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AIR RESOURCES BOARD

# Improving Energy Consumption Rate Estimates for Zero Emission Vehicles in EMFAC202Y

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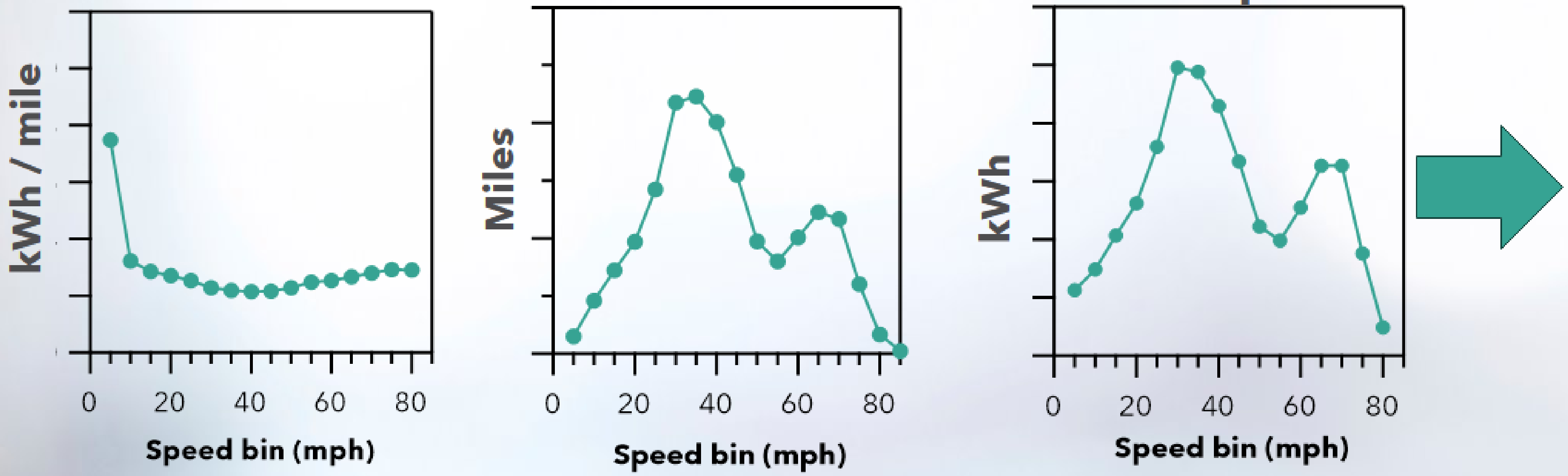
# EMFAC's energy module

- EMFAC is CARB's model to estimate LD and HD on-road emissions across the state.
- With the implementation of the Advanced Clean Cars II regulation, electrical demand of EVs will continue to increase in coming years.
- The energy module can help estimate the demands put on the electric infrastructure with the transition to a larger EV fleet.
  - Other groups such as CEC are also estimating these values as part of Integrated Energy Policy Reports (IEPR).

# How the energy module works in EMFAC

Energy Consumption Rate x eVMT = Energy Consumption




Sums to Total energy consumption kWh per day

# EMFAC energy module data sources

| | EMFAC 2021 (Current Version) | EMFAC202Y (Future Version) |
|---|---|---|
| **Data type** | Trip-by-trip data submitted by OEMs | Second-to-second real-world driving data, UC Davis dataset* |
| **Model years** | 2011-2016 | 2012-2019 |
| **Model notes** | Excludes Tesla | Includes Tesla |
| **Charging info** | Basic charge loss correction | Charge loss update, Stop-loss addition |

*Contract 12-319 1. "Advanced Plug-in Electric Vehicle Travel and Charging Behavior"

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# Planned Process

## DMV Inventory

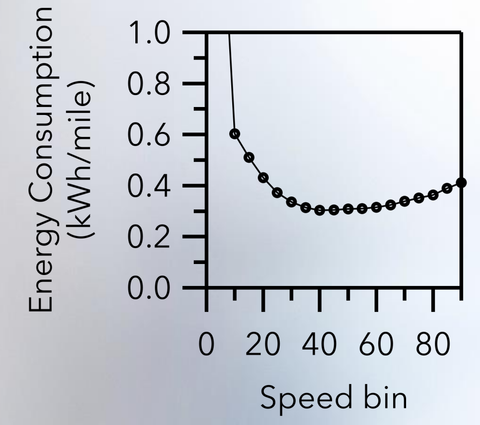
LDA LDT1 LDT2 MDV

**FuelEconomy.gov**

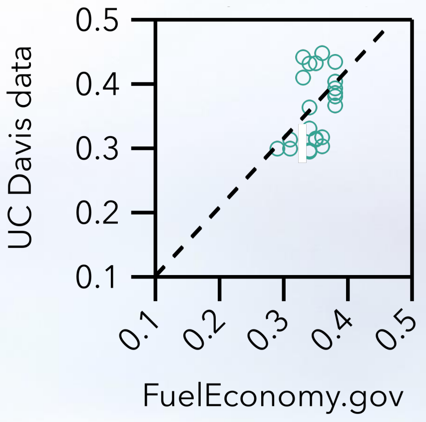
| Energy consumptions avg. (kWh/mile) | | | |
|---|---|---|---|
| LDA | LDT1 | LDT2 | MDV |
| 0.30 | 0.33 | 0.37 | 0.44 |

