CARTEEH

Center for Advancing Research in Transportation Emissions, Energy, and Health

A USDOT University Transportation Center

www.carteeh.org

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CARTEEH Summer Internship Presentation

Diesel vs. Electric School Buses:
Route Electrification Study & Impact on the Environment

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Background & Research Question

- In TX, between 2022-2023, 50,000 school buses transported over 900,000 students (K-12) daily with an annual route mileage just under 200,000,000 (1).
- Nearly 25 million children ride over 500,000 buses to school in the United States each day (2).
- Asthma and other heath effects exacerbated or caused by diesel exhaust (3).
- **What proportion of school bus routes in TX can be electrified? What is the impact on the environment?**

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Methodology

1. Collection of school bus data
   a. Statewide bus inventory report data from TEA database
   b. 32 ISD currently committed to operating ESBs (4).
   c. Collect detailed bus route data from 2 ISDs (Everman & Dallas)
2. Determine compatibility of ESBs on existing routes in TX
   a. Range of ESBs (IC Electric School Bus, Blue Bird, Lion Electric)
   b. Which ISDs can be served by ESBs (proportion of eligible districts that fall w/in specified range)
   c. Create graphical representations of eligible ISDs (ArcGIS)
3. If route is compatible, what are the benefits? LCA results?
   a. LCA results
   b. GREET 1, 2 models

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Results

- 1,218 total districts, data from 982 used in study (excludes charter schools)
- TEA districts types:
  - A. Major Urban
  - B. Major Suburban
  - C. Other Central City
  - D. Other Central City Suburban
  - E. Independent Town
  - F. Non-Metropolitan: Fast Growing
  - G. Non-Metropolitan: Stable
  - H. Rural
  - I. Charter School Districts
- Adjusted Daily Mileage Per Bus

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Comparing the Largest ESB Manufacturers

Manufacturer	Range (mi)	Gross Vehicle Weight (lbs)
IC (5)	135	31,000
Blue Bird (6)	130	33,000
Lion Electric (7)	155	31,000

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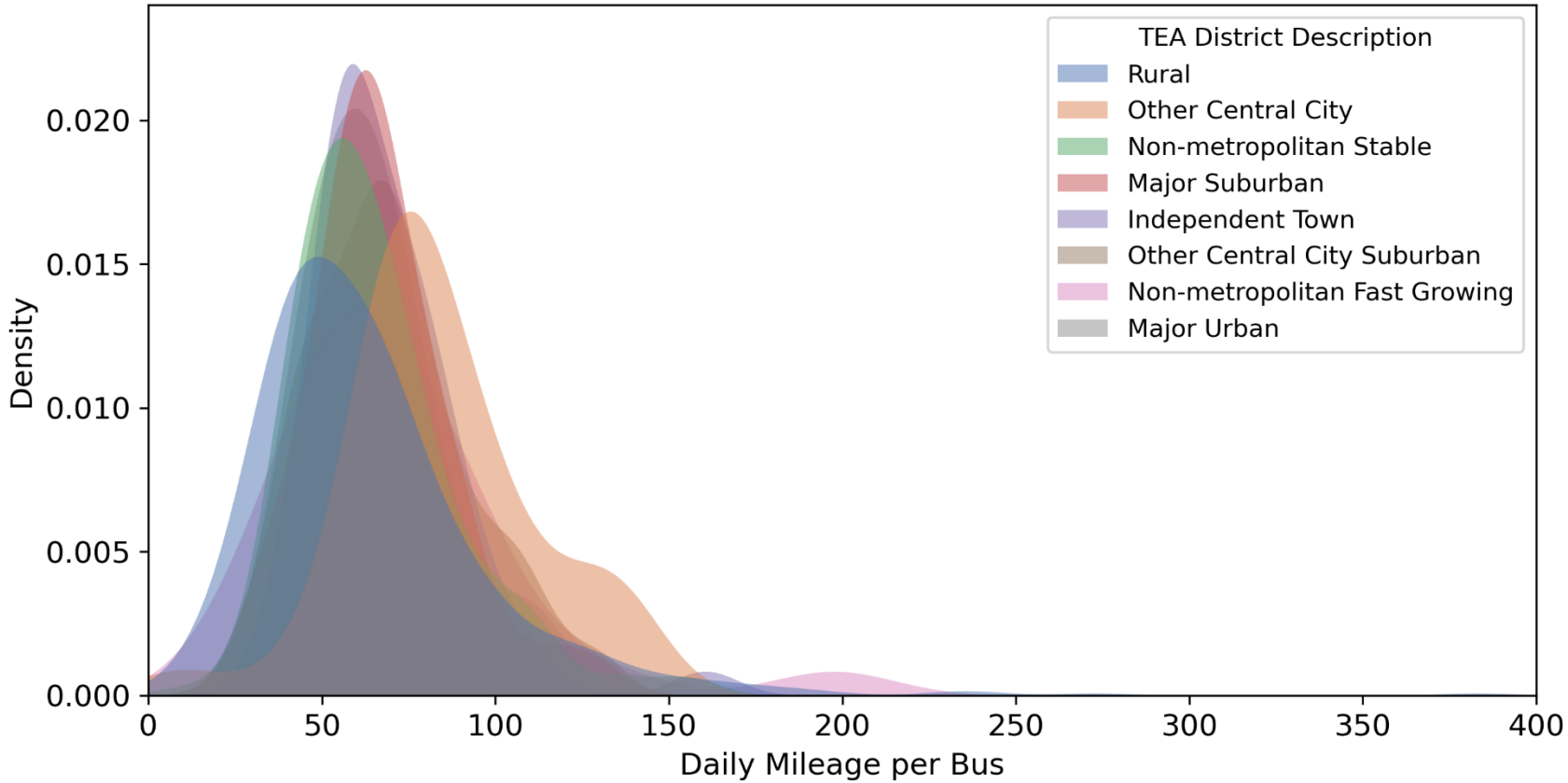
School bus operation in Texas

