Hourly Load Profile Dataset for Federal, State, and Municipal Electric Vehicle Fleets in the United States

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List of Acronyms

EV	electric vehicle
EVER	electric vehicle efficiency ratio
GGE	gasoline gallon equivalent
ICEV	internal combustion engine vehicle

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1 Introduction

The electrification of U.S. federal, state, and municipal fleets is accelerating rapidly, driven by an increased availability of competitive electric vehicle (EV) options and supportive policies and targets. At the federal level, fleets previously had a mandate that all new light-duty vehicle fleet acquisitions should be zero emission by 2027, with a broader goal of all federal fleet acquisitions being zero emission by 2035 regardless of vehicle type. If market forces drive fleets to adopt EVs at a similar rate, utilities will need to anticipate and address increased electricity demand from EVs. Understanding where federal, state, and local government fleets are located and how they might consume electricity will help utilities plan their electric infrastructure to support the increased demand.

Government fleets deliver diverse and essential services across the full geography of the United States. Federal fleets span critical applications such as providing health services, mail delivery, land and infrastructure management, armed services support, and law enforcement. State and local government fleets mirror this diversity, with applications tailored to regional and community-specific needs. Electrifying these fleets will require a market-ready supply of EVs across the full spectrum of on-road vehicle types, ranging from passenger cars to highly specialized heavy vocational vehicles.

However, the transition to EVs will not progress uniformly across all regions and vehicle types. Government fleet procurement cycles are guided by vehicle age, operational demands, and budgetary constraints. In general, light-duty vehicles tend to be replaced on shorter, more predictable schedules, while medium- and heavy-duty vehicles with more specialized capabilities have longer replacement cycles, often aligned with the end of their operational life spans. Because light-duty EVs are widely available and affordable today, they are expected to electrify soonest, while highly specialized medium- and heavy-duty vehicles may take longer.

Achieving a smooth and efficient transition to government EVs will require strategic alignment between fleet procurement, infrastructure development, and EV technology advancements. The dataset described in this report, accessible at data.nrel.gov/submissions/280, provides a critical initial foundation for identifying fleet electricity demand, projecting these future demands, and developing actionable strategies to support the widespread electrification of government fleets.

The dataset incorporates available fleet data, including 54% of federal agency vehicles approved for analysis (notably, the U.S. Postal Service is absent). Additionally, it includes data from 50,000 state government vehicles and 94,000 local government vehicles. While this represents a small fraction of the 4.4 million vehicles owned by state and local governments reported by the Federal Highway Administration (2022), the framework supports future expansion as more fleet inventory data become available.

2 Methods

This analysis estimates the hourly electricity demand of government fleets at a detailed spatial resolution by integrating available fleet resource data with known vehicle locations. It leverages real-world fleet energy usage—and makes approximations where necessary—to project electricity demand under a fully electrified fleet scenario. While current data sources do not provide a complete representation of all government vehicles, this dataset provides a solid foundation for analysis, which can be expanded and refined as more data become available.

2.1 Government Fleet Data

The U.S. Department of Energy supports government fleets through three key programs: (1) the Federal Energy Management Program, which supports non-tactical federal fleets; (2) the State and Alternative Fuel Provider Fleet Program, which assists state government fleets; and (3) the Clean Cities and Communities Partnership, which aids a variety of fleets, including those operated by local governments. These programs collect fleet data for regulatory compliance and outreach purposes, including vehicle location data—a critical input for this analysis.

Among these initiatives, the Federal Automotive Statistical Tool (FAST), managed under the Federal Energy Management Program, provides the most comprehensive dataset for federal fleets included in this analysis. Federal agencies are required to report their vehicle inventory and fuel consumption by garage location on an annual basis. Figure 1 illustrates the composition of the civilian federal fleet, which is primarily made up of light-duty vehicles but also includes low-speed vehicles, vocational vehicles, and heavy-duty trucks and buses. Notably, the U.S. Postal Service fleet is absent from this dataset and analysis.

