A Cross-Country Analysis of Medium-Duty and Heavy-Duty Electric Vehicle Deployments

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EVS35
OSL2022

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Data on MHD EVs is lacking

Several barriers to adoption still exist across different MHD applications:

Range | Efficiency impacts | Duty cycle suitability

Using data to address the knowledge gaps

Improving the public understanding of current deployment of MHD EVs is essential for accelerating EV adoption

Project objective

- Collect, validate, analyze and provide summary results on operational data collected from more than 200 MD and HD EVs.

Desired impact

- Expanded national EV dataset to better inform future policy and deployment decisions
- Identification of regional and national trends in MHD EV deployment and operating performance

Timeline

Start date: October 2019

End date: September 2023

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The team

Department of Energy
Project Sponsor

- National Renewable Energy Lab
- Argonne National Lab
- Idaho National Lab

National Lab Advisors

UCR
Technical Partner

CALSTART
Prime/Project Lead

TETRA TECH
GEOTAB
VIRICITI
Implementation Partners

Clean Cities Coalitions

Data parameters and sources

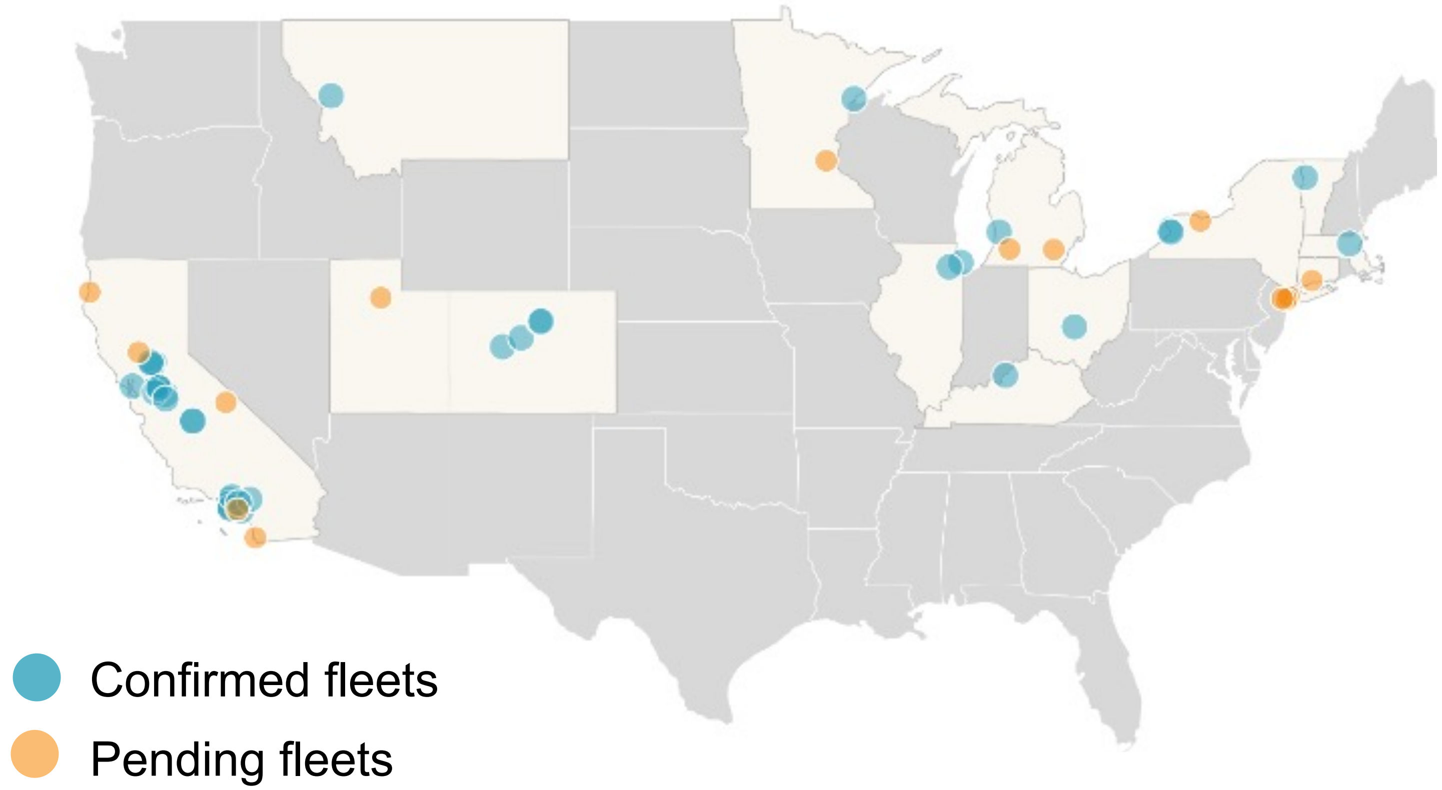
Data Type	Source
Vehicle performance	On-board data loggers
Charger performance	EVSE charging management software or portal
Facility	Electricity consumption/utility records
Maintenance	Service calls, availability of vehicles, preventive maintenance logs