- Kernel Density Plot – All TEA ISD Types



School bus operation in Texas

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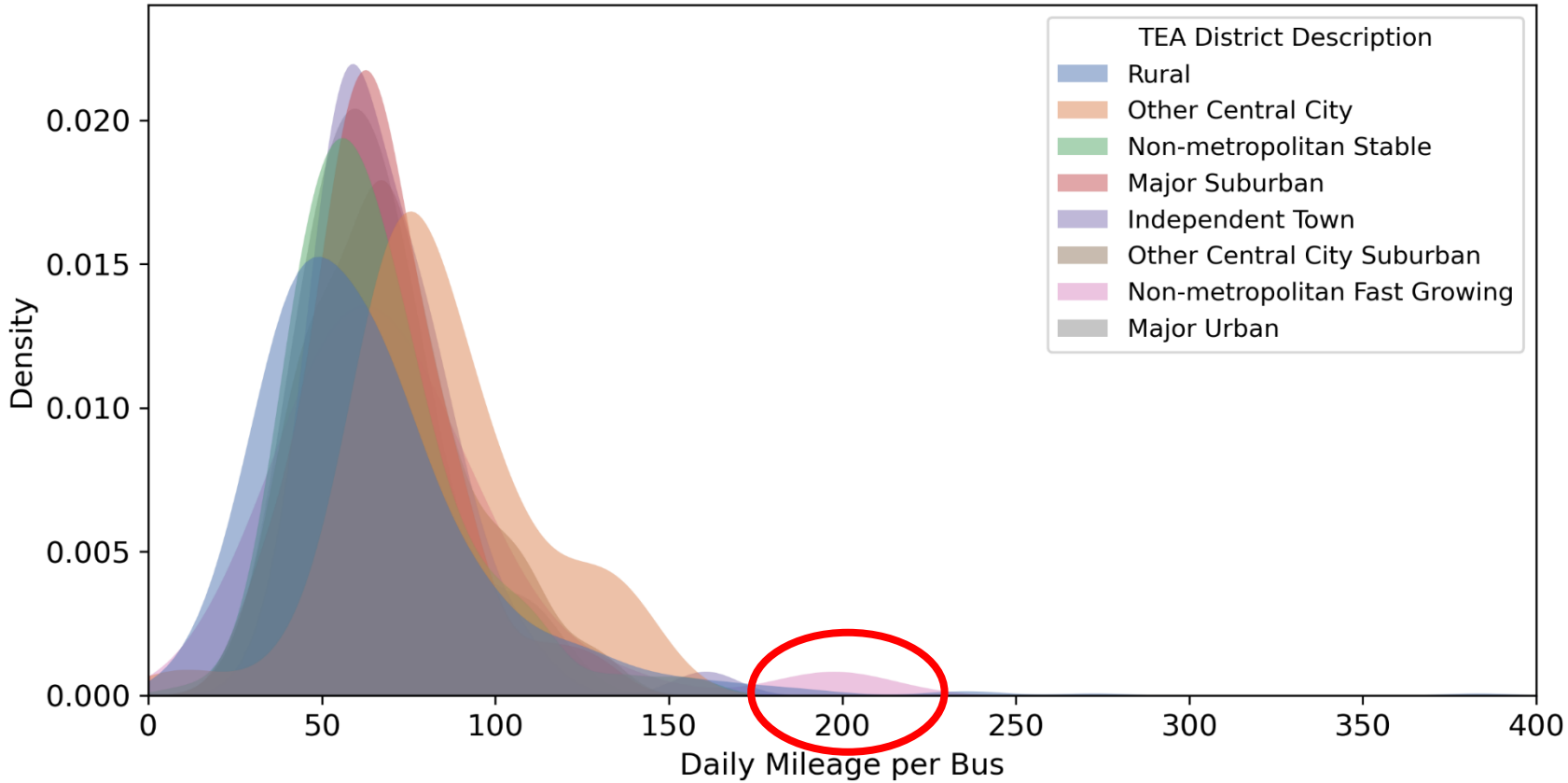
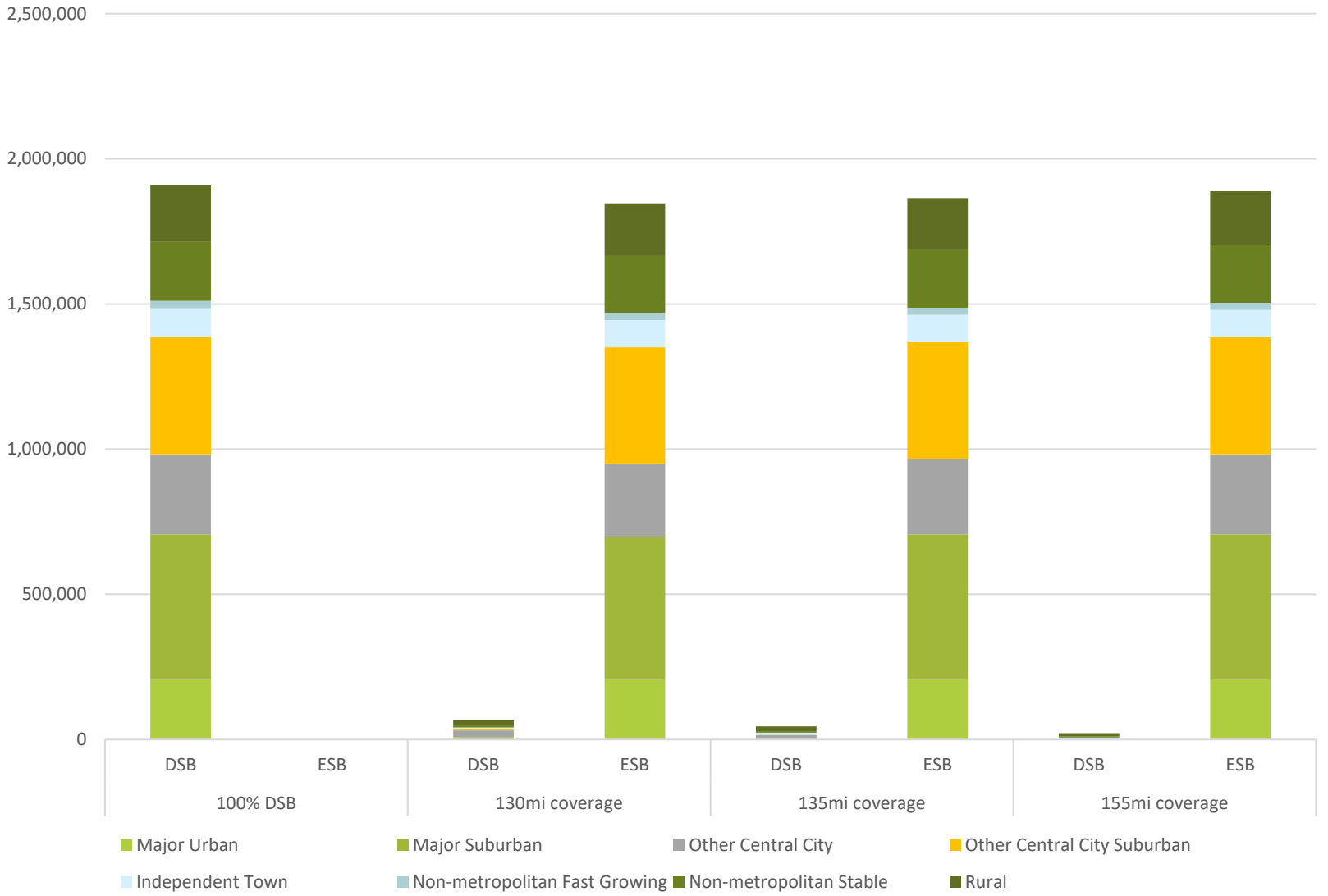