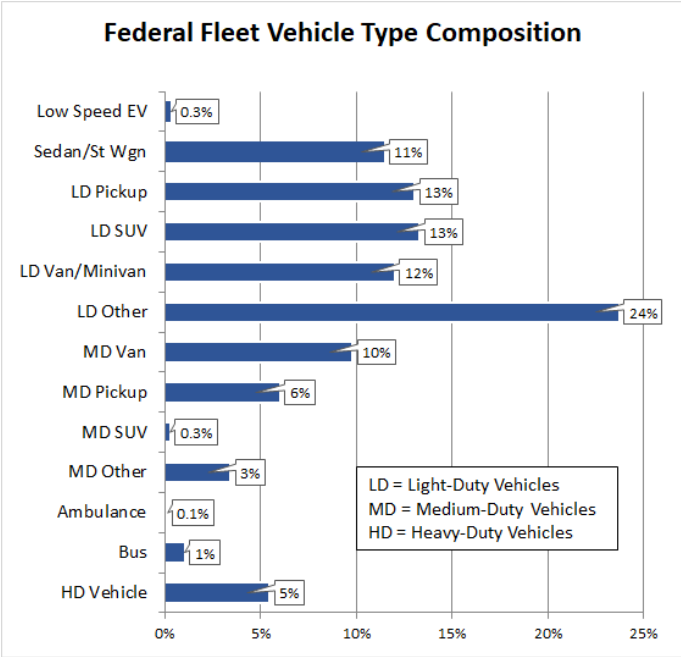

Figure 1. Federal fleet vehicle type composition (excluding U.S. Postal Service vehicles)

Agreements were secured with federal agencies to access data for approximately 330,000 vehicles, representing 54% of the domestic on-road non-tactical federal fleet. This dataset,

derived from the Federal Automotive Statistical Tool, is based on the Fiscal Year 2022 fleet inventory and includes details on vehicle types and fuel consumption, expressed in gasoline gallon equivalents (GGEs), aggregated by garage location.

For simplicity, the analysis assumes that all the federal fleet energy consumption in Fiscal Year 2022 is associated with internal combustion engine vehicles (ICEVs), given the limited adoption of EVs in federal fleets at the time. Under the terms of our federal data-sharing agreements, all vehicle data were aggregated into a single location-based output, anonymized, and then integrated with broader fleet data sources for analysis.

In addition to federal fleets, certain state fleets report their annual vehicle acquisitions to the U.S. Department of Energy through the State and Alternative Fuel Provider Fleet Program, as mandated by the Energy Policy Act. This program provided 5 years of data (2019–2023), covering vehicle acquisitions from 44 states and including records for more than 50,000 state government vehicles. The dataset includes details on vehicle type and vehicle address.

For this analysis, all vehicles are assumed to remain active within their respective fleets throughout the study period. Due to the unavailability of fuel consumption data for state fleets, estimates are derived by applying federal average annual fuel consumption rates by vehicle type to corresponding state fleet vehicles. This approach produces estimated energy consumption by vehicle type and location, expressed in GGE, under the assumption that all vehicles operated as ICEVs from 2019 to 2023. Figure 2 shows the state government fleet composition by vehicle type based on the available dataset.