## UC Davis dataset

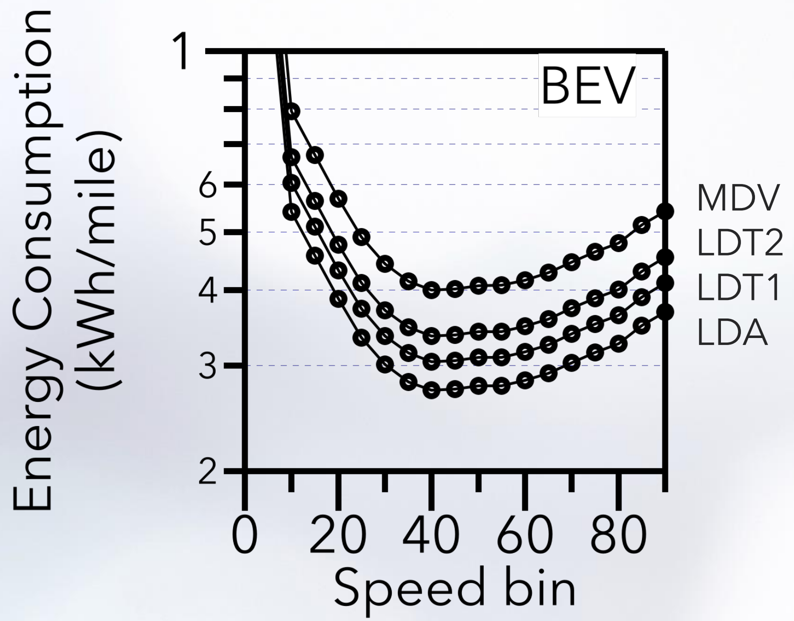
**Speed distribution**



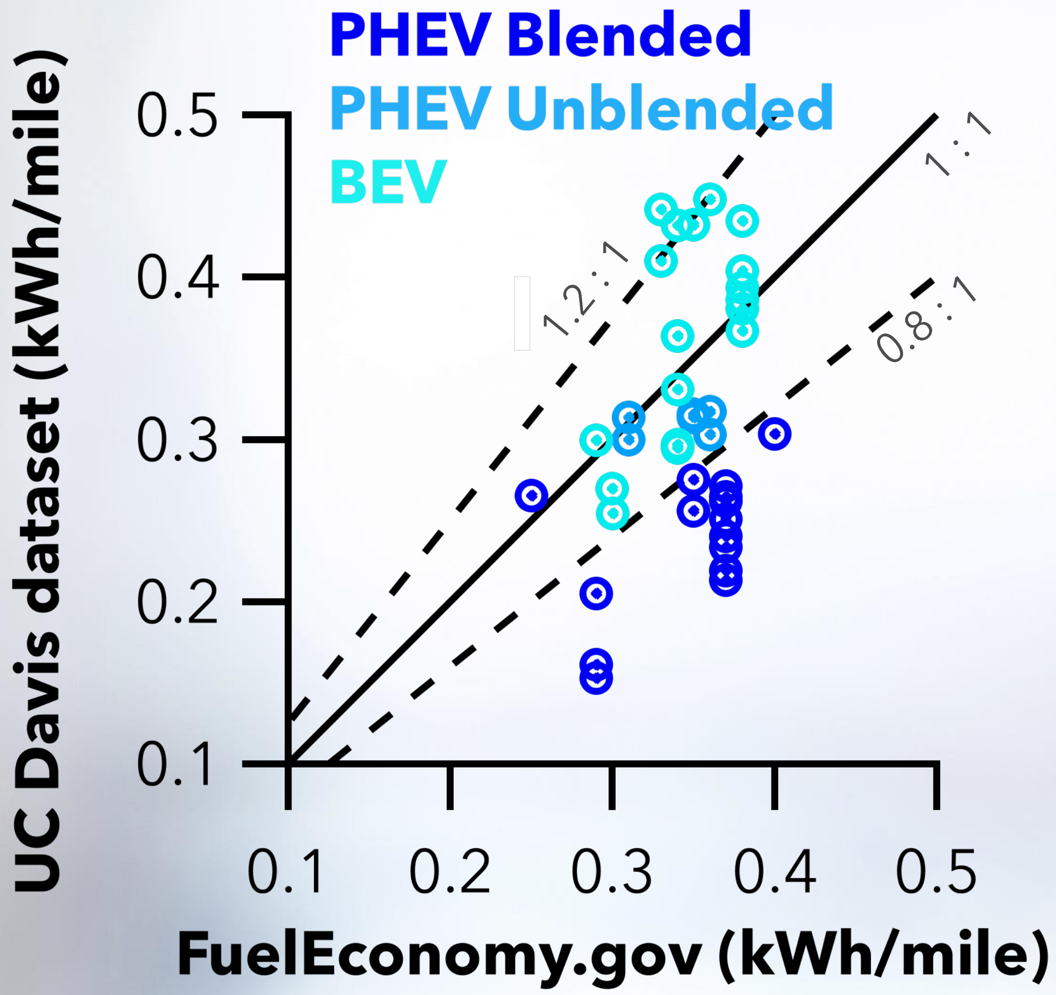

**Real-world correction**




## Final Result



# Comparing to FuelEconomy.gov




- Correction applied to UC Davis data for 14.3% charging losses (*Sears et al 2014*)
- Blended PHEVs show real-world kWh/mile ratings that are more efficient than fueleconomy.gov