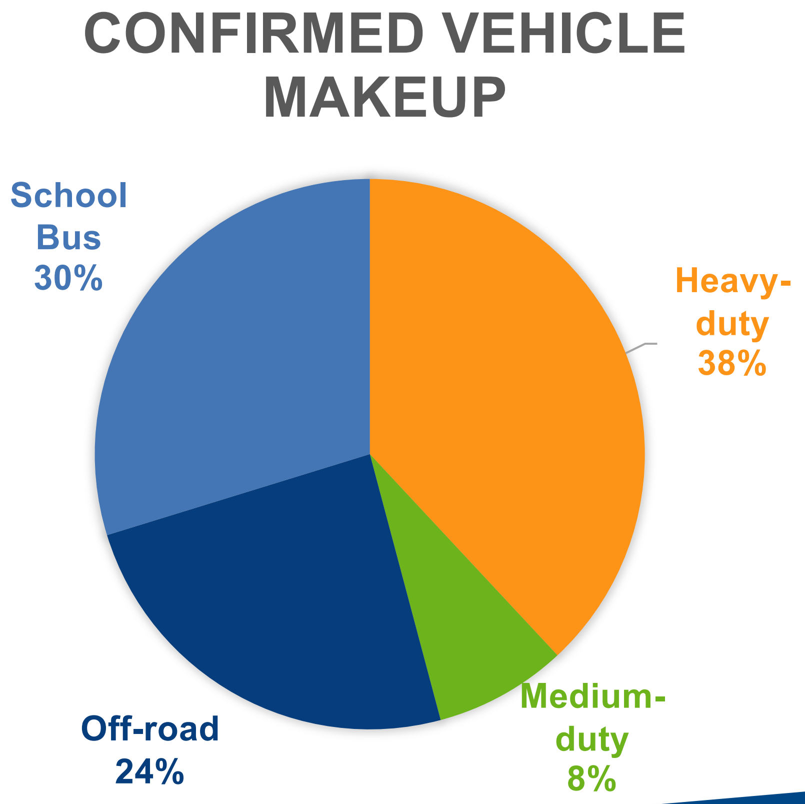
Vehicle Attributes	
Weight class	Nominal efficiency
Nominal efficiency	Battery capacity
Towing Capacity	Region
Vocation	Vehicle platform
Body Style	

BASIC PARAMETERS
Year, Make, Model
Unique Vehicle ID
Local Trip Start Time
Local Trip End Time
Trip Origin Zip
Trip Destination Zip
Trip Distance
Trip Duration
Trip Initial SOC
Trip Final SOC
Trip Energy Consumption
Ambient Temperature
Initial Odometer
Final Odometer

Capturing diversity in the data

242 vehicles across **13** states and **29** distinct fleets participating in the program





	Vehicle Types	Number of Vehicles Confirmed	Number of Vehicles in Analysis	Number of Vehicle Days in Analysis
HD	Transit Buses	124	34	3,791
	Class 7 Box Trucks	5	5	478
	Class 8 Day Cab Tractor	14	14	1,057
MD	Class 6 Trucks	54	10	220
Off-Road	Yard Tractors	45	28	6,695
Total		**242**	**91**	**12,241**

Growing suitability but still limitations

- Based on observable data and fleet interactions,
  Most EV yard tractors, MD trucks, delivery vans and transit buses have been found to perform comparably to the conventional baseline vehicles used on similar duty cycles.