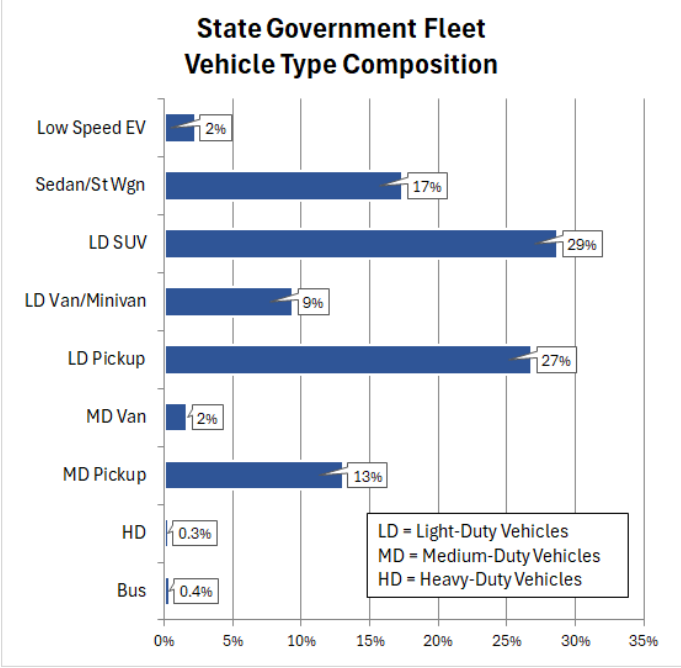

Figure 2. State government fleet vehicle type composition

The Clean Cities and Communities Partnership coalitions report stakeholder fleet activities to support their mission of advancing clean transportation solutions. Local government fleets are key coalition stakeholders, and their activities are included in these reports. These data cover a

range of vehicle types, including electric and hybrid vehicles, as well as vehicles participating in fuel economy improvement projects.

The 2022 partnership data include 94,000 vehicles operated by local governments, with details specifying city or county operating geographies. While the reporting process allows fleets to include petroleum fuel use quantities, this information is not required. Thus, to address gaps in fuel use reporting, fuel consumption is estimated using median fuel use rates by vehicle type derived from other projects. As with the federal and state fleet datasets, total fleet energy consumption is calculated by vehicle type and location, expressed in GGE. Figure 3 shows the composition of local government fleets by vehicle type based on the available dataset.

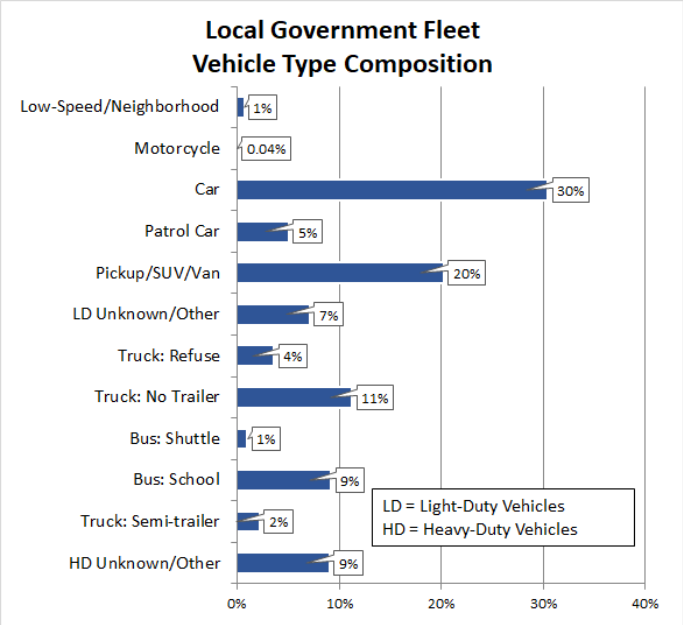

Figure 3. Local government fleet vehicle type composition

2.2 Estimating Annual EV Electricity Demand

The annual electricity requirements needed to support federal, state, and local government fleets under a fully electrified scenario is estimated by accounting for the higher relative efficiencies of EV powertrains compared to ICEVs. The resulting energy requirements, initially expressed in GGE, are converted to kilowatt-hours of electricity.

Electric vehicle efficiency ratios (EVERs) represent the ratio of energy required by ICEVs to the energy required by comparable EVs to travel the same distance (Singer et al. 2023). For vehicles with known fuel economy ratings, an EVER can be calculated by dividing the EV miles/GGE rating by the comparable ICEV miles/gallon. EVERs by vehicle weight class, shown in Table 1, were applied to support this high-level analysis.