- Ultimately an overall correction of 9% is needed for FuelEconomy.gov values

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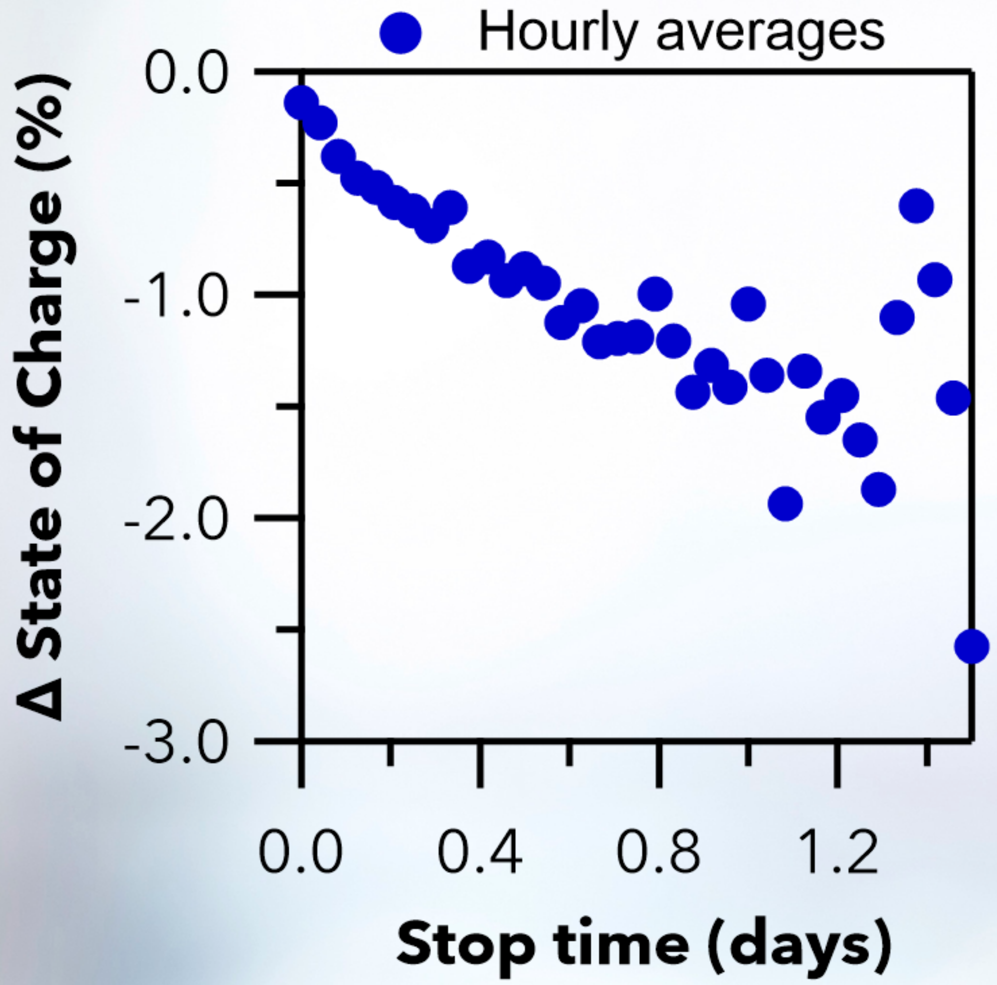
# Correcting for energy loss while parked




- The state of charge (SoC) of batteries can decrease while EV is parked ("stop loss")
- We estimated a 2.3% increase of energy demand for entire EV fleet.

