



Analyzing Clean Fuel Alternatives to a Battery Electric Fleet

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TriMet Context

- Fleet today - 700 diesel buses and 5 BEBs
- Two FTA Low-No grants in 2016 and 2018
- Adopted Non-Diesel Bus Plan in 2018
- State of Oregon has provided funding for electric buses



Portland Region Context

- Regional and local climate action plans
- City of Portland recently selected for a Bloomberg American Cities Climate Challenge grant
- State of Oregon debating a cap-and-trade program to reduce carbon emissions

Oregon Gov. Kate Brown says she's 'not backing down' on climate change agenda

Updated Jul 2, 2019; Posted Jul 2, 2019

Source: www.oregonlive.com, 2019

Bloomberg gives Portland \$2.5 million to fight congestion, climate change

Posted Oct 17, 2018

Fuel Types Considered

- Biodiesel/renewable diesel
- Renewable natural gas
- Battery electric
- Hydrogen fuel cell

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CUSTOM REPORT

Alternative Fuel Options for TriMet

An Assessment of Approaches Using Local Alternative
Fuels to Reduce Bus Fleet Carbon Emissions

Published 2Q 2019

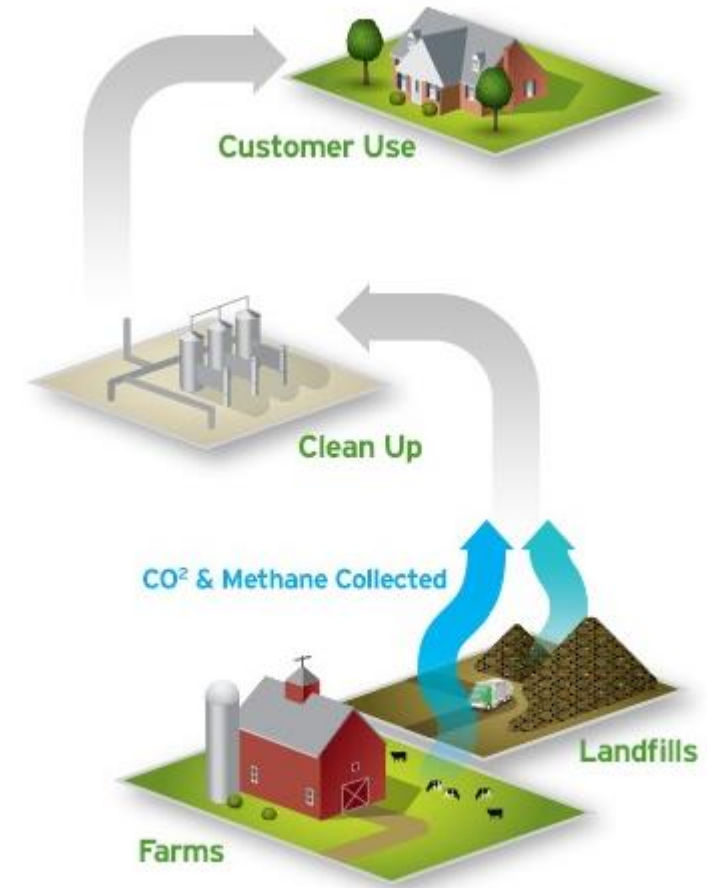
Commissioned by TriMet

Biodiesel & Renewable Diesel

- Biodiesel is made from vegetable oils or animal fats;
 - Generally mixed with petroleum diesel
- Renewable diesel is also made from vegetable oils or animal fats
 - Processed differently and does not have to be mixed with petroleum diesel
- Either fuel can be used in a traditional diesel bus

Renewable Natural Gas

- Common source is the naturally-occurring breakdown of organic waste such as at wastewater treatment plants and landfills
- Same operations and maintenance requirements as natural gas



Courtesy of the American Gas Association

Battery Electric

- Can come with different battery sizes
- Different charging options – “slow-charge” and “fast-charge”



Hydrogen Fuel Cell

- **Substantially longer range than battery electric**
- **Hydrogen can be produced two ways:**
 - From CNG/RNG via steam methane reformation
 - From electricity via water electrolysis