Table 1. EVERs Assumed by Vehicle Weight Class

Vehicle Weight Class	EVER	Source
Light-duty	4.4	Singer et al. (2023)
Medium-duty	4.8	Argonne National Laboratory (2023)
Heavy-duty	3.5	Argonne National Laboratory (2023)

Fleet electricity demand by location and vehicle type is estimated using the following equation:

$$EV\ Electricity\ Demand\ (kWh) = \frac{ICEV\ Fuel\ Demand\ (GGE)}{Vehicle\ Weight\ Class\ EVER} \times 33.3 \frac{kWh}{GGE} \times \frac{1}{EVSE\ Efficiency}$$

It is assumed that fleet vehicles are charged with 88% efficiency (*EVSE Efficiency*), with the remaining 12% consumed by battery conditioning or lost due to transmission inefficiencies (Voelker 2021).

2.3 EV Adoption

At the time of this study, the federal government was working toward EV adoption targets of 100% zero-emission light-duty vehicle fleet acquisitions by 2027 and 100% zero-emission acquisitions for all vehicle types by 2035. These targets provide a plausible scenario for projecting the rate of EV adoption across federal, state, and municipal government fleets.

This study assumes a gradual linear increase in the share of EVs acquired each year to align with these targets. This assumption allows for estimating the annual percentage of the fleet inventory composed of EVs from 2023 to 2035, as illustrated in Figure 4.

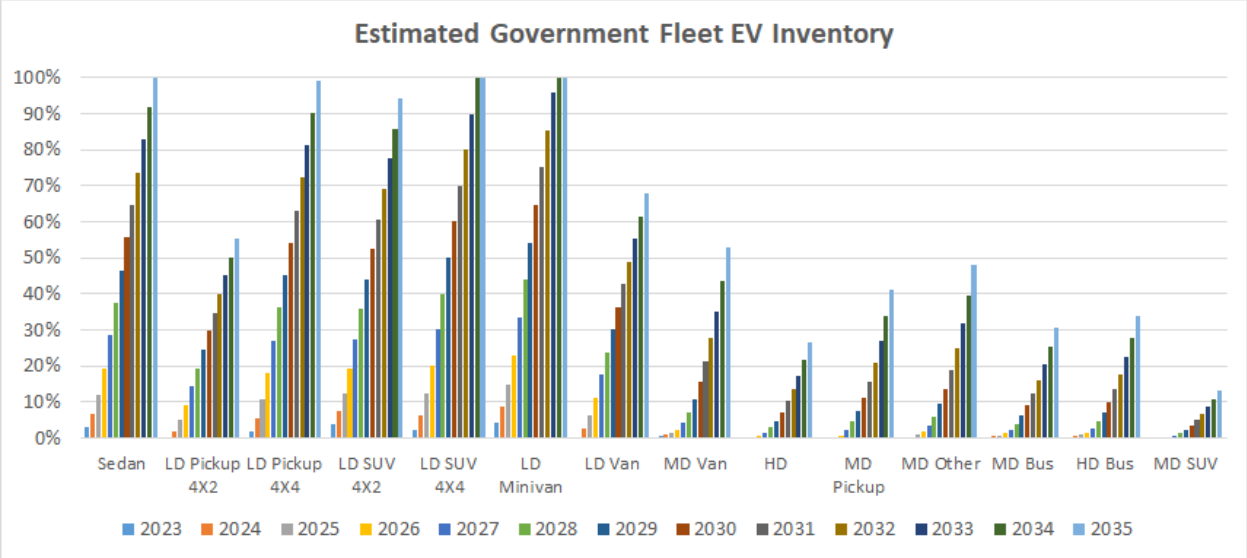

Figure 4. Projected government fleet EV penetration rate by vehicle type from 2023 to 2035.