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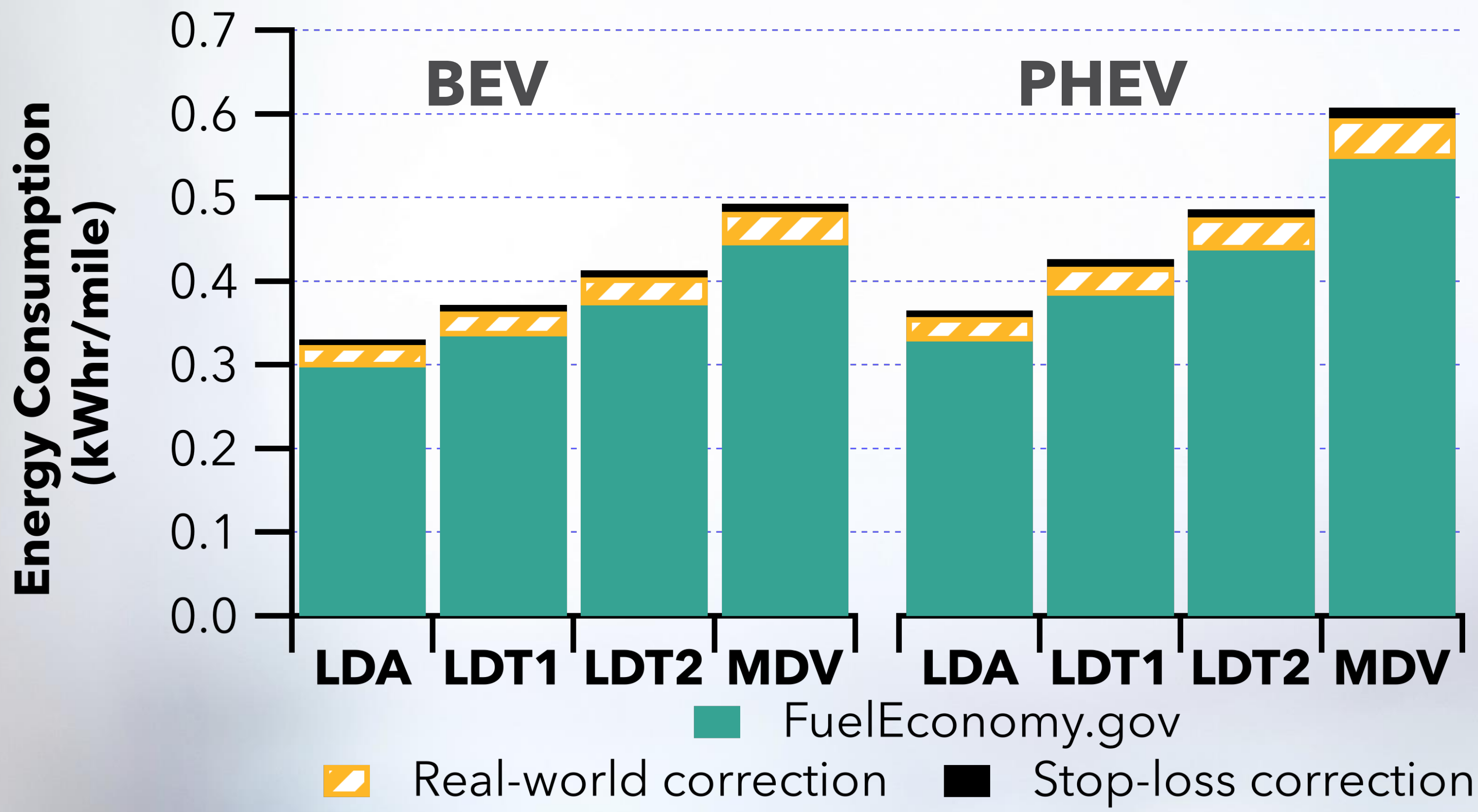
# Preliminary results: Energy consumption averages




- FuelEconomy.gov values are increased by 9% to account for real-world driving and charging effects.
- Another 2.3% increase applied for SoC stop losses.

