequency.

Because Corvallis operates a fare-less transit system, annual revenue is not dependent on ridership. Thus, Corvallis does not face some of the challenges peer transit agencies will have to contend with due to the increased popularity of ride hailing and other transportation services that compete with public transit. This allows Corvallis to make investments with the benefit of near term revenue stability.

A key component of the transition to BEBs is the training of maintenance staff, drivers, and first responders. Corvallis directly employs maintenance staff, but drivers are a contracted service. Significant training on BEB operations and technical components will be necessary and new contracts and/or job descriptions may be necessary to accommodate changes to the work flow and responsibilities of both groups. First responders will also require training on how to safely engage with BEBs in an emergency event. Corvallis benefits from the Advanced Transportation Technology Center at Linn-Benton Community College which offers training for first responders and technicians.

Proposed Cost

Utilizing information from the literature search, transit operator interviews and potential vendor contacts, understand the costs of vehicles and any associated infrastructure. This section will also include exploration of grant opportunities that could help offset the cost of vehicles and infrastructure.

Average Capital Costs[3]

- Bus - $887,308
- Slow charge infrastructure – $67,050 (generally serves two buses)
- Fast charge infrastructure - $698,447 (can serve up to six buses per hour)

Electricity Costs

- $0.112/kWh[4]

Maintenance Costs

- Bus maintenance – $22,067/year[5]

[3] Transit Cooperative Research Program. *Battery Electric Buses – State of the Practice*. Transportation Research Board, 2018.
[4] Average 2018 utility cost for City of Corvallis, per Scott Dybvad.
[5] Per Tim Bates, City of Corvallis. Total fleet maintenance costs $331,000 for 15 buses.

- Slow charger maintenance - $200/year[6]
- Fast charger maintenance - $0.026/kWh[7]

Table 1: BEB vs Diesel Bus Cost Comparison

Cost Category	BEB Cost vs Diesel	Notes
Vehicle	Higher	Vehicles at least 40% more expensive, primarily due to battery cost[8]
Fueling Infrastructure	Higher	New infrastructure needed, significant capital and installation costs
Maintenance (Vehicle)	Lower	May initially be higher due to training needs, long term lower due to fewer parts
Maintenance (Fueling Infrastructure)	Equal/Higher	Slow charger maintenance estimated equal to diesel fueling station maintenance. Fast charger maintenance estimated more expensive
Fuel Costs	Varies	Depends on utility rate structure, charging type, and local diesel price
Lifecycle GHG Emissions	Lower	74% lower lifecycle GHG emissions vs diesel[9]
Tailpipe Emissions	Zero	BEBs have zero tailpipe emissions

Social Costs

Electric buses produce no tailpipe emissions and are quieter than conventional diesel buses, and given the high percentage of hydropower in Oregon's electricity mix, lifecycle GHG emissions are reduced through BEB use. These social benefits can't be captured in real dollars by transit providers (unless cap-and-trade policies are adopted at the state or federal level) but they can justify the increased bus and infrastructure costs for transitioning to a zero-emission transit fleet.

Table 2: Vehicle Emission Social Cost per Metric Ton

Emission Type	Cost	Impact Area
CO_2	$45	global
NO_X	$8,335	local
SO_X	$25,794	local
PM2.5	$35,120	local
PM10	$3,307	local

Source: ODOT Alternative Fuel Bus Cost Calculator

With a 74% reduction in GHG emissions and zero tailpipe emissions, BEBs represent an annual savings of over $7,500 per bus in social costs for the Corvallis community.