HD: heavy duty; LD: light duty; MD: medium duty

Notably, ICEVs are projected to remain the majority in many vehicle categories beyond 2030. This is primarily driven by slower replacement rates and less aggressive EV adoption in certain segments. While the actual adoption will vary across jurisdictions, for consistency across the analysis, these projected EV penetration rates from the federal fleet are also applied to state and local government fleet estimates, despite the absence of a similar mandate.

2.4 Generating Hourly EV Load Profiles

Hourly fleet EV electricity demand profiles are estimated by modeling anticipated charging behavior across different vehicle types. Drawing on a separate analysis by the National Renewable Energy Laboratory for hourly charging energy shares by location type (e.g., at depots versus other locations) (Muratori et al., forthcoming), it is assumed that vehicles primarily operate during a 5-day workweek across 52 weeks per year.

To estimate hourly electricity demand, the annual demand is first divided by 260 workdays per year to represent average daily electricity demand. The daily demand is then distributed across 24 hours using hourly energy share distributions specific to each vehicle type and location from Muratori et al. (forthcoming). The resulting hourly load profiles represent the average electricity demand for each hour of the day across an entire year. Fleets with an average peak hourly electricity demand below 1.8 kW (roughly equivalent to 120-V Level 1 AC charging) are excluded from the final dataset.

3 Hourly Electricity Demand Dataset for Government Fleets

The final dataset includes records for each fleet location, represented at varying geographic resolutions, and spans the years 2023 to 2035, along with a full (100%) EV penetration scenario. Fleet location data are aggregated across vehicle types to maintain anonymity in compliance with data-sharing agreements.

Fleet locations are provided at one of three geographic resolutions:

- Hexagonal Hierarchical Spatial (H3) Index – Resolution 8: The most granular level, roughly corresponding to an area of 0.74 km^2 (Uber Technologies Inc. 2018).
- County: Used when data aggregation is necessary for privacy purposes.
- City: Applied when data are reported at the city level.

Table 2 provides an overview of the dataset fields.

Table 2. Government Fleets Electricity Demand Dataset Description

Feature	Details
Vehicle segment(s)	Federal, state, and local government fleets (all vehicle classes)
Years	2023–2035 and 100% EV
Spatial resolution	Variable–H3 Index (Resolution 8), county, or city
Temporal resolution	Hourly (average)

4 Dataset Guidelines and Limitations

The initial government fleet electricity demand dataset, available at data.nrel.gov/submissions/280, is developed to provide a first estimate of how electricity demand could evolve as government fleets transition to EVs. These estimates aim to support fleets, utilities, and energy planning stakeholders in proactively scaling electric infrastructure capacity to meet anticipated demand. The dataset addresses a notable gap in the current data landscape by offering a foundation for modeling fleet electrification impacts on electricity systems.

The dataset incorporates available fleet data, including 54% of federal agency vehicles approved for analysis (notably, the U.S. Postal Service is absent). Additionally, it includes data from 50,000 state government vehicles and 94,000 local government vehicles. While this represents a small fraction of the 4.4 million vehicles owned by state and local governments reported by the Federal Highway Administration (2022), the framework supports future expansion as more fleet inventory data become available.

This analysis benefits from detailed vehicle inventories, including specific vehicle types and garage locations, enabling a granular assessment of electricity demand patterns. The resulting hourly load profiles represent average electricity demand for each hour of the day across the year, smoothing out the variability seen in actual daily charging behavior. In reality, daily load profiles would exhibit more pronounced peaks and troughs, reflecting variations in vehicle usage, charging schedules, and operational constraints on specific days. The averaged profiles, while valuable for long-term planning and infrastructure scaling, do not capture short-term fluctuations or extreme daily scenarios.

Furthermore, the varying spatial resolution of the dataset introduces limitations for detailed planning purposes. However, achieving consistent high-resolution data is inherently challenging due to the number of stakeholders and privacy constraints in fleet reporting. In this study, data are supplied at the highest resolution permissible under data-sharing agreements, balancing data utility with privacy requirements.

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