Daily VMT


2,500,000
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DSB
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ESB
100% DSB
130mi coverage
135mi coverage
155mi coverage
Major Urban
Major Suburban
Other Central City
Other Central City Suburban
Independent Town
Non-metropolitan Fast Growing
Non-metropolitan Stable
Rural

How many ISDs can be served by ESBs?

Manufacturer	Range (mi)	Gross Vehicle Weight (lbs)	% of Serviceable ISDs (Based on Adjusted Daily Mileage Per Bus)
IC	135	31,000	97.4%
Blue Bird	130	33,000	96.5%
Lion Electric	155	31,000	98.5%

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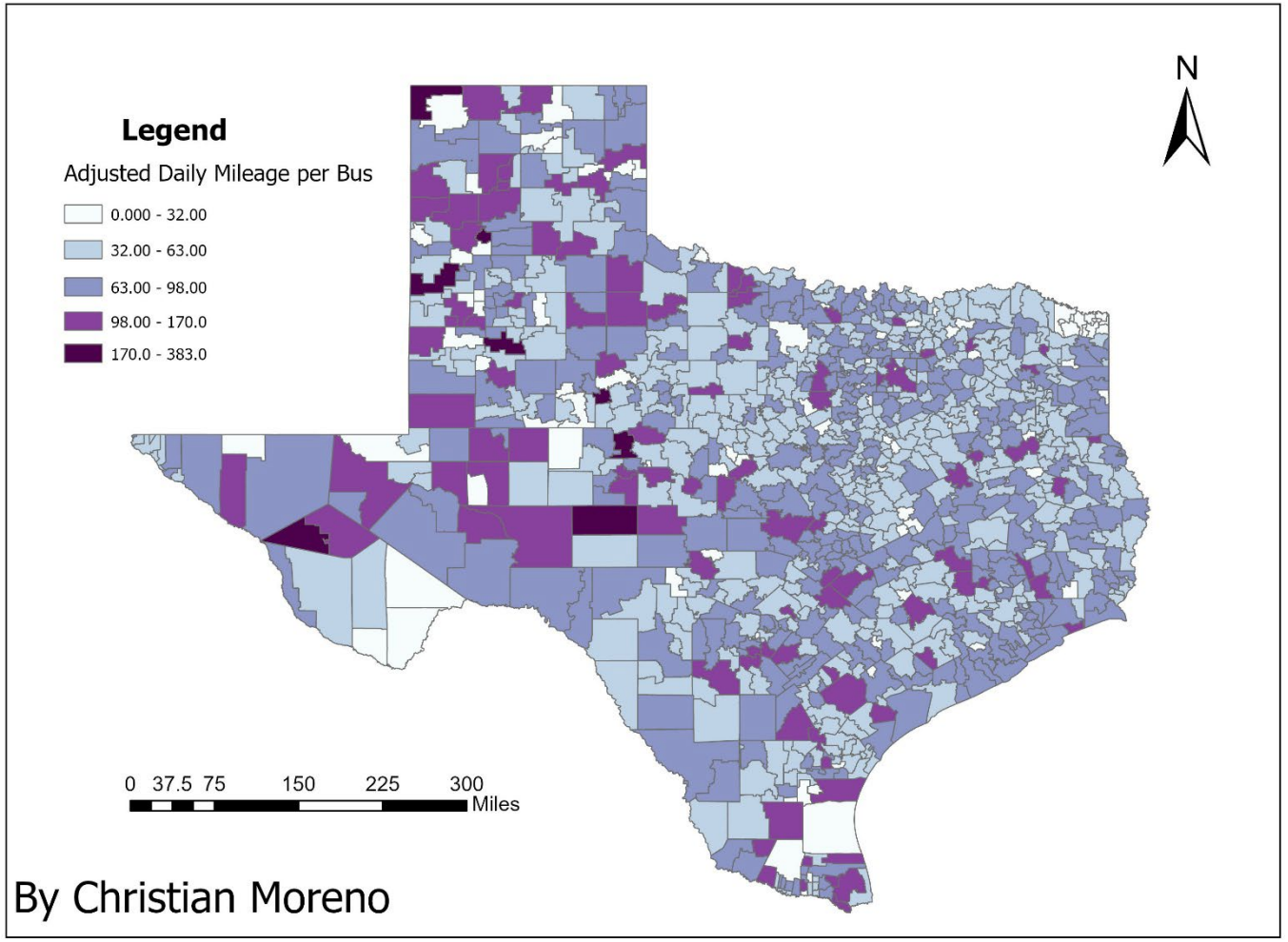
All Routes in TX

