King County Metro
Sustainably and equitably achieving a zero-emission fleet
Agenda

Background
- Purpose
- Service area
- Fleet size
- Climate goals

Process
- Stakeholder engagement

Analyses
- Service
- Equity

Final findings
Purpose

Develop a road map to guide King County Metro to transition to a zero-emission fleet.
King County Metro

• 10th largest transit bus agency in the U.S. by ridership
• Operates the 4th largest fleet of buses in the country (1,420 buses)
• Second largest trolleybus system in the country by ridership and fleet size
Metro’s Fleet

- Metro’s current zero-emission fleet includes three Proterra all-electric, fast-charge battery-operated buses, as well as a fleet of 174 electric trolley buses.
Proterra battery bus
The future of Metro

◦ Transportation accounts for nearly half of all greenhouse gas emissions in Washington.
◦ In King County, fossil fuel use for transportation is one of the top two sources of GHG emissions.
◦ A key strategy for reducing vehicle emissions is to integrate innovative technologies and lower-carbon fuels into operations.
The future of Metro

In 2015, Metro had **126 million boardings**. In the past year, the King County region has had the **highest transit growth** for all large metropolitan areas in the U.S.

Targets or priority actions:

- Increase ridership to 142 million boardings by 2020, and to 225 million boardings by 2040
- Grow transit service through 2020 with no increase in GHG emissions.
- Increase the use of alternative fuels (e.g. electricity, biofuels) in Metro’s fleet by 10 percent by 2025
Battery-electric bus technology

**Slow-charge bus**
- Charges at base
- Range of 140 miles
- ~2 to 5 hours to charge midday or overnight
- Charger cost is $34k per bus

**Fast-charge bus**
- Charges at bus layover
- Range of 25 miles
- 10 minutes to charge
- Charger cost is $144k per bus
Battery-electric bus technology

**SLOW-CHARGE**

- Bus Base
- 140 miles or less

**FAST-CHARGE**

- Bus Layover (10 minutes)
- 25 miles or less
- 25 miles or less
- Bus Layover (10 minutes)
Battery- electric bus technology benefits

- Eliminates GHG emissions from fleet operations
- Eliminates tailpipe air pollution emissions
- Reduces noise to levels equivalent to a passenger car
Metro’s current battery fleet

BATTERY-ELECTRIC BUS FLEET

Data

<table>
<thead>
<tr>
<th>Fleet Size</th>
<th>Data Since</th>
<th>Last Updated</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>1/1/2016</td>
<td>04/25/2017</td>
</tr>
</tbody>
</table>

- Fleet Miles Driven To Date: 1,073,066
- Diesel Gallons Saved To Date: 170,322
- Fleet Electricity Consumed To Date (kWh): 2,438,666
- Pounds of CO2 Tailpipe Emissions Saved To Date: 381,535

Source: Proterra and King County Metro
Battery-electric bus market

- Battery-electric bus manufacturing and technology are still in their development stages, but they are progressing rapidly.
- Currently, five agencies in the United States are operating 10 or more electric buses.
- 38 agencies in the U.S. have at least one electric bus in service.
- The industry is currently focusing mainly on 40-foot standard bus designs. Offerings in the 60-foot articulated bus category are still growing.
PROCESS
King County Council Motion

- Recommendation on whether Metro should adopt a carbon-neutral or a zero-emission fleet goal
- Requested cost and benefit, technology, service, and equity analyses
Internal technical review panel

- Vehicle Maintenance
- Service Development
- Power and Facilities
- Finance and Budget
- Human Resources
- Operations
- Design and Construction
- Strategy and Performance
Common themes and lessons learned

**INFRASTRUCTURE:** Charging station siting and power requirements

**SCALABILITY:** Choosing what is right for Metro and thinking about long-term universal charging needs

**SERVICE QUALITY:** Changes in quality of service and scheduling

**COORDINATION:** Communication between all departments and relationships with utility companies and jurisdictions

**MAINTENANCE AND OPS:** Input and support from operators and training needs
ANALYSES
Service Analysis
Service analysis

◦ Purpose
  ◦ Battery-electric buses should be introduced into the bus network in a way that minimizes impacts on operations and service
  ◦ How does Metro’s service match the operational characteristics of new battery-electric buses?
Service analysis

- Methodology
  - Using HASTUS (planning/scheduling software) outputs, analyzed where and how far buses travel throughout King County
  - Looked only at bus scheduling and service design to determine the number of buses that could potentially transition to battery-electric buses
  - Considered layover locations and bus bases
Example bus base schedule
Service analysis results

- Between 140-187 diesel and hybrid buses—35 to 47 percent of the 40-foot fleet—could be transitioned to battery-electric fast-charge buses
  - Must consider siting constraints and efficiency of charging infrastructure
- Current slow-charge battery-electric technology could meet service needs of 70 percent of Metro’s current operations
  - 90 percent could be served by next generation battery range
Equity Analysis
Equity analysis

- Low-income families and people of color are more likely to live in neighborhoods that have high concentrations of air pollution.
- Providing public transit to disadvantaged populations is key to advancing equity, but the diesel technology currently in use throughout the county imposes undesirable effects on those very populations.
Equity analysis

Purpose

◦ This analysis focuses on how the air pollution benefits of zero-emission technology could advance social equity by first serving communities most vulnerable to air pollution.
Equity analysis methodology

Collaboration with King County Health, Puget Sound Clean Air Agency, US EPA

1. Collect data for census block groups
2. Weight all factors
   - Double weight for low-income %, minority % and asthma prevalence
3. Divide into quintiles and apply score
4. Buffer 200 meters around each bus route
5. Apply rating for each route based on average score of census blocks within 200 meters
6. Examine by bus base
Equity analysis data