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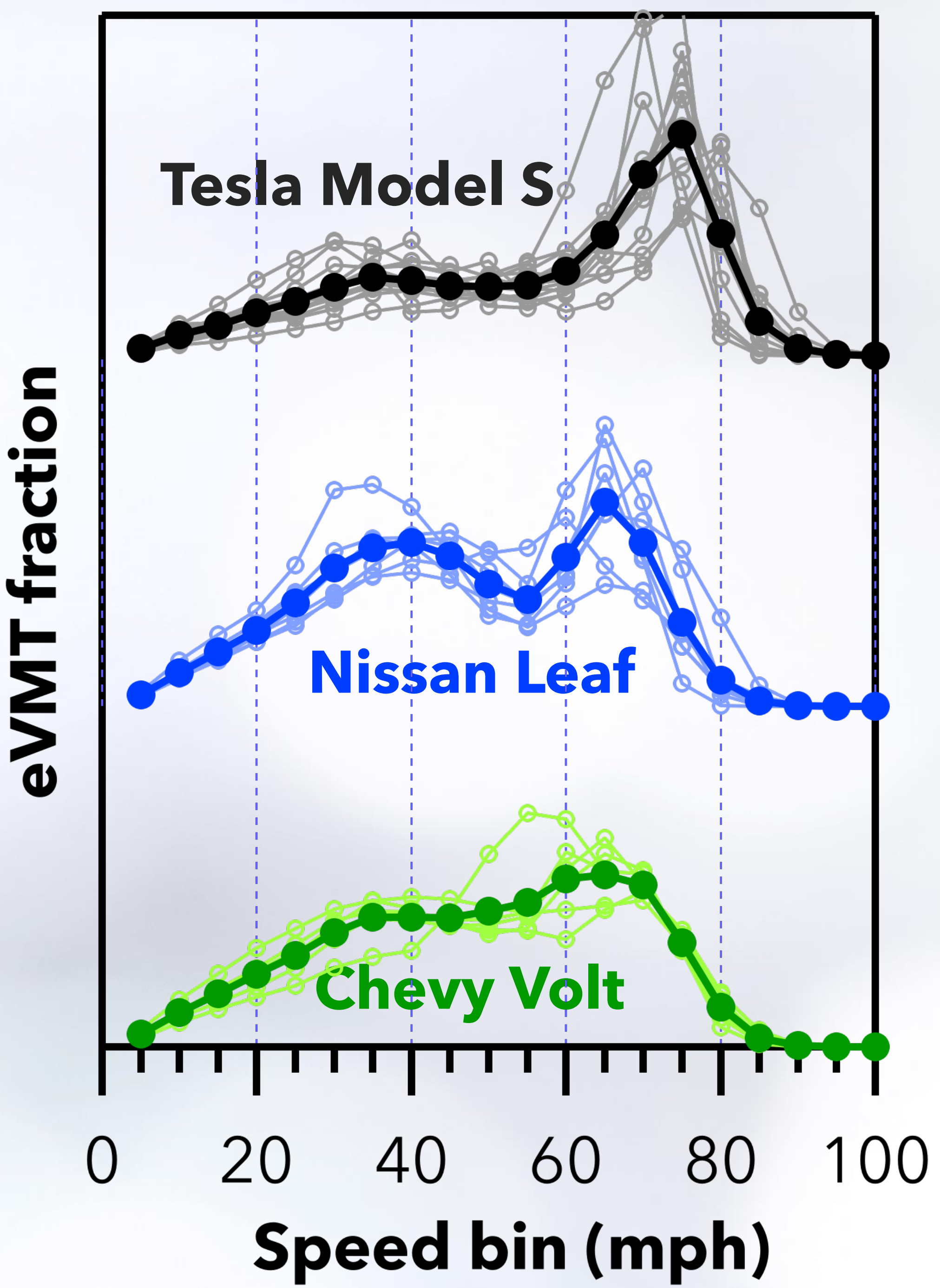
# Speed-binned eVMT

- Models each exhibit some form of bimodal distribution.
  - Volt distribution used to represent all PHEVs eVMT in EMFAC202Y.
  - A Tesla : Nissan weighted average used to represent BEVs.

eVMT definition for PHEV: VMT while RPM = 0

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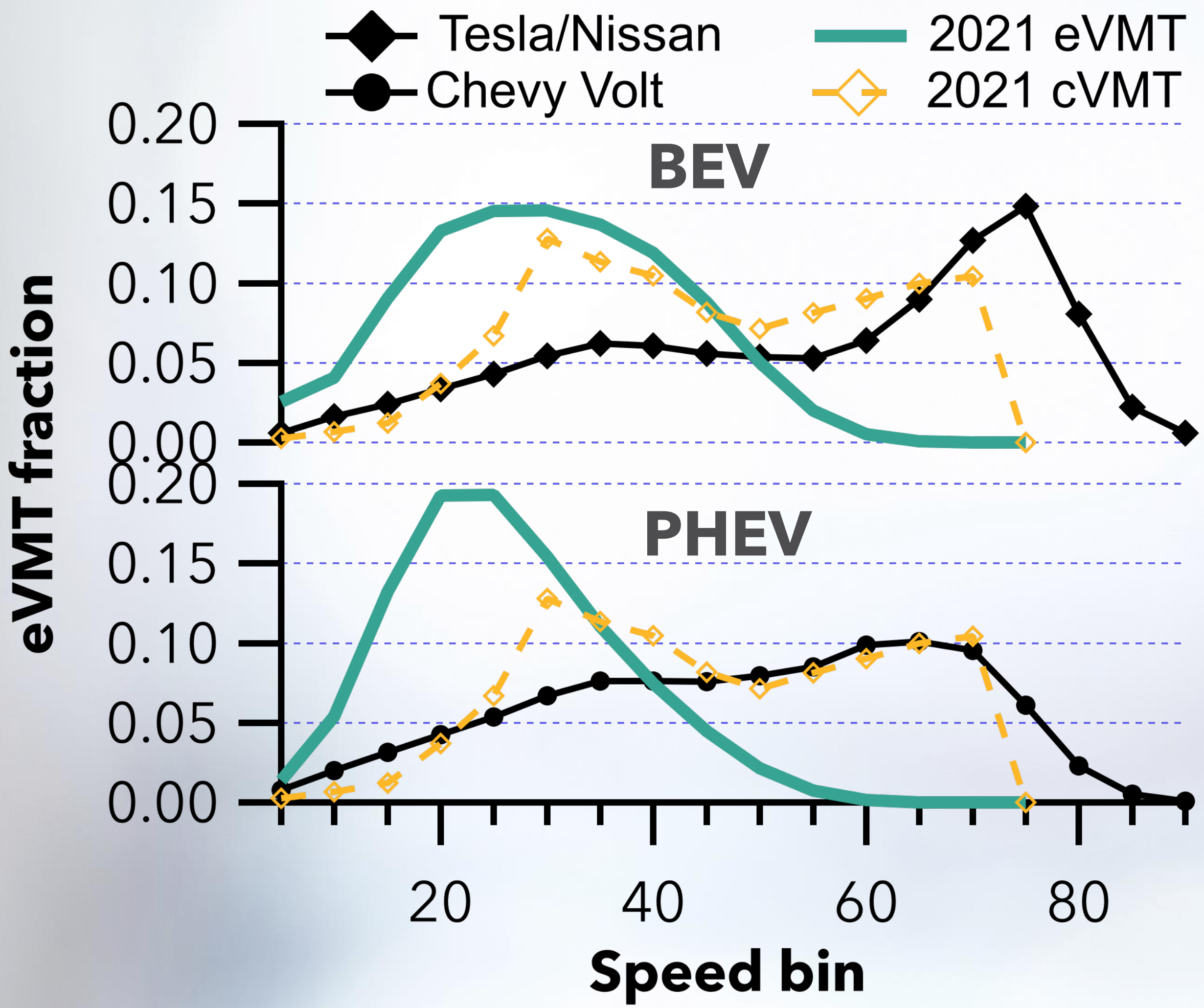
# Preliminary results: eVMT by speed bin