Adjusted Daily Mileage Per Bus by ISD



Note: Data not shown for all districts

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Route Study

- 2 ISDs chosen for route-level analysis
  - All 9 schools in Everman ISD
  - 3 schools in Dallas ISD: 1 high school, 2 elementary schools
- Artificial routes created using ArcGIS Network Analyst – shortest route
- Electrification study based on individual routes instead of entire districts (i.e. adjusted daily mileage)
- Allows for more granular implementation of ESBs

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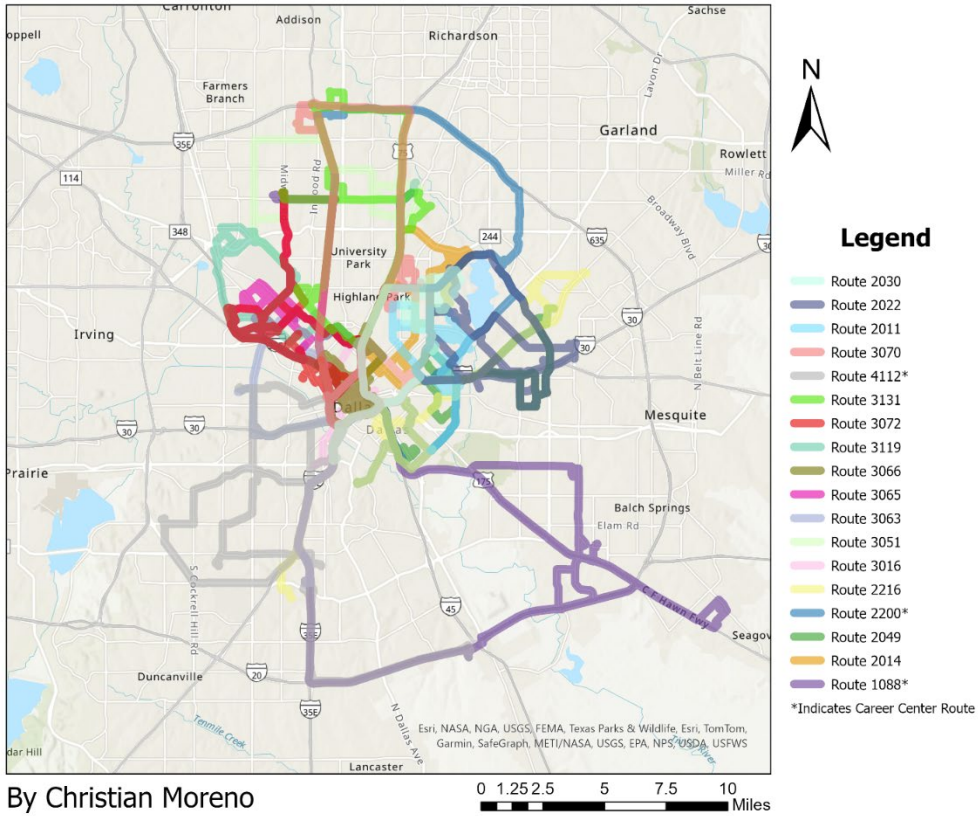
DISD Route Characteristics