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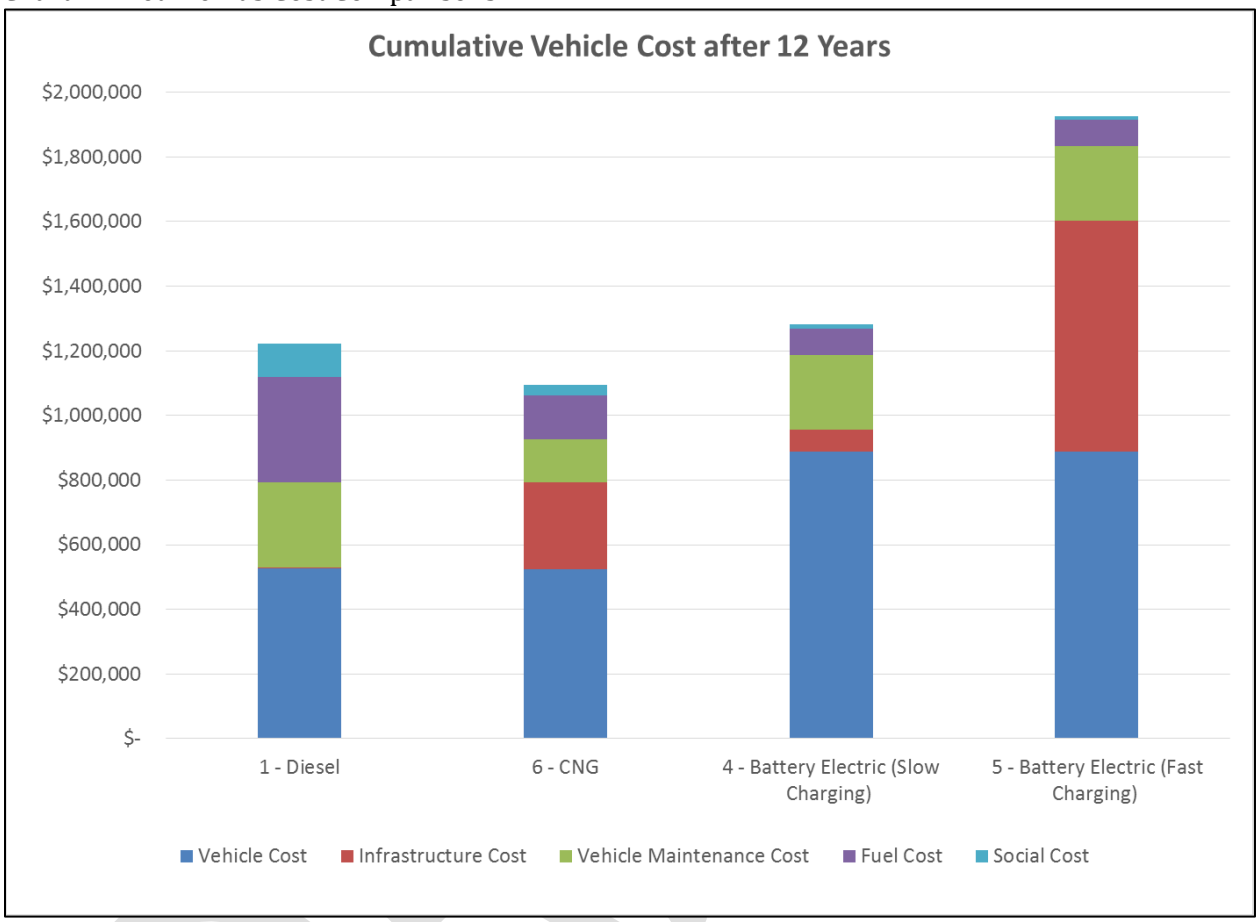
[6] King County Feasibility Study Metro Transit Division. *Feasibility of Achieving a Carbon-Neutral or Zero-Emission Fleet*. King County Metro Department of Transportation, 2017.

[7] California Air Resources Board. *Transit Fleet Cost Model Spreadsheet*. 2018 https://www.arb.ca.gov/regact/2018/ict2018/appk-transitfleetcostmodel.xlsx?_ga=2.117480393.1599391041.1549383500-1021018514.1549383500 (accessed February 5, 2019).

[8] Transit Cooperative Research Program. *Battery Electric Buses – State of the Practice*. Transportation Research Board, 2018.

[9] O'Dea, Jimmy. "Electric vs. Diesel vs. Natural Gas: Which Bus is Best for the Climate?" Union of Concerned Scientists, 2018 https://blog.ucsusa.org/jimmy-odea/electric-vs-diesel-vs-natural-gas-which-bus-is-best-for-the-climate (accessed September 11, 2018).