Analysis Criteria

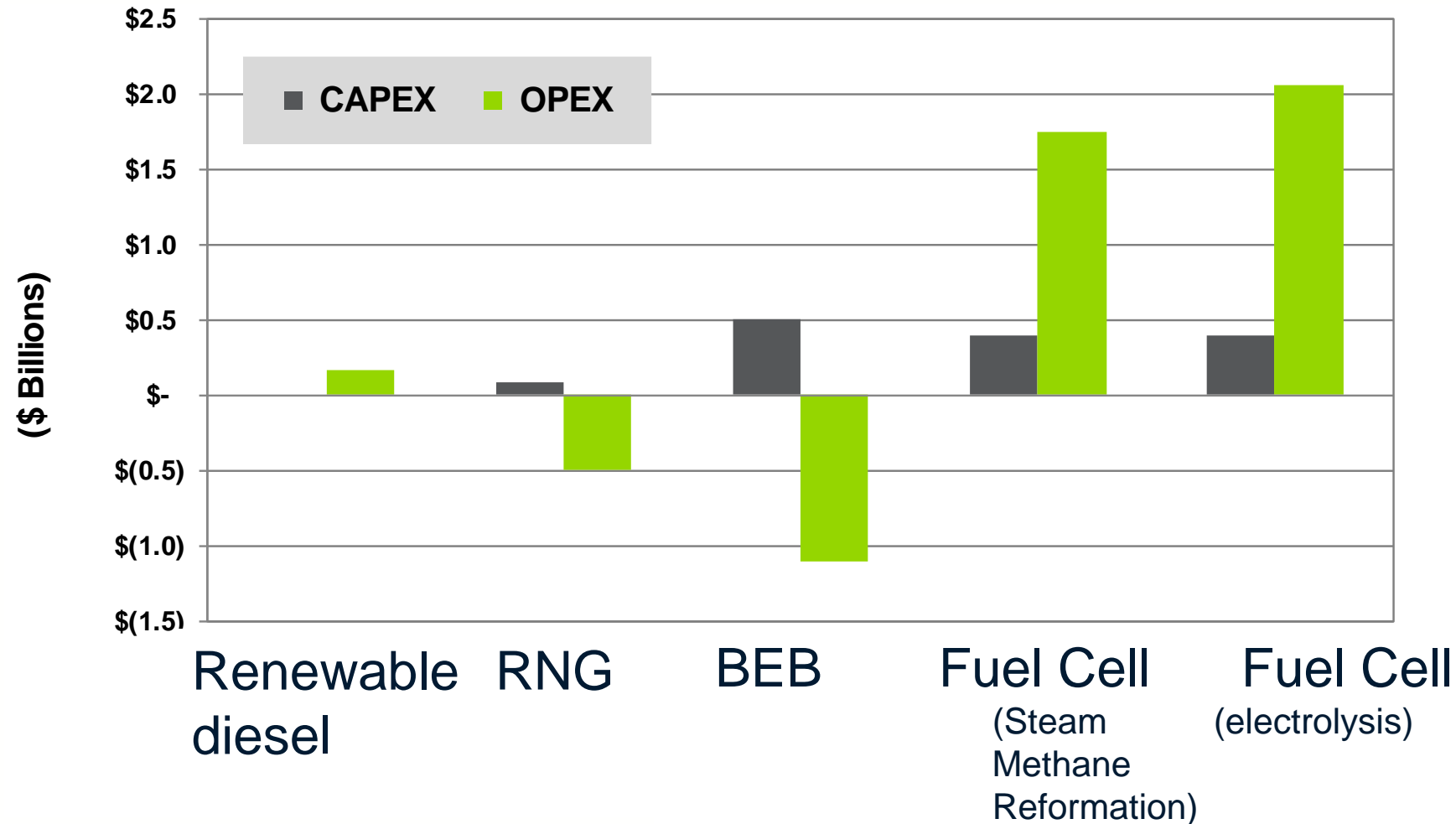
- **Reduction in Greenhouse Gas Emissions**
- **Costs:**
 - Vehicle purchase
 - Infrastructure
 - Operations & maintenance
 - Assumed renewable energy credits

Reduction in GHG Emissions 2019-2055

Fuel type	GHG Reduction Relative to Diesel Fleet
Biodiesel or renewable diesel	5%-49%
Renewable natural gas	65%
Battery electric	56%
Hydrogen fuel cell	6-65%

Source: Navigant Research, 2019

Cumulative Cost, 2020-2040



Source: Navigant Research, 2019

Cumulative Cost (continued)

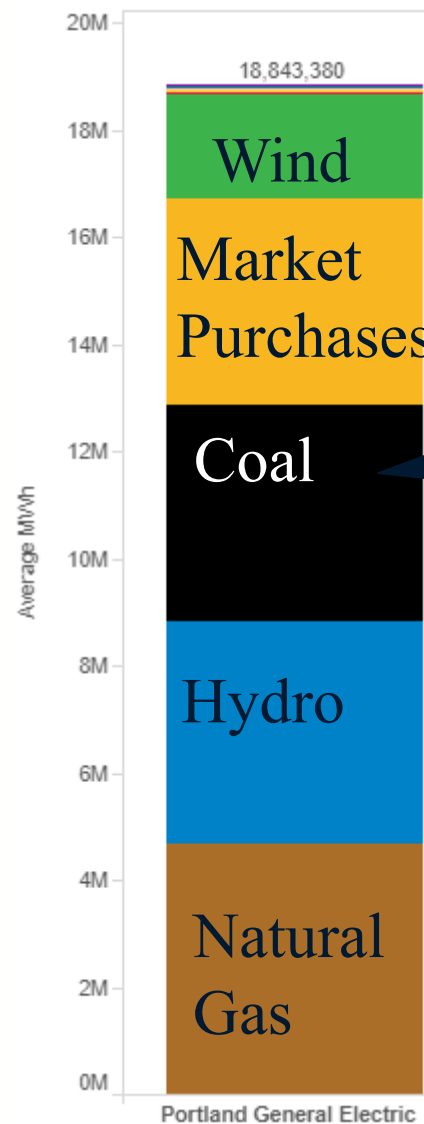
- Battery electric is the most promising in the long-run because of savings in O&M
- However, the emissions reductions with renewable diesel can be substantial and require no additional capital cost

TriMet's Anticipated Path Forward

- Purchase up to 80 battery electric buses using state funding
- 3-month test of renewable diesel
- Test diesel-to-electric conversion
- Pursue new sources of funding for full fleet conversion to battery electric

Electricity Generation in the Portland Area

(Portland General Electric)



There is only one coal plant in Oregon and it is scheduled to close in 2020.

Source: Oregon Department of Energy

Suggested Considerations for Other Transit Agencies

- Consider RNG if you already operate CNG
- Look closely at how electricity is generated in your area
- Consider renewable diesel

Questions?

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in **June 2020** for
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Electric Vehicle
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