- 19 routes & 494 stops
- Average length: 81.2 miles
- Average number of stops: 26
- Longest route: 165 miles (Route 1088)
- Shortest route: 55 miles (Route 2030)
- 95% of routes can be serviced (assuming 130 mi range)

DISD Bus Routes



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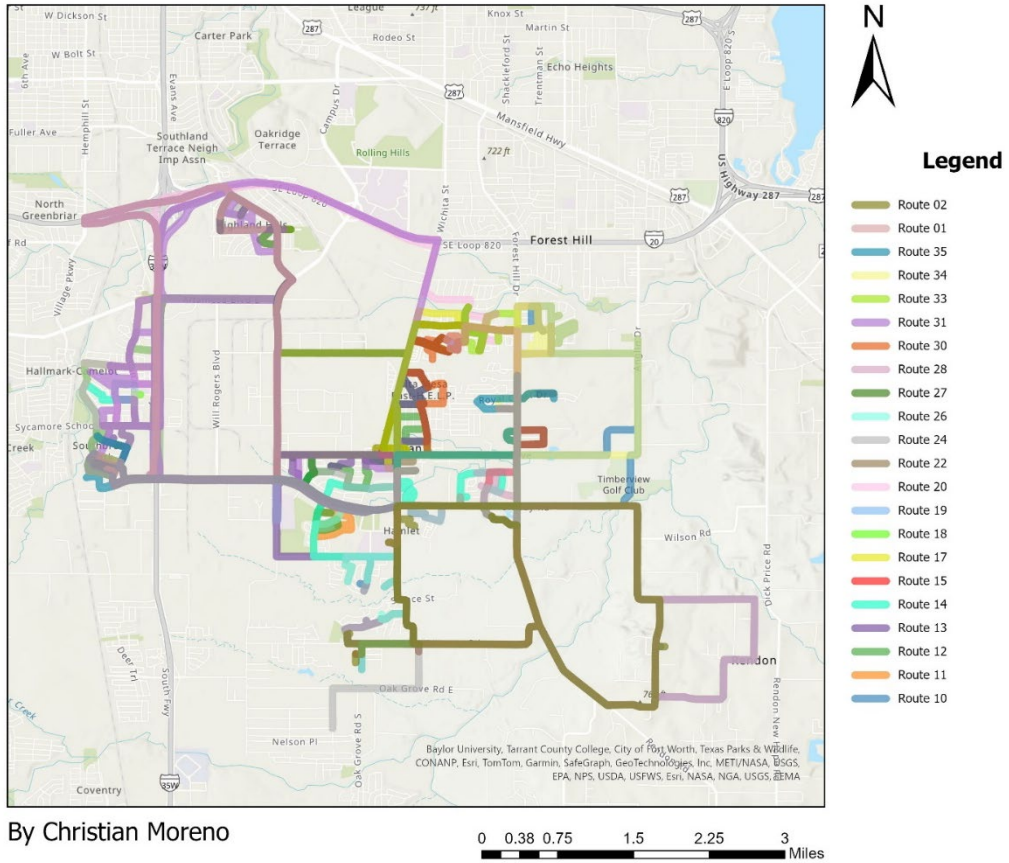
EISD Route Characteristics

- Total of 22 routes & 716 stops
- Average length: 41.8 miles
- Average number of stops: 32.5
- Longest route: 90 miles (Route 31)
- Shortest route: 15 miles (Route 02)
- 100% of routes can be serviced (assuming 130 mi range)