- However, EV models in the HD truck segment proved capable of meeting duty cycles limited to one shift and less than 200 miles (322 km) per day. **Challenges are found when there is dynamic/unpredictable routing, longer routes, longer idling time or trucks not returning to the base each day to charge.**





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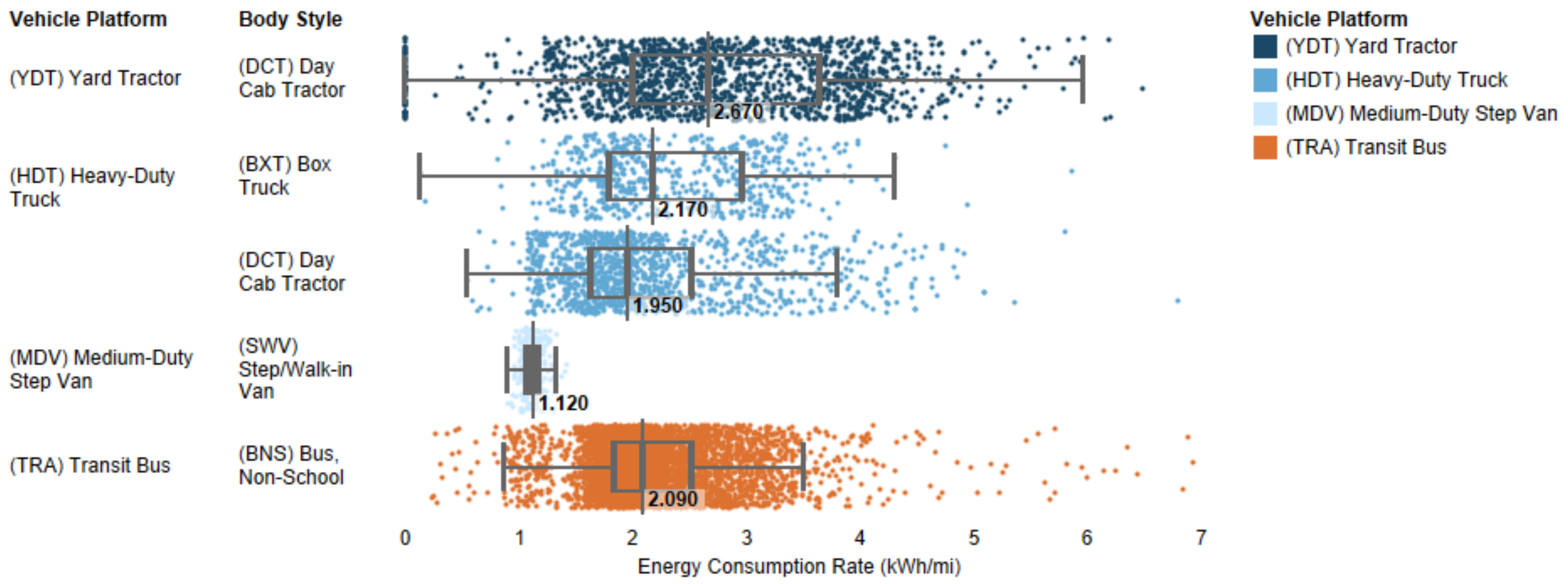
Vehicle Type	Daily Distance (mi)	Daily Key-on Time (hr)	Daily Average Driving Speed (mph)	Description and Use Case
Transit Bus 	92	14	18	City routes, returning to bus depot each day. Buses rely on overnight depot charging.
MD Step Van 	44	14	23	Return to base, urban delivery of mail or packages, variable routes
HD Day Cab Tractor 	58	4	20	Return to base, port drayage or regional duty cycle, fixed routes
HD Box Truck 	48	4	16	Return to base, regional duty cycle, fixed routes
Yard Tractor 	32	10	3	Single to multiple shifts, fixed routes

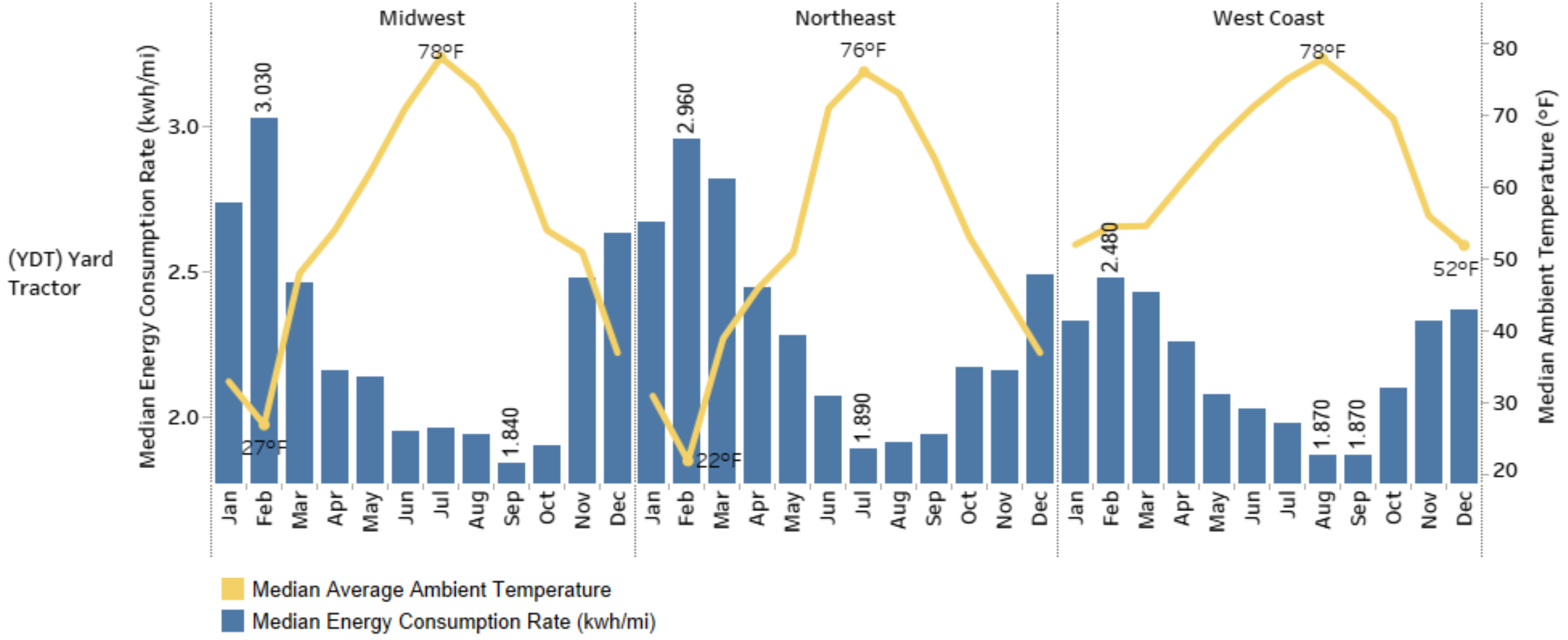
MHD EVs achieve much greater efficiency



- MHD EVs were found to be **2-4 times more efficient** than comparable diesel vehicles
- **Most real-world efficiency were not able to reach the nominal efficiency cited by manufacturer**, under a combination of variations in their duty cycle, environment and driving conditions.

Strong seasonal patterns across regions

- Seasonal patterns in vehicle efficiency were observed across different regions, indicating a possible correlation between ambient temperature and vehicle efficiency.

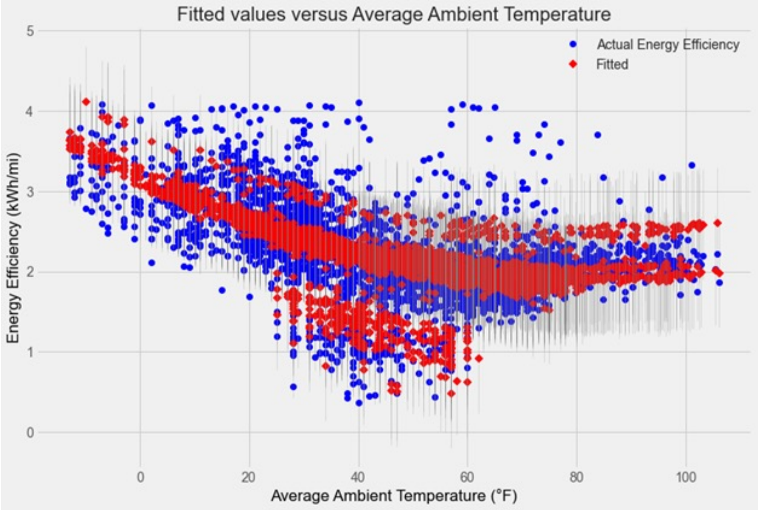


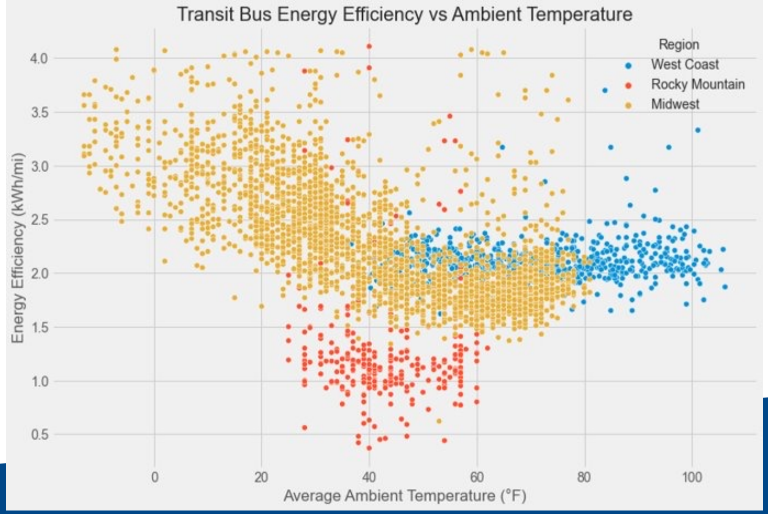
Regression analysis confirms eff/temp correlation

$$Energy\ Efficiency = \beta_0 + \beta_1 Average\ Ambient\ Temperature + \beta_2 (Average\ Ambient\ Temperature)^2 + \sum \beta_i Region_i + \sum \theta_j Control_j + \varepsilon$$

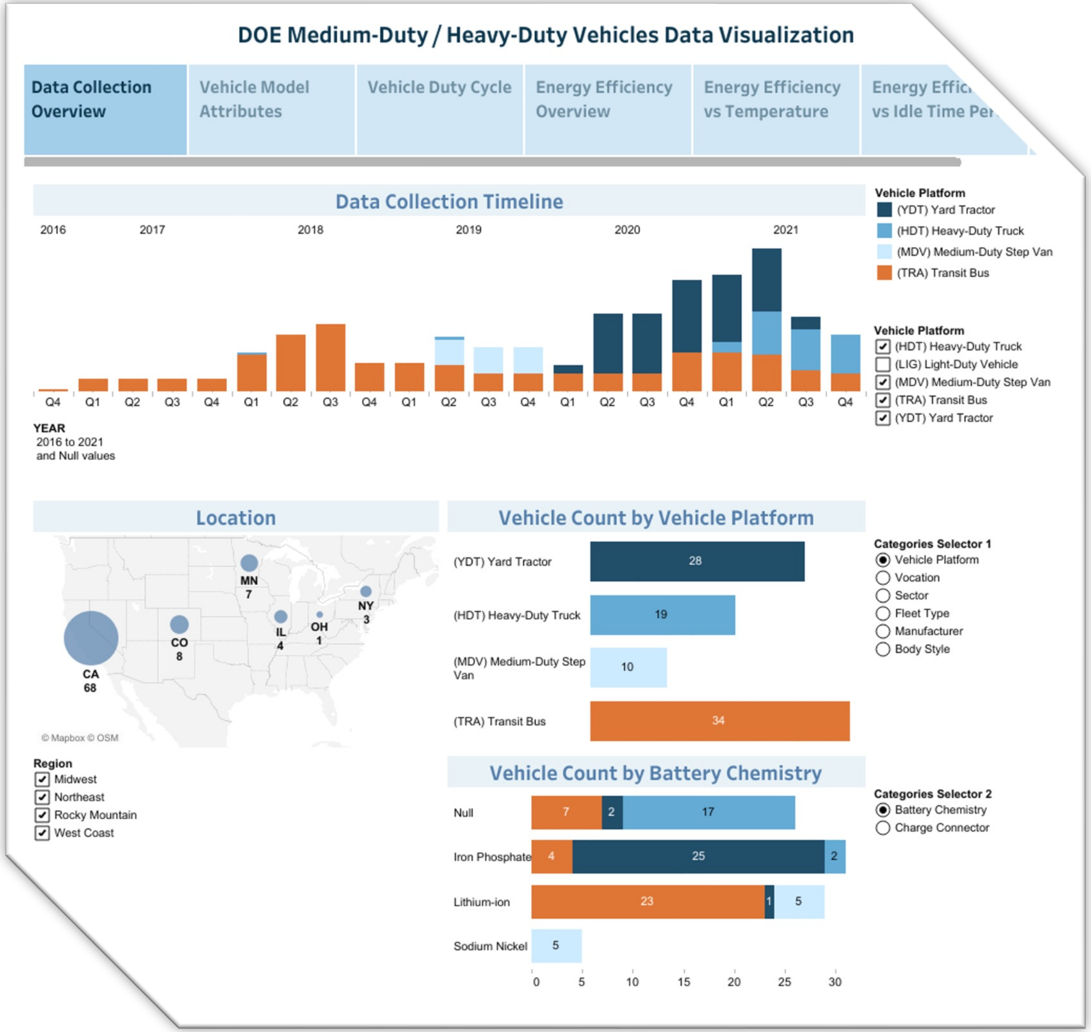
30°F (-1°C) to 55°F (12°C)	56°F (13°C) and 78°F (26°C)
1°F lower in ambient temperature is associated with **1-2 kWh additional energy consumption** every 100 miles	1°F lower in ambient temperature is associated with **0.1-1 kWh additional energy consumption** every 100 miles

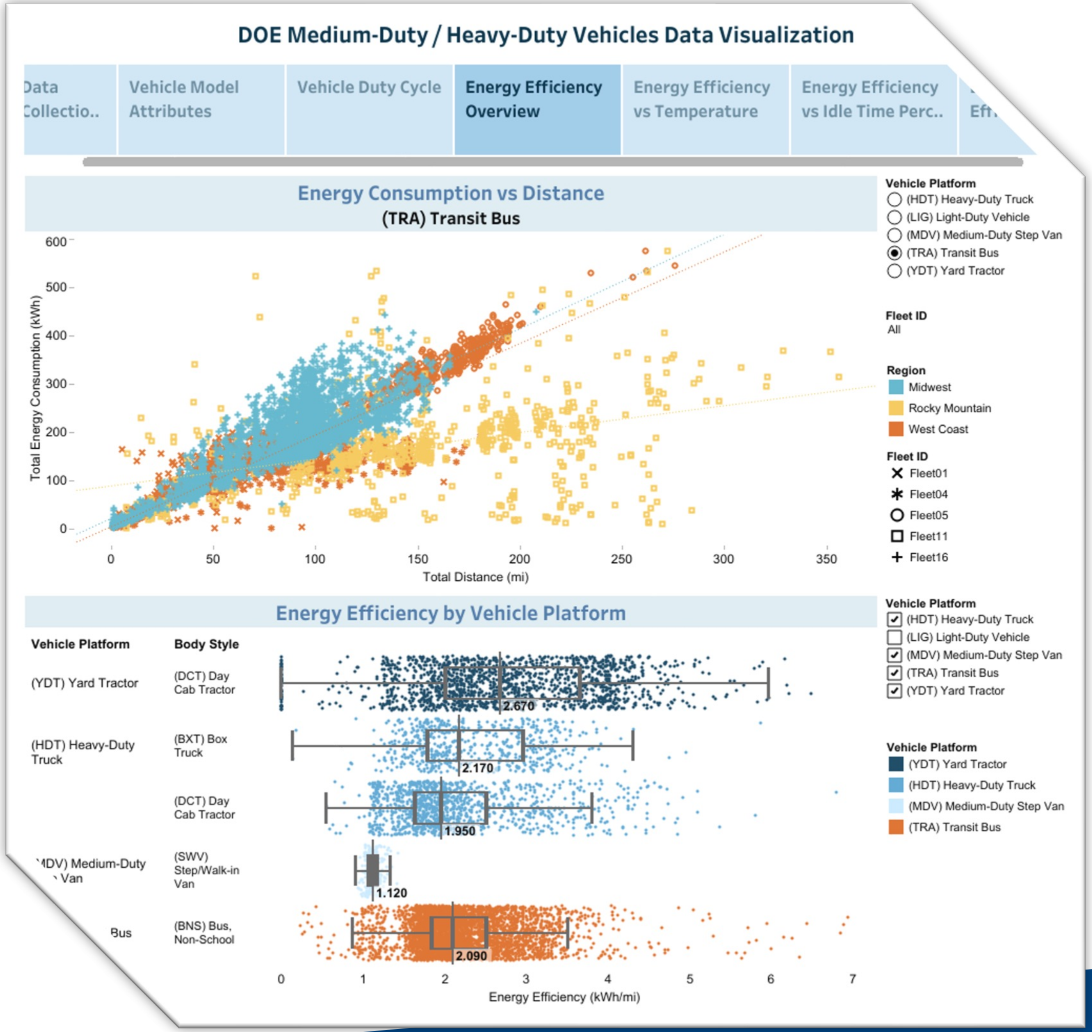
- The **optimal ambient temperature** for transit bus efficiency is around **81°F (27°C),** holding other variables constant.





Data will be made publicly accessible





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Acknowledgements

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