Chart 1: Lifetime Bus Cost Comparisons



Source: ODOT Alternative Fuel Bus Cost Calculator

Potential Funding Sources

There are a number of federal grant programs Corvallis could apply for the purchase of battery electric buses. These include:

- FTA Lo-No program grants
- FTA TIGGER grants
- FTA Clean fuels grant program

In addition, some opportunities exist at the state level, including:

- HB 2017 STIF funds
- Tax credits
- Clean fuel credits

Feasibility Considerations

Feasibility Determination

Based on the literature review, transit provider interviews, and cost considerations, OCWCOG staff have determined that battery electric buses can feasibly be implemented in Corvallis. Many transit agencies in the US are successfully operating BEBs, and Corvallis does not have any unique challenges that suggest BEBs would not be able to meet the needs of CTS. However, there are many variables determining the cost, efficiency, and long term impacts of BEB operations within the context of the Corvallis Transit System that need to be chosen using a policy and/or economic lens.

Planning and Procurement:

- Who will be responsible for evaluating the necessary battery range and appropriate charging infrastructure?
- Who will assure a quality product is delivered by the manufacturer?
- Oregon transit agencies that were interviewed recommend dedicating a full time staff person or the use of a consultant.
- Agencies surveyed in TCRP study responded that over half relied on staff and almost one third used a consultant. Some agencies also used modeling and simulation techniques, though a key finding from the study was that the availability of useful BEB modeling software is lacking.

Fast vs Slow Charging:

- Slow charging infrastructure is cheaper, only requires new infrastructure in one location (typically the bus depot/maintenance facility), and more closely matches the fueling process of diesel buses.
- Slow charge buses generally have larger batteries and thus have higher capital costs. If the range isn't enough to run all day they can't be quickly refueled and may need to be swapped with a second bus if downtime isn't scheduled into their route.
- Fast charge buses generally have smaller batteries, and thus have a shorter range. However, smaller batteries result in lower bus costs.
- Fast charge infrastructure is more expensive and depending on the route length, multiple chargers may be needed to maintain bus charge.
- Electricity access can be more difficult for fast chargers as they are often dispersed in the community. Corvallis may be able to use the Downtown Transit Center as a fast charge hub for all buses, but additional chargers may be needed on longer routes.
- Fast charge infrastructure is route dependent, moving the chargers due to route changes would be prohibitively costly meaning routes would be less flexible.

Buy vs Lease:

- Rapid technology change makes leasing attractive as agencies could more quickly take advantage of battery and charging improvements while still gaining experience with BEB operations.
- Lease contracts can provide a safety net in case the vehicle or battery lifespan is less than the manufacturer expects. The oldest BEB currently in operation in the US is seven years old, and the full lifespan of BEBs and their batteries is yet unknown.
- Most transit agencies choose to purchase BEBs. This may be due to leasing costs or funding options that prevent leasing.
- Current cost calculations show that BEBs are more expensive than diesel or CNG buses over a 12 year lifespan.
- Buying allows for reuse opportunities of decayed batteries. Batteries are unusable for bus propulsion once they degrade below 70% capacity, but they are still useful for energy storage. Old batteries could be used as emergency backups or for solar power storage. Scott

Chancy at Josephine County Transit mentioned an idea from Antelope Valley in which they are planning to use old batteries to store solar power that will be used to power their transit fleet. When Antelope Valley plans to implement this idea is unknown as it is not referenced on their website or in their long range plan.

Conclusion & Next Steps

The Corvallis Area MPO recommends a conversation with city staff on the policy considerations outlined above. This information can then be brought forward to City Council and the general public for discussion.

In our interviews with providers around the state, agencies moved forward with electric buses for one of three reasons:

1) The environmental benefits, supported and advocated for by the community at large (Policy Decision)
2) The reduced fuel and maintenance costs seen internally (Financial Decision)
3) Both environmental and cost benefits