EISD Bus Routes



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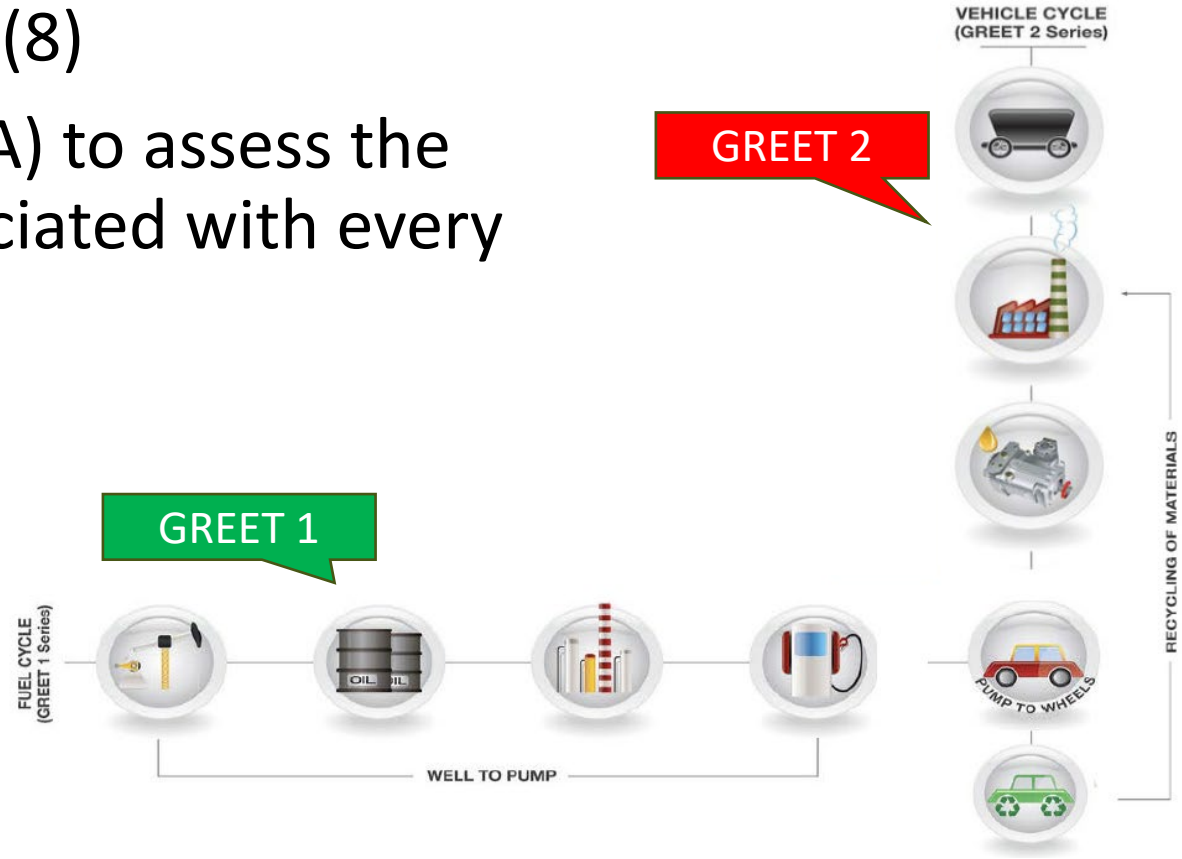
GREET Model

- What is GREET?
- **G**reenhouse gases, **R**egulated **E**missions, and **E**nergy use in **T**echnologies (8)
- Uses Life Cycle Analysis (LCA) to assess the environmental impact associated with every stage of the supply chain
- GREET 1: “well-to-pump”
- GREET 2: “well-to-wheel”



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GREET Result – default values (GHG g/mi)

	DSB	ESB
WTP	305.4	887.3
Operation	1363.0	0.0
Components	159.6	164.6
ADR	110.0	108.4
Fluids	19.9	4.4
Battery	0.9	263.4
Total	**1958.8**	**1428.8**

