Replacing Buses Upon Retirement Will Allow Electrification of Port Authority Buses by 2032

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MOTIVATION

- Transportation is the largest contributor to greenhouse gas emissions in the U.S[1].
- Port Authority has worked towards better sustainability in its Pittsburgh public transportation over the past 30 years, using the cleanest diesel possible since 1991 and introducing biodiesel fuel buses since 2009[2]
- As of 2018, the company has 741 buses that use mostly diesel and biodiesel at an efficiency of 3.91 miles/gallon[3]
- Electric buses can save over 55% of energy use compared to diesel.

OBJECTIVES

- Analyze the energy savings of replacing all Port Authority buses with New Flyer electric buses by 2031
- Determine the logistics of the changes in infrastructure necessary for the switch
- Identify the optimal path to electrification

Port Authority (2018)

Hirsch, J. O'dell, Falkenberg-Hull, E. (2018)

Port Authority Bus and New Flyer Electric Bus

REFERENCES

1: EPA. (2019). "Carbon Pollution from Transportation".
2: Port Authority of Allegheny County. (2019) "Operating and Capital Improvement Budget: Fiscal Year 2019".
3: American Public Transportation Association (2017). "National Transit Database Tables".

METHODS

Major Cases:

Base Case

- Replace buses 1:1 as they retire
- Charging stations in all garages

Route Prioritization

- Replace buses as they retire in only the East Liberty and West Mifflin garages (430 buses)
- Charging stations in those two garages only

Increased Adoption

- Replace 20% of the fleet each year, allowing electrification in 5 years
- Charging stations in all garages

Research Steps:

Collect data about diesel and electric buses

Current Port Authority bus statistics	New Flyer electric bus statistics

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Assess reductions in energy consumption

Increase in electricity demand vs. decrease in diesel demand

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Model differences in costs

Raw costs vs. factoring social costs and benefits

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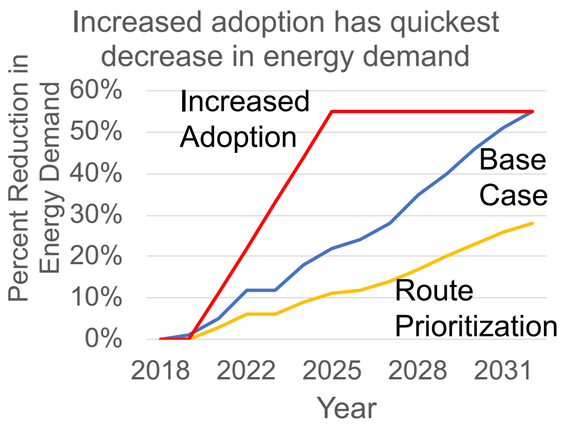
Identify optimal pathway to electrification

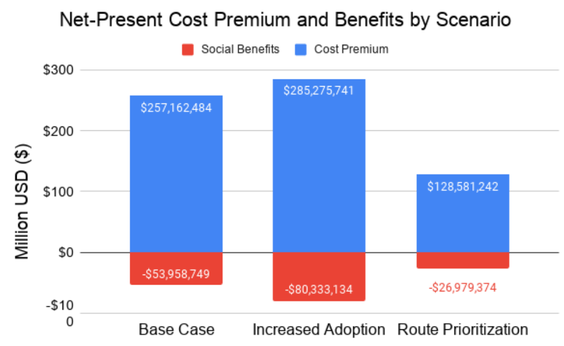
Choose the case that would provide the most benefits for a feasible cost

RESULTS & DISCUSSION

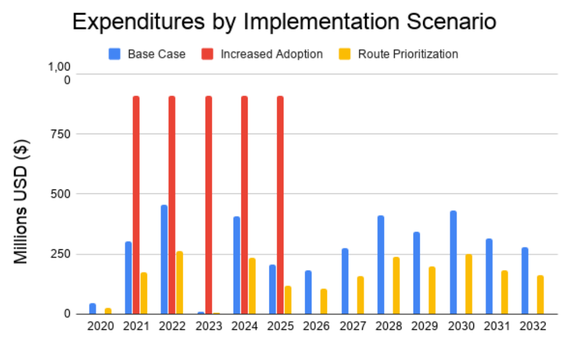
- The system can have fully electric buses by 2032 in the base case and by 2025 in the increased adoption case
- Increased adoption provides the greatest reductions in energy demand in the shortest amount of time



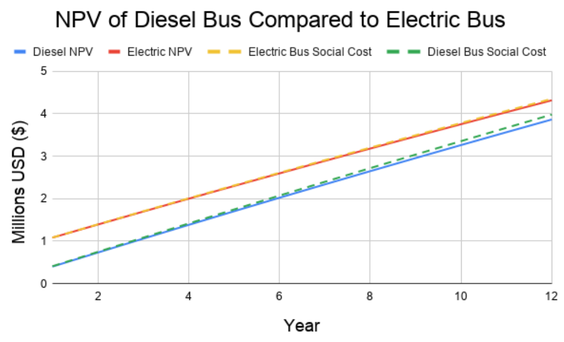
- Increased adoption has the greatest social benefit to cost premium ratio



- 1,135 tonnes of GHG emissions are saved over the lifetime of a bus
- The base and route prioritization cases spread out the costs of implementation

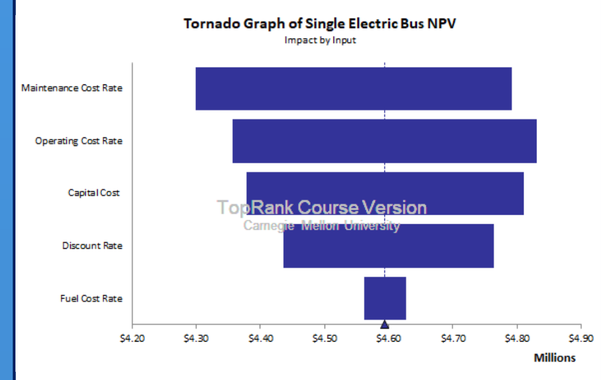


- Regardless of case, electric buses will cost more than diesel buses, even when factoring the social cost of carbon



SENSITIVITY ANALYSIS

- NPV is most sensitive to changes in maintenance cost rate



- Capital cost of an electric bus would need to be $650,000 to breakeven
- Breakeven carbon price is lowest for the base case

Case	Breakeven Carbon Price ($/tonne)
Base Case	$178
Route Prioritization	$185
Increased Adoption	$1,182

CONCLUSIONS

- The base case is the most feasible route to full electrification of Port Authority buses because of the lower yearly expenditures and lower breakeven carbon cost
- Despite the greater benefits of increased adoption, the case is too costly during the time period of the switch
- If there are not enough funds for full electrification, route prioritization will still reduce energy demand by 28%
- The ultimate choice will depend on how much the government is willing to subsidize the project

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