- Updated distributions show peak eVMT at much higher speed bins than previous EMFAC version.

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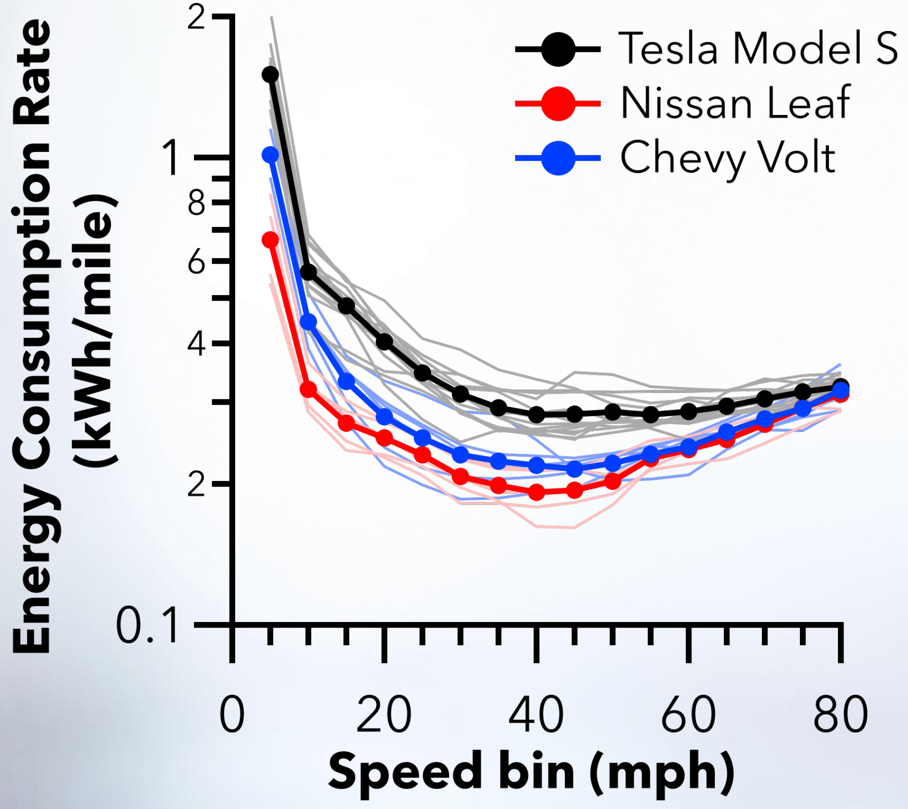
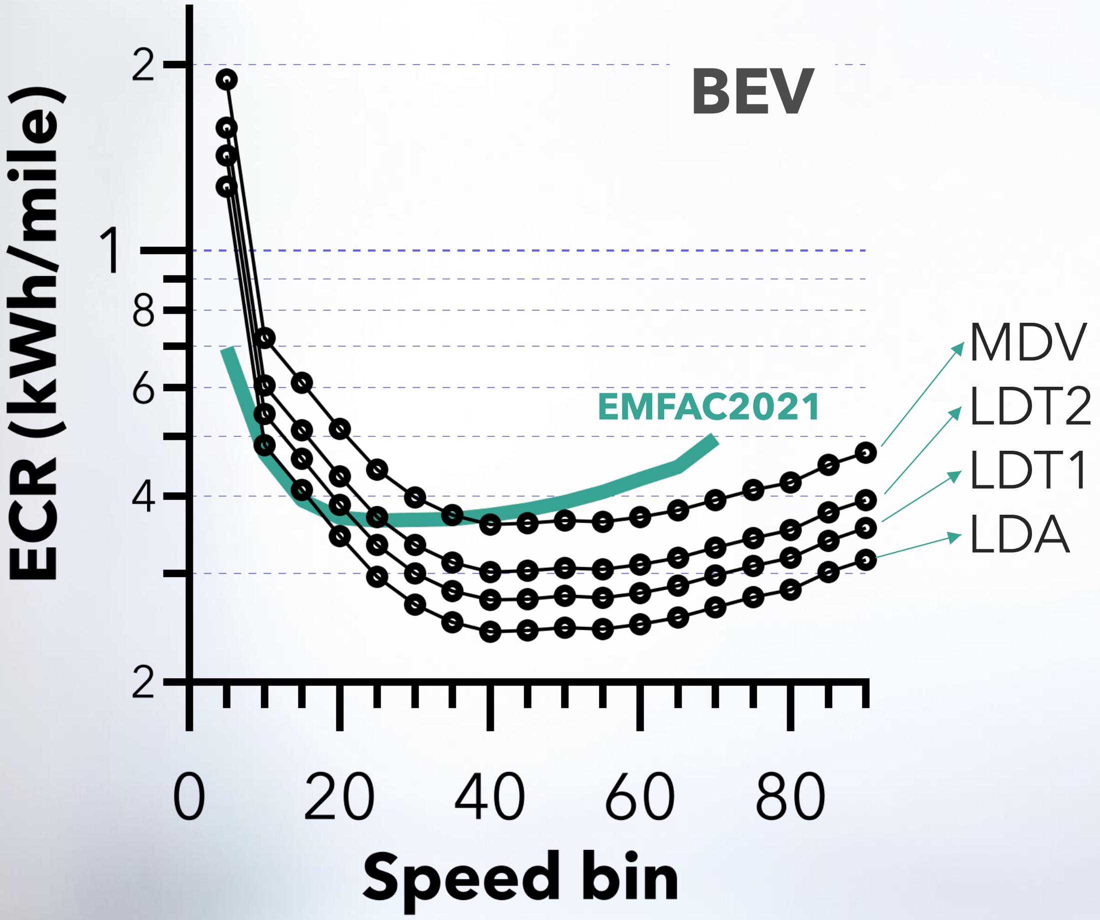
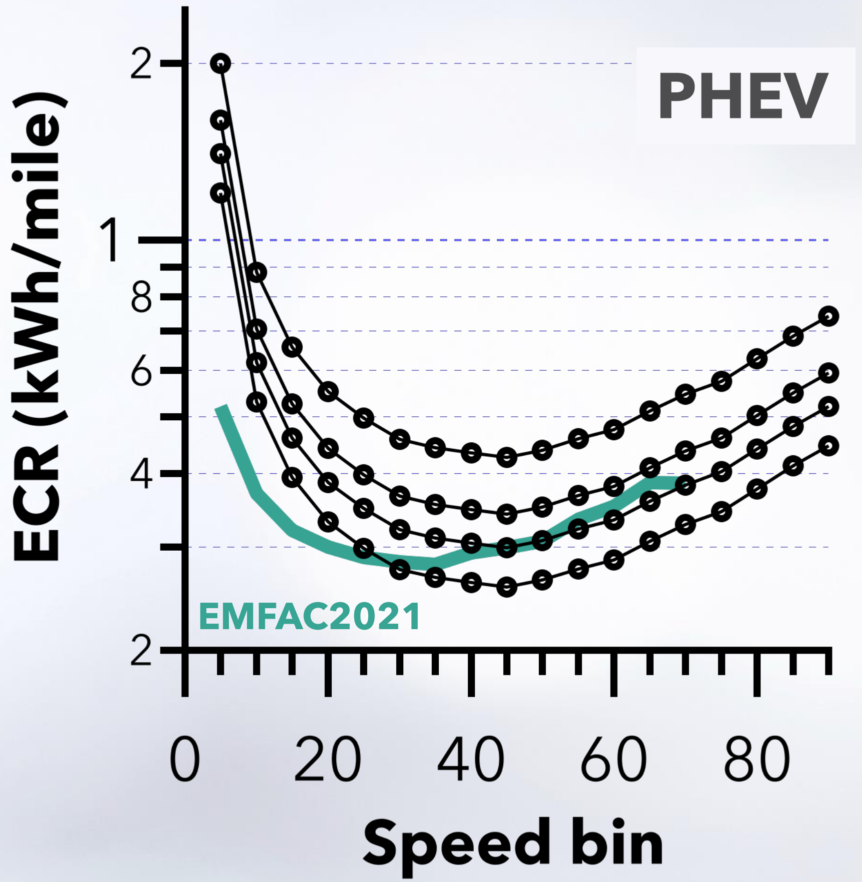
# Speed-binned energy consumption




- Similar kWh/mile speed distributions across models.
- Tesla models consistently higher, blended PHEVs lowest.
  - Chevy Volt distribution to represent all PHEVs in EMFAC 202Y.
  - We use a Tesla : Nissan weighted average to represent BEVs.