Poor air quality
- Diesel emissions
- Wood as primary heating fuel %
- Proximity to WSDOT traffic
- Sources with air operating permits

Existing health conditions
- Cardiac hospitalizations
- COPD hospitalizations
- Asthma prevalence

Social factors
- Minority %
- Low income %
- Population under 18
- Population over 64
- High school diploma %
- Households with linguistic isolation
- Single female head of household %
Scored census block groups

Darkest shades indicate most vulnerable populations
Existing zero-emission bus routes

Red routes indicate high priority routes that operate near most vulnerable populations
Non-zero-emission bus routes

Red routes indicate **high priority** routes that operate near most vulnerable populations.
Identify bus base with high priority routes

Two methods:

- Daily service mileage in each quintile
- Number of census block groups routes intersect in each quintile
## Total daily bus route mileage per scoring quintile

<table>
<thead>
<tr>
<th>Bus Base</th>
<th>1 (bottom 20%)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 (top 20%)</th>
<th>Total Miles</th>
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</thead>
<tbody>
<tr>
<td>South</td>
<td>2,257</td>
<td>5,720</td>
<td>1,352</td>
<td>8,967</td>
<td>14,956</td>
<td>33,252</td>
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<tr>
<td>Current zero-emission fleet</td>
<td>1,066</td>
<td>959</td>
<td>1,727</td>
<td>3,902</td>
<td>4,035</td>
<td>11,689</td>
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<tr>
<td>Ryerson</td>
<td>1,302</td>
<td>1,566</td>
<td>2,721</td>
<td>4,252</td>
<td>3,598</td>
<td>13,439</td>
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<tr>
<td>Central</td>
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<td>4,875</td>
<td>2,136</td>
<td>2,252</td>
<td>1,278</td>
<td>10,541</td>
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<tr>
<td>Atlantic</td>
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<td>0</td>
<td>872</td>
<td>96</td>
<td>147</td>
<td>1,115</td>
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<tr>
<td>Bellevue</td>
<td>8,831</td>
<td>1,059</td>
<td>1,524</td>
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<td>0</td>
<td>11,414</td>
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<tr>
<td>East</td>
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<td>409</td>
<td>2,651</td>
<td>93</td>
<td>0</td>
<td>8,423</td>
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<tr>
<td>North</td>
<td>1,737</td>
<td>3,667</td>
<td>10,905</td>
<td>629</td>
<td>0</td>
<td>16,938</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>20,464</strong></td>
<td><strong>18,255</strong></td>
<td><strong>23,887</strong></td>
<td><strong>20,190</strong></td>
<td><strong>24,014</strong></td>
<td><strong>106,811</strong></td>
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</table>
## Total census block groups intersected by routes per scoring quintile

<table>
<thead>
<tr>
<th>Bus Base</th>
<th>1 (bottom 20%)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 (top 20%)</th>
<th>Total census block groups intersected</th>
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<tbody>
<tr>
<td>South</td>
<td>45</td>
<td>98</td>
<td>112</td>
<td>194</td>
<td>205</td>
<td>654</td>
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<tr>
<td>Central</td>
<td>39</td>
<td>91</td>
<td>100</td>
<td>83</td>
<td>117</td>
<td>430</td>
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<tr>
<td>Ryerson</td>
<td>33</td>
<td>98</td>
<td>102</td>
<td>81</td>
<td>94</td>
<td>408</td>
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<tr>
<td>Current zero-emission fleet</td>
<td>10</td>
<td>46</td>
<td>56</td>
<td>50</td>
<td>90</td>
<td>252</td>
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<tr>
<td>North</td>
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<td>81</td>
<td>78</td>
<td>64</td>
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<tr>
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<td>15</td>
<td>4</td>
<td>25</td>
<td>34</td>
<td>80</td>
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<tr>
<td>East</td>
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<td>63</td>
<td>62</td>
<td>31</td>
<td>20</td>
<td>234</td>
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<tr>
<td>Bellevue</td>
<td>120</td>
<td>96</td>
<td>89</td>
<td>41</td>
<td>9</td>
<td>355</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>377</strong></td>
<td><strong>588</strong></td>
<td><strong>603</strong></td>
<td><strong>569</strong></td>
<td><strong>611</strong></td>
<td><strong>2,708</strong></td>
</tr>
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*Lowest score for poor air quality, health, social conditions

*Highest score for poor air quality, health, social conditions*
Equity Analysis Results

South Base has greatest number of high priority route miles and intersected block groups

62 percent of the highest scoring route mileage originates at South Base.

31 percent of the census blocks that South Base routes travel through are considered the most vulnerable.
What does this mean for Metro?

A mix of slow-charge and fast-charge technology, along with some service adjustments, could make it possible for Metro to achieve a 100 percent battery-electric bus fleet.

According to the fleet replacement plan, this could be achieved by 2034 under a 14-year replacement schedule or by 2036 under a 16-year replacement.

This will help to achieve King County’s GHG emission reduction goals.
Future considerations

- Vehicle and charging technology
- Charging station siting
- Renewable energy supplies
- Safety for both customers and employees
- Public outreach processes
- Equity impact review
- Continued monitoring of total costs
- Emergency preparedness plan
King County buys nation’s largest fleet of battery-electric buses

January 2017

- King County Metro Transit announced it will acquire 120 all-electric fast-charge battery buses by 2020
- Will also acquire up to nine slow-charge long-range electric buses from different manufacturers to test the battery technology with a range of about 140 miles