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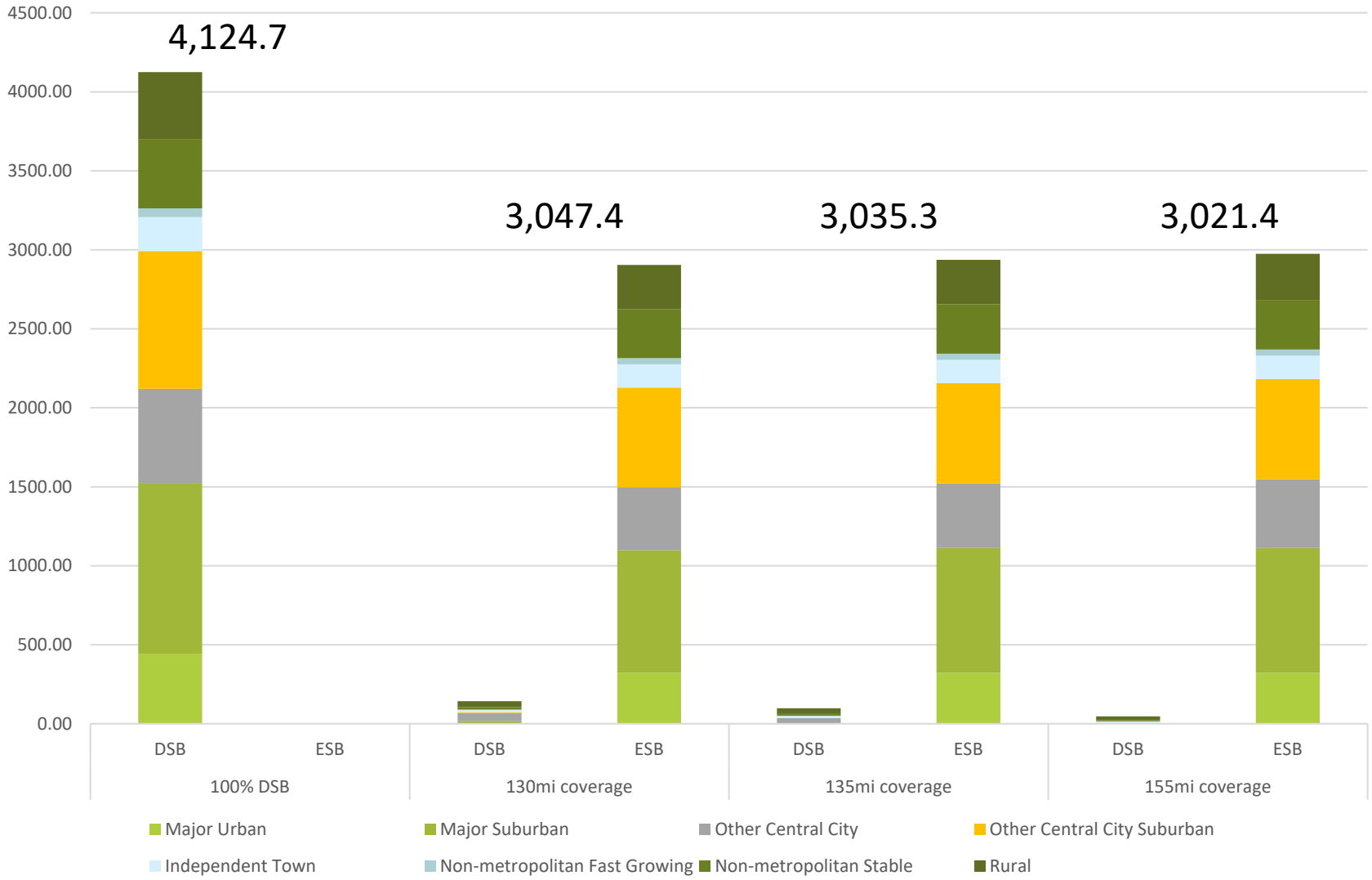
GREET Result – VMT * GREET result (GHG tn/day)



Conclusion

- A large proportion of ISDs can be serviced by ESBs (>97%)
  - 100% of routes in EISD
  - 95% of routes in 3 DISD schools
- Range is not a major obstacle for ESB adoption
- Environmental impact of ESBs less than that of DSBs
- Significant reduction in GHGs
  - 130 mi scenario: 26% decrease
  - 135 mi scenario: 26% decrease
  - 155 mi scenario: 27% decrease
- Policymakers should consider that for every ESB replacing DSB, there will be a net reduction in GHG emissions
  - Incentives for ISDs to electrify their fleets: tax credits, bonds, etc.

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Sources

1. https://www.schoolbusfleet.com/management/10211604/u-s-state-by-state-school-transportation-statistics-2022-23
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