

# *Zero Emission Transit Buses*

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# About CTE

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**Mission:** To advance clean, sustainable, innovative transportation and energy technologies



- Non-profit, membership-based organization founded in 1993
- Portfolio - \$325+ million
  - Research, development, demonstration, and deployment
  - Alternative fuel and advanced vehicle technologies
- Project sponsorship
  - Federal Transit Administration
  - Departments of Energy, Defense, Interior, NASA, and EPA



# Why Zero Emission Buses?

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- Reduce dependency on foreign oil
- More energy efficient
- Cleaner emissions, and getting better
- Quieter
- Passengers prefer to ride
- Lower Operating Costs\*

*\*Depending on use case!*



# What's happening today in ZEB

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## They are here!

- Growing number of deployed ZEB in US - 100+
- Growing funding for deployment programs
- 26,000 FCB for Korea just announced



# Zero Emission Bus (ZEB) Types

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- Fast charge buses – recharge in minutes
  - Unlimited range with return to charger
- Overnight charge – 100 – 200 mile range
  - Simpler route planning, low electric rate possible
- H<sub>2</sub> fuel cell – extended range, falling cost
  - Zero emission, not typically range limited

# ZEB vs. Incumbent Fossil Fuel Deployment

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Diesel “just works” – What are questions when choosing ZEB?

- What is the range?
- What is the fuel cost?
- How does weather conditions affect bus performance?
- What happens as the batteries age?
- Is an overnight or on-route charge system the best fit for my application?



# What is the range?

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## Range in Battery Electrics varies greatly with usage

	Route A – Best Case	Route A – Worst Case
<b>BEV Bus Performance</b>	142 miles	59 miles

- Efficient driving has much larger impact
- Heating and Cooling has much larger impact
- Duty Cycle, Passenger load, outside temperature and driver are all big factors in actual range
- Simulation can predict range of reliable operation

# What is the fuel cost?

- Rate structures vary region to region, and city to city
- Multiple price structures are usually available
- Electric per mile cost can exceed diesel in some cases, or can be 80% lower

- Demand charges vary seasonally:
  - winter: \$7.31 per kW
  - summer: \$15.54 per kW
- TOU and flat rate pricing options

- Fixed demand charge
- TOU and flat price options



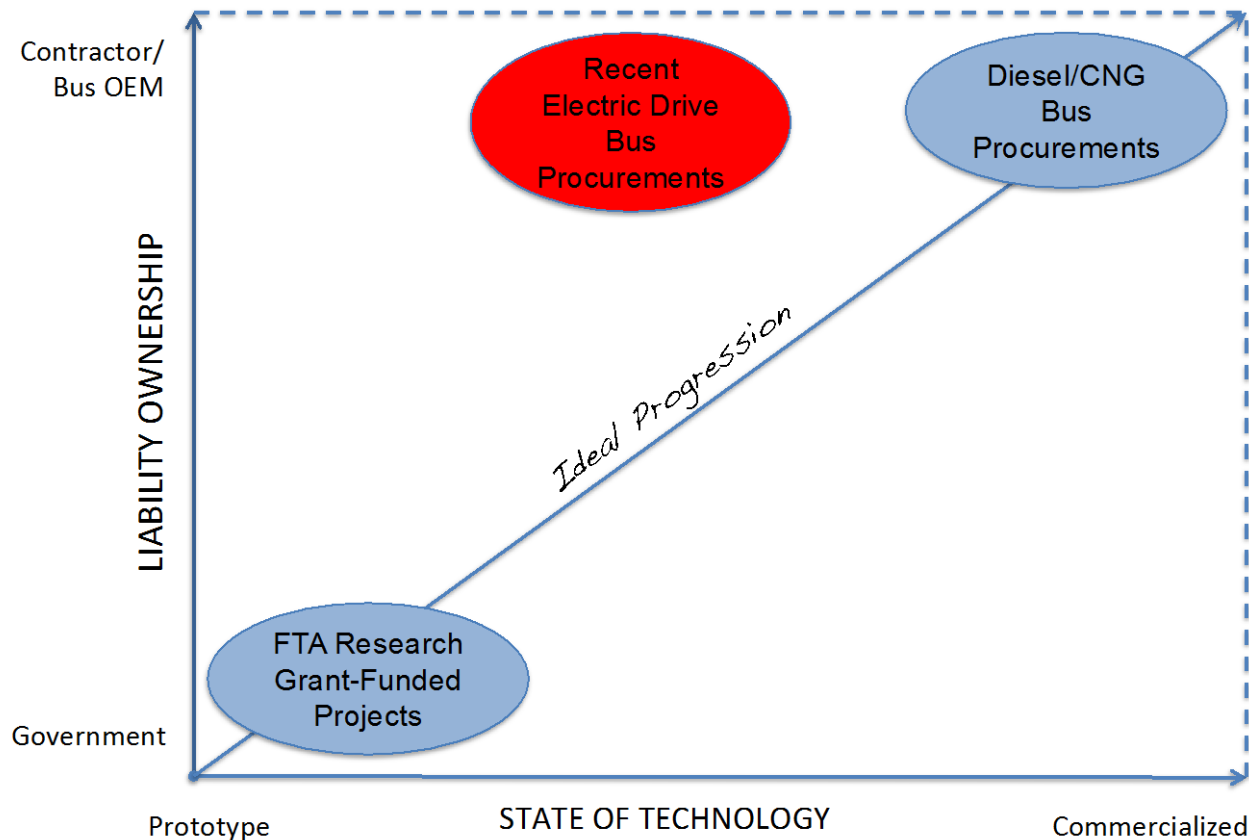
- 6 applicable rate structures!
- Demand charges are constant

- no demand charge
- 2 applicable rate structures
- tiered price structure based on kWh consumed



# Current Challenges to Adoption

- CTE formed Procurement Committee to develop solutions to bridge the gap between Research and deployment



# Procurement Committee Recommendations

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- Build Operator Knowledge Base
  - ZEB Technology Education Program for Transit Managers
  - New Altoona ZEB Testing Guidelines
- Subcomponent Lease Options
- Spare Ratio Exemption
- Suggest revisions to Standard Bus Procurement Guidelines (SBPG) for ZEB-specific terms and conditions for bus RFPs
- Charging standards should be created

# What does it take to implement ZEB?

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- Local Zero Emission Champion(s)
  - Possibly the most critical element
- Capital Investment
  - Possible to achieve operating savings
- Federal and State grant programs are available
  - One Federal program now open