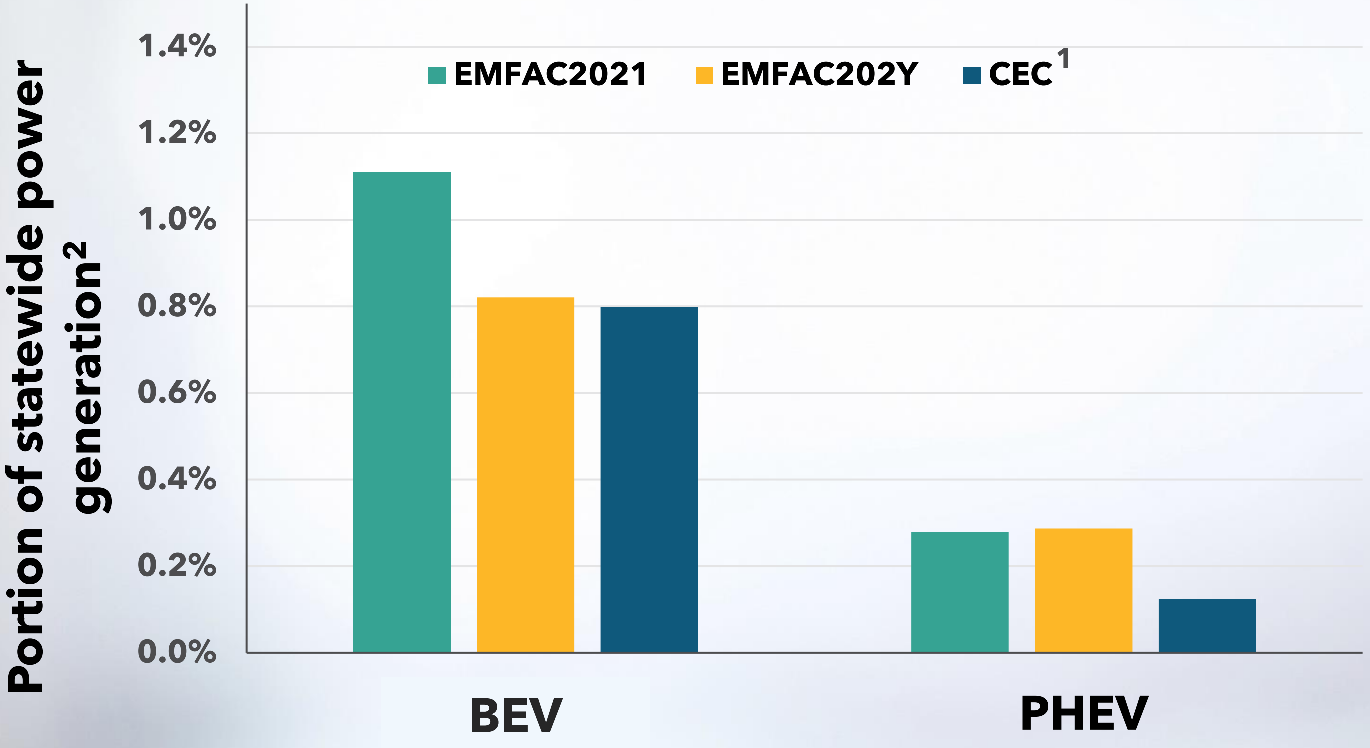
# Energy consumption rate curves




Energy consumption curves for EMFAC202Y are now split into 4 weight classes, and better represent real-world driving conditions.

# Preliminary results: CY 2022 Annual energy consumption estimates




- EMFAC202Y predicts less energy use for BEVs, but a similar energy use for PHEVs, relative to EMFAC2021.
- Note: eVMT used for PHEVs in EMFAC202Y is still under development.

1. CEC estimates based on 2023 Integrated Energy Policy Report (IEPR)
2. Statewide power generation was 287,220 GWh in 2022. https://www.energy.ca.gov/data-reports/energy-almanac/california-electricity-data/2022-total-system-electric-generation

# Summary

- Energy consumption inversely correlates with vehicle weight
- BEVs are more efficient than PHEVs of corresponding weight
  - Due to difficulty in separating ICE/EV operating modes, blended PHEVs were not used to inform EMFAC202Y
- Updated eVMT distributions are bimodal with that show increased driving at higher speeds
- Results to be released in next EMFAC version, expected Spring 2025